DIGITAL & VECTOR SIGNAL GENERATOR

2050T SERIES

Operating Manual

Document part no. 46892/296

Issue 14

15 May 2007

DIGITAL & VECTOR SIGNAL GENERATORS

2050T SERIES

2050T 10 kHz to 1.35 GHz
2051T 10 kHz to 2.7 GHz
2052T 10 kHz to 5.4 GHz

Includes information on:
Option 001 - Second modulation oscillator
Option 002 - Pulse modulation
Option 006 - Avionics
Option 008 - RF profiles and complex sweep
Option 012 - Electronic attenuator
Option 100 - Single fuse version
Option 105 - Modified pulse modulator
Option 112 - EXT MOD 2 input 600 Ω

This manual applies to instruments with software issues of 9.07 and higher.

Manual part no. 46892/296 (PDF version)
Based on Issue 14 of the printed manual.

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About this manual

This manual explains how to use the 2050T series of Digital & Vector Signal Generators.

Intended audience

Persons engaged on work relating to equipment who have a need for accurately generated signals in the VHF and UHF spectrum.

It is assumed that the reader will be familiar with telecommunication terms used in modern communication systems.

Structure

Chapter 1	Main features and performance data
Chapter 2	Installation details
Chapter 3	Operation, comprising digital, vector and analog operation
Chapter 4	GPIB operation with keywords and sample programs
Chapter 5	Brief technical description
Chapter 6	Instructions for doing acceptance testing
Appendix A	Acceptance testing - second modulation oscillator option
Appendix B	Acceptance testing - pulse modulation option
Appendix C	Acceptance testing - electronic attenuator option
Annex A	Option 006 - Avionics
Annex B	Option 008 - RF profiles and complex sweep

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Document conventions

The following conventions apply throughout this manual:-

RF OUTPUT	Titles marked on the instrument panel are shown in capital letters
[TRIGGER]	Key titles are as shown on the key - caps in square brackets.
Disable	Messages on the display are shown in italic letters.
[Pulse]	Italics in square brackets indicate soft key titles, e.g. *[Pulse]* means the soft key adjacent to the *Pulse* title box at the side of the menu.

Associated publications

There is one other publication covering specific aspects of this equipment:-

Service Manual	(46880/078)	Covers maintenance and repair of the equipment.

Contents

Preface

Patent protection

The 2050T series Digital & Vector Signal Generators are protected by the following patents:

GB 2030391	GB 2214012	
US 4323943	US 4870384	
FR 80.26256	GB 1601822	
GB 2064892	US 4194164	
US 4400630	EP 0125790	
GB 2158999	GB 2140232	
US 4672336	US 4609881	
GB 2217542	GB 2258774	Instruments fitted with Option 006
US 5061909	US 5375065	
EP 0322139		

Precautions

WARNING **CAUTION** **Note**

These terms have specific meanings in this manual:

WARNING	**information to prevent personal injury.**
CAUTION	**information to prevent damage to the equipment.**
Note	**important general information.**

Hazard symbols

The meaning of hazard symbols appearing on the equipment and in the documentation is as follows:

Symbol	Description
⚠	Refer to the operating manual when this symbol is marked on the instrument. Familiarize yourself with the nature of the hazard and the actions that may have to be taken.
⚡	Dangerous voltage
☠	Toxic hazard

General conditions of use

This product is designed and tested to comply with the requirements of IEC/EN61010-1 'Safety requirements for electrical equipment for measurement, control and laboratory use', for Class I, portable equipment and is for use in a pollution degree 2 environment. The equipment is designed to operate from an installation category I and II supply.

Equipment should be protected from the ingress of liquids and precipitation such as rain, snow, etc. When moving the equipment from a cold to a hot environment, it is important to allow the temperature of the equipment to stabilize before it is connected to the supply to avoid condensation forming. The equipment must only be operated within the environmental conditions specified in Chapter 1 'Performance data' in the Operating manual, otherwise the protection provided by the equipment may be impaired.

This product is not approved for use in hazardous atmospheres or medical applications. If the equipment is to be used in a safety-related application, e.g. avionics or military applications, the suitability of the product must be assessed and approved for use by a competent person.

WARNING

Electrical hazards (AC supply voltage)

This equipment conforms with IEC Safety Class I, meaning that it is provided with a protective grounding lead. To maintain this protection the supply lead must always be connected to the source of supply via a socket with a grounded contact.

Be aware that the supply filter contains capacitors that may remain charged after the equipment is disconnected from the supply. Although the stored energy is within the approved safety requirements, a slight shock may be felt if the plug pins are touched immediately after removal.

Do not remove instrument covers as this may result in personal injury. There are no user-serviceable parts inside.

Refer all servicing to qualified personnel. See list of Service Centers at rear of manual.

Fuses

Note that there are supply fuses in both the live and neutral wires of the supply lead. If only one of these fuses should rupture, certain parts of the equipment could remain at supply potential.

For Option 100, single fuse version only:

Fuses

Note that the internal supply fuse is in series with the live conductor of the supply lead. If connection is made to a 2-pin unpolarized supply socket, it is possible for the fuse to become transposed to the neutral conductor, in which case, parts of the equipment could remain at supply potential even after the fuse has ruptured.

WARNING

Fire hazard

Make sure that only fuses of the correct rating and type are used for replacement.

If an integrally fused plug is used on the supply lead, ensure that the fuse rating is commensurate with the current requirements of this equipment. See under 'Performance data' in Chapter 1 for power requirements.

WARNING

Toxic hazards

Some of the components used in this equipment may include resins and other materials which give off toxic fumes if incinerated. Take appropriate precautions, therefore, in the disposal of these items.

WARNING

Beryllia

Beryllia (beryllium oxide) is used in the construction of some of the components in this equipment.

This material, when in the form of fine dust or vapor and inhaled into the lungs, can cause a respiratory disease. In its solid form, as used here, it can be handled quite safely although it is prudent to avoid handling conditions which promote dust formation by surface abrasion.

Because of this hazard, you are advised to be very careful in removing and disposing of these components. Do not put them in the general industrial or domestic waste or dispatch them by post. They should be separately and securely packed and clearly identified to show the nature of the hazard and then disposed of in a safe manner by an authorized toxic waste contractor.

WARNING

Lithium

A Lithium battery (or a Lithium battery contained within an IC) is used in this equipment.

As Lithium is a toxic substance, the battery should in no circumstances be crushed, incinerated or disposed of in normal waste.

Do not attempt to recharge this type of battery. Do not short circuit or force discharge since this might cause the battery to vent, overheat or explode.

WARNING

Heavy equipment

The weight of this equipment exceeds the 18 kg (40 lb) guideline for manual handling by a single person. To avoid the risk of injury, an assessment should be carried out prior to handling which takes account of the load, workplace environment and individual capability, in accordance with European Directive 90/269/EEC and associated National Regulations.

WARNING

Tilt facility

When the instrument is in the tilt position, it is advisable, for stability reasons, not to stack other instruments on top of it.

CAUTION

Pulse input

Before switching the instrument on, ensure that no signal voltage is present on the PULSE INPUT socket.

CAUTION

Static sensitive components

This equipment contains static sensitive components which may be damaged by handling — refer to the Maintenance Manual for handling precautions.

CAUTION

Suitability for use

This equipment has been designed and manufactured by Aeroflex to generate low-power RF signals for testing radio communications apparatus.

If the equipment is not used in a manner specified by Aeroflex, the protection provided by the equipment may be impaired.

Aeroflex has no control over the use of this equipment and cannot be held responsible for events arising from its use other than for its intended purpose.

Précautions

WARNING CAUTION Note

Les termes suivants ont, dans ce manuel, des significations particulières:

WARNING contient des informations pour éviter toute blessure au personnel.

CAUTION contient des informations pour éviter les dommages aux équipements.

Note contient d'importantes informations d'ordre général.

Symboles signalant un risque

La signification des symboles de danger apparaissant sur l'équipement et dans la documentation est la suivante:

Symbole	Nature du risque
	Reportez-vous au manuel d'utilisation quand ce symbole apparaît sur l'instrument. Familiarisez-vous avec la nature du danger et la conduite à tenir.
	Tension dangereuse
	Danger produits toxiques

Conditions générales d’utilisation

Ce produit a été conçu et testé pour être conforme aux exigences des normes CEI/EN61010-1 “Règles de sécurité pour appareils électriques de mesurage, de régulation et de laboratoire”, pour des équipements Classe I, portables et pour une utilisation dans un environnement de pollution de niveau 2. Cet équipement est conçu pour fonctionner à partir d’une alimentation de catégorie I et II.

Cet équipement doit être protégé de l’introduction de liquides ainsi que des précipitations d’eau, de neige, etc... Lorsqu’on transporte cet équipement d’un environnement chaud vers un environnement froid, il est important de laisser l’équipement se stabiliser en température avant de le connecter à une alimentation afin d’éviter toute formation de condensation. L'appareil doit être utilisé uniquement dans le cadre des conditions d'environnement spécifiées dans ‘Performance data’ dans le chapitre 1 du manuel d'utilisation, toute autre utilisation peut endommager les systèmes de protection.

Ce produit n’est pas garanti pour fonctionner dans des atmosphères dangereuses ou pour un usage médical. Si l'équipement doit être utilisé pour des applications en relation avec la sécurité, par exemple des applications militaires ou aéronautiques, la compatibilité du produit doit être établie et approuvée par une personne compétente.

WARNING

Sécurité électrique (tension d’alimentation alternative)

Cet appareil est protégé conformément à la norme CEI de sécurité Classe 1, c’est-à-dire que sa prise secteur comporte un fil de protection à la terre. Pour maintenir cette protection, le câble d’alimentation doit toujours être branché à la source d’alimentation par l’intermédiaire d’une prise comportant une borne de terre.

Notez que les filtres d’alimentation contiennent des condensateurs qui peuvent encore être chargés lorsque l’appareil est débranché. Bien que l’énergie contenue soit conforme aux exigences de sécurité, il est possible de ressentir un léger choc si l’on touche les bornes sitôt après débranchement.

Ne démontez pas le capot de l'instrument, car ceci peut provoquer des blessures. Il n'y a pas de pièces remplaçables par l'utilisateur à l'intérieur.

Faites effectuer toute réparation par du personnel qualifié. Contacter un des Centres de Maintenance Internationaux dans la liste jointe à la fin du manuel.

Fusibles

Notez qu’il y a deux fusibles, l’un pour la phase et l’autre pour le neutre du câble d’alimentation. Si un seul fusible est coupé, certaines parties de l’appareil peuvent rester au potentiel d’alimentation.

Option fusible simple

Notez que le fusible d’alimentation interne est en série avec la phase du câble d’alimentation. Si la prise d’alimentation comporte deux bornes non polarisées, il est possible de connecter le fusible au neutre. Dans ce cas, certaines parties de l’appareil peuvent rester à un certain potentiel même après coupure du fusible.

WARNING

Risque lie au feu

Lors du remplacement des fusibles vérifiez l'exactitude de leur type et de leur valeur.

Si le cable d'alimentation comporte une prise avec fusible intégré, assurez vous que sa valeur est compatible avec les besoins en courant de l'appareil. Pour la consommation, reportez vous au chapitre 1 ‘Performance data’.

WARNING

Danger produits toxiques

Certains composants utilisés dans cet appareil peuvent contenir des résines et d'autres matières qui dégagent des fumées toxiques lors de leur incinération. Les précautions d'usages doivent donc être prises lorsqu'on se débarrasse de ce type de composant.

WARNING

Le Beryllia

Le Béryllia (oxyde de Béryllium) entre dans la composition de certains composants de cet appareil.

Cette matière peut, lorsqu’elle est inhalée sous forme de vapeur ou de fine poussière, être la cause de maladies respiratoires. Sous sa forme solide, comme c’est le cas ici, cette matière peut être manipulée sans risque, bien qu’il soit conseillé d’éviter toute manipulation pouvant entraîner la formation de poussière par abrasion de la surface.

Il est donc conseillé, pour éviter ce risque, de prendre les précautions requises pour retirer ces composants et s’en débarrasser. Ne les jetez pas avec les déchets industriels ou domestiques ou ne les envoyez pas par la poste. Il faut les emballer séparément et solidement et bien indiquer la nature du risque avant de les céder, avec précautions, à une entreprise spécialisée dans le traitement de déchets toxiques.

WARNING

Lithium

Une pile au Lithium ou un CI contenant une pile au Lithium est utilisé dans cet équipement.

Le Lithium étant une substance toxique, il ne faut en aucun cas l’écraser, l’incinérer ou le jeter avec des déchets normaux.

N’essayez pas de recharger ce type de pile. Ne court-circuitez pas ou ne forcez pas la décharge de la pile car cela pourrait causer une fuite, une surchauffe ou une explosion.

WARNING

Equipement lourd

Le poids de cet appareil est supérieur à la limite de 18 kg (40 lb), fixée pour le transport par une seule personne. Afin d’éviter tout risque de blessure, il est nécessaire de faire, avant le transport, une évaluation de la charge, des contraintes de l’environnement et des capacités de l’individu, en conformité avec la Directive Européenne 90/269/EEC ainsi que les recommandations Nationales concernées.

WARNING

Position inclinée

Lorsque l'appareil est dans une position inclinée, il est recommandé, pour des raisons des stabilité, de ne pas y empiler d'autres appareils.

CAUTION

Utilisation

Cet équipement a été conçu et fabriqué par Aeroflex pour générer des signaux RF de faible puissance pour le test d'appareils de radio communications.

La protection de l'équipement peut être altérée s'il n'est pas utilisé dans les conditions spécifiées par Aeroflex. Aeroflex n'a aucun contrôle sur l'usage de l'instrument, et ne pourra être tenu pour responsable en cas d'événement survenant suite à une utilisation différente de celle prévue.

Vorsichtsmaßnahmen

WARNING **CAUTION** **Note**

Diese Hinweise haben eine bestimmte Bedeutung in diesem Handbuch:

WARNING dienen zur Vermeidung von Verletzungsrisiken.

CAUTION dienen dem Schutz der Geräte.

Note enthalten wichtige Informationen.

Gefahrensymbole

Die Bedeutung der Gefahrensymbole auf den Geräten und in der Dokumentation ist wie folgt:

Symbol	Gefahrenart
	Beziehen Sie sich auf die Bedienungsanleitung wenn das Messgerät mit diesem Symbol markiert ist. Machen Sie sich mit der Art der Gefahr und den Aktionen die getroffen werden müssen bekannt.
	Gefährliche Spannung
	Warnung vor giftigen Substanzen

Allgemeine Hinweise zur Verwendung

Dieses Produkt wurde entsprechend den Anforderungen von IEC/EN61010-1 “Sicherheitsanforderungen für elektrische Ausrüstung für Meßaufgaben, Steuerung und Laborbedarf”, Klasse I, transportabel zur Verwendung in einer Grad 2 verunreinigten Umgebung, entwickelt und getestet. Dieses Gerät ist für Netzversorgung Klasse I und II zugelassen.

Das Gerät sollte vor dem Eindringen von Flüssigkeiten sowie vor Regen, Schnee etc. geschützt werden. Bei Standortänderung von kalter in wärmere Umgebung sollte das Gerät wegen der Kondensation erst nach Anpassung an die wärmere Umgebung mit dem Netz verbunden werden. Das Gerät darf nur in Umgebungsbedingungen wie im Kapitel 1 ‘Leistungsdaten (Performance data)’ der Bedienungsanleitung beschrieben, betrieben werden; ansonsten wird der vom Gerät vorgesehene Schutz des Anwenders beeinträchtigt.

Dieses Produkt ist nicht für den Einsatz in gefährlicher Umgebung (z.B. Ex-Bereich) und für medizinische Anwendungen geprüft. Sollte das Gerät für den Einsatz in sicherheitsrelevanten Anwendungen wie z.B. im Flugverkehr oder bei militaerischen Anwendungen vorgesehen sein, so ist dieser von einer für diesen Bereich zuständigen Person zu beurteilen und genehmigen.

WARNING

Elektrische Schläge (Wechselspannungsversorgung)

Das Gerät entspricht IEC Sicherheitsklasse 1 mit einem Schutzleiter nach Erde. Das Netzkabel muß stets an eine Steckdose mit Erdkontakt angeschlossen werden.

Filterkondensatoren in der internen Spannungsversorgung können auch nach Unterbrechung der Spannungszuführung noch geladen sein. Obwohl die darin gespeicherte Energie innerhalb der Sicherheitsmargen liegt, kann ein leichter Spannungsschlag bei Berührung kurz nach der Unterbrechung erfolgen.

Öffnen Sie niemals das Gehäuse der Geräte das dies zu ernsthaften Verletzungen führen kann. Es gibt keine vom Anwender austauschbare Teile in diesem Gerät.

Lassen Sie alle Reparaturen durch qualifiziertes Personal durchführen. Eine Liste der Servicestellen finden Sie auf der Rückseite des Handbuches.

Sicherungen

Es ist zu beachten, daß es Sicherungen in beiden (spannunsführenden und neutralen) Zuleitungen gibt. Wenn nur eine von diesen Sicherungen schmilzt, so bleiben einige Geräteteile immer noch auf Spannungspotential.

Einsicherungs-Option

Die interne Sicherung in der Spannungszuführung ist in Reihe mit der spannungsführenden Zuleitung geschaltet. Bei Verbindung mit einer zweiadrigen, nicht gepolten Steckdose kann die Sicherung in der Masseleitung liegen, so daß auch bei geschmolzener Sicherung Geräteteile immer noch auf Spannungspotential sind.

WARNING

Feuergefahr

Es dürfen nur Ersatzsicherungen vom gleichen Typ mit den korrekten Spezifikationen entsprechend der Stromaufnahme des Gerätes verwendet werden. Siehe hierzu die Leistungsdaten (‘Performance data’ in Kapitel 1.

WARNING

Warnung vor giftigen Substanzen

In einigen Bauelementen dieses Geräts können Epoxyharze oder andere Materialien enthalten sein, die im Brandfall giftige Gase erzeugen. Bei der Entsorgung müssen deshalb entsprechende Vorsichtsmaßnahmen getroffen werden.

WARNING

Beryllium Oxid

Beryllium Oxid wird in einigen Bauelementen verwendet.

Als Staub inhaliert kann Beryllium zu Schädigungen der Atemwege führen. In fester Form kann es ohne Gefahr gehandhabt werden, wobei Staubabrieb vermieden werden sollte.

Wegen dieser Gefahren dürfen diese Bauelemente nur mit der entsprechenden Vorsicht ausgebaut und entsorgt werden. Sie dürfen nicht mit Industrie oder Hausmüll vermengt oder per Post versandt werden. Sie müssen separat verpackt und entsprechend der Gefährdung markiert werden. Die Entsorgung muß über einen autorisierten Fachbetrieb erfolgen.

WARNING

Lithium

Eine Lithium Batterie oder eine Lithium Batterie innerhalb eines IC ist in diesem Gerät eingebaut.

Da Lithium ein giftiges Material ist, sollte es als Sondermüll entsorgt werden.

Diese Batterie darf auf keinen Fall geladen werden. Nicht kurzschließen, da sie dabei überhitzt werden und explodieren kann.

WARNING

Schweres Gerät

Das Gewicht dieses Geräts liegt über der 18 kg (40 lb) Grenze für Transport durch eine einzelne Person. Zur Vermeidung von Verletzungen sollten vor einem Transport die Arbeitsumgebung und die persönlichen Möglichkeiten im Verhältnis zur Last abgewogen werden, wie in der EU-Regelung 90/269/EEC und nationalen Normen beschrieben.

WARNING

Schrägstellung

Bei Schrägstellung des Geräts sollten aus Stabilitätsgründen keine anderen Geräte darauf gestellt werden.

CAUTION

Eignung für Gebrauch

Dieses Gerät wurde von Aeroflex entwickelt und hergestellt um HF Signale geringer Leistung zum Test von Kommunikationseinrichtungen zu erzeugen.

Sollte das Gerät nicht auf die von Aeroflex vorgesehene Art und Weise verwendet werden, kann die Schutzfunktion des Gerätes beeinträchtigt werden.

Aeroflex hat keinen Einfluß auf die Art der Verwendung und übernimmt keinerlei Verantwortung bei unsachgemässer Handhabung.

Precauzioni

WARNING CAUTION Note

Questi termini vengono utilizzati in questo manuale con significati specifici:

WARNING riportano informazioni atte ad evitare possibili pericoli alla persona.

CAUTION riportano informazioni per evitare possibili pericoli all'apparecchiatura.

Note riportano importanti informazioni di carattere generale.

Simboli di pericolo

Il significato del simbolo di pericolo riportato sugli strumenti e nella documentazione è il seguente:

Simbolo	Tipo di pericolo
	Fare riferimento al manuale operativo quando questo simbolo è riportato sullo strumento. Rendervi conto della natura del pericolo e delle precauzioni che dovrete prendere.
	Tensione pericolosa
	Pericolo sostanze tossiche

Condizioni generali d'uso

Questo prodotto è stato progettato e collaudato per rispondere ai requisiti della direttiva IEC/EN61010-1 'Safety requirements for electrical equipment for measurement, control and laboratory use' per apparati di classe I, trasportabili e per l'uso in un ambiente inquinato di grado 2. L'apparato è stato progettato per essere alimentato da un alimentatore di categoria I e II.

Lo strumento deve essere protetto dal possibile ingresso di liquidi quali, ad es., acqua, pioggia, neve, ecc. Qualora lo strumento venga portato da un ambiente freddo ad uno caldo, è importante lasciare che la temperatura all'interno dello strumento si stabilizzi prima di alimentarlo per evitare formazione di condense. Lo strumento deve essere utilizzato esclusivamente nelle condizioni ambientali descritte nel capitolo 1 'Performance data' del manuale operativo, in caso contrario le protezioni previste nello strumento potrebbero risultare non sufficienti.

Questo prodotto non è stato approvato per essere usato in ambienti pericolosi o applicazioni medicali. Se lo strumento deve essere usato per applicazioni particolari collegate alla sicurezza (per esempio applicazioni militari o avioniche), occorre che una persona o un istituto competente ne certifichi l'uso.

WARNING

Pericoli da elettricità (alimentazione c.a.)

Quest 'apparato è provvisto del collegamento di protezione di terra e rispetta le norme di sicurezza IEC, classe 1. Per mantenere questa protezione è necessario che il cavo, la spina e la presa d'alimentazione siano tutti provvisti di terra.

Il circuito d'alimentazione contiene dei filtri i cui condensatori possono restare carichi anche dopo aver rimosso l'alimentazione. Sebbene l'energia immagazzinata è entro i limiti di sicurezza, purtuttavia una leggera scossa può essere avvertita toccando i capi della spina subito dopo averla rimossa.

Non rimuovete mai le coperture perché così potreste provocare danni a voi stessi. Non vi sono all'interno parti di interesse all'utilizzatore.

Tutte gli interventi sono di competenza del personale qualificato. Vedi elenco internazionale dei Centri di Assistenza in fondo al manuale.

Fusibili

Notare che entrambi i capi del cavo d'alimentazione sono provvisti di fusibili. In caso di rottura di uno solo dei due fusibili, alcune parti dello strumento potrebbero restare sotto tensione.

Opzione singolo fusibile

Notare che un fusibile è posto sul filo caldo del cavo di alimentazione. Qualora l'alimentazione avvenga tramite due poli non polarizzati, è possibile che il fusibile vada a protezione del neutro per cui anche in caso di una sua rottura, l'apparato potrebbe restare sotto tensione.

WARNING

Pericolo d'incendio

Assicurarsi che, in caso di sostituzione, vengano utilizzati solo fusibili della portata e del tipo prescritti.

Se viene usata una spina con fusibili, assicurarsi che questi siano di portata adeguata ai requisiti di alimentazione richiesti dallo strumento. Tali requisiti sono riportati nel capitolo1 'Performance data'.

WARNING

Pericolo sostanze tossiche

Alcuni dei componenti usati in questo strumento possono contenere resine o altri materiali che, se bruciati, possono emettere fumi tossici. Prendere quindi le opportune precauzioni nell'uso di tali parti.

WARNING

Berillio

Berillio (ossido di berillio) è utilizzato nella costruzione di alcuni componenti di quest'apparato.

Questo materiale, se inalato sotto forma di polvere fine o vapore, può causare malattie respiratorie. Allo stato solido, come è usato qui, può essere maneggiato con sufficiente sicurezza anche se è prudente evitare condizioni che provochino la formazione di polveri tramite abrasioni superficiali.

A cause di questi pericoli occorre essere molto prudenti nella rimozione e nella locazione di questi componenti. Questi non devono essere gettati tra i rifiuti domestici o industriali né. vanno spediti per posta. Essi devono essere impacchettati separatamente ed in modo sicuro e devono indicare chiaramente la natura del pericolo e quindi affidate a personale autorizzato.

WARNING

Litio

Quest 'apparato incorpora una batteria al litio o un circuito integrato contenente una batteria al litio**.**

Poiché il litio è una sostanza tossica, la batteria non deve essere mai né rotta, né incenerita, né gettata tra i normali rifiuti.

Questo tipo di batteria non può essere sottoposto né a ricarica né a corto-circuito o scarica forzata. Queste azioni possono provocare surriscaldamento, fuoriuscita di gas o esplosione della batteria.

WARNING

Instrumento pesado

El peso de este equipo excede de los 18 kg (40 lb), lo que debe tenerse en cuenta si va ser transportado manualmente por una sola persona. Para evitar el riesgo de lesiones, antes de mover el equipo deberá evaluar la carga, el entorno de trabajo y la propia capacidad, de acuerdo con la Directiva Europea 90/269/EEC y el Reglamento Nacional Asociado.

WARNING

Posizionamento inclinato

Quando lo strumento è in posizione inclinata è raccomandato, per motivi di stabilità, non sovrapporre altri strumenti.

CAUTION

Caratteristiche d’uso

Questo strumento è stato progettato e prodotto da Aeroflex generare segnali RF in bassa potenza per provare apparati di radio comunicazione.

Se lo strumento non è utilizzato nel modo specificato da Aeroflex, le protezioni previste sullo strumento potrebbero risultare inefficaci.

Aeroflex non può avere il controllo sull’uso di questo strumento e non può essere ritenuta responsabile per eventi risultanti da un uso diverso dallo scopo prefisso.

Precauciones

WARNING **CAUTION** **Note**

Estos términos tienen significados específicos en este manual:

WARNING contienen información referente a prevención de daños personales.

CAUTION contienen información referente a prevención de daños en equipos.

Note contienen información general importante.

Símbolos de peligro

El significado de los símbolos de peligro en el equipo y en la documentación es el siguiente:

Símbolo	Naturaleza del peligro
	Vea el manual de funcionamiento cuando este símbolo aparezca en el instrumento. Familiarícese con la naturaleza del riesgo y con las acciones que deban de tomarse.
	Voltaje peligroso
	Aviso de toxicidad

Condiciones generales de uso

Este producto ha sido diseñado y probado para cumplir los requerimientos de la normativa IEC/EN61010-1 “Requerimientos de la normativa para equipos eléctricos de medida, control y uso en laboratorio”, para equipos clase I, portátiles y para uso en un ambiente con un grado de contaminación 2. El equipo ha sido diseñado para funcionar sobre una instalación de alimentación de categorías I y II.

Debe protegerse el equipo de la entrada de líquidos y precipitaciones como nieve, lluvia, etc. Cuando se traslada el equipo de entorno frío a un entorno caliente, es importante aguardar la estabilización el equipo para evitar la condensación. Solamente debe utilizarse el equipo bajo las condiciones ambientales especificadas en el Capítulo 1 ‘Especificaciones’ o ‘Performance data’ del Manual de Operación, en caso contrario la propia protección del equipo puede resultar dañada.

Este producto no ha sido aprobado para su utilización en entornos peligrosos o en aplicaciones médicas. Si se va a utilizar el equipo en una aplicación con implicaciones en cuanto a seguridad, como por ejemplo aplicaciones de aviónica o militares, es preciso que un experto competente en materia de seguridad apruebe su uso.

WARNING

Nivel peligroso de electricidad (tensión de red)

Este equipo cumple las normas IEC Seguridad Clase 1, lo que significa que va provisto de un cable de protección de masa. Para mantener esta protección, el cable de alimentación de red debe de conectarse siempre a una clavija con terminal de masa.

Tenga en cuenta que el filtro de red contiene condensadores que pueden almacenar carga una vez desconectado el equipo. Aunque la energía almacenada está dentro de los requisitos de seguridad, pudiera sentirse una ligera descarga al tocar la clavija de alimentación inmediatamente después de su desconexión de red.

No retire las cubiertas del chasis del instrumento, ya que pudiera resultar dañado personalmente. No existen partes que puedan ser reparadas en su interior.

Deje todas las tareas relativas a reparación a un servicio técnico cualificado. Vea la lista de Centros de Servicios Internacionales en la parte trasera del manual.

Fusibles

Se hace notar que el Equipo está dotado de fusibles tanto en el activo como el neutro de alimentación. Si sólo uno de estos fusibles fundiera, existen partes del equipo que pudieran permanecer a tensión de red.

Opción fusible único

Se hace notar que el fusible de alimentación interno está enserie con el activo del cable de alimentación a red. Si la clavija de alimentación de red cuenta con sólo dos terminales sin polaridad, el fusible puede pasar a estar en serie con el neutro, en cuyo caso existen partes del equipo que permanecerían a tensión de red incluso después de que el fusible haya fundido.

WARNING

Peligro de incendio

Asegúrese de utilizar sólo fusibles del tipo y valores especificados como recuesto.

Si se utiliza una clavija con fusible incorporado, asegúrese de que los valores del fusible corresponden a los requeridos por el equipo. Ver sección de especificaciones del capítulo 1 del Manual de Operación para comprobar los requisitos de alimentación.

WARNING

Aviso de toxicidad

Alguno de los componentes utilizados en este equipo pudieran incluir resinas u otro tipo de materiales que al arder produjeran sustancias tóxicas, Por tanto, tome las debidas precauciones en la manipulación de esas piezas.

WARNING

Berilio

Berilio (óxido de berilio) Este material es utilizado en la fabricación de alguno de los componentes de este equipo.

La inhalación de este material, en forma de polvo fino o vapor, entrando en los pulmones, puede ser causa de enfermedades respiratorias. En forma sólida, como se utiliza en este caso, puede manipularse con bastante seguridad, aunque se recomienda no manejarlo en aquellas condiciones que pudieran favorecer la aparición de polvo por abrasión de la superficie.

Por todo lo anterior, se recomienda tener el máximo cuidado al reemplazar o deshacerse de estos componentes, no tirándolos en basuras industriales o domésticas y no utilizar el correo para su envío. Deben, ser empaquetados de forma segura y separada, y el paquete debidamente etiquetado e identificado, señalando claramente la naturaleza del riesgo y ponerlo a disposición de un destructor autorizado de productos tóxicos.

WARNING

Litio

En este equipo se utiliza una batería de litio (o contenida dentro de un CI).

Dada que el litio es una substancia tóxica las baterías de este material no deben ser aplastadas, quemadas o arrojadas junto a basuras ordinarias.

No trate de recargar este tipo de baterías. No las cortocircuite o fuerce su descarga ya que puede dar lugar a que la esta emita gases, se recaliente o explote.

WARNING

Instrumento pesado

El peso de este equipo excede de los 18 kg (40 lb), lo que debe tenerse en cuenta si va ser transportado manualmente por una sola persona. Para evitar el riesgo de lesiones, antes de mover el equipo deberá evaluar la carga, el entorno de trabajo y la propia capacidad, de acuerdo con la Directiva Europea 90/269/EEC y el Reglamento Nacional Asociado.

WARNING

Tener en cuenta con el equipo inclinado

Si utiliza el equipo en posición inclinada, se recomienda, por razones de estabilidad, no apilar otros equipos encima de él.

CAUTION

Idoneidad de uso

Este equipo ha sido diseñado y fabricado por Aeroflex para generar señales de VHF y UHF de bajo nivel de potencia para prueba de equipos de radiocomunicaciones.

Si el equipo fuese utilizado de forma diferente a la especificada por Aeroflex, la protección ofrecida por el equipo pudiera quedar reducida.

Aeroflex no tiene control sobre el uso de este equipo y no puede, por tanto, exigirsele responsabilidades derivadas de una utilización distinta de aquellas para las que ha sido diseñado.

Chapter 1
GENERAL INFORMATION

Contents

List of figures

Introduction

The 2050T series Digital and Vector Signal Generators offer a wide range of analog and digital modulation facilities covering the frequency ranges 10 kHz to 5.4 GHz with three models: 2050T (10 kHz to 1.35 GHz), 2051T (10 kHz to 2.7 GHz) and 2052T (10 kHz to 5.4 GHz). A dot matrix display with soft key selected screen options allow flexibility of operation and ease of use. The output can be modulated by conventional analog methods - amplitude, frequency, phase and pulse modulation (optional). Digital and vector modulation in PSK, QAM, FSK, GMSK and IQ formats are available and these signals can be modulated to simulate a faded signal environment.

Microprocessor control ensures that the instruments are flexible and easy to use and allows programming by the General Purpose Interface Bus (GPIB). The GPIB is designed to IEEE Standard 488.2 and is a means of sending commands to an instrument, via a data bus, from a remote controller or personal computer. The instruments can therefore be used manually or as part of a fully automated test system.

These instruments are suitable for a wide range of applications including the testing of new digital communication systems.

The 2050T series includes provision for low adjacent channel power in TETRA modulation to meet the needs of TETRA selectivity measurements.

Main features

The 2050T series provide the following capabilities:

- Improved adjacent channel power for TETRA
- Digital and vector modulation capabilities
- I and Q modulation to 10 MHz
- Wide carrier frequency range
- External digital input to 34 ksymbols/sec
- Excellent accuracy and stability
- Rician and Rayleigh fading simulation
- Envelope control for generating RF bursts
- Internal PRBS source
- Programmable channel filter characteristics
- Programmable data rate
- Pre-programmed standard formats such as NADC (D_AMPS), PDC (JDC), TETRA, TFTS, APCO 25 (π/4 DQPSK), Inmarsat M, VDR, GSM, PCN (DCS1800), CDPD, DSRR, MC9, MD24-192, Mobitex, Modacom, POCSAG, CITYRUF, ERMES, APCO 25 (4FSK)
- Full AM, FM, ΦM capability
- Wideband DC coupled FM for FSK
- IQ baseband outputs
- Modulated IF

Operation

Selection of parameters on the screen may involve one or more of the numeric, hard or soft keys or the rotary knob. Hard keys have single or dual functions which remain constant throughout, whereas soft keys have functions dependent on the present mode of operation. Parameters may be set to specific values by numeric key entry, while values may be varied in steps of any size using the ⇩/⇧ keys or altered by moving the knob, set to a particular sensitivity.

The SIG GEN, LF, SWEEP, MEM (memory), Δ (delta) and UTIL (utility) menus are selectable, at any point of operation, via the keys below the display panel. Within the display, the soft key functions are indicated by labels which appear alongside the keys situated at either side of the display panel.

Display

The display is a dot matrix liquid crystal panel, with backlighting. Carrier frequency, modulation and RF level are shown in horizontal regions on the principal screen. The display features 11-digit resolution for carrier frequency, 4-digit for RF level and 3-digit for modulation, with unit annunciators.

Display contrast may be varied, using the control knob, to optimize the viewing angle. Differing lighting conditions may be accommodated using the backlight intensity function, variable from no backlight to full intensity. A full graphical display test is available, refer to the Service Manual.

Frequency selection

Carrier frequency is selected via the soft key option on the SIG GEN display and direct entry via the keyboard. Alternatively, selection may be made via the General Purpose Interface Bus (GPIB). Frequency resolution is 0.1 Hz across the band. Carrier frequencies can be stored in a non-volatile memory with complete recall when required. An ON-OFF key is provided to completely disable the output.

Output

RF output up to +13 dBm (+6 dBm (PEP) in digital and vector modes, −6 dBm (PEP) in advanced digital mode) can be set by direct keyboard entry with a resolution of 0.1 dB or better over the entire range.

An extended hysteresis facility allows for extended electronic control of RF output level without introducing mechanical attenuator transients when testing squelch systems.

A low intermodulation mode can be selected which disables the RF levelling system and improves the intermodulation performance when combining the outputs of two signal generators.

A choice of calibration units is available to the operator and provision is made for the simple conversion of units (for example, dBm to μV). Calibration data for the output level is held in memory and may be altered from the front panel or over the interface bus.

The output level can be offset by up to ±2 dB by keyboard entry. Offsets from the calibrated value may be used to compensate for cable or switching losses external to the generator. This facility can be used as a means of deliberately offsetting the output level to ensure that all generators in an area give identical measurements. While using the offsetting facility, the principal calibration of the generator is not lost and may be returned to at any time.

An electronic trip protects the generator output against reverse power of up to 50 W, preventing damage to output circuits when RF or DC power is accidentally applied.

Modulation

Comprehensive amplitude, frequency (plus wide bandwidth FM), phase and optional pulse modulation are combined with an analog IQ (vector) capability. A digital mode of operation uses internal digital signal processing to convert digital data into the complex modulation formats used on modern digital communication systems. An internal modulation oscillator is provided, having a frequency range of 0.1 Hz to 500 kHz, with a resolution of 0.1 Hz. A second modulation oscillator can be included as an option. Two independent BNC inputs on the front panel allow external modulation signals to be mixed with the internal signal(s). Therefore, a maximum of four modulation sources may be available at one time. These sources may be combined to give the single, dual, composite, dual composite and vector and digital modes.

The wide frequency modulation range capability provides a 1 dB bandwidth of 1 MHz and provides FM deviation up to a maximum of 1 MHz for frequencies up to 21 MHz, 1% of carrier frequency elsewhere. Phase modulation is also available with a 10 kHz bandwidth up to a maximum of 10 radians.

Both AC and DC coupled FM is available. In the DC coupled FM mode a patented offset correction system eliminates the large carrier frequency offsets that occur with normal signal generators. As a result the 2050T series signal generators can be used confidently for testing tone and message paging equipment.

Wideband frequency modulation with a 3 dB bandwidth of 10 MHz is provided via a rear panel BNC socket for tests on equipment using frequency shift keying for high speed digital transmission.

Amplitude modulation with a bandwidth of typically greater than 50 kHz and with modulation depths of up to 99.9% is available with a resolution of 0.1%. Pulse modulation is available as an option with typical rise and fall times of 5 ns and 70 dB on/off ratio.

An automatic level control facility is provided for both of the external modulation inputs and provides correctly calibrated modulation for input levels varying from 0.7 to 1.4 V RMS. HI and LO indications show when the input level is outside the range of the ALC system.

The signalling facility allows testing of radio equipment with sequential and sub-audible tone capability. The sequential calling tone system is accessible from the utility menu for all four modulation modes. Sub-audible calling tones are specified within the modulation source select display.

Vector modulation

In vector modulation the generator provides IQ modulation at frequencies from 10 MHz to 1.35 GHz (2050T) or to 2.7 GHz (2051T and 2052T) by frequency conversion of one of four IFs to the required output frequency. Analog I and Q inputs are provided with a typical bandwidth of 10 MHz.

The wide IQ bandwidth allows the generation of direct sequence spread spectrum signals as well as OFDM and QAM signals for new broadcasting formats.

Precision radar chirp signals can be simulated to test radar receivers using a dual arbitrary waveform generator to provide the required I and Q signals.

A linear envelope input allows for external voltage control of the RF output level to simulate the RF burst signals used on Time Domain Duplex (TDD) and Time Domain Multiple Access (TDMA) systems.

A switchable input impedance of 50 Ω or 300 Ω simplifies operation with 50 Ω voltage sources and interfacing with operational amplifiers or digital to analog converters.

Digital modulation

In addition to the wideband analog I and Q inputs a digital mode of operation is provided. This allows the user to generate a vector modulated RF carrier from digital data inputs. The bandwidth of the digital mode is sufficient to simulate radio systems which have been designed to work in the frequency allocation of an analog voice channel. The digital modulation can be set to symbol rates from 512 Hz to 34 kHz, and internal channel filters are applied with raised cosine, root raised cosine or Gaussian characteristics.

Modulation formats can be defined as PSK, differential PSK, phase offset differential PSK, QAM, FSK and GMSK with from one to eight bits per symbol (i.e. up to 256 QAM). The programmable channel filter and data rate ensures that many of the different types of narrow band digital modulation standards can be simulated by a single instrument.

The flexible digital interface gives the freedom to accept digital signals in bit or symbol format using an internal or external data clock. The digital interface can be set to use positive- or negative-edge triggering and normal or inverted data. An internal data source is also available which can supply a PRBS (Pseudo Random Bit Sequence), all '1's or all '0's. A burst control pin allows the generation of TDMA bursts with controlled rise and fall times.

The modulator can be requested to introduce IQ phase and gain errors and carrier leak to simulate the performance of a receiver operating on non-ideal waveforms.

Advanced digital modulation

In advanced digital mode the instrument will produce TETRA modulation, π /4 DQPSK at 18 ksymbols/s through a root raised cosine filter with α of 0.35.

Modulation formats

Generic modulation types can be selected which include Phase Shift Keying (PSK), Differential PSK (DPSK), Phase Offset DPSK (i.e. π/4 DQPSK), Time Offset PSK (OQPSK), Gaussian Minimum Shift Keying (GMSK), Frequency Shift Keying (FSK) and Quadrature Amplitude Modulation (QAM).

Specific modulation formats can be selected which provide the default data rates and channel filter settings for numerous predefined systems which include NADC (D_AMPS), PDC (JDC), TETRA, TFTS, APCO 25 (π/4 DQPSK), Inmarsat M, VDR, GSM, PCN (DCS1800), CDPD, DSRR, MC9, MD24-192, Mobitex, Modacom, POCSAG, CITYRUF, ERMES, APCO 25 (4FSK). New user settings can be created and stored to define other modulation standards.

Envelope control

For both vector and digital modes the front panel ENVELOPE IN socket may be used to simulate the effect of varying the RF levels being received from mobiles in TDMA systems. It may also be used to shape the rise and fall of an RF burst. Additionally, in digital modulation mode, the burst control on the rear panel AUXILIARY IN/OUT socket allows RF bursts to be generated with profiled rise and fall times synchronised with the data inputs.

Fading simulation

The built-in Rician and Rayleigh fading simulator with programmable path ratio and Doppler speed allows the testing of receivers under the adverse propagation conditions, but note that this is not available for GSM.

Incrementing

All major parameters can be incremented or decremented in step sizes entered via keyboard entry or the GPIB. If no step size is entered for a parameter, the steps are preset to 1 kHz for carrier frequency, 1 kHz for modulation oscillator and LF frequency, 1 kHz for FM deviation, 1% for AM depth and 1 dB for output level.

In addition the rotary control can be used to vary the parameter with the sensitivity of the knob being changed by means of the $\times$10 and $\div$10 keys.

Sweep

The sweep capability of the 2050T Series allows comprehensive testing of systems. Four parameters are used to specify sweep; start, stop, number of steps and time per step. These are specified by the user, with upper and lower limits for the parameter values being dependent on the function. The sweep markers menu is available by soft key selection on the sweep display, allowing the placement of up to five user defined markers.

Non-volatile memory

The non-volatile memory allows 50 complete instrument settings, 50 partial settings, 100 carrier frequency settings, 20 sweep settings and 20 signalling tone sequences to be stored for later use at any time.

Programming

A GPIB interface is fitted so that all functions are controllable via the interface bus which is designed to the IEEE Standard 488.2. The instrument can function both as a talker and a listener.

Software protection

To prevent accidental interference with the contents of internal memories, internal data is protected by a secure key sequence.

Two levels of protection are offered, appropriate to the function being accessed. The most secure is reserved for features which alter the calibration data of the instrument.

Spectral purity

With an SSB phase noise performance at of typically -122 dBc/Hz at 470 MHz (20 kHz offset), the 2050T Series can be used for both in-channel and adjacent channel receiver measurements. Harmonically related signals and non-harmonics are better than -30 dBc and -70 dBc respectively.

Calibration

The 2050T Series has a recommended two year calibration interval and is calibrated entirely by electronically controlled adjustment. There are no internal mechanically adjustable components to affect the calibration. The calibration display is available via soft key selection at the utilities menu.

In both digital and vector modes a self calibration system optimises the performance of the vector modulator. The instrument displays a warning when the calibration validity has expired.

Date stamping

After readjustment the instrument updates the calibration data and records the date of adjustment. The calibration due date can be set and when this date is reached a message advises the operator to return the unit for calibration.

Options

The following factory-fitted options are available:

Option 001 - Second modulation oscillator

An additional modulation oscillator is available to enable greater flexibility. This second oscillator has the same specification as the first and allows full use of complex modulation modes.

Option 002 - Pulse modulation

The pulse modulation facility allows radar RF and IF stages to be tested and features rise and fall times of less than 25 ns with an on/off ratio of better than 70 dB.

Option 006 - Avionics

Provides internally generated modulation waveforms suitable for the testing of Instrument Landing Systems (ILS) and VHF Omni Range (VOR) beacons.

Option 008 - RF profiles and complex sweep

The RF profile facility provides compensation for frequency dependent level errors introduced by cables, amplifiers and signal combiners. The complex sweep facility generates sweeps whose step size, step time and RF level change while the sweep is in progress. These features are particularly useful for EMC, Tempest and ATE applications.

Option 012 - Electronic attenuator

Designed to meet demanding extended life requirements for repetitive switching, such as are found in high volume production applications.

Option 100 - Single fuse

A single fuse is used in place of the standard double fuse.

Option 105 - Modified pulse modulator

Modifies the pulse modulator (Option 002) to provide a slower rise and fall time for testing time domain duplex and time domain multiple access receivers.

Option 112 - EXT MOD 2 input 600 Ω

The EXT MOD 2 INPUT socket has a 600 Ω input impedance in place of 100 k Ω.

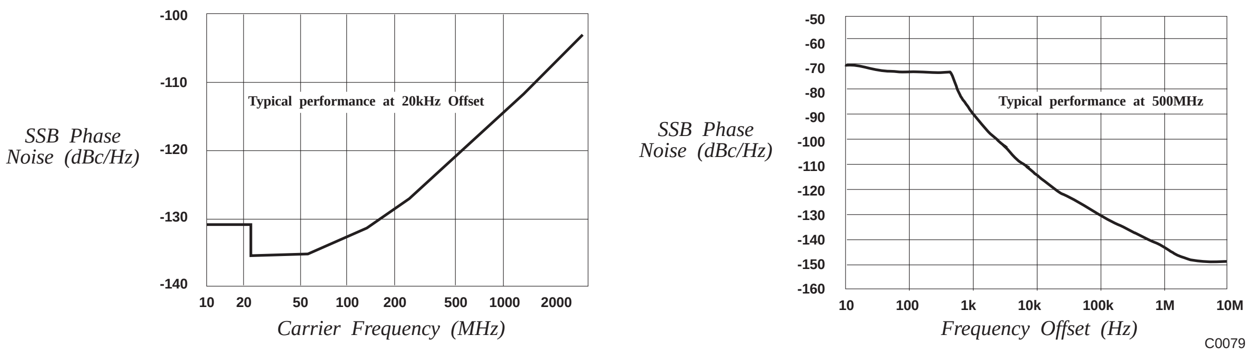

Fig. 1-1 Typical phase noise performance of 2050T Series in non-digital and -vector modes

Performance data

Carrier frequency

Range	10 kHz to 1.35 GHz (2050T); 10 kHz to 2.7 GHz (2051T); 10 kHz to 5.4 GHz (2052T). In digital and vector modes the lowest frequency is 10 MHz and for 2050T the highest frequency is reduced to 2.7 GHz.
Selection	By keyboard entry of data. Variation by ⇩/⇧ keys and by rotary control.
Indication	11 digits with annunciators
Resolution	0.1 Hz.
Accuracy	As frequency standard.
Phase incrementing	The carrier phase can be advanced or retarded in steps of 1.5° using the rotary control.

RF output

Range (analog mode)	In analog modulation or CW mode range is -144 dBm to +13 dBm. Maximum guaranteed output level above 2.7 GHz is +11 dBm. When AM is selected the maximum output level reduces linearly with AM depth to +7 dBm at maximum AM depth.
Range (digital or vector mode)	−138 dBm to +6 dBm peak envelope power*. RF output level is defined with PRBS modulation applied in digital mode or with 0.5 V applied to either the I or Q input in vector mode. *Maximum level is reduced to −6 dBm PEP when advanced digital mode is selected.
Selectable overrange mode	Allows uncalibrated output levels to +19 dBm to be generated in analog mode.
Selectable extended hysteresis	Provides for uncalibrated RF level control with up to 24 dB range without level interruption.
Selection	By keyboard entry of data. Variation by ⇩/⇧ keys and by rotary control. Units may be μV, mV, V EMF or PD; dB relative to 1 μV, 1 mV EMF or PD; dBm.
Indication	4 digits with unit annunciators.
Resolution	0.1 dB.
Accuracy	At 22°C ±5°C in non-digital or vector modes:

Output level	Carrier frequency range <1.35 GHz	<2.7 GHz	<5.4 GHz
> 0 dBm	±0.50 dB	±0.7 dB	±1.0 dB
> −50 dBm	±0.85 dB	±1.0 dB	±1.5 dB
> −127 dBm	±0.85 dB	±1.0 dB	-
Temperature stability (dB/°c)	±0.005	±0.01	±0.02

In digital or vector modulation modes (auto IF selection):
At a temperature of 22°C ±5°C:
<2 GHz ±1.5 dB
<2.7 GHz ±2 dB

Temperature coefficient is less than 0.04 dB/°C.

VSWR	For output levels less than 0 dBm: Less than 1.25:1 to 2.2 GHz (return loss greater than 19.1 dB); Less than 1.4:1 to 2.7 GHz (return loss greater than 15.6 dB); Less than 1.5: 1 to 5.4 GHz (return loss greater than 14 dB).
Output protection	An electronic trip protects the generator output against reverse power of up to 50 W from a source VSWR of up to 5:1.

Spectral purity (analog mode)

At RF levels up to +7 dBm in CW and analog modulation modes:-

Harmonics	2050T, 2051T: Better than −30 dBc for carrier frequencies to 1 GHz; Better than −27 dBc for carrier frequencies from 1 GHz to 1.35 GHz. Better than −27 dBc for carrier frequencies above 1.35 GHz. 2052T: Better than −30 dBc for carrier frequencies to 1 GHz; Better than −27 dBc for carrier frequencies from 1 GHz to 1.35 GHz. Better than −25 dBc for carrier frequencies above 1.35 GHz.
Sub-harmonics	Better than −90 dBc to 1.35 GHz. Better than −40 dBc to 2.3 GHz. Better than −30 dBc to 5.4 GHz.
Non-harmonics	Better than −70 dBc at offsets from the carrier frequency of 3 kHz or greater.
Residual FM (FM off)	Less than 7 Hz RMS deviation in a 300 Hz to 3.4 kHz unweighted bandwidth at 470 MHz.
SSB phase noise	Less than −116 dBc/Hz (typically −122 dBc/Hz) at an offset of 20 kHz from a carrier frequency of 470 MHz.
RF leakage	Less than 0.5 µV PD generated at the carrier frequency across a 50 Ω load by a two-turn 25 mm loop, 25 mm or more from any part of the case.
FM on AM	Typically less than 100 Hz for 30% AM depth at a modulation frequency of 1 kHz and a carrier frequency of 500 MHz.
ϕM on AM	Typically less than 0.1 radian at a carrier frequency of 500 MHz for 30% AM depth for modulation rates up to 10 kHz.

Spectral purity (digital and vector modes)

In digital and vector modes of operation:	Modulation is generated by converting a 120, 132, 160 or 176 MHz intermediate frequency (IF) to the required carrier frequency. Additional signals are present at the local oscillator frequency, image frequency and frequencies equivalent to the harmonics of the IF mixed with the local oscillator.
Phase noise:	In vector mode: As analog modulation and CW modes. In digital mode: As analog modulation modes for offsets >100 kHz; better than −108 dBc/Hz at 20 kHz offset from a 1 GHz carrier.

Modulation modes	Seven modulation modes are available:
Single	FM, Wideband FM, ΦM, AM or pulse (optional).
Dual	Two independent channels of differing modulation type (e.g. AM with FM).
Composite	Two independent channels of the same modulation type. (e.g. FM1 with FM2).
Dual composite	A combination of Dual and Composite modes providing four independent channels (e.g. AM1 with AM2 and FM1 with FM2).
Vector	Provides IQ modulation facility.
Digital	Accepts digital inputs and converts the signal to QAM, PSK, FSK or GMSK formats.
Advanced digital	Accepts digital inputs and converts the signal to accurate TETRA modulation with low levels of adjacent channel power.

Frequency modulation

Deviation	Peak deviation from 0 to 1 MHz for carrier frequencies up to 21.09375 MHz; Peak deviation from 0 to 1% of carrier frequency above 21.09375 MHz.
Selection	By keyboard entry of data. Variation by ⇩/⇧ keys and by rotary control.
Indication	3 digits with annunciators.
Displayed resolution	1 Hz or 1 least significant digit, whichever is greater.
Accuracy at 1 kHz	±5% of indication ±10 Hz excluding residual FM.
1 dB bandwidth	DC to 300 kHz (DC coupled). 10 Hz to 300 kHz (AC coupled).
3 dB bandwidth	Typically greater than 1 MHz. Input is capable of accepting external sources of FSK signals.
Group delay	Less than 1 μs, 3 kHz to 500 kHz.
Carrier frequency offset	In DC FM less than ±(1 Hz + 0.1% of set deviation) after using DC FM nulling facility.
Distortion	Using external modulation without ALC: Less than 3% at maximum deviation for modulation frequencies up to 20 kHz; Less than 0.3% at 10% of maximum deviation for modulation frequencies up to 20 kHz.
Modulation source	Internal LF generator or external via front panel sockets.

Wideband FM

Deviation	As FM.
Indication	3 digits with annunciators.
Selection	By keyboard entry of data. The sensitivity is controlled in 3 dB steps and the display indicates the nearest value of deviation to that requested.
Input level	1.414 V peak (1 V RMS sine wave) to achieve indicated deviation.
Accuracy	As FM.
3 dB bandwidth	Typically 10 MHz (DC or AC coupled).
Group delay	Less than 0.5 μs, 3 kHz to 10 MHz.
Modulation source	External via rear panel socket (50 Ω impedance).

Phase modulation

Deviation	0 to 10 radians.
Selection	By keyboard entry of data. Variation by ⇩/⇧ keys and by rotary control.
Indication	3 digits with annunciators.
Resolution	0.01 radians.
Accuracy at 1 kHz	Better than ±5% of indicated deviation excluding residual phase modulation.
3 dB bandwidth	100 Hz to 10 kHz.
Distortion	Less than 3% at maximum deviation at 1 kHz modulation rate.
Modulation source	Internal LF generator or external via front panel sockets.

Amplitude modulation

For carrier frequencies up to 1 GHz:	
Range	0 to 99.9%.
Selection	By keyboard entry of data. Variation by ⇩/⇧ keys and by rotary control.
Resolution	0.1%
Indication	3 digits with annunciator.
Depth accuracy at 1 kHz	$\pm$4% of setting $\pm$1%.
External AM 1 dB bandwidth	With modulation ALC off; DC to 30 kHz in DC coupled mode and 10 Hz to 30 kHz in AC coupled mode. Typical modulation bandwidth exceeds 50 kHz.
Distortion	For a modulation rate of 1 kHz: Less than 1% total harmonic distortion for AM depths up to 30%; Less than 3% total harmonic distortion for AM depths up to 80%.
Modulation source	Internal LF generator or external via front panel connectors.

Digital modulation

In digital mode the instrument can be used over the carrier frequency range 10 MHz to 2.7 GHz (to 1.35 GHz for 2050T) and accepts internal or external data to modulate the RF output. The modulation can be applied in common digital formats and the channel filter characteristics specified.

Internal data: All '0's, '1's or selectable PN 2 to 7, 9 to 11 or 15 PRBS sequence.

Note that in GSM mode, PRBS is limited to PN9 or 15. All 0's and 1's are available.

External data: Accepts data as a serial or parallel input from a 25-way AUXILIARY D-type connector on the rear panel. Accepts symbols containing 1 to 8 data bits with internally or externally generated clock sources. In GSM mode external input must be supplied as 8-bit parallel data.

All inputs and outputs are TTL/CMOS logic compatible.

Symbol rate

Modulation type	Filter type	Symbol rate (sym/s)
PSK / QAM	Nyquist / Root Nyquist	1900–34000
PSK / QAM	Gaussian	1900–25000
FSK / GMSK	Gaussian	512–25000
FSK	Nyquist / Root Nyquist	1900–25000
OQPSK	All filters	1900–16000

Symbol source can be internal or external (on rear panel connector).
Internal symbol rate is adjustable in 0.1 symbol/s steps.
Symbol rate must be within 2% of the external symbol rate to maintain modulation accuracy.

Generic modulation types	Can select PSK, differential PSK, differential phase offset PSK (π/4 DQPSK), time-offset QPSK, QAM, GMSK and FSK. Number of bits per symbol can be selected from 1 to 3 for PSK systems, 2 to 8 for QAM systems and 1 or 2 for FSK systems.
RF channel filters	Root raised cosine, raised cosine or Gaussian. Filter bandwidth can be selected as follows: Raised cosine or root raised cosine for α from 0.2 to 0.8 in 0.01 steps. Gaussian 3 dB bandwidth from 0.4 of symbol rate (0.2 of symbol rate as IQ baseband filter) up to a maximum of 22.6 kHz.

Predefined modulation types — The following can be selected:

Modulation type	System
π/4 DQPSK	NADC (DAMPS), PDC (JDC), TETRA, APCO25, TFTS
GMSK	GSM, Mobitex, CDPD, MC9, DSRR, MD24-192N/W, Modacom
FSK	POCSAG, CITYRUF
4FSK	ERMES, APCO25
OQPSK	Inmarsat 'M'
8DPSK	VDR (VDL)

Modulation accuracy — At the decision points with the envelope input at 1 V or disabled, and filter above 0.25 for raised cosine filters and 0.3 for root raised cosine filters:
PSK and QAM <1.5% RMS vector error;
NADC and PDC <1% RMS vector error (EIA, RCR 27A method);
GSM and CDPD <3° RMS phase error (typical).

FSK/GMSK — Frequency deviation can be set with 1 Hz resolution across the range 100 Hz to 20 kHz.

Accuracy: <1% of set deviation.

Modulation errors — Modulation errors can be added to simulate:
IQ skew from 0 to ±20° in 0.1° steps,
IQ imbalance from 0 to ±10 dB in 0.1 dB steps,
Carrier leak from 0 to 10% in 0.1% steps.
Range of errors allowed is limited by the peak envelope power.

Modulation errors are not available in GSM or OQPSK modes.

IQ outputs — Baseband IQ output signals available on the front panel at a level of 0.5 V PD nominal into 50 Ω. Levels are reduced by 12 dB in advanced digital mode.

Burst control — Available on the rear panel D-type connector. A logical '1' on the burst control turns the RF on over a time interval corresponding to three data symbols. Propagation delay is matched to the data path delay. Can be used at the same time as the ENVELOPE input.

ON/OFF ratio — Greater than 80 dB.

Advanced digital modulation — In advanced digital mode the instrument produces TETRA modulation, π /4 DQPSK at 18 ksymbols/s through a root raised cosine filter with α of 0.35.

Adjacent channel power — Adjacent channel power across RF frequency range 100 to 490 MHz and temperature range +25°C ±5°C with IQ errors and fading disabled: <70 dBc at +25 kHz offset.

Carrier leak — Better than −35 dBc (typically −38 dBc).

Vector modulation — Provides for IQ modulation of the carrier output from an external source for carrier frequencies of 10 MHz to 1.35/2.7 GHz.

Carrier leakage and SSB suppression — Following self-calibration, the RF carrier leakage and SB image rejection are typically 50 dB.

Vector inputs — IQ inputs on the front panel. The RF level requested is obtained with 0.5 V DC applied to one of the inputs.
Input impedance is selectable between 50 Ω and 300 Ω.

DC vector accuracy — For carrier frequencies up to 2 GHz:
±1% amplitude of full scale;
±1° at full scale.
For carrier frequencies above 2 GHz:
±1.5% amplitude of full scale;
±1.5° at full scale.

Vector bandwidth — ±0.5 dB wrt DC for modulation frequencies up to 3 MHz.
±1 dB wrt DC for modulation frequencies up to 10 MHz and carrier frequencies up to 2 GHz.
.±1.3 dB wrt DC for carrier frequencies up to 2.7 GHz

IQ modulation calibration	The signal generator can calibrate the vector modulator automatically. After a $^{1}/_{2}$ hour warm-up period the calibration remains valid for at least three hours over a temperature range of ±5°C. The instrument displays a warning if the calibration validity time or temperature range has been exceeded. Calibration is valid for both digital and vector modes.
Fading simulation	Rayleigh and Rician fading can be simulated in vector, digital and advanced digital modulation modes. Doppler speed can be entered from 0 to 200 Hz with a maximum ratio of 2:1 between the direct and scattered speed. Path ratio can be set to ±50 dB. Note: fading simulation is not available in either GSM or OQPSK modes.
Envelope control	The RF level can be varied by applying a control voltage to the ENVELOPE input in digital and vector modes. The input may be used to shape the rise and fall of an RF burst and simulate the effect of varying RF levels being received from mobiles in TDMA systems. Applying 1 V gives the set RF level and 0 V suppresses the carrier.
Linear range	Greater than 30 dB. Linearity typically better than ±0.5 dB at −20 dBV (100 mV input).
ON/OFF ratio	Greater than 80 dB.
Envelope delay	Less than 10 μs, typically 6 μs.
Rise/fall time	Less than 13 μs to −70 dBc.
IF output	An IF output is available on the rear panel, modulated by the selected digital or vector modulation. The IF output can be inhibited by software control. The IF output can be used to provide modulated carriers at higher frequencies by external frequency conversion. The RF output from the front panel connector can be used as an LO for external frequency conversion.
Modulation oscillator	
Frequency range	0.1 Hz to 500 kHz (sine wave).
Selection	By keyboard entry of data. Variation by ⇩/⇧ keys and by rotary control.
Indication	7 digits with annunciators.
Resolution	0.1 Hz.
Frequency accuracy	As frequency standard.
Distortion	Less than 0.1% THD in sine wave mode at frequencies up to 20 kHz.
Alternative waveforms	A triangular wave is available in addition to the sine wave for frequencies up to 100 kHz.
Signalling tones	The modulation oscillator can be used to generate sequential (up to 16 tones) or sub-audible signalling tones in accordance with EIA, ZVEI, DZVEI, CCIR, EURO1, EEA, NATAL and DTMF* standards. Facilities are also available for creating and storing user-defined tone systems. *Requires second modulation oscillator (Option 001) to be fitted.
External modulation	Two independent inputs on the front panel with BNC connectors, EXT MOD 1 and EXT MOD 2. The modulation is calibrated with 1.414 V peak (1 V RMS sine wave) applied. Input impedance 100 kΩ nominal.
Modulation ALC	The EXT MOD 1 and EXT MOD 2 modulation inputs can be levelled by an ALC system.
Level range	1 to 2 V peak (0.7 V to 1.4 V RMS sine wave).
Distortion	Less than 0.1% additional distortion for frequencies up to 20 kHz at 1 V RMS sine wave (typically less than 0.1% up to 50 kHz).
1 dB bandwidth	Typically 10 Hz to 500 kHz.

LF output		Front panel BNC connector. The output may be configured in either LF Generator Mode to give an output from the internal modulation oscillator or in LF Monitor Mode to give an output from the internal modulation signal paths.
	Selection	By keyboard entry of data. Variation by ⇩/⇧ keys and by rotary control.
	Indication	7 digits with unit annunciators for frequency and 4 digits with unit annunciators for level.
	Level	100 μV to 5 V RMS with a load impedance of greater than 600 Ω. 100 μV to 1.4 V RMS with a load impedance of greater than 50 Ω.
	Source impedance	5.6 Ω nominal.
	Level accuracy at 1 kHz	With a load impedance of greater than 10 kΩ: LF ±5% for levels above 50 mV and LF ±10% for levels from 500 μV to 50 mV.
	Frequency response	Typically better than ±1 dB from 0.1 Hz to 300 kHz.
Sweep		
	Control modes	Start/stop values of selected parameter; Number of steps; Time per step.
	Step time	1 ms to 20 s per step.
	Sweep ramp	Synchronized analog ramp with an amplitude of nominally 0 V to 10 V peak on rear panel BNC connector.
	Markers	User selectable markers for frequency or level provide an indication when specified parameter values have been reached. Output 0 V to +5 V nominal from 600 Ω on rear-panel BNC socket.
	Trigger	Rear-panel BNC connector. Applying 0 V or a switch closure starts the sweep. Connector is internally connected via 10 kΩ pull-up resistor to +5 V.
Frequency standard		
	Frequency	10 MHz.
	Temperature stability	Better than ±5 in 10^8 over the operating range of 0 to 50°C.
	Warm-up time	Within 2 in 10^7 of final frequency within 10 minutes from switch-on at 20°C ambient.
	Aging rate	Better than 2 in 10^7 per year.
	Output	Rear panel BNC socket provides an output at frequencies of 1, 5 or 10 MHz with a nominal 2 V pk-pk level into 50 Ω. Output can be disabled.
	External input	Rear panel BNC socket accepts an input of 220 mV RMS to 1.8 V RMS into 1 kΩ at a frequency of 1, 5 or 10 MHz.
GPIB interface		A GPIB interface is fitted. All functions except the supply switch are remotely programmable.
	Capabilities	Designed in accordance with IEEE488.2. Complies with the following subsets as defined in IEEE Std. 488.1. SH1, AH1, T6, L4, SR1, RL1, PP0, DC1, DT1, C0, E2.
Electro-magnetic compatibility		Conforms with the protection requirements of the EC Directive 2004/108/EC. Conforms with the limits specified in the following standards: IEC/EN 61326-1 : 1997 + A1 : 1998 + A2 : 2001 + A3 : 2003, RF Emission Class B, Immunity Table 1, Performance Criterion B
Safety		Conforms with the requirements of EC Directive 2006/95/EC (as amended) and the product safety standard IEC/EN 61010-1 : 2001 + C1 : 2002 + C2 : 2003 for Class 1 portable equipment, for use in a Pollution Degree 2 environment. The instrument is designed to operate from an Installation Category 2 supply.
Rated range of use		
(Over which full specification is met).		
	Temperature	0 to 55°C.
	Humidity	Up to 93% at 40°C.

Conditions of storage and transport

Temperature	−40°C to +71°C.
Humidity	Up to 93% relative humidity at 40°C.
Altitude	Up to 4600 m (15,000 ft).

Power requirements

AC supply	Four voltage settings covering	100 V~ (limit 90–115 V~) 120 V~ (limit 105–132 V~) 220 V~ (limit 188–242 V~) 240 V~ (limit 216–264 V~)
	Frequency: 50–400 Hz (limit 45 Hz–440 Hz) 180 VA max.	

Calibration interval 2 years.

Dimensions and weight (Over projections but excluding front panel handles):

Height	**Width**	**Depth**	**Weight**
152 mm	425 mm	525 mm	21 kg
6.0 in	16.6 in	20.5 in	46 lb

Option 1: Second modulation oscillator option Specification as Modulation Oscillator.

Option 2: Pulse modulation Pulse modulation may be used alone or in conjunction with FM, ΦM, wideband FM, vector or digital modulation.

Rise/fall time	25 ns
Control	0 V for carrier off, +5 V for carrier on. Threshold level is typically +2.5 V.
ON/OFF ratio	Better than 70 dB.
Input impedance	50 Ω nominal.

Option 105: Slow rise time pulse modulation Modifies pulse modulation option for a typical rise and fall time of 1 µs.

Option 6: Avionics See Annex A.

Option 8: RF profiles and complex sweep See Annex B.

Option 12: Electronic attenuator

Carrier frequency range	250 kHz* to 1.35 GHz (2050T), 250 kHz* to 2.7 GHz (2051T). *Usable to 10 kHz (50 MHz in digital, advanced digital or vector modes, usable to 10 MHz).
RF output range	Analog mode: −138 dBm to +10 dBm. When AM is selected the maximum output level reduces linearly with AM depth to +4 dBm at maximum AM depth. Digital or vector mode: −132 dBm to +3 dBm peak envelope power. Advanced digital mode: −144 dBm to −9 dBm peak envelope power.
Accuracy	±1.2 dB in non-digital or vector modes for output levels >−127 dBm at 22°C ±5°C.
Temperature stability	±0.01 dB/°C.
VSWR	<1.5:1 for output levels less than 0 dBm.
Reverse power handling	1 W from a source VSWR of up to 5:1.
Amplitude modulation	Standard specification applies for carrier frequencies above 50 MHz (above 100 MHz for Option 6).

Versions, options and accessories

When ordering please quote the full ordering number information.

Ordering numbers	Versions
2050T	10 kHz to 1.35 GHz Digital and Vector Signal Generator for TETRA.
2051T	10 kHz to 2.7 GHz Digital and Vector Signal Generator for TETRA.
2052T	10 kHz to 5.4 GHz Digital and Vector Signal Generator for TETRA.
	Options
	Options are factory fitted only and must be specified at the time of ordering.
Option 001	Second modulation oscillator.
Option 002	Pulse modulation.
Option 006	Avionics (must be ordered with Option 001).
Option 008	RF profiles and complex sweep.
Option 012	Electronic attenuator (2050T and 2051T only).
Option 105	Increased pulse modulation rise and fall time (must be ordered with Option 002).
Option 112	External modulation inputs (2) 600 Ω impedance.
	Supplied accessories
-	AC supply lead (see 'Power cords', Chap. 2).
46882/296	Operating manual (this manual) for 2050T series.
	Optional accessories
46880/078	Service manual for 2050T series.
43139/042	RF connector cable, double screened, 50 Ω, 1.5 m, BNC.
54311/092	Coaxial adapter N-type male to BNC female.
59999/163	Precision coaxial adapter, N-type male to SMA female.
54311/095	RF connector cable, 1 m, N-type connectors.
43129/189	GPIB lead assembly.
46883/408	IEEE/IEC adapter block for GPIB socket.
46884/291	Rack mounting kit (with slides) for rack cabinets with depths from 480 mm to 680 mm.
46884/292	Rack mounting kit (with slides) for rack cabinets with depths from 680 mm to 840 mm.
46884/541	Rack mounting kit containing front mounting brackets only.
46884/444	Maintenance kit for 2050T series.
46662/525	Transit case.
54112/164	Soft carrying case.
54499/044	DECT filter.
44991/144	Breakout box. Converts AUXILIARY I/O connector to 8 data, 1 burst control line and 2 clock lines on BNC connectors. Daisy chain connection allows the monitoring of the signals (on BNC connectors).

EC Declaration of Conformity

Certificate Ref. No.: DC227

The undersigned, representing:

Manufacturer:	**Aeroflex International Ltd.**
Address:	**Longacres House, Six Hills Way,** **Stevenage, Hertfordshire, UK SG1 2AN**

Herewith declares that the product:

Equipment Description:	Digital and Vector Signal Generators
Model No.	2050, 2051, 2052
Options:	1, 2, 4, 6, 8, 12, 100, 101, 102, 105, 108, 112

is in conformity with the following EC directive(s)
(including all applicable amendments)

Reference No.	**Title:**
2006/95/EC	Low Voltage Directive
2004/108/EC	EMC Directive

and that the standards and/or technical specifications referenced below have been applied:

Safety:

IEC/EN61010-1 : 2001 + C1 : 2002 + C2 : 2003

EMC:

IEC/EN 61326-1:1997 + A1 : 1998 + A2 : 2001+ A3 : 2003

RF Emission Class B, Immunity Table 1 and Performance Criterion B

Qualifying Notes:

Aeroflex Stevenage (Place) 26 April 2007 (Date)

(Signature)

Richard Dickens — Quality Manager

Chapter 2
INSTALLATION

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WARNING

Initial visual inspection

After unpacking the instrument, inspect the shipping container and its cushioning material for signs of stress or damage. If damage is identified, retain the packing material for examination by the carrier in the event that a claim is made. Examine the instrument for signs of damage; do not connect the instrument to a supply when damage is present, internal electrical damage could result in shock if the instrument is turned on.

Mounting arrangements

Excessive temperatures may affect the performance of the instrument. Completely remove the plastic cover, if one is supplied over the case, and avoid standing the instrument on or close to other equipment which is hot.

CAUTION

Installation requirements

Ventilation

This instrument is forced air cooled by a fan mounted on the rear panel. Air must be allowed to circulate freely through the ventilator grills located on the side and underside of the instrument. Before switching on the instrument, ensure that the air outlet on the rear panel is not restricted (i.e. clearance of at least 75 mm at the rear, 25 mm at each side, 15 mm on the underside). Failure to provide adequate clearances will increase internal temperatures and reduce the instrument reliability, so its performance may not meet specification.

Class I power cords (3-core)

General

When the equipment has to be plugged into a Class II (ungrounded) 2-terminal socket outlet, the cable should either be fitted with a 3-pin Class I plug and used in conjunction with an adapter incorporating a ground wire, or be fitted with a Class II plug with an integral ground wire. The ground wire must be securely fastened to ground. Grounding one terminal on a 2-terminal socket will not provide adequate protection.

In the event that a moulded plug has to be removed from a lead, it must be disposed of immediately. A plug with bare flexible cords is hazardous if engaged in a live socket outlet.

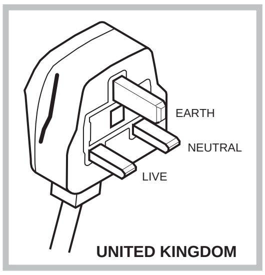
Power cords with the following terminations are available from Aeroflex. Please check with your local sales office for availability.

This equipment is provided with a 3-wire (grounded) cordset which includes a moulded IEC 320 connector for connection to the equipment. The cable must be fitted with an approved plug which, when plugged into an appropriate 3-terminal socket outlet, grounds the case of the equipment. Failure to ground the equipment may expose the operator to hazardous voltage levels. Depending upon the destination country, the colour coding of the wires will differ:

	North America	Harmonised
Line (Live)	Black	Brown
Neutral	White	Blue
Ground (Earth)	Green	Green/Yellow

British

Country	IEC 320 plug type	Part number
United Kingdom	Straight through	23422/001
United Kingdom	Right angled	23422/002



C3510

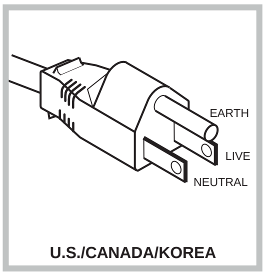
The UK lead is fitted with an ASTA approved moulded plug to BS 1363.

A replaceable 13 A fuse to BS 1362 is contained within the plug. This fuse is only designed to protect the lead assembly. Never use the plug with the detachable fuse cover omitted or if the cover is damaged.

The fuse(s) or circuit breaker to protect the equipment is fitted at the back of the equipment.

North American

Country	IEC 320 plug type	Part number
North American	Straight through	23422/004
North American	Right angled	23422/005

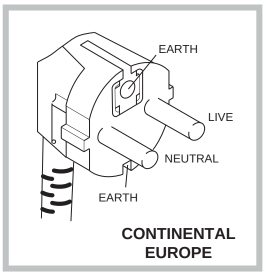


C3511

The North American lead is fitted with a NEMA 5-15P (Canadian CS22.2 No 42) plug and carries approvals from UL and CSA for use in the USA and Canada.

Continental Europe

Country	IEC 320 plug type	Part number
Europe	Straight through	23422/006
Europe	Right angled	23422/007



C3512

The Continental European lead is fitted with a right angle IEC83 standard C4 plug (CEE 7/7) which allows it to be used in sockets with either a male earth pin (standard C 3b) or side earth clips (standard C 2b) the latter is commonly called the German ‘Schuko’ plug. In common with other Schuko style plugs, the plug is not polarized when fitted into a Schuko socket. The lead carries approvals for use in Austria, Belgium, Finland, France, Germany, Holland, Italy, Norway and Sweden. Note that this plug will not fit Italian standard CEI 23-16 outlets. The lead should not be used in Denmark given that the earth connection will not be made.

Français

Le câble d'alimentation d'Europe Continentale est muni d'un connecteur mâle à angle droit type CEI83, standard C4 (CEE 7/7), qui peut être utilisé dans une prise femelle à ergot de terre (standard C 3b) ou à clips latéraux (standard C 2b), cette dernière étant communément appelée prise “Schuko” allemande. De la même façon que les autres connecteurs de type Schuko, celui-ci n'est pas polarisé lorsqu'il s'adapte à une prise femelle Schuko. Ce câble d'alimentation est homologué en Allemagne, Autriche, Belgique, Finlande, France, Hollande, Italie, Norvège et Suède. A noter que ce connecteur n'est pas compatible avec les prises de courant italiennes au standard CEI 23-16. Ce câble ne doit pas être utilisé au Danemark à cause du défaut de connexion de masse.

Deutsch

Das kontinentaleuropäische Netzkabel ist mit einem rechtwinkeligen Stecker nach IEC83 C4 (CEE7/7) Standard versehen, welcher sowohl in Steckdosen mit Erde-Stift (Standard C 3b) oder seitlichen Erdeklemmen, im allgemeinen “Schukosteckdose” genannt, paßt. Üblicherweise ist der Schukostecker bei Verwendung in Schukosteckdosen nicht gepolt. Dieses Netzkabel besitzt Zulassung für Österreich, Belgien, Finnland, Frankreich, Deutschland, Holland, Italien, Norwegen und Schweden.

Hinweis: Dieser Schukostecker paßt nicht in die italienischen Standardsteckdosen nach CEI 23-16 Norm. Dieses Netzkabel sollte nicht in Dänemark verwendet werden, da hier keine Erdeverbindung hergestellt wird.

Español

El cable de alimentación tipo Europeo Continental dispone de una clavija C4 normalizada IEC83 (CEE 7/7) que permite su utilización tanto en bases de enchufe con toma de tierra macho (tipo C 3b) o con toma de tierra mediante contactos laterales (tipo C 2b) que, en este último caso, suele denominarse “Schuko”. Al igual que cualquier otra clavija tipo Schuko, las conexiones a red no están polarizadas cuando se conectan a una base tipo Schuko. El cable lleva autorización para su uso en Austria, Bélgica, Finlandia, Francia, Alemania, Holanda, Italia, Noruega y Suecia. Observe que este cable no se adapta a la norma italiana CEI 23-16. El cable no debe utilizarse en Dinamarca en el caso de no efectuarse conexión a tierra.

Italiano

I cavi d'alimentazione per l'Europa continentale vengono forniti terminati con una spina ad angolo retto del tipo C4 secondo lo standard IEC83 (CEE 7/7) che può essere usato in prese in cui la terra può essere fornita o tramite connettore maschio (C 3b) o tramite clips laterali (C 2b), quest'ultima comunemente detta di tipo tedesca “Schuko”. Questa spina, quando collegata ad una presa Schuko, non è polarizzata.

Il cavo può essere usato in Austria, Belgio, Finlandia, Francia, Germania, Olanda, Norvegia, Svezia ed Italia. E' da notare che per l'Italia questo non risponde allo standard CEI 23-16.

Questa spina non dovrebbe invece essere usata in Danimarca in quanto non realizza il collegamento di terra.

Goods-in checks

The following goods-in checks verifies that the instrument is functioning correctly, but does not verify conformance to the listed specification. To verify that the instrument conforms to the specification given in Chapter 1, refer to Chapter 6, 'Acceptance testing':

1. Inspect the shipping container and instrument for any signs of damage. If damage is evident, do not plug in, turn on or attempt to operate the instrument. Repackage it and return it to Aeroflex.
2. Verify that your order is complete, including any accessories and options that you may have ordered.
3. Check that the setting of the voltage selector switch matches the supply voltage available at the installation site. The voltage selector is an integral part of the supply connector, located on the rear panel of the instrument. If different, refer to **Voltage selector** section and Fig. 2-1 for information on settings.
4. Check that the correct fuse(s) are fitted and correspond to your supply voltage. If different, replace with the same type and rating as marked adjacent to the supply connector (fuse(s) integral to supply connector: see **Fuses** section and Fig. 2-1 for guidance).
5. Switch on the instrument and check that a display is present.
6. If the instrument appears to be completely dead, carry out the following:

   Check that the mains power supply line is providing power to the instrument.
   Check that the mains fuse(s) have not blown.

Connecting to supply

The instrument is a Safety Class 1 product and therefore must be earthed. Use the supplied power cord or an appropriate replacement. Make sure that the instrument is plugged into an outlet socket with a protective earth contact.

Disconnecting device

The detachable power cord is the instrument's disconnecting device, but if the instrument is integrated into a rack or system, an external power switch or circuit breaker may be required. Whatever the disconnecting device, make sure that you can reach it easily and that it is accessible at all times.

Before connecting the instrument to the AC supply, check the setting of the voltage selector switch which is an integral part of the supply connector at the rear of the instrument.

Voltage selector

The selected voltage is displayed in a window at the top of the connector. The instrument is normally despatched with the selector set to 240 V. To select another voltage, insert a screwdriver into the slot at the top of the moulding and twist slightly so that the cover is free to hinge downwards. Rotate the barrel so that the correct setting is displayed, see Fig. 2-1.

Setting	Voltage range limit
100 V	90 - 115 V
120 V	105 - 132 V
220 V	188 - 242 V
240 V	216 - 265 V

Fuses

The correct fuse rating for each voltage setting is as follows:

100 V to 120 V, TT1.6AL250V (1.6 amp double time lag)

220 V to 240 V, TT1AL250V (1 amp double time lag)

Fuses are cartridge type measuring 20 mm x 5 mm.

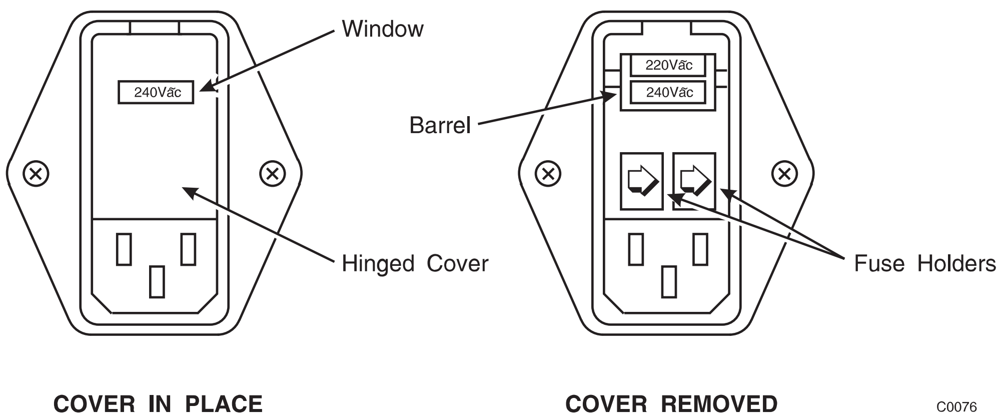


Fig. 2-1 AC connector showing voltage selector and fuse holders

General purpose interface bus (GPIB)

The GPIB interface built into the 2050T series enables the signal generators to be remotely controlled to form part of an automatic measuring system.

GPIB cable connection

Connection to other equipment which has a 24-way connector to IEEE Standard 488 is made using the rear panel GPIB socket. For this purpose, the GPIB cable assembly, available as an optional accessory, (see Chap. 1 'Accessories') may be used.

GPIB connector contact assignments

The contact assignments of the GPIB cable connector and the device connector are as shown in Fig. 2-2.

Contact	Function	Contact	Function
1	Data I/O 1	13	DataI/O 5
2	Data I/O 2	14	DataI/O 6
3	Data I/O 3	15	DataI/O 7
4	Data I/O 4	16	DataI/O 8
5	EOI	17	REN
6	DAV	18	Pair with 6
7	NRFD	19	Pair with 7
8	NDAC	20	Pair with 8
9	IFC	21	Pair with 9
10	SRQ	22	Pair with 10
11	ATN	23	Pair with 11
12	Ground shield	24	Logic ground

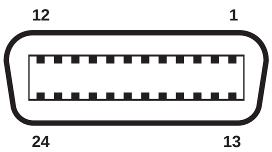


Fig. 2-2 GPIB connector contact assignments (viewed from rear of instrument)

IEEE to IEC conversion

An optional IEEE to IEC adapter is also available (see Chap. 1 'Optional Accessories') for interfacing with systems using a 25-way bus connector to IEC Recommendation 625. The method of use is shown in Fig. 2-3.

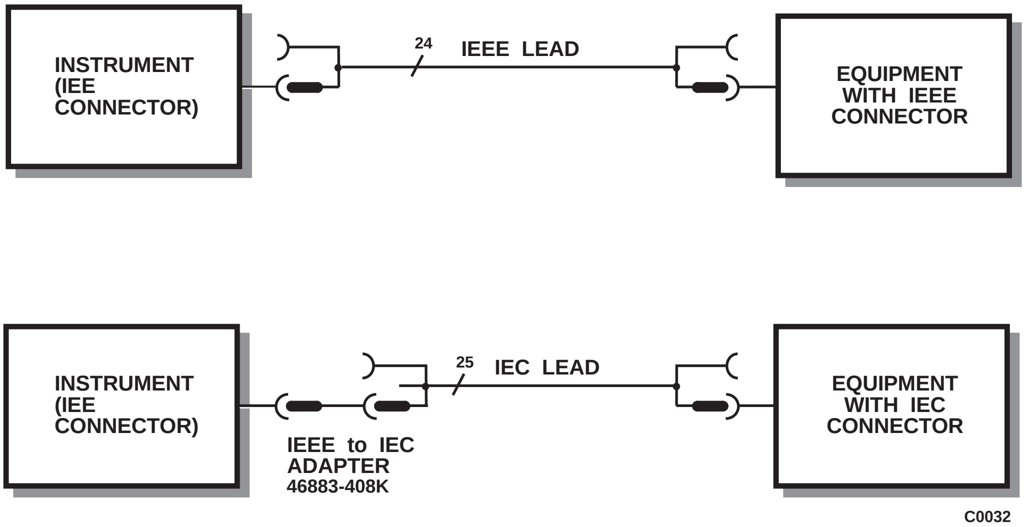


Fig. 2-3 IEEE to IEC conversion

Interface bus connection

The cables for the interface bus use special male-female connectors at both ends. This allows several connectors to be stacked one on top of another permitting several cables to be connected to the same source and secured by a lockscrew mechanism. Too large a stack, however, may form a cantilevered structure which might cause damage and should be avoided. The piggyback arrangement permits star or linear interconnection between the devices with the restriction that the total cable length for the system must be:-

(1) No greater than 20 m (65 ft).

(2) No greater than 2 m (6 ft) times the total number of devices (including the controller) connected to the bus.

Auxiliary I/O connector

The rear panel 25-way female D-type AUXILIARY I/O connector is shown in Fig. 2-4. This carries modulation data inputs and power supply outputs as well as having contacts used for external control.

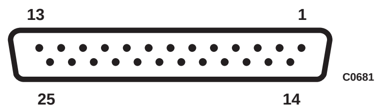


Fig. 2-4 25-way AUXILIARY I/O connector

Modulation data

Data for the modulator and burst control are carried on the contacts for the various formats as shown by Table 2-1.

Table 2-1 Modulation data contact assignments

DATA FORMAT	CONTACT							
	11	14	15	16	17	18	19	20	21
Serial	Burst control	X	X	X	X	X	X	X	Data
2-bit parallel	Burst control	X	X	X	X	X	X	D0	D1
3-bit parallel	Burst control	X	X	X	X	X	D0	D1	D2
4-bit parallel	Burst control	X	X	X	X	D0	D1	D2	D3
5-bit parallel	Burst control	X	X	X	D0	D1	D2	D3	D4
6-bit parallel	Burst control	X	X	D0	D1	D2	D3	D4	D5
7-bit parallel	Burst control	X	D0	D1	D2	D3	D4	D5	D6
8-bit parallel	Burst control	D0	D1	D2	D3	D4	D5	D6	D7

where X = don't care and D0 is the least significant bit

Note that in parallel data modes the data is shifted from parallel to serial internally hence contact 21 is always the most significant data bit.

The strobes for the above data have selectable polarity and direction. For loading parallel data the symbol clock is used. For loading serial data both the symbol and bit clocks are used.

SYMBOL CLOCK I/O	contact 10
DETECTION	contact 22 - DO NOT USE
BIT CLOCK I/O	contact 23
BIT CLOCK OUTPUT	contact 24

All data and clock signals are TTL/CMOS compatible.

Power supply outputs

The following power supply outputs are available for driving external interfaces:

GROUND	contact 12
+22 V, 33 mA max	contact 13
-12 V, 300 mA max	contact 25

Auxiliary outputs

The following outputs can be used for controlling external devices:

AUX 0	contact 1
AUX 1	contact 2
AUX 2	contact 3
AUX 3	contact 4
AUX 4	contact 5
AUX 5	contact 6
AUX 6	contact 7
AUX 7	contact 8
AUX ENABLE	contact 9

Each output is CMOS compatible. The aux enable input needs to be set to a logical high to enable the outputs.

Rack mounting

The instrument, which is normally supplied for bench mounting, may be mounted in a standard 19 inch rack (see Chap. 1 'Optional Accessories'). There are two slide rack mounting kits to accommodate different depths of cabinet. These kits include full fitting instructions. A rack mounting kit without slides is also available which contains front panel mounting brackets only.

CAUTION

Routine maintenance

Safety testing and inspection

In the UK, the ‘Electricity at Work Regulations’ (1989) section 4 (2) places a requirement on the users of equipment to maintain it in a safe condition. The explanatory notes call for regular inspections and tests together with a need to keep records.

The following electrical tests and inspection information is provided for guidance purposes and involves the use of voltages and currents that can cause injury. It is important that these tests are only performed by competent personnel.

Prior to carrying out any inspection and tests, the instruments must be disconnected from the mains supply and all external signal connections removed. All tests should include the instrument’s own supply lead, all covers must be fitted and the equipment supply switch must be in the ‘ON’ position.

The recommended inspection and tests fall into three categories and should be carried out in the following sequence:-

1. Visual inspection
2. Earth bonding tests
3. Insulation resistance test

1. Visual inspection

A visual inspection should be carried out on a periodic basis. This interval is dependent on the operating environment, maintenance and use, and should be assessed in accordance with guidelines issued by the Health and Safety Executive (HSE). As a guide, this instrument when used indoors in a relatively clean environment would be classified as ‘low risk’ equipment and hence should be subject to safety inspections on an annual basis. If the use of the equipment is contrary to the conditions specified, you should review the safety re-test interval.

As a guide, the visual inspection should include the following where appropriate:

Check that the equipment has been installed in accordance with the instructions provided (e.g. that ventilation is adequate, supply isolators are accessible, supply wiring is adequate and properly routed).

The condition of the mains supply lead and supply connector(s).

Check that the mains supply switch isolates the instrument from the supply.

The correct rating and type of supply fuses.

Security and condition of covers and handles.

Check the supply indicator functions (if fitted).

Check the presence and condition of all warning labels and markings and supplied safety information.

Check the wiring in re-wireable plugs and appliance connectors.

If any defect is noted this should be rectified before proceeding with the following electrical tests.

2. Earth bonding tests

Earth bonding tests should be carried out using a 25 A (12 V maximum open circuit voltage) DC source. Tests should be limited to a maximum duration of 5 seconds and have a pass limit of 0.1 Ω after allowing for the resistance of the supply lead. Exceeding the test duration can cause damage to the equipment. The tests should be carried out between the supply earth and exposed case metalwork, no attempt should be made to perform the tests on functional earths (e.g. signal carrying connector shells or screen connections) as this will result in damage to the equipment.

3. Insulation tests

A 500 V DC test should be applied between the protective earth connection and combined live and neutral supply connections with the equipment supply switch in the 'on' position. It is advisable to make the live/neutral link on the appliance tester or its connector to avoid the possibility of returning the equipment to the user with the live and neutral poles linked with an ad-hoc strap. The test voltage should be applied for 5 seconds before taking the measurement.

Aeroflex employs reinforced insulation in the construction of its products and hence a minimum pass limit of 7 MΩ should be achieved during this test.

Where a DC power adapter is provided with the equipment, the adapter must pass the 7 MΩ test limit.

We do not recommend dielectric flash testing during routine safety tests. Most portable appliance testers use AC for the dielectric strength test which can cause damage to the supply input filter capacitors.

4. Rectification

It is recommended that the results of the above tests are recorded and checked during each repeat test. Significant differences between the previous readings and measured values should be investigated.

If any failure is detected during the above visual inspection or tests, the equipment should be disabled and the fault should be rectified by an experienced Service Engineer who is familiar with the hazards involved in carrying out such repairs.

Safety critical components should only be replaced with equivalent parts, using techniques and procedures recommended by Aeroflex.

The above information is provided for guidance only. Aeroflex designs and constructs its products in accordance with International Safety Standards such that in normal use they represent no hazard to the operator. Aeroflex reserves the right to amend the above information in the course of its continuing commitment to product safety.

Battery replacement

The instrument contains a realtime clock which is powered by a lithium battery when the normal power is removed. Although battery life can extend to five years, this will depend on conditions of use, e.g. battery life is reduced as the temperature is increased. To avoid loss of data it is recommended that the battery is replaced every two years.

Replace the battery as follows:

(1) Ensure that the instrument is switched on; this will provide power for the non-volatile memory while the battery is replaced. If this is not possible. the clock will continue to run for approximately 30 seconds, whilst the replacement is made.

(2) Using a coin or suitable took. unscrew the battery compartment cover at the rear of the instrument.

(3) Remove the battery, noting its orientation. Insert the replacement, then replace the battery compartment cover.

The replacement battery should be SAFT L56 or equivalent. This is a lithium 3.5 V type, rated at 1800 mAH, size AA. If a lithium battery is unobtainable an alkaline battery can be used but it will have a shorter life. A suitable battery can be obtained from Aeroflex (part number 23711/106).

Cleaning

Before commencing any cleaning, switch off the instrument and disconnect it from the supply. The exterior surface of the case may be cleaned using a soft cloth moistened in water. Do not use aerosol or liquid solvent cleaners.

Cleaning the LCD window

To prevent damage to the LCD window, care should be taken not to scratch the surface during use and also when cleaning. The LCD window should be cleaned by wiping a slightly damp, soft, lint-free cloth gently over the surface

Putting into storage

If the instrument is to be put into storage, ensure that the following conditions are maintained:

Temperature range:	-40 to 70°C
Humidity:	Less than 93% at 40°C

Chapter 3
OPERATION

Contents

List of tables

List of figures

Introduction

This chapter explains how to:

- Set up the signal generator to produce a typical basic signal.
- Select the main operating parameters; carrier frequency, output level and type of modulation.
- Use the full range of supporting facilities.

Note...

When connecting the PULSE INPUT connector to external equipment, a double screened coaxial cable is used in order for the instrument to conform to EMC requirements.

Conventions

The following conventions are used in this chapter:

RF OUTPUT	Capitals refer to titles marked on the panel.
[MEM]	Text in square brackets indicate hard key titles.
Int. F4	Italics refer to data or messages on the display.
[Pulse]	Italics in square brackets indicate soft key titles, e.g. *[Pulse]* means the soft key adjacent to the *Pulse* title box at the side of the menu.

Front panel

Parameters are selected by means of hard keys, which have their function printed on them, soft keys, which do not have any notation, a numerical key pad and a rotary control knob, see Fig. 3-1. The hard keys have functions which do not change, whereas the soft key functions are determined by the menu which is being displayed. The numerical keys are used to set parameters to specific values which can also be varied in steps of any size by using the ⇩/⇧ keys or the rotary control knob.

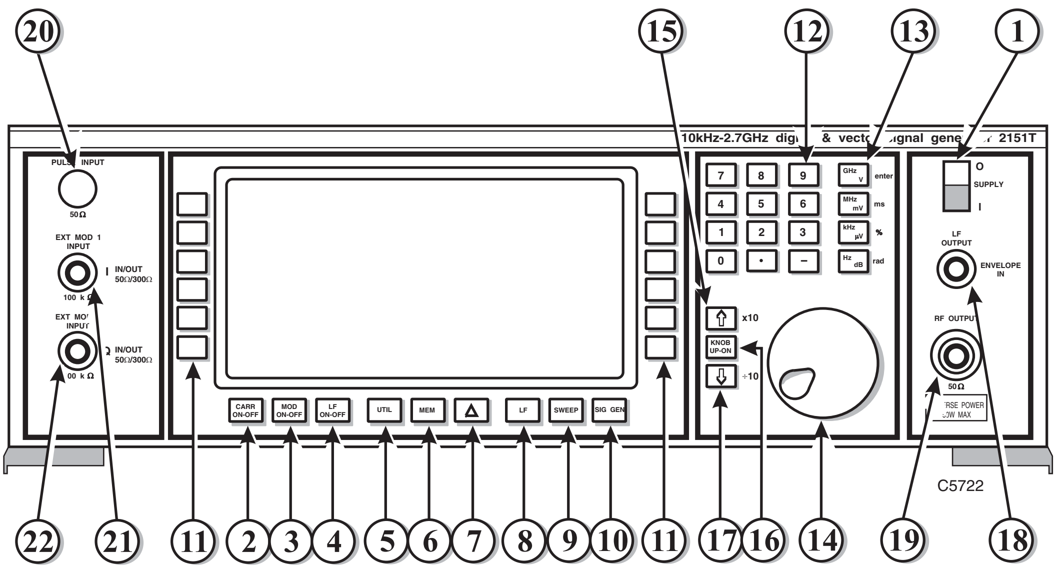


Fig. 3-1 2051T front panel.

(1)	SUPPLY	Switches the AC supply voltage on and off.
(2)	CARR ON-OFF	Enables or disables the carrier frequency.
(3)	MOD ON-OFF	Enables or disables the modulation.
(4)	LF ON-OFF	Switches the low frequency output on and off.
(5)	UTIL	Displays the utilities menu.
(6)	MEM	Displays the memory store/recall menu.
(7)	Δ	Displays the total shift menu.

(8)	LF	Displays the LF and monitor menus.
(9)	SWEEP	Displays the sweep status menu.
(10)	SIG GEN	Displays the main menu.
(11)	SOFT KEYS	Twelve function keys change notation as the menu changes.
(12)	NUMERICAL KEY PAD	For changing the value of a selected parameter. Minus sign and decimal point are included.
(13)	UNITS KEYS	Determine the units of set parameters and terminate the numerical entry.
(14)	CONTROL KNOB	When enabled, adjusts the value of the selected parameter.
(15)	⇧ ×10	When knob disabled, increments a selected parameter. When knob enabled, increases knob sensitivity by factor of ten.
(16)	KNOB UP-DN	Switches between control knob and ⇩⇧ keys.
(17)	⇩ ÷10	When knob disabled, decrements a selected parameter. When knob enabled, decreases knob sensitivity by factor of ten.
(18)	LF OUTPUT	BNC socket provides a low impedance output at the frequency selected at the *LF GENERATOR MENU* or monitors the modulating signal.
	ENVELOPE IN	In both vector and digital modes, enables a control voltage to vary the RF OUTPUT level.
(19)	RF OUTPUT	50 Ω N type socket with reverse power protection.
(20)	PULSE INPUT	50 Ω BNC socket (if fitted) accepts a pulsed signal.
(21)	EXT MOD 1 INPUT	100 kΩ BNC socket. An independent input which allows an external modulation signal to be applied.
	I IN/OUT 50Ω/300Ω	In vector operation this socket has a menu-selectable 50 Ω or 300 Ω input impedance. In digital mode provides the I (in phase) channel modulation output signal. In vector mode allows a voltage to vary the I component of the RF output.
(22)	EXT MOD 2 INPUT	100 kΩ BNC socket, similar to (21).
	I IN/OUT 50Ω/300Ω	In vector operation this socket has a menu-selectable 50 Ω or 300 Ω input impedance. In digital mode provides the Q (quadrature) channel modulation output signal. In vector mode enables a voltage to vary the Q component of the RF output.

Rear panel

The following facilities are available on the rear panel, see Fig. 3-2.

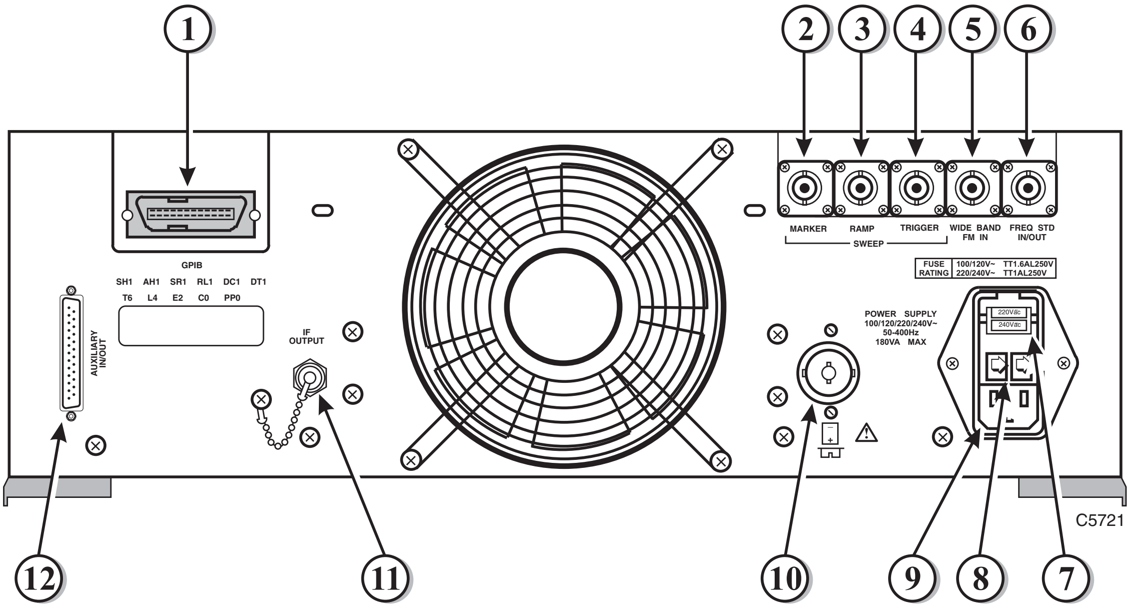


Fig. 3-2 2051T rear panel

(1) GPIB		24 pin socket accepts standard IEEE connector to allow remote control of the instrument.
(2)	SWEEP MARKER	BNC socket supplies sweep marker.
(3)	SWEEP RAMP	BNC socket provides a ramp output at 0 to 10 V peak to peak.
(4)	SWEEP TRIGGER	BNC socket provides access for a trigger input.
(5)	WIDE BAND FM IN	BNC socket accepts a wide bandwidth FM signal into 50 Ω with a typical bandwidth of 10 MHz.
(6)	FREQ STD IN/OUT	BNC socket for standard frequencies at 1, 5, or 10 MHz with a nominal 2 V pk-pk level into 50 Ω.
(7)	VOLTAGE SELECTOR	Removable cover reveals barrel which can be rotated to select the required voltage range.
(8)	FUSES	AC fuses rated at TT1.6AL250V for the 100 to 120 V range and 1TT1AL250V for the 220 to 240 V range.
(9)	AC SUPPLY INPUT	3 pin plug integral with voltage selector and fuse holders. Mates with supply lead socket.
(10)	BATTERY HOLDER	Houses battery for real time clock.
(11)	IF OUTPUT	BNC socket supplies an IF modulated by the selected digital or vector modulation. Can be used with an external mixer.
(12)	AUXILIARY IN/OUT	25-pin plug. Can accept external data to modulate the RF OUTPUT level or be used to control external devices. For pin-out see 'Auxiliary I/O connector' in Chapter 2.

The menus

The 2050T Series instruments are operated by calling up various displays or menus on the screen. Menus are accessed via both hard and soft keys. Pressing a hard key normally causes the appropriate primary menu to appear on the screen regardless of the current working position within the menu hierarchy. As the display changes from one menu to another, so the 12 soft keys assume those functions necessary to drive the instrument from that menu. Secondary menus are displayed by pressing a soft key while in a primary menu. Some sub-menus are nested e.g. UTILITIES. Clearance from these is obtained by pressing the *[EXIT]* or [UTIL] key.

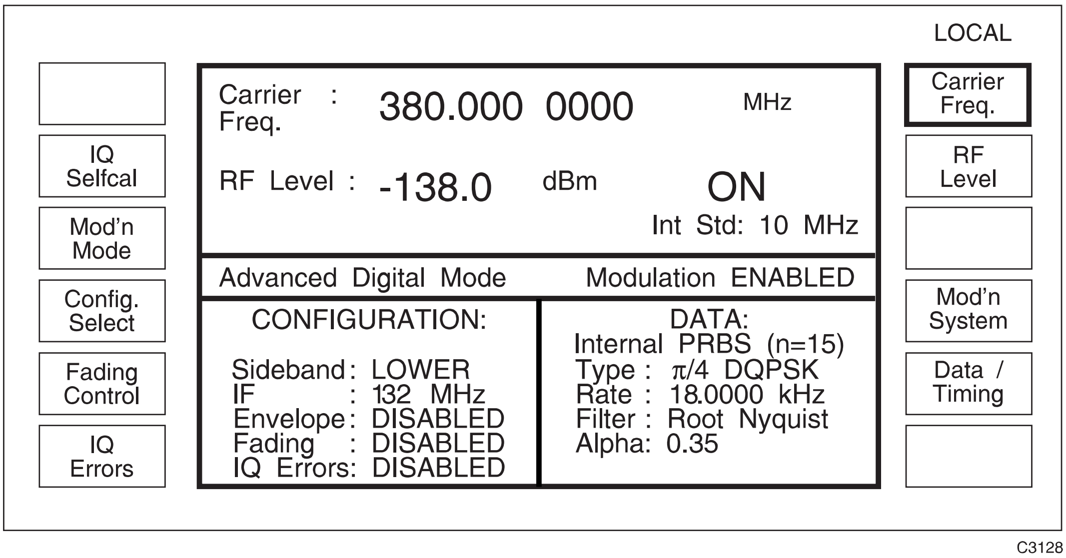


Fig. 3-3 Sig Gen menu - default display for 2050T series

First-time use

First-time users can quickly become familiar with the principles of control and display by carrying out the following exercise, which demonstrates how to set up a typical basic signal having the following parameters:

Carrier frequency:	100 MHz.
Output level:	–10 dBm.
Amplitude modulation:	30% depth at 1 kHz.

Switching on

(1) Before switching the instrument on, check that the voltage selector has been set to the value of the power supply as described in Chapter 2, and that no signal voltage is present on the PULSE INPUT socket.

(2) If the default display shown in Fig. 3-3 is not obtained, a previous user may have set the instrument to switch on with one of the other user memories displayed. Before proceeding any further you should reset this selection, see 'Power up options'. Switch off and on again. Alternatively use the [MEM] key followed by entering 50 and terminating by pressing the [enter] key. This will reset the instrument to the 2050T series default setting.

If the RF level units and the internal/external standard are not as shown, they can be changed as described on Page 3-77, 'RF level units' and Page 3-71 'Selection of frequency standard'.

(3) Observe that the main menu appears on the display showing default parameters for advanced digital modulation. The soft key label marked *[Carrier Freq.]* is highlighted (i.e. the line bordering the label is increased in thickness to about 1 mm), which means that anything entered at this stage will change the carrier frequency.

(4) If necessary, adjust the display for brightness and contrast, see 'UTILITIES' Page 3-69.

Changing the value of the selected parameter

If an error is made when keying in, press the soft key again and key in the correct value. If an error message is displayed, it can be cancelled by entering a value which is within limits.

(1) Press *[Mode'n Mode]* or [UTIL] *[Mod'n Mode]* and then press the *[Single]* key. The modulation mode will change to FM single modulation.

(2) Using the numerical key pad, enter 100 MHz by pressing keys [1], [0], [0] and the key marked [MHz/mV/ms]. Observe that the Carrier Freq. display changes to *100.000 0000* MHz.

(3) Press *[RF level]*. The *RF level* soft key label is now highlighted.

(4) Using the numerical key pad, enter –10 dBm by pressing keys [–], [1], [0] and the key marked [Hz/dB/rad]. Observe that the RF Level display changes to *–10.0 dBm*.

(5) Press *[AM]* on the left-hand side of the display. The menu will now change to display AM modulation parameters in the lower panel. The *[FM Devn.]* soft key on the right hand side of the menu changes to *[AM depth]* and this label is now highlighted. *AM* disappears from the left-hand side.

(6) Using the numerical key pad, enter 30% AM depth by pressing [3], [0] and [kHz/μV/%]. Observe that the *AM* depth display changes to *30%*. The display will now be as in Fig. 3-4 and the selected signal will now be present at the RF OUTPUT socket.

Enabling or disabling the modulation

The modulation is ON by default, but the AM can be turned ON and OFF by pressing *[AM ON/OFF]* at the right hand side of the display and the modulation can be enabled or disabled by pressing [MOD ON-OFF]. These are both toggle actions, i.e. press ON, press OFF. The soft key acts only on the selected modulation whereas the [MOD ON-OFF] acts on <u>all</u> modulations.

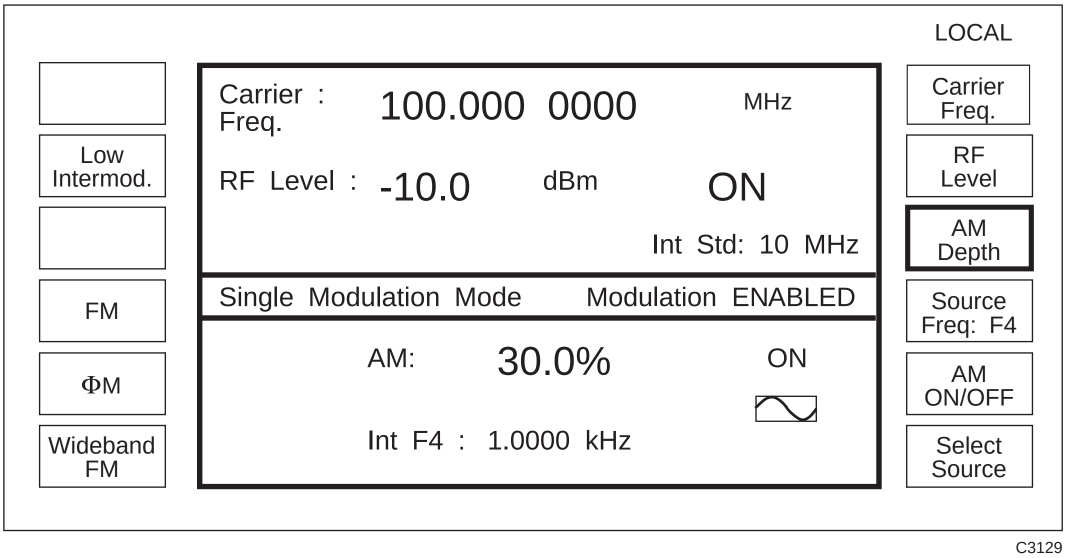


Fig. 3-4 Amplitude modulation - menu configuration

Using the [⇧ ×10] and [⇩ ÷10] keys

When a parameter has been selected via the numerical key pad, its value can be incremented or decremented either in steps using the [⇧] key and the [⇩] key, or continously with the control knob. Select *[Carrier Freq.]* and observe that the effect of pressing the [⇧] and [⇩] keys is to change the carrier frequency in steps of 1 kHz. Default step sizes are assigned to all parameters but these can be changed, see 'INCREMENTING (using Δ)'.

Using the control knob

(1) Press [KNOB UP-DN] to enable the control knob.

(2) On the display, brackets will appear above and below the selected parameter. These brackets embrace the part of the value which the control knob can change. Pressing the [×10] key shortens the bracket length by one decimal place. Pressing the [÷10] key increases the bracket length by one decimal place. In this way the sensitivity of the control knob can be increased or decreased by a factor of ten.

(3) Rotate the control knob and observe the change in the selected parameter. Press [KNOB UP-DN] to disable the knob.

(4) For other parameters, press the relevant soft key and use the [⇧]and [⇩] keys or the control knob.

Note

For *RF Level* the knob resolution is fixed at 0.1 dB.

Detailed operation

Carrier frequency

The carrier frequency is selected from the *Sig Gen* menu by pressing *[Carrier Freq.]*, unless it is already highlighted as in the default display.

Enter the required value via the numerical key pad. The value can then be incremented or decremented using the control knob and its associated keys, [KNOB UP-DN], [×10] and [÷10].

If a value outside the specified range is requested, the message:

ERROR 51: Carrier Outside Limits

is displayed on the screen when the terminator key is pressed, and the instrument is automatically set to the end of the range.

Carrier ON/OFF

The carrier may be switched *ON* or *OFF* at any time via the [CARR ON-OFF] key. This effectively switches the output ON and OFF, retaining the 50 Ω output impedance.

Output level

The output level is selected at the *Sig Gen* menu by pressing *[RF Level]* and entering the required value on the numerical key pad. The value can then be incremented or decremented using the control knob and its associated keys, [KNOB UP-DN], [×10] [÷10]. If a value outside the specified range is requested the message:

ERROR 52: RF Level Outside Limits

or

ERROR 17: RF Level limited by AM

is displayed and the instrument is automatically set to the end of the range.

Note **The knob resolution is fixed at 0.1 dB.**

Choice of units

Units may be μV, mV, V or dB. Conversion between dB and the voltage units is carried out by pressing the appropriate units key, i.e. to change dBm to a voltage unit, press any voltage key for the correct conversion. The choice of Volts EMF, Volts PD, and the dB reference is made by using the *[RF Level Units]* utility, see Page 3-77, 'RF level units'.

Reverse power protection

Accidental application of power to the RF OUTPUT socket trips the reverse power protection circuit (RPP) and a flashing message appears on the display, see Fig. 3-5.

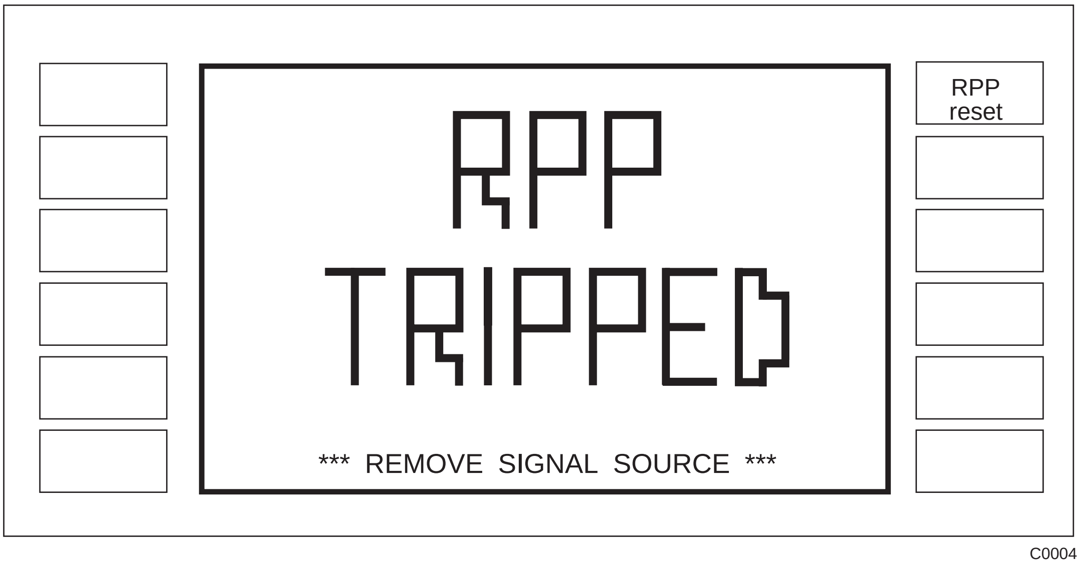


Fig. 3-5 RPP tripped

Pressing *[RPP Reset]* resets the RPP and returns the display to the menu in use when the reverse power protection was tripped. If *[RPP Reset]* is pressed with the signal still applied, the RPP will trip again.

Modulation

The carrier frequency can be modulated by conventional analog methods - frequency, amplitude, phase (with pulse modulation as an option) - as well as the more complex modulation techniques - PSK, QAM, FSK, GMSK, IQ.

Complex modulation modes

Digital

In the digital mode of operation the instrument can generate user-defined modulation formats from either an internal data source or accept external data. Modulation can be applied in PSK, FSK, GMSK and QAM formats with specified channel filter characteristics.

Advanced digital

In the advanced digital mode of operation the instrument has improved adjacent channel performance for TETRA. The digital mode of operation is now limited to the TETRA modulation format.

Vector

In the vector mode of operation the instrument provides IQ modulation of the carrier from an external source by using the I IN/OUT and Q IN/OUT connectors on the front panel.

Analog modulation modes

Two independent inputs on the front panel — EXT MOD 1 INPUT, EXT MOD 2 INPUT — allow external modulation signals to be summed with signals from the internal oscillator and a second optional internal oscillator (if fitted). Thus up to four analog modulations may be available at one time. These can be combined to give single, dual, composite and dual composite modes of operation.

Single

In the single mode, only one modulation can be active at any one time. Selecting another modulation mode cancels the first.

Dual

In the dual mode, a common carrier wave is modulated by two different types of modulation, e.g. one AM and one FM. Each type of modulation can carry separate information.

Composite

This mode consists of two modulating channels of the same type of modulation (e.g. FM1 + FM2) with the effective modulation being the sum of the two waveforms.

Dual composite

This mode is similar to the composite mode of operation but with the two modulating channels being the sum of two sources, e.g. FM1 + FM2 and AM1 + AM2.

Modulation mode selection

In order to select a different modulation mode:

(1) Press [UTIL]. *Utilities Selection Menu 1* will appear on the display.

(2) Press the *[Mod'n Mode]* key. This calls up the *Modulation Mode Selection Menu* shown in Fig. 3-6. The six possible modulation modes are shown. Press the required soft key.

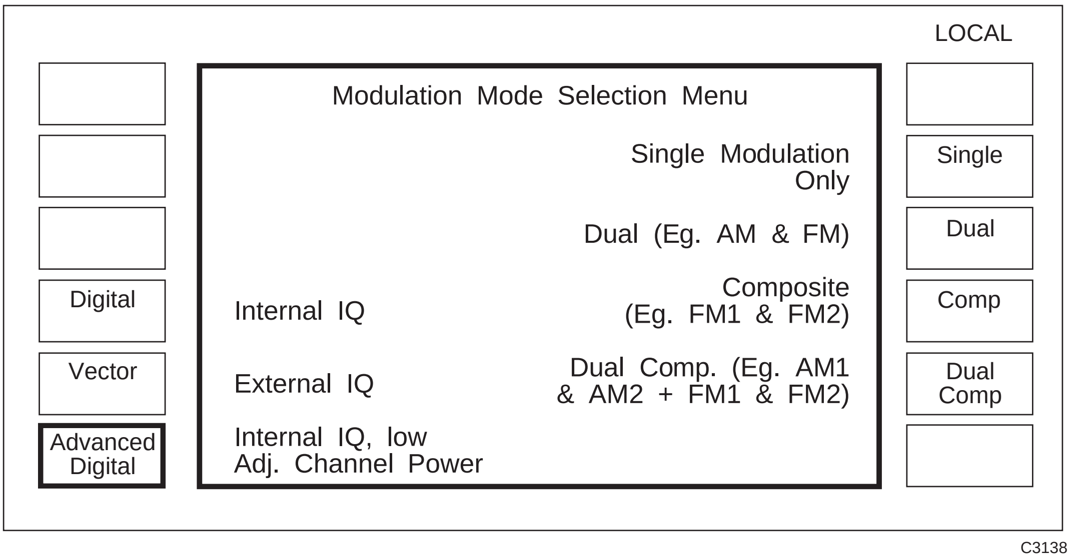


Fig. 3-6 Modulation mode selection menu

Note

If the Avionics option (Option 006) is fitted an additional soft key *[Avionics Modes]* will be displayed. See Annex A for avionics modes selection.

(3) Press [SIG GEN] to return to the *Sig Gen* menu where the modulation mode and individual source parameters (where applicable) will be shown. For composite mode selection a menu similar to Fig. 3-7 will be displayed.

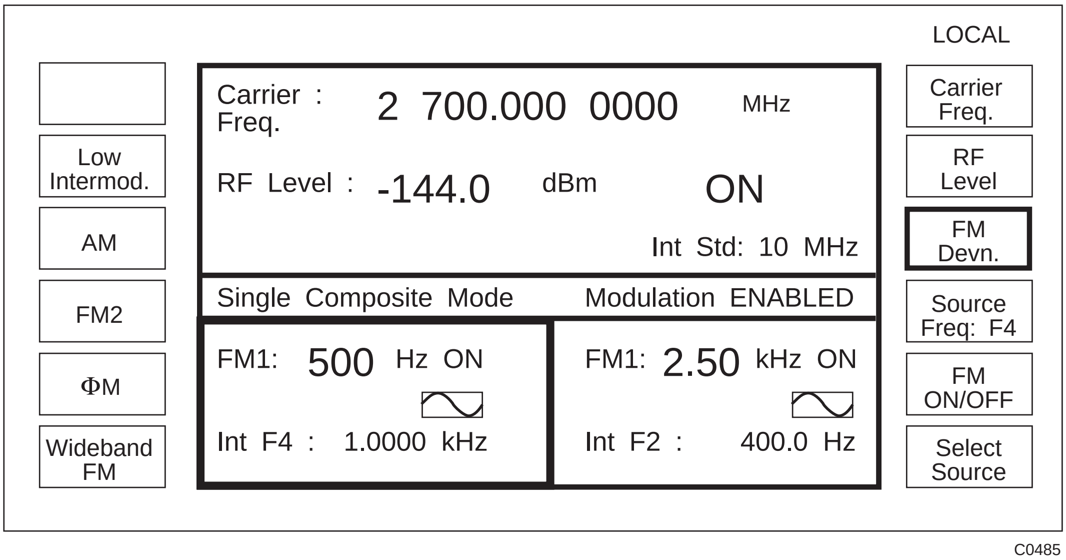


Fig. 3-7 Sig Gen menu with two modulation channels (composite mode)

Note

Full information on the range of utilities can be found under 'UTILITIES'.

Digital modulation mode

Digital modulation

In the digital mode of operation the instrument can generate user-defined modulation formats from either an internal or external data source. Modulation can be applied in FSK, GMSK, PSK and QAM formats with specified channel filter characteristics. When defined these parameters may be stored and subsequently recalled. The RF level can be varied by applying an envelope control voltage. Modulation errors and fading effects can be simulated. Provision is also made for using an external mixer to generate a modulated carrier at a higher frequency than can be provided internally by the instrument.

To select the Digital control function press the *[Digital]* key on the *Modulation Mode Selection Menu* (see Fig. 3-6), followed by [SIG GEN]. This causes the *Sig Gen* menu shown in Fig. 3-8 to be displayed.

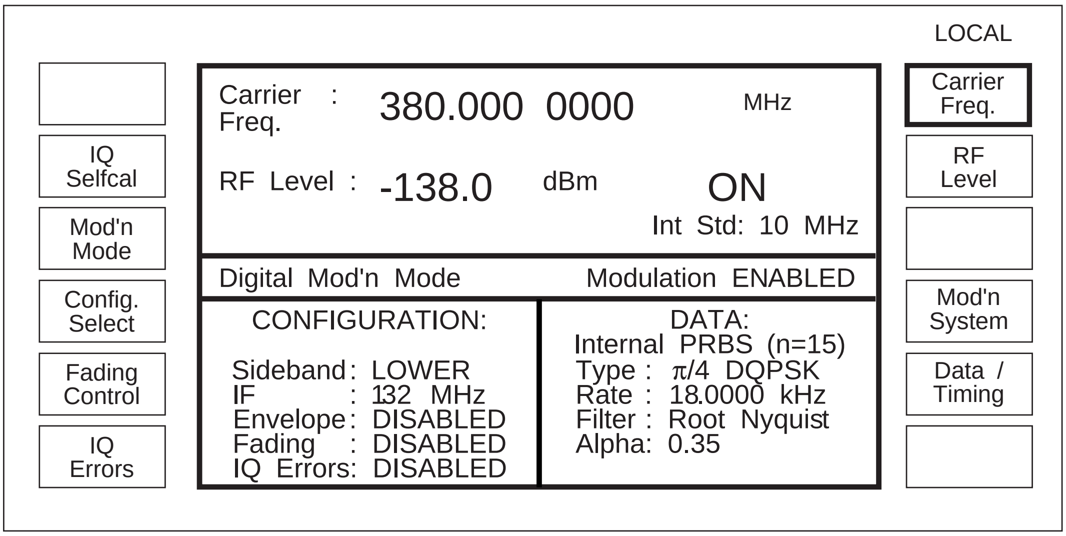


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Fig. 3-8 Sig Gen menu in digital modulation mode

Setting the output carrier

In digital modulation mode the carrier output frequency and level are set by pressing the *[Carrier Freq.]* and *[RF Level]* keys respectively and entering the values in the normal way.

Self-calibration

To achieve the high precision of the complex modulation the 2050T series Signal Generators have an IQ self-calibration feature which automatically adjusts the modulator for optimum performance minimising vector errors. The instrument generates a warning message at the top of the screen when an IQ self-calibration is advisable. This will occur 30 minutes after power-on and thereafter at 3 hour intervals.

To perform a self-calibration press *[IQ Selfcal]*. The calibration process is entirely automatic and during operation the message *IQ MODULATOR CALIBRATION IN PROGRESS PLEASE WAIT ...* appears. Calibration takes approximately 45 seconds and normally remains valid for 3 hours.

Setting the digital modulation system

The *[Mod'n System]* key on the *Sig Gen* menu (Fig. 3-44) is used to select the modulation system or type, set the channel filter characteristics and set the symbol data rate. User defined systems can be created and stored for subsequent recall. Providing Test Tones has not been selected, pressing the *[Mod'n System]* key causes the *Digital Modulation System Menu* shown in Fig. 3-9 to be displayed. If Test Tones has been selected, the *Digital Modulation System Menu* shown in Fig. 3-27 is displayed instead.

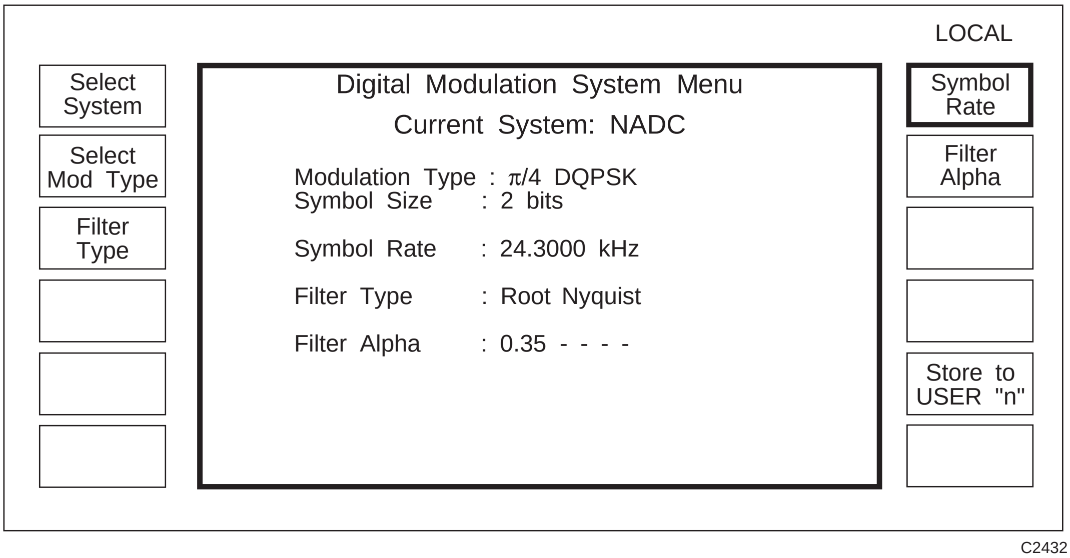

Fig. 3-9 Digital modulation: Modulation system menu with NADC (D-AMPS) selected

Modulation type and system selection

The type of modulation to be generated can be set either by selecting a preset system (either user-defined or predefined) using the *[Select System]* key or by defining the type of modulation (FSK, GMSK, PSK, QAM,) using the *[Select Mod Type]* key. Symbol rate, filter type and filter bandwidth may also be specified. System selection is summarized in Fig. 3-10.

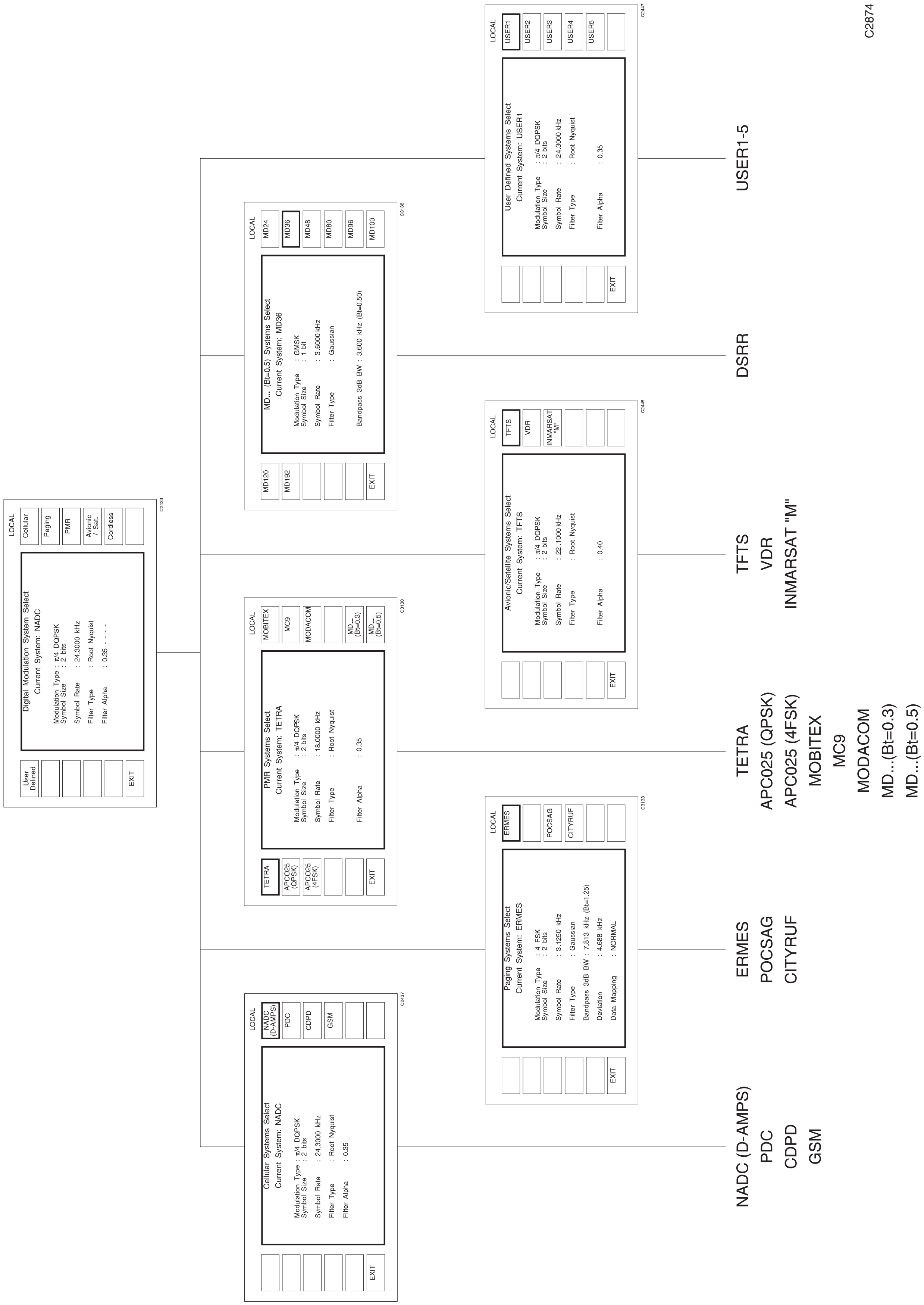

Fig. 3-10 Summary of digital modulation system selection

Storing a user-defined system

When a modulation system has been defined the setting can be stored in one of five non-volatile stores. To do this, press the *[Store to User "n"]* key which causes the additional message *Store to User:-* to be displayed. Enter a user number in the range 1 to 5 and follow by [enter]. Entering a number outside this range causes the message *Error 50: Out of Range* to be displayed and the user number must be re-entered. A stored system can be recalled from the *System Select* menu shown in Fig. 3-11.

To select a preset modulation system, press *[Select System]* which displays a further menu (see Fig. 3-11 below).

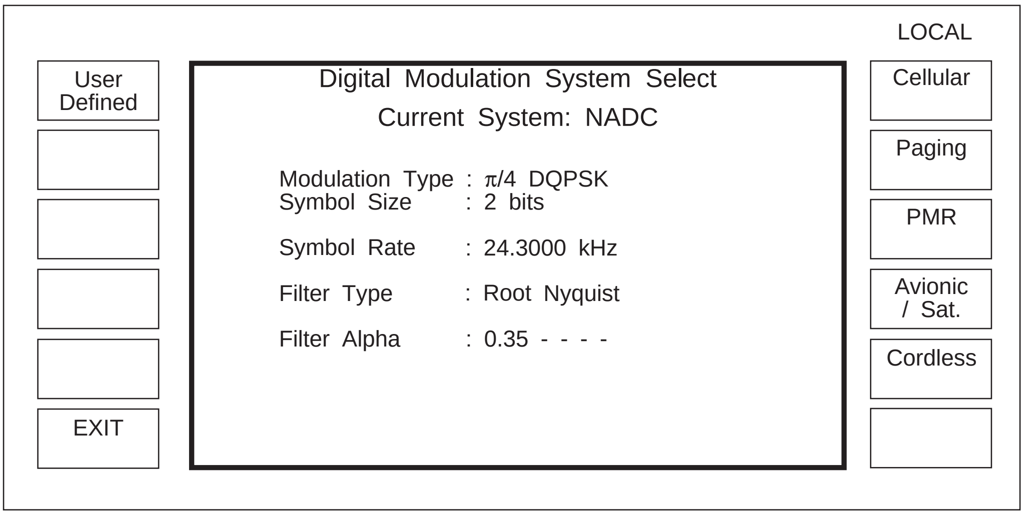

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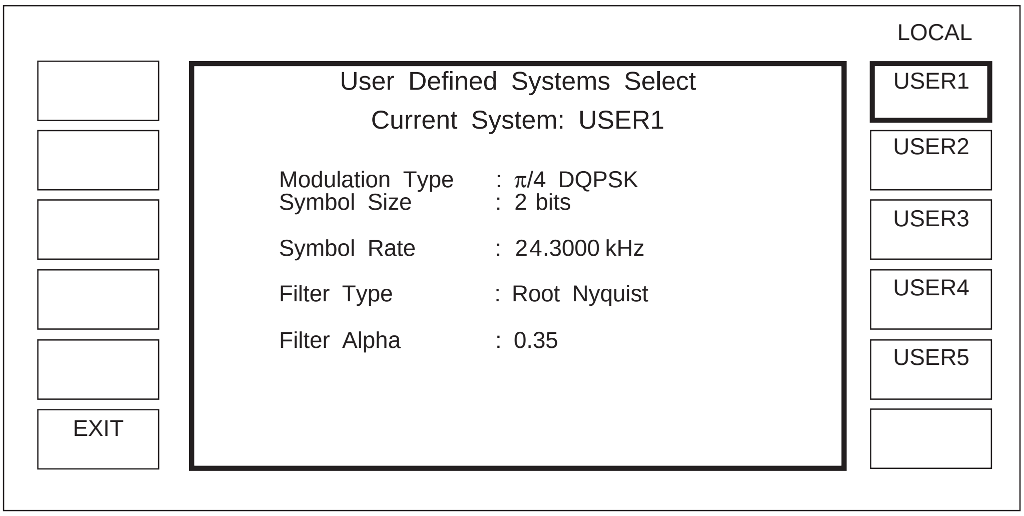
Fig. 3-11 Digital modulation: Modulation system select menu with NADC (D-AMPS) selected

Selecting *[Cellular]*, *[Paging]*, *[PMR]*, *[Avionic/Sat.]* or *[Cordless]* displays a further menu which allows predefined modulation systems to be selected (e.g. NADC, PDC, ERMES, POCSAG). These menus are described below.

Selecting *[User Defined]* displays a further menu (see Fig. 3-12 below) which allows a modulation system previously stored as a user defined system to be recalled by a single key press of the *[USER1]* to *[USER5]* keys. Pressing *[EXIT]* returns to the *Digital Modulation System Select* menu (Fig. 3-11).



C2447

Fig. 3-12 Digital modulation: User defined systems select menu with USER1 selected

Cellular systems selection

Pressing the *[Cellular]* key displays the *Cellular Systems Select* menu shown in Fig. 3-13.

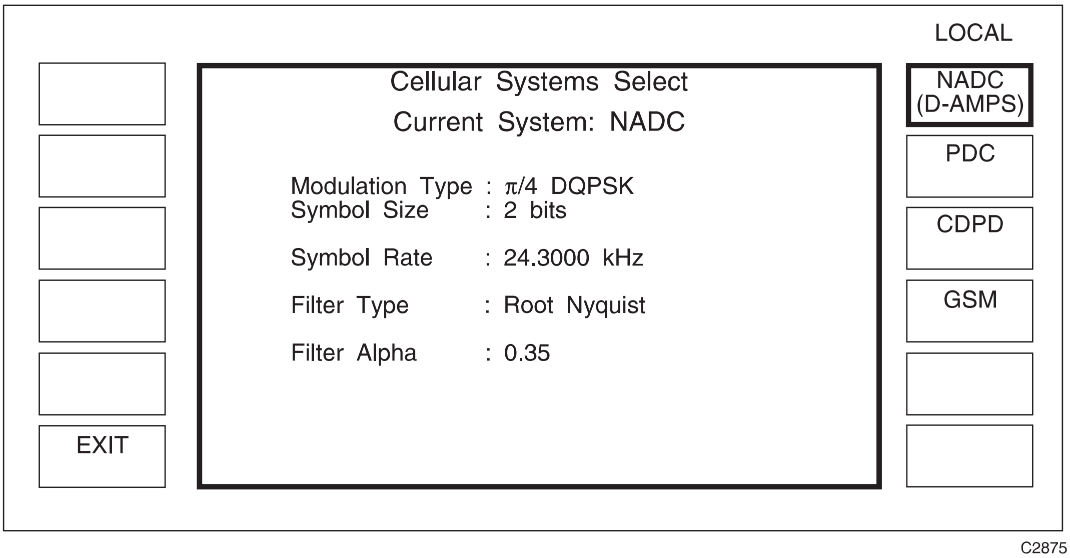


Fig. 3-13 Digital modulation: Cellular systems select menu with NADC (D-AMPS) selected

Pressing *[NADC]*, *[PDC]*, *[CDPD]* or *[GSM]* respectively selects NADC (D-AMPS), PDC, CPDP or GSM as the current modulation system.

Menu exit

Pressing *[EXIT]* returns to the *Digital Modulation System Select* menu (Fig. 3-11).

Paging systems selection

Pressing the *[Paging]* key displays the *Paging Systems Select* menu shown in Fig. 3-14.

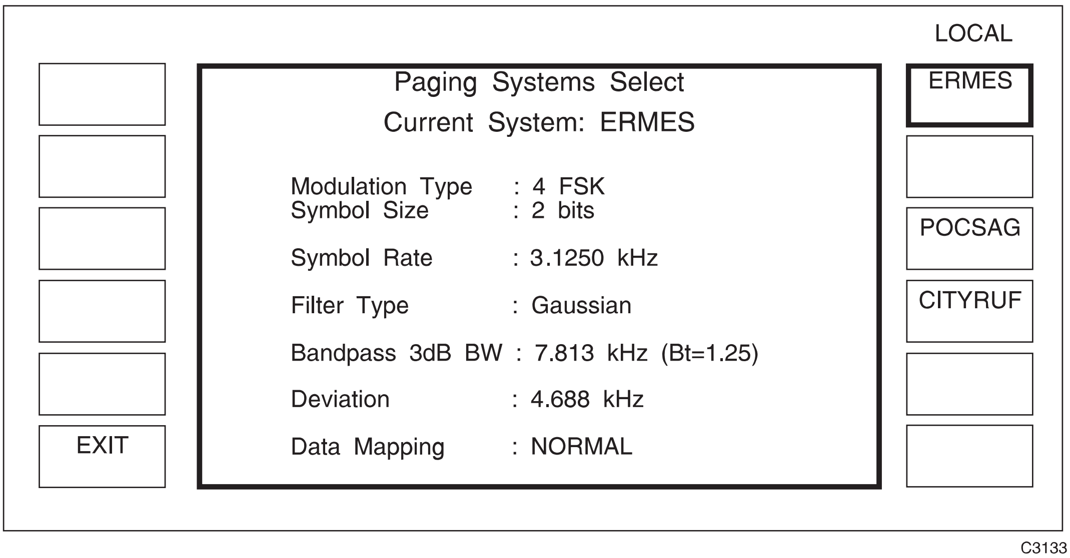


Fig. 3-14 Digital modulation: Paging systems select menu with ERMES selected

Pressing *[ERMES]* selects ERMES as the current modulation system.

Selecting *[POCSAG]* or *[CITYRUF]* displays a further menu (see Fig. 3-15 or Fig. 3-16 respectively below) which allows POCSAG or CITYRUF systems with a specific bit rate to be selected.

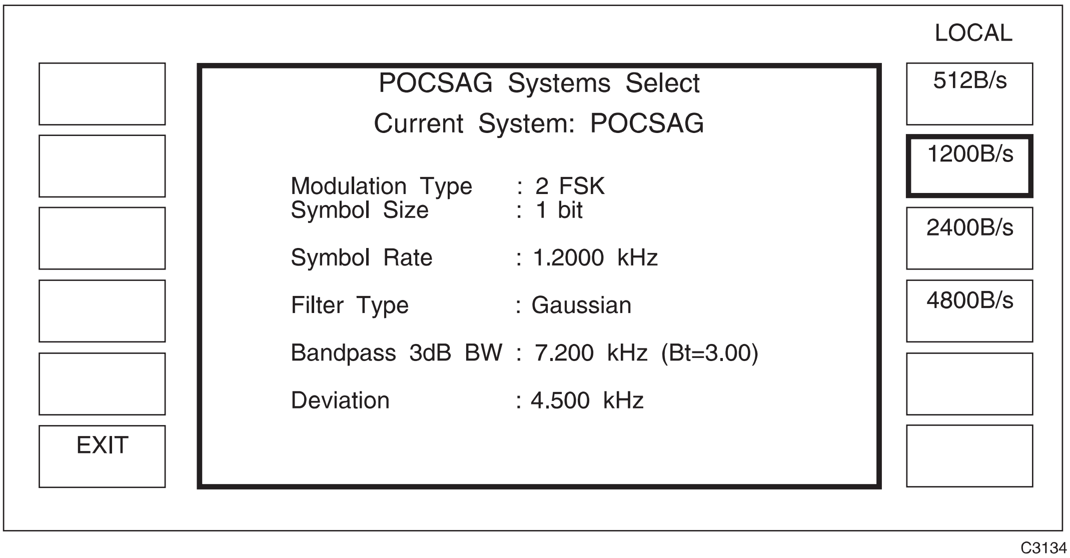


Fig. 3-15 Digital modulation: POCSAG systems select menu with POCSAG selected

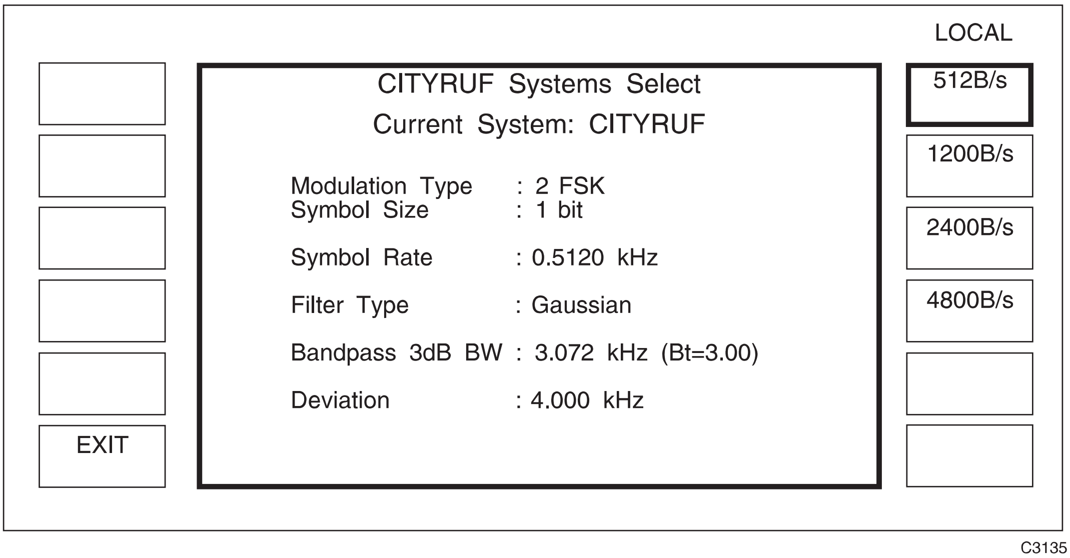


Fig. 3-16 Digital modulation: CITYRUF systems select menu with CITYRUF selected

Menu exit

Pressing *[EXIT]* returns to the *Digital Modulation System Select* menu (Fig. 3-11).

PMR systems selection

Pressing the *[PMR]* key displays the *PMR Systems Select* menu shown in Fig. 3-17.

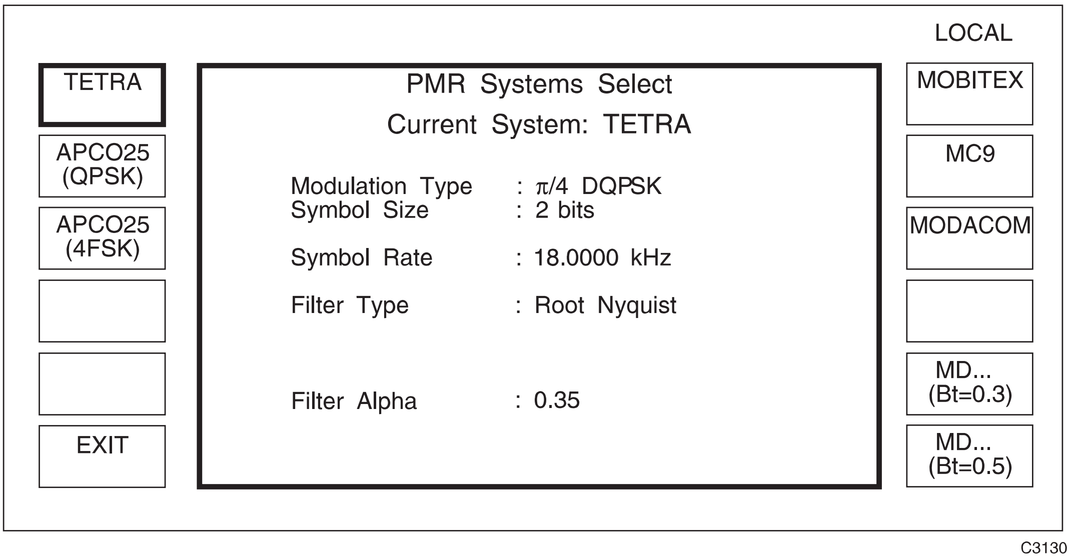


Fig. 3-17 Digital modulation: PMR systems select menu with TETRA selected

Pressing *[TETRA]*, *[APCO25 (QPSK)]*, *[APCO25 (4FSK)]*, *[MOBITEX]*, *[MC9]* or *[MODACOM]* respectively selects TETRA, APCO 25 (QPSK) APCO25 (4FSK), Mobitex, MC9 or Modacom as the current modulation.

Selecting *[MD... (Bt=0.3)]* or *[MD... (Bt=0.5)]* displays a further menu (see Fig. 3-18 and Fig. 3-19 respectively below) which allows MD systems with a specific bit rate and Bt product to be selected.

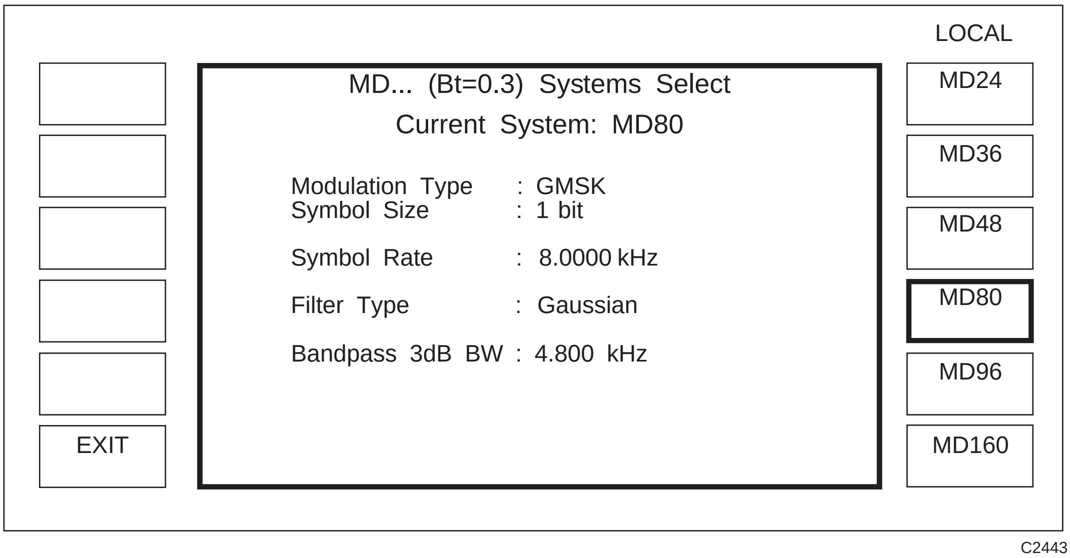


Fig. 3-18 Digital modulation: MD... (Bt=0.3) systems select menu with MD80 selected

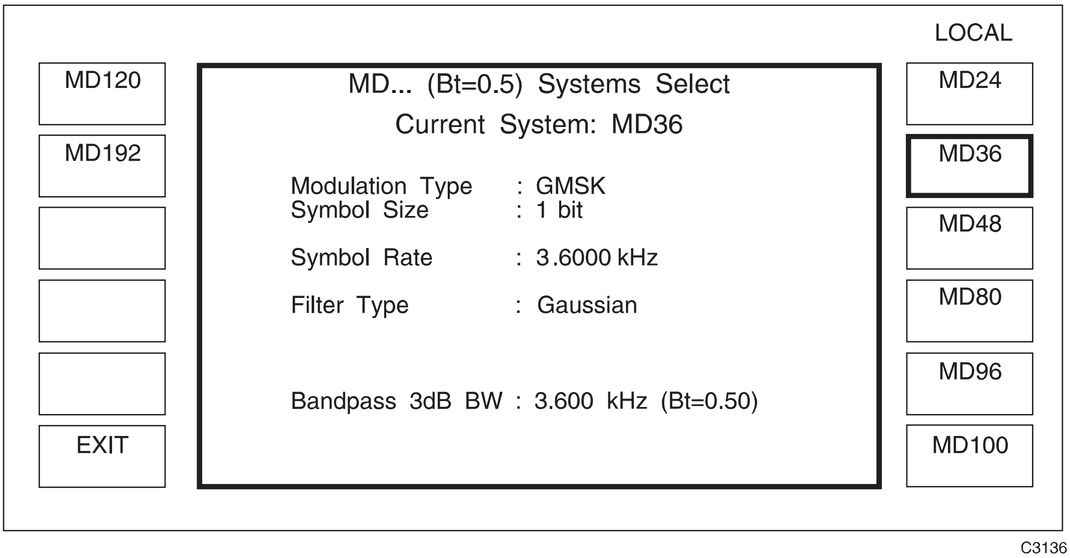


Fig. 3-19 Digital modulation: MD... (Bt=0.5) systems select menu with MD36 selected

Menu exit

Pressing *[EXIT]* returns to the *Digital Modulation System Select* menu (Fig. 3-11).

Avionic/Satellite systems selection

Pressing the *[Avionic/ Sat.]* key displays the *Avionic/Satellite Systems Select* menu shown in Fig. 3-20.

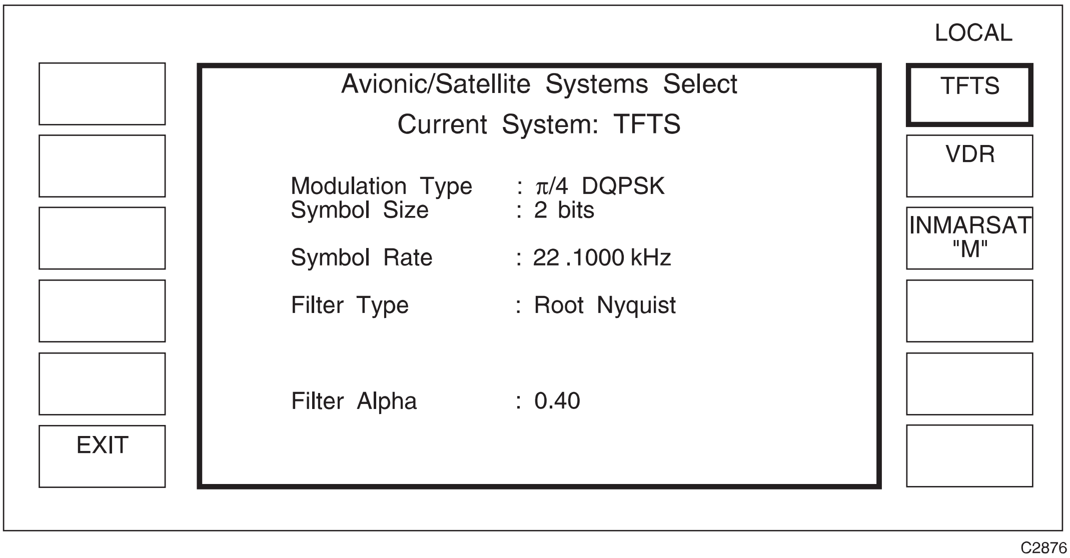


Fig. 3-20 Digital modulation: Avionic/Satellite systems select menu with TFTS selected

Pressing *[TFTS]*, *[VDR] or [INMARSAT“M”]* selects TFTS, VDR or INMARSAT“M” as the current modulation system.

Menu exit

Pressing *[EXIT]* returns to the *Digital Modulation System Select* menu (Fig. 3-11).

Cordless systems selection

Pressing the *[Cordless]* key displays the *Cordless Systems Select* menu shown in Fig. 3-21.

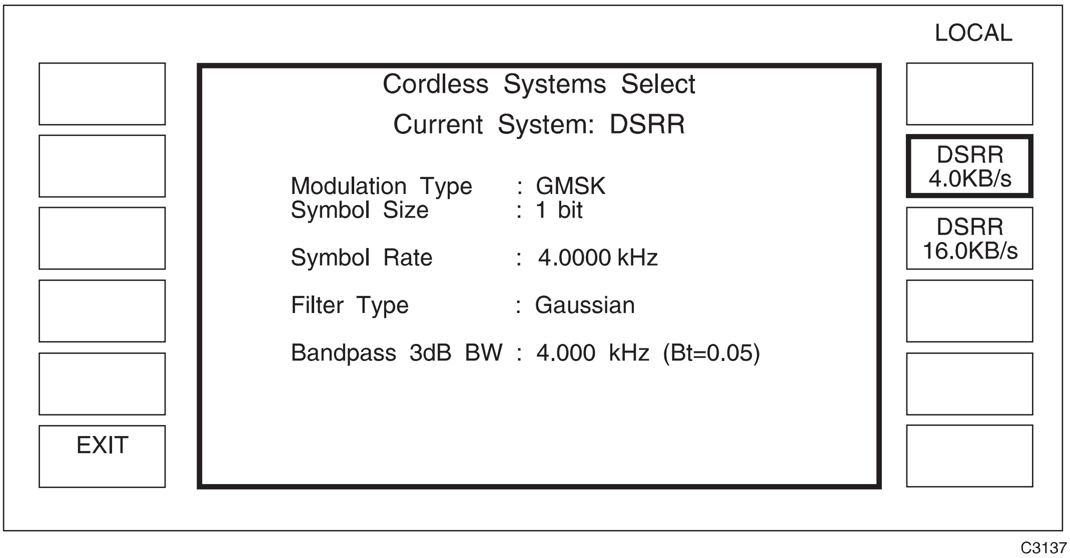


Fig. 3-21 Digital modulation: Cordless systems select menu with DSRR 4.0KB/s selected

Pressing *[DSRR 4.0KB/s]* or *[DSRR 16.0KB/s]* selects Digital Short Range Radio as the current modulation system with the appropriate bit rate.

Menu exit

Pressing *[EXIT]* returns to the *Digital Modulation System Select menu* (Fig. 3-11).

Pressing *[EXIT]* again returns to the *Digital Modulation System Menu* (Fig. 3-9).

Creating a modulation system

To define a modulation system not included in the *Modulation System Menu* the modulation type, symbol rate, filter type and filter bandwidth must be specified.

Selecting the modulation type

Pressing the *[Select Mod Type]* key displays the *Digital Modulation Type Selection* menu shown in Fig. 3-22 which allows the modulation type to be set to QAM, PSK, FSK or GMSK.

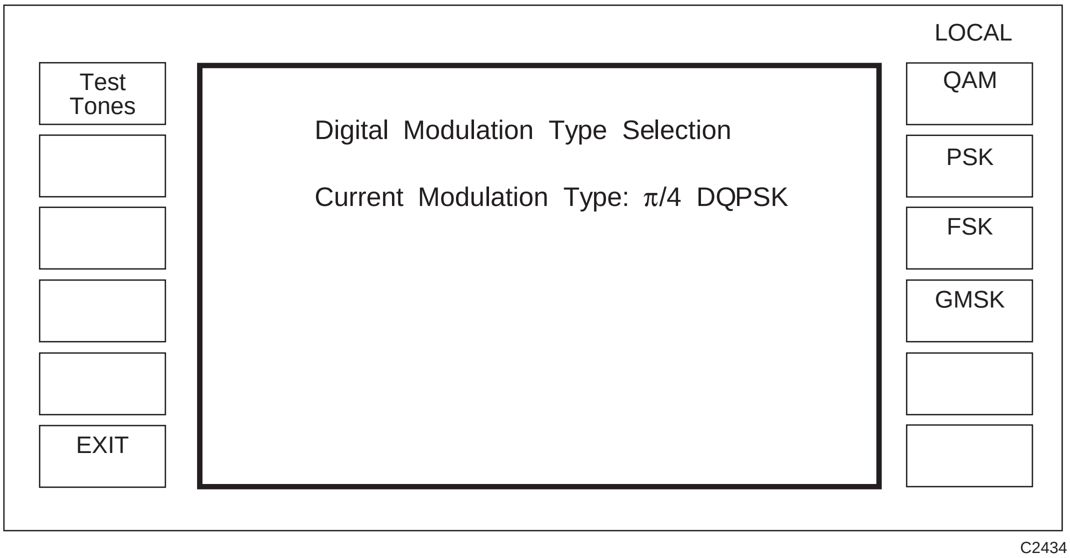


Fig. 3-22 Digital modulation: Modulation type selection menu with π/4 DQPSK selected

Selecting *[QAM]*, *[PSK]* or *[FSK]* displays a further menu (see Fig. 3-23, 3-24 or 3-25 respectively below).

Pressing *[GMSK]* selects GMSK as the current modulation type.

Pressing *[Test Tones]* enters the Test Tones utility which is mainly used for diagnostic purposes (see 'Test Tones utility' below).

Pressing *[EXIT]* returns to the *Digital Modulation System Menu* (Fig. 3-9).

Note

For the detail on how data is mapped on the RF carrier see 'Digital data mapping' on page 3-33 below.

QAM selection menu

For quadrature amplitude modulation pressing the *[QAM]* key displays the *QAM Selection Menu* shown in Fig. 3-23.

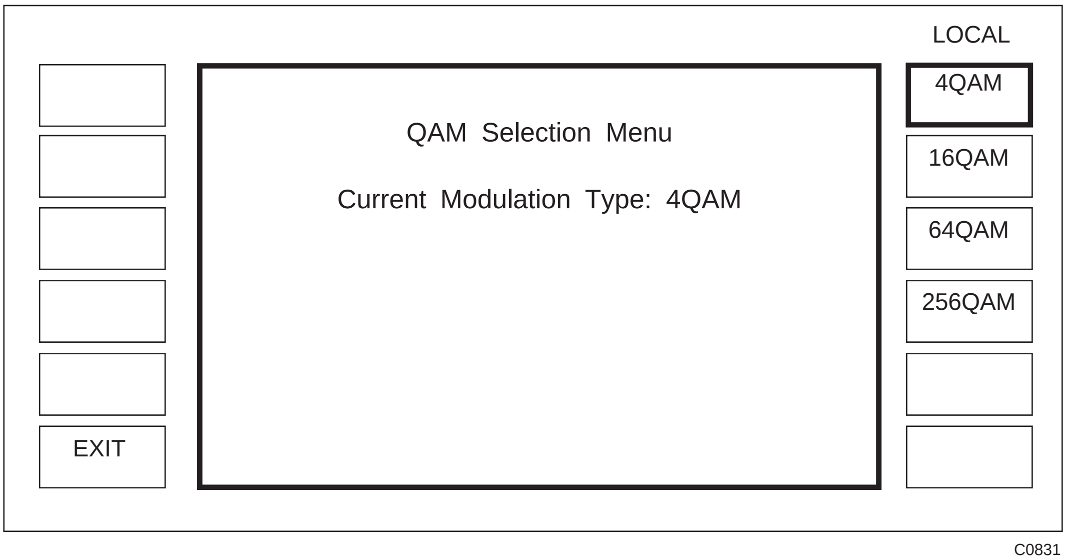


Fig. 3-23 Digital modulation: QAM selection menu with 4QAM selected

Pressing any of the keys in the menu makes *[4QAM]*, *[16QAM]*, *[64QAM]* or *[256QAM]* the current modulation type and selects a modulation system consisting of 2, 4, 6 or 8 bits per symbol organised as square constellations.

Menu exit

Pressing *[EXIT]* returns to the *Digital Modulation Type Selection* menu (Fig. 3-22).

PSK selection menu

For phase shift keying pressing *[PSK]* displays the *PSK Selection Menu* shown in Fig. 3-24.

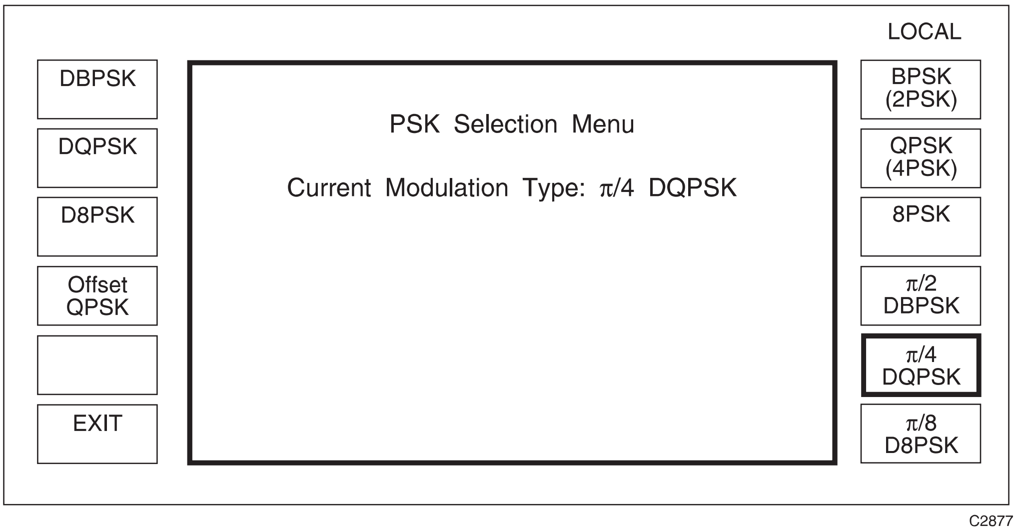


Fig. 3-24 Digital modulation: PSK selection menu with phase offset π/4 differential QPSK selected

The modulation types that can be generated are PSK, differential PSK, phase offset differential PSK and time offset QPSK. Pressing any of the keys makes this selection the current modulation type and selects a modulation system consisting of 1, 2 or 3 bits per symbol.

FSK selection menu

For frequency shift keying pressing *[FSK]* displays the *FSK Selection Menu* shown in Fig. 3-25.

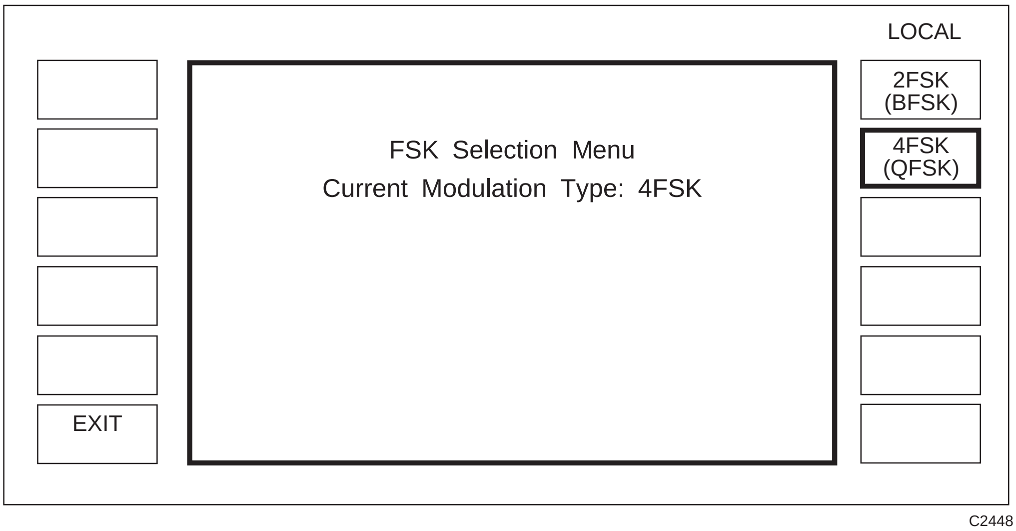


Fig. 3-25 Digital modulation: FSK selection menu with 4FSK selected

Pressing *[2FSK]* or *[4FSK]* respectively selects 2FSK or 4FSK as the current modulation type and selects a modulation system consisting of 1 or 2 bits per symbol.

Menu exit

Pressing *[EXIT]* returns to the *Digital Modulation Type Selection* menu (Fig. 3-22).

Symbol rate setting

The symbol source can either be internally generated or sourced externally from the rear panel AUXILIARY IN/OUT connector. To set the source rate, press *[Symbol Rate]*, enter a rate using the numeric key pad and terminate with the [kHz] or [Hz] key. If an out of range value is entered the appropriate upper or lower limit will be automatically selected. Note that for an external source, the symbol rate supplied must be within 2% of the entered rate to maintain modulation accuracy.

Data source, symbol clock and polarity selection are made using the *Data/Timing Control Menu* (see Fig. 3-28 below).

Filter selection

To select the channel filter type between Root Raised Cosine, Raised Cosine and Gaussian, press *[Filter Type]* which displays the *[Channel Filter Selection]* menu (see Fig. 3-26 below).

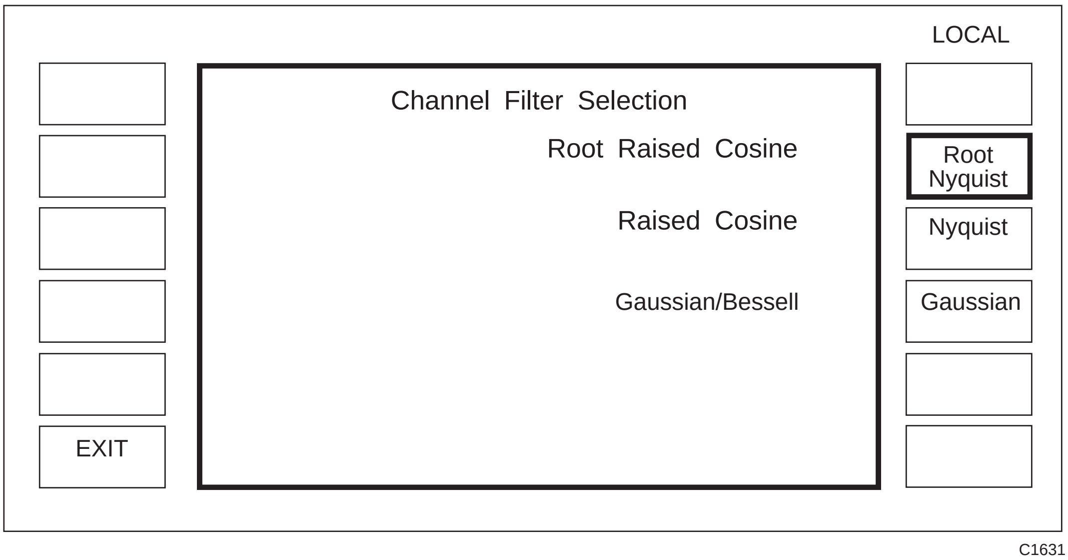


Fig. 3-26 Digital modulation: Channel filter selection menu

Pressing *[Root Nyquist]*, *[Nyquist]* or *[Gaussian]* respectively selects root raised cosine, raised cosine or gaussian/bessel as the current RF channel filter.

Menu exit

Pressing *[Exit]* returns to the *Digital Modulation System Menu* (Fig. 3-9).

Filter α setting

When a Raised Cosine or Root Raised Cosine filter has been selected from the *Channel Filter Selection* menu, the α of the filter can be set. Press the *[Filter Alpha]* key, enter the numeric value of α and terminate with the [enter] key.

Filter band-pass 3 dB bandwidth setting

When a gaussian filter has been selected from the *Channel Filter Selection* menu, the band-pass 3 dB bandwidth of the filter can be set. Press the *[Bandpass 3 dB BW]* key, enter the band-pass 3 dB bandwidth point and terminate with either the [Hz] or [kHz] key.

Frequency deviation setting

When FSK modulation has been selected from the *FSK Selection Menu*, the frequency deviation of the modulation system can be set. Press the *[Deviat'n]* key, enter the frequency deviation value and terminate with either the [Hz] or [kHz] key.

Menu exit

Press [SIG GEN] to return to the *Sig Gen* menu where further selections may be made.

Parameter constraints

The modulation type selected has an effect on the setting of the symbol rate and on the selection of the channel filter in the following manner:

Modulation type	Symbol rate range	Channel filter selection
PSK, QAM	1.9 - 34.0 kHz 1.9 - 25.0 kHz	Nyquist/Root Nyquist Gaussian
FSK	1.9 - 25.0 kHz	Nyquist/Root Nyquist
FSK, GMSK	512 Hz - 25.0 kHz	Gaussian
OQPSK	1.9 - 16.0 kHz	All filters

The band-pass 3 dB bandwidth minimum and maximum limits are determined by the symbol rate setting. The minimum value is defined as 0.4 of the symbol rate (0.2 of the symbol rate as IQ baseband filter). The maximum value will lie in the range 11 to 22.6 kHz.

Test tones utility

The test tones facility allows verification of the instrument performance by internally generating two audio sources with independent level and phase adjustment and a DC offset control. The facility can also be used for generating SSB signals.

Selecting Test Tones from the *Digital Modulation Type Selection* menu (Fig. 3-22), causes the *Digital Modulation System Menu* to be displayed as shown in Fig. 3-27.

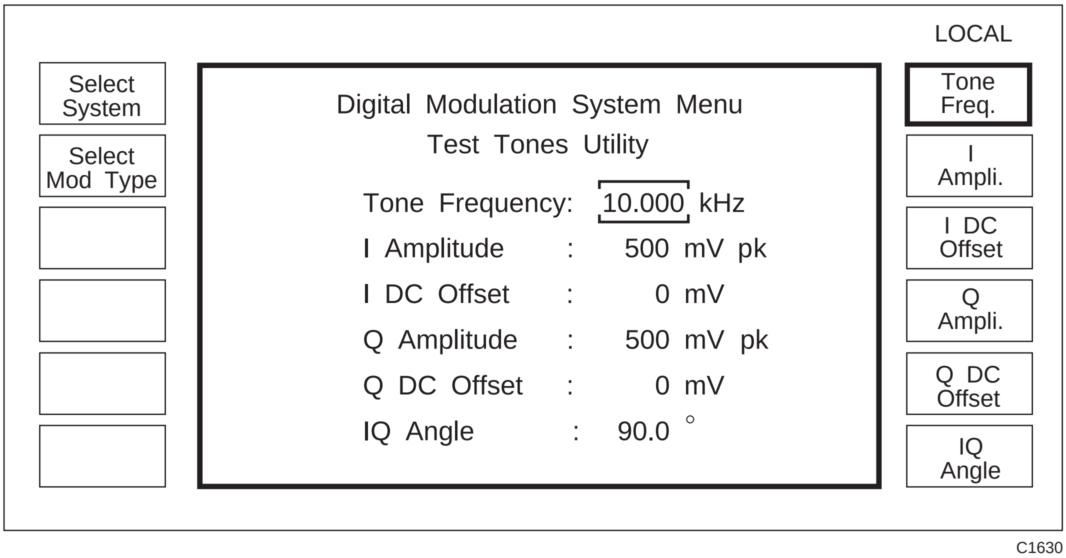


Fig. 3-27 Digital modulation: Modulation system menu with test tones selected

Test tones operation

With *[IQ O/P Enable]* selected from the *Digital Modulation Configuration* menu (see Fig. 3-40 below), the test tones generated at the I and Q IN/OUT sockets are sine waves at a selected frequency and phase angle. If the test tones are set to generate equal amplitude signals separated by 90° or 270° the RF output will be an SSB signal. Adjusting the DC offset will introduce carrier leak. The I and Q amplitudes and DC offsets can be individually set as follows:

To set the test tone frequency press *[Tone Freq.]* and enter a frequency up to 29 kHz to a resolution of 1 Hz.

To set the IQ angle, press *[IQ Angle]* and enter an angle in the range 0° to 360° to a resolution of 0.1°.

To set the I or Q amplitude, press either *[I Ampli.]* or *[Q Ampli.]* respectively and enter a voltage to a maximum of 1.6 V and a resolution of 1 mV.

To set the I or Q DC offset, press either *[I DC Offset]* or *[Q DC Offset]* respectively and enter a voltage to a maximum of 1.6 V and a resolution of 1 mV.

Menu exit

Press *[Select System]* or *[Select Mod Type]* to return to the respective menus. Press [SIG GEN] to return to the *Sig Gen* menu where further selections may be made.

Data/timing

The *[Data/Timing]* key on the *Sig Gen* menu is used to select the modulating data source and to define the bit clock and symbol clock operation. Pressing the *[Data/Timing]* key causes the *Data/Timing Control Menu* shown in Fig. 3-28 to be displayed (this key is not available in test tone mode).

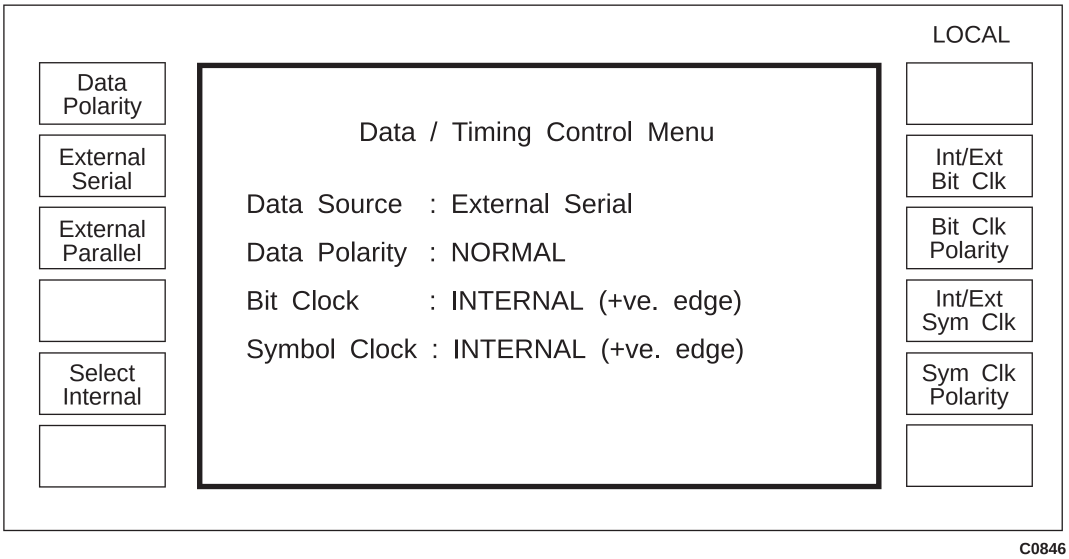


Fig. 3-28 Digital modulation: Data/Timing control menu

Data

Data input may be selected between external i.e. connected to the rear panel AUXILIARY IN/OUT connector, and internal i.e. generated by the instrument as follows:

For external data input select either serial or parallel data by pressing either the *[External Serial]* or *[External Parallel]* key. Note that the soft keys controlling the bit clock are suppressed for parallel data operation. For the modulation data contact assignments for the rear panel connector see Table 2-1.

To change the data polarity press the *[Data Polarity]* key which toggles between normal and inverse polarity.

For internal data generation press *[Select Internal]* which displays a further menu (see Fig. 3-29 below).

Note

For details on how data is mapped on the RF carrier see 'Digital data mapping' below.

Timing

The clock timing sources can be selected between externally and internally derived. The signals are applied to, or are available, on the appropriate contact of the rear panel AUXILIARY IN/OUT connector. (For pin-out see 'Auxiliary I/O connector' in Chap. 2.)

Timing selection is as follows:

To select the symbol clock source for parallel operation press the *[Int/Ext Symbol Clk]* key to toggle between an external input and an internally generated source.

To change the symbol clock polarity press *[Sym Clk Polarity]* to toggle between positive and negative edge triggering.

For serial data operation, the bit clock source may be selected by pressing the *[Int/Ext Bit Clock]* to toggle between an external clock input and one being generated internally.

To change the bit clock polarity press *[Bit Clk Polarity]* to toggle between positive and negative edge triggering.

Menu exit

Press [SIG GEN] to return to the *Sig Gen* menu where further selections may be made.

Selecting internal data

Pressing *[Select Internal]* displays the *Internal Data Selection* menu shown in Fig. 3-29.

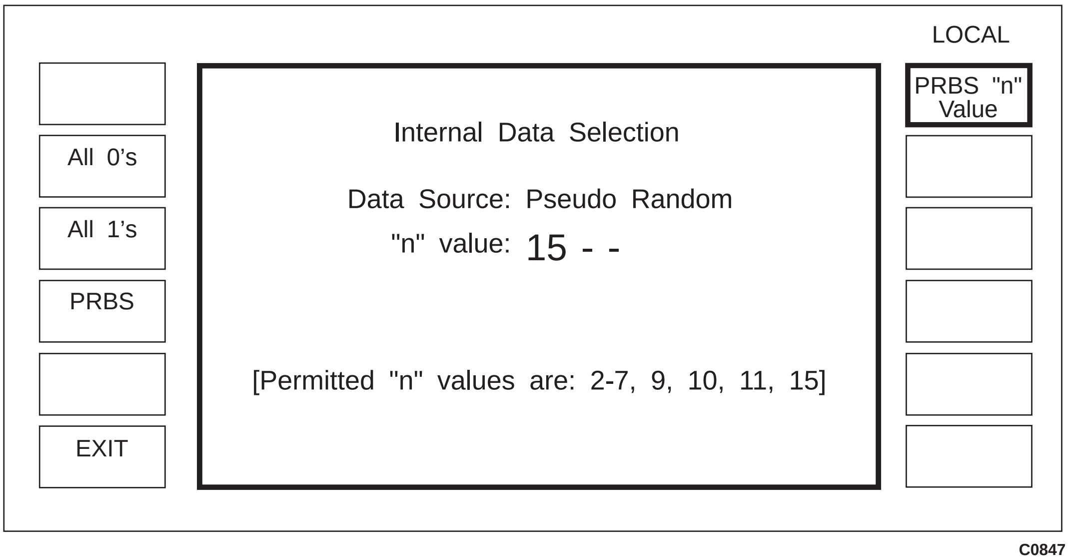


Fig. 3-29 Digital modulation: Internal data selection menu with PRBS selected

This menu enables the bit stream to be set to *[All 0's]*, *[All 1's]* or *[PRBS]*.

When pseudo random bit stream is selected, the length of the sequence can be entered. To do this, press the *[PRBS "n" Value]* key and enter an allowed value of n, then terminate by the [enter] key.

Menu exit

Pressing *[EXIT]* returns to the *Data/Timing Control Menu* (Fig. 3-28).

Digital data mapping

The signal generator converts digital signals to the required modulation format mapped onto an I,Q diagram. Digital data is mapped for the modulation types selected from the *Digital Modulation Type Selection* menu (Fig. 3-22). Data mapping is defined as follows:

1. I is in phase with the carrier whereas Q is in quadrature with the carrier.
2. The Q-channel lags the I-channel by 90°.
3. An increase in frequency results in the rotation of a vector in a counter-clockwise direction.

PSK

For PSK the codes are mapped to specific points which are independant of the previous states. For all the forms of PSK detailed below the vectors lie on a circle but the amplitude of the signal will be non-constant between sampling points.

BPSK (2PSK)

The BPSK constellation is defined below and shown in Fig. 3-30.

Data	Vector point
0	P0
1	P1

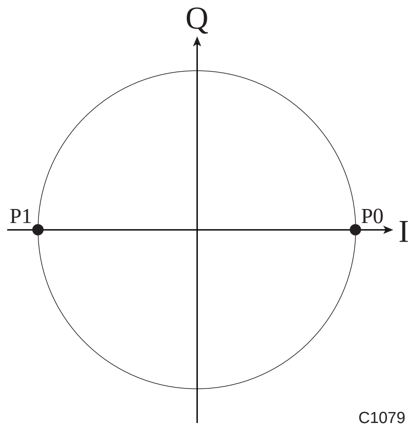


Fig. 3-30 BPSK constellation

QPSK (4PSK)

The QPSK constellation is defined below and shown in Fig. 3-31.

Data	Vector point
00	P0
01	P1
10	P2
11	P3

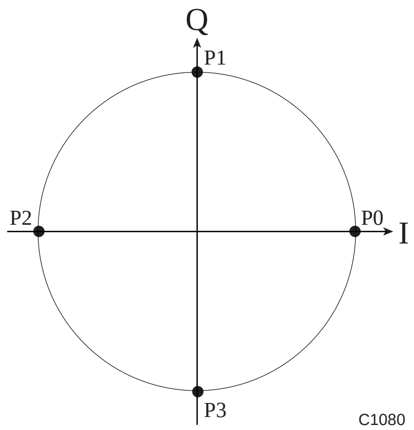


Fig. 3-31 QPSK constellation

8PSK

The 8PSK constellation is defined below and shown in Fig. 3-32.

Data	Vector point	Phase
000	P0	0°
001	P1	+45°
010	P2	+90°
011	P3	+135°
100	P4	180°
101	P5	-135°
110	P6	-90°
111	P7	-45°

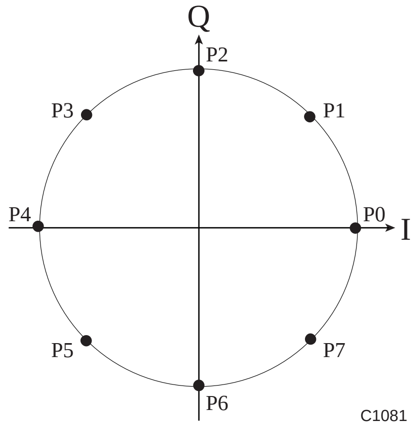


Fig. 3-32 8PSK constellation

Time offset QPSK

For time offset QPSK each data state is mapped to a specific point on the I,Q diagram. The time offset QPSK constellation is defined below and shown in figure 3-33.

Data	Vector point
00	P0
01	P1
10	P2
11	P3

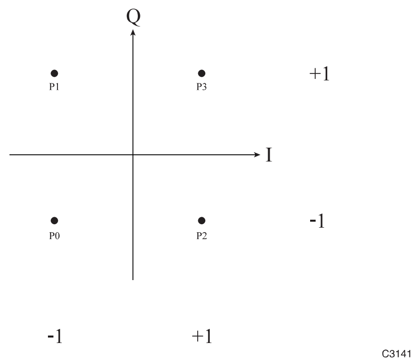


Fig. 3-33 Time offset QPSK constellation

Differential PSK

For differential PSK the I,Q diagram uses the previous bit as a reference phase (ie as the I axis) when deciding the next mapping point. In the case of differential BPSK a logical '0' results in a static phase while a logical '1' results in a continuous string of 180° phase changes.

Differential BPSK

Data	Phase change
0	0°
1	180°

The vector points are the same as for BPSK (Fig. 3-30).

Differential QPSK

Data	Phase change
00	0°
01	+90°
10	-90°
11	180°

The vector points are the same as for QPSK (Fig. 3-31).

Differential 8PSK

Data	Phase change
000	0°
001	+45°
010	+135°
011	+90°
100	-45°
101	-90°
110	180°
111	-135°

The vector points are the same as for 8PSK (Fig. 3-32).

Phase offset differential PSK

Phase offset differential PSK uses a $\pi/2^n$ phase shift between constellation points on the I,Q diagram where n is the number of bits per symbol. The phase of the previous state is used as the reference phase for the next state.

Phase offset π/2 differential BPSK

The phase offset $\pi/2$ differential BPSK constellation is defined below and shown in Fig. 3-34.

Data	Phase change	Example state changes
0	+90°	P0 $\rightarrow$ P1
1	-90°	P0 $\rightarrow$ P3

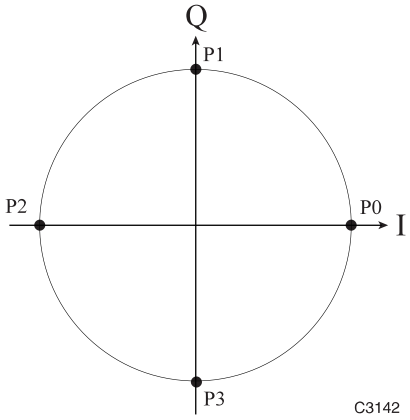


Fig. 3-34 Phase offset $\pi/2$ differential BPSK constellation

Phase offset π/4 differential QPSK

The phase offset π/4 differential QPSK constellation is defined below and shown in Fig. 3-35.

Data	Phase change	Example state changes
00	+45°	P0 → P1
01	+135°	P0 → P3
10	-45°	P0 → P7
11	-135°	P0 → P5

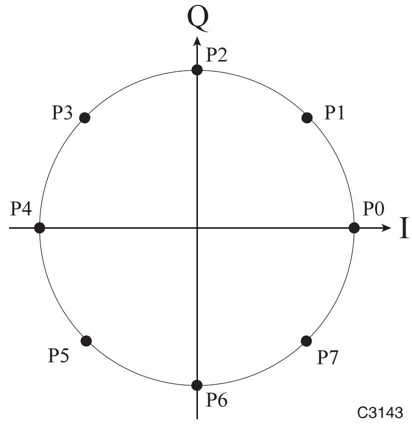


Fig. 3-35 Phase offset π/4 differential QPSK constellation

Phase offset π/8 differential 8PSK

The offset π/8 differential 8PSK constellation is defined below and shown in Fig. 3-36.

Data	Phase change	Example state changes
000	+22.5°	P0 → P1
001	+67.5°	P0 → P3
100	-22.5°	P0 → P15
011	+112.5°	P0 → P5
100	-67.5	P0 → P13
101	+157.5°	P0 → P7
110	-112.5°	P0 → P11
111	-157.5°	P0 → P9

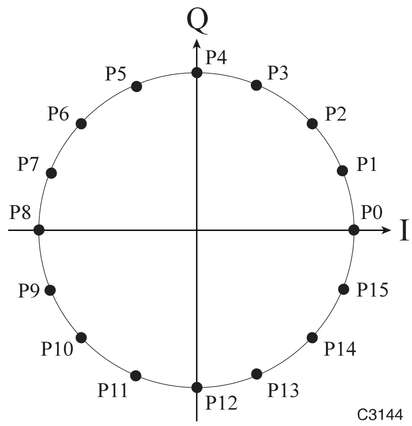


Fig. 3-36 π/8 differential 8PSK constellation

QAM

For QAM each data state is mapped to a specific point on the I,Q diagram. There are 4 levels of QAM allowed: 4QAM, 16QAM, 64QAM and 256QAM.

For each of the following state diagrams each state is labelled with a decimal number. The decimal number is the condition of the data applied to the AUXILIARY I/O connector e.g. for 16QAM state 14 is obtained with D3 to D0 set to 1110 respectively.

4QAM

The 4QAM constellation is shown in Fig. 3-37.

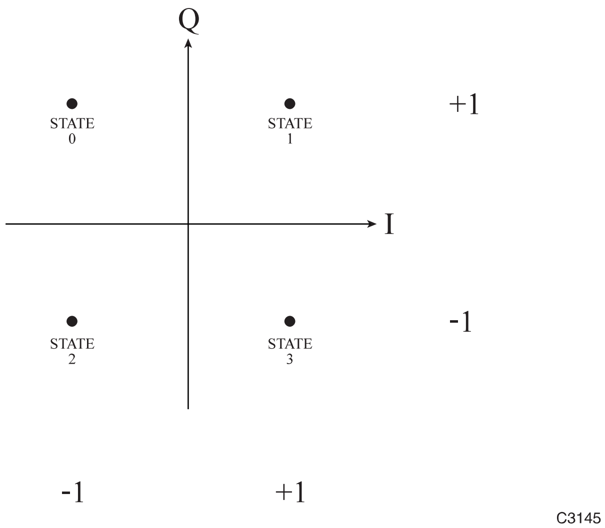


Fig. 3-37 4QAM constellation

16QAM

The 16QAM constellation is shown in Fig. 3-38.

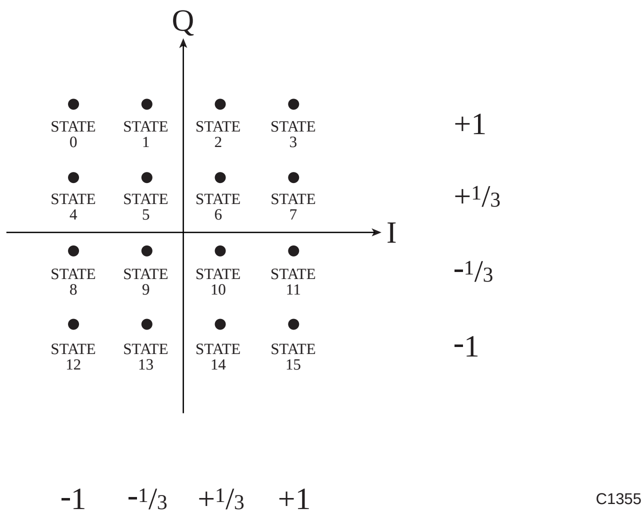


Fig. 3-38 16QAM constellation

64QAM and 256QAM

For these forms of QAM the vector diagram states are similar to 4QAM and 16QAM insofar as state 0 is always at the top left-hand corner of the diagram, and the intermediate vector values between 0 and +1 are derived as follows:

$$\text{1st value above 0} = \frac{1}{(\sqrt{n}-1)}$$

where n = the total number of states for the QAM constellation pattern.

$$\text{subsequent values} = 2 \times \frac{1}{(\sqrt{n}-1)} + \text{last value}$$

Negative values of I and Q are the same except for the sign.

FSK

The symbol mapping of the signal is as follows:

2FSK

Data	**Nominal frequency**
1	carrier + frequency deviation
0	carrier – frequency deviation

4FSK (Grey coded, normal mapping)

Data	**Nominal frequency**
10	carrier + frequency deviation
11	carrier + (frequency deviation/3)
01	carrier – (frequency deviation/3)
00	carrier – frequency deviation

4FSK (Grey coded, inverse mapping)

Data	**Nominal frequency**
01	carrier + frequency deviation
00	carrier + (frequency deviation/3)
10	carrier – (frequency deviation/3)
11	carrier – frequency deviation

Modulation configuration

The *Digital Modulation Configuration* menu is used for controlling the conversion of an IQ modulated IF to the required carrier frequency and for enabling the required inputs and outputs. A simplified block diagram of the system is shown in Fig. 3-39. To control these functions press the *[ConFig. Select]* key on the *Sig Gen* menu which causes the *Digital Modulation Configuration* menu shown in Fig. 3-40 to be displayed.

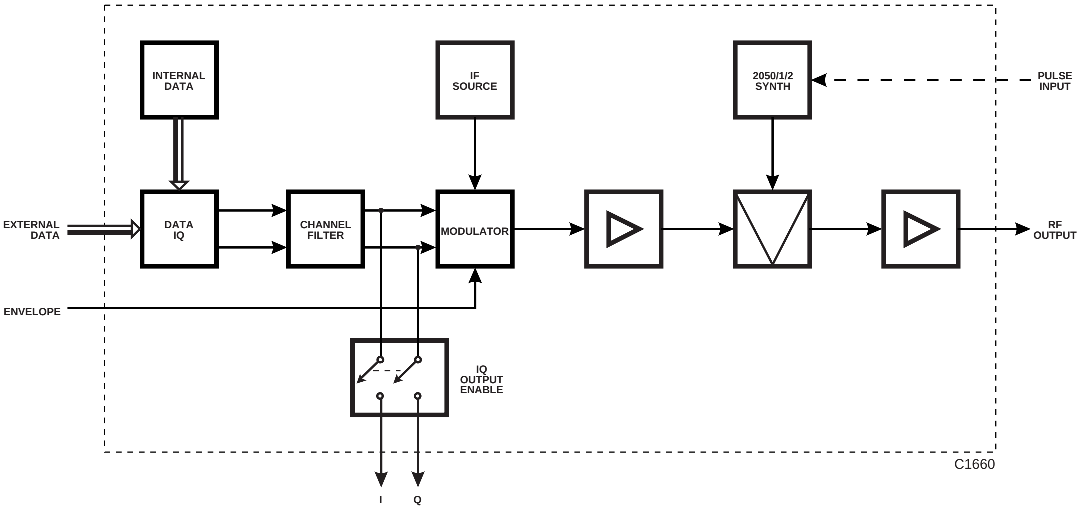


Fig. 3-39 Simplified block diagram: Digital mode with internal mixing

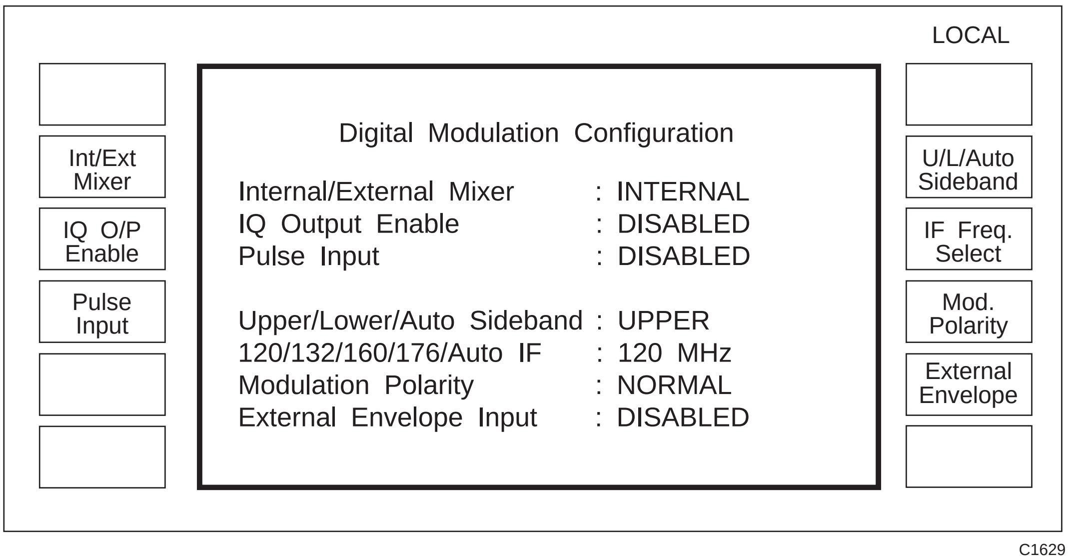


Fig. 3-40 Digital modulation: Modulation configuration menu

IQ output enable

The *[IQ O/P Enable]* key enables the I and Q outputs to be selected as on or off.

Mixer selection

Pressing the *[Int/Ext Mixer]* key toggles between internal and external mixer selection. When set to internal mixer the configuration is as shown in Fig. 3-39 where an internal mixer is used to convert the IQ modulated IF to the required carrier frequency. When external mixer is selected the normal signal generator output is made available on the RF OUTPUT connector and the configuration is as shown in Fig. 3-41. The output can then be used as a local oscillator for external frequency multiplication and mixing with the IF to produce higher frequencies than those available internally.

Note

When set to internal mixer the IF output is disabled. When set to external mixer the IF output is enabled and appears at the rear panel IF OUTPUT connector.

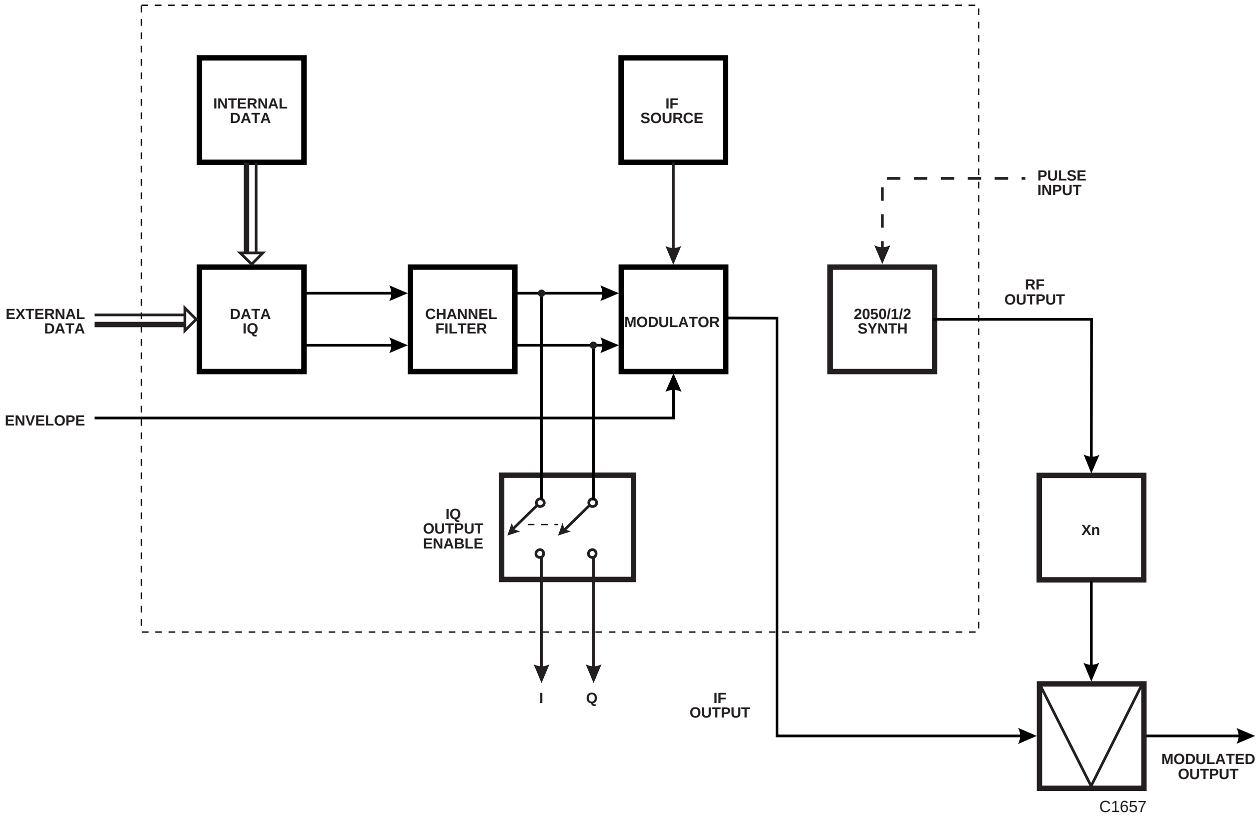


Fig. 3-41 Simplified block diagram: Digital mode with external mixing

Pulse input selection (applies if Option 002 fitted)

Pressing the *[Pulse Input]* key enables and disables the pulse input. With pulse input enabled, applying 5 V to the PULSE INPUT connector turns the RF carrier on and 0 V turns the carrier off. This facility enables the RF output to be rapidly turned on or off.

Sideband and IF selection

The *Digital Modulation Configuration* menu is used to determine which of four IFs is used and whether the selected carrier frequency corresponds to the upper or lower sideband frequency in the mixing process. Automatic selection is also available which minimises the effects of any mixing products resulting from the frequency conversion process.

To select the required sideband, repetitively press the *[U/L/Auto Sideband]* key which cycles through the selections *UPPER*, *LOWER* and *AUTO SIDEBAND* as shown by the display. When *AUTO* is selected, the selection is displayed in brackets. Manual settings which are unacceptable (depending on carrier frequency) are disallowed and an error message is displayed.

To select the required IF, repetitively press the *[IF Freq Select]* key which cycles through the selections *120 MHz, 132 MHz, 160 MHz, 176 MHz* and *AUTO* IF as shown by the display. When *AUTO* is selected, the automatically chosen optimum IF is additionally displayed in brackets.

Modulation polarity

To change the modulation polarity press the *[Mod. Polarity]* key which toggles between *NORMAL* modulation sense and *INVERSE* modulation sense. *INVERSE* can be used to simulate IF signals where the modulation sense has been reversed in frequency converting the input RF signal.

External envelope

Pressing the *[External Envelope]* key toggles between enabling and disabling an external envelope input connected to the front panel ENVELOPE IN connector. The RF level output can be linearly controlled, 0 V producing no output and +1 V producing the set RF output.

Note

When enabled, Rayleigh and Rician fading cannot be simulated.

Menu exit

Press [SIG GEN] to return to the *Sig Gen* menu where further selections may be made.

Modulation fading

The signal generator is able to simulate the effects of fading in a transmission system. Pressing the *[Fading Control]* key on the *Sig Gen* menu causes the *Digital Modulation Fading Control* menu shown in Fig. 3-42 to be displayed.

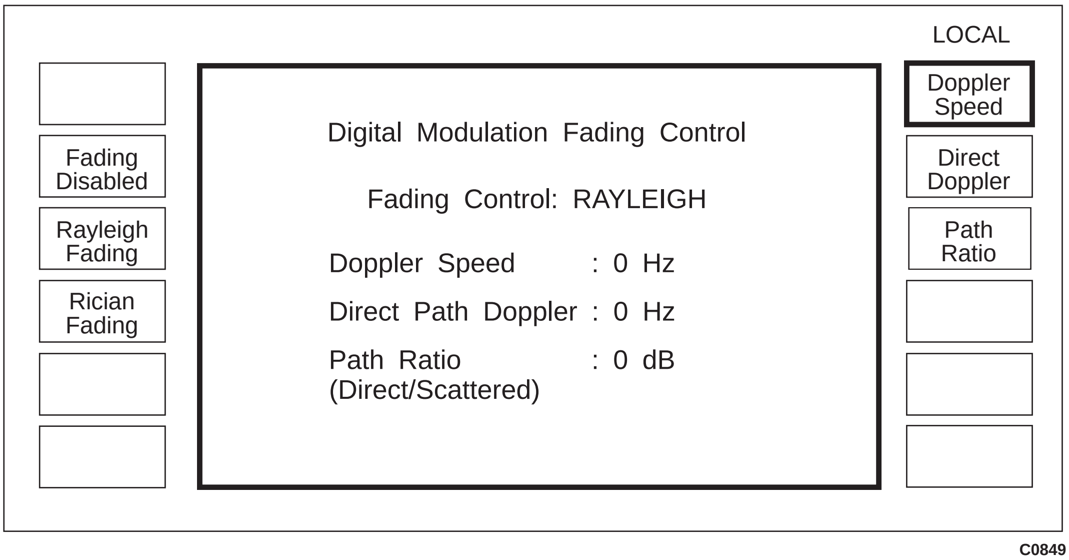


Fig. 3-42 Digital modulation: Fading control menu showing Rayleigh fading selected

Select between the two types of fading by pressing the *[Rayleigh Fading]* or *[Rician Fading]* key.

Doppler speed for Rayleigh fading and the scattered path for Rician fading can be entered using the *[Doppler Speed]* key.

To set the direct/scattered path ratio for Rician fading, press the *[Path Ratio]* key, enter the path ratio in dB (positive or negative) and terminate the entry with the [dB] key. The direct path doppler speed for Rician fading can be entered using the *[Direct Doppler]* key. The entered value must be within a factor of 2 of the scattered path doppler.

When not required fading can be disabled using the *[Fading Disabled]* key.

Note that when Rayleigh fading is enabled the direct path doppler and the path ratio settings are ignored.

Menu exit

Press [SIG GEN] to return to the *Sig Gen* menu where further selections may be made.

IQ modulator errors

The *[IQ Errors]* key on the *Sig Gen* menu can be used to introduce deliberate modulation errors. Pressing the *[IQ Errors]* key causes the *IQ Modulator Errors* menu shown in Fig. 3-43 to be displayed.

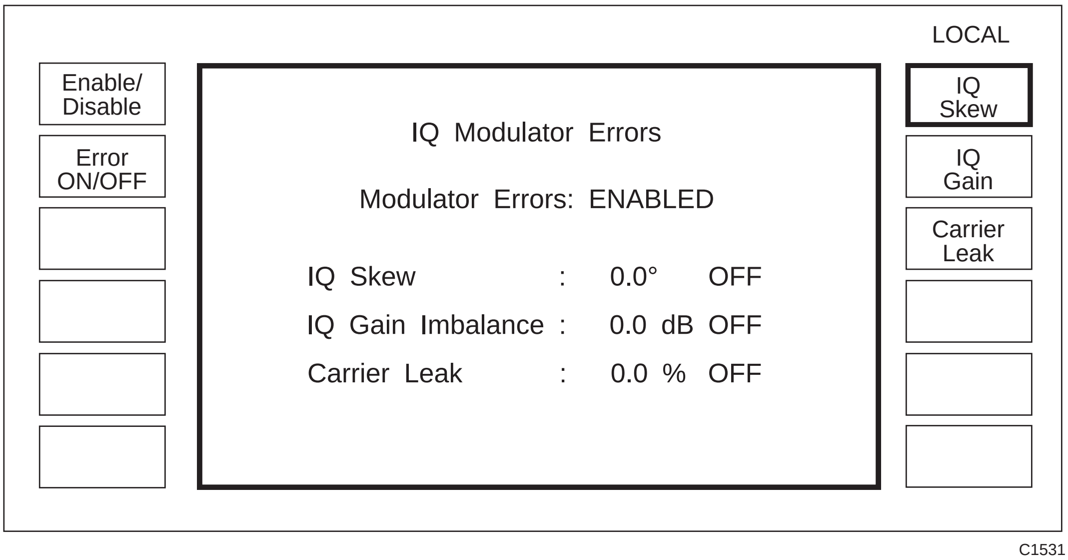


Fig. 3-43 Digital modulation: IQ modulator errors menu

Each of the three modulation errors, IQ skew error, IQ gain error and carrier leak error may be individually set as follows:

To set the IQ skew error, press the *[IQ Skew]* key and enter the error in the range 0° to 20° to a resolution of 0.1°. Terminate the entry with the [enter] key.

To set the IQ gain imbalance error, press the *[IQ Gain]* key and enter the error in the range 0 to 10 dB to a resolution of 0.1 dB.

To set the carrier leak error, press the *[Carrier Leak]* key and enter the error in the range 0 to 10% to a resolution of 0.1%.

After making any of the above three selections, pressing the *[Error ON/OFF]* key toggles between the on and off states to select any combination of errors.

Pressing the *[Enable/Disable]* key allows all the errors that have been set to be toggled on or off.

Menu exit

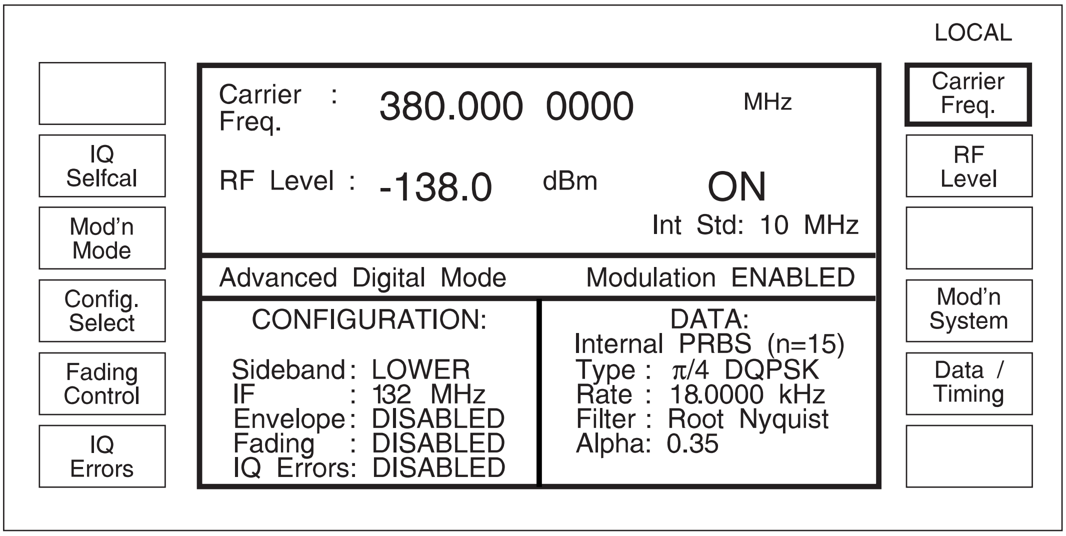
Press [SIG GEN] to return to the *Sig Gen* menu where further selections may be made.

Advanced digital modulation mode

Advanced digital modulation

In the advanced digital mode of operation the instrument can generate TETRA specific modulation from either an internal or external data source. The RF level can be varied by applying an envelope control voltage. Modulation errors and fading effects can be simulated. Provision is also made for using an external mixer to generate a modulated carrier at a higher frequency than can be provided internally by the instrument.

To select the advanced digital control function press the *[Advanced Digital]* key on the *Modulation Mode Selection Menu* (see Fig. 3-6), followed by [SIG GEN]. This causes the *Sig Gen* menu shown in Fig. 3-44 to be displayed.



C3128

Fig. 3-44 Sig Gen menu in advanced digital modulation mode

Setting the output carrier

In advanced digital modulation mode the carrier output frequency and level are set by pressing the *[Carrier Freq.]* and *[RF Level]* keys respectively and entering the values in the normal way.

Self-calibration

To achieve the high precision of the complex modulation the 2050T series Signal Generators have an IQ self-calibration feature which automatically adjusts the modulator for optimum performance minimising vector errors. The instrument generates a warning message at the top of the screen when an IQ self-calibration is advisable. This will occur 30 minutes after power-on and thereafter at 3 hour intervals.

To perform a self-calibration press *[IQ Selfcal]*. The calibration process is entirely automatic and during operation the message *IQ MODULATOR CALIBRATION IN PROGRESS PLEASE WAIT ...* appears. Calibration takes approximately 45 seconds and normally remains valid for 3 hours.

Modulation type and system selection

In advanced digital modulation mode the modulation system is fixed as TETRA. This is $\pi/4$DQPSK modulation, 18 ksymbols/s rate, root nyquist filter with α of 0.35.

Vector modulation mode

Vector modulation

In vector mode operation the instrument provides IQ modulation of the carrier from an external source. The RF level can be varied by applying an envelope control voltage. Fading errors can be simulated. Provision is also made for using an external mixer to generate a modulated carrier at a higher frequency than can be provided by the instrument.

To select the Vector control function press the *[Vector]* key on the *Modulation Mode Selection Menu* (see Fig. 3-6), followed by [SIG GEN]. This causes the *Sig Gen* menu shown in Fig. 3-45 to be displayed.

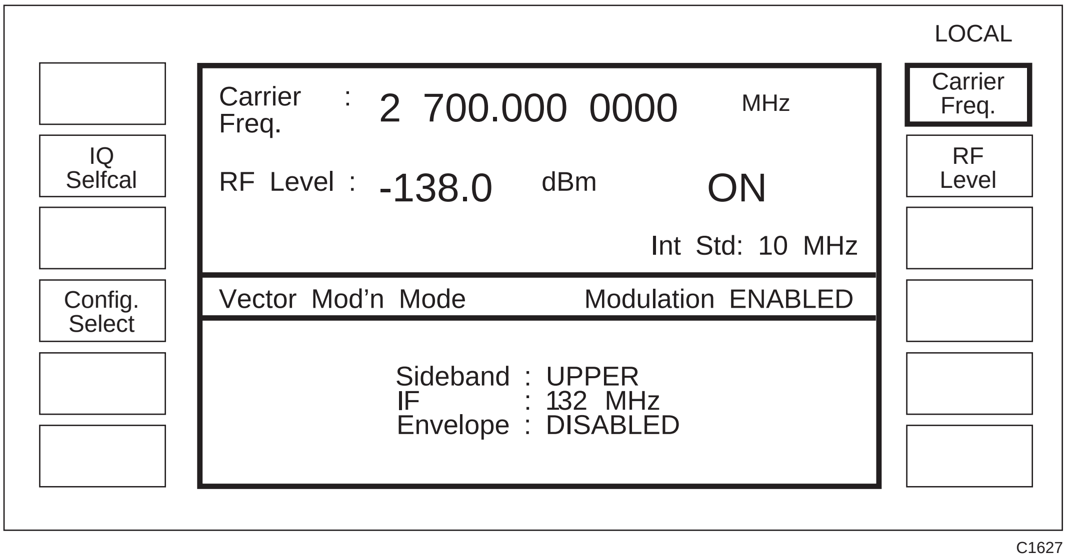


Fig. 3-45 Sig Gen menu in vector modulation mode

Setting the output carrier

In vector modulation mode the carrier output frequency and level are set by pressing the *[Carrier Freq.]* and *[RF Level]* keys respectively and entering the values in the normal way.

Self-calibration

To achieve the high precision of the complex modulation the 2050T series Signal Generators have an IQ self-calibration feature which automatically adjusts the modulator for optimum performance minimising vector errors. The instrument generates a warning message at the top of the screen when an IQ self-calibration is advisable. This will occur 30 minutes after power-on and thereafter at 3 hour intervals.

To perform a self-calibration press *[IQ Selfcal]*. The calibration process is automatic and during operation the message *IQ MODULATOR CALIBRATION IN PROGRESS PLEASE WAIT ...* appears.

Modulation configuration

The *Vector Modulation Configuration* menu is used for converting an IQ modulated IF to the required carrier frequency and for enabling the required inputs and outputs. A simplified block diagram of the system is shown in Fig. 3-46. To control these functions press the *[ConFig. Select]* key on the *Sig Gen* menu which causes causes the *Vector Modulation Configuration* menu shown in Fig. 3-47 to be displayed.

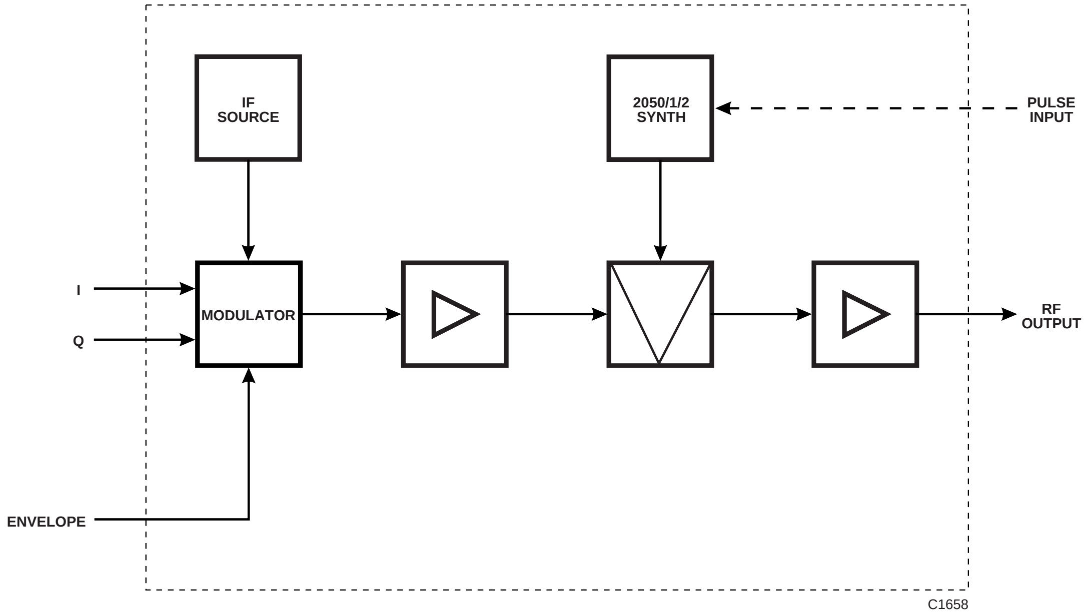


Fig. 3-46 Simplified block diagram: Vector mode with internal mixing

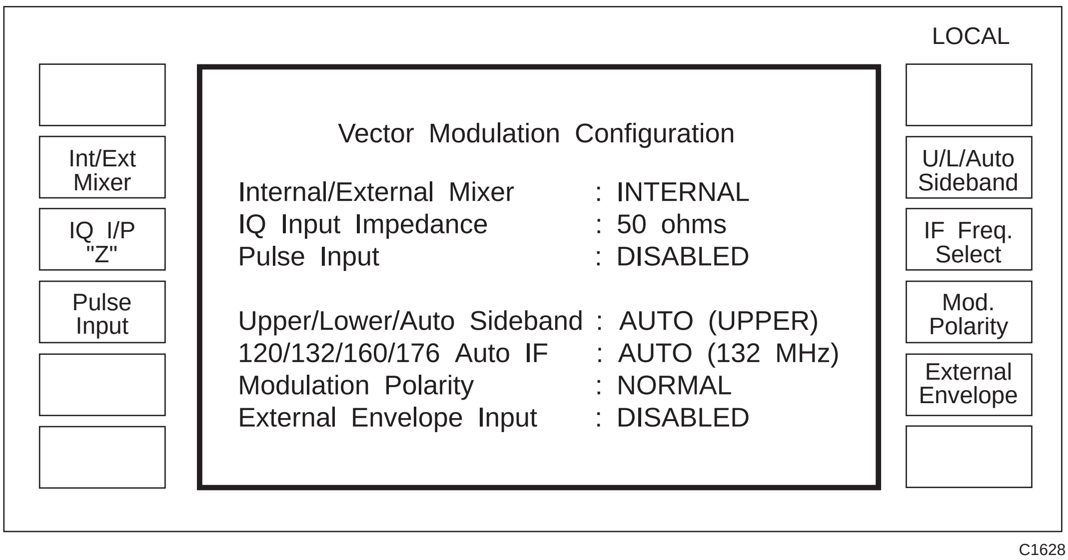


Fig. 3-47 Vector modulation: Modulation configuration menu with internal mixer selected

Mixer selection

Pressing the *[Int/Ext Mixer]* key toggles between internal and external mixer selection. When set to internal mixer the configuration is as shown in Fig. 3-46 where an internal mixer is used to convert the IQ modulated IF to the required carrier frequency. When external mixer is selected the normal signal generator output is made available on the RF OUTPUT connector and the configuration is as shown in Fig. 3-48. The output can then be used as a local oscillator for external frequency multiplication and mixing with the IF to produce higher frequencies than those available internally.

Note

When set to internal mixer the IF output is disabled. When set to external mixer the IF output is enabled and appears at the rear panel IF OUTPUT connector.

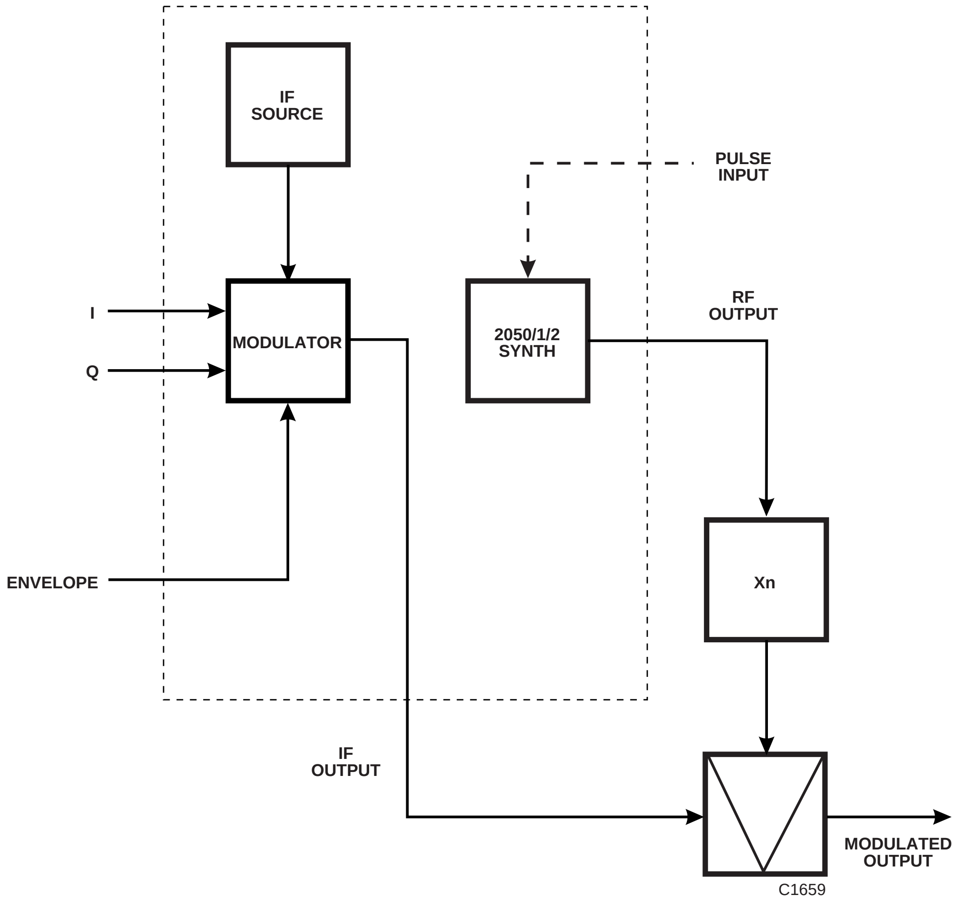


Fig. 3-48 Simplified block diagram: Vector mode with external mixing

IQ input impedance selection

The I and Q connector input impedances can be selected between 50 Ω and 300 Ω by pressing the *[IQ I/P "Z"]* key. The 300 Ω setting is provided for use with lower power sources such as A/D converters or operational amplifiers.

Pulse input selection (applies if Option 002 fitted)

Pressing the *[Pulse Input]* key enables and disables the pulse input. With pulse input enabled, applying 5 V to the PULSE INPUT connector turns the RF carrier on and 0 V turns the carrier off. This facility enables the RF output to be rapidly turned on or off.

Sideband and IF selection

The *Vector Modulation Configuration* menu is used to determine which of four IFs is used and whether the selected carrier frequency corresponds to the upper or lower sideband frequency in the mixing process. Automatic selection is also available which minimises the effects of any mixing products resulting from the frequency conversion process.

To select the required sideband, repetitively press the *[U/L/Auto Sideband]* key which cycles through the selections *UPPER, LOWER* and *AUTO SIDEBAND* as shown by the display. When *AUTO* is selected, the selection is displayed in brackets. Manual settings which are unacceptable (depending on carrier frequency) are disallowed and an error message is displayed.

To select the required IF, repetitively press the *[IF Freq Select]* key which cycles through the selections *120 MHz, 132 MHz, 160 MHz, 176 MHz* and *AUTO* IF as shown by the display. When *AUTO* is selected, the automatically chosen optimum IF is additionally displayed in brackets.

Modulation polarity

To change the modulation polarity press the *[Mod. Polarity]* key which toggles between NORMAL modulation sense and INVERSE modulation sense. INVERSE can be used to simulate IF signals where the modulation sense has been reversed in frequency converting the input RF signal (in effect this exchanges the I and Q inputs).

External envelope

Pressing the *[External Envelope]* key toggles between enabling and disabling an external envelope input connected to the front panel ENVELOPE IN connector. But note that when enabled, Rayleigh and Rician fading cannot be simulated. The level is linearly controlled with 0 V producing no output and +1 V producing the set RF output.

Menu exit

Press [SIG GEN] to return to the *Sig Gen* menu where further selections may be made.

Modulation fading

The signal generator is able to simulate the effects of fading in a transmission system. Pressing the *[Fading Control]* key on the *Sig Gen* menu causes the *Vector Modulation Fading Control* menu shown in Fig. 3-49 to be displayed.

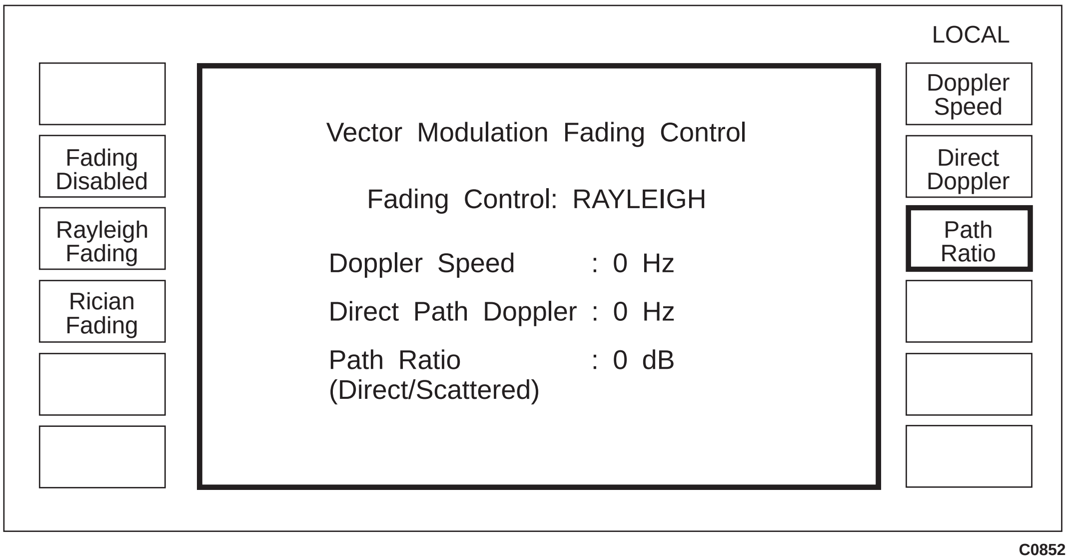


Fig. 3-49 Vector modulation: Fading control menu showing Rayleigh fading selected

Select between the two types of fading by pressing the *[Rayleigh Fading]* or *[Rician Fading]* key.

Doppler speed for Rayleigh fading and the scattered path for Rician fading can be entered using the *[Doppler Speed]* key.

To set the direct/scattered path ratio for Rician fading, press the *[Path Ratio]* key, enter the path ratio in dB (positive or negative) and terminate the entry with the [dB] key. The direct path doppler speed for Rician fading can be entered using the *[Direct Doppler]* key. The entered value must be within a factor of 2 of the scattered path doppler.

When not required the fading may be disabled using the *[Fading Disabled]* key.

Note

When Rayleigh fading is enabled the direct path doppler and the path ratio settings are ignored.

When fading is enabled the DCFM control of the main instrument synthesizer is used, hence when first enabled, or during an IQ selfcal, a nulling operation occurs. This ensures accurate carrier frequency output. The legend:

***** DCFM NULLING *****

appears briefly on the display.

Menu exit

Press [SIG GEN] to return to the *Sig Gen* menu where further selections may be made.

Analog modulation mode

Analog modulation

The carrier can be frequency, amplitude, or phase modulated, with pulse modulation as an option. The internal modulation oscillator has a frequency range of 0.1 Hz to 500 kHz, with a resolution of 0.1 Hz.

To select the Analog control function press one of the *[Single]*, *[Dual]*, *[Comp] or [Dual Comp]* keys on the *Modulation Mode Selecton Menu* (see Fig. 3-6), followed by [SIG GEN]. This causes the *Sig Gen* menu similar to that shown in Fig. 3-50 to be displayed.

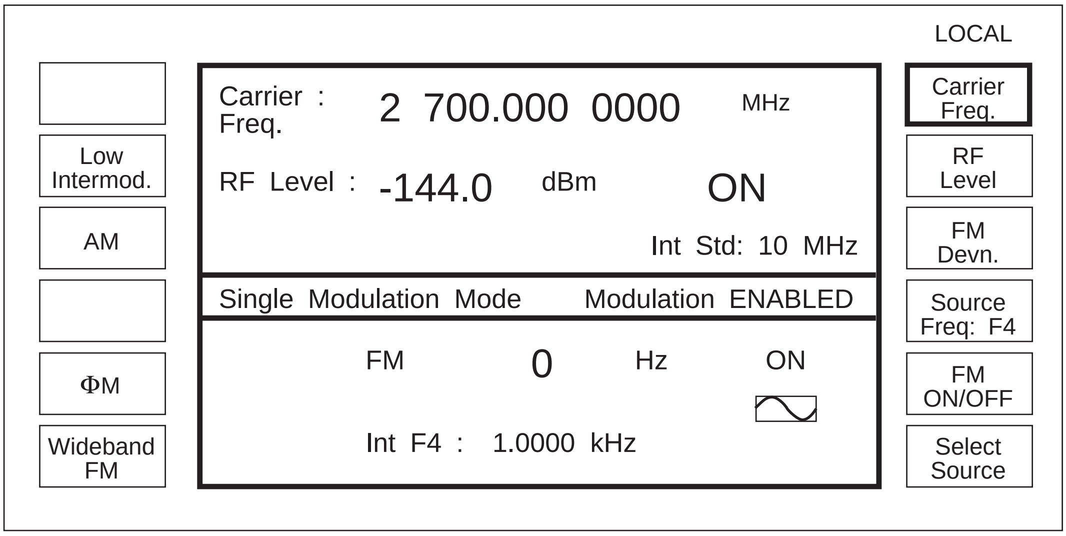


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Fig. 3-50 Sig Gen menu - default display for 2051T

Selecting the modulation

The type of analog modulation required, AM, FM, ΦM, wideband and optional pulse modulation can be selected by soft keys at the *Sig Gen* menu. Four analog modulation modes are available, see 'Modulation mode selection' above.

Modulation ON/OFF

[MOD ON-OFF] switches all modulation *ON* or *OFF* and the condition is indicated in the centre of the main display, e.g:

Modulation DISABLED

Modulation is also controlled by a soft key which turns the selected modulation on and off. For modulation to appear on the carrier, modulation must be both enabled with the [MOD ON-OFF] hard key and turned on via the soft key. In single modulation modes the [MOD ON-OFF] key and the *[FM ON/OFF]*, *[AM ON/OFF]*, *[ΦM ON/OFF]* keys appear to carry out the same function, but the action is different, particularly in the FM mode. The *[FM ON/OFF]* etc. soft keys only reduce the modulation to zero whereas the [MOD ON-OFF] key completely disables the modulation system so that the instrument reverts to a carrier frequency generator.

Selecting amplitude modulation

(1) At the *Sig Gen* menu, press *[AM]*, the *[AM Depth]* box is now highlighted.

(2) Enter the required modulation depth via the numerical key pad and terminate with the [%] key. If the modulation depth requested exceeds 99.9%, the depth is reset to the maximum value available and the message:

ERROR 56: AM Outside Limits

is displayed at the top of the screen.

(3) Switch the AM ON or OFF by pressing *[AM ON/OFF]*. The AM information is displayed in the lower half of the screen.

Selecting frequency modulation

(1) At the *Sig Gen* menu, press *[FM]*, the *[FM Devn.]* box will be highlighted.

(2) Enter the FM deviation value via the numerical key pad and terminate it with [Hz], [kHz] or [MHz].

(3) Switch the FM ON or OFF via *[FM ON/OFF]*. The FM information is displayed in the lower half of the screen.

Selecting phase modulation

(1) At the *Sig Gen* menu, press *[ΦM]*. The *[ΦM Devn.]* box will be highlighted.

(2) Enter the phase modulation deviation value via the numeric key pad and terminate it with the [rad] key.

(3) Switch the ΦM ON or OFF via the *[ΦM ON/OFF]* key. The ΦM information is displayed in the lower half of the screen.

Selecting wideband frequency modulation

(1) At the *Sig Gen* menu, press *[Wideband FM]*. The *[Wideband FM]* box will be highlighted.

(2) The value can be changed via the key pad and frequency terminator key. To preserve the widest bandwidth, the control of the wideband FM is carried out in a series of fixed steps and the signal generator automatically displays the calculated fixed step which is closest to the keyed in value. Applying a 1 V RMS sine wave to the rear panel WIDE BAND FM IN socket will produce the indicated deviation.

(3) Pressing *[AC/DC Coupling]* changes the coupling from AC to DC and vice versa. When the input is DC coupled, small frequency offsets can be reduced by using the nulling facility. Nulling can be effected by pressing *[DCFM Nulling]*. The legend:

**** DCFM NULLING ****

appears briefly on the display.

Note **The [⇧] and [⇩] keys and the control knob do not operate for wideband FM.**

CAUTION

The WBFM socket input impedance is 50 Ω. The DC component of of any applied voltage must not exceed 5 V.

Modulation source frequency

(1) At the *Sig Gen* menu press *[Source Freq.]*.

(2) Enter the required source frequency and terminate the entry with [Hz], [kHz] or [MHz].

Note **When the modulation source is operating as a continuous signalling tone the *[Source Freq.]***

legend is replaced with the *[Tone Number]*. Pressing the key allows a new tone number to be entered.

Source selection - internal

The modulation source may be selected by pressing *[Select Source]*. Sources may be internal or external. If the currently selected source is internal, the *Internal Source Selection Menu* is displayed, giving a choice of six frequencies, F1-F6, see Fig. 3-51. The frequency assigned to the highlighted F number may be changed by the numerical key pad and terminated with [Hz], [kHz], [MHz] or [GHz]. Soft keys allow the selection of either a sine or triangular waveform. The selection of sub-audible continuous tones can be achieved by pressing *[CTCSS]*, see 'SIGNALLING'. Pressing *[Mod. Src Phase]* displays the *LF Source Phase Control* menu, see Fig. 3-52. The LF source phase angle can be varied from –180° to +180°. The pictograms at the end of each line show a symbolic sine wave when a source is selected. This changes to a triangular wave if *[Triangle Wave]* is selected or a square wave if *[Square Wave]* is selected. These symbols also appear on the main menu. A horizontal bar is shown when a source is not selected or is not available.

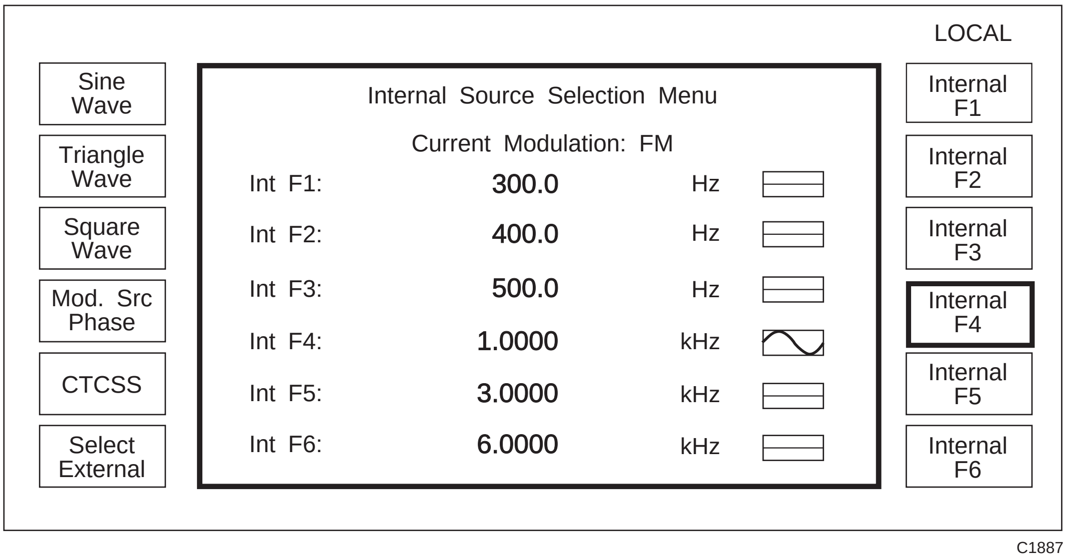


Fig. 3-51 Internal source selection menu

LF phase

When an internal source has been selected, its phase relative to the second modulation oscillator (if fitted) can be changed by pressing *[Mod. Src Phase]* and entering the required value. Where two internal modulation frequencies are active, the starting phase difference between the two signals can be set up and the phase angle is referred to the currently selected oscillator.

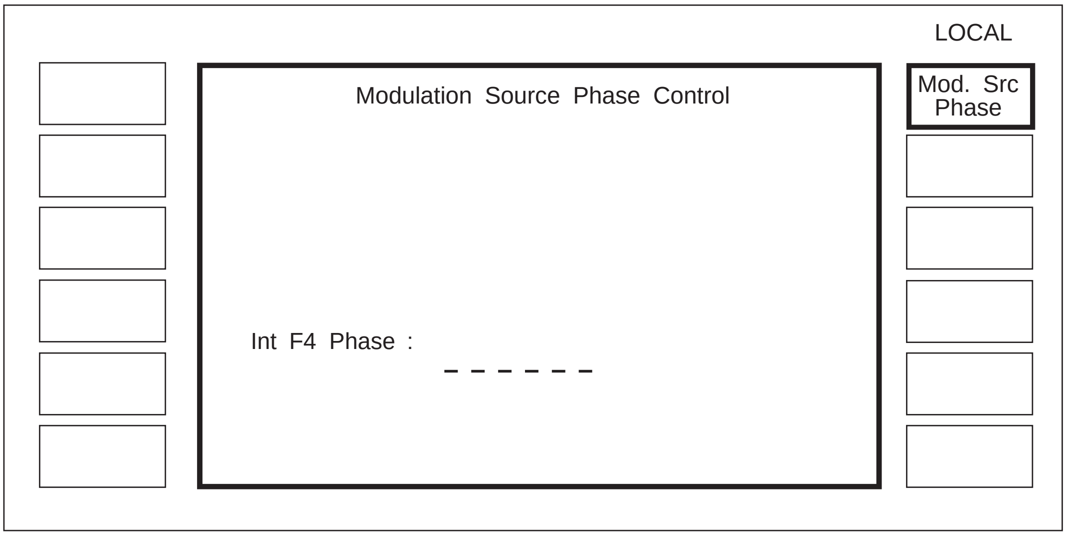


Fig. 3-52 LF phase control

Source selection - external

An external source may be selected by pressing *[Select External]*. The *External Source Selection Menu* is then displayed on the screen (This menu is displayed immediately when pressing *[Select Source]* if the currently selected source is external). This menu allows the choice of two input sockets EXT MOD 1 INPUT and EXT MOD 2 INPUT and AC, ALC, or DC coupling by pressing the appropriate soft key. The pictograms at the end of each line show a symbolic arbitrary waveform when an external source is selected. This symbol also appears on the main menu. A horizontal bar is shown when a source is not selected or is not available. When the input is DC coupled, small frequency offsets can be reduced by using the nulling facility. Nulling can be effected by pressing *[DCFM Nulling]*.

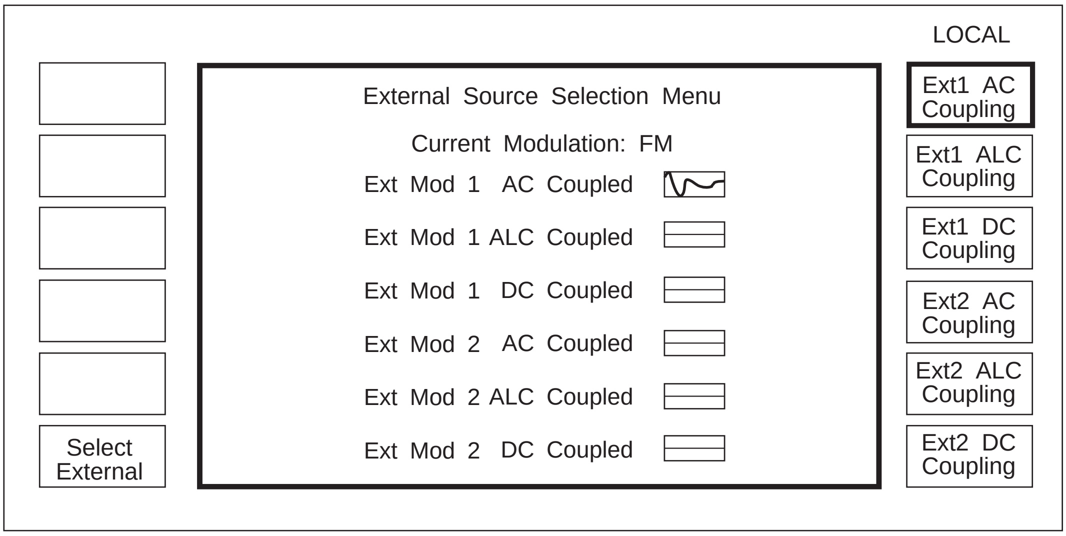


Fig. 3-53 External source selection menu

Modulation ALC

The automatic levelling control (ALC) is used in conjunction with an external source and can be disabled when not required. To enable the ALC, proceed as follows:

(1) At the *Sig Gen* menu, press *[Select Source]*. The display will show the *Internal* or *External Source Selection Menu* (Fig. 3-51 or Fig. 3-53).

(2) If necessary press *[Select External]* to obtain the *External Source Selection Menu* (Fig. 3-53).

(3) Select the required external source from the options shown, e.g. *[Ext 1 ALC Coupling]* or *[Ext 2 ALC Coupling]*. The pictogram at the end of each line will change from a horizontal line to an arbitrary waveform symbol when the source is selected.

(4) Return to the *Sig Gen* menu by pressing [SIG GEN]. The legend *Ext Mod 1 (*or *2) ALC coupled* appears at the bottom of the display.

(5) Apply a signal to the EXT MOD 1 or EXT MOD 2 input socket and vary the level. If the input applied to the external modulation socket is outside the ALC range (at least 0.7 to 1.4 V RMS) *HI LO* will be indicated and an error message will be displayed at the top of the screen. If the level is within the required range, the arbitrary waveform symbol will appear alongside the modulation value.

Pulse modulation (applies if Option 002 is fitted)

Enabling the pulse modulation disables the RF ALC system which is used to control the output level from the generator. The signal generator sets the requested RF output level using a digitally derived control signal whose level is equivalent to that which would be generated by the RF ALC system.

The calibration of the RF level can be set up to work in two possible ways. The normal method is that when a new carrier frequency or RF level is entered the RF ALC system is enabled and a CW signal is generated. The generator then sets up the digitally derived control signal so that it is at the same level as the RF ALC control signal and the instrument disables the RF ALC and subsititutes the digitally derived signal. The user of the signal generator will observe that when the level or frequency of the generator is changed a CW output burst (at the requested output level) is generated for up to 100 ms.

In some applications, such as live radar testing, the CW burst can cause problems. The alternative mode of operation is to enable a CW Burst Suppression facility. In this mode when pulse modulation is first enabled, a calibration of the digitally derived control signal is performed automatically which generates a tabulation of the RF level against the control signal level. During calibration the RF output is suppressed by the output attenuator. After calibration changes in level or frequency do not generate CW bursts. An RF level recalibration can be performed on demand. When the carrier frequency is changed by more than 15 MHz from the frequency at which the level was calibrated, or the new requested frequency results in a major change of characteristic (such as a VCO change), the RF level display is blanked and an UNCAL annunciator is displayed. Initiating an RF level calibration will restore the RF level display.

Selecting the pulse modulation mode

(1) Press the *[RF Level Utility]* on the *Utilities Selection Menu 2*. The display will show the *RF Level Utility Menu* shown in Fig. 3-76.

(2) Use the *[CW Burst Control]* key to disable the Burst Suppression mode for normal operation or enable it for Burst Suppression mode.

(3) Selecting the [SIG GEN] key will return the display to the *Sig Gen* menu.

Selecting pulse modulation

From the *Sig Gen* menu press *[Pulse Mod]* to obtain the Pulse Mod display shown in Fig. 3-54.

Note

The [RF Level Autocal] key will only appear if the CW burst suppression mode has been enabled in which case a temporary calibration display will appear for approximately 1.5 s while calibration is undertaken.

Modulation can be enabled with FM but not with AM.

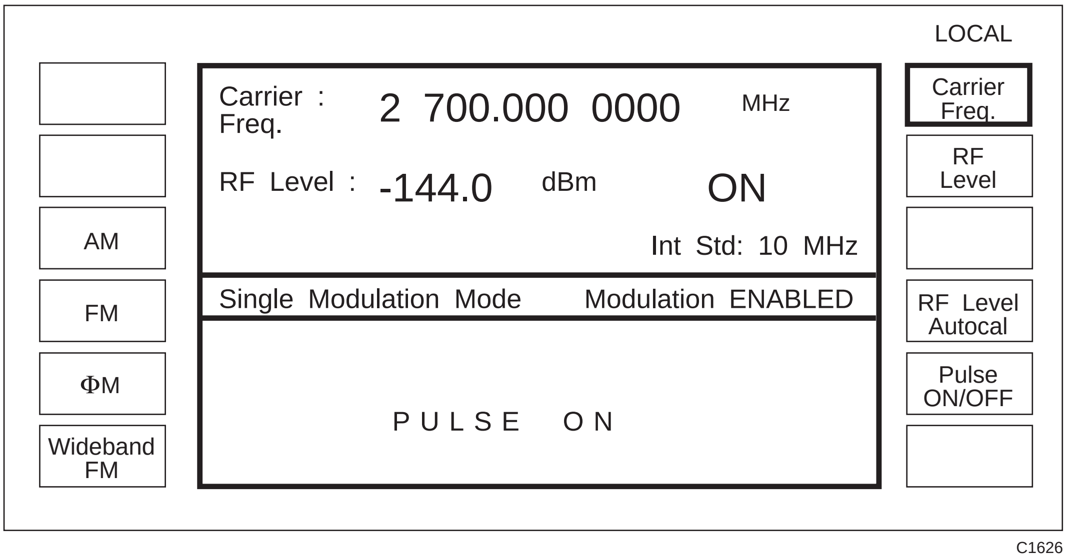


Fig. 3-54 Sig Gen menu with pulse modulation selected

The *[Pulse On/Off]* key can be used to disable or enable the pulse modulator without enabling the RF ALC system.

The [MOD ON-OFF] key will also disable or enable the modulator; the status being shown on the display.

With the modulation disabled using this key the RF ALC system is operating.

If the CW Burst Suppression mode has been enabled the *[RF Level Autocal]* key can be used to recalibrate the RF output level on demand.

Pulse modulation input level

Switch pulse mod on or off with the *[Pulse On/Off]* key. When 'On', the carrier is controlled by the logic level applied to the PULSE INPUT socket mounted on the front panel. A logical '1' (a voltage between 3.5 and 5 V) allows carrier output, a logical '0' (a voltage between 0 and 1.0 V) suppresses it. Turning pulse mod off effectively applies a logical '1' allowing carrier output. Note that the input impedance is 50 Ω.

Low intermodulation mode

When carrying out intermodulation tests the output signal from two signal generators is combined using a resistive or hybrid combiner. If the carrier frequencies are relatively close together each generator will receive an interfering signal from the other source. The RF ALC system will detect a beat frequency equal to the difference in carrier frequencies and attempt to apply AM in order to cancel the signal. In so doing the RF ALC system will generate AM sidebands which are indistinguishable from intermodulation products. By using the low intermodulation mode the RF ALC system can be disabled to prevent the injection of AM sidebands.

If pulse modulation is not fitted proceed as follows:

(1) At the *Sig Gen* menu press *[Low Intermod]*.

(2) This causes either *Low Intermodulation Disabled* or *Low Intermodulation Enabled* to be displayed in the lower panel.

(3) Press the [MOD ON-OFF] key to toggle between the enabled and disabled states.

(4) If an attempt is made to *[Set Steps]* from the Δ menu, the message *Low Intermod: No Steps Allowed* will be displayed.

If pulse modulation (Option 002) is fitted proceed as follows:

(1) Press the *[Pulse Mod]* key.

(2) This causes the message *PULSE ON* to be displayed.

(3) Press the *[Pulse ON/OFF]* key.

(4) This causes *PULSE OFF* to be displayed together with *Low Intermodulation Disabled* or *Low Intermodulation Enabled* shown in the lower panel.

(5) Press the [MOD ON-OFF] key to toggle between the enabled and disabled states.

(6) If an attempt is made to *[Set Steps]* from the Δ menu, the message *PULSE : No Steps Allowed* will be displayed.

Note **AM is not available in the Pulse Modulation or Low Intermodulation modes of operation.**

Signalling

CTCSS

A CTCSS tone is any one of 32 standard sub-audible tones ranging from 67 Hz to 250.3 Hz and would generally be used in conjunction with an audible modulation signal in a composite modulation mode. The procedure for initiating these tones is as follows:

Tone selection

(1) At the *Sig Gen* menu, press *[Select Source]*.

(2) At the *Internal Source Selection Menu*, press *[CTCSS]*. The *Continuous Tone Selection Menu* is now displayed, see Fig. 3-55.

(3) Key in the required tone number (0 to 15) and press [enter].

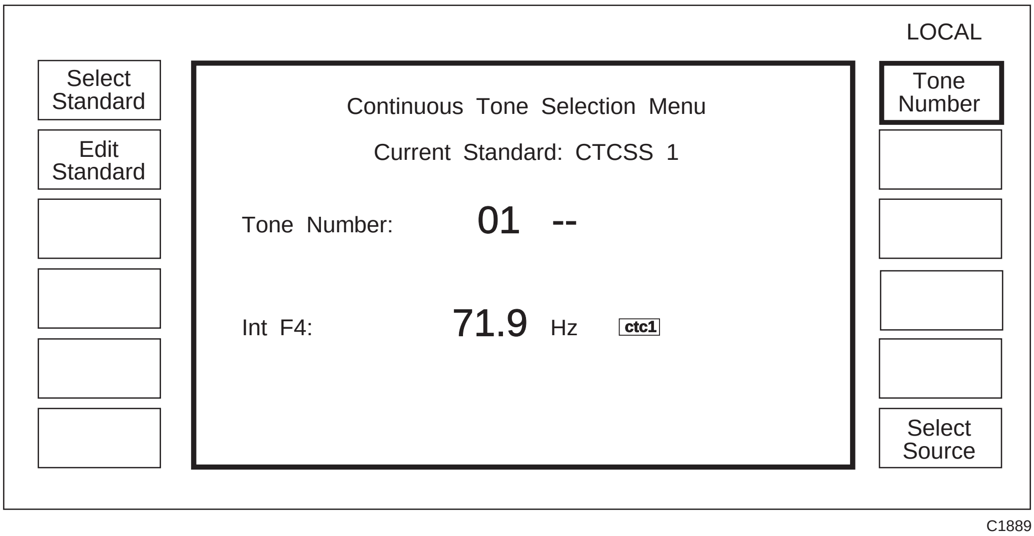


Fig. 3-55 Continuous tone selection menu

Selecting alternative tone standards

A list of the 16 tones of the current standard is available by pressing *[Select Standard]*. This action displays the *Tone Standard Selection Menu* with the current standard highlighted. To select from further lists of 16 tones, press *[CTCSS2]* or *[USER]*. The *Tone Standard Selection Menu* changes to show the new list.

Editing a tone standard

Pressing *[TEMP]* displays a further list of 16 tones set to the default value of 10 Hz. The standard can be edited by selecting *[Edit Standard]* from the menu in Fig. 3-55. This gives you the *Continuous Tone Edit Utility* menu.

CTCSS 1, CTCSS 2 or USER can be be loaded to TEMP, which is a volatile store of 16 tones set at a default value of 10 Hz at switch on. Tones can then be changed by using *[Tone No]*, *[Tone Freq]*, *[Next Tone]* or *[Previous Tone]*. When the required changes have been made, the new standard can be saved by pressing *[Store to User]*. *USER* then becomes a user defined standard.

Note

Selecting *[CTCSS1], [CTCSS2], [USER]* or *[TEMP]* from the *Tone Standard Selection Menu* causes the pictogram in the *Continuous Tone Selection Menu* and the *Internal Source Selection Menu* to change e.g. *ctc1*. The pictogram is repeated in the modulation section of the *Sig Gen* menu.

Sequential calling tones

There are eight sequential calling tone standards available, each having 16 set tones, see Tone Standard Selection Menu, Fig. 3-59. They are, CCIR, EURO, DZVEI, ZVEI1, ZVEI2, EEA, EIA and NATEL. There is also provision for the user to define sets of user tones in USER1 and USER2. DTMF signalling tones can also be generated if the second modulation oscillator (Option 001) is fitted.

Sequential calling tones are set up from a utility menu, Fig. 3-69, and are activated by pressing *[Send Tones]* which appears on the main menu after the tones have been set up. *[Send Tones]* also appears on the calling tones menu.

Tone selection

Pressing the *[Calling Tones]* soft key at *Utilities Selection Menu 1* calls up the *Sequential Calling Tones Utility* menu, see Fig. 3-56.

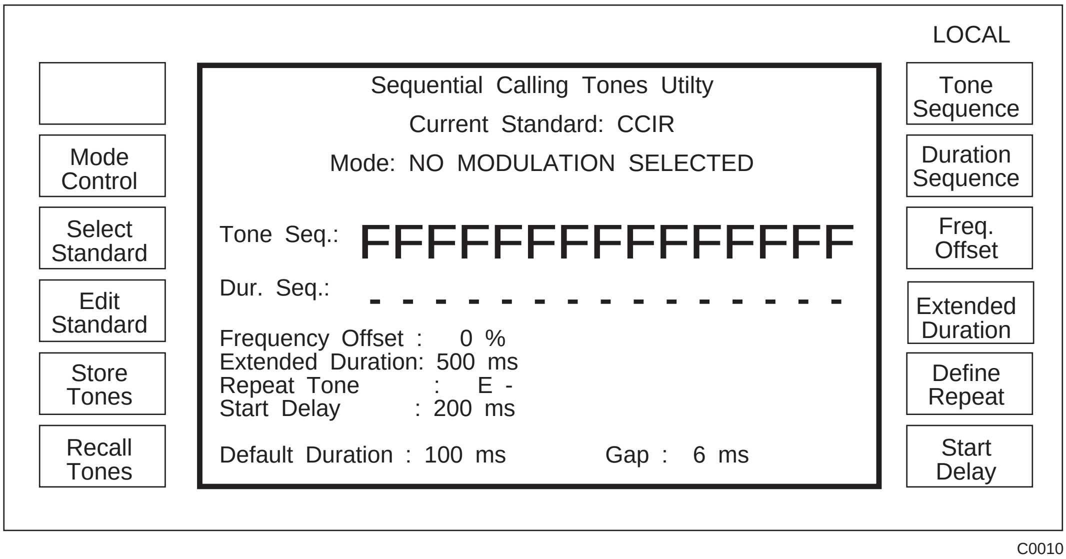


Fig. 3-56 Sequential calling tones utility menu

[Tone Sequence] Pressing this key causes hexadecimal data entry keys to appear at the left-hand side of the menu. To change the sequence, enter the tone numbers via the digits 0-9 on the numerical key pad and the soft keys *[A]* to *[F]* and press [enter].

[Duration Sequence] Pressing this key causes *[Default Duration]* and *[Extended Duration]* to appear at the left hand side of the menu. Press either key in turn to set the duration of tones in the sequence. A dash (-) indicates the default duration and **E** indicates an extended duration. These two keys disappear when [enter] is pressed.

[Define Repeat] allows a repeat tone to be defined, by using the *[A]* to *[F]* keys and the key pad and pressing enter. For example, if the repeat tone is defined as tone C, the sequence 11111 will be sent as 1C1C1 so that the receiver decoders will sense a change in frequency at the start of each digit sent.

[Freq. Offset] This facility alters the nominal tone frequency by a set percentage (up to ±10%) for use in tolerance testing. To change the frequency offset value, select *[Freq. Offset]* and enter the new value on the key pad. Terminate with the [%] key.

[Store Tones] Up to 20 sequence set-ups can be stored. Use the key pad to enter the store location number and press [enter].

[Recall Tones] To recall a tone sequence, use the key pad to select the required store location and press [enter].

[Start Delay] The delay before the tone sequence starts and the gap between sequences can be adjusted by pressing this soft key, entering the required delay time on the key pad and pressing [ms].

[Mode Control] Pressing this enables the user to assign the calling tones to a selected type of modulation, see Fig. 3-58. Modulation, on the selected channel, is turned off when the tones are triggered and restored after the tones have been sent. Modulation on other channels is not affected by the calling tones and this allows sequential signalling tones to be combined with sub-audible tones. *[NO mod]* This option effectively inhibits sequential tones. The tone sequence can be sent between 1 and 9 times, set by *[No. of Repeats]*, every time the *[Send Tones]* key is pressed. Setting the number of repeats to 10 allows the tones to be sent continually under control of the *[Send Tones]/[Stop Tones]* key at the main menu.

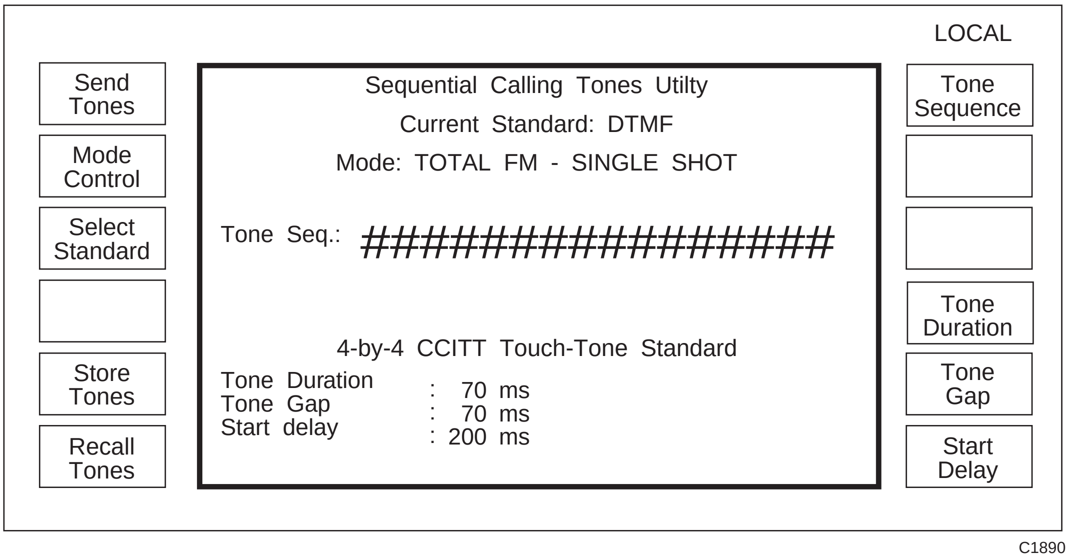


Fig. 3-57 Sequential calling tones utility menu (DTMF mode)

On 2050T series fitted with the second modulation oscillator (Option 001) the DTMF signalling capability is also provided. If this standard is selected then the main menu accessed after pressing *the [Calling Tones]* soft key at *Utilities Selection Menu 1* will be as shown in Fig. 3-57. The functions of the soft keys are as follows:

[Tone Sequence] Pressing this key allows a tone sequence to be set up using the digits 0-9 on the numerical key pad and the soft keys *[A]*, *[B]*, *[C]*, *[D]*, *[*]* and *[#]*. The sequence entry is terminated by pressing [enter].

[Tone Duration] The default duration of 70 ms for each tone in the sequence can be changed by pressing this key, entering the required duration value and pressing [ms].

[Tone Gap] The default gap duration of 70 ms between each tone in the sequence can be changed by pressing this key, entering the required gap length and pressing [ms].

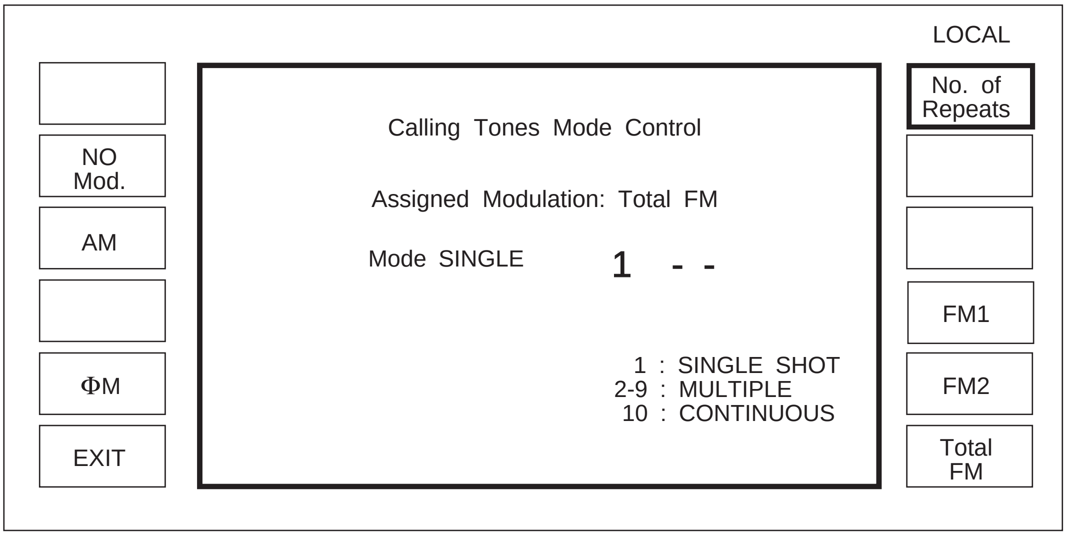
[Start Delay] The delay before the tone sequence starts and the gap between sequences can be adjusted by pressing this soft key, entering the required delay time on the key pad and pressing [ms].

[Mode Control] Pressing this enables the user to assign the calling tones to a selected type of modulation, see Fig. 3-58. Modulation, on the selected channel, is turned off when the tones are triggered and restored after the tones have been sent. Modulation on other channels is not affected by the calling tones and this allows sequential signalling tones to be combined with sub-audible tones. *[NO Mod.]* This option effectively inhibits sequential tones. The tone sequence can be sent between 1 and 9 times, set by *[No. of Repeats]*, every time the *[Send Tones]* key is pressed. Setting the number of repeats to 10 allows the tones to be sent continually under control of the *[Send Tones]/[Stop Tones]* key at the main menu.

[Select Standard] Selection of alternative signalling standards is achieved by pressing this key to access the *Select Standard Menu*.

[Store Tones] Up to 20 sequence set-ups can be stored. Use the key pad to enter the store location number and press [enter].

[Recall Tones] To recall a tone sequence, use the key pad to select the required store location and press [enter].

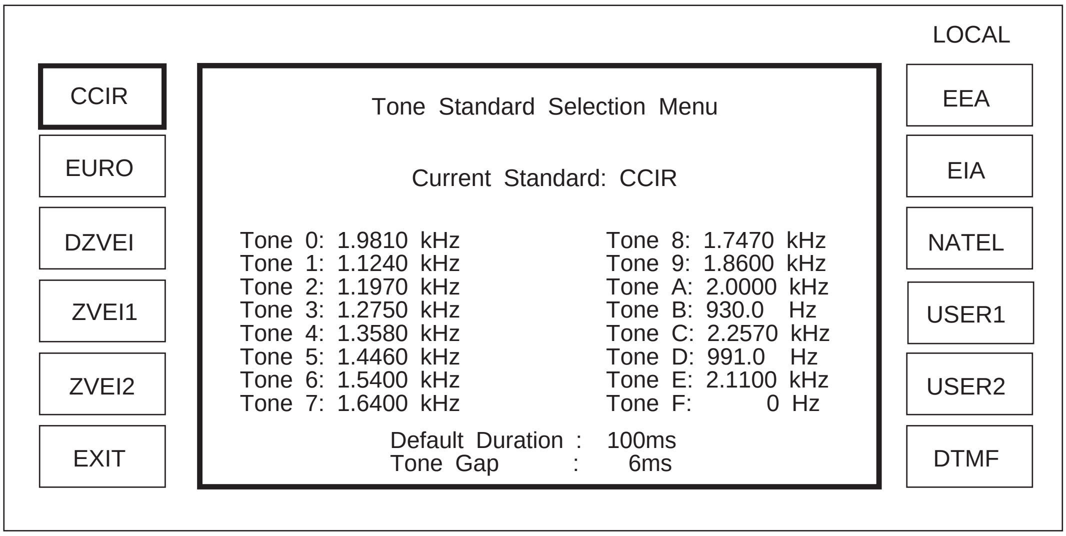


C0011

Fig. 3-58 Calling tones mode control menu (with [FM] selected)

Selecting alternative tone standards

The *[Select Standard]* key causes the *Tone Standard Selection Menu* to be displayed, see Fig. 3-59.



C0012

Fig. 3-59 Tone standard selection menu

The tone sequential standard to be used is selected by pressing the appropriate soft key. This menu also shows the frequency and timing characteristics for each tone in the standard. User 1 and User 2 are user defined tone standards stored in non-volatile memory. The *[DTMF]* soft key only appears on the display if the instrument is fitted with a second modulation oscillator (Option 001 fitted). If only a single oscillator is fitted the *[DTMF]* key is left blank

Editing a tone standard

Pressing the *[Edit Standard]* key when in the *Sequential Calling Tones Utility* menu (Fig. 3-56) will produce the *Edit Sequential Tones* Utility, see Fig. 3-60, which allows a user defined tone system to be set up.

All editing is carried out in a tone standard called TEMP which is not stored beyond switch off. To ensure that the alterations are available for future use the newly defined tone standard must be saved to non-volatile storage in either USER1 or USER2.

The editing facility allows the user to define the frequency of each of the 16 tones in the system and to set the default duration of each tone in the sequence and the gap between tones (if any). All other settings are handled in the normal *Sequential Tones Utility* menu.

The currently selected tone standard may be copied into the TEMP working space using the top left soft key (shown *[CCIR to TEMP]* in Fig. 3-60) and often this is a convenient way to start, particularly when the user defined system is similar to one of the standard systems.

To edit the system in TEMP use *[Tone Number]* to select the number of the tone to be edited (0 to 15) and after pressing *[Tone Freq.]* enter the new frequency to be assigned to this tone number. Select other tones in the system by means to the *[Tone Number]* key or use the *[Next Tone]* and *[Previous Tone]* keys to step through the list. Enter the frequencies of the tones and then use *[Default Duration]* and *[Tone Gap]* to set the times in milliseconds for the default duration of each tone and the gap between each tone.

Finally store the user defined tone system parameters in USER1 or USER2 by pressing *[Store to USER1]* or *[Store to USER2]*.

Note that when using the DTMF tone signalling capability no editing facility is provided. Changes to the default settings are made directly on the *Calling Tones Utility Menu*.

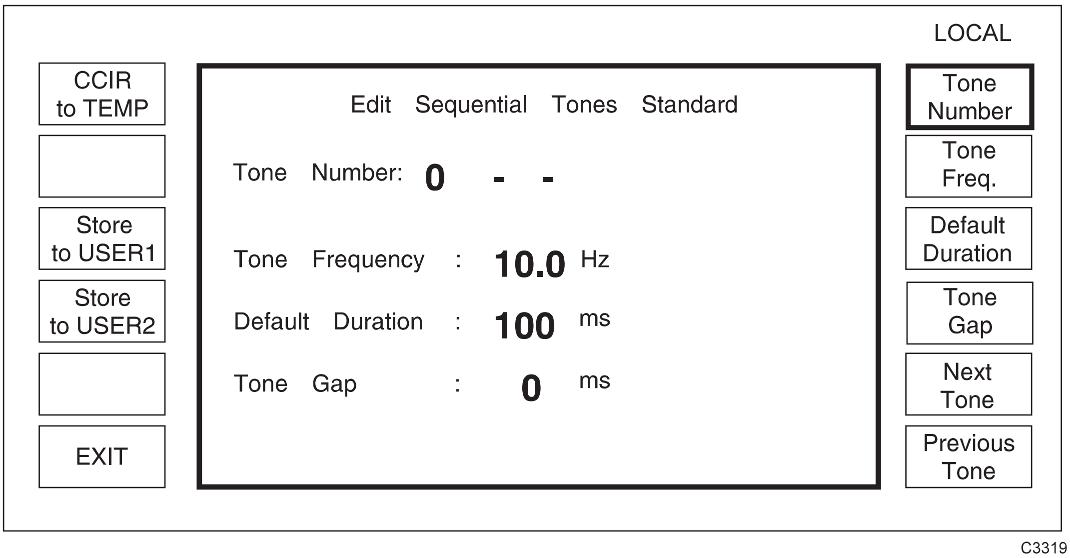


Fig. 3-60 Edit sequential tones standard menu

Incrementing (using Δ)

Displaying shifts

Press the [Δ] hard key. The total shift menu is displayed as shown in Fig. 3-61. This menu displays the difference between the current value and the keyed-in value. Parameters can be incremented or decremented by using the [⇧] or [⇩] key or the control knob, see 'Using the control knob' on Page 3-11. To cancel any changes made by the rotary control or the ⇩/⇧ keys, press *[Return Value]*. This will restore the setting of the selected parameter to the keyed-in value, i.e. the indicated shift will return to zero. Pressing *[Transfer Value]* transfers the current value to the *Sig Gen* menu as the keyed-in value.

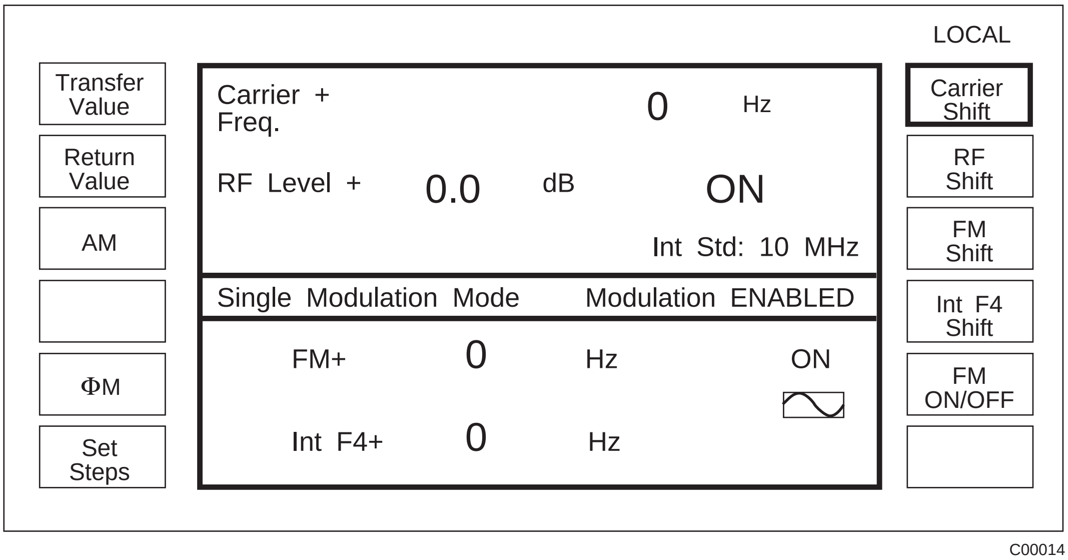


Fig. 3-61 Total shift menu

Setting increment values

(1) From the total shift menu select *[Set Steps]*. The screen shows the currently set step sizes.

(2) Select *[Carrier Step]*, enter the value on the key pad and press a terminator key. The step value will appear on the screen.

(3) Return to the *Sig Gen* menu by pressing [SIG GEN].

(4) Using the ⇩/⇧ keys respectively will now increment or decrement the carrier frequency by the set value.

(5) *[RF Level Step]*, *[AM Step]* and *[Source Step]* values can be entered in the same way.

Note **Wideband FM and Pulse modulation parameters cannot be incremented in this manner.**

Sweep

The sweep capability allows the comprehensive testing of systems, as measurements at single points will not necessarily give an overall indication of the performance. The sweep function is specified by the following parameters:

- Start value
- Stop value
- Number of steps
- Time per step

Up to five individually adjustable markers may be set. Each marker can be turned on and off separately. Sweep functions available are:

- Carrier frequency with or without modulation
- RF level
- Internal modulation rate
- LF frequency (if in LF generator mode)
- LF level (if in LF generator mode).

The sweep can be operated in single shot or continuous modes with the start command triggered by a key press, an external pulse or GPIB control. Once started, the sweep can be stopped at any time when the display will indicate the current parameter value. The sweep can be used with oscilloscopes, X-Y display units and X-Y plotters by connecting the display unit X input to the SWEEP RAMP output on the rear panel.

A sweep routine is set up as described in the following paragraphs:

Sweep type

(1) Press the [SWEEP] hard key. The sweep parameters display, with soft key options, appears on the screen, see Fig. 3-62.

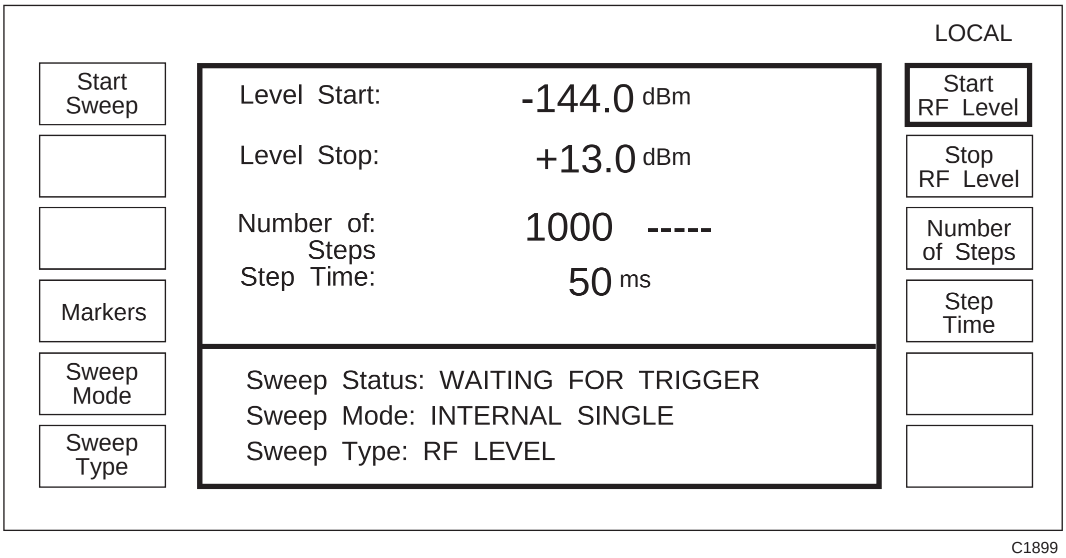


Fig. 3-62 Sweep parameters display

(2) Press *[Sweep Type]*. The *Sweep Type Menu* is displayed, see Fig. 3-63.

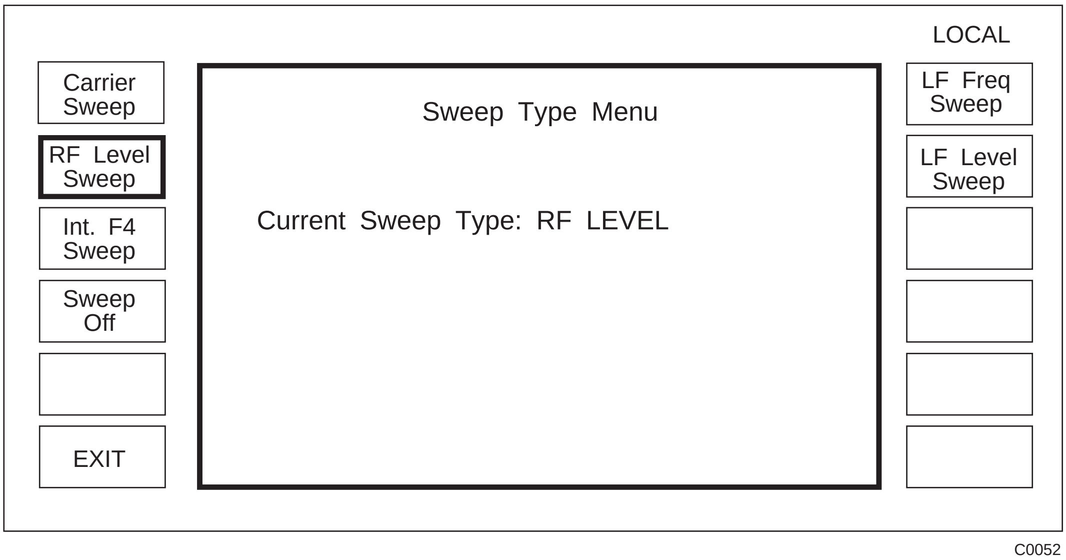


Fig. 3-63 Sweep type menu

The instrument must be in the LF generator mode before an LF frequency sweep and LF level sweep can be initiated.

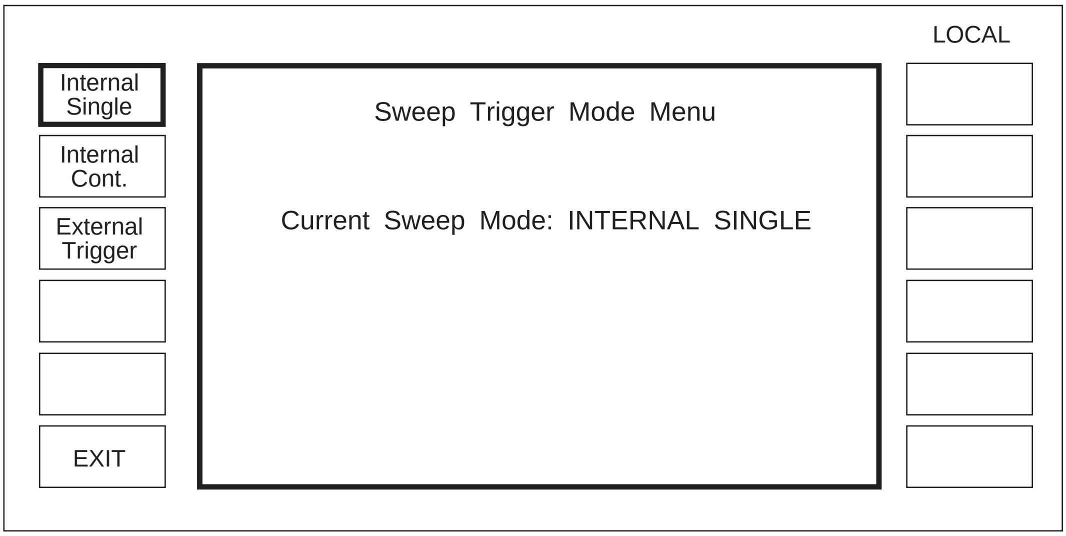
Modulation required during sweep should be entered before putting the instrument in the sweep mode.

(3) Select the required sweep type by pressing the appropriate soft key, e.g. *[Carrier Sweep]*. The Sweep Type screen changes to confirm the selection.

(4) Press *[EXIT]* or [SWEEP] to return to the sweep parameters display.

Sweep mode

(1) At the sweep parameters menu, press *[Sweep Mode]*. The *Sweep Trigger Mode Menu* is displayed, see Fig. 3-64.



C0017

Fig. 3-64 Sweep trigger mode menu

(2) Select the sweep mode, [Internal Single], [Internal Cont.], or [External Trigger].

(3) Press [EXIT] to return to the sweep parameters display menu.

(4) If [External trigger] is selected, press [UTIL], select [Utils. Menu 1] and from this menu press [External Trigger]. The External Trigger Selection Menu will be displayed. Then press [SWEEP] to return to the Sweep Parameters display.

Sweep parameter entry

Start value

(1) Select the appropriate soft key to enter the start value, e.g. *[Start Freq]*.

(2) Enter the required start value via the numerical key pad and the appropriate terminator key.

Stop value

(1) Select the appropriate soft key to enter the stop value, e.g. *[Stop Freq]*.

(2) Enter the required stop value via the numerical key pad and the appropriate terminator key.

When carrier frequency parameters are entered, the instrument calculates all the individual step values together with any level and modulation correction factors. While this process is taking place, the sweep status line changes to indicate '*CALCULATING SWEEP*'.

Number of steps

(1) Select [Number of Steps].

(2) Enter the number of steps via the numerical key pad and the [GHz/V/enter] terminator key.

Note

If an inappropriate number of steps is selected, the instrument will automatically choose a more reasonable value. The number of steps available depends on the operating mode and the maximum values are:

250	**or carrier frequency with FM, ΦM or Wideband FM enabled.**
1,000	**for carrier frequency without FM, ΦM or Wideband FM enabled.**
10,000	**for RF level, RF modulation frequency, LF frequency and LF level.**

Step time

(1) Select *[Step Time]*.

(2) Enter the step time via the numerical key pad and the [MHz/mV/ms] terminator key.

Markers

A facility exists for producing markers, controlled by the *Sweep Markers Menu*, see Fig. 3-65.

Fig. 3-65 Sweep markers menu

To set a marker, press one of the marker soft keys e.g. *[Marker 3]*, enter the required value on the key pad and terminate with the appropriate units hard key. Turn the marker ON using the *[Marker ON/OFF]* key. When all markers have been entered use the *[Enable/Disable]* key to activate the marker output on the rear panel. The marker output produces a positive going pulse with a duration of one sweep step when the sweep passes a marker value.

Sweep control

Starting the sweep

From the sweep parameters menu, press *[Start Sweep]*. The single sweep status line display changes from *WAITING FOR TRIGGER* to *SWEEPING* and a solid bar increments to show the sweep progression, see Fig. 3-66.

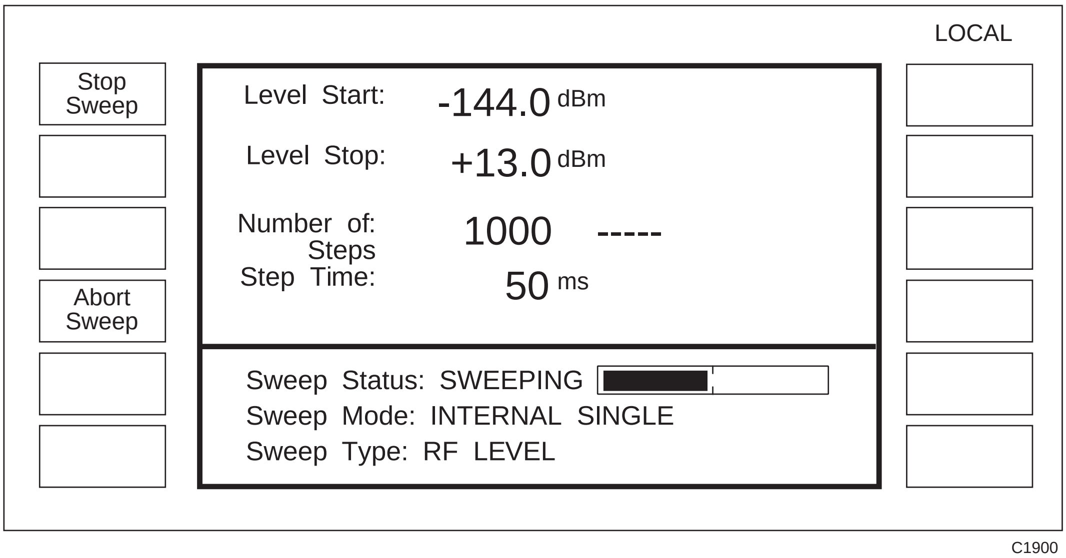


Fig. 3-66 Sweep in progress

Note

When the sweep is in progress, all the hard keys are disabled and only the *[Stop Sweep]* and *[Abort Sweep]* soft keys are active .

Stopping the sweep

Press *[Stop Sweep]*. The sweep stops and the menu presents the opportunity to press:-

[Reset Sweep] to change the sweep parameters, or

[Continue Sweep] to continue the sweep, or

[Transfer] to transfer the current value of the swept parameter as the last keyed in value in the [SIG GEN] or [LF](*[LF Gen]*) mode, see Figs. 3-67 and 3-68. When the sweep is in the paused state, the [⇧] and [⇩] keys can be used to step the parameter up or down. The sweep can then be continued by pressing *[Continue Sweep]*.

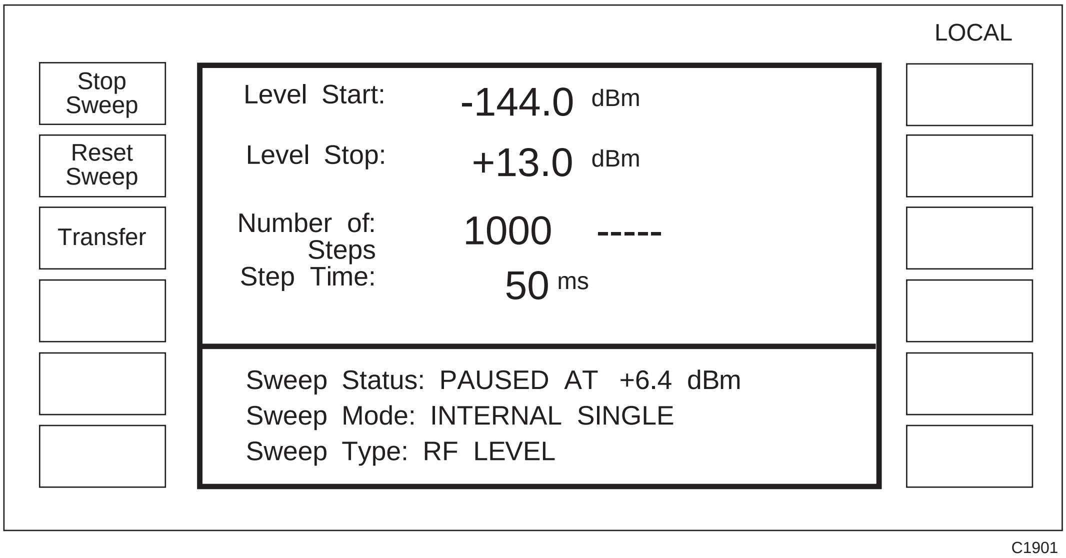


Fig. 3-67 Sweep stopped

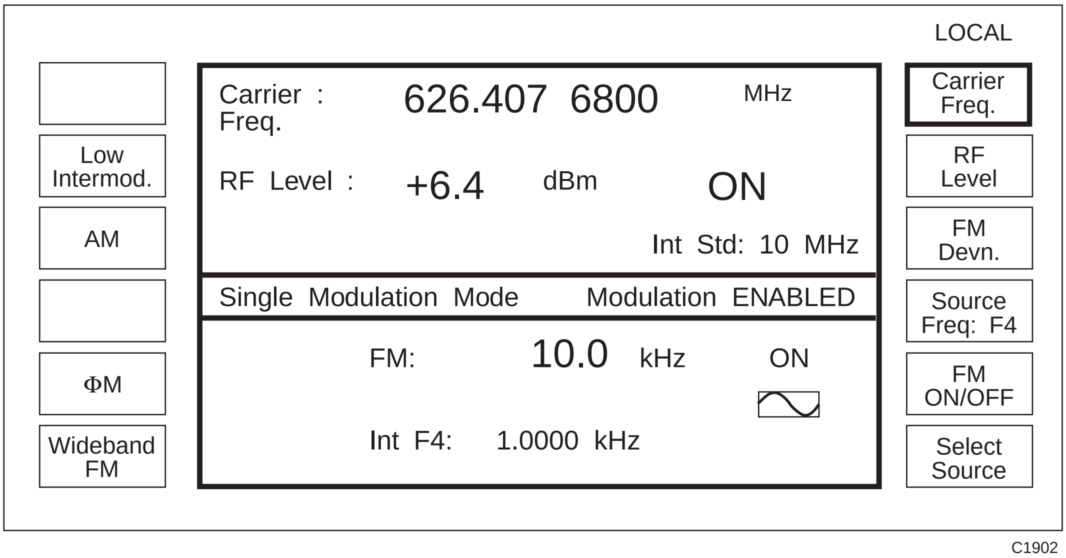


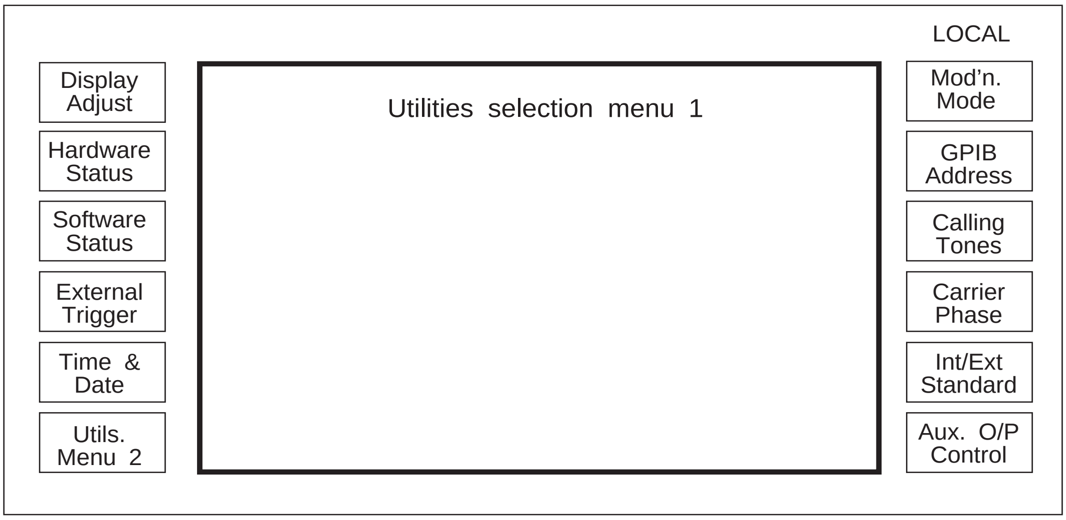
Fig. 3-68 RF level transferred

Aborting the sweep

Press *[Abort Sweep]*. The sweep is reset and the RF (or LF) signal is removed from the appropriate output socket. The *Sweep Parameters Menu* as shown in Fig. 3-62 is displayed. If the sweep is restarted with the signal disabled, the *[Abort Sweep]* key is not displayed thus giving the user an indirect indication that no signal is being output from the instrument.

Utilities

The utilities options are accessible from two primary menus, *Utilities Selection Menu 1* and *Utilities Selection Menu 2*. When a selection is made from either of these menus and [UTIL] is subsequently pressed, the primary menu is re-displayed. However, if instead a selection is made and then one of the other hard keys e.g. [SWEEP] is pressed, pressing [UTIL] subsequently once returns to the sub-menu, pressing it again returns to the primary menu. This provides an operating short-cut in that it allows a sub-menu to be re-accessed without first having to go again through the primary menu. This scheme does not apply to the *[Time & Date]* or to the *[Set Time & Date]* soft keys. The display for *Utilities Selection Menu 1* is shown in Fig. 3-69. To obtain *Utilities Selection Menu 2* from the menu, press *[Utils. Menu 2]*.

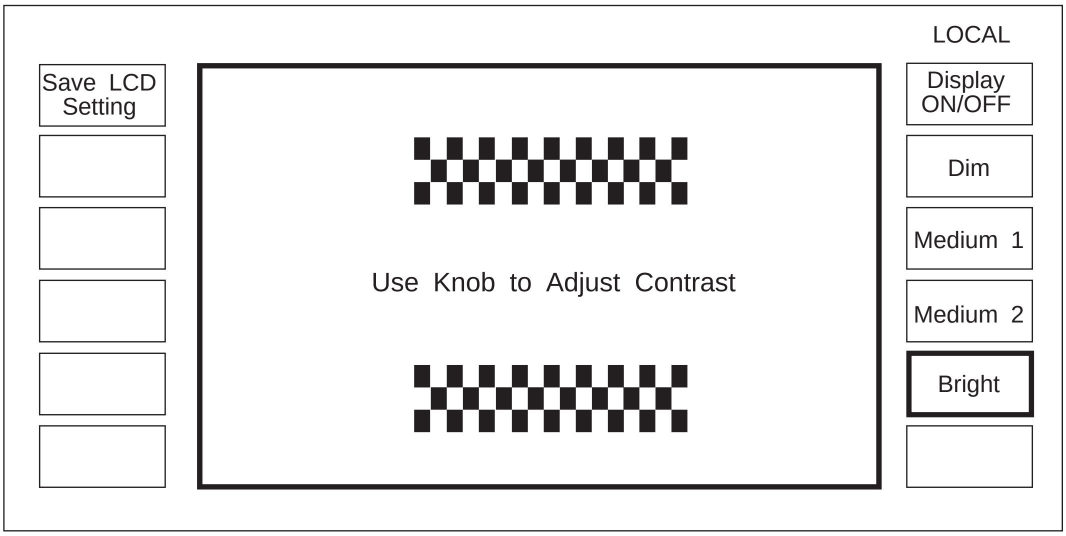


C1655

Fig. 3-69 Utilities selection menu 1

Adjusting the display

To adjust the display, press *[Display Adjust]*. The *Display Adjust* menu is displayed on the screen, see Fig. 3-70. The backlight, which is on when the instrument is switched ON, can be toggled ON or OFF using the *[Display ON/OFF]* key, and when ON can be varied in brightness by *[Dim]*, *[Medium 1]*, *[Medium 2]* and *[Bright]*. Contrast is adjusted with the control knob. Once adjusted, the LCD setting can be stored in the the non-volatile memory by pressing *[Save LCD Setting]*. The instrument always activates the backlighting whenever it is switched on.



C0024

Fig. 3-70 Display adjust menu

Hardware information

To obtain a description of the instrument hardware, press *[Hardware Status]* and the following information is displayed:

Instrument type (e.g. *2051T*)

Serial no. (e.g. *1543256/045*)

Options fitted (e.g. *SECOND LF OSC.*)

Attenuator type and serial number.

For attenuator calibration information, refer to the Service Manual.

Software information

To obtain a description of the instrument software, press *[Software Status]* and the following information is displayed:

Software Version Number e.g. *7.001*

Part number e.g. *44533-1-419*

GPIB address e.g. *01*

External trigger

The external trigger facility allows the rear panel TRIGGER input to be set up so as to initiate a defined change in the generator setting. To define the function press *[External Trigger]*. The display changes to show the *External Trigger Selection Menu* which has the following options:

[Sweep Start]	Starts the external sweep.
[Sweep Step]	Goes to next step of external sweep.
[Send Seq Tones]	Equivalent to *[Send Tones]* on main menu.
[Recall Up]	Recall next store.
[Recall Down]	Recall previous store.
[No Ext. Trigger]	Trigger ignored (default).

The external TRIGGER input requires a TTL type input and includes an internal pull-up resistor to +5 V. A switch closure to ground or an applied voltage transition from +5 V to 0 V on the rear panel socket initiates the defined trigger action.

Setting the modulation mode

Modulation mode selection allows the generator to be configured to provide carriers modulated by one, two or four (2 internal and 2 external) modulation sources.

Press *[Mod'n Mode]* to display the *Modulation Mode Selection Menu*, choose the type of modulation required by pressing *[Single]*, *[Dual]*, *[Comp]* or *[Dual Comp]*, see 'Modulation mode selection' above.

Setting the GPIB address

Press *[GPIB Address]* to display the *GPIB Address Change Menu*. To change the address, enter the address, in the range 0-30, via the numerical key pad and press [enter]. The data is then saved automatically in the non-volatile memory. For information on operating the instrument via the GPIB, refer to Chapter 4.

Sequential calling tones

Sequential calling tones are set up from a utility menu, Fig. 3-69, and are activated by pressing *[Send Tones]* which appears on the main menu after the tones have been set up. *[Send Tones]* also appears on the calling tones menu. Pressing the *[Calling Tones]* soft key at *Utilities Selection Menu 1* calls up the *Sequential Calling Tones Utility* menu, see 'SIGNALLING'.

Carrier phase adjustment

Pressing *[Carrier Phase]* displays the *Carrier Phase Control Menu*. To advance or retard the carrier phase (with respect to its current phase) in steps of π/128 radians, approximately 1.4°, rotate the control knob clockwise to advance the phase and counter-clockwise to retard the phase.

Selection of frequency standard

Pressing *[Int/Ext Standard]* changes the menu to display the *Frequency Standard Selection Menu* which controls the internal/external frequency standard facilities. The signal generator can be set to operate from an external standard or from the internal standard with or without the standard being provided on the rear panel FREQ STD IN/OUT connector.

The menu has the following options:

Output DISABLED	Internal standard disabled at the FREQ STD IN/OUT connector.
1 MHz Int. Std. *5 MHz Int. Std.* *10 MHz Int. Std.*	Internal standard with an output at the selected frequency on the FREQ STD IN/OUT connector.
1 MHz Ext. Std. *5 MHz Ext. Std.* *10 MHz Ext. Std.*	Accepts an external frequency standard at the selected frequency on the FREQ STD IN/OUT connector.

These settings are saved in non-volatile memory to ensure that the settings are recalled when power to the instrument is restored.

Latch data utility

The *[Aux. O/P Control]* key on the *Utilities Selection Menu 1* is used as a convenient means to change the data in the internal hardware latches as well as to control an external device connected to the AUXILIARY IN/OUT connector. Pressing the *[Aux. O/P Control]* key causes the latch data utility shown in Fig. 3-71 to be displayed.

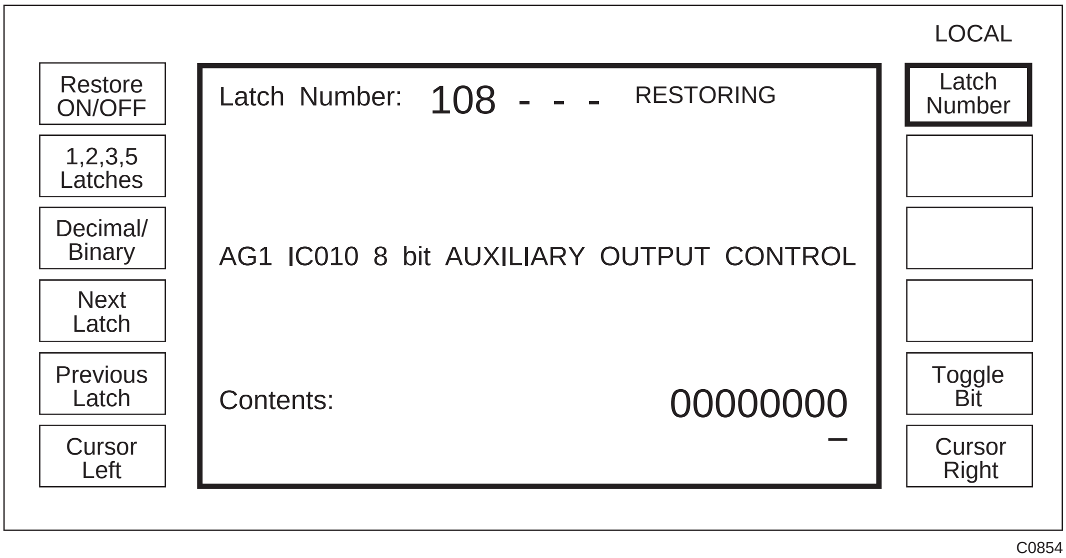


Fig. 3-71 Latch data utility with single latch selected in binary mode

Pressing the *[Restore ON/OFF]* soft key on the utility toggles between Restoring and Non-Restoring mode.

In Restoring mode latches whose values have been changed by the user are restored to their previous value when ANY latch is updated outside the utility (i.e. by changing any parameter). This allows the user to select for example the *Sig Gen* menu to inspect the settings and return to the Latch Data Utility without restoring, but ensures that the instrument will operate in the correct manner after using this utility.

In Non-Restoring mode the modified latch will not be restored until that particular latch requires updating because of a changed parameter. The user should be aware that changing a parameter may affect latches associated with other functions, in particular changing the carrier frequency is likely to update latches associated with modulation and RF level as well as the ones associated with frequency.

[Latch Number] is a function to specify the index number of the latch to be inspected or set. Press numeric keys and terminate with [enter]. Information about the selected latch is displayed on the screen, this includes the board designation, the IC designation and a brief description of the function of the latch e.g. Latch 0 - *AA1 IC402 12 bit FM CH1 DAC (low byte)*. Latch numbers are indicated in a box adjacent to the appropriate IC on the circuit diagrams.

Selecting latch 108 enables 8 output lines to be configured to the rear panel AUXILIARY IN/OUT connector. These may be used to drive external switches, filters etc.

[1,2,3,5 Latches] allows groups of consecutive latches to be treated as a single number. The 2 latches setting is useful for the various 12-bit DACs, the 3 latches setting for the 24-bit numbers used for the modulation oscillators and the 5 latches setting for the 40-bit numbers used in the fractional-N controller. Each press of this key advances the selection in the sequence 1-2-3-5-1... Information about the selected number of latches (starting at the chosen Latch Number) is displayed.

[Decimal/Binary] selects whether latch data is displayed or entered in decimal or binary format. Binary is only available when the number of latches selected is 1 or 2.

In Decimal Mode:-

[Latch Data] is a function key that allows decimal data to be written to the selected latch or latches. When this key is highlighted the user may enter a number in the ranges 0 to 255, 0 to 65535, 0 to 16777215 or 0 to 1099511627775 (for 1, 2, 3 or 5 latches) terminated with [enter], at which time the data is written to the latch.

In Binary Mode:-

[Cursor Left], [Cursor Right] moves the cursor (underscore) left or right along the 8 or 16 displayed bits.

[Toggle Bit] changes the state of the bit at the cursor from 1 to 0, or 0 to 1, the new 8- or 16-bit value is written to the latch/latches immediately.

[Next Latch], [Previous Latch] increments/decrements the Latch Number by 1, 2, 3 or 5 (as selected by *[1,2,3,5 Latches]*).

A list of hardware latches is given in the Maintenance Manual.

Note

Certain latches are read-only, this is usually obvious from the latch description. If this is the case entered data has no effect and the old value is redisplayed.

Changes to the GPIB write latches (112 to 119) can only be restored by switching the instrument off and on again, so should be used with caution.

The Nibble Bus Protocol Latch (111) is always restored.

Menu exit

Press [SIG GEN] to return to the *Sig Gen* menu where further selections may be made.

Selection menu 2

Press *[Utils. Menu 2]* from *Utilities Selection Menu 1*. The display now changes to show *Utilities Selection Menu 2,* see Fig. 3-72. This menu allows access to the protected data. Utilities on this menu have either 1st or 2nd level protection.

If the instrument is locked, the appropriate level must be unlocked otherwise the utility will only be usable in a read only mode. To change parameters, the function must be unlocked. The procedure is:

> [UTIL] ⇒ *[Utils. Menu 2]* ⇒ *[Lock & Unlock]* ⇒ *Function Unlocking Utility* menu ⇒ *[Unlock Level 1]* or, for servicing, *[Unlock Level 2]*.

The correct password must be entered. Many of these activities are intended for use in servicing and are described in the Service Manual.

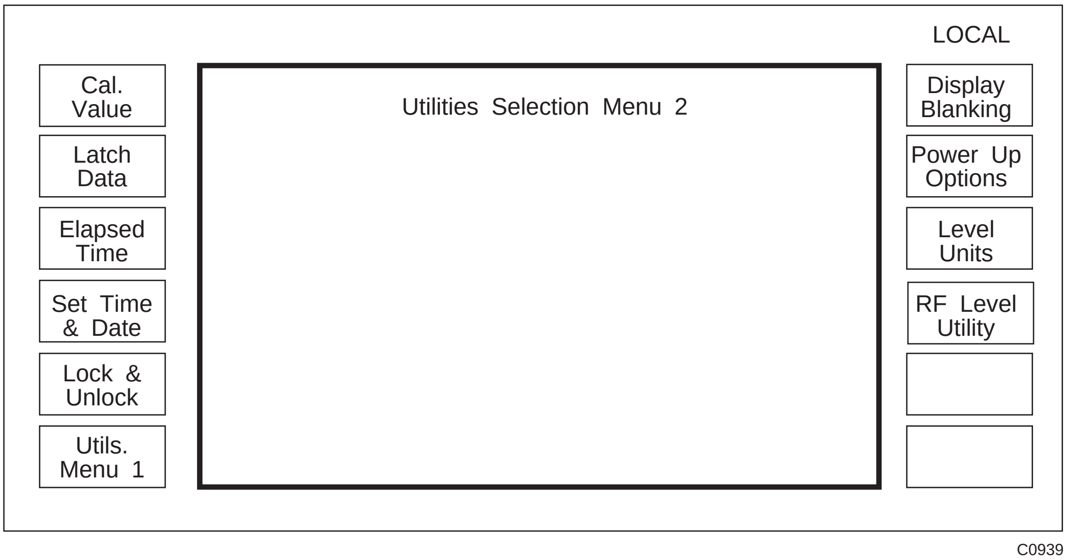
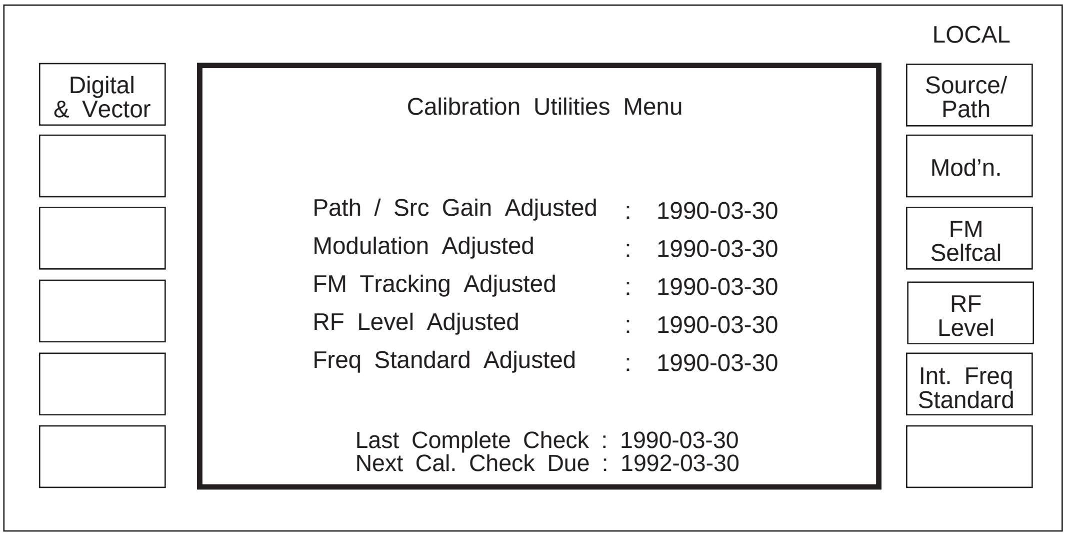


Fig. 3-72 Utilities selection menu 2

Calibration

Pressing *[Cal. Value]* brings the *Calibration Utilities Menu* to the display, see Fig. 3-73. This menu shows when the last complete check was made and when the next calibration check is due. It also shows the date on which the individual items were adjusted. It is possible to inspect the calibration value of these items but calibration cannot be carried out unless the protection facility is unlocked at Level 2. Full details regarding calibration can be found in the Service Manual.



C1656

Fig. 3-73 Calibration utilities menu

Latch data

The latch data menu is intended for use as a diagnostic aid by allowing data to be sent to latches within the instrument. For further information consult the Service Manual.

Elapsed time

The elapsed time facility displays the number of operating hours since the function was last reset. Pressing *[Elapsed Time]* displays the number of operating hours and the date on which the function was last set to zero. This facility can be used to assess the instrument's operational reliability and utilisation.

Locking and unlocking

Press *[Lock & Unlock]*. When Level 1 and Level 2 are both locked, the menu displays three soft keys:

Unlock Level 1

Unlock Level 2

Serial No. Set

Press *[Unlock Level 1]* and the message *Enter 4 Digit Password*: will appear on the display. Level 1 is unlocked by entering the 4 digits on the key pad and pressing [enter]. The menu will change and two soft keys, *[Lock level 1]* and *[Lock Keyboard]*, will appear on the left-hand side. The default password is 1234. If this password is not recognised by the instrument, the password has been changed by your calibration/repair department personnel who should be consulted for further information. *[Unlock Level 2]* is only used during servicing. Refer to the Service Manual for details.

Setting time and date

Unlock to Level 1 (see 'Selection menu 2' and 'Locking and unlocking' above). Set the time and date by pressing *[Set Time & Date]* at *Utilities Selection Menu 2*. The screen shows the current time, date and day of the week. The time shown does not change during display. The clock is powered by a rear panel battery, see Chapter 2, 'BATTERY REPLACEMENT'.

[Set Time] Press this key to set the time. Using the key pad enter the hour and minutes (24 hour clock). Separate the hour and minutes fields by a hyphen, e.g. 21-30. Terminate the entry by [enter] which starts the clock.

[Set Date] Press this key to set the date (in ISO format). Using the key pad enter the year, month and day. Separate the year, month and day fields by a hyphen e.g. 1994-04-23. Terminate the entry by [enter]. The day of the week is automatically determined when the date is set.

Keyboard locking

Unlock to Level 1, see 'Selection menu 2' and 'Locking and unlocking' above. Keyboard operation is disabled by pressing *[Lock Keyboard]*. The instrument automatically returns to the main menu which indicates the locked status by displaying a key-shaped icon in the top left-hand corner of the display. The keyboard can be re-enabled by entering the 4 digit password for Level 1 using the key pad and pressing [enter]. The keyboard status is saved in the non-volatile memory.

Display blanking

To prevent sensitive data from being displayed, the 2050T Series Signal Generators include a display blanking facility. This allows various parts of the display to be replaced by a series of dashes so that values entered by the user or recalled from the memory will not be visible. The instrument must be unlocked to Level 2 to enable or disable this facility. Consult the Service Manual for further information.

Power up options

Unlock to Level 1, see 'Selection Menu 2' and 'Locking and Unlocking' above. Two options are available by pressing *[Power Up Options]* at *Utilities Selection Menu 2*. These options are *[Factory]* and *[Memory]*. When *[Factory]* is pressed, the factory set power up state is recalled. Pressing *[Memory]* causes *[Memory Number]* to appear at the right-hand side of the menu.

To change the power up state of the instrument to a particular setting, enter the memory number of the full store on the key pad and press [enter].

RF level units

RF output level units can be altered using the *[Level Units]* key. The level units may be entered as an EMF or PD, and the logarithmic units can be referred to volts (dBV), millivolts (dBmV), microvolts (dBµV) or to 1 milliwatt into 50 Ω (dBm). Select the units by pressing *[Level Units]* which displays the *RF Level Units Selection Menu* shown in Fig. 3-74.

To change the default RF level units shown at switch on, first unlock the instrument to Level 1. This causes an additional soft key to be displayed in the top left box (see Fig. 3-74). Select the required RF level units and press the additional *[Save RF Units]* key to save these as the default units.

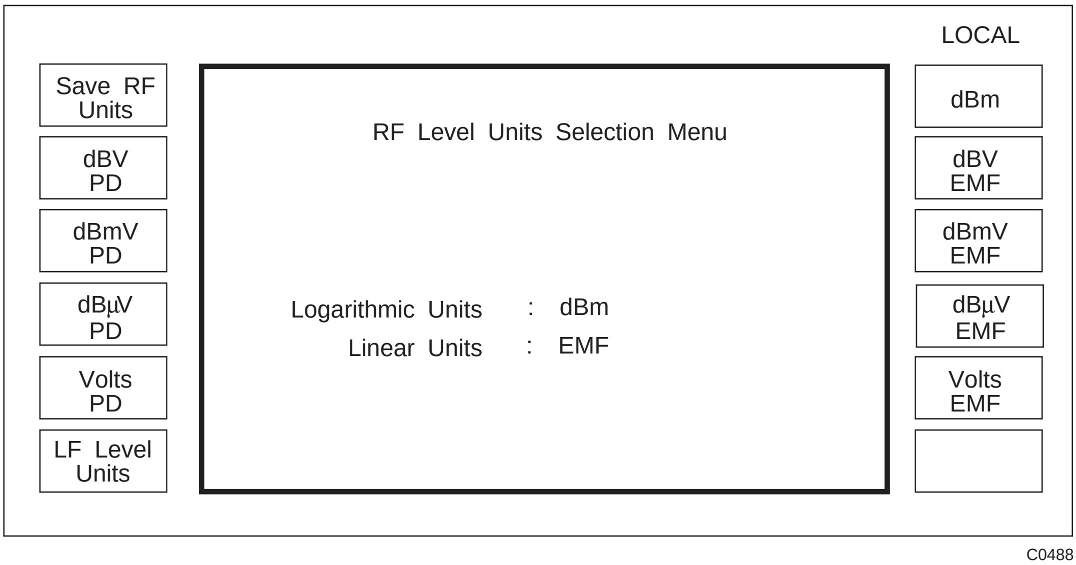


Fig. 3-74 RF level units selection menu (shown unlocked to level 1)

LF level units

LF level logarithmic units may be referenced to 1 volt EMF (dBV EMF), 1 millivolt EMF (dBmV EMF) or 1 milliwatt into 600 Ω(dBm). Linear units are always set EMF values.

Select the units by pressing the *[LF Level Units]* soft key on the *RF Level Units Selection Menu* which calls up the *LF Level Units Selection Menu* shown in Fig. 3-75.

To change the default LF level units shown at switch on, first unlock the instrument to Level 1. This causes an additional soft key to be displayed in the top left box (see Fig. 3-75). Select the required LF level units and press the additional *[Save LF Units]* key to save these as the default units.

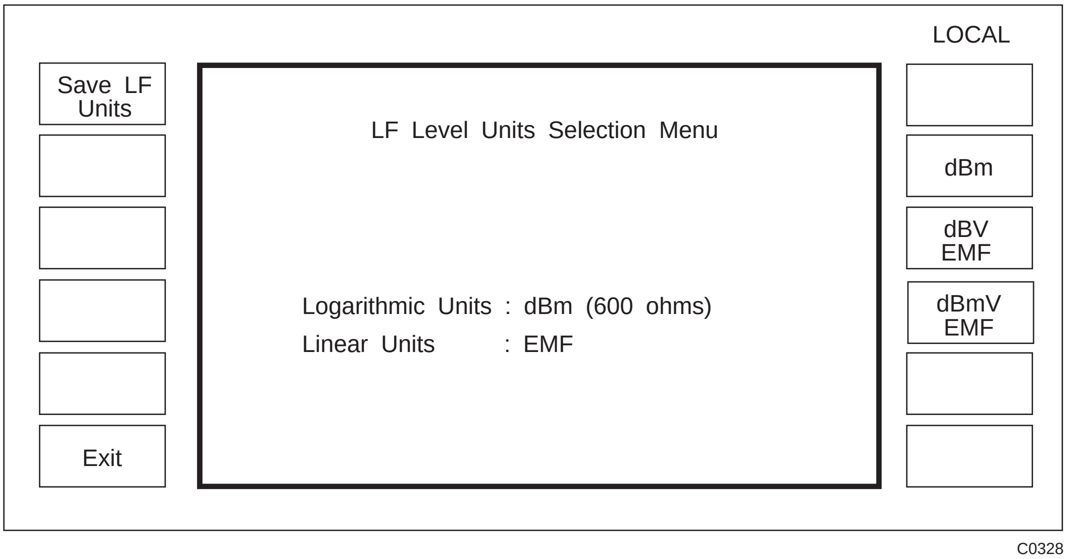


Fig. 3-75 LF level units selection menu (shown unlocked to level 1)

RF level utility

Selecting *[RF Level Utility]* from the *Utilities Selection Menu 2* displays the *RF Level Utility Menu* shown in Fig. 3-76.

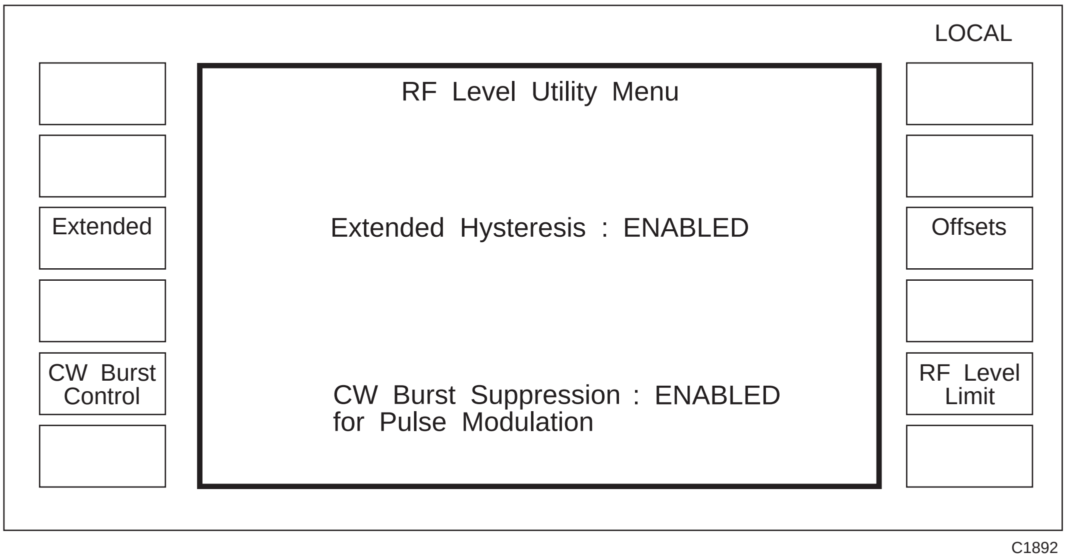


Fig. 3-76 RF level utility menu ([CW Burst Control] and associated text only appear when the relevant option is fitted)

Extended hysteresis

Pressing the *[Extended]* soft key toggles the status (Enable/Disable) of extended hysteresis. When enabled, this provides an electronic level function which uses the internal D/A converter, rather than the attenuators, to provide an uninterrupted (glitch-free) level control. This increases the electronic level control range to +12 to -18 dB. A *+HYST* or *-HYST* message is displayed on the *Sig Gen* menu to indicate when in hysteris and in which direction.

During normal operation the RF output is controlled as shown in Fig. 3-77 by electronically controlling the output level over a limited range (normally approximately 0 to +6 dBm) and switching in 6 dB attenuator pads to provide lower RF levels.

When the hysteresis function is enabled and a keyboard entry of the RF level is made, the signal generator sets the level in the normal way. However, when the rotary control is enabled and used to adjust the RF level, the normal attenuator changes are suppressed. When the level is increased, the attenuator change is suppressed for 6 dB above the normal range and *+HYST* is displayed. Similarly, when the level is reduced attenuator changes are suppressed for 12 dB below the normal range and *-HYST* is displayed. When the extended hysteresis range is exceeded the attenuator and the electronic control are reset to values corresponding to the normal operation of the generator. An example of extended hysteresis operation is shown in Fig. 3-78.

With the rotary control in use in the hysteresis range of operation, the generator can be instructed to set the RF level to the same value, but set using the [V], [mV], [μV] or [dB] keys. This is a useful facility if the user is investigating squelch systems and wants to ensure that varying the level around the current value will not result in an attenuator change.

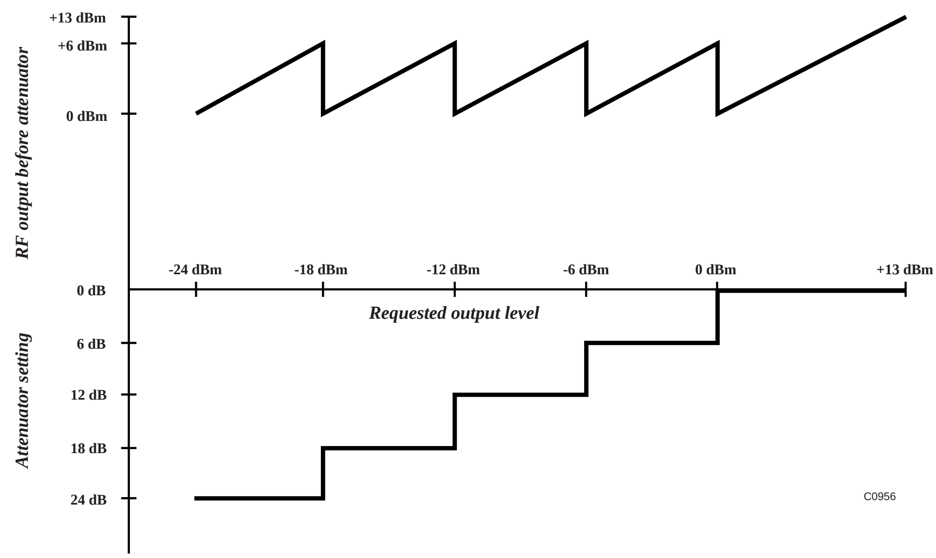


Fig. 3-77 Normal signal generator level control operation

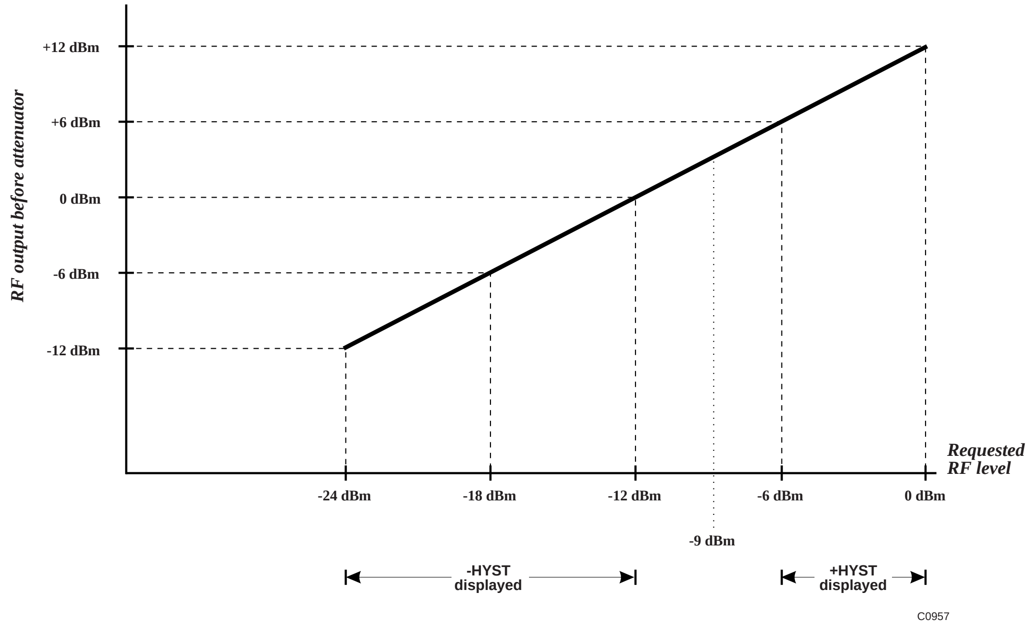


Fig. 3-78 Extended hysteresis operation with an RF level of -9 dBm as the starting level

Note

In the hysteresis range the RF level is set in a different way to the normal operation and this will affect some performance aspects. AM distortion and accuracy will be affected. With no AM selected, the effect on RF accuracy in the +HYST region will be relatively minor. But the effect in the -HYST region on RF level accuracy will be more significant.

Burst control

Applies only if Option 002, Pulse Modulation is fitted. Pressing the *[CW Burst Control]* key toggles between normal operation and Burst Suppression operation. For details refer to 'Pulse modulation' above.

RF offset

With the instrument unlocked to Level 1, see 'Locking and unlocking' above, pressing *[Offsets]* produces the layout for the soft keys shown in Fig. 3-79.

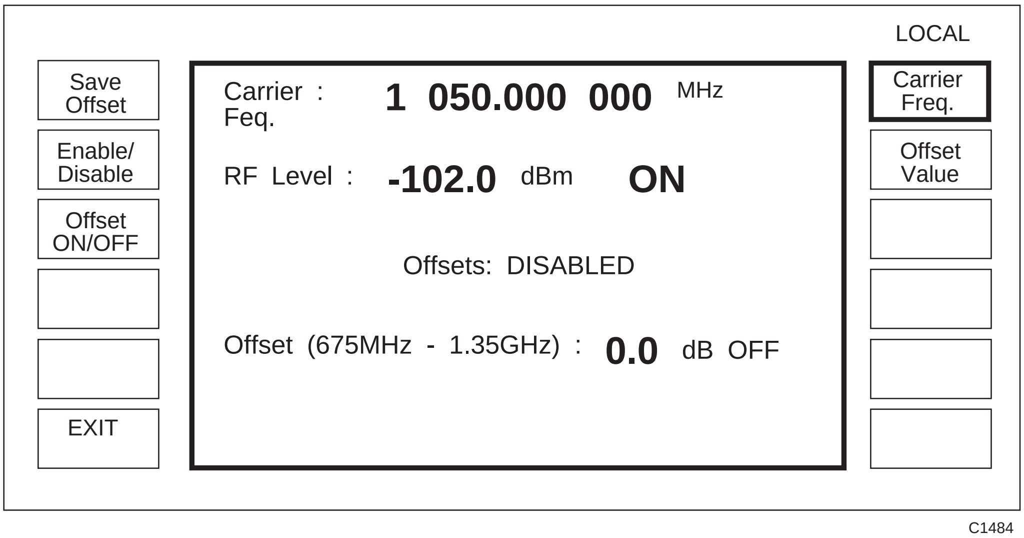


Fig. 3-79 RF offset adjustment menu

To compensate for cable or switching losses or to standardize a group of instruments so that they give identical measurements, the RF output level can be offset by up to ±2 dB. This is done by selecting *[Offset Value]* and either keying in the value or making the adjustment with the control knob. A separate offset can be set for the carrier frequency range 10 kHz to 337.5 MHz and each octave above this. Offsets can be turned on or off individually using the *[Offset ON/OFF]* key or all offsets can be turned on or off via the *[Enable/Disable]* key.

Note

This facility is replaced by a more versatile system on generators supplied with Option 008, RF profiles and complex sweep (see Annex B).

RF level limit

With the instrument unlocked to level 1, see 'Locking and unlocking' above, pressing the *[RF Level Limit]* key causes the *RF Level Limit Menu* shown in Fig. 3-80 to be displayed.

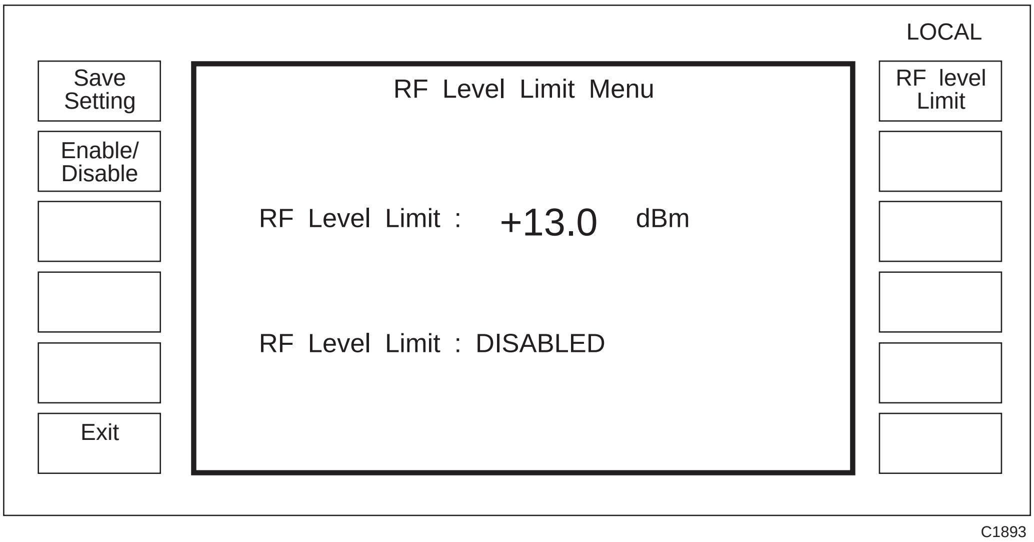


Fig. 3-80 RF level limit menu

The maximum peak RF level output can be specified in the range -138 to +19 dBm. As a result the keyed-in RF output value can be limited as a measure of protecting sensitive devices connected to the RF output of the signal generator. Alternatively, the RF output power can be extended by an additional 6 dB for overrange testing. If the requested output level is in the overrange region the *uncal* message is displayed on the *Sig Gen* menu.

The RF level limit is set by selecting *[RF Level Limit]* and entering the value required. Units may be µV, mV or dB. The choice of volts EMF, volts PD and the dB reference is made by using the RF Level Units utility (see 'RF level units' above). The RF level limit can be turned on or off by means of the *[Enable/Disable]* key.

By pressing the *[Save Setting]* key, the RF level limit value and status is stored to non-volatile memory which is recalled at switch-on and during an instrument reset.

Note

When in the overrange region, the signal generator is capable of generating much higher signal levels. If the frequency is set below 21.09375 MHz and the RF output is not terminated in 50 Ω, the RPP may be tripped by the internal RF signal. If this happens the RPP can only be reset if a 50 Ω termination is connected to the RF OUTPUT socket.

Low frequency operation

The instrument has two modes of LF operation. The LF output can be used either as a modulation signal monitor or as an independent low frequency generator. Pressing [LF] displays either the *LF Monitor Menu* or the *LF Generator Menu*, depending on which mode was last selected.

Note **These modes are not available in digital and vector modulation since the connector is redirected for envelope control.**

LF monitor

The left-hand side of the *LF Monitor Menu*, varies according to the modulation mode; single, composite, dual or dual composite. In each case the right-hand side is occupied by a single soft key, *[LF Gen.]*.

Table 3-1
List of available soft keys for analog modulation modes

Single	Composite	Dual	Dual Composite
Mod. Drive	Mod. Drive	AM Drive	AM Drive
Mod. Source	Mod. 1 Source	AM Source	AM 1 Source
-	Mod. 2 Source	-	AM 2 Source
-	-	FM/ΦM Drive	FM/ΦM Drive
-	-	FM/ΦM Source	FM/ΦM 1 Source
-	-		FM/ΦM 2 Source

Modulation source monitoring

Internal sources only may be monitored. To monitor a modulating signal source, press the appropriate key. The source monitor level and the source information appear on the display. The modulating signal output is fed to the LF OUTPUT socket at a fixed level of 1 V.

Modulation drive monitoring

Modulation drive monitoring is intended for the user to monitor complex modulating signals from both internal and external sources. To monitor a modulation drive, press the appropriate key. The LF Monitor Level and the selected drive are displayed.

When the summed AM drive signal is selected, a signal which is the sum of both AM channels is fed to the LF OUTPUT socket, if in a composite or dual composite mode. The LF level function controls the output level at 100% depth, therefore the actual output voltage depends on the modulation depth. If AM is turned off, the associated LF output is removed.

The summed FM/ΦM drive signal is also fed to the LF OUTPUT socket. The signal is the sum of both FM/ΦM channels. The FM drive signal at the monitored point is nominally 1 V but varies over a range of approximately 3 dB (except at deviation values below about 1 kHz) depending on the set modulation and the carrier frequency selected. If FM/ΦM is turned off, the LF signal is removed. If one component of a composite modulation setting is turned off, the component which is left on remains at its original level.

Note **Wideband FM and pulse modulating signals are not accessible via the monitor mode. enabled**

Use as an independent LF generator

To use the instrument as an independent LF generator, select *[LF Gen.]* at the *LF Monitor Menu*. The *LF Generator Menu* appears on the display as shown in Fig. 3-81.

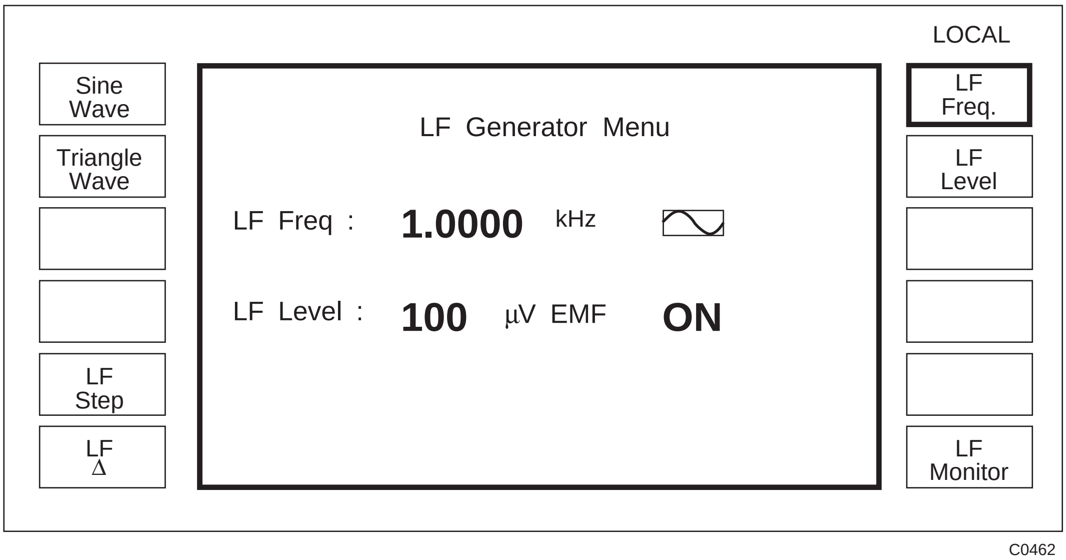


Fig. 3-81 LF generator menu

In this mode, one internal oscillator must be used exclusively for this task. Consequently if only one oscillator is fitted, no internal modulation is available to the signal generator while the LF generator is in use. If a second oscillator is fitted, only one is available to the signal generator.

LF frequency and LF level are adjusted by pressing the appropriate key and entering the value via the numerical key pad and pressing [enter]. To set step values, press *[LF Step]* for the *LF Step Menu*. *[Freq. Step]* or *[Level Step]* can be selected and the values entered as before. To display the *LF Total Shift Menu*, press *[LF Δ]*.

To regain the oscillator as a modulation source, select the monitor mode.

Note

The LF output is entered as V/mV/mV or dBm/dBV/dBmV representing the open circuit voltage fed to a high impedance, but the steps are entered in dB and the control knob has a fixed resolution of 0.1 dB.

Memory

Memory recall

Pressing the [MEM] hard key after switch on, causes the *Memory Recall Menu*, Fig. 3-82, to be displayed. There are four types of recall, full, partial, carrier frequency and sweep. Provision is made for an option not to recall the carrier frequency for full and partial stores. This allows one carrier frequency to be used with a series of stored settings. Pressing *[Inhibit ON/OFF]* turns the option ON and OFF. The state of the option is indicated on the display.

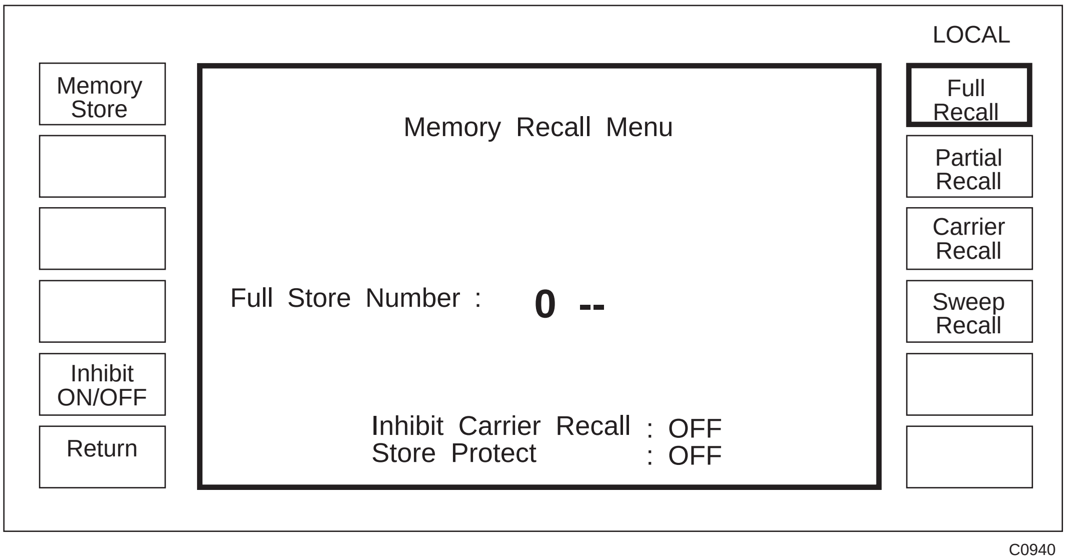


Fig. 3-82 Memory recall menu

Full recall

Selecting *[Full Recall]* enables the recall of a complete instrument setting, i.e. carrier frequency, RF level, modulations and their increments, ON/OFF and source information. Also recalled are all 6 modulation oscillator frequencies, plus one increment, and the LF Generator/Monitor setting. *[Inhibit ON/OFF]* provides the option not to recall the carrier frequency setting. The state of the option is indicated on the display. There are 50 locations (numbered 0 to 49) for full recall. A further location (50) allows the factory default settings to be recalled. The factory default settings are listed in Table 4-1.

Partial recall

This is a less comprehensive recall of only those parameters which currently affect the RF output; carrier frequency, RF level, modulations in use (without increments), ON/OFF and source information and the two modulation oscillator frequencies in use. As with full store, the option not to recall the carrier frequency is provided. There are 50 locations (numbered 0 to 49) for partial storage.

Carrier recall

The carrier frequency store has 100 locations (numbered 0 to 99) which may be recalled when required.

Sweep recall

The sweep store has 20 locations (numbered 0 to 19) containing complete sets of sweep parameters which may be recalled when required.

Note **Sweep parameters can be recalled whether the instrument is in sweep mode or not. They are only used when sweep is selected.**

Recalling data

To recall data, press the soft key for the type of recall required, e.g. *[Carrier Recall]* and select the location by means of the key pad. The [⇧] and [⇩] keys can be used to recall the next locations. Pressing *[Return]* recalls the location last specified on the numerical key pad.

Stores can be incremented or decremented externally by means of the SWEEP TRIGGER socket (see 'External trigger' above).

Note **The settings for the sequential calling tones are recalled via the calling tones menu in UTILITIES, see Fig. 3-69. These stores can be erased from the *Store Erase Menu.***

Inhibit ON/OFF

When recalling full or partial stores it is sometimes useful for the existing carrier frequency setting to remain and not be replaced by the stored setting. The Inhibit Carrier Recall facility offers this capability. To prevent the current carrier frequency from being replaced use the *[Inhibit ON/OFF]* key to set the *Inhibit Carrier Recall* annunciator to *ON*.

To allow the carrier frequency setting to be overwritten use the *[Inhibit ON/OFF]* key to set the *Inhibit Carrier Recall* annunciator to *OFF*.

Memory stepping facility

The [Sig Gen] key has a toggle action in that pressing the key a second time displays the *Memory Stepping* menu shown in Fig. 3-83. This facility enables the memory to be stepped up and down from a start location (selected using the *Memory Recall Menu*), whilst displaying the settings for that memory.

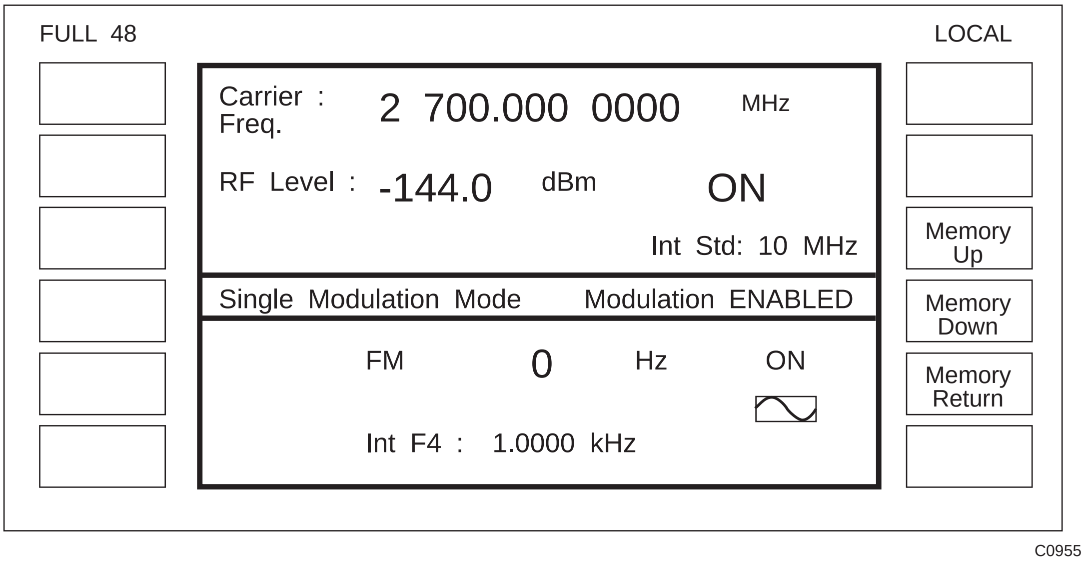


Fig. 3-83 Memory stepping menu

Pressing *[Memory Up]* or *[Memory Down]* respectively increments or decrements the memory location. With each step the settings stored in the location are displayed together with, at the top left of screen, the memory type and location e.g. *Full 48*. Incrementing and decrementing can also be done externally by means of the SWEEP TRIGGER socket (see 'External trigger' above). Pressing *[Memory Return]* at any time returns to the start location.

When a limit is reached, e.g. for Full Recall locations 0 and 49, a further step will reset to the start location. But note that if the start location coincides with a limit, trying to step past that limit will cause the limit and start locations (in this case the same numbered locations) to be alternately displayed. To make the user aware of this situation, the message *At Top Limit* or *At Bottom Limit* is displayed at the top centre of screen.

Memory store

Pressing the *[Memory Store]* soft key on the *Memory Recall Menu* causes the *Memory Store Menu*, Fig. 3-84, to be displayed. There are four types of store, full, partial, carrier frequency and sweep.

To prevent the accidental overwriting of memory contents, a store protection facility is provided. If this feature is enabled, the screen legend will indicate *Store Protect: ON* and the store key legends at the right of the screen will not appear.

Note

Sequential calling tone sequences can be stored from the *Sequential Calling Tones Utility* menu. There is provision for storing up to 20 tone sequences.

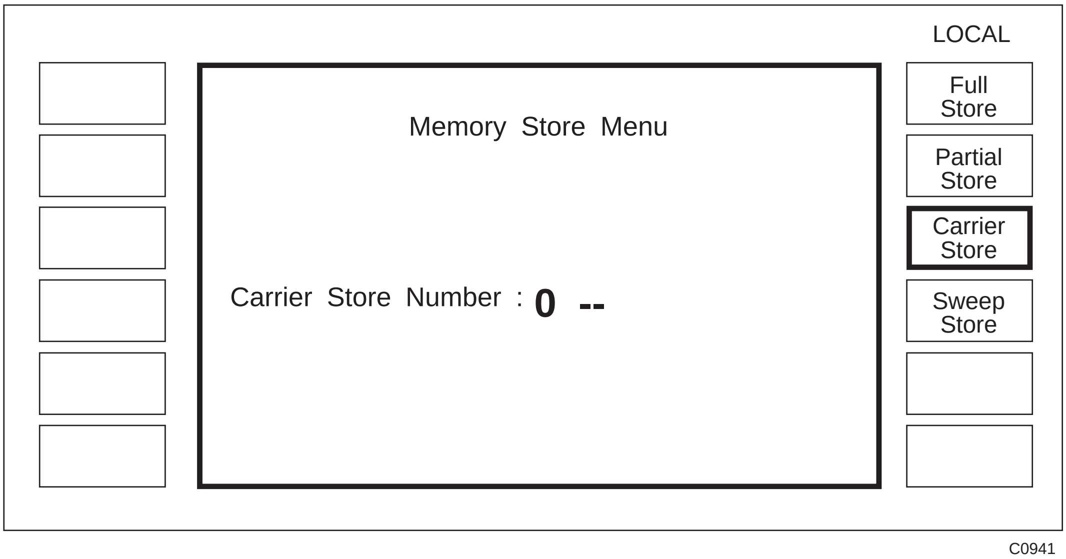


Fig. 3-84 Memory store menu

Full store

Selecting *[Full Store]* enables the storage of a complete instrument setting, i.e. carrier frequency, RF level, modulations and their increments, ON/OFF and source information. Also stored are all 6 modulation oscillator frequencies, plus one increment, and the LF Generator Monitor setting. There are 50 locations (numbered 0 to 49) for full storage. A further location (50) holds the factory default settings. This memory cannot be written to by the user. The factory default settings are listed in Table 4-1.

A Full Store contains the following information:

Carrier frequency setting
Carrier frequency step size
RF level setting
RF level step size
All modulation settings
All modulation step sizes
Modulation mode and status
All six internal oscillator frequency settings
The modulation frequency step size
LF generator frequency setting
LF generator frequency step size
LF generator level setting
LF generator level step size
LF monitor settings
Display blanking settings

Note **In digital and vector modes the parameters are stored in place of the analog modulation parameters.**

Partial store

This is a less comprehensive store of only those parameters which currently affect the RF output; carrier frequency, RF level, modulations in use (without increments), ON/OFF and source information and the two modulation oscillator frequencies in use. There are 50 locations (numbered 0 to 49) for partial storage.

A Partial Store contains the following information:

Carrier frequency setting
RF level setting
The active modulation settings
Modulation mode and status
The frequency of the active modulation frequencies
Either the LF generator frequency and level setting or the LF monitor setting (depending on which mode is selected)

Note **In digital and vector modes the parameters are stored in place of the analog modulation parameters.**

Carrier store

The carrier frequency store has 100 locations (numbered 0 to 99) for the storage of carrier frequency only. This store can be used in conjunction with the full and partial stores to apply a set of test conditions to a range of frequencies.

Sweep store

The sweep store has 20 locations (numbered 0 to 19) for the storage of complete sets of sweep parameters.

Storing data

To store data, press the soft key for the type of store required, e.g. *[Partial Store]* and define a store location via the numerical key pad, then press [enter].

Note

The settings for the sequential calling tones are stored via the calling tones menu in UTILITIES, see Fig. 3-69. These stores can be erased from the *Store Erase Menu.*

Store erase

Unlock to Level 1. Pressing *[Store Erase]* causes the *Store Erase Menu* to appear on the screen. The opportunity to erase all the stores of a given type is available by pressing the relevant key and then pressing *[Erase]*.

Frequency hopping

Carrier frequency hopping is a GPIB operation where the instrument can be instructed to hop between any of the frequencies contained in the carrier frequency stores and a sequence of up to 1024 hops may be entered. The time interval between hops can also be entered.

Before executing a carrier hopping sequence, the frequencies must be loaded into the carrier frequency stores (0 - 99). This can be achieved via the GPIB using the following commands:

CFRQ < frequency value >
STO:CFRQ < store number >

To enter the frequency hopping mode, enter the following GPIB commands:

IMODE SWEEPER
SWEEP:TYPE HOP

This will cause the screen as shown in Fig. 3-85 to appear on the signal generator:

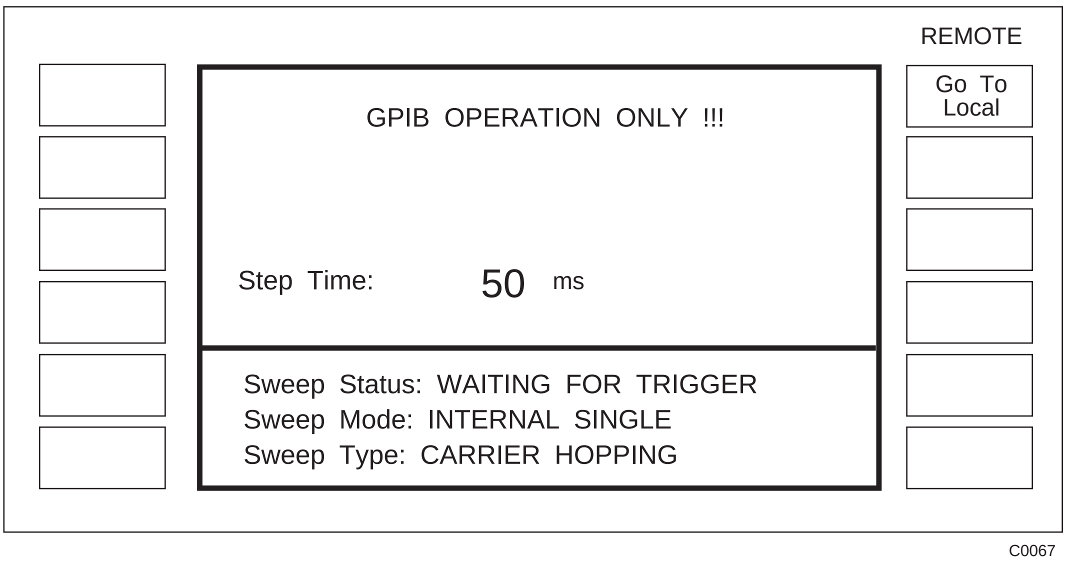


Fig. 3-85 Frequency hopping menu

To load in a sequence, the following command is used:

HOPSEQ<n0>,<n1>,<n2>,<n3>,<n4>.....

where <n0> - <n> are numeric values in the range 0-99 corresponding to the carrier frequency store at which the necessary frequency is stored. The hopping sequence length is determined by the amount of numbers entered.

The other parameter that can be set to control the hopping sequence is the time between steps. This is done using the command:

SWEEP:HOP:TIME < t >

where t represents the number of milliseconds.

The 100 frequencies are precalculated and loaded into a software sweep table using the GPIB command:

SWEEP:CALC

Note

If any of the carrier frequency stores have become corrupt and so result in a checksum error, the following message will appear in the centre of the screen:

CARRIER STORE < x > CORRUPTED.
RE - ENTER FREQUENCY.

where x is the corrupted store number.

With the frequencies, sequence and step time loaded, the hopping operation is controlled in the same manner as the ordinary sweeps by using the following commands:

SWEEP:GO	starts the hopping sequence (and will do any precalculation if required).
SWEEP:HALT	pause the hopping sequence.
SWEEP:UP	go up to the next step while paused.
SWEEP:DN	go down to previous step while paused.
SWEEP:CONT	continue hopping sequence.
SWEEP:RESET	reset sequence to start value.

When paused the carrier store number is displayed on the screen.

Note

There are no markers available and the operation of transferring the paused value to the main parameter is not permitted..

To enter a new sequence use the HOPSEQ command but the number 255 is inserted at the beginning of the string.

e.g. existing sequence - 0, 6, 53, 72, 43, 96

sequence required - 22, 16, 7, 41, 59, 66

send GPIB command:

```
HOPSEQ  255,22,16,7,41,59,66
```

To add to an existing sequence, use the HOPSEQ command without 255 at the beginning of the string.

e.g. existing sequence - 12, 24, 36, 48

sequence required - 12, 24, 36, 48, 60, 72, 84

send GPIB command:

```
HOPSEQ  60,72,84
```

To determine the length of the hopping sequence the following GPIB command is used:

```
HOPSEQ?
```

This returns a value 1 - 1024.

Like other sweep settings the frequency hopping mode can be set to:

single sweep (internal trigger),

continuous sweep (internal trigger) or

external sweep (external trigger)

by using the following commands:

SWEEP:MODE SNGL

SWEEP:MODE CONT

SWEEP:MODE EXT

For externally triggered operation the trigger facility can be used in the same manner as another sweep function.

Error handling

Errors may be divided into three groups - foreground errors generally caused by a user, background errors which represent a condition of the instrument and GPIB errors which occur only when the unit is being controlled by a GPIB controller.

Background errors

An incorrect operating condition within the instrument automatically generates an error message to warn the operator. For example, if the internal frequency standard should fail the message *Int. Standard Failure* will be displayed at the top of the screen. Background errors are listed in Table 3-2.

Foreground errors

Attempts to set the instrument to a parameter value outside its known range result in the generation of an error message. For example, trying to select a carrier frequency above or below the specified range results in the message *Carrier Outside Limits* being displayed at the top of the screen. Foreground errors are cleared automatically when a correct entry is made by the user. Foreground errors are listed in Table 3-3.

GPIB errors

Errors caused by incorrect programming are displayed at the top of the screen and may also generate a Service Request if the relevant status registers are set. GPIB errors are listed in Table 3-4.

Error display

Front panel

Errors are displayed as a single line of text at the top of the screen. If more than one error is present an internal priority ordering algorithm determines which error is displayed.

GPIB

When an error occurs, its number is entered into the Error Queue. Errors are not removed from the queue when they are cleared, but only by the ERROR? query, which returns the error at the head of the queue, or by the *CLS command which clears the whole queue. When the queue contains an error entry, a bit (<erb>) on the status byte is set.

The error queue has a capacity of 100 error numbers. If an error occurs while the queue is full the last error number is replaced with 255 so that the ERROR? query returns a value of 255 to indicate a full queue. An empty queue returns a value of 0 following an ERROR? query.

In addition to the error queue entry, the appropriate bit in the Standard Event Register will also be set (one of <cmd>, <exe>, <dde> or <qye>). Many background errors are also reported in the Hardware and Coupling Status Registers. For the above registers see Chap. 3-2.

Table 3-2 Background errors

Error No.	Error Type	Descriptive text	Error No.	Error Type	Descriptive text
1	dde	RPP Tripped	6	dde	VCXO Out of Lock
2	dde	Fractional N Out of Lock	7	dde	Ext1 Too Low
3	dde	Int. Standard Failure	8	dde	Ext1 Too High
4	dde	Ext. Standard Failure	9	dde	Ext2 Too Low
5	dde	Incorrect Ext. Standard	10	dde	Ext2 Too High
11	dde	IF Loop Out of Lock	16	-	-
12	dde	IQ Mod. Freq. Std. Failure	17	exe	RF Level limited by AM
13	dde	16/26 Reference Too High	18	exe	FM limited by Carrier
14	dde	16/26 Reference Too Low	19	exe	WBFM limited by Carrier
15	dde	IQ MOD. AUTOCAL REQUIRED	20	exe	AM2 limited by AM1
21	exe	FM2 limited by FM1	26	dde	Real Time Clock Problem
22	exe	PM2 limited by PM1	27	dde	Calibration Date Expired
23	exe	Steps limited by Span	28	dde	Pad Calibration Checksum
24	exe	FM Selfcal Error	29	dde	RF Calibration Checksum
25	dde	Internal Osc.1 Missing	30	dde	FM Calibration Checksum
31	dde	Path/Source Calibration	36	-	-
32	dde	Absolute Mod. Calibration	37	-	-
33	dde	Freq. Std. Calibration	38	-	-
34	dde	IQ MOD. RF Calibration	39	-	-
35	dde	IQ Modulator Calibration	40	exe	Profile Outside RF Limits
41	dde	Incorect Software Fitted			
42	exe	RF Lvl. Limited by IQ Mode			
43	exe	S’band Sel. Not Possible			
44	exe	IF Selection Not Possible			
45	exe	Carr. Limited by IQ Mode			

Table 3-3 Foreground errors

Error No.	Error Type	Descriptive text	Error No.	Error Type	Descriptive text
46	exe	Recall Checksum	51	exe	Carrier Outside Limits
47	exe	Incorrect Setup	52	exe	RF Level Outside Limits
48	exe	Invalid Memory Number	53	exe	Mod Rate Outside Limits
49	exe	MODULATION NOT ENABLED	54	exe	LF Freq. Outside Limits
50	exe	Out of Range	55	exe	LF Level Outside Limits
56	exe	AM Outside Limits	61	exe	RF Level Step Too Big
57	exe	FM Outside Limits	62	exe	Mod Rate Step Too Big
58	exe	PM Outside Limits	63	exe	LF Freq. Step Too Big
59	exe	WBFM Outside Limits	64	exe	LF Level Step Too Big
60	exe	Carrier Step Too Big	65	exe	AM Step Too Big
66	exe	FM Step Too Big	71	exe	Sweep Stop Out of Range
67	exe	PM Step Too Big	72	exe	Sweep Steps Out of Range
68	exe	Invalid Latch Number	73	exe	Sweep Time Out of Range
69	exe	Invalid Latch Data	74	exe	Sweep Marker Out of Range
70	exe	Sweep Start Out of Range	75	exe	Attenuator EAROM Read
76	exe	Attenuator EAROM Write	81	exe	EAROM Wrap Around Error
77	exe	RF Option Box EAROM Read	82	exe	Continuous Tone Checksum
78	exe	RF Option Box EAROM Write	83	exe	Sequential Tone Checksum
79	exe	EAROM Write Error	84	exe	Tone data Out of Range
80	exe	EAROM Read Error	85	exe	Tone Offset Out of Range
86	exe	Clock Data Entry Error	91	exe	RF levelling fault
87	exe	At Top Limit	92	exe	REPEAT THIS CALIBRATION
88	exe	At Bottom Limit	93	exe	DSP Not Responding
89	exe	Ext. Trigger Disabled	94	exe	A/D Conversion Failure
90	dde	Int. Std. Not Selected	95	exe	Tone Sequence Incorrect
96	exe	Mod. Autocal Failure			
97	-	-			
98	exe	Direct Doppler Limited			
99	exe	Insufficient Points			
100	exe	Carrier Outside Profile			

Table 3-4 GPIB errors

Error No.	Error Type	Descriptive text	Error No.	Error Type	Descriptive text
101	-	-	106	cmd	Data Expected
102	cmd	Mnemonic Fault	107	cmd	Illegal Data
103	cmd	Block Definition	108	cmd	Terminator Expected
104	cmd	Block Size	109	cmd	GET Error
105	cmd	Numeric Syntax	110	cmd	EOM Error
111	exe	Illegal Modulation Mode	116	qye	Unterminated
112	exe	No Such Monitor Mode	117	qye	Interrupted
113	exe	Cannot Monitor	118	qye	Deadlock
114	exe	Instrument Mode Wrong	119	cmd	Missing Quote
115	cmd	Lost Data After Comma	120	cmd	Terminator Expected
121	exe	String Length	126	exe	Illegal Seq Tones Mode
122	exe	Illegal Tone Character	127	exe	Overflow
123	exe	Illegal Duration Char	128	cmd	Data Too Long
124	exe	Illegal Standard	129	exe	Voltage Type Error
125	exe	Illegal Save Destination	130	exe	Sweep Not Possible
131	exe	Unknown Cal Point	136	exe	Unknown Freq. Standard.
132	exe	Unknown RF Band	137	exe	User Data Locked
133	exe	Unknown Instrument Mode	138	exe	Trigger Unknown
134	exe	User Data Checksum	139	exe	Illegal Tones Operation
135	qye	Query Lost after arb. char	140	cmd	Error in Char Data
141	exe	Wrong RF units	146	exe	Wrong Family For Command
142	cmd	Data Unknown	147	exe	Not Suitable For Hopping
143	exe	Negative Value Illegal	148	exe	Hopping Sequence Full
144	exe	Illegal Modulation Mode	149	-	-
145	exe	Unavailable Mod Source	150	exe	Wrong LF Units
151	-	-	156	exe	Text Tone Util. Selected
152	-	-	157	exe	Illegal Sequence Char.
153	-	-	158	exe	Point not in Profile
154	exe	Unknown Waveform ROM Type	159	exe	Unkown External Box Type
155	exe	IQ Mode Parameter Unkown	160	-	

Table 3-5 Fatal errors

Error No.	Error Type	Descriptive text	Error No.	Error Type	Descriptive text
171	exe	Main RAM Faulty	176	-	-
172	exe	Main PROM Faulty	177	-	-
173	exe	Microwave Board Error	178	-	-
174	exe	Attenuator Type Unknown	179	-	-
175	exe	Wrong Attenuator fitted	180	-	-

Chapter 4
GPIB OPERATION

Contents

List of tables

Introduction

The 2050T Series signal generators can be operated remotely from a personal computer fitted with a GPIB interface card or a dedicated GPIB controller. All functions can be controlled by coded messages sent over the interface bus via the 24-way socket on the rear panel of the instrument. IEEE Standard 488.2 (1987) is implemented, which defines the protocols and syntax of commands. The 2050T Series commands are compatible with 2030 Series signal generators.

The instrument can function either as a talker or a listener. In the listen mode, it will respond to IEEE 488.2 common commands and queries and device-specific commands and queries. These allow various device functions to be controlled and operating parameters to be set. In the talk mode, device status information and parameter settings can be read from the instrument.

For full information on the IEEE protocols and syntax the IEEE 488.2 Standard should be consulted.

GPIB functions

The IEEE 488.1 interface functions offered by 2050T Series are as follows:

Source handshake	(SH1) complete capability.
Acceptor handshake (AH1)	complete capability.
Talker (T6)	basic talker, serial poll, unaddress if MLA.
Listener (L4)	basic listener, unaddress if MTA.
Service Request (SR1)	complete capability.
Remote/Local (RL1)	complete capability.
Device clear (DC1)	complete capability.
Device trigger (DT1)	complete capability.
Parallel Poll (PP0)	no capability.
Controller (C0)	no capability.
Tri-state drivers (E2)	as opposed to open collector drivers.

Device listening elements

The following is a list of the device listening elements (as defined in the IEEE 488.2 standard) which are used in the 2050T Series of signal generators:

<PROGRAM MESSAGE>
<PROGRAM MESSAGE TERMINATOR>
<PROGRAM MESSAGE UNIT>
<PROGRAM MESSAGE UNIT SEPARATOR>
<COMMAND MESSAGE UNIT>
<QUERY MESSAGE UNIT>
<COMPOUND COMMAND PROGRAM HEADER>
<COMPOUND QUERY PROGRAM HEADER>
<PROGRAM HEADER SEPARATOR>
<PROGRAM DATA>
<PROGRAM DATA SEPARATOR>
<DECIMAL NUMERIC PROGRAM DATA>
<CHARACTER PROGRAM DATA>
<SUFFIX PROGRAM DATA>
<STRING PROGRAM DATA>
<ARBITRARY BLOCK PROGRAM DATA>

Device talking elements

The following is a list of the device talking elements (as defined in the IEEE 488.2 standard) which are used in the 2050T Series of signal generators:

<RESPONSE MESSAGE>
<RESPONSE MESSAGE TERMINATOR>
<RESPONSE MESSAGE UNIT>
<RESPONSE MESSAGE UNIT SEPARATOR>
<COMPOUND RESPONSE HEADER>
<RESPONSE HEADER SEPARATOR>
<RESPONSE DATA>
<RESPONSE DATA SEPARATOR>
<NR1 NUMERIC RESPONSE DATA>
<NR2 NUMERIC RESPONSE DATA>
<ARBITRARY ASCII RESPONSE DATA>
<CHARACTER RESPONSE DATA>
<STRING RESPONSE DATA>
<DEFINITE LENGTH ARBITRARY BLOCK RESPONSE DATA>

Programming

Program messages

A message consists of one or more message units. Message units are separated by a semi-colon (;). The whole message is ended by the Program Message Terminator (or End Of Message) defined as one of the following:

(1) <newline> (ASCII 10 - often known as 'line feed') or

(2) <newline> + END (the EOI line is asserted as well) or

(3) + END (EOI is asserted in the last data byte of the message)

Note **A response message is always terminated by <EOM> consisting of <newline> + END.**

A message unit consists of a mnemonic header which may be followed by data. If data follows, then it must be separated from its header by at least one space

<header><SPACE><data>
e.g. RFLV:INC 6.0 dB

Spaces may be freely inserted in a message to improve readability, except within a header or within data.

A header may be a command or a query. A query has a '?' as its final character and causes the generation of a response message which will be read by the controller. Common commands and queries (defined in IEEE 488.2) begin with a '*'.

Upper and lower case characters are considered equivalent (i.e. FM fm Fm fM are all interpreted by the 2050T Series in the same way).

Compound headers

The 2050T Series implements compound headers which allow a complex set of commands to be built up from a small set of basic elements in a 'tree and branch' structure. The elements of a compound header are separated by a colon (:). Spaces are not allowed within a header.

Special rules apply when more than one compound header is used in one message. When the separator ';' is encountered, all headers except the trailing element of the previous header in the message are assumed to precede the following header, for example:

AM:DEPTH 30PCT;ON

is equivalent to the two commands:

AM:DEPTH 30PCT
and AM:ON

This does not apply to common commands (*RST etc.). The rule may be overridden by preceding a header with a colon, for example:

AM:ON;:FM:ON

Most main functions have a short form of header which may be used for clarity and brevity in simple messages, for example:

CFRQ 1.25GHZ is the same as CFRQ:VALUE 1.25GHZ

Program data

Data can take many forms, as follows:

Decimal Numeric Data is a flexible numeric format which encompasses integer, fixed point and floating point (mantissa and exponent) representations. Data is rounded to a resolution appropriate to the function. Decimal data can, in most cases, be followed by the appropriate units. If no units are present, the specified default units are assumed.

Character Data is an alphanumeric word.

String Data consists of a number of 7-bit ASCII characters enclosed in quotes, either a pair of single ('ASCII 39') or double ("ASCII 34") quotes may be used.

Block Data is used by *PUD and allows a number of 8-bit bytes to be transferred. For further information see the Service Manual.

Some commands can accept Multiple Data items which are separated by commas, for example MODE FM,AM.

Message exchange protocol

The controller should not attempt to read a response until it has sent the entire query message (terminated by EOM). Also, it should not start to send a new message until it has read the entire response (terminated by EOM). The query message may contain more than one query message unit, but only one response message (containing several response message units) is generated.

Failure to follow the protocol will generate a query error:

UNTERMINATED (error 116) occurs when the controller attempts to read a response without having sent a query.

INTERRUPTED (error 117) occurs when the controller starts to send a new message before having read the response to a preceding query.

DEADLOCK (error 118) can only occur if the input and output buffers are both filled by the controller having sent an extra long Message containing several query message units.

The 2050T Series have input buffer stores of 256 characters and an output buffer of two response message units.

Remote/local operation

When the 2050T Series Signal Generator is addressed by the controller it will enter its remote mode and the screen will have only one key legend, *[LOCAL]*. Pressing this key returns the unit to normal manual operation, unless Local Lockout has been asserted by the controller.

Common commands and queries (IEEE 488.2)

The IEEE 488.2 standard defines a set of common commands and queries which implement common system functions.

Common command and query mnemonics are preceded by an asterisk (*) to distinguish them from device dependent data such as instrument programming strings. The following common commands and queries are implemented in the 2050T Series:

Mnemonic	**Name and Description**
*IDN?	Identification Query. Returns an arbitrary ASCII response comprising four data fields in the format: <Manufacturer>,<type number>,<serial number>,<firmware version number><EOM>. Example: `IFR ,2051,123456789,2.001<EOM>`
*OPT?	Option Identification Query. Returns an arbitrary ASCII response containing a data field for each fitted option in the format: <option a>,<option d>, ... ,<option *n*><EOM> Example: `SECOND OSCILLATOR,PULSE MODULATION,+19 dBm OUTPUT<EOM>` If no options are fitted, ASCII '0' is returned.

Note

Because an Arbitrary ASCII Response ends with the Response Message Terminator (<EOM>) either *IDN? or *OPT? must be the last Query Message Unit in a Program Message.

Mnemonic *(contd.)*	**Name and Description**
*RST	Reset Command. Sets the instrument functions to the factory default power up state. The default settings appear in Table 4-1.
*TST?	Self Test Query. Returns a '0' when the GPIB interface and processor are operating.
*OPC	Operation Complete Command. Sets the Operation Complete bit in the Standard Event Status Register when execution of the preceding operation is complete.
*OPC?	Operation Complete Query. Returns a '1' when the preceding operation has been completed.
*WAI	Wait to Continue Command. Inhibits execution of an overlapped command until the execution of the preceding operation has been completed.
*TRG	Trigger Command. Equivalent to Group Execute Trigger.
*PUD <block>	Protected User Data Command. Sets the Protected User Data, accepts Definite Block Data when enabled. This command is covered in further detail in the Service Manual.
*PUD?	Protected User Data Query. Returns the User Data as a Definite Block Response.
Example:	`#221Inventory Number 1234`
*STB?	Read Status Byte Query. Returns the value of the Status Byte as an nr1 number (0-255).
*SRE <nrf>	Service Request Enable Command. Sets the Service Request Enable Register.
*SRE?	Service Request Enable Query. Returns the value of the Service Request Enable Register as nr1.
*ESR?	Standard Event Status Register Query. Returns the value of the Status Event Status Register as nr1.
*ESE <nrf>	Standard Event Status Enable Command. Sets the Standard Event Enable Register.
*ESE?	Standard Event Status Enable Query. Returns the value of the Standard Event Status Enable Register as nr1.
*CLS	Clear Status Command. Clears all the Status Event registers and clears the Error Queue. Does not affect the Enable Registers.

Note

The IEEE 488.2 Device Clear function only affects the GPIB functions. The input and output buffers are cleared and the instrument put into a state to accept new Messages. It no longer puts the instrument functions into a defined state, this is now performed by the *RST common command.

Device dependent commands

The following list describes the features of the device dependent mnemonics for the 2050T Series signal generators together with simple examples of their use within each major section (carrier frequency, RF level, etc.) the root mnemonic is listed first followed by the lower level mnemonics. Each group is followed by a list of requirements for data type and suffix.

In addition to the normal listen commands the 2050T Series accept query commands which cause the instrument to prepare a message which will be sent to the controller when the instrument is next addressed to talk. For each query an example of a response is given. Where responses are similar for a group of queries not all are listed. Some queries can produce more than one type of response - an example of each is usually given.

In the list which follows, the abbreviations <char>, <nrf> and <str> have the following meanings:

<char> = Character Program Data
<nrf> = Decimal Numeric Program Data
<str> = String Program Data

Where the data format is Decimal Numeric Program Data, the value may be expressed as a signed or unsigned number in any of the following formats:

nr1: Decimal integer, e.g. 1234 or -567
nr2: Floating point number, e.g. 1.234 or -56.789
nr3: Floating point number with exponent, e.g. 1.2345E5 or -12.47E-8

Default settings

These are the settings assigned to instrument functions in the following cases:

(i) Power-up to factory default settings.

(ii) Execution of *RST command.

(iii) Recall Full Store 50.

The instrument functions set to the factory default power-up state by the reset command (*RST) are as shown in Table 4-1.

Table 4-1 Instrument default settings

Instrument mode		:	Normal	
Carrier frequency		:	(Maximum available) 1.35 GHz/2.7 GHz/5.4 GHz	
	Step	:	1 kHz	
RF level		:	-144 dBm	
	Step	:	1 dB	
	Status	:	ON	
Modulation mode		:	Single FM , modulation enabled	
Modulations		:	FM1 :	0 Hz, Int F4, ON
			FM2 :	0 Hz, Ext 1 ALC, ON
			ΦM1 :	0 rad, Int F4, ON
			ΦM2 :	0 rad, Ext 1 ALC, ON
			AM1 :	0%, Int F4, ON
			AM2 :	0%, Ext 2 ALC, ON
			WBFM:	(Minimum setting), AC coupled, ON
	Steps	:	ΔFM 1 kHz, Δ ΦM 0.1 rad, ΔAM 1%	

Table 4-1 Instrument default settings (continued)

Modulation source		
	IntF1 :	300 Hz sine
	IntF2 :	400 Hz sine
	IntF3 :	500 Hz sine
	IntF4 :	1 kHz sine
	IntF5 :	3 kHz sine
	IntF6 :	6 kHz sine
	Step :	1 kHz
LF	Mode :	Monitor, mod source
LF generator		
	Frequency :	1 kHz sine, step 1 kHz
	Level :	100 μV
	Step :	1 dB
	Status :	ON
Sweep:		
Type :		RF level
Mode :		Single internal
RF level sweep :		
	Start :	-144 dBm
	Stop :	10 dBm
	Steps :	100
	Time :	50 ms
	Markers :	2, 4, 6, 8, 10 dBm, disabled
Carrier freq sweep	:	
	Start :	100 MHz
	Stop :	(Maximum available)
	Steps :	250
	Time :	50 ms
	Markers :	200, 400, 600, 800, 1000 MHz, disabled
Mod source freq	:	
	Start :	0.1 Hz
	Stop :	500 kHz
	Steps :	10,000
	Time :	500 ms
	Markers :	100, 20, 30, 400, 500 kHz
	Sequential tones :	
	Mode :	No modulation selected
	Standard :	CCIR
	Sequence :	16 Tone Fs
	Duration :	All normal
	Frequency offset :	0
	Extended duration :	500 ms
	Repeat tone :	E
	Start delay :	200 ms

Instrument mode

IMODE — Select instrument mode

Data type : Character Program Data (either NORMAL for signal generator operation or SWEEPER for swept operation)
Allowed suffices : None
Default suffix : None

Example: `IMODE NORMAL`

Carrier frequency

CFRQ — Set Carrier Frequency (short form)

:VALUE — Set Carrier Frequency

:INC — Set Carrier Frequency step

Data type : Decimal Numeric Program Data
Allowed suffices : Any one of: GHZ, MHZ, KHZ or HZ
Default suffix : HZ

:UP — Go UP one step

:DN — Go DOWN one step

:RET — Return to original setting

:XFER — Transfer current value to be the new setting

Data type : None
Allowed suffices : None
Default suffix : None

:PHASE — Adjust Phase of Carrier in steps of p/128 radians (approximately 1.4°) over a range of ±255 steps

Data type : Decimal Numeric Program Data
Allowed suffices : None
Default suffix : None

Examples:
```
CFRQ:VALUE 1.23MHZ;INC 10KHZ
CFRQ:UP;XFER
```

CFRQ? — Prepares message containing information on Carrier Frequency setting in the following format:

:CFRQ:VALUE <nr2>; INC <nr2>

Example: `:CFRQ:VALUE 1000000000.0;INC 25000.0`

RF level

RFLV		Set RF output level (short form)
:VALUE		Set RF output level
	Data type :	Decimal Numeric Program Data
	Allowed suffices :	Any one of: DBM, DBV, DBMV, DBUV, V, MV or UV
	Default suffix :	dBm unless changed by UNITS command
:INC		Set RF level step (dB)
	Data type :	Decimal Numeric Program Data
	Allowed suffices :	DB only
	Default suffix :	DB
:UP		Go UP one step
:DN		Go DOWN one step
:RETN		Return to original setting
:XFER		Transfer current value to be the new setting
:ON		Turn RF output ON
:OFF		Turn RF output OFF
	Data type :	None
	Allowed suffices :	None
	Default suffix :	None
:TYPE		Selects EMF or PD for voltage related units
	Data type :	Character Program Data (EMF or PD)
	Allowed suffices :	None
	Default suffix :	None
:UNITS		Select default RF level units.
	Data type :	Character Program Data (DBM, DBV, DBMV, DBUV, V, MV or UV)
	Allowed suffices :	None
	Default suffix :	None
	Examples:	`RFLV:VALUE -27.3DBM;ON` `RFLV:TYPE PD;VALUE 1.23UV`
:OFFS		[not used alone]
:VALUE		Set Offset of current band
	Data type :	Decimal Numeric Program Data
	Allowed suffices :	DB only
	Default suffix :	DB
:ON		Turn ON offset of current band
:OFF		Turn OFF offset of current band
:ENABLE		Enable Offsets
:DISABLE		Disable Offsets
:SAVE		Store Offsets in memory
	Data type :	None
	Allowed suffices :	None
	Default suffix :	None
	Example:	`RFLV:OFFS:VALUE -0.2DB;ON;ENABLE`

RFLV (continued)

RFLV?

Prepares message containing information on RF Level setting in the following format:

:RFLV:UNITS <unit>;TYPE <type>;VALUE <nr2>;INC <nr2>;<status>

where: <unit> is character program data defining the default RF level units (DBM, DBV, DBMV, DBUV, V, MV or UV), <type> is character program data indicating EMF or PD and <status> is a program mnemonic indicating whether the RF output is ON or OFF.

Examples:
```
:RFLV:UNITS DBM;VALUE -103.5;INC 2.0;ON
:RFLV:UNITS DBV;TYPE EMF;VALUE -83.2;INC 0.5;ON
```

RFLV:OFFS?

Prepares message containing information on RF Level offsets in the following format:

:CFRQ:VALUE <nr2>;:RFLV:OFFS:VALUE <nr2>;<status>;<activity>

where: <status> is a program mnemonic indicating whether the RF offset is ON or OFF and <activity> is a program mnemonic indicating whether the offset mode is enabled or disabled.

Example:
```
:CFRQ:VALUE 500000000.0;:RFLV:OFFS:VALUE -0.4;ON;ENABLE
```

RFLV

:HYST	[not used alone]
:ENABLE	Enable Extended Hysteresis mode
:DISABLE	Disable Extended Hysteresis mode

Data type : None
Allowed suffices : None
Default suffix : None

:RFLV:HYST?

Responds with status as follows:

:RFLV:HYST:ENABLE

or :RFLV:HYST:DISABLE

RFLV

:LIMIT	Set RF output level limit (short form)
:VALUE	Set RF output level limit.

Data type : Decimal Numeric Program Data
Allowed suffices : Any one of DBM, DBV, DBMV, DBUV, V, MV or UV
Default suffix : dBm unless changed by UNITS command (see above).

:ENABLE	Enable RF output level limit
:DISABLE	Disable RF output level limit
:SAVE	Save RF output level limit to memory

Data type : None
Allowed suffices : None
Default suffix : None

RFLV:LIMIT?

Prepares message containing information on RF level setting in the following format:

:RFLV:UNITS <unit>;TYPE <type>;LIMIT:VALUE<nr2>;<status>

where: <unit> is character program data defining the default RF level units (DBM, DBV, DBMV, DBUV, V, MV or UV), <type> is character program data indicating EMF or PD and <status> is a program mnemonic indicating whether the RF level limit is enabled or disabled.

Examples:
```
:RFLV:UNITS DBM;LIMIT:VALUE -10.2;ENABLE
:RFLV:UNITS V;TYPE PD;LIMIT:VALUE 0.224;DISABLE
```

Modulation mode

MODE Set modulation mode

Data type : Character Program Data (valid combinations of AM, AM1, AM2, FM, FM1, FM2, PM, PM1, PM2, WBFM or PULSE, see Table below)

Allowed suffices : None

Default suffix : None

Examples:

```
MODE AM,FM
MODE FM1,FM2
MODE DIGITAL
MODE ADV_DIG
```

VALID MODE COMBINATIONS TABLE

Digital	Adv. Dig.	Vector
Digital	Adv. Dig.	Vector

Single	Composite	Dual	Dual Composite
AM1	AM1,AM2	AM1,FM1	AM1,AM2,FM1,FM2
FM1	FM1,FM2	AM1,PM1	AM1,AM2,PM1,PM2
PM1	PM1,PM2	AM1,WBFM	AM1,AM2,WBFM
WBFM		PULSE,FM1	PULSE,FM1,FM2
PULSE		PULSE,PM1	PULSE,PM1,PM2
		PULSE,WBFM	

Note:

At any time the '1' may be omitted, for example FM is equivalent to FM1. Order is not important, for example AM,FM is equivalent to FM,AM.

For instruments without pulse modulation (Option 002) fitted, select Low Intermodulation mode by using character data type PULSE.

MODE? Prepares message containing information on Modulation Mode in the following format:

:MODE:<mode>

where: <mode> is character program data indicating the modulation mode settings.

Example:

```
:MODE FM1,FM2
:MODE VECTOR
```

Modulation control

MOD [not used alone]

:ON Turn modulation globally ON

:OFF Turn modulation globally OFF

Examples:

```
MOD:ON
MOD:OFF
```

MOD? Prepares message containing information on Modulation Control in the following format:

:MOD:<status>

where: <status> is a program mnemonic indicating whether the Modulation is globally ON or OFF.

Example:

```
:MOD:ON
```

Digital modulation

MODE

Set digital modulation mode (in addition to existing modulation mode commands)

Data type : Character Program Data
Allowed suffices : None
Default suffix : None

Example: `MODE DIGITAL`

MODE?

Prepares message containing information on modulation mode in the following format:

:MODE <mode>

where: <mode> is character program data indicating the modulation mode setting.

Example: `:MODE DIGITAL`

DIGITAL

[not used alone]

:MODOPT

[not used alone]

:SBAND

Select sideband control

Data type : Character Program Data (any one of: UPPER, LOWER, AUTO)
Allowed suffices : None
Default suffix : None

:IF

Select IF control

Data type : Character Program Data (any one of: MHZ120, MHZ132, MHZ160, MHZ176, AUTO)
Allowed suffices : None
Default suffix : None

:MODPOL

Select modulation polarity control

Data type : Character Program Data (either NORMAL or INVERSE)
Allowed suffices : None
Default suffix : None

:ENVELOPE

Select external envelope input control

Data type : Character Program Data (either DISABLED or ENABLED)
Allowed suffices : None
Default suffix : None

:CONFIG

[not used alone]

:MIXER

Select mixer control

Data type : Character Program Data (either INTERNAL or EXTERNAL)
Allowed suffices : None
Default suffix : None

:CONFIG

:IQ

Select IQ output enable control

Data type : Character Program Data (either DISABLED or ENABLED)
Allowed suffices : None
Default suffix : None

:PULSE

Select pulse input control

Data type : Character Program Data (either ENABLED or DISABLED)
Allowed suffices : None
Default suffix : None

DIGITAL (continued)

:FADING — [not used alone]

:CTRL — Select fading control

Data type : Character Program Data (any one of: DISABLED, RAYLEIGH, RICIAN)
Allowed suffices : None
Default suffix : None

:SPEED — Set doppler speed

Data type : Decimal Numeric Program Data
Allowed suffices : Any one of GHz, MHz, kHz, Hz
Default suffix : Hz

:DIR_DOPP — Set direct doppler path

Data type : Decimal Numeric Program Data
Allowed suffices : Any one of: GHz, MHz, kHz, Hz
Default suffix : Hz

:RATIO — Set path ratio (direct to scattered) - Rayleigh Fading only

Data type : Decimal Numeric Program Data
Allowed suffices : DB only
Default suffix : DB

:ERROR — [not used alone]

:ENABLE — Enable IQ modulator errors

:DISABLE — Disable IQ modulator errors

Data type : None
Allowed suffices : None
Default suffix : None

:SKEW — Set IQ skew error (short form)

:VALUE — Set IQ skew error

Data type : Decimal Numeric Program Data
Allowed suffices : DEG
Default suffix : DEG

SKEW

:ON — Turn on IQ skew error

:OFF — Turn off IQ skew error

Data type : None
Allowed suffices : None
Default suffix : None

:GAIN — Set IQ gain imbalance error (short form)

:VALUE — Set IQ gain imbalance error

Data type : Decimal Numeric Program Data
Allowed suffices : DB only
Default suffix : DB

:ON — Turn on IQ gain imbalance error

:OFF — Turn off IQ gain imbalance error

Data type : None
Allowed suffices : None
Default suffix : None

DIGITAL (continued)

:LEAK — Set carrier leakage error (short form)

:VALUE — Set carrier leakage error

Data type : Decimal Numeric Program Data
Allowed suffices : PCT
Default suffix : PCT

:ON — Turn on IQ carrier leakage error

:OFF — Turn off IQ carrier leakage error

Data type : None
Allowed suffices : None
Default suffix : None

:SYSTEM — [not used alone]

:FORMAT — Select modulation type

Data type : Character Program Data (any one of: QAM4, QAM16, QAM64, QAM256, BPSK, QPSK, PSK8, O_BPSK, O_QPSK, O_PSK8, D_BPSK, D_QPSK, D_PSK8, FSK2, FSK4, GMSK, TOQPSK, T_TONES)
Allowed suffices : None
Default suffix : None

:FILTER — Select filter type

Data type : Character Program Data (any one of: R_R_COS, R_COS, GAUSS)
Allowed suffices : None
Default suffix : None

:SYSTEM

:SYM_RATE — Set symbol rate

Data type : Decimal Numeric Program Data
Allowed suffices : Any one of: GHz, MHz, kHz, Hz
Default suffix : Hz

:ALPHA — Set filter alpha

Data type : Decimal Numeric Program Data
Allowed suffices : None
Default suffix : None

:THREE_DB — Set filter 3 dB

Data type : Decimal Numeric Program Data
Allowed suffices : Any one of: GHz, MHz, kHz, Hz
Default suffix : Hz

:DEVN — Set FSK deviation

Data type : Decimal Numeric Program Data
Allowed suffices : Any one of: GHz, MHz, kHz, Hz
Default suffix : Hz

:MAPPING — Set 4FSK mapping

Data type : Character Program Data (either NORMAL or INVERSE)
Allowed suffices : None
Default suffix : None

:SELECT — Select an IQ system

Data type : Character Program Data (any one of: NADC, PDC, TETRA, Q_APCO25, F_APCO25, MODACOM, ERMES, POC512, POC1200, POC2400, POC4800, CITY512, CITY1200, CITY2400, CITY4800, MOBITEX, MC9, MD24N, MD36N, MD48N, MD80N, MD96N, MD160N, MD24W, MD36W, MD48W, MD80W, MD96W, MD100W, MD120W, MD192W, TFTS, DSRR4, DSRR16, CDPD, GSM, INMAR_M, VDR, USER1, USER2, USER3, USER4, USER5)
Allowed suffices : None
Default suffix : None

:STO — Store setup to user defined system

Data type : Character Program Data (any one of: USER1, USER2, USER3, USER4, USER5)
Allowed suffices : None
Default suffix : None

DIGITAL (continued*)*

:EXT_SER [not used alone]

:DATAPOL Select external serial data and specify the data polarity

Data type : Character Program Data (either NORMAL or INVERSE)
Allowed suffices : None
Default suffix : None

:BITSTAT Select external serial data and specify the bit clock status

Data type : Character Program Data (either INTERNAL or EXTERNAL)
Allowed suffices : None
Default suffix : None

:EXT_SER

:BITPOL Select external serial data and specify the bit clock polarity

Data type : Character Program Data (either POS_EDGE or NEG_EDGE)
Allowed suffices : None
Default suffix : None

:SYMSTAT Select external serial data and specify the symbol clock status

Data type : Character Program Data (either INTERNAL or EXTERNAL)
Allowed suffices : None
Default suffix : None

:SYMPOL Select external serial data and specify the symbol clock polarity

Data type : Character Program Data (either POS_EDGE or NEG_EDGE)
Allowed suffices : None
Default suffix : None

:EXT_PAR [not used alone]

:DATAPOL Select external paralled data and specify the data polarity

Data type : Character Program Data (either NORMAL or INVERSE)
Allowed suffices : None
Default suffix : None

:EXT_PAR

:SYMSTAT Select external parallel data and specify the symbol clock status

Data type : Character Program Data (either INTERNAL or EXTERNAL)
Allowed suffices : None
Default suffix : None

:SYMPOL Select external parallel data and specify the symbol clock polarity

Data type : Character Program Data (either POS_EDGE or NEG_EDGE)
Allowed suffices : None
Default suffix : None

:INT_0S [not used alone]

:DATAPOL Select internal "all-zeros" data and specify the data polarity

Data type : Character Program Data (either NORMAL or INVERSE)
Allowed suffices : None
Default suffix : None

:CLOCK Select internal "all-zeros" and specify the clock source

Data type : Character Program Data (any one of: INT_SYM, EXT_SYM, EXT_BIT)
Allowed suffices : None
Default suffix : None

:INT_0S

:CLOCKPOL Select internal "all-zeros" and specify the clock polarity

Data type : Character Program Data (either POS_EDGE or NEG_EDGE)
Allowed suffices : None
Default suffix : None

DIGITAL (continued*)*

:INT_1S [not used alone]

:DATAPOL Select internal "all-ones" data and specify the data polarity

Data type : Character Program Data (either NORMAL or INVERSE)
Allowed suffices : None
Default suffix : None

:INT_1S

:CLOCK Select internal "all-ones" and specify the clock source

Data type : Character Program Data (any one of: INT_SYM, EXT_SYM, EXT_BIT)
Allowed suffices : None
Default suffix : None

:CLOCKPOL Select internal "all-ones" and specify the clock polarity

Data type : Character Program Data (either POS_EDGE or NEG_EDGE)
Allowed suffices : None
Default suffix : None

:PRBS Select internal "prbs" data and specify the "n" value

:VALUE Select internal "prbs" data and specify the "n" value

Data type : Decimal Numeric Program Data
Allowed suffices : None
Default suffix : None

:DATAPOL Select internal "prbs" data and specify the data polarity

Data type : Character Program Data (either NORMAL or INVERSE)
Allowed suffices : None
Default suffix : None

:CLOCK Select internal "prbs" data and specify the clock source

Data type : Character Program Data (any one of: INT_SYM, EXT_SYM, EXT_BIT)
Allowed suffices : None
Default suffix : None

:CLOCKPOL Select internal "prbs" data and specify the clock polarity

Data type : Character Program Data (either POS_EDGE or NEG_EDGE)
Allowed suffices : None
Default suffix : None

:T_TONES [not used alone]

:FREQ Specify the test tone frequency setting

Data type : Decimal Numeric Program Data
Allowed suffices : Any one of: GHZ, MHZ, kHZ, HZ
Default suffix : Hz

:I_AMP Specify the test tone I amplitude setting

Data type : Decimal Numeric Program Data
Allowed suffices : V only
Default suffix : V

:I_DC Specify the test tone I DC-offset setting

Data type : Decimal Numeric Program Data
Allowed suffices : V only
Default suffix : V

:Q_AMP Specify the test tone Q amplitude setting

Data tDype : Decimal Numeric Program Data
Allowed suffices : V only
Default suffix : V

:Q_DC Specify the test tone Q DC-offset setting

Data type : Decimal Numeric Program Data
Allowed suffices : V only
Default suffix : V

DIGITAL:T_TONES (continued*)*

:ANGLE — Specify the test tone IQ angle setting

Data type : Decimal Numeric Program Data
Allowed suffices : DEG
Default suffix : DEG

:CAL — Execute IQ Autocal

Data type : None
Allowed suffices : None
Default suffix : None

:MODOPT? — Prepares message containing information on DIGITAL modulation control setting in the following format:

:DIGITAL:MODOPT:SBAND<status>;IF<status>;MODPOL <status>;ENVELOPE<status>

where: <status> is character program data for the specified mnemonic.

Example: `:DIGITAL:MODOPT:SBAND AUTO;IF MHZ120;MODPOL INVERSE;ENVELOPE DISABLED`

:CONFIG? — Prepares message containing information on DIGITAL modulation setting in the following format:

:DIGITAL:CONFIG:MIXER<status>;IQ<status>;PULSE<status>

where: <status> is character program data for the specified mnemonic.

Example: `:DIGITAL:CONFIG:MIXER EXTERNAL;IQ DISABLED;PULSE ENABLED`

:FADING? — Prepares message containing information on DIGITAL modulation fading setting in the following format:

:DIGITAL:FADING:CTRL<status>;SPEED <nr2>;DIR_DOPP <nr2>; RATIO <nr2>

where: <status> is character program data for the specified mnemonic.

Example: `:DIGITAL:FADING:CTRL RAYLEIGH;SPEED 52;DIR_DOPP 0;RATIO 12`

:ERROR? — Prepares message containing information on the IQ error control in the following format:

:DIGITAL:ERROR:<status>

where: <status> is a program mnemonic indicating whether the IQ errors are globally ENABLE or DISABLE.

Example: `:DIGITAL:ERROR:ENABLE`

:SKEW? — Prepares message containing information on the IQ skew error setting in the following format:

:DIGITAL:SKEW:VALUE <nr2>;<status>

where: <status> is a program mnemonic indicating whether the IQ skew error is ON or OFF.

Example: `:DIGITAL:SKEW:VALUE 10.1; OFF`

:GAIN? — Prepares message containing information on the IQ gain imbalance error setting in the following format:

:DIGITAL:GAIN:VALUE <nr2>; <status>

where: <status> is a program mnemonic indicating whether the IQ gain imbalance error is ON or OFF.

Example: `:DIGITAL:GAIN:VALUE -27; ON`

DIGITAL (continued)

:LEAK?

Prepares message containing information on the carrier leakage error setting in the following format:

:DIGITAL:LEAK:VALUE <nr2>; <status>

where: <status> is a program mnemonic indicating whether the carrier leakage error is ON or OFF.

Example:

```
:DIGITAL:LEAK:VALUE 0.0; OFF
```

:SYSTEM?

Prepares message containing information on the modulation system setup in one of the following formats:

AL:SYSTEM:FORMAT<status>;FILTER<status>; SYM_RATE <nr2>;ALPHA <nr2>

:DIGITAL:SYSTEM:FORMAT<status>;FILTER<status>; SYM_RATE <nr2>;THREE_DB<status>

where: <status> is character program data for the specified mnemonic.

Examples:

```
:DIGITAL:SYSTEM:FORMAT QAM256;FILTER R_R_COS;
SYM_RATE 24300.0; ALPHA 0.45
```

```
:DIGITAL:SYSTEM:FORMAT BPSK; FILTER GAUSS;
SYM_RATE 6000.0;THREE_DB 1200
```

DIGITAL?

Prepares message containing information on the data and timing selected in one of the following formats:

:DIGITAL:EXT_SER:DATAPOL<status>;BITSTAT<status>; BITPOL<status>; SYMSTAT<status>;SYMPOL<status>

:DIGITAL:EXT_PAR:DATAPOL<status>;SYMSTAT<status>;SYMP OL<status>

:DIGITAL:INT_0S:DATAPOL<status>;CLOCK<status>; CLOCKPOL<status>

:DIGITAL:INT_1S:DATAPOL<status>;CLOCK<status>; CLOCKPOL<status>

where: <status> is character program data for the specified mnemonic.

Examples:

```
:DIGITAL:EXT_PAR:DATAPOL INVERSE;SYMSTAT
EXTERNAL;SYMPOL NEG_EDGE
```

```
:DIGITAL:PRBS:VALUE 6;DATAPOL NORMAL;CLOCK
INT_SYM; CLOCKPOL POS_EDGE
```

DIGITAL:T_TONES:FREQ?

Prepares message containing information on the test tone frequency setting in the following format:

DIGITAL:T_TONES:FREQ <nr2>

Example:

```
:DIGITAL:T_TONES:FREQ 1000
```

:T_TONES:I_AMP?

Prepares message containing information on the test tone I amplitude setting in the following format:

:DIGITAL:T_TONES:I_AMP <nr2>

Example:

```
:DIGITAL:T_TONES:I_AMP 2.763
```

DIGITAL:T_TONES:FREQ? (continued*)*

:T_TONES:I_DC?

Prepares message containing information on the test tone I DC-offset setting in the following format:

:DIGITAL:T_TONES:I_DC <nr2>

Example: `:DIGITAL:T_TONES:I_DC -0.423`

:T_TONES:Q_AMP?

Prepares message containing information on the test tone Q amplitude setting in the following format:

:DIGITAL:T_TONES:Q_AMP <nr2>

Example: `:DIGITAL:T_TONES:Q_AMP 0.500`

:T_TONES:Q_DC?

Prepares message containing information on the test tone Q DC-offset setting in the following format:

:DIGITAL:T_TONES:Q_DC <nr2>

Example: `:DIGITAL:T_TONES:Q_DC 2.000`

:T_TONES:ANGLE?

Prepares message containing information on the test tone IQ angle setting in the following format:

:DIGITAL:T_TONES:ANGLE<nr2>

Example: `:DIGITAL:T_TONES:ANGLE 263.7`

Advanced digital modulation

MODE

Set digital modulation mode (in addition to existing modulation mode commands)

Data type : Character Program Data
Allowed suffices : None
Default suffix : None

Example: `MODE ADV_DIG`

MODE?

Prepares message containing information on modulation mode in the following format:

:MODE <mode>

where: <mode> is character program data indicating the modulation mode setting.

Example: `:MODE ADV_DIG`

DIGITAL [not used alone]

:MODOPT [not used alone]

:SBAND Select sideband control

Data type : Character Program Data (any one of: UPPER, LOWER, AUTO)
Allowed suffices : None
Default suffix : None

:IF Select IF control

Data type : Character Program Data (any one of: MHZ120, MHZ132, MHZ160, MHZ176, AUTO)
Allowed suffices : None
Default suffix : None

:MODPOL Select modulation polarity control

Data type : Character Program Data (either NORMAL or INVERSE)
Allowed suffices : None
Default suffix : None

:ENVELOPE Select external envelope input control

Data type : Character Program Data (either DISABLED or ENABLED)
Allowed suffices : None
Default suffix : None

:CONFIG [not used alone]

:MIXER Select mixer control

Data type : Character Program Data (either INTERNAL or EXTERNAL)
Allowed suffices : None
Default suffix : None

:CONFIG

:IQ Select IQ output enable control

Data type : Character Program Data (either DISABLED or ENABLED)
Allowed suffices : None
Default suffix : None

:PULSE Select pulse input control

Data type : Character Program Data (either ENABLED or DISABLED)
Allowed suffices : None
Default suffix : None

ADVANCED DIGITAL (continued)

:FADING	[not used alone]
:CTRL	Select fading control
Data type :	Character Program Data (any one of: DISABLED, RAYLEIGH, RICIAN)
Allowed suffices :	None
Default suffix :	None
:SPEED	Set doppler speed
Data type :	Decimal Numeric Program Data
Allowed suffices :	Any one of GHz, MHz, kHz, Hz
Default suffix :	Hz
:DIR_DOPP	Set direct doppler path
Data type :	Decimal Numeric Program Data
Allowed suffices :	Any one of: GHz, MHz, kHz, Hz
Default suffix :	Hz
:RATIO	Set path ratio (direct to scattered) - Rayleigh Fading only
Data type :	Decimal Numeric Program Data
Allowed suffices :	DB only
Default suffix :	DB
:ERROR	[not used alone]
:ENABLE	Enable IQ modulator errors
:DISABLE	Disable IQ modulator errors
Data type :	None
Allowed suffices :	None
Default suffix :	None
:SKEW	Set IQ skew error (short form)
:VALUE	Set IQ skew error
Data type :	Decimal Numeric Program Data
Allowed suffices :	DEG
Default suffix :	DEG
SKEW	
:ON	Turn on IQ skew error
:OFF	Turn off IQ skew error
Data type :	None
Allowed suffices :	None
Default suffix :	None
:GAIN	Set IQ gain imbalance error (short form)
:VALUE	Set IQ gain imbalance error
Data type :	Decimal Numeric Program Data
Allowed suffices :	DB only
Default suffix :	DB
:ON	Turn on IQ gain imbalance error
:OFF	Turn off IQ gain imbalance error
Data type :	None
Allowed suffices :	None
Default suffix :	None

ADVANCED DIGITAL (continued)

:LEAK	Set carrier leakage error (short form)
:VALUE	Set carrier leakage error
Data type :	Decimal Numeric Program Data
Allowed suffices :	PCT
Default suffix :	PCT
:ON	Turn on IQ carrier leakage error
:OFF	Turn off IQ carrier leakage error
Data type :	None
Allowed suffices :	None
Default suffix :	None
:EXT_SER	[not used alone]
:DATAPOL	Select external serial data and specify the data polarity
Data type :	Character Program Data (either NORMAL or INVERSE)
Allowed suffices :	None
Default suffix :	None
:BITSTAT	Select external serial data and specify the bit clock status
Data type :	Character Program Data (either INTERNAL or EXTERNAL)
Allowed suffices :	None
Default suffix :	None
:EXT_SER	
:BITPOL	Select external serial data and specify the bit clock polarity
Data type :	Character Program Data (either POS_EDGE or NEG_EDGE)
Allowed suffices :	None
Default suffix :	None
:SYMSTAT	Select external serial data and specify the symbol clock status
Data type :	Character Program Data (either INTERNAL or EXTERNAL)
Allowed suffices :	None
Default suffix :	None
:SYMPOL	Select external serial data and specify the symbol clock polarity
Data type :	Character Program Data (either POS_EDGE or NEG_EDGE)
Allowed suffices :	None
Default suffix :	None
:EXT_PAR	[not used alone]
:DATAPOL	Select external paralled data and specify the data polarity
Data type :	Character Program Data (either NORMAL or INVERSE)
Allowed suffices :	None
Default suffix :	None
:EXT_PAR	
:SYMSTAT	Select external parallel data and specify the symbol clock status
Allowed suffices :	None
Default suffix :	None
:SYMPOL	Select external parallel data and specify the symbol clock polarity
Data type :	Character Program Data (either POS_EDGE or NEG_EDGE)
Allowed suffices :	None
Default suffix :	None
:INT_0S	[not used alone]
:DATAPOL	Select internal "all-zeros" data and specify the data polarity
Data type :	Character Program Data (either NORMAL or INVERSE)
Allowed suffices :	None
Default suffix :	None
:CLOCK	Select internal "all-zeros" and specify the clock source
Data type :	Character Program Data (any one of: INT_SYM, EXT_SYM, EXT_BIT)
Allowed suffices :	None
Default suffix :	None

ADVANCED DIGITAL (continued)

:INT_0S	
:CLOCKPOL	Select internal "all-zeros" and specify the clock polarity
Data type :	Character Program Data (either POS_EDGE or NEG_EDGE)

Allowed suffices : None
Default suffix : None

:INT_1S [not used alone]

:DATAPOL Select internal "all-ones" data and specify the data polarity

Data type : Character Program Data (either NORMAL or INVERSE)
Allowed suffices : None
Default suffix : None

:INT_1S

:CLOCK Select internal "all-ones" and specify the clock source

Data type : Character Program Data (any one of: INT_SYM, EXT_SYM, EXT_BIT)
Allowed suffices : None
Default suffix : None

:CLOCKPOL Select internal "all-ones" and specify the clock polarity

Data type : Character Program Data (either POS_EDGE or NEG_EDGE)
Allowed suffices : None
Default suffix : None

:PRBS Select internal "prbs" data and specify the "n" value

:VALUE Select internal "prbs" data and specify the "n" value

Data type : Decimal Numeric Program Data
Allowed suffices : None
Default suffix : None

:DATAPOL Select internal "prbs" data and specify the data polarity

Data type : Character Program Data (either NORMAL or INVERSE)
Allowed suffices : None
Default suffix : None

:CLOCK Select internal "prbs" data and specify the clock source

Data type : Character Program Data (any one of: INT_SYM, EXT_SYM, EXT_BIT)
Allowed suffices : None
Default suffix : None

:CLOCKPOL Select internal "prbs" data and specify the clock polarity

Data type : Character Program Data (either POS_EDGE or NEG_EDGE)
Allowed suffices : None
Default suffix : None

:CAL Execute IQ Autocal

Data type : None
Allowed suffices : None
Default suffix : None

:MODOPT? Prepares message containing information on advanced DIGITAL modulation control setting in the following format:

:DIGITAL:MODOPT:SBAND<status>;IF<status>;MODPOL <status>;ENVELOPE<status>

where: <status> is character program data for the specified mnemonic.

Example:

```
:DIGITAL:MODOPT:SBAND AUTO;IF MHZ120;MODPOL
 INVERSE;ENVELOPE DISABLED
```

:CONFIG? Prepares message containing information on DIGITAL modulation setting in the following format:

:DIGITAL:CONFIG:MIXER<status>;IQ<status>;PULSE<status>

where: <status> is character program data for the specified mnemonic.

Example:

```
:DIGITAL:CONFIG:MIXER EXTERNAL;IQ DISABLED;PULSE
ENABLED
```

ADVANCED DIGITAL (continued)

:FADING? Prepares message containing information on DIGITAL modulation fading setting in the following format:

:DIGITAL:FADING:CTRL<status>;SPEED <nr2>;DIR_DOPP <nr2>; RATIO <nr2>

where: <status> is character program data for the specified mnemonic.

Example: `:DIGITAL:FADING:CTRL RAYLEIGH;SPEED 52;DIR_DOPP 0;RATIO 12`

:ERROR?

Prepares message containing information on the IQ error control in the following format:

:DIGITAL:ERROR:<status>

where: <status> is a program mnemonic indicating whether the IQ errors are globally ENABLE or DISABLE.

Example: `:DIGITAL:ERROR:ENABLE`

:SKEW?

Prepares message containing information on the IQ skew error setting in the following format:

:DIGITAL:SKEW:VALUE <nr2>;<status>

where: <status> is a program mnemonic indicating whether the IQ skew error is ON or OFF.

Example: `:DIGITAL:SKEW:VALUE 10.1; OFF`

:GAIN?

Prepares message containing information on the IQ gain imbalance error setting in the following format:

:DIGITAL:GAIN:VALUE <nr2>; <status>

where: <status> is a program mnemonic indicating whether the IQ gain imbalance error is ON or OFF.

Example: `:DIGITAL:GAIN:VALUE -27; ON`

:LEAK?

Prepares message containing information on the carrier leakage error setting in the following format:

:DIGITAL:LEAK:VALUE <nr2>; <status>

where: <status> is a program mnemonic indicating whether the carrier leakage error is ON or OFF.

Example: `:DIGITAL:LEAK:VALUE 0.0; OFF`

:SYSTEM?

Prepares message containing information on the modulation system setup in the following format:

DIGITAL:SYSTEM:FORMAT<status>;FILTER<status>; SYM_RATE <nr2>;ALPHA <nr2>

where: <status> is character program data for the specified mnemonic.

Examples: `:DIGITAL:SYSTEM:FORMAT O_QPSK;FILTER R_R_COS; SYM_RATE 18000.0; ALPHA 0.35`

DIGITAL?

Prepares message containing information on the data and timing selected in one of the following formats:

:DIGITAL:EXT_SER:DATAPOL<status>;BITSTAT<status>; BITPOL<status>; SYMSTAT<status>;SYMPOL<status>

:DIGITAL:EXT_PAR:DATAPOL<status>;SYMSTAT<status>;SYMPOL<status>

:DIGITAL:INT_0S:DATAPOL<status>;CLOCK<status>; CLOCKPOL<status>

ADVANCED DIGITAL (continued)

DIGITAL? *(contd.)*

:DIGITAL:INT_1S:DATAPOL<status>;CLOCK<status>; CLOCKPOL<status>

where: <status> is character program data for the specified mnemonic.

Examples: `:DIGITAL:EXT_PAR:DATAPOL INVERSE;SYMSTAT EXTERNAL;SYMPOL NEG_EDGE`

```
:DIGITAL:PRBS:VALUE 6;DATAPOL NORMAL;CLOCK
INT_SYM; CLOCKPOL POS_EDGE
```

Vector modulation

MODE Set vector modulation mode (in addition to existing modulation mode commands)

Data type : Character Program Data
Allowed suffices : None
Default suffix : None

Example: `MODE VECTOR`

MODE? Prepares message containing information on modulation mode in the following format:

:MODE <mode>

where: <mode> is character program data indicating the modulation mode setting.

Example: `:MODE VECTOR`

VECTOR [not used alone]

:MODOPT [not used alone]

:SBAND Select sideband control

Data type : Character Program Data (any one of: UPPER, LOWER, AUTO)
Allowed suffices : None
Default suffix : None

:IF Select IF control

Data type : Character Program Data (any one of: MHZ120, MHZ132, MHZ160, MHZ176, AUTO)
Allowed suffices : None
Default suffix : None

:MODPOL Select modulation polarity control

Data type : Character Program Data (either NORMAL or INVERSE)
Allowed suffices : None
Default suffix : None

:ENVELOPE Select external envelope input control

Data type : Character Program Data (either DISABLED or ENABLED)
Allowed suffices : None
Default suffix : None

:CONFIG [not used alone]

:MIXER Select mixer control

Data type : Character Program Data (either INTERNAL or EXTERNAL)
Allowed suffices : None
Default suffix : None

:IQ Select IQ input impedance

Data type : Character Program Data (either OHMS50 or OHMS300)
Allowed suffices : None
Default suffix : None

VECTOR:CONFIG (continued)

:PULSE Select pulse input control

Data type : Character Program Data (either ENABLED or DISABLED)
Allowed suffices : None
Default suffix : None

:FADING [not used alone]

:CTRL Select fading type

Data type : Character Program Data (any one of: DISABLED, RAYLEIGH, RICIAN)
Allowed suffices : None
Default suffix : None

:SPEED — Set doppler speed

Data type : Decimal Numeric Program Data
Allowed suffices : Any one of GHz, MHz, kHz, Hz
Default suffix : Hz

:DIR_DOPP — Set direct doppler path

Data type : Decimal Numeric Program Data
Allowed suffices : Any one of: GHz, MHz, kHz, Hz
Default suffix : Hz

:RATIO — Set path ratio (direct to scattered) - Rayleigh Fading only

Data type : Decimal Numeric Program Data
Allowed suffices : DB only
Default suffix : DB

:MODOPT? — Prepares message containing information on VECTOR modulation control setting in the following format:

:VECTOR:MODOPT:SBAND<status>;IF<status>;MODPOL <status>;ENVELOPE<status>

where: <status> is character program data for the specified mnemonic.

Example:
```
:VECTOR:MODOPT:SBAND LOWER;IF MHZ176;MODPOL
 NORMAL;ENVELOPE ENABLED
```

:CONFIG? — Prepares message containing information on VECTOR modulation setting in the following format:

:VECTOR:CONFIG:MIXER<status>;IQ<status>,PULSE<status>

where: <status> is character program data for the specified mnemonic.

Example:
```
:VECTOR:CONFIG:MIXER EXTERNAL;IQ OHMS50;PULSE
DISABLED
```

:FADING? — Prepares message containing information on VECTOR modulation fading settings in the following format:

:VECTOR:FADING:CTRL<status>;SPEED <nr2>;DIR_DOPP <nr2>; RATIO <nr2>

where: <status> is character program data for the specified mnemonic.

Example:
```
:VECTOR:FADING:RICIAN;SPEED 100;DIR_DOPP
200;RATIO 25
```

:CAL — Execute IQ Autocal

Data type : None
Allowed suffices : None
Default suffix : None

Frequency modulation

FM or FM1 or FM2	Set FM deviation (short form)
:DEVN	Set FM deviation
:INC	Set FM step size
Data type : Allowed suffices : Default suffix :	Decimal Numeric Program Data Any one of: GHZ, MHZ, KHZ or HZ HZ
:<src>	Select modulation source where <src> is any one of: INTF1, INTF2, INTF3, INTF4, INTF5, INTF6, EXT1DC, EXT1AC, EXT1ALC, EXT2DC, EXT2AC or EXT2ALC
:ON	Turn FM ON (locally)
:OFF	Turn FM OFF (locally)
:UP	Go UP one step
:DN	Go DOWN one step
:RETN	Return to original setting
:XFER	Transfer current value to be the new setting
DCFMNL	Perform DC FM/WBFM null operation
Data type : Allowed suffices : Default suffix :	None None None

Examples:	`FM:DEVN 25KHZ;INTF4;ON`
	`FM1:DEVN 15KHZ;INC 1KHZ;EXT1DC`
	`DCFMNL`

FM? or FM1? or FM2?	Prepares message containing information on FM setting in one of the following formats: :FM:DEVN <nr2>;<src>;<status>;INC <nr2> :FM1:DEVN <nr2>;<src>;<status>;INC <nr2> :FM2:DEVN <nr2>;<src>;<status>;INC <nr2> where: <src> is a program mnemonic representing the source of the modulation signal and <status> is a program mnemonic indicating whether the modulation is locally ON or OFF
Example:	`:FM1:DEVN 25000.0;INTF1;ON;INC 1000.0`

Phase modulation

PM or PM1 or PM2	Set Phase deviation (short form)
:DEVN	Set Phase deviation
:INC	Set Phase Modulation step size
Data type : Allowed suffices : Default suffix :	Decimal Numeric Program Data RAD or RADS RAD
:<src>	Select modulation source where <src> is any one of: INTF1, INTF2, INTF3, INTF4, INTF5, INTF6, EXT1DC, EXT1AC, EXT1ALC, EXT2DC, EXT2AC or EXT2ALC
:ON	Turn PM ON (local)
:OFF	Turn PM OFF (local)
:UP	Go UP one step
:DN	Go DOWN one step
:RETN	Return to original setting
:XFER	Transfer current value to be the new setting
Data type : Allowed suffices : Default suffix :	None None None
Examples:	`PM:DEVN 2.5RAD;INTF4;ON` `PM1:DEVN 1.5RAD;INC 0.1RAD;EXT1AC`
PM? or PM1? or PM2?	Prepares message containing information on Phase Modulation setting in one of the following formats: :PM:DEVN <nr2>;<src>;<status>;INC <nr2> :PM1:DEVN <nr2>;<src>;<status>;INC <nr2> :PM2:DEVN <nr2>;<src>;<status>;INC <nr2> where <src> is a program mnemonic representing the source of the modulation signal and <status> is a program mnemonic indicating whether the modulation is locally ON or OFF
Example:	`:PM2:DEVN 2.30;INTF4;OFF;INC 0.05`

Amplitude modulation

AM or AM1 or AM2	Set AM Depth (short form)
:DEPTH	Set AM Depth
:INC	Set AM step size
Data type :	Decimal Numeric Program Data
Allowed suffices :	PCT
Default suffix :	PCT
:<src>	Select modulation source where <src> is any one of: INTF1, INTF2, INTF3, INTF4, INTF5, INTF6, EXT1DC, EXT1AC, EXT1ALC, EXT2DC, EXT2AC or EXT2ALC
:ON	Turn AM ON (local)
:OFF	Turn AM OFF (local)
:UP	Go UP one step
:DN	Go DOWN one step
:RETN	Return to original setting
:XFER	Transfer current value to be the new setting
Data type :	None
Allowed suffices :	None
Default suffix :	None

Examples:

```
AM:DEPTH 30PCT;INTF4;ON
AM1:DEPTH 40PCT;EXT1DC;ON
```

AM? or AM1? or AM2?

Prepares message containing information on Amplitude Modulation setting in one of the following formats:

:AM:DEPTH <nr2>;<src>;<status>;INC <nr2>
:AM1:DEPTH <nr2>;<src>;<status>;INC <nr2>
:AM2:DEPTH <nr2>;<src>;<status>;INC <nr2>

where <src> is a program mnemonic representing the source of the modulation signal and <status> is a program mnemonic indicating whether the modulation is locally ON or OFF

Example:

```
:AM1:DEPTH 56.6;INTF3;ON;INC 5.0
```

Wideband FM

WBFM	Sest WBFM deviation (short form)
:DEVN	Set WBFM deviation
Data type :	Decimal Numeric Program Data
Allowed suffices :	Any one of: GHZ, MHZ, KHZ or HZ
Default suffix :	HZ
:ON	Turn WBFM ON (local)
:OFF	Turn WBFM OFF (local)
:AC	Select AC coupling
:DC	Select DC coupling
Data type :	None
Allowed suffices :	None
Default suffix :	None
DCFMNL	Perform DC FM/WBFM null operation

Examples:

```
WBFM:DEVN 10MHZ;ON;AC
WBFM:DEVN 13MHZ;ON;DC;:DCFMNL
```

WBFM?

Prepares message containing information on Wideband Frequency Modulation setting in the following format:

:WBFM:DEVN <nr2>;<coupling>;<status>

where <coupling> is a program mnemonic indicating AC or DC coupling of the modulation signal and <status> is a program mnemonic indicating whether the modulation is locally ON or OFF

Example:

```
:WBFM:DEVN 500000.0;AC;ON
```

Pulse modulation

PULSE	[not used alone]
:ON	Turn Pulse modulation ON
:OFF	Turn Pulse modulation OFF and select Low Intermodulation
:CAL:ENABLE	Enable CW Burst Suppression mode
:DISABLE	Disable CW Burst Suppression mode
Data type :	None
Allowed suffices :	None
Default suffix :	None
Examples:	PULSE:ON PULSE:OFF PULSE:CAL:DISABLE
PULSE?	Prepares message containing information on Pulse Modulation setting in the following format: :PULSE:CAL:<status> where: <status> is a program mnemonic indicating whether the modulation is ON or OFF.
Examples:	:PULSE:ON :PULSE:OFF
PULSE:CAL?	Prepares message containing information on CW Burst Suppression mode in the following format: :PULSE:CAL:<status> where: <status> is a program mnemonic indicating whether the CW burst suppression mode is ENABLED or DISABLED
Example:	:PULSE:CAL:ENABLE

Modulation frequency

INTF1 or INTF2 or INTF3 or INTF4 or INTF5 or INTF6 — Set modulation oscillator frequency (short form)

:FREQ	Set modulation oscillator frequency
:INC	Set modulation oscillator frequency step size
Data type :	Decimal Numeric Program Data
Allowed suffices :	Any one of: GHZ, MHZ, KHZ or HZ
Default suffix :	HZ
:SIN	Select sinusoidal waveform
:TRI	Select triangle wave
:UP	Go UP one step
:DN	Go DOWN one step
:RETN	Return to original setting
:XFER	Transfer current value to be the new setting
Data type :	None
Allowed suffices :	None
Default suffix :	None
:PHASE	Adjust phase of modulation oscillator
Data type :	Decimal Numeric Program Data
Allowed suffices :	DEG
Default suffix :	DEG
:CTC1	Select tone number (0 to 15) from Continuous Tone Group 1
:CTC2	Select tone number (0 to 15) from Continuous Tone Group 2
:USER	Select tone number (0 to 15) from Continuous Tone USER group
:TEMP	Select tone number (0 to 15) from Continuous Tone TEMP group
Data type :	Decimal Numeric Program Data
Allowed suffices :	None
Default suffix :	None

Examples:

```
INTF1:FREQ 1.5KHZ;SIN
INTF1:CTC1 3
```

INTF1? or INTF2? or INTF3? or INTF4? or INTF5? or INTF6? — Prepares message containing information on modulation oscillator setting in one of the following formats:

:INTF1:FREQ <nr2>;INC <nr2>;<waveform>

:INTF6:<standard> <nr1>

where: <waveform> is a program mnemonic (SIN or TRI) indicating the waveform shape and <standard> is a program mnemonic (CTC1, CTC2, USER or TEMP) indicating the continuous tone signalling standard selected.

Examples:

```
:INTF2:FREQ 440.0;INC 100.0;SIN
:INTF3:CTC1 5
```

CTCSS tones edit

CTONES [not used alone]

:EDIT [not used alone]

:TNUM Select tone number 0-15

Data type : Decimal Numeric Program Data
Allowed suffices : None
Default suffix : None

:TFRQ Set tone frequency

Data type : Decimal Numeric Program Data
Allowed suffices : Any one of: GHZ, MHZ, KHZ or HZ
Default suffix : HZ

:LOAD Copy Standard to TEMP for editing

Data type : Character Program Data (any one of: CTC1, CTC2 or USER)
Allowed suffices : None
Default suffix : None

:SAVE Save TEMP to USER after editing for non-volatile storage (if required)

Data type : None
Allowed suffices : None
Default suffix : None

CTONES? [not used alone]

CTONES:EDIT? Prepares message containing information on the current tone number being edited and its frequency in the following format:

:CTONES:EDIT:TNUM <nr1>;TFRQ <nr2>

Example: `:CTONES:EDIT:TNUM 5;TFRQ 202.8`

Sequential tones

SEQT [not used alone]

:SEQ Set Tone sequence

Data type : String Program Data consisting of up to 16 characters from 0 to 9 and A to F between string delimiters (eg. "123C5" or '123C5'). For DTMF E and F are not allowed and are replaced by * and #.
Allowed suffices : None
Default suffix : None

:DUR Set Duration Mask

Data type : String Program Data consisting of up to 15 characters "-" or "E" between string delimiters (eg. "---E-" or '---E-')
Allowed suffices : None
Default suffix : None

:SEND Send Sequence *n* times where *n* has the value 1 to 9 indicating the number of tone sequences to be sent, or 10 for continuous sending.

Data type : Decimal Numeric Program Data
Allowed suffices : None
Default suffix : None

:STOP Stop sending sequence.

Data type : None
Allowed suffices : None
Default suffix : None

:MODE [not used alone]

:STD Select Tones standard

Data type : Character Program Data (any one of: CCIR, EURO, DZVEI, ZVEI1, ZVEI2, EEA, EIA, NATEL, TEMP, USER1, USER2 or DTMF).
Allowed suffices : None
Default suffix : None

:MOD Select Modulation Channel

Data type : Character Program Data (any one of: AM1, AM2, FM1, FM2, PM1, PM2, TOTAL_AM, TOTAL_FM, TOTAL_PM or NO_TONES)
Allowed suffices : None
Default suffix : None

:PARAM [not used alone]

:EXTD Set the duration of the Extended tone.

:SDLY Set Starting Delay

Data type : Decimal Numeric Program Data
Allowed suffices : MS
Default suffix : MS

:SHFT Set Frequency Shift (up to ±10.0%)

Data type : Decimal Numeric Program Data
Allowed suffices : PCT
Default suffix : PCT

:RPTT Select Repeat Tone

Data type : String Program Data (any one of 0 to 9 or A to F between strings delimiters (eg. "E" or 'E').
Allowed suffices : None
Default suffix : None

:TDUR Set DTMF Tone duration

SEQT:PARAM (continued)

:TGAP		Set DTMF inter-element gap
	Data type :	Decimal Numeric Program Data
	Allowed suffices :	MS
	Default suffix :	MS
:EDIT		[not used alone]
:TNUM		Select Number of Tone to Edit
	Data type :	Decimal Numeric Program Data
	Allowed suffices :	None
	Default suffix :	None
:TFRQ		Set Tone Frequency of tone selected by TNUM
	Data type :	Decimal Numeric Program Data
	Allowed suffices :	Any one of: GHZ, MHZ, KHZ or HZ
	Default suffix :	HZ
:TDUR		Set Normal Tone Duration
:TGAP		Set Inter-element Gap
	Data type :	Decimal Numeric Program Data
	Allowed suffices :	MS
	Default suffix :	MS
:LOAD		Losad a Standard to TEMP for editing
	Data type :	Character Program Data (any one of: CCIR, EURO, DZVEI, ZVEI1, ZVEI2, EEA, EIA, NATEL, USER1 or USER2)
	Allowed suffices :	None
	Default suffix :	None
:SAVE		Copy TEMP to USER1 or USER2
	Data type :	Character Program Data (either USER1 or USER2)
	Allowed suffices :	None
	Default suffix :	None

Examples:

```
SEQT:SEQ "12245B7";DUR "----E--"
SEQT:MODE STD CCIR;MOD TOTAL_FM
SEQT:PARAM:EXTD 200MS;SHFT 0.5PCT
SEQT:EDIT:TNUM 3;TFRQ 1342.7HZ;SAVE USER1
```

SEQT?

Prepares message containing information on the signalling sequence and duration settings in the following format:

:SEQT:SEQ <toneseq>;DUR <durseq>

where: <toneseq> is string program data defining the tone sequence and <durseq> is string program data defining the duration sequence.

Examples:

```
:SEQT:SEQ "12245B7";DUR "----E--"
:SEQT:SEQ "12345*#9"           (DTMF ONLY)
```

SEQT:MODE?

Prepares message containing information on the signalling standard and the modulation channel selected in the following format:

:SEQT:MODE:STD <standard>;MOD <modchannel>

where: <standard> is a program mnemonic defining the tone standard and <modchannel> is character program data defining the modulation channel allocated to tone signalling.

Example:

```
:SEQT:MODE:STD ZVEI;MOD TOTAL_FM
```

SEQT (continued)

SEQT:PARAM?

Prepares message containing information on signalling parameter settings in the following format:

:SEQT:PARAM:EXTD <nr1>;SHFT <nr2>;RPTT <rpt>;SDLY <nr1>

where: <rpt> is string program data defining the tone number used to represent the repeat tone.

Examples:

```
:SEQT:PARAM:EXTD 200;SHFT -1.6;RPTT "E";SDLY 300
:SEQT:PARAM:SDLY 30;TDUR 100;TGAP 75
(DTMF ONLY)
```

SEQT:EDIT?

Prepares message containing information on signalling editing in the following format:

:SEQT:EDIT:TNUM <nr1>;TFREQ <nr2>;TDUR <nr1>;TGAP <nr1>

Example:

```
:SEQT:EDIT:TNUM 3;TFREQ 1342.7;TDUR 40;TGAP 0
```

LF control

LF [not used alone]

:ON Turn LF output ON

:OFF Turn LF output OFF

:GEN Select LF Generator

Data type : None
Allowed suffices : None
Default suffix : None

:MON Select source monitor mode

Data type : Character Program Data (any one of: AM1S, AM2S, AMD, ANG1S, ANG2S, ANGD or OFF, where AM represents Amplitude Modulation, ANG represents Angular Modulation, the suffix 'S' indicates Source and 'D' indicates Drive)
Allowed suffices : None
Default suffix : None

Examples:

```
LF:MON FM;ON
LF:MON ANGD
LF:GEN
```

LF?

Prepares message containing information on the LF operation in one of the following formats depending on which LF mode is currently in use:

:LF:GEN;<status>

:LF:MON <source>;<status>

where: <source> is character program data representing the source being monitored and <status> is a program mnemonic indicating whether the output is ON or OFF.

Examples:

```
:LF:GEN;ON
:LF:MON AM1S;OFF
```

LF generator frequency

LFGF	Set LF Generator frequency (short form)
:VALUE	Set LF Generator frequency
:INC	Set LF Generator frequency step
Data type :	Decimal Numeric Program Data
Allowed suffices :	Any one of: GHZ, MHZ, KHZ or HZ
Default suffix :	HZ
:UP	Go UP one step
:DN	Go DOWN one step
:RETN	Return to original setting
:XFER	Transfer current value to be the new setting
:SIN	Select sinusoidal waveform
:TRI	Select triangle wave
Data type :	None
Allowed suffices :	None
Default suffix :	None
Example:	`LFGF:VALUE 25KHZ;INC 500HZ`
LFGF?	Prepares message containing information on LF Generator Frequency setting in the following format: :LFGF:VALUE <nr2>;INC <nr2>
Example:	`:LFGF:VALUE 25067.8;INC 500.0`

LF generator level

LFGL Set LF Generator level (short form)

:VALUE Set LF Generator level

Data type : Decimal Numeric Program Data
Allowed suffices : V, MV, UV, DBMV
Default suffix : V

:INC Set LF Generator level step

Data type : Decimal Numeric Program Data
Allowed suffices : DB
Default suffix : DB

:UP Go UP one step

:DN Go DOWN one step

:RETN Return to original setting

:XFER Transfer current value to be the new setting

Data type : None
Allowed suffices : None
Default suffix : None

:UNITS Select default LF level units

Data type : Character Program Data (DBM, DBV, DBMV, V, MV, or UV)
Allowed suffices : None
Default suffix : None

Examples:

```
LFGL:VALUE 75.6MV;INC 20DB
LFGL:UP
```

LFGL? Prepares the message containing information on LF Generator Level setting in the following format:

:LFGL:UNITS<unit>;VALUE<nr2>;INC<nr2>

where: <unit> is character programmed data defining the default LF level units (DBM, DBV, DBMV, V, MV or UV).

Example:

```
:LFGL:UNITS MV;VALUE 125.8;INC 1.0
```

Memory - store

STO	[not used alone]
:FULL	Full Store 0-49
:PART	Partial Store 0-49
:CFRQ	Carrier Freq Store 0-99
:SEQT	Sequential Tones Store 0-19
:SWEEP	Sweep Store 0-19
Data type :	Decimal Numeric Program Data
Allowed suffices :	None
Default suffix :	None
Examples:	:STO:FULL 17 :STO:CFRQ 83

Memory - recall

RCL	[not used alone]
:FULL	Recall Full 0-49
:FXCF	Recall Full 0-49 (without carrier frequency)
:PART	Recall Partial 0-49
:PXCF	Recall Partial 0-49 (without carrier frequency)
:CFRQ	Recall Carrier Freq 0-99
:SEQT	Recall Sequential Tones Sequence 0-19
:SWEEP	Recall Sweep 0-19
Data type :	Decimal Numeric Program Data
Allowed suffices :	None
Default suffix :	None
Examples:	:RCL:FULL 15 :RCL:CFRQ 75

Memory - erase

ERASE	[not used alone]
:FULL	Erase all Full Stores
:PART	Erase all Partial Stores
:CFRQ	Erase all Carrier Freq Stores
:SEQT	Erase all Sequential Tones Stores
:SWEEP	Erase all Sweep Stores
:ALL	Erase <u>all</u> Stores
Data type :	None
Allowed suffices :	None
Default suffix :	None
Examples:	:ERASE:FULL 12 :ERASE:ALL

Sweep operation

IMODE Select Instrument Mode

Data type : Character Program Data (either NORMAL for signal generator operation or SWEEPER for swept operation)
Allowed suffices : None
Default suffix : None

Example: `IMODE SWEEPER`

SWEEP [not used alone]

:MKRON Enable Sweep Markers

:MKROFF Disable sweep Markers

Data type : None
Allowed suffices : None
Default suffix : None

Examples:
```
SWEEP:CFRQ:START 75MHZ;STOP 150MHZ;STEP 100;TIME
10MS
SWEEP:RFLV:START -56DBM;STOP -12DBM;STEP
440;TIME 25MS
SWEEP:CFRQ:MKRNUM 1;VALUE 83MHZ;MKRON
```

:CFRQ [not used alone]

:<cmd> Select Carrier Frequency sweep parameter entry where <cmd> is replaced by one of the commands (START, STOP, STEP, TIME, MKRNUM, MKRON, MKROFF or VALUE)

:RFLV [not used alone]

:<cmd> Select RF Level sweep parameter entry where <cmd> is replaced by one of the commands (START, STOP, STEP, TIME, MKRNUM, MKRON, MKROFF or VALUE)

:LFGF [not used alone]

:<cmd> Select LF Generator Frequency sweep parameter entry where <cmd> is replaced by one of the commands (START, STOP, STEP, TIME, MKRNUM, MKRON, MKROFF or VALUE)

:LFGL [nost used alone]

:<cmd> Select LF Generator Level sweep parameter entry where <cmd> is replaced by one of the commands (START, STOP, STEP, TIME, MKRNUM, MKRON, MKROFF or VALUE)

:INTF [not used alone]

:<cmd> Select Internal Modulation Oscillator Frequency sweep parameter entry where <cmd> is replaced by one of the commands (START, STOP, STEP, TIME, MKRNUM, MKRON, MKROFF or VALUE)

HOP [not used alone]

:<cmd> Select Frequency Hopping sweep parameter entry where <cmd> is replaced by TIME.

:START Select start value of the parameter to be swept.

:STOP Select stop value of the parameter to be swept.

Data type : As used for the parameter
Allowed suffices : As used for the parameter
Default suffix : As used for the parameter

:STEP Select number of steps in the sweep.

Data type : Decimal Numeric Program Data
Allowed suffices : None
Default suffix : None

:TIME Select time per sweep step

Data type : Decimal Numeric Program Data
Allowed suffices : MS
Default suffix : MS

SWEEP (continued)

:MKRNUM Select marker

Data type : Decimal Numeric Program Data
Allowed suffices : None
Default suffix : None

:MKROFF Turn Current Marker OFF

:MKRON Turn Current Marker ON

Data type : None
Allowed suffices : None
Default suffix : None

:VALUE Set Value of Current Marker

Data type : Decimal Numeric Program Data
Allowed suffices : As used for the parameter
Default suffix : As used for the parameter

SWEEP? Prepares message containing information on Sweep Type, Mode and Marker status in the following format:

:SWEEP:TYPE <mode>;MODE <type>;<status>

where: <type> is a program mnemonic representing the sweep type selected, <mode> is a program mnemonic representing the sweep mode selected and <status> is a program mnemonic indicating whether the Marker output is ON or OFF.

Sample responses:
```
:SWEEP:MODE CONT;TYPE CFRQ;MKROFF
:SWEEP:TYPE HOP:MODE SNGL
```

:CFRQ? Prepares message containing information on Carrier Frequency Sweep settings in the following format:

:SWEEP:CFRQ:START <nr2>;STOP <nr2>;STEP <nr1>;TIME <nr1>

Sample response:
```
:SWEEP:CFRQ:START 1230000.0;STOP 1330000.0;STEP
100;TIME 20
```

:VALUE? Prepares message containing information on the current carrier frequency marker settings in the following format:

:SWEEP:CFRQ:MKRNUM <nr1>;VALUE <nr2>;<status>

where: <status> is a program mnemonic indicating whether the selected Marker is ON or OFF.

Sample response:
```
:SWEEP:CFRQ:MKRNUM 2:VALUE 1240000.0;MKRON
```

:RFLV? Prepares message containing information on RF Level Sweep settings in the following format:

:SWEEP:RFLV:START <nr2>;STOP <nr2>;STEP <nr1>;TIME <nr1>

Sample response:
```
:SWEEP:RFLV:START -107.0;STOP -27.0;STEP 80;TIME
50
```

:VALUE? Prepares message containing information on the current RF level marker settings in the following format:

:SWEEP:RFLV:MKRNUM <nr1>;VALUE <nr2>;<status>

where: <status> is a program mnemonic indicating whether the selected Marker is ON or OFF.

Sample response:
```
:SWEEP:RFLV:MKRNUM 2:VALUE -97.0;MKRON
```

SWEEP (continued)

:LFGF?

Prepares message containing information on the current LF Generator Frequency Sweep settings in the following format:

:SWEEP:LFGF:START <nr2>;STOP <nr2>;STEP <nr1>;TIME <nr1>

Sample response: `:SWEEP:LFGF:START 300.0;STOP 3000.0;STEP 2700;TIME 1`

:VALUE?

Prepares message containing information on the current LF generator frequency marker settings in the following format:

:SWEEP:LFGF:MKRNUM <nr1>;VALUE <nr2>;<status>

where: <status> is a program mnemonic indicating whether the selected Marker is ON or OFF.

Sample response: `:SWEEP:LFGF:MKRNUM 2:VALUE 400.0;MKRON`

:LFGL?

Prepares message containing information on LF Generator Level Sweep settings in the following format:

:SWEEP:LFGL:START <nr2>;STOP <nr2>;STEP <nr1>;TIME <nr1>

Sample response: `:SWEEP:LFGL:START 1.0;STOP 120.0;STEP 120;TIME 10`

:VALUE?

Prepares message containing information on the current LF generator level marker settings in the following format:

:SWEEP:LFGL:MKRNUM <nr1>;VALUE <nr2>;<status>

where: <status> is a program mnemonic indicating whether the selected Marker is ON or OFF.

Sample response: `:SWEEP:LFGL:MKRNUM 2:VALUE 5.0;MKRON`

:INTF?

Prepares message containing information on Modulation Oscillator Frequency Sweep settings in the following format:

:SWEEP:INTF:START <nr2>;STOP <nr2>;STEP <nr1>;TIME <nr1>

Sample response: `:SWEEP:INTF:START 270.0;STOP 3300.0;STEP 500;TIME 1`

:VALUE?

Prepares message containing information on the current modulation oscillator frequency marker settings in the following format:

:SWEEP:INTF:MKRNUM <nr1>;VALUE <nr2>;<status>

where: <status> is a program mnemonic indicating whether the selected Marker is ON or OFF.

Sample response: `:SWEEP:INTF:MKRNUM 2:VALUE 2900.0;MKRON`

:HOP?

Prepares message containing information on Frequency Hopping Sweep in the following format:

:SWEEP:HOP:TIME<nr1>

Sweep mode/type

SWEEP [not used alone]

:MODE Select Mode of operation for Sweep generator (single shot, continuous or externally triggered)

Data type : Character Program Data (any one of SNGL, CONT or EXT)
Allowed suffices : None
Default suffix : None

:TYPE Select Type of Sweep (Carrier Frequency, RF Level, LF Generator Frequency, LF Generator Level, Internal Modulation Oscillator Frequency or Off)

Data type : Character Program Data (any one of: OFF, CFRQ, RFLV, LFGF, LFGL, INTF1, INTF2, INTF3, INTF4, INTF5, INTF6, HOP or OFF)
Allowed suffices : None
Default suffix : None

Examples:
```
:SWEEP:MODE SNGL;TYPE CFRQ
:SWEEP:MODE CONT;TYPE INTF4
```

SWEEP? Prepares message containing information on Sweep Mode, Type and Marker status in the following format:

:SWEEP:MODE <mode>;TYPE <type>;<status>

where: <mode> is a program mnemonic representing the sweep mode selected, <Type> is a program mnemonic representing the sweep type selected and <status> is a program mnemonic indicating whether the Marker output is ON or OFF.

Examples:
```
:SWEEP:MODE CONT;TYPE CFRQ;MKROFF
:SWEEP:TYPE HOP:MODE SNGL
```

Sweep control

SWEEP	[not used alone]
:GO	Commence Sweep
:CALC	Initiate Pre-calculation
:HALT	Pause Sweep
:CONT	Continue Sweep
:RESET	Reset sweep to Start Value
:XFER	Transfer Paused Value to Main Parameter
:UP	Go UP one sweep step while paused
:DN	Go DOWN one sweep step while paused

Data type : None
Allowed suffices : None
Default suffix : None

Examples:
```
SWEEP:GO
SWEEP:RESET
```

Frequency hopping

HOPSEQ Enter frequency hopping sequence

Data type : Decimal Numeric Program data (can be multiple)
Allowed suffices : None
Default suffix : None

Examples:
```
HOPSEQ 56, 72, 0, 4, 99, 72
HOPSEQ 255, 0, 4, 17, 23, 64, 72
```

HOPSEQ? Returns a value 0-1024 indicating the number of steps in the Frequency Hopping Sequence.

Miscellaneous commands

IMODE Select Instrument Mode

Data type :	Character Program Data (either NORMAL for signal generator operation or SWEEPER for swept operation)
Allowed suffices :	None
Default suffix :	None

RPPR Reset reverse power protection trip

Data type :	None
Allowed suffices :	None
Default suffix :	None

FSTD Select internal or external frequency standard

Data type :	Character program data (any one of INT0, INT1, INT5, INT10, EXT1, EXT5 or EXT10)
Allowed suffices :	None
Default suffix :	None

Examples:
```
FSTD INT10
FSTD EXT5
```

FSTD? Prepares message containing information on frequency standard selection in the format:

:FSTD <char>

Example:
```
:FSTD EXT10
```

BLANK Blank or unblank various parts of the display. The number sent after the command determines the action to be taken as follows:

0 blank or unblank the Carrier Frequency display
1 blank or unblank the RF Level display
2 blank or unblank the Modulation Frequency display
3 blank or unblank the Modulation display
4 blank all displays

Data type :	Decimal Numeric Program Data (any one of 0, 1, 2, 3 or 4)
Allowed suffices :	None
Default suffix :	None

Examples:
```
BLANK 0
BLANK 4
```

BACKL [not used alone]

:ON Backlighting On

:OFF Backlighting Off

Data type :	None
Allowed suffices :	None
Default suffix :	None

Examples:
```
BACKL:ON
BACKL:OFF
```

TIME? Prepares message containing information on current real time clock time setting in the format:

<HH:MM>

where: <HH:MM> is string program data representing the time in hours and minutes using the 24 hour clock notation.

Example:
```
"17:55"
```

DATE? Prepares message containing information on current real time clock date setting in the format:

<YYYY-MM-DD>

where: <YYYY-MM-DD> is string program data representing the date in ISO notation (year number, month number, day number).

Example: `"1990-04-01"`

OPER?

Prepares message containing information on total operating hours in the following format:

<nr2>

Example: `1453.0`

ELAPSED?

Prepares message containing information on elapsed operating hours since last reset in the following format:

<nr2>

Example: `454.5`

ERROR?

Prepares message containing the number of the next error in the error queue in the following format:

<nr1>

The numeric value returned is either that of the next error number or 0 if the queue is empty or 255 if the queue is full

Example: `37`

DEVTRG

Set Device Trigger Function (action on receipt of *TRG)

Data type : Character Program Data (any one of: SEQT, FLSWP, SSSWP or VOID)
Allowed suffices : None
Default suffix : None

EXTTRG

Set External Trigger Function (action on Low signal being applied to External Trigger Socket).

Data type : Character Program Data (any one of: SEQT, FLSWP, SSSWP, MEMUP, MEMDN or VOID)
Allowed suffices : None
Default suffix : None

Examples:

```
DEVTRG SEQT
EXTTRG MEMUP
```

KLOCK

Disables keyboard entry except RPP Reset and Go to Local

Data type : None
Allowed suffices : None
Default suffix : None

KUNLOCK

Enables keyboard entry

Data type : None
Allowed suffices : None
Default suffix : None

The status byte

The Status Byte provides information about events and conditions within the instrument. It may be read by a conventional Serial Poll or its value obtained as a response to the *STB? query. Bits 0 to 5 and bit 7 are each single bit Summary Messages which may be of two types (or not used at all).

(i) Query Status - a '1' indicates that an associated Queue is non-empty and has data available to be read.

(ii) Status Register Summary - reports the occurrence of an enabled event monitored by a Status Register Structure.

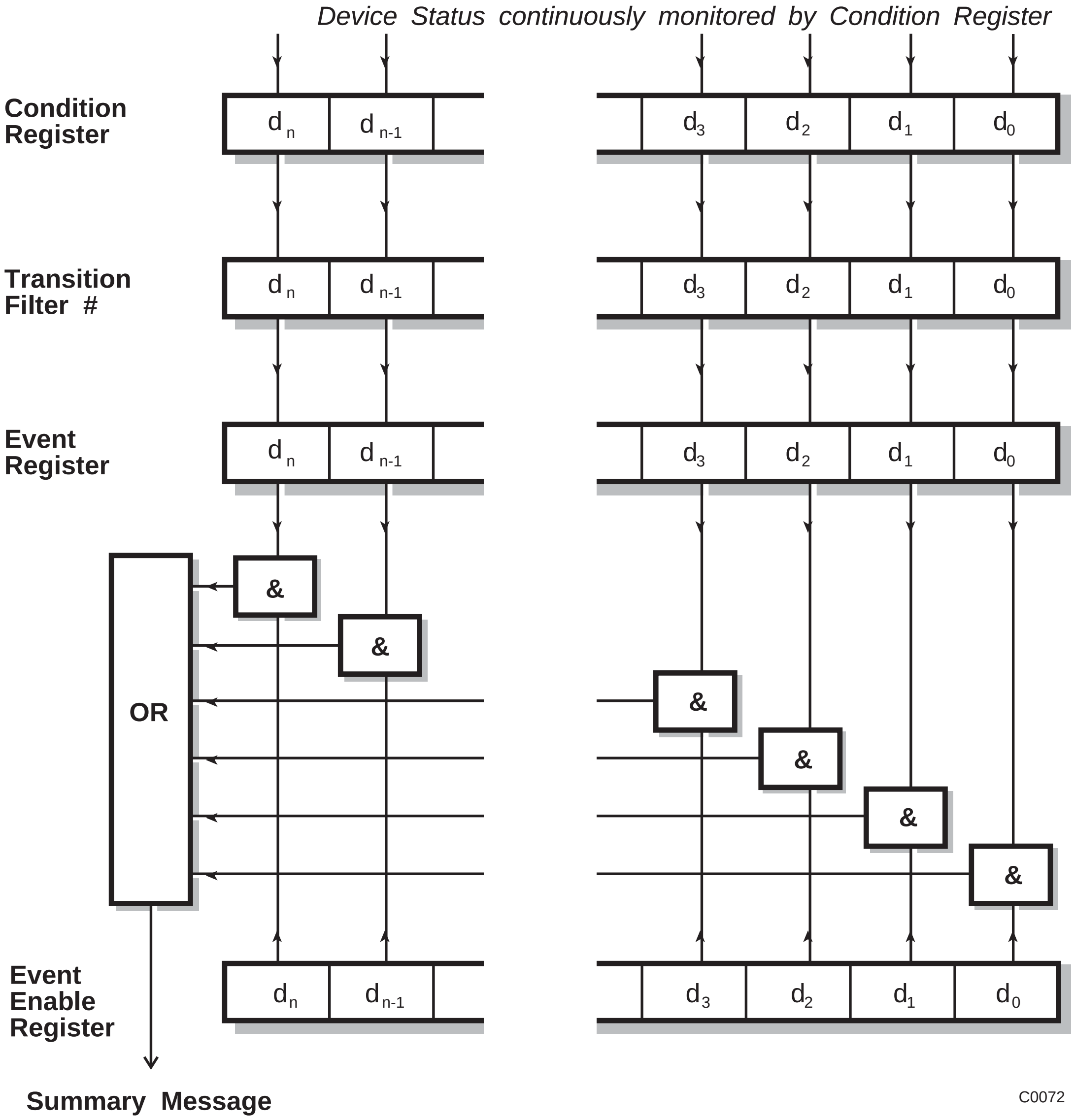
The Service Request Enable Register determines which of the bits can generate an SRQ, this register may be set by *SRE or read by *SRE?. If the bitwise -AND of the Status Byte and the Enable Register is non-zero the Flag Master Summary Status (<mss>) is True. Bit 6 of the Status byte value read by *STB? holds <mss>. However bit 6 of the Status Byte when Serial Polled is the Request For Service bit used to determine which device on the Bus has asserted SRQ, and is cleared by a Serial Poll.

The IEEE 488.2 Standard defines bit 4 as Message Available (<mav>), the Queue Summary for the Output Buffer, indicating whether any part of a Response Messages is available to be read. Bit 5 is the Event Summary Bit (<esb>), the Summary Message from the Standard Event Status Register.

In 2050T series, bit 7 is a Queue Summary for the Error Queue. Bits 1, 2, and 3 are Status summaries for the Instrument Status, Coupling Status and Hardware Status Registers. Bit 0 is unused.

Status data structure - register model

Below is a generalised model of the Register Set which funnels the monitored data into a single summary bit to set the appropriate bit in the Status Byte.



Notes...

The Device Status is continuously monitored by the Condition Register. If a Query to read a Condition Register is provided, the Response represents the Status of the instrument at the moment the Response is generated. A Condition Register cannot be written to.

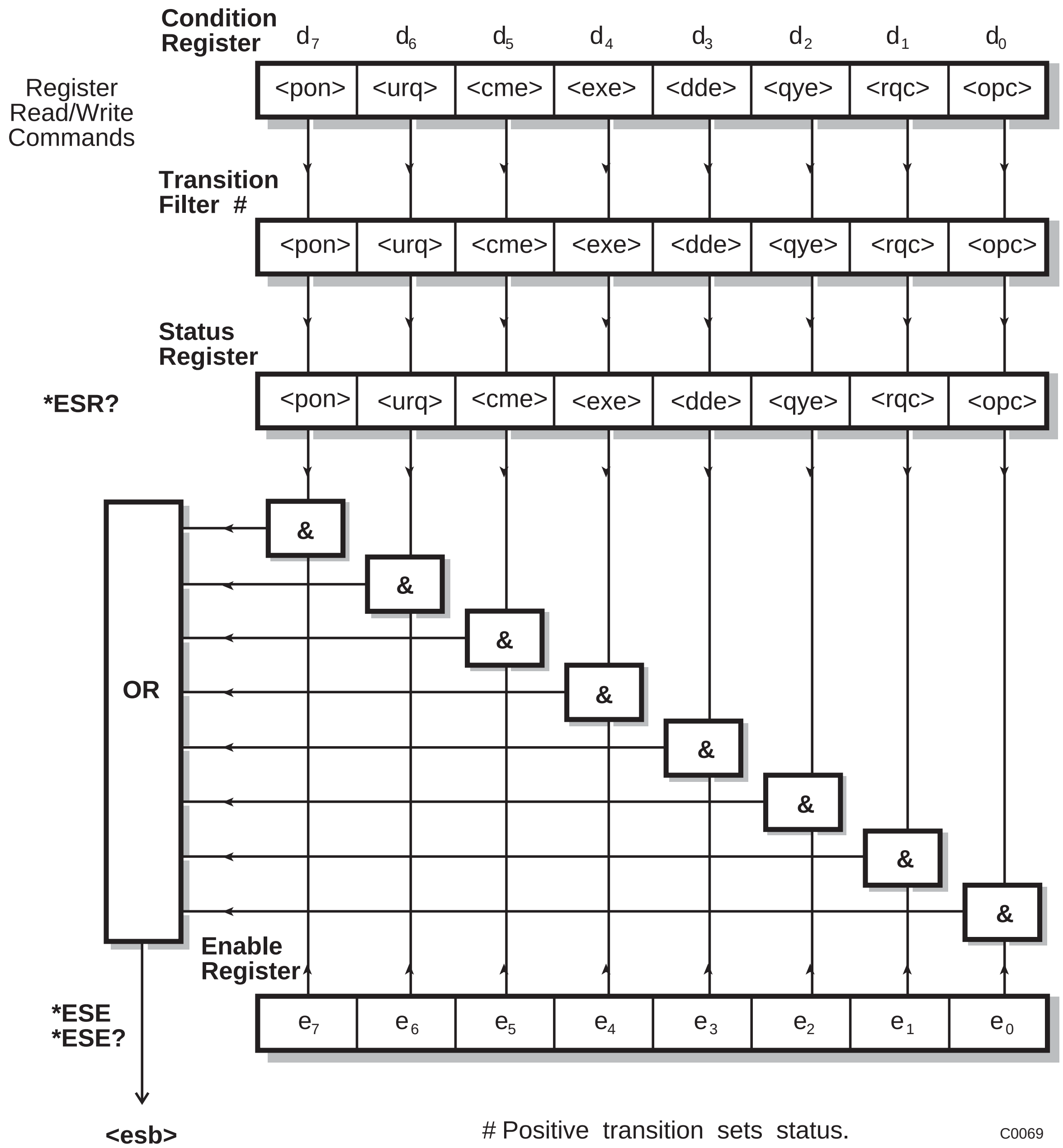
The Transition Filter determines which transition of the Condition Register data bits will set the corresponding bit in the Event Register. Either positive-going, negative-going or both transitions can set bits in an Event Register. But in the 2050T series the Transition Filters are pre-set as either Positive or Negative, as described in the following pages.

The bits in an Event Register are "latched". Once set they remain set, regardless of subsequent changes in the associated condition bit until the Event Register is cleared by being read or by the *CLS common command. Once cleared, an Event Register bit will only be set again if the appropriate change in the Condition bit occurs.

The Event Enable Register may be both written to and read from. It is bitwise AND-ed with the Event Register and if the result is non-zero the Summary Message is true, otherwise the Summary Message is false. Enable Registers are not affected by *CLS but are however clear at power-on.

Standard event registers

This Register is defined by IEEE 488.2 and each bit has the meaning shown below:-

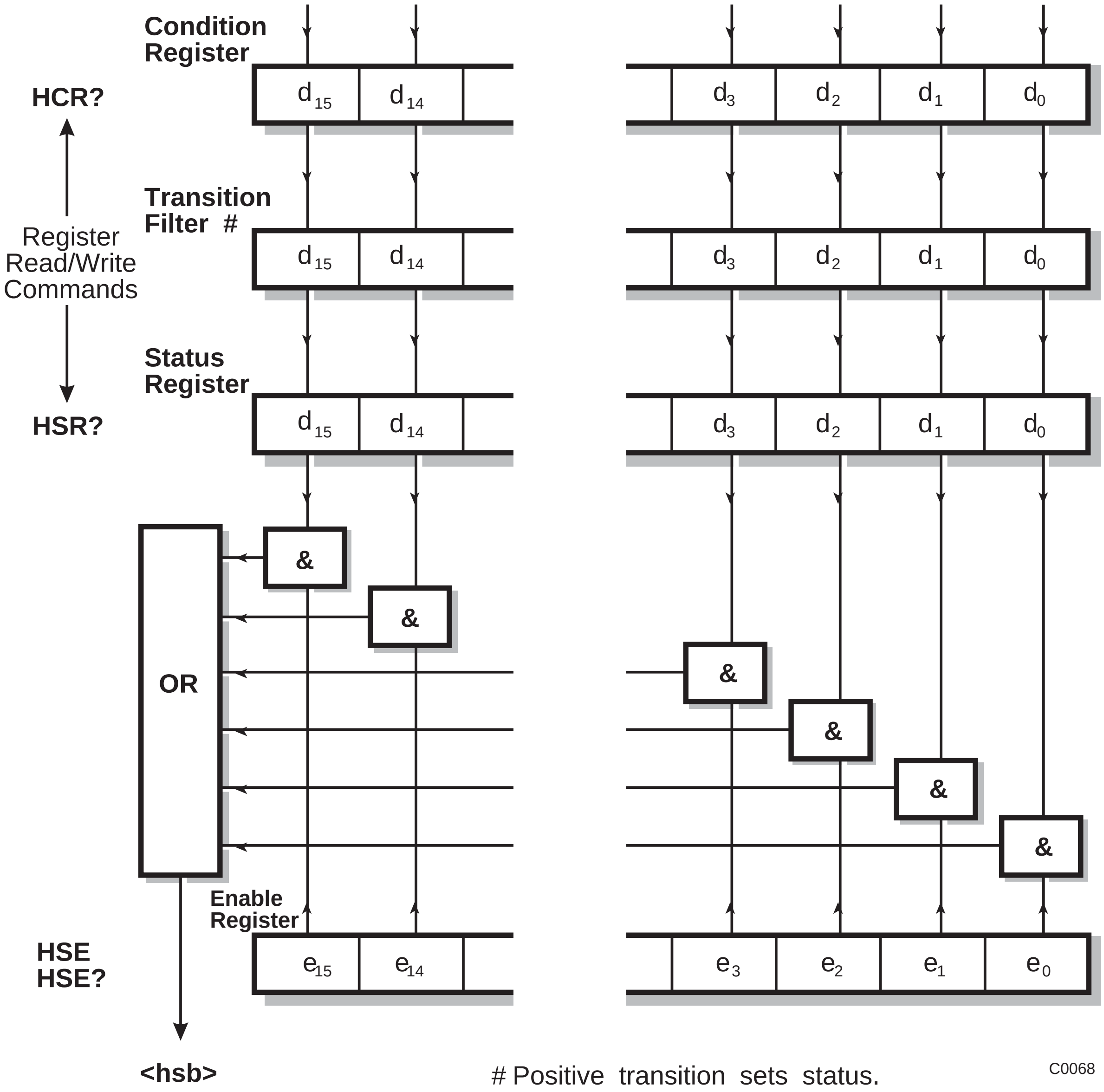


<pon> power on
<urq> user request - used by screen edit facility
<cme> command error
<exe> execution error
<dde> device dependent error
<qye> query error
<rqc> request control - not implemented in this product
<opc> operation complete - set in response to the *OPC command for synchronisation.

<esb> standard event register summary bit

Hardware event registers

This is a device dependant Register and the bits have meanings as shown in the list at the bottom of the page.

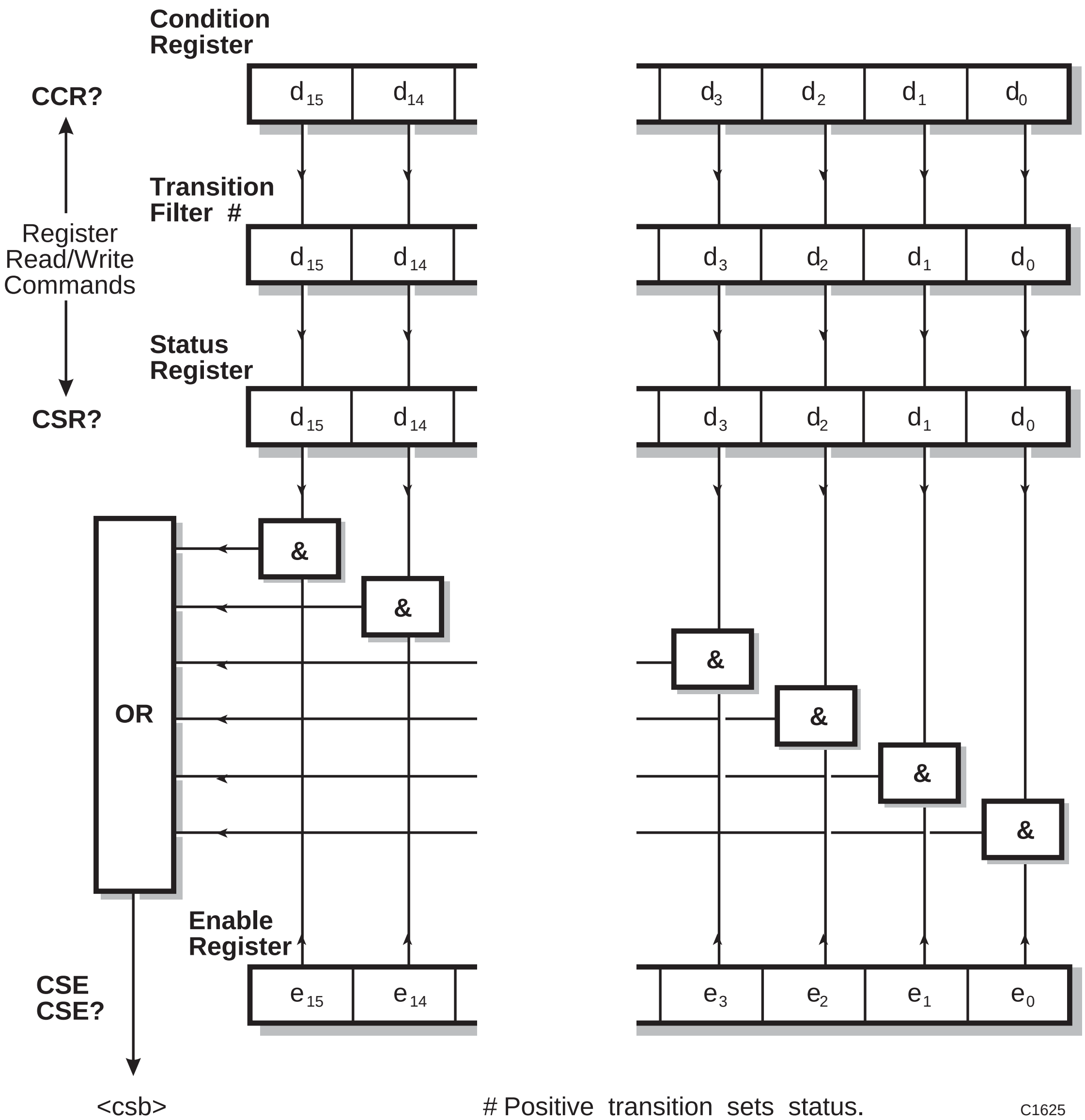


d_0	reverse power protection tripped	d_8	IF loop out of lock
d_1	fractional-n system out-of-lock	d_9	not used
d_2	vcxo out-of-lock	d_{10}	16/26 reference too high
d_3	frequency standard missing	d_{11}	16/26 reference too low
d_4	external mod 1 alc loop signal too low	d_{12}	IQ modulator calibration required
d_5	external mod 1 alc loop signal too high	d_{13}	not used
d_6	external mod 2 alc loop signal too low	d_{14}	RF level uncalibrated
d_7	external mod 2 alc loop signal too high	d_{15}	Extended hysteresis

<hsb> hardware event register summary bit

Coupling event registers

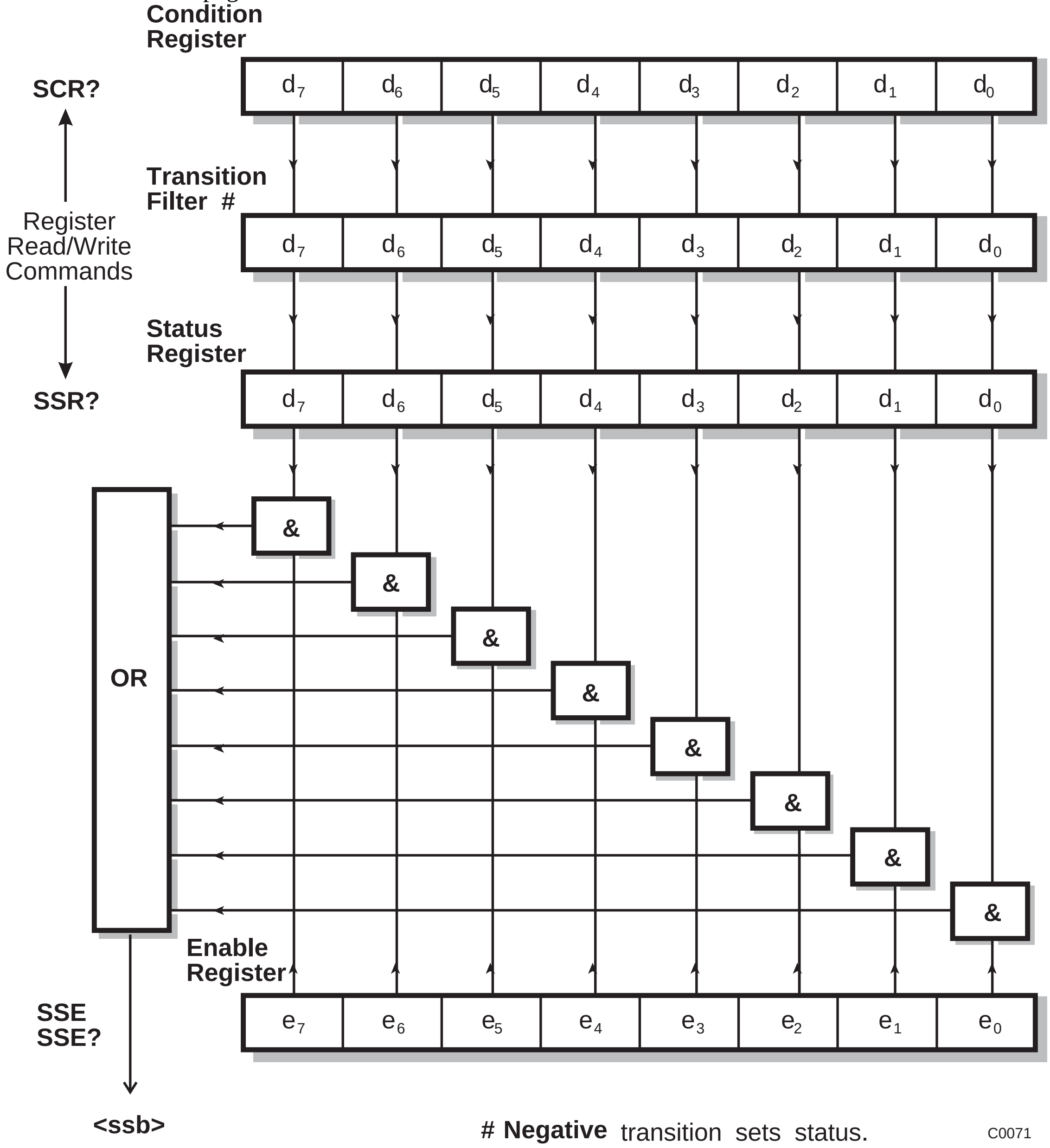
This is a device dependant Register and the bits have meanings as shown in the list at the bottom of the page.



d_0	rf level restricted by requested am
d_1	fm restricted by requested carrier frequency
d_2	widebandfm restricted by requested carrier frequency
d_3	am2 depth restricted by requested am1 depth
d_4	fm2 deviation restricted by requested fm1 deviation
d_5	pm2 deviation restricted by requested pm1 deviation
d_6	number of sweep steps restricted by other parameters
d_7	carrier restricted by modulation mode
d_8	rf level restricted by modulation mode
<csb>	coupling event register summary bit

Instrument event registers

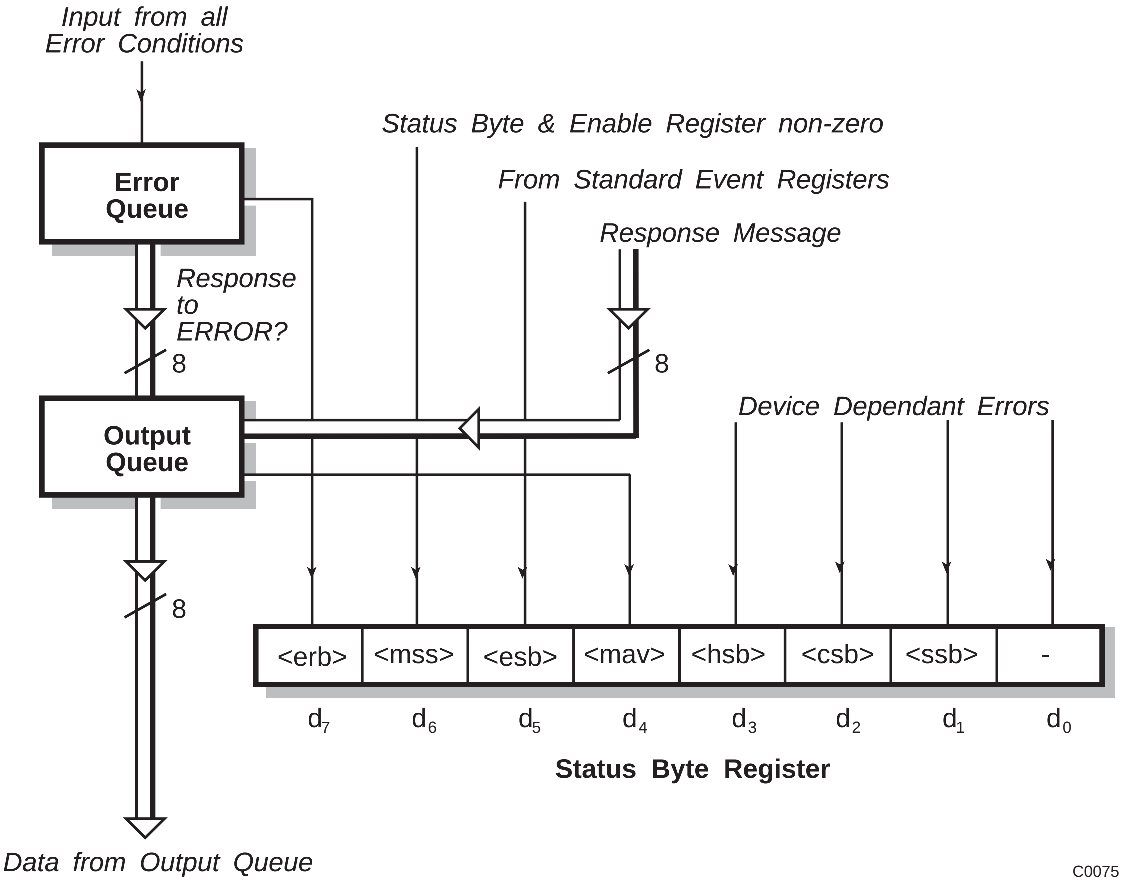
This is a device dependant Register and the bits have meanings as shown in the list at the bottom of the page.



	Condition (*SCR?)	Event Status (*SSR?)
d_0	sweep in progress	end of sweep
d_1	sending tones	tones sent
d_2	selfcal in progress	selfcal completed
d_3	dc fm null in progress	dc fm null completed
d_4	not used	not used
d_5	not used	not used
d_6	not used	not used
d_7	not used	not used

<ssb> instrument event register summary bit

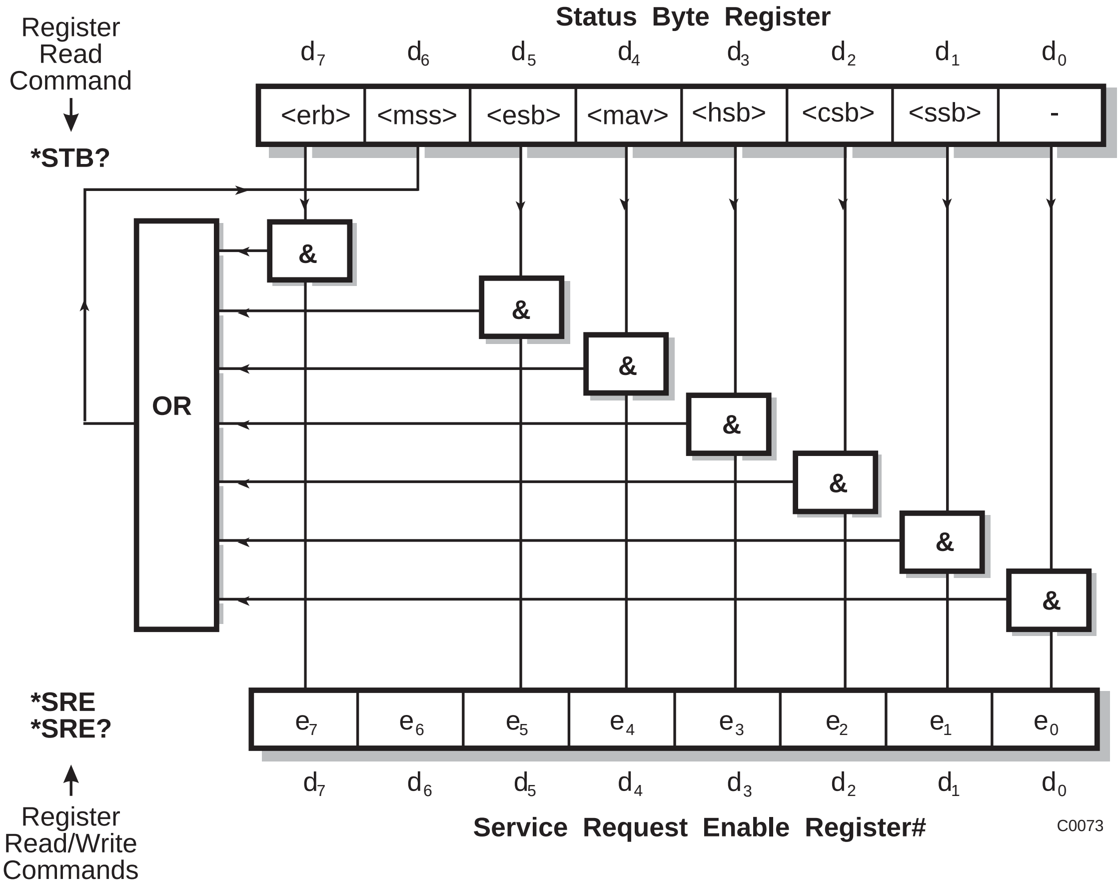
Queue flag details



The <mav> status bit is set when one or more bytes are available to be read from the Output Queue.

The <erb> status bit is set when one or more errors are present in the Error Queue. The ERROR? query will place a nr1 response message in the Output Queue representing the Error at the head of the queue, if the queue is empty then this message will be 0.

Status byte when read by *stb?



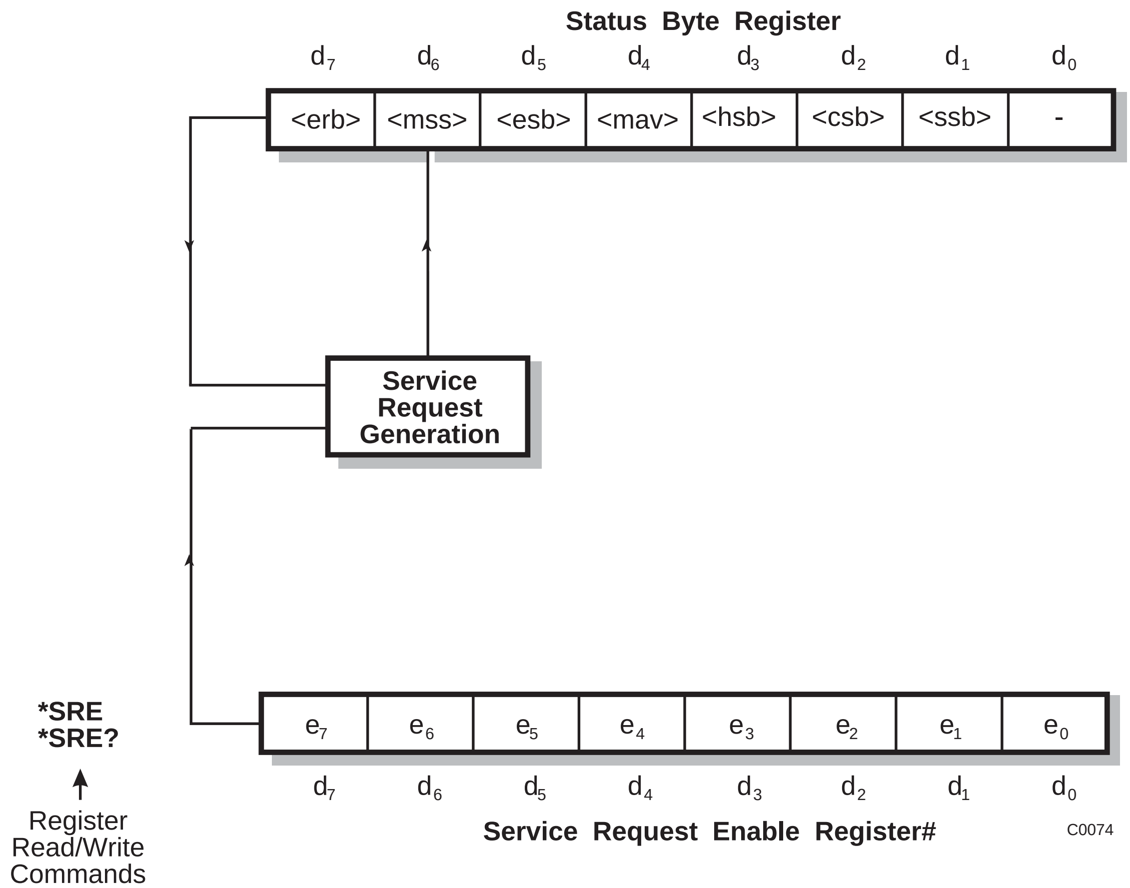
Bit 6 in this register ignores data sent by ***SRE** and always returns 0 in response to ***SRE?**

<rqs>, <esb> and <mav> are defined in IEEE 488.2

<erb> is a device defined queue summary bit indicating that the error queue is non-empty.
<mss> is true when (Status Byte) AND (Enable register) > 0.
<esb> is the standard event register summary bit.
<mav> is 'message available' indicating that the output queue is non-empty.
<hsb> is 'hardware status' summary bit
<csb> is 'coupling status' summary bit
<ssb> is 'instrument status' summary bit

Note **The Status Byte Register is Not cleared by the *STB? query.**

Status byte when read by serial poll



Bit 6 in this register ignores data sent by *SRE and always returns 0 in response to *SRE?

<erb> is a device defined queue summary bit indicating that the error queue is non-empty.
<rqs> is set by a request for service and is cleared by the poll.
<esb> is the standard event register summary bit.
<mav> is 'message available' indicating that the output queue is non-empty.
<hsb> is 'hardware status' summary bit
<csb> is 'coupling status' summary bit
<ssb> is 'instrument status' summary bit

<rqs>, <esb> and <mav> are defined in IEEE 488.2

<rqs> (request for service) will produce an SRQ at the controller. It is set by a change to either the Status Byte or the Service Enable Register that results in a New Reason for Service. It is cleared when <mss> goes FALSE (i.e. no reason for service) or by Serial Poll.

Summary of status reporting commands and queries

***CLS**	Clears Status Registers and the Error Queue
***ESE<nrf>**	Writes to Standard Event Enable Register
***ESE?**	Reads from Standard Event Enable Register
***ESR?**	Reads from Standard Event Status Register
***SRE<nrf>**	Writes to Service Request Enable Register
***SRE?**	Reads from Service Request Enable Register
***STB?**	Reads from Status Byte Register
CCR?	Reads from Coupling Condition Register
CSE<nrf>	Writes to Coupling Status Enable Register
CSE?	Reads from Coupling Status Enable Register
CSR?	Reads from Coupling Status Register
HCR?	Reads from Hardware Condition Register
HSE<nrf>	Writes to Hardware Status Enable Register
HSE?	Reads from Hardware Status Enable Register
HSR?	Reads from Hardware Status Register
SCR?	Reads from Instrument Condition Register
SSE<nrf>	Writes to Instrument State Enable Register
SSE?	Reads from Instrument State Enable Register
SSR?	Reads from Instrument State Status Register
<nrf>	Decimal Numeric Program Data

All of the above queries respond with a nr1 numeric format.

Chapter 5
BRIEF TECHNICAL DESCRIPTION

Introduction

The 2050T series signal generators cover a wide range of frequencies from 10 kHz to 1.35 GHz (2050T), 10 kHz to 2.7 GHz (2051T) and 10 kHz to 5.4 GHz (2052T). Output levels from -144 or -138 dBm to +13 dBm are available. The simplified block schematic diagram for the instrument is shown in Fig. 4-1.

Modulation

The carrier frequency can be frequency, phase or amplitude modulated from internal or external modulation sources. A maximum of four modulation channels can be made available by the use of the internal oscillator and a second optional internal oscillator together with two external modulation signals applied to the EXT MOD 1 INPUT and EXT MOD 2 INPUT connectors on the front panel.

In vector modulation IQ modulation is provided from 10 MHz up to 2.7 GHz by frequency conversion of 1 of 4 IFs to the required output frequency. In digital modulation a vector modulated RF carrier is generated from data inputs.

Frequency generation

Four voltage controlled oscillators (VCOs) covering the frequency range 675 to 1350 MHz are phase locked to a 10 MHz oven controlled crystal oscillator using a fractional-N synthesizer system. Additional frequency coverage is achieved by means of frequency division or multiplication. Low frequencies are generated by a beat frequency oscillator (BFO) system.

Display

The display is a high definition dot matrix liquid crystal panel with backlighting to cater for variations in ambient light conditions. The display can be adjusted for both contrast and brightness.

Control

The 2050T series are menu driven instruments. Main menus are displayed by the use of hard keys, and parameters are changed by means of soft keys which change as the menu changes. Internal control of the instruments is achieved by a microprocessor which receives data from the various controls and sends instructions via an internal 8-bit data bus to the signal processing circuits.

The instruments can also be controlled by the built in general purpose interface bus (GPIB). This facility enables the instruments to be used both as manually operated bench mounted instruments or as part of a fully automated test system.

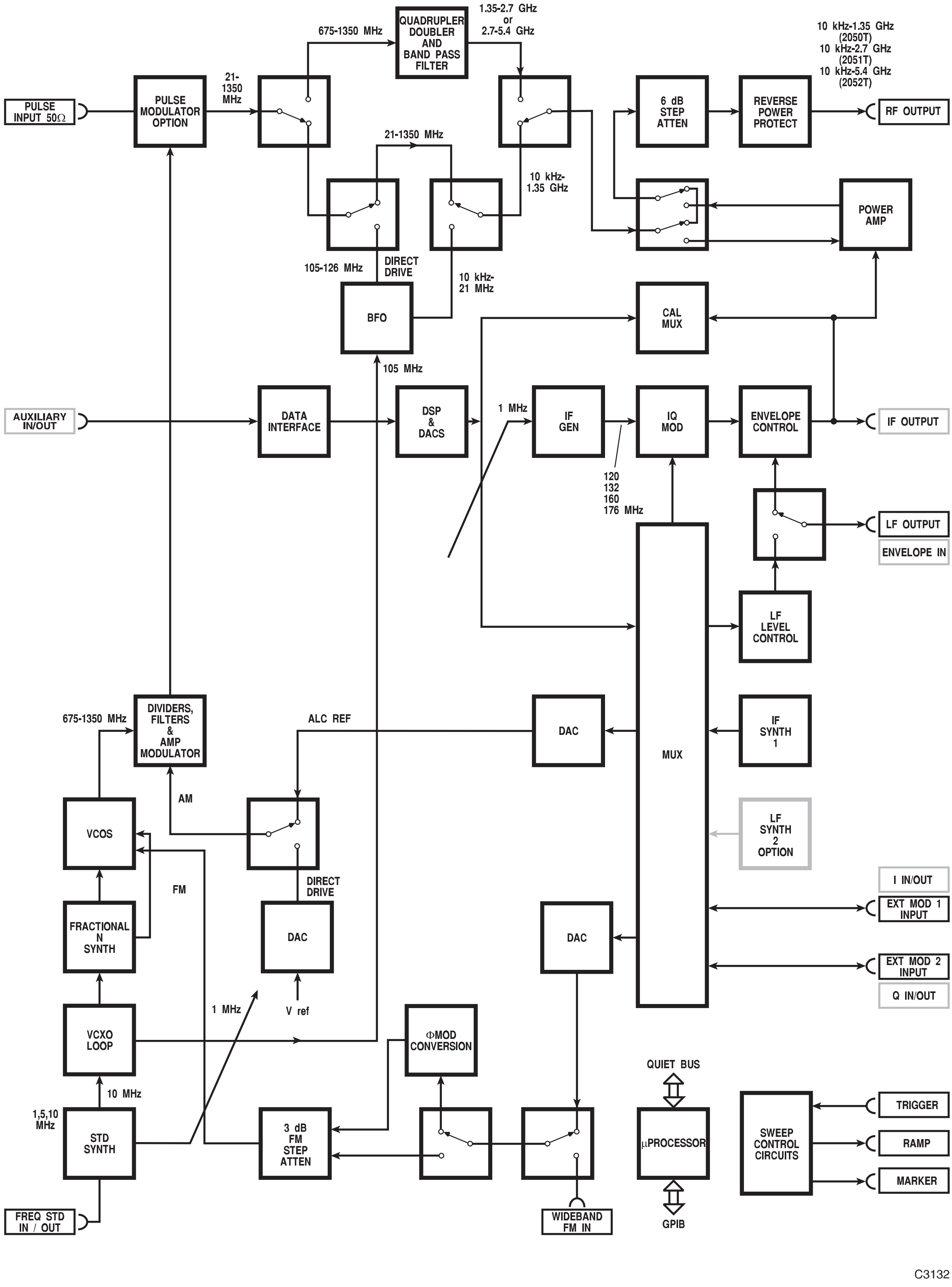


Fig. 5-1 Block schematic diagram

Chapter 6
ACCEPTANCE TESTING

Contents

List of tables

List of figures

Introduction

Test procedures described in this chapter may be simplified and of restricted range compared with those that relate to the generally more comprehensive factory test facilities which are necessary to demonstrate complete compliance with the specifications.

Performance limits quoted are for guidance and should not be taken as guaranteed performance specifications unless they are also quoted under 'Performance Data' in Chapter 1.

When making tests to verify that the instrument meets the stated performance limits, always allow for the uncertainty of the test equipment.

For those signal generators with options fitted, the appendixes at the end of this Chapter and the Annexes at the end of this manual must be referred to.

Recommended test equipment

The test equipment recommended for acceptance testing is shown in Table 6-1. Alternative equipment may be used provided it complies with the stated minimum specification.

Table 6-1 Recommended test equipment

Description	Minimum specification	Example
Power meter	±0.1 dB from 10 kHz to 5.4 GHz	Aeroflex 6960B and 6910 or 6912 sensor
Measuring receiver	0 dBm to -127 dBm; 2.5 to 1300 MHz	HP8902A and 11722A sensor and 11793A down converter#
Signal generator	8 dBm from 32.5 MHz to 5.4 GHz	Aeroflex 2032
Frequency counter	10 Hz to 5.4 GHz	ETP 535B or Aeroflex 2440
Audio analyzer	Capable of measuring THD below 0.03%m from 50 Hz to 20 kHz. Capable of measuring 0.5 mV ±3% and levels at 10 Hz	Rohde & Schwarz UPA3
Digital multimeter	DC to 500 kHz, 1 mV to 5 V Resistance measurement capability	Datron 1061A
Modulation meter	AM, FM and ΦM. 1.5 MHz to 1 GHz. Accuracy better than 1.1%. Modulation freqs from 30 Hz to 50 kHz. Capable of measuring Residual FM less than 7 Hz.	Aeroflex 2305 plus distortion option*
Spectrum analyzer	10 kHz to 16.2 GHz Dynamic range greater than 80 dB Capable of measuring less than -70 dBm.	Aeroflex 2386
Break-out box		Aeroflex 44991/144
Function generator	DC to 10 MHz sine ±0.6 dB flatness	HP3325B

***** The distortion option of the 2305 Modulation Meter allows modulation distortion tests to be carried out with greater ease. If a 2305 with a distortion option is not available, the Audio Analyzer may be connected to the Modulation Meter LF output and set to measure distortion.

If receiver and down converter are not available, an alternative procedure to ensure attenuator pad accuracy using a power meter is given.

Test procedures

Before each test, it is recommended that the UUT is reset to its switch-on conditions which are as follows:

Carrier freq	1.35 GHz (2050T), 2.7 GHz (2051T), 5.4 GHz (2052T)
RF level	-144 dBm
FM	0 Hz ON
Single modulation mode	
Modulation	ENABLED

RF output

Specification

Level range: -127 dBm to +13 dBm (usable to -144 dBm)

Accuracy:

(2050T, 2051T and 2052T)
±0.85 dB from 10 kHz to 1.35 GHz at levels >-127 dBm
±0.50 dB from 10 kHz to 1.35 GHz at levels >0 dBm

(2051T and 2052T)
±1.0 dB from 1.35 GHz to 2.7 GHz at levels >-127 dBm
±0.7 dB from 1.35 GHz to 2.7 GHz at levels >0 dBm

(2052T only)
±1.5 dB from 2.7 GHz to 5.4 GHz at levels >-100 dBm
±1.5 dB from 2.7 GHz to 5.4 GHz at levels >-50 dBm
±1.0 dB from 2.7 GHz to 5.4 GHz at levels >0 dBm

Test equipment

Description	Minimum specification	Example
RF power meter	±0.1 dB from 30 kHz to 2.7 GHz	Aeroflex 6960B and 6910 or 6912 sensor
Measuring receiver	0 dBm to –127 dBm; 2.5 MHz to 1300 MHz	HP 8902A and 11722A sensor and 11793A down converter
Signal generator	8 dBm from 32.5 MHz to 5.4 GHz	Aeroflex 2032

Test procedures

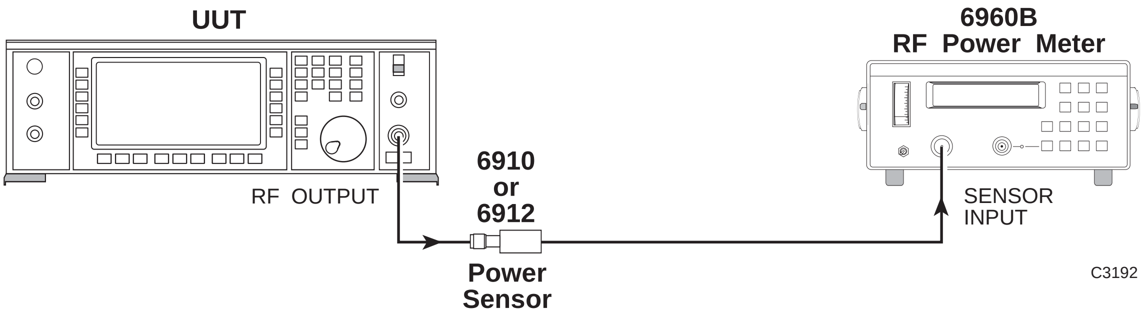


Fig. 6-1   RF output test set-up

(1) Connect the test equipment as shown in Fig. 6-1.

(2) Set the UUT to *[RF Level]* 0 dBm *[Carrier Freq.]* 30 kHz.

(3) Check that the output level is within specification at the frequencies shown in Table 6-2.

When checking a 2052T signal generator, the 6912 sensor must be replaced with 6910 sensor for frequencies above 2700 MHz.

(4) Set the UUT RF output to 7 dBm and repeat (3) above.

(5) Set the UUT RF output to 13 dBm and repeat (3) above.

Table 6-2 Frequency settings for output levels

FREQUENCY (MHz)				
(2050T/1T/2T)	1125	2025	2925	4425
0.03	1275	2175	3075	4575
0.1	1350	2325	3225	4725
75		2475	3375	4875
225	**(2051T/2T)**	2625	3525	5025
375	1351	2700	3675	5175
525	1425		3825	5325
675	1575	**(2052T)**	3975	5400
825	1725	2701	4125	
975	1875	2775	4275	

ALC linearity

(1) Connect the test equipment as shown in Fig. 6-1.

(2) Set the UUT to *[RF Level]* 0 dBm *[Carrier Freq.]* 2.5 MHz.

(3) Increment the RF output of the UUT in 1 dB steps up to 12 dBm and in 0.1 dBm steps up to 13 dBm, measuring the RF level at each step. Check that the RF output level variation is within ±0.1 dB.

(4) Set the UUT carrier frequency to 500 MHz and repeat (3) above.

(5) Set the UUT carrier frequency to 2.7 GHz and repeat (3) above.

(6) Replace the 6912 sensor with the 6910 sensor, set the UUT carrier frequency to 5.4 GHz and repeat (3) above.

Attenuator accuracy

The following test will confirm that the attenuator performs to the published performance specification. In the event of the receiver/down converter not being available, an alternative method to functionally test the attenuator is also suggested (see 'Alternative attenuator functional check' below).

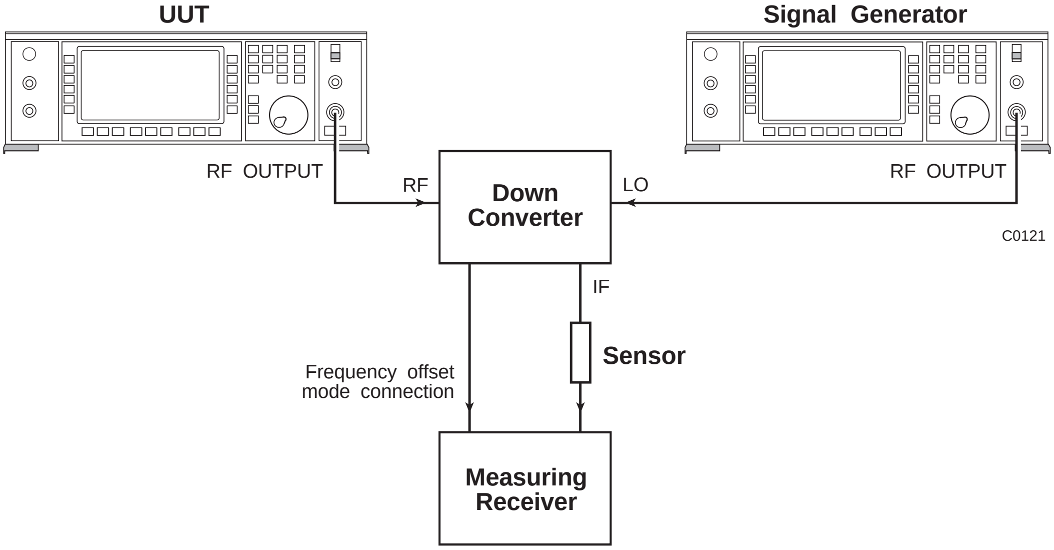


Fig. 6-2 Attenuator accuracy test set-up

(1) Connect the test equipment as shown in Fig. 6-2.

(2) Set the UUT to *[RF Level]* 0 dBm *[Carrier Freq.]* 2.5 MHz.

(3) Tune the receiver to 2.5 MHz and measure the RF level.

(4) Set the UUT to *[RF Level]* -6.1 dBm and measure the RF level.

(5) Decrement the output of the UUT in 6 dB steps down to an RF level of -120.1 dBm measuring the RF level at each step. Check that the measured level is within specification.

(6) Repeat (2) to (5) at the frequencies given in Table 6-3.

(7) Set the local oscillator to +8 dBm at the frequencies indicated in brackets in Table 6-3.

Table 6-3 Attenuator frequency settings

Frequency (MHz)

2050T/1T/2T	*2051T/2T	**2052T
2.5	1725 (1662)	2775 (2712)
31	2700 (2637)	4125 (4062)
325		5400 (5337)
1125		1275

*At frequencies above 1300 MHz the down converter will automatically be enabled.

**At frequencies above 2700 MHz it is only necessary to test down to -96.1 dBm (determined by 8902 accuracy).

The frequency of the local oscillator will have to be entered on the receiver followed by the test frequency. This will automatically set the receiver to the required IF frequency.

Alternative attenuator functional check

(1) Connect the test equipment as shown in Fig. 6-1.

(2) Set the UUT to *[Carrier Freq.]* 1.35 GHz *[RF Level]* 13 dBm.

(3) Set a reference on the power meter.

(4) Using the latch poke facility on the UUT, select each attenuator pad individually as follows:

[UTIL] *[Utils. Menu 2] [Latch Data]* 95 [enter]

[Decimal/Binary]

The binary latch data will now appear in the bottom right-hand side of the display.

(5) By using the *[Toggle Bit]* and the *[Cursor Left] [Cursor Right]* soft keys, select each attenuator pad in turn which should give the nominal readings on the power meter in the following sequence:

-24 dB -36 dB -6 dB -12 dB -24 dB -36 dB

Note that no software correction is applied to the attenuator when performing this test.

Carrier frequency accuracy

Specification

Frequency range:	10 kHz to 1.35 GHz (2050T) 10 kHz to 2.7 GHz (2051T) 10 kHz to 5.4 GHz (2052T)
Accuracy:	Determined by the frequency standard accuracy
Resolution:	0.1 Hz

Test equipment

Description	Minimum specification	Example
Frequency counter	10 kHz to 5.4 GHz	ETP 535B or Aeroflex 2440

Test procedures

Fig. 6-3 Carrier frequency accuracy test set-up

(1) Connect the test equipment as shown in Fig. 6-3.

(2) Set the UUT to *[RF Level]* 0 dBm *[Carrier Freq.]* 10 kHz.

(3) Referring to Table 6-4, check that the carrier frequencies can be selected correctly and are within specification. It will be necessary to disconnect the 50 Ω load and reconnect the UUT RF OUTPUT to the B input and C input where indicated.

Table 6-4 Carrier frequencies

Carrier frequencies (Hz)

(2050T/1T/2T)			**(2052T)**
A Input	**B Input**	805,306,368.0	2,700,001,000.0
		952,945,868.8	5,400,000,000.0
10,000.0	168,749,999.9	959,656,755.2	
4,226,750.0	337,499,999.9	1,134,139,801.6	
8,443,500.0	572,662,306.1	1,140,850,688.0	
12,660,250.0		1,145,324,612.2	
16,887,000.0	**C Input**	1,348,888,166.4	
21,093,749.9			
21,039,750.0	674,999,999.9	**(2051T/2T)**	
42,187,499.9	677,799,526.4	1,350,001,000.0	
84,374,999.9	798,595,481.6	2,700,000,000.0	

Modulation oscillator

Specification

Frequency range:	0.1 Hz to 500 kHz
Accuracy:	Equal to the frequency standard accuracy
Resolution:	0.1 Hz
Distortion:	Less than 0.1% THD at frequencies up to 20 kHz sine wave mode

Test equipment

Description	Minimum specification	Example
Frequency counter	10 Hz to 500 kHz	ETP 535B or Aeroflex 2440
Audio analyzer	Capable of measuring down to 0.03% THD from 100 Hz to 20 kHz	Rohde & Schwarz UPA 3

Modulation oscillator frequencies

Test procedures

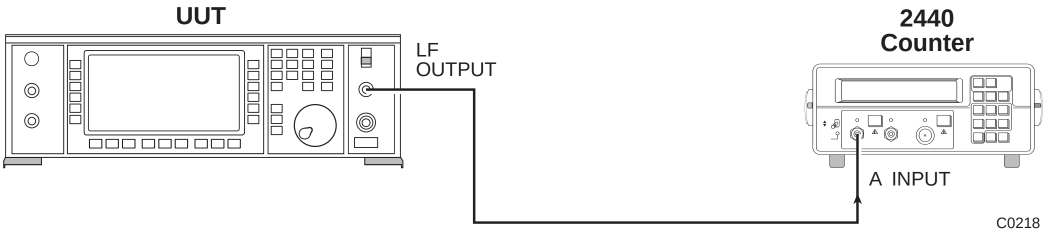


Fig. 6-4 Modulation oscillator frequencies test set-up

(1) Connect the test equipment as shown in Fig. 6-4.

(2) Set the UUT to *[Source Freq: F4]* 10 Hz.

(3) Referring to Table 6-5, check that the oscillator frequencies can be selected correctly and are within specification.

Table 6-5 Modulation oscillator frequencies

Modulation oscillator frequencies (Hz)	
10.00	279,620.20
139,810.10	500,000.00

Modulation oscillator distortion

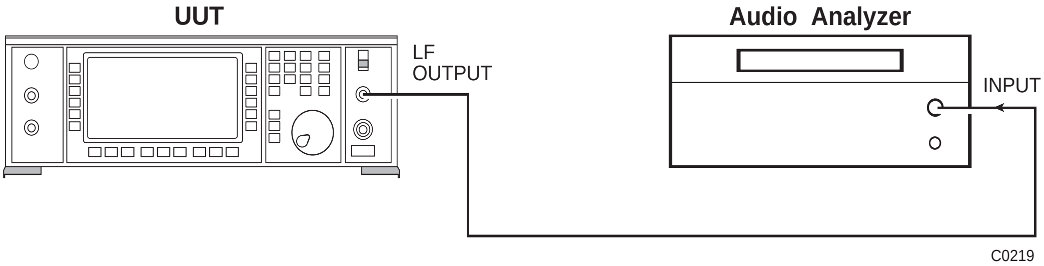


Fig. 6-5 Modulation oscillator distortion test set-up

(1) Connect the test equipment as shown in Fig. 6-5.

(2) Set the UUT to *[Source Freq: F4]* 100 Hz.

(3) Check that the distortion measured on the audio analyzer at the frequencies indicated in Table 6-6 is less than 0.1%.

Table 6-6 Distortion frequency settings

Modulation oscillator frequencies	
100 Hz	10 kHz
1 kHz	20 kHz

LF output

Specification

Level accuracy: ±5% for levels above 50 mV
±10% for levels from 500 µV to 50 mV
(With a load impedance >10 kΩ)

Frequency response: Typically better than 1 dB from 0.1 Hz to 300 kHz

Test equipment

Description	Minimum specification	Example
Digital multimeter	DC to 300 kHz, 1 mV to 5 V	Datron 1061A
Audio analyzer	Capable of measuring 0.5 mV ±3% and levels at 10 Hz	Rohde & Schwarz UPA3

Level accuracy

Test procedures

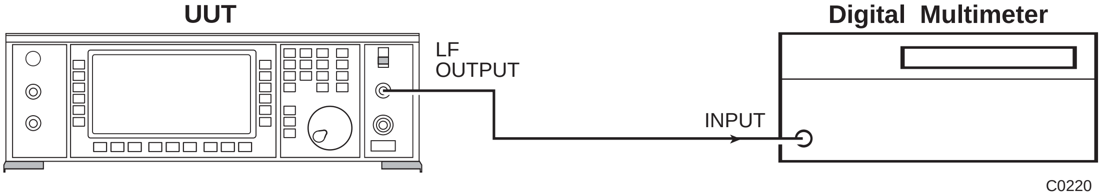


Fig. 6-6 Level accuracy test set-up

(1) Connect the test equipment as shown in Fig. 6-6.

(2) Set the UUT to give an LF output of 5 V at 1 kHz as follows:

[LF] *[LF Gen] [LF Freq]* 1 kHz *[LF Level]* 5 V

(3) The level measured on the digital multimeter should read 5 V ±0.25 V.

(4) Check the LF output of the UUT at the levels indicated in Table 6-7. Check that the measured levels are within specification.

Table 6-7 Level accuracy output levels

LF output levels (V)

5.0000	0.1000	0.0050
2.0000	0.0500	0.0020
1.0000	0.0200	0.0010
0.5000	0.0100	*0.0005
0.2000		

*For the last measurement it will be necessary to use the audio analyzer. Connect the test equipment as shown in Fig. 6-5.

Frequency response

(1) Connect the test equipment as shown in Fig. 6-6.

(2) Set the UUT to give an LF output of 1 V at 1 kHz on the first modulation oscillator (see 'Level accuracy' (2) above).

(3) Reference this level on the digital voltmeter using the dB relative function.

(4) Set the modulation oscillator to the frequencies given in Table 6-8 measuring the difference from the reference in (3) above which should be less than 1 dB.

Table 6-8 Frequency response test frequencies

Test frequencies		
*10 Hz	1 kHz ref	70 kHz
*30 Hz	10 kHz	100 kHz
*100 Hz	30 kHz	300 kHz

* For these measurements it will be necessary to use the audio analyzer. Connect the test equipment as shown in Fig. 6-5, referencing the audio analyzer at 1 kHz.

External modulation

Specification

	With ALC off, the modulation is calibrated for an input level of 1.0 V PD RMS
	With ALC on, the modulation is calibrated for input levels between 0.7 V and 1.4 V PD RMS
Distortion:	Additional 0.1% from 50 Hz to 20 kHz at 1 V RMS with ALC on
Flatness:	Typical 1 dB bandwidth, 10 Hz to 500 kHz

Test equipment

Description	Minimum specification	Example
Function generator	10 Hz to 500 kHz sine wave ±0.6 dB flatness	HP 3325B
Digital multimeter	10 Hz to 500 kHz	Datron 1061A
Audio analyzer	Capable of measuring THD down to 0.03% from 50 Hz to 20 kHz	Rohde & Schwarz UPA3

Mod ALC on flatness

Test procedures

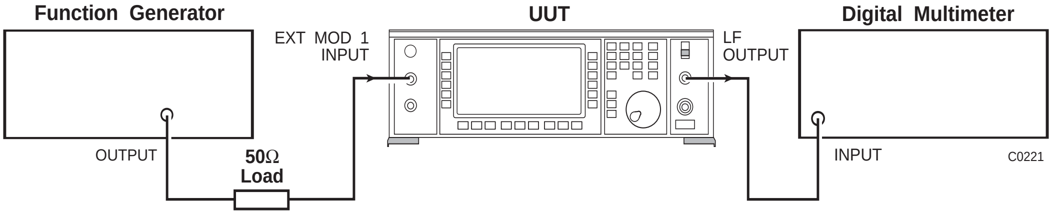


Fig. 6-7 External modulation test set-up

Mod input 1

(1) Connect the test equipment as shown in Fig. 6-7.

(2) Set the function generator to 1 V RMS sine wave output at a frequency of 1 kHz.

(3) Set the UUT to EXT MOD 1 INPUT with ALC ON as follows:

[LF] *[Mod Drive]*
[SIG GEN] *[FM]* 90 kHz *[Select Source]*
[Select External] [Ext1 ALC Coupling] [SIG GEN]

(4) Set the digital multimeter to read dB and measure and record this value.

(5) Set the function generator to the frequencies given in Table 6-9 and measure the LF output relative to that reading taken in (4) above. The difference should be less than 1 dB.

(6) Set the function generator to give 0.7 V output and repeat (4) and (5) above.

(7) Set the function generator to give 1.4 V output and repeat (4) and (5) above.

Mod input 2

(8) Connect the test equipment as in Fig. 6-7 except with the function generator output connected to EXT MOD 2 INPUT on the UUT.

(9) Set the UUT to EXT MOD 2 INPUT with ALC ON as follows:

[Select source] [Ext2 ALC Coupling] [SIG GEN]

(10) Reset the function generator as in (2) above and repeat (4) to (7) above.

Table 6-9 EXTERNAL MODULATION FREQUENCIES

External modulation frequencies			
10 Hz	50 Hz	20 kHz	200 kHz
20 Hz	1 kHz ref	100 kHz	300 kHz

Modulation ALC distortion

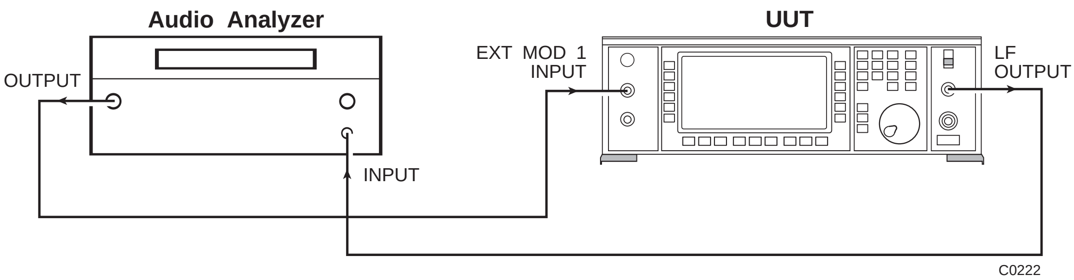


Fig. 6-8 Modulation ALC distortion test set-up

(1) Connect the test equipment as shown in Fig. 6-8.

(2) Set the UUT as in 'Mod input 1' (3) above.

(3) Set the audio analyzer to give 1 V RMS output and monitor distortion.

(4) Set the audio analyzer to 50 Hz, 1 kHz and 20 kHz measuring the distortion at each frequency which must be less than 0.4%.

(5) Connect the test equipment as in Fig. 6-8 except with the output from the audio analyzer connected to EXT MOD 2 INPUT on the UUT and set the UUT as in 'Mod input 2' (9) above.

(6) Repeat (4) above.

Internal AM depth and distortion

Specification

Range: 0 to 99% in 0.1% steps.

Accuracy: For carrier frequencies up to 1 GHz, ±4% of setting ±1% depth.
Usable to1.35 GHz (2050T), 2.7 GHz (2051T), 5.4 GHz (2052T).

Envelope distortion: Less than 3% THD for AM depths up to 80% at 1 kHz modulation frequency.
Less than 1% THD for AM depths up to 30% at 1 kHz modulation frequency.

Phase mod on AM: Typically less than 0.1 rad at 30% depth on a 500 MHz carrier.

Test equipment

Description	Minimum specification	Example
Modulation meter	1.5 MHz to 1 GHz. Accuracy: Better than 1.1%.	Aeroflex 2305 + distortion option

Test procedures

Fig. 6-9 Internal AM depth and distortion test set-up

(1) Connect the test equipment as shown in Fig. 6-9.

(2) Set the UUT to *[RF Level]* 0 dBm *[Carrier Freq.]* 1.5 MHz *[AM]* 30%.

(3) Measure the AM depth and the envelope distortion on the modulation meter using the 50 Hz to 15 kHz filter setting at the frequencies shown in Table 6-10. Check that the measured AM depth and distortion are within specification.

(4) Set the UUT to an AM depth of 80% and repeat (3) above.

(5) Set the UUT to *[RF Level]* +7 dBm (+4 dBm for instruments fitted with Option 012) and repeat (3) and (4) above.

Table 6-10 AM depth and distortion frequencies

Carrier frequencies (MHz)

1.5	400
31.0	500
43.0	850
200.0	1000

AM scale shape

(1) Connect the test equipment as shown in Fig. 6-9.

(2) Set the UUT to *[RF Level]* 0 dBm *[Carrier Freq.]* 100 MHz *[AM]* 1%.

(3) Measure the AM on the modulation meter at the depths shown in Table 6-11. Check that the measured depths are within specification.

Table 6-11 AM DEPTHS

AM depth (%)									
1	10	31	34	37	39.1	39.4	39.7	40	70
2	20	32	35	38	39.2	39.5	39.8	50	80
5	30	33	36	39	39.3	39.6	39.9	60	85

Phase modulation on AM

(1) With the test equipment set up as in Fig. 6-9, set the UUT to *[Carrier Freq.]* 500 MHz *[RF Level]* 0 dBm *[AM]* 30%.

(2) Measure the incidental phase modulation which should be typically less than 0.1 radian.

External AM

Specification

Accuracy:	With ALC OFF the modulation is calibrated for an input level of 1.0 V PD RMS sine wave.
Bandwidth:	±1 dB, DC to 30 kHz relative to 1 kHz Typically ±1 dB DC to 50 kHz, relative to 1 kHz.

Test equipment

Description	Minimum specification	Example
Modulation meter	Modulation frequencies from 30 Hz to 50 kHz.	Aeroflex 2305
Function generator	DC to 50 kHz.	HP3325B
Power meter	Capable of measuring levels at 400 MHz.	Aeroflex 6960B and 6912 sensor

Test procedures

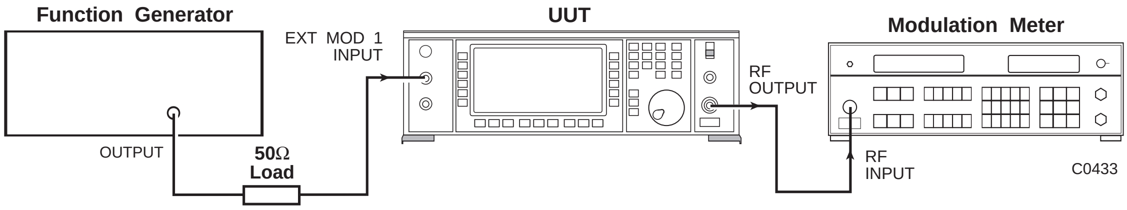


Fig. 6-10 External AM test set-up

(1) Connect the test equipment as shown in Fig. 6-10.

(2) Set the UUT to *[RF Level]* +7 dBm (+4 dBm for instruments fitted with Option 012) *[Carrier Freq.]* 400 MHz *[AM]* 80%. Then select EXT MOD 1 INPUT, DC coupled as follows:

[Select Source] [Select External] [Ext1 DC Coupling]
[SIG GEN]

(3) Set the function generator to give 1 V RMS at 1 kHz sine wave.

(4) With the modulation meter set to measure AM, set a reference using the relative function.

(5) Set the function generator to the frequencies shown in Table 6-12 and measure the change in external AM response which should be less than 1 dB with respect to 1 kHz.

Table 6-12 External AM test frequencies

Modulation frequency		
100 Hz	1 kHz	30 kHz
300 Hz	10 kHz	50 kHz

Internal FM deviation

Specification

Range:	1 MHz max for frequencies up to 21.09375 MHz. Up to 1% of carrier frequency for carrier frequencies above 21.09375 MHz.
Resolution:	3 digits.
Accuracy:	±5% of indication ±10 Hz at 1 kHz rate internal modulation source.
Distortion:	Less than 3% at maximum deviation for modulation frequencies up to 20 kHz.

Test equipment

Description	Minimum specification	Example
Modulation meter	Minimum frequency 20 MHz	Aeroflex 2305 + distortion option

Test procedures

(1) Connect the test equipment as shown in Fig. 6-9.

(2) Set the UUT to *[Carrier Freq.]* 21 MHz *[RF Level]* 0 dBm *[FM Devn.]* 210 kHz. Measure the FM deviation on the modulation meter.

(3) Set up a carrier frequency step on the UUT of 1 MHz as follows:

[Δ] *[Set Steps] [Carrier Step]* 1 MHz [SIG GEN]

(4) Set up an FM deviation of 500 kHz and increment the carrier frequency up to 42 MHz using the '⇧' key, measuring the deviation and distortion on the modulation meter at each step. (Note that the deviation will automatically be limited to 1% of the carrier frequency for each step.) Check that the measured deviations are within specification.

FM attenuator

(1) With the test equipment connected as in Fig. 6-9, set the UUT to *[Carrier Freq.]* 31.64 MHz *[RF Level]* 0dBm *[FM Devn.]* 1,260 Hz.

(2) Measure the FM on the modulation meter at the deviations indicated in Table 6-13. Check that the measured deviations are within specification.

Table 6-13 FM attenuator deviations

Deviation (kHz)		
1.26	79	224
20	159	316

FM scale shape

(1) With the test equipment connected as in Fig. 6-9, set the UUT to *[Carrier Freq.]* 31.64 MHz *[RF Level]* 0 dBm *[FM Devn.]* 224 kHz.

(2) Referring to Table 6-14, measure the FM on the modulation meter at the deviations indicated.

Table 6-14 FM scale shape deviations

Deviation (kHz)		
224	256	289
228	261	293
233	265	298
238	270	302
242	275	307
247	279	312
252	284	316

External FM

Specification

Accuracy:	With ALC OFF the modulation is calibrated for an input level of 1.0 V PD RMS sine wave.
±1 dB bandwidth:	DC to 300 kHz. Typically 500 kHz.

Test equipment

Description	Minimum specification	Example
Modulation meter	Modulation frequencies from 30 Hz to 50 kHz.	Aeroflex 2305
Function generator	DC to 300 kHz sine wave.	HP3325B
Frequency counter	Up to 40 MHz.	ETP 535B or Aeroflex 2440

Test procedures

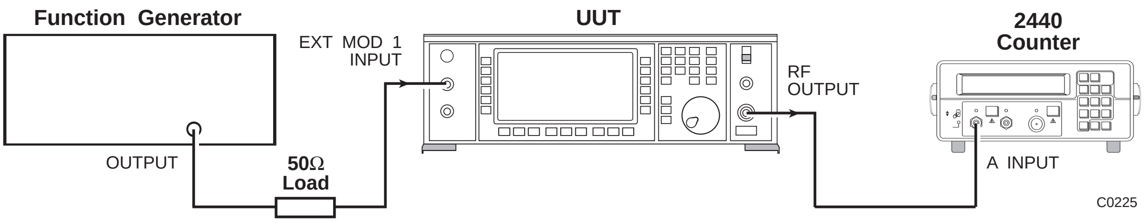


Fig. 6-11 External FM test set-up

(1) Connect the test equipment as shown in Fig. 6-10.

(2) Set the UUT to *[Carrier Freq.]* 35,468,750.1 Hz *[RF Level]* 0 dBm *[FM Devn.]* 40 kHz.

[UTIL] *[Mod'n Mode] [Comp]*

[SIG GEN] *[Select Source] [Select External]*

[Ext1 AC Coupling]

[SIG GEN] *[FM2] [Select Source] [Ext2 AC Coupling]*

[SIG GEN] 40 kHz *[FM1]* 40 kHz

The UUT will now produce FM when the external modulating source is applied to either modulation input.

(3) Set the function generator to give 1 V RMS at 1 kHz sine wave.

(4) With the modulation meter set to measure FM, set a reference using the relative function.

(5) Set the function generator to the frequencies shown in Table 6-15 and measure the change in external FM response which should be less than 1 dB with respect to 1 kHz.

(6) To measure the FM deviation at DC, it will be necessary to connect the test equipment as shown in Fig. 6-11 and DC couple the EXT MOD 1 INPUT as follows:

[Select Source] [Ext1 DC Coupling] [SIG GEN]

(7) Using the DC offset facility on the function generator, set up a voltage of +1.4142 V (i.e. $\sqrt{2}$).

(8) Measure and record the frequency indicated on the counter (F1).

(9) Set the function generator to give a DC voltage of -1.4142 V.

(10) Measure and record the frequency indicated on the counter (F2).

(11) Calculate the FM deviation using the following formula:

$$\frac{F1 - F2}{2} = \text{Measured dev} = FM1$$

(12) It will now be necessary to reconnect the test equipment as shown in Fig. 6-10, reset the function generator to 1 kHz and measure the FM deviation on the modulation meter (FM2).

(13) Using the following formula, calculate the change in response which should be less than 1 dB:

$$20 \log_{10}\frac{FM2}{FM1}$$

(14) Transfer the function generator output to EXT MOD 2 INPUT on the UUT, select [FM2] and repeat (3) to (13) above.

Table 6-15 External FM response frequencies

Modulating frequency (Hz)				
0	100	1,000	50,000	200,000
30	300	10,000	100,000	300,000

Carrier frequency offset

Specification

In DC FM mode; less than ±(1 Hz +0.1% of the set deviation)

Test equipment

Description	Minimum specification	Example
Frequency counter	Up to 40 MHz.	ETP 535B or Aeroflex 2440

Test procedures

(1) Connect the test equipment as shown in Fig. 6-3.

(2) Short circuit the EXT MOD 1 INPUT.

(3) Set the UUT to *[Carrier Freq.]* 1.35 GHz *[RF Level]* 0 dBm *[FM Devn.]* 13.5 MHz, then proceed as follows:

[Select Source] [Select External] [Ext1 AC Coupling][SIG GEN]

(4) Measure and record the carrier frequency on the counter.

(5) Set the UUT to DC coupled EXT MOD 1 INPUT as follows:

[Select Source] [Ext1 DC Coupling] [DCFM Nulling] [SIG GEN]

(6) Measure the change in carrier frequency (offset) which must be less than 13,501 Hz.

(7) Change the settings of the UUT as follows:

[Select Source] [Ext2 AC Coupling] [SIG GEN]

(8) Short circuit the EXT MOD 2 INPUT.

(9) After a 10 second settling period, measure and record the carrier frequency on the counter.

(10) Set the UUT to DC coupled EXT MOD 2 INPUT as follows:

[Select Source] [Ext2 DC Coupling] [DCFM Nulling] [SIG GEN]

(11) Measure the change in carrier frequency (offset) which must be less than 13,501 Hz.

Internal phase modulation

Specification

Range:	Up to 10 radians in 0.01 radian steps
Accuracy:	Better than ±5% at 1 kHz
Distortion:	Less than 3% at 1 kHz modulation rate
Bandwidth:	±3 dB, 100 Hz to 10 kHz

Test equipment

Description	Minimum specification	Example
Modulation meter	Minimum frequency 20 MHz	Aeroflex 2305 + distortion option

Test procedures

(1) Connect the test equipment as shown in Fig. 6-9.

(2) Set the UUT to *[Carrier Freq.]* 21,093,750.1 Hz *[RF Level]* 0 dBm *[ΦM]* 10 rad.

(3) Measure the phase modulation on the modulation meter which should read 10 rad ±0.5 rad.

Internal phase modulation flatness

(1) Connect the test equipment as shown in Fig. 6-9.

(2) Set the UUT to *[Carrier Freq.]* 21,093,750.1 Hz *[RF Level]* 0 dBm *[ΦM]* 10 rad *[Select Source: F4]* 1 kHz.

(3) Set the modulation meter to measure FM with the 50 Hz - 15 kHz LF filter selected.

(4) Measure deviation on the modulation meter and calculate phase modulation using the formula:

$$\Phi M = \frac{\text{FM dev (Hz)}}{\text{mod freq}^{1}\text{ (Hz)}}$$

(5) Select the modulation source frequencies as shown in Table 6-16 using *[Select Source: F4]* on the UUT, then enter the frequency.

(6) Measure the deviation on the modulation meter for each modulation frequency and calculate the phase modulation for each step using the formula in (4) above.

(7) Using the figure recorded in (4) as a reference, calculate the change in response at each modulation frequency using the formula:

$$20\log_{10}\frac{\text{Figure recorded in (6)}}{\text{Figure recorded in (4)}}$$

The change in response should be less than 1 dB with respect to 1 kHz.

(8) Reset the modulation frequency on the UUT to 1 kHz.

(9) Using the modulation meter set to ΦM, select DIST and measure the distortion which must be less than 3%.

Table 6-16 Modulation source frequencies

Modulating frequency (Hz)

100	1,000	10,000
300	3,000	

[1] No allowances need be made for the modulation frequency accuracy since it is derived from the crystal reference oscillator in the UUT.

Spectral purity

Specification

For analog modulation and CW modes:

Harmonically related signals for RF levels up to +7 dBm:	Less than -30 dBc for carrier frequencies up to 1 GHz. Less than -27 dBc for carrier frequencies up to 2.7 GHz (2051T and 2052T). Less than -27 dBc for carrier frequencies up to 5.4 GHz (2052T only).
Sub-harmonics:	Less than -90 dBc for carrier frequencies up to 1.35 GHz. Less than -40 dBc for carrier frequencies up to 2.3 GHz (2051T and 2052T). Less than -30 dBc for carrier frequencies up to 2.7 GHz (2051T and 2052T). Less than -30 dBc for carrier frequencies up to 5.4 GHz (2052T only).
Non-harmonics:	Less than -70 dBc for carrier frequencies up to 2.7 GHz at offsets of 3 kHz or greater. Less than -64 dBc for carrier frequencies up to 5.4 GHz (2052T only).
Residual FM:	Less than 7 Hz RMS in a 0.3 to 3.4 kHz unweighted bandwidth at a 470 MHz carrier.

Test equipment

Description	Minimum specification	Example
Modulation meter	Capable of measuring residual FM less than 7 Hz	Aeroflex 2305
Spectrum analyzer	10 kHz to 16.2 GHz frequency coverage	Aeroflex 2386

Residual FM

Test procedures

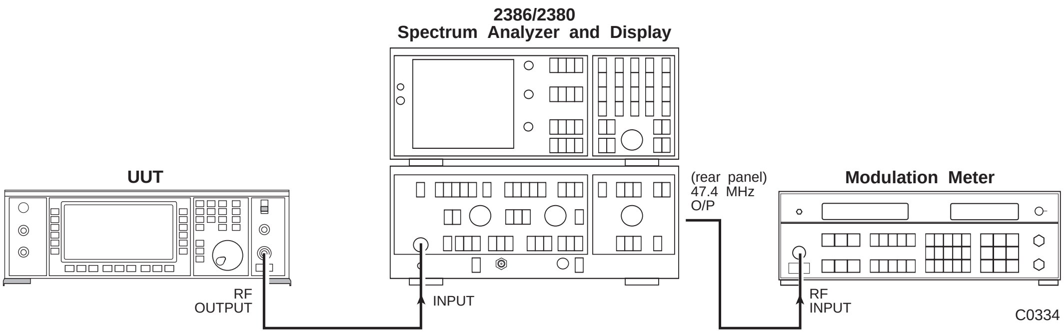


Fig. 6-12 Residual FM test set-up

(1) Connect the test equipment as shown in Fig. 6-12.

(2) Set the UUT to *[Carrier Freq.]* 470 MHz *[RF Level]* 0 dBm, modulation OFF.

(3) Set the spectrum analyzer to 470 MHz zero span.

(4) Measure the residual FM on the modulation meter in a 300 Hz to 3.4 kHz bandwidth, which must be less than 7 Hz.

Carrier harmonics

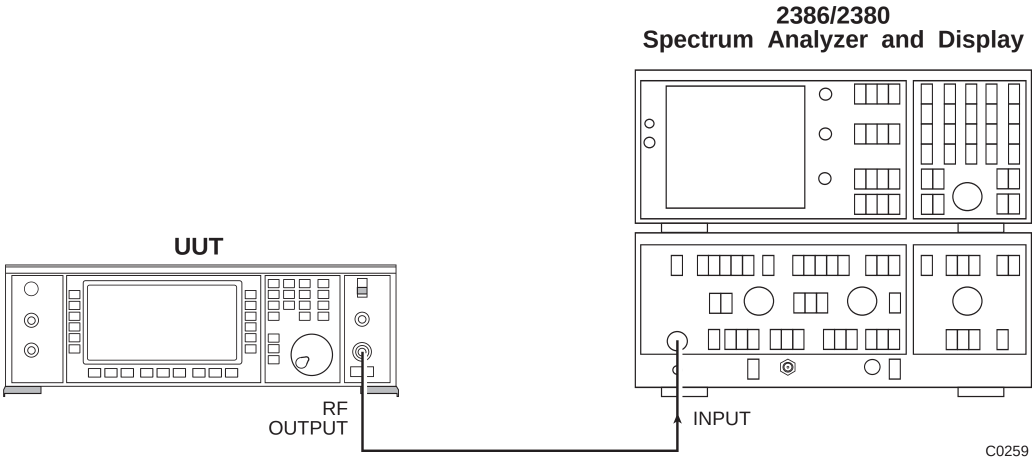


Fig. 6-13 Carrier harmonics test set-up

(1) Connect the test equipment as shown in Fig. 6-13.

(2) Set the UUT to *[Carrier Freq.]* 10 kHz *[RF Level]* 7 dBm.

(3) On the spectrum analyzer measure the 2nd and 3rd harmonics of the carrier frequency which must be less than -30 dBc for carrier frequencies up to 1 GHz and less than -27 dBc for carrier frequencies above 1 GHz.

(4) Set the UUT to the frequencies indicated in Table 6-17 and repeat (3) above.

Table 6-17 Carrier harmonic frequencies

Carrier frequencies (Hz)

(2050T/1T/2T)		**(2051T/2T)**	**(2052T only)**
10,000.0	42,187,500.1		
100,000.0	84,375,000.3		
10,000,000.0	168,750,000.5	1,350,000,001.0	2,700,000,001.0
20,000,000.0	337,500,001.1	1,920,000,000.0	4,050,000,000.0
21,093,750.1	675,000,002.1	2,699,999,999.0	5,400,000,000.0

Carrier sub-harmonics (2051T and 2052T only)

(1) Connect the test equipment as shown in Fig. 6-13.

(2) Set the UUT to *[RF Level]* +13 dBm (+10 dBm for instruments fitted with Option 012) *[Carrier Freq.]* 1,350,100,000.0 Hz.

(3) Referring to Table 6-18, measure the level of the sub-harmonics on the spectrum analyzer at the frequencies indicated. Check that the levels are within specification.

Table 6-18 Carrier sub-harmonic frequencies

UUT carrier frequency (Hz)	Spectrum analyzer frequency (Hz)	
	$\frac{fc}{2}$	$\frac{3fc}{2}$
(2051T/2T)		
1,350,100,000.0	675,050,000.0	2,025,150,000.0
1,500,000,000.0	750,000,000.0	2,250,000,000.0
2,000,000,000.0	1,000,000,000.0	3,000,000,000.0
2,299,999,990.0	1,149,999,995.0	3,449,999,985.0
2,300,000,010.0	1,150,000,005.0	3,450,000,015.0
2,649,000,000.0	1,324,500,000.0	3,973,500,000.0
2,700,000,000.0	1,350,000,000.0	4,050,000,000.0
	$\frac{fc}{4}$ and $\frac{3fc}{4}$	$\frac{fc}{2}$ and $\frac{5fc}{4}$
(2052T)		
2,701,000,000.0	675,250,000.0	1,350,500,000.0
	2,025,750,000.0	3,376,250,000.0
3,375,000,000.0	843,750,000.0	1,687,500,000.0
	2,531,250,000.0	4,218,750,000.0
4,050,000,000.0	1,012,500,000.0	2,025,000,000.0
	3,037,500,000.0	5,062,500,000.0
4,725,000,000.0	1,181,250,000.0	2,362,500,000.0
	3,543,750,000.0	5,906,250,000.0
5,400,000,000.0	1,350,000,000.0	2,700,000,000.0
	4,050,000,000.0	6,750,000,000.0

Non-harmonics

(1) Connect the test equipment as shown in Fig. 6-13.

(2) Set the UUT to *[RF Level]* 0 dBm *[Carrier Freq.]* 10 kHz.

(3) Set the spectrum analyzer to a span of 100 Hz, 10 Hz filter, and referring to Table 6-19, measure the level of the non-harmonics at the frequencies indicated ensuring that the levels measured are less than -70 dBc.

Table 6-19 Carrier non-harmonic frequencies

UUT carrier frequency (Hz)	Spectrum analyzer frequency (Hz)
(2050T/1T/2T)	
10,000.0	104,867,600.0
1,000,000.0	105,857,600.0
20,000,000.0	124,857,600.0
21,093,749.0	125,951,349.0
200,000,000.0	104,867,600.0
1,350,000,000.0	1,348,322,280.0 & 1,351,677,720.0
(2051T/2T)	
2,700,000,000.0	2,500,000,000.0
(2052T)	
5,400,000,000.0	5,200,000,000.0

SSB phase noise

Specification

SSB phase noise :	Less than –116 dBc /Hz (typically -122 dBc/Hz) at an offset of 20 kHz from a carrier frequency
Digital mode:	Less than –108 dBc/Hz at an offset of 20 kHz.

Test equipment

Description	Minimum specification	Example
Phase noise measuring device	Capable of measuring phase noise of –116 dBc	Aeroflex L262
Signal generator	SSB phase noise at least –116 dBc at 20 kHz offset from a 470 MHz carrier signal	Aeroflex 2040
Spectrum analyzer	Capable of measuring 100 Hz to 100 kHz	Aeroflex 2382

Test procedures

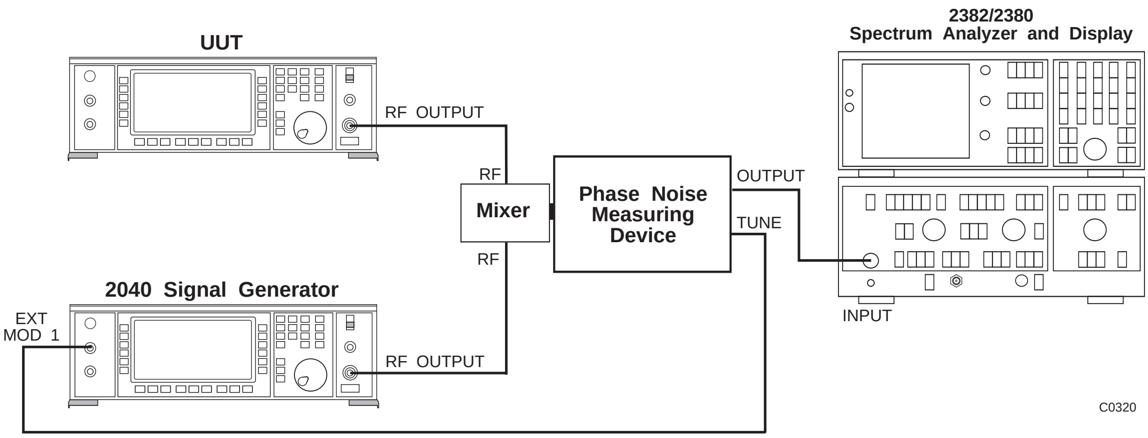


Fig. 6-14 SSB phase noise test set-up

(1) Connect the test equipment as shown in Fig. 6-14.

(2) Set the UUT to *[Carrier Freq.]* 470 MHz *[RF Level]* 7 dBm, modulation to OFF.

(3) Using the phase noise measuring device, measure SSB phase noise at a 20 kHz offset which must be less than –116 dBc.

(4) Set the UUT to provide +6 dBm in Digital Modulation Mode, Test Tones selected with the I and Q inputs set to 0 mV and DC offset set to 500 mV as follows:-

[RF Level] 6 dBm [UTIL]*[Mod'n. Mode][Digital]*[SIG GEN]*[Mod'n System]*
[Select Mod. Type][Test Tones][EXIT]
[I Ampli.] 0 mV
[Q Ampli.] 0 mV
[I DC Offset] 500 mV

(5) Using the phase noise measuring device, measure SSB phase noise at a 20 kHz offset, which must be less than -108 dBc.

Digital modulation mode

IQ outputs

Baseband IQ output signals are available on the front panel at a level of 0.5 V pk PD nominal into 50 Ω. The following test uses these outputs to provide an operational test of the drive signals for the IQ modulator in digital mode.

Test equipment

Description	Minimum specification	Example
Oscilloscope	2 channel inputs with X-Y facility	Tektronix 2235

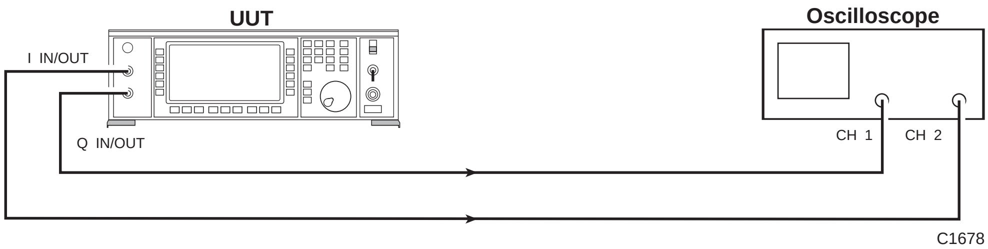


Fig. 6-15 IQ output test set-up

(1) Connect the test equipment as shown in Fig. 6-15.

(2) Set the UUT to Digital Modulation Mode, IQ output enabled, 8PSK modulation and a Nyquist filter as follows:-

[UTIL]*[Mod'n Mode][Digital]*[SIG GEN]
[Config. Select][IQ O/P Enable] [SIG GEN]
[Mod'n System][Select Mod. Type][PSK][8PSK]
[EXIT] [EXIT] [Filter Type][Nyquist][EXIT]
[SIG GEN]

(3) Set the oscilloscope to X-Y, channel 1 and channel 2 sensitivities to 0.2 V/div, and check for 8 clearly defined points on the constellation as shown in Fig. 6-16.

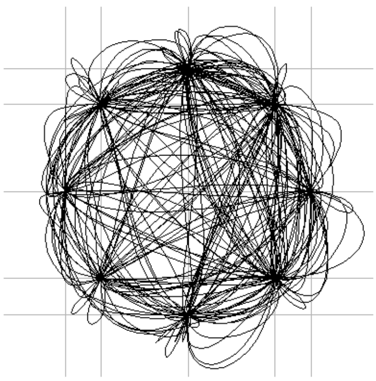


Fig. 6-16 8PSK constellation

(4) Set the UUT to generate phase offset π/4 differential QPSK as follows:-

[Mod'n System][Select Mod. Type][PSK][π/4 DQPSK]

(5) Check for 8 clearly defined points on the constellation as shown in Fig. 6-17.

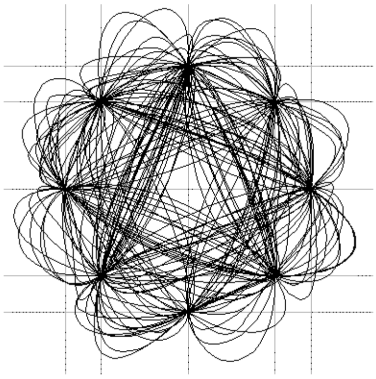


Fig. 6-17 π/4 DQPSK constellation

(6) Set the UUT as follows:-

[EXIT][QAM][16 QAM]

(7) Check for 16 clearly defined points on a 4 by 4 matrix corresponding to that shown in Fig. 6-18.

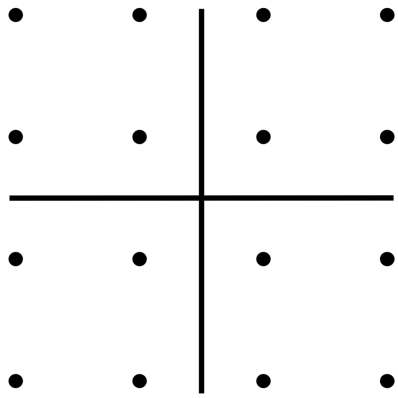


Fig. 6-18 16 QAM constellation

Level accuracy

Because of the presence of frequency conversion products in digital modulation mode, it is necessary to calibrate the RF levels on a spectrum analyzer. The first part of this process, steps (1) to (8), calibrates the spectrum analyzer against a power meter using CW only. Taking a photocopy of Table 6-20 will greatly assist when performing this procedure.

Specification

Level accuracy ±1.5 dB for carrier frequencies to 2 GHz,
±2 dB for carrier frequencies to 2.7 GHz
at 23° ±5°C.

The temperature coefficient is ±0.04 dB/°C

Test equipment

Description	Minimum specification	Example
RF power meter	±0.1 dB from 30 kHz to 2.7 GHz	Aeroflex 6960B and 6912 Sensor
Spectrum analyzer	30 kHz to 2.7 GHz freq coverage	Aeroflex 2383
Function generator	DC to 10 MHz freq coverage, ±0.6 dB flatness	HP3325B

Test procedures

(1) Connect the test equipment as shown in Fig. 6-1.

(2) Set the UUT to CW mode (not digital or vector) then:

[RF Level] 0 dBm *[Carrier Freq.]* 10 MHz

(3) Measure and record the level in Table 6-20, column **2**.

(4) Repeat at the frequencies listed in Table 6-20, column **1**.

Steps (5) to (9) which follow calibrate the spectrum analyzer.

(5) Connect the test equipment as shown in Fig. 6-13.

Table 6-20 Calculating level accuracy in digital modulation mode

	1	2	3	4	5	6
	Carrier frequency	**Level measured on power meter (dBm)**	**Level measured on spec anal (dBm)**	**Difference (dB)**	**Level recorded on spec anal with UUT in digital mode (dBm)**	**Result (dBm)**
	Example	–0.17	–0.24	+0.07	–0.38	–0.31
RF level 0 dBm	10 MHz					
	850 MHz					
	1750 MHz					
	2000 MHz					
	2700 MHz					
RF level +6 dBm	10 MHz					
	850 MHz					
	1750 MHz					
	2000 MHz					
	2700 MHz					

(6) Reset the UUT to *[Carrier Freq.]* 10 MHz and set the spectrum analyzer as follows:-

Reference frequency	10 MHz
Reference level	10 dBm
Span/div	1 kHz

(7) Using the peak find facility on the spectrum analyzer, record the level at each of the frequencies. Record this figure in Table 6-20, column **3**.

(8) Subtract the figures recorded in step (7) above from the figures recorded in step (5) and record this difference in Table 6-20, column **4**.

Steps (9) to (15) which follow correlate the RF level accuracy in digital mode to the RF level accuracy in vector mode.

(10) Enable an IQ self cal as follows:-

[UTIL]*[Mod'n Mode][Vector]*[SIG GEN]*[Carrier Freq.]* 10 MHz *[IQ Selfcal]*

(10) Connect the test equipment as shown in Fig. 6-19.

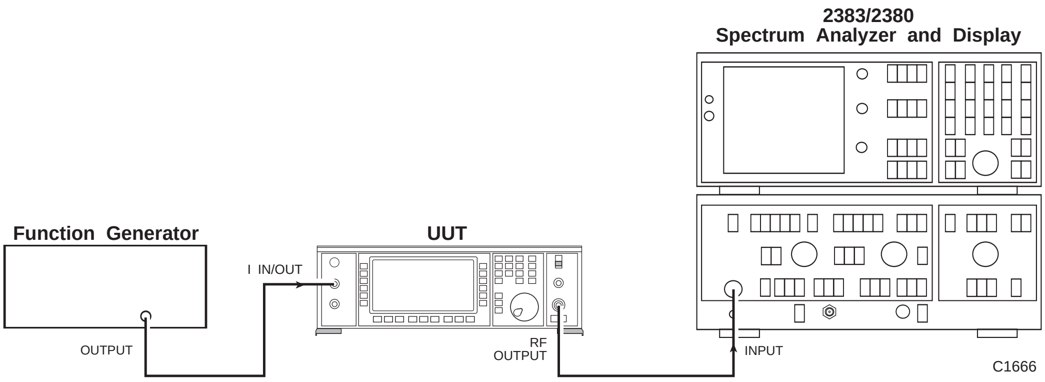


Fig. 6-19 Level accuracy test set-up

(10) Set the function generator to give 0.5 V DC (into 50 W).

(11) Record the level measured on the spectrum analyzer.

(12) Disconnect the DC voltage from the I IN/OUT socket of the UUT.

(13) Set the UUT to Digital Modulation Mode with Test Tones selected and the I, Q amplitude set to 0 mV and DC offset to 500 mV as follows:-

[UTIL]*[Digital]*[SIG GEN]*[Mod'n System][Select Mod. Type][Test Tones][EXIT]*
[I Ampli.] 0 mV
[Q Ampli.] 0 mV
[I DC Offset] 500 mV

(10) Measure the level of the signal on the spectrum analyzer and compare this figure with that recorded in step (12) above. The difference must not be greater than 0.1 dB.

(11) Having correlated the RF level accuracies in both digital and vector modes, the remainder of the RF level accuracy test is performed in digital mode only.

(12) Set the UUT to [SIG GEN] and record the RF level values on the spectrum analyzer at each of the frequencies given in Table 6-20 . Record these figures in column **5**.

(13) Add the figures recorded in column **5** with the difference figures recorded in column **4**, and record the result in column **6**.

(14) Check the results ensuring that there are no errors greater than ±1.5 dB at carrier frequencies up to 2 GHz, or greater than ±2.0 dB at carrier frequencies up to 2.7 GHz (2051T and 2052T only).

(15) Repeat steps (1) to (18) at an RF level of +6 dBm, resetting the UUT where necessary.

Modulation accuracy

Specification

At the decision points with the envelope input at 1 V or disabled:
<1.5% for PSK systems
<1.5% for QAM systems
<1.0% for NADC, PDC (EIA & RCR 27A methods)

Test equipment

Description	Minimum specification	Example
Spectrum analyzer	30 kHz to 2.7 GHz freq coverage	Aeroflex 2383
DVM	AC volts measurement to 25 kHz	Datron 1061A

The RMS vector error is measured using DSP-generated test tones and calculated from the RSS of the following five erors:

1. Carrier leak
2. Signal compression
3. I/Q channel balance
4. Channel frequency response errors
5. DSP coding errors (±0.3%)

Establishing carrier leak

(1) Connect the test equipment as shown in Fig. 6-13.

(2) Set the UUT to a carrier of 11 MHz, an RF level of 0 dBm, in Digital Modulation Mode with Test Tones selected and the IQ angle set to 270° as follows:-

[Carrier Freq.] 11 MHz [RF Level] 0 dBm [UTIL]*[Mod'n Mode][Digital]*
[SIG GEN]

[IQ Selfcal][Mod'n System][Select Mod. Type][Test Tones][EXIT]

[IQ Angle] 270 [enter]

(3) Set the spectrum analyzer as follows:-

Reference frequency	11 MHz
Reference level	10 dBm
Span/div	5 kHz
Video averaging	4 sweeps

(4) Using the markers 1 and 2 facility on the spectrum analyzer, measure the amplitude of the carrier leak relative to the upper sideband (see Fig. 6-20).

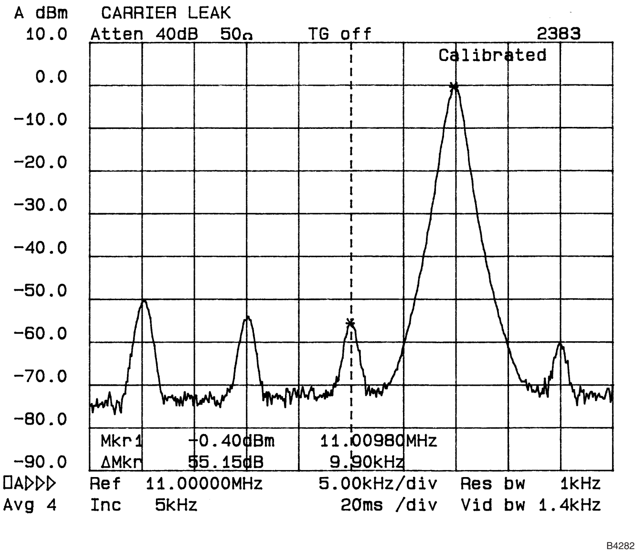


Fig. 6-20 Spectrum analyzer trace for carrier leak measurement

Carrier leak = ______________ dBc (*A*)

Establishing signal compression

(5) Set the UUT as follows:

[Q Ampli.] 0 mV *[IQ Angle]* 0 [enter]

(6) Set the spectrum analyzer as follows:-

Span/div 10 kHz

(7) Using the markers 1 and 2 facility on the spectrum analyzer, measure the amplitude of the 3rd order intermodulation products relative to the tone amplitudes. Take the worst case figure. See Fig. 6-21.

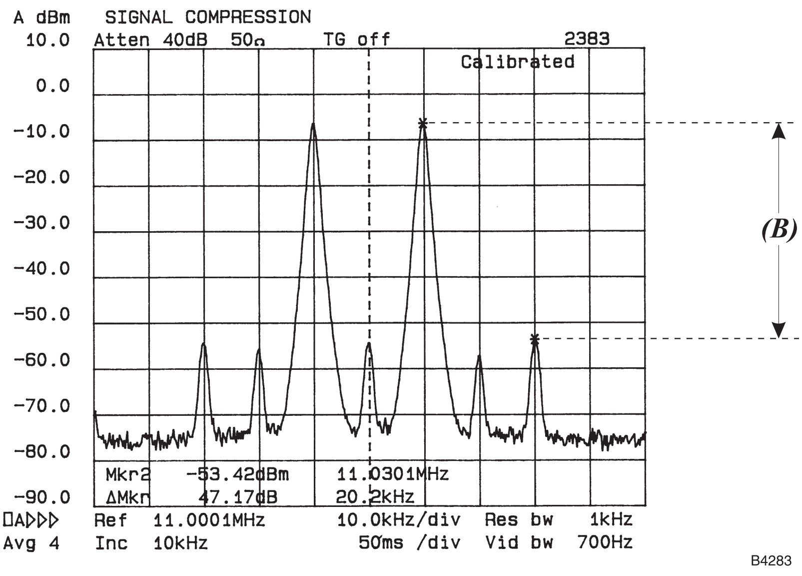


Fig. 6-21 Spectrum analyzer trace for signal compression measurement

Signal compression = ______________ dBc (*B*)

Establishing IQ channel balance

(8) Set the UUT as follows:

[Q Ampli.] 500 mV *[IQ Angle]* 270 [enter]

(9) Set the spectrum analyzer as follows:-

Span/div 5 kHz

(10) Using the markers 1 and 2 facility on the spectrum analyzer, measure the amplitude of the suppressed lower sideband relative to the upper sideband. See Fig. 6-22.

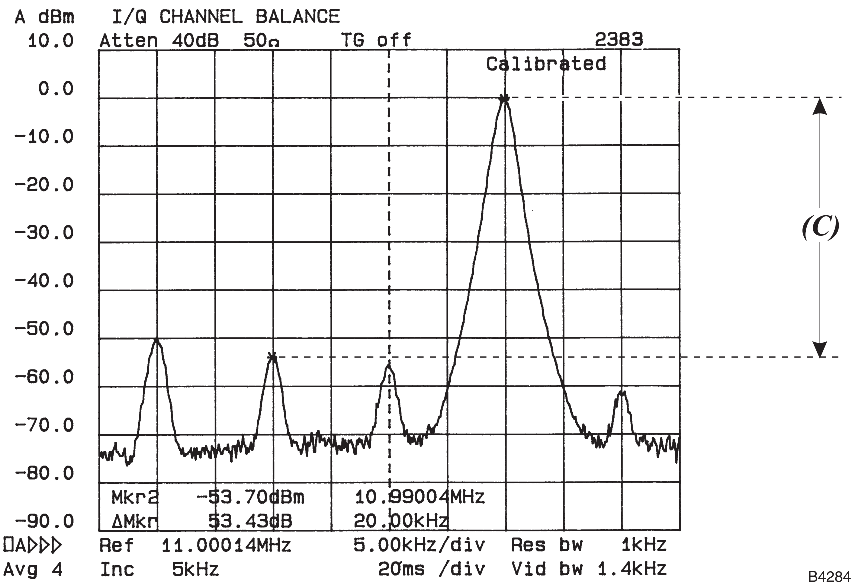


Fig. 6-22 Spectrum analyzer trace for IQ channel balance measurement

IQ channel balance = ______________ dBc (*C*)

Establishing channel frequency response errors

(11) Connect the test equipment as shown in Fig. 6-23.

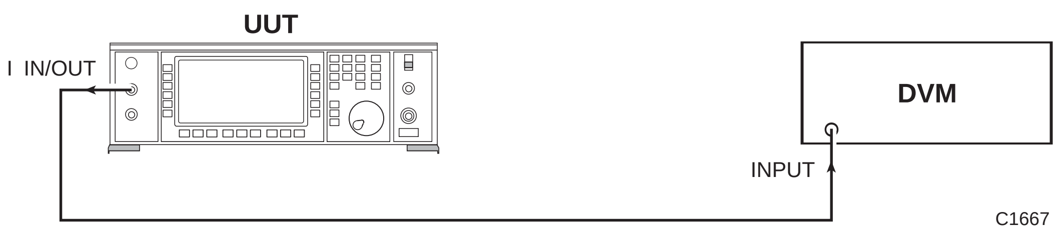


Fig. 6-23 Channel frequency response test set-up

(12) Enable the UUT IQ output in Test Tone Mode with a tone frequency of 1 kHz as follows:-

[SIG GEN]*[Config. Select][IQ O/P Enable]*[SIG GEN]
[Mod'n System][Tone Freq.] 1 kHz

(13) Set the DVM to measure AC volts and record the measured voltage:

Voltage V_1 = _____________ volts

(14) Set the UUT to *[Tone Freq.]* 25 kHz and record the measured voltage:

Voltage V_2 = ______________ volts

(15) Calculate the percentage error using the formula:

$$\frac{V_1 - V_2}{V_1} \times 100\%$$

(16) Transfer the DVM to the Q output of the UUT.

(17) Repeat steps (11) to (15) above.

(18) Take the larger of the values recorded in steps (15) and (17) and record as:

Channel frequency response = ____________ % (*D*)

(19) Convert results *A*, *B* and *C* into a percentage ratio using the formula:

$$\text{percentage ratio} = \text{antilog}\left(\frac{\text{dBc}}{20} \times 100\right)$$

(Reminder: do not forget the minus sign on the dBc figure!)

(20) Calculate the final 'digital modulation mode accuracy' vector error figure. The vector error is the RSS of *A*, *B*, *C* and *D* and 0.3% DSP coding error. Hence the result is:

$$\%\ \text{vector error} = \sqrt{A^2 + B^2 + C^2 + D^2 + 0.3^2}$$

where *A*, *B* and *C* are percentages

(21) Set the UUT to [SIG GEN]*[ConFig. Select]*.

(22) Select an IF of 176 MHz using *[IF Freq. Select]*.

(23) Repeat steps (1) to (20) above.

(24) Repeat steps (1) to (23) above at a carrier frequency of 850 MHz, and 1750 MHz and 2700 MHz for 2051T and 2052T.

Burst control

Specification

On/off ratio: Greater than 70 dB

Test equipment

Description	Minimum specification	Example
Spectrum analyzer Break-out box	80 dB dynamic range at 100 MHz	Aeroflex 2383 Aeroflex 44991-144

(1) Connect the test equipment as shown in Fig. 6-24.

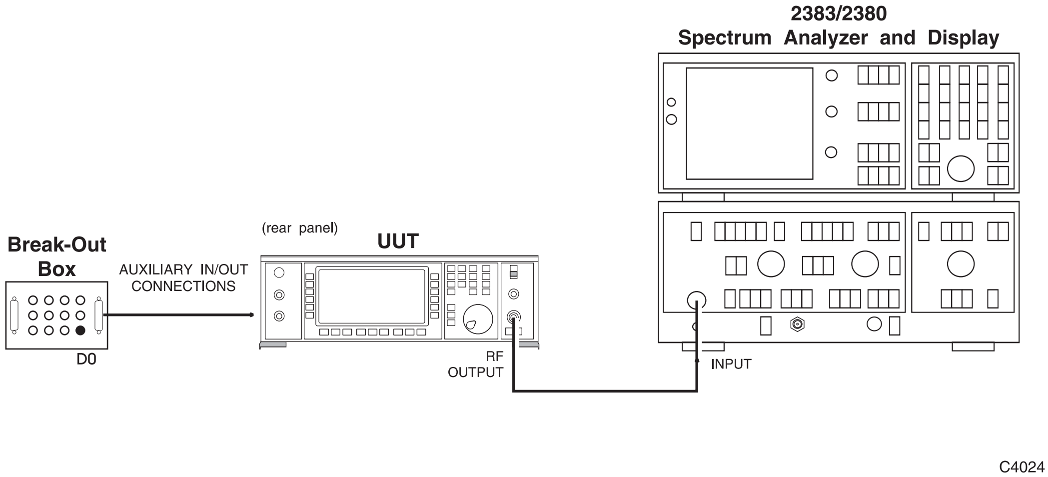


Fig. 6-24 Burst control test set-up

(2) Set the UUT to 100 MHz in Digital Modulation Mode generating QPSK from external parallel data as follows:

[Carrier Freq.] 100 MHz [RF Level] 0 dBm [UTIL]*[Mod'n Mode][Digital]*
[SIG GEN]
[Mod'n System][Select Mod. Type][PSK][QPSK(4PSK)][SIG GEN]
[Data/Timing][External Parallel]

(3) Set the spectrum analyzer as follows:-

Reference frequency	100 MHz
Reference level	0 dBm
Span/div	1 kHz
Peak find	
MKR 1 Sets Ref Level	
2nd funct dB	

(4) Apply a short circuit to the BURST BIT I/P socket on the break-out box. The marker reading must be better than -70 dB.

Advanced digital mode

Adjacent channel performance

This parameter can only be verified by using a measurement technique dependant on the use of specialist test equipment and complex data processing software. It is therefore recommended that if calibration (with national traceability) of the adjacent channel performance is required, the unit is returned to the UK Service Division.

Vector modulation mode

Specification

Vector input impedance	Selectable between 50 Ω and 300 Ω.
DC vector accuracy	For carrier frequencies up to 2 GHz: ±1% amplitude of full scale, ±1° at full scale. For carrier frequencies above 2 GHz: ±1.5% amplitude of full scale, ±1.5° at full scale.
Vector bandwidth	±0.5 dB wrt DC for frequencies up to 3 MHz, ±1 dB wrt DC for frequencies up to 10 MHz.
Carrier suppression	Typically 50 dB at 10 kHz rate.
SSB image suppression	Typically 50 dB at 10 kHz rate, typically 50 dB at 1 MHz rate, typically 45 dB at 3 MHz rate, typically 38 dB at 10 MHz rate.

Test equipment

Description	Minimum specification	Example
Digital voltmeter (DVM)	Resistance measurement capability	Datron 1061A
Spectrum analyzer	30 kHz to 2.7 GHz freq coverage, 60 dB dynamic range	Aeroflex 2383
Function generator	DC to 10 MHz sine wave, ±0.2 dB flatness to 1 MHz, ±0.6 dB flatness to 10 MHz.	HP3325B

Vector input impedance

(1) Connect the test equipment as shown in Fig. 6-23 above.

(2) Set the UUT as follows:

[UTIL]*[Mod'n Mode][Vector]*[SIG GEN]
With the DVM set to measure resistance, check for a reading of approximately 50 Ω.

(3) Set the UUT IQ input impedance to 300 Ω using *[Config Select][IQ I/P"Z"]*.

(4) Check for a reading on the DVM of approximately 300 Ω.

(5) Repeat steps (2) to (5) for the UUT Q input. (Ensure that the input impedance is returned to 50 Ω by using *[IQ I/P "Z"]*.)

DC vector accuracy

The RMS vector error is calculated from the RSS of the following three errors:

1. Carrier leak*
2. Signal compression
3. Channel balance*

* These figures are copied from the 'Digital modulation mode', 'Modulation accuracy test', results derived on page 6-33 and 6-35 in steps (4) and (10) respectively.

Establishing signal compression

(1) Connect the test equipment as shown in Fig. 6-19.

(2) Set the UUT as follows:

[Carrier Freq.] 11 MHz *[RF Level]* 0 dBm [UTIL]*[Mod'n Mode]*
[Vector][SIG GEN]*[IQ Selfcal]*

(3) Set the function generator to give 0.5 V pk (into 50 Ω) at 10 kHz sine wave.

(4) Set the spectrum analyzer as follows:

Reference frequency	11 MHz
Reference level	10 dBm
Span/div	10 kHz
Video averaging	4 sweeps

(5) Referring to Fig. 6-21, use markers 1 and 2 on the spectrum analyzer to measure the worst case 3rd order intermodulation product relative to the tone amplitude.

Signal compression = ______________ dBc (*E*)

(6) Convert result E into a percentage using the formula given in step (19) of the 'Digital modulation mode', 'Modulation accuracy' test.

(7) Calculate the final ‘DC vector accuracy’ error:

$$\textbf{\% vector error} = \sqrt{A^2 + C^2 + E^2}$$

where *A*, *C* and *E* are percentages

A result of less than 1% will ensure that both the ±1% amplitude and ±1° specifications have been met.

(8) Set the UUT to [SIG GEN]*[ConFig. Select]*.

(9) Select an IF of 176 MHz using *[IF Freq. Select]*.

(10) Repeat steps (2) to (7) above.

(11) Repeat steps (2) to (10) above at a carrier frequency of 850 MHz, 1750 MHz (2051T/2T) and 2700 MHz (2051T/2T). At 2700 MHz the result should be better than ±1.5% amplitude and ±1.5°phase.

Vector bandwidth

(1) Connect the test equipment as shown in Fig. 6-23.

(2) Set the UUT to 101 MHz in Vector Mode as follows:

[Carrier Freq.] 101 MHz *[RF Level]* 0 dBm [UTIL]*[Mod'n Mode]*

[Vector][SIG GEN]*[IQ Selfcal]*

(3) Set the function generator to give 0.5 V pk (into 50 Ω) at 100 kHz sine wave.

(4) Referring to Table 6-21, set the spectrum analyzer as follows:

Reference frequency	101.1 MHz
Reference level	10 dBm
Span/div	20 kHz
Peak find	

Record the marker 1 level as the reference.

Table 6-21 Vector bandwidth settings

	Function generator	Spec an	MKR1 reading
Upper sideband	100 kHz 1 MHz 3 MHz 10 MHz	101.1 MHz 102 MHz 104 MHz 111 MHz	______ ref ______ ±0.5 dB ______ ±0.5 dB ______ ±1 dB
Lower sideband	100 kHz 1 MHz 3 MHz 10 MHz	100.9 MHz 100 MHz 98 MHz 91 MHz	______ ref ______ ±0.5 dB ______ ±0.5 dB ______ ±1 dB

(5) Again referring to Table 6-21, set the function generator and the spectrum analyzer to the frequencies indicated, recording the marker 1 level on each occasion.

(6) Compare each level against the reference for each of the sidebands, ensuring that the difference is within the given limits.

Envelope control

Specification

Applying 1 V gives the set RF level and 0 V suppresses the carrier.

Linear range	Greater than 30 dB
Linearity	Typically better than 0.5 dB at -20 dB (100 mV input)
On/off ratio	Greater than 80 dB
Envelope delay	Less than 10 μs
Rise/fall time	Less than 20 μs to -70 dBc

Test equipment

Description	Minimum specification	Example
Oscilloscope	100 MHz bandwidth	Tektronix 2235
Spectrum analyzer	80 dB dynamic range at 10 MHz	Aeroflex 2383
Function generator	Square wave capability, DC offset facility	HP3325B

Linearity

(1) Connect the test equipment as shown in Fig. 6-25.

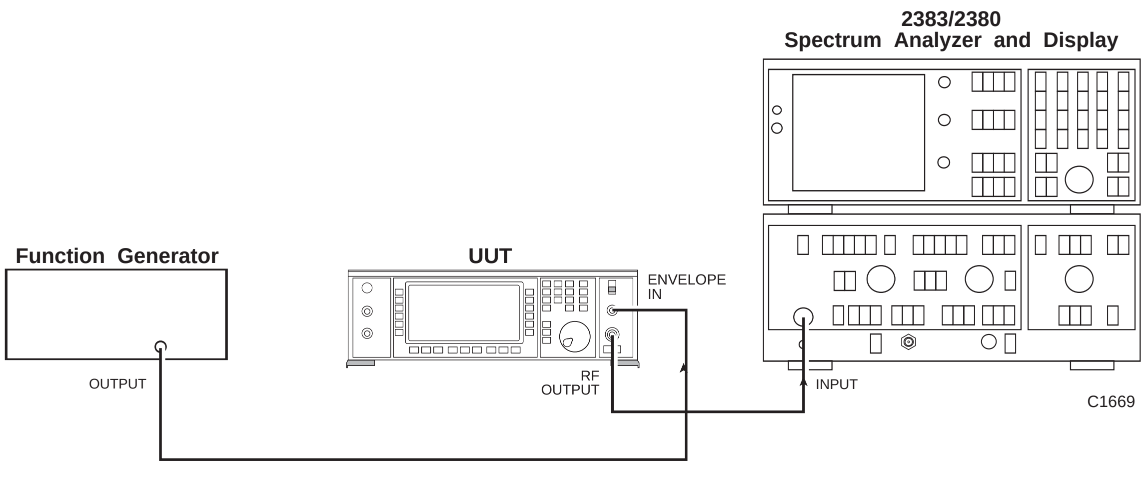


Fig. 6-25 Linearity test set-up

(2) Set the UUT to a carrier of 10 MHz at 0 dBm in Test Tone Mode with the I and Q amplitude set to 0 mV and the DC offset set to 500 mV as follows:-

[Carrier Freq.] 10 MHz *[RF Level]* 0 dBm [UTIL]*[Mod'n. Mode][Digital]*
[SIG GEN]
[Mod'n System][Select Mod. Type][Test Tones][EXIT]
[I Ampli.] 0 mV
[Q Ampli.] 0 mV
[I DC Offset] 500 mV
[SIG GEN]*[Config. Select][External Envelope]*

(3) Set the spectrum analyzer as follows:

Reference frequency	10 MHz
Reference level	10 dBm
Span/div	5 kHz

(4) Set the function generator to give 1 V DC (into high impedance).

(5) Select Peak Find on the spectrum analyzer and record the marker 1 level:

Marker 1 level = __________ dBm

(6) Set the function generator to give 0.1 V DC (into high impedance).

(7) Record the marker 1 level:

Marker 1 level = ___________ dBm

The difference between this value and that recorded in step (5) above should be 20 ±0.5 dBm.

On/off ratio

(8) Set the spectrum analyzer as follows:-

Reference level	–10 dBm

(9) Disconnect the envelope input from the UUT and apply a short circuit.

(10) Record the marker 1 level:

Marker 1 level = ____________ dBm

The difference between this value and that recorded in step (5) above must be greater than 80 dB.

Envelope delay

(11) Connect the test equipment shown in Fig. 6-26.

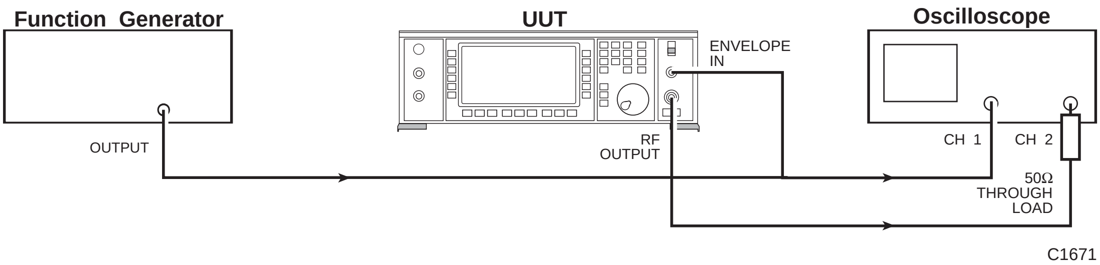


Fig. 6-26 Envelope delay test set-up

(12) Set the function generator to give 1 V pk with 0.5 V DC offset (into high impedance) square wave at 10 kHz.

(13) Set the UUT as follows:

[SIG GEN]*[Mod'n System]*
[I Ampli.] 500 mV
[Q Ampli.] 500 mV
[I DC Offset] 0 mV

(14) Set the oscilloscope CH1 sensitivity to 0.5 V/div, the CH2 sensitivity to 0.1 V/div, both traces, timebase 2 µs/div.

(15) Check that the delay from the transitions of the function generator output to the 50% point of the corresponding transitions of the UUT RF level is less than 10 µs.

(16) Viewing CH2 only on the oscilloscope, measure the rise and fall times (the time of the transition between 10% and 90% of the high and low RF levels) ensuring that they are less than 13.5 µs. This includes a 6.5 µs allowance for the difference between the 10/90% and the 0/70 dB rise-times.

IF output

Specification

Output level	Nominally -10 dBm

Test equipment

Description	Minimum specification	Example
Spectrum analyzer	200 MHz frequency coverage	Aeroflex 2383

(1) Connect the test equipment as shown in Fig. 6-27.

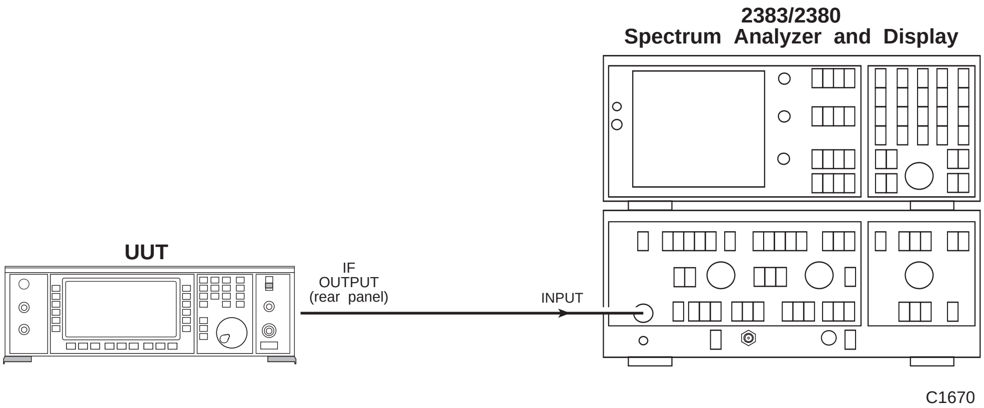


Fig. 6-27 IF output level test set-up

(2) Set the UUT to Digital Modulation Mode and Test Tones selected with I and Q amplitude of 0 mV and DC offset of 500 mV. Select external mixer to enable the IF OUTPUT as follows:

[RF Level] 0 dBm [UTIL]*[Mod'n. Mode][Digital]*[SIG GEN]
[Mod'n System][Select Mod. Type][Test Tones][EXIT]
[I Ampli.] 0 mV
[Q Ampli.] 0 mV
[I DC Offset] 500 mV
[SIG GEN]*[Config. Select][Int/Ext Mixer]*

(3) Set the spectrum analyzer as follows:

Reference frequency	132 MHz
Reference level	0 dBm
Span/div	5 kHz

(4) Select Peak Find on the spectrum analyzer. The marker 1 level should read nominally -10 dBm.

(5) Set the UUT to IFs of 120, 160 and 176 MHz in turn (using *[IF Freq. Select]),* resetting the reference frequency of the spectrum analyzer accordingly, ensuring that the marker 1 level is nominally -10 dBm on each occasion.

Last complete check date

On completion of the adjustment routine or of a calibration check, the date can be recorded. To do this, unlock the instrument to level 2, select the Calibration Utilities Menu, then press the *[Checks Complete]* key. This will result in the *Last Complete Check* date being updated to the current date.

Calibration due date

The date of the next calibration check can be entered from the calibration utilities menu by pressing the *[Set Next Cal Date]* key. On reaching the calibration date, the instrument will display an error message indicating that it should be returned for a calibration check. The recommended calibration interval is 2 years.

Real time clock battery

The real time clock uses a lithium battery to provide uninterrupted power regardless of whether the instrument is switched on or off. Although the estimated life of this battery is 5 years, customers may wish to replace it every 2 years.

Chapter 6
Appendix A
ACCEPTANCE TESTING
SECOND MODULATION OSCILLATOR OPTION

Contents

List of tables

List of figures

Modulation oscillators

The following tests are for a 2050T, 2051T or 2052T with the 2nd modulation oscillator fitted.

Specification

Frequency range:	0.1 Hz to 500 kHz
Accuracy:	Equal to the frequency standard accuracy
Resolution:	0.1 Hz
Distortion:	Less than 0.1% THD at frequencies up to 20 kHz sine wave mode

Test equipment

Description	Minimum specification	Example
Frequency counter	10 Hz to 500 kHz	ETP 535B or IFR 2440
Audio analyzer	Capable of measuring down to 0.03% THD from 100 Hz to 20 kHz	HP 8903B Rhode & Schwarz UPA 3

Modulation oscillator frequencies

Test procedures

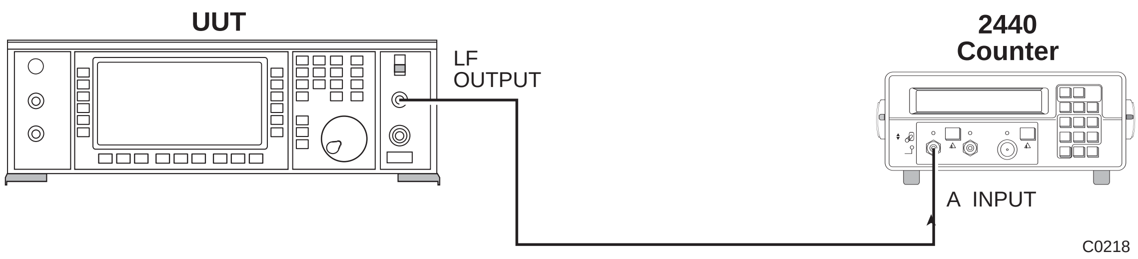


Fig. 6-A-1 Modulation oscillator frequencies test set-up

(1) Connect the test equipment as shown in Fig. 6-A-1.

(2) To enable both the modulation oscillators on the UUT, it will be necessary to carry out the following procedure:-

Press the following sequence of keys:

[UTIL] *[Mod'n Mode] [Comp]* **[SIG GEN]** *[Source Freq:]*

The frequencies of the first modulation oscillator may now be entered.

(3) Referring to Table 6-A-1, check that the oscillator frequencies can be selected correctly and are within specification.

(4) To monitor the second modulation oscillator, enter the following:

[FM2] [Select Source] [Select Internal] [Internal F1]

[LF] *[Mod2 Source]* **[SIG GEN]** *[Source Freq:]*

The frequencies of the second modulation may now be entered.

(5) Repeat (3) above.

Table 6-A-1 Modulation oscillator frequencies

Modulation oscillator frequencies (Hz)	
10.00	279,620.20
139,810.10	500,000.00

Modulation oscillator distortion

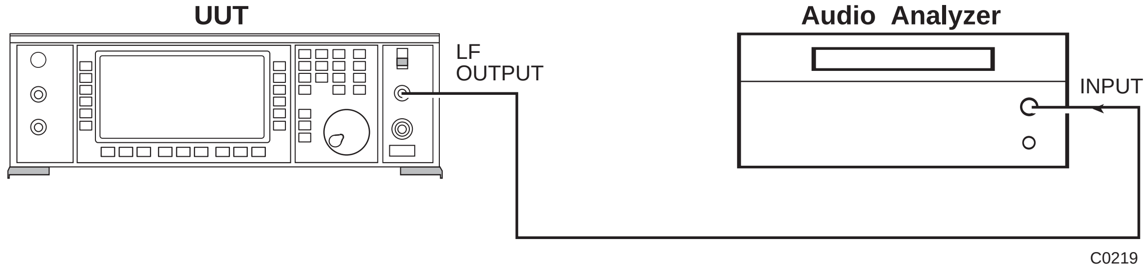


Fig. 6-A-2 Modulation oscillator distortion test set-up

(1) Connect the test equipment as shown in Fig. 6-A-2.

(2) Set the UUT such that the first modulation oscillator may be tested (refer to 'Modulation oscillator frequencies' step (2) above).

(3) Check that the distortion measured on the audio analyzer at the frequencies indicated in Table 6-A-2 is less than 0.1%.

(4) Set the UUT such that the second modulation oscillator may be tested (refer to 'Modulation oscillator frequencies' step (4) above).

(5) Repeat (3) above.

Table 6-A-2 Distortion frequencies

Modulation oscillator frequencies	
100 Hz	10 kHz
1 kHz	20 kHz

LF output

Specification

Level accuracy: ±5% for levels above 50 mV, ±10% for levels from 500 μV to 50 mV (with a load impedance >10 kΩ)

Frequency response: Typically better than 1 dB from 0.1 Hz to 300 kHz

Test equipment

Description	Minimum specification	Example
Digital multimeter	DC to 300 kHz, 1 mV to 5 V	Datron 1061A
Audio analyzer	Capable of measuring 0.5 mV ±3% and levels at 10 Hz	HP8903B Rhode & Schwarz UPA3

Level accuracy

Test procedures

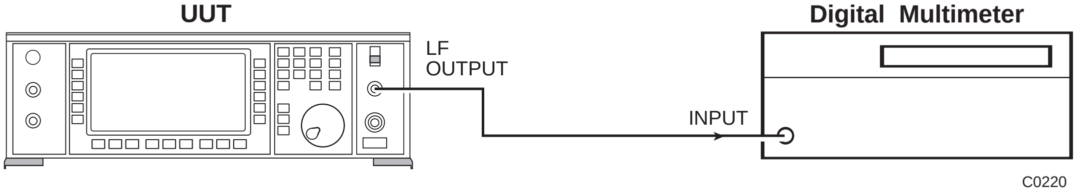


Fig. 6-A-3 Level accuracy test set-up

(1) Connect the test equipment as shown in Fig. 6-A-3.

(2) Set the UUT to give an LF output of 5 V at 1 kHz by entering the following:

[LF] *[LF Gen] [LF Freq]* 1 kHz, *[LF Level]* 5 V

(3) The level measured on the digital multimeter should read 5 V ±0.25 V.

(4) Check the LF output of the UUT at the levels indicated in Table 6-A-3. Check that the measured levels are within specification.

Table 6-A-3 LF output levels

LF output levels (V)

5.0000	0.1000	0.0050
2.0000	0.0500	0.0020
1.0000	0.0200	0.0010
0.5000	0.0100	*0.0005
0.2000		

*For the last measurement it will be necessary to use the audio analyzer. Connect the test equipment as shown in Fig. 6-A-4.

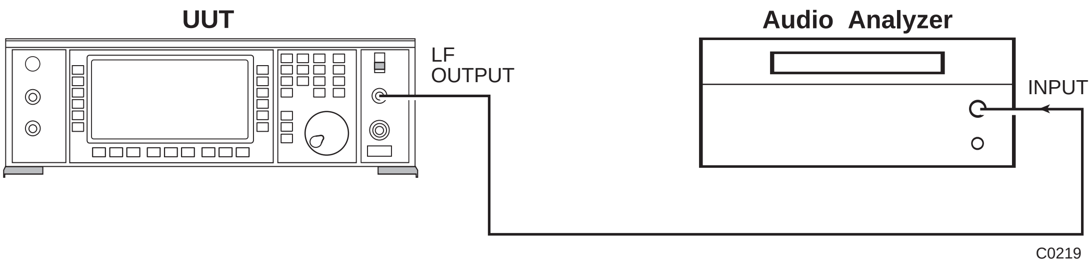


Fig. 6-A-4 LF output levels test set-up for 0.0005 V

Frequency response

(1) Connect the test equipment as shown in Fig. 6-A-2.

(2) Set the UUT to give an LF output of 1 V at 1 kHz on the first modulation oscillator (refer to 'Level accuracy' above).

(3) Reference this level on the audio analyzer using the dB relative function.

(4) Set the modulation oscillator to the frequencies given in Table 6-A-4 measuring the difference from the reference in (3) above which should be less than 1 dB.

(5) Set the UUT to give an LF output of 1 V at 1 kHz on the second modulation oscillator (refer to 'Level accuracy' above).

(6) Repeat (3) and (4) above.

Table 6-A-4 Test frequencies

Test frequencies		
10 Hz	1 kHz ref	70 kHz
30 Hz	10 kHz	100 kHz
100 Hz	30 kHz	300 kHz

AM scale shape

Specification

Range: 0 to 99% in 0.1% steps

Accuracy: For carrier frequencies up to 1 GHz, ±4% of setting, ±1% depth.
Usable to 2.7 GHz **(2051T)**.
Usable to 5.4 GHz **(2052T)**.

Test equipment

Description	Minimum specification	Example
Modulation meter	1.5 MHz to 1 GHz Accuracy: better than 1.1%	IFR 2305 + distortion option

Test procedures

Fig. 6-A-5   AM scale shape test set-up

(1) Connect the test equipment as shown in Fig. 6-A-5.

(2) Set the UUT to *[RF level]* 0 dBm, *[Carrier freq.]* 100 MHz, then enter the following:

[UTIL] *[Mod'n mode] [Comp]*

[SIG GEN] *[AM]* 1%

(3) Measure the AM on the modulation meter at the depths shown in Table 6-A-5. Check that the measured AM depth is within specification.

(4) Set the UUT by entering the following:

[AM1 ON/OFF] [AM2] [Select Source] [Select internal]

[Internal F4] **[SIG GEN]** 1%

(5) Repeat (3) above.

Table 6-A-5   AM depths

AM depth (%)

1	10	31	34	37	39.1	39.4	39.7	40	70
2	20	32	35	38	39.2	39.5	39.8	50	80
5	30	33	36	39	39.3	39.6	39.9	60	85

FM scale shape

Specification

Range:	1 MHz max for frequencies up to 21.09375 MHz. Up to 1% of carrier frequency for carrier frequencies above 21.09375 MHz
Resolution:	3 digits
Accuracy:	±5% of indication ±10 Hz at 1 kHz rate internal modulation source

Test equipment

Description	Minimum specification	Example
Modulation meter	Minimum frequency 20 MHz	IFR 2305 + distortion option

Test procedures

(1) With the test equipment connected as in Fig. 6-A-5, set the UUT to *[Carrier freq.]* 31.64 MHz, *[RF level]* 0 dBm then enter the following:

[UTIL] *[Mod'n Mode] [Comp]*
[SIG GEN] *[FM2] [Select Source] [Select Internal] [Internal F4]*
[SIG GEN] *[FM1]*

(2) The deviation for FM1 can now be entered. Referring to Table 6-A-6, measure the FM on the modulation meter at the deviations indicated. Check that the measured deviation is within specification.

(3) Set FM1 to 0 Hz deviation and select *[FM2]*.

(4) The deviation for FM2 can now be entered. Repeat (2) above.

Table 6-A-6 Deviation frequencies

Deviation (kHz)		
224	256	289
228	261	293
233	265	298
238	270	302
242	275	307
247	279	312
252	284	316

Chapter 6
Appendix B
ACCEPTANCE TESTING
PULSE MODULATION OPTION

Contents

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Pulse modulation

The following tests are for a 2050T, 2051T or 2052T with the pulse modulation option fitted.

Specification

Maximum input level:	+5 V.
Minimum ON Level:	+3.5 V.
Maximum OFF level:	+1.0 V.
OFF/ON ratio :	Greater than 70 dB at the carrier frequency. Typically greater than 80 dB.
Additional output level error:	Less than 0.5 dB.

Test equipment

Description	Minimum specification	Example
Power meter	±0.1 dB from 30 kHz to 2.7 GHz.	IFR 6960B and 6912 sensor
Spectrum analyzer	Frequencies up to 1.4 GHz. Capable of measuring <-70 dBm.	IFR 2386
Function generator	DC capability.	HP3325B

Test procedures

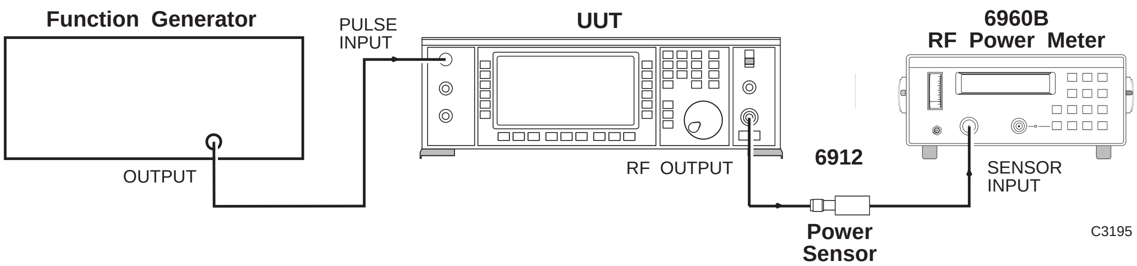

Fig. 6-B-1 Levels test set-up

Minimum 'ON' level

(1) Connect the test equipment as shown in Fig. 6-B-1.

(2) Set the UUT to *[RF Level]* 0 dBm *[Carrier Freq.]* 10 MHz and *[Pulse Mod.]*.

(3) Set the function generator to give +3.5 V DC. The 0 dBm level should now appear on the power meter.

Maximum 'OFF' level

(4) Set the function generator to give 1.0 V DC. The 0 dBm level should now disappear from the power meter.

Additional level error

(1) Set the UUT to [Carrier Freq.] 1 MHz, [RF level] 0 dBm.

(2) Measure and record the RF level indicated on the power meter (P1).

(3) Set the UUT to *[Pulse Mod.]*

(4) Set the function generator to give +5 V DC.

(5) Measure and record the RF level indicated on the power meter (P2).

(6) The difference between P1 and P2 must be less than 0.5 dBm.

ON/OFF ratio

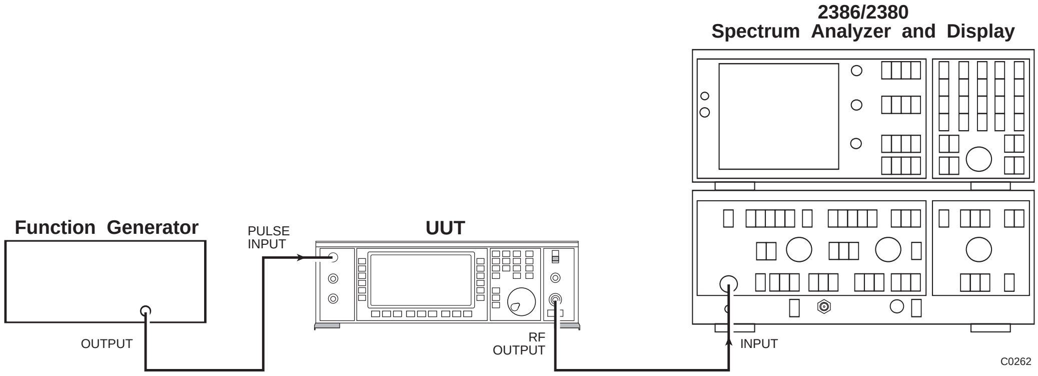

Fig. 6-B-2 ON/OFF ratio test set-up

(1) Connect the test equipment as shown in Fig. 6-B-2.

(2) Set the UUT to *[Carrier Freq.]* 11 MHz, (RF level) 0 dBm, and *[Pulse Mod]*.

(3) Set the function generator to give +5 VDC.

(4) Set the spectrum analyzer to 11 MHz, span/div 10 kHz, and, using the 'Peak Find' facility, measure the amplitude of the carrier signal and record as (P1).

(5) Set the function generator to give 0 V DC.

(6) Measure the amplitude of the carrier signal and record as (P2). The difference between P1 and P2 must be greater than 70 dB.

(7) Repeat (3) to (6) above for the UUT and spectrum analyzer frequencies shown in Table 6-B-1.

Table 6-B-1 ON/OFF ratio carrier frequencies

Carrier frequencies		
11 MHz	675 MHz	1.349,999 GHz
111 MHz	1 GHz	

Chapter 6
Appendix C
ACCEPTANCE TESTING
ELECTRONIC ATTENUATOR

Contents

List of tables

List of figures

Test procedures

Before each test, it is recommended that the UUT is reset to its switch-on conditions which are as follows:

Carrier freq	1.35 GHz (2050T), 2.7 GHz (2051T)
RF level	-138 dBm
FM	0 Hz ON
Single modulation mode	
Modulation	ENABLED

RF output

Specification

Level range:	-127 dBm to +10 dBm (usable to -138 dBm)
Accuracy:	**(2050T and 2051T)** ±1.2 dB from 10 kHz to 1.35 GHz at levels >-127 dBm **(2051T)** ±1.2 dB from 1.35 GHz to 2.7 GHz at levels >-127 dBm

Test equipment

Description	Minimum specification	Example
RF power meter	±0.1 dB from 30 kHz to 2.7 GHz	IFR 6960B and 6910 or 6912 sensor
Measuring receiver	0 dBm to –127 dBm; 2.5 MHz to 1300 MHz	HP 8902A and 11722A sensor and 11793A down converter
Signal generator	8 dBm from 32.5 MHz to 5.4 GHz	IFR 2032

Test procedures

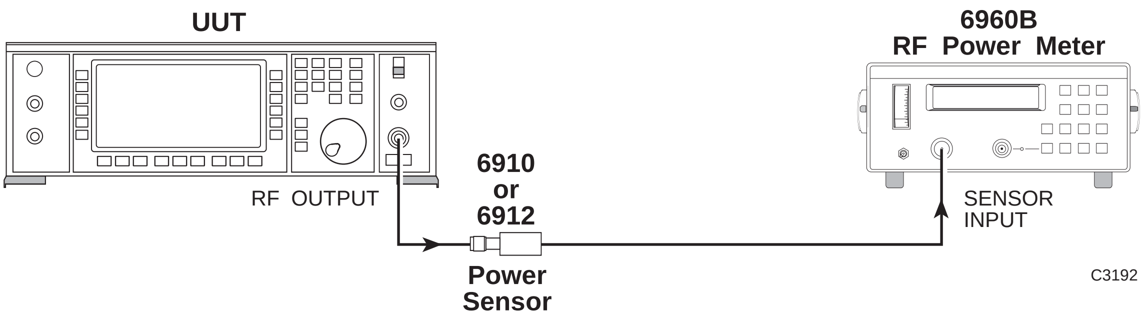

Fig. 6-C-1 RF output flatness test set-up

(1) Connect the test equipment as shown in Fig. 6-C-1.

(2) Set the UUT to *[RF Level]* 0 dBm *[Carrier Freq.]* 250 kHz.

(3) Check that the output level is within specification at the frequencies shown in Table 6-C-1.

(4) Set the UUT RF output to 10 dBm and repeat (3) above.

Table 6-C-1 Frequency settings for output levels

FREQUENCY (MHz)		
(2050T/1T)	1275	2175
0.25	1350	2325
75		2475
225	**(2051T)**	2625
375	1351	2700
525	1425	
675	1575	
825	1725	
975	1875	
1125	2025	

ALC linearity

(1) Connect the test equipment as shown in Fig. 6-C-1.

(2) Set the UUT to *[RF Level]* -3 dBm *[Carrier Freq.]* 2.5 MHz.

(3) Increment the RF output of the UUT in 1 dB steps up to 9 dBm and in 0.1 dBm steps up to 10 dBm, measuring the RF level at each step. Check that the RF output level variation is within ±0.1 dB.

(4) Set the UUT carrier frequency to 500 MHz and repeat (3) above.

(5) Set the UUT carrier frequency to 2.7 GHz and repeat (3) above.

Attenuator accuracy

The following test will confirm that the attenuator performs to the published performance specification. In the event of the receiver/down converter not being available, an alternative method to functionally test the attenuator is also suggested (see 'Alternative attenuator functional check' below).

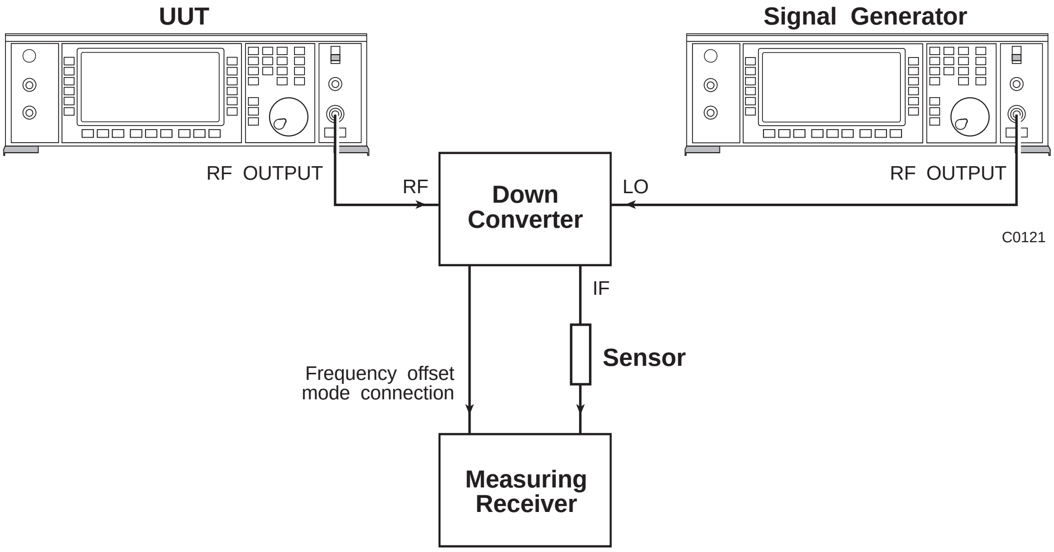

Fig. 6-C-2 Attenuator accuracy test set-up

(1) Connect the test equipment as shown in Fig. 6-C-2.

(2) Set the UUT to *[RF Level]* 0 dBm *[Carrier Freq.]* 2.5 MHz.

(3) Tune the receiver to 2.5 MHz and measure the RF level.

(4) Set the UUT to *[RF Level]* -6.1 dBm and measure the RF level.

(5) Decrement the output of the UUT in 6 dB steps down to an RF level of -120.1 dBm measuring the RF level at each step. Check that the measured level is within specification.

(6) Repeat (2) to (5) at the frequencies given in Table 6-C-2.

(7) Set the local oscillator to +8 dBm at the frequencies indicated in brackets in Table 6-C-2.

Table 6-C-2 Attenuator frequency settings

Frequency (MHz)	
2050T/1T	***2051T**
2.5	1725 (1662)
31	2700 (2637)
325	
1125	

*At frequencies above 1300 MHz the down converter will automatically be enabled.

The frequency of the local oscillator will have to be entered on the receiver followed by the test frequency. This will automatically set the receiver to the required IF frequency.

Alternative attenuator functional check

(1) Connect the test equipment as shown in Fig. 6-C-1.

(2) Set the UUT to *[Carrier Freq.]* 1.35 GHz *[RF Level]* 10 dBm.

(3) Set a reference on the power meter.

(4) Using the latch poke facility on the UUT, select each attenuator pad individually as follows:

[UTIL] *[Utils. Menu 2] [Latch Data]* 95 [enter]

[Decimal/Binary]

The binary latch data will now appear in the bottom right-hand side of the display.

(5) By using the *[Toggle Bit]* and the *[Cursor Left] [Cursor Right]* soft keys, select each attenuator pad in turn which should give the nominal readings on the power meter in the following sequence:

-60 dB -30 dB -12 dB -30 dB -24 dB -30 dB

Note that no software correction is applied to the attenuator when performing this test. Therefore errors in the nominal values are not necessarily reflected in the RF level accuracy.

Annex A
OPTION 006 AVIONICS

Contents

List of figures

General description

This option provides internal generation of waveforms suitable for testing Instrument Landing Systems (ILS) and VHF Omnidirectional Radio Range (VOR) systems. Option 006 requires Option 001 (Second Modulation Oscillator) to be fitted.

ILS mode

In ILS mode the SDM (Sum of Depth of Modulation) of the 90 Hz and 150 Hz tones is entered to a resolution of 0.1% AM depth. The DDM (Difference in Depth of Modulation) is entered to a resolution of 0.01% depth for a DDM up to 20% and 0.1% for higher DDM settings. A choice of which tone is dominant is available to the user. DDM is also displayed in μA, to a resolution of 0.01 μA.

The 30 Hz repetition frequency of the ILS waveform can be adjusted in 0.1 Hz steps. For 0% DDM additional modulation signals can be added to the ILS waveform.

Marker beacon mode

In marker beacon mode the outer, middle and inner beacons can be tested by simple key selection.

VOR mode

In VOR mode the AM depth of the sub-carrier and 30 Hz tone can be independently set and the relative phase of the 30 Hz tone and the modulation tone on the sub-carrier is set by directly entering the bearing information in degrees. The VOR rate repetition rate of 30 Hz can be adjusted in 0.1 Hz steps. For a fixed bearing additional modulation can be applied to simulate voice/identity signal. A *[To/From]* beacon key provides a rapid means of reversing a bearing entry and accounting for different bearing conventions.

ADF mode

The ADF mode provides a simple method of testing automatic direction finding receivers operating on carriers with amplitude modulation.

SEL-CAL mode

In SEL-CAL mode the signal generator enables selective calling tones to be generated as amplitude modulation. This facility can be used to test the aircraft operator's communication system on commercial aircraft.

Performance data

The following specification is in addition to that included in the 2050T series specification.

ILS mode

Sum of Depth of Modulation (SDM)

Range:	0 to 99.9% in 0.1% steps representing the arithmetic sum of the individual tone depths.
Selection:	By keyboard entry of data and variation by ⇧/⇩ keys and rotary control.
Accuracy of SDM:	±2% of setting for carrier frequencies up to 400 MHz.

Difference in Depth of Modulation (DDM) — DDM can be entered in % or as a modulation index.

Range:	0 to 20% in 0.01% steps. 20 to 99.9% in 0.1% steps.
Selection:	By keyboard entry of data and variation by ⇧/⇩ keys and rotary control.
Accuracy of DDM:	±0.02 of DDM setting ±0.0003 DDM (0.03% depth). At 0 DDM (on course) accuracy is ±0.0003 DDM (0.03% depth); At 0.155 DDM accuracy is ±0.0034 DDM (0.34% depth).

Tone frequencies: 90 Hz, 150 Hz nominal. Tone frequency may be adjusted by varying the ILS repetition rate of 30 Hz in 0.1 Hz steps. Tone frequencies maintain 3:1 and 5:1 relationships with the ILS rate.

Tone suppression: Either tone can be suppressed.

Additional modulation: Available for 0% DDM from an internal or external modulation source.

Frequency accuracy: As frequency standard.

LF output: Available from the LF OUTPUT connector.

Accuracy of DDM: Equivalent to ±0.0003 DDM ±0.005 of setting. At 0 DDM (on course), accuracy is ±0.0003 DDM.

Marker beacon mode

Provides default modulation of 95% AM depth on a 75 MHz carrier at the modulation rate of 400 Hz (outer beacon), 1.3 kHz (middle beacon) or 3 kHz (inner beacon). AM depth, carrier frequency and modulation frequency can be changed from the default values.

VOR mode

9.96 kHz sub-carrier

Range:	0 to 49.9% depth in 0.1% steps.
Modulation:	Frequency modulated by a 30 Hz tone with settable deviations of 240 Hz, 300 Hz, 360 Hz, 420 Hz, 450, 480 Hz, 510 Hz and 540 Hz.

30 Hz tone

Range:	0 to 49.9% depth in 0.1% steps. Arithmetic sum of 30 Hz tone and sub-carrier AM depth are limited to 99.8%.

Selection: By keyboard entry of depth and variable by ⇧/⇩ keys and rotary control.

Bearing control: Relative phase of 30 Hz tone and sub-carrier modulation adjustable from 0° to 359.99° in 0.01° steps by entering VOR bearing. Bearing can be entered as TO or FROM the beacon.

Bearing accuracy ±0.05°.

Additional modulation: Available on 0° bearing from an internal or external modulation source.

AM depth accuracy: ±3% of setting ±0.5% for carrier frequencies up to 400 MHz (from 100 MHz to 400 MHz with Option 12).

Frequency: The VOR repetition frequency of 30 Hz may be varied in 0.1 Hz steps. The sub-carrier frequency and deviation maintain a fixed relationship with the VOR repetition rate

Frequency accuracy:	As frequency standard.
Audio output:	Available from the LF OUTPUT socket.

ADF mode:

Does not apply with Option 12 fitted. Provides default modulation of 30% AM depth on a 190 kHz carrier at 1 kHz modulation rate. AM depth, carrier frequency and modulation rate can be changed from the default values.

SEL-CAL MODE

Provides amplitude modulation with SEL-CAL (SELective CALling) tones.

Data entry	By soft keys labelled A to S, of up to 2 pairs of characters.
Timing:	Default 1 s tone duration, 250 ms tone gap. Tone gap, duration and start delay can be changed from the default values.

Avionics operation

This section explains how to use Option 006 when fitted to a 2050T series Signal Generator. Familiarity with the normal operation of the instrument is assumed.

The Avionics option offers modes of operation suitable for testing ILS and VOR systems. It also provides efficient testing of ADF (Automatic Direction Finders) and SEL-CAL receivers. It is assumed that the operator has some knowledge of the operation of these avionics systems.

The Avionics mode is selected by pressing the [UTIL] key and selecting the *[Mod'n Mode]* key on the Utilities 1 page shown in Fig. A-1 to obtain the menu shown in Fig. A-2. Selecting *[Avionics Mode]* from this menu will result in the *Avionics Mode Selection* shown in Fig. A-3 being displayed. Pressing the appropriate soft key will result in the instrument entering the required mode of operation; pressing *[Other Modes]* returns the display to the *Modulation Mode Selection menu*.

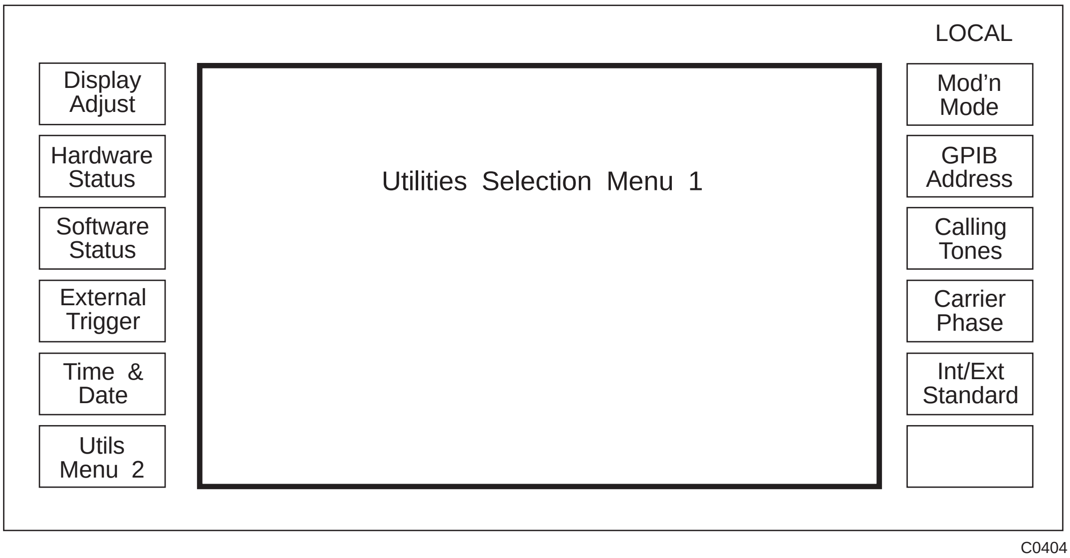

Fig. A-1   Utilities selection menu 1

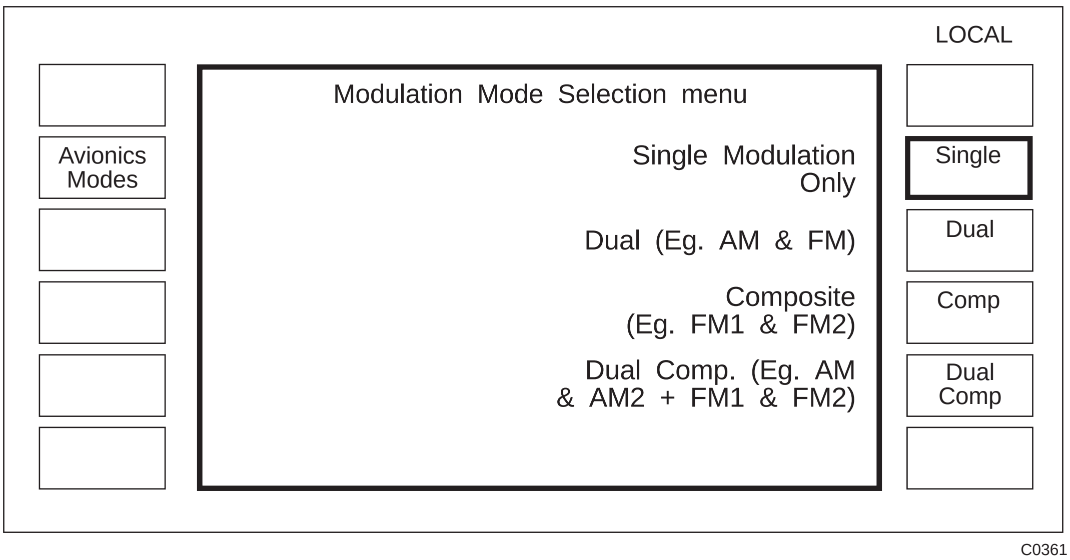

Fig. A-2   Modulation mode selection menu

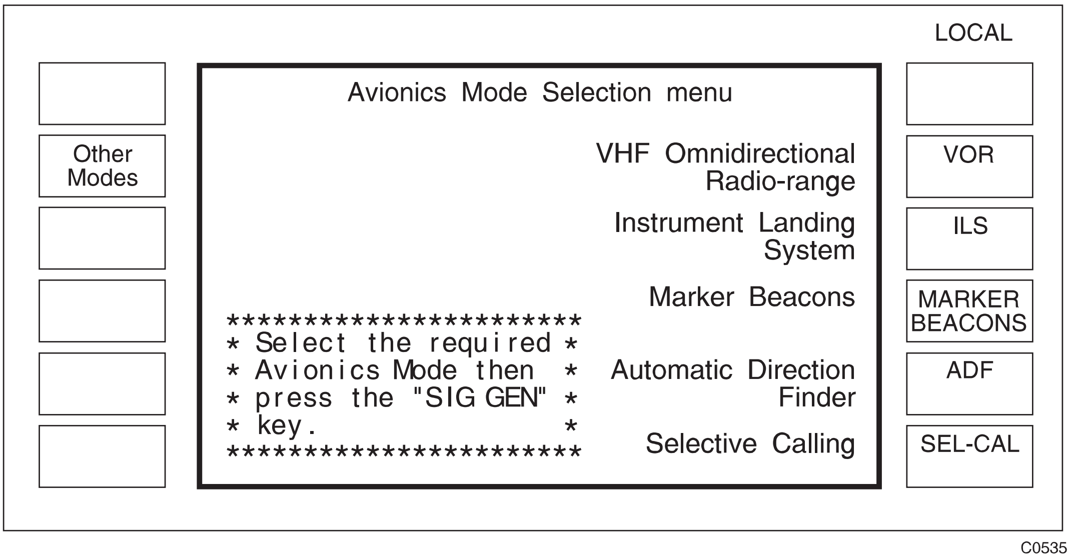

Fig. A-3   Avionics mode selection menu

ILS mode

Pressing *[ILS]* and then pressing the [SIG GEN] key will result in the display shown in Fig. A-4. The default carrier frequency for ILS mode is 108.1 MHz.

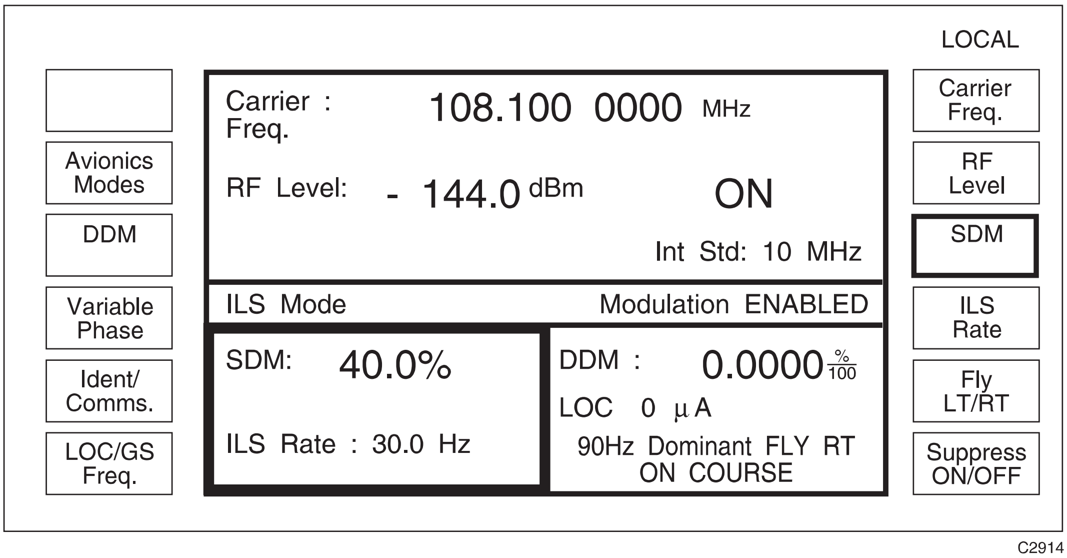

Fig. A-4   SDM selection menu

The sum of depth of modulation (SDM) is the arithmetic sum of depth of the modulating 90 Hz and 150 Hz tones. Using the *[SDM]* key the depth can be entered in %. The ILS rate is normally set to 30 Hz and is the ILS waveform repetition rate. Its frequency can be modified using the *[ILS Rate]* key. If the ILS rate is adjusted the frequency of the 90 Hz and 150 Hz alter on a pro-rata basis (e.g. If ILS Rate = 29 Hz the tone frequencies are 87 Hz and 145 Hz).

DDM control

From the SDM Selection Menu (Fig. A-4) DDM may be entered by pressing the *[DDM]* key to obtain the display shown in Fig. A-5.

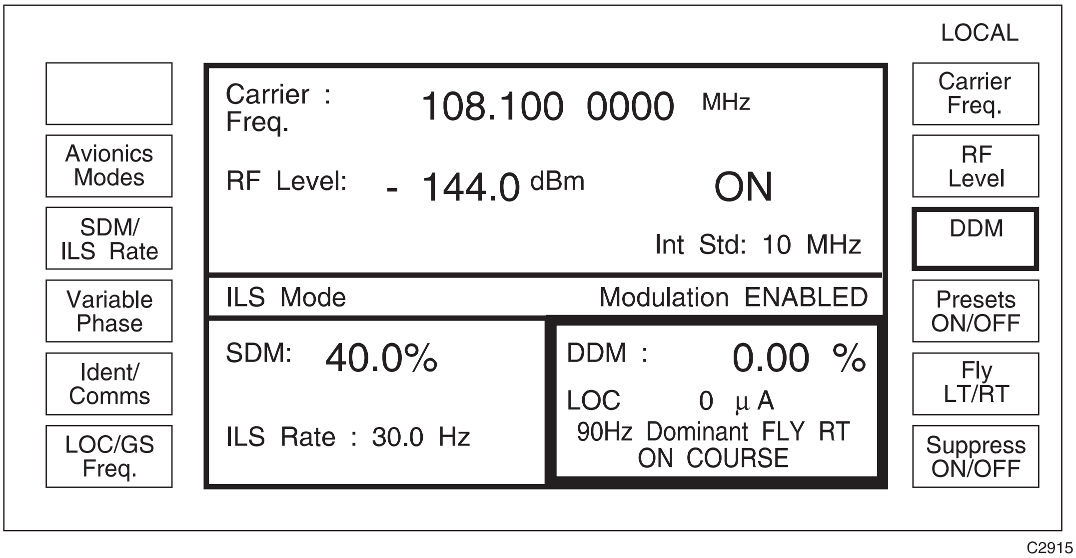

Fig. A-5 DDM selection menu

The DDM can be entered in %, as a modulation index (%/100) or in microamps (µA) and displayed on the *Sig Gen* menu in %, as a modulation index, microamps or as the attenuation ratio between the 90 Hz and 150 Hz tones in dB, according to the formula:

$$R_{dB} = 20 \log_{10} \left\{ \frac{SDM + DDM}{SDM - DDM} \right\} \mu A$$

If the setting to be entered is a modulation index terminate the entry with the [enter] key. Alternatively, if the setting to be entered is in microamps terminate the entry with the [ms] key. The microamp entry is converted to the nearest 0.01%. If the carrier frequency is below 200 MHz the signal is assumed to be for a localiser and if it is above 200 MHz the signal is assumed to be for a glideslope. The following conversion factors are used:

150 µA ≡ 15.5% DDM on the localiser

150 µA ≡ 17.5% DDM on the glideslope

The units displayed can be changed without entering any data. Press the [enter] and [%] keys to toggle between modulation index and percentage. Press the [ms] and [dB] keys to toggle between microamps and attenuation ratio.

The *[Fly/LT/RT]* key can be used to set which tone has the greater depth of modulation and the dominant tone is displayed under the DDM set. When 90 Hz is dominant the aircraft is either to the left (localiser) or too high (glideslope). The corresponding action to be taken is displayed as *FLY RT* and *FLY DN*. Similarly when 150 Hz is dominant the aircraft is either to the right (localiser) or too low (glideslope). The corresponding action to be taken is displayed as *FL LT* and *FLY UP*. If 0% DDM is set the additional text *ON COURSE* is displayed.

DDM values can be entered using the DDM presets which provide a fast method of selecting commonly used DDM values. The DDM presets are selected using the *[Presets ON/OFF]* key and Fig. A-6 is produced.

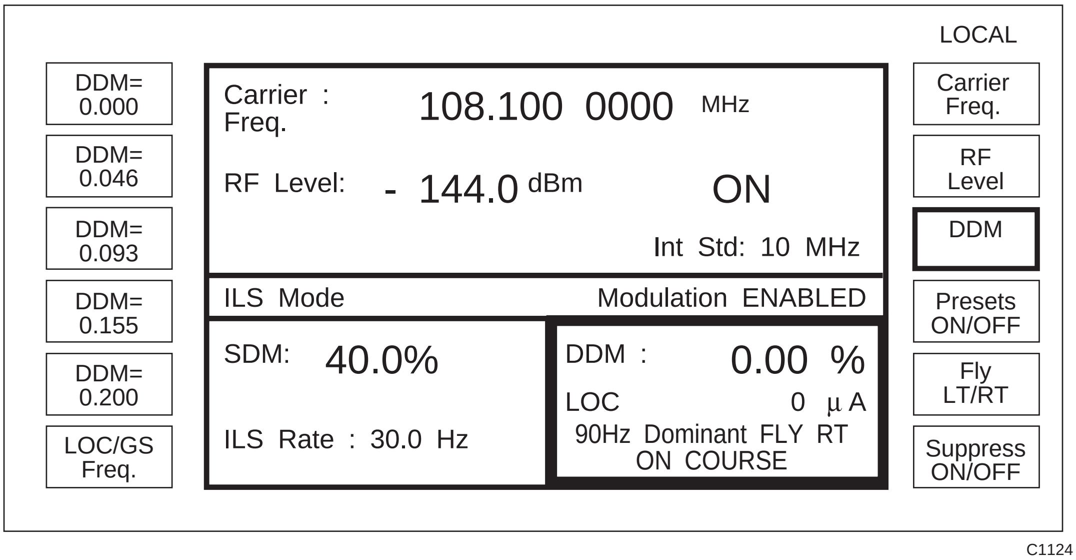

Fig. A-6 DDM selection menu with presets

Five DDM preset values can be selected for either localizer or glideslope frequencies. The DDM value can still be modified by the normal numeric entry, increment or rotary controls as well as the preset mechanism. The DDM value is displayed in modulation index format when a preset value is chosen. The equivalent glideslope DDM preset keys (0.000, 0.045, 0.092, 0.175, 0.400) are displayed when a glideslope frequency is entered. The normal DDM selection menu is selected by pressing the *[Presets ON/OFF]* key.

Localiser/glideslope frequency conversion

International agreements specify that localiser and glideslope frequencies are paired on any ILS installation. The *[LOC/GS Freq.]* provides a convenient means of switching between the localiser and glideslope frequencies. Provided the carrier frequency is set near to a recognised ILS frequency, pressing *[LOC/GS Freq.]* will result in the carrier being changed to appropriate paired frequencies.

Note

If the carrier frequency is not set precisely to the glideslope or localiser channel frequency and *[LOC/GS Freq.]* is pressed twice, the frequency will be reset to the nominal localiser/glideslope frequency.

The default SDM is 40% for localiser and 80% for glideslope, and pressing *[LOC/GS Freq.]* will automatically reset the SDM to the default value.

When changing from localiser to glideslope the *[Ident/Comms]* key will disappear and then reappear when changing back to localiser.

Tone suppression

The 90 Hz or 150 Hz tone can be suppressed when either the SDM or DDM display box is selected for data entry, using the *[Suppress ON/OFF]* key. This will result in the non-dominant tone being suppressed without altering the SDM or DDM (% or index) as shown in Fig. A-7. Selecting *[Suppress 90/150]* will change the tone to be suppressed. The modulation depth value of the active tone is displayed under the SDM setting.

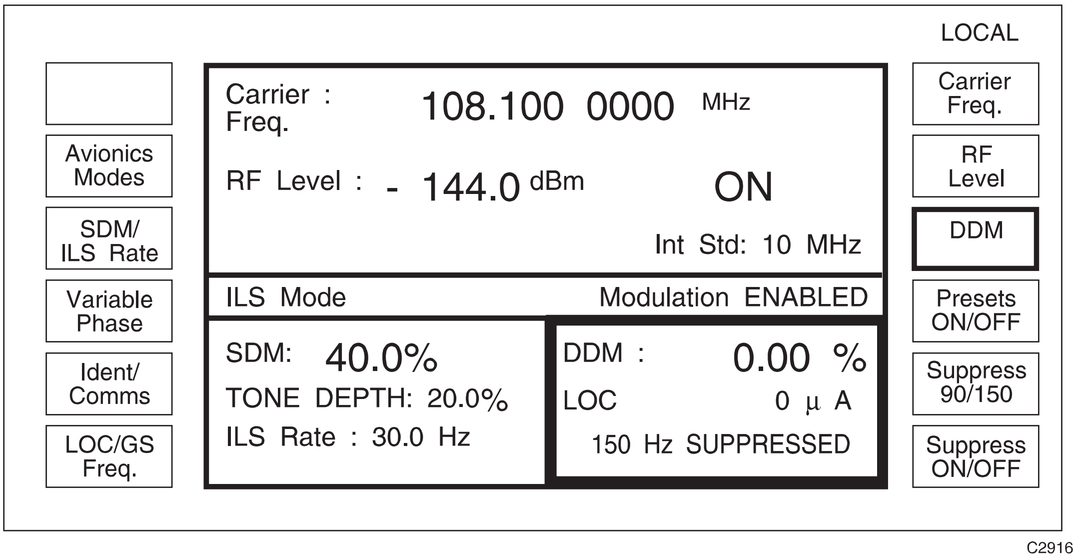

Fig. A-7   Tone suppression menu

Communication channel testing

ILS systems allow the provision of an emergency voice channel on localiser frequencies. This channel can be tested by selecting the *[Ident/Comms]* key to produce a display similar to the one shown in Fig. A-8.

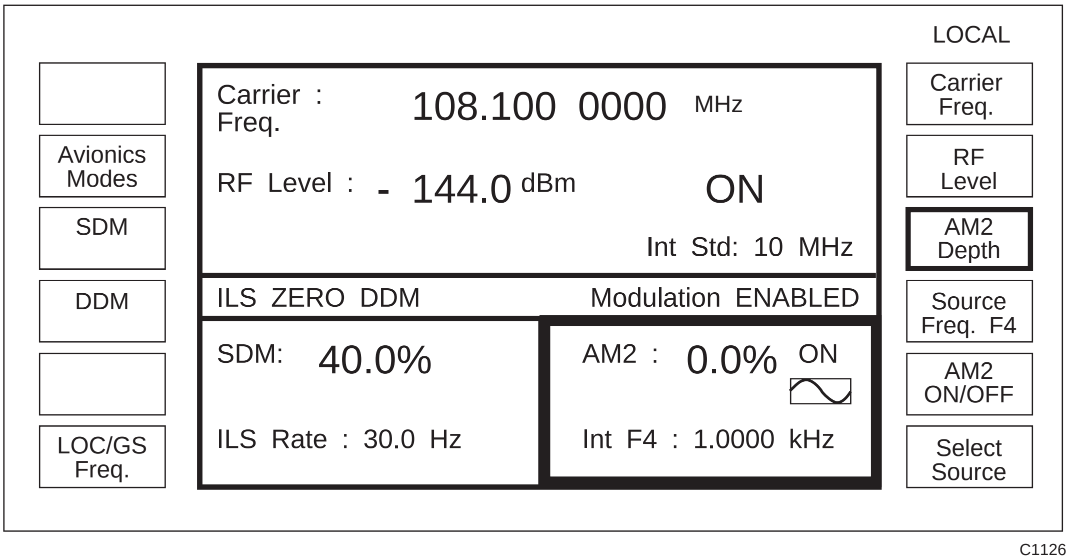

Fig. A-8   Ident/Comms selected

In this mode a fixed 0% DDM signal is provided and an additional modulation signal can be added using the *[AM2 Depth]* key. The source of this additional modulation can be set using the *[Select Source]* key. If internal modulation is selected the source frequency can be modified using the *[Source Freq.]* key. Selecting *[DDM]* will return the instrument to normal ILS mode.

Communication channel testing is normally only required on localiser frequencies and consequently changing from localiser to glideslope using the *[LOC/GS Freq.]* key will result in the *[Ident/Comms]* key disappearing. Additional modulation can be obtained on a glideslope frequency by directly entering the glideslope frequency instead using the numeric keys.

Tone phase variability

For normal ILS operation the phase setting between the 90 Hz and 150 Hz tones is automatically set to 0°. The *[90/150 Phase]* key can be used to adjust the phase relationship of the two tones. Selecting the *[90/150 Phase]* key produces the display shown in Fig. A-9.

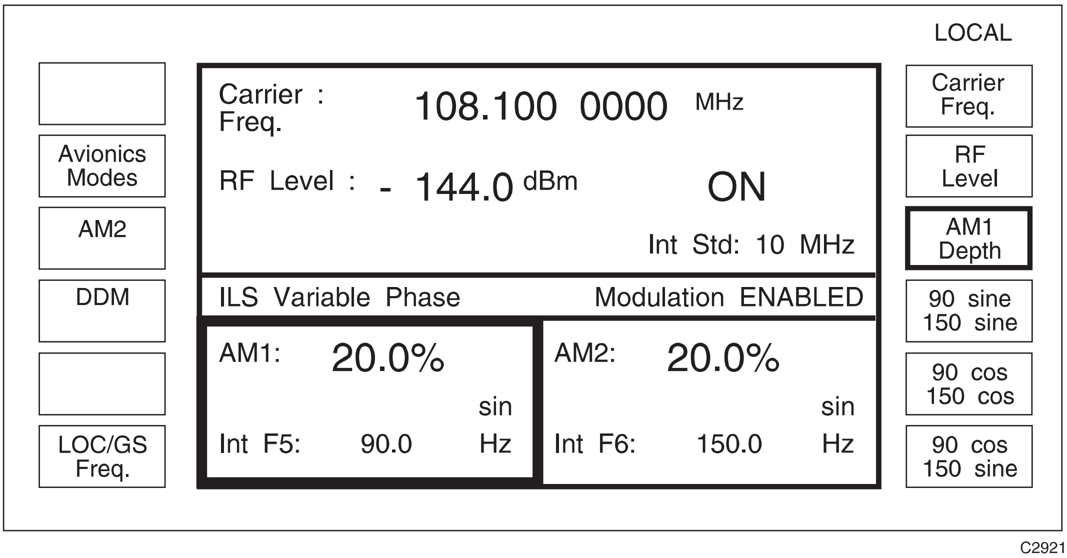

Fig. A-9   ILS variable phase sub-menu

Three phase relationships can be selected:

90 Hz sine/150 Hz sine

90 Hz cosine/150 Hz cosine

90 Hz sine/150 Hz cosine (≡ 90 Hz cosine/150 Hz sine)

Selecting *[DDM]* will return the instrument to normal ILS mode.

Marker beacon mode

The marker beacon mode is selected using the *[MARKER BEACONS]* key on the *Avionics Mode Selection Menu* shown in Fig. A-3. Selecting maker beacon mode and pressing the [SIG GEN] key produces the display shown in Fig. A-10. Initially the outer beacon is selected by default. The *[Middle Beacon]* and *[Inner Beacon]* keys change the modulation frequency to 1.3 kHz and 3 kHz respectively. Carrier frequency and AM depth can be altered, but always default to 75 MHz and 95% respectively. Modulation frequency can be changed using the *[Source Freq: F1]* key. Modulation source can be changed using the *[Select Source]* key. Pressing the *[Avionics Modes]* key returns the display to the *Avionics Mode Selection Menu*.

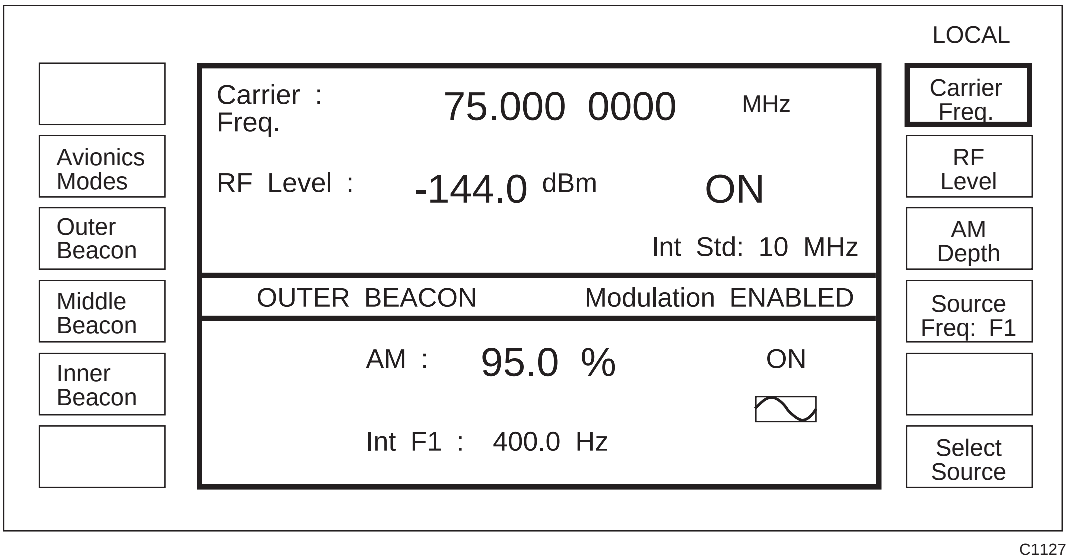

Fig. A-10 Marker beacon mode selection menu

VOR mode

VOR operation can be obtained from the *Avionics Mode Selection Menu* (Fig. A-3) or if other avionics modes have been selected, by first pressing the *[Avionics Modes]* key. Selecting *[VOR Mode]* will produce the display shown in Fig. A-11. The default carrier frequency for the VOR mode is 108 MHz.

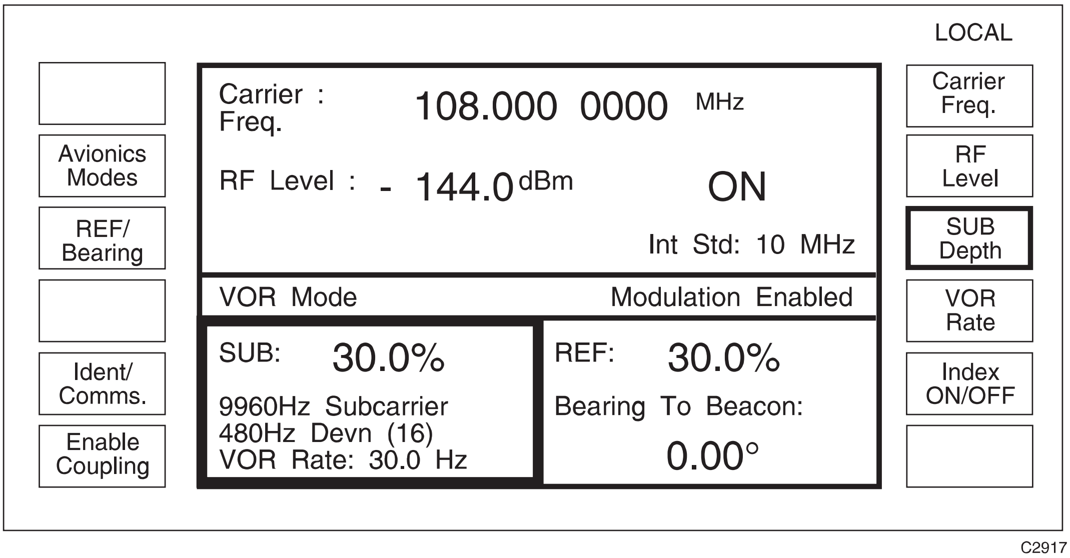

Fig. A-11 VOR mode operation

Sub-carrier peak deviation

For normal VOR operation the 30 Hz reference signal, which FM modulates the 9960 Hz sub-carrier, has a peak deviation of 480 Hz (Index=16). The *[Index ON/OFF]* key can be used to adjust the amount of peak deviation applied. Selection the *[Index ON/OFF]* key produces the display shown in Fig. A-12.

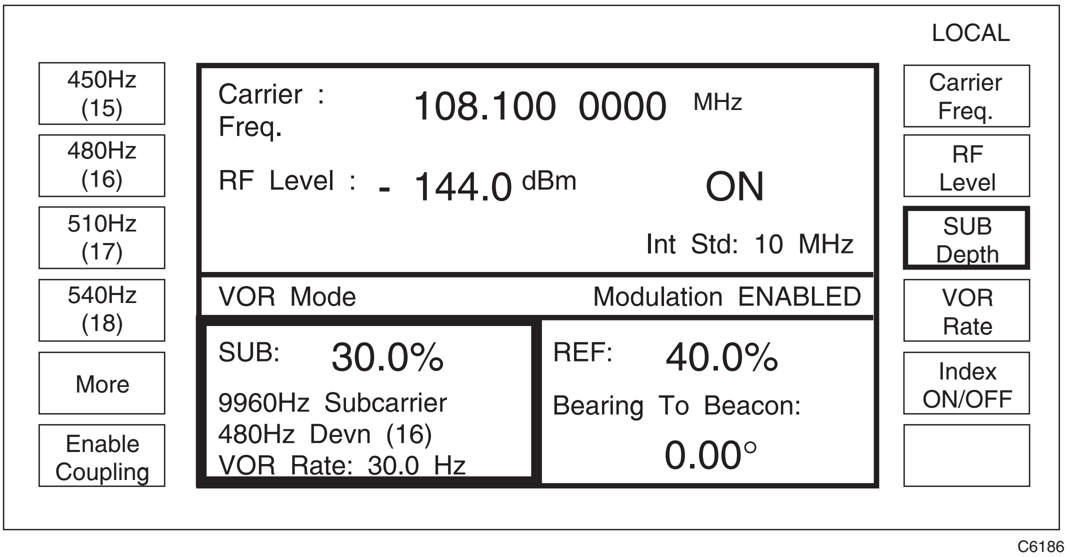

Fig. A-12 VOR mode operation with peak deviation selection(screen 1)

Four modulation index values (15-18) can be selected with the current selection displayed under the SUB setting.

Press *[More]* to display a choice of a further four modulation index values (8-14) as shown in Fig. A-13. Press *[More]* again to return to the previous modulation index screen.

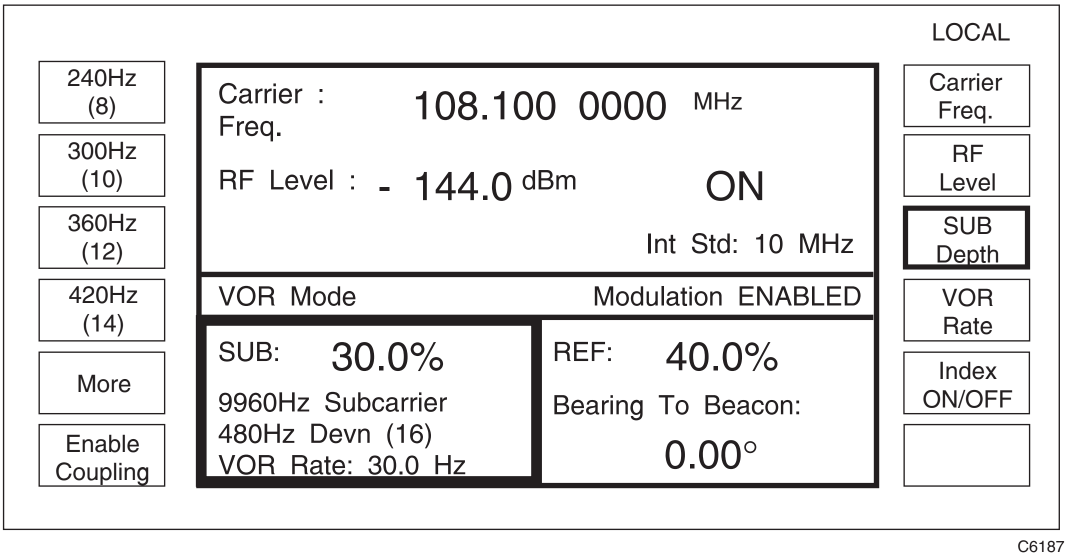

Fig. A-13 VOR mode operation with peak deviation selection (screen 2)

Normal VOR mode is returned by pressing the *[Index ON/OFF]* KEY.

Note

The 9960 Hz sub-carrier and the peak deviation value will change in relation to the VOR rate setting.

Example: **For a VOR rate of 25 Hz, the sub-carrier will be 8300 Hz and the peak deviation (for an index = 6) will be 400 Hz.**

The display always reflects the sub-carrier and peak deviation settings for a VOR rate of 30 Hz.

Using the *[SUB Depth]* key the AM depth of the 9960 Hz sub-carrier can be entered in % and the *[VOR Rate]* key can be used to vary the VOR repetition rate from its normal setting of 30 Hz.

To vary the 30 Hz tone AM depth or the VOR bearing select the *[REF]* key to produce the display shown in Fig. A-14. The 30 Hz tone AM depth can be entered using the *[REF Depth]* key and bearing information can be entered in degrees using the *[Bearing]* key followed by the bearing data and the [enter] key. Conventions for bearing are not internationally consistent so a *[To/From]* key is provided to allow toggling between these two conventions. Operating this key does change the bearing but not the value displayed. It also provides a convenient way of providing a 180° bearing reversal.

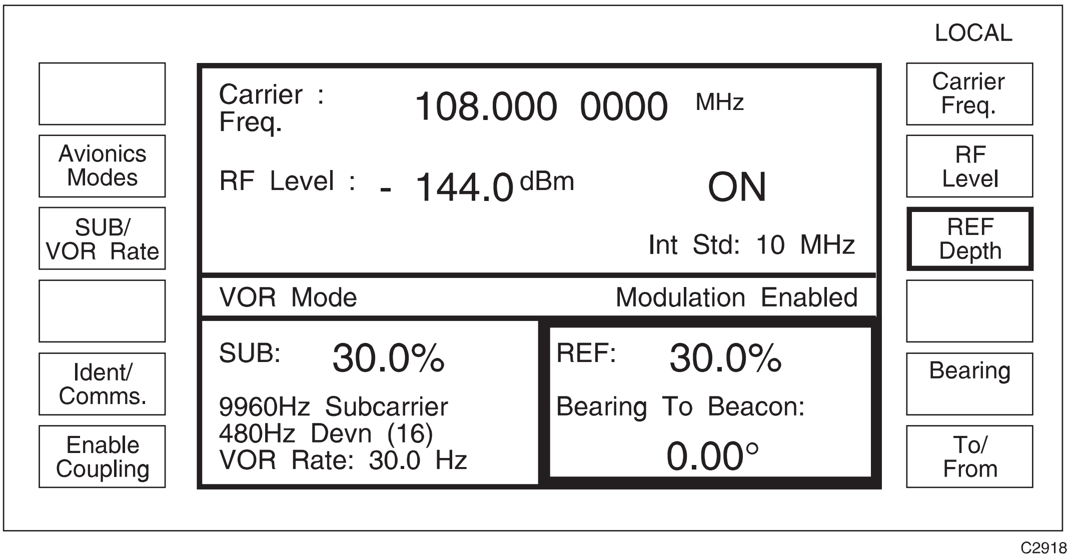

Fig. A-14 REF selected

The AM depth of the 9960 Hz sub-carrier and the 30 Hz tone can be varied simultaneously by pressing the *[Enable Coupling]* key which produces the display shown in Fig. A-15.

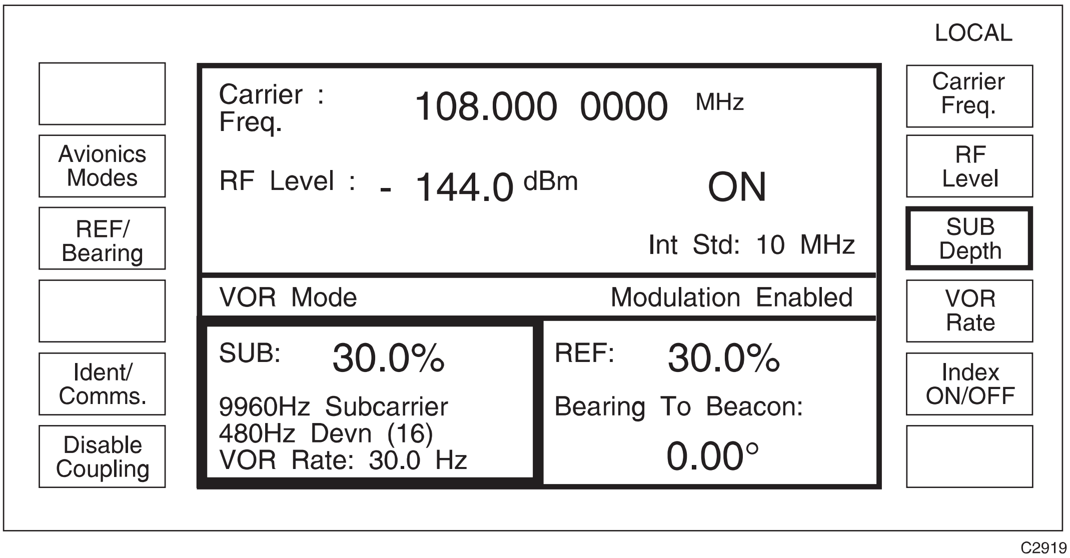

Fig. A-15 VOR made operation with "Coupling" enabled

When "coupling" is enabled, the 30 Hz AM depth is set to be equal to the 9960 Hz sub-carrier AM depth setting as the sub-carrier depth is varied. Similarly, the sub-carrier depth is set to the 30 Hz tone depth when the 30 Hz tone depth is varied. This mode of operation is disabled by pressing the *[Disable Coupling]* key.

Identity channel

VOR signals often carry a morse coded tone to identify the transmitter. This signal can be simulated by selecting the *[Ident/Comms]* key to produce a display similar to the one shown in Fig. A-16.

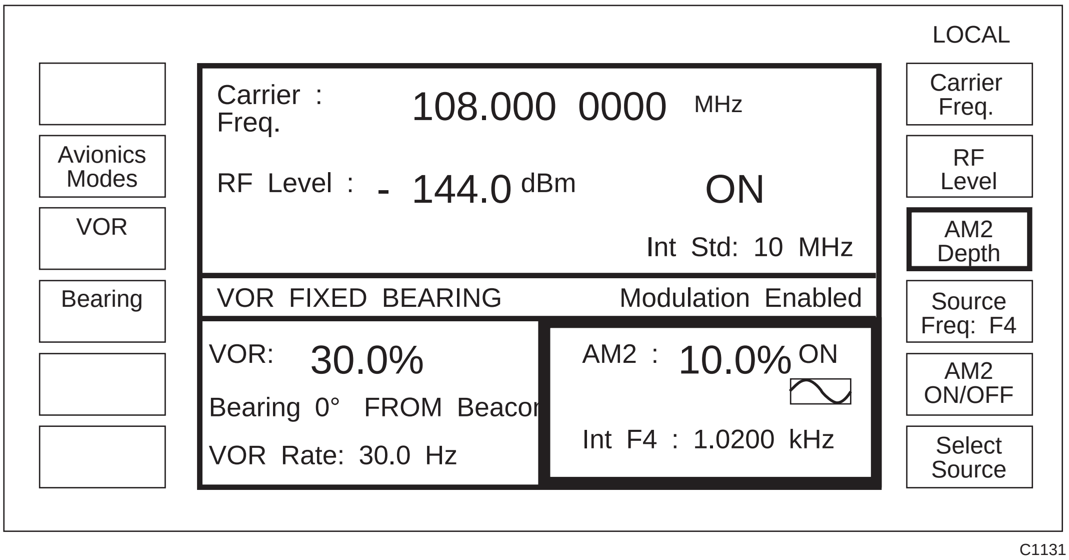

Fig. A-16 Ident/Comms selected

The instrument will generate a VOR signal having equal sub-carrier and 30 Hz tone depths with a 0° bearing. The AM depth displayed is the depth of each tone and can be changed using the *[VOR]* key.

An additional AM signal, AM2, can be added to this waveform. The source of this modulation can be selected using the *[Select Source]* key and if internal modulation has been selected the modulation frequency can be set using the *[Source Freq.]* key. The depth of this additional signal can be set by the *[AM2 Depth]* key.

ADF mode

The ADF mode is selected using the *[ADF]* key on the *Avionics Mode Selection Menu* shown in Fig. A-3. This menu can be selected from other aviation modes (VOR, ILS, MARKER BEACON, SEL-CAL) using the *[Avionics Modes]* key. Selecting the ADF mode and pressing the [SIG GEN] key produces the display shown in Fig. A-17.

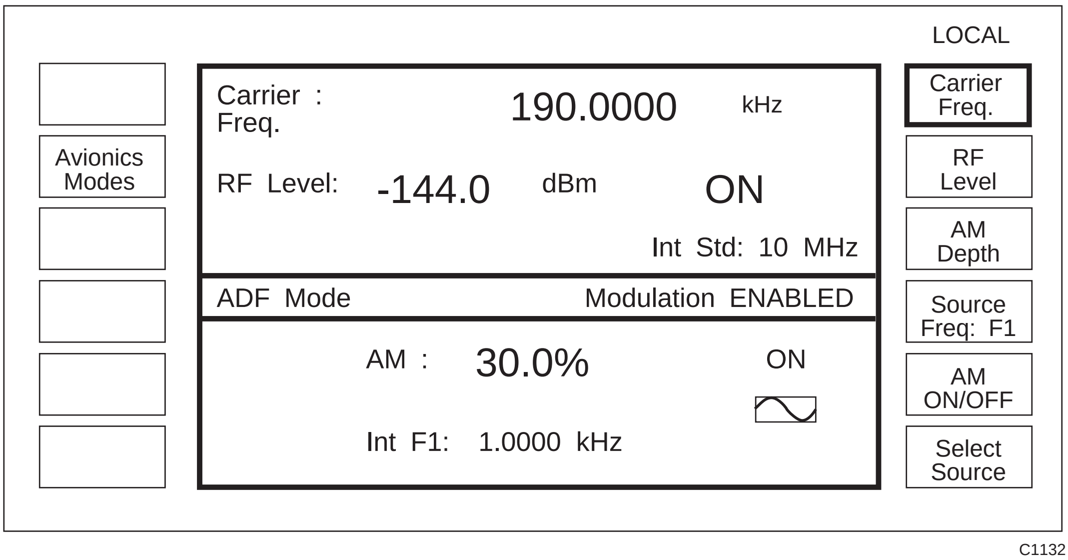

Fig. A-17 ADF mode selection menu

The carrier frequency will default to 190 kHz and the modulation depth to 30% from a 1 kHz source. This setting is used to simulate a long wave transmitter for direction finding purposes. The instrument operation is very similar to non-avionics modes with a single modulation selected (except that FM cannot be selected).

Pressing the *[Avionics Modes]* key returns the display to the *Avionics Mode Selection Menu* shown in Fig. A-3.

SEL-CAL mode

The SEL-CAL mode can be used to test receivers using AM Selective Calling Tones to the selective calling format. The mode can be selected from the *Avionics Mode Selection Menu* shown in in Fig A-3. Selecting *[SEL-CAL* and pressing the [SIG GEN] key produces the display shown in Fig. A-18.

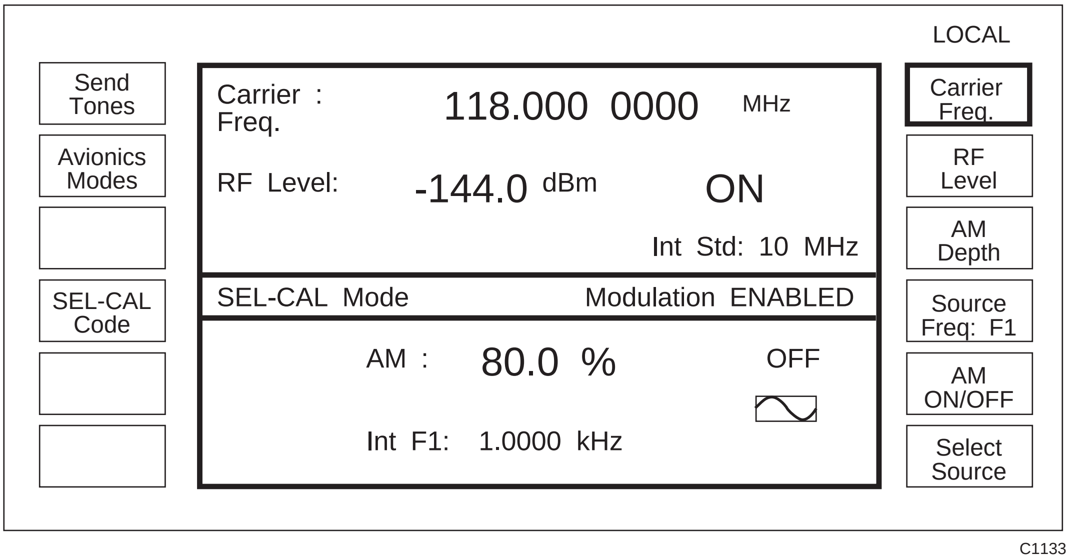

Fig. A-18 SEL-CAL mode selection menu

The instrument operation is similar to that in non-avionics modes with a single modulation selected (except that FM cannot be selected). Carrier frequency and AM depth can be altered, but always default to 118 MHz and 80% respectively.

The SEL-CAL tones can be sent by pressing the *[Send Tones]* key. While the tones are being sent *Modulation ENABLED* is replaced by the message *** *SENDING TONES* *** and the normal modulation tone is suppressed.

The SEL-CAL code can be modified by pressing the *[SEL-CAL Code]* key to produce a display similar to the one shown in Fig. A-19. Operation of this facility is identical to that of the *Sequential Calling Tones Utility* in non-avionics mode. The tone duration and gap can be set but the default values are those usually used for SEL-CAL. Alternative standards can be selected using the *[Select Standard]* key. The *[Mode Control]* key can be used to change the mode from single shot but the default setting in always single shot.

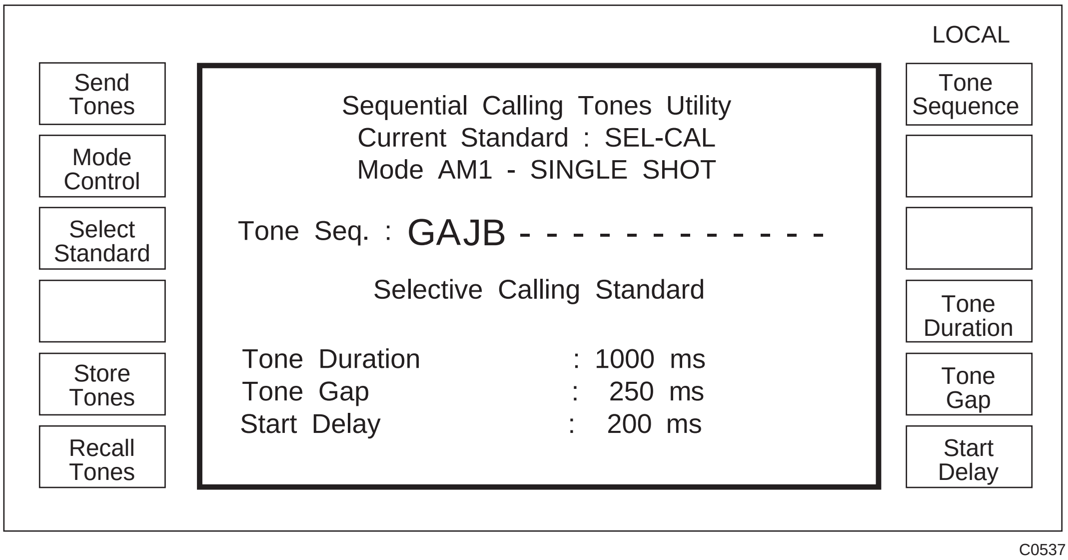

Fig. A-19 SEL-CAL tones utility

Tone sequences are entered using the *[Tone Sequence]* key to produce the display shown in Fig. A-20.

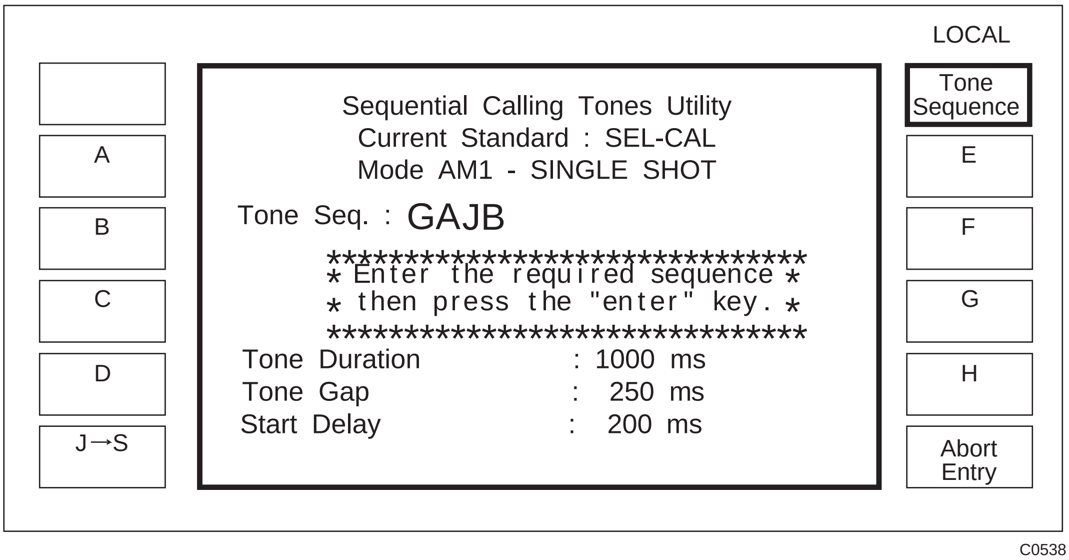

Fig. A-20 SEL-CAL tone entry

Characters A to H may be directly entered. To enter characters J to S first select the key *[J→S]*. An even number of characters is required to be entered up to a maximum of 4 (2 pairs). When the entry is complete terminate the code using the [enter] key. The display will return to that shown in Fig. A-19.

Note

The SEL-CAL calling tones can also be selected from the Calling Tones utility used for other calling tone standards. In this mode FM is also allowed.

Rotary control

The rotary control can be used to vary major parameters in all Avionics modes by pressing the [KNOB UP-DN] key. The sensitivity of the rotary control can be changed using the [⇧] and [⇩] keys.

GPIB operation

MODE

Set avionics mode
(in addition to existing modulation mode commands)

Data type : Character Program Data (valid combinations of SDM, DDM, VOR, BEAR or AM2, see Table below)
Allowed suffices : None
Default suffix : None

Examples
```
MODE SDM,DDM (select ILS mode with DDM)
MODE SDM,AM2 (select ILS mode with AM2) MODE SDM
(select ILS variable phase mode)
```

VALID MODE COMBINATION TABLE

ILS	VOR
SDM,DDM	VOR,BEAR
SDM,AM2	VOR,AM2

Note:

Order is not important, for example SDM,DDM is equivalent to DDM,SDM.

MODE?

Prepares message containing information on Modulation Mode in the following format:

:MODE<mode>

where: <mode> is character program data indicating the modulation mode settings.

Examples:
```
:MODE VOR,BEAR
:MODE SDM,DDM
:MODE SDM
```

ILS (Instrument Landing System) **mode**

SDM Set Sum of Depth of Modulation (short form)

:DEPTH Set SDM Depth

:INC Set SDM step size

Data type : Decimal Numeric Program Data
Allowed suffices : **PCT**
Default suffix : **PCT**

:UP Go UP one step

:DN Go DOWN one step

:RETN Return to original setting

:XFER Transfer current value to be the new setting

Data type : None
Allowed suffices : None
Default suffix : None

Example: `SDM:DEPTH 40PCT;INC 2;UP;UP;UP`

:PHASE Specify the phase relationship between the 90 Hz and 150 Hz tones.

Data type : Character Program Data (any one of SIN_SIN, COS_COS or SIN_COS).
Allowed suffices : None
Default suffix : None

SDM Set Sum of Depth of Modulation (short form)

Example: `SDM:PHASE SIN_COS`

SDM? Prepares messages containing information on SDM in the following format:
:SDM:DEPTH <nr2>;INC <nr2>

Example: `:SDM:DEPTH 40.0;INC 0.5`

SDM:PHASE? Prepares messages containing information on the phase relationship between the 90 Hz and 150 Hz tones in the format:
:SDM:PHASE <char>

Example: `:SDM:PHASE SIN_COS`

DDM90 Set Difference in Depth of Modulation with 90 Hz tone predominant (short form)

:DEPTH Set DDM90 Depth

DDM150 Set Difference in Depth of Modulation with 150 Hz tone predominant (short form)

:DEPTH Set DDM150 Depth

SDM Set Sum of Depth of Modulation (short form)

:DEPTH Set SDM Depth

Data type : Decimal Numeric Program Data
Allowed suffices : **PCT**
Default suffix : **None**

Note:
When there is no suffix it is assumed that the entry is in DDM index (%/100).

:UP Go UP one step

:DN Go DOWN one step

:RETN Return to original setting

SDM *(continued)*

:XFER Transfer current value to be the new setting

Data type : None
Allowed suffices : None
Default suffix : None

Example:
```
DDM90:DEPTH 40PCT;INC 0.1;DN;DN
DDM150:DEPTH 0.1554;INC 0.0002;UP;UP;UP
```

DDM?

Prepares messages containing information on DDM in the following format:
:<ddm>:DEPTH <nr2>;INC <nr2>

where <ddm> is a program mnemonic indicating the predominant tone (DDM90 or DDM150).

Example:
```
DDM90:DEPTH 0.2000;INC 0.01
:DDM150:DEPTH 0.4000;INC 0.01
```

SUPPRESS

[not used alone]

:TONE90	Suppress the 90 Hz tone
:TONE150	Suppress the 150 Hz tone
:NONE	Remove tone suppression

Data type : None
Allowed suffices : None
Default suffix : None

Example:
```
:SUPPRESS;TONE150
:SUPPRESS:NONE
```

SUPPRESS?

Prepares messages containing information on tone suppression control in the following format:
:SUPPRESS:<status>

where: <status> is a program mnemonic indicating the tone suppresson state.

ILSF

Set ILS Frequency (short form)

:VALUE	Set ILS Frequency
:INC	

Data type : Decimal Numeric Program Data
Allowed suffices : **GHz, MHz, KHz, Hz**
Default suffix : **Hz**

:UP	Go UP one step
:DN	Go DOWN one step
:RETN	Return to original setting
:XFER	Transfer current value to be the new setting

Data type : None
Allowed suffices : None
Default suffix : None

Example:
```
ILSF:VALUE 30 Hz;INC 0.1;DN;DN;DN
```

ILSF?

Prepares messages containing information on ILS Frequency in the following format:
:ILSF:VALUE <nr2>;INC <nr2>

Example:
```
:ILSF:VALUE 30.0;INC 0.5
```

Marker beacon mode

There are no additional commands for marker beacon testing, the required setting is obtained by using the appropriate standard commands.

Example for setting up and sending 400 Hz outer marker beacon:

Example:
```
:CFRQ 75 MHZ;RFLV:VALUE 0 DBM;ON;:AM1:DEPTH
95 PCT;INTF1;ON;:INTF1 400 HZ;:MOD:ON;:MODE AM
```

Example for setting up and sending 1300 Hz middle marker beacon:

Example:
```
:CFRQ 75 MHZ;RFLV:VALUE 0 DBM;ON;:AM1:DEPTH
95 PCT;INTF1;ON;:INTF1 1300 HZ;:MOD:ON;:MODE AM
```

Example for setting up and sending 3000 Hz inner marker beacon:

Example:
```
:CFRQ 75 MHZ;RFLV:VALUE 0 DBM;ON;:AM1:DEPTH
95 PCT;INTF1;ON;:INTF1 3000 HZ;:MOD:ON;:MODE AM
```

VOR (VHF Omnidirectional Radio Range) mode

VOR or SUB	Set SUB Subcarrier Signal (9960 Hz) Depth (short form)
:DEPTH	Set SUB Depth
:INC	Set SUB step size
Data type :	Decimal Numeric Program Data
Allowed suffices :	**PCT**
Default suffix :	**PCT**
:UP	Go UP one step
:DN	Go DOWN one step
:RETN	Return to original setting
:XFER	Transfer current value to be the new setting
:ENABLE	Enable Subcarrier and variable signal depth coupling
:DISABLE	Disable Subcarrier and variable signal depth coupling
Data type :	None
Allowed suffices :	None
Default suffix :	None
Example:	`SUB:DEPTH 30PCT;INC 2;UP;UP;UP`
:DEVN	Specify Subcarrier deviation
Data type :	Character Program Data (any one of Hz_240, Hz_300, Hz_360, Hz_420, Hz_450, Hz_480, Hz_510 or Hz_540)
Allowed suffices :	None
Default suffix :	None
Example:	`:VOR:DEVN HZ_450`
VOR? or SUB?	Prepares messages containing information on SUB in the following format: :SUB:DEPTH<nr2>;INC<nr2>
Example:	`:SUB:DEPTH 30.0;INC 0.5;DISABLE`
VOR:DEVN?	Prepares messages containing information on VOR Subcarrier deviation selection in the format: :VOR:DEVN<char>
Example:	`:VOR:DEVN HZ_480`
REF	Set REF Variable Signal (30 Hz) Depth (short form)
:DEPTH	Set REF Depth
:INC	Set REF Step Size
Data type :	Decimal Numeric Program Data
Allowed suffices :	**PCT**
Default suffix :	**PCT**
:UP	Go UP one step
:DN	Go DOWN one step
:RETN	Return to original setting
:XFER	Transfer current value to be the new setting
Data type :	None
Allowed suffices :	None
Default suffix :	None
Example:	`REF:DEPTH 30PCT;INC 2;DN;DN;DN`

REF? Prepares messages containing information on REF in the following format:
:REF:DEPTH <nr2>;INC <nr2>

Example: `:REF:DEPTH 30.0;INC 0.5`

BEARTO Set VOR Bearing To Beacon (short form)

:VALUE Set VOR Bearing To Beacon

BEARFR Set VOR Bearing From Beacon (short form)

:VALUE Set VOR Bearing From Beacon

BEARTO or BEARFR

:INC

Data type : Decimal Numeric Program Data
Allowed suffices : **DEG**
Default suffix : **DEG**

:UP Go UP one step

:DN Go DOWN one step

:RETN Return to original setting

:XFER Transfer current value to be the new setting

Data type : None
Allowed suffices : None
Default suffix : None

Example:
```
BEARTO:VALUE 90DEG;INC 0.1;UP;UP;UP
BEARFR:VALUE 270DEG;INC 0.1;DN;DN;DN
```

BEAR? Prepares messages containing information on VOR BEARING in the following format:
:<bear>:VALUE <nr2>;INC <nr2>

where <bear> is a program mnemonic indicating the Bearing convention (BEARTO or BEARFR).

Example:
```
:BEARFR:VALUE 60.0;INC 0.5
:BEARTO:VALUE 300.0;INC 0.5
```

VORF Set VOR Frequency (short form)

:VALUE Set VOR Frequency

:INC

Data type : Decimal Numeric Program Data
Allowed suffices : **GHz, MHz, KHz, Hz**
Default suffix : **Hz**

:UP Go UP one step

:DN Go DOWN one step

:RETN Return to original setting

:XFER Transfer current value to be the new setting

Data type : None
Allowed suffices : None
Default suffix : None

Example: `VORF:VALUE 30Hz;INC 0.1;DN;DN;DN`

VORF? Prepares messages containing information on VOR Frequency in the following format:
:VORF:VALUE <nr2>;INC <nr2>

Example: `:VORF:VALUE 30.0;INC 0.5`

ADF (Automatic Direction Finder) mode

There are no additional commands for ADF testing, the required setting is obtained by using the appropriate standard commands.

Example:
```
:CFRQ 190 KHZ;RFLV:VALUE +10 DBM;ON;:AM1:
DEPTH 30 PCT;INTF1;ON;:INTF1 1 KHZ;:MOD:ON;:MODE AM
```

Sel-cal mode

SEL-CAL adds the following to the Sequential Calling Tones. SEL-CAL is an additional valid type. The data string representing the Tone Sequence is an even number of characters selected from the set {ABCDEFGHJKLMPQRS}.

Example for setting operating conditions:

Example:
```
:CFRQ 118 MHZ;RFLV:VALUE 0 DBM;ON;:AM1:DEPTH
80 PCT;INTF1;OFF;:INTF1 1 KHZ;:MOD:ON;:MODE AM
```

Example for setting up SEL-CAL and sending tones:

Example:
```
:SEQT:MODE:STD SELCAL;MOD AM1;:SEQT:SEQ
"GABD";SEND 1
```

ACCEPTANCE TESTING

Introduction

The test procedures in this section enable you to verify that the electrical performance of the avionics signal generator complies with the Performance Data given earlier. The test equipment recommended for this purpose is listed in Table A-1. All tests may be performed with the covers in place and are intended to be carried out in the order given. For convenience, the test equipment and specification for each test are summarized before the test procedure. These tests are in addition to those for non-avionics versions of the instrument.

These acceptance tests give a high degree of confidence that the instrument meets its specification, without the use of specialised test equipment.

The avionics option uses a method of Direct Digital Synthesis (DDS) to generate the required avionics waveforms. The accuracy of the generated waveform is therefore determined by stored digital data and the AM performance of the signal generator. These tests check the waveform generation and analogue and RF signal paths in the signal generator. Additional tests can be undertaken using specialised ILS and VOR receivers if they are available.

Test equipment

The test equipment recommended for acceptance testing is shown in Table A-1. Alternative equipment may be used provided it complies with the stated minimum specification.

Table A-1 Recommended test equipment

	Test equipment	
Description	**Minimum specification**	**Example**
Spectrum analyzer	DC to 400 MHz Level accuracy ±1 dB	IFR* 2382
Modulation meter	500 kHz to 1 GHz AM accuracy ±1% of reading Selectable ILS filter	IFR* 2305
Oscilloscope	100 MHz bandwidth	Tektronix 2235

*IFR Ltd was previously known as Marconi Instruments Ltd

Functional testing of ILS waveform generation

Test equipment

Description	Minimum specification	Example
Spectrum analyzer	100 Hz to 400 MHz	IFR 2382
Oscilloscope	100 MHz bandwidth	Tektronix 2235

IFR uses a method of Direct Digital Synthesis (DDS) to generate the ILS waveforms. One DDS generated waveform contains both the 90 Hz tone and the 150 Hz tone with 0% DDM (Difference Depth of Modulation).

A second waveform is generated with 0% DDM but with the relative phase of the 150 Hz tone reversed compared to that of the 90 Hz tone.

When small levels of the second waveform are added to the first, the resultant waveform has a constant SDM and adding a proportion of the second waveform will result in the DDM of the resultant signal changing.

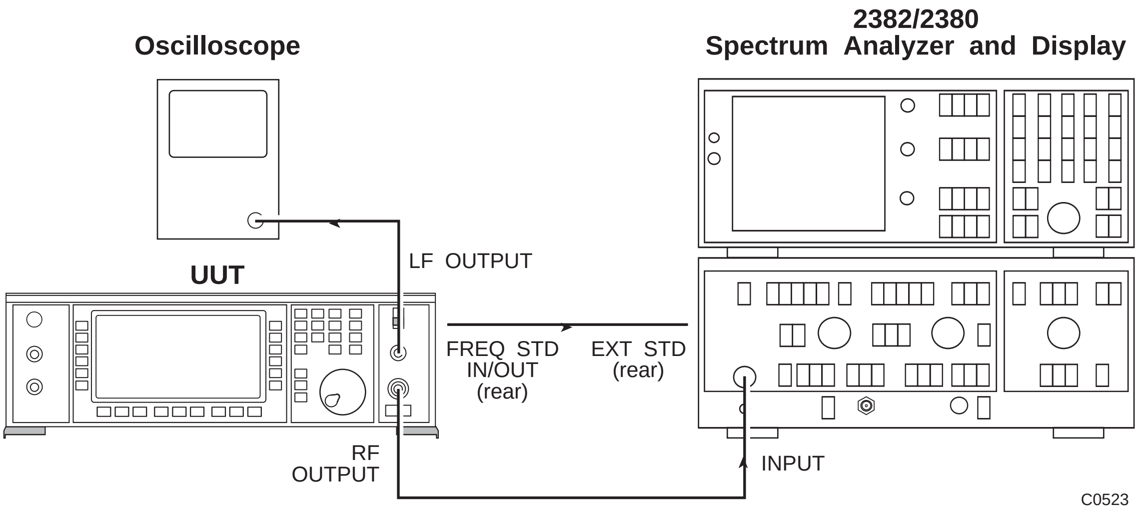

Fig. A-21 ILS functional test set-up

(1) Connect the test equipment as shown in Fig. A-21.

(2) Set up the test equipment as follows:-

Unit under test

ILS mode

Carrier freq	108.1 MHz
RF level	7 dBm
SDM	40 %
ILS rate	30 Hz
DDM	0 %
90 Hz dominant	Fly RT

Oscilloscope

Volts/div	0.2 V
Time base	5 ms/div

Spectrum analyzer

Preset and calibrate	
Reference frequency	108.1 MHz
Reference level	10 dBm
Span/div	50 Hz
Resolution bandwidth	10 Hz

(3) The typical traces on the oscilloscope and the spectrum analyzer are shown in Figs. A-22 and A-23. These traces are for the 90 Hz and the 150 Hz tones' having equal amplitudes (i.e. 0% DDM).

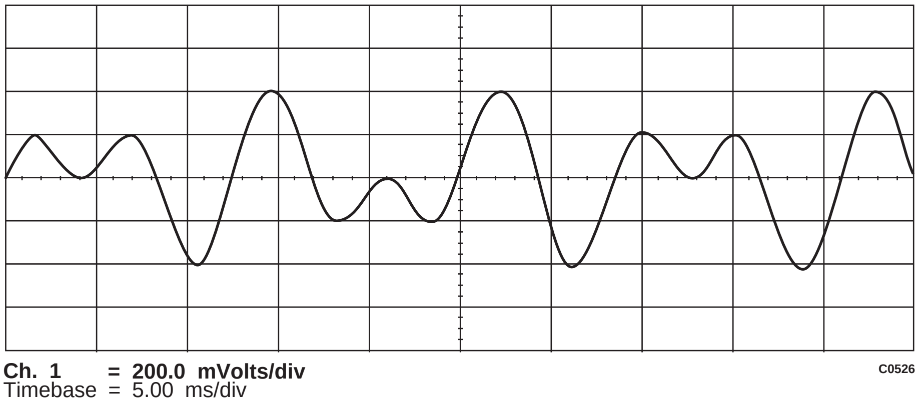

Fig. A-22 Oscilloscope trace for a 0% DDM waveform.

(4) On the UUT reduce the SDM depth using the rotary control. This will cause a reduction in the amplitude of the oscilloscope trace and the sidebands on the spectrum analyzer trace. Reset the SDM to 40%.

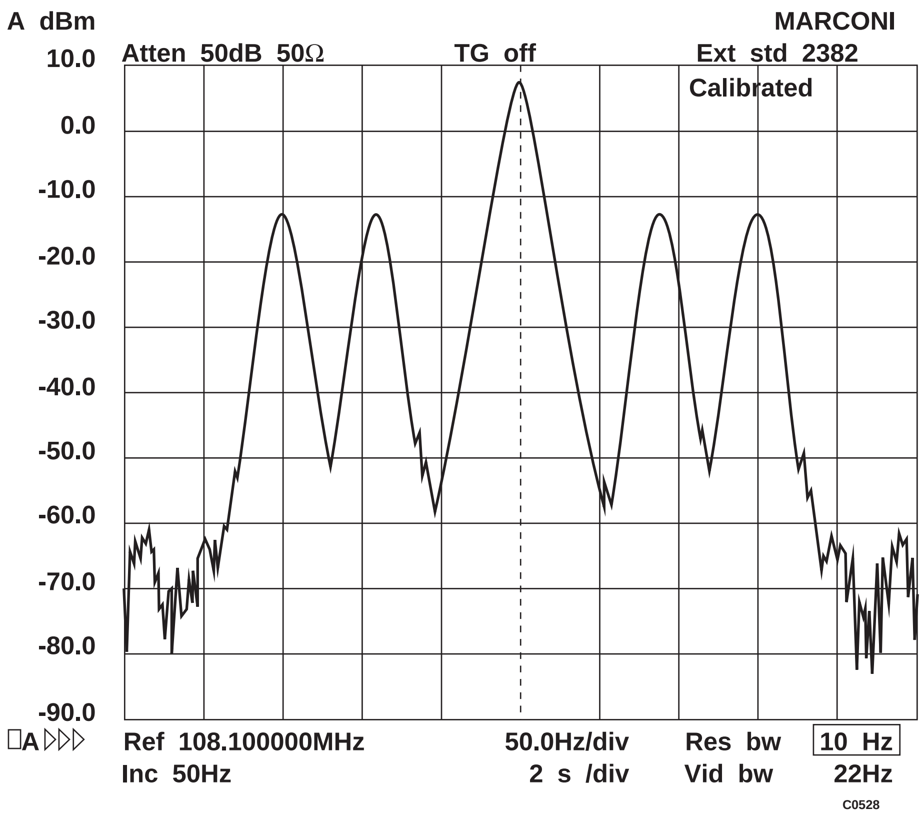

Fig. A-23 Spectrum analyzer trace for a 0% DDM waveform.

(5) On the UUT select DDM. Increase the DDM from 0% to 40% using the knob control. As the change occurs, the 90 Hz sideband should increase and the 150 Hz sideband should decrease. For a signal with a DDM of 40% the 150 Hz sideband will be suppressed as shown in Figs. A-24 (the trace is 2 ms/div) and A-25.

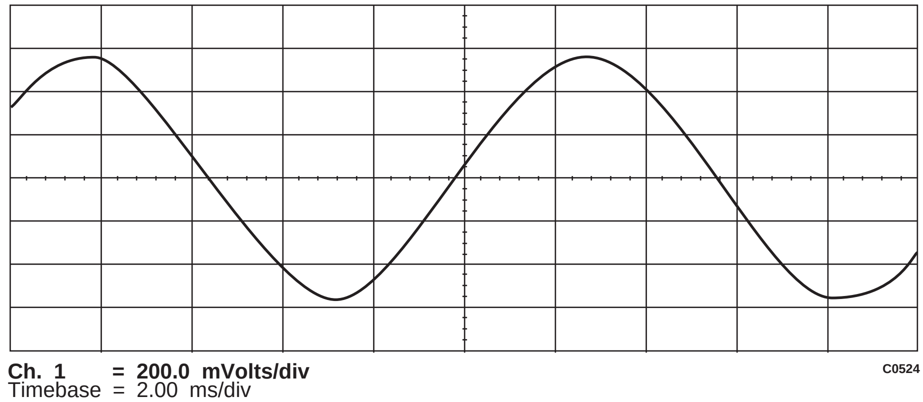

Fig. A-24 Oscilloscope trace for a 40% DDM waveform.

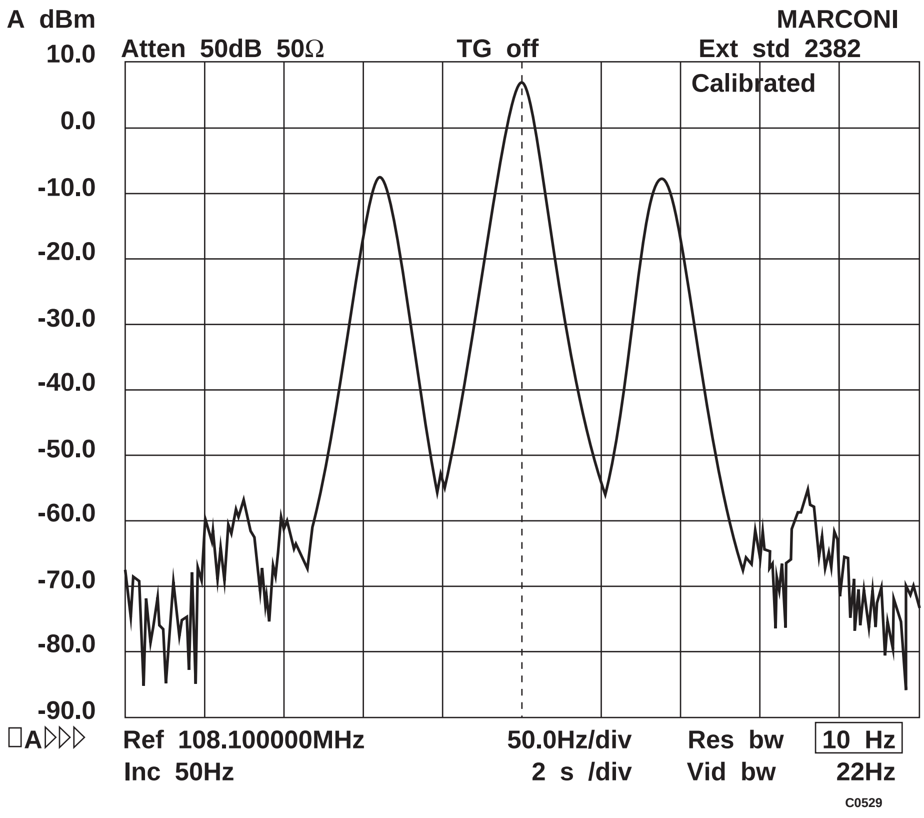

Fig. A-25 Spectrum analyzer trace for a 40% DDM waveform.

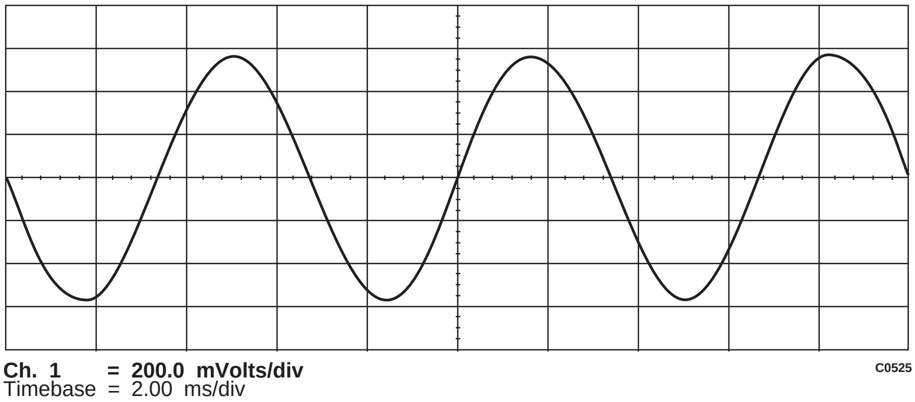

Fig. A-26 Oscilloscope trace for a 150 Hz dominant waveform.

(6) On the UUT select the 150 Hz tone to be dominant. The 90 Hz sideband should be suppressed and the 150 Hz sideband should be present as shown in Figs. A-26 (the trace is 2 ms/div) and A-27.

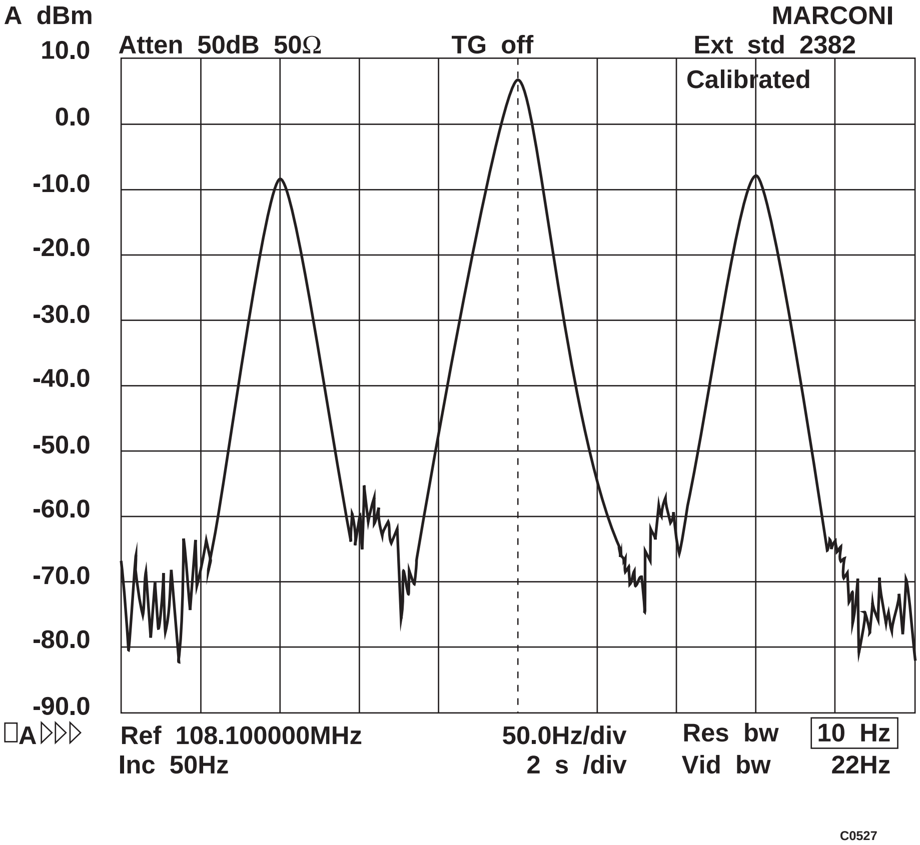

Fig. A-27 Spectrum analyzer trace for a 150 Hz dominant waveform.

Accuracy of SDM (Sum Depth of Modulation) signal path

Specification

±2% of setting for carrier frequencies up to 400 MHz

The signal generator has a 1 dB AM bandwidth from DC to at least 30 kHz and consequently the difference in AM response between 90 Hz and 150 Hz will be small and can be neglected. Because of this, it is possible to test the SDM and the DDM accuracy of the instrument by the use of a single tone modulation at 124 Hz rate (the geometric mean of 90 Hz and 150 Hz).

The 0% DDM signal is generated using the AM 1 channel. The phase shifted signal is generated on the AM 2 channel. The design of the instrument ensures that the AM accuracy of each channel at a fixed frequency is equal to the accuracy of the ILS waveform generated by the instrument.

Test equipment

Description	Minimum specification	Example
Modulation meter*	50 kHz to 1 GHz AM accuracy ±0.5% of reading at 40% depth ±0.7% of reading at 80% depth Selectable ILS filter	IFR 2305

*The SDM and DDM accuracy of the Avionics Option can not be verified with a modulation meter calibrated to its published performance specification. A specially calibrated modulation meter is necessary. If more than an approximate verification is required, consult your local IFR agent or the Service Division for further details.

Fig. A-28 Accuracy of SDM signal path test set-up

(1) Connect the test equipment as shown in Fig. A-28.

(2) Set up the test equipment as follows:-

Unit under test

[UTIL] *[Mod'n Mode] [Composite]*
[SIG GEN]
Carrier freq 108.1 MHz
RF level 7 dBm

[AM]
AM 1 depth 40 %
[Select Source] [Internal F1] 120 Hz sinewave
[SIG GEN]
AM 1 Off

AM 2 depth 0 %
[Select Source] [Select Internal] [Internal F2] 124 Hz sinewave
[SIG GEN]
AM 2 Off

Modulation meter

tune	Autotune
Function	AM
Second function 28	On (see note)

Note

In order to select second function 28 it is first necessary to unlock the 2305 to its 1st level of protection (this is detailed in the operating manual).

Second function 28 selects an ILS filter. This is a 15 kHz low-pass filter selected separately from, and without any accompanying high-pass section. This provides sufficient high frequency bandwidth for the AM ILS signal without admitting an excessive amount of noise. In the left-hand window a 1 selects the filter and a 0 deselects it.

(3) With AM channels 1 and 2 turned off, allow the modulation meter reading to settle, then measure the residual AM noise and note the reading.

Residual AM noise depth ____________%

(4) On the UUT turn the AM 1 channel on. Allow the reading on the modulation meter to settle and note it. (This is equivalent to an SDM of 40 %.)

Measured AM depth ____________%

Actual AM depth = Measured AM depth - Residual AM noise

Set AM	Minimum	Actual	Maximum
40%	39.2%	______%	40.8%

(5) Repeat (4) for an AM 1 depth of 80% (this is equivalent to an SDM of 80%) with the carrier frequency set to 330 MHz.

Set AM	Minimum	Actual	Maximum
80%	78.4%	______%	81.6%

Accuracy of DDM (Difference Depth of Modulation) waveform

Specification

±0.03% of depth ±0.02 of setting

This specification is checked by measuring the modulation channel balance at 19.9% and 40% SDM (with and without final divide-by-5 internal attenuator).

Test equipment

Description	Minimum specification	Example
Spectrum analyzer or FFT analyzer	DC to 25 kHz 3 Hz filter	IFR 2382

(1) Connect the test equipment as shown in Fig. A-29.

(2) Set up the test equipment as follows:-

Unit under test

ILS mode

Carrier freq	108.1 MHz
LF output	Monitor AM drive
SDM	40%
DDM	0%
Dominant tone	90 Hz

Spectrum analyzer

Span/div	20 Hz
Frequency	0 to 200 Hz
Ref level	20 dBm
Resolution bandwidth	3 Hz
Input	DC coupled

The spectrum analyzer should display equal amplitude tones of 90 Hz and 150 Hz.

(3) Reset the test equipment as follows:

Unit under test

DDM	40%

The 150 Hz tone should now be suppressed. Check that the residual level is at least 52 dB lower than the 90 Hz tone.

(4) Reset the test equipment as follows:

Unit under test

SDM	19.9%
DDM	19.9%

The 150 Hz tone should still be suppressed. Check that the residual level is at least 52 dB lower then the 90 Hz tone.

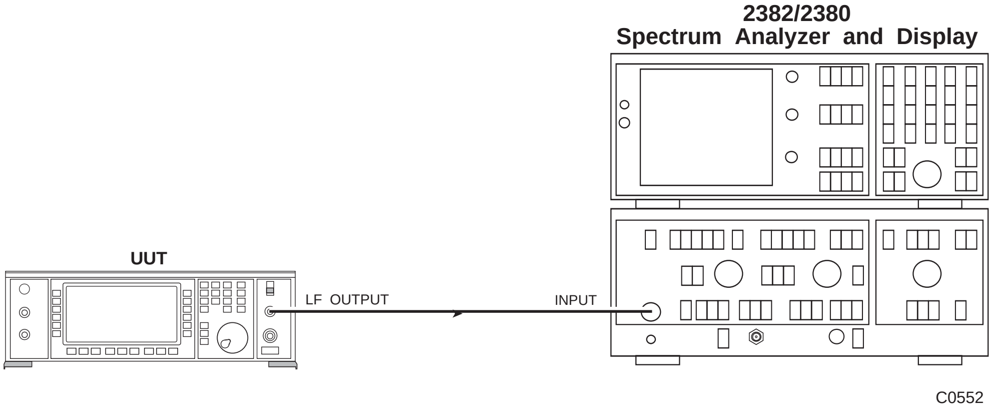

Fig. A-29 Equipment configuration for DDM waveform accuracy

VOR waveform depth accuracy

SPECIFICATION

±3% of setting ±0.5% for carrier frequencies up to 400 MHz

Test equipment

Description	Minimum specification	Example
Modulation meter	Freq range to 400 MHz AM accuracy ±1% of reading Selectable ILS filter	IFR 2305

(1) Connect the test equipment as shown in Fig. A-28.

(2) Set up the test equipment as follows:-

Unit under test

VOR mode

Carrier freq	108 MHz
RF level	7 dBm
SUB depth	0 %
REF depth	0 %

Modulation meter

Freq tune	108 MHz
Function	AM
Second function 28	On

(3) With SUB and REF set to 0% measure the residual AM noise. Note the reading.

Residual AM noise depth ____________%

(4) On the UUT select a SUB depth of 30% and a REF depth of 0%. Allow the reading on the modulation meter to settle and note it.

Measured AM depth ____________%

Actual SDM = Measured AM depth - Residual AM noise

Minimum	Actual	Maximum
28.60%	______%	31.40%

Ensure that the measured depth is in specification.

(5) Repeat (4) for a SUB depth of 0% and a REF depth of 30%.

Minimum	Actual	Maximum
28.60%	______%	31.40%

(6) Repeat (4) for a SUB depth of 30% and a REF depth of 30%).

Minimum	Actual	Maximum
57.70	______%	62.30%

VOR waveform test

Test equipment

Description	Minimum specification	Example
Spectrum analyzer or FFT analyzer	DC to 25 kHz 3 Hz filter	IFR 2382

(1) Connect the test equipment as shown in Fig. A-29.

(2) Set up the test equipment as follows:

Unit under test

VOR mode

SUB depth	30%
REF depth	30%

Spectrum analyzer

Span/div	200 Hz
Ref freq	9.96 kHz
Ref level	10 dBm
Bandwidth	30 Hz

(3) Check that a display similar to that shown in Fig. A-30 is obtained. This shows the presence of the 9.96 kHz sub-carrier with 30 Hz rate, 480 Hz deviation frequency modulation present.

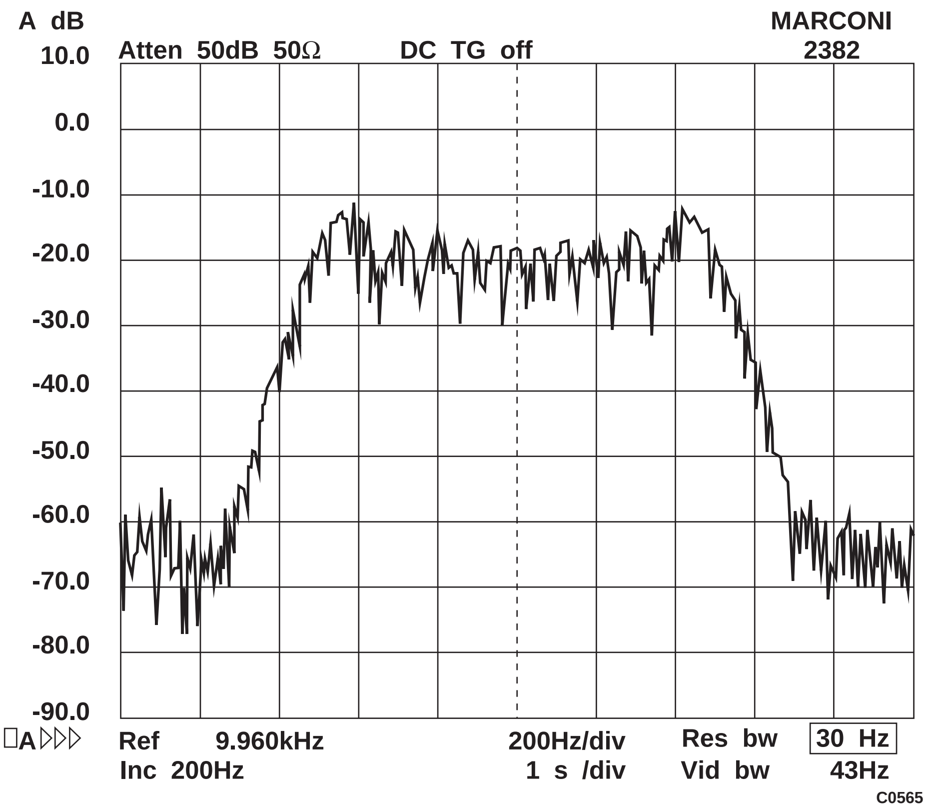

Fig. A-30 9.96 kHz sub-carrier with frequency modulation

Waveform phase control

This test is a functional test of the phase control system used on the DDS sources. The two sources are set to the same frequency and their outputs are summed together. As the relative phase of the source is changed the resulting signal amplitude will change.

Test equipment

Description	Minimum specification	Example
Oscilloscope	100 MHz bandwidth	Textronix 2235

(1) Connect the test equipment as shown in Fig. A-31.

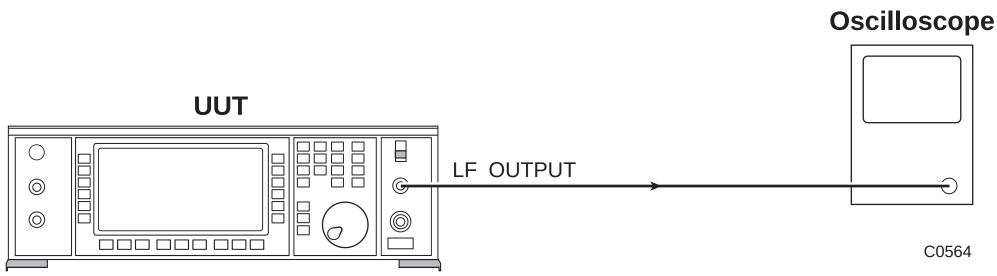

Fig. A-31 Waveform phase control test set-up

(2) Set up the test equipment as follows:

Unit under test

[UTIL] *[Mod'n Mode] [Composite]*
[SIG GEN]

LF output	Modulation monitor
Modulation drive	
AM1	30% ON
AM2	30 % ON
INT F1	30 Hz
INT F2	30 Hz
Set AM1 source to INT F1	

Set AM2 source to INT F2

Oscilloscope

Set to monitor LF OUTPUT waveform .

(3) On the UUT select the *Internal Source Selection Menu* and press the *[Mod. Src Phase]* key. Enter a phase of 0° (to beacon).

Check that the LF OUTPUT is approximately 1.69 V pk-pk.

(4) Enter a phase of 180°. Check that the output tone is substantially suppressed to a level less than 80 mV pk-pk.

(5) Enter a phase of 90° and check that the output tone is approximately 1.2 V pk-pk.

(6) Enter a phase of 270° and check that the output tone has the same amplitude as in (5) above.

Annex B
OPTION 008 RF PROFILES AND COMPLEX SWEEP

Contents

List of figures

Performance data

General description

Option 008 software provides additional sweep, RF offset and RF level profiling facilities to support the use of 2050T series Signal Generators with external amplifiers and attenuators. The RF output from the external device can be calibrated and displayed on the front panel of the signal generator using the RF offset and RF profile facilities.

The following specification is in addition to the specification for the 2050T series Signal Generators.

RF offsets	The displayed signal generator output level can be offset by +80 dB to -40 dB (in 0.1 dB steps) from the actual RF output level. Up to 5 offset values may be defined and selected in turn. RF offsets can be enabled and disabled and their value and status stored in non-volatile memory. RF offsets may be used in normal signal generator modes or combined with the segmented sweep facility.
RF profile	The actual RF output level can be adjusted by ±40 dB from its nominal value without changing the displayed level. Up to 10 profiles may be defined and selected in turn. RF profiles can be enabled and disabled and all RF profile information can be stored in non-volatile memory. Profile values can be entered at up to 100 carrier frequencies. The RF output level is linearly interpolated between profile points. RF profiles may be used in normal signal generator modes or combined with the segmented sweep facility to produce complex sweeps.
Segmented sweep	Carrier frequency sweeps can be generated which contain defined segments each of which can have a different step size, start and stop frequency, step time and RF level.
Start and stop	Start and stop frequency for each segment can be freely defined within the frequency capability of the signal generator.
Step size	Minimum step size is 0.1 Hz. Maximum step size is determined by the frequency capability of the signal generator. Number of steps for a particular segment is implied by the step size and the start and stop frequencies.
Step time	20 ms to 20 s per step.
RF level	The RF level for each segment can be freely defined within the output level capability of the signal generator.
Segments	Up to 10 segments may be defined and freely combined in any order to produce a segmented sweep. Segmented sweeps can be stored in non-volatile memory by using the sweep stores (0 to 19).
Modulation waveforms	Sine, triangle or square wave modulation is available to provide amplitude, phase or frequency modulation.

Introduction to Option 008

This section describes how to use the additional software features provided when Option 008 RF profile and complex sweep is fitted to a 2050T series Signal Generator. Familiarity with normal operation of the signal generator is assumed.

Option 008 provides two principle facilities. The RF offset facility enables the user to effectively display the RF output level when the signal generator is connected to an external device, such as an attenuator or an amplifier. If the external device gain or loss is frequency dependent then the signal generator can substantially eliminate the frequency dependence using RF profiles.

The segmented sweep facility allows for the generation of sweeps where the sweep is split into segments which can have independent start, stop, step size, step time and RF levels. The complex sweeps are generated using the segmented sweep mode and can be used in combination with the RF profile and RF offset facility. This is particularly useful for electromagnetic immunity and Tempest testing.

Complex sweeps can be generated by combining the RF offset, RF profile and segmented sweep facilities.

RF offset and profiles

These facilities provide the capability for setting the signal generator to display the RF power at the output of a device connected to the signal generator. The RF offset facility is used to compensate for the nominal gain (or loss) of the external device. Adding an offset value does not change the RF output level of the signal generator but does change the displayed RF output level. If, for example, the signal generator is connected to a 20 dB amplifier the offset value can be set to +20 dB. If the signal generator output level is set to +20 dBm then +20 dBm is displayed but the actual signal generator output level will be 0 dBm.

The RF profile facility allows the output level to be corrected to allow for frequency dependent gain (or loss) errors. If, for example, the gain of the amplifier at 100 MHz is 20 dB, at 150 MHz it is 19 dB and at 200 MHz it is 19.5 dB the RF profile facility can introduce 0 dB, 1 dB and 0.5 dB level compensation at 100 MHz, 150 MHz and 200 MHz respectively to compensate for the frequency/gain errors. The RF level profile is linearly interpolated between these frequencies to minimise level errors at intermediate frequencies.
The profile values do not change the displayed RF level but do change the RF output level of the signal generator.

Access to RF offset and profile

The RF offsets and profiles are initially accessed via the Utilities Selection Menu 2. To obtain this menu, press [UTIL]. If *Utilities Selection Menu 1* is displayed, press the *[Utils. Menu 2]* key. The required display is shown in Fig. B-1.

Note

If the utility facility has already been previously accessed it may be necessary to press the [UTIL] key a second time and then select *[Utils. Menu 2]*.

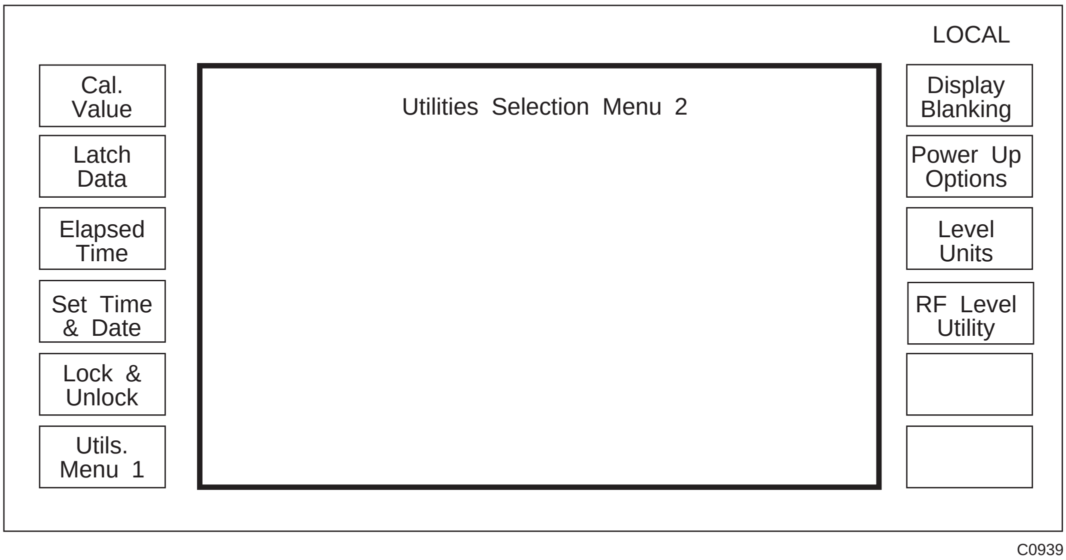

Fig. B-1 Utilities selection menu 2

Press *[RF Level Utility]* to obtain the display shown in Fig. B-2. The *[Offsets]* or *[Profiles]* key can now be selected as required.

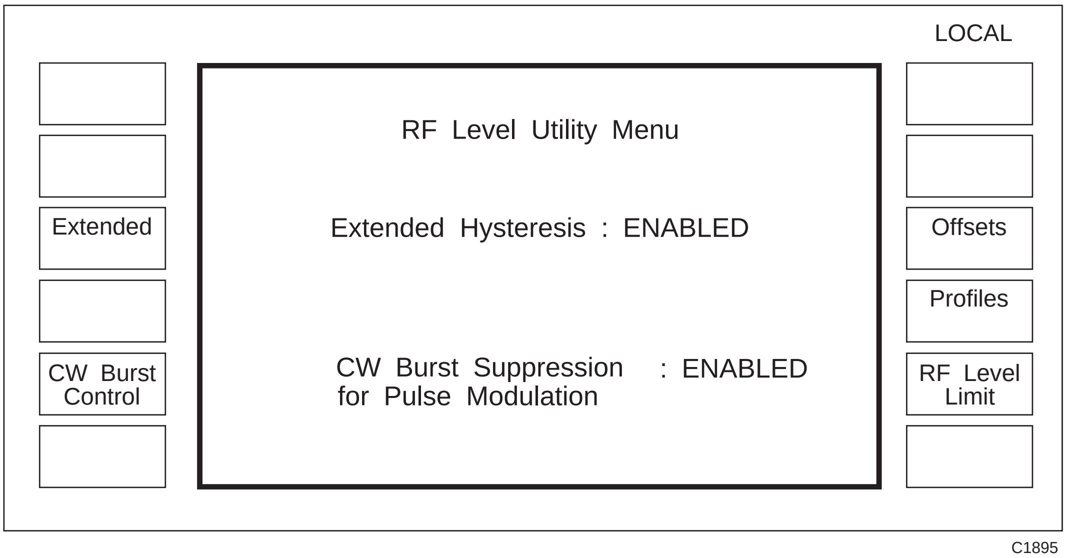

Fig. B-2 RF level utility menu ([CW Burst Control] and associated text only appear when the relevant optio n is fitted)

RF offset

Selecting the *[Offsets]* key will result in a display similar to that shown in Fig. B-3. But note that the *[Save Setting*] key will only appear if the instrument has been unlocked to Level 1.

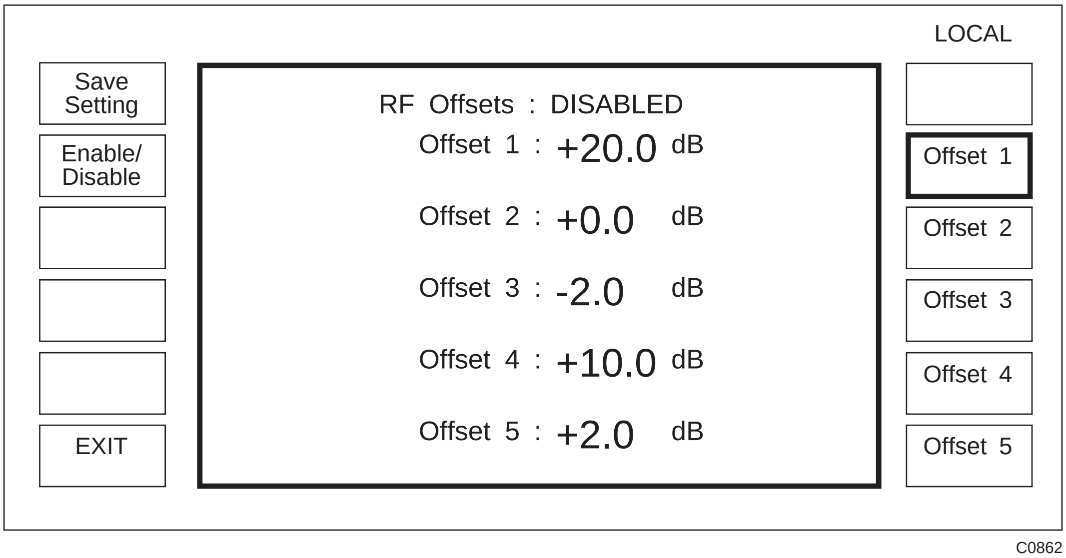

Fig. B-3 RF offset selection (shown unlocked to Level 1)

Selecting one of the *[Offset]* keys will allow an offset of up to +80 dB to -40 dB to be entered using the numerical key pad and the [dB] terminator key. Any of the five offset values may be selected by pressing the appropriate soft key.

The offset values can be changed at any time. The set of values displayed when the instrument is first switched on can also be changed by the user. The generator should be unlocked to Level 1 so that the *[Save Setting*] key is displayed If the offset values are then changed to the required power up settings and the *[Save Setting*] key is pressed the values are stored in non-volatile memory. If the instrument is switched off then when power is restored the saved values of offsets will be automatically recalled and displayed. If the offset values are edited but not saved the edited values will be lost when the instrument is switched off.

The offset facility can be enabled or disabled using the *[Enable/Disable]* key. The state of the Enable/Disable function is stored in non-volatile memory if the *[Save Setting*] key is pressed. If the instrument power is turned off and then on, the stored condition of the Enable/Disable function is recalled.

The RF offset facility can be left by pressing *[EXIT]* to obtain the *RF Level Utility Menu* of Fig. B-2, or by pressing any of the keys underneath the display. If the offset facility is enabled and [SIG GEN] is pressed the main signal generator screen shown in Fig. B-4 is displayed. The display shows that in this example the RF offset facility is enabled and the value of the offset in use is +20 dB. For the set RF level of 0 dBm the signal generator output will be -20 dBm.

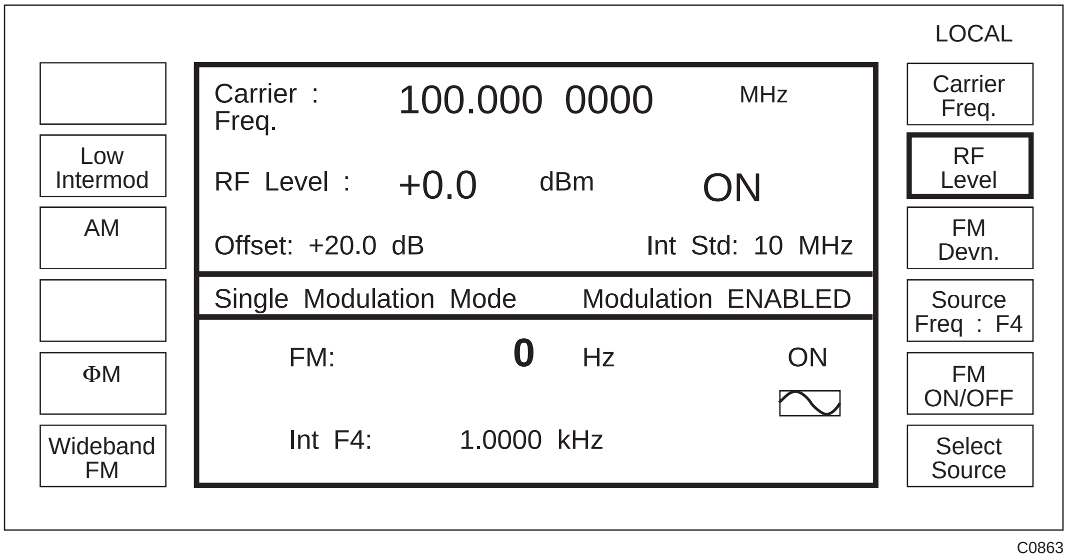

Fig. B-4 Main signal generator screen with RF offset enabled

RF profiles

If the *[Profiles]* key is selected from the menu shown in Fig. B-2 the display shown in Fig. B-5 is displayed. But note that the *[Save Setting]* and *[Edit Profile]* keys will only appear if the instrument is unlocked to Level 1.

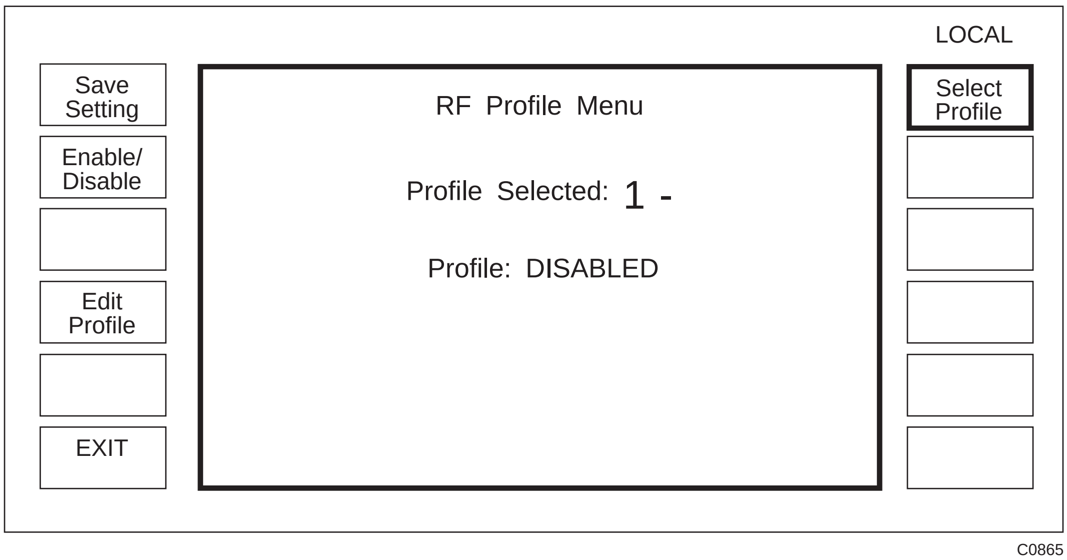

Fig. B-5 RF profile menu (shown unlocked to Level 1)

Up to 10 profiles may be generated and stored using this facility. The profiles are identified as Profile 0 to Profile 9. Each profile can have up to 100 frequencies at which the output level of the signal generator can be adjusted by up to ±40 dB to compensate for the frequency response of an external device without altering the displayed RF level of the signal generator.

Creating a profile

An RF profile editor is provided to create or edit profiles. The instrument must be unlocked to Level 1 in order to use the editor. To use the profile editor press the *[Edit Profile]* key to give the display shown in Fig. B-6.

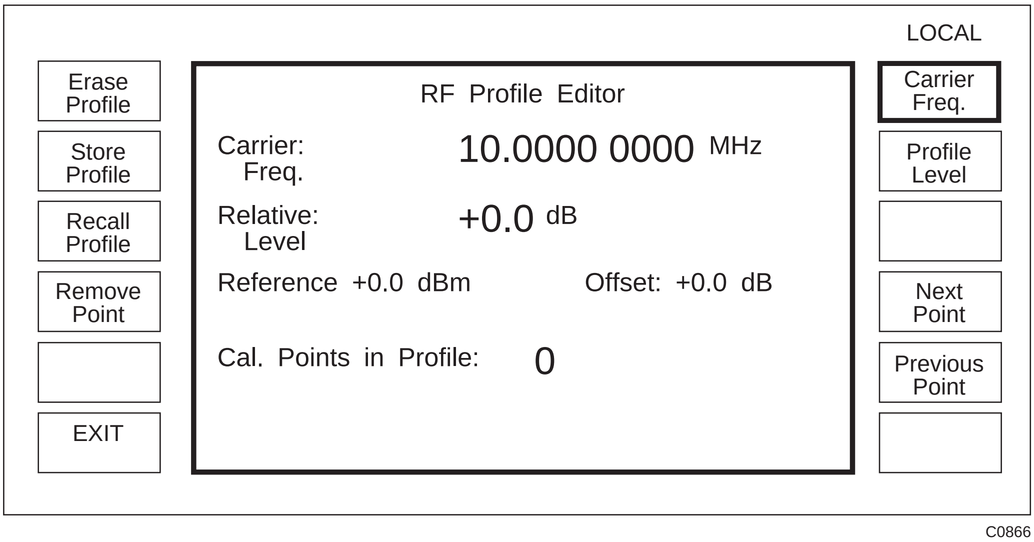

Fig. B-6 RF profile editor menu

The RF offset will only be displayed if an offset value has been selected and enabled. The signal generator's RF level setting is displayed as the reference level.

If the user wishes to edit an existing profile, pressing *[Recall Profile]* followed by the profile number (0 to 9) and the [enter] key will recall a profile into the editor. A profile can be erased by pressing *[Erase Profile]* followed by the profile number (0 to 9) and the [enter] key.

Profiles are constructed by entering the carrier frequency at which a correction is to be applied and then adjusting the RF output level until the required setting is obtained. The relative level shows how much the RF level has been adjusted from its nominal value. A positive value of relative level increases the RF output level.

To construct a profile first select the required carrier frequency using the *[Carrier Freq.]* key. The relative level at that frequency can then be adjusted by pressing *[Profile Level]*. The carrier frequency or profile level can be entered using the keyboard or the rotary control.

When the required value of level has been set up the point is saved using the *[Save Point]* key which appears in place of the *[Remove Point]* key. The *Cal Points in Profile* display shows how many points form the profile (a profile can have up to 100 points).

When a profile has been constructed (or is being entered) the points can be inspected by using the *[Next Point]* or *[Previous Point]* keys. To make the user aware that a limit has been reached i.e. the first or last point in a profile, the message *At Top Limit* or *At Bottom Limit* is displayed at the top of the screen. Points can be deleted using the *[Remove Point]* key. When *[Remove Point]* has been pressed, an additional key *[Restore Point]* appears. This allows a point which has been accidentally removed to be reinserted.

Points can be added to the profile in any frequency order so that if, for instance, it is found necessary to add a point between two existing points, then when the point is saved the software automatically re-orders the points into an ascending frequency order, and provides interpolation between these points.

Hint:

The rotary control provides a very useful means of editing or creating a profile. If the control is used to adjust carrier frequency while the power at a remote point is monitored, the control gives a good feel for where points should be inserted. The interpolation of the correction data between frequencies results in the most useful location for correction points to be either at or at either side of maximum or minimum values of power.

Note

If a profile point is added at the same frequency as an existing point in that profile, the old profile level will be automatically overwritten by the new value.

Once two or more points have been entered in a profile the profile can be stored by pressing the [Store Profile] key followed by the profile number (0 to 9) and the [enter] key.

Enabling a profile

To enable or disable a profile first use the *[Select Profile]* key shown in Fig. B-5 and enter the profile number (0 to 9) to be used and terminate the entry using the [enter] key.

The *[Enable/Disable]* key can then be used to enable or disable the profile.

The profile facility can be set to be on or off when an instrument is switched on using the save setting facility. If the generator is unlocked to Level 1 pressing the *[Save Setting]* key on the *RF Profile Menu* of Fig. B-5 will result in the state of profile enable/disable flag and the selected profile number being stored in non-volatile memory. If the profile is enabled then at power on the generator will recall the profile and apply it to the RF output.

The *RF Profile Menu* can be left by using the *[EXIT]* key to obtain the *RF Level Utility Menu* of Fig. B-2 or by using the keys underneath the display. If the [SIG GEN] key is pressed to obtain the main signal generator screen, and the profile facility is enabled, the profile selected is displayed as shown in Fig. B-7. The correction value corresponding to the selected carrier frequency will be applied to the RF level.

Note

Where the carrier frequency is set to a value less then the lowest profile frequency the value at the lowest profile will be used. Similarly if the set carrier frequency is higher than the highest profile frequency the value of the highest profile value will be used.

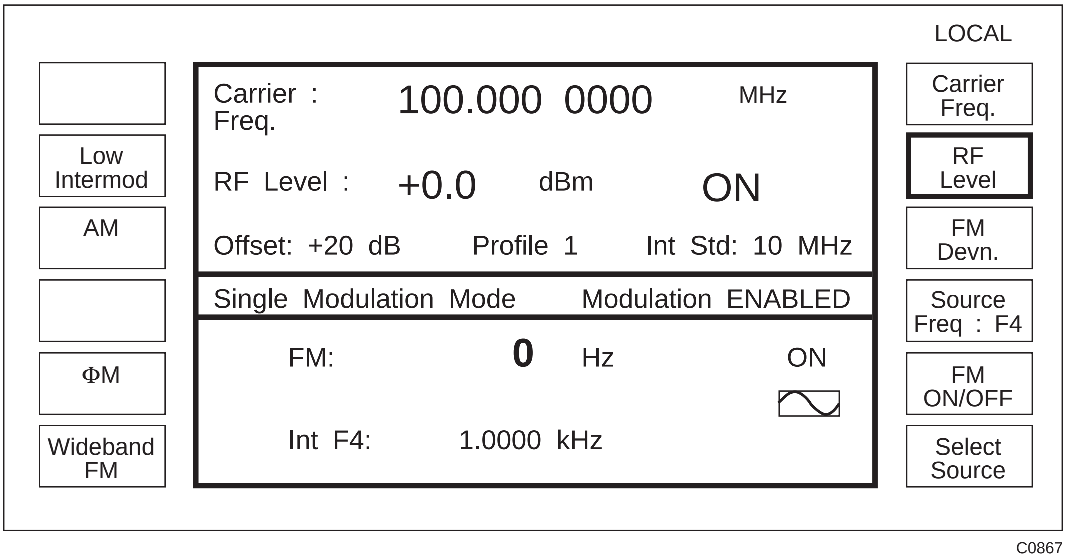

Fig. B-7 Main signal generator screen with RF offset and profiles enabled

Tutorial examples for RF offset and profiles

Example 1: RF offset - compensating for a combiner

Problem:

An application requires the addition of two RF signals with a combiner as shown in Fig. B-8. The combiner has 6 dB insertion loss and it is desirable for the signal generators to display the signal level after the combiner.

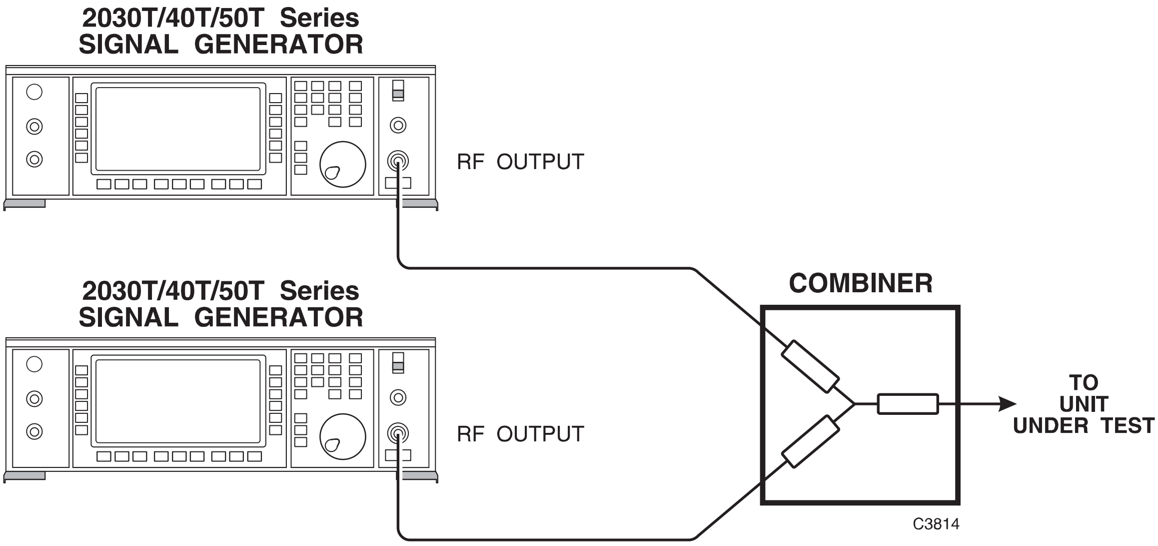

Fig. B-8 Two signal generator testing with a resistive combiner

Solution:

Use the RF offset facility. Set the RF output level (for example to +6 dBm). Then set *Offset 1* (see Fig. B-3) to -6 dB and enable the offset. The signal generators provide outputs of +6 dBm to compensate for the signal loss of the combiner whilst now displaying the signal level after the combiner (in the example 0 dBm) as required.

Note that the maximum displayed RF level will now be limited to +7 dBm since this represents +13 dBm at the RF output connector (unless the overrange facility is enabled).

If the save setting facility is used (Fig. B-3) the generator can be set so that every time it is switched on a -6 dB offset is applied.

Example 2: RF offset and profiles - compensating for an amplifier

Problem:

The signal generator is being used with an external amplifier having a nominal gain of 28 dB. The generator is being used over the frequency range 100 MHz to 500 MHz. Amplifier frequency response and cable losses result in the overall gain of the amplifier system varying between 25 dB and 31 dB. The signal generator is required to display the power at the output of the amplifier.

Solution:

Use both RF offset and RF profile. First use the RF offset facility to enter an offset value of 28 dB (i.e. the mid-point of 25 and 31 dB). Connect a power meter to the amplifier as shown in Fig. B-9 after making sure that the amplifier output is at a level which will not damage the power meter.

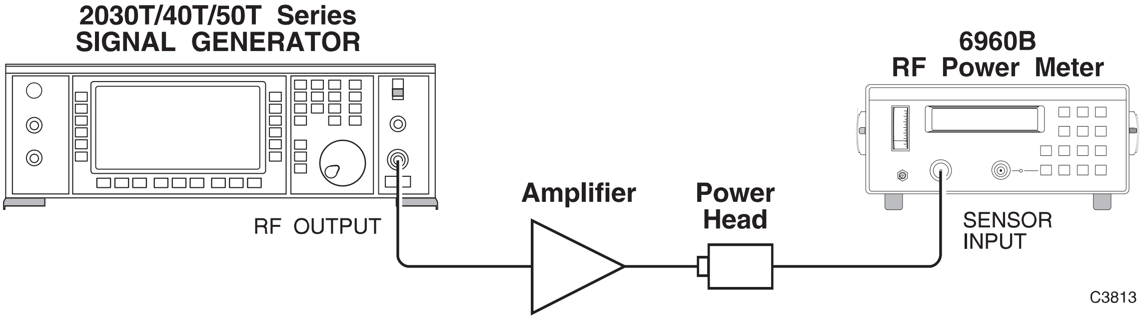

Fig. B-9 Using a signal generator with an external amplifier

A profile can now be added to reduce the frequency dependent RF level errors. With the signal generator level set at (for example) 0 dBm and unlocked to Level 1, select the *RF Profile Editor* shown in Fig. B-6.

Enter a carrier frequency of 100 MHz. Adjust the *Profile Level* until the power meter reads 0 dBm and then save the point. Repeat for carrier frequencies of 150 MHz, 200 MHz, 250 MHz, 300 MHz, 350 MHz, 400 MHz, 450 MHz and 500 MHz. The profile will now have 9 calibration points entered.

Use the *[Store Profile]* key to store as Profile 0. Exit to the *RF Profile Menu* and select and enable Profile 0.

Press the [SIG GEN] key to obtain the main Sig Gen menu. Use the rotary control to vary the carrier frequency between 100 MHz and 500 MHz and check that the power meter reading is acceptably close to 0 dBm. Extra points can be added to the profile if required to reduce errors at intermediate frequencies.

Note

If the carrier frequency is set (in this example) below 100 MHz or above 500 MHz the error message *Carrier Outside Profile* will be displayed. The profile value at 100 MHz will be applied to the RF output level for frequencies below 100 MHz. Similarly the profile value at 500 MHz will be applied to the RF output level for frequencies above 500 MHz.

Sequence sweep

The sequence sweep facility allows sweeps to be defined and generated containing up to 10 segments with independent parameters.

The sweep segments differ from the normal sweep facility on 2050T Series Signal Generators in that the step size is defined rather than the number of steps in a sweep. Each sweep segment can have a different RF level, step size and step time as well as independent start and stop frequencies. A sweep similar to that shown in Fig. B-10 can therefore be generated.

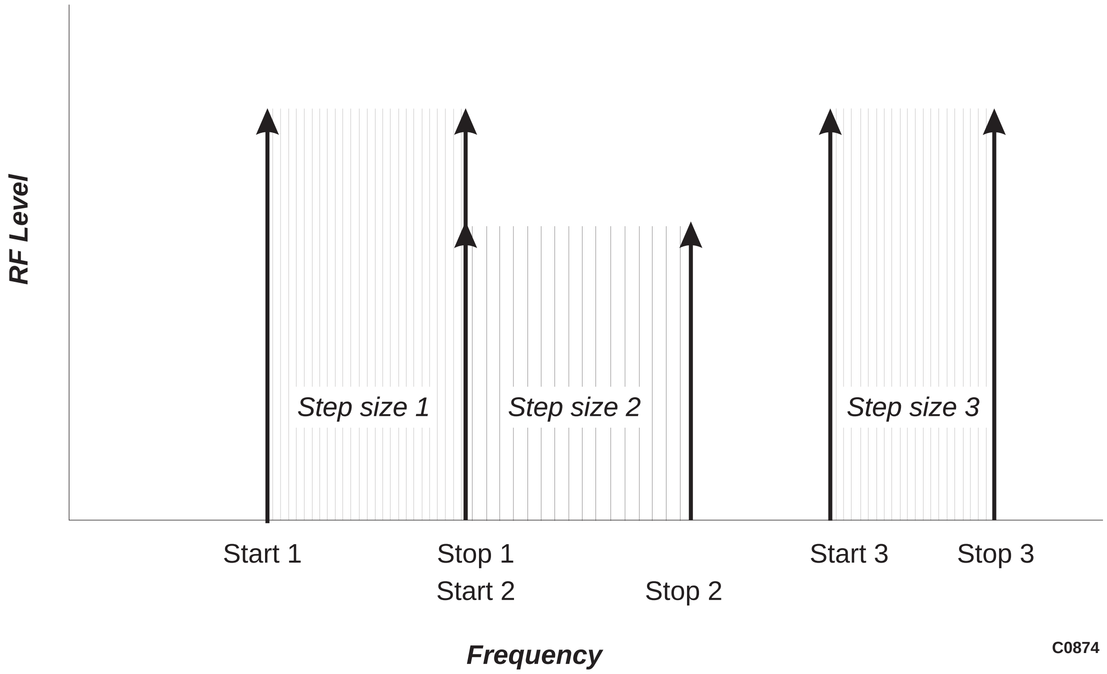

Fig. B-10 Example for a segmented sweep

The segments can be executed in any order. The RF Profile and RF Offset facility can be enabled to correct for the use of external amplifiers and cables.

Selecting a sequence sweep

To enter the Sequence Sweep mode press the [SWEEP] key to obtain the main sweep generator menu. If the last used sweep is not a sequenced sweep press [Sweep Type] to obtain the display shown in Fig. B-11, press [Sweep Sequence] and use the [EXIT] or [SWEEP] key to return to the Sweep Sequence selection menu shown in Fig. B-12.

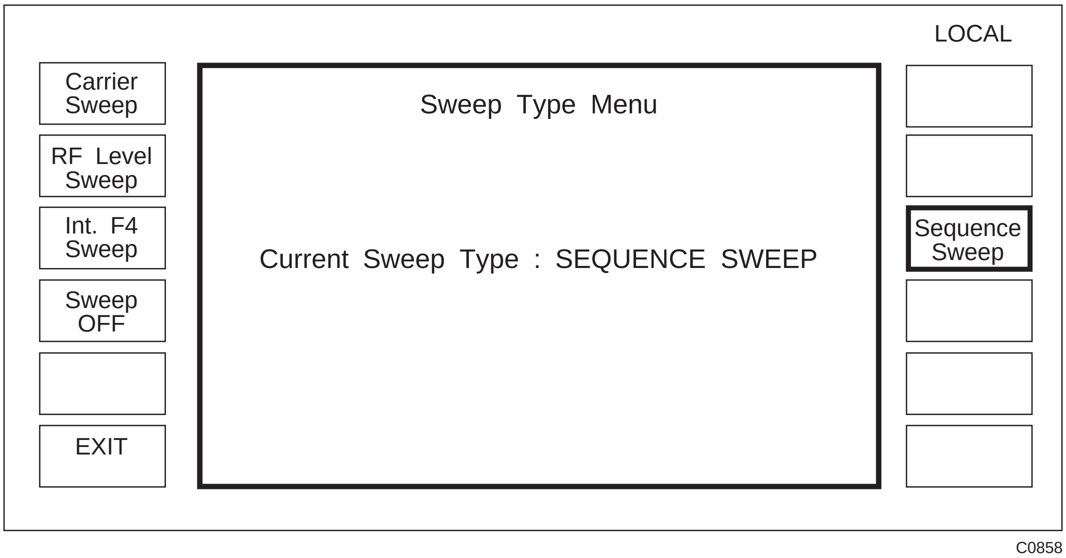

Fig. B-11 Sweep type menu

Note

RF profiles cannot be applied to the normal carrier sweep provided on the generator. If RF profiles are enabled the *[Carrier Sweep]* key in Fig. B-11 will not be displayed.

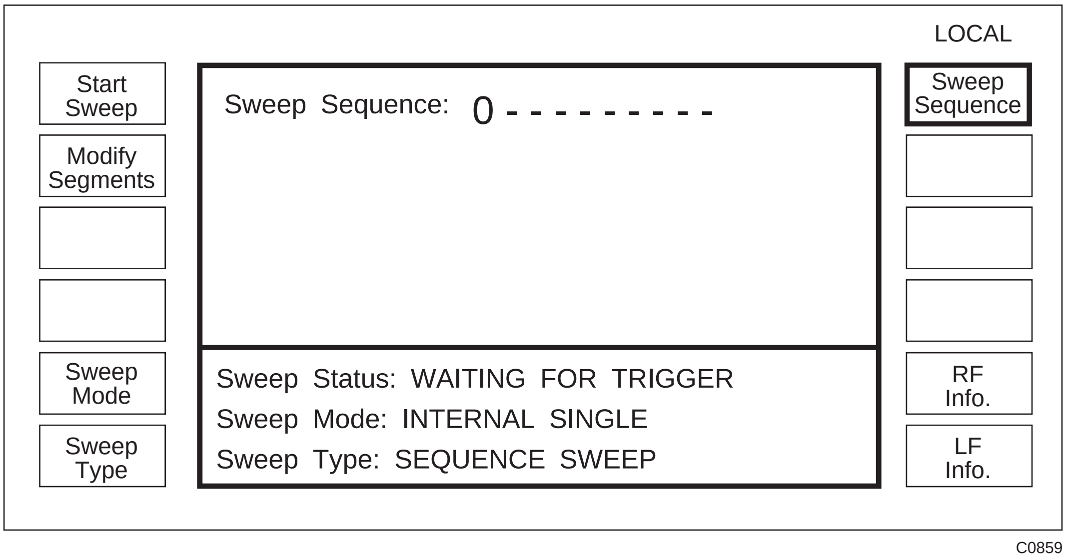

Fig. B-12 Sweep sequence selection menu

Modifying segments

Sequenced sweeps are defined by a series of segments each of which has independent settings. The segments can be constructed from the menu shown in Fig. B-13 called up by pressing the *[Modify Segments*] key.

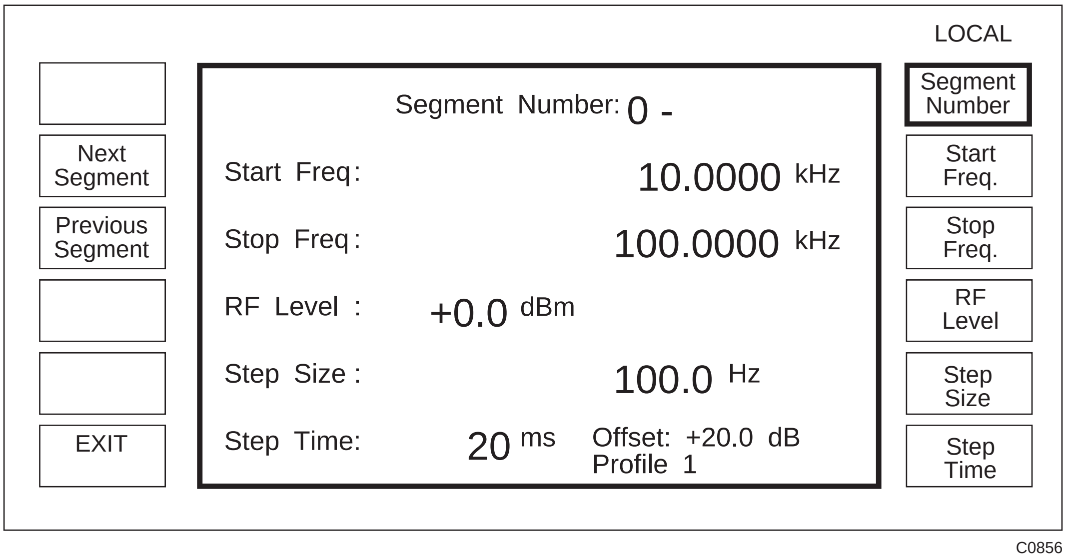

Fig. B-13 Sweep segment editor

Up to 10 segments can be defined as Segments 0 to 9. If an existing segment is to be inspected (or a segment similar to an existing one is required) the segment can be recalled by pressing *[Segment Number*] followed by the segment number (0 to 9) and the [enter] key. Pressing *[Next Segment*] or *[Previous Segment*] will increment or decrement through the segments. For each segment the *[Start Freq.*], *[Stop Freq.*], *[RF Level*], *[Step Size*] and *[Step Time*] keys can be used to define the segment parameters.

Once the user has defined the required segments in a sweep pressing the *[EXIT]* key returns the user to the *Sweep Sequence Selection Menu* shown in Fig. B-12.

Note

The segment settings are not automatically stored in the non-volatile memory. To store the settings press the [MEM] key. If the memory recall menu is displayed press *[Memory Store]*. Press *[Sweep Store]* followed by the sweep store number (0 to 19) and the [enter] key.

Entering a sweep sequence

From the sweep menu in Fig. B-12 a sweep sequence can be defined by pressing *[Sweep Sequence*] followed by the segment numbers (0 to 9) in the order that they are required to be generated. A minimum of one and a maximum of 10 segments is allowed.

Sweep mode

The [Sweep Mode] key can be used to set the sweep to be externally or internally triggered and to be in continuous or single shot mode.

Note

This is identical to the trigger system used in the other sweep modes.

Starting to sweep

To start a sweep press the [Start Sweep] key on the Sweep Sequence selection menu (Fig. B-12). The signal generator will start sweeping and display the current frequency, RF level, step time and the segment number it is currently in. If the sweep has been set to go through a number of segments at different levels the display is updated to show the change of setting.

Before the start of a sweep the RF or LF settings of the generator can be inspected by pressing the *[RF Info*.] or *[LF Info*.] keys.

When a sweep is in progress the sweep can be stopped at any point using the *[Stop Sweep*] key and a display similar to Fig. B-14 will be shown. The carrier frequency and RF level can be varied by using the rotary control.

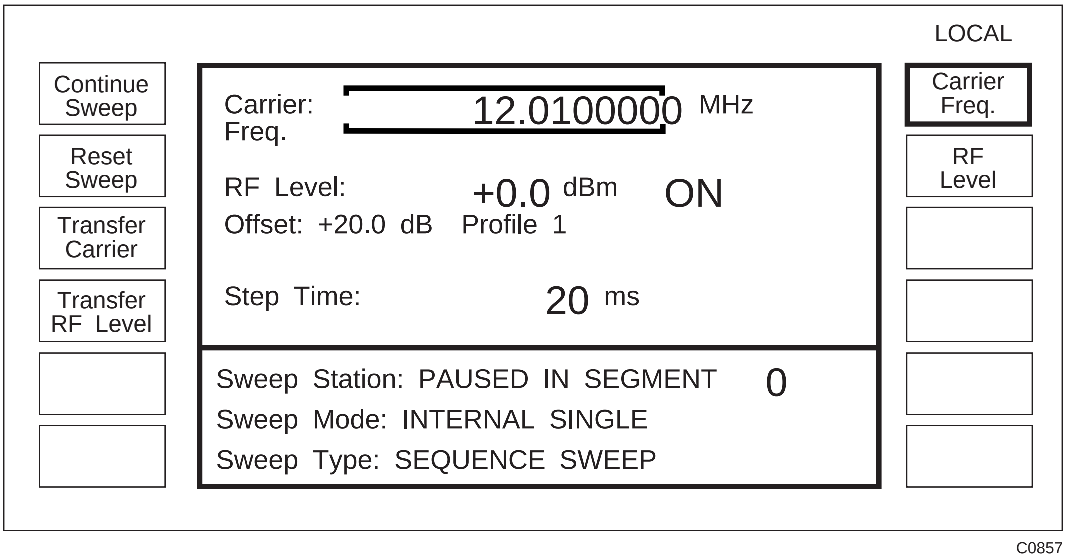

Fig. B-14 Sweep menu display with the sweep halted

Pressing *[Continue Sweep*] will result in the sweep restarting from the same frequency and level as it was stopped at.

Pressing *[Reset Sweep*] will return the sweep to the starting point.

Pressing *[Transfer Carrier*] and/or *[Transfer RF Level]* will transfer the current setting to the main signal generator carrier and RF level settings (obtained by pressing [SIG GEN]).

Tutorial examples for sequence sweep

Example 1: System immunity test

Problem:

A digitally stepped signal is required to test the immunity of a system to RF signals applied at harmonics of the internal clock frequencies of a unit under test. The test requires that the first 20 harmonics are checked and that the signal is swept 10 kHz either side of the nominal clock frequency. The unit under test contains clock frequencies of 8 MHz (for the microprocessor) and 10 MHz.

Solution:

Set the signal generator to provide a frequency modulated signal from the internal triangle source at a rate of 20 Hz and a deviation of 10 kHz.

Use the segmented sweep facility to set up Segment Number 0 to start at 8 MHz with a step size of 8 MHz, a step time of 100 ms and a stop frequency of 160 MHz.

Set up Segment Number 1 to start at 10 MHz with a step size of 10 MHz, a step time of 100 ms and a stop frequency of 200 MHz.

Create a sequence sweep using Segment Number 0 and Segment Number 1. Set the sweep trigger to continuous.

If the sweep is now started it will generate a stepped sweep alternating between harmonics of the 8 MHz and 10 MHz clock and the FM signal will sweep the frequency over a range of ±10 kHz. The FM signal will nominally sweep linearly over the 10 kHz range twice in each direction on each step since the modulation rate is 20 Hz and the step time is 100 ms.

Example 2: Blocking performance test

A radio is being tested for blocking performance. The radio is tuned to 356.55 MHz and uses 12.5 kHz channel spacing. A sweep is required which extends from 10 MHz below the wanted channel to 10 MHz above the wanted channel but excludes the adjacent and next adjacent channels. The RF level is required to be set to -37 dBm during the sweep.

Solution:

Set Segment Number 0 to start at 346.55 MHz, stop at 356.5125 MHz with a step size of 12.5 kHz and a step time to 100 ms to allow enough time for the radio to respond. The RF level should be set to -37 dBm.

Set Segment Number 1 to start at 356.5875 MHz, stop at 366.55 MHz with a step size of 12.5 kHz, a step time of 100 ms and an RF level of -37 dBm.

Set up Segment Number 2 with a start frequency of 356.5125 MHz, a stop frequency of 356.5875 MHz at step size of 100 kHz and a step time of 100 ms. Set the RF level to -144 dBm.

Set up a sequence sweep using Segment Numbers 0, 2 and 1. The signal generator will now sweep from 346.55 MHz to 356.5125 MHz at -37 dBm, then turn the carrier off, step to 356.5875 MHz, turn the carrier on and then sweep to 366.55 MHz as required.

Complex sweeps

RF profiles, offset and sequence sweep

The sequence sweep can be combined with the RF profile and RF offset facility to provide a swept signal source where the signal generator displays the RF level at the output of an external frequency dependent amplifier or attenuator.

To set up a sweep of this type use the required sequence sweep, and RF profile and RF offset can be set up as previously described. If the required RF offset and RF profile are then enabled and the sequence sweep selected a complex sweep incorporating all these facilities can be generated.

Suppressing attenuator changes

In addition to being used with RF profiles and RF offsets, sequence sweeps can also be used in conjunction with Extended Hysteresis. Sweeps generated with the Extended Hysteresis mode enabled, will use the modified electronic control facility to apply the RF profiles and to vary the RF output level. Provided the required level does not exceed the Extended Hysteresis electronic control range the mechanically actuated attenuator will not be operated.

Note

When the -HYST flag is displayed the RF level of the generator is not as accurate as normal modes of operation.

Tutorial example for immunity testing

Example: Immunity testing in a GTEM cell

Problem:

A device is to be tested to check its immunity to electro-magnetic fields using a GTEM cell. The test requires that the device is tested for field strengths of 10 V/m at frequencies from 1 MHz to 100 MHz and 3 V/m from 100 MHz to 400 MHz. The tests call for checks to be made at 10 kHz intervals from 1 MHz to 30 MHz, 12.5 kHz from 30 MHz to 100 MHz and 100 kHz intervals from 100 MHz to 400 MHz. The GTEM system requires a nominal signal of -10 dBm to drive an amplifier that provides a 10 V/m field strength in the cell.

Solution:

The test requires a combination of the sequence sweep, RF offset and RF profile facilities. In this case the "RF Levels" required at the remote point are field strengths of 10 V/m and 3 V/m. The RF offset facility can be used to convert a nominal signal of -10 dBm to a displayed 10 V PD by using an offset of +43 dB (10 V PD is approximately +33 dBm).

Use a field probe to check the field strength in the GTEM cell. With the generator set to 10 V PD use the RF profile facility to obtain a 10 V/m reading on the field probe for frequencies between 1 MHz and 400 MHz. While creating the RF profile remember that the signal generator software interpolates between profile points so points need to be entered only when the profile slope changes. Store the RF profile produced and check that the field strength is substantially constant as the frequency is changed.

Note

In this example it is assumed that the RF amplifier is capable of generating a field of 10 V/m at all frequencies and that the amplifier is working in the linear region.

Set up a sequence sweep using segments providing the following characteristics:-

	START	STOP	STEP SIZE	RF LEVEL	STEP TIME
Segment Number 0	1 MHz	30 MHz	10 kHz	10 V PD	100 ms
Segment Number 1	30 MHz	100 MHz	12.5 kHz	10 V PD	100 ms
Segment Number 2	100 MHz	400 MHz	100 kHz	3 V PD	100 ms

Select a sequence sweep using Segment Numbers 0, 1 and 2. With the RF profile and RF offset enabled and the device under test inserted in the GTEM in place of the field probe a swept test can now be undertaken.

The test can be repeated at higher or lower field strength by simply redefining the RF level in the sweep segments.

Square wave modulation

Generators supplied with Option 008 fitted can generate square wave modulation in addition to the standard sine and triangle waveforms. Square wave modulation can be selected from the main signal generator menu with the modulation set to internal by pressing *[Select Source*] to obtain the *Internal Source Selection Menu* and then pressing *[Square Wave*] to select the square wave modulation source.

The rise and fall times of the square wave are shaped to ensure that minimal overshoot is obtained for AM with frequencies up to at least 2 kHz.

GPIB operation

The following GPIB mnemonics are used to control the RF profile and complex sweep option in addition to those described in Chapter 3-2.

Segmented sweeps

Segmented sweep is a new sweep type which enables the user to set up segments of carrier sweep and store these away in non-volatile memory for future use. Each segment will consist of a START and STOP frequency, RF LEVEL, STEP SIZE and STEP TIME.

A complex sweep can be set up by specifying a sequence of these segments; on completion of sweeping one segment the sweep will jump to the start of the next segment and continue sweeping.

The following GPIB commands are used to provide GPIB control of the segmented sweep.

SWEEP — [not used alone]

:TYPE — <character program data>
Select type of sweep

Data type: SEQ (Segmented Sweep)
Allowed Suffices: None
Default Suffix: None

SWEEP? — Responds with information on Sweep Type and Sweep Mode status as follows:
:SWEEP:TYPE <type>;MODE <mode>

Example: `:SWEEP:TYPE SEQ;MODE SNGL`

SWEEP — [not used alone]

:SEQUENCE — <string program data>
Select Segmented Sweep Sequence

Data type: String of Segment numbers (0-9) with up to 10 characters between string delimiters (e.g. "1238976" or '987665')
Allowed Suffices: None
Default Suffix: None

SWEEP:SEQUENCE? — Responds with currently selected Sequence as follows:

:SWEEP:SEQUENCE <string program data>

Example: `:SWEEP:SEQUENCE "5675676543"`

SWEEP — [not used alone]

:SEG0
↓ — [not used alone]
:SEG9

:<cmd> — Select a Segment to edit where <cmd> is replaced by one of the following:

:START — Select start frequency

:STOP — Select stop frequency

:SIZE — Select step size

Data type: Decimal Numeric Program Data
Allowed Suffices: GHZ, MHZ, KHZ, HZ
Default Suffix: HZ

:RFLV — Select RF Level

Data type: Decimal Numeric Program Data
Allowed Suffices: DBM, DBV, DBMV, DBUV, V, MV, UV
Default Suffix: DBM unless changed by UNITS command

:TIME — Select step time

Data type: Decimal Numeric Program Data
Allowed Suffices: MS
Default Suffix: MS

SWEEP:SEG0?
↓

:SEG9?	Responds with parameter settings for segment number specified (0-9) as follows: :SWEEP:SEG<nr1>:START <nrf>;STOP <nrf>; RFLV <nrf>;SIZE <nrf>;TIME <nrf>
Example:	`:SWEEP:SEG2:START 125000000.0; STOP 1750000000.0; RFLV -32.4; SIZE 50000000.0; TIME 20`
:XFER:CW	Transfer Paused Carrier value to main parameter
Data type:	None
Allowed Suffices:	None
Default Suffix:	None
:XFER:RFLV	Transfer Paused RF Level value to main parameter
Data type:	None
Allowed Suffices:	None
Default Suffix:	None

RF profil

Used for specifying a level profile over a frequency range. Consists of relative offsets, from a presedefined reference level, at user defined frequencies. Linear interpolation is used to calculate the level between frequency points. Up to 10 profiles can be stored away in non-volatile memory for future use.

These profiles can be used in conjunction with segmented sweeps as well as in NORMAL instrument mode, but not with ordinary frequency carrier sweeps.

The following GPIB commands are used to provide GPIB control of the RF profiles.

PROFILE	[not used alone]
:STATUS	[not used alone]
:NUM	Select Profile (0-9)
Data type:	Decimal Numeric Program Data
Allowed Suffices:	None
Default Suffix:	None
:ENABLE	Enable Selected Profile
:DISABLE	Disable Selected Profile
:SAVE	Store profile setting and status in memory
Data type:	None
Allowed Suffices:	None
Default Suffix:	None
PROFILE:STATUS?	Responds with Selected Profile number (0-9) and Status as follows: :PROFILE:STATUS:NUM <nr1>;<status>
Example:	`:PROFILE:STATUS:NUM 4;ENABLE`

To edit a profile, first set the instrument mode to PROFILE

IMODE	Select instrument mode
Data type:	Character program data (NORMAL, SWEEPER or PROFILE)
Allowed Suffices:	None
Default Suffix:	None
Example:	`IMODE PROFILE`
PROFILE	[not used alone]
:EDIT	[not used alone]
:CFRQ	Set Carrier Frequency
Data type:	Decimal Numeric Program Data

Allowed Suffices:	GHZ, MHZ, KHZ, HZ
Default Suffix:	HZ
:OFFS	Set Relative Offset
Data type:	Decimal Numeric Program Data
Allowed Suffices:	dB
Default Suffix:	dB
:SAVE	Save profile point
Data type:	None
Allowed Suffices:	None
Default Suffix:	None
:REMOVE	Remove a profile point (1 - Number of Points in profile)
Data type:	Decimal Numeric Program Data
Allowed Suffices:	None
Default Suffix:	None
:POINT	Select a profile point (1 - Number of Points in profile)
Data type:	Decimal Numeric Program Data
Allowed Suffices:	None
Default Suffix:	None
:ERASE	Clear profile in memory (0-9)
:STO	Store profile in memory (0-9)
:RCL	Recall profile from memory (0-9)
Data type:	Decimal Numeric Program Data
Allowed Suffices:	None
Default Suffix:	None

PROFILE:EDIT:POINT? Responds with Carrier Frequency and Relative Offset for the point requested as follows:
:PROFILE:EDIT:CFRQ <nrf>;OFFS <nrf>

Data type:	Decimal Numeric Program Data
Allowed Suffices:	None
Default Suffix:	None

Example: `:PROFILE:EDIT:CFRQ 10000000.0;OFFS -9.9`

PROFILE:EDIT? Responds with the Number of Points in Profile Editor as follows:
<number of points>

Example: `20`

RF offsets

The GPIB commands for RF LEVEL OFFSETS are as follows:

RFLV

:OFFS	[not used alone]
:NUM	*Select RF Offset (1-5)*
Data type:	*Decimal Numeric* Program Data
Allowed Suffices:	
Default Suffix:	

RFLV:OFFS *(continued)*

:VALUE	Set current RF Offset value
Data type:	Decimal Numeric Program Data
Allowed Suffices:	dB
Default Suffix:	dB
:ENABLE	Enable Selected RF Offset
:DISABLE	Disable Selected RF Offset
:SAVE	Store RF Offsets and status in non-volatile memory

Data type: None
Allowed Suffices: None
Default Suffix: None

RFLV:OFFS?

Responds with RF Offset Selected, its Value and its Status as follows:
:RFLV:OFFS:NUM <nr1>;VALUE <nrf>;<status>

Example: `:RFLV:OFFS:NUM 3;VALUE -40.0;ENABLE`

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CHINA Beijing
Tel: [+86] (10) 6539 1166
Fax: [+86] (10) 6539 1778

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Tel: [+86] (21) 5109 5128
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Tel: [+358] (9) 2709 5541
Fax: [+358] (9) 804 2441

FRANCE
Tel: [+33] 1 60 79 96 00
Fax: [+33] 1 60 77 69 22

GERMANY
Tel: [+49] 8131 2926-0
Fax: [+49] 8131 2926-130

HONG KONG
Tel: [+852] 2832 7988
Fax: [+852] 2834 5364

INDIA
Tel: [+91] 80 5115 4501
Fax: [+91] 80 5115 4502

KOREA
Tel: [+82] (2) 3424 2719
Fax: [+82] (2) 3424 8620

SCANDINAVIA
Tel: [+45] 9614 0045
Fax: [+45] 9614 0047

SPAIN
Tel: [+34] (91) 640 11 34
Fax: [+34] (91) 640 06 40

UK Burnham
Tel: [+44] (0) 1628 604455
Fax: [+44] (0) 1628 662017

UK Stevenage
Tel: [+44] (0) 1438 742200
Fax: [+44] (0) 1438 727601
Freephone: 0800 282388

USA
Tel: [+1] (316) 522 4981
Fax: [+1] (316) 522 1360
Toll Free: (800) 835 2352

web **www.aeroflex.com** Email **info-test@aeroflex.com**

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