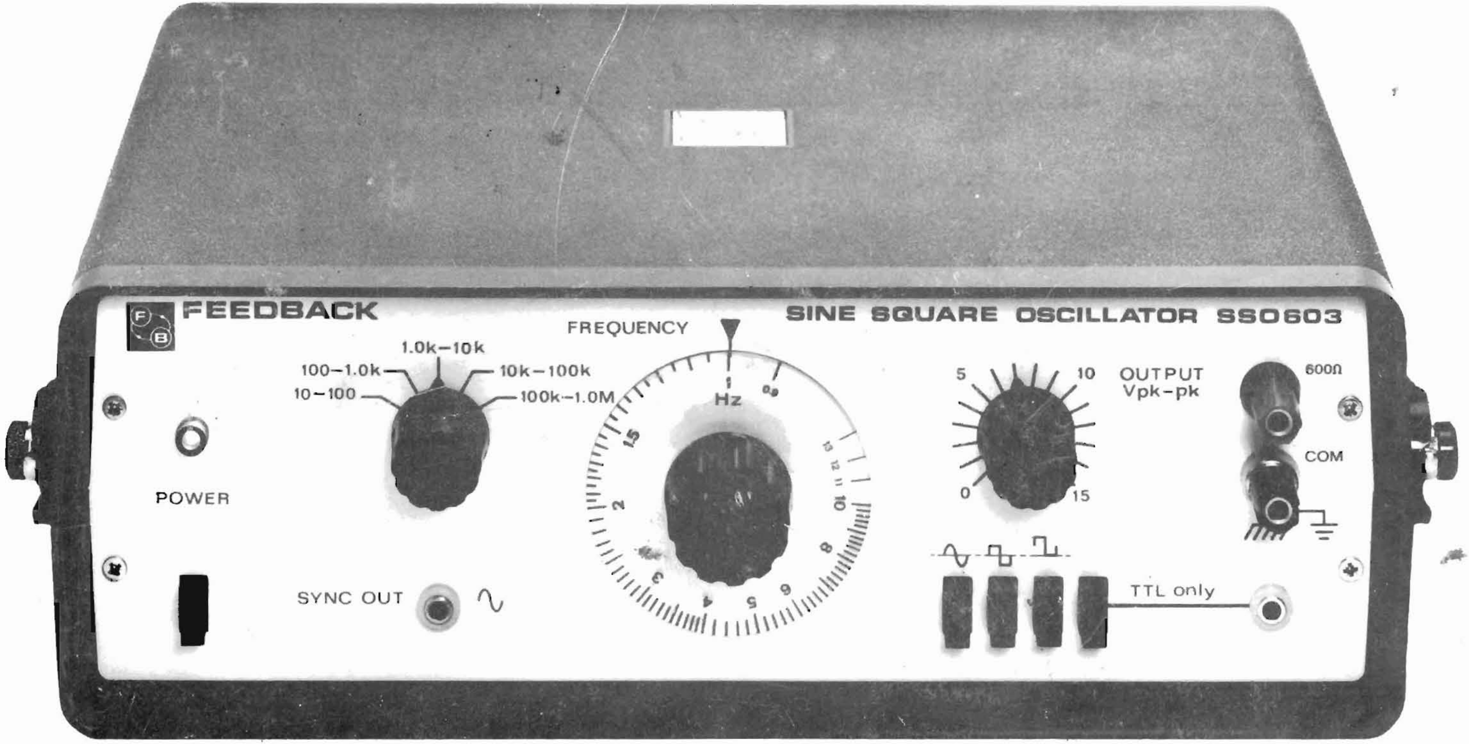
Sine-Square Oscillator SSO603



FEEDBACK

Sine-Square Oscillator SSO603

Contents

FEEDBACK INSTRUMENTS LIMITED CROWBOROUGH SUSSEX ENGLAND

Telephone: Crowborough (089 26) 3322 Cables: Feedback Crowbr Telex: 95255

Manual 603 *EdC 0480* *Printed in England by FI Ltd, Crowborough*

Component replacement

Although this Feedback manual was believed to be correct at the time of printing, components supplied may differ slightly from those described.

We endeavour continually to improve our equipment by incorporating the latest developments and components, even up to the time of despatch. Whenever possible we will include such new or revised information.

Whenever possible, replacement components should be similar to those originally supplied. These may be ordered direct from Feedback Instruments Limited or its agents by quoting the following information:

1. Equipment type
2. Equipment serial number
3. Component reference
4. Component value

Standard components can often be replaced by alternatives available locally.

COPYRIGHT NOTICE

The Health and Safety at Work Act 1974

We are required under the Health and Safety at Work Act 1974, to make available to users of this equipment certain information regarding its safe use.

The equipment, when used in normal or prescribed applications within the parameters set for its mechanical and electrical performance, should not cause any danger or hazard to health and safety if normal engineering practices are observed and they are used in accordance with the instructions supplied.

If, in specific cases, circumstances exist in which a potential hazard may be brought about by careless or improper use, these will be pointed out and the necessary precautions emphasized.

While we attempt to give the fullest possible user information in our handbooks, if there is any doubt whatsoever about any aspect relating to the proper use of this equipment the user should contact the Product Safety Officer at Feedback Instruments Limited, Crowborough.

DESCRIPTION

SECTION 1

1.1 Introduction

The Feedback SSO603 Sine-Square Oscillator is based on a novel RC oscillator circuit that generates sine waves. A block diagram of the main features of the circuit is shown in fig 1.1. The fine frequency controlling element is a dual-gang air-spaced capacitor effectively giving infinite resolution, and the ranges are selected by switching the requisite resistors.

A thermistor is used to control the amplitude of oscillation.

A current input Schmitt trigger is used to produce a square waveform from the sine wave for the various square-wave output options.

The output amplifier provides a current which is connected to the slider of the 600-ohm output resistance, thus providing an output from a true 600-ohm output impedance.

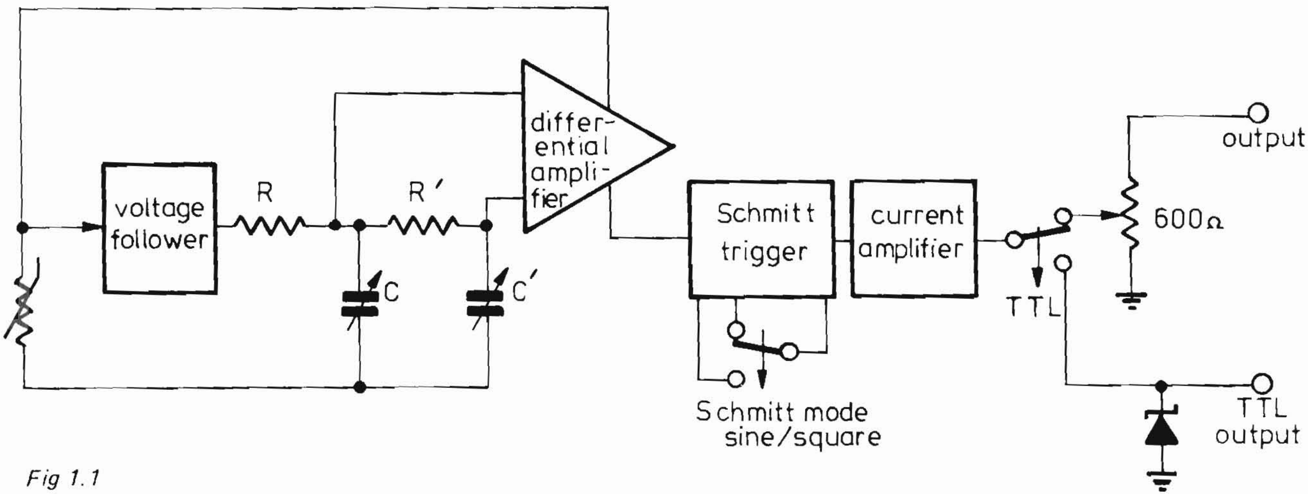


Fig 1.1

When the TTL output is selected the output current is shunted by a zener diode to keep the output voltage and output impedance at values suitable for TTL.

A separate sinewave 'sync' output is continuously available for oscilloscope synchronisation or frequency monitoring.

1.2 Mechanical

The SSO603 is housed in an ABS plastic case made in two halves each secured by two screws on each side. The case provides the main structural strength of the instrument. Removal of the case gives access to all components. Without the cover the SSO603 consists of a horizontal PWB fixed by small plastic brackets to the

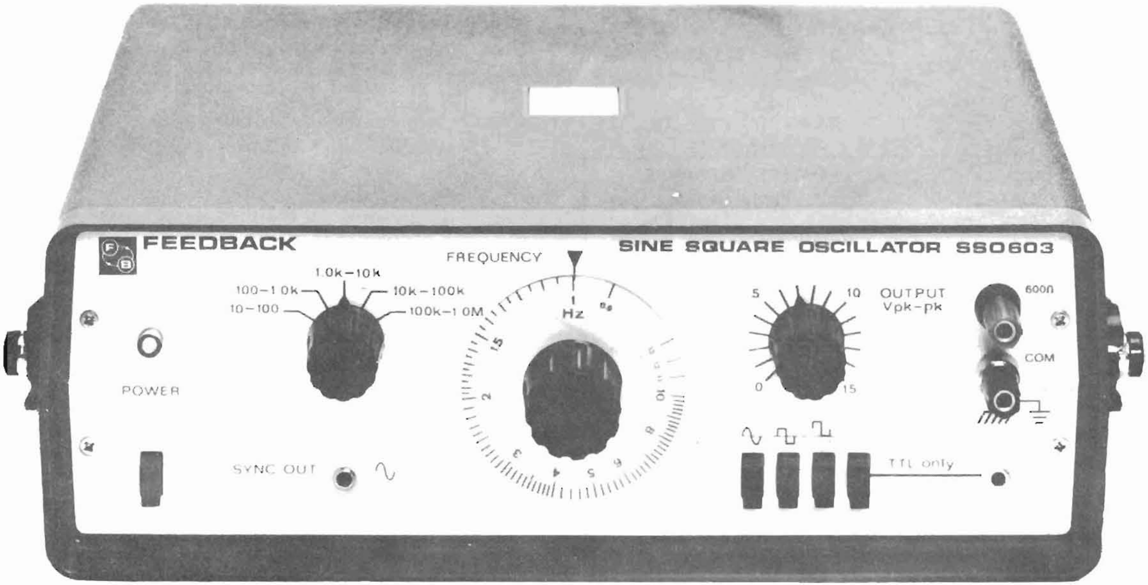


Fig 1.2

front and rear panels. This provides a structure strong enough for normal handling and maintenance.

The low power dissipation of the SSO603 obviates the need for ventilation holes. The oscillator tuning capacitor and associated resistors are mounted in a die-cast metal screening box fixed to the front panel. This provides complete electrostatic screening and protection from dust for the sensitive high-impedance circuit.

All controls are situated on the front panel shown in fig 1.2. They are:

Power	Red pushbutton power switch Separate red power indicator
Frequency	Rotary range switch Fine frequency control (approximately logarithmic calibrated frequency dial)
Waveform Selection	Four black pushbuttons
Amplitude	Single rotary control
Output terminals	Main output from pair of Red and Black 4mm socket binding posts
TTL Output	Separate 4mm socket
Sync out	4mm socket

1.3 Specification of type SSO603

The SSO603 is a general-purpose, solid state 'RC' sine oscillator providing sine wave or square wave outputs.

Frequency

Range 10Hz to 1MHz in five switched ranges.
Resolution – infinite.

Range Overlap

25% at top of each range and 10% at bottom of each range.

Scale Accuracy

±5% of setting. Typically ±2% of setting.

Frequency Stability

Measured at 1kHz on 1 to 10kHz range.

Drift Typically 50ppm per 10 minutes measured after 10 minutes warm up.

Supply voltage change Typically 0.003% for 10% change in supply voltage.

Main Output

Waveforms

Sine, Square or Positive-only Square wave selected by pushbuttons.

Output

Impedance nominally 600 ohms.

Amplitude Control

Single continuous control nominally 0-15V pk-pk at 1V pk-pk intervals.

Minimum Usable Output

Typically 200mV pk-pk.

Amplitude Stability

Typically ±1% over frequency range.

Offset

The d.c component on the sine and square waveforms is separately set by internal adjustments and is normally set to within 0.1V of zero. This d.c component is reduced proportionally to the signal output by the output control (or by resistive loading).

Terminations

4mm binding posts (Hi-red and Lo-black) on ¾'' pitch.

Purity

Sine distortion less than 0.5% at 1kHz.
Square wave rise and fall times – less than 100ns.

Auxiliary Outputs

TTL compatible square wave Available only when appropriate pushbutton is depressed.

Amplitude +3.5 to +4.5V in the 'high' state and 0 to -1V in the 'low' state.

Rise Time Less than 100ns.

Current sink capacity Eight standard TTL loads.

Termination 4mm socket

Sync Out Continuously available sine waveform

Amplitude 2 to 6V pk-pk

DC component Less than 4V d.c

Impedance 1kΩ

Termination 4mm socket

Power requirements

Line voltage

200/250V or 100/125V rms, 50 or 60Hz.

Consumption

5VA

Fuse

315mA slow blow (20mm x 5mm) Littel fuse style 213
Beswick TDC123
Buss GMA

Dimensions and Weight

Width	300mm (12in)
Height (with feet)	115mm (4.5in)
Depth	225mm (9in)
Weight	2.1kg (4.63lb)

OPERATION

SECTION 2

2.1 Installation of SSO603

The oscillator is packed in inserts of expanded polystyrene to prevent damage in transit. On opening the end of the corrugated cardboard container, the inserts together with the SSO603 should be smoothly withdrawn from the container. Take care that the inserts and the SSO603 are held together during this time.

Inspect the SSO603 and if any damage is evident immediately notify the carrier.

2.2 Voltage Selection

Ensure that the instrument is set to the appropriate voltage supply. This is effected either by inspecting the tag (if fitted) on the power cable or by checking the voltage selection switch after removing the top cover of the instrument.

Voltage selection is accomplished by a slide switch on the printed circuit board; it has positions marked '115' and '230'.

Set the switch to '115' for operation from 100 to 125 volts and to '230' for 200 to 250 volts.

Wire connections. The colour code of the power supply cable is:

Brown	Live
Blue	Neutral
Green/Yellow	Ground

The ground wire is connected to the front and rear panels of the SSO603 and to the common terminal on the front panel.

2.3 Frequency Selection

Any value of frequency in the range 10Hz to 1MHz may by obtained by use of the range switch and fine frequency control. The rotary range switch provides the following frequency decades:

10Hz to 100Hz
100Hz to 1.0kHz
1.0kHz to 10kHz
10kHz to 100kHz
100kHz to 1MHz

The required frequency is set by the variable control, graduated 1 to 10 (0.9 to 13 with overlap). For example, to set 3.6kHz turn the range switch to the 1.0kHz to 10kHz range and turn the variable control to 3.6.

2.4 Outputs

Selection

A required output waveform is selected by pushing one of the four output selection buttons – Sine, Square, positive only square wave or TTL-compatible square wave. Of these four options, only the TTL output is available from a separate 4mm socket, the remainder being available from the Main Output.

Main Output

The amplitude of the output waveform is set by the output control knob calibrated from 0 to 15V pk-pk and is the open-circuit or no-load voltage. The output impedance is 600 ohms and any loading will lower the output voltage. In particular if loaded with 600 ohms the terminal voltage will be half that indicated.

TTL Output

This output is available from a separated 4mm socket when the appropriate pushbutton is depressed. The separate output is provided as a precaution against accidental damage that might ensue should an overvoltage be applied and the wrong waveform pushbutton depressed.

The output amplitude is fixed and is 5-volt TTL-compatible. The output impedance is low when in the '0' or '1' condition and is high during transition.

Sync Output

This extra sinewave is continuously available and is intended for such functions as frequency monitoring and/or oscilloscope synchronisation. In the latter case the use of a sinewave allows a certain amount of phase adjustment of the oscilloscope display by adjustment of the oscilloscope trigger level.

Phase relationships

The sync output is in phase with the main sine wave output and in approximate anti-phase to the various square wave outputs.

CIRCUIT DESCRIPTION

SECTION 3

For convenience the circuits in this section are simplified or in the form of block diagrams.

The full circuit is shown in fig 4.4.

3.1 RC Frequency Network

The basic oscillator is based on the circuit shown in fig 3.1.

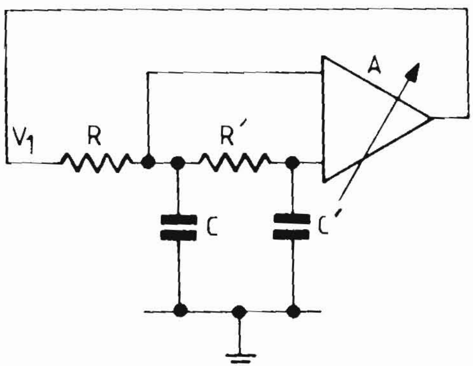


Fig 3.1

This circuit was used in preference to other RC circuits because it enables the frame of the double-gang variable capacitor C, C′ to be grounded. At resonance the oscillatory voltages will be as in the phasor diagram fig 3.2. The amplifier A amplifies $V_{R'}$ by X3, to provide the voltage V_1 to maintain oscillation. The phase and gain relationship of the network RCR′C′ is very similar to that of the active side of the well-known Wien Bridge.

The resonant frequency is $f = \frac{1}{2\pi RC}$ where R = R′ and C = C′.

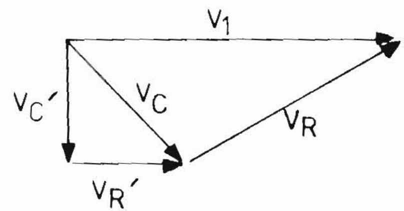


Fig 3.2 Phasor diagram

The amplitude of oscillation is maintained by controlling the gain of the oscillator loop by means of a thermistor.

3.2 RC Oscillator Amplifier

Fig 3.3 shows the amplifier used to maintain oscillation in the RC network. The FET's TR9a and TR9b provide suitable high impedance inputs for connection from the RC network. The differential input stage TR9-11 has two outputs. One output is used for feedback to the RC network via the thermistor and the emitter follower TR14 while the other output goes to the output circuit which includes the Schmitt trigger. The gain of the amplifier is principally determined by the ratio of resistor network R_A and resistor R_2. For steady oscillation this ratio has to be about 1:3. When the thermistor R_2 is cold the ratio is much greater than 3 and the amplitude of oscillation builds up. The power then dissipated in the thermistor causes its resistance to drop so reducing the rate of build up of oscillation. A point of equilibrium is reached where the thermistor resistance is just three times that of resistor network R_A, so stabilising the amplitude of oscillation.

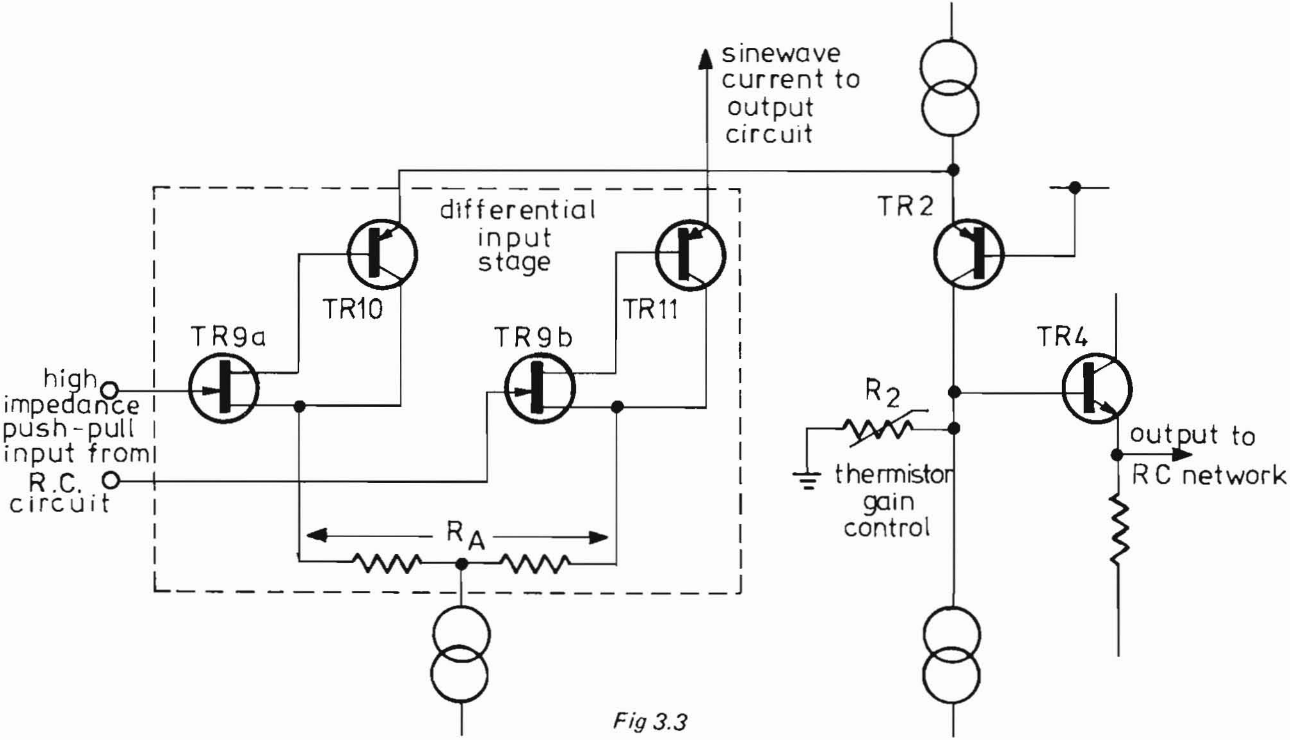


Fig 3.3

3.3 Schmitt Trigger

Unless 'the sine wave main 'output' is selected, the Schmitt Trigger produces a square waveform from the sinewave input. The circuit is shown in fig 3.4(a) and the corresponding waveforms in 3.4(b).

When the sinewave is selected resistor R42 is shunted by resistor R34 so that switching does not take place and a sine voltage waveform is available at the emitter of transistor TR13.

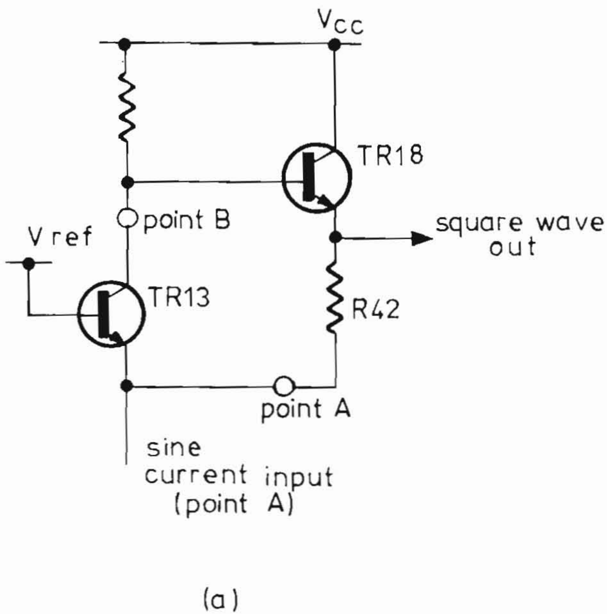


Fig 3.4a

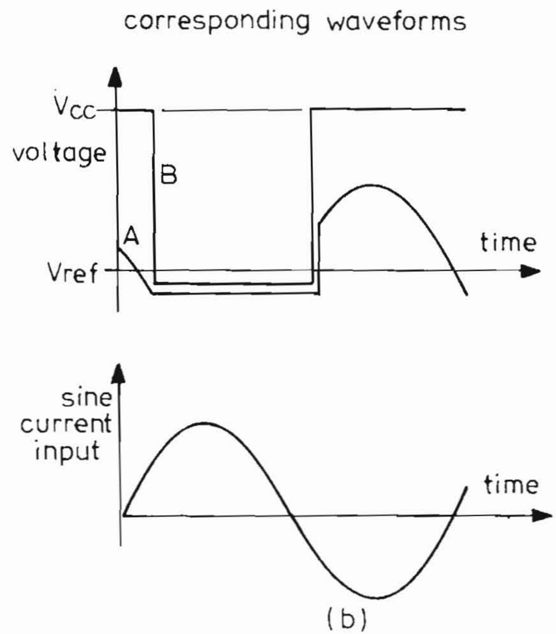


Fig 3.4b

3.4 Output Circuit

The sine or square-wave voltage waveforms generated by the circuit in fig 3.4(a) are converted to a corresponding current waveform by transistor TR16. Transistor TR19 provides a constant-current load switched to the appropriate value for the selected waveform.

When TTL is selected the output current is fed to a Zener diode to limit the voltage excursion abruptly at positive and negative limits suitable for 5-volt TTL.

For all other output options the output current is connected to the slider of the linear output potentiometer which is shunted to provide a 600-ohm output impedance.

3.5 Power Supply

The SSO603 circuit operates from unregulated positive and negative voltage lines of about 25 volts.

The mains transformer has a double primary winding connected in series for 200 to 250-volt operation and in parallel for 100 to 125-volt supplies. Voltage selection is effected conveniently by a slide switch positioned on the main PWB.

MAINTENANCE

SECTION 4

4.1 Fault location

Faults will appear as abnormal outputs from the oscillator or as calibration inaccuracies. The nature of the abnormality allows the area in which the fault is located to be narrowed.

The oscillator has been designed to allow access to most of the components by removal of the case. Position the carrying handle as in fig 4.1 thereby allowing access to the four case-fixing screws. Unscrew with a Posidrive No. 2 screwdriver, the four screws on each side of the case and then remove the handle, while pulling outwards as shown in fig 4.2 to avoid scratching the case.

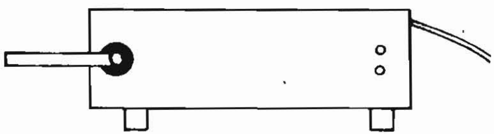


Fig 4.1

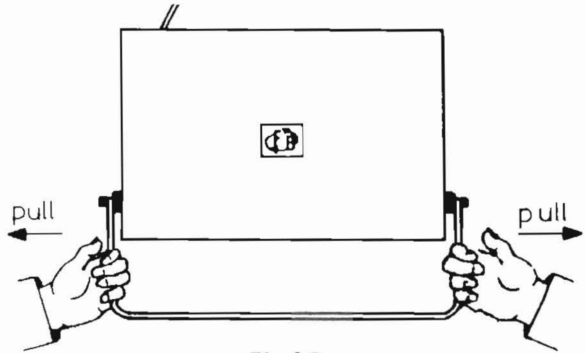


Fig 4.2

The top and bottom halves of the cover can then be lifted off. The chassis formed by the PWB and front and rear panels is strong enough for normal handling during maintenance.

Positions of components and test points referred to in the following tables can be found by reference to the component diagram fig 4.3 and the complete circuit diagram fig 4.4.

4.2 Preset Controls

Before assuming a fault condition, check that the preset controls are not in need of adjustment. The following is a list of the controls and the malfunctions that can occur if the controls are improperly set.

Symptom	*Control*
Amplitude of sine wave wrong	R27
DC offset on square wave and sine wave	R41
DC offset on sine wave	R36
Mark/Space ratio of square wave	R32
Frequency calibration out at all frequencies	Positions of frequency knob and dial on shaft
Frequency calibration at 1MHz	C7

4.3 Setting-up Procedure

This is a procedure for bringing the SSO603 up to specification – it is not a fault-finding procedure, although failure to set-up will indicate a fault condition.

1. Select square waveform and display the SSO603 output at maximum amplitude on an oscilloscope.

   Set the SSO603 to about 1kHz on the 1 to 10kHz range. Then adjust potentiometer R41 to bring the square wave symmetrical about 0 volts.

2. Select sine waveform from the main output and adjust potentiometer R36 so that the sine wave is also symmetrical about 0 volts and adjust potentiometer R27 so that the maximum pk-pk sine amplitude is 15 volts.

3. Return to square waveform and adjust potentiometer R32 to bring mark/space ratio to unity.

4. While still on 1kHz to 10kHz range adjust the position of the dial and knob on the dual-gang capacitor shaft so that the SSO603 generates 10kHz when the dial indicates 10kHz.

   Check other graduations to be within ±5% of frequency.

5. Switch to the top of the frequency range and adjust capacitor C7 to make calibration at 1MHz correct.

4.4 Diagnostic Table

Unless otherwise stated, set the controls on the instrument as follows.

Frequency range	1kHz to 10kHz
Frequency dial	1.0
Output amplitude	maximum
Waveform	Sine

Symptom	*Test point*	*Correct output at Test Point*	*Probable location of fault*
Power indicator lamp not lighting	Check power supply. Check fuse.	Voltage in range 100-125V or 200-250V	Power supply
Failure to function properly	+ve line	+25 ±5V	Power supply or S/C on lines
	-ve line	-25 ±5V	
	Across D1	8.2V ±0.5V	TR2, TR14
Failure to function properly	Across D2	8.25V ±0.5V	TR7, TR12, TR3, TR5, TR19, TR8
Failure to function properly	Across C1	7.5V ±1V	TR8, TR7, TR1
Failure to function properly	Across C7	0V ±0.2V	TR9, 10, 11 (inside box)
Failure to function properly	Across R45 (+ve supply) current	2.6 ±0.3V (Note (these (values (apply (only	Excessive voltage implies excess current and short circuits. Look for burnt components.
Failure to function properly	Across R46 (-ve supply) current	2.35 ±0.3V (for (sine (output	Low readings suggest o/c components.

4.5 Component Replacement Table

The SSO603 is not critical with regard to component types but proper performance can only be expected if component replacements are of reasonably similar types.

A brief general specification of suitable components is listed together with a look-up table.

Component *Resistors*	*Spec*	*Component*	*Spec*	*Component*	*Spec*	*Component* *Capacitors*	*Spec*
R1	A	R16	B	R31	A	C1	Q
R2	Thermistor	R17	B	R32	E	C2	P
R3	A	R18	B	R33	A	C3	M
R4	A	R19	B	R34	A	C4	M
R5	A	R20	B	R35	A	C5	L
R6	A	R21	B	R36	E	C6	P
R7	A	R22	B	R37	A	C7	L
R8	A	R23	A	R38	A	C8	Q
R9	A	R24	A	R39	A	C9	Q
R10	A	R25	A	R40	A	C10	Q
R11	B	R26	A	R41	E	C11	Q
R12	B	R27	E	R42	A		
R13	B	R28	A	R43	H		
R14	B	R29	A	R44	A		
R15	B	R30	A	R45	A		
				R46	A		

Spec	*Type*	*Rating*	*Tolerance*	*Fixing*	*Position*
A	Resistor	1/8W or more	5% or less	PWB hole ctrs 0.6" Res. dia. less than 0.2"	R1, R3 to 10, R28 to 31, R33 to 35, R37 to 40, R42, R44 to 46.
B	Resistor	1/8W	1%	Mounted on frequency switch	R11 to 22
E	Preset carbon or Cermet pots	0.1W or more	20% or less	See fig 4.3	R27, R32, R36, R41
H	Potentiometer wirewound 1kΩ	½W	±10%	15/16" diam. 1" shaft 5/8" FMF	R43
K	Capacitor	100V	±2½%	see fig 4.3	C5
L	Capacitor compression	100V		PWB centres 0.6" 0.4" wide	C7
M	Jackson Bros. type P222 two-gang 510pF per section				C3, C4
P	Capacitor Ceramic			See fig 4.3	C2, C6
Q	Capacitor Electrolytic	35V wkg	-20 + 80%		C1, C8, C9, C10, C11.

Transistors

If the Ferranti transistor types are not available the following types bearing EIA or Pro-Electron type numbers may be used. This table does not imply that the types listed are equivalents in any other situation

Ferranti	*EIA*	*Pro-Electron*
ZTX108CK	2N930	BC108C
ZTX213CK	2N3251	BC213C
ZTX313CK	2N2369	BSX20

Other components are listed below with the Manufacturer's name.

Circuit ref	*Type No*	*Manufacturer*
TR9	J412	Siliconix
R2	RA54	STC

Other components including mains transformer and switches are supplied to Feedback specifications and should be ordered through Feedback Instruments Limited, Crowborough, Sussex.

Returned instruments

Should the instrument be returned for repair and recalibration at any time, the mains plug should be removed, as no provision for the plug is included in the packing when we return the instrument to you. The address to which an instrument should be returned is:

Feedback Instruments Limited,
Servicing Department,
Park Road,
Crowborough, TN6 2QR,
Sussex, England.

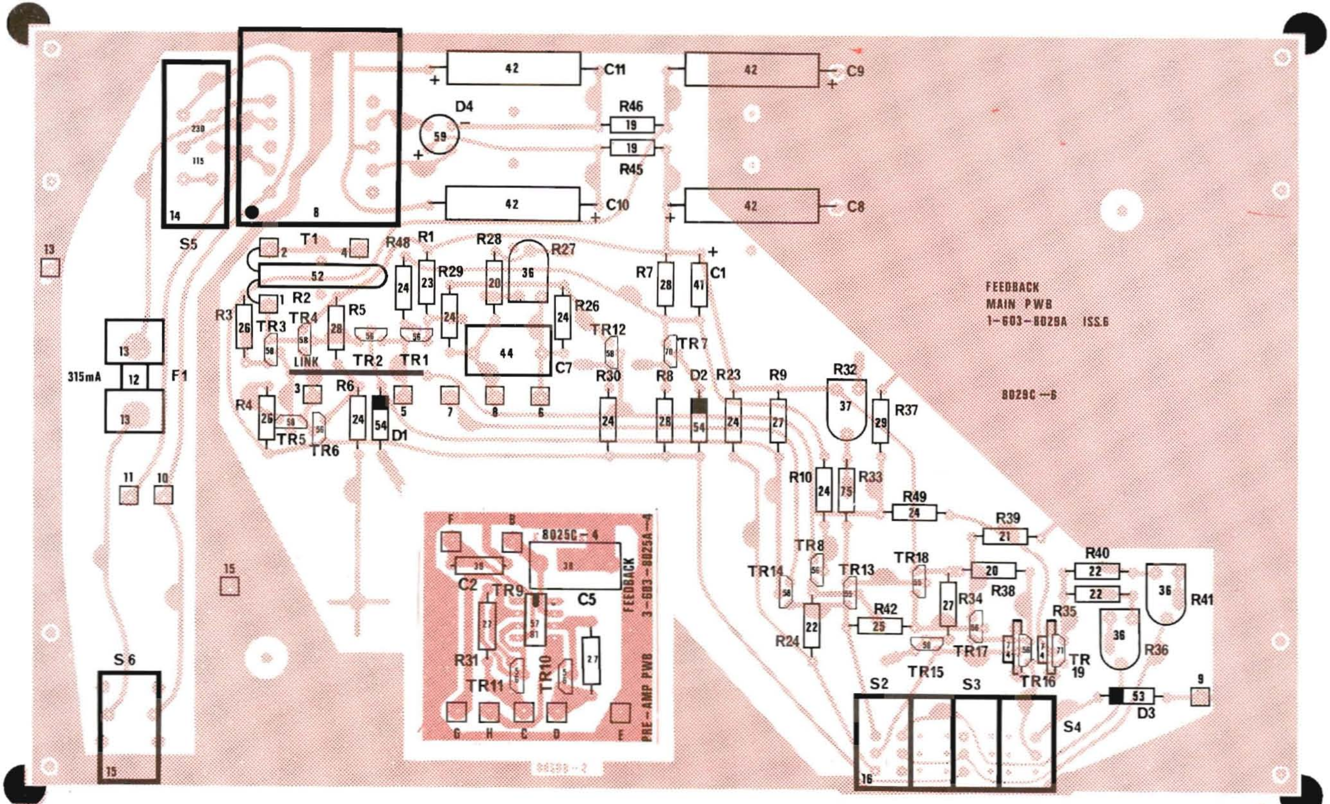

FEEDBACK
MAIN PWB
1-603-8029A ISS.6
8029C-6
8025C-4
FEEDBACK 3-603-8025A-4
PRE-AMP PWB
315mA
F1
S5
S6
T1
LINK
C1
C2
C5
C7
C8
C9
C10
C11
D1
D2
D3
D4
S2
S3
S4

Fig 4.3

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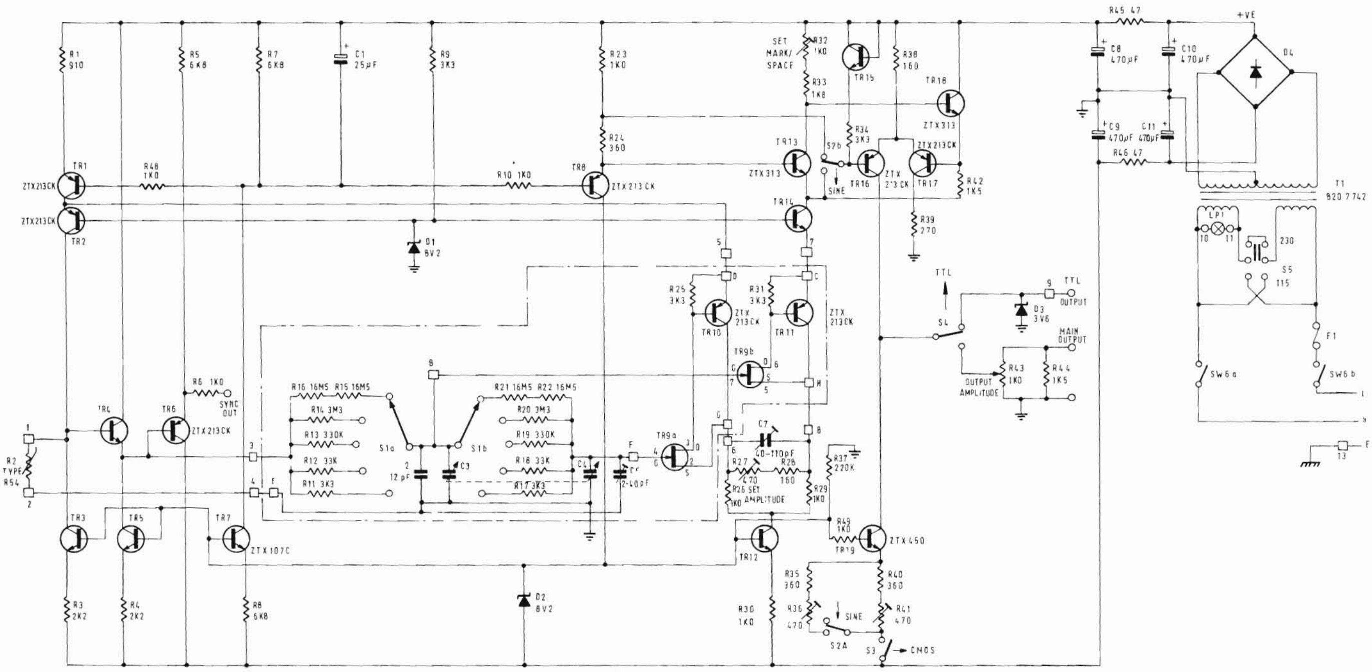

ALL NPN ZTX 108CK EXCEPT WHERE OTHERWISE STATED
ALL RESISTORS ± 5%. 1/4W UNLESS STATED

Fig 4.4 CIRCUIT DIAGRAM SS603