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S Series SGA Signal Generator

Operating Manual

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Operating Manual

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About the SGA Signal Generator

The S-Series SGA signal generator is a compact, easy to use, high performance signal generator for R&D, manufacturing and the field.

The SGA employs a large touch screen user-interface to provide a signal generator with unparalleled ease-of-use. With such a small form-factor, the SGA is equally at home in the field as it is in the laboratory or a production line. The use of Aeroflex's Fast Low Noise Synthesis (FLNS) technology, added to the experience gained through decades of developing leading-edge signal source products, ensures that signal purity and integrity have not been sacrificed in the quest for speed; the SGA excels in all respects. With a comprehensive range of features and options, the SGA meets the needs for a general-purpose signal generator while offering the high performance required of demanding, critical receiver measurements or rapid manufacturing.

SGA Signal Generator

Table of contents

Welcome to SGA-3 and SGA-6

Welcome to the Help for the SGA-3 and SGA-6 S-Series Signal Generators. These compact, easy to use, high performance instruments have a touch-screen interface that simplifies operation and is intuitive to use. This Help is intended to support you in operating the instrument, to provide detailed information about each function, and to provide examples of how to use the instrument for making measurements.

Please take time to read the safety information first.

About SGA gives information about the use and user of the instrument, together with patent information.

Installation is primarily for first-time users, with information on positioning and power connections.

Getting started gives information about front- and rear-panel connections, and explains how to use the touch screen.

An example setup demonstrates practical use of the instrument.

Generating signals details the available generation modes, which include all common modulation schemes.

Maintenance covers routine maintenance and safety checks.

A glossary includes all terms used in this operating manual.

If at any time you have an unresolved question, or you suspect that the instrument is not functioning correctly, please contact our technical support.

Associated publications

If you want to…	Refer to…
View safety information and basic setup and operation instructions in pdf format.	**SGA Signal Generators Getting Started Guide** Part no. 47090/066 On the CD-ROM and at www.aeroflex.com/.
View safety information and basic setup and operation instructions in printed format.	**SGA Signal Generators Getting Started Guide** Part no. 47000/066 Supplied with the instrument.
View operating information for the instrument in html Help format.	**SGA Signal Generators Help** Part no. 47090/067 On the CD-ROM and at www.aeroflex.com/.
View operating information for the instrument in pdf format.	**SGA Signal Generators Operating Manual** Part no. 47090/068 On the CD-ROM and at www.aeroflex.com/.
View operating information for the instrument in printed format.	**SGA Signal Generators Operating Manual** Part no. 47000/068 Available as an optional extra.
View GPIB programming information for the instrument in pdf format.	**SGA Signal Generators GPIB Command Reference Manual** Part no. 47090/071 On the CD-ROM and at www.aeroflex.com/.
View GPIB programming information for the instrument in printed format.	**SGA Signal Generators GPIB Command Reference Manual** Part no. 47000/071 Available as an optional extra.

Viewing the SGA Help file

Help

The SGA Help manual (part no. 47090/067) on the CD-ROM provides html help on all aspects of installing and operating the instrument. You should be able to view the Help manual on all browsers although you may observe slight changes in presentation depending on the browser used.

***Note**: if you copy the Help manual file from the CD-ROM to your computer, be aware that, for security reasons, Windows™ XP restricts access to HTML help (x.chm) files across network drives. If you try to view any html help file on a network drive, you will see an error message. You need to move such files to your C drive to view them. There should be no problems running the html Help manual directly from the CD-ROM.*

Operating manual

This operating manual (part no. 47090/068) provides the same information on installing and operating the instrument as the Help file, but in an A4 PDF format. It is available also as a printed document, part no. 47000/068.

Safety

This section contains important information about protecting yourself and the instrument from harm.

Precautions

Precautions

These terms have specific meanings in this document:

WARNING

...information to prevent personal injury.

CAUTION

...information to prevent damage to the instrument.

Hazard symbols

The meaning of hazard symbols appearing on the instrument 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.
	Toxic hazard

WARNING

After unpacking the instrument, inspect the shipping container and its cushioning material for signs of stress or damage.

If there is damage, 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, as internal electrical damage could result in a shock if the instrument is turned on.

General conditions of use

This product is designed and tested to comply with the requirements of IEC/EN 61010-1 ‘Safety requirements for electrical equipment for measurement, control and laboratory use’, for Class 1 portable equipment and is for use in a pollution degree 2 environment. The instrument is designed to operate from an installation category II supply.

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

This product is not approved for use in hazardous atmospheres or medical applications. If the instrument 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 instrument conforms with IEC Safety Class 1, meaning that it is provided with a protective grounding conductor. To maintain this protection the power cord 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 instrument 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.

Fuses

Note that the internal supply fuse is in series with the live conductor of the power cord. 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 power cord, ensure that the fuse rating is commensurate with the current requirements of this instrument. See the data sheet for power requirements.

WARNING

Toxic hazards

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

WARNING

Heavy instrument

The weight of this instrument may exceed 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

Lithium

A Lithium battery 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

Tilt facility

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

WARNING

Liquid crystal display (LCD) module

The liquid crystal substance within the display panel used in this instrument is a toxic substance. If the display panel is damaged and any of the liquid crystal substance leaks out, do not allow it to come into contact with your mouth. If the substance comes into contact with your skin, immediately wash the affected areas with soap and water, and seek medical advice.

The display panel is made of glass. Therefore do not subject the instrument to mechanical shocks that might cause fractures.

Do not dispose of these modules, or any part of them, in domestic waste. Use only approved waste disposal methods.

CAUTION

Suitability for use

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

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

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

Précautions

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.

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.
	Danger produits toxiques

WARNING

Inspection visuelle initiale

Lors du déballage de l'instrument, examinez l'emballage ainsi que les matériaux de protection afin de détecter tout signe de contrainte ou de dommage. Dans ce cas, gardez l'emballage pour le faire examiner par le transporteur et présenter une éventuelle réclamation. Détectez également tout signe de dommage sur l'équipement; ne pas mettre sous tension un équipement présentant des dommages, tout dommage électrique interne pouvant provoquer un choc lors de la mise en route.

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 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 la fiche technique, 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.

Fusibles

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 lié au feu

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

Si le câble d’alimentation comporte une prise avec fusible intégré, assurez vous que sa valeur est compatible avec les besoins de la fiche technique.

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

Equipement lourd

Le poids de cet appareil peut être 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

Lithium

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

Position inclinée

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

WARNING

Module d’affichage à cristaux liquides

Ne pas démonter le module d’affichage à cristaux liquides.

La matière contenue dans l’afficheur à cristaux liquides utilisé dans cet appareil est une substance toxique. Si l’afficheur est endommagé ou si la matière des cristaux liquides s’écoule, il faut éviter de la mettre en contact avec sa bouche. En cas de contact avec la peau, laver immédiatement la surface touchée avec de l’eau et du savon et s’adresser à un service médical.

L’afficheur est en verre. Il faut donc éviter de lui faire subir des chocs mécaniques pouvant causer des dégâts.

Ne pas se débarrasser de ces modules ni d’aucun de leurs composants dans une poubelle à usage domestique. Utilisez uniquement les containers à déchets appropriés.

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

Diese Hinweise haben eine bestimmte Bedeutung in diesem Handbuch:

WARNING

...dienen zur Vermeidung von Verletzungsrisiken.

CAUTION

...dienen dem Schutz der Geräte.

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.
	Warnung vor giftigen Substanzen

WARNING

Sofortige visuelle Überprüfung

Nach dem Auspacken des Gerät es ist die Verpackung und das Ausfütterungsmaterial auf Druckstellen und Beschädigung hin zu überprüfen. Bei Feststellung von Beschädigung sollte die Verpackung, für den Fall daß Ansprüche an den Spediteur entstehen, sichergestellt werden. Begutachten Sie anschließend das Gerät auf Anzeichen von Beschädigung und verbinden Sie dieses nicht mit dem Netz falls solche vorhanden sind. Interne elektrische Beschädigung kann beim Einschalten zu einem Stromschlag führen.

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 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 Datenblatt 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.

Sicherungen

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 im Datenblatt.

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

Schweres Gerät

Das Gewicht dieses Geräts kann über der 18 kg (40 lb) Grenze für Transport durch eine einzelne Person liegen. 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

Lithium

Eine Lithium Batterie 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

Schrägstellung

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

WARNING

Das LCD Modul

Demontieren Sie in keinem Fall das LCD Modul.

Die Flüssigkristallsubstanz, die im Displaymodul dieses Gerätes enthalten ist, enthält giftige Substanzen. Falls das Displaymodul beschädigt wird und die darin enthaltene Flüssigkristall-substanz entweicht, so achten Sie darauf, daß diese Substanz in keinem Fall mit Schleimhäuten in Berührung kommt. Sollte die Substanz mit Ihrer Haut in Berührung kommen, so waschen Sie die betroffenen Hautpartien mit Wasser und Seife ab und geben sich in ärztliche Behandlung.

Das Display besteht aus Glas. Mechanische Einwirkungen können das Glas zerstören.

Entsorgen Sie diese Module oder Teile davon nicht über den normalen Hausmüll, sondern über eine geeignete Sondermüllverwertung.

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

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.

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.
	Pericolo sostanze tossiche

WARNING

Ispezione visiva iniziale

Dopo aver sballato lo strumento, ispezionare l'imballo e verificare che non vi siano segni di urti o deformazioni. Nel caso si dovessero riscontrate dei danni, conservare l'imballo per un'eventuale contestazione al cordiere.

Verificare che lo strumento non abbia segni di danni, nel caso si dovessero riscontrate tali segni, non dare alimentazione in quanto vi potrebbero essere dei danni interni causa di possibili shock.

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 portatili e per l'uso in un ambiente inquinato di grado 2. L'apparato è stato progettato per essere alimentato da un alimentatore di categoria 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 nella scheda tecnica, 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.

Fusibili

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 nella scheda tecnica.

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

Strumento pesante

Il peso di questo strumento può superare i 18 kg (40 lb) raccomandati come limite per il trasporto manuale da parte di singola persona. Per evitare rischi di danni fisici è bene quindi considerare il carico complessivo, le condizioni del trasporto e le capacità individuali in accordo con la direttiva comunitaria 90/269/EEC e con eventuali regolamenti locali.

WARNING

Litio

Quest ’apparato incorpora 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

Posizionamento inclinato

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

WARNING

Schermo a cristalli liquidi (LCD - Liquid Crystal Display)

Non disassemblare il modulo LCD.

La sostanza contenuta nello schermo LCD è tossica. Se il modulo LCD viene danneggiato e si ha una perdita di liquido, occorre evitarne il contatto con la bocca. In caso di contatto con la pelle, lavare immediatamente le aree interessate con acqua e sapone e contattare un medico.

Lo schermo LCD è di vetro, per cui non devono essere sottoposti a shock meccanici che possono causarne la rottura.

Il modulo LCD, il tubo CCFT o i loro residui vanno eliminati come residui speciali secondo la normativa vigente.

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

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.

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.
	Aviso de toxicidad

WARNING

 Inspección visual inicial

Tras desembalar el equipo inspeccione tanto la caja como el material de amortiguamiento para verificar si han sido forzados o dañados. Si encuentra daños, retenga el embalaje para que, en caso de reclamación, pueda ser inspeccionado por el transportista. Examine el equipo para verificar que no ha sufrido daños. No conecte el equipo a al alimentación cuando esté dañado, la avería interna podría originar una descarga al encender el equipo.

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 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 la hoja técnica, 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 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 repuesto.

Si se utiliza una clavija con fusible incorporado, asegúrese de que los valores del fusible corresponden a los requeridos por el equipo. Consulte la hoja técnica 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

Instrumento pesado

El peso de este equipo podrá ser superior a la recomendación de 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

Litio

En este equipo se utiliza una batería de litio.

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

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.

WARNING

Módulo de visualizador de cristal liquido

No desmonte el módulo del Visualizador.

La sustancia que forma el Cristal Liquido del panel de visualización es tóxica. En caso de dañarse el visualizador y salir a exterior dicha sustancia, no permita que la misma entre en contacto con su boca. Si la sustancia se pusiera en contacto con su piel, lave inmediatamente las áreas afectadas con agua y jabón y busque asistencia médica.

El visualizador es de vidrio. Por tanto no lo someta a golpes que puedan romperlos.

No tire estos módulos, ni parte de ellos a la basura doméstica. Deshágase de ellos con métodos aprobados para residuos industriales

CAUTION

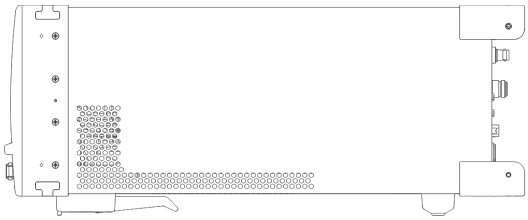
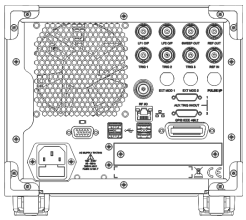
Idoneidad de uso

Este equipo ha sido diseñado y fabricado por Aeroflex para generar señales de RF de bajo nivel para probar 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.

About SGA

The Aeroflex SGA is a fast low-noise analog signal generator, packaged as a compact, bench-top instrument with touch-screen operation. It provides comprehensive features and options that satisfy the need for a general-purpose signal generator, while offering the high performance required of demanding critical receiver measurements or rapid manufacturing.

The instrument software runs on a Windows™ operating system that can be accessed for standard file-handling procedures. Many functions are protected however, to ensure correct operation of the SGA software.

In its base configuration, the SGA is a CW generator. All the key generator functions are provided, together with list mode sweep. Options provide AM and FM modulation, pulse modulation, high power output, reverse power protection, removable hard disk, and connection via the rear panel.

Remote operation is provided through USB, Ethernet and GPIB interfaces. SCPI-like commands are used where possible.

Up to three S-Series modules lock together to form a unit that functions physically and electrically as a single integrated test instrument. Test applications (supplied by Aeroflex or created by you) then control the composite instrument, providing precisely the test capabilities that you need for the production line, the laboratory, or in the field.

The SGA is currently available in two frequency ranges:

SGA-3	100 kHz to 3 GHz
SGA-6	100 kHz to 6 GHz

Data sheet

For a product overview, technical specifications, and information about options and accessories, see the latest S Series SGA data sheet (part number 46891/421) at aeroflex.com.

Who uses SGA?

The SGA Signal Generator is designed for all engineering personnel engaged in the design, development and testing of RF devices, sub-systems and modules. This documentation assumes that you are familiar with the terms and concepts commonly used in RF measurements.

Power supply

Voltage range: 100 to 240 VAC (the instrument configures automatically to voltages within this range).

Frequency range: 50 to 60 Hz

Power consumption: 250 VA max. (depending on configuration)

See also: Fuses

Disconnecting device

Heavy instrument

This instrument is light enough to be handled by one person. However, if two or more instruments are attached together using the Aerolock mechanism, the combined weight of instruments may become more than 18 kg (40 lb), which exceeds the recommended maximum weight for manual handling by a single person.

In this case, ***use two people*** to lift the instrument. Lift it by the front handles and rear bumpers to avoid trapping fingers underneath.

Declaration of conformity

A copy of the EC declaration of conformity for the SGA Signal Generator is available on request from Aeroflex Ltd. The document number of the declaration of conformity is DC282.

China RoHS

A declaration of specified hazardous substances that applies when this product is exported to China is available on request from the Aeroflex help desk at www.aeroflex.com/ats/contact.cfm.

A copy of the declaration is provided by default with each shipment of the product to China.

Installation

When combined with other S-Series modules, this may become a heavy instrument; observe the warning about handling it.

Carry out an initial visual inspection before turning the instrument on.

Position the instrument carefully.

Check the installation requirements to ensure that cooling is not impaired.

Connect the instrument to the supply.

Switch the instrument on with the standby/on switch.

Perform a goods-in check to establish that the instrument is functional.

Initial visual inspection

WARNING

After unpacking the instrument, inspect the shipping container and its cushioning material for signs of stress or damage.

If there is damage, 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, as internal electrical damage could result in a shock if the instrument is turned on.

Positioning the instrument

CAUTION

Excessive temperatures may affect the performance of the instrument. Completely remove any protective plastic covering, and avoid standing the instrument on or close to another instrument that is hot.

Stability

If you stand the instrument on end on its rear-panel protectors, make sure that you provide support to prevent it from toppling over.

Ventilation

This instrument is forced-air-cooled by a fan mounted on the rear panel. Air must be allowed to enter freely through the ventilator grilles on the underside of the instrument.

Before switching on the instrument, ensure that the fan outlet on the rear panel is not restricted (leave a clearance of at least 75 mm (3 in) at the rear and 25 mm (1 in) at each side).

If you do not provide adequate clearance, internal temperatures will increase and may affect the instrument’s performance adversely.

Power cord

When the instrument has to be plugged into a Class II (ungrounded) 2-terminal socket outlet, the power cord 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.

Fasten the ground wire securely to ground. Grounding one terminal on a 2-terminal socket does not provide adequate protection.

If a molded plug has to be cut off a power cord, dispose of it immediately. A plug with bare wires is hazardous if it is inserted into a live socket outlet.

The power cord is the instrument's disconnecting device.

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.

Ensure that the AC supply is correctly connected to the instrument's power receptacle. For line power in the range 100 to 240 V~, the PSU automatically selects the appropriate range.

No manual voltage-range selection is provided.

Class 1 product

As defined in IEC/EN 61010-1, a Class 1 product contains basic insulation between live parts and exposed conductive parts such as the metal enclosure. Exposed conductive parts are connected to ground by a conductor. If a fault occurs and a live part contacts the enclosure of the product, a current flows in the ground conductor, tripping a protective device.

Category II supply

As defined in IEC/EN 61010-1, a Category II supply is a supply circuit for domestic or digital devices that may include transients with an average value; for example, a power supply suitable for household appliances and portable tools.

Pollution degree 2 environment

As defined in IEC/EN 61010-1, a pollution degree 2 environment is one in which normally non-conductive pollution occurs, but occasionally a temporary conductivity caused by condensation must be expected.

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 is required.

Whatever the disconnecting device, make sure that you can reach it easily and that it is accessible at all times.

Use only an approved power cord no longer than three meters.

On/off switch

The switch on the front panel does not isolate the instrument from the supply. Remove the power cord from the socket outlet to isolate the instrument.

To turn the instrument on, ensure that the power cord is inserted into both the socket outlet and the power supply receptacle on the rear panel. Then press the front-panel on/off switch. The instrument starts up Windows®. After that has loaded, the instrument loads the SGA software, and displays the signal generator screen.

AC fuses

The fuse-holder is integral with the 3-pin supply receptacle on the rear panel. To change the fuse, remove the power cord and then use a screwdriver to lever out the holder.

For the AC voltage range of 100 to 240 V, the fuse rating is T3.15AL250V.

One fuse is fitted, in the live line of the supply. It is a glass cartridge type, measuring 5 mm × 20 mm.

The plug attached to the line cord is fitted with a 5 A fuse also (in the UK only).

External equipment

Connect only equipment complying with the relevant IEC safety standards to the connectors on the instrument, in order to maintain the protection provided by the instrument.

To minimize electromagnetic interference (EMI), follow the following recommendations:

- Do not use connecting cables longer than 1 m.
- Use double-screened cables where possible.

Goods-in check

The following goods-in check confirms only that the instrument is functioning correctly. It does not verify conformance to the specification given in the data sheet.

1. Ensure that the correct fuse is fitted and that the supply is in the range specified on the data sheet.
2. Connect the instrument to the supply.
3. Press the standby/on switch on the front panel. The instrument starts up and displays the signal generator menu.
4. If the instrument appears to be completely dead, do the following:

   Check that the power cord is providing power to the instrument.

   Check that the instrument's fuse has not blown.

Powering up

1 Plug the line cord into the supply socket and the power supply receptacle on the rear panel.

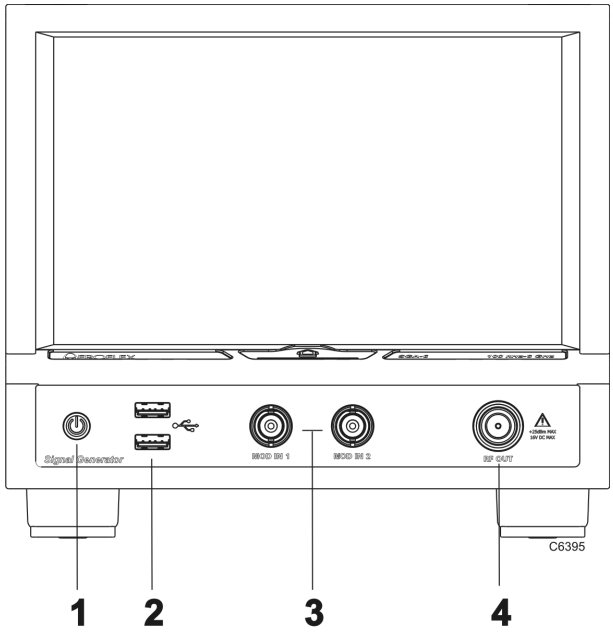
2 Press the on/off switch on the front panel. The instrument starts up, first loading Windows®, and then the SGA application.

Allow 5 minutes warm-up time for the instrument's circuits to stabilize.

Getting started

This chapter introduces you to the instrument's controls and connectors. It then takes you through a simple example set-up exercise to provide some familiarity with operating the instrument.

Front panel

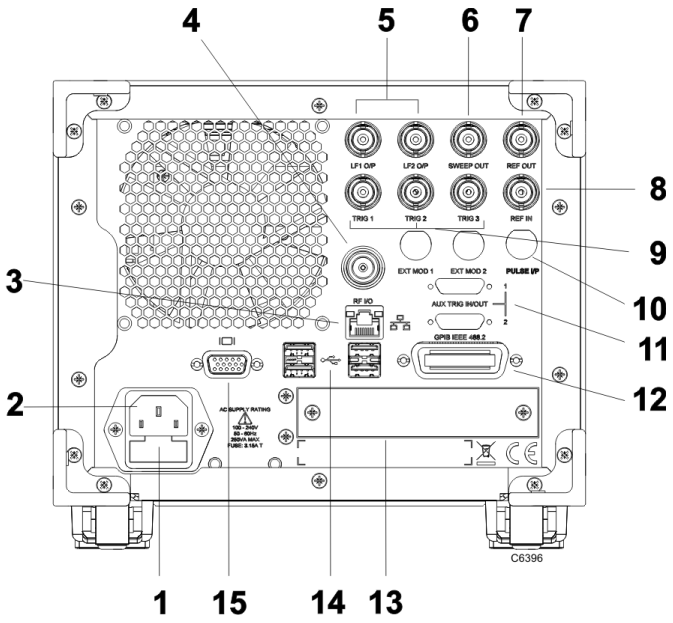


Front panel

See the data sheet for all available options.

1	On/off switch	Switches the instrument using a press on, press off action. ***Note**: to remove AC line power from the instrument, you must disconnect the power cord.*
2		Dual USB 2.0 socket. Used to transfer memory stores, ARB waveforms or other files, or to connect a mouse or keyboard.
3	MOD IN 1 and 2	External modulation inputs, selectable input impedance >100 kΩ or 600 Ω. N-type socket. AC or DC coupled. Modulation calibrated for 1 V RMS or 1 V peak (selectable). Damage level: ±5 V.
4	RF OUT	50 Ω N-type socket. Signal generator output. **Option 002 only.** This option protects SGA-3 against the application of reverse power at this port of up to 20 dBm (50 W) from a 50 Ω source. Protection remains active when AC line power is removed from the instrument. **CAUTION** SGA-6 cannot be provided with reverse power protection. Reverse power damage level for SGA-6 is +25 dBm, ±16 V DC.

Rear panel



Rear panel

1	Fuse holder	Contains 5 x 20 mm AC line fuse.
2	Power supply receptacle	3-pin IEC C14 filtered panel-mounted male power inlet.
3		Ethernet connector for LAN (local area network), UUT (unit under test), inter-SGA system connections.
4	RF I/O	**Option 007 only.** 50 Ω N-type socket. The RF output is moved to the rear panel.
5	LF1and LF2 O/P	5.6 Ω BNC sockets: can be configured to provide an output from the internal modulation oscillator or from the internal modulation paths.
6	SWEEP OUT	50 Ω BNC socket: generates 0 to 10 V when the generator is sweeping.
7	REF OUT	50 Ω BNC socket: 10 MHz at 2 V p-p into 50 Ω. Damage level: -0.5 V/+6 V.
8	REF IN	50 Ω BNC socket: accepts reference frequency of 1, 5, 10 MHz at 200 mV to 2 V RMS into 1 kΩ. Damage level: -0.5 V/+10 V.
9	TRIG1, 2, 3	50 Ω BNC sockets (TTL): apply 0 V to start sweep or step from point to point on a sweep. Sockets pulled up to +5 V by 10 kΩ. Damage level: ±5 V.
10	PULSE I/P	**Option 004 only.** 50 Ω BNC socket (TTL/CMOS): accepts an external pulse trigger. See *Pulse modulation*.

11	AUX TRIG IN/OUT	For future use. 25-way connector inputs/outputs burst gate control signals; A/B level burst attenuation control signals; ARB trigger; markers.
12	GPIB IEEE488.2	24-pin socket accepts a standard GPIB connector to allow remote operation of the instrument.
13	Removable hard drive	**Option 005 only**. Removable serial ATA 80 Gbyte 2.5 inch drive. Contains the instrument's operating software and user memory stores.
14		Four USB 2.0 sockets. Used to transfer memory stores, ARB waveforms or other files, or to connect a mouse or keyboard. Also provide electrical connections between multiple S-Series modules.
15		15-way D-type for connecting a VGA monitor.

Using a keyboard and mouse

You can use the instrument with or without keyboard and mouse (see Touch!).

If you are using keyboard and mouse, they need to be USB compatible. Plug them into the USB sockets on the front or rear panel.

If you are using the instrument without keyboard or mouse, you can access all Windows™ functions through your fingertips. To access Windows, close down the SGA software by pressing the ***Exit Application*** button on the menu tab, as explained in Accessing Windows.

***Note**: connecting a mouse and/or keyboard may compromise the EMC performance of the instrument.*

Touch areas on the screen

Touch!

In this document, when we use the term 'touch', it describes the action of touching lightly on an area on the screen with a finger
or
clicking on that area with a mouse.

Similarly, ‘double-touch and ‘drag’ are familiar terms that work equally well for mouse or fingertip.

Referring to parameters on the screen

Titles that appear on the screen are represented as **bold** text. For example:

Carrier

Waveform

Referring to touch areas

Touch areas like menu items, value fields and soft buttons are displayed in the main screen area. They are represented as ***bold italics***. For example:

Looks like this on the screen:	Represented in this document as:
	***Store/Recall***
	***2000.000000MHz***
	***Modulation***

How the screen is laid out

This is the main screen, which is divided into a number of functional areas:

Main screen layout

RF field

This displays the current RF frequency and RF level settings, and lets you change them using the popup keypad and slider. You can also select the frequency standard, and enable/disable RF output and overall modulation.

Function field

In this field, you set up the signal's modulation and configure sweep and External In/Out modes. Modulation setup is the default.

Touch the ***Forward*** button  to see the Sweep and External In/Out modes.

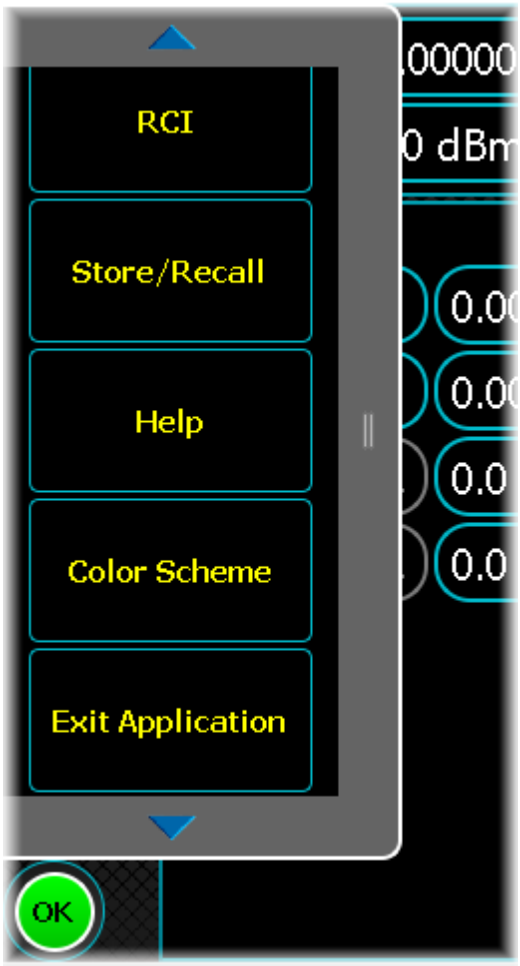
The ***Home*** button  takes you back to the Modulation field.

Status bar

Touch the ***Status*** button  to see the current state of subsystems such as the frequency standard. Some error messages are displayed here.

Menu tab

The menu tab contains all the system functions. It is normally collapsed in order to make space for the main SGA menus. Touch anywhere on the menu tab to expand it:



The menu tab does the following:

It shows the model number (SGA-3/SGA-6).

ISCO/SPA Front Panel is used for controlling other S-Series instruments.

RCI provides access to the remote control interface.

Store/Recall saves and recalls instrument settings.

Help provides details of the instrument and its software.

Color Scheme selects how the screen is presented, for increased visibility where required.

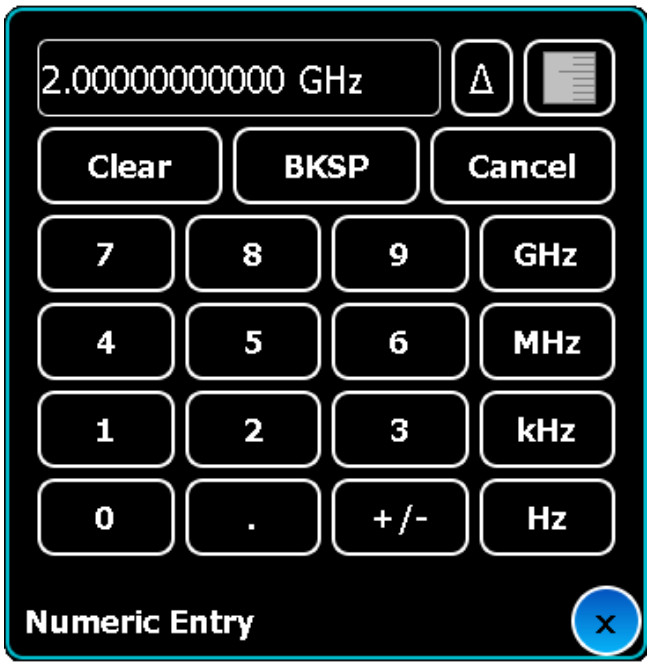
Exit Application closes the SGA application.

Popups

To ensure that the screen is not cluttered with unnecessary information, the instrument displays a popup keypad, and sometimes a slider adjustment, that overlay the fixed window layout when numeric entries are required.

Popup keypad

In this example, the popup keypad lets you enter a new value of frequency. There are similar popup keypads for power level and voltage entries.



Popup keypad

Popup keypads are overlaid on the main window. They have a standard set of features:

-  button. Defines the size of a frequency or power step.
-  button. Shows or hides the popup slider.
- ***Clear*** button. Clears the current displayed value.
- ***BKSP*** button. Deletes the last entry.
- **X** button. Closes the popup window.

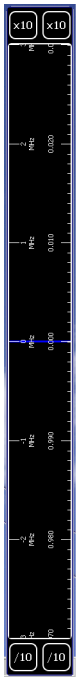
Enter and confirm value

Enter the value required. The entry is confirmed when you touch the units key.

Popup slider

For all numeric entries, there is also a slider adjustment.

- The slider provides fast adjustment of a parameter. It consists of a high- and a low-resolution slider (as shown below). Drag the sliders with your fingertip to change the value.



Slider adjustment

Use the **/10** and **x10** factor buttons to increase or decrease the resolution of the sliders. To see how this works, set the top slider to maximum resolution (touch **/10** repeatedly) and the lower slider to minimum resolution (touch **x10** repeatedly). Now drag the lower slider. You can see that it acts as a vernier scale for the upper slider, which moves accordingly.

Step button

When you press the step button  on a popup keypad, the 'Edit Step' dropdown menu appears.

Use this to:

- set the size of up/down step increments
- quickly change a displayed value using the step up/down arrows.

1 Touch Edit Step. The title at the bottom of the keypad popup changes from Numeric Entry to Step Entry to show that you are in Edit Step mode.

2 Now enter the step size, and terminate with a units key.

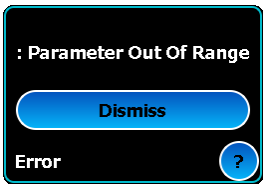
3 The popup keypad reverts to Numeric Entry.

4 Now touch the step button to use the up/down arrows

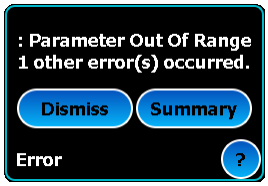
Error messages

System errors

System errors display because of an error notified by the system logic — for example, a failure to locate a training signal. A popup error message displays the information:



Touch **Dismiss** to clear the message popup. If another error occurs while the popup is visible, it shows that other system errors have been logged:



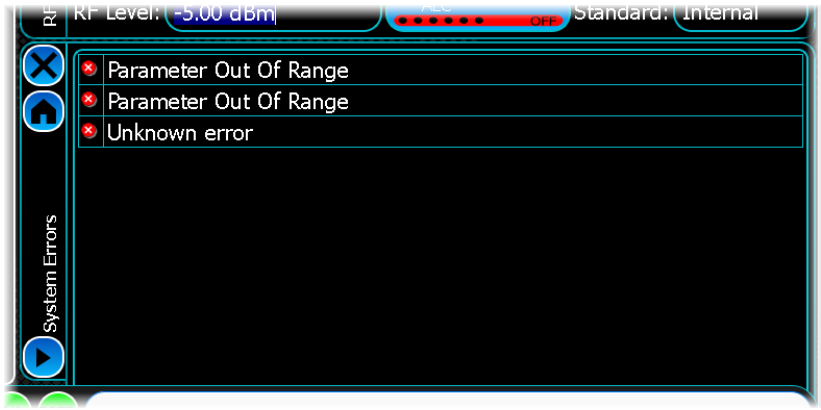
To see logged system errors

Touch **Summary** on the popup error message

or

Expand the status bar by touching the 

button. Touch the status bar to display the summary of logged system errors:



The summary provides a record of all errors that have occurred since the instrument booted. It can be erased only by re-booting the instrument.

Severity

Symbols in the column to the left of the error descriptions show the severity of the error. A red background shows the error is severe; a green background shows that the error is minor.

UI errors

UI (user interface) errors are less severe than system errors — for example, a UI error might occur if a frequency value is entered that exceeds the allowed range:

Error: Value is greater than maximum limit : 10.000000 MHz

Frequency standard errors

If the frequency standard experiences a fault — for example, a failure to locate an external signal — the 

button becomes red and an explanatory popup message appears. Touch the popup to dismiss the message.

External inputs and ouputs

You can select the coupling, the input impedance, and the sensitivity for each external modulation input.

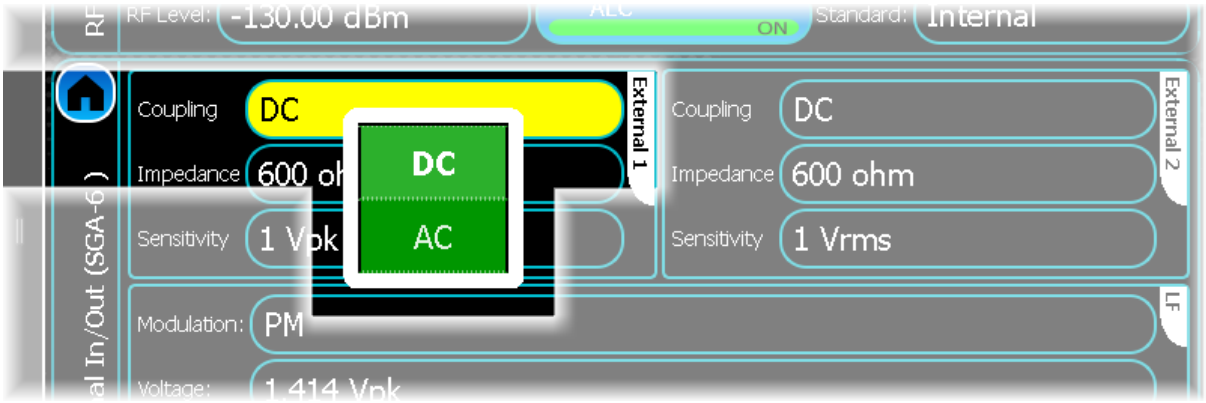
You can also select the type of LF modulation being applied.

Touch  and select External In/Out from the drop-down menu...

MOD IN 1 and 2 are external modulation inputs. They are shown as External 1 and External 2 on the screen, and have identical characteristics.

AC/DC coupling

Select AC or DC coupling.

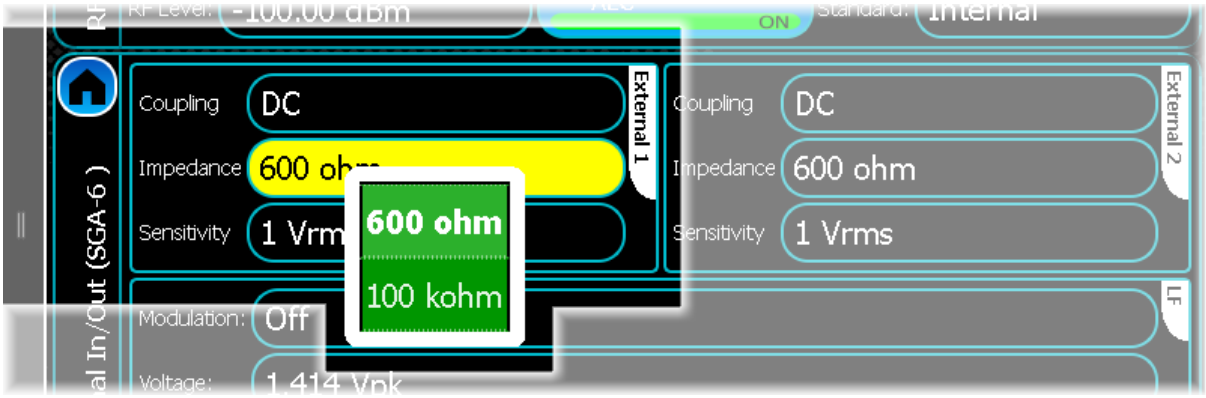


DC coupling prevents the instrument being affected or damaged by a DC level on which the modulating signal is superimposed.

External input impedance

Set the external modulation input to an impedance of >100 kΩ or 600 Ω.

...and set the external modulation impedance from the screen:



Sensitivity

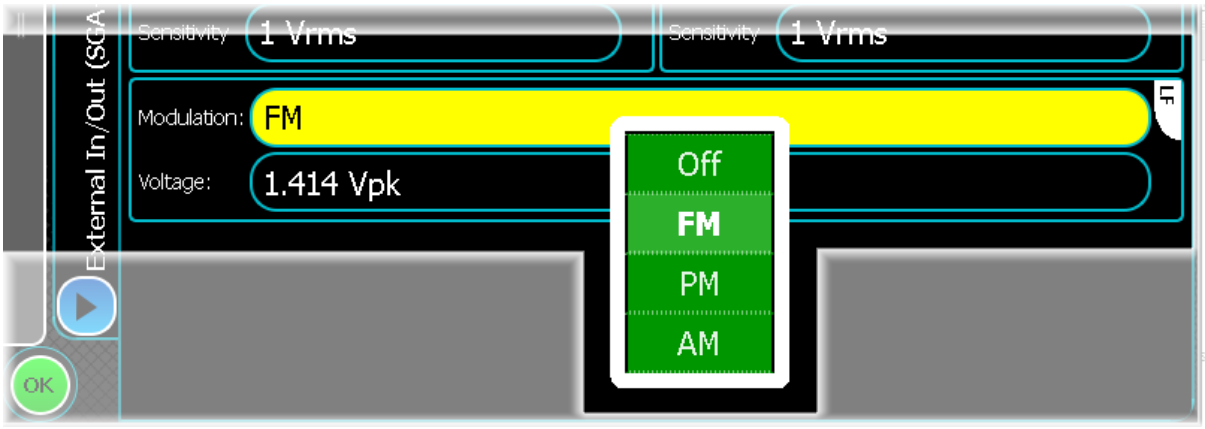
Specify the sensitivity of the external modulation input:

either 1 V RMS or 1 V peak at the input gives the chosen AM depth/FM or PM deviation.

LF output modulation

The output of the LF modulator is routed to a connector on the rear panel.

Select an external modulation type from the drop-down menu:



Example setup

To help you quickly become familiar with the basic operation of the instrument, try the following exercise, which demonstrates how to set up a typical signal with these parameters:

Carrier frequency: 100 MHz

Output level: -10 dBm

Frequency modulation: 100 kHz deviation at 500 Hz modulation.

Once you have followed this example once, you are unlikely to need it again — the instrument is very intuitive to use!

Setting the carrier frequency

1 Touch the ***Carrier*** button 

and select carrier frequency as the current function.

2 Use the popup numeric keypad to enter 100 MHz, by:

entering **100**

and terminating with the **MHz** button.

3 The frequency displayed changes to 100.000000 MHz.

Backspace and clear buttons

If you make a mistake when keying in, touch the backspace button BKSP and enter the correct value. You can also clear the entire entry by touching the ***Clear*** button.

Setting RF level

1 Touch the ***RF Level*** button 

. . . and select RF level as the current function.

2 Use the popup numeric keypad to enter -10 dBm, by:

touching 

entering **10**

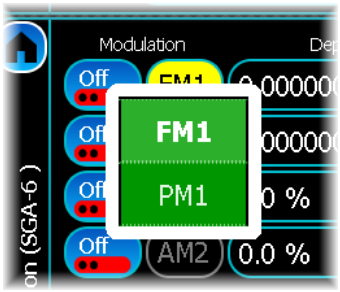
and terminating with the **dBm** button.

3 The RF level displayed changes to -10.0 dBm.

A 100 MHz, -10 dBm RF carrier now appears at the RF OUT socket.

Setting analog modulation

1 Touch any ***Modulation*** button and select the FM1 modulation type from the dropdown menu:



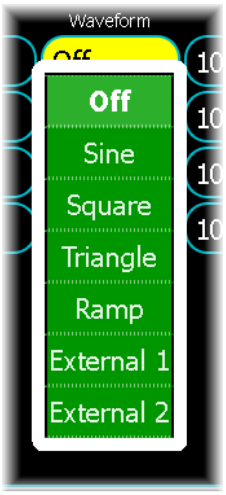
2 Touch the ***Depth/Deviation*** button.

Use the popup numeric keypad to enter 100 kHz deviation by:

entering **100**

and terminating with the **kHz** button.

3 Touch the ***Waveform*** button and select the sine waveform shape from the dropdown menu:



4 Touch the ***Frequency*** button.

Use the popup numeric keypad to enter 500 Hz modulating frequency by:

entering **500**

and terminating with the **Hz** button.

Turning a selected modulation source on and off

Touching the ***Source*** button toggles the selected modulation on and off. Turn the modulation source on:

Turning all modulation on and off

Touching the ***Modulation ON/OFF*** button toggles all modulation on the output on and off. Select Modulation ON.

Turning modulated carrier on and off

Touching the ***RF*** button toggles the RF output on and off. Select RF ON.

A 100 MHz, -10 dBm carrier, with 100 kHz deviation, modulated at 500 Hz, now appears at the RF OUT socket.

And that's about it!

These few steps have shown you the fundamentals of operating the instrument — which apply throughout the manual. We hope and believe that you will find operation intuitive and simple.

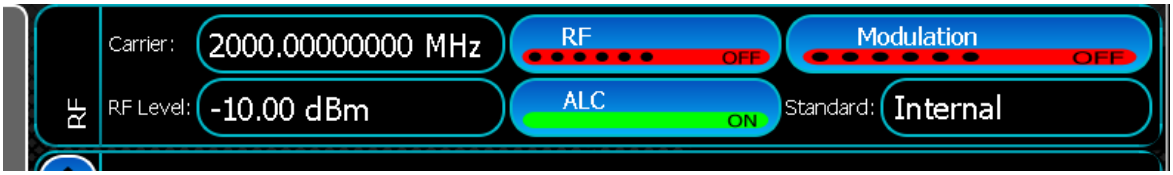
If you need help, just refer back to this page.

Generating signals

It is easy to set the instrument up to generate CW and modulated signals. The example shows the basic principles; this section provides full details of the setup.

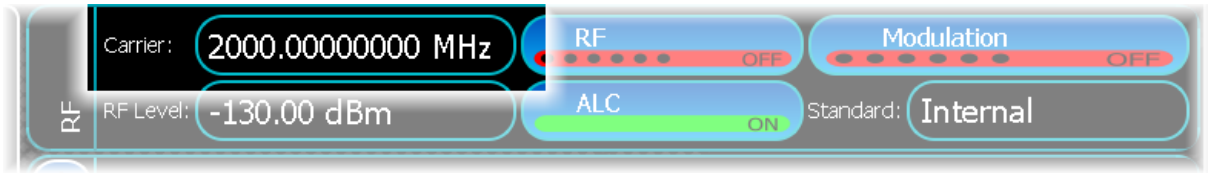
- First, define the RF parameters: frequency, RF level.
- Then configure the analog modulation.
- If you intend to sweep the signal, set this up in the separate field.
- Finally, enable modulation and RF output as required.

RF parameters



The RF field appears at the top of all modulation screens. Here, you set up carrier frequency and RF level, and enable/disable the RF output and overall modulation. You can enable or disable ALC. You also define the source for the frequency standard.

Carrier frequency



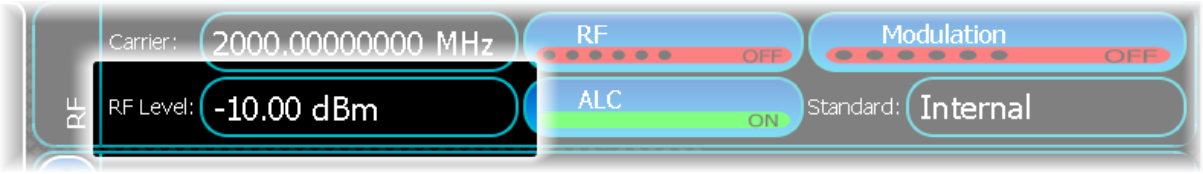
This shows the current carrier frequency setting. Touch the button to set a different frequency. Enter a carrier frequency in the range

100 kHz to 3 GHz	SGA-3
100 kHz to 6 GHz	SGA-6

and touch the appropriate units button to terminate.

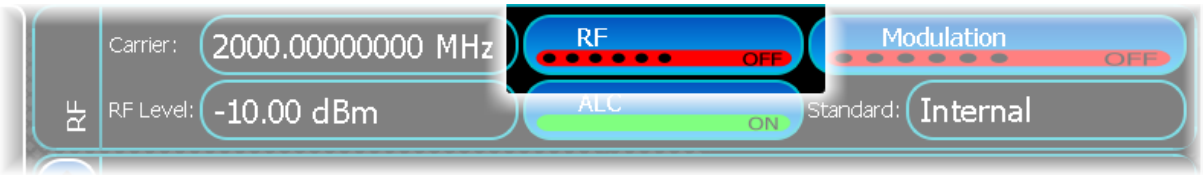
Resolution varies according to the frequency selected: refer to the data sheet for values.

RF level



This shows the current carrier output level. Touch the button to set a different level. This is limited to +13 dBm maximum, or +20 dBm if Option 003 is fitted.

RF on/off



Switch the carrier ON or OFF at any time using the ***RF ON/OFF*** button 

.

This turns the RF output on and off, whilst retaining the 50 Ω output impedance.

Modulation on/off

All modulation

Switch all modulation ON or OFF at any time using the ***Modulation ON/OFF*** *button* 

.

Individual modulation

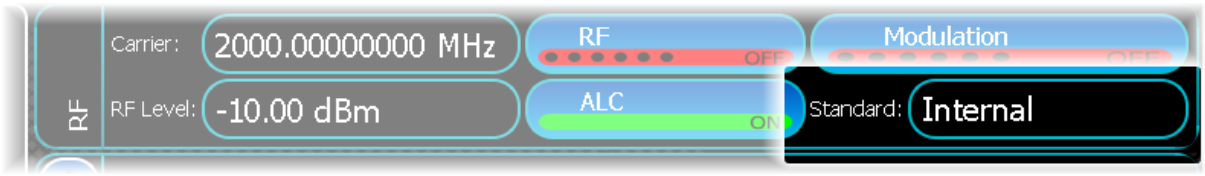
Modulation from each source is also enabled or disabled by the individual modulation ***ON*** and ***OFF*** buttons 

and 

. For modulation to appear on the carrier, modulation must be enabled both with the ***Modulation ON/OFF*** *button* and the individual AM, FM and ΦM ***ON/OFF*** buttons.

Individual modulation ***ON/OFF*** buttons only reduce the modulation to zero, whereas the ***Modulation ON/OFF*** button completely disables the modulation system so that the instrument reverts to being a carrier frequency generator.

Frequency standard



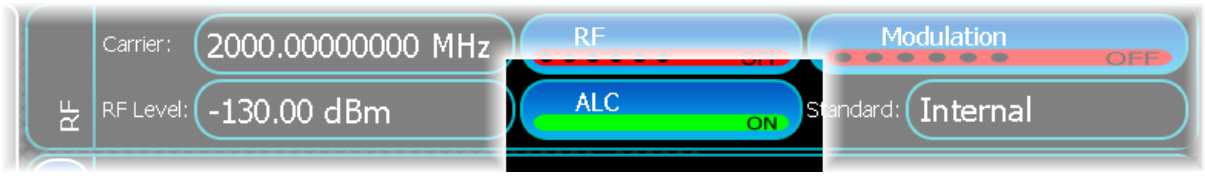
Select either the internal 10 MHz frequency standard or an external frequency standard. Apply an external frequency standard to the REF IN socket on the rear panel.

When the Standard is set to External, the internal OCXO locks to the external standard

Frequency reference output

When the Standard is set to Internal Out, the instrument outputs a 10 MHz square wave (2 V p-p into 50 Ω) as standard at the REF OUT socket.

ALC



Turning off ALC disables the ALC loop and the leveling detector to improve intermodualation performance. When the ALC is disabled, the output power is frozen at the gain setting determined while the ALC was enabled.

Switch ALC ON or OFF at any time using the **ALC ON/OFF** button 

.

Modulation

Touch  and select **Modulation** from the drop-down menu. This displays the modulation field, which lets you set the instrument up to generate CW and modulated signals:

You define the modulation type and parameters in this field. See Setting analog modulation for information.

You also enable or disable the individual source modulation.

***Note**: this section applies only if you have FM and AM modulation (Option 001) fitted to your instrument.*

The carrier can be amplitude, frequency, phase and pulse modulated from internal and/or external sources, using a combination of four internal sources and two external sources.

Allowed combinations of internal sources are:

Up to two simultaneous AM

and/or

up to two simultaneous FM or ΦM

Note that FM and ΦM modulation is mutually exclusive.

Valid modulation modes

Only certain combinations of modulation are possible: see *Valid modulation modes* for full details.

External modulation

The MOD IN1 and MOD IN2 sockets on the front panel allow external modulation signals to be added to the signals from the internal oscillator. This allows up to four modulations to be applied to the carrier: for example, two external FM with internal AM1 and AM2. You can select high or medium input impedance for these inputs.

Internal modulation

Internal modulation can be the sum of up to four signals — AM1 + AM2, FM1 + FM2 or ΦM1 + ΦM2 — each of which can have its own depth/deviation and modulation frequency.

Pulse modulation (Option 004)

If Option 004 is fitted, pulse modulation may be applied in addition to any normal modulation combination.

Sweep

Sweep capability allows comprehensive testing of systems, since measurements at single points do not necessarily give an overall indication of the performance.

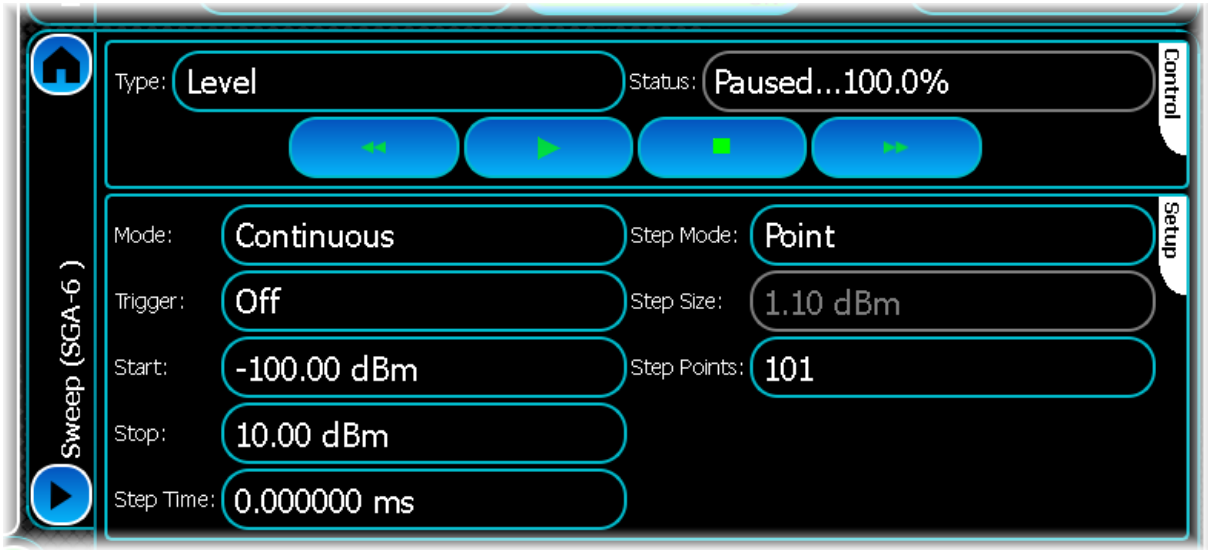
You can:

- Define the parameter (frequency or RF level) that is to be swept
- Define whether the sweep is to be continuous or single-shot
- Define how the sweep is controlled (start/stop point, number of steps, time per step and size of step)

You can operate the sweep in single-shot or continuous mode, with the start command triggered by a touching a button, an external pulse, or remote control. Once started, the sweep can be stopped at any time, and the display indicates the current parameter values.

Sweep setup

Touch  and select **Sweep** from the drop-down menu. The sweep screen looks like this:



Note that the full set of sweep control buttons appears only after you click on the Play button.

Mode

- ***Single***: the sweep steps from the start value to the stop value and halts, displaying the stop value.
- ***Continuous***: the sweep steps from the start value to the stop value, and then repeats.

Trigger

Set up the trigger action as follows:

- ***Off*** disables the external trigger. Control the triggering manually using the Sweep control buttons.
- ***Start*** makes the external trigger start the sweep. During the sweep, further trigger inputs are ignored. At the end of the sweep the trigger latch resets, ready for the next input.
- ***Start/Stop*** makes the first external trigger start the sweep, and the next trigger pause it, so that you can (for example) investigate a particular point of interest. A further trigger causes the sweep to resume from the point at which it paused.
  The trigger latch resets after each start/stop.
- ***Step*** makes each external trigger increment the sweep by the size of one frequency step.
  The trigger latch resets after each step.

External trigger

Apply an external trigger to the TRIG 50 Ω BNC socket (TTL) on the rear panel. A 0 V level starts the sweep or steps from point to point on a sweep. The sockets are pulled up to +5 V by 10 kΩ.

Damage level is ±5 V.

Trigger polarity

The trigger input has a pull-up resistor, so the closure of any external switch is treated as a trigger event.

The sweep control buttons override any external trigger signals.

Type

Specify ***Frequency*** or ***Level*** sweep.

Start

Enter the start frequency or level for the sweep.

Stop

Enter the stop frequency or level for the sweep.

Step Time

Enter the step time (duration of the step) to a resolution of 1 ns.

Spacing

Specify linear or logarithmic spacing of the step points.

Step Mode

Specify whether the sweep is based on the size of step, or the number of steps.

Step Size

Enter the step size - in the range 1 Hz to the instrument's maximum frequency, or 1 dBm to 113 dBm - to a resolution of 1 Hz/1 dBm.

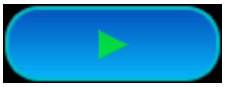
Step Points

Enter the number of frequency or level steps.

Sweep control

Use the buttons in the Control field to start, stop and pause the sweep operation.

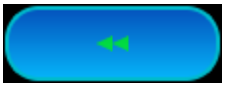
Status messages show the current progress of the sweep.



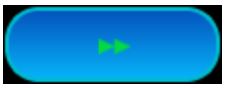
Touch the Play button to start a sweep. If the sweep is set to Continuous it runs indefinitely.

Touch the Pause button to stop the sweep. Then use the  and  buttons to step the current value backwards and forwards.

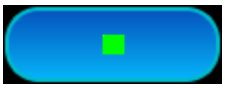
Touch  again to continue the sweep.



Whilst the sweep is paused, touch this button to decrease the current sweep frequency or level one step at a time.



Whilst the sweep is paused, touch this button to increase the current sweep frequency or level one step at a time.

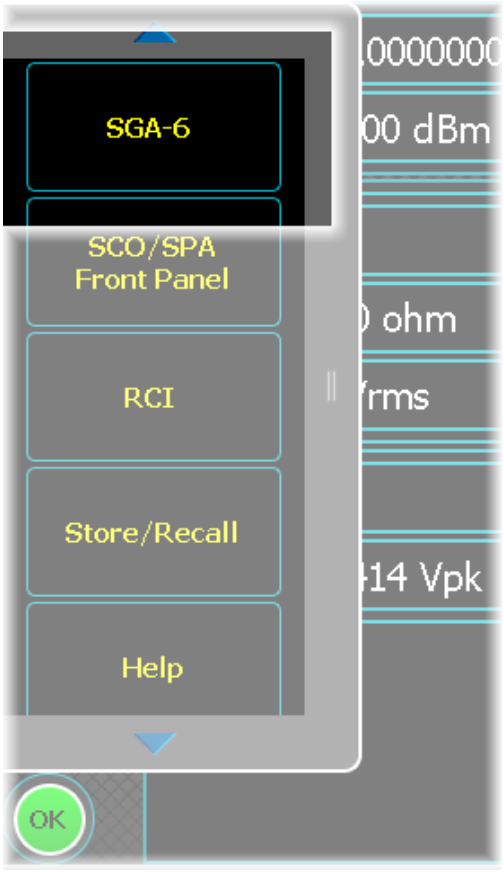


Stop the sweep at any time by touching this button. The sweep halts and the frequency or level resets to its start value.

Return to the Modulation screen.

Controlling the SGA

You have a choice of location from which you control the SGA. You can control all functions of the SGA from the main screen. Or you can control it from the SGA-3/SGA-6 button on the menu tab:



This button displays further buttons that change the main display in exactly the same way as the ***Forward*** button 

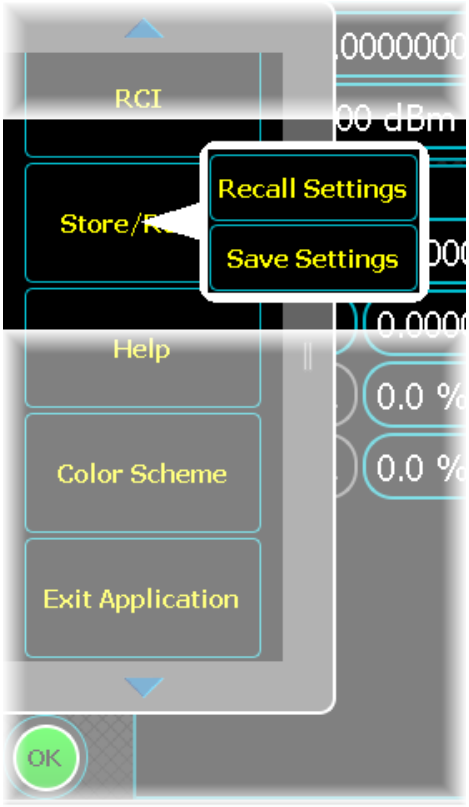
Controlling another S Series instrument

You can attach S Series instruments together physically (using Aerolock™) and electrically (via USB plug & play) to form a combined instrument with multiple functions. After you connect a module to the SGA via USB, its presence is recognized automatically, and the features and applications relevant to that module become available in the on-screen menu of the controlling SGA, whose menu bar shows 'SCO/SPA Front Panel'.

Many applications are being supported, including tests for power amplifiers, receiver selectivity, intermodulation, adjacent channel power and mixer testing, with further developments all the time: check the current data sheet at Aeroflex.com.

Storing and recalling instrument settings

You can save the setup of the instrument using a file name, and then recall the setting later. This lets you return easily to a preferred measurement configuration.



Store

Touch ***Store/Recall***, ***Save Settings***. The popup shows the current file location.

Enter a file name using the virtual keyboard that pops up when you touch the File Name field.

When you touch ***Save***, the instrument stores the current configuration and settings to the removable hard drive.

Recall

Touch ***Store/Recall***, ***Recall Settings***. A popup lets you browse for currently stored files.

Touch the file you want to recall, and the instrument is configured with the stored settings.

Remote operation

You can operate the instrument remotely via GPIB.

Remote operation via GPIB

You can operate the SGA remotely via the GPIB interface. The GPIB (General Purpose Interface Bus) interface provides instrument control with full talk and listen capability. The command syntax conforms to IEEE 488.2.

Background to GPIB

GPIB is a high-performance bus that allows instruments and computers to be combined into integrated test systems. The bus and its associated interface operations are defined by the IEEE 488.1 standard. The later IEEE 488.2 standard defines the interface capabilities of instruments and controllers in a measurement system. This standard also defines a set of commands that a device must accept, and programming errors that a device must recognize and report. The cables that link the devices on the bus consist of 16 signal lines that are divided into three groups:

- Data bus: eight signal lines that are used to send data from one device to another.
- Handshake lines: the transfer of each byte of information over the data bus is controlled by a three-wire handshake process between the source of the data (talker) and the destination device (listener). This forces data transfers to occur at the speed of the slowest device, and ensures data integrity in multiple listener transfers. The handshake cycle is usually performed automatically and is transparent to the GPIB programmer.
- Control lines: five control lines (or interface management lines) are used to both send bus commands and to address devices.

Devices that send data over the data lines are called talkers; devices that receive data over the same lines are called listeners. Controllers are devices that use the control lines to specify the talker and listener in a data exchange. A GPIB system can contain more than one device with controller capabilities, but only one is allowed to control data exchanges at any given time.

The device currently controlling data exchanges is called the active controller. One of the controller-capable devices can be designated as the system controller, which can take control of the bus even if it is not the active controller. Up to 15 instruments can be connected to a GPIB system. GPIB addresses are used to identify devices on the bus. The active controller uses these addresses to specify which device talks (via a Talk Address) and which device listens (via a Listen Address) during a data exchange. Each device must therefore have a unique address, and is set on the instrument itself, using either a front-panel key sequence or a rear-panel switch. Any given device address can specify two corresponding address codes, a Talk Address and a Listen Address. The decimal equivalent of the allowable address range is 0 to 30 inclusive.

SCPI compatibility

This instrument may be operated remotely via an interface that conforms to:

- IEEE Std 488.1-1987, which defines the electrical, mechanical and low-level protocol characteristics of the bus structure, the GPIB (General Purpose Interface Bus)
- IEEE Std 488.2-1987, which defines standard codes, formats, protocols and common commands for use with IEEE Std 488.1.

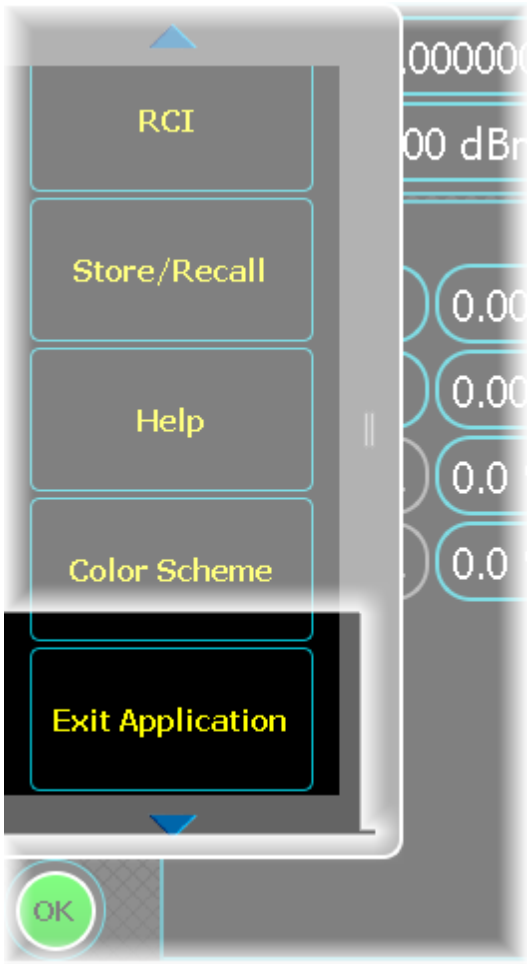
The instrument is not fully compliant with SCPI (Standard Commands for Programmable Instruments) because many product features are not covered by that standard, and modern software trends favor the use of instrument drivers as a means of achieving interchangeability. However, we recognize that SCPI is in common use by system developers and a number of SCPI features that make system integration easier have been implemented. These include the extended status reporting structure, the error-numbering scheme, the command mnemonic derivation rules (long and short form), and many of the most frequently used commands themselves. Refer to SCPI 1999 (standard available from the IVI Foundation) for details.

Command Reference Manual

All available GPIB commands, together with an introduction to the conventions used for GPIB programming, are listed in the SGA Command Reference Manual, part no. 47090/071.

Accessing Windows

Touch the ***Exit Application*** button (on the menu tab) to close the SGA application:



The SGA application closes and you now see the Windows™ desktop.

Powering down

Press the on/off switch on the front panel.

The instrument takes a few seconds to power down, first closing the SGA application, then Windows®. There is no need to exit Windows separately.

Removing power

Note: the on/off switch does not isolate the instrument from the line power. To remove all power from the instrument, disconnect the power cord.

CAUTION

Do not disconnect the line cord until the instrument has finished powering down, as (similar to a PC) you may corrupt data.

Help

Touch the ***Help*** button (on the menu tab) to see information about the instrument, such as serial number, software version, options fitted:

Color scheme

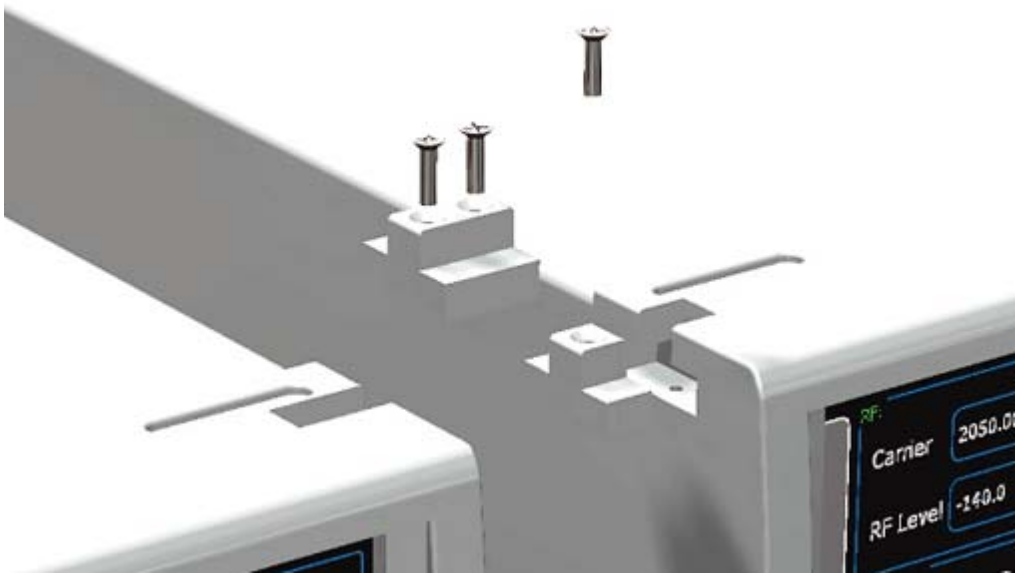
Touch the ***Color Scheme*** button (on the menu tab) to change the appearance of the SGA screen:

Standard displays white text on a black background, with colored buttons.

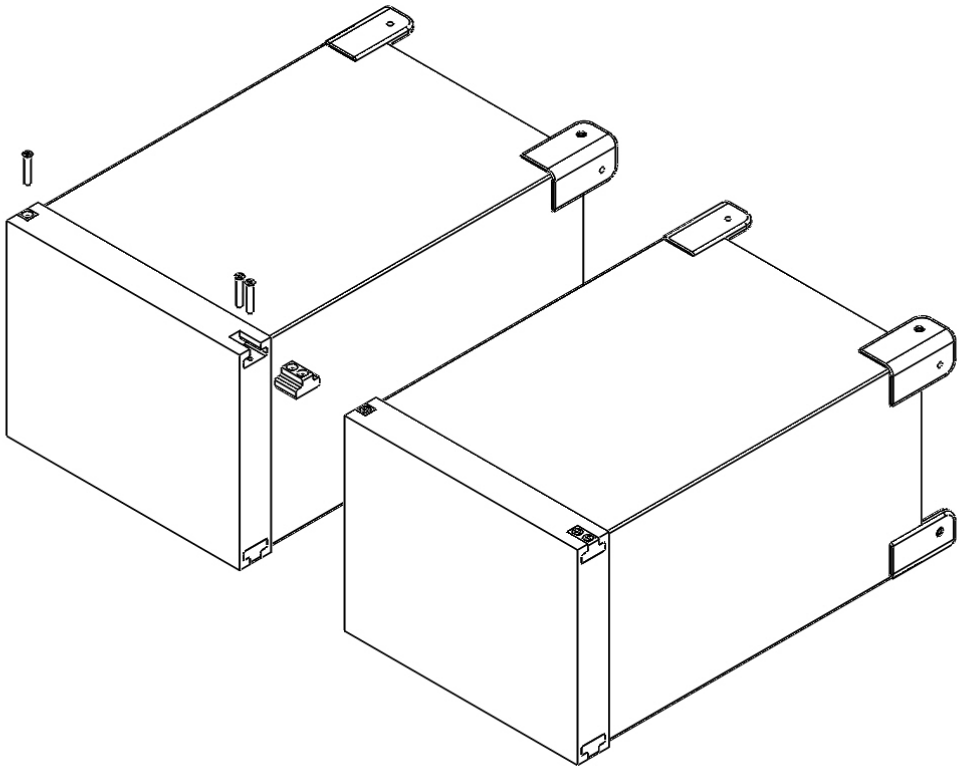
High Visibility displays black text on a white background, with minimal color on the screen.

Aerolock

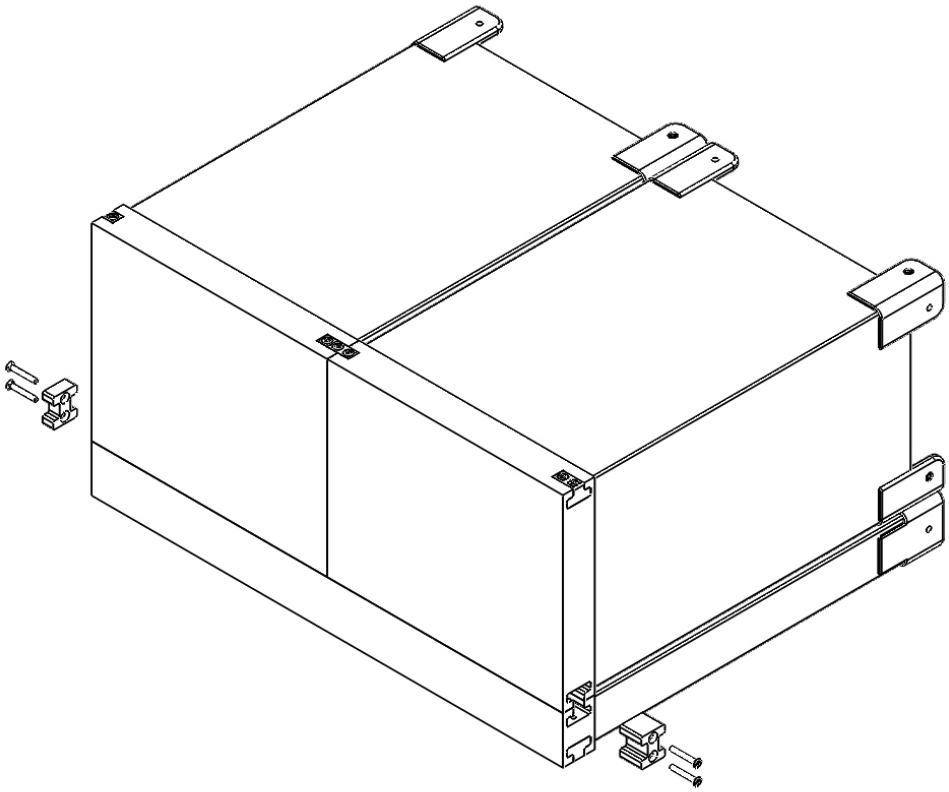
Aerolock™ is a simple, strong interlocking mechanism...



...that allows SGA instruments and a full-rack width module, or two half-rack-width modules, to be joined together.



Full-width modules fit underneath two half-rack-width modules:



Electrical connections

Signal and control connections are created by USB cables that link the master instrument (the SGA) and further modules such as signal generators, analyzers, and combiner.

Technical support

Aeroflex products are designed and manufactured to provide a high level of trouble-free performance. However, instruments typically require routine maintenance and calibration and installation of new software. If you require help or have a question, you can contact a service facility in your area. In the first instance, contact the Aeroflex help desk at www.aeroflex.com/ats/contact.cfm.

Maintenance

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.

Calibration

The recommended calibration interval is 2 years. If the instrument is due for calibration, or you suspect that it is not performing correctly, contact the Aeroflex help desk at www.aeroflex.com/ats/contact.cfm.

Customer download portal

Aeroflex software products are available for download from the Aeroflex customer download portal (CDP) at http://cdp.aeroflex.com/. You need a user account to use the Aeroflex CDP. If you do not already have access, request a user account by contacting the Aeroflex help desk.

Installing software

You can download new software from the customer download portal (CDP). Talk to an engineer at the help desk for assistance.

Routine

Safety testing and inspection

Prior to carrying out any inspection and tests, you must disconnect the instrument from the power supply, and remove all external signal connections. All tests should include the instrument's own power cord, all covers must be fitted and the power 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

Carry out a visual inspection 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) or national or local regulations. As a guide, this equipment, 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 retest 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 (for example, that ventilation is adequate, supply isolators are accessible, supply wiring is adequate and properly routed).
- Check the condition of the power cord and supply connector(s).
- Check that the disconnecting device or isolator is easily accessible.
- Check the correct rating and type of supply fuses.
- Check the security and condition of covers and handles.
- Check the presence and condition of all warning labels and markings, and supplied safety information.
- Check the wiring in rewireable plugs and appliance connectors.
- Check the cleanliness and condition of any ventilation fan filters.
- Check that the power supply switch isolates the equipment from the supply.
- Check the supply indicator functions (if fitted).

If any defects are noted, rectify them before proceeding with the following electrical tests (unless local instructions apply).

2 Ground bonding tests

Ground bonding tests should be carried out using a 25 A (12 V maximum open circuit voltage) DC source. Limit tests to a maximum duration of 5 seconds. The pass limit should be 0.1 Ω after allowing for the resistance of the power cord. Do not exceed the test duration, as this may cause damage to the equipment. Carry out the tests between the supply ground and exposed case metalwork. Make no attempt to perform the tests on functional grounded areas (for example, signal-carrying connector shells or screen connections), as this will result in damage to the equipment.

3 Insulation resistance tests

Apply a 500 V DC test between the protective ground 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 a temporary strap. Apply the test voltage for 5 seconds before taking the measurement.

Aeroflex employs reinforced insulation in the construction of its products, so 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.

Rectification

We recommend that the results of the above tests are recorded and checked during each repeat test. Investigate significant differences between the previous readings and measured values.

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

Replace safety-critical components with equivalent parts only, 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 the products 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.

Cleaning

Before starting any cleaning, switch off the instrument and disconnect it from the supply.

Case exterior: use a soft cloth moistened with water to clean the case; do not use aerosol or liquid solvent cleaners.

Touch screen: take care not to scratch the touch screen during use or when cleaning. Clean the touch screen by wiping a slightly damp, soft, lint-free cloth gently over the surface. If this does not remove finger marks, dampen the cloth sparingly with isopropyl alcohol.

WARNING *Isopropyl alcohol is flammable.*

Air inlet remove dust and any other impediments to airflow from the air inlet holes on the underside of the instrument

Putting into storage

If you are putting the instrument into storage, ensure that the following conditions are maintained:

Temperature range:	20 to +70°C
Humidity:	5 to 93% non-condensing

Removing the hard drive

1. Shut down the instrument.
2. Undo the two captive thumbscrews retaining the hard drive unit to the rear panel.
3. Slide out the hard drive unit.
4. Protect the connectors on the hard drive unit. Seal it in an antistatic bag, enclose it in bubble wrap, and protect it from mechanical shocks.

Glossary

ADC	Analog-to-Digital Converter: converts a time-varying signal to discrete binary values.
ALC	Automatic Level Control
AM	Amplitude Modulation: modulation of the amplitude of a carrier wave.
CW	Continuous Wave: electromagnetic waves, the successive oscillations of which are identical under steady-state conditions, which can be interrupted or modulated to convey information.
DAC	Digital-to-Analog Converter: device that converts a digital code to a time-varying analog signal.
dB	Decibel: a dimensionless logarithmic unit of measurement that expresses the ratio of a power relative to a specified or implied reference level.
dBc	Decibel value specified relative to the carrier level.
dBm	Decibels value specified relative to 1 mW.
FM	Frequency Modulation: modulation of the frequency of a carrier wave.
GND	Ground
GPIB	General Purpose Interface Bus: a parallel interface defined by the IEEE 488 standard, used for attaching sensors and programmable instruments to a computer.
GSM	Global System for Mobile communications: the first all-digital (2G) mobile network.
GUI	Graphical User Interface
HF	High Frequency: radio signals in the range 3 MHz to 30 MHz.
IF	Intermediate Frequency: a frequency to which a carrier frequency is shifted as an intermediate step in superheterodyne transmission or reception.
IM(D)	Intermodulation (Distortion): the result of mixing different frequencies together, producing additional signals that are not generally harmonics of the originals.
LED	Light Emitting Diode
LO	Local Oscillator: an electronic device used to generate a signal normally used to convert a signal of interest to a different frequency using a mixer. See IF.
LVDS	Low-Voltage Differential Signaling: uses a current source to transmit and receive fast signals over simple twisted-pair cable.
MF	Medium Frequency: radio signals in the range 300 kHz to 3 MHz.
PNP	Plug-‘N’-Play
PXI	PCI eXtensions for Instrumentation
PXI Express	Backwards-compatible with PXI, but providing faster timing and signal lines.

RF	Radio Frequency
RMS	Root Mean Square: the most common mathematical method of defining the effective voltage or current of an AC waveform.
SCO	S Series combiner module
SFP	Soft Front Panel: a representation of an instrument's control panel, generated in software, that allows the user to control the underlying software and hardware.
SMA	SubMiniature version A (connector)
SMB	SubMiniature version B (connector)
SPA	S Series spectrum analyzer module
TTL	Transistor-Transistor Logic: switching voltage ranges are VOL = 0.4 V, VOH = 2.4 V, VIL = 0.8 V, VIH = 2.0 V
UE	User Equipment: a device with which the user communicates with the base station over a radio network. Usually a mobile telephone, but may be a laptop computer or similar device.
UHF	Ultra High Frequency: radio signals in the range 300 MHz to 3 GHz.
USB	Universal Serial Bus: a serial bus standard for connecting devices to a host computer, using a standardized interface socket and allowing devices to be connected and disconnected without removing power.
UUT	Unit Under Test
VCO	Voltage-Controlled Oscillator: a frequency generator whose output frequency is a function of an applied voltage. If the applied voltage varies, the output is modulated.
VHF	Very High Frequency: radio signals in the range 30 MHz to 300 MHz.
VSWR	Voltage Standing-Wave Ratio: the voltage ratio of the amplitude of a partial standing wave at an antinode (maximum) to the amplitude at an adjacent node (minimum), in a transmission line. A measure of the matching, and efficiency, of transmission devices.
VXI	VMEbus Extension for Instrumentation

Appendix A Valid modulation modes

	Int AM1	Int AM2	Int (AM1 +AM2)	Ext AM1	Ext AM2	Int FM1	Int FM2	Int (FM1 +FM2)	Ext FM1	Ext FM2	Int FM1	Int FM2	Int (FM1 +FM2)	Ext FM1	Ext FM2	Pulse
Int AM1		√		√	√	√	√	√	√	√	√	√	√	√	√	√
Int AM2	√			√	√	√	√	√	√	√	√	√	√	√	√	√
Int (AM1 +AM 2)				X	X	√	√	√	√	√	√	√	√	√	√	√
Ext AM1	√	√	X		√	√	√	√	√	√	√	√	√	√	√	√
Ext AM2	√	√	X	√		√	√	√	√	√	√	√	√	√	√	√
Int FM1	√	√	√	√	√		√		√	√	X	X	X	X	X	√
Int FM2	√	√	√	√	√	√			√	√	X	X	X	X	X	√
Int (FM1 +FM 2)	√	√	√	√	√				X	X	X	X	X	X	X	√
Ext FM1	√	√	√	√	√	√	√	X		√	X	X	X	X	X	√
Ext FM2	√	√	√	√	√	√	√	X	√		X	X	X	X	X	√
Int FM1	√	√	√	√	√	X	X	X	X	X		√		√	√	√
Int FM2	√	√	√	√	√	X	X	X	X	X	√			√	√	√
Int (FM1 +FM 2)	√	√	√	√	√	X	X	X	X	X				X	X	√
Ext FM1	√	√	√	√	√	X	X	X	X	X	√	√	X		√	√
Ext FM2	√	√	√	√	√	X	X	X	X	X	√	√	X	√		√
Pulse	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	

√ Allowed combination

X Disallowed combination

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