GERRY

thandar / SINCLAIR

PFM 200 FREQUENCY METER

SERVICE MANUAL

CONTENTS

GENERAL

Service Handling Precautions

The instrument has been designed to require the minimum amount of service attention. Service work or recalibration should only be carried out by skilled engineers.

Please note the following points before commencing work.

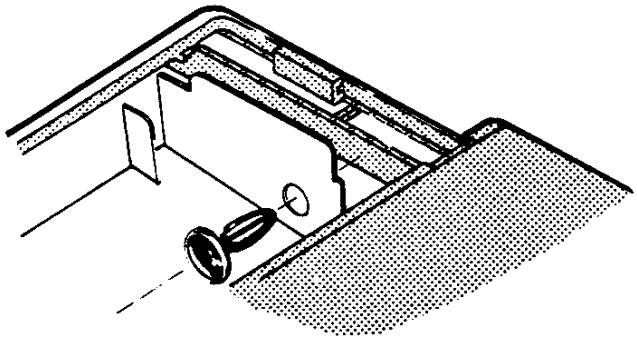
The tracks on the printed circuit board are very fine and may lift if subjected to excess heat. Use only miniature temperature-controlled soldering irons and remove all solder (on both sides of a joint) with solder wick or suction before attempting to remove a component.

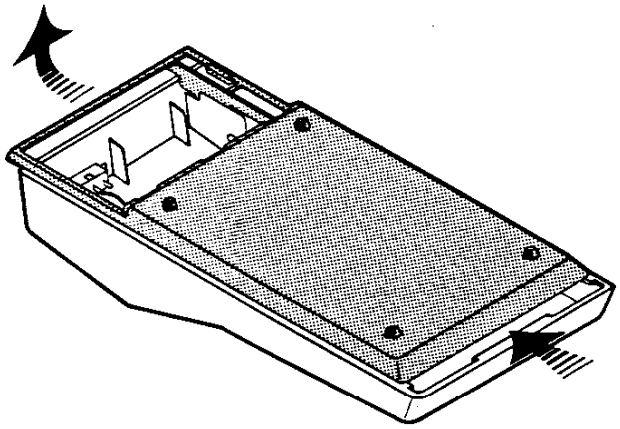
The integrated circuit IC4 is a CMOS device and care should be taken when handling it to avoid damage by static discharge.

Dismantling the Instrument

1. Remove battery cover and battery.
2. Lever out retaining clip with a small screwdriver (as shown).
3. Slide case lower towards back of instrument and remove.
4. Unsolder the four connections to the input sockets. Only the minimum amount of heat must be used to avoid damage to the plastic bushes.
5. Carefully remove the knob from the range switch.
6. Lever up the P.C.B. from its three retaining pillars, leaving the retaining clip in place in the P.C.B.

To re-assemble, reverse this procedure.





TECHNICAL SPECIFICATION

Range A

Frequency range	20Hz-10MHz	
Gate time	Resolution	Reading rate
10 secs	0.1Hz	0.1Hz
1 sec	1 Hz	0.8Hz
0.1 secs	10 Hz	3.3Hz
0.01 secs	100 Hz	4.8Hz

Range B

Frequency range	5MHz-200MHz	
Gate time	Resolution	Reading rate
2 sec	10 Hz	0.4Hz
0.2 sec	100 Hz	1.6Hz
0.02 sec	1kHz	2.4Hz

Accuracy

± 1 count ± time base error

Time Base

10MHz crystal oscillator

Initial adjustment error ⩽2ppm at 22°C

Ageing rate <10ppm/year

Temperature coefficient<0.3ppm/°C

FOR SERVICE MANUALS
CONTACT:
MAURITRON TECHNICAL SERVICES
www.mauritron.co.uk
TEL: 01844 - 351694
FAX: 01844 - 352554

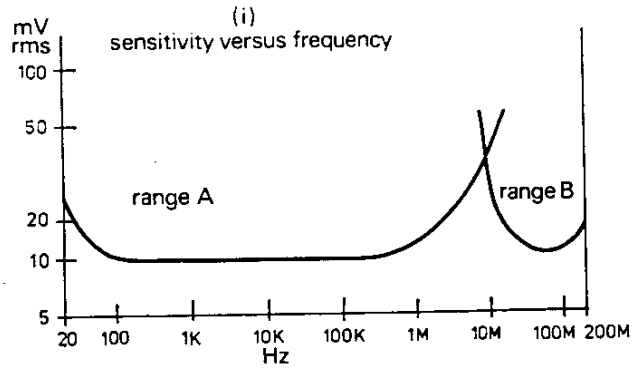
Input Sensitivity

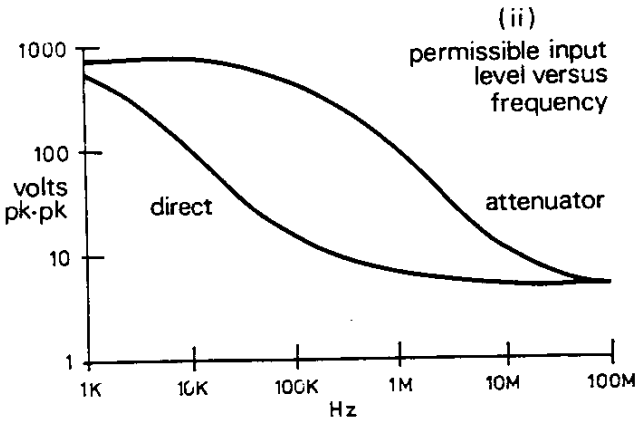
Input characteristic 1MΩ/ /50pF nominal

Typical sensitivity as graph (i)

Attenuator –20dB nominal

Input protected to 250VAC 50Hz R.M.S. Maximum permissible voltage at other frequencies as graph (ii)





Operating Voltage

6V–15V DC

Operating current

20-65mA depending on range and display content.

CIRCUIT DESCRIPTIONS

Power Supply and low battery indicator

TR9, D6 and R30 form a 5 volt series regulator effective for an input supply in the range 6V to 15V.

To minimise power consumption, the +Vcc rail is switched by SW1 to power up either the A amplifier when the A range is selected, or the B amplifier and pre-scaler when the B range is selected.

Low battery sensing is by TR8, R28, R29. When the input supply voltage falls below 6 volts TR8 turns on and all decimal points illuminate.

Frequency counter

IC4 contains all the decade counters, timebase circuitry, decoders and multiplexed display drivers necessary for a complete 10MHz frequency counter.

XL1, R27, C15, C16 and C17 together with an inverting amplifier on IC4, form a 10MHz crystal oscillator whose frequency is trimmed by C15. The oscillator output (IC4 pin 26) is buffered by IC3A and then fed back into the external oscillator input through either IC3B when range A is selected by SW1, or through IC2B divide-by-two and then IC3B when range B is selected, to give 10MHz and 5MHz clocks respectively. D4/R24 ensure that IC3B pin 5 is held high when range A is selected and D5/R25 ensure IC3B pin 4 is held high when range B is selected thus preventing any spurious inputs to IC3B from the unselected signal path.

IC4 is designed such that the control (pin 1), external decimal point (pin 13) and range (pin 14) inputs must be time multiplexed by connecting to the digit drive line to select the required input functions. Thus the gate time switch SW2 connects either D0, D1, D2 or D3 to pin 14, selecting gate times of 10^5, 10^6, 10^7 and 10^8 clock periods respectively, ie. .01, .1, 1 and 10 secs on range A and .02, .2, 2 and 20 secs on range B.

When range A is selected the control input is held high by D9/R31 and the decimal point is automatically positioned by IC4 according to the gate time selected by SW2. When range B is selected D2 is connected to the control input by diode D8 and R31, selecting the external decimal point option; the decimal point position is then determined by which digit drive (D0 to D3) is connected to pin 13 by SW2. Thus the decimal point position is positioned correctly to give a display reading in kHz even though the signal being measured is pre-scaled on range B by IC1 (÷10) and IC2A (÷2).

Range A input amplifier

When the A range is selected the signal to be measured is fed directly, or from the 20dB attenuator consisting of R7, R12 in parallel with C5, C9, through R3 and C3 to the gate of the source follower TR3. The output of TR3 is fed through C8 to a high gain amplifier, TR5 and TR6, which drives a Schmitt trigger TR7 and IC3C. Finally, the signal is buffered by IC3D and fed to the input (pin 28) of IC4. R4 defines the amplifier input impedance and biases TR3. R3, C3, D1 and D2 provide input overload protection.

Range B input amplifier

When the B range is selected, the signal is fed directly, or from the same R7, R12, C5, C9 attenuator, via C2 to the input of the differential amplifier TR1, TR2. TR4, R5, R41, R10 bias the amplifier. Diode D3 ensures symmetrical clipping with large input signals.

The amplifier output is fed via C20 to the input of the high-speed divide-by-10, IC1. This has a differential input but is used in single-ended mode by biassing the other input with R18 which is decoupled by C12. The output of IC1 is further divided by the D-type IC2A connected as a divide-by-two to give an overall pre-scaling of 20. The output of IC2A is then fed through IC3C and IC3D to the input of IC4. All H.F. sections of the circuit are decoupled to the ground plane by ceramic capacitors.

Display

IC4 provides the multiplexed high-current segment information and digit sink capability required to drive the 8-digit 7-segment L.E.D. display. Resistors R33 to R40 define the segment current.

CALIBRATION

Calibration consists only of the fine adjustment of the 10MHz oscillator frequency by C15.

Set the instrument to range A and with an accurate source (e.g. 1MHz or 10MHz off-air standard or crystal reference oscillator) adjust C15 to give the correct display $\pm$ 1 p.p.m.

FAULT FINDING

Typical circuit voltages

The following values are for +Vcc = 5V and the input terminals shorted.

Range A:	C6	4.5V
	TR3 source	0.8V
	TR3 gate	OV
	TR6 collector	1.7V

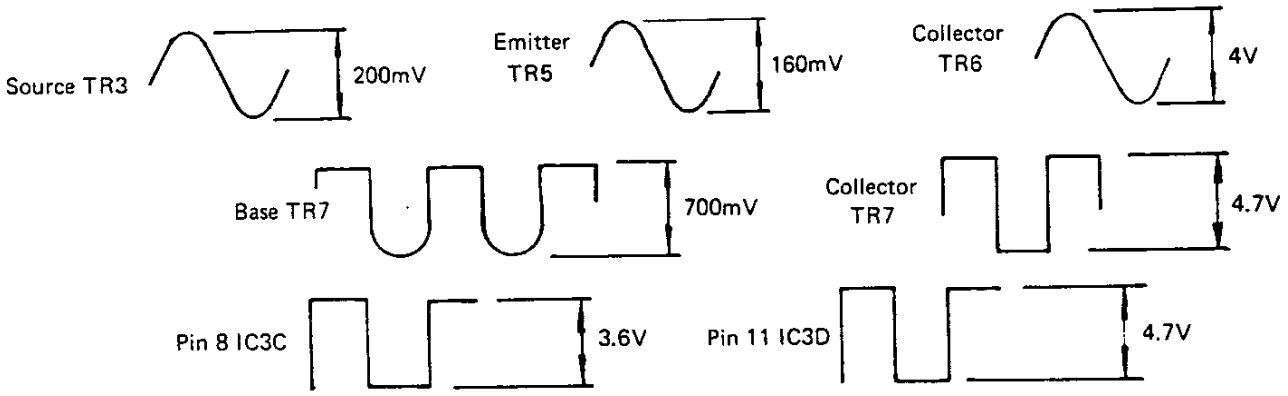
Range B:	C1	4.1V
	TR1, TR2 emitters	1.15V
	TR1 collector	3.5V
	TR2 collector	3.5V

For $V_{battery}$ = 6 to 15 volts, +Vcc should be 5V $\pm$ 0.25V

Typical circuit waveforms

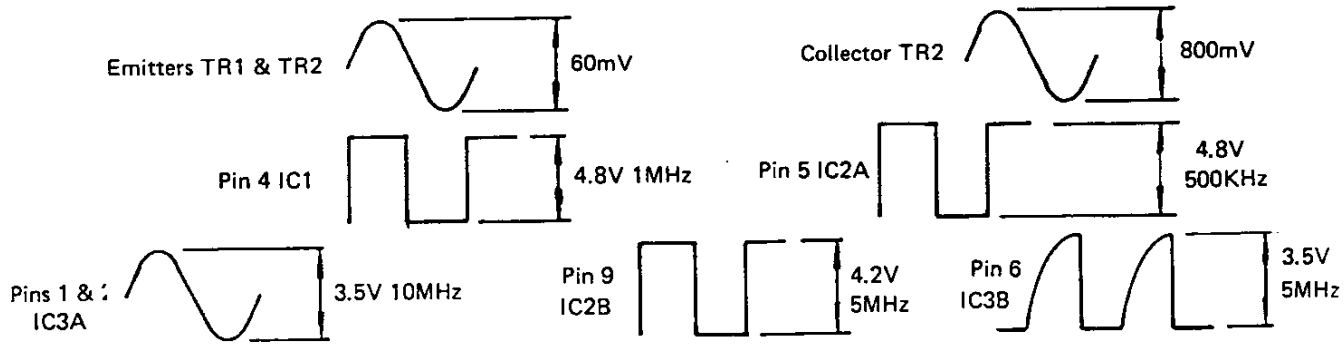
Range A

Input signal, 1KHz sine wave 300mV Pk-Pk



Range B

Input signal, 10MHz sine wave 300mV Pk-Pk



FAULT FINDING CHART

1. Is there anything visible on the display ?

YES NO→Check input voltage (6V-15V) and power lead connections. Check for broken or short circuit PCB tracks. Check Vcc on pin 14 IC3 is 4.75 - 5.25V.

2. Is display operating correctly ?

YES NO→Missing segments can be more easily checked by connecting a diode as follows. Anode of the diode to the junction of D7, D8 and R31. Cathode of the diode to pin 11 on IC4. This is a display test and lights up all the digits, segments and decimal points, thus giving 8.8.8.8.8.8.8.8.

3. Is the Instrument counting ?

YES NO→**Range A**

Observe the waveforms under the heading 'typical circuit waveforms', and where the signal is lost or incorrect, check the d.c. voltages in that stage as outlined under the heading 'typical circuit voltages'. If the signal is lost at pin 8, IC3 but present on pin 9, ensure that pin 10 is high, approx. +2V. If it is not check for shorts on the track which goes between pin 10 IC3 and pin 5 IC2 along the component side of Pcb, or replace IC2. If the signal is present on Pin 28, IC4, check its surrounding components and if these are o.k. replace IC4.

Range B

Again check signal and d.c. voltages for the correct values, as outlined under the heading 'typical circuit waveforms'. Note if it counts on Range A then IC4 is not faulty.

4. Counts, but answer is incorrect

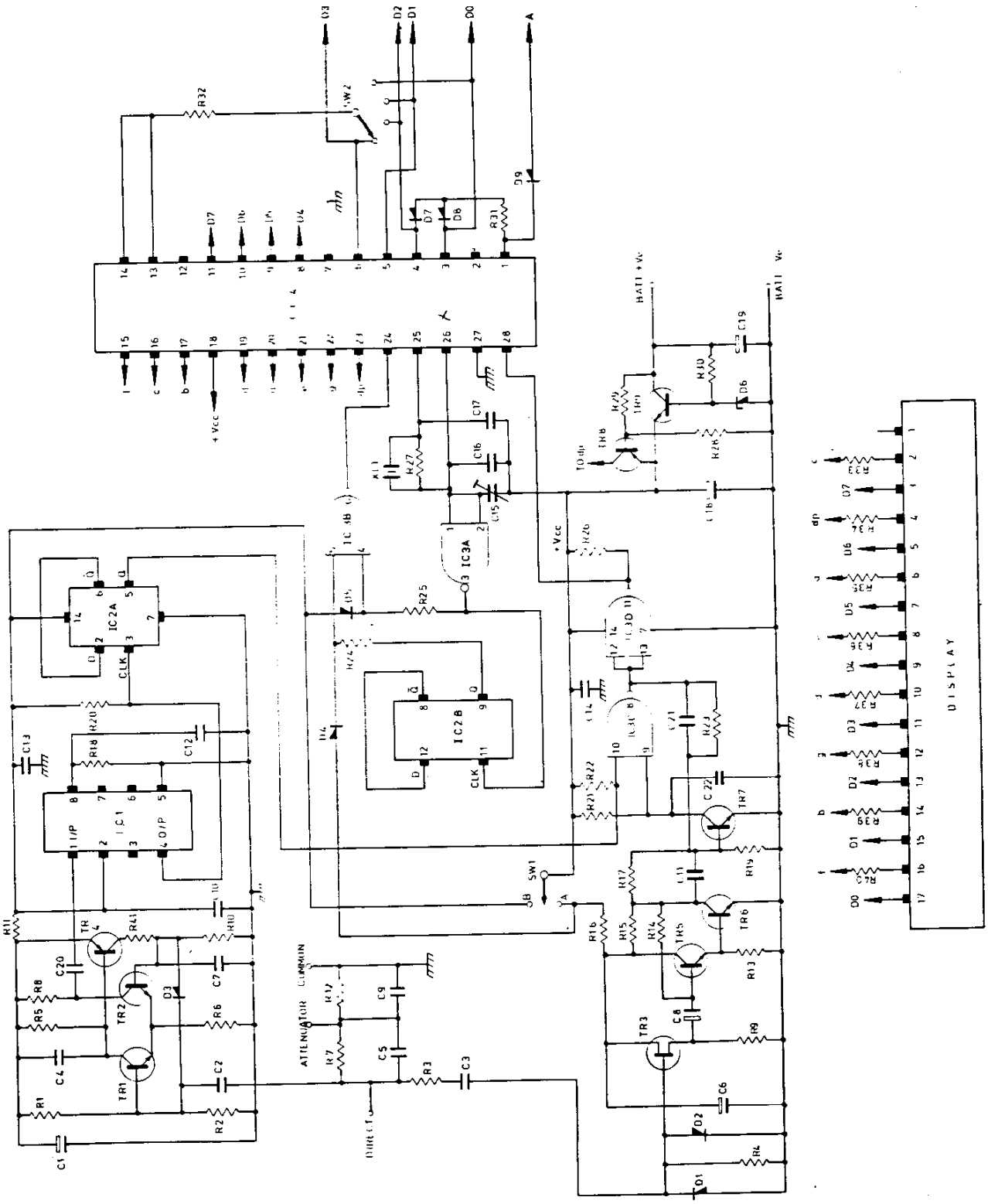
Range A

Follow calibration procedure to check the 10MHz oscillator. Check the input waveform, ensure it is clean and free from ringing as the frequency meter will try to read the extra spikes on the waveform. Check the signal and d.c. voltages at each stage.

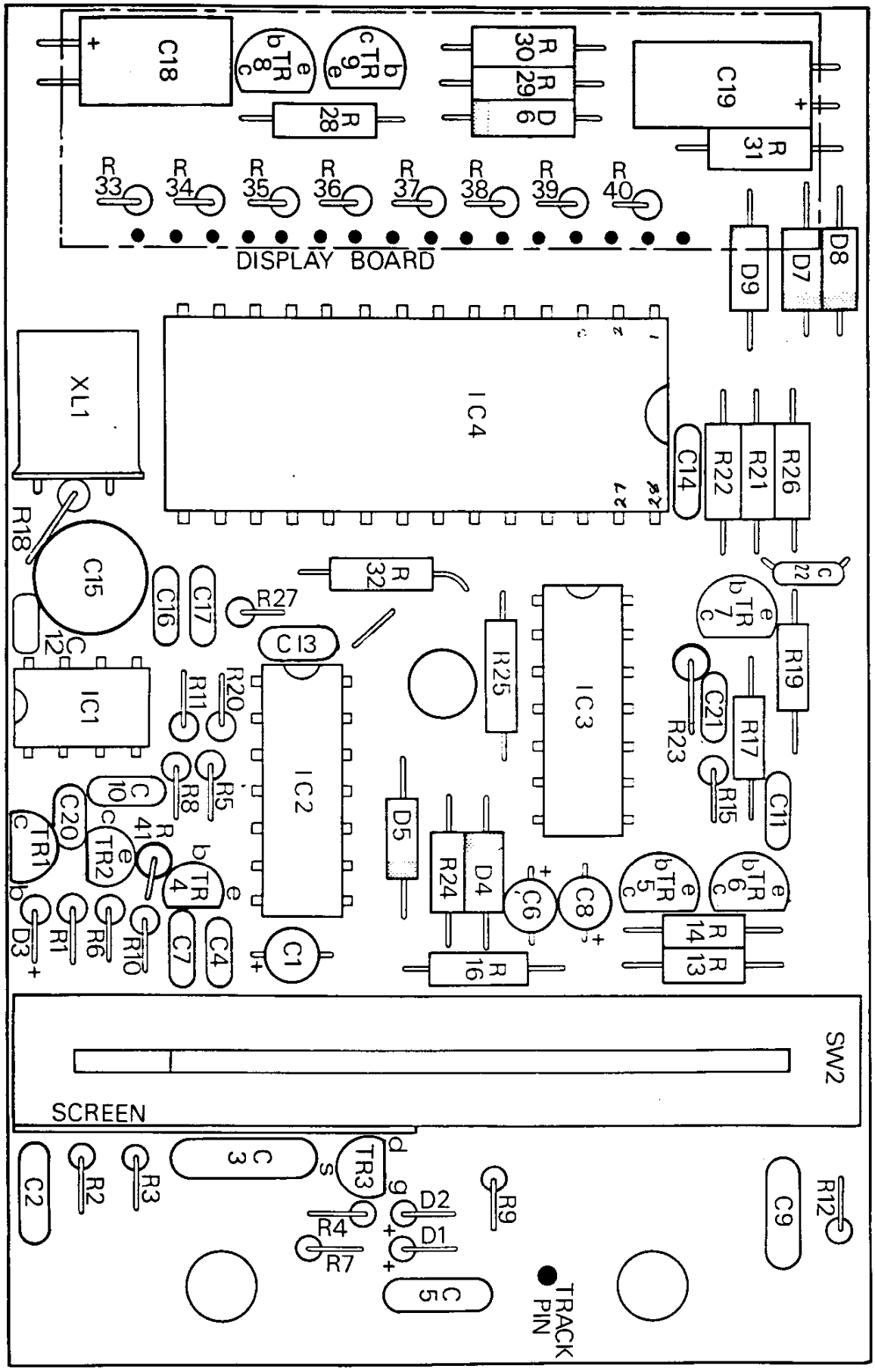
Range B

Ensure that the instrument operates correctly on range A first. Try a low level sinewave and if it is counting half ensure that the external clock is selected and divided by 2. If the answer is constantly changing check the d.c. voltages and H.F. decoupling around TR1, TR2 and IC1.

CIRCUIT DIAGRAM



COMPONENT LAYOUT



PARTS LIST

Resistors

Ref	Description	Part No	Ref	Description	Part No
R1	2K7J W25 CF	23199-0413	R22	4K7J W33 CF	23180-0148
R2	2K7J W25 CF	23199-0413	R23	220KJ W33 CF	23180-0107
R3	390RJ W25 CF	23199-0431	R24	2K2J W33 CF	23180-0101
R4	1M0J W25 CF	23199-0428	R25	2K2J W33 CF	23180-0101
R5	120RJ W25 CF	23199-0434	R26	3K3J W33 CF	23180-0111
R6	100RJ W25 CF	23199-0408	R27	10MK W33 CF	23180-0203
R7	10MK W33 CF	23180-0203	R28	4K7J W33 CF	23180-0148
R8	100RJ W25 CF	23199-0408	R29	2K2J W33 CF	23180-0101
R9	2K2J W25 CF	23199-0412	R30	560RJ W33 CF	23180-0118
R10	2K7J W25 CF	23199-0413	R31	10KJ W33 CF	23180-0103
R11	68RJ W25 CF	23199-0432	R32	10KJ W33 CF	23180-0103
R12	1M0J W25 CF	23199-0428	R33	330RJ W125CF	23198-0422
R13	680RJ W33 CF	23180-0156	R34	330RJ W125CF	23198-0422
R14	120KJ W33 CF	23180-0149	R35	330RJ W125CF	23198-0422
R15	1K0J W33 CF	23180-0135	R36	330RJ W125CF	23198-0422
R16	100RJ W33 CF	23180-0134	R37	330RJ W125CF	23198-0422
R17	10KJ W33 CF	23180-0103	R38	330RJ W125CF	23198-0422
R18	82KJ W33 CF	23180-0113	R39	330RJ W125CF	23198-0422
R19	6K8J W33 CF	23180-0158	R40	330RJ W125CF	23198-0422
R20	2K2J W25 CF	23199-0412	R41	1K0J W33 CF	23180-0135
R21	4K7J W33 CF	23180-0148			

Capacitors

Ref	Description	Part No
C1	10UF 16V Tant	23594-0219
C2	47PK 500V Cer	23450-0036
C3	10NS 500V Cer	23424-0435
C4	10NZ 63V Cer	23427-0302
C5	4P7D 500V Cer	23450-0037
C6	10UF 16V Tant	23494-0219
C7	10NZ 63V Cer	23427-0302
C8	10UF 16V Tant	23594-0219
C9	47PK 500V Cer	23450-0036
C10	10NZ 63V Cer	23427-0302
C11	2P2J 63V Cer	23427-0528
C12	10NZ 63V Cer	23427-0302
C13	10NZ 63V Cer	23427-0302
C14	10NZ 63V Cer	23427-0302
C15	Trimmer Cap 2 - 30pF	23984-0003
C16	18PJ 63V Cer	23427-0275
C17	22PG 100V Cer	23427-0268
C18	33UF 16V Elec	23557-0216
C19	33UF 16V Elec	23557-0216
C20	10NZ 63V Cer	23427-0302
C21	2P2J 63V Cer	23427-0528
C22	4P7J 63V Cer	23427-0527

Semi-conductors

Ref	Description	Part No
D1	Dio BA244	25030-0901
D2	Dio BA244	25030-0901
D3	Dio BA244	25030-0901
D4	Dio 1N4148TA	25021-0901
D5	Dio 1N4148TA	25021-0901
D6	Dio Zen 5V6 W75 BZX415V6	25131-0800
D7	Dio 1N4148TA	25021-0901
D8	Dio 1N4148TA	25021-0901
D9	Dio 1N4148TA	25021-0901
TR1	Tran NPN BF199	25388-0207
TR2	Tran NPN BF199	25388-0207
TR3	Tran FET BF245A	25601-0003
TR4	Tran PNP ZTX214	25341-0214
TR5	Tran NPN ZTX239	25380-0229
TR6	Tran NPN ZTX313	25380-0230
TR7	Tran NPN ZTX313	25380-0230
TR8	Tran PNP ZTX214	25341-0214
TR9	Tran NPN BFR41	25383-0501
IC1	IC SP8660PD	27251-0001
IC2	IC DM74LS74N	27232-0001
IC3	IC DM74LS00N	27203-0003
IC4	IC ICL7216DIPI	27250-0403

R/S 7216C
C

Opto, Electro/Mechanical, Mechanical and Packaging Parts

Description	Part No
10MHz Crystal XL1	28500-0108
Function Switch SW1	22218-0004
Range Switch SW2	22218-0302
Switch Screen	31331-0550
Display NSA 1588A	43734-0280
28 Pin DIL IC Holder	22574-0110
Earthing tag	35358-0440
PCB	35555-0150
ON/OFF Switch	22218-0004
Battery Connector	22577-0006
Foam Pad	20661-0301
Ext Power Socket	22581-0505
Nut for Power skt	22581-0802
Socket Shroud	33311-0010
W Button - PCB fixing - 3 off	20041-0201
W Button - Case fixing	20041-0202
Upper Case	33536-0330
Face Plate	33331-0220
Window	37634-0060
Window Shroud	33533-0040
Lower Case	33536-0090
Lower Case Insulator	31333-0040
Lower Case Screen	31333-0050
Rubber Foot - 4 off	31141-0020
Battery Cover	33533-0330
Control Knob	37131-0270
Input Socket Connector	31514-0010
Test Lead Assembly	43181-0180

Description	Part No
Instruction Booklet	48581-0180
Translation Sheet	48581-0130
Guarantee Registration Card	48581-0170
Aircap Bag	10615-0302
Aircap Bag per 50 Pack	10612-0004
Vinyl Pouch	38631-0120
Printed Carton	38338-0590
Bulk Pack X50 Outer	38112-0210
Bulk Pack X50 Inner	38114-0004

Parts for Optional Connector Pack

Description	Part No
Aircap Bag	10615-0302
Carton	38111-0030
Carton Label	37538-0120
Aerial Assembly	43712-0030
BNC/Coax Adaptor Assembly	46813-0020
DIN/Phono Adaptor Assembly	46813-0030
Instruction Leaflet	48581-0160

ISSUED: MARCH 1982 R/4024

R.S. Components Ltd.
13-17 Epworth Street
London EC2P 2HA
Tel: 01-250 4000 & 01-253 1222

Data Sheet

Frequency Counter I.C. RS7216C

Stock No. 308-837

The RS7216C Frequency Counter IC is a fully integrated 8 digit frequency counter, which combines a high frequency oscillator, a decade timebase counter, an eight decade data counter and latches, a seven segment decoder, digit multiplexers and eight segment and eight drivers which can directly drive large LED displays (e.g. 0.5" multiplexed displays 587-024).

The counter input has a maximum frequency of 10MHz. However, the maximum frequency may be extended by use of prescaling techniques e.g. to increase the range to 50MHz a 74LS90 decade counter (307-610) may be used or to increase the range to at least 100MHz the RS÷100 Prescaler IC (307-474) may be employed. The input is a digital input, and therefore in many applications the input signal will need amplification and level shifting to give the correct digital signal.

The counter normally uses a 10MHz quartz crystal timebase (but a 1MHz quartz crystal timebase is possible), in addition the timebase may be driven from an external oscillator. The user can select accumulation times of 0.01 sec, 0.1 sec, 1 sec and 10 sec. With a 10 sec accumulation time, the frequency can be displayed to an accuracy of 0.1Hz in the least significant digit. There is 0.2 sec between measurements in all ranges.

The RS7216C incorporates leading zero blanking and automatic decimal point setting as the range is changed, but this may be overridden using the external decimal point control when required. The reading displayed is in kilohertz in the frequency modes and micro-seconds for the time measurement modes. The display is multiplexed at 500Hz with a 12.5% duty cycle for each digit with a typical peak segment current of 25mA. In the display mode, both digit drivers and segment drivers are turned off allowing the display off to be used for other functions if required.

FEATURES

- Functions as a Frequency Counter, Measures from DC to 10MHz
- Four Internal Gate Times: 0.01 sec, 0.1 sec, 1 sec & 10 sec
- Decimal Point and Leading Zero Blanking May be Externally Selected
- Measurement in Progress Output
- Eight Digit Multiplexed LED Outputs
- Output Drivers will Directly Drive Both Digits and Segments of Large LED Displays.
- Single Nominal 5V Supply Required
- Stable High Frequency Oscillator, Uses Either 1MHz or 10 MHz Crystal
- Internally Generated Multiplex Timing with Interdigit Blanking, Leading Zero Blanking and Overflow Indication
- Decimal Point and Leading Zero Blanking Controlled Directly by the Chip
- Display Off Mode Turns Off Display and Puts Chip into Low Power Mode
- Hold and Reset Inputs for Additional Flexibility
- All Terminals Protected Against Static Discharge

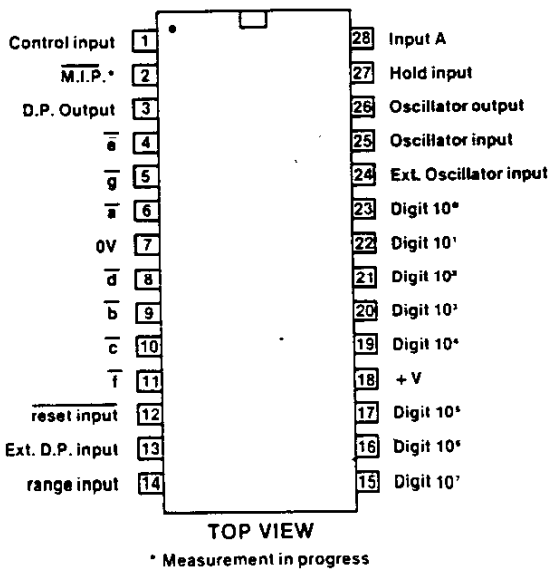


Figure 1 Pin Connections

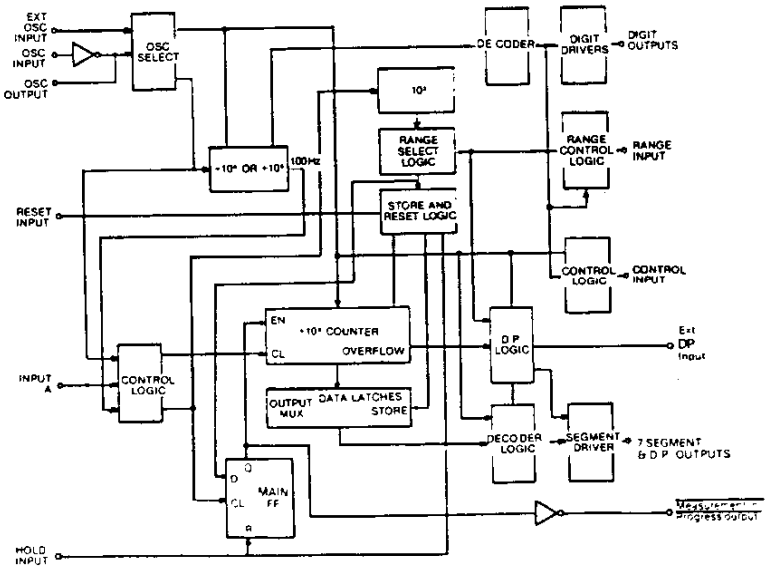


Figure 2 Block Diagram

ABSOLUTE MAXIMUM RATINGS

Maximum Supply Voltage (+V) ..... 6·5V
Maximum Digit Output Current 400mA
Maximum Segment Output Current 60mA
Voltage On Any Input or
Output Terminal[1] ..... +V +0·3V to -0·3V
Maximum Power Dissipation at 70°C ..... 1·0W
Maximum Operating Temperature
Range ..... -20°C to +70°C
Maximum Storage Temperature
Range ..... -55°C to +125°C

Notes:
1. The RS7216C may be triggered into a destructive latchup mode if either input signals are applied before the power supply is applied or if input or outputs are forced to voltages exceeding + V by more than 0.3V.

ELECTRICAL CHARACTERISTICS

TEST CONDITIONS +V = 5·0V, Test Circuit, T_A = 25°C, unless otherwise specified.

PARAMETER	SYMBOL	CONDITION	MIN.	TYP.	MAX.	UNITS
Operating Supply Current	I_{DD}	Display Off, Unused Inputs to 0V		2	5	mA
Supply Voltage Range	+V	−20°C < T_A < +70°C. Input A. Frequency at F_{MAX}	4·75		6·0	V
Maximum Frequency Input A, Pin 28	F MAX	−20°C < T_A < +70°C 4.75 < +V <6·0V. Figure 3	10			MHz
Maximum Osc. Freq. and Ext. Osc. Frequency		−20°C < T_A < +70°C 4·75 < +V <6·0V	10			MHz
Minimum Ext. Osc. Freq.					100	kHz
Oscillator Transconductance	gm	+V = 4.75V, T_A = +70°C	2000			µmhos
Multiplex Frequency	f_{mux}	f_{OSC} = 10MHz		500		Hz
Time Between Measurements		f_{OSC} = 10MHz		200		ms
Input Voltages: Pins 12,27,28 Input Low Voltage Input High Voltage	V_{IL} V_{IH}	−20°C < T_A < +70°C	3·5		1·0	V V
Input Resistance to −V Pins 12,24	R	V_{IN} = +V−1·0V	100	400		kΩ
Input Leakage Pin 27, Pin 28	I_L				±0	µA
Output Current Pin 2	I_{OL}	V_{OL} = 0.4V	0.36			mA
	I_{OH}	V_{OH} = +V −0.8V	265			µA
Digit Driver: Pins 15, 16, 17, 19, 20, 21, 22, 23 High Output Current Low Output Current	I_{OH} I_{OL}	V_{OUT} = +V−2·0V V_{OUT} = +1·0V	−150	−180 +0.3		mA mA
Segment Driver: Pins 3,4,5,6,8,9,10,11 Low Output Current High Output Current	I_{OL} I_{OH}	V_{OUT} = +1·5V V_{OUT} = +V−2·5V	25	30 −100		mA µA
Multiplex Inputs: Pins 1, 3, 14 Input Low Voltage Input High Voltage Input Resistance to 0V	V_{IL} V_{IH} R	V_{IN} = +1·0V	+2·0 50	100	0·8	V V kΩ

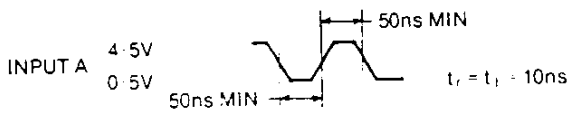


Figure 3. Waveform for Guaranteed Minimum F

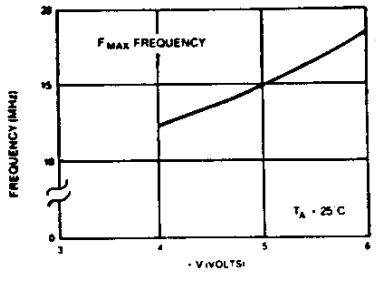


Figure 4 Typical Operating Characteristics

F_{MAX}, as a Function of +V

APPLICATIONS NOTES

GENERAL

Input A

Input A is a digital input with a typical switching threshold of 2.0V at +V = 5.0V. For optimum performance the peak-to-peak input signal should be at least 50% of the supply voltage and centred about the switching voltage. When the input is being driven from TTL logic, it is desirable to use a pullup resistor. The circuit counts high to low transitions at both inputs.

Note: The amplitude of the input should not exceed the supply, otherwise, the circuit may be damaged.

Multiplexed Inputs

The range, control and external decimal point inputs are time multiplexed to select the input function desired. This is achieved by connecting the appropriate digit driver output to the inputs. The range and control inputs must be stable during the last half of each digit output. (typically 125µs). The multiplex inputs are active high for a common anode display.

Noise on the multiplex inputs can cause improper operation. For maximum noise immunity, a 10kΩ resistor should be placed in series with the multiplex inputs and a 68pF decoupling capacitor between the multiplex input and 0V, as shown in figure 9.

Table 1 shows the functions selected by each digit for these inputs.

Control Input Functions

Display Test — All segments are enabled continuously, giving a display of all 8's with decimal points. The display will be blanked if Display Off is selected at the same time.

Display Off — To enable the Display Off mode it is necessary to connect $D10^3$ to the control input and have the HOLD input at +V. The chip will remain in the Display Off mode until HOLD is switched back to 0V. While in the Display Off mode, the segment and digit driver outputs are open. During Display Off the oscillator continues to run with a typical supply current of 1.5mA with a 10 MHz crystal and no measurements are made. In addition, inputs to the multiplexed inputs will have no effect. A new measurement is initiated when the HOLD input is switched to 0V.

1 MHz Select — The 1 MHz enable mode allows use of a 1 MHz crystal with the same digit multiplex rate and time between measurements as with a 10 MHz crystal.

External Oscillator Enable — In this mode the external oscillator input is used instead of the on-chip oscillator for the Timebase input. The on-chip oscillator will continue to function when the external oscillator is selected. The external oscillator input frequency must be greater than 100 kHz or the chip will reset itself to enable the on-chip oscillator. (The RS 10 MHz crystal oscillator is ideally suited as an external oscillator).

Range Input — The range input selects whether the measurement is made for 1, 10, 100, 1000 counts of the reference counter. A change in the range input will stop the measurement in progress without updating the display and then initiate a new measurement. This prevents an erroneous first reading after the Range Input is changed.

TABLE 1

	FUNCTION	DIGIT CONNECTION
Range Input Pin 14	1 hertz	$D10^0$
	10 hertz	$D10^1$
	100 hertz	$D10^2$
	1000 hertz	$D10^3$
Control Input Pin 1	Blank Display	$D10^3$ and Hold
	Display Test	$D10^7$
	1 MHz Enable	$D10^1$
	External Oscillator Enable	$D10^0$
	External Decimal Point Enable	$D10^2$
External Decimal Point Input Pin 13.	Decimal point is output for same digit that is connected to this input (except $D10^7$).	

External Decimal Point Enable — When external decimal point is enabled a decimal point will be displayed whenever the digit driver connected to the external decimal point is active (except MSD). Leading Zero Blanking will be disabled for all digits following the decimal point.

Hold Input — When the Hold Input is at +V, any measurement in progress is stopped, the main counter is reset and the chip is held ready to initiate a new measurement. The latches which hold the main counter data are not updated so the last complete measurement is displayed. When Hold is changed to OV, a new measurement is initiated.

$\overline{\text{Reset}}$ Input — The $\overline{\text{Reset}}$ Input is the same as a Hold Input, except the latches for the Main Counter are enabled, resulting in an output of all zeros.

DISPLAY CONSIDERATIONS

The display is multiplexed at a 500 Hz rate with a digit time of 244µs. An interdigit blanking time of 6µs is used to prevent ghosting between digits. The decimal point and leading zero blanking have been implemented for right hand decimal point displays. Any zeros following the decimal point will not be blanked. Also, the leading zero blanking will be disabled when the Main Counter overflows.

The RS7216C is designed to drive common anode LED displays at peak current of 25mA/segment, using displays with V_F = 1·8 V at 25mA. The average DC current will be over 3mA under these conditions.

Resistors can be added in series with the segment drivers to limit the display current in very efficient displays, if required. Figures 5, 6 and 7 show the digit and segment currents as a function of output voltage. (V_{out} referred to OV)

To obtain additional brightness from the displays, +V may be increased up to 6.0V. However, care should be taken to see that maximum power and current ratings are not exceeded.

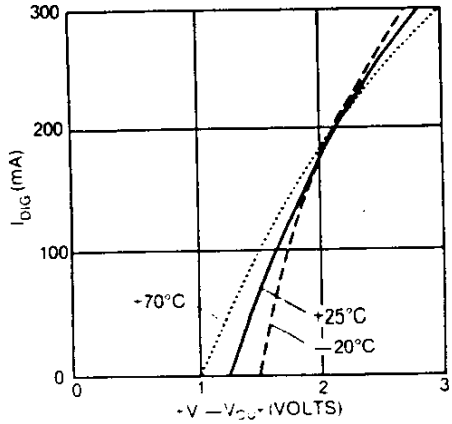


Figure 5. Typical I_{DIG} vs. +V —V_{OUT} (4·5V <+V< 6·0V)

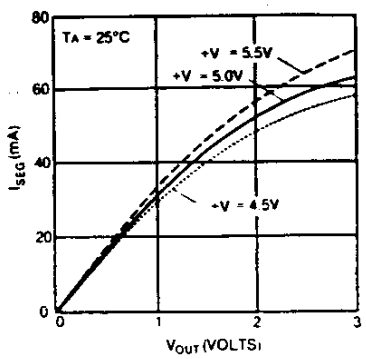


Figure 6. Typical I_{SEG} vs. V_{OUT} (+V Varied)

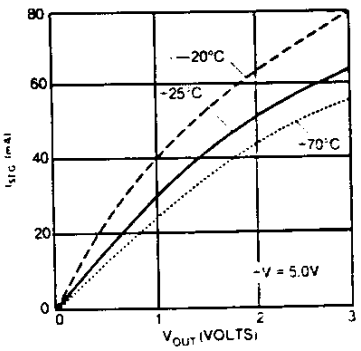
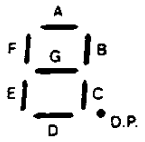


Figure 7. Typical I_{SEG} vs. V_{OUT} (Temperature Varied)

The segment and digit outputs in the RS7216C are not directly compatible with either TTL or CMOS logic. Therefore, level shifting with discrete transistors may be required to use these outputs as logic signals.

Segment Identification:



N.B. The correct display to use with this device is a common anode with right hand decimal point e.g. RS multiplexed seven segment display Stock No 587-024

ACCURACY

In a Frequency Counter crystal drift and quantization errors cause measurement errors. When measuring frequency a signal derived from the oscillator is used in the Reference Counter, therefore, an error in the oscillator frequency will cause an identical error in the measurement. For instance, an oscillator temperature coefficient of 20ppm/°C will cause a measurement error of 20ppm/°C.

In addition, there is a quantization error inherent in any digital measurement of ±1 count. Clearly this error is reduced by displaying more digits. With frequency measurement obviously the maximum accuracy is obtained with high frequency inputs.

OSCILLATOR CONSIDERATIONS

The easiest way of implementing the timebase oscillator is to use a 10MHz crystal (307-799) and associated circuitry as shown in figure 8.

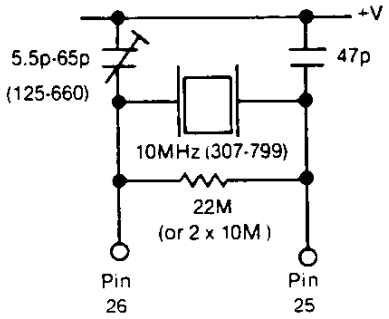


Figure 8. Crystal Oscillator Circuit

If the 1MHz enable option is to be used, this may be implemented simply by substituting a 1MHz crystal (307-761) for the 10MHz crystal in figure 8 and connecting the 1MHz enable control circuitry.
An external oscillator, e.g. the RS 10MHz Crystal Oscillator may be used by connecting the oscillator output to pin 24 and connecting the external oscillator enable control circuitry. (N.B. oscillator output must meet input voltage criteria as detailed in maximum ratings and electrical characteristics sections).

CIRCUIT APPLICATIONS

GENERAL NOTES

The Range and Function input switches should be break before make types.
The control, hold and reset switches, being individual switches may be miniature toggle, slide or pushbutton types, as required. (N.B. all switches, however, should have gold contacts).
The display may be made up using two multiplexed displays (587-024), or eight 0.5in individual displays (587-254).
The recommended supply decoupling is a 220µ electrolytic capacitor and a 100 n disc ceramic (124-178), as close to the device supply pins as possible.

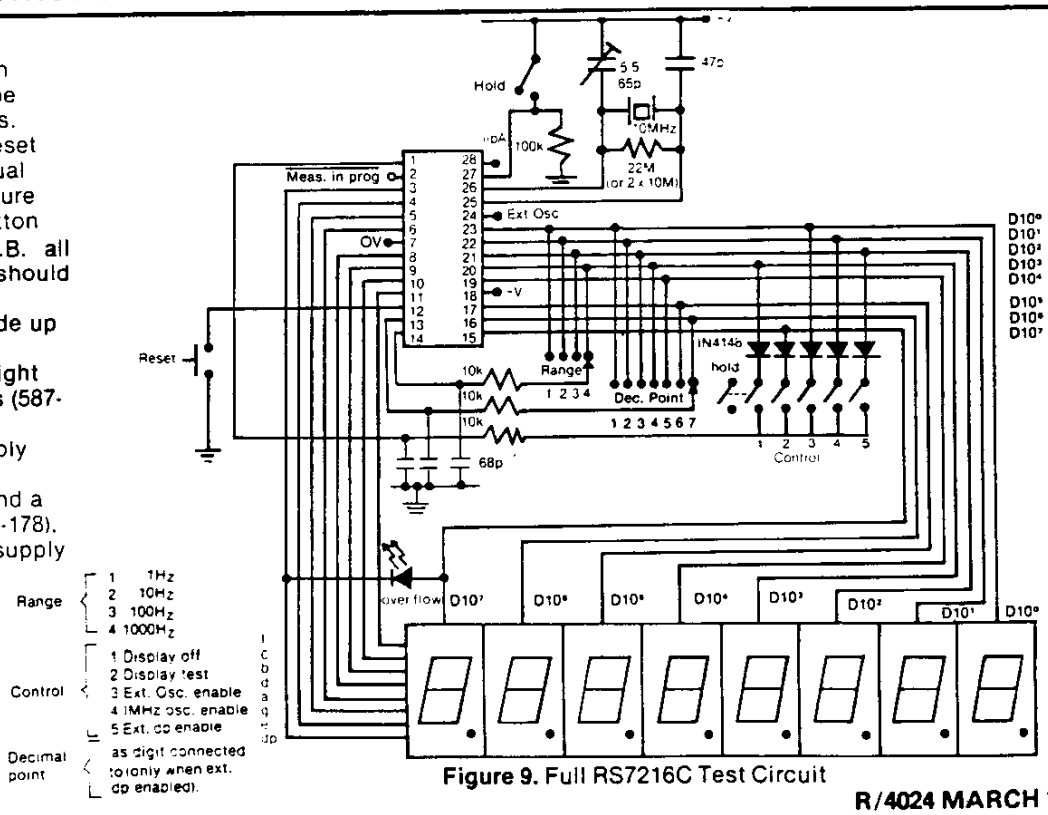


Figure 9. Full RS7216C Test Circuit

The RS7216C has been designed for use in a wide range of Frequency Counter applications. In many cases, prescalers will be required to reduce the input frequencies to under 10 MHz. Because Input A is a digital input, additional circuitry will often be required for input buffering, amplification, hysteresis, and level shifting to obtain a good digital signal. The complexity for doing this can vary widely depending on the sensitivity and maximum frequency required.

PRESCALER TECHNIQUES

Prescaler ÷ 10 up to 50 MHz

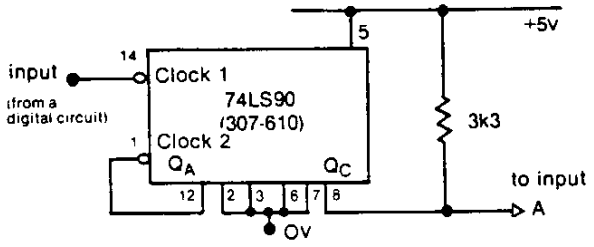


Figure 10. Divide by Ten Prescaler

Note. The output from the 74LS90 comes from QC rather than QD to obtain an input duty cycle of 40% for the RS7216C. If the signal at input A has a very low duty cycle it may be necessary to use a monostable (74LS123 or similar) to stretch the pulse width to guarantee a 50ns minimum pulse width.

Prescaler ÷ 100 up to 150 MHz

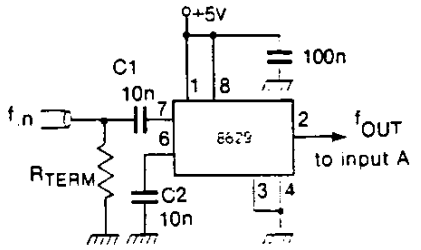


Figure 11. Divide by 100 High Frequency, Single-Ended Input

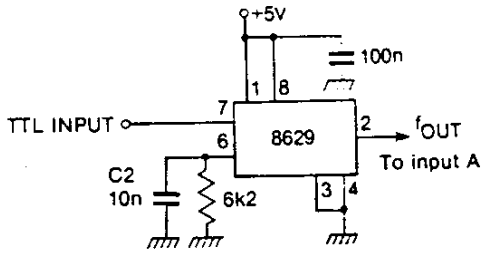


Figure 12. Divide by 100 TTL Input (DC<f_{in}<f_{max})

For further details of the RS8629, Stock No 307-474, see data sheet R/3059.

The use of the external decimal point control allows the correct positioning of the decimal point (and zero blanking) when prescalers are used — see page 3.

MEASUREMENT IN PROGRESS OUTPUT

The most simple use this output may be put to is to enable a visual indication of a measurement in progress to be displayed (see figure 13). In more sophisticated systems, however, this output may be used to control any function which needs to be synchronised with the start of the measurement cycle (e.g. prescalers etc).

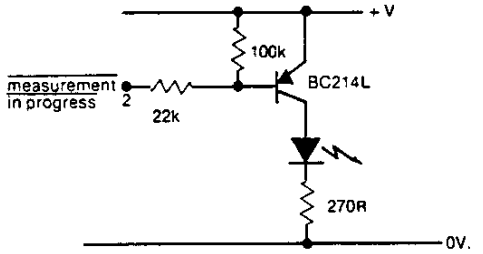


Figure 13. Measurement in Progress Display

Prices £ each		
1+	25+	100+
2.120	1.590	1.060
2.120	1.590	1.060
6.100	4.550	3.030
6.100	4.550	3.030

ge Reference

Prices £ each		
1+	25+	100+
5.870	4.760	4.210
0.740	0.610	0.510
8.800	7.440	5.950
6.080	5.100	4.080
1.350	1.150	0.910
2.070	1.730	1.450
1.010	0.850	0.680
0.440	0.370	0.300
29.920	25.500	21.080
20.060	17.000	13.600
13.260	11.280	9.070
5.370	4.550	3.630
3.700	2.960	2.270
1.220	1.020	0.850
3.970	3.650	3.060
5.690	5.220	4.370
9.920	9.120	7.630
3.970	3.650	3.060
5.690	5.220	4.370

ge Regulators

Prices £ each		
1+	25+	100+
31.230	28.710	24.010
31.230	28.710	24.010

Current Zener Diodes

Prices £ each		
1+	25+	100+
6.120	4.890	4.080
6.120	4.890	4.080
6.120	4.890	4.080

Prices £ each		
1+	25+	100+
1.034	0.869	0.693
0.374	0.319	0.252

d Current Regulators

Prices £ each		
1+	25+	100+
0.[illegible]	1.150	1.410
5.410	4.060	4.890

TIMERS

Fairchild Timers

REFERENCE TABLE

Type No.	Stock No.	Description	Prices £ each 1+	25+	100+
μA555TC	37528C	Single Timer	0.412	0.298	0.209
μA556PC	67161C	Dual Timer	0.844	0.611	0.428

Ferranti Timers

REFERENCE TABLE

Type No.	Stock No.	Description	Prices £ each 1+	25+	100+
ZN1034E	67579F	Precision Counter Timer	1.650	1.430	1.210

Motorola Timers

REFERENCE TABLE

Type No.	Stock No.	Description	Prices £ each 1+	25+	100+
MC1455P1	63756B	Wide range adjustable single	0.485	0.375	0.260
MC1555G	64037D	Wide range adjustable single	2.460	1.850	1.230

National Semiconductor Timers

REFERENCE TABLE

Type No.	Stock No.	Description	Prices £ each 1+	25+	100+
LM122H	36301B	Precision Single Timer	5.100	4.080	3.400
LM322N	34831D	Precision Single Timer	1.190	0.950	0.780
LM555CH	34701B	Single Timer	0.850	0.680	0.570
LM555CN	34598A	Single Timer	0.580	0.460	0.290
LM555H	36441X	Single Timer	2.440	2.040	1.700
LM556CN	36678B	Dual Timer	0.930	0.740	0.460
LM556J	47564G	Dual Timer	4.520	3.700	3.160

RCA Timers

REFERENCE TABLE

Type No.	Stock No.	Description	Prices £ each 1+	25+	100+
CA555CE	26478F	Single Timer	0.628	0.366	0.281
CA555E	26477H	Single Timer	0.774	0.451	0.346
CA555T	64672E	Single Timer	1.338	0.780	0.599
CA555CS	21911G	Single Timer	1.283	0.748	0.575
CA555CT	64670R	Single Timer	1.259	0.733	0.563

Signetics Timers

REFERENCE TABLE

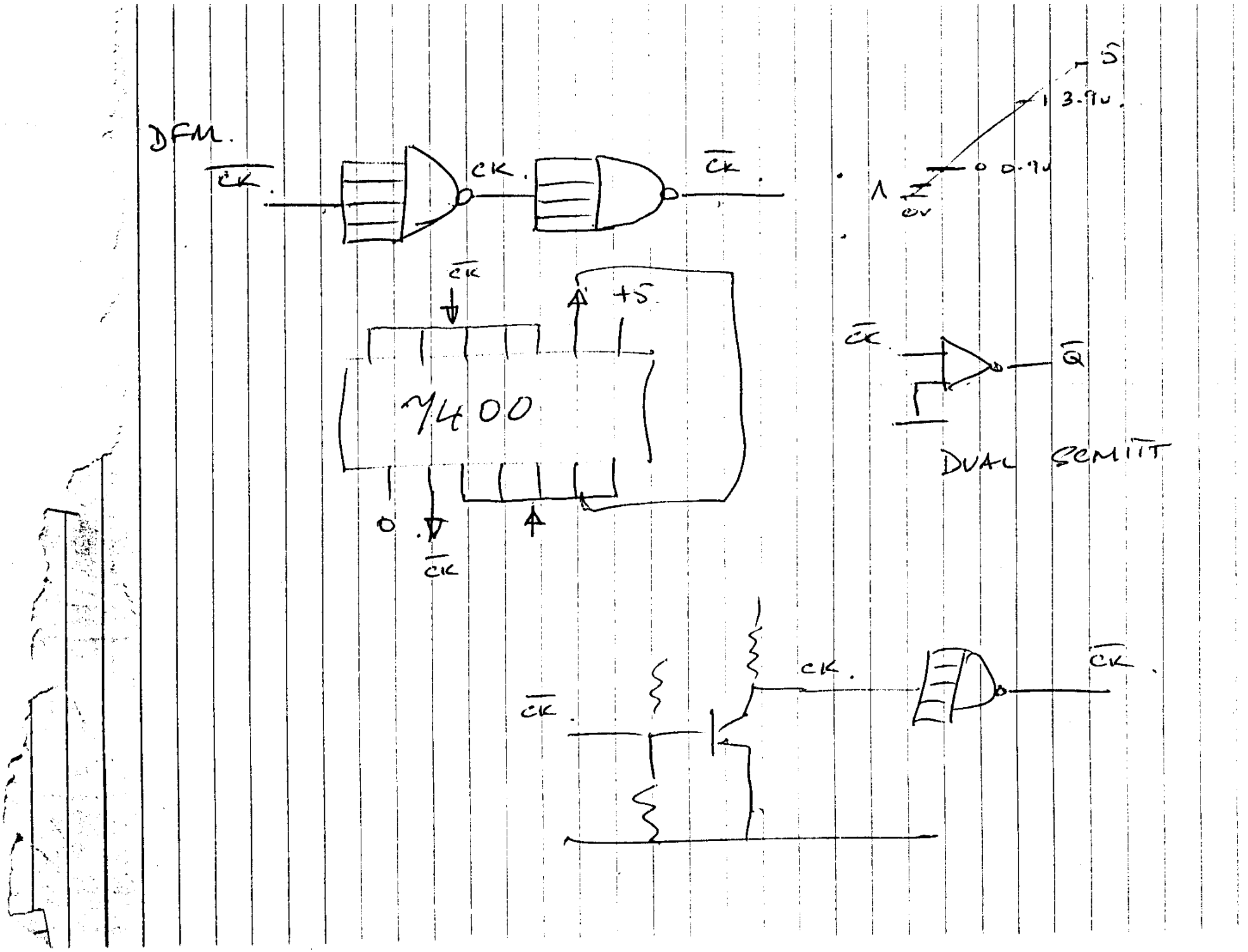
Type No.	Stock No.	Description	Prices £ each 1+	25+	100+
NE555F	56028F	Single Timer	1.130	0.900	0.750
NE555N	56029D	Single Timer	0.429	0.352	0.2827
NE556F	56034X	Dual Timer	1.408	1.177	0.9438
NE556N	56035H	Dual Timer	0.660	0.550	0.440
NE558N	56489C	Quad Timer	1.880	1.000	0.794
SE555F	56031E	Single Timer	—	—	—
SE555N	56032C	Single Timer	1.500	1.250	1.001
SE556H	56033A	Single Timer	2.700	2.160	1.800
SE556F	56036F	Dual Timer	4.130	3.440	2.752

Texas Instruments Timers

REFERENCE TABLE

Type No.	Stock No.	Description	Prices £ each 1+	25+
NE555P	96184H	General Purpose	0.817	0.463
NE556J	48344D	Dual NE555	3.029	2.851
NE556N	48343F	Dual SE556	1.506	0.853
SE555JG	91182A	General Purpose	1.837	1.358

13


DFM.
CK.
CK.
CK.
+5
7400
0
CK
CK
+5
3.9v.
0 0.9v
0v
CK.
Q
DUAL SCHMITT
CK.
CK.
CK.

Addendum for PFM200A

From September 1981 the PFM200A supersedes the PFM200. The PFM200A has standard BNC connectors in place of the 4mm sockets plus improved cosmetics but is otherwise electronically identical to the PFM200. A number of incidental changes have been made, partly resulting from the ongoing modifications made to the case for other instruments, but these should all be self-evident from the parts list differences shown below.

Note: The BNC sockets prevent the case lower being slid off as described in the manual. Instead, after levering out the retaining clip as shown, squeeze one of the long edges of the lower inwards and ease away from the case upper, working from the battery compartment downwards. Replace by engaging one long edge and snapping in the other.

Parts List Differences

Component	PFM200	PFM200A
Input socket connector (4-way)	31514-0010	Not used
Rivets for socket connector	31123-0070	"
BNC socket	Not used	22588-0004
W-button, pcb fixing	20041-0201	20041-0202
Case-upper	33536-0330	33536-0420
Faceplate	33331-0220	33331-0440
ON-OFF switch	22218-0004	22218-0007
Rivets for ON-OFF switch	20028-0006	Not used
Screw M2/8 poly/c for ON-OFF	Not used	20234-0021
M2 nut for ON-OFF	"	20210-0100
Battery Connector	22577-0006	22577-0007
Foam Pad	20661-0301	Not used
Insulator	31333-0040	31344-0050
Earthing spring	35358-0440	35358-0470
Aircap bag	10615-0302	10615-0300
Vinyl pouch	38631-0120	Not used
Test leads	43181-0180	Not used
Printed carton	38338-0590	38338-0650
Instructions	48581-0180	48581-0420
Translation sheet	48581-0130	Not used
Shroud for jack socket	33311-0010	Not used

September 1981

thandar

PFM200A FREQUENCY METER

INTRODUCTION

The PFM200A is a battery operated pocket-size frequency meter featuring a 20Hz to 200MHz measurement range, a high accuracy crystal timebase and an 8 digit L.E.D. display.

There are two ranges. Range A has a measurement capability of 20Hz to 10 MHz and 4 gate times giving a resolution down to 0.1Hz. Range B has measurement capability of 5MHz to 200MHz and 4 gate times giving a resolution down to 1Hz.

Input sensitivity is typically 10mV rms at the 0dB input and 100mV rms at the −20dB input. Both inputs are via BNC sockets and have an input impedance of nominally 1MΩ/50pF.

The display reads out directly in kHz, with automatic decimal point positioning, and also has a low battery indication. Typical battery life is 10 hours from a 9V alkaline type and the meter can also be operated from an optional AC adaptor.

ACCESSORIES AVAILABLE

AC adaptors for 117V, 220V or 240V
TP600 600MHz Prescaler
x1 Probe, x 10 Probe
Padded Carrying Case
Service Manual

SAFETY SYMBOLS

Internationally recognised safety symbols are used on the PFM200A front panel and in this manual. They are:-

meaning **CAUTION.** Carefully read the caution statements with regard to proper use of the instrument. Damage to the instrument may occur if these precautions are ignored.

meaning **WARNING.** Carefully read the warning statements with regard to proper use and handling of the instrument. Serious personal injury may result if these precautions are ignored.

Thandar Electronics Ltd.,
London Road, St. Ives,
Huntingdon, CAMBS.
Tel: (0480) 64646

Leaflet No. 48581-0420

SPECIFICATION

FUNCTIONS

Range A

Frequency range:	20Hz-10MHz
Gate Times:	.01 secs to 10 secs in 4 decade steps
Readout:	kHz
Resolution:	100Hz to 0.1Hz in step with gate times of 0.01 to 10 secs
Accuracy:	± (1 count + timebase accuracy)

Range B

Frequency range:	5MHz - 200MHz
Gate Times:	0.02 secs to 20 secs in 4 decade steps
Readout:	kHz
Resolution:	1kHz to 1Hz in step with gate times of 0.02 to 20 secs.
Accuracy:	± (1 count + timebase accuracy)

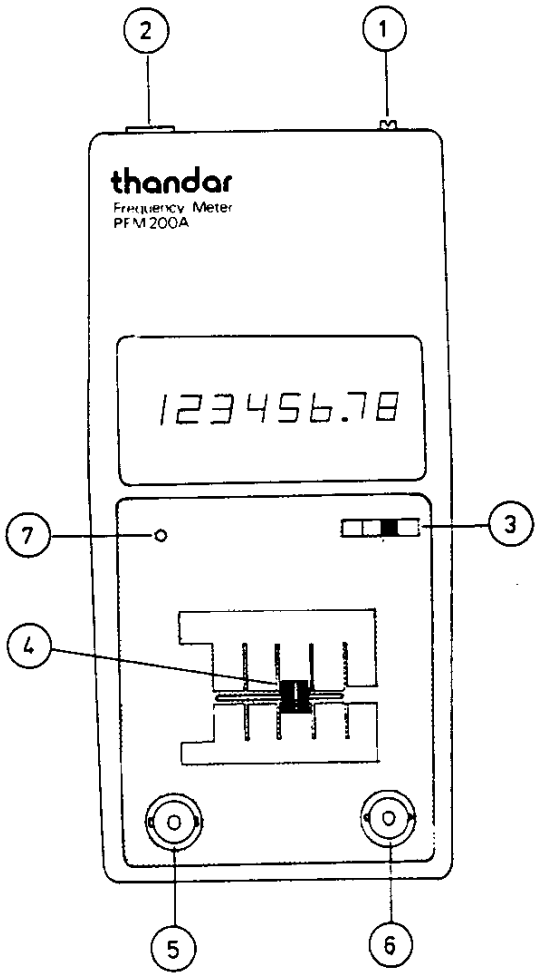
INPUTS

0dB

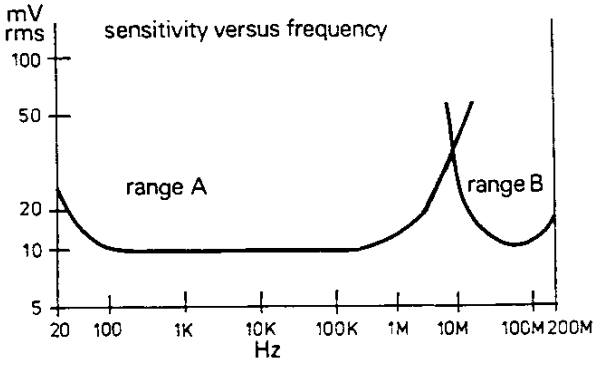
Input Impedance:	1MΩ/50pF nominal
Sensitivity:	Typically 10mV rms, see graph A
Maximum permissible input voltage:	See graph B.

−20dB

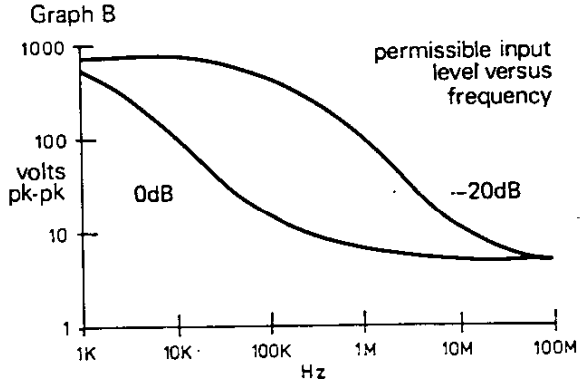
Input Impedance:	1MΩ/50pF nominal
Sensitivity:	Nominally −20dB with respect to 0dB input
Maximum permissible input voltage:	See graph B



Graph A



Graph B



TIMEBASE

Crystal oscillator frequency:	10MHz
Initial oscillator adjustment error:	$<\pm$ 2ppm at 22°C
Oscillator temperature coefficient:	$<\pm$ 0.3ppm/°C
Oscillator ageing rate:	$<\pm$ 10ppm per year

GENERAL

Power Requirements

Battery type:	9V alkaline or zinc carbon type
Battery life:	Typically 10 hours using alkaline type, depending on range and display.
Low battery indicator:	All decimal point illuminated
External power:	6V-15V DC at 100mA via 2.5mm jack (tip positive) from approved AC adaptor, car battery etc.
Environmental Operating Range:	5°C to 40°C
Environmental Storage Range:	–40°C to –60°C

MECHANICAL

Case Size	157 x 76 x 32mm
Weight	170 gms excluding battery

OPERATION

Power

The PFM200A requires a 9 volt alkaline or zinc carbon battery. Alkaline types are recommended and should give a battery life of typically 10 hours, depending on range and display. To fit or change the battery ensure the ON-OFF switch (1) is in the OFF position then slide off the battery cover in the direction shown by the arrow on the cover.

WARNING. To prevent shock hazard, all inputs must be removed before changing the battery.

Fit the battery **observing the correct polarity.** Reverse battery connection will cause rapid battery discharge and may damage the instrument.

Low battery voltage is indicated by the illumination of all decimal points. Correct operation will continue for a short period but the battery should be replaced as soon as possible.

Always remove an exhausted battery from the instrument to avoid possible damage through leakage.

Alternatively, the meter may be powered from an external source such as an approved AC adaptor or a 12 volt car battery via the cigar lighter. Connection to the external power socket (2) is by means of a 2.5mm jack plug, tip positive and the DC source must be in the range 6V-15V, with a current capability of 100mA.

Range and Gate Time Selection

For frequencies in the range 20Hz to 10MHz select range A with the range switch (3).

For frequencies above 10MHz select range B with the range switch (3). Range B may be used down to 5MHz but sensitivity will deteriorate below 10MHz. Operation above 200MHz is typically possible but not guaranteed; exceeding the maximum frequency capability will result in an unstable reading.

In both cases select the shortest gate time that gives the desired resolution with the Gate Time switch (4). The decimal point is always positioned correctly to give the readout in kHz.

Inputs

Both inputs have an impedance of nominally 1M /50pF.

Use the 0dB input (5) for low level signals; sensitivity is typically 10mV rms but varies with frequency, see Specification. The sensitivity values shown apply to the r.m.s. value of a sine-wave signal but the instrument will operate with signals of any wave shape whose peak-to-peak value is greater than 3 x the indicated sensitivity, up to about 5 volts peak-to-peak. Above 800mV peak-to-peak, however, diode clipping occurs and the input impedance becomes non-linear. It may then be necessary to use the attenuated input.

The –20dB socket (6) is an attenuated input with a sensitivity approximately ten times lower and can be used for signals up to the maximum rated level given in the Specification.

Further attenuation can be provided by the connection of an external series network. 10MΩ in parallel with 5pF will give a further –20dB as will a suitably adjusted x10 oscilloscope probe. This can be done with either input and has the advantage of reducing the load on the signal source by a factor of 10.

Overload Protection

Both inputs are protected against the connection of line voltages. The maximum permissible input voltage at other frequencies is given in the Specification, graph B.

SAFETY PRECAUTIONS

When working with high voltage signals, safety rules must be observed. Remember that the signal ground is directly connected to the negative side of the power input. The following rules are recommended.

1. Use only an approved AC adaptor. Any other external source of power should be soundly grounded.
2. Use extreme caution when working with voltages above 50V; always disconnect power from the circuit being tested whilst connecting or disconnecting test leads.
3. Never unplug a test lead from the instrument while it is still connected to a high voltage.
4. Take special care when working with high power transmitters.

CALIBRATION AND MAINTENANCE

Calibration is guaranteed as in the Specification. However, although the crystal in the oscillator is pre-aged before assembly, further ageing of up to $\pm$ 10ppm can occur in the first year. Since this ageing rate decreases exponentially with time, it is an advantage to recalibrate the instrument after about six months when the ageing rate has slowed down.

Recalibration may be carried out without dismantling the instrument by accessing the trimmer through the hole in the front panel marked CAL (7).

Adjustment can be monitored by using a frequency standard or standard frequency receiver to provide a high accuracy signal at the input.

Use a non-metallic trimming tool when adjusting the oscillator. If only a metal tool is available, allow for the frequency shift that the metal tool introduces whilst making the adjustment so that the meter reads correctly with the trimming tool withdrawn.

The Manufacturers, or their agents overseas, will provide repair for any meter developing a fault. Where owners wish to undertake their own maintenance work, this should only be done in conjunction with the Service Manual which may be purchased directly from the Manufacturer or their agents overseas.

GUARANTEE

For guarantee details please see separate insert contained in packaging.