

OPERATOR'S MANUAL

# **Model 25**

**Precision 5MHz  
Function Generator**

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## Introduction

The Model 25 is a precision 5MHz function generator with waveforms of sine, triangle, ramp, pulse and DC from a variable amplitude 50 $\Omega$  or 600 $\Omega$  output. A TTL/CMOS auxiliary output is also provided.

The frequency range is 0.005Hz to 5MHz selected by a seven decade range multiplier and calibrated vernier. Both the frequency vernier and the sweep input can give 1000:1 frequency change within a selected range. Frequency can be locked to a crystal reference to give superior frequency stability. A 10:1 symmetry range permits ramp and pulse waveforms to be produced.

The generator output level is 20Vpk-pk maximum from a 50/600 $\Omega$  source. The level is set via a switched attenuator plus vernier with a total range of >80dB. DC offset is vernier adjustable over a  $\pm 10$ V range with centre detent for 0V. Waveform quality is good at all frequencies and signal levels.

The Model 25 also has internal LIN/LOG sweep with sweep output. Amplitude modulation of up to 100% is possible using the internal 400Hz oscillator or an external source.

The large liquid crystal display shows frequency and amplitude simultaneously. Good resolution and a fast display update rate are maintained at all frequencies. The display can also be used as an external 20MHz frequency meter with up to 7-digit resolution.

Additional display annunciators indicate generator status when sweep, AM, etc. are in use.

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# Specification

Specifications apply at 18° - 28° after one hour warm-up, at maximum output into 50Ω.

## FREQUENCY

Frequency Range:	0.005Hz to 5MHz in 7 overlapping decade ranges with adjustment by coarse and fine verniers.
Vernier Range:	1000:1 on each range.
Frequency Display:	Auto-ranging reciprocal measurement giving 4-digit resolution down to 10Hz (to 1Hz on the 5Hz range); resolution is fixed at 0.01Hz below 10Hz (0.001Hz below 1Hz on the 5Hz range).  Accuracy is $\pm 1$ digit to 2.1Hz (to 0.21Hz, Symmetry off, or to 0.42Hz, Symmetry on, on the 5Hz range); below this the accuracy is $\pm 1\%$ of range full scale (unspecified with Symmetry on).
Frequency Locking:	With vernier setting between 10% and 100% of range maximum, frequency can be locked to the crystal reference to maintain it at the displayed value $\pm 0.01\%$ .

## WAVEFORMS

Waveform specifications apply for the top decade of each frequency range.

### SINUSOIDAL

Distortion:	Less than 0.5% on 500Hz, 5kHz and 50kHz ranges; less than 1% on 5Hz, 50Hz and 500kHz ranges; all harmonics >25dB below fundamental on 5MHz range.
Amplitude Flatness:	$\pm 0.2$ dB to 200kHz; $\pm 2$ dB to 5MHz.

### TRIANGLE

Linearity:	Better than 99% to 200kHz.
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### QUASISQUAREWAVE

Rise and Fall Times:	<45ns.
Mark-Space Ratio:	1:1 $\pm 1\%$ to 100kHz.

### VOLTA

Range:	$\pm 10$ V (unterminated).
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### SYMMETRY

Symmetry Range:	Variable typically between 1:9 and 9:1 (on top decade of each range), frequency divided by 10 when Symmetry is selected.
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## MODULATION MODES

Modulation can be used with all waveforms and at any frequency.

### SWEEP

Sweep Mode:	Internal: linear or logarithmic; sweep Start and Stop frequencies displayed at a press of a button. External: linear.
Sweep Width:	Up to 1000:1 within each range.
Sweep Rate:	Internal sweep rate adjustable from typically 20ms to 20s.
External Sweep:	By signal applied by SWEEP IN/OUT socket.

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## Amplitude Modulation

Modulation Depth: Variable 0 to 100% typical.  
Modulation Frequency: 400Hz internal. DC to 100kHz external.  
External Modulation: By signal applied to COUNT/AM IN socket.

## OUTPUTS

### 50Ω Main Out

Output Impedance: 50Ω.  
Amplitude: 2mV to 20V peak-peak open circuit (1mV to 10V peak-peak into 50Ω) in four switch-selectable ranges with 20dB vernier control within each range.  
Attenuator: 0, -20, -40 or -60dB.  
DC Offset Range: ±10V. DC offset plus signal peak limited to ±10V (±5V into 50Ω); CLIP shows in display when offset + signal peak exceeds ±10V. DC offset plus waveform attenuated proportionally by the attenuator.

### 600Ω Main Out

Alternative output socket providing the same signal as the 50Ω Main Out but from 600Ω. The 50Ω and 600Ω sockets are not independent.

### Aux Out

Output Characteristics: Frequency, symmetry and phase the same as main outputs.  
Output Level: 0 to 5V TTL/CMOS logic levels capable of driving 2 standard TTL loads.


### Sweep Out

When internal sweep is selected the sweep signal is available as a 0 to 3V ramp from 600Ω.

## INPUTS


### Sweep In

The SWEEP IN/OUT socket is set to Sweep In when EXT SWEEP is selected.

Input Impedance: 10kΩ.  
Input Sensitivity: 0 to 3V for 1000:1 sweep.  
 Maximum Allowable Input Voltage: ±10V.  
Sweep Linearity: Better than 1%  
Maximum Slew Rate of Sweep Voltage: 0.1V/μs.

### AM In

The AM/COUNT IN socket is set to AM input when EXT AM is selected.

Input Impedance: 40kΩ.  
Input Sensitivity: Approximately 2V peak-peak for 50% modulation.  
 Maximum Allowable Input Voltage: ±10V.

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## Count In

The AM/COUNT IN socket is set to external frequency measurement when EXT COUNT is selected.

Input Impedance: 1M $\Omega$ /25pF.

Input Sensitivity: 50mVrms (sinewave).

Maximum Allowable Input Voltage: 50Vdc/50Vrms to 400Hz with respect to ground  $\frac{1}{\infty}$ , reducing to 1Vrms above 1MHz.

## DISPLAY FUNCTIONS

The LCD shows generator frequency simultaneously with output amplitude/offset, together with various status annunciators. Alternatively, it is the external frequency measurement display.

### External Measurement Accuracy

Frequency: Auto-ranging reciprocal measurement giving 4-digit resolution down to 10Hz (to 1Hz on the 5Hz range); resolution is fixed at 0.01Hz below 10Hz (0.001Hz below 1Hz on the 5Hz range).  
Accuracy is  $\pm 1$  digit to 2.1Hz (to 0.21Hz, Symmetry off, or to 0.42Hz, Symmetry on, on the 5Hz range); below this the accuracy is  $\pm 1\%$  of range full scale (unspecified with Symmetry on).

Amplitude: Display shows peak-to-peak amplitude or rms value. Display corrected for attenuator setting. 3-digit resolution, accuracy typically  $\pm 5\%$  of range full scale.

DC Offset: 3-digit resolution; accuracy typically  $\pm 2\%$  setting  $\pm 1$  digit. Display corrected for attenuator setting.

### External Frequency Measurement

Frequency Range: 5Hz to 20MHz, fully autoranging.

Input Sensitivity: 50mVrms (sinewave).

Measurement Time: Selectable 0.5s or 5s.

Resolution: 6 digits in 0.5s; 7 digits in 5s.

Accuracy:  $\pm 1$  digit  $\pm$  timebase accuracy.

Timebase Accuracy:  $\pm 10$ ppm initial error;  $\pm 5$  ppm/year ageing rate; typically less than 0.5 ppm/ $^{\circ}$ C.

## GENERAL

### OPERATING REQUIREMENTS

AC Input Voltage: 230V or 115V nominal, 50/60Hz, by internal adjustment; operating range  $\pm 14\%$  of nominal. Installation Category II.

Power Consumption: 25VA max.

Operating Range:  $+5^{\circ}$ C to  $+40^{\circ}$ C, 20% to 80% RH.

Storage Range:  $-10^{\circ}$ C to  $+65^{\circ}$ C

Environmental: Indoor use at altitudes up to 2000m, Pollution Degree 2.

Size: 260 (W) x 88 (H) x 235 (D) mm (10.2 x 3.4 x 9.2") excluding handle and feet.

Weight: 1.9kg (4.2lb).

Safety: Complies with EN61010-1.

EMC: Complies with EN61326.

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This instrument has been designed to meet the requirements of the EMC Directive 89/336/EEC.  
Compliance was demonstrated by meeting the test limits of the following standards:

**Emissions**

EN61326 (1998) EMC product standard for Electrical Equipment for Measurement, Control and Laboratory Use. Test limits used were:

- a) Radiated: Class B
- b) Conducted: Class B
- c) Harmonics: EN61000-3-2 (2000) Class A; the instrument is Class A by product category.

**Immunity**

EN61326 (1998) EMC product standard for Electrical Equipment for Measurement, Control and Laboratory Use.

Test methods, limits and performance achieved were:

- a) EN61000-4-2 (1995) Electrostatic Discharge : 4kV air, 4kV contact, Performance A.
- b) EN61000-4-3 (1997) Electromagnetic Field, 3V/m, 80% AM at 1kHz, Performance A.
- c) EN61000-4-11 (1994) Voltage Interrupt, 1 cycle, 100%, Performance B.
- d) EN61000-4-4 (1995) Fast Transient, 1kV peak (AC line), 0.5kV peak (signal lines), Performance B.
- e) EN61000-4-5 (1995) Surge, 0.5kV (line to line), 1kV (line to ground), Performance A.
- f) EN61000-4-6 (1996) Conducted RF, 3V, 80% AM at 1kHz (AC line only; signal connections <3m not tested), Performance A.

According to EN61326 the definitions of performance criteria are:

**Performance criterion A:** 'During test normal performance within the specification limits.'

**Performance criterion B:** 'During test, temporary degradation, or loss of function or performance which is self-recovering'.

**Performance criterion C:** 'During test, temporary degradation, or loss of function or performance which requires operator intervention or system reset occurs.'

Where Performance B is stated it is because the parameters of the output signal may deviate beyond Specification under test conditions, e.g. deviation from the set amplitude level during the Voltage Interrupt test. However, the possible deviations are still small and unlikely to be a problem in practice.

Note that if operation in a high RF field is unavoidable it is good practice to connect the PSU to the target system using screened leads which have been passed (together) through an absorbing ferrite sleeve fitted close to the PSU terminals.

**Cautions**

To ensure continued compliance with the EMC directive the following precautions should be observed:

- a) connect the generator to other equipment using only high quality, double-screened cables.
- b) after opening the case for any reason ensure that all signal and ground connections are remade correctly before replacing the cover. Always ensure all case screws are correctly refitted and tightened.
- c) In the event of part replacement becoming necessary, only use components of an identical type, see the Service Manual.

This instrument is Safety Class I according to IEC classification and has been designed to meet the requirements of EN61010-1 (Safety Requirements for Electrical Equipment for Measurement, Control and Laboratory Use). It is an Installation Category II instrument intended for operation from a normal single phase supply.

This instrument has been tested in accordance with EN61010-1 and has been supplied in a safe condition. This instruction manual contains some information and warnings which have to be followed by the user to ensure safe operation and to retain the instrument in a safe condition.

This instrument has been designed for indoor use in a Pollution Degree 2 environment in the temperature range 5°C to 40°C, 20% - 80% RH (non-condensing). It may occasionally be subjected to temperatures between +5°C and -10°C without degradation of its safety. Do not operate while condensation is present.

Use of this instrument in a manner not specified by these instructions may impair the safety protection provided. Do not operate the instrument outside its rated supply voltages or environmental range.

### **WARNING! THIS INSTRUMENT MUST BE EARTHED**

Any interruption of the mains earth conductor inside or outside the instrument will make the instrument dangerous. Intentional interruption is prohibited. The protective action must not be negated by the use of an extension cord without a protective conductor.

When the instrument is connected to its supply, terminals may be live and opening the covers or removal of parts (except those to which access can be gained by hand) is likely to expose live parts. The apparatus shall be disconnected from all voltage sources before it is opened for any adjustment, replacement, maintenance or repair.

Any adjustment, maintenance and repair of the opened instrument under voltage shall be avoided as far as possible and, if inevitable, shall be carried out only by a skilled person who is aware of the hazard involved.

If the instrument is clearly defective, has been subject to mechanical damage, excessive moisture or chemical corrosion the safety protection may be impaired and the apparatus should be withdrawn from use and returned for checking and repair.

Make sure that only fuses with the required rated current and of the specified type are used for replacement. The use of makeshift fuses and the short-circuiting of fuse holders is prohibited.

Do not wet the instrument when cleaning it.

The following symbols are used on the instrument and in this manual:-



**Caution** - refer to the accompanying documentation, incorrect operation may damage the instrument.



terminal connected to chassis ground.



alternating current.

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# Installation

## Mains Operating Voltage

The operating voltage of the instrument is shown on the rear panel. Should it be necessary to change the operating voltage from 230V to 115V or vice-versa, proceed as follows:

1. Disconnect the instrument from all voltage sources.
2. Remove the 4 screws which hold the upper and lower case halves together and lift off the case lower.
3. Remove the 6 screws securing the main pcb to the case upper and lift the pcb free, complete with front and rear panels.
4. Change the appropriate zero-ohm links beside the transformer on the pcb:  
Link LK2 only for 230V operation  
Link LK1 and LK3 only for 115V operation
5. Refit the pcb to the case upper, ensuring all connections (especially safety earth) are remade as before, and refit the case lower.
6. To comply with safety standard requirements the operating voltage marked on the rear panel must be changed to clearly show the new voltage setting.
7. Change the fuse to suit the new operating voltage, see below.

## Fuse

The correct time-lag fuse must be fitted for the selected operating voltage.

For 230V operation use 125mA (T) 250V HBC.

For 115V operation use 250mA (T) 250V HBC.

Make sure that only fuses with the required rated current and of the specified type are used for replacement. The use of makeshift fuses and the short-circuiting of fuse holders are prohibited.

## Mains Lead

When a three core mains lead with bare ends is provided it should be connected as follows:


<b>Brown</b>	-	<b>Mains live</b>
<b>Blue</b>	-	<b>Mains Neutral</b>
<b>Green/Yellow</b>	-	<b>Earth</b>

### **WARNING! THIS INSTRUMENT MUST BE EARTHED**

Any interruption of the mains earth conductor inside or outside the instrument will make the instrument dangerous. Intentional interruption is prohibited.

## Switching On

Switch on the generator using the ON/OFF switch on the rear panel. To fully disconnect from the AC supply unplug the mains cord from the back of the instrument or switch off at the AC supply outlet; make sure that the means of disconnection is readily accessible. Disconnect from the AC supply when not in use.

Ensure that the push-button switches in the SWEEP and AM/EXTERNAL COUNTER sections of the control panel are all set to the  position, i.e. set the generator to its normal, unmodulated, running mode. The display will show the frequency and peak-to-peak output amplitude with appropriate range annunciators.

## Frequency

### Frequency Setting

Frequency is set by pressing the appropriate FREQUENCY RANGE push button and rotating the calibrated FREQUENCY vernier; precise adjustments can be made using the FINE control. The vernier controls provide a 1000:1 frequency change within each range. The auto-ranging meter makes reciprocal frequency measurements down to 2.1Hz (to 0.21Hz on the 5Hz range); the display update rate in this mode is 130ms or 1 waveform period, whichever is the longer. Below these frequencies a fast measurement update rate is maintained by changing the measurement method but accuracy is reduced, see Specification.

When SYMMETRY is switched ON the SYMMETRY control can be used to vary the duty cycle from 1:10 to 10:1 to produce sawtooth and variable pulse-width waveforms. Optimum performance of the SYMMETRY control is achieved on the top decade of each frequency range. When SYMMETRY is selected SYM shows in the display and the generator frequency is divided by 10; the display shows the correct frequency. The changeover in frequency measurement method now happens at 0.21Hz on the 50Hz range and 0.42Hz on the 5Hz range.

### Frequency Locking

The set frequency can be maintained precisely by using the FREQUENCY LOCK feature. Press the LOCK button once to light the READY lamp. With READY lit set the required frequency in the usual way, ensuring that the FREQUENCY RANGE has been selected such that the FREQUENCY vernier control is within its top decade, i.e. between 0.5 and 5.

Press LOCK a second time to activate frequency locking; the LOCKED lamp will light to show that frequency locking is operational. Frequency locking is disabled by pressing LOCK again (the LOCKED lamp goes off) or by changing the frequency using the vernier or frequency range switches.

Frequency Locking employs a 'measure-and-correct' technique; at low frequencies the time between measurements is long (2s at 0.5Hz) and frequency stability may therefore be poorer.

Warning is given if frequency lock is about to be lost by flashing the LOCKED lamp; this may occur with extreme variations of time and temperature which may cause the natural frequency of the generator to drift outside the frequency locking control range.

## Waveform

The output waveform shape is selected by depressing one of the three function buttons to give sine, square or triangle. With all three switches out (accomplished by half-depressing any one) the output will be a DC level only; this is useful as it permits input threshold testing of a circuit without having to connect up an external DC supply.

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## Amplitude

The amplitude of the MAIN OUT outputs is set by the AMPLITUDE control and the ATTENUATOR switches. Maximum output is 20 volts peak-to-peak open-circuit, 10 volts peak-to-peak when terminated with the outputs characteristic impedance.

The AMPLITUDE control has greater than 20dB range; the ATTENUATOR switches permit selection of up to -60dB attenuation (both switches pressed together). Used together these controls provide a range of 20V peak-to-peak down to 2mV peak-to-peak, or 10V peak-to-peak down to 1mV peak-to-peak into the output's characteristic impedance.

Still greater attenuation of the 50Ω MAIN OUT can be achieved by using standard 50Ω BNC attenuators. To maintain waveform integrity only 50Ω cable should be used and the receiving end should be terminated with a 50Ω load.

The MAIN OUT outputs will withstand a short circuit for a period of 10 minutes at maximum output and greater periods at lower output levels. However, damage will occur if an external voltage is connected to the output sockets.

The 50Ω and 600Ω outputs are not independent; terminating one will affect the amplitude of the other.

The amplitude is displayed on the right-hand side of the LCD; pressing the PK-PK/RMS button beside the display will alternate the reading between peak-to-peak volts (Vp-p) and r.m.s. volts (Vrms). The readout is correctly adjusted for attenuator setting and waveform shape.

The display shows open circuit voltage; the actual voltage at the socket will be half the displayed value when the output is terminated with its characteristic impedance.

## DC Offset

The DC OFFSET control has a range of  $\pm 10$  volts from 50Ω/600Ω in all output modes; the control has a centre detent for 0 volts. DC offset plus signal peak is limited to  $\pm 10$ V ( $\pm 5$ V into the characteristic output impedance); CLIP shows in the display when this limit is exceeded. DC offset plus waveform is attenuated proportionally by the ATTENUATOR switches.

The DC offset can be displayed in place of the output amplitude by pressing the OFFSET button beside the display. The display shows open circuit voltage offset; the actual voltage at the socket will be half the displayed value when the output is terminated with its characteristic impedance.

## Auxiliary Output

The AUX OUT output provides a fixed 0 to 5V TTL/CMOS pulse output at the same frequency, symmetry and phase as the MAIN OUT outputs and is capable of driving 2 standard TTL loads.

## Internal Sweep

With INT SWEEP selected the output of the internal sweep generator is summed with the FREQUENCY vernier. Select LIN or LOG sweep mode; the annunciators LIN-SWP or SWP-LOG will show in the display accordingly.

## Frequency Selection

Using the FREQUENCY RANGE switches select the lowest range within which the upper sweep limit can be set; in this way the best setting resolution and the widest sweep range can be realised.

## Sweep Limits

Turn the STOP control to minimum (fully-anticlockwise). Hold the SET START button and set the START (lowest) frequency on the display using the FREQUENCY vernier; the START frequency must be set first. Now release the SET START button, hold in the SET STOP button and set the STOP (highest) frequency on the display using the STOP control; release the SET STOP button. Note that both the FREQUENCY vernier and the STOP control have a log characteristic when LOG mode is selected.

The sweep limits can be checked at any time by depressing the SET START or SET STOP.

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### **sweep Rate**

The generator sweeps both up and down at the speed set by the RATE control, i.e. it does not reset rapidly after the upward sweep. This has the advantage that the suitability of the selected sweep time can be continuously monitored.

### **sweep Out**

When INT SWEEP is selected the SWEEP IN/OUT socket becomes an output providing a 0V to 3V ramp from 600Ω impedance to drive the X-input of an oscilloscope or chart recorder. Terminating this output with a resistor will reduce the output amplitude. Terminating with 600Ω will halve the output giving 0V to 3V.

Holding in the SET STOP button holds the ramp at the maximum and can therefore be used to set full scale on the oscilloscope or chart recorder.

Note that when SWEEP IN/OUT is used as an output to drive the X-input of an oscilloscope, the oscilloscope should be set to DC coupling and not AC coupling which will cause a double image at slow sweep speeds.

### **External Sweep**

When EXT SWEEP is selected the SWEEP IN/OUT socket becomes an input. The generator frequency can be swept, DC programmed or modulated by a suitable control voltage applied to this input. The instrument sums the SWEEP IN voltage with the internal control voltage derived from the FREQUENCY vernier to determine the operating frequency; the display shows the resultant frequency.

A positive voltage increases the frequency; for frequency control with positive-going DC inputs the vernier should therefore be set to the lower frequency limit of the range to be swept. For example, a 0V to +3V signal will sweep the generator 3 decades up from range minimum, set by the vernier, to range maximum.

Similarly, a negative voltage decreases the frequency and for negative-going DC inputs the vernier should be set to the upper frequency limit of the range to be swept. For example, a 0V to -3V signal will sweep the generator 3 decades down from range maximum, set by the vernier, to range minimum.

To use a sweep signal which is symmetrical about ground, the vernier should be set to give a frequency at approximately the centre of the band to be swept.

In external sweep mode the LIN/LOG selection is inoperative, i.e. the FREQUENCY vernier is always operating linearly, as marked.

Note: Non-linear operation may result when the sweep input voltage is excessive; that is, when the attempted generator frequency exceeds the range limits.

### **Amplitude Modulation**

Depressing the AM ON/OFF button selects AM. The depth of modulation can be adjusted over a 0% to 100% range using the modulation DEPTH control. When AM is selected the output amplitude will drop to 50% at 0% modulation.

With the AM INT/EXT button in the INT (internal) position, the modulation source is an internal 400Hz sinewave oscillator. The INT-AM annunciator is displayed.

With the AM INT/EXT button in the EXT (external) position, and the EXT COUNT/EXT AM button in the EXT AM position, external AM modulation is possible via the AM/COUNT IN socket; the AM-EXT annunciator is displayed. The modulating signal applied should have no DC offset or should be AC coupled. A 2V peak-to-peak signal gives approximately 50% modulation with the modulation control at maximum. Modulating the generator with a squarewave gives step changes in the output amplitude which are suitable for testing signal compressors and automatic gain controlled circuits.

Applying a DC offset of approximately -1V gives suppressed carrier modulation. The DC offset should first be adjusted to suppress the carrier, and the modulating signal then applied.

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Applying a DC offset greater than -1V will invert the MAIN OUT outputs with respect to AUX OUT.

The generator can also be asynchronously gated on and off using the AM facility. Select EXT AM and apply a suitably offset squarewave to the AM/COUNT IN input. The squarewave  $V_{low}$  should be approximately -1V to give carrier suppression and the  $V_{high}$  should be +3V to +4V to give normal full output.

## External Counter

Selecting EXT COUNT sets the AM/COUNT IN socket to external frequency measurement. The display changes to show a 6-digit frequency measurement and annunciators EXT and 0.5s show in the display to indicate external measurement and a 0.5s gate time. Alternate presses of the GATE TIME button beside the display selects between 0.5s and 5s gate time; measurement resolution is 7-digit with 5s gate time.

In external counter mode the AM/COUNT IN socket has an impedance of  $1M\Omega$  in parallel with 25pF. Input frequency range is 5Hz to 20MHz.

Care should be taken when measuring input signals above 350mV rms (the onset of diode clipping) with poor signal to noise ratios as under these circumstances it is possible for noise to generate spurious counts. To ensure a correct count, therefore, noisy signals should be attenuated externally before being presented to the counter. A convenient attenuation factor of 10 can be achieved by the use of a x10 oscilloscope probe.

The function generator continues to perform normally when EXT COUNT is selected with the exception that frequency locking is disabled while external frequency measurement is in use.

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# Calibration and Maintenance

## Calibration

The frequency meter is provided with a user recalibration facility which is useful for correcting for crystal ageing. Since the ageing rate decreases exponentially with time it is an advantage to recalibrate after the first six months.

Recalibration may be carried out by accessing the trimmer through the hole marked CAL beside the display using a non-metallic trimmer tool. Adjustments can be monitored by using a frequency standard or standard frequency receiver to provide a high accuracy signal for the counter set to external frequency measurement.

## Maintenance

The Manufacturers or their agents overseas will provide a repair service for any unit developing a fault. Where owners wish to undertake their own maintenance work, this should only be done by skilled personnel in conjunction with the service manual which may be purchased directly from the Manufacturers or their agents overseas.

## Cleaning

If the instrument requires cleaning use a cloth that is only lightly dampened with water or a mild detergent.

**WARNING! TO AVOID ELECTRIC SHOCK, OR DAMAGE TO THE INSTRUMENT, NEVER ALLOW WATER TO GET INSIDE THE CASE. TO AVOID DAMAGE TO THE CASE NEVER CLEAN WITH SOLVENTS.**