Operation Manual

Option CWG – Rev 1.0 P/N 160938-10

CURRENT WAVEFORM GENERATOR OPTION

ADAPTIVE POWER SYSTEMS™

ADAPTIVE Power Systems

Worldwide Supplier of Power Equipment

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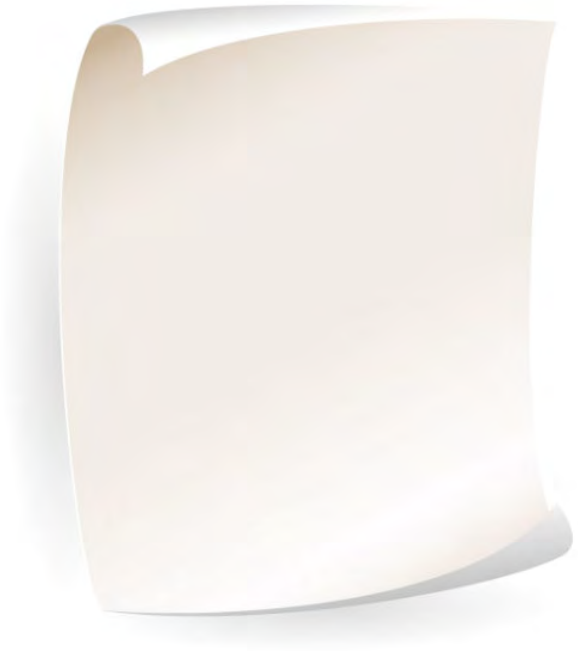

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1 Contact Information

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2 Front Matter

2.1 Limited Warranty

Adaptive Power Systems, Inc. (APS) warrants each unit to be free from defects in material and workmanship. For the period of one (1) year from the date of shipment to the purchaser, APS will either repair or replace, at its sole discretion, any unit returned to the APS factory in Irvine, California or one of its designated service facilities. It does not cover damage arising from misuse of the unit or attempted field modifications or repairs. This warranty specifically excludes damage to other equipment connected to this unit.

Upon notice from the purchaser within (30) days of shipment of units found to be defective in material or workmanship, APS will pay all shipping charges for the repair or replacement. If notice is received more than thirty (30) days from shipment, all shipping charges shall be paid by the purchaser. Units returned on debit memos will not be accepted and will be returned without repair.

This warranty is exclusive of all other warranties, expressed or implied.

2.2 Service and Spare Parts Limited Warranty

APS warrants repair work to be free from defects in material and workmanship for the period of ninety (90) days from the invoice date. This Service and Spare Parts Limited Warranty applies to replacement parts or to subassemblies only. All shipping and packaging charges are the sole responsibility of the buyer. APS will not accept debit memos for returned power sources or for subassemblies. Debit memos will cause return of power sources or assemblies without repair.

This warranty is exclusive of all other warranties, expressed or implied.

2.3 Safety Information

This chapter contains important information you should read BEFORE attempting to install and power-up APS Equipment. The information in this chapter is provided for use by experienced operators. Experienced operators understand the necessity of becoming familiar with, and then observing, life-critical safety and installation issues. Topics in this chapter include:

- Safety Notices
- Warnings
- Cautions
- Preparation for Installation
- Installation Instructions

Make sure to familiarize yourself with the **SAFETY SYMBOLS** shown on the next page. These symbols are used throughout this manual and relate to important safety information and issues affecting the end user or operator.

SAFETY SYMBOLS

Direct current (DC)

Alternating current (AC)

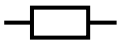
Both direct and alternating current

Three-phase alternating current

Protective Earth (ground) terminal

On (Supply)

Off (Supply)



Fuse

Caution: Refer to this manual before this Product.

Caution, risk of electric shock

2.4 Safety Notices

SAFETY SUMMARY

The following general safety precautions must be observed during all phases of operation, service, and repair of this instrument. Failure to comply with these precautions or with specific warnings elsewhere in this manual violates safety standards of design, manufacture, and intended use of the instrument. Adaptive Power Systems assumes no liability for the customer's failure to comply with these requirements.

GENERAL

This product is a Safety Class 1 instrument (provided with a protective earth terminal). The protective features of this product may be impaired if it is used in a manner not specified in the operation instructions.

ENVIRONMENTAL CONDITIONS

This instrument is intended for indoor use in an installation category I, pollution degree 2 environments. It is designed to operate at a maximum relative humidity of 80% and at altitudes of up to 2000 meters. Refer to the specifications tables for the ac mains voltage requirements and ambient operating temperature range.

BEFORE APPLYING POWER

Verify that the product is set to match the available line voltage and the correct fuse is installed.

GROUND THE INSTRUMENT

This product is a Safety Class 1 instrument (provided with a protective earth terminal). To minimize shock hazard, the instrument chassis and cabinet must be connected to an electrical ground. The instrument must be connected to the AC power supply mains through a properly rated three-conductor power cable, with the third wire firmly connected to an electrical ground (safety ground) at the power outlet. Any interruption of the protective (grounding) conductor or disconnection of the protective earth terminal will cause a potential shock hazard that could result in personal injury.

FUSES

Only fuses with the required rated current, voltage, and specified type (normal blow, time delay, etc.) should be used. Do not use repaired Fuses or short circuit the fuse holder. To do so could cause a shock or fire hazard.

DO NOT OPERATE IN AN EXPLOSIVE ATMOSPHERE.

Do not operate the instrument in the presence of flammable gases or fumes.

KEEP AWAY FROM LIVE CIRCUITS.

Operating personnel must not remove instrument covers. Component replacement and internal adjustments must be made by qualified service personnel. Do not replace components with power cable connected. Under certain conditions, dangerous voltages may exist even with the power cable removed. To avoid injuries, always disconnect power, discharge circuits and remove external voltage sources before touching components.

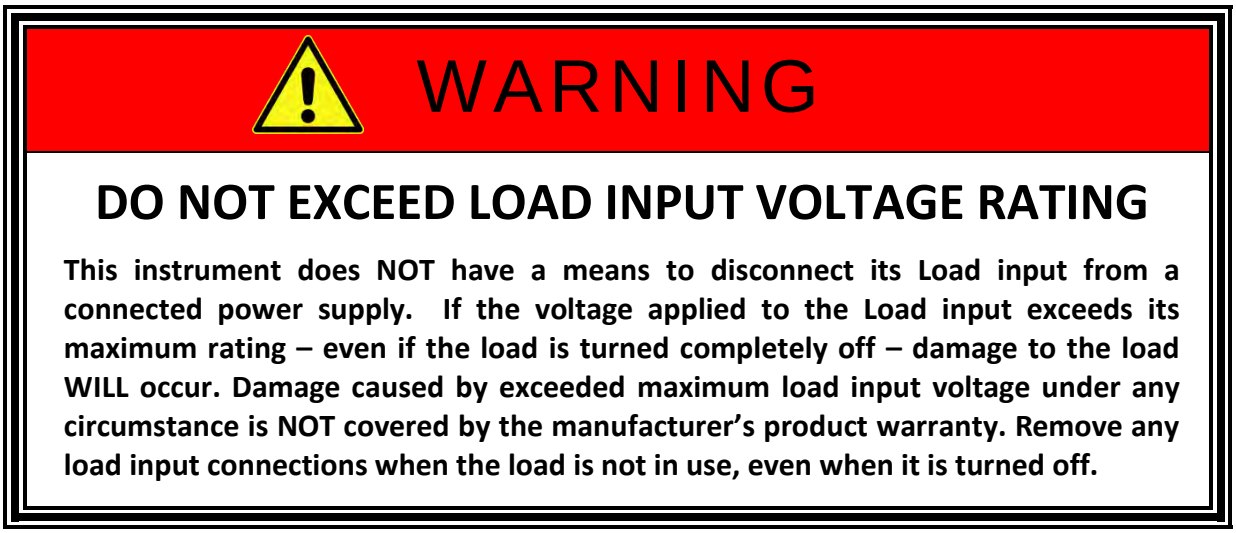
DO NOT SERVICE OR ADJUST ALONE.

Do not attempt internal service or adjustment unless another person, capable of rendering first aid and resuscitation, is present.

DO NOT EXCEED INPUT RATINGS.

This instrument may be equipped with a line filter to reduce electromagnetic interference and must be connected to a properly grounded receptacle to minimize electric shock hazard. Operation at line voltages or frequencies in excess of those stated on the data plate may cause leakage currents in excess of 5.0 mA peak.

DO NOT EXCEED LOAD INPUT VOLTAGE RATING.



DO NOT SUBSTITUTE PARTS OR MODIFY INSTRUMENT.

Because of the danger of introducing additional hazards, do not install substitute parts or perform any unauthorized modification to the instrument. Return the instrument to an Adaptive Power Systems Sales and Service Office for service and repair to ensure that safety features are maintained.

Instruments that appear damaged or defective should be made inoperative and secured against unintended operation until they can be repaired by qualified service personnel.

3 Product Overview

3.1 General Description

The DC load current waveform generator option is designed to simulate the actual discharge current waveforms that occur when discharging batteries. The use of batteries to power a multitude of portable devices such as mobile phones, tablets, laptops, etc. as well as mobility products like electric bicycles, scooters and cars has become widespread.

During actual operation in these applications, the battery output current changes dynamically with the operation of the product. In order to assess battery life, capacity and any time related characteristics that may occur during use, it is important to test the batteries using actual battery load current waveforms under both general and worst case conditions.

To implement these irregular load current waveforms on an electronic DC load, there are two methods that can be used:

The first method relies on the use of a digital storage oscilloscope and a current measuring device such as a current probe or shunt to capture the actual battery discharge current waveform under real world conditions. Once captured, the next step is to take this waveform data and transfer it to an arbitrary waveform generator.

1. Use the arbitrary waveform generator to edit the load current waveforms manually as needed.
2. The output of the arbitrary waveform generator is then sent to the analog input of the DC load.

The more convenient method is to use the CWG load current generator which can be installed on a wide range of Adaptive Power Systems DC electronic loads. The generator output is connected to the DC load's analog input using the provided BNC cable and eliminates the need for a separate arbitrary generator. Use either manual waveform data editing or import and oscilloscope waveform to generate simulated load current waveform on the DC load.

PC application software is provided with the CWG option to allow waveform editing, oscilloscope waveform download and other programming functions.

3.2 Applications

The CWG output is connected to the ANALOG INPUT terminal of the electronic load to generate the load current waveform sink current. The sink current example as shown in Figure below has an output of 10V which is equal to the maximum current value of the electronic load. A 5V output is equal to 1/2 the maximum rated current of electronic load, etc.

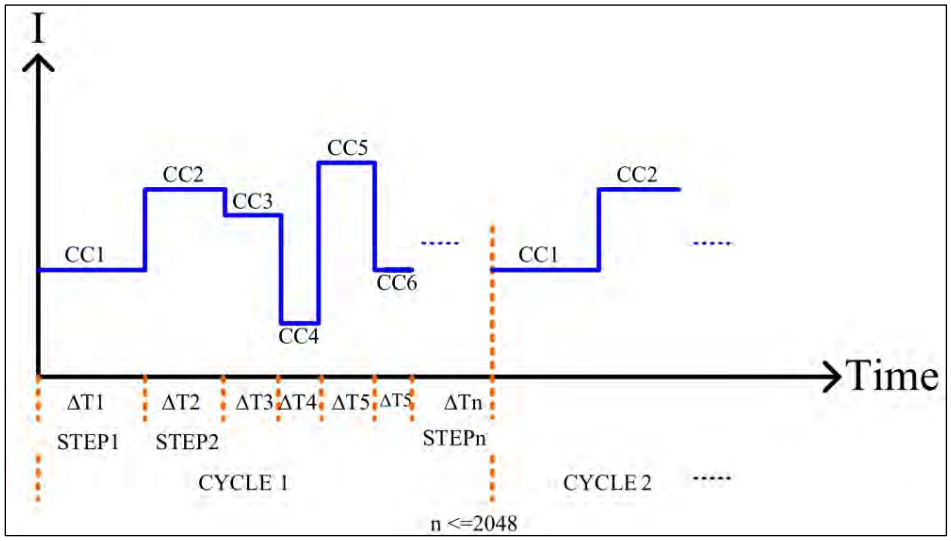


Figure 3-1: Application Example

3.3 Product Features

The following key characteristics apply to the CWG Option:

- Adds Current Waveform Programming to APS Electronic DC Loads
- Eliminates the need for an Arbitrary Function Generator
- 2048 Waveform Data Points for High Resolution Wave shapes
- Visual Strip Chart display of all Load Measurements
- Waveform Editor Windows Software included
- Capture Current waveform on DSO and transfer to DC load
- Compatible with 4-Series, 5-Series and 5VP-Series DC load families
- Includes RS232 Serial Control Interface

3.4 Compatible APS DC Load Models

The CWG option is compatible with the APS DC Load model series shown in the table below.

Model Series	Description
4 Series	Compatible with single channel 41Lxxx load modules. Option installs in 44M01, 44M02 or 44M04 Mainframe. Interface is RS232
5L, 5V, 5P Series	DC Loads. Interface is RS232
5VP Series	High Power DC Loads. Interface is RS232

Table 3-1: Compatible DC Load Models

3.5 Accessories Included

No accessories are included with this option.

3.6 Interface

The CWG Option includes a RS232 interface using a DB9 connector. Refer to the relevant DC Load Operation Manual for the load in which the CWG Option is installed for details on using the RS232 interface.

4 Technical Specifications

Technical specifications shown here apply at an ambient temperature of 25° C ± 5°. For all other specifications, refer to the relevant DC Load Operation Manual in which the CWG Option is installed.

Parameter	Specification			
Amplitude	Range: 0 ~ 10V for 0 ~ full scale Load Current Resolution: 16 bits Accuracy: ± 0.05% (setting + range)			
Arbitrary Waveform	1 ~ 2048 Data points (steps)			
No. Outputs	3 (duplicate Analog outputs)			
Time Scale				
Range:	0	1	2	3
	50us~650ms	1 ms~6500ms	1s~6500s	10s~130ks
Resolution:	10us	0.1ms	0.1s	2s
Accuracy:	±15us	±0.15ms	±0.15s	±0.5s
Repeat Count	1 ~ 9999			
Interface	RS232 Serial			

Table 4-1: Technical Specifications

5 Unpacking and Installation

5.1 Inspection

The CWG option boards are carefully inspected before shipment. If damage has occurred during transport, please inform Adaptive Power Systems' nearest sales and service office or representative.

5.2 Option Installation and Removal in Mainframe

The CWG Option must be installed in a suitable 44M0X mainframe or 5 Series DC Load chassis to be used. The mainframe or mainframe provides all required bias supply voltages for the option board.

If ordered at the same time as a 44M0X mainframe or DC Load, the option will be shipped already installed from the factory. If this option requires installation or removal in the field, the end user can perform this task easily using the steps below.

CAUTION

The CWG Option is not hot-swappable! Always turn OFF and disconnect the mains power to the 44M0X mainframe or DC Load before installing or removing a load module.

5.2.1 Option Removal

1. First, ensure AC power to the 44M0X mainframe is switched **OFF and disconnected**. Failure to do so may result in damage to the load. The option is NOT hot-swappable.
2. Loosen and completely remove the two Phillips screws that hold the cover plate on the rear in place or remove any interface option that is installed on the load to make room for the CWG option board.
3. Once the screws and cover are removed, the CWG board can be pushed into the board guides and mated with the internal connector.
4. Replace the two Phillips screws to secure the board in place.

Refer to Figure 5-3 on next page for an illustration.

Figure 5-1: CWG Option Installation

5.3 In Case of Malfunction

In the unlikely event of an instrument malfunction or if the instrument does not turn on despite the presence of the correct AC line voltage, please attach a warning tag to the instrument to identify the owner and indicate that service or repair is required. Contact Adaptive Power Systems or its authorized representative to arrange for service.

5.4 Analog Output Connections

The outputs of the CWG board must be connected to the analog input or inputs of the DC load at the rear panel.

For 41L Series modular loads, all four loads in a 44M04 mainframe can receive the same analog input from the CWG option. There are three analog output terminals on the rear of the CWG board. If a fourth load input needs to be connected, the user can use two pair of wires on one of the analog output connector pairs.

For use with a 44M02 Dual or 44M01 Single load module mainframe, there are sufficient analog output terminal posts available to connect all installed loads as needed.

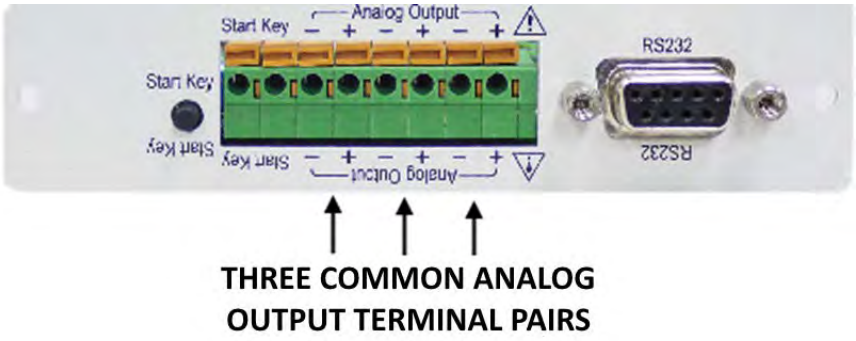


Figure 5-2: Analog Output Connector on CWG Option

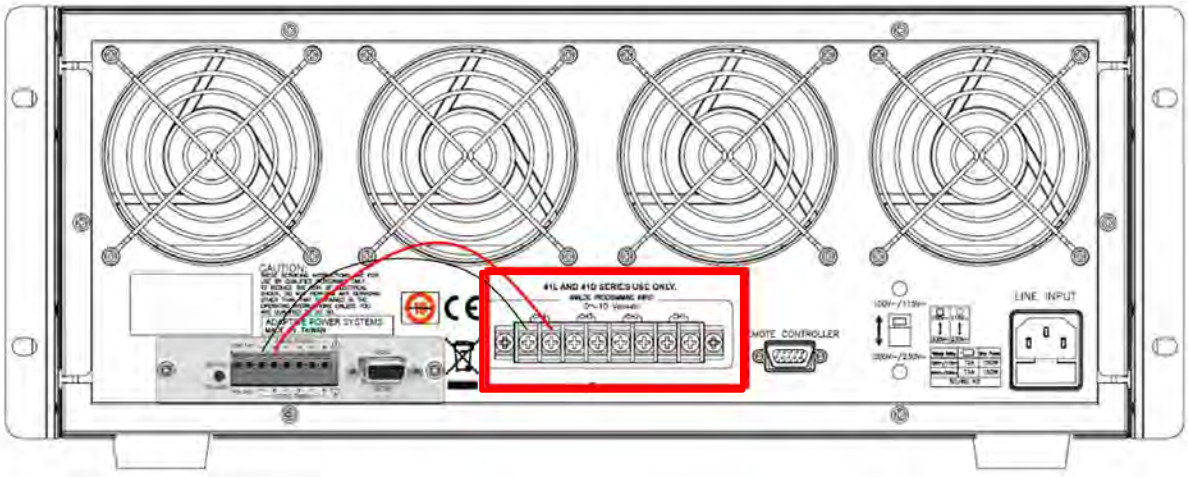


Figure 5-3: Location and Pin-out of Analog Programming Input Connector

5.5 Parallel Load Operation

The CWG can be used to parallel multiple DC loads if needed. Since the current waveform generator uses the Analog Input of the DC load to control the load current, when the load power or load current is insufficient, higher load power and current can be achieved through the parallel control.

The user can directly connected to up to three electronic loads Analog inputs through the CWG rear panel triple sets of Analog outputs.

In the case of more than three loads in parallel, the user may use a T-type BNC connector or wire and output connector directly in parallel.

Keep in mind that when using parallel loads, the voltage level settings used in the Current Waveform Generator Application Software will result in current multiplication by the number of DC loads used in parallel.

For example, when 3 sets of 41L0660, 60V / 60A / 300W load modules are required to test 120A, each 41L0660 must allocate 40A current Analog input. To obtain the correct total current, 40A per load is required or 6A / V, 40/6 = 6.66V setting. The CWG application software voltage must be set to 6.66V for 120A total.

The required connection for three loads is shown below.

Figure 5-4: Parallel Load Mode Connection

6 Front Panel Operation

The CWG option is controlled manually using the Start Key or “Start” input contact closure on the CWG Analog output connector. Programming can be done with the included Windows software using the RS232 interface.

There is no front panel on the CWG option.

7 Software Operation

7.1 Overview

The included Windows Waveform Editor software provides a convenient means to create, capture, file, organize and download waveforms to the DC load.

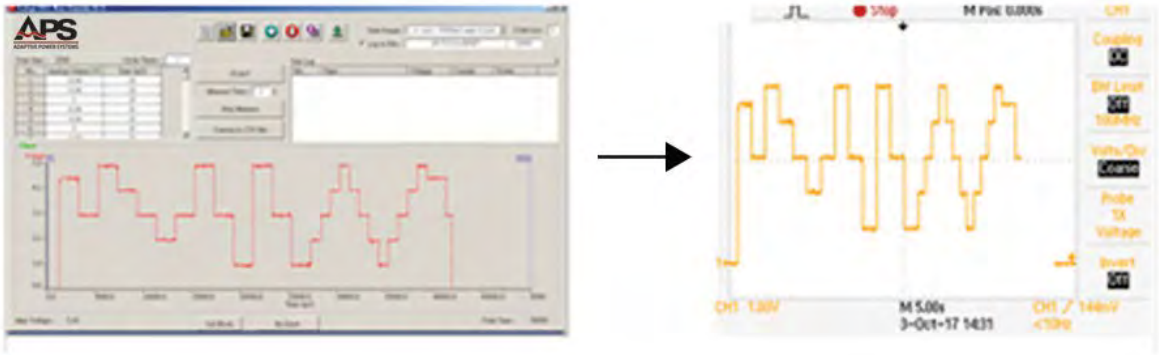


Figure 7-1: CWG Option Windows Software

7.2 Waveform Editing

The Current Waveform Generator Application Software can be used to edit current waveforms allowing load current application to simulate a wide variety of real load conditions to the power supply under test. Each waveform sequence can have up to 2048 individual amplitude steps. The timing for each step can be edited individually as needed.

The waveform timing sequence can be repeated (cycled) up to 9999 times. The minimum time for each timing step is 50us and the maximum supported duration is about 130000 seconds or about 36 hours.

Using the electronic load's measurement function, the software can also monitor the voltage, current and power status while sinking current waveforms.

7.3 Waveform Capture Mode

In addition to self-editing the required sink current waveform, the user can also use a digital storage oscilloscope to capture an actual current waveform. A captured waveform must first be exported as a comma separated value file format (*.CSV).

The CWG application software can read this current waveform file (*. CSV) and download it to the Waveform Generator for electronic load simulation use.

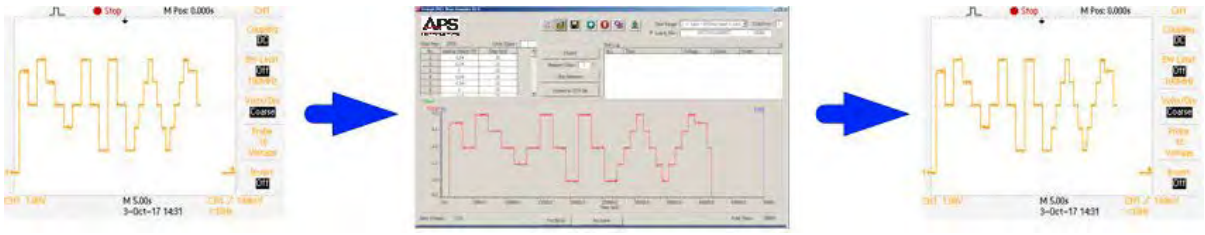


Figure 7-2: Actual Current Waveform Capture, Import, and Download

7.4 Typical Applications

Some typical application of the CWG option are:

1. Battery discharge simulation application for notebook computers, electric vehicles, electric scooters, etc. By using a range of dynamic load sink current waveform profiles, life cycle performance of the battery can be evaluated.
2. Simulation of voltage regulation performance for power supplies using dynamic load modulation.
3. Load simulation for fuel cell life cycle testing.

7.5 Software Use

7.5.1 Waveform Editing

Direct creation of waveforms using edit mode.

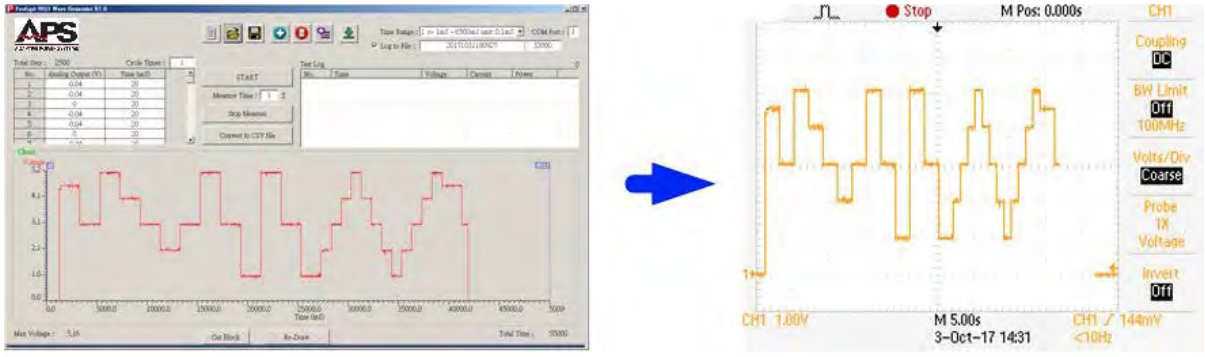


Figure 7-3: Waveform Edit Window (left) and Reproduction captured on scope (right)

7.5.2 Time Scale Programming

The Time Range setting determines the timing resolution of each step or data point. Here are four ranges that can be selected, 0 through 3, each with a different resolution. The are:

Range:	0	1	2	3
	50us~650ms	1 ms~6500ms	1s~6500s	10s~130ks
Resolution:	10us	0.1ms	0.1s	2s
Accuracy:	±15us	±0.15ms	±0.15s	±0.5s

The Time Range control is located in the upper right hand corner of the Main window as indicated below. The selected resolution applies to all steps of the waveform.

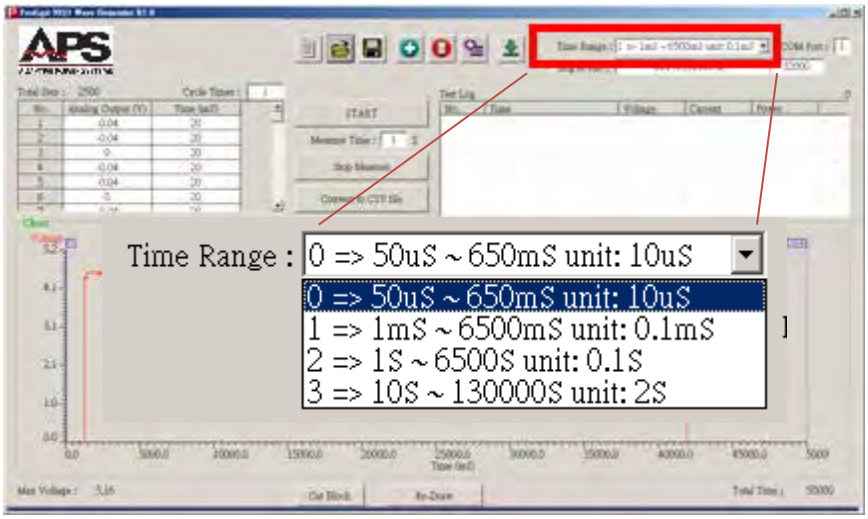


Figure 7-4: Time Range Control location

7.5.3 File Management

Saved waveform files can be retrieved from disk using the file controls on the upper left hand side of the Main window.

Creates a new file.

Opens an existing waveform step file or captured .csv file. Once opened, the data can be downloaded to the CWG board for subsequent use.

Saves an newly created or modified (Edited) waveform step file to disk.

7.5.4 Waveform Edit Controls

The following waveform edit controls are available for use. These controls are located in the top center of the Main Window as shown below.

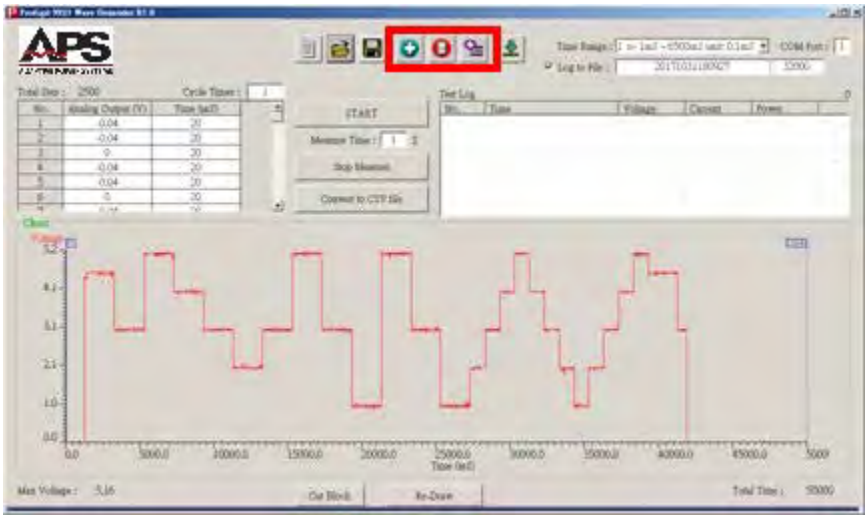


Figure 7-5: Step Editing Controls locations

Add Step. Adds a test step at the end of the sequence. An error message will be display if a step number higher than 2048 is reached.

Adding a new step will prompt the user to enter an amplitude and time value for the new step. This dialog box is shown below. Amplitude values must be between -10V and +10V. The time value that can be entered is determined by the selected Time Range which is shown for reference in the dialog box.

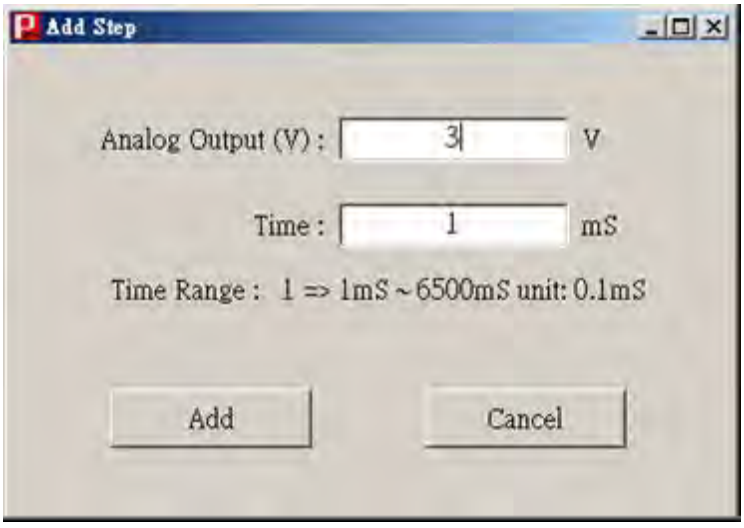


Figure 7-6: Add Step User Data Entry Dialog Box

Press Add to confirm the addition of this new step. Press Cancel to abort addition of new step.

Deletes the currently selected step from the sequence.

Insert Step. Inserts a new step at the current position in the sequence. An error message will be display if this results in more than 2048 steps.

The same step data entry dialog will appear as described under “Add Step” earlier.

7.5.5 Cycle Time

The cycle time determines how often the waveform is repeated. Available range is from 1 through 9999. This value is entered directly above the display step sequence table on the left hand side of the main window as shown below.

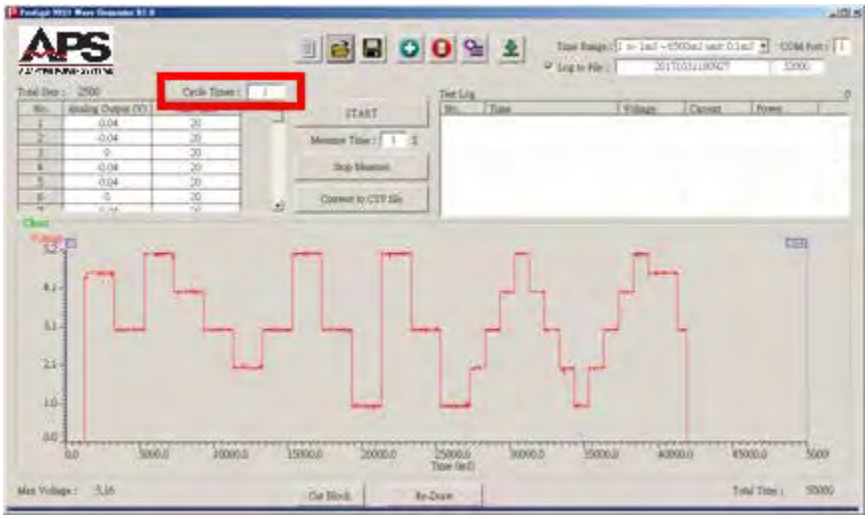


Figure 7-7: Cycle Time Control location

7.5.6 Test Step List Table

The table on the left show the voltage and time setting for each step point. The list can be scrolled up or down as needed. A graphical representation of the step data is shown in the lower half of the main window.

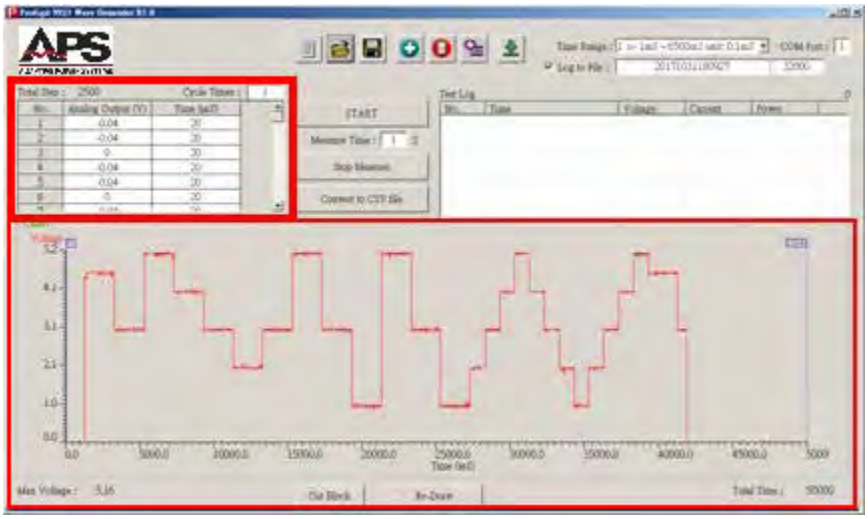


Figure 7-8: Step List Table and Preview window locations

To edit any data point, use the following method:

1 Double-click to edit the column, press [Enter] to set. Without pressing the [Enter] key, no changes will be made.

2 When the changes are made, the timing diagram will update and the next step point will automatically be selected for editing.

3 When the [Enter] key is pressed while in the last step, the program will automatically go to the next available channel to allow changes there.

7.5.7 Downloading Waveform Data

The waveform download button is located on the top middle directly to the right of the Step edit controls as shown below.

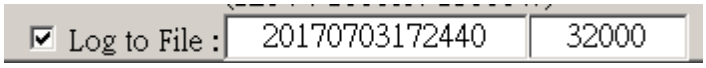
Figure 7-9: Waveform Download Control location

Download waveform data to CWG control board.

Note: To download a waveform, the RS232 interface must be set up correctly and the DC load must be connected to the PC.

7.5.8 Data Logging

Data logging is available while the program is connected to the DC load. Data logging is enabled by checking the check box located in the upper right corner of the main window.



Checking the "Log to File" checkbox will automatically generate a date and time based serial number YYYYMMDDhhmmss. The user can edit the number if needed. This field will be used to create a log to file name and will be followed by 0001 count number.

The test log file will be stored in the TestLog folder.

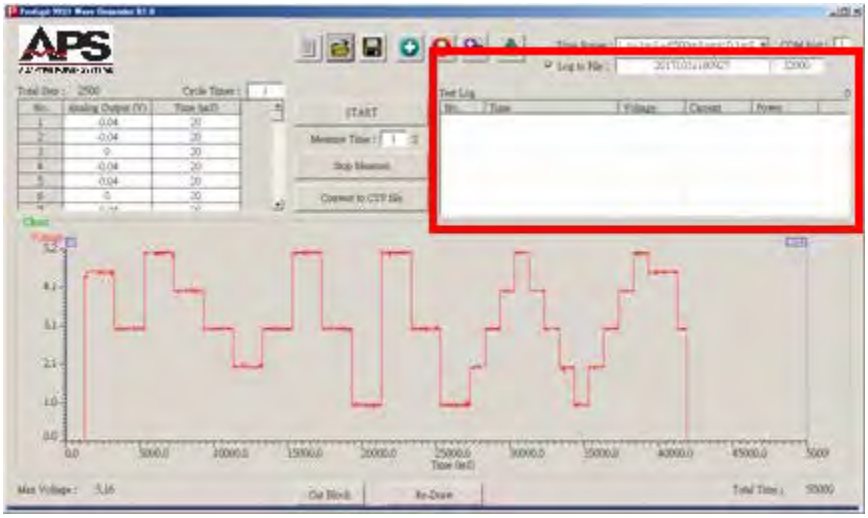


Figure 7-10: Data Logging Window location

7.6 Starting a Test

Once data is downloaded to the CWG, a test can be started using the START button located in the upper center as shown below.

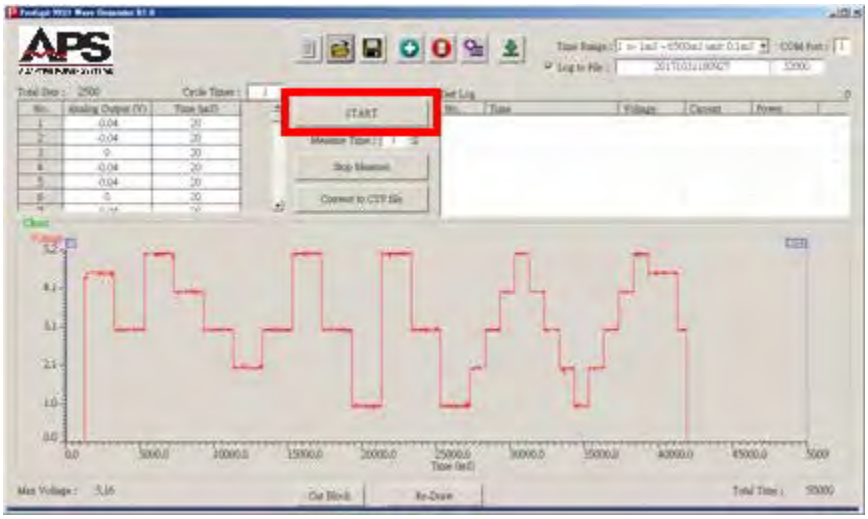


Figure 7-11: Start Button location

7.6.1 Start

To Start a test, the PC must be connected to the Load with the CWG option. The program will try to detect the load at the COM port number set in the upper right corner of the main window.

If the program does not detect the CWG card or the Load has already been started and has not restarted yet, the program will prompt an alert message

[Please check CWG card is in Load, and restart the Load.]

Press “OK” to exit the start function.

7.6.2 Waveform Data Mismatch

The next step will be to compare the test steps, the CWG software will not download to the waveform memory of the CWG card if the test steps are not the same. Instead, the program will prompt the user whether to download the new waveform data to the CWG.

The system will prompt a message:

[Data mismatch. Do you want to download to LOAD?]

Click “OK” to download new data and start the test or click on “Cancel”.

7.6.3 Measurement Logging

If a Measurement log Time greater than 0 is set, the program will measure voltage, current, power and other information according to the time interval set and record this data in the Test Log.

7.6.4 Stop Test

A test will run till the total time determined by the test sequence duration and cycle count has expired.

7.6.5 Stop Data Logging

To stop logging measurement data, click on the “Stop Measure” button located in the middle of the main window.

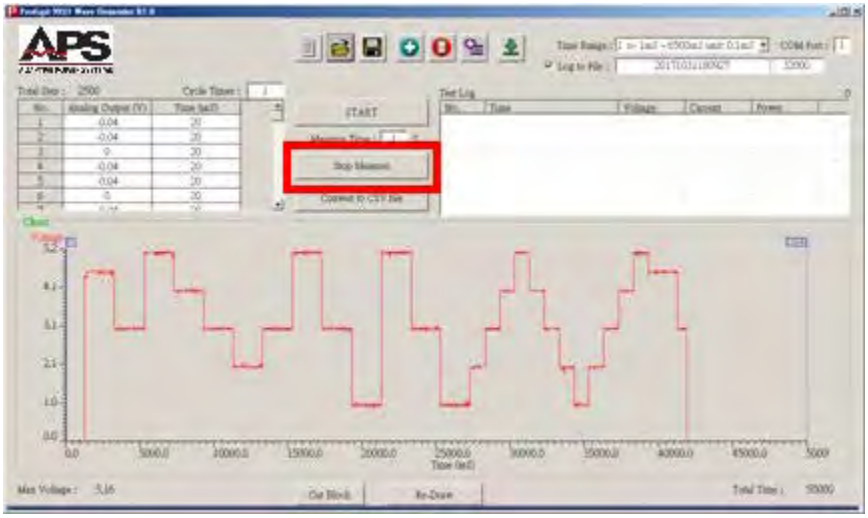
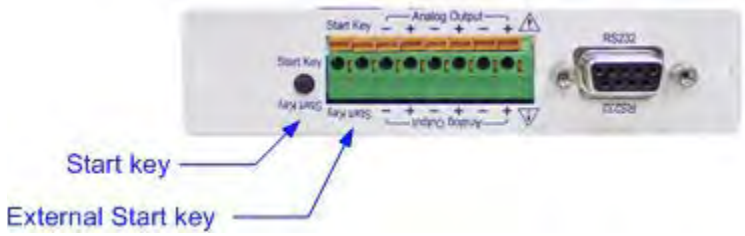


Figure 7-12: Stop Measure Button location

7.7 Stand-Alone Operation (No PC)

The CWG option may be used stand-alone, with a PC connected to the load. In this mode, there is no available measurement data logging of course. However, load patterns can be run by using either the manual start button on the back of the CWG option plug-in or remotely started by using a contact closure on the External Start terminal pins.

Of course this requires that user waveform data was downloaded to the CWG's nonvolatile waveform memory earlier.



Analog output will begin to load according to the programmed voltage level and the analog input of the timing output voltage signal to the electronic load.

8 Calibration

8.1 Overview

All APS products ship with factory calibration. No additional calibration is required when first received.

8.2 Calibration Interval

There are no calibration coefficients associated with the CWG option.

9 RoHS Material Content Declaration

The table below shows where these substances may be found in the supply chain of APS's products, as of the date of sale of the relevant product. Note that some of the component types listed above may or may not be a part of the enclosed product.

Part Name	Hazardous Substance					
	Pb	*Hg*	*Cd*	*Cr6+*	*PBB*	*PBDE*
PCB Assy's	**x**	**0**	**x**	**0**	**0**	**0**
Electrical Parts not on PCB Assy's	**x**	**0**	**x**	**0**	**0**	**0**
Metal Parts	**0**	**0**	**0**	**x**	**0**	**0**
Plastic Parts	**0**	**0**	**0**	**0**	**x**	**x**
Wiring	**x**	**0**	**0**	**0**	**0**	**0**
Packaging	**x**	**0**	**0**	**0**	**0**	**0**

Legend:

0: Indicates that the concentration of the hazardous substance in all homogeneous materials in the parts is below the relevant RoHS threshold.

x: Indicates that the concentration of the hazardous substance of at least one of all homogeneous materials in the parts is above the relevant RoHS threshold.

Notes:

1. APS has not fully transitioned to lead-free solder assembly at this point in time. However, the vast majority of components used in production are RoHS compliant.
2. These APS products are labeled with an environmental-friendly usage period in years. The marked period is assumed under the operating environment specified in the product specifications.

Example of marking for a 10 year period.

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