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1998 AND 1999

1.3 GHz AND 2.6 GHz FREQUENCY COUNTERS

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MINISTRY OF DEFENCE

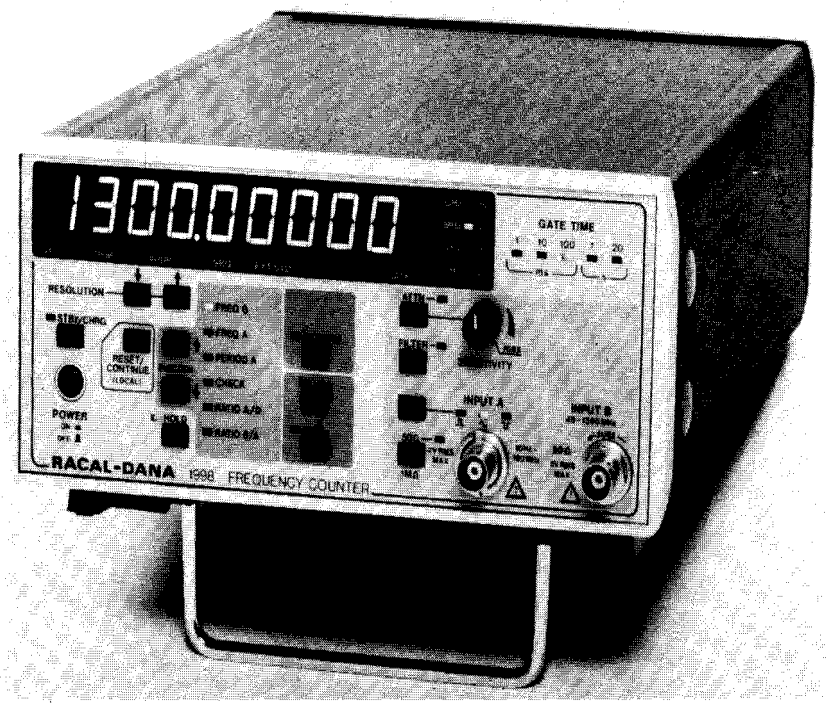
FREQUENCY COUNTER (1 GHZ)

NSN 6625-99-786-4628

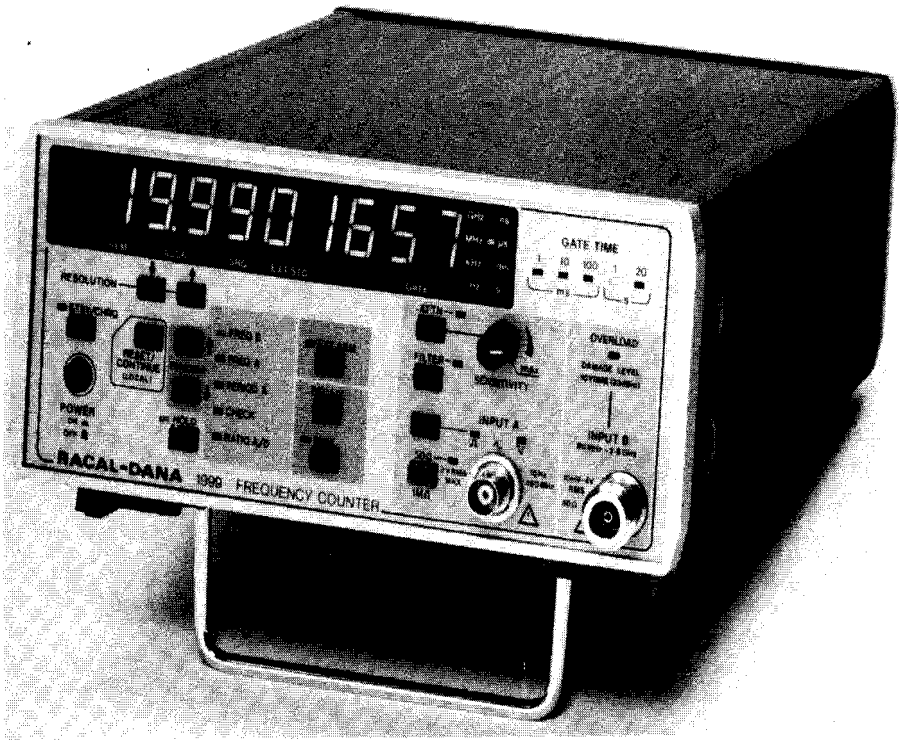
Model 1998 with Options 04E, 10, 55, 60 and Extended Rear Feet

Accessories include:

	Nato Stock Number
Operators Manual (A5 size)	Not coded
2 metre power cable (23-3416)	5995-99-649-8050
Storage pouch with Velcro fasteners (15-7008)	6625-99-831-3971
Spare 250mA power fuse (23-0056)	5920-99-352-6626
Spare 500mA power fuse (23-0052)	5920-99-791-3495
Spare packet RF fuses (11-1718)	5920-99-950-3898
Protective front cover (15-5004)	6625-99-781-1571



Frequency Counter 1998



RACAL

TH 8230

Frequency Counter 1999

HANDBOOK AMENDMENTS

Amendments to this handbook (if any), which are on coloured paper for ease of identification, will be found at the rear of the book. The action called for by the amendments should be carried out by hand as soon as possible.

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Input Characteristics

Input A

Frequency Range	10Hz to 160MHz
Input Impedance (nominal)	
X1 attenuation	1 Megohm/40pF (AC coupled) or 50 ohms (DC coupled)
X20 attenuation	1 Megohm/25pF (AC coupled) or 50 ohms (DC coupled)
Dynamic Range	±1V pk (X1), ±20V pk (X20)
Sensitivity	
Sinewave	<10mV rms, 20Hz to 120MHz <50mV rms, 120MHz to 160MHz <20mV rms, 10Hz to 20Hz
Pulse	5nS min. pulse width (∿) 45mV pk-pk at 25% and 75% duty cycles (⎍/⎍) 28mV pk-pk at up to 10% duty cycles 45mV pk-pk at 25%/75% duty cycle
Input Attenuation Range	0dB to approx. 58dB in two ranges, continuously variable using sensitivity control and X1/X20 attenuator control
Maximum Input (without damage)	
50 ohms	10Vrms (DC coupled)
1 Megohm (X1 attenuation)	260V (DC + AV rms) from DC to 10kHZ, decreasing to 10V rms above 250kHz.
1 Megohm (X20 attenuation)	260V (DC + AC rms) From DC to 200 kHz, decreasing to over 10V rms at 5MHz and above.
Trigger Levels	Three selectable trigger levels are available to provide optimum triggering on waveforms with different duty cycles. (Sens control set to maximum, X1 attn.)

	Offset	Trigger edge
(⎍)	+9mV	Negative
(∿)	0mV	Positive
(⎍)	-9mV	Positive

Filter	50kHz nominal low pass filter. Attenuation rate 20dB/decade nom.

Input B (Model 1998)

Frequency Range	40MHz to 1.3GHz, AC coupled
Input	50ohms nominal (BNC connector)
VSWR	⩽2:1 (IGHz)
Operating Range (sinewave)	<10mV to 5V rms to 1GHz <50mV to 5V rms to 1.3GHz
Maximum Input	7V rms (fuse protected).
Damage Level	25W

Input B (Model 1999)

Frequency Range	80MHz to 2.6GHz (3GHz under restricted operating conditions)
Input	50ohms nominal, AC coupled ('N' type connector)
VSWR	⩽2:1 to 2.6GHz (typically <1.5:1)
Operating Range (sinewave)	<10mV to 4V rms min. 80MHz to 2.6GHz
Overload	Protection/indication above 4V min.
Damage Level	+33dBm, ±40V DC or pulsed.
AM Tolerance	⩾90% up to 1.3GHz

Input D

	Used in Ratio A/D mode.
Frequency Range	10kHz to 10MHz usable down to 1kHz with reduced sensitivity.
Input Impedance (nominal)	1kohm for signals <1V p-p, decreasing to 500 ohm for signals ⩾10V p-p. (AC coupled.)
Input Signal Range (sinewave)	100mV to 10V rms, 10kHz to 10MHz. Typically 1V to 10V rms, 1kHz to 10kHz.
Damage Level	260V (DC +AC rms) up to 384 Hz decreasing to 10V rms above 10kHz.

External Arming

	External TTL timing signal can be applied to EXT ARM INPUT (rear panel).
Damage Level	10V rms or ±15V pk
Input Impedance	1 kohm nominal, (DC coupled)
Slope	Armed on positive edge
Slew rate	2V/μs min
Pulse Width	200nS min.
Set Up Time	100nS after input edge.

Measurement Modes

Frequency A and B

Range	
Frequency A	10Hz to 160MHz
Frequency B	40MHz to 1.3GHz (Model 1998) 80MHz to 2.6GHz (Model 1999)
Digits Displayed	3 to 10 digits
LSD Displayed (Hz)	$F \times 10^{-D}$ (F = Frequency rounded up to next decade, D = No. of digits).
Resolution* (Hz)	±n LSD† ± (Trigger Error* X Freq)/Gate Time
Accuracy* (Hz)	± Resolution ± (Timebase Error X Freq.)

Period A (Period Average)

Range	6.25nS to 100mS
Digits Displayed	3 to 10 digits
LSD Displayed (Sec)	$P \times 10^{-D}$ (P = Period rounded up to next decade, D = No. of digits).
Resolution *(Sec)	±n LSD† ±1.4 (Trigger Error* X Period)/Gate Time
Accuracy *(Sec)	± Resolution ± (Timebase Error X Period).

† n = 1 for 3-5 and 10 digits or 2 for 6-9 digits.
* See Definitions

Ratio B/A (Model 1998 Only)

Specified for higher frequency applied to input B

Range

Input A	10Hz to 100MHz
Input B	40MHz to 1.3GHz
LSD Displayed	1 to 8 digits determined by Freq A and gate time selected
Resolution*	±LSD ±1.4 (Trigger Error (A)* X Ratio)/Gate Time
Accuracy*	±Resolution

Ratio A/D

Specified for higher frequency applied to input A

Range

Input A	10Hz to 100MHz
Input D	1kHz to 10MHz
LSD Displayed	1 to 8 digits determined by Freq D and gate time selected
Resolution*	±LSD ±1.4 (Trigger Error (A)* X Ratio)/Gate Time
Accuracy*	±Resolution

Burst

Min Burst time 1mS + Gate Time*

General

Internal Timebase

Crystal Controlled

Frequency	10MHz
Aging Rate	2×10^{-6} in the first year
Temperature Stability	$\pm 1 \times 10^{-5}$ over the range 0° to 50°C.
Adjustment	Via rear panel

Frequency Standard Output

Frequency	10MHz
Amplitude	TTL levels giving approx. 1V p-p into 50 ohms.
Impedance	90 ohms nominal.
Max. Reverse Input	±15V

External Standard Input

Frequency	10MHz (see also Option 10 for other frequencies). See Input D for further specifications.

Gate Time

Automatically determined by number digits selected. LED annunciators indicate gate time.

No. of Digits Selected	Gate Time (Seconds)
10	20
9	1
8	0.1
7	0.01
6,5,4,3	0.001

These nominal gate times will be extended depending on period of input signal (see definitions).

Gate Output	Available as a TTL compatible signal at the rear panel.

Single Cycle (Hold)

Enables a single measurement to be initiated and held.

Display

10 digit high brightness, 14mm LED display.

Power Requirements

Voltage	90–110 103–127 188–237 212–265 (externally selectable)
Frequency	45–440Hz
Rating	25VA typically.

Operating Temperature Range	0° to +50°C (0° to +40°C with battery pack).
Storage Temperature Range	-40°C to +70°C (-40°C to +60°C with battery pack).
EMC/RFI	MIL-STD-461B
Environmental	Designed to meet MIL-T-28800 and DEF-STD-66/31
Safety	Designed to meet the requirements of IEC 348 and follow the guidelines of UL1244.
Weight	Net 3.6kg (8lb) excluding battery 6.8kg (15lb) including battery Shipping 5.5kg (12lb) excluding battery 8.7kg (19lb) including battery
Normal Dimensions	See back page
Shipping Dimensions	430 X 360 X 280mm (16.91 X 14.2 X 11.0 in)

Options

Option 01 Rear Panel Inputs

A rear panel input, factory fitted option, is available for ATE applications. Input A is in parallel with those on the front panel while input B is fitted in place of the front panel input.

Options 04T

Temperature Compensated Crystal Oscillator

Frequency	10MHz
Aging Rate	3×10^{-7}/month 1×10^{-6} in the first year
Temperature Stability	$\pm 1 \times 10^{-6}$ over the range 0°C to +40°C (operable to +50°C)

Option 04A

Ovened Oscillator

Frequency	10MHz
Aging Rate	3×10^{-9}/day averaged over 10 days after 3 months continuous operation.
Temperature Stability	$\pm 3 \times 10^{-9}$/°C averaged over range 0°C to +45°C (operable to +50°C)
Warm Up	Typically $\pm 1 \times 10^{-7}$ within 6 minutes.

† n = 1 for 3-5 and 10 digits or 2 for 6-9 digits.
* See Definitions

Option 04B

High Stability Ovened Oscillator

Frequency	10MHz
Aging Rate	5×10^{-10}/day averaged over 10 days after 3 months continuous operation.
Temperature Stability	$\pm 6 \times 10^{-10}$/°C averaged over range 0°C to + 50°C
Warm Up	$\pm 1 \times 10^{-7}$ within 20 minutes

Option 04E

Ultra High Stability Ovened Oscillator

Frequency	10MHz
Ageing Rate	$\leq 5X10^{-10}$ per day after 2 days
Temperature Stability	$\pm 7X10^{-9}$ over range 0-50°C (with respect to 25°C)
Warm Up	$\pm 5X10^{-9}$ within 5 hours

Option 07

Rechargeable Battery Pack and External DC Operation

Battery Type	Sealed lead-acid cells
Battery Life (at 25°C)	Typically 5 hours (24 hrs on standby) - 1998
	Typically 3.75 hours (12 hrs on standby) - 1999
Battery Condition	Display indicates battery low
External DC	11-16V via socket on rear panel (-ve ground, not isolated).

Option 10

Reference Frequency Multiplier

Input Frequency	1,2,5 or 10MHz ($\pm 1 \times 10^{-6}$)

Option 55

GPIB Interface	Complies with IEEE-STD-488 (1978) and to conform with the guidelines of IEEE-STD-728 (1982).
Control Capability	All functions/controls programmable except power on/off, standby/charge and sensitivity potentiometer.
Output	Engineering format (11 digits and exponent)
IEEE-STD-488 Subsets	SH1, AH1, T5, TE0, L4, LE0, SR1, RL1, PP0, DC1, DT1, C0, E2.
Handshake Time	250 μS to 1mS/character dependent on message content.
Read Rate	Typically 18/sec dependent upon measurement function.

Definitions

† **LSD** (Least Significant Digit)
In frequency and Period modes display automatically upranges at 1.1 X decade and downranges at 1.05 X decade, except on Input B for input frequency >1GHz. Above 1GHz no ranging on 1998. Model 1999 upranges at 1.25GHz and downranges at 1.3GHz. Accuracy and Resolution expressed as an RMS value.

* **Trigger Error** RMS

$$\text{Trigger Error} = 1.4\ \frac{\sqrt{(e_i^2 + e_n^2)}}{S}$$

Where e_i = input amplifier RMS noise (typically 150μV RMS in 160MHz bandwidth)
e_n = input signal RMS noise in 160MHz bandwidth
S = Slew rate at trigger point V/Sec.

Gate Time
The gate time will be extended as below.

Function	Gate Time extended by
Freq. B	64 periods (1998)
	256 periods (1999)
Freq. A, Period A (∿)	2 periods
Freq. A, Period A (⊓, ⊔)	1 period
Ratio B/A, A/D	1 period of Input A

Supplied Accessories

Power Cord
Spare Fuse
Operator's Manual
Spare 1.3GHz Fuse (Model 1998 Only)

Ordering Information

1998	1.3GHz Frequency Counter
1999	2.6GHz Frequency Counter

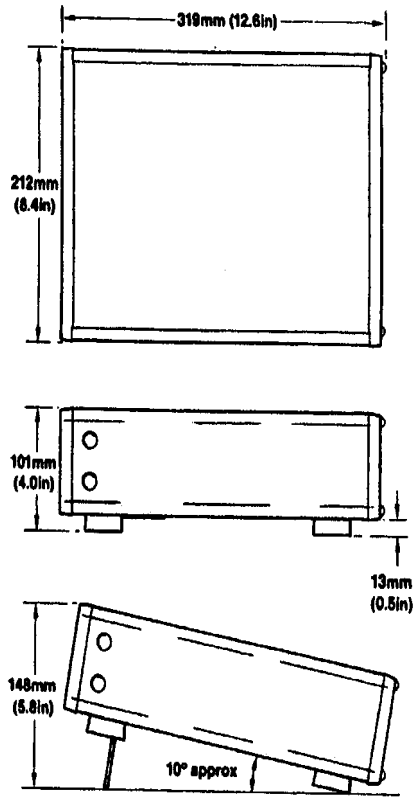
Options and Accessories

01*	Rear Panel Inputs (1998/1999)	11-1734/1735
04T**	TCXO	11-1713
04A**	Oven Oscillator	11-1710
04B**	High Stability Ovened Oscillator	11-1711
04E**	Ultra High Stability Oven Oscillator	11-9096
07†	Battery Pack	11-1625
10	Reference Frequency Multiplier	11-1645
55†	GPIB Interface	11-1724
60	Handles	11-1730
60A	Rack Mounting Kit (Fixed Single)	11-1648
60B	Rack Mounting Kit (Fixed Double)	11-1649
61	Carrying Case	15-0773
61M	Protectomuff Case	15-0736
65	Chassis Slides (incl. Rack Mounts)	11-1716
	Telescopic Antenna	23-9020
	High Impedance 100MHz Probe	23-9104
	1.3GHz Fuse (Pkt. 5) Model 1998 Only	11-1718

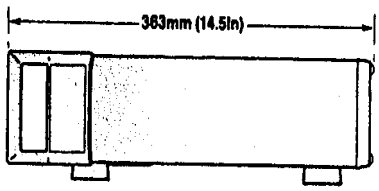
† The battery pack and GPIB options cannot both be fitted.

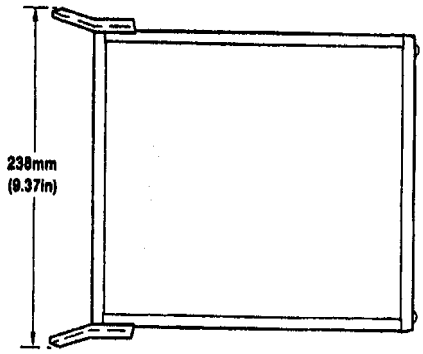
** Only one frequency standard may be fitted at any one time. The standard reference will be supplied unless option 04T, 04A, 04B or 04E is specified.

* Fitting Option 01 may affect certain specification parameters.



With Optional Handles Fitted





SECTION 2 GENERAL DESCRIPTION

INTRODUCTION

1 The Racal-Dana frequency counters Models 1998 and 1999 are microprocessor-controlled instruments offering high-accuracy measurements with a comprehensive range of facilities.

MEASURED FUNCTIONS

Frequency A Function

2 The Frequency A function is used to measure the frequency of the signal applied to the channel A input. A resolution of nine digits is available with a one-second gate time.

Frequency B Function

3 The Frequency B function is used to measure the frequency of the signal applied to the channel B input. A resolution of nine digits is available with a one-second gate time.

Period A Function

4 The Period A function is used to measure the period of the waveform applied to the channel A input. A number of periods, depending upon the resolution (and therefore the gate time) selected, are measured, and the average value is displayed.

Ratio A/D Function

5 The Ratio A/D function is used to measure the ratio of the frequency applied to the channel A input to that applied to the channel D input.

Ratio B/A Function (1998 Only)

6 The Ratio B/A function is used to measure the ratio of the frequency applied to the channel B input to that applied to the channel A input.

CHECK FUNCTION

7 With the Check function selected a number of functional tests of the instrument's circuits can be made without the use of additional test equipment. Although these tests do not check the instrument's performance to its published specification, they can be used to verify that the equipment is operating correctly. A suitable functional check procedure is given in Section 3.

SIGNAL INPUT CHANNELS

8 Signal input channels A and B are fully independent.

9 Channel A is provided with controls to permit the selection of:

(1) 1 MΩ or 50 Ω input impedance.

(2) Input attenuation continuously variable from 0 dB to approximately 58 dB using the ATTN (X20) and SENSITIVITY controls.

(3) 50 kHz low-pass filter.

(4) Pulse offset (trigger level) to cater for signals of various duty cycles.

10 Channel B has a 50 Ω input impedance. On the 1998 the input is fuse-protected for signals above 7 V. On the 1999 the input is protected by an internal attenuator for signals above 4 V.

ERROR INDICATION

11 Certain errors in the operation of the instrument will result in the generation of error codes, which will be displayed. Details are given in Section 4 of this manual.

EXTERNAL ARMING

12 External arming of the start circuit for the measurement interval can be carried out by means of signals connected to a BNC connector mounted on the rear panel.

DISPLAY

13 A 10-digit numeric display with units annunciators is used. Indicators are provided to show when overflow of the most significant digit occurs, and to show the measurement interval (gate time).

HOLD FEATURE

14 The hold feature allows readings to be held indefinitely. A new measurement cycle is initiated using the RESET key.

RESOLUTION AND GATE TIME

15 The gate time is determined by the display resolution selected. Details of the relationship between gate time and display resolution for each measurement mode are given in Section 4 of this manual.

GATE OUTPUT

16 The internally-generated gate signal is available at a pin on the rear panel. The gate output will be delayed relative to the internal measurement gate by 10 nsec typically (15 nsec maximum).

17 When used in the single-shot mode, the gate waveform comprises a short trigger pulse, followed by a hold-off time of about 1 ms followed by the measurement gate waveform proper; this is to allow the external circuit output to stabilise after triggering.

EXTERNAL FREQUENCY STANDARD INPUT

18 The instrument may be operated using an external frequency standard. The instrument will operate from the external standard, in preference to the internal standard, whenever the signal at the EXT STD INPUT socket is of sufficient amplitude. It will revert to operation from the internal standard automatically if the input from the external standard is removed.

STANDBY MODE

19 When the instrument is switched to standby, the internal frequency standard continues to operate and the instrument status is maintained but the measuring circuits are switched off. If the battery pack option is fitted and an external power supply is connected, the battery is charged at the full rate.

NULL FUNCTION

20 With the NULL function active the instrument displays the difference between the measured value and the value held in the internal NULL store.

INITIALIZATION

21 When the instrument is first switched on, or when it is initialised via the GPIB, it is set to the following conditions:

Measurement Function	FREQ A
Display Resolution	8 digits (0.1 second gate time)
Channel A Input	1 MΩ input impedance No trigger offset (∿) LF filter disabled X1 attenuation
Null Function Null Store	Disabled 0
External Arming	Disabled
Hold Function	Disabled

OPTIONS AVAILABLE

Frequency Standards (04X Options)

22 A wide range of internal frequency standard options is available. The technical specifications are given in Section 1 of this manual. The frequency standard can be changed, if required, by the customer: instructions are given in Section 3.

Reference Frequency Multiplier (Option 10)

23 The reference frequency multiplier is an internally-mounted, phase-locked multiplier, which permits the use of external frequency standard signals at 1 MHz, 2 MHz, 5 MHz or 10 MHz. The multiplier can be fitted by the customer: instructions are given in Section 3.

GPIB Interface (Option 55)

24 An internally mounted interface to the IEEE-488-GPIB is available. This permits remote control of all the instrument's functions except the power ON/OFF switching, the standby switching, and the channel A sensitivity potentiometer setting. The interface can be fitted by the customer: instructions are given in Section 3. The GPIB interface cannot be fitted to an instrument already fitted with the battery pack option. An adapter, Racal-Dana part number 23-3254, to convert the connector to the IEC 625-1 standard is available as an accessory.

Battery Pack (Option 07)

25 Fitting the internal Battery Pack Assembly permits the instrument to be used in locations where no suitable AC supply is available. The option also allows operation from an external DC supply.

26 The battery is trickle-charged whenever the instrument is operated from an AC supply and the internal/external switch is at INTERNAL BATTERIES. Charging at the full rate is carried out when the instrument is switched to the standby mode and connected to an external AC or DC supply. A full charge requires approximately 14 hours.

27 The instrument will operate continuously from a fully-charged battery for approximately 4.5 hours (1998) and 3.75 hours (1999). It will switch off automatically when the battery reaches the discharged condition. The STBY/CHRG indicator starts to flash approximately 15 minutes before this occurs. The battery life can be extended by use of the Battery-Save facility.

28 The battery pack can be fitted by the customer. Instructions are given in Section 3. When using the GPIB interface option the battery pack cannot be fitted.

Rack Mounting Kits

29 The following kits permitting the instrument to be mounted in a standard 19-inch rack are available:

(1) Single instrument, fixed-mount kit (Option 60A).
(Racal-Dana part number 11-1648).
The mounted instrument occupies half the rack width and is two rack units (3.5 inches) in height. The instrument is mounted offset in the rack and may be at either side.

(2) Double instrument, fixed-mount kit (Option 60B).
(Racal-Dana part number 11-1649).
The panel of the mounting kit occupies the full rack width and is two rack units (3.5 inches) in height. Two instruments can be mounted side-by-side.

30 All the kits can be fitted by the customer. Instructions are given in Section 3.

SECTION 3 PREPARATION FOR USE

UNPACKING

1 Unpack the instrument carefully to avoid unnecessary damage to the factory packaging.

2 If it becomes necessary to return the instrument to Racal-Dana Instruments for calibration or repair, the original packaging should be used. If this is not possible, a strong shipping container should be used. Ensure that sufficient internal packing is used to prevent movement of the instrument within the container during transit.

POWER SUPPLY

AC Line Voltage Setting

3 Before use, check that the AC voltage selector is set correctly for the local AC supply. The voltage range already set can be seen through a window in the selector board retaining clamp to the left of the AC power plug.

4 If it is necessary to change the setting, proceed as follows:

(1) Undo the selector board retaining clamp on the rear panel.

(2) Withdraw the board.

(3) Replace the board with the required voltage setting positioned so that it will show through the window in the retaining clamp.

(4) Replace the retaining clamp.

Line Fuse

5 Check that the rating of the line fuse is suitable for the AC voltage range in use. The fuse should be of the ¼ in x 1¼ in, glass cartridge, surge-resisting type. The required rating is:

90 V to 127 V: 500 mAT (Racal-Dana part number 23-0052).
188 V to 265 V: 250 mAT (Racal-Dana part number 23-0056).

Power Cord

6 The 1998/99 is a Safety Class 1 instrument, and is designed to meet international safety standards. A protective ground terminal, which forms part of the power-input connector on the rear panel, is provided. The instrument is supplied with a 3-core power cord. Only the power cord supplied should be used to make electrical connection to the power-input connector.

7 AC power for the instrument must be taken from a power outlet incorporating a protective ground connector. Whem the green/yellow conductor of the power cord is joined to this connector the exposed metalwork of the instrument is grounded. The continuity of the protective ground connection must not be broken by the use of 2-core extension cords or 3-prong to 2-prong adapters.

8 Connection of the power cord to the power outlet must be made in accordance with the standard colour code.

	European	American
Line	Brown	Black
Neutral	Blue	White
Ground (Earth)	Green/Yellow	Green

FUNCTIONAL CHECK

9 The check given in paragraph 10 tests the operation of most of the instrument's ciecuits to establish whether the instrument is functioning correctly. The procedure should be followed when the instrument is first taken into use, and after transportation to a new location. It does not check that the instrument is operating to the published specification. Detailed specification tests are given in Section 7 of the maintenance manual.

10 (1) Connect the instrument to a suitable AC supply.

(2) Switch the instrument on. Check that the instrument type-number appears in the display for approximately two seconds, followed by a number which indicates the software version and issue number.

(3) Press the FUNCTION ▼ key until the CHECK indicator lights. Check that the display shows 10.0000000 and that the GATE indicator is flashing.

(4) Press the RESOLUTION ▼ key five times, ensuring that the resolution of the display is decreased by one digit each time.

(5) Press the RESOLUTION ▲ key six times to increase the resolution to nine digits, and check that the GATE TIME indicator shows 1 second.

(6) Press the INPUT A pulse offset key. Check that all LEDs, with the exception of REM, ADDR, SRQ, GATE and STBY/CHRG flash on and off every two seconds. If the GPIB option is installed, the REM, ADDR and SRQ indicators should be lit.

(7) Switch the instrument off.

FREQUENCY STANDARD

11 If it is intended to use an external frequency standard, the frequency standard should be connected to the EXT STD INPUT connector on the rear panel of the instrument. The connection should be made using coaxial cable. Switch on the frequency standard and the instrument: check that the EXT STD indicator on the front panel of the instrument lights.

12 A 10 MHz signal, derived from the frequency standard in use, is available at the 10 MHz STD OUT connector on the rear panel of the instrument. If this signal is used, the connection should be made using coaxial cable.

EXTERNAL ARMING

13 If external arming is to be used, the arming signal should be connected to the EXT ARM INPUT connector on the rear panel.

GATE OUTPUT

14 The gate output is available via probe-hook connectors on the rear panel.

PREPARATION FOR USE WITH THE GPIB

Introduction

15 The instrument must be prepared for use in accordance with the instructions given in Paragraphs 3 to 8 before the instructions given in this section are implemented.

Connection to the GPIB

16 Connection to the GPIB is made via a standard IEEE-488 connector, mounted on the rear panel. The pin assignment is iven in Table 3.1. An adapter, Racal-Dana part number 23-3254, to convert the connector to the IEC 625-1 standard is available as an optional accessory.

TABLE 3.1

GPIB Connector Pin Assignment

Pin	Signal Line	Pin	Signal Line
1	DIO 1	13	DIO 5
2	DIO 2	14	DIO 6
3	DIO 3	15	DIO 7
4	DIO 4	16	DIO 8
5	EOI	17	REN
6	DAV	18	Gnd (6)
7	NRFD	19	Gnd (7)
8	NDAC	20	Gnd (8)
9	IFC	21	Gnd (9)
10	SRQ	22	Gnd (10)
11	ATN	23	Gnd (11)
12	SHIELD	24	Gnd (5 and 17)

Address Setting and Display

17 The interface address is set using five switches, A1 to A5, which are mounted on the rear panel. The permitted address settings, in binary, decimal and ASCII character form, are given in Table 3.2. The GPIB address set can be displayed, in decimal form, by pressing

RECALL LOCAL .

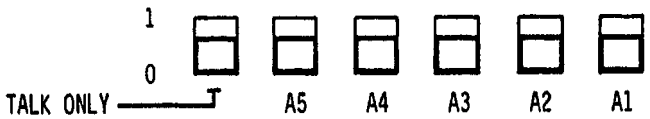
If the address is changed, this key sequence must be repeated to display the new address. The instrument is returned to the measurement mode by pressing

CONTINUE .

18 For addressed operation, the TALK ONLY switch must be in the logic '0' position (down). When this switch is in the logic '1' position, the interface is switched to the talk-only mode. The settings of switches A1 to A5 are then irrelevant.

TABLE 3.2

Address Switch Settings



SWITCH SETTINGS					ADDRESS CODES		
A5	A4	A3	A2	A1	DECIMAL	ASCII LISTEN ADDRESS	ASCII TALK ADDRESS
0	0	0	0	0	0	SP	@
0	0	0	0	1	1	!	A
0	0	0	1	0	2	"	B
0	0	0	1	1	3	#	C
0	0	1	0	0	4		D
0	0	1	0	1	5	%	E
0	0	1	1	0	6	&	F
0	0	1	1	1	7	'	G
0	1	0	0	0	8	(	H
0	1	0	0	1	9	)	I
0	1	0	1	0	10	*	J
0	1	0	1	1	11	+	K
0	1	1	0	0	12	,	L
0	1	1	0	1	13	-	M
0	1	1	1	0	14	.	N
0	1	1	1	1	15	/	O
1	0	0	0	0	16	0	P
1	0	0	0	1	17	1	Q
1	0	0	1	0	18	2	R
1	0	0	1	1	19	3	S
1	0	1	0	0	20	4	T
1	0	1	0	1	21	5	U
1	0	1	1	0	22	6	V
1	0	1	1	1	23	7	W
1	1	0	0	0	24	8	X
1	1	0	0	1	25	9	Y
1	1	0	1	0	26	:	Z
1	1	0	1	1	27	;	[
1	1	1	0	0	28	<	\
1	1	1	0	1	29	=	]
1	1	1	1	0	30	>	^

GPIB CHECK

19 The procedure which follows checks the ability of the instrument to accept, process and send GPIB messages. The correct functioning of the instrument under local control should be verified before the procedure is attempted.

20 The recommended test equipment is the Hewlett-Packard HP-85 GPIB controller, with the I/O ROM in the drawer. It is assumed that the select code of the controller I/O port is 7, and that the address of the instrument is 16 (to change the address see Paragraph 17). If any other controller or select code/address combination is used, the GPIB commands given in the following paragraphs will require modification. The controller should be connected to the GPIB interface of the instrument via a GPIB cable. No connection should be made to the channel A or B inputs, or to the D input.

21 Successful completion of the GPIB check proves that the instrument's GPIB interface is operating correctly. The procedure does not check that all the device-dependent commands can be executed. However, if the GPIB interface works correctly and the instrument operates correctly under local control, there is a high probability that it will respond to all device-dependent commands.

Remote and Local Message Check

22 Switch the instrument on. Check that the REM, ADDR and SRQ indicators flash on and off once. If the indicators do not flash, or if they flash continuously, there is a fault on the GPIB board.

23 Test as follows:

Action	HP-85 Code	Your Controller
Send the REN message true, together with the instrument's listen address	REMOTE 716	

Check that the REM indicator lights.

24 Test as follows:

Action	HP-85 Code	Your Controller
Send the device-dependent command CK	OUTPUT 716; "CK"	

Check that the ADDR indicator lights and that the Check mode is selected.

25 Test as follows:

Action	HP-85 Code	Your Controller
Send the instrument's listen address followed by the GTL message	LOCAL 716	

Check that the REM indicator is off. The ADDR indicator will also be off if the controller used sends the unlisten message (UNL) true automatically. This is the case when using the HP-85.

Local Lockout and Clear Lockout Check

26 Test as follows:

Action	HP-85 Code	Your Controller
Send the REN message true, together with the instrument's listen address	REMOTE 716	
Send the LLO message	LOCAL LOCKOUT 7	

Check that the REM indicator lights. Operate the LOCAL key on the front panel and verify that the REM indicator remains lit.

27 Test as follows:

Action	HP-85 Code	Your Controller
Send the REN message false	LOCAL 7	

Check that the REM indicator is off.

28 Test as follows:

Action	HP-85 Code	Your Controller
Send the REN message true, together with the instrument's listen address	REMOTE 716	

Check that the REM indicator lights. Press the LOCAL key and verify that the REM indicator turns off.

Data Output Check

29 Test as follows:

Action	HP-85 Code	Your Controller
Set the instrument to the check mode by sending the listen address, followed by the device-dependent command CK	OUTPUT 716; "CK"	
Prepare a store to receive a 21-byte data string	DIM Z$ [21]	
Send the instrument's talk address. Store the 21-byte data string in the prepared store	ENTER 716; Z$	
Display the contents of the store	DISP Z$	

Check that the display reads CK+0010.0000000E+06 with the cursor moved to the next line, indicating that carriage return (CR) and line feed (LF) have been accepted.

SRQ and Status Byte Check

30 Test as follows:

Action	HP-85 Code	Your Controller
Send the REN message true	REMOTE 7	
Set the instrument to send the SRQ message when an error is detected, and force the generation of error code 05 by sending the device-dependent commmand XXX	OUTPUT 716;"IPXXX"	
Store the status of the GPIB interface of the controller, in binary form, as variable T	STATUS 7, 2; T	
Display the status of the SRQ line	DISP"SRQ=";BIT(T,5)	

Check that the HP-85 displays SRQ=1, the SRQ status bit is at logic '1' or the SRQ line is $\leqslant$0.8 V. Check that the SRQ indicator on the instrument is lit.

31 Test as follows:

Action	HP-85 Code	Your Controller
Conduct a serial poll and store the status byte as variable R	R = SPOLL (716)	
Display variable R	DISP "R="; R	

Check that the SRQ indicator is turn off when the serial poll is made. The value of R shoud be 101 (in binary form, R should be 0000000001100101). If using an HP-85 controller, check that the ADDR indicator is turned off.

Device Clear and Selected Device Clear Check

32 Test as follows:

Action	HP-85 Code	Your Controller
Set the instrument to the FREQ B mode by sending the listen address, followed by the device-dependent command FB	OUTPUT 716;"FB"	
Send the DCL message true	CLEAR 7	

Check that the function indicated on the instrument front panel changes to FREQ A.

33 Test as follows:

Action	HP-85 Code	Your Controller
Reset the instrument to the FREQ. B mode by sending the listen address, followed by the device-dependent command FB	OUTPUT 716;"FB"	
Send the SDC message true	CLEAR 716	

Check that the function indicated on the instrument front panel changes to FREQ A.

IFC Check

34 Test as follows:

Action	HP-85 Code	Your Controller
Send the ATN message false Send the IFC message true	RESUME 7 ABORTIO 7	

Check that the ADDR indicator is turned off.

TALK ONLY Selector Test

35 (1) Set the TALK ONLY switch in the instrument rear panel to '1'. Check that the REMOTE indicator is turned off and the ADDR indicator lights.

(2) Set the TALK ONLY switch to '0'. Check that the ADDR indicator is turned off.

OPTION FITTING INSTRUCTIONS

Single-Instrument Fixed Rack Mounting Kit 11-1648 (Option 60A)

36 The kit comprises:

Item	Qty	Racal-Dana Part Number
Short mounting bracket	1	16-0643
Long mounting bracket	1	16-0644
Screw, M4 x 16	4	24-7733
Crinkle washer M4	4	24-2802
Spacer, plain M4 x 5	4	24-4112
Screw, M6 x 16	4	24-7995
Cup washer, M6	4	24-2809
Caged nut, M6	4	24-2240

37 Assemble the kit to the instrument as follows:

(1) Disconnect the AC power cord at the rear panel.

(2) Remove the two screws which secure the bezel to the rear panel: remove the bezel.

(3) Remove the bottom cover by sliding it towards the rear of the instrument.

(4) Remove the instrument's feet from the bottom cover.

(5) Replace the bottom cover. Replace and secure the bezel.

(6) Remove the four blind grommets from the sides of the instrument. This will reveal two threaded holes in each side frame.

(7) At one side of the instrument, secure a mounting bracket to the side frame, using two spacers, M4 screws and crinkle washers. Position the spacers between the mounting bracket and the side frame.

(8) Repeat step (7) at the other side of the instrument.

(9) Fit the cup washers to the M6 screws. Offer the instrument up to the rack in the required position, and secure the brackets to the rack using the M6 screws and nuts.

Double-Instrument Fixed Rack Mounting Kit 11-1649 (Option 60B)

38 The kit comprises:

Item	Qty	Racal-Dana Part Number
Short mounting bracket	2	16-0643
Screw, M4 x 16	4	24-7733
Crinkle washer, M4	4	24-2802
Spacer, plain, M4 x 5	4	24-4112
Spacer, female	2	14-1583
Spacer, male	2	14-1584
Mating plate	1	13-2000
Rivet, plastic	4	24-3211
Screw, M6 x 16	4	24-7995
Cup washer, M6	4	24-2809
Caged nut, M6	4	24-2240

39 Prepare both instruments as follows:

(1) Disconnect the AC power cord at the rear panel.

(2) Remove the two screws which secure the bezel to the rear panel: remove the bezel.

(3) Remove the bottom cover by sliding it towards the rear of the instrument.

(4) Remove the instrument's feet from the bottom cover.

(5) Replace the bottom cover. Replace and secure the bezel.

(6) Remove the four blind grommets from the sides of the instrument. This will reveal two threaded holes in each side frame.

(7) Remove two buffers from the bezel at the side which is to be at the centre of the rack.

40 Assemble the kit to the instruments as follows:

(1) At the sides which are to be at the centre of the rack, secure the female spacers to one instrument and the male spacers to the other. The spacers screw into the threaded holes in the side frames.

(2) At the other side of each instrument, secure a mounting bracket to the side frame, using two plain spacers, M4 screws and crinkle washers. Position the spacers between the mounting bracket and the side frame.

(3) Fit the male spacers on one instrument into the female spacers on the other.

(4) Position the mating plate to bridge the gap between the bezels. Secure it by pushing the plastic rivets through the plate into the buffer holes.

(5) Fit the cup washers to the M6 screws. Offer the two instruments up to the rack in the required position, and secure the brackets to the rack using the M6 screws and nuts.

PCB-Mounted Frequency Standard, 11-1713 (Option 04T)

41 The kit comprises:

Item	Qty	Racal-Dana Part Number
Plate assembly	1	11-1610
Oscillator PCB	1	19-1208
Crinkle washer M3	3	24-2801
Screw, M3 x 6	3	24-7721

Installation

42 (1) Disconnect the AC power cord at the rear panel.

(2) Remove the two screws which secure the bezel to the rear panel: remove the bezel.

(3) Remove the top cover by sliding it towards the rear of the instrument.

(4) Remove the frequency standard already fitted. Instructions are given in Paragraph 43 or Paragraph 46, according to type.

(5) Secure the PCB to the plate assembly, using an M3 screw and washer from the kit. The screw should be passed through the mounting hole in the board and screwed into the threaded spacer of the plate assembly. The component side of the board should be towards the plate assembly.

(6) Connect the PCB to the motherboard at PL14, with the plate assembly towards the rear panel of the instrument.

(7) Secure the plate assembly to the rear panel, using two M3 screws and washers. The screws pass through the holes adjacent to the FREQ STD ADJUST aperture and screw into the plate assembly.

(8) Replace the top cover. Replace and secure the bezel.

Removal

43 (1) Remove the two screws adjacent to the FREQ STD ADJUST aperture in the rear panel.

(2) Pull the PCB and plate assembly upwards until the board is disconnected from the motherboard.

Ovened Frequency Standards 11-1710, 11-1711 and 11-9096 (Options 04A, 04B and 04E)

44 The kit comprises:

Item	Qty	Racal-Dana Part Number
Oscillator assembly	1	9444 for 11-1710 9423 for 11-1711 9462-10 for 11-9096
Crinkle washer, M3	2	24-2801
Screw, M3 x 6	2	24-7721

Installation

45 (1) Disconnect the AC power cord at the rear panel.

(2) Remove the two screws which secure the bezel to the rear panel: remove the bezel.

(3) Remove the top cover by sliding it towards the rear of the instrument.

(4) Remove the frequency standard already fitted. Instructions are given in Paragraph 43 or Paragraph 46, according to type.

(5) Connect the flying lead on the oscillator assembly to SK14 on the motherboard.

(6) Secure the oscillator assembly to the rear panel of the instrument, using the M3 screws and washers. The screws pass through the holes adjacent to the FREQ STD ADJUST aperture and screw into the oscillator assembly.

(7) Replace the top cover. Replace and secure the bezel.

Removal

46 (1) Remove the two screws adjacent to the FREQ STD ADJUST aperture in the rear panel.

(2) Lift the oscillator assembly out of the chassis and disconnect the flying lead from the motherboard at PL14.

Reference Frequency Multiplier Option 11-1645 (Option 10)

47 The kit comprises:

Item	Qty	Racal-Dana Part Number
Frequency multiplier	1	19-1164
Crinkle washer, M3	2	24-2801
Screw, M3 x 6	2	24-7721

48 (1) Disconnect the AC power cord at the rear panel.

(2) Remove the two screws which secure the bezel to the rear panel: remove the bezel.

(3) Remove the top cover by sliding it towards the rear of the instrument.

(4) Remove the frequency standard if an ovened type is fitted.

(5) Remove the shorting links from between pins 5 and 6 and pins 8 and 9 on PL16.

NOTE:
These links should be stored in a safe place. They must be replaced if Option 10 is removed from the instrument.

(6) Connect the frequency multiplier PCB to the motherboard at PL16 and PL17, with the threaded spacers towards the right-hand side frame.

(7) Secure the PCB to the side frame, using the M3 screws and washers.

(8) Replace and secure the frequency standard if it was removed in (5).

(9) Replace the top cover. Replace and secure the bezel.

GPIB Option 11-1724 (Option 55)

49 The kit comprises:

Item	Qty	Racal-Dana Part Number
GPIB board assembly	1	19-1146
Bracket	2	11-1728
Speednut	2	24-0146
Shakeproof washer, M3	2	24-2813
Screw, M3 x 6	3	24-7721
Washer Plain M3	1	24-2703
Washer Crinkle M3	1	24-2801
Screw, M4 x 10 C'SK	4	24-7543
Washer Nylon	4	24-2816

NOTE 1:
This option cannot be fitted to an instrument aleady fitted with the battery pack option.

NOTE 2: (1999 only)
One speednut, bracket and fixing screw are not required for this instrument and should be discarded.

50 (1) Disconnect the AC power cord at the rear panel.

(2) Remove the two screws which secure the bezel to the rear panel: remove the bezel.

(3) Remove the top cover by sliding it towards the rear of the instrument.

(4) Remove the blanking plate from the rear panel by pushing out the plastic rivets from the inside of the instrument.

(5) Slide a speednut onto a bracket. Ensure that the flat non-threaded face of the speednut is uppermost.

(6) (a) Secure a bracket to LH sideframe of the instrument using the M4 screws and nylon washers supplied.

(b) 1998 only: secure a bracket to RH sideframe of the instrument using the M4 screws and nylon washers supplied. Ignore the two holes near the rear of the instrument.

(7) Hold the GPIB board, component side down, with the GPIB connector towards the rear panel. Connect the ribbon-cable to the motherboard at SK4.

(8) Tilt the GPIB board, and lower it into the instrument, easing the GPIB connector into the shaped cut-out in the rear panel of the instrument.

(9) (a) 1998 only: line-up the holes in the GPIB board with the speednuts (move the speednuts slightly if necessary). Insert the two self-tapping screws through the board into the speednuts. Do not tighten screws.

(b) 1999 only: line-up the hole and slot in the GPIB board with the speednut and threaded hole in the prescaler screen (move the speednut slightly if necessary). Insert, through the board, the self-tapping screw into the speednut and the M3 screw with crinkle and plain washers into the threaded hole, in the prescaler screen. Do not tighten screws.

(10) Secure the bracket which carries the GPIB connector to the rear panel, using the two M3 screws and shakeproof washers. Tighten screws.

NOTE:
The screws and washers provide the ground connection between the GPIB connector and the instrument chassis. Tighten the screws firmly to ensure that a good connection is obtained.

(11) Tighten screws in Para 50, 9(a) or 9(b).

(12) Replace the top cover. Replace and secure the bezel.

Battery Pack Option 11-1625 (Option 07)

51 The kit comprises:

Item	Qty	Racal-Dana Part Number
PCB assembly	1	11-1722
Mounting bracket	1	11-1599
Battery pack	1	11-1723
Cover plate	1	13-2040
Crinkle washers, M3	5	24-2801
Screws, M3 x 6	5	24-7721
Crinkle washers, M4	2	24-2802
Screws, M4 x 8	2	24-7730
Plain washers, M4	2	24-2705
Spare fuse, 3A	1	24-0069
Plastic rivet	1	24-0252
Washer, nylon	4	24-2816
Screw, M4 x 10 C'SK	4	24-7543
Plain washer M3	3	24-2703

NOTE 1:
This option cannot be fitted to an instrument already fitted with the GPIB interface option.

NOTE 2:
1999 only: the RH mounting bracket with some screws and washers included in the kit are not required for this instrument and should be discarded.

52 (1) Disconnect the AC power cord at the rear panel.

(2) Remove the two screws which secure the bezel to the rear panel: remove the bezel.

(3) Remove the top cover by sliding it towards the rear of the instrument.

(4) Remove the blanking plate from the rear panel by pushing out the plastic rivets from the inside of the instrument.

(5) If a PCB-mounted frequency standard is fitted, remove the two screws adjacent to the FREQ STD ADJUST aperture.

(6) Remove the four screws which secure the rear panel to the side frames.

(7) Ease the rear panel away from the instrument until it disconnects from the motherboard at PL19 and PL20.

(8) Hold the PCB assembly with the switches towards the rear of the instrument and the PCB connector pointing downwards.

(9) Lower the assembly into the chassis and connect the PCB to the motherboard at PL21, taking care that it mates correctly.

(10) Replace and secure the rear panel.

(11) If a PCB-mounted frequency standard is fitted, secure it to the rear panel with the screws removed in (5).

(12) Position the cover plate over the switches protruding through the rear panel. Secure the cover plate and the rear panel to the PCB assembly, using the M3 screws and crinkle washers.

(13) 1998 only: Secure the mounting bracket to the right-hand side frame, using two M4 screws and crinkle washers. The horizontal flange should be towards the top of the instrument.

(14) Position the battery pack within the chassis with the flying lead towards the rear of the instrument and the supporting lugs resting on the mounting bracket for the 1998 or prescaler screen for the 1999. Secure the battery pack to the left-hand side frame, using, for the 1998, two M4 screws, two crinkle washers and the plastic rivet. For the 1999 use the two M4 C'SK screws, two nylon washers and the plastic rivet.

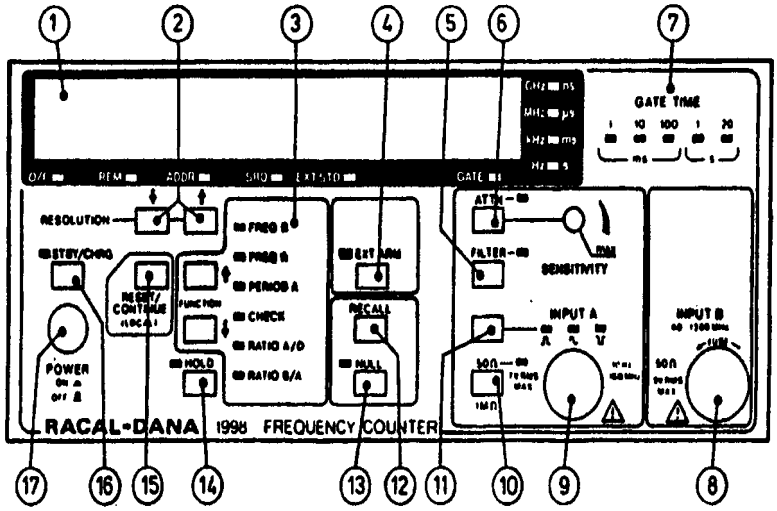
(15) Secure the supporting lugs to the mounting bracket (1998) using M4 screws, plain and crinkle washers or to the prescaler screen (1999), using M3 screws, plain and crinkle washers.

(16) Connect the flying lead on the battery pack to the connector on the PCB assembly.

(17) Replace the top cover. Replace and secure the bezel.

INTRODUCTION

1 The instrument should be prepared for use in accordance with the instructions given in Section 3. If the instrument is being used for the first time, or at a new location, pay particular attention to the setting of the AC voltage selector.



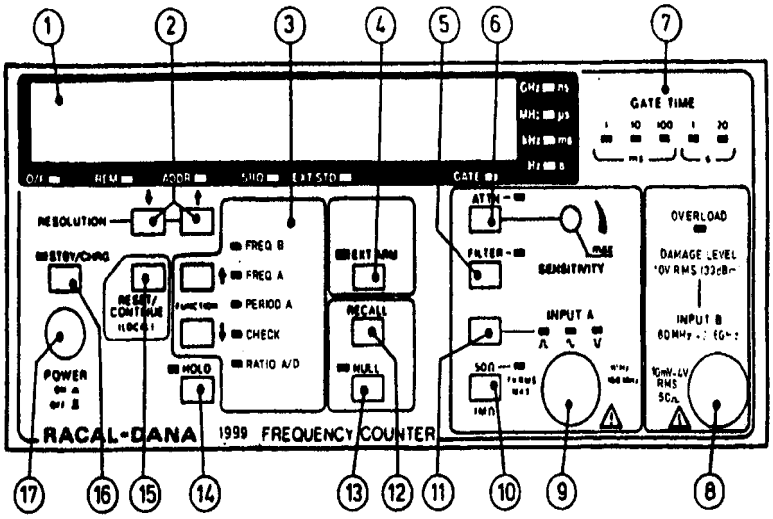
DESCRIPTION OF CONTROLS, INDICATORS AND CONNECTORS

Front Panel Items

2

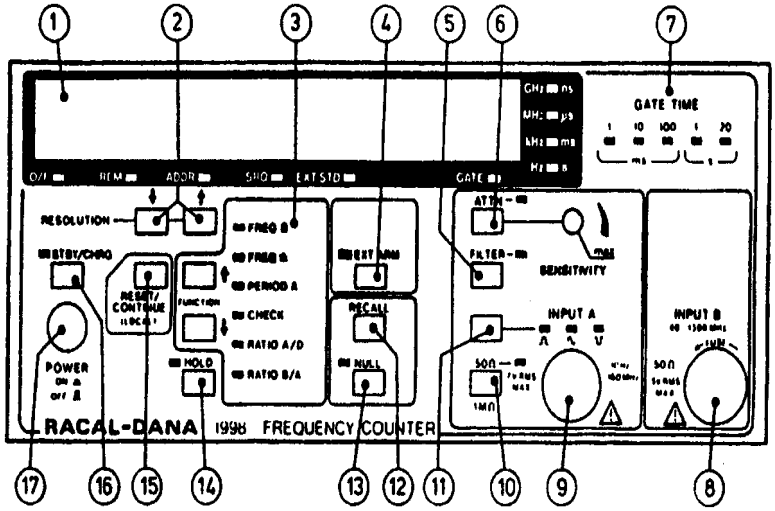
Reference	Item	Description
①	Display	A 10-digit LED display, used to display (1) The result of a measurement (2) A number recalled from an internal store. (3) Error indications.

Reference	Item	Description
	O/F Indicator	Lights when the measurement result has overflowed the most significant digit of the display.
	REM Indicator	Lights when the instrument is operating under remote control.
	ADDR Indicator	Lights when the instrument is acting as a listener or as a talker.
	SRQ Indicator	Lights when the instrument generates a service request.
	EXT STD Indicator	Lights when the instrument is operating from an external frequency standard.
	GATE Indicator	Lights while a measurement cycle is in progress.
	Display Units Indicators	Four indicators show the scale of the display in terms of frequency or time period.
②	Resolution Control Keys	Used to step the display resolution up or down as shown by the arrows
③	Function Selector	The functions can be selected in turn using the FUNCTION ↑ and ↓ keys. The function selection 'wraps round' at both ends.
④	EXT ARM Key and Indicator	Used to enable and disable the external start arming. The indicator lights when the external arming facility is selected.
⑤	FILTER Key	Successive operations enable and disable the channel A input filter. The indicator lights when the filter is enabled.
⑥	ATTN and SENSITIVITY controls and indicator	ATTN selects x1 or x20 input signal attenuation. The indicator lights when x20 attenuation is selected. The sensitivity can be continuously adjusted over a range of approximately 58 dB by means of the SENSITIVITY control and the x20 attenuator.



Reference	Item	Description
⑦	GATE TIME Indicators	These show the gate time as set by the selected resolution.
⑧	INPUT B Connector (1998) INPUT B Connector (1999) and O/load Indicator	BNC fused connector for inputs from 40 MHz to 1.3 GHz. N type connector for inputs from 80 MHz to 2.6 GHz. Overload indicator lights when B input signal exceeds 4.8 V ± 0.8 V. NOTE: Due to hysterisis, the input signal overload indicator will only be extinguished by substantially reducing the input signal voltage level.
⑨	INPUT A Connector	BNC connector for inputs from 10 Hz to 160 MHz.
⑩	50 Ω/1 MΩ Key	Used to select 50 Ω or 1 MΩ input impedance. The indicator lights when 50 Ω is selected.
⑪	INPUT A pulse offset key	Used to select the trigger level according to the mark/space ratio of the input waveform. The indicators show the mark/space ratio range: ⎍ low (less than 1:2.5) ∿ medium (1:2.5 to 2.5:1) ⎍ high (more than 2.5:1) The key selects each in turn at successive presses.

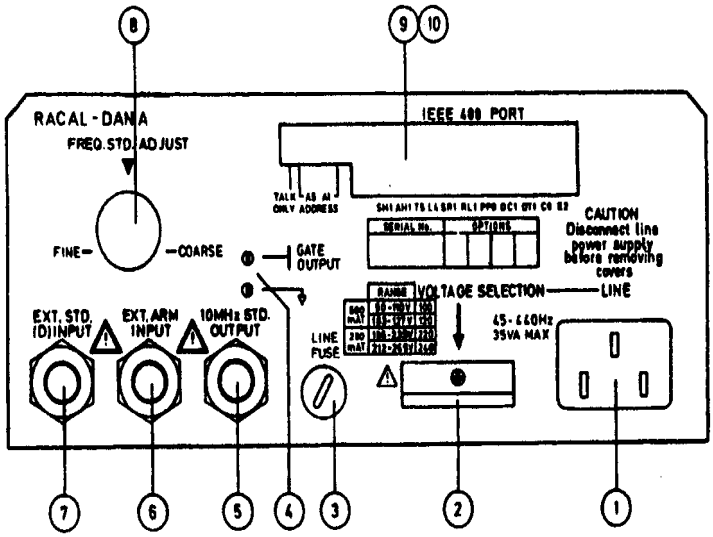
Reference	Item	Description
⑫	RECALL Key	Used in conjunction with NULL and RESET keys. [RECALL] [NULL] displays the value in the null store. [RECALL] [RESET] displays the GPIB address when this option is fitted.
⑬	NULL Key and Indicator	Key enables and disables the NULL function. At the time that the NULL function is enabled the currently-displayed value is stored in the null register. The indicator lights when NULL is selected.
⑭	HOLD Key and Indicator	Successive operations put the instrument into and out of the Hold (single-shot measurement) mode. The indicator lights when the instrument is in the Hold mode. Readings are triggered using the RESET key.
⑮	RESET/CONTINUE (LOCAL) Key	This key has three functions. RESET Clears the display and triggers a new measurement cycle when the instrument is in the measurement mode. CONTINUE Returns the instrument to the measurement mode and triggers a measurement cycle. It can also be used to clear the OP Er indication. LOCAL Returns the instrument to local control from remote GPIB control provided local lockout is not set.



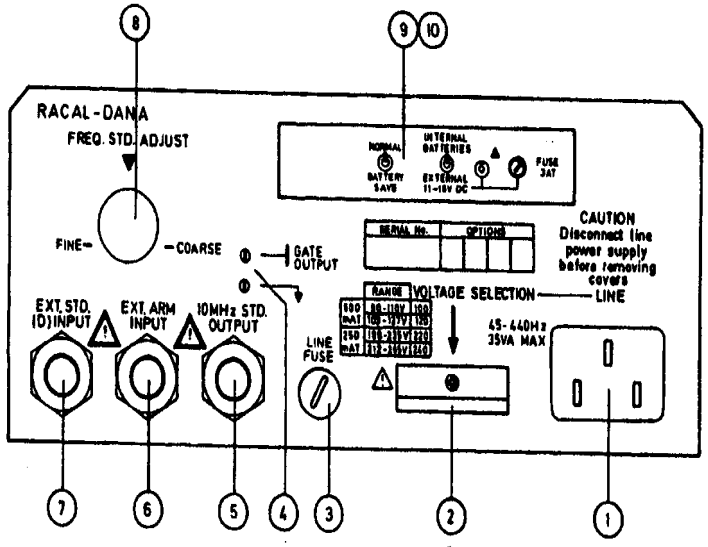
Reference	Item	Description
(16)	STBY/CHRG Key and Indicator	Successive operations switch the instrument into and out of the standby state. The indicator lights when the instrument is in the standby state. If the battery pack option is installed the indicator flashes when the battery approaches the discharged state. The battery is charged at the full rate when the instrument is in standby and external power is applied.
(17)	POWER Switch	Controls the AC or DC power to the instrument.

3 Rear Panel Items

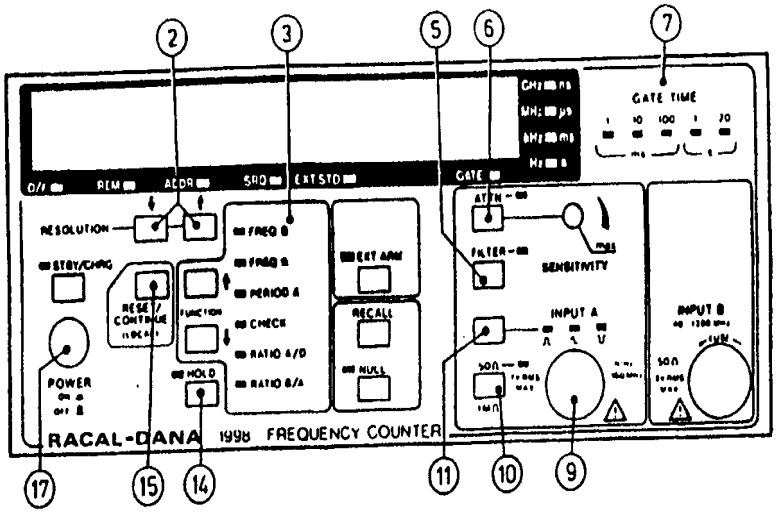
Reference	Item	Description
①	AC Power Input Plug	A standard connector for the AC power supply. A RFI filter is incorporated.
②	Line Voltage Selector	Voltage selection is changed by repositioning a printed circuit board. The voltage selected can be seen through a window in the retaining clamp of the card.
③	Line Fuse	A ¼ in x 1¼ in, surge-resistant, glass cartridge fuse. The required fuse ratings for different line voltage ranges are shown on the panel and in Section 3 of this manual.
④	GATE OUTPUT	The gate output is available at a pair of tags for use with hook probes. The gate waveform is delayed by 10 nsec typically (15 nsec maximum).
⑤	10 MHz STD OUTPUT	A BNC connector, providing a 10 MHz signal locked to the frequency standard in use.
⑥	EXT ARM INPUT	A BNC connector for accepting external arming signals.
⑦	EXT STD (D) INPUT	A BNC connector for connecting an external frequency standard input. The frequency required is 10 MHz unless the reference frequency multiplier option is fitted. With this option, frequencies of 1 MHz, 2 MHz, 5 MHz and 10 MHz are acceptable. This connector is also used as the signal input for channel D.
⑧	FREQ. STD. ADJUST	This aperture provides access to allow adjustment of the internal frequency standard.



Reference	Item	Description
(9)	GPIB Option	
	GPIB Address Switches	Switches A1 to A4 define the listen and talk addresses for GPIB operation in the addressed mode. The talk-only switch must be in the '0' position. With the talk-only switch in the '1' position the instrument is set to the talk-only condition. The positions of switches A1 to A5 are then irrelevant.
	GPIB Connector	An IEEE-488-1978 standard connector used to connect the instrument to the GPIB. An adapter, Racal-Dana part number 23-3254, to convert the connector to the IEC 625-1 standard is available as an accessory.



Reference	Item	Description
(10)	Battery-pack Option	
	External DC Input	Permits the instrument power to be derived from an external fused DC supply.
	Battery NORMAL/SAVE Switch	Used to select the Battery-Save facility.
	INTERNAL/EXTERNAL DC Supply Switch	Used to select operation from the internal battery or an external DC supply.
	DC Supply Fuse	A ¼ in x 1¼ in glass cartridge fuse of the surge-resistant type. The required rating is 3 AT.



FREQUENCY MEASUREMENT - INPUT A

4 This facility measures either sinewave or pulse-train. For measuring bursts of signal refer also to Paragraph 9.

(1) Press the POWER switch (17) to switch on.

(2) Select FREQ A, using the FUNCTION keys (3) .

(3) Select the required input impedance (10) and attenuation (6) .

(4) Select the trigger level (11) according to the mark/space ratio of the input waveform.

(5) Select the required display resolution, using the RESOLUTION keys (2) . Note that the gate time is related to the resolution. One of the GATE TIME indicators (7) will show the gate time.

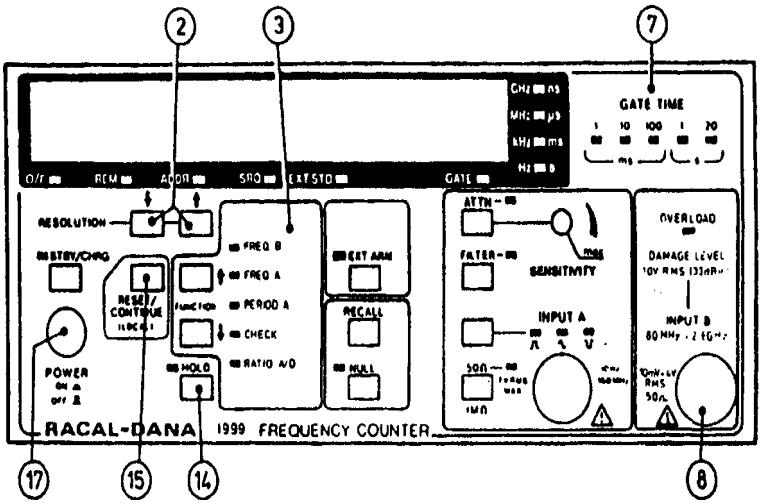
(6) If a frequency below 50 kHz is to be measured in the presence of HF noise, select the low-pass input filter (5) .

(7) Connect the signal to be measured to INPUT A (9) .

CAUTION: SIGNAL LEVEL
ENSURE THAT THE INPUT SIGNAL LEVEL DOES NOT EXCEED THE DAMAGE LEVELS SPECIFIED IN SECTION 1 OF THIS MANUAL.

(8) Adjust the SENSITIVITY control (6) for a stable reading (can usually be left at MAX).

(9) If hold mode operation is required, select HOLD (14) . To take a measurement, press the RESET key (15) . Check that the GATE indicator lights during the measurement period. To retun to the continuous measurement mode, press the HOLD key (14) again.



FREQUENCY MEASUREMENT - INPUT B

5 This facility measures either sinewave or pulse-train. For measuring bursts of signal, refer also to Paragraph 9.

(1) Press the POWER switch (17) to switch on.

(2) Select FREQ B, using the FUNCTION keys (3) .

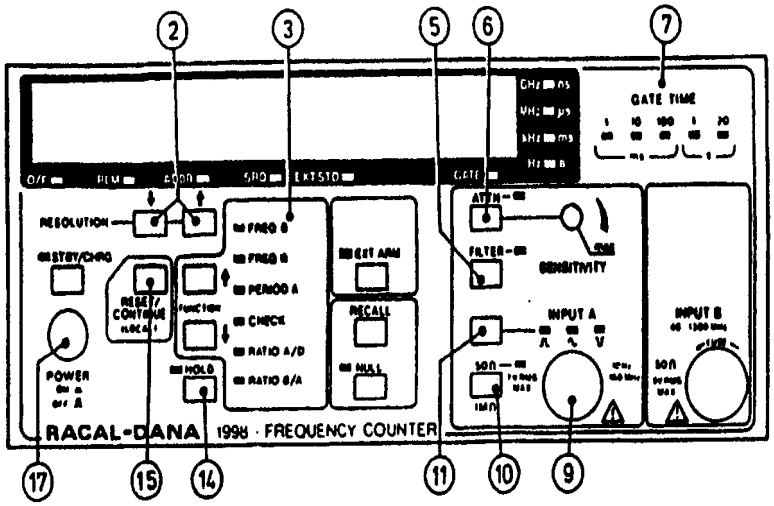
(3) Connect the signal to be measured to INPUT B (8) .

(4) Ensure overload LED is not lit. (1999 ONLY).

CAUTION: SIGNAL LEVEL
ENSURE THAT THE INPUT SIGNAL LEVEL DOES NOT EXCEED THE DAMAGE LEVELS SPECIFIED IN SECTION 1 OF THIS MANUAL.

(5) Select the required display resolution, using the RESOLUTION keys (2) . Note that the gate time is related to the resolution. One of the GATE TIME indicators (7) will show the gate time.

(6) If hold mode operation is required, select HOLD (14) . To take a measurement, press the RESET key (15) . Check that the GATE indicator lights during the measurement period. To return to the continuous measurement mode, press the HOLD key (14) again.



PERIOD MEASUREMENT

6 This facility measures the period of either sinewave or pulse-train signals. For period measurements on bursts of signal, refer also to Paragraph 9.

(1) Press the POWER switch (17) to switch on.

(2) Select PERIOD A, using the FUNCTION keys (3) .

(3) Select the required input impedance (10) and attenuation (6) .

(4) Select the trigger level 11 according to the mark/space ratio of the input waveform.

(5) Select the required display resolution, using the RESOLUTION keys (2) . Note that the gate time is related to the resolution. One of the GATE TIME indicators (7) will show the nominal gate time.

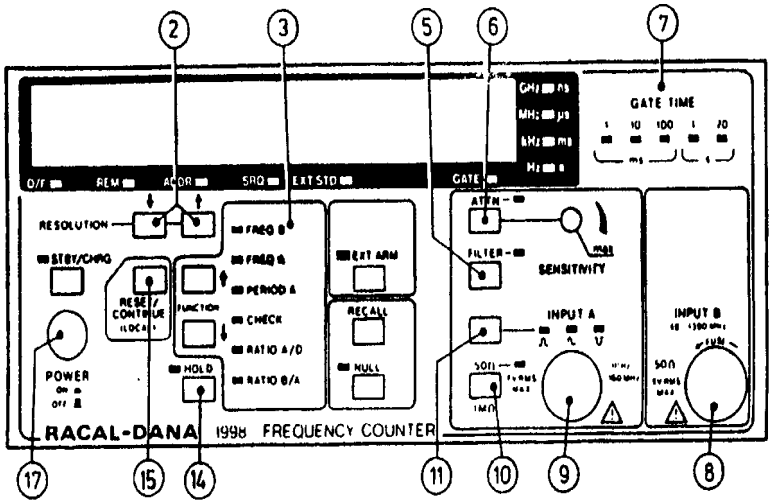
(6) If a frequency below 50 kHz is to be measured in the presence of HF noise, select the low-pass input filter (5) .

(7) Connect the signal to be measured to INPUT A (9) .

CAUTION: SIGNAL LEVEL
ENSURE THAT THE INPUT LEVEL DOES NOT EXCEED THE DAMAGE LEVELS SPECIFIED IN SECTION 1 OF THIS MANUAL.

(8) Adjust the SENSITIVITY control (6) for a stable reading (can usually be left at MAX).

(9) If hold mode operation is required, select HOLD (14) . To take a measurement, press the RESET key (15) . Check that the GATE indicator lights during the measurement period. To return to the continuous measurement mode, press the HOLD key (14) .



RATIO MEASUREMENT B/A (1998 only)

7 This facility measures the frequency ratio of the signals at INPUT B and INPUT A. It provides, for example, an easy way of setting an adjustable signal source to match that of a fixed source of an awkward value - simply adjust for a reading of 1.0.

(1) Press the POWER switch (17) to switch on.

(2) Select RATIO B/A, using the FUNCTION keys (3) .

(3) Select the required A channel input impedance 10 and attenuation (6) .

(4) Select the trigger level (11) according to the mark/space ratio of the input waveform.

(5) If a frequency of the A channel input is known to be below 50 kHz, and is in the presence of HF noise, select the low-pass input filter (5) .

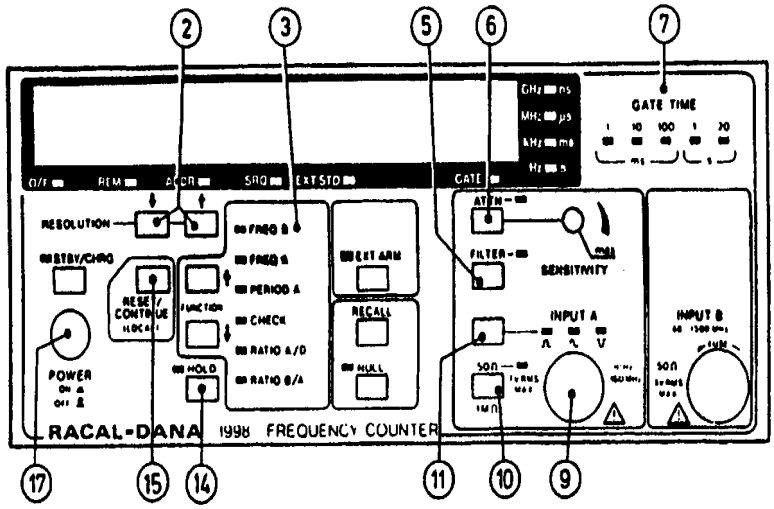
(6) Connect the lower-frequency signal to INPUT A (9) , and the higher-frequency signal to INPUT B (8) .

CAUTION: SIGNAL LEVEL
ENSURE THAT THE INPUT LEVEL DOES NOT EXCEED THE DAMAGE LEVELS SPECIFIED IN SECTION 1 OF THIS MANUAL.

(7) Adjust the SENSITIVITY control (6) for a stable reading (can usually be left at MAX).

(8) Select the required display resolution, using the RESOLUTION keys (2) . Note that the gate time is related to the resolution. One of the GATE TIME indicators (7) will show the nominal gate time.

(9) If hold mode operation is required, select HOLD (14) . To take a measurement, press the RESET key (15) . Check that the GATE indicator lights during the measurement period. To return to the continuous measurement mode, press the HOLD key (14) .



RATIO MEASUREMENT A/D

8 This facility measures the frequency ratio of the signals at INPUT A and the EXT. SD. (D) INPUT connector on the rear panel.

(1) Press the POWER switch (17) to switch on

(2) Select RATIO A/D, using the FUNCTION keys (3) .

(3) Select the required A channel input impedance (10) and attenuation (6) .

(4) Select the trigger level (11) according to the mark/space ratio of the input waveform.

(5) If a frequency below 50 kHz is to be measured in the presence of HF noise, select the low-pass input filter (5) .

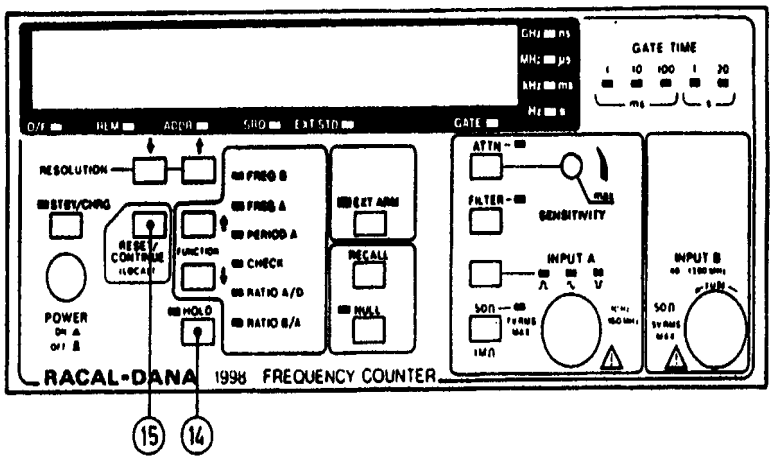
(6) Connect the higher-frequency signal to INPUT A (9) , and the lower-frequency input signal to the rear-panel EXT. STD. (D) INPUT connector.

CAUTION: SIGNAL LEVEL
ENSURE THAT THE INPUT LEVEL DOES NOT EXCEED THE DAMAGE LEVELS SPECIFIED IN SECTION 1 OF THIS MANUAL.

(7) Adjust the SENSITIVITY control (6) for a stable reading (can usually be left at MAX).

(8) Select the required display resolution, using the RESOLUTION keys (2) . Note that the gate time is related to the resolution. One of the GATE TIME indicators (7) will show the nominal gate time.

(9) If hold mode operation is required, select HOLD (14) . To take a measurement, press the RESET key (15) . Check that the GATE indicator lights during the measurement period. To return to the continuous measurement mode, press the HOLD key (14) .



SIGNAL BURST (SINGLE-SHOT) MEASUREMENT

9 This facility is for measuring individual burst of signals, either sinewave or pulse-train.

(1) Set the instrument up for normal measurements, as described in Paragraphs 4 to 8.

(2) Ensure that the displayed gate time selected is at least 1 msec shorter than the signal burst to be measured.

(3) Press the HOLD key (14) . If there is an existing reading on the display, this will be held.

(4) Press the RESET key (15) to clear the instrument's registers and prime the circuits ready for the input signal burst. The measurement will be preceded by a 1 ms delay to allow for the input signal settling time, and is initiated upon receipt of the input signal.

(5) Check that the GATE indicator lights during the measurement period.

(6) The reading is held until either a new measurement is primed by pressing RESET, or the HOLD key is pressed again to return the instrument to the continuous measurement mode.

NULL FACILITY

10 The null facility allows a displayed value to be entered into the internal NULL store. When the null facility is enabled (NULL indicator lit) the display indicates

(measured value minus the value held in the NULL store).

11 The null facility is available with the frequency, period and ratio functions.

12 (1) If nulling from the present measured value use the procedures given in Paragaphs 4 to 8 to make the instrument display the required value. If nulling from a value already in the NULL store, press

RECALL NULL .

The value in the NULL store will be displayed.

(2) To enable the NULL facility, press

NULL .

The NULL indicator will light. The displayed value will be entered into the NULL store. When a new measurement is made the display indicates the difference between the measured value and the value in the NULL store.

(3) To disable the null facility, press

NULL .

The NULL indicator will go out and the display will indicate the measured value. The value in the NULL store is unchanged.

13 The value held in the NULL store can be displayed at any time by pressing

RECALL NULL .

To return the instrument to the status existing before the NULL store contents were displayed press

CONTINUE .

EXTERNAL ARMING

14 External arming allows a measurement to be started at a particular time, so allowing measurements to be made on predetermined parts of the input waveform (such as a particular tone burst in a tone-burst sequence).

15 The start circuit is armed by a positive-going edge of the external arming signal. The gate will be opened by the signal to be measured. The gate time is set by the RESOLUTION controls. A new measurement cycle will be re-armed by the first external arming pulse received after the internal gate is closed and computation is completed. External arming pulses occurring while the gate is open are ignored.

16 External arming may also be used in conjunction with the hold facility. A single measurement will be made and held on the display following the receipt of an external arming pulse. Further arming pulses will be ignored until the RESET key is pressed. A new measurement cycle will then be started by the next arming pulse received.

17 External arming is enabled and disabled by pressing the EXT ARM key. The indicator lights when external arming is enabled.

18 The external arming signal is connected to the EXT ARM INPUT socket on the rear panel. The pulse must have a minimum duration of 200 ns. There is a delay of not more than 100 ns between the positive-going edge of the arming pulse and the completion of arming.

DISPLAY RESOLUTION

19 Resolution refers to the number of zeros displayed when no signal is applied at the input. The resolution can be set to display from 3 to 10 decimal places. A 10% overrange of the display is permitted without a change of range. Because of this, an additional digit with a value of 1 may appear at the more significant end of the display when measurements are made. With a resolution of 10 selected, the presence of this extra digit is shown by the overflow indicator.

20 When ratio measurements are made, no more than seven digits (plus a possible overrange digit) are displayed, regardless of the resolution selected.

21 The resolution is changed using the step-up ↑ and step-down ↓ keys. To step up from nine to ten digits, the step-up key must be held down for about two seconds.

GATE TIME

22 Gate time is related to the resolution selected, as shown in Table 4.1.

TABLE 4.1

Resolution and Gate Time

Resolution	Gate Time
10	20 s
9	1 s
8	100 ms (see NOTE 2)
7	10 ms
6	1 ms
5	1 ms
4	1 ms (see NOTE 3)
3	1 ms

NOTE 1:
The gate times shown are nominal. Due to the use of the reciprocatic counting technique the gate time may be extended by:

(1) Up to two periods of the input signal on FREQ A and PERIOD A.

(2) Up to 64 (for 1998); 256 (for 1999) periods of the input signal on FREQ B.

(3) Up to one period of the input signal on channel A when measuring RATIO B/A (1998 only) or RATIO A/D.

NOTE 2:
A resolution of 8 is selected when the instrument is first switched on.

NOTE 3:
With resolutions of 3, 4 and 5 selected, measurements are averaged.

GATE OUTPUT SIGNAL

23 The internally generated gate waveform is available at the GATE OUTPUT connectors on the rear panel. The waveform is delayed by not more than 15 ns relative to the true measurement period.

24 This waveform can be used, together with external arming, to assist in selecting a single tone burst from a tone burst sequence. Displaying the signal to be measured and the gate waveform on an oscilloscope allows the external arming pulse to be delayed until the gate time falls within the specific burst of interest.

25 When the instrument is operating in the hold mode, the gate waveform is preceded by a 100 µs prepulse and a hold-off period of approximately 1 ms.

26 Typical gate waveforms are shown in Fig 4.1.

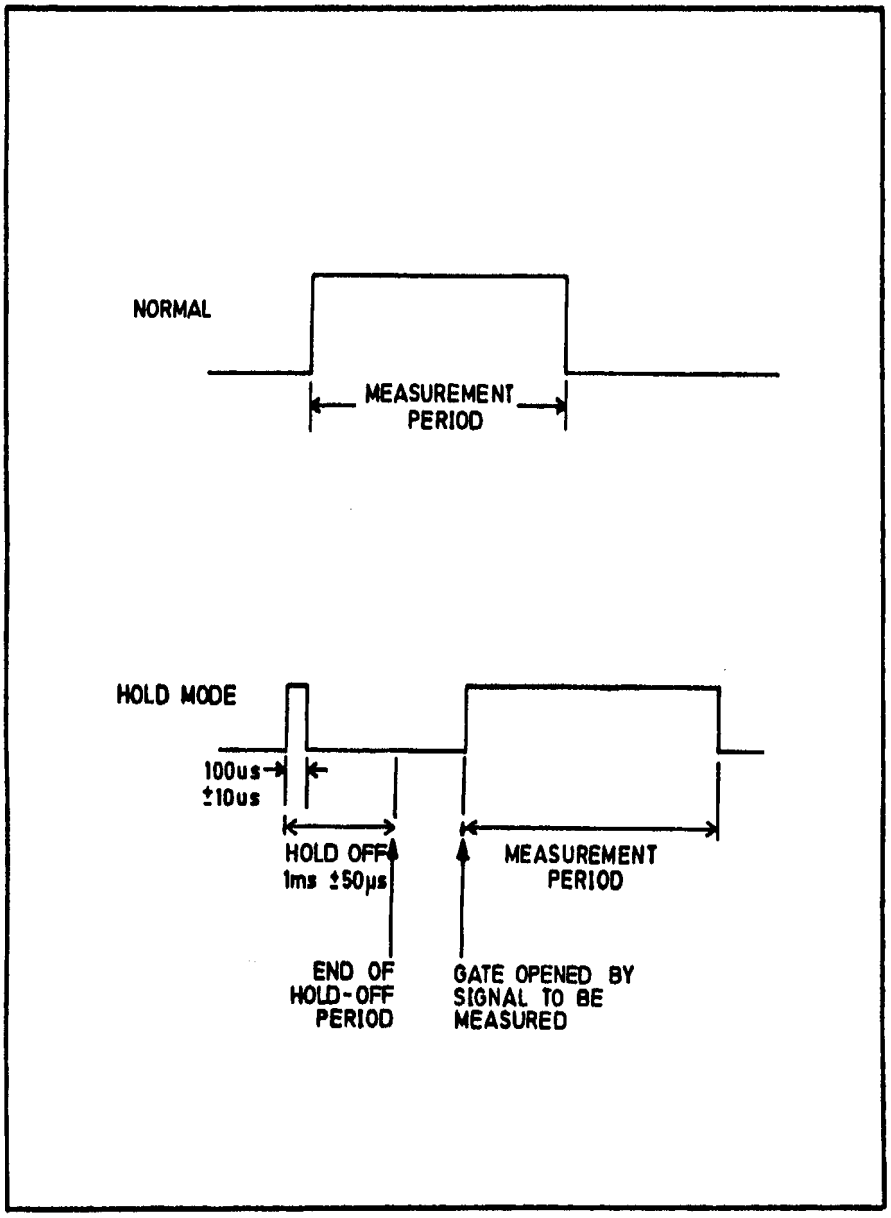


Fig. 4.1 Gate Output Waveforms

ERROR CODES

27 The instrument is able to detect a number of error states, which are indicated on the display. The meanings of the error codes are shown in Table 4.2.

TABLE 4.2

Error Codes

Display	Error
Er 02	Measurement result too large for the display.
Er 03	Overflow of internal counters.
Er 05	Programming error (GPIB only).
Er 50	Incorrect result obtained when in check mode.
Er 61	RAM failure.

Clearing the Error Codes

28 Error codes Er 02 and Er 03 are cleared by:

(1) Obtaining a measurement result that is within range.

(2) Selecting another measurement function.

USING THE BATTERY PACK OPTION

WARNING: LETHAL VOLTAGE
IF MEASUREMENTS ARE MADE ON SIGNAL SOURCES AT VOLTAGES ABOVE 50 V DC WITH THE INSTRUMENT POWERED FROM THE INTERNAL BATTERY OR AN EXTERNAL DC SUPPLY THE GROUND CONNECTOR OF THE AC POWER INPUT MUST BE CONNECTED TO GROUND.

Power Supply Changeover

29 When the battery pack option is installed, the instrument can be powered from the internal battery, an external DC supply of 11 V to 16 V, or an external AC supply. If the instrument is operating from either the external DC supply or the battery, it will automatically change to operation from the AC supply when this is connected. To prevent accidental battery discharge, the battery will not take over from either the AC or DC supply if that supply fails. An external DC supply will not take over from the AC supply if the AC supply fails.

Battery-Low Indication

30 When the instrument is operating from the internal battery, or from an external DC supply, the STBY/CHRG indicator will start to flash as the supply voltage approaches the minimum permissible level. This occurs regardless of whether the instrument is in the standby mode or not. When operating from the battery, the instrument can be used in the measurement mode for approximately 15 minutes after the indicator commences flashing.

31 When the voltage of the battery or the external DC supply reaches the minimum permissible level, the instrument shuts down completely.

Operating Instructions

32 Instructions for preparing the instrument to make measurements are given in the following paragraphs. No other change in the operating procedure is required.

Operating From the Battery

33 (1) Set the internal/external switch on the rear panel to INTERNAL BATTERIES.

(2) Set the BATTERY SAVE/NORMAL switch to NORMAL.

(3) Switch the instrument on.

(4) Check that the instrument goes through the normal switch-on sequence. If the STBY indicator is flashing, or if there is no display, charge the battery.

34 If the battery-save facility is to be used, set the BATTERY SAVE/NORMAL switch to BATTERY SAVE. The instrument will remain in the measurement mode for approximately one minute and will then switch to standby. It can be returned to the measurement mode for a further period of one minute by pressing the STBY/CHRG key.

Operation From an External DC Supply

35 (1) Ensure that the instrument is switched off.

(2) Connect the DC supply to the DC power-input plug on the rear panel. The mating connector is a 2.1 mm coaxial socket.

CAUTION: SUPPLY POLARITY
THE POSITIVE SIDE OF THE SUPPLY MUST BE CONNECTED TO THE CENTRE CONDUCTOR.

(3) Set the internal/external switch on the rear panel to EXTERNAL 11-16 V DC.

(4) Switch the instrument on. Check that the instrument goes through the normal switch-on sequence.

If the external DC supply is interrupted the instrument will not necessarily power-up again when the supply voltage is restored. In this event, switch off and then on again using the front-panel POWER switch.

Battery Charging

36 The battery is trickle-charged whenever the instrument is operated from an AC supply and the internal/external switch is at INTERNAL BATTERIES. To charge the battery at the full rate, connect the instrument to an external AC or DC supply, switch on and select the standby mode.

SECTION 5 OPERATION VIA THE GPIB

INTRODUCTION

1 The instrument must be prepared for use in accordance with the instructions given in Section 3. If the instrument is being used for the first time, or at a new location, pay particular attention to the setting of the AC line voltage selector.

GPIB OPERATING MODES

2 The instrument can be operated via the GPIB in either the addressed mode or the talk-only mode.

TALK-ONLY MODE

3 The talk-only mode may be used in systems which do not include a controller. Such a system permits remote reading of the instrument's measurement data, but the instrument is operated by means of the front-panel controls as described in Section 4.

4 The rate at which measurements are made is determined by the instrument. The output buffer is updated at the end of each measurement cycle, overwriting the previous measurement data if this has not been transferred to the listener.

5 The transfer of data from the instrument to the listener is triggered by the listener. The instrument's output buffer is cleared when the data transfer is complete. Problems arising from the differences between the measurement rate and data transfer trigger rate are resolved according to the following protocol:

(1) If data transfer is in progress at the end of a measurement cycle, the updating of the output buffer is delayed. The data transferred will relate to the previous measurement cycle.

(2) If the data transfer trigger occurs during a measurement cycle and the output buffer is empty, data transfer will be delayed until the buffer is updated. The data transferred will then relate to the latest measurement cycle.

(3) If a measurement cycle is completed before the results of the previous cycle have been transferred to the listener, the buffer will be updated. The data for the previous cycle will be overwritten and lost.

6 The rate at which measurements are made can be controlled in the following ways:

(1) The gate time of the instrument (duration of the measurement cycle) can be controlled by choosing an appropriate display resolution.

(2) The instrument can be operated in the hold mode. Single measurement cycles can be triggered, when required, by means of the RESET key.

7 The format of the data output is described in Table 5.1

ADDRESSED MODE

8 In addressed-mode operation, all the instrument's functions, except the channel A sensitivity potentiometer setting and the power ON/OFF and standby switching, can be controlled by means of device-dependent commands, sent via the bus, when the instrument is addressed to listen. The measurements made, and data regarding the instrument's status, can be read via the bus when the instrument is addressed to talk. If the instrument is addressed to talk when the output buffer is empty, no data transfer can take place and bus activity will cease. Data transfer will commence when the output buffer is updated at the end of the next measurement cycle.

DATA OUTPUT FORMAT

9 The same output message format is used for the transmission of measured values and numbers recalled from the instrument's internal stores. The message consists of a string of 21 ASCII characters for each value transmitted. These are to be interpreted as shown in Table 5.1. The units should be assumed to be Hz, seconds, or a ratio, depending upon the commands previously given to the instrument.

DEFERRED COMMANDS AND IMMEDIATE COMMANDS

10 Some commands (known as Deferred Commands) are accepted until a terminating character or message is received, see Table 5.5. The whole string will then be obeyed. Other commands (known as Immediate Commands) are obeyed as soon as they are received. These are indicated, in Table 5.16, by an asterisk.

Example: OUTPUT 716; FA ALI SRS85 S81 CR LF

Because SRS is an immediate command, Frequency A, A Channel Negative Slope, and 5 digit Resolution will be set following receipt of SRS5.

TABLE 5.1

Output Message Format

Byte No	Interpretation	Permitted ASCII Characters
1	Function letter	See Table 5.2
2	Function letter	
3	Sign of measurement	+ or -
4	Most significant digit	0 to 9
5	Digit	0 to 9 or .
6	Digit	0 to 9 or .
7	Digit	0 to 9 or .
8	Digit	0 to 9 or .
9	Digit	0 to 9 or .
10	Digit	0 to 9 or .
11	Digit	0 to 9 or .
12	Digit	0 to 9 or .
13	Digit	0 to 9 or .
14	Digit	0 to 9 or .
15	Least significant digit	0 to 9 or .
16	Exponent indicator	E
17	Sign of exponent	+ or -
18	More significant digit	0 to 9
19	Less significant digit	0 to 9
20	Carriage return	CR
21	Line Feed	LF

NOTE 1:
Bytes 4 to 15 will always include 11 digits and a decimal point. Zeros will be added, where necessary, in the more significant digit positions.

NOTE 2:
The exponent indicated by bytes 18 and 19 will always be a multiple of three.

NOTE 3: (1999 only)
When B input is overloaded the frequency result will read 9.999999999 GHz.

TABLE 5.2

Function Letters

Function	Function Letters
Frequency A	FA
Frequency B	FB
Ratio A/D	RA
Ratio B/A (1998 only)	RB
Period A	PA
Check	CK
Recalled Data	**Function Letters**
Unit type	UT
Resolution	RS
Null store	NS
Special function	SF
Master software issue number	MS
GPIB software issue number	GS

NOTE:
Spaces are substituted for the function letters when special function S81 is active.

SERVICE REQUEST

11 The instrument can be set, by means of device-dependent commands, to generate the service request message (SRQ) when:

(1) A measurement cycle is completed.
(2) A change of frequency standard occurs.
(3) An error state is detected.
(4) Any combination of (1), (2) and (3).

12 The generation of the SRQ may also be inhibited. The necessary commands are given in Table 5.15. Option (3) of Paragraph 11 is selected when the instrument is first switched on.

STATUS BYTE

The format of the status byte, generated in response to a serial poll, is given in Table 5.3.

TABLE 5.3

Status Byte Format

DIO Line	Function
1	LSB ┐
2	├ Number of error detected (binary)
3	MSB ┘ (See NOTE 1)
4	'1' = frequency standard changed
5	'1' = reading ready (See NOTE 2)
6	'1' = error detected
7	'1' = service requested
8	'1' = gate open

NOTE 1:
The error code numbers which can occur are:

2 Result out of range of the display.
3 Overflow of internal counters.
4 Error in numerical entry.
5 Syntax error in GPIB command.

No measurement data string is available if error code 2 or 3 is generated.

NOTE 2:
Regardless of the SRQ mode in use, the SRQ message that a reading is ready is not generated following a data-recall operation.

NOTE 3:
The errors are cleared as follows:

Error 2: The error is cleared when an in-range measurement is completed.

Error 3: The error is cleared when an in-range measurement is completed.

Error 4: The error is cleared when a valid numerical entry is made.

Error 5: The command string will be correctly executed up to the point at which the error occurs. The remainder of the string will be hand-shaken, but not executed. The error is cleared when the next valid command is received.

EXPLANATION OF RESPONSE TO INTERFACE MESSAGES

14 The instrument will respond to all valid device-dependent commands which are received after it has been addressed to listen. Device-dependent commands are recognised as such because they are transmitted with the attention (ATN) message false.

15 The instrument also responds to a number of multi-line interface messages. These are recognised because they are transmitted with the ATN message true. Table 5.4 gives the instrument's response to different bus messages. The following paragraphs detail the instrument's response to these messages. Any multi-line message not specifically mentioned is hand-shaken, but is otherwise ignored.

Address Messages

16 The instrument responds to address messages defined by the setting of the address switches, A1 to A5, on the rear panel.

17 On receipt of its listen address, the instrument becomes a listener. If it has previously been addressed to talk it ceases to act as a talker. If in the local control state when the address is received, the instrument goes to the remote control state provided that the REN message is true.

18 On receipt of its talk address, the instrument becomes a talker. If it has previously been addressed to listen it ceases to act as a listener. If in the local control state when the address is received, it will remain under local control.

19 If the instrument has been addressed to talk, and then receives the talk address of another device, it ceases to act as a talker.

Local Lockout

20 The instrument will respond to the local lockout (LLO) message regardless of its addressed state. The return-to-local function of the LOCAL key on the front panel is disabled (the RESET/CONTINUE function remains enabled when in local control).

21 Local lockout is cleared by sending the remote enable (REN) message false. This returns all devices on the bus to the local control state.

Device Clear and Selected Device Clear

22 The instrument only responds to the device clear (DCL) message and the selected device clear (SDC) message when it is in the remote control state. It will only respond to the SDC message if it is a listener, but will respond to the DCL message regardless of its addressed state.

23 The instrument responds to either message by reverting to the functions and settings of the power-up state. No change is made to the condition of the GPIB interface.

TABLE 5.4

Response to Bus Messages

Message	Addressed State	Instrument Response
Address	Any	For listen address: Becomes a listener and goes to the remote control state. If previously addressed to talk, ceases to act as a talker. For talk address: Becomes a talker. If previously addressed to listen, ceases to be a listener. For talk address of another device: If previously addressed to talk, ceases to be a talker.
Local Lockout (LLO)	Any	LOCAL key disabled. (Cleared by sending the REN message false).
Device Clear (DCL) Selected Device Clear (SDC)	Any, but must be in remote control. Listen and in remote control	Reverts to power-up state.
Serial Poll Enable (SPE) Serial Poll Disable (SPD)	Any Any	Enters the serial poll mode state (SPMS). If addressed to talk while in this state, sends the status byte. Enters the serial poll idle state (SPIS). If addressed to talk while in this state, sends data in the output message format.
Group Execute Trigger (GET)	Listen, and no measurement cycle in progress	Takes a measurement.
Go to Local (GTL)	Listen	Reverts to local control.
Untalk Unlisten	Talk Listen	Ceases to be a talker. Ceases to be a listener. The ADDR indicator is turned off.

Serial Poll Enable and Serial Poll Disable

24 The instrument responds to both the serial poll enable (SPE) message and the serial poll disable (SPD) message regardless of its addressed state.

25 The instrument responds to the SPE message by entering the serial poll mode state (SPMS). If the instrument is addressed to talk while in this state, it will put its status byte onto the bus instead of its normal data output string.

26 The instrument responds to the SPD message by leaving the SPMS and entering the serial poll idle state (SPIS). If the instrument is addressed to talk while in this state, it will put its data output string onto the bus provided data is available in the output buffer.

Group Execute Trigger

27 The instrument responds to the group execute trigger (GET) message provided that it is a listener and no measurement cycle is in progress. Except for the inability to retrigger during a measurement cycle, the response to the GET message is the same as to the device-dependent command T2.

Go to Local

28 The instrument responds to the go to local (GTL) message provided that it is a listener. The instrument reverts to the local control state, but remains addressed to listen. It will return to remote control on receipt of the first byte of a device-dependent command.

Untalk and Unlisten

29 If addressed to talk, the instrument will go to the talker idle state (TIDS) on receipt of the untalk message. If addressed to listen, it will go to the listener idle status (LIDS) on receipt of the unlisten message. The ADDR indicator will be turned off.

INPUT COMMAND CODES

29 When the instrument is addressed to listen it can be controlled by means of device-dependent commands given in Table 5.6 to 5.15. All the device-dependent commands are listed in alphabetic order in Table 5.16.

31 If more than one command is to be sent. no delimiters are required. If necessary, commas, spaces and semicolons may be included in command strings as an aid to clarity without affecting the operating of the instrument. Each command string must be followed by an end-of-string terminating group. The permitted terminating groups are shown in Table 5.5.

TABLE 5.5

Permitted Terminators

1	2	3	4	5	6
LF	LF EOI true	CR EOI true	CR LF	CR LF EOI true	Last Character EOI true

NOTE: LF = Line feed
CR = Carriage return

TABLE 5.6

Instrument Preset Code

Function	Code
Set instrument functions and settings to the power-up state	IP

TABLE 5.7

Measurement Function Codes

Function	Code
Frequency A	FA
Frequency B	FB
Period A	PA
Ratio A/D	RA
Ratio B/A (1998 only)	RB
Check	CK

TABLE 5.8

Input Control Codes (Channel A)

Function	Code
1 MΩ input impedance selected	AHI
50 Ω input impedance selected	ALI
Positive pulse offset (M/S ratio less than 1:2.5) selected	APS
Sinewave offset (M/S ratio between 1:2.5 and 2.5:1) selected	ASS
Negative pulse offset (M/S ratio more than 2.5:1) selected	ANS
X20 attenuator disabled	AAD
X20 attenuator eanabled	AAE
Channel A filtering enabled	AFE
Channel A filtering disabled	AFD

TABLE 5.9

Measurement Control Codes

Function	Code
Select continuous measurement mode	TØ (see NOTE 1)
Select one-shot measurement mode	T1 (see NOTE 2)
Take one measurement	T2
Null disabled	ND
Null enabled	NE
Reset (Stop measurement cycle and clear output buffer)	RE

NOTE 1:
When making continuous measurements the output buffer is updated at the end of each gate period. If the buffer is being read via the GPIB when the gate period ends, updating is delayed until reading is complete.

NOTE 2:
When one-shot measurements are being made, the output buffer is cleared each time command T2 is received. The measurement made must, therefore, be read before a further measurement cycle is triggered.

TABLE 5.10

Store and Recall Codes

Function	Code
Recall unit type	RUT
Store display resolution number	SRS
Recall display resolution number	RRS
Store null value	SN
Recall null value	RN
Recall special function register	RSF
Recall master software issue number	RMS
Recall GPIB software issue number	RGS

NOTE 1:
Numbers to be stored should follow the store command. The format to be used for numerical entry is given in Table 5.11. The limiting values for numerical entries are given in Table 5.12.

NOTE 2:
The instrument returns to the measurement mode automatically at the completion of a store or recall operation.

NOTE 3:
No SRQ message is generated for recalled data.

TABLE 5.11

Numerical Input Format

Byte No	Interpretation	Permitted ASCII Characters
1	Sign of mantissa	+ or -
2	Most significant digit	0 to 9 or .
3	Digit	0 to 9 or .
4	Digit	0 to 9 or .
5	Digit	0 to 9 or .
6	Digit	0 to 9 or .
7	Digit	0 to 9 or .
8	Digit	0 to 9 or .
9	Digit	0 to 9 or .
10	Digit	0 to 9 or .
11	Digit	0 to 9 or .
12	Least significant digit	0 to 9 or .
13	Exponent indicator	E or e
14	Sign of exponent	Space, + or -
15	More significant digit	0 to 9
16	Less significant digit	0 to 9

NOTE 1:
Spaces, nulls or zeros occurring immediately before byte 1 will be ignored.

NOTE 2:
Byte 1 may be omitted. A positive mantissa will then be assumed.

NOTE 3:
Bytes 2 to 12 may contain up to ten digits and a decimal point. If more than ten digits are entered without a decimal point, excess digits will be truncated. The excess digits will, however, increase the power of ten stored.

If fewer than ten digits are required the unused bytes may be omitted.

NOTE 4:
Spaces or nulls entered between bytes 12 and 13 will be ignored.

NOTE 5:
The exponent group, bytes 13 to 16, may be omitted.

NOTE 6:
Byte 14 may be omitted or transmitted as a space. In either case a positive exponent will be assumed.

NOTE 7:
Byte 16 may be omitted for a single-digit exponent.

TABLE 5.12

Numerical Input Range

Function	Command Code	Numerical Limits	
		Low	High
Null Store	SN	1×10^{-9}	1×10^{10}
		0	
		-1×10^{10}	-1×10^{-9}

TABLE 5.13

Gate Times

Number of digits in Freq. Period and Check	Gate Time	Resolution Number
10	20 s	10
9	1 s	9
8	100 ms	8
7	10 ms	7
6	1 ms	6
5	1 ms	5
4	1 ms	4
3	1 ms	3

TABLE 5.14

Special Function Codes

Function	Code
Internal arm	S10
External arm	S11
Basic 10 MHz check	S70
Indicators check	S71
These codes are reserved for diagnostic purposes and are described in the Maintenance Manual	S72 S73 S74 S75
Leading (function) letters in O/P string	S80
No leading (function) letters in output string	S81

NOTE:
Special functions 71 to 75 can be entered into the special functions register at any time. They are active only when the instrument is in the Check mode.

TABLE 5.15

Service Request Codes

Function	Code
Inhibit generation of SRQ	Q0
SRQ generated when error is detected	Q1
SRQ generated for measurement ready	Q2
SRQ generated for measurement ready or error detected	Q3
SRQ generated for frequency standard changeover	Q4
SRQ generated for frequency standard changeover or error detected	Q5
SRQ generated for measurement or frequency standard changeover	Q6
SRQ generated for measurement ready, error detected or frequency standard changeover	Q7

NOTE:
SRQ is not generated by data recalled from store.

TABLE 5.16

Alphabetic List of Command Codes

	Code		Code		
	AAD	A channel X20 attenuator disabled	PA	Period A	
	AAE	A channel X20 attenuator enabled	Qn	SRQ mode	*
	AFD	A channel filtering disabled	RA	Ratio A/D	
	AFE	A channel filtering enabled	RB	Ratio B/A (1998 only)	
	AHI	A channel, 1 MΩ	RE	Reset measurement	
	ALI	A channel, 50 Ω	RGS	Recall GPIB software issue	*
	ANS	A channel, negative pulse offset	RMS	Recall master software issue number	* *
	APS	A channel, positive pulse offset	RN	Recall null value	*
	ASS	A channel sinewave offset	RRS	Recall resolution	*
	CK	Check	RSF	Recall special function	*
	FA	Frequency A	RUT	Recall unit type	*
	FB	Frequency B	Snn	Special function	
*	IP	Instrument preset	SN	Store null value	*
*	ND	Null disabled	SRS	Store resolution	*
*	NE	Null enabled	Tn	Measurement mode or trigger a reading	

NOTE:
n represents a single digit.
* indicates an Immediate mode command. (See Page 5-2).