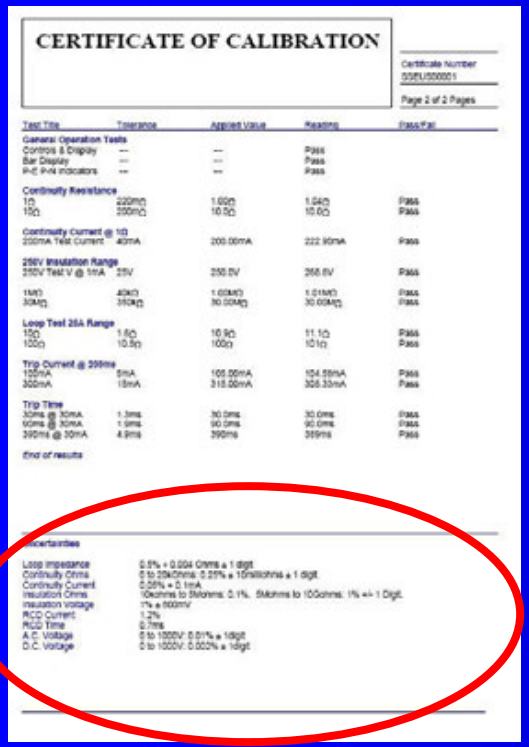
Understanding How Procal Present and calculates Uncertainties

Procal offers several options for Presenting & Calculating uncertainties



CERTIFICATE OF CALIBRATION

Certificate Number
SSRUS00001

Page 2 of 2 Pages

Test Title	Tolerance	Applied Value	Reading	Pass/Fail
General Operation Tests				
Controls & Display	---	---	Pass	
Bar Display	---	---	Pass	
H-E H-N Indicators	---	---	Pass	
Continuity Resistance				
1Ω	220mΩ	1.00Ω	1.04Ω	Pass
15Ω	200mΩ	10.0Ω	10.0Ω	Pass
Continuity Current @ 1Ω				
200mA Test Current	40mA	200.00mA	222.90mA	Pass
250V Insulation Range				
250V Test V @ 1mA	25V	250.0V	266.6V	Pass
1MΩ	40kΩ	1.00MΩ	1.01MΩ	Pass
30MΩ	360kΩ	30.00MΩ	30.00MΩ	Pass
Loop Test 25A Range				
15Ω	1.5Ω	10.9Ω	11.1Ω	Pass
100Ω	10.5Ω	100Ω	101Ω	Pass
Trip Current @ 200ms				
120mA	5mA	100.00mA	104.58mA	Pass
300mA	18mA	316.00mA	308.33mA	Pass
Trip Time				
30mA @ 30mA	1.3ms	30.0ms	30.0ms	Pass
60mA @ 30mA	1.9ms	60.0ms	60.0ms	Pass
390mA @ 30mA	4.9ms	390ms	389ms	Pass

End of results

Uncertainties

Loop impedance	0.5% + 0.004 Ohms ± 1 digit
Continuity Ohms	0 to 20kOhms: 0.25% ± 10milliohms ± 1 digit
Continuity Current	0.05% + 0.1mA
Insulation Ohms	10kohms to 9Mohms: 0.1%. 9Mohms to 10Gohms: 1% +/- 1 Digit.
Insulation Voltage	1% ± 800mV
RCD Current	1.2%
RCD Time	0.1ms
A.C. Voltage	0 to 1000V: 0.01% ± 1digit
D.C. Voltage	0 to 1000V: 0.002% ± 1digit

Uncertainty Statements



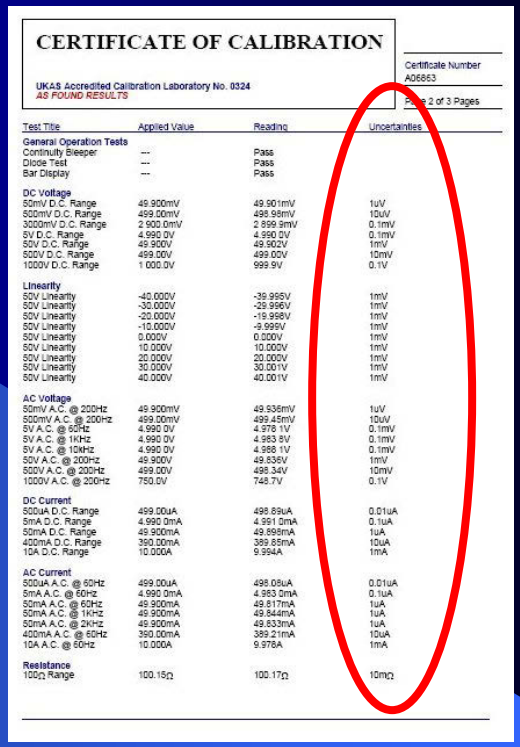
CERTIFICATE OF CALIBRATION

Certificate Number
STD0026

Page 2 of 2 Pages

Test Title	Tolerance	Applied Value	Reading	Pass/Fail
DC Voltage				
200mV D.C. Range	2mV	199.00mV	199.00mV	Pass
2V D.C. Range	20mV	1.990 0V	1.990 0V	Pass
20V D.C. Range	200mV	19.900V	19.900V	Pass
200V D.C. Range	2V	199.00V	199.00V	Pass
1000V D.C. Range	10.1V	1 000.0V	1 000.0V	Pass
The Uncertainties For DCV were 0.003% + 1 Digit				
20V Linearity	151mV	-15.000V	-15.000V	Pass
20V Linearity	101mV	-10.000V	-10.000V	Pass
20V Linearity	51mV	-5.000V	-5.000V	Pass
20V Linearity	1mV	0.000V	0.000V	
20V Linearity	51mV	5.000V	5.000V	Pass
20V Linearity	101mV	10.000V	10.000V	Pass
20V Linearity	151mV	15.000V	15.000V	Pass
The Uncertainties For DCV were 0.003% + 1 Digit				
AC Voltage				
200mV A.C. @ 50Hz	2mV	199.00mV	199.00mV	Pass
2V A.C. @ 60Hz	20mV	1.990 0V	1.990 0V	Pass
20V A.C. @ 60Hz	200mV	19.900V	19.900V	Pass
200V A.C. @ 60Hz	2V	199.00V	199.00V	Pass
750V A.C. @ 60Hz	7.5V	750.0V	750.0V	Pass
The Uncertainties For ACV were 0.01% + 1 Digit				
DC Current				
200uA D.C. Range	2uA	199.00uA	199.00uA	Pass
2mA D.C. Range	20uA	1.990 0mA	1.990 0mA	Pass
20mA D.C. Range	200uA	19.900mA	19.900mA	Pass
200mA D.C. Range	2mA	199.00mA	199.00mA	Pass
2A D.C. Range	20mA	1.990 0A	1.990 0A	Pass
10A D.C. Range	101mA	10.000A	10.000A	Pass
The Uncertainties For DCI were 0.03% + 1 Digit				
AC Current				
200uA A.C. @ 50Hz	2uA	199.00uA	199.00uA	Pass
2mA A.C. @ 50Hz	20uA	1.990 0mA	1.990 0mA	Pass
20mA A.C. @ 60Hz	200uA	19.900mA	19.900mA	Pass
200mA A.C. @ 50Hz	2mA	199.00mA	199.00mA	Pass
2A A.C. @ 60Hz	20mA	1.990 0A	1.990 0A	Pass
10A A.C. @ 50Hz	101mA	10.000A	10.000A	Pass
The Uncertainties For DCI were 0.03% + 1 Digit				
Resistance				
100Ω Range	1Ω	100.00Ω	100.00Ω	Pass
1kΩ Range	10.1Ω	1.000 0kΩ	1.000 0kΩ	Pass
10kΩ Range	101Ω	10.000kΩ	10.000kΩ	Pass
100kΩ Range	1kΩ	100.00kΩ	100.00kΩ	Pass
1MΩ Range	10.1kΩ	1.000 0MΩ	1.000 0MΩ	Pass
The Uncertainties For DCI were 0.03% + 1 Digit				

Body Uncertainty



CERTIFICATE OF CALIBRATION

Certificate Number
A06863

UKAS Accredited Calibration Laboratory No. 0324
AS FOUND RESULTS

Page 2 of 3 Pages

Test Title	Applied Value	Reading	Uncertainties
General Operation Tests			
Continuity Bleeper	---	Pass	
Diode Test	---	Pass	
Bar Display	---	Pass	
DC Voltage			
50mV D.C. Range	49.900mV	49.901mV	1uV
500mV D.C. Range	499.00mV	498.98mV	10uV
3000mV D.C. Range	2 900.0mV	2 899.9mV	0.1mV
5V D.C. Range	4.990 0V	4.990 0V	0.1mV
50V D.C. Range	49.900V	49.902V	1mV
500V D.C. Range	499.00V	499.00V	10mV
1000V D.C. Range	1 000.0V	999.9V	0.1V
Linearity			
50V Linearity	-40.000V	-39.995V	1mV
50V Linearity	-30.000V	-29.996V	1mV
50V Linearity	-20.000V	-19.998V	1mV
50V Linearity	-10.000V	-9.999V	1mV
50V Linearity	0.000V	0.000V	1mV
50V Linearity	10.000V	10.000V	1mV
50V Linearity	20.000V	20.000V	1mV
50V Linearity	30.000V	30.001V	1mV
50V Linearity	40.000V	40.001V	1mV
AC Voltage			
50mV A.C. @ 200Hz	49.900mV	49.936mV	1uV
500mV A.C. @ 200Hz	499.00mV	499.45mV	10uV
5V A.C. @ 60Hz	4.990 0V	4.978 1V	0.1mV
5V A.C. @ 1kHz	4.990 0V	4.983 8V	0.1mV
5V A.C. @ 10kHz	4.990 0V	4.988 1V	0.1mV
50V A.C. @ 200Hz	49.900V	49.636V	1mV
500V A.C. @ 200Hz	499.00V	498.34V	10mV
1000V A.C. @ 200Hz	750.0V	748.7V	0.1V
DC Current			
500uA D.C. Range	499.00uA	498.89uA	0.01uA
5mA D.C. Range	4.990 0mA	4.991 0mA	0.1uA
50mA D.C. Range	49.900mA	49.898mA	1uA
400mA D.C. Range	390.00mA	389.85mA	10uA
10A D.C. Range	10.000A	9.954A	1mA
AC Current			
500uA A.C. @ 50Hz	499.00uA	498.08uA	0.01uA
5mA A.C. @ 60Hz	4.990 0mA	4.983 0mA	0.1uA
50mA A.C. @ 60Hz	49.900mA	49.817mA	1uA
50mA A.C. @ 1kHz	49.900mA	49.844mA	1uA
50mA A.C. @ 2kHz	49.900mA	49.833mA	1uA
400mA A.C. @ 60Hz	390.00mA	389.21mA	10uA
10A A.C. @ 50Hz	10.000A	9.976A	1mA
Resistance			
100Ω Range	100.15Ω	100.17Ω	10mΩ

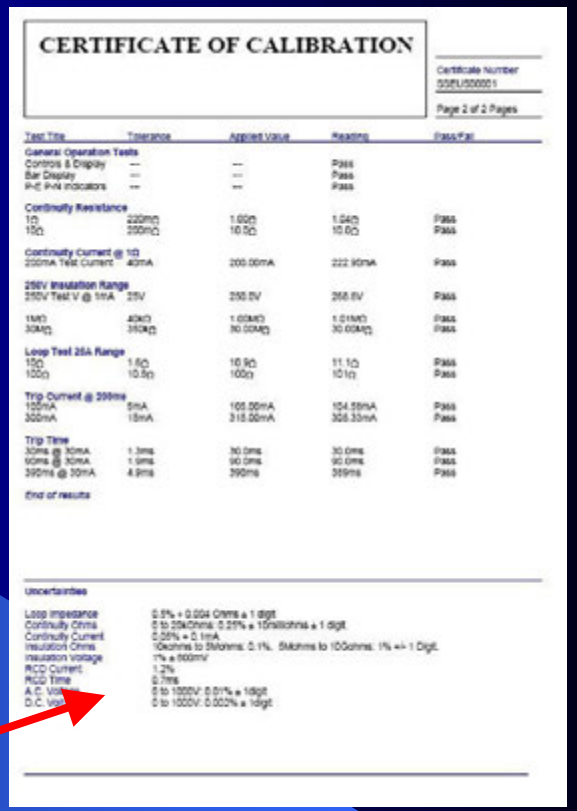
Line Uncertainties

1: Uncertainty Statements

- Prints up to 10 lines of uncertainty statements at the end of the certificate page.
- The uncertainty statements are created and edited in the utilities menu in Proedit.
- The Procedure includes the lines to be printed
- When a procedure is run by Procal the uncertainty statements are copied to the certificate, no calculations are preformed

Uncertainties

Loop Impedance	0.5% + 0.004 Ohms ± 1 digit
Continuity Ohms	0 to 20kOhms: 0.25% ± 10milliohms ± 1 digit.
Continuity Current	0.05% + 0.1mA
Insulation Ohms	10kohms to 5Mohms: 0.1%, 5Mohms to 10Gohms: 1% +/- 1 Digit.
Insulation Voltage	1% ± 800mV
RCD Current	1.2%
RCD Time	0.7ms
A.C. Voltage	0 to 1000V: 0.01% ± 1digit
D.C. Voltage	0 to 1000V: 0.002% ± 1digit



2: Uncertainties Printed in the body of the Certificate

Uncertainties can be printed between measurement anywhere on the certificate

The uncertainty line printed can either be a fixed comment line or an editable comment line as entered in the procedure

20V D.C. Range	200mV	19.900V
200V D.C. Range	2V	199.00V
1000V D.C. Range		1 000.0V

The Uncertainties For DCV were 0.003% + 1 Digit



CERTIFICATE OF CALIBRATION

Certificate Number STD0026

Page 2 of 2 Pages

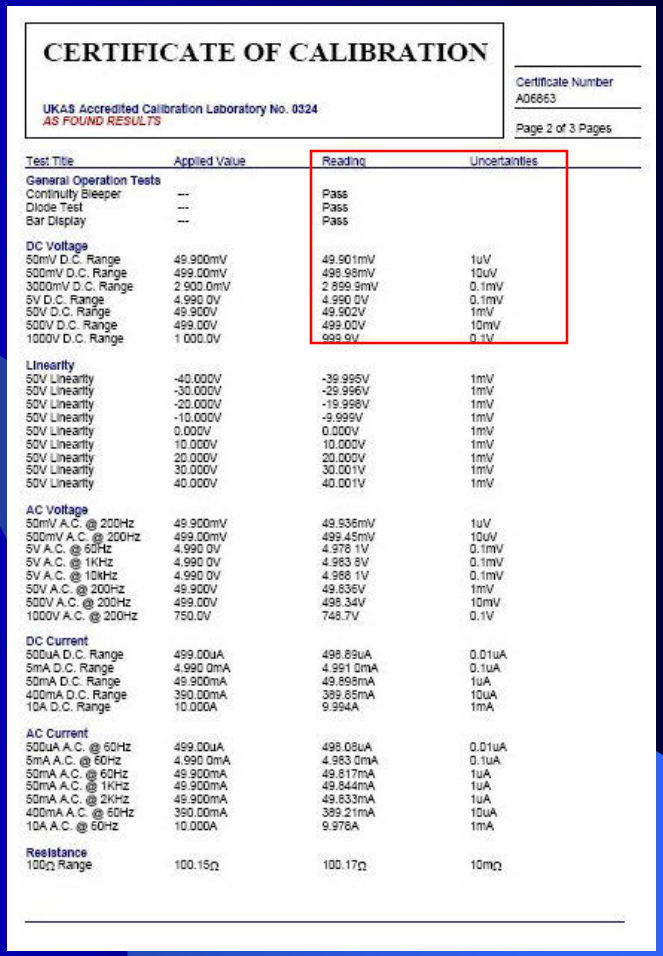
Test Title	Tolerance	Applied Value	Reading	Pass/Fail
DC Voltage				
200mV D.C. Range	2mV	199.00mV	199.00mV	Pass
2V D.C. Range	20mV	1.990 0V	1.990 0V	Pass
20V D.C. Range	200mV	19.900V	19.900V	Pass
200V D.C. Range	2V	199.00V	199.00V	Pass
1000V D.C. Range	10.1V	1 000.0V	1 000.0V	Pass
The Uncertainties For DCV were 0.003% + 1 Digit				
Linearity				
20V Linearity	151mV	-15.000V	-15.000V	Pass
20V Linearity	101mV	-10.000V	-10.000V	Pass
20V Linearity	51mV	-5.000V	-5.000V	Pass
20V Linearity	1mV	0.000V	0.000V	
20V Linearity	51mV	5.000V	5.000V	Pass
20V Linearity	101mV	10.000V	10.000V	Pass
20V Linearity	151mV	15.000V	15.000V	Pass
The Uncertainties For DCV were 0.003% + 1 Digit				
AC Voltage				
200mV A.C. @ 50Hz	2mV	199.00mV	199.00mV	Pass
2V A.C. @ 50Hz	20mV	1.990 0V	1.990 0V	Pass
20V A.C. @ 50Hz	200mV	19.900V	19.900V	Pass
200V A.C. @ 50Hz	2V	199.00V	199.00V	Pass
750V A.C. @ 50Hz	7.5V	750.0V	750.0V	Pass
The Uncertainties For ACV were 0.01% + 1 Digit				
DC Current				
200uA D.C. Range	2uA	199.00uA	199.00uA	Pass
2mA D.C. Range	20uA	1.990 0mA	1.990 0mA	Pass
20mA D.C. Range	200uA	19.900mA	19.900mA	Pass
200mA D.C. Range	2mA	199.00mA	199.00mA	Pass
2A D.C. Range	20mA	1.990 0A	1.990 0A	Pass
10A D.C. Range	101mA	10.000A	10.000A	Pass
The Uncertainties For DCI were 0.03% + 1 Digit				
AC Current				
200uA A.C. @ 50Hz	2uA	199.00uA	199.00uA	Pass
2mA A.C. @ 50Hz	20uA	1.990 0mA	1.990 0mA	Pass
20mA A.C. @ 50Hz	200uA	19.900mA	19.900mA	Pass
200mA A.C. @ 50Hz	2mA	199.00mA	199.00mA	Pass
2A A.C. @ 50Hz	20mA	1.990 0A	1.990 0A	Pass
10A A.C. @ 50Hz	101mA	10.000A	10.000A	Pass
The Uncertainties For DCI were 0.03% + 1 Digit				
Resistance				
100Ω Range	1Ω	100.00Ω	100.00Ω	Pass
1kΩ Range	10.1Ω	1.000 0kΩ	1.000 0kΩ	Pass
10kΩ Range	101Ω	10.000kΩ	10.000kΩ	Pass
100kΩ Range	1kΩ	100.00kΩ	100.00kΩ	Pass
1MΩ Range	10.1kΩ	1.000 0MΩ	1.000 0MΩ	Pass
The Uncertainties For DCI were 0.03% + 1 Digit				

3: Line Uncertainties

Uncertainties are printed next to the measurement on the same line

The uncertainty printed can be fixed in the procedure or calculated at the time of measurement by Procal

Reading	Uncertainties
Pass	
Pass	
Pass	
49.901mV	1uV
498.98mV	10uV
2 899.9mV	0.1mV
4.990 0V	0.1mV
49.902V	1mV
499.00V	10mV
999.9V	0.1V



CERTIFICATE OF CALIBRATION

UKAS Accredited Calibration Laboratory No. 0324
AS FOUND RESULTS

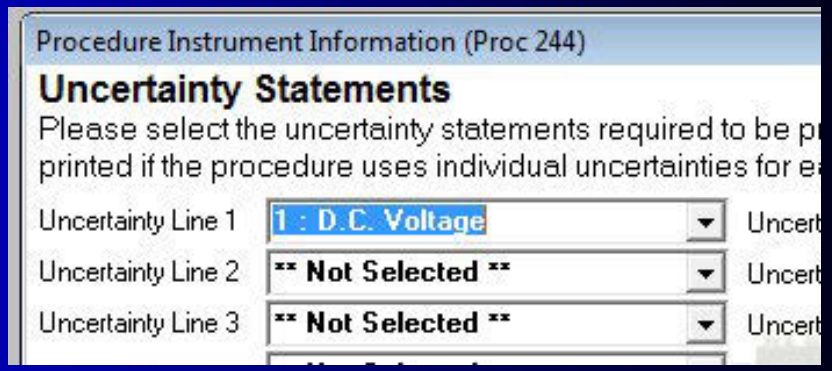
Certificate Number A06863

Page 2 of 3 Pages

Test Title	Applied Value	Reading	Uncertainties
General Operation Tests			
Continuity Beeper	---	Pass	
Diode Test	---	Pass	
Bar Display	---	Pass	
DC Voltage			
50mV D.C. Range	49.900mV	49.901mV	1uV
500mV D.C. Range	499.00mV	498.98mV	10uV
3000mV D.C. Range	2 900.0mV	2 899.9mV	0.1mV
5V D.C. Range	4.990 0V	4.990 0V	0.1mV
50V D.C. Range	49.900V	49.902V	1mV
500V D.C. Range	499.00V	499.00V	10mV
1000V D.C. Range	1 000.0V	999.9V	0.1V
Linearity			
50V Linearity	-40.000V	-39.995V	1mV
50V Linearity	-30.000V	-29.996V	1mV
50V Linearity	-20.000V	-19.998V	1mV
50V Linearity	-10.000V	-9.999V	1mV
50V Linearity	0.000V	0.000V	1mV
50V Linearity	10.000V	10.000V	1mV
50V Linearity	20.000V	20.000V	1mV
50V Linearity	30.000V	30.001V	1mV
50V Linearity	40.000V	40.001V	1mV
AC Voltage			
50mV A.C. @ 200Hz	49.900mV	49.936mV	1uV
500mV A.C. @ 200Hz	499.00mV	499.45mV	10uV
5V A.C. @ 60Hz	4.990 0V	4.978 1V	0.1mV
5V A.C. @ 1KHz	4.990 0V	4.983 8V	0.1mV
5V A.C. @ 10kHz	4.990 0V	4.988 1V	0.1mV
50V A.C. @ 200Hz	49.900V	49.836V	1mV
500V A.C. @ 200Hz	499.00V	498.34V	10mV
1000V A.C. @ 200Hz	750.0V	748.7V	0.1V
DC Current			
500uA D.C. Range	499.00uA	498.69uA	0.01uA
5mA D.C. Range	4.990 0mA	4.991 0mA	0.1uA
50mA D.C. Range	49.900mA	49.898mA	1uA
400mA D.C. Range	390.00mA	389.65mA	10uA
10A D.C. Range	10.000A	9.994A	1mA
AC Current			
500uA A.C. @ 60Hz	499.00uA	498.08uA	0.01uA
5mA A.C. @ 60Hz	4.990 0mA	4.983 0mA	0.1uA
50mA A.C. @ 60Hz	49.900mA	49.817mA	1uA
50mA A.C. @ 1KHz	49.900mA	49.844mA	1uA
50mA A.C. @ 2KHz	49.900mA	49.833mA	1uA
400mA A.C. @ 60Hz	390.00mA	389.21mA	10uA
10A A.C. @ 60Hz	10.000A	9.978A	1mA
Resistance			
100Ω Range	100.15Ω	100.17Ω	10mΩ

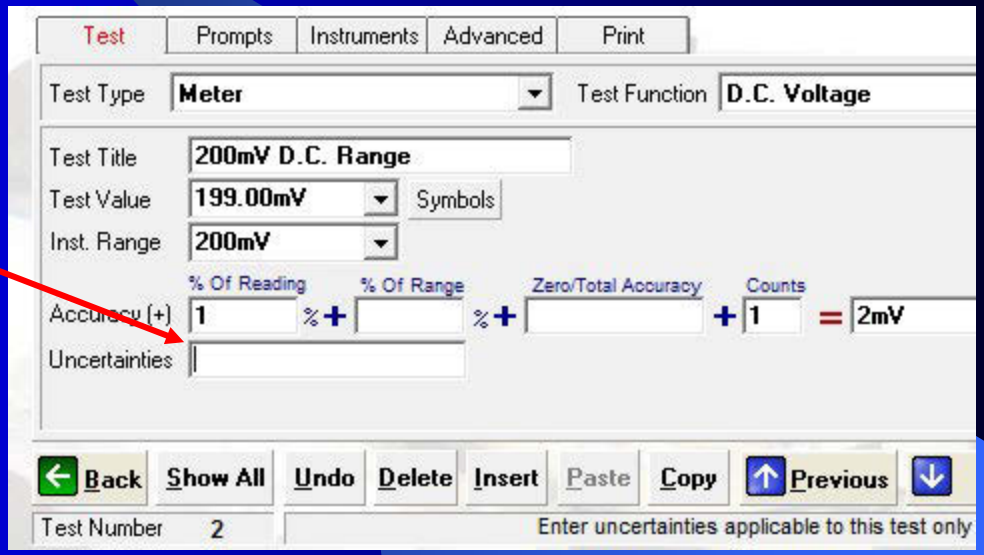
How Procal selects which method to use

1: If an Uncertainty Statement is selected in the procedure then Uncertainty statements will be printed at the end of the page



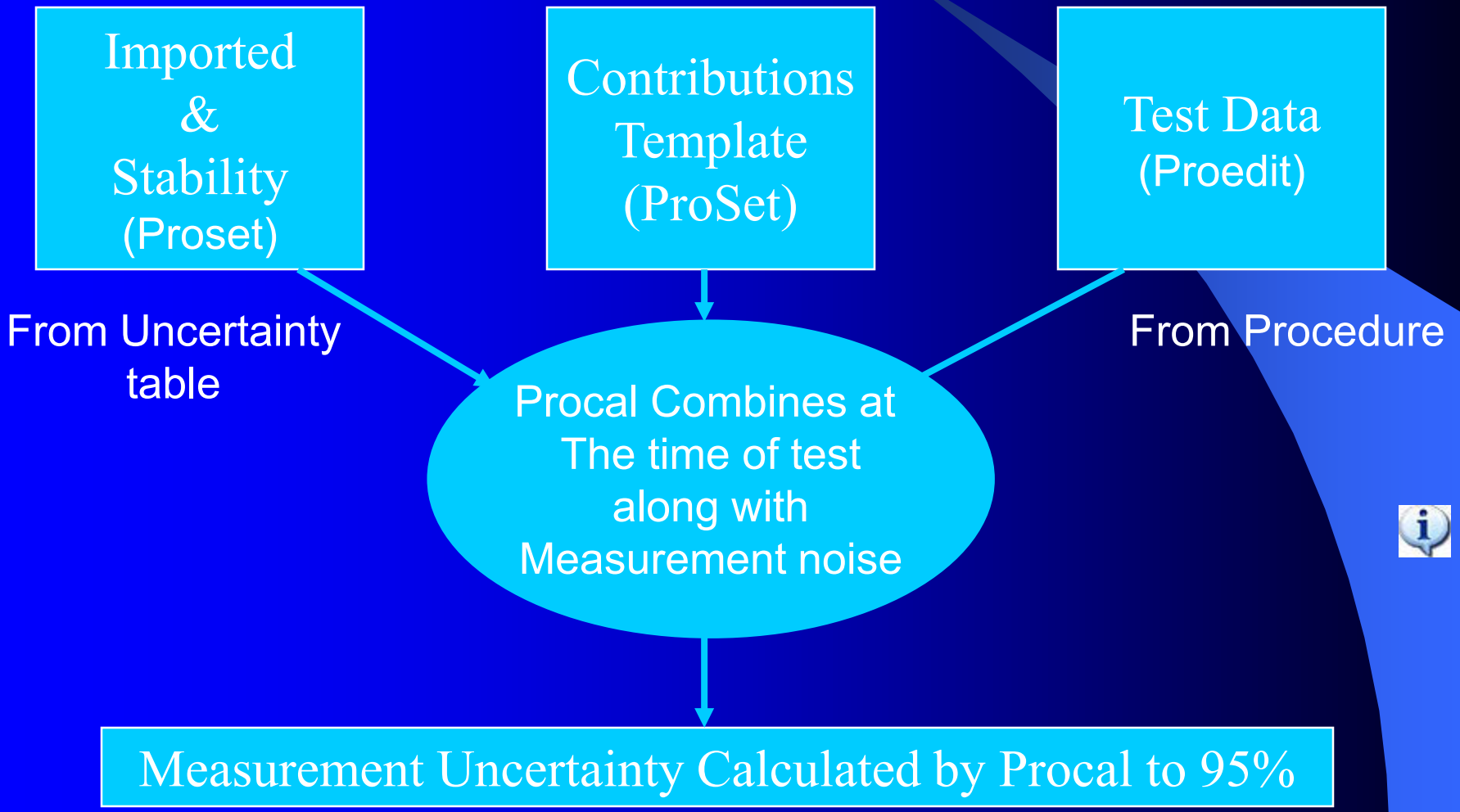
2: If no uncertainty statement is chosen then Procal will Print line uncertainties.

If the uncertainty box on the procedure is empty then Procal will calculate the uncertainty for that test when it is run



How Procal Calculates UNCERTAINTIES

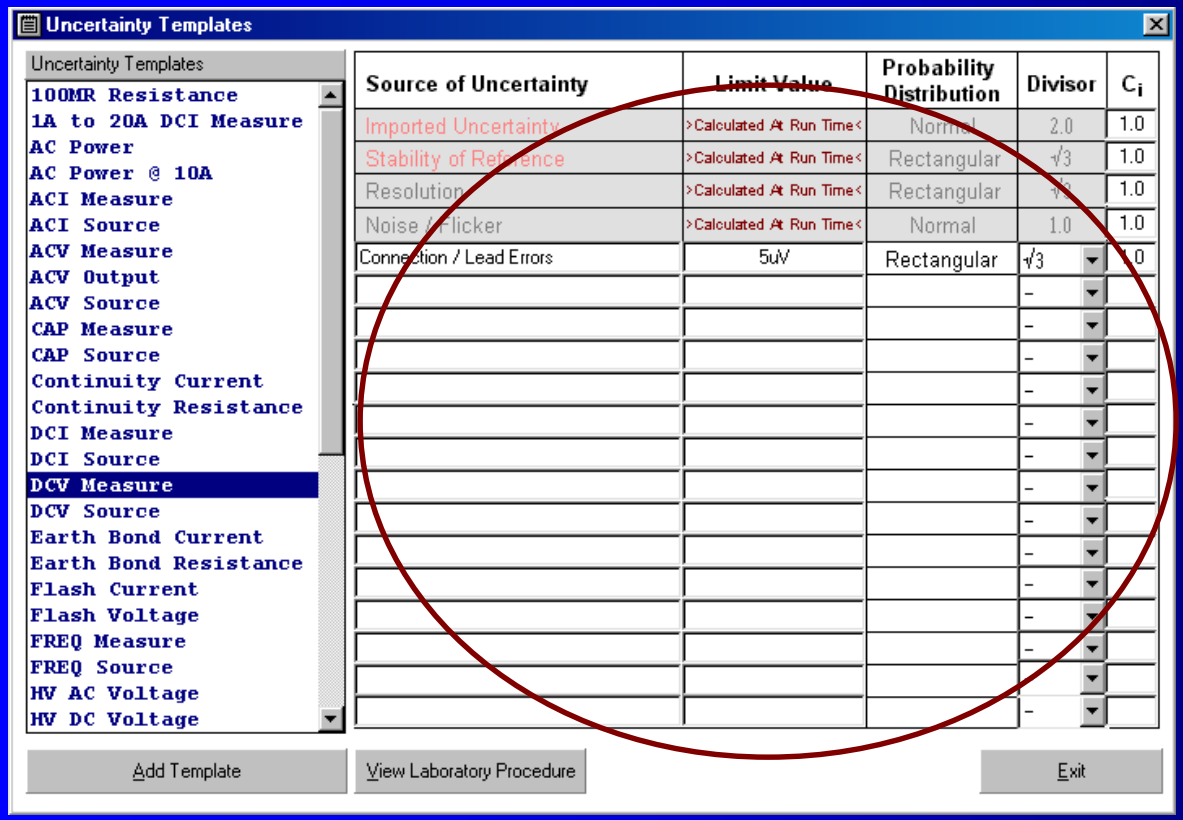
➔**The uncertainties function takes information from several sources to combine in a statistical calculation.**



UNCERTAINTIES – Uncertainty Templates 1

➔The uncertainties function takes information from several sources to combine in a statistical calculation.

➔Each parameter, eg. DC Voltage Source, has a template set up which contains all the information required to calculate the uncertainty for a specific test.



➔Imported Uncertainty

➔Stability of Reference

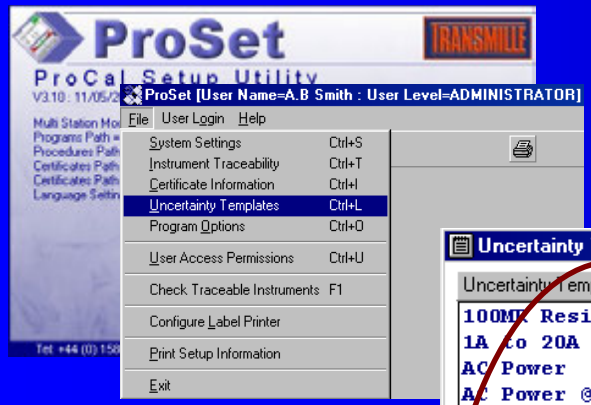
➔Resolution

➔Noise / Flicker

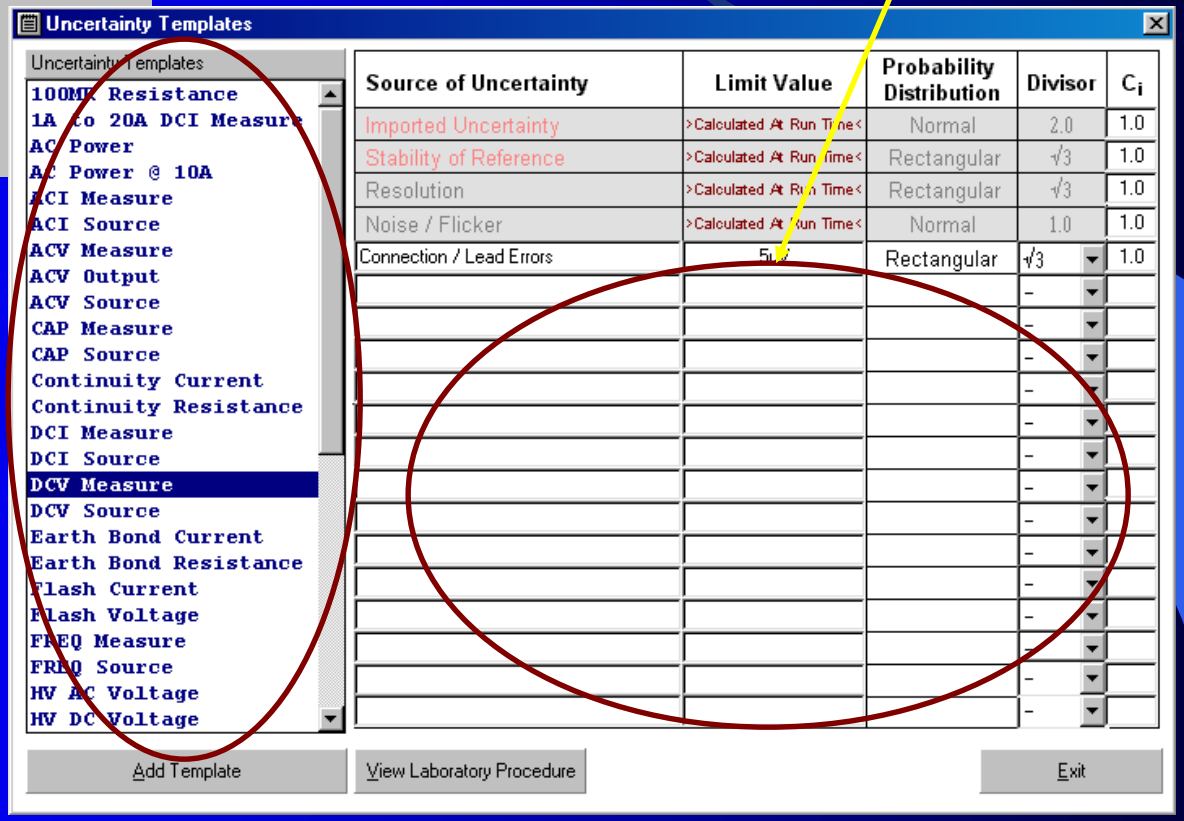
➔Up to 15 additional sources of uncertainty

➔A set of common uncertainty templates are installed with ProCal (AC/DC Voltage, Current Resistance etc.)

UNCERTAINTIES – Uncertainty Templates 2



Up to 15 user defined sources of uncertainty can be added

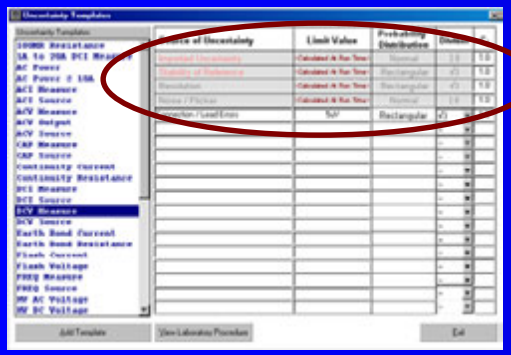


List of available uncertainty templates →

Click here to add a new template →

➔ Each parameter has its own template which includes the four main sources of uncertainty. Up to 15 user defined sources of uncertainty can also be added.

UNCERTAINTIES – Uncertainty Templates 3

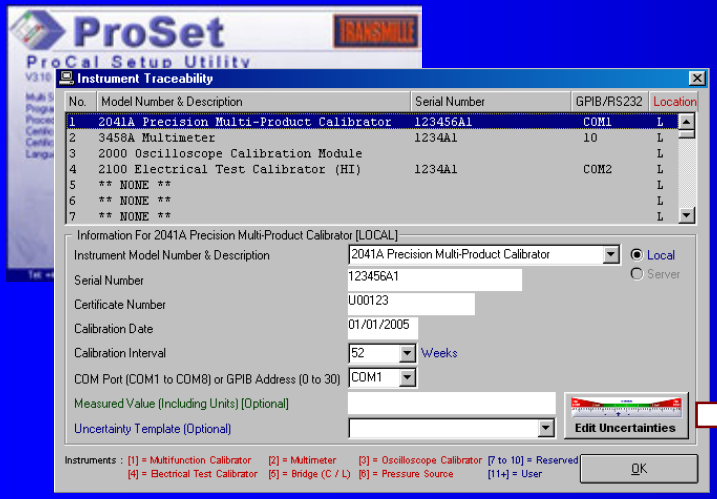


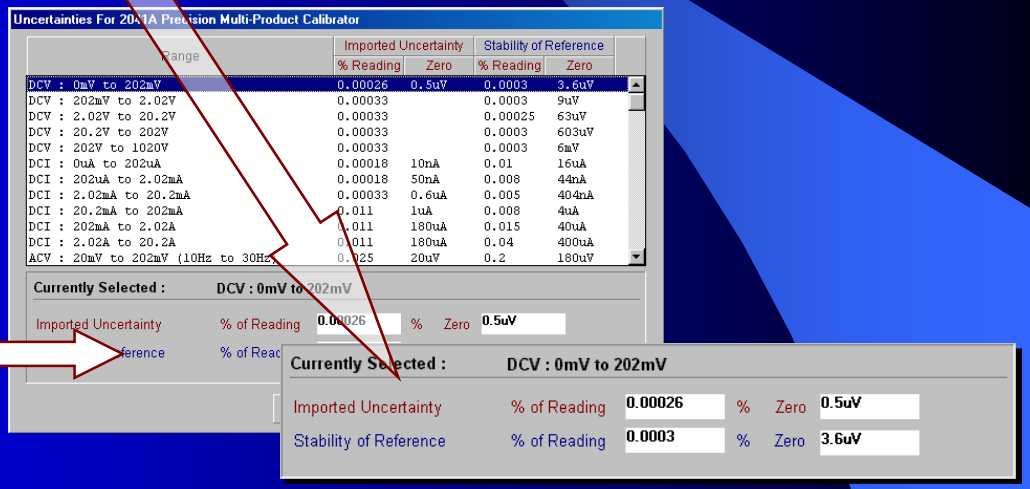
Source of Uncertainty	Limit Value	Probability Distribution	Divisor	C_i
Imported Uncertainty	>Calculated At Run Time<	Normal	2.0	1
Stability of Reference	>Calculated At Run Time<	Rectangular	√3	1
Resolution	>Calculated At Run Time<	Rectangular	√3	1
Noise / Flicker	>Calculated At Run Time<	Normal	1.0	1
Connection / Lead Errors	0.5uV	Rectangular	√3	1.0

- Each line of the uncertainty template is comprised of the following :
- Source of Uncertainty : A description of the uncertainty
- Limit value : The contribution of the uncertainty source
- Probability Distribution : A description of the distribution, as determined by the divisor
- Divisor : Divisor term (1.0, 2.0, √2, √3)
- Ci : Multiplier
  used to scale different measurement functions uncertainty eg.
  measuring current using a shunt
  with a reading returned in volts)

UNCERTAINTIES – Reference Instrument Data

Source of Uncertainty	Limit Value	Probability Distribution	Divisor	C_i
Imported Uncertainty	>Calculated At Run Time<	Normal	2.0	
Stability of Reference	>Calculated At Run Time<	Rectangular	√3	





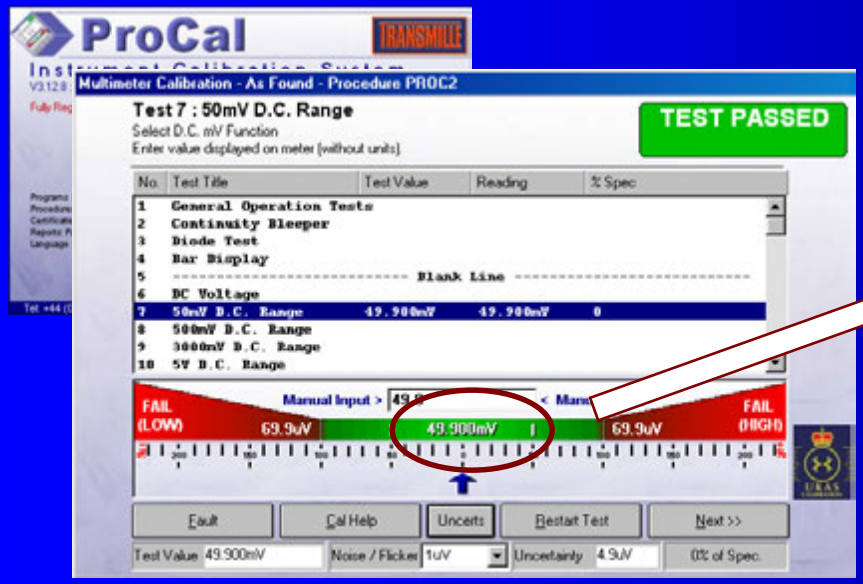
➔The reference uncertainty is calculated from the reference database (set using ProSet) - this data includes :

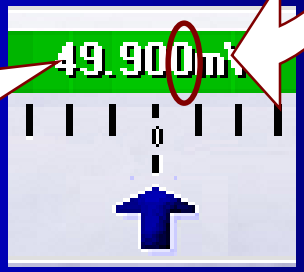
➔IMPORTED uncertainty (from the laboratory which calibrated to instrument)

➔STABILITY of reference (accuracy of instrument from manufacturer specifications)

UNCERTAINTIES – Resolution

Source of Uncertainty	Limit Value	Probability Distribution	Divisor	C_i
Resolution	>Calculated At Run Time<	Rectangular	√3	



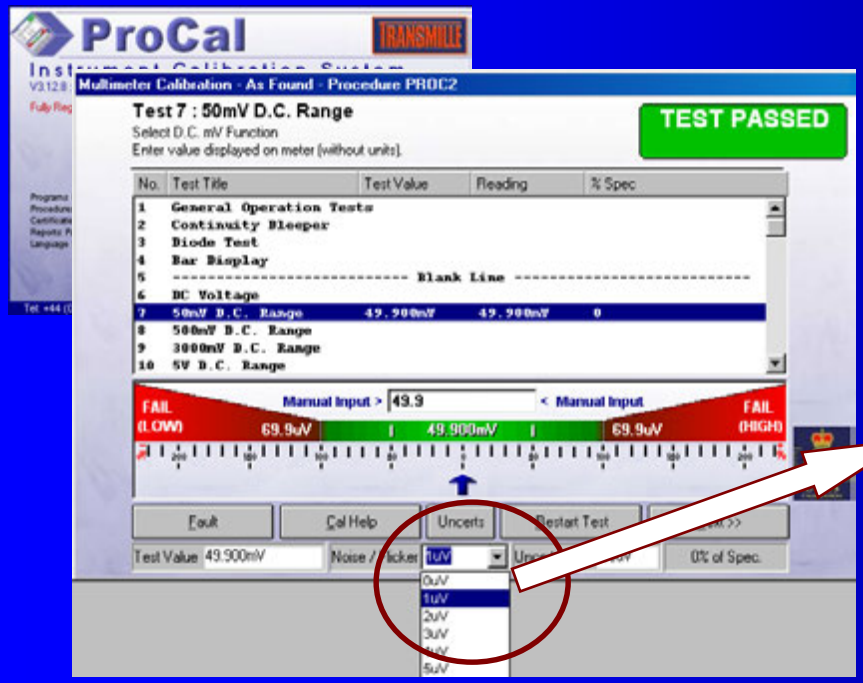


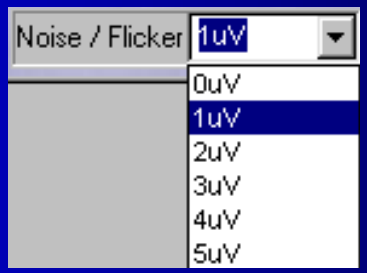
➔The resolution of the instrument is determined when the test is run in ProCal.

➔This is based on the number of decimal places, and is calculated as 1 count.

UNCERTAINTIES – Noise / Flicker

Source of Uncertainty	Limit Value	Probability Distribution	Divisor	C_i
Noise / Flicker	>Calculated At Run Time<	Normal	1.0	

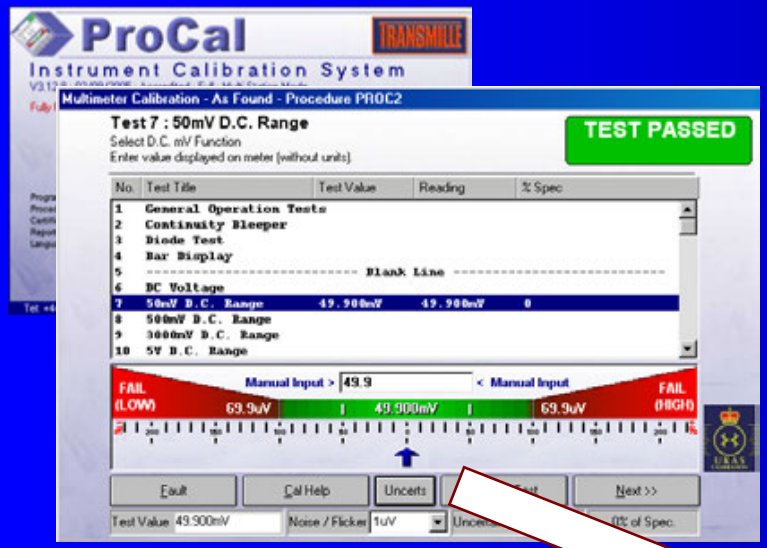




➔The noise / flicker is any observed change in the reading

➔This is selected from the drop down list provided on screen

UNCERTAINTIES – The complete calculation



M3003 Uncertainties Calculation Using 'DCV Source' Uncertainty Template

Source of Uncertainty	Limit Value	Probability Distribution	Divisor	C_i	$\pm U_i$
Imported Uncertainty	516.6nV	Normal	2.0	1.0	258.3nV
Stability of Reference	3.7uV	Rectangular	√3	1.0	2.2uV
Resolution	1.0uV	Rectangular	√3	1.0	0.6uV
Noise / Flicker	1uV	Normal	1.0	1.0	1.0uV
Connection / Lead Errors	0.5uV	Rectangular	√3	1.0	288.7nV
Combined Standard Uncertainty		Normal			2.5uV
Expanded Uncertainty		Normal (k=2)			5uV

2041A Precision Multi-Product Calibrator
Line 1 [DCV : 0mV to 202mV] - Calibration = 0.00026% ± 0.5uV : Stability = 0.0003% ± 3.6uV

Close

➔The complete calculation brings all these components together and produces a single uncertainty figure for the test.

➔By pressing the CALC button the spreadsheet style view of the uncertainty calculation can be displayed.

UNCERTAINTIES – The complete calculation (Cont'd)

- IMPORTED UNCERTANY
- STABILITY OF REFERENCE





- RESOLUTION



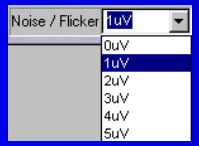




- NOISE / FLICKER







M3003 Uncertainties Calculation Using 'DCV Source' Uncertainty Template

Source of Uncertainty	Limit Value	Probability Distribution	Divisor	C_i	$\pm U_i$
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Noise / Flicker	1uV	Normal	1.0	1.0	1.0uV
Connection / Lead Errors	0.5uV	Rectangular	√3	1.0	288.7nV
Combined Standard Uncertainty		Normal			2.5uV
Expanded Uncertainty		Normal (k=2)			5uV

2041A Precision Multi-Product Calibrator
Line 1 [DCV : 0mV to 202mV] - Calibration = 0.00026% ± 0.5uV : Stability = 0.0003% ± 3.6uV

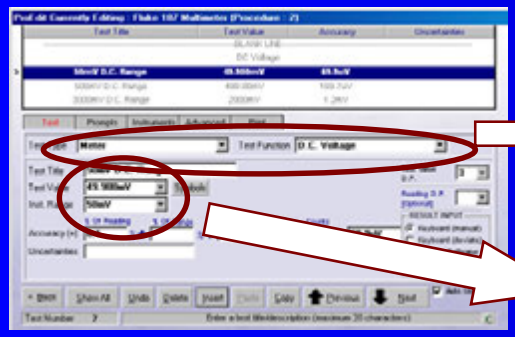
Close

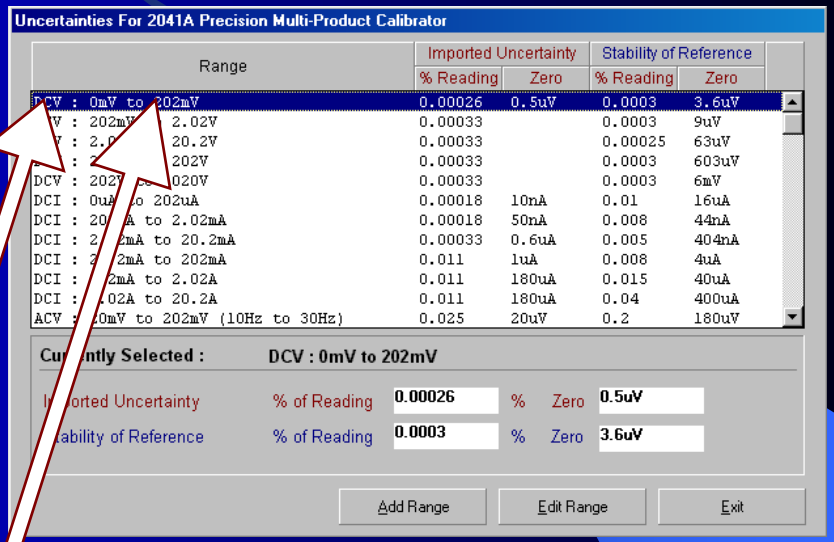
➔ The uncertainty template screen displays the reference instrument description and uncertainty line used at the bottom of the screen.

UNCERTAINTIES – Reference Range Lookup

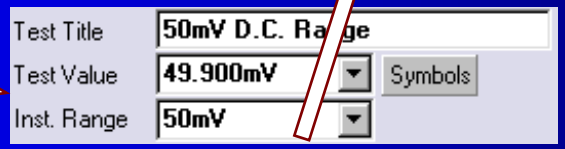
➔If the reference has multiple functions / ranges, ProCal is required to determine which function / range to use.

➔The complete range of Transmille calibrators has a **built in lookup table** which enables ProCal to automatically find the correct line to use – for all other references the procedure will require the exact uncertainty line to be selected using ProEdit.









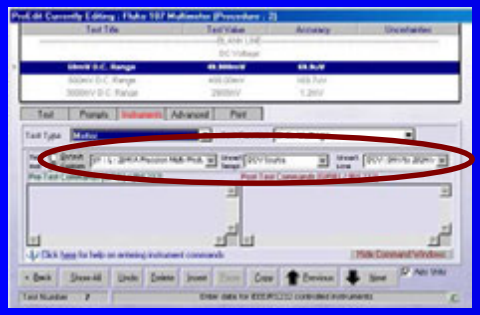


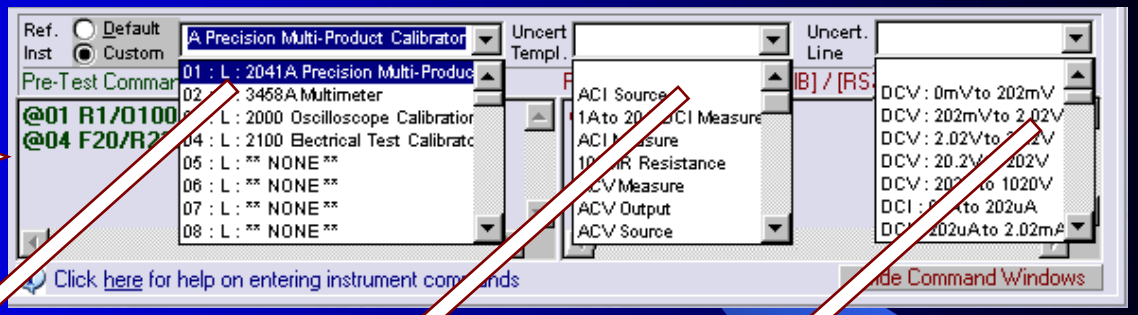
➔ProCal can also look up the uncertainty template required, based on the test type and function

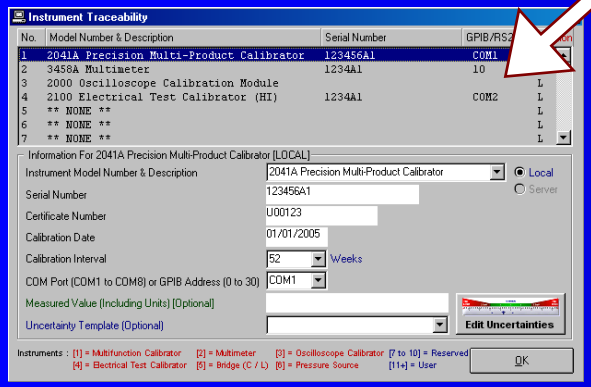
➔ProCal looks up based on Test Type, Function & Test Value to determine the correct reference instrument line to select.

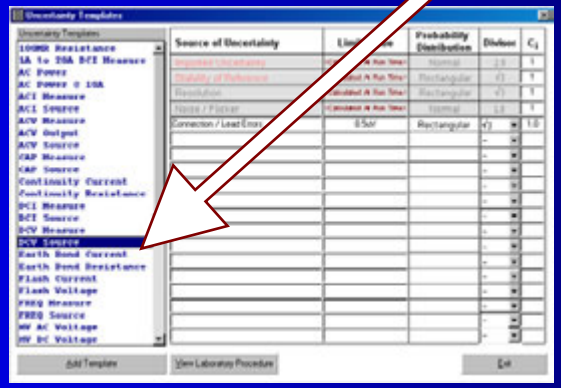
UNCERTAINTIES – Reference Range Lookup (Cont'd)

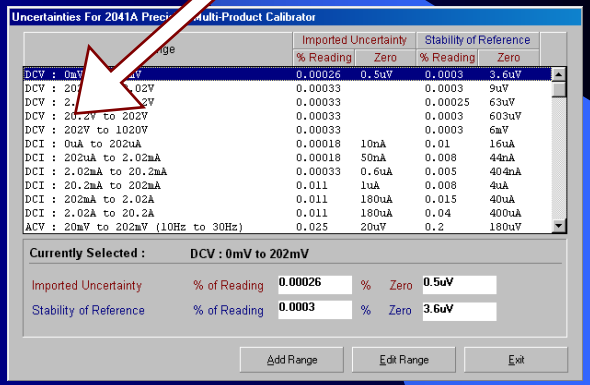
➔ For other multi-range references, the specific reference line needs to be selected in ProEdit











➔Reference Instrument selection

➔Uncertainty table selection

➔Reference table line selection

➔These selections tell ProCal which reference table, reference table line and uncertainty statement to use when calculating the uncertainty for this test.