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ME3200 Electronic Instrumentation and Measurement Courseware

Ready-to-Teach Package for Electronic Instrumentation and Measurement

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Quick Start Guide

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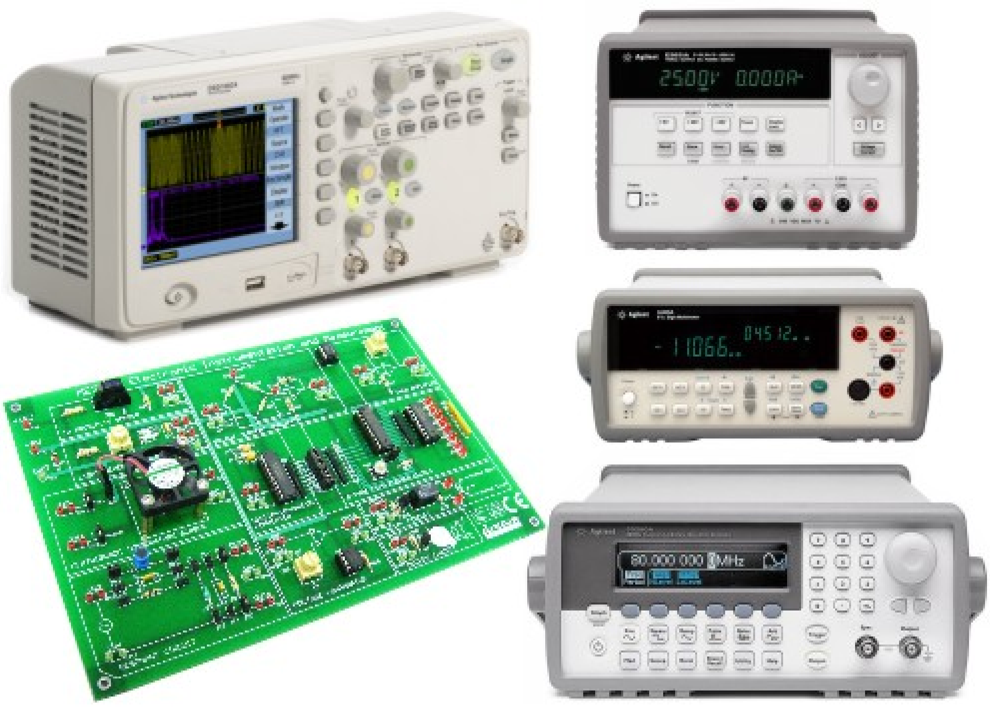


NOTE:

This product has been tested and found to conform to the following EMC standards. The limits are designed to provide reasonable protection against harmful interference in a laboratory installation.

Standard	Limit
EMC: IEC61326-1:2005 / EN61326-1:2006	
CISPR11:2003/EN55011:2007	**Class A, Group 1**
IEC 61000-4-3:2002 / EN 61000-4-3:2002	**3 V/m (80 MHz-1.0 GHz)** **3 V/m (1.4 GHz-2.0 GHz)** **1 V/m (2.0 GHz-2.7 GHz)**

This product complies with the requirements of the Low Voltage Directive 73/23/EEC and EMC Directive 89/336/EEC, and carries the CE-marking.

CAUTION – ESD!

THIS PRODUCT CONTAINS ELECTRONIC COMPONENTS SENSITIVE TO ELECTROSTATIC DISCHARGE.

An electrostatic discharge generated by a person or an object coming in contact with the electrical components may damage or destroy the product. To avoid the risk of electrostatic discharge, please observe the handling precautions and recommendations contained in the EN100015-1 standard. Do not connect or disconnect the device while it is being energized.

WARNING:

CHANGES OR MODIFICATIONS NOT EXPRESSLY APPROVED BY THE PARTY RESPONSIBLE FOR COMPLIANCE WITH THE EMC RULES COULD VOID THE USER'S AUTHORITY TO OPERATE THE PRODUCT.

Table of Contents

1. Read Me First

Congratulations on your purchase of the *ME3200 Electronic Instrumentation and Measurement* courseware! Please read this Quick Start Guide carefully to ensure you get the most out of your investment in this solution.

This courseware includes the following items:

Item	Quantity	Description
CD	1	o Teaching slides (Microsoft® PowerPoint format) o Lab sheets (Microsoft® Word format) o Problem-based assignments (Microsoft® Word format)
ME3200 Electronic Instrumentation Kit	1	The hardware kit consists of – Sensors: IR proximity sensor, light dependent resistor, centigrade temperature sensor – Signal conditioning circuits: bridge, current amplifier, non-inverting amplifier, voltage comparator – Digital Output circuits: D-type flip-flops/latches, mechanical relay, buzzer – Others: Resonant circuit, analog-to-digital converter
Power supply cable	1 set	4 x banana-to-grabber clips
Jumper cables	6	Cable terminated with grabber clips at both ends
BNC cables	1	BNC(m)-to-grabber clip cable
	1	BNC(f)-to-BNC(f) cable
Antistatic wrist strap	1	For ESD protection (required to wear when handling the device)

The following items are <u>not included</u> in this solution but are required/recommended:

- One PC running Microsoft Windows 2000/XP/Vista® with a minimum of 512 MB RAM
- Appropriate measurement instruments (see Section 3.5, "Lab Station" for details)
- Appropriate Train-the-Trainer Program (see Section 3.6, "Train-the-Trainer Program" for details)

Complete the steps in Section 4, "Quick Setup and Verification" to start using the ME3200 Electronic Instrumentation Kit.

Thank you for your purchase and do contact us (see Section 5, "Support and Warranty") if you require any assistance.

IMPORTANT

The ME3200 Electronic Instrumentation kit can be damaged by excessive power levels from the instruments. Please adhere strictly to the power levels recommended in the instructions.

2. Courseware Overview

The ME3200 is a ready-to-teach package targeting 1st or 2nd year undergraduates. This solution focuses on electronic instrumentation and measurement techniques. To achieve a better understanding on the subject, students are required to complete the lab exercises and assignments using Agilent basic instruments such as the 34405A digital multimeter, the E3631A power supply, the 33220A function generator, and the DSO1002A oscilloscope. The training kit consists of sensors, signal conditioning circuits, digital output circuits, and resonance circuit, which allow students to explore the functionalities and applications of typical end-to-end measurement systems.

This courseware consists of:

- Teaching slides (editable with Microsoft PowerPoint)
- Training kit: Electronic Instrumentation Kit
- Lab sheets (editable with Microsoft Word)
- Problem-based assignments (editable with Microsoft Word)
- Model answers and solutions (downloadable by registered instructors)

The following items are not included but recommended:

- Agilent Technologies 34405A 5½ Digit Multimeter
- Agilent Technologies DSO1002A 60 MHz Oscilloscope
- Agilent Technologies 33220A Function Generator
- Agilent Technologies E3631A Triple Output DC Power Supply
- Train-the-Trainer Program

This complete solution is designed to impart knowledge in:

- Measurement principles
- End-to-end measurement system
- Introduction to measurement instruments
- Usage of instrument programming tools
- Usage of basic instruments

Figure 1 – ME3200 Training Kit and Recommended Instruments

3. Courseware Configuration

3.1 Teaching Slides

Editable slides in Microsoft PowerPoint format are provided for the following topics:

- Digital Multimeter*
- DC Power Supply*
- Function Generator*
- Digital Oscilloscope*
- Basic Principles of Measurement
- Measurement of Electrical Quantities
- Quality of Measurement
- Sensors and Transducers
- Analog Signal Conditioning
- Electronic Measurement Instruments
- Introduction to Instrument Systems
- The Basics of Instrument Programming Using VEE

* For Induction Program

3.2 ME3200 Electronic Instrumentation Kit

- Sensors
    - IR proximity sensor
    - Light dependent resistor
    - Centigrade temperature sensor
- Signal conditioning circuits
    - Bridge
    - Current amplifier
    - Non-inverting amplifier
    - Voltage comparator
- Digital Output circuits
    - D-type flip-flops/latches
    - Mechanical relay
    - Buzzer
- Others
    - Resonant circuit
    - Analog-to-digital converter

3.3 Lab Sheets

No	Lab Sheet	Objective	Duration
1	Measurement of Voltage and Current	To perform basic measurement of voltage and current	3 Hours
2	Measurement of Time-Dependent Signals	To study and measure time-dependent signals	3 Hours
3	Quality of Measurement 1	To study quality measurement parameters	3 Hours
4	Quality of Measurement 2	To study quality measurement parameters	3 Hours
5	Analog Signal Conditioning	To understand the basic operation of analog signal conditioning circuits	3 Hours
6	Measurement of Digital Signals	To study and measure digital signals	3 Hours
7	Introduction to Data Flow Programming[1]	To understand the basics of data flow programming using VEE	3 Hours
8	Measurement Automation[1]	To perform measurement automation using VEE	3 Hours

[1] Agilent VEE is required for this lab.

3.4 Problem-based Assignments

No	Assignment
1	Case Study on Dynamometry
2	Motor Current and Speed-Torque Characteristics

3.5 Lab Station

Basic Setup
1 x Agilent 34405A 5½ Digit Multimeter 1 x Agilent DSO1002A 60 MHz Oscilloscope 1 x Agilent 33220A Function Generator 1 x Agilent E3631A Triple Output DC Power Supply

The above instruments are recommended, but may be replaced by other models with equivalent performance.

The following table shows the training kit and recommended instruments used in each lab.

	Training Kit	Required Instrument(s)		
	ME3200 Electronic Instrumentation Kit	Option 1 Power Supply & Multimeter	Option 2 Power Supply, Function Generator, & Oscilloscope	Option 3 Power Supply, Function Generator, Multimeter, & Oscilloscope
Lab 1	✓	✓		✓
Lab 2	✓		✓	✓
Lab 3	✓	✓		✓
Lab 4	✓	✓		✓
Lab 5	✓		✓	✓
Lab 6	✓		✓	✓
Lab 7				
Lab 8	✓			✓

3.6 Train-the-Trainer Program (recommended, not included in courseware)

Lectures

- Electronic Instrumentation – Part 1
- Electronic Instrumentation – Part 2
- Selected topics from the courseware teaching material

Lab Exercises

- Selected exercises from the lab sheets

Training details are available at http://dreamcatcher.asia/

4. Quick Setup and Verification

The following steps demonstrate the basic setup and lab test of the ME3200 Electronic Instrumentation Kit:

- Power on the ME3200 Electronic Instrumentation Kit
- IR Proximity Sensor Test and Verification
- Light Dependent Resistor Test and Verification
- Centigrade Temperature Sensor Test and Verification
- Resonant Circuit Test and Verification

4.1 Power on the ME3200 Electronic Instrumentation Kit

1. The ME3200 Electronic Instrumentation Kit requires two power supplies **(+5 V** and **+9 V)** in order to operate.
2. Turn on the power supply unit. Set the dual channel output voltages to exactly **+5 V** and **+9 V,** respectively. Set both current limits to **1.0 A**.
3. Next, connect the power supply to the ME3200 Electronic Instrumentation Kit as shown in Figure 2.

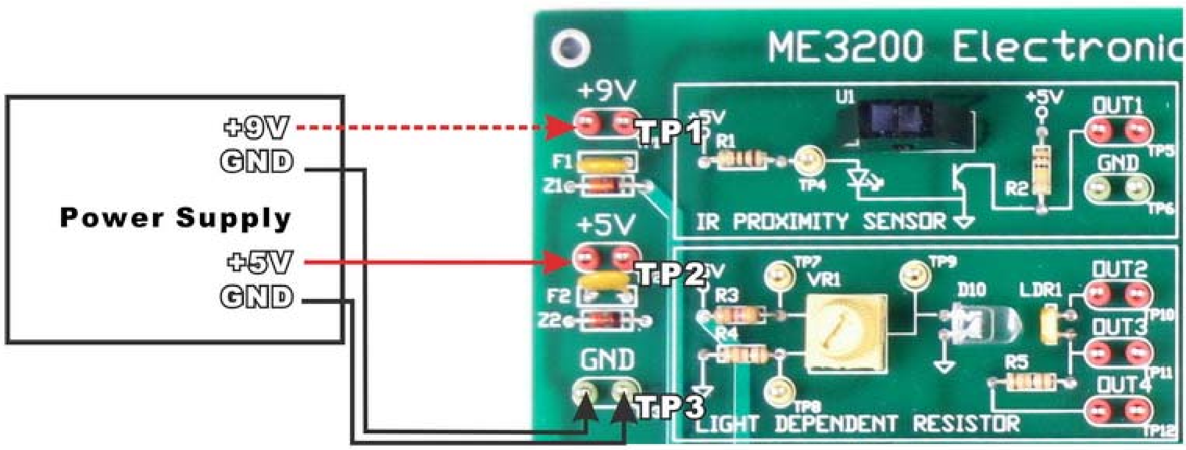


Figure 2 – Connections Between the Power Supply and the ME3200 Electronic Instrumentation Kit

4. Connect the **+9 V** power supply output to test point **TP1** and **GND** to **TP3** of the ME3200 Electronic Instrumentation Kit (at the top left-hand corner of the board).
5. Connect the **+5 V** power supply output to test point **TP2** and **GND** to **TP3** of the ME3200 Electronic Instrumentation Kit respectively.
6. Make sure that the polarities of the terminals are correctly connected. Refer to

Table 1 to verify your connections.

Table 1 – Connection Between the Power Supply and the ME3200 Electronic Instrumentation Kit

ME3200 Electronic Instrumentation Kit	Power Supply Unit
+9 V Terminal, TP1	+9V Terminal
GND Terminal, TP3	GND Terminal
+5 V Terminal, TP2	+5 Terminal
GND Terminal, TP3	GND Terminal

7. Enable the power supply outputs and the annunciators at the front panel should be turned on (providing a constant voltage supply).
8. If the **CC** annunciator is on, disable the power supply output by pressing the **Output On/Off** button. Check if this is due to current limit setting or a faulty connection.

   Caution:
   *The ME3200 Electronic Instrumentation Kit does not contain an on-board voltage regulation circuit. **DO NOT OVER SUPPLY** the maximum required voltages to the ME3200 Electronic Instrumentation Kit as this might damage the components on the board.*
9. The red LED **D9** on the Relay Circuit will be turned on if +5 V is correctly supplied to the ME3200 Electronic Instrumentation Kit.
10. Adjust the potentiometer **VR1** on the **Light Dependent Resistor** module; this will vary the brightness of the white LED **D10** if +9 V is correctly supplied.
11. Turn off the ME3200 Electronic Instrumentation Kit by disabling the power supply output.

4.2 IR Proximity Sensor Test and Verification

1. The IR Proximity Sensor Test will be carried out using three modules on the ME3200 Electronic Instrumentation Kit. These modules are the **IR Proximity Sensor**, the **Voltage Comparator**, and the **Relay Circuit**.
2. Maintain the same connections between the ME3200 Electronic Instrumentation Kit and power supply as prepared in Section 4.1
3. Connect the IR Proximity Sensor, the Voltage Comparator, and the Relay Circuit as shown in Figure 3.
4. See Table 2 to verify your connections.

Table 2 – Circuit Connections for the IR Proximity Sensor Test

From	To
OUT1 terminal, TP5 of the IR Proximity Sensor	IN9 terminal, TP38 of the Voltage Comparator
OUT10 terminal, TP41 of the Voltage Comparator	IN10 terminal, TP43 of the Relay Circuit

5. Turn on the ME3200 Electronic Instrumentation Kit by enable the power supply output.

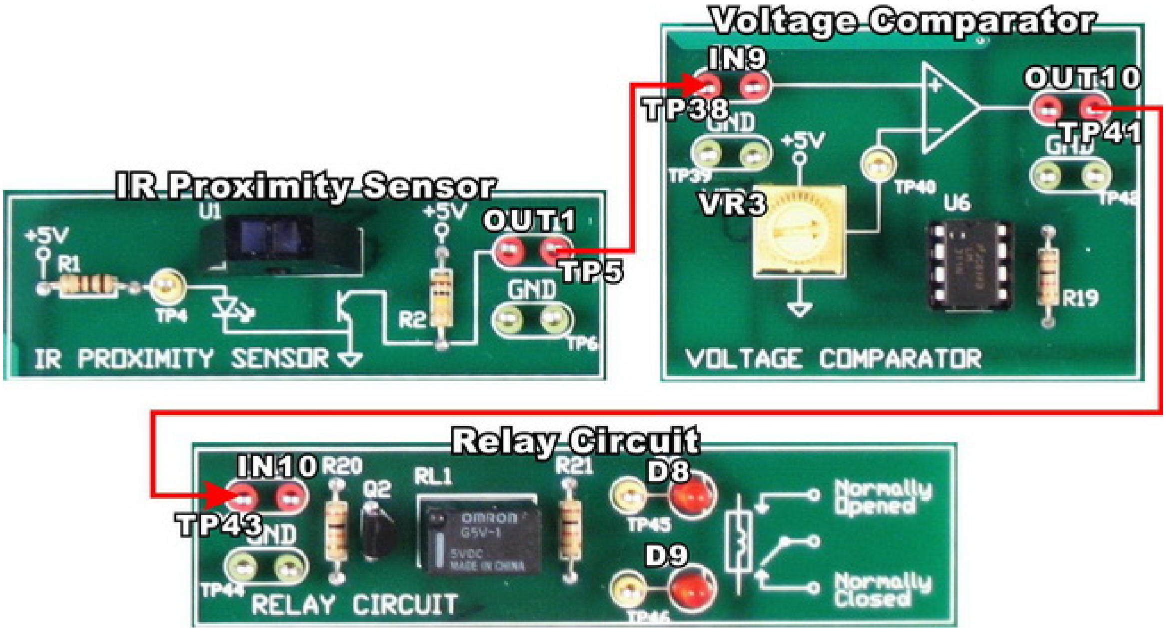


Figure 3 – Circuit Connections for the IR Proximity Sensor Test

6. The red LED **D8** on the Relay Circuit will be turned on if the connections are correct. The relay circuit is in the normally opened condition at the beginning.
7. Turn the variable resistor **VR3** in the clockwise direction until it stops. This will set the inverting input voltage (V–) of the voltage comparator to **5 V**.
8. Use a piece of white paper as an obstacle and place it in front of the IR proximity sensor. Slowly decrease the distance between the paper and the sensor by moving the paper towards the sensor.
9. When the distance between the obstacle and the sensor reaches about **2 cm** to **3 cm**, the relay circuit will be triggered to close normally and the LED **D9** will be turned on.
10. This test can be considered successful if the results as discussed in the previous steps can be obtained. Verify your connections if you fail to obtain the desired results.
11. Turn off the ME3200 Electronic Instrumentation Kit by disabling the power supply output.

4.3 Light Dependent Resistor Test and Verification

1. The Light Dependent Resistor Test will be carried out using four modules on the ME3200 Electronic Instrumentation Kit. These modules are the **Light Dependent Resistor**, the **Bridge Current Amplifier**, the **Voltage Comparator**, and the **Buzzer Circuit**.
2. Maintain the same connections between the ME3200 Electronic Instrumentation Kit and power supply as prepared in Section 4.1.
3. Connect the Light Dependent Resistor, the Bridge Current Amplifier, the Voltage Comparator, and the Buzzer Circuit as shown in Figure 4.

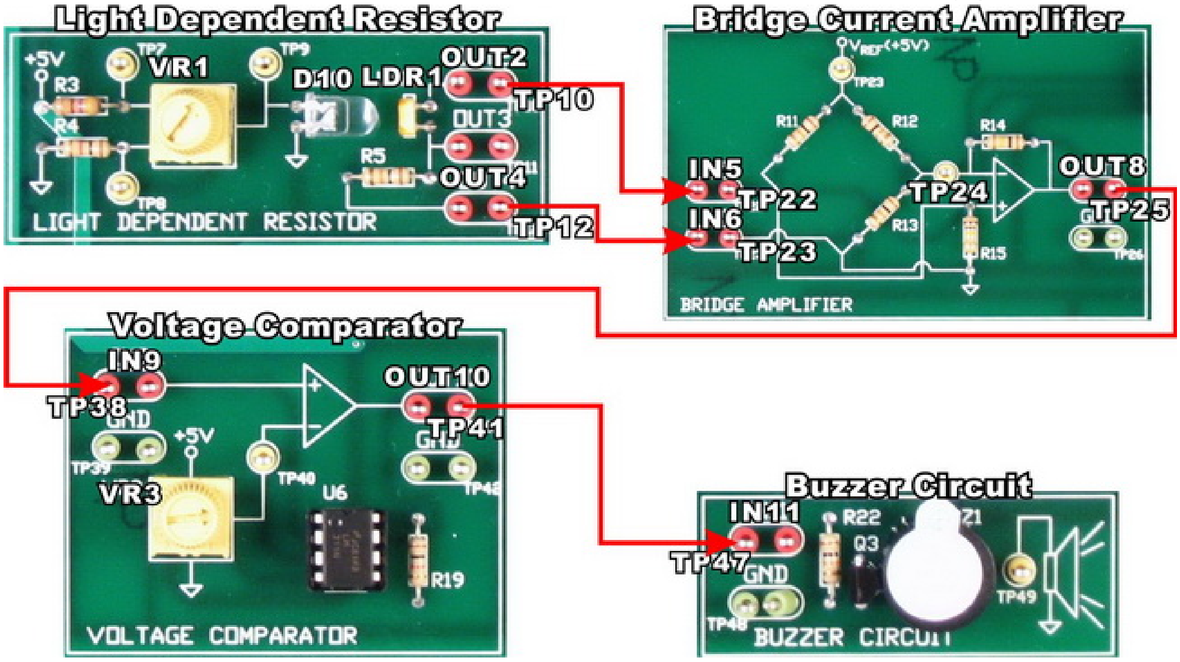


Figure 4 – Circuit Connections for the Light Dependent Resistor Test

4. See Table 3 to verify your connections.

Table 3 – Circuit Connections for Light Dependent Resistor Test

From	To
OUT2 terminal, TP10 of the Light Dependent Resistor	IN5 terminal, TP22 of the Bridge Current Amplifier
OUT4 terminal, TP12 of the Light Dependent Resistor	IN6 terminal, TP23 of the Bridge Current Amplifier
OUT8 terminal, TP25 of the Bridge Current Amplifier	IN9 terminal, TP38 of the Voltage Comparator
OUT10 terminal, TP41 of the Voltage Comparator	IN11 terminal, TP47 of the Buzzer Circuit

5. Turn on the ME3200 Electronic Instrumentation Kit by enable the power supply output.
6. The red LED **D9** on the Relay Circuit will be turned on if the connections are correct.
7. Turn the variable resistor **VR1** in order to adjust the brightness of the white LED **D10** (the clockwise direction to increase and the counter-clockwise direction to decrease). The resistance of the light dependent resistor, **LDR1** will be varied according to the intensity of light that strikes on it.
8. Measure the voltage at terminal **TP50** on the bridge current amplifier. This is the non-inverting input voltage of the bridge current amplifier. The measured voltage should in the range of **2.55 V** (when D10 is Off) to **2.48 V** (when D10 is On).
9. Next, test the functionality of the buzzer circuit by adjusting the variable resistor **VR1**. Fully turn the **VR1** in the clockwise direction in order to set the brightness of the white LED **D10** to maximum.
10. The buzzer is turned off when the brightness of LED **D10** is set to maximum. Slowly reduce the brightness of the LED until it is turned off. When the brightness of the LED is reduced to a certain level, the buzzer circuit will be turned on and you should be able to hear a long beep produced by the buzzer.
12. This test can be considered successful if the results as discussed in previous steps can be obtained. Verify your connections if you fail to obtain the desired results.
13. Turn off the ME3200 Electronic Instrumentation Kit by disabling the power supply output.

4.4 Centigrade Temperature Sensor Test and Verification

1. The Centigrade Temperature Sensor Test will be carried out using four modules on the ME3200 Electronic Instrumentation Kit. These modules are the **Centigrade Temperature Sensor**, the **Gain Amplifier**, the **Analog-To-Digital Converter**, and the **Buzzer Circuit**.
2. Maintain the same connections between the ME3200 Electronic Instrumentation Kit and power supply as prepared in Section 4.1.
3. Connect the Centigrade Temperature Sensor, the Gain Amplifier, Analog-To-Digital Converter and the Buzzer Circuit as shown in Figure 5.

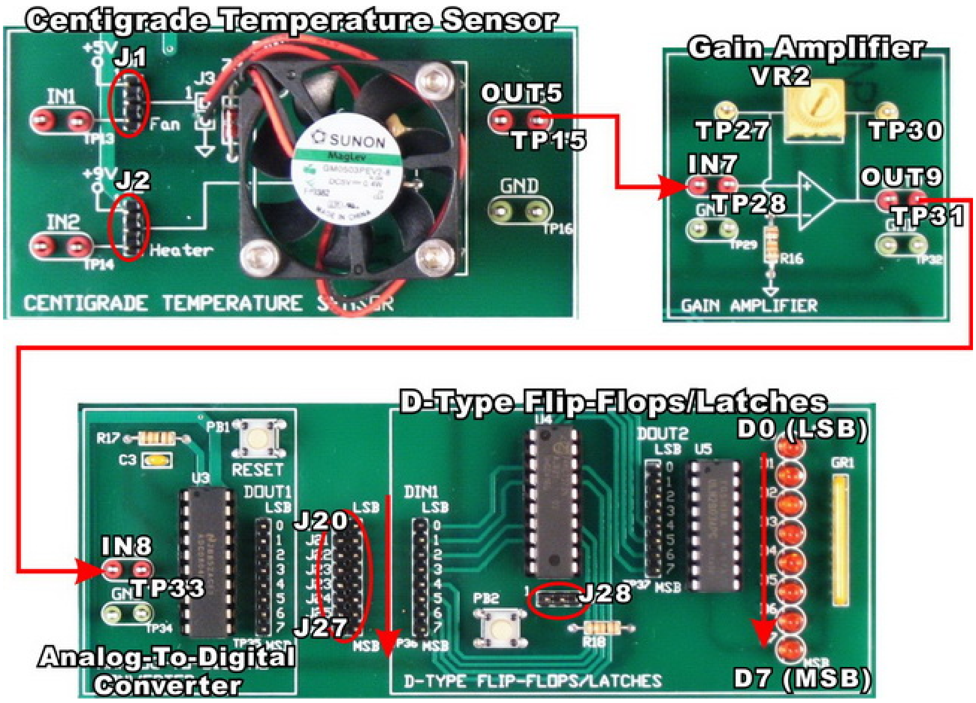


Figure 5 – Circuit Connections for the Centigrade Temperature Sensor Test

4. Refer to Table 4 to verify your connections.

Table 4 – Circuit Connections for Centigrade Temperature Sensor Test

From	To
OUT5 terminal, TP15 of the Centigrade Temperature Sensor	IN7 terminal, TP28 of the Gain Amplifier
OUT9 terminal, TP31 of the Gain Amplifier	IN8 terminal, TP33 of the Analog-To-Digital Converter

5. Connect all jumpers from **J20** to **J27** as shown in Figure 5 if they are not yet connected.
6. Connect the jumper on **J28** to **position 2** and **3** as shown in Figure 6.

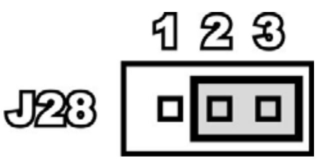


Figure 6 – Position of the Jumper on J28

7. Turn on the ME3200 Electronic Instrumentation Kit by enable the power supply output.
8. The red LED **D9** on the Relay Circuit will be turned on if the connections are correct.
9. Turn the variable resistor **VR2** in order to vary the gain of the amplifier (the counter-clockwise direction to increase and the clockwise direction to decrease). Set the resistance of **VR2** to **40 kΩ**. You may measure the resistance through **TP27** and **TP30**. This will allow the analog output voltage from the temperature sensor to be scaled to five times larger than the original magnitude.
10. Measure the voltage at terminal **OUT5**, **TP15** on the centigrade temperature sensor using a digital multimeter. The measured voltage should be in **mV**, which is the output of the temperature sensor **LM35**. The sensitivity of the temperature sensor **LM35** is **10 mV per degree Celsius**. The room temperature sensed by the sensor is $\frac{Measured\ Voltage}{10mV}$.
11. The gain ratio of the gain amplifier is about **5**. Next, measure the voltage at terminal **OUT9**, **TP31** on the gain amplifier. The measured voltage should be amplified about **five times** compared to the voltage measured in step 10.
12. The 8-bit analog-to-digital converter (ADC) on the ME3200 Electronic Instrumentation Kit takes the analog output from the temperature sensor and turns it into a binary number. Thus, each binary number from the ADC represents a certain voltage level. The resolution of the 8-bit ADC is **256**. The red LEDs **D0** and **D7** are the **LSB** and **MSB** for the output of the ADC respectively. Observe the condition of the red LEDs from **D0** to **D7**. They represent the digital output of the temperature sensor.
13. Resistors **R6** and **R7**, which are installed under the DC Axial Fan with the LM35 temperature sensor, are used as the heating source in the circuit.
14. Next, connect the jumper on **J2** (Heater) to **position 1** and **2** as shown in Figure 7. This will turn on the heater with a 9 V power supply to heat up resistors **R6** and **R7**. The digital output LEDs will increase bit by bit linearly as the temperature on the **LM35** temperature sensor increases.

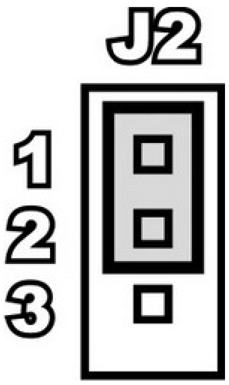


Figure 7 – Position of the Jumper on J2

15. Turn off the heater by connecting the jumper on **J2** to position **2** and **3**.
16. Connect the jumper on **J1** (Fan) to **position 1** and **2** as shown in Figure 8. This will turn on the fan with a 9 V power supply in order to cool down the **LM35** temperature sensor. The digital output LEDs will decrease bit by bit linearly as the temperature on **LM35** temperature sensor decreases.

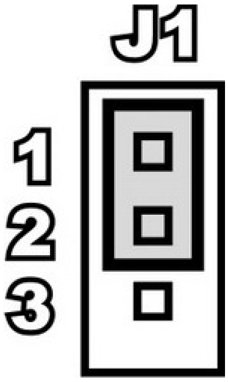


Figure 8 – Position of the Jumper on J1

17. Turn off the fan by connecting the jumper on **J1** to position **2** and **3.**
18. This test can be considered successful if the results as discussed in the previous steps can be obtained. Verify your connections if you fail to obtain the desired results.
19. Turn off the ME3200 Electronic Instrumentation Kit by disabling the power supply output.

4.5 Resonant Circuit Test and Verification

1. The Resonant Circuit Test will be carried out using one module on the ME3200 Electronic Instrumentation Kit. This module is the **Resonant Circuit**.
2. No power supply is required under this test. You may disconnect the power supply on **TP1**, **TP2**, and **TP3**. Only the function generator and the oscilloscope are used in this test.
3. The resonant circuit is able to be a low pass filter (LPF) or a high pass filter (HPF) according to the connections of the jumpers on **J4** to **J19**. Figure 9 shows the resonant circuit module on the ME3200 Electronic Instrumentation Kit.

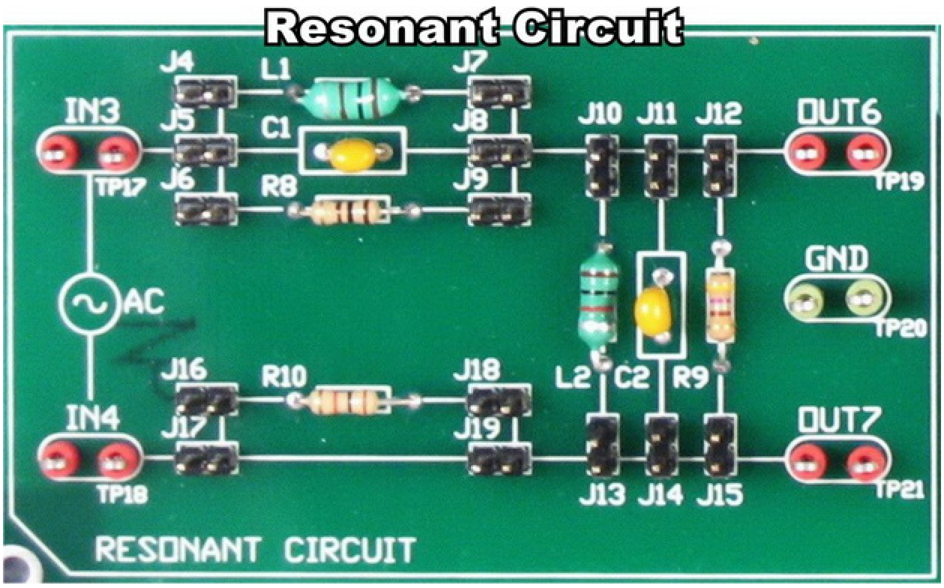


Figure 9 – Resonant Circuit Module

4. Four types of filter can be constructed based on the connections of jumpers. This is shown in Table 5.

Table 5 – Configurations of Jumpers on the Resonant Circuit

Type of Filter	Connection of Jumper
RC Low Pass Filter (LPF)	Connect jumpers on J6, J9, J11, J14, J17, and J19
RC High Pass Filter (HPF)	Connect jumpers on J5, J8, J12, J15, J17, and J19
RL Low Pass Filter (LPF)	Connect jumpers on J4, J7, J12, J15, J17, and J19
RL High Pass Filter (HPF)	Connect jumpers on J6, J9, J10, J13, J17, and J19

4.5.1 RC Low Pass Filter

1. Complete the connections for the resonant circuit as shown in Figure 10.

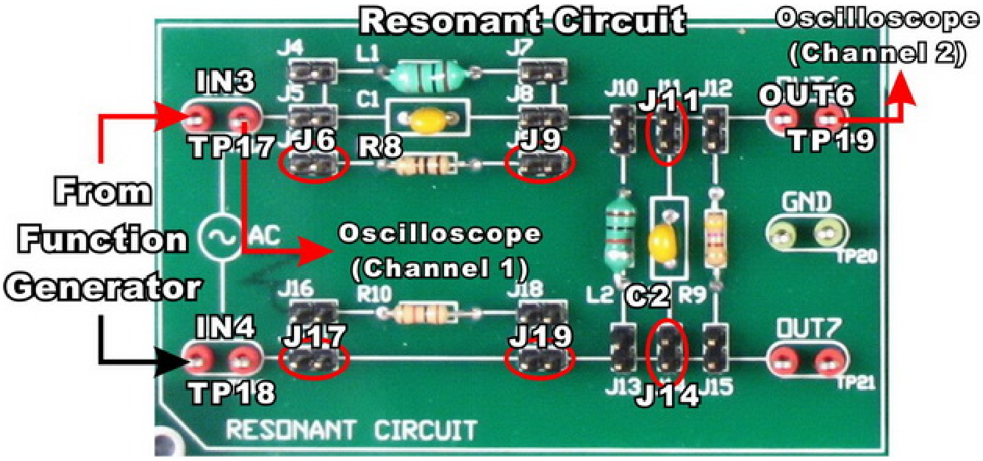


Figure 10 – RC Low Pass Filter

2. Connect the red probe and black probe of the function generator to **IN3** terminal **(TP17)** and **IN4** terminal **(TP18)** respectively.
3. Connect six jumpers on **J6**, **J9**, **J11**, **J14, J17**, and **J19** to form an RC low pass filter. Verify your connections by referring to Table 5. Leave the other jumpers disconnected.
4. Next, turn on the function generator and generate a pure sine wave with the amplitude of **5 V** and frequency of **500 Hz**.
5. The signal from the **IN3** terminal **(TP17)** is the input signal to the RC low pass filter, while the signal from the **OUT6** terminal **(TP19)** is the output signal of RC low pass filter.
6. Use an oscilloscope to observe the signal from the **IN3** terminal **(TP17)** and the **OUT6** terminal **(TP19)**. The signal on both channels should be exactly the same because the signal is still within the low pass region.
7. The resistance and capacitance of **R8** and **C2** are **100 Ω** and **0.1 µF** respectively; they are used to set the cut-off frequency of the low pass filter at **15.923 kHz**. Disable the output of the function generator.
8. Set the function generator to the Linear Sweep mode. Set the start and stop frequencies to **20 Hz** and **20 kHz**. Enable the output of the function generator.
9. You should be able to observe that the amplitude of the output signal on the oscilloscope is attenuated when the frequency is increased beyond the cut-off frequency. Signals higher than the cut-off frequency will be filtered out. Disable the output of function generator.

4.5.2 RC High Pass Filter

1. Complete the connections for the resonant circuit as shown in Figure 11.

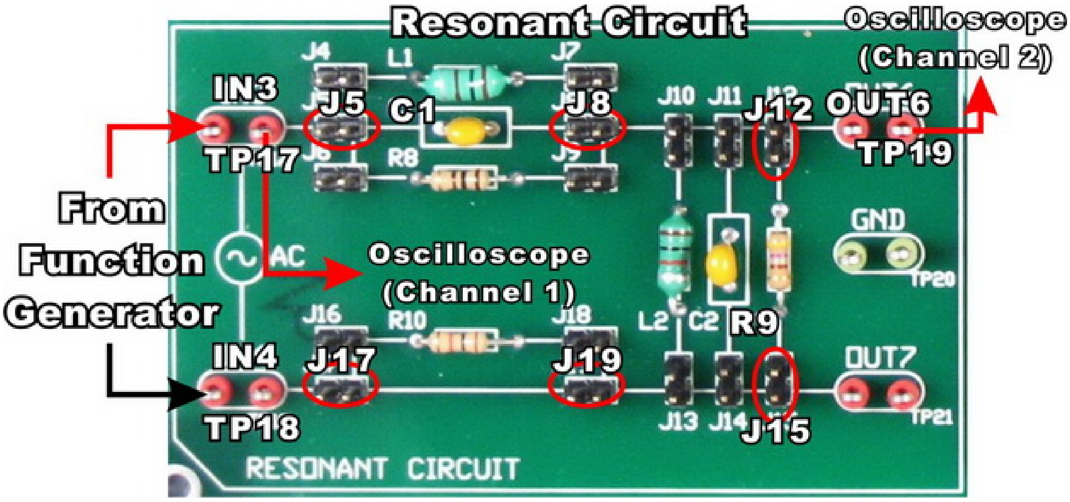


Figure 11 – RC High Pass Filter

2. Connect the red probe and black probe of function generator to the **IN3** terminal **(TP17)** and the **IN4** terminal **(TP18)** respectively.
3. Connect six jumpers on **J5**, **J8**, **J12**, **J15, J17**, and **J19** to form an RC high pass filter. Verify your connections by referring to Table 5. Leave the other jumpers disconnected.
4. Next, turn on the function generator and generate a pure sine wave with the amplitude of **5 V** and frequency of **500 Hz**.
5. The signal from the **IN3** terminal **(TP17)** is the input signal to the RC high pass filter, while the signal from the **OUT6** terminal **(TP19)** is the output signal of RC high pass filter.
6. Use an oscilloscope to observe the signal from the **IN3** terminal **(TP17)** and the **OUT6** terminal **(TP19)**. The signal on both channels should be exactly the same because the signal is still within the high pass region.
7. The resistance and capacitance of **R9** and **C1** are **470 Ω** and **1 μF** respectively; they are used to set the cut-off frequency of the high pass filter as **338 Hz**. Disable the output of the function generator.
8. Set the function generator to the Linear Sweep mode. Set the start and stop frequencies to **20 Hz** and **20 kHz**. Enable the output of the function generator.
9. You should be able to observe that the amplitude of the output signal on the oscilloscope is attenuated when the frequency is decreased beyond the cut-off frequency. Signals lower than the cut-off frequency will be filtered out. Disable the output of function generator.

5. Support and Warranty

5.1 Terms and Conditions

The use of the courseware product and all other products developed and/or distributed by *Acehub Vista Sdn. Bhd.* are subject to the applicable License Agreement.

For further information, see the Courseware Product License Agreement.

To retrieve the password for installation of the provided materials and software as well as the model answers and solutions for lab sheets, please register yourself at http://dreamcatcher.asia/cw under the Product Registration menu using the product key provided with the teaching courseware.

5.2 Product Warranty

- *Acehub Vista Sdn. Bhd.* warrants that its products sold will at the time of shipment be free from defects in material and workmanship and will conform to *Acehub Vista Sdn. Bhd.*'s applicable specifications.

- If *Acehub Vista Sdn. Bhd.* receives notice of a defect or non-conformance during the **one year warranty** period, *Acehub Vista Sdn. Bhd.* will, at its option, repair or replace the affected product. Buyer will pay shipping expenses for return of such product to *Acehub Vista Sdn. Bhd.* or its authorized reseller. *Acehub Vista Sdn. Bhd.* or its authorized reseller will pay expenses for shipment of the repaired or replacement product.

- This warranty shall not apply to any products *Acehub Vista Sdn. Bhd.* determines have been, by Buyer or otherwise, subject to operating and/or environmental conditions in excess of the maximum values established in applicable specifications, or have been subject to mishandling, misuse, neglect, improper testing, repair, alteration, damage, assembly, or processing that alters physical or electrical properties.

- In no event will *Acehub Vista Sdn. Bhd.* be liable for any incidental or consequential damages.

- This warranty extends to Buyer only and not to Buyer's customers or users of Buyer's products and is in lieu of all other warranties whether expressed, implied, or statutory including implied warranties of merchantability of fitness.

- For technical support and warranty, e-mail cw.support@dreamcatcher.asia

Appendix A: ME3200 Electronic Instrumentation Kit

As shown in Figure 12, the hardware kit consists of the following:

- Sensors: IR proximity sensor, light dependent resistor, centigrade temperature sensor
- Signal conditioning circuits: bridge, current amplifier, non-inverting amplifier, voltage comparator
- Digital Output circuits: D-type flip-flops/latches, mechanical relay, buzzer
- Others: Resonant circuit, analog-to-digital converter

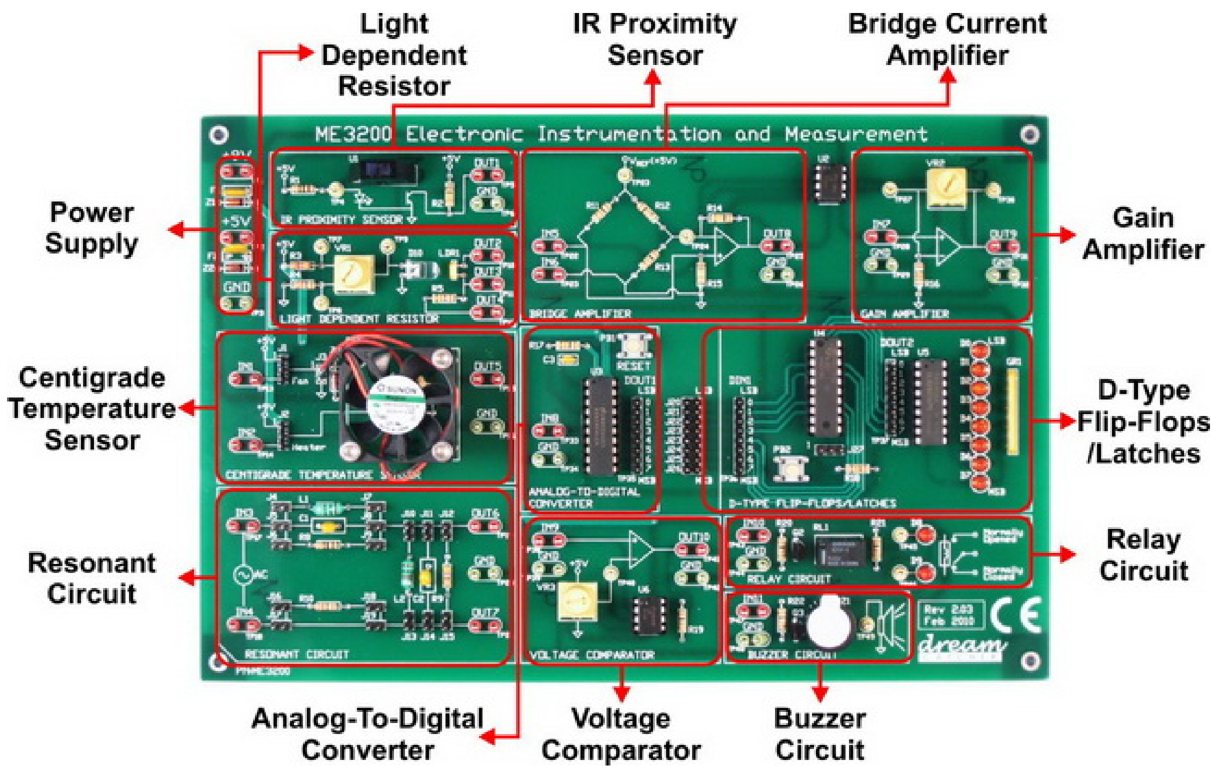


Figure 12 – ME3200 Electronic Instrumentation Kit

Appendix B: Specifications

POWER SUPPLY
Line voltage range 50/60 Hz, 100 VAC to 240 VAC

POWER ADAPTER
Output voltage 12 VDC

OPERATING ENVIRONMENT
Operating temperature at ambient environment condition at 35° C
Up to 95% RH at 40°C (non-condensing)

STORAGE COMPLIANCE
–40°C to 70°C

SAFETY
This product is rated for indoor use only.

EMC
IEC 61326-1:2005 / EN 61326-1:2006
Canada: ICES/NMB-001: Issue 4, June 2006
Australia/New Zealand: AS/NZS CISPR 11:2004

DIMENSIONS (W x H x D)
230 mm x 65 mm x 180 mm

WEIGHT
0.6 kg

WARRANTY
12 months

OTHERS

ME3200 – Electronic Instrumentation Kit	Min	Max	Unit
Input voltage (+5 V)	4.5	5.5	V
Input voltage (+9 V)	8.5	9.5	V
Input current (+5 V)	10.0	80.0	mA
Input current (+9 V)	100.0	400.0	mA

Appendix C: Using Modular Instruments

Tips on How to Use the Agilent U2741A USB Modular Digital Multimeter

Front Panel of the Agilent U2741A USB Modular Digital Multimeter

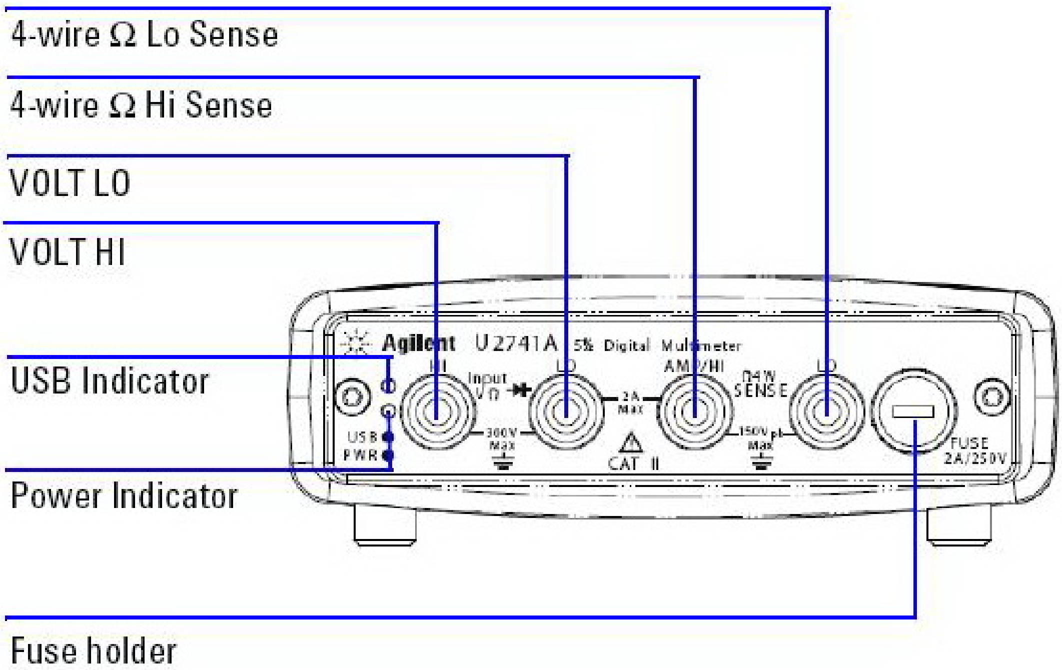


Figure C-1 – Front Panel of the Digital Multimeter

Setting Up the Connection

1. Connect the digital multimeter to the PC using a USB cable.
2. Power on the digital multimeter.
3. Launch the **Agilent IO Control** and the **Agilent Measurement Manager (AMM)**.
4. The **Select USB Device** dialog box will appear displaying the connected **U2741A** devices. To start the application, select a **U2741A** device and click **OK** to establish the connection
5. The U2741A can only be operated via the USB interface. On the front panel of the U2741A, there are two LED indicators. The power indicator lights up once the U2741A is powered on. There is a system error if the indicator blinks after the U2741A is powered on. The USB indicator will only blink when there is data exchange activity between the U2741A and the PC.
6. You can control the U2741A via the **Agilent Measurement Manager (AMM)** for U2741A or via **SCPI commands** sent through the USB interface from your own application programs.
7. Launch the **Agilent IO Control** and **AMM**.
8. The **Select USB Device** dialog box will appear displaying the connected **U2741A** devices. To start the application, select a **U2741A** device and click **OK** to establish the connection. You may start to use the digital multimeter now.

Measuring DC Voltage

1. The DC voltage measurement function of the U2741A has the following features:
   - five ranges to select: **100 mV**, **1 V, 10 V**, **100 V**, and **300 V**; or **auto** range
   - input impedance is **10 MΩ** for all ranges (typical)
   - input protection is **300 V** on all ranges (**HI** terminal)

2. Make the connection as shown in **Figure** B-2 in order to measure DC voltage. You can control the U2741A via the **Agilent Measurement Manager (AMM)** software for U2741A or via **SCPI commands** sent through the USB interface from your own application programs.

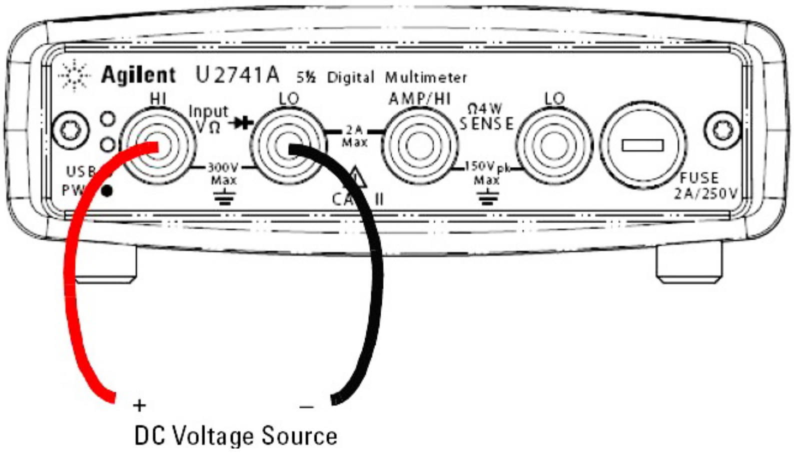


Figure C-2 – Measuring DC Voltage

3. If you are using the **AMM**, select the **DCV** function located at the top-left corner. Set the desired range under **Range** section. A suitable range should be selected to give the best measurement resolution. The reading is displayed and updated continuously.
4. If you are using **SCPI commands**, enter `MEASure[:VOLTage]:DC?` in order to make a DC voltage measurement.

Measuring DC Current

1. The DC current measurement function of the U2741A has the following features:
   - three ranges to select: **10 mA**, **100 mA, 1 A**, and **2 A**; or **auto** range
   - input impedance is **10 MΩ** for all ranges (typical)
   - input protection fuse is **2 A,** voltage rating **250 V** on all ranges
2. Make the connection as shown in **Figure** in order to measure DC current. You can control the U2741A via the **Agilent Measurement Manager (AMM)** software for U2741A or via **SCPI commands** sent through the USB interface from your own application programs.

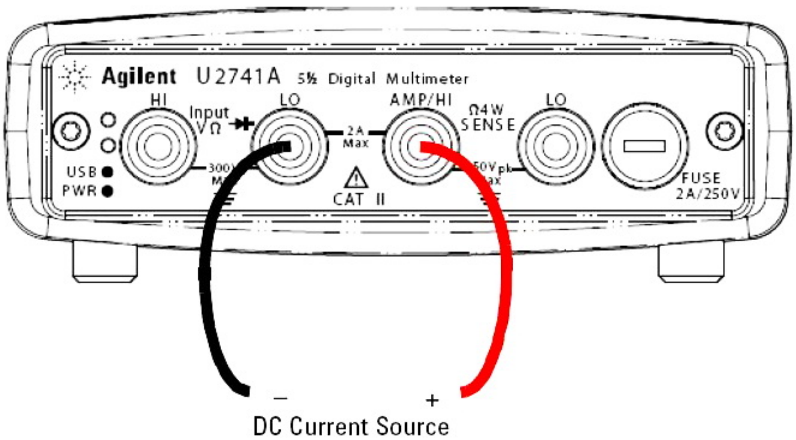


Figure C-3 – Measuring DC Current

3. If you are using the **AMM**, select the **DCI** function located at the top-left corner. Set the desired range under the **Range** section. A suitable range should be selected to give the best measurement resolution. The reading is displayed and updated continuously.
4. If you are using **SCPI commands**, enter `MEASure:CURRent[:DC]?` in order to make a DC current measurement.

Tips on How to Use the Agilent U2761A USB Modular Function Generator

Front Panel of the Agilent U2761A USB Modular Function Generator

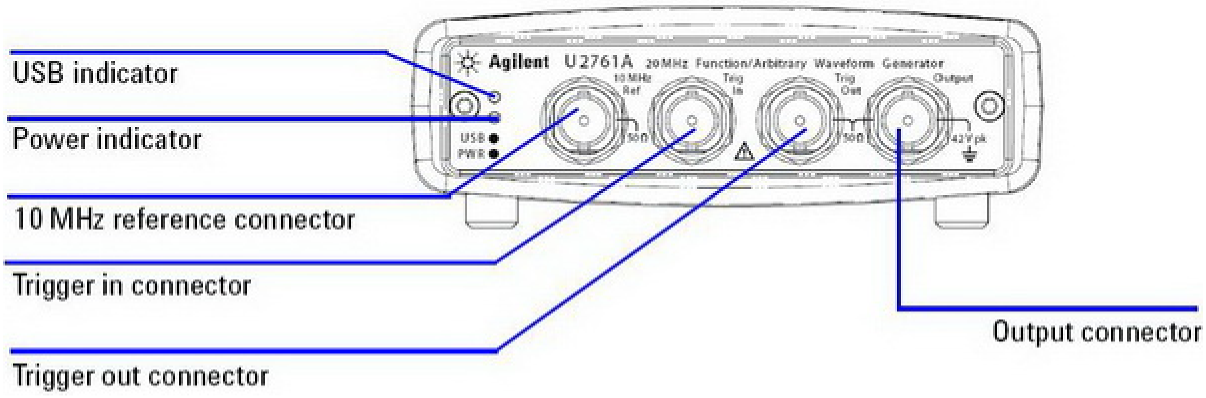


Figure A-1 – Front Panel of the U2761A

Setup Connection

9. Connect the function generator to the PC using a USB cable.
10. Power on the function generator.
11. Launch the **Agilent IO Control** and the **Agilent Measurement Manager (AMM)**.
12. The **Select USB Device** dialog box will appear displaying the connected **U2761A** devices. To start the application, select a **U2761A** device and click **OK** to establish the connection.
13. Click **Output** to enable or disable the output of the function generator after the desired parameters are set.
14. The U2761A is able to output **five** standard waveforms that are **Sine**, **Square**, **Ramp**, **Triangle**, **Pulse**, and **DC**.
15. You can select one of the three built-in Arbitrary waveforms or create your own custom waveforms.
16. You can also internally modulate Sine, Square, Ramp, Triangle, and Arbitrary waveforms using **AM**, **FM**, **PM**, **FSK**, **PSK**, or **ASK**.
17. The **linear** or **logarithmic** frequency sweeping is available for Sine, Square, Ramp, Triangle, and Arbitrary waveforms.
18. Table A- shows which output functions are allowed with modulation and sweep.
19. Each √ indicates a valid combination. If you change to a function that is not applicable for modulation, or sweep; then the modulation or mode will be disabled.

Table A-1 – Output Functions

	Sine	Square	Ramp	Triangle	Pulse	DC	Arbitrary
AM, FM, PM, FSK, PSK, ASK Carrier	√	√	√	√			√
AM, FM, PM Internal Modulation	√	√	√	√			√
FSK, PSK, ASK Internal Modulation		√					
Sweep Mode	√	√	√	√			√

Agilent Measurement Manager Soft Front Panel (Function Generator)

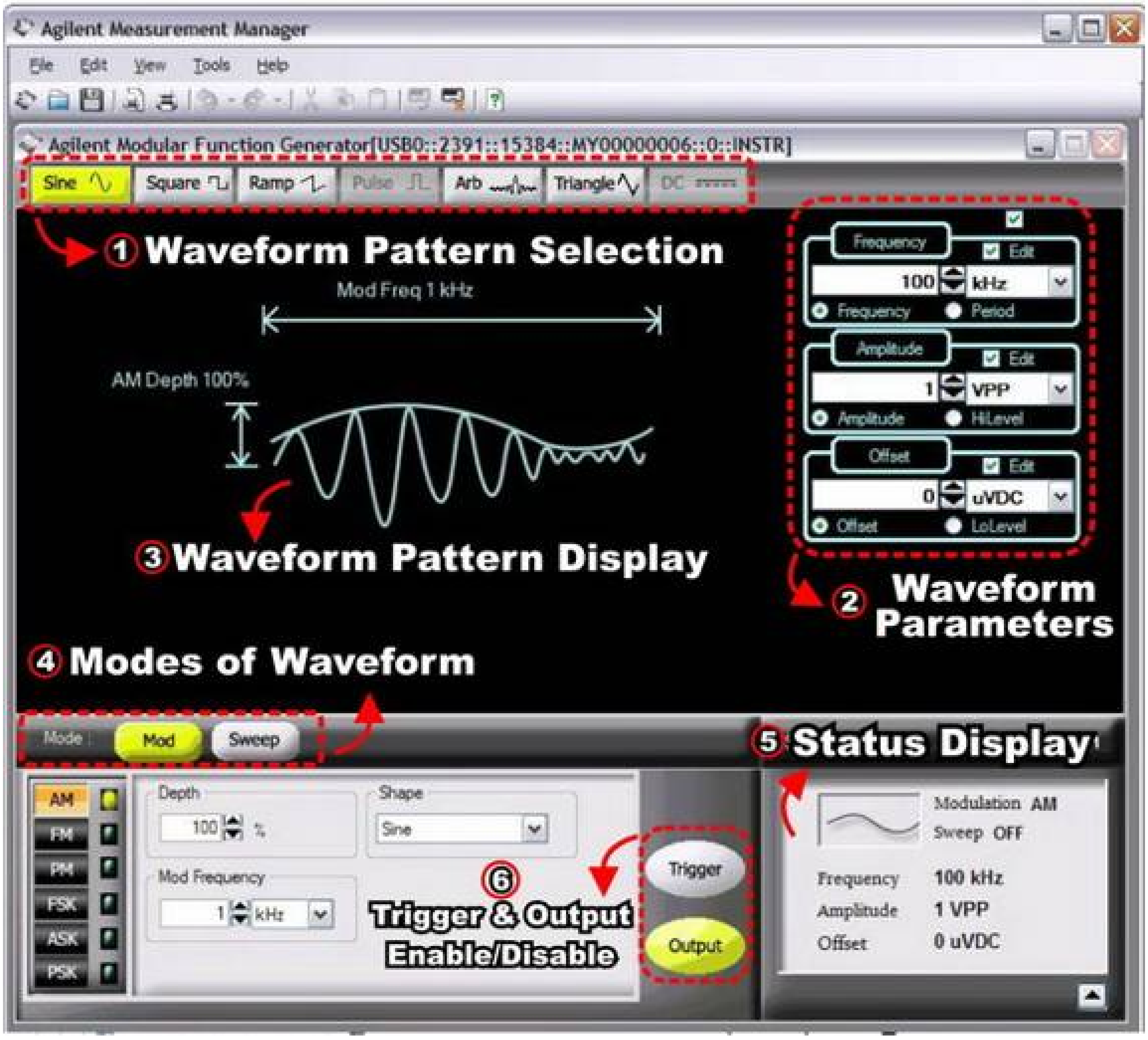


Figure A-2 – Graphic User Interface of the Agilent Measurement Manager (Function Generator)

Figure A-2 shows the graphic user interface of the Agilent Modular Function Generator under the Agilent Measurement Manager (AMM). Table A- shows the features of each panel of the interface.

Table A-2 – Features of the AMM Function Generator Interface

No.	Panel	Features
1	Waveform Pattern Selection	Select various types of output function by clicking the buttons.
2	Waveform Parameters	Configure the function parameters (Frequency, Amplitude, and Offset)
3	Waveform Pattern Display	Display a graph representation of the output function
4	Modes of Waveform	Configure to modulation mode or sweep mode
5	Status Display	Display the parameters and status of the configured output waveform
6	Trigger & Output Enable/Disable	Enable/disable the Trigger and Output buttons (they are highlighted when enabled and grey when disabled)

Function Limitation

If you change to a function where the maximum frequency is less than the current function, the frequency will be adjusted to the maximum value for the new function. For example, if you are currently outputting a **20 MHz sine wave** and then change to the **Ramp** function, the U2761A will automatically adjust the output frequency to **200 kHz** (the upper limit for Ramp). As shown in Table A-, the output frequency range depends on the function currently selected. The default frequency is **1 kHz** for all functions.

Table A-3 – Output Frequency Range

Function	Minimum Frequency	Maximum Frequency
Sine	1 µHz	20 MHz
Square	1 µHz	20 MHz
Ramp, Triangle	1 µHz	200 MHz
Pulse	500 µHz	5 MHz
DC	Not applicable	Not applicable
Arbitrary	1 µHz	200 kHz 2 MHz (U2761A Option 801)

Amplitude Limitation

The default amplitude is **1 Vpp** (into 50 Ω) for all functions. If you change to a function where the maximum amplitude is less than the current function, the amplitude will automatically adjust to the maximum value for the new function. This may occur when the output units are **Vrms** or **dBm** due to the differences in crest factor for the various output functions. For example, if you output a **2.5 Vrms Square wave** (into 50 Ω) and then change to the **Sine wave** function, the U2761A will automatically be adjusted the output amplitude to **1.768 Vrms** (the upper limit for Sine wave in Vrms).

Duty Cycle Limitations

For Square waveforms, the U2761A may not be able to use the full range of duty cycle values at higher frequencies as shown below:

- 20% to 80% (frequency 10 MHz)
- 40% to 60% (frequency 10 MHz)

If you change to a frequency that cannot produce the current duty cycle, the duty cycle is automatically adjusted to the maximum value for the new frequency. For example, if you currently have the duty cycle set to **70%** and then change the frequency to **12 MHz**, the U2761A will automatically adjusts the duty cycle to **60%** (the upper limit for this frequency).

Output Termination

This configuration applies to output amplitude and offset voltage only. The U2761A has a fixed series output impedance of 50 Ω to the device output connector. If the actual load impedance is different from the specified value, the amplitude and offset levels will be incorrect.

- The range of the output termination is **1 Ω** to **10 kΩ**, or **Infinite**. The default value is **50 Ω**.
- The output termination setting is stored in volatile memory and upon power-off or after a remote interface reset, the setting will return to a default value.
- If you specify a **50 Ω** termination but are actually terminating into an open circuit, the actual output will be **twice** the value specified. For example, if you set the offset to **100 mVDC** (and specify a **50 Ω** load) but are terminating the output into an open circuit, the actual offset will be **200 mVDC**.
- If you change the output termination setting, the output amplitude and offset levels are automatically adjusted (no error will be generated). For example, if you set the amplitude to 5 V_{pp} and then change the output termination from **50 Ω** to **high impedance**, the amplitude value will

double to **10 V_{pp}**. If you change from **high impedance** to **50 Ω**, the displayed amplitude value will drop to half.

- You cannot specify the output amplitude in dBm if the output termination is currently set to *high impedance*. The units are automatically converted to V_{pp}.

You may configure the output termination by clicking **Tools** in the menu bar. Select **Waveform Gen** followed by the **Output Setup** tab; input the desired load impedance value on the **Impedance Load** panel, and select the unit from the drop down list; or select **High Z** for high impedance load.

Tips on How to Use the Agilent U2701A USB Modular Oscilloscope

Front Panel of the Agilent U2701A USB Modular Oscilloscope

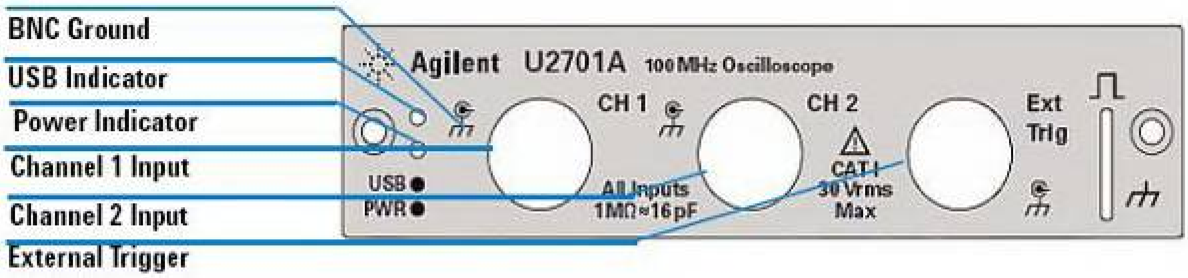


Figure C-1 – Front Panel of the U2701A

Setup Connection

1. Connect the oscilloscope to the PC using a USB cable.
2. Power on the oscilloscope.
3. Launch the **Agilent IO Control** and the **Agilent Measurement Manager (AMM)**.
4. The **Select USB Device** dialog box will appear displaying the connected **U2701A** devices. To start the application, select a **U2701A** device and click **OK** to establish the connection.
5. Figure C-2 shows the general graphical user interface of the Agilent Modular Oscilloscope on the Agilent Measurement Manager.

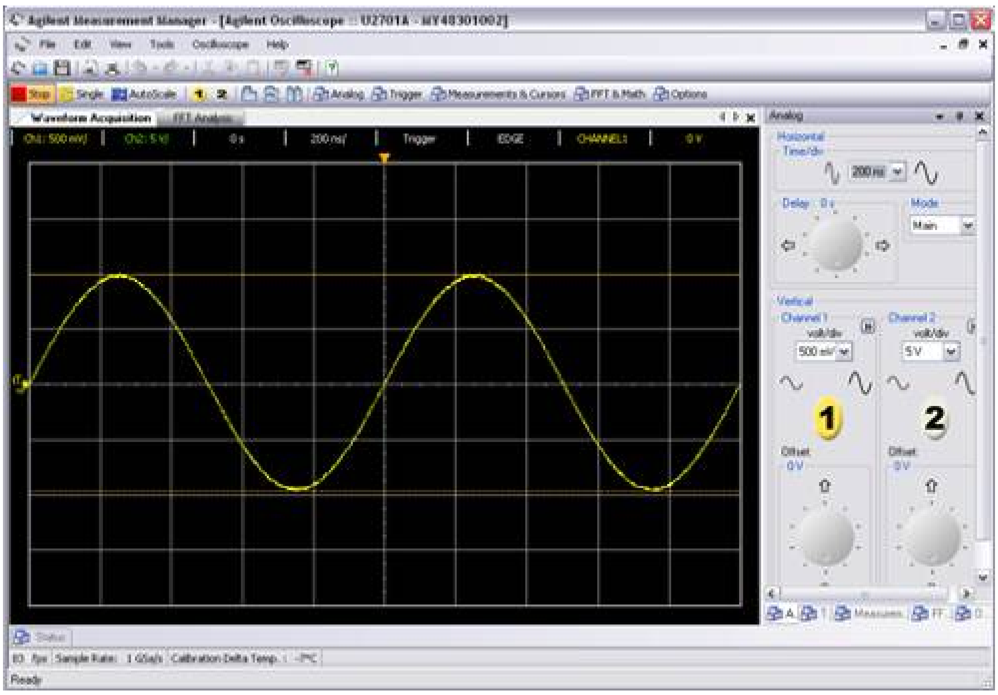


Figure C-2 – Graphical User Interface of the Agilent Measurement Manager (Oscilloscope)

Agilent Measurement Manager Soft Front Panel (Oscilloscope)

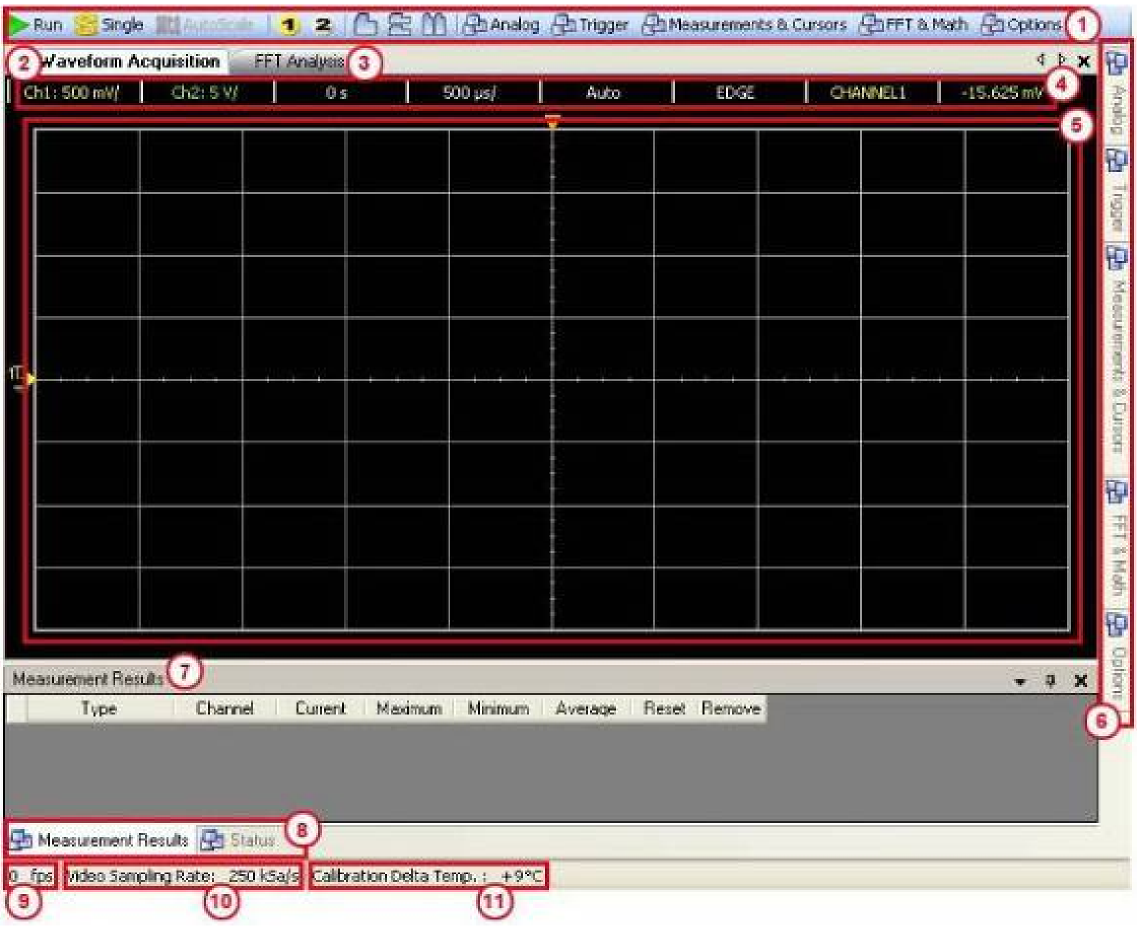


Figure C-313 – Soft Front Panel of the Oscilloscope

Figure **C-313**C-3 shows the graphic user interface of Agilent Modular Oscilloscope under Agilent Measurement Manager together with the label of each panel. Table **C-1**C-1 shows the features of each panel of the interface.

Table C-1 – Features of the AMM Oscilloscope Interface

No.	Panel	Description
1	Oscilloscope toolbar	Consists of oscilloscope tools
2	Waveform Acquisition tab	Displays the time-domain waveform for the oscilloscope
3	FFT Analysis tab	Displays the FFT spectrum of the signal
4	Configuration summary	Displays the configured functions and settings
5	Waveform graph display	Displays the output of the data acquired
6	Scope control tabs	Consists of all the sub functions of the oscilloscope
7	Measurement Results panel	Displays the measurement results of the scope operations
8	Status tab	Displays the status panel, which shows the history of operations
9	Refresh rate	Displays the graph update rate in frame/sec.
10	Video Sampling Rate	Displays the video sampling rate (in number of samples per second taken from a continuous signal)
11	Calibration Delta Temp. indicator	Displays the calibration delta temperature of the connected device

Analog Controls

The analog control panel of the interface consists of a vertical control and a horizontal control that are used to control and set the waveform of the graph display. The vertical control is used to change the vertical scale and position of the waveform. The soft front panel of the vertical system control is shown in Figure .

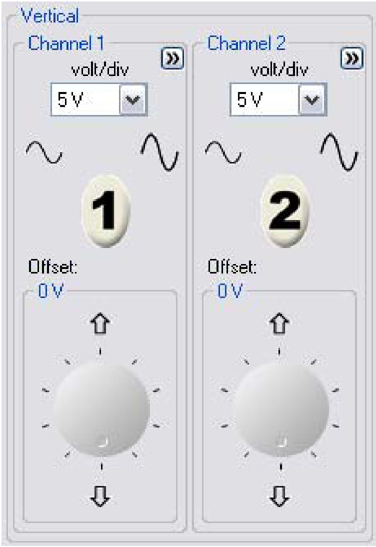


Figure C-4 – Soft Front Panel of the Vertical System Control

1. To display waveform from channel 1 / channel 2, click **1 / 2** or press the shortcut key **F5 / F6**.
2. To toggle the channel on or off, click the channel buttons on the vertical control panel or click the toolbar to toggle the channel on or off, as shown below.

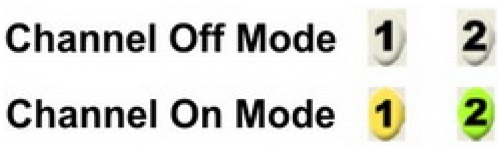


Figure C-514 – Channel On/Off Mode

3. The channel options provide four types of adjustment to the channel waveform; these options are **AC Coupling**, **Invert**, **BW Limit**, and **Attenuation (1X, 10X, 100X)**. You may click the  button as shown in Figure to set the channel options.

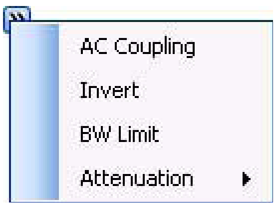
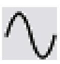


Figure C-6 – Channel Options

4. The **Volt/Div** control sets the sensitivity of the channel. You can select the channel sensitivity from the drop-down list.
5. You can also use the  button or  button to increase or decrease the sensitivity of both channel 1 and channel 2.
6. You can also configure the offset of the oscilloscope by using the offset control as shown in Figure . The offset is used to configure the position of the ground relative to the center of the display.

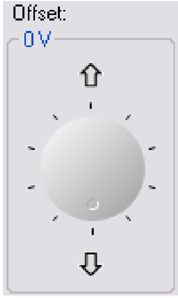


Figure C-7 – Soft Front Panel of the Offset Control

7. The oscilloscope shows the time per division in the scale readout. As all waveforms use the same time base, the oscilloscope only displays one value for all channels.
8. The horizontal controls allow you to adjust the horizontal scale and position of waveforms. The horizontal center of the screen is the time reference for waveforms. Changing the horizontal scale causes the waveform to expand or contract in the center of the screen. It provides functions of **Time Base**, **Delay**, and **Mode** for the horizontal scale adjustment. This is shown in Figure C-815.

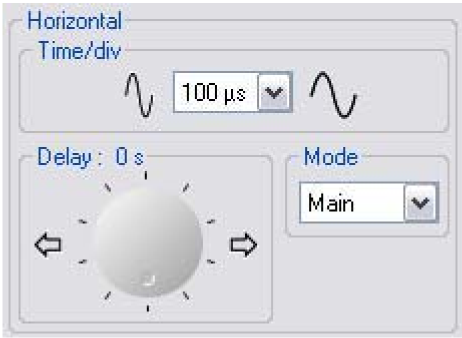


Figure C-815 – Soft Front Panel of the Horizontal System Controls

9. Time base allows you to control how often the values are digitized. The soft front panel of the time-base control is shown in Figure C-916.

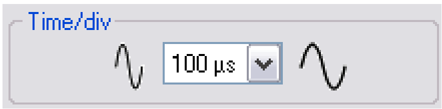
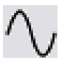


Figure C-916 – Soft Front Panel of the Time-Base Control

10. You may click  or  to increase or decrease the horizontal sweep speed.

11. Select the time base from the drop-down list to adjust the horizontal sweep speed.
12. Delay setting allows you to set the specific location of the trigger event with respect to the time reference position. When the delay time knob is turned, the trigger point will move to the left or right of the waveform graph display. You may adjust the delay time to change the trigger point. This is shown in Figure .

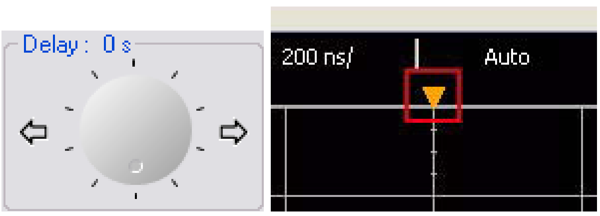


Figure C-10 – Soft Front Panel of the Delay Control and Trigger Point

13. You may click ⇦ or ⇨ to increase or decrease the delay time.
14. The oscilloscope offers three types of horizontal mode functions, which are **Main Mode**, **Roll Mode**, and **XY Mode**. You may select the horizontal mode by clicking the drop-down list under **Mode**.

Measurement and Cursor Controls

1. The **Measurements & Cursors** button is located on the toolbar of the soft front panel.
2. Click Measurements & Cursors to activate the automated measurement and cursor system. This will display the window as shown below:

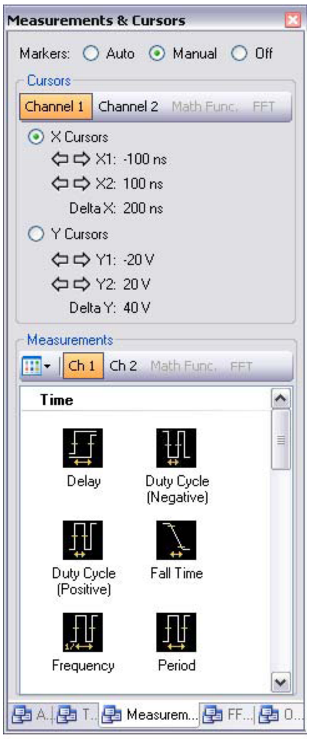


Figure C-11 – Soft Front Panel of the Measurement and Cursor Controls

3. The oscilloscope provides three types of settings for marker property, which are **Auto**, **Manual**, and **Off**.
4. **Auto** marker automatically places the cursors on the graph based on the selected measurements.
5. **Manual** marker allows the cursors to be placed manually on the graph for customized measurements. This will enable the **Cursors** panel.
6. **Off** will disable the graph markers from the graph display.
7. If the **Manual** marker is selected, the **Cursors** control will be enabled. This is shown in Figure .

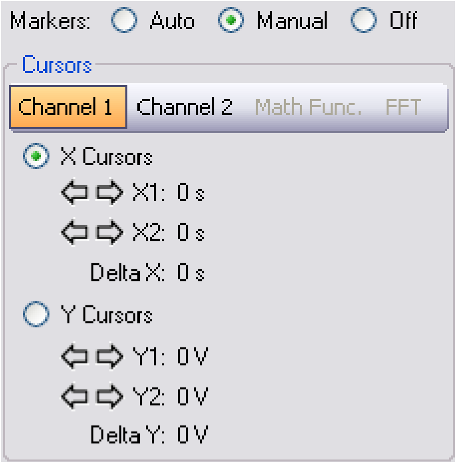


Figure C-12 – Cursor Controls

8. **X Cursors** places two cursors on the **X-Axis** of the waveforms to measure the **time difference** between the two cursors (X2 minus X1). **Delta X** denotes the **time difference**.
9. **Y Cursors** places two cursors on the **Y-Axis** of the waveforms to measure the **voltage difference** between the two cursors (Y2 minus Y1). **Delta Y** denotes the **voltage difference**.

AutoScale and Run/Stop

1. **AutoScale** automatically configures the oscilloscope to best display the input signal by analyzing any waveforms connected to the channel and external trigger inputs. If **AutoScale** fails, your current setup will remain unchanged.
2. Click AutoScale on the oscilloscope toolbar or via the **Tools** menu once you have obtained a running signal.
3. The auto scaling may take awhile for the application to analyze and adjust the waveform.
4. Once the auto scaling has completed, you will see a best fit waveform displayed on your graph.
5. Use the **Run/Stop** button to manually start or stop the oscilloscope acquisition system for acquiring waveform data.
6. You may click Run or Stop to start or stop acquiring the waveform.

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