RS Components Limited

100 MHz UNIVERSAL COUNTER-TIMER

INSTRUCTION MANUAL

WARNING

THIS INSTRUMENT IS MAINS OPERATED. POTENTIALLY LETHAL VOLTAGES ARE PRESENT INSIDE THE CASE. BEFORE OPENING THE CASE, DISCONNECT THE SUPPLY BY REMOVING THE MAINS CABLE FROM THE REAR PANEL SOCKET.

N.B. THIS INSTRUMENT MUST BE EARTHED

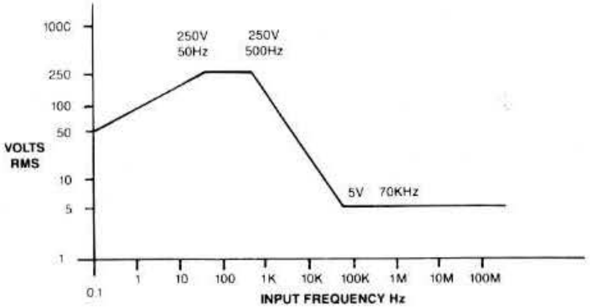
SPECIFICATIONS

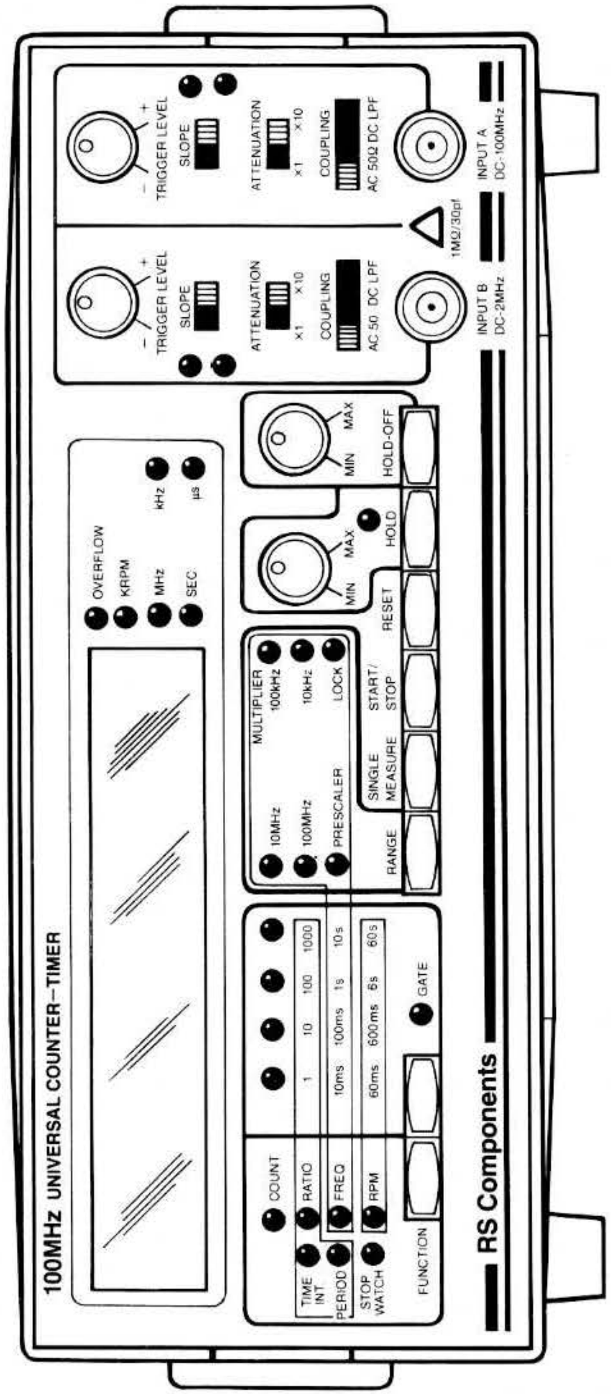
TIMEBASE **Crystal Oscillator Frequency**	10MHz	
Time between measurements	Adjustable 200ms to 10 sec. nom. (Hold Control)	
Aging	< ±5ppm/year	
Setability	< ±0.5ppm	
Temperature Stability	±10ppm −10°C to +70°C Typ. ±2.5ppm +10°C to +40°C	
INPUT A **Bandwidth/Sensitivity**	10MHz range <5mV DC − 10MHz 100MHz range <10mV 1MHz − 50MHz <30mV 50 MHz − 100MHz	
Coupling and Input Impedance	DC @ 1MΩ//30pF; AC @ 1MΩ//30pF; 50Ω	
Low Pass Filter	Coupling DC; cut-off frequency 50kHz nom; switch selectable	
Maximum Input Voltage	AC Coupling: 50V DC or 250V rms @ 50Hz decreasing to 5V rms @ >70k Hz; DC Coupling: 300V DC	
Triggering	Level adjustable, + ve or − ve edge, L.E.D.'s indicate when triggered	
Attenuator	× 1, × 10 switchable	
INPUT B **Bandwidth/Sensitivity**	<5mV DC − 2MHz	
Coupling and Input Impedance	DC @ 1MΩ//30pF; AC @ 1MΩ//30pF; 50Ω	
Low Pass Filter	Coupling DC; cut-off frequency 50k Hz; switch selectable	
Maximum Input Voltage	AC Coupling: 50V DC or 250V rms @ 50Hz decreasing to 5V rms @ >70k Hz; DC Coupling: 300V DC	
Triggering	Level adjustable, + ve or − ve edge, L.E.D.'s indicate when triggered	
Attenuator	× 1, × 10 switchable	
FREQUENCY A **Gate Times**	0.01 sec; 0.1 sec; 1 sec; 10 sec.	
	RANGE	RESOLUTION
Ranges Resolution	1MHz − 100MHz DC − 10MHz	(10÷Gate Time) Hz (1÷Gate Time) Hz
	Multiplier 6Hz − 100k Hz (<5 sec. setting time)	(0.1÷Gate Time) Hz
	Multiplier 14Hz − 10k Hz (<5 sec. setting time)	(0.01÷Gate Time) Hz
Accuracy	± (1 count + timebase accuracy)	
FREQUENCY RATIO A TO B **Frequency Maximum**	Input A: 10MHz; Input B: 2MHz	
Ratio Averaged Over	1, 10, 100, 1000 cycles of Input B	
Resolution	100ns ÷ no. of cycles averaged	
Accuracy	± (timebase accuracy + resolution + [trigger error* − no. of cycles averaged])	
TIME INTERVAL A TO B **Range**	250ns − 10 sec.	
Display	µs	
Minimum Pulse Width	250ns	
Maximum Frequency	2MHz	
Time Interval Averaged Over	1, 10, 100, 1000 intervals	
Resolution	100ns ÷ no. of intervals averaged	
Accuracy	± (timebase accuracy + resolution + [trigger error* − no. of intervals averaged])	

COUNT A	
Count Maximum	$10^8 - 1$
Input Frequency	10MHz max
Resolution	1 count
Reset	Manual (reset button) or External reset Input
Gating	Manual (stop/start button) or Input B
STOPWATCH	
Display	Seconds
Times to	10^6 sec. (>11 days)
Resolution	10ms
Accuracy	± (timebase accuracy + 10ms)
Reset	Manual (reset button) or External reset Input
Gating	Manual (stop/start button) or Input B
RPM A	
Display	1000's RPM
Range	1 to 10^{11} RPM
Gate Time	0.06 sec; 0.6 sec; 6 sec; 60 sec.
Resolution	(60÷Gate Time) RPM
Accuracy	± (timebase accuracy + 1 count)
EXTERNAL TIMEBASE OSCILLATOR	External oscillator in/Internal oscillator out; switch selectable; TTL compatible
Calibration Frequency	10MHz
Input Frequency Range	100k Hz nom. min. to 10MHz
Input Voltage Range	0V to + 5V max.
Input Load	1 HCMOS Input
Output Frequency	10MHz
Output Drive	Sink 5mA, source 5mA
EXTERNAL RESET INPUT	Active low; TTL compatible; Input Voltage range ±20V max.
POWER REQUIREMENTS	Mains operation only. 100 − 120V, 220 − 240V AC 50 − 60Hz; 24VA
DISPLAYS	8 Digit 7-segment 0.5" bright L.E.D.'s; automatic decimal point; leading zero suppression Unit Indicators for MHz, kHz, sec, µsec, kRPM; overflow indicator; gate indicators
ANCILLARY CONTROLS	Display Hold: adjustable 200ms to 10 sec. nom. Trigger Hold-off: adjustable 5 to 500ms nom. Single Measurement.
General	
Environmental Operating Range	0°C to +40°C (10% − 80% RH non-condensing)
Case	Custom-moulded, sturdy, lightweight ABS, with tilt stand
Size	219mm × 240mm × 98mm (product only) 321mm × 352mm × 174mm (packed)
Weight	2.2Kg (product only) 2.9Kg (packed)
Supplied Accessories	Mains Lead, Instruction Manual, Spare Fuse
Rear Panel facilities	Power on/off; spare fuse; External reset Input; External timebase

*Typical Trigger Error = $\frac{1.6}{\text{Slope (V/µs)}}$ ns

MAXIMUM INPUT VOLTAGES





FRONT PANEL

FRONT PANEL CONTROLS

FUNCTION PUSHBUTTON
Sets the counter to the desired measurement function. LED indicators illuminate to indicate the selected function.

FREQ (A)
Sets the counter to measure the frequency of the signal connected to input A.

RATIO (A/B)
Sets the counter to measure the frequency ratio A/B of the signals connected to inputs A and B.

COUNT (A)
Sets the counter to totalize the number of selected signal edges appearing at input A. The count may be gated by input B or controlled by the START/STOP button. The counter is reset to zero by the front panel RESET button or rear panel RESET input.

TIME INT (A-B)
Sets the counter to measure the time interval between the selected signal edge at input A and the selected signal edge at input B.

PERIOD (A)
Sets the counter to measure the period time of a repetitive signal applied to input A.

STOPWATCH
Sets the counter to the Stopwatch mode of operation. The Stopwatch is controlled by the START/STOP button or alternatively by a gating signal applied to input B. The counter is reset to zero by either the front panel RESET button or the rear panel external RESET input.

RPM
Sets the counter to perform a revolution per minute measurement of the signal applied to input A.

GATE
(i) Sets the gate time of the internal counter circuitry for frequency and RPM measurements.
(ii) Selects the number of signal cycles over which the measurement is averaged for TIME INT, PERIOD and RATIO functions.

RANGE PUSHBUTTON
Sets the counter to the desired frequency range when performing frequency measurements. Indicator LED's illuminate to show the selected range.

10MHz
Sets the counter to measure frequency to a maximum of 10MHz.

100MHz
Sets the counter to measure frequency to a maximum of 100MHz.

PRESCALER
The prescaler position provides correct decimal point positioning when using the counter with an external ÷ 10 prescaler to extend frequency measurement to 1GHz.

MULTIPLIER 10KHz
Provides a 100-fold increase in resolution when making frequency measurements between 14Hz and 10KHz.

MULTIPLIER 100KHz
Provides a 10-fold increase in resolution when making frequency measurements between 6Hz and 100KHz.

LOCK LED
Indicates the status of the multiplier circuitry.
BLINKING = multiplier action in progress
ON = display valid.

SINGLE MEASURE
When depressed sets the counter to single time interval measurement.
In this mode the counter performs a single time interval measurement between a signal edge at input A and a signal edge at input B.

N.B. Before performing a single time interval measurement the counter must be "primed" (see Operating Instructions section, p. 11).

START/STOP
The START/STOP button controls the counter in the Stopwatch and Count modes of operation and is used in the priming procedure when making single time interval measurements.

RESET
Resets the counter when pressed, halting any measurement in progress, returns the display to zero and prepares the counter for the next measurement.

HOLD
Depressing the HOLD pushbutton illuminates the HOLD LED and causes the counter to hold the display at the last measurement made.

VARIABLE HOLD CONTROL
With the HOLD button released the variable control sets the delay time between the end of one measurement and the start of the reset, during which the display holds the result of the last measurement. Adjustable from 200ms to 10 sec.

HOLD-OFF
With the hold off button depressed the counter ignores all input B events during the set hold-off time. The hold-off time is adjustable from 5ms to 500ms. Normal operation resumes when the button is released.

INPUT AMPLIFIERS

TRIGGER LEVEL
The Trigger Level control provides a variable trigger level of nominally ±200mV. When the X10 Attenuator is selected the effective Trigger level becomes ±2V.

SLOPE
When set to the _|‾ position, triggering occurs as the positive going edge of the input waveform and when set to the ‾|_ position, triggering occurs on the negative going edge of the input waveform.

ATTENUATION
When set to the X10 position the sensitivity of the input amplifiers is decreased by a factor of 10 and the effective trigger level becomes ±2V.

COUPLING
A.C. – blocks the D.C. component of the input signal. The lower 3dB frequency when AC coupled is ≃ 0.7Hz. Input impedance is nominally 1MΩ//30pF.

D.C. – the input signal is directly coupled to the input amplifier. The input impedance is nominally 1MΩ//30pF.

L.P.F. (Low Pass Filter) – the input signal passes through a 50kHz Low Pass Filter which improves the triggering of noisy low frequency signals. The input is D.C. coupled and the input impedance is nominally 1MΩ//30pF.

50Ω – terminates the input signal with a nominal impedance of 50Ω. The input circuitry comprises a series combination of a 6n8 capacitor and a 51Ω resistor giving a lower 3dB frequency of ≃ 460kHz.

REAR PANEL

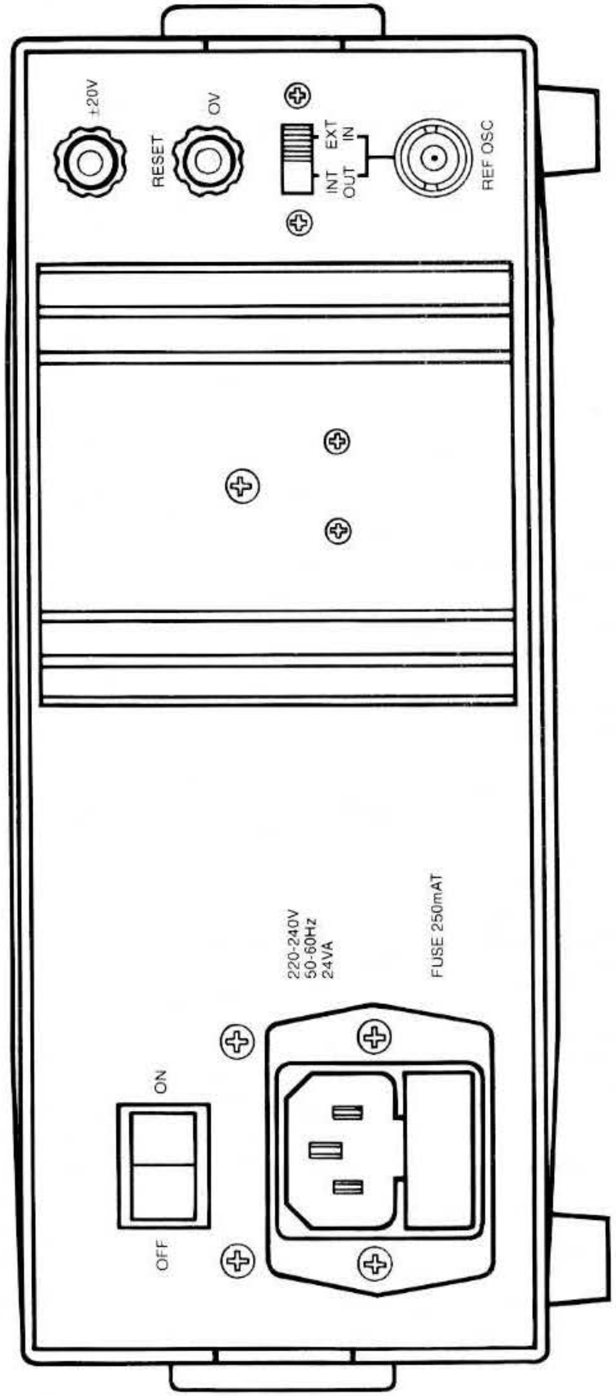
OFF ... ON
Supplies mains power to the counter in the ON position and switches the counter off in the OFF position. The switch has a double pole action.

RESET
This input has the same function as the front panel RESET button.
The input is active low and is TTL compatible.

REF. OSC
With the switch in the INT O/P position the internal 10MHz reference signal is available on the adjacent B.N.C. connector. With the switch in the EXT I/P position the B.N.C. connector becomes the input for an external reference signal.

POWER SOCKET AND FUSE
The power socket is the 3 pin I.E.C. type with an integral fuse holder and spare fuse compartment. The fuse is a 20mm 250mA anti-surge.

NO OTHER TYPE SHOULD BE USED.



REAR PANEL

OPERATING INSTRUCTIONS

Before commencing with any measurement ensure that the REF. OSC. switch on the rear panel is in the INT. O/P position. Ensure that the SINGLE MEASURE and HOLD push buttons are released, unless they are required for the particular measurement to be made.

FREQUENCY MEASUREMENT (A)

1. Select FREQ function.
2. Select required GATE time for optimum resolution and measurement time.
3. Select input COUPLING to suit signal to be measured.
4. Connect signal to be measured to input A.
5. Set ATTENUATION A and adjust TRIGGER LEVEL A until both trigger LED's are illuminated and a stable reading is present.
6. Adjust variable HOLD for optimum display time.

PERIOD MEASUREMENT (A)

1. Select PERIOD function.
2. Select number of cycles over which measurement is to be averaged to obtain optimum resolution, accuracy and measurement time.
3. Select input COUPLING to suit signal to be measured.
4. Connect signal to be measured to input A.
5. Set ATTENUATION A and adjust TRIGGER LEVEL A until both trigger LED's are illuminated and a stable reading is present.
6. Adjust variable HOLD control for optimum display time.

TIME INTERVAL (A-B)

There are two modes of operation for the Time Interval measurement function.

(a) Single Time Interval measurement.
The counter measures the time interval between a start event on input A and a stop event on input B.

(b) Time Interval Average
The counter measures the time interval average of a repetitive signal, over 1, 10, 100 or 1,000 cycles, between a start event on input A and a stop event on input B.

SINGLE TIME INTERVAL

1. Select TIME INT function.
2. Select 1 cycle measure with GATE pushbutton.
3. Press START/STOP button. The GATE LED will illuminate to indicate that the counter is primed and ready to make a measurement. The timing cycle begins when a signal edge of the selected slope appears at input A.
   The timing cycle ceases, and the result is displayed, when a signal of the selected edge appears at input B.
   The displayed result is held until a RESET occurs or another counter function is selected.
4. To re-prime the counter for subsequent measurements, press RESET followed by STOP/START.
5. Adjust TRIGGER LEVEL, COUPLING, SLOPE and ATTENUATION to ensure correct triggering of measured signals.

TIME INTERVAL AVERAGE

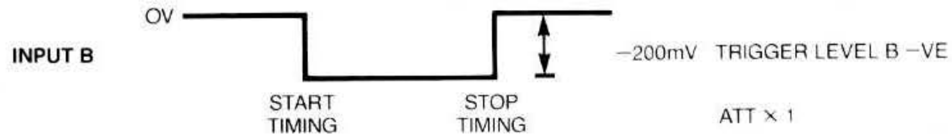
1. Select TIME INT function.
2. Select COUPLING, ATTENUATION, SLOPE and adjust TRIGGER LEVEL to suit signals to be measured.
3. Select number of cycles over which measurement is to be averaged to give optimum resolution and measurement time.

COUNT

1. Select COUNT mode.
2. Set TRIGGER LEVEL B fully anticlockwise.
3. Set ATTENUATION, SLOPE and COUPLING to suit signal to be counted.
4. To initiate count press START/STOP button.
5. To stop count press START/STOP button again.
6. The total count is held on the display until a RESET is initiated or another counter function is selected.

COUNT A GATED BY B

In this mode the counter totalizes the number of selected signal edges appearing at input A during the time interval between the leading and trailing edges of a negative going gating signal applied to input B.



1. Select COUNT mode.
2. Set TRIGGER LEVEL (A), SLOPE (A), ATTENUATION A, COUPLING (A) to suit signal to be counted.
3. Set TRIGGER LEVEL (B), ATTENUATION (B) to suit gating signal.
4. Set COUPLING (B) to DC or LPF.
5. Connect signal to be counted to input A.
6. Connect gating signal to input B.
   The counter is reset to zero by initiating a RESET or by selecting another counter function.

STOPWATCH

1. Select STOPWATCH function.
2. Set TRIGGER LEVEL B fully anticlockwise.
3. Press START/STOP button to start timing.
4. Press START/STOP button to stop timing.
5. Displayed time is held until stopwatch is re-started by pressing START/STOP button, timing then commences from last displayed value.
6. The stopwatch is reset to zero by initiating a RESET.
7. The HOLD pushbutton provides a lap-timer function when used in conjunction with the stopwatch. When depressed the displayed time is held, but the internal timing continues. When the HOLD button is released the display updates to the internal timing and the stopwatch continues.

STOPWATCH GATED BY B

Apart from the manual operation of the stopwatch using the START/STOP button, the stopwatch can also be controlled by an externally applied gating signal applied to input B.

1. Select STOPWATCH function.
2. Set TRIGGER LEVEL (B) and ATTENUATION to suit gating signal.
3. Set COUPLING (B) to DC or LPF.
4. Connect gating signal to input B.

FREQUENCY RATIO A/B

1. Select RATIO function.
2. Select required GATE time for optimum resolution and measurement time.
3. Select input A and B COUPLING and ATTENUATION to suit signals to be measured.
4. Connect higher frequency to input A and lower frequency to input B.
5. Adjust TRIGGER LEVEL controls until trigger LED's are illuminated and a stable reading is obtained.

R.P.M.

The counter performs a revolutions per minute measurement on the signal connected to input A. The result is displayed as kRPM, (thousands of revolutions per minute), provided that the transducer used gives only one pulse output per revolution. The internal counter circuitry performs the R.P.M. measurement in the same way as a frequency measurement, except that the gate time is six times that of a frequency measurement.

The setting up procedure is as for a frequency measurement. The maximum available resolution in the R.P.M. mode is 1 RPM when using a 60 second gate time. In some circumstances a long gate time may be unacceptable, in which case it is preferable to make a frequency measurement and then convert the measured frequency to R.P.M. using the following formula:

$$\text{RPM} = \frac{\text{FREQUENCY (Hz)} \times 60}{n}$$

where n = number of transducer pulses per revolution.

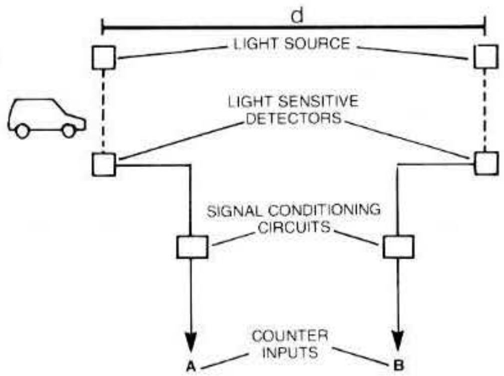
APPLICATION EXAMPLES

1. FREQUENCY RATIO

The Frequency ratio mode of measurement can be especially useful when calibrating an oscillator to an awkward frequency, say for example a frequency of 1.784MHz. The procedure is to connect the reference signal to A and the oscillator to be calibrated to input B. The oscillator is then adjusted until the counter reads 1.000, which is much easier to read than 1.784MHz.

2. VELOCITY MEASUREMENTS

One of the many practical uses of the counter is velocity measurement of a travelling object. The diagram below outlines the arrangement needed to measure the speed of a vehicle.



Using the counters' TIME INT function the speed of the vehicle is calculated from the following formula.

$$\text{Speed} = \frac{d}{t}$$

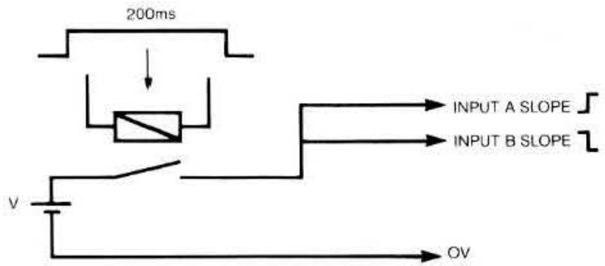
Where d = the distance travelled and t = the measured time interval.
Note, due to the many and varied types of photo detectors available some form of signal conditioning circuit may be necessary to interface these devices with the counter.

3. MICROPROCESSOR CLOCK FREQUENCY MEASUREMENT

Due to the counters' high accuracy it is most suitable for measuring and adjusting clock oscillators in microprocessor circuitry. It is always advisable to measure this type of oscillator via a buffering stage to avoid loading of the circuit. If this is not possible then it is recommended that a × 10 probe is used to minimize the loading effect.

4. MEASUREMENT USING HOLD OFF

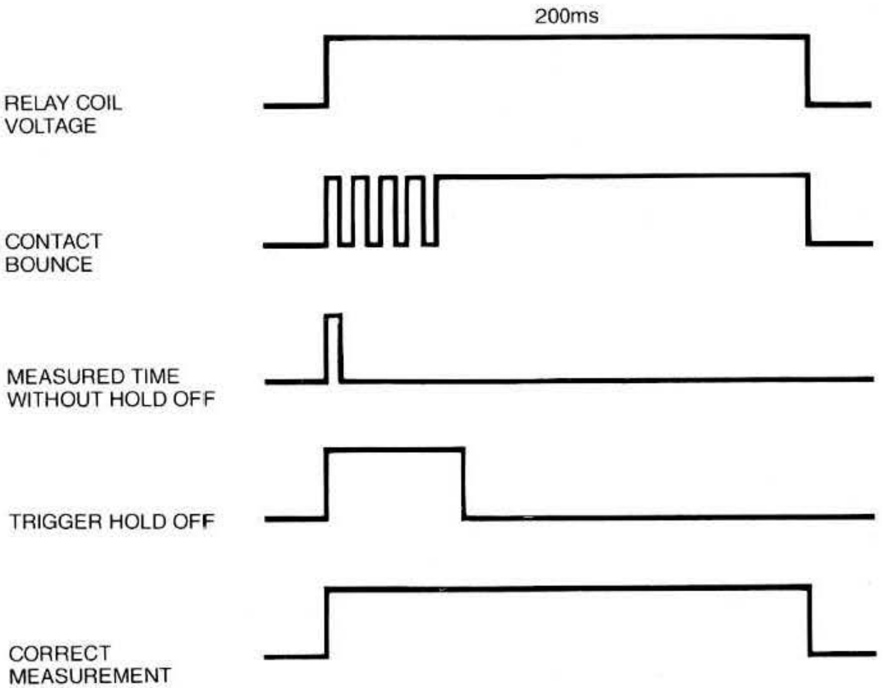
The Trigger Hold-Off control is normally used in conjunction with the TIME INT function. The purpose of the hold- off facility is to avoid false triggering or spurious or unwanted signals. A typical example is when measuring the time that relay contacts remain closed. The diagram below shows an example of such a measurement.



Say for example the relay is energised for 200ms and it is necessary to check that the contacts are closed for the required period.

Incorrect measurements can result due to relay contact bounce. However with the TRIGGER HOLD-OFF set to a time greater than the contact bounce time, correct measurement is obtained.

The following waveforms show the effectiveness of the hold off facility.



CALIBRATION

For optimum accuracy the instrument requires calibration from time to time. How frequently will depend on the user and application but once every twelve months would normally be adequate.

For calibration please refer to RS Components Ltd.