Maintenance manual

9901
Universal Counter-Timer

RACAL
The Electronics Group

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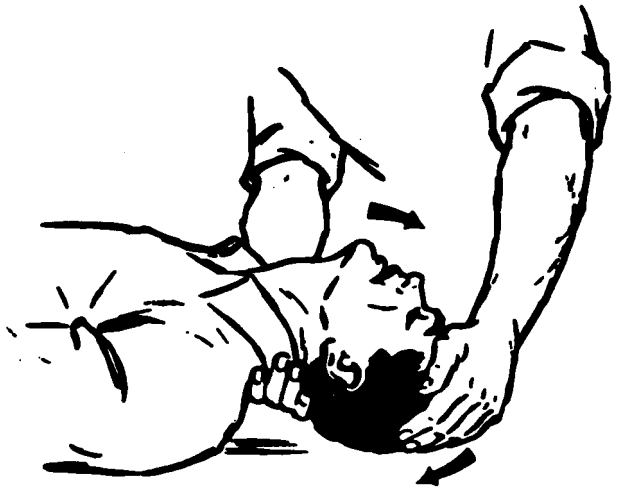
LETHAL WARNING

Voltages within this equipment are sufficiently high to endanger life.

Covers are NOT to be removed except by persons qualified and authorised to do so and these persons should always take extreme care once the covers have been removed.

Resuscitation instructions are given overleaf.

FIRST AID in case of Electric Shock

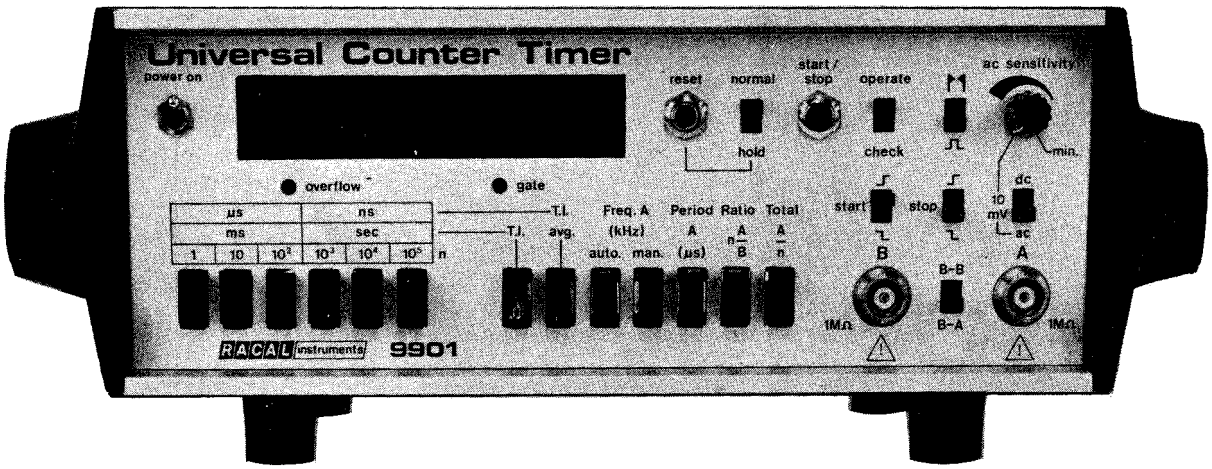


1. Lay victim on his back.
2. Clear victim's mouth and throat.
3. Tilt victim's head back as far as possible and raise his head.
4. Pinch victim's nostrils.
5. Take a deep breath.
6. Cover the victim's mouth with yours and blow, watching his chest rise.
   Note: Blow forcefully into adults, but gently into children.
7. Move your face away to allow victim to breathe out, watching his chest fall.
8. Repeat first five to ten breaths at a rapid rate; thereafter, take one breath every three to five seconds.
9. Keep victim's head back as far as possible all the time.

Have someone else send for a Doctor

Keep patient warm and loosen his clothing

DO NOT Give liquids until patient is conscious



WOH 6201

Universal Counter Timer 9901

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SECTION 1

TECHNICAL SPECIFICATION

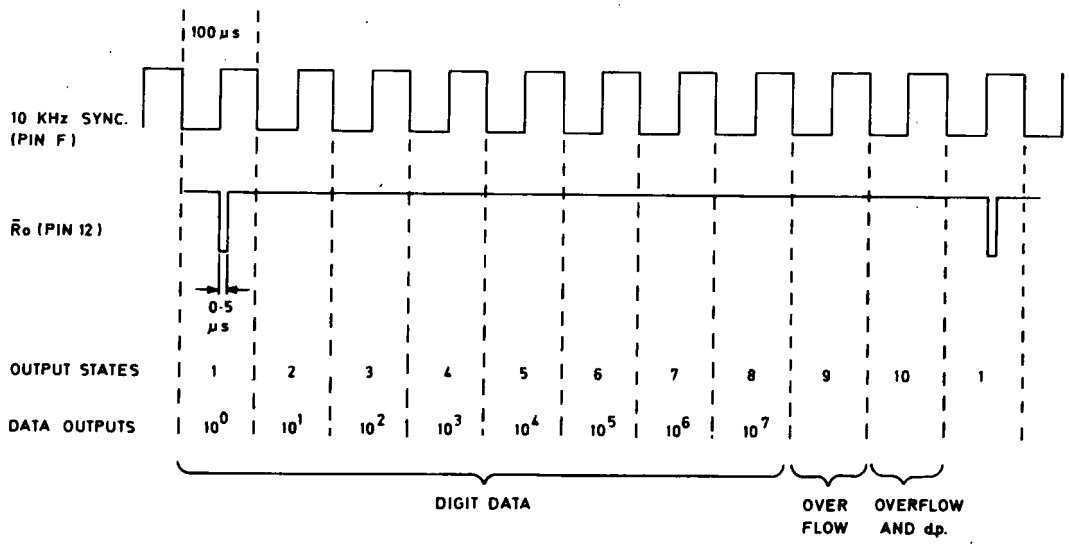
DATA FORMAT PRINCIPLES

DATA OUTPUT FORMAT

A4. In standard format the b.c.d. output data is available at the 28-way edge connector in a bit parallel byte serial form. The data is sequenced by a 10 kHz synchronising signal. The data presentation is delayed 0.5 μs from the negative edge of the synchronising signal. An additional synchronising pulse (Ro) determines the first state (10^0 digit). Accessories are available to give data output in parallel format (for printers etc.) or IEC/ASCII bus compatible format. (Options)

The ten data output states are as follows: the timing is shown below.

States	Facility
1 to 8	Digit (display information).
9	Overflow for 10^3, 10^4, 10^6 and 10^7 digits on pins D, E, 4 and 5 respectively.
10	Decimal point position in kHz units, plus overflow information for 10^5 digit, via pin 5.



Data Sequence Diagram **Fig A.1**

TECHNICAL SPECIFICATION

1. GENERAL

Model 9901 is a 6 digit 50 MHz Autoranging Universal Counter Timer.

2. MEASURING FUNCTIONS

Modes of Operation:	Frequency (Manual), Frequency (Autoranging), Single and Multiple Period, Single and Multiple Ratio, Single and Double Line Time Interval, Single and Double Line Time Interval Averaging; Totalizing.

3. DISPLAY

Format:	Six digit in-line, LED seven segment display. Decimal point automatically positioned.
Latch:	The display is latched for Frequency, Period and Ratio measurement and automatically unlatched in all other modes.
Overflow Indicator:	LED illuminated when overflow occurs.
Gate indicator:	LED illuminated when gate is open.
Display Time:	Gate time plus 0.25s in Frequency, Period and Ratio modes. 2.0s in other modes. A switched hold position is provided.
Measurement Check:	Counter reads 1 MHz.
Segment Check:	Sets display LED's to 8 when Check and Reset selected.
Reset:	Manual by push-button, or automatic.

4. CHANNEL A INPUT - A.C. COUPLED

Frequency Range:	10 Hz to 50 MHz.
Sensitivity:	10 mV r.m.s.
Maximum Input Level:	250V r.m.s. up to 10 kHz. 50V r.m.s. up to 100 kHz. 10V r.m.s. above 100 kHz. 400V d.c.

Input Impedance:	1 MΩ in parallel with approximately 25pF.

5. CHANNELS A & B - D.C. COUPLED

Frequency Range:	DC to 10 MHz.
Sensitivity:	± 0.25V about +1V nominal or contact closure to earth.
Maximum Input Level:	± 35V.
Pulse Duration:	50 ns minimum at trigger points.
Input Impedance:	Approximately 10 kΩ (Falling to 1kΩ above approximately +5V).

6. FREQUENCY MEASUREMENT

Input:	Channel A.
Frequency Range:	DC to 50 MHz (direct).
Coupling:	AC or DC
Gate Times:	Manual: 1 ms to 100s in decade steps. Automatic: Gate times up to 1s are selected automatically to avoid overspill. Designed hysteresis avoids undesirable range changing at small frequency deviations.

7. SINGLE & MULTIPLE PERIOD MEASUREMENT

Input Channel:	Channel A.
Range:	1 μs to 1s.
Clock Unit:	1 μs.
Coupling:	AC or DC
Periods Averaged:	1 to 10^5 in decade multiples
Accuracy:	$\pm \frac{0.3\%}{\text{Number of periods averaged}} \pm$ Freq. standard accuracy (at 50 mV r.m.s. a.c. input with 40 dB S/N ratio).
Bandwidth:	Automatically reduced to 10 MHz (3 dB) when Period selected.

8. TIME INTERVAL SINGLE & DOUBLE LINE

Input Channel:	Single Line: Channel B. Double Line: Start Channel B: Stop Channel A.
Time Range:	100 ns to 10^4s (2.8 hours approximately).
Clock Units:	100 ns to 10 ms.
Coupling:	DC
Start/Stop Signals:	Electrical or contact
Manual Start/Stop:	By single push button on fromt panel.
Trigger Slope Selection:	Electrical. Positive or negative slopes can be selected on both Start and Stop signals. Contact. Opening or closure can be selected on both Start and Stop signals. For trigger error see page Tech. Spec. (4).
Accuracy:	± 1 count ± trigger error ± frequency standard accuracy.
Bounce Protection:	A 10 ms dead time is automatically included when contact operation is selected.

9. TIME INTERVAL AVERAGING SINGLE & DOUBLE LINE

Input Channel:	Single Line: Channel B. Double Line: Start Channel B: Stop Channel A.
Time Range:	150 ns to 0.1s
Dead Time between Intervals:	150 ns minimum.
Clock Unit:	100 ns.
Time Intervals Averaged:	1 to 10^5 in decade multiples.
Accuracy:	± Frequency standard accuracy ± system error ± averaging error. System error: 10 ns per input channel. This is the difference in delays between start and stop signals and can be minimised by matching externally.

Accuracy: (Cont'd).

Averaging Error: $\frac{\text{Trigger error + 100 ns}}{\sqrt{(\text{Intervals Averaged})}}$

Trigger Error (ns): $\frac{5}{\text{Signal slope at trigger point (V/µs)}}$

10. RATIO

One Frequency Input:	Channel A
Other Frequency Input:	Channel B
Frequency Range (channel A)	DC to 50MHz
Frequency Range (channel B)	DC to 10 MHz
Accuracy:	± 1 count ± trigger error on channel B (see above)
Reads:	$\frac{\text{Frequency A x n}}{\text{Frequency B}}$
Multiplier n:	1 to 10^5 in decade multiples

11. TOTALIZING

Input Channel:	Channel A (DC to 10 MHz).
Maximum Rate:	10^7 events per second.
Pulse Width:	50 ns minimum at trigger points.
Prescaling:	Events can be prescaled in decade multiples. (n) from 1 to 10^5.
Reads:	$\frac{\text{Number of input events}}{\text{n}}$
Manual Start/Stop:	Single push button on front panel.
Electrical Start/Stop:	By electrical signal applied to Channel B. Specification as for Time Interval, single line working.

12. FREQUENCY STANDARD — See also Option 04A and 04B.

Frequency:	5 MHz.
Temperature Stability:	± 8 parts in 10^6, over temperature range 0°C to +55°C. ± 3 parts in 10^6 over temperature range +20°C to +40°C.

	Average Ageing Rate:	± 1 part in 10^6 per month three months after delivery but less than ± 1 part in 10^5 in the first year.
	Frequency Standard Output:	1 MHz t.t.l. compatible rectangular wave.

13. EXTERNAL STANDARD

Frequency:	1 MHz.
Input Socket:	Applied to channel B input socket and provides external standard for Frequency and Period measurement only.

14. EXTERNAL SIGNALS

Data Outputs:	Eight digits with overflow and decimal points in serial BCD form at standard t.t.l. levels. Refer to Table 1 on page (7).
Other Outputs:	Function and timebase data. Schmitt trigger outputs from both channels.
Inputs:	Reset and print hold. (Also refer to Option 01).

15. POWER REQUIREMENTS

Supply:	94V to 265V r.m.s., 45 to 450 Hz a.c.
Voltage Ranges (a.c.):	Eight ranges selected by transformer connection and link:

94V to 106V	200V to 225V
106V to 119V	212V to 239V
118V to 132V	223V to 251V
188V to 212V	235V to 265V

Consumption:	20 VA approximately.

16. ENVIRONMENTAL & SAFETY SPECIFICATIONS

Operating Temperature Range:	$0^{\circ}C$ to $+55^{\circ}C$.
Storage Temperature Range:	$-40^{\circ}C$ to $+70^{\circ}C$.
Humidity:	95% r.h. at $+40^{\circ}C$.
Mechanical:	In accordance with IEC 68.
Safety:	Meets IEC 348 (BS4743)

17. MECHANICAL

	Height	Width	Depth
Case	83 mm	240 mm	
Overall	110 mm	284 mm	268 mm
Weight	2.6 kg approximately.		

18. OPTION 01 SERIAL TO PARALLEL INTERFACE

Data and Control Information: 8 decades of data in 4 line BCD weighted 1248, 3 line decimal point position, print command, print hold, reset, overflow and time-base information. All logic levels t.t.l. compatible. For further details refer to the Appendix in Section 4 at the back of the book.

19. OPTION 04A FREQUENCY STANDARD 9442

Frequency:	5MHz.
Ageing Rate:	± 3 parts in 10^9/day after 3 months continuous operation.
Warm-up Time:	Better than ± 2 parts in 10^7 within 6 minutes.
Temperature Stability:	Better than ± 3 parts in 10^9 per °C over the range -10°C to +45°C.

20. OPTION 04B FREQUENCY STANDARD 9421

Frequency:	5MHz.
Ageing Rate:	± 5 parts in 10^{10}/day after 3 months continuous operation.
Warm-up Time:	Better than ± 1 part in 10^7 within 20 minutes.
Temperature Stability:	Better than ± 6 parts in 10^{10} per °C over the range -10°C to +45°C.

21. ACCESSORIES

Accessories Supplied:	Operating handbook and spare fuses.
Accessories Available:	19-inch rack mounting kit. Carrying Case.

SUPPLEMENTARY DATA

DATA OUTPUT CONNECTIONS

A1 Data and command information is provided on a 28-way edge connector accessible via a removable cover on the rear panel. The facilities and pin connections are listed in Table 1 below. The logic for time base and function data is given in Tables 2 and 3.

TABLE 1

Data Output Socket

Pin	Facility	Pin	Facility
1	-5V (nominal)	A	0V
2	+5V (nominal)	B	$\overline{\text{Overflow}}$ (static indication)
3	Key Way	C	Key Way
4	$\overline{4}$ (BCD)	D	$\overline{1}$ (BCD)
5	$\overline{8}$ (BCD)	E	$\overline{2}$ (BCD)
6	$\overline{\text{External Hold}}$ Input	F	10 kHz Sync.
7	$\overline{\text{External Reset}}$ Input	H	$\overline{\text{Main Gate}}$
8	Auto	J	Not Used
9	$\overline{c}$ Function	K	$\overline{z}$ Time Base
10	$\overline{b}$ Information	L	$\overline{y}$ Information
11	$\overline{a}$ (See Table 2)	M	$\overline{x}$ (See Table 3)
12	$\overline{\text{Ro}}$	N	Not Used
13	$\overline{\text{Hold/Reset}}$	P	Schmitt 'B' See
14	Not Used	R	Schmitt 'A' NOTE 1

NOTES: 1. Schmitt 'A' and Schmitt 'B' outputs on pins R and P show the states of d.c. channel Schmitt triggers.

2. External Hold Input
To extend the cycle time the external hold signal (logic '0') must be applied during the gate or hold time. To initiate a new measurement cycle the external hold must go 'high' for not less than 200 μs.

3. External Reset Input
To apply external reset the level at pin 7 must go to logic '0' for not less than 5 ms. On reverting to '1' level the display resets to 'all zeros' and a new measurement commences.

FUNCTION AND TIMEBASE LOGIC CODES

Function Data

A2 Function information format: 3 lines coded as follows. The table gives the logic available at the edge connector. The inverse levels are applied to the CDI Chip in the instrument.

TABLE 2

Function Information

Function	Code		
	$\overline{a}$	$\overline{b}$	$\overline{c}$
Frequency	1	1	1
Average Period	0	1	1
Totalize $\frac{A}{n}$	0	1	0
Ratio $n\frac{A}{B}$	1	1	0
T.I. (single line or double line not averaged)	0	0	1
T.I. (single line or double line averaged)	1	0	1

Time Base Selection Data Output

A3 Time Base information: 3 lines coded as follows.

TABLE 3

Time Base Selection

Code $\overline{x}$	$\overline{y}$	$\overline{z}$	Frequency Gate Time	Multiplier 'n'	Time Interval Clock
1	1	1	1 ms	1	0.1 µs
0	1	1	10 ms	10_2	1 µs
1	0	1	100 ms	10^2	10 µs
0	0	1	1 sec	10^3	100 µs
1	1	0	10 sec	10^4	1 ms
0	1	0	100 sec	10^5	10 ms

SECTION 2

DESCRIPTION

OPERATION & MAINTENANCE

CHAPTER 1

GENERAL DESCRIPTION

INTRODUCTION

1.1 The 9901 is a six-digit auto ranging universal counter timer, powered from a.c. mains and providing a comprehensive range of facilities. The heart of the instrument is a large scale integration element (IC2) which performs all the measuring functions of a 50 MHz universal counter timer. This integrated circuit will commonly be referred to as the 'CDI Chip'.

OPERATING FACILITIES

1.2 (a) Frequency measurement ranges: AC coupled: 10 Hz to 50 MHz.
DC coupled: DC to 10 MHz.
In AUTO mode the instrument automatically selects the gate time (.01, 0.1 or 1s) which gives optimum resolution on the display.

(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 manual or electrical start/stop signals, trigger slope selection and choice of pulse or contact timing control.

(e) Time Interval average, single or double line, with trigger slope selection and choice of pulse or contact timing control.

(f) Totalize, with electronic or manual start/stop.

In addition, other control facilities provide AC/DC input selection, manual hold and reset, and self check.

POWER SUPPLY

1.3 The instrument operates from a.c. supplies between 94V and 265V, 45 to 450 Hz. A tapping and link on the internal mains transformer must be correctly set according to the user's supply voltage, as described in Chapter 5. A label fixed to the rear panel should indicate the selected range. Spare labels are supplied with the instrument for voltage ranges other than 223V to 251V.

CHECK FACILITIES

1 MHz Readout

1.4 When the OPERATE/CHECK switch is set to CHECK the 1 MHz internal reference signal is fed through the instrument to provide an operational check on 'Frequency' and 'Period' modes.

Segment Check

1.5 With CHECK selected the instrument will display 'all eights' when the RESET button is pressed, thus checking all segments in the display LED's.

DATA OUTPUT AND CONTROL

1.6 The instrument uses a parallel-to-serial data output system. The data is available at a 28-way connector accessible at the rear panel. Details are given in Table 1 in the Technical Specification. Accessories are available to convert the data output to parallel format. Provision is made, via the data output connector, for the application of external hold and reset control signals to the counter in the CDI Chip.

FREQUENCY STANDARD

1.7 A discrete component 5 MHz oscillator is fitted in the basic versions of the instrument, but at customer's option a high stability fast-warm-up oscillator unit from the Racal range may be fitted. The optional unit should be serviced only by Racal Instruments or authorized agent. An aperture in the rear panel provides access for oscillator calibration.

1.8 An external standard, which will automatically over-ride the internal standard, can be applied via the front panel 'B' input socket for use on Frequency and Period mode. A 1 MHz reference, derived from the standard in use, is available via a rear panel BNC socket.

CARRYING HANDLE

1.9 The instrument is fitted with a combined carrying handle and bench stand. To adjust the stand, press in the two handle bosses simultaneously while setting the stand to the desired position.

MAINTENANCE

1.10 The customer is recommended to take advantage of the servicing facilities offered by Racal Instruments Ltd., and agents.

CHAPTER 2

OPERATING INSTRUCTIONS

POWER SUPPLY

2.1 Before operating a new instrument, or at a new location, check that the mains voltage selection is correct (check rear panel label) and that the fuse has the specified rating.

FREQUENCY MEASUREMENT

2.2 In this mode the unknown frequency is gated to the counter decades for the gating period selected by the chosen Range push-button (n). 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' MAN.

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

(c) If using AC mode set the SENSITIVITY control initially to the maximum clockwise position.

(d) CHECK/OPERATE switch to OPERATE.

(e) HOLD/NORMAL switch to NORMAL.

(f) Pulse/Contact switch to Pulse (⎍⎍).

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

(4) If counting is not satisfactory adjust the SENSITIVITY control anti-clockwise towards the 10 mV setting until a stable reading is obtained.

(5) Select the 'n' push-button which fills the display, or switch to AUTO for optimum resolution. The frequency readout is in kHz.

(6) If operating on HOLD, press and release the RESET button to obtain a new reading.

PERIOD MEASUREMENT

2.3 This mode is recommended for measuring low frequencies in the range 1 Hz to 10 kHz with improved 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 in microseconds. Greater accuracy is obtained by selecting a longer gate time, thus taking the measurement over a greater number of periods.

Period Operation

2.4 (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 SENSITIVITY control initially to maximum clockwise.

(d) PULSE/CONTACT switch to PULSE (⎍⎍).

(e) CHECK/OPERATE switch to OPERATE.

(f) HOLD/NORMAL switch to NORMAL.

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

(4) Select the number of periods to be timed, by depressing the relevant Range ('n') push-button. A greater number of periods gives increased resolution, but longer measuring time.

(5) Adjust the SENSITIVITY control anticlockwise to obtain steady counting. This control is useful in filtering out h.f. interference on low frequency measurements.

(6) If operating on HOLD press and release the RESET button to obtain a new reading.

TIME INTERVAL (T.I. and T.I. Average)

2.5 In this mode the instrument is effectively serving as a stop watch by counting clock pulses derived from the frequency standard. The time interval may be controlled by successive events on a single line (such as pulse widths) in which case Input 'B' is used with the B-B/B-A switch set to B-B.

2.6 For timing events on separate lines the B-B/B-A switch must be set to B-A. The 'start' signal applied to the 'B' Input and the 'stop' signal to the 'A' input. Trigger slopes can be selected by the START/STOP slope switches.

2.7 The T.I. mode is most suited to the measurement of single intervals such as pulse widths. A range of widths from 100 ns to several hours may be measured by selecting the appropriate clock unit. The maximum clock rate is 100 ns, therefore resolution on short duration pulses is likely to be unsatisfactory, but can be improved by the use of T.I. Average mode, which increases resolution by the averaging of the inherent ± 1 count 'gate uncertainty' factor over a number of time intervals (1 to 10^5). It should be noted, when time averaging, that the repetition rate of the pulses under measurement must not be synchronous with the frequency standard in use.

Time Interval Operation

2.8 (1) Set the POWER switch to ON.

(2) Set the following controls:-

(a) Function: depress the T.I. or T.I. Avg. button, as required.

(b) Pulse/Contact switch: as required.

(c) B-B/B-A switch: for single line select B-B. For double line select B-A and AC/DC switch to DC.

(d) *START and STOP slope switches: select required triggering polarities (not required for manual timing).

(e) HOLD/NORMAL switch: select NORMAL.

(3) Connect the input(s) for electronic timing. For single line timing connect the external signals to Input 'B'. For double line connect the 'start' line to 'B' and the 'stop' line to 'A'.

(4) Press the Range (n) button which provides the appropriate readout. The guide lines from the T.I. buttons indicate the time units of the display.

(5) For manual timing press the START/STOP push-button, as required.

(6) If operating on HOLD press and release the RESET button to initiate a new (non-manual) timing process.

*NOTE: On Time Interval Average (single line) the ⌐¯ to ⌐¯ and ¯⌐ to ¯⌐ measurement is effectively equivalent to Period mode. Therefore the user is recommended to use Period for this particular type of measurement as the accuracy is greater and the measurement time reduced.

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

2.9 In this mode, two unknown signals are fed to inputs 'A' and 'B'. Generally the higher frequency is fed via 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. 10 mV) 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 $\frac{A}{B}$.

Ratio Operation

2.10

(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, the Pulse/Contact switch and HOLD/NORMAL switch set as required.

(3) Connect the input signals to sockets 'A' and 'B'. (See para 2.9).

(4) Press the Range button which gives a full display without overspill. If operating on HOLD press and release the RESET button for a new reading.

(5) If on 'AC' adjust the SENSITIVITY control as necessary.

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

TOTALIZE $\frac{A}{n}$

Theoretical Considerations

2.11 In Totalize mode, signals on the 'A' input socket are prescaled and taken to the counter decades. The count can be controlled manually by the START/STOP button or electrically by timing signals connected to the 'B' input socket. This mode permits a number of events occurring with random timing to be counted over a chosen period. A counter time base in Totalize mode is generally designed to reset to either 0 or 9; in either case a rounding off of the count occurs to an accuracy of ± 1 count, as shown in the following table. It may be noted that the Racal counters (9901, 9903 and 9905) reset to 9.

No. of i/p pulses * ($n = 10^3$ selected)	Counter Display t/b reset 9	Counter Display t/b reset 0	Error Reset 9	Error Reset 0
1	1	0	0.999	0.001
999	1	0	0.001	0.999
1000	1	1	0	0

* See NOTE on page 2-5.

NOTE:

Using n = 10^3 the error of ± 1 count is relative to 'n minus one' input pulses (i.e. 999 pulses). For full resolution n = 1 could have been selected, then the error of ± 1 count would have been related to the display or the number of input pulses (i.e. 1 pulse).

Thus an increase in n division will give an increase in counter range, but a decrease in resolution.

Totalize Operation

2.12 (1) Set the POWER switch to ON and other controls as follows:-

(a) The Function switch to TOTAL A.

(b) The AC/DC switch to DC.

(c) The B-B/B-A switch to B-B.

(d) The CHECK/OPERATE switch to OPERATE.

(e) The Pulse/Contact switch as required.

(f) The HOLD/NORMAL switch as required.

(g) The START and STOP slope switches to select the required trigger edge polarities.

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

(3) Press 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 (within the accuracy of measurement).

NOTE: If the range n = 1 is used, a count of 1 will be displayed when the main gate opens.

(4) If operating on HOLD, press and release the RESET button before taking a reading.

(5) If manual control is being used press START/STOP button to commence counting and again to terminate counting. The display will be held for about four seconds before automatically clearing.

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

DESCRIPTION OF CONTROLS

Function Push-Button Switch Bank:

This bank of seven push button switches, located near the centre of the front panel, select the following measurement modes:-

(i) T.I.

Provides time interval measurement between two successive events. The events may be on one line (B-B) or separate lines (B-A), with start and stop slopes of the same or opposite polarity.

(ii) T.I. Avg.

This mode is suitable for the measurement of short repetitive events, with start/stop controls as in T.I. By averaging over a number of events the resolution is increased.

(iii) FREQ. 'A'

Provides frequency measurement of the 'A' channel input with readout in kHz.

AUTO and MANUAL Modes

With the MAN (manual) switch depressed, the required gate time can be selected from the Range ('n') buttons. With the AUTO switch depressed, the instrument will automatically select the gate time (.01, 0.1 or 1 second) which gives optimum resolution on the display.

(iv) PERIOD 'A'

Provides period measurement on 'A' channel signal with readout in microseconds.

(v) RATIO $n\frac{A}{B}$

Refer to para.2.9.

(vi) TOTAL $\frac{A}{n}$

Provides accumulated total of events applied to Channel 'A', with prescaling by the factor 'n' according to the switch selected in the Range switch bank.

Time Base Range Push-Buttons:

This bank of six 'n' switches offers a choice of gate times. The multiplier 'n' associated with each switch may also be defined as follows:-

(a) The number of periods averaged on 'period average' measurement.

(b) The 'A' input prescale factor on 'totalize'.

(c) The 'B' input prescale factor on 'ratio'.

(d) The number of intervals averaged on 'time interval average'.

(e) The switch bank also is used to select the clock unit on 'time interval'.

START Slope Switch:

A slide switch which selects either positive-going or negative-going trigger edge for start of time interval, time interval average, and totalize measurements. Applies to the 'B' channel only.

STOP Slope Switch:

Selects the required 'stop' trigger edge polarity on time interval, time interval average, and totalize.

Line Selection:

Position B-B select single line 'start/stop' for time interval measurement (Channel 'B'). Position B-A selects 'start' Channel 'B' and 'stop' Channel 'A' on time interval measurements.

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 Hz).

(b) For signals of rectangular waveform which have a mark/space ratio other than 1:1, provided the frequency is less than 10 MHz.

Pulse/Contact Switch:

This switch selects the input timing mode for the 'A' and 'B' channel d.c. amplifiers.

(a) Pulse (⌐¬) position. The position is for operating with electronically derived signals.

(b) Contact (⌐) position. This position is used for measurement where the timing signals are obtained from contacts. The Start/Stop switches must be set so that ¬ is used for contact closing and ⌐ for contact opening. A capacitor is introduced internally to reduce the effects of contact bounce.

OPERATE/CHECK Switch:

OPERATE is normal setting. CHECK provides a 1 MHz readout of the internal reference frequency for self-check of counting and display circuits.

Segment Check

To check all LED segments in the display, press the RESET button while in CHECK mode. This will produce an "all 8" display.

START/STOP Push-Button:

Provides manual start/stop on Time Interval and Totalize modes.

NORMAL/HOLD Switch:

In the NORMAL position the instrument provides continuous updating of the display. In the HOLD position the display is held but a single shot update can be obtained by depressing the adjacent RESET button.

RESET Push-Button:

When the RESET button is depressed and released the instrument will clear down to zero and initiate a new measurement. The RESET button is also used in the segment check.

POWER ON/OFF Switch:

Switches off the internal d.c. supplies.

INDICATORS

OVERFLOW: The OVERFLOW indicator will illuminate when the count exceeds the capacity of the display.

GATE: The GATE indicator illuminates when the counter gate is 'open'. Thus the illumination period is related to gate time selected.

REAR PANEL ITEMS

1 MHz O/P Socket: A 1 MHz reference signal derived from the frequency standard in use is available at this BNC socket.

Data Output Connector: The facilities provided by the 28-way edge connector are listed in Table 1 in the Technical Specification (supplement) at the front of the book.

Power Plug: A three-core power lead is supplied with the instrument.

Power Fuse: Fuse ratings are annotated on the rear panel.

Osc. Adjust: This aperture provides access to the calibration adjustment in the 5 MHz oscillator. In a few early models the standard oscillator is mounted on the main p.c.b.

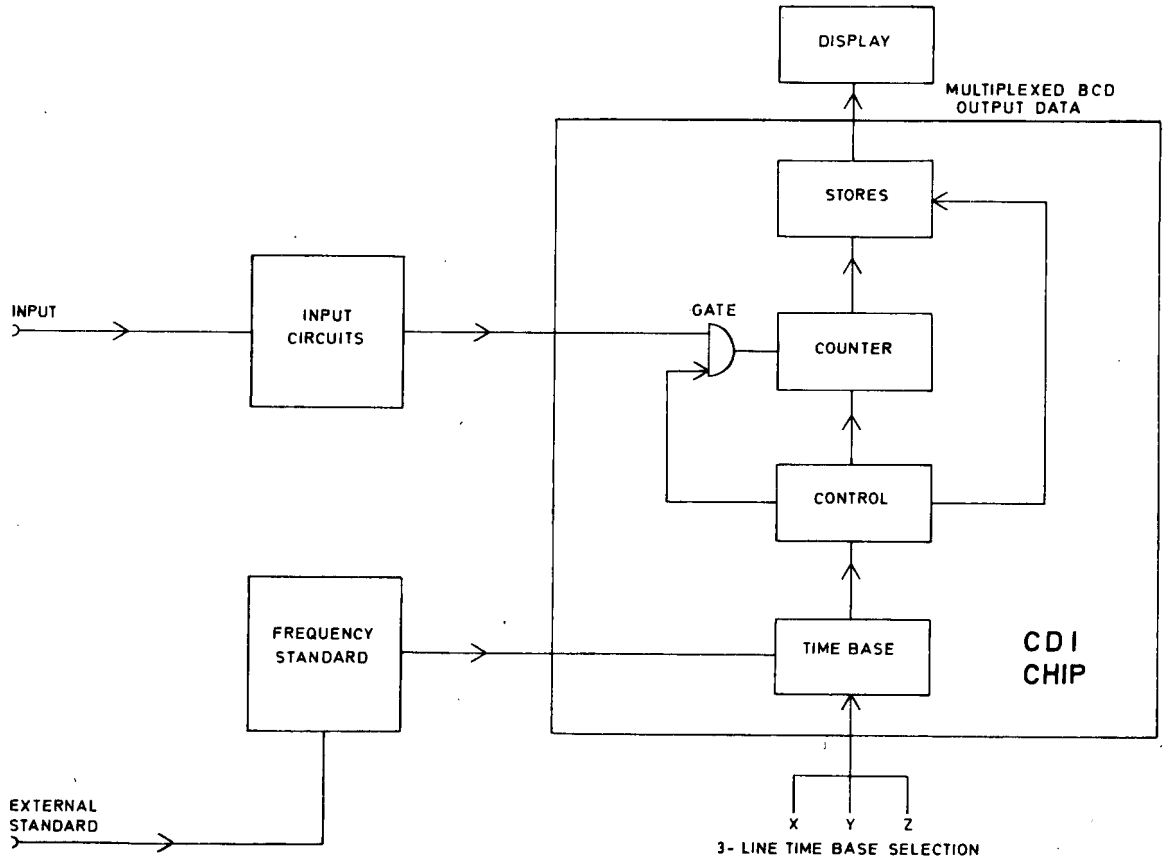
CHAPTER 3

PRINCIPLES OF OPERATION

THE CDI CHIP

3.1 A basic digital frequency meter comprises a chain of decade counters feeding b.c.d. data into latched stores. Counting is controlled via a main gate which is opened for a period determined by the timebase. Provision is made for resetting the counter and releasing the data for display. In the 9901 these functions are carried out in the integrated circuit IC2, which achieves large scale integration, using the collector-diffusion-isolation principle. For convenience, IC2 will often be referred to in the handbook as the 'CDI Chip'.

3.2 In addition to frequency measurement, the CDI Chip performs numerous other functions such as Autorange operation and the correct routeing of signals for start/stop, time base drive and external standard input, etc.



Basic Frequency Meter Fig. 3.1

GENERAL CIRCUIT FUNCTIONS

3.3 Outside the CDI Chip, other circuit functions are carried out, such as:-

(a) Input amplification and signal shaping. Sensitivity control and input (channel) selection. Check signal routeing.

(b) A six-digit display system in bit-parallel byte serial (multiplex) form, with data readout available for external use.

(c) Clock (reference) frequency generation using a discrete 5 MHz oscillator circuit, or an optional high-stability temperature controlled oscillator. The reference frequency is doubled to 10 MHz for use in the CDI Chip.

(d) Trigger slope selection, bounce protection, display time, decimal point selection and external reset are provided by means of discrete circuits.

(e) The power system operates from a.c. mains feeding +5V and -5V rectifiers and stabilizing circuits and +2V supply to the CDI Chip.

Dynamic Display System

3.4 The seven-digit display uses light-emitting diodes as numerical indicators. These indicators are driven by b.c.d. data from the CDI Chip, via a seven-segment decoder. Each displayed numeral is formed by illuminating an appropriate number of short straight segments. The numeral '8', for example, is formed from 7 segments, whereas the numeral '6' will require only 5 segments.

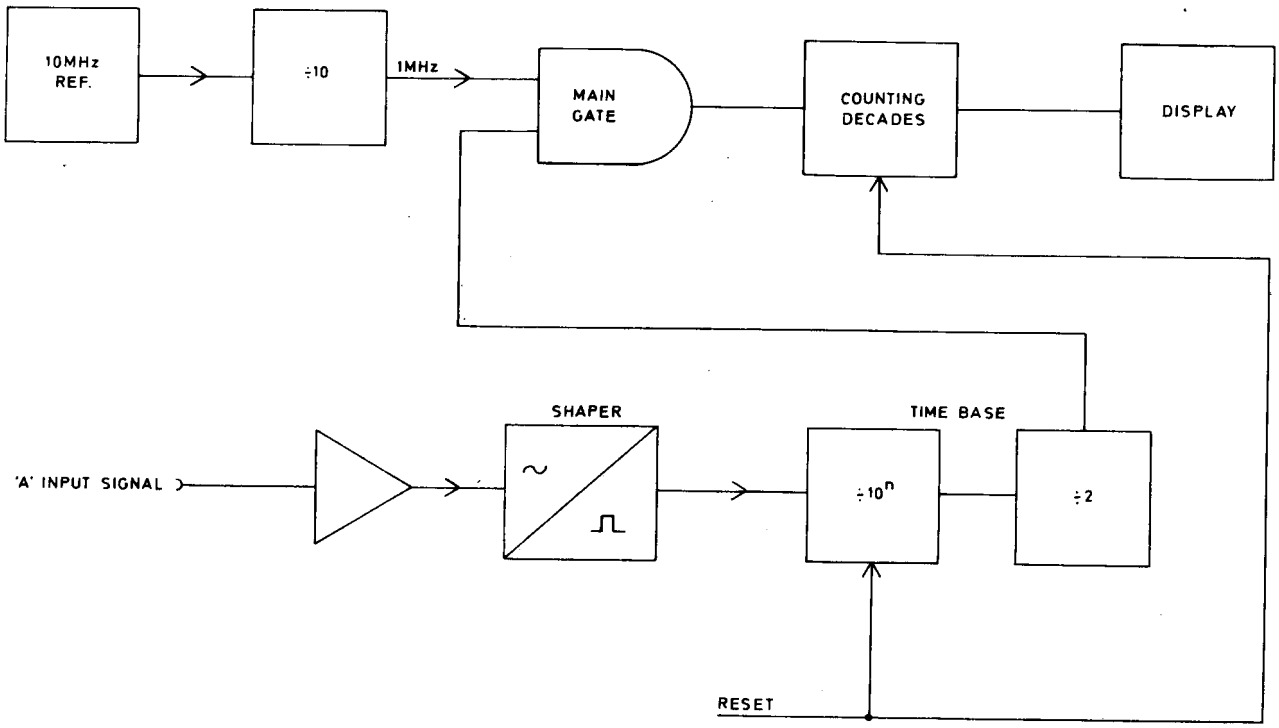
SELF CHECK

3.5 In the Self Check mode the standard frequency of 1 MHz takes the place of the unknown frequency, thus providing a check on the measurement system in the different modes.

AVERAGE PERIOD MEASUREMENT

3.6 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. As shown in Figure 3.2, 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 ('n') push-button. The chosen gating waveform is applied to the main gate to control the number of periods during which the measurement is taken.

3.7 Clock pulses from the frequency standard are fed to the signal input of the main gate and are counted 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, with decimal point positioned to indicate the average period of the signal.



Period Measurement Fig. 3.2

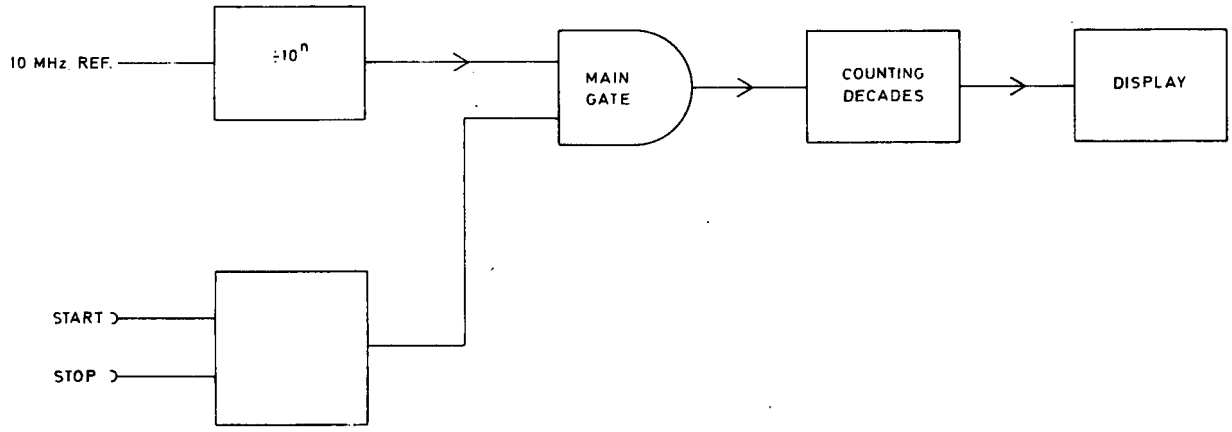
TIME INTERVAL-B (SINGLE LINE)

3.8 In this mode the instrument is effectively serving as a stop-watch. Start and Stop signals are supplied from an input on the 'B' channel or by operating the manual START and STOP buttons. The time interval is measured by counting clock units derived from the frequency standard.

3.9 The 0.1 microsecond output from a 10 MHz frequency reference is applied to the time base decades and a suitable clock unit is selected by depressing an appropriate Range push-button. These clock 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. At the end of the count the total of time units is displayed. The time value of the chosen unit is marked beside the Range button ('n').

TIME INTERVAL B-A (DOUBLE LINE)

3.10 The operating principle is the same as for single line, except that the start and stop signals are on separate inputs. The display will read the true time interval between events on the separate 'A' and 'B' channels.



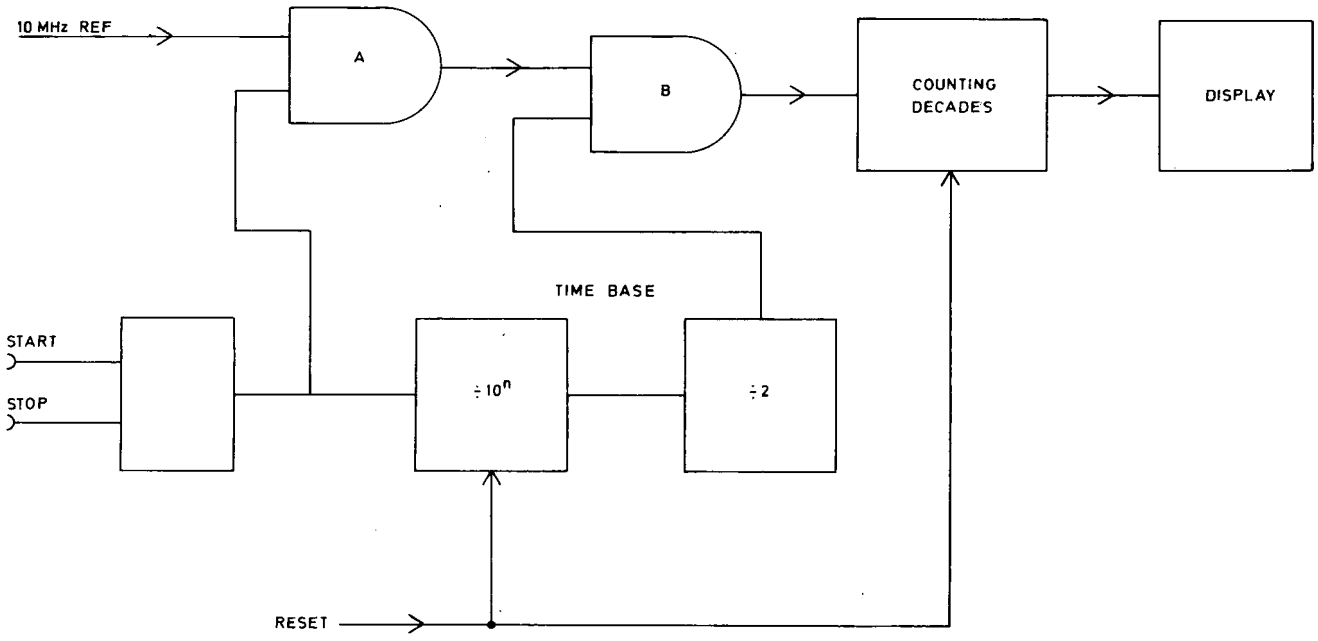
Time Interval Measurement Fig. 3.3

TIME INTERVAL AVERAGE

3.11 The reference frequency is 10 MHz, thus the shortest available clock unit is 100 ns, which places a limit on the resolution available for such measurements such as narrow pulse widths. Greater resolution is achieved by the 'averaging' technique, which functions as follows:-

3.12 Referring to Figure 3.4 the clock input to the counter has to pass through two gates in series (gates 'A' and 'B' in the diagram). The successive Start and Stop pulses open and close Gate 'A' allowing 10 MHz clock pulses to pass to Gate 'B' during each 'gate open' period. Gate 'B' is held open by the time base for the selected time (10^n) and the clock pulses are totalled in the counter. At the end of the selected time base period Gate 'B' closes and the count is displayed as the average time interval.

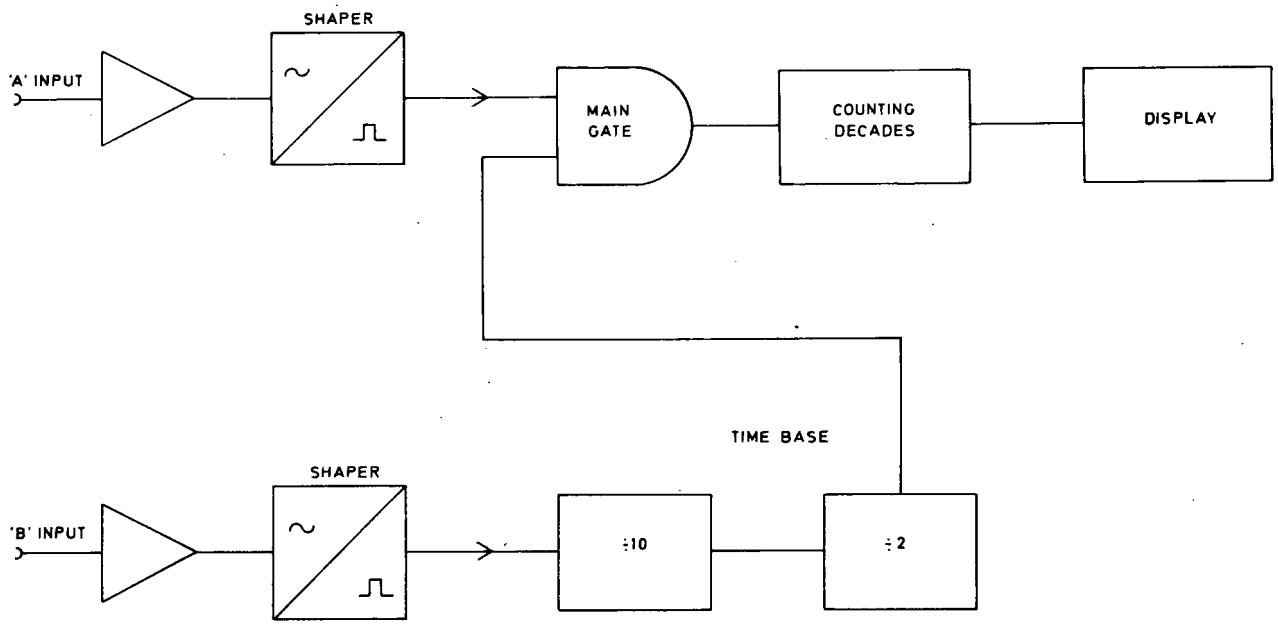
NOTE: To obtain the improved resolution from time interval averaging, the recurrence frequency of the timing input signal must not be harmonically related to the frequency standard of the counter.



Time Interval Average Measurement Fig. 3.4

RATIO

3.13 The principle of operation is very similar to frequency measurement, except that the time base output is not derived from the frequency standard. Instead, the lower of the frequencies to be compared is applied to the 'B' Input and divided in the time base. The higher frequency is applied to the 'A' Input and fed via the main gate to the counter. 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 ('n') push-button. Since the time base output is a divided version of the 'B' signal, the readout 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.

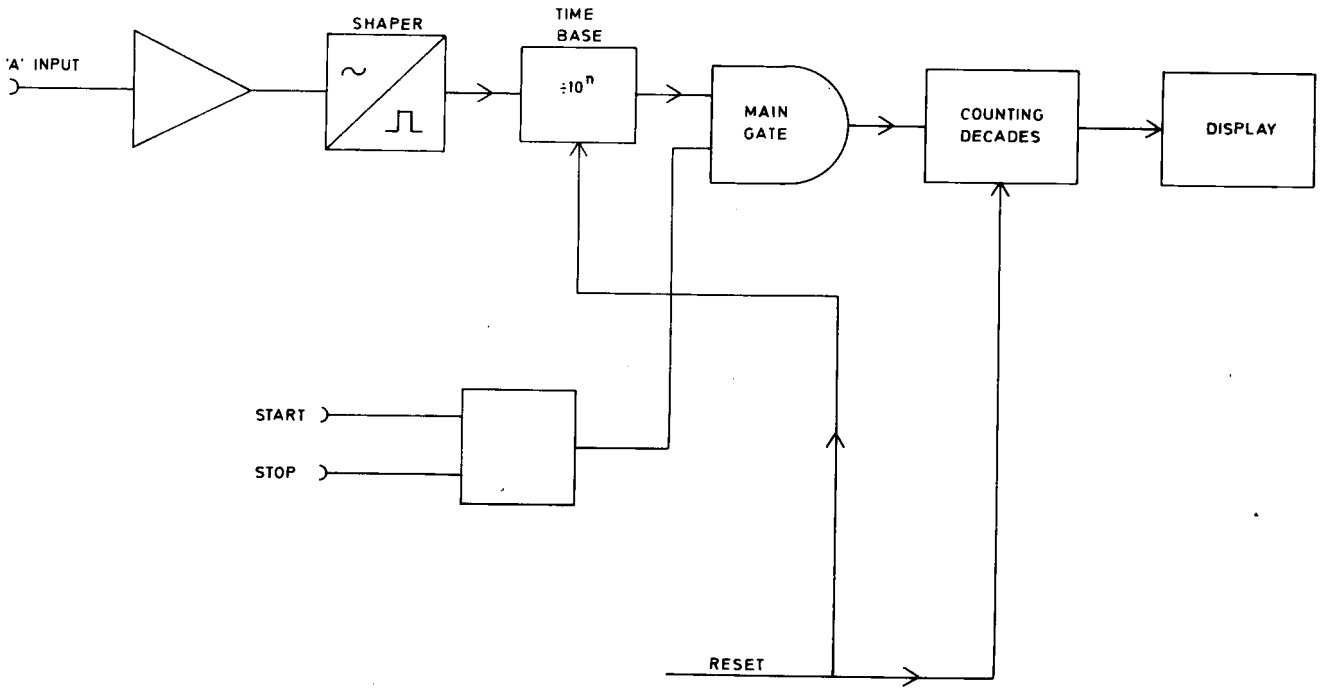


Ratio Measurement **Fig. 3.5**

TOTALIZE

3.14 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 'n' push-button. This scaled output is coupled to the signal input of the main gate.

3.15 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.

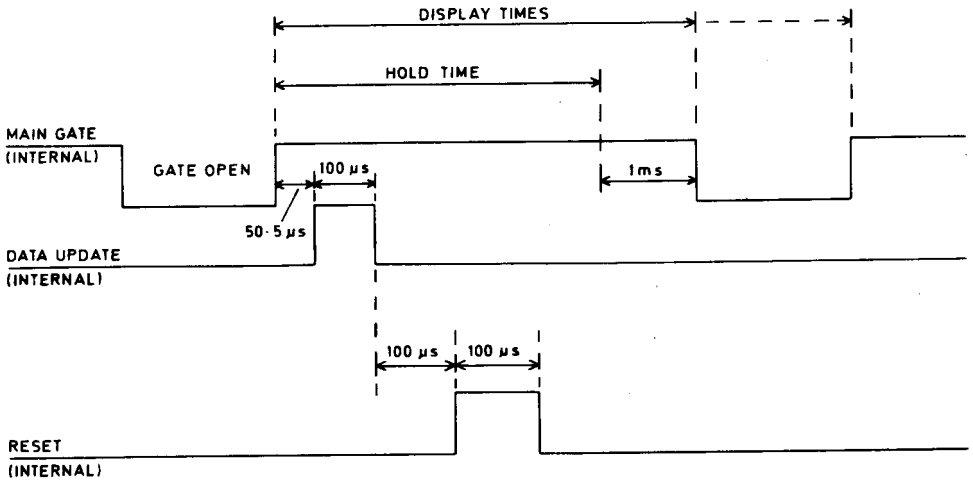


Totalizing

Fig. 3.6

CONTROL SEQUENCE

3.16 Figure 3.7 shows the control sequence diagrammatically (not to scale). The longer display time shown in the diagram applies to the latched modes (Frequency, Period and Ratio).



Control Sequence Diagram Fig. 3.7

External Hold

3.17 If, when used with external circuitry, it is required to extend the cycle time, the external hold signal (logic '0') at pin 6 of the data connector, must be applied before the end of the gate or hold time. To allow a new measurement cycle to commence, the external hold input must go 'high' for not less than 200 µs.

External Reset

3.18 External reset is achieved by the application of logic '0' to pin 7 of the connector for a period of not less than 5 ms; on reverting to '1' level this will reset the display to 'all zeros' and initiate a new measurement cycle.

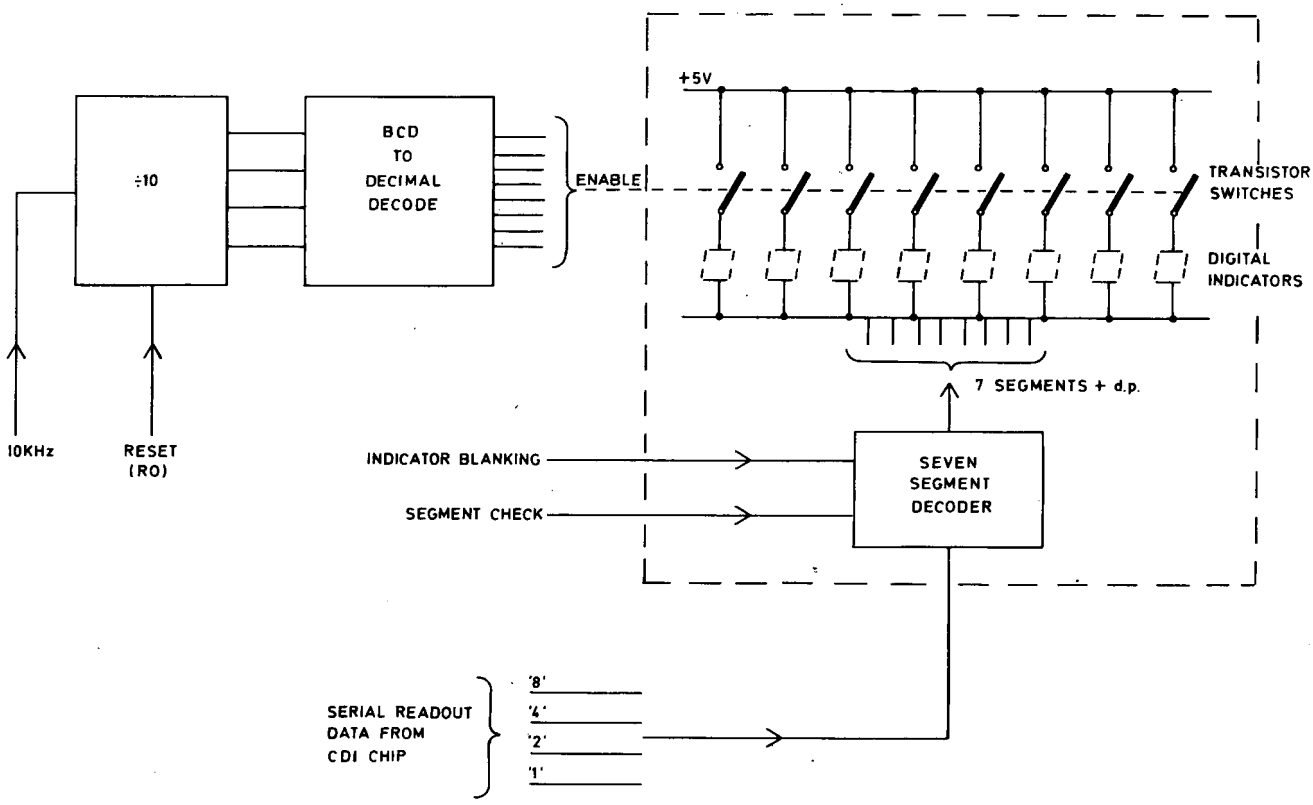
DISPLAY AND DATA OUTPUT SYSTEM

Multiplex Readout

3.19 The readout data is fed from the CDI Chip to the display decode via a single four-wire b.c.d. connection. To permit this simple interconnection a parallel-to-serial (multiplex) system is used. The principles are shown in Figure 3.8, although it should be noted that part of the system is in the CDI Chip.

3.20 In the CDI Chip the data stores feed in parallel into a common b.c.d. four-line output. The store outputs are enabled in turn for approximately 100 μs by a 10 kHz reference signal, derived from the frequency standard.

3.21 The b.c.d. data is fed to a 7-segment decoder (IC17) which offers the decoded data to the bank of LED digital indicators. The 10 kHz reference signal is fed to a BCD/Decimal decoder which 'enables' each display LED in turn for 100 μs. A reset pulse (Ro) which is generated in the 10^{o} state of the counter, ensures that the display enable is synchronised with the data store readout. A diagram showing the data output format is given on page 9 of the Technical Specification.



Multiplex Display System Fig. 3.8

3.22 In the LED indicators each displayed numeral is formed by illuminating an appropriate number of short straight segments. The numeral '8', for example, is formed from 7 segments, whereas the numeral '6' will require only 5 segments. The segments can be checked by selecting CHECK and pressing the RESET button. This calls up an 'all eights' display.

Decimal Point

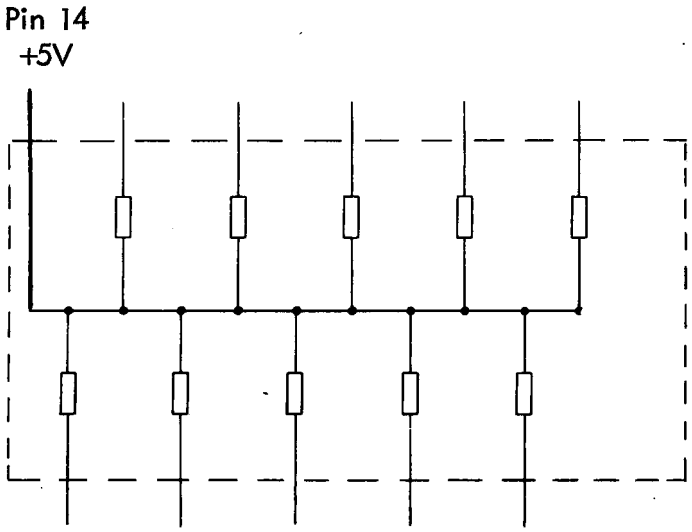
3.23 Decimal point (d.p.) information is obtained by encoding the four line b.c.d. output data from the CDI Chip with the display enable signal. This encode turns on a d.p. drive transistor at the correct instant to illuminate the appropriate decimal point.

Control Information

3.24 Function selection in the instrument is performed by a 3-line binary coded system identified as lines a, b and c. The time base ('n') units are also selected by a 3-line system identified as lines x, y and z. The inverse of the logic used in the CDI Chip is available at the rear panel data output connector. The logic decode is given in Table 2 and Table 3 in the Technical Specification at the front of the book.

Resistor Arrays

3.25 Many of the integrated circuits are 'open collector' types. For these IC's discrete 'pull-up' resistors are provided in the circuit. These resistors may be mounted in sealed dual-in-line (d.i.l.) packages, for example R83 (Fig. 4) which has seven 56Ω resistors with a common connection to +5V. Such arrays cannot be serviced and must be changed in the event of a faulty resistor. Figure 3.9 shows a typical array schematically. Another type of resistor array comprises a d.i.l. package containing separate resistors of identical values, for example R83 which contains seven 56 Ω resistors.



D.I.L. Resistor Array Fig. 3.9

CHAPTER 4

TECHNICAL DESCRIPTION

INTRODUCTION

4.1 Apart from some switches and certain items of the power supply, the circuit for the instrument is mounted on one main p.c.b. assembly. The optional fast warm-up oscillator is available as a separate unit.

LOGIC CIRCUIT SYMBOLS

4.2 Extensive use is made of integrated circuits (IC's) and these are identified by a number and suffix letter. In the circuit description a particular IC pin will be identified by a reference such as 'IC10a/3', which indicates pin 3 on that particular gate. The logic symbols used in the circuits are those found in most manufacturers IC data sheets to which reference should be made if detailed information is required. The CDI Chip, IC2 is, however, available only through the Service Department of Racal Instruments Ltd.

OPERATING CONTROLS

4.3 It is assumed that the reader understands the operational function of each control, as described in Chapter 2.

FUNCTION AND RANGE SWITCHING

Switch Selection

4.4 In the circuit diagram, Fig. 4 at the back of the book, the Function and Range push-button banks S1 and S2 are at the lower left corner. It should be noted that the PERIOD and 'n' (1) switches are shown as selected and all other push-buttons are at 'off'. Switching functions are directed by logic signals, the +5V supply and 'pull-up' resistors being provided in the d.i.l. resistor array R63 and discrete resistors R53-R55.

Control Codes

4.5 Operational modes within the CDI Chip (other than AUTO) are selected by the switch bank S1 and the $\bar{a}$,$\bar{b}$ and $\bar{c}$ lines, which are connected via inverters IC1a, c and e to IC2. Table 4, below, gives the logic coding at the switch connections. Time base (range) selection is made via switch bank S2 and lines $\bar{x}$,$\bar{y}$ and $\bar{z}$, which control the gate times in IC2 via the inverters IC1b,d and f. Table 5 gives the logic coding at the switch connections.

Frequency Auto Mode

4.6 The autoranging facility operates on Frequency mode and automatically selects the

gate time (.01, 0.1 or 1 second) which gives optimum resolution. When pin 4 on the CDI Chip is allowed to float it automatically selects AUTO operation and also latches the display.

4.7 Depressing the FREQ AUTO button produces the following action:-

(1) Pin 4 on IC2 has a tri-state capability and when this pin is allowed to float free the Chip automatically changes to AUTO operation. By pressing the FREQ AUTO button the open collector resistor (R53) of IC13e is disconnected, allowing IC2/4 to float.

TABLE 4

Function Information

Function	Code		
	$\bar{a}$	$\bar{b}$	$\bar{c}$
Frequency	1	1	1
Average Period	0	1	1
Totalize $\frac{A}{n}$: Start/Stop 'B'	0	1	0
Ratio n $\frac{A}{B}$	1	1	0
T.I.(single or double line not averaged)	0	0	1
T.I.(single or double line averaged)	1	0	1

TABLE 5

Time Base Selection

Code			Frequency Gate Time	Multiplier 'n'	Time Interval Clock
$\bar{x}$	$\bar{y}$	$\bar{z}$			
1	1	1	1 ms	1	0.1 μs
0	1	1	10 ms	10	1 μs
1	0	1	100 ms	10^2	10 μs
0	0	1	1 sec	10^3	100 μs
1	1	0	10 sec	10^4	1 ms
0	1	0	100 sec	10^5	10 ms

Data Latch/Unlatch

4.8 This is determined by the logic level applied to IC2/4, as follows:-

Latch ..... logic '1'

Unlatch ..... logic '0'

4.9 In Totalize and in both Time Interval modes the data stores in IC2 are unlatched by a logic '0' at IC2/4. This is arranged by Function switch S1 which applies an earth to R55 when the FREQ., PERIOD and RATIO buttons are not selected, this '0' is then fed through inverters IC13c and IC13b to IC2/4.

Normal/Hold and Reset

4.10 The NORMAL/HOLD switch 1S7 is mounted on the Display Assembly and shown on the right hand side of the circuit diagram (Fig. 4). In the NORMAL position the display is continuously updated, the automatic reset being produced within the CDI Chip.

4.11 The HOLD connection to the CDI Chip is at IC2/13, the logic requirements at this point are:-

IC2/13 (Hold..... '1'
(Free Run..... '0'
(Reset..... Transition '1' to '0'

The Hold and manual Reset signals are applied via the display time generator and associated circuit described in paras. 4.39 and 4.40.

'A' CHANNEL INPUT

Introduction

4.12 The 'A' channel has alternative amplifier paths, selected by the AC/DC switch 1S1. The two amplifier paths have a common output stage (Q8) which feeds into the counter of the CDI Chip at IC2/22.

'A' Channel AC Amplifier

4.13 Signals in the range 10 Hz to 50 MHz which are applied to the 'A' input socket are fed via the AC/DC switch (AC position) and capacitor IC1 to the SENSITIVITY potentiometer 1R1. From 1R1 the signal is fed via a coaxial lead to the a.c. amplifier on the main p.c.b.

4.14 The a.c. amplifier has a high impedance FET input (Q1) with overload protection by the clipping resistor R1 together with the gate-drain junction and diode D1. The output from the source of Q1 drives a wideband amplifier IC21, which feeds via C8 into emitter follower Q3. Transistor Q2 is turned off in all modes except PERIOD. In PERIOD mode the removal of the earth via switch S1 turns on Q2, to restrict the bandwidth by the introduction of capacitor C9.

4.15 Transistor Q3 drives the Schmitt Trigger shaper Q4/Q5. Potentiometer R11 sets the bias on Q3 to ensure that the mean signal level is correctly set relative to the two triggering levels of the Schmitt circuit, thus ensuring maximum sensitivity. From Q5 the shaped signal is fed via Q7 and Q8 to the counter at IC2/22.

4.16 When the AC/DC switch is set to DC, and also when CHECK is selected, the AC amplifier is disabled (except the output stage Q8) by a '1' applied to the base of Q6 via the inverter IC14d.

D.C. AMPLIFIERS

4.17 The 'A' and 'B' channel d.c. amplifiers are basically identical. The description of the 'B' amplifier and contact bounce protection, given below, applies to both circuits.

'B' Channel D.C. Amplifier

4.18 The 'B' input is fed in via pin 12 on the main p.c.b. and emitter-follower Q11 to the input of IC22d which is a dual line receiver adapted by feedback to operate as a Schmitt trigger shaper.

4.19 The shaped output from IC22c/9 is fed via the slope selection gate IC19b and inverters IC14b and IC14c to the output stage Q12 which feeds the signal to the Start input of the CDI Chip at IC2/20. Simultaneously, the output from IC22c/9 is fed via IC19a, IC18b, IC18c and Q10 to the Stop input at IC2/21. On single line operation IC2 interprets the positive edge of the first pulse received as the start, and the positive edge of the second pulse as the stop. For single line (B-B) operation the 'B' channel Stop path is enabled at IC18b/3 by a '1', applied via inverter IC14a from an earth at switch 1S2. For double line (B-A) operation IC18b is disabled by a '0' from inverter IC14a.

4.20 The emitters of Q10 and Q12 are connected to 0V via transistor Q13 which is normally conducting, except when manual start/stop is used (see para. 4.29). The states of the Schmitt triggers at IC22b/4 and IC22c/9 are fed to the data output connector at pins R and P for external information.

Bounce Protection

4.21 Fixed bounced protection is provided when the Pulse/Contact switch is at 'Contact'. Referring to the 'B' amplifier, for example, if the external timing contact is open,

Q11 will be non-conducting due to the +5V applied via the Pulse/Contact switch 1S6, R45 and D18 to the base of Q11.

4.22 When the external timing contact closes to earth, it discharges C21 via D18 and R42, thus pulling down the base and turning on Q11. This sends a signal to the Start and Stop inputs of the CDI Chip.

4.23 Contact bounce pulses are prevented from causing a spurious 'stop' because they are of too short a duration to re-charge C21, thus Q11 is unaffected until the timing contact re-opens, C21 is then able to re-charge and Q11 turns off, thus the bounce protection period is determined by the value of C21.

'A' Channel D.C. Amplifier

4.24 The 'A' amplifier and its bounce protection circuit function in the same manner as the 'B' amplifier described above. The input signal is supplied when the AC/DC switch 1S1 is set to DC. There is also an additional gating stage in the output (IC18a) which inhibits the 'A' d.c. amplifier output when the B-B/B-A switch 1S2 is set to B-B for single line Time Interval mode.

CHECK Mode

4.25 In CHECK the 'A' channel a.c. amplifier is inhibited and the 1 MHz reference is fed to the counter in the CDI Chip. The 1 MHz reference from IC2/6 is fed to IC15c which is enabled by a '1' on IC15c/9 when switch 1S5 is set to CHECK. (The pull-up resistor is R95 on the right hand side of the circuit diagram). From IC15c the 1 MHz is fed via IC15b and C14 to the output stage Q8, thence to the counter via IC2/22.

4.26 To inhibit the 'A' amplifier in CHECK mode a '0' is provided by switch 1S5 which is inverted in IC14d and turns on Q6, which shunts the amplifier. The same inhibit is applied when the AC/DC switch is at DC.

SLOPE SELECTION

4.27 The polarities of the Start/Stop triggering edges are selected by switches 1S3 (STOP slope) and 1S4 (START slope) in conjunction with the Exclusive-OR gates IC19a, 19b and 19d. An Exclusive-OR gate gives a '1' output when the input pins have opposite logic signals. By means of the slope selection switches alternative logic levels can be applied to these gates, which can thus determine which edge of the input pulse shall perform the start or stop function.

4.28 The selected triggering edge is differentiated by R40/C19 in the stop line and R50/C22 in the start line to provide the appropriate triggering pulse. The slope gates have the following functions:-

Gate	Function
IC19a	'B' channel stop (single line timing and totalizing)
IC19b	'B' channel start (single and double line timing, and totalizing).
IC19d	'A' channel stop in Time Interval double line.

MANUAL START/STOP

4.29 The emitters of the Start and Stop transistors Q12 and Q10 are connected to 0V via the snap-action transistor switch Q16/Q13 and R56. This circuit provides a pulse when manual start/stop is used, which eliminates contact bounce effects. Under normal conditions capacitor C23 is charged up, and Q16 and Q13 are turned on. When the START/STOP button S50 is pressed, it rapidly discharges C23 and turns off Q16 and Q13. Turning off Q16 and Q13 effectively turns off Q12 and Q10, producing the appropriate pulses for start and stop at the inputs to the CDI Chip. Because Q16 and Q13 cannot turn on again until C23 has charged up the contact bounce pulses are suppressed.

DATA OUTPUT AND DISPLAY SYSTEM

NOTE: Refer to the Supplementary Data in the Technical Specification at the front of the book for a summary and diagram of the data output format.

Multiplex Readout and Display

4.30 The Display Assembly contains a 6-digit readout system using light-emitting diode (LED) numerical indicators. The display data is fed from IC2 on pins 15 to 18, this 4-way output being fed from a parallel-to-serial (multiplex) system within the CDI Chip, to the 7-segment decoder IC17.

4.31 In the multiplex system the b.c.d. outputs from the data stores are fed in sequence on to the 4-way output. This is determined by a 10 kHz synchronising signal (derived from the frequency standard) which interrogates each decade store in turn for a period of 100 µs. The same 10 kHz signal is used (via IC10) to 'enable' the appropriate LED in the Display.

4.32 The system is set by the (Ro) signal which occurs in the 10^{o} state of the data output at IC2/14. This sets IC10 to the '0' state, and via IC16/1, turns on Q19. This enables the 10^{o} digital indicator D.I.2 which displays the digit determined by the 7-segment decoder IC17. The other display LED's are then enabled in sequence for a period of 100 µs each.

Decimal Point and Overflow Decode

4.33 The d.p. and overflow data is fed out from the CDI Chip during the ninth state of

the counter and is stored in the latch package IC7. Decimal point information in IC7 is applied via pins 1, 8 and 11 to the Exclusive OR gates IC11a, b and d where it is compared with the b.c.d. drive to the digit enable circuit. When the threee Exclusive-OR gates have the correct logic inputs a signal will pass via the inverters IC11a-b-c to turn on Q25 at the appropriate time to achieve the correct decimal point position. When the 10^5 decade in the counter overflows, a 'carry' level is fed to IC7 during the ninth state. This appears at IC7/15 as a 'low' which turns on the indicator LP1. The same signal is supplied to the rear data output connector at pin B. The latched store IC7 is triggered during the ninth state by a '0' at IC16/11 which is inverted in IC11c and fed to IC7/13. Later Display Assemblies are fitted with links LK1 and LK2. See Notes on Parts List 1 and Fig. 4.

Gate Indicator

4.34 The LED LP2 illuminates in synchronism with the counter main gate when measurement is in progress. The main gate waveform at IC2/19, which goes 'low' when the gate is open, is inverted in IC6c and thus turns on Q28 to illuminate LP2 during the 'gate open' periods. The action of D7 and C44 is to stretch the gate lamp drive signal.

DISPLAY TIME AND RESET GENERATOR

Introduction

4.35 This circuit is centred on IC9a, IC9b and transistors Q29, Q30 and Q31. It produces a display time of approximately 400 ms which is extended to approximately 2 seconds in Time Interval, Time Interval Average and Totalize. At the end of the display time a negative-going transition resets the counter in IC2/13.

Display Time Circuit

4.36 The main gate signal at IC2/19 is fed to the control bistable at IC9b/11. At the end of the main gate period IC9b/11 goes high, sending IC9b/8 low. This removes the clamp from the display time capacitor C46 and allows it to charge up via R96, R93, Q29 (see next para.) and switch 1S7 (NORMAL position).

4.37 Q29 is turned off by a '1' supplied to the base via inverter IC13c from an earth on R55 when the FREQ., PERIOD and RATIO switches are not selected. This adds R92 to the charging circuit which increases the display time to about 2 seconds.

4.38 Capacitor C46 charges until the voltage at Q30 emitter rises above that at the base (fixed by R101/R102) at which point Q30 begins to conduct and a regenerative action develops which allows C46 to discharge very rapidly through R100 and Q30/Q31. The time taken for this discharge determines the width of the reset pulse, which should be not less than 100 ns.

Reset Pulse and Hold State

4.39 When the regenerative switch Q30/Q31 fires, the voltage at Q31 collector falls sharply. This negative-going pulse is fed to IC9b/13 and clears the control bistable. The transition at IC9b/8 is fed via IC6b to reset the counter by a '1' to '0' transition

at IC2/13. This reset signal is differentiated in C43/R85 and turns off Q27. The 'high' at Q27 collector is inverted in IC12e and the resultant '0' at IC17/4 briefly blanks the display while the instrument is preparing for a new measurement. When switch 1S7 is set to HOLD the +5V supply is disconnected and capacitor C46 cannot charge up, thus preventing any reset action.

Manual Reset

4.40 This is generated in IC9a. Pressing the manual RESET button (S52) puts a '0' on IC9a/1. The resulting '0' at IC9a/5 is inverted in IC6b to put a 'hold' on the counter via IC2/13. Release of the manual RESET allows the 10 kHz clock signal at IC9a/3 to drive the 'Q' output (IC9a/5) to the '1' state, which resets the counter via IC2/13. At the same time the transition of IC9a/6 from '0' to '1' is differentiated by R68/R90/C45 and applied to IC2/4 via IC6a and IC13e to momentarily unlatch the data stores and clear the previous reading.

External Reset

4.41 An external reset signal with a minimum duration of 5 ms can be applied via pin 7 of the rear data connector. This reset is applied to IC9a/1 and operates in the same way as manual reset (see previous para.).

Segment Check

4.42 This is obtained by selecting CHECK and holding down the manual reset button. In Check position the switch 1S5 (via R95) applies a '1' to enable IC15a. Depressing the manual reset switch S52 applies a '1' (via IC13a/2) to IC15a/1. This feeds a '0' to the segment decoder IC17/3 which produces an 'all eights' display while the reset button is held down.

FREQUENCY STANDARD

Standard Oscillator Assembly 19-0834

4.43 In the standard instrument the reference frequency is generated in a 5 MHz discrete component assembly attached to the rear panel with access to the trimming capacitor (C4), via a rear panel aperture. The circuit is shown in the main p.c.b. circuit (Fig. 4) and also in Fig. 2. In early models the 5 MHz oscillator was mounted on the main p.c.b. and the output connected via link LK1. This early circuit (Q17, XL1, C35 etc.) is shown in Fig. 4. The circuit is identical to the 19-0834 in Fig. 2, but the component references are different.

Optional Oscillator

4.44 The fast warm up oscillator Type 9442 is mounted a B7G base and connected as shown in the circuit diagram (Fig. 4). This a precision item. If a fault develops, users are advised to return the oscillator unit to Racal Instruments Ltd. or approved agent, for servicing. No parts list or circuit information is provided in this handbook.

Frequency Doubler

4.45 The 5 MHz reference from the oscillator is fed via C32 to a shaper formed by IC3d with L2 and diodes D5/D6. The square wave signal is then fed via IC3a to the monostables IC4a and IC4b. A positive monostable pulse is produced from each edge of the input and fed from IC4a/4 and IC4b/12 respectively to the Nand gate IC3c, thus producing a 10 MHz input to the CDI Chip at IC2 pin 5. In earlier models (refer to handbook Issue 1) the shaped signal is fed via an inverter IC4a to the two branches of a digital doubler with output at IC3a/3. By a process which delays the signal in one path by a series of inverters, then by an Exclusive-OR arrangement, the two signal paths produce a doubling effect.

1 MHz Reference Output

4.46 The 1 MHz reference is fed from IC2/6 via the buffer IC15d to the 1 MHz BNC output socket on the rear panel.

External Standard Input

4.47 A 1 MHz reference can be fed in via the 'B' input socket as this socket is not used in Frequency and Period modes. The input path is via the 'B' channel amplifier and the Start gates IC19b etc to Q12 and thence to the input of the CDI Chip at IC2/20.

POWER SUPPLY

4.48 The a.c. supply is fed in via a 3-pin fixed plug on the rear panel, thence via the anti-surge fuse FS50 to the transformer T50. The transformer tappings are arranged to suit the local supply voltage as shown in the diagram on page 5-3. The output at secondary winding 'A' is rectified to provide +5V by the potted bridge rectifier D50, which is mounted on the rear panel for adequate heat dissipation. The -5V supply is provided by the discrete diode bridge D11-D14. Smoothing and reservoir capacitors are C49, C51, C53 and C54. Capacitor C50 ensures that any ripple in the +5V line will not affect the -5V stabilizing comparator IC5b, and C52 and C60 stabilize the system.

+5V Stabilization

4.49 The reference is provided from the +5V rail by zener diode D10 which is connected to the comparator IC5a/2. The other input to the comparator (IC5a/1) is from the 0V rail. The comparator function is to ensure that the 0V rail is maintained 5.1V below the voltage of the +5V rail. Any change from this state will cause IC5a to apply a signal to Q33 which will regulate the current in Q50 to restore the correct condition.

-5V Stabilization

4.50 The -5V stabilizing comparator is IC5b, in which both inputs should be at 0V when conditions are correct. IC5b/7 is connected to the 0V rail and IC5b/6 to the mid-point of a potential divider (R104, R105 and R106) which is connected between the stabilized +5V rail and the -5V rail. If the level at IC5b/6 departs from 0V then a correcting signal

from IC5b/10 will regulate the current in Q32 to correct the error.

On/Off Switching

4.51 The single pole Power on/off switch S51 operates in the negative supply from the rectifiers D11-D14. It also switches off the +5V supply by disconnecting the reference zener diode D10 in the 'off' position.

CDI Chip 2V Supply

4.52 A stabilized +2V supply is derived from the +5V rail via the regulator Q14 which is controlled by Q15 from a reference voltage provided by the CDI chip at IC2/11.

CHAPTER 5

MAINTENANCE

TABLE 6: TEST EQUIPMENT REQUIRED

Item No.	Preferred Item	Remarks
1	Digital Multimeter Racal 9077	Provides 10 mV resolution on 50V range. DC Input resistance 10 MΩ
2	Oscilloscope BWD 525	Bandwidth d.c. to 50 MHz Sensitivity 50 mV/cm
3	Frequency Standard	1 MHz; accuracy ± 1 part in 10^8 Output 1V r.m.s. nominal
4	Signal Generator Racal 9061) 9062) combi- 9063) nation	Required frequency range 10 Hz to 60 MHz Output from 5 mV r.m.s. to 1V r.m.s., into 50Ω NOTE: LF Signal Generator must have signal-to-noise ratio better than 40 dB.
5	Millivoltmeter Racal 9301	Required frequency range: 10 kHz to 60 MHz Measurement: 1 mV to 3V
6	Coaxial leads, 50Ω	BNC to BNC. Length 3 ft (1 metre) approximately.
7	Terminating Pad, BNC, 50Ω (quantity 1)	
8	Terminating connector, BNC. 50Ω (T Piece, quantity 3)	
9	Power Supply 240V ± 2%, 50 Hz Single phase, line neutral and earth.	
10	Pulse Generator	1 kHz to 1 MHz p.r.f. Pulse width 100 ns to 0.1 ms. Amplitude 50 mV to +3V.

REMOVAL OF COVERS

WARNING: DANGEROUS AC VOLTAGES ARE EXPOSED WHEN COVERS ARE REMOVED WITH AC SUPPLY CONNECTED.

5.1 (1) Set the POWER switch to 'off', switch off the a.c. supply at the supply point and unplug the power lead.

(2) Remove the rubber plugs (located near to the rear end) from both side panels of the instrument and slacken, by about two turns, the screws revealed.

(3) Grip the rear panel assembly and ease it back from the main case to the maximum extent available (about 5 mm).

(4) The rear edge of either cover can now be lifted and the cover withdrawn outwards and rearwards.

(5) To replace the covers reverse the above procedure.

TRANSFORMER VOLTAGE SELECTION

5.2 The instrument will normally be dispatched with the transformer primary tapping set to the 223-251V supply range. To check the selection proceed as follows.

(1) Unplug the power cable from the supply and remove the top cover (see para. 5.1).

(2) Refer to the diagrams on the next page and:-

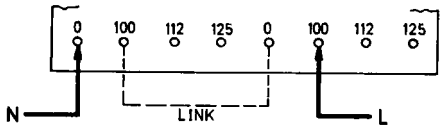
(a) Note the diagram which corresponds to the local a.c. supply voltage.

(b) Connect the correct link(s) and make the required line lead connection (L) as indicated in the appropriate diagram.

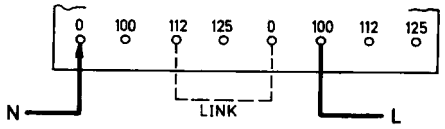
(3) Verify that the label on the rear panel indicates correctly the selected voltage range. Alternative labels are provided with the instrument for ranges other than 223V to 251V.

(4) Replace the top cover.

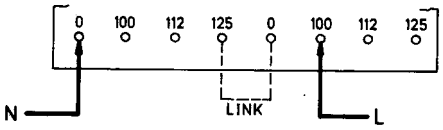
188-212V



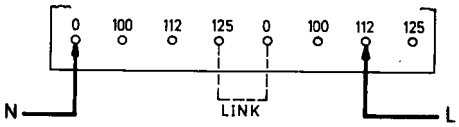
200-225V



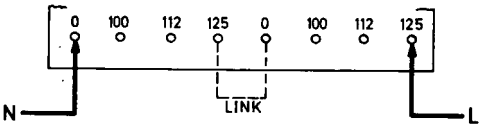
212-239V



223-251V

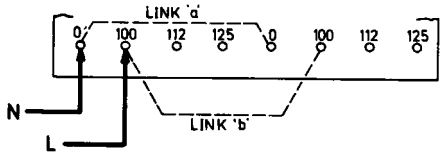


235-265V

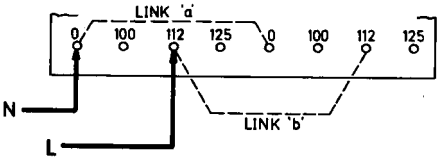


188V TO 265V

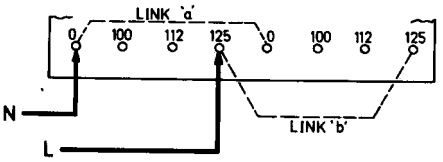
94-106V



106-119V



118-132V



94V TO 132V

WOH6201/9901

Mains Transformer Voltage Selection Diagrams

Fig. 5·1

FUSES

5.3 (1) Check that the power fuse on the rear panel is correctly rated for the supply voltage, as follows. The fuse is a glass cartridge type, 5 x 20 mm.

Supply Range	Fuse Rating	Racal Part No.
188V to 265V	100 mA anti-surge	23-0033
94V to 132V	200 mA anti-surge	23-0027

POWER LEAD

5.4 Fit a suitable plug to the power lead in accordance with the standard colour code: -

Brown ..... Line
Blue ..... Neutral
Green/Yellow .... Earth (Ground)

POWER SUPPLY CHECK

5.5 (1) Remove the covers and prepare the power supply as described in the preceding paragraphs. Check that the a.c. supply voltage is correct.

(2) With power supply connected, switch POWER to ON.

(3) Using the multimeter (Page 5.1, Table 6, item 1) check the d.c. voltages at the following points on the main p.c.b. Fig. 3 at the back of the book shows the component layout.

Test Point	Measurement	Remarks
TP7	+5.1V ± 0.3V)	Relative to chassis.
TP6	-5.1V ± 0.4V)	

NOTE: There are no adjustments in the power supply circuit. If the 5V supplies are outside the limits given above, the mains supply voltage and the transformer line lead connection and links (see page 5-3) should be carefully checked. If these are correct the zener reference diode D10 should be checked.

NOTE: If the Racal Synthesized Signal Generator is used, with its frequency standard synchronised to that of the 9901, a readout accuracy of ±1 count will be obtained.

Segment, Decimal Point and Self Check

5.6 (1) Connect the a.c. supply and set the POWER switch to ON.

(2) Set the CHECK/OPERATE switch to CHECK.

(3) Depress the FREQ. 'A' MAN button and verify that the GATE indicator illuminates.

(4) The instrument should now read 1000 kHz. Refer to Table 7 and check the display and decimal points (Freq. column) for each 'n' range button.

(5) Depress the PERIOD 'A' button and verify the readout and decimal points according to the Period column of Table 7.

(6) Briefly hold in the RESET button and check that the display reads 'all eights' (segment check).

TABLE 7

SELF CHECK READOUT

Range 'n' Selected	Gate Time	Display (± 1 count)	
		Frequency	Period
1	1 ms	001000.	000001.
10	10 ms	01000.0	00001.0
10^2	100 ms	1000.00	0001.00
10^3	1 sec	* 000.000	001.000
10^4	10 sec	* 00.0000	01.0000
10^5	100 sec	* 0.00000	1.00000

NOTE: With readouts marked (*) the most significant digit will overspill and the OVERFLOW lamp will illuminate after the appropriate gate time.

(7) Depress the FREQ. AUTO button and verify that display reads 1000.00. This checks that the AUTO facility has selected the optimum time base range (10^2) for the 1 MHz signal.

(8) Finally set the CHECK/OPERATE switch to OPERATE.

Sensitivity Checks: Input 'A'

5.7 Equipment Required

HF Signal Generator (Page 5-1, Table 6, item 4).

5.8 Frequency and Period Check

(1) Set the controls as follows:-

(a) HOLD/NORMAL to NORMAL.
(b) AC/DC to AC.
(c) FREQ. 'A' MAN.
(d) AC SENSITIVITY control anticlockwise to 10 mV position.
(e) Select Range button n = 10.

(2) Terminate the 'A' input socket in 50Ω and apply 55 MHz at a level of 10 mV r.m.s.

(3) * Verify a correct and stable count. If necessary adjust potentiometer R11 (on the main p.c.b.) to obtain steady counting. (Refer to Fig. 3 at back of book for component location).

(4) Apply the signal frequencies listed in Table 8 below. Select an appropriate 'n' button and verify a stable count in each case.

TABLE 8

'A' Input Sensitivity Check

Range Selection ('n')	Input Frequency	Signal Level (r.m.s.)	Tolerance
n = 1	55 MHz	)	See Note at top of page 5-5
n = 1	10 MHz	) 10 mV	
n = 10^3	1 MHz	)	
n = 10^3	1 kHz	)	

* If IC21 has been serviced and sensitivity is still low, insert R7, 100Ω, as shown in circuit diagram, Fig. 4.

(5) Apply a 1 kHz signal at 10 mV r.m.s.

(6) Depress the PERIOD 'A' and n = 10^3 Range buttons.

(7) Verify a display of approximately 1000.00.

(8) Depress the FREQ. 'A' button. Change the signal generator to 20 MHz at 1V r.m.s. approximately.

(9) Turn the SENSITIVITY control clockwise and verify that counting ceases before the control reaches the fully clockwise position.

(10) Reset the SENSITIVITY to the 10 mV position and disconnect the signal generator.

Time Interval Single Line Check

5.9 Equipment Required

Timing source such as a pulse generator.

5.10 Procedure

(1) Set the following controls:-

(a) HOLD/NORMAL to NORMAL.
(b) Pulse/Contact to Pulse .
(c) B-B/B-A switch to B-B.
(d) Depress the TI button.

(2) Set the pulse generator to 1 kHz p.r.f. 1:1 mark/space ratio and amplitude 1.25V peak to peak. Connect to the 'B' input socket terminated in 50Ω.

(3) Select the n = 10^2 Range button. Set the START and STOP slope switches to the positions in Table 9 and verify the measurements in column (x) bearing in mind the calibration accuracy of the pulse generator.

(4) Set the pulse generator to 4:1 mark/space ratio and verify the measurements in Table 9 column (y). This checks for correct switch connections, if for example, the display board has been replaced.

TABLE 9

Time Interval Single Line Check

Slope Switch Selection		Displayed Measurement with 1 kHz Input	
Start	Stop	(x) Mark/Space 1:1	(y) Mark/Space 4:1
(a) ⌐	⌐	1 ms	1 ms
(b) ⌙	⌙	1 ms	1 ms
(c) ⌐	⌙	500 µs	800 µs
(d) ⌙	⌐	500 µs	200 µs

Time Interval Double Line Check

5.11 Equipment Required

Pulse Generator (Page 5-1, Table 6, item 10)
Two BNC 'T' Pieces: one 50Ω termination.

5.12 Procedure

(1) Set the B-B/B-A switch to B-A and the AC/DC switch to DC.

(2) Connect the pulse generator to both input sockets, using two BNC 'T' pieces with a single 50Ω termination.

(3) Refer to Table 9 and with the Pulse Generator on 4:1 mark/space ratio perform checks (c) and (d), column (y).

Time Interval Average Check

NOTES: 1. The repetition rate of the timing pulses used for this test must not be harmonically related to the frequency standard of the counter.

2. The minimum space (dead time) between intervals is 150 ns.

5.13 (1) Set up the 9901 controls as for Time Interval single line (para. 5.10).

(2) Set the pulse generator to a pulse width of 200 ns, and a p.r.f. not harmonically related to 1 MHz. (See also NOTE 2 above).

(3) Set the START slope switch to ⌐ and the STOP slope switch to ¬.

(4) Depress the 10^3 Range button and verify that the display reads the pulse duration as set on the pulse generator, bearing in mind the calibration accuracy of the pulse generator.

Ratio Check

5.14 Equipment Required

Pulse Generator (Page 5-1, Table 6, item 10).
Two BNC 'T' Pieces and one 50Ω termination.

5.15 Procedure

(1) Set the 9901 controls as follows:-

(a) AC/DC switch to DC.
(b) Pulse/Contact switch to 'Pulse'.
(c) HOLD/NORMAL to NORMAL.
(d) Depress the RATIO button.

(2) Set the pulse generator to 1MHz at 1.25V peak to peak.

(3) Connect the pulse generator output to the 'A' and 'B' input sockets, using two BNC 'T' pieces with a single 50Ω termination.

(4) Depress the n = 1 Range button and verify that the display reads 000001 + 1 count.

(5) Depress the Range buttons (10) to (10^5) in turn and check that the ratio reading increases by a factor of ten at each step.

(6) Disconnect the pulse generator from the 'B' input.

Totalize Check

5.16 Equipment Required

Signal Generator (Page 5-1 Table 6 Item 4).

5.17 Procedure

(1) Set the CHECK/OPERATE switch to CHECK.

(2) Depress the TOTAL and n = 10^5 buttons. (To increase the counting rate a smaller 'n' factor may be selected).

(3) Press and release the START/STOP button and check that each display indicator counts through 0 to 9 and that the OVERFLOW indicator illuminates. Decimal points are not displayed.

(4) Press and release the START/STOP button to stop the count.

(5) Select:-

(a) CHECK/OPERATE to OPERATE.
(b) HOLD/NORMAL to HOLD.
(c) AC/DC switch to AC.
(d) SENSITIVITY control fully anticlockwise (10 mV).

(6) Set the signal generator to 10 MHz at 10 mV r.m.s. and connect to the terminated 'A' input socket.

(7) Depress the n = 10 Range button. Press and release the START/STOP button and note that:-

(a) The GATE indicator illuminates.
(b) The OVERFLOW indicator illuminates after one second.
(c) That counting continues.

(8) Press and release the START/STOP button and note that the GATE indicator extinguishes and the display is held.

(9) Set the NORMAL/HOLD switch to NORMAL. Repeat operations (7) and (8) and check that the display automatically resets, two seconds after the GATE indicator has extinguished.

(10) Disconnect all test equipment.

Frequency Standard Calibration

5.18 The 'cycle drift' method of frequency calibration, described below, is suitable for oscillators which have temperature stability characteristics of up to 1 part in 10^7. The higher stability oscillators, such as the Racal 9421 and 9442, require specialised equipment such as the Tracor Frequency Difference Meter Type 527A, if the optimum calibration is to be achieved.

5.19 Equipment Required

Oscilloscope.
1 MHz external frequency standard, with accuracy better than one part in 10^7.

5.20 Procedure

(1) Allow a suitable warm-up period (not less than one hour for a temperature controlled oscillator).

(2) Set the oscilloscope time base to 1 μs/cm.

(3) Connect the 1 MHz external standard to the 'External Trigger' input of the oscilloscope.

(4) Connect the oscilloscope lead to the inner pin of the '1 MHz OUTPUT' socket on the rear panel (Screen to chassis).

(5) Observe the oscilloscope display and check that in a period of 10 seconds not more than one cycle of displayed waveform moves past a fixed point on the oscilloscope face.

(6) If necessary, adjust the oscillator trimmer to obtain a stationary trace. The trimmer is accessible via an aperture in the rear panel, except for a few early models in which the standard oscillator is mounted on the main p.c.b.

DISMANTLING

Removal of Display PCB

5.21 To change a component such as an LED indicator it is necessary to detach the Display Assembly from the front panel, but complete removal should be avoided if possible because of the numerous connections to the main p.c.b.

(1) Disconnect power. Remove covers (para. 5.1).

(2) Remove the carrying handle as follows:-

(a) Insert a suitable tool such as a flat bladed screwdriver into the slot in the boss of each carrying handle and prise off the cap, thus exposing the retaining screws.

(b) Extract the screws which hold the carrying handle to the main frame, and remove the handle.

(3) With the handle removed slide back the short length of coloured metal strip into the space normally occupied by the handle boss. This will allow access to the screws which secure the front panel to the main frame. Remove these screws.

(4) The front panel assembly can now be carefully withdrawn as far as the wiring permits. Take care not to damage the flexible wiring connector to the main p.c.b. when withdrawing and re-fitting.

(5) To detach the Display Assembly:-

(a) Remove the knob from the SENSITIVITY control.
(b) Unsolder the earth connection and input capacitor connection at the 'B' input socket, and the START/STOP switch connection.
(c) Remove the four Pozidriv screws which secure the p.c.b. to the front panel. The p.c.b. can now be detached from the panel.
(d) For complete removal, unsolder the connections to the main p.c.b., noting the colour coding.

Removal of Main PCB

5.22 Due to excellent accessibility for servicing, removal of the main p.c.b., will rarely be necessary. It can be withdrawn either from the front or the rear. The rear panel method is described below.

(1) Completely remove the two screws which are referred to in cover removal (paragraph 5.1).

(2) Remove the covers and withdraw the rear panel as far as the wiring permits.

(3) Unsolder the wiring between rear panel items and main p.c.b.

(4) Unsolder the connections between the main p.c.b. and the regulator transistor on the side frame, and the rectifier on the rear panel.

NOTE: If preferred the transistor and rectifier can remain connected to the p.c.b. and be unscrewed from their mountings, but these items are not supplied with a replacement p.c.b.

(5) Carefully unsolder the 33-way flexible wiring. If this needs to be renewed the Part No. is 25-6027.

(6) Remove the three Pozidriv screws which secure the p.c.b. to the main frame, and slide out the p.c.b. towards the rear.

Replacement of Main PCB

5.23 (1) Fit and secure the main p.c.b.

(2) Refit the rear panel. Solder the connections, and secure the transistor Q50 the side frame and rectifier D50 to the rear panel.

(3) Refit the two screws in the side members.

(4) Refit the covers when tests are completed. Replace the rubber plugs over the side panel screws.

FITTING OPTIONAL FREQUENCY STANDARD UNIT

NOTES: 1. Operation (1) applies only to early models. In later models the oscillator is on a separate p.c.b. attached to the inner face of the rear panel.

2. The black plate referred to below is not fitted on early models.

Procedure

5.24 (1) If the discrete component oscillator is mounted on the main p.c.b. (early models) remove link LK1 and crystal XL1 from the p.c.b.

(2) Unsolder the leads from pins 1, 2 and 3 of the discrete component oscillator p.c.b. (later models). Extract the two retaining screws (and spacers) from the rear panel and remove the p.c.b.

(3) Remove the black plate (if fitted) from the rear panel trimming aperture, and retain the screws.

(4) Attach the optional frequency standard unit to the inner face of the rear panel, align the fixing holes in the top of the unit with the rear panel holes and make secure with two M3, 6 mm, screws. (The screws removed with the black plate can be used).

(5) Solder the connecting leads to pins 1, 4 and 7 of the frequency standard base, as shown in the circuit diagram.

(6) If frequency standard Type 9421 is being fitted check that pins 5 and 6 on the base are linked.

(7) Carry out the instrument CHECK procedure to verify satisfactory functioning.

(8) Calibration of the frequency standard must be carried out before operational use. Refer to para. 5.18.

(9) Replace the instrument cover.

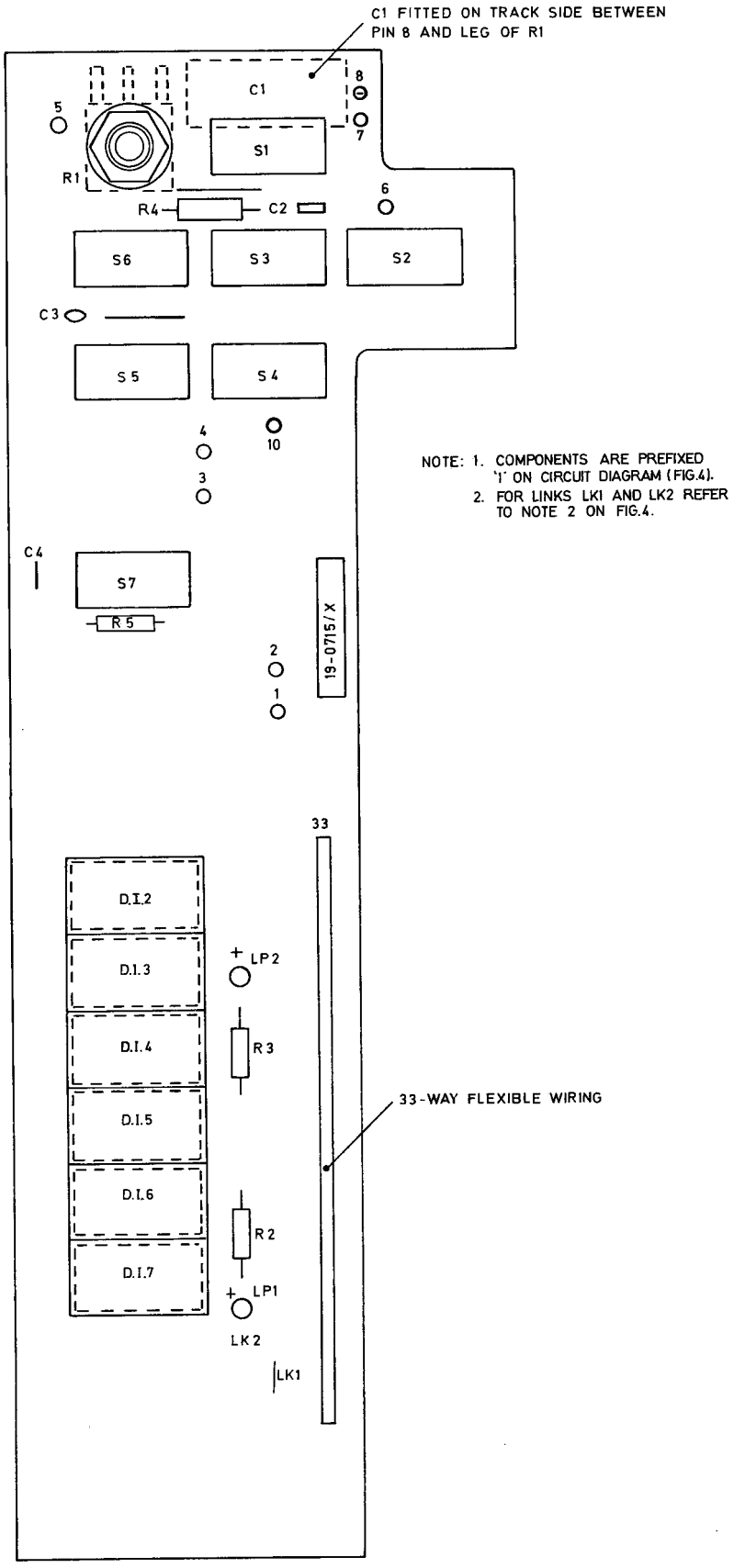
SECTION 3

PARTS LISTS

CIRCUIT DIAGRAMS

AND

COMPONENT LAYOUTS



NOTE: 1. COMPONENTS ARE PREFIXED '1' ON CIRCUIT DIAGRAM (FIG.4).
2. FOR LINKS LK1 AND LK2 REFER TO NOTE 2 ON FIG.4.

NOTE · COMPONENTS ARE PREFIXED '1' ON THE CIRCUIT DIAGRAM (FIG. 4)

Component Layout: Display Assembly 19-0715

Fig.1

WOH 6201/9901	19-0715
1 2 3 4 5	

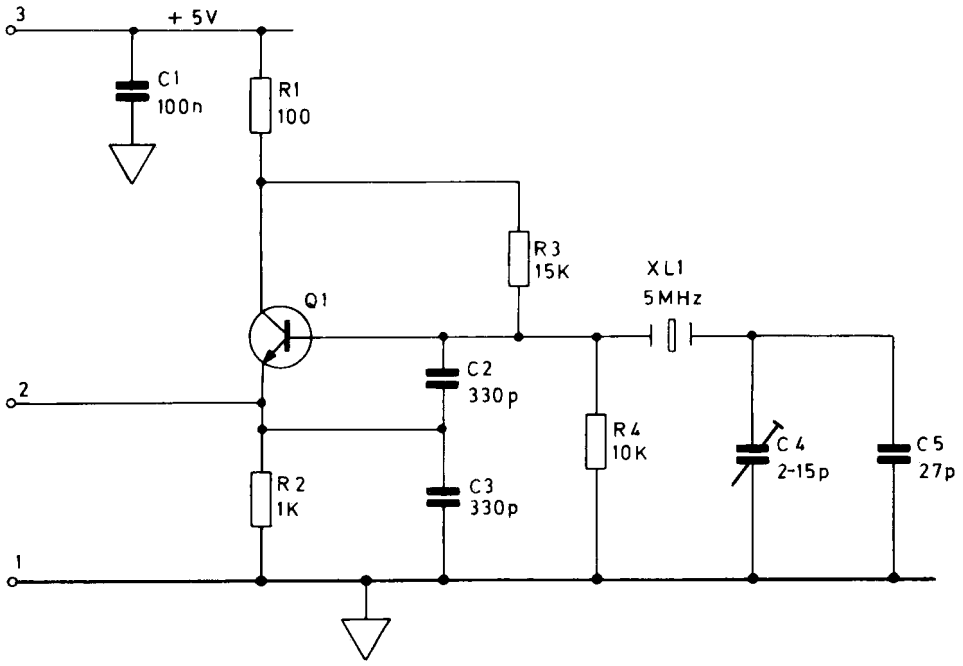
PARTS LIST: DISPLAY ASSEMBLY 19-0715

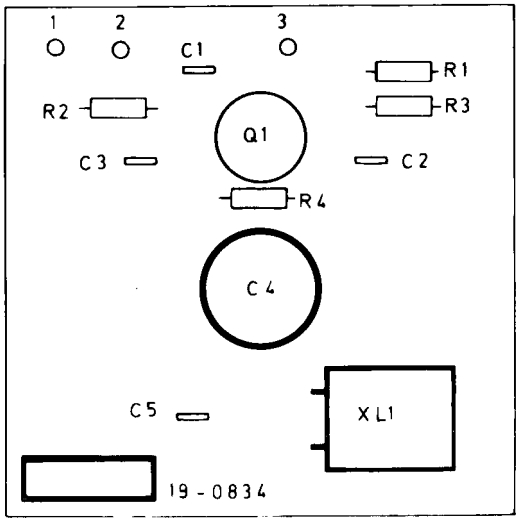
NOTE: Components are prefixed '1' on the circuit diagram (Fig. 4).

Part No.	Description	Rat	Tol %	Value	Component Reference
	Resistors	W		Ω	
20-6627	Variable, log.		20	1M	R1
20-2331	Carbon Film	¼	5	330	R2, R3
20-2221	Carbon Film	¼	5	220	R4, R5
	Capacitor	V		F	
21-4528	Polyester	400	10	47n	C1
21-1616	Ceramic	12	-20+80	100n	C4
21-1708	Ceramic	50	20	100n	C2, C3
	Switches				
23-4081	Slide switches:-				
	AC/DC				1S1
	B-B/B-A				1S2
	Stop Slope				1S3
	Start Slope				1S4
	Check/Operate				1S5
	Pulse/Contact				1S6
	Normal/Hold				1S7
	Indicators				
*	Numerical display, LED, 7-segment				D.1.2 to D.1.7
26-5004	Indicators LED:- Overflow, Gate				LP.1 LP.2
	Miscellaneous				
25-6027	Flexible wiring, 33 way				

* SEVEN SEGMENT DIGITAL INDICATORS

The 7-segment indicators normally fitted have been the Texas TIL312 with long pins (Part No. 26-1505). This version is no longer manufactured but will be available from Racal-Dana Service Department for an indefinite period. It can be recognised by its gold-coloured pins. Later production will be fitted with the short pin version of the TIL312 (Part No. 26-1509) which can be recognised by its silver-coloured pins. The two types are electrically identical, but the customer should specify the correct Part number when ordering a replacement.





WOH 6201	19-0834
1	

Circuit And Layout
5MHz Oscillator PCB 19-0834

Fig. 2

PARTS LIST

5 MHz CRYSTAL OSCILLATOR ASSEMBLY (19-0834)

(Fig. 2)

Part No.	Description	Rat.	Tol %	Value	Component Reference
	Resistors	W		Ω	
20-2101	Carbon Film	$\frac{1}{4}$	5	100	R1
20-2102	Carbon Film	$\frac{1}{4}$	5	1k	R2
20-2103	Carbon Film	$\frac{1}{4}$	5	10k	R4
20-2153	Carbon Film	$\frac{1}{4}$	5	15k	R3
	Capacitors	V		F	
21-1616	Ceramic	12	+80-20	100n	C1
21-2621	Silver Mica	125	5	27p	C5
21-2631	Silver Mica	125	5	330p	C2, 3
21-6030	Trimmer			2-15p	C4
	Transistors				
22-6017	Silicon NPN (2N2369)				Q1
	Crystal				
17-2087	Crystal Assembly, 5 MHz				XL1

PARTS LIST

CHASSIS, FRONT AND REAR PANELS (Fig. 4)

Part No.	Description	Rat	Tol %	Value	Component Reference
CHASSIS ASSEMBLY COMPONENTS (11-1059)					
	Miscellaneous				
21-0575	Capacitor, Electrolytic	16V		4700µ	C101*
22-6081	Transistor, npn, (MJE 520)	25W			Q50
FRONT PANEL COMPONENTS (11-1081)					
	Switches and Sockets				
23-4013	Switch, push-button, START/STOP				S50
23-4065	Switch, toggle, POWER				S51
23-4013	Switch, push-button, RESET				S52
23-3005	Sockets, BNC, Inputs 'A' and 'B'				
	For other switches refer to Display Assembly and Main PCB Assembly parts list.				
REAR PANEL ASSEMBLY COMPONENTS (11-1089)					
17-4057	Transformer, mains				T50
19-0834	Oscillator PCB (refer to Parts List 19-0834)				
22-1650	Bridge rectifier, 200V, 2A (VS 248)				D50
23-0033	Fuselink (188V/265V) 100 mA antisurge				FS50
23-0027	Fuselink (94V/132V) 200 mA antisurge				
23-0044	Fuseholder for FS50				
23-3005	Socket BNC STD input and output				
23-3194	Power Input (Mains) plug, panel mounted				

* C101 is mounted on a side panel

PARTS LIST

MAIN PCB ASSEMBLY 19-0707 (Fig. 4)

Part No.	Description	Rat	Tol %	Value	Component Reference
	Resistors	**W**			
20-4658	Metal Oxide	1	5	100k	R1
20-2106	Carbon Film	¼	10	10M	R2
20-2120	Carbon Film	¼	10	12	R3
20-1532	Carbon Film	10	5	470	R41
20-1538	Carbon Film	10	5	10k	R84
20-2100	Carbon Film	¼	5	10	R96
20-2101	Carbon Film	¼	5	100	*R7,86,89,100
20-2102	Carbon Film	¼	5	1k	R5,6,9,14,58, 65,66,68,103, 109
20-2103	Carbon Film	¼	5	10k	R10,20,22,27 to 30 32,43,54,55,61,64,90, 94,97,113,114,115,
20-2181	Carbon Film	¼	5	180	R26*
* R26 is 'select on test', in the range 150 to 270Ω.					
20-2121	Carbon Film	¼	5	120	R15, 33, 62
20-2122	Carbon Film	¼	5	1.2k	R116
20-2124	Carbon Film	¼	5	120k	R93
20-2150	Carbon Film	¼	5	15	R59,60
20-2152	Carbon Film	¼	5	1.5k	R78,110
20-2182	Carbon Film	¼	5	1.8k	R107
20-2220	Carbon Film	¼	5	22	R119,120
20-2221	Carbon Film	¼	5	220	R21,25,
20-2222	Carbon Film	¼	5	2.2k	R4,101,118
20-2223	Carbon Film	¼	5	22k	R34,45,85
20-2272	Carbon Film	¼	5	2.7k	R91
20-2331	Carbon Film	¼	5	330	R23,37,48,56
20-2332	Carbon Film	¼	5	3.3k	R12,102
20-2392	Carbon Film	¼	5	3.9k	R98,99
20-2470	Carbon Film	¼	5	47	R8,13
20-2471	Carbon Film	¼	5	470	R51,53,112
20-2472	Carbon Film	¼	5	4.7k	R17,24,40,50,87, 121
20-2560	Carbon Film	¼	5	56	R52
20-2561	Carbon Film	¼	5	560	R16,18,35,46
20-2562	Carbon Film	¼	5	5.6k	R38, 44,57,88,95
20-2564	Carbon Film	¼	5	560k	R92
20-2681	Carbon Film	¼	5	680	R19
20-2682	Carbon Film	¼	5	6.8k	R39,49
20-2820	Carbon Film	¼	5	82	R80
20-2821	Carbon Film	¼	5	820	R36,47,117
20-3820	Metal Oxide	½	5	82	R108
20-4094	Metal Oxide	¼	1	6.8k	R106
20-4103	Metal Oxide	¼	1	1.2k	R104
20-4107	Metal Oxide	¼	1	5.6k	R105
20-4668	Metal Oxide	1	5	33	R111
20-5064	Wirewound	2½	5	680	R31,42
20-6544	Variable, linear	½W	20	3.3k	R11

Part No.	Description	Rat	Tol %	Value	Component Reference
	Resistor Arrays				
20-5503	D.I.L. Array 13 x 10k				R63
20-5502	D.I.L. Array 13 x 1k				R76
20-5501	D.I.L. Array 8 x 220				R77
20-5500	D.I.L. Array 7 x 56				R83
	Capacitors	**V**		**F**	
21-1039	Tantalum	16	20	22µ	C4, 55
21-0566	Electrolytic	25		1000µ	C54
21-1513	Ceramic	500	10	27p	C30
21-1000	Tantalum	35	20	3.3µ	C16,21,23,44,46
21-1038	Tantalum	6	20	47µ	C3,8,15,26,48, 49,50,51,52 58,59,60
21-1048	Tantalum	35	20	2.2µ	C56
21-1512	Ceramic	500	10	22p	C13
21-1514	Ceramic	500	10	33p	C14
21-1516	Ceramic	500	10	47p	C19,
21-1524	Ceramic	500	10	220p	C9
21-1525	Ceramic	500	10	270p	C1
21-1532	Ceramic	500	20	1n	C27,32,45
21-1538	Ceramic	500	20	3.3n	C42
21-1589	Ceramic	10	+50 -20	220n	C28
21-1616	Ceramic	12	-20 +80	100n	C2,5,6,10,11, 12, 17,18,25, 29,38,41,43, 47
21-1616	Ceramic	500	10	68p	C22
	Diodes				
22-1029	Silicon, general purpose (1N4149)				D1,3,4,7,8 15,16,17,18
22-1602	Rectifier, 100V.5A (1N4002)				D11,12,13,14
22-1805	Voltage reg. 3.9V	5%			D9
22-1808	Voltage reg. 5.1V	5%			D2,10

* R7 is fitted if required by test

MAIN PCB ASSEMBLY 19-0707 (Continued)

Part No.	Description	Rat	Tol %	Value	Component Reference
	Integrated Circuits				
22-4044	Quad 2-Input Pos. NAND Gate (7400)				IC3,15
22-4051	Quad latch (7475)				IC7
22-4048	Dual-D Bistable (7474)				IC9
22-4049	Decade Counter				IC10
22-4053	Triple 3 Input Pos. NAND Gate (7410)				IC6,18
22-4123	BCD to 10 Line Decoder (74145)				IC16
22-4059	Hex. Inverter (7404)				IC1,8,14
22-4061	Hex. Inverter Open Collector O/P (7405)				IC12,13
22-4128	BCD to 7-Segment Decoder (74247)				IC17
22-4202	Dual Freq. Comparator Op. Amp (747)				IC5
22-4207	Differential Video Amp. (72733)				IC21
22-4517	Quad I/P Exclusive OR Gate (7486)				IC11,19
22-4527	Dual Line Receiver (75107A)				IC22
22-4537	Retriggerable Monostable*				IC4
22-4601	CDI LSI				IC2

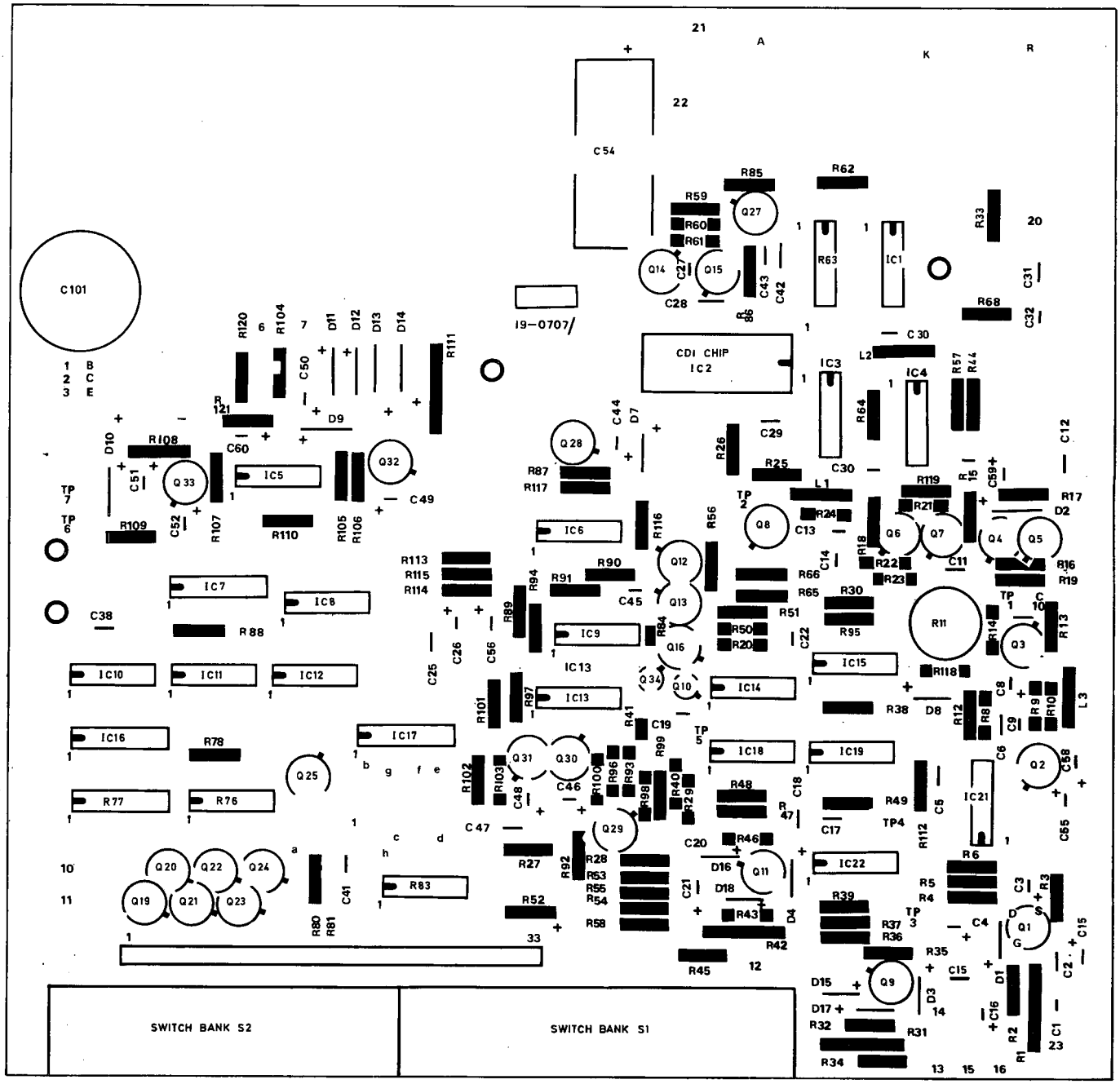
* Only Texas Instruments 74123N to be used

Part No.	Description	Rat	Tol %	Value	Component Reference
	Transistors				
22-6101	FET, N Channel (W300A)				Q1
22-6009	Silicon, npn (2N4124)				Q3,27
*22-6079	Silicon, npn (ZTX313L)				Q2,4,5,6,7, 8,10,12,13,15, 25,28,31,34
22-6010	Silicon, pnp (2N4126)				Q9,11
22-6113	Silicon, pnp (ZTX 550)				Q14,16,19,20, 21,22,23,24, 29,30,33
22-6112	Silicon, npn (ZTX 450)				Q32
	Inductors				
23-7007	Inductor			0.68µH	L1
23-7056	Inductor			100 µH	L2
23-7107	Inductor			470 µH	L3
	Switches				
23-4077	Switch bank, Function				S1
23-4078	Switch bank, Time Base				S2
	Miscellaneous				
23-3213	IC Holder for IC2				

*Except for Q8, type 2N2369 (22-6017) is alternative

AMENDMENT INFORMATION

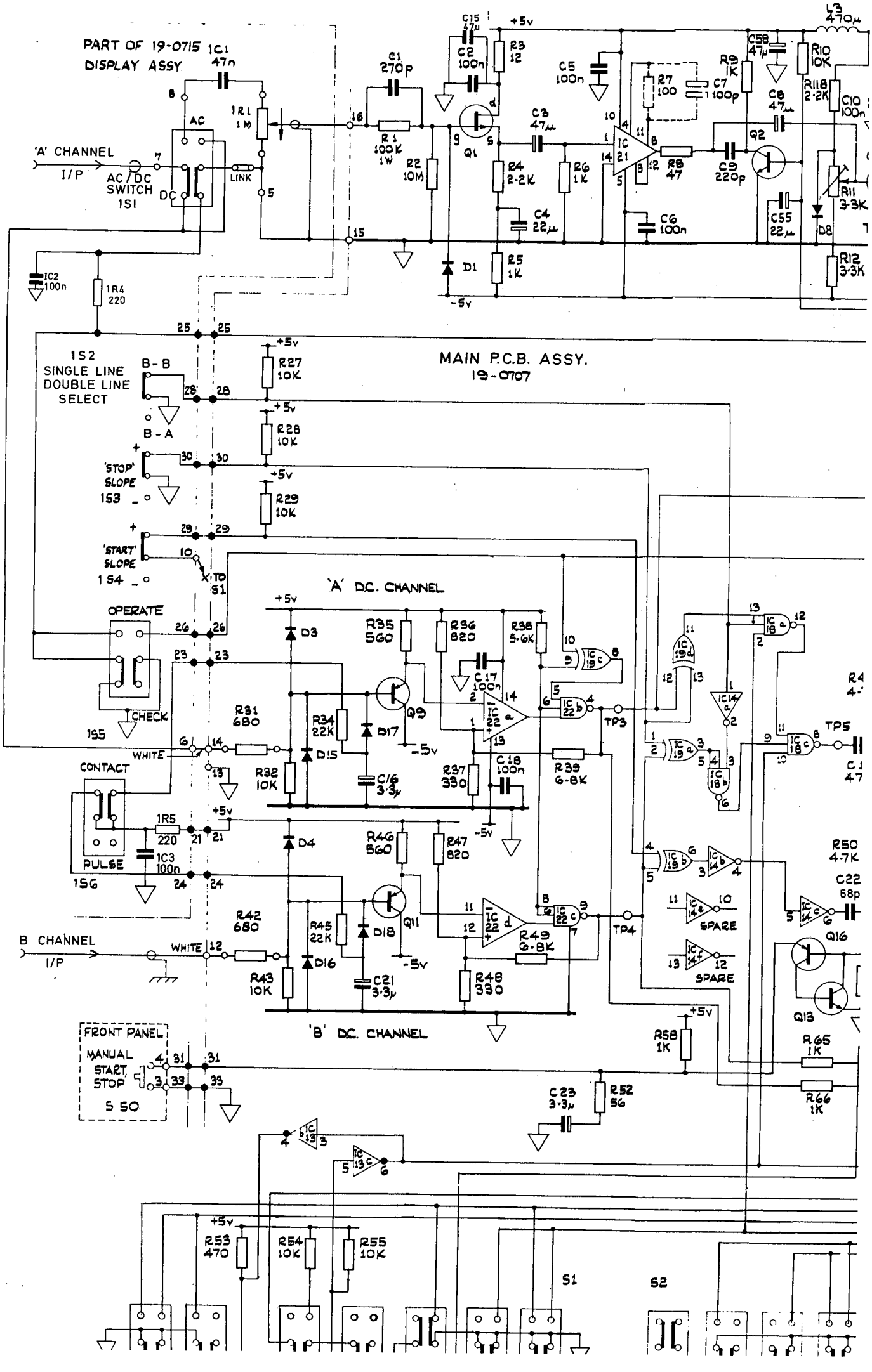
Check with Section 4 at the back of the book for change information.

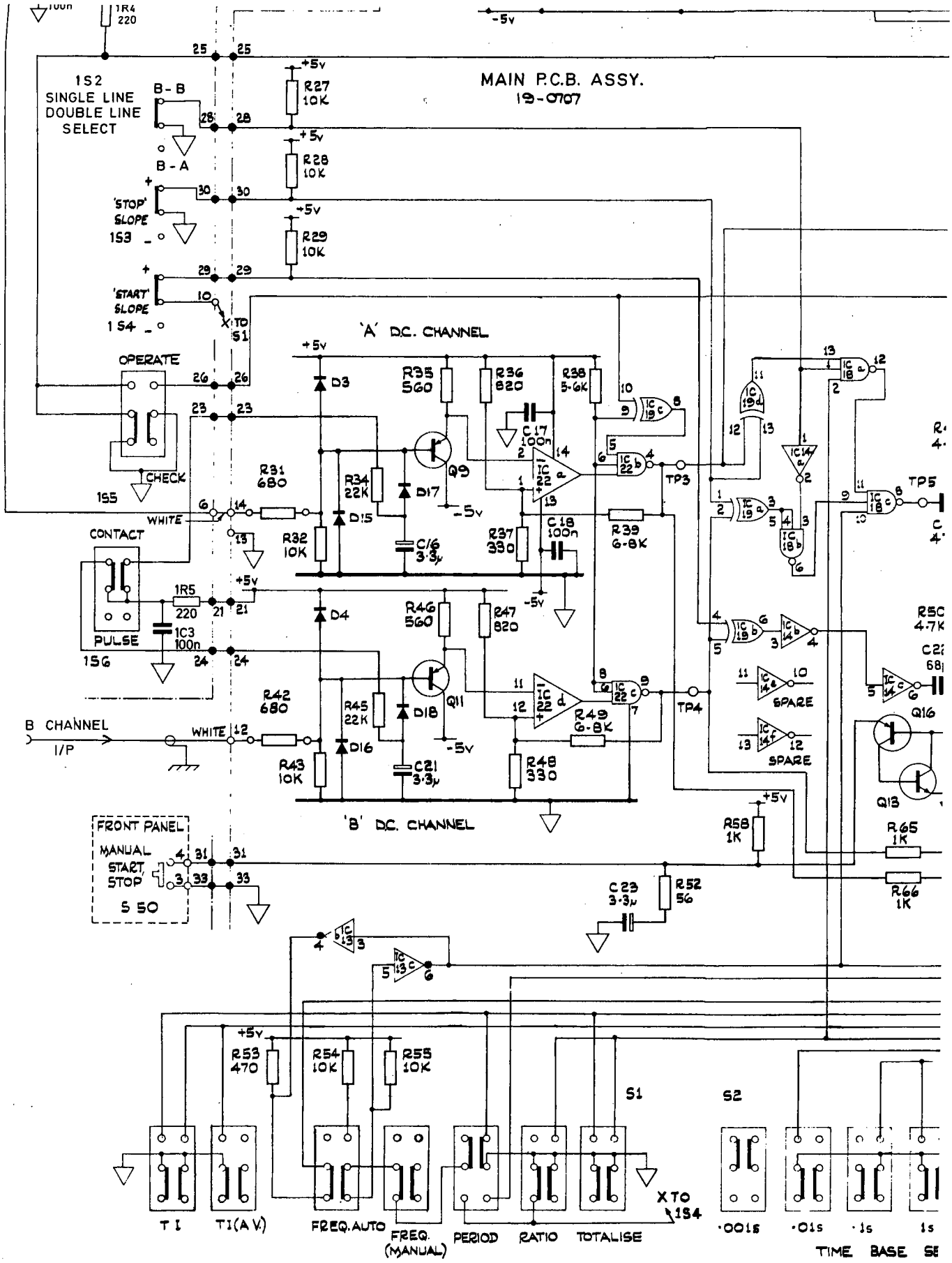


WOH 6021/9901 | 19-0707
1 | 2 | 3 | 4 |

Component Layout: Main P.C.B. Assembly 19-0707

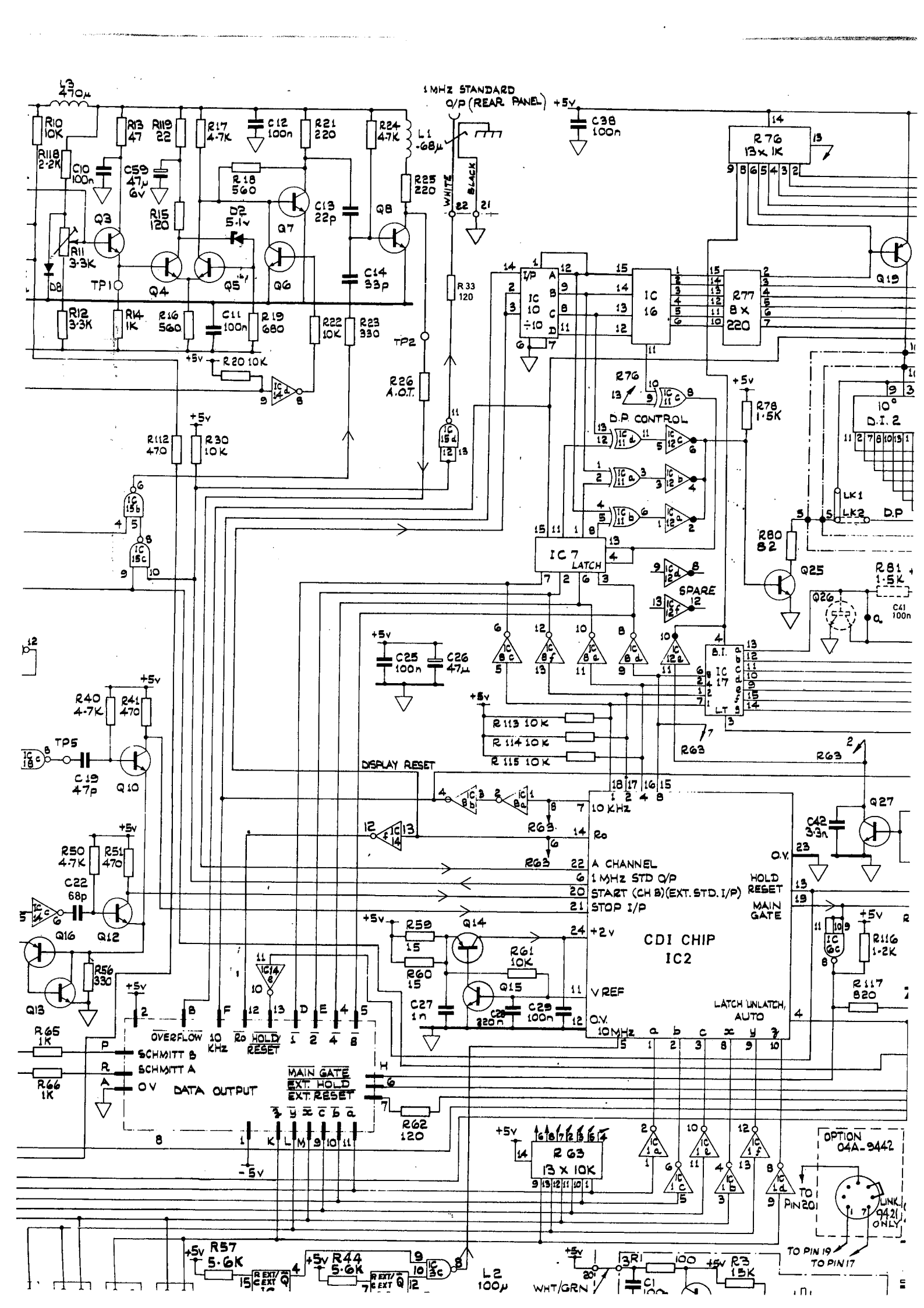
Fig.3

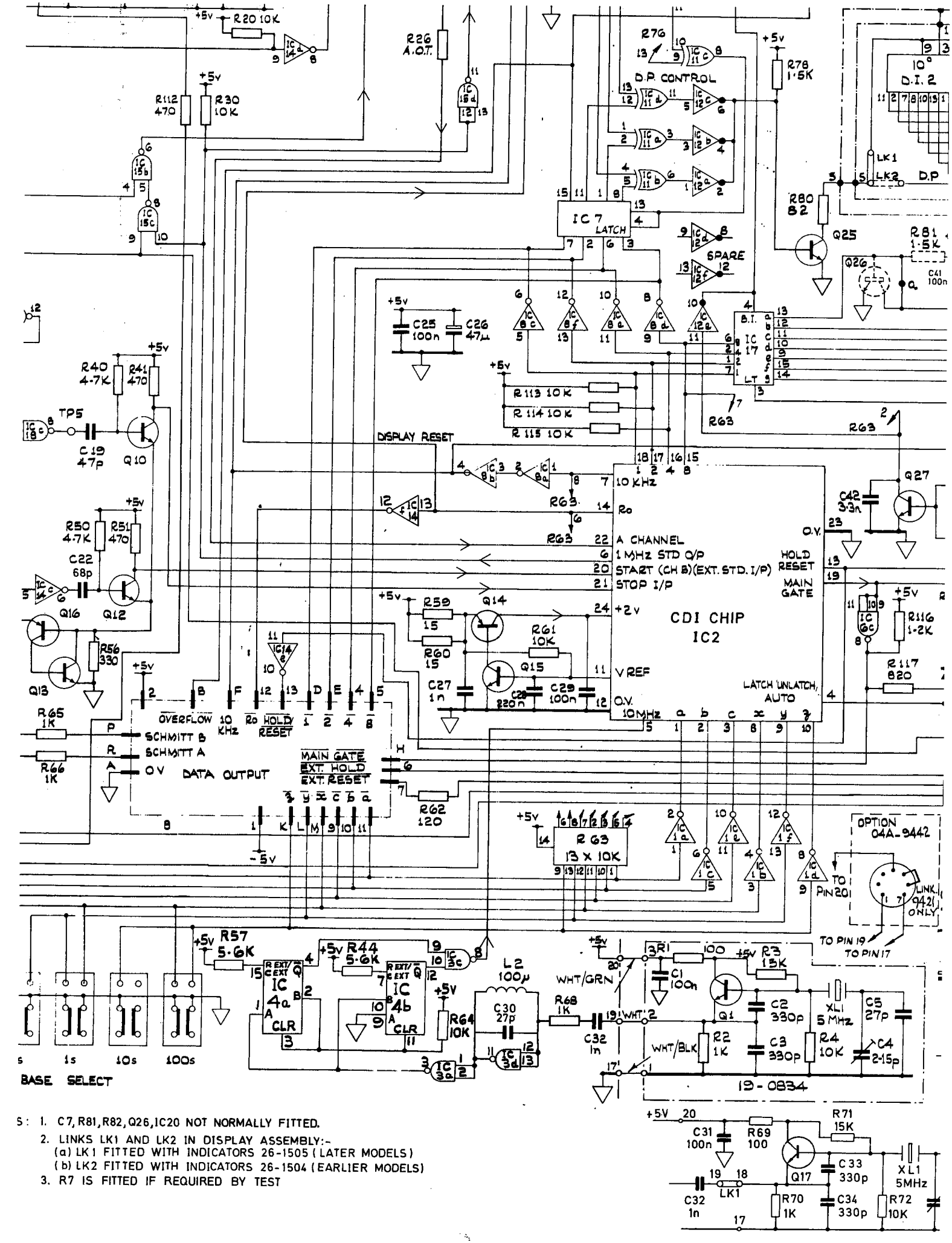

PART OF 19-0715 DISPLAY ASSY
MAIN P.C.B. ASSY. 19-0707
'A' CHANNEL I/P
AC/DC SWITCH 1S1
AC
DC
LINK
1S2 SINGLE LINE DOUBLE LINE SELECT
B-B
B-A
'STOP' SLOPE 1S3
'START' SLOPE 1S4
TO S1
OPERATE
CHECK 1S5
CONTACT
PULSE 1S6
WHITE
B CHANNEL I/P
FRONT PANEL
MANUAL START STOP S 50
'A' D.C. CHANNEL
'B' D.C. CHANNEL
SPARE
SPARE
S1
S2
C1 270p
C2 100n
C3 47µ
C4 22µ
C5 100n
C6 100n
C7 100p
C8 47µ
C9 220p
C10 100n
C15 47µ
C17 100n
C18 100n
C21 3·3µ
C22 68p
C23 3·3µ
C55 22µ
C58 47µ
L3 470µ
R1 100K 1W
R2 10M
R3 12
R4 2·2K
R5 1K
R6 1K
R7 100
R8 47
R9 1K
R10 10K
R11 3·3K
R12 3·3K
R27 10K
R28 10K
R29 10K
R31 680
R32 10K
R34 22K
R35 560
R36 820
R37 330
R38 5·6K
R39 6·8K
R42 680
R43 10K
R45 22K
R46 560
R47 820
R48 330
R49 6·8K
R50 4·7K
R52 56
R53 470
R54 10K
R55 10K
R58 1K
R65 1K
R66 1K
R118 2·2K
Q1
Q2
Q9
Q11
Q13
Q16
D1
D3
D4
D8
D15
D16
D17
D18
IC 21
IC 22 a
IC 22 b
IC 22 c
IC 22 d
IC 19 a
IC 19 c
IC 19 d
IC 18 a
IC 18 b
IC 18 c
IC 14 a
IC 14 b
IC 14 c
IC 14 e
IC 14 f
IC 13 a
IC 13 c
TP3
TP4
TP5



IC REF	+5V PIN	0V PIN	-5V PIN
IC1, 3, 6, 8, 9, 11, 12, 13, 14, 15, 18, 19	14	7	
IC 5	9, 13	–	–
IC 7	5	12	–
IC10	5	10	
IC16, 17, IC4	16	8	
IC 21	10		5
IC 22	14	7	13

NOTES: 1. C7,
2. LIN
(a) I
(b) I
3. R7

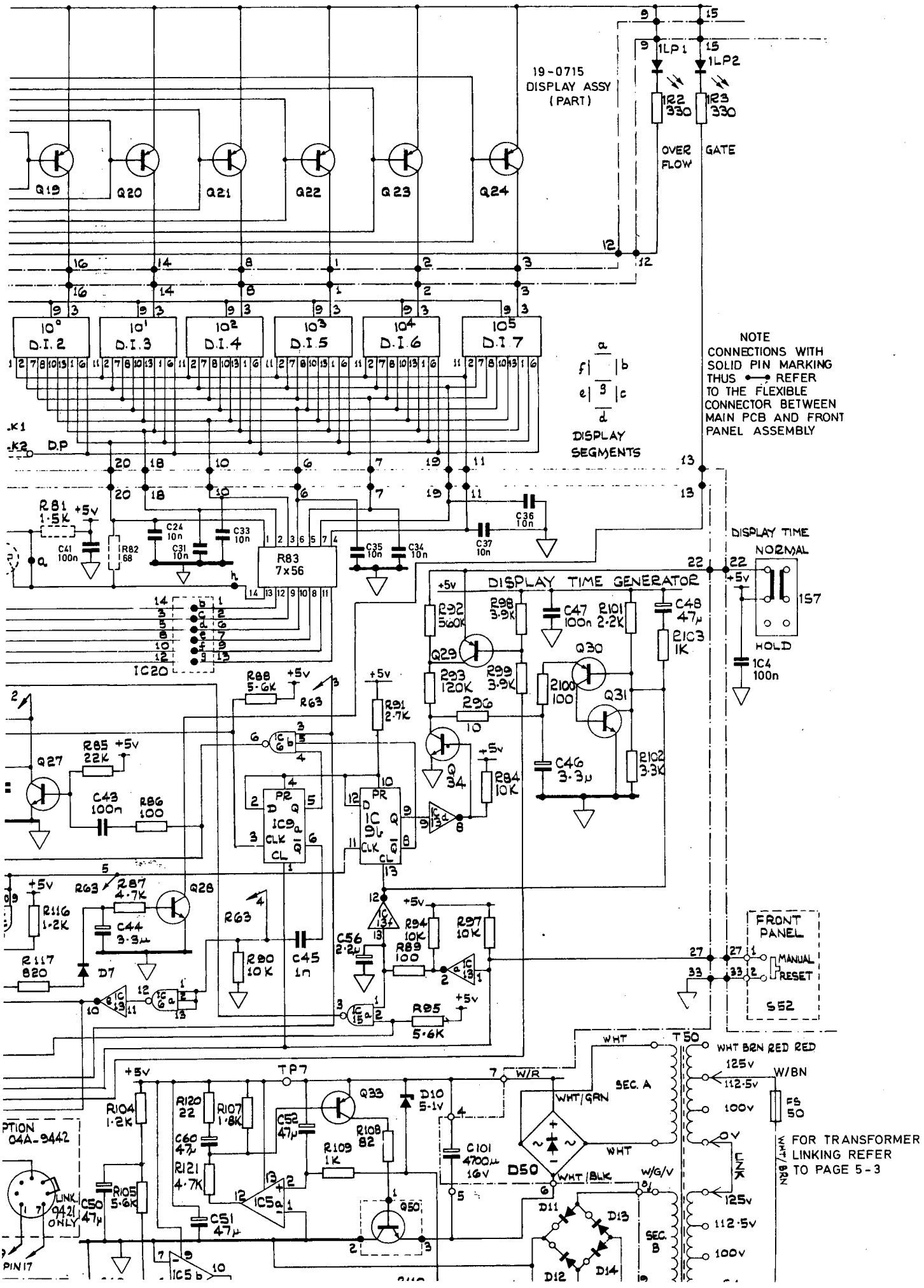

L3 470µ
1MHz STANDARD O/P (REAR PANEL)
+5v
C38 100n
R10 10K
R13 47
R119 22
R17 4.7K
C12 100n
R21 220
R24 4.7K
L1 .68µ
WHITE
BLACK
R118 2.2K
C10 100n
C59 47µ 6v
R18 560
R25 220
R15 120
D2 5.1v
C13 22p
Q8
Q3
Q7
R11 3.3K
Q4
Q5
Q6
C14 33p
D8
TP1
R33 120
R12 3.3K
R14 1K
R16 560
C11 100n
R19 680
R22 10K
R23 330
TP2
R20 10K
R26 A.O.T.
IC 10 ÷10
IC 16
R77 8 X 220
R76 13x 1K
Q19
R78 1.5K
D.P. CONTROL
10° D.I. 2
LK1
LK2
D.P
R112 470
R30 10K
IC 7 LATCH
SPARE
R80 82
Q25
R81 1.5K
Q26
C41 100n
C25 100n
C26 47µ
B.I.
IC 17 LT
R113 10K
R114 10K
R115 10K
R63
DISPLAY RESET
R40 4.7K
R41 470
TP5
C19 47p
Q10
10 KHz
Ro
A CHANNEL
1 MHz STD O/P
START (CH B)(EXT. STD. I/P)
STOP I/P
HOLD RESET
MAIN GATE
O.V.
C42 3.3n
Q27
R50 4.7K
R51 470
C22 68p
Q16
Q12
Q13
R56 330
R59 15
Q14
R60 15
R61 10K
Q15
+2v
VREF
O.V.
10MHz
CDI CHIP
IC2
LATCH UNLATCH, AUTO
C27 1n
C28 220n
C29 100n
R116 1-2K
R117 820
R65 1K
R66 1K
SCHMITT B
SCHMITT A
O V
DATA OUTPUT
OVERFLOW
10 KHz
Ro
HOLD RESET
1 2 4 8
MAIN GATE
EXT. HOLD
EXT. RESET
R62 120
R63 13 X 10K
OPTION 04A-9442
TO PIN20
LINK (9421 ONLY)
TO PIN 19
TO PIN 17
R57 5.6K
R44 5.6K
L2 100µ
WHT/GRN
R1 100
R3 15K
C1

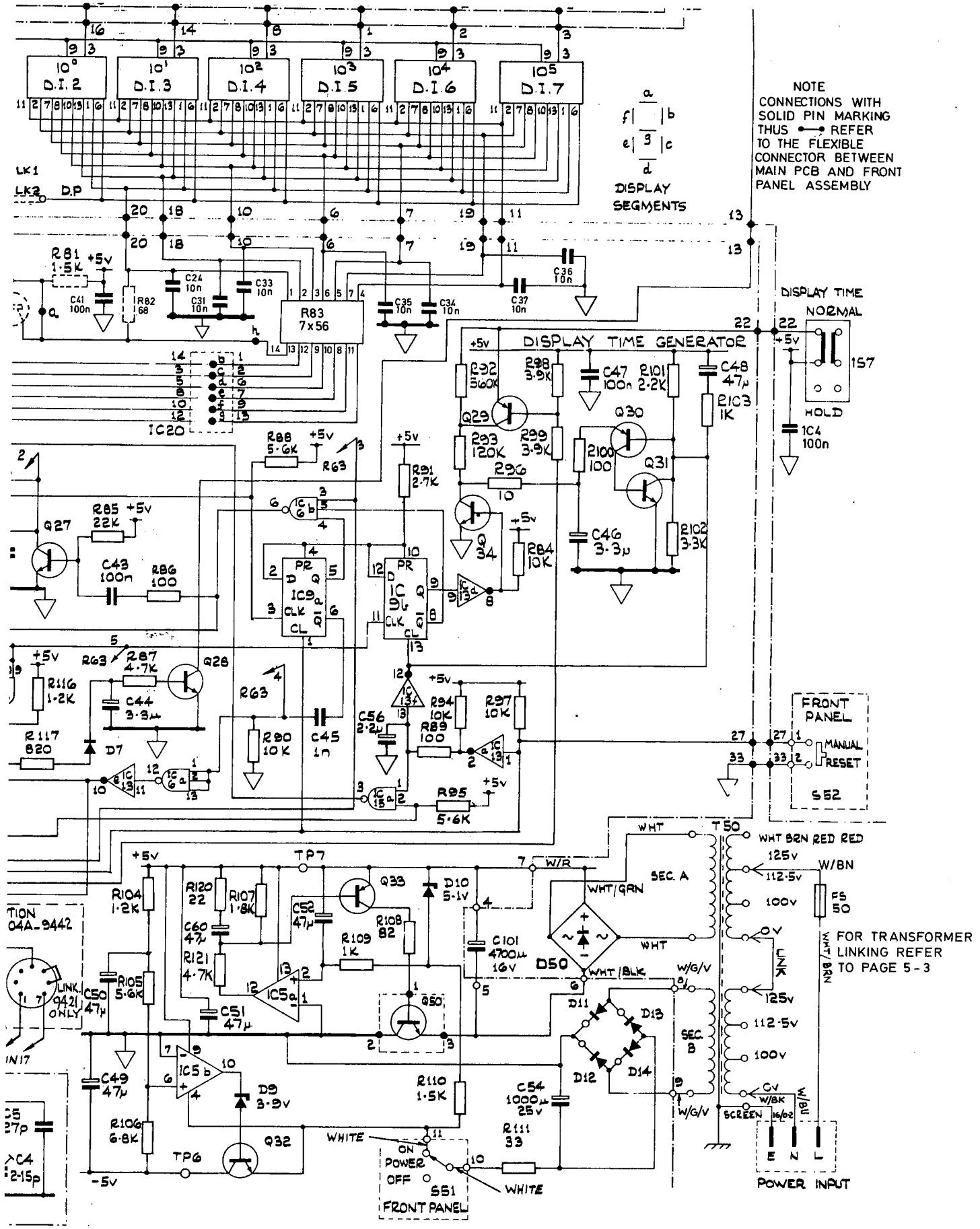


S: 1. C7, R81, R82, Q26, IC20 NOT NORMALLY FITTED.

2. LINKS LK1 AND LK2 IN DISPLAY ASSEMBLY:-
   (a) LK1 FITTED WITH INDICATORS 26-1505 (LATER MODELS)
   (b) LK2 FITTED WITH INDICATORS 26-1504 (EARLIER MODELS)

3. R7 IS FITTED IF REQUIRED BY TEST


19-0715
DISPLAY ASSY
(PART)
1LP1
1LP2
R122 330
R123 330
OVER FLOW
GATE
Q19
Q20
Q21
Q22
Q23
Q24
10⁰ D.I.2
10¹ D.I.3
10² D.I.4
10³ D.I.5
10⁴ D.I.6
10⁵ D.I.7
D.P
DISPLAY SEGMENTS
NOTE
CONNECTIONS WITH SOLID PIN MARKING THUS ●— REFER TO THE FLEXIBLE CONNECTOR BETWEEN MAIN PCB AND FRONT PANEL ASSEMBLY
R81 1·5K
C41 100n
R82 68
C24 10n
C31 10n
C33 10n
R83 7x56
C35 10n
C34 10n
C36 10n
C37 10n
IC20
DISPLAY TIME
NORMAL
HOLD
157
C48 47µ
C104 100n
DISPLAY TIME GENERATOR
R92 560K
R98 3·9K
C47 100n
R101 2·2K
R103 1K
Q29
Q30
Q31
R93 120K
R99 3·9K
R96 10
R100 100
C46 3·3µ
R102 3·3K
Q34
R84 10K
R88 5·6K
R91 2·7K
R63
IC 9µ
R85 22K
C43 100n
R86 100
Q27
R87 4·7K
Q28
R116 1·2K
C44 3·3µ
R117 820
D7
R90 10K
C45 1n
C56 2·2µ
R89 100
R94 10K
R97 10K
R95 5·6K
FRONT PANEL
MANUAL RESET
S52
T50
WHT
WHT BRN RED RED
125v
112·5v
100v
0V
W/BN
FS 50
SEC. A
SEC. B
WHT/GRN
WHT/BLK
W/G/V
D50
D10 5·1V
C101 4700µ 16V
Q33
R104 1·2K
R120 22
R107 1·8K
C52 47µ
R108 82
R109 1K
C60 47µ
R121 4·7K
C50 47µ
R105 5·6K
C51 47µ
IC5a
IC5b
Q50
D11
D13
D12
D14
TP7
W/R
OPTION 04A-9442
LINK 9421 ONLY
PIN 17
FOR TRANSFORMER LINKING REFER TO PAGE 5-3



Overall Circuit 9901 Fig. 4

SECTION 4

APPENDICES

AND

CHANGE INFORMATION

OPTION 01

SERIAL TO PARALLEL INTERFACE UNIT

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TABLES

Table 1 Flying Lead Connections
Table 2 50 way Connector

SERIAL TO PARALLEL INTERFACE UNIT

OPTION 01

INTRODUCTION

1. The interface comprises a metal box, measuring approximately 132 x 95 x 36mm containing the p.c.b assembly 19-0851. Connections are made to printer or data display via a 50-way fixed socket and to the '99' instrument via a flying lead fitted with a 28-way edge connector. The unit is designed to operate with the following Racal counters, referred to in this description as the '99' series'

Frequency Meters		Universal Counter Timers (UCT)	
9911	9912	9901	9902
9913	9914	9903	9904
9915	9916	9905	9906
9917	9917A		9908
9919			

2. Definition of Terms

(1) Hold Signal : a signal returned by the users equipment to the interface for control purposes.

(2) Print Command : a signal output by the interface to indicate that new measurement information is available.

(3) Print Hold input : An input which allows the user's Hold Signal to prevent the parallel information from changing.

(4) Hold/Reset input : An input which allows the user's signal to prevent the parallel information from changing and which resets the instrument when the Hold Signal returns to its normal state, thus starting a new measurement.

(5) Hold Control : An input to the interface which determines the mode of operation.

FUNCTION

3. The function of the Interface Unit is to convert the serial b.c.d. data output from a '99 series' counter to a static parallel form, suitable for driving a printer, data display or processing equipment.

4. The parallel output data is updated at the end of each gate time unless the printer (or other data processing equipment) is applying a Hold Signal. In addition to measurement data the interface also transfers information on decimal point position, selected range (gate time) and the 'overflow' state of the counter display. Information supplied is for 8 digits (excluding decimal point data) on all units except the 9917 which supplies information for 9 digits.

5. Fig. A1. shows the sequence of events which occurs at the end of the gate time. Note that when using counters 9911 and 9919 all timings are doubled, except the print command pulse width.

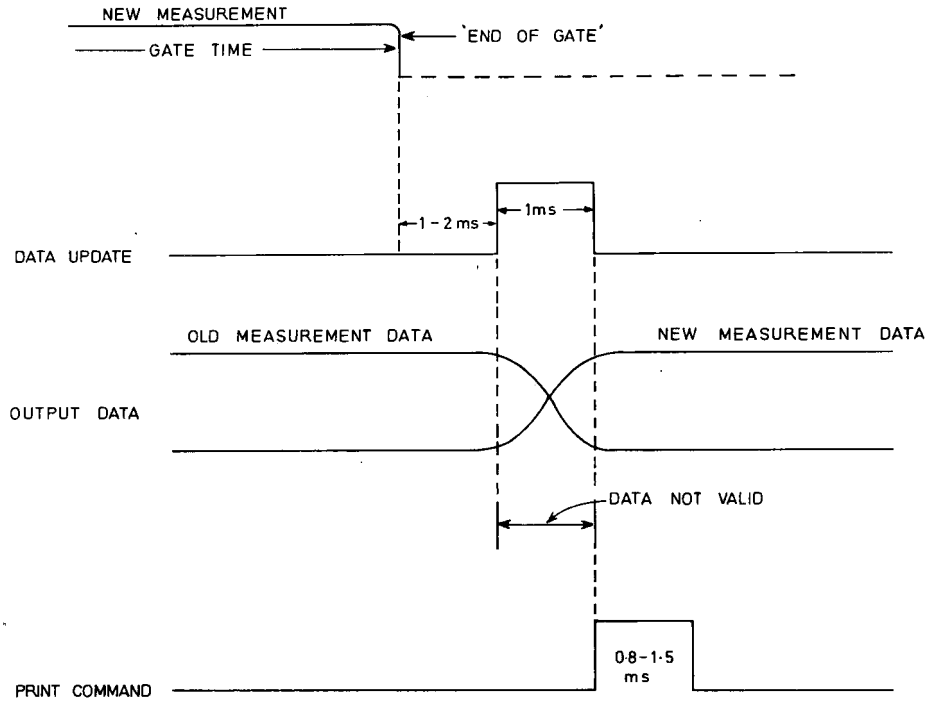


Fig. A1

CONNECTION

6. Before connecting the Interface Unit to the counter refer to the modes of operation in paras 8 to 18 and make the necessary changes to the 50-way connection or 28-way flying lead, according to the type of counter in use and the required function. All changes on the 50-way connection should be made at the customers connector.

7. Having checked the appropriate connection changes in paras 8 to 18, the interface should be connected up as follows:-

(1) Remove the black plate which covers the DATA OUTPUT aperture on the rear panel of the counter. Retain the two screws.

(2) Slacken off the cable clamp on the metal cover on the cable of the flying lead, and push the cover away from the connector.

(3) Plug the flying lead connector into the Data Output edge connector in the counter, noting the keyway which ensures correct orientation.

(4) To minimise r.f. radiation interference, the metal cover on the cables

(4) should be placed over the edge connector and held into place by the two screws which originally secured the cover plate removed in (1). The cable clamp should then be tightened.

(5) Connect the interface unit to the data processing equipment via the fixed 50-way socket.

MODES OF OPERATION

REMOTE DISPLAYS

Connections

8. If the interface is required to drive a remote display, or such other equipment that does not require the data to be held for a period longer than the gate time, check the following pin conditions on the 50-way connector:-

Pin No.	Required Connection
19	Must be either open circuit
24	or connected to OV.
49	

Latched Operation

9. The display is latched and is updated at the end of each gate time, irrespective of the counter function.

Unlatched Operation

10. (1) If the interface Unit is connected to a genuine remote display the subjective result is that the display will appear to follow the counter , for both latched and unlatched counter modes.

(2) The data outputs will be updated every 3 to 4 ms.

(3) The blue wire 'H' on the 28-way flying lead connector should be disconnected and reconnected to 'F' together with the violet wire. For other applications refer to paras 16 to 18.

USING EQUIPMENT WHICH PROVIDES HOLD SIGNALS

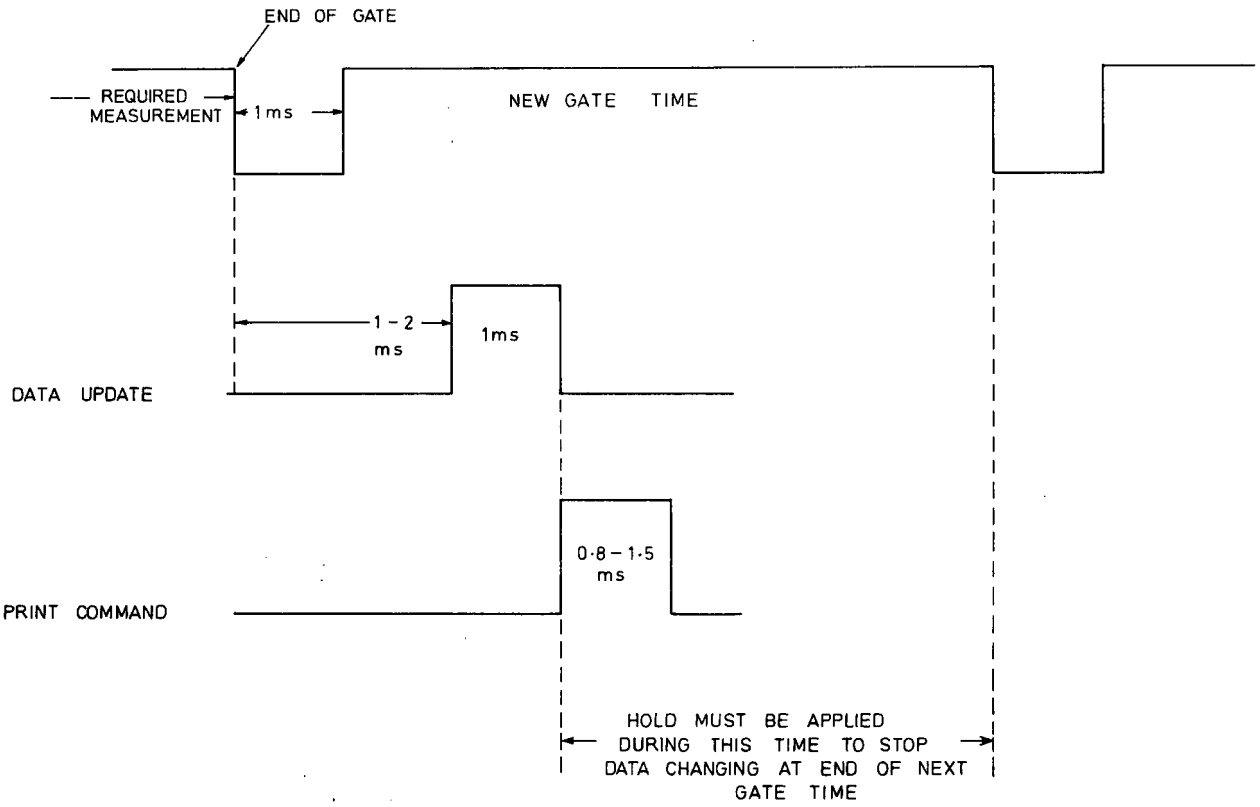
11. Differing instructions apply, depending on whether the counter is a frequency meter or universal counter timer (UCT) as described in paras 12 to 15.

Frequency Meters - Normal Use

12. (1) Check the following pin connections on the 50 way connector:-

Pin No.	Required Connection
19 and 24	Open Circuit, or connected to OV
49	Connected to the Hold signal

(2) The Hold signal (logic level '1' to hold) should be applied to the interface after receiving the Print Command signal, but before the end of the next gate time (ie 7 ms for 10 ms gate time), and should remain at logic level '1' for the period that the information on the data output is required to remain unchanged. Although the outputs from the interface will remain unchanged whilst a Hold is applied, the counter continues its normal measurement sequence, i.e. 'free run'. This has the advantage that the next Print Command will be given at the end of the gate time immediately following the release of the Print Hold. This result in a more rapid measurement sequence. From Fig. A2. it can be seen that a Print Command signal occurs 3 to 4 ms after an end of gate, by which time the gate time for a new measurement will have commenced. *



* NOTE: In the 9919 the timings are double those in Fig.A2

Fig. A2

Universal Counter Timers (UCT's) - Basic Hold Requirements

13. The measurement cycle of the 99 series of UCT's has two distinct phases; the Gate Time during which the measurement is made, and the Display Time during which the results are displayed. If the hold time required by the equipment to which the interface is connected is less than the display time, the remainder of the display time is effectively wasted. The interface can be used to shorten the display time, but in so doing the counter display is reset, which may not be convenient. For this reason the interface can be used with UCT's in two modes, the Print Hold and the Hold/Reset modes, as described in paras 14 and 15. It should be noted that, with UCT's, the interface will not produce a data change or Print Command signal from the operation of a front panel RESET control.

UCT's Using Print Hold Mode

14. In the Hold/Reset mode the Hold signal extends the display time indefinitely the next gate time commencing when the Hold is released or when the normal display period has ended, whichever period is the longer. The Hold signal must be applied within the display time period in order to halt the measurement cycle. The required pin connections on the 50 way connector are as follows:-

Pin No.	Required Connection
Pin 19	Connected to Pin 50 (or to 5V via 180Ω)
Pin 49	Connected to the Hold signal source
Pin 24	To be open circuit or connected to OV

UCT's Using Hold/Reset Mode

15. In the Hold/Reset mode the Hold signal (minimum width 5 ms) extends the display time indefinitely, but when it is released the counter display resets and a new measurement commences. This result in a more rapid measurement sequence, again the Hold signal must be applied within the display time period in order to halt the measurement cycle. The required pin connections on the 50-way connector are as follows:-

Pin No.	Required Connection
Pin 19	Connected to pin 50 (or to 5V via 180Ω)
Pin 24	Connected to the Hold signal source
Pin 49	To be open circuit or connected to OV

SPECIAL APPLICATIONS

Remote Display-Special Applications

16. When used in the unlatched mode with certain types of equipment other than remote displays (for example a digital comparator) there is a limit to the maximum possible counting rate. Therefore the reading for which the comparator is looking could be missed, i.e. there is a maximum update rate for the option of 3-4 ms. This corresponds to an input frequency of 200 Hz (N=1) on Totalize mode and a maximum resolution of 10ms on Time Interval mode. The counting rate can be increased if a degree of overshoot can be tolerated.

The maximum overshoot that will occur is given by:-

$$\text{Counting Rate} \times 4 \times 10^{-3} \text{ counts.}$$

It is advisable to use the Print Command as a 'data valid' signal in such systems.

Frequency Meters - Special Applications

17. In some applications it is not possible to use the interface in the manner described in Para 12. For example, in control systems, where the output of the interface is used as feedback to the device on the input of the counter, problems arise because the next gate time has already started before the information becomes available from the previous one. Therefore, even if the feedback correction is made almost instantly, the reading at the end of the next gate time will be incorrect. Alternatively, if the correction process takes more than one gate time, the end of gate time immediately following the process will also give incorrect results. These problems may be overcome by applying a Hold signal to the Print Hold input (pin 49) for the length of time that the correction takes, plus an additional time to ensure that the gate time from which the next data is to be taken cannot start until the correction process has been completed, as shown in Fig. A3.

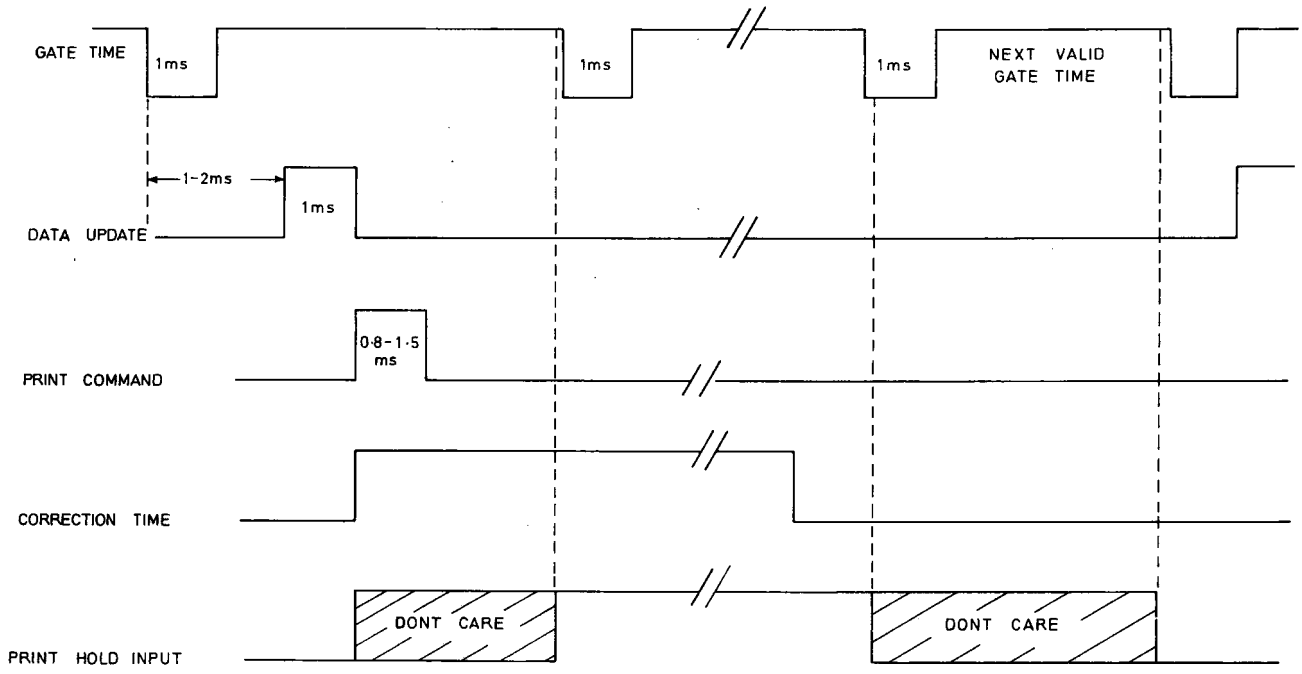


Fig. A3

18. An alternative to para 17, particularly when fast cycle times are desired, is to connect the Hold signal to the Hold/Reset input. If this is done, a stretched version must additionally be applied to the print Hold input (pin 49). The Hold signal should be at least as long as the correction process, and the signal applied to the Print Hold input should be approximately 200μs longer than that applied to the Hold/Reset input. This is to prevent the interface responding to the end of gate time produced by the reset. For cases where the correction time is short (less than the Print Command pulse width) this may be implemented by linking the Print Command output (pin 48) to the Hold/Reset input (pin 24) and by applying a stretched version of the Print Command to the Print Command to the Print Hold input (pin 49). In this way cycle times as short as 'Gate Time + 5ms' can be achieved. This is illustrated in Fig. A4.

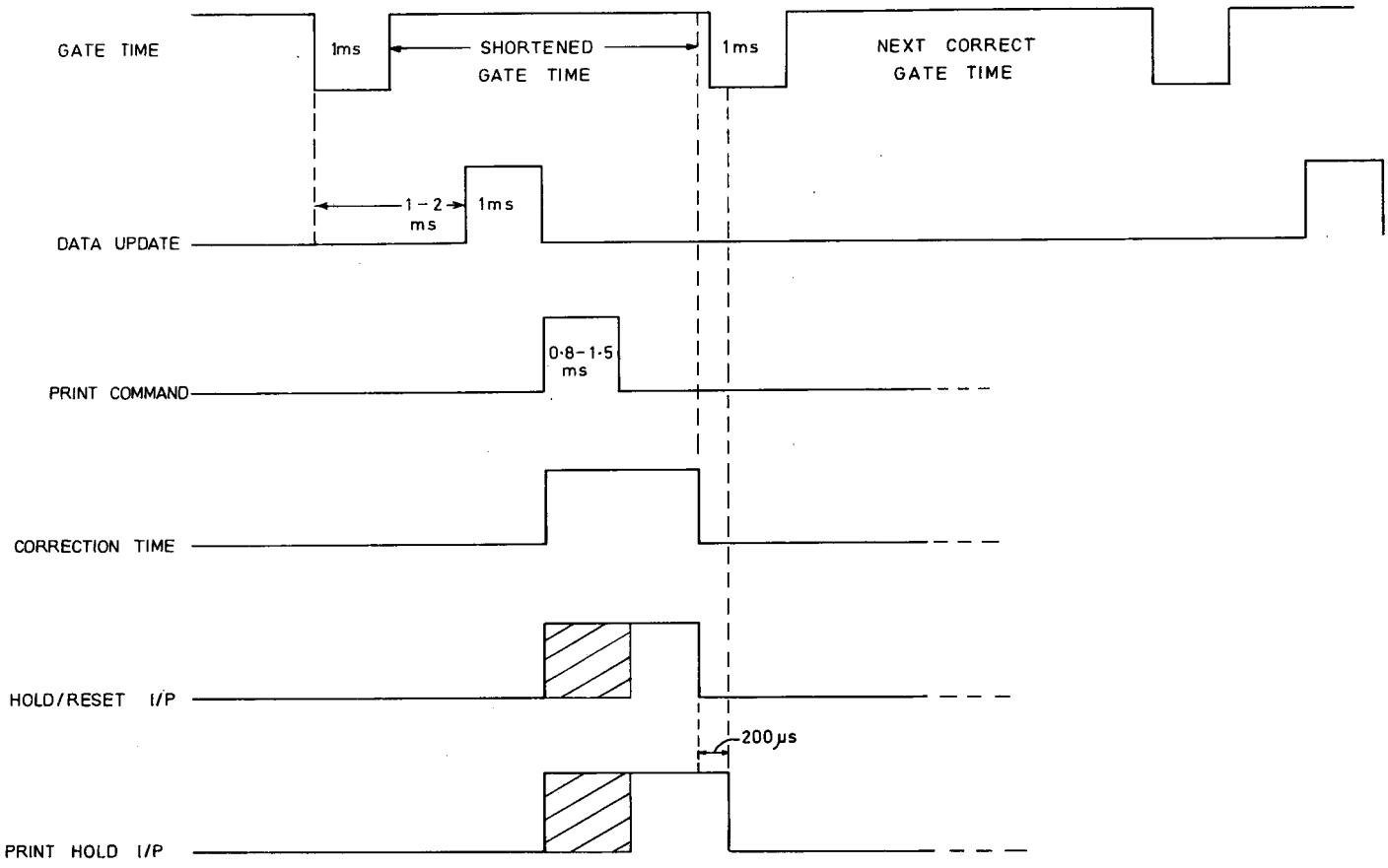


Fig. A4

TABLE 1.

FLYING LEAD CONNECTIONS

Pin No.		Pin No.	
1.	Not Connected	A	0V
2.	+ 5V (nominal)	B	$\overline{\text{OVERFLOW}}$
3.	KEYWAY	C	KEYWAY
4.	$\overline{4}$ BCD DATA	D	$\overline{1}$ BCD DATA
5.	$\overline{8}$	E	$\overline{2}$
6.	$\overline{\text{COUNTER HOLD}}$	F	Multiplex Sync (Note 2)
7.	$\overline{\text{COUNTER RESET}}$	H	$\overline{\text{MAIN GATE}}$
8.	DIGIT 10^8 SELECT	J	Not Connected
9.	Not Connected	K	$\overline{Z}$)
10.	Not Connected	L	$\overline{Y}$) TIME BASE
11.	Not Connected	M	$\overline{X}$)
12.	$\overline{\text{Ro}}$	N	Not Connected
13.	$\overline{\text{HOLD/RESET}}$	P	Not Connected
14.	See NOTE 1	R	Not Connected

NOTE 1. In option 01 units with serial numbers after 1389, pin 14 of the flying lead connection is connected within the interface unit to pin 43 of the 50 way connector. This permits a remote indication when instruments are in the divide by ten prescale mode.

NOTE 2. The multiplex sync. signal on pin F is 10 KHz, except with 9911 and 9919 instruments when it is 5 KHz.

TABLE 2.

50-WAY CONNECTOR

Pin No.	Facility		Pin No.	Facility	
1.	1	10^0 DIGIT	26.	1	10^1 DIGIT
2.	2		27.	2	
3.	4.		28.	4	
4.	8		29.	8	
5.	1	10^2 DIGIT	30.	1	10^3 DIGIT
6.	2		31.	2	
7.	4		32.	4	
8.	8		33.	8	
9.	1	10^4 DIGIT	34.	1	10^5 DIGIT
10.	2		35.	2	
11.	4		36.	4	
12.	8		37.	8	
13.	1	10^6 DIGIT	38.	1	10^7 DIGIT
14.	2		39.	2	
15.	4		40.	4	
16.	8		41.	8	
17.	OVERFLOW		42.	4	10^8 DIGIT
18.	1	10^8 DIGIT	43.	See table 1 NOTE 1.	
19.	HOLD CONTROL I/P		44.	8	10^8 DIGIT
20.	2	10^8 DIGIT	45.	1	DECIMAL POINT
21.	$\overline{X}$	TIME BASE	46.	2	
22.	$\overline{Y}$		47.	4	
23.	$\overline{Z}$		48.	PRINT COMMAND O/P	
24.	HOLD/RESET I/P		49.	PRINT HOLD I/P	
25.	0V		50.	+ 5V (VIA 180Ω)	