Quick Start Guide

revision 1.03
Printed on 20 September 2012
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.

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

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.
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1. Read Me First

Congratulations on your purchase of the ME3100 Analog Circuit Design 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:

<table>
<thead>
<tr>
<th>Item</th>
<th>Quantity</th>
<th>Description</th>
</tr>
</thead>
</table>
| CD                                  | 1        | o Teaching slides (Microsoft® PowerPoint format)  
|                                     |          | o Lab sheets (Microsoft® Word format)  
|                                     |          | o Problem-based assignments (Microsoft® Word format)  |
| ME3100 Analog Circuit Design Kit    | 1        | The hardware kit consists of  
|                                     |          |   - Standard On-Board Components  
|                                     |          |   o Audio speaker, embedded audio player, LED audio  
|                                     |          |   VU meter, analog potentiometer, seven-segment  
|                                     |          |   display, insulation transformer, and various test  
|                                     |          |   points for measurements  
|                                     |          |   - Prototyping Area  
|                                     |          |   o Breadboard with three standard miniature blocks,  
|                                     |          |   with 1200 holes for connections  |
| Power supply cable                  | 1 set    | 4 x banana-to-banana power cable  |
| Jumper cables                       | 1 set    | 6 x cable terminated with grabber clips at both ends  |
| BNC cable                           | 1        | BNC(m)-to-grabber clip cable  |
| Electronic components               | 1 set    | Consists of passive components such as resistors, capacitors,  
|                                     |          | and active components such as transistors and op-amps  |
| Antistatic wrist strap               | 1        | For ESD protection (required to wear when handling the device)  |

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

- 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 ME3100 Analog Circuit Design kit.

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

**IMPORTANT**

The ME3100 Analog Circuit Design 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 ME3100 serves as a ready-to-teach package in the areas of practical analog circuit analysis, design, and its applications. This is an advanced course, generally taught in the 3rd or final year undergraduate study. The aim is to enhance student’s understanding in analog circuits and improve their practical skills in circuit design. The lab experiments are designed using a problem-based approach, allowing students to learn and solve practical analog circuit design tasks.

This courseware consists of:
- Teaching slides (editable with Microsoft PowerPoint)
- Training kit: Analog Circuit Design 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:
- Analog circuit analysis
- Passive and active components
- BJT circuit analysis and design
- Practical op-amp design
- Active filter design
- Usage of measurement instruments

![Figure 1 – ME3100 Analog Circuit Design Kit and Recommended Instruments](image-url)
3. Courseware Configuration

3.1 Teaching Slides

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

- Component Characteristics for Resistor, Capacitor, and Inductor
- Resistor-Capacitor-Inductor-Based Circuits
- Review of Practical Circuit Analysis Techniques
- Diode Characteristics and Applications
- Bipolar Junction Transistor and MOSFET Circuits Design
- Op-Amp-Based Circuits Design
- Active Filter Design and Implementation
- Case Studies 1: Wide Bandwidth Amplifier Design
- Case Studies 2: High Precision Voltage Regulator Design

3.2 ME3100 Analog Circuit Design Kit

- Standard on-board components
  - Audio speaker
  - Embedded audio player
  - LED audio VU meter
  - Analog potentiometer
  - Seven-segment display
  - Insulation transformer
  - Various test points for measurements

- Prototyping Area
  - Breadboard with three standard miniature blocks, with 1200 holes for connections
3.3 Lab Sheets

<table>
<thead>
<tr>
<th>No</th>
<th>Lab Sheet</th>
<th>Objective</th>
<th>Duration</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Designing a Voltage Regulator</td>
<td>To design and build a DC voltage regulator circuit, and measure its performance under varying operating conditions; as well as understand the improvements that can be made to achieve better performance</td>
<td>3 Hours</td>
</tr>
<tr>
<td>2</td>
<td>Designing an IR Transceiver Circuit</td>
<td>To design and test the performance of infrared based circuits; as well as understand design improvements to achieve better performance</td>
<td>3 Hours</td>
</tr>
<tr>
<td>3</td>
<td>Designing a BJT-Based Amplifier</td>
<td>To design and compare the performance of the different biasing schemes and their effects on input impedance, output impedance, and amplifier gain variation</td>
<td>3 Hours</td>
</tr>
<tr>
<td>4</td>
<td>Designing a FET-Based Amplifier</td>
<td>To design and evaluate the performance of an NMOS enhancement-mode MOSFET based amplifier</td>
<td>3 Hours</td>
</tr>
<tr>
<td>5</td>
<td>Designing Op-Amp-Based Precision Circuits</td>
<td>To investigate the use of feedback loop in designing precision rectifier of various configurations</td>
<td>3 Hours</td>
</tr>
<tr>
<td>6</td>
<td>Designing an Audio Equalizer</td>
<td>To design and evaluate the performance of an op-amp-based audio equalizer</td>
<td>3 Hours</td>
</tr>
<tr>
<td>7</td>
<td>Designing a High Sensitivity IR Detector</td>
<td>To study the use of op-amps in designing a highly sensitive IR detector circuit</td>
<td>3 Hours</td>
</tr>
<tr>
<td>8</td>
<td>Designing a High Precision Voltage Regulator</td>
<td>To study the use of op-amps in designing a high precision voltage regulator</td>
<td>3 Hours</td>
</tr>
</tbody>
</table>

3.4 Problem-based Assignments

<table>
<thead>
<tr>
<th>No</th>
<th>Assignment</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>High Sensitivity RTD Sensing</td>
</tr>
<tr>
<td>2</td>
<td>Ultrasonic Range Finder</td>
</tr>
</tbody>
</table>

3.5 Lab Station

<table>
<thead>
<tr>
<th>Basic Setup</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 x Agilent 34405A 5½ Digit Multimeter</td>
</tr>
<tr>
<td>1 x Agilent DSO1002A 60 MHz Oscilloscope</td>
</tr>
<tr>
<td>1 x Agilent 33220A Function Generator</td>
</tr>
<tr>
<td>1 x Agilent E3631A Triple Output DC Power Supply</td>
</tr>
</tbody>
</table>

*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.

<table>
<thead>
<tr>
<th>Training Kit</th>
<th>Required Instrument(s)</th>
<th>Option 1</th>
<th>Option 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>ME3100 Analog Circuit Design Kit</td>
<td>Power Supply, Function Generator, &amp; Oscilloscope</td>
<td></td>
<td>Power Supply, Function Generator, Multimeter, &amp; Oscilloscope</td>
</tr>
<tr>
<td>Lab 1</td>
<td>✔</td>
<td>✔</td>
<td>✔</td>
</tr>
<tr>
<td>Lab 2</td>
<td>✔</td>
<td>✔</td>
<td>✔</td>
</tr>
<tr>
<td>Lab 3</td>
<td>✔</td>
<td>✔</td>
<td>✔</td>
</tr>
<tr>
<td>Lab 4</td>
<td>✔</td>
<td></td>
<td>✔</td>
</tr>
<tr>
<td>Lab 5</td>
<td>✔</td>
<td>✔</td>
<td>✔</td>
</tr>
<tr>
<td>Lab 6</td>
<td>✔</td>
<td>✔</td>
<td>✔</td>
</tr>
<tr>
<td>Lab 7</td>
<td>✔</td>
<td>✔</td>
<td>✔</td>
</tr>
<tr>
<td>Lab 8</td>
<td>✔</td>
<td>✔</td>
<td>✔</td>
</tr>
</tbody>
</table>

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

Lectures
- Essentials of Analog Circuit Design
- Selected topics from the courseware teaching material

Lab Exercises
- Selected exercises from the lab sheets

*Training details are available at [http://dreamcatcher.asia/](http://dreamcatcher.asia/)*
4. 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

4.1 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 2.
5. Extend the power source from T3 (5 V) and T4 (Gnd) to the breadboard as shown in Figure 2.

6. Connect T13 and T14 to the extended 5 V and GND on the breadboard respectively. This is shown in Figure 3. 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.
7. Next, connect T15 (Speaker+) and T16 (Speaker–) to T37 and T38 respectively, as shown in Figure 4.

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 4, 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.
4.2 LED Audio VU Meter Test and Verification

1. Build a single band equalizer by following the schematic connections as shown in Figure 5 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 5 – Single Band Equalizer with VU Meter](image)

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

<table>
<thead>
<tr>
<th>Label</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>R₁</td>
<td>1.5 kΩ</td>
</tr>
<tr>
<td>R₉</td>
<td>120 kΩ</td>
</tr>
<tr>
<td>Rₗ</td>
<td>330 Ω</td>
</tr>
<tr>
<td>C₉₁</td>
<td>2.2 µF</td>
</tr>
<tr>
<td>Cₗ₁</td>
<td>4.5 nF</td>
</tr>
</tbody>
</table>

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.
4.3 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 2.

2. Build a 3-band gyrator-based equalizer with UV meter by following the schematic connections as shown in Figure 6 on the breadboard of the ME3100 Analog Circuit Design kit. Refer to the appendix for the pin layout of op-amp LM158.

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

   ![Figure 6 – Schematic Diagram of the 3-Band Gyrator-Based Equalizer with VU Meter](image)

   **Table 2 – Value of Components**

<table>
<thead>
<tr>
<th>Label</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>R1</td>
<td>1.5 kΩ</td>
</tr>
<tr>
<td>RF</td>
<td>120 kΩ</td>
</tr>
<tr>
<td>RL</td>
<td>330 Ω</td>
</tr>
<tr>
<td>CF1</td>
<td>560 nF</td>
</tr>
<tr>
<td>CF2</td>
<td>2.2 µF</td>
</tr>
<tr>
<td>CF3</td>
<td>150 nF</td>
</tr>
<tr>
<td>CL1</td>
<td>1.2 nF</td>
</tr>
<tr>
<td>CL2</td>
<td>4.5 nF</td>
</tr>
<tr>
<td>CL3</td>
<td>270 pF</td>
</tr>
</tbody>
</table>

4. Figure 6 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 6, 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.
5. Support and Warranty

5.1 Terms and Conditions

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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: ME3100 Analog Circuit Design Kit

As shown in Figure 7, 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 7 - ME3100 Analog Circuit Design Kit](image-url)
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**

<table>
<thead>
<tr>
<th>ME3100 – Analog Circuit Design Kit</th>
<th>Min</th>
<th>Typical</th>
<th>Max</th>
</tr>
</thead>
<tbody>
<tr>
<td>Input voltage supply (variable, 0 – 15 Vdc)</td>
<td>0 V</td>
<td>15.5 V</td>
<td></td>
</tr>
<tr>
<td>Input current supply</td>
<td>1.0 A</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Embedded Audio Player</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sampling rate</td>
<td>6 kHz</td>
<td>32 kHz</td>
<td></td>
</tr>
<tr>
<td>MicroSD memory slot capacity</td>
<td></td>
<td>4 GB</td>
<td></td>
</tr>
<tr>
<td>Voltage supply</td>
<td>2.7 V</td>
<td>3.6 V</td>
<td></td>
</tr>
<tr>
<td>Idle current</td>
<td>8 µA</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Built-in Speaker</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Frequency response</td>
<td>500 Hz</td>
<td>2000 Hz</td>
<td></td>
</tr>
<tr>
<td>Impedance</td>
<td>8 Ω</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Power rating</td>
<td></td>
<td>0.15 W</td>
<td></td>
</tr>
</tbody>
</table>
Appendix C: Pin Layout of LM158

Figure 8 – Pin Layout of LM158
Appendix D: 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 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 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.

![Diagram of DC Voltage Source](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 Agilent Measurement Manager (AMM) software for U2741A or via SCPI commands sent through the USB interface from your own application programs.

![Diagram of DC Current Source](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 Agilent U2761A USB Modular Function Generator

Front Panel of the Agilent U2761A USB Modular Function Generator

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-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 A-1 – Output Functions

<table>
<thead>
<tr>
<th></th>
<th>Sine</th>
<th>Square</th>
<th>Ramp</th>
<th>Triangle</th>
<th>Pulse</th>
<th>DC</th>
<th>Arbitrary</th>
</tr>
</thead>
<tbody>
<tr>
<td>AM, FM, PM, FSK, PSK, ASK Carrier</td>
<td>√</td>
<td>√</td>
<td>√</td>
<td>√</td>
<td>√</td>
<td></td>
<td>√</td>
</tr>
<tr>
<td>AM, FM, PM Internal Modulation</td>
<td>√</td>
<td>√</td>
<td>√</td>
<td>√</td>
<td></td>
<td></td>
<td>√</td>
</tr>
<tr>
<td>FSK, PSK, ASK Internal Modulation</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>√</td>
</tr>
<tr>
<td>Sweep Mode</td>
<td>√</td>
<td>√</td>
<td>√</td>
<td>√</td>
<td></td>
<td></td>
<td>√</td>
</tr>
</tbody>
</table>
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

<table>
<thead>
<tr>
<th>No.</th>
<th>Panel</th>
<th>Features</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Waveform Pattern Selection</td>
<td>Select various types of output function by clicking the buttons.</td>
</tr>
<tr>
<td>2</td>
<td>Waveform Parameters</td>
<td>Configure the function parameters (Frequency, Amplitude, and Offset)</td>
</tr>
<tr>
<td>3</td>
<td>Waveform Pattern Display</td>
<td>Display a graph representation of the output function</td>
</tr>
<tr>
<td>4</td>
<td>Modes of Waveform</td>
<td>Configure to modulation mode or sweep mode</td>
</tr>
<tr>
<td>5</td>
<td>Status Display</td>
<td>Display the parameters and status of the configured output waveform</td>
</tr>
<tr>
<td>6</td>
<td>Trigger &amp; Output Enable/Disable</td>
<td>Enable/disable the Trigger and Output buttons (they are highlighted when enabled and grey when disabled)</td>
</tr>
</tbody>
</table>
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>
<thead>
<tr>
<th>Function</th>
<th>Minimum Frequency</th>
<th>Maximum Frequency</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sine</td>
<td>1 µHz</td>
<td>20 MHz</td>
</tr>
<tr>
<td>Square</td>
<td>1 µHz</td>
<td>20 MHz</td>
</tr>
<tr>
<td>Ramp, Triangle</td>
<td>1 µHz</td>
<td>200 MHz</td>
</tr>
<tr>
<td>Pulse</td>
<td>500 µHz</td>
<td>5 MHz</td>
</tr>
<tr>
<td>DC</td>
<td>Not applicable</td>
<td>Not applicable</td>
</tr>
<tr>
<td>Arbitrary</td>
<td>1 µHz</td>
<td>200 kHz</td>
</tr>
<tr>
<td></td>
<td></td>
<td>2 MHz (U2761A Option 801)</td>
</tr>
</tbody>
</table>

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 adjust 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 Vpp 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 $\Omega$, 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

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 D-2 shows the general graphical user interface of the Agilent Modular Oscilloscope on the Agilent Measurement Manager.
Agilent Measurement Manager Soft Front Panel (Oscilloscope)

Figure D-39 – Soft Front Panel of the Oscilloscope

Figure D-39 shows the graphic user interface of Agilent Modular Oscilloscope under Agilent Measurement Manager together with the label of each panel. Table D-1 shows the features of each panel of the interface.

Table D-1 – Features of the AMM Oscilloscope Interface

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

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.

![Soft Front Panel of the Vertical System Control](image)

**Figure D-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.

![Channel Off Mode](image)

![Channel On Mode](image)

**Figure D-510 – 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.

![Channel Options](image)

**Figure D-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.
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-811.

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-912.

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 .
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 to activate the automated measurement and cursor system. This will display the window as shown below:

![Figure D-11 – Soft Front Panel of the Measurement and Cursor Controls](image)

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 .
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.
Contact Us

Acehub Vista Sdn Bhd (785702-P)
A member of the DreamCatcher group
10, Persiaran Mahsuri 1/2,
Sunway Tunas, Bayan Lepas,
11900 Penang, Malaysia.

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