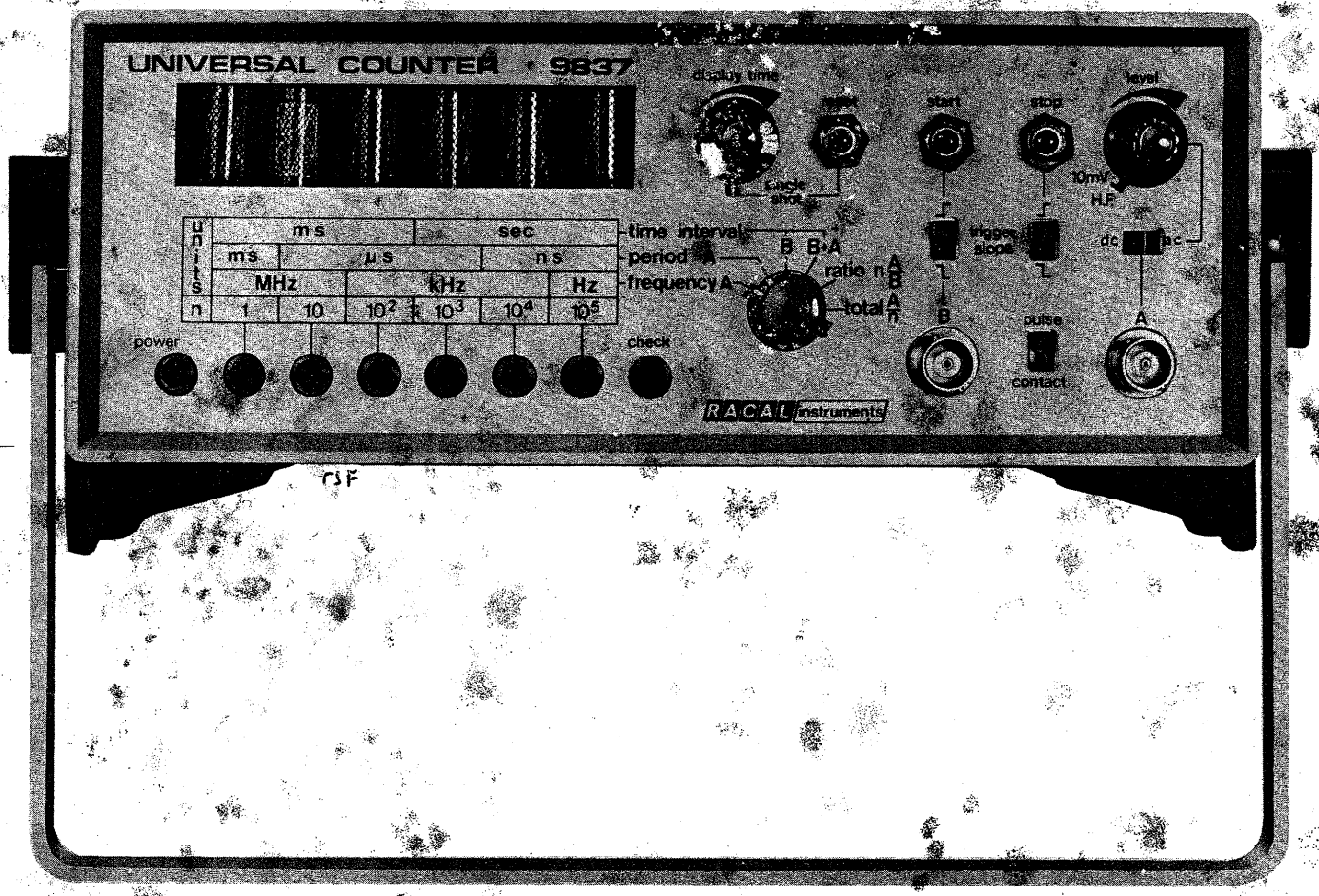

UNIVERSAL COUNTER 9837
display time
gate
single shot
start
stop
level
10mV H.F.
dc
ac
trigger slope
units
n
m s
sec
ms
µs
ns
MHz
kHz
Hz
1
10
10^2
10^3
10^4
10^5
time interval
period A
frequency A
B
B÷A
ratio
total
power
check
pulse
contact
A
B
RACAL instruments

'POZIDRIV' SCREWDRIVERS

Metric thread cross-head screws fitted to Racal equipment are of the 'Pozidriv' type. Phillips type and 'Pozidriv' type screwdrivers are not interchangeable, and the use of the wrong screwdriver will cause damage. POZIDRIV is a registered trade mark of G.K.N. Screws and Fasteners Limited. The 'Pozidriv' screwdrivers are manufactured by Stanley Tools Limited.

SECTION 1

TECHNICAL SPECIFICATION

HANDBOOK VALIDITY

This Issue of the handbook is prepared for the following instrument serial numbers:-

9835: commencing at No. 1630
9837: commencing at No. 1730

TECHNICAL SPECIFICATION

TYPES 9835 and 9837

NOTE: The data given applies to both instruments except where otherwise indicated.

1. MEASURING FUNCTIONS

Frequency,
Single Period and Multiple Period
Ratio and Multiple Ratio
Time Interval - Single Line and Double Line
Totalizing.

2. PRINCIPAL ELECTRICAL PARAMETERS

2.1 Channel 'A' Input Amplifier (A.C. Coupled)

	9835	9837
Frequency Range:	10Hz to 20MHz	10Hz to 80MHz

Sensitivity:

9835: 10mV (variable by means of LEVEL control).
9837: As for 9835 up to 20MHz. Above 20MHz the LEVEL control is operated in the "HF" (switched) position with fixed 10mV sensitivity up to 60MHz
Above 60MHz the sensitivity is reduced to 20mV.

Maximum Input Level:

250V r.m.s. up to 10kHz
50V r.m.s. up to 100kHz
10V r.m.s. above 100kHz.

Input Impedance: 1M ohm shunted by 25pF

Coupling: 400V D.C.

Connection: B.N.C. socket mounted on front panel.

2.2 Channels 'A' and 'B' (D.C. Coupled)

Frequency Range: D.C. to 5MHz.

Sensitivity: +1V $\pm$ 0.25V or contact closure to earth.

Maximum Input Level: $\pm$ 35V.

Pulse Duration: 100ns minimum at trigger points.

Input Impedance:	Approximately 10k ohm.
Connection:	B.N.C. socket mounted on front panel.

2.3 Frequency Measurement

Input:		Channel 'A'.
Frequency Ranges and Gate Times:	9835	A.C. Mode: 10 Hz to 20 MHz D.C. Mode: D.C. to 5 MHz Gate Times: 100μs to 10s in decade steps
	9837	"H.F." A.C.:- 10 Hz to 80 MHz "Normal" A.C.:- 10 Hz to 20 MHz. D.C. Mode:- D.C. to 5 MHz. Gate Times:- 100μs to 10s, except in "H.F." mode where gate times are 400μs to 40s.

2.4 Period Measurement

Range:	1μs - 1 sec.
Clock Unit:	1μs
Input Channel:	'A'
Coupling:	A.C. or D.C.
Periods Averaged:	1 - 10^5 in decade steps.
Single Period:	Can be measured also as specified under "Time Interval (Single Line)" below.

2.5 Time Interval (Single Line)

Time Range:	1μs to 10^5 sec. (Approximately 28 hours).
Input Channel:	'B', D.C. coupled.
Trigger Slope:	Start:- + or - slope selection switch. Stop:- + or - slope selection switch.
Clock Units:	1μs - 100ms in decade steps

Input: Positive pulse or contact closure. (Pins are provided for fitting bounce protection capacitors).

2.6 Time Interval (Double Line)

Time Range: 1μs to 10^5 sec. (Approximately 28 hours).

Start Channel: 'B'

Stop Channel: 'A'

Coupling: D.C.

Other details are for single line measurement.

2.7 Single Period Measurement

See 2.5 above.

2.8 Ratio Measurement

Inputs:

2.8.1 Higher Frequency Input: Channel 'A'.

Coupling: A.C. or D.C.

Frequency Range: 0 - 20 MHz.

2.8.2 Lower Frequency Input: Channel 'B'.

Coupling: D.C.

Frequency Range: 0 - 2 MHz for n = 1
0 - 5 MHz for n = 10 to 10^5.

Reads: $\frac{\text{Frequency A}}{\text{Frequency B}} \times n$

Multiplier 'n': 1 - 10^5 in decade steps.

2.9 Totalising

Input Channel: 'A'.

Coupling: A.C. or D.C.

Maximum Rate: 5×10^6 events per second.

Pulse Pair Resolution:	Not less than 0.2μsec.
Pulse Width:	100ns minimum at trigger points.
Prescaling:	Events may be pre-scaled in decade steps from 1 - 10^5 (n).
Reads:	$\frac{\text{No. of Input Events}}{n}$
Manual Start - Stop:	By push buttons on front panel. Successive operation of the start - stop buttons will allow accumulation of events, when using 'Single Shot'.
Electrical Start - Stop:	As for 2.5 Time Interval (Single Line).

2.10 Frequency Standard

2.10.1

Frequency:	5MHz.
Temperature Stability:	± 8 parts in 10^6 over instrument operating temperature range. ± 3 parts in 10^6 over temperature range +20 to +40°C.
Average Ageing Rate:	Better than ± 1 part in 10^6 per month.

2.10.2 Internal Standard Output

Frequency:	1 MHz.
Output Level:	3V p-p rectangular wave.
Connector:	B.N.C. socket at rear of instrument.
Impedance:	Approximately 1k Ω.

2.10.3 External Standard Input

NOTE: It should be noted that the accuracy of measurement is directly related to the accuracy of the frequency standard used.

Frequency:	1 MHz.
Minimum Level:	100mV r.m.s.
Maximum Level:	10V r.m.s., 400V d.c.

Input Impedance:	1k ohm approximately (A.C. coupled).
Connector:	B.N.C. socket at rear of instrument.

2.11 Display

Number of Digits:	Six in-line numerical indicator tubes with automatically positioned decimal points. Latching is provided as an option (Option 03).
Sample Rate:	Display time continuously variable from 0.25 to typically 7 seconds, with a switched SINGLE SHOT position.
Check:	Push-button selects check or operate mode.
Reset:	Push button for manual reset or single shot.

2.12 Power Supply

Voltage Ranges (a.c.):	Selected by soldered connection to tappings on power transformer. The following ranges are provided for:- 103-116V 188-212V 113-127V 207-233V 226-254V A notice on the rear panel must show the voltage range selected. Suitable adhesive labels are supplied with the instrument for use with ranges other than 226-254V.
Frequency:	45 - 440 Hz.
Consumption:	Approximately 30 V.A.

3. PRINCIPAL MECHANICAL PARAMETERS

3.1 Dimensions:

Height:	Case	82.6mm (3.1/4")
	Overall	100mm (3.15/16")
Width:	Case	219mm (8.5/8")
	Overall	248mm (9.3/4")
Depth:	Case	254mm (10")
	Overall	276mm (10.7/8")
Weight:		2.7kg. (6 lbs.)

4. ENVIRONMENTAL CONDITIONS

4.1	Operating Temperature Range:	9835: 0 to +55°C 9837: 0 to +45°C up to 60MHz, +15 to +35°C above 60MHz
4.2	Storage Temperature Range:	-20°C to +70°C.
4.3	Humidity:	95% R.H. at 40°C.

5. OPTIONS

5.1 Data Output Option 01

NOTE: All logic levels are TTL Compatible

Information Format:	4 line BCD weighted 1248 per display tube and 3 line decimal point positions.
Logic Levels:	'1' state +2.5V to +4.5V '0' state 0 to +0.5V.
Supply Output:	0V and +5V from 180Ω source.
Command Output:	2.5V to 4.5V Off level 0 to 0.5V.
Hold Input:	2.5V to 4.5V Off level 0 to 0.5V When Hold goes from '1' to '0' level it automatically instigates a reset action.

9.2 Latch Display Option 03

Previous measurement is displayed whilst the instrument resets and completes a new measurement. The instrument automatically updates the display at the end of each measurement.

The instrument is automatically unlatched for Time Interval and Totalise Modes.

9.3 Option 04: 9440 Frequency Standard

Frequency:	5MHz.
Temperature Stability:	± 1 part in 10^6 over the temperature range 0 - 55°C.
Warm-up Time:	2 minutes for 1 p.p.m.
Average Ageing Rate:	+3 parts in 10^7 during first month. +2 parts in 10^6 during first year. +1 part in 10^6 in second year and thereafter.

SECTION 2

DESCRIPTION

OPERATION & MAINTENANCE

CHAPTER 1

GENERAL DESCRIPTION

INTRODUCTION

1.1 The Universal Counters Type 9835 and 9837 are compact lightweight instruments providing a wide range of facilities in convenient form at moderate cost. The two instruments are almost identical in basic design, construction and facilities provided, except that the model 9837 employs a divider assembly which extends the range of frequency measurement to at least 80 MHz without reduction of resolution. The contents of this handbook apply equally to both instruments except for a few items, principally concerned with frequency measurement on the "h.f." range, where additional circuit information should be noted.

FACILITIES

1.2 (a) Frequency measurement ranges:

9835: A.C. coupled: up to 20 MHz
D.C. coupled: up to 5 MHz.

9837: A.C. coupled: up to 80 MHz.

D.C. coupled: up to 5 MHz.

(b) Period Measurement, 1 to 10^5 periods in decade steps, a.c. or d.c. coupled.

(c) Ratio Measurement.

(d) Time Interval, single or double line, with either manual or electrical start/stop signals, the latter having trigger-slope selection and choice of either pulse or contact closure source.

(e) Totalize, with electronic or manual control.

1.3 By potentiometer control the display time can be varied between $\frac{1}{4}$ second and 10 seconds approximately, and by turning this control fully anti-clockwise a Hold (Single Shot) facility is obtained. In this Hold condition single shot readings are obtainable by use of the adjacent Reset push-button. The readout is displayed on six in-line numerical indicator tubes with automatic positioning of the decimal point. In the standard version the display is unlatched, but a latched (stored) display is available at customer's option (Option 03).

INPUTS

Model 9835

1.4 The Channel 'A' input feeds into either an a.c. or a d.c. coupled amplifier, according to the setting of the AC/DC Selector switch. The 'Level' control which operates on the input to Channel 'A', provides fine adjustment of signal attenuation to assist stable counting in the presence of background "noise". When this control is set to minimum attenuation the instrument has a sensitivity of 10mV r.m.s. (a.c. coupled). The Channel 'B' input is exclusively d.c. coupled.

Model 9837

1.5 For measurements below 20 MHz the input details described in the previous paragraph apply equally to the 9837. For frequency measurement above 20 MHz, however, the LEVEL control in the 9837 may be switched to a fixed "HF" position which introduces a divide-by-four stage into the 'A' channel signal path. The sensitivity in this mode is fixed at 10mV. On "HF", division by four is also introduced into the frequency reference path, thus extending the gate times by a factor of 4 thereby maintaining the same resolution as on the lower frequency measurements.

FREQUENCY REFERENCE OSCILLATOR

1.6 A discrete component 5 MHz oscillator is fitted in the standard version of the instrument, but at customer's option a fast-warm-up oscillator unit from the Racal range may be fitted. (Option 04). The internal reference is available as a 1 MHz square-wave signal from a 1kΩ source at a socket on the rear panel. Also on the rear panel a socket is available for the connection of an external 1 MHz frequency standard.

DATA OUTPUT (Option 01)

1.7 At customer's option a 36-way socket can be fitted to the rear panel which will provide a 4-line b.c.d. output weighted 1 2 4 8 per display tube. Also provided are decimal point (d.p.) information, 'Hold' and 'Command' lines and an auxiliary +5V output via 180 ohms.

CONSTRUCTION

1.8 The instrument circuits are contained on two printed circuit boards. The larger assembly is referred to as the Motherboard, the circuit details of which are shown in Fig.4.6 at the rear of the handbook. Mounted above the Motherboard is the smaller Counter Display Assembly which can be easily detached, whilst remaining fully operational, thus providing excellent access to all parts of the instrument for servicing purposes.

MODIFICATIONS

1.9 Commencing at serial number 1630 (9835) and 1730 (9837) the plug-in voltage selector is discontinued and a toggle-type Power switch is fitted to conform with I.E.C. regulations. The text of the handbook conforms to the new arrangement.

CHAPTER 2

PREPARATION AND OPERATING

POWER CHECKS

Connecting Plug

2.1 Fit a suitable plug to the power lead in accordance with the following colour code:-

Brown	line
Blue	neutral
Green/Yellow	earth (ground)

A.C. Voltage Selection and Fuse

2.2 (1) Check that the power fuse on the rear panel is correctly rated for the local a.c. supply, as follows:-

200 - 250V	125 mA anti-surge
100 - 125V	250 mA anti-surge

(2) Check that the voltage tapping on the power transformer is correct for the local a.c. supply. Verify that the label on the rear panel indicates correctly the selected voltage range. Alternative labels are provided with the instrument. To remove the case unscrew the two captive "Pozidriv" screws which are recessed in the plastic "feet" on the rear panel. The chassis can then be withdrawn.

INSTRUMENT SELF-CHECK

2.3 In the CHECK mode the 1 MHz reference derived from the frequency standard is fed through the counting and display circuits. Complete details of the self-check on all functions are contained in Chapter 5. The rapid operational check, given in Table 2.1 below, will confirm that the instrument is counting correctly on all functions.

(1) On the rear panel set the Frequency Standard switch to INT. (or to EXT. if external standard is in use).

(2) Connect the instrument to the mains supply and set the POWER switch to ON. Note that the display tubes illuminate.

(3) Set the DISPLAY TIME controls to a short display time (anti-clockwise).

(4) Depress the CHECK push-button.

(5) Operate the Function switch and Range buttons and check the readouts according to Table 2.1 below. For comprehensive details of the check refer to Chapter 5 para. 5.2).

(6) Rotate the DISPLAY TIME control and check that the display time varies accordingly.

TABLE 2.1

Instrument Self-Check Operation

FUNCTION	REQUIRED READOUT
Frequency-A	Reads 1 MHz
Period-A	Reads 1μs
Time Interval B & B-A	Counts chosen clock units when START button depressed
Ratio $_n \frac{A}{B}$	Refer to Chapter 5, para. 5.6.
Totalize $\frac{A}{n}$	Totalizes chosen clock units (according to Range button selected) for operations of Start and Stop buttons

Amplifier Serviceability

2.4 To supplement the Self-Check procedure of para. 2-3, the serviceability of the input amplifiers can be verified by feeding the signal from the 1 MHz O/P socket on the rear panel into the 'A' and 'B' input sockets on the front panel. (See Chapter 5, para. 5.7). Channel 'A' may be checked using both positions of the AC/DC switch.

CONNECTION OF EXTERNAL FREQUENCY STANDARD

2.5 The requirements for the external reference frequency source are given in the Technical Specification. It should be borne in mind that the accuracy of measurement is directly related to the accuracy of the frequency standard used.

(1) Set the slide switch on the rear panel to EXT.

(2) Connect the external frequency standard source to the socket marked 1 MHz INPUT on the rear panel.

OPERATING

NOTE: If unfamiliar with the instrument the user is recommended to read the description of the controls and connections commencing on page 2-8.

FREQUENCY MEASUREMENT

2.6 In this mode the unknown frequency is gated to the counter decades for the gating period selected by the chosen Range push-button. For frequencies below 10 kHz the use of period mode will give greater resolution.

(1) Set the POWER switch to ON.

(2) Set the following controls:-

(a) Function switch to FREQUENCY-'A'.

(b) AC/DC switch to AC or DC, as required.

(c) If using A.C. mode set the LEVEL control as follows:-

(i) 9835: As required for signal conditions.

(ii) 9837: Frequencies up to 20 MHz, same as 9835. Frequencies above 20 MHz set LEVEL control to "H.F." (switched) position.

(d) PULSE/CONTACT switch to PULSE.

(3) Connect the unknown signal to the 'A' input socket.

(4) Select the Range push-button which fills the display. (See para.2.6a)

(5) Adjust the DISPLAY TIME control as required. If operating on SINGLE SHOT press the RESET button when a new reading is required.

(6) If counting is erratic adjust the LEVEL control to obtain steady counting.

(7) To interpret the display follow the guide line from the selected Function Switch position and note the units engraved above the particular Range button in use.

Overspill Procedure

2.6a To obtain high resolution when measuring higher frequencies it may be necessary to "overspill" one or more of the left-hand digits. First of all, select a short gate time and record the most significant digits displayed, then select a Range button giving a longer gate time to display the less significant digits to the required resolution.

PERIOD MEASUREMENT

2.7 This mode is recommended for measuring low frequencies in the range 10 Hz to 10 kHz with inproved resolution. The incoming unknown signal is taken to the time-base decade dividers, the output of which (selected by the Range push buttons) is used to gate the internal frequency standard to the counter decades. The display indicates the actual value of the period of the incoming signal.

(1) Set the POWER switch to ON.

(2) Set the following controls:-

(a) Function switch to PERIOD 'A'.

(b) AC/DC switch to AC or DC, as required.

(c) If using AC mode, set the LEVEL control according to Signal conditions.

(d) PULSE/CONTACT switch to PULSE.

(3) Connect the unknown signal to the 'A' input socket.

(4) Select the number of cycles to be timed, by depressing the relevant Range push-button. A greater number of cycles gives enhanced resolution.

(5) Set the DISPLAY TIME control to give a suitable display time and if necessary adjust the LEVEL control for steady counting.

(6) If operating on SINGLE SHOT press the RESET button when a new reading is required.

TIME INTERVAL B

2.8 This mode is used for measuring time interval between successive events such as chronometer readings, and is particularly useful for pulse width measurement.

2.9 In this mode, the counter decades count the 'clock' pulses derived from the internal frequency standard which are selected by the Range buttons. Measurement control is on a single line by start/stop signals derived from the 'B' input, or manually by operation of the START/STOP push-buttons.

TIME INTERVAL B (Continued)

(1) Set the POWER switch to ON.

(2) Set the following controls:-

(a) The Function switch to TIME INTERVAL 'B'.

(b) The PULSE/CONTACT switch as required,

(c) Set the left-hand TRIGGER SLOPE switch to ⌐ or ¬ to determine the polarity of the switching edge required to start the count.

(d) Set the right-hand TRIGGER SLOPE switch to determine the Stop edge polarity.

(3) Connect the unknown signal to input socket 'B'.

(4) Select the Range push-button which fills the display.

(5) Adjust the DISPLAY TIME control as required.

(6) If operating on SINGLE SHOT press the RESET button whenever a new reading is required.

(7) For manual control press the START and STOP buttons as required.

TIME INTERVAL B → A

2.10 This mode is similar to that for Time Interval - B, except that the measurement control is on two lines. The start and stop commands are given either manually by operation of the start/stop push-buttons or electronically by the start/stop signals being fed to the B and A channels respectively.

(1) Set the POWER switch to ON.

(2) Set the following controls:-

(a) The FUNCTION switch to TIME INTERVAL B → A.

(b) The AC/DC switch to DC.

(c) The PULSE CONTACT switch as required,

(d) Set the left-hand TRIGGER SLOPE switch to ⌐ or ¬ to determine the polarity of the switching edge required to start the count.

(e) Set the right-hand trigger switch to determine the Stop edge polarity.

(3) For electronic control connect the Start signal to input socket 'B' and Stop signal to input socket 'A'.

(4) Select the Range push-button which fills the display.

(5) Adjust the DISPLAY TIME control as required.

(6) If operating on SINGLE SHOT press the RESET button whenever a new reading is required.

(10) For manual control press the START and STOP buttons as required.

RATIO $n\frac{A}{B}$

2.11 In this mode, two unknown signals are fed to inputs 'A' and 'B'. Generally the higher frequency is fed from input socket 'A' to the counter decades and the lower frequency is fed through input socket 'B' to the time-base decades, but this input arrangement may be reversed, as for example, when the lower frequency has a smaller amplitude (e.g. 10mV) and the higher frequency a considerably larger amplitude. The display indicates the ratio $n\frac{A}{B}$ and the reading must be divided by the factor 'n' to obtain the ratio $\frac{A}{B}$.

(1) Set the POWER switch to ON.

(2) Set the following controls:-

(a) The FUNCTION switch to RATIO $n\frac{A}{B}$.

(b) The AC/DC switch to AC or DC as appropriate.

(c) The PULSE/CONTACT switch to PULSE.

(3) Connect the input signals to sockets 'A' and 'B'. (See para. 2.11 above).

(4) Set the DISPLAY TIME control to give a suitable display time, and, if on AC, adjust the LEVEL control for stable measurement.

(5) If operating on SINGLE SHOT press the RESET button whenever a new reading is required.

(6) Press the Range push-button which gives a full display without overspill.

(7) To obtain the true ratio the displayed reading must be divided by the factor 'n' indicated above the selected Range button.

TOTALIZE $\frac{A}{n}$

2.12 In this mode, signals on input socket 'A' are prescaled and taken to the counter decades. The count can be controlled manually by the START and STOP buttons, or electrically by timing signals connected to socket 'B'. This mode permits a number of events occurring with random timing to be counted over a chosen period.

(1) Set the POWER switch to ON.

(2) Set the following controls.

(a) The Function switch to TOTAL $\frac{A}{n}$.

(b) The AC/DC switch to DC.

(c) The PULSE/CONTACT switch as required.

(d) Set the left-hand TRIGGER SLOPE switch to ⌐ or ¬ to determine the polarity of the switching edge required to start the count.

(e) Set the right-hand TRIGGER SLOPE switch to determine the Stop edge polarity.

(3) Connect the signal to be totalized to socket 'A' and the electrical timing signals (if used) to socket 'B'.

(4) Select the Range push button which will provide suitable units for the count. For example, if the 10^3 button is depressed the display will be in units of 1000.

(5) Set the DISPLAY TIME control as required.

(6) If operating on SINGLE SHOT, press the RESET button before taking a reading.

(7) If manual control is being used press the START button to commence counting and the STOP button to terminate counting.

(8) In order to obtain the true total the displayed reading must be multiplied by the scaling factor 'n' indicated above the selected Range button.

TABLE 2.2

DESCRIPTION OF CONTROLS

Function Switch

A six-position rotary switch which selects the facility required, as follows:-

Position	Mode
1 ...	Frequency Measurement ('A' Channel)
2 ...	Period Measurement ('A' Channel)
3 ...	Time Interval, single line. (Start and stop signals are applied to the 'B' Channel input).
4 ...	Time Interval; double line. (Start signal on Channel B, Stop signal on Channel A).
5 ...	Ratio $n\frac{A}{B}$ see para. 2.11.
6 ...	Total $\frac{A}{n}$. Provides accumulated total of events applied to Channel A, with pre-scaling by the factor 'n' according to the switch selected in the Range push-button bank.
NOTE:	To read the display in the correct units for a particular function, simply follow the guide line from the chosen Function switch position to the appropriate line in the table of units engraved above the Range push-buttons.

Push Button Switch Bank

This switch bank of 7 push buttons selects the following:

(a) Six operating ranges (gate times) in decade steps. These are referred to in the handbook as the "Range" push-buttons.

(b) Self Check (CHECK button depressed) or normal operation (CHECK button released).

PULSE/CONTACT switch

This slide switch selects the input mode for the input d.c. amplifiers, as follows:-

(a) PULSE Position. This position is for normal operation with electronically derived signals. Triggering occurs at a nominal +1 volt d.c.

(b) CONTACT Position. This position is used for measurement where the timing signals are obtained from contact closures. The Trigger slope selection still applies in this mode, for example, ⌐ trigger slope is used for contact closing and the ⌐ slope for contact opening.

AC/DC Switch

This switch selects either a.c. or d.c. coupling in the 'A' channel amplifier.

Operation on DC Mode

The use of d.c. mode is recommended in the following circumstances:

(a) For signals having a slow rate of rise and fall (e.g. sinusoidal signals of frequency lower than 10 Hertz).

(b) For signals of rectangular waveform which have a mark/space ratio other than 1:1, provided the frequency is less than 5 MHz.

LEVEL Control

This potentiometer control sets the level of signal applied to the A.C. amplifier. In the 9837 the control has a switched position ("H.F.") which is provided for operation in "Frequency" mode above 20 MHz. In this setting the sensitivity is fixed at 10mV.

START and STOP Push Buttons

These push buttons provide for manual control of start and stop in the time interval and totalizing functions.

TRIGGER SLOPE switches

These slide switches permit selection of either positive-going or negative-going triggering edges.

RESET Push Button

To obtain a new reading when on long or infinite display time the RESET button should be briefly depressed, which clears the instrument down to zero and initiates a new measurement.

DISPLAY TIME Control	A combined potentiometer and switch. Turned clockwise it increases the display time. If turned fully anti-clockwise until the switch operates, the display is then held and further updating is prevented except by use of the RESET push button, which gives a Single Shot facility.
POWER Switch	This is a single-pole toggle switch in the line side of the a.c. supply between the mains filter and the mains transformer primary.

CHAPTER 3

PRINCIPLES OF OPERATION

INTRODUCTION

3.1 This chapter briefly outline thebasic principles of the instruments, with simplified block diagrams to represent the principles of each setting of the Function switch. Refinements such as Trigger Slope controls are not shown. Note that the ÷4 stages shown for the 9837 in Fig.2.1 apply only in the Frequency measurement mode and therefore do not appear in subsequent block diagrams.

FREQUENCY MEASUREMENT (Fig.2.1)

3.2 The signal of unknown frequency is applied to the 'A' Input where it is amplified, shaped, and applied to the signal input of the main gate. The decade dividers of the time base are driven by the frequency standard and provide a selection of gate waveforms, one of which is chosen by depressing the appropriate Range push-button. The chosen gate waveform is applied to the main gate where it allows the unknown signal to pass through to the decade counting chain for a defined time interval. At the end of the gating period the count is stopped and the total displayed. Unless SINGLE SHOT has been selected the counter will then reset and repeat the cycle of operations. When measuring frequency with the 9837 model the input signal is divided by 4 whenever the LEVEL control is set to 'H.F.' The 1 MHz reference is also divided by 4 to provide extended gate times which permit the input frequency to be read without applying a correction factor.

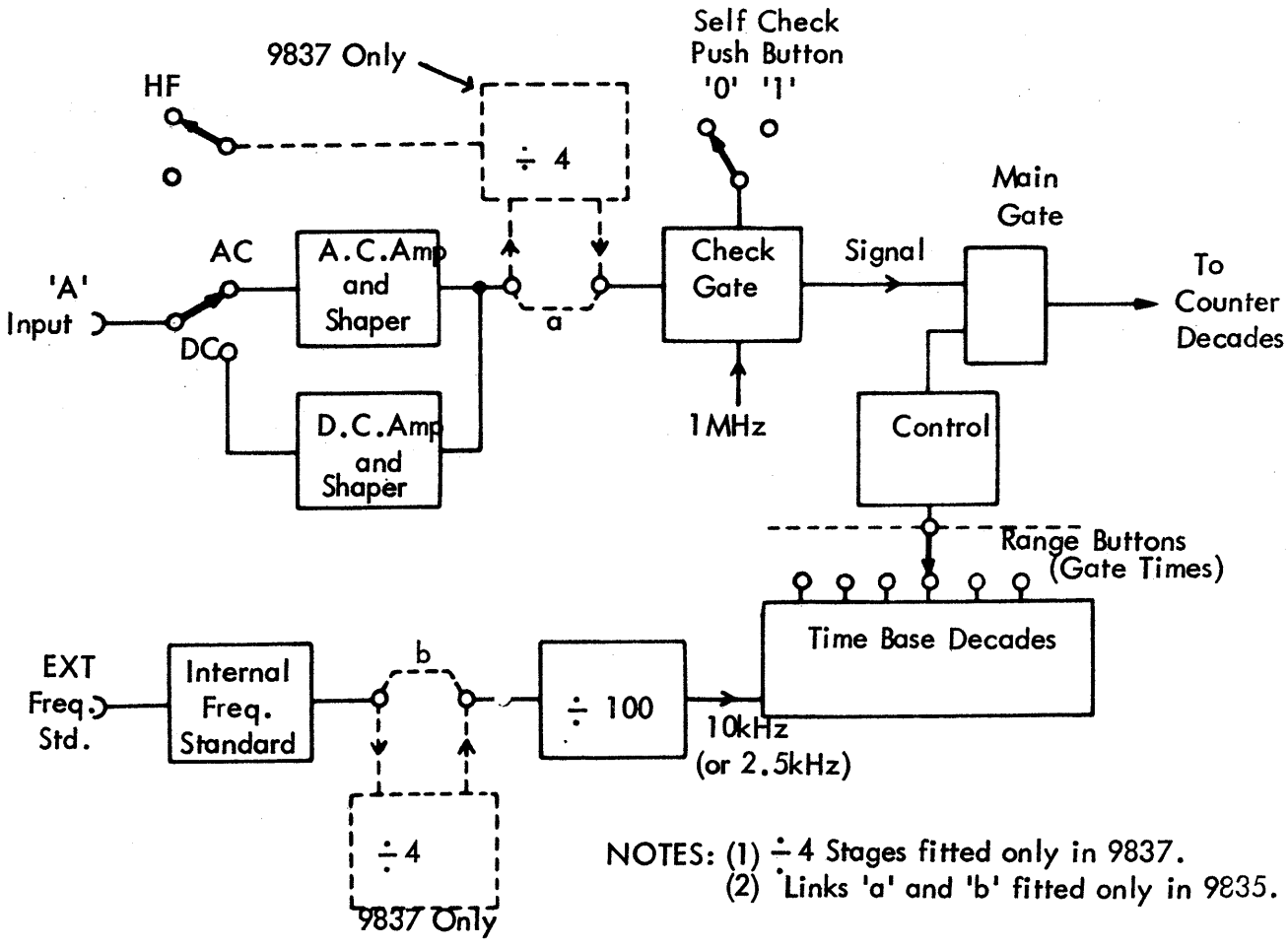


Fig.2.1 Frequency Measurement

SELF CHECK

3.3 In the Self Check mode the standard frequency of 1 MHz takes the place of the 'A' channel unknown frequency, thus providing a check on the frequency measurement system. This self check is also applicable to the other functions of the instrument. The 1 MHz readout being interpreted as frequency or time units of 1 microsecond, as appropriate to the function selected. On the subsequent block diagrams the CHECK gate is omitted for clarity purposes.

PERIOD MEASUREMENT (Fig. 2.2)

3.4 The period of a waveform is measured by counting the number of clock pulses which occur during one or more cycles of that waveform. Greater accuracy is obtained by measuring over as many cycles as possible.

3.5 The signal of unknown frequency is applied to the 'A' Input and after amplification and shaping is applied to the time base decades. In the time base the unknown signal generates a selection of gate waveforms, one of which is selected by depressing the appropriate Range push-button. The chosen gating waveform is applied to the main gate to determine the number of clock pulses counted.

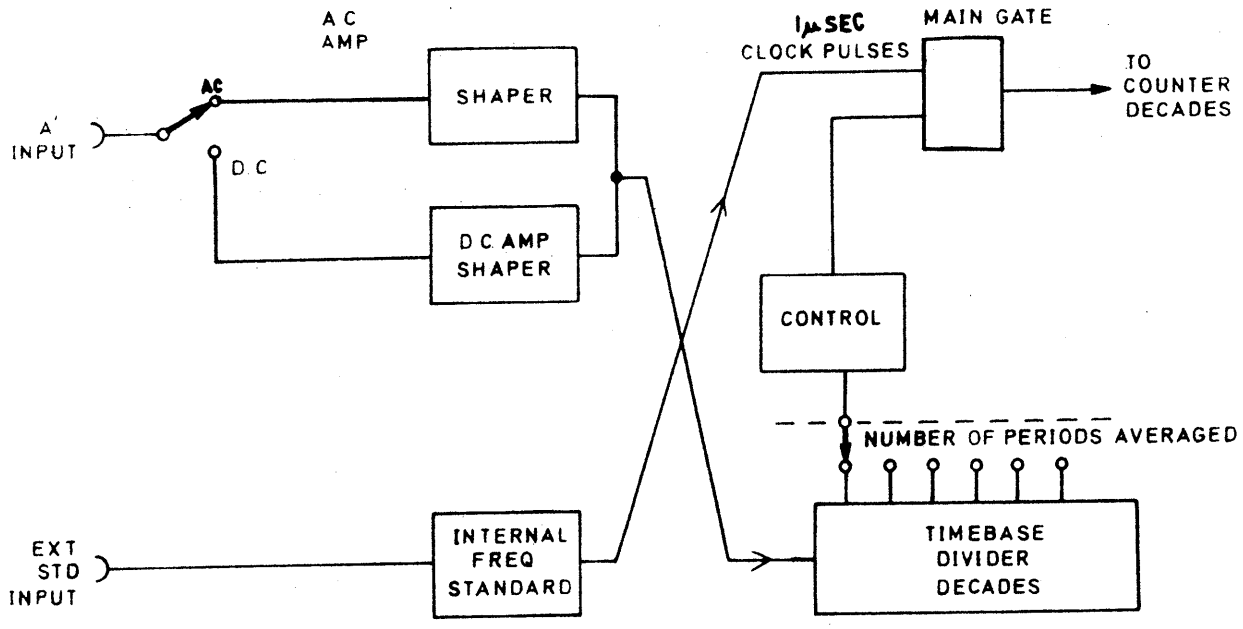


Fig. 2.2 Period Measurement

3.6 Clock pulses from the frequency standard are fed to the signal input of the main gate and are counted in the counting decades during the time interval controlled by the selected time base output. The main gate then closes and the display shows the total of clock pulses counted, which is the average period of the unknown signal.

TIME INTERVAL - B (Fig. 2.3)

3.7 In this mode the instrument is effectively serving as a stop-watch. Start and Stop signals are supplied electronically from an input on the 'B' channel or manually by operating the START and STOP buttons. The polarities of the input triggering edges are determined by the Trigger Slope switches, the left hand switch for the Start polarity and the right hand switch for Stop polarity. The time interval is measured by counting clock units derived from the frequency standard.

3.8 The 1 microsecond output derived from the frequency standard is applied to the time base decades and a suitable clock unit is selected from the decade outputs by depressing an appropriate Range button. These pulses are then coupled to the signal input of the main gate and are totalled in the counter decades during the interval between the Start and Stop signals. The resultant time units are displayed for a period determined by the setting of the Display Time control.

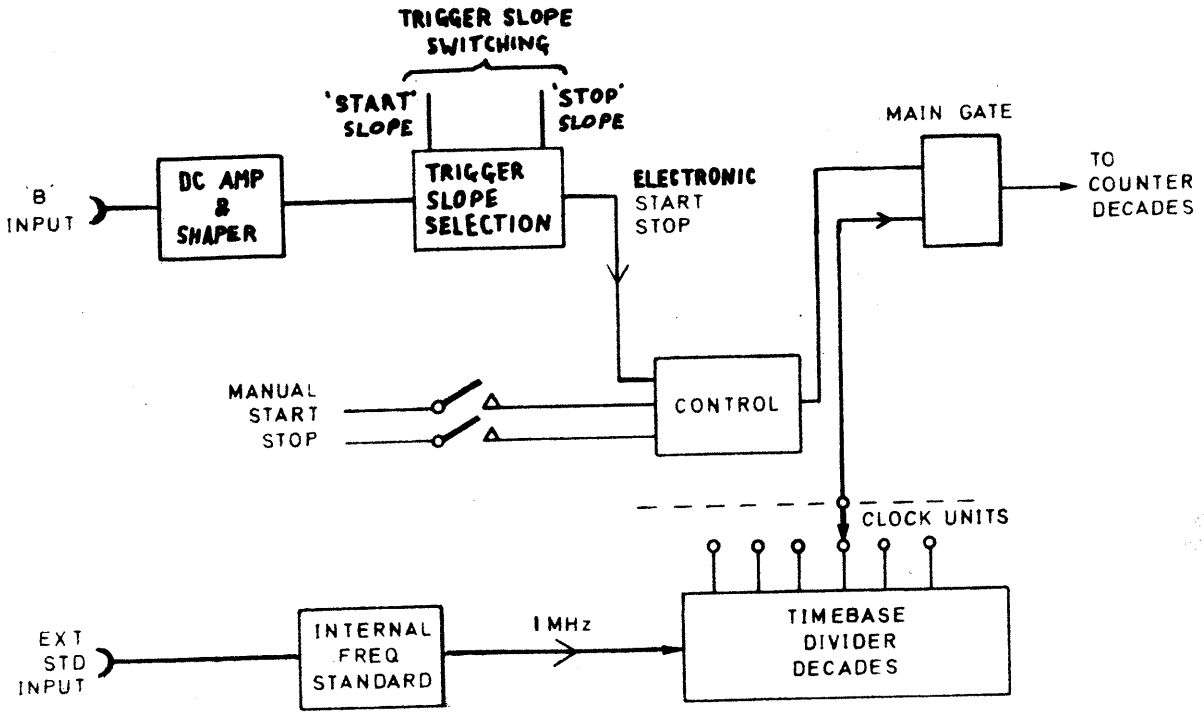


Fig. 2.3 Time Interval - Single Line

TIME INTERVAL B→A (Fig. 2.4)

3.9 This mode operates on principles similar to TIME INTERVAL - B, except that control is on two lines. The Start command is selected from events occuring on the 'B' Input, and Stop commands from events on the 'A' Input. The readout, which represents the true time interval between events on the 'B' and 'A' channels, is displayed for a period determined by the Display Time control.

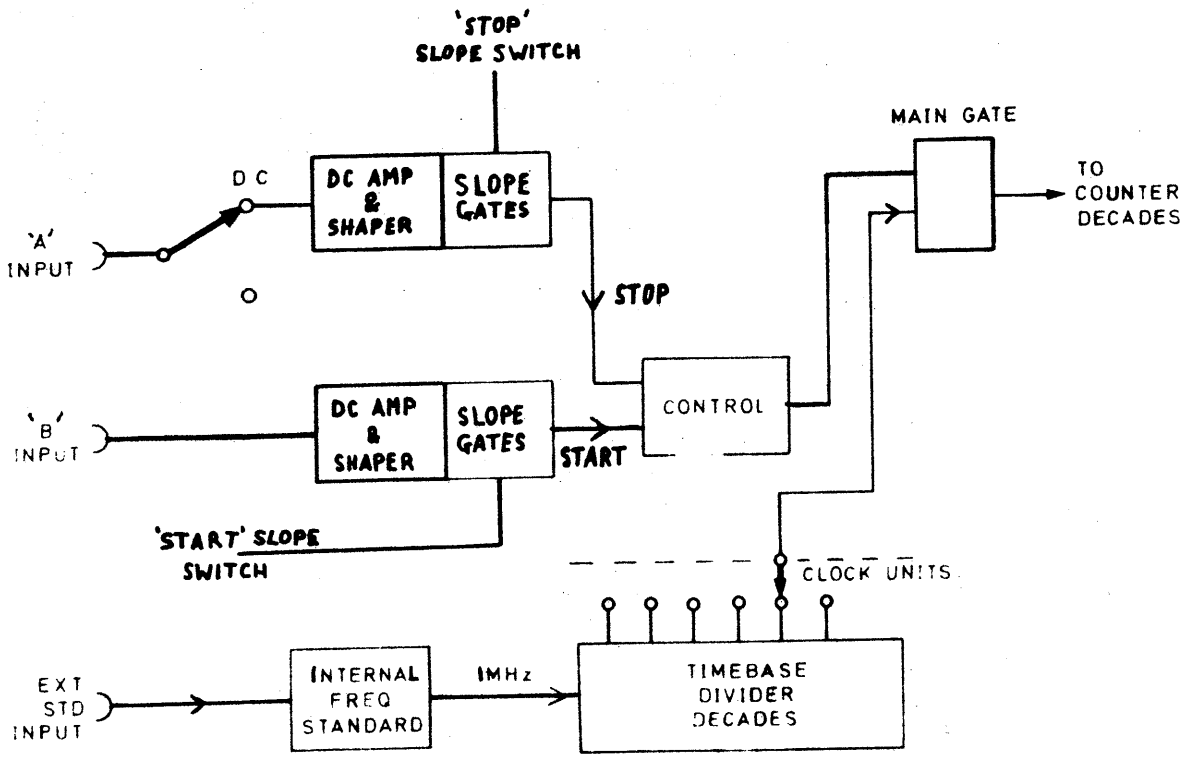


Fig. 2.4 Time Interval - Double Line

RATIO n $\frac{A}{B}$ (Fig. 2.5)

3.10 The principle of operation is very similar to Frequency Measurement, except that the time base output is not derived from the frequency standard. Instead, one of the frequencies to be compared (usually the lower of the two) is applied to the 'B' Input and divided in the time base decades (factor 'n'). The other frequency is applied to the 'A' Input and coupled to the signal input of the Main Gate. A waveform from the time base decades (derived from the 'B' Input) is selected to gate the 'A' channel signal by depressing an appropriate Range push-button. Since the time base output is a divided version of the 'B' signal, the read-out gives a count which corresponds to the ratio of the two input frequencies multiplied by the factor 'n'. The particular 'n' factor used is that shown adjacent to the selected push-button.

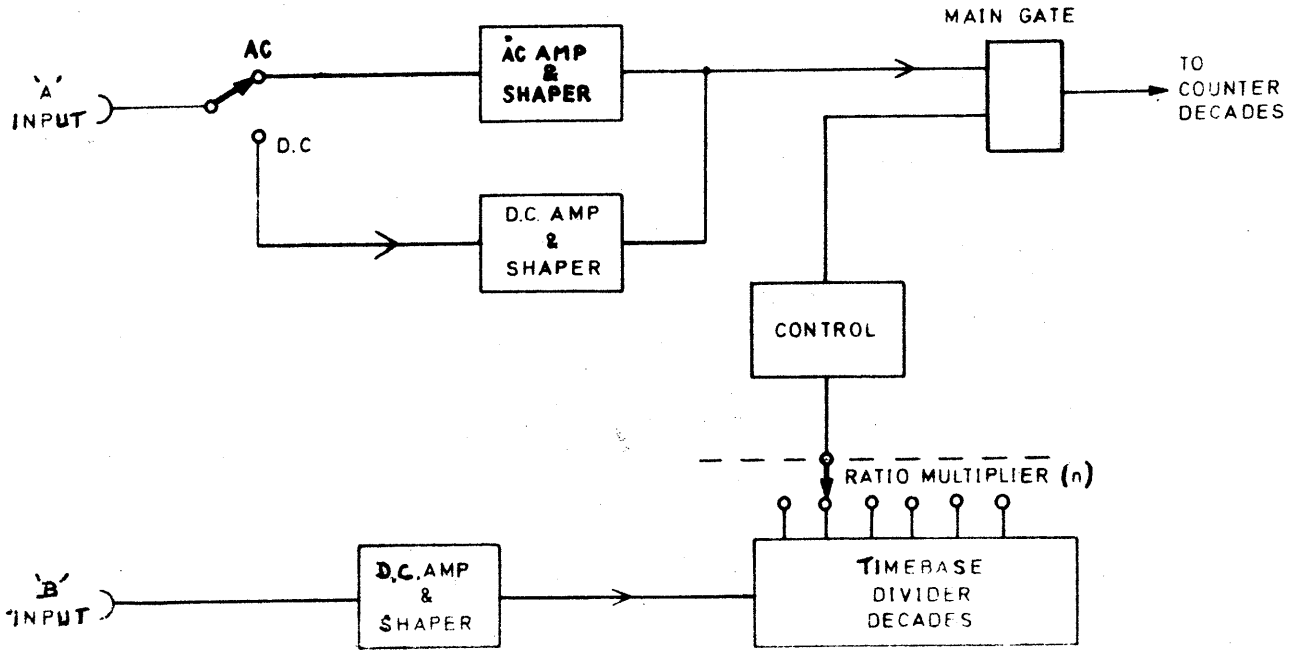


Fig. 2.5 Ratio Measurement

TOTAL $\frac{A}{n}$ (Fig. 2.6)

3.11 The events to be counted are applied to the 'A' Input and after amplification and shaping are coupled to the input of the time base decades. An output is selected from an appropriate time base decade by depressing the relevant Range push-button. This scaled output is coupled to the signal input of the Main Gate.

3.12 A command level from the START push-button opens the Main Gate and allows counting to commence; the gate is closed by a command from the STOP push-button. Automatic Start/Stop can be arranged by applying suitable control pulses to the 'B' Input socket.

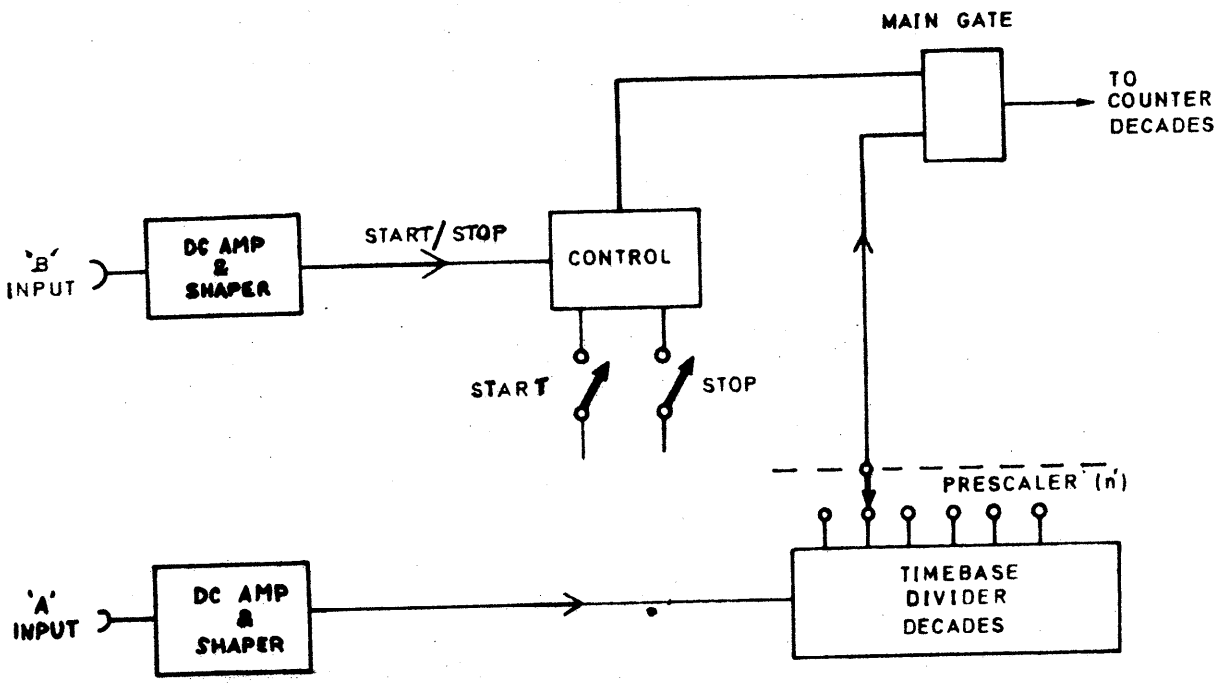
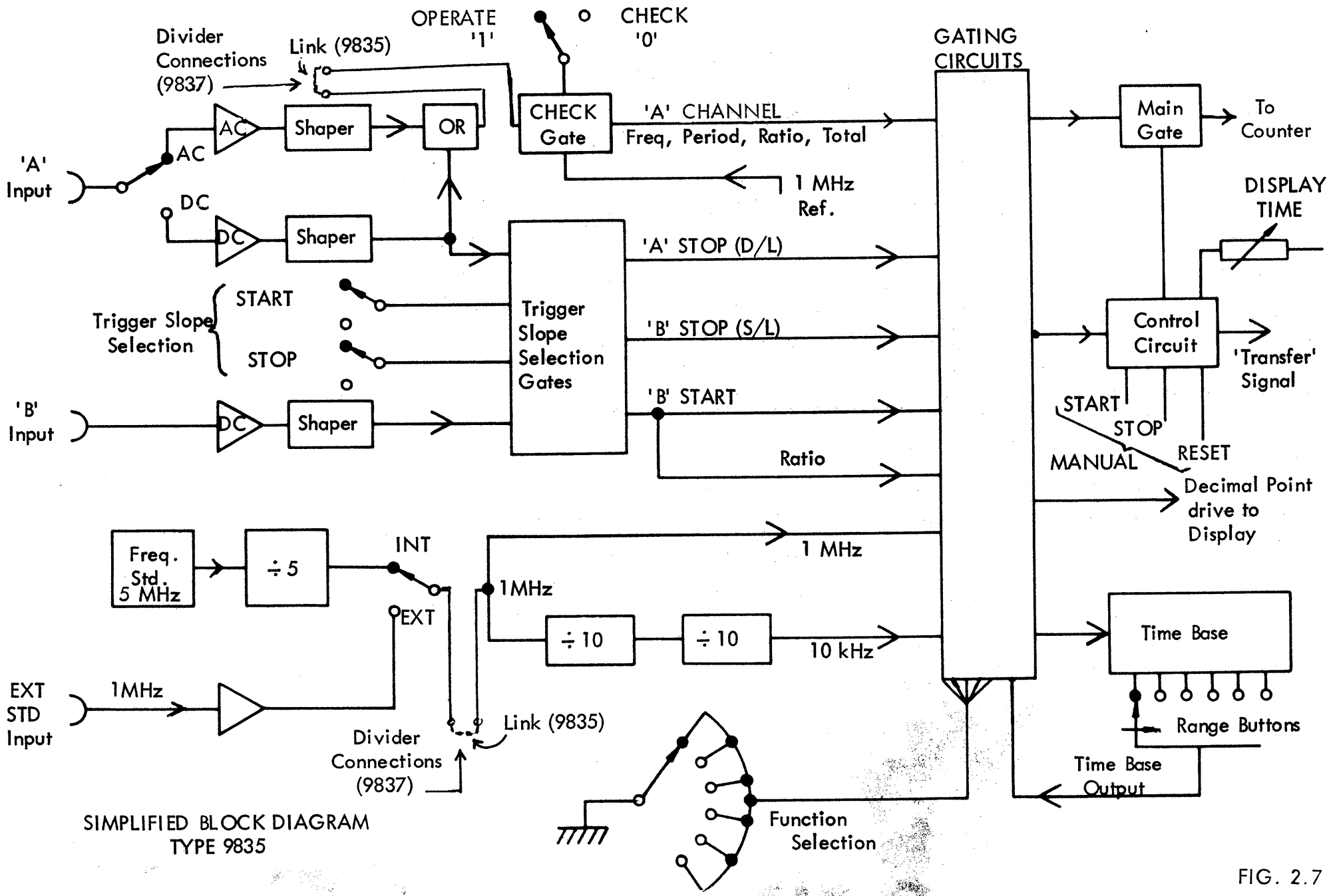


Fig. 2.6 Totalize



SIMPLIFIED BLOCK DIAGRAM
TYPE 9835

FIG. 2.7

CHAPTER 4

TECHNICAL DESCRIPTION

INTRODUCTION

4.1 Except for the Counter Display Assembly and heavier items of the power supply, the entire circuit for the instrument is mounted on a single printed circuit board (p.c.b.) referred to as the Motherboard. The overall circuit is shown in Fig.4.6 at the back of the book; on this diagram coloured boundary lines are superimposed in order to indicate approximately the functional areas of the circuit. These marked areas, which are identified by the code letters A to M, have no significance other than to assist comprehension of the circuit description and are referred to in the text as follows:-

Area on Fig.4.6	Title	Area on Fig.4.6	Title
A	A.C.Amplifier and Shaper	G	Decimal Point (D.P.)Encoding
B	Frequency Standard	H	Time Base Input Gating
C	D.C.Amplifiers and Shapers	J	Time Base Dividers and Range Push-Buttons
D	Trigger Slope Selection	K	Main Control Circuit
E	Counter Gating	L	Power Supply Circuit
F	Control Circuit Gating	M	Divider Board (fitted in Model 9837 only)

4.2 In the instrument extensive use is made of integrated circuit packages, and these are identified by the annotation "IC" with a number to identify the particular package and a suffix letter (e.g. IC21a) to identify that part of a particular IC being referred to in the description. Near the lower right hand corner of Fig.4.6 will be found a key to the logic symbols used, which conform to the type of symbol found in the manufacturer's data sheets, to which reference should be made for detailed information on the various IC packages.

SIGNAL PATHS

NOTE 1: Reference should be made to the Simplified Block Diagram on page 3-7.

2: For a description of the H.F. Divider Board refer to page 4-17.

'A' Channel Signal Paths

4.3 The 'A' Channel employs separate amplifier/shapers for a.c. and d.c., the individual shaper stages feeding into a common output stage. (Q9). Signals are applied at SK1 and selection of the required amplifier path is made by the AC/DC switch S11. In the AC position of the switch the signal amplitude can be adjusted by the LEVEL control R151, from which signals are applied via pin 38 to the A.C. amplifier stages Q1 to Q9.

4.4 A.C. Amplifier. The input employs a high impedance low capacitance F.E.T. stage, followed by amplifiers Q2 to Q5 which drive the Schmitt Trigger shaper Q7/Q8 via the emitter-follower Q6. The shaped signal is applied via C14 to the base of Q9, this stage being common to both a.c. and d.c. paths.

4.5 D.C. Amplifier. The d.c. amplifier employs an integrated circuit Schmitt Trigger IC23a, which feeds via C15 to the base of Q9. This amplifier is discussed in the paragraphs dealing with the Pulse/Contact switch (para.4.50).

'A' Channel Output (Type 9835)

4.6a From Q9 the signal passes via a link to IC22d/IC22f where the path divides, signals in the Frequency or Ratio modes being offered to the Counter gating at IC18a for release to the Main Gate IC18c, the signal being also offered to the time base input gating (IC6d) for application to the time base in the Period and Totalize modes. When the CHECK mode is selected Q10 is turned on, thus inhibiting the external signals at Q9 and releasing the 1 MHz reference to the signal paths via IC22e.

'A' Channel Output (Type 9837)

4.6b The link referred to in para.4.6a is not fitted in the 9837, the signal from Q9 being fed from pin 49 of the Motherboard to the H.F. Divider Board (Area M in Fig.4.6) returning to the common signal path via pin 47. The H.F. Divider Board is described on page 4.17 and the divider switching on page 4-3.

'B' Channel Signal Paths

4.7 Signals applied to the 'B' input socket (SK2) either have a timing function (Stop/Start) in which case they are applied to the Main Control Circuit, or they are used in Ratio measurement, in which case they are directed via IC6e to the Time Base.

4.8 After amplification in Q14 and shaping in the Schmitt Trigger IC23b the signals are processed by the Trigger Slope Selection gates IC21 (Fig. 4.6 Area D) with Gating (Area H) according to the position of the Function switch.

SELF CHECK MODE

4.9 As shown in Fig.4.6, the CHECK push-button S2g in the "Normal" operating position applies 0V to the junction of R35/R36, which keeps Q10 turned 'off' and allows 'A' channel signals to flow through Q9 and IC22d/IC22f. At the same time the 0V applied to IC22e/4 inhibits the 1 MHz reference signal which is present on pin 5 of this IC.

4.10 When the push-button S2g is depressed (CHECK), the 0V connection is removed, thus allowing Q10 to turn on which inhibits the 'A' channel signals at Q9. The logical '1' at the junction of R35/R36 opens IC22e which releases the 1 MHz reference signal into the 'A' channel signal paths. By use of the Function switch the operation of the instrument using this 1 MHz reference can be checked in Frequency, Period and Totalize modes. It will be noted that this check procedure does not include the amplifiers, these can be checked however,

by linking SK4 (1 MHz O/P) to the 'A' and 'B' input sockets in turn, as described in Chapter 5 para. 5.7.

4.10a In the 9837 if Self Check is operated when in FREQUENCY mode, with the LEVEL control set to "H.F.", the reference frequency will be divided by four. The readout, however, is the same as with a 1MHz reference because the ratio of signal to time base drive is still 1:1.

FUNCTION SWITCHING

4.11 Function selection involves the routeing of signals to their appropriate destinations via a system of logic gates, employing Boolean algebra applied to the selected position of the Function switch S1. Referring to Fig. 4.6 it will be seen that the principal gating systems are associated with the Counter, Control Circuit, Time Base and decimal point encoding, in Areas E, F, G and H. Each of these gating systems is discussed separately although provision of a detailed logical analysis is beyond the scope of this handbook.

Function Logic Levels

4.12 The switching logic levels are derived from +5V via the resistor bank R67 to R71 in conjunction with the Function switch S1. The resistors have a common connection to +5V whilst their opposite ends are connected individually to the contacts of switch S1 and to the various gating lines throughout the system. Thus the gating lines will be at logical '1' (+5V) except the line for the chosen operating mode, which will be earthed (logical '0') by the selected contact of switch S1.

4.13a To provide decimal point (d.p.) information the d.p. encoder gates (Area G) interrogate not only the Function switch setting but also the time base selection. This is discussed in para. 4.23.

H.F. Mode (Type 9837 only)

4.13b In the 9837 the LEVEL control has a ganged switch. In the 'H.F.' position of this control the switch is opened, thereby applying a '0' to the gating circuits in the H.F. Divider Board. Provided the Function switch is on FREQUENCY this introduces division-by-four into the 'A' channel signal path and also into the path of the 1 MHz reference which drives the time base. The divider action can only operate when a '0' is also supplied from the Function switch S1, which occurs only in the FREQUENCY setting. On all other modes the H.F. Divider Assembly provides a straight-through path. Refer to page 4-17 for a description of the Divider Assembly.