PART 3

1281 Performance

Final Width = 175mm

Section 6 Specifications

Section 7 Specification Verification

Section 8 Routine Calibration

final width = 175mm

SECTION 6 SPECIFICATIONS

SECTION 6 SPECIFICATIONS

GENERAL

POWER SUPPLY	Voltage: 100V-130V or 200V-260V (Selectable from Rear Panel). Line Frequency: 47Hz to 63Hz. Power: 50 VA max.
MECHANICAL	Height: 88mm (3.46ins). Width: 427mm (16.8ins). Overall Depth: 488mm max (19.2ins), which includes 18mm (0.71ins) of extended terminals. Rack Depth: 467mm (18.4ins) excluding Rear Panel connectors. Rack Mounting: Rack mounting ears to fit standard 19inch rack (ANSI-E1A-310-C). Conversion to accept 0.5ins wide slides, including MATE standard (Drg. No. 2806701, Sperry). Weight: 13.5kg (30 lbs) approx.
TEMPERATURE	Operating: 0°C to 50°C. Storage: -40°C to 75°C.
HUMIDITY RANGE	Operating (non-condensing): 0°C to 30°C : < 95% ± 5% RH. 30°C to 40°C : <75% ± 5% RH. 40°C to 50°C : < 45% ± 5% RH.
ALTITUDE	Operating: 0-3,050m (10,000 feet). Non-Operating: 0-12,000m (40,000 feet)
SHOCK AND VIBRATION	Meets the requirements of: MIL-T-28800C, Type III, Class 5, Style E equipment
SAFETY	Meets the requirements of : UL 1244 • ANSI C39.5 Draft 5 • • EN61010-1:1993/A2:1995 • BSI 4743.
WARM UP	4 hours to full accuracy.
AUTORANGE	Range Up: 200% of nominal range. Range Down: 18% of nominal range.
DIGITAL ERROR	Computation: ±1 digit (assumes no error in stored value). Spec. readout: <1% of displayed spec.
MEASUREMENT ISOLATION	'Guard' to Safety Ground: <300pF, >10GΩ; 'Lo' to 'Guard' in Remote Guard : <700pF, >10MΩ. In Local Guard, the 'Lo' and 'Guard' terminals are internally short circuited.

Final Width = 175mm

Maximum RMS Inputs

N.**B**. Refer to *page 6-4* for notes to these tables.

Front Terminals

DC and AC Voltage

Hi	Lo	I+	I-	Guard	Ω Guard	Safety Ground	Logic Ground
1000V							
250V	1000V						
1000V	250V	1000V					
1000V	250V	1000V	250V				
1000V	250V	1000V	250V	250V			
1000V	650V	1000V	650V	650V	650V		
1000V	650V	1000V	650V	650V	650V	0V	

DC and AC Current

Hi	Lo	I+	I-	Guard	Ω Guard	Safety Ground	Logic Ground
250V							
250V	250V						
250V	250V	250V					
250V	250V	250V	250V				
250V	250V	250V	0V	250V			
900V	650V	900V	650V	650V	650V		
900V	650V	900V	650V	650V	650V	0V	

Resistance

Hi	Lo	I+	I-	Guard	Ω Guard	Safety Ground	Logic Ground
250V							
250V	250V						
250V	250V	250V					
250V	250V	250V	250V				
250V	250V	250V	250V	250V			
900V	650V	900V	650V	650V	650V		
900V	650V	900V	650V	650V	650V	0V	

Final Width = 175mm

Maximum RMS Inputs

N.**B**. Refer to *page 6-4* for notes to these tables.

Channels A and B (Rear Inputs)

DC and AC Voltage

Hi	Lo	I+	I-	Guard	Ω Guard	Safety Ground	Logic Ground
50V							
50V	50V						
50V	50V	50V					
50V	50V	50V	50V				
50V	50V	50V	50V	50V			
50V	50V	50V	50V	50V	50V		
50V	50V	50V	50V	50V	50V	0V	

DC and AC Current

Hi	Lo	I+	I-	Guard	Ω Guard	Safety Ground	Logic Ground
50V							
50V	50V						
50V	50V	50V					
50V	50V	50V	50V				
50V	50V	50V	0V	50V			
50V	50V	50V	50V	50V	50V		
50V	50V	50V	50V	50V	50V	0V	

Final Width = 175mm

Resistance

Hi	Lo	I+	I-	Guard	Ω Guard	Safety Ground	Logic Ground
50V							
50V	50V						
50V	50V	50V					
50V	50V	50V	50V				
50V	50V	50V	50V	50V			
50V	50V	50V	50V	50V	50V		
50V	50V	50V	50V	50V	50V	0V	

Maximum RMS Inputs

Notes to Maximum Input Tables

[1] Maximum RMS inputs specified assume a peak of < RMS x 1.414

[2] Maximum differential ‘stand off’ voltage between channels must not exceed the maximum specified voltage of the Front Terminals.

Maximum ‘switched’ voltage between channels must not exceed the maximum specified voltage of either channel (whichever is the lower input limit).

[3] All ‘In-Guard’ inputs are flash-tested with respect to ‘Safety Ground’ at 2.5kV in accordance with UL 1244.

[4] Maximum slew rate of ‘Guard’ with respect to ‘Safety Ground’ or ‘Logic Ground’ is:

Transient immunity (no corruption):	1kV/µs
Transient protection (no damage):	10kV/µs

[5] With ‘Remote Guard’ not selected, ‘Guard’ is internally linked to ‘Lo’, so for the selected channel(s), all limits between these terminals reduce to zero.

[6] ‘Logic Ground’ is internally connected to ‘Safety Ground’.

[7] Current ranges are protected against overload by a rear panel fuse.

Final Width = 175mm

ACCURACY

DC Voltage

Range [1]	**Accuracy Relative to Calibration Standards** [2][3] ± [ppmR + ppmFS] [4]			**Calibration Uncertainty** [ppm]	**Temperature Coefficient** [ppm/°C] 13°C - 18°C 28°C - 33°C	
	24 hour	**1 Year**				
		Normal	Enhanced			
	23°C ± 1°C	23°C ± 5°C	23°C ± 5°C [5][6]	[7]	Normal	Enhanced[5]
100.000 00mV	1 + 0.5	7 + 0.5	6 + 0.5	6.5	0.6	0.3
1.000 000 00V	0.5 + 0.2	6 + 0.2	3 + 0.2	3.5	0.5	0.25
10.000 000 0V	0.5 + 0.1	6 + 0.1	3 + 0.1	2.5	0.5	0.25
100.000 000V	1 + 0.2	10 + 0.2	6 + 0.2	3.5	0.8	0.4
1000.000 00V	1 + 0.2	10 + 0.2	6 + 0.2	3.5	0.8	0.4

Final Width = 175mm

DC CURRENT (Option 30)

Range [1]	**Accuracy Relative to Calibration Standards** [2][3] ± [ppmR + ppmFS] [4]			**Calibration Uncertainty** [ppm]	**Temperature Coefficient** [ppm/°C] 13°C - 18°C 28°C - 33°C	
	24 hour	**1 Year**				
		Normal	Enhanced			
	23°C ± 1°C	23°C ± 5°C	23°C ± 5°C [5][6]	[7]	Normal	Enhanced[5]
100.000 0µA	20 + 2	100 + 2	25 + 2	35	12	8
1.000 000mA	20 + 2	100 + 2	25 + 2	20	12	8
10.000 00mA	20 + 2	100 + 2	25 + 2	20	12	8
100.000 0mA	30 + 5	100 + 5	50 + 5	25	12	8
1.000 000A	100 + 10	200 + 10	150 + 10	40	12	10

Final Width = 175mm

AC VOLTAGE - Option 10 [8][9][10]

Range [1] and **Frequency**	**Accuracy Relative to Calibration Standards** [2][3] ± [ppmR + ppmFS] [4]			**Calibration Uncertainty** [ppm] [7]	**Temperature Coefficient** [ppm/°C] 13°C - 18°C 28°C - 33°C	
	24 hour 23°C ± 1°C	**1 Year** Normal 23°C ± 5°C	Enhanced 23°C ± 5°C [5] [6]		Normal	Enhanced
100.000 0mV						
1Hz - 10Hz [16]	80 + 70	100 + 70	100 + 70		20	10
10Hz - 40Hz	80 + 20	120 + 20	120 + 20	155	20	10
40Hz - 100Hz	60 + 20	100 + 20	100 + 20	155	15	5
100Hz - 2kHz	40 + 10	100 + 10	100 + 10	155	15	5
2kHz - 10kHz	60 + 20	100 + 20	100 + 20	155	15	5
10kHz - 30kHz	250 + 30	300 + 40	300 + 40	220	20	10
30kHz - 100kHz	400 + 100	700 + 100	700 + 100	430	50	40
1.000 000V to 100.000 0V						
1Hz - 10Hz [16]	70 + 60	100 + 60	100 + 60		15	10
10Hz - 40Hz	70 + 10	100 + 10	100 + 10	80	15	10
40Hz - 100Hz	50 + 10	80 + 10	80 + 10	75	10	5
100Hz - 2kHz	30 + 10	60 + 10	60 + 10	35	10	5
2kHz - 10kHz	50 + 10	80 + 10	80 + 10	35	10	5
10kHz - 30kHz	100 + 20	200 + 20	200 + 20	50	15	10
30kHz - 100kHz	250 + 100	500 + 100	500 + 100	70	50	40
100kHz - 300kHz	0.15% + 0.1%	0.3% + 0.1%	0.3% + 0.1%	180	75	40
300kHz - 1MHz	1% + 0.5%	1% + 1%	1% + 1%	1400	100	40
1000.000V[11]						
1Hz - 10Hz [16]	70 + 35	100 + 35	100 + 35		20	15
10Hz - 40Hz	70 + 10	100 + 10	100 + 10	75	15	10
40Hz - 10kHz	50 + 10	80 + 10	80 + 10	75	10	10
10kHz - 30kHz	100 + 20	200 + 20	200 + 20	250	15	10
30kHz - 100kHz	250 + 100	500 + 100	500 + 100	700	50	40

SPOT FREQUENCY - AC VOLTAGE [8][9][10][12][13]

Range [1] and **Frequency**	**Accuracy Relative to Calibration Standards** [2][3] ± [ppmR + ppmFS] [4]			**Calibration Uncertainty** [ppm] [7]	**Temperature Coefficient** [ppm/°C] 13°C - 18°C 28°C - 33°C	
	24 hour 23°C ± 1°C	**1 Year** Normal 23°C ± 5°C	Enhanced 23°C ± 5°C [5] [6]		Normal	Enhanced [5]
100.000 0mV						
40Hz - 10kHz	40 + 10	200 + 10	100 + 10	155	15	5
10kHz - 30kHz	60 + 25	250 + 25	150 + 25	220	20	10
30kHz - 100kHz	100 + 100	500 + 100	500 + 100	430	50	40
1.000 000V to 100.000 0V						
40Hz - 10kHz	30 + 5	130 + 5	60 + 5	75	10	5
10kHz - 30kHz	50 + 15	200 + 15	150 + 15	50	15	10
30kHz - 100kHz	100 + 50	400 + 50	400 + 50	70	50	40
100kHz - 300kHz	0.1% + 0.05%	0.2% + 0.05%	0.2% + 0.05%	180	75	40
300kHz - 1MHz	0.2% + 0.3%	0.5% + 0.3%	0.5% + 0.3%	1400	100	40
1000.000V[11]						
40Hz - 10kHz	30 + 5	130 + 5	60 + 5	75	10	10
10kHz - 30kHz	50 + 15	200 + 15	150 + 15	250	15	10
30kHz - 100kHz	100 + 50	400 + 50	400 + 50	700	50	40

AC CURRENT(Option 30) [8]

Range [1]	**Freq. (Hz)**	**Accuracy Relative to Calibration Standards** [2][3] ± [ppmR + ppmFS] [4]			**Calibration Uncertainty** [ppm] [7]	**Temperature Coefficient** [ppm/°C] 13°C - 18°C 28°C - 33°C	
		24 hour 23°C ± 1°C	**1 Year** Normal 23°C ± 5°C	Enhanced 23°C ± 5°C [5] [6]		Normal	Enhanced [5]
100.000µA	10 - 5k	150 + 50	300 + 100	200 + 100	200	20	15
1.000 00mA	10 - 5k	150 + 50	300 + 100	200 + 100	200	20	15
10.000 0mA	10 - 5k	150 + 50	300 + 100	200 + 100	200	20	15
100.000mA	10 - 5k	150 + 50	300 + 100	200 + 100	200	20	15
1.000 00A	10 - 1k	400 + 100	600 + 200	500 + 200	200	20	15
	1k - 5k	0.1% + .03%	0.2% + .04%	0.15% + .04%	350	20	15

Final Width = 175mm

Final Width = 175mm

RESISTANCE (Option 20) [14]

Range [1]	**Constant Current Value**	**Relative to Calibration Standards** [2][3] ± [ppmR + ppmFS] [4]			**Calibration Uncertainty** [ppm] [7]	**Temperature Coefficient** [ppm/°C] 13°C - 18°C 28°C - 33°C	
		24 hour 23°C ± 1°C	**1 Year** Normal 23°C ± 5°C	Enhanced 23°C ± 5°C [5] [6]		Normal	Enhanced [5]
NORMAL MODE							
10.000 000Ω [15]	10mA	3 + 1	15 + 1	12 + 1	15	1.2	0.8
100.000 000Ω	10mA	1.5 + 0.3	11 + 0.3	8 + 0.3	7.5	1	0.5
1.000 000 00kΩ	1mA	1 + 0.3	9 + 0.3	6 + 0.3	6	1	0.5
10.000 000 0kΩ	100µA	1 + 0.3	9 + 0.3	6 + 0.3	5.5	1	0.5
100.000 000kΩ	100µA	1 + 0.3	9 + 0.3	6 + 0.3	10	1	0.8
1.000 000 00MΩ	10µA	2 + 0.7	14 + 0.7	10 + 0.7	20	1.5	1
10.000 000 0MΩ	1µA	4 + 4	30 + 4	20 + 4	30	2	1.5
100.000 0MΩ	100nA	30 + 45	300 + 45	200 + 45	140	20	15
1.000 000GΩ	10nA	300 + 450	0.3% + .045%	0.2% + .045%	350	200	150
LOW CURRENT MODE							
10.000 000Ω [15]	10mA	3 + 1	15 + 1	12 + 1	15	1.2	0.8
100.000 000Ω	1mA	5 + 1	15 + 1	12 + 1	7.5	1.2	0.8
1.000 000 00kΩ	100µA	5 + 1	15 + 1	12 + 1	6	1.2	0.8
10.000 000 0kΩ	10µA	5 + 1	20 + 1	15 + 1	5.5	1.5	1
100.000 000kΩ	1µA	50 + 3	80 + 3	70 + 3	10	2.5	2
1.000 000 00MΩ	100nA	200 + 10	500 + 10	400 + 10	20	20	15

Notes to Accuracy Specifications

[1] 100% overrange on all ranges (except 1kV DC & AC).

[2] Combined uncertainties to 95% minimum confidence level for maximum resolution in each function, normal read mode, internal trigger, zero offsets corrected (DCV, DCI, Ohms), optimum filter selected (ACV, ACI).

[3] Assumes 4 hour warm up period.

[4] FS = 2 x Full Range.

[5] Valid for 24 hours after Selfcal and within ±1°C of Selfcal temperature.

[6] Specification equivalent to 90 day performance (23°C ± 1°C) without Selfcal.

[7] Relative to National Standards. Better uncertainties are available - contact factory for details.

[8] Valid for signals >1% FS. Signal must be DC coupled <40Hz.

[9] Assumes transfer mode on.

[10] Max Volt x Hertz: 3×10^7.

[11] >300V, add $\pm 0.0024(R-300)^2$ ppm of reading.

[12] Valid within ±10% of calibrated RMS value and Spot Frequency.

[13] Instrument normally shipped with Spot Frequencies uncalibrated. Please contact the factory for available Spot Frequency calibration prices.

[14] True Ohms mode available from 10Ω to 100kΩ ranges.

[15] 10Ω range available only in True Ohms mode.

[16] Measurement results are invalid when using internal triggers in Transfer mode with the 1Hz filter selected. Results are valid using external triggers and 'Sample', and when triggering via the IEEE-488 interface.

Final Width = 175mm

Final Width = 175mm

TEN MINUTE STABILITY SPECIFICATIONS

FUNCTION and RANGE	FREQUENCY (Hz)	STABILITY AFTER SETTLING ±(ppmR + ppmFS)
DCV		
100.000 00mV		0.2 + 0.25
1.000 000 00V		0.2 + 0.075
10.000 000 0V		0.2 + 0.05
100.000 000V		0.2 + 0.075
1000.000 00V		0.2 + 0.05
ACV		
100.000 0mV	100Hz - 2kHz	20 + 2.5
	40Hz - 10kHz	20 + 5
	10Hz - 30kHz	40 + 5
	1Hz - 100kHz	60 + 5
1.000 000V	100Hz - 2kHz	20 + 2.5
10.000 00V	40Hz - 10kHz	20 + 2.5
100.000 0V	10Hz - 30kHz	40 + 2.5
	1Hz - 100kHz	60 + 2.5
1000.000V	40Hz - 10kHz	40 + 10
	10Hz - 30kHz	80 + 10
RESISTANCE		
10.000 000Ω		0.2 + 1
100.000 000Ω		0.2 + 0.1
1.000 000 00kΩ		0.2 + 0.1
10.000 000 0kΩ		0.2 + 0.1
100.000 000kΩ		0.2 + 0.05
1.000 000 00MΩ		0.3 + 0.05
10.000 000 0MΩ		2 + 0.05
100.000 0MΩ		40 + 1
1.000 000GΩ		400 + 1

NOTES

[1] The specifications above do not include any noise or drift in the source being measured.

[2] Valid for temperatures of 23°C ± 1°C.

ADDITIONAL ERRORS AS A FUNCTION OF MODE

FUNCTION	DIGITS	READ RATE (Readings/s) [5]				ADDITIONAL ERRORS ±(ppmR + ppmFS)	
		Normal		Fast		Normal	Fast
DCV	8	1/25		1/6		0 + 0	0 + 0.1
Resistance [1]	7	1/6		1/2		0 + 0.1	0 + 0.4
DCI [2]	6	2		35		0 + 0.5	0 + 3
	5	35		150		0 + 5	0 + 30
	4	35		150		0 + 50	0 + 50
		100Hz	**40Hz**	**10Hz**	**1Hz**		
ACV [3]							
ACI [4]							
Transfer	6	3	1	1/2.5	1/25	200 + 20	
Off	5	4	1	1/2.5	1/25	200 + 20	
	4	4	1	1/2.5	1/25	200 + 20	
Transfer	6	1	1/2	1/5	1/50	0 + 0	
On	5	2	1/2	1/5	1/50	0 + 5	
	4	2	1/2	1/5	1/50	0 + 50	

Final Width = 175mm

NOTES

[1] True Ohms - varies between 1 reading/sec and 1 reading/20 secs, depending on Filter and Range selections.

[2] Maximum DCI resolution is 6.5 digits.

[3] Assumes frequency monitor is set to Fast Gate.

[4] Maximum ACI resolution is 5.5 digits. Read rate same as ACV Transfer Off. Additional error is 0 + 0.

[5] Choice of system controller, algorithm and language can affect these figures.

Final Width = 175mm

OTHER SPECIFICATIONS

DCV

Type		Multi-slope, multi-cycle A-D converter.
CMRR (1kΩ unbalanced):		140dB at DC >80dB + NMRR at 1-60Hz
NMRR:	filter out	60dB at 50/60Hz ± 0.9%
	filter in	110dB at 50/60Hz
Protection:	all ranges	1kV rms
Input Impedance:		
0.1V to 10V ranges		>10,000MΩ
100V & 1000V ranges		10MΩ ± 0.1%
Max Input Current:		50pA
Ratio Accuracy:		±(Net ChA Accuracy + Net ChB Accuracy)
Settling Time:		
To 10ppm step size		
filter out		<50ms
filter in		<1s

DCI

Type:	Multi-slope, multi-cycle A-D converter.
Protection:	<2A, internally clamped; >2A, rear panel fuse.
Ratio accuracy:	±(Net ChA accuracy + Net ChB accuracy).
Settling time:	As DVC.

RESISTANCE

Type:	True 4-wire with Ohms guard. 2-wire selectable.
Max Lead Resistance:	100Ω in any or all leads
Protection: all ranges	250Vrms
Ratio Accuracy:	±(Net ChA Accuracy + Net ChB Accuracy)
Settling Time:	Up to 100kΩ range generally the same as DCV, but depends on external connections.

OTHER SPECIFICATIONS *(Contd.)*

ACV	Type:	True RMS, AC coupled measures AC component with up to 1000V DC bias on any range. DC coupled gives $\sqrt{(AC^2 + DC^2)}$
	CMRR (1kΩ unbalanced):	>90dB at DC-60Hz
	Crest Factor:	5:1 at Full Range (10:1 at 25% of range)
	Protection: all ranges	1kV rms
	Input Impedance:	1MΩ in parallel with 150pF
	DC Accuracy: (DC coupled)	Add ±(50ppmR + 20ppmFS + 20μV)
	Ratio Accuracy:	±(Net ChA Accuracy + Net ChB Accuracy)
	Settling Time:	
	To 100ppm step size	
	100Hz	<500ms
	40Hz	<1.25s
	10Hz	<5s
	1Hz	<50s
	Frequency Resolution and Accuracy:	
	Normal Mode:	6.5 digits
	Frequency Range:	10Hz - 1.999 900MHz
	Accuracy: (1 year, 13°C - 33°C)	±10ppm of reading ±2 digits
	Fast Gate Mode:	4.5 digits
	Frequency Range:	200Hz - 1.999 9MHz
	Accuracy: (1 year, 13°C - 33°C)	± 2 digits

ACI	Type:	True RMS AC coupled. DC coupled gives $\sqrt{(AC^2 + DC^2)}$
	Crest Factor:	3:1 at Full Range
	Protection:	<2A, internally clamped >2A, rear panel fuse
	Ratio Accuracy:	±(Net ChA Accuracy + Net ChB Accuracy)
	Settling Time:	As ACV

Final Width = 175mm

final width = 175mm

SECTION 7 SPECIFICATION VERIFICATION

SECTION 7 SPECIFICATION VERIFICATION

Introduction

The factory calibration of the 1281 ensures traceable accuracy to national standards. Its performance is quoted in the specifications of Section 6, related to time since calibration.

On receipt, it is recommended that the instrument is throughly checked. This section deals with user verification of the 1281 performance to specification. Tables and calculations are provided enabling the user to verify each of the parameters listed below.

Equipment Requirements

1281 CONFIGURATIONS[1]	**EQUIPMENT REQUIRED**[2]
No Options fitted (DCV only)	Model 4708 (Option 10) **or** Model 4000A
+ Option 10 (DCV & ACV)	Model 4708 (Options 10 & 20) **or** Model 4000A & Model 4200A (Option 10)
+ Option 20 & 30 (DCV, Ω & DCI)	Model 4708 (Options 10 & 30) **or** Model 4000A (Option 20) } **PLUS** 100MΩ(4000A only) & 1GΩ Resistance Standards
+ Option 10, 20 & 30	Model 4708 (Options 10, 20 & 30) **or** Model 4000A (Option 20) & M odel 4200A (Option 10 & 30) } **PLUS** 100MΩ(4000A only) & 1GΩ Resistance Standards

[1] Although the keys for all the functions are present on the front panel, certain options (ACV, Ohms, DCI and ACI) may not have been purchased. Check the option numbers quoted on the rear panel.

[2] To give the desired traceability on AC the 4200 or 4708 may require characterization.

Final Width = 175mm

User's Uncertainty Calculations

The accuracy and traceability of a user's standards affects the manner in which the performance of any new equipment can be verified. Users will need to evaluate the effects of the uncertainties associated with their own equipment, in conjunction with those of the instrument, therefore calculations for total tolerance limits (Validity Tolerance) are required.

The 'Validity Tolerance'

It is impossible to verify the specification of an instrument with absolute certainty, even using the original calibration equipment to make the measurements. All measurements carry a degree of uncertainty, this being quantified by the traceability of the measuring equipment to National Standards.

The measurements which follow are intended to establish that the instrument performs within its specifications, meaning it operates within the tolerance of its accumulated uncertainties. As the measurements to be taken have their own accumulated uncertainties, these must be added to those of the instrument in order to set a 'Validity Tolerance'.

Final Width = 175mm

The Validity Tolerance is obtained by adding together all the intervening uncertainties at the time the measurement is made. The specification sets out the worst-case allowances (relative tolerances) for the instrument's performance. For the standards equipment used, worst-case tolerances must also be assumed. Complete the following tables and calculate the validity tolerance limits using the formulae provided. If any range fails to verify and the instrument is to be returned, please be certain to include copies of the verification report sheets and give as much detail as possible.

Abbreviations Used

Hr	1281 upper relative accuracy tolerance limit
Lr	1281 lower relative accuracy tolerance limit
Uf	Factory calibration standard uncertainty relative to National Standards
Um	Sum of uncertainties from 1281 terminals through the user's measurement system to National Standards

Verification Report Sheets

Model 1281 Serial Number..... Calibration Interval --- *90days*---

Date..... Checked by..... Company/Dept.....

Note: It is advisable to make duplicate copies of the report sheets for future use. Check at the values shown in the tables. Contact your authorized Service Centre if the instrument fails to verify and please include copies of the completed verification report sheets if the instrument is returned.

Implementation on Receipt of Instrument

The tables in this report document provide columns to enter both the user's calculations of tolerance limits and the results of measurements made. Guidance is given in the form of calculation equations and tables to simplify the calculations. The relative accuracy tolerance figures (90 day Specification) and the factory's calibration standards uncertainty are already entered in the columns.

Implementation after User-calibration

Once the instrument has been re-calibrated against the user's standards, as in Section 8, the factory's calibration uncertainties can be ignored. Validity tolerance limits should then be recalculated to include the user's uncertainties in place of factory values.

Final Width = 175mm

Preparation

1. Turn on the instrument to be checked and allow at least 4 hours warm-up in the specified environment.

2. Ensure that the calibration switch (S2) is left in the disable position.

3. Consult the appropriate manufacturers' handbooks before connecting and operating any of their equipment.

4. Press the 'Test' key to enter the test menu. Select 'Full'. (Full test is valid between 13°C and 33°C). Should the instrument fail, contact your local authorised Service Center, ensuring that the full circumstances of the failure are reported.

5. If 'Spec' mode is required, select Monitor and press 'Spec'. If the instrument was last calibrated by the factory, the figures displayed in Spec Mode are relative to factory calibration standards.

6. Although the checks are carried out with 'Corrections Off', the figures given in the tables are based on the 'Enhanced' 1 year specification. This specification is equivalent to the 1281's performance up to 90 days from the most recent external calibration, or, if the instrument has been self-calibrated, for 24 hours after Selfcal.

Self-calibration can be repeated up to 1 year from external calibration (see page 4-58).

Final Width = 175mm

1. DC VOLTAGE Full Range Checks

1281 RANGE & 4708 output	Relative Accuracy Tolerance Limits		Factory Cal. Std Uncert'y ±Uf	User's Measurement Tolerance ±Um	Validity Tolerance Limits		1281 READING
	Lower(Lr)	Higher(Hr)			Lower	Higher	
+ 100mV	+99.99930	+100.00070	0.00065mV				
- 100mV	-100.00070	-99.99930	0.00065mV				
+ 1V	+0.99999660	+1.00000340	0.00000350V				
- 1V	-1.00000340	-0.99999660	0.00000350V				
+ 10V	+9.9999680	+10.0000320	0.0000250V				
- 10V	-10.0000320	-9.9999680	0.0000250V				
+100V	+99.999360	+100.000640	0.000350V				
-100V	-100.000640	-99.999360	0.000350V				
+1000V	+999.99360	+1000.00640	0.00350V				
-1000V	-1000.00640	-999.99360	0.00350V				

On receipt from factory, Validity Tolerance Calculations:

Higher Limit = Hr + Uf + Um
Lower Limit = Lr - Uf - Um

Following User Calibration, Validity Tolerance Calculations:

Higher Limit = Hr + Um
Lower Limit = Lr - Um

2. AC VOLTAGE Full Range Checks

1281 RANGE (Tfer Mode)	4708 FREQ	Wideband Relative Accuracy Tolerance Limits		Factory Cal. Std. Uncert'y	User's Measurement	Validity Tolerance Limits		1281 READING
		Lower(Lr)	Higher (Hr)	±Uf	±Um	Lower	Higher	
100mV	1kHz	99.9860	100.0140	0.0155mV				
100mV	60kHz	99.9100	100.0900	0.0430mV				
1V	1kHz	0.999920	1.000080	0.000035V				
1V	60kHz	0.999300	1.000700	0.000070V				
10V	1kHz	9.99920	10.00080	0.00035V				
10V	60kHz	9.99300	10.00700	0.00070V				
100V	1kHz	99.9920	100.0080	0.0035V				
100V	60kHz	99.9300	100.0700	0.0070V				
1000V	1kHz	999.900	1000.100	0.075V				
1000V	30kHz	999.300	1000.700	0.250V				

AC VOLTAGE Linearity Checks (Performed on 10V Range)

1V	1kHz	0.99974	1.00026	0.00035V				
10V	1kHz	9.99920	10.00080	0.00035V				
19V	1kHz	18.99866	19.00134	0.00035V				

On receipt from factory, Validity Tolerance Calculations:

Higher Limit = Hr + Uf + Um
Lower Limit = Lr - Uf - Um

Following User Calibration, Validity Tolerance Calculations:

Higher Limit = Hr + Um
Lower Limit = Lr - Um

Final Width = 175mm

Final Width = 175mm

3. RESISTANCE Full Range Checks

1281 RANGE (4708 nom. value)	4708 Resistance Value (Vr)	δR (Vr - Nom.)	Relative Accuracy Tolerance Limits		Factory Cal. Std Uncert'y ±Uf	User's Measurement Tolerance ±Um	Validity Tolerance Limits		1281 READING
			Lower(Lr)	Higher(Hr)			Lower	Higher	

Normal current mode, 4 wire connection ≤1MΩ, 2 wire ≥10MΩ

10Ω			9.999860	10.000140	0.000150				
100Ω			99.999140	100.000860	0.000750				
1kΩ			0.99999340	1.00000660	0.00000600				
10kΩ			9.9999340	10.0000660	0.0000550				
100kΩ			99.999340	100.000660	0.001000				
1MΩ			0.99998860	1.00001140	0.00002000				
10MΩ			9.9996700	10.0003300	0.0003000				
100MΩ			99.9610	100.0390	0.0140				
1GΩ			0.996100	1.003900	0.000350				

On receipt from factory, Validity Tolerance Calculations:

Higher Limit = Hr + δR + Uf + Um
Lower Limit = Lr + δR - Uf - Um

Following User recalibration, Validity Tolerance Calculations:

Higher Limit = Hr + δR + Um
Lower Limit = Hr - δR - Um

4. DC CURRENT Full Range Checks

1281 RANGE & 4708 output	Relative Accuracy Tolerance Limits		Factory Cal. Std Uncert'y	User's Measurement Tolerance	Validity Tolerance Limits		1281 READING
	Lower(Lr)	Higher(Hr)	±Uf	±Um	Lower	Higher	
+100µA	+99.9971	+100.0029	0.0035µA				
-100µA	-100.0029	-99.9971	0.0035µA				
+1mA	+0.999971	+1.000029	0.000020mA				
-1mA	-1.000029	-0.999971	0.000020mA				
+10mA	+9.99971	+10.00029	0.00020mA				
-10mA	-10.00029	-9.99971	0.00020mA				
+100mA	+99.9940	+100.0060	0.0025mA				
-100mA	-100.0060	-99.9940	0.0025mA				
+1A	+0.999830	+1.000170	0.000040A				
-1A	-1.000170	-0.999830	0.000040A				

Final Width = 175mm

On receipt from factory, Validity Tolerance Calculations:

Higher Limit = Hr + Uf + Um
Lower Limit = Lr - Uf - Um

Following User recalibration, Validity Tolerance Calculations:

Higher Limit = Hr + Um
Lower Limit = Hr - Um

5. AC CURRENT Full Range Checks

1281 RANGE (Tfer Mode)	4708 FREQ	Wideband Relative Accuracy Tolerance Limits Lower(Lr)	Higher (Hr)	Factory Cal. Std. Uncert'y ±Uf	User's Measurement ±Um	Validity Tolerance Limits Lower	Higher	1281 READING
100µA	300Hz	99.960	100.040	0.020µA				
	5kHz	99.960	100.040	0.020µA				
1mA	300Hz	.99960	1.00040	0.00020mA				
	5kHz	.99960	1.00040	0.00020mA				
10mA	300Hz	9.9960	10.0040	0.0020mA				
	5kHz	9.9960	10.0040	0.0020mA				
100mA	300Hz	99.960	100.040	0.020mA				
	5kHz	99.960	100.040	0.020mA				
1A	300Hz	.99910	1.00090	0.00020A				
	5kHz	.99770	1.00230	0.00035A				

Final Width = 175mm

On receipt from factory, Validity Tolerance Calculations:

Higher Limit = Hr + Uf + Um
Lower Limit = Lr - Uf - Um

Following User recalibration, Validity Tolerance Calculations:

Higher Limit = Hr + Um
Lower Limit = Hr - Um

SECTION 8 ROUTINE EXTERNAL CALIBRATION

Final Width = 175mm

Final Width = 175mm

SECTION 8 ROUTINE EXTERNAL CALIBRATION

Introduction

Read This First

To verify the instrument specification without affecting the calibration memory, please refer to Section 7 of this handbook.

For information on other forms of calibration, such as the types of repairs which must be followed by calibration, refer to Section 1 of the Calibration and Servicing handbook.

The instrument should be thoroughly checked before attempting calibration (See Section 7, Verification).

Autocal

The autocal feature allows full external calibration of all 1281 functions from the front panel (or remotely via the IEEE 488.2 Interface). Thus thermal disturbance is avoided and recalibration on a regular basis (24 hrs, if desired) is possible.

For each combination of function and range, an appropriate calibration standard is input. At each setting, one keystroke immediately calibrates to the standard by updating an internal memory. The instrument automatically determines whether the operation is to be a Zero or Nominal Full Range (range-gain) calibration; or for AC ranges whether it is to be a Zero, LF gain or HF gain calibration.

The Autocal process can operate only when the rear panel lockswitch is in the ‘Enable’ position.

Accuracy

In order to meet the published specification, a required resolution is given with each procedure. Lower resolutions can be used which speed up the process, but will lead to loss of accuracy.

Only one type of process (HF calibration in ACV or ACI) benefits from iteration. For other processes, allowing adequate settling time (before pressing the 'Caltrig' key) is all that is required.

A facility is provided to enter the calibration uncertainty associated with each source; this figure will be incorporated into the MONITOR SPEC readout calculation. The instrument allows one entry for each range on any function except for AC, where three uncertainties can be entered (to cover the frequency range).

Time Taken to Calibrate

It is advisable that any calibration procedure be completed within a period of 24 hours. If this is not done, full use cannot be made of the high-accuracy self-test or self-calibration.

Internal Source Characterization

The internal calibration sources used for self-calibration can be characterized only after a full external calibration. This procedure is carried out at manufacture, before the instrument is shipped.

The EXT CAL Menu

Features

N.B. It is emphasized that it is not necessary, on every occasion, to perform the full range of procedures detailed in this section. If, for instance, it is required to recalibrate a DC range every 24 hours for a particular purpose, then this does not invalidate the calibration of other functions.

The EXT CAL menu is central to the routines which are detailed in this section. It allows nominal zero and full range calibration directly, or selection of the non-nominal calibration operations of **Set** and **Std**.

The menu also offers a means of entering the user's calibration uncertainties, which are applied to calculate the specification readout function which is accessible during normal operation via the MONITOR menu.

Finally it allows access to define the passnumber and the selfcal access restraints via the LOCK selection.

Important:
In this menu the **Caltrig** key is enabled, and when pressed alters the calibration memory. To reduce the possibility of inadvertently obliterating the previous calibration, the key should only be used during a genuine recalibration.

Menu Selections

No Selection:
Once the 'Cal' annunciator on the main display is lit, the major function hard keys can be selected and the various ranges calibrated at nominal zero and full range, using the **Caltrig** direct action key.

For as long as the 'Cal' annunciator remains lit, the front panel **Cal** key accesses the EXT CAL menu directly - it does not force the repeated use of the passnumber.

Spcl:
The **Spcl** key accesses other procedures which are not required for a routine calibration. It should **only** be used as detailed in Section 1 of the Calibration and Servicing Handbook.

Set:
The **Set** feature is available in all functions, allowing the user to enter the true value of the calibration standard where it differs from nominal full range or zero.

Pressing **Set** displays the SET VALUE menu except in ACV Spot Frequency mode, when the SPOT CAL menu is displayed. Spot Frequency calibration reduces flatness errors within ±10% of the spot frequency.

continued overleaf

Final Width = 175mm

Menu Selections *(continued)*

Std:
This allows the instrument to be re-standardized against a new reference value (for instance: when the International Volt is redefined). Std affects all functions and ranges.

Re-standardization should be performed using the function and range which carries the highest accuracy. It is therefore highly recommended that Std be used only on the 10V DC range or, if more convenient, on the 1V DC range.

Pressing **Std** displays the STD VALUE menu.

Spec:
This feature leads to entry of user's calibration uncertainties which are used in calculating the spec readout function.

The next menu after **Spec** is pressed depends on the function which is active:

Active Function	Menu
DCV, DCI, or Ohms:	SPEC
ACV or ACI:	FREQ BAND
ACV Spot Frequency:	SPOT SPEC

Lock:
This allows access to change both the passnumber and the selfcal enable conditions.

Pressing **Lock** displays the LOCK menu

Quit:
Exits from the EXT CAL mode; the Cal legend on the main display turns off.

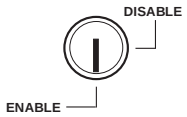
Quitting from the EXT CAL menu exits via the INTERNAL SOURCE CALIBRATION menu, where, by pressing Trig, the Selfcal source can be characterized if required.

Next, quitting from the INTERNAL SOURCE CALIBRATION menu exits via the EXT CAL DUE? menu, where the next calibration date can be entered if required, before finally quitting to the CAL menu.

Final Width = 175mm

General Sequence for Full Instrument Calibration

*(**NB**. to meet user's need, just one range on one function can be calibrated)*



ENABLE Calibration.
Access EXT CAL menu via Passnumber (if set).

DCV

Zeros and Full Ranges (100mV to1kV).

ACV

Zeros: 100mV to 1kV ranges (Tfer On @ 1kHz).
Gain: 10V FR @1kHz. Check DCcp and Tfer.
Complete all FRs @ 1kHz and 60kHz (not 1kV range).
1kV range: 500V @ 1kHz and 30kHz.

Ohms

Ohms: 100Ω Range to 10MΩ Range; then LoI Ohms.
TruΩ: 10Ω Range only.
HiΩ: 100MΩ and 1GΩ Ranges.

DCI

Zeros and Full Ranges

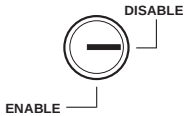
ACI

Zeros (10% of range on 100µA range - 1% for all other zeros).
Full Ranges at 300Hz (LF).

Internal Source Cal

EXT CAL DUE?

Quit the EXT CAL menu.
Characterize the instrument's internal calibration source for Selfcal?
Set the date for the next external calibration?



Turn the rear panel lockswitch to DISABLE.

Final Width = 175mm

Equipment Requirements

The equipment required for calibration is dependent on the options fitted:

1281 CONFIGURATIONS	***EQUIPMENT REQUIRED**	
No Options fitted	Model 4708 (Opt. 10) **or** Model 4000A	
+ Option 10 (DCV & ACV)	Model 4708 (Opt. 10 & 20) **or** Model 4000A & Model 4200/A (Opt. 10)	
+ Option 20 & 30 (DCV, Ω & DCI)	Model 4708 (Opts. 10 & 30) **or** Model 4000A (Opt. 20)	**PLUS** 100MΩ & 1GΩ Resistance Standards
+ Option 10, 20 & 30 (DCV, ACV, Ω, DCI & ACI)	Model 4708 (Opts. 10, 20 & 30) **or:** Model 4000A (Opt. 20) **and** Model 4200/A (Opts. 10 & 30)	**PLUS** 100MΩ & 1GΩ Resistance Standards

*To give the desired traceability, the 4200 or 4708 used may require characterization.

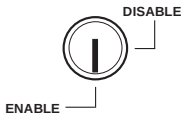
Final Width = 175mm

Preparation

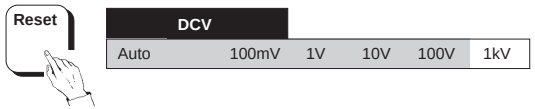
NB. The following procedures represent the recommended order of calibration, giving all the necessary setting-up commands.

1. Leave the instrument to warm-up in the specified environment for at least 4 hours.

2. Set the rear panel keyswitch to '**Enable**'.



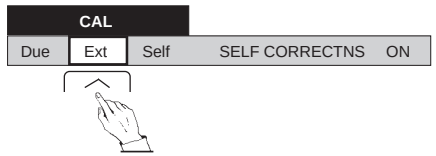
3. Press the **Reset** key; this forces the power-on-state defaults (the input zero stores are unaffected) and displays the DCV menu.



4. Press the **Cal** key.
The CAL menu is displayed.

Final Width = 175mm

6. Press **Ext** to select the external calibration menu. If the instrument is passnumber protected, the PASS# menu appears (see page 4-48). You must supply a valid passnumber to proceed.



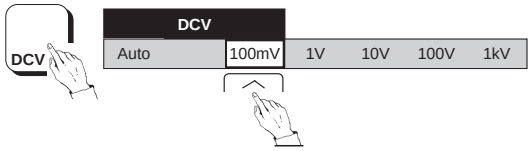
The external calibration menu appears as shown, and the **cal** annunciator lights on the main display.

DC VOLTAGE CALIBRATION (Zero and Full Range)

Final Width = 175mm

Initial 1281 Setup

1. Press the **DCV** key; select the **100mV** range.



2. Press the **Config** key; select **Filt**.

3. Press the **Resl** key and select the resolution that you desire (default is 7 for full published specification).

4. Reselect **DCV**.

Connect 1281 to Calibrator

WARNING **THIS INSTRUMENT CAN DELIVER A LETHAL ELECTRIC SHOCK. NEVER TOUCH ANY LEAD OR TERMINAL UNLESS YOU ARE ABSOLUTELY CERTAIN THAT NO DANGEROUS VOLTAGE IS PRESENT.**

MAKE SURE THAT SIGNAL LEADS ARE IN A SAFE CONDITION BEFORE YOU HANDLE THEM ANY WAY.

FIT THE REAR TERMINAL COVER PLATE WHEN THE REAR INPUTS ARE NOT IN USE.

1. Ensure that the calibrator OUTPUT is OFF and Local Guard is selected.

2. Connect the Calibrator to the 1281 (Refer to pages 4-2 and 4-6 in Section 4)

To Calibrate DC Voltage at Nominal or Non-Nominal Values

After the initial setup and connecting up, use the following general sequence to calibrate zero, then positive and negative full range on all DCV ranges. Just one range can be calibrated if required, but for a full calibration start with the 100mV range and work up to the 1kV range.

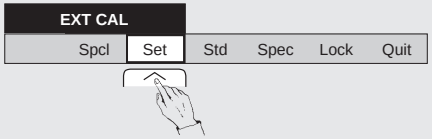
Nominal: To calibrate at Nominal values, **omit** the operations in the shaded boxes.
Non-Nominal: The **Set** feature allows a user to enter the true output value of the calibration standard where it differs from nominal full range or zero. In this case **include** the shaded operations.

Zero Point

1281
Ensure that the required Range is selected.

Calibrator
Select Range, Zero Output and Output ON.

1281
Press the **Cal** key to see the EXT CAL menu.
Select **Set**.



The SET VALUE menu always shows 8.5 digits resolution.

Using the **numeric** keys, **key in** the true output value of the standard, then press the **Enter** key.

1281
Press **Caltrig**. Calibration is complete when the **Busy** legend goes out.

Full Range Point

Calibrator
Select Full Range Output.

1281
Press the **Cal** key to revert to EXT CAL menu.
Select **Set**. Use the **numeric** keys with the SET VALUE menu to **key in** the true output value of the calibrator (as for the zero point, but now at its full range value), then press **Enter**.

1281
Press **Caltrig**. Calibration is complete when the **Busy** legend goes out.

Calibrator
Set Output OFF.

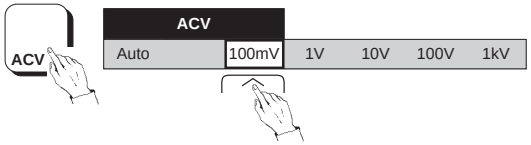
Press the **DCV** key to revert to the ranges menu.

Final Width = 175mm

AC VOLTAGE CALIBRATION (Nominal)

Initial 1281 Setup

1. Press the **ACV** key; select the **100mV** range.



Note:

- When entering Cal mode, AC-DC transfer defaults to On for enhanced performance. Resolution defaults to '6' and the appropriate low frequency filter is automatically selected.

Connect 1281 to Calibrator

WARNING **THIS INSTRUMENT CAN DELIVER A LETHAL ELECTRIC SHOCK. NEVER TOUCH ANY LEAD OR TERMINAL UNLESS YOU ARE ABSOLUTELY CERTAIN THAT NO DANGEROUS VOLTAGE IS PRESENT.**

MAKE SURE THAT SIGNAL LEADS ARE IN A SAFE CONDITION BEFORE YOU HANDLE THEM ANY WAY.

FIT THE REAR TERMINAL COVER PLATE WHEN THE REAR INPUTS ARE NOT IN USE.

1. Ensure that the calibrator OUTPUT is OFF and Local Guard is selected.

2. Connect the Calibrator to the 1281 (Refer to pages 4-2, 4-6 and 4-10 in Section 4).

Final Width = 175mm

To Calibrate at Nominal Values (For Non-Nominal see page 8-12)

Using the following general sequence, starting with the 100mV range, calibrate all ranges at the frequencies and nominal values detailed in the table.

Note:
On each range, the 1281 recognizes either 10% or 1% of Full Range value as range zero (see table).

1281
Select the required Range.

Calibrator
Select Range, Frequency and Output Voltage.
Set Output ON.

1281
Press **Caltrig**. Calibration is complete when the **Busy** legend goes out.

Calibrator
Set Output OFF.

1281
Press the **ACV** key to revert to the ranges menu.

1281	CALIBRATOR	
Range	**Output**	**Frequency**
LF		
100mV	10mV *(10%FR)*	1kHz
100mV	Full Range	1kHz
1V	10mV *(1%FR)*	1kHz
1V	Full Range	1kHz
10V	100mV *(1%FR)*	1kHz
10V	Full Range	1kHz
100V	1V *(1%FR)*	1kHz
100V	Full Range	1kHz
1000V	10V *(1%FR)*	1kHz
1000V	Full Range	1kHz
HF (Iteration can improve the result)		
100mV	Full Range	60kHz
1V	Full Range	60kHz
10V	Full Range	60kHz
100V	Full Range	60kHz
1000V	Full Range	30kHz

Final Width = 175mm

AC VOLTAGE CALIBRATION (contd.)

Final Width = 175mm

To Calibrate at Non-Nominal Values (not in Spot Frequency mode)

The **Set** feature allows a user to enter the true RMS value of the calibration standard where it differs from nominal full range or zero.

After the initial setup and connecting up, use the following general sequence, starting with the 100mV range, to calibrate all ACV ranges at the frequencies detailed in the table.

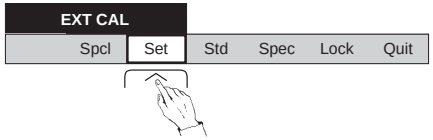
It is also preferable to choose calibration values close to those in the table.

All Points

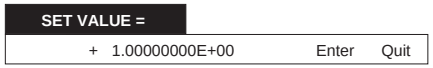
1281
Select the required Range.

Calibrator
Select Range, Output value and Output ON.

1281
Select **Set** from the EXT CAL menu.



The SET VALUE menu always shows 8.5 digits resolution.



Using the **numeric** keys, **key in** the normalized true RMS output value of the standard, then press the **Enter** key.

Press **Caltrig**. Calibration is complete when the **Busy** legend goes out.

Calibrator
Set Output OFF.

1281 Range	CALIBRATOR Output	Frequency
LF		
100mV	10mV *(10%FR)*	1kHz
100mV	Full Range	1kHz
1V	10mV *(1%FR)*	1kHz
1V	Full Range	1kHz
10V	100mV *(1%FR)*	1kHz
10V	Full Range	1kHz
100V	1V *(1%FR)*	1kHz
100V	Full Range	1kHz
1000V	10V *(1%FR)*	1kHz
1000V	Full Range	1kHz
HF (Iteration can improve the result)		
100mV	Full Range	60kHz
1V	Full Range	60kHz
10V	Full Range	60kHz
100V	Full Range	60kHz
1000V	Full Range	30kHz

AC VOLTAGE CALIBRATION (contd.)

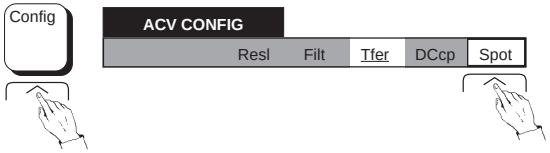
To Calibrate at Spot Frequencies

Spot Calibration is available only when in AC Voltage function with Spot already selected on the ACV CONFIG menu. Each spot (six per range) can be calibrated at a valid input frequency to a non-nominal RMS value. In subsequent use, flatness errors are reduced within ±10% of the calibrated spot frequency.

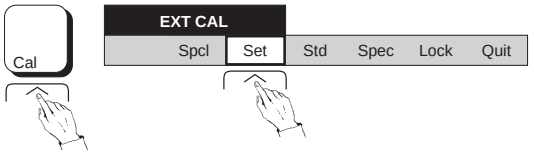
Assuming that the instrument is in external calibration mode and the setup is connected as described on page 8-10, configuration defaults to **Tfer** and **RESL6** (both required). Proceed as follows:

Re-select **ACV** and select the required Range.

Press the **Config** key and select **Spot**.

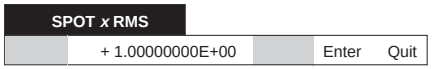


Press the **Cal** key. The EXT CAL menu is displayed. Select **Set**.



The SPOT CAL menu is displayed. Select the soft key for the required spot, 1 to 6 (**Sp1** to **Sp6**).

The SPOT (*x* = 1 to 6) RMS menu is displayed.



Key in the true RMS output value of the standard, then select **Enter**. The SPOT FREQUENCY menu is displayed, showing the frequency at which the spot will be calibrated.

Press **Caltrig**. Calibration is complete when the **Busy** legend goes out. The display reverts to the SPOT CAL menu.

Calibrator - set output OFF.

1281 - select other spots as required, repeating the process for each selection. Exit from the SPOT CAL menu by pressing any hard key.

Final Width = 175mm

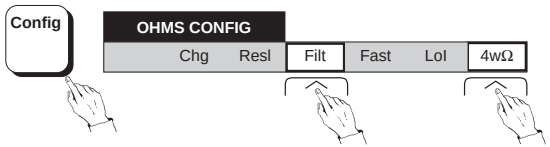
RESISTANCE CALIBRATION

Normal 'Ohms' Sub-Function

Initial 1281 Setup

1. Press the **OHMS** key and select the **100Ω** range.

2. Press the **CONFIG** key and select **Filt** and **4wΩ**.



3. Press the **RESL** key and select the resolution that you desire (7 digits for full published specification).

4. Reselect **OHMS**.

Connect 1281 to Calibrator

1. Ensure that the calibrator OUTPUT is OFF and Local Guard is selected.

2. Connect the Calibrator or standard 100Ω resistor in '4-wire' to the 1281.
(Refer to pages 4-2 and 4-14 in Section 4)

Note: In a noisy environment, it may be advisable to use the '4-Wire High Resistance' connections on page 4-15 for the higher Ohms ranges.

To Calibrate Normal Ohms at Nominal or Non-Nominal Values

After the initial setup and connecting up, use the following general sequence, starting with the 100Ω range, to calibrate zero and full range on all normal Ohms ranges.

'Resistance Standard'
The1281 can be calibrated using the ohms ranges of a calibrator such as the Wavetek 4000A or 4708, or against Standard Resistors. In the procedure, a general term (Resistance Standard) is used to refer to either of these.

Refer to the manufacturers' handbooks for the specifics of operating these items.

LoI Facility Calibration
This procedure automatically calibrates the low-current facility on each range as it performs the normal calibration.

continued next page

Final Width = 175mm

Nominal (only valid if the Calibrator or Standard Resistor is known to be at the Nominal Full Range value): **omit** the operations in the shaded boxes.

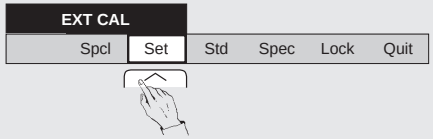
Non-Nominal: The **Set** feature allows a user to enter the true value of the Resistance Standard where it differs from nominal full range or zero.
In this case **include** the shaded operations.

Zero Point

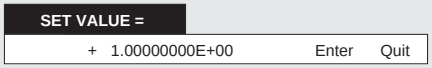
1281
Ensure that the required Range is selected.

Resistance Standard
Connect as a true 4-wire zero (page 4-15).

1281
Press the **Cal** key to see the EXT CAL menu.
Select **Set**.



The SET VALUE menu always shows 8.5 digits resolution.



Using the **numeric** keys, **key in** the true zero value of the Standard, then press the **Enter** key.

1281
Press **Caltrig**. Calibration is complete when the **Busy** legend goes out.

Full Range Point

Resistance Standard
Connect in '4-Wire' (page 4-14).

1281
Press the **Cal** key to revert to EXT CAL menu.
Select **Set**. Use the **numeric** keys with the SET VALUE menu to **key in** the true value of the Resistance Standard (as for the zero point, but now at its full range value), then press **Enter**.

1281
Press **Caltrig.** Calibration is complete when the **Busy** legend goes out.
Press the **Ohms** key for the ranges menu.

Other Normal Ohms Ranges

Repeat the calibration for the other Ohms ranges, selecting the appropriate value of Resistance Standard for the range being calibrated, and using the 'Set' facility as required.

Note: The identical ranges in **TruΩ** sub-function are automatically calibrated at the same time as those of the **Ohms** sub-function.

Final Width = 175mm

HiΩ Sub-Function

This procedure assumes that Normal Ohms calibration has been successfully completed (page 8-14)

Connect 1281 to Standard Resistor

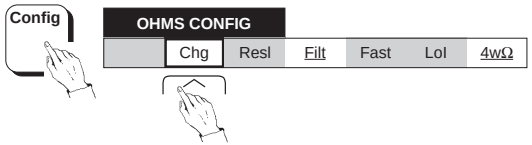
It would be unusual for a calibrator to have a sufficiently accurate100MΩ or 1GΩ range, so this procedure calibrates against Standard Resistors.

1. **If a calibrator is already connected**: Ensure that the calibrator OUTPUT is OFF and Local Guard is selected. Disconnect the calibrator from the 1281.

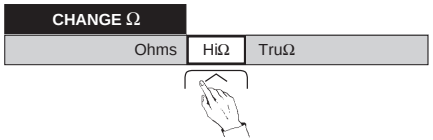
2. Connect a standard resistor to the 1281 in '4-Wire High Resistance'. (Refer to pages 4-2 and 4-15 in Section 4)

1281 Setup in HiΩ (from Normal Ohms)

Press the **Config** key. The OHMS CONFIG menu appears. Press the **Chg** key.

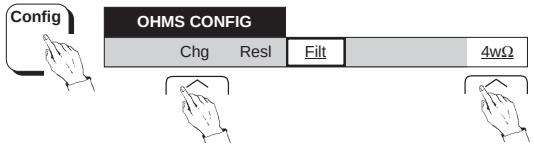


The CHANGE Ω menu appears;
Select **HiΩ**.

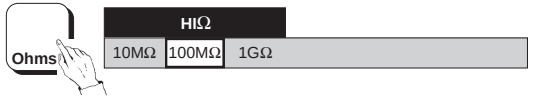


The HI Ω menu appears;
Select **100MΩ**.

Press the **Config** key. The HIΩ CONFIG menu appears. Select **Filt** and **4wΩ**.



Reselect **HIΩ** using **OHMS** key.



continued next page

Final Width = 175mm

To Calibrate HiΩ at Nominal or Non-Nominal Values

Nominal (only valid if the Resistance Standard is known to be at Nominal Zero or Full Range value): **omit** the operations in the shaded boxes.

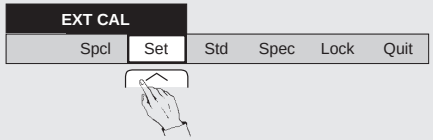
Non-Nominal: The **Set** feature allows a user to enter the true value of the Resistance Standard where it differs from nominal full range or zero.
In this case **include** the shaded operations.

Zero Point

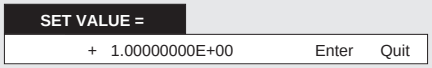
1281
Ensure that the 100MΩ range is selected.

Resistance Standard
Connect as a true 4-wire zero (page 4-15).

1281
Press the **Cal** key to see the EXT CAL menu.
Select **Set**.



The SET VALUE menu always shows 8.5 digits resolution.



Using the **numeric** keys, **key in** the true zero value of the Standard, then press the **Enter** key.

1281
Press **Caltrig**. Calibration is complete when the **Busy** legend goes out.

Full Range Point

Resistance Standard
Connect in '4-Wire High Resistance' (page 4-15).

1281
Press the **Cal** key to revert to EXT CAL menu.
Select **Set**. Use the **numeric** keys with the SET VALUE menu to **key in** the true value of the Resistance Standard (as for the zero point, but now at its full range value), then press **Enter**.

1281
Press **Caltrig.** Calibration is complete when the **Busy** legend goes out.
Press the **Ohms** key for the HIΩ ranges menu.

1 GΩ Range

Repeat the calibration for the 1GΩ range using a 1GΩ Resistance Standard, using the 'Set' facility as required.

Final Width = 175mm

TruΩ Sub-Function

This procedure assumes that Normal Ohms calibration has been successfully completed (page 8-14)

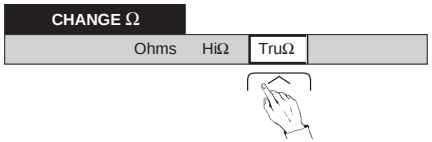
If normal Ohms calibration is successfully completed, all the TruΩ ranges other than the 10Ω range will have been calibrated automatically. The following procedure calibrates the 10Ω range.

Final Width = 175mm

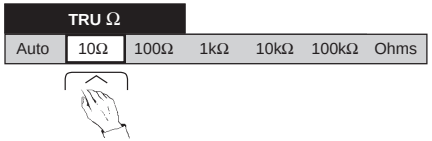
1281 Setup in TruΩ

Press the **Config** key. The OHMS CONFIG or HIΩ CONFIG menu appears. Press the **Chg** key.

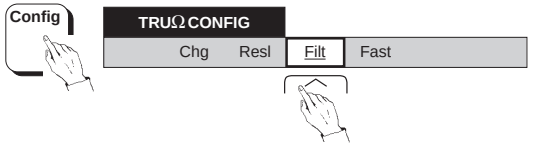
The CHANGE Ω menu appears;
Select **TruΩ.**



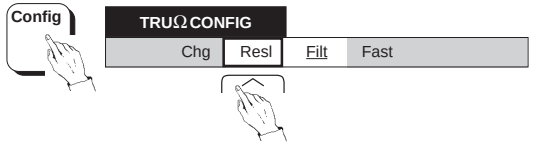
The TRU Ω menu appears;
Select **10Ω.**



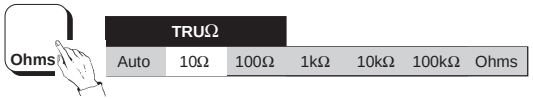
Press the **Config** key for the TRUΩ CONFIG menu and select **Fil**t.



On entry to Cal mode, resolution defaults to 6 digits. Select RESL 7 for full published specification:



Reselect **TRUΩ** using **OHMS** key.



Connect 1281 to Standard Resistor

1. **If a calibrator is already connected**:
   Ensure that the calibrator OUTPUT is OFF and Local Guard is selected.

2. Connect the calibrator or a standard resistor to the 1281 in '4-Wire'.
   (Refer to pages 4-2 and 4-14 in Section 4)

continued next page

To Calibrate TruΩ at Nominal or Non-Nominal Values

Nominal (only valid if the Resistance Standard is known to be at Nominal Zero or Full Range value): **omit** the operations in the shaded boxes.

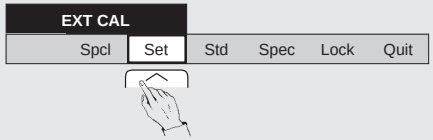
Non-Nominal: The **Set** feature allows a user to enter the true value of the Resistance Standard where it differs from nominal full range or zero.
In this case **include** the shaded operations.

Zero Point

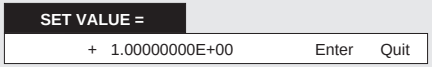
1281
Ensure that the 10Ω range is selected.

Resistance Standard
Connect as a true 4-wire zero (page 4-15).

1281
Press the **Cal** key to see the EXT CAL menu.
Select **Set**.



The SET VALUE menu always shows 8.5 digits resolution.



Using the **numeric** keys, **key in** the true zero value of the Standard, then press the **Enter** key.

1281
Press **Caltrig**. Calibration is complete when the **Busy** legend goes out.

Full Range Point

Resistance Standard
Connect in '4-Wire' (page 4-14).

1281
Press the **Cal** key to revert to EXT CAL menu.
Select **Set**. Use the **numeric** keys with the SET VALUE menu to **key in** the true value of the Resistance Standard (as for the zero point, but now at its full range value), then press **Enter**.

1281
Press **Caltrig.** Calibration is complete when the **Busy** legend goes out.

To Calibrate other TRUΩ Ranges

This is **not necessary** if the normal Ohms sub-function has just been calibrated, because the matching TruΩ ranges will have been calibrated at the same time.

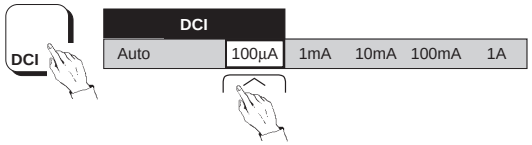
To calibrate individual TruΩ ranges, repeat the steps above for each range using the appropriate resistance standard.

Final Width = 175mm

DC CURRENT CALIBRATION (Zero and Full Range)

Initial 1281 Setup

1. Press the **DCI** key; select the **100µA** range.



Note: When entering Cal mode, the resolution defaults to '6'.

Final Width = 175mm

Connect 1281 to Calibrator

WARNING **THIS INSTRUMENT CAN DELIVER A LETHAL ELECTRIC SHOCK. NEVER TOUCH ANY LEAD OR TERMINAL UNLESS YOU ARE ABSOLUTELY CERTAIN THAT NO DANGEROUS VOLTAGE IS PRESENT.**

MAKE SURE THAT SIGNAL LEADS ARE IN A SAFE CONDITION BEFORE YOU HANDLE THEM ANY WAY.

FIT THE REAR TERMINAL COVER PLATE WHEN THE REAR INPUTS ARE NOT IN USE.

1. Ensure that the calibrator OUTPUT is OFF and Local Guard is selected.

2. Connect the Calibrator to the 1281 (Refer to pages 4-18 and 4-2 in Section 4)

continued next page

To Calibrate DC Current at Nominal or Non-Nominal Values

After the initial setup and connecting up, use the following general sequence to calibrate zero, then positive and negative full range on all DCI ranges. Just one range can be calibrated if required, but for a full calibration start with the 100µA range and work up to the 1A range.

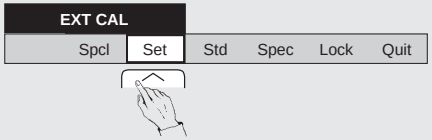
Nominal: To calibrate at Nominal values, **omit** the operations in the shaded boxes.
Non-Nominal: The **Set** feature allows a user to enter the true output value of the calibration standard where it differs from nominal full range or zero. In this case **include** the shaded operations.

Zero Point

1281
Ensure that the required Range is selected.

Calibrator
Select Range, Zero Output and Output ON.

1281
Press the **Cal** key to see the EXT CAL menu.
Select **Set**.



The SET VALUE menu always shows 8.5 digits resolution.

Using the **numeric** keys, **key in** the true output value of the standard, then press the **Enter** key.

1281
Press **Caltrig**. Calibration is complete when the **Busy** legend goes out.

Full Range Point

Calibrator
Select Full Range Output.

1281
Press the **Cal** key to revert to EXT CAL menu.
Select **Set**. Use the **numeric** keys with the SET VALUE menu to **key in** the true output value of the calibrator (as for the zero point, but now at its full range value), then press **Enter**.

1281
Press **Caltrig**. Calibration is complete when the **Busy** legend goes out.

Calibrator
Set Output OFF.

Press the **DCI** key to revert to the ranges menu.

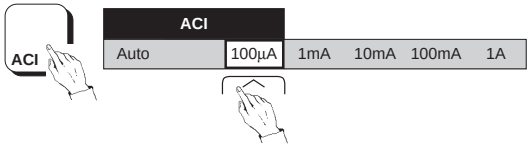
Final Width = 175mm

AC CURRENT CALIBRATION (Nominal)

Final Width = 175mm

Initial 1281 Setup

1. Press the **ACI** key; select the **100µA** range.



Notes:

- When entering Cal mode, resolution defaults to '5', and an appropriate low frequency filter is automatically selected.

Connect 1281 to Calibrator

WARNING **THIS INSTRUMENT CAN DELIVER A LETHAL ELECTRIC SHOCK. NEVER TOUCH ANY LEAD OR TERMINAL UNLESS YOU ARE ABSOLUTELY CERTAIN THAT NO DANGEROUS VOLTAGE IS PRESENT.**

MAKE SURE THAT SIGNAL LEADS ARE IN A SAFE CONDITION BEFORE YOU HANDLE THEM ANY WAY.

FIT THE REAR TERMINAL COVER PLATE WHEN THE REAR INPUTS ARE NOT IN USE.

1. Ensure that the calibrator OUTPUT is OFF and Local Guard is selected.

2. Connect the Calibrator to the 1281 (Refer to pages 4-20 and 4-2 in Section 4).

continued next page

AC CURRENT CALIBRATION *(contd.)*

To Calibrate at Nominal Values (For Non-Nominal see next page)

Use the following general sequence to calibrate zero and full range. Just one range can be calibrated if required, but for a full calibration on all ACI ranges follow the order detailed in the table.

Note:
On each range, the 1281 recognizes either 10% or 1% of Full Range value as range zero (see table).

1281
Select the required Range.

Calibrator
Select Range, Frequency and Output Current.
Set Output ON.

1281
Press **Caltrig**. Calibration is complete when the **Busy** legend goes out.

Calibrator
Set Output OFF.

1281
Press the **ACI** key to revert to the ranges menu.

1281 Range	CALIBRATOR Output	Frequency
LF		
100µA	10µA *(10%FR)*	300Hz
100µA	Full Range	300Hz
1mA	10µA *(1%FR)*	300Hz
1mA	Full Range	300Hz
10mA	100µA *(1%FR)*	300Hz
10mA	Full Range	300Hz
100mA	1mA *(1%FR)*	300Hz
100mA	Full Range	300Hz
1A	10mA *(1%FR)*	300Hz
1A	Full Range	300Hz
HF		
100µA	Full Range	5kHz
1mA	Full Range	5kHz
10mA	Full Range	5kHz
100mA	Full Range	5kHz
1A	Full Range	5kHz

Final Width = 175mm

Final Width = 175mm

To Calibrate at Non-Nominal Values

The **Set** feature allows a user to enter the true RMS value of the calibration standard where it differs from nominal full range or zero.

After the initial setup and connecting up, use the following general sequence to calibrate zero and full range. Just one range can be calibrated if required, but for a full calibration on all ACI ranges follow the order detailed in the table.

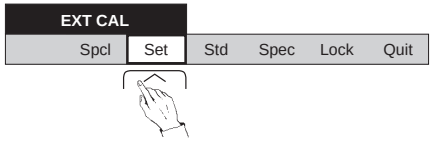
It is also preferable to choose calibration values close to those in the table.

All Points

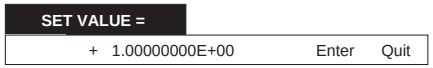
1281
Select the required Range.

Calibrator
Select Range, Output value and Output ON.

1281
Select **Set** from the EXT CAL menu.



The SET VALUE menu always shows 8.5 digits resolution.



Using the **numeric** keys, **key in** the normalized true RMS output value of the standard, then press the **Enter** key.

Press **Caltrig**. Calibration is complete when the **Busy** legend goes out.

Calibrator
Set Output OFF.

1281 Range	CALIBRATOR Output	Frequency
LF		
100µA	10µA *(10%FR)*	300Hz
100µA	Full Range	300Hz
1mA	10µA *(1%FR)*	300Hz
1mA	Full Range	300Hz
10mA	100µA *(1%FR)*	300Hz
10mA	Full Range	300Hz
100mA	1mA *(1%FR)*	300Hz
100mA	Full Range	300Hz
1A	10mA *(1%FR)*	300Hz
1A	Full Range	300Hz
HF		
100µA	Full Range	5kHz
1mA	Full Range	5kHz
10mA	Full Range	5kHz
100mA	Full Range	5kHz
1A	Full Range	5kHz

ENTRY OF USER'S CALIBRATION UNCERTAINTIES

Introduction

In normal use, the 1281 is able to provide a readout of the accuracy of its currently-displayed measurement. This readout appears on the dot-matrix display when accessed via the MONITOR menu, and includes elements accounting for calibration uncertainty. When the instrument is delivered from manufacture, these elements represent the manufacturer's traceability, relative to National Standards.

Recalibration invalidates the SPEC readout unless the manufacturer's uncertainties are replaced by those of the calibration standards used. For those users wishing to restore the validity of the readout, the following procedures detail the steps in entering user's calibration uncertainties in place of manufacturer's.

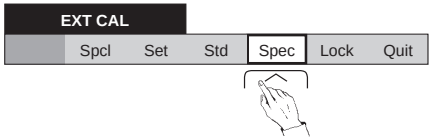
As the requirements can vary between functions, ranges, specification period and the uncertainties of the individual items of standards equipment in the traceability path; several procedural routes have been provided (refer to Section 4, page 4-43 - 4-45). Therefore each function has its own appropriate instructions to enter the relevant uncertainties. In the following pages, similar versions are grouped.

Final Width = 175mm

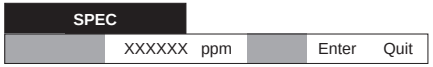
Entry of User's Calibration Uncertainties - DC Voltage or DC Current Functions

The starting point is the EXT CAL menu (any range).

Press the **Spec** key.



The SPEC menu appears.



To escape from the SPEC menu to the EXT CAL menu without affecting the stored uncertainty, press **Quit**.

To change the stored uncertainty:
Using the **numeric** keys, **key in** the requisite calibration uncertainty in parts per million, then press the **Enter** key. As the figures are stored, the display reverts to the EXT CAL menu.

Repeat for the other DCV or DCI ranges.

Final Width = 175mm

Entry of User's Calibration Uncertainties - Resistance Function

For the resistance ranges, calibrating on the normal Ohms ranges also calibrates LoI and the identical TruΩ ranges. Similarly, by entering the calibration uncertainties for the Ohms ranges, the same figures are employed in calculating the uncertainty element for corresponding LoI and TruΩ ranges. After entering the figures for normal Ohms, only the two HiΩ ranges and the TruΩ 10Ω range are not covered, so the uncertainties for these should be entered separately.

Enter the appropriate uncertainties, selecting the relevant resistance modes for the ranges as listed below, using the same procedure as for DCV and DCI:

Ohms: 100Ω, 1kΩ, 10kΩ, 100kΩ, 1MΩ & 10MΩ. **HiΩ**: 100MΩ & 1GΩ. **TruΩ**: 10Ω.

Entry of User's Calibration Uncertainties - AC Voltage or Current Functions

AC Voltage Frequency Bands

For AC Voltage, the procedure for entry of user's calibration uncertainties (given on page 8-28) employs the FREQ BAND menu. There are six soft keys, each labelled with a frequency value. These labels should be regarded only as symbols, each representing the highest frequency in a band.

The specification readout, accessed in normal use via the MONITOR menu, is valid only between the frequencies of 40Hz and 1MHz. Thus the calibration uncertainties are not required (and cannot be entered) outside this range.

As can be seen from Section 6, the uncertainties inherent in the measurement of AC Voltage are minimized between 100Hz and 2kHz. It is expected that user's equipment used to verify the accuracy of the 1281, or calibrate it, will possess a similar uncertainty spectrum.

So the uncertainties to be entered by the user will naturally fall into frequency bands. The seven bands provided via the six keys of the menu (listed in the table opposite) should prove the most useful for this purpose.

The bands are indexed in the table by their selection symbols from the menu. Uncertainties entered in the SPEC menu after selecting a particular key will apply only to that band (with the one exception - <10k - see the table).

Spot Frequency Calibration Uncertainties

Each spot (from six per range) can be calibrated at a valid input frequency. In subsequent use, flatness errors are reduced within ±10% of the calibrated spot frequency. See page 8-29 for the calibration procedure.

AC Current Frequency Bands

For AC Current, the procedure for entry of user's calibration uncertainties (given on page 8-30) employs the FREQ BAND menu.

The specification readout is valid only between 40Hz and 5kHz for AC Current.

Two soft keys are used, for the two bands provided in the menu:

<1k = 40Hz to 1kHz;
<5k = 1kHz to 5kHz.

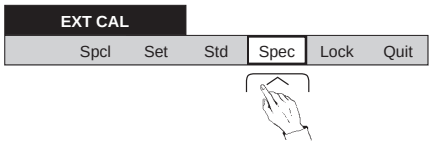
Uncertainties entered in the SPEC menu after selecting a key will apply only to that key's band.

Final Width = 175mm

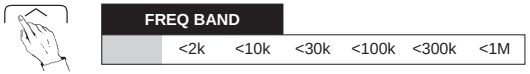
Entry of Uncertainties - AC Voltage Function (not Spot)

The starting point is the EXT CAL menu (any range).

Press the **Spec** key.



The FREQ BAND menu appears, defining six *band selection* keys:



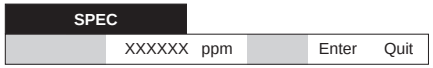
The table shows how the six soft keys select seven frequency bands over which the uncertainties will be applied.

Selection Key	Frequency Band
<2k	100Hz to 2kHz
<10k	2kHz to 10kHz 40Hz to 100Hz
<30k	10kHz to 30kHz
<100k	30kHz to 100kHz
<300k	100kHz to 300kHz
<1M	300kHz to 1MHz

Note that when an uncertainty value is entered via the **<10k** key for the 2kHz to 10kHz band; the same value is applied both when the input frequency is between 2kHz and 10kHz, and when it is between 40Hz and 100Hz.

For each of the selections, the SPEC menu is displayed, and the calibration uncertainty for that frequency band can be entered.

Press the <2k frequency band key.
The SPEC menu appears.



To escape from the SPEC menu to the EXT CAL menu without affecting the stored uncertainty: Press **Quit**.

To change the stored uncertainty:
Using the **numeric** keys, **key in** the requisite calibration uncertainty in parts per million, then press the **Enter** key. As the figures are stored, the dot-matrix display reverts to the EXT CAL menu.

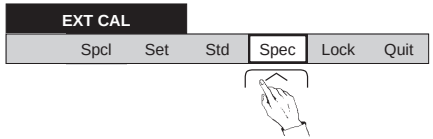
Repeat for each of the six band selection keys.

Final Width = 175mm

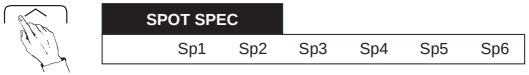
Entry of Uncertainties - AC Voltage Spot Frequency Function

The starting point is the EXT CAL menu with Spot already selected (any range).

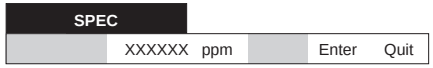
Press the **Spec** key.



The SPOT SPEC menu appears, defining six *spot selection* keys:



Select the spot that you wish to calibrate.
The SPEC menu appears.



To escape from the SPEC menu to the EXT CAL menu without affecting the stored uncertainty: Press **Quit**.

To change the stored uncertainty:
Using the **numeric** keys, **key in** the requisite calibration uncertainty in parts per million, then press the **Enter** key. As the figures are stored, the dot-matrix display reverts to the EXT CAL menu.

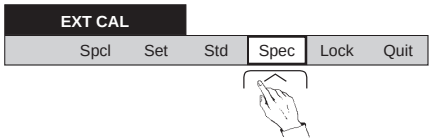
Repeat for each spot that you wish to calibrate.

Final Width = 175mm

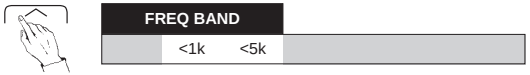
Entry of Uncertainties - AC Current Function

The starting point is the EXT CAL menu (any range).

Press the **Spec** key.



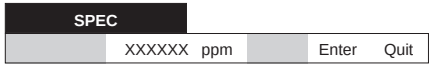
The FREQ BAND menu appears, defining two *band selection* keys:



For each selection, the SPEC menu is displayed, and the calibration uncertainty for that frequency band can be entered.

Press the <1k frequency band key.

The SPEC menu appears.



To escape from the SPEC menu to the EXT CAL menu without affecting the stored uncertainty: Press **Quit**.

To change the stored uncertainty:
Using the **numeric** keys, **key in** the requisite calibration uncertainty in parts per million, then press the **Enter** key. As the figures are stored, the dot-matrix display reverts to the EXT CAL menu.

Repeat for the <5k band selection key.

Final Width = 175mm