ME3100 Analog Circuit Design
Ready-to-Teach Package for Electronic Instrumentation and Measurement

Quick Start Guide

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. Quick Setup and Verification

The following steps demonstrate the basic setup and lab test of the ME3100 Analog Circuit Design kit:

— Embedded Audio Player Test and Verification

— LED Audio VU Meter Test and Verification

— Equalizer and LED Audio VU Meter Test and Verification

1.1 Embedded Audio Player Test and Verification

1. The ME3100 Analog Circuit Design kit consists of an embedded audio player, which is able to play and audio files stored in the provided microSD memory card.
2. Make sure the memory card is inserted into the **Embedded Audio-Sound Module, M1** that is located at the left corner of the ME3100 Analog Circuit Design kit.
3. Turn on the power supply unit. Set one of the dual channel output voltages to exactly **+5 V**. Set current limits to **1.0 A**.
4. Connect the **+5 V** power supply output to test points **T3 (V$_a$)** and **GND** to **T4 (Gnd)** of the ME3100 Analog Circuit Design kit respectively. This is shown in Figure 1.
5. Extend the power source from **T3 (5 V)** and **T4 (Gnd)** to the breadboard as shown in Figure 1.
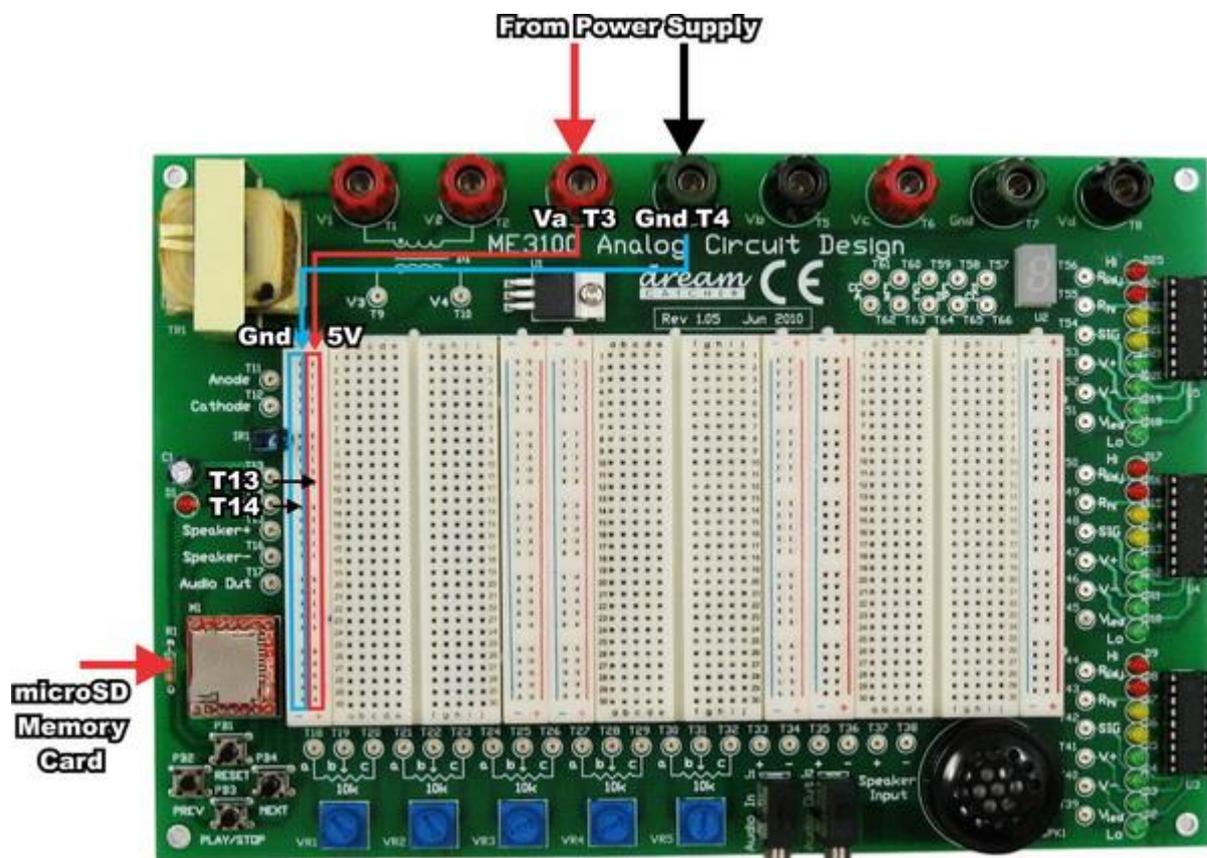

Figure 1 – Connections Between the Power Supply and the ME3100 Analog Circuit Design Kit

6. Connect **T13** and **T14** to the extended **5 V** and **Gnd** on the breadboard respectively. This is shown in Figure 2. These connections allow you to control the music playback using the push buttons **PB1**, **PB2**, **PB3**, and **PB4** on the ME3100 Analog Circuit Design kit.
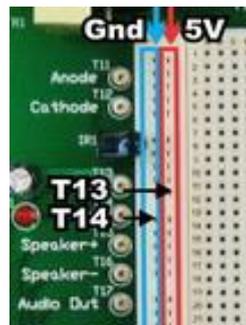
Figure 2 – Connections of T13 and T14 on the Breadboard

7. Next, connect **T15 (Speaker+)** and **T16 (Speaker–)** to **T37** and **T38** respectively, as shown in Figure 3.
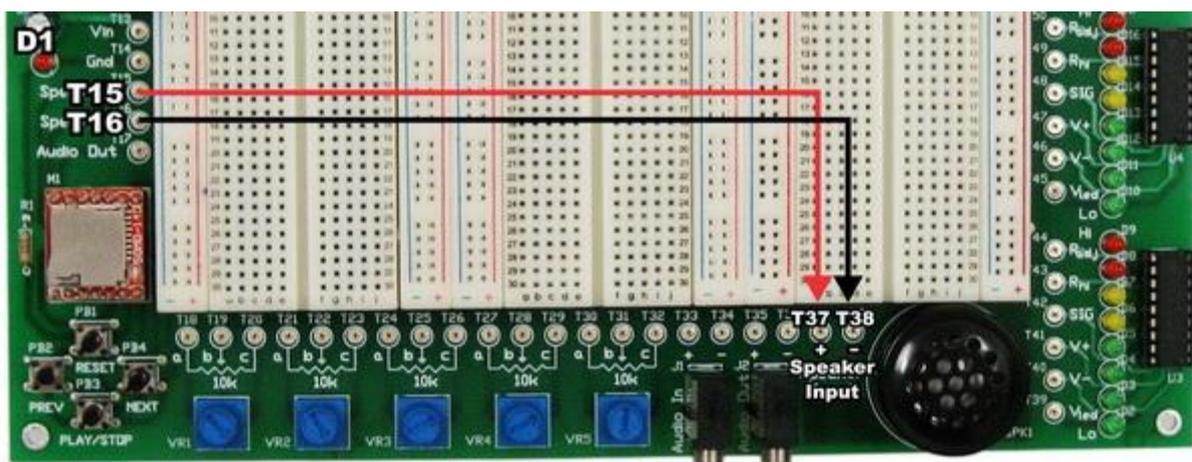

Figure 3 – Connections of T15 and T16 to the On-Board Speaker

8. Make sure that the polarities of the connections are correct.
9. After the connections are verified, enable the power supply outputs. The annunciators on the display panel of the power supply should be turned on. This indicates that the power supply is providing a constant voltage supply to the ME3100 Analog Circuit Design kit.
10. If the **CC** annunciator is on, disable the power supply output. Check if this is due to a current limit setting or a faulty connection.
11. The red LED **D1**, as shown in Figure 3, will blink for a moment if +5 V is correctly supplied to the ME3100 Analog Circuit Design kit.
12. Press the **PLAY/STOP** button to play or stop the music. The LED **D1** will be turned on when the module is playing the music and turned off when the music is stopped.
13. Press the **NEXT** or **PREV** button to play the next or previous audio file.
14. Press the **RESET** button to reset the audio module. The LED **D1** will blink for a moment.
15. Turn off the ME3100 Analog Circuit Design kit by pressing the **Output On/Off** button on the power supply.

1.2 LED Audio VU Meter Test and Verification

1. Build a single band equalizer by following the schematic connections as shown in Figure 4 on the breadboard of the ME3100 Analog Circuit Design kit. This single band equalizer will be used to test the functionality of the Audio VU Meter. Refer to the appendix for the pin layout of the op-amp **LM158**.
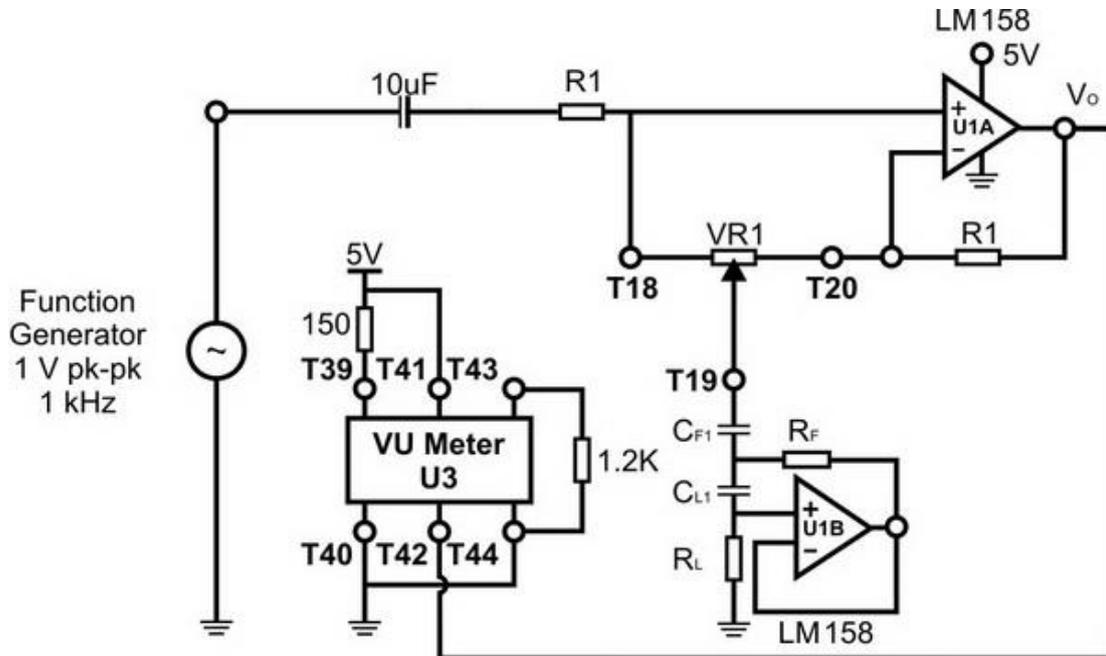

Figure 4 – Single Band Equalizer with VU Meter

2. Table 1 shows the value of the electronics components in the schematic.

Table 1 – Value of Components

Label	Value
R_1	1.5 kΩ
R_F	120 kΩ
R_L	330 Ω
C_{F1}	2.2 µF
C_{L1}	4.5 nF

3. The resonant frequency of the filter is **1 kHz**. Hence, connect the function generator to the input pin of the amplifier with **1 V** peak-to-peak (pk-pk) and frequency of **1000 Hz**.
4. Vary the gain of equalizer by adjusting the potentiometer **VR1**.
5. You should be able to observe the display of LED bar (LEDs **D2** to **D9**) varies according to the adjustment.

1.3 Equalizer with LED Audio VU Meter Test and Verification

1. Remain the same connections of the ME3100 Analog Circuit Design kit as shown in Figure 1.
2. Build a 3-band gyrator-based equalizer with UV meter by following the schematic connections as shown in Figure 5 on the breadboard of the ME3100 Analog Circuit Design kit. Refer to the appendix for the pin layout of op-amp **LM158**.
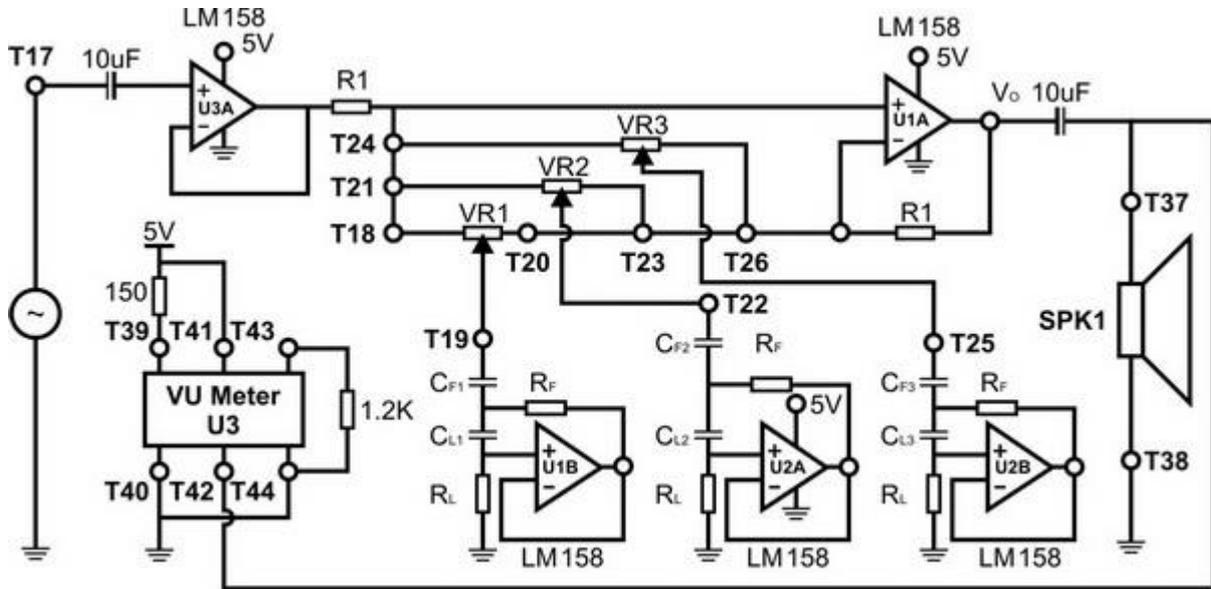

Figure 5 – Schematic Diagram of the 3-Band Gyrator-Based Equalizer with VU Meter

3. Table 2 shows the value of the electronics components of the schematic.

Table 2 – Value of Components

Label	Value
R_1	1.5 kΩ
R_F	120 kΩ
R_L	330 Ω
C_{F1}	560 nF
C_{F2}	2.2 µF
C_{F3}	150 nF
C_{L1}	1.2 nF
C_{L2}	4.5 nF
C_{L3}	270 pF

4. Figure 5 shows a 3-band equalizer based on a single variable gain amplifier using, the gyrator-based bandpass filter. The resonant frequencies of the filter are **250Hz**, **1 kHz**, and **4 kHz**.
5. The op-amp **U3A** is acting as a buffer circuit (unity gain amplifier) in order to isolate the signal sources from the equalizer filter banks.
6. With all the connections properly connected as shown in Figure 5, configure the power supply as described in Section 4.1 and turn it on. The red LED **D1** on the ME3100 Analog Circuit Design kit will blink for a moment.

7. Press the **PLAY/STOP** button to play the audio files stored in the microSD memory card. The LED **D1** will be turned on when the module is playing the audio file.

8. The LEDs **(D2-D9)** of the UV meter will visualize the output of the equalizer when the audio file is played.

9. Adjust the potentiometer **VR1**, **VR2**, or **VR3** to control the equalizer.

10. You would be able to hear the change in the music quality as you adjust the equalizer controls.

2. Support and Warranty

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- 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.

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

Appendix A: ME3100 Analog Circuit Design Kit

As shown in Figure A-1, the ME3100 Analog Circuit Design kit consists of the following:

— Audio Speaker
— Embedded Audio Player
— LED Audio UV Meter
— Analog Potentiometer
— Seven-Segment Displays
— Insulation Transformer
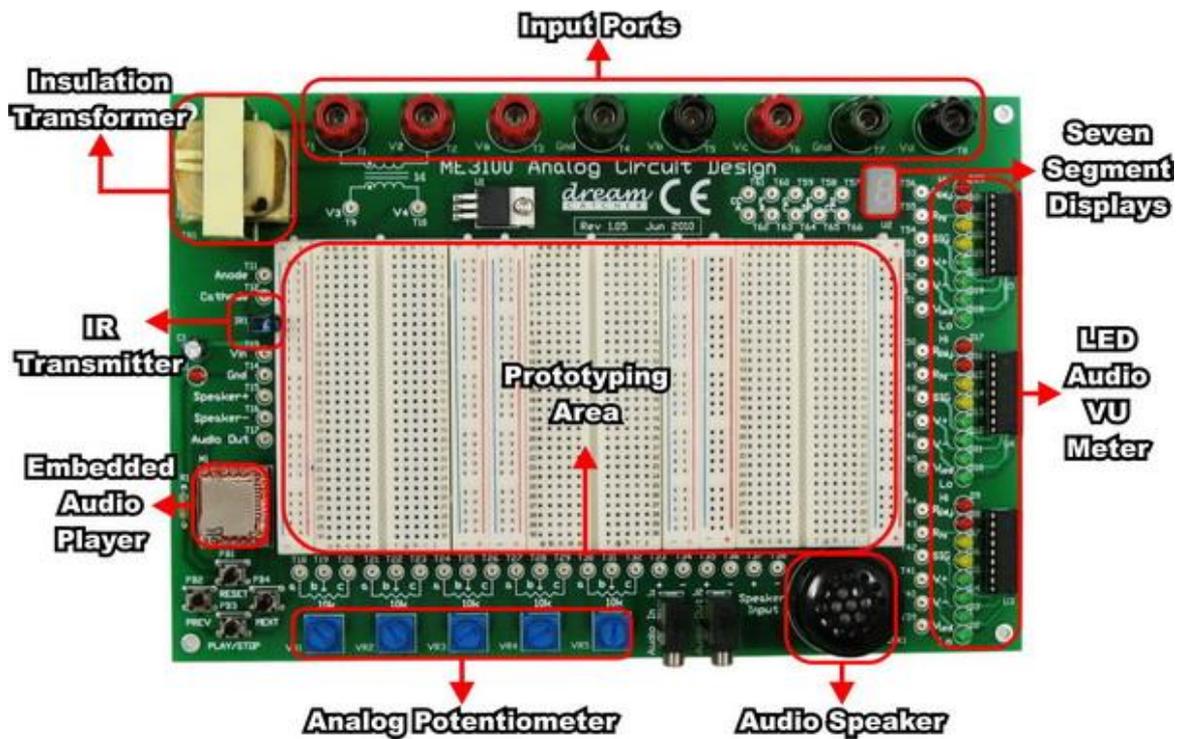— Various test points for measurements

Figure A-1 – ME3100 Analog Circuit Design 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

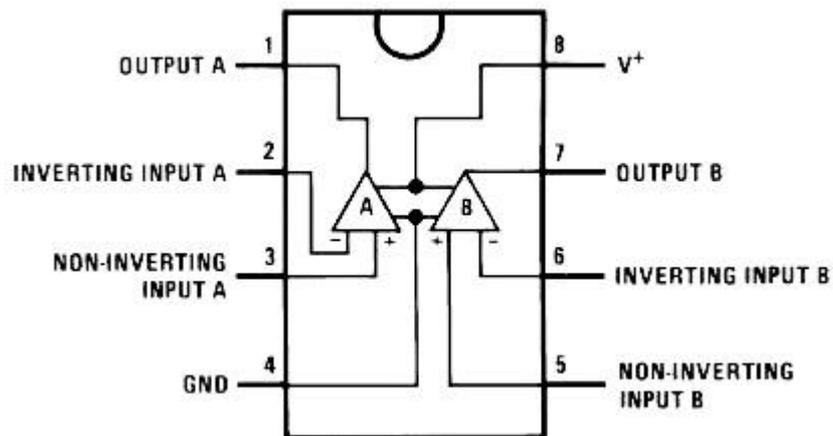| ME3100 – Analog Circuit Design Kit	Min	Typical	Max
Input voltage supply (variable, 0 – 15 Vdc)	0 V		15.5 V
Input current supply		1.0 A	
Embedded Audio Player			
Sampling rate	6 kHz		32 kHz
MicroSD memory slot capacity			4 GB
Voltage supply	2.7 V		3.6 V
Idle current		8 µA	
Built-in Speaker			
Frequency response	500 Hz		2000 Hz
Impedance		8 Ω	
Power rating		0.15 W	

Appendix C: Pin Layout of LM158

Figure C-1 – Pin Layout of LM158

Appendix D: Using Modular Instruments

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

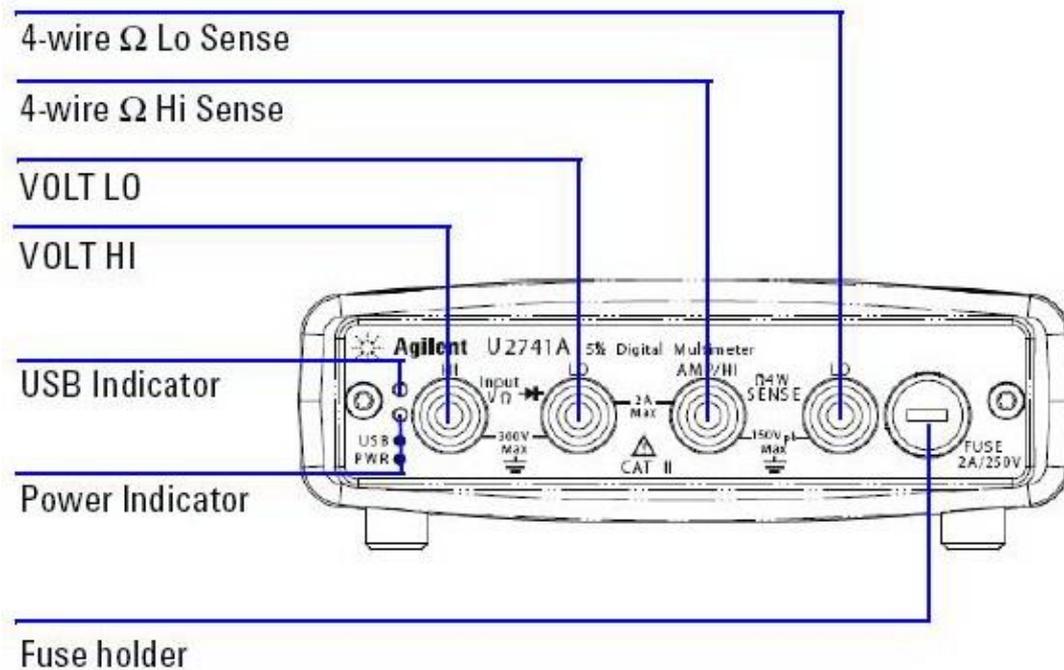**Front Panel of the Keysight U2741A USB Modular Digital Multimeter**

Figure D-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 **Keysight IO Control** and the **Keysight 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 **Keysight Measurement Manager (AMM)** for U2741A or via **SCPI commands** sent through the USB interface from your own application programs.

7. Launch the **Keysight 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** D-2 in order to measure DC voltage. You can control the U2741A via the **Keysight Measurement Manager (AMM)** software for U2741A or via **SCPI commands** sent through the USB interface from your own application programs.
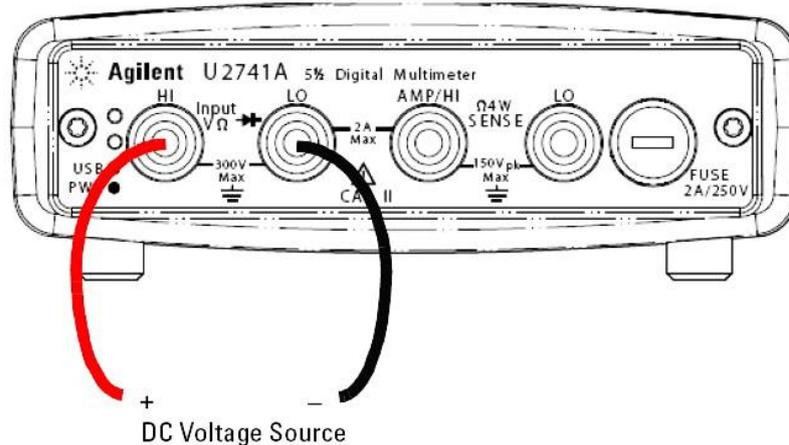

Figure D-2 – Measuring DC Voltage

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 **Keysight Measurement Manager (AMM)** software for U2741A or via **SCPI commands** sent through the USB interface from your own application programs.
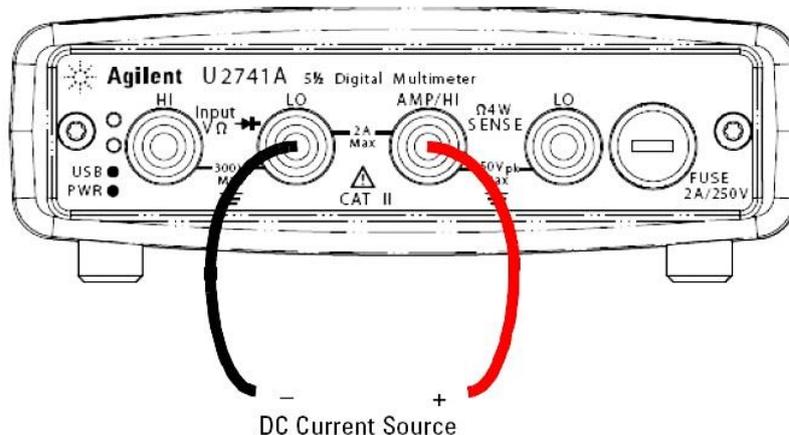

Figure D-3 – Measuring DC Current

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 Keysight U2761A USB Modular Function Generator

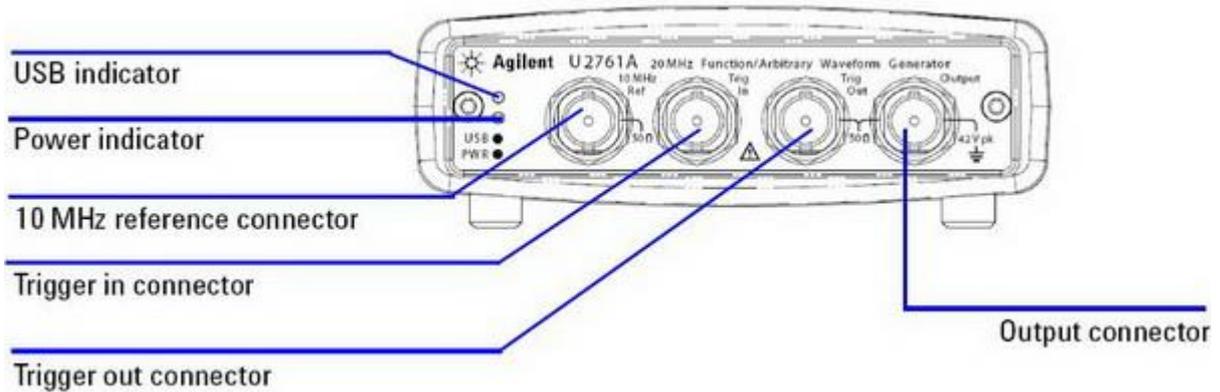**Front Panel of the Keysight U2761A USB Modular Function Generator**

Figure D-4 – 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 **Keysight IO Control** and the **Keysight 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 D-1 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 D-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	√	√	√	√			√

Keysight Measurement Manager Soft Front Panel (Function Generator)
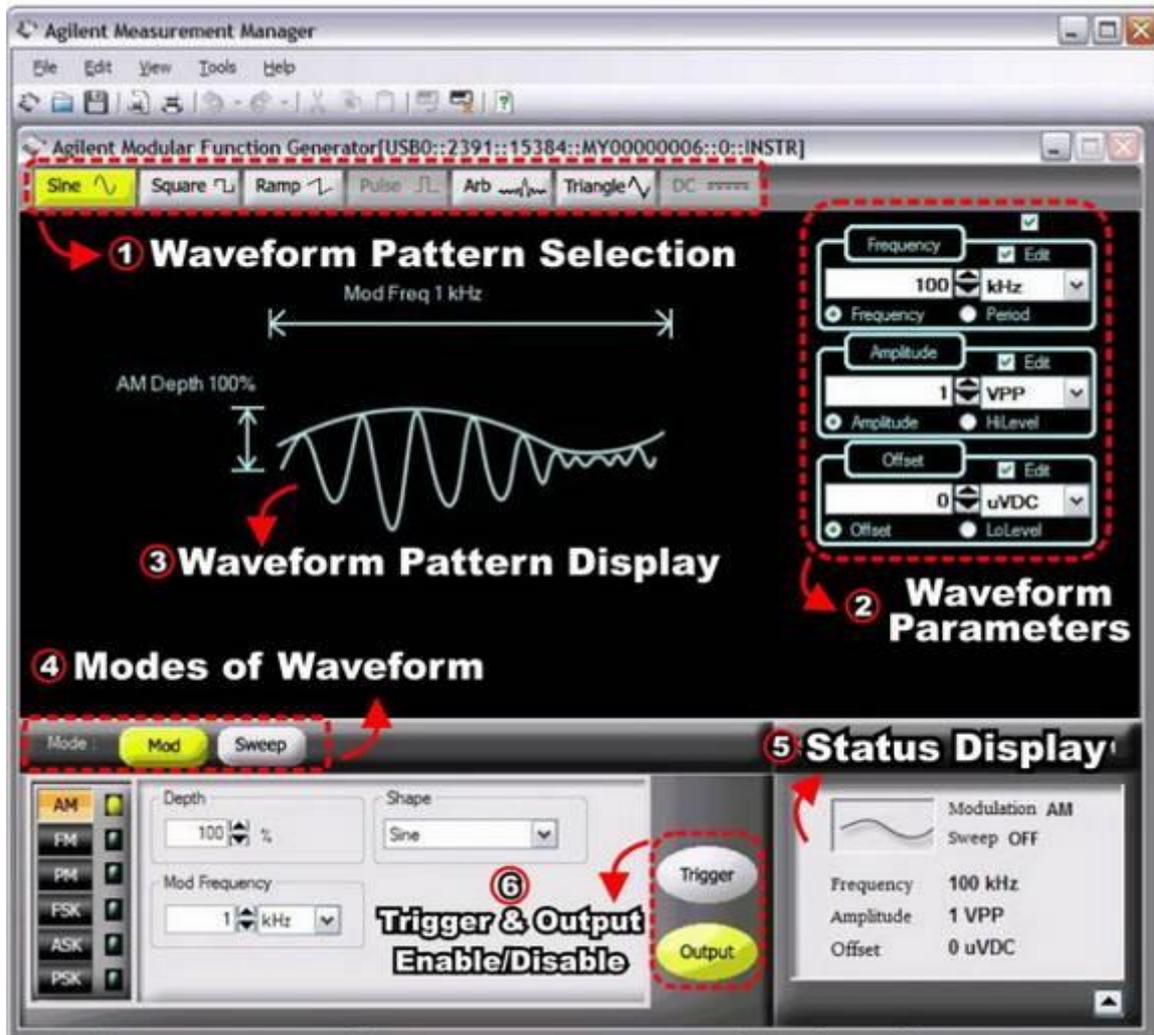

Figure D-5 – Graphic User Interface of the Keysight Measurement Manager (Function Generator)

Figure D-5 shows the graphic user interface of the Keysight Modular Function Generator under the Keysight Measurement Manager (AMM). Table D- shows the features of each panel of the interface.

Table D-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 D-, the output frequency range depends on the function currently selected. The default frequency is **1 kHz** for all functions.

Table D-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 Keysight U2701A USB Modular Oscilloscope

Front Panel of the Keysight U2701A USB Modular Oscilloscope

Figure D-6 – 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 **Keysight IO Control** and the **Keysight 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 D-7 shows the general graphical user interface of the Keysight Modular Oscilloscope on the Keysight Measurement Manager.
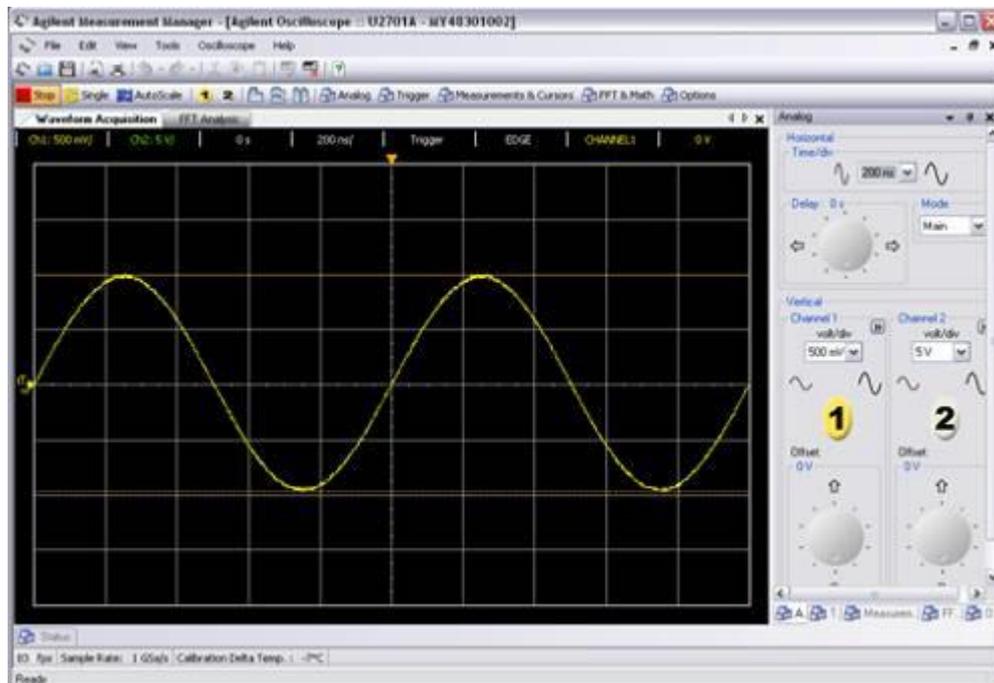
Figure D-7 – Graphical User Interface of the Keysight Measurement Manager (Oscilloscope)

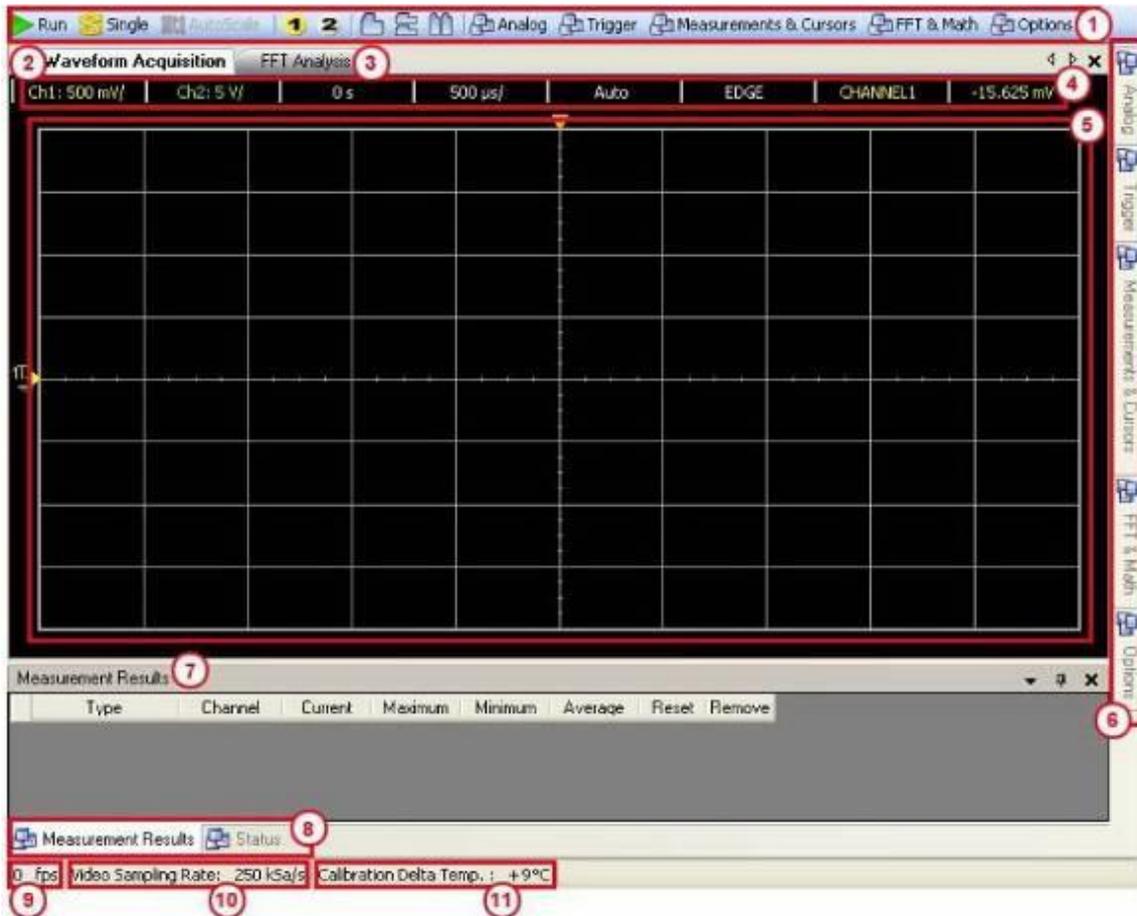**Keysight Measurement Manager Soft Front Panel (Oscilloscope)**

Figure D-86 – Soft Front Panel of the Oscilloscope

Figure **D-86**D-8 shows the graphic user interface of Keysight Modular Oscilloscope under Keysight Measurement Manager together with the label of each panel. Table **D-**D-4 shows the features of each panel of the interface.

Table D-4 – 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 9.
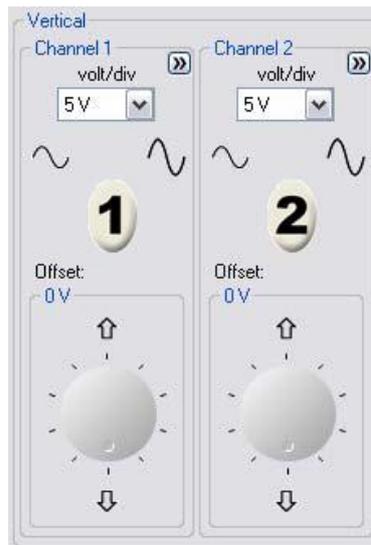

Figure D-9 – Soft Front Panel of the Vertical System Control

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.
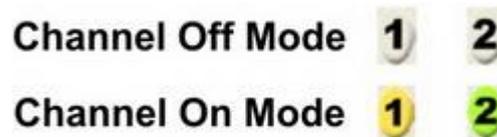

Figure D-107 – Channel On/Off Mode

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.
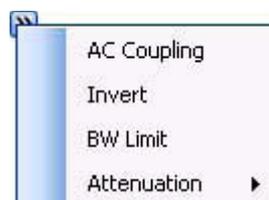

Figure D-11 – Channel Options

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.
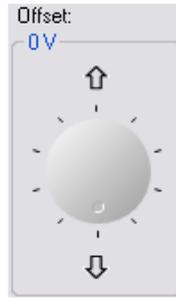
Figure D-12 – Soft Front Panel of the Offset Control

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 D-13813.
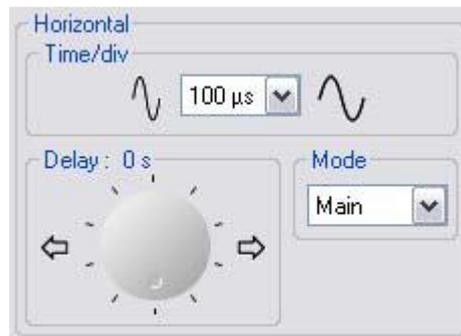

Figure D-138 – Soft Front Panel of the Horizontal System Controls

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 D-149.

Figure D-149 – Soft Front Panel of the Time-Base Control

10. You may click $\sim$ or $\sim$ 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 5.

Figure D-15 – 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:
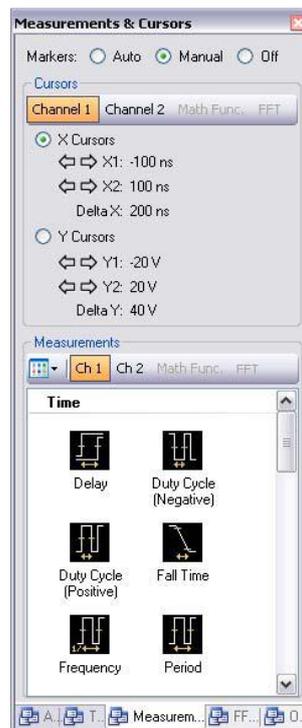

Figure D-16 – Soft Front Panel of the Measurement and Cursor Controls

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 7.
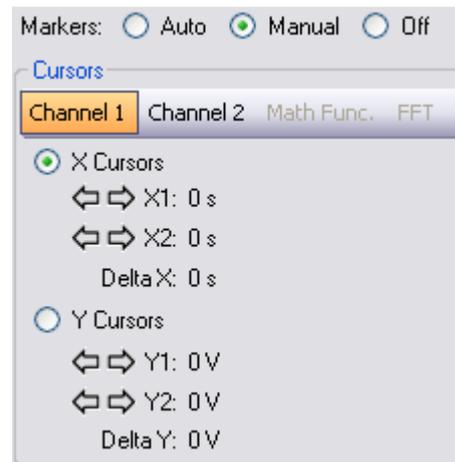
Figure D-17 – Cursor Controls

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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