5041
Oscilloscope & Timer Counter Calibrator

Technical Manual

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Chapter 1 - INTRODUCTION

5041 OSCILLOSCOPE & TIMER/COUNTER CALIBRATOR

The 5041 is a versatile high accuracy calibrator capable of calibrating a wide range of oscilloscopes and timer/counters to 2.2GHz. It provides a wide range of calibrated outputs for amplitude, frequency, period and bandwidth.

The 5041 is compatible with Time Electronics' well established EasyCal software.

The 5041 follows the modern trend of instrumentation which is PC control based and has few front panel controls and switches. A virtual front panel is displayed on the PC screen and communication with the unit is via the RS232 (serial) or GPIB (IEEE) port.

The 5041 is supplied as standard with a Windows based control program that is both user friendly and simple to use. The program will be supported and updated free of charge for the life of the instrument.

For a greater precision of bandwidth determination and additionally, a frequency response analysis function, a 10MHz to 2.2GHz levelised sine wave option is available. The frequency over this range can be swept manually or under the control of the manual control program or Time Electronics' EasyCal software. This enables precision response analysis of and oscilloscopes input amplifiers (and any other high frequency amplifier). If read-back of the amplifier's output is available, either via the serial link or GPIB, a fully closed loop calibration can be done.

For calibration of oscilloscope current probes an optional external battery powered adapter is available. This converts the 5041's amplitude output to current and covers the range 0.1 – 100 mA pk-pk, 0.2% accuracy, DC or 1kHz.

Enhanced timing performance is optionally available by specifying a rubidium atomic clock module (9762). This option is required to achieve the timing accuracy required to calibrate high performance Timer/Counters which need accuracies of 1 part in 10 E-10.

By using a GPS frequency standard it is possible to cross check to International Standards the accuracy of the Rubidium oscillator.

Chapter 2 SPECIFICATIONS

AMPLITUDE CALIBRATION

Output Levels per Div	1mV to 50V in 1,2,5 sequence, 1kHz square wave or DC.
Graticule Divisions X	1, 2, 4, 6, 8. Max output 200V pk-pk into >500kohm/100pF or 2V into 50ohm
Accuracy	1mV-200mV: 0.2%+/-4uV. >300mV: 0.05%. Into 50ohm: 0.25%+/-4uV. TC<20ppm/C

FREQUENCY CALIBRATION

Low Range	0.1Hz to 170kHz (in steps equivalent to 1µs intervals). Output: 1Vpp into 50ohm
High Range	200, 500kHz, 1, 2, 5,10, 20, 50, 100MHz. Output: 400mVpp into 50ohm
Accuracy	10MHz & below: 0.02ppm, <0.1ppm/yr stab. 20/50/100MHz: 5ppm, <10ppm/yr stab

PERIOD CALIBRATION

Low Frequency Mode	6µs to 15s (settable in 1µs steps). Output: 1V pp into 50ohm (2Vpp into open circuit)
High Frequency Mode	10, 20, 50, 100, 200, 500ns, 1, 2, 5µs. Output: 400mVpp into 50ohm
Accuracy	100ns - 15s: 0.02ppm +/- 30ps, <0.1ppm/yr. 10/20/50 ns: +/- 50ps, <10ppm/yr

MARK/SPACE RATIO

Range	0.01% to 99.99% for periods >20ms. For periods <20ms the % mark/space resolution is determined by a minimum 2us step. Output level: as Frequency and Period

FAST RISE

Fast Rise Time	< 300ps. Allows bandwidth checking up to 1 GHz. Output: 400mVpp into 50ohm.

PROGRAMMABLE OPERATION

Interfaces	SERIAL (RS232) and GPIB (IEEE-488)
Commands	A full command set allows complete control of all functions by an external computer

SOFTWARE

PC Program	An easy-to-use program allows full control of the calibrator from an external PC
PC Requirement	PC running Windows 98, ME, 2000, or XP. RS232 serial or GPIB port
EasyCal	The 5041 is fully compatible with Time Electronics' **EasyCal** software which includes an in-built driver to allow speedy automatic calibration runs.

OPTIONS

1GHz sweep	10MHz - 2.2GHz levelised sine wave output (1Vpp). Precision bandwidth calibration
Rubidium reference	Rubidium atomic clock frequency reference. Increases freq/per acc to 1 in 10 E 10
Current probe adapter	A battery powered adapter for checking current probes. 0.1-100mA, 0.2% accuracy

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GENERAL INFORMATION
Power: 100 - 230V AC (+/-7%)   50 or 60Hz
Dimensions: 43cm wide x 25cm deep x 15cm high (17 x 10 x 6 ins)   7Kg (15 lbs)

ORDERING INFORMATION	**Order Code**
Scope and Timer/Counter Calibrator for use with external PC	5041
EasyCal Software	9747
1 GHz sweep	9761
Rubidium frequency reference	9762
Current probe calibration adapter	9764
Rack mount kit (standard 19")	9728
PCI GPIB board	9743

Chapter 3   SETUP & FRONT PANEL

3.1   Mains Input Voltage

The supply power is connected via a standard IEC Euro connector on the rear panel. The standard voltage supply is 100V - 230V 50/60Hz. There are two protection fuses mounted in the IEC connector assembly, both are T3.15A slow blow.

3.2   Communication Settings

The 5041 can communicate via GPIB or RS232 (serial) connection. GPIB preferred if other instruments are to be used on the same bus. Note GPIB operation requires the PC to be fitted with a GPIB interface card and the relevant software drivers. Time Electronics option 9743 or equivalent are suitable.

The 5041 hardware communications settings are set using the DIP Switch on the rear panel. Note: All switches are in the OFF position when set to the left, and ON when set to the right.

(see rear panel photo on following page).

DIP Switch	Use
1	GPIB/RS232 OFF = GPIB ON = RS232

2-6	Binary-coded GPIB address (not used if RS232 is selected)
	When the switches are OFF (to the left) they have the value 0
	When the switches are ON (to the right), they have the values,
	
	   Switch 2 = 1
	   Switch 3 = 2
	   Switch 4 = 4
	   Switch 5 = 8
	   Switch 6 = 16
	
	The GPIB address is determined by the sum of the switch values.
	For example, to set the GPIB address to 20:
	Set switch 4 (value 4) and switch 6 (value 16) ON
	Set switches 2, 3, and 5 OFF
	
	Address = 0+0+4+0+16 = 20

7-8	Not used – Keep in the OFF position

Only change the DIP switch settings while the unit is turned off – changes in DIP switch settings will not be recognized while the unit is on.

3.3   Communication Connections

The 5041 must be connected to the PC by a GPIB cable or a "straight-through" RS232 cable. Do not connect or disconnect the unit from the PC while the 5041 or PC is switched on.

3.4 GPIB User Commands

Note that all commands taking parameters must have at least one space after the command itself before the first parameter. Multiple parameters must be separated by commas, although spaces are optional.

Standard Function Commands

These are the commands that are used to set the output of the device.

Command	Description	Example
FUNC?	Return the output current function. Will return either "F", "P", "A", "FR" or "OFF"	FUNC?
F <Hertz>	Set the frequency to the value specified in Hertz (0.1 – 100000000)	F 0.15
F?	*Return current frequency setting in Hz	F?
P <seconds>	Set the period to the value specified in seconds (0.00000001 – 15)	P 0.5
P?	*Return the current period setting in seconds	P?
D <%>	*Set the duty cycle to the value specified in % (0.0001 – 99.9999)	D 20.2
D?	*Return the current duty cycle setting	D?
SWA <mV>	Sets the 2.2 GHz Sweep Amplitude (in mV)	SWA 1000
SWF <kHz>	Sets the 2.2 GHz Sweep Frequency (in kHz)	SWF 10000
A <Volts>	Set the output voltage to the value specified in Volts (0.000001 – 20)	A 10.2
A?	+Return the current amplitude setting in Volts	A?
G <graticules>	+Set the graticule height to the number specified (0 – 9)	G 1
G?	+Return the current graticule height	G?
WAVE DC	+Set the wave to DC	WAVE DC
WAVE SQ	+Set the wave to 1kHz square wave	WAVE SQ
WAVE?	+Return the current wave setting	WAVE?
50R ON	+Turn on 50Ohm mode	50R ON
50R OFF	+Turn off 50Ohm mode	50R OFF
50R?	+Return the 50Ohm mode setting	50R?
FR	Switch to fast rise output mode	FR
OFF	Turn all outputs off	OFF

* - Command is valid only in frequency or period mode.
+ - Command is valid only in amplitude mode.

Other User Commands

Other commands the user may need to use to set-up the unit.

Command	Description	Example
ERROR?	Return the error code of the last error	ERROR?
GET ON	Enter GET mode	GET ON
GET OFF	Leave GET mode	GET OFF
*TRG	GET mode trigger	*TRG
TERM 1	Set the transmit terminator to CR	TERM 1
TERM 2	Set the transmit terminator to LF	TERM 2
TERM 12	Set the transmit terminator to CR+LF	TERM 12
TERM 21	Set the transmit terminator to LF+CR	TERM 21
TERM 0	Set the transmit terminator nothing	TERM 0
*IDN?	Return the identity of the unit	*IDN?
*RST	Perform a full reset of the unit	*RST
*TST?	Perform a self-test of the unit. Returns an error code or 0.	*TST?

3.5   Front Panel

The LED indicators on the front panel are, Mains On, Amplitude, GHz Sweep, Time Markers and Data. The data transfer over the communications link is indicated by the Data led flashing.

The 16-character alphanumeric display indicates the unit's current output, e.g. the output frequency, period, or amplitude. It also shows error messages which are also indicated by a short beep from the internal buzzer.

LED	Meaning
Power	The unit is switched on
Data	Flashes to indicate data received on the comms port (GPIB or RS232)
Amplitude	When lit, this indicates that there is output from the amplitude BNC connector.
Time Markers	When lit, indicates that there is an output signal from the Time Markers BNC connector
GHz Sweep (if fitted)	When lit, indicates that there is an output signal from the GHz Sweep connector

3.6   Output Connections

There are 2 (or 3, if the GHz sweep option is fitted) connectors on the front panel of the 5041. From left to right these are:

Amplitude Output

The output from this connector is used to calibrate the amplitude scale of oscilloscopes. Output can be varied between 1mV and 200V maximum. Output is either DC or 1kHz square wave.

GHz Sweep Output

This is only present if the 2.2GHz Sweep option is fitted. The output is adjustable from 10MHz up to 2.2GHz. When an output signal is present, the LED above the connector is lit.

Time Marker

The output from this BNC is used to calibrate the time-base of oscilloscopes, and the period and frequency readouts of digital oscilloscopes. It is also suitable for calibration of timer/counters. Duty cycle calibration is also performed using this BNC. When an output signal is present on this connector, the LED above is lit.

Note:

Good quality, 50 Ohm impedance leads e.g. RG58C/U are recommended for correct performance at high frequencies. Length is not critical but 1 metre or less is recommended.

Chapter 4   OPERATION

4.1   PC Control Program

Installation
1.   Insert supplied CD.
2.   Locate and run the application "PCControl5041Setup.exe".
3.   Follow the steps guiding you through the setup program.
4.   Once completed, the program can be run from the "Time Electronics 5041" entry in the Start/ Programs list or a desktop Icon.

Program Configuration
Before running the program the hardware configuration should be set as described in Chapter 3. Once this has been done it is necessary to set-up the program configuration to match the hardware configuration. To enter the program configuration press the 'Setup' function button.

Select either GPIB or RS232 for the desired control mode.

In GPIB mode the GPIB address will need to be set to match that which has been set on the 5041 (see Chp 3). Note that for GPIB operation the PC must have a GPIB adapter fitted and the relevant driver software installed.

For RS232 mode only the COM port needs to be selected. Either COM1 or COM2 can be selected. The baud rate and the other serial communication parameters are fixed and the program and 5041 firmware are matched.
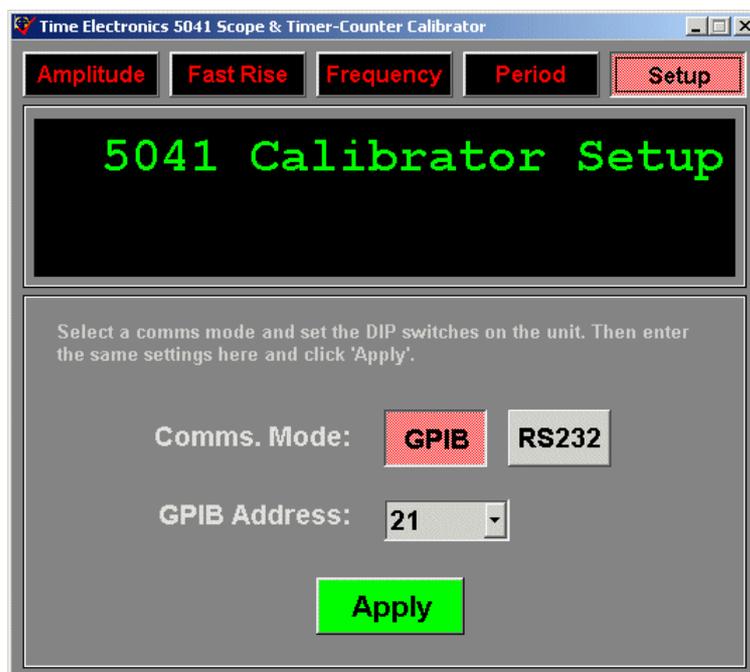
4.2   Amplitude Function

To enter the amplitude calibration function, click the "Amplitude" tab at the top of the window.

Note: It is recommended that when calibrating high frequency (>100MHz) that the lowest bandwidth setting be used. This is to reduce the amount of spurious pickup noise that is present on the low mV ranges

To provide an amplitude output, both the range (mV or V/div) and the number of graticule divisions must be selected. The graticule divisions are designed to match the number of main divisions found on the majority of scopes. A choice of output types is available, '1 KHz Square' (a square wave), 'DC' (a DC level), or 'Zero' (a zero voltage on the output).

To speed up calibration and get a direct read-out of the % error it is possible to deviate the output in small increments. Press the Deviation button to enter this mode. The legend on the button indicates whether or not the unit is in this mode. When Deviation mode is ON additional buttons appear and allow the output to be incremented or decremented in 0.01% or 0.1% steps. A '0' button allows the deviation to be immediately removed. The amount of deviation is shown adjacent to the buttons and is the direct read-out of the error when the output has been adjusted to give the correct reading on the scope. Please note that deviation is not available for the maximum output of 200V DC or square wave

Full information about the output signal is given in the main display window.

The 5041 is capable of driving a 50 ohm termination with 2V DC or pk-pk signals. Note that the resulting accuracy is reduced - see Chp 2 specification. Also note that the final accuracy will be further reduced by the accuracy of the 50 ohm termination resistor. For precision calibration the user should make allowance by consulting the scope manufacturer's specification.
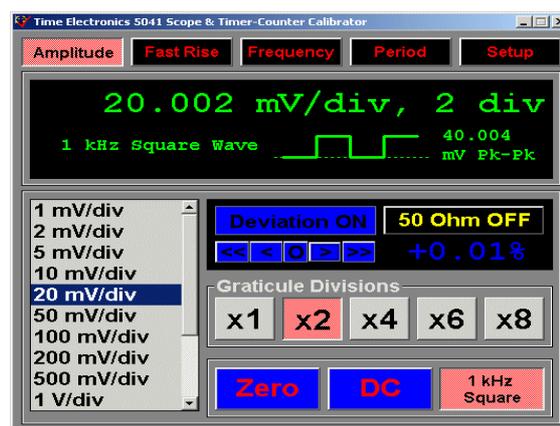
Note: Modern oscilloscopes with digital read-outs tend to give poor performance at low levels (<20mV/div), particularly with wide bandwidths due to the noise that is internally generated in the scope's input amplifiers. It should also be noted that most digital scopes have two ways of displaying the amplitude value of a square wave, the averaged top and bottom mode should be used since the pk-pk mode will pick up on any the noise and small spikes on the signal and give an incorrect value. The following screen pictures show these effects.

Typical Amplitude outputs:
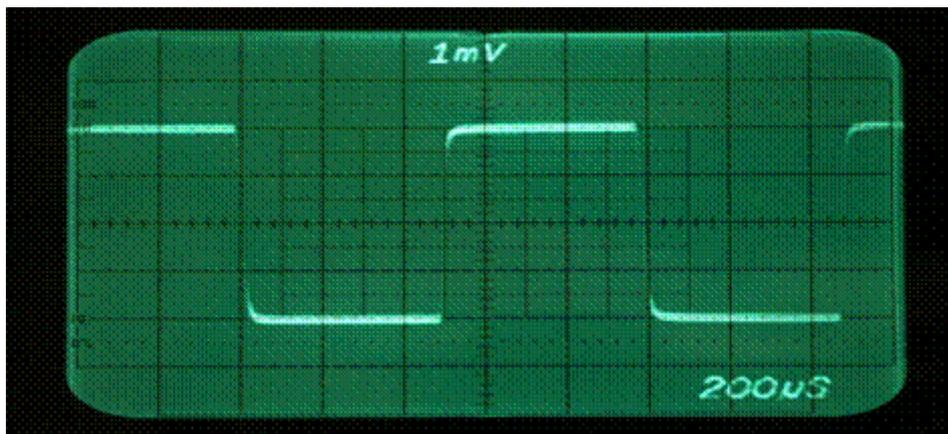
Tektronix 7A22 1mV/div 1 MHz bandwidth
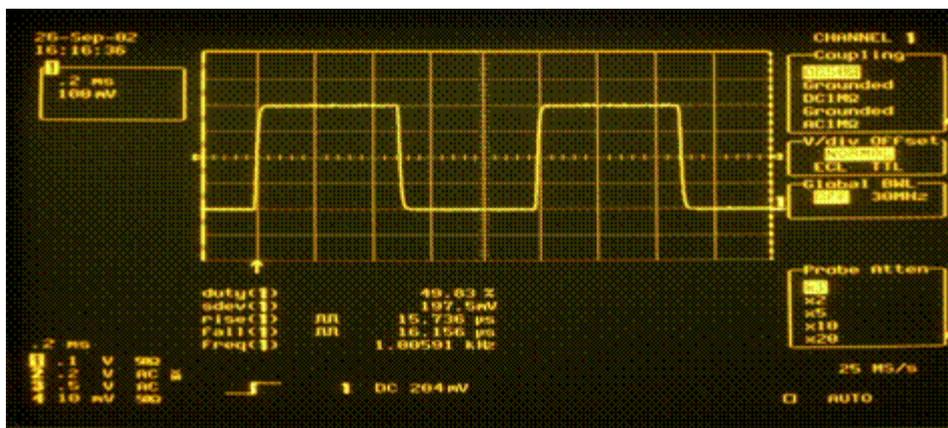
LeCroy 9314AM digital   100mV/div, 50 ohm terminated, full bandwidth
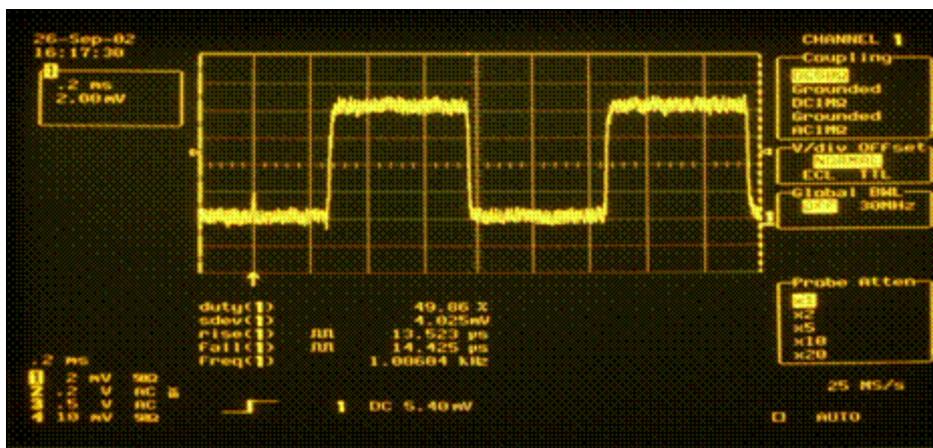
**LeCroy 9314AM digital   2mV/div, 50 ohm terminated, full bandwidth
(notice the internal scope generated noise)**

4.3 Fast Rise Function (Bandwidth determination)

The fast rise screen provides a means for calculating the approximate bandwidth of a scope. Selecting this function provides the fast rise-time signal needed for the determination of a scope's rise time. The signal is output from the Time Marker's connector.

The bandwidth is calculated by first measuring the scopes displayed rise time using the very fast rising edge of the 5041's fast-rise signal. The rise time value is then input to the program and a bandwidth calculated using a mathematical formula. The result is shown in the main display window.

It is very important with all scopes to use a 50 ohm terminated input. Some scopes, such as the LeCroy and most of the Tektronix range have the ability to allow the user to switch in an internal 50 ohm termination. If this is not available, an external 50 ohm through termination - available from Time Electronics or main line electronics component distributors.

Set the "flat" portions of the waveform on 0% and 100% and measure the 10% to 90% rise time. The rise time (in nanosec) should be entered into the relevant box on the PC window. Clicking on the 'Calculate' button or hitting the "Return" key will show the approximate bandwidth in the main display window. Note: The bandwidth calculation automatically compensates for the 5041 signal output rise time.
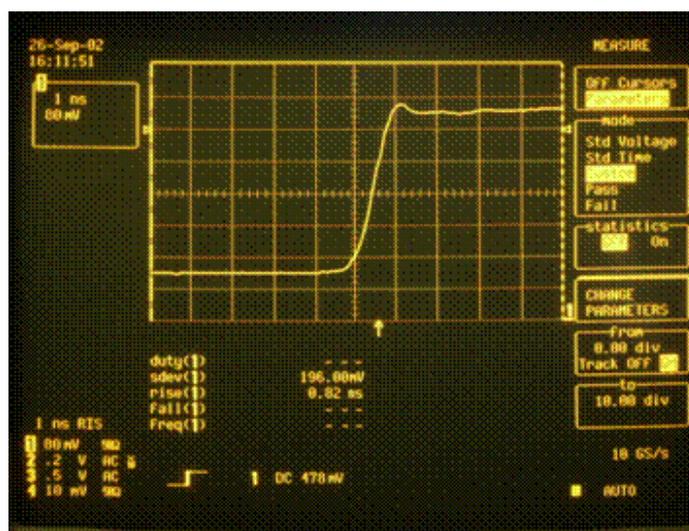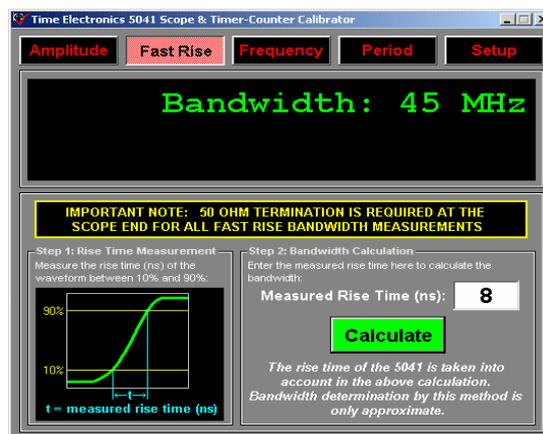
LeCroy 9314AM bandwidth determination: Measured rise time is about 0.8ns (the scope read-out shows 0.82ns) If 0.8ns is entered into the program calculator a bandwidth of 460 MHz is shown, which is approximately correct for this scope.

4.4 Frequency (Time Base) Function

The 5041 provides frequencies from 0.1Hz to 100MHz in two basic ranges. Low Range is 0.1Hz to 170kHz , and the High Range is 200kHz to 100MHz. This function is suitable for calibrating oscilloscope time bases and also timer-counters.

For the Low Range the output is a nominal 1V pk-pk square wave when driving a 50 ohm termination, and a nominal 2V pk-pk when driving high impedance (>10Kohms).

For the High Range the nominal output is 400mV pk-pk into 50 ohms. It is recommended that only 50 ohm termination be used for this range to prevent waveform distortion due to ringing and reflections. However, some distortion of the waveform will not affect the frequency accuracy and output level will be approximately 800mV.

For the Low Range the required frequency is entered via a numeric keypad. After entering the required value either Hz or kHz should be selected. Due to resolution considerations not all frequencies are available. For example 10KHz and 8kHz are available but for 9kHz only 9.009kHz is available.

If an unavailable frequency is selected, the nearest available frequency will automatically be displayed in a pop-up window and the user will have the option to accept or reject.

Duty cycle setting:
For all frequencies in the Low Range the duty cycle of the output square wave can be set. This is done in the same way as frequency setting on the numeric keypad. However, after entering the value (as a %), the '% Duty Cycle' button should be pressed. As with the frequencies not all values of duty cycle are available, a pop-up window will show the user the closest duty cycle available and allow accept/reject.
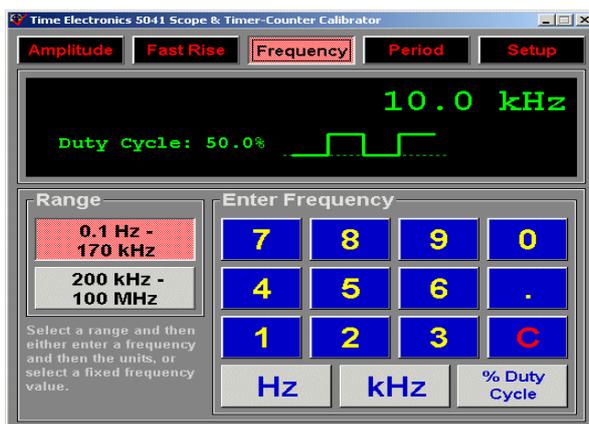
On the High Range (200 kHz to 100 MHz), only fixed frequencies are available. These are selected using the labelled buttons, shown below.
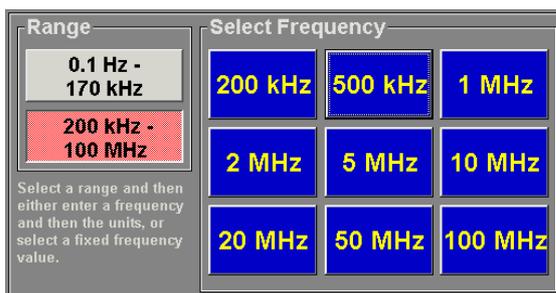
Examples of Frequency function outputs:
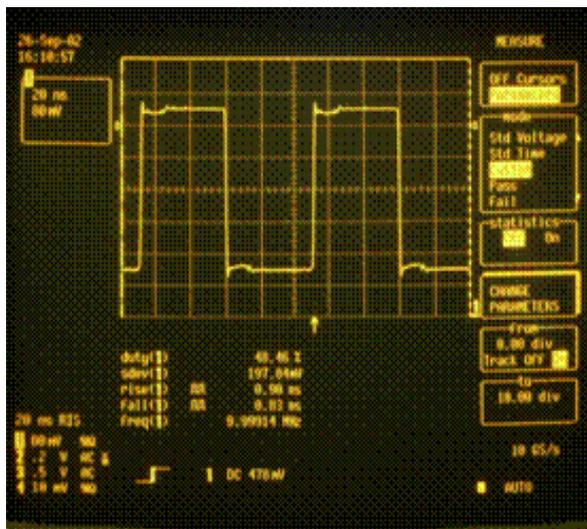
Example of effect of a poor quality cable
(Note the distortion effects)
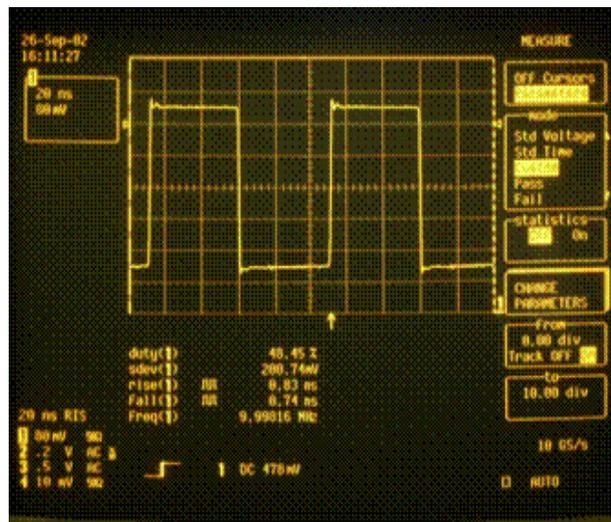
The same conditions with a good quality cable
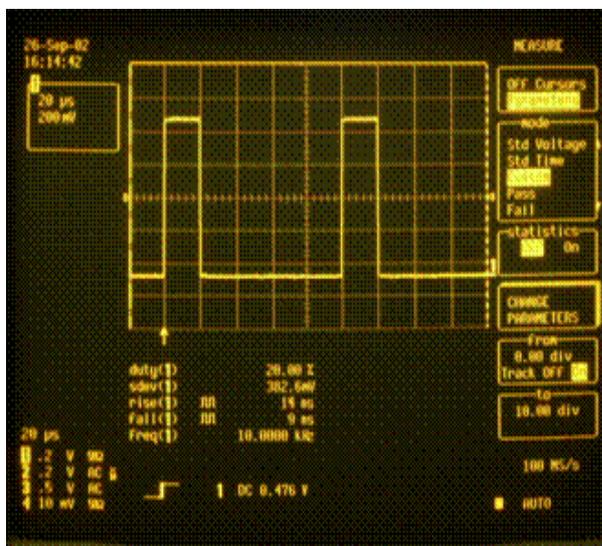
Example of a 20% Mark/Space output

The 100MHz output displayed on a Tek 3000

4.5   Period Function

The period function mirrors the frequency mode, again having two ranges.

The Short Period Range provides fixed periods from 10ns to 5µs.
The Long Period Range provides periods from 6µs to 15s.

As with frequency the short period range has fixed values and the long period range has numeric keypad entry. Similarly various periods can not be set and the user is informed of the nearest available value.

Duty cycle setting is again available on the long period range with the same limitations on the values that are available.
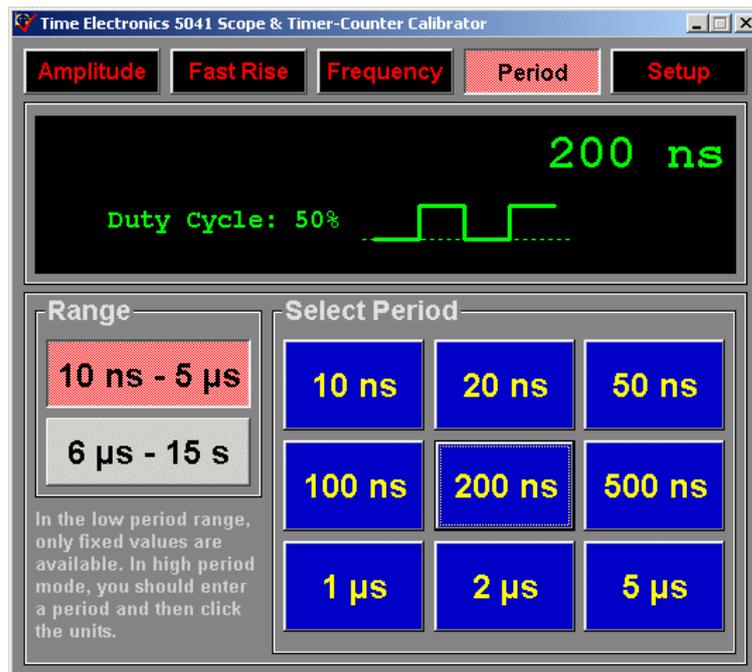
4.6   2.2 GHz Levelised Sine Wave Function

This option provides a pure sine-wave of controlled amplitude from 10MHz to 2GHz.

Oscilloscope bandwidths can be accurately determined by sweeping the frequency up to the 3dB point (approximately a 30% reduction)

For high frequency timer counter calibration the accuracy is determined by an oven controlled crystal oscillator with an accuracy of 0.02 ppm and 0.1ppm per year stability.

SPECIFICATION:

FREQUENCY

Frequency range	10MHz to 2.2GHz
Frequency resolution	25KHz
Frequency accuracy/stability	0.02 ppm / 0.1ppm per year. Oven controlled crystal oscillator

AMPLITUDE (into 50 ohm load)

10MHz to 2GHz (adjustable)	150mV min - 400 mV max rms (default apprx 360mV)
Above 2GHz	not levelised - uncontrolled
Amplitude levelling accuracy	+/- 1% up to 200MHz +/- 4% 200MHz to 500MHz +/- 10% 500MHz to 1GHz +/- 20% 1GHz to 2GHz

OPERATION:
This function is selected from the main menu. The output is via the centre connector on the front panel.

Please note that the 5041's display is not active for this function.

The frequency sweep is controlled by three sets of buttons which increment/decrement in 1, 10, 100MHz steps. Specific frequencies to a resolution of 0.025 MHz can be entered via the numeric keypad.

For direct read-out of error, a deviation feature is provided - this allows the frequency to be deviated up to +/-10% with a 0.001% resolution. Please note that the deviation setting is limited by the frequency setting resolution of 25KHz. This means that it is not always possible to achieve the deviation accuracy shown in the display. Deviation control is only usable above 15MHz.

The amplitude can be adjusted with +/- buttons and reset to the default switch on value (360mV rms) using the 'R' button.

Oscilloscope Bandwidth and Frequency Response Calibration:

An oscilloscope's bandwidth and frequency response can be checked using a sine-wave signal that has an accurately controlled amplitude over a wide range of frequency. The absolute accuracy of the sine-wave is not important, only its stability with change in frequency.

For frequency response checking it is usual to set a known output level at the lowest frequency of interest and increase the frequency in desired steps. The response (output) of the instrument under test is then recorded at each of the required frequencies.

For oscilloscopes, the low end frequency amplitude should be set to a convenient number of graticules using the +/- buttons. The amplitude should then be monitored as the frequency is increased. The oscilloscopes bandwidth is the frequency at which the amplitude falls to 70% (3dB down) of the originally set value.

Please note that the output impedance is 50 ohms and the amplitude setting range is 140 - 400mV rms when driving into 50 ohms. If the output is un-loaded the setting range is 280 - 800mV.

It is important to ensure at high frequencies (>100MHz) that the output is terminated into 50 ohms, otherwise ringing and reflections in the connecting cables will cause errors. For frequencies above 200MHz it is important to use high quality coaxial cable to prevent erroneous errors occurring.

When calibration digital oscilloscope's digital display of frequency it is recommended that the averaging function on the scope be used to ensure a stable reading.

Above 2GHz the output is available up to 2.2GHz, but the amplitude is no longer levelised and falls away rapidly. It is therefore not recommended for amplitude calibration, but is still accurate and suitable for frequency calibration.
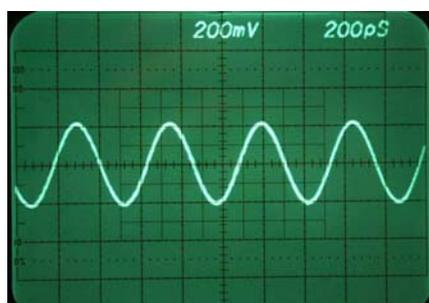
Output at 2.2GHz

Chapter 5   EasyCal

Using the 5041 in conjunction with EasyCal allows automated oscilloscope and timer/counter calibration runs to be performed.

Please Note: In order to use EasyCal with the 5041 you must be using EasyCal version 5.25 or later.

Adding the 5041 to the List of Calibration Instruments

To use the 5041 with EasyCal, first you need to add it to the list of calibration instruments. To do this:
1) Start EasyEdit
2) Select menu option **System Setup**
3) Select menu option **Calibration Instruments.**
   The screen will look something like this:
4) Click **Add…** Another screen will appear. Using the pull-down list in the **Type**

Calibration Instruments

ID	Description	Serial Number	Certificate Num...	Cal Date	Cal Period	Gpib Address
1GPB	Fluke 5500A Calibrator	6470032	04311	03 Apr 2000	52 weeks	4
1std	Digital Thermometer	234DT5	00642	08 Oct 1998	52 weeks	N/A
28GPB	HMI38 Humidity Data ...			14 Aug 2001	52 weeks	
29GPB	Datron 1081 DMM			21 Aug 2001	52 weeks	22
5022	5022 Multifunction Cali...			21 Nov 2001	52 weeks	24
5075	5075 Digital Multimeter			28 Feb 2000	0 weeks	16
5GPB	TIME 9814 Calibrator			11 Aug 2000	52 weeks	1
6GPB	HP3631A Triple O/P P...			11 Aug 2000	52 weeks	1
7GPB	TE 9815 Program Scre...			15 Aug 2000	52 weeks	8
9822	9822 Multifunction Cali...			30 May 2000	52 weeks	24

Print   Delete   Add...   Edit...   User-defined Readback Drivers...   Exit

entry box, select **5041 Scope and Timer/Counter Cal**. Enter the GPIB address of the 5041 and other details of the unit. The screen will look something like this:

Add New Calibration Instrument/Standard

Details

Type: 5041 Scope & Timer/Counter Cal
Description: 5041 Scope & Timer/Counter Cal
Serial Number: 1019F3
Certificate Number: 28363
Calibration Interval: 52 Weeks
(select 0 if cal not required)
Last Calibration Date: 18 Sep 2002

Comms
GPIB   Address 21
RS232
None

Uncertainties

OK   Cancel

5) Click **OK**. The screen will close and return you to the list of calibration instruments. You will see that the 5041 has been added to the list.

6) Click **Exit** to close the calibration instruments list. You may now exit EasyEdit in the normal way.

Entering Procedures that use the 5041

Now that the 5041 is in the list of EasyCal's calibration instruments, it is easy to add tests to a procedure that use the 5041. Here are the steps involved:

1) Create a new procedure or open an existing procedure in the normal way using EasyEdit.
2) Click the **Test Data…** button to list the tests (if any) in the procedure.
3) Click **Add** to add a new test to the procedure.
4) Select **Test Type** as **Time (EasyCal) Calibrator/DMM**, and the **5041** as the calibrator, so that the screen looks like this:
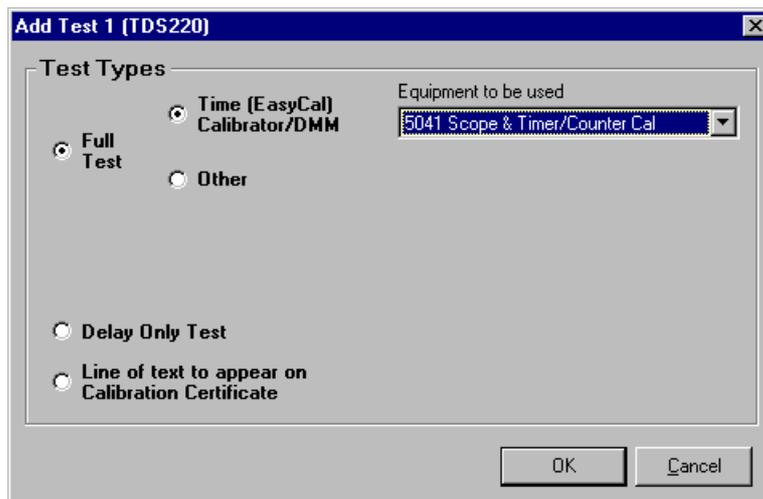
5) Now click OK. The test entry screen will appear. Enter the test name and prompt in the normal way. Then, depending on your test, select the function you want to use from this list:
- Amplitude
- Timebase
- Bandwidth using fast rise
- Frequency
- Period
- Duty Cycle

We will now deal with each type of test in turn.

Entering an Amplitude Test

Amplitude tests can be used to calibrate an oscilloscope's amplitude scale, and its peak-to-peak digital readout if it has one.
Above is an example of an amplitude test. Taking each field in turn:

Waveform
Select either DC or Square Wave. Square Wave will cause the output to be a 1kHz square wave at 50% duty cycle.

Input Method
Choices are the standard EasyCal options. Included is Deviate. If selected, this allows the operator to deviate the output of the 5041 calibrator until the instrument under test reads the required voltage.

Volts per Div
Select the required volts per division from the choices available (1mV/Div to 50V/Div).

Graticule Height
Choices of 1, 2, 4, 6, and 8 graticule heights are available. The total Required Value (volts) is calculated using this formula:

$$Required\ Voltage\ =\ Volts\ per\ Div\ *\ Graticule\ Height$$

If you wish to perform peak-to-peak testing, then select a graticule height of 1 – this allows calibration of the digital peak-to-peak readout (if present) of an oscilloscope. The remaining fields are used in the normal way.

Entering a Period Test

Period tests are used to calibrate an oscilloscope's time-base, or a timer/counter's period function. A period test entry screen looks similar to this:

Input Method
Available input methods are Keyboard Input, Spinbox and Pass/Fail. These are used in the normal way in EasyCal.

Required Value
Select the required time-base from the list of available timebases (100ns to 10s). The 5041 will output a 50% duty cycle square wave of the selected period.

The remaining fields are used in the normal way of EasyCal.

Entering a Bandwidth using Fast Rise Test

It is possible to measure the bandwidth of an oscilloscope using this type of test. The 5041 will output a square wave at 10MHz. By measuring the rise time of the instrument under test at calibration time, it is possible to determine the bandwidth of the instrument. The entry screen for a bandwidth test is shown below.

Select the **Input Method** that you want to use. Enter the **Required Value** and **Allowed Error** as required. The remaining fields are used in the normal manner of EasyCal.

Entering a Frequency Test

Frequency tests are used to calibrate the frequency function of a timer/counter or the frequency readout of a digital oscilloscope. The 5041 outputs a square wave (50% duty cycle) at the selected frequency. A frequency test entry screen looks like this:

Enter your selection of **Input Method**, **Required Value** and **Allowed Error** in the normal way.

Entering a Duty Cycle Test

Duty cycle tests can be used to test the duty cycle function of an oscilloscope or timer/counter. As well as being able to select the duty cycle required, the test also includes a choice of periods, from 100µs to 5s. The 5041 outputs a square wave of the chosen duty cycle and of the selected period.
The test entry screen looks like this:

Select the period you require from the **Period** pull-down list.

Enter the **Required Value** as the value of the duty cycle you require in percent. Note that the 5041 has a minimum resolution of 1µs for its on-time and its off-time. This limits the resolution of duty cycles available at different periods. For example, at the fastest rate of 100µs, the duty cycle resolution is 1%. Whereas, with a 10ms period, the duty cycle resolution is 0.01%. When you click **Save** to save the test, EasyCal will tell you if the duty cycle selected is not obtainable and adjust it for you to the nearest value.

GHz Sweep Control Commands

Control of the GHz sweep function from EasyCal is by using direct GPIB or RS232 commands. These are entered on the procedure test as follows,

Amplitude setting: **SWAxxxx** where xxxx is the required amplitude in mV rms

Frequency setting: **SWFxxxxxxx** where xxxxxxxx is the required frequency in KHz

The required amplitude should be determined by trial and error for a particular scope - it should align the peak of the signal trace with a suitable number of graticules (for a frequency well below that expected for the bandwidth. A series of tests with keyboard or spin box entry should be created for frequencies up to slightly above the expected bandwidth. The nominal value should be set as the value determined above. The allowed error should be set to 70% of this. All test should pass until the level shown on the scope falls to 70% of the nominal.

Calibration Runs using the 5041

When performing a calibration run that uses the 5041 then, as with all calibration instruments, ensure that it is switched on and connected to the PC running EasyCal before you start the calibration run from the CalRun application.

Before each test starts, ensure the oscilloscope or timer/counter is connected to the appropriate BNC connector of the 5041:

- Amplitude tests – **Amplitude**
- Period, frequency, fast-rise, duty cycle – **Time Markers**

Amplitude Test with Input Method of Deviate
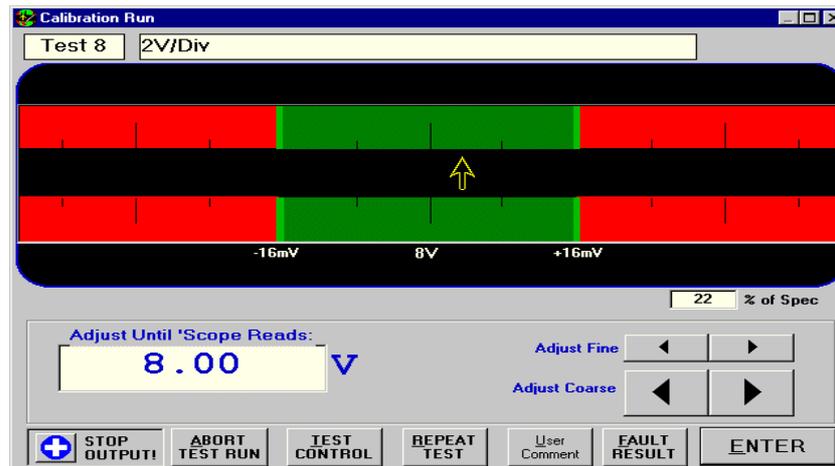
Use the **Adjust Fine** and **Adjust Coarse** buttons to vary the amplitude output of the 5041 until the oscilloscope reads the required value (e.g. in the example above, 8V). Click ENTER when the value is reached.

Note, if you are testing the peak-to-peak digital readout of a scope, then adjust the scope's graticule height to whatever you require for testing.

Amplitude or Period Test using the Spin-box Input Method

The screen will look like this:

This example is of a period calibration test, but the display for amplitude is similar. Use the **Adjust Fine** and **Adjust Coarse** buttons to vary the value shown in the 'Scope Reading box until it matches the reading of the oscilloscope.

Bandwidth using Fast Rise Test

The screen will look like this (if **Keyboard Input** method is selected, then it will vary slightly):
Remember to connect a 50 Ohm termination between the oscilloscope and the Time Markers BNC connector of the 5041.

To calculate the bandwidth of the oscilloscope:
1)   Configure the oscilloscope so that a single wave cycle fills the screen.

2)   Measure the rise time in nanoseconds between 10% of the rising-edge's amplitude and 90% of its amplitude
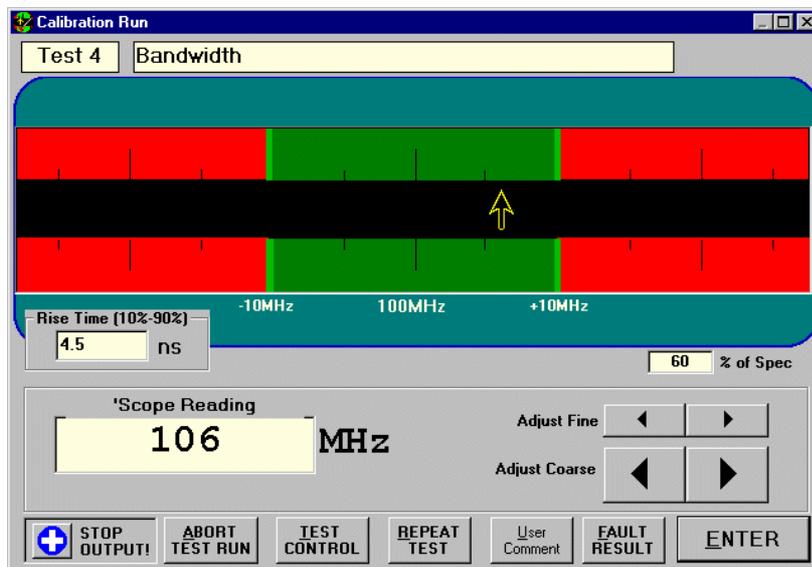
3) Use the **Adjust Fine** and **Adjust Coarse** buttons to change the contents of the **Rise Time** box until it matches your calculated value as closely as possible (in the example above, it is 4.5ns).
4)   The bandwidth of the oscilloscope is now shown in the **Scope Reading** box (in the example above, 106MHz).

Click **ENTER** to save the result and exit the test.

Frequency Test

Shown here is an example of a frequency test being performed. In this example, the input method is **Keyboard Input** – the screen will vary slightly for other input methods.
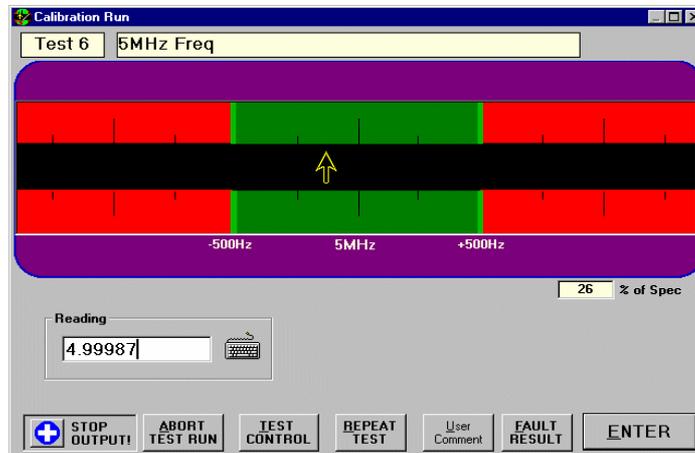
Enter the frequency reading shown on the timer/counter or oscilloscope under test into the box labelled **Reading**. You must use the same units as shown in the middle of the bar display (in the example above, the value is entered in MHz.) Click **ENTER** when you have entered the reading.

Duty Cycle Test

Here is an example duty cycle test run screen (input method is **Spinbox**, so the screen will vary for other input methods).
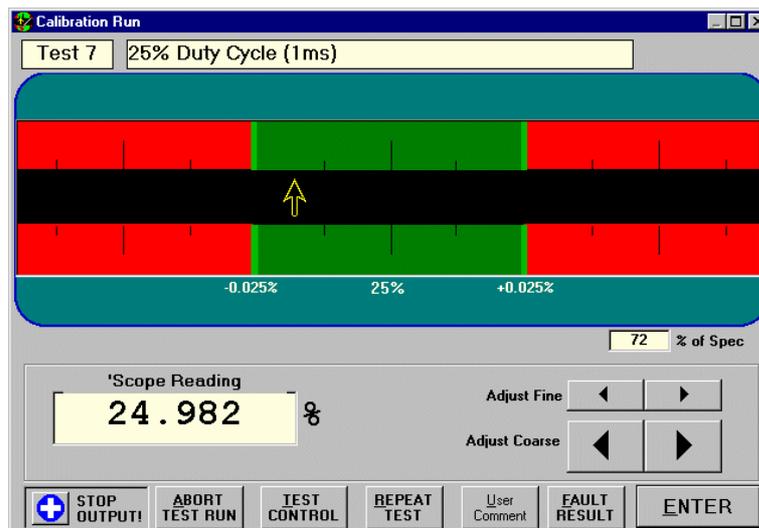
Use the **Adjust Fine** and **Adjust Coarse** buttons to vary the reading on the screen until it matches the reading of the oscilloscope or timer/counter. Click **ENTER** to save the result.

Chapter 6 FAULT DIAGNOSIS

This section gives details of fault conditions, and how to identify and correct them. Faulty items may be returned for repair or, replacement boards obtained. Please ensure you always quote your 5041's serial number, and give exact details of the fault. Time Electronics and their authorised agents offer an exchange service for all modules and cards including the power module.

The modules and boards are housed in a euro-card size frame. Generally it is recommended that the instruments 'U' shaped top cover is removed to expose the frame, before cards and modules are removed. The cover is removed by levering off the chrome plated handle covers with a small screw driver. This exposes the screws that locate the cover on the frame.

The modules/boards are removed from the rear of the 5041 by removing the screws that locate the sub-panels in the rear cross members of the frame. In some cases it will be necessary to disconnect wires of cables that are connected to the board. These can usually be accessed from the top of the frame after the 'U' shaped top cover has been removed.

The power module can be removed in the same way to allow access to the fuses. See later in this section for fuse information and locations.

6.1 Fault check list

1) If the unit is completely dead with no front panel lights, check the following:

    A) Mains supply present.
    B) Mains supply fuse in mains plug.
    C) Mains supply fuse in instrument inlet IEC connector
    D) Internal fuses in power module (see fuse replacement below)

    Please note that if a fuse is blown this may indicate that a fault, or component failure has occurred within the 5041. If the replacement fuse also blows investigate which section of the unit is faulty.

2)   If the front panel data led does not flash when commands are sent check:

    A) Faulty or incorrectly connected GPIB or RS232 cable.
    B) GPIB address set incorrectly or wrong com port being used.
    C) Incorrect terminating characters in user written command software.
    D) Malfunctioning of the PC

Various error messages will be displayed on the 16 character front panel display during normal operation. These are all recoverable errors and are self explanatory. Generally they warn the user of invalid operations or selections. In some cases an error message is given when the comms link with the PC is not functioning correctly.

For operations involving removal of the 5041's cover, users should be aware that certain sections of the circuitry carry high voltages, which are hazardous.

Mains Power Supply

The supply power is connected via a standard IEC Euro connector on the rear panel. The standard voltage supply is 100V - 230V 50/60Hz. There are two protection fuses mounted in the IEC connector assembly, both are 3.15A slow blow.

Mains Power Unit - Rear Panel

Cooling Fan

IEC Power Inlet Connector

Power ON/OFF

Fuses
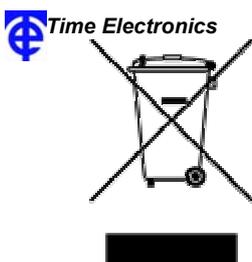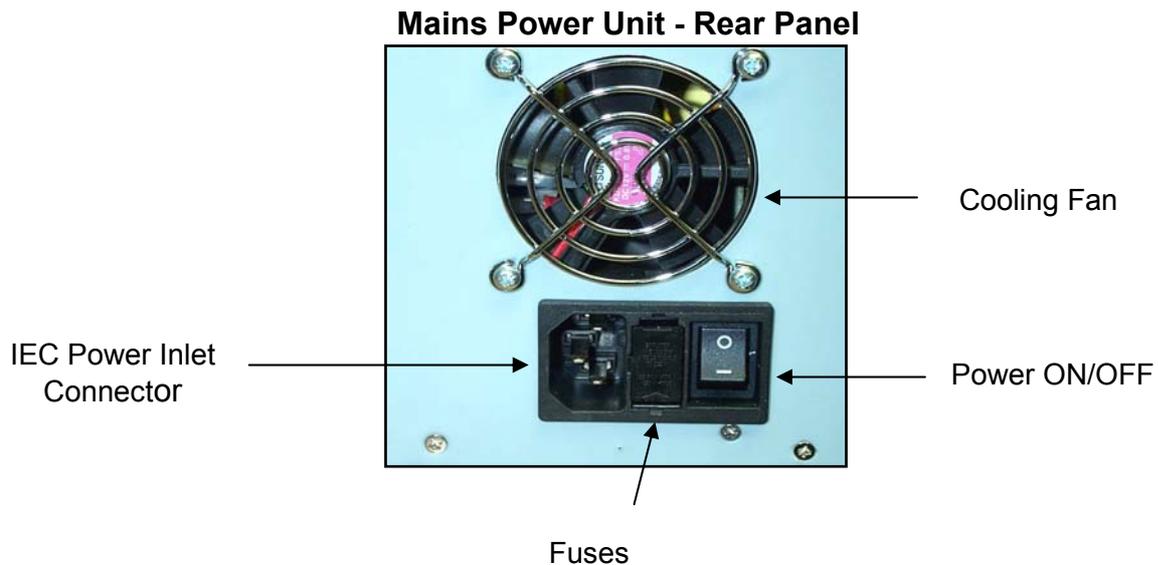
Time Electronics

Disposal of your old equipment

1. When this crossed-out wheeled bin symbol is attached to a product it means the product is covered by the European Directive 2002/96/EC.
2. All electrical and electronic products should be disposed of separately from the municipal waste stream via designated collection facilities appointed by the government or the local authorities.
3. The correct disposal of your old appliance will help prevent potential negative consequences for the environment and human health.
4. For more detailed information about disposal of your old appliance, please contact your city office, waste disposal service or return to Time Electronics.

Chapter 7 - GUARANTEE AND SERVICE FACILITIES

RETURNING - GUARANTEE PERIOD

The 5041 is guaranteed against defects in materials and workmanship for a period of two years from its delivery to the customer.

During this period, we will at our discretion, repair or replace the defective item.

For servicing under guarantee, the instrument type and serial number must always be quoted, together with details of any fault and the service required. The purchaser of the instrument must prepay all shipping charges. We will pay return shipping charges.

This guarantee is void if servicing has been attempted by an unauthorised person or agent.

If, during the guarantee period, failure is due to misuse or abuse of the unit, the repair will be put in hand without delay and charged unless other instructions are received.

We guarantee that the software and firmware for this instrument will execute its programmed function. We do not guarantee that the operation will be uninterrupted or error free.

INSTRUMENTS

When returning instruments, please ensure that they have been adequately packed, preferably in the original packing supplied. Please ensure that all instruments have details of the service required and all relevant paperwork including a contact name.

SERVICE AFTER GUARANTEE PERIOD

After the guarantee period has expired, we can recalibrate and service your instrument.

As the manufacturer, we have specialised knowledge needed to keep your instrument in peak condition and we maintain a comprehensive spare parts service.

Routine servicing and recalibration of your instrument is an essential part in the life of any calibration instrument. This will ensure that your instrument is performing to its specifications.

All repairs are made using high grade and specialised components to ensure on-going accuracy and performance.