Arbin Instruments

MitsPro8.0

User's Manual

Version: 8.0, Rev. 7; May. 2020

About This Manual

Welcome to the MITS Pro 8.0 User Manual. This manual will introduce you to Arbin's MITS Pro 8.0 software and will provide the basic procedures to begin your testing and research. This manual will teach you the basic features of MITS Pro 8.0, including the user interface, an introduction to the hardware, and data analysis tools provided by Arbin. Designed to inform users of the fundamentals quickly and easily, this manual provides step-by-step procedures to start using the most powerful testing suite available on the market.

This manual will provide extensive support on using our MITS Pro 8.0 software. If at any time you have questions regarding your test station or software, please feel free to contact Arbin directly at:

Telephone: (979) 690-2751
Fax: (979) 690-2761
Email: support@arbin.com
Website: www.arbin.com

Arbin Instruments MITS Pro8.0 software is already installed in the controlling computer if user bought it from Arbin. **The MITS Pro 8.0 requires registration**. Arbin provides a trial period for customers to use the software. However, after the trial period, the software will stop running and all running tests will stop. Before the trial period expires, please register MITS Pro8.0 using the registration key provided by Arbin. To release the registration key is related to the balance of payment. Please contact Arbin Customer Service for the registration key.

Registration key: ____________________________

Updated: February 2020

General Safety Information

Use the following safety guidelines to help ensure your own personal safety and to help protect your equipment and working environment from potential damage.

Please refer to the manual in all cases where symbol ⚠ is marked, in order to find out the nature of the potential HAZARDS and any actions where must be taken to avoid them.

⚠**Warning:** Do not operate the Arbin Machine outside of its published voltage and current specifications. Refer to the SN production record or the label on the chassis for this information**.**

⚠**Warning**: Do not expose to moisture, liquid, heat, or corrosive vapor. Do not use a power cord that is under rated for the Arbin chassis. To prevent shock, connect the power cord to an electrical outlet with appropriate facility grounding**.**

⚠**Warning:** If the Arbin is operated outside of its specified voltage and/or current ranges, the protection circuits for the device under test and the Arbin chassis may be impaired.

⚠**Warning**: It is the responsibility of the end user to perform the appropriate tests for the specific device under test and to be fully aware of any characteristic and possible hazards (fire, explosion, burns, electrolyte exposure, etc.) the device under test may pose.

⚠**Warning:** Do not operate your equipment with any cover(s) (including computer covers, bezels, filler brackets, front-panel inserts, etc.) removed.

⚠**Warning:** For safety reasons only use Arbin approved accessories.

⚠**Warning:** Do not replace the main chassis power cord with an inadequately rated power cord. To prevent electrical hazard, connect the instrument to an electrical outlet using a three-prong socket for proper grounding.

⚠**Warning:** Fans mounted to the front of the Arbin unit pull air into the chassis. Loose clothing or objects can be pulled into the fan assembly**.**

: For systems weighing more than 18kg and less than 35kg, please use two persons lift.

Chapter 1 Getting Started with Arbin Testing System

Thanks for allowing Arbin to provide you with your testing system. By choosing Arbin, you have chosen the most advanced circuit designs and software functionality available on the market, which will provide superior test performance and allow wide ranging flexibility in the configuration of your test schedules.

Arbin Instruments designs test stations for specific applications utilizing some or all of the control types listed in Appendix A. Please see the production record for your specific serial number to see the available control types and voltage/current specifications.

Each Arbin system has been fully tested, calibrated and operated under a full-load burn-in at the factory. However, since equipment sometimes experiences rough handling during shipping, please take a few minutes to go through the check out procedures shown below to ensure that this system is ready to use. If you experience any difficulties during the set-up or operation of the system, please contact:

Arbin Customer Service
762 Peach Creek Cut Off Rd.
College Station, Texas 77845
Tel: (979) 690-2751
Fax: (979) 690-2761
Support@arbin.com

1.1 Pre-start Checklist

Receiving the System

Please make the following inspections before turning on the machine. **(Note: be sure that the power cord of the test stand is not plugged in while the inspections are performed.)**

1. Inspect all packages for external damage before opening. In case of visible damage or indications from the alerts on the packaging, report the problem to the shipping company immediately.

2. Confirm that all of the board/module thumbscrews are tightened securely to the front of the chassis.

3. Ensure that the panel-mounted Ethernet connector on the front of the test stand (if unit is so equipped) is fastened securely to the front panel.

4. Examine the major components in the test stand cabinet for visible signs of shipping damage.

This check should reveal the following conditions:

a. Exterior of the test stand and computer equipment should have no visible damage.

b. No loose parts should be visible or heard from inside the test station chassis or PC.

c. Circuit boards should be vertical or horizontal. A tilted orientation indicates that the system was severely dropped or abused during shipping and that the circuit board mounting assembly or rails have failed.

d. Check the security of the connection of each circuit board to the backplane to ensure good contact for electrical and communication signals.

Assembling the System

Perform the following to get the system ready for use.

1. Connect the computer components together. These articles include the computer, monitor, keyboard, mouse, speaker and UPS (where supplied).

   Note for UPS: **under no circumstance should the user install any other UPS management software**. MITS Pro 8.0 contains its own power failure trigger. The presence of any other utility compromises the system's ability to detect failures and respond appropriately with shutdown or test resumption. Please refer Appendix J: UPS feature.

   Connect an Ethernet cable (TCP/IP) from the computer to the front of the Arbin Testing System (Figure 1-1).

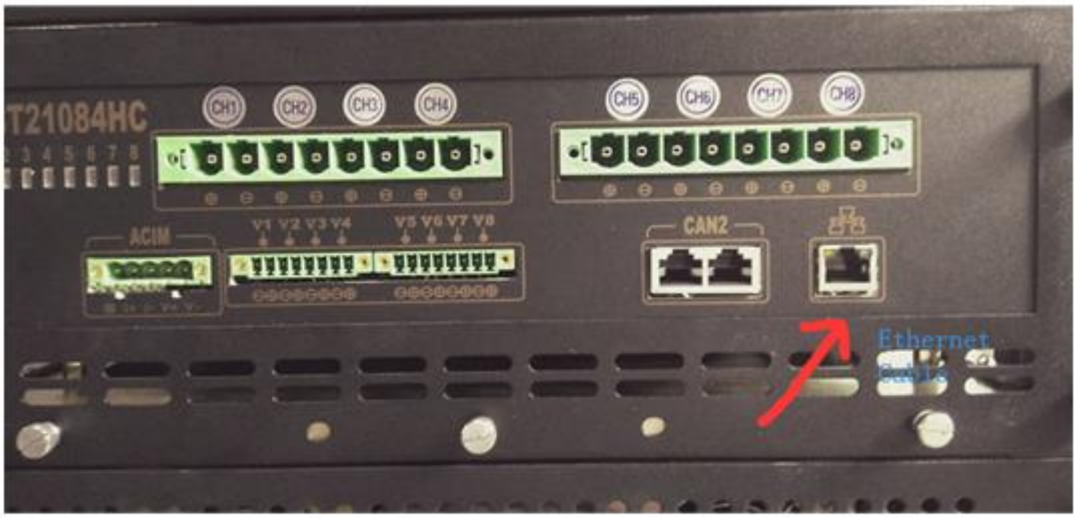


Figure 1-1 Communication Connection on the Front Panel

2. Refer to Chapter 10 for the specific hardware platform being used for detailed instructions on different ways to configure the cell cables.

3. Machine Specs

Being aware of IV Channel Spec, Aux Channel Spec, Additional Function Spec and Power Spec of the test stand is extremely important. These ratings are listed in the labels on the front or rear of the test stand. Following this sheet is a standard blank format for machine specs. A fully filled one is attached at beginning of manual which indicates the specs of this machine**.**

CUSTOMER ORDER SPECIFICATION SHEET

The following are the specifications of the Arbin unit being built. Please plan accordingly to prepare for the arrival of the unit.

CUSTOMER:		**Circuitry:** ☐ BIPOLAR ☐ PWM
System Serial No.:		
Model:		
Est. Delivery Date:		

Current & Voltage Channel Specifications

CH No.	IH Range	IM Range	IL Range	V Range H/L	Max. Power

Auxiliary Channel & Additional Function Specifications

CH No.	Second Voltage	Temperature	Pressure	High Speed Pulse	ACIM	Others

Chassis Dimensions:	W x L x H: (Inch)	

Power Requirements:

Single-Phase: (V)		Max. Power: (VA)		Frequency: (Hz)
Three-Phase: (V)		Max. Power: (VA)		

Power Socket Requirements:	Refer to specification Sheet attached.

Notes:

	For 3-phase Y-connected power supply, please ensure the following Voltages :
	V_{Phase} - V_{Ground} = 110V (for all three phases)
	*V_{phase} - V_{phase} = 208 V (for all three phases)

*The unit can also be configured to run at 208V three-phase if your facility requires that configuration. Please let us know immediately if that is your requirement.

1.2 Start-up

Initialization of Arbin Machine with MITS Pro-equipped Computer

Warning!! Windows® 10 and MITS Pro 8.0 software have been installed and configured on your computer before shipping. Do not re-install any Microsoft or Arbin software without instruction from Arbin customer service.

1. Connect the Arbin cabinet and the computer to the appropriate power source. Note that the cabinet and computer may have different supply voltage ratings (220V or 208V vs. 110V).
2. Next, as shown in Figure 1-1**,** connect an Ethernet cable between the computer and the cabinet. If a different connection scheme is required, it will be supplied.
3. Switch "on" the cabinet and then the computer, entering the user name "Arbin" and the password "arbin" to access the Windows® desktop. Or contact Arbin Customer Service for the appropriate password.
4. Open the desktop program icon "console.exe",  by double-clicking. The opening page of MITS Pro8.0 will be displayed on the screen. The User Login interface will be shown on top of **MITS Pro**. There are three kinds of users with different authoritys to access **MITS Pro**. See Chapter 4 User Permission.
5. Click the 'Launch' button . Wait until the message "Cluster 1(ID xxxx; Start Time (null)) is connected." is shown on the 'Hint' pane at the bottom of the **Monitor & Control Window**. The "DAQ.exe"  utility will open and minimize automatically on the task bar at the bottom of the screen. Note: Arbin recommends that DAQ window be minimized at all times during channel operation. Accidental closing of DAQ window will terminate channel operation.

Start-up Diagnostic

Arbin Instruments recommends that each new installation begin with a diagnostic check to validate the new system's performance prior to analyzing any proprietary or non-standard samples. This check requires either a resistor for research instruments with bipolar current and power ratings or a battery for systems designed for studying and characterizing specific devices. Each type of test object-resistor or cell will be tested by a special diagnostic schedule found in the "QC" directory of the hard drive where MITS Pro8.0 resides (C:\ArbinSoftware\QC-xxxxxx, serial number, typically).

If a resistor of appropriate load value is available, then connect it to one of the physical channels on the chassis. If several such resistors are available, then distribute them among the different chassis, modules, and units. The appropriate test schedule is "AB-FUNSC.sdx."

Arbin custom designs test equipment ranging in power from less than one watt up to hundreds of kilowatts. In order to design these systems, Arbin uses a variety of different types of circuitry. Your Arbin test station was tested with a variety of schedules at the factory. These schedules and their generated results were provided to you on the PC provided by Arbin as well as the CD at the front of this manual. Also provided is a document with a description of the device(s) used to conduct the specific test for your Arbin. To conduct your own performance test, you can use this information to duplicate our test conditions. You can then compare your data to the Arbin generated data to ensure proper functionality.

Over time, this folder may have been deleted or the PC may have been replaced. The same files and information are on a CD that was provided along with the backup copy of MITS Pro8.0 software. The quality control, QC, data is located on a CD that typically has a white label with the specific machines serial number typed on it.

If you cannot find this information in either location, contact Arbin Customer Support at support@arbin.com.

For both options

Note: specific instructions for creating and editing test schedule (procedure) are found in **Chapter 5** of this manual.

1. Find "AB-FUNSC.sdx" in the "C:\ArbinSoftware\QC-XXXXXX" folder and copy the file to the folder, "C:\ArbinSoftware\ MITS_Pro\Work".
    - For a suitable device to use for the test, please open the test schedule and click on the "Global" tab. You

will see a section labeled "Comments" with a description of the device we used at Arbin to test your channels. Distribute the devices amongst various channels on your system to ensure that each board is functioning properly.

2. Highlight Schedule Name column from the "monitor & control window", then right click to assign "AB-FUNSC.sdx" to the channels having the test article connected. (See more about assigning schedules in Section 7.1).
3. On the **Monitor & Control Window**, highlight the channels on which resistors or cells have been loaded. Click the **Start Channels** button. (See Section 7.1) In the startup dialog, assign the test name, "FunsC." Note: during the Rest step, the first step of AB-FUNSC.sdx, the voltage reading on the **Monitor & Control Window** should be near the nominal voltage rating if the test object is a cell or near zero if the test object is resistor. Otherwise, there is a communication problem between the cabinet and the computer. If a problem exists, please contact Arbin Customer Service (979-690-2751).

If 'Unsafe' shows up after proceeding to the second step, "Current Ramp," please check the battery voltage and the connection to the cabinet.

The resulting data should be similar, with different values depending on your system, to that shown on the graph in **Figure 1-2** below. If the data appear dissimilar to this figure, then save a copy of the chart and contact Arbin Customer Service at 979-690-2751.

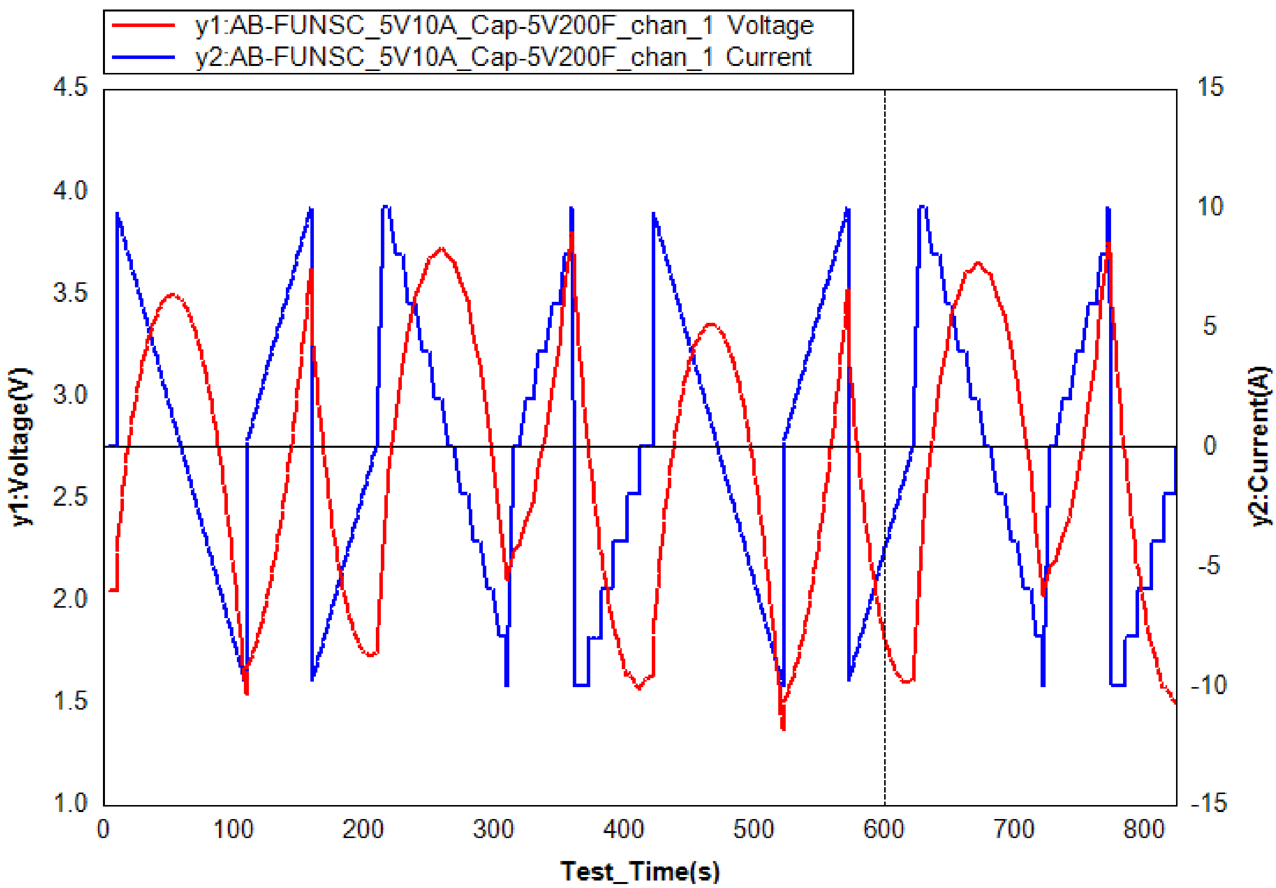


Figure 1-2 Voltage and Current Graph of Function Test, AB-FUNSC

Following is a detailed description of the schedule template and the purpose behind recommending this signature diagnostic.

A pre-defined schedule, AB-FUNSC.sdx, is used to inspect all standard functions of the Arbin system. These control steps are designed to test every available mode of the hardware-software interface. The channel response to this proprietary test is an invaluable indicator of system health. It conducts the following procedure.

Note: The maximum current mentioned below is the maximum current for Range 1, and the minimum current is the negative of the maximum current.

1. Rest for 10 seconds.
2. Run a current ramp using Range 1 from the maximum current to the minimum current.
3. Charge using a current ramp from 0A to the maximum current using Range1.
4. Discharge using a current ramp from the minimum current to 0A using Range 1.
5. Run a current staircase from the maximum current to the minimum current using Range 1.
6. Run a current staircase from 0A to the maximum current.
7. Run an internal resistance check on Range 4.
8. Run an internal resistance check on Range 3.
9. Run an internal resistance check on Range 2.
10. Run an internal resistance check on Range 1.
11. Discharge using a current staircase from the minimum current to 0A.
12. Increment the cycle index, and repeat once.

Turning Off the System

1. Close the **Monitor & Control Window** first, then **DAQ**.exe.
2. Close the MITS Pro8.0 program.
3. Turn off the power on the computer and on the cabinet.

Chapter 2 An Overview of MITS Pro8.0 Software

2.1 MITS Pro8.0 Software Construction and Terminology

File Details

All executable and executive programs are located in the main directory, C:\ArbinSoftware\MITS_Pro. The main directory also contains an important file - "ArbinSys.cfg." This file contains the settings of all memory addresses and the calibration data, upon which the accuracy of the testing system depends. All schedules and batch files are included in the C:\ArbinSoftware\MITS_PRO\work directory. See Table 2-1.

Table 2-1 MITS Pro8.0 File Type Descriptions, Locations

Directory name	Location	Files
Main (programs) directory	C:\ArbinSoftware\MITS_PRO	Console.exe, DAQ.exe, ArbinSys.cfg, ArbinAdvSys.cfg, ArbinSduModel.xml, ArbinSys.DBCF
Work Directory[1]	C:\ArbinSoftware\MITS_PRO\Work(\…)	all batch files (*.bth) all schedule files (*.sdx)
Profiles_TestObject	C:\ArbinSoftware\MITS_PRO\ Profiles_TestObject	all test object files (*.to)
Profiles_ReportChart	C:\ArbinSoftware\MITS_PRO\ Profiles_ReportChart	all statistical report files (*.sr), all chart files(*.cht)
Profiles_BMS	C:\ArbinSoftware\MITS_PRO\ Profiles_BMS	all CAN BMS configure files(*.can)
Profiles_SMB	C:\ArbinSoftware\MITS_PRO\ Profiles_SMB	all SMB configure files(*.smb)
Profiles_Simualtion	C:\ArbinSoftware\MITS_PRO\ Profiles_Simulation	simulation files(*.txt)
System Directory	C:\Windows\System32	Registry codes and system linking files (*.dll)
Data Watcher Directory	C:\ArbinSoftware\DataWatcher	Data Watcher.exe
Support Directory	C:\ArbinSoftware\MITS_PRO\Support	All AutoCalibration files, online edited schedule files, Data Log Information file, My Arbin Information files, Report Problems, Schedule online edit Record files, System Version information files, and Temp ChamberData
PWMConfig	C:\ArbinSoftware\MITS_PRO\PWMConfig	

A Schedule file (denoted by the file extension ".sdx") provides information to run a test on a battery or other storage device. The Mapping file (denoted by the file extension ".bth") provides the Mapping page where associations between main IV channels and auxiliary channels are mapped. The Test Object File (denoted by the file extension ".to") provides inputs for safety limits of the charging and discharging and for identifying characteristics of the test articles. The Report Chart file contains two kinds of files Report (denoted by the file extension ".sr" for statistical report) and Chart (denoted by

[1] ***MITS Pro*** now affords users the option to create sub-folders under the work directory. These directories are shown in the console file directory tree.

the file extension ".cht" for chart plotting). They provide settings for DataWatcher.exe. The BMS file (denoted by the file extension ".can") provides inbound CAN signal configuration, outbound CAN Message Broadcasting and CAN message formula view. The SMB file (denoted by the file extension ".smb") provides the smart battery signal configuration. The System Config files contain six files: Arbinsys.cfg, ArbinAdvSys.cfg, ArbinSys.DBCF (SQL Database Setting), Operation Permission, Backup and Arbin Testing Config (Only Super Administrator). Note the software schematic below.

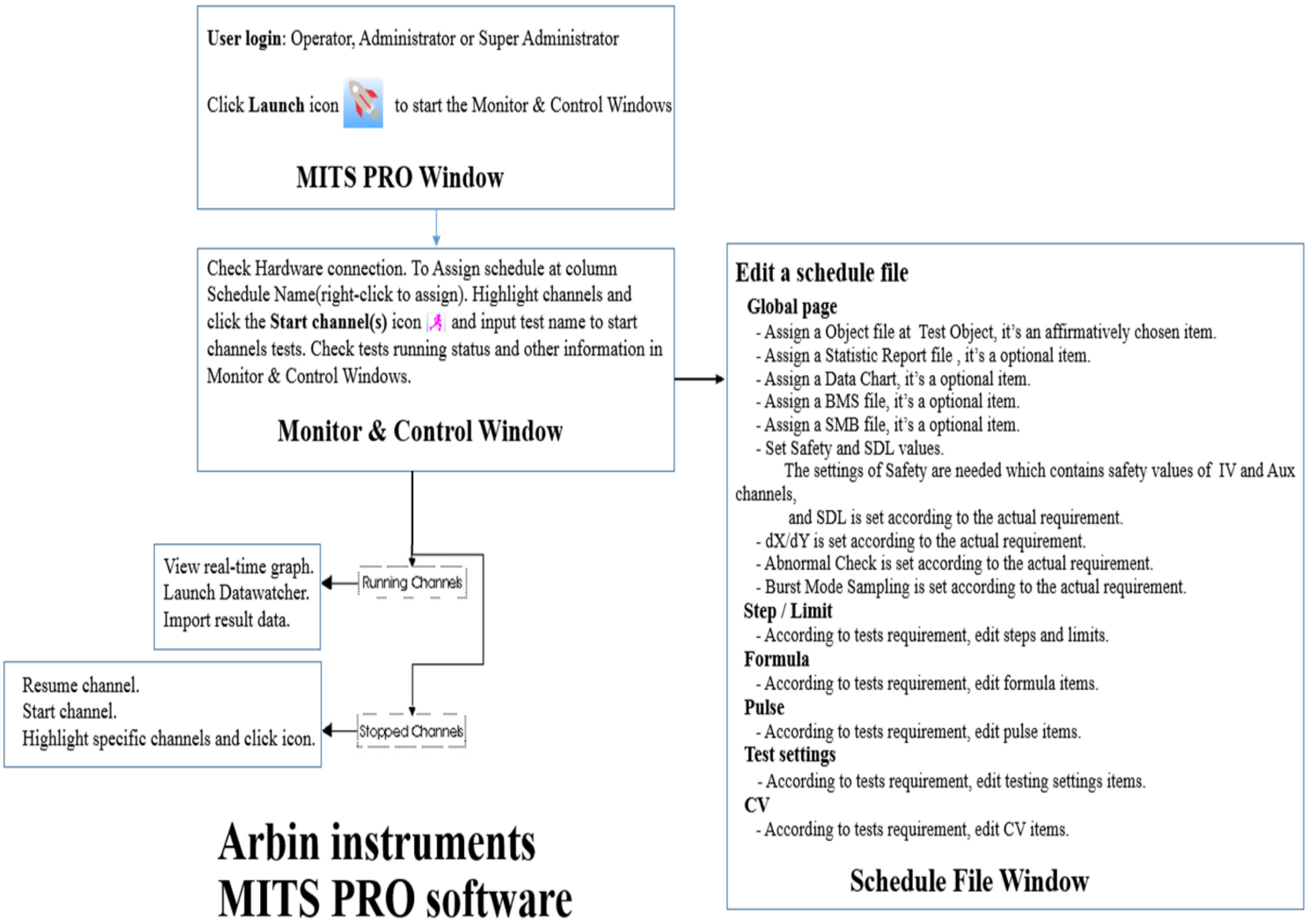


Figure 2-1 The software schematic

2.2 Working with MITS Pro8.0 Interface

Console Window

The user interface for working with MITS Pro8.0 is the console window, the first window visible when MITS Pro8.0 is launched. This console window provides options for editing files such as schedules, Object files, Report Chart files, BMS files, SMB files, Mapping files and system configuration files; launching and controlling tests; calibrating hardware; launching DataWatcher and other miscellaneous tools. As shown in **Figure 2-2**, it consists of a menu, a header bar, directory tree and a right pane, a hint bar and a status bar.

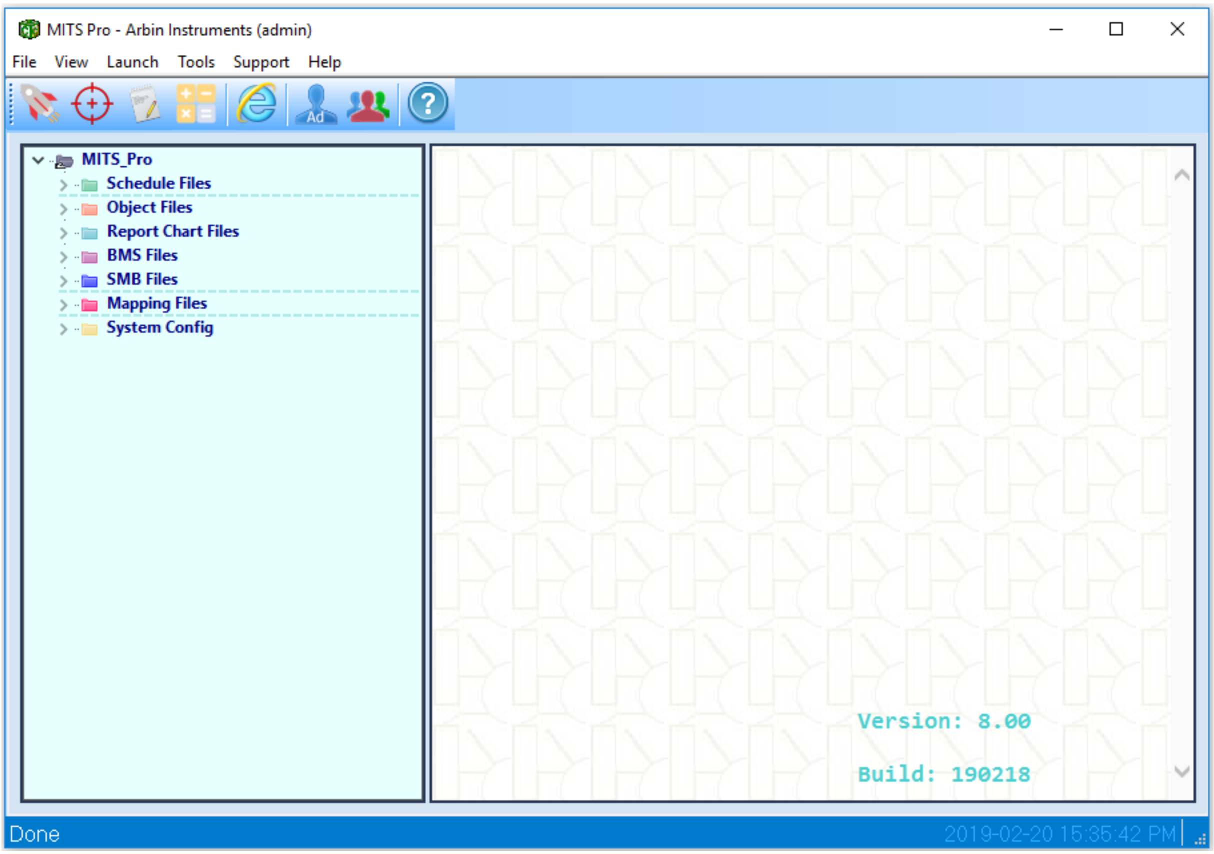


Figure 2-2 The main console window for MITS Pro8.0

1. **Menu Bar** - The menu at the top of the window contains six choices: **File**, **View**, **Launch**, **Tools**, **Support** and **Help**.

   The following choice is available from the File menu.
   - Exit - Exit **MITS Pro8.0.**

   The following choices are available from the View menu.
   - Header bar - Show or hide the header bar.
   - Hint Bar - Show or hide the message bar.
   - Status Bar - Show or hide the bars state.
   - Save Bars State – Save the bars state.
   - Load Bars State - Load the bars state.
   - Minimize All - Minimize all working windows.
   - Windows - Lists open MITS Pro8.0 files.

   The following options are available from the Launch menu.

- Monitor & Control – Open the "monitor & control" window. Loads ArbinSys.bth in the control window.
- Hardware Calibration - Displays calibration screen.
- Launch Data Watcher - Launches DataWatcher to view data result or export the data.

The following options are available from the Tools menu.

- Windows Explorer - Starts Windows Explorer in MITS_Pro directory.
- Notepad - Open a blank Notepad document.
- Calculator - Invokes calculator utility in default view (Standard or Scientific).
- Calendar - Invokes computer's calendar.
- Set TcpAckFrequency - Set value of TcpAckFrequency from system register file.
- Reset Environment - Reset the software Environment.

The following options are available from the Support menu.

- Setup Debug Trace - Helps debug the software problem.
- Backup Auto Calib Data - backup the ArbinSys.cfg file which contents original calibration data.
- Setup Schedule Editor Mode - Select an Editor Mode of schedules (classic, or new, or classic/new).
- Edit Schedule Step Template - edit and save a schedule template.

The following choices are available from the Help menu:

- Help - Display the MITS Pro8.0 help file.
- Arbin Web Site -Go to Arbin home page at http://www.arbin.com.
- About MITS Pro - Display program information, version number and copyright. Note: this information is available from any MITS Pro8.0 screen.
- Report A Problem -- MITS Pro8.0 software provides a convenient way for customers to submit their problems to Arbin Customer Service. Customers only need to click Help and choose Report a Problem, and follow the instructions to load the necessary files to help Arbin customer service engineers diagnose and troubleshoot the submitted questions. See **Figure 2-3**.
- Register MITS Pro – Arbin Instruments MITS Pro8.0 software requires registration. Arbin provides a trial period (e.g., 30 days) for customers to use the full capability of the software. However, after the trial period, the software will stop running and all running tests will stop. Please register MITS Pro8.0 before the trial period expires using the registration key provided by Arbin.
- License Agreement - Displays the license agreement between Arbin and the user.
- My Arbin - Displays the brief information of machine system. See **Figure 2-4.**
- Arbin Testing Info - Includes detailed hardware information as well as software information about the system. It also contains quality control certification, customer specification form, and calibration forms etc.

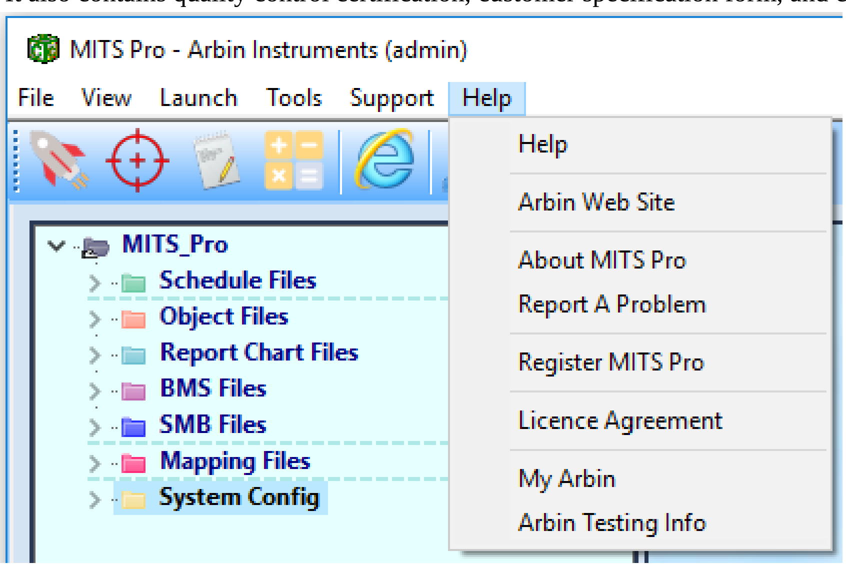


Figure 2-3 Click Help, and choose Report a Problem.

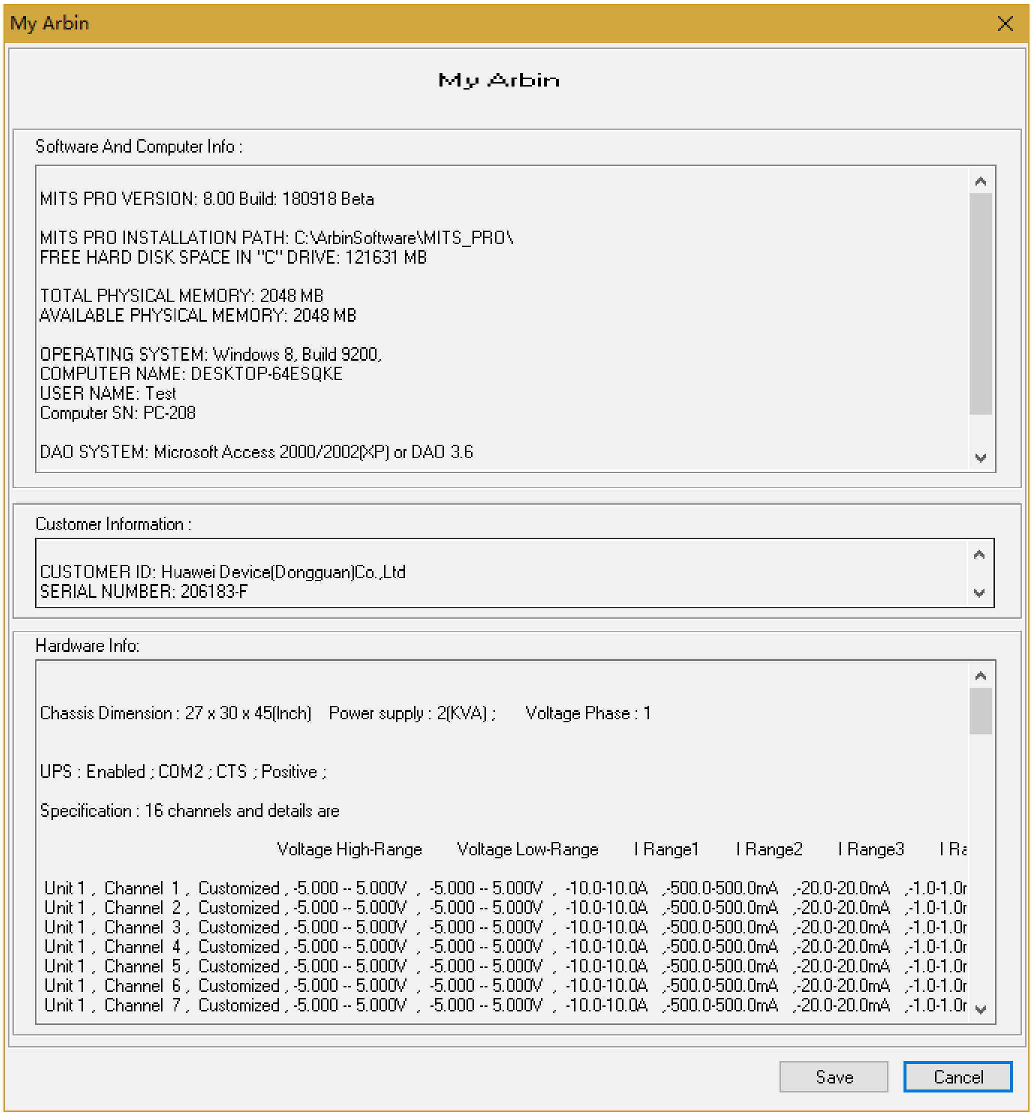
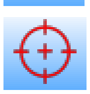


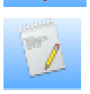
Figure 2-4 My Arbin Briefly Describes the Arbin System

2. **Header Bar** - The header bar contains the following choices:

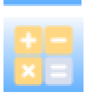
Monitor & Control – Launch **Monitor & Control Window.**



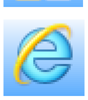
Hardware Calibration – Open **Calibration Window.**



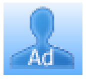
Open a blank **Notepad** document.

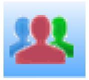


Launch System **Calculator.**



http://www.arbin.com – Open Arbin's home page.


User Login – Contains Operator, Administrator and Manufacturer login.


User Management – Create and Edit the User.


Help – open the **MITS** help file.

a. **Files**

There is a directory of file folders under MITS Pro8.0 **FILES**. The following choices are available following a right-click on the folder names:

MITS Pro Files

- Refresh - Refresh file directory.

Schedule Files [and sub-folders]

- New Schedule File - Create a new schedule (*.sdx) file.
- New Folder - Create a new schedule file folder.
- Load Pack From… -- Load the packed (*. PackSch) file which includes the Schedule File, Object File, Statistic Report File, Data Chart File, BMS File, SMB File and Simulation File.
- Save Pack To… -- Package the schedule (*.sdx) file and files which are assigned in the schedule, including Object File, Statistic Report File, Data Chart File, BMS File, SMB File and Simulation File. This will generate a file with extension “. PackSch”.
- Rename Folder
- Delete Folder
- Delete All Schedule Files in Folder
- Delete All Schedule Files and Sub-folders
- Set Read-Only Recursively - designate schedule as read-only.
- Remove Read-Only Recursively - clear the read-only characteristic.
- Start Windows Explorer Here - Starts Windows Explorer in MITS_Pro directory.
- Refresh

Object Files

- New Test Object File - Create a new Object (*.to) file.
- New Folder - Create a new folder.
- Rename Folder
- Delete Folder
- Refresh

Report Chart Files

Statistical Report Files/Chart Files

- New Statistic Report File - Create a new statistic report (*.sr) file.
- New Data Chart File - Create a new data chart (*.cht) file.
- Start Windows Explorer Here - Starts Windows Explorer in MITS_Pro directory.
- Refresh

CAN BMS Files

- New CAN Config File - Create a new CANConfig (*.can) file.
- Delete All CAN Config Files

- Start Windows Explorer Here - Starts Windows Explorer in MITS_Pro directory.
- Refresh

SMB Files

- New SMB Config File - Create a new SMBConfig (*.smb) file.
- Delete All SMB Config Files
- Start Windows Explorer Here - Starts Windows Explorer in MITS_Pro directory.
- Refresh

Mapping Files

- Open System Mapping File - Open ArbinSys.bth.
- New Mapping File - Create a new Mapping (*.bth) file.
- Delete All Mapping Files
- Start Windows Explorer Here - Starts Windows Explorer in MITS_Pro directory.
- Refresh

System Config

- Create Blank System Config - Create a blank system configuration file ArbinSys.cfg. (only one ArbinSys.cfg can exist for the machine.)
- Copy From. - Copy a system configuration file from a different directory and saved to ArbinSys.cfg.
- Start Windows Explorer Here - Starts Windows Explorer in MITS_Pro directory.

ArbinSys.cfg - Open, Delet, Save to: Configures software and hardware device connection information. Only the manufacture can edit it.

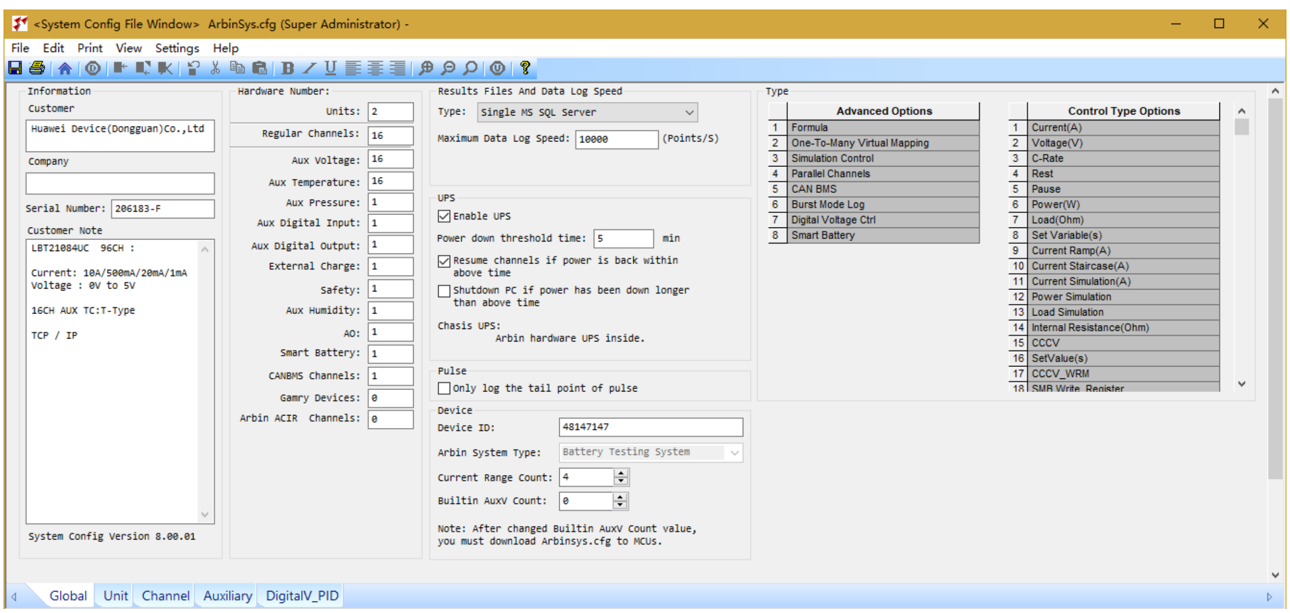


Figure 2-5 ArbinSys.cfg Window

ArbinAdvSys.cfg — sets the required functions according to the device series. Only the manufacture can edit it.

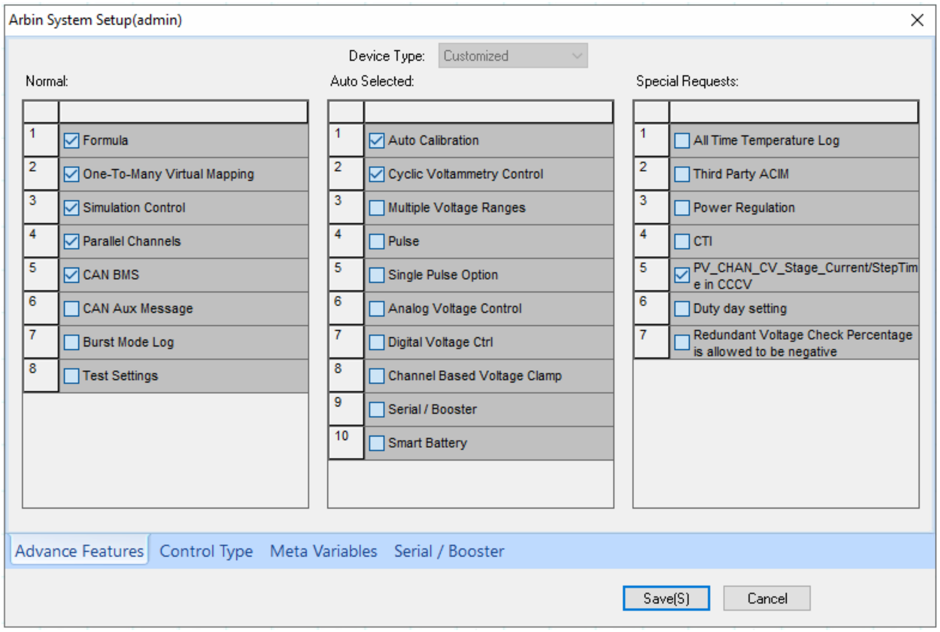


Figure 2-6 ArbinAdvSys.cfg Window

ArbinSys.DBCF — Sets up the information about connecting to the SQL server database. Only the manufacture can edit it.

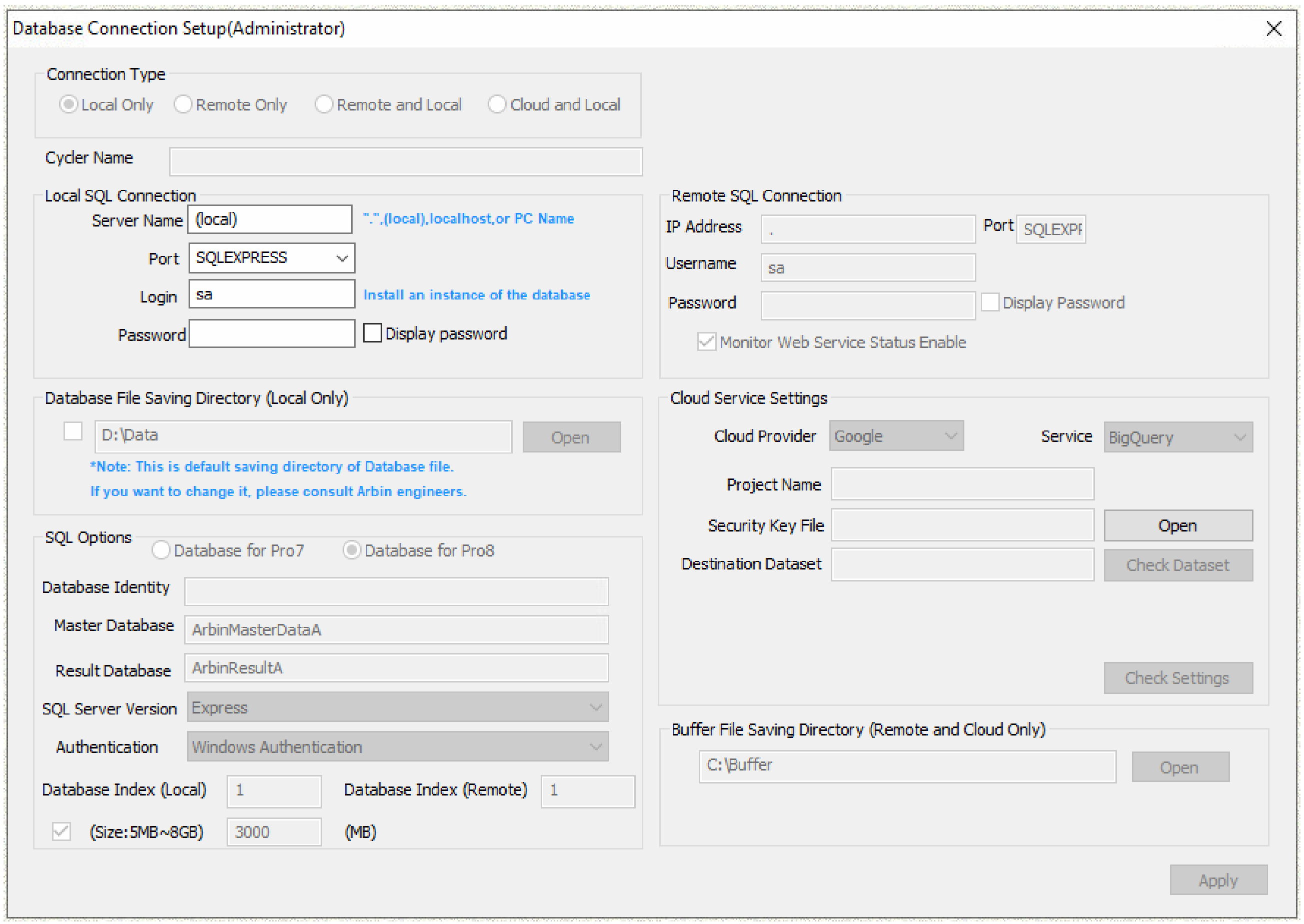


Figure 2-7 SQL Connection Setup Window

Operation Permission —Provides the user to set up the authorization configuration for the MITS Pro8. Higher level can edit lower level.

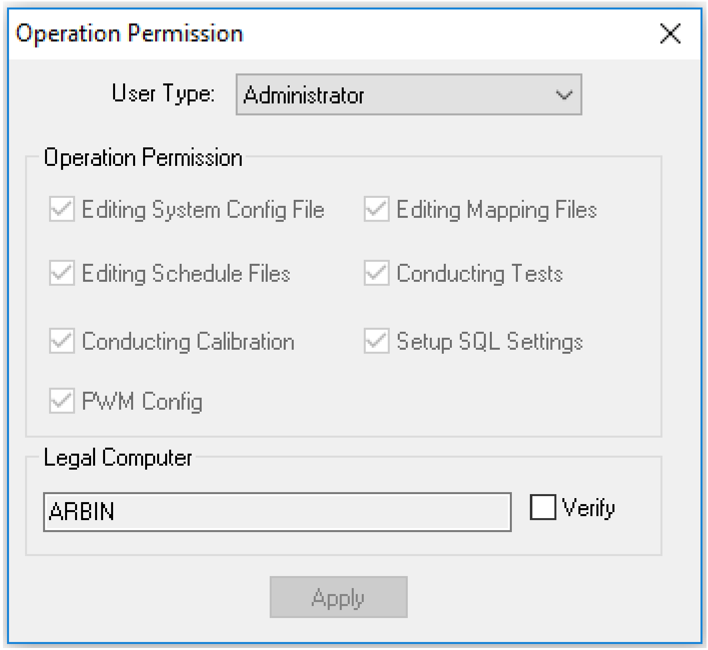


Figure 2-8 Operation Permission Window

Arbin Testing Config — this file is only used by manufacture.

Chapter 3 System Requirements & Installation

3.1 System Requirements for MITS Pro8.0

Recommended configuration:

- 2GB RAM or more
- 8GB free disk space
- Windows 7 or Windows 10.
- Microsoft® Office 2010, 2013, 2016
- Microsoft HTML Help or Internet Explorer 5.0 or later (for viewing help file)

3.2 Installing MITS Pro8.0

Pre-installation Checklist

- Windows 7 or Windows 10.
- Microsoft Office 2010, 2013, or 2016 installed

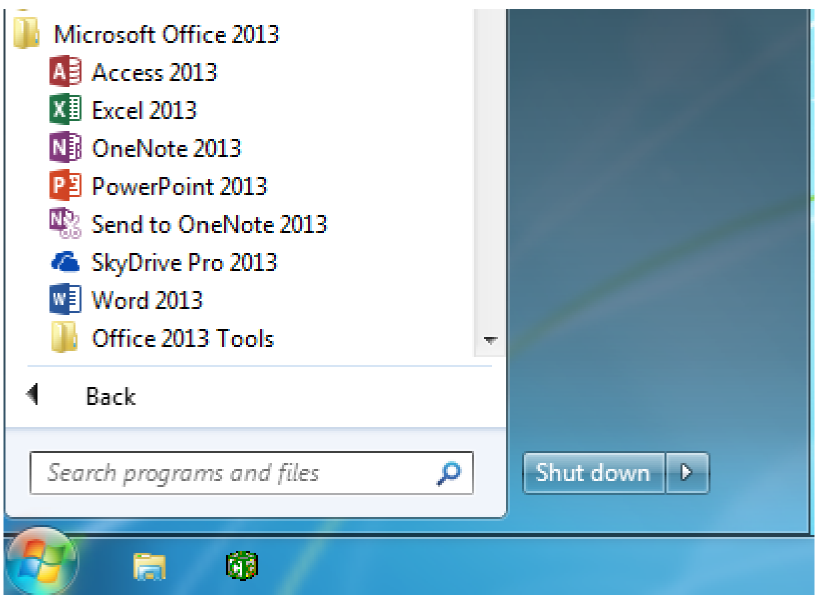


Figure 3-1 Click Start - All Programs to Check the Installation of Microsoft® Office 2013

During the installation of the Microsoft Office package, select appropriate options for a complete installation. If you are simply re-installing **MITS Pro**, skip the Microsoft Office installation.

1. Set time to current time.

   Note: Remember to disable "**Automatically adjust clock for daylight saving time**" and "**Synchronization with an Internet Time Server**".

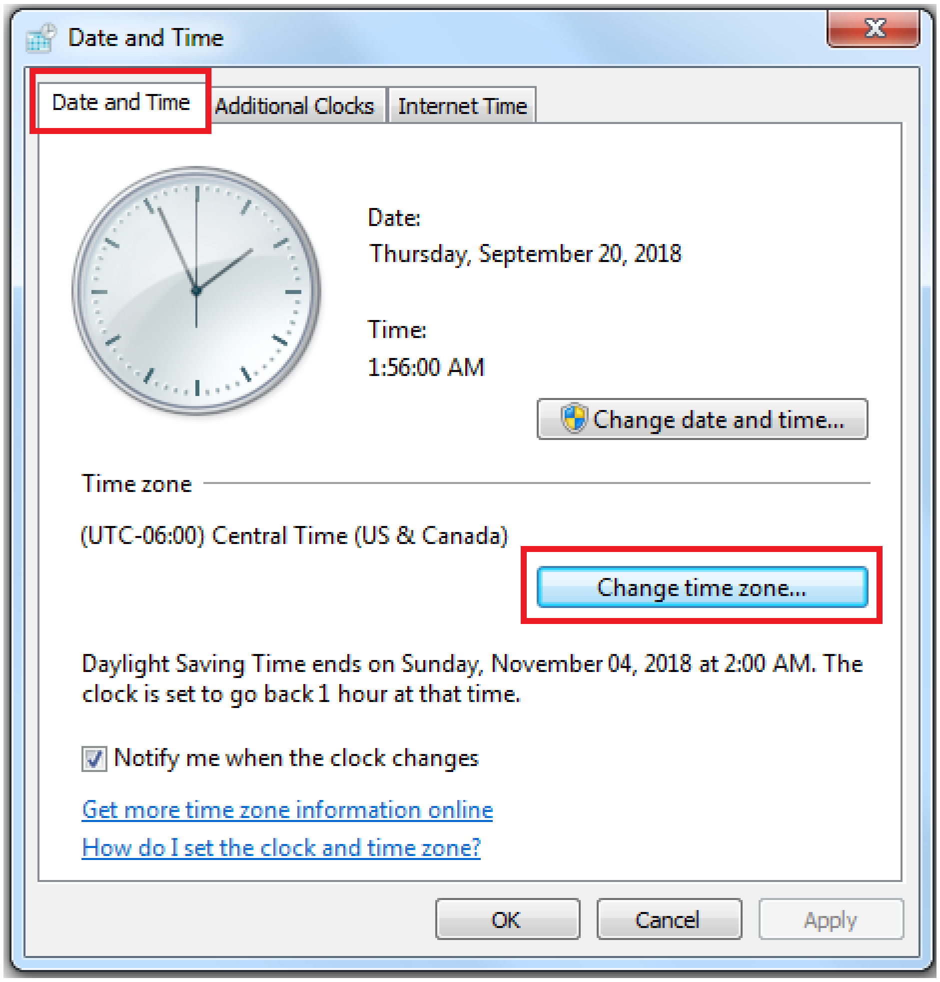


Figure 3-2 Right Click Clock on Desktop to Permit Setting Computer Clock.

Click Change time zone, and uncheck “Automatically adjust clock for Daylight Saving Time”.

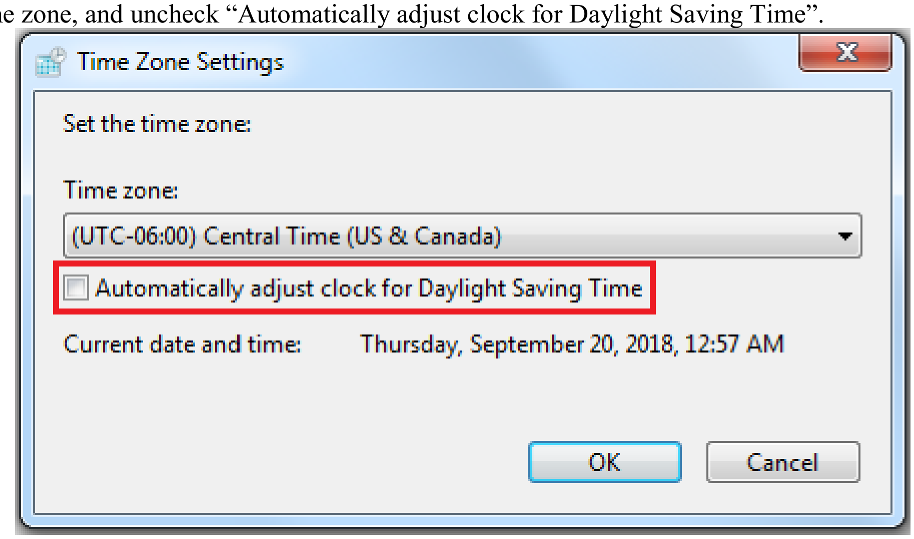


Figure 3-3 Uncheck Automatically Adjust Clock for Daylight Saving Time

2. Disable automatic synchronization with an internet time server.

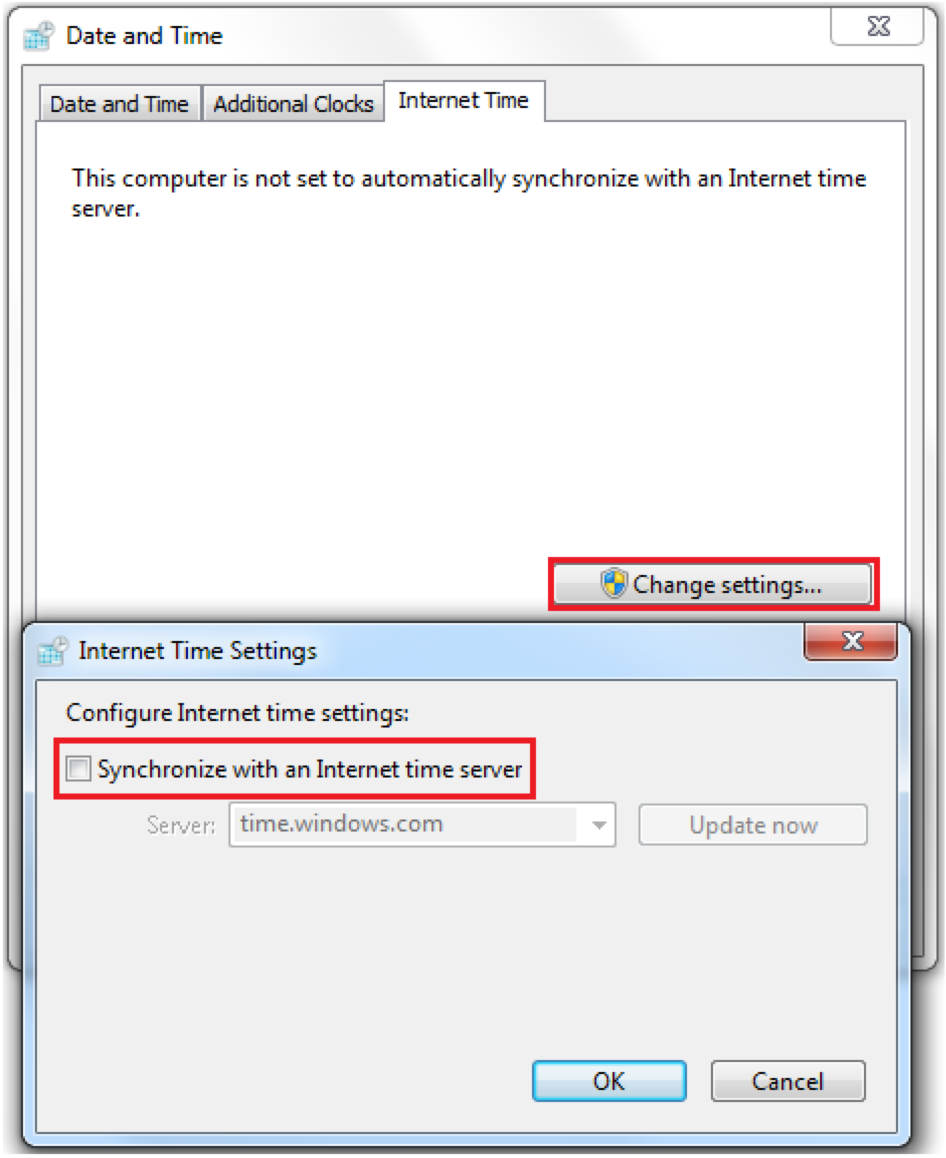


Figure 3-4 Disable Synchronization with an Internet Time Server

Right click on the Desktop Clock to Permit Setting the Internet Time. Click Change settings. **Uncheck** "Synchronize with an Internet time server" as shown in **Figure 3-4**.

3. Close all applications. From the Windows desktop, run Task Manager program by pressing <Ctrl><Alt><Delete> or by right-clicking on the task bar and selecting **Task Manager**; make sure there is no other application running. Specifically, **DAQ.exe must be closed**.

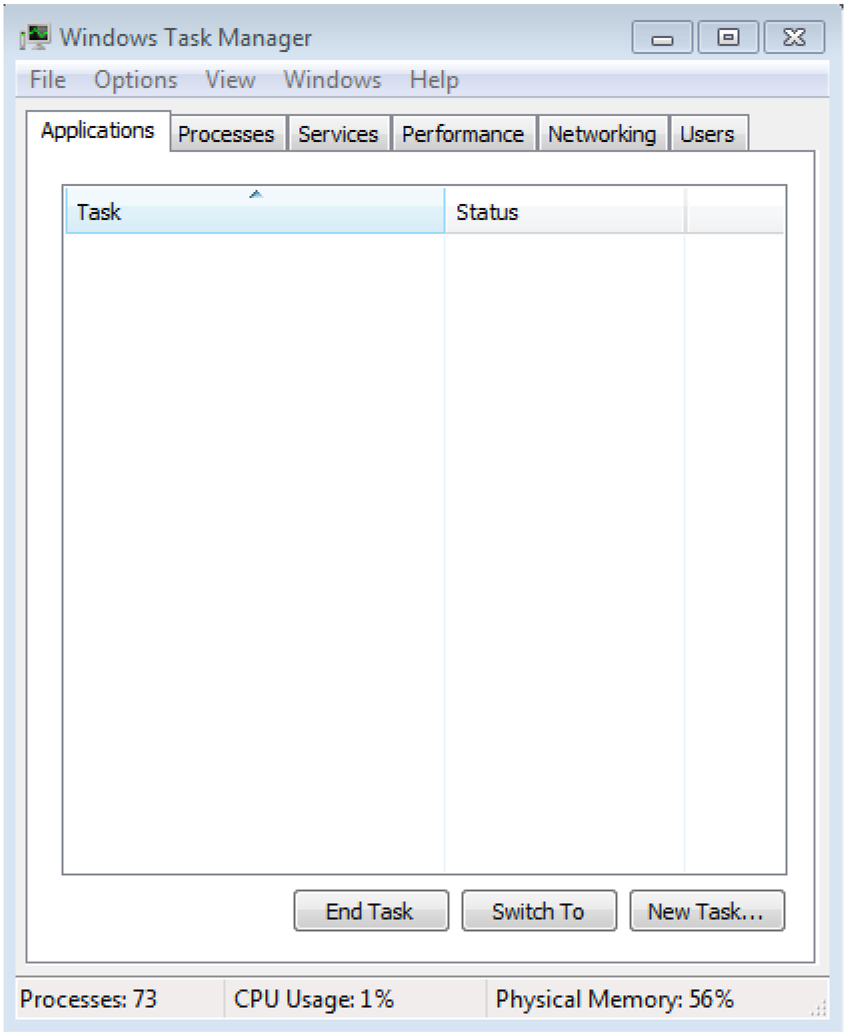


Figure 3-5 No Program Runs in Task Manager

Setting TCP/IP Address

1. Click Start→Control Panel→Network and Internet→View network status and tasks →Change Adapter Settings,
2. Double click the network adapter which is used for the connection of Arbin Machines (as shown in **Figure 3-6**).
3. Double click Local Area Connection. From the Local Area Connection Properties Window shown in **Figure 3-7**, select Internet Protocol Version 4(TCP/IPv4) and double click it. Note: deselect other connection items.
4. Set TCP/IP address of 196.168.1.100 as shown in **Figure 3-8**. Subnet mask of 255.255.255.0 will be automatically appear.
5. Click Advanced…. The Advanced TCP/IP Settings Window will pop up. Select WINS (**Figure 3-9**), to disable NetBIOS over TCP/IP.

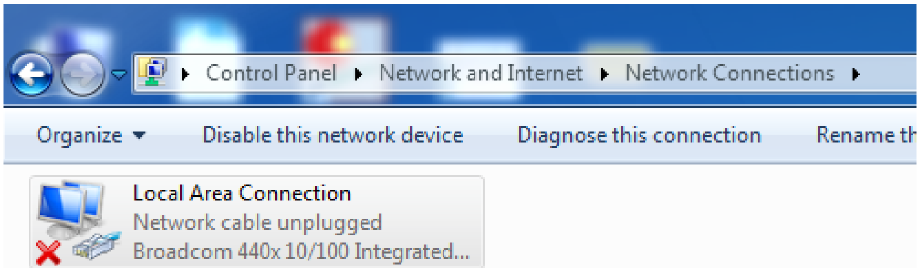


Figure 3-6 Double Click Local Area Connection

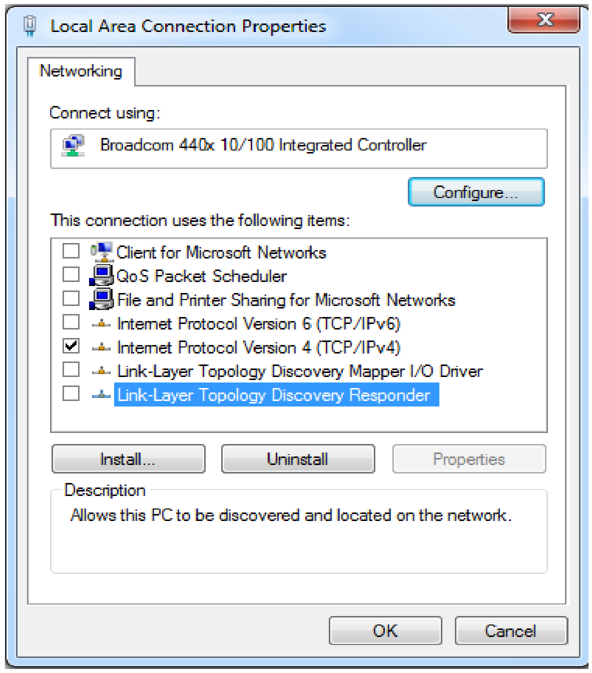


Figure 3-7 Local Area Connection Properties

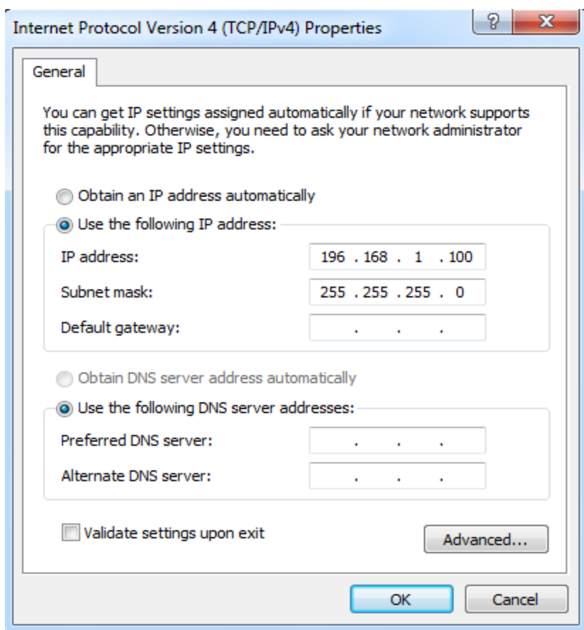


Figure 3-8 Setting TCP/IP Address as 196.168.1.100

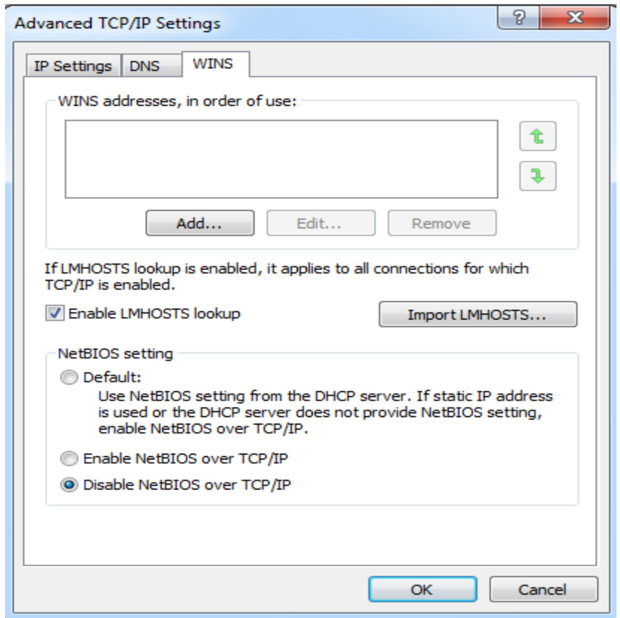


Figure 3-9 Disable NetBIOS over TCP/IP

Installing MITS Pro8.0

1. Insert the MITS Pro8.0 CD into the driver. From the 'Start' menu, choose 'Run'. Type "D:\setup" (assume D for CD-ROM drive) and press <Enter>.

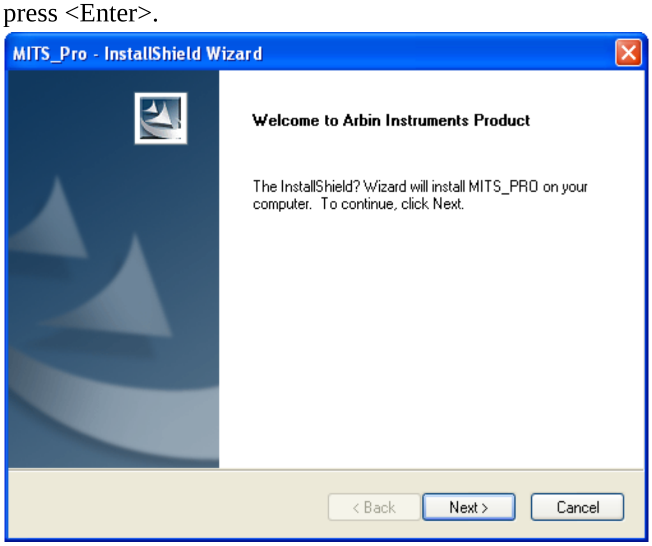


Figure 3-10 MITS Pro8.0 Installation Page 1 Click **Next >.**

The dialog box tells you this program will install **MITS Pro**. Select Next > to continue. (See **Figure 3-10**)

2. Choose an installation package and the destination folder. Then click Next > button to continue.

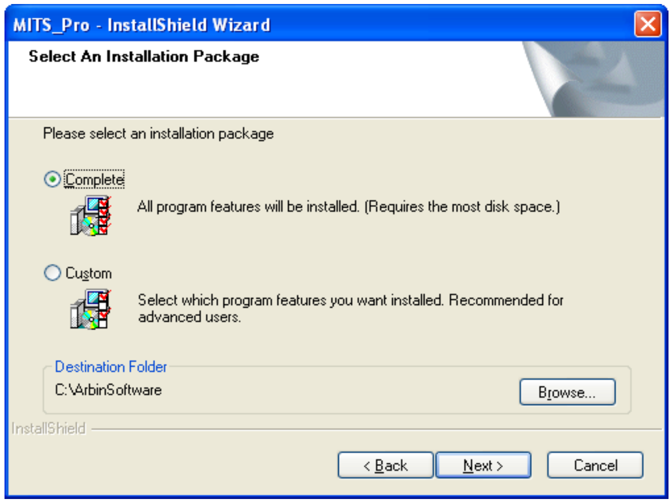


Figure 3-11 Select **Complete** Installation

The default destination folder is C:\ArbinSoftware. Click the button, "Browse...", to choose a destination folder for installation.

3. Select components to install if you selected "Custom" last step. (See **Figure 3-12**)

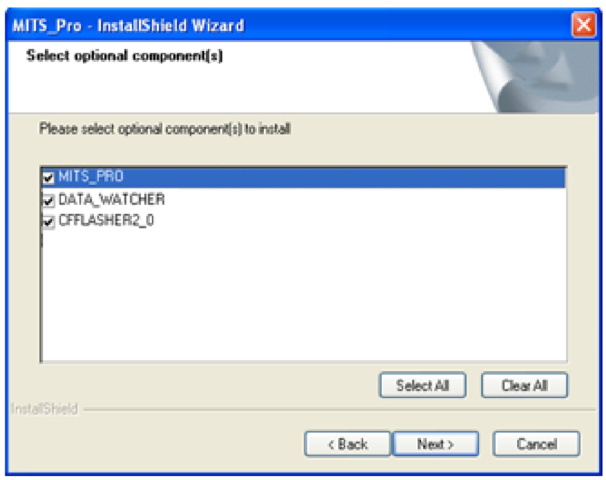


Figure 3-12 Options in **Custom** Installation

MITS_Pro: Arbin's battery or fuel cell testing software

Data_Watcher: a convenient data-watch tool to monitor testing result data in graph with minimum use of computer resources.What's more, it can convert the result data to Excel or CSVformat for further process.

4. Add Program Group.

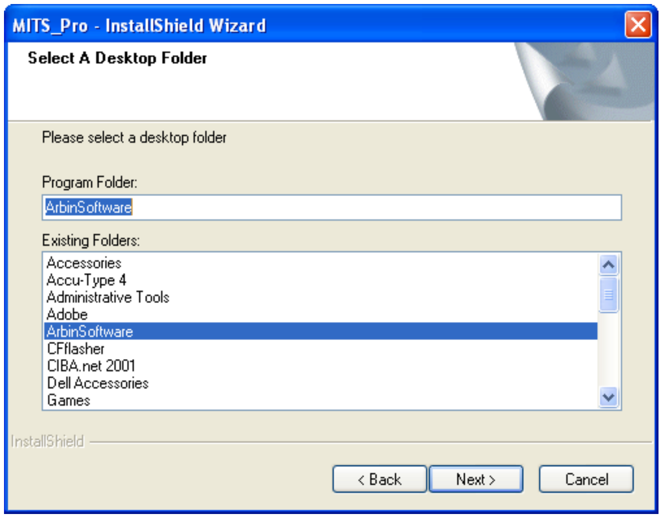


Figure 3-13 Desktop Folder Selection

5. If there is an existing system configuration file under the destination folder, users are prompted to choose whether to overwrite it with the default system configuration file on the CD-ROM. Selecting No will retain the existing ArbinSys.cfg. Please consult Arbin customer service before overwriting or deleting system configuration files.

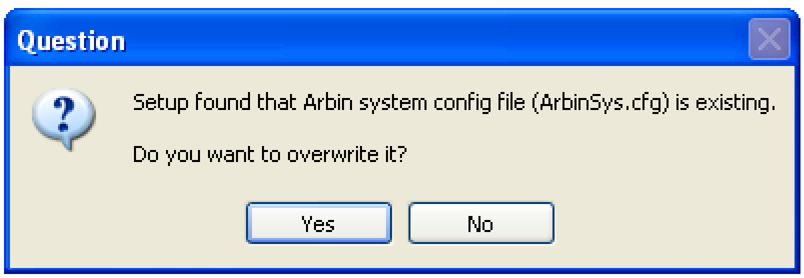


Figure 3-14 Existing System Configuration File Found

6. Arbin Instruments MITS Pro8.0 software requires registration. Arbin provides a trial period (e.g., 30 days) for customers to use the software. However, after the trial period, the software will stop running and all running tests will stop. Before the trial period expires, please register MITS Pro8.0 using the registration key provided by Arbin. If the registration key is available now, please enter it now and click OK. Otherwise, click Cancel to continue the installation process and register it later - either when the following window pops up or at the under the “Help” button in the MITS Pro8.0 console window.

Figure 3-15 Input Registration Code

7. Click the Finish button to complete the setup program.

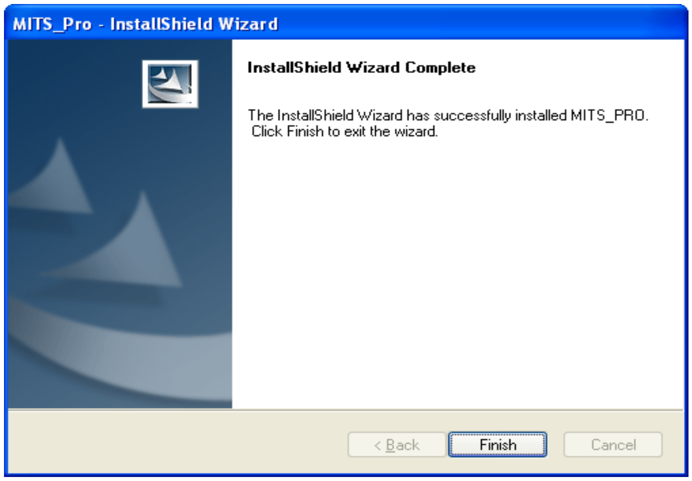


Figure 3-16 Final Setup Pane

Remove the MITS Pro8.0 CD from the CD-ROM drive.

8. Double click MITS Pro8.0 icon on Desktop or go to Start->Programs->ArbinSoftware->MITS Pro to run the program (console.exe).
9. If this is a computer that was setup by Arbin Instruments, you may also need to install Internet Explorer 5.0 or later to view the help file in **MITS Pro8.0**.

3.3 Removing MITS Pro8.0

1. Click **Start** on the task bar of Windows 7, or Windows 10. Highlight **Settings** and click **Control Panel (Figure 3-17**).
2. Double-click the Add/Remove Programs icon. A Windows dialog box will pop up. (**Figure 3-18**).
3. Select "MITSPro" from the list. Click the Change/Remove button and follow the instructions to remove **MITS Pro8.0**.

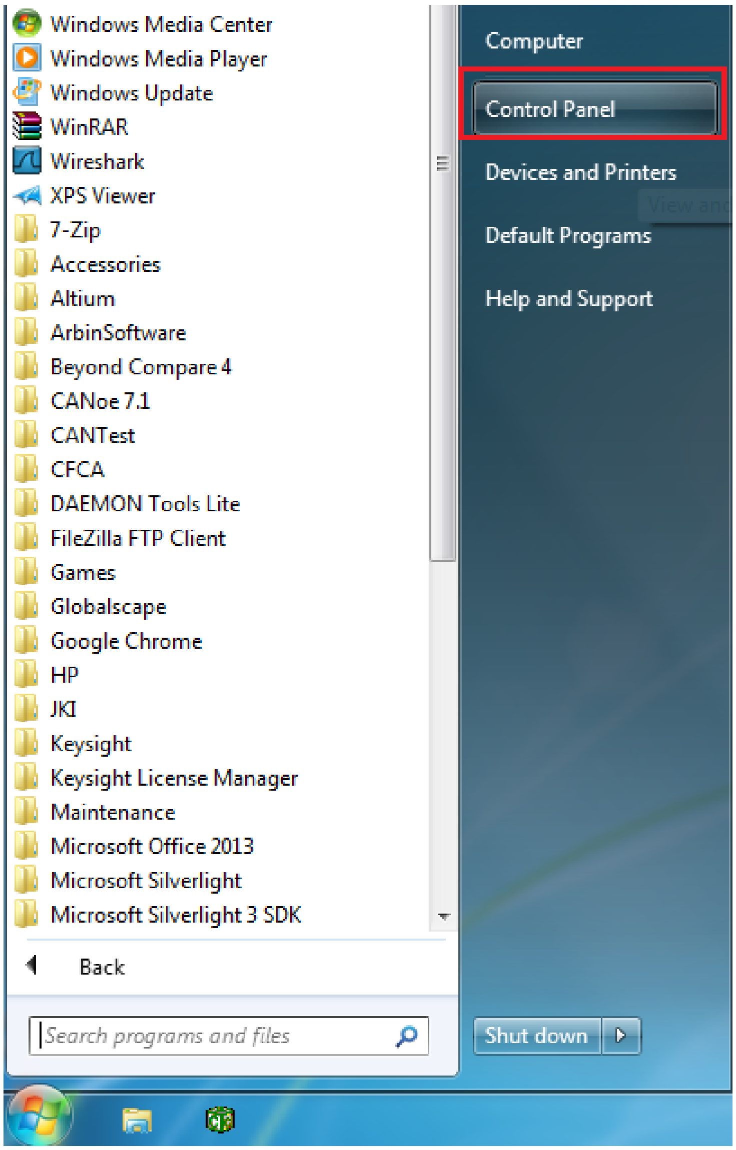


Figure 3-17 Get into Control Panel

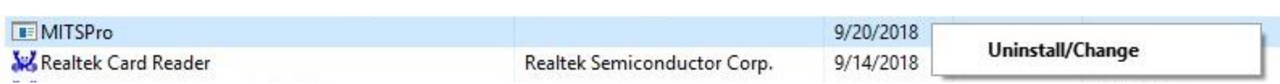


Figure 3-18 Remove MITS_Pro

4. Right-click Add/Remove Programs icon. A Windows dialog box will pop up. (**Figure 3-18**).

3.4 Hardware Test

1. Power on the Arbin tester by flipping the toggle switch which can be on the front or back of the chassis) or pressing the green "Start" button on the front of the chassis. (See **Chapter 10 An Overview of the Hardware** for specific instructions.)
2. Double-click Console.exe icon **(Figure 3-20)**. The main MITS Pro8.0 window will pop up as follows. For admin user, the default password is "000000".

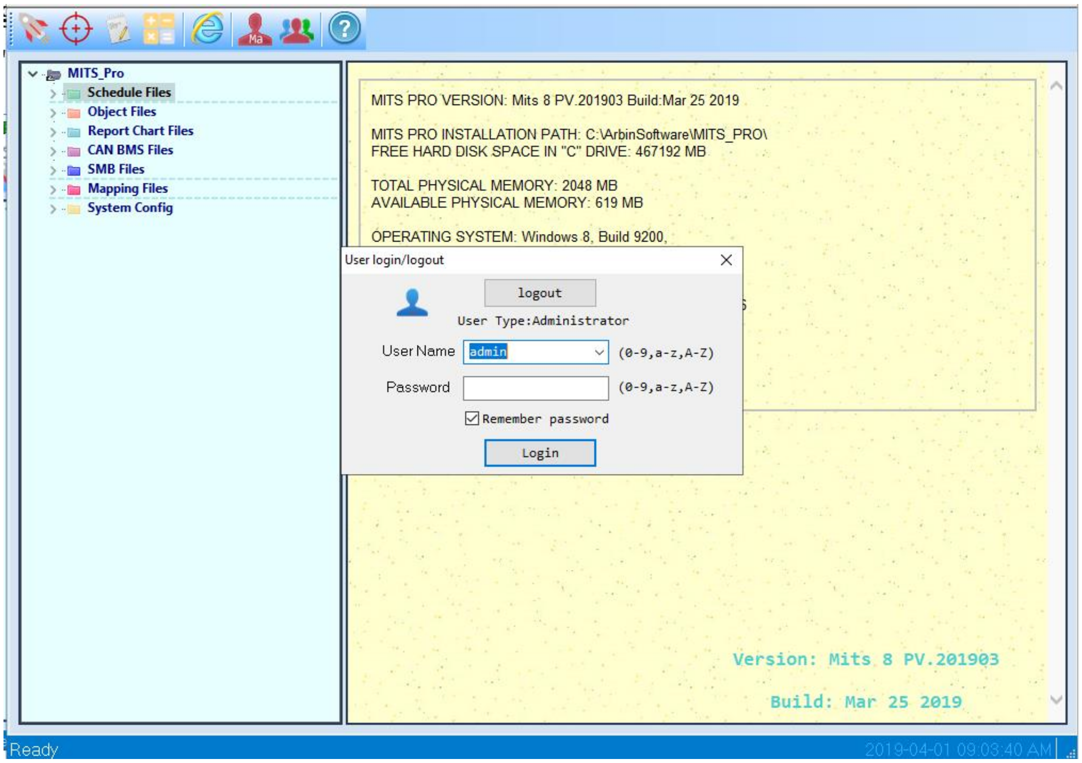


Figure 3-19 Main MITS Pro8.0 Window

Then, from "Help – My Arbin" to see the hardware setted and the testing functions of the machine. Or, double-click the system configuration, ArbinSys.cfg, in the left pane (**Figure 3-21**). The system's settings should match the hardware, such as in the number of channels, etc (**Figure 3-22** & **Figure 3-23**). Close the configuration file. Open a new mapping file. Save it as **ArbinSys.bth** to replace the old mapping file.

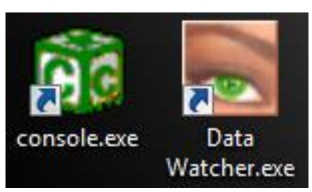


Figure 3-20 Two Icons of MITS Pro8.0 on Desktop

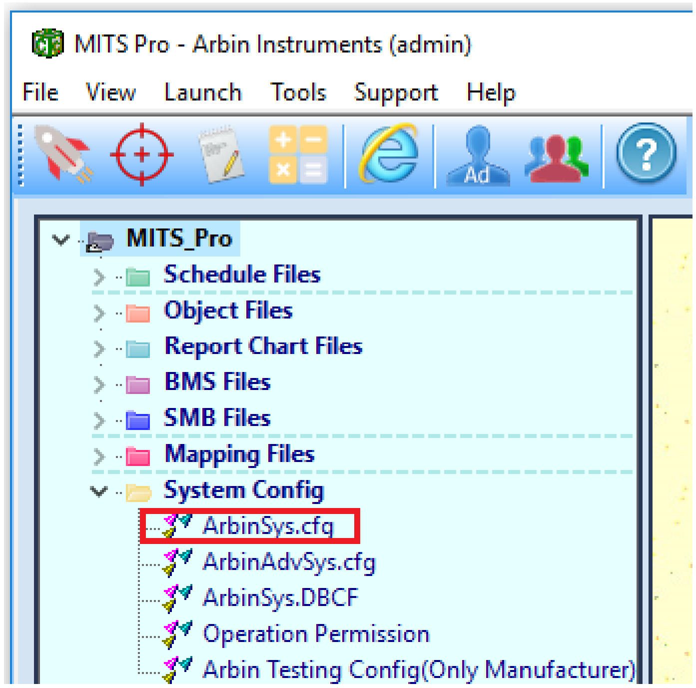


Figure 3-21 MITS Pro 8.0 main window

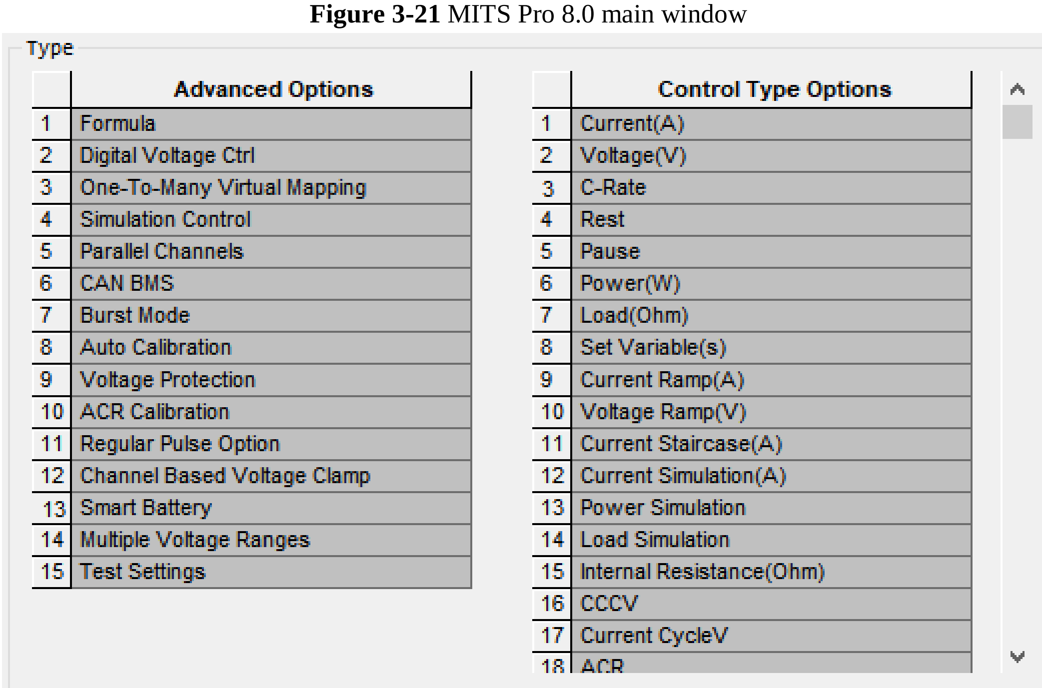


Figure 3-22 Advanced Options of the ArbinSys.cfg

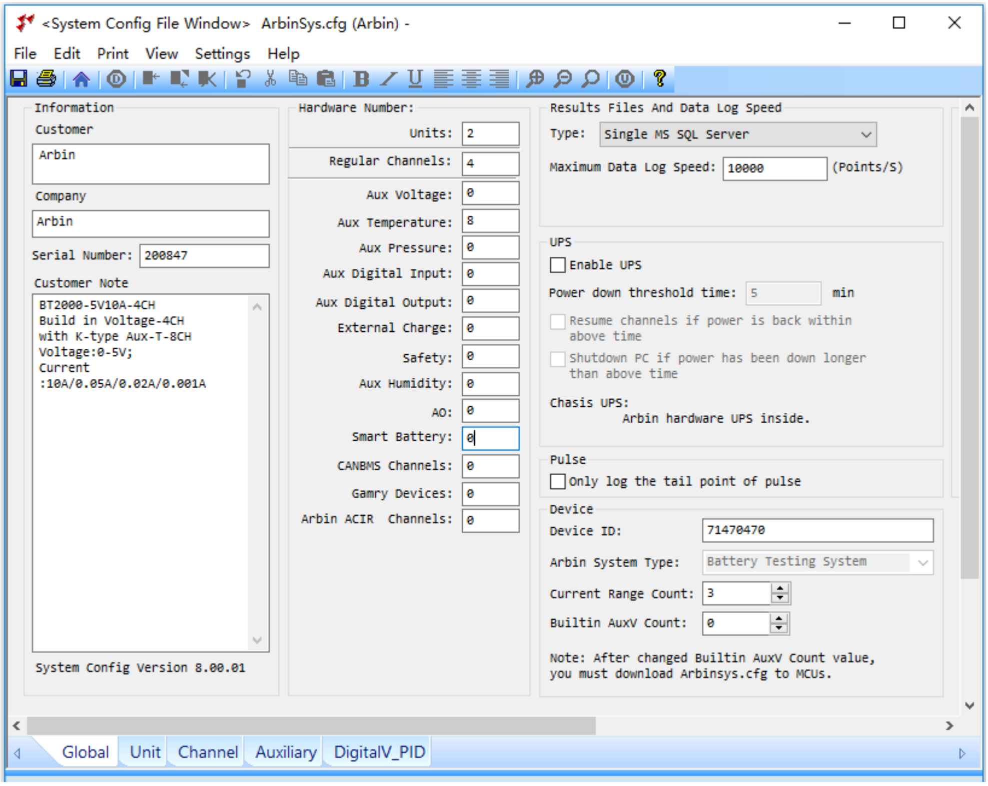


Figure 3-23 Basic Settings of the ArbinSys.cfg

3. Click the **Launch** button  (**Figure 3-21**) and wait until the message "Cluster (or Instrument) 1 is connected." appears in the lower hint box of the **Monitor and Control Window** (**Figure 3-24**). close the **Monitor & Control Window**

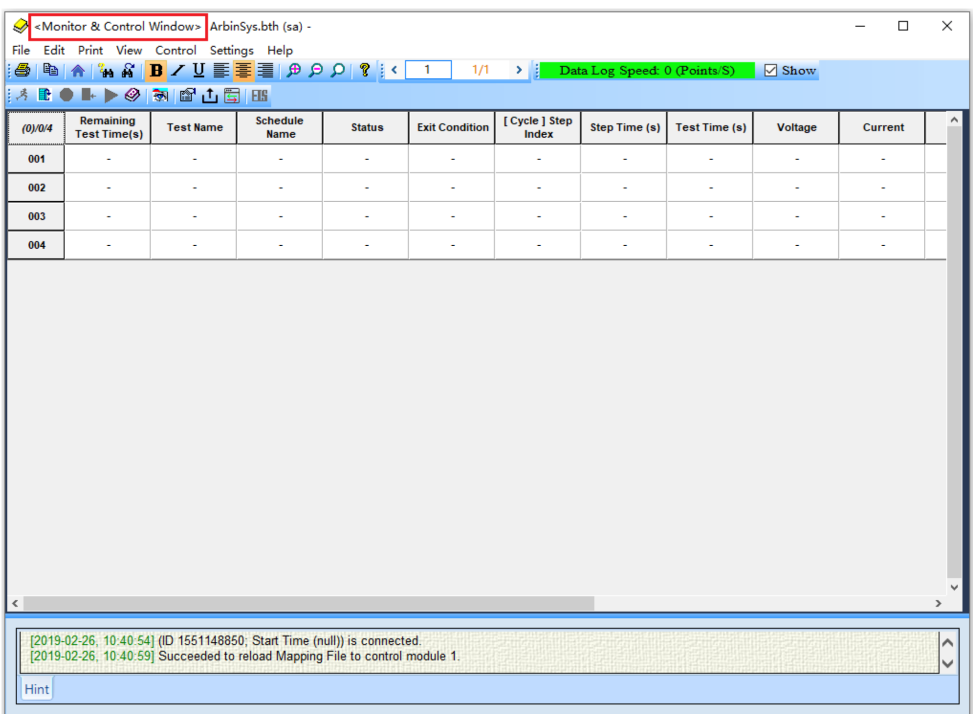


Figure 3-24 Launch Monitor & Control Window

4. Click the **Calibrate** button  (**Figure 3-21**) among the property sheets of the MITS Pro8.0 console window. The calibration window will pop up (**Figure 3-25**). On the **Manual Calibration** page of the **Calibration** window, input 0 into the textbox labeled **Desired Value**. Set **Start Chan**: 1, **Chan Count**: 4 (If there are more than 4 I/V channels. Otherwise, put 1 here). Click the **Set** button. The red LEDs of channels 1-4 (or channel 1) on front panel should light up if the basic communication is established.

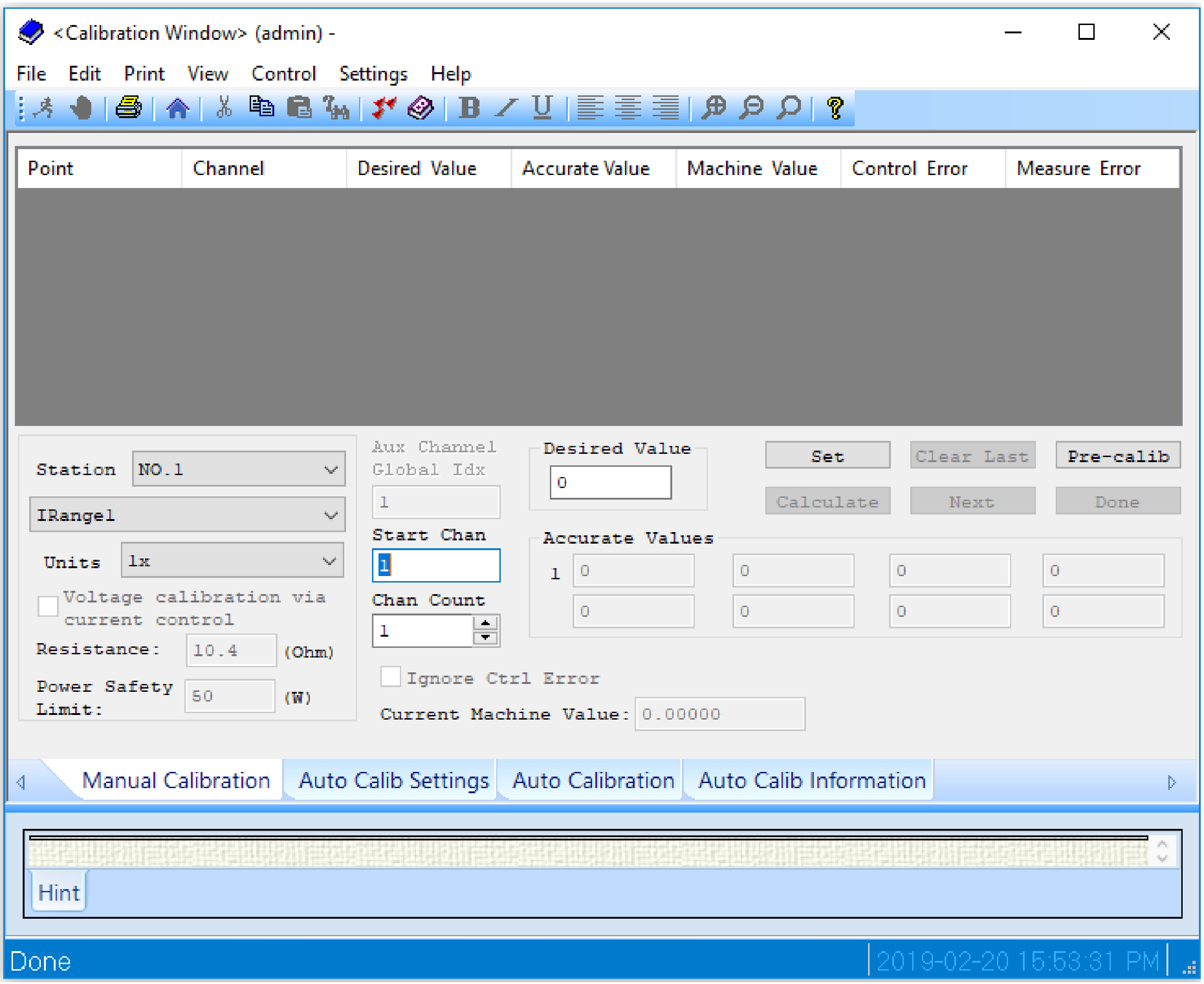


Figure 3-25 the Manual Calibration of Calibration Window

5. Click the **Next** button; the LEDs should switch off. Other channels may be tested by changing Start Chan if there are more than 4 channels. Then close the **Calibration** window.

   Never click Done or Pre-calibrate **in the calibration window unless being instructed to do so or performing an actual calibration**. Otherwise, it might overwrite existing calibration data.

6. Read the manual carefully about editing schedules and other files. (See Chapter 5, 6, and 7 for details) Try a simple schedule on a 1.0Ω resistor before testing a battery. Ensure that the safety limits shown in the **Global** page of the schedule are appropriate for the specific test implemented.

   If communication between the computer and the Arbin testing stand is not established readily, then check the ethernet cable, the ethernet port for Arbin tester of the computer, and whether the network connection is working on the PC.

7. Report any trouble to Arbin Customer Service Support.

3.5 MITS Pro8.0 Directory Tree

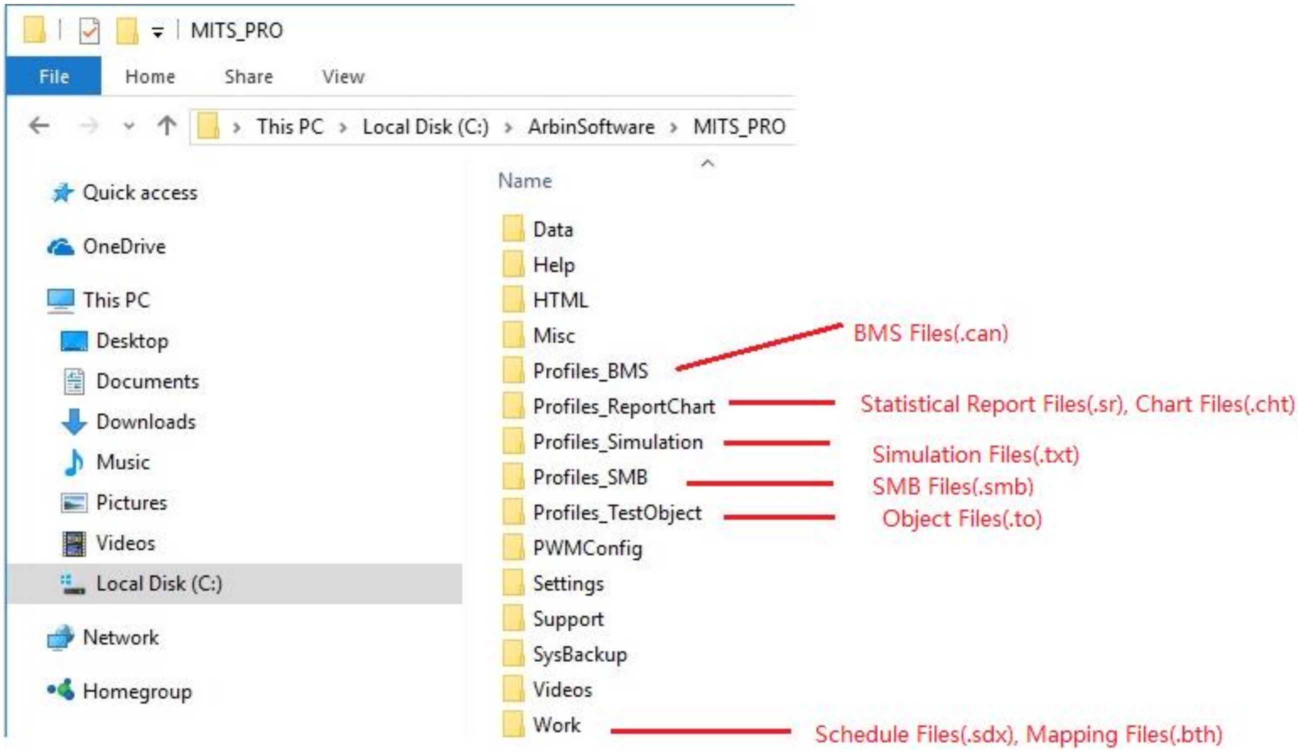


Figure 3-26 MITS Pro8.0 Directory Tree

Chapter 4 User Permission

4.1 Background information

Advanced options for setting up MITSProbably8.0 can be accessed by different accounts with varying levels of authority:

- **Operator** – The "Operator" account has the lowest authority in the MITS Pro 8.0 software. By default, it can only run schedules and edit Mapping file.
- **Administrator** – The "Administrator" account, used by the persons who manage this equipment, has the authority to edit schedules, edit mapping file, and calibration etc.
- **Manufacturer** – This account has the highest authority in the MITS Pro 8.0 software and is for Arbin internal use only.

Higher level can change lower level authorization. Below is a list of operating permissions:

Editing System Config File – Gives permission to modify the ArbinSys.cfg.
Editing Mapping Files -- Gives permission to modify the Mapping file.
Editing Schedule Files -- Gives permission to modify the Schedule file.
Conducting Tests -- Gives permission to conduct tests in the Monitor & Control Window, and allows a user to **start**, **resume**, **jump** or **stop** a schedule.
Conducting Calibration -- Gives permission to conduct hardware calibration in the Calibration window.
Setup SQL Settings -- Gives permission to modify the settings in ArbinSys.DBCF.
PWM Config – This function is under development.

4.2 The Login Form

The "User login/logout" window will automatically pop up when launch the MITS Pro.

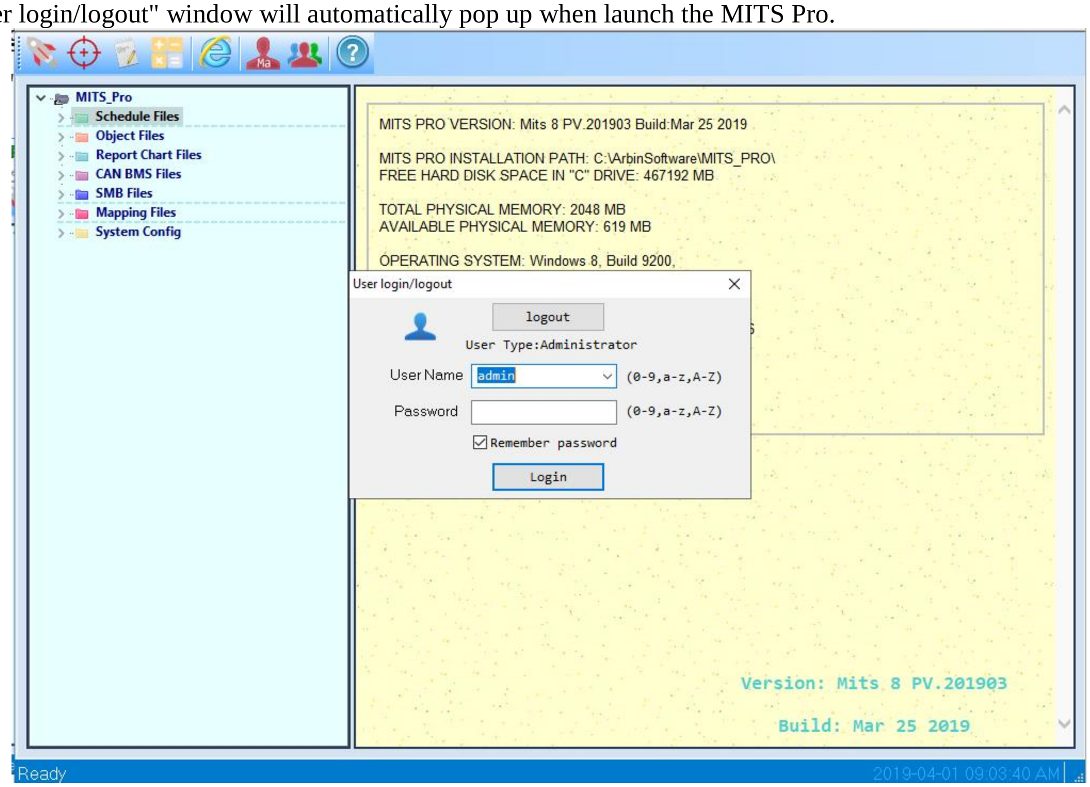
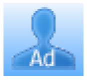


Figure 4-1 The Login/logout Form

Logout: Log out the account and no operation of the software is allowed anymore.
User Type: The type of the current account.
Username: The name of the account (numbers and letters, case sensitive).
Password: Account password (numbers and letters, case sensitive).
Remember password: Remember the password so you can log in next time without typing it again.
Login: Log in account.

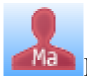
For the first time login, the person in charge of the system should use "User Name: admin, Password: 000000" to log in. Once admin logined, he/she needs to change the password to a secured password. Admin then can add other users at administrator or operator level, setup their password and authorizations.

The “User Login” icon on the toolbar will change color according to user account type.



Blue means “Administrator”.

Green means “Operator”.



Red means “Manufacturer”.

When the mouse is moved to  the account information will be displayed.

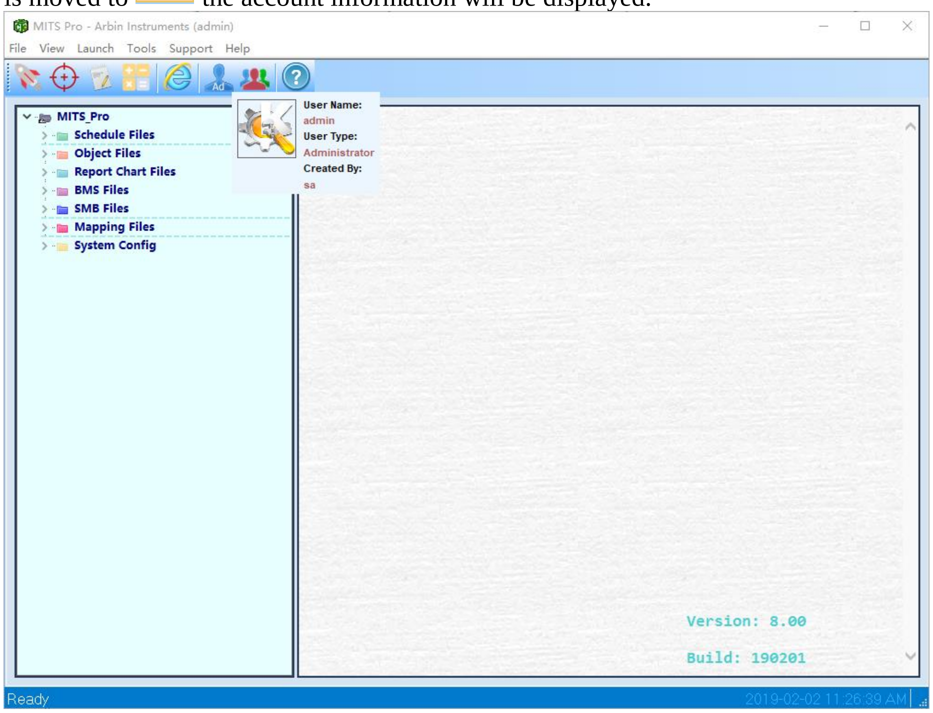


Figure 4-2 The account information

If the admin forgets password, he or she can enter a wrong one. Then click the Login button. This will trigger the password forgotten resolution dialog.

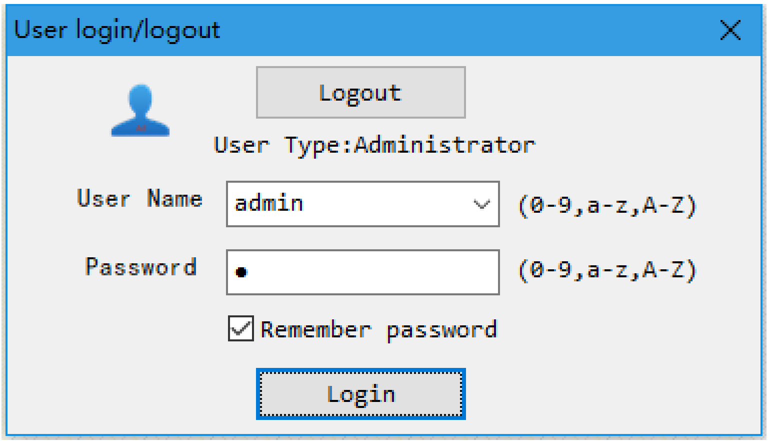


Figure 4-3 Input the wrong password for admin

The dialog reminds you that the password is incorrect. Please click “Yes” if you forgot your password.

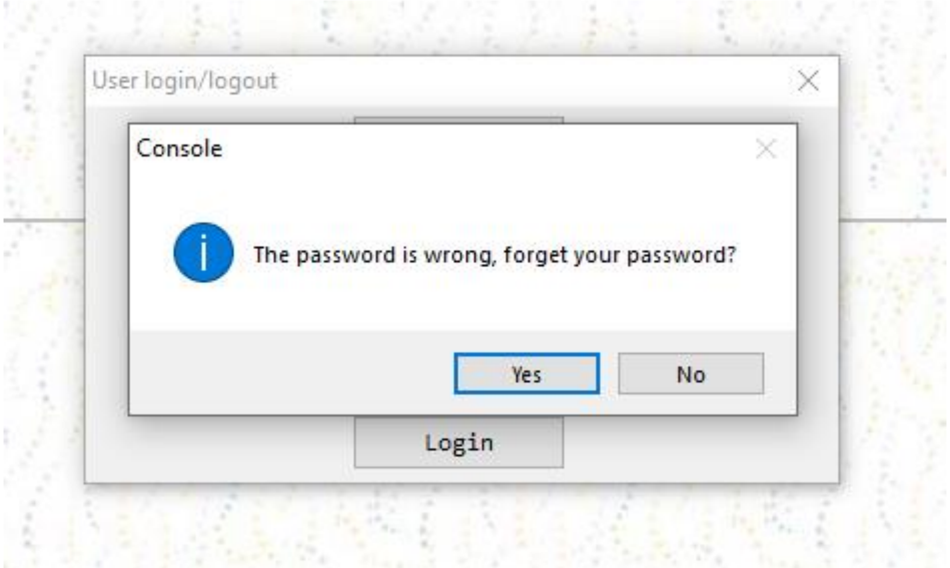


Figure 4-4 The tip of wrong password for admin

Then send the code“MDAwMDAw” (as shown in Figure4-5) to Arbin customer service. Arbin customer service will send the correct password to you according to this code. You can copy the code by left-click of your mouse button.

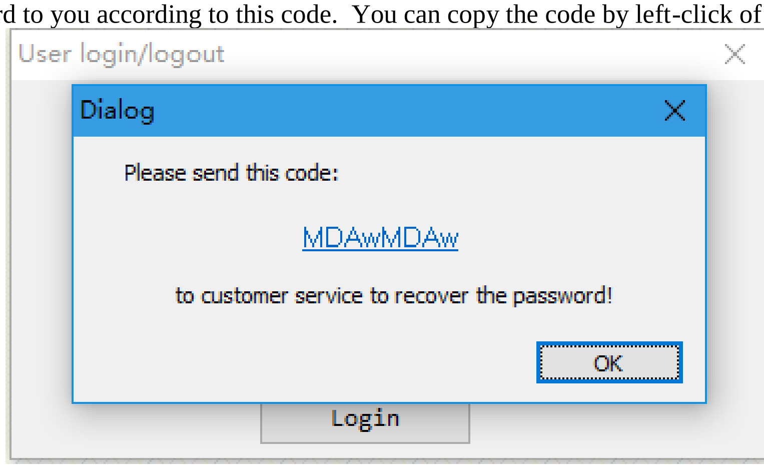


Figure 4-5 The code of admin

For other users, admin can reset the password for them if they forget their password. Please see below.

4.3 User Account Setting

The account name for this demo will use ***admin***. (Note that the account *admin* cannot be added or deleted, it is created by software)

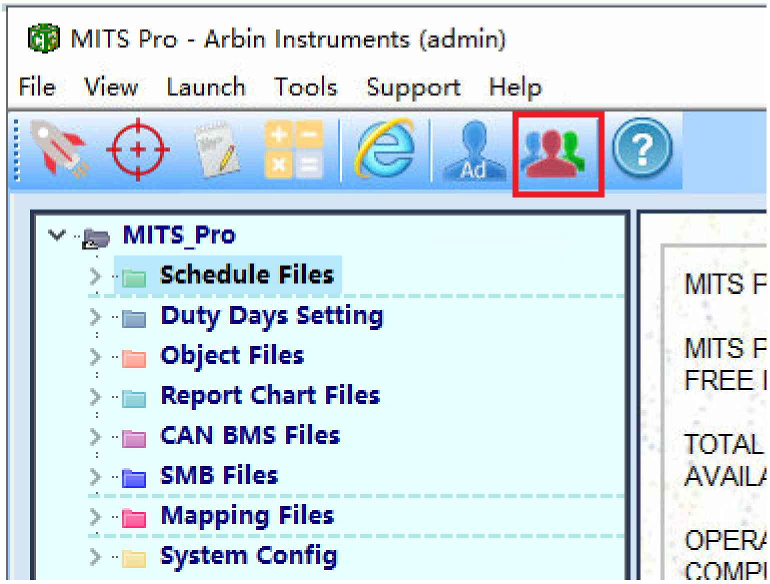


Figure 4-6 Click the User Management button

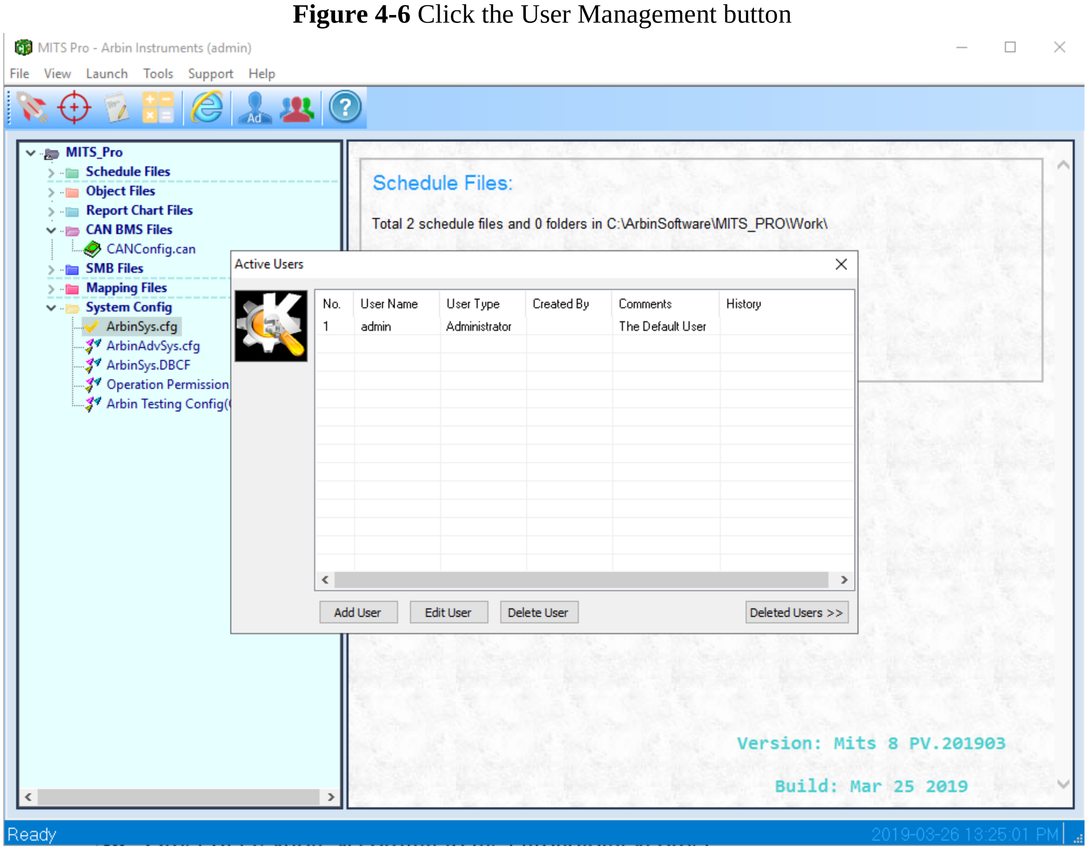


Figure 4-7 the Active Users Window

Below is a list of the Active Users Window:

No.: Order of creation, according to the chronological order.
Username: The name of the account (numbers and letters only, case sensitive).
User Type: The type of account.
Created By: Who created the account.
Comments: A short note about this account.
History: A specific account operation log.
Add User (button): Add new account.
Edit User (button): Edit the account information, including the password.
Delete User (button): Remove the account from the management.
Deleted Users (button): View all deleted account records.

Account Addition

Create a user account named "user1" and password “123” as an example:

Left click on “Add User” button, the new account edit form will be popped up.

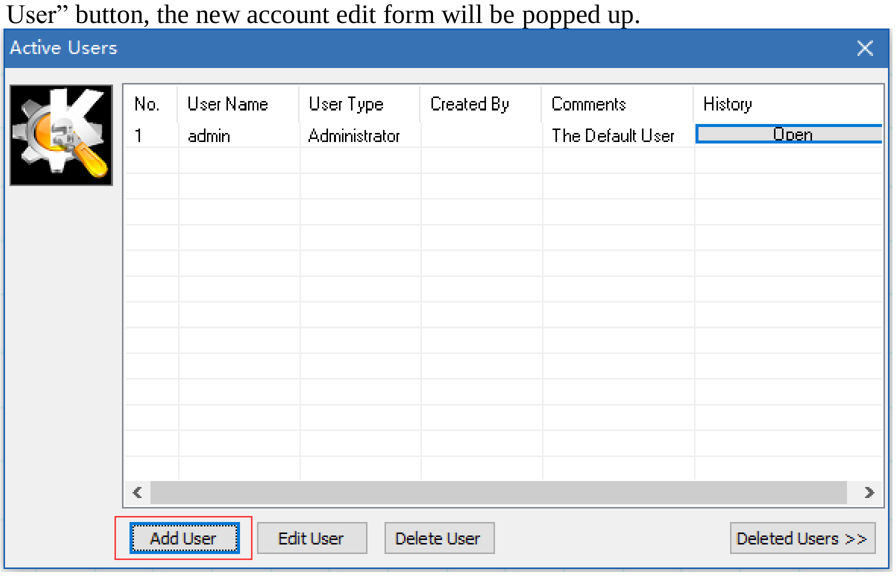


Figure 4-8 Click the Add User button

Fill in the "user1" in the Username, "123" in the Password, and "123" in the Confirm Password. Add a test picture (option), **user Type** selects the Operator and write the notes in the comments. (Reference to Account Edition).

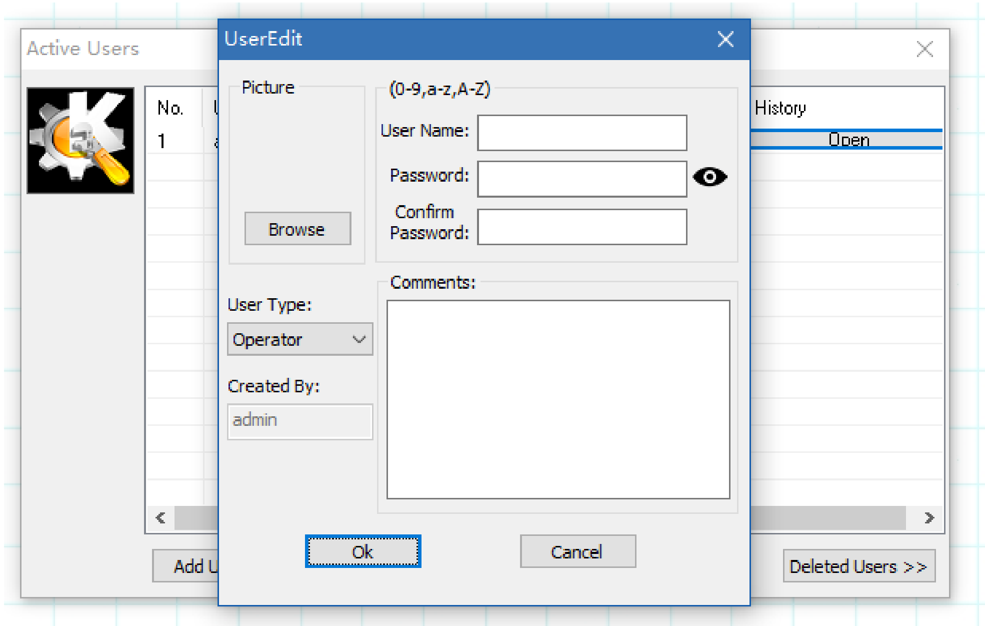


Figure 4-9 The User Edit Window

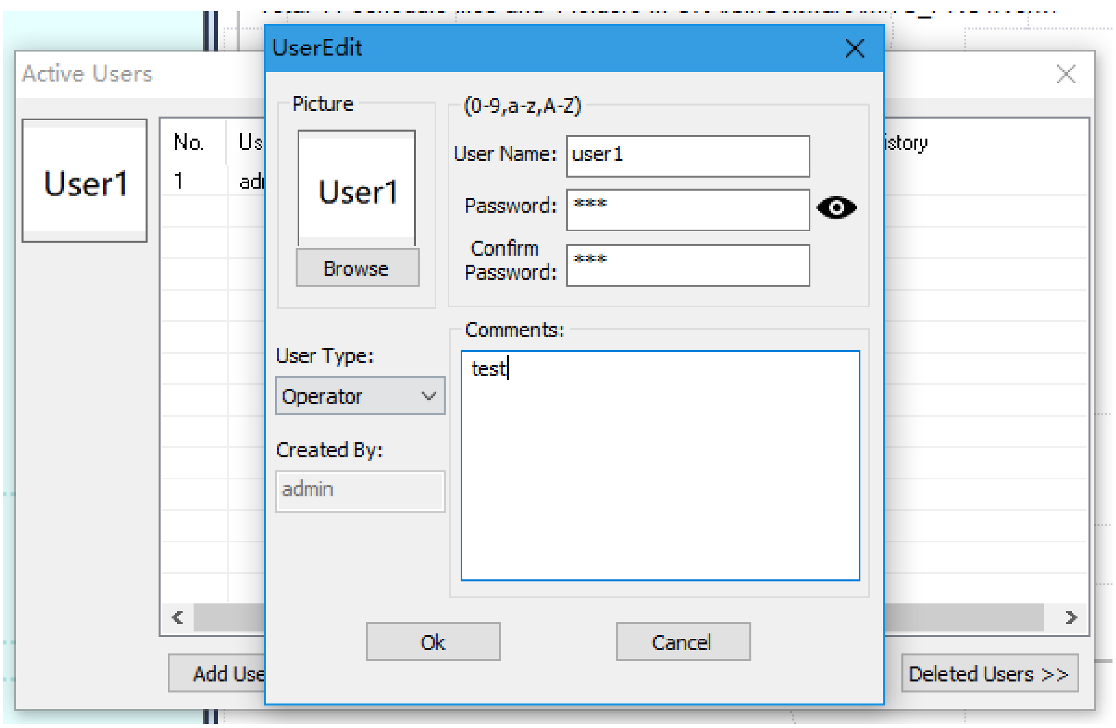


Figure 4-10 Click the Ok button then finish editing

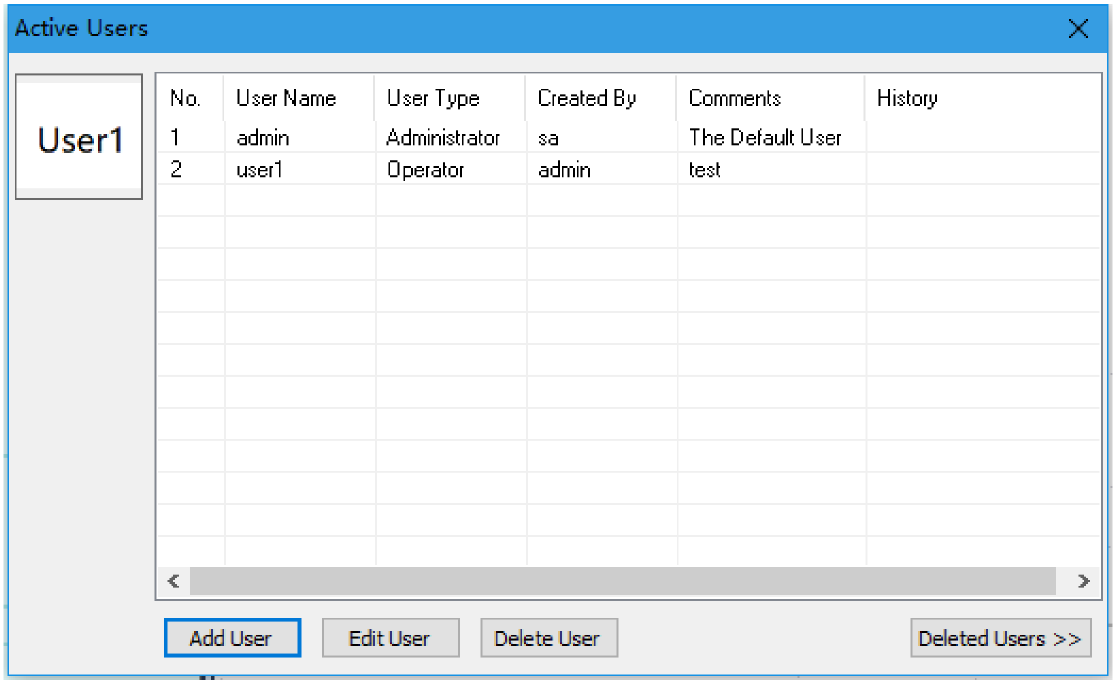


Figure 4-11 The account information is displayed in the form

Account Edition

Let’s edit the default account **admin**, to make an example.
Left click on the row with No at "1" (first row) in the table, select it, and then click "Edit User" to pop up the edit window.

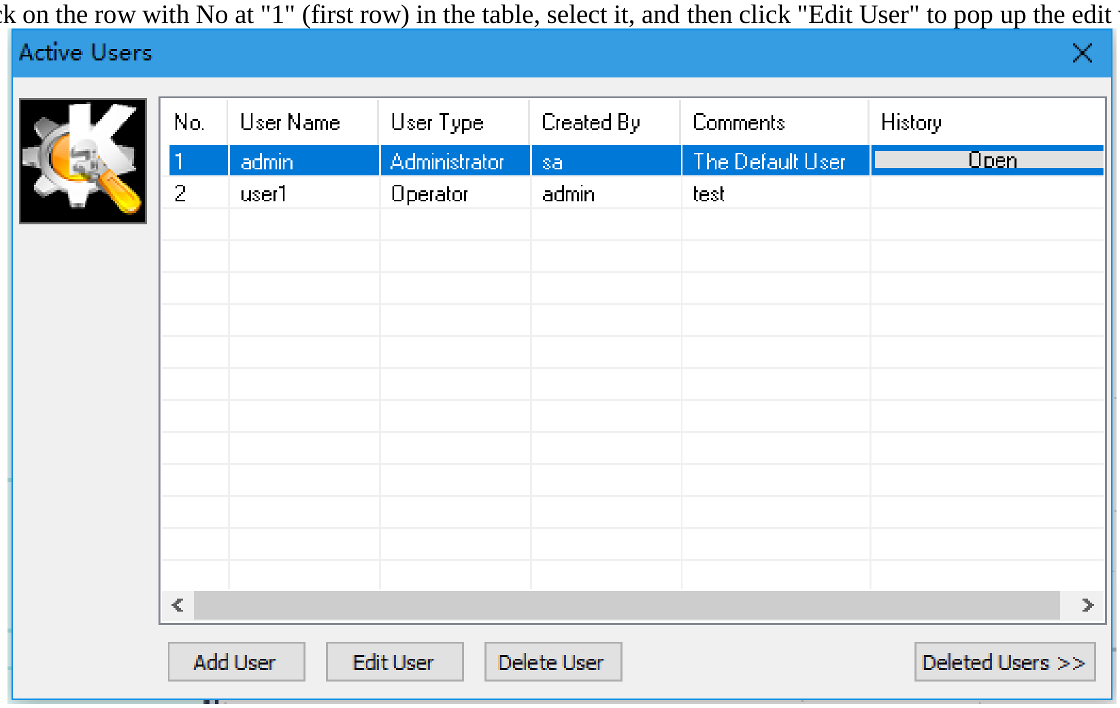


Figure 4-12 choose the admin then click the Edit User

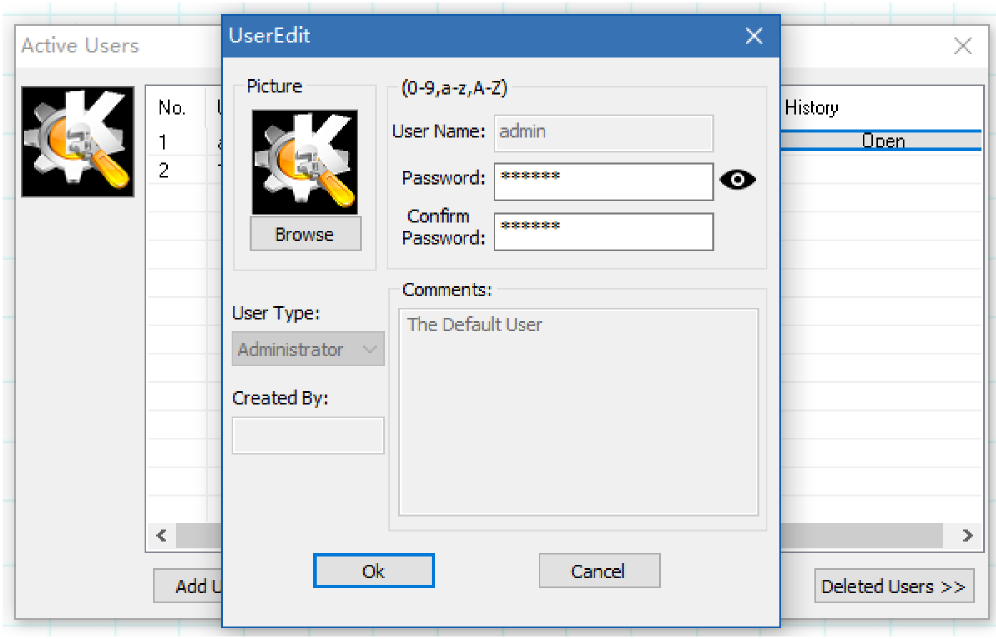


Figure 4-13 The User Edit Window

Below is a list of The User Edit Window:

Username: The name of the account ("admin" is reserved and not allowed to change).
Password: Change the password of the account.
Confirm Password: Enter the password again to ensure correctness.
Browse: the picture that can be used to identify the account (option)
User Type: Type of account (refer to account type)
Created By: Explain who created the account
Comments: Description of the account (the example account "admin" cannot change Comments).

This time, the picture and password (password is 123) have been modified for the "admin" account. Then click the "OK" button.

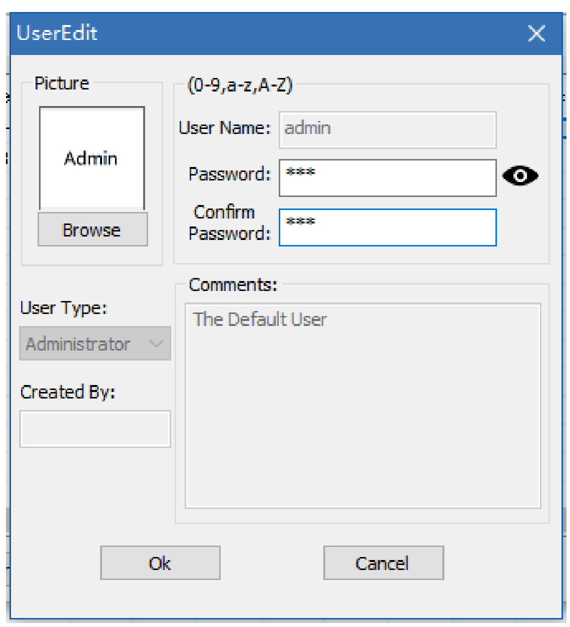


Figure 4-14 Modify the password for admin

Account Deletion

In the account list, left click on the account you want to delete and click on “Delete User”. A confirmation window pops up, select "OK" to confirm it.

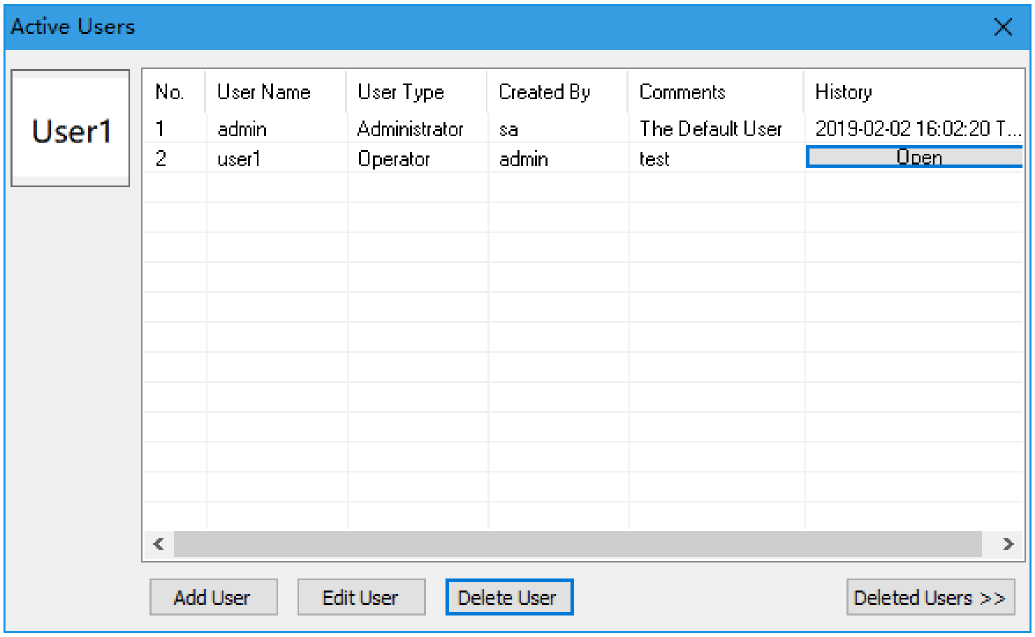


Figure 4-15 Choose a user

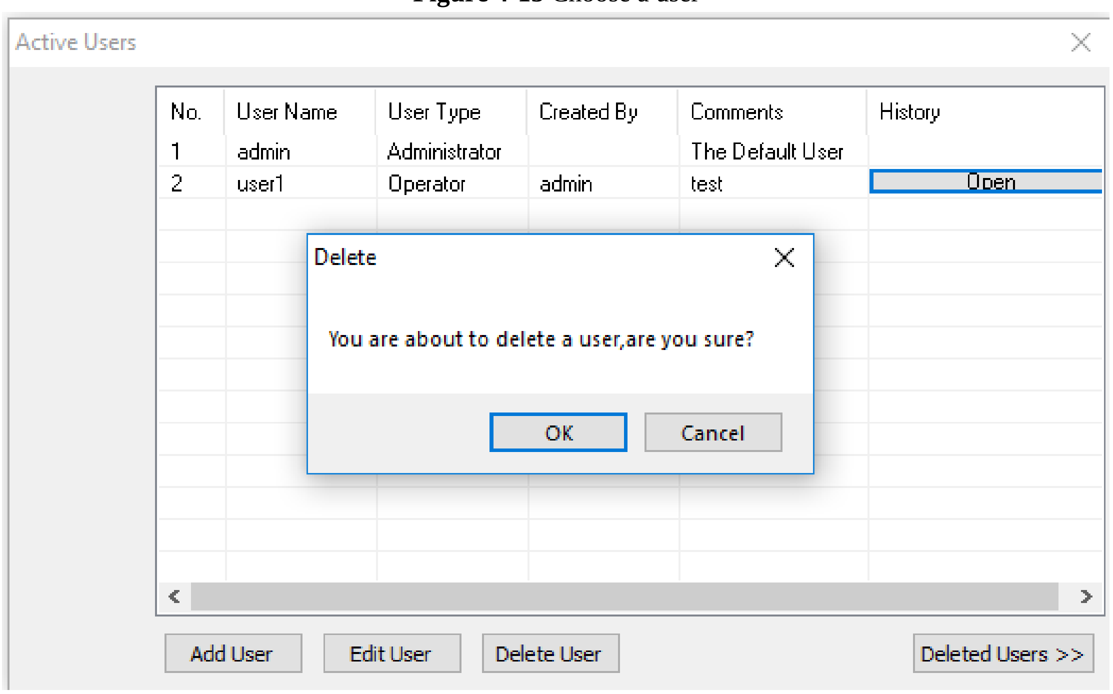


Figure 4-16 Delete a user

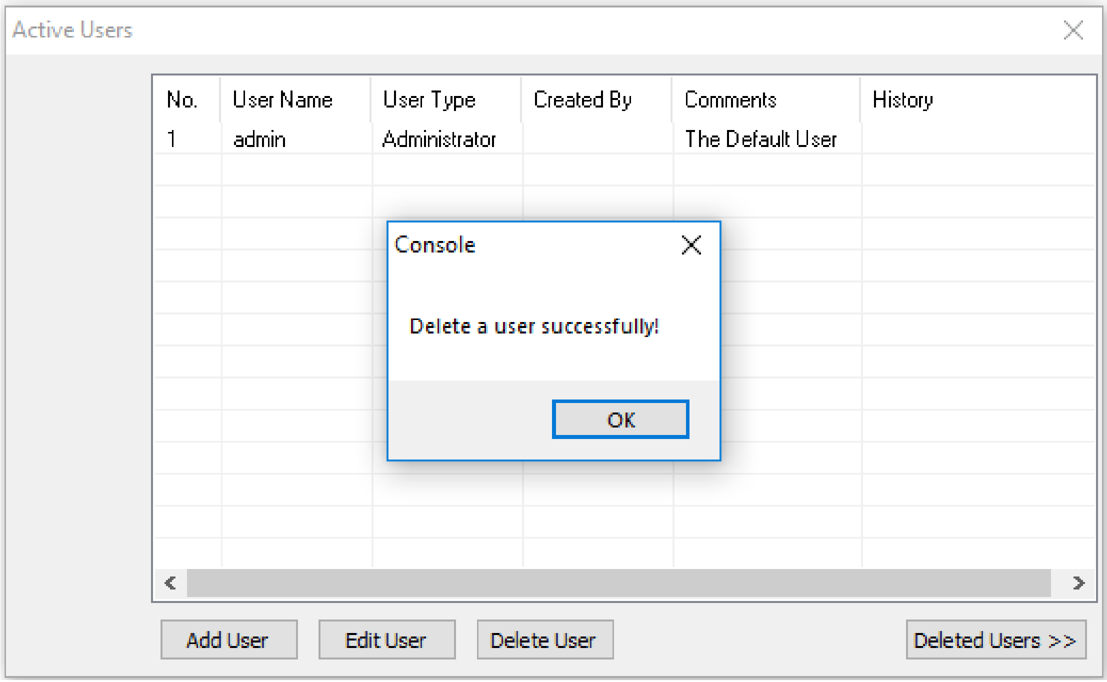


Figure 4-17 Delete a user successfully

The action of deleting the account will be recorded in a log record.
Left click on “Deleted Users >>”button to display the log record.

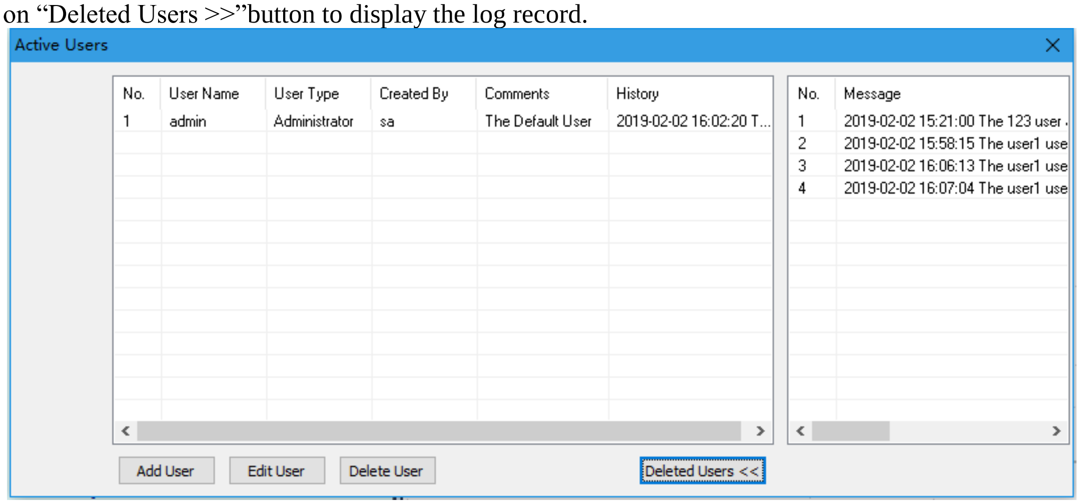


Figure 4-18 The Message is displayed in extension window

Account Type

Account Type determine the following functions：
The permission of **Add User**, **Edit User** and **Delete User**.
Manufacturer type account has the highest authority to modify the other user’s information.
Administrator type account: Special administrator account, “admin”, can change, add, or delete information for any other user accounts. Regular administrator accounts similar to admin, except not allowed to change the password of another administrators.
Operator type account can only change its own information (including passwords, browse and comments, but usernames and user types cannot be modified).

Account operation record

Left click the item "admin", then you can find the "open" button is displayed in the "History" column, and click this button.

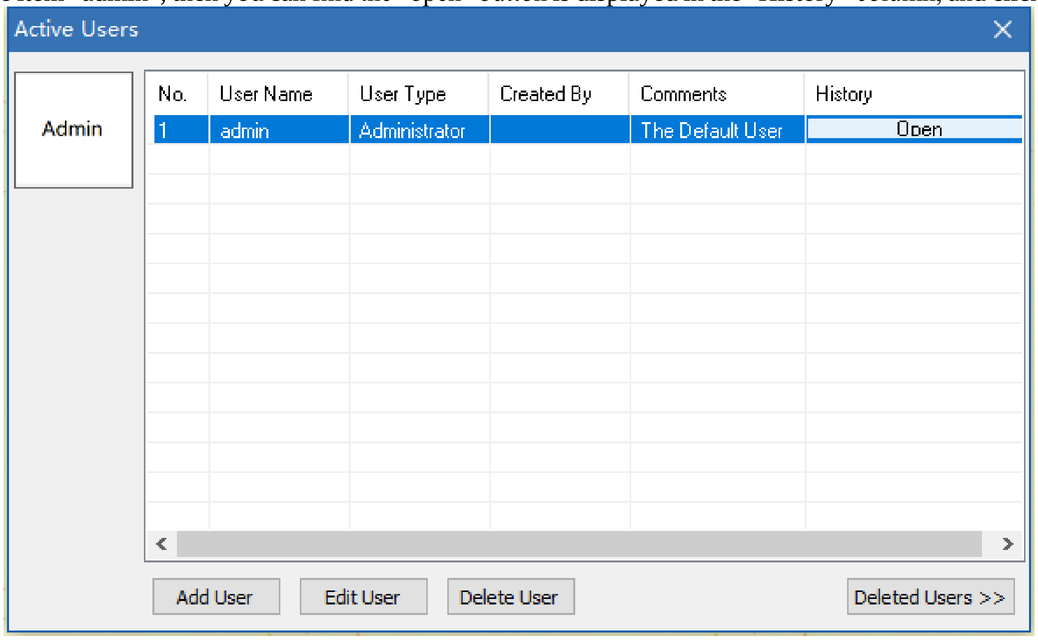


Figure 4-19 Click the Open button in the History column

As you can see, there are two historical records: modifying the password and modifying the operation permission for Operators

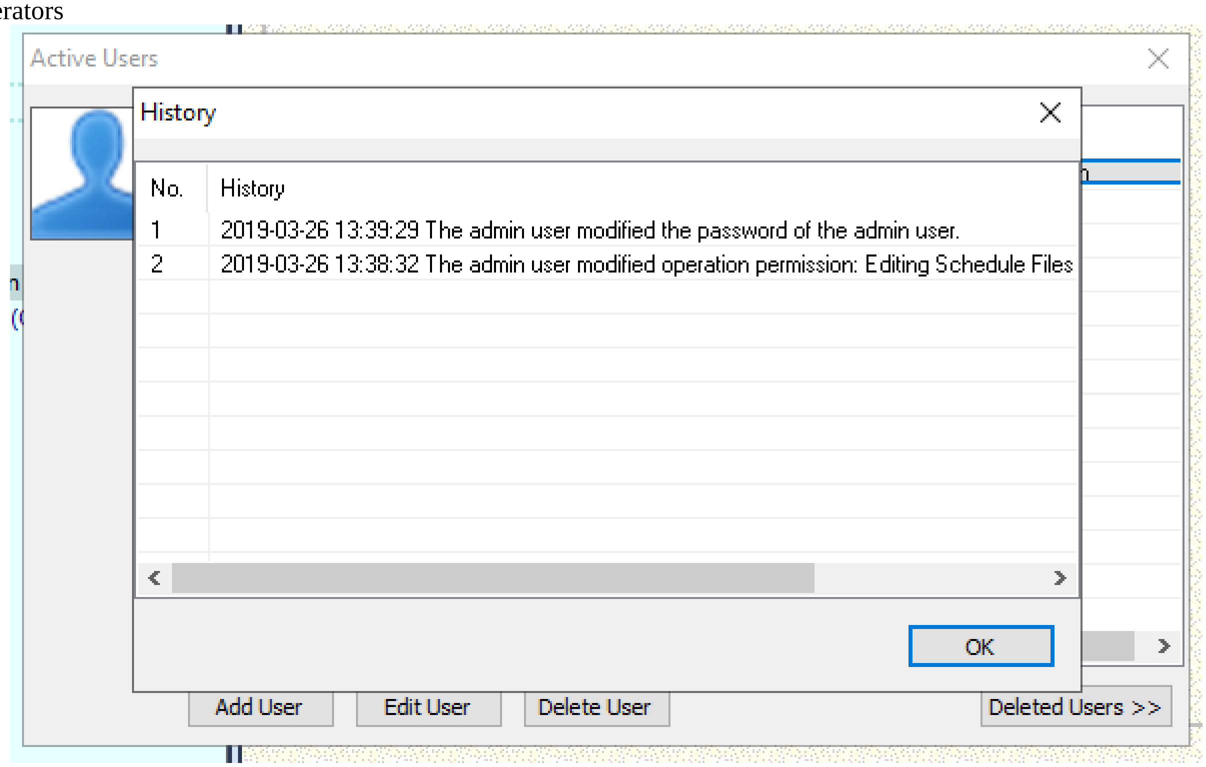


Figure 4-20 The History Window

For example, admin can enable Operator type of user to “Edit Schedule Files.”, and this action will be recorded in the history of admin as shown in the record of No.2.

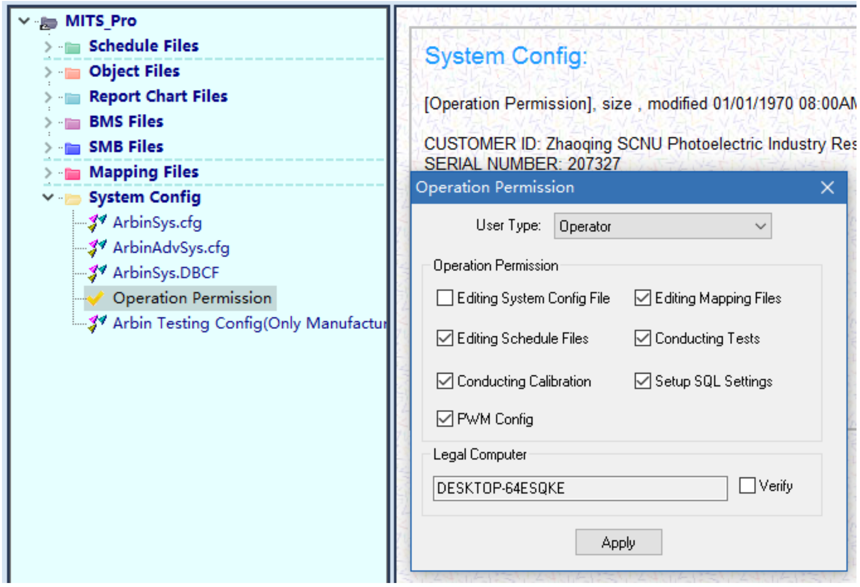


Figure 4-21 Check the Editing Schedule in Operation Permission

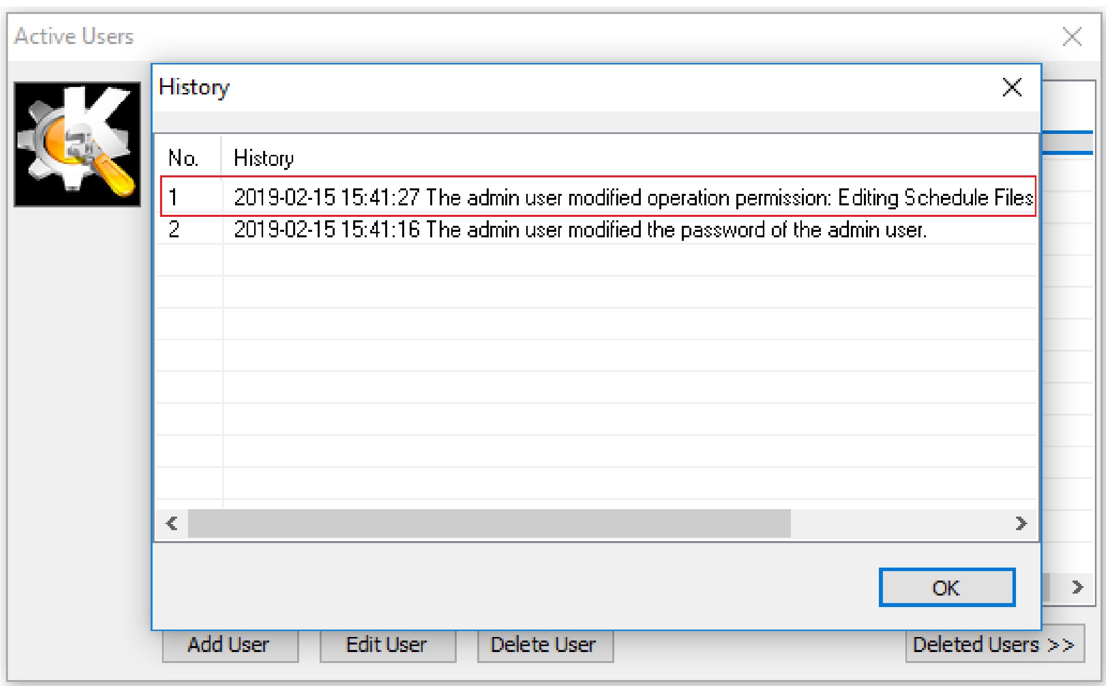


Figure 4-22 The record in the History Window

In Edit User, admin changed password, and this action is recorded in the history, too.

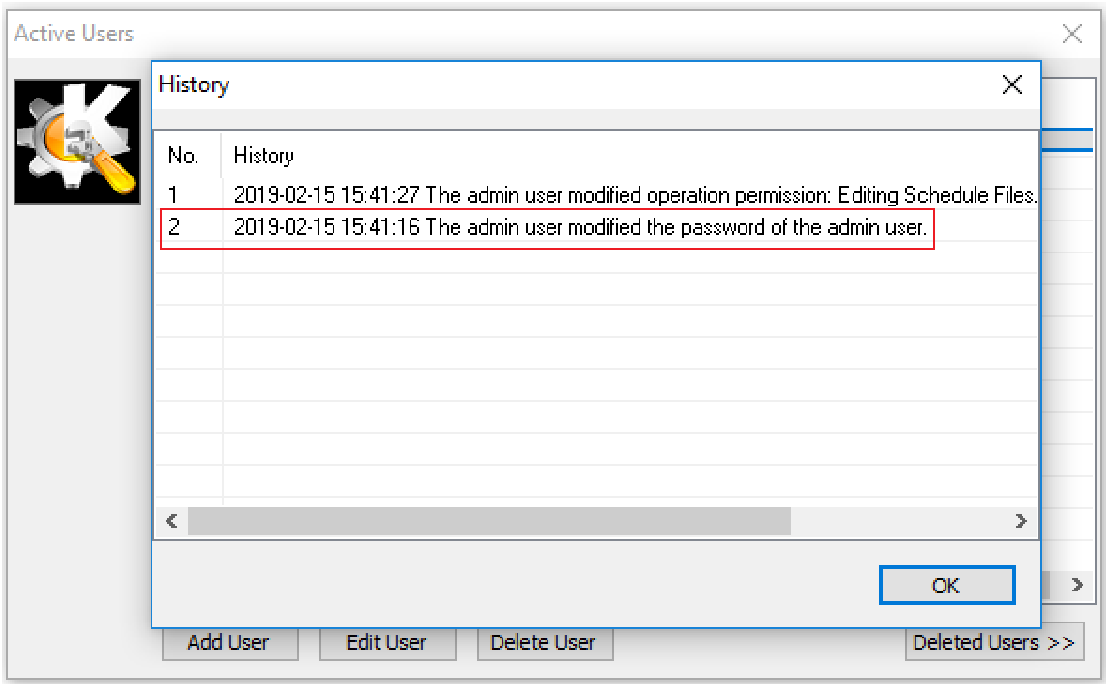


Figure 4-23 The record in the History Window

Chapter 5 Test Schedule

5.1 What is a Schedule?

A schedule is a user-defined test procedure. Each schedule is a combination of sequential steps that are defined.

- A controlling test function and its value,
- The termination conditions for each step,
- The next step that the testing is scheduled to go to when the present step is finished.
- Data logging criteria.

Stored in a file with an extension of *.sdx, each schedule may consist of as many steps as desired. Once the test schedules are defined, each schedule can then be assigned to any channel (s).

A schedule is divided into up to 7 pages (depending upon system configuration options)-the **Global**, **Log**, **Step/Limit** , **Formula**, **Pulse**, **Cyclic Voltammetry** and **Test Setting** (only for systems with the third-party temperature chambers, AIAO and DIDO signals) pages.

User can choose a way of creating or opening a new/existing schedule in a Classic Mode or New Mode by clicking Support=>Setup Schedule Editor Mode (**Figure 5-1**).

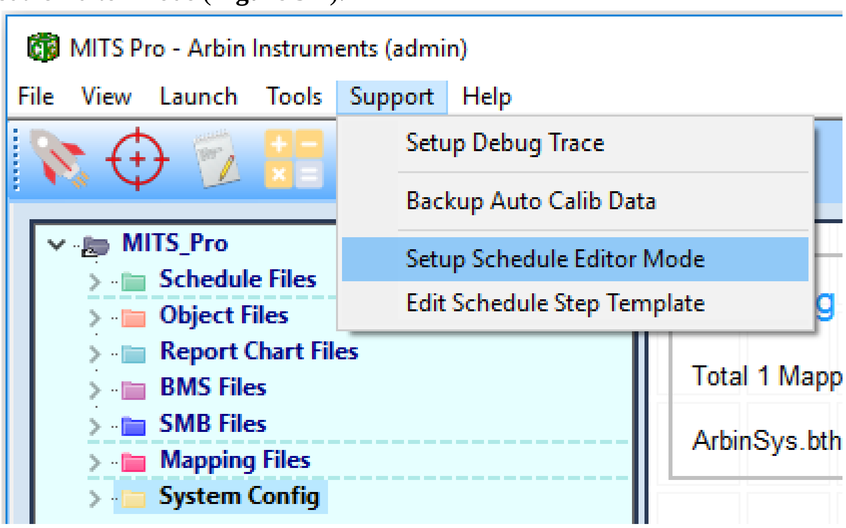


Figure 5-1 Setup Schedule Editor Mode Selection

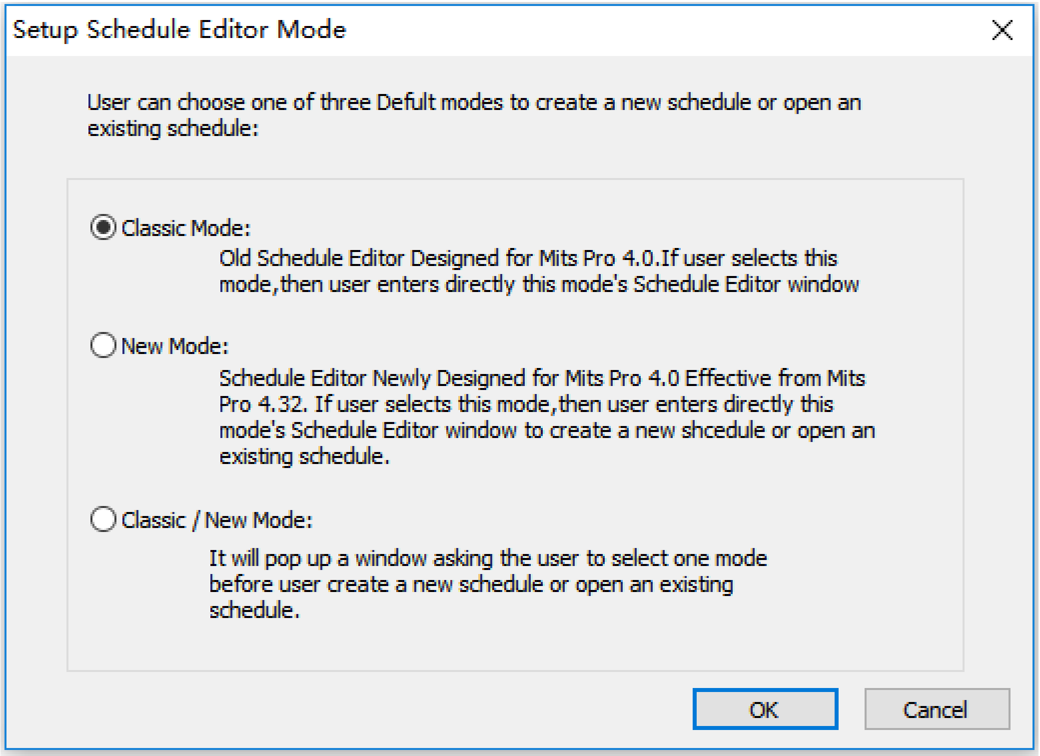


Figure 5-2 Setup Schedule Editor Mode Window

See also

- Creating a Schedule
- Global Page of a Schedule
- Log Page of a Schedule
- Creating and Editing Steps
- Creating and Editing Limits
- Copying and Pasting a Step/Limit
- Creating and Editing Pulse Control
- Creating and Editing a Formula
- Creating and Editing a Cyclic Voltammetry Control
- Creating and Editing Simulations
- Creating Test Settings profile

5.2 Creating a Schedule

New TestObject File

What is a TestObject? This file describes the important physical properties of the test objects, such as battery, super capacitor and others, which is to protect the test object during the test.

Right-click the **Object Files** folder in the left pane of the main window; then select **New Test Object File**.

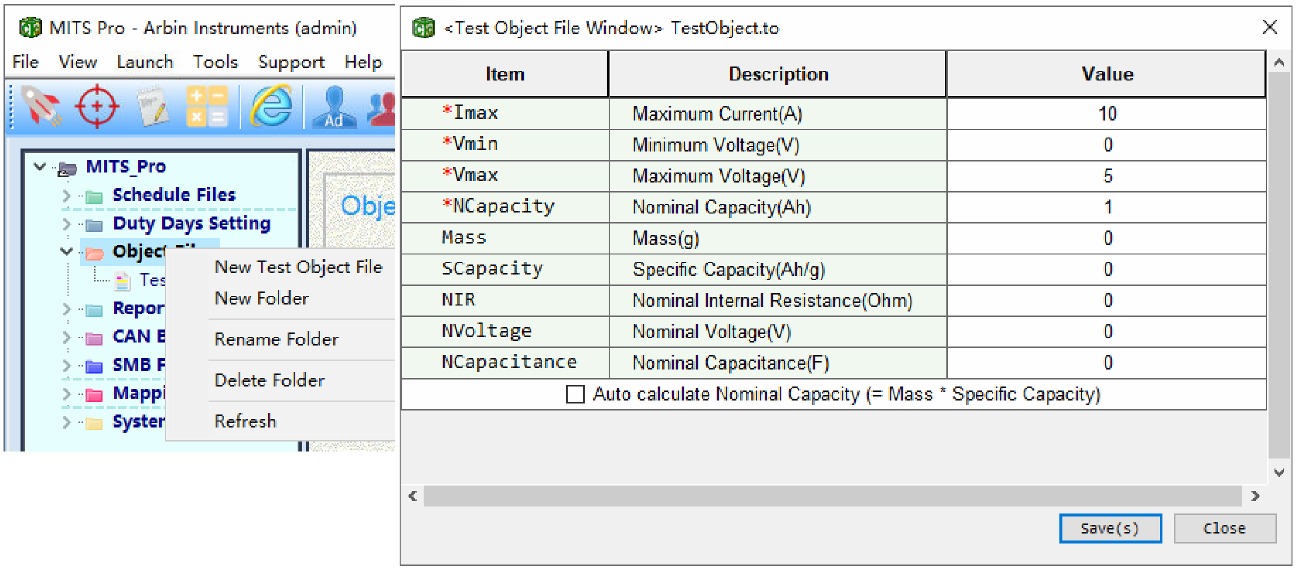


Figure 5-3 New Test Object file

When checking the Auto calculate Nominal Capacity in Test Object file, the value will be filled in NCapacity area according to the formula: Mass * Specific Capacity.

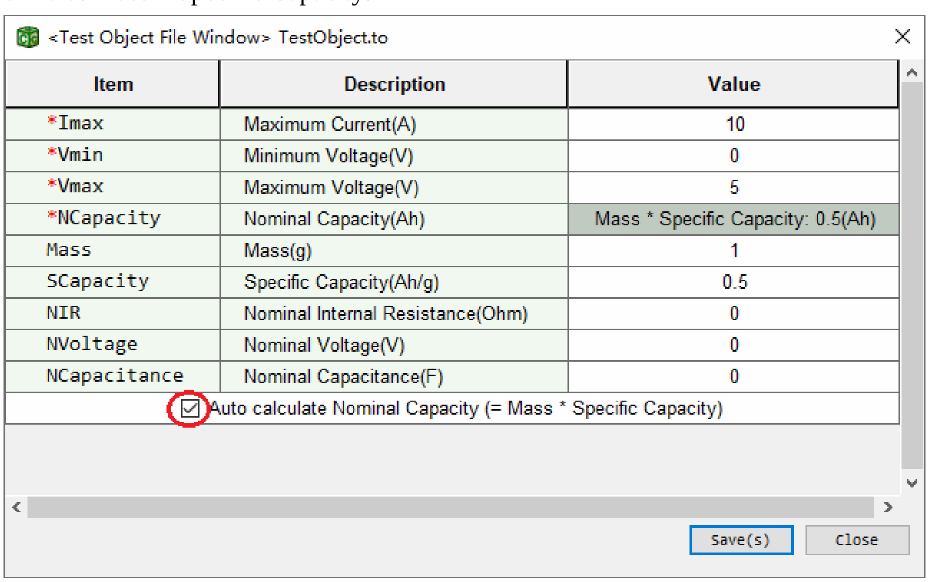


Figure 5-4 Check the **Auto calculate Nominal Capacity**

New Schedule File/Folder

Right-click the **Schedule Files** folder in the left pane of the main window; then select **New Schedule File/New Folder**. User can rename the new schedule file. **Note no space, insteaded by underscore, in the name.**

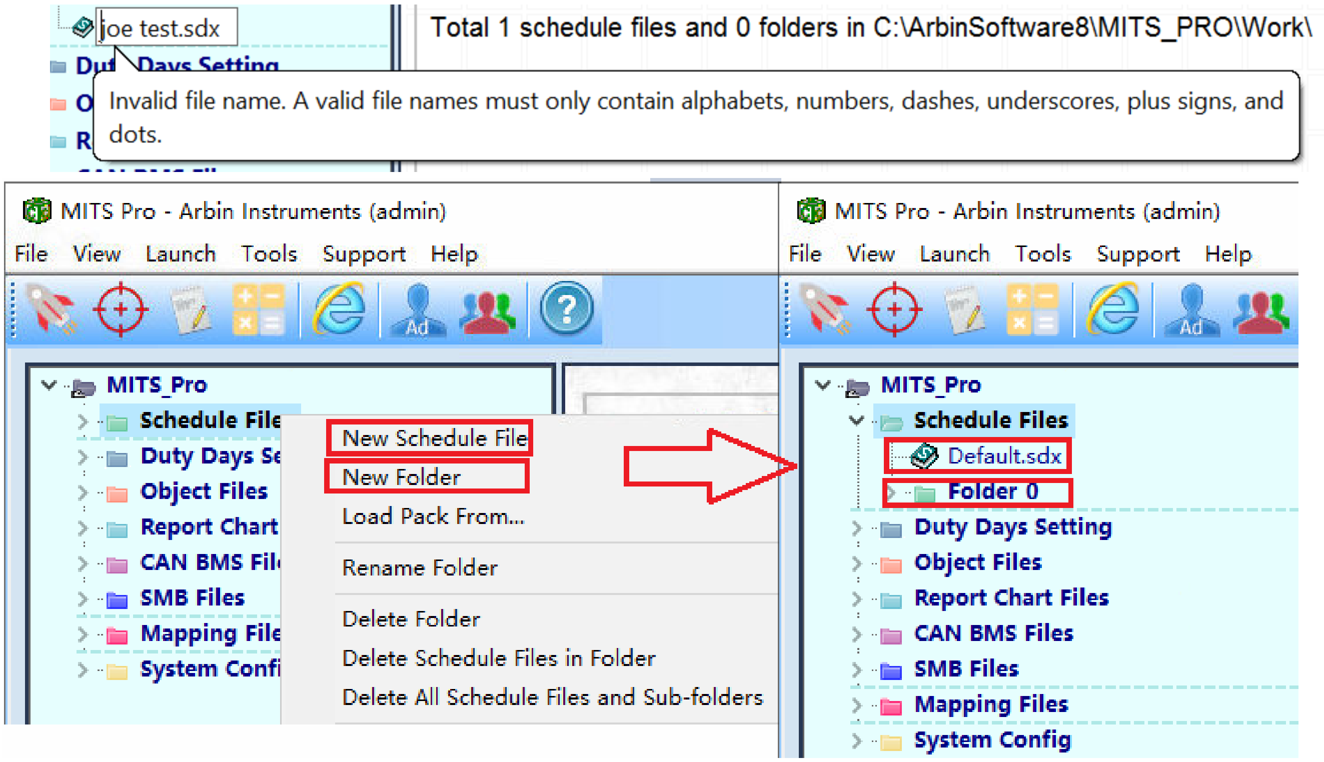


Figure 5-5 Creating a new schedule/folder

How to assign a Test Object File

1. Open the newly added schedule file by double-clicking its icon or by right clicking the icon and then selecting "Open". After opening the schedule file, it will go to the **Global** page for the user to set a Test Object file and Safety information. **Without a Test Object file and Safety information, the user can not save a schedule.** There will be warning messages to remind the user to assign a test object file first, as shown in **Figure 5-8.**

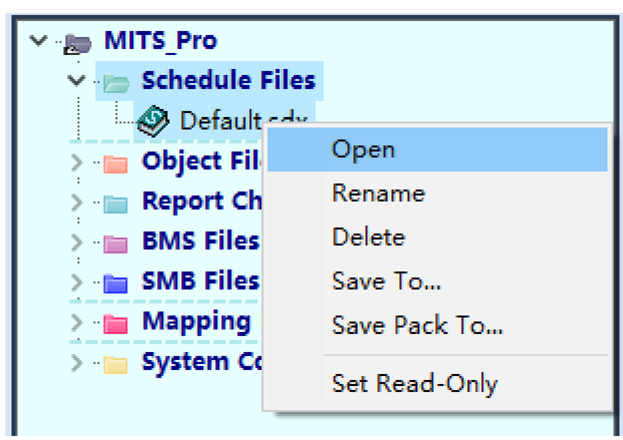


Figure 5-6 Opening a new schedule file

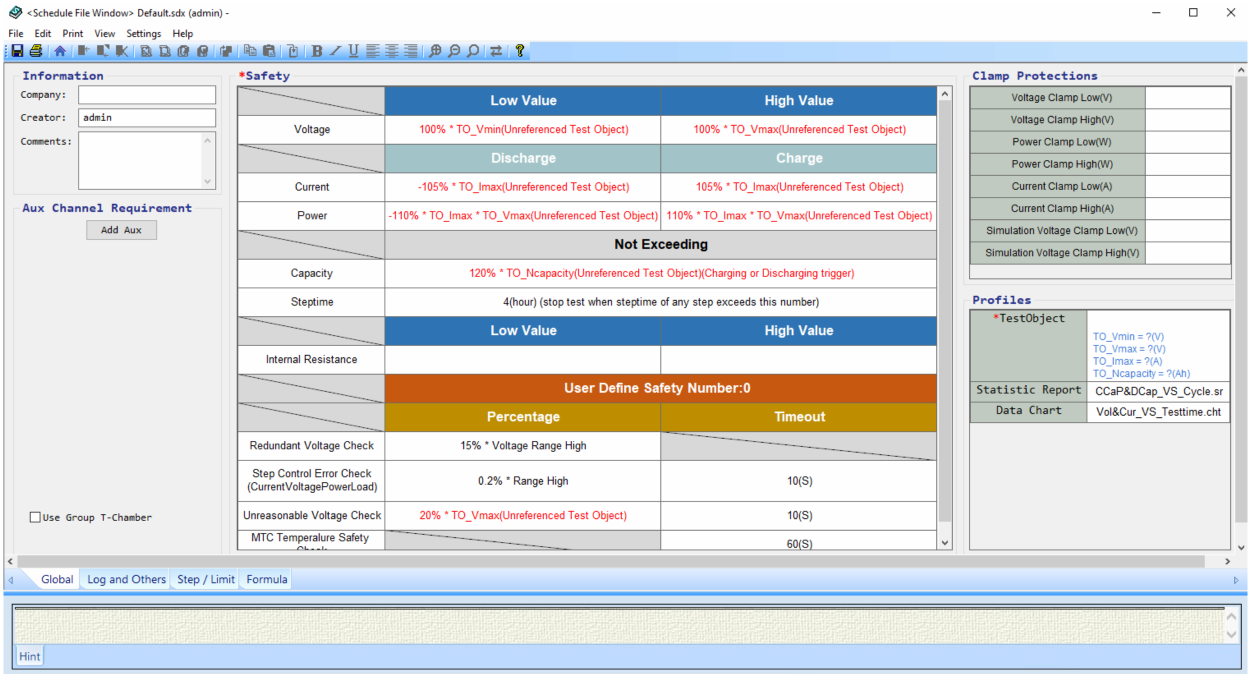


Figure 5-7 New schedule file is opened to the Global Page

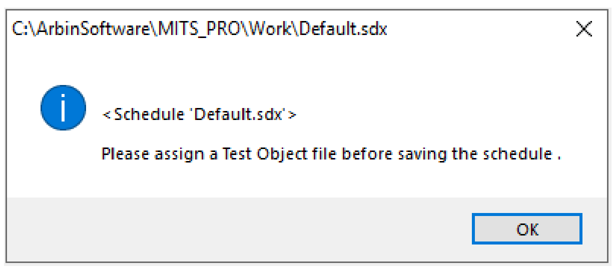


Figure 5-8 Warning when Trying to Save a Schedule File without assigning a Test Object file

2. In the **Global** page of the schedule, assign a Test Object File. The user can edit the Object File in the Object File directory by right clicking the Edit box and then selecting Open to edit the test object file.

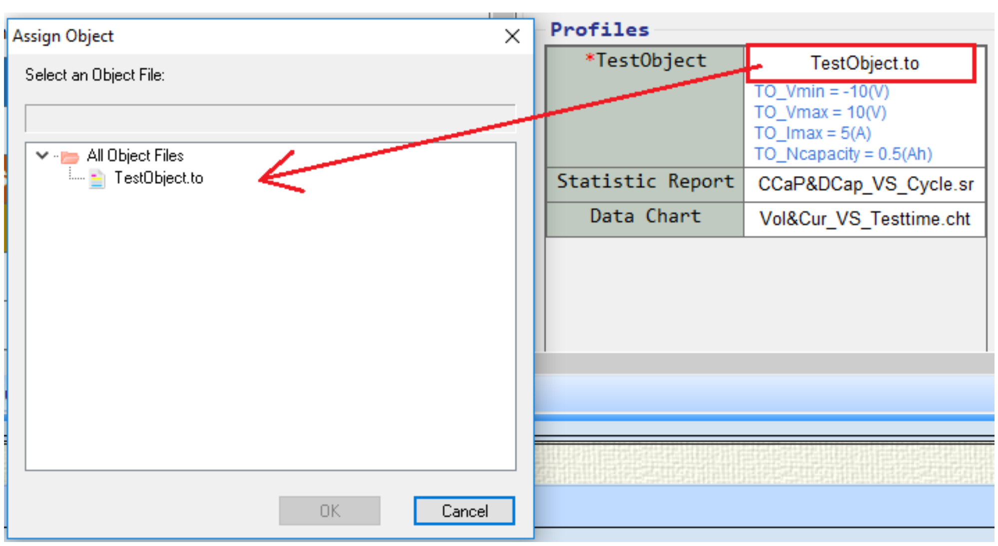


Figure 5-9 Assign a Test Object file

3. The schedule file is opened in the form of a tabbed window. You can switch between different pages by clicking the page name on the left bottom of the window (**Figure 5-11)**. Note: page options follow system configuration (ArbinAdvSys.cfg) settings. See Appendix D: System Configuration Description. The default page is the **Global** page shown in **Figure 5-7**.

*Safety

	Low Value	High Value
Voltage	100% * TO_Vmin(Unreferenced Test Object)	100% * TO_Vmax(Unreferenced Test Object)
	Discharge	Charge
Current	-105% * TO_Imax(Unreferenced Test Object)	105% * TO_Imax(Unreferenced Test Object)
Power	-110% * TO_Imax * TO_Vmax(Unreferenced Test Object)	110% * TO_Imax * TO_Vmax(Unreferenced Test Object)
	Not Exceeding	
Capacity	120% * TO_Ncapacity(Unreferenced Test Object)(Charging or Discharging trigger)	
Steptime	4(hour) (stop test when steptime of any step exceeds this number)	
	Low Value	High Value
Internal Resistance		
	User Define Safety Number:0	
	Percentage	Timeout
Redundant Voltage Check	15% * Voltage Range High	
Step Control Error Check (CurrentVoltagePowerLoad)	0.2% * Range High	10(S)
Unreasonable Voltage Check	20% * TO_Vmax(Unreferenced Test Object)	10(S)
MTC Temperature Safety Check		60(S)

Figure 5-10 Safety Limits in Schedule Global Page

4. On the **Global** Page, enter the information in the Company and Creator and Comments. Set the safety limits. Assign profiles. Add Aux-channel(s) if any step in the schedule is set by aux-channel(s) values.

Note: data logging options follow system configuration (ArbinSys.cfg) settings. See **Appendix D**: System Configuration Description for details of system specification in the configuration file.

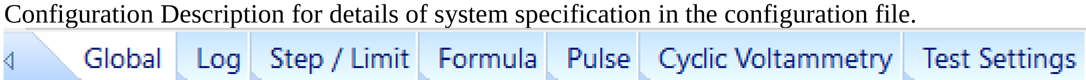


Figure 5-11 Switching between Schedule Page Tabs

5. Click the **Step/Limit** tab to switch to the **Step/Limit** page as shown in **Figure 5-12**. The Screen now displays the main schedule editing page (Step/Limit Page). **Figure 5-12** shows the step view of schedule editor in a classic mode. By clicking Limit View icon from the tool bar menu, schedule editor will be shown in the Limit View as shown in **Figure 5-13**. By clicking Step View icon from the tool bar menu, schedule editor will be displayed in Step View (**Figure 5-14**).

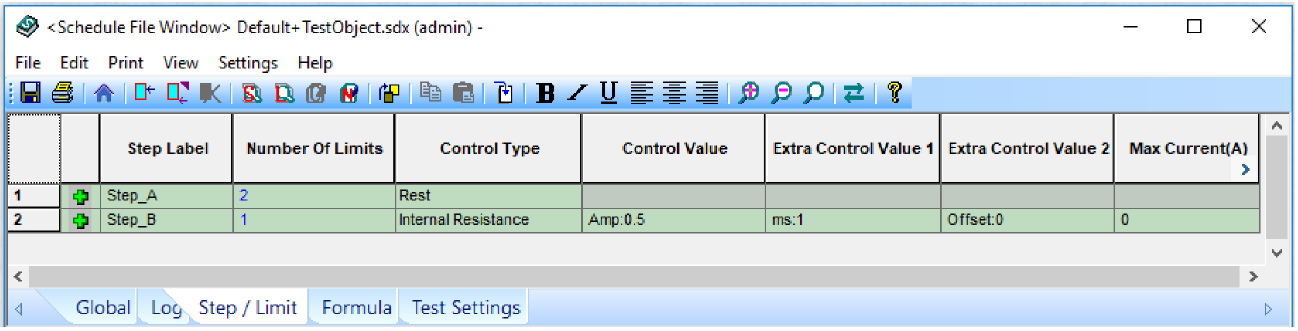
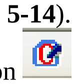


Figure 5-12 Schedule Editor in Step View, Step/Limit Page

6. In MITS Pro 8.0, there are two ways of editing schedule files. Users can switch schedule editor modes by selecting New Mode or Classic Mode.

Figure 5-13 shows a schedule file in Classic Mode. By selecting New Mode from **View** - **New Mode**, or clicking the New Mode icon  from the tool bar menu, the schedule file window will be displayed in New Mode (**Figure 5-14**). The schedule file window can be switched back to the classic mode display by clicking the Classic Mode icon  from the tool bar menu or choosing **View** - **Classic Mode**.

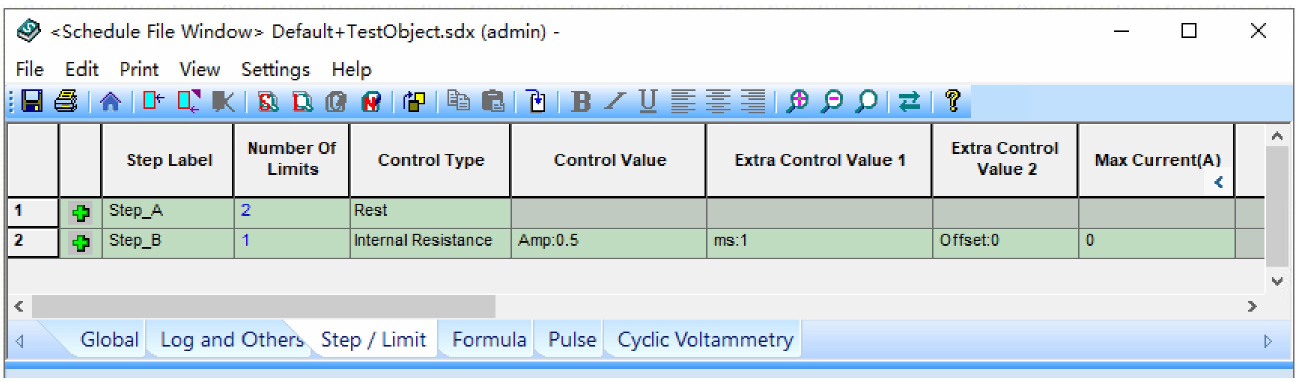


Figure 5-13 Schedule Editor in Limit View, Step/Limit Page (Classic Mode)

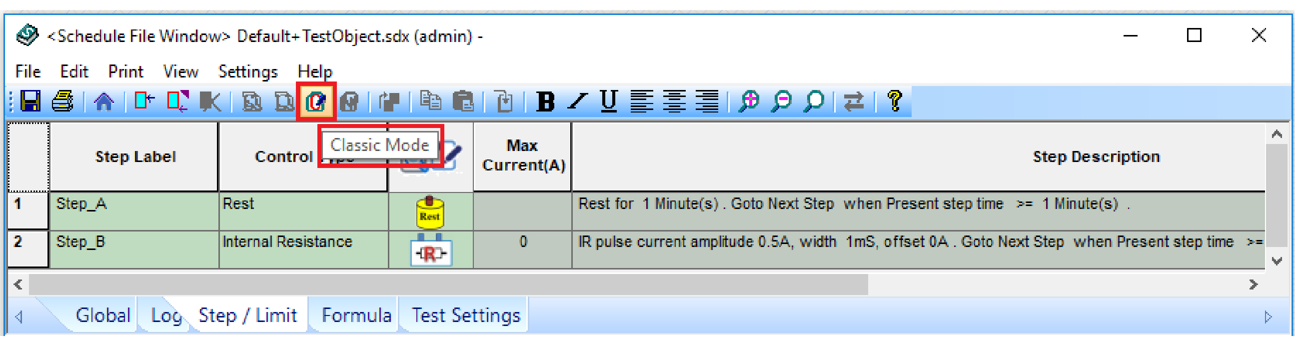


Figure 5-14 Schedule File Window Displayed in New Mode

7. In MITS Pro 8.0, there is a Show or Hide Col. icon  to show or hide unused columns in a schedule **(Figure 5-15)**.

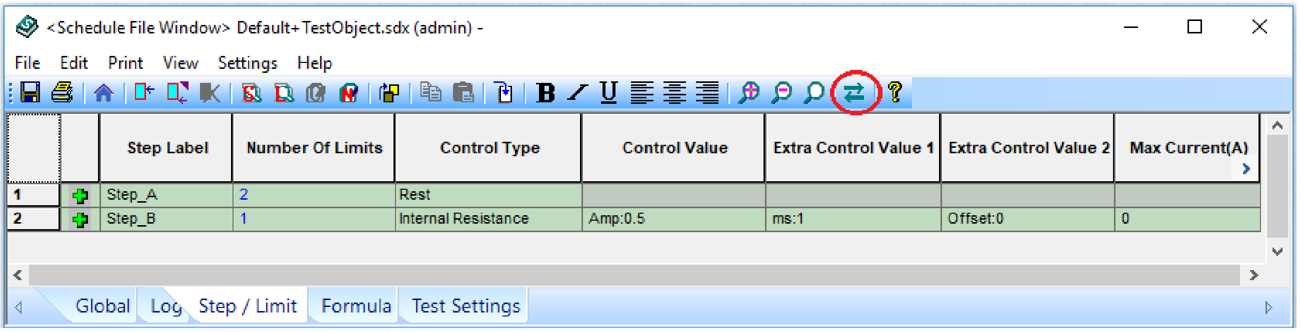


Figure 5-15 Show or Hide Col of Schedule File Window

How to Save a Schedule

8. Click “File” on the menu; click “Save” to save the schedule file with the original name or click Save as to save the schedule file as a new file (**Figure 5-16**).

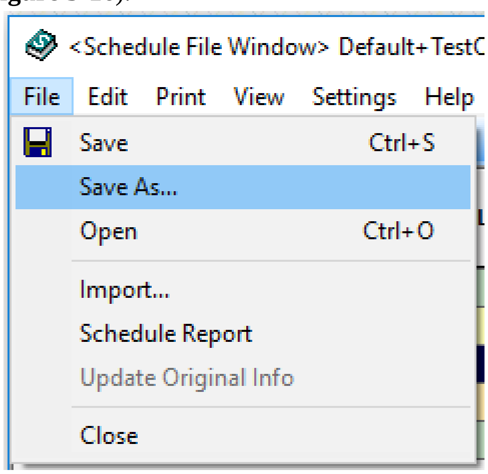


Figure 5-16 Saving a Schedule

Alternatively, click on the diskette icon in the tool bar menu as shown in **Figure 5-17**.

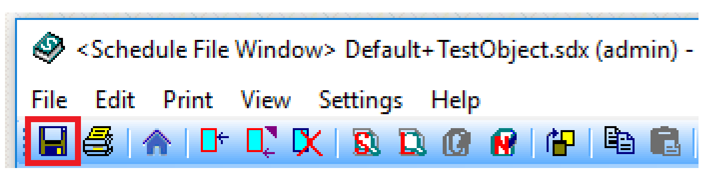


Figure 5-17 The Save Icon

5.3 Creating a Schedule Template

MITS Pro 8.0 provides the ability to save a **Template** which the user can assign in future steps or schedules. The **Template** itself acts as a copy/paste function.

In New Mode, left click over the icon  in the field of . The control type window will pop up. One can edit **Control Parameters** information in the top region of this window.

Once complete control parameters and Step/Log limits have been written, the user can save this certain format as a **Template** (**Figure 5-18**). Click the Save As Template button and assign a schedule template name: for example, Current 3A. After assigning a name and clicking Ok, "Current 3A" will be shown in the pop list of Select in Template area of top right side.

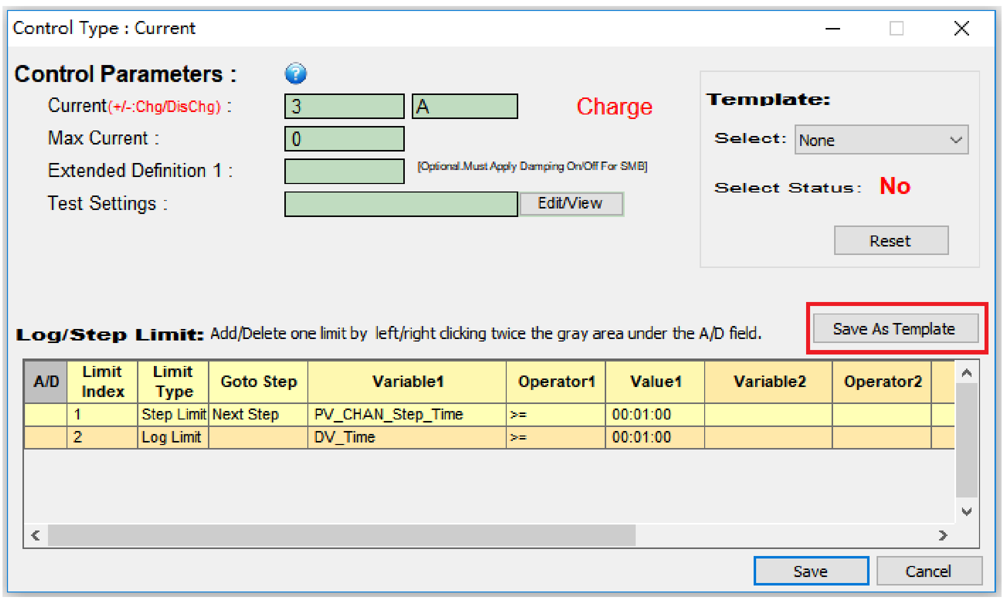


Figure 5-18 Save a Template

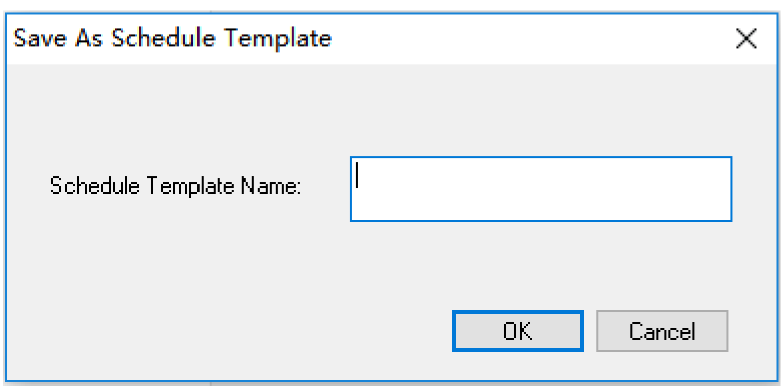
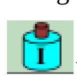


Figure 5-19 Naming a Schedule Template

To select a saved control type template, click the icon  to open the Control Type window. Click "template", a list of all available templates associated with the control type appears in the drop-down box under Template. By selecting the specific template, the step will be auto filled. All these templates will be automatically saved in C:\ArbinSoftware\MITS_PRO\Work.

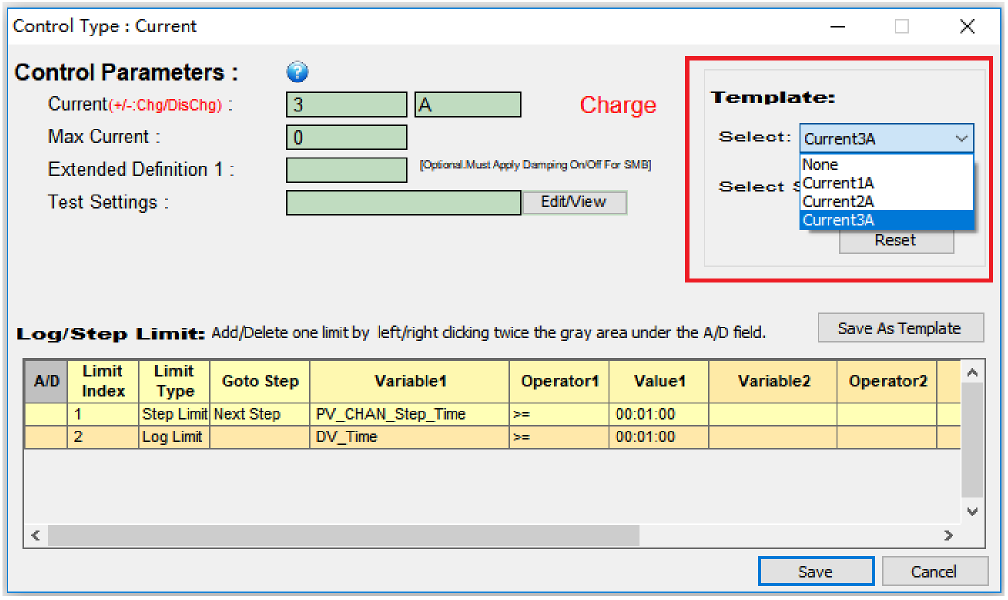


Figure 5-20 Select a Template from the Drop-Down List

5.4 The Global Page of a Schedule

The **Global** page of a schedule provides general information regarding the test schedule such as safety limits, the creator, comments and current version. Information in the **Global** page can be divided into five main parts - **Information**, **Aux Channel Requirement**, **Safety**, **Clamp Protection** and **Profiles**.

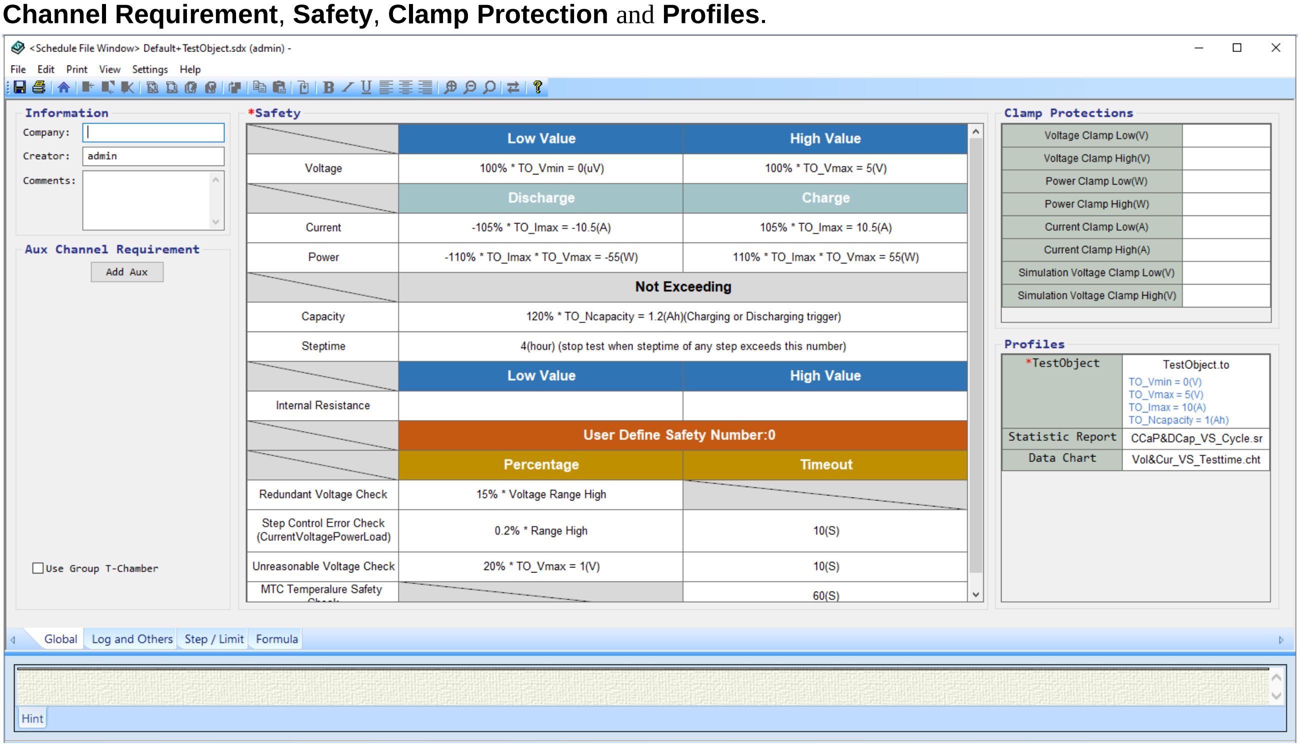


Figure 5-21 Global Page of a Schedule

Information

- Company -- Enter the name of the cell or battery company.
- Creator -- Enter the name of the person responsible for the creation of this schedule or use the login name for this user.
- Comments -- Enter general comments about this test schedule.

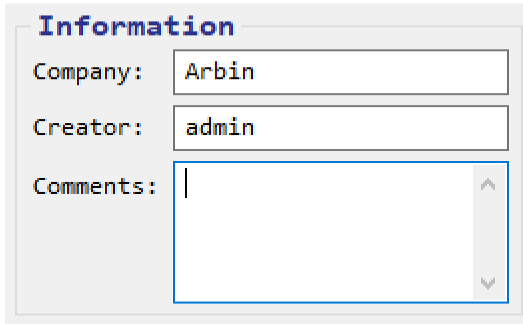
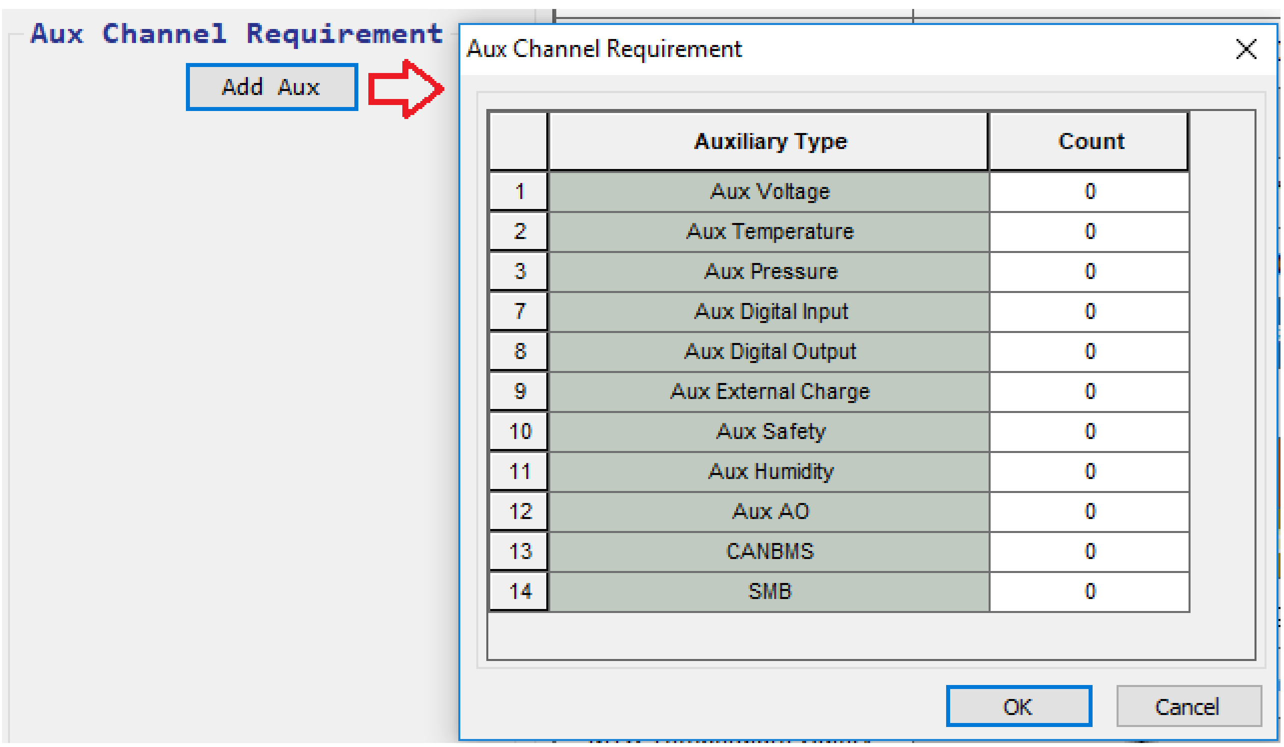


Figure 5-22 Information of Global Page

Aux Channel Requirement

In this part, if the test involves using any kind of auxiliary devices, including but not limited to, tempareture, second voltage, CANBMS, and SMB, you must set it by clicking the Add Aux button to open the Aux Channel Requirement window. The Count stands for how many aux channels are required to run this schedule on **one** regular IV channel. This will help to cross check if the aux mapping meets the requirement or not.



	Auxiliary Type	Count
1	Aux Voltage	0
2	Aux Temperature	0
3	Aux Pressure	0
7	Aux Digital Input	0
8	Aux Digital Output	0
9	Aux External Charge	0
10	Aux Safety	0
11	Aux Humidity	0
12	Aux AO	0
13	CANBMS	0
14	SMB	0

Figure 5-23 Aux Channel Requirement of Global Page

Safety

Safety is used to set the high and low values of Current, Voltage and Power limits and the high value of Capacity and StepTime limits (effect to all steps) for the test being controlled by the active schedule for regular channels. In order to protect the cell or battery being tested, the user may also enter other safety limit parameters, such as auxiliary voltage, auxiliary temperature, auxiliary pressure, auxiliary pH and auxiliary safety. (The user should also be aware of the hardware voltage and current limits of the machine and should not exceed these limits). If any of the parameters exceed the limits that have been set in the active schedule, then the machine will terminate the test to protect the machine and testing device and the channel status in the **Monitor & Control Window** will reflect an **Unsafe** with the condition of exceeding a limit. After assign a Test Object File, some safety limits fill in automatically. User can change them manually.

- **Voltage --** Enter regular channel voltage Low and High safety limits for the test schedule. Regular channel refers to the main IV channels. The safety limits' values can be absolute numerical values, for example, 2 V, or values relevant to the Vmax/Vmin of the Test Object File, for example, 80%. If the values are relevant to the Vmax/Vmin, please enter any percentage from -100 to 100 to limit the current safety limits of the instrument.
- **Current --** Enter regular channel current Low and High safety limits for the test schedule. The safety limit values can be absolute numerical values or values relevant to the Imax of the Test Object File. If the values are relevant to the Imax, please enter any percentage from -105 to 105 to limit the current safety limits of the instrument.
- **Power --** Enter regular channel power Low and High value safety limits for the test schedule. The safety limit values can only be absolute numerical values. If the values are relevant to the Imax/Vmax/Vmin of the Test Object File, please enter any percentage from -110 to 110 to limit the current safety limits of the instrument.
- **Capacity --** Enter regular channel capacity safety limits for the test schedule. The safety limit values can only be absolute numerical values. If the values are relevant to the Ncapacity of the Test Object File, please enter any percentage from -120 to 120 to limit the current safety limits of the instrument.
- **Step Time --** Enter regular channel Step time value safety limits for the test schedule. The safety limit values can only be absolute numerical values. The default value here is 4 hours when you create a new schedule, and you can re-enter other positive numbers as well. Setting Step Time limit is to prevent an unwanted and unnoticed over charging or discharging. This time limit effects all steps of the schedule.

Example: If the Imax of the active channel were 3A, then the low current safety limit is **-105% *Imax** for current would be -3.15A. If this schedule is assigned to another channel with other Imax 5A, the effective high current safety limit will be **105% *Imax,** 5.25A. The determination of the Voltage safety limits setting is the same as for the current safety limits setting.

- **Internal Resistance** - Enter a number into the "low value" and "high value" for IR value safety limits. The unit is mOhm.
- **Aux Safety** – After adding aux channels, there is aux safety line(s). Enter the high and low safety limits for Auxiliary Voltage, Temperature, Pressure, pH, and Flow Rate measurement channels. Auxiliary channels refer to inputs ancillary to the main IV control channels. While no control over these channels and the associated parameters is possible, the input from them can be used to exercise control over the operation of the main hardware output channels. The availability of these inputs is dictated by pertinent hardware and the system configuration.
- **User Define Safety Number** – Enter a number into the Label to generate some Edit boxes for additional user-defined safety limits. Supported variables include Present Value, Last Step Value, Last Cycle Value and CAN BMS Value.

The software applies the Abnormal Check to stop the schedule or give a warning during testing. If an abnormal or unreasonable event (such as a sudden voltage drop or IV channel cables disconnecting) occurs, it would produce bad data from the experiment, or in the worst case scenario, would result in the battery being over-charged or drained too much. Thus, the abnormal detect mechanism has been introduced to the system to prevent such an event. The Abnormal Check includes **Redundant Voltage Check, Step Control Error Check (Current Voltage Power Load), Unreasonable Voltage Check** and **MTC Temperature Safety Check**. When moving mouse to these words, a meaning of these checks will show up. **Seting 0 to disable these checks.**

- **Redundant Voltage Check:** Report unsafe when redundant voltage sampling value minus voltage safety high value is great than the percentage times voltage range high, or, voltage safety low value minus redundant voltage sampling value is great than the percentage times voltage range high. Note: **The Redundant Voltage Check requires hardware's support.**
- **Step Control Error Check (Current, Voltage, Power, Load):** MITS Pro8.0 monitors the values of Current, Voltage, Power, and Load during the test. If the sampling value is beyond a certain percentage of the control values, it will be considered an abnormal event. The default value in **Percentage** is 0.2%, and **Timeout** is 10s, which means if the output is 0.2% off from the target value for 10 seconds, the test will be stopped, or a warning will be issued.
- **Unreasonable voltage Check**: If the voltage sampling value is lower than a certain percentage of the Vmax, it will be considered an abnormal event. The default value in **Percentage** is 20% which is relevant to the Vmax, and **Timeout** is 10s. Note: The range of percentage is from 0 to 100.
- **MTC Temperature Safety Check:** Interval of each MTC check, the default value is 60 seconds;

*Safety

	Low Value	High Value
Voltage	100% * TO_Vmin = 0(uV)	100% * TO_Vmax = 5(V)
	Discharge	Charge
Current	-105% * TO_Imax = -10.5(A)	105% * TO_Imax = 10.5(A)
Power	-110% * TO_Imax * TO_Vmax = -55(W)	110% * TO_Imax * TO_Vmax = 55(W)
	Not Exceeding	
Capacity	120% * TO_Ncapacity = 1.2(Ah)(Charging or Discharging trigger)	
Steptime	4(hour) (stop test when steptime of any step exceeds this number)	
	Low Value	High Value
Internal Resistance		
	User Define Safety Number:0	
	Percentage	Timeout
Redundant Voltage Check	15% * Voltage Range High	
Step Control Error Check (CurrentVoltagePowerLoad)	0.2% * Range High	10(S)
Unreasonable Voltage Check	20% * TO_Vmax = 1(V)	10(S)
MTC Temperalure Safety Check		60(S)

Figure 5-24 Safety part of the Global Page

Clamp Protections

This part sets the clamp protection. In order to clamp voltage or power at a constant value, users need to enter the limits by clicking the empty box. The default value in these clamp protections is empty, which means the clamp protections are not activated. Arbin strongly suggested using clamping pretection wherever possible to prevent over charging or discharging.

Voltage Clamp Low/Voltage Clamp High: If the battery is charged or discharged to the target voltage value, the output of current will be attenuated. The voltage clamp requires special hardware, not all the system has voltage clamp protection.

All control types can be supported.

Power Clamp Low/Power Clamp High: The battery is charged or discharged within these power limits. All control types can be supported.

Current Clamp Low/ Current Clamp High: The current value does not exceed the set value while the battery is charging or discharging. All control types can be supported.

Simulation Voltage Clamp Low/ Simulation Volatage Clamp High: If this clamp is enabled, the schedule must set the IR value or have an IR step first. In addition, only the relevant step such as Current Simulation, Power Simulation and Load Simulation are supported.

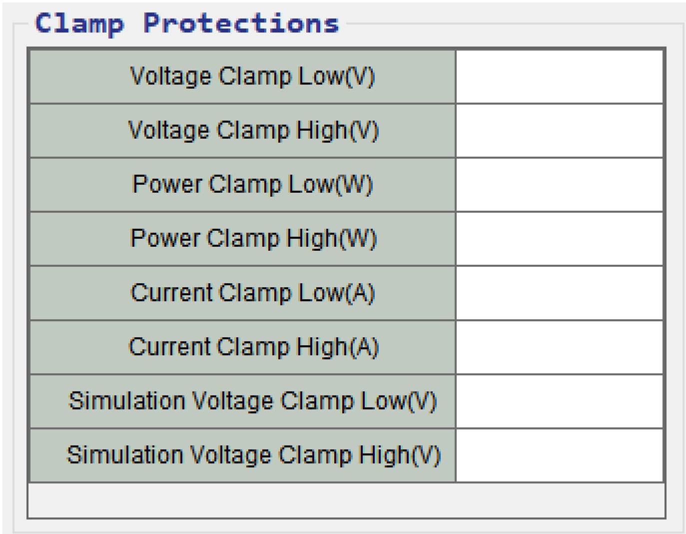


Figure 5-25 Clamp Protections part of Global Page

Profiles

In this part, the user can assign a Test Object file, CAN BMS file, SMB file, Statistic Report file and Data Chart file. To assign CAN BMS and SMB file, adding these aux channel is required.

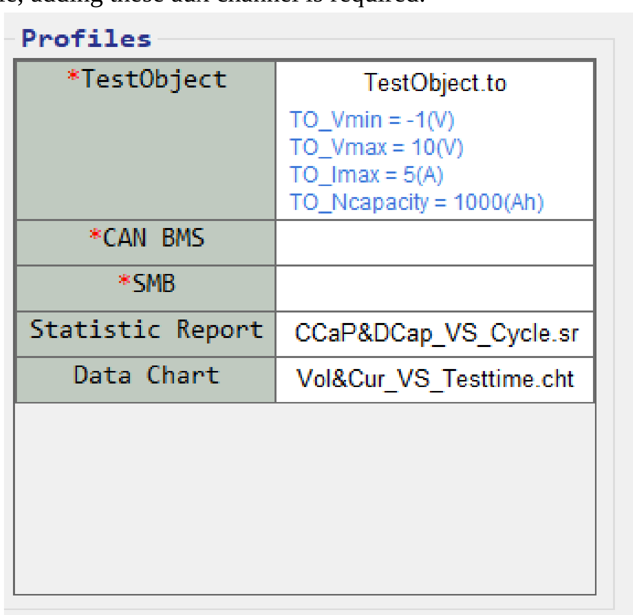


Figure 5-26 Profiles part of Global Page

5.5 The Log and Others Page of a Schedule

The **Log and Others** page of a schedule provides general information regarding the data sampling such as SDL, Burst Mode Sampling. As well, there are other informations like User Defined MetaVariables, Estimated Test Time, dX/dY settings, and Power Adjustment.

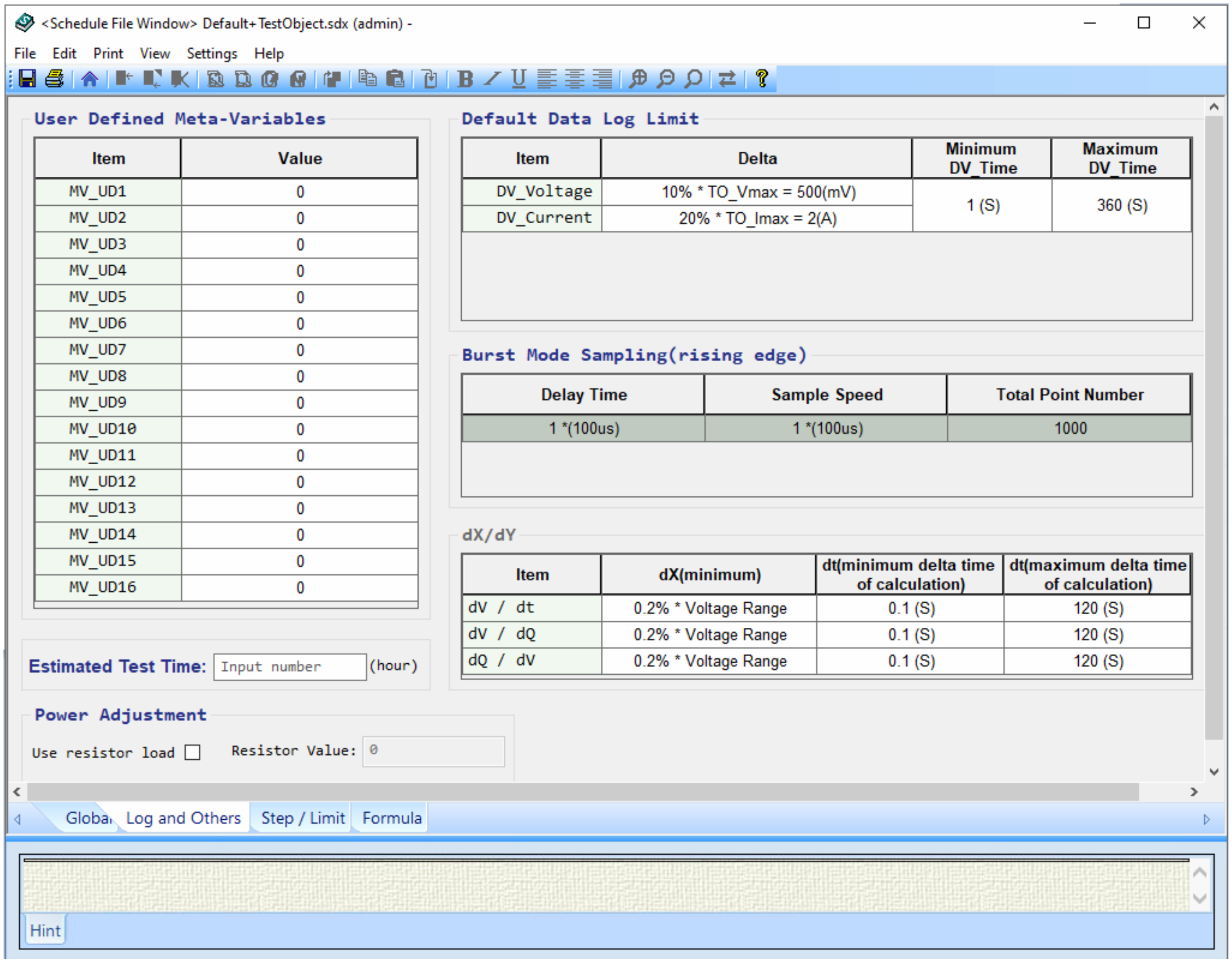


Figure 5-27 Log Page of a Schedule

User Defined Meta-Variables

This part allows user to define some variables which can be used in a schedule for control purpose. The user can only assign a number to these variables in the Log page, but can assign values of such as Present Values, Last Step Value, and Last Cycle Value and so on in the Step/Limit page through **SetValue** control type. **(Figure 5-29)**

User Defined Meta-Variables

Item	Value
MV_UD1	1
MV_UD2	2
MV_UD3	3
MV_UD4	0
MV_UD5	0
MV_UD6	0
MV_UD7	0
MV_UD8	0
MV_UD9	0
MV_UD10	0
MV_UD11	0
MV_UD12	0
MV_UD13	0
MV_UD14	0
MV_UD15	0
MV_UD16	0

Figure 5-28 User Defined Meta-Variables of Log Page

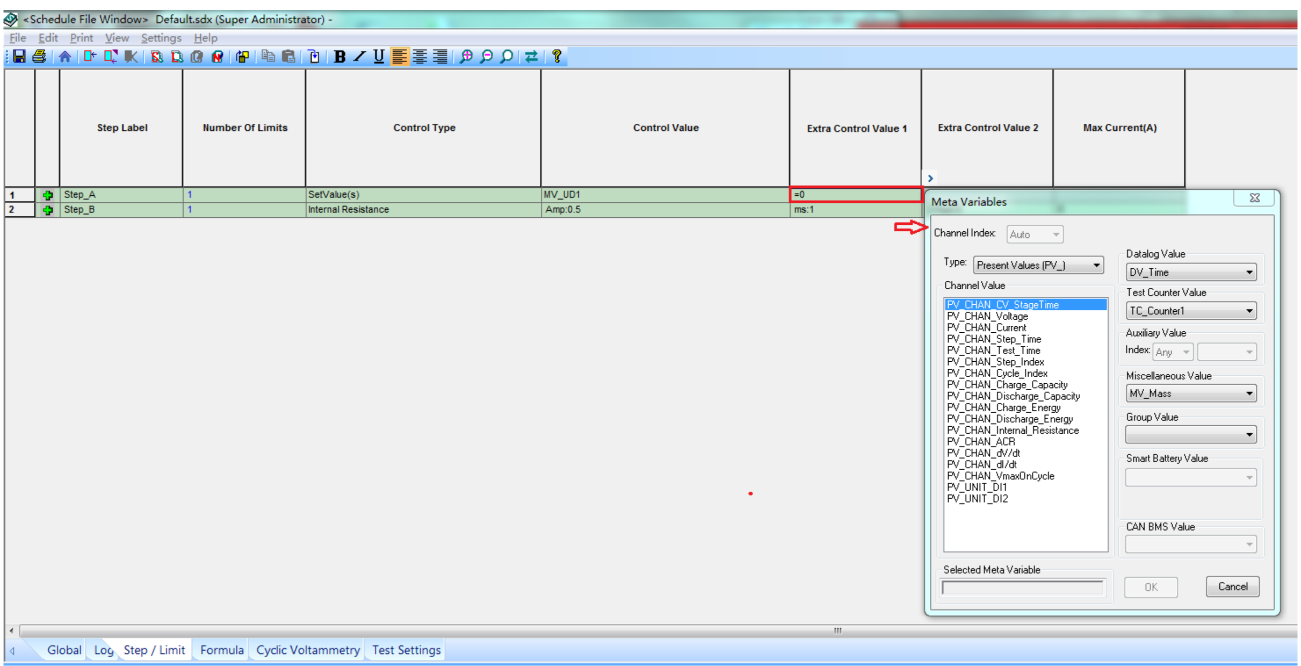


Figure 5-29 User Defined Meta-Variables are used in Step/Limit page

Estimated Test Time

- Estimated Test Time– Set predicted test time, using units of hours. When running a test, there is a column labeled “Remaining Time” shown in the Monitor & Control Window. This column provides the schedule with the prediction for the time remaining in the test.

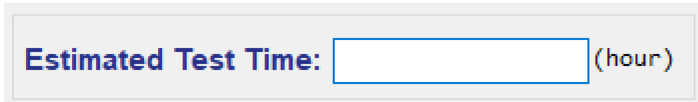
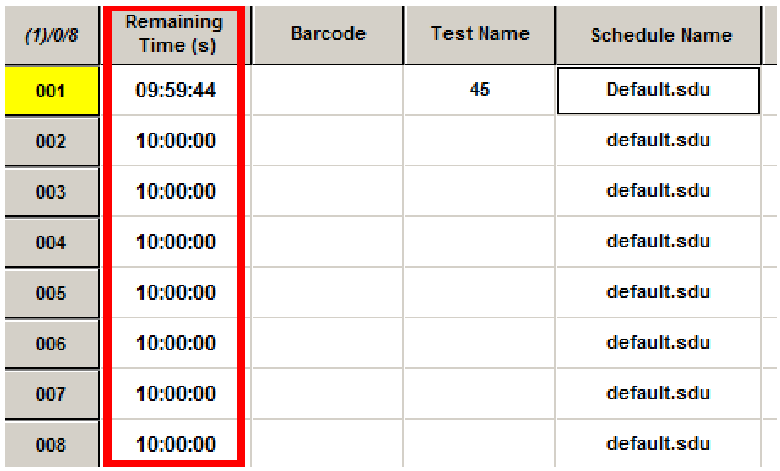


Figure 5-30 Estimated Test Tmie of Log Page



(1)/0/8	Remaining Time (s)	Barcode	Test Name	Schedule Name
001	09:59:44		45	Default.sdu
002	10:00:00			default.sdu
003	10:00:00			default.sdu
004	10:00:00			default.sdu
005	10:00:00			default.sdu
006	10:00:00			default.sdu
007	10:00:00			default.sdu
008	10:00:00			default.sdu

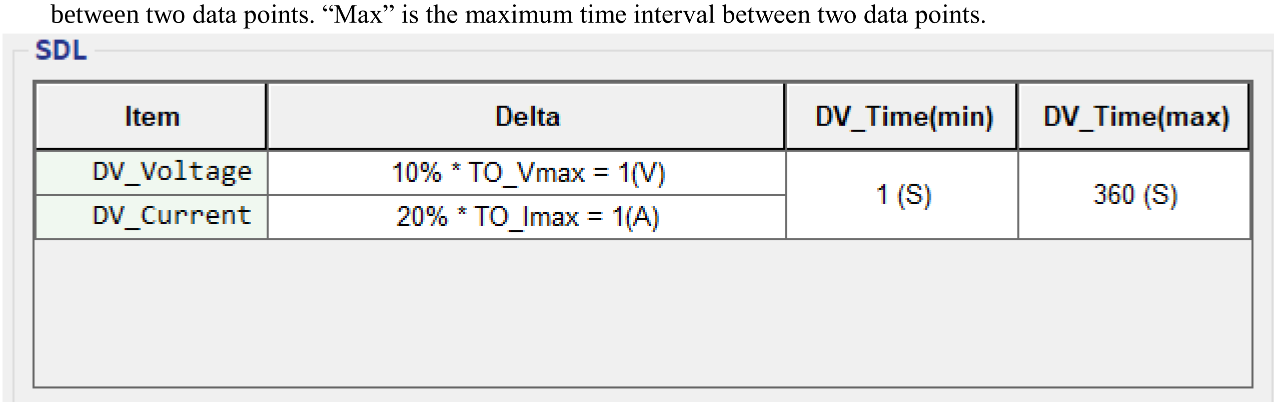
Figure 5-31 Remaining Time(s) column of **Monitor & Control Window**

SDL （Smart Data Log）

SDL is abbreviation for Smart Data Log. In Step/Limit Page of the schedule, if there is no specific log limit, the system will automatically use Smart Data Log Interval (SDL) as the logging limit.

- **Current**: Current data point will be logged at an interval of **x% of Imax** (Set in Test Object File). It is equivalent to DV_Current in Control Value field.
- **Voltage**: Voltage data point will be logged at an interval of **x% of Vmax** (Set in Test Object File). It is equivalent to DV_Voltage in Control Value field.

The “DV_Time” is a logical “and” relation with DV_Voltage and DV_Current. “Min” is the minimum time interval between two data points. “Max” is the maximum time interval between two data points.



SDL

Item	Delta	DV_Time(min)	DV_Time(max)
DV_Voltage	10% * TO_Vmax = 1(V)	1 (S)	360 (S)
DV_Current	20% * TO_Imax = 1(A)		

Figure 5-32 SDL of Log Page

Burst Mode Sampling

Burst mode sampling is to log a large amont of data in a short time interval to see the current and voltage changes with high temporal resolution. Note: Not all series of equipments have this feature. For more informations, please consult Arbin salesman.

- **Delay Time --** Delay time from the start of the step to start log Burst mode sampling data. The default value is 1*(100us). The range is from 0 to 10000*100us.
- **Sample Speed --** Burst Mode Sampling data log interval. The default value is 1*(100us). The range is from 1 to 10*100us.
- **Total Point Number --** When met, the Burst Mode Sampling tests will be stopped. The default value is 1000. The range is from 100 to 1000.

Burst Mode Sampling(rising edge)

Delta Time	Sample Speed	Total Point Number
1 *(100us)	1 *(100us)	1000

Figure 5-33 Burst Mode Sampling of Log Page

dX/dY

- This part is to set the minmum window size for calculating differential values, such as dV/dt, dV/dQ and dQ/dV. Minimal Calculation Interval (s) are required to do numerical differenatial calculation. The intervals must be greater than the accuracy of the measurements. Otherwise, the results will be less useful because of the impact of noises. An appropriate value of time interval for dV/dt, dI/dt, dT/dt, etc. is 15 seconds. If maximum delta time of calculation reaches, the calculation will be performed no matter what dX is.
- **dV/dt –** Change in voltage over an interval of time, dt
- **dV/dQ** – Change in voltage with change in battery’s or capacitor’s electrical charge.
- **dQ/dV** – Change in battery’s or capacitor’s electrical charge over a change in voltage.

dX/dY

Item	dX(minimum)	dt(minimum delta time of calculation)	dt(maximum delta time of calculation)
dV / dt	0.2% * Voltage Range	0.1 (S)	120 (S)
dV / dQ	0.2% * Voltage Range	0.1 (S)	120 (S)
dQ / dV	0.2% * Voltage Range	0.1 (S)	120 (S)

Figure 5-34 dX/dY of Log Page

5.6 Creating and Editing Steps

Overview of Step/Limit

The schedule **Step/Limit** page is a page in which steps and their corresponding limit conditions are defined. The schedule may consist of only one step or a virtually unlimited number of steps. The test steps may be set to run in consecutive sequence, a sequence that loops back for a specifiable number of iterations, or any combination thereof. A step normally consists of four components - a **Control Type**, a **Control Value**, termination conditions (limits), and data logging criteria.

A test step will continue to run until a termination condition (step limit) is reached. The termination conditions are defined in each limit's row. They are logical “or” relation. The following figure shows the **Step/Limit** Page with three steps, each with different limits, Step_A with 5 limits, Step_B with 1 limit and Step_C with 2 limits. Step Limits are shown on a yellow background and Log limits are shown on an orange background. The command line is shown on a green background.

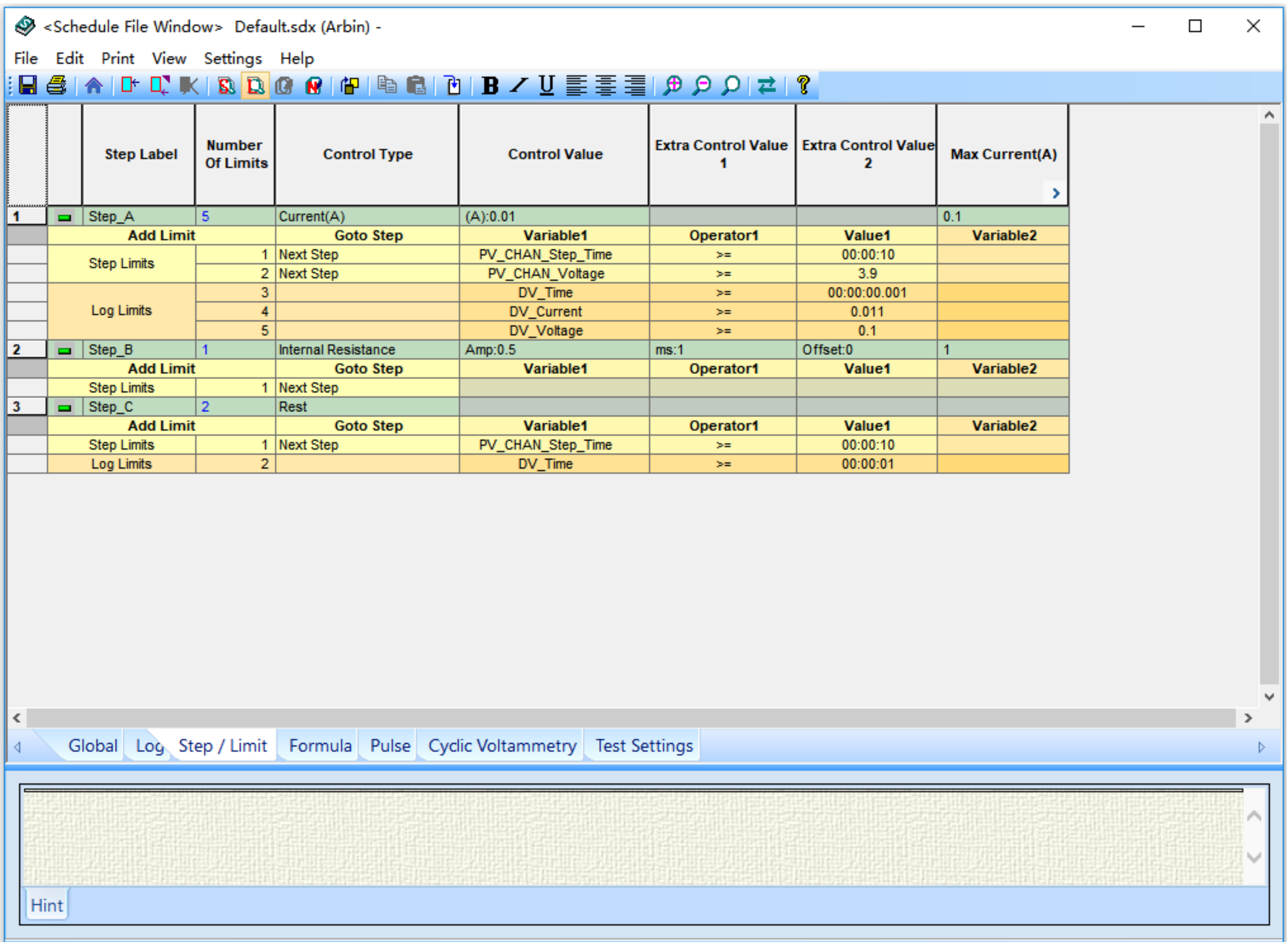


Figure 5-35 The Step/Limit Page

The following tables enumerate and explain the headings of the many fields in the schedule editor. Note that some of the fields are not shown in the figure above but are visible in a full-screen view of the **Step/Limit** page.

Field Descriptions of Step Rows

Field Name	Description
Step Label	This field names the step. A step label may not be blank.
Number of Limits	This shows the number of limits created for this step. This field cannot be updated by users.
Control Type	This field allows the user to select the proper control type for this step, which determines what action the instrument will perform.
Control Value	This field provides a set point value or function for the selected **Control Type**. It can be a Constant, a Meta Variable, Simulation File or a Formula.
Extra Control Value 1	This field is enabled when some specific control type is selected.
Extra Control Value 2	This field is enabled when some specific control type is selected.
Max Current	This box references hardware current range settings. Users may enter the maximum value of current the step might need. Enter "0" here, MITS Pro 8.0 will auto select a current range for the **Control Value** selected.
Extended Definition	This field is enabled to hold a Specified Pulse, or Cyclic Voltammetry (CV_V, CV_A) or simulation label when the control type selected is Current or Voltage Pulse or Current CV or Voltage CV or simulation
Test Settings	Test Settings are defined in order to integrate the operations of the main IV channels and auxiliary temperature, flow, or digital input, output channels provided for the third-party temperature chamber, or other auxiliary control boards (optional).
Log Clock Stretch	Toggle "On" or "Off" to choose whether to log the Clock Stretch value in the result file.
Synchronized Start with ACS	Synchronized start with ACS.
Burst Mode	Toggle "On" or "Off" to choose to enable or disable Burst Mode Sampling.

Table 5-1 Field Descriptions of Step Rows

Field Descriptions for Limit Rows

Field Name	Description
Log Limit	The software will log a data point when the limit is true.
Step Limit	The test will proceed to the step indicated in the **Goto Step** field when the limit is true.
Goto Step	Indicates the next step to go to when the currently running step is finished.
[a]**Variable 1**	Meta Variable or Formula used as the step limit or the log limit.
Operator1	Signs used to indicate greater than, equal to (≧) or less than, equal to (≦) or greater than (>), or less than (<) [note: equal (=) is only for Cycle Index and Step Index]
Value1	Numerical or formulaic values for selected Meta Variables.
[a]**Variable 2**	Same as **Variable 1**
Operator2	Same as **Operator 1**
Value2	Same as **Value1**
[a]**Variable3**	Same as **Variable 1**
Operator 3	Same as **Operator 1**

Value3	Same as **Value1**

Table 5-2 Field Descriptions of Limit Rows

Note:

a. Variable 1, 2, and 3 constitute logical "AND" relation.

Creating a New Step

1. Click **Step/Limit** tab at the bottom of the schedule page.
2. Click on one of the step rows (identified by bold numeral in the leftmost column) in the schedule editor.
3. Double click the leftmost column index field; a new step will be appended below the step currently highlighted. Or, on the menu bar, select Edit - Append Step or Edit - Insert Step. A new step labeled Step_X and a default limit for this new step will be generated. When Insert Step is selected, the new step will be inserted immediately **above** the step currently highlighted in the step table. The shortcut toolbar icon may also be used to append or insert the step. **Note**: The maximum step in a schedule is limited to 200.

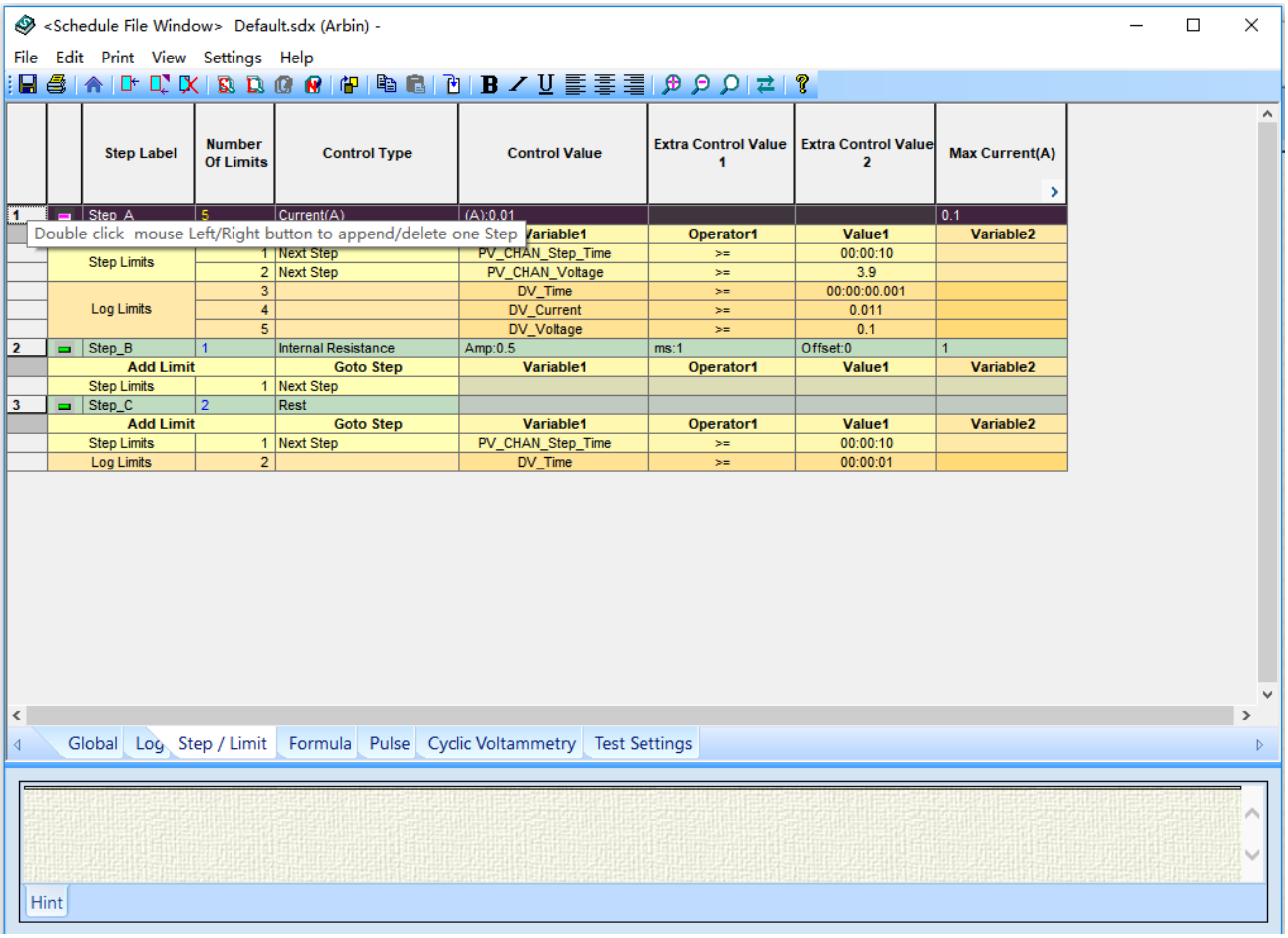


Figure 5-36 Place the Cursor over the Leftmost Column and Double Click

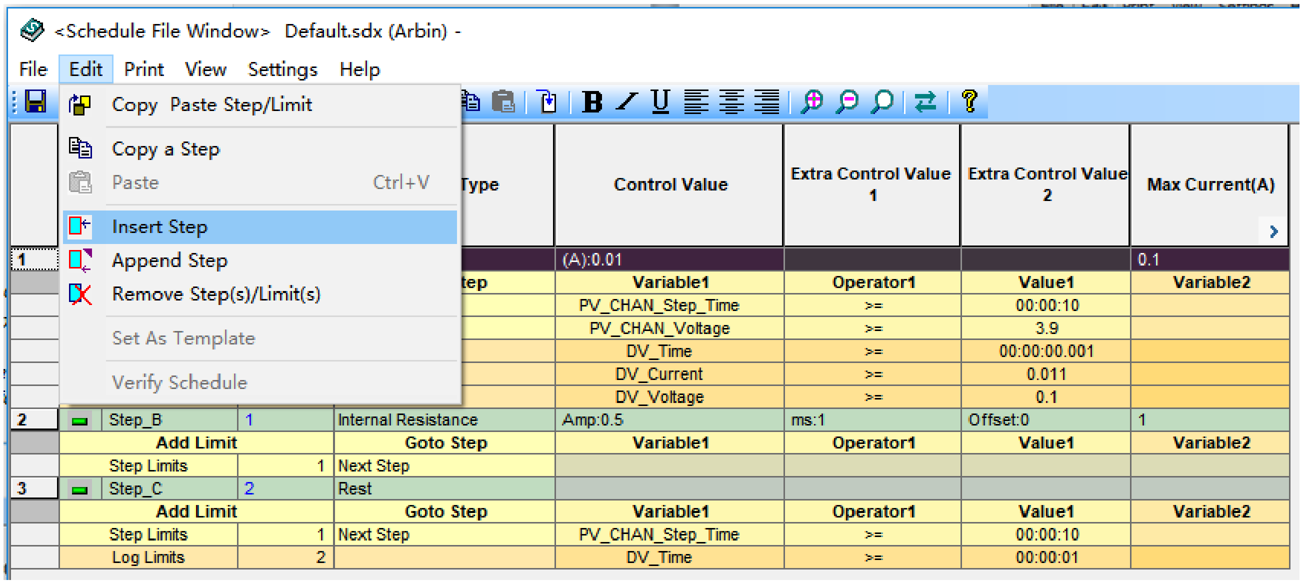


Figure 5-37 Insert or Append a Step from the Edit Menu

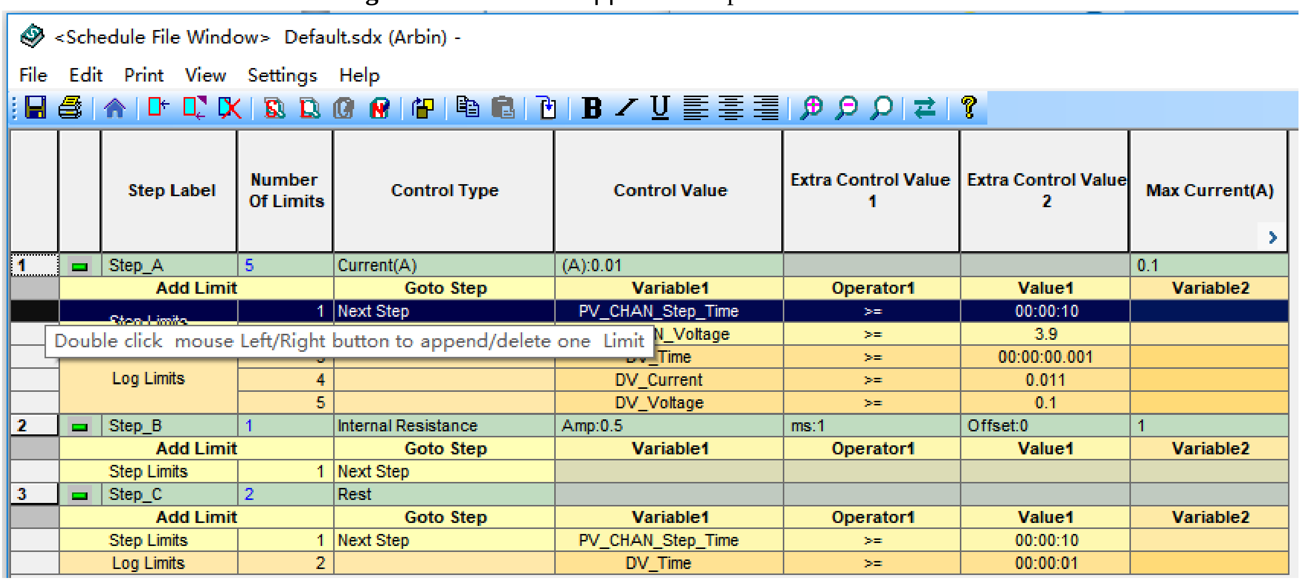


Figure 5-38 New Step Created with a Default Limit

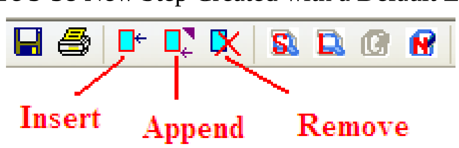


Figure 5-39 Toolbar Icon Shortcuts

4. Rename the label in the **Step Label** field or use the default labels.
5. Click the field under **Control Type**; select a proper **Control Type** from the drop-down menu.

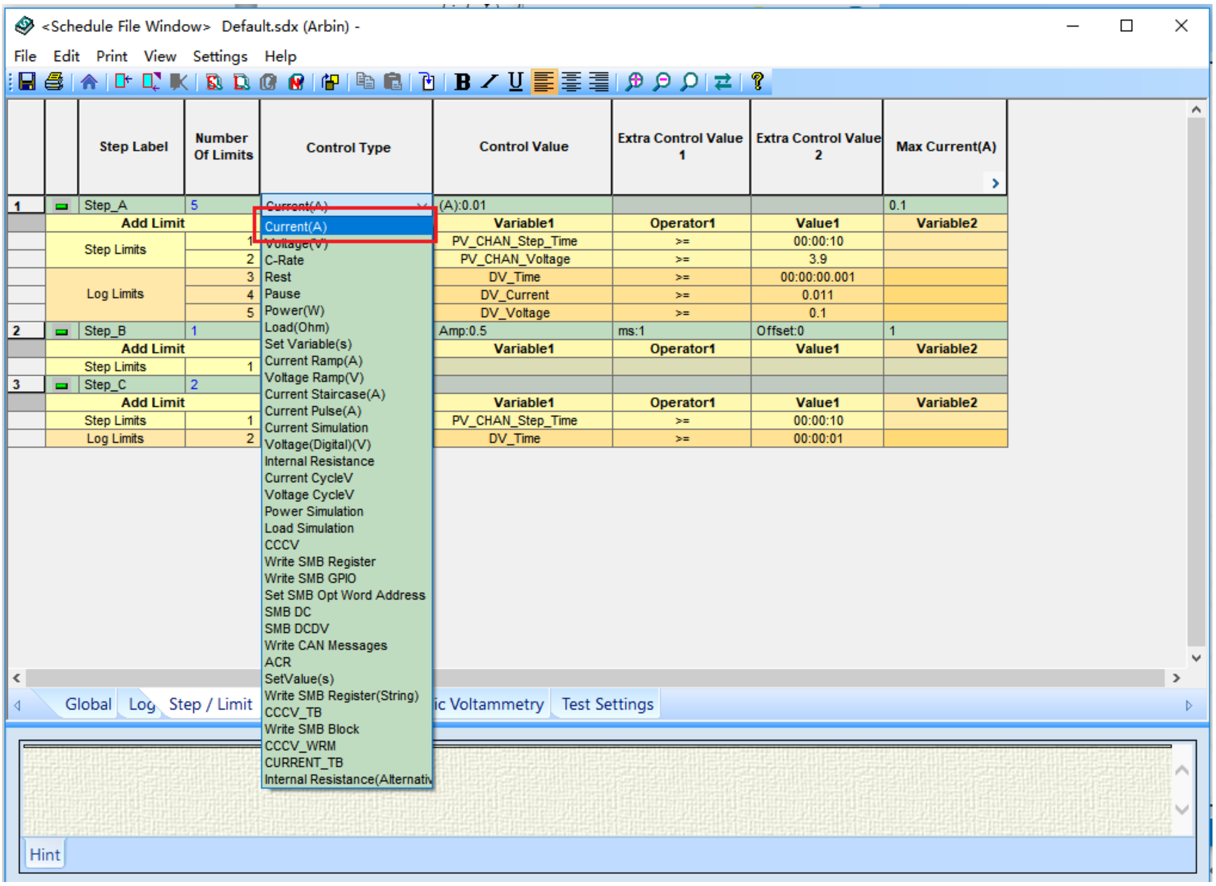


Figure 5-40 Selecting **Control Type** in the Step

6. Enter the desired value for the **Control Type** in the **Control Value** field. For ramp and staircase functions, the **Control Value** indicates the starting value. The **Extra Control Value1** can be used to define the scan rate for the ramp function or dV(I)/stair for the staircase function. The **Extra Control Value2** can be used to define the stair time for the staircase control type.

   Set value of Max Current (A). Or set "0", MITS Pro8.0 software will auto match the current range for the test. Setting a proper value for Max Current (A) is very important. Setting a value of Max Current(A) in a high range scope for low-current tests will result in lower resolution and accuracy. Users need to refer to the Machine Specs when setting a value for Max Current (A). The rated values for the current ranges of hardware are labeled on the front of the tester and differ between instruments.

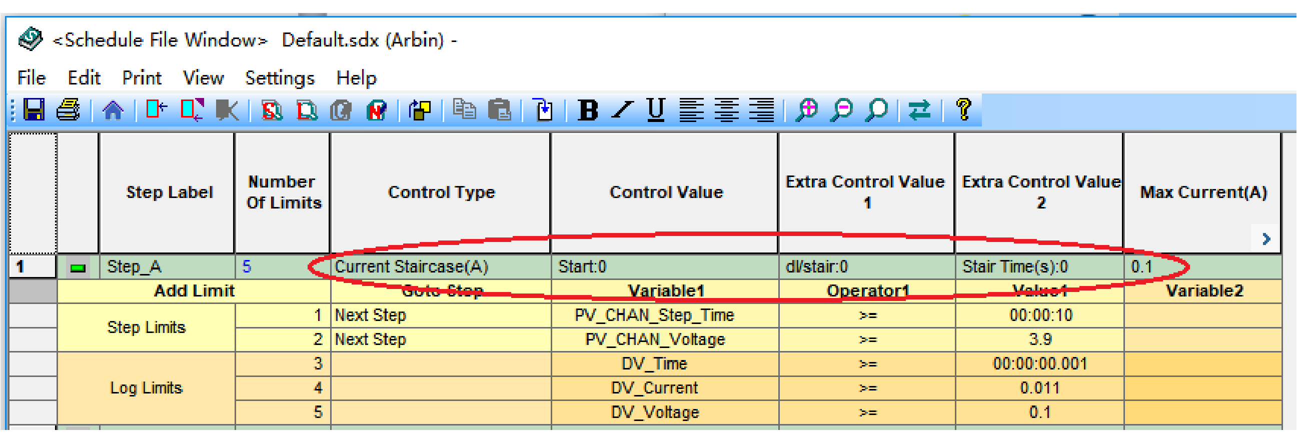


Figure 5-41 Enter Control Type and Control Value(s).

7. The Pulse, Cyclic Voltammetry and Simulation **Control Types** require the use of the **Extended Definition** field. The Pulse and Cyclic Voltammetry profiles can be created on the appropriate pages of the schedule file. Simulation requires the creation of an ASCII file with the basis data set. For more detailed descriptions, see the appropriate sections of this manual, beginning with Section 5.9, 5.12 and 5.13.

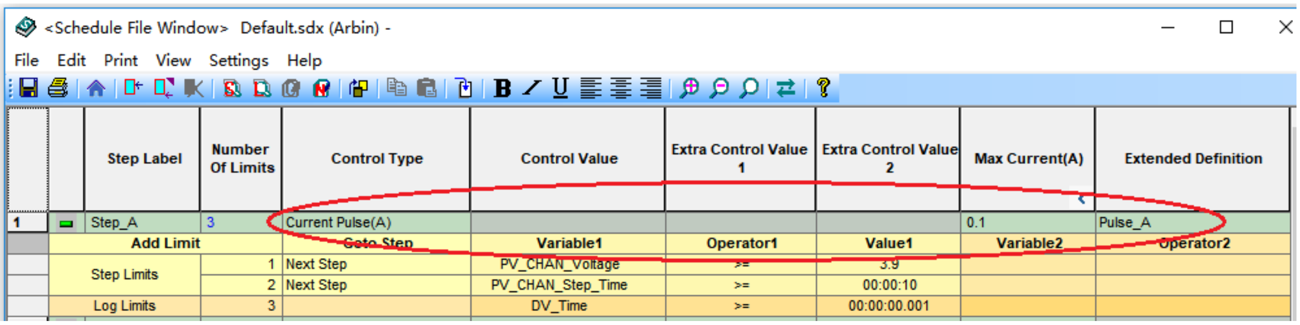


Figure 5-42 Extended Definition for the Pulse Control Type

Adding More Steps

1. Highlight a step; double click the leftmost column or click the Append Step button on the tool bar. A new step will be added as the last step.
2. Refer to **Creating a New Step** points 3 through 7 above for instructions for creating steps, defining the **Control Type**, editing the control value, and setting the current range.

Inserting Steps

1. Highlight a step and click the Insert Step button on the tool bar. A new step will be inserted immediately prior to the step currently highlighted in the step table.
2. Edit the content of the step according to the outline under the heading **Creating a New Step**.

Deleting Steps

Highlight the step you want to delete and double click the leftmost column or click the **Remove Step** button on the tool bar. The step and corresponding limit(s) will be deleted.

Importing Steps from Other Schedules

1. Click the Import icon in the icon bar or select Import in the menu.
2. Select a schedule you want to import steps from in the schedule files list dialog and click **OK** to import steps.

If imported steps contain the same labels as steps in the current schedule, another label will be assigned to prevent duplication. You can also import formula, pulse, Cyclic Voltammetry, and Test Settings from other schedules, respectively.

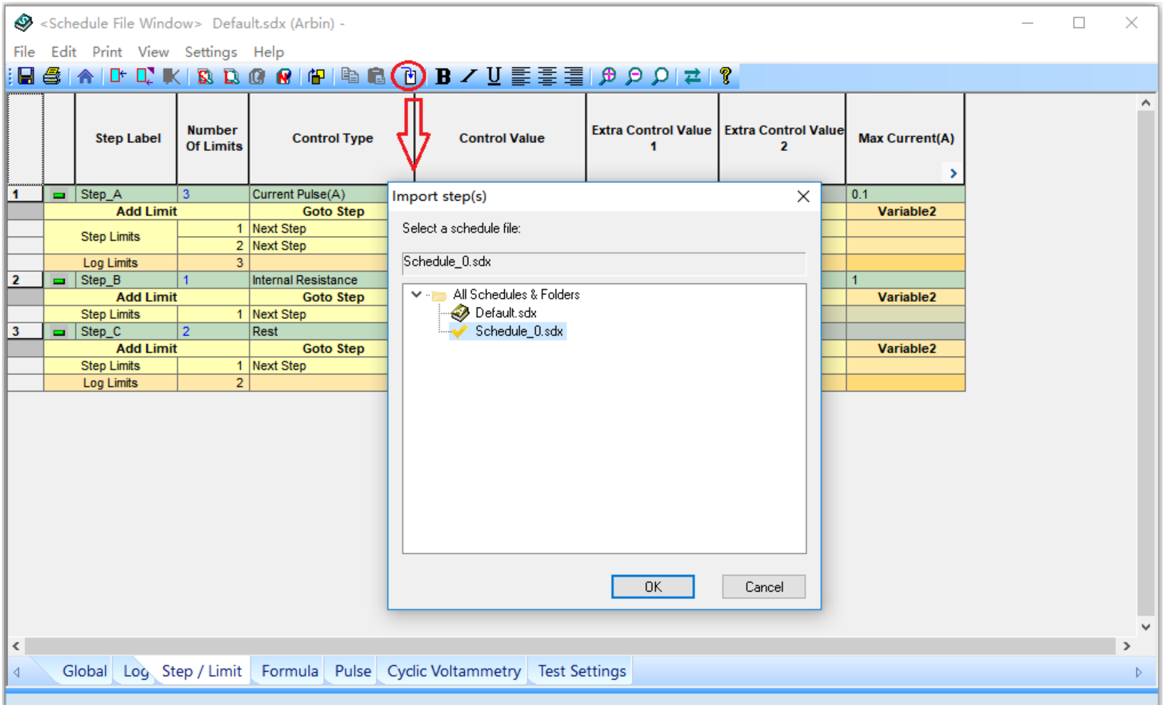


Figure 5-43 Import Icon in the Schedule to Import Steps

Executing Cycles and Loops

A test can be scheduled to run a looping sequence that loops back for a specific number of iterations by using Cycle_Index, or TC_Counter X. Note: **Loop Times** is a function that was used in earlier versions of the **MITS** software, but this option is no longer available, having been replaced entirely by usage of **Cycle_Index** and **TC_Counter X**.

Cycle: Cycle_Index is a schedule-scope index of iterations shared by all steps. It can be viewed as a global variable in the schedule level. Unlike the former **Loop Times**, the Cycle_Index is recorded in the column of Cycle_Index in the results database. Cycle_Index is initialized as "1" and can be incremented each time by 1 in the Set Variable(s) – Increment step. Each time that Cycle_Index must be incremented, a Set Variable(s) control step must be added.

Using the Cycle_Index, one can create flexible and complicated schedules in which the **Control Type** Set Variable(s) is required to increment the cycle index. The following example shows a simple loop during whose iteration Cycle_Index increments from 1 to 3.

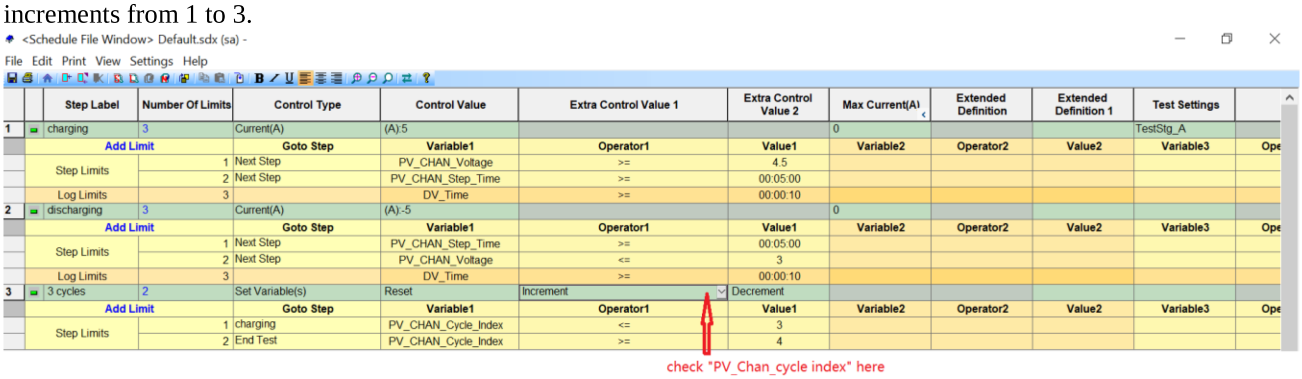


Figure 5-44 Example of Cycle_Index

Note the **Control Type** Set Variable(s) in step **3**. This step generates the increment of Cycle_Index. A drop-down menu under the **Extra Control Value 1** heading permits the selection of the index, which will be updated by each loop.

The following example invokes TC_Counter X (X=1 to 4) and Cycle_Index to create a schedule with 3 loops above (steps **2** through **3**) and another charge-discharge experiment (step **5** through **6**) next within another 3 loops. The Cycle_Index is incremented within each pass through each of the parallel inner loops and will be recorded in the results database. The database data will show the cycle index changing from 1 to 100. **Note**: Whereas **Cycle_Index increments from 1 to n, TC_Counter X increments from 0.**

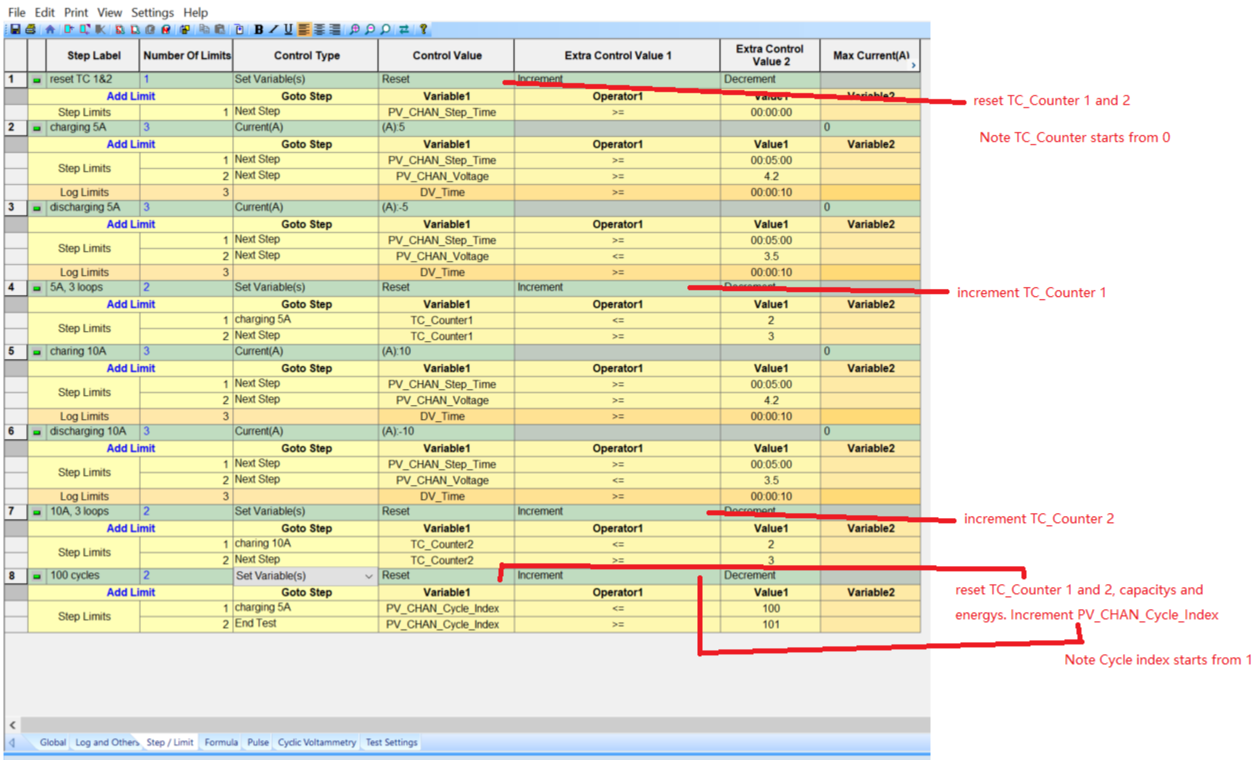


Figure 5-46 Example of Cycle_Index with TC_Counter

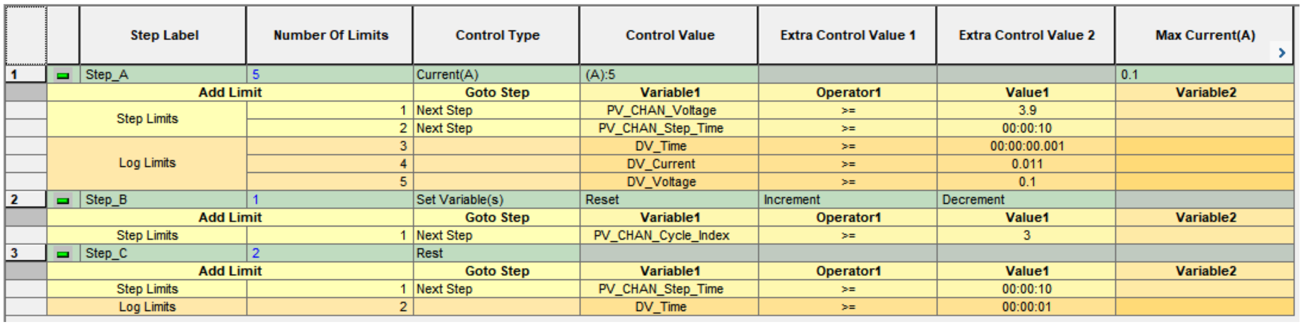
In step **8,** TC_Counter1 and 2 must be reset to 0 to begin the second iteration of the outer loop, executing the 2 inner loops another 3 times.

There are many more permutations for complex looping within schedules. Call Arbin customer service for hints and assistance with other applications.

5.7 Creating and Editing Step/Log Limit

What is a Step/Log Limit?

A limit is a set of conditions that, when satisfied, direct the software to perform certain actions. A step has two types of limits. One is the **Step Limit** which is used to terminate the currently active step; the other is the **Log Limit** which is used to trigger data collection.



	Step Label	Number Of Limits	Control Type	Control Value	Extra Control Value 1	Extra Control Value 2	Max Current(A)
1	Step_A	5	Current(A)	(A):5			0.1
	Add Limit		Goto Step	Variable1	Operator1	Value1	Variable2
	Step Limits	1	Next Step	PV_CHAN_Voltage	>=	3.9	
		2	Next Step	PV_CHAN_Step_Time	>=	00:00:10	
	Log Limits	3		DV_Time	>=	00:00:00.001	
		4		DV_Current	>=	0.011	
		5		DV_Voltage	>=	0.1	
2	Step_B	1	Set Variable(s)	Reset	Increment	Decrement	
	Add Limit		Goto Step	Variable1	Operator1	Value1	Variable2
	Step Limits	1	Next Step	PV_CHAN_Cycle_Index	>=	3	
3	Step_C	2	Rest				
	Add Limit		Goto Step	Variable1	Operator1	Value1	Variable2
	Step Limits	1	Next Step	PV_CHAN_Step_Time	>=	00:00:10	
	Log Limits	2		DV_Time	>=	00:00:01	

Figure 5-47 Limit Types

The parameters used for setting step limits and log limits are Meta Variables and Formulas. For detailed descriptions of each Meta Variable, see **Appendix B: Meta Variables**.

A step may terminate based upon a single condition or multiple conditions. Logical conditions may also be specified. The three types of conditions within one limit row are related by a Boolean AND. Multiple limits rows for a single step are related by Boolean OR. The number of limits that can be configured in this way is virtually unlimited. The following figure (**Figure 5-48**) shows three types of conditions in limit 3 which constitute a logical AND relation; the relation between limit 1 and limit 2 is a logical OR.

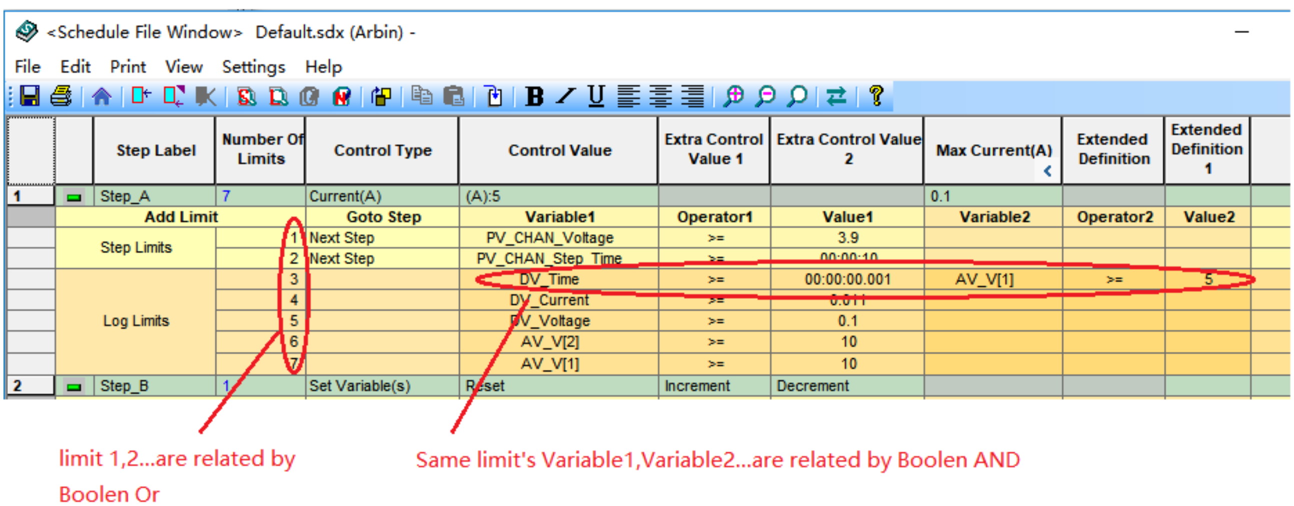


Figure 5-48 Relationships between Limits

Creating Step/Log Limit

1. There are some ways of adding limit:

   A) From the tool bar menu, highlight a limit line, click the **Append** or **Insert** tool bar icon to add a new limit.

   B) From main menu, highlight a limit line, select **Edit** - **Append Limit** or **Insert Limit**.

C) To add a limit, place the cursor on the label **Step Limits** or **Log Limits**, click the right mouse button to open the menu. (see **Figure 5-49)**

D) Place the cursor on the label **Add Limit**, then click the right mouse button to select **Add Step Limit** or **Add Log Limit**. (see **Figure 5-50)**

E) Double click the leftmost column of the limit row to append a new row of limits as shown in **Figure 5-51**. One can append/delete a new row of log/limit in new mode as shown in **Figure 5-52**.

2. Left click the field under **Variable1**. Select from the list of commonly used Meta Variables or select More…. The Meta Variables dialog box will appear.
3. In the Meta Variables dialog box, select the appropriate Meta Variable. After selecting the Meta Variable, click OK to return to the **Step/Limit** page.
4. Click the field under **Operator1**. Point to a sign and click. Click the field under **Value1** and enter a value.
5. If you need to use a formula, then in step **3** click Formula…. A formula list will appear. For instructions on creating and using a formula, see **Section 5.11** Select the desired formula. Click OK to return to the **Step/Limit** page.
6. Each step can have up to 45 limits.

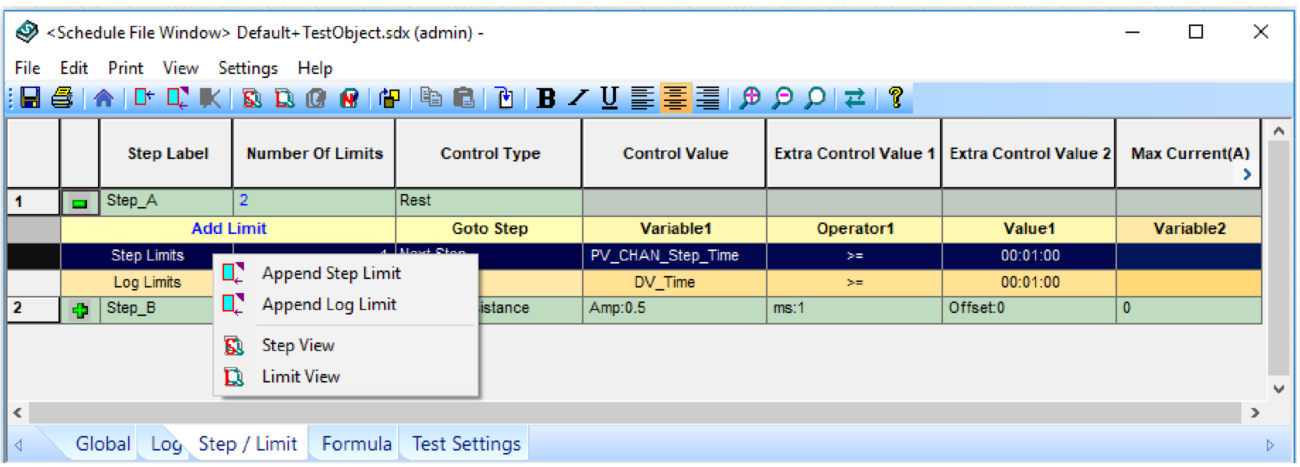


Figure 5-49 Append a Limit from the label **Step Limits** or **Log Limits**

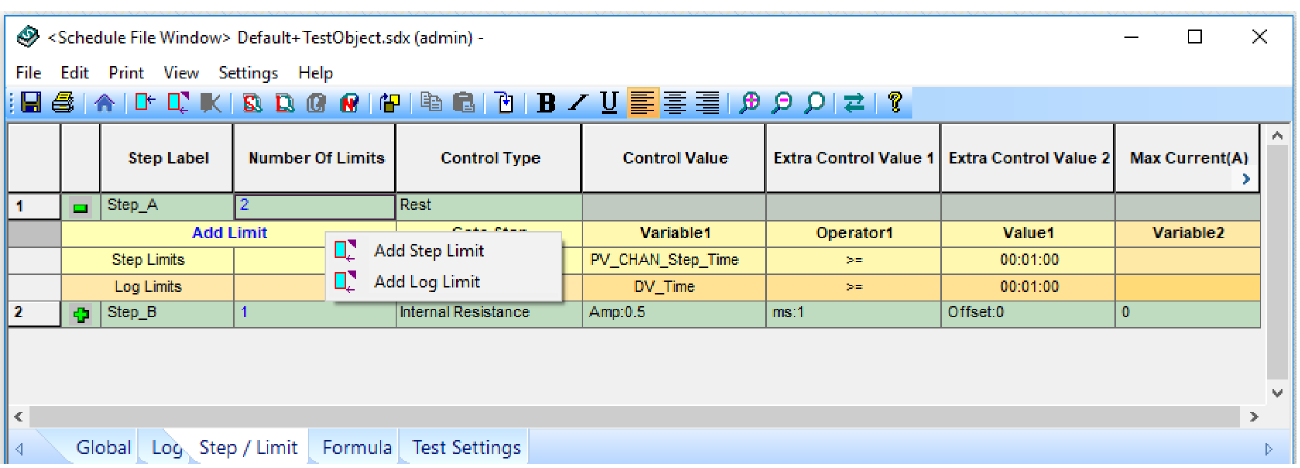


Figure 5-50 Add Step/Log Limit from the label **Add Limit**

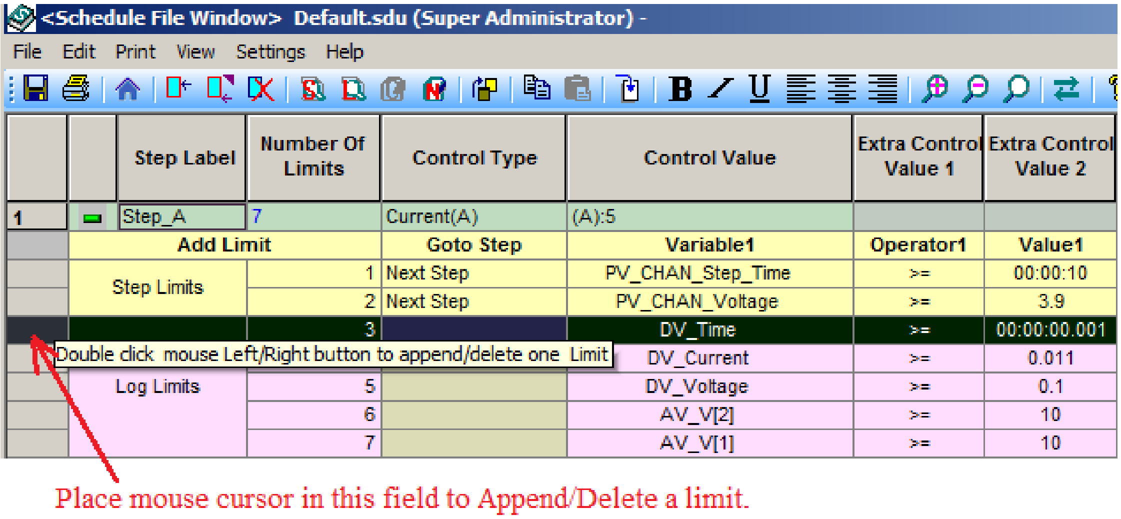


Figure 5-51 Appending Limits by Double Clicking Mouse

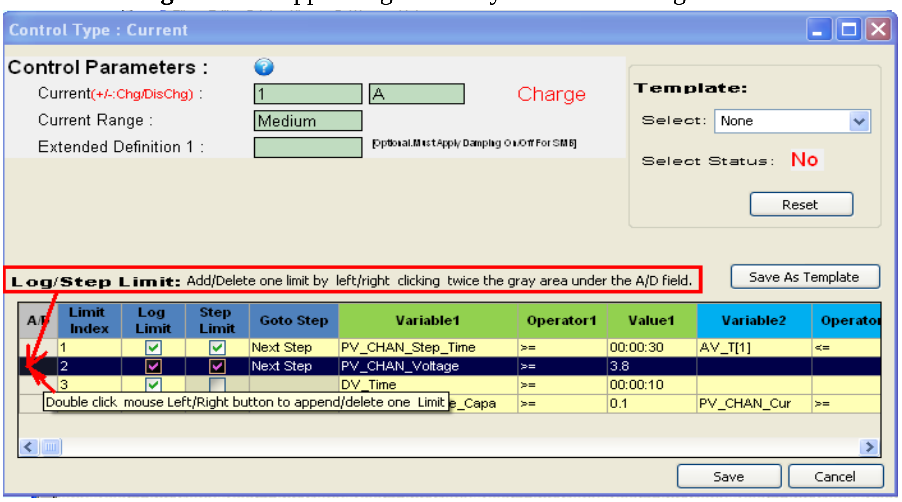


Figure 5-52 Append/Delete one Log/Step Limit in Schedule New Mode

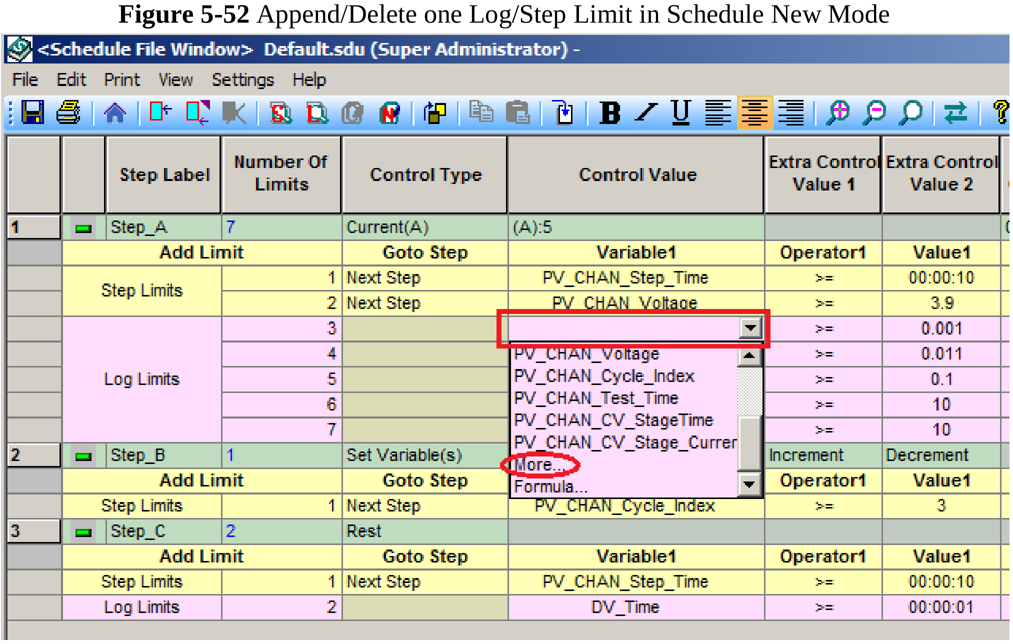


Figure 5-53 Adding Limits-Steps 2 & 3

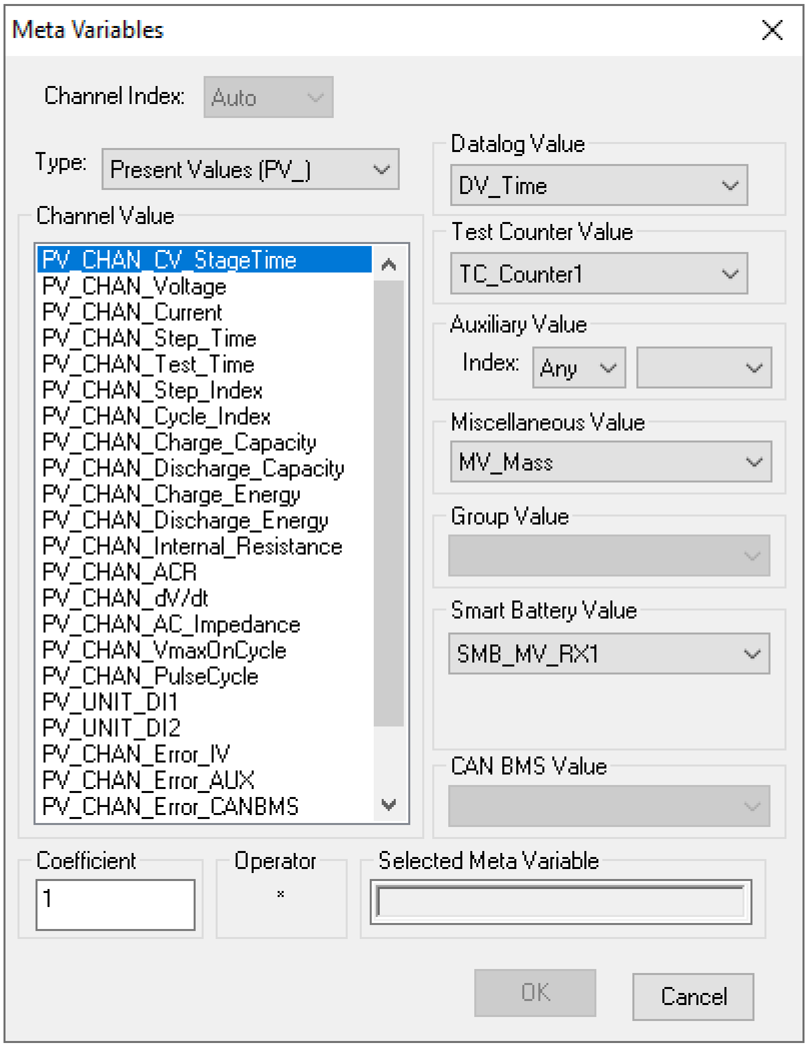


Figure 5-54 Adding Limits-Step 4

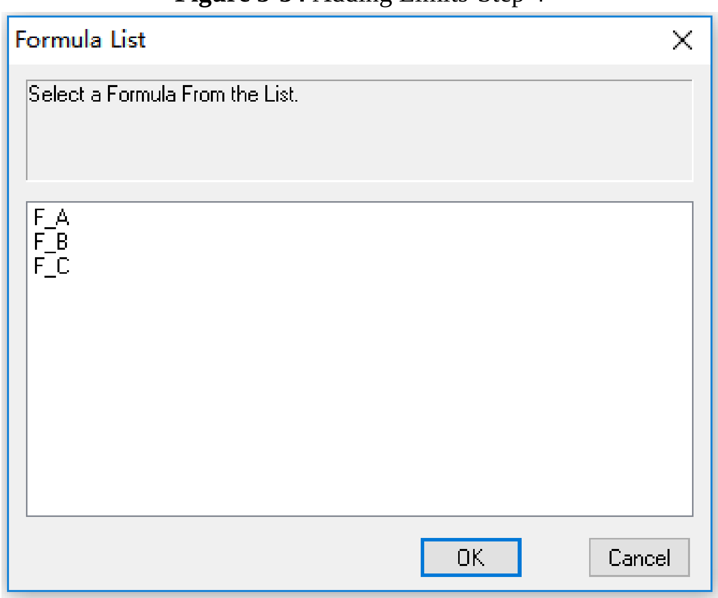


Figure 5-55 Adding Limits of Formula-Step 5

Deleting Step/Log Limit

There are three ways of deleting a step in both modes: The following example shows how in Classic Mode.

A) From the tool bar menu, click the **Remove** tool bar icon to delete a limit.

B) From main menu, select **Edit** - **Remove Limit(s)**.

C) Place the cursor on the channel index, double click the right mouse button to delete a Limit.

How to Set a Step/Log Limit

In Classic Mode, click the Limit View icon in the tool bar menu to display the schedule in a detailed view. Left click the field under **Variable 1**; a drop-down menu will appear. Select one of the common **Meta Variables** or select **More** to see other options. Select the appropriate **Meta Variable**; click **OK**. Click in the field under **Operator 1** and select the desired inequality symbol (>,>= or <, <=) from the drop-down menu. Enter a value under the field **Value1** (**Figure 5-56**).

MITS Pro 8.0 provides multiple means for establishing data logging criteria. The most means is logging according to a time interval. Click on the field under **Variable 1** and select **DV_Time** (DV stands "Datalog Value") from the drop-down menu. Enter the logging interval under the **Value 1** label (**Figure 5-57**).

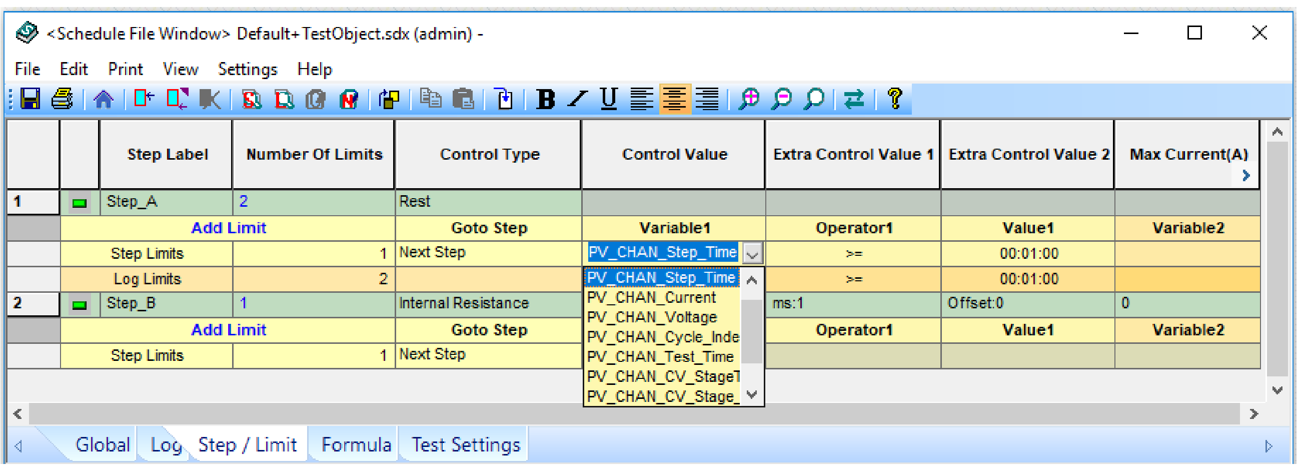


Figure 5-56 Setting the Step Limit in Classic Mode

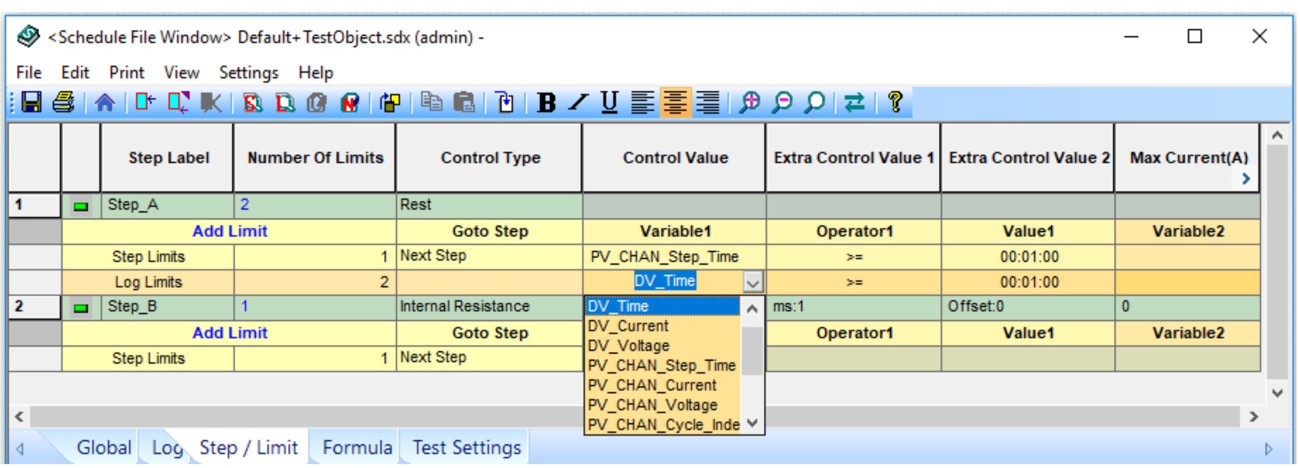


Figure 5-57 Setting the **Data Log** Limit in Classic Mode

In New Mode, left click the  icon in the field under . The control type window will pop up. One can edit Log/Step Limit information in the bottom region of this window.

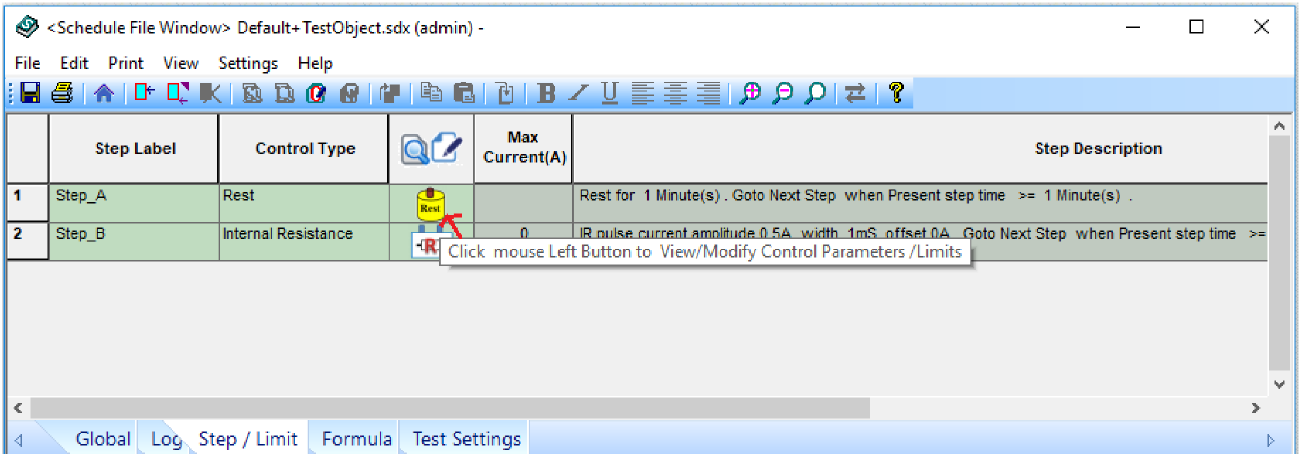


Figure 5-58 To Enter View/Modify Control Type Window

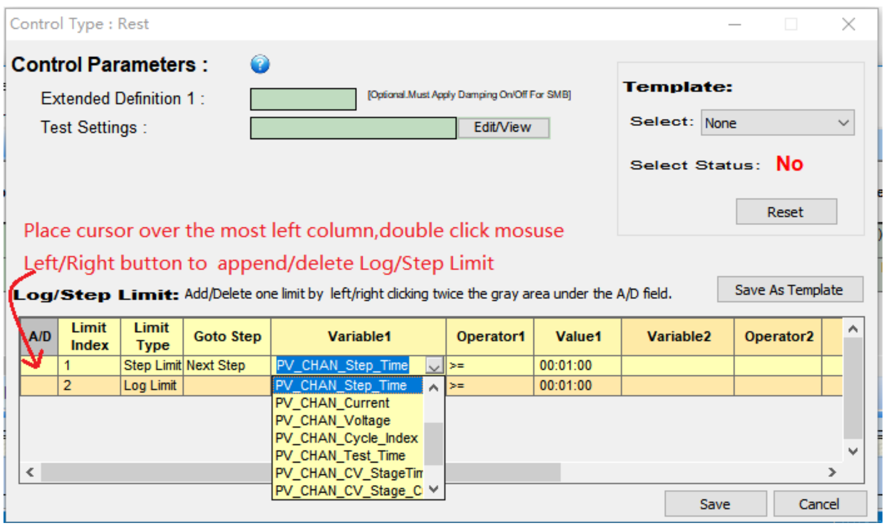


Figure 5-59 Set Log/Step Limit in New Mode

The procedure of setting a Log/Step Limit in New Mode is like the method of setting limits in Classic Mode.

Adding Logical AND Limit Conditions

Repeat steps 1-6 of **Creating Step Limits** for **Variable2** and **Variable3** to add logical **AND** limit conditions.

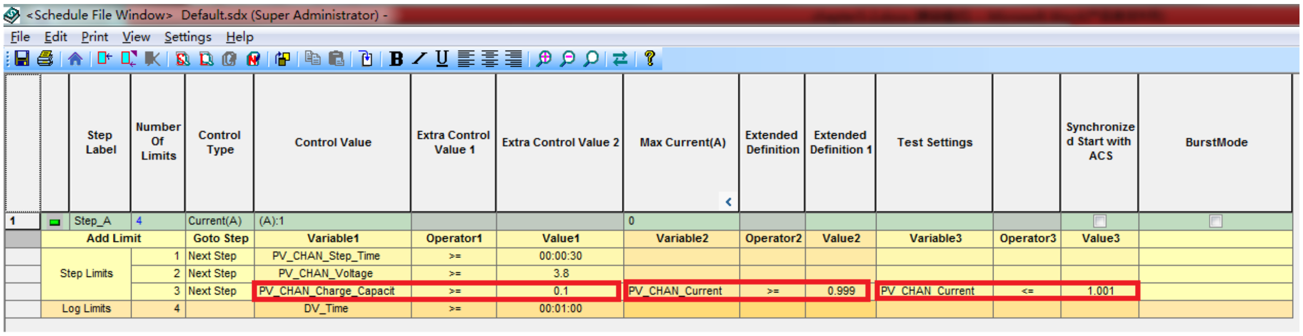


Figure 5-60 Logical AND Limit Conditions

Adding Logical OR Step Limit

- Place the cursor on the field before the limit index. Right-click, and a menu will appear.
- Click Insert Limit or Append Limit in the drop-down menu. A new limit line will appear.
- Repeat steps 3 through 9 of **Creating Step Limit** to define logic **OR** limit conditions.

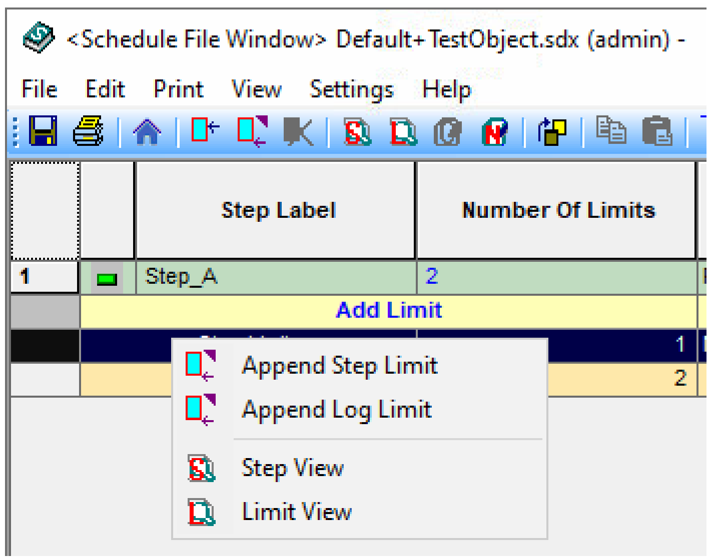


Figure 5-61 Adding Logical OR Step Limit

Step Limit by Auxiliary Input

Auxiliary input values can be used in the **Step Limit**, such as auxiliary voltage, temperature, pressure, etc. For example, a temperature AV_T [1], (auxiliary value temperature input, virtual index 1) is selected from the Meta-variable table for a step limit.

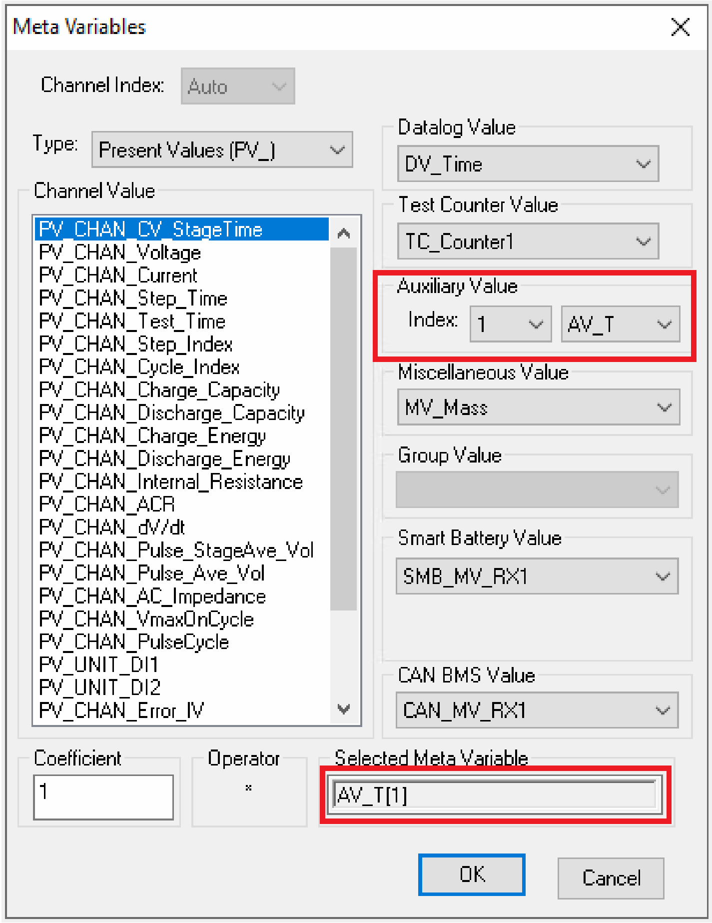


Figure 5-62 Auxiliary Temperature Input, Virtual Index 1 is Selected in the Meta-variable Table

Below, AV_T [1] is used in a testing schedule so that when the temperature exceeds 40°C, the test goes to Next Step.

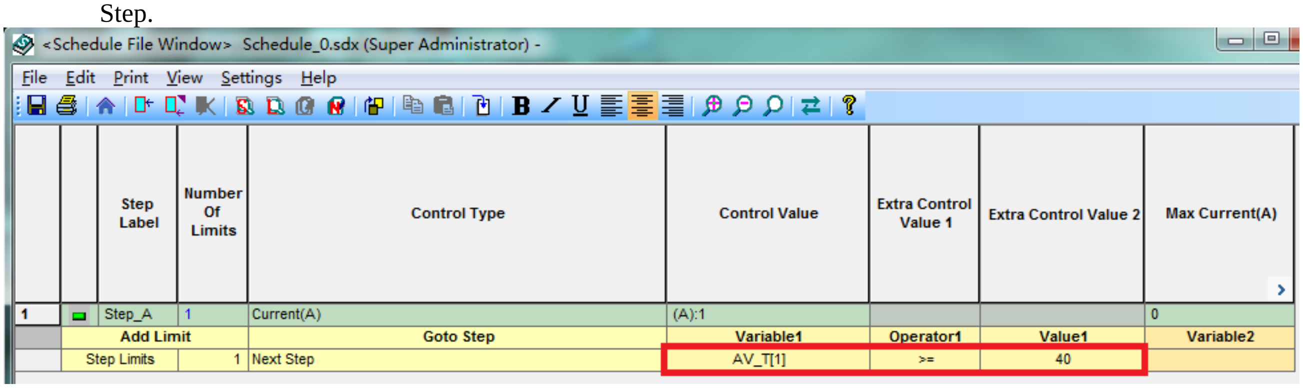


Figure 5-63 Auxiliary Temperature Input, Virtual Index 1 is Used

A unique virtual index, **Any**, is available for any auxiliary type shown in the auxiliary type drop-down list. If **Any** is selected for the virtual index, when any auxiliary channel mapped to a main IV channel satisfies the limit condition, then the **Goto Step** acts. In **Figure 5-64**, an auxiliary temperature with virtual index **Any** is selected from the meta-variable table, AV_T.

Notice the difference between AV_T[1] and AV_T. AV_T[1] indicates virtual index 1 is selected, and AV_T represents that the virtual index **Any** is selected.

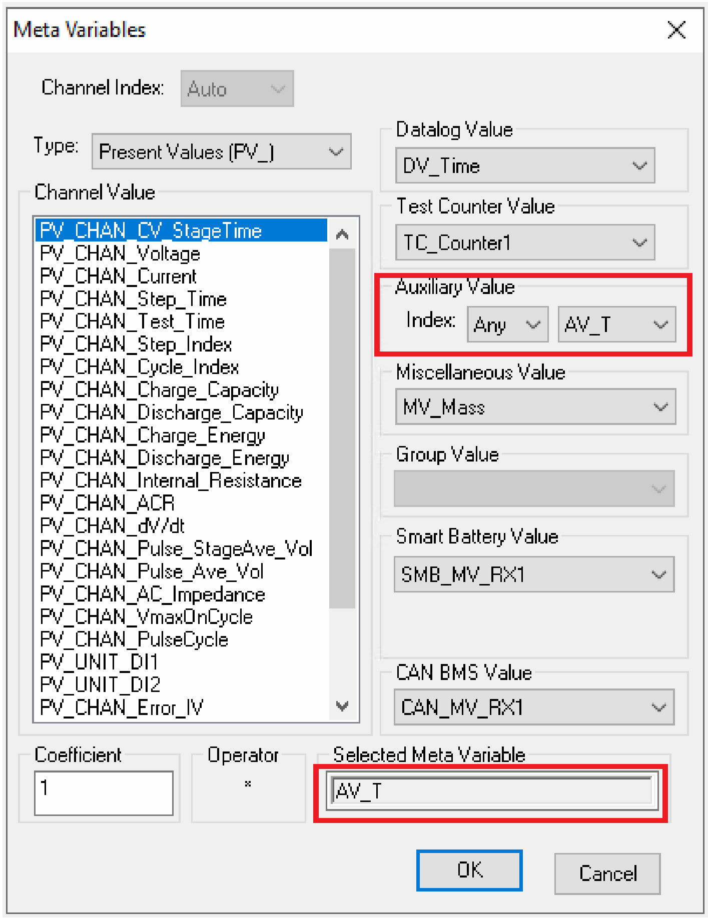


Figure 5-64 Auxiliary temperature Input, Virtual Index **Any** is Selected in the Meta-variable Table

As an example, shown in **Figure 5-65**, the aux-voltage and the index **Any** are selected in a testing schedule. Thus, when any auxiliary voltage channel mapped to a main IV channel exceeds 4.1V, the testing goes to the next step.

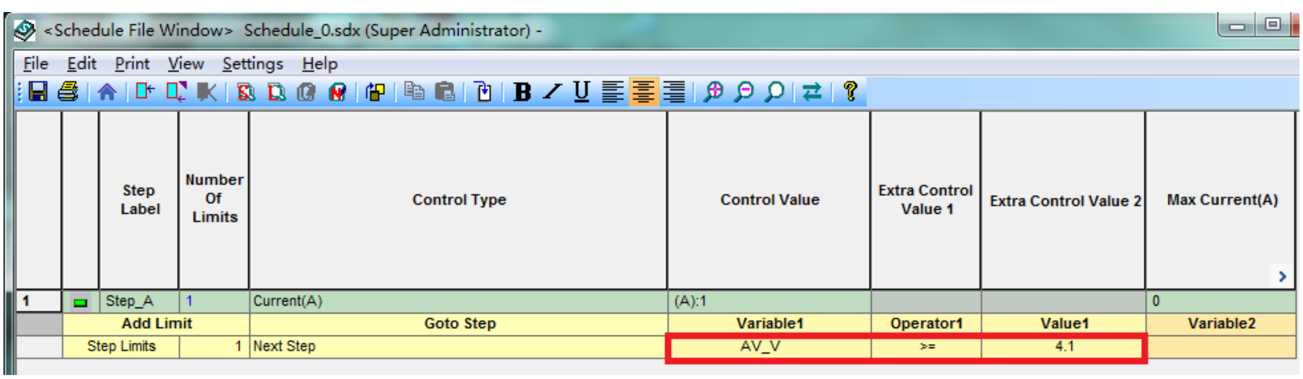


Figure 5-65 Auxiliary Voltage Input, Virtual Index **Any** is used

From **Figure 5-65**, we can see the virtual index **Any** only applies on the auxiliary voltage. Its typical application example is as follows:

While charging a battery pack of several cells in serial connection, when any cell voltage (auxiliary) exceeds the 4.1 V, the testing must go to a different action, stop, rest, or bypass etc. In this case, the virtual index, **Any**, is provided to facilitate this kind of control.

Defining Log Limit

- When tests are running, the system will only store data in a database. The **Log Limit** sets the conditions for triggering data collection. Users can define log data limits to record only necessary data. Different log limits can be used for each step. Three common parameters are available to define the log data condition. They are DV_Time, DV_Voltage, and DV_Current.

  DV_Time - Data logging based upon a time increment.

  DV_Voltage - Data logging based upon voltage change.

  DV_Current - Data logging interval defined by current change.

  DV_PulseCycle - Data logging based upon pulse cycle.

  DV_CCCV_TB_PulseInterval - Data logging based upon CCCV_TB control type. TB stands Turbo Boost.

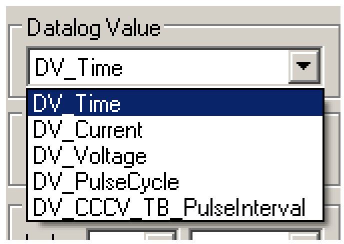


Figure 5-66 Log Limit variables

- Users can also use Meta Variables to set log limits. To define more complicated log data conditions, you can create a formula (See **Section 5.11**).

Setting Data Log Limit

1. Review steps 1 through 3 of **Creating Step Limits** above for instructions on inserting or appending new limits.
2. Select the appropriate parameter from among the three data logging Meta Variables.
3. Note that only the **Step Limits** box has **Goto Step** down-drop list to choose. **Log Limits** has no **Goto Step** to select and it is for data logging only.

As an example of logical **OR** log limits, modified from **Figure 5-67**, the schedule step 1 in **Figure 5-67** will result in collection of data every 10s, or every 0.3V voltage change or every 0.1A current change during the test.

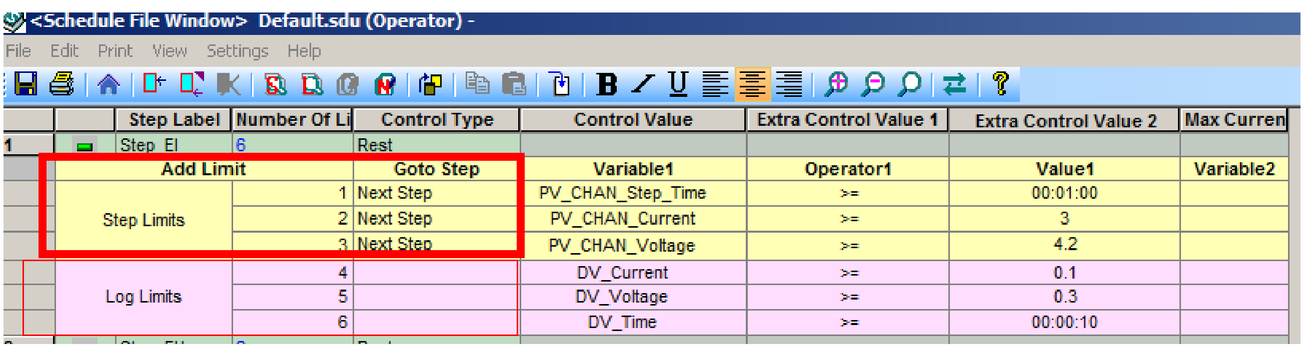


Figure 5-67 Step Limits and Log Limits of Step 1

As an example of logical AND log limits, modified from **Figure 5-68**, the schedule step 2 in **Figure 5-68** will result in collection of data with the condition meet at least 60s **and** at least 0.1A current change at the same time during the test.

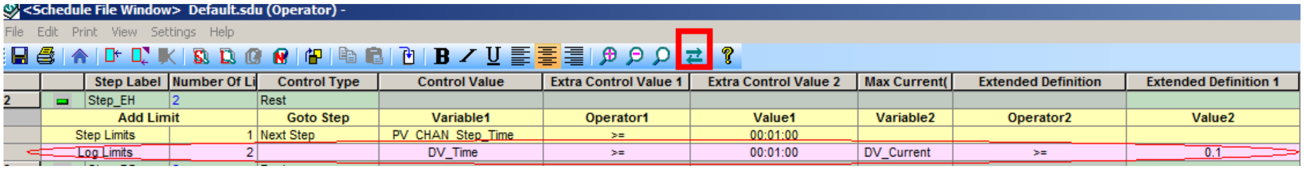


Figure 5-68 Log Limits of Step 2

Using a Formula as Log Limit

1. Create a formula in the schedule **Formula** page.
2. Append a limit. Right-click the field under **Variable1** and click on Formula….
3. In the formula list, select the desired formula and then click OK. The screen will return to **Step/Limit** page.
4. Click the field under **Operator1**. Click a sign >=, >**,** <= or <.
5. Click the field under **Value1**. Enter a value.

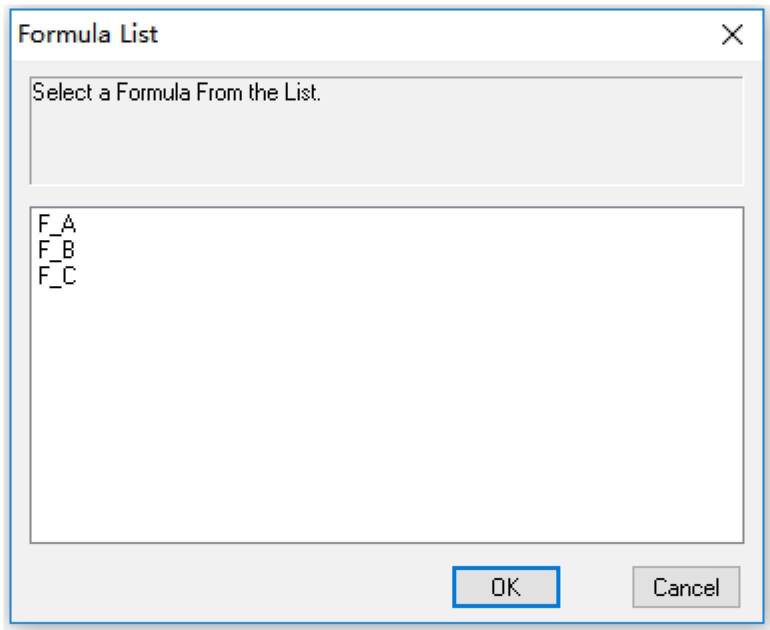


Figure 5-69 Formula List Dialog

Rest			
Goto Step	Variable1	Operator1	Value1
Next Step	PV_CHAN_Step_Time	>=	00:00:05
	F_A	>=	0.001

Figure 5-70 Completed Step with a Formula Defining Logging Criterion

5.8 Copying and Pasting a Step or Limit

1. Under the edit menu, select "Copy and Paste Step/Limit" in the schedule editor window.

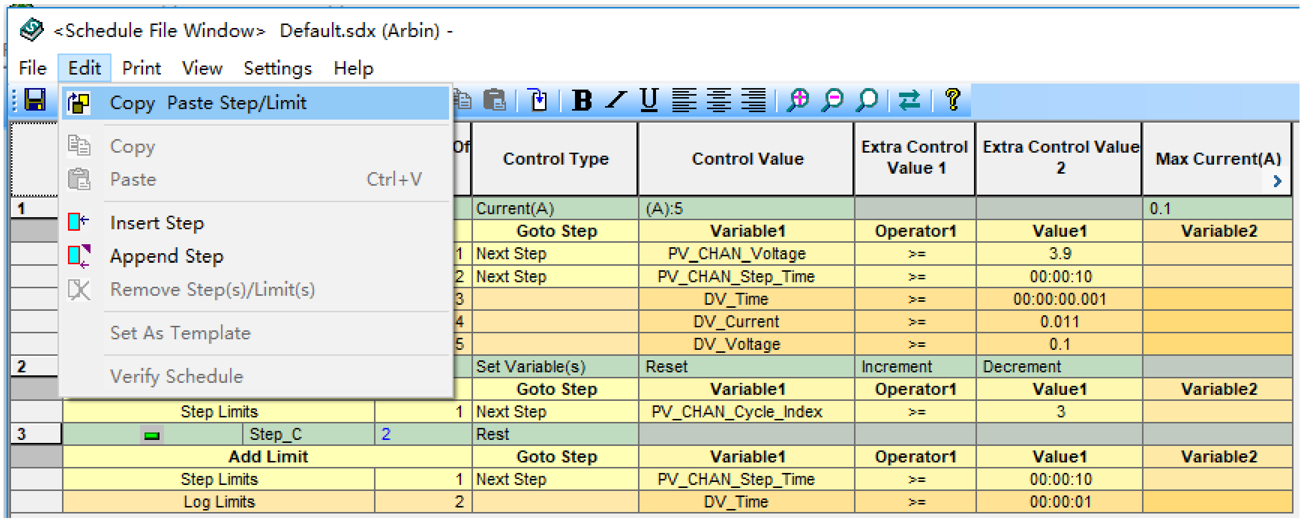


Figure 5-71 Copy & Paste Step/Limit Menu

2. Select the step you want to copy. (e.g., Step A).
3. Select the copy option as Step & Limit which enables copying both step and limit information.

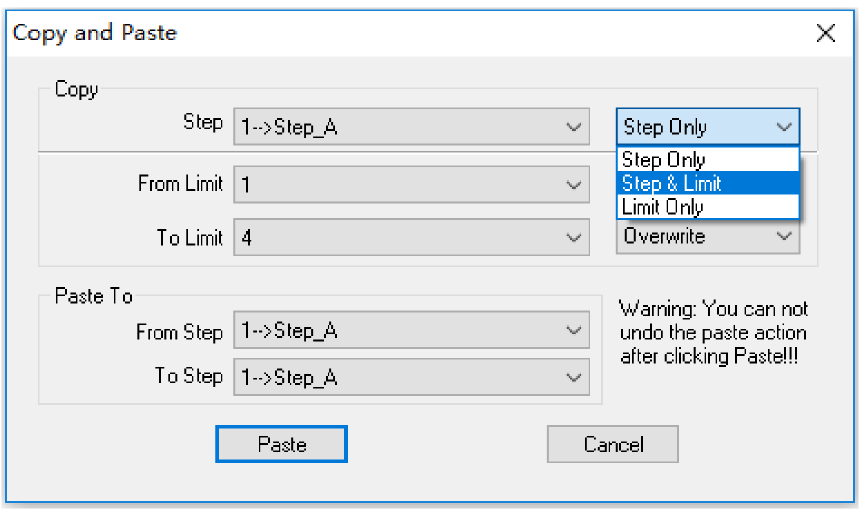


Figure 5-72 Copy and Paste Step, Limit Dialog

4. Select the range of limits you want to copy from (e.g., from limit 1 to limit 4).
5. Select limit Copy option. Three options are provided.
   a. Overwrite - Overwrite existing limits.
   b. Append - Add new steps under existing limits.
   c. Insert - Insert new limits prior to existing limits.
6. Select the step you want to paste. Users can paste one step at a time or several steps at the same time. To paste one step, such as Step C, select From Step C to Step C; to paste more steps, as from step B to step D, select From Step B to Step D.

Copying Step Only

Follow the procedure above. When selecting copy options from the dialog, select Step Only.

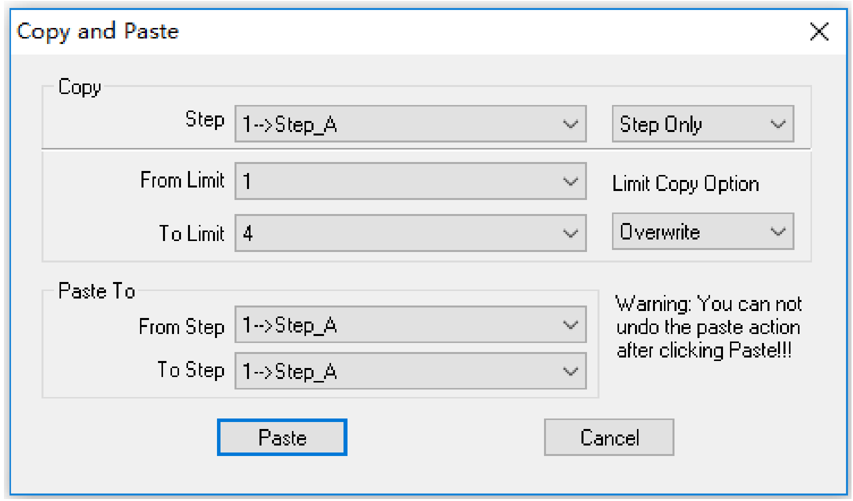


Figure 5-73 Copy and Paste Dialog-Step Only Selected

Copying Limit Only

Follow the procedure above. When selecting copy options from the dialog, select Limit Only.

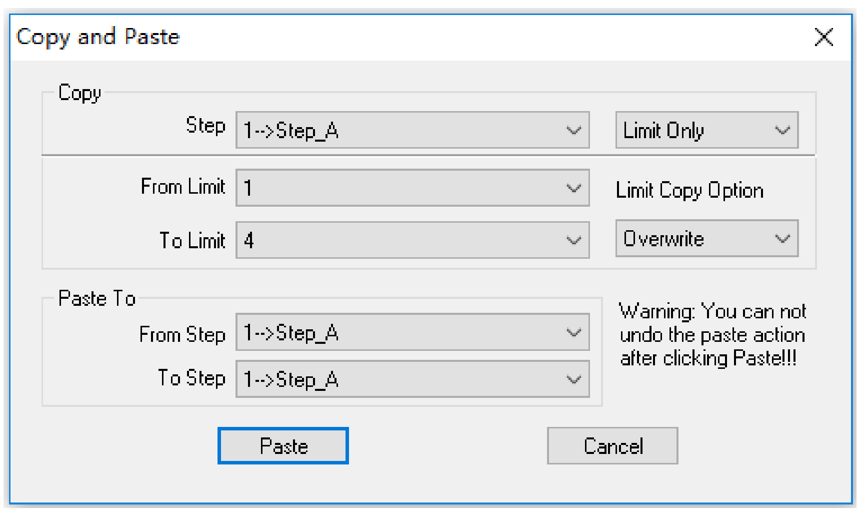


Figure 5-74 Copy and Paste Dialog-Step Only Selected

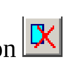
Copy and Paste Button

To copy a single step or limit, users can still use the above method; however, there is a simpler way:

Highlight a step or limit you want to copy, click the Copy shortcut icon on the tool bar.

Highlight the step or limit you want to paste, click the Paste shortcut icon  on the tool bar.
This method copies one step or one limit at a time.

Deleting Step or Limit

Highlight the step(s) or limit(s). Click the Remove shortcut icon  on the tool bar.

5.9 Programming Pulse Control

What is Pulse Control?

MITS Pro8.0 can control some Arbin hardware with the capability of delivering pulses in a general schedule. These pulses can be programmed to have a maximum of 30 stages each. Each schedule can have a maximum of 20 pulses. The pulse width can be defined as small as 100μs on **HS21044** machine and above series machines. (Note, however, that the execution of such narrow time-domain pulses may require specific hardware that is designed especially for the implementation of GSM and other high-speed pulse profiles. Consult the Arbin salesman for details concerning the construction of the instruments.)

On machines with **Pulse** enabled, a **Pulse** page is added in the schedule editor for pulse definition.

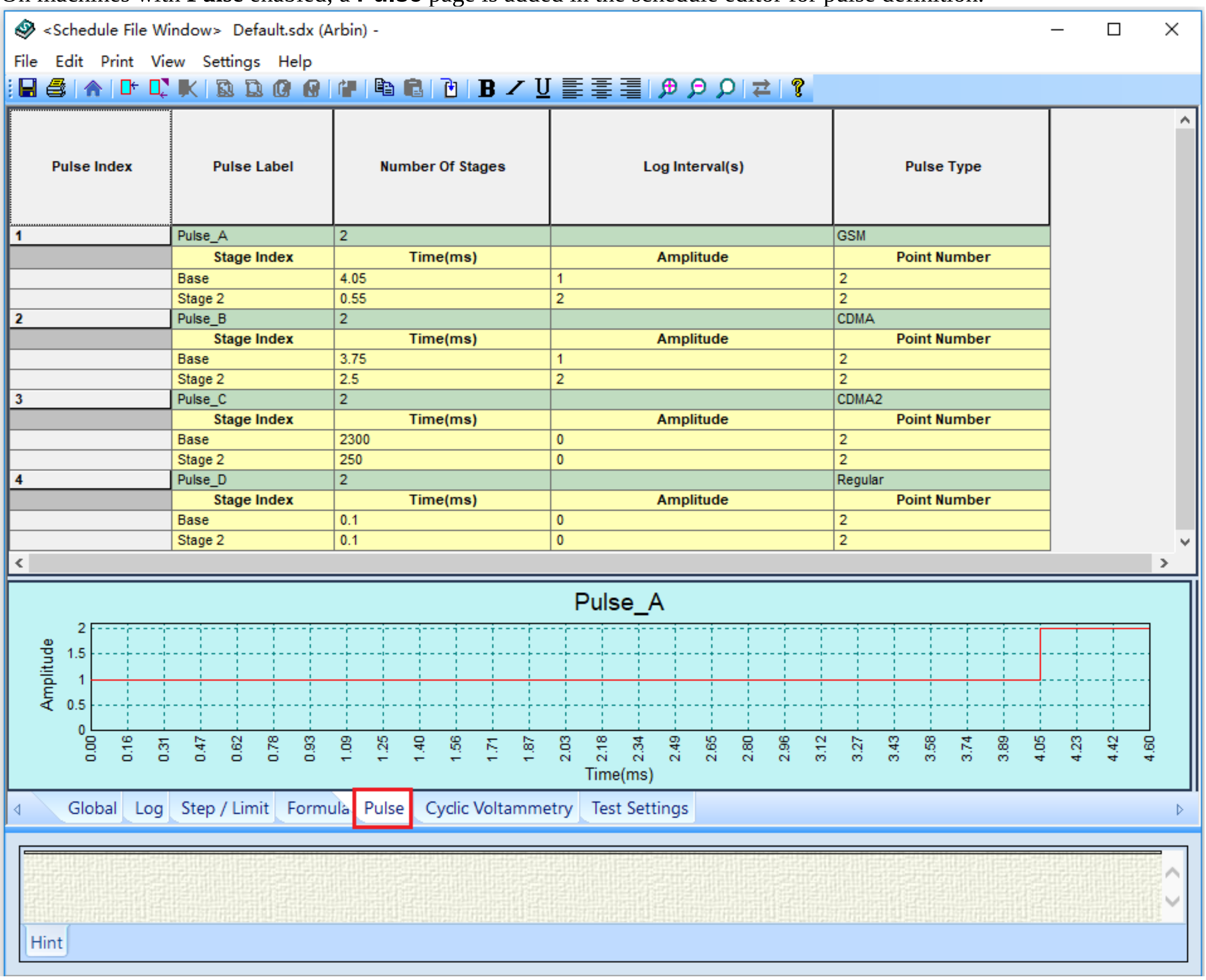


Figure 5-75 Pulse Page in the Schedule File Window

A **Pulse** must contain at least two stages and be limited to 30.

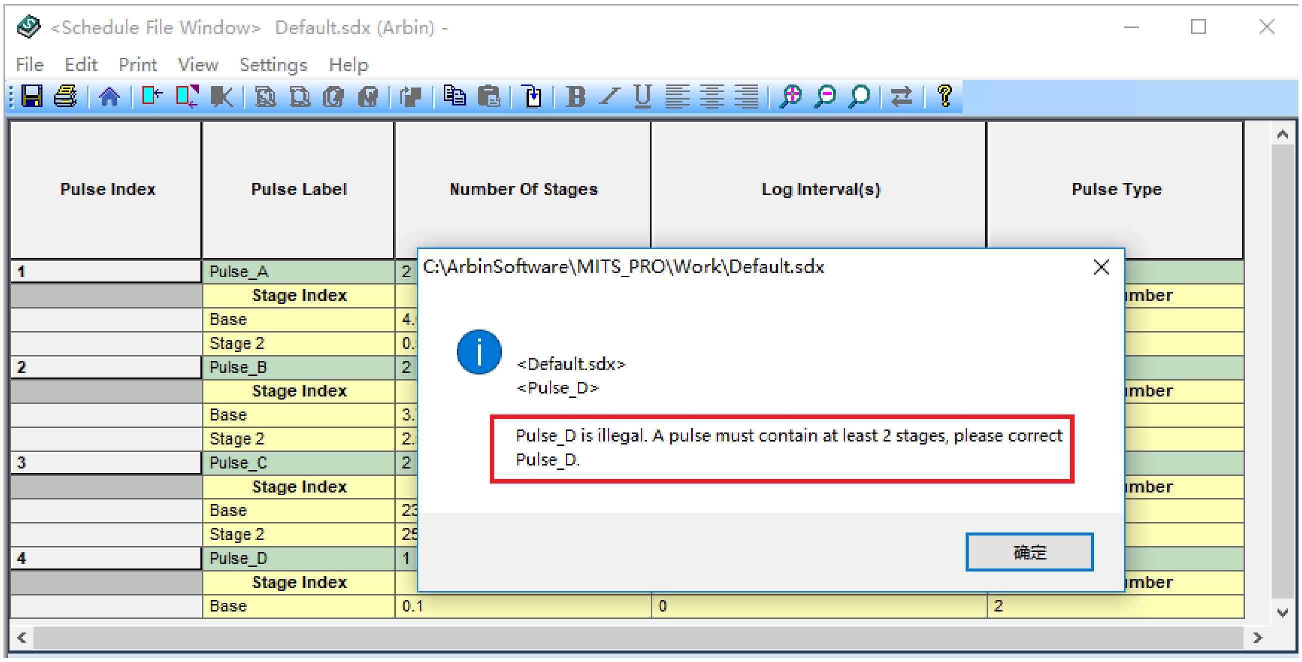


Figure 5-76 A **Pulse** must contain at least two stages

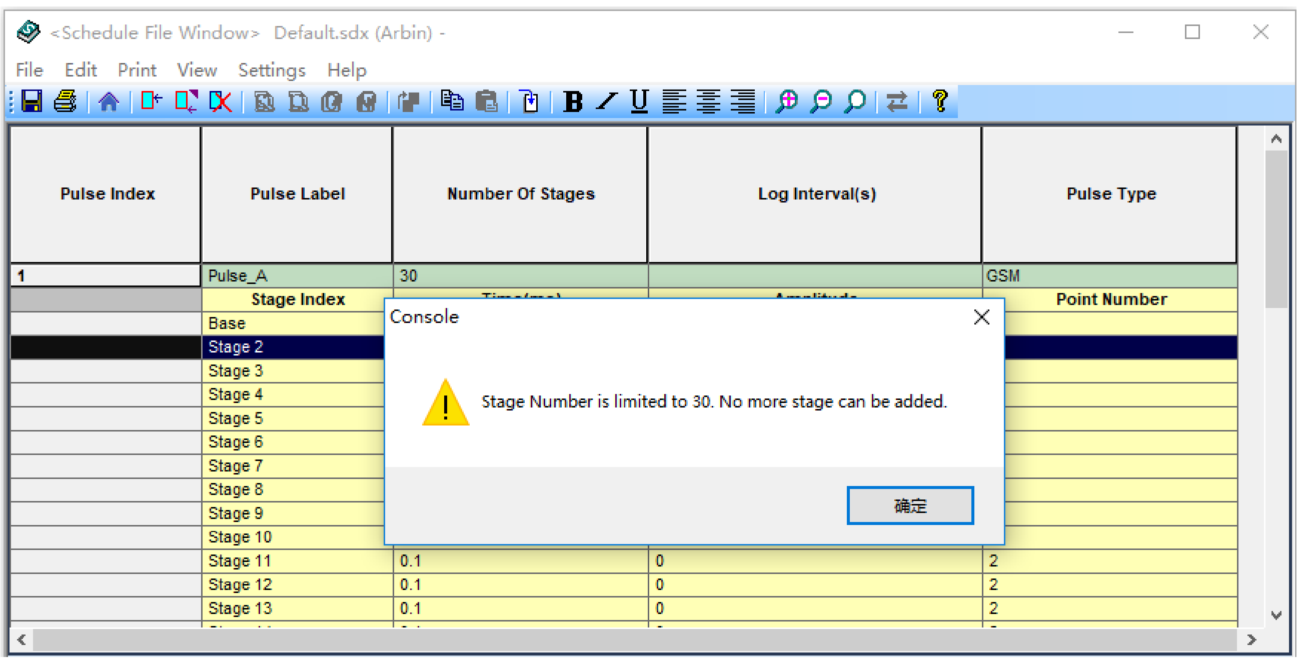


Figure 5-77 A **Pulse** contains at most 30 stages

If the system requires the pulse control function, then Pulse control is checked in the option box **Pulse Control** under the section in the **Advanced Features** page of the ArbinAdvSys.cfg. Then, a Pulse page is added in the **Schedule File Window**.

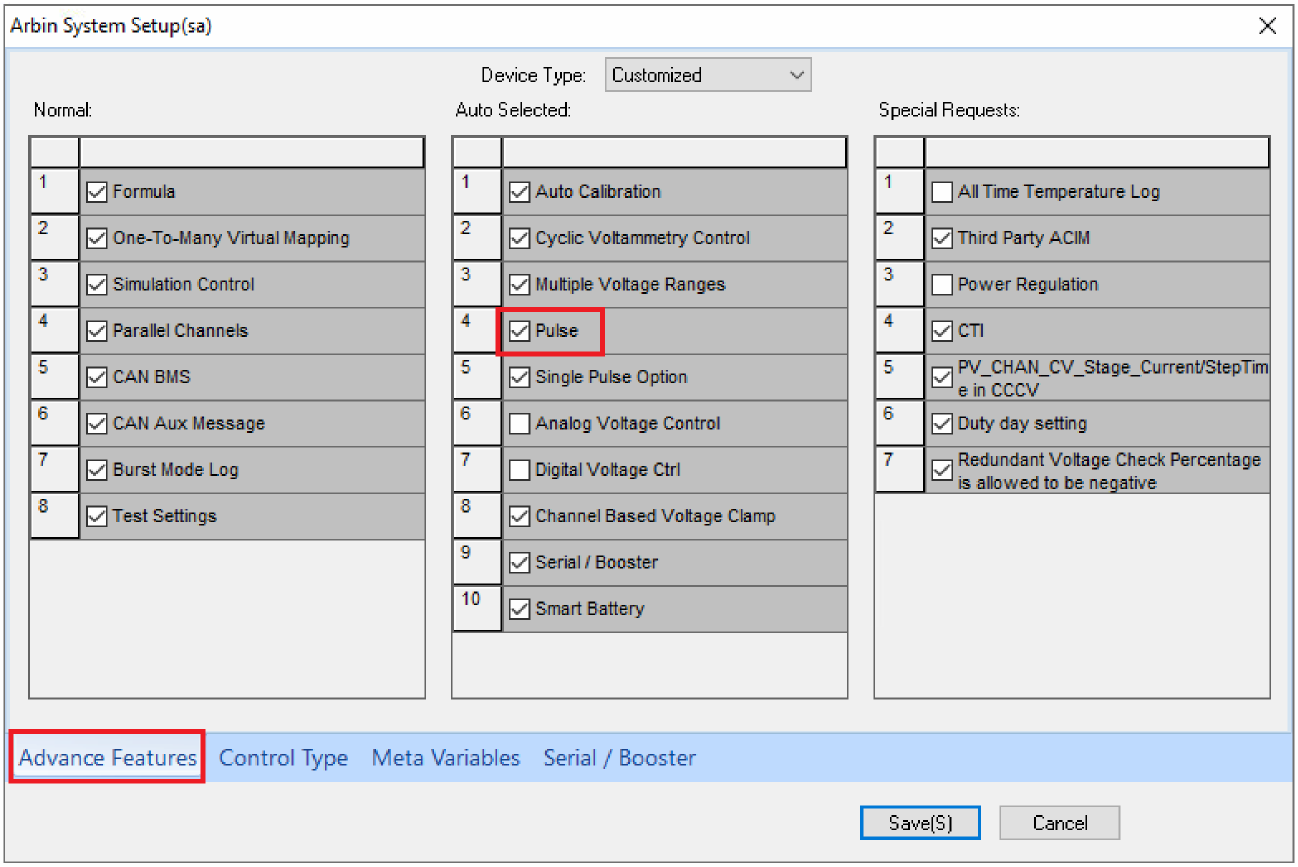


Figure 5-78 Enabling **Pulse Option** in the Advance Features Page of ArbinAdvSys.cfg

Field Descriptions of Pulse Page

Pulse Index -- Indicate the serial number of the pulse.

Pulse Label -- Gives the pulse profile a name. Users can use a default name or rename the pulse profile. To rename, double-click the **Pulse Label** field and enter a new name.

Number of Stages -- Automatically shows the stage number created in a pulse profile. This field is non-editable.

Log Interval(s) -- One of the key features of Arbin digital pulse generation design is that data acquisition is synchronized with pulse generation. However, if data logging were to occur constantly to record every pulse, the computer hard disk drive would fill up quickly. The **Log Interval(s)** specifies at what interval of time to record pulses. For example, if the user enters 300 in this field, then the software records the pulse every 5 minutes. The minimum interval is 1s. This option is not editable. However, right now, the Log Intervals is reserved and has no effect. Actual data log interval is decided by DV_PulseCycle.

Pulse Type -- This field specifies the general pulse type. The options are "Regular" (completely user-definable multi-stage waveform), "GSM", "CDMA", and "CDMA2" (all industry-standard waveforms).

Is Single Pulse (SP)? – If checked here, it is a single Pulse. Otherwise, it is a continuous pulse.

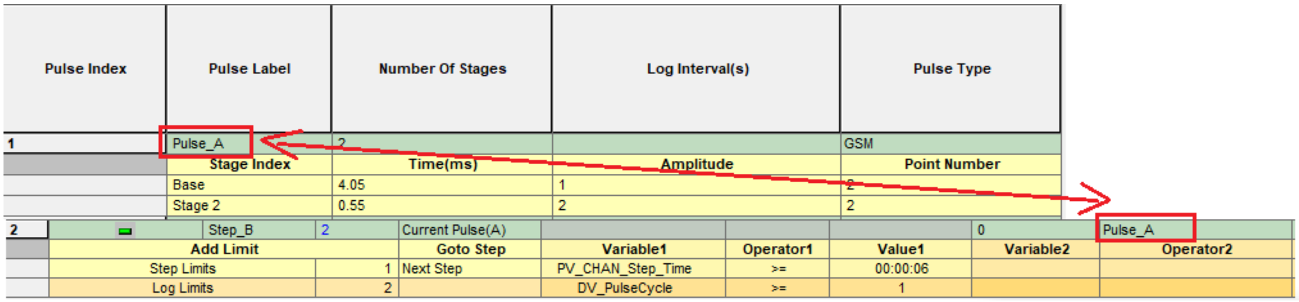


Figure 5-79 A Sample Schedule using a Pulse. This Pulse Width is 4.05 ms and 0.55ms, and PV_CHAN_Step_Time >= 60ms, and DV_PulseCycle>=1.

Stage Index -- automatic identification of the pulse stage (non-editable)

Base -- The first stage in every pulse profile is defined as the base stage. The **Base** setting determines the starting point for the pulse. The minimum base width is 100µs, but there is no limit to the value of the amplitude within the capabilities of the machine.

Stage x -- The user can append more stages (minimum of 1, shown Stage 2) to a pulse profile. Minimum stage width is 100µs, and the maximum allowable number of stages is 30 (including the Base).

Time(ms) – Used to define the pulse width. Though the actual limits in the software are extremely wide, performance is best with durations limited to 2ms. The minimum stage width is 100µs, maximum stage width is 1 hour, and the minimum increment width is 0.01ms.

Amplitude – Used to define the pulse height. For the current pulse, the unit is A; for the voltage pulse, the unit is V.

Point Number –Currently is set to 2.

Pulse Specification: The following lists some specifications for regular and single pulses. In **Figure 5-80** the specific pulse specification is listed in the field of regular pulse option and single pusle option.

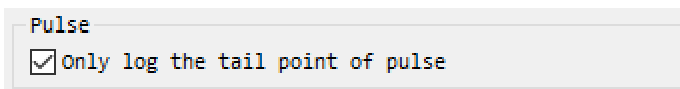


Figure 5-80 Enable only log the tail point of pulse in ArbinSys.cfg

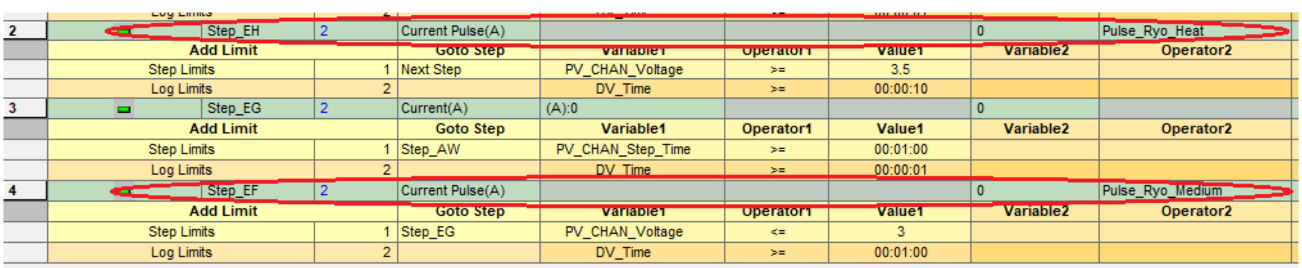


Figure 5-81 Step Limits in Current Pulse Steps

Creating Pulse Profile

1. Click the **Pulse** tab at the bottom of the schedule page.

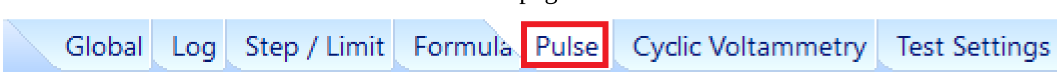


Figure 5-82 Pulse Tab of Schedule

2. On the menu bar, click Edit, Append Pulse or Edit, Insert Pulse. A pulse labeled as Pulse_A and its base stage appears. Alternatively, simply click the Append or Insert shortcut button on the tool bar to append or insert a new pulse.

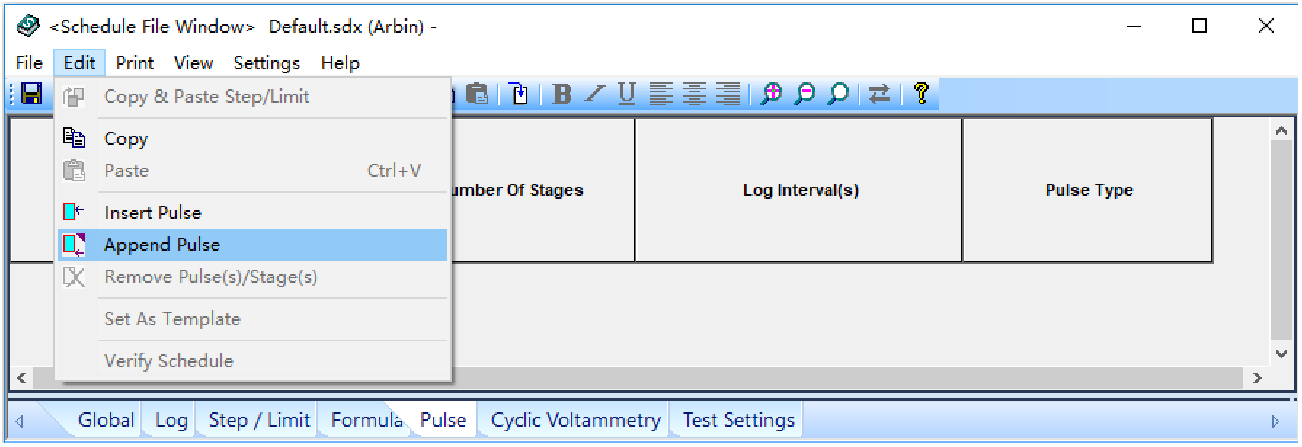


Figure 5-83 Append Pulse from the Edit menu

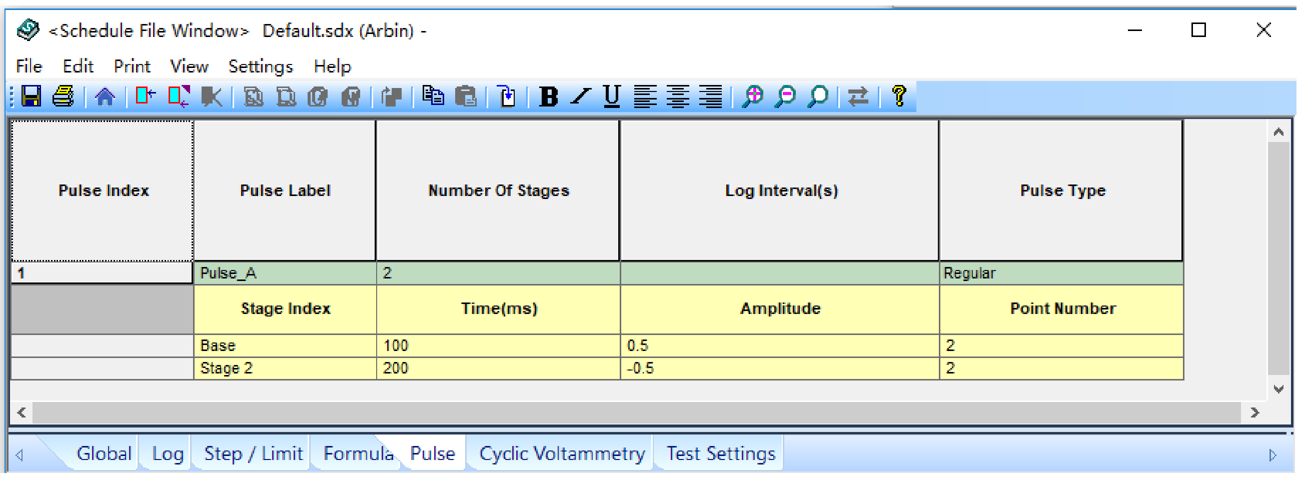


Figure 5-84 Appended Pulse with Default Parameters

3. Give the pulse a new label or use the default label. To change the pulse label, click the field containing Pulse_A and enter a new label.
4. Identify the type of pulse - Regular (user-defined), or standard (GSM, CDMA, CDMA2). For the standard pulse regimes, the **Pulse Label**, **Stage Index**, **Number of Stages** and **Time (ms)** fields are all overwritten.

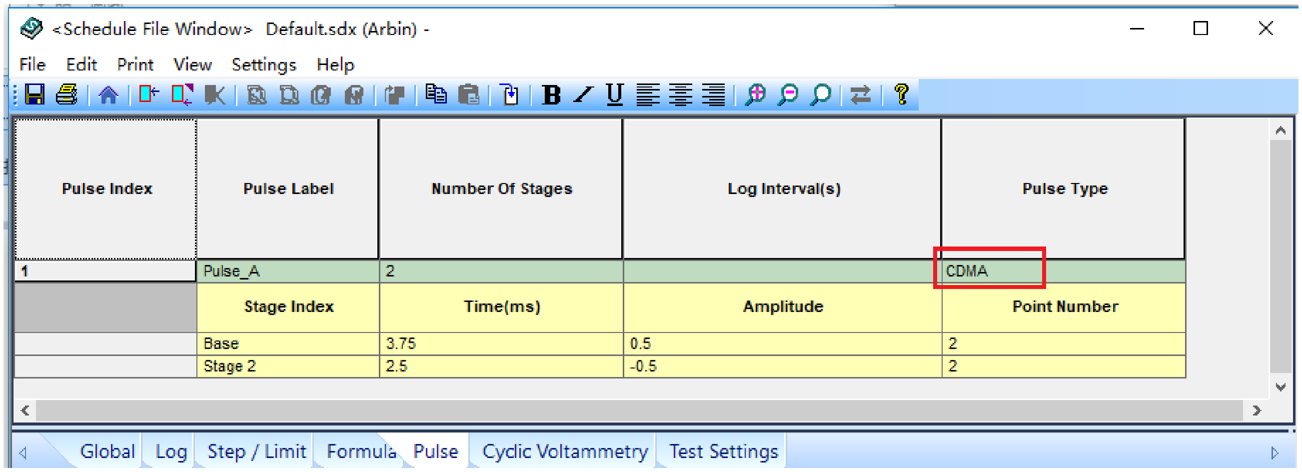


Figure 5-85 CDMA Pulse Definition (Time Base Fixed)

5. Define Base Stage. Enter the desired value in the **Time** and **Amplitude** fields. Amplitude is the output current during the pulse. This value can be positive, negative or zero. Any value is permitted within the current or voltage capabilities of the hardware. The time value of the instrument may be as small as 100µs and may be increased by increments of 50µs. (Note: execution of GSM pulses and user-defined stages of <100ms in duration may not be possible without special hardware modifications. Consult Arbin for system ratings to determine if the hardware is pulse capable.)
6. Append Stage n. To append a new stage, highlight Base under **Pulse Index** and click the Append (or Insert) shortcut button on the tool bar. Any pulse profile must have at least two stages (Base +Stage 2).

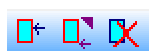


Figure 5-86 Insert-Append-Remove Icons

7. Define Stage 2. Enter the desired value in the fields **Time** and **Amplitude**. Again, the range of values that may be entered is limited by the specifications of the instrument.
8. To append more stages, place the cursor on the field to the left of **Pulse Index** and right click. Select Edit - Append Stage or Edit - Insert Stage or click on one of the icons in **Figure 5- 86** above. Enter the desired value in the fields **Time (ms)** and **Amplitude** to define each stage. The user can append up to **30** stages at for each pulse.

A pulse chart can be shown on the bottom side of the schedule editor for the pulse profile. When the cursor is placed on a certain pulse, for example Pulse B, the chart plots the Pulse B Profile as implemented in the schedule. The chart profile is plotted as Amplitude versus Time. The time units include ms (milliseconds) and seconds. Log Preview is based on the log intervals. One can set how many pulses to preview. **(Figure 5-87A and B)**

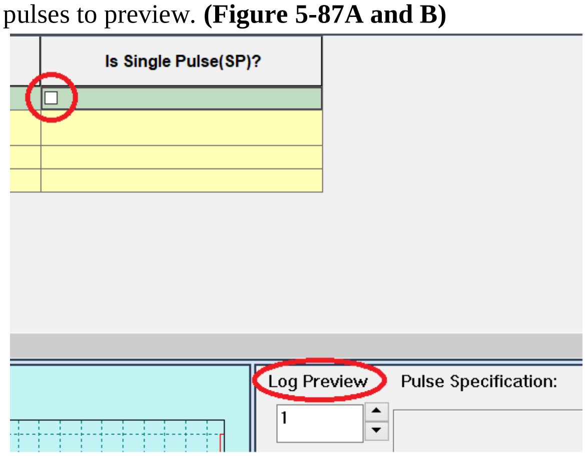


Figure 5-87A Single pulse or not, and how many puleses to preview

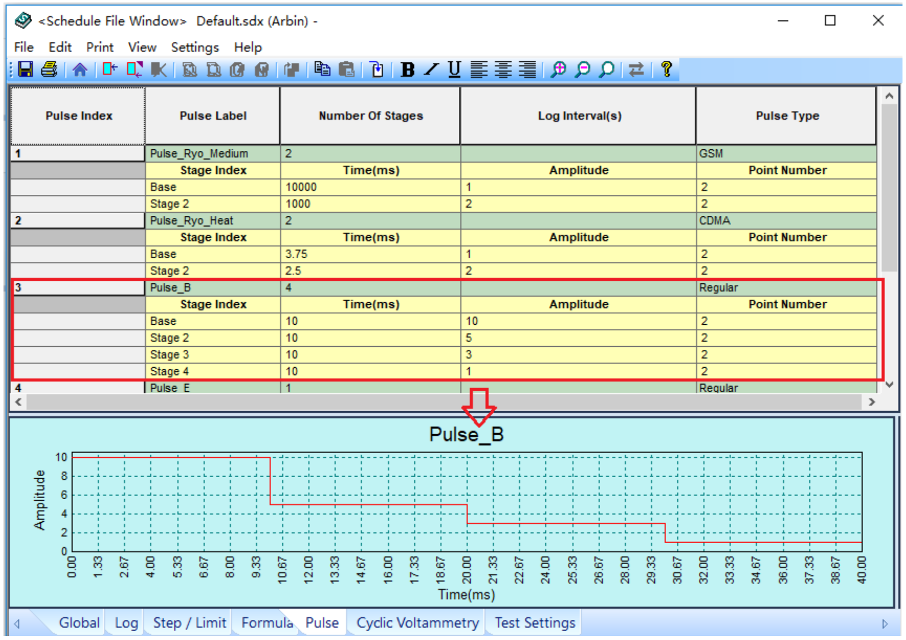


Figure 5-87B Chart Displays Pulse B Profile Implemented in Pulse Schedule

Creating More Pulse Profiles

On the menu bar, click Edit - Append Pulse or Edit - Insert Pulse. Clicking Append Pulse will add the new pulse after Pulse_A; clicking Insert Pulse will insert the new pulse prior to Pulse_A. Follow steps 3 and 5 through 8 of **Creating Pulse Profile** (above).

Creating Pulse Control Step

1. Following the steps of **Creating Pulse Profile**, create your desired pulse profile in the pulse page.
2. Select "Current Pulse(A)" as the **Control Type** for current pulse. The amplitude unit is ampere (A).
3. Click the field under **Extended Definition**. From the drop-down menu, select the desired pulse profile. This field will be enabled after a pulse profile has been created.
4. Set the value for **Max Current(A)**. MITS Pro8.0 will auto switch the current range according to Max Current if setting “0” here.

   User can set different max current value here also. Choose the proper value of Max current based upon the maximum amplitude in the pulse profile. Users need to refer to the hardware current range settings too. The rated values for the current ranges of the hardware differ from one tester to another and are identified on the front of the tester.

   One pulse can execute within only one current range, even though it may contain several different amplitude stages. For a current pulse with multiple stages, compare the highest amplitude value with hardware current range settings and enter the proper current value of Max current(A).
5. Set step limits for a pulse step by following the instruction of **Section 5.7** . Termination conditions, such as PV_Chan_Voltage <= x, will reference the second stage of the pulse.

   Example:

   In the case shown in **Figure 5-88**, the voltage will be compared to the cut-off value in the **Step/Limit** page only in the second stage of the pulse. Given this specification, users should construct the pulses to realize the termination condition at the preferred point in the pulse sequence.

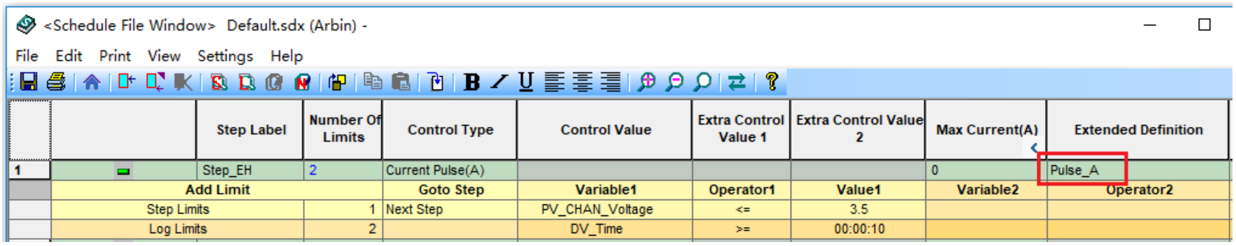


Figure 5-88 Select a Pulse on Step/Limit Page

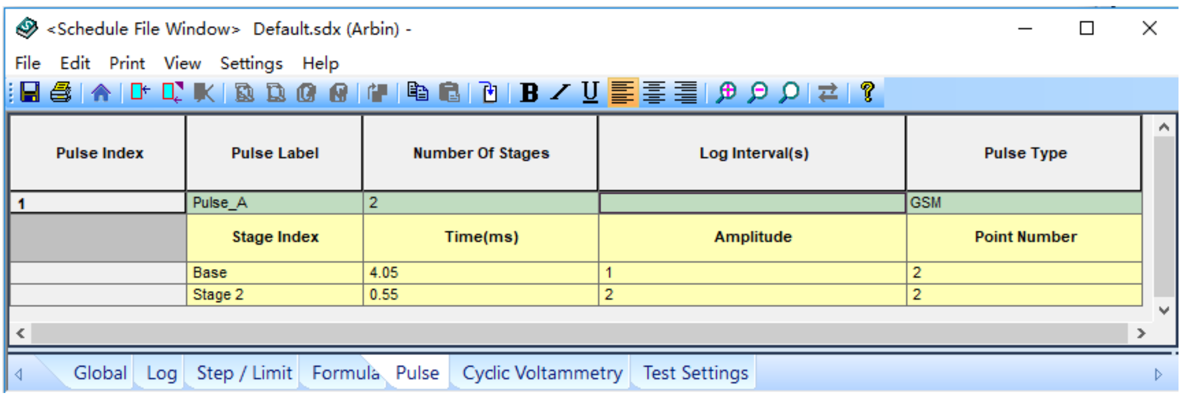


Figure 5-89 Current or Voltage Limit in Step/Limit Page Applied on Stage 2

Note1: **Do not establish any AND limits in pulse steps**. Further, log limits can only use two meta-variables (DV_Time, DV_PulseCycle) in the pulse step.

Note2: Only some machines can run high speed pulse (for exsmapl, HS21044 machine) can run pulse steps. Please consult Arbin if your machine can do it.

In the new mode of Control Type: Current Pulse page, one can choose Current Range (Max Current), Current Pulse Profile, and Add/Delete Log/Step Limit by double clicking the left/right mouse button. By clicking the "Edit/View" button, the pulse profile page will be shown to allow the user to modify pulse profiles. By clicking the Pulse Specification button in Control Type: Current Pulse Page, the detailed pulse specification information will be provided as shown in **Figure 5-92**.

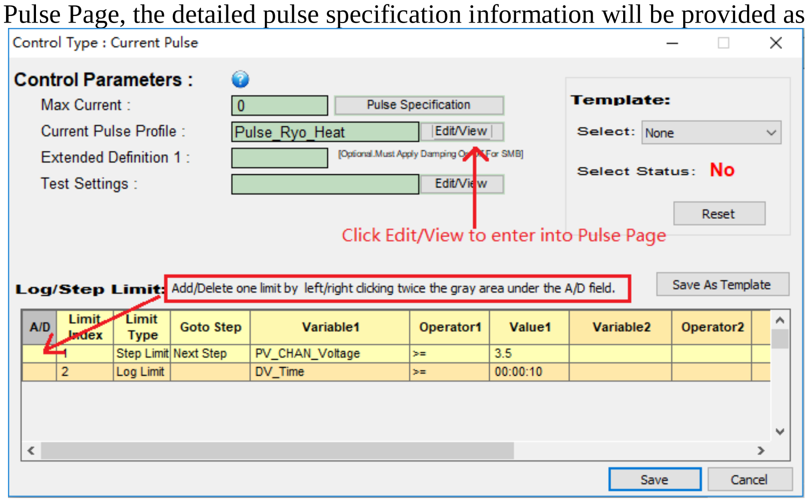


Figure 5-90 Current Pulse Page in New Mode

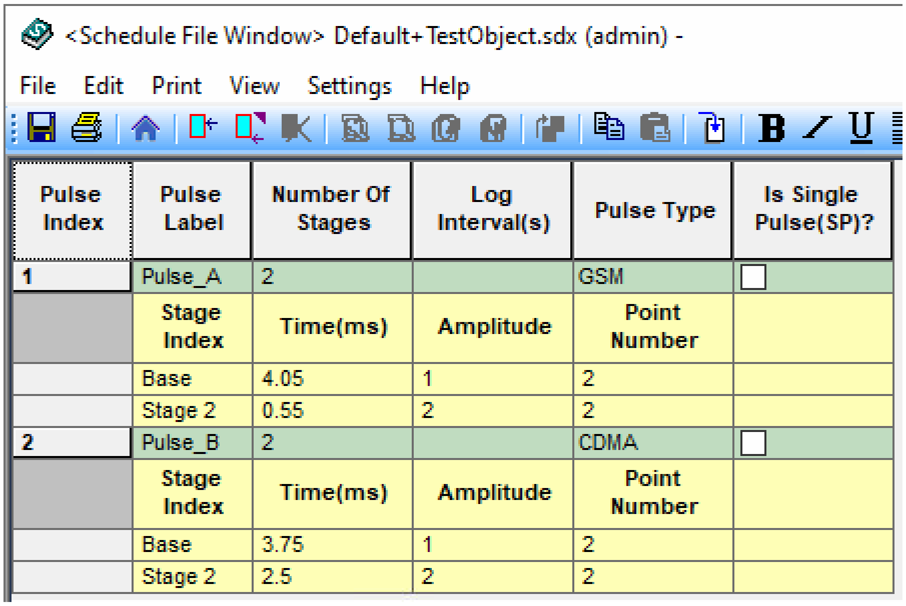


Figure 5-91 Clicking the Edit/View Button to Enter into Pulse Page

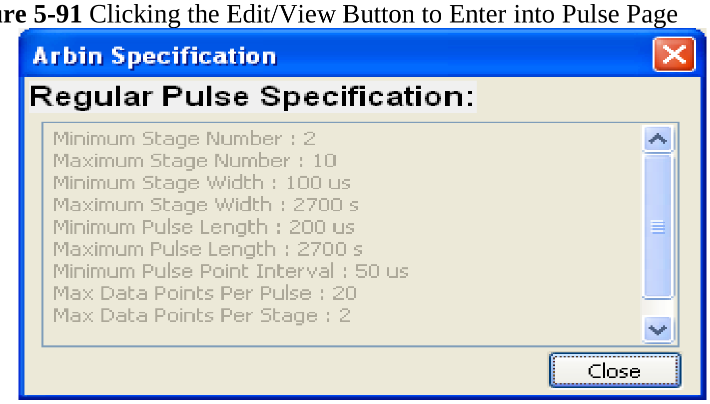


Figure 5-92 Click Pulse Specification Button to View Detailed Pulse Specification

5.10 Internal Resistance Measurement

In MITS Pro 8.0, the measurement of Internal Resistance (IR) for batteries, or Equivalent Serial Resistance (ESR) for capacitors, is a standard feature. IR or ESR measurement can be integrated in an operation, which conducts the charge-discharge cycling, the capacity calculation, and other MITS standard controls in one measurement.

Previous Method to Measure Internal Resistance

At current amplitude setting, I_{IR}, the pulse current changes between $I_0 - I_{IR}$ and $I_0 + I_{IR}$. I_0 is the offset of the current, i.e. the base current during IR measurement. On that IR method, the data points are picked up at P_2 and P_3, time T_1 after the current interrupt, as shown in the figure below. The IR data is an average over **ten** pulses.

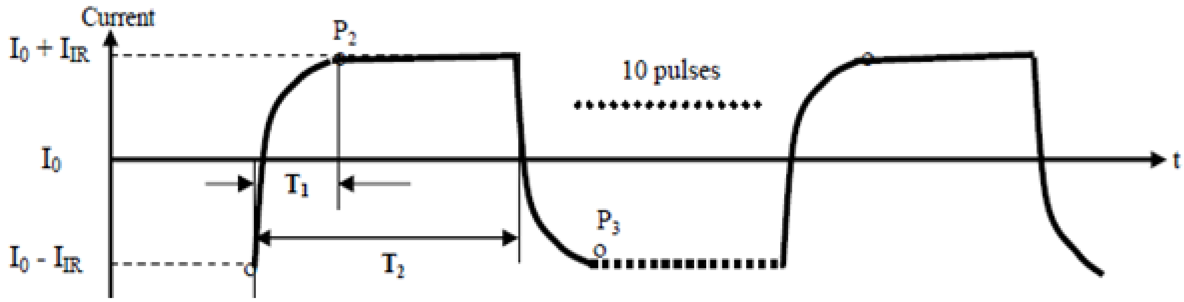


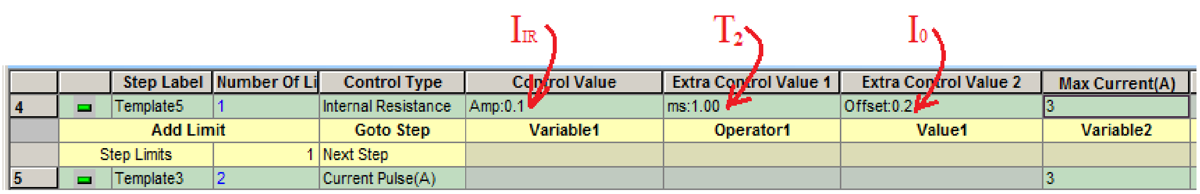
Figure 5-93 Pulse Profile for IR Measurement

The formula to calculate IR is

$$\textbf{IR} = \text{Average }\{(\text{Voltage at } P_2 - \text{Voltage at } P_3) / (2\ I_{IR})\}.$$

IR Pulse Width T_2, and Data Sampling Time T_1 in Previous Method

The **Data Sampling Time**, T_1, for IR pulse is adjustable from 50 µs to 2 milliseconds. Each pulse width can't be pre-fixed; this depends upon the configuration of the testing system, and total testing load on the system. T_2 takes about five to six times T_1. Ten pulses for the IR measurement take 120 x T_1, plus non-pulse time of 55 ~ 60 ms before 10 pulses and of 60 ~ 65 ms after 10 pulses, to make up one IR or ESR measuring of total ~ 120 x T_1 + 125 ms.



		Step Label	Number Of Li	Control Type	Control Value	Extra Control Value 1	Extra Control Value 2	Max Current(A)
4		Template5	1	Internal Resistance	Amp:0.1	ms:1.00	Offset:0.2	3
	Add Limit			Goto Step	Variable1	Operator1	Value1	Variable2
	Step Limits		1	Next Step				
5		Template3	2	Current Pulse(A)				3

Figure 5-94 Parameters in the Schedule for IR Measurement

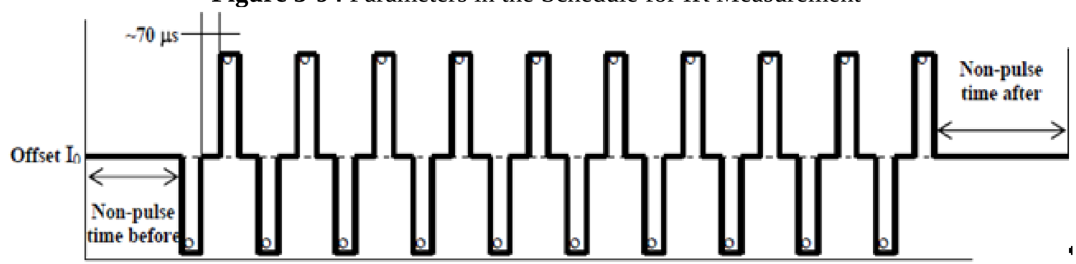


Figure 5-95 Time Base of Each IR Measurement

Updated Method to Measure Internal Resistance

To more precisely measure the IR, minimizing interference from electrochemical and concentration polarizations as much as possible, the tester still generates 10 pulses with an improved shape. In the improved IR method, the data points are picked up at P_2 at the end of T_1 and P_3 right before the rising current, as shown in the figure below. An average over ten pulses is adapted.

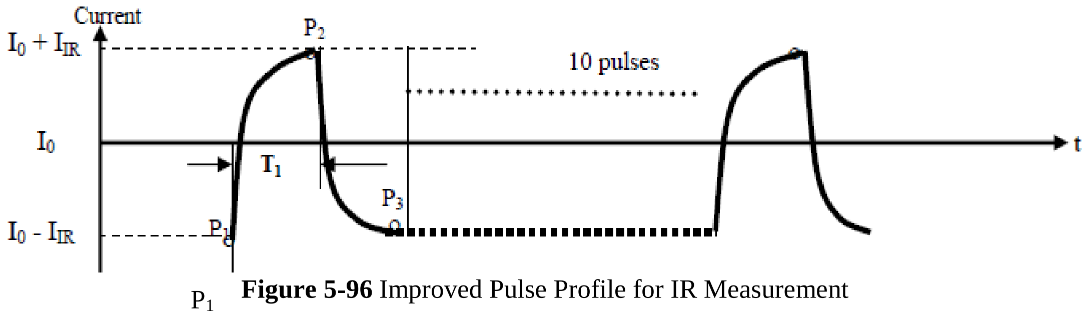


Figure 5-96 Improved Pulse Profile for IR Measurement

The formula to calculate IR is the same

IR = Average {(Voltage at P_2 – Voltage at P_3) / 2 (I_{IR})}.

T_1, IR Pulse Width or Data Sampling Time, in Improved Method

In this improved method, $T_1 = T_2$, the **Data Sampling Time equals Pulse Width**. T1 is adjustable from 1 ms to 100 ms. Rest of settings for IR measurement is the same as the previous method.

How to create an IR step

User can create an IR step before or after any step in a schedule. It is a independent step in the schedule.

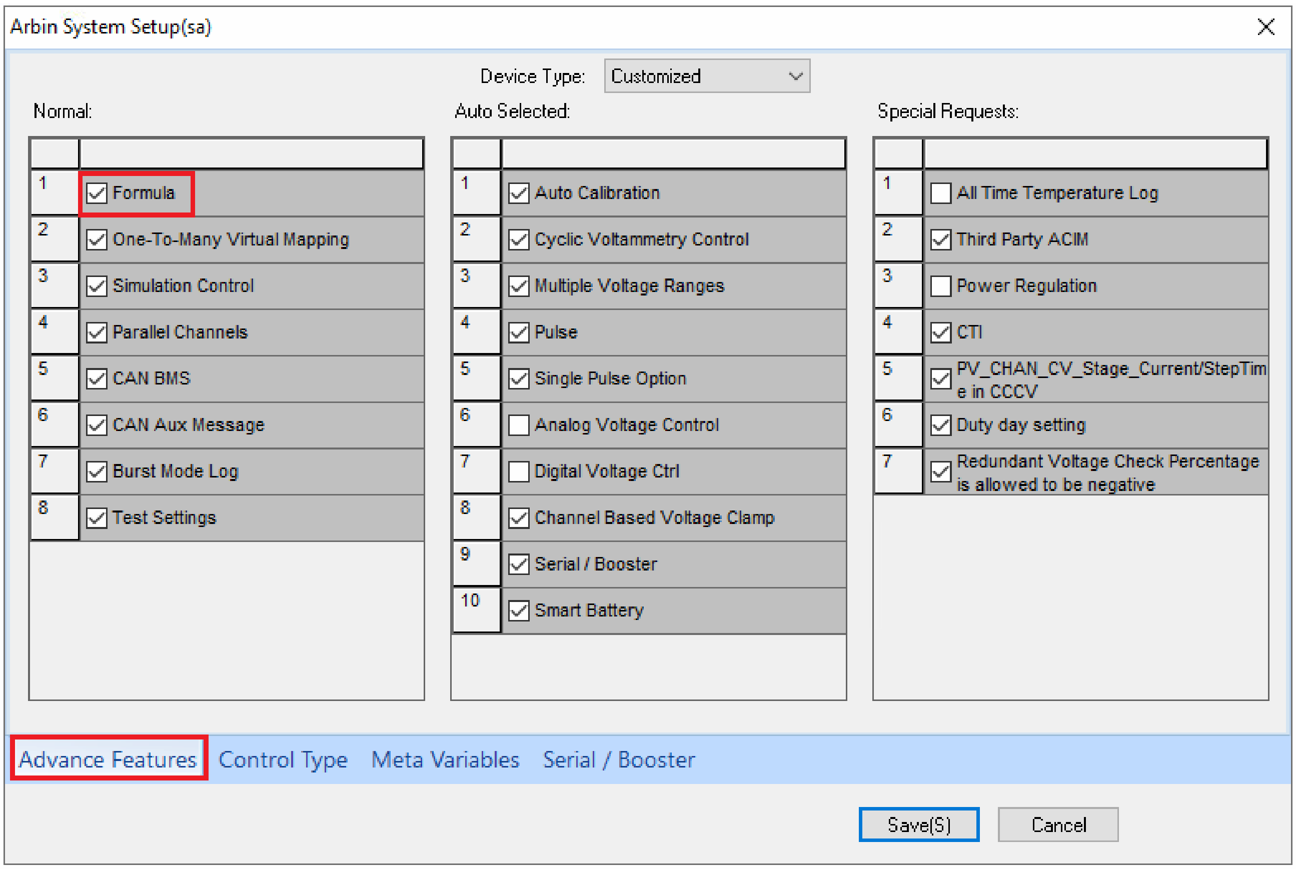
1. Select “Internal Resistance” as the “control type” for measurement IR.
2. Set I_{IR} in the field of “Amp” (unit is A), T_1 in the field of “ms” (unit is ms), base current I_0 in the field of “offset” (unit is A).
3. User don’t need to set up any step/log limit.

5.11 Creating and Editing a Formula

What is a Formula?

MITS Pro8.0 allows users to create a formula for their special applications. A formula can be used to substitute for Meta Variables, define step and log limits, or act as a control value.

The formula function in **MITS Pro8.0** is enabled when the Formula among the Advance Features tab of ArbinAdvSys.cfg is selected. Then, a Formula page shows up in the Schedule File Window.



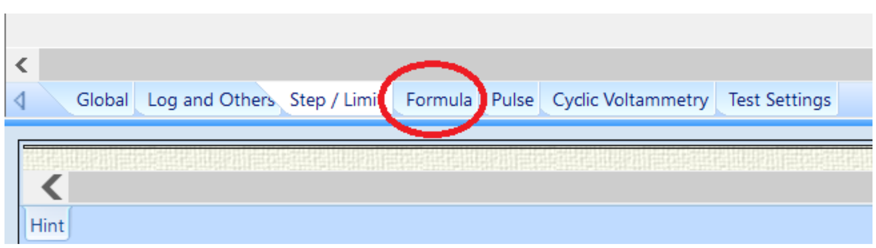


Figure 5-97 Enabling Formula

Definition a formula

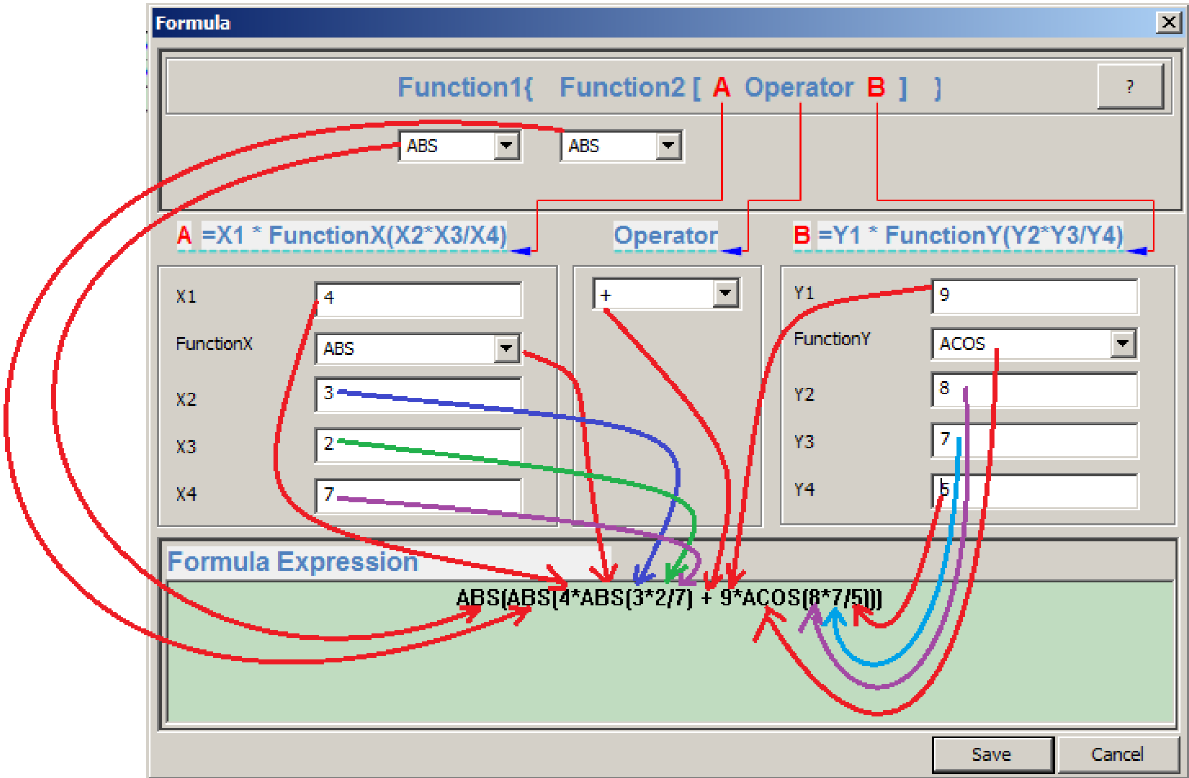


Figure 5-98 Formula Definition

X1, **X2**, **X3**, **X4**, **Y1**, **Y2**, **Y3** and **Y4** can be numerical values or Meta Variables. Note that 0 in the position of **X1**, **X2**, **X3**, **Y1**, **Y2** or **Y3** will result in elimination of the respective term.

Functions such as Func1, Func2, FuncX, and FuncY include:

ABS -- Return the absolute value of a number, i.e., ABS(x) = |x|.

ACOS -- Return the arccosine of a number, in radians in the range of 0 to pi, i.e., ACOS(x)..

ASIN -- Return the arcsine of a number in radians, i.e., ASIN(x).

CEILING -- Return the smallest integer that is greater than or equal to a given number, e.g., CEILING (2.99) =3.

COS -- Return the cosine of an angle, i.e., cos(x).

CUBIC -- Return the cubic of a number, i.e., x^3

EVEN -- Round a number up to the nearest even integer. Negative numbers are adjusted away from zero.

EXP -- Return e raised to the power of a given number, i.e., EXP (n) = e^n .

FACT -- Return the factorial of a number.

FLOOR -- Return the largest integer that is less than or equal to a given number.

INT -- Round a number down to the nearest integer.

LN -- Return the natural logarithm of a number, i.e., ln(x).

LOG10 -- Return the base-10 logarithm of a number, i.e., $\log_{10}(x)$.

ODD -- Round a number up to the nearest odd integer.

RANDOM -- Return an evenly distributed random number greater than or equal to 0 and less than or equal to a given positive number; return an evenly distributed random number less than or equal to 0 and greater or equal to a given negative number.

SIGN -- Return the sign of a number: 1 if the number is positive, zero if the number is zero, or -1 if the number is negative. E.g. SIGN (-1) =-1; SIGN (+1) =1; SIGN (0) =0.

SIN -- Return the sine of an angle, i.e., sin(x).

SQR -- Return the square of a number.
SQRT -- Return the positive square root of a number. i.e., SQRT(X)=x^(1/2).
TAN -- Return the tangent of an angle, i.e., tan(x).
TRUNC -- Return an integer for a number by removing the decimal, or factional, part of the number. i.e., TRUNC (2.12) =2
Operators include: **+ - × / %** (Modulus operator returns the remainder when the first operand is divided by the second.).

Figure 5-99 shows a sample formula **F_A**: ΔV (dV) for charging termination condition of sealed Ni-Cd cells.

In F_A, X1 is selected as precent channel voltage value, Y1 is selected as Precent channel maximum voltage on cycle value, X2=X3=X4 =Y2=Y3=Y4=1, and operator is " - ", and no function was used in this formula. **Figure 5-99** also presents two sample formulas **F_B** and **F_C**, where functions are used.

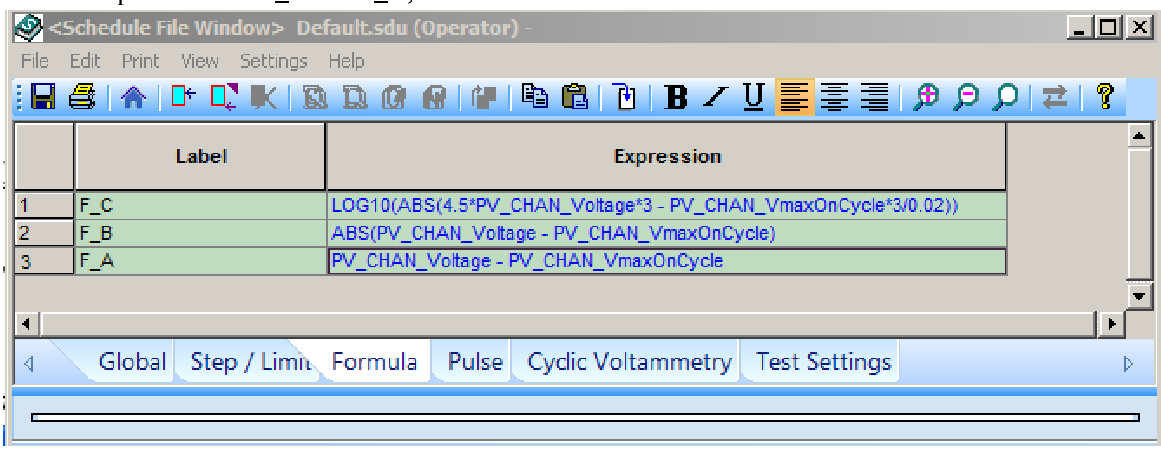


Figure 5-99 Charge Termination Formula F_A

Creating a Formula

1. Click **Formula** tab at the bottom of schedule page.

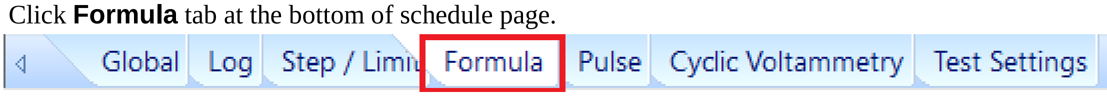


Figure 5-100 Schedule Editor **Formula** Tab

2. On the menu bar click Edit, then click on Append Formula or Insert Formula. A new formula labeled as "F_A" appears.

   A simpler method to append or insert a new formula is to use the shortcut button on the tool bar. To append a new formula, click the Append shortcut button. Formulas in other schedules can also be imported into the current schedule by clicking the Import icon.

   To insert a new formula, click the Insert shortcut button.

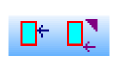
Insert  Append

Figure 5-101 Icons to Create Formula

3. Click the field under **Label** and give the formula a new name if desired.
4. Define values among **X1**, **X2**, **X3**, **X4**, **Y1**, **Y2**, **Y3** and **Y4**. **X1**~**X4** and **Y1**~**Y4** can be numeric values or Meta Variables or Formula. Numeric values can be entered directly in the field under **Xi** or **Yi**. Xi represents **X1**, **X2**, **X3**, and **X4**; **Yi** represents **Y1**, **Y2**, **Y3** and **Y4**. In order to use Meta Variable or Formula, right-click the field under **Xi** or **Yi** and select the appropriate Meta Variable from the **Meta Variables** dialog or select the appropriate **Formula** from formula list.

   Users can see **Appendix B: Meta Variables** for a thorough description of all Meta Variables.

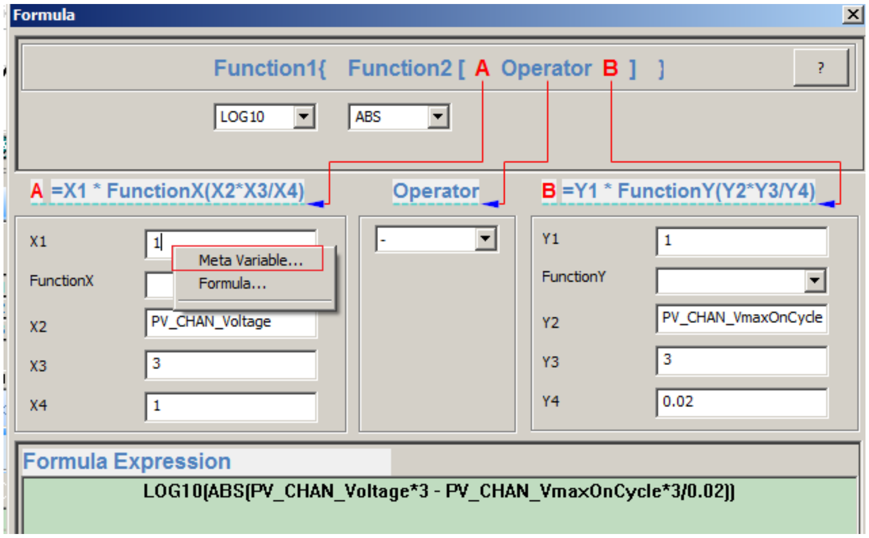


Figure 5-102 Invoking **Meta Variables** or **Formulas** Menu through Formula editor window

5. Select the proper function and operator.

To select a function, click the field under **Function 1**, **Function 2**, **Function X** or **Function Y** and select a function from the drop-down list.

To select an operator, click the field under **Operator** and select an operator from the drop-down list. The final form of the created formula appears in the field under **Expression**. Users can create as many formulas as they want with widely varying degrees of complexity.

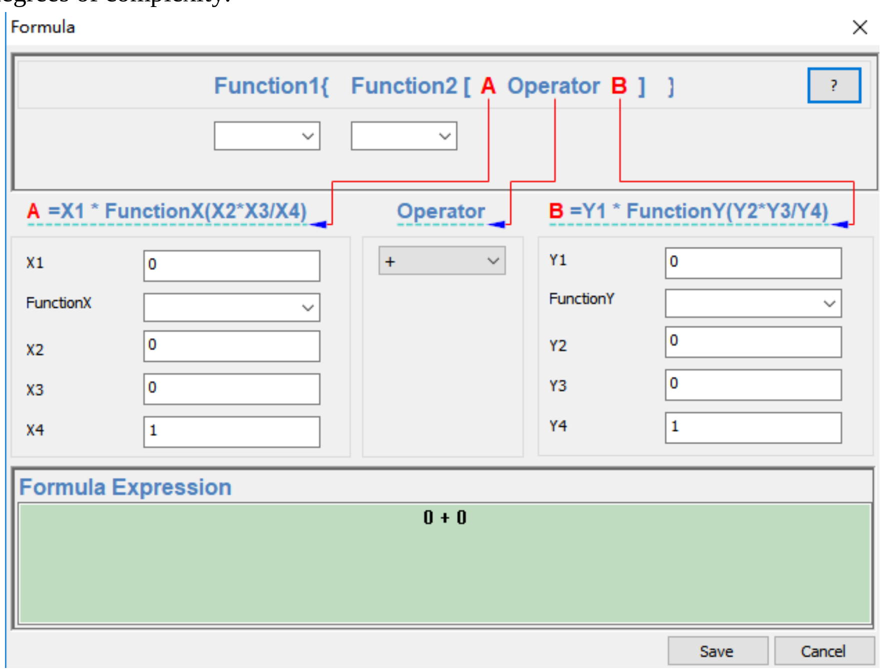


Figure 5-103 Default settings of Formula editor window

Note that the default value for each of the X and Y parameters is "0", except X4 and Y4. Users must specify "1" for each of these variables in order to prevent the cancellation of either of the terms in the Expression.

Formula Interface

1. Click the **Formula** tab at the bottom of the schedule page.
2. Place the cursor under the field Expression and clicking the left button of the mouse to enter the Formula Page.

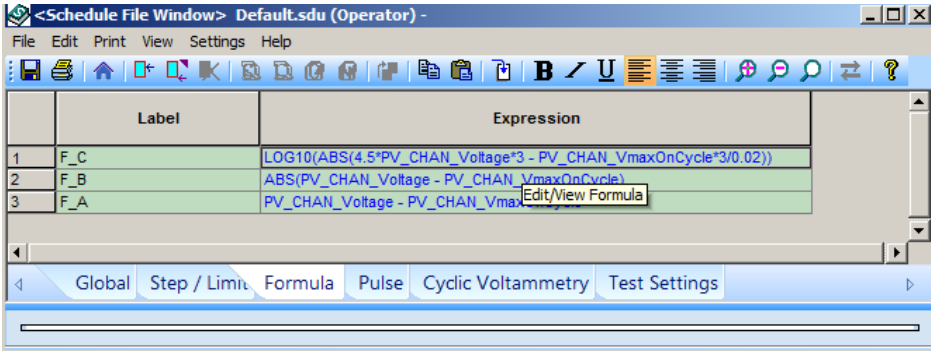


Figure 5-104 Place Cursor under Field Expression and left click once

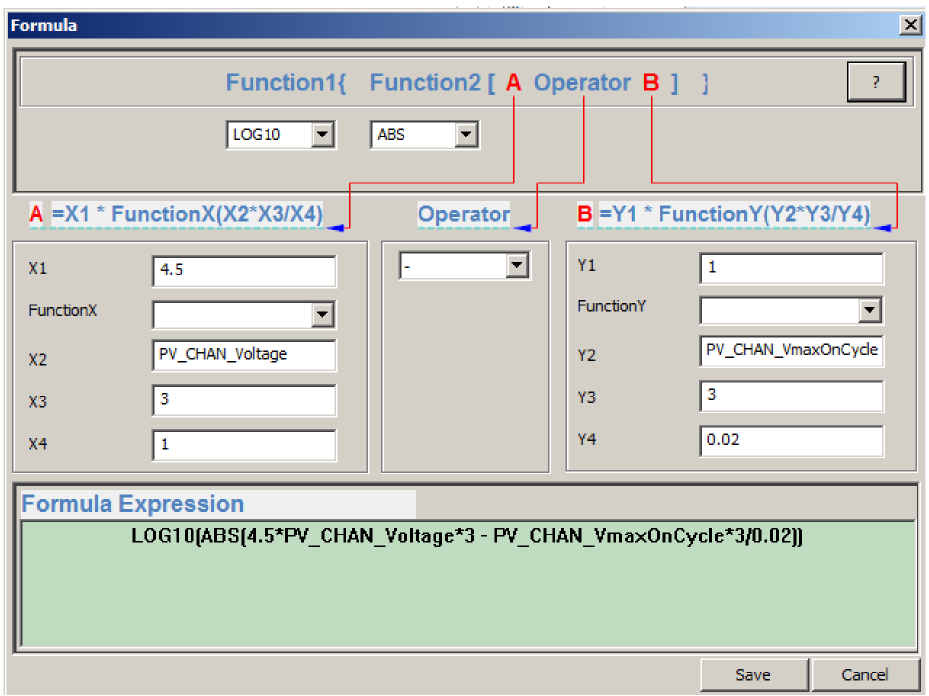


Figure 5-105 Formula Interface

3. After creating formula, go back to "step/limit" page. Righ click anywhere you want to use the formula, such as "Control Value" in command line, "Variable X", "Value X" in limit lines, select "formula" and choose a formula name from the list.

5.12 Programming Cyclic Voltammetry (CV)

What is Cyclic Voltammetry?

Cyclic Voltammetry is a method of electrochemical analysis. Conventionally, Cyclic Voltammetry involves a bi-directional linear voltage ramp applied between the electrodes of a sample in order to identify and characterize certain electrochemical processes.

While **MITS Pro8.0** is able to effect this test through the use of Voltage Ramp steps (one forward step, one reverse step), the Cyclic Voltammetry **Control Type** permits users to control the experiment in a manner more consistent with analog instrumentation, quantifying each sweep direction, range and rate through a single stage definition. Furthermore, using the same parameters, bi-directional current sweeps (designated as Current CycleV) may also be imposed. (Note: citations hereafter of Cyclic Voltammetry refers to the **Control Type** and not the strict definition of the analytical technique.) The Cyclic Voltammetry test is outlined in the **Cyclic Voltammetry** page of a schedule file.

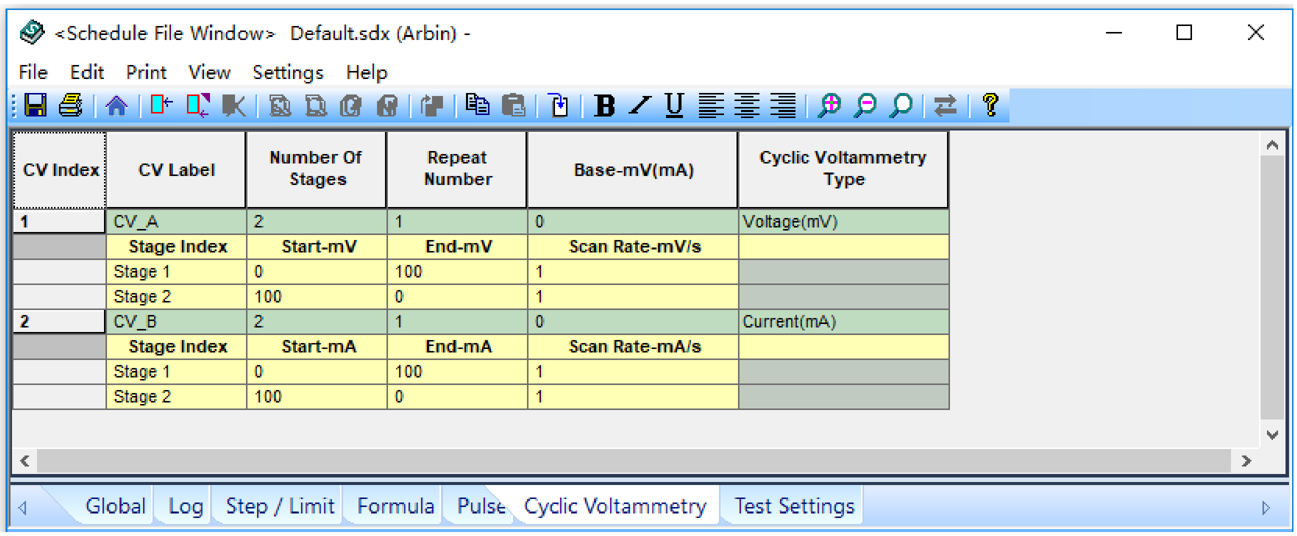


Figure 5-106 Cyclic Voltammetry page in the Schedule File Window

If the system requires the Cyclic Voltammetry control function, then the Cyclic Voltammetry control is enabled by checking the option box Cyclic Voltammetry Control under the section in the **Advanced Features** page of the ArbinAdvSys.cfg. Then, a Cyclic Voltammetry page is added in the Schedule File Window when one prepares a schedule file, and the Cyclic Voltammetry profile as shown in detail in the **Section 5.11**. If this option is not checked, then the Cyclic Voltammetry page in the schedule will be disabled, and the Cyclic Voltammetry profile cannot be edited.

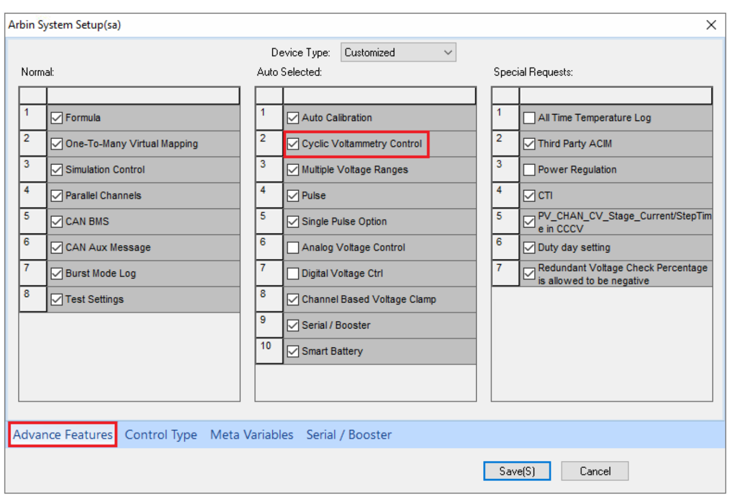


Figure 5-107 Enabling **Cyclic Voltammetry Control** in the Advanced Features page of the ArbinAdvSys.cfg

Field Descriptions of Cyclic Voltammetry Page

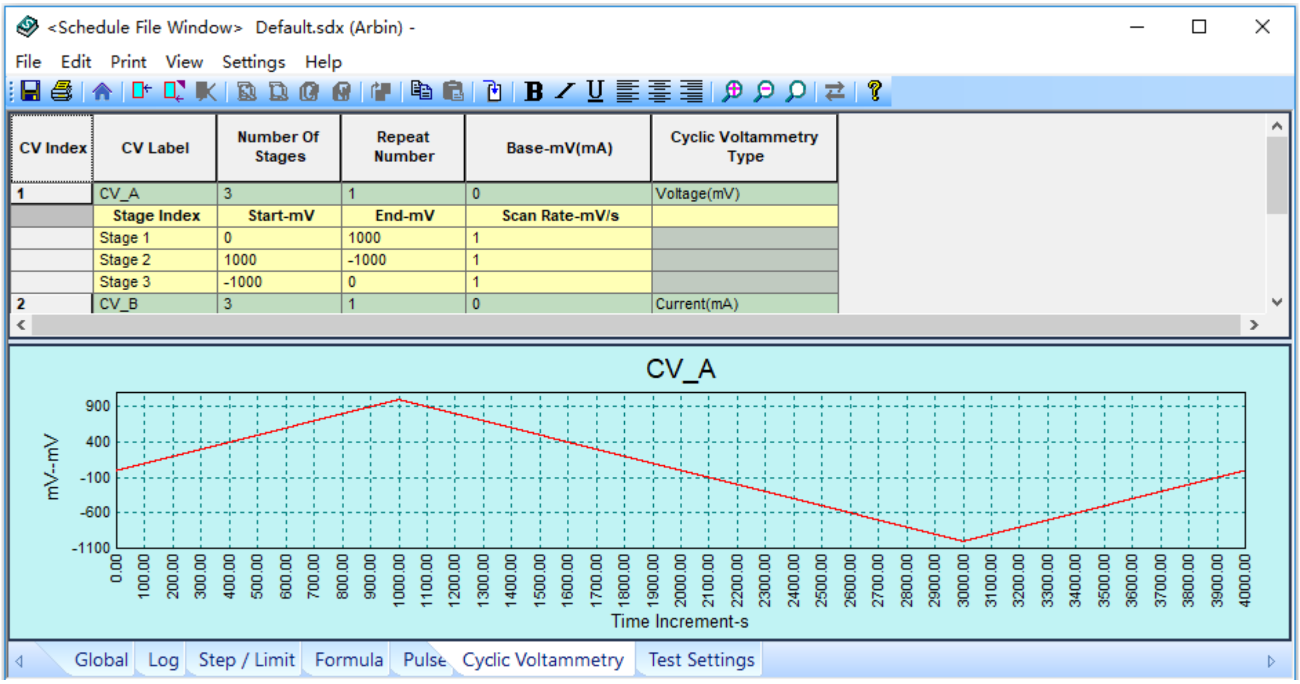


Figure 5-108 Cyclic Voltammetry Editor

Note: CV is short for Cyclic Voltammetry.

CV Index -- Numeric index of Cyclic V profiles created within a single schedule file, beginning with 1

CV Label -- User-definable alphanumeric identifier, referenced in the Extended Definitions in the **Step/Limit** page of the schedule file

Number of Stages -- Total number of stages created in a Cyclic Voltammetry definition, non-editable

Repeat Number -- User-definable input prescribing the number of iterations applicable to all stages in the Cyclic Voltammetry definition

Base-mV (mA) -- constant voltage or current value to be maintained following the course of the Cyclic Voltammetry sweep(s)

Cyclic Voltammetry Type – select Voltage (mV) or Current (mA) for this CV from drop-down list.

Stage Index -- automatic, sequential identification of the Cyclic Voltammetry sweep directions

Start-mV (mA) -- beginning value of the Cyclic Voltammetry sweep (Note that the determination of the linear sweep concerning voltage or current is made in the **CV Type** selection.)

End-mV (mA) -- final value of the Cyclic Voltammetry sweep

Scan Rate-mV (mA)/s -- slope of the linear sweep (Note that the sign is always positive.)

Creating Cyclic Voltammetry Profile

1. Click the **Cyclic Voltammetry** tab at the bottom of the schedule page.

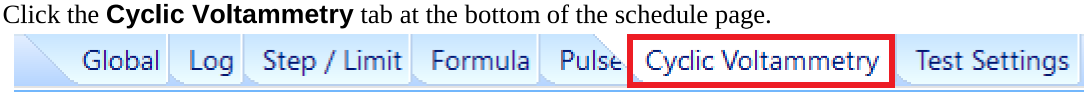


Figure 5-109 Cyclic Voltammetry Tab on a Schedule Page

2. On the menu bar, click Edit - Append CV or Edit - Insert CV. A pulse labeled CV_A with one stage appears. Alternatively, simply click the Append or Insert shortcut button on the tool bar to create a new CV profile.

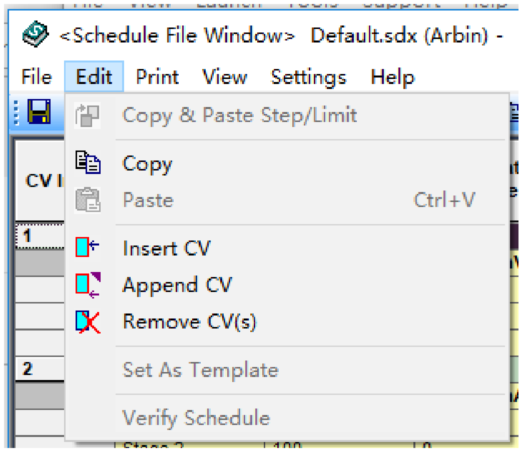


Figure 5-110 Insert CV, Append CV from Menu->Edit

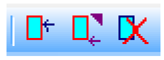


Figure 5-111 Toolbar Icons

3. Give the CV a new label name or use the default label name. To change the CV label, click the field containing "CV_A" and enter a new name, for example “CV_V1”.
4. Define Stage 1. Enter the desired values in the **Start-mV (mA)**, **End-mV (mA)** and the **Scan Rate-mV (mA)/s** fields.
5. Add additional stages to the CV definition by right-clicking next to the **Stage Index** number or following instructions in step 2 above.

For example: Creating the first linear voltage sweep profile (CV_V1) from 0 to 1V, 1V to -1V and back to 0 at 1mV/sec, and the second linear voltage sweep profile (CV_V2) from 0 to 0.5V, 0.5V to -0.5V and back to 0.5 at 2 mV/sec. The CV profile chart will be displayed on the bottom part of the CV schedule editor. The user can place the cursor on the CV_V1, so the CV_V1 line is highlighted, and the corresponding CV_V1 chart profile is demonstrated in the schedule editor.

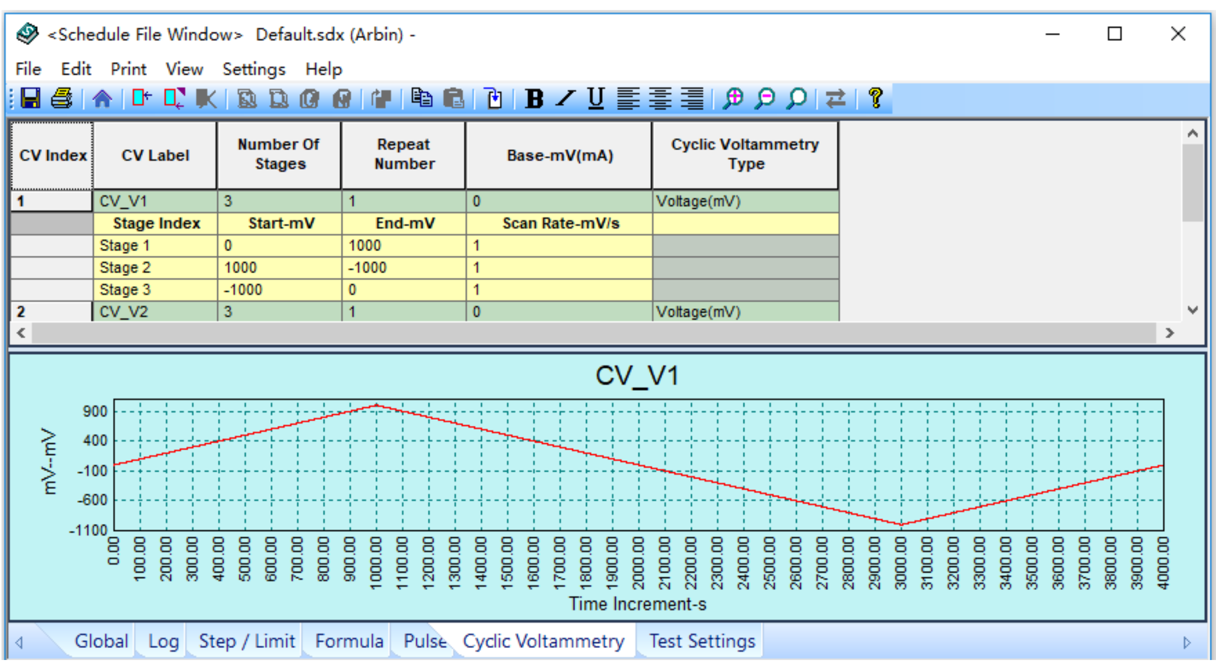


Figure 5-112 Example **CV** Definition and CV Profile Chart Display

This definition of CV_V1 will result in a sweep that will terminate with a 0mV value. The profile may then be bounded through the implementation of limits in the **Step/Limit** page of the schedule editor.

6. Select "Voltage _CycleV" or "Current_CycleV" in the field of "Control Type"
7. Specify the newly created Cyclic Voltammetry profile in the **Extended Definition** field of the step.

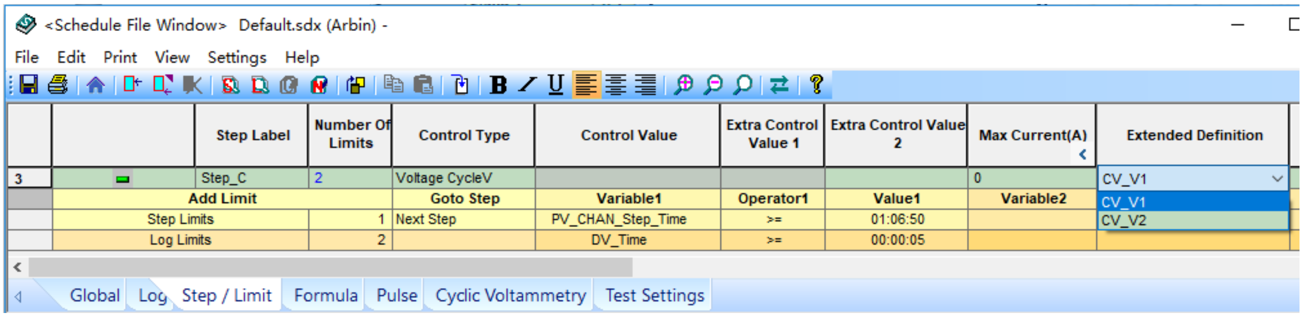


Figure 5-113 Reference to **Cyclic Voltammetry** in **Step/Limit** Page

In this instance the schedule would execute the first CV_V1 of sweeping profile (~3000s) and maintain the 0mV final potential for the remainder of the 4010s Step_Time, collecting data every 5s. The "PV_CHAN_Step_Time" should be longer than the time to finish the CV profile.

Creating More Cyclic Voltammetry Profiles

On the menu bar, click Edit - Append CV or Edit - Insert CV. Clicking Append CV will add the new CV profile after CV_ A; clicking Insert CV will insert the new CV profile prior to CV_ A. Follow steps 3 - 5 of **Creating Cyclic Voltammetry Profile**.

5.13 Programming Simulation

What is Simulation?

Simulation refers to the ability to input data collected from a non-formulated dynamic regime (i. e. other than CI, CV, CP, ramp, staircase, pulse or formula) as a control function. In some cases, Arbin customers are developing batteries whose performance is characterized by sporadic, non-periodic surges of discharge or charge energy. Two categories of simulation can be performed in MITS Pro8.0, they are **Current/Power/Load simulation** and **Battery simulation**.

Enabling Simulation Control

Simulation control is enabled by checking the option Simulation Control under **Advanced Features** in the **System Config** File ArbinAdvSys.cfg. If this option is checked, then these four simulation control types in the schedule will be selectable.

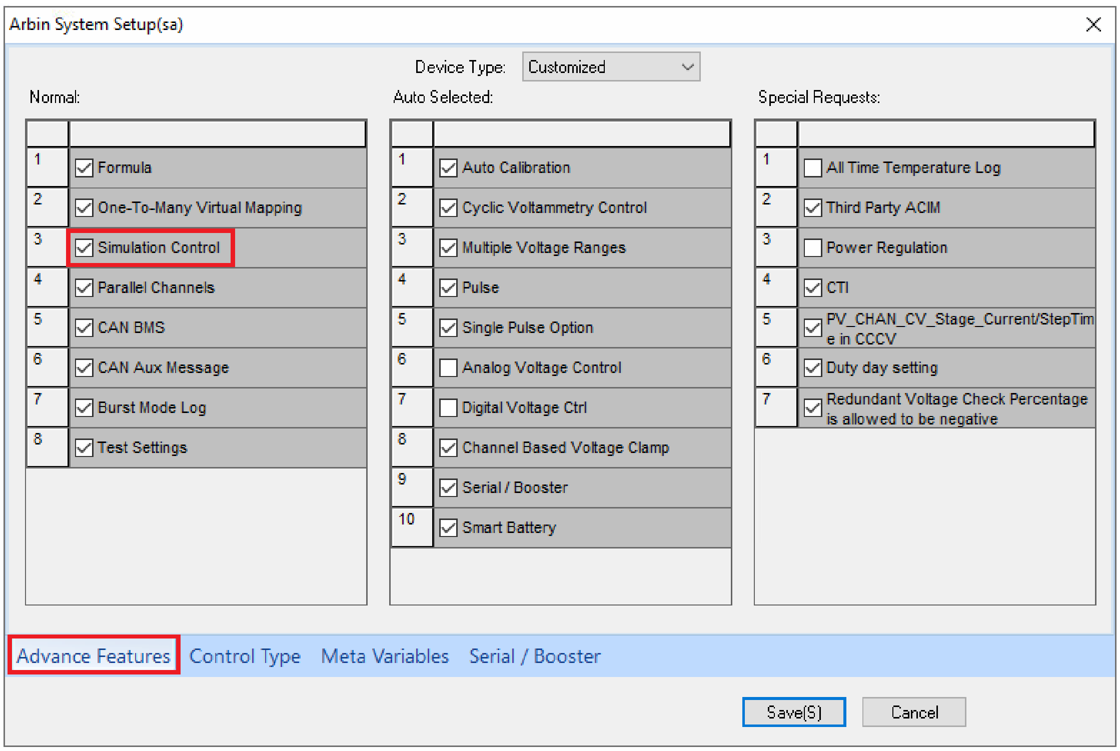


Figure 5-116 Enabling Simulation Control in the Advance Features of ArbinAdvSys.cfg file

Current/Power/Load Simulation

Consider the following time-domain current profile.

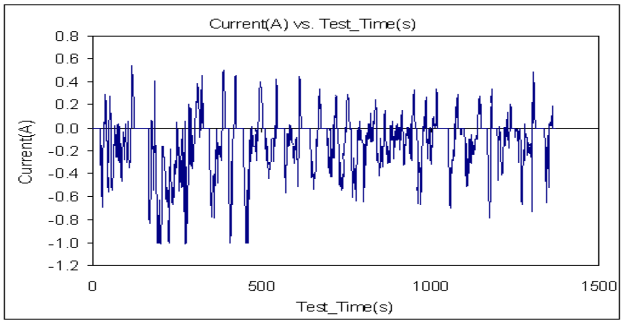


Figure 5-117 Non-formulated Time-domain Test Sequence

None of the conventionally available **Control Types** would be able to reproduce this profile. However, with the unique flexibility of Simulation Control, users can easily duplicate this arbitrary, transitory function using the data set as a complex control parameter, called a **Simulation File**.

Creating Simulation File

The simulation file for Current/Power/Load Simulation begins with a time-domain data set in current, voltage, power or load that has been collected through some means, such as Arbin's external load, charge adapter (See **Chapter 10.5 Hardware Accessories**) a third-party data logger, or a regulated standard profile. Import the data set into Excel or a text file.

An example data set in Excel spreadsheet format is shown as follows.

time (s)	current (A)
19	0
20	0
21	-0.24051
22	-0.23671
23	-0.38354
24	-0.46835
25	-0.52911
26	-0.58481
27	-0.15949
28	-0.23291
29	-0.6962
30	-0.32911
31	-0.26582
32	-0.11519
33	0.021519
34	0.044304
35	0.044304
36	0.031646
37	0.041772
38	0.287342

39	0.179747
40	-0.04557
41	-0.11519
42	-0.11772
43	-0.1619
44	-0.30127

Table 5-3 Simulation Data Set

For implementation as a simulation file, the data set must be saved as a **text (*.txt)** file in the folder, C:\Arbinsoftware\MITS_Pro\Profiles_Simulation, in the format shown in **Figure 5-118**. Note that there are no column headings and that the columns are time and current, respectively, which means up to time *x* keeps the current to be *y*

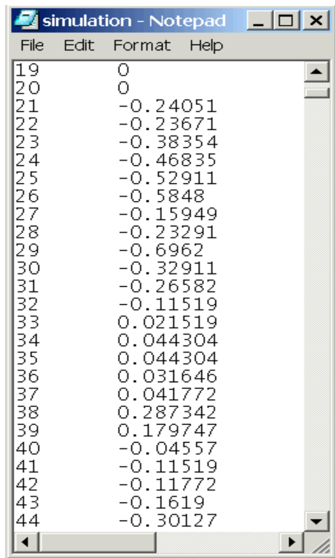


Figure 5-118 Data Entered as Text (*.txt) File

Editing Simulation Schedule

1. In the schedule, select **Control Type** and select Current Simulation, or Power Simulation, or Load Simulation.

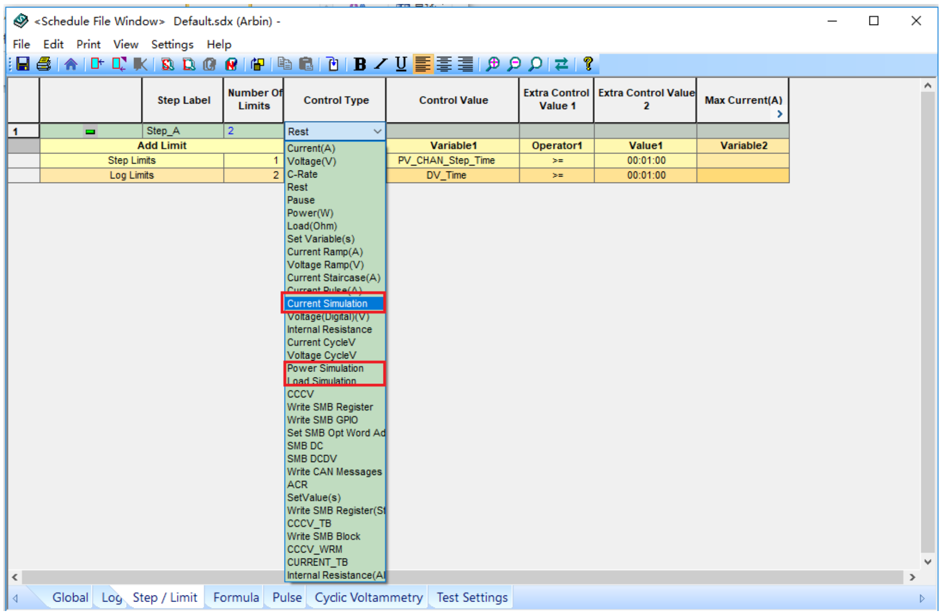


Figure 5-119 Selection of Simulation Control Type

2. To specify the simulation file that will be used, right-click in the field under the heading **Control Value** and select Assign Simulation File.

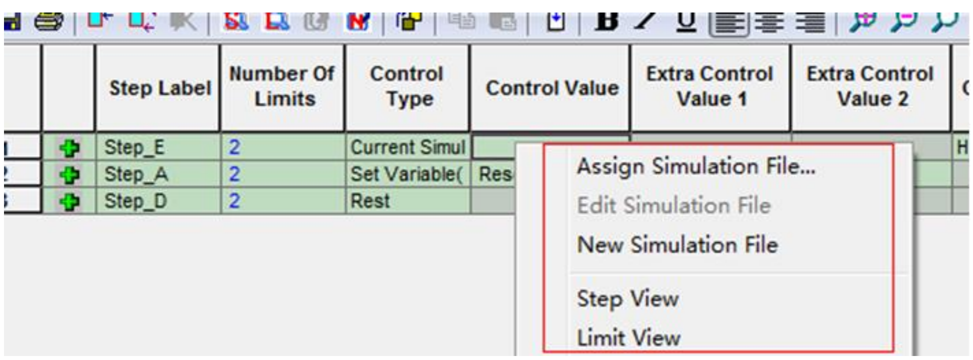


Figure 5-120 Simulation File Manipulation

3. The following menu appears.

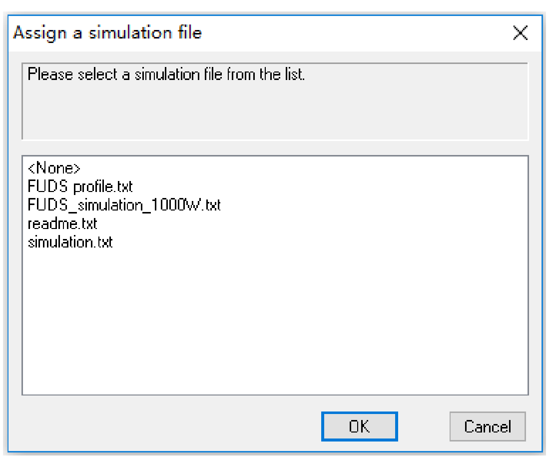


Figure 5-121 Selection of Governing Simulation File

1. Assuming that the profile lasts 500s, we may set the step limit to terminate at 501s. Refer to this chapter for instructions on setting the current range (See **Section 5.6**) and data logging condition (**Section 5.7**).
2. If you want to repeat the simulation profile more than one time, for example, for 3 times, you can choose "repeat without extra 2 points, or repeat with extra 2 points", and set the step limit to terminate at 1501s. The two extra points are to record front and end edges of each time stage.

	Step Label	Number Of Limits	Control Type	Control Value	Extra Control Value 1	Extra Control Value 2	Max Current(A)
	Step_A	2	Current Simulation	Simu_0.txt			5
Add Limit			Goto Step	Variable1	Operator1	Value1	Variable2
Step Limits		1	Next Step	PV_CHAN_Step_Time	>=	00:08:21	
Log Limits		2		DV_Time	>=	00:00:01	

Figure 5-122 Assign Simulation

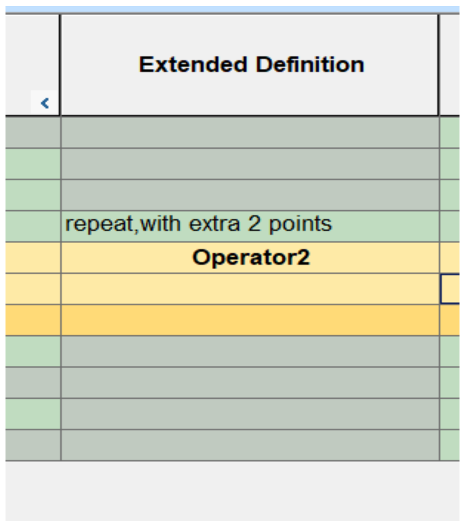


Figure 5-123 Complete Step Definition for Simulation

Note: Simulation Control is not designed for reproduction of high-speed, transient profiles. For best results the events represented in the simulation file should be resolved by > 0.01s. Excessive demands on the software can produce results inconsistent with those desired and can have adverse effects on the performance of the devices tested. The software allows up to 1.2 million points in an assigned simulation file. The smallest set interval is 10ms, the longest set interval period is 30 days. The shortest log interval is 1ms/log if it is a one-channel system. Up to 50 simulations can be assigned in a schedule. Please consult Arbin Instruments for advice on testing requirements.

Battery Simulation

With the Battery Simulation control type, the Arbin tester acts as a real battery in numerous applications when a simplified theoretical model for this battery is available. The model of the battery used in this simulation consists of the relations of two factors, Open Circuit Voltage (OCV) and DC Internal Resistance (r) vs. The State of Charge (See **Figure 5-124**).

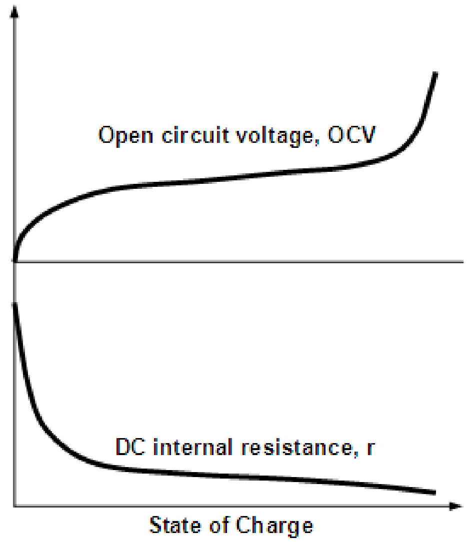


Figure 5-124 OCV and DC Internal Resistance (r) vs. State of Charge

Creating Battery Simulation File

In MITS Pro8.0, “The State of Charge” is replaced by “Capacity” by the equation,

“Capacity” = “Nominal Capacity” x “The State of Charge”

Here “Capacity” represents the Remain Capacity of the battery at certain value of “The State of Charge”.

The Battery Simulation Data File (Table 5-4) is different from the Simulation File (Table 5-3) for Current/Voltage/Power Simulation. In the left most column list the values of “Capacity”, in middle column list corresponding OCV values, and in the right most column list corresponding DC internal resistance values. An example of this battery simulation file, BS.txt, is shown as follows.

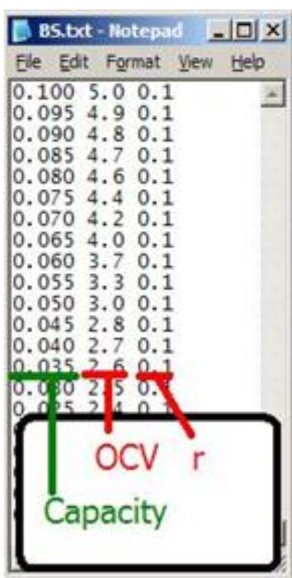


Table 5-4 Battery Simulation Data File

For implementation as a battery simulation file, it also needs to be saved in the folder, C:\Arbinsoftware\MITS_Pro\Profiles_Simulation. Note that there are no column headings and that the columns are “Capacity”, OCV, and r, respectively.

Editing Battery Simulation Schedule

1. In the testing schedule, under **Control Type**, select Battery Simulation.

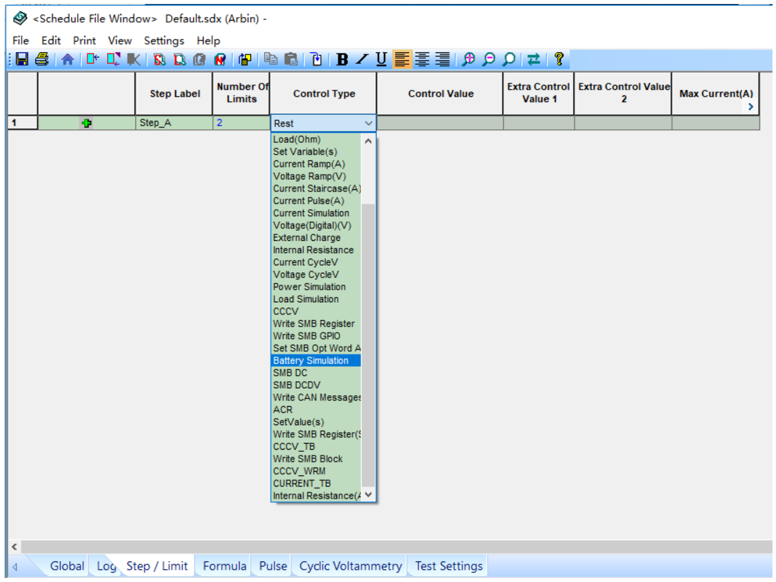


Figure 5-125 Selection of the Battery Simulation Control Type

2. Next, enter Initial Capacity under the heading, **Extra Control Value 1**, and Initial IR under the heading **Extra Control Value 2.**
3. Specify the battery simulation file that will be used. Right-click in the field under the heading **Control Value** and select Assign Simulation File....

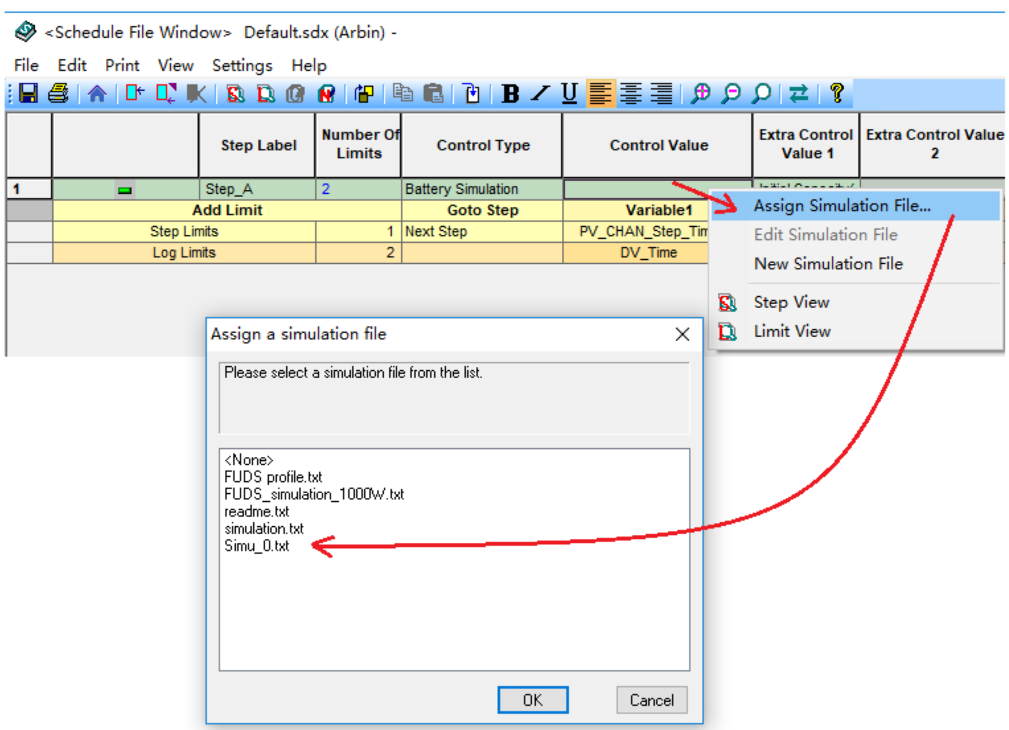


Figure 5-126 Simulation File Manipulation

4. A selection box for the simulation file appears as in **Figure 5-126**.
5. The remaining procedure is the same as for Current/Power/Load simulation.

5.14 Implementing Test Settings

What is a Test Setting?

Test Setting is a fundamental advance in the pursuit toward system integration. With this latest feature, MITS Pro8.0 seamlessly complements the function of Arbin's electrochemical test instrumentation with peripheral hardware, beginning with the facilitated interface with the third-party temperature chamber. Additionally, MITS Pro8.0 can handle TTL signals through Digital Input and Digital Output functionality, and Analog output as well.

Test Setting is enabled by checking the **Test Settings** option under **Advanced Features** in the system configuration file. If this option is checked, then the **Test Settings** page in the schedule will be enabled, and temperature control can be implemented. Usually, another option, **One-to-Many Virtual Mapping**, is also checked for temperature chamber control. Special hardware is required to perform **Test Setting** functions.

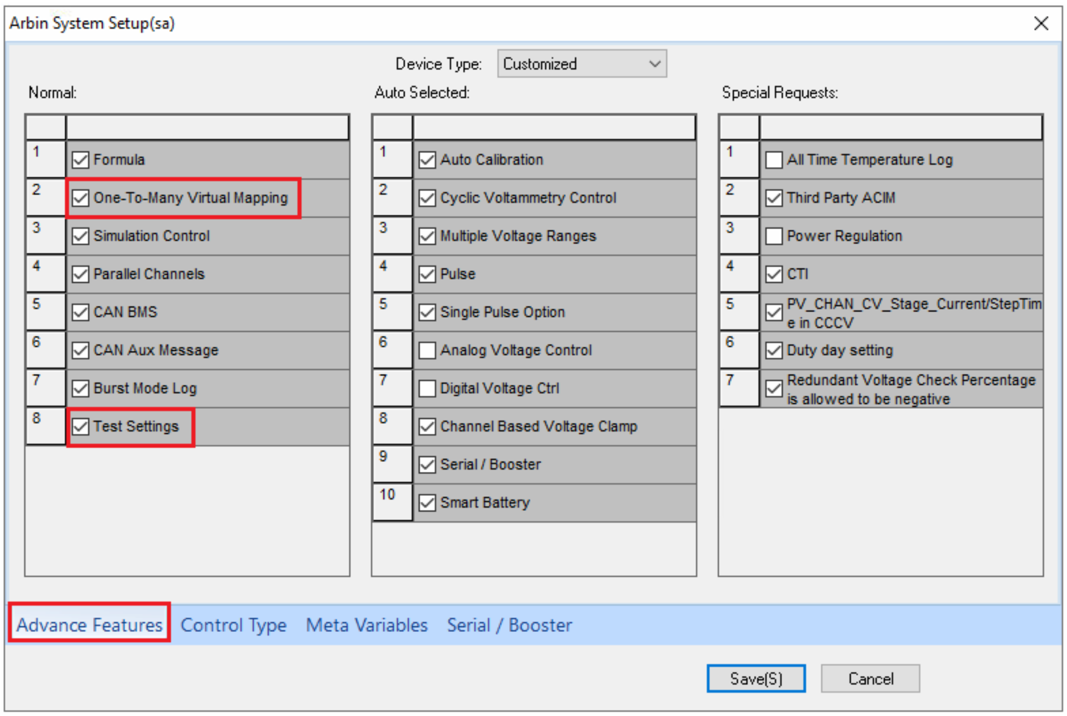


Figure 5-127 Enabling Test Settings in the Advanced Features of ArbinAdvSys.cfg

Field Descriptions of Test Settings Page

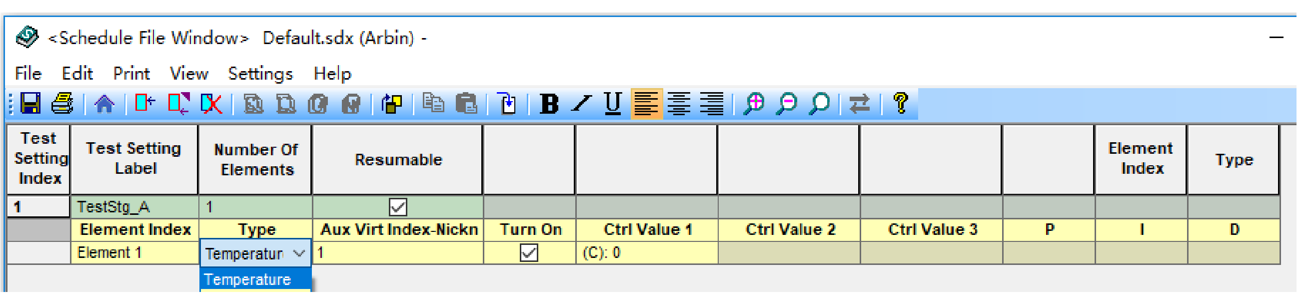


Figure 5-128 Test Setting Definition

Test Setting Index -- Numeric index of **Test Settings** created within a single schedule file, beginning with 1

Test Setting Label -- User-definable alphanumeric identifier, referenced in the **Test Setting** fields in the **Step/Limit** page of the schedule file

Number of Elements -- Total number of control elements created in a **Test Setting** definition. It is non-editable. Note: multiple elements must refer to different auxiliary indices.

Resumable – When this box checked, if a channel test is stopped and then resumed, the Test Setting condition is attained before the main operation (charge or discharge, etc.) is continued.

Element Index -- Automatic, sequential identification of the control parameters and conditions (only one Element with the designated Aux Type, Aux Index and Position)

Type -- Selection of the control to be exercised by implementation of the Test Setting: Temperature, Flow rate, Digital Output, Analog output or Pressure. (Note: Flow rate and Pressure work for Fuel Cell Testing System only)

Aux Virt Index -- Nickname-- Reference to the Auxiliary Virtual Channel mapped to a main I/V channel to be controlled, according to **Auxiliary Channel Virtual index** in batch file

Turn On -- Check to enable the Auxiliary Virtual Channel.

Ctrl Value 1 -- Temperature set point (°C) to be maintained for the specified **Aux Virt Index**

Ctrl Value 2 -- This value is work for Analog Output (AO) signal. There are two types of control: close loop control and open loop control. For close loop control an analog input channel is required for feedback.

Ctrl Value 3 -- This setting (AI) is work for AO signal. When **Ctrl Value 2** was set to close loop control, **Ctrl Value 3** was activated. Type "t" for aux-temerature, "v" for aux-voltage, "p" for aux-pressure. [index] refer to the aux virtual index.

P, I, D – These values (PID) are work for controlling of the output AO signal. When **Ctrl Value 2** was set to close loop control, **P, I, D** were activated.

Creating a Test Setting

As we noted in the introduction, Test Settings can affect two kinds of control and signal processing—**Thermal Control** and **Digital Signal or Analog signal Handling**. While both are implemented within the bounds of the functional elements above, certain parameters are specific to one **Type**. We, therefore, address these two modes separately below.

Thermal Control

The thermal control aspect of the **Test Setting** feature performs two functions - **1**) the third-party temperature chambers and **2**) to determine the relative priority of the main IV channel versus thermal compartment operation. The following schedule page identifies the parameters that must be defined in order to fulfill functions **1**) and **2**). Refer to the **Field Descriptions of Test Settings Page** above for explanations.

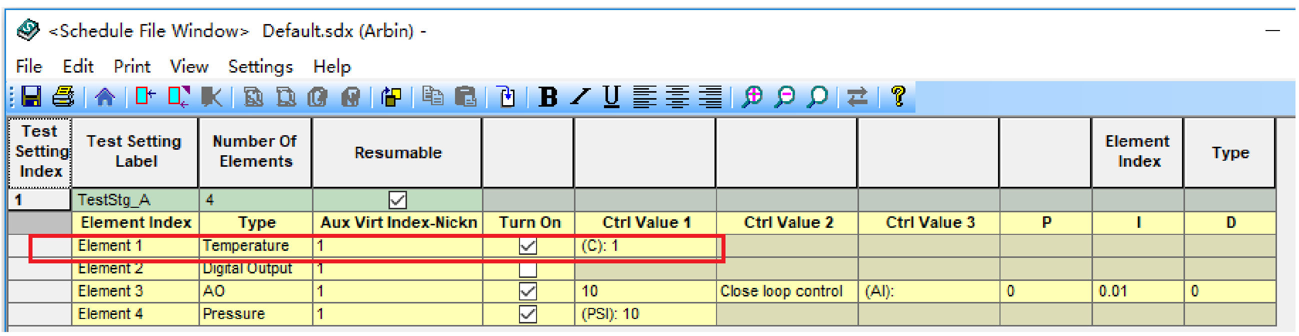


Figure 5-129 Test Setting **Page in the S**chedule **File Window**

Software configuration

With either hardware type-**PMTC** or third-party temperature controller, there are some software settings that must be checked prior to operation. These settings are found in multiple pages of the system configuration file, ArbinSys.cfg.

Note that the system configuration file contains all the information concerning the system composition and calibration. The file should come from the factory pre-configured and no modification is required. Before modifying any parameter, please contact Arbin customer support and back up the file to an alternate location.

1. Ensure that the system has been configured to accept the additional temperature channels. In this example, the two auxiliary temperature channels correspond to the temperature in each of the two chamber compartments.

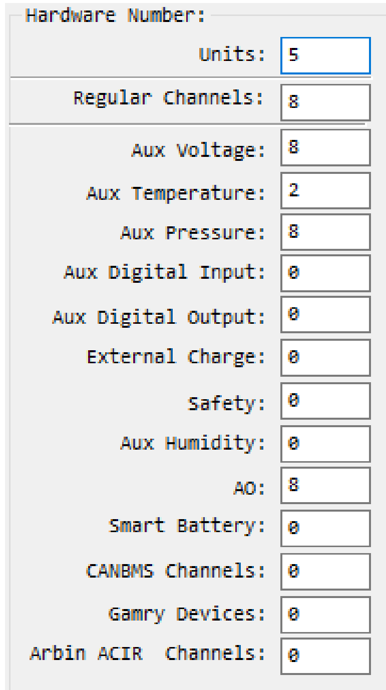


Figure 5-130 Hardware Number part of Global Page in the System Configuration Window

2. Identify the relevant channels as **Controllable** so that the integrated microcontroller will actively regulate the chamber temperature.

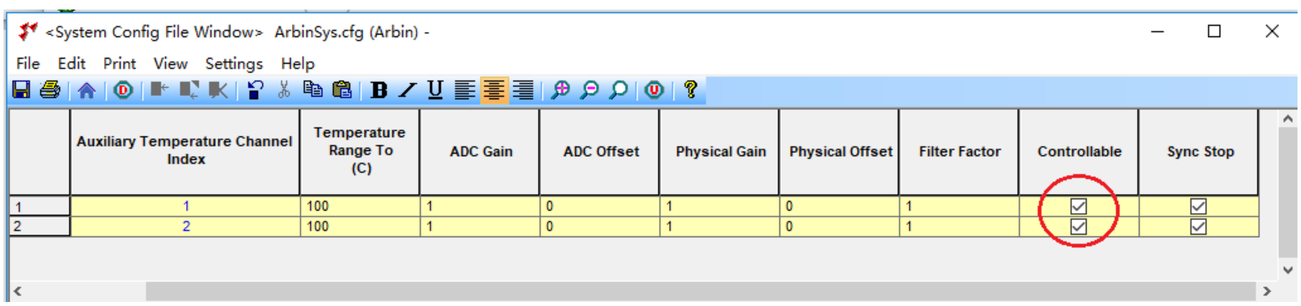


Figure 5-131 Controllable Option in Temperature - Auxiliary-in System Configuration

3. Map a thermal chamber to a main IV channel through the batch file, ArbinSys.bth. Refer to Section 6.4 for more information of editing auxiliary maps.

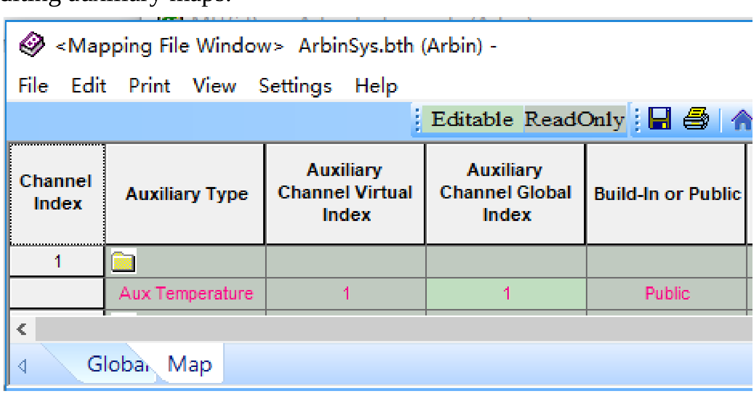


Figure 5-132 Map Temperature Chamber to a Main IV Channel in Batch File

4. Save and close the ArbinSys.bth.

Schedule Setting

The next segment describes how the enabled temperature channels are integrated with main IV channel operation through the definition of the **Test Setting**.

1. Click on the **Test Settings** tab of an enabled schedule.

Figure 5-133 Test Settings **Tab on** Schedule **File Window**

2. Select Edit - Append or Edit - Insert **Test Setting**.

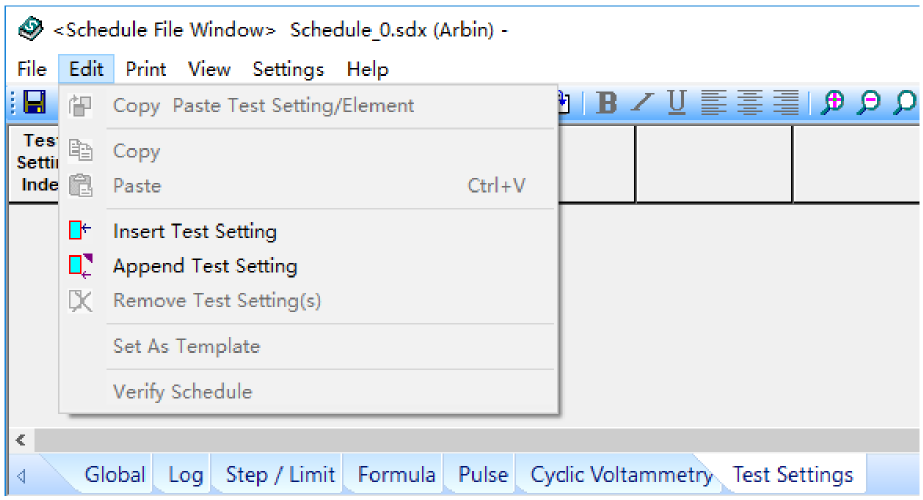


Figure 5-134 Test Setting Additional Options

A **Test Setting** with a single default Element 1 will be created. The default parameters presume that one device is placed in a single thermal chamber, denoted by **Aux Index** (See Section 6.4 for instructions concerning correlating main IV channel data and auxiliary data.)

The compartment will maintain conditions at a given temperature (**Value**). Moreover, the default conditions direct the schedule to refer to the thermal conditions continuously via the **Resumable** toggle box. See more explanation below.

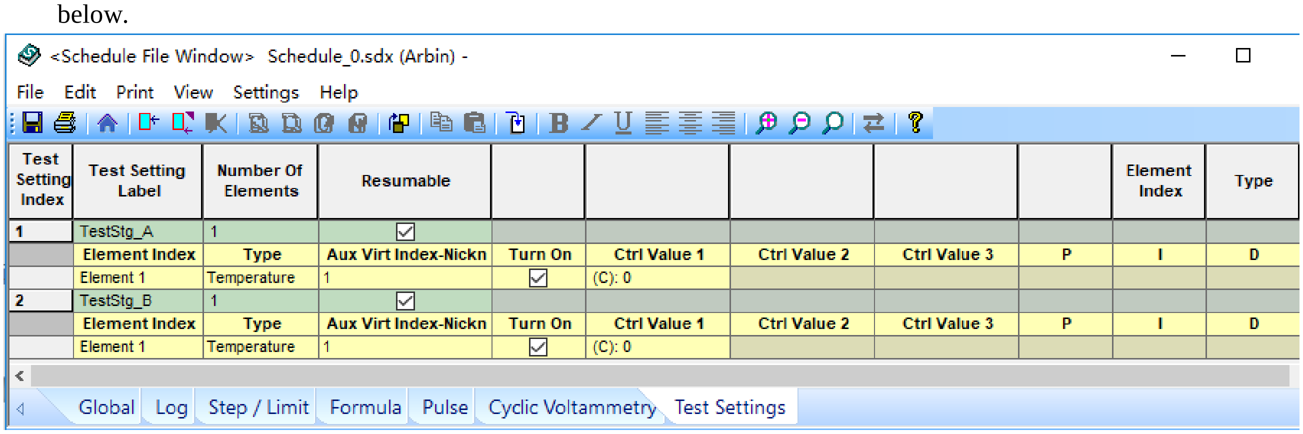


Figure 5-135 Default Test Setting Configuration

3. Modify the Test Setting by selecting the parameters according to the descriptions above. Some different scenarios are laid out here.

Test Setting Index	Test Setting Label	Number Of Elements	Resumable						Element Index	Type
1	TestStg_A	1	☑							
	Element Index	Type	Aux Virt Index-Nickn	Turn On	Ctrl Value 1	Ctrl Value 2	Ctrl Value 3	P	I	D
	Element 1	Temperature	1	☑	(C): 25					
2	TestStg_B	1	☑							

Figure 5-136 25°C Test Setting Definition

Reference to this Test Setting will result in attainment and maintenance of a 25°C temperature in thermal chamber. If there is no other Test Setting has been called, the chamber teperature control will maintain 25°C temperature until another Test Setting be called. If the testing stopped due to power failure, when power comes back and one resumes the testing, the user has to resume the test from the step that the Test Setting be called for setting up chamber temperature again.

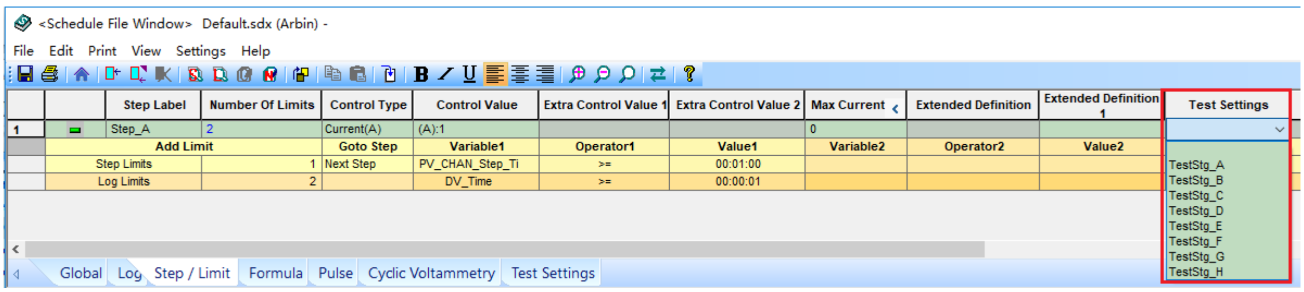


Figure 5-137 Schedule Reference to Test Settings

Digital Signal Handling

Many of Arbin's advanced features are driven by applications and the specialized testing requirements that arise in these new arenas of implementation. The most pronounced of these new technologies is fostered by Arbin's fuel cell testing instrumentation - **FCTS**. In this hardware platform, the Arbin hardware and software must interface with new peripheral components, such as valves, sensors and alarms. In order to accomplish this new level of coordination, Arbin Instruments has expanded the impressive hardware capability with new digital (or analog) input and output routing circuitry.

MITS Pro8.0 complements the new auxiliary hardware through the inclusion of a new Test Setting Element **Type** and new auxiliary values (See Appendix B: **Auxiliary Measurement-Related Parameter**). This procedure will provide details on the configuration of a system equipped with digital hardware and describe the two scenarios envisioned in the inception of the new control.

1. Confirm in the system configuration file that Digital Input and Digital Output channels are enabled.

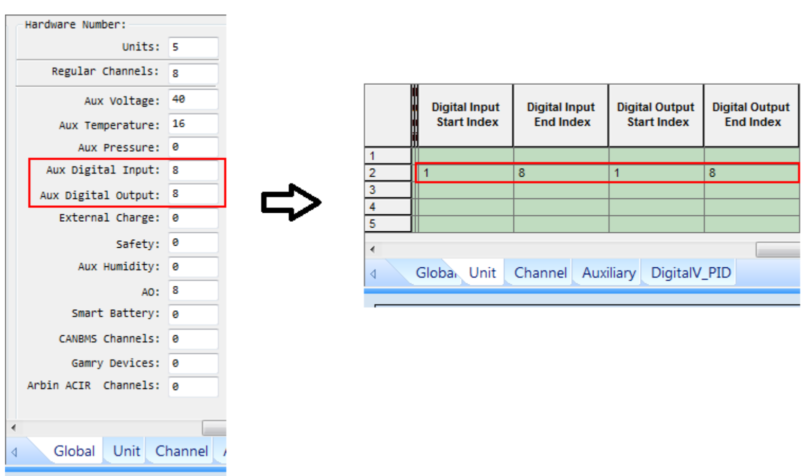


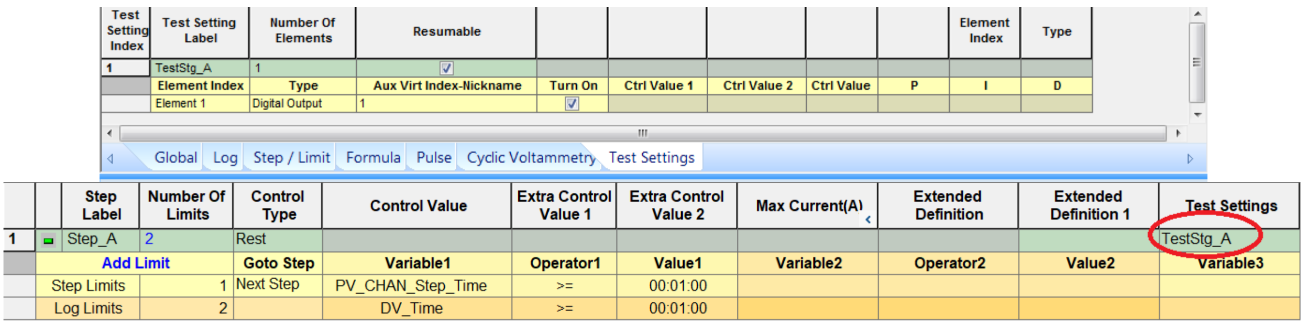
Figure 5-140 Aux Digital Input and Output Specified in System Configuration File

2. Map one or more digital channels to a main IV channel in the batch file (ArbinSys.cfg). (See Section 6.4 for instructions concerning correlating main IV channel data and auxiliary data.)

3. Repeat steps 1 and 2 under **Thermal Control – Schedule setting** above.

4. Modify the parameters as appropriate for the **FCTS**-related applications, beginning by choosing Digital Output as the Element **Type**. The two operations that are proposed here are A). Commencing testing by opening a purge gas solenoid valve and B). Handling a sensor alarm signal and subsequently shutting down the system while activating a siren.

   a. Fuel cell tests may begin by actuating a valve regulating the purge gas line to eliminate residual reagent gases from the feed lines. This initialization could be accomplished in the following manner.



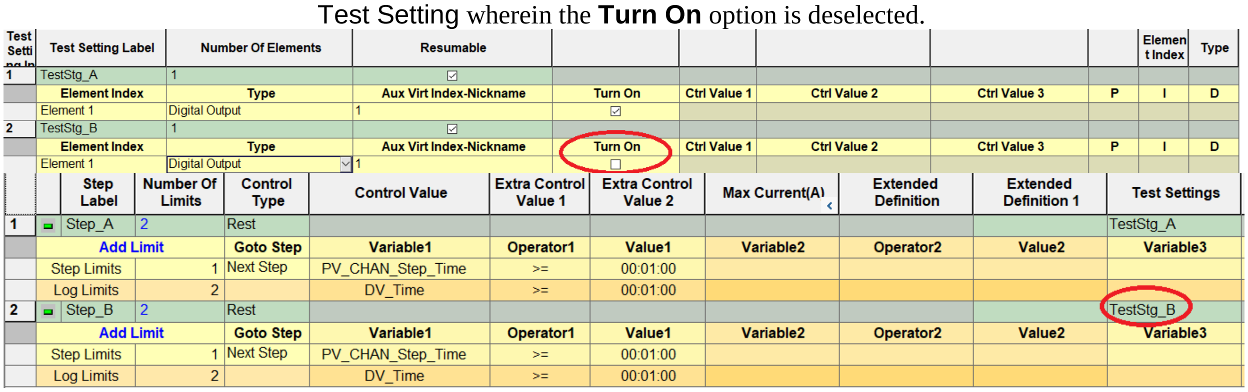
Test Setting Index	Test Setting Label	Number Of Elements	Resumable						Element Index	Type
1	TestStg_A	1	☑							
	Element Index	Type	Aux Virt Index-Nickname	Turn On	Ctrl Value 1	Ctrl Value 2	Ctrl Value	P	I	D
	Element 1	Digital Output	1	☑						

		Step Label	Number Of Limits	Control Type	Control Value	Extra Control Value 1	Extra Control Value 2	Max Current(A)	Extended Definition	Extended Definition 1	Test Settings
1		Step_A	2	Rest							TestStg_A
	Add Limit			Goto Step	Variable1	Operator1	Value1	Variable2	Operator2	Value2	Variable3
	Step Limits		1	Next Step	PV_CHAN_Step_Time	>=	00:01:00				
	Log Limits		2		DV_Time	>=	00:01:00				

Figure 5-141 Test Setting and Schedule Invoke for Initiating Test with Purge

The Element denotes that Digital Output index 1 will send an "on" signal to the associated device (Read "valve.").

Note: users should recall that Test Setting Elements remain in effect until a contradictory Test Setting is encountered. Therefore, in order to terminate this initial purge step, the user would be required to create a subsequent Test Setting wherein the **Turn On** option is deselected.

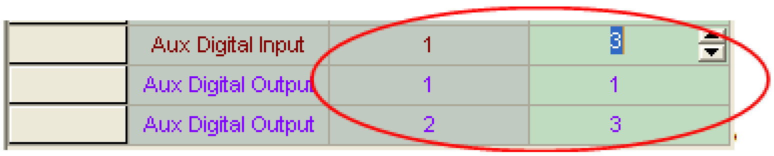


Test Setting Index	Test Setting Label	Number Of Elements	Resumable						Element Index	Type
1	TestStg_A	1	☑							
	Element Index	Type	Aux Virt Index-Nickname	Turn On	Ctrl Value 1	Ctrl Value 2	Ctrl Value 3	P	I	D
	Element 1	Digital Output	1	☑						
2	TestStg_B	1	☑							
	Element Index	Type	Aux Virt Index-Nickname	Turn On	Ctrl Value 1	Ctrl Value 2	Ctrl Value 3	P	I	D
	Element 1	Digital Output	1	☐						

		Step Label	Number Of Limits	Control Type	Control Value	Extra Control Value 1	Extra Control Value 2	Max Current(A)	Extended Definition	Extended Definition 1	Test Settings
1		Step_A	2	Rest							TestStg_A
	Add Limit			Goto Step	Variable1	Operator1	Value1	Variable2	Operator2	Value2	Variable3
	Step Limits		1	Next Step	PV_CHAN_Step_Time	>=	00:01:00				
	Log Limits		2		DV_Time	>=	00:01:00				
2		Step_B	2	Rest							TestStg_B
	Add Limit			Goto Step	Variable1	Operator1	Value1	Variable2	Operator2	Value2	Variable3
	Step Limits		1	Next Step	PV_CHAN_Step_Time	>=	00:01:00				
	Log Limits		2		DV_Time	>=	00:01:00				

b. The second scenario is somewhat more complicated, requiring the ability to sense an input TTL signal and perform a subsequent action. In this mode the digital circuitry acts as a signal handler, responding to a digital input and generating an appropriate digital signal out in this case to a flammable gas alarm siren.

i. As in the case of Temperature-based Test Settings and the previous Digital Output example, the first requirement is to map the auxiliary channels to one or more main IV channels. Since typical **FCTS** chassis house only one channel, users may opt to use the Auxiliary Map Wizard (See Section 6.4 "Default Map") to create a One-to-Many map. In this instance, however, we map one Digital Input and an additional Output channel to the main IV channel. Note that the **Virtual Channel** need not match the **Physical Channel**.



	Aux Digital Input	1	3
	Aux Digital Output	1	1
	Aux Digital Output	2	3

Figure 5-142 Batch File Map for Handling Fault Condition

ii. Create a Test Setting for generating the appropriate TTL “high” signal (**Turn On** selected).

Test Setting Index	Test Setting Label	Number Of Elements	Resumable		
1	TestStg_A	1	☑		
	Element Index	**Type**	**Aux Virt Index-Nickname**	**Turn On**	**Ctrl Value 1**
	Element 1	Digital Output	2	☑	

Figure 5-143 Aux Virtual Index 2 is Set for the Connection to the Siren

Note that we use the second output signal (**Aux virtual Index 2, the Physical index here is 3**) for the connection to the siren.

iii. Create a schedule sequence to affect the desired response.

	Step Label	Number Of Limits	Control Type	Control Value	Extra Control Value 1	Extra Control Value 2	Max Current(A)
1	Step_A	2	Rest				
	Add Limit		**Goto Step**	**Variable1**	**Operator1**	**Value1**	**Variable2**
	Step Limits	1	Next Step	PV_CHAN_Step_Time	>=	00:01:00	
	Log Limits	2		DV_Time	>=	00:01:00	
2	Step_B	3	Current(A)	(A):-100			0
	Add Limit		**Goto Step**	**Variable1**	**Operator1**	**Value1**	**Variable2**
	Step Limits	1	Next Step	PV_CHAN_Step_Time	>=	01:00:00	
		2	unsafe	AV_DI[1]	>=	1	
	Log Limits	3		DV_Time	>=	00:01:00	
3	Step_C	3	Current(A)	(A):-200			0
	Add Limit		**Goto Step**	**Variable1**	**Operator1**	**Value1**	**Variable2**
	Step Limits	1	Next Step	PV_CHAN_Step_Time	>=	01:00:00	
		2	unsafe	AV_DI[1]	>=	1	
	Log Limits	3		DV_Time	>=	00:01:00	
4	Step_D	2	Rest				
	Add Limit		**Goto Step**	**Variable1**	**Operator1**	**Value1**	**Variable2**
	Step Limits	1	Next Step	PV_CHAN_Step_Time	>=	00:01:00	
	Log Limits	2		DV_Time	>=	00:01:00	
5	unsafe	1	Rest				
	Add Limit		**Goto Step**	**Variable1**	**Operator1**	**Value1**	**Variable2**
	Step Limits	1	Unsafe	PV_CHAN_Step_Time	>=	00:00:00	

Figure 5-144 The Siren Alarm is Associated with TestStg-A

In this example the tester will discharge the cell stack at two increasing current levels. Note in limit 2 of steps **2** and **3** that the value of Aux Digital Input index 1 is monitored. If at any time during the discharge the gas sensor detects flammable gas above the threshold level, then it will generate a high (=1) signal that will trigger the DI channel and result in a step jump to step **5** (“unsafe”). At this point the previous Test Setting (TestStg _A) activates, causing the alarm siren to be triggered, and the channel immediately reports an “Unsafe Status” in the **Monitor & Control Window**.

Binding a Test Setting to a Schedule Step

As we noted above, the Test Settings are bound to a schedule by reference in the **Test Setting** field of a step.

5.15 Duty Days Setting

What is a Duty Days Setting?

This function mainly determines whether to skip to the next step in working time and nonworking time.

How to configure Duty Days Setting?

The **Duty Days Setting** is enabled by checking the option box Duty day setting under the section in the **Advanced Features** page of the ArbinAdvSys.cfg and click the Save button. Then, Duty Days Setting dialog appears in schedule file folder window. If this option is not checked, then the Duty Days Setting in the file folder will not appear.

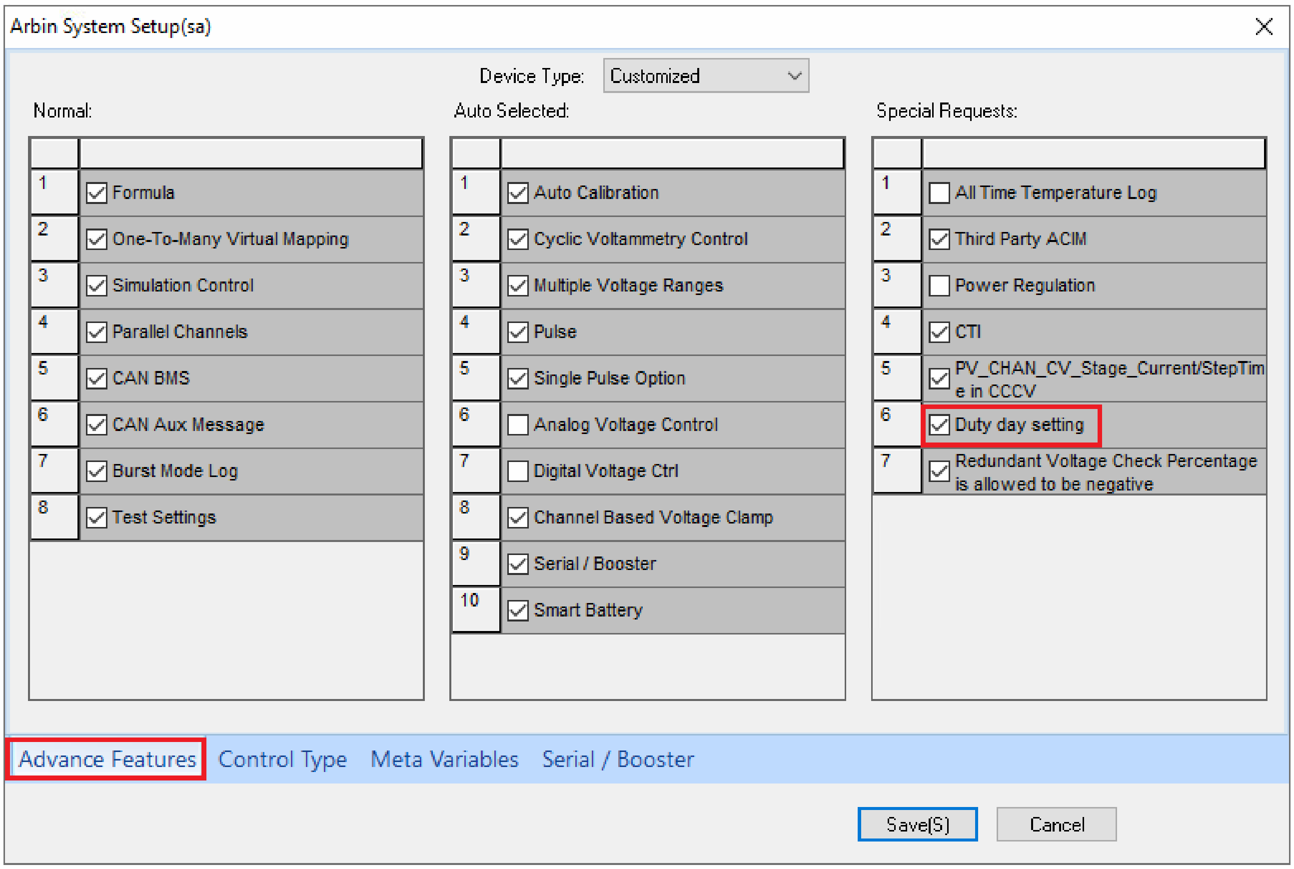


Figure 5-145 Enabling Duty day setting in the Advance Features of ArbinAdvSys.cfg file

1. Open “On duty configure” in the file directory of Duty Days Setting. Then the dialog window will appear. In the dialog, there are three sections: Week-day, Hour and Pause.

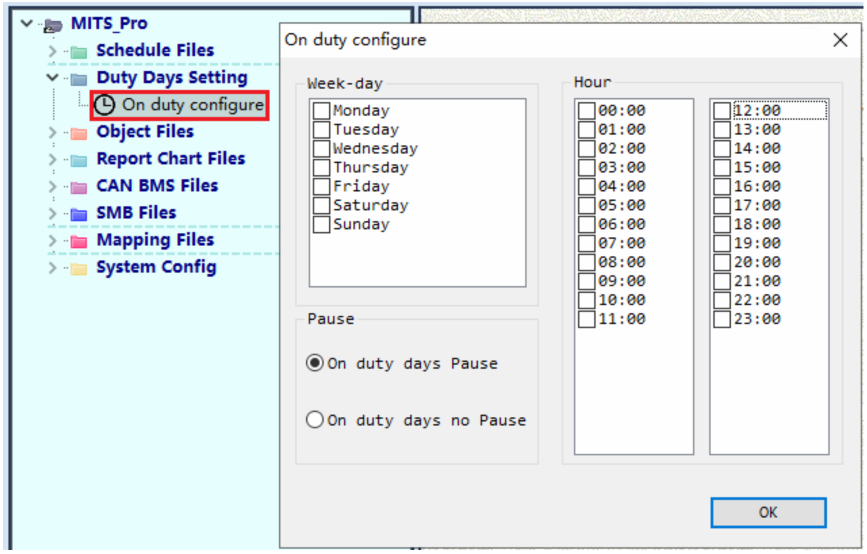


Figure 5-146 Open **On duty configure**

2. Now, the user checks the option from Monday to Friday in Week-day, from 9:00 to 18:00 in Hour, on duty days Pause in Pause.

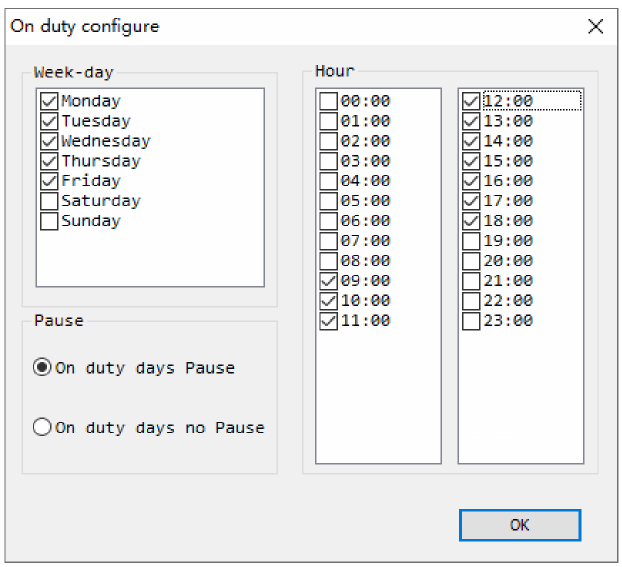


Figure 5-147 On duty configure dialog

3. Select “Pause” in the drop-down list of control type, then select the **On duty time**. When the test runs to **Pause** step, and assuming it is working time, the test will not automatically skip to the next step, otherwise it will skip to the next step.

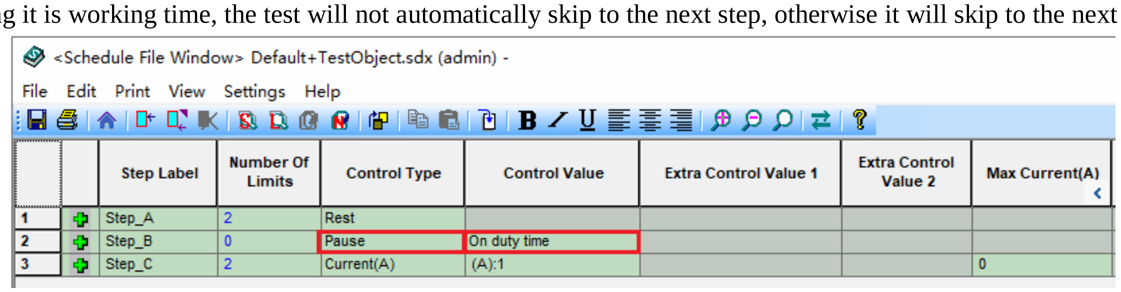


Figure 5-148 use **On duty configure** in schedule

Chapter 6 Mapping Files

6.1 What is a Mapping file?

A mapping file is a catalog in which test schedules are assigned to specific channels. Through the creation and editing of mapping files, users may organize arrays of tests that will execute in concert with one another. Specifically, the test mapping file allows one to:

- Group channels for parallel operation,
- Map an auxiliary measurement (e.g., auxiliary voltage, temperature, pressure and pH) channel to a main IV Channel.
- Map SMB and CAN channels to a main IV Channel.

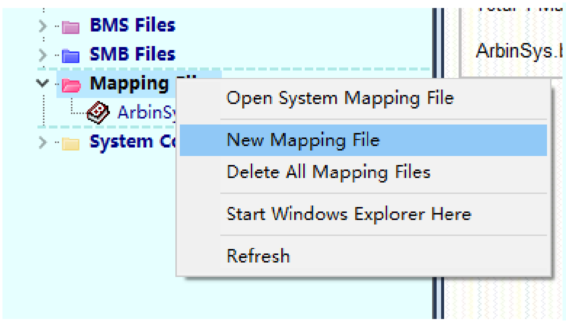
Users can create multiple map files, but the map file named “ArbinSys.bth” is the only map file that can be used actively during a test. Any subsequent test environments must be launched as ArbinSys.bth, thereby overwriting the previous contents of the system map file. ArbinSys.bth can also be edited and take effect without interrupting tests during real-time controlling.

See Also

- Creating a file
- Editing the **Global** Page of a Mapping File
- Mapping Auxiliary Measurements

6.2 Creating a Mapping file

1. Afer opening the Console, it will automatically generate a file called ArbinSys.bth.Or you can create a new Mapping file and rename it ArbinSys.bth to replace it. In the MITS Pro8.0 opening screen, right-click the **Mapping Files** folder; click **New Mapping File**.
2. Double-click the newly added batch file or right-click the newly added batch file name and click **Open**.



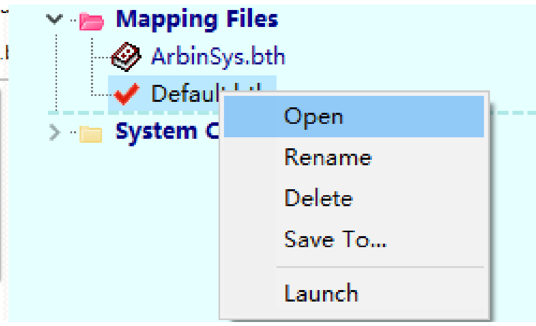


Figure 6-1 Create Mapping File-Step 1 **Figure 6-2** Create Mapping File-Step 2

3. Enter information in the **Global** Page (optional).
4. Click the **Mapping** page. Here, users may associate auxiliary input channels with the main IV control channels.
5. In the **Group T-Chamber Mapping** page. It mainly configures the information about Group T-Chamber.

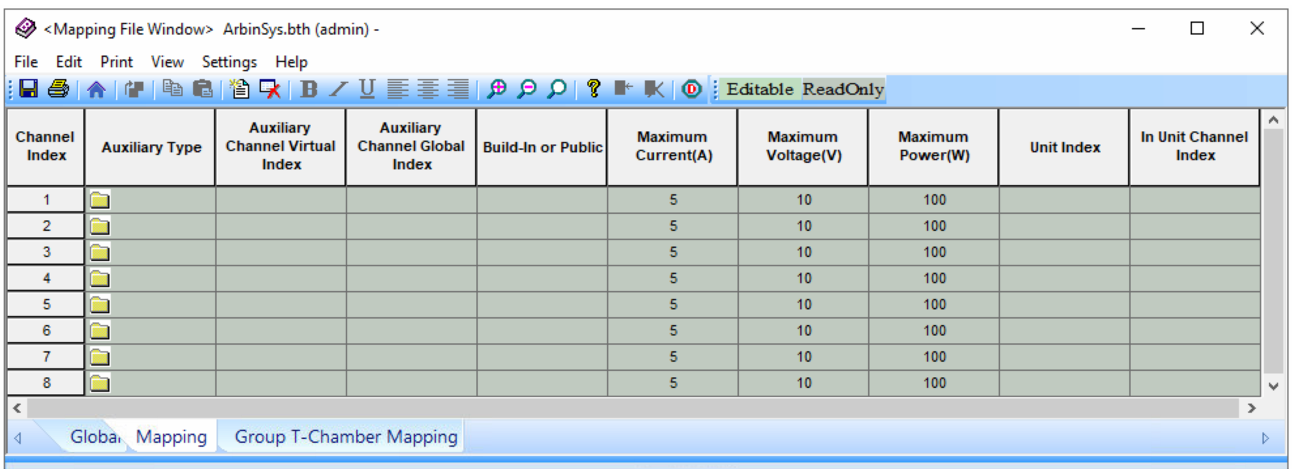


Figure 6-3 Mapping File Default View

6.3 Editing the Global Page of a Mapping File

The **Global** Page of a Mapping File is used to enter or edit general information about the test batch. This page is selected by clicking the **Global** tab that is visible whenever a batch file is open.

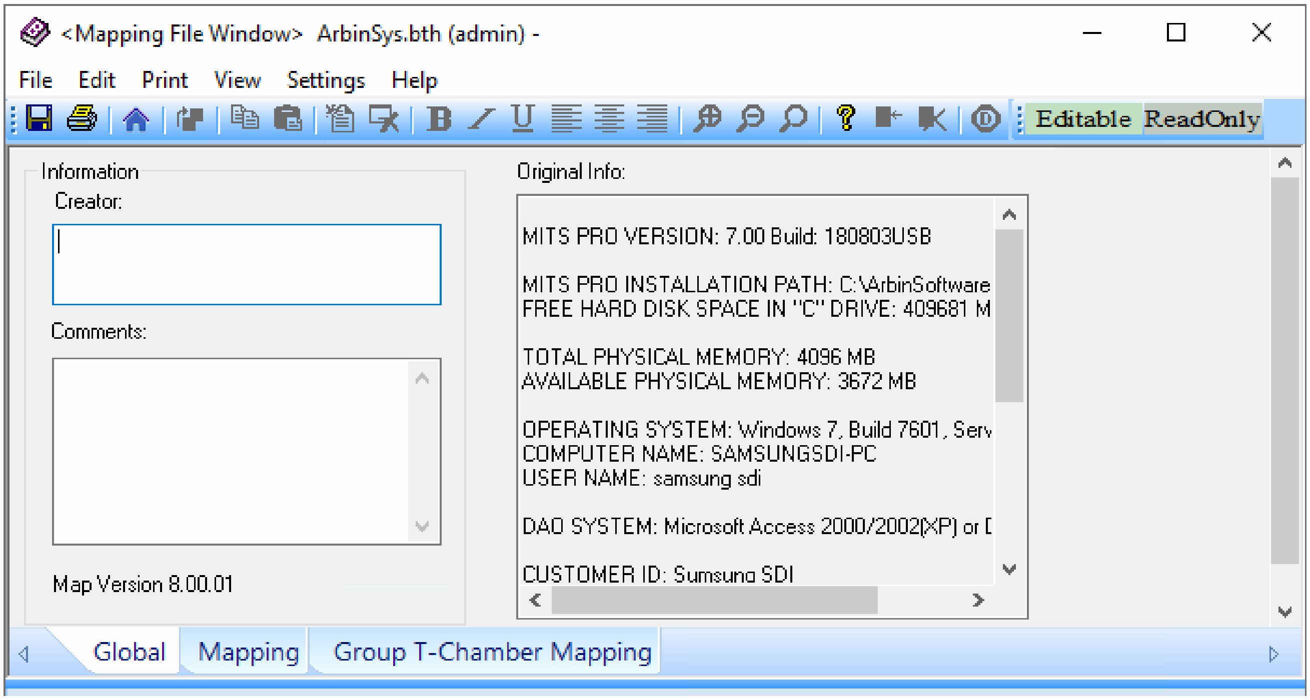


Figure 6-4 Global Page

Field Descriptions

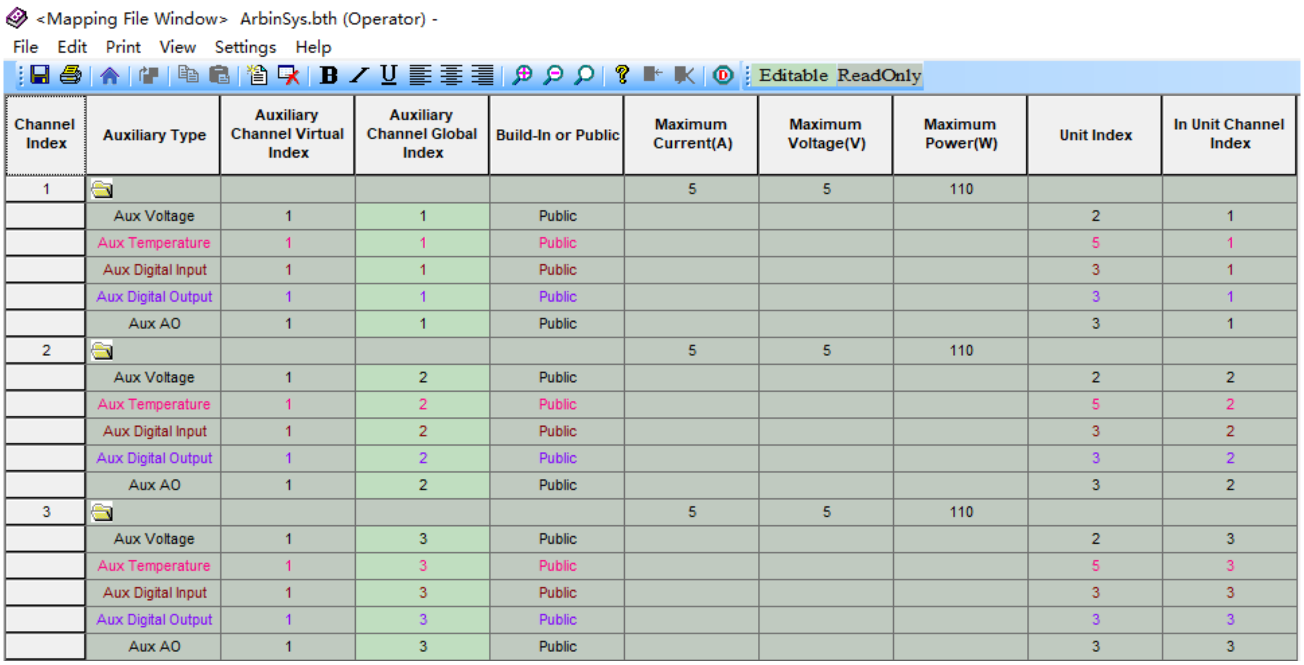
Creator: The name of the person responsible for the creation of this test batch.

Comments: Available for general comment use.

6.4 Mapping Auxiliary Measurements

The **Mapping** page of a batch is the area where an auxiliary measurement channel (temperature, pressure, auxiliary voltage, pH, flow rate and concentration if the hardware equipped) is assigned to a regular output channel. The data from these mapped channels will appear in the results from the main IV channel when the appropriate settings are enabled in the schedule file.

To switch to the **Mapping** page, click the **Mapping** tab on the task bar.



Channel Index	Auxiliary Type	Auxiliary Channel Virtual Index	Auxiliary Channel Global Index	Build-In or Public	Maximum Current(A)	Maximum Voltage(V)	Maximum Power(W)	Unit Index	In Unit Channel Index
1					5	5	110		
	Aux Voltage	1	1	Public				2	1
	Aux Temperature	1	1	Public				5	1
	Aux Digital Input	1	1	Public				3	1
	Aux Digital Output	1	1	Public				3	1
	Aux AO	1	1	Public				3	1
2					5	5	110		
	Aux Voltage	1	2	Public				2	2
	Aux Temperature	1	2	Public				5	2
	Aux Digital Input	1	2	Public				3	2
	Aux Digital Output	1	2	Public				3	2
	Aux AO	1	2	Public				3	2
3					5	5	110		
	Aux Voltage	1	3	Public				2	3
	Aux Temperature	1	3	Public				5	3
	Aux Digital Input	1	3	Public				3	3
	Aux Digital Output	1	3	Public				3	3
	Aux AO	1	3	Public				3	3

Figure 6-5 Mapping Page in Batch File

Unit Index -- Auxiliary unit number. Uneditable.

In Unit Channel Index -- Reference to the aux channel physical index in the unit. Uneditable.

Auxiliary Type -- Identification of auxiliary voltage, temperature, pressure, digital input, digital output, ex charge, safety, humidity, AO or pH measurement if the hardware equipped.

Auxiliary Channel Virtual Index-- Numeric index of the number of auxiliary inputs assigned to a main IV channel

Auxiliary Channel Global Index -- Reference to the specific auxiliary channel number as shown on the panel of auxiliary boxes or in ArbinSys.cfg.

Maximum Current (A) – Maximum current that the IV channel can provide. Uneditable.

Maximum Voltage (V) – Maximum voltage that the IV channel can provide. Uneditable.

Maximum Power (A) – Maximum power that the IV channel can provide. Uneditable.

Procedure for Mapping Auxiliary Measurement

In the case that the mapping is not pre-defined, users may map auxiliaries to IV channels flexibly

1. Switch to the **Mapping** page by clicking the **Mapping** tab on the task bar.

Figure 6-6 Mapping File Tabs

2. Place the mouse cursor on the **Channel Index** number. When the right arrow appears, right-click the mouse and select **Append**. An auxiliary measurement types menu appears; select auxiliary measurement type.

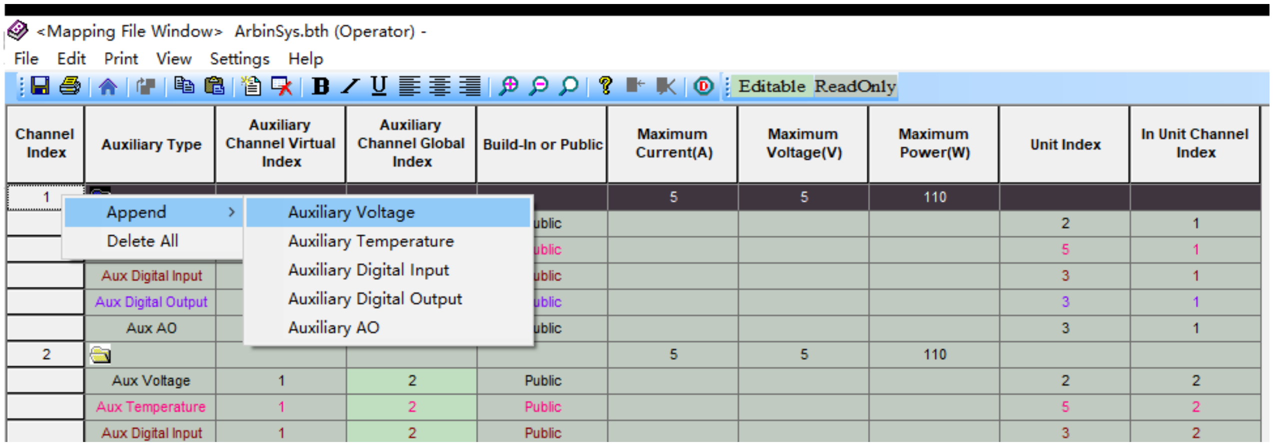


Figure 6-7 Appending Auxiliary Map

An auxiliary measurement type is enabled only when the hardware is so configured. (See notes on system configuration file in [Appendix D](#).) For example, if the hardware system configuration has 8 auxiliary voltage channels and 8 auxiliary temperature channels, then Auxiliary Voltage and Auxiliary Temperature will be enabled in the auxiliary measurement type menu. All other types will be disabled.

Additional Note: The system comes completely configured through ArbinSys.cfg from the factory. Under normal circumstances, the user will never have occasion to modify these system-level parameters.

3. Enter the auxiliary channel number in the field under **Auxiliary Channel Global Index**. For example, if you want to use auxiliary voltage channel 1 to measure the half-cell voltage change of a battery connected with main IV channel 1, then enter "1" in this field. (**Figure 6-8**)

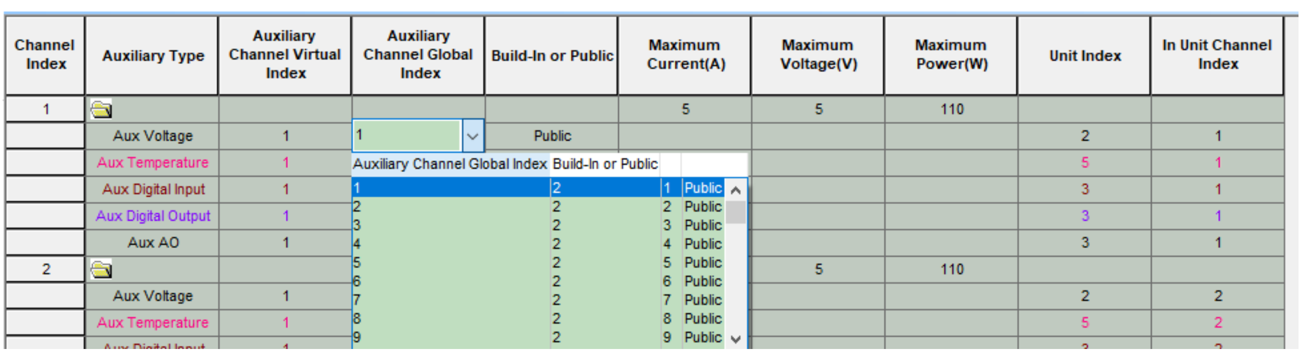


Figure 6-8 Specification of Auxiliary Channels

3. To map more auxiliary measurement channels, repeat steps 2 and 3.

   Note that, regardless of the designation of the **Auxiliary Channel Globle Index**, the **Auxiliary Virtual Channel Index** increments for each new auxiliary input referenced.

4. To remove an auxiliary measurement channel, place the cursor on the mapping and right-click. Select **Delete**, to delete that particular mapping or **Delete All** to delete all the mappings on that channel. Alternatively, highlight the channel and click **Edit**. Select **Remove Auxiliary Mapping** and click the selected auxiliary measurement type.

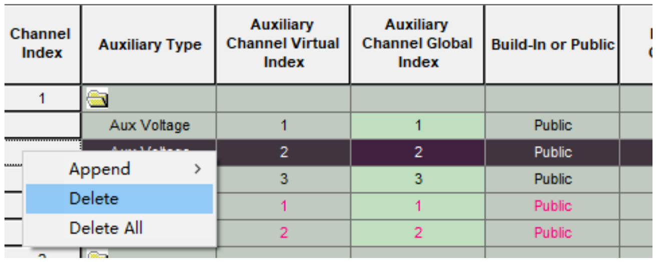


Figure 6-9 Delete one Mapping in Batch File

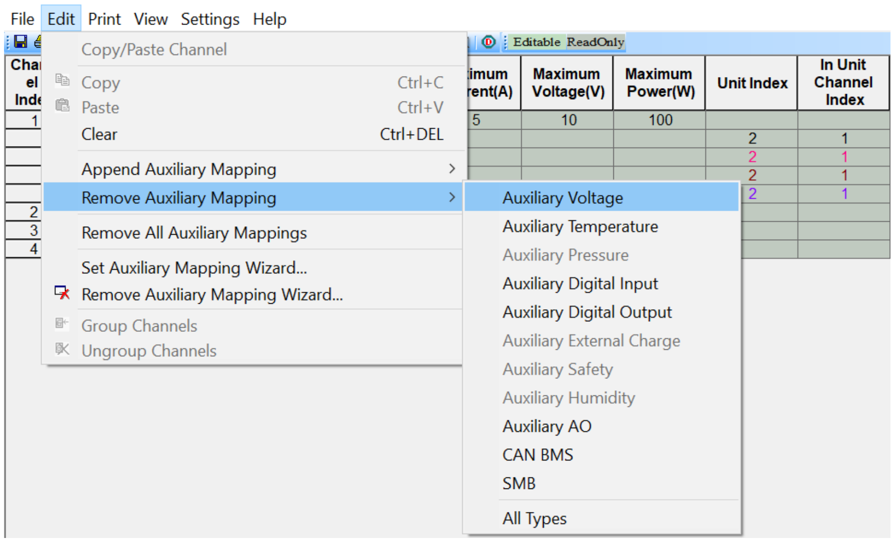


Figure 6-10 Removing Auxiliary Map

Default Mapping

Two default mapping styles are provided:

- **One-to-One Mapping -** Auxiliary channel 1 maps to regular channel 1, and Auxiliary channel 2 maps to regular channel 2, and so on.
- **One-to-Many Mapping -** many auxiliary channels map to a single regular channel. Ensure the option **One-To-Many Virtual Mapping** is enabled in the system configuration file **Advanced Options.**

Set Auxiliary Mapping Wizard

To Set Default Mapping

- On the menu click **Edit** - **Set Auxiliary Mapping Wizard**. A dialog box will appear.

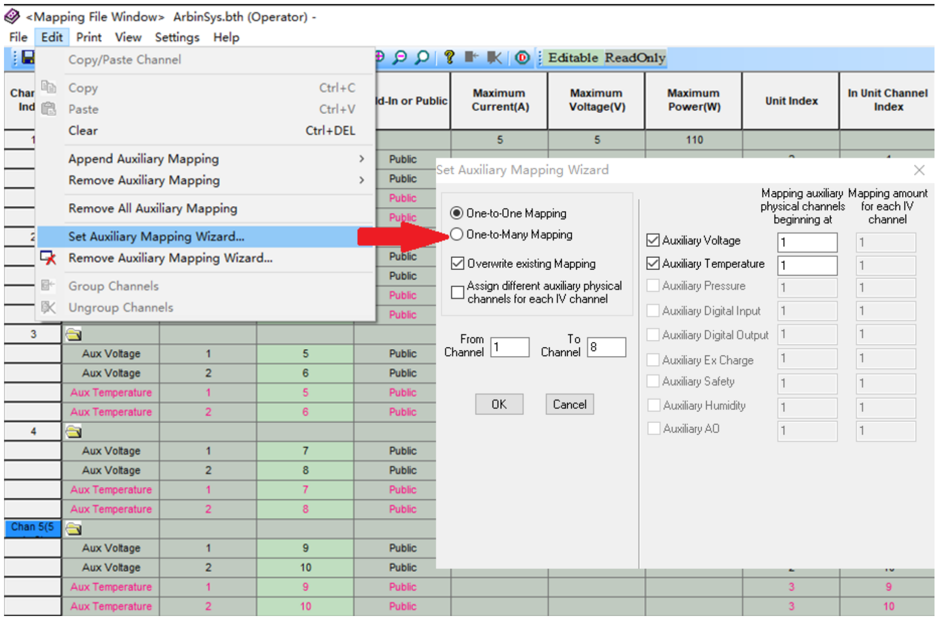


Figure 6-11 Select the Desired Mapping Style and Click **OK**

The user can overwrite an existing mapping by checking the "Overwrite existing maps" box. When the box labeled "Assign different auxiliary physical channels for each IV channel" is checked, the software avoids mapping the same auxiliary physical channels to multiple IV channels.

One-to-One Mapping assigns only one of each selected type of auxiliary physical channel to an IV channel. Hence, the Auxiliary Virtual Channel Index is always 1(**Figure 6-12**).

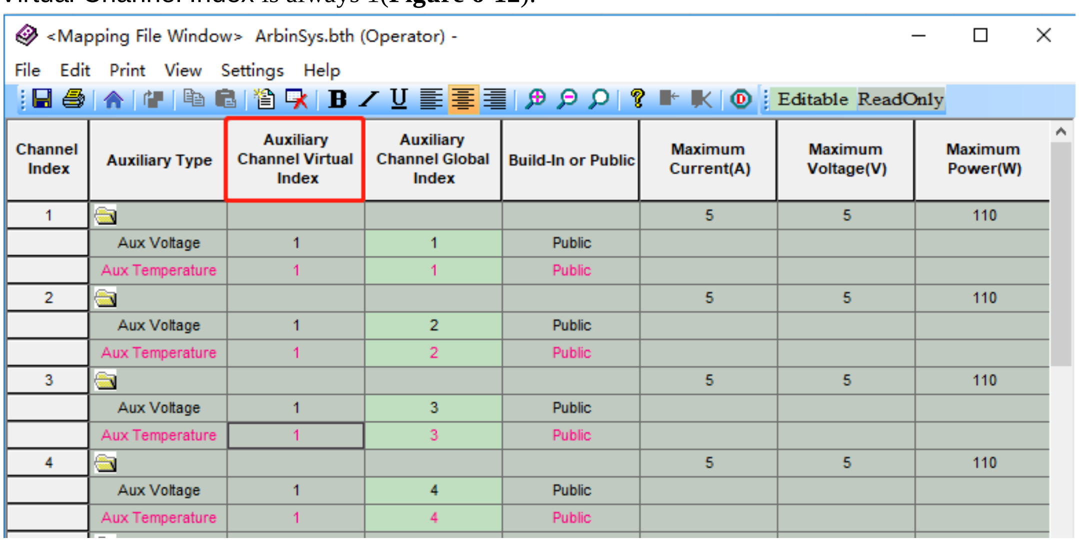


Figure 6-12 One-to-One Mapping

One-to-Many mapping assigns many of a certain type of auxiliary physical channels to the selected IV channels. Hence, the Auxiliary Virtual Channel Indexes are arranged in order (**Figure 6-13**).

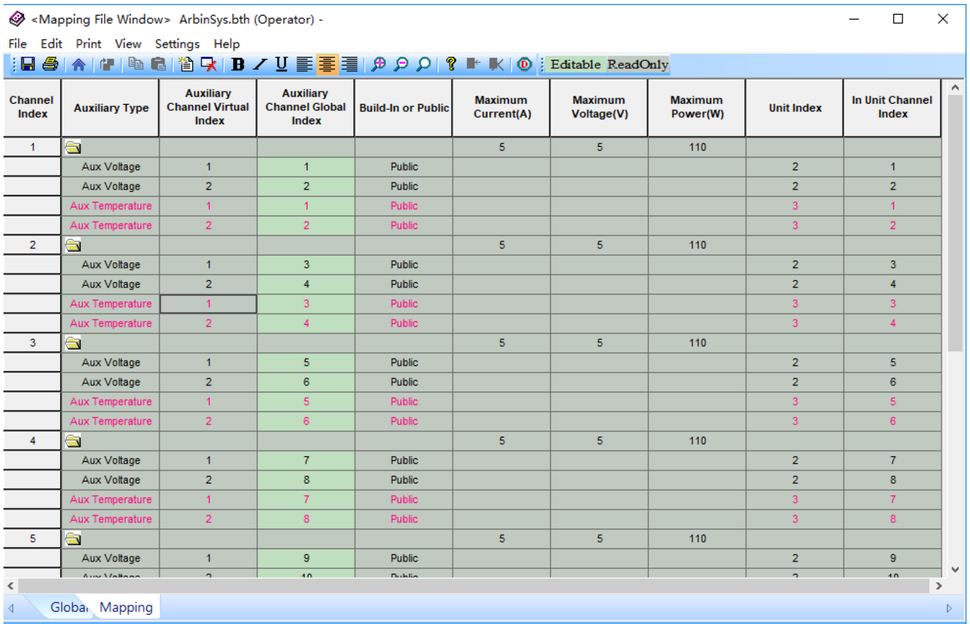


Figure 6-13 One-to-Many Mapping

When One-to-Many Mapping selected, "From/To Channel" can be set the index of IV channels to map, "Mapping auxiliary physical channels beginning at" can be set the first physical index of being mapped aux-channel, "Mapping amount for each IV channel" can be set the virtual number of aux-channels being mapped to one IV channel.

Remove all Auxiliary Mappings

On the menu, click Edit - Remove all Auxiliary Mappings.

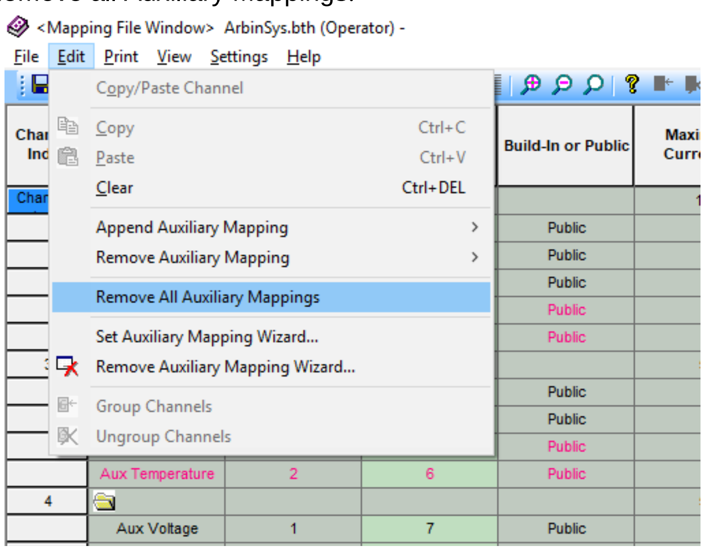


Figure 6-14 Remove all Auxiliary Mappings

Please download the map information by press button on the menu bar whenever you changed the map, including removing all the map information. Otherwise, the change might not take effect.

6.5 Parallel Channels

If the user wishes to conduct tests that require more than the maximum current-delivering capability of one IV channel, then channels may be grouped in parallel to increase the current.

a. Ensure that the "Parallel Channels" option is enabled in **Advanced Options** page of the system configuration file ArbinAdvSys.cfg.

b. Select consecutive IV channels with the same specification with the same voltage and current rating in the mapping page of the ArbinSys.bth file. Click to group selected channels. The parallel channels work on current High Range only.

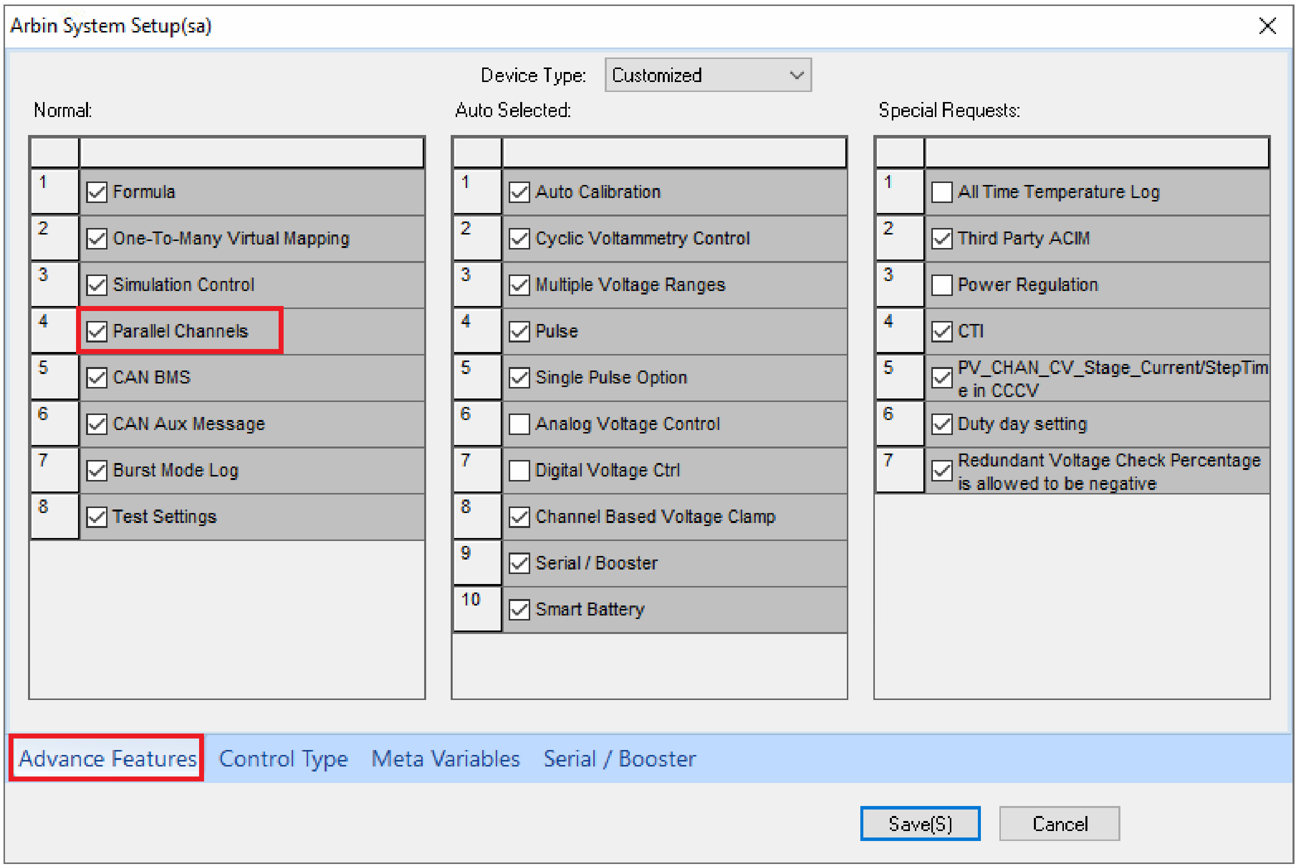


Figure 6-15 Check the box of **Parallel Channels** in **Advanced Features** of ArbinAdvSys.cfg

c. Note that only the following control types can be done in Parallel: Current, Voltage, C-Rate, Rest, Power, Load, Set Variables, Current Ramp, Voltage Ramp, Current Staircase, Voltage Staircase, CCCV, and CCCV_WRM.

d. In the mapping file, highlight Channel Index such as channel 1 and 2 to be grouped. Highlight the group ($n \leq 32$ or channel number, whichever is less) of contiguous channels whose current will be combined. The maxima output charging/discharging current is N x $I_{range\ 1}$. Here "N" is the number of paralleled channels, $I_{range\ 1}$ is the current of range 1.

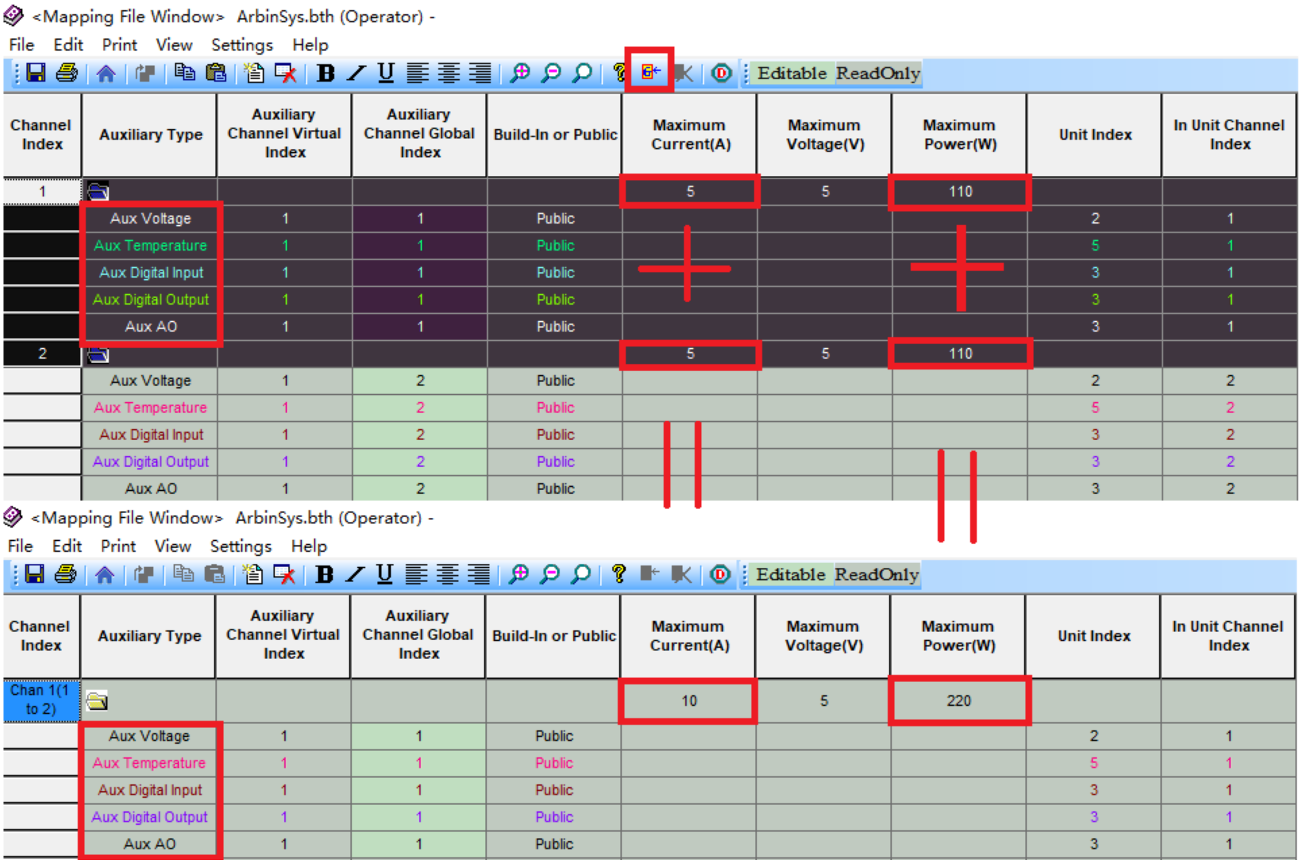


Figure 6-16 Grouping channels 1 and 2

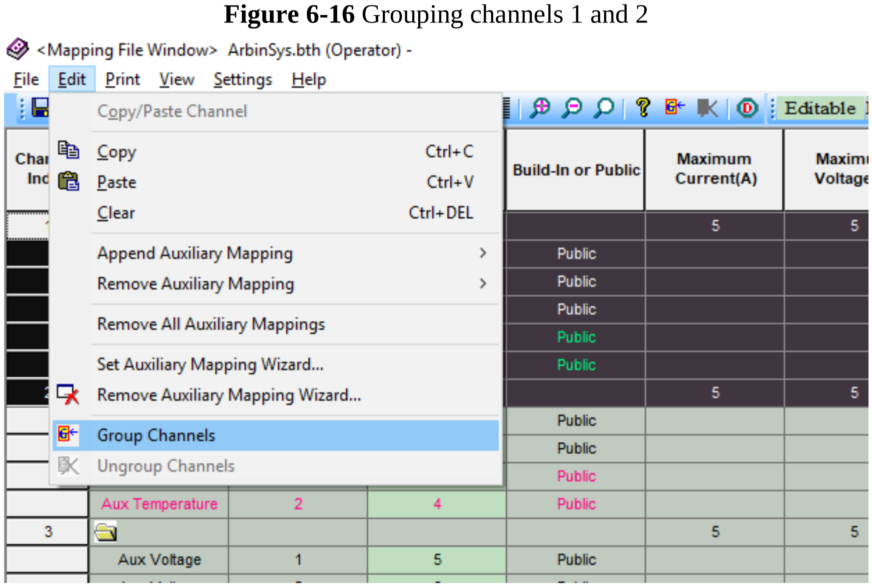


Figure 6-17 Select Edit - Group Channels

e. One could also group channels in **Edit - Group Channels (Figure 6-17)**. After grouping the channels, only auxiliary channels which have been mapped to the first channel will work for parallel tests.

f. Connect all the red-insulated (+I) and white-insulated (+V) leads to the device (+) terminal and all the black-(-I) and green-insulated (-V) leads to the device (-) terminal.

g. **Figure 6-18** shows an example of parallel channels connection.

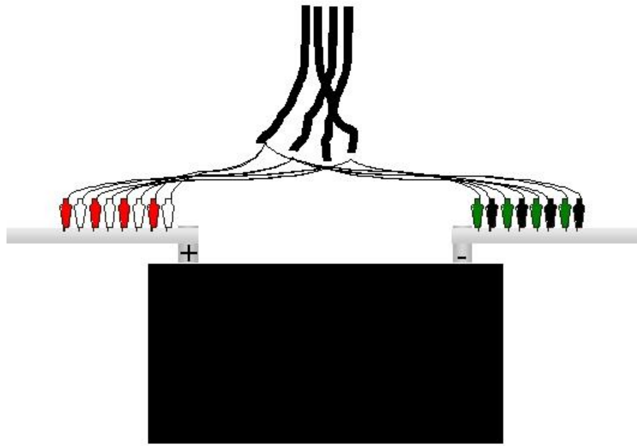


Figure 6-18 Parallel Channels Connection (4-Channel Example)

h. Verify that the schedule safety limits are wide enough to accommodate the total Current (A) **Control Value**.

i. In ArbinSys.cfg, the displayed **Current Safety Limit** has not been affected by the parallel operation. The acting safety limit for paralleled channels (let's say, 4 channels with 50A of range 1 each paralleled, each channel has safety limit -52.5 to 52.5A in ArbinSys.cfg) is **n** x $\mathbf{I}_{\text{LIMIT-cfg}}$, where **n** is number of IV channels paralleled and $\mathbf{I}_{\text{LIMIT-cfg}}$ is Current Safety Limit in ArbinSys.cfg. In this example, acting safety limit range is 4 x ±52.5A = ±210A

	Current Range1 Value(A)		Current Safety Limit(A)	
	Min	Max	Low	High
1	-50	50	-52.5	52.5
2	-50	50	-52.5	52.5
3	-50	50	-52.5	52.5
4	-50	50	-52.5	52.5

Figure 6-19 Current High Range and Safety Limits in ArbinSys.cfg

j. If the current safety ranges between the schedule and the system configuration are not consistent, the program takes the overlapped range for the limits. For the example above, when the safety-range of -150 A to 250 A is set in the schedule, and -210 A to 210A calculated according to the system configuration, then the actual limit is from -150 A to 210A.

k. The data from paralleled channels will be stored on the first channel (leader channel) of the group. For example, grouping from channels 4 through 8, the data will be stored on channel 4 only. Further, other channels will contain no auxiliary channel data.

Note: Make sure **Parallel** range value when you want to make a schedule for Parallel Channels.

l. To ungroup the paralleled channels, select the grouping, and click the button highlighted in **Figure 6-20 & Figure 6-21**.

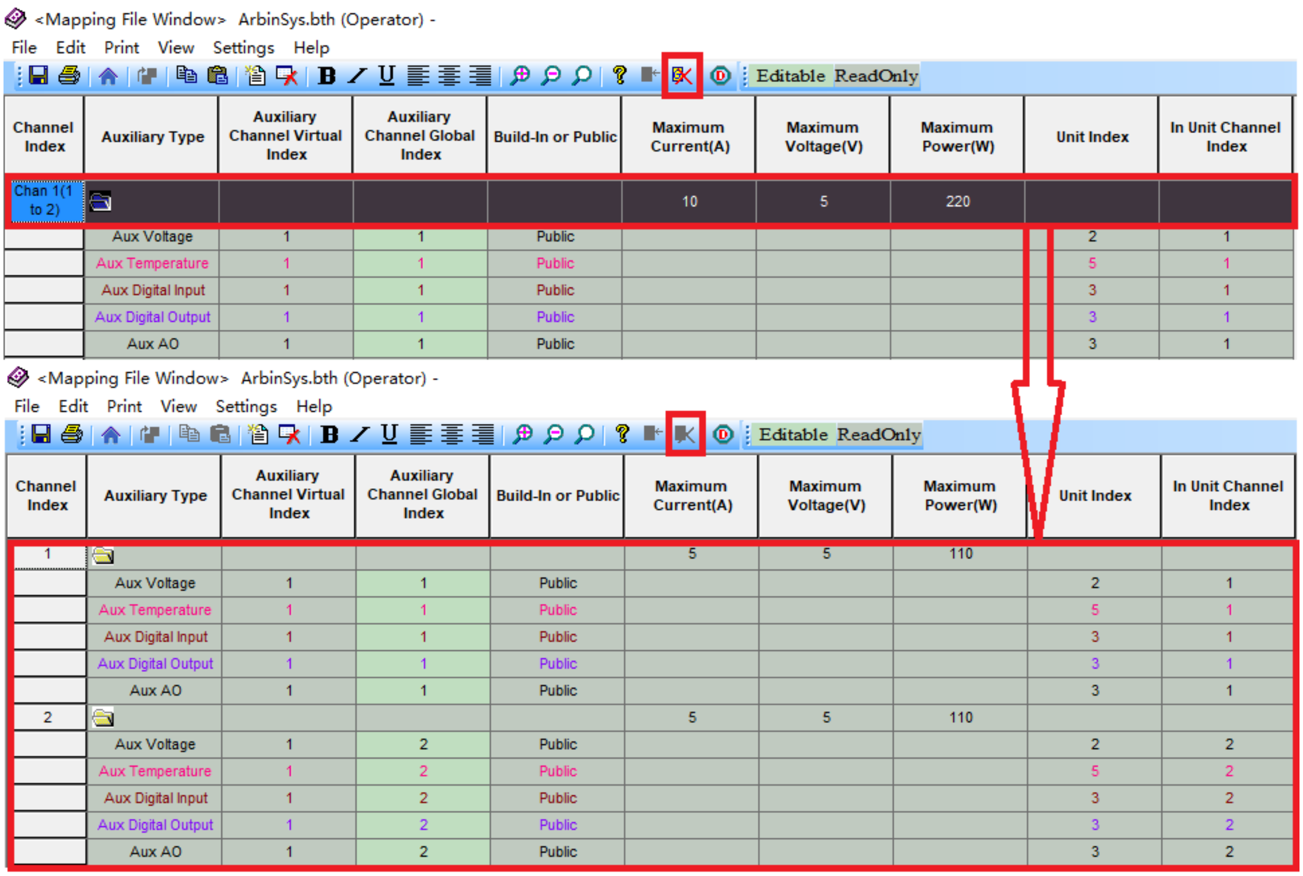


Figure 6-20 Ungrouping channel 4 to 8

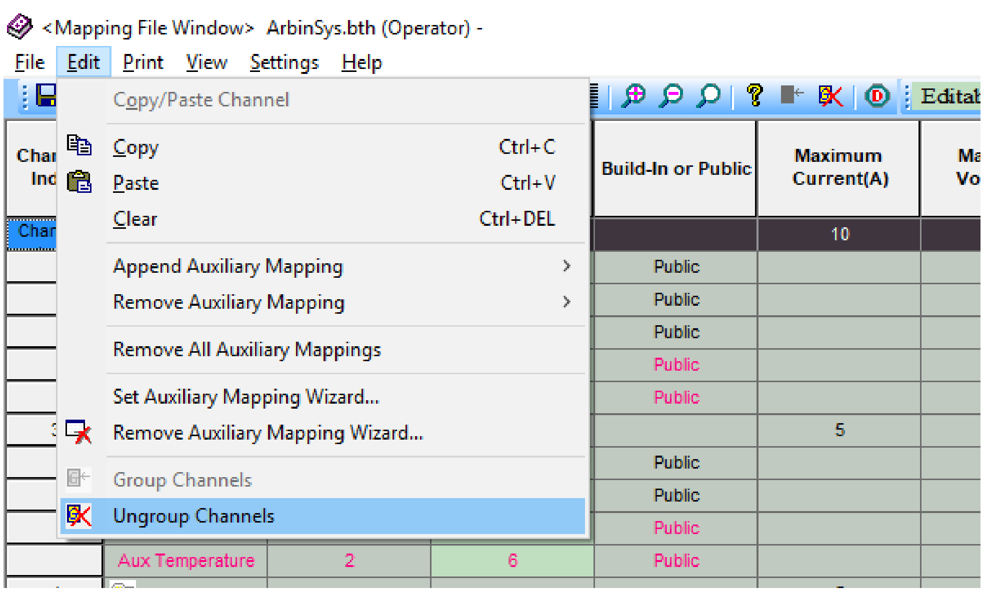


Figure 6-21 Select **Ungroup channels**

m. To map auxiliary channels to parallel channels, users need to map auxiliary channel to the leader channel only before grouping.

n. **Note: It is important to have the right order in assigning a schedule to grouped channels and mapping the auxiliary channels to the leader channel of IV channels to be grouped; Damage could happen to**

your test articles if you do not follow the procedures above.

o. Contiguous channels can be paralleled either within the same unit (within one Microcontroller) or between units (in different Microcontrollers).

p. Only auxiliary channels which are mapped to the leader channel can be used and can log data.

q. If grouping several channels in parallel, all individual channel's protection mechanisms will still take effect. If any of channels in parallel trigger the unsafe condition, each of the parallel channels will stop the test, and MITS Pro8.0 will show the "unsafe" message in the corresponding lead channel.

6.6 MTCI Group Managenment (under developing)

This page allows the chamber to be mapped to multiple channels on the machine. But please note that only supports channels on a single unit.

1. Identify the relevant channels as Controllable so that the integrated microcontroller will actively regulate the chamber temperature.

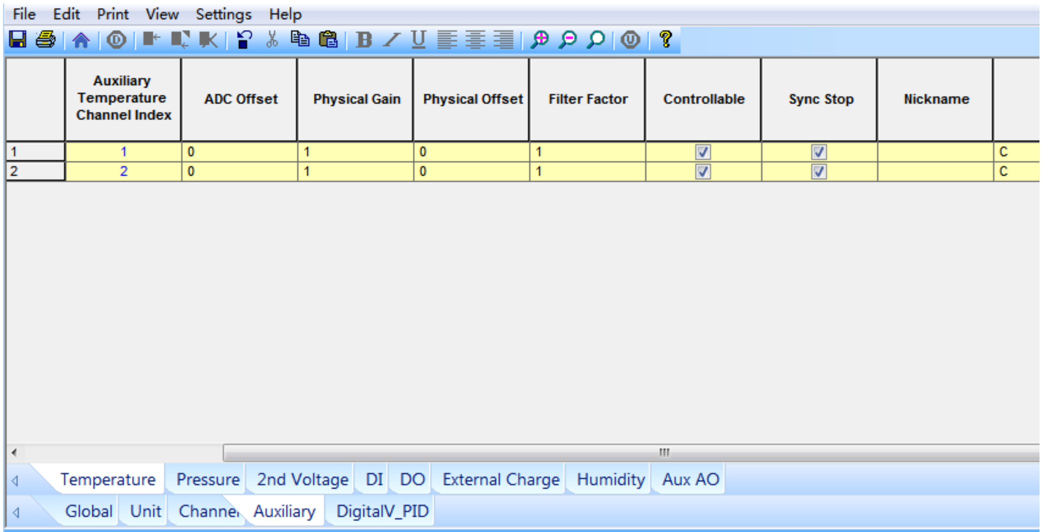


Figure 6-22 Controllable Option in Temperature - Auxiliary-in System Configuration

2. Open the Mapping File, then click on the **Group T-Chamber Mapping** tab.

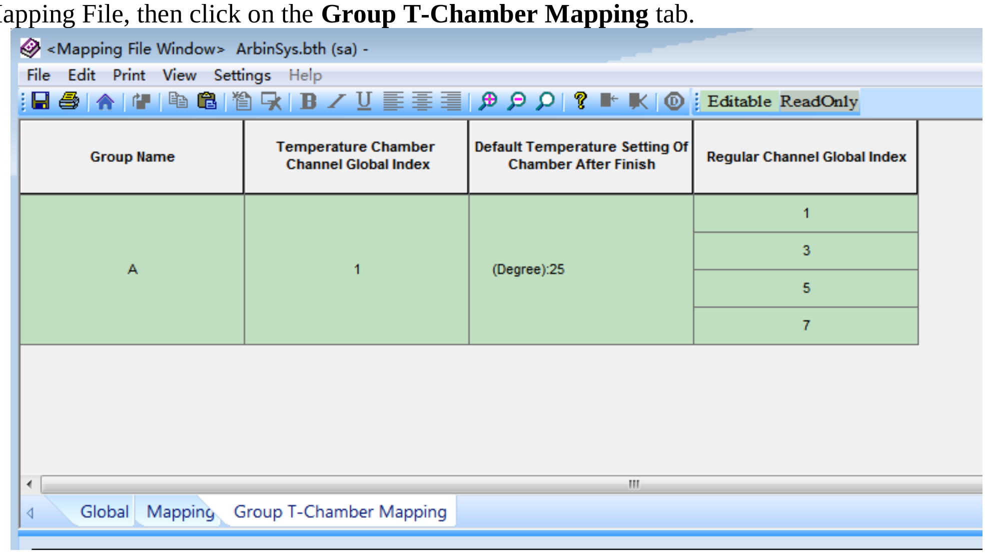


Figure 6-23 Group T-Chamber Mapping tab on Mapping File

Description:
Group Name: The nick name.
Temperature Chamber Channel Global Index: The No. of Temperature Chamber.
Default Temperature Setting Of Chamber After Finishing: The Default is 25.
Regular Channel Global Index: The No. of Regular Channel.

3. Place the cursor on the **Group Name** then right click to create a group.

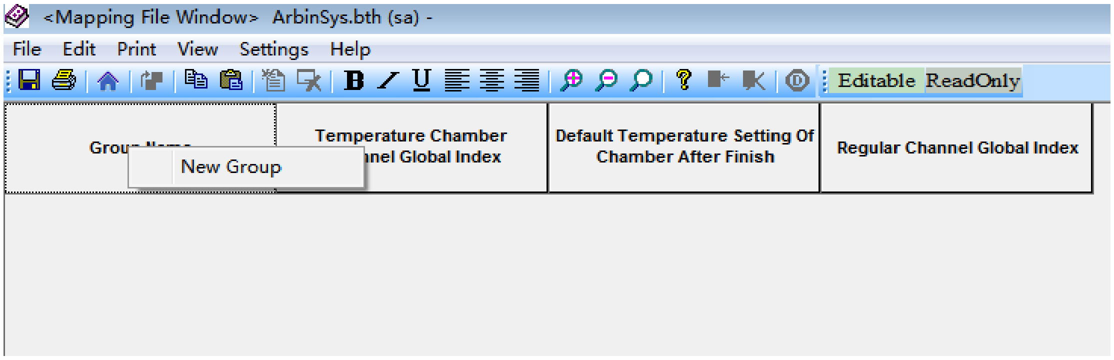


Figure 6-24 New or Delete Group

4. After a group is created, then place the cursor under the "**Regular Channel Global Index**" column, and right click to append/delete channel.

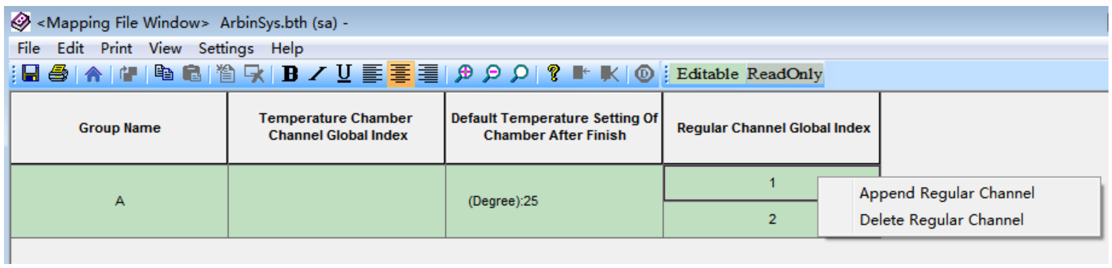


Figure 6-25 Append or Delete Regular Channel

5. Check the **Use Group T-Chamber** Option in schedule file. Or the test will fail to start.

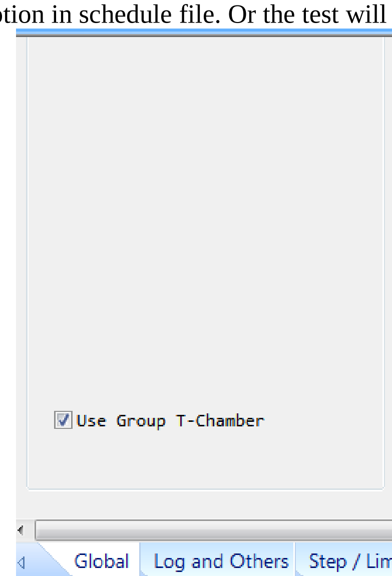


Figure 6-26 Check the Use Group T-Chamber in Global page in Schedule File

Chapter 7 Test Control and Real-Time Monitoring

The **Monitor & Control Window** is the primary means of controlling and monitoring channel tests. Whenever the monitor screen is visible, the channel data are updated according to the data refresh rate in monitor Settings (default is 3 seconds). There are three types of views in the **Monitor & Control Window**, they are **Detail View**, **Brief View**, and **Channel View.** Test controlling can be performed in **Brief View, Detail View** and **Channel View** areas. **Channel View** provides detailed real-time data for a selected channel, as well as smart battery or CAN message data if a smart battery is being tested, or CAN device is been connected and enabled. **Detail View** and **Channel View** by default is shown side by side but can be separated by clicking "Pop up **Channel View**" button. Brief view can be activated by clicking "Switch Brief/Detail View".

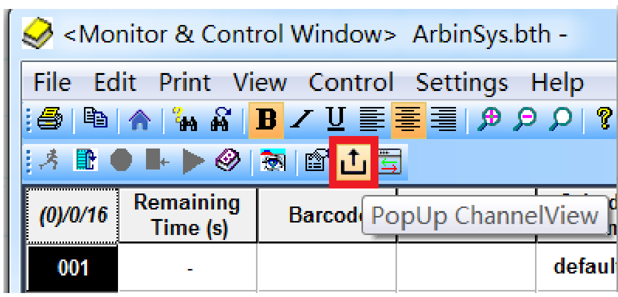


Figure 7-1 Pop up **Channel View**

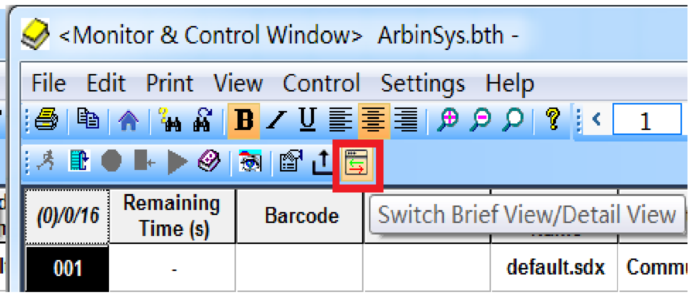


Figure 7-2 Switch Brief/Detail View

See Also

- Launching a Test
- Controlling Tests
- Field Description of the **Start Channel(s)** Dialog Box
- Monitor & Control Window
- Updating Schedule

7.1 Launching a Test

1. Common method: Click the space shuttle icon in the property sheets of the MITS Pro8.0 console screen.
2. Alternate method: Click the **Mapping Files** folder from the main window. Right-click to load a named batch and select Launch from the pop-up menu.

   A message box pops up asking for confirmation of overwriting the existing ArbinSys.bth**.** Click **Yes** if the new batch file contains information relevant to the instrument configuration and the tests that are to be performed. Note that the system always loads the batch called ArbinSys.bth. If a user launches a different map file, it will automatically be copied to ArbinSys.bth. Therefore, the final loaded map file is always ArbinSys.bth.

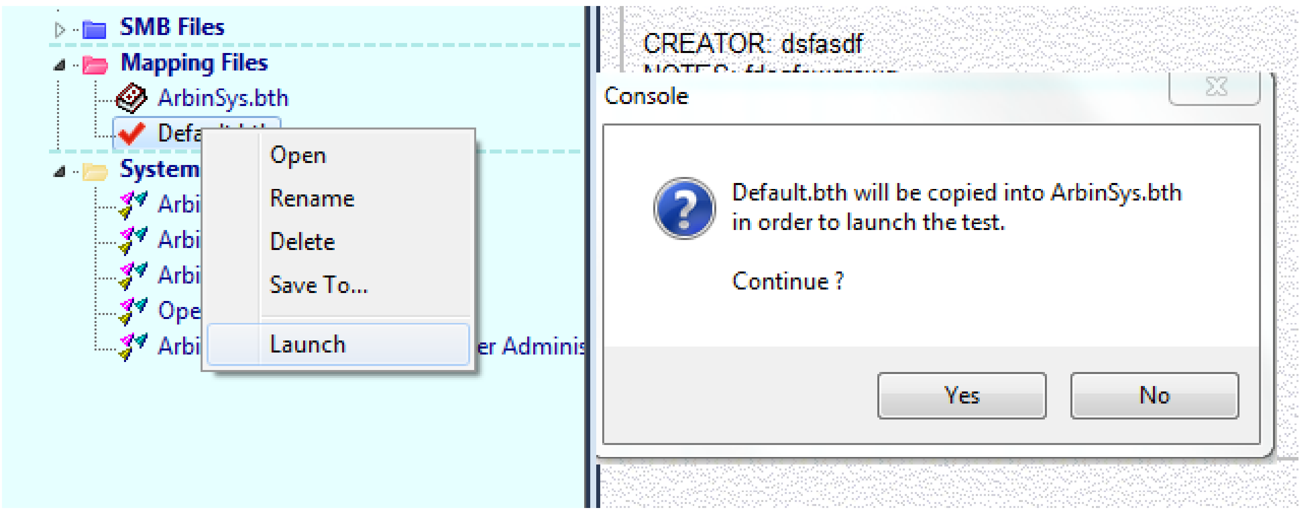


Figure 7-3 Launching Main Console Window from **Mapping file**

After launching, the **Monitor & Control Window** will appear with the window containing three areas **Detail View, Channel View** and **Schedule view**.

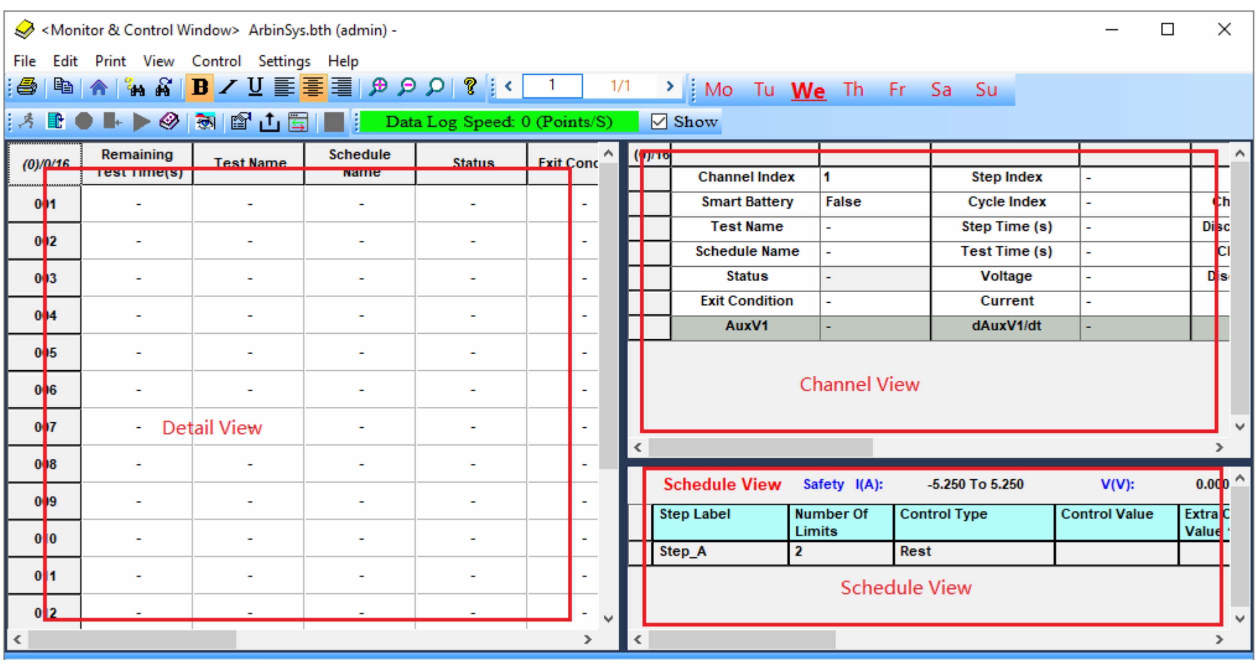
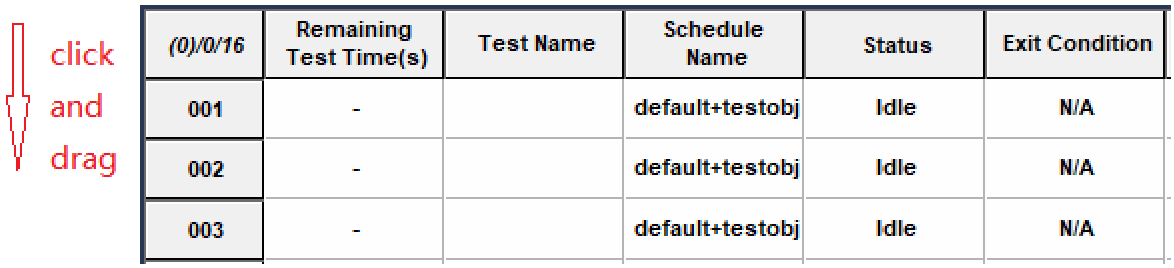


Figure 7-4 Monitor & Control Window

Selecting Channels

1. **MITS Pro** provides several means of selecting channels for testing in the **Detail View** area.
   - On the leftmost column which shows channel index, highlight the channel row by clicking the selected channel index. Click and drag to select contiguous channels.



(0)/0/16	Remaining Test Time(s)	Test Name	Schedule Name	Status	Exit Condition
001	-		default+testobj	Idle	N/A
002	-		default+testobj	Idle	N/A
003	-		default+testobj	Idle	N/A

Figure 7-5 Selecting Contiguous Channels

   - Users may also select a contiguous range of channels by right-clicking on channel sum index and choosing Select Channels…. Multiple non-adjacent channels can be selected by pressing <Shift> or <Ctrl> and clicking.

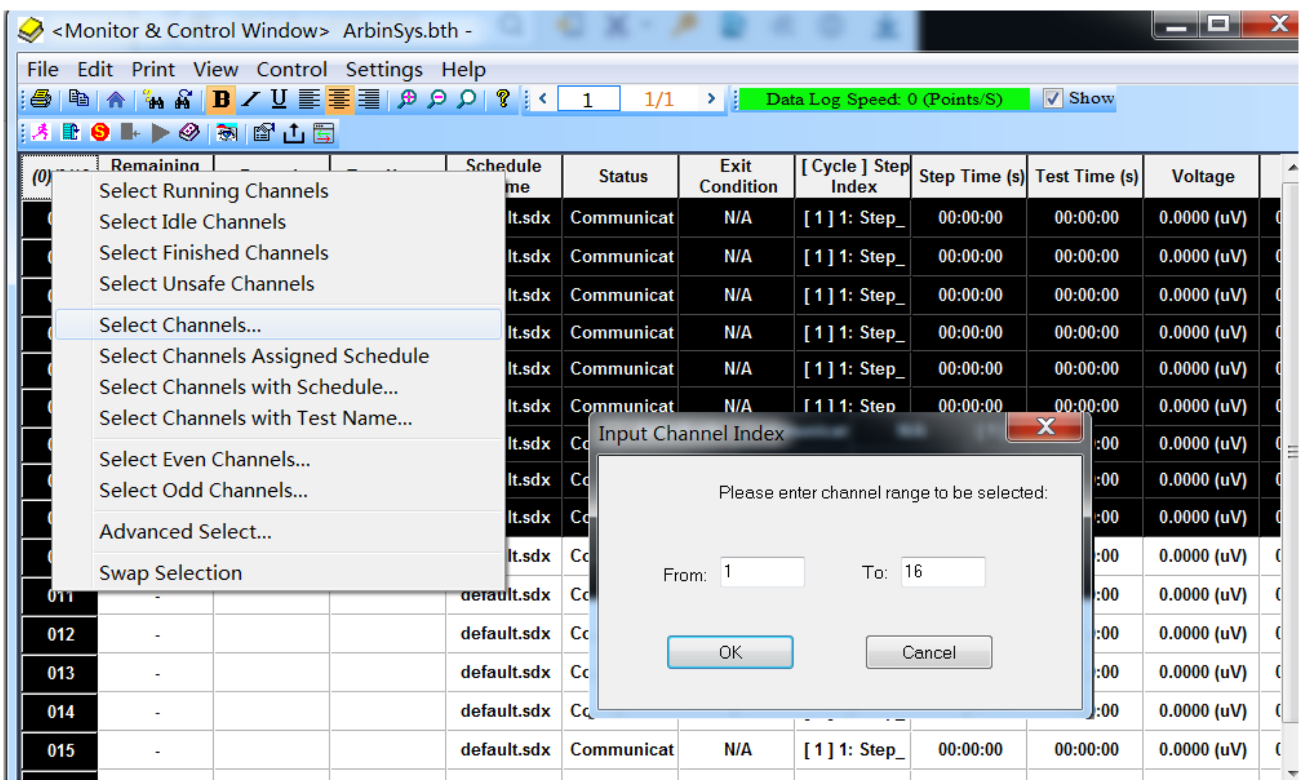


Figure 7-6 Select Channels… Menu Option

   - Users may open DataWatcher.exe to check test results by highlight a channel and click icon .

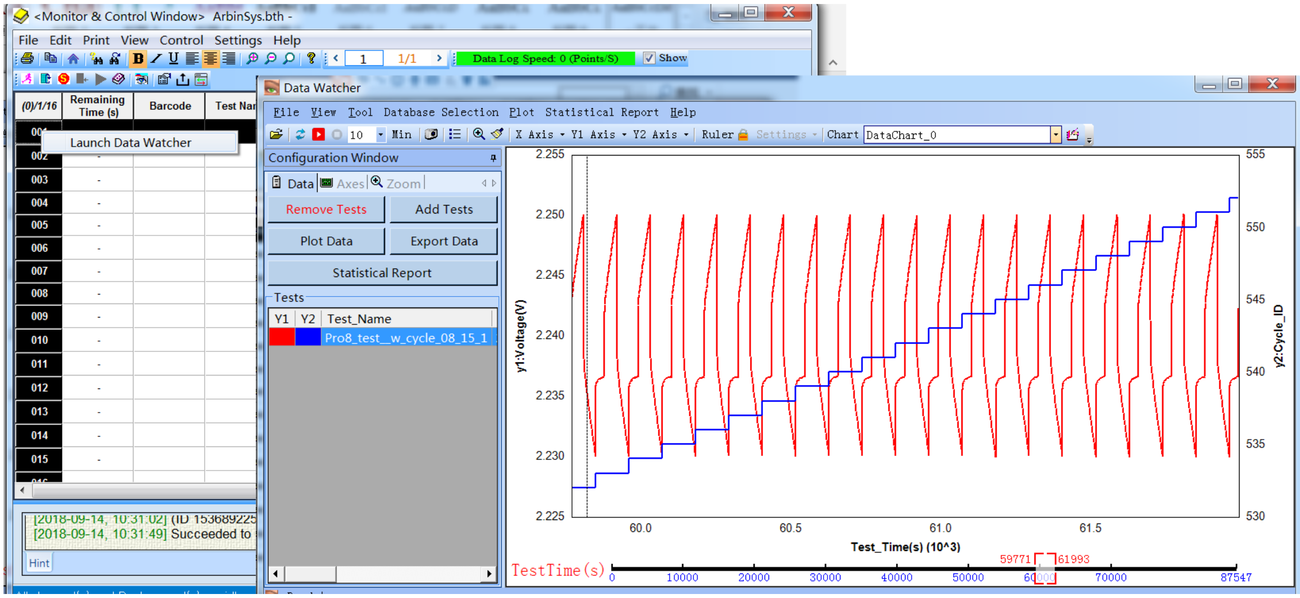


Figure 7-7 Open DataWatcher

2. Only a single channel can be chosen in **Channel View** area. If a channel or range of channels has been selected in another view, then **Channel View** area will reflect only the first channel selected.

Starting Channel(s), Test

Tests can be started from **Detail View**, **Brief View** or **Channel View**. In first two views, multiple channels can be started at the same time. In the **Channel View**, only the channel presented in the view can be started.

1. Start a test from the **Detail View** window.
   - Click "Control" menu on the menu bar, select Start Channels... or simply click the Start Channels toolbar icon. A **Start Channel(s)** dialog pops up. Additionally, one may right-click on any of the selected channels' index to commence channel operation.
   - Enter necessary information, such as the test name, in the Start Channel(s) dialog, and then click OK.

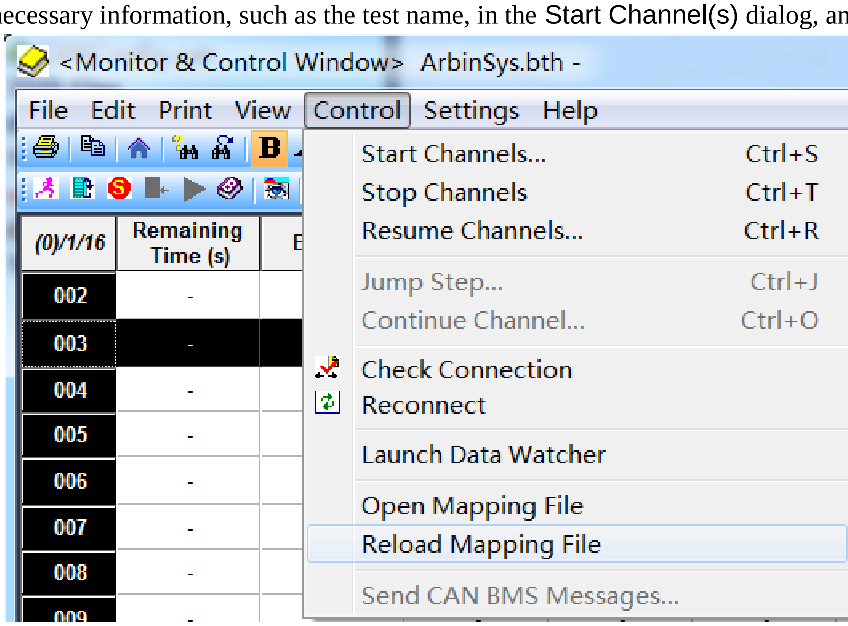


Figure 7-8 Starting a Test from the **Detail View**

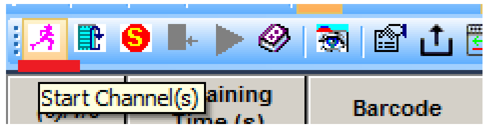


Figure 7-9 Start Channels Icon

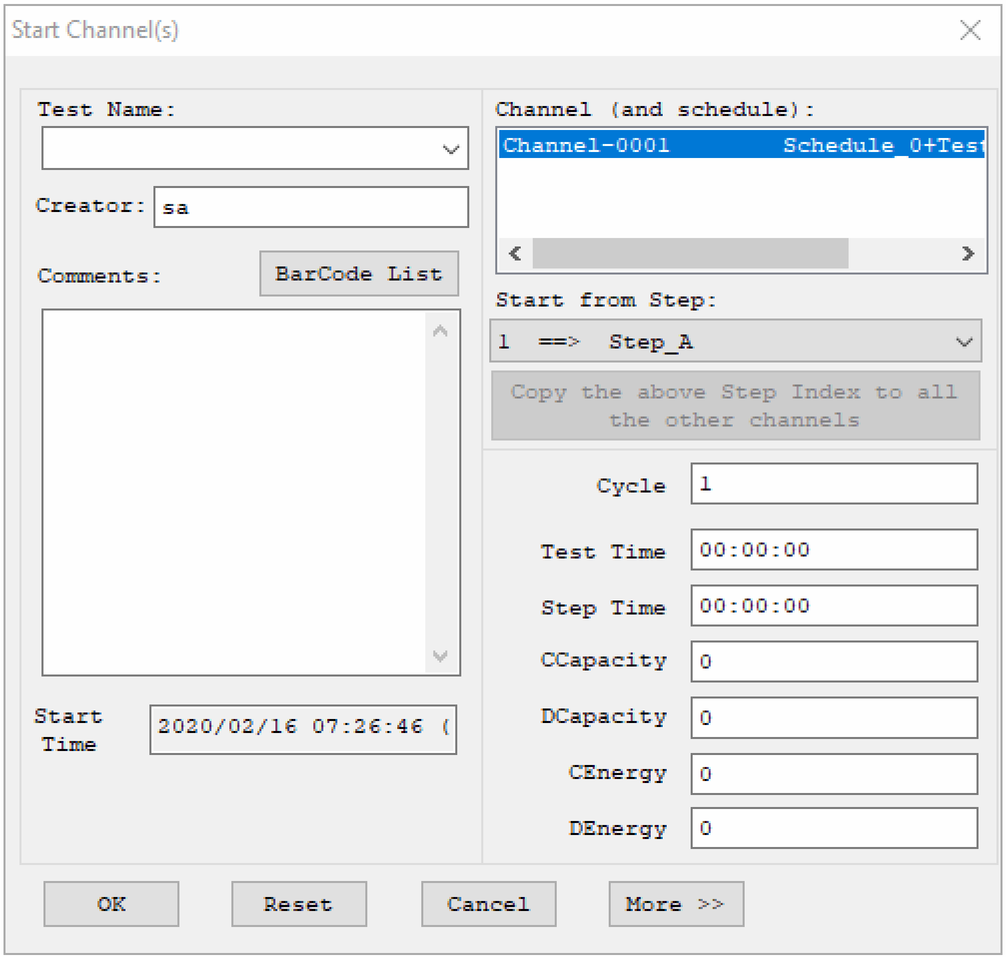


Figure 7-10 Start Channel(s) Dialog

- The test name chosen, and the data logged from the test will be stored in ArbinPro8MasterInfo.mdf file of MS SQL Server. The test name can contain 26 letters, numbers, underscores and so on, but no space (insteaded by underscores). If the same test name is used, run a test to generate new data will not overwrite the original data. The difference is the start time.
- Adding Creator and Comments will help to locate the testname in database.
- To start from beginning, user can keep other fields as defaut, otherwise, user can edit them according to your requirements.
- Field Description of the Start Channel(s) Dialog Box

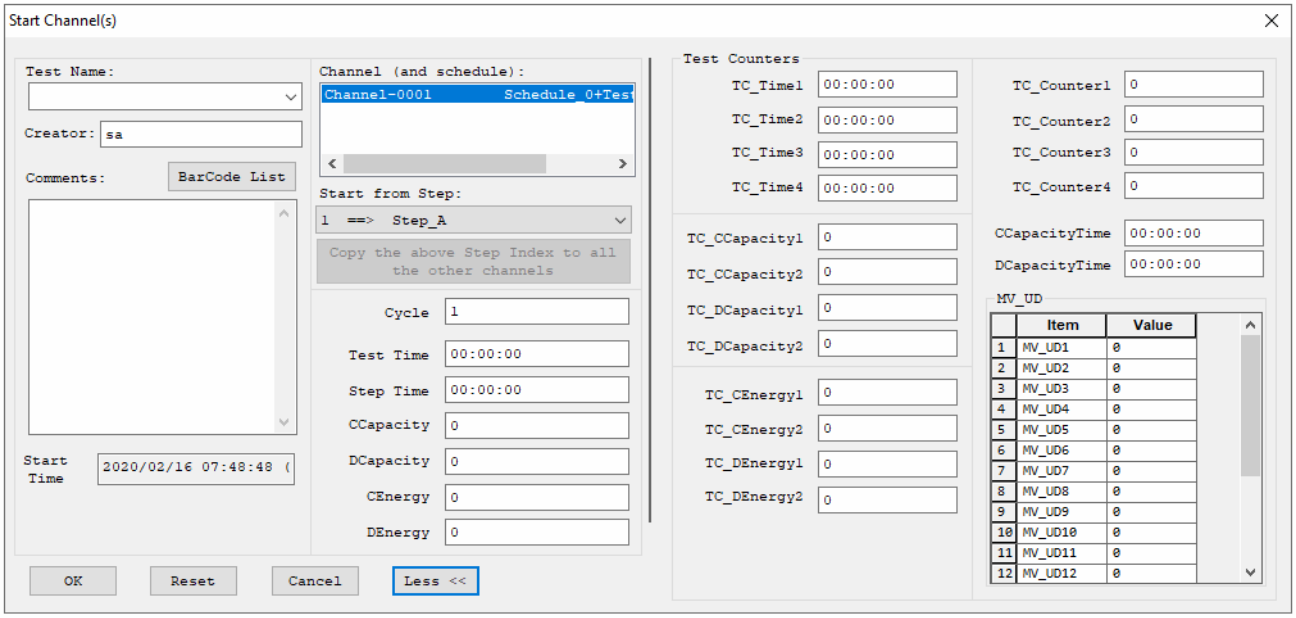


Figure 7-15 Start Channel(s) Dialog

Channel (and Schedule) -- shows the starting test channel index and its test schedule. If more than one channel is started at one time, it will show the first channel index and its test schedule.

Test Name -- Enter the results file name for the channel(s) to be started. The user can select from the drop-down list an existing file name as the test name. It will not overwrite the older data.

Creator -- The person who started this test (optional);

Comments -- Any comments related to this test (optional).

Barcode List – A "Barcode edit" window will pop up for adding the barcode here (Figure 7-15a). If a barcode is added here, it will be displayed in "Monitor and Control" window (figure 7-15b), and from the DataWacther, User can find the testing data according to the barcode (see Figure 8-12).

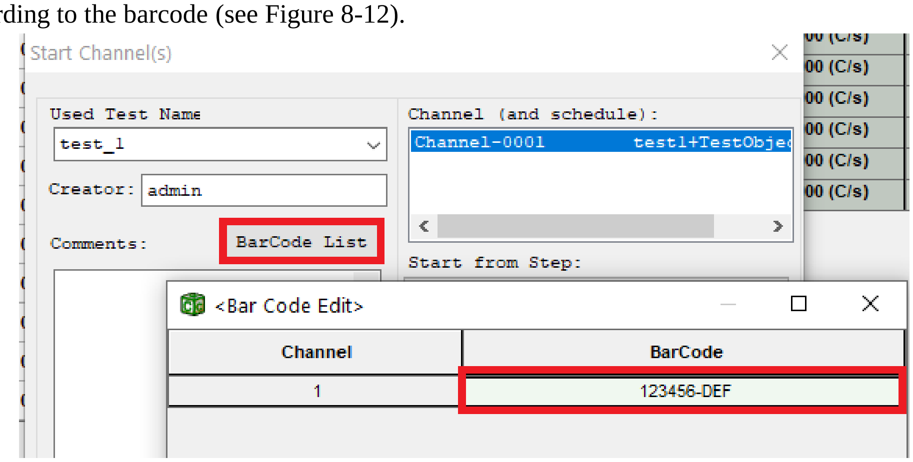


Figure 7-15a input Barcode

(1)/16								
	Channel Index	1	Step Index	1: Step_F, Rest	Power	0.0000 (uW)	dV/dQ	0.0000 (uV/s)
	Smart Battery	False	Cycle Index	1	Charge Capacity	0.0000 (mAh)	Vmax On Cycle	0.0000 (uV)
	Test Name	test_1	Step Time (s)	00:00:00	Discharge Capacity	0.0000 (mAh)	Internal Resistance	0.0000 (uOhm)
	Schedule Name	test1+TestObj	Test Time (s)	00:00:00	Charge Energy	0.0000 (mWh)	ACIM Mod/ACR	0.0000 (uOhm)
	Status	Communicatio	Voltage	0.0000 (uV)	Discharge Energy	0.0000 (mWh)	ACIM Phase	0.0000 (deg)
	Exit Condition	N/A	Current	0.0000 (uA)	dV/dt	0.0000 (uV/s)	Barcode	123456-DEF

Figure 7-15b Monitor and Control Window shows Barcode

Start Time – To record the test start time.

Start from Step -- Select the step you wish to start the test. The default is the first step of your schedule.

Apply to All Channels -- Applies the selected step starting point [if other than step 1] to all selected channels.

Cycle -- Enter the initial cycle number for the test. The default value is 1.

Capacity/Energy -- Enter the starting value for **CCapacity** (charge capacity), **DCapacity** (discharge capacity), The defaulkt values are 0.

CEnergy (charge energy), **DEnergy** (discharge energy). The default starting value of these parameters are 0.

Test Counters -- Enter the starting value for test counters. The test counters are the test time counters, charge capacity counters, discharge capacity counters, charge energy counters, discharge energy counters and counters. The default starting value of these counters are 0(00:00:00).

CCapacityTime -- Charge capacity time.

DCapatityTime -- Discharge capacity time.

MV_UD – user define meta_variables.

Reset -- Clicking this button will reset all the Capacity/Energy and Test Counter-related values.

7.2 Controlling Tests

MITS Pro8.0 provides the following functions to control a test.

- **Start** a test on any channel or a selected group of channels.
- **Stop** a test on any channel or a selected group of channels.
- **Resume** a test on any channel or a selected group of channels from the stopped point.
- **Jump** to a new step of a schedule on any channel or a selected group of channels.
- **Continue** a test on any channel or selected group of channels from Pause status.
- Check **connection** between PC and Arbin tester.
- **Reconnect** PC and Arbin tester if they were disconnected for some reasons.
- Open the **mapping file** (Arbinsys.bth) for viewing and editing.
- **Reload** Arbinsys.bth after editing the file.
- Send **CAN BMS Broadcast Messages**.

These control functions are executed in the **Detail View** monitor screen.

Control Command

Click Control on the menu to show available commands.

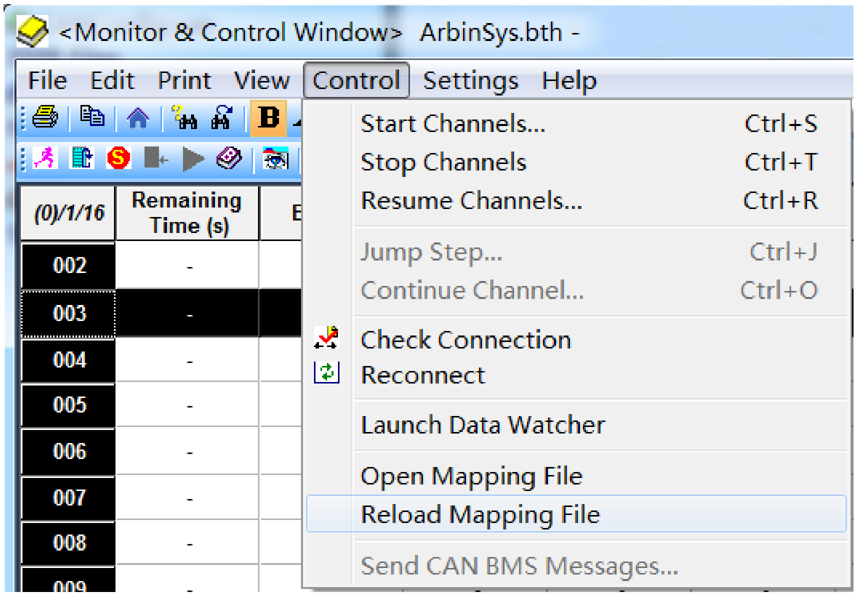


Figure 7-11 **Control** Menu

Control Commands in **Monitor & Control Window**

Command	Action
Start Channels...	starts a test on selected channels
Stop Channels	stops a test on selected channels
Resume Channels...	resumes a channel test at the point from which it was stopped
Jump Step...	jumps to a new step in the schedule
Continue Channel…	continues a test on selected channels from Pause status
Check Connection	checks the communication between PC and Arbin tester
Reconnect	tries to recover the communication between PC and Arbin tester
Launch Data Watcher	starts Data Watcher program
Open Mapping File	opens the mapping file (Arbinsys.bth) for viewing and editing
Reload Mapping File	reloads Arbinsys.bth after editing the file
Send CAN BMS Messages…	send CAN BMS broadcast messages.

Table 7-1 Control Command Description Table

Toolbar Icons for Control Command

Most command functions are accessible as icons on the tool bar. To display the function of each icon, place the mouse cursor on the icon; the icon label will then appear on the screen.

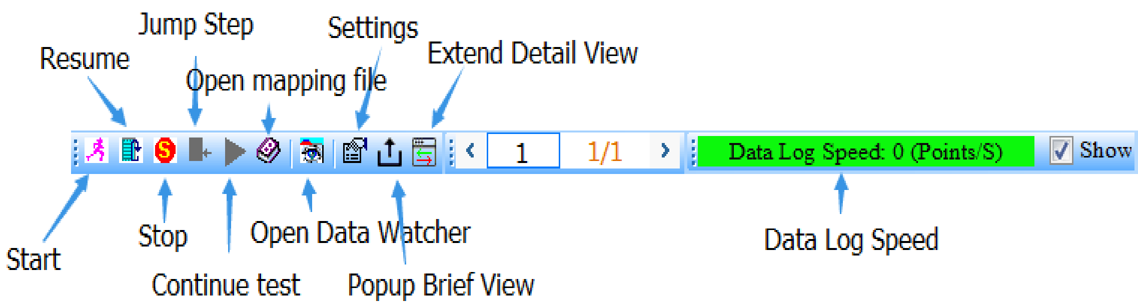


Figure 7-12 Control Icons

Starting Channels

- Highlight the channel (or channels with a same test name) you wish to start testing.
- Click the Start channels icon or click the Control drop-down menu. Click Start Channels….
- Review **7.1 Launching a Test**

Stopping Channels

- Highlight the channel(s) you wish to stop testing.
- Click the Stop channels icon or click the Control drop-down menu. Select Stop Channels. (See **toolbar icons for Control command.**)

Resuming Channels

- Click the channel number index you want to resume.
- Click the Resume channels icon or click the Control drop-down menu. Select Resume Channels.
- A message box appears. Enter the information in the message box and click OK. The default information are the stopped point.
- Several highlighted channels can be resumed together. Each channel will resume for its stopped point separately. Resume from Step: Select a step from an ative schedule, then click the button "Copy the above Step Index to all the other channels". All selected channels will jump to the specified step.

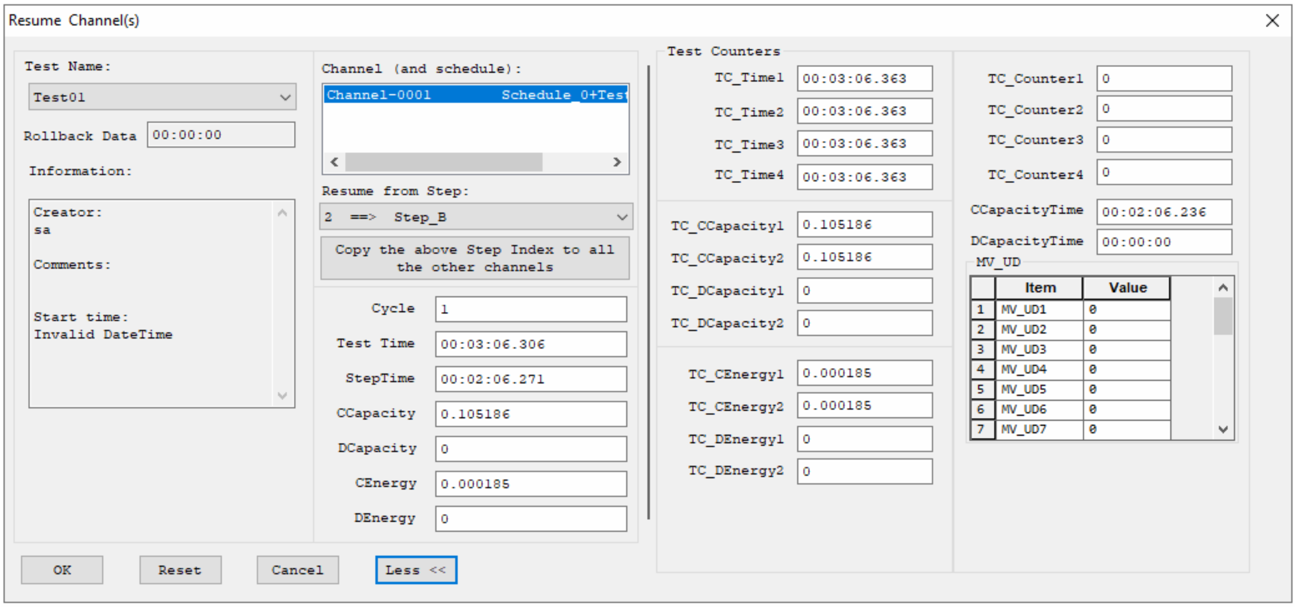


Figure 7-13 Resume Channel(s) Dialog

Starting Tests from a Previous End Point

- Follow the steps for **Resuming Channels**.

Jumping to other Step

- Click the channel number index for whose test the steps are to be jumped.
- Click the Jump Step icon or click the Control drop-down menu. Select Jump Step.... A message box appears.
- From the drop-down list select the step you want to jump to. If the step involves looping, then enter the cycle number in the Cycle box. However, Cycle number cannot be smaller than the last cycle ran. Check the appropriate box in order to affect all selected channels. Click OK.

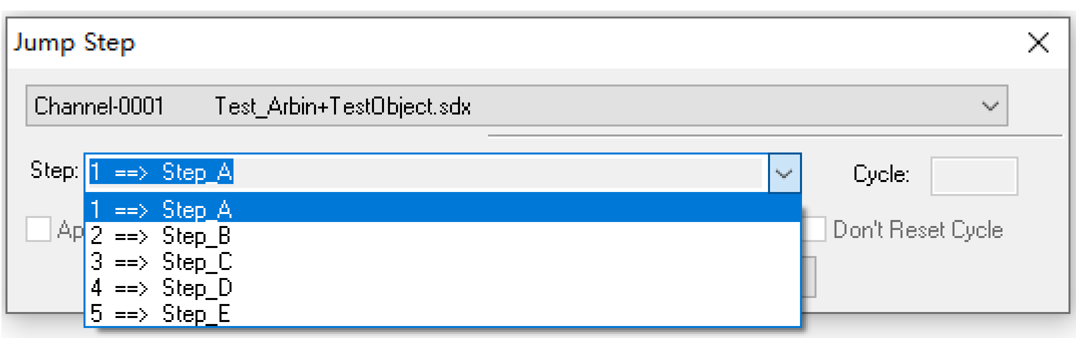


Figure 7-14 Jump Step Dialog

Continue

- If "pause" control type is selected in a schedule, when the test has reached the "pause" step, the test will be paused as scheduled. At this point, no data is logging, and the channel is turned off.
- Click  button to continue the test from "pause" point.

7.3 Monitor & Control Window

MITS Pro8.0 provides three areas of monitor screen to display the current test status of each channel of the tester. The user can view tests information at the monitor window.

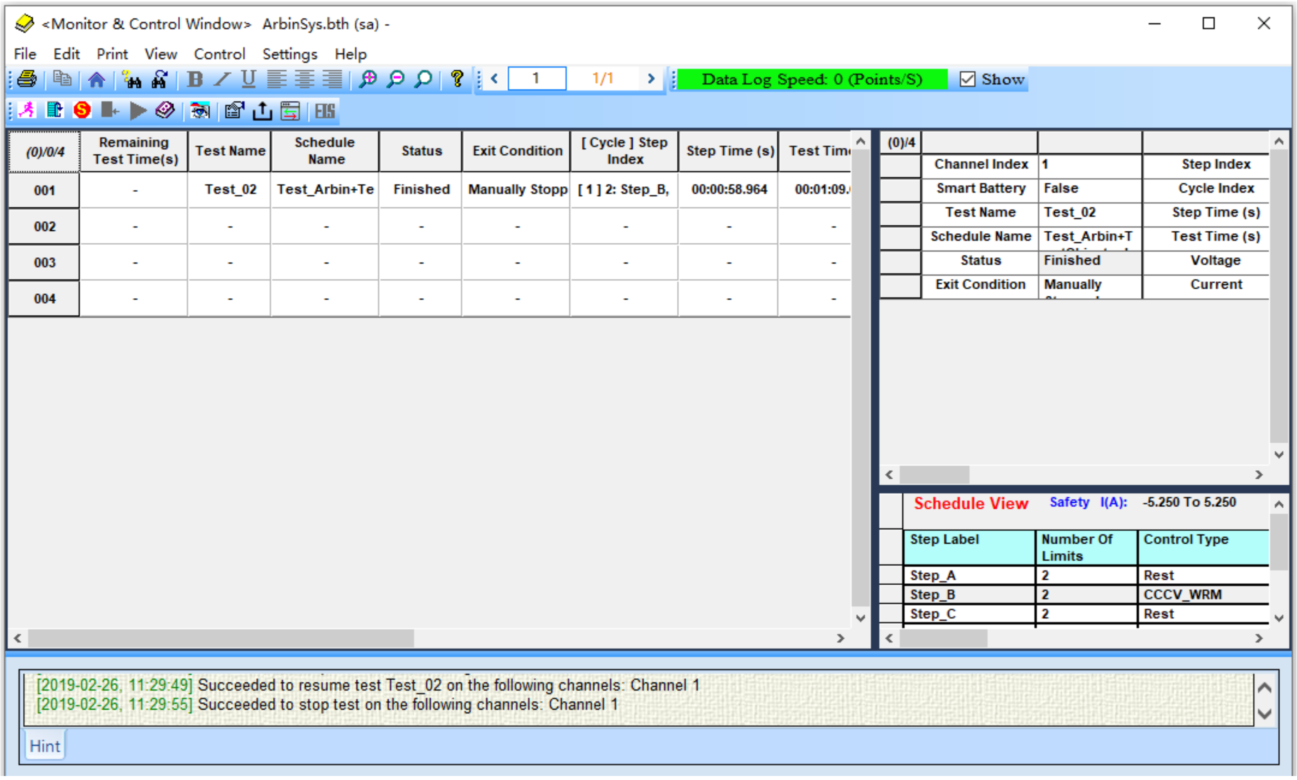


Figure 7-16 **Monitor & Control** Window

Monitor Settings

The monitor window can be customized through the Monitor Settings... dialog. Click Settings-Monitor Settings... to open the **Monitor Settings Property Sheet**.

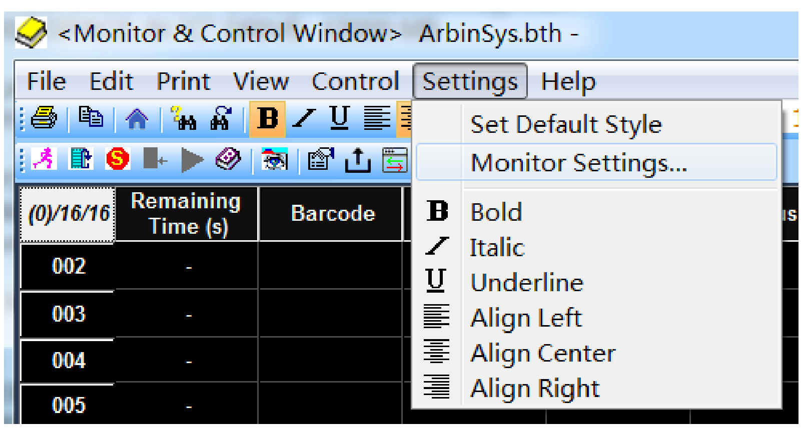


Figure 7-17 **Settings** Sub-Menu

There are three tabs in the **Monitor Setting Property Sheet**, they are General, Detail View and Graph View. The initial page corresponds to the view screen from which page the dialog was invoked, excepting the **Channel View**.

General Settings

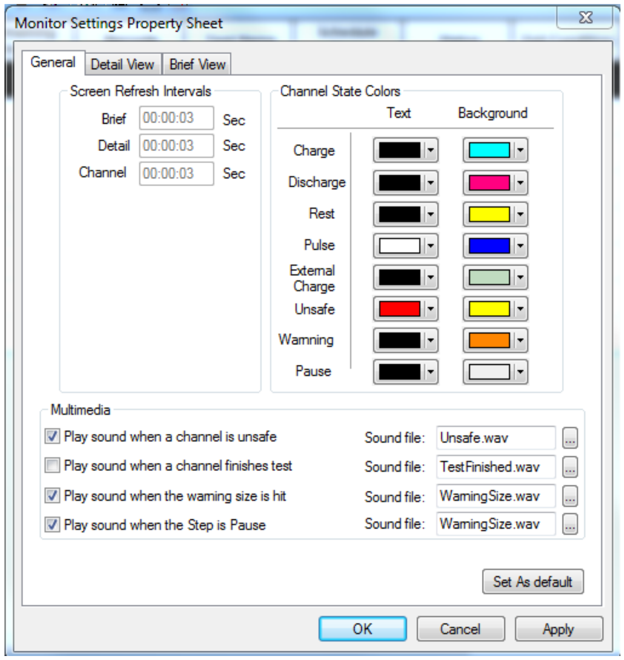


Figure 7-18 General Settings Dialog

Screen Refresh Intervals -- The refresh settings here determine the data refresh rate in each view. The default refresh rate is 3 seconds.

Channel State Colors -- Channel states are indicated visually by various colors. A default color scheme is provided by the system; however, users can specify colors of each state in the General Settings Dialog.

Multimedia – set to play sounds

Detail View Settings

By default, the data grid area color is white. In order to customize the colors, one must un-check Use Default (Windows) Colors before choosing your colors. User can select "Show Iterms" and other three options.

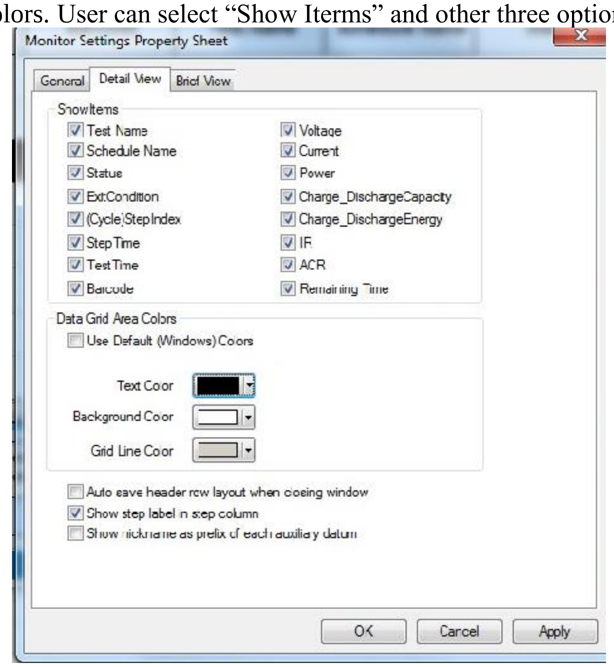


Figure 7-19 Detail View Settings Dialog

Brief View Settings

By default, the brief view only displays current and voltage, for CAN testing, you may choose to display more information in each unit.

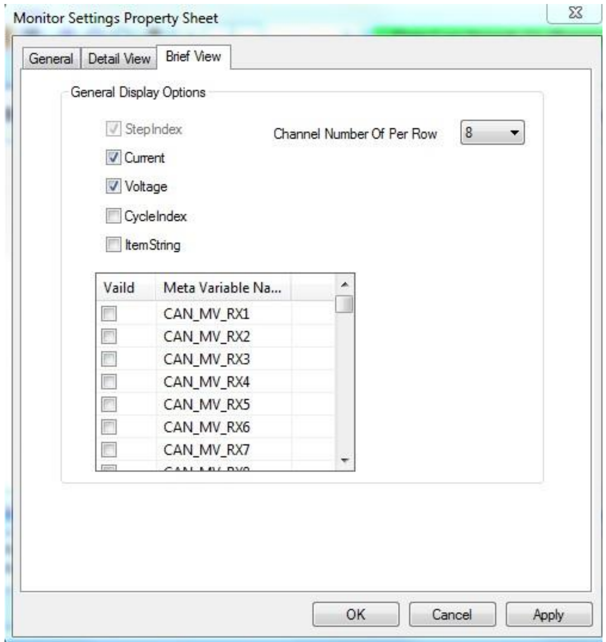


Figure 7-20 Brief View Settings Dialog

Detail View area

Detail view provides the user with detailed information on active test channels. The channel data is updated according to the parameter in the General Settings of the **Monitor Settings Property Sheet**.

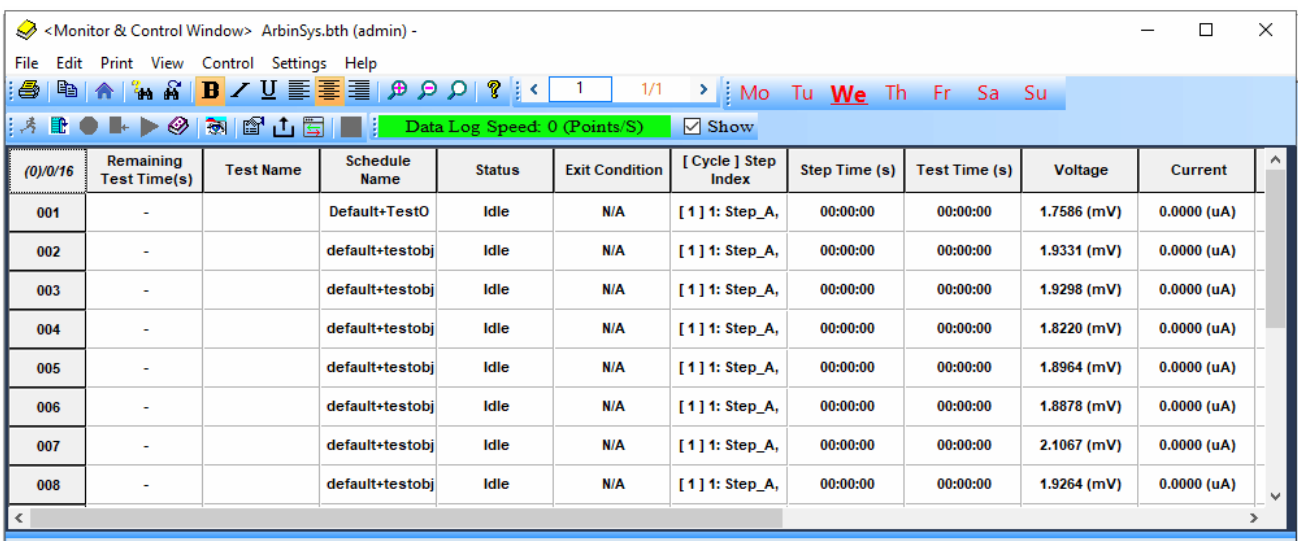


Figure 7-21 Detail View area

Please refere Appendix E "Description of **Detail View** Screen".

Status	Indication
Idle	Channel is not being used.
Rest	The charge/discharge circuits are disconnected from the test sample, but the voltage measurement circuit is still connected.
Charge	Present measured channel current is positive.
Discharge	Present measured channel current is negative.
Pulse	Channel is generating current or voltage pulses
Internal Resistance	Channel is executing internal resistance diagnostic.
Unsafe	Value of any parameters exceeds the safety limit set in schedule **Global** page, or in config file.
External Charge	**MITS Pro** disables the current and voltage control of the main IV channel and records the current that flows through the External Charge adaptor and voltage of object. Main IV channel can disconnect the charger with the test object by the voltage or the step time.
Finished	The test has proceeded to completion and terminated according to scheduled limit conditions.
Transition	The microcontroller has delayed data acquisition while it is processing operations associated with step changes.
Test Setting	**MITS Pro** maintains a waiting condition on a channel while attempting to attain **Test Setting Value**s.
Pause	It may be at ACIM, T-Chamber, or On Duty Time step. The charge/discharge circuits are disconnected from the test sample, but the voltage measurement circuit is still connected, no data log and press continue button test will go to next step.

Table 7-21A about Channel **Status**

Channel View area

The **Channel View** area is used to view the channel data on one page (and smart battery data, CAN data, if available). Channel number can be selected from the **Channel Index** drop-down list. The data fields in the yellow background represent smart battery data (SMBus) as shown in **Figure 7-23**.

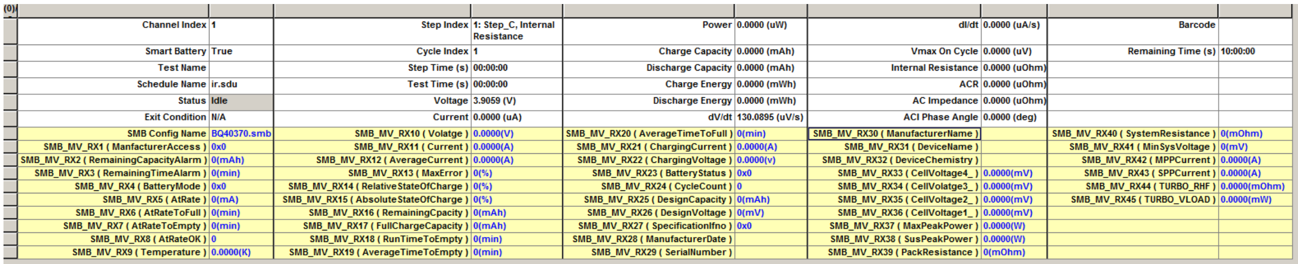


Figure 7-22 **Channel View** Screen with Smart Battery Data

The data fields in the pure green background represent CANBMS data as shown in **Figure 7-24**.

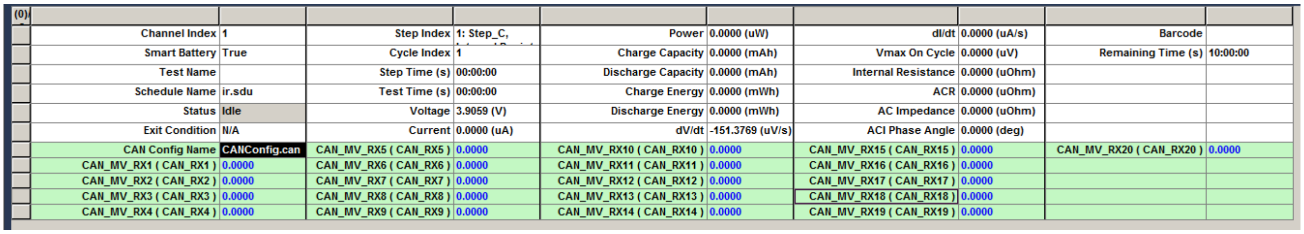


Figure 7-23 **Channel View area** with CAN BMS Data

On the bottom side of the **Channel View** window, a Schedule View of the running step of the testing schedule is dynamically displayed as shown in **Figure 7-24**. In Schedule View, the safety limits information located in the Global page of the schedule file are displayed on the top side of the Schedule View.

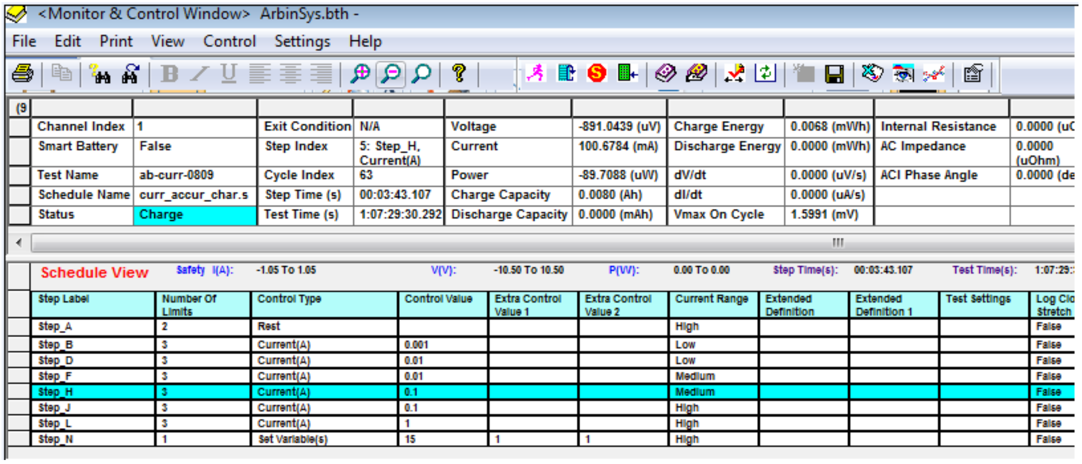


Figure 7-24 Schedule View in **Channel View** Window

7.4 Updating Schedule Online

MITS Pro allows users to make changes to their schedules while tests are running, and the changes will be updated to the current test after saving schedule successfully. But only some contents from the Schedule file Step/Limit pages are supported to update during test. Here are some of the rules for schedule updating online.

- Only single Step or single Limit can be updated at a time.
- Only numeric values can be updated to numeric values. Modification of variables is not allowed.
- Some control types are not allowed to be updated, such as Internal Resistance, Set Variable(s), Pause, External Charge, AC Impedance, (Current/Voltage/Power/Battery) Simulation, Write CAN Messages, (Current/Voltage) Current Pulse, and so on.
- Adding or deleting steps or limits is not allowed.
- It is not allowed to update the control values of auxiliary variables or CAN variables.
- The schedule assigned to different IV running channels, is not allowed to be updated online.

The Contents of Schedule Supported Updating

In the schedule Step/Limit page, customers can be update such as Control Value, Current Range, Goto Step, Limit Value.

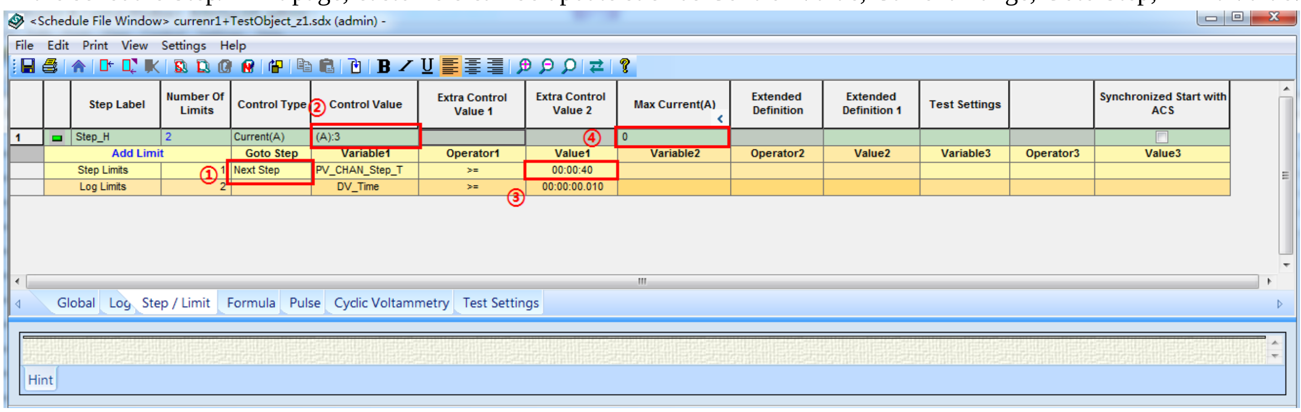


Figure 7-25 Step/Limit Page Updating

1. Users are allowed to modify the jump of **Step Limit** during test.
2. Users are allowed to modify the **Control Value** from numeric value to another numeric value during test.
3. Users are allowed to modify the **Limit Value** from numeric value to another numeric value during test.
4. Users are allowed to modify the **Max Current** during test.

Updating Schedule during Test

In the monitor **Detail View** screen, right click the schedule name, and click Open.

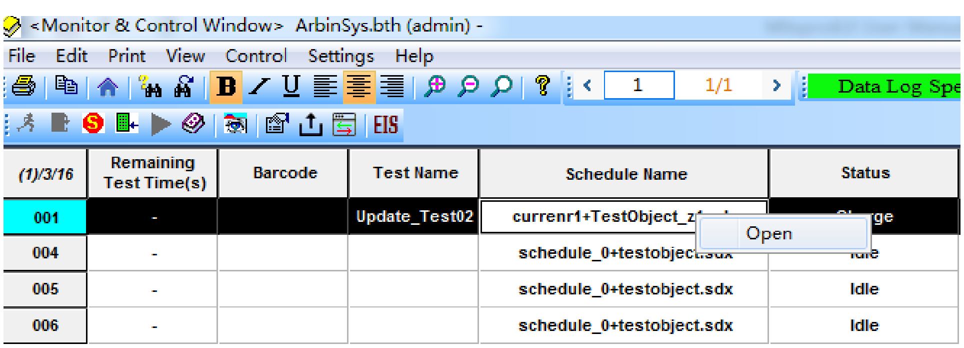


Figure 7-26 Schedule Assignment Menu

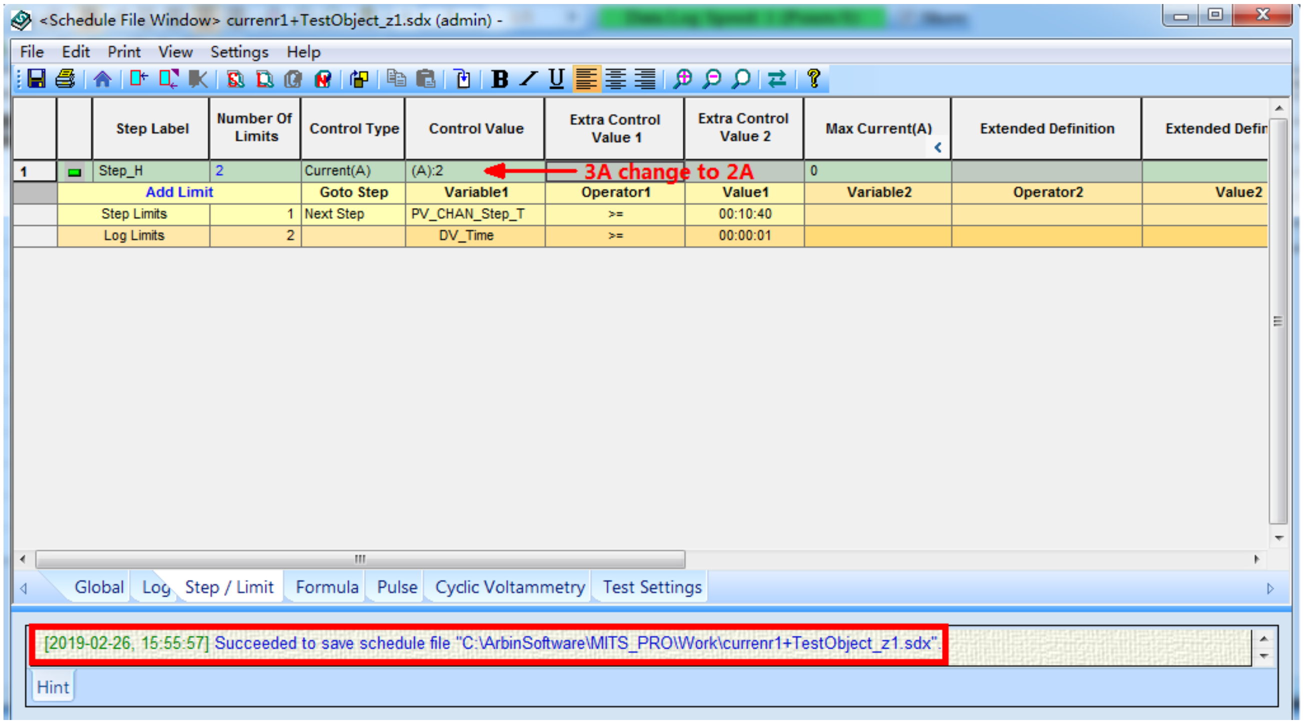


Figure 7-27 Modifying Control Value

Checking the current value in monitor, the value of the current output was successfully updated.

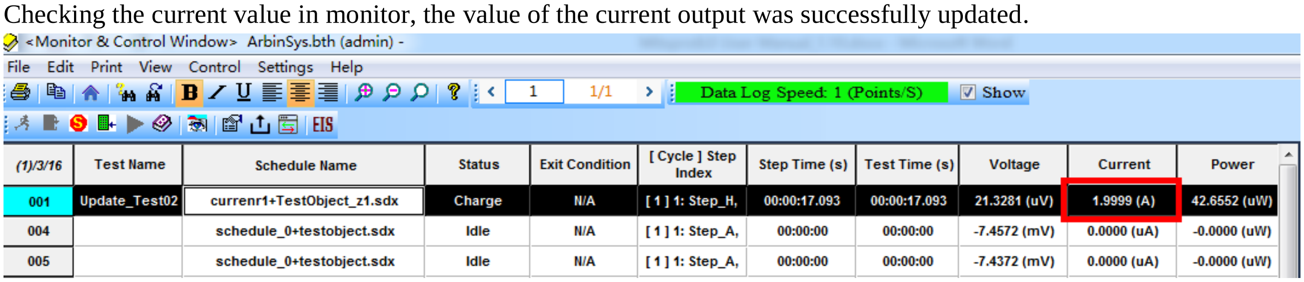


Figure 7-28 Current Output Updated Successfully

If more than one channel is running with the same schedule, updating schedule online will not be allowed and the prompt window will pop up.

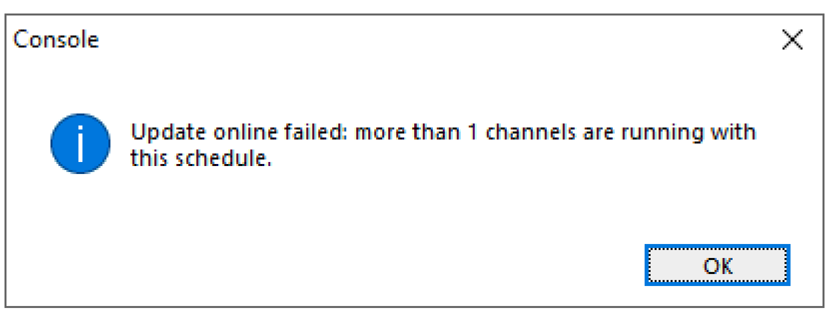


Figure 7-29 Updating Online Failed

Chapter 8 Viewing Results Data

8.1 Exporting Results Data through Data Watcher

Launching Data Watcher from MITS Pro

To open Data Watcher from **MITS Pro8.0** main screen, click **Launch** on the menu bar then select Data Watcher. Alternatively, double-click the Data Watcher icon on the desktop to launch Data Watcher.

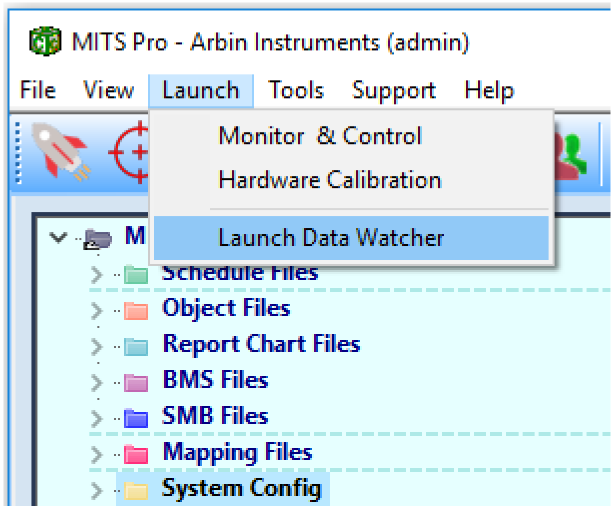


Figure 8-1 Launch Data Watcher on the menu

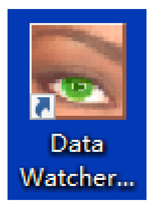


Figure 8-2 Launch Data Watcher Icon

Exporting MITS Pro Test Data to Excel or CSV file using Data Watcher

In **Data Watcher**'s opening screen, click Add Tests button to open the **Tests Info** window, select the tests name that you want to export the data. If several testings used the same test name, please note the channel index and the different testing time to open right data you want. Users can select one test at one time or select multiple tests by pressing <Ctrl> or <Shift>, then click Export Data button to open **Filter** dialog box.

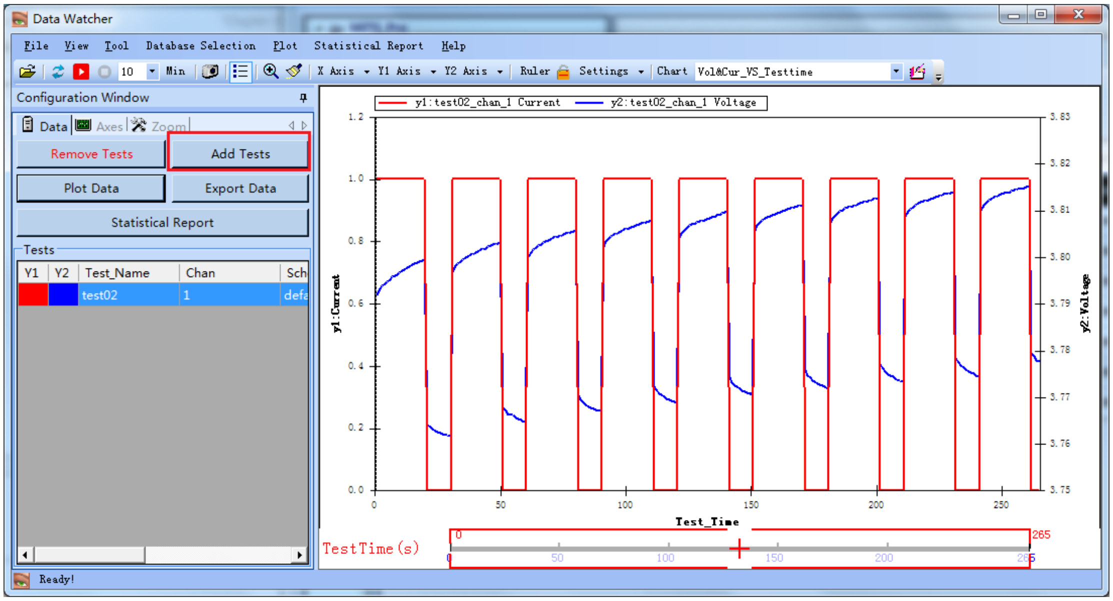


Figure 8-3 Data Watcher

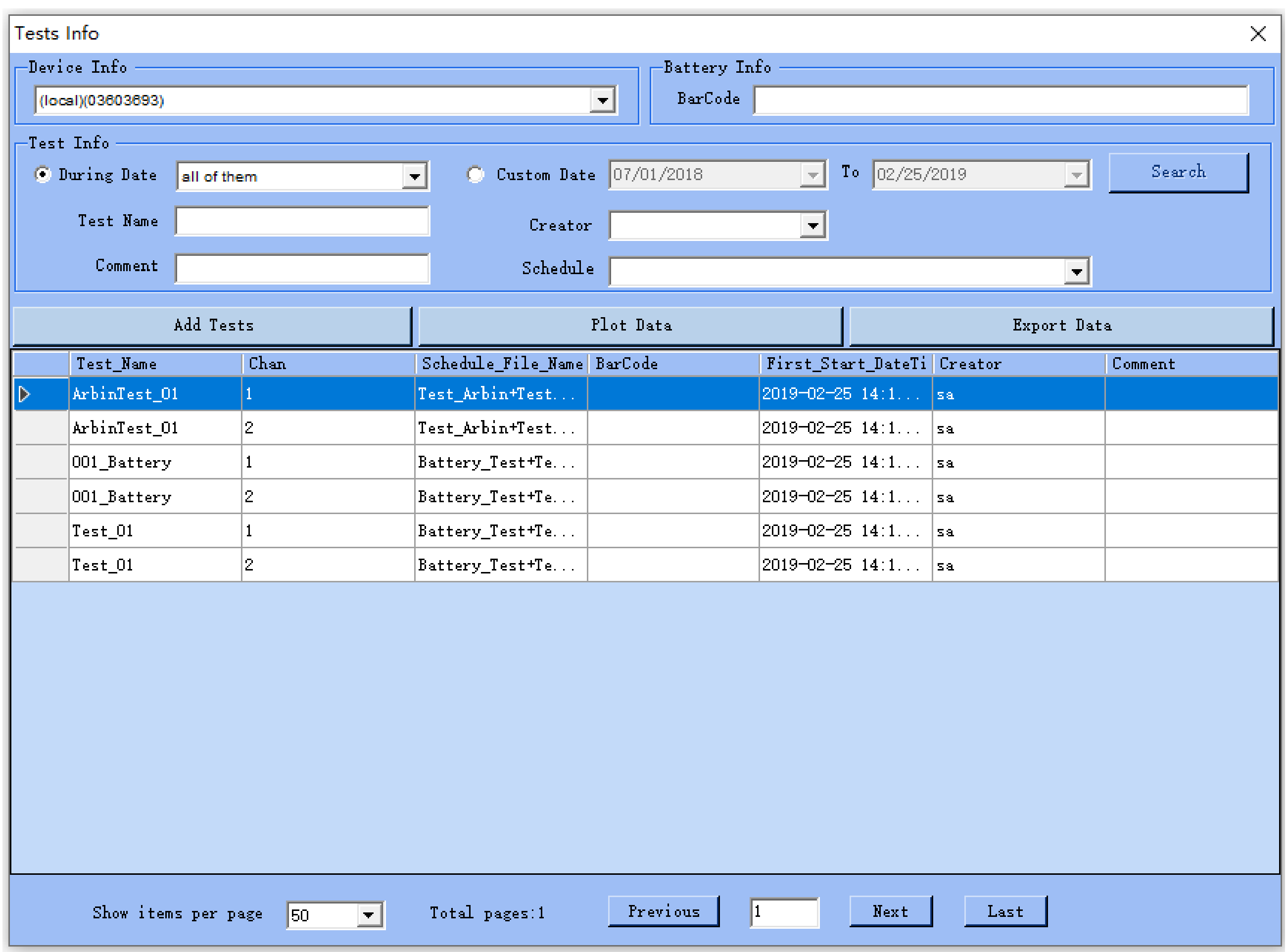


Figure 8-4 Tests Info Window

In the Filter dialog box, users can export the data according to their requirements. Select the data you want, and set the path to save exported data, then click Export to Files button. Data Watcher will estimate the rows of data exported and the time taken, click YES to start exporting data. And the exported data will be saved as an Excel files whose name is a combination of test name and channel index.

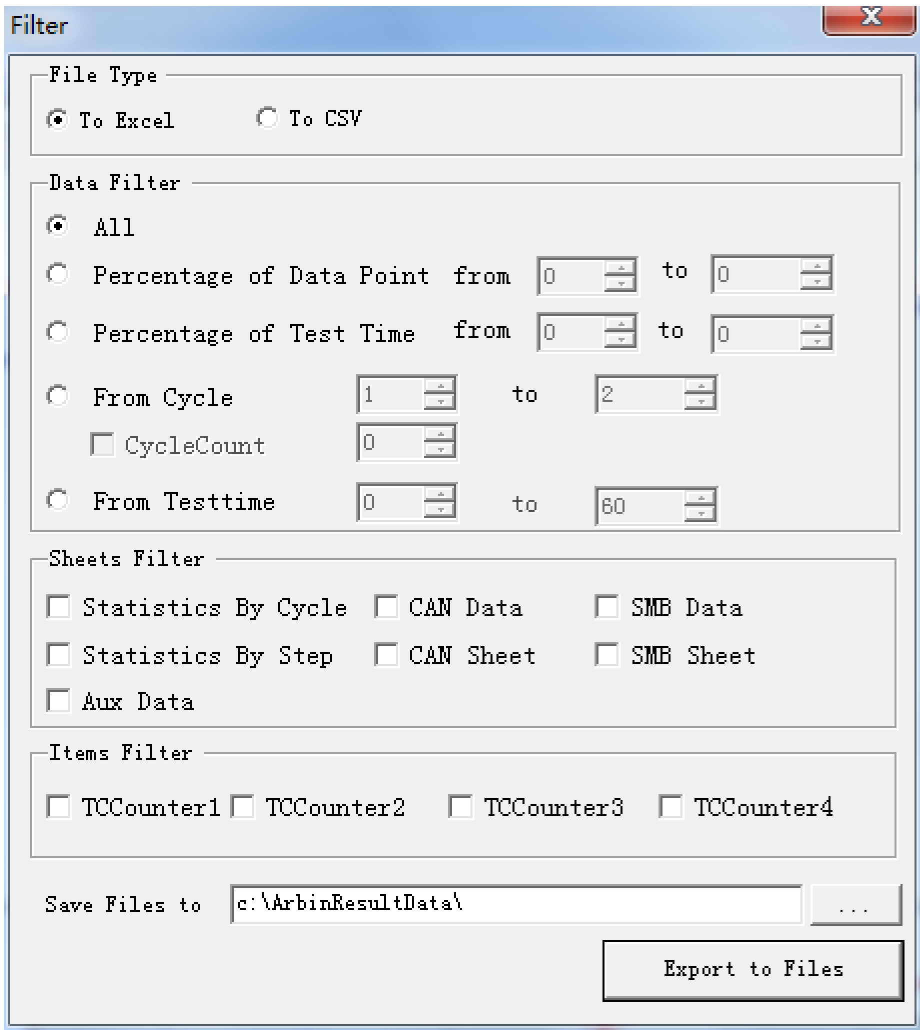


Figure 8-5 Filter Dialog Box

Filters in the **Filter** dialog box:

i. File Type: Check the To Excel button that the data will be denoted by the file extension *.xlsx, Check the To CSV button that the data will be denoted by the file extension *.csv .

ii. To export all the data points within the result file (default), click the All option button.

iii. To export based on a percentage of channel data points, click the second option button. Then enter the desired percentage value in the From and To boxes. (e.g. If the whole results file contains 1000 points and you enter from 5 to 10 in the percent box, then the DataWatcher will import points 50th to 100th.)

iv. To export based on a percentage of test time, click the third option button. Then enter the desired percentage value in the From and To boxes. (e.g. If the whole results file contains 1000 seconds test time and you enter from 5 to 10 in the percent box, then the DataWatcher will import the points whose test time are between 50 seconds and 100 seconds.)

v. To export data from a selected number of contiguous cycles, click the fourth option button. Enter the beginning cycle and ending cycle numbers in the From Cycle and To boxes. If Cycle count is checked and is set to a non-zero value, for example 10, then the exported data will be saved in a series of separate files in sets of 10 cycles.

vi. To export data from a test time to another test time, click the fifth option button. Enter the selected beginning test time and ending test time in the From Testtime and To boxes.

vii. Determine the types of data exported by selecting the appropriate Sheets Filter, such as Aux Data, CAN Data, CAN Sheet, SMB Data, SMB Sheet, Statistics by Cycle and Statistics by Step. If nothing is selected, only the default normal data (current, voltage, capacity, energy, internal resistant, and so on) will be exported.

viii. Determine the data imported by selecting the appropriate Item Filter, such as TCCounter1, TCCounter2, TCCounter3, TCCounter4.

ix. Save Files to: The target path to save the data file.

A window will pop up after successfully exporting. Users can open the selected workbook of excel to check the data or go to the folder where the data has been saved.

The Excel data

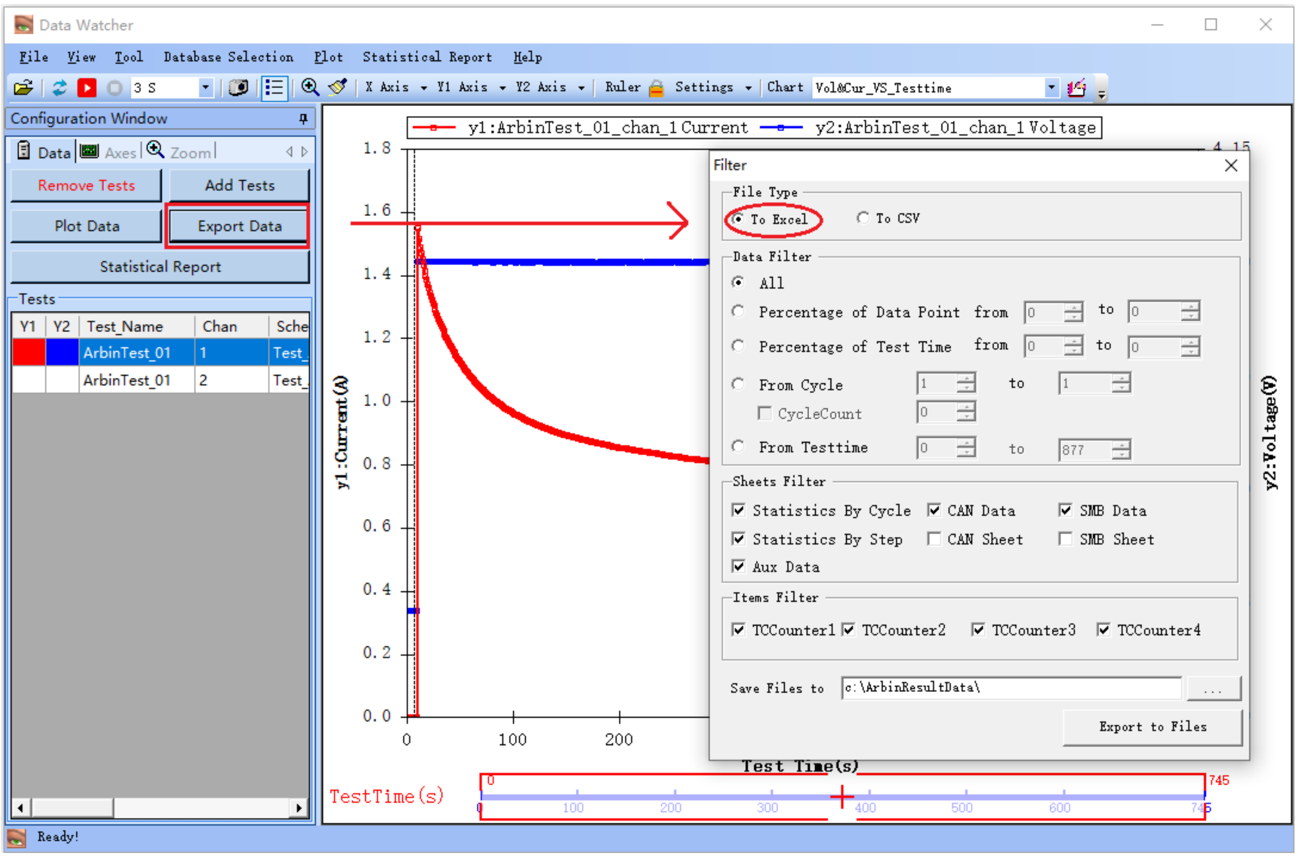


Figure 8-6 Check the To Excel

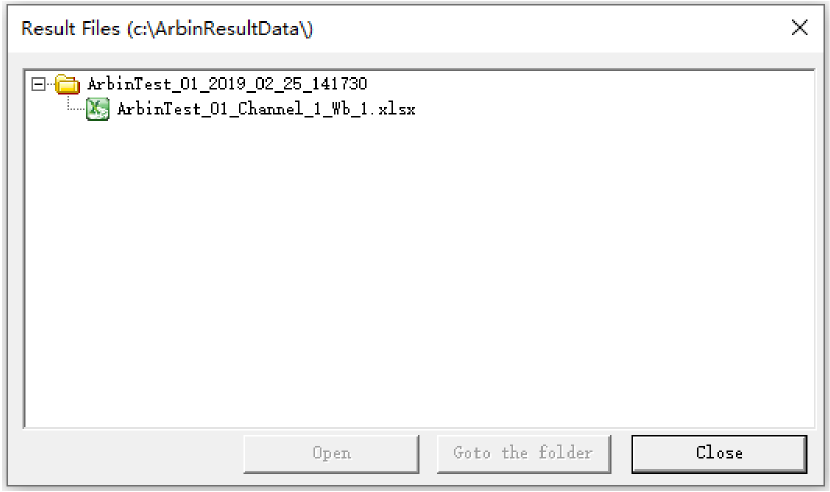


Figure 8-7 The result file of excel

Data_Point	Date_Time	Test_Time(s)	Step_Time(s)	Cycle_Index	Step_Index	TC_Counter1	TC_Counter2	TC_Counter3	TC_Counter4	Current(A)	Voltage(V)	Power(W)
1	02/25/2019 14:14:49.612	1.000	1.000	1	1	0	0	0	0	0	3.946892	0
2	02/25/2019 14:14:50.612	2.000	2.000	1	1	0	0	0	0	0	3.946862	0
3	02/25/2019 14:14:51.612	3.000	3.000	1	1	0	0	0	0	0	3.946872	0
4	02/25/2019 14:14:52.612	4.000	4.000	1	1	0	0	0	0	0	3.946872	0
5	02/25/2019 14:14:53.612	5.000	5.000	1	1	0	0	0	0	0	3.94679	0
6	02/25/2019 14:14:54.612	6.000	6.000	1	1	0	0	0	0	0	3.946821	0
7	02/25/2019 14:14:55.612	7.000	7.000	1	1	0	0	0	0	0	3.94675	0
8	02/25/2019 14:14:56.612	8.000	8.000	1	1	0	0	0	0	0	3.946689	0
9	02/25/2019 14:14:57.612	9.000	9.000	1	1	0	0	0	0	0	3.946668	0
10	02/25/2019 14:14:58.612	10.000	10.000	1	1	0	0	0	0	0	3.946607	0
11	02/25/2019 14:14:58.613	10.001	10.001	1	1	0	0	0	0	0	3.946607	0
12	02/25/2019 14:14:59.667	11.055	1.000	1	2	0	0	0	0	1.548131	4.100264	6.347746
13	02/25/2019 14:15:00.667	12.055	2.000	1	2	0	0	0	0	1.513693	4.100213	6.206464
14	02/25/2019 14:15:01.667	13.056	3.001	1	2	0	0	0	0	1.488632	4.100243	6.103753
15	02/25/2019 14:15:02.667	14.055	4.000	1	2	0	0	0	0	1.467404	4.100203	6.016654
16	02/25/2019 14:15:03.667	15.055	5.000	1	2	0	0	0	0	1.447992	4.100152	5.936987
17	02/25/2019 14:15:04.667	16.055	6.000	1	2	0	0	0	0	1.430377	4.100253	5.864908
18	02/25/2019 14:15:05.667	17.056	7.001	1	2	0	0	0	0	1.413808	4.100223	5.796928
19	02/25/2019 14:15:06.667	18.055	8.000	1	2	0	0	0	0	1.398352	4.100132	5.733428
20	02/25/2019 14:15:07.667	19.055	9.000	1	2	0	0	0	0	1.384373	4.100253	5.67628
21	02/25/2019 14:15:08.667	20.055	10.000	1	2	0	0	0	0	1.370049	4.100253	5.617548
22	02/25/2019 14:15:09.667	21.055	11.000	1	2	0	0	0	0	1.357293	4.100101	5.565038
23	02/25/2019 14:15:10.667	22.056	12.001	1	2	0	0	0	0	1.34529	4.100243	5.516016
24	02/25/2019 14:15:11.667	23.055	13.000	1	2	0	0	0	0	1.333215	4.100203	5.466452
25	02/25/2019 14:15:12.667	24.056	14.001	1	2	0	0	0	0	1.322204	4.100182	5.421277
26	02/25/2019 14:15:13.667	25.055	15.000	1	2	0	0	0	0	1.311063	4.100193	5.375611
27	02/25/2019 14:15:14.667	26.055	16.001	1	2	0	0	0	0	1.300313	4.100162	5.331494
28	02/25/2019 14:15:15.667	27.055	17.000	1	2	0	0	0	0	1.290254	4.100101	5.290172
29	02/25/2019 14:15:16.667	28.055	18.000	1	2	0	0	0	0	1.280824	4.100172	5.251599
30	02/25/2019 14:15:17.667	29.055	19.000	1	2	0	0	0	0	1.271275	4.100152	5.212421

Figure 8-8 The result data

The CSV data

There is one important advantage for exporting the data in csv file. It will take less time to export the million data. If the computer has the good performance in hardware, it can export 60000 to 100000 data per second. But if you want to export the data in excel, it will be about 10000 data per second. What's more, the csv data can be viewed in Excel.

In the Filter Window, check the To CSV button, then click the Export to Files button, it will pop up Result Files Window. In this dialog, choose the file that you want to open. These csv data files are saved in the path ArbinResultDataCSV File Folder as default.

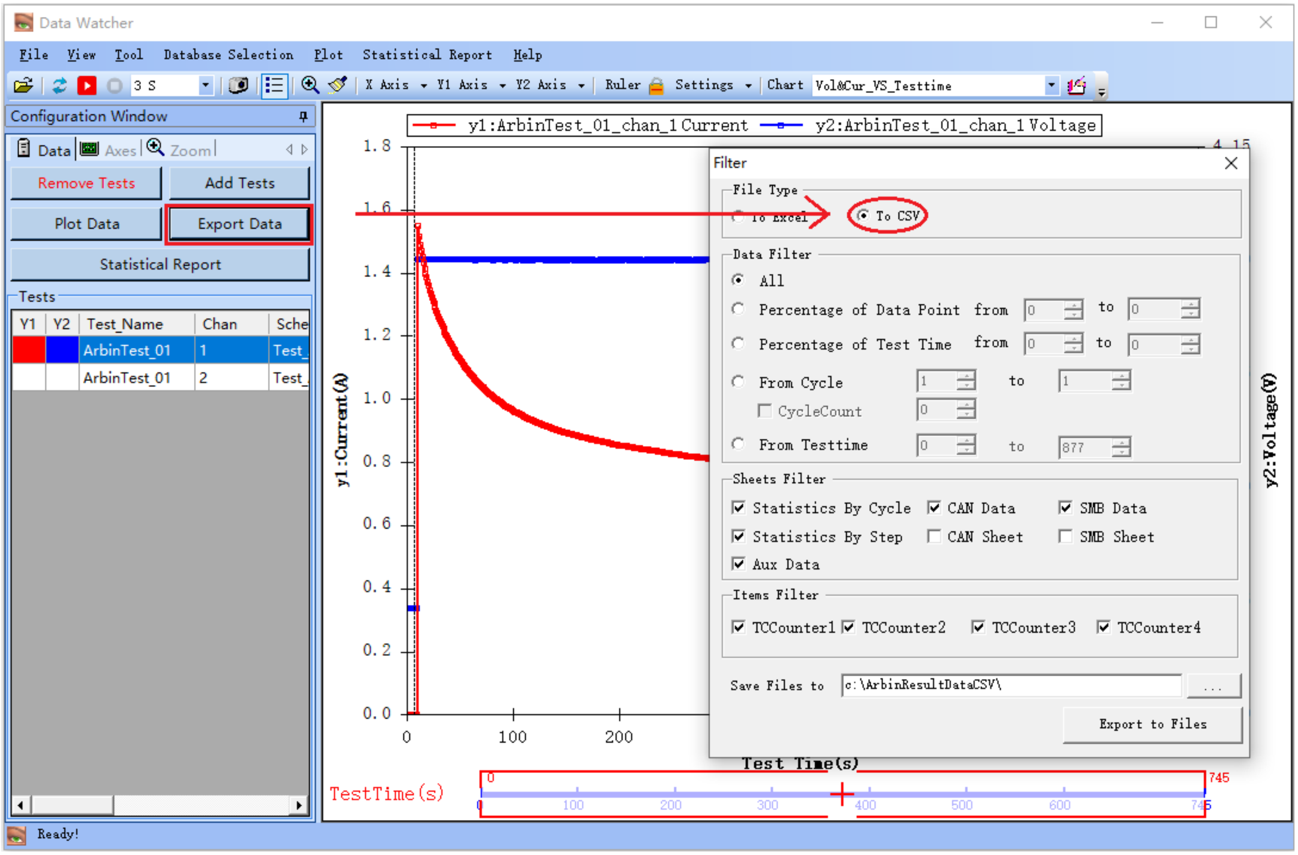


Figure 8-9 Check the To CSV

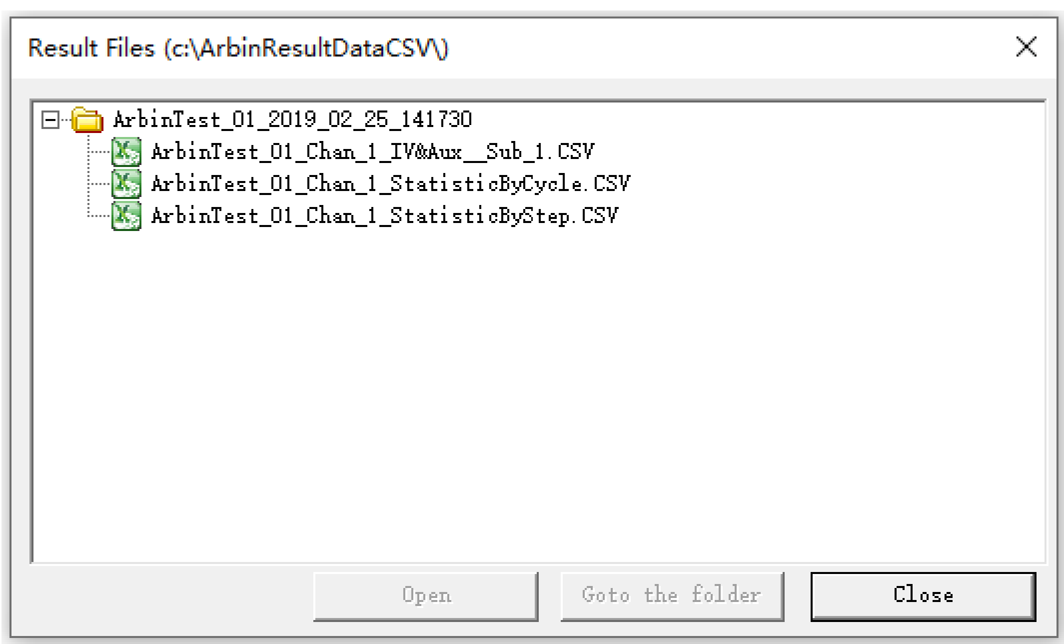


Figure 8-10 The result file of csv

Data_Poir	Date_Time	Test_Time	Step_Time	Cycle_Inc	Step_Inde	TC_Counte	TC_Counte	TC_Counte	TC_Counte	Current(A	Voltage(V	Power(W)	Charge_Ca	Discharge	Charge_Er	Discharge	dV/dt(V/s	dV/dQ(V/A	dQ/dV(Ah/	Internal_Resistance(Ohm)
1	14:49.6	1	1	1	1	0	0	0	0	0	3.94689	0	0	0	0	0	0	0	0	
2	14:50.6	2	2	1	1	0	0	0	0	0	3.94686	0	0	0	0	0	0	0	0	
3	14:51.6	3	3	1	1	0	0	0	0	0	3.94687	0	0	0	0	0	0	0	0	
4	14:52.6	4	4	1	1	0	0	0	0	0	3.94687	0	0	0	0	0	0	0	0	
5	14:53.6	5	5	1	1	0	0	0	0	0	3.94679	0	0	0	0	0	0	0	0	
6	14:54.6	6	6	1	1	0	0	0	0	0	3.94682	0	0	0	0	0	0	0	0	
7	14:55.6	7	7	1	1	0	0	0	0	0	3.94675	0	0	0	0	0	0	0	0	
8	14:56.6	8	8	1	1	0	0	0	0	0	3.94669	0	0	0	0	0	0	0	0	
9	14:57.6	9	9	1	1	0	0	0	0	0	3.94667	0	0	0	0	0	0	0	0	
10	14:58.6	10	10	1	1	0	0	0	0	0	3.94661	0	0	0	0	0	0	0	0	
11	14:58.6	10.001	10.001	1	1	0	0	0	0	0	3.94661	0	0	0	0	0	0	0	0	
12	14:59.7	11.055	1	1	2	0	0	0	0	1.54813	4.10026	6.34775	0.00042	0	0.00172	0	0	0	0	
13	15:00.7	12.055	2	1	2	0	0	0	0	1.51369	4.10021	6.20646	0.00084	0	0.00345	0	0	0	0	
14	15:01.7	13.056	3.001	1	2	0	0	0	0	1.48863	4.10024	6.10375	0.00126	0	0.00516	0	0	0	0	
15	15:02.7	14.055	4	1	2	0	0	0	0	1.4674	4.1002	6.01665	0.00167	0	0.00684	0	0	0	0	
16	15:03.7	15.055	5	1	2	0	0	0	0	1.44799	4.10015	5.93699	0.00207	0	0.0085	0	0	0	0	
17	15:04.7	16.055	6	1	2	0	0	0	0	1.43038	4.10025	5.86491	0.00247	0	0.01013	0	0	0	0	
18	15:05.7	17.056	7.001	1	2	0	0	0	0	1.41381	4.10022	5.79693	0.00287	0	0.01175	0	0	0	0	
19	15:06.7	18.055	8	1	2	0	0	0	0	1.39835	4.10013	5.73343	0.00326	0	0.01335	0	0	0	0	
20	15:07.7	19.055	9	1	2	0	0	0	0	1.38437	4.10025	5.67628	0.00364	0	0.01493	0	0	0	0	
21	15:08.7	20.055	10	1	2	0	0	0	0	1.37005	4.10025	5.61755	0.00402	0	0.0165	0	0	0	0	
22	15:09.7	21.055	11	1	2	0	0	0	0	1.35729	4.1001	5.56504	0.0044	0	0.01805	0	0	0	0	
23	15:10.7	22.056	12.001	1	2	0	0	0	0	1.34529	4.10024	5.51602	0.00478	0	0.01959	0	0	0	0	
24	15:11.7	23.055	13	1	2	0	0	0	0	1.33322	4.1002	5.46645	0.00515	0	0.02111	0	0	0	0	
25	15:12.7	24.056	14.001	1	2	0	0	0	0	1.3222	4.10018	5.42128	0.00552	0	0.02262	0	0	0	0	
26	15:13.7	25.055	15	1	2	0	0	0	0	1.31106	4.10019	5.37561	0.00588	0	0.02412	0	0	0	0	
27	15:14.7	26.055	16.001	1	2	0	0	0	0	1.30031	4.10016	5.33149	0.00625	0	0.02561	0	0	0	0	
28	15:15.7	27.055	17	1	2	0	0	0	0	1.29025	4.1001	5.29017	0.0066	0	0.02708	0	0	0	0	
29	15:16.7	28.055	18	1	2	0	0	0	0	1.28082	4.10017	5.2516	0.00696	0	0.02854	0	0	0	0	
30	15:17.7	29.055	19	1	2	0	0	0	0	1.27128	4.10015	5.21242	0.00732	0	0.02999	0	0	0	0	

Figure 8-11 The result data

Searching the Test Name

Users can search for the information we need according to the **Barcode**, the **Test Name**, the **Creator**, the **Comment** and the **Schedule**, and show some of the testings information for a period of time.

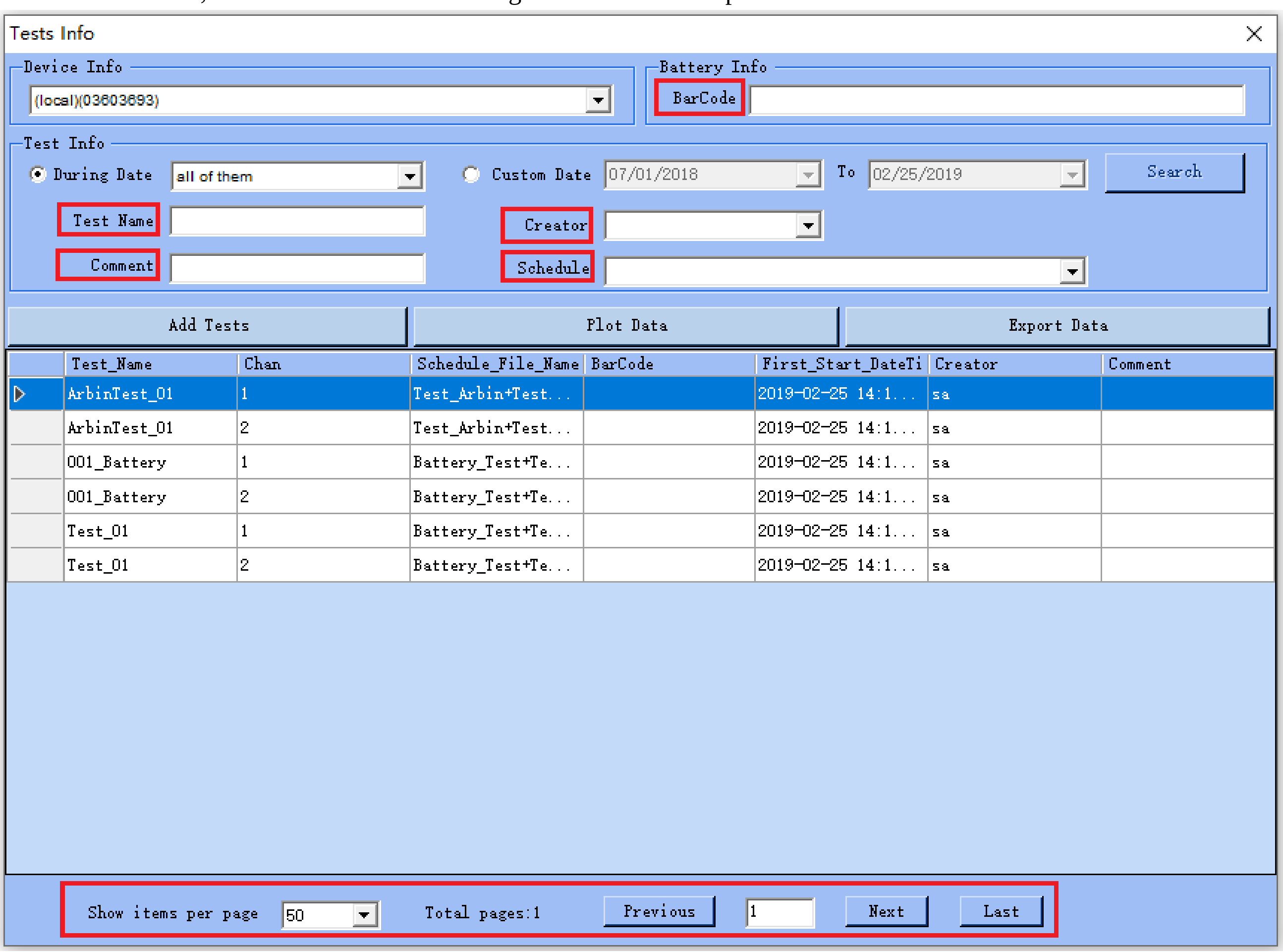


Figure 8-12 Conditions of the search

Viewing Statistical Report

The statistical data is the last data point of each cycle or step. The **Statistical Report** is convenient for users viewing the statistical data. In Data Watcher's opening screen, click Statistical Report button or click Statistical Report on the menu bar. Select Statistical Report to open the Statistic Report window.

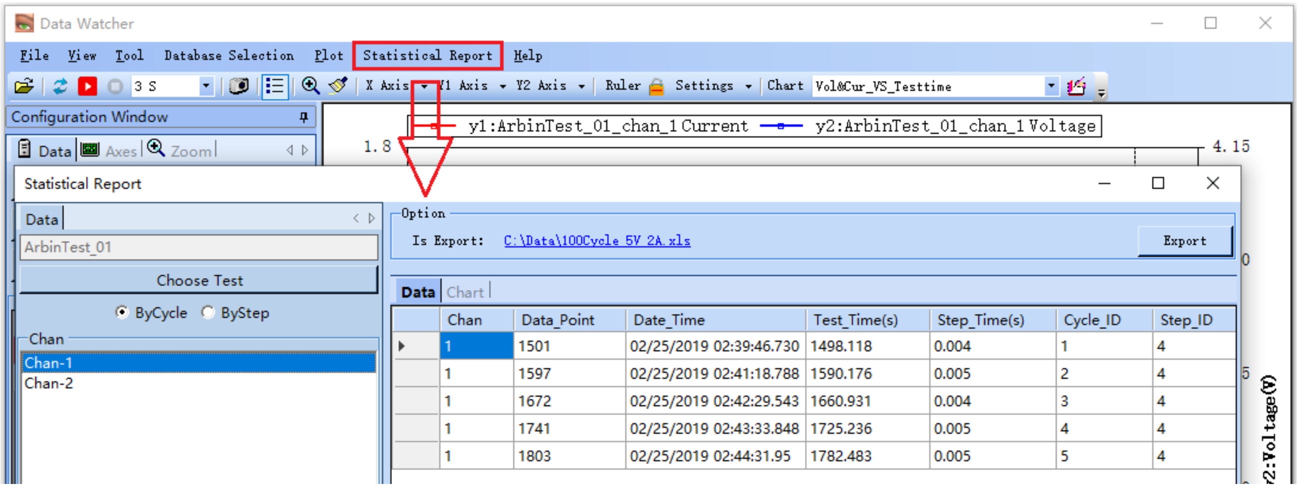


Figure 8-13 Opening **Statistic Report Window**

Click the option button **ByCycle** or **ByStep** to decide what kind of statistic data to show in the window. Then click **Choose Tests** button to open the **Tests Info** window, select the tests name for the desired data you want the statistical report on and double-click on it.

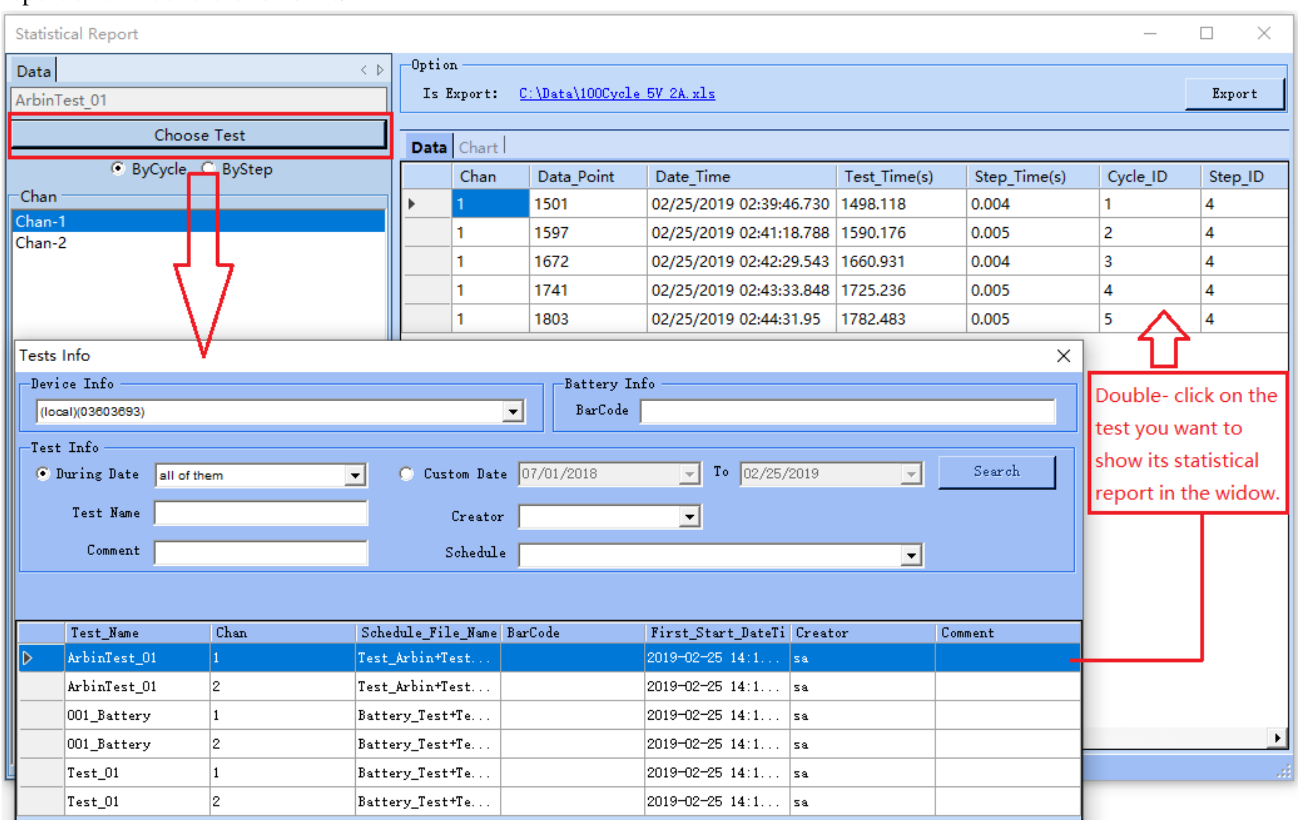


Figure 8-14 Choose Test in Test Info

Users can switch to the **Chart** page in the Test Info widow for viewing statistical data chart.

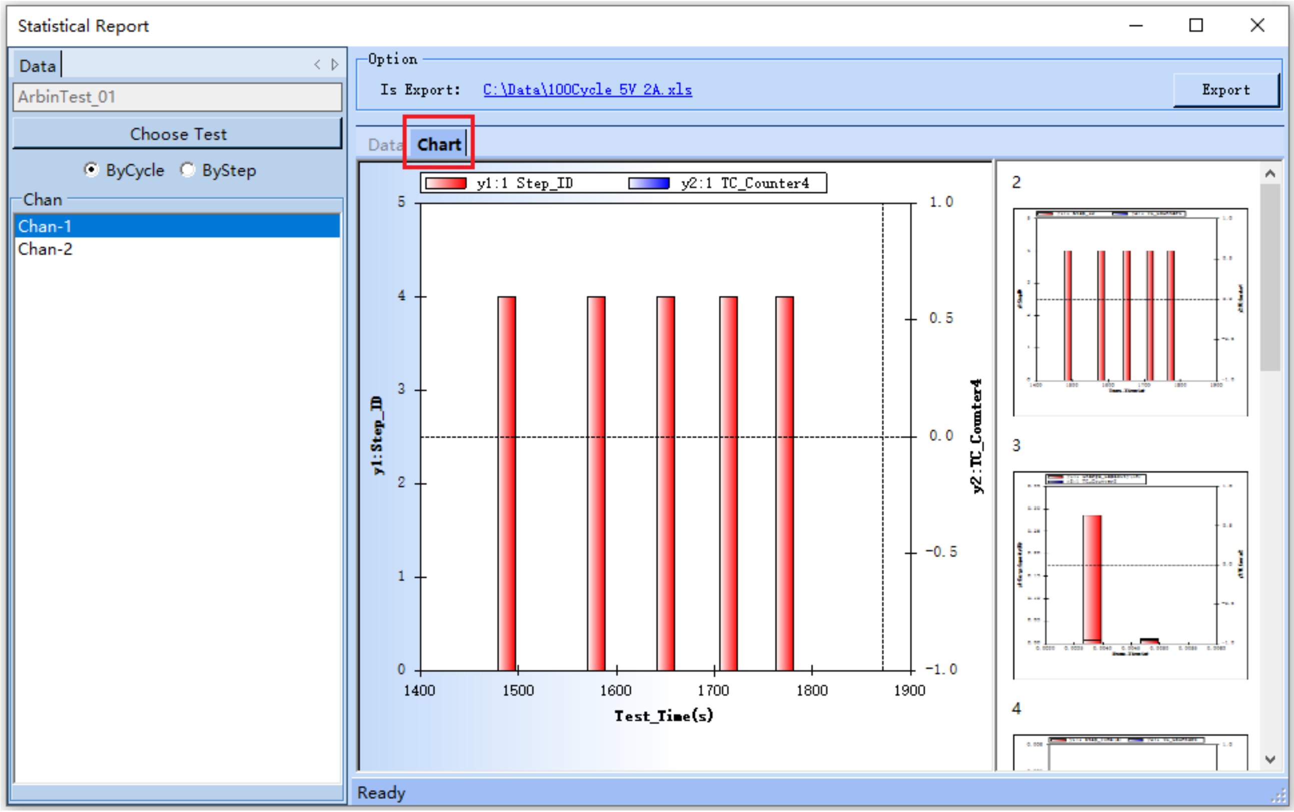


Figure 8-15 View statistical chart in Test Info

Users can also export the statistic report and picture to an Excel file and the chart by clicking the **Export** button. Otherwise, click the **"+"** to open the statistical report option window. Users can add Statistical Report Charts made up of different axes. Further, users can create the Statistical Report Chart in the MITS Pro8.0 Console Window.

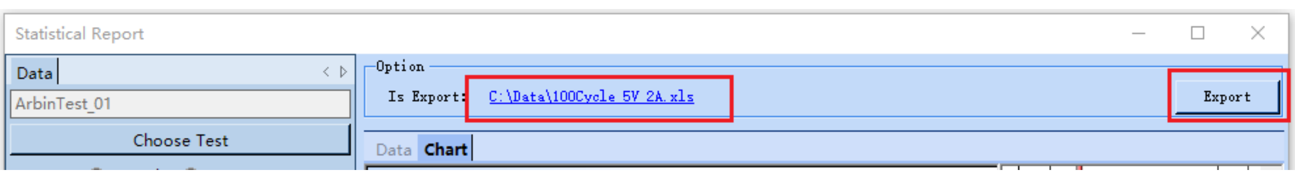


Figure 8-16 Export the statistic report data and picture.

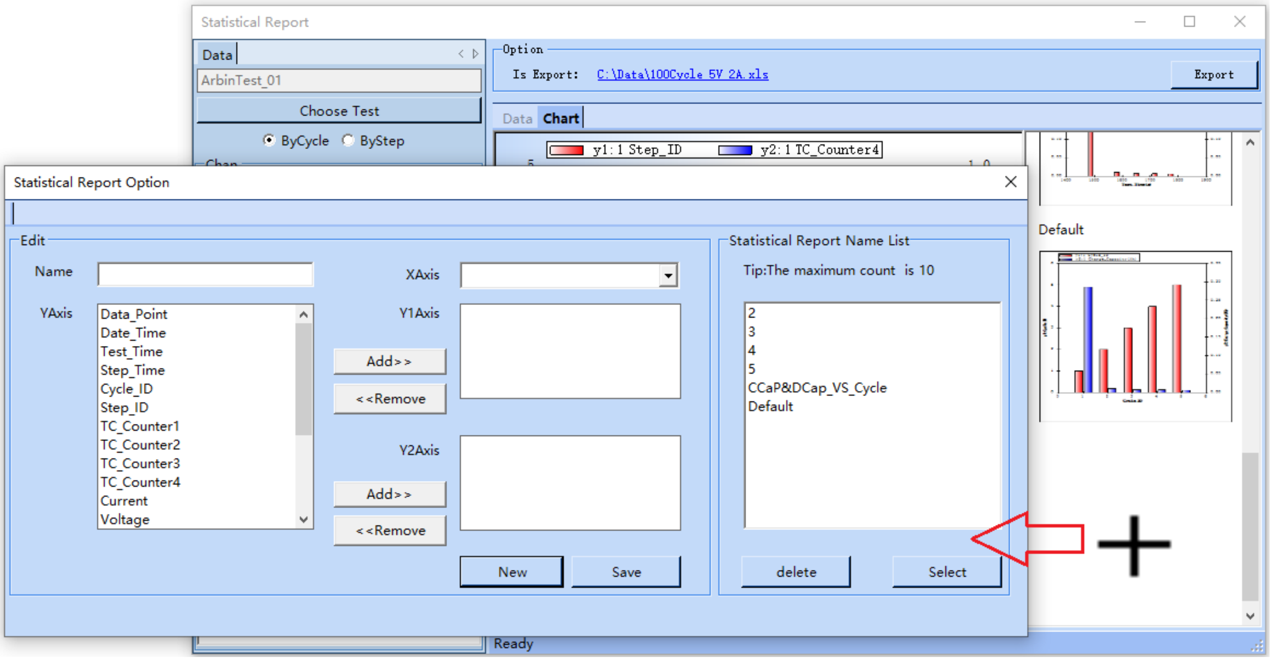


Figure 8-17 Add statistical report chart in Test Info

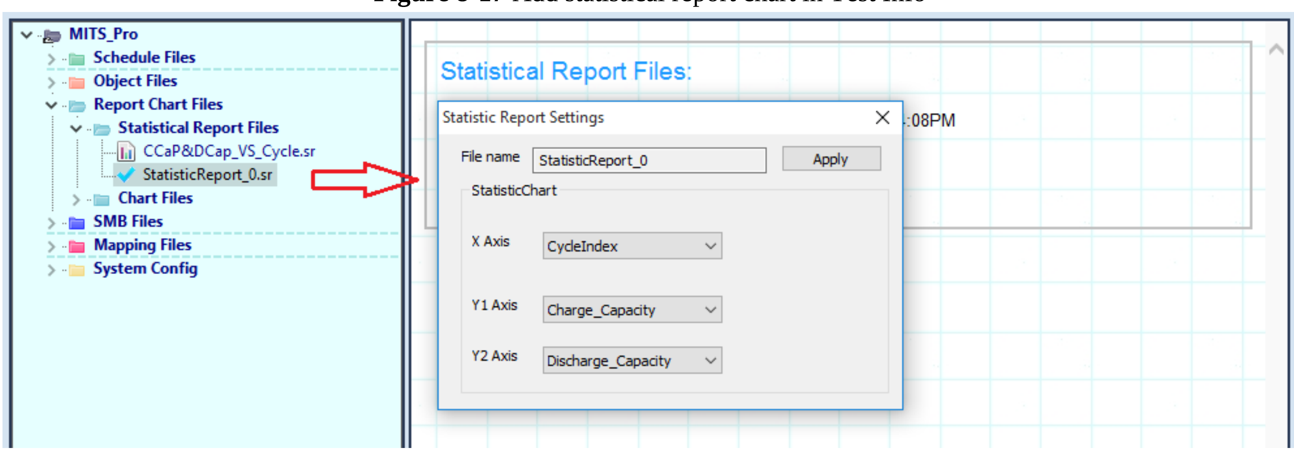


Figure 8-18 Create the Statistical report chart in MITS Pro8.0

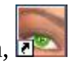
Naming rule:

For the test named 002 in channel 3, the Excel Workbook name is "002_Channel_3_Wb_1" in Default.xls file. For the test named 002 statistic data, the Excel Workbook name is “002-StatisticData” in Default.xls file.

8.2 Viewing Results Data through Data Watcher

Data Watcher functions as an additional monitoring tool. Test data could be previewed through Data Watcher. It is convenient for users to monitor a running testing. And meanwhile, it will take much less computer resources, CPU and Memory, and reduce interference on data acquisition.

Launch Data Watcher

During a running testing, or after the testing is completed, either click on icon,  **Data Watcher**, on the desktop or Data Watcher icon in the toolbar of Monitor & Control window as shown in **Figure 8-19** to open **Data Watcher** window.

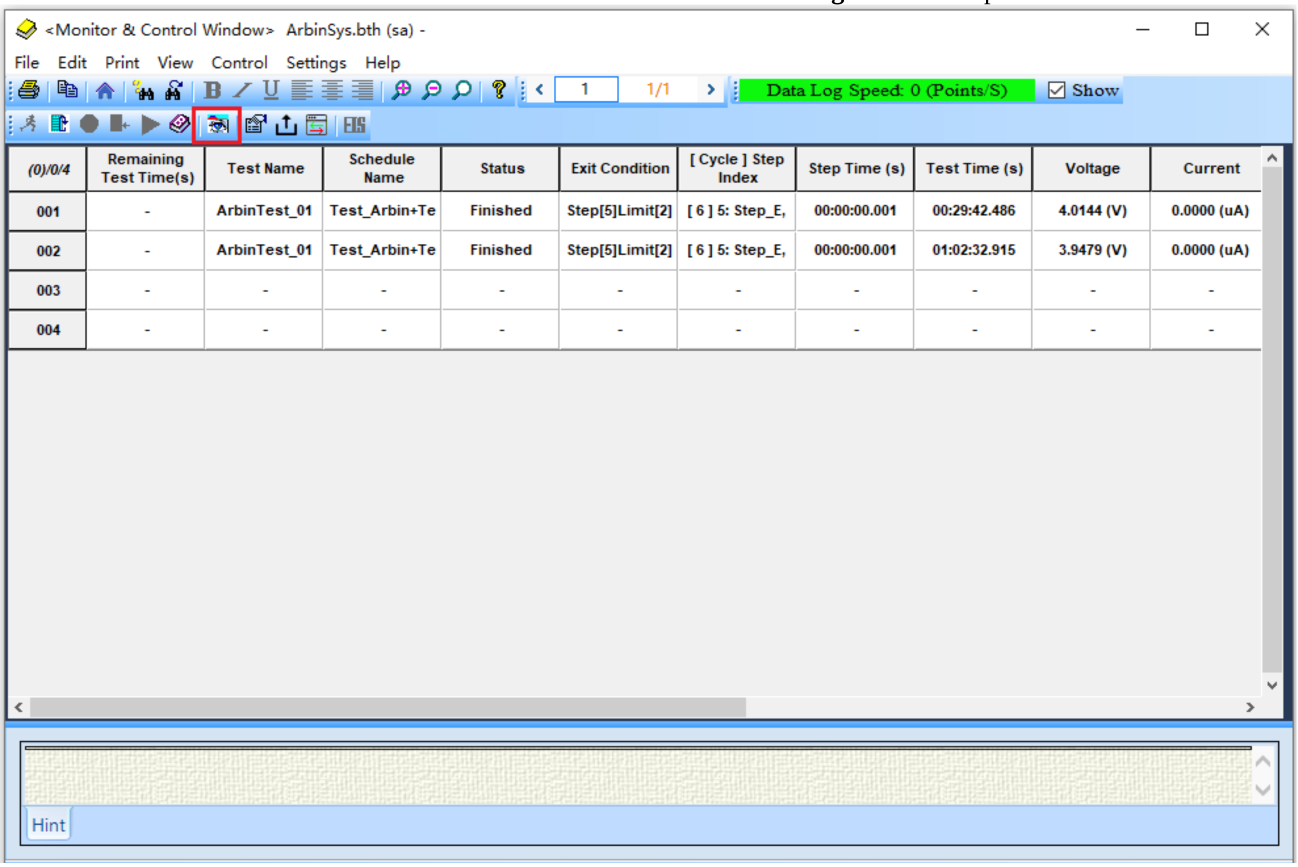


Figure 8-19 Data Watcher icon in the Tool Bar of Monitor & Control Window

Import Data

The result data files can be imported automatically by highlighting one or several channels and clicking Data Watcher icon in the toolbar of Monitor & Control Window. This feature provides a real time view of the testing result file.

For example, start running schedule ec.sdx and pro8.sdx, give a test name of "test_0911" and "example". Highlight channel 1 and channel 2, then click Data Watcher icon in the toolbar of the Monitor & Control window. The data for "test_0911" and "example" is loaded and plotted automatically.

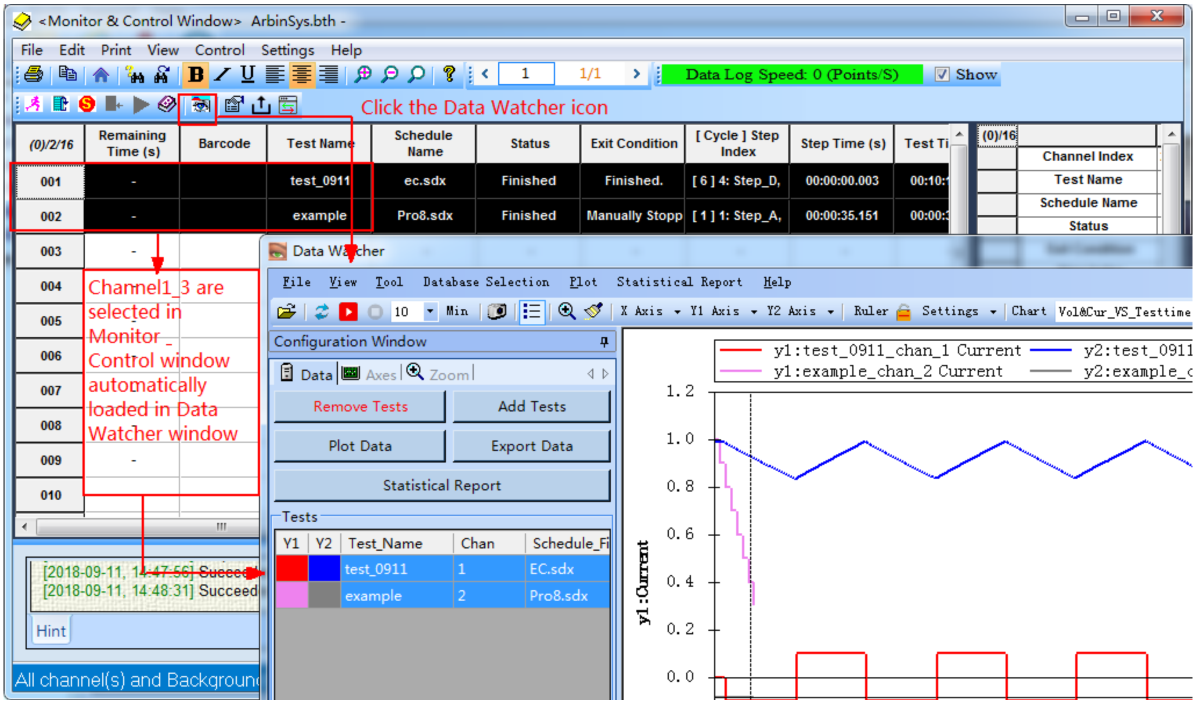


Figure 8-20 Automatically Import the Result Data File

In addition, users prefer to view a chart containing multiple tests, select multiple tests by pressing <Ctrl> or <Shift>, then click the Plot Data button.

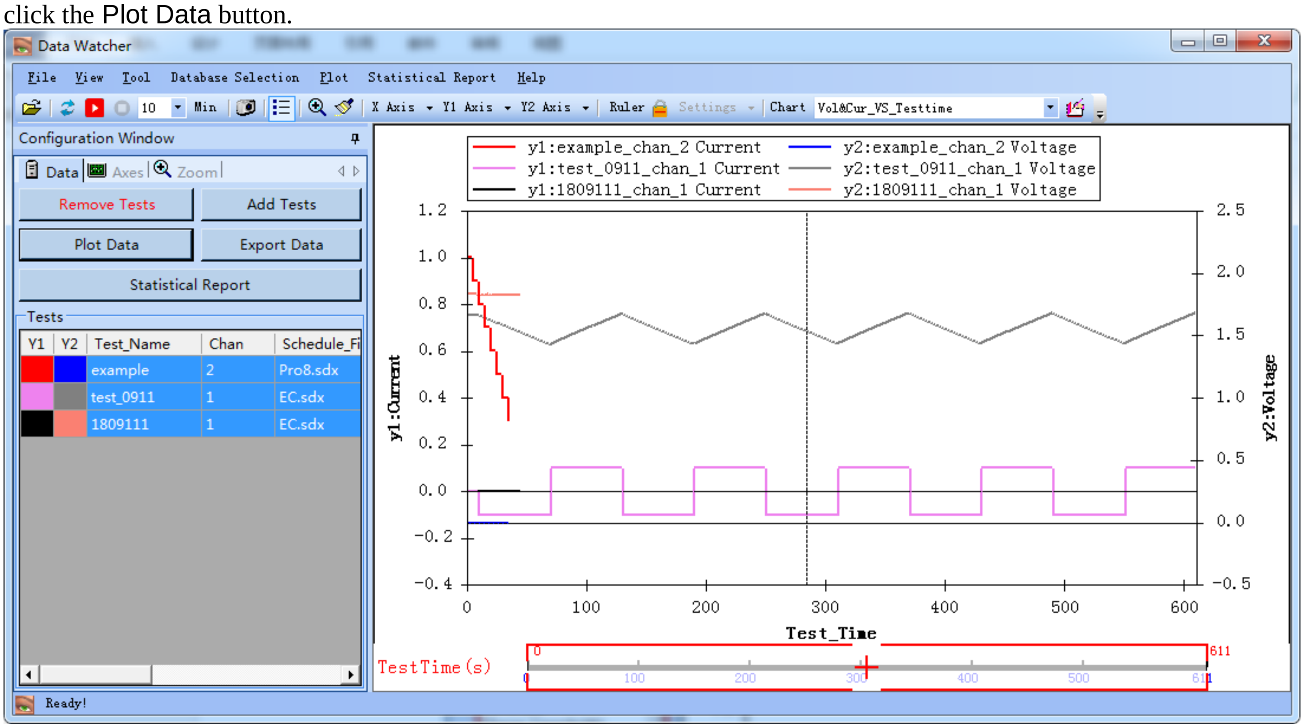


Figure 8-21 Select Multiple Tests Plotting Data

Select Parameter for Coordinate Axes

Select a channel or channels, and then shift to "**Axes**" tab. With X axis, the corresponding Y-coordinates are Y1 and Y2. For example, user place the cursor on X Axis, then select X-coordinate from the dropdown list. (e.g. "**Test time**" in

Figure 8-22), and Y-coordinates from the tree list, two Y-coordinates, Y1 and Y2 are available (**Figure 8-23**).

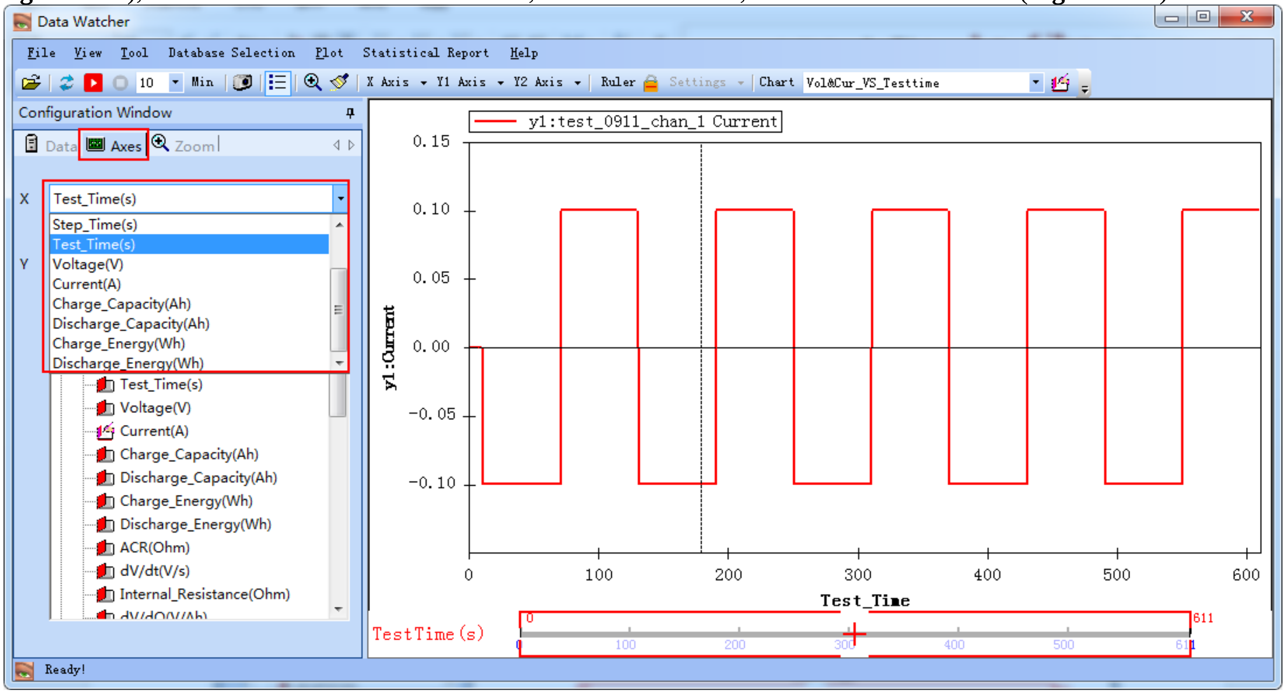


Figure 8-22 Select Coordinate Axes.

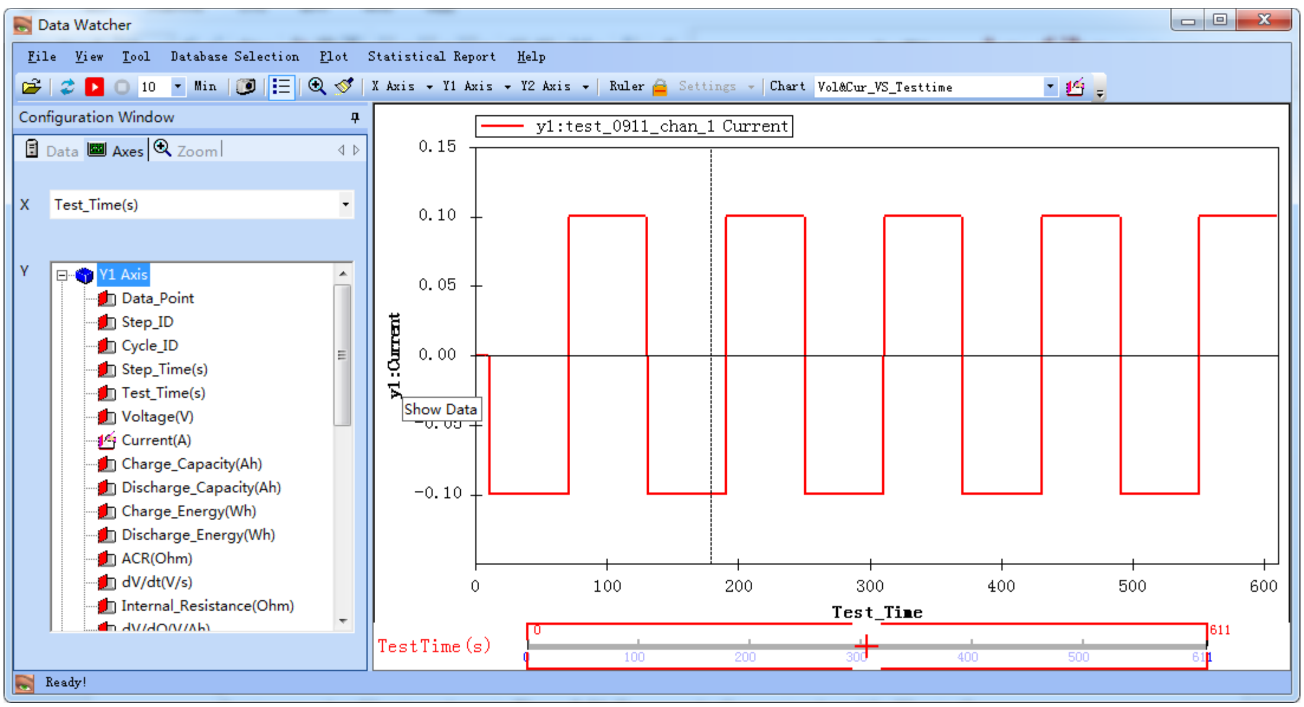


Figure 8-23 Select Coordinate Axes, Y1 -Axis as current in Axes

The selected parameter(s) for coordinate axes displays with an icon (as shown in **Figure 8-23**, current is selected for Y1). Other parameters display with different icon. At the same time, since X-axis and one Y-axis are selected, a graph displays on the right box.

Continue to select Y2 axis as shown in **Figure 8-24**. For example, Voltage is selected for Y2 axis. One more curve (Voltage) automatically is added into the graph.

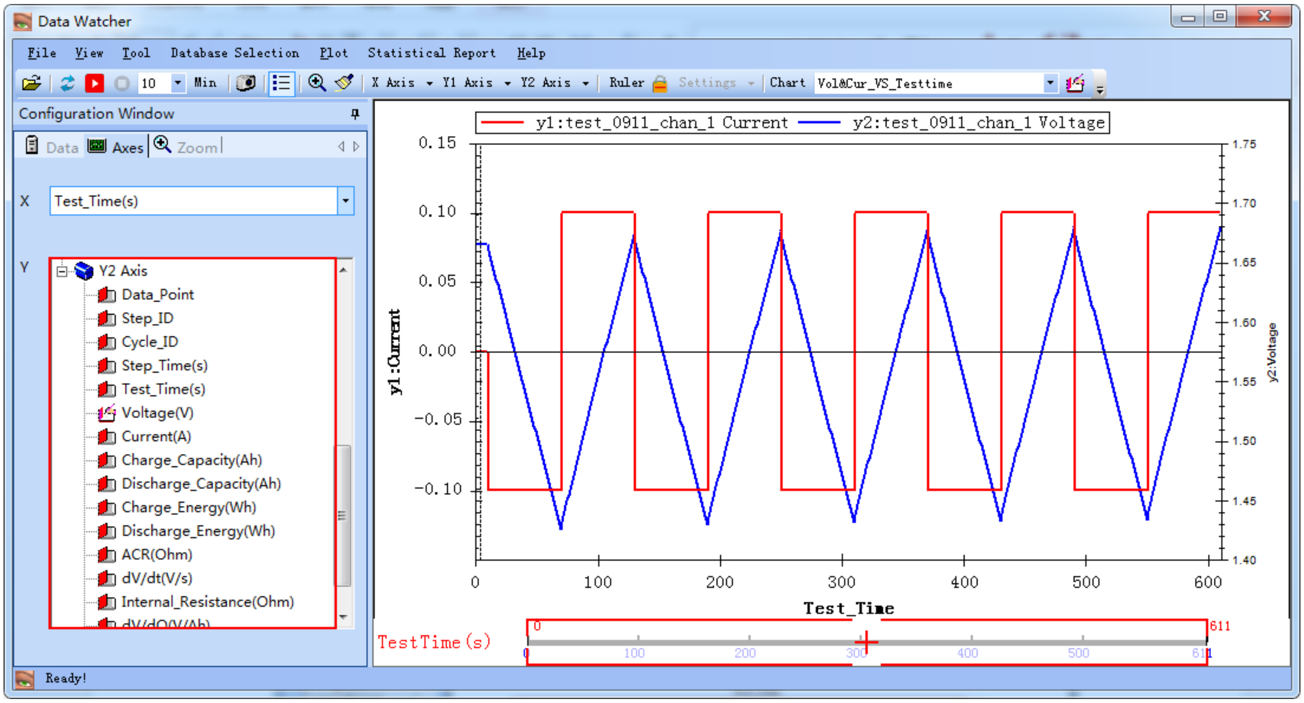


Figure 8-24 Select Coordinate Axes, Y2-axis as voltage in Axes

Users can also select coordinate axes from the top menu bar.

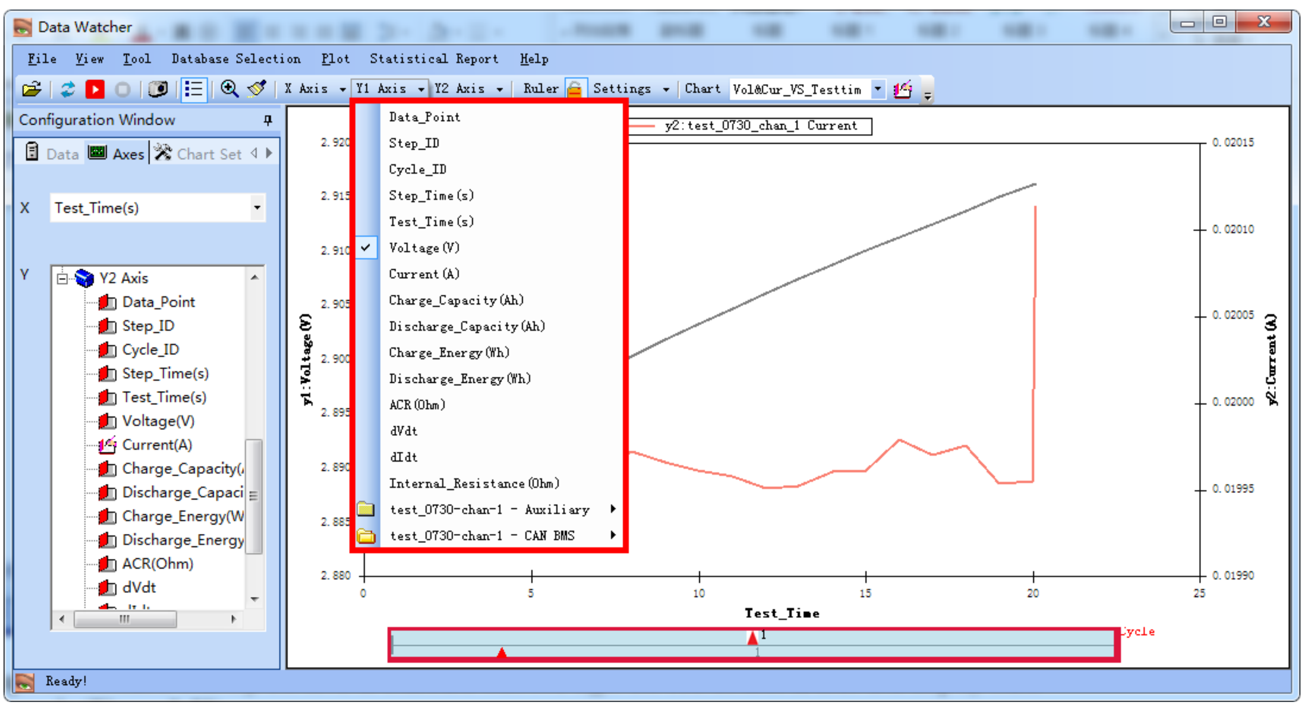


Figure 8-25 Axes Selections from the Top Menu Bar

The default graph view of X axis can be modified by clicking the menu Tool and choose Edit Chart Template, then the Chart Template window pops up. The default settings are: X axis: Test_Time(s), Y1: Current (A), Y2: Voltage (V).

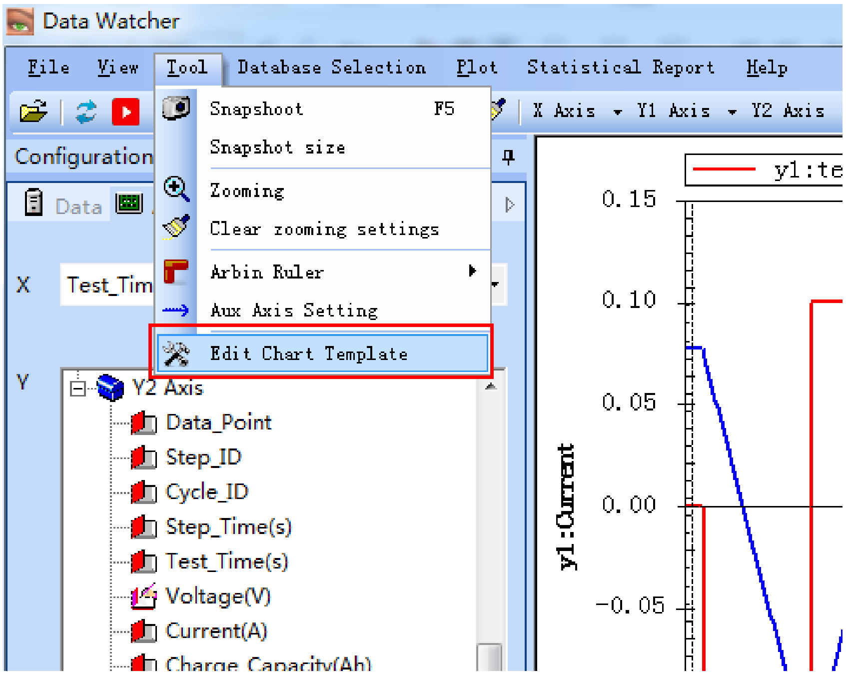


Figure 8-26 Click the Tool Menu and Select Edit Chart Template

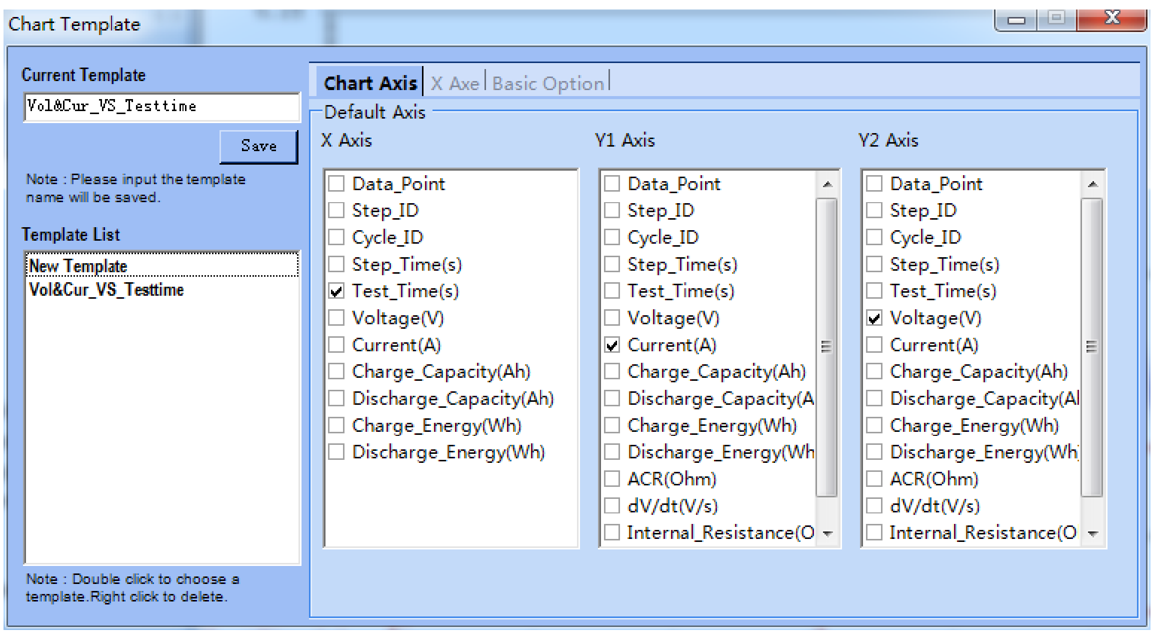


Figure 8-27 Chart Template Window

For a better view, users can set the fonts of the axes title, grid line, and tick numbers in the graph. For example, in Chart Template window, click on X Axe, then select the setup fonts of the tick and title in X, Y1 and Y2 axes window pops up (**Figure 8-28**). In addition, user can setup fonts of chart titles and legends in the graph as shown in (**Figure 8-29**). Further, users can create the Chart Template in MITS Pro8.0 Console Window.

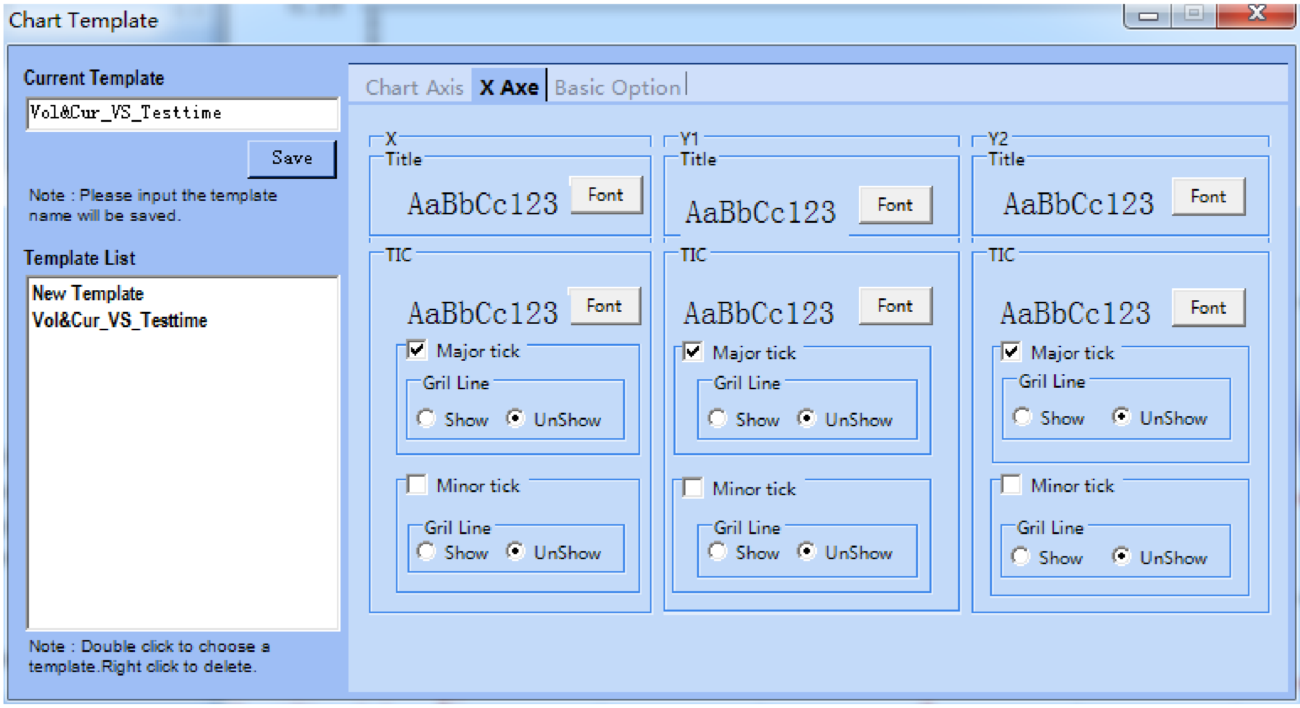


Figure 8-28 Setup Fonts of the Tick and Title in X, Y1 and Y2 Axes

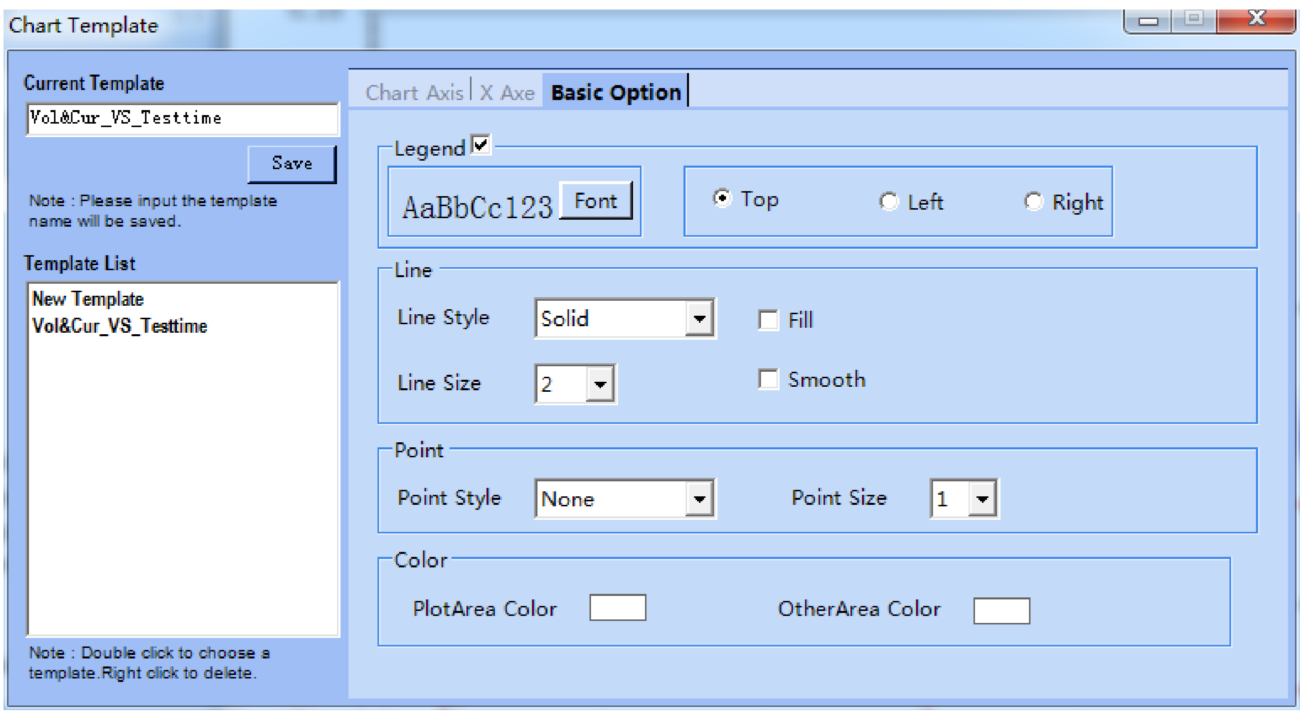


Figure 8-29 Setup Fonts of the Chart Title and Legend

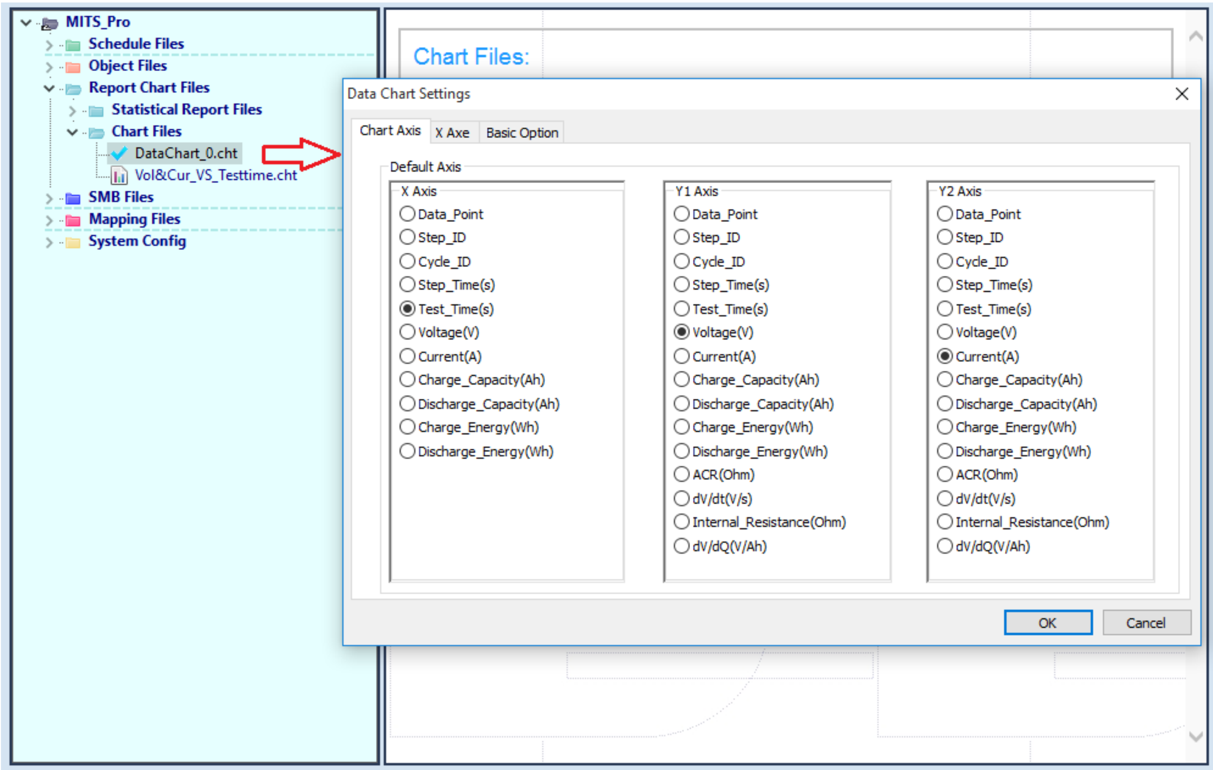


Figure 8-30 Creating a Chart Template in MITS Pro8.

As an example, the following diagram shows a snapshot of a graph with customized labels and tic numbers.

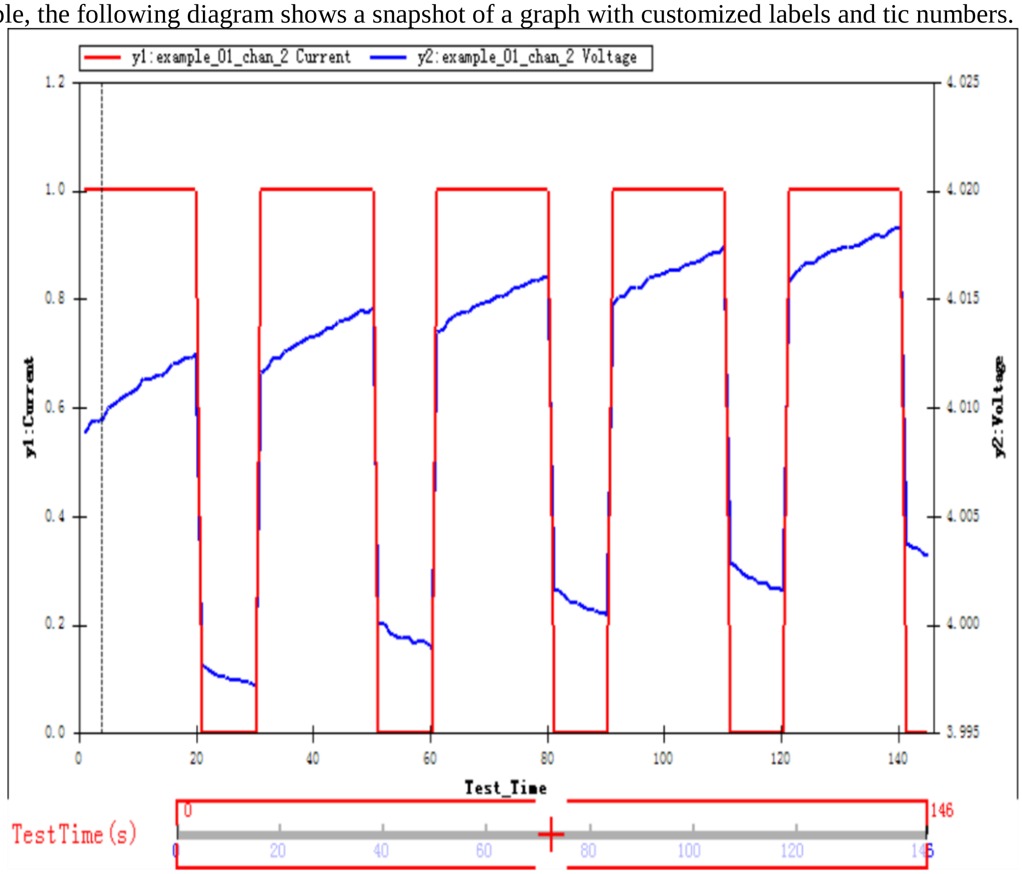


Figure 8-31 Snapshot of a Graph with Customized Labels and Tic Numbers

Arbin Ruler

To view X/Y coordinates of any points which is interested in, one can either click Arbin Ruler from the main menu by selecting Tool→Arbin Ruler or just clicking the icon on the top of the plot to enable Arbin Ruler as shown in **Figure 8-32**.

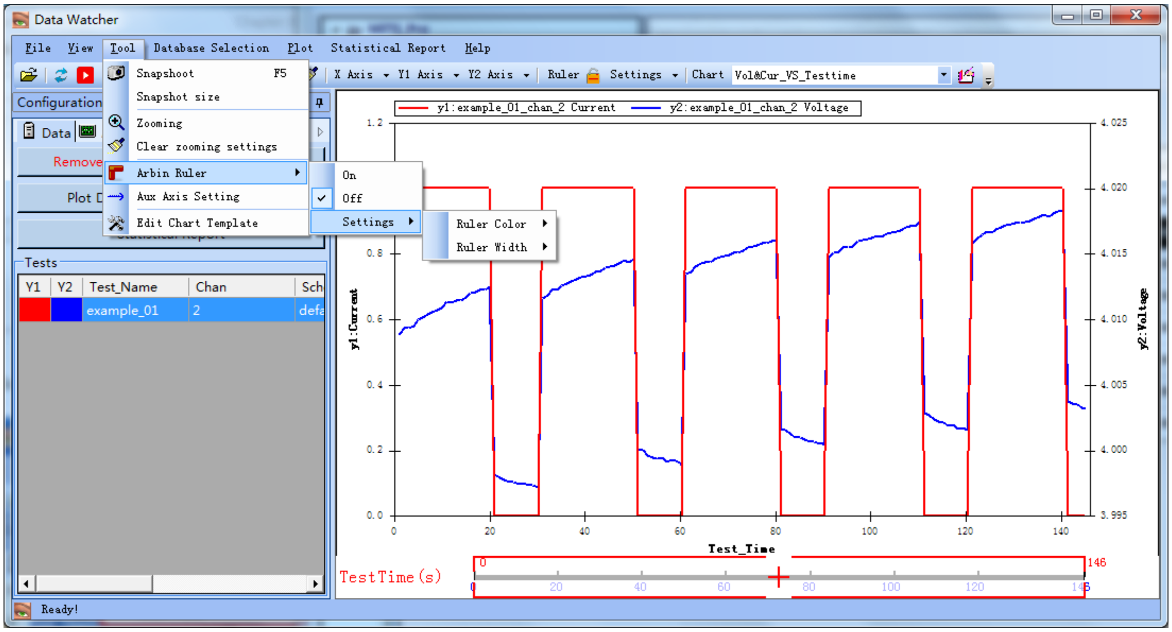


Figure 8-32 Arbin Ruler Selection by clicking Tool→Arbin Ruler

With Arbin Ruler tool, it is convenient to display the data point of interest. Move the cursor within the plot area and click the mouse right button over the points of interest, the value of all intersections of this axis and the graph will be displayed. It will display the value of the point, the cycle number and the step number. (**Figure 8-33**)

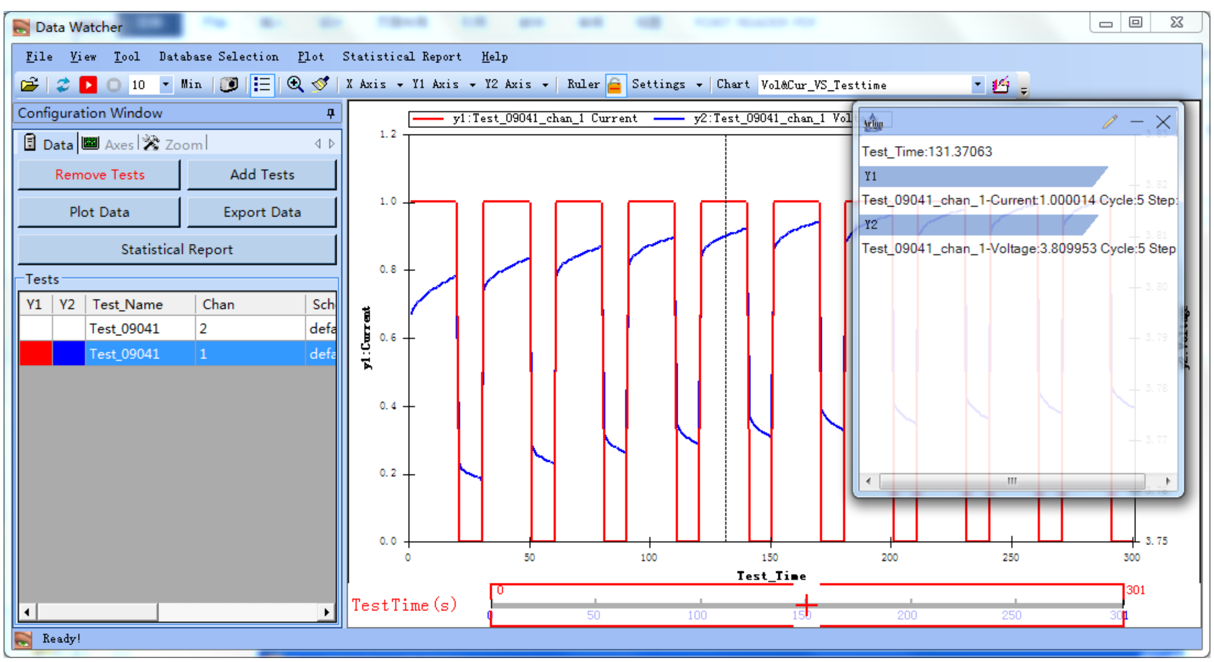


Figure 8-33 Display Points by Clicking Mouse Right Button

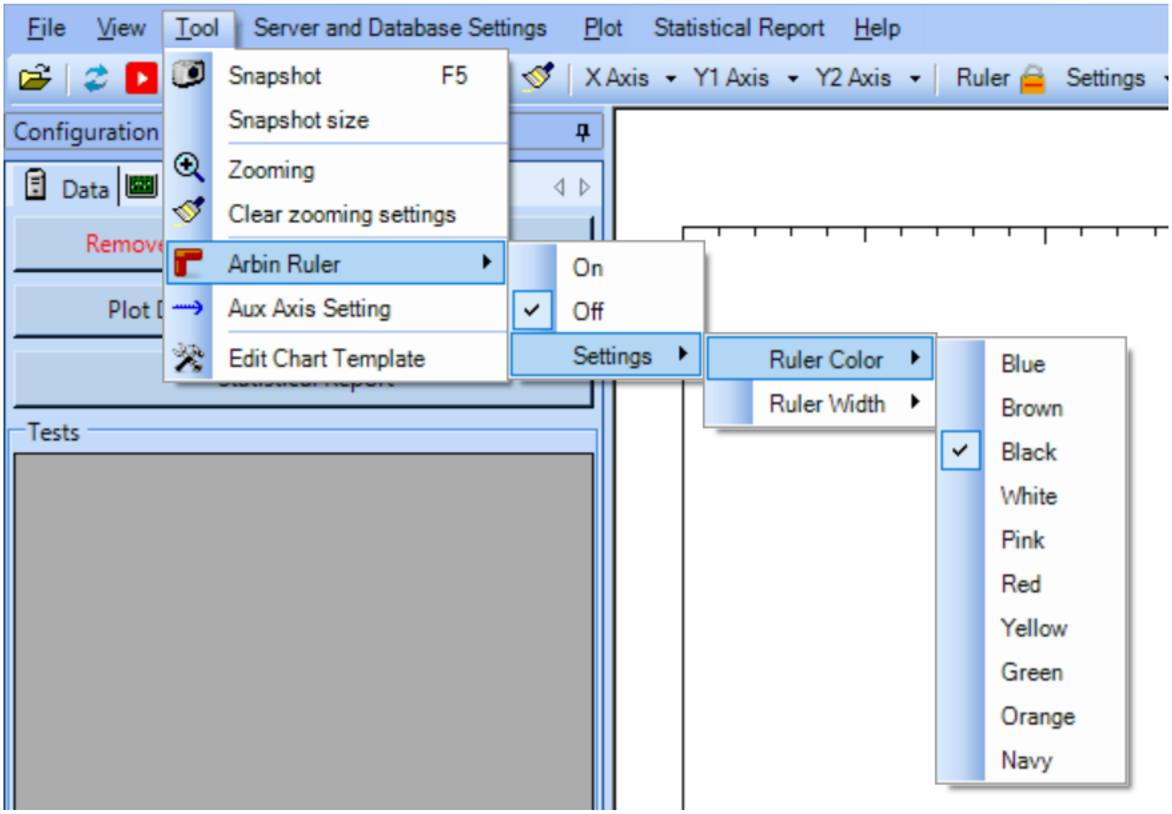


Figure 8-34 Arbin Ruler Setting Option

One can modify Ruler Color, Ruler Width by either clicking Tool→Arbin Ruler→Settings (**Figure 8-34**) or clicking Arbin Ruler Command Bar as shown in **Figure 8-35**.

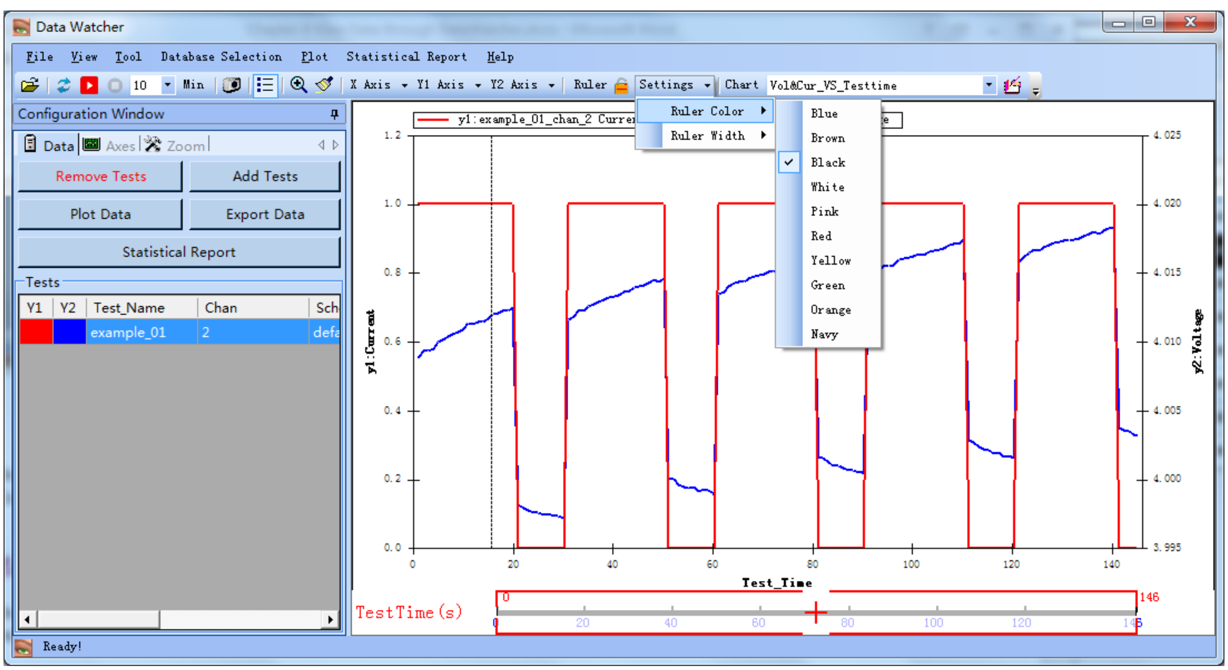


Figure 8-35 Arbin Ruler Setting Option

Zoom

On tab, "**Zoom**" (**Figure 8-36**), the operator may manually change parameter selections, such as minimum and maximum values of each axis.

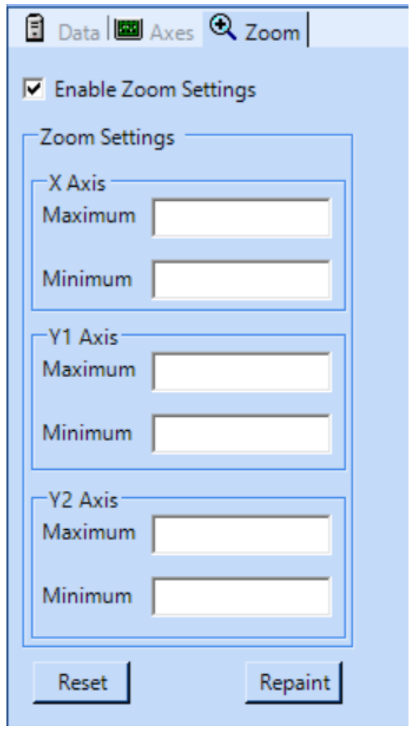


Figure 8-36 Zoom Setting

Chart View

Data Watcher draws the curve on the plot automatically based on **Axes** and **Chart Settings**. A list of icons on the top tool bar provides flexibility for display.

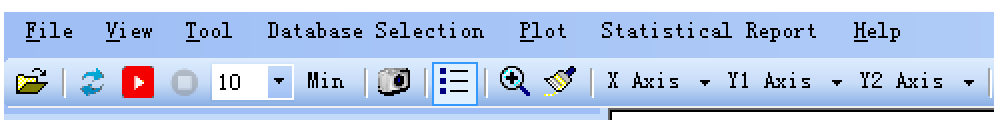
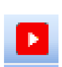


Figure 8-37 Top Tool Bar

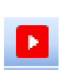
Manual Refresh of Plot

Click  button on the toolbar for the plot to immediately refresh the newly acquired data points. This action makes the plot refresh only once, requiring clicking the button again to get the new data points.

Automatic Refresh of Plot

Click the  button on the toolbar, the plot gets immediate refresh when new data point acquired. But it takes a time set in 

to execute again, this makes the plot refresh automatically for the selected time interval.

The button , next to  on the toolbar may be used to stop refresh actions.

Zoom-in and Zoom-out

Click the button on the toolbar, then frame an area of a chart using the cursor. Data Watcher zooms within selected frame.

Move the cursor within the plot area and scroll up or down the mouse pulley to zoom-out or zoom-in the chart area.

The button is provided to remove all **Zoom-in** and **Zoom-out** actions and return to the initial plot.

Show/Hide Legend

A button on the toolbar toggles the chart legend between display and hide.

Convert Chart to in JPEG Format

Click the icon on the top tool bar. It converts the chart to a JPEG image and opens a window to save the graph of chart.

Range Definer

The X/Y axis, users can move the axis, or move cursor to the Range Definer to adjust the range of the Range Definer for viewing part of the curve. For example, just show the graph of all TestTime as shown in **Figure 8-38**. Then select a range by draggin or moving the Range Definer. For Example, just show the graph of TestTime from 0 to 600 seconds as shown in **Figure 8-39.** Click on TestTime(s) change to CycleIndex Range Definer, as shown in **Figure 8-40.** As soon as you click on CycleIndex again it will change the Range Definer to TestTime(s) as shown in **Figure 8-39.**

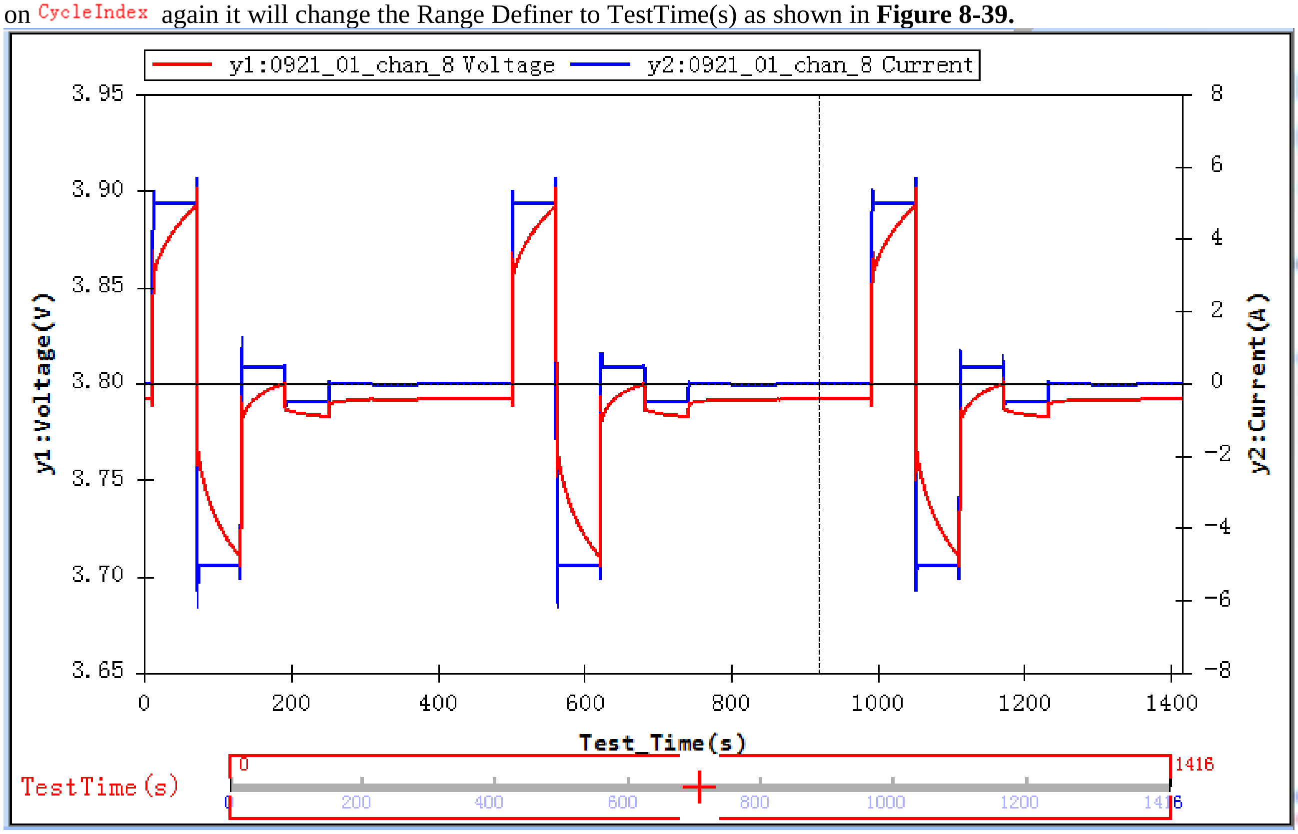


Figure 8-38 TestTims(s) of Range Definer

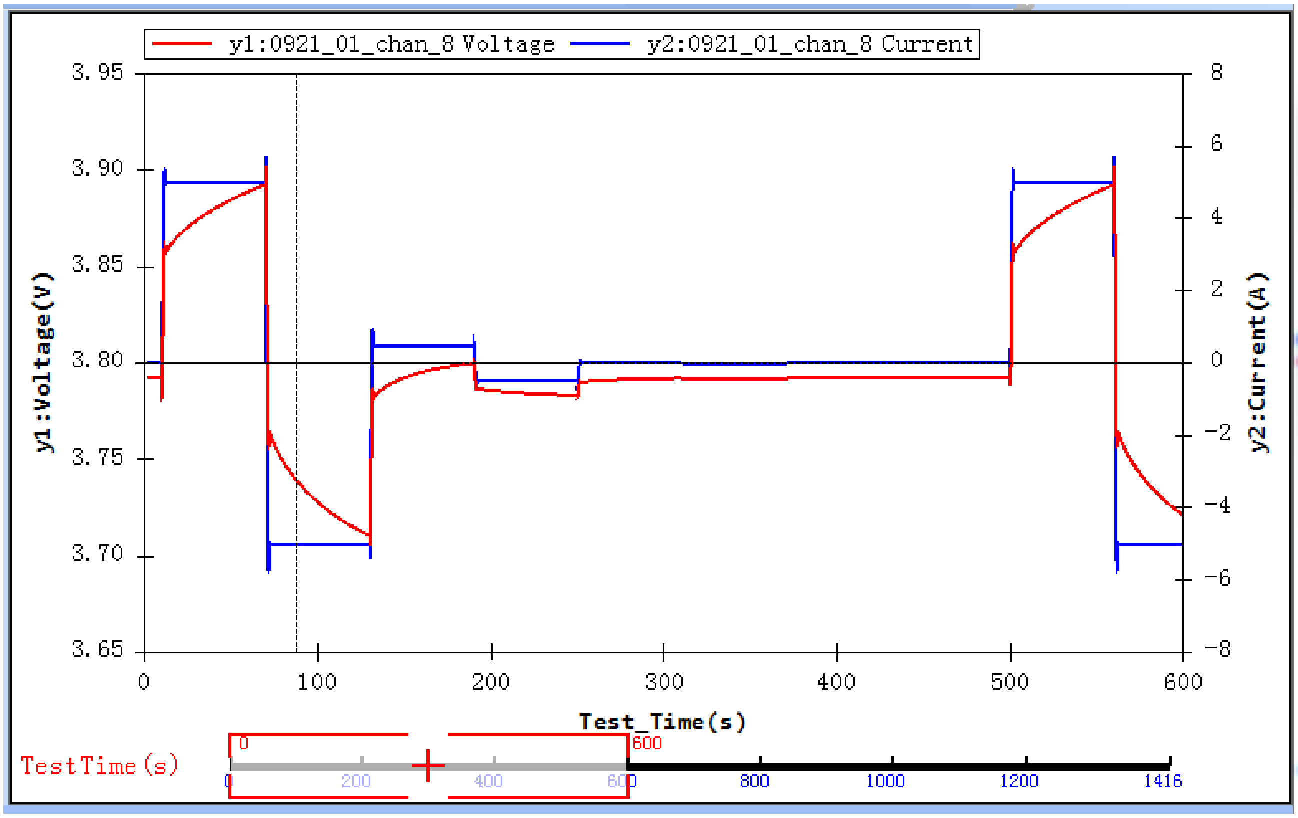


Figure 8-39 TestTime(s) from 0 to 600

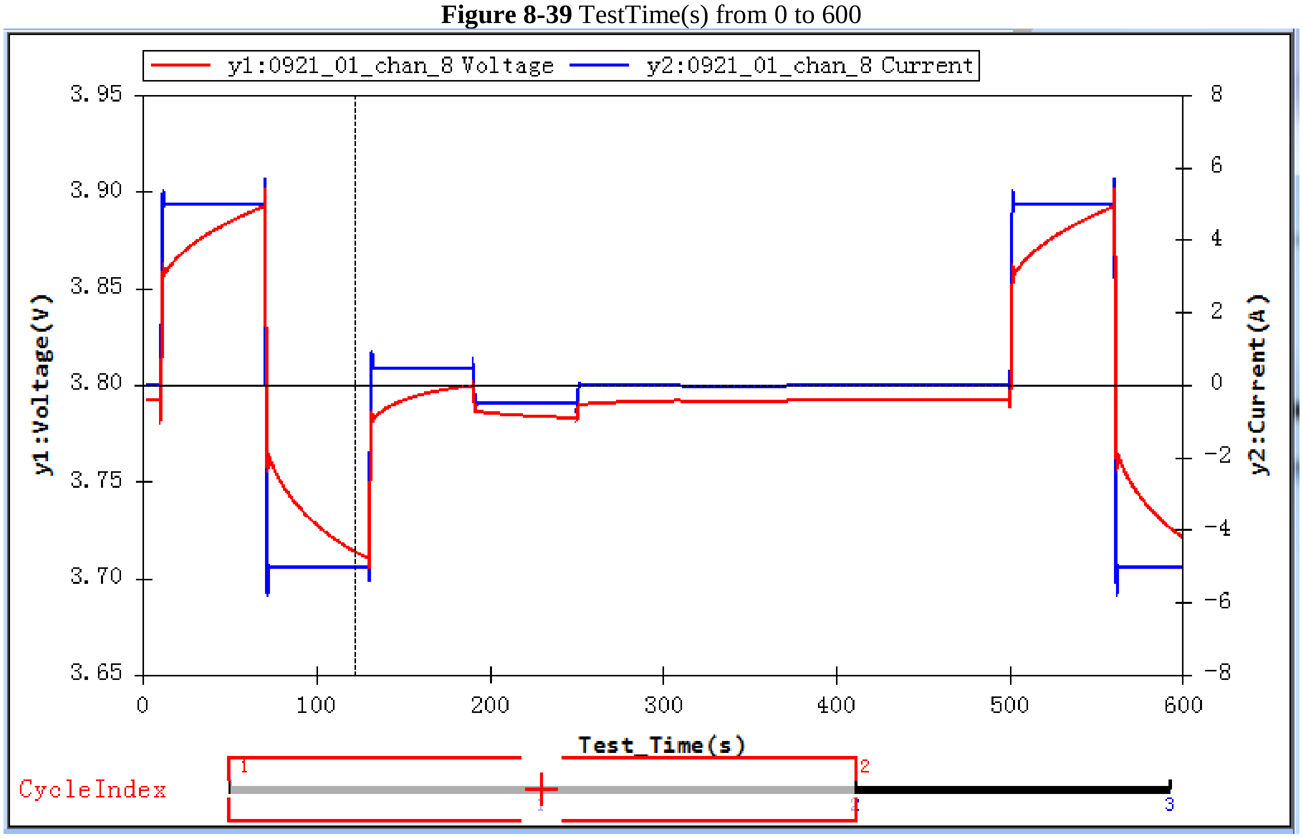


Figure 8-40 CycleIndex of Range Definer

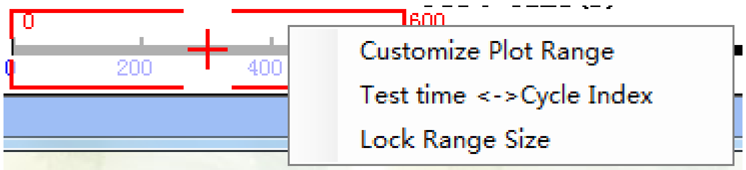


Figure 8-41 Drop-Down menu of Range Definer brought up by right clicking

Customize Plot Range
Exact selection range with want to watch test data of TestTime or Cycle range.

Figure 8-42 TestTime

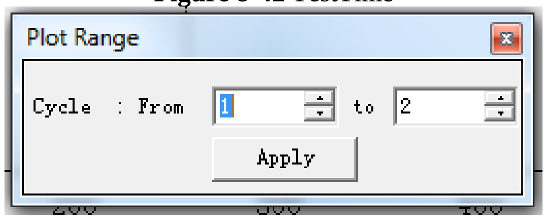


Figure 8-43 CycleIndex

Test time < - > Cycle Index
Change Range Definer model between Test Time and Cycle Index.

Lock Range Size
Check off: it will allow changing the Range Definer size by dragging, moving or zooming in or out.
Check on: it will not allow changing the Range Definer size by any other operation.
Double click the Range Definer to toggle between locking and unlocking Range Definer.

Mouse Pulley Event

Use the mouse pulley to zoom in or zoom out. DataWatcher will re-plot with the zoom in or zoom out. If the Range Definer is locked, the Range Definer does not change. If the Range Definer is unlocked, the Range Definer will change with mouse pulley to zoom in or zoom out.

Data View

Display Representing Data at a Point of the Curve

Move cursor exactly on the X axis of the curve, a data box appears that displays the experiment data at this data point.

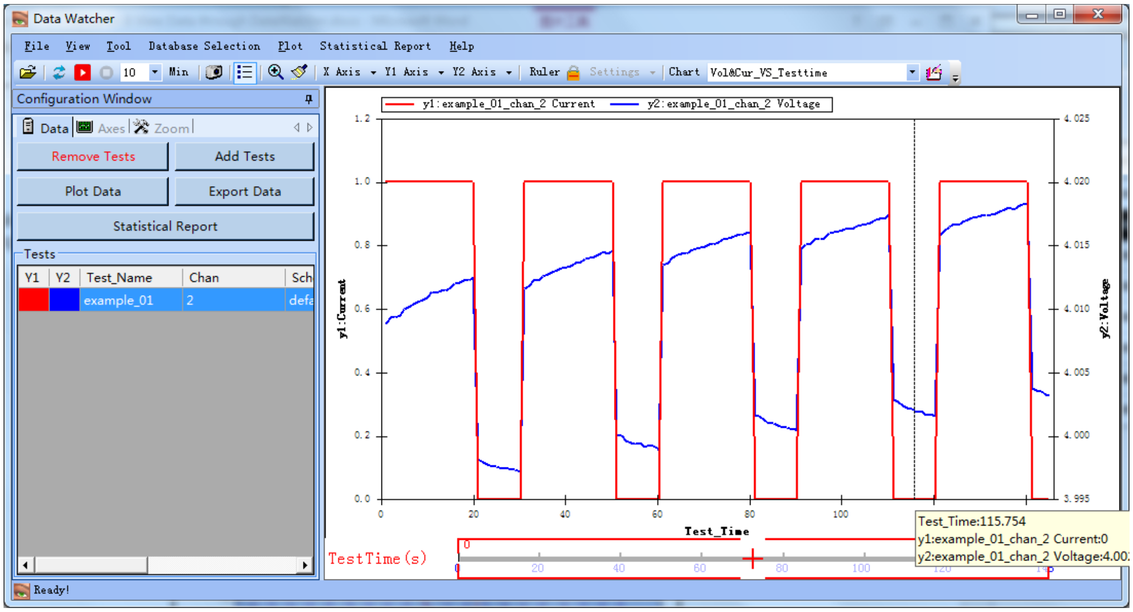


Figure 8-44 Representing Data at a Point of the Curve in Data Watcher

View Entire Data of a Curve

Move the cursor on any variable. Left click on it. A window containing data representing that curve opens.

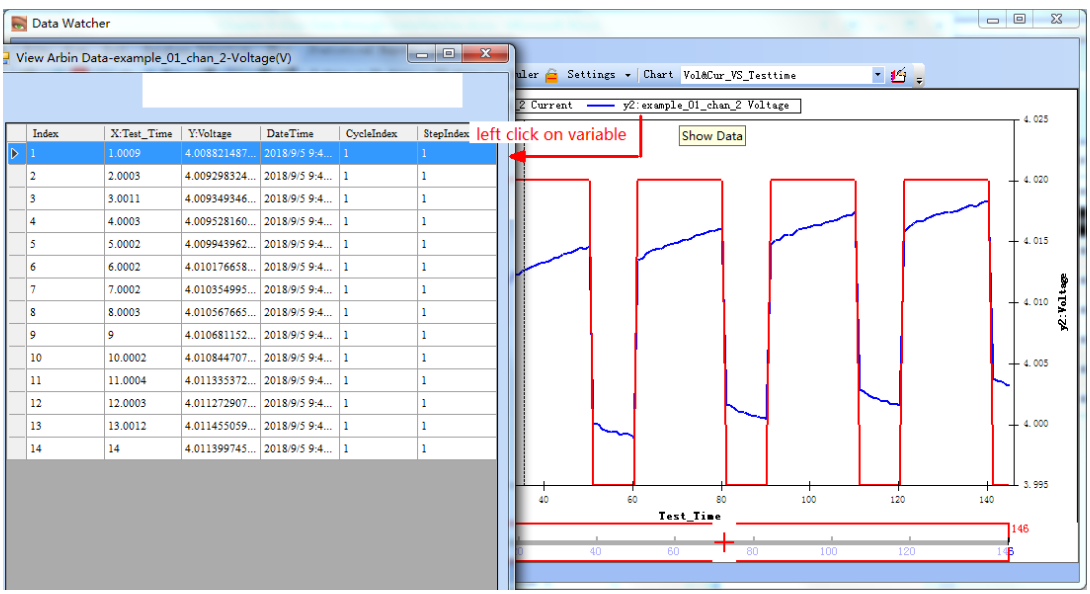


Figure 8-45 Entire Data of the Curve in Data Watcher

Chapter 9 Hardware Calibration

The calibration process is used to calibrate the channel DAC （digital and analog convert）and ADC （analog and digital convert）factors for voltages, currents and resistances. DAC and/or ADC values are saved into ArbinSys.cfg and the Microcontrllor (MCU). DAC factors are appropriate to the **Control Error** which is the comparison of the Desired Value and the Accurate Value. ADC factors are appropriate to the **Measure Error** which is comparison of the Machine Value and the Accurate Value. For I/V channels, DAC and ADC factors will be calibrated simultaneously. For most Auxiliary channels, only ADC factors will be calibrated. A digital multimeter (DMM) of at least 6½ digits or greater is required to perform an accurate and precise calibration. A minimum of three measurements spread across the range are required for a successful calibration. After performing the hardware calibration, the system will calculate the appropriate calibration factors. Arbin recommends customers to perform calibration for their Arbin testing equipment **once every year**.

Note: All tests should be stopped, and all channels should be disconnected from cells prior to performing any calibration!

To start **Manual Calibration**, click the following calibration icon  on the main console window to enter into the calibration screen.

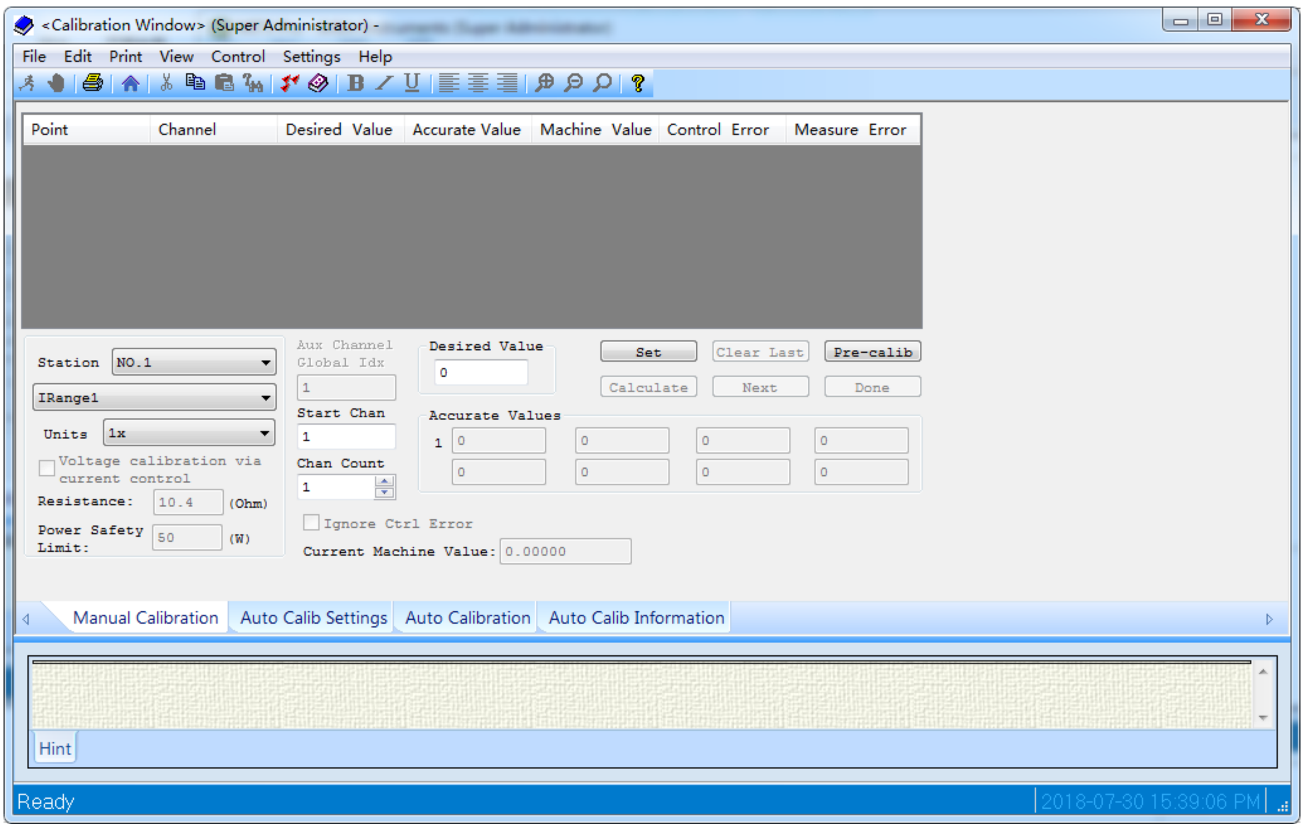


Figure 9-1 Manual Calibration Page

9.1 Universal Descriptions and Procedures for Manual Calibration

Explanation of Manual Calibration Window

The following section will describe the meaning of the different elements of the Manual Calibration window.

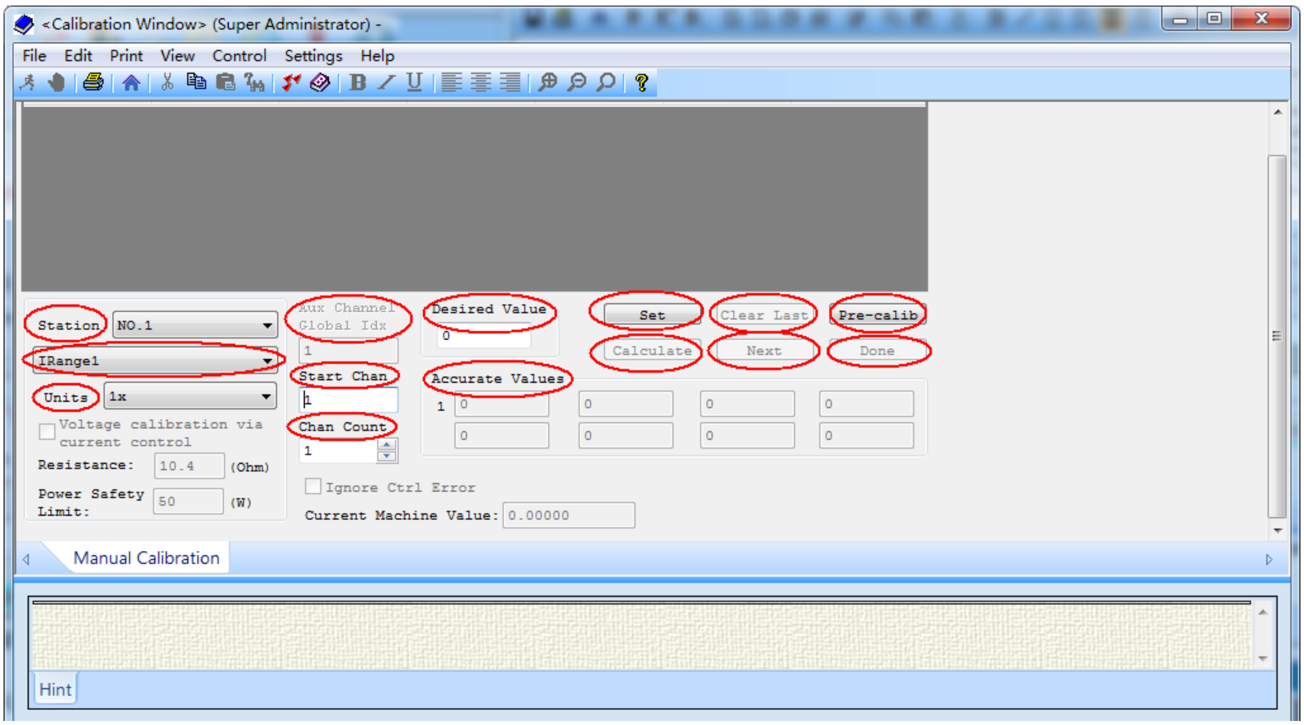


Figure 9-2 Manual Calibration Page Input Section

Station – Index of the chassis to be calibrated-typically limited to 1.

Calibration Type (this field is not labeled on the Calibration screen) – The default value that appears on opening the Calibration window is **IRange1 (Current-High).** Use the pull-down menu to select the desired type to calibrate. Even though some types appear on the pull-down menu, they may not be available on your specific machine.

Units – The default value that appears on opening the Calibration window is **1x**. Choices are **1x**, **milli**, and **micro**. The unit refers to the unit of measure used for the calibration value of the chosen type. The values entered the **Desired Value** and the **Accurate Value** fields should correspond to the **Units** selected. Example - If 1A is desired and the Unit selected is **1x**, 1 should be entered into the **Desired Value** box. If 0.1A is desired and the Unit selected is **milli**, 100 should be entered into the **Desired Value** box.

Start Chan – Index of the I/V channel selected to check or calibrate.

Aux Channel Global Idx – This field is grayed out for Main I/V Calibration Parameters. This field will illuminate when an Auxiliary Calibration Parameter is chosen. It refers to the physical input (Auxiliary channel) being calibrated. It is only available for the Arbin testing equipment with Auxiliary Channels. Users should input the auxiliary channel index match with the index of auxiliary channel in the Auxiliary page of ArbinSys.cfg file.

Chan Count – This field selects the number of channels to be turned on. This is normally left at **1**. Only one main channel or aux-channel should be calibrated at a time. The calibration screen is also used to troubleshoot communication. This field is manipulated to facilitate turning on multiple channels for communication troubleshooting.

Desired Value – This field is used to enter the selected target output value for the calibration process. The value entered is directly related to the **Units** selected. For aux-channel calibration, input "0" here.

Set – This button is clicked to turn on the channel and initialize output (Desired Value). Clicking this button turns on the channel and creates a calibration point as shown in figure 9-3. **Note after click "set", the channel is turned on until click "Next".**

Accurate value – This field is grayed out until the "Set" button is clicked. This is the field used to enter the value read, including the **sign**, from the appropriate digital multimeter (DMM) used to perform the calibration.

Calculate – This button is clicked after the DMM value is entered into the Accurate Value box. Clicking this button generates a Machine Value and compares it to the DMM calculating the Control Error and the Measure Error for the I/V channel calibration.

Clear Last – This button clears the last generated calibration point. It is used to remove a generated data point that may have had an incorrect entry (such as an incorrect sign) without disturbing the previously generated values.

Next – This button turns off the channel being calibrated without saving or altering the existing stored calibration data. It is used when verifying calibration or to abort the calibration process for that channel/parameter. When this button is clicked, all calibration data points will disappear.

Pre-calib – This button is used to reset present calibration factors of this channel to **default** in the ArbinSys.cfg file. It only affects the factors of calibration type selected. When clicked, a warning window will come up which allows you to abort the process. This button should not be used except in specific circumstances that include calibrating a new replaced channel, or when the normal calibration process is unsuccessful.

Done – This button saves the calibration data calculated from the displayed calibration points. It is grayed out until at least two data points have been generated. It will give you a warning before changing calibration factors in the ArbinSys.cfg, which allows you to abort the process if desired.

Point	Channel	Desired Value	Accurate Value	Machine Value	Control Error	Measure Error
1	2	1.00000 A	0.99980 A	0.99981 A	0.002%	0.000%
2	2	-1.00000 A	-1.00031 A	-1.00033 A	0.003%	-0.000%
3	2	4.00000 A	3.99950 A	3.99971 A	0.005%	0.002%
4	2	-4.00000 A	-3.99960 A	-4.00031 A	-0.004%	-0.007%

Figure 9-3 Manual Calibration Page Display Section

This is the description for the calibration window where the calibration points are displayed.

Point – This column indicates which data point has been generated, starting from 1.

Channel – This column contains the channel number of the channel being calibrated. When calibrating Auxiliary Index, this column will contain the Auxiliary channel number of the file ArbinSys.cfg.

Desired Value – This column displays the value for that point which was entered into the Desired Value box.

Accurate Value – This column displays the value that was typed in by the operator from the observed value on the DMM.

Machine Value –This column displays the value that was measured by the channel of Arbin machine.

Control Error – This column displays the calculated accuracy percentage based on Desired Value and Accurate Value.

Measure Error – This column displays the calculated accuracy percentage based on Machine Value and Accurate Value.

Control Error and Measured Error values are only generated for Main I/V channels. No values are generated in these columns for Auxiliary channels. The operator needs to manually compareing the input value with machine value.

Manual Calibration Procedures

The following procedures go into more specific detail in how to perform a manual calibration for: Main I/V channel (current, voltage and voltage clamp) calibration, Auxiliary Voltage Channel Calibration, Auxiliary Temperature Channel Calibration, Auxiliary Pressure channel Calibration, Auxiliary External Charge Current Channel Calibration. Please read the following chapters for additional details before attempting the calibration process.

Additionally, prior to calibrating any auxiliary channels, users should input the auxiliary channel index match with the index of auxiliary channel in the Auxiliary page of ArbinSys.cfg file. Calibrating auxiliary channels has nothing to do with I/V channels, or the mapping between auxiliary channels and I/V channels.

Since the new calibration DAC and ADC values will coverwhite the old values and be saved to ArbinSys.cfg, before attempting a Manual Calibration, we strongly recommend that the customer saves a copy of the Arbin system configuration file, ArbinSys.cfg (located in the C:\ArbinSoftware\MITS-PRO directory) with the original calibration parameters. This file should be saved with a different name in the case is required for troubleshooting. User can right click “ArbinSys.cfg” on the main console window and select “Save to”. In case operator wants to recover the original config file, one can right click “System Config”, select “copy from….” and choose the config file you saved.

1. To start Manual Calibration, click the following calibration icon on the main console window to enter the calibration screen.

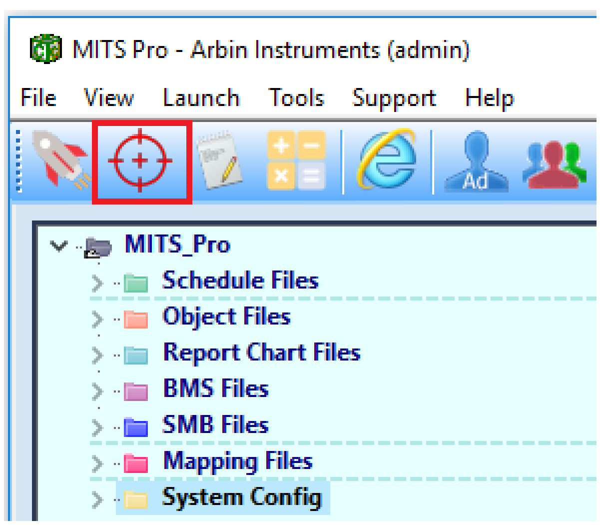


Figure 9- 4 Calibration Icon

2. Select the **calibration type** you want to perform from the pull-down menu.

3. Ensure the **channel’s hardware is correctly connected** using the appointed diagram. For I/V channels, please refer to

IV Channel Calibration Record Sheet [1] and diagrams in Section 9.2 . For Aux channels, please refer to the diagrams in Section 9.3 ~ **Auxiliary Voltage Channel Calibration.**

4. Select the **scale in units** you prefer from the "Units" pull-down menu. There are three options available to choose, "1x, milli, or micro".

5. For I/V channel calibration, Input the **I/V channel number** you want to perform in the "Start Chan" field.

6. For Auxiliary channel calibration, Input the **auxiliary channel index** you want to perform in the "Aux Global Channel Idx" field.

7. Select a number to decide how many channels you want to output at the same time in the "Channel Count" field. The maximum number is 8. For calibration, please keep it as "1". Other number is only used for communication troubleshooting.

8. "**Pre-Calib**" [2] is to reset present calibration factors of this channel to the default value in the system configuration. Do not click it unless requested by Arbin Technical support.

9. For I/V channels, input first point of **setting value** in the "Desired Value" field. Please refer to **IV Channel Calibration Record Sheet** for recommended 3~4 points of setting values.

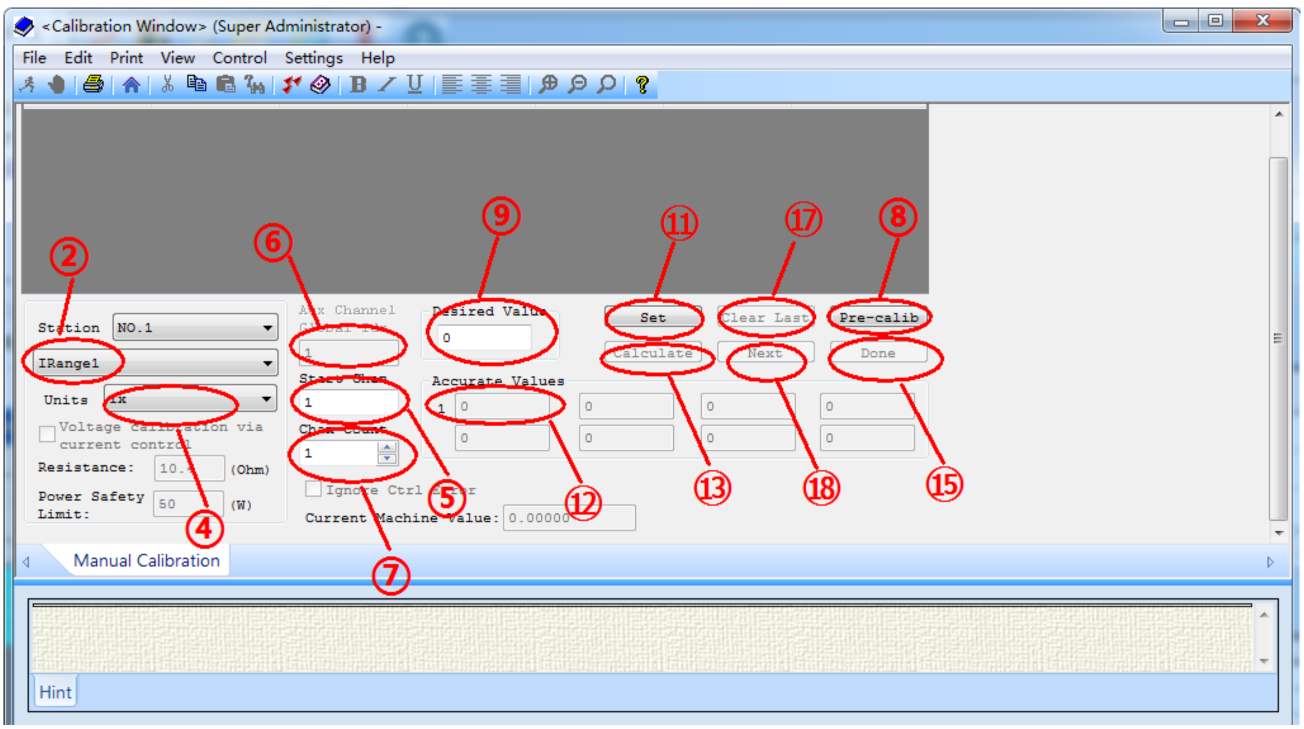


Figure 9- 5 Manual Calibration Sequence

10. For Aux channels, only ADC factors needs to be calibrated. Please refer to Calibration Tables (Section 9.3 ~ Auxiliary Voltage Channel Calibration) for recommended 3~4 points of values , then **do adjustment to the circuitry to make the real measurement close to the recommended values**. Always **enter 0** in "Desired Value" field.

[1] The sheet is attached in the beginning of this manual for customer reference.
[2] This action may need to be applied only after a incorrect calibration.

11. Click "**Set**" button.

12. **Input the output value** read from the digital multimeter in the “Accurate Value” field.

13. Click the “**Calculate**” button. Accurate value will be loaded into system and the machine value will be available to read in the calibration window. Control Error and Measure Error will be calculated as shown in Figure 9-3**Error! No bookmark name given.**[3]. **If any error is big, stop next step, click “Next” to turn off the channel, and call Arbin Customer Service.**

14. **Repeat** Step 9~13 for other calibration points. **A minimum of 2 calibration points** is required.

15. Click the “**Done**[4]” button to finish this calibration. The new calculated calibration factors are saved to the Arbin system configuration file.

16. **Confirm your calibration**. For I/V channel, set the channel maximum range value in the “desired values” field, record accurate value in "Accurate Value" field. Click "Calculate" button to ensure both Control Error and Measure Error are within accuracy specifications. Note: **don’t try using calibration to fix any problem of hardware or software issue if any error is big.**

17. Click the “**Clear Last**” button to clear last point of calibration record in **Figure 9- 5**.

18. Click the “**Next**” button to turn off the channel and clear all points of calibration shown in **Figure 9- 5**.

[3] Control Error and Measure Error of Aux channel are not available to be shown in upper window.
[4] Be careful when clicking *Done*. Make sure that the calibration points are valid.

9.2 Main I/V Channel Calibration

Main I/V channels refer to those channels which have charge and/or discharge functions on current and voltage. People may call them main channels or I/V channels compared with auxiliary channels which mainly take measurement function (except digital I/O channels and integrated channels for temperature chamber). Generally Current calibration, Voltage calibration and Clamp Voltage calibration are related to the I/V Channel calibration. DAC and ADC factors which are saved in ArbinSys.cfg are calibrated simultaneously and are related to the control and measurement of the I/V channel.

Initial Understanding

Arbin has two standard types of circuitry for I/V channels; they are **Linear-Bipolar** and **PWM**.

Regarding **Clamp Voltage**, please refer to Section 5.4 - **"The Global Page of a Schedule"** for the definition and application.

I/V channels can have up to four current ranges. IV channels can have up to two voltage ranges which are Voltage-High and Voltage-Low. If only one voltage range, Voltage-High will be the default. Clamp voltage ranges should be equivalent to voltage ranges which are Clamp Voltage-High and Clamp Voltage-Low. If only one clamp voltage range, Clamp Voltage-High will be the default. Please notice Clamp Voltage-High and Clamp Voltage-Low in Calibration Windows (the system has two voltage ranges) have different meanings from voltage clamp high and voltage clamp low (charging and discharging clamp values) in schedule file.

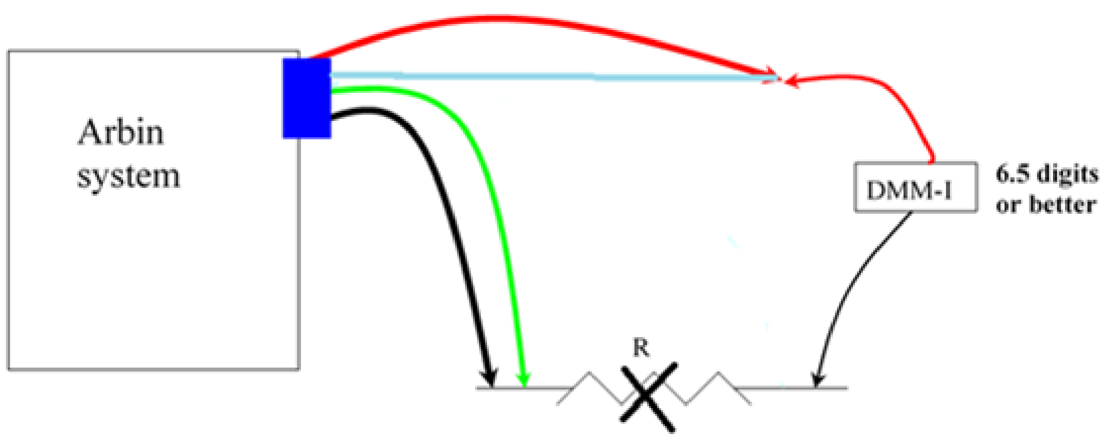
For additional information refer to the **IV Channel Calibration Record Sheet** attached in the beginning of this manual.

Connection Diagrams

The following Diagrams indicate the I/V channel hardware connection for different IV channel calibration conditions. Some devices are required to perform a calibration such as a Digital Multimeter (DMM), Precision Shunt, Resistor, Battery, Capacitor and Cable. Recommendations on conection diagrams, devices, and calibration points are indicated in the **IV Channel Calibration Record Sheet** and can be used for reference.

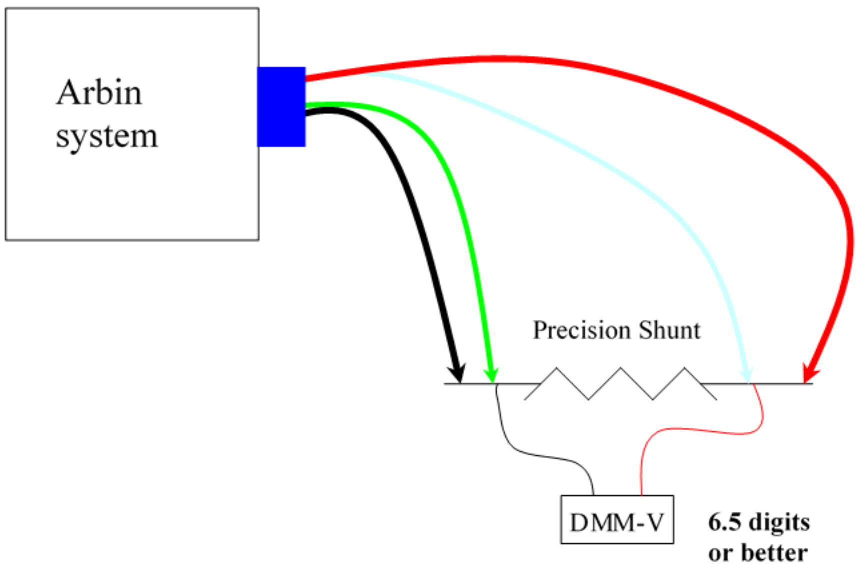
Diagram 1: Current Calibration for |I| <=3A

(if DCI range of the meter is 3A)



Notes: Set Digital Multimeter for DC current measurement (DCI). Resistor can be waived as Cable Short for most of cases.

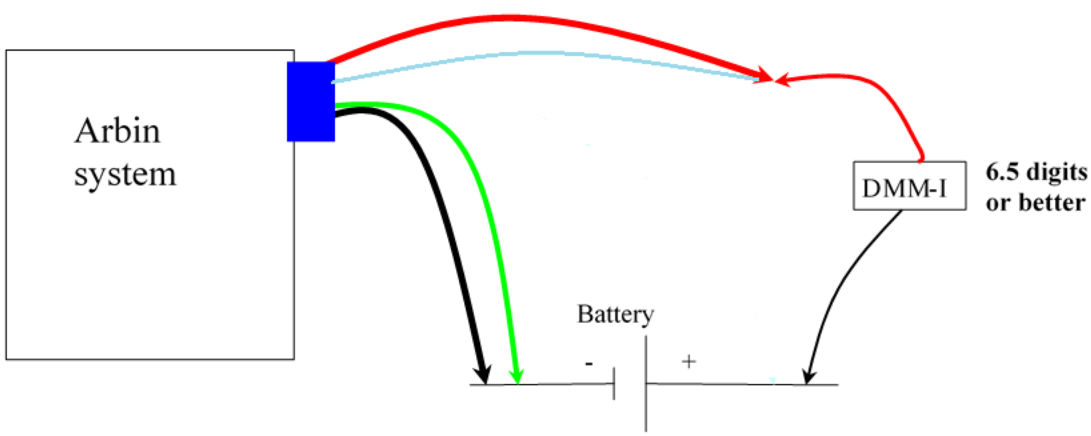
Diagram 2: Current Calibration for $|I| >$ The DCI range of the meter



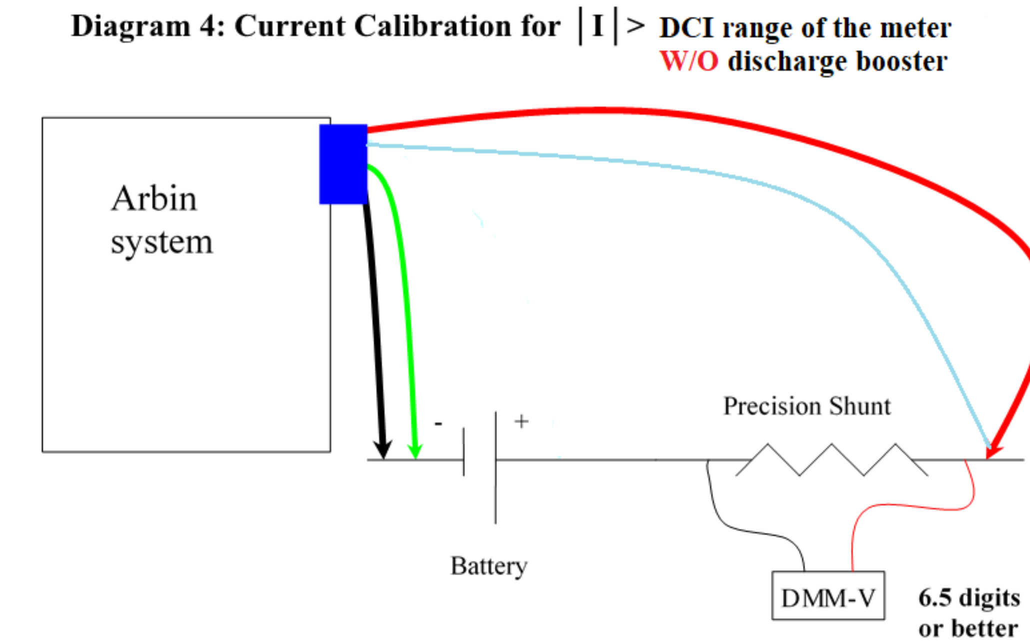
Notes: Set DMM for DC voltage measurement (DCV).

Diagram 3: Current Calibration for $|I| \leqslant 3A$ w/o discharge booster

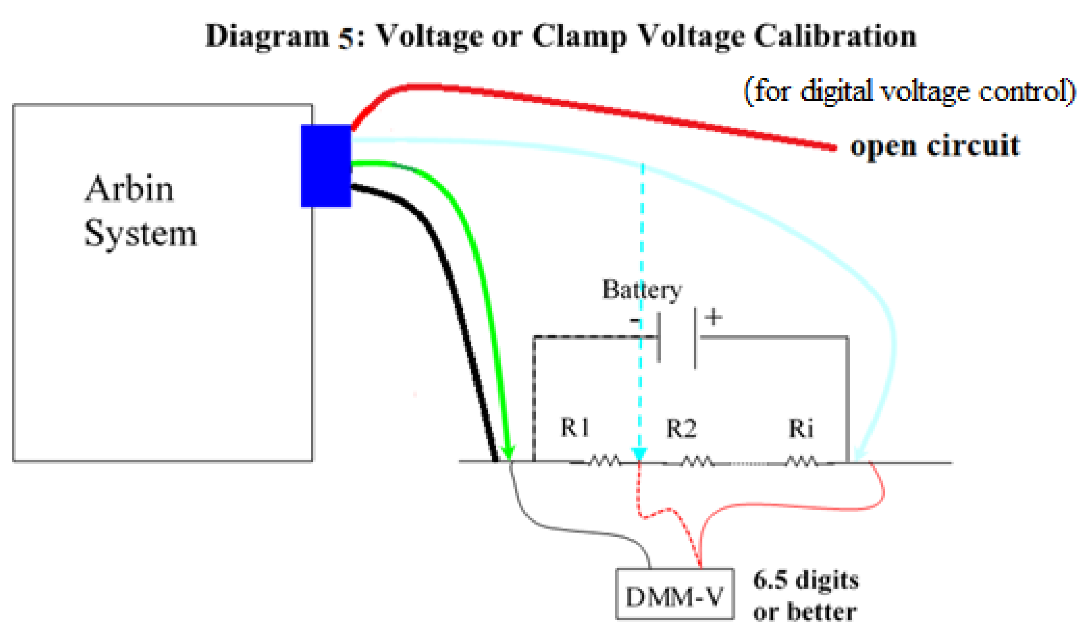
(If DCI range of the meter is 3A)



Notes: Set DMM for DC current measurement (DCI).

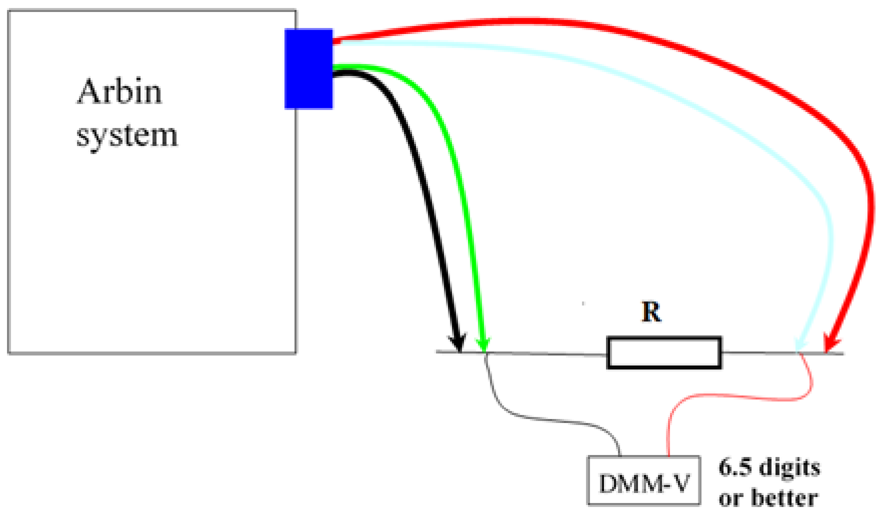


Notes: Set DMM for DC voltage measurement (DCV).



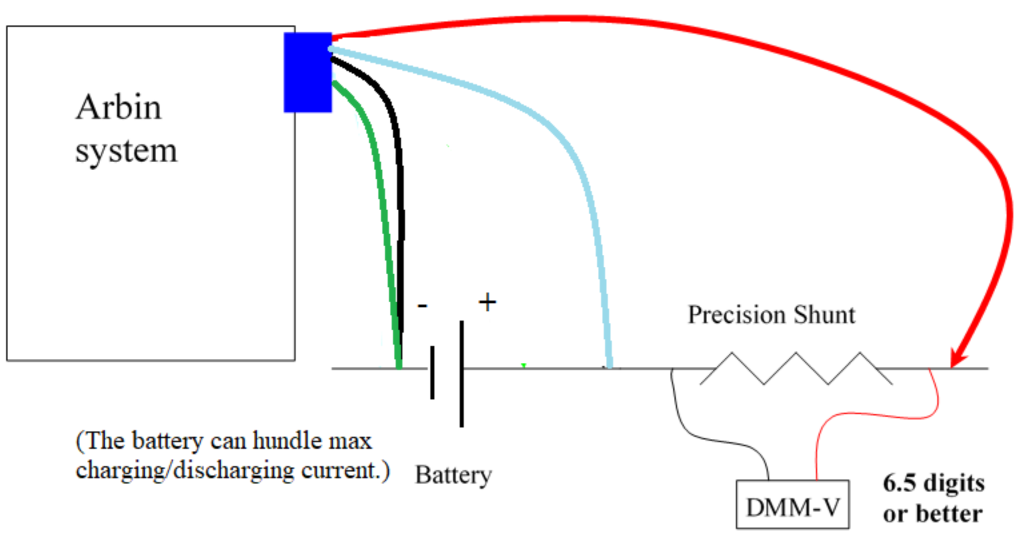
Notes: The voltage of the battery is less than the voltage range. R_i can be Kohms. Set DMM for DC voltage measurement (DCV). One or more batteries can be used to be the source of DC voltage. Single or multiple resistors are either in series or parallel connections to generate differenent voltage readings for calibration.

Diagram 6: PWM Voltage or Clamp Voltage Calibration

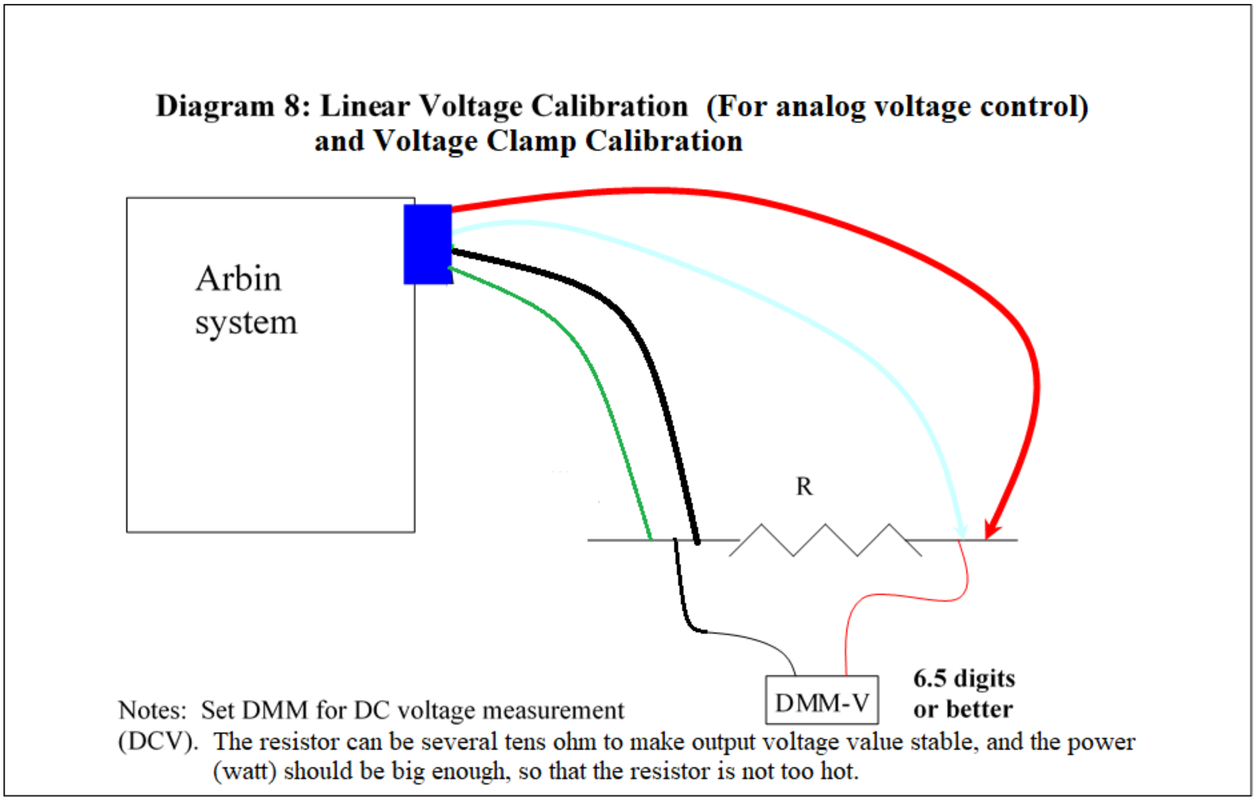


Notes: Set DMM for DC voltage measurement (DCV). The resistor value may be hundreds ohm/watt according to the voltage range, for exsample, 6 x 100ohm/225watt. The desired values of voltage must be positive.

Diagram 7: PWM current calibration |I|>DCI range of the meter



Notes: Set DMM for DC voltage measurement (DCV).



In MITS 8.0 software, there are two types of control: Digital Control and Analog Control. Digital control option is pre-set in the ArbinSys configuration file by Arbin. See the Figure 9-6 below. Diagram 5 (for digital control) and Diagram 8 (for analog control) are two different approaches to calibrate voltage. Diagram 5 uses a serial-resistor as voltage inputing sources to calibrate voltage ADC only. Diagram 8 uses a resistor as a load to make voltage output value more stable. Diagram 8 is for calibration both DAC and ADC.

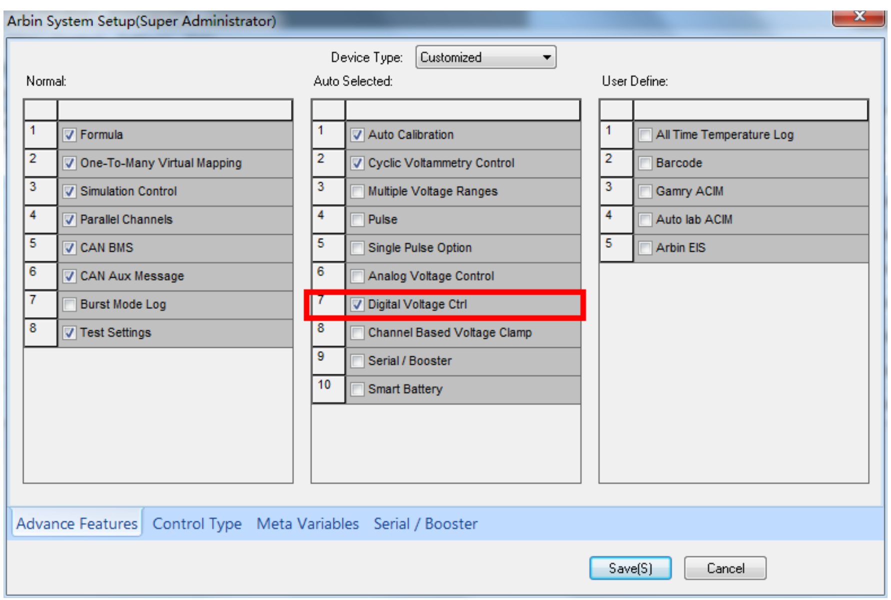
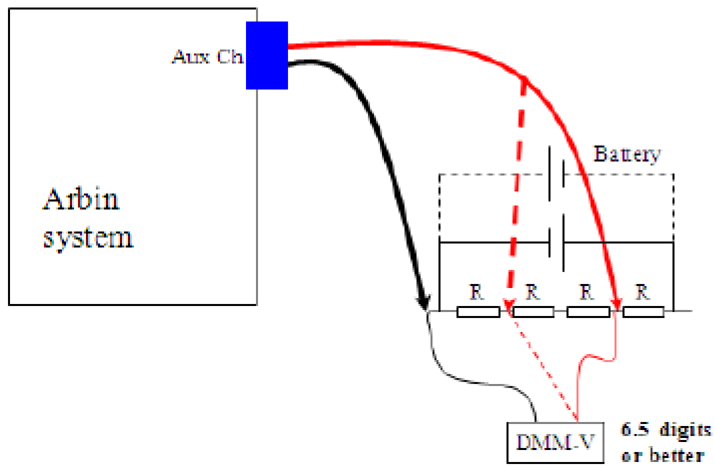


Figure 9-6 Digital Control option in the System Configuration File

9.3 Auxiliary Voltage Channel Calibration

Connect the hardware as shown in the following diagram. Change the V+ connection position to achieve various voltage values as requested. Battery can be reversely connected to achieve negative voltage values.

Diagram 9: Aux Voltage Calibration



Notes:

- Set DMM for DC voltage measurement.
- Prepare 1 Battery and 4 Resistors (1KΩ5W).
- Battery can be reversely connect to achieve negative values.
- Connect as diagram to achieve various voltage values for calibration.

Please follow the universal procedures in Section **9.1** to perform Auxiliary Voltage Channel Calibration. Please refer to following table for recommendation of Device and Calibration Points.

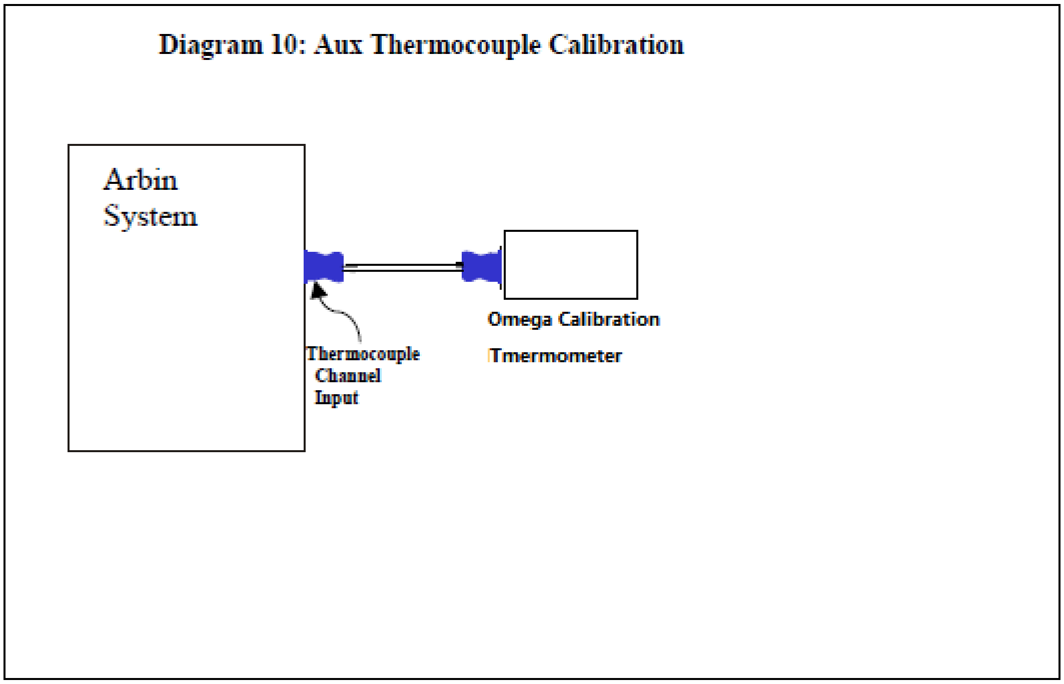
Aux Voltage Range	Recommended Battery	Recommended Calibration Points			
		Point 1	Point 2	Point 3	Point 4
-1V to 1V	1.2V	1 resistor	3 resistors	Reversed battery 1 resistor	Reversed battery 3 resistors
-2V to 2V	2V				
-5V to 5V	6V				
-10V to 10V	12V				
-20V to 20V	24V				

Users may select different Calibration points for actual application range.

9.4 Auxiliary Thermocouple Channel Calibration

Use **Omega Calibration Thermometer** to verify the temperature accuracy. Input temperature values and read out the corresponding output values.

Connect the hardware as shown in the following diagram.



Please follow the universal procedures in Section 9.1Error! Reference source not found. to perform Auxiliary Thermocouple Channel Calibration. Please refer to following table for recommendation of Calibration Points.

Thermocouple Type	Temperature Range	Voltage Range	Recommended Calibration Points			
			Point 1	Point 2	Point 3	Point 4
T type	-200 ~ 400 °C	/	10° C	100° C	150° C	200° C
K type	-200 ~ 1370 °C	/	10° C	300° C	800° C	1200° C
Absolute Temperature Error		/	<1° C	<1° C	<1° C	<1° C

Table 9-1 Voltage Range of K-, T-TYPE Thermocouples at Specified Temperature Range and recommended calibration points.

If the absolute error is within +/- 1° C, it is acceptable. Absolute Error = Input Value – Reading Value

User may select different Calibration points per actual application range.

After all channels are done, use **Omega Calibration Thermometer** to verify the temperature accuracy. Input temperature values and read out the corresponding output values, for example, 10, 100 and 200 ºC shown inTable 9-2:

Temperature point	Temperature 1 [ºC]	Temperature 2 [ºC]	Temperature 3 [ºC]
Input Value	10	100	200
Reading Value	10.1	100.5	200.9
Absolute Temp. Error	0.1	0.5	0.9

Table 9-2 Input/Output Values from Omega Calibrator Thermometer.

If the absolute error is out of +/-1 ºC, user may input an average **Absolute Temp. Error** in the cell "**Physical Offset**" in the Auxiliary **Temperature** page of the system configure file (see **Figure 9-7** shown below). Adjust this Physical Offset until it makes the absolute error smaller than +/- 1 ºC.

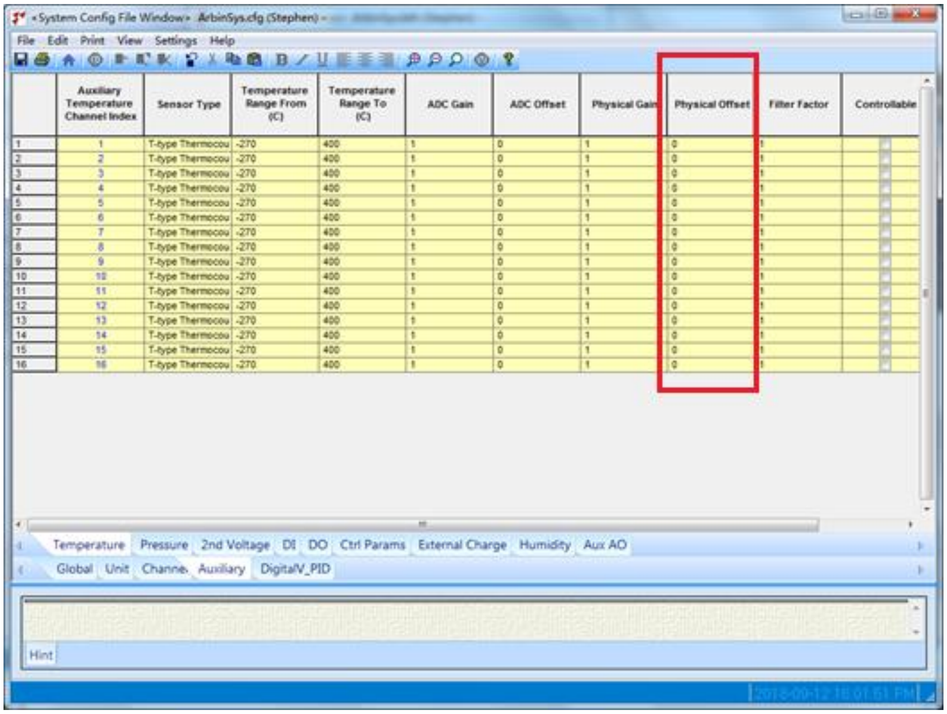


Figure 9-7 Auxiliary Page in System Configuration File

The regular thermocouples provided by Arbin cannot operate in temperatures higher than 200ºC. For higher temperature applications, the user can use compatible higher rated temperature thermocouples.

Once you have completed the calibration of the auxiliary temperature channels, you need to click the download button on the menu bar of this page. It will download the information to the MCU.
When you want to acquire the auxiliary information from the MCU, the user can click the upload button on the menu bar of this page. Then it will generate a new called McuSys.cfg. This file has saved the auxiliary hardware information.

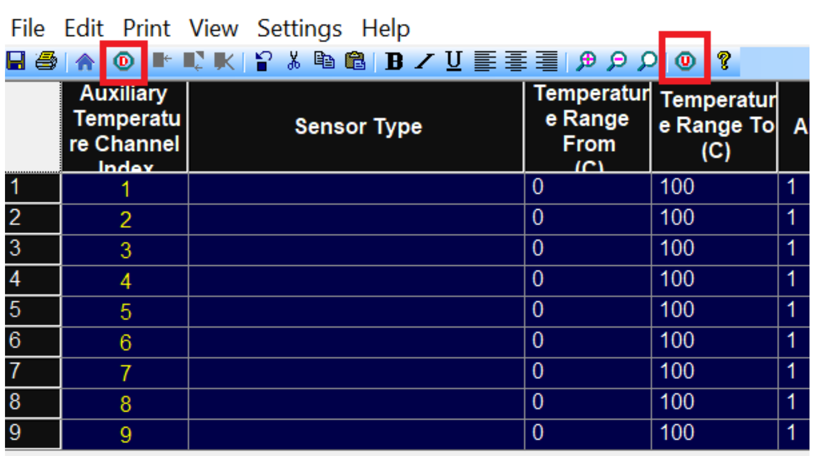


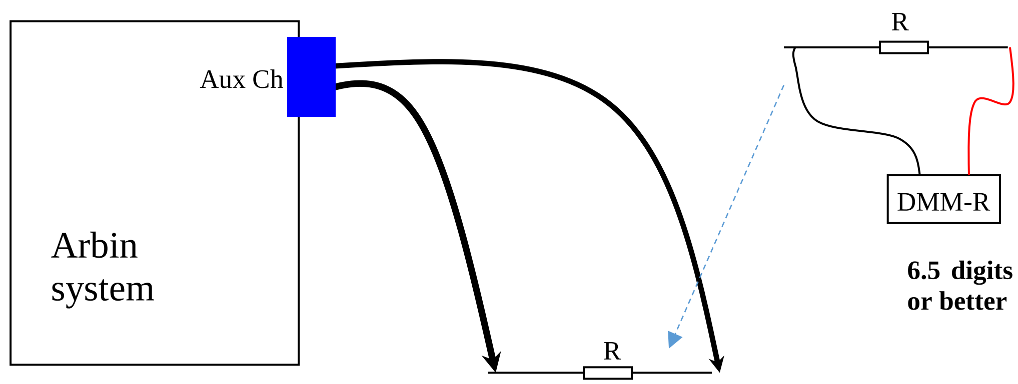
Figure 9-8 Download/Upload Config File to/from MCU.

9.5 Auxiliary Thermistor Channels Calibration

This calibration is aims to improve the measurement of the resistance signal from the thermistor. Arbin does not provide calibration for the thermistor itself. Hence, resistance signals are necessary for calibration to simulate thermistor output signals by a 6 ½ digits or batter multimeter.

Connect the hardware as shown in the following diagram.

Diagram 11: Aux Thermistor Calibration



Notes:

- Set DMM for resistance measurement, and measure the resistance of resistance, then plug into the auxiliary channel.
- Replace the resistor according as recommended calibration points to achieve various resistance signals.

Please follow the universal procedures in Section 9.1**Error! Reference source not found.**to process Auxiliary Thermistor Channel Calibration. Please refer to the following table for recommendation of Calibration Points.

Thermistor Type	Temperature Range	Resistance Range	Recommended Calibration Points			
			Point 1	Point 2	Point 3	Point 4
10K Thermistor	-80 ~ 150 ^{o}C	3558K ~ 237 Ω	50K Ω	10K Ω	3K Ω	1K Ω
PT100	-80 ~ 600 ^{o}C	18.52 ~ 332.79 Ω	90 Ω	120 Ω	150 Ω	180 Ω

Table 9-3 Different Calibration Points Per Actual Application Range

9.6 Auto Calibration

Auto Calibration requires **MITS Pro8.0** software, an Arbin testing system, an Arbin Auto Calibration Box, and a compatible digital multimeter (DMM, optional, see below). Comptatible digital multimere includes the HP34401A, HP34410A, HP3458A and Keithley 2000. There are two auto calibration modes: one requires a digital multimeter (Meter Mode) and the other one does not (stand-alone). Stand-alone auto calibration mode does not require a digital multimeter. Meter auto calibration mode required a digital multimeter. It is required that all tests to be stopped before attempting to use the Auto Calibration feature.

Hardware Setup for Meter Mode

Connect the hardware for meter mode as shown in the **Figure 9-9**. Please note that purpose-built bus bars with 4 connectors each (1 bus bar per **HS21044** channel board) are supplied with each auto calibration module. (The connector on earlier model testers may not match with this strip. If so, an optional adapter can be ordered.) Connect one end of the Arbin-supplied cable to the channel and connect the four alligator clips on the other end directly to the auto calibration board. Connect the alligators to the metal bar in accordance with the colored labels on the board. Connect the multi-meter to the computer COM port (1 or 2) with a serial cable. (The default COM port setting for auto calibration is COM1.) If COM1 of the tester is committed to other attachments, e.g. Smart Battery, then please disable that function before beginning calibration.

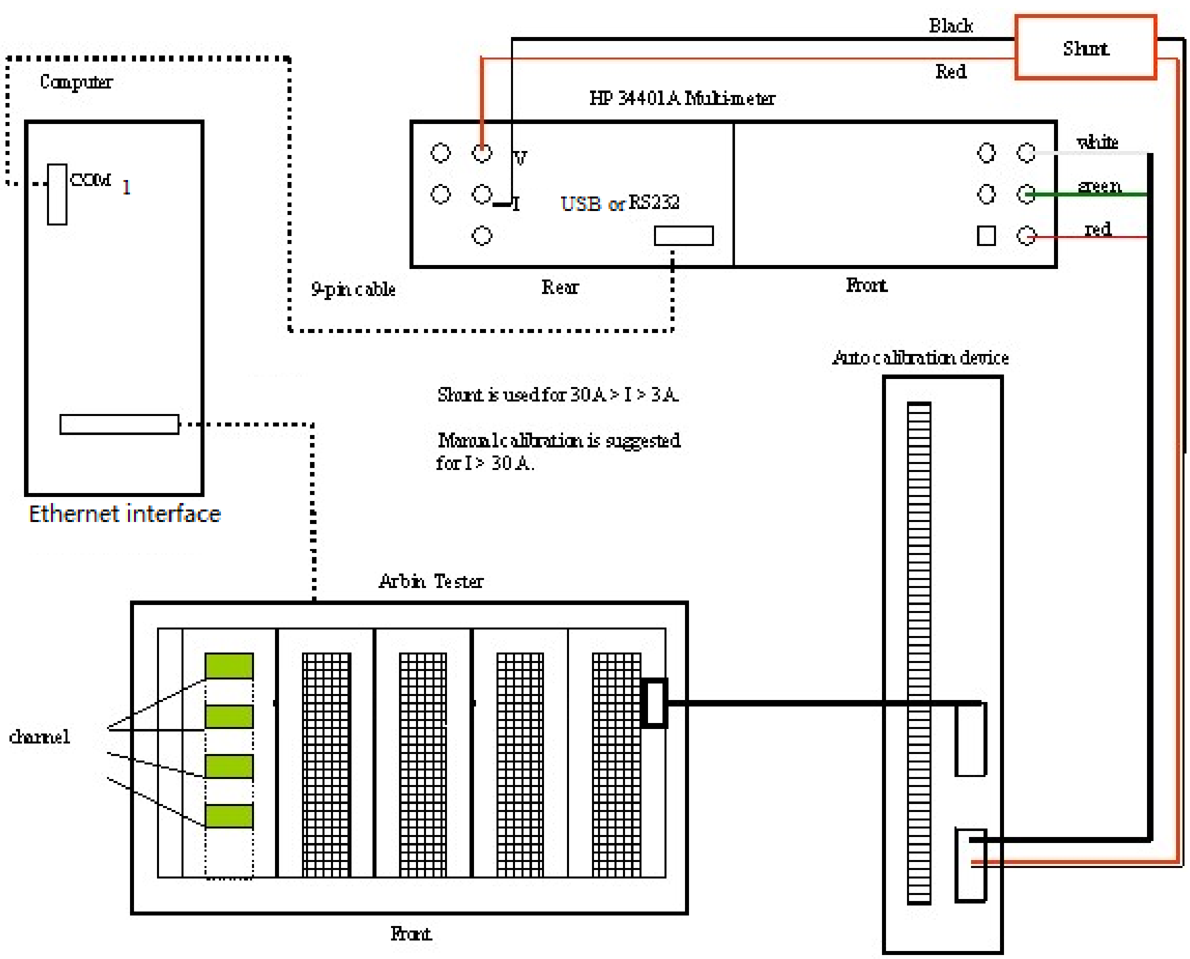


Figure 9-9 Auto Voltage, Current Calibration Hardware Setup Diagram for Meter Mode

One cable (USB cable for HP 34410A meter or 9-pin cable for HP 34401A meter) carries communication between the calibration system and the computer. When the current range is less than 3A, a 3-wire cord is used for current and voltage calibration. When calibrating current ranges greater than 3 Amperes, you must use an HP34330A current shunt (1mV~1A) and use the rear voltage measurement terminals. If the operator does not do so, the program will automatically prompt the user to correct the hardware setting. If the current range of the channels to be calibrated is greater than 20A, manual calibration is suggested.

Selecting the Remote Interface

The multi-meter is shipped with two interfaces: HP-IB/GPIB (IEEE-488) and RS-232. Only one interface can be enabled at a time. The HP-IB/GPIB interface is selected as the default setting, however, the RS-232 interface or USB interface is required for the Arbin Auto Calibration process. The following is a simple procedure on how to enable the RS-232 interface. (For more detailed information, please refer to your multi-meter User's Manual)

For HP 34401A:

1. Turn on the front-panel menu. **A: MEAS MENU** will be shown on the screen.
2. Move across to the I/O MENU choice on this level. **E: I/O MENU** will be shown on the screen.
3. Move down a level and then across to the INTERFACE command. **2: INTERFACE** will be shown on the screen
4. Move down to the "parameter" level to select the interface. Use the left/right arrow keys to see the interface choices. Choose RS-232.
5. Save the change and turn off the menu.

For HP 34410A/HP 3458A (see **Appendix G** for installing related third-party software and other information):

1. Turn on the front-panel menu. **A: MEAS MENU** will be shown on the screen.
2. Move across to the I/O MENU choice on this level. **E: I/O MENU** will be shown on the screen
3. Move down a level and then across to the INTERFACE command. **2: INTERFACE** will be shown on the screen
4. Move down to the "parameter" level to select the interface. Use the left/right arrow keys to see the interface choices. Choose USB
5. Save the change and turn off the menu

For Keithley 2000:

1. Access the RS-232 configuration by pressing SHIFT then RS232. **RS232: OFF** will be shown on the screen.
2. Move to the on/off selection by pressing the > key. The **OFF** selection will be blinking.
3. Turn on the RS-232 interface by toggling the selection to **ON** using the up or down key and press ENTER.
4. Press the up or down key to scroll to the **BAUD:<rate>** field. Press the > key to access this field. The **<rate>** selection will be blinking. Select **9600** and press ENTER to confirm.
5. Press the up or down key to scroll to the **FLOW:<control>** field. Press the > key to access this field. The **<rate>** selection will be blinking. Select **XonXoFF** and press ENTER to confirm.
6. Press the up or down key to scroll to the **TX TERM:<terminator>** field. Press the > key to access this field. The **<terminator>** selection will be blinking. Select **LF** and press ENTER to confirm.
7. Press EXIT to save the change and leave the configuration menu.

Launching the Auto Calibration Window

To Start Manual Calibration, click the following **Calibrate Hardware** icon  on the main window to enter the calibration screen. Then go to the **Auto Calib Settings** page.

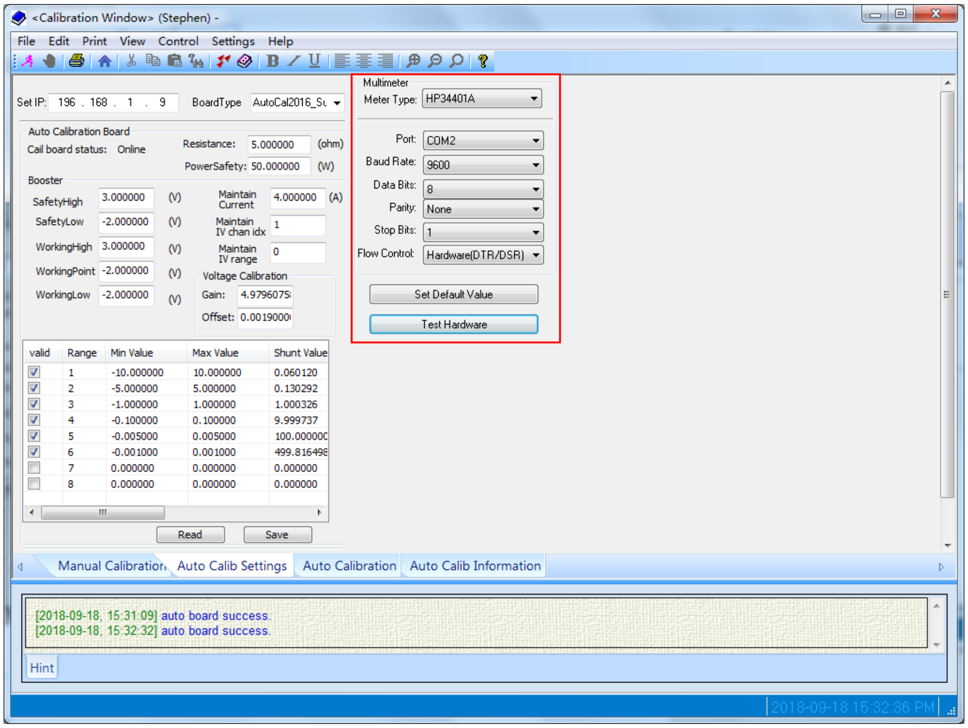


Figure 9-10 Auto Calib Settings Page– HP34401A Meter Using RS232

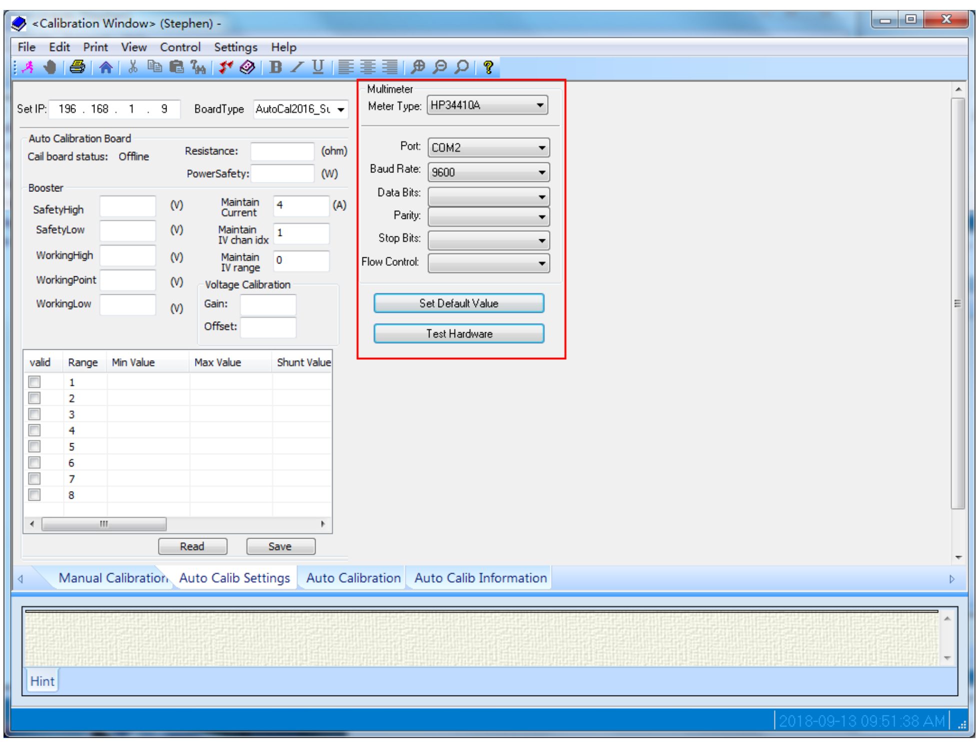


Figure 9-11 Auto Calib Settings Page HP34410A Meter Using USB. See Appendix G for Details

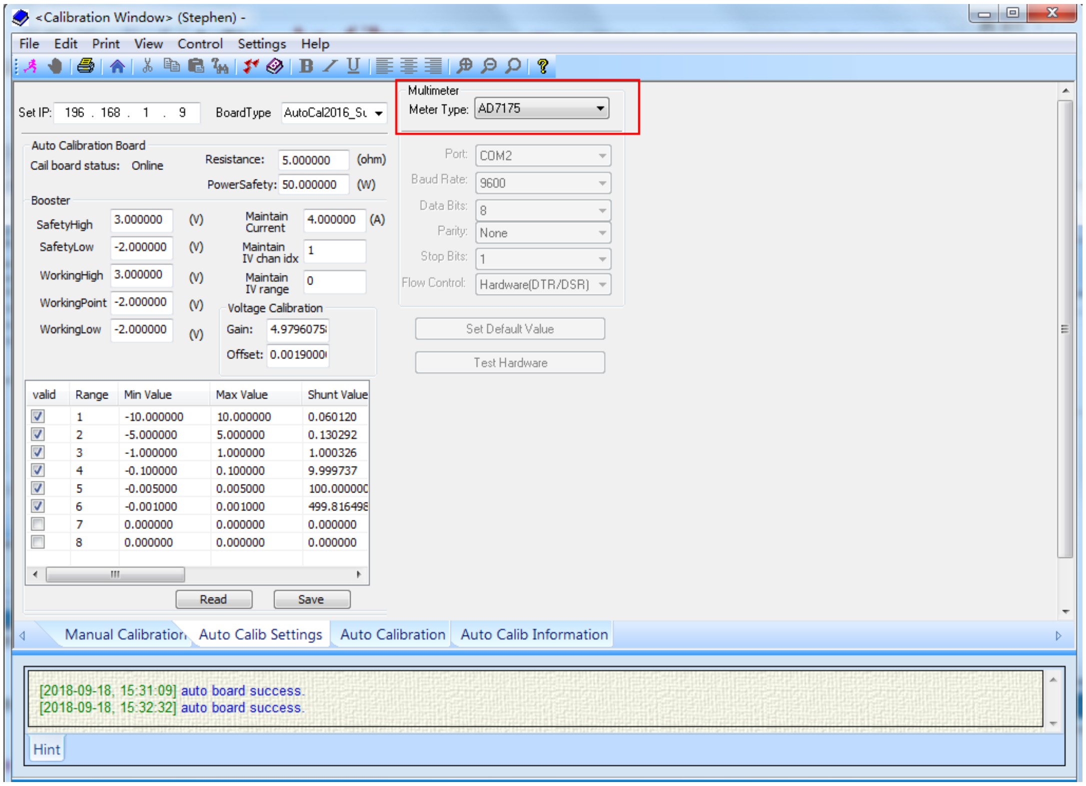


Figure 9-12 Auto Calib Settings Page AD7175 for Auto Calibration Board Mode

Hardware Test for Meter before Auto Calibration

Conducting a hardware test before auto calibration ensures that the connection is correct between hardware items and adjusts setting parameters of the auto calibration board and the multi-meter (Selecting auto calibration board mode can skip the testing part). The hardware test is done in the **Auto Calib Settings** window where all parameters have been established with default values. Follow the procedure below step by step.

1. Click icon  and go into **MITS Pro Auto Calib Settings** page. Select the correct COM port for the multi-meter. The default value is COM2. Keep other values intact unless notified by Arbin's customer service representative.
2. Turn on the power for the testing system, auto calibration board and multi-meter. Switch the multi-meter terminal to **Front** status.
3. Click the **Test Hardware** button. A hardware test includes a self-test of the multi-meter and the auto calibration board and tests of the cable and connection scheme. When cable tests are done, resistance of the shunt for current less than 1mA will be measured and filled in the settings window. If the test is not passed, then the user should be prompted to check the hardware connection and restart the multi-meter. Often, failures are a result of crossed connections with the I/V cable assembly. Check the configuration and re-test. If problems persist, then contact Arbin customer service.
4. All hardware testing parameters are saved in the file \Settings\Auto_Calib_Board.stg.

Upload Parameters from Auto Calibration Board

Uploading the parameters from auto calibration board ensures that the connection is correct between PC and auto calibration board. Follow the procedure below step by step.

1. Click icon  and go into **MITS Pro Auto Calib Settings** window. Input the IP address of auto calibration

board in the **Set IP** and select the **Board Type** of auto calibration board.

2. Click the **Read** button to upload the parameters of auto calibration board, **Cali board status** turns to online. Adjusts setting parameters of the auto calibration board and then click the **Save** button to write the parameters in auto calibration board.

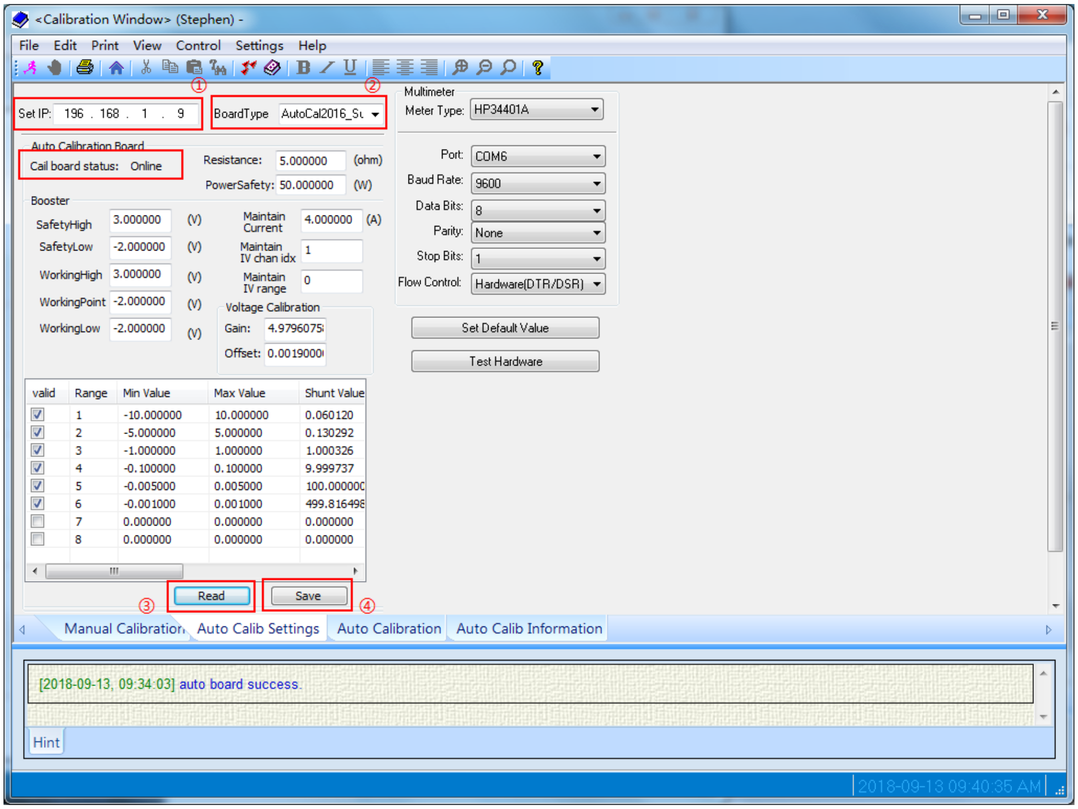


Figure 9-13 Read Auto Calibration Board Parameters

Auto Calibration Settings

After a successful hardware test (Meter Mode only), switch to the **Auto Calibration** window where all auto calibration parameters are located. All auto calibration parameters described below are saved in the file \Settings\Auto_Calib_Param.stg. If the software will not permit switching to the **Auto Calibration** page successfully, delete the existing Auto_Calib_Param.stg and then try again.

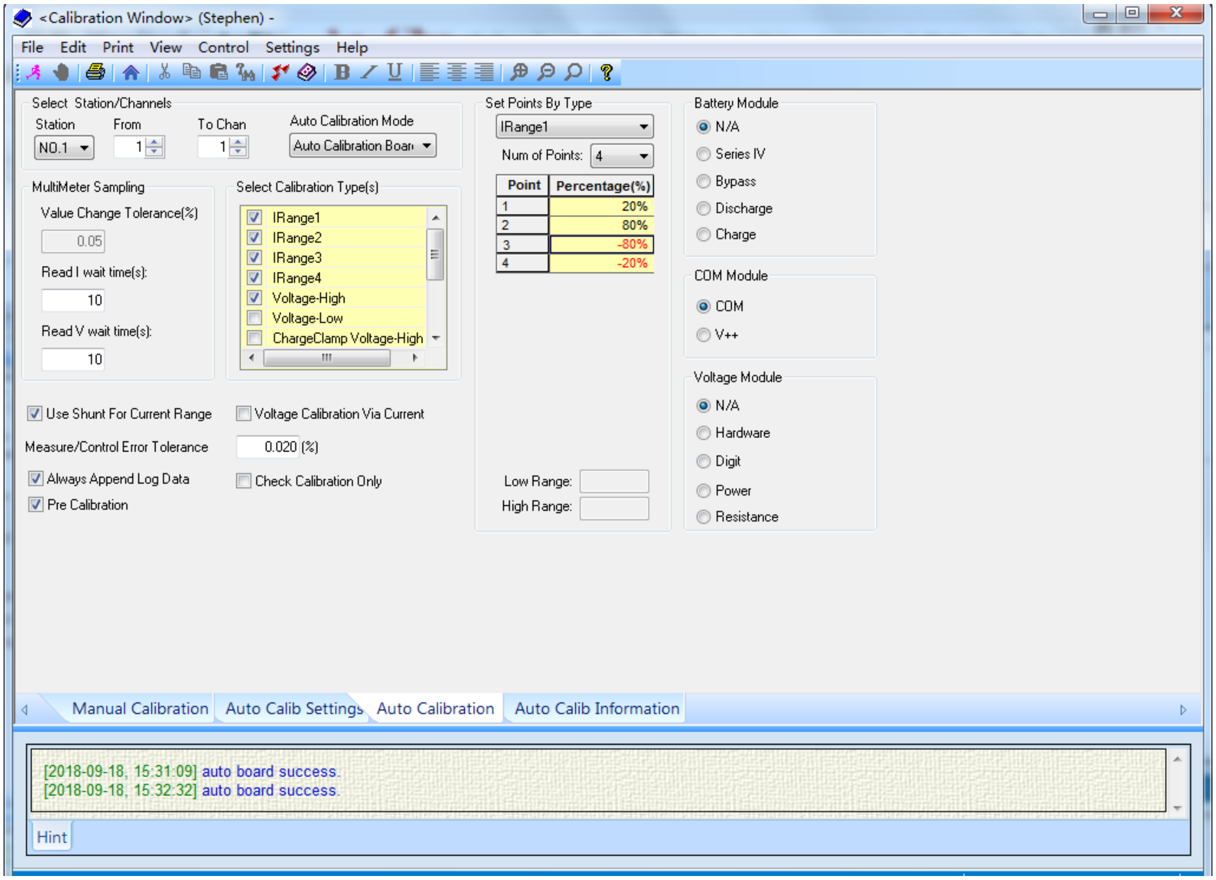


Figure 9-14 Auto Calibration Page in Calibration Window

Fill in the following general settings as instructed below.

1. Select Station/Channels settings:

   Select Station (Data Acquisition Unit) No. It is always 1. Auto calibration cannot be accomplished for multiple stations at the same time.

   Select a channel range for auto calibration.

2. Select Calibration Type(s) setting:

   Select type, current range, and Voltage-High range for auto calibration. Those channel types not included in the current system configuration are disabled in the type list.

3. Auto Calibration Mode setting:

   Select mode, the new auto calibration board can calibrate channels without a multi-meter. When selecting Auto Calibration Board that mode means auto calibrates channel sampled by auto calibration board instead of multi-meter.

4. Multi-Meter Sampling settings:

   Value Change Tolerance (%) (% of channel's full range scope) - reflects the stability of the sampling values read from the multi-meter. Sampling values will be kept in a buffer, and the difference between the largest and smallest values among them will be selected for comparison with the tolerance percentage of the channel's full range scope. These values only apply to current, voltage and auxiliary voltage auto calibration. The default value is 0.05, and useless in MITS 8.0.

   Read I wait time(s) - refers to the time interval for checking the meter reading. Each value will be read at the input-value intervals. The default value is 30. This means that values will be sampled by the multi-meter for each 30 seconds.

   Read V wait time(s) - refers to the time interval for checking the meter reading. Each value will be read at the input-value intervals. The default value is 120. This means that values will be sampled by the multi-meter for each 120 seconds.

Use Shunt for Current Range - This switch permits the user to verify the calibration of current range with the shunt of auto calibration board, it's only related with current calibration.

Voltage Calibration via Current - This switch permits the user to verify the calibration of voltage range via current. If uncheck the box, the traditional way of voltage calibration will be used, it's only related with voltage calibration.

Measure/Control Error Tolerance - Refers to the accuracy of the auto-calibration. (Refer to the individual machine specification. The default value is 0.1%). This value is used when calculating measurement error and control error.

Always Append Log Data –All auto calibration data are saved in the file\HTML\Auto_Calibration_Log.dat. Check the option to append data to file, otherwise the previous data. This log file (Auto_Calibration_Log.dat) can be opened in **Auto Calib Information** Window or opened using any text editor or spreadsheet editor.

Check Calibration Only - This switch permits the user to verify the calibration without editing the constants in ArbinSys.cfg.

Set Points by Type - checks channel types to be auto calibrated. Those channel types not included in the current system configuration are disabled in the type list.

Current Auto Calibration

Current auto calibration includes Range1, Range2 and Range3 calibration, if available in the hardware. Check the types in the calibration type and set number of points and point's data for each range. Typical values for Num of Points: are 6 with **Percentage (%)** values corresponding to -20%, -50%, -80%, 20%, 50%, 80% of full-scale range (FSR). Values may be changed by entering the desired percentage in decimal form (eg. -0.20=-20%).

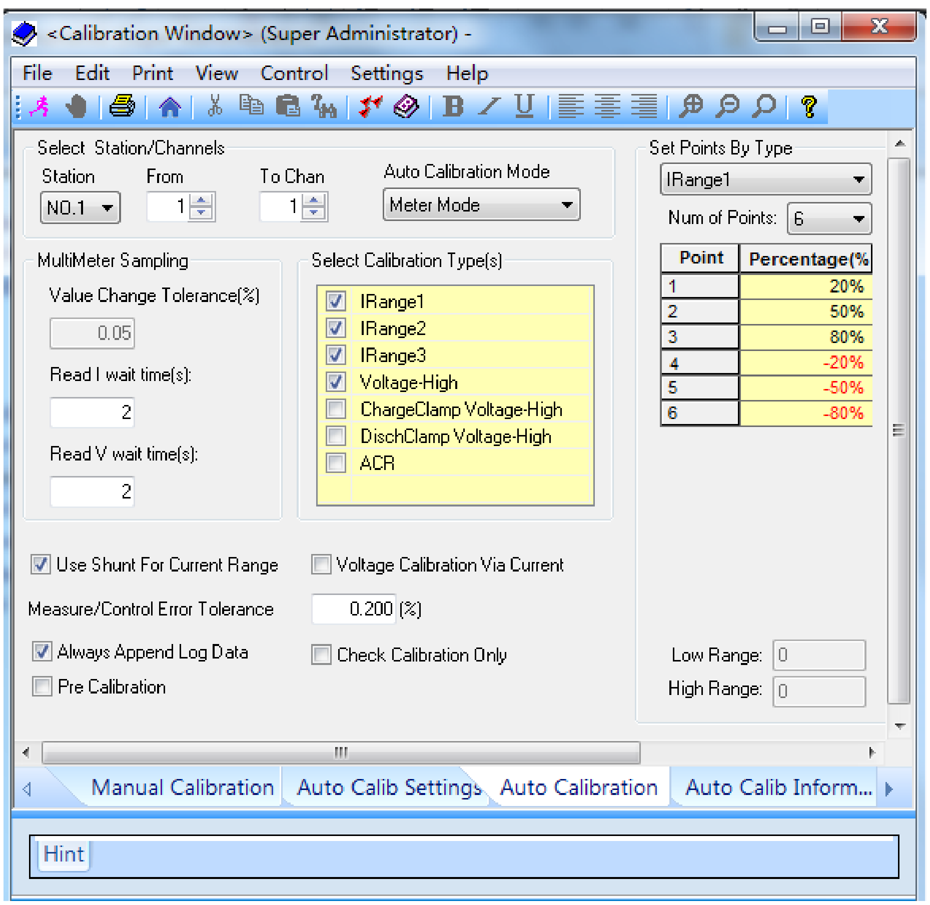


Figure 9-15 Set Points Data for Current Auto Calibration

Auto Calibration of Voltage

Low and High values of the voltage range must be filled in. Please refer to the label on the hardware for voltage specifications. Select Voltage-High in the calibration type; set number of points and points data for each range. Typical values for Num of Points: are 6 with **Percentage (%)** values corresponding to -20%, -50%, -80%, 20%, 50%, 80% of full-scale range (FSR).

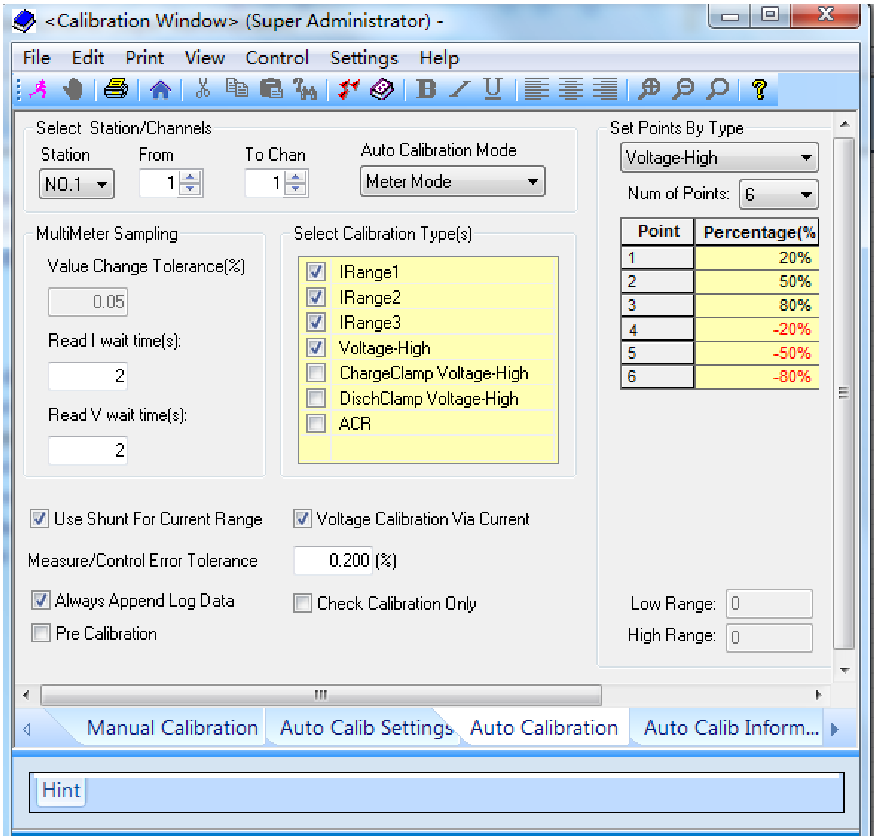


Figure 9-16 Set Points Data for Voltage Auto Calibration

Starting Auto Calibration

After all parameters have been filled in, click the Start Auto Calibration icon on menu to start auto calibration.

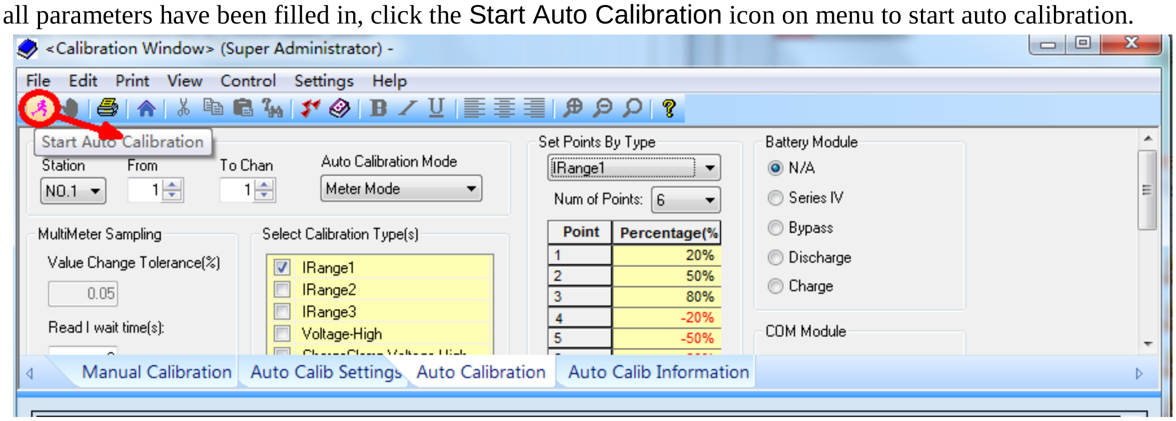
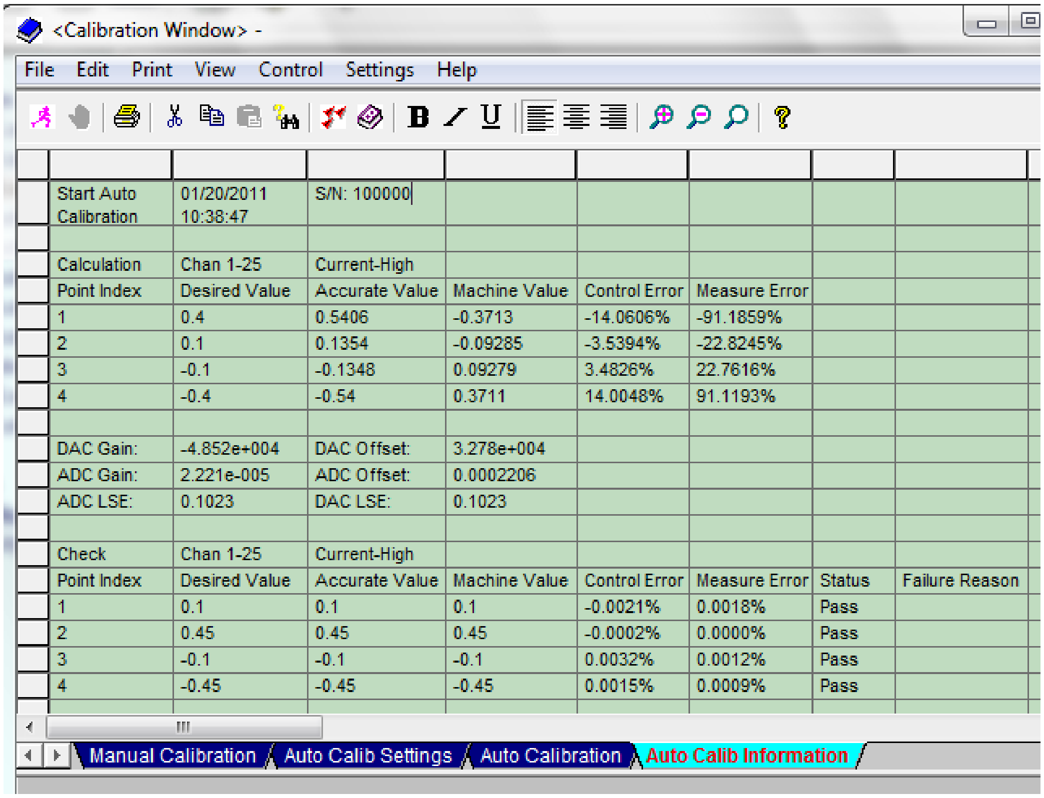


Figure 9-17 Start Auto Calibration Icon

The **Auto Calib Information** page will be invoked and will display data from and indicate the progress of auto calibration.



Start Auto Calibration	01/20/2011 10:38:47	S/N: 100000					
Calculation	Chan 1-25	Current-High					
Point Index	Desired Value	Accurate Value	Machine Value	Control Error	Measure Error		
1	0.4	0.5406	-0.3713	-14.0606%	-91.1859%		
2	0.1	0.1354	-0.09285	-3.5394%	-22.8245%		
3	-0.1	-0.1348	0.09279	3.4826%	22.7616%		
4	-0.4	-0.54	0.3711	14.0048%	91.1193%		
DAC Gain:	-4.852e+004	DAC Offset:	3.278e+004				
ADC Gain:	2.221e-005	ADC Offset:	0.0002206				
ADC LSE:	0.1023	DAC LSE:	0.1023				
Check	Chan 1-25	Current-High					
Point Index	Desired Value	Accurate Value	Machine Value	Control Error	Measure Error	Status	Failure Reason
1	0.1	0.1	0.1	-0.0021%	0.0018%	Pass	
2	0.45	0.45	0.45	-0.0002%	0.0000%	Pass	
3	-0.1	-0.1	-0.1	0.0032%	0.0012%	Pass	
4	-0.45	-0.45	-0.45	0.0015%	0.0009%	Pass	

Figure 9-18 Auto Calibration Information Window

Auto Calibration Log data file will be saved as a new name for each auto calibration. All the logged data files are saved in the folder of C:\ArbinSoftware\MITS_Pro\Support\AutoCalib.

Calibration Procedure for Auto-Calibration Box

Table of Contents:

Figure 9-19 Auto-Calibration Box

I. Introduction to Auto-Calibration Box and Calibration Procedure

The Auto-Calibration Box (ACB) is used to calibrate the IV channels of an Arbin Tester machine. The ACB physically connects to the Arbin Tester with an IV cable and to a high precision digital multimeter. MITS Pro software controls the ACB process of calibrating the IV channel.

To calibrate the ACB, two high precision digital multimeters are required. A high precision digital multimeter includes the Keysight 3458A and the Fluke 8508A meters. One meter is used to measure the accurate current while the other one is used to measure the voltage across the shunt inside the ACB. Accurate current can be measured with two methods depending on the current range being calibrated. The first method is used for current ranges larger than 100mA consists of converting the voltage reading from the accurate reference to a current reading using Ohm's Law.

$$I_{Accurate} = \frac{V_{Reference}}{R_{Reference}}$$

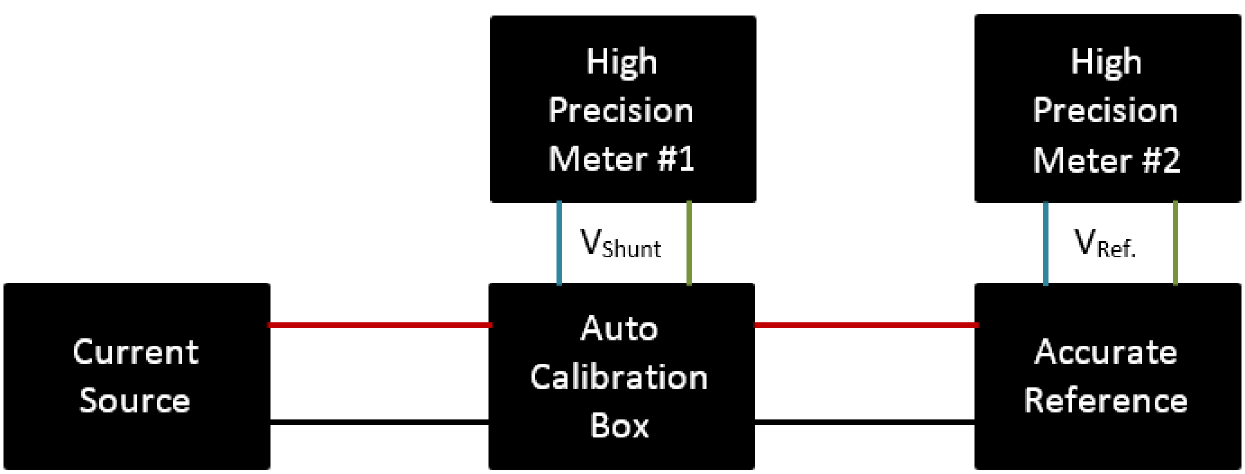


Figure 9-20 Calibration method for Currents Ranges higher than 100mA.

The second method is used for current ranges smaller than 100mA; the high precision digital multimeter current reading is considered the accurate meter.

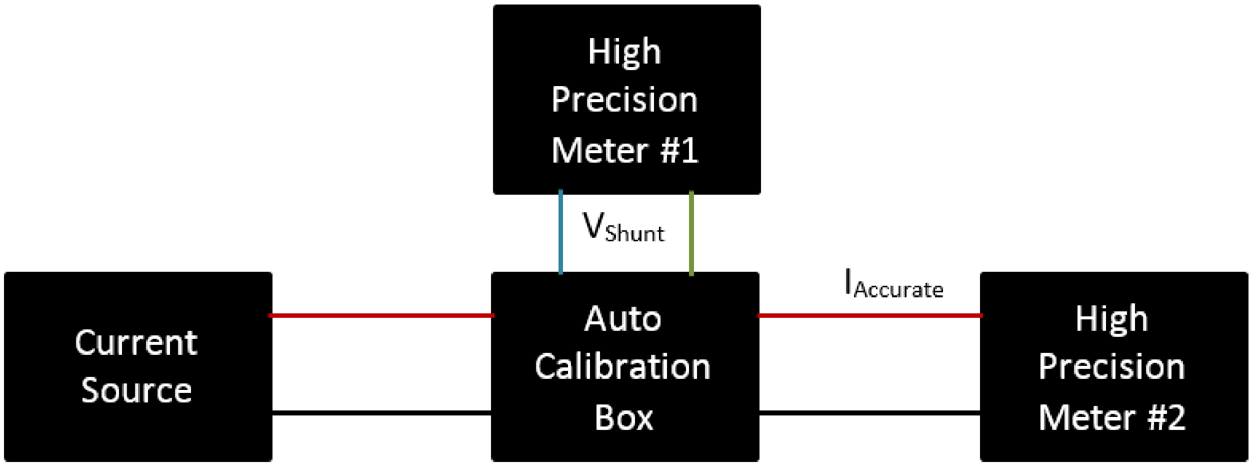


Figure 9-21 Calibration method for Current Ranges smaller than 100mA.

II. Calibration for Current Ranges (300A to 300mA)

A current comparator and a standard resistor are used for large current ranges. The primary current is connected in series with the ACB and the current source, and the secondary current is connected in series to a standard resistor. Both high precision digital multimeters are connected in a DC-Voltage configuration. Meter #1 reads the voltage across the precision shunt inside the ACB, and meter #2 reads the voltage across the Standard Resistor.

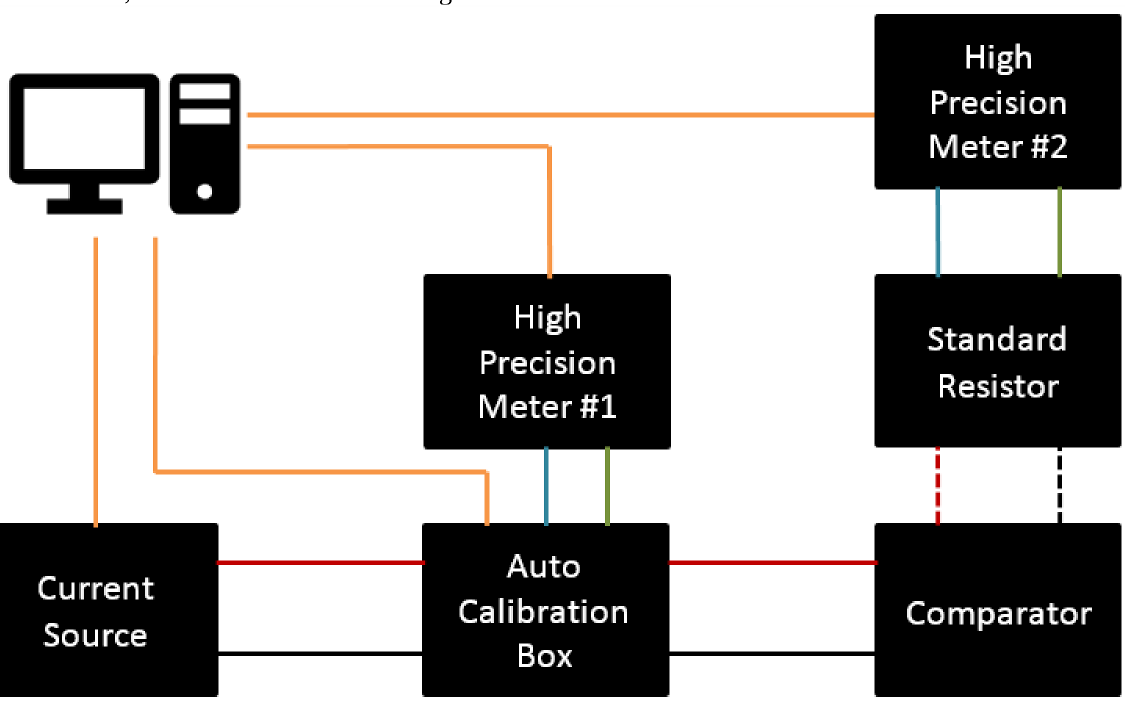


Figure 9-22 Calibration setup using the Current Comparator and Standard Resistor.

III. Calibration for Current Ranges (300mA to 100mA)

For smaller current ranges (between 300mA to 100mA) only the standard resistor is used and is connected in series with the ACB and the current source. Both high precision digital multimeters are connected in a DC-Voltage configuration. Meter #1 reads the voltage across the precision shunt inside the ACB, and meter #2 reads the voltage across the Standard Resistor.

IV. Calibration for Current Ranges (Below 100mA)

For smaller current ranges smaller than 100mA the high precision digital multimeter #2 is connected in series with the ACB and the current source. Meter #1 is connected in a DC-Voltage configuration while meter #2 is connected in a DC-Current configuration. Meter #1 reads the voltage across the precision shunt inside the ACB, and meter #2 reads the accurate current directly.

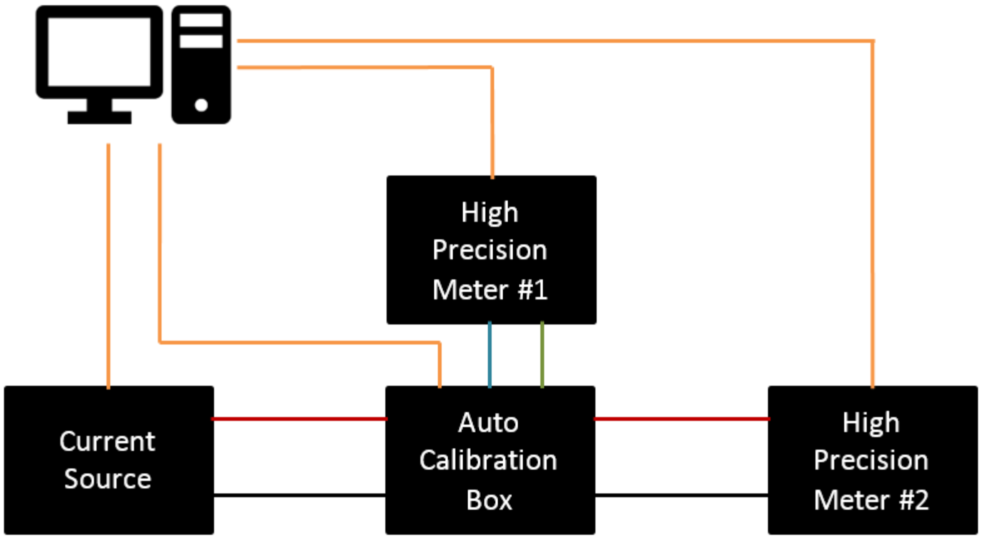


Figure 9-23 Calibration setup for current ranges smaller than 100mA.

V. Calibration using Arbin Shunt

When using the Arbin Shunt as the accurate reference, connect the Arbin Shunt in series with the ACB and the current source. Both high precision digital multimeters are connected in a DC-Voltage configuration. Meter #1 reads the voltage across the precision shunt inside the ACB, and meter #2 reads the voltage across the Arbin Shunt.

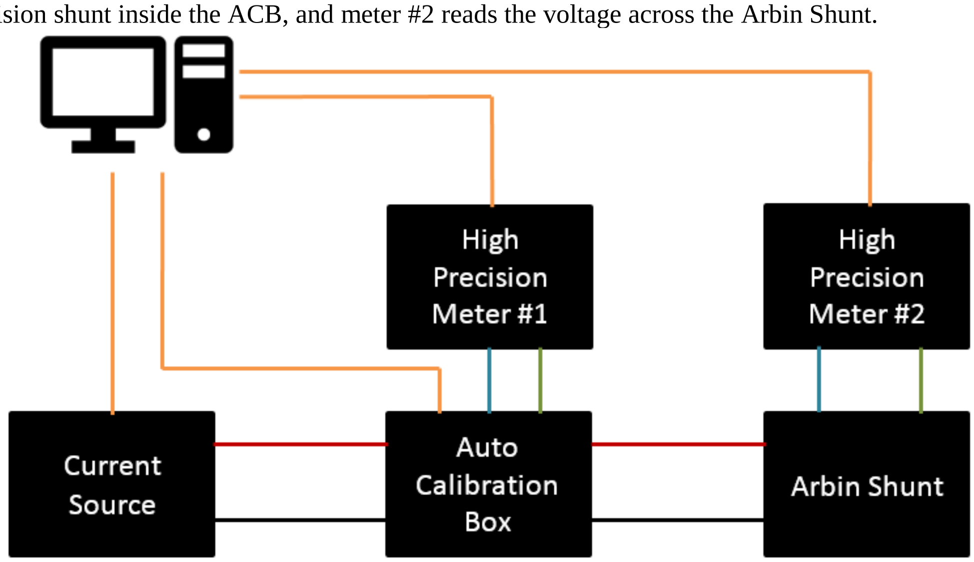


Figure 9-24 Calibration setup when using the Arbin Shunt.

VI. Calibration Data Processing

A 6-point calibration is performed for the ACB this includes: +90%, +60%, +30%, -30%, -60%, and -90% of the current range being calibrated. A sample data processing of this procedure is shown below for a current range of 5A.

Step 1: Data Collection

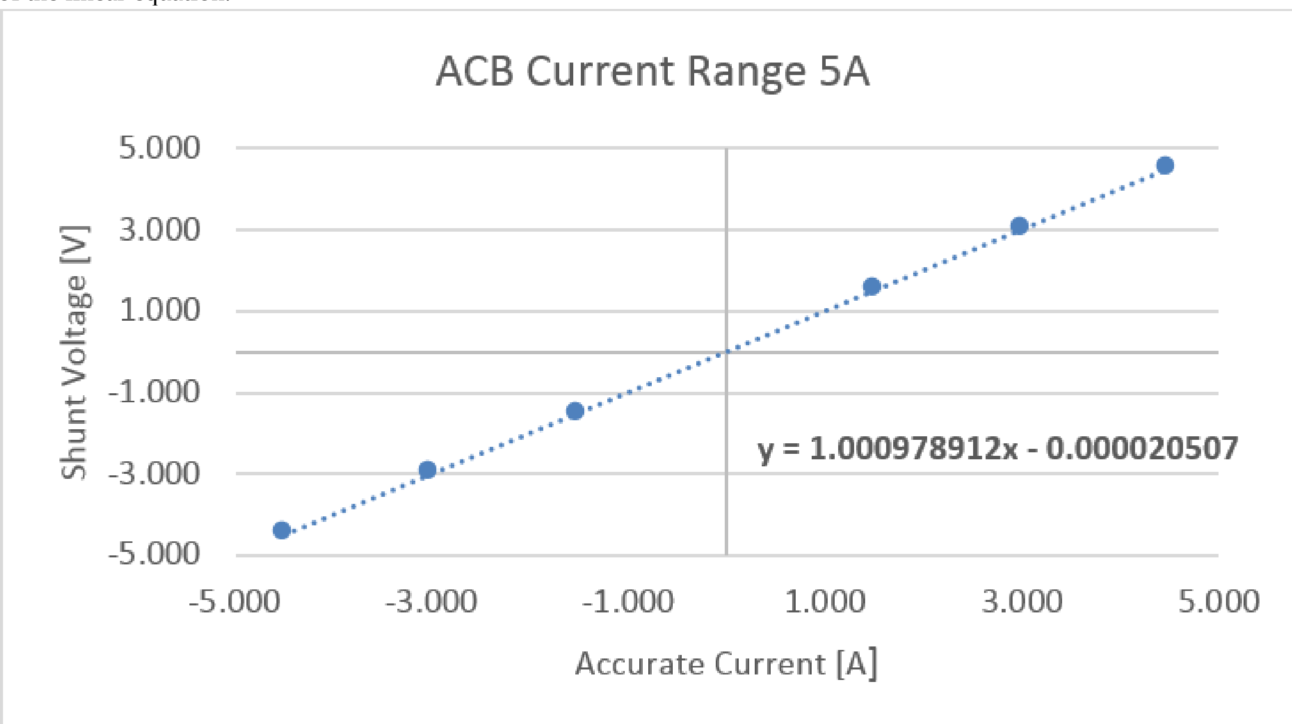
Input the nominal Shunt Value and an Offset of zero for the current range being calibrated.

Nominal Shunt Value	0.130
Nominal Offset	0

Data Point	Current Range	Test Current [A]	ACB Meter	Accurate Meter	
			Shunt Voltage [V]	Reference Voltage [V]	Reference Current [A]
1	90%	4.500	4.504 581	0.315 063	4.500 166
2	60%	3.000	3.002 779	0.210 033	2.999 879
3	30%	1.500	1.501 491	0.105 037	1.500 054
4	-30%	-1.500	-1.501 784	-0.105 004	-1.500 274
5	-60%	-3.000	-3.003 031	-0.209 998	-3.000 059
6	-90%	-4.500	-4.504 664	-0.315 022	-4.500 271

Step 2: Calculate the Shunt Value and Offset

Graph the Shunt Voltage with respect to the Accurate Current and add a linear trendline. The Shunt Offset is given by the second term of the linear equation. The Shunt Value is calculated by multiplying the Nominal Shunt Value by the first term of the linear equation.



Shunt Value	0.130 127 259
Offset	0.000 020 487

Step 3: Verification of Shunt Value and Offset

Input the Shunt Value and Offset from step 2 and repeat step 1. Compare the ACB Current reading and the Accurate Current reading. If the differences between them are below 25ppm the values are valid.

Chapter 10 An Overview of the Hardware

Disclaimer: This chapter attempts to describe all possible configurations for the LBT Series research instrument. Mention here does not guarantee the presence of a given feature or component in the user's system. Please refer to the Arbin Sales Order and the CUSTOMER ORDER SPECIFICATION SHEET found in the **Getting Started with Arbin Testing System** section of this manual for actual system specifications.

Equipment repair and servicing must be performed by authorized Arbin personnel.

The LBT Series system is a fully functional testing system, which is designed specifically for the research/development of batteries with various chemistries. This design comports flexible control, comprehensive function and smooth transition between different control modes, as well as preventive safety and system reliability. Moreover, it provides individual control for each potentiostatic/galvanostatic channel.

10.1 Construction of the Hardware

System Assemblies

LBT Series testers are based on a modular design with a few basic assemblies used to build a complete chassis. Basic assemblies include a DC control power supply, IV channel boards with MCU, Charge/Discharge power supplys, controller PC, and/or Auxiliary chassis. LBT series testers communicate via standard TCP/IP communications protocol using a series of static IP addresses. LBT Series hardware can be catagorgized as low power, medium power or high power roughly based on the system’s IV channel output power.

DC Control Power Supply Assembly

The DC control power supply assemblies are used to power on and off the main Arbin chassis. It typically will comprise of a Green On/Off switch and an EMO (Emergency Machine Off) switch. In addition to turning the Arbin chassis on and off, the assembly also provides control power to the IV channels control circuit.

IV Channel Boards

IV channel boards are used to regulate Current/Voltage via software control between the Arbin tester and and the device under test. Low power IV channel boards will typically have more than 1 controllable channel per board and the charge/discharge power supply can be part of the board assembly. Low power boards can have either 1/2/4/8/16 channels per board. Each board will have 1 or more microcontrollers (units). Medium power boards will typically have 1 or 2 channels per board with 1 microcontroller per board. High power boards will have 1 channel per board, or a single channel is created from multiple parallel boards.

Charge/Dicharge Power Supply Assembly

All Arbin testers have some combination of charge/discharge power supplies. These power supplies are used as the power source between the IV channel’s and the device under test (DUT). Charge power supply provides charge current to the DUT and discharge power supply provides discharge current to the DUT. The number of charge/discharge power supplies used in a chassis is dependent on many variables such as facility power requirements, number of IV channels, power per channel, and other variables at the point of sale and engineering design.

Controller PC

The controller PC duty is to interface between the end user and the Arbin Tester through the MITS Pro software. The controller PC is used to write test schedules, run tests, and perform data analysis. While much of the processing power of running test have been moved to the microcontroller level, the controller PC still requires full time connection to the Battery tester for proper operation.

Auxiliary/Accessories Assembly

The LBT series offers a large variety of Auxiliary options. Auxiliary channels are selected based on the customer's testing needs. Arbin has some auxiliary channels designed into the IV channels while other auxiliary options are provided by an auxiliary box external to the main Arbin chassis. Auxiliary assembly can be configured in a large variety of ways depening on the auxiliary option selected at purchase. Please see sales documentation for available auxiliary options.

Low Power

Low power systems typically will have multiple IV channels per mondule with a single charge/discharge power supply that will provide power to all IV channels. Each module can have 1 or more microcontrollers per module. The number of microcontrollers can range based on the testing needs. Pulse and simulation testing will require more microcontrollers per module while battery cycle test can be perfomed with a single micronctroller per module.

An example of a low power module can be found in figure 10.1. From the figure the DC control power supply, IV channel module, and chage/discharge power supply has been integrated into one assembly.

Figure 10-1

For systems requiring a higher number of IV channels, the low power assembly can be installed into a larger chassis. In this configuration each individual assembly will be connected to a DC control power supply that is used to swich all assemblys on and off via a single green power switch. In some cases, depending on the total facility power requirements the larger chassis may have additional AC circuitry such as breakers, contactors, and additional wiring to provide AC power to each assembly. Communications networks are typically wired external to the main chassis assembly. **Figure 10-2** is an example of the same lower power assembly installed into a larger chassis with a DC contoler power supply, and a HUB for communications between all power assemblies.

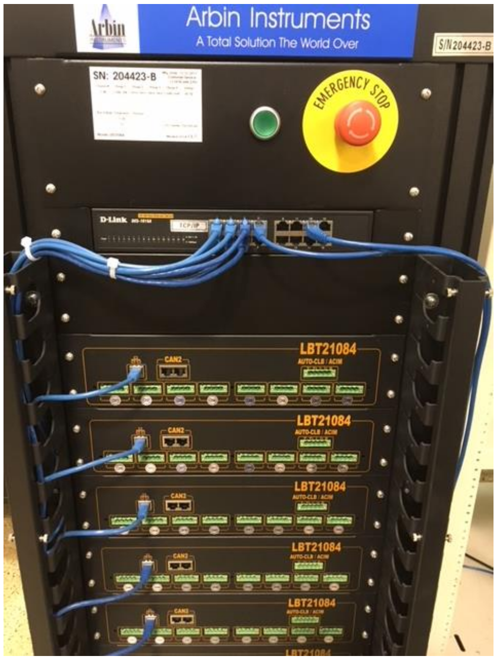


Figure 10-2

Medium Power

Med power systems will typically have 1 to 8 IV channels per module. Each module will generally have 1 microcontroller per module. For med power systems the DC control power supply and charge/discharge power supplies are separated from the IV channle modules. Depending on many variables the construction of a complete system can have 1 charge/discharge power supply assembly to multiple IV channel modules or 1 charge/discharge power supply assembly to 1 IV channel module. In most cases there will be only 1 DC control power supply assembly used to power the complete system on and off via a green power switch. **Figure 10-3** is an example of a med power system.

Figure 10-3

From F**igure 10-3** each IV channel module has a dedicated charge/discharge power supply assembly. Due to the higher power, the charge/discharge power supply assemblies have protection breakers located on each assembley. The system has 1 DC control power supply used to power on/off the Arbin chassis. In this configuration the TCP/IP communications cables and HUB have been re-located to inside the main chassis. The top left panel is comprised of TCP/IP network ports for connecting the controller PC and any Aux chassis that may be part of the system.

Figure 10-4

Figure 10-4 is an example of a med power chassis that has 8 channels per IV module and uses the same charge/discharge power supply assembly for 2 IV channel modules. A total of 16 IV channels utilize the same charge/discharge power supply. The Arbin system has 1 DC control power supply used to power the chassis on/off via a green power button. In this example the TCP/IP communications is connected externally to the Arbin chassis using a HUB.

High Power

High power systems can be comprised of linear circuitry or PWM circuitry. Linear circuitry is generally the use of a series of MOSFET’s as the power regulation circuit between the Arbin system and the DUT. MOSFET’s dissipate unused power via heat. For high power systems a large amount of heat can be produced using linear circuitry. PWM technology takes advantage of IGBT’s which can be used to convert the un-used energy back to AC power and places it back onto the customers AC power grid. For many years, high power systems were designed using complicated linear circuitry design, due to newer IGBT technology more high power systems are taking advantage of the PWM technology. High power Arbin systems are more complicated in design but still utilize the same basic building blocks of a system.

Most high-power systems will have fewer channels per chassis with one or more IV boards connected in a parallel to build a single high power channel. IV channels will have 1 or more microcontroller boards depending on features purchased.

Figure 10-5

Figure 10-5 shows an example of a 2 channel PWM chassis. Each PWM chassis will have different charge/discharge power supply designs depending on the system and facility requirements. PWM systems use internal TCP/IP communications structure with the HUB located inside the main chassis. Communications ports are used to connect the controller PC to the system and Aux channles depending on the option choosen.

Channel output Connection Mode

Arbin systems utilize various types of Pheonix connectors, lugs, and twist lock connectors to interface between different IV channels and DUT's. Arbin also offers custom built cable solutions to meet testing needs. Cable lengths can range from 6 feet to several feet. It's recommended to use the shortest cable possible to meet the testing need. Longer cables will pick up noise and may reduce the Arbin's ability to accurately control current. Voltage drop across a longer cable will also require a higher compliance voltage from the Arbin tester.

Typically, low power systems us Pheonix connectors as the IV channel cable connection method. Different Pheonix connectors are used based on the current rating of the lower power IV channel boards. Typical connectors are 10A, 20A, and 50A connectors. Low power systems have the option to terminate cables with alligator clips, ring terminals, or bare wire as desired by the customer. Medium power system will use either Pheonix connectors or cable lugs depending on the current requiremnts. These cables typically terminate with larger alligator clips or lugs. High power systems will generally use twist lock connectiors to connect to the IV channel and terminate with lugs. High power cables are built as short as possible to meet the customers testing needs.

All Arbin IV channel cables regardless of their power rating will utilize 4 connections to the DUT. Two smaller cables are used to measure the battery voltage and will come with various colors. The more standard colors for the voltage cables are white (V+) for the positive connection to the battery and green (V-) for the negative connection to the battery. The two larger cables are used to carry the charge and discharge current. Current cables are typically red (I+) for the positive battery connection and black (I-) for the negative battery connection. This connection scheme is often called the 4-point Kelvin connection.

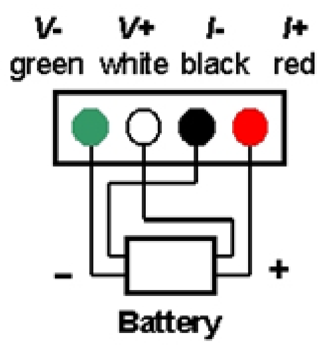


Figure 10-6

Figure 10-6 is an example of the 4-point Kelvin connection between a low power IV channel and a battery. In general, the best possible connection is to connect the voltage senser leads as close to the battery terminals as physically possible followed by the current leads. It's important to note that connecting to a battery in any other configuration may or may not cause issues with the Arbin's current/voltage control circuits.

Power Supplies

The newer LBT tester design uses 2 basic power supplies, DC control power supply and the charge/discharge power supply. The DC control power supply is used to switch on main arbin chassis. The DC control power supply typically has input voltage range from 90 to 230 VAC. The ouput of the DC control power supply is generally a 24V DC signal that is used to supply power to the IV channel board assembly and provide a 24V DC turn on signal to the the charge/discharge power supply. The DC control power supply is identified by the Green Power on/off switch on the front panel and the EMO (Emergency Machine Off) switch. In the most common configuration, the Arbin system will have 1 DC control power supply assembly.

Charge/Discharge power supply assembilies are mostly designed by Arbin. There are many different configurations for the charge/discharge power supply assembly. Factors that determine the assembly used in an Arbin system include facility AC power requirements, total IV channel power requiremnts, and other variables. AC Input voltage can range from 110V/220V single phase to various three phase voltages. Regardless of the AC input voltage and the DC output voltage of the power supply assembly the primary purpose is the same. The Charge/Discharge power supply assembly is used to provide the charge and discharge current to the device on test via the regulation circuit (IV channel). The same power supply can be used as the power source for 1 or more IV channels. The standard charge/discharge power supply will have an input voltage/current rating followed by a output voltage and max current rating for both charge and discarge power. During the engineering phase of the chassis assembly engineers will connect as many IV channel board assembiles without exceeding the charge/discharge power supply rating.

Fuses and Breakers

The DC control power supply is generally fused at the AC input terminal. The input terminal has a serviceable fuse that can be replaced in the case of an over current condition.

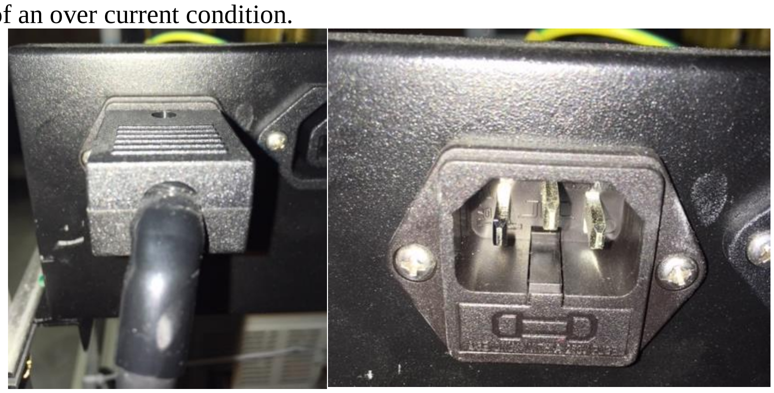


Figure 10-7

Figure 10-7 shows the typical fuse location of the DC control power supply. The plastic piece that shows the fuse symbol can be removed to gain access to the fuse. The fuse rating will be different depending on the Arbin chassis configuration. To ensure the correct replacement fuse is used it’s best to use the existing fuse as the rating refrence.

Charge/discharge power supplies assemblies will have many different combinations of over current protection. Most power supply assemblies will have breakers to protect the individual assembly from an overcurrent condition. In larger systems that are composed of more than 1 power supply assembly a larger system level breaker/contactor circuit may exist as additional current protection. It’s important to follow the Arbin recommened breaker/power drop ratings for the facility protection circuits.

The LBT series testers do not have serviceable fuses for lower power IV channel board assemblies. Med and Higher power systems will in some occasions have protection fuses located near the front of the IV channel boards. Contact Arbin customer service for further information regarding fuse location and replacement procedure for IV channel board assemblies.

Cabinet Ventilation

All Arbin testing equipment is air cooled. Proper airflow is important to ensure that the equipment will meet published performance specifications. For the LBT series testers, the air flow is typically side to side for lower power systems and front to back for medium and high power systems. All systems are comprised of fan assemblies that will adjust the fan speed based on calculated power being utilized while testing. If an over temperature condition or damaged fan is sensed by the Arbin SW, the IV channel or channels will be stopped.

Warning- Operating the Arbin equipment outside of the recommended enviorment may reduce system performance; increase calibration frequency requirement; and reduce the lifespan of the electronic components.

The equipment is designed for the following enviorment conditions:

- Usage: Indoor
- Altitude: <3,000m
- Temperature: 10 ºC to 35ºC
- Maximum relative humidity: 80% for temperature up to 31 ºC decreasing linearly to 50% at 40 ºC, Non-Condensing.

10.2 Electrical Connections

System Connections

The Arbin LBT series testers have a wide range of AC power connection schemes. Please see production records for a specific Arbin serial number for specific power requirements. New system orders will have AC power information available during the sales process.

Channel Connections and Current, Voltage Sign Conventions

With any of the various proprietary Arbin Kelvin circuitry cell holders (optional), the operator may follow polarity designations and compare with installation instructions to verify connections. Two examples of cell holder connections are four-pin probes and lithium-polymer flat cell contacts. The probes are designed for cylindrical, button and coin cells and contact these cells independently on both opposing terminals. Similarly, the flat cell holders provide isolated I, V measurement for the foil tabs of lithium-polymer and plastic lithium ion cells. A ‘press-down’ tab protector will localize the cell tabs ensure continuity with the contact pad on the holder.

The sign convention for all charge and discharge current is that the positive current is for a cell that is charging, the negative current for a cell which is discharging. The white V+ and green V- leads both are for the voltage sensor. During calibration, the sign convention for voltage has been assigned so that the positive voltage for higher potential is on the white lead with respect to the green lead. For testing batteries using the Arbin systems, the cell must be connected with **the red and white leads to the positive end of the cell or battery and the green and black leads to the negative end of the cell or battery**.

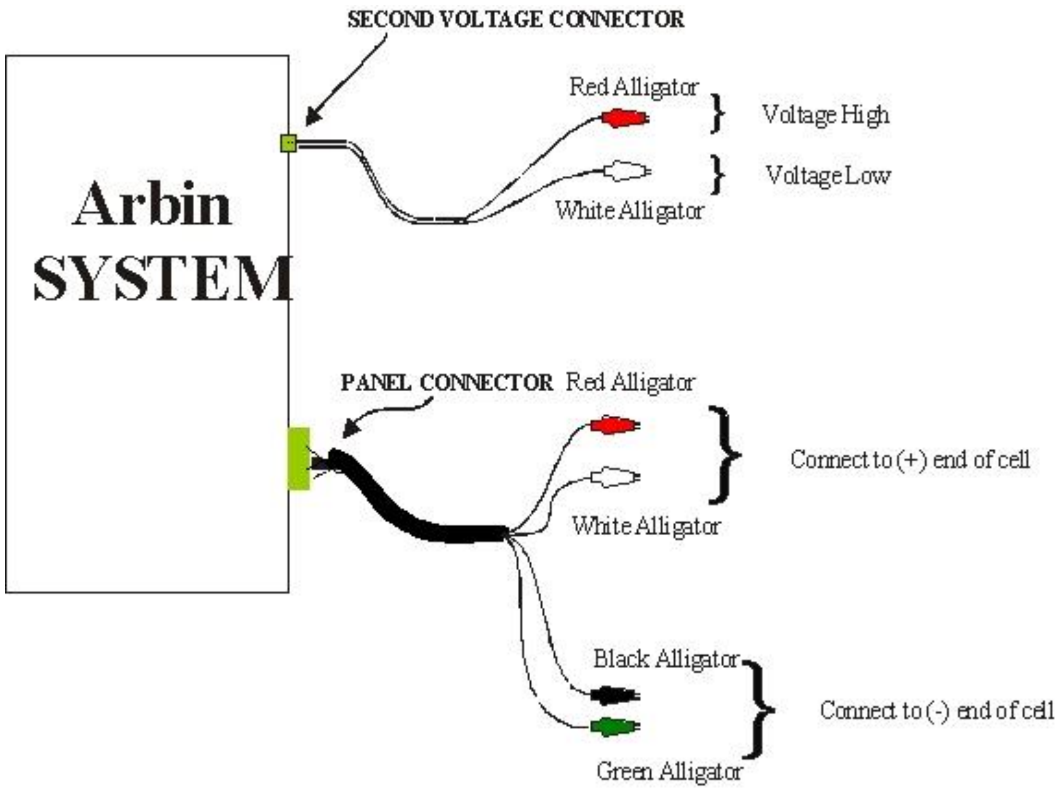
Caution!! Electronically, a reversed connection of voltage leads won’t affect circuit operation. However, a wrong voltage reading may immediately interrupt the test. Please, check the voltage reading on the **Monitor & Control Window** immediately after the starting the test. (Note: starting a schedule with a Rest step will facilitate this initial inspection.) In many cases proper global safety setting in the schedule will also stop a test if cables are accidently connected to the battery incorrectly.

Warning!! Reversing the current leads is damaging to the cell, and in the worst possible case it could cause an explosion of or fire within the cell, e. g. lithium-based cells. In such cases the current reading may appear normal, but the polarity is reversed. Double-checking the current leads connection is a mandatory step in the system operation. In addition, appropriate voltage limits should be set to prevent from potential danger if the battery or cell chemistry is rechargeable.

Auxiliary Inputs

Second Voltage

Auxiliary Voltage inputs (referred to as Second Voltage) are connected using 2-contact mini-Phoenix connectors to the testing stand and alligator clips for the cell connections.



Terminal connections for battery testing using Arbin System

Figure 10-8

From **Figure 10-9** the red lead connects to the higher or positive potential. The black lead connects to the lower or negative potential. For three-electrode experiments the reference potential may be measured by using either the green and white leads or the second voltage inputs. However, only the potential measured by the green and white channel leads can be used for voltage control in the potentiostatic mode. (The second voltage input is only for measurement: the testing stand will not control the voltage measured by the second voltage input.) Consider the following illustrations of the configurations possible with the auxiliary voltage measurement capability of Arbin systems.

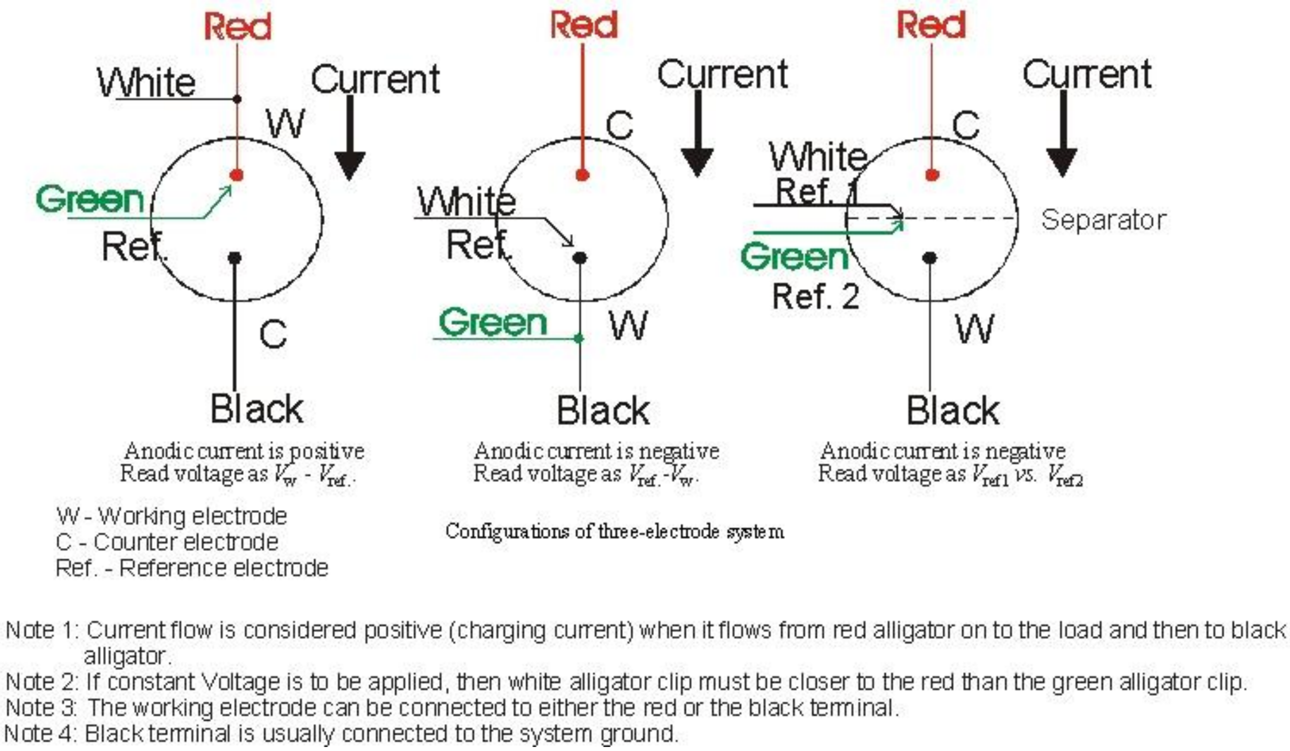


Figure 10-9 Multi-electrode Connection Schemes

Auxiliary Voltage range vs. Common-mode Voltage

Auxiliary V channels are typically engineered with a –10V to +10V differential measurement capability. Another design parameter, however, is the maximum common-mode voltage-the maximum potential between the (+) lead and circuit ground (isolated from chassis ground). This maximum value is typically ~12V and represents a fundamental limit on the maximum potential measurable by any input.

Example:

An instrument has a main IV channel range of 30V and is being used to charge a string of 5 lithium-chemistry cells, each monitored by a separate auxiliary voltage channel, to a maximum potential of 21V. If the voltage of each cell is assumed to be 4.2V, then a correct auxiliary reading would only be generated for the first three cells (common-mode voltage for channel 3 ~12.6). The fourth channel, having exceeded the maximum, would return the maximum voltage for its input +10V.

Solution:

Where requirements for common-mode measurement up to the maximum control voltage of the main IV channel exist, users should inform Arbin engineers, who have designed high common mode circuitry for fulfilling such requirements.

Temperature

Thermocouple connections are designed to accept thermocouples with type SMP miniature jacks (available from Omega). Systems may be furnished with type J, K, E or T connectors (user-specified). User-specified thermistor inputs, when supplied, are generally furnished with user-specified connections. The panel connection is a 2-contact mini-Phoenix connector.

10.3 Operation Instructions

Mechanical Considerations

The front and rear sides of the tester should be free of obstructions so that forced cooling air to the chassis may flow unrestricted. Ideally, three feet of clearance should be provided on each side or more if adjacent equipment generates a significant amount of heat and ensure the power cable is accessible by the user. However, if the tester is seldom operated with all channels at full power simultaneously, then a somewhat less conservative approach to clearances can be taken. Under no circumstances should there be less than two feet of clearance on each side of the system. The hot air from mounted fans may be conducted outside of the facility to reduce the effect on the room temperature.

When an LBT system is powered on, often a few clicking sounds can be noticed followed by the cooling fans turning on at higher RPM at first then slowing down to an idle state. For some chassis the Green power on/off switch will be illuminated indicating that the system has been powered on.

Ground Connections

The ground connections are very important for the LBT systems. AC 3-phase input (the ground of the cabinet) and AC single-phase input must have the same ground. If the system does not include a UPS attachment, the ground of the AC input for the computer must be kept at the same potential as the cabinet ground, particularly for a tester powered by single-phase AC input. Otherwise, the differing potential between the cabinet ground and the computer ground may generate a current through the grounding wire that could disable the system. The mentioned ground connections are generally addressed by a properly grounded facility power distribuition panels.

Any other devices or attachments, e.g. an environmental control chamber, to be connected to the LBT system must be grounded at the same potential as the cabinet ground. The ground connections of those devices or attachments must be checked before they are connected to the LBT system.

Environmental Considerations

Arbin systems must be set up in a laboratory or on a plant floor where no other facilities generate dust or harmful chemical vapor, such as graphite powder or corrosive solvent. Chemical vapor or dust can cause internal circuit damage and can even lead to electric shock. Filters installed on the fans in the tester do not catch fine powder particles or vapor.

<u>Warning!!</u> An environmentally induced system malfunction is not covered by the Arbin limited warranty agreement. For repair of damage due to the environment, a service charge will apply for either Arbin factory service or on-site service.

Training for System Operation

One week a month Arbin offers a factory training course that customer can sign up for. The training class is offered at a discounted rate for new chassis purchases. The 2 day training course is held at Arbin headquartes located in College Station, TX. In addition to factory training, Arbin also offers on-site training that can be purchased at the point of sale for a discounted rate or anytime for a standard rate. Please contact Arbin customer service or sales team member for additional details for on-site training courses.

Safety Net

Safety is a primary consideration in LBT system design. In Arbin battery testing or formation systems, an interrelated safety mechanism has been established to protect the system, the cell and the user.

Hardware Level: All LBT series boards have a series of hardware level safety circuits designed to stop any running test in the event of communications loss to the controller PC, loss of power to the DC control power supply and/or loss of power to the charge/discharge power supply. In addition, all IV channel board assemblies are designed to protect the MOSFET network in the case of a single component failure at the MOSFET feedback loop and limit current in the case of a component failure at the current feedbackup loop. The voltage circuit's PID controller has many safety checks programmed for the purpose of stopping a test in the case of sensed voltage control errors.

Software Level: MITS Pro8.0 SW has incorporated programmed safety settings for Power, Current, and Voltage. These settings are set at both the system level and the individual test level. Low power LBT system utilize a redundant safety voltage circuit that is indepent of the digital voltage circuit for double checking the volage read by the two circuits are the same. If they are not, the system will stop a running test. Med and High power systems have incorporated a voltage clamp low and voltage clamp high hardware controlled circuit that can be used to limit current/voltage of a running test.

Digital voltage control now has many new safety considerations as part of the PID controller. The digital voltage control circuit is used to ramp voltage to set point in a controlled manor to reduce current spikes at turn on and during transition between current and voltage control. In the event of a schedule programming mistake, the voltage control circuit can limit current to 100% of a range to reduce the chances of HW damage to the LBT system. Adnormal safety settings are also available, for the purposes of monitoring the test schedule vs. the current test condition. If the Arbin is operating outside of a reasonable window of operation the SW will stop a running test.

Computer-tester Communications

The controller PC communicates with the Arbin hardware via a program called DAQ. The DAQ program will automatically start and minimize itself when the monitor and control window is launched. Communicaton errors will be reported in the DAQ program and in the DAQInfoLog file. In the event of a communication error the monitor and control window will show an error message.

LBT series testers use a standard TCP/IP communications port with a static IP address. Each microcontroller located on the IV channel board assemblies will have an assigned IP address. A general communication scheme is used for the Arbin tester communications network. The controller PC will have a static IP address of 196.168.1.100. Microcontroller #1 in the Arbin system will have an IP address of 196.168.1.1, microcontroller # 2 in the Arbin system will have an IP addres of 196.168.1.2, and so on. The number of microncontrollers and the IV channel or Aux channel assignment can be found in the ArbinSys.cfg file for each LBT system. All commuincations cables, HUB's, and other network devices are standard devices that can be purchased on the market. A standard 6 Ft cable is provided by Arbin. Depending on testing requirements a longer cable may be required to locate the controller PC further away from the Arbin tester. Refer to the standard TCP/IP communications protocol for cable length limiations.

Calibration

The calibration process develops correction factors which are used to compensate for errors occurring in two places: a) the digital-to-analog (DAC) converters which convert user input data to electrical voltages and currents in the testing system, and b) the analog-to-digital (ADC) converters which convert the stand's internal measurements of its own output to digital signals used in the microcontrollers. The DAC correction corrects errors in the chain of signals between the desired value and accurate value (defined below). The ADC correction corrects errors in the chain of signals between the accurate value and measurement value. Both sets of correction factors are stored in the microcontroller memory and the computer system configuration files. Calibration data can be "uploaded" from microcontroller's memory to the ArbinSys.cfg file and can be "downloaded" from ArbinSys.cfg to the microcontroller's memory. Being able to pass calibration in both directions can be useful in different senarious. One common example is if a customer experiences a PC failure. In this scenario a backup copy of ArbinSys.cfg is required to properly recover. If an up to date ArbinSys.cfg is not available an older file can be used, when the new PC is connected to the Arbin Hardware the calibration data can be "uploaded" from the Arbin HW to the older .cfg file updating it with the new calibration data. At this point running tests can be resumed without having to re-calbrate the LBT tester. Recovery time can be very quick if a replacement PC is available.

Detailed calibration procedures are covered in **Chapter 9 Hardware Calibration**. The various measured values and error calculations are defined as follows.

Desired Value **(DV):** the value entered into the computer by the user.

Accurate Value **(AV):** the value produced by the LBT tester, as measured by an external meter.

Machine Value **(MV):** the LBT tester's internal measurement of its own output. Machiene value recorded in the data.

Control Error**:** Defined as {[(DV) - (AV)] / FSR} * 100%.

Measured Error**:** Defined as {[(MV) - (AV)] /FSR} * 100%.

10.4 Specifications

System Specifications

System specifications vary based on low, medium, or high power LBT systems. A list of standard system specifications can be provided by an Arbin sales representative.

Software Specifications

Software specifications can vary based on LBT system design and features purchased. A list of standard SW specifications can be provided by an Arbin sales representative.

10.5 Hardware Accessories

Smart Battery Interface

Hardware Description

Arbin's SMBus is derived from I2C, and its pin definition is shown as **Figure 10-10**. This hardware interface will be available on some series of devices. If a test is required to do, please use the cable to connect the smart battery.

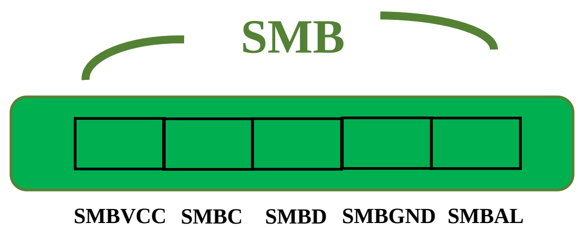


Figure 10-10 Arbin SMB hardware interface

SMBVCC: +5V power supply.
SMBC: SMBus clock pin.
SMBD: SMBus data pin.
SMBGND: SMBus ground pin. (when IV channel is closed, SMBGND will be tied to I-)
SMBAL: SMBus alert pin.
Arbin's SMBus I/O voltage level is 5V.

Arbin's SMBus support SMBus v1.1 protocol. Clock speed is 10kHz ~100kHz.

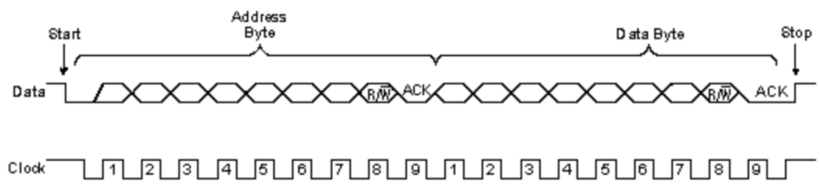


Figure 10-11 Timing diagram

Start and Stop conditions: These are especially important in that they are ways of signaling to an interface that it needs to go to an initialized or reset state. SMBD and SMBC must be high to generate Start or Stop conditions. Start and Stop conditions are the only times there will be a transition on the SMBD while SMBC is high.

Communication: Data can change state only when SMBC is low during a communication. The data on SMBD must always be ready just prior to a high on SMBC and be changed only after SMBC has gone low (with the exception of Start and Stop conditions).

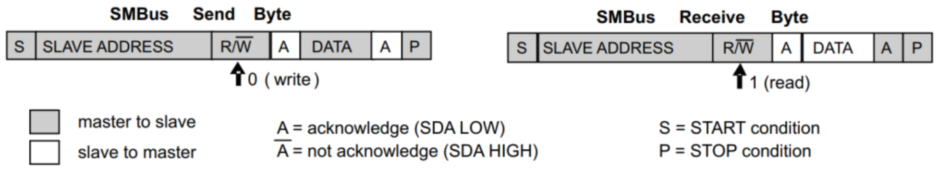
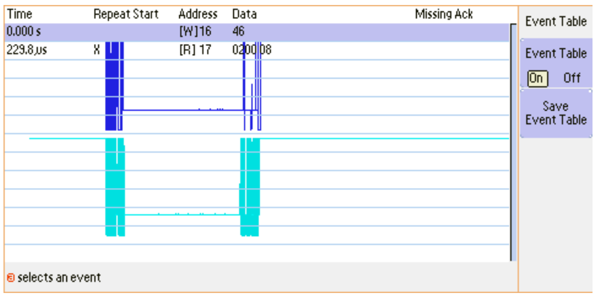


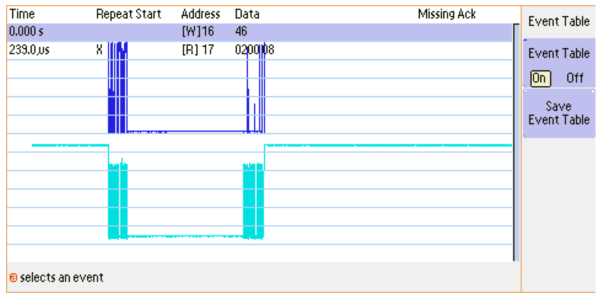
Figure 10-12 SMBus protocol

Arbin's SMBus protocol is defined as the same as the standard SMBus protocol.

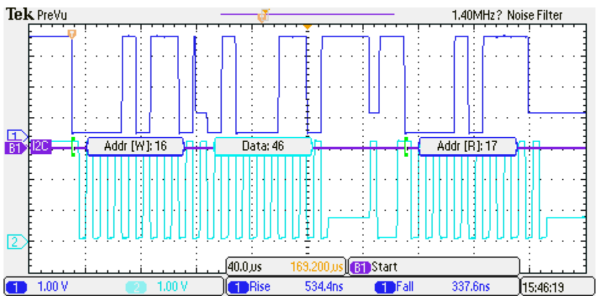
Captured Screen Image of Oscilloscope



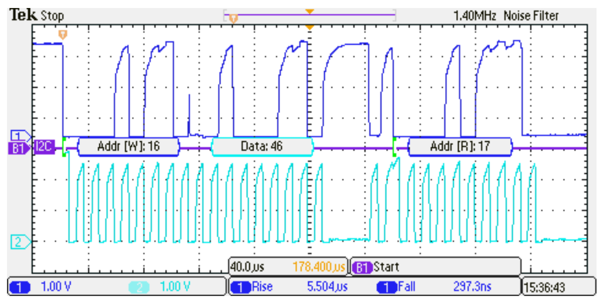
(a) Arbin SMBus Tester



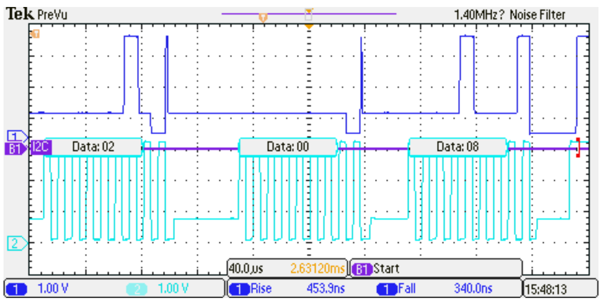
(b) TI EV2400



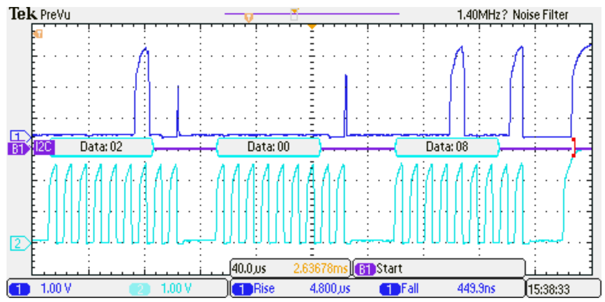
(c) Arbin SMBus Tester



(d) TI EV2400



(e) Arbin SMBus Tester



(f) TI EV2400

Figure 10-13 A comparison between Arbin and TI EV2400

Smart Battery configuration

1. Enable the SMB feature

In the Global page of the system configure, **Smart Battery** in the list of **Advanced Options** must be checked for systems that have SMB feature. Correspondingly, a new control type, known as **Set SMB Opt Word Address** and others are also checked in **Control Type Options**. Please remember check this before using SMB.

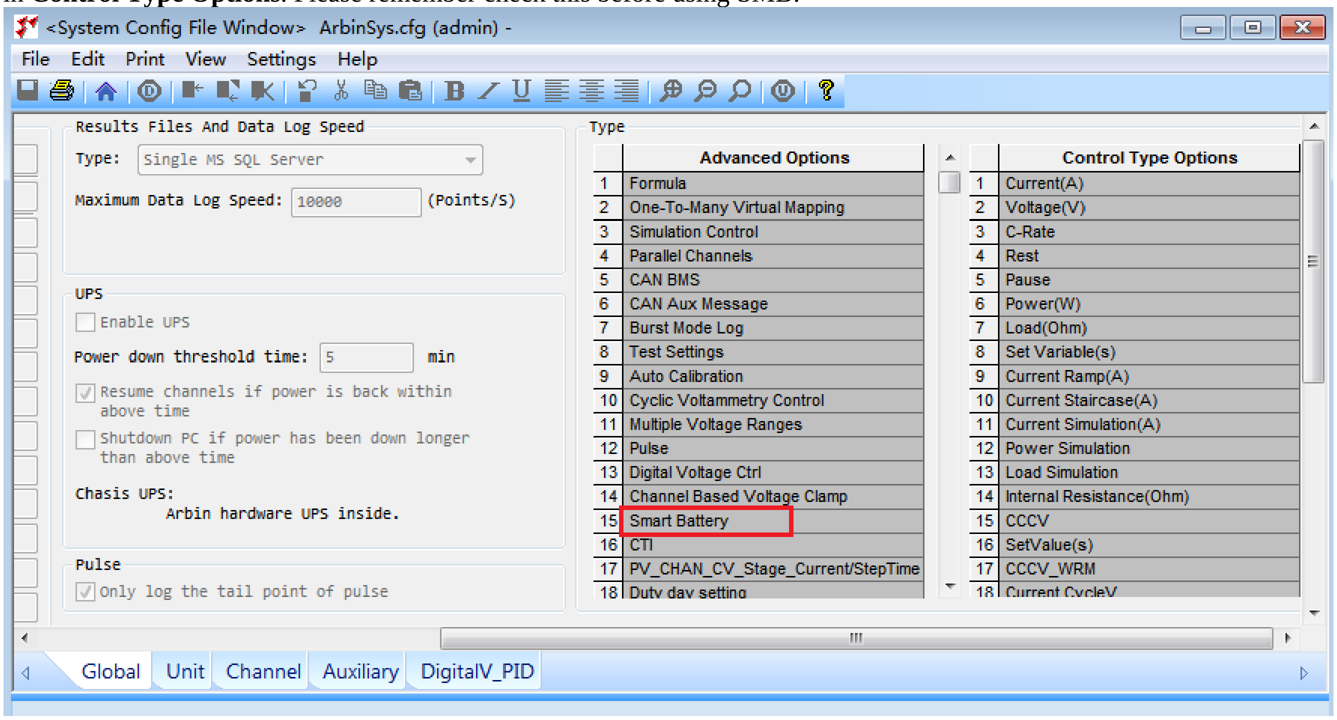


Figure 10-14 Ensure SMB feature is checked in ArbinSys.cfg file

2. Create a SMB configuration file

Double click **Smart Battery Files** icon, then right click on the icon. Select **New SMB Config File**.

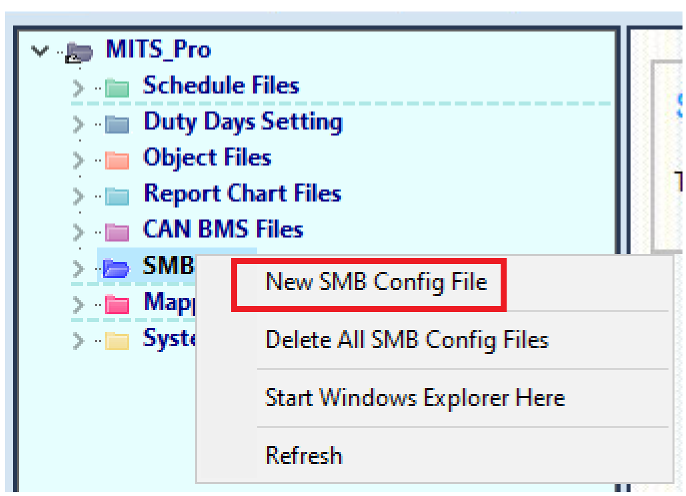


Figure 10-15 New SMB file

3. Configure SBS command(s) for data logging

Open a smart-battery configuration file (.*smb* file). Add and configure SBS commands in the file.

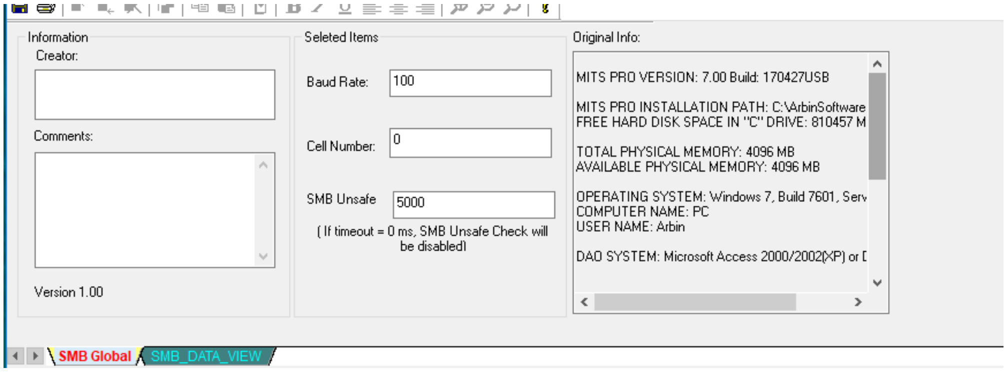
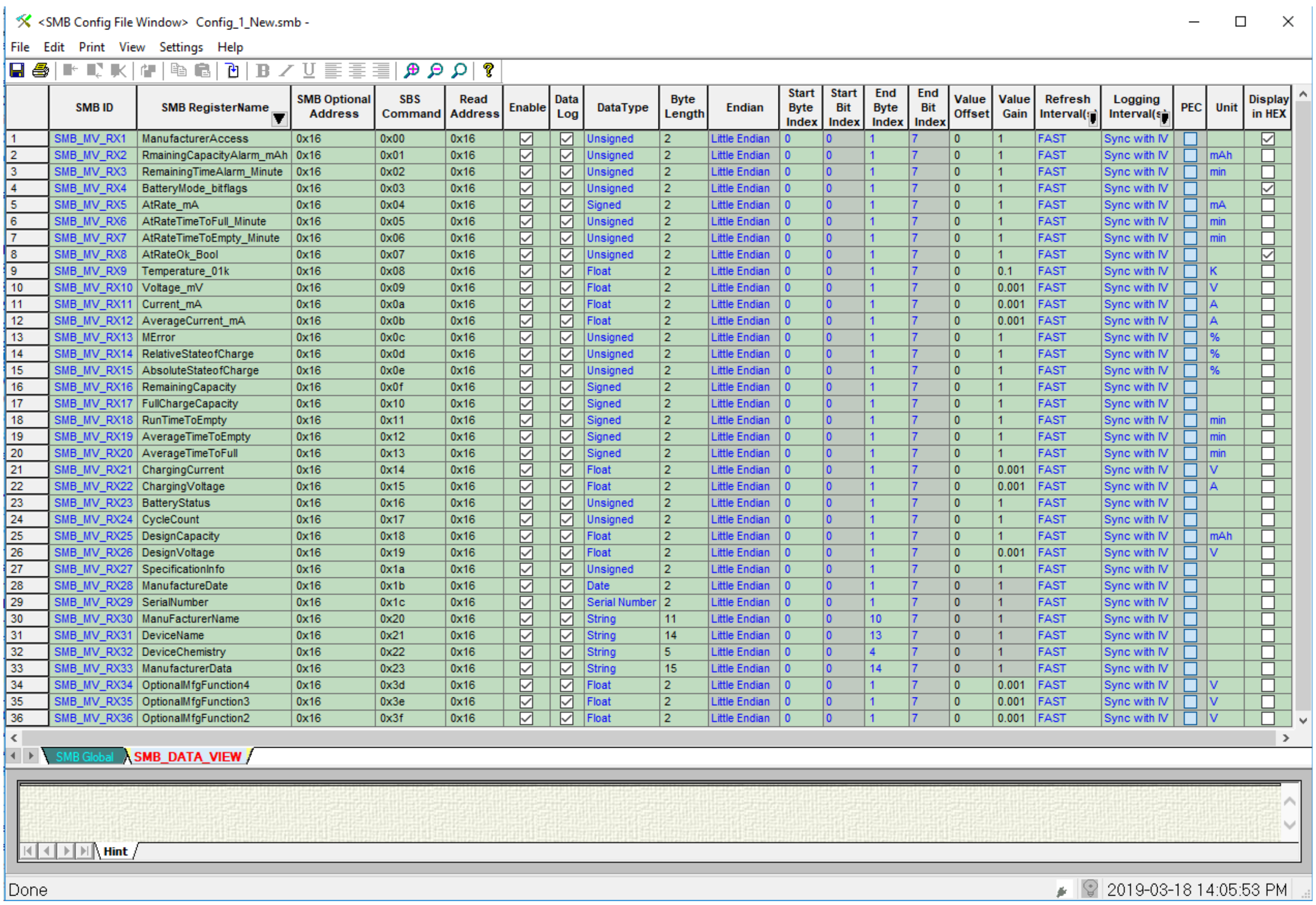


Figure 10-16 The SMB Global view of SMB file

Click tab **SMB Global**, and set **Baud Rate (kHz)** and **SMB Unsafe (ms)** timeout value.

Baud Rate: The maximum value can up to 400kHz.

SMB Unsafe: The maximum value is 5000ms. When the time interval between SMB receiving data is greater than this value, the test will stop and give an alarm.



	SMB ID	SMB RegisterName	SMB Optional Address	SBS Command	Read Address	Enable	Data Log	DataType	Byte Length	Endian	Start Byte Index	Start Bit Index	End Byte Index	End Bit Index	Value Offset	Value Gain	Refresh Interval(s)	Logging Interval(s)	PEC	Unit	Display in HEX
1	SMB_MV_RX1	ManufacturerAccess	0x16	0x00	0x16	☑	☑	Unsigned	2	Little Endian	0	0	1	7	0	1	FAST	Sync with IV	☐		☑
2	SMB_MV_RX2	RmainingCapacityAlarm_mAh	0x16	0x01	0x16	☑	☑	Unsigned	2	Little Endian	0	0	1	7	0	1	FAST	Sync with IV	☐	mAh	☐
3	SMB_MV_RX3	RemainingTimeAlarm_Minute	0x16	0x02	0x16	☑	☑	Unsigned	2	Little Endian	0	0	1	7	0	1	FAST	Sync with IV	☐	min	☐
4	SMB_MV_RX4	BatteryMode_bitflags	0x16	0x03	0x16	☑	☑	Unsigned	2	Little Endian	0	0	1	7	0	1	FAST	Sync with IV	☐		☑
5	SMB_MV_RX5	AtRate_mA	0x16	0x04	0x16	☑	☑	Signed	2	Little Endian	0	0	1	7	0	1	FAST	Sync with IV	☐	mA	☐
6	SMB_MV_RX6	AtRateTimeToFull_Minute	0x16	0x05	0x16	☑	☑	Unsigned	2	Little Endian	0	0	1	7	0	1	FAST	Sync with IV	☐	min	☐
7	SMB_MV_RX7	AtRateTimeToEmpty_Minute	0x16	0x06	0x16	☑	☑	Unsigned	2	Little Endian	0	0	1	7	0	1	FAST	Sync with IV	☐	min	☐
8	SMB_MV_RX8	AtRateOk_Bool	0x16	0x07	0x16	☑	☑	Unsigned	2	Little Endian	0	0	1	7	0	1	FAST	Sync with IV	☐		☑
9	SMB_MV_RX9	Temperature_01k	0x16	0x08	0x16	☑	☑	Float	2	Little Endian	0	0	1	7	0	0.1	FAST	Sync with IV	☐	K	☐
10	SMB_MV_RX10	Voltage_mV	0x16	0x09	0x16	☑	☑	Float	2	Little Endian	0	0	1	7	0	0.001	FAST	Sync with IV	☐	V	☐
11	SMB_MV_RX11	Current_mA	0x16	0x0a	0x16	☑	☑	Float	2	Little Endian	0	0	1	7	0	0.001	FAST	Sync with IV	☐	A	☐
12	SMB_MV_RX12	AverageCurrent_mA	0x16	0x0b	0x16	☑	☑	Float	2	Little Endian	0	0	1	7	0	0.001	FAST	Sync with IV	☐	A	☐
13	SMB_MV_RX13	MError	0x16	0x0c	0x16	☑	☑	Unsigned	2	Little Endian	0	0	1	7	0	1	FAST	Sync with IV	☐	%	☐
14	SMB_MV_RX14	RelativeStateofCharge	0x16	0x0d	0x16	☑	☑	Unsigned	2	Little Endian	0	0	1	7	0	1	FAST	Sync with IV	☐	%	☐
15	SMB_MV_RX15	AbsoluteStateofCharge	0x16	0x0e	0x16	☑	☑	Unsigned	2	Little Endian	0	0	1	7	0	1	FAST	Sync with IV	☐	%	☐
16	SMB_MV_RX16	RemainingCapacity	0x16	0x0f	0x16	☑	☑	Signed	2	Little Endian	0	0	1	7	0	1	FAST	Sync with IV	☐		☐
17	SMB_MV_RX17	FullChargeCapacity	0x16	0x10	0x16	☑	☑	Signed	2	Little Endian	0	0	1	7	0	1	FAST	Sync with IV	☐		☐
18	SMB_MV_RX18	RunTimeToEmpty	0x16	0x11	0x16	☑	☑	Signed	2	Little Endian	0	0	1	7	0	1	FAST	Sync with IV	☐	min	☐
19	SMB_MV_RX19	AverageTimeToEmpty	0x16	0x12	0x16	☑	☑	Signed	2	Little Endian	0	0	1	7	0	1	FAST	Sync with IV	☐	min	☐
20	SMB_MV_RX20	AverageTimeToFull	0x16	0x13	0x16	☑	☑	Signed	2	Little Endian	0	0	1	7	0	1	FAST	Sync with IV	☐	min	☐
21	SMB_MV_RX21	ChargingCurrent	0x16	0x14	0x16	☑	☑	Float	2	Little Endian	0	0	1	7	0	0.001	FAST	Sync with IV	☐	V	☐
22	SMB_MV_RX22	ChargingVoltage	0x16	0x15	0x16	☑	☑	Float	2	Little Endian	0	0	1	7	0	0.001	FAST	Sync with IV	☐	A	☐
23	SMB_MV_RX23	BatteryStatus	0x16	0x16	0x16	☑	☑	Unsigned	2	Little Endian	0	0	1	7	0	1	FAST	Sync with IV	☐		☐
24	SMB_MV_RX24	CycleCount	0x16	0x17	0x16	☑	☑	Unsigned	2	Little Endian	0	0	1	7	0	1	FAST	Sync with IV	☐		☐
25	SMB_MV_RX25	DesignCapacity	0x16	0x18	0x16	☑	☑	Float	2	Little Endian	0	0	1	7	0	1	FAST	Sync with IV	☐	mAh	☐
26	SMB_MV_RX26	DesignVoltage	0x16	0x19	0x16	☑	☑	Float	2	Little Endian	0	0	1	7	0	0.001	FAST	Sync with IV	☐	V	☐
27	SMB_MV_RX27	SpecificationInfo	0x16	0x1a	0x16	☑	☑	Unsigned	2	Little Endian	0	0	1	7	0	1	FAST	Sync with IV	☐		☐
28	SMB_MV_RX28	ManufactureDate	0x16	0x1b	0x16	☑	☑	Date	2	Little Endian	0	0	1	7	0	1	FAST	Sync with IV	☐		☐
29	SMB_MV_RX29	SerialNumber	0x16	0x1c	0x16	☑	☑	Serial Number	2	Little Endian	0	0	1	7	0	1	FAST	Sync with IV	☐		☐
30	SMB_MV_RX30	ManuFacturerName	0x16	0x20	0x16	☑	☑	String	11	Little Endian	0	0	10	7	0	1	FAST	Sync with IV	☐		☐
31	SMB_MV_RX31	DeviceName	0x16	0x21	0x16	☑	☑	String	14	Little Endian	0	0	13	7	0	1	FAST	Sync with IV	☐		☐
32	SMB_MV_RX32	DeviceChemistry	0x16	0x22	0x16	☑	☑	String	5	Little Endian	0	0	4	7	0	1	FAST	Sync with IV	☐		☐
33	SMB_MV_RX33	ManufacturerData	0x16	0x23	0x16	☑	☑	String	15	Little Endian	0	0	14	7	0	1	FAST	Sync with IV	☐		☐
34	SMB_MV_RX34	OptionalMfgFunction4	0x16	0x3d	0x16	☑	☑	Float	2	Little Endian	0	0	1	7	0	0.001	FAST	Sync with IV	☐	V	☐
35	SMB_MV_RX35	OptionalMfgFunction3	0x16	0x3e	0x16	☑	☑	Float	2	Little Endian	0	0	1	7	0	0.001	FAST	Sync with IV	☐	V	☐
36	SMB_MV_RX36	OptionalMfgFunction2	0x16	0x3f	0x16	☑	☑	Float	2	Little Endian	0	0	1	7	0	0.001	FAST	Sync with IV	☐	V	☐

Figure 10-17 The SMB_DATA_VIEW view of SMB file

Click tab **SMB_DATA_VIEW**, and please fill in data according to the actual battery information.
SMB ID: The meta-variable name of SMB register. (Reserved)
SMB Register Name: User-defined name of SMB register. (Configurable)
SMB Optional Address: Slave address of SMB battery. (Configurable, typical value is 0x16)

SBS Command: SBS command. (Configurable)
Read Address: SMBus address of the smart battery. (Configurable, typical value is 0x16)
Enable: Enable or Disable the register. If a register is enabled, it will display on ChannelView window. (Configurable)
Data Log: Select if the read value of a SBS command is required to be recorded in database. (Configurable if this SBS command is enabled)
Data Type: Unsigned integer, Signed Integer, Float, String, Date, Serial Number and Bits Control. Unsigned integer signed integer and float DO NOT support the data longer than 2 bytes. String, Date and Serial Number will be recorded in the database once. Ask for Hex, please refer to Display in Hex. (Configurable)
Byte Length: The data length of expected return value. (Configurable)
Endian: If it is little endian or not. (Only little endian is available currently)
Start Byte Index: Valid start byte index of return value. (Configurable)
Start Bit Index: Valid start bit index of read data in last byte. (Available for Bit Control data type only, and for other data types, it is always 7 in default, regardless of the actual value set by user)
End Byte Index: Valid end byte index of return value. (Configurable)
End Bit Index: Valid end bit index of read data in last byte. (Available for Bit Control data type only, and for other data types, it is always 7 in default, regardless of the actual value set by user)
Value Offset: Add an offset to return value. (Configurable)
Value Gain: Add a gain to return value. (Configurable)
Refresh(ms): Refresh frequency. (Configurable. Must be greater than 100ms)
PEC: Reserved. (Reserved)
Unit: Pre-defined or customer-defined unit can be applied to the unit value. (Configurable)
Display in HEX: If it is selected, the return value will be displayed in HEX. (Configurable)

4. Configure the SMB in Mapping file
Open the ArbinSys.bth. Place the cursor on the channel index column, then right click to popup up menu and select SMB.

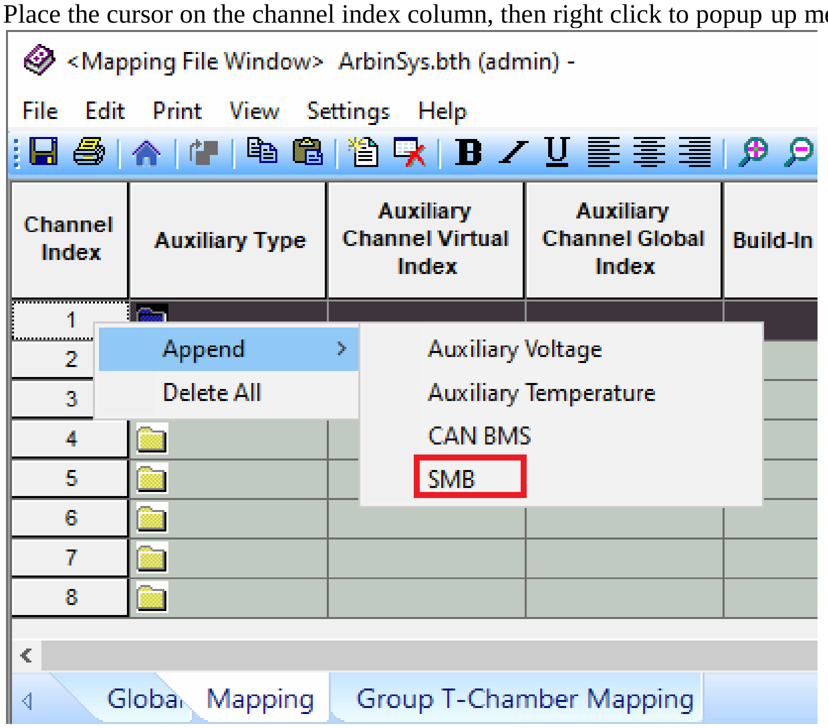


Figure 10-18 Configure the SMB in the Mapping file

5. Assign SMB File
Open the schedule. Click the Add Aux, then fill number in SMB area and click OK to save.

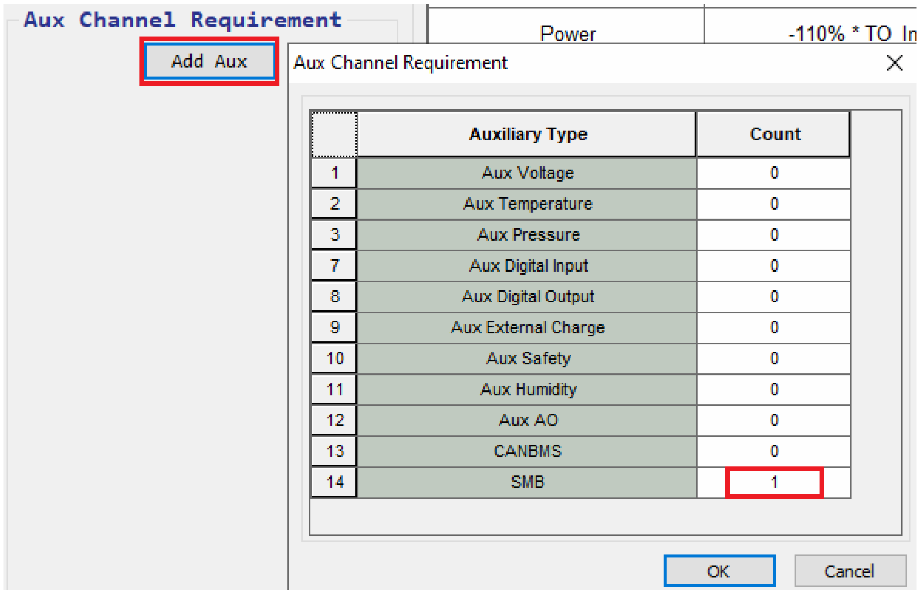


Figure 10-19 Add SMB feature in schedule

Open the schedule. Right click on SMB File in Global view of schedule, and assign the *.smb* configuration file to schedule.

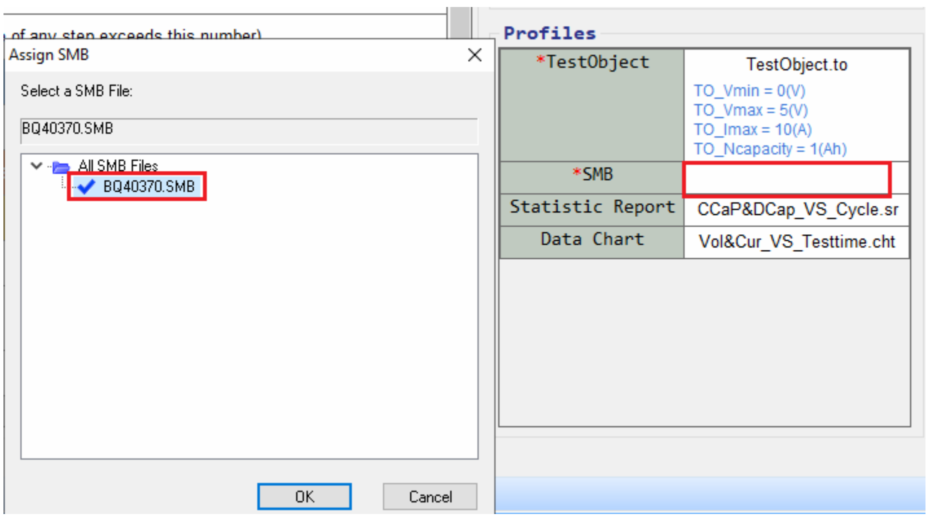


Figure 10-20 Assign SMB File in schedule

Smart Battery Register Access

Create a schedule file as the following example to send SBS command to smart battery.

The first step must be **Set SMB Opt Word Address** and fill the address in Extra Control Value 1. The typical value is 0x16.

Then choose **Write SMB Register** for Control Type, and Arbin tester can send Extra Control Value 1 (Data) to Control Value (SBS Command).

In general, 0x08 command needs to be sent before battery charging test, and 0x00 command needs to be sent for discharging.

		Step Label	Number Of Limits	Control Type	Control Value	Extra Control Value 1
1		Step_A	1	Set SMB Opt Word Address	Optional 1st VCell Addr	0x16
2		Step_B	2	Rest		
3		Step_C	1	Write SMB Register	0x00	0x0008
4		Step_D	1	Write SMB Register	0x01	0x0320
5		Step_E	1	Write SMB Register	0x02	0x0002
6		Step_F	1	Write SMB Register	0x03	0xE000
7		Step_G	1	Write SMB Register	0x04	0x0004
8		Step_H	2	Rest		

(1)

Channel Index	1	Exit Condition	N/A	Voltage	7.3606 (V)	Charge Energy	0.0000 (mWh)	Internal Resistance	0.0000 (uOhm)
Smart Battery	True	Step Index	2: Step_B, Rest	Current	0.0000 (uA)	Discharge Energy	0.0000 (mWh)	ACR	0.0000 (uOhm)
Test Name	test	Cycle Index	1	Power	0.0000 (uW)	dV/dt	0.0000 (uV/s)	AC Impedance	0.0000 (uOhm)
Schedule Name	RegisterAcce	Step Time (s)	00:00:00	Charge Capacity	0.0000 (mAh)	dI/dt	0.0000 (uA/s)	ACI Phase Angle	0.0000 (deg)
Status	Rest	Test Time (s)	00:00:00.001	Discharge Capacity	0.0000 (mAh)	Vmax On Cycle	0.0000 (uV)		
SMB Config Name	Config_1.smb	SMB_MV_RX8 (AtRateOk_Bool)	0x1	SMB_MV_RX16 (RemainingCapacity)	2969	SMB_MV_RX24 (CycleCount)	54	SMB_MV_RX32 (DeviceChemistry)	[redacted]
SMB_MV_RX1 (ManufacturerAccess)	0x4180	SMB_MV_RX9 (Temperature_01k)	299.5000(K)	SMB_MV_RX17 (FullChargeCapacity)	7389	SMB_MV_RX25 (DesignCapacity)	8157.0000(mAh)	SMB_MV_RX33 (ManufacturerData)	
SMB_MV_RX2 (RmainingCapacityAlarm_mAh)	815(mAh)	SMB_MV_RX10 (Voltage_mV)	7.6860(V)	SMB_MV_RX18 (RunTimeToEmpty)	-1(min)	SMB_MV_RX26 (DesignVoltage)	7.6000(V)	SMB_MV_RX34 (OptionalMfgFunction4)	0.0000(V)
SMB_MV_RX3 (RemainingTimeAlarm_Minute)	10(min)	SMB_MV_RX11 (Current_mA)	0.0000(A)	SMB_MV_RX19 (AverageTimeToEmpty)	-1(min)	SMB_MV_RX27 (SpecificationInfo)	[redacted]	SMB_MV_RX35 (OptionalMfgFunction3)	0.0000(V)
SMB_MV_RX4 (BatteryMode_bitflags)	0x6080	SMB_MV_RX12 (AverageCurrent_mA)	0.0000(A)	SMB_MV_RX20 (AverageTimeToFull)	-1(min)	SMB_MV_RX28 (ManufactureDate)		SMB_MV_RX36 (OptionalMfgFunction2)	3.8430(V)
SMB_MV_RX5 (AtRate_mA)	0(mA)	SMB_MV_RX13 (MError)	8(%)	SMB_MV_RX21 (ChargingCurrent)	3.7120(V)	SMB_MV_RX29 (SerialNumber)		SMB_MV_RX37 (OptionalMfgFunction1)	3.8430(V)
SMB_MV_RX6 (AtRateTimeToFull_Minute)	1(min)	SMB_MV_RX14 (RelativeStateofCharge)	40(%)	SMB_MV_RX22 (ChargingVoltage)	8.8000(A)	SMB_MV_RX30 (ManuFacturerName)		SMB_MV_RX38 (OptionalMfgFunction5)	0x14
SMB_MV_RX7 (AtRateTimeToEmpty_Minute)	1(min)	SMB_MV_RX15 (AbsoluteStateofCharge)	37(%)	SMB_MV_RX23 (BatteryStatus)	0xC7	SMB_MV_RX31 (DeviceName)			

SMB Config Name	Config_1.smb	SMB_MV_RX8 (AtRateOk_Bool)	0x1	SMB_MV_RX16 (RemainingCapacity)	2256	SMB_MV_RX24 (CycleCount)	54	SMB_MV_RX32 (DeviceChemistry)	[redacted]
SMB_MV_RX1 (ManufacturerAccess)	0x188	SMB_MV_RX9 (Temperature_01k)	299.7000(K)	SMB_MV_RX17 (FullChargeCapacity)	5616	SMB_MV_RX25 (DesignCapacity)	6200.0000(mAh)	SMB_MV_RX33 (ManufacturerData)	
SMB_MV_RX2 (RmainingCapacityAlarm_mAh)	800(mAh)	SMB_MV_RX10 (Voltage_mV)	7.6860(V)	SMB_MV_RX18 (RunTimeToEmpty)	-1(min)	SMB_MV_RX26 (DesignVoltage)	7.6000(V)	SMB_MV_RX34 (OptionalMfgFunction4)	0.0000(V)
SMB_MV_RX3 (RemainingTimeAlarm_Minute)	2(min)	SMB_MV_RX11 (Current_mA)	0.0030(A)	SMB_MV_RX19 (AverageTimeToEmpty)	-1(min)	SMB_MV_RX27 (SpecificationInfo)	[redacted]	SMB_MV_RX35 (OptionalMfgFunction3)	0.0000(V)
SMB_MV_RX4 (BatteryMode_bitflags)	0x1F80	SMB_MV_RX12 (AverageCurrent_mA)	0.0000(A)	SMB_MV_RX20 (AverageTimeToFull)	-1(min)	SMB_MV_RX28 (ManufactureDate)		SMB_MV_RX36 (OptionalMfgFunction2)	3.8430(V)
SMB_MV_RX5 (AtRate_mA)	4(mA)	SMB_MV_RX13 (MError)	8(%)	SMB_MV_RX21 (ChargingCurrent)	3.7120(V)	SMB_MV_RX29 (SerialNumber)		SMB_MV_RX37 (OptionalMfgFunction1)	3.8430(V)
SMB_MV_RX6 (AtRateTimeToFull_Minute)	12484(min)	SMB_MV_RX14 (RelativeStateofCharge)	40(%)	SMB_MV_RX22 (ChargingVoltage)	8.8000(A)	SMB_MV_RX30 (ManuFacturerName)		SMB_MV_RX38 (OptionalMfgFunction5)	0x14
SMB_MV_RX7 (AtRateTimeToEmpty_Minute)	1(min)	SMB_MV_RX15 (AbsoluteStateofCharge)	37(%)	SMB_MV_RX23 (BatteryStatus)	0xC7	SMB_MV_RX31 (DeviceName)			

Figure 10-21 The SMB data in Channel View window

Return value of each register can be monitored in **Channel View** Window.

AC Impedance Testing

Arbin Instruments has teamed up with Gamry to integrate various Gamry equipments with the LBT series testers. Supported Gamry devices include 1010E, 5000E, 5000P, and ref 3000. One or more Gamry devices can be connected to one or multiple Arbin IV channel assemblies. ACIM testing is multiplexed though the Arbin IV channels allowing for ACIM testing without disconnecting from the Arbin equipment. Each supported Gamry device has different published specifications. Appropriate selection is required to meet specific testing needs. The Gamry option is setup and tested during production. Contact Arbin sales team for further details.

Hardware Connection

Below is a hardware example of Gamry integration of a low power system:

The Gamry connection for this machine is made up of four small boards that plug into the Auto-Cal/ACIM plug for each board see figure 10-22 below:

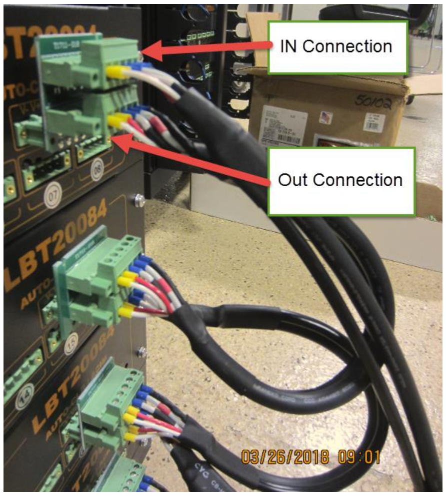


Figure 10-22

Each board has two – five pin phoenix connectors, the top connector is for the IN connection and the bottom connector is for the out connection.
The Gamry comes with a current connector cable, as shown in *Figure 10-23* of the *ACIM testing with the Gamry manual*, there are four colored connectors that connect to the Arbin current connector cable (white, green, red, and blue). The multi-channel Arbin current connector cable seen in figure 2 below, has the same connectors and a **black plug** that is **NOT USED** in this process. Note: The orange and **black** connectors on the Gamry cable are not used, and it is the longest of the supplied cables.

Figure 10-23

The end of the Arbin current connector cable has a 5-pin phoenix connector that plugs into the top/IN connector of the first board. Next, connect one of the smaller cables to the bottom/OUT connector that is on the first board and then connect the other end of that cable to the second boards IN connector. Repeat this step to set up a daisy chain effect, where the Gamry can work on every board, see Figure 10-24 below:

Figure 10-24

Enabling ACIM

ACIM is enabled by checking the option Third Party under **Advanced Features** in the **System Config** File ArbinAdvSys.cfg. If this option is not checked, then these four simulation control types in the schedule will not be selectable.

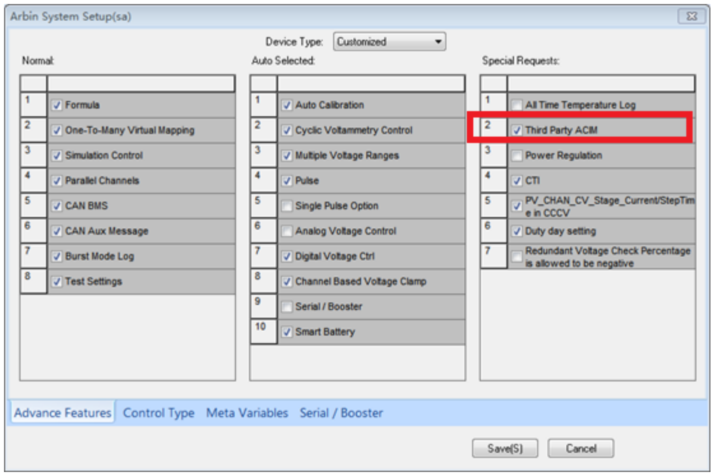


Figure 10-24

Software Setting

Gamry testing can be enabled/disabled in the menu bar by check/unchecking the button "EIS".

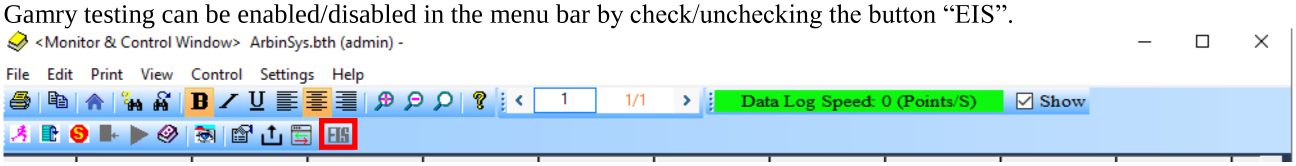


Figure 10-25

If you plan on running the Gamry on some channels at some point, please enable EIS test. MITS Pro8.0 will launch the Gamry Framework and check the Gamry device connection at the beginning of test.

Schedule Writing

To write an ACIM step, choose "Pause" in the Control Type drop box and "ACIM" in the Control Value drop box. The control parameters will appear automatically:

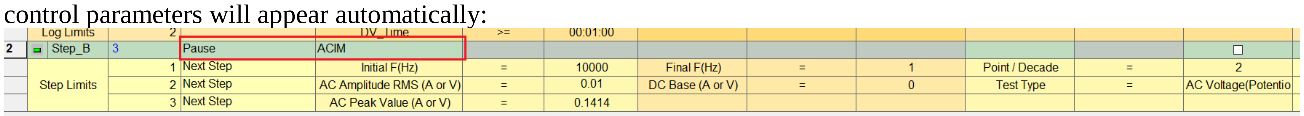


Figure 10-26

Initial F(Hz): Initial frequency in ACIM test
Final F(Hz): Final frequency in ACIM test
Point/Decade: Number of testing points in each decade of frequency (2 – 20)
AC Amplitude RMS (A or V): AC RMS current/voltage
*DC Base (A or V): DC current/voltage ($-1<DC+\sqrt{2}$ X $AC<1$)
Test Type: Choose test type between AC Current (Galvanostat) or AC Voltage (Potentiostat)
AC Peak Value (A or V): The maximum value of AC.

* Some channel types allow more than 1A current amplitude, check with technical support for details.

Results Data

EIS data can be checked in DataWatcher. DataWatcher will provide special option (Figure 10-27) for tests with ACIM data, you can Plot EIS spectrum or export them to text file.

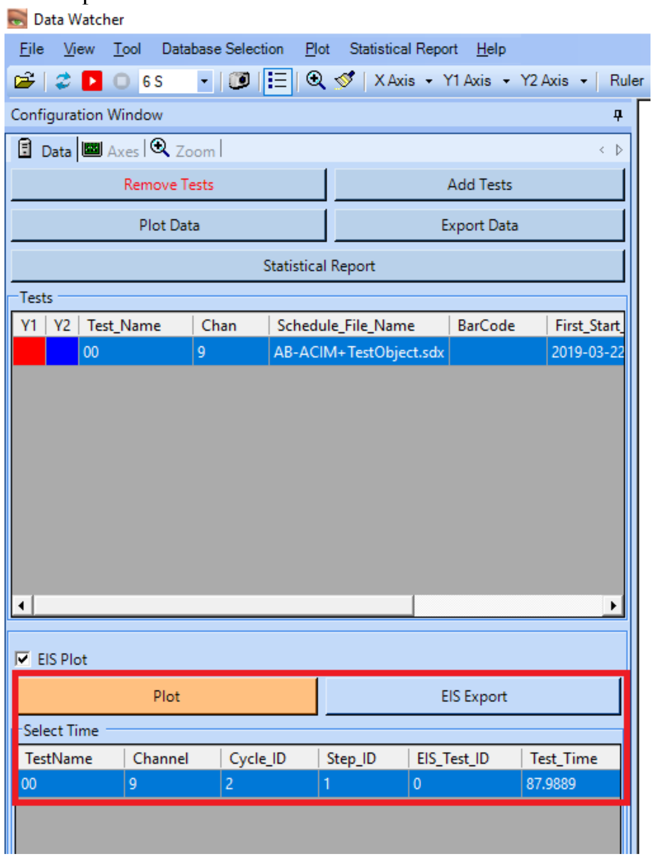


Figure 10-27

You can also export ACIM data to excel as part of a regular test data, there will be a separate sheet in excel showing EIS data. See figure 10-28 and 10-29.

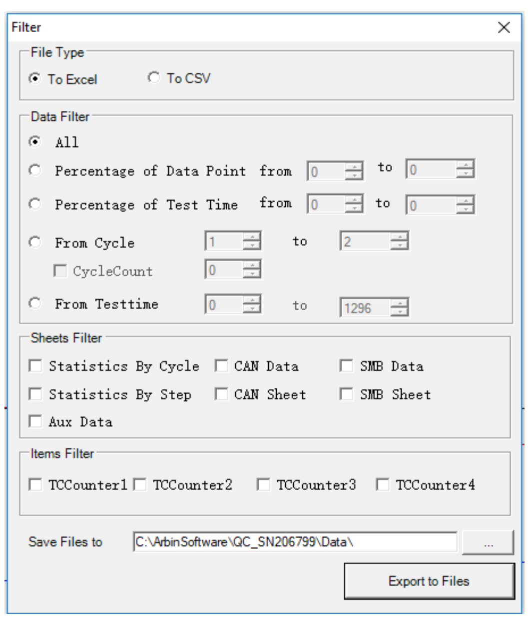


Figure 10-28

Device_ID	Channel_ID	Test_Time	Cycle_ID	Step_ID	EIS_Test_ID	EIS_Data_Point	Frequency	Zmod	Zphz	Zreal	Zimg	OCV	AC_Amp_RMS	DC_Base	Driven_Type	Product_ID
48147147	9	87.9889	1	2	0	0	10019.5303	0.0738156	28.7984505	0.064686	0.035559	3.2176931	0.01	0	Potentiostatic	Gamry_1
48147147	9	87.9889	1	2	0	1	3144.05493	0.0605327	13.2730999	0.058916	0.013898	3.2176931	0.01	0	Potentiostatic	Gamry_1
48147147	9	87.9889	1	2	0	2	1000.70203	0.0567194	4.474195	0.056547	0.004425	3.2176931	0.01	0	Potentiostatic	Gamry_1
48147147	9	87.9889	1	2	0	3	315.504791	0.0565672	0.55426258	0.056565	0.000547	3.2176931	0.01	0	Potentiostatic	Gamry_1
48147147	9	87.9889	1	2	0	4	99.7340012	0.057534	-1.15858102	0.057522	-0.001163	3.2176931	0.01	0	Potentiostatic	Gamry_1
48147147	9	87.9889	1	2	0	5	31.6723003	0.0589933	-1.95310605	0.058959	-0.002011	3.2176931	0.01	0	Potentiostatic	Gamry_1
48147147	9	87.9889	1	2	0	6	9.97340012	0.0606903	-2.56167698	0.06063	-0.002713	3.2176931	0.01	0	Potentiostatic	Gamry_1
48147147	9	87.9889	1	2	0	7	3.17581296	0.0627372	-3.65381789	0.06261	-0.003998	3.2176931	0.01	0	Potentiostatic	Gamry_1
48147147	9	87.9889	1	2	0	8	0.997765	0.0664341	-5.45128012	0.066134	-0.006311	3.2176931	0.01	0	Potentiostatic	Gamry_1
48147147	9	87.9889	1	2	0	9	0.31672299	0.0714471	-7.45388222	0.070843	-0.009269	3.2176931	0.01	0	Potentiostatic	Gamry_1
48147147	9	87.9889	1	2	0	10	0.1001603	0.0769906	-12.4559097	0.075178	-0.016606	3.2176931	0.01	0	Potentiostatic	Gamry_1

Global_Info | Channel-9_1 | EIS_chan_9

Figure 10-29

Digital I/O

The Aux feature digital I/O allows for SW controlled inputs and outputs that can be used to interact with customer defined interfaces. It can be used to start pumps, exit based on an external signal, many other customer needs.

Digital inputs have two states: off and on. If voltage is flowing, the circuit is on. If it's not flowing, the circuit is off.

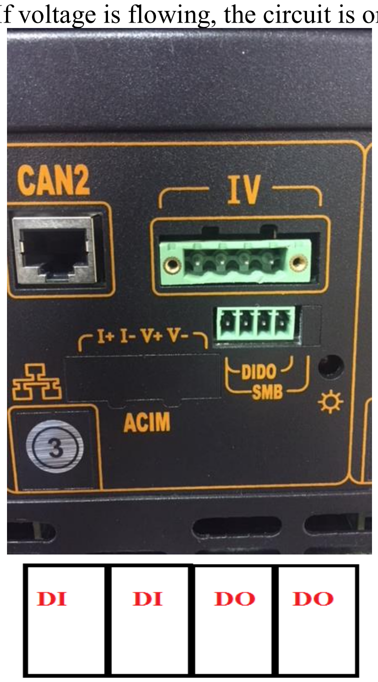


Figure 10-30

Digital I/O stands for Digital Input and Output. Digital Inputs allow a microcontroller to detect logic states, and Digital Outputs allow a microcontroller to output logic states.

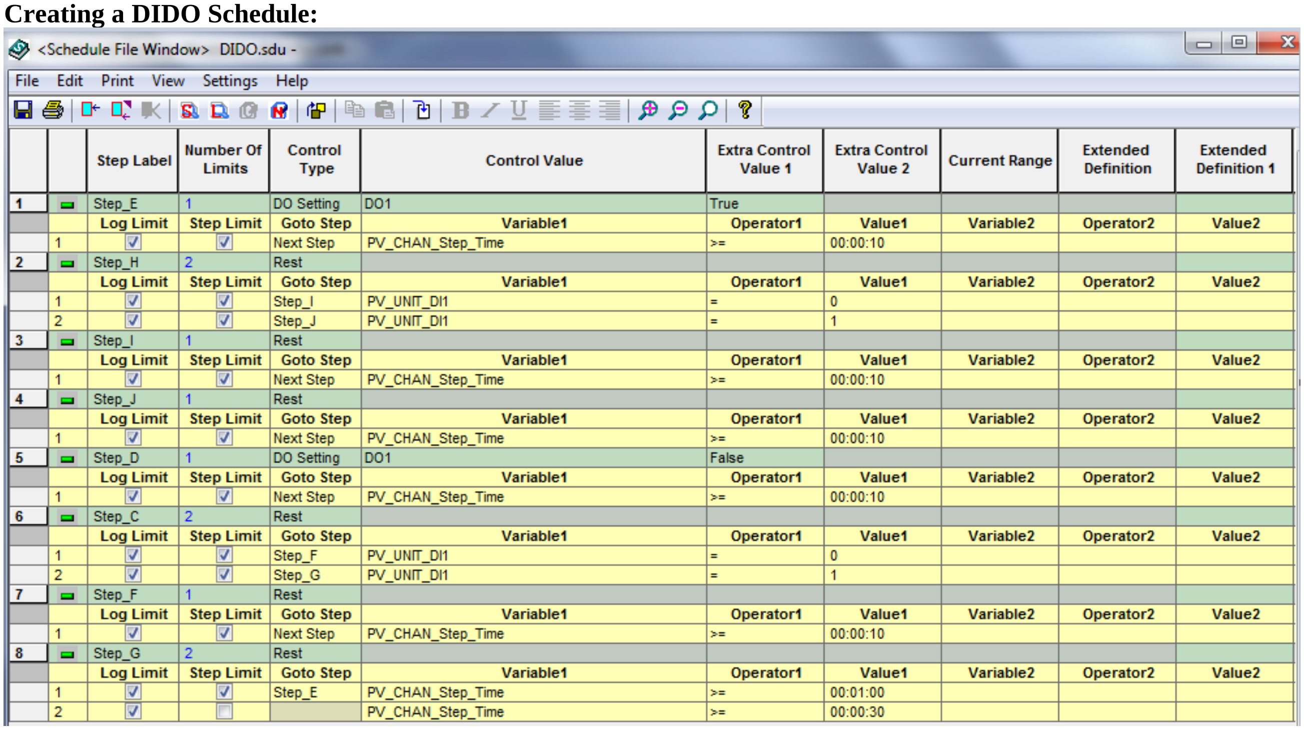
There are two types of DIDO boards:

1. Relay Style – the maximum current that can be driven through the relay is 12A.
2. TTL Style – if the voltage is less than 0.5V, the board will see the DIDO as **Open (for false)** and if the voltage is greater than 4V, the board will see the DIDO as **Closed (or true)**

Digital Output is responsible for the opening and closing signal
- When DO = 0 or True, then DI = Closed circuit

Digital Input is detectable for the opening and closing of the circuit
- When DO = 1 or False then DI = Open circuit

Creating a DIDO Schedule:


<Schedule File Window> DIDO.sdu -

File Edit Print View Settings Help

		Step Label	Number Of Limits	Control Type	Control Value	Extra Control Value 1	Extra Control Value 2	Current Range	Extended Definition	Extended Definition 1
1		Step_E	1	DO Setting	DO1	True				
		Log Limit	Step Limit	Goto Step	Variable1	Operator1	Value1	Variable2	Operator2	Value2
	1	✓	✓	Next Step	PV_CHAN_Step_Time	>=	00:00:10			
2		Step_H	2	Rest						
		Log Limit	Step Limit	Goto Step	Variable1	Operator1	Value1	Variable2	Operator2	Value2
	1	✓	✓	Step_I	PV_UNIT_DI1	=	0			
	2	✓	✓	Step_J	PV_UNIT_DI1	=	1			
3		Step_I	1	Rest						
		Log Limit	Step Limit	Goto Step	Variable1	Operator1	Value1	Variable2	Operator2	Value2
	1	✓	✓	Next Step	PV_CHAN_Step_Time	>=	00:00:10			
4		Step_J	1	Rest						
		Log Limit	Step Limit	Goto Step	Variable1	Operator1	Value1	Variable2	Operator2	Value2
	1	✓	✓	Next Step	PV_CHAN_Step_Time	>=	00:00:10			
5		Step_D	1	DO Setting	DO1	False				
		Log Limit	Step Limit	Goto Step	Variable1	Operator1	Value1	Variable2	Operator2	Value2
	1	✓	✓	Next Step	PV_CHAN_Step_Time	>=	00:00:10			
6		Step_C	2	Rest						
		Log Limit	Step Limit	Goto Step	Variable1	Operator1	Value1	Variable2	Operator2	Value2
	1	✓	✓	Step_F	PV_UNIT_DI1	=	0			
	2	✓	✓	Step_G	PV_UNIT_DI1	=	1			
7		Step_F	1	Rest						
		Log Limit	Step Limit	Goto Step	Variable1	Operator1	Value1	Variable2	Operator2	Value2
	1	✓	✓	Next Step	PV_CHAN_Step_Time	>=	00:00:10			
8		Step_G	2	Rest						
		Log Limit	Step Limit	Goto Step	Variable1	Operator1	Value1	Variable2	Operator2	Value2
	1	✓	✓	Step_E	PV_CHAN_Step_Time	>=	00:01:00			
	2	✓			PV_CHAN_Step_Time	>=	00:00:30			

Figure 10-31 Select "DO Setting" as a Control type in the System Settings of MITS Pro

To make the DIDO step, select DO Setting as a Control Type and choose DO1 as the control Value

The Extra Control Value 1 will either be True or False (based on what you want the DO1 step to do). And Variable1 should be PV_CHAN_Step_Time >= the amount of time needed/desired for the DO1 step to operate, i.e. 10 sec like the above schedule.
The next step should be a Rest step where the Arbin checks the True/False status of the DI1 (Digital Input 1) port via the PV_UNIT_DI1 variable and then follows the schedule based on the result of DI1.
To insert the PV_UNIT_DI1 variable, click in the Variable box and select More… from the drop-down menu.

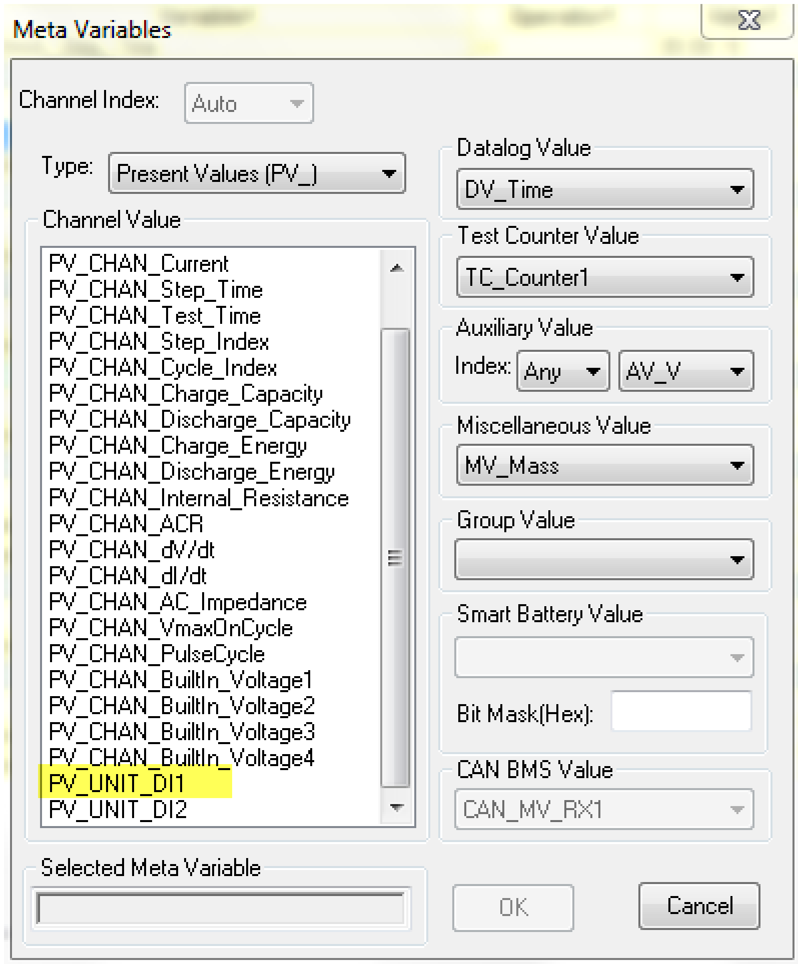


Figure 10-32

Click on PV_UNIT_DI1 and click on OK

In this schedule, if DI1 is 0 (or True) it will then proceed to Step I, if DI1 is 1 (of False) it will then proceed to Step J

Chapter 11 Troubleshooting

11.1 How to Report a Problem

After you have followed the instructions in the previous section and have re-installed MITS Pro8.0 software, you may verify that the system is ready for performance by conducting the following channel diagnostic procedure (Refer to **Figure 11-3**) to check the MITS Pro8.0 system control.

A. Current Diagnostic Connection Scheme

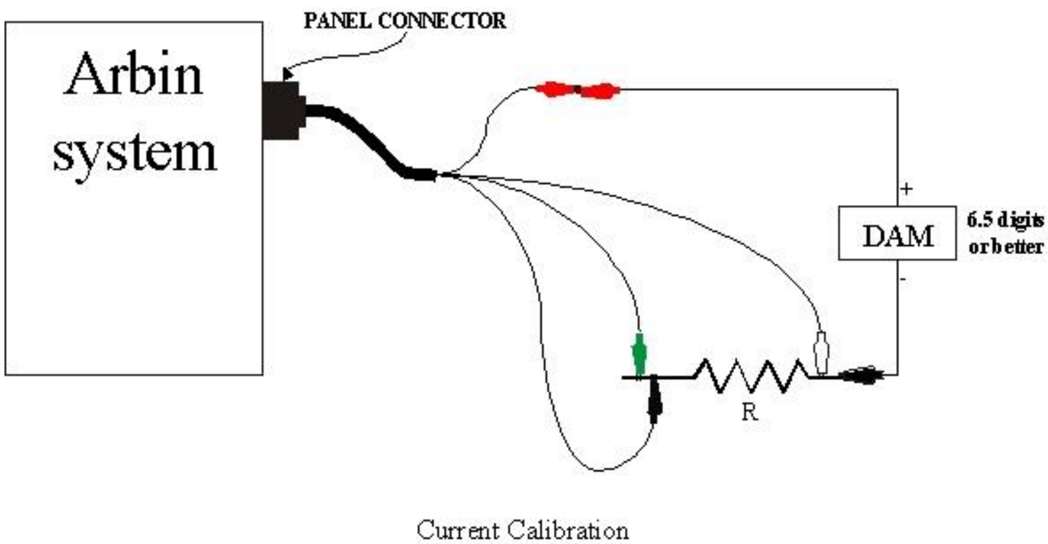


Figure 11-1 Current Diagnostic Connection Scheme

1. Make the connection as shown in Figure 11-1 above on Channel N. R value should be to limit the current I $=V_{max}/R < 3A$, and the walt of R should be > V_{max} x $I_{desired\ value}$
2. Start **MITS Pro8.0**.
   From the MITS Pro8.0 console click the **Hardware Calibration** button.
3. On the **Calibration** window, choose the options as shown below. The mouse cursor or the <Tab> key can be used to move between fields:
   Start Chan: N, **Chan Count**: 1, **IRange1 (high range)**, **Units**: 1x.
4. Enter “0” as the **Desired Value**.
5. Click **Set** button; the red LED of channel N will light. Once this condition is verified, then proceed with **Desired Values** as specified by **Table 11-1**. Failure in this step indicates trouble with the system communication. Contact Arbin customer service for hardware troubleshooting support.
6. Read the value on the ammeter and enter it with the appropriate sign in the **Accurate Values** field.
7. Click **Calculate** button. The **Machine Value** will display on the Calibration Window. Enter the appropriate parameters into the diagnostic data report.
8. Click **Next** button to turn off the channel. Repeat step 3-7 for other current ranges.

B. Voltage Diagnostic Connection Scheme

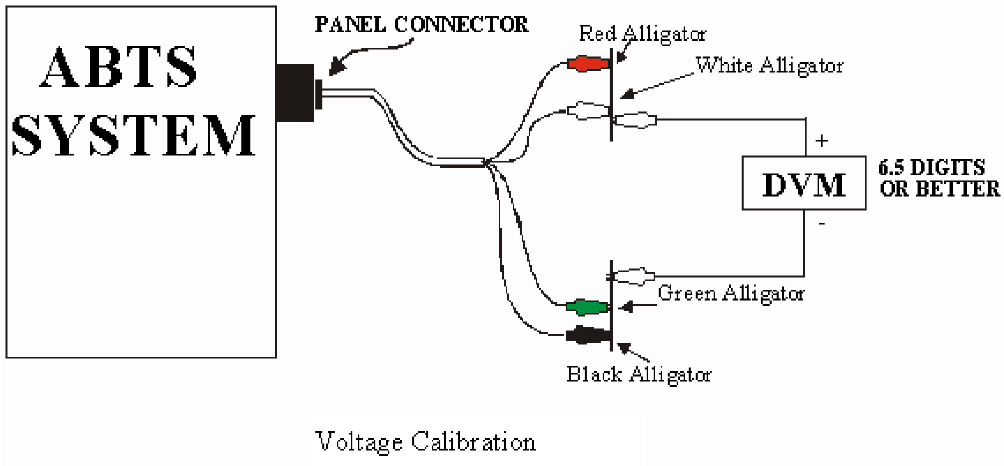


Figure 11-2 Voltage Diagnostic Connection Scheme

1. Change the connection to match the scheme shown on Figure 11-2 above.
2. Verify the settings as follows

   Start Chan: N, **Chan Count**: 1, **Voltage-High**, **Units**: 1x.
3. Enter 1/5 – 1/2 of full range value as the **Desired Value** for the range. Click **Set** button.
4. Read the value on the Voltmeter and enter it with the appropriate sign in the **Accurate Values** field.
5. Click **Calculate** button; the **Machine Value** will display on the Calibration Window.
6. Repeat steps 3 through 5 for every data point required.
7. **The Desired Values**, **Accurate Values** and **Machine Values** will be tabulated in the display on the Calibration Window. Enter the appropriate parameters in the diagnostic data report.
8. If the differences between the **Desired Value**, **Accurate Value** and **Machine Value** are less than the tolerance (0.1% of Full-Scale Range), then the system is performing satisfactorily to specification. Otherwise, fill out the following forms (Table 11-1) and report the problem to Arbin Customer Service.

C. Click `Next` and Close the Calibration Window.

NOTE: Never click the **Done** or **Pre-Calib** button, unless you are told to do so by technical support personnel from Arbin Customer Service!

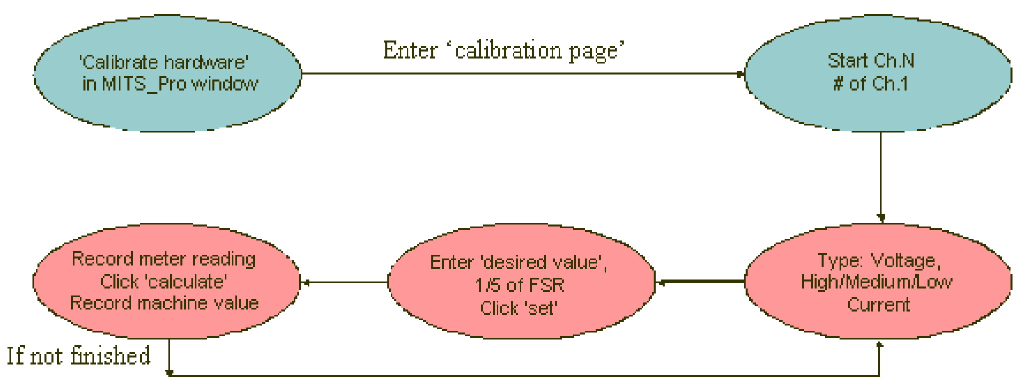


Figure 11-3 Procedure to Report Channel Problem

Channel Number: __ Current, Voltage, other Range: __

	Desired Value	**Accurate Value**	**Machine Value**
1/5 of FSR (H), Voltage			
Charge Current (<3A)			
Discharge Current (<3A, if minimum voltage <=0)			

Table 11-1 Channel Diagnostic Report Form on Channel N, Range X

11.2 Troubleshooting Hints

Symptom 1: No green board LEDs on after turning on the testing stand with computer being turned off.

Possible Cause:

- Power to the testing stand is off
- 3-phase protector does not function properly
- Fuses on AC main power have blown

Solution:

- Check building power supply
- Check voltages of 3-phase lines and adjust the pot on the 3-phase detector
- Check to see if testing stand's fans are running to verify if the main fuse is blown

Symptom 2: With computer on, green LEDs are on. But all channel red LEDs do not follow the command.

Possible Cause:

- Channel run in REST step
- Computer is not communicating with the testing stand
- Control DC power supply failure
- **MITS Pro** software has stopped due to some problems with the operation
- **MITS Pro** software has stopped due to some problems with the defect file in HD
- Ethernet communication cable(s) fails to connect to the HUB

Solution:

- It is normal
- Check data cable connection between computer and testing stand. (Also check Ethernet port for Arbin tester in the computer)
- Check voltage on control DC connector; check fuses
- Check the task bar; see if the DAQ and LOG tasks are running. If either one has been accidentally closed, a system reboot will be necessary
- Open Control panel/devices to see that all drivers are present in the system. If not, call the factory Reinstallation of MITS Pro8.0 Software should be the last solution
- Connect the cable(s), or replace the cable(s), or change the port in the HUB, or call the factory

Symptom 3: Red LEDs on all channels of a board did not follow the command.

Possible Cause:

- incorrect jumper (address) setting on module

Solution:

Call the factory for further assistance.

Symptom 4: The channel red LEDs followed the command, but the channel only delivered micro/milli Amperes charge and discharge current on a single channel.

Possible Cause:

- Channel fuse F1 and/or F2 has blown.

Solution:

Pull the module out. Check the fuse and replace it if it is blown. F1 affects all ranges; F2 affects medium and low ranges, but not high range.

Symptom 5: The channel red LEDs followed the command. But the channel only delivered micro/mA current on all channels of one board.

Possible Cause:

- DC charging/discharging power fuse(s) has(have) blown.
- The charging/discharging power supply(s) is(are) damaged.
- Bad connection between the charging/discharging power and the board.

Solution:

- Measure the voltage and check the fuse for DC main power (red wire for charge and white wire for discharge current, black wire is the ground).
- Call the factory.
- To tight the connection.

Symptom 6: The channel red LEDs followed the command, but the channel only delivered micro/mA current on all channels of the testing stand.

Possible Cause:

- DC charging/discharging power supply which supplys power to whole channels is failed. DC charging/discharging power fuse(s) may be blown.
- Bad connection between the charging/discharging power and the board.

Solution:

- Measure the voltage and check the fuse for DC main power (red wire for charge and white wire for discharge current, black wire is the ground). Contact the factory for instruction.
- To tight the connection.

Symptom 7: No fan noise can be heard, but the unit works normally for a while and then shuts down.

Possible Cause:

- Fan fuses are blown, and unit is tripping off on thermal override.

Solution:

- Replace fan fuses or fans.

Symptom 8: Fans run OK, but the current reaches the desired value momentarily, then drops down to a much lower value.

Possible Cause:

- A defective FET chip(s).

Solution:

- Check the FET chips, which are attached on the aluminum heat sink. Inspect for any visible damage. Call the factory for further assistance.

Symptom 9: Red LED illuminates, but both current and voltage fluctuate irregularly on all channels.

Possible Cause:

- Defective DC charging/dsicahrging power supply
- Bad ground connection

Solution:

- Check the ground connection between the power supply and chassis.
- Measure the voltage fluctuation on the DC main power supply.

Symptom 10: Red LED works well, but both current and voltage fluctuate irregularly on all channels of a board.

Possible Cause:

- Bad connection between the supply and the board.
- Bad connection on the board.

Solution:

- Check all connecting points from DC main power supply through the board.
- Press all chips on the board to ensure firm connections.
- Call the factory.

Symptom 11: Current control is OK, but a voltage spike occurred on all channels of a board.

Possible Cause:
- defective microcontroller board

Solution:
- Call the factory for repair or replacement.

Symptom 12: Current control is OK, but a voltage spike occurred on a single channel.

Possible Cause:
- defective the IV cable.
- defective microcontroller board

Solution:
- Check the cable connection.
- Call the factory for repair or replacement.

Symptom 13: System communication looks OK, but the actual values or display values are different from the desired values.

Possible Cause:
- The system configuration file, ArbinSys.cfg has an error or was corrupted.
- Calibration is required.
- The hardware(s) is(are) damaged

Solution:
- Check the system configuration through the **MITS** window. Replace it from the backup CD onto the C:\MITS_Pro if something wrong is found in ArbinSys.cfg.
- Re-calibrate the system annually; or in case of abnormal values, re-calibrate to bring the system back into conformance.
- Call the factory for repair or replacement.

Symptom 14: After a power outage, an error message was displayed while the system was trying to reestablish communication.

Possible Cause:
- The computer system has hung somewhere.
- The GAL or EPROM chips in the testing stand were damaged.
- Damage in a program file
- AC input or DC control power fuses blown.

Solution:
- Reboot the computer.
- Call the factory.
- Reinstall **MITS Pro8.0**.
- Replace fuses.

Symptom 15: Communication cannot be re-established. No power outage is involved.

Possible Cause:
- A new schedule in the working batch has a logic error.
- A wrong key strike caused the system to jam.

Solution:
- Open Console.exe without DAQ and clear the wrong schedule. Restart the system.
- Reboot the computer or re-install **MITS Pro8.0**.

- Use the <Alt>-<Tab> keys to page through the open applications until the original **MITS** screen that was being used is found. Since DAQ is booted automatically when the system is turned on, check to see if more than one application is open; press the <Ctrl> and <Esc> keys simultaneously to view the task list.

Symptom 16: The test control was OK but became interrupted or began to run slower after a while.

Possible Cause:

- Schedule is not compatible with the cell; it was outside control limits.
- Hard disk drive is full.
- Virtual memory is too small.

Solution:

- Copy old files to disk or tape to another computer over the network and delete from Arbin computer drive to free up space.
- Delete or revise the wrong schedule.
- Go through ‘control panel/system’ to increase the size of the virtual memory to 200MB.

Symptom 17: Channels do not follow schedule properly after resuming tests.

Possible Cause:

- File identification information was lost due to the power failure or computer failure, which originally interrupted the test.

Solution:

- When resuming channels after a power failure, computer outage or other incident which forces the DAQ application to close; one must resume the channels individually and select a specific file (test name) to write the data to. When resuming after such a failure, the user should not select "same as last test" because when DAQ was closed during the test, the computer lost the information necessary to properly perform this function. Additionally, when resuming channels, care should be taken to select only the data file in use at the time the test was interrupted. Selecting a different test could cause similar errors.

Symptom 18: An error message appears at start up, such as "Could not open the system configuration file using default values."

Possible Cause:

- Some of the files for MITS are not in the correct directory.

Solution:

- In the Program Manager, check all directories in C:\ArbinSoftware\MITS_Pro directory. Each file should be in the directory as shown in Table 11-3.

Directory name	Location	Files
Main (programs) directory	C:\ArbinSoftware\MITS_Pro	Console.exe, DAQ.exe, ArbinSys.cfg
Work Directory	C:\ArbinSoftware\MITS_Pro\Work(\…)	all mapping files (*.bth) all schedule files (*.sdx)
System Directory	C:\Windows\System32	Registry codes and system linking files (*.dll)
Data Watcher Directory	C:\ArbinSoftware\DataWatcher	DataWatcher.exe
Support Directory	C:\ArbinSoftware\MITS_Pro\Support	All Auto calibration files; online edited schedule files, Data log information

Table 11-2 MITS Pro8.0 File Type Descriptions, Locations

Note: If any of these files are misplaced, please call Arbin customer support.

11.3 FAQs about Arbin Testing Systems

General Questions

What is MITS Pro?

MITS means Multiple Integrated Testing System. "Pro" simply refers to the latest version of the software. It was designed to run under the Windows XP, Windows 7, Windows 10 operating system.

Hardware

1. **How is the battery being tested connected to the channel cable?**

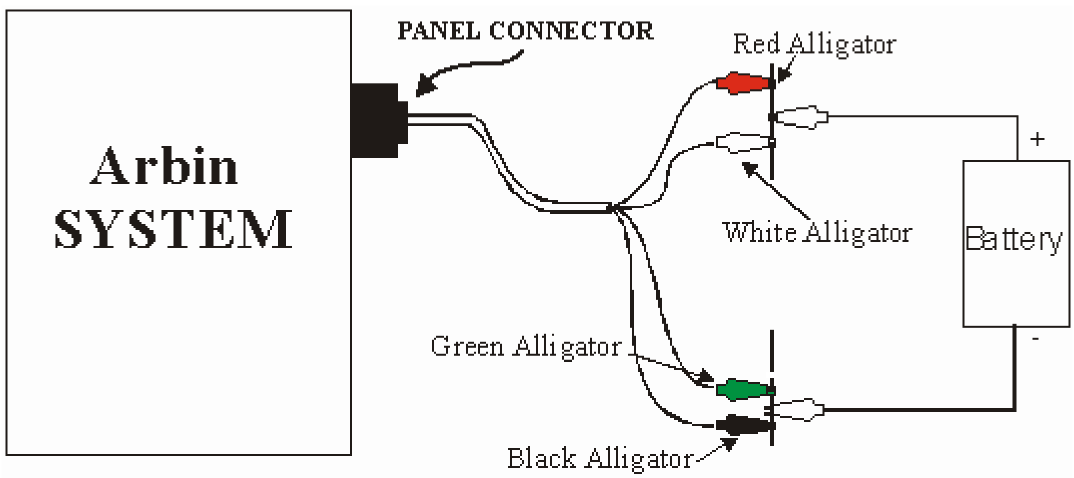


Figure 11-4 Battery Connection Scheme

The Red and White alligator clips connect to the positive terminal of the battery, and the Green and Black alligator clips go to the negative terminal of the battery (see the **Figure 11-4**).

2. **How is the electrochemical cell connected to the channel cable?**

The Red and White alligator clips connect to the Working Electrode, the Green alligator clip connects to the Reference Electrode, and the Black alligator clip connects to the Counter Electrode.

Software - MITS Pro

1. **How fast can MITS Pro8.0 acquire data?**

First, let us clarify several terminologies referenced by software engineers.

- Data sampling - the process of getting data from Arbin instruments.
- Data logging - the process of saving data from real-time buffer to results database file.
- Data acquiring - the overall process of data sampling and data logging.

Data sampling and data logging are two independent processes. Data sampling is executed by the MC, and its rate is determined mainly by the time required to sample all operating channels. Data logging is executed in the foreground scan loop. Whenever a schedule log limit is evaluated, the data will have its chance to be saved to results file. If the logging data speed is faster than sampling data speed, then there exists a chance of saving duplicate data.

Normally, customers will mention "acquire data" although for us it stands for two independent processes. So, the question "How fast can MITS Pro8.0 acquire data" actually is the combination of two questions: "How fast can MITS Pro8.0 log data" and "How fast can MITS Pro8.0 sample data".

a. How fast can MITS Pro8.0 log data?

There is no straightforward formula to calculate the speed. However, we provide an answer based on tests here. Keep it in mind: if you want very fast logging speed, be sure to set a big enough logging buffer in system configure

b. How fast can MITS Pro8.0 sample data?

There is no straightforward formula to calculate the speed either.

For regular 2ADC systems (two ADCs and eight channels on each board), every time **MITS Pro8.0** updates voltage and current for all channels once, one auxiliary data will be updated.

2. How much RAM does MITS Pro8.0 need?

First, there is no formula to calculate the exact amount of RAM that MITS Pro8.0 needs.

Here is a rough guideline.

- More than 256MB is needed if total channel number is greater than 64 or intensive data logging is required.

3. Should we take any precautions while installing a JAZ or ZIP drive and software?

So far there is no conflict between ZIP drive and JAZ drive. Please contact Arbin customer service with questions about specific devices.

4. After I shut down and restart channels the data in the results file shows readings of 0 Volts and 0 ampere reading. Is the cell really on open circuit, or is channel reading an artifact of the system/software?

NOTE: such occurrences make good event markers.

Software is responsible for giving control commands and sampling data back to hardware. Software is not aware of whether the whole instrument is powered on or not, and the software is not aware of whether the circuit is open or not either. There is only one exception: if the hardware is connected to a UPS, and UPS is correctly configured in Arbin configuration file, then when MITS Pro8.0 is running it can check UPS status and will turn all channels off if power failure signal from UPS is detected.

5. Will we be able to update future editions of MITS Pro8.0 on-site?

As software revisions usually involve new features, there are often firmware updates associated with the change. These modifications may be made easily by the customer, but users must be aware that the updates must be affected concurrently with one another. Always ask about the possibility of a firmware change when inquiring about software updates.

6. What is statistical data in the result file?

Statistical Data is information specially designed for battery testing procedures that involve the execution of many charge-discharge cycles for a battery. It provides a data summary of each cycle and includes the last data point of each cycle, consisting of current, voltage, capacity and energy. Maximum voltage of each cycle is also tracked and included in the statistical data.

Note:

Statistical Data implies the use of the **Control Type** Set Variable(s) with an appropriate **Goto Step** designation (See below.). If there is no such control defined in a schedule, then there will be no data presented in the statistical data sheet.

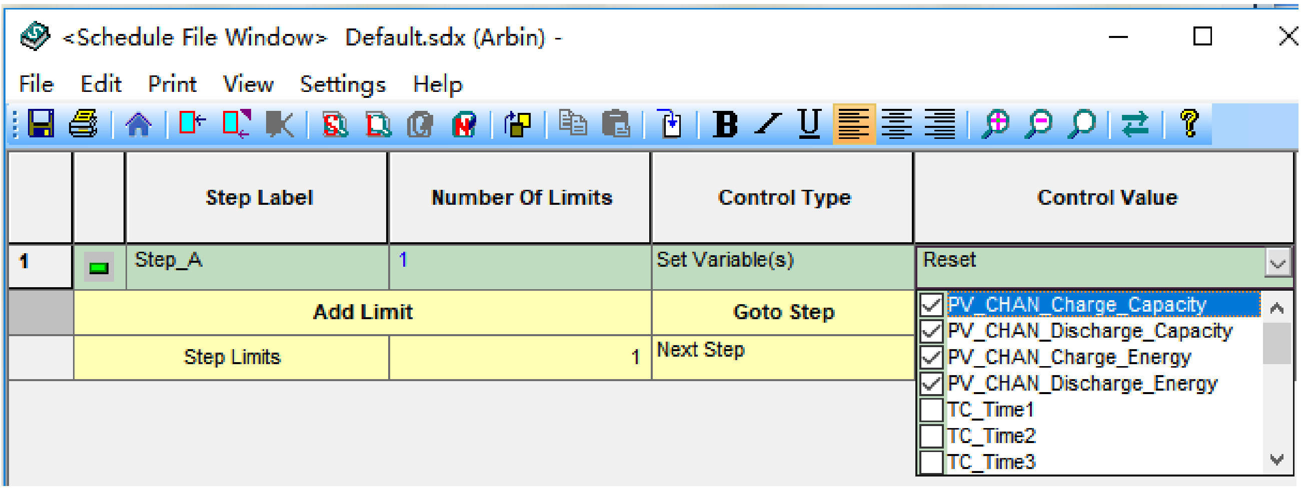


Figure 11-5

Example: A cycle test needs to count the charge capacity and discharge capacity by each cycle.

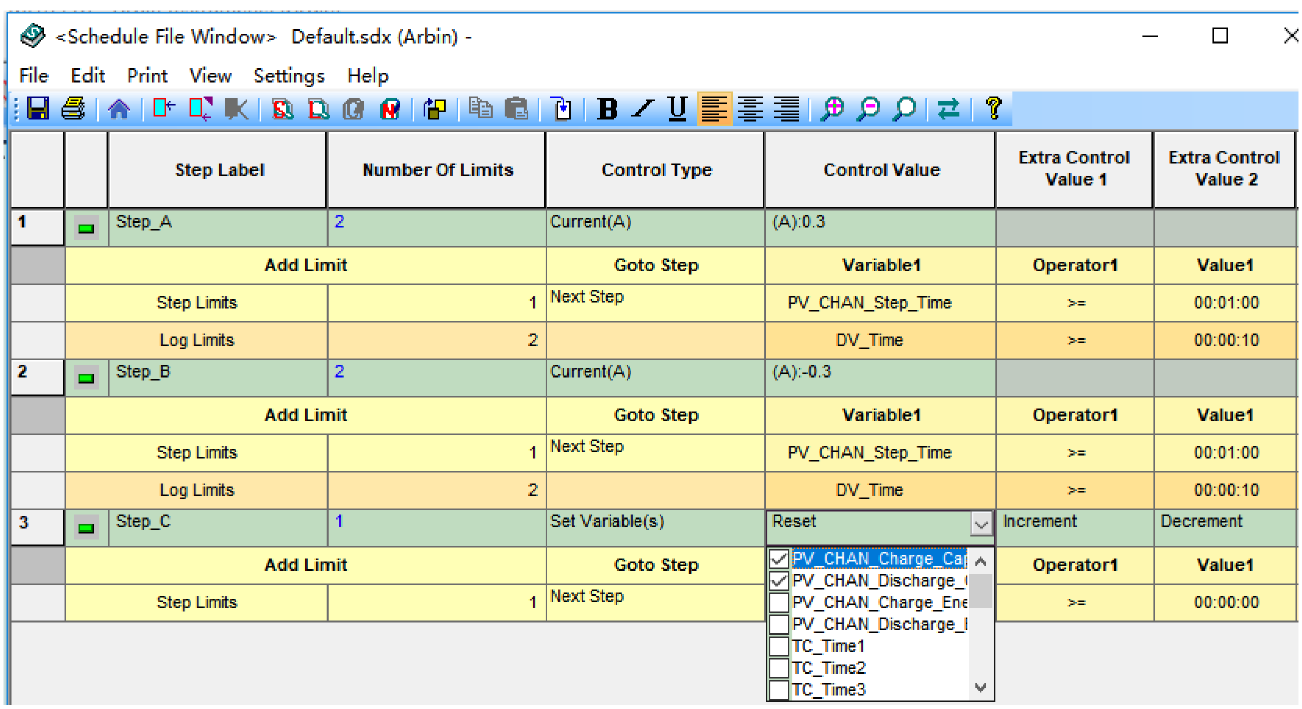


Figure 11-6

7. What is Set Variable(s)? How does this function work?

Set Variable(s) can be considered a special control type. It is purely a software function, and no hardware operation is involved. There are three functions associated with this control type:

a. Reset

Checking the box that corresponds to the parameter will reset this parameter. The parameters include charge capacity, discharge capacity, charge energy, discharge energy, time counter, capacity counter, energy counter, and miscellaneous value counter. These counters will be activated automatically when a test is started and will continue to accumulate as the test proceeds.

b. Increment

Checking the box that corresponds to the parameter will increase this parameter by 1. For example, checking the box that corresponds to the cycle index will add 1 to the total cycle number.

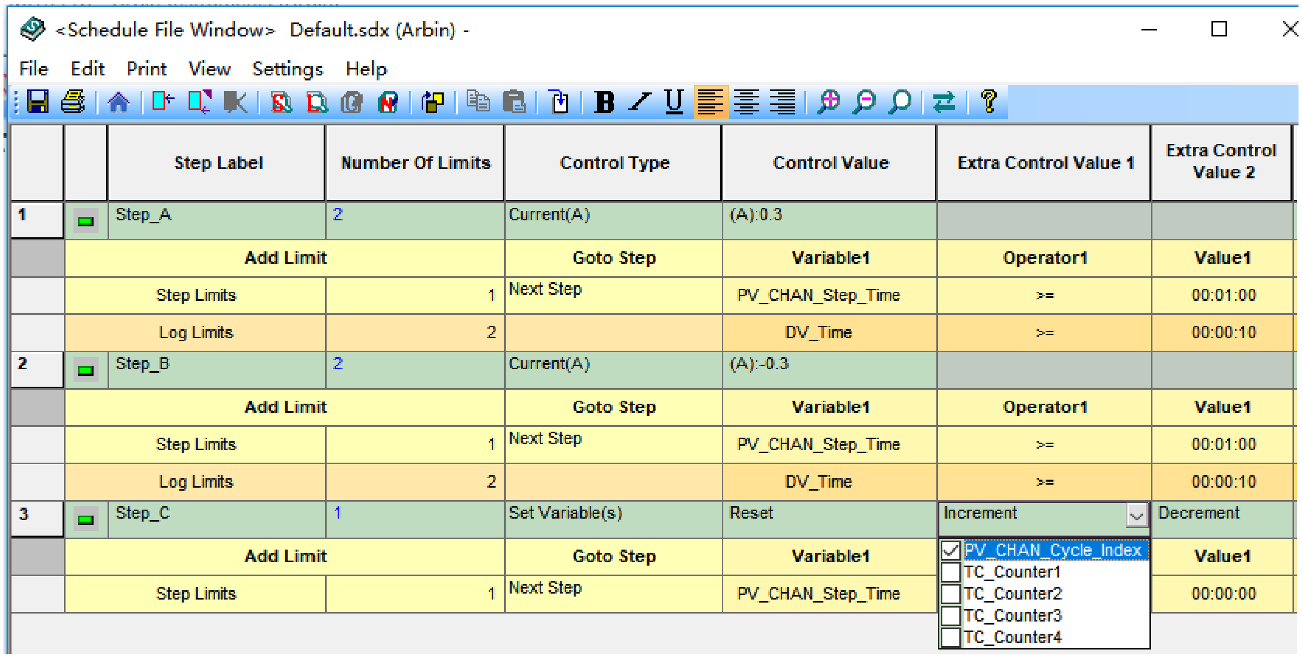


Figure 11-7

Example: A cycle test needs to count the cycle number as the test proceeds.

c. Decrement

This function works in the same way as Increment except it subtracts 1 from the total number. For example, if the value of TC_Counter1 is 4 when the schedule executes the decrement, then the software calculator will reduce the value to 3.

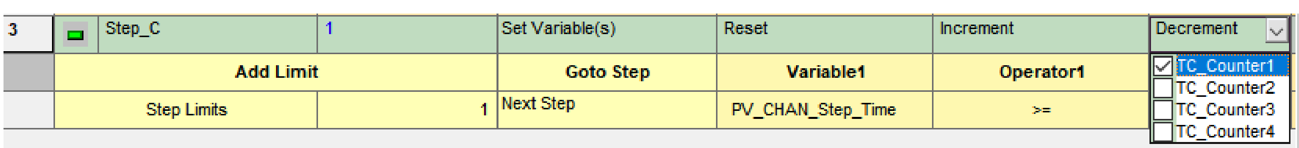


Figure 11-8

8. Why does the cycle number remain 1 during a cycle test?

In a schedule one must add a Set Variable(s) step to the end of the cycle and check the **PV_Chan_Cycle_Index** in the **Increment** field. Moreover, the **Goto Step** designations in the schedule must reflect some cyclical movement within the schedule.

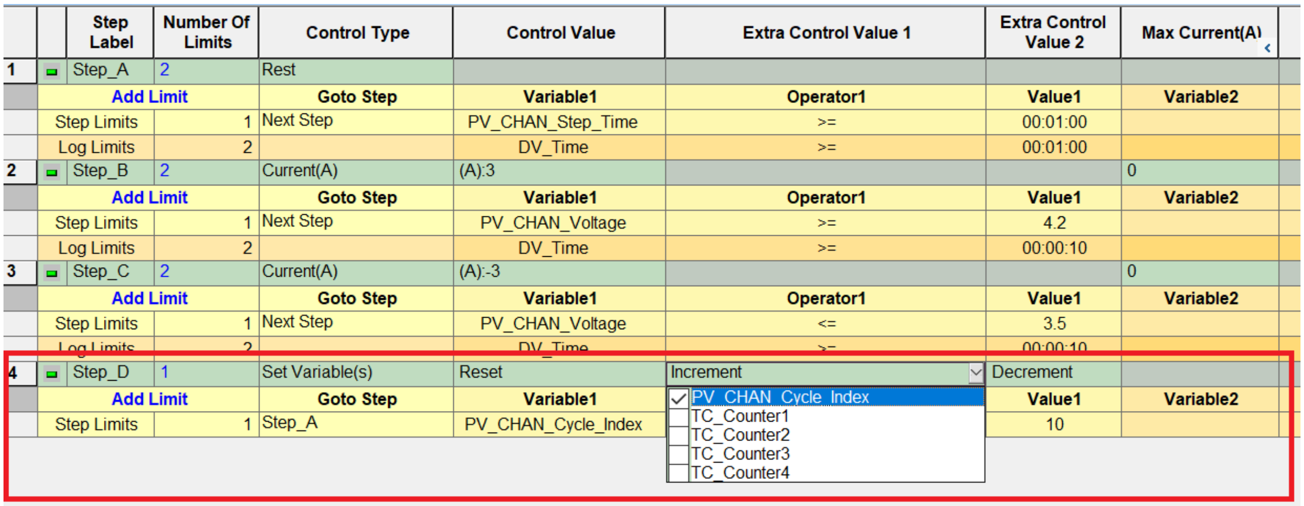


Figure 11-9

9. **What is TC_Time1, TC_Time2, TC_Time3, and TC_Time4?**

TC_Time1, TC_Time2, TC_Time3, and TC_Time4 are time counters. Time counters can be used to count the total test time of a group of steps. Further, the time counters can be used as the step termination limit or logging data limit.

Example: A charging process consists of two steps, constant current following a constant voltage. The termination condition of this charging process is total time = 5 hours.

To program this charging process:

a. Reset the time counter at the beginning of the charging process, e.g., TC_Time1.
b. Set the TC_Time1 >= 5 hours as the step termination condition for the second step of the charging process.

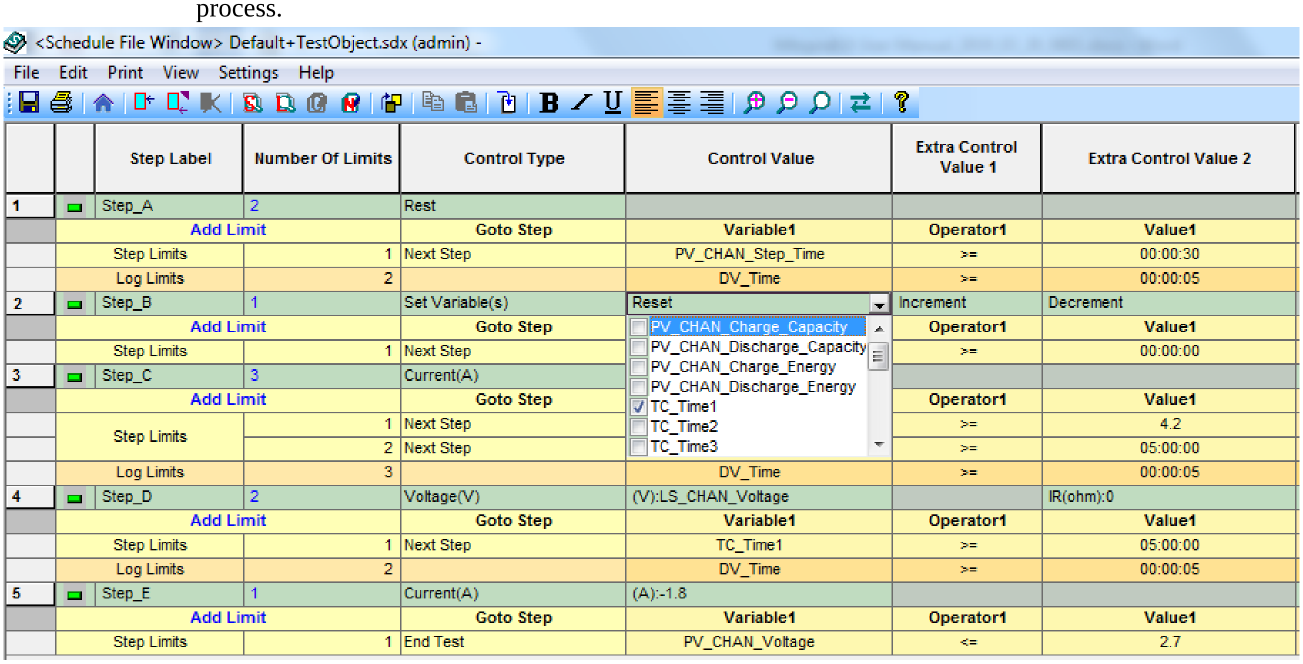


Figure 11-10

10. What are TC_Charge_Capacity1, TC_Charge_Capacity2, TC_Discharge_Capacity1, TC_Discharge_Capacity2, TC_Charge_Energy1, TC_Charge_Energy2, TC_Discharge_Energy1, and TC_Discharge_Energy2?

- TC_Charge_Capacity1 and TC_Charge_Capacity2 are charge capacity counters. The charge capacity is the capacity when the current is positive.
- TC_Disharge_Capacity1 and TC_Disharge_Capacity2 are discharge capacity counters. The discharge capacity is the capacity when the current is negative.
- TC_Charge_Energy1 and TC_Charge_Energy2 are charge energy counters. The charge energy is the positive energy value when calculated by the formula ∫ I*V*dt.
- TC_Discharge_Energy1 and TC_Discharge_Energy2 are discharge energy counters. The discharge energy is the negative energy value when calculated by the formula ∫ -I*V*dt.

The user can apply the capacity counters and the energy counters when the capacity or energy of the individual step or a group of steps needs to be counted separately. In most cases, the capacity or energy counters are used as the step termination condition or logging data condition.

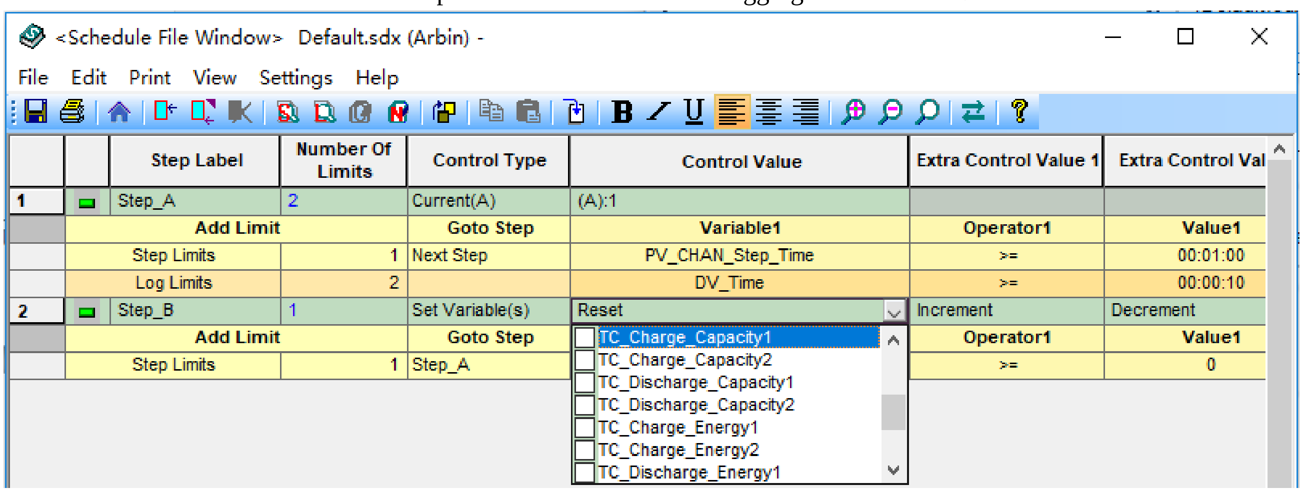


Figure 11-11

11. How does one implement Cyclic Voltammetry (CV) on Arbin test systems?

While some of the phenomena in this response are consistent with the latest **MITS** technology, users should note that CV methodology is most easily implemented through the using of CV Control.

Some users try to run cyclic Voltammegram on an Arbin test system. Under certain conditions, a fluctuated current curve may accompany a seemingly linear voltage ramp. However, it may not fit or may not be ready for some particular experiments. For example, there is a certain limitation on conducting Cyclic Voltammetry.

Since the nature of the digital control in our present product, a voltage ramp actually consists of numerous tiny stairs (See below, left.)

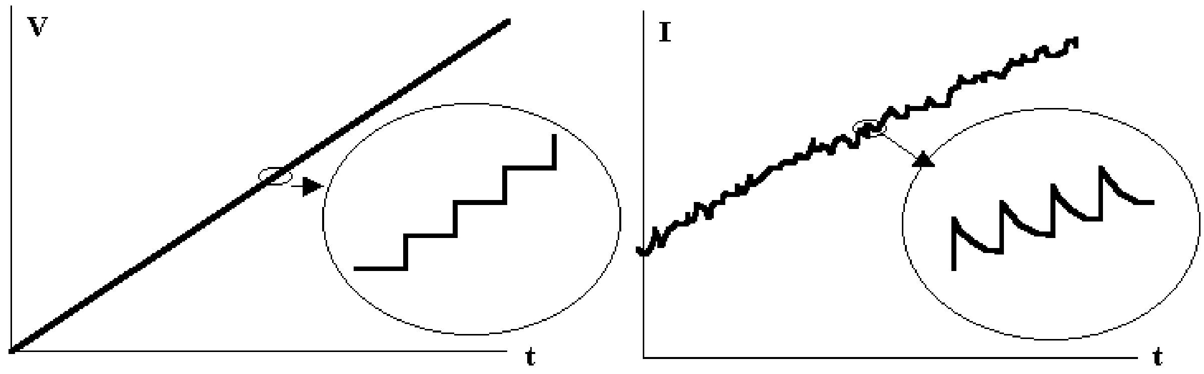


Figure 11-12

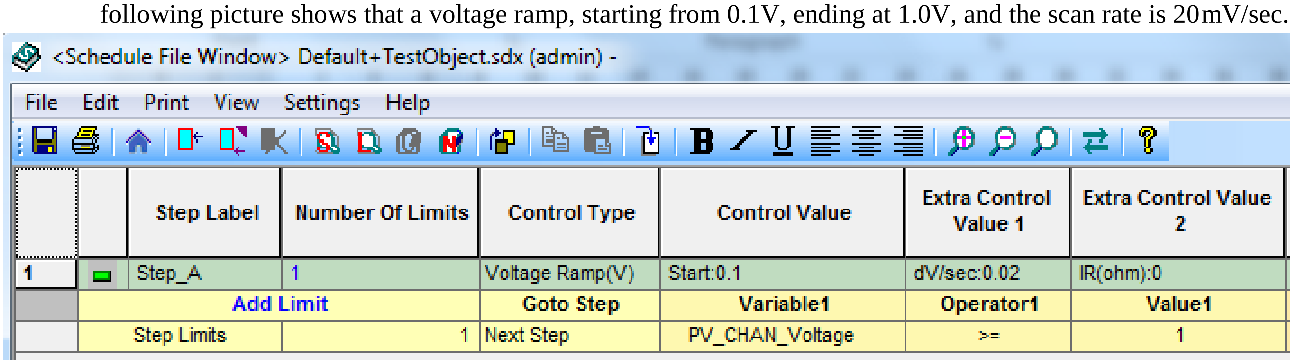
The height of one stair is: H_{stair} = FSR of the voltage range/2^{16} (16-bit ADC word)
Or H_{stair} = FSR of the voltage range/2^{24}(24-bit ADC word)

Example
Consider a **LBT21** series with a voltage range of –100V to +100V. The Full-Scale Range (FSR) of the voltage is 200V, and H_{stair} is about 3.1mV. Therefore, this instrument would not be capable of producing a CV with a scan rate any slower than 3.1 mV/second.

Furthermore, when the linear voltage scan is invoked, the system actually generates a stair-like function. The voltage rising or drop related to each stair on an electrochemical device will introduce current response in the pattern similar to that shown in the chart above, right.

Here is an example of how a CV has been historically scheduled in **MITS** software.

To generate a voltage ramp function, select "Voltage Ramp(V)" as the control type. Enter the starting potential in the **Control Value** field and enter the scan rate (sweep rate) in the **Extra Control Value 1**. Set the termination condition for the ramp. Users can use current, voltage, time, capacity, … to terminate the ramp function. The following picture shows that a voltage ramp, starting from 0.1V, ending at 1.0V, and the scan rate is 20mV/sec.



		Step Label	Number Of Limits	Control Type	Control Value	Extra Control Value 1	Extra Control Value 2
1		Step_A	1	Voltage Ramp(V)	Start:0.1	dV/sec:0.02	IR(ohm):0
	Add Limit			Goto Step	Variable1	Operator1	Value1
	Step Limits		1	Next Step	PV_CHAN_Voltage	>=	1

Figure 11-13

Note:
MITS Pro now contains an imbedded Control Type for single-step definition and implementation of Voltammetric and galvanometric sweeps. More information about this new CV Control may be found in chapter **5.10**.

The same procedures apply to the generation of current ramps.

12. How is the Current Staircase function used?

Current Staircase can generate the following function. (See diagram.)

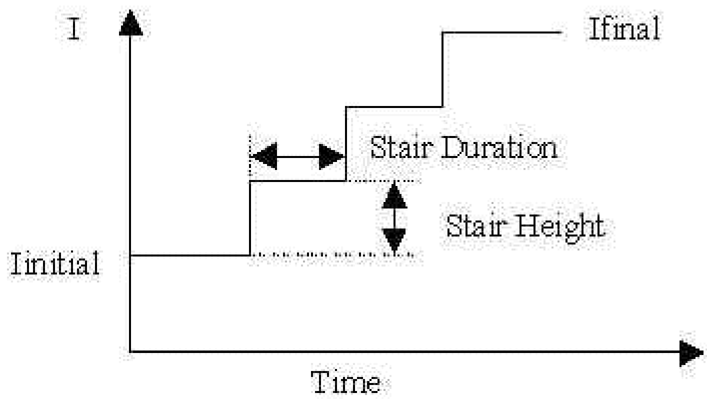


Figure 11-14

Example: Starting from 0.5 A, increase current 50mA every 20 seconds until the current reaches 2.0A. To program this function, select control type as **Current Staircase**. Enter 0.5 in the **Control Value** field and 0.050A in the **Extra Control Value1** field and 20s in the **Extra Control Value2** filed. Set the termination condition as in the following picture.

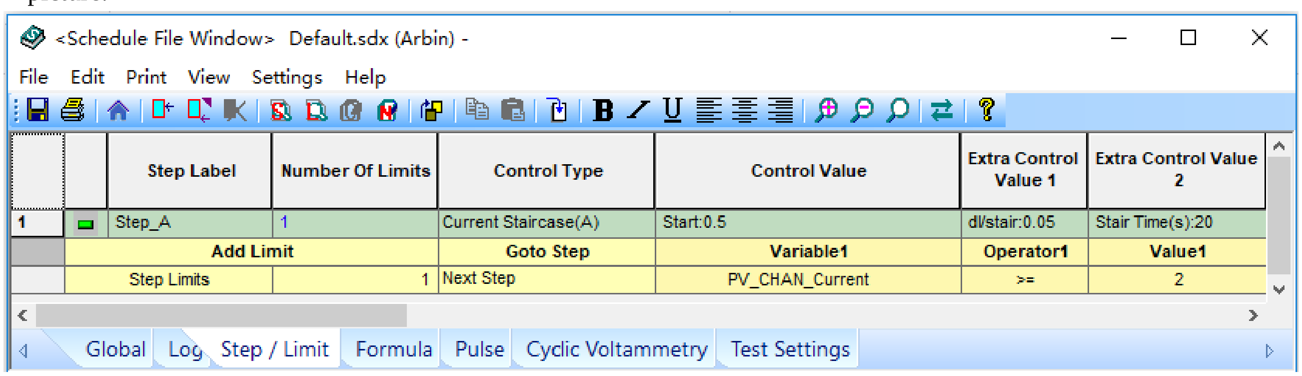


Figure 11-15

13. Why does voltage overshoot during voltage control?

In a present Arbin system, function of the voltage limit is controlled through the software, rather than through specialized circuitry on the board. During data acquisition, a delay time is experienced with respect to limit checking. In the earlier **ABTS** software, this delay time on single channel was about 200ms. Furthermore, this condition was exacerbated with increased channel activity. With a system containing 64 to 128 channels, the delay time could reach 1-2 seconds.

Under certain conditions, where voltage increases rapidly, crossing the limit value, such delay could cause the voltage to overshoot.

Example

A fully charged battery has initial voltage at 4.09V. The voltage limit was set at 4.1V for a step with 1.0C constant charge current. Under this relatively high charge current, voltage overshoot is definitely expected.

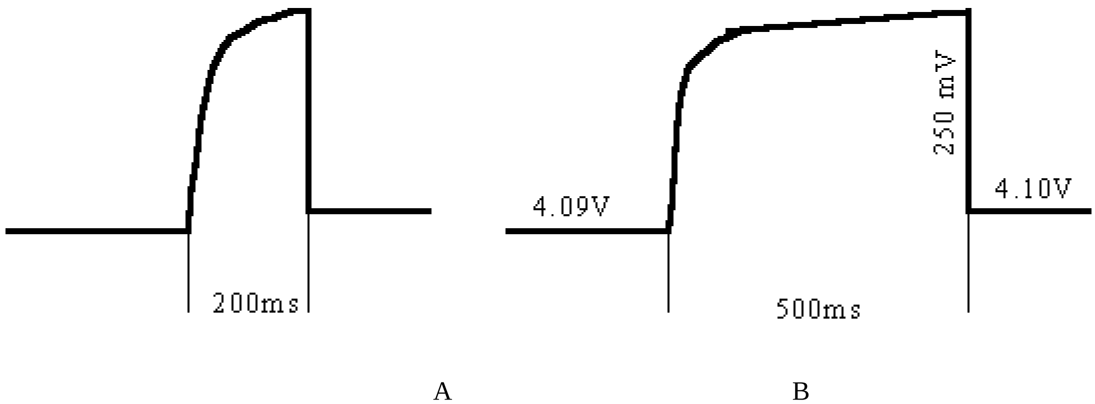


Figure 11-16

The above shows voltage overshoot during constant 1C current charge (A) with voltage limit 4.1V, (B) with time limit 0.5s. ABTS 4.0 and 2ADC machine. Observed on an oscilloscope.

The question is how fast the software can cut off the overshoot. The shorter the delay of the limit checking, the lesser the overshoot will be. If the delay time is 1-2 seconds, then the overshoot with several hundred millivolts can be resulted in.

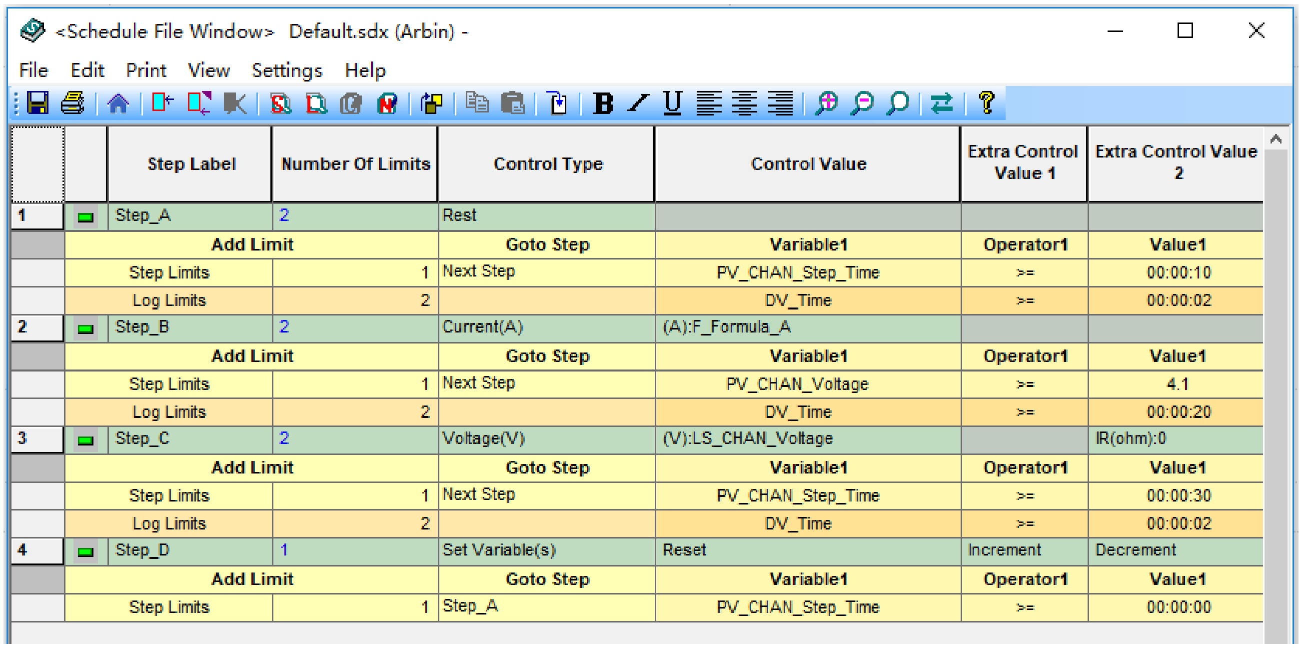
With our new software, **MITS Pro8.0**, the limit checking on single channel is faster than it is with ABTS 4.0. It takes about 100 ms. The advantage in MITS Pro8.0 is that the delay time of the limit checking is only slightly changed with number of running channels. Therefore, under MITS Pro8.0 control, the risk of voltage overshoot will be reduced.

In this case several approaches can be employed to eliminate the overshoot. The first option is to decrease the constant charge current, i.e. from 1.0C to 0.1C. The lower charge current generates slower voltage rising and much smaller voltage overshoot. Select lesser current if the initial voltage difference is close to the voltage limit. The second option is to use the formula to schedule a tailed current continuously in one step.

$I = (V_{limit} - V_{present}) * F$ (1)

The value of the factor F has to be determined through several tests and vary with the type of the battery. As the present voltage approaches the voltage limit, the current value will be decreasing. An actual schedule is shown in the following picture.

Step 1. ‘Rest’, for 10 seconds.
Step 2. ‘Formula I control value’, with voltage limit V_{limit}.
Step 3. ‘Constant V’, for 30 seconds.



		Step Label	Number Of Limits	Control Type	Control Value	Extra Control Value 1	Extra Control Value 2
1		Step_A	2	Rest			
		Add Limit		Goto Step	Variable1	Operator1	Value1
		Step Limits	1	Next Step	PV_CHAN_Step_Time	>=	00:00:10
		Log Limits	2		DV_Time	>=	00:00:02
2		Step_B	2	Current(A)	(A):F_Formula_A		
		Add Limit		Goto Step	Variable1	Operator1	Value1
		Step Limits	1	Next Step	PV_CHAN_Voltage	>=	4.1
		Log Limits	2		DV_Time	>=	00:00:20
3		Step_C	2	Voltage(V)	(V):LS_CHAN_Voltage		IR(ohm):0
		Add Limit		Goto Step	Variable1	Operator1	Value1
		Step Limits	1	Next Step	PV_CHAN_Step_Time	>=	00:00:30
		Log Limits	2		DV_Time	>=	00:00:02
4		Step_D	1	Set Variable(s)	Reset	Increment	Decrement
		Add Limit		Goto Step	Variable1	Operator1	Value1
		Step Limits	1	Step_A	PV_CHAN_Step_Time	>=	00:00:00

Figure 11-17

(In Formula_A, X1 = 4.1, X2 = 1.35, X3 = X4 = 1; Y1 = V $_{precent}$, Y2 = 1.35, Y3 = Y4 = 1)

An additional improvement is implemented in this example, as; instead of commanding a Control Value of 4.1V, the nominal cutoff for step 2; a meta variable is chosen. By selecting LS_CHAN_Voltage (Read "last step channel voltage.") the software will simply maintain the last value that triggered the step termination and avoid the discontinuity that the voltage feedback loop would otherwise create by trying to assume a distinct decimal value.

14. Why does the system shut down by itself?

Several reasons: such as power failure, lightning strike, circuitry failure, computer failure; can cause interruptions of Arbin systems. Also, software defects (Read "bugs.") are a possible cause to freeze the system. In spite of continuous effort expended toward software debugging, most commercial software still has minor bugs. Even though Windows is a well recognized [purportedly stable] operating system, minor bugs still exist there, too.

For the safety of the Arbin testing stand and the device tested, Arbin hardware and software have many safety provisions to protect from such problems.

- current-limiting circuitry to prevent current from exceeding maximum current range even when shorted
- watchdog to turn off the system in a few seconds after CPU hangs up or communication breaks down, whether it is caused by software bug or hardware connection
- five sets of fuses set in the chassis or on the board to prevent damage from unexpected shortage or over-current
- thermal switches set on each control board for module with current rate >2A to prevent overheating from abnormally large current or breakdown of cooling fans
- optional UPS (uninterruptible power supply) to prevent the data loss or system damage from power failure
- software safety limit in each schedule. There are safety limits of current, voltage, auxiliary voltage, temperature, and pressure for the whole test. Whenever any limit is exceeded, the channel will exit the test.
- software step limit in each step of a schedule, there can be limits of any variable(s) or meta-variable(s) that can be set for termination of the step or the test.

In case of system shutdown, first, the user should check out if it is any problem other than software bug that causes the shut down. In many cases the shutdown is caused by software problem. However, all hardware, external connection and internal fuses and components must be checked. Fix the hardware problem or report to Arbin customer service for further assistance.

If there is no obvious problem with the hardware, then the operator may try to close the Arbin software through the Windows Task Manager, turn on the testing stand and restart the software. In most cases the system can be restored, and test resumption will be successful. Avoid rebooting the computer as much as possible, since sometimes this action may obviate resumption of tests.

If any problem with current or voltage control is found after system shut down, do not try to calibrate the channel. Check the fuse(s) first. The user may refer to **Chapter 7** in this manual for further details.

15. What causes a current spike related to the constant voltage control?

On a present Arbin system, a current spike may be acquired during the transition from a constant current (I) step with voltage limit, V_{limit}, to a constant voltage step $V = V_{limit}$. Several factors can cause such a spike, among them the internal resistance of the device.

Arbin instrumentation provides voltage accuracy of 0.1% of full scale range (FSR). For example, for a **LBT21** series with a voltage range of –10 to +10V, FSR 20V, the error of the voltage control could be 20 mV (δV). For a device with impedance of 10 milliohm (δR), such voltage error could cause a current spike

$I = \delta V/\delta R = 2.0$ A.

The voltage accuracy is a factor to introduce the spike. Second, under certain conditions, the battery status changes quickly from one data point to another, particularly when the charge current in current charge step is close or greater than at 1C rate. The difference between the last point in the current step and first point in the voltage step could reach tens of milliVolts. This voltage difference also can cause current spike during the transition from constant current control to the constant voltage control. Using 'LastValue' instead of exact value for voltage control may reduce the problem from wrong timing of transition but not from changing status of the battery.

Several approaches can be employed to reduce the current spike. The first approach is to decrease the constant charge current is a way to reduce the voltage difference caused by battery status change. Select a lesser current if the initial voltage difference is close to the voltage limit. The second approach is to use the formula to schedule a tailed current continuously in the current step. The third approach is to check the voltage/currant calibration. In case a current spike triggers a current limit in the voltage step, the test may be stopped. The user could edit an 'AND' condition with a time limit to accompany the current limit, such as

I < 20mA AND the step time > 1 second in the voltage step.

It allows the test to run continuously.

16. What is C-Rate? How is C-Rate used to control tests?

C-Rate is a common reference for indicating the discharge and charge current of a battery. It can be expressed as $I=M\times C$,

where I = current (A); C = capacity of battery (Ah); M is the C-rate value.

In **MITS Pro**, to use C-Rate control, enter the battery rated capacity in the **Object Files** and enter the nominal capacity value in the **Capacity (Ah)** field. The software will calculate an output current value automatically. Positive C-Rate refers to charge current and negative C-Rate refers to discharge current. For example, if the capacity of the cell being tested is 1.2Ah and the C-Rate value was set as 0.5, then the output current should be

1.2(Ah)×0.5=0.6A.

Alternatively, quantities for **Specific Capacity (Ah/g)** and **Mass (g)** may be entered into the table to calculate the nominal capacity for a given sample.

eg. 0.023g of doped carbonaceous material bears a Faradaic equivalent of 0.315Ah/g. Entering these values results in a calculated capacity of 0.023×0.315=0.0072Ah that would subsequently be used in the determination of nominal capacity as above.

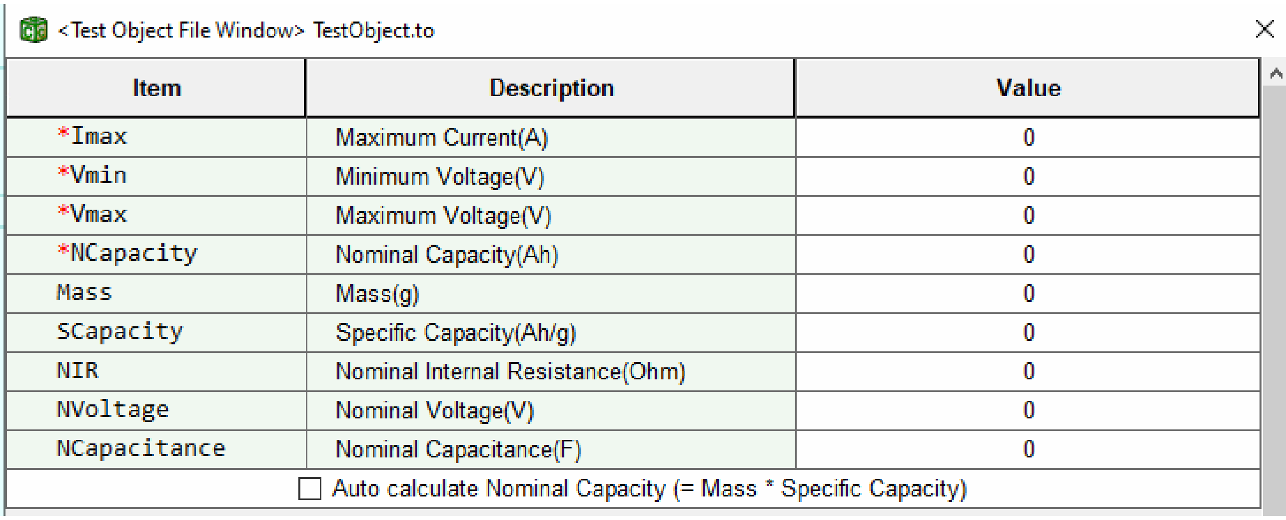


Figure 11-18

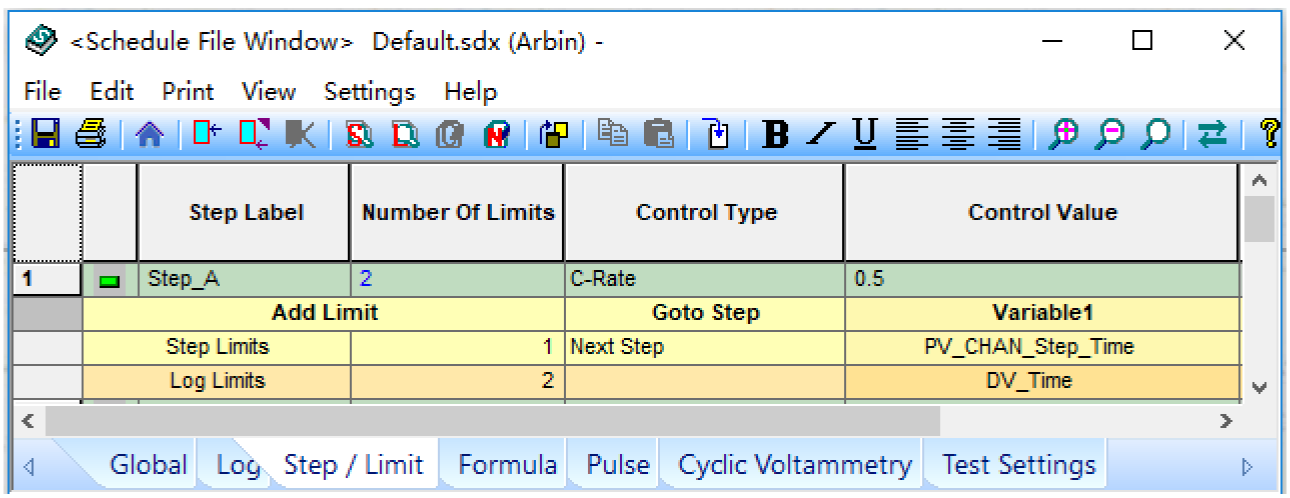


Figure 11-19

17. What is the meaning of dV?

dV = V-Vmax

Here:

V represents the present measured voltage value. V_{max} represents the measured maximum voltage during a test. dV is designed to be used as the termination condition for the charge process of Ni-MH or Ni-Cd cells. For a Ni-MH or Ni-Cd cell, a complete charge process is signaled by the drop in voltage of the cell after the cell voltage reaches its maximum value (See the following diagram). User can use the formula $V_{present\ value} - V_{max}$ to terminate the constant current charging step.

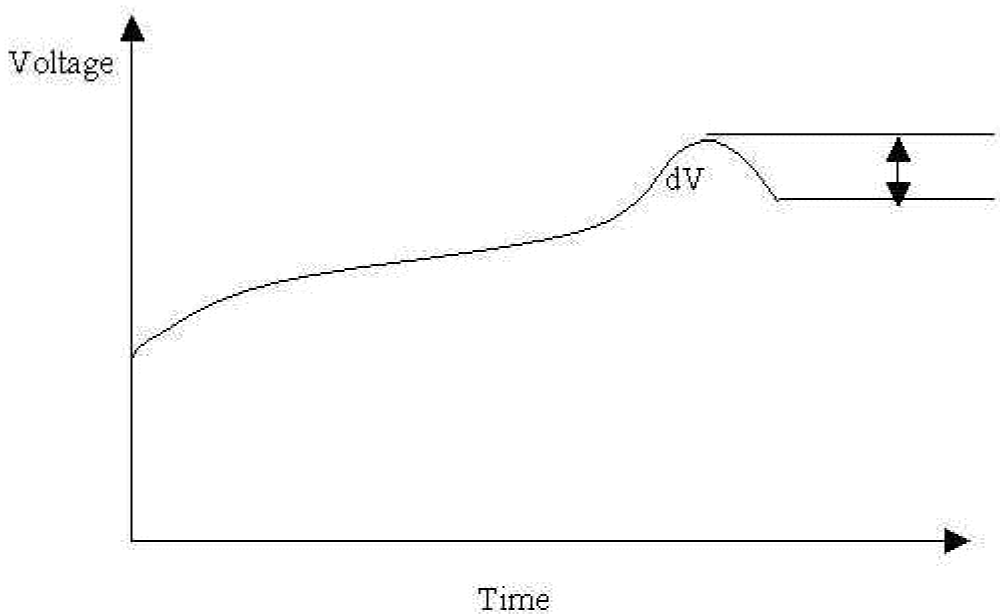


Figure 11-20

18. What is the meaning of dV/dt? How is this parameter used as a termination condition?

$dV/dt = (V_2 - V_1) / (t_2 - t_1)$

V_2 is the measured voltage at time t_2. V_1 is the measured voltage at time t_1.

Example:

To charge a cell at 1A to the voltage change of 100mV per second.

In MITS Pro8.0 the dX represents the rate of change of voltage, dt represents the time interval which have minimum and maximum value. Note, the Voltage Range in dX filed is base on the ArbinSys.cfg.

Item	dX(minimum)	dt(minimum delta time of calculation)	dt(maximun delta time of calculation)
dV / dt	0.2% * Voltage Range	0.1 (S)	120 (S)

Figure 11-21

		Step Label	Number Of Limits	Control Type	Control Value	Extra Control Value 1	Extra Control Value 2
1		Step_A	2	Current(A)	(A):1		
	Add Limit			Goto Step	Variable1	Operator1	Value1
		Step Limits	1	Next Step	PV_CHAN_dV/dt	>=	0.1
		Log Limits	2		DV_Time	>=	00:00:05

Figure 11-22

19. What is the meaning of dT/dt? How is this parameter used as a termination condition?

$dT/dt = (T_2 - T_1) / (t_2 - t_1)$

T_2 is the measured temperature at time t_2.
T_1 is the measured temperature at time t_1.

Example

To charge a cell to dT/dt = 2.5°C per second if temperature > 38°C.

Add Limit		Goto Step	Variable1	Operator1	Value1	Variable2	Operator2	Value2
Step Limits	1	Next Step	AV_dT/dt[1]	>=	2.5	AV_T[1]	>=	38

Figure 11-23

Note: the argument [1] denotes that the temperature value that will be referenced in this limit will be the quantities reported from thermistor or thermocouple **Auxiliary Channel virtual Index 1**.

20. Schedule Files Listed in C:\ArbinSoftware\MITS_PRO\Work disappear when Trying to Assign a Schedule.

Problem Description: Schedule Files listed in **C:\ArbinSoftware\MITS_PRO\Work** disappear when one tries to assign a schedule (see below)

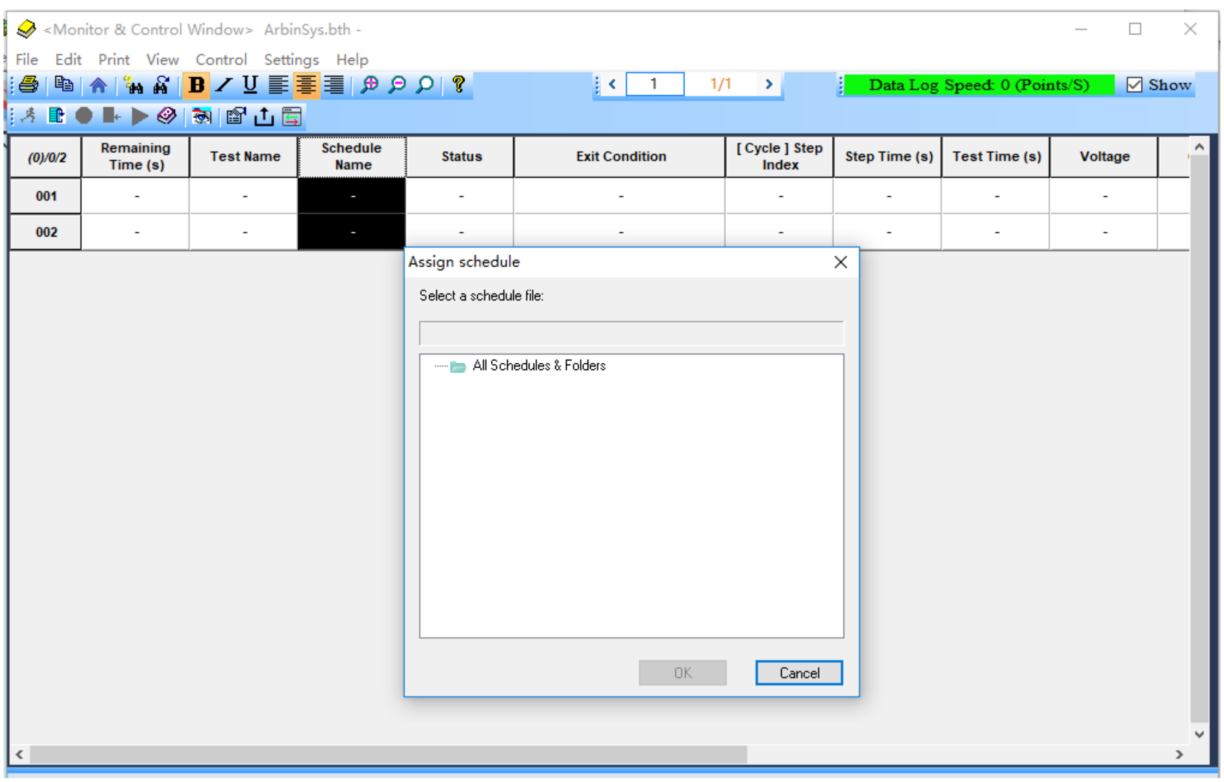


Figure 11-24

Problem source: In **Advanced Attributes** of the file folder **\ArbinSoftware** properties, the box "**For fast searching, allows Indexing Service to index this folder**" is not checked (see below).

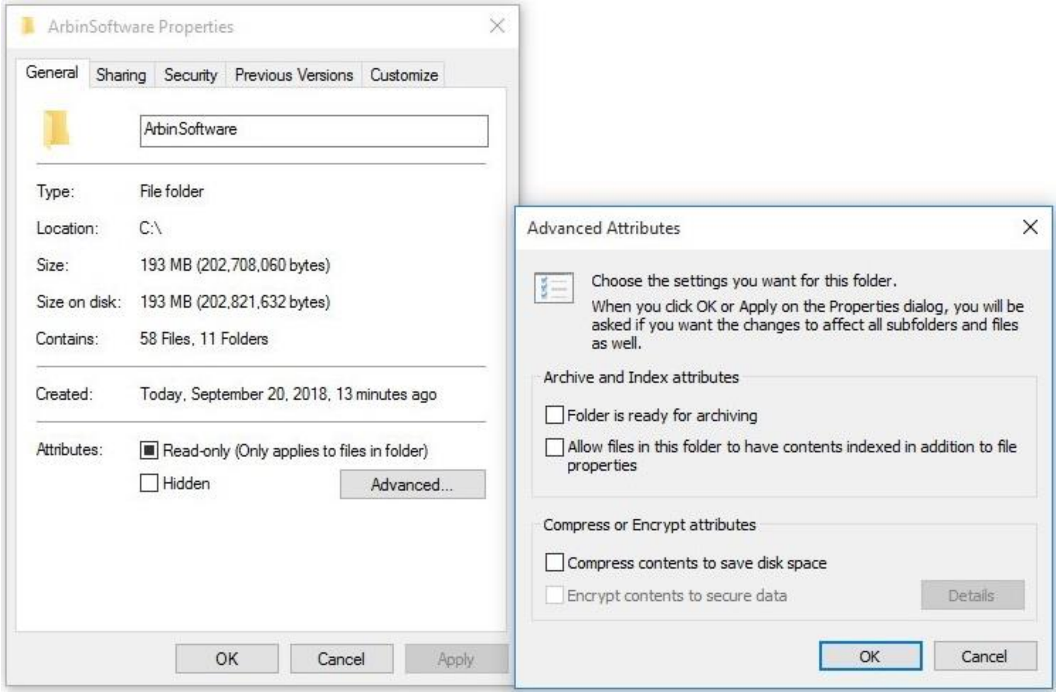


Figure 11-25

Solution for above problem.

1. Right click the folder \ArbinSoftware

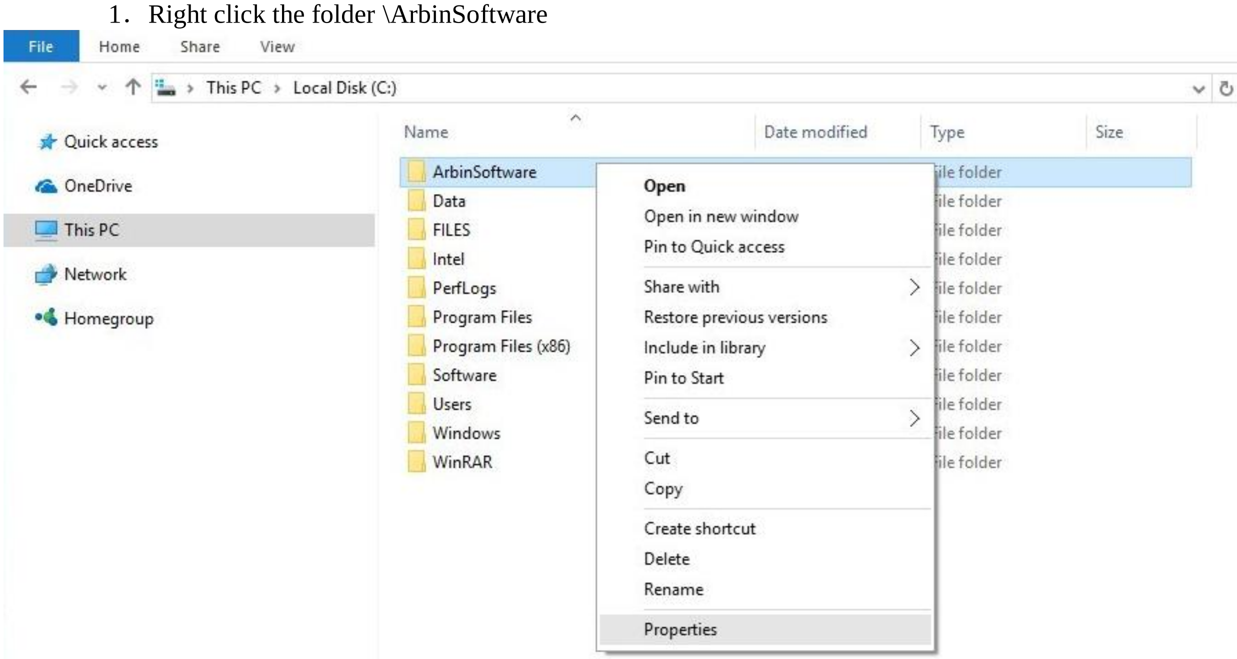


Figure 11-26

2. Then, click **Properties.** Go to **General,** click **Advanced.** An **"Advanced Attributes"** window appears

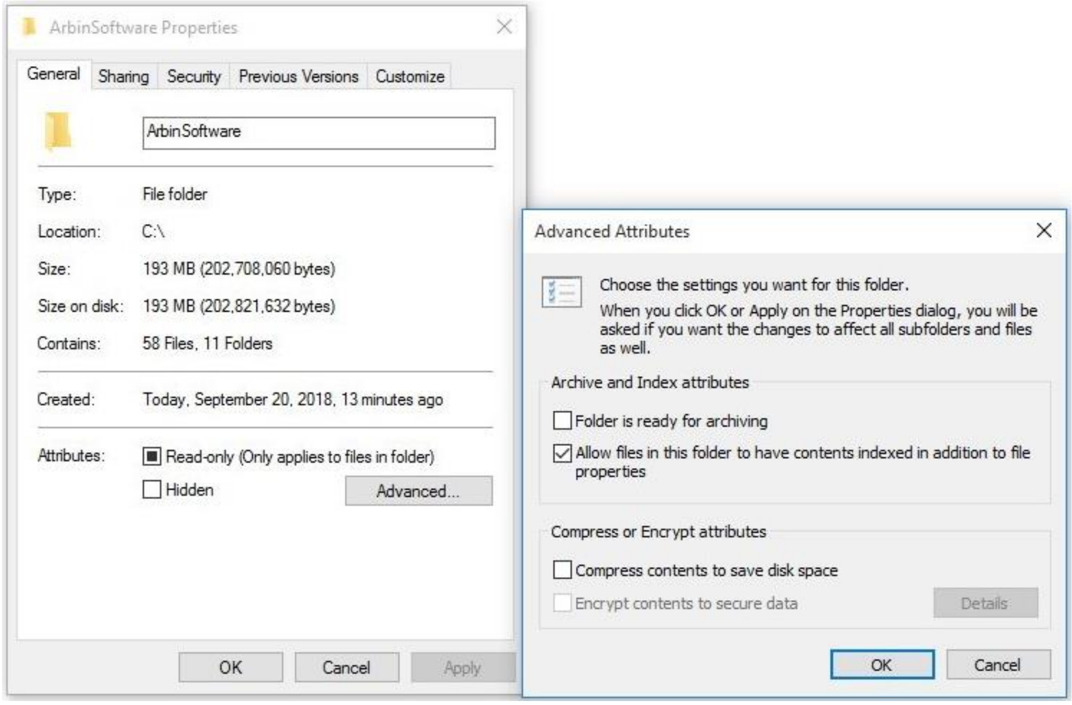


Figure 11-27

3. In “**Advanced Attributes**” window, check the box “**Allow files in this folder to have contents indexed in addition to file propeties**”. Then, one can see the listed schedule files when trying to assign a schedule (see below)

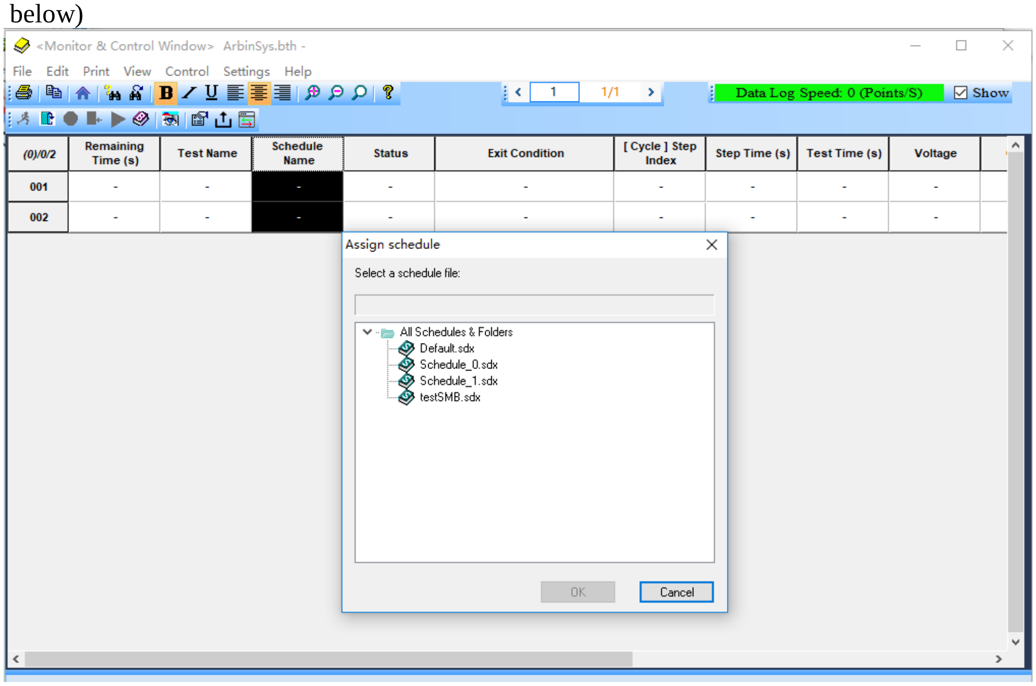


Figure 11-28

MITS Pro Bugs and Fixes

Contact Arbin customer support for information on perceived bugs and fixes.

Appendix A: Control Type

This Control Type	Does this
Current(A)	Outputs constant current to the cell or battery at the value specified. Positive current refers to charge, and negative current refers to discharge. Parallel Channel feature is allowed.
Voltage(V)	Outputs constant voltage to the cell or battery at the value specified. Parallel Channel feature is allowed.
C-Rate	C-Rate is a common method for indicating the discharge as well as the charge current of a battery. It can be expressed as I = M*C Where I = current A; C = capacity of battery; M is the C-rate value. To use C-Rate control, enter the battery's nominal capacity in the active object file, and enter the C-Rate value in the field of **Control Value** in a schedule. The software will automatically calculate an output current value. Positive C-Rate refers to charge current, and negative C-Rate refers to discharge current. This type can be done in parallel channel.
Rest	The battery is disconnected from the charge/discharge circuit but remains connected to the voltage measurement circuit to enable open-circuit voltage measurement.
Pause	When a test executes a “pause” step, no data logging or relay switching will occur until the “continue” button is clicked. This control type has no limit.
Power(W)	Outputs constant power to the cell or battery at the value specified. This is accomplished by iteratively measuring the battery voltage and calculating the current necessary, according to Ohm's Law V=IR and P=IV, to achieve the power level set by the user. Each time the channel is sampled, the calculation is performed, and the current will quickly stabilize at the desired power level and maintain this power level as the voltage changes. Parallel Channel feature is allowed.
Load (Ohm)	Applies a constant resistance load to the battery at the value specified. For this Load control, the current should always be discharging. Parallel Channel feature is allowed.
Set Variable(s)	Change test related variables including channel capacity, energy and all test counter variables. Clicking the check box before these variables will change the corresponding variables. Variables can be reset [to 0] or be increased or decreased by 1. Cycle_Index, capacities and energies can only be reset, i.e., cannot be reset or decreased. Charge_Capacity – channel charge capacity. Discharge_Capacity – channel discharge capacity. Charge_Energy – channel charge energy. Discharge_Energy – channel discharge energy. TC_Time1 – time counter 1. TC_Time2 – time counter 2. TC_Time3 – time counter 3. TC_Time4 – time counter 4. TC_Charge_Capacity1 – test counter charge capacity 1. TC_Discharge_Capacity1 – test counter discharge capacity 1. TC_Charge_Capacity2 – test counter charge capacity 2. TC_Discharge_Capacity2 – test counter discharge capacity 2. TC_Charge_Energy1 – test counter charge energy 1.

	TC_Discharge_Energy1 – test counter discharge energy 1. TC_Charge_Energy2 – test counter charge energy 2. TC_Discharge_Energy2 – test counter discharge energy 2.
Current Ramp(A)	Generates a current ramp. To generate a current ramp, enter the start value in the **Control Value** field, and enter the scan rate in the **Extra Control Value1** field. Positive scan rate generates increasing current ramp, and negative scan rate generates decreasing current ramp. Parallel Channel feature is allowed.
Current Staircase(A)	Generates a current staircase. To generate a current staircase, enter the start value in the **Control Value** field, enter the step amplitude in the **Extra Control Value1** field and enter the step duration in the **Extra Control Value2** field. Positive **dI/stair** generates an increasing current staircase and negative **dI/stair** generates a decreasing current staircase. Parallel Channel feature is allowed.
Current Pulse(A)	Applies a predefined current pulse profile to the cell or battery under test. Click the field under **Extended Definition** and select a desired pulse profile from the drop down list. User can create a pulse profile in the pulse page. See 5.9 Programming Pulse Control.
Current Simulation	Non-standard time-domain functions may be input from external sources as ASCII data streams and used as control parameters for repetitive tests. See 5.13 Programming Simulation for more information. This type can not be done in parallel.
Load Simulation	See Current Simulation. This type can not be done in parallel.
Power Simulation	See Current Simulation. This type can not be done in parallel.
Battery Simulation	With this control type, Arbin tester acts as a real battery in numerous applications when a simplified theoretical model for this battery is available. A simplified model of the battery used in this simulation consists of the relations of two factors, Open Circuit Voltage and DC Internal Resistance vs The State of Charge. Parallel Channel feature isn't allowed.
External Charge	An External Charger should be connected to the provided input and will take control to charge/discharge the battery under test while the Arbin testing system samples data for real time monitoring and logs data to the database file. No control values are needed to be entered in the schedule file, except terminating the step by step limit.
Internal Resistance	This function applies a 10-pulse train with >1ms pulse width of the specified magnitude [+ and -] following a constant-current charge or discharge step. $\Delta V/\Delta I$ is computed, and data are reported directly in the results file. *Some Arbin testers provide variable pulse widths. Contact Arbin customer service for clarification.
Current Cycle V(A)	This mode permits the user to create linear sweeps in one step, eliminating the need to jump steps to reverse sweep directions. For more see Section 5.12
Voltage Cycle V(V)	See above.
CCCV	**MITS Pro8.0** allows users to implement a constant-current-constant-voltage charge regime in one step through this control mode. Users specify the bulk charge current (CC(A):) and the voltage limit (CV(V):). Charging may be terminated via a time or current limit. Note that this **Control Type** is only available for specific hardware configurations. This type can be done in parallel.
CCCV_WRM	This control type is similar to CCCV, it gets internal resistant value of tested object.
Write CAN Messages	Write value to CAN Bus.

	Control Type: Write CAN messages. Control Value: The period of continuously sending CAN messages. Extra Control Value1: CAN message ID. Extra Control Value2: CAN message data. Message byte 0 to message byte 7, separated with a space. Extended Definition: CAN message data length (DLC: 0-7), Frame Type (0: Standard, 1: Extended), Stop One (0: No, 1: Yes), Stop All (0: No, 1: Yes), separately with space. Send messages to CAN BMS frequently.
Write SMB Register	Write word data to SMBus writable registers.
Write SMB Register (String)	Write ASCII string to SMBus writable registers.
Write SMB Block	Write SMB block with SBS Command.
CURRENT_TB	Specify the bulk charge current (dynamically changed) (DC) and the voltage limit (dynamically changed) (DV). Charging may be terminated via a time or current limit. Note that this Control Type is only available for specific SMB hardware. DC1(A): Discharge Current Pulse Value1. DC2(A): Discharge Current Pulse Value2.
CCCV_TB	Turbo Boost (CCCV_TB) functionality adds discharge current pulse to normal CCCV charging, starting from 0% RSOC to 100% RSOC. Switch from CC to CV by given top charge voltage. CCCV_TB control type has six control values – CC(A), CC Width(ms), DC(A), Current Range, DC Width(ms), CV(V). •CC(A): Charge Current Value. It must be a POSITIVE value which is used to set the charge current for battery. •CC Width(ms): Charge Current Duration. The charge current duration before the discharge pulse. It must be ⩾ 10ms. •DC(A): Discharge Current Pulse Value. It must be a NEGATIVE value which is used to set the discharge current pulse. •DC Width(ms): Discharge Current Pulse Width. It must be ⩾ 10ms. •CV(V): Voltage Target Value for Constant Voltage Stage. It must be a POSITIVE value.
Voltage (Digital) (V)	Outputs constant voltage to the cell or battery at the value specified. Digital Voltage control will give you a smoother transistion from current control to Digital Voltage Control. Digital Voltage control is not suitable for open circuit voltage control and potentiostat type control. Note that this **Control Type** is only available for specific hardware.
Voltage (Analog) (V)	Outputs constant voltage to the cell or battery at the value specified.
Set SMB Opt Word Address	Assign the Vcell address of the 1st Cell of the smart battery.
SetValue(s)	Allows sixteen new metavariables to be custom-defined on each TestObject. These metavariables can be pre-defined or edited in the test schedule based on active test readings.
DO Setting	Turn the digital output of the channel on or off.
Internal Resistance (Alternative)	This function applies a 10-pulse train with >1ms pulse width **(Extra Control Value2)** of the specified magnitude currents [high current **(Control Value)** and low current **(Extra Control Value1)**] following a constant-current charge or discharge step. ΔV/ΔI is computed, and data are reported directly in the results file. *Some Arbin testers provide variable pulse widths. Contact Arbin customer service for clarification.

Appendix B: Meta Variables

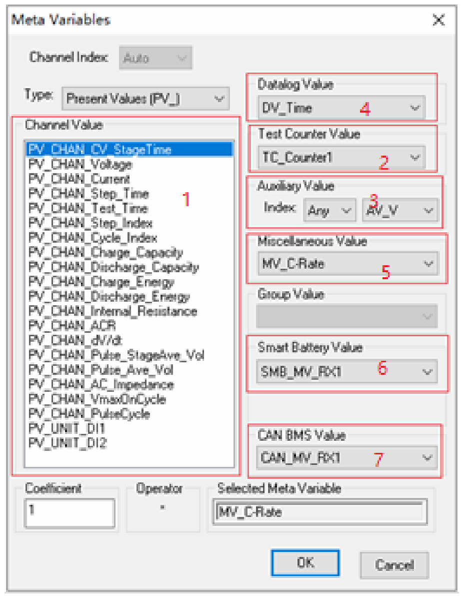


Fig 1 Meta Variables dialog

The Meta Variables can be divided into seven categories:

1) Channel-related 2) Test Counter-related 3) Auxiliary related 4) Datalog-related 5) Miscellaneous- related 6) Smart Battery-related and 7) CAN BMS-related

Logging Data Conditions

Meta Variables are used to define logging data conditions. Four parameters related to current, voltage, time and pulse count are listed. Users can invoke the **Formula** feature in schedules to create similar Meta Variables for other parameters such as temperature, pressure, charge capacity, discharge capacity, etc.

Channel-related

Channel-related meta variables refer to those parameters associated with a specified channel. In the Channel Index drop-down list, Auto refers to the channel assigned to the present running channel.

For example:

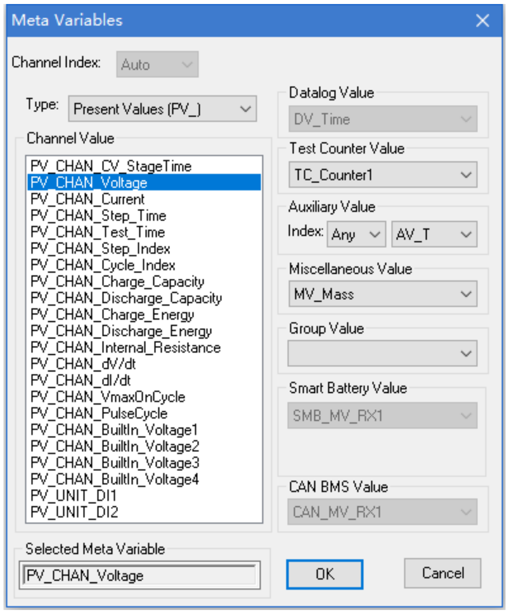


Fig 2 The Channel Value

In this picture the Channel Index is set to Auto, the meta variables type Present Values (PV_), and the parameter is CHAN_Voltage. The final selected meta variable is PV_CHAN_Voltage and represents the data buffer voltage value of the presently running channel.

Channel-related Meta Variables can be further divided into three types:

This parameter	Means This
Present Values (PV_)	Present measured values.
Last Step Values (LS_)	The values when last step switched to present step.
Last Cycle Values (LC_)	The values at the time last cycle was switched to present cycle.

Channel-related parameters

This parameter	Means This
CHAN_CV_StageTime	Control the CV constant voltage charging time under CCCV_WRM and jump directly when the time set by this parameter is reached, instead of continuing to charge according to the StepTime.
CHAN_Test_Time	The total elapsed time counted from the point when the test was started.
CHAN_Step_Time	The elapsed time counted from the point when a specific step was started.
CHAN_Voltage	Measured channel voltage value in (V)
CHAN_Current	Measured channel current value in (A)
CHAN_Charge_Capacity	Measured channel charge capacity value in (Ah). Data is presented with positive values.
CHAN_Discharge_Capacity	Measured channel discharge capacity in (Ah). Data is presented with positive values.
CHAN_Charge_Energy	Measured channel charge energy value in (Wh). Data is presented with positive values.

CHAN_Discharge_Energy	Measured channel discharge energy value in (Ah). Data is presented with positive values.
CHAN_dV/dt	Channel voltage change rate. See note 1
CHAN_dI/dt	Channel current change rate. See note 2
CHAN_Step_Index	The sequential step number in the active schedule
CHAN_Cycle_Index	Cycle Number of the currently running step
CHAN_Internal_Resistance	Measured Internal Resistance
CHAN_AC_Impedance	Measured AC Impedance
PV_CHAN_Pulse_StageAve_Vol	Average voltage of the stage within the pulse step
PV_CHAN_Pulse_Ave_Vol	Average voltage of the pulse step
PV_CHAN_PulseCycle	Pulse cycle number of pulse step
PV_CHAN_VmaxOnCycle	Maximum voltage value in Cycle
UNIT_DI1	Built-In digital output variable
UNIT_DI2	Built-In digital output variable

Note 1: dV/dt = (present V - Buffer V)/d t

Where:

dV/dt is the first-order rate of change of voltage.
Present V is the voltage value for the present data point.
Buffer V is the last queued voltage value in the circular buffer.
dt is the time interval between the present and the queued data points.

Note 2: dI/dt = (present I - Buffer I)/d t

Where:

dI/dt is the first-order rate of change of current.
Present I is the current value for the present data point.
Buffer I is the last queued current value in the circular buffer.
dt is the time interval between the present and the queued data points.

Test Counter-related

The software provides five types of counters: time, charge capacity, discharge capacity, charge energy, and discharge energy. These counters can be activated and reset at any step of a schedule, and the counter value can be used as a step termination condition or a log data condition. These are applied when the user does not want to use or reset the main test time, test capacity, test energy, or cycle count.

Test counter-related variables

This parameter	Means This
TC_Time 1	Time counter 1
TC_Time 2	Time counter 2
TC_Time 3	Time counter 3
TC_Time 4	Time counter 4
TC_Charge_Capacity 1	Charge capacity counter 1
TC_Charge_Capacity 2	Charge capacity counter 2
TC_Discharge_Capacity 1	Discharge capacity counter 1

TC_Discharge_Capacity 2	Discharge capacity counter 2
TC_Charge_Energy 1	Charge energy counter 1
TC_Charge_Energy 2	Charge energy counter 2
TC_Discharge_Energy 1	Discharge energy counter 1
TC_Discharge_Energy 2	Discharge energy counter 2
TC_Counter1	Universal Counter 1
TC_Counter2	Universal Counter 2
TC_Counter3	Universal Counter 3
TC_Counter4	Universal Counter 4

Auxiliary-related

Auxiliary measurements include second voltage, temperature, and pressure. The relationship between the auxiliary measurement channel and a regular channel can be established in the **Mapping** page of the **Mapping Files**. Since more than one auxiliary measurement channel can be assigned to a single regular channel, a user needs to select the auxiliary virtual index in the index box. In the case that several auxiliary channels are assigned to a regular channel; then the index choice can be one of them: **Any**, **1, 2**,…

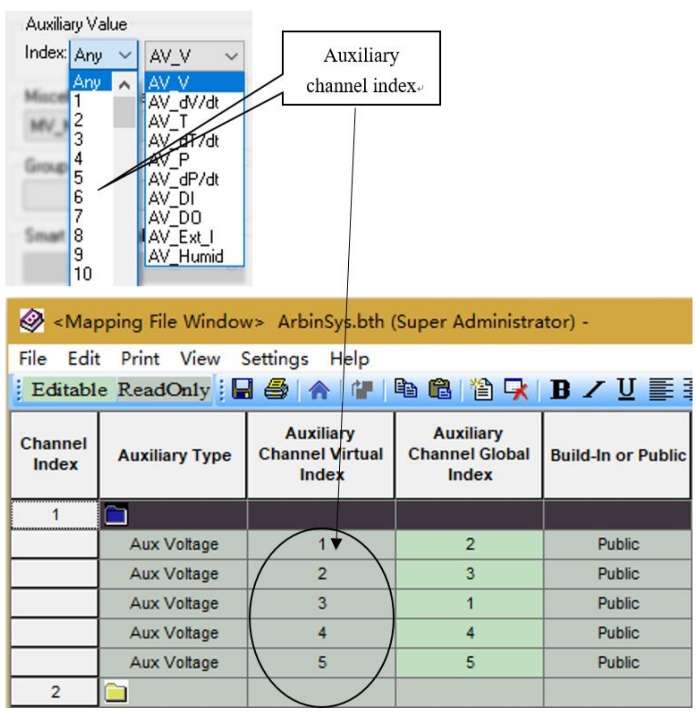


Fig 3 The auxiliary index in mapping file

A choice of the index for auxiliary voltage is **Any.** In the case several auxiliary voltages are mapped onto a main IV channel, these auxiliary voltages form a group. When **Any** is selected as a virtual index for a desired step limit, this step limit acts when any one of the auxiliary voltages in the group satisfies the limit condition.

Auxiliary measurement-related parameters

This parameter	Means This
AV_V	The measured auxiliary voltage or second voltage value in Volts

AV_dV/dt	Auxiliary voltage change rate (See note 1.)
AV_T	measured auxiliary temperature value in °C
AV_dT/dt	Auxiliary temperature change rate (See note 2.)
AV_P	measured auxiliary pressure value in psi
AV_dP/dt	Auxiliary pressure change rate (See note 3.)
AV_DI	present value of auxiliary digital input channel [1 ("on"), 0 ("off")]
AV_DO	present value of auxiliary digital output channel [1 ("on"), 0 ("off")]
AV_Ext_I	measured auxiliary External Charge value in Amp(A)
AV_ Humidity	measured auxiliary Humidity value in %

Note 1: AV_dV/dt = (present AV_V - Buffer AV_V) / dt

Where:

AV_dV/dt is the first-order rate of change of auxiliary voltage.
Present AV_V is the voltage value for the present data point.
Buffer AV_V is the last queued voltage value in the circular buffer.
dt is the time interval between the present and the queued data points.

Note 2: AV_dT/dt = (present AV_T - Buffer AV_T)/dt

Where:

AV_dT/dt is the first-order rate of change of auxiliary temperature.
Present AV_T is the temperature value for the present data point.
Buffer AV_T is the last queued temperature value in the circular buffer.
dt is the time interval between the present and the queued data points.

Note 3: AV_dP/dt = (present AV_P - Buffer AV_P) / dt

Where:

AV_dP/dt is the first-order rate of change of auxiliary pressure.
Present AV_P is the pressure value for the present data point.
Buffer AV_P is the last queued pressure value in the circular buffer.
dt is the time interval between the present and the queued data points.

Datalog-related

This Parameter	Means This
DV_Time	The time interval between two data collection points. DV_Time= (PV_CHAN_Test_Time –LL_CHAN_Test_Time)
DV_Current	The current change between two data collection points. DV_Current = (PV_CHAN_Current –LL_CHAN_Current)
DV_Voltage	The voltage change between two data collection points. DV_Voltage = (PV_CHAN_Voltage –LL_CHAN_Voltage)
DV_PulseCycle	Pulse cycle difference between data collection points.
DV_CCCV_TB_PulseInterval	Only valid for CCCV_TB. The MCU records a complete discharge pulse every few discharge pulses.

Miscellaneous-related

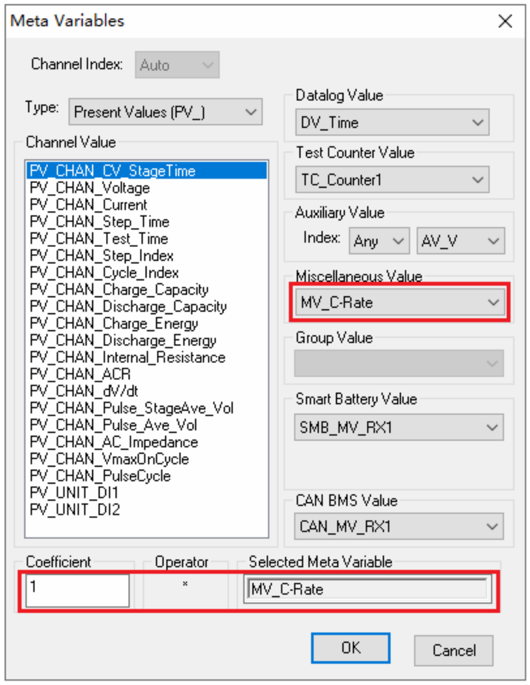


Fig 4 The MV_C-Rate

In schedule, the C-Rate can be used in Control Type and Limit. The Coefficient can be filled in float number, and its default value is 1. The **Selected Meta Variable** can display the value that you selected.

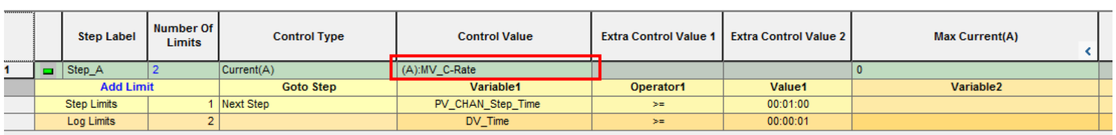


Fig 5 C-Rate in Step

This parameter	**Means This**
MV_Mass	Reference to the mass specified in the Object file
MV_SpecificCapacity	Reference to specific capacity entered in the Object file
MV_NominalCapacity	Reference to nominal capacity entered in the Object file
MV_IHmin	Current high range minimum value
MV_IHmax	Current high range maximum value
MV_IMmin	Current medium range minimum value
MV_IMmax	Current medium range maximum value
MV_ILmin	Current low range minimum value
MV_ILmax	Current low range maximum value
MV_Vmin	Voltage minimum value
MV_Vmax	Voltage maximum value
MV_UD	Custom user-defined variable values
MV_C-Rate	The C-Rate value

Smart Battery-related

Smart Battery-related parameters

This parameter	Means This
SMB_MV_RX N	Smart battery variable

CAN BMS-related

CAN-related parameters

This parameter	Means This
CAN_MV_RX N	CAN channel BMS value

Appendix C: Results Data Unit

Normal Data	Unit	Description
Data_Point		Data point number
Data_Time		Date and Time in the format of hh:mm:ss.sss when viewed in Excel
Test_Time	second	Time the data is taken, start of test = 0
Step_Time	second	Time the data is taken, start of each step = 0
Cycle_Index		Cycle Number of active steps at this point
Step_Index		Step Number at this point
Current	A	Current at this point
Voltage	V	Voltage at this point
Charge_Capacity	Ah	Charge Capacity at this point (always positive)
Discharge_Capacity	Ah	Discharge Capacity at this point (always positive)
Charge_Energy	Wh	Charge Energy at this point (always positive)
Discharge_Energy	Wh	Discharge Energy at this point (always positive)
dV/dt	V/s	dV/dt, Differential Current
dV/dQ	V/Ah	dV/dQ, Differential Voltage
Internal_Resistance	Ohm	Internal resistance
Aux_Voltage1 *	V	Auxiliary voltage at this point
DAux_Voltage1/dt *	V/s	Auxiliary voltage change rate
Temperature1 *	°C	Temperature at this point
Dtemperature1/dt *	°C/s	Temperature change rate
Pressure *	psi	Pressure at this point
Concentration 1*	Ppm	Concentration at this point
DI1 *		Digital input at this point
DO1*		Digital output at this point
AO		Analog output as this point
External Charge	A	External Charge at this point
Humidity	%	Humidity at this point
CAN_RX1		CAN BMS Variable 1
CAN_RX2		CAN BMS Variable 2
CAN_RXn		CAN BMS Variable n
SMB_RX1		Smart battery Variable 1
SMB_RX2		Smart battery Variable 2
SMB_RXn		Smart battery Variable n

Statistics Data	Unit	Description
Charge_Time	second	Charge Time for this cycle (always positive)
Discharge_Time	second	Discharge Time for this cycle (always positive)
Vmax_On_Cycle	V	Maximum voltage during this cycle
Coulombic_Efficiency	%	Coulombic Efficiency for this cycle (always positive)

ACIM Data	Unit	Description
Product_ID		ACIM Type[1=Gamary;2=AutoLab;3=ArbinACIR;4=ArbinACIM]
Test_ID		Test Index
Channel_ID		Channel Index
Cycle_Index		Cycle Index
Step_Index		Step Index
Pt		Data point number, starting from 0. In an ACIM step test, each frequency corresponds to one Pt.
Freq	Hz	AC signal frequency, in unita of “Hz”
Zmod	Ohm	Modulus of AC impedance, in units of “Ohm”
Zphz	^{0}	AC impedance phase angle, in units of “degrees”

SMB Info

Channel	Creator	Comments	Config File Name	BaudRate	Frame Type	Cell Number	SMB Unsafe Timcout	Signal Enable Count	Signal Log Count	
1			DELL-0224.smb	1K	Standard	0	ate0x160x(	83	55	

Meta Variable Name	SMBRegisterName	SMB Message ID	SMBWriteAddress	SMBReadAddress	SMBByteLength	SMBRefresh	StartByteIndex	StartBitIndex	EndByteIndex	EndBitIndex	ByteOr
SMB_MV_RX1	ManfacturerAccess	0x16	0x00	0x16	16	1.00E+02	1	0	2	0	Littl
SMB_MV_RX2	RemainingCapacityAlarm	0x16	0x01	0x16	16	1.00E+02	1	0	2	0	Littl
SMB_MV_RX3	RemainingTimeAlarm	0x16	0x02	0x16	16	1.00E+02	1	0	2	0	Littl
SMB_MV_RX4	BatteryMode	0x16	0x03	0x16	16	1.00E+02	1	0	2	0	Littl
SMB_MV_RX5	AtRate	0x16	0x04	0x16	16	5.00E+02	1	0	2	0	Littl
SMB_MV_RX6	AtRateTimeToFull	0x16	0x05	0x16	16	5.00E+02	1	0	2	0	Littl
SMB_MV_RX7	AtRateTimeToEmpty	0x16	0x06	0x16	16	5.00E+02	1	0	2	0	Littl
SMB_MV_RX8	AtRateOK	0x16	0x07	0x16	16	5.00E+02	1	0	2	0	Littl
SMB_MV_RX9	Temperature	0x16	0x08	0x16	16	1.50E+03	1	0	2	0	Littl
SMB_MV_RX10	Volatge	0x16	0x09	0x16	16	1.50E+03	1	0	2	0	Litt.
SMB_MV_RX11	Current	0x16	0x0a	0x16	16	1.50E+03	1	0	2	0	Littl
SMB_MV_RX12	AverageCurrent	0x16	0x0b	0x16	16	1.50E+03	1	0	2	0	Littl

SMB Data

Data_Point	Date_time	Test_Time(s)	Step_Time(s)	Cycle_Index	Step_Index	ManfacturerAccess	RemainingCapacityAlarm(mAh)	RemainingTimeAlarm(min)	BatteryMode
10	09/17/2018 16:01:06.928	10.001	10.001	1	1	0x188	800	2	0x2000
11	09/17/2018 16:01:06.928	10.001	10.001	1	1	0x188	800	2	0x2000
12	09/17/2018 16:01:07.931	11.004	1.000	1	2	0x188	800	2	0x2000
13	09/17/2018 16:01:08.931	12.004	2.000	1	2	0x188	800	2	0x2000
14	09/17/2018 16:01:09.931	13.004	3.000	1	2	0x188	800	2	0x2000
15	09/17/2018 16:01:10.931	14.004	4.000	1	2	0x188	800	2	0x2000
16	09/17/2018 16:01:11.931	15.004	5.000	1	2	0x188	800	2	0x2000
17	09/17/2018 16:01:12.931	16.004	6.000	1	2	0x188	800	2	0x2000
18	09/17/2018 16:01:13.931	17.004	7.000	1	2	0x188	800	2	0x2000
19	09/17/2018 16:01:14.931	18.005	8.001	1	2	0x188	800	2	0x2000
20	09/17/2018 16:01:15.931	19.004	9.000	1	2	0x188	800	2	0x2000
21	09/17/2018 16:01:16.931	20.004	10.000	1	2	0x188	800	2	0x2000
22	09/17/2018 16:01:16.932	20.005	10.001	1	2	0x188	800	2	0x2000
23	09/17/2018 16:01:17.935	21.008	1.000	1	3	0x188	800	2	0x2000
24	09/17/2018 16:01:18.935	22.008	2.000	1	3	0x188	800	2	0x2000
25	09/17/2018 16:01:19.935	23.008	3.000	1	3	0x188	800	2	0x2000
26	09/17/2018 16:01:20.935	24.008	4.000	1	3	0x188	800	2	0x2000
27	09/17/2018 16:01:21.935	25.008	5.000	1	3	0x188	800	2	0x2000
28	09/17/2018 16:01:21.936	25.009	5.001	1	3	0x188	800	2	0x2000
29	09/17/2018 16:01:22.939	26.012	1.000	1	4	0x188	800	2	0x2000
30	09/17/2018 16:01:23.939	27.012	2.000	1	4	0x188	800	2	0x2000
31	09/17/2018 16:01:24.939	28.012	3.000	1	4	0x188	800	2	0x2000
32	09/17/2018 16:01:25.939	29.012	4.000	1	4	0x188	800	2	0x2000

CAN BMS Information Data

			CAN REPORT										
			2015/3/6										
Channel	Creator	Comments	Config File Name	BaudRate	Frame Type	Signal Enable Count	Signal Log Count						
1			CANConfigmy-1.can	500K	Standard	18	18						
Channel 0-001													
Meta Variable Name	Nick Name	CAN Message ID	DLC of CAN Message	Byte Order	DataType	Start Byte Index	Start Bit Index	End Byte Index	End Bit Index	Value Offset	Value Scale Factor	Enable	
CAN_MV_RX3	CAN_RX3	0x21	8	Little Endian	Unsigned	0	0	7	7	0	0.100000001	YES	
CAN_MV_RX4	CAN_RX4	0x22	8	Little Endian	Unsigned	0	0	7	7	0	1	YES	
CAN_MV_RX5	CAN_RX5	0x1	8	Little Endian	Unsigned	0	0	1	1	0	1	YES	
CAN_MV_RX6	CAN_RX6	0x2	8	Little Endian	Unsigned	0	0	1	7	0	1	YES	
CAN_MV_RX7	CAN_RX7	0x3	8	Little Endian	Unsigned	0	0	1	7	0	1	YES	
CAN_MV_RX8	CAN_RX8	0x4	8	Little Endian	Unsigned	0	0	1	7	0	1	YES	
CAN_MV_RX9	CAN_RX9	0x5	8	Little Endian	Unsigned	0	0	1	7	0	1	YES	
CAN_MV_RX10	CAN_RX10	0x6	8	Little Endian	Unsigned	0	0	1	7	0	1	YES	
CAN_MV_RX11	CAN_RX11	0x7	8	Little Endian	Unsigned	0	0	1	7	0	1	YES	
CAN_MV_RX12	CAN_RX12	0x8	8	Little Endian	Unsigned	0	0	1	7	0	1	YES	
CAN_MV_RX13	CAN_RX13	0x9	8	Little Endian	Unsigned	0	0	1	7	0	1	YES	
CAN_MV_RX14	CAN_RX14	0x10	8	Little Endian	Unsigned	0	0	1	7	0	1	YES	
CAN_MV_RX15	CAN_RX15	0x11	8	Little Endian	Unsigned	0	0	1	7	0	1	YES	
CAN_MV_RX16	CAN_RX16	0x12	8	Little Endian	Unsigned	0	0	1	7	0	1	YES	
CAN_MV_RX17	CAN_RX17	0x13	8	Little Endian	Unsigned	0	0	1	7	0	1	YES	
CAN_MV_RX18	CAN_RX18	0x14	8	Little Endian	Unsigned	0	0	1	7	0	1	YES	
CAN_MV_RX19	CAN_RX19	0x15	8	Little Endian	Unsigned	0	0	1	7	0	1	YES	
CAN_MV_RX20	CAN_RX20	0x16	8	Little Endian	Unsigned	0	0	1	7	0	1	YES	

CAN BMS Data

	A	M	N	O	P	Q	R	S	T
1	Date_Time	CAN_RX3	CAN_RX4	CAN_RX5	CAN_RX6	CAN_RX7	CAN_RX8	CAN_RX9	CAN_RX10
2	03/05/2015 09:55:53.340	2.4	0	22	24	8	19	19	20
3	03/05/2015 09:55:54.339	2.4	0	22	24	8	19	19	20
4	03/05/2015 09:55:54.340	2.4	0	22	24	8	19	19	20
5	03/05/2015 09:55:54.363	2.4	0	22	24	8	19	19	20
6	03/05/2015 09:55:54.363	2.4	0	22	24	8	19	19	20
7	03/05/2015 09:56:54.363	2.4	0	22	24	8	19	19	20
8	03/05/2015 09:56:54.365	2.4	0	22	24	8	19	19	20
9	03/05/2015 09:56:55.388	2.4	0	22	24	8	19	19	20
10	03/05/2015 09:56:56.388	2.4	0	22	24	8	19	19	20
11	03/05/2015 09:56:56.392	2.4	0	22	24	8	19	19	20
12	03/05/2015 09:56:56.416	2.4	0	22	24	8	19	19	20
13	03/05/2015 09:56:56.419	2.4	0	22	24	8	19	19	20

ACIM Data

Cycle_ID	Step_ID	Pt	Freq	Zmod	Zphz
1	5	20	110	3	89
2	5	20	110	3	89
3	5	20	110	3	89

Appendix D: System Configuration Description

The system configuration file, ArbinSys.cfg, may be found under the heading **System Config File** on the MITS Pro8.0 opening screen. Refer to **2.2 Working with MITS Pro8.0 Interface Console** Window.

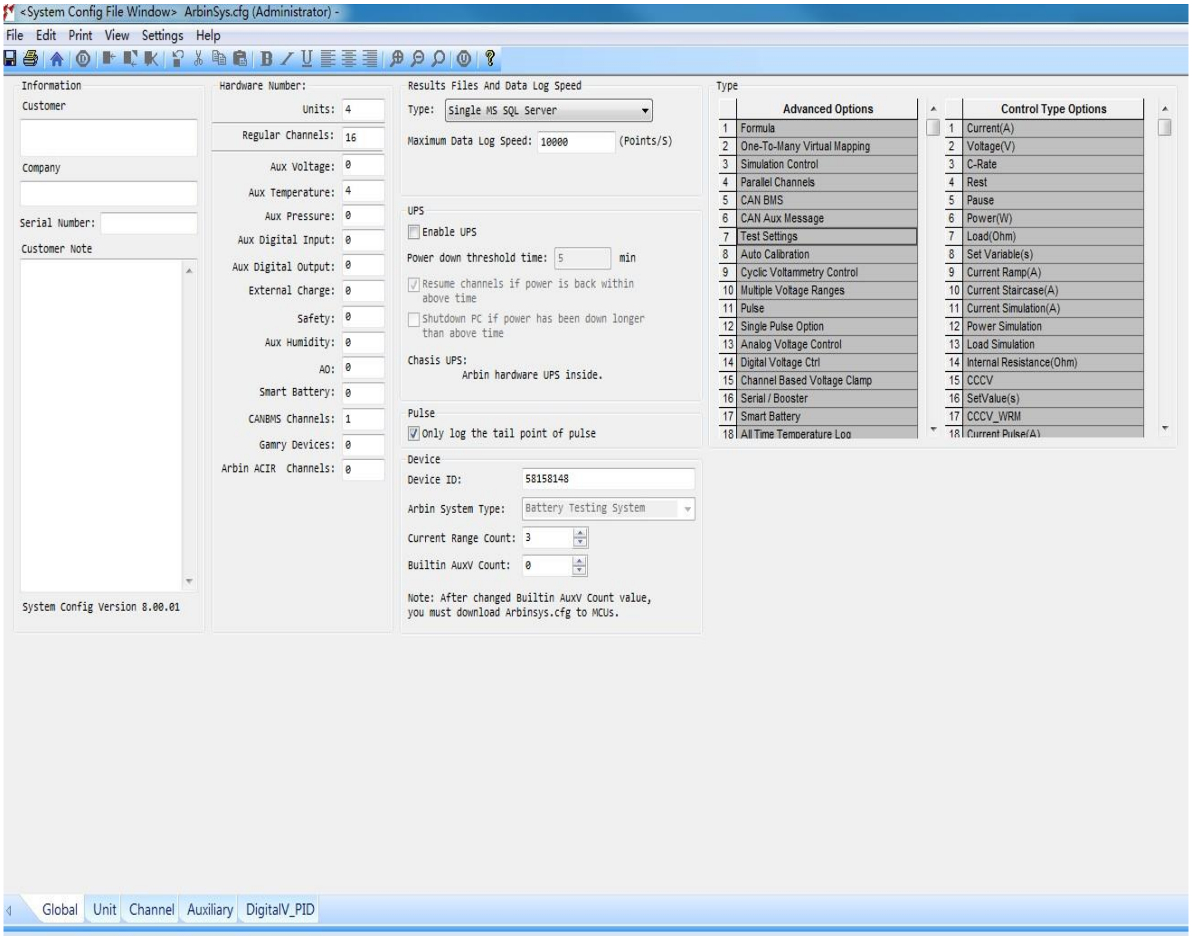


Fig 1 The ArbinSys.cfg file

Global

Advanced Options

The Advanced Options provide extended functionality for MITS Pro8.0 users. Below is a brief description of each option and an identification of how the option is expressed in the software.

Formula

The Formula option equips the user with the ability to control and limit schedule steps according to dynamic mathematical equations, rather than constants or instantaneous channel data. When this option is enabled, a separate **Formula** editing page is added to the schedule file. No special hardware or software module is required.

One-to-Many Virtual Mapping

This selection allows the referencing or mapping of multiple auxiliary inputs to one main IV channel through Mapping files/ArbinSys.bth. Auxiliary channels moduel is required.

Simulation Control

Checking this box enables three additional **:** Control Type in the schedule editor-Current, Voltage, Power and Battery Simulation. No supplemental hardware is required.

Parallel Channels

Users may increase the current-delivering capability of the instrument by grouping channels in the ArbinSys.bth file. In accordance with Ohm's Law, current from the several channels is additive.

Important Note: **A Rest step must be added in between the charge step and the discharge step to prevent the possibility of a short circuit between two channels.**

CAN BMS

This option is designed for system with CAN function.

CAN Aux Message

This option is designed for Can auxiliary message sending function.

Burst Mode Log

High speed data acquisition.

Test Setting

This option is used for systems interfacing with a controllable temperature chamber a third-party temperature chamber, digitally actuated devices or mass flow controllers (MFCs) for fuel cell testing. See Section **5.14** for more information concerning the implementation of the Test Setting. When this option is enabled, a separate **Test Setting** editing page is added to the schedule file.

Auto Calibration

With appropriate hardware this option expands the Calibrate Hardware utility to provide autonomous calibration of selected system inputs and outputs.

Cyclic Voltammetry Control

Enable the ability to create single-step voltage and/or current sweeps and slow pulses through this selection. When this option is enabled, a separate **Cyclic Voltametry** editing page is added to the schedule file.

Multiple Voltage Ranges

This option is designed for systems with voltage high and voltage low ranges. Relative IV channel module is required.

Pulse Control

Pulse Control enables users to implement industry-standard and user-defined pulses in schedules. The pulses may be defined through a separate Pulse page that appears in the schedule file. Additionally, Current Pulse (A) is added to the Appendix A: Control Type list.

Single Pulse Option

This option is in development. Please contact Arbin Customer Service for further information

Analog Voltage Control

The function switch of Analog Voltage Control.

Digital Voltage Ctrl

The function switch of Digital Voltage Control.

Channel Based Voltage Clamp

Determines whether hardware Clamp Voltage is shared by all channels in Unit.

Enabled: Each channel in unit has independent Clamp Voltage

Disabled: All channels in unit share single Clamp Voltage.

Serial/Booster

Serial channels connection and A master-slave relationship. Ask Arbin for details.

Smart Battery

This option is used in conjunction with hardware specifications in the Unit page. Where appropriate hardware is present, checking this option and Smart Battery in the Logging Data Options of the schedule Global page enables the display of smart battery data in the Monitor & Control Window **Channel View**.

Barcode

The function switch of Barcode.

Gamry ACIM

Enabling this option allows users to connect Gamry Electrochem Instruments.

Auto lab ACIM

The function switch of Auto lab ACIM.

Arbin EIS

The function switch of Arbin EIS.

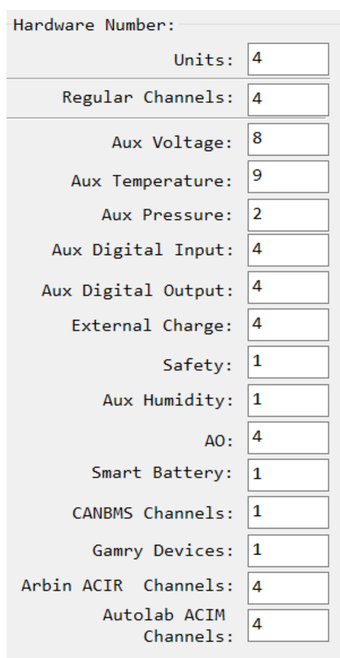
Important Note:

With little exception, customers will generally not have any need to modify the settings beyond the Global page. Doing so can adversely and severely affect the function of the Arbin testing system, so users are directed to contact Arbin customer service prior to making any change other than those modifications effected through hardware calibration. Even in such cases, users are encouraged strongly to backup the existing ArbinSys.cfg prior to altering.

Arbin customer service does retain copies of the original installation so that users may recover from accidental or inadvertent corruption of the file.

Hardware Number

These settings reflect the number and type of main IV and auxiliary channels that are installed in the Arbin testing stand. Note: customers will never have occasion to modify these parameters except in the event of adding hardware modules.



Results Files

- Type

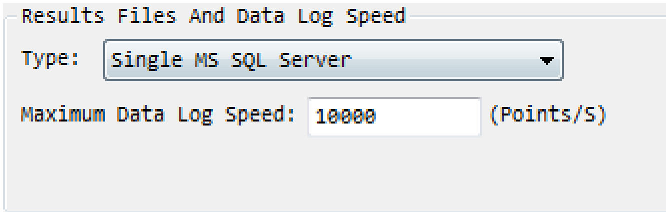


Fig 2 The database type

Users can store data in SQL database (by selecting **Single MS SQL Server)** in multiple files whose name is determined by the test name specified in the **Monitor & Control Window.**

Maximum Data Log Speed: Record the maximum frequency of data logging.

UPS

If systems equipped with a UPS, these settings are used to determine how the system responds to a power interruption. The figure below shows the fields and parameters that may be configured for customizing the interface. However, Arbin strongly recommends that the first three fields remain at the default settings, as they are optimum for integration of the leading manufacturer-and Arbin's chief supplier-of UPSs.

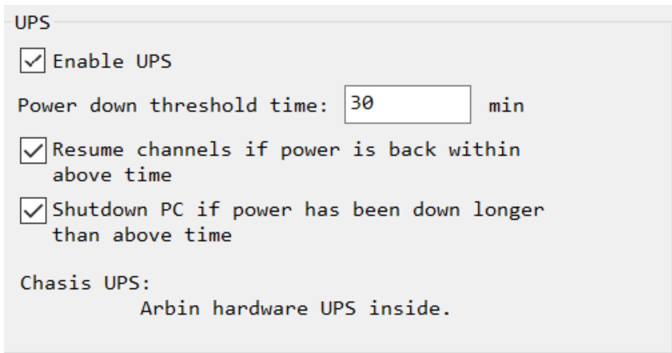


Fig 3 The UPS section

The bottom pane shows the threshold time within which the tests are resumed automatically, and outside of which the computer is powered off safely. Note: Users should consider the total load on the UPS battery when selecting the time period. For more details, please refer **Appendix J: UPS Feature**.

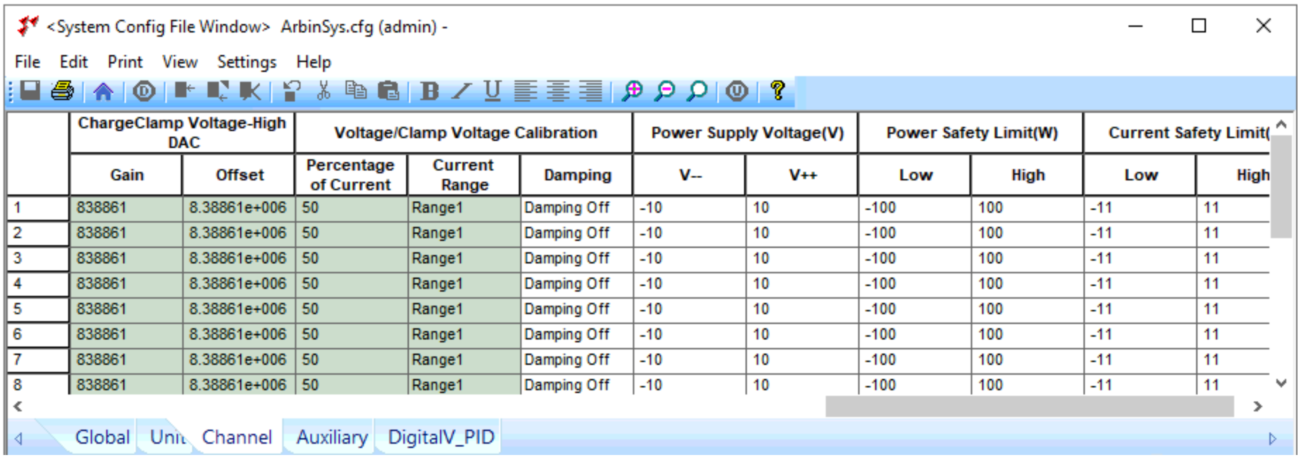
Unit

These settings identify the connection between the tester and the computer, as well as the structure of the hardware. Again, users will never have occasion to alter these values unless directed specifically by an Arbin customer service representative.

Channel

The remaining pages in ArbinSys.cfg store the current and voltage ranges and the calibration data for the channels' DACs and ADCs. These values are set before shipment from the Arbin factory, and users will ordinarily modify certain constants only through calibration process.

Additionally, global limits for safety may be set for the instrument in the last four columns of the **Channel** page. These limits override any parameters entered in the schedule **Global** page. Both high and low limits may be disabled by entering "0" in the fields. However, if only one limit gets "0", then both limits act normally. For example, if setting "0" in Current Safety Limit Low and a positive value in Current Safety Limit High, both current safety limits work even during calibration and testting.



	ChargeClamp Voltage-High DAC		Voltage/Clamp Voltage Calibration			Power Supply Voltage(V)		Power Safety Limit(W)		Current Safety Limit(	
	Gain	Offset	Percentage of Current	Current Range	Damping	V--	V++	Low	High	Low	High
1	838861	8.38861e+006	50	Range1	Damping Off	-10	10	-100	100	-11	11
2	838861	8.38861e+006	50	Range1	Damping Off	-10	10	-100	100	-11	11
3	838861	8.38861e+006	50	Range1	Damping Off	-10	10	-100	100	-11	11
4	838861	8.38861e+006	50	Range1	Damping Off	-10	10	-100	100	-11	11
5	838861	8.38861e+006	50	Range1	Damping Off	-10	10	-100	100	-11	11
6	838861	8.38861e+006	50	Range1	Damping Off	-10	10	-100	100	-11	11
7	838861	8.38861e+006	50	Range1	Damping Off	-10	10	-100	100	-11	11
8	838861	8.38861e+006	50	Range1	Damping Off	-10	10	-100	100	-11	11

Fig 4 The Channel View of ArbinSys.cfg

The following pages contain information specific to the configuration of an individual system. Where systems do not bear the input types indicated, there will be no information listed on the respective page of the file.

Aux Temperature

As was noted above, most fields are edited only through calibration. However, following the use of a third-party temperature chamber, thermal inputs associated with the independent compartments represent parameters that may be regulated. Some exceptions are the **Nickname** field present for all auxiliary channels and the designation of certain auxiliary channels, such as temperature and flow rate, as **Controllable**.

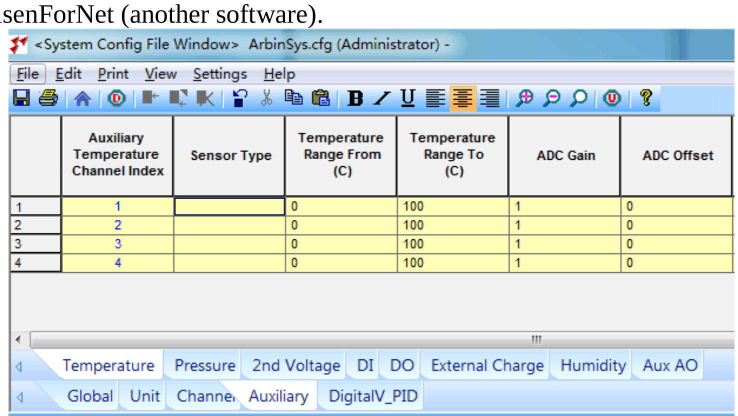
By checking the **Controllable** option in ArbinSys.cfg, assigning the channel in ArbinSys.bth and creating a Test Setting, a user specifies that the temperature reported will be used to control the environment in the enclosure.

	Auxiliary Temperature Channel Index	Sensor Type	Temperature Range From (C)	Temperature Range To (C)	ADC Gain	ADC Offset	Physical Gain	Physical Offset	Filter Factor	Controllable	Sync Stop	Nickname	Unit
1	1		0	100	1	0	1	0	1	☐	☑		C
2	2		0	100	1	0	1	0	1	☐	☑		C
3	3		0	100	1	0	1	0	1	☐	☑		C
4	4		0	100	1	0	1	0	1	☐	☑		C
5	5		0	100	1	0	1	0	1	☐	☑		C
6	6		0	100	1	0	1	0	1	☐	☑		C
7	7		0	100	1	0	1	0	1	☐	☑		C
8	8		0	100	1	0	1	0	1	☐	☑		C
9	9		0	100	1	0	1	0	1	☑	☑	chamber	C

Fig 5 The Auxiliary View of ArbinSys.cfg

Conversion Formula for Thermocouple

For thermocouple inputs, the setup for the conversion formula is in default as it shows below. For thermocouple of E, J, K, or T-type, read through LisenForNet (another software).



	Auxiliary Temperature Channel Index	Sensor Type	Temperature Range From (C)	Temperature Range To (C)	ADC Gain	ADC Offset
1	1		0	100	1	0
2	2		0	100	1	0
3	3		0	100	1	0
4	4		0	100	1	0

Fig 6 The Auxiliary Temperature View

Conversion Formula for Thermistor

For thermistor inputs, the setup for the conversion formula depends on nominal resistance. The "default" formula is for a thermistor with nominal resistance 10 kΩ. (Read through LisenForNet)
For thermistors of another resistance, please call Arbin customer service for suitable selection of a conversion formula in a pull-down menu. For example, select PT100 for platinum resistor of 100 Ω. To be noted, it should be Digital for the third-party temperature chamber.

Aux Pressure

Aux Pressure channels behave in a similar fashion as Aux Temperature channels. Read through LisenForNet.

Aux Voltage

Aux Voltage channels behave in a similar fashion as Aux Temperature channels. Read through LisenForNet.

DI/DO

Aux DI/DO channels behave in a similar fashion as Aux Temperature channels. Read through LisenForNet.

External Charge

Aux External Charge channels behave in a similar fashion as Aux Temperature channels. Read through LisenForNet.

Humidity

Aux Humidity channels behave in a similar fashion as Aux Temperature channels. Read through LisenForNet.

Aux Ao

Aux Ao channels behave in a similar fashion as Aux Temperature channels. Read through LisenForNet.

Example:

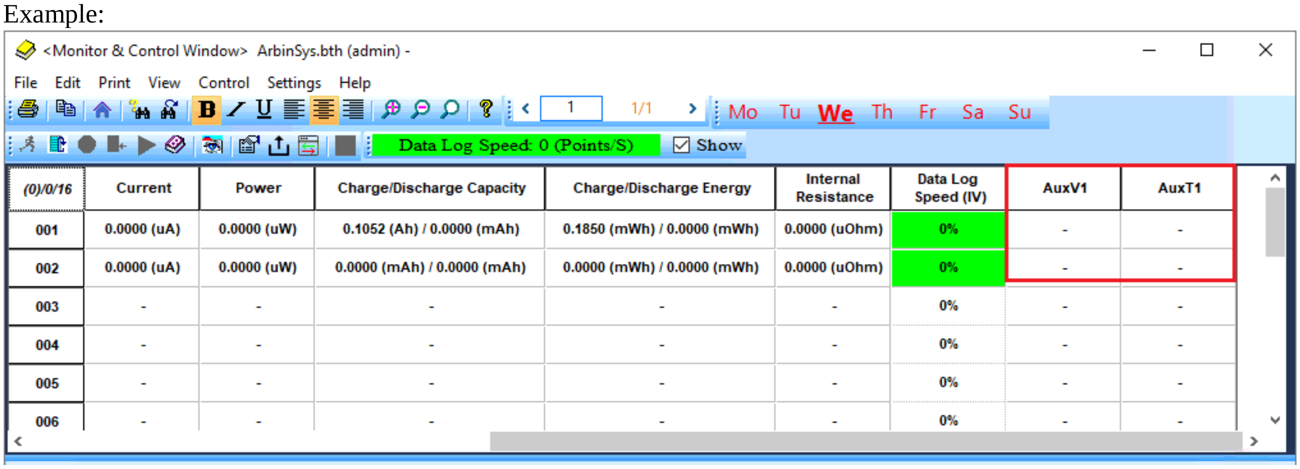


Fig 7 The Auxiliary Info in Channel View of Monitor Window

The headings in Monitor & Control window bear the nicknames for each AuxTemperature control channel

Appendix E: Monitor and Control Fields

Field	Display
Remaining Time(s)	Estimated remaining time required for the test
Barcode	The Barcode of Battery
Test Name	Result file name
Schedule Name	The file name of the schedule currently assigned to the channel
Status	Present status of a channel (See **Color-Status**.)
Exit Condition	The stop or exit condition of test
[Cycle] Step Index	Currently running [Cycle number] step number in the active schedule
Step Time (s)	Elapsed time counted from the starting point of present active step
Test Time (s)	Elapsed time counted from the starting point of present active test
Voltage	Measured value of present channel voltage
Current	Measured value of present channel current
Power	Calcuted value of present channel power by I x V
Charge/Discharge Capacity	Cumulative value charge/discharge capacity for the channel's present cycle
Charge/discharge Energy	Cumulative value charge/discharge energy for the channel's present cycle
dV/dt	The first-order change rate of voltage
dV/dQ	The first-order change rate of voltage capacity
Vmax on Cycle	The maximum value of the measured voltage of present active cycle
Internal Resistance	Calculated internal resistance (See more at **Appendix A**-Internal Resistance **Control Type**.)
AC_Impedance	Calculated value of impedance resulting from 1kHz imposed sine wave. (See **Appendix A**-AC Impedance.)
Data Log Speed (IV)	Displayed the speed at which IV data enter the database
ACI_Phase_Angle	Phase angle value of the AC impedance in degree.
Aux Value 1	Input value from auxiliary sensor 1 (**Value**=**Temperature**, **Voltage**, **Pressure with nick name**)
dAux Value 1/dt	First-order change rate of auxiliary input 1
Aux Value x	Input value from auxiliary sensor x (**Value**=**Temperature**, **Voltage**, **Pressure**), reflecting the parameters in Arbinsys.cfg. (See **Appendix E-Cluster** definition.)
dAux Value x/dt	First-order change rate of auxiliary input x

Table 11-1 description of Detail View screen

Appendix F: Agilent 34410A Meter & Auto Calibration

1. Install Agilent 34410A Digital Multi-meter driver on "**Agilent IO Library Suite, Agilent Automation-Ready C**" following the **Step A** in the following guide **"(A) Agilent 34410A Meter: Guide for Using USB Port for Internal Bus-Based Auto Calibration**"

2. Install MITS Pro8.0 software (**Please check Arbin if the MITS Pro8.0 version to support Agilent 34410A meter or not.**) at the default path (**C:\ArbinSoftware)** on the computer following Chapter 3 this manual.

3. Set up a nickname "**MyHP34410A**" for Agilent 34410A meter, referring to **"(B) Set Up Nickname for Using HP34410A USB Multimeter in Auto-calibration".**

4. Testing Agilent 34410A meter in Arbin software, MITS Pro 8.0 following the **Step C** in the following guide "**Agilent 34410A Meter: Guide for Using USB Port for Internal Bus-Based Auto Calibration**" .

5. Run Auto Calibration: Follow **Chapter 9.6**: **Auto Calibration**.

   NOTE: When switch between 34401A and 34410A meters, please run **Test Hardware** in between before switching to another meter.

6. The **Internal Bus-Based Auto Calibration** does not support the auto calibration of Auxiliary channels currently.

(A) Agilent 34410A Meter: Guide for Using USB Port for Internal Bus-Based Auto Calibration

A. Install the **Agilent 34410A** meter software "**Agilent IO Library Suite 15.0, Agilent Automation-Ready CD**" clicking **Click Here to Install Now** as shown below and following the installation guide of this software.

Figure 1 The program will be installed at the default path "C:\Program Files\IVI Foundation".

[NOTE: Please DO NOT change the path.]

B. After the installation of **Agilent 34410A** Digital Multi-meter software, connect the multi-meter to one of the USB ports in the computer:

(a) The Windows Operation System should recognize the multi-meter immediately. The multi-meter is shown in the Agilent Connection Expert.

(b) If not, a pop-up dialog would show up at the right-bottom corner of the windows saying, "Found new hardware". There are two ways to refresh the USB driver for the new hardware "Agilent 34410A Digital Multi-meter".

(1) Click this small dialog (do NOT close it). A window will pop up in order to find the software.

Figure 2. Found new hardware, click Next

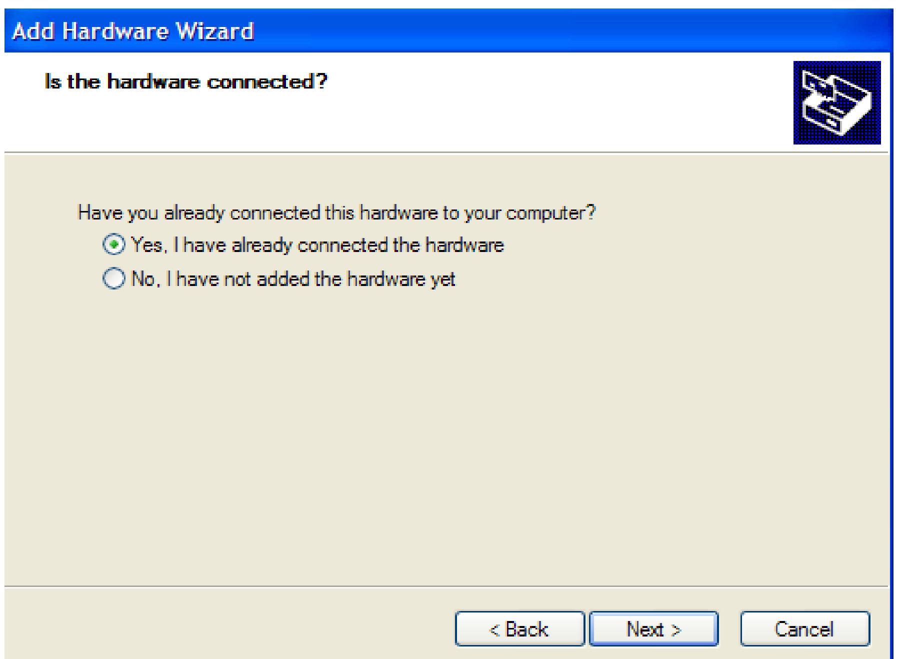


Figure 3. Choose Yes and then click Next button. Make sure you connect the multimeter

(2) Go to **Start** -> **Control Panel,** double click “**Add Hardware**”, then a window as shown in Figure 2 will pop up. Follow the steps in Figure 3. Then, choose the “**Recommend**” choice, click “**Next**”. After some file copied, it will show that the hardware installation is complete Click “**Finish**” button.

C. Testing **Agilent 34410A** meter in Arbin software, MITS Pro (**Version 8.00**):

(a) Connect **Agilent 34410A** meter to **Arbin Tester** as shown in Figure 4.

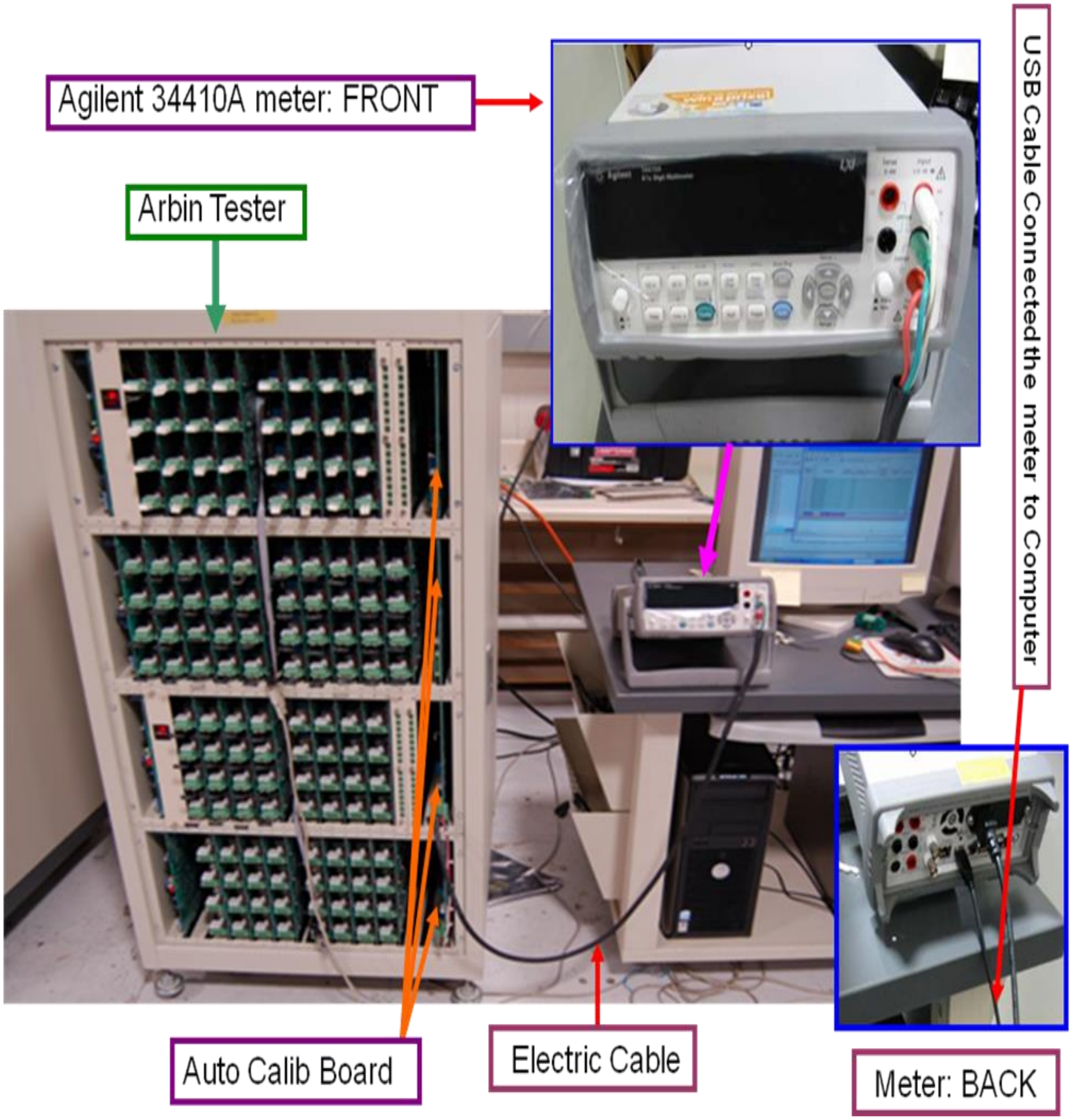


Figure 4: Arbin Tester, Auto Calibration Board, Agilent 34410A meter (Front and Back), USB cable, and Computer

(b) Run **Hardware Calibration** as shown in Figure 5

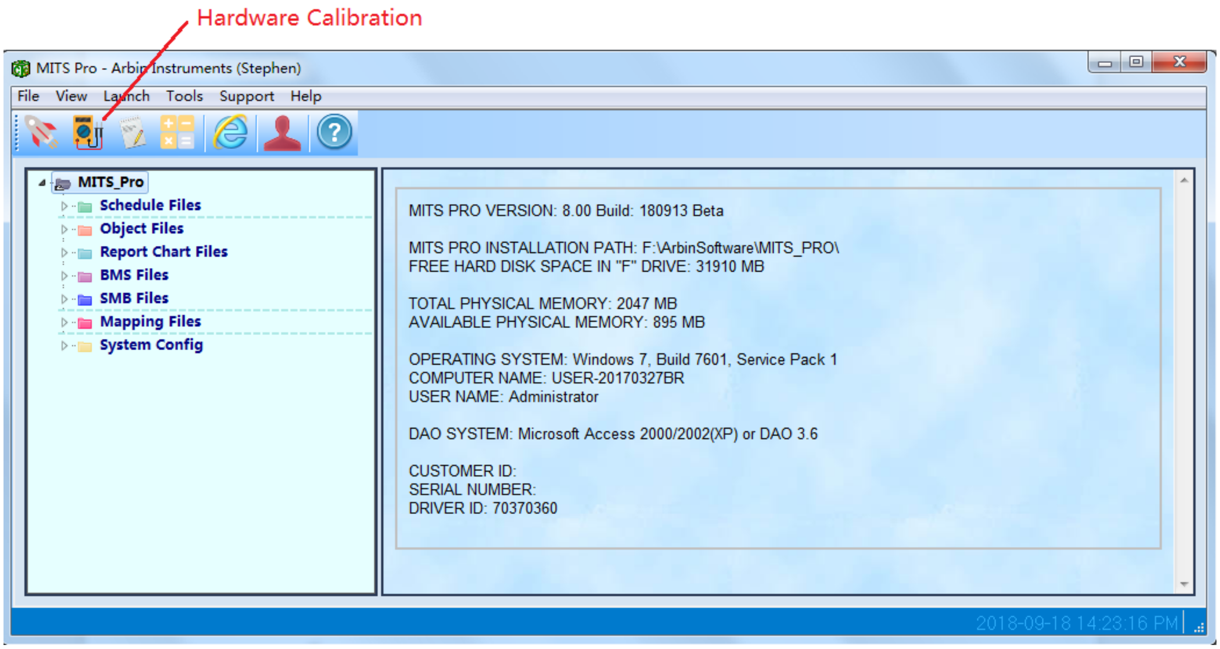


Figure 5 Run Hardware Calibration in MITS Pro8.0 or Above

(c) Then, as shown in 6, **Calibration Window** pops up

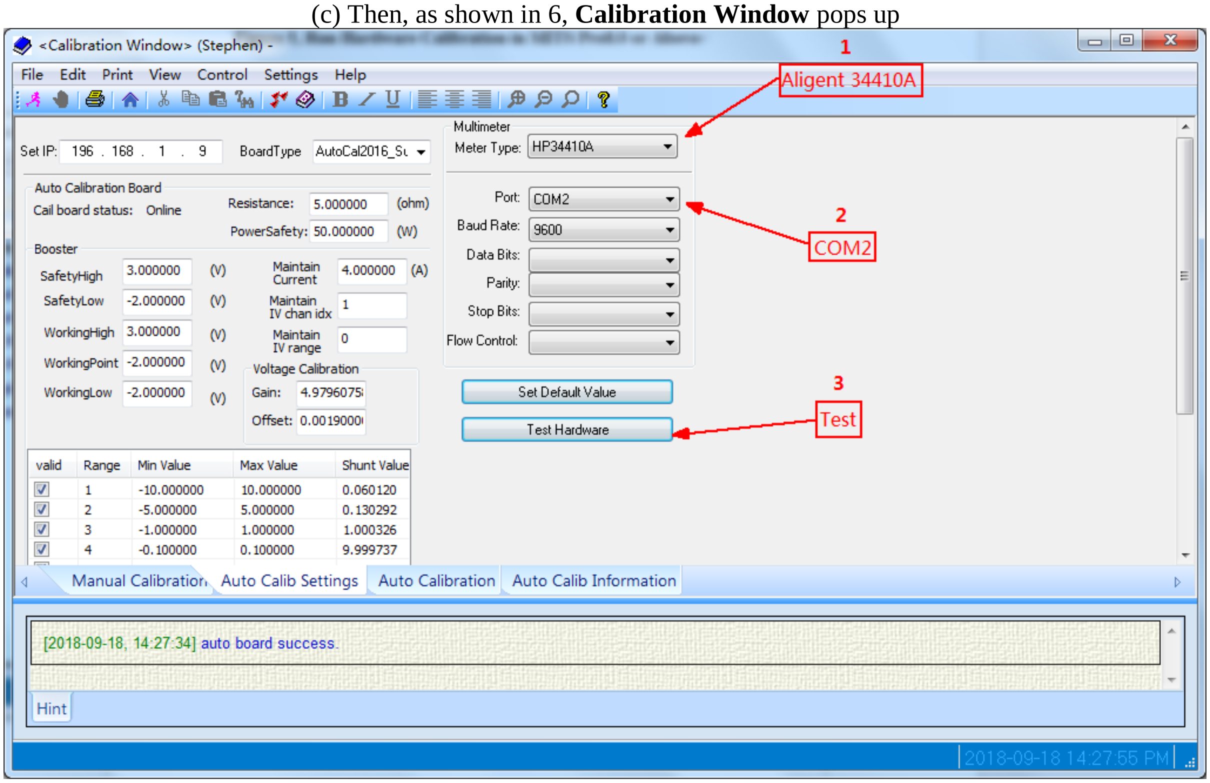


Figure 6. Auto Calib Setting: Choose Agilent 34410A meter and COM port. Then run Test Hardware

(d) Click **Auto Calib Settings.**

(e) Choose **Agilent 34410A** meter**: HP34410A.**

(f) Choose **COM2** port.

(g) Turn on the power for the testing system, and multi-meter. Switch the multi-meter terminal to the **Front** status.

(h) Click the **Test Hardware** button. A hardware test includes a self-test of the multi-meter and the auto calibration board and tests of the cable and connection scheme. If the test is not passed, then the user will be prompted to check the hardware connection. Often, failures are a result of crossed connections with the I, V cable assembly. Check the configuration and re-test. If problems persist, then contact Arbin customer service. All hardware testing parameters are saved in the following file:

C:\ArbinSoftware\MITS_PRO\Settings \Settings\Auto_Calib_Board.stg.

Note: The shunt resistor measurement is not applicable to Agilent 34410A meter. Simply ignore the value

(B). Set Up Nickname for Using HP34410A USB Multimeter in Auto-calibration

In MITS Pro, nick name "MyHP34410A" is used for HP34410A USB multimeter. Therefore, to use the HP34410A multimeter, use the defined nickname "MyHP34410A".

Step 1. Open Connection Expert of Agilent IO Libraries Suite 15 (see Figure 7)

Figure 7. Open Connection Expert of Agilent IO Libraries Suite 15

Step2: Choose the USB port which is connected with the HP34410A multimeter. (see Figure 8)

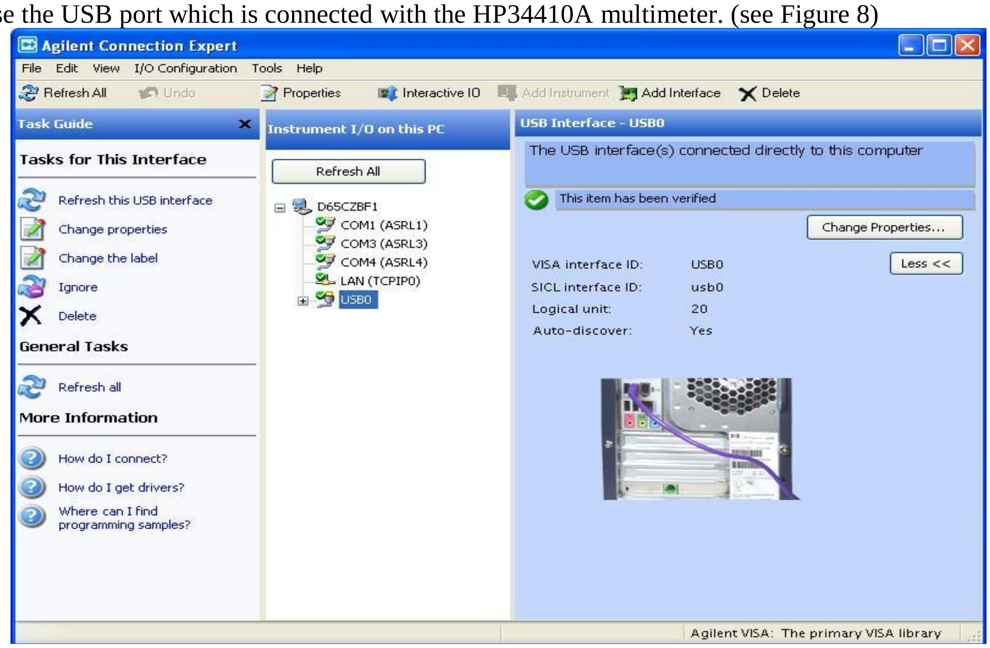


Figure 8. Choose the USB port which is connected with the HP34410A multimeter.

Step 3. "MyHP34410A" Turn on the multimeter which has been correctly connected to the USB port. The multimeter device will show up in the "Instrument I/O on this PC" column under the USB port item. Choose the device (see Figure 9).

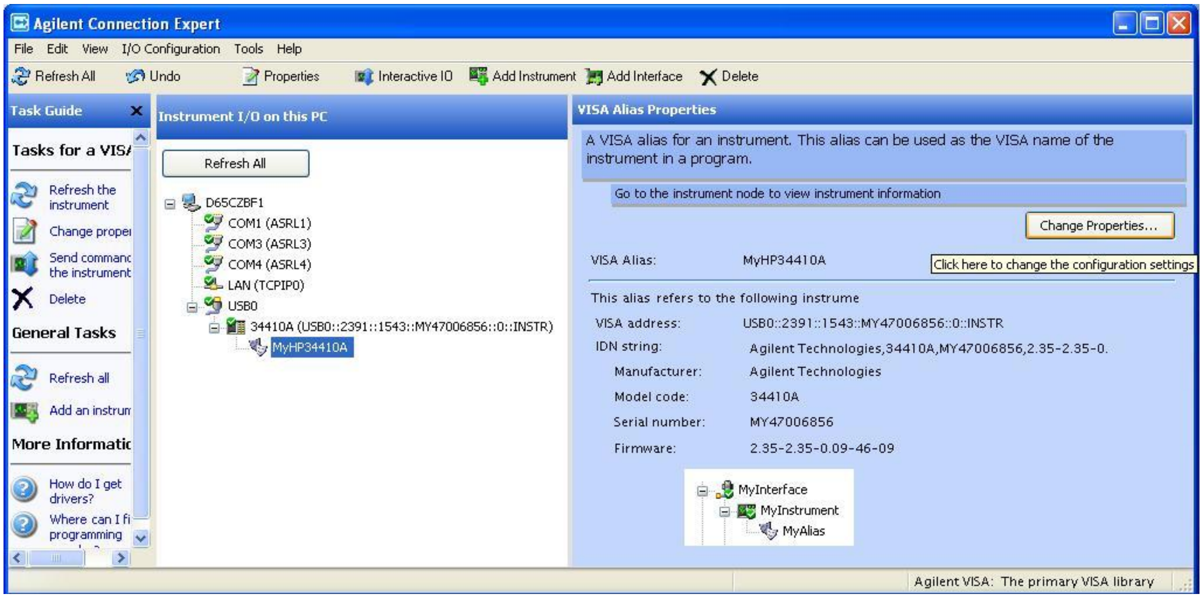


Figure 9. The multimeter device will show up. Choose the device.

Step 4: Click the "Change Properties..." button on the right side of the window (as shown in Figure 10). A window "VISA Alias Properties" will pop up. Input “MyHP34410A” at VISA alias space. Click OK button.

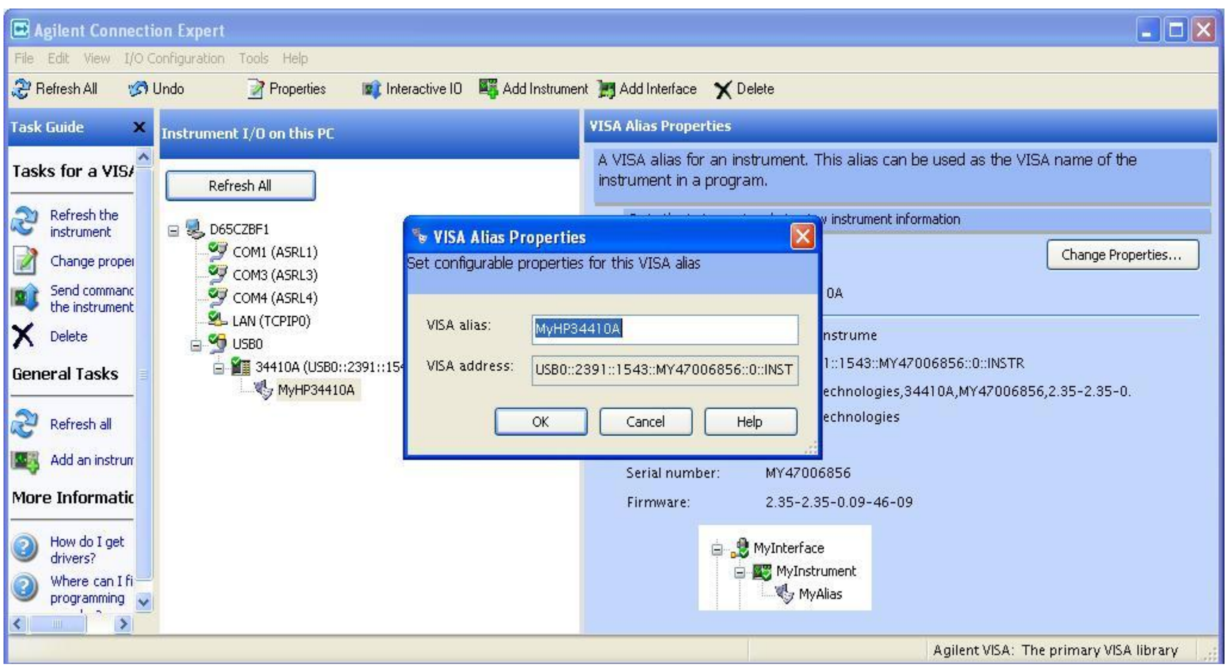


Figure 10.

Appendix G: Arbin CAN BMS

Arbin Battery Testing System provides CAN-Bus communication for most of EVTS systems and high voltage battery testing systems that will be used to test battery pack with BMS. Arbin MITS Pro software allows Arbin test equipments to be programmed to both **receive CAN messages from and transmit CAN messages to** customers' CAN devices. **No 3rd party equipment, no 3rd party DLL package, or no 3rd party license is needed**

Basic steps that are needed to know before using Arbin CAN:

1)**CAN Configuration Files**: Compose a configuration file that describes the Baud rate of the CAN communication, Frame type, and the bit allocations of the signals in the incoming CAN messages. (Section B)

2)**Batch File**: Map a CAN BMS channel to I/V channel that is connected to the CAN port. (Section C)

3)**Schedule File**: Add a CAN BMS channel in the Aux Channel Requirement and assign a valid CAN configure file to the schedule in the Profiles of Global page of the schedule. Then assign this schedule to the I/V channel mapped a CAN BMS channel. (Section D)

4)To send a CAN message from MITS Pro8.0 to an external CAN BMS, user can either from a schedule or the "Send **CAN Messages** " item in **Control** Menu of **Channel View** Tab. (Section D & Section E)

5)To receive a **CAN signal**, and set its value for step conditions, use its Meta variable in schedule. (Section B)

6)To view the received **BMS signals**, use **Channel View**. (Section B2 & Section E)

7)To view logged CAN signal data, use Data Watcher. (Section F)

System Configure

In the Global page of the system configure, **CAN BMS** in the list of **Advanced** Options must be checked for systems that have CAN BMS feature. Correspondingly, a new control type, known as **Write CAN Messages** is also checked in **Ctrl Type** Options (see Fig. 1). Please check this before using CAN. Otherwise, if need to broadcast CAN aux message, **CAN Aux Message** in the list of **Advanced** Options must be checked too for systems.

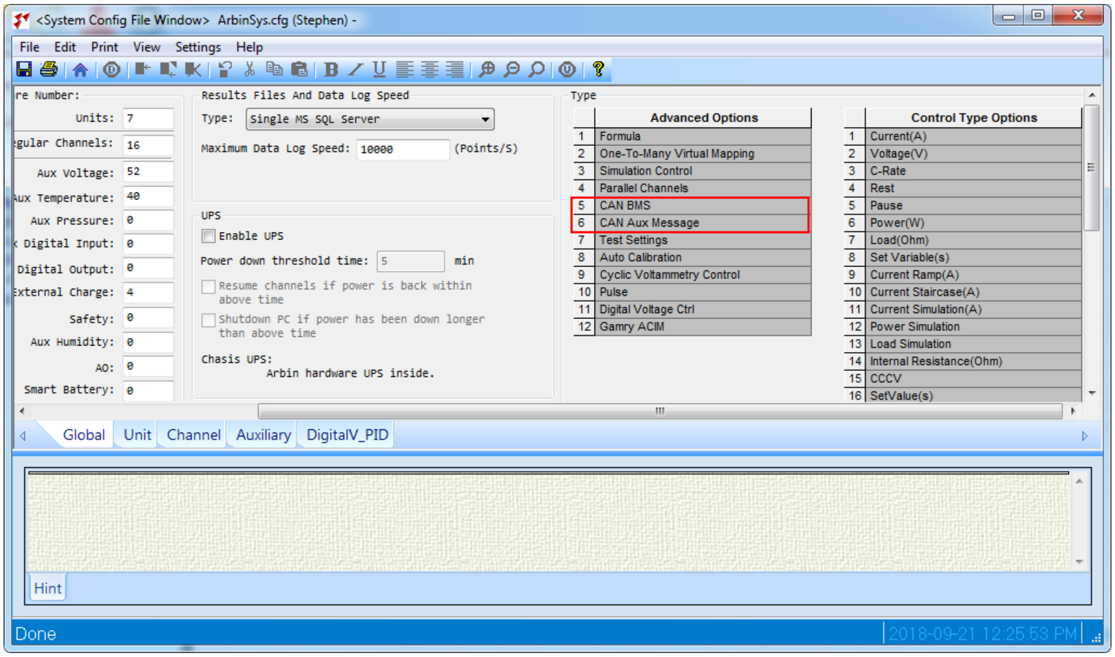


Fig 1 CAN BMS and CAN Aux Message is listed in Advanced Options, the Global page of the System Configure

CAN Configure File Editor

If **CAN BMS** is listed in Advanced Options, the Global page of the System Configure, the CAN Configure File Editor interface, **BMS Files**, is shown up in the user interface MITS Pro-Arbin Instruments (see Fig.2) . If BMS is not listed **Advanced Options** in the **Global page** of the System Configure, the CAN Configure File Editor interface, BMS Files, will not be shown up

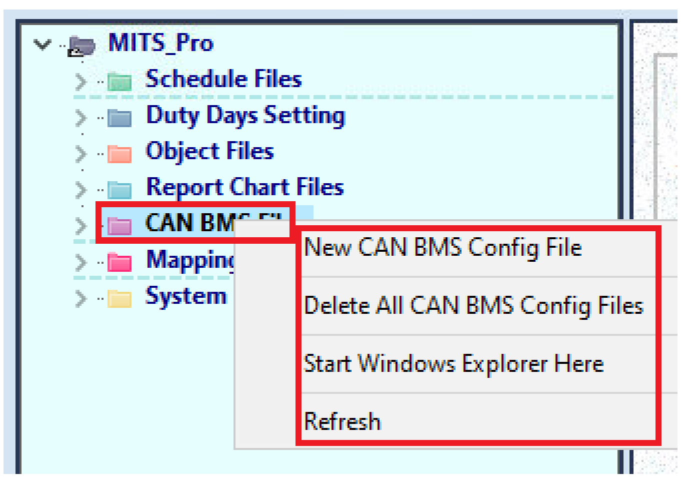


Fig 2 CAN Configure File Edit Interface

User can create, edit, or delete a CAN Configuration file. To create a CAN configuration file, click New CAN Config File. Then a <Can Config File Window> pops up (note: the extension name of a Can Configure file is ".can", i.e., the file name is CANConfig.can). In this file, the CAN Global page is shown in Fig.3(a).

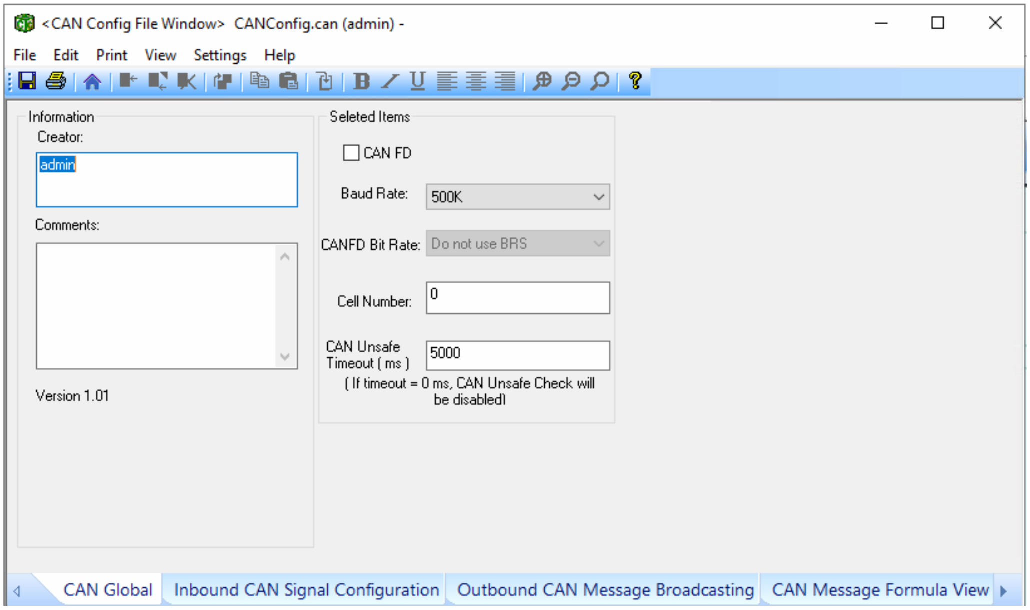


Fig 3(a) CAN Global page

Description of some fields in Figure 3(a):

1. **Baud Rate**: 125K, 250K, 500K, 1M. User must choose a Baud Rate to match the Baud Rate of the CAN BMS.

2. **Cell Number:** Integer, 0, 1, 2,….. (under development)

3. **CAN Unsafe Timeout** (ms): If no any CAN BMS signal has been received for a period of time, the alarm will be raised and the test will be stopped.

The CAN Signal Configuration page is shown in Fig.3(b), User can define the CAN message information received and resolved in this page. The Outbound CAN Message Broadcasting page is shown in Fig.3(c). User can broadcast some CAN message containing Formula, Meta Variables, and float data, to the 3rd party CAN equipment. Move mouse over the edit box and right-click to select the data you want to broadcast. Otherwise, user also can broadcast auxiliary channel data such as Aux Temperature channel and Aux Voltage data in the page Aux Outbound CAN Message Broadcasting shown in Fig.3(d). All the definition of each field is explained as follow:

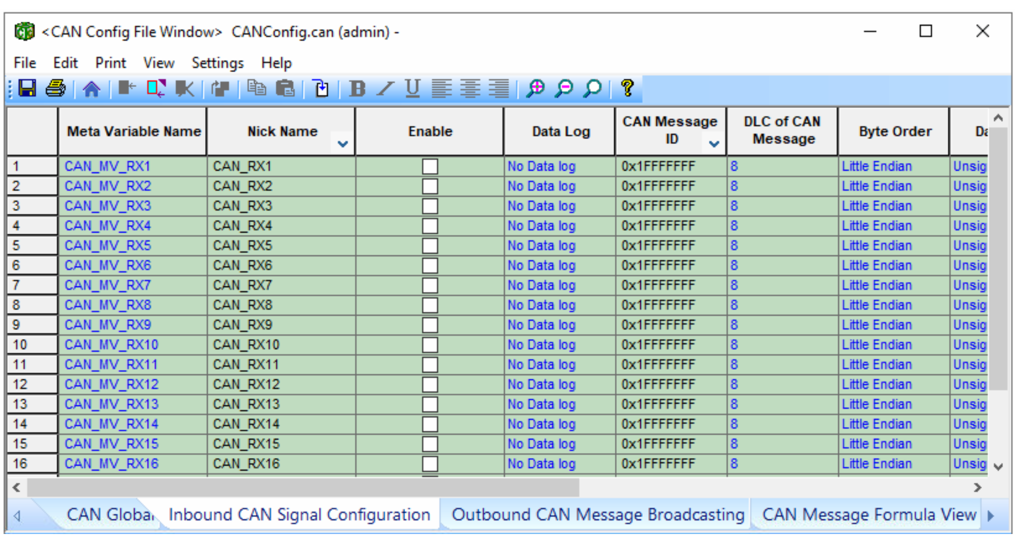


Fig. 3(b) CAN signal definition

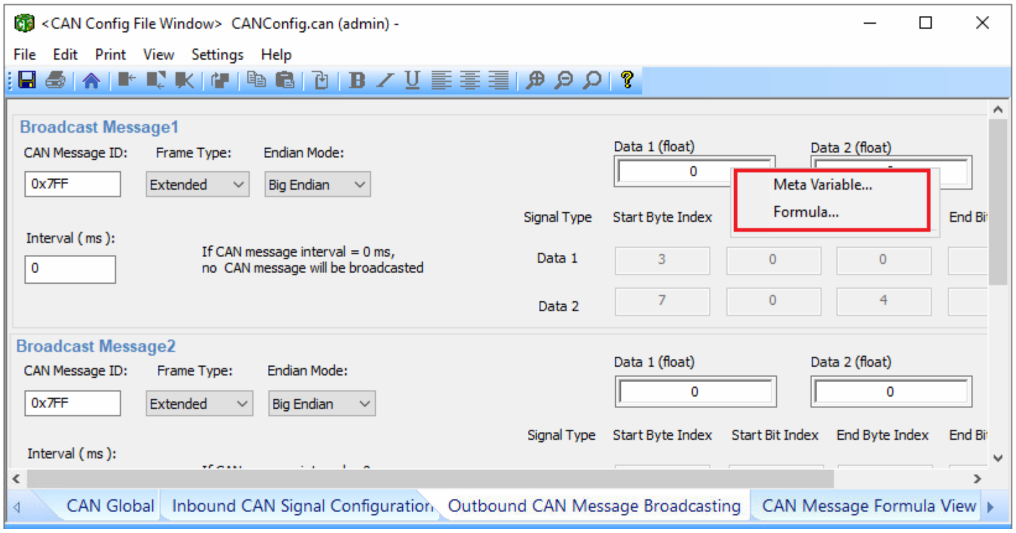


Fig. 3(c) Outbound CAN Message Broadcasting

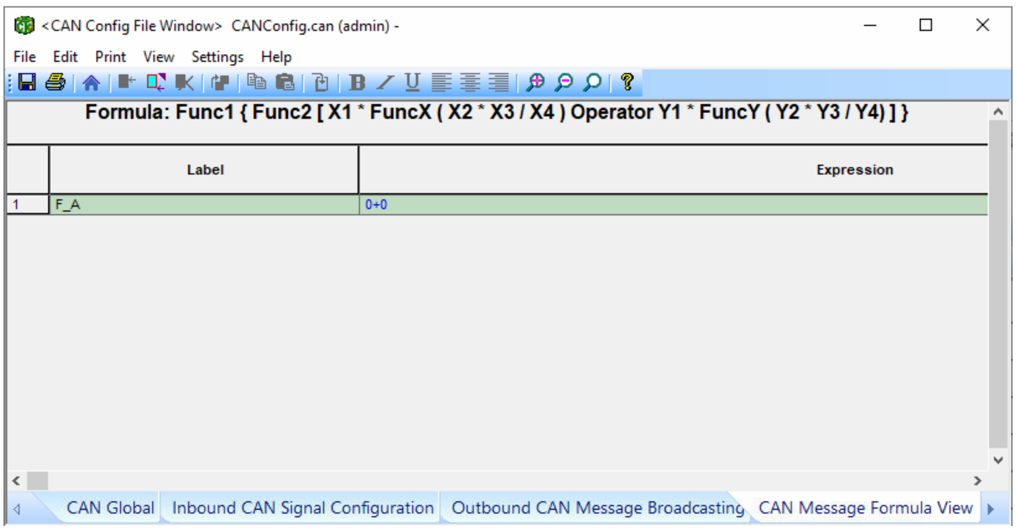


Fig 3(d) CAN Message Formula View

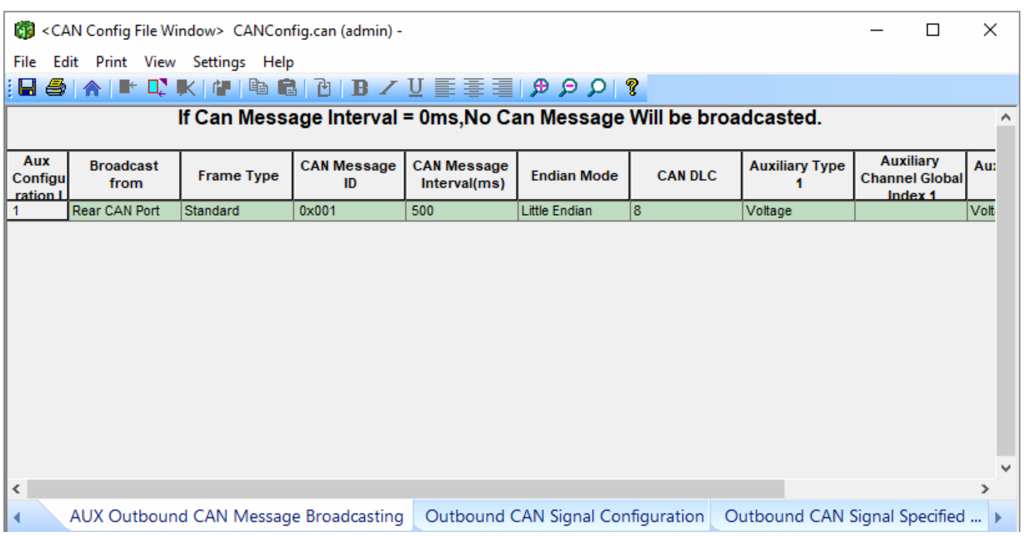


Fig 3(e) Aux Outbound CAN Message Broadcasting

Description of the fields in **Figure 3(b)**

4. **Meta Variable Name**:

It is predefined in MITS Pro. Users cannot edit or change it. The Meta variables are used to store the value of a CAN signals and make them available for step controls in schedules. The name is defined as CAN_MV_RXn, where n=1, 2, …., 512. As shown in Fig.4(a), CAN BMS values are listed in the Meta Variables window in “Monitor and Control Window”.

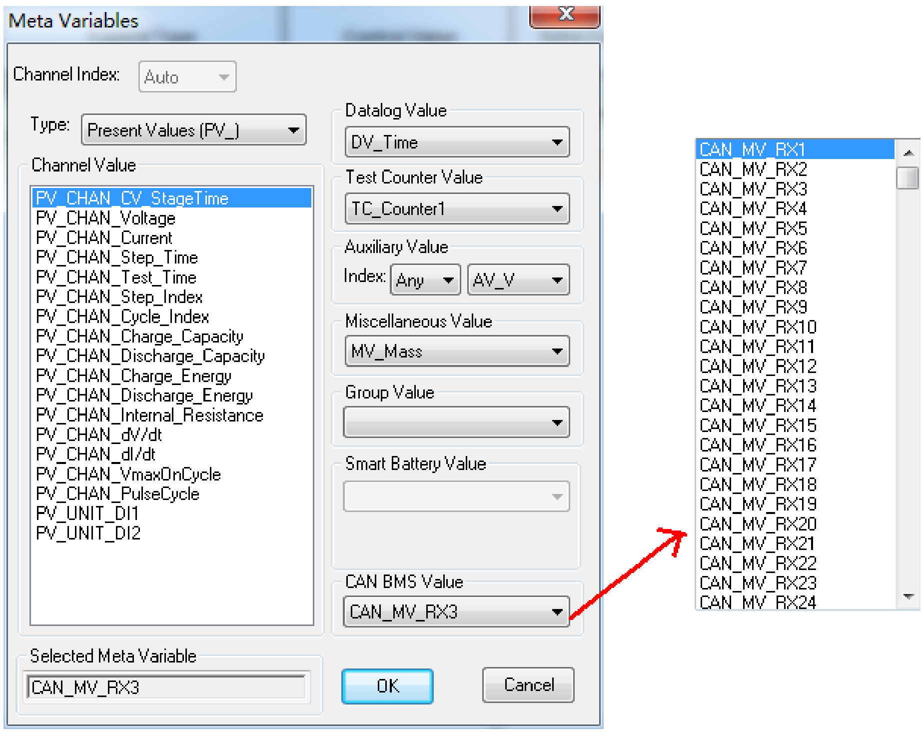


Fig 4(a) CAN BMS Meta Variables

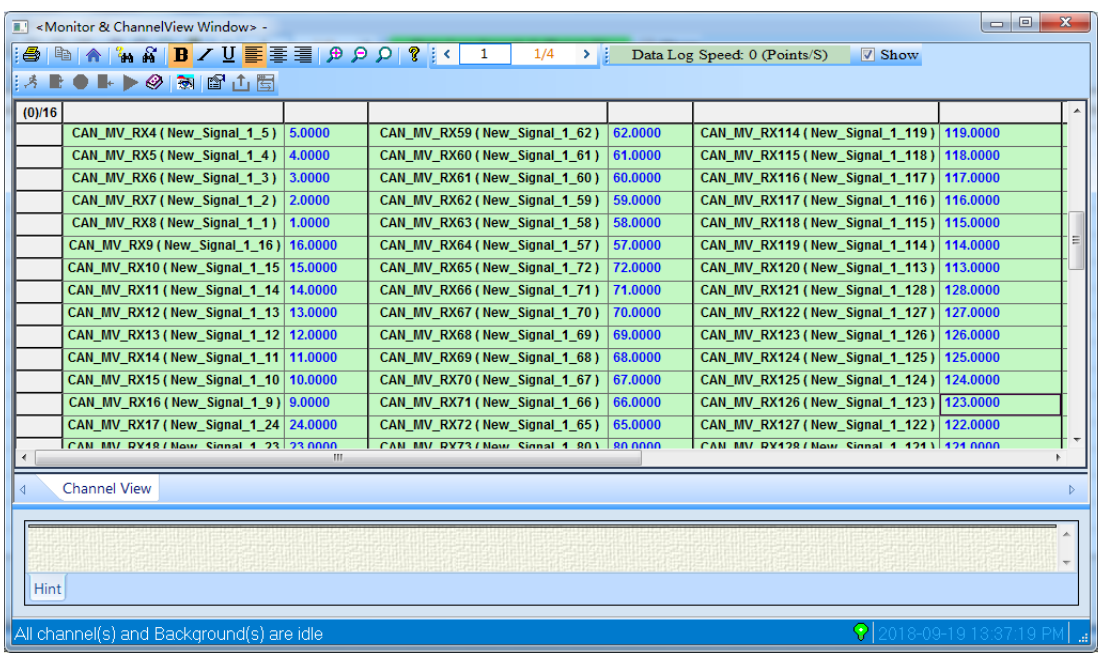


Fig 4(b): **Channel View** for received CAN signals. The field name is labeled as Meta Variable Name (Nick Name)

5. **Nick Name**

User can designate a meaningful name for a received CAN signal. A good nickname will help user to differentiate one signal from the others. The default nick name is Can_RXn (n=1,2,…512). Nick name are mainly used for displaying and logging data. In the **Channel View**, as shown in Fig.4(b), the nick name is displayed by following its Meta variable name.

6. **Enable**

Check this checkbox to enable the use of the definition of the CAN signal. If the signal is not enabled here, MITS Pro will ignore this definition, and no data will be sampled, displayed, or logged. User can Check ALL or Uncheck ALL by move the mouse pointer over "Enable" and click the right button of the mouse.
Please be noted that **do not enable a signal unless you really need it**. Otherwise, it will waste computing resources.

7. **Data Log**

Set the data log for the CAN signal. For an enabled CAN signal, if Data Log column is selected No Data Log, the data will not be logged in the result files. User can set a data log interval by move the mouse pointer over "Data Log" and select an interval.

8. **CAN Message ID**

The ID of the CAN message that contains the signal.

9. **DLC of Can Message**

The DLC of the CAN message that contains the signal.
Please be noted the software will use both CAN Message ID and DLC to determine if the received CAN message is a validated one.

10. **Start Byte Index**

Define the Least Significant Byte of the signal. If the signal begins from the first byte of an 8- byte data, then the Start Byte Index is 0. If the signal begins from the 8th byte of an 8- byte data, then the Start Byte Index is 7.

11. **Start Bit Index**

Define the Least Significant Bit of the signal in the Least Significant Byte. If the signal begins from the first bit of the Least Significant Byte, then the Start Bit Index is 0. If the signal begins from the 8th bit of the Least Significant Byte, then the Start Bit Index is 7.

12.**End Byte Index**

Define the Most Significant Byte of the signal. If the signal ends at the first byte of an 8- byte data, End Byte Index is 0. If the signal ends at the 8th byte of an 8- byte data, then the End Byte Index is 7.

13. **End Bit Index**

Define the Most Significant Bit of the signal in the Most Significant Byte. If the signal ends at the first bit of the Most Significant Byte, then the End Bit Index is 0. If the signal ends at the 8th bit of the Most Significant Byte, then the End Bit Index is 7.

14. **Byte Order**

There are two options:
Little Endian: Little-Endian Byte Order counts from the Least Significant Bit to the Lowest Address. It is also called **Intel Format.** In Little-Endian format, Start Byte Index is not greater than End byte Index. For example, if you pack one byte of

data in little-endian format, with the Least Significant Bit at 20 of the Fig. 5(a), this signal will have Start Byte Index=2, Start Bit Index=4, End Byte Index=3, and End Bit Index=3 in Arbin's CAN configuration.

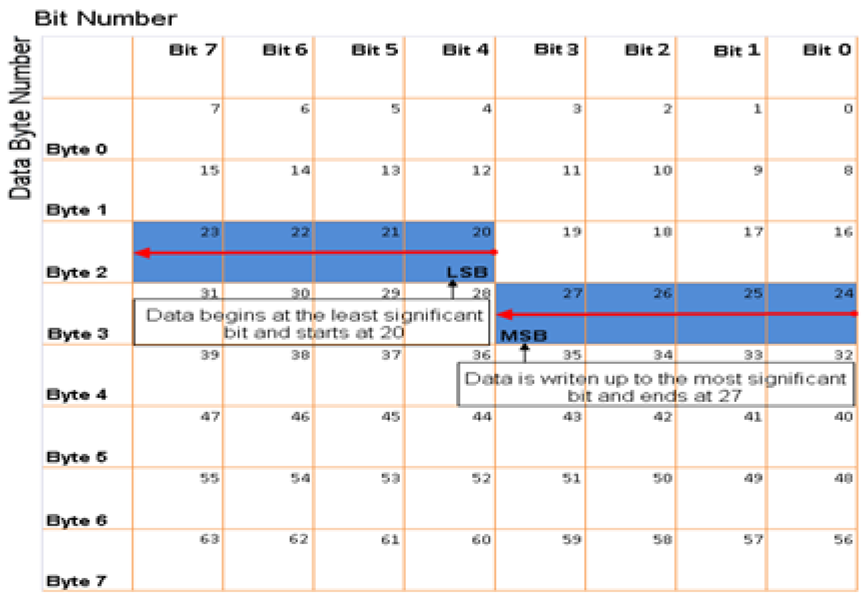


Fig 5(a) Little Endian Format

Big Endian: Big-Endian Byte Order Counts from the Least Significant Bit to the Highest Address. It is also called **Motorola Format**. In Big-Endian format, Start Byte Index is not less than End byte Index. For example, if you pack one byte of data in big-endian format, with the Least Significant Bit at 20 in Fig. 5(b), this signal will have Start Byte Index=2, Start Bit Index=4, End Byte Index=1, and End Bit Index=3, in Arbin's CAN configuration

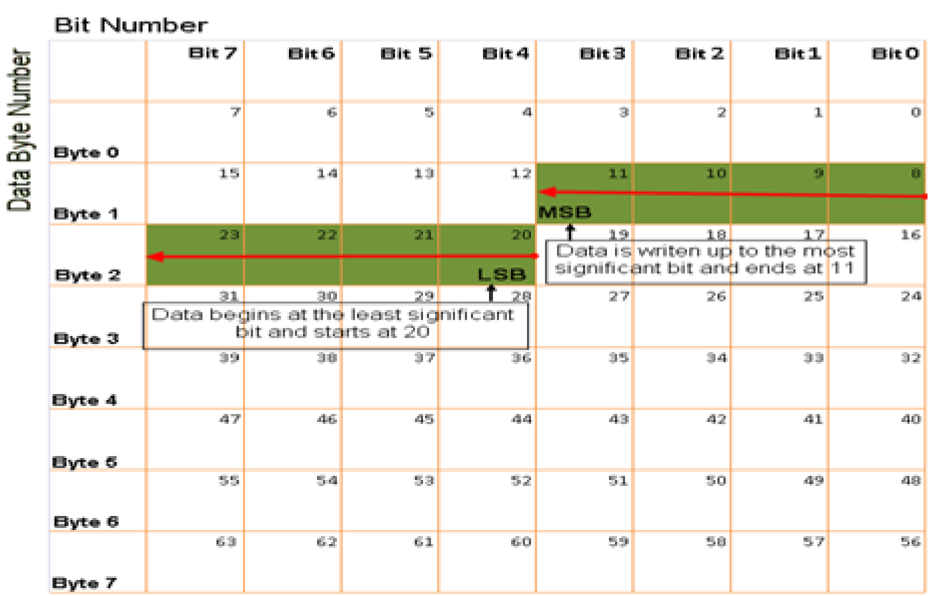


Fig 5(b) Big-Endian format

15. **Data Type**:

Specify how the incoming CAN data should be interpreted, as an unsigned data, a signed data, a float data, or a string. (Strings are limited up to 6 ASCII characters)

16. **Value Offset**

Specify the Value Offset value applied to convert the raw value (CAN data value) to its signal value.

17. **Value Scale Factor:**

Specify the Value Scale Factor value applied to convert the raw value (CAN data value) to its signal value.

18. **Unit**

Choose the unit for the CAN signal. The unit will be used for display and data logging.
Please be noted that MITS Pro does not support any unit symbol in Unicode.

Description of some fields in Fig.3(c):
19. **Frame Type**: Two types: Standard, Extended

Description of the fields in Fig.3(d):
20. **Broadcast from**
Choose the CAN port for auxiliary board where the aux CAN message broadcast.

21. **CAN DLC**
If select 4, only one auxiliary channel data can be broadcasted. Otherwise, select 8, two auxiliary channel data can be broadcasted, but the two of auxiliary in the same CAN frame must belong to the same Unit.

22. **Auxiliary Type**
Select the auxiliary type of auxiliary channel. Only support auxiliary Temperature and auxiliary Voltage.

23. **Auxiliary Channel Global Index**
The global index of auxiliary channel refers to the Auxiliary page of ArbinSys.cfg file.

The conversion formula from received CAN data to its signal values is

Signal_value = Raw_CAN_value * Scale_Factor + Offset

where Raw_CAN_value is the value of the CAN data, and Signal_value is linear transformation of the raw value based on Scale Factor and Offset values.

Conversion of DBC File: CAN configuration can be imported from a dbc file, provided it has been converted into a txt file format (note: please use the extension .dbc). Fig.6 shows the steps to import a dbc file:

- Step 1: Click File menu and then click **Import**
- Step 2: Choose a dbc file. Click **Open**
- Step 3: If successful, it will show "**.dbc file has been imported successfully!"**
- Step 4: Select an appropriate unit for CAN variable

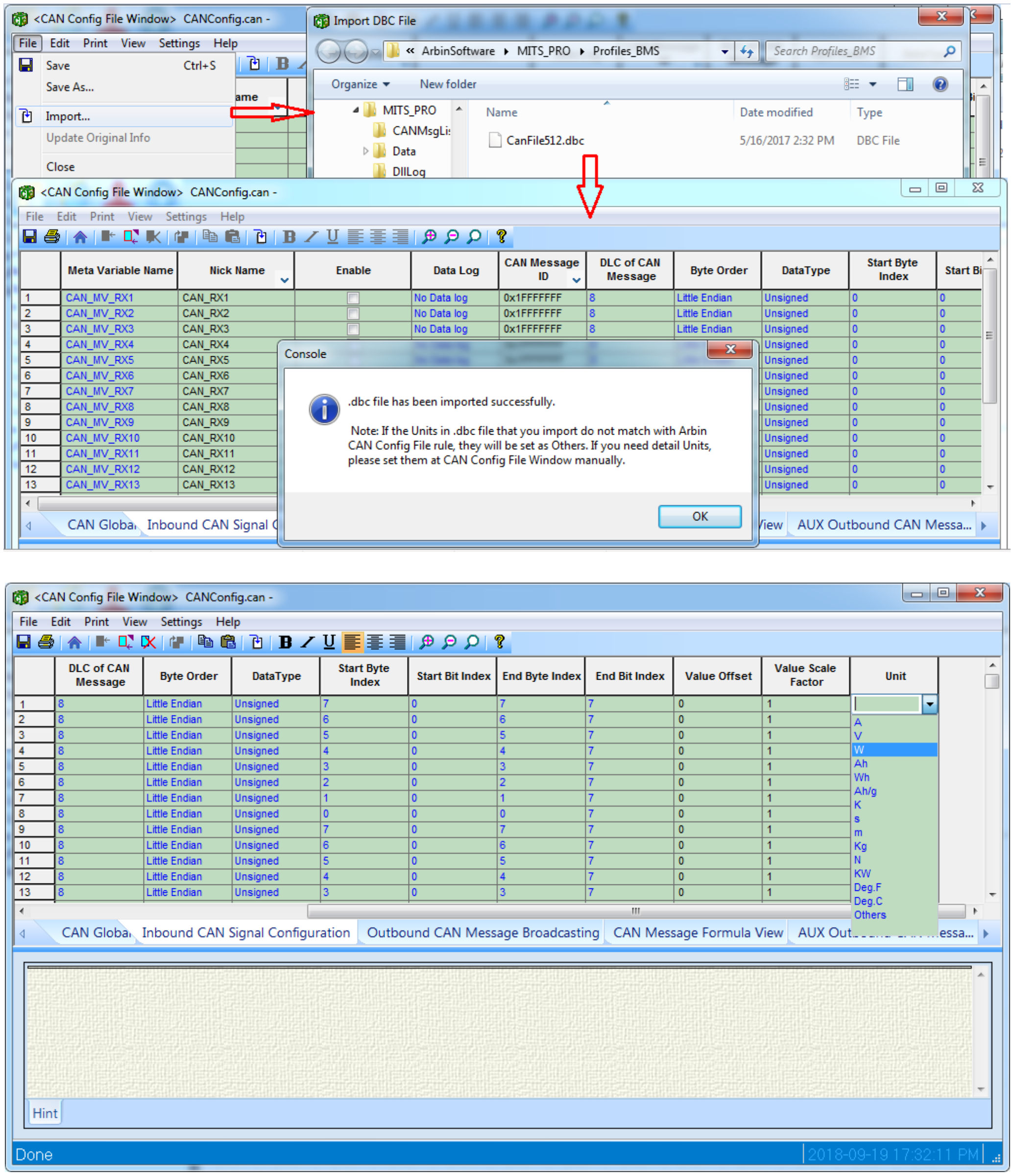


Fig 6 The procedure of importing a dbc file

Mapping

In the Map page of the System Batch file, user must map a CAN BMS channel to I/V channel. Fig.7 presents an example for channel 1.

Only the channel with a schedule that has CAN Configuration file being assigned can be connected to a CAN BMS device.

Please be noted that once the channel has a CAN Configuration file being assigned, it MUST has an active CAN BMS being connected. If the system does not receive any CAN message for more than 5 seconds, it will assume that the CAN communication is disconnected, and an "UNSAFE" warning will be given.

Each time when the contents of the CAN configuration file are changed, user needs to save the batch file to ensure that the batch file is updated.

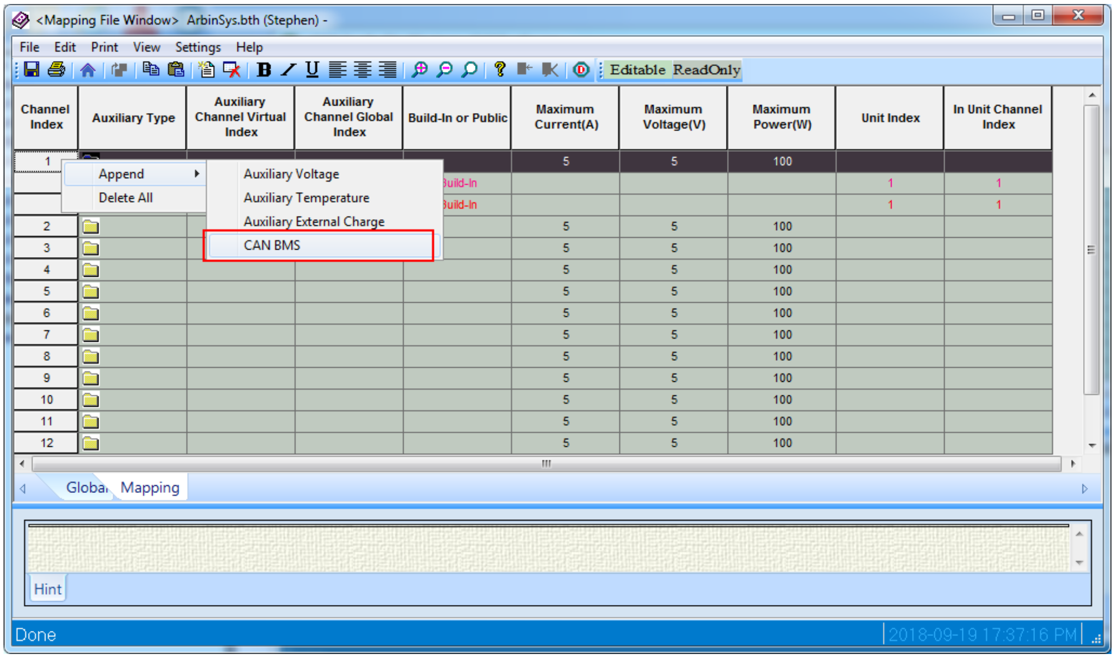


Fig 7 Map a CAN BMS Channel in the Mapping

When user is trying to run tests, the software will check if any schedule contains any CAN Meta Variables that are not defined or not enabled in its corresponding CAN configuration file. If true, warning messages will be given (Fig 8), and the test will not be started.

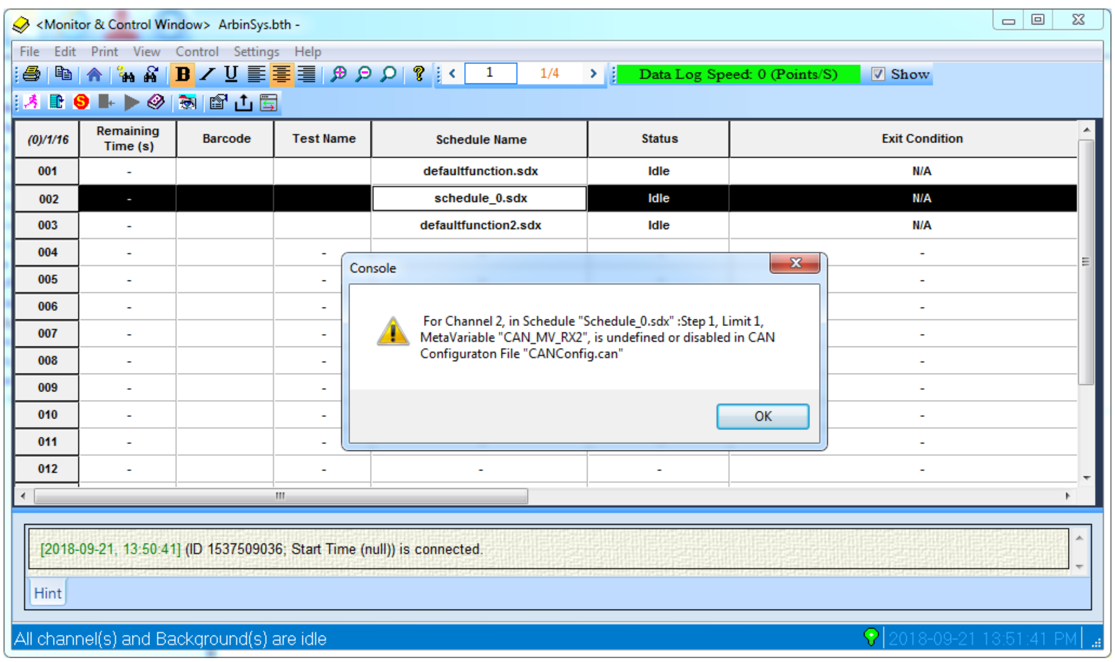


Fig 8 Warning message for not find CAN Meta Variables

Schedule Editor

User is supposed to add a CAN BMS channel and assign a CANConfig file in the Global page of schedule. In the Global page, click Add Aux button, then an Aux Channel Requirement dialog pops up, input the number of CANBMS channels (see Fig.9(a)). In the schedule of the Global page, right-click the BMS edit box and select Assign, then a CANConfig file selecting dialog pops up, select a CANConfig file for assigning. (see Fig.9(b)).

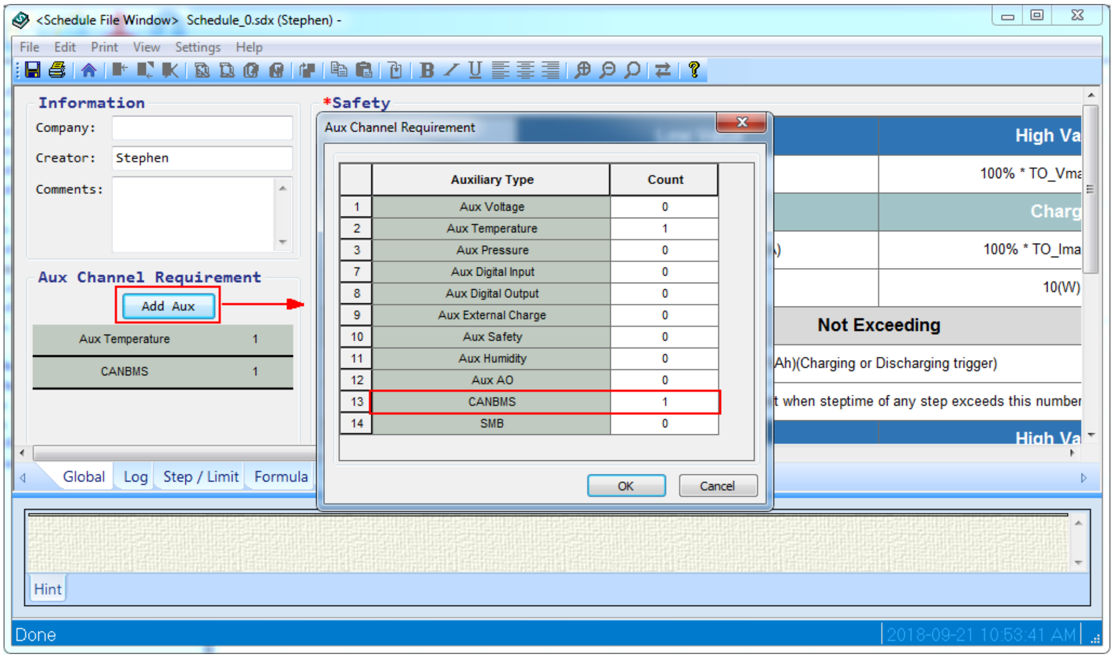


Fig 9(a) Add a CAN BMS channel

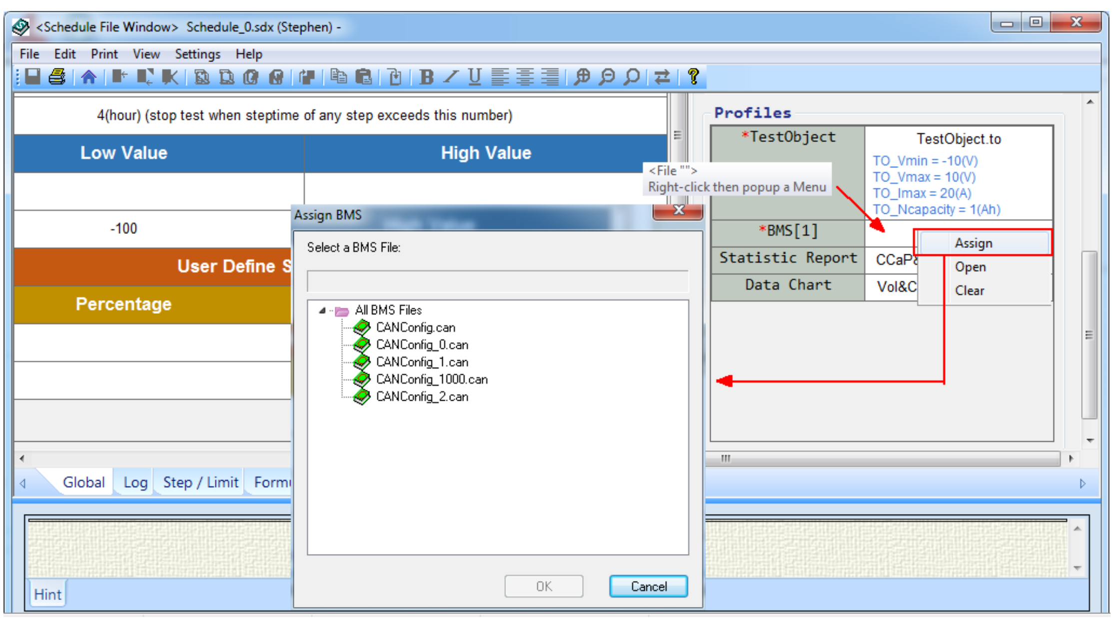


Fig 9(b) Assign a CANConfig file

Control Type: Add a new control type, known as Write Can Messages (see Fig.11). For this control type, it needs to input the following info.

Field	Description	Notes
Control Value	CAN Message Period (ms)	0 for sending one-shot message
Extra Control Value 1	CAN Message ID	
Extra Control Value 2	CAN Message Data: Byte 0, Byte 1, Byte 2, Byte 3, Byte 4, Byte 5, Byte 6, Byte 7	Leave one space between Bytes.
Extended Definition	DLC, Frame Type, Stop One, Stop ALL DLC=0-8. Frame Type: Standard 0; Extended=1. Stop One: Yes=1; No=0 Stop ALL: Yes=1; No=0	Leave one space between each flags

Fig 10 Informaiton for Write CAN Message

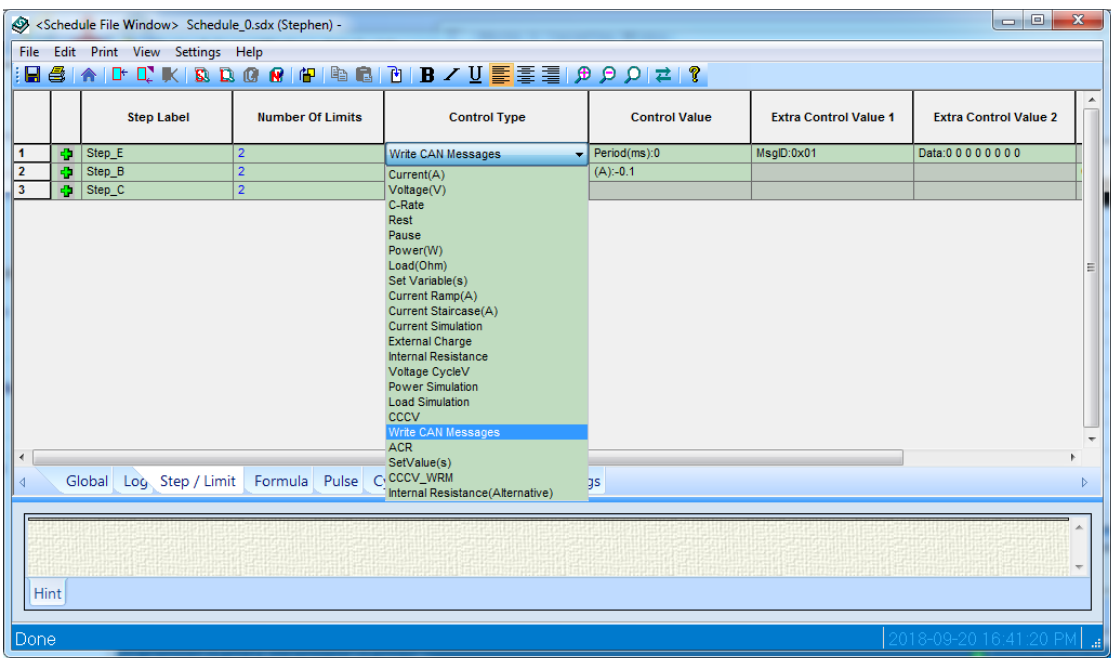


Fig 11 New control type: Write CAN Messages

All the numbers should be entered in decimal. When user moves mouse cursor to each field, a tip message will be displayed as shown in Fig.12

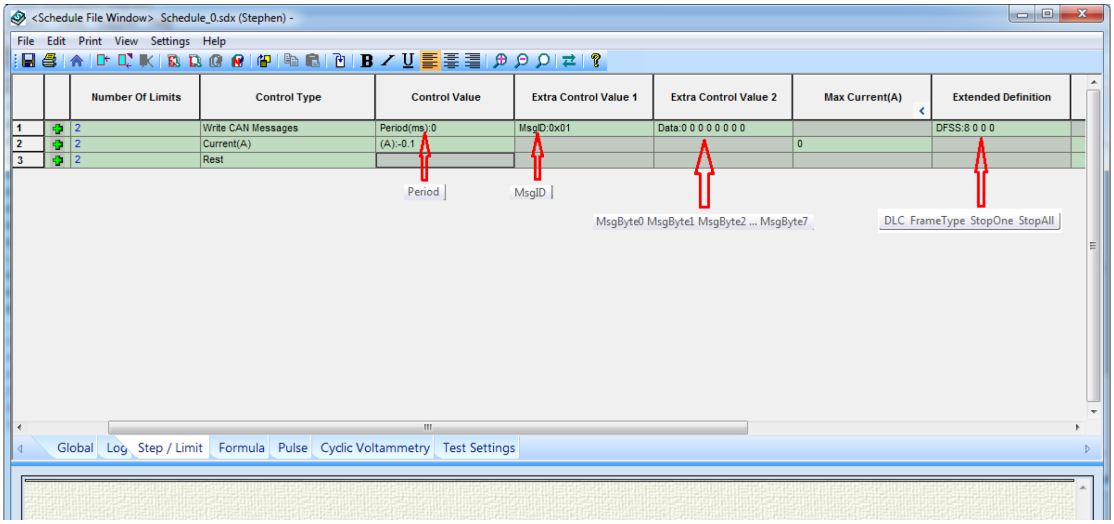


Fig 12 Write Can Message: Tip info for Control Value, Extra Control Value 1, Extra Control Value 2, Extended Definition

•Example 1

Write_CAN_Messages 0 110 11 22 33 44 55 66 77 88 8 1 0 0
Send one-shot message with
CAN Message ID=110
Byte0 = 11; Byte1 = 22, Byte2 = 33, Byte3 = 44, Byte4 = 55, Byte5 = 66, Byte6=77, Byte7=88
DLC=8 Frame Type=Extended Stop One=No Stop ALL=No

•Example 2：

Write_CAN_Messages 200 110 11 22 33 44 55 66 77 88 8 1 0 0
Repeatedly sending CAN message with
CAN Message ID=110， time interval= 200 millisecond
Byte0 = 11; Byte1 = 22, Byte2 = 33, Byte3 = 44, Byte4 = 55, Byte5 = 66, Byte6 = 77, Byte7 = 88
DLC=8 Frame Type=Extended Stop One=No Stop ALL=No

•Example 3：

Write_CAN_Messages x 110 x x x 1 0
Stop repeatedly sending the CAN message with
CAN Message ID=110，
Stop One=Yes Stop ALL=No x could be any number, for example, 0

•Example 4：

Write_CAN_Messages x x x x x x 1
Stop repeatedly sending all ongoing CAN messages. Stop ALL=Yes x could be any number, for example, 0

Use CAN Signal in Step Limit Conditions

In Variable column, open the combo list, and choose “More” (Fig. 13(a))

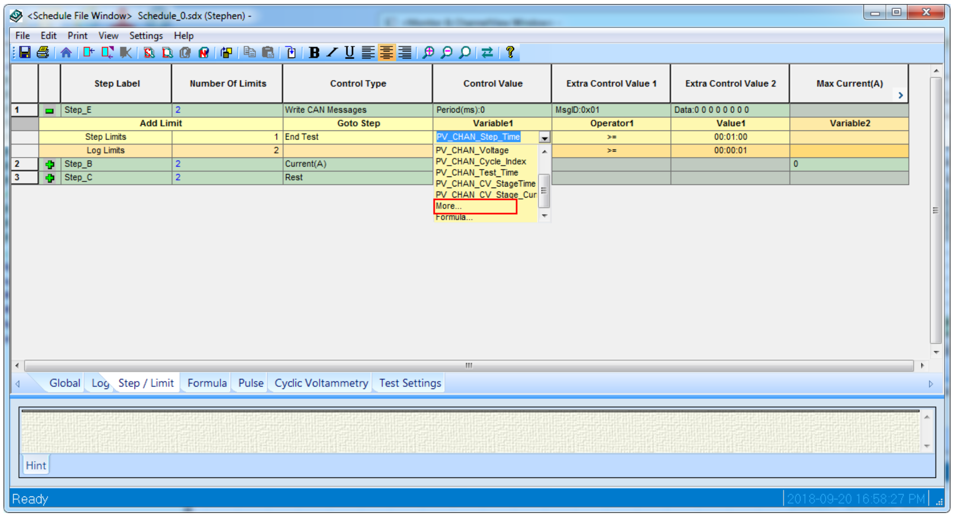


Fig 13 (a) Use CAN signal in Step Limit Conditions

In the Meta Variable dialog, choose CAN BMS values (cf. Fig. 13(b)

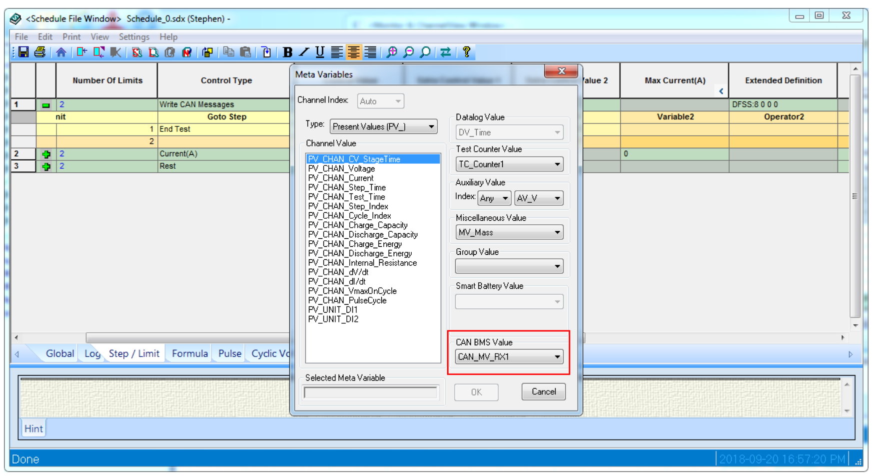


Fig 13(b) Choose CAN BMS values in the Meta Variable Dialog

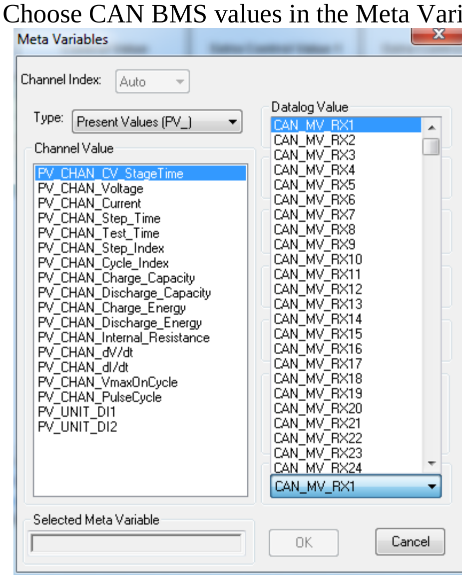


Fig 13 (c) Choose CAN Meta Variables in Limits

View Received CAN Signals

In the **Channel View** of the Monitor & Control Window, the received CAN Signals are displayed as shown in Fig.4(b). User can view the CAN Configuration by opening the CAN Config Name.
In the Control menu, there is a feature Send CAN Message (see Fig.14(a)). Otherwise, user can send a message list containing maximum 256 CAN messages in the page Send CAN Message List of Send CAN Message window (see Fig.14(b)). The two pages are independent of each other.

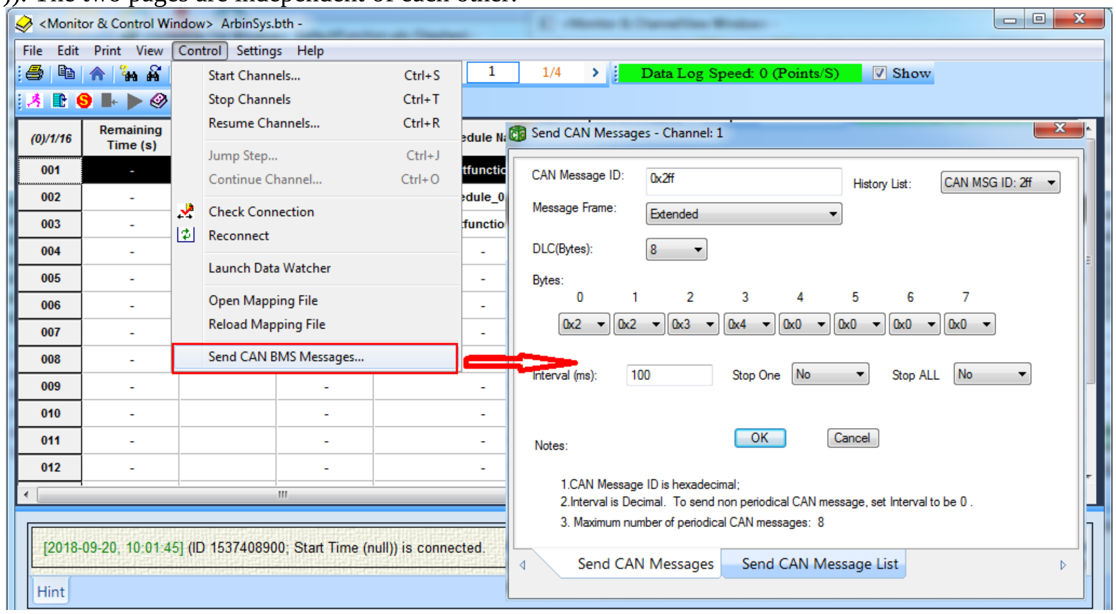


Fig 14(a) Sending CAN messages from Control menu

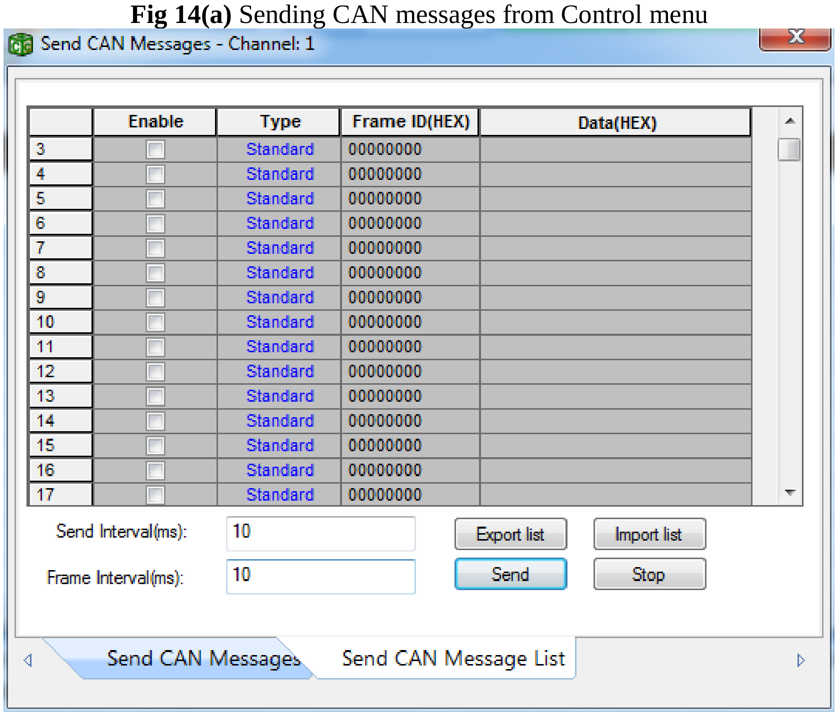


Fig 14(b) Sending CAN Message List

Figure 14 shows the description of some fields.
CAN Message ID: A hexadecimal number
Time Interval:

- Decimal number. Unit: millisecond. If the time interval is 0, only send one-shot CAN message; Otherwise, it will repeat sending the CAN message with the designated time interval. The minimum time interval is 1 ms.

Stop One:

- For Yes, it will stop the ongoing repeating CAN message with the designed CAN ID.
- For No, it will not stop the repeating CAN message with the designed CAN ID.

Stop ALL:

- For YES, it will stop all ongoing repeating CAN messages, regardless what CAN ID they have.
- For No, it will not stop all ongoing repeating CAN messages.

Currently at most 8 CAN messages can be repeatedly sent!

CAN FD

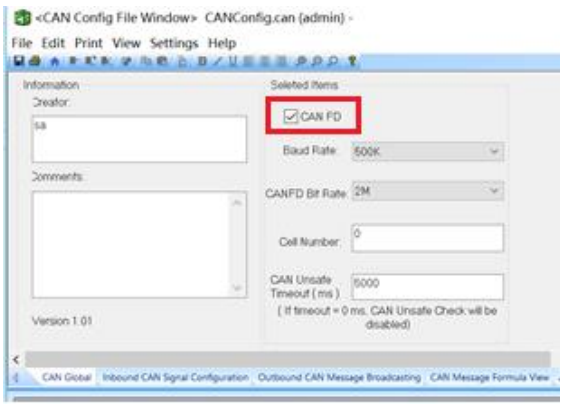


Fig 15 CAN FD in CAN Global page

CANFD function: Check the box before CANFD to enable CANFD. When CANFD function is enabled, Baud Rate and CANFD Bit Rate can be used together.

CANFD Bit Rate: “Do not use the BRS”, “2M”, “3M” and “4M”. Users can choose an appropriate CANFD Bit Rate to match the Baud Rate.

Write Signal Specified CAN Message function

It sends the current, voltage, variable, or formula as a CAN value broadcast.

1. Check Write Signal Specified CAN Message in the Arbin System Setup window and click the save button.

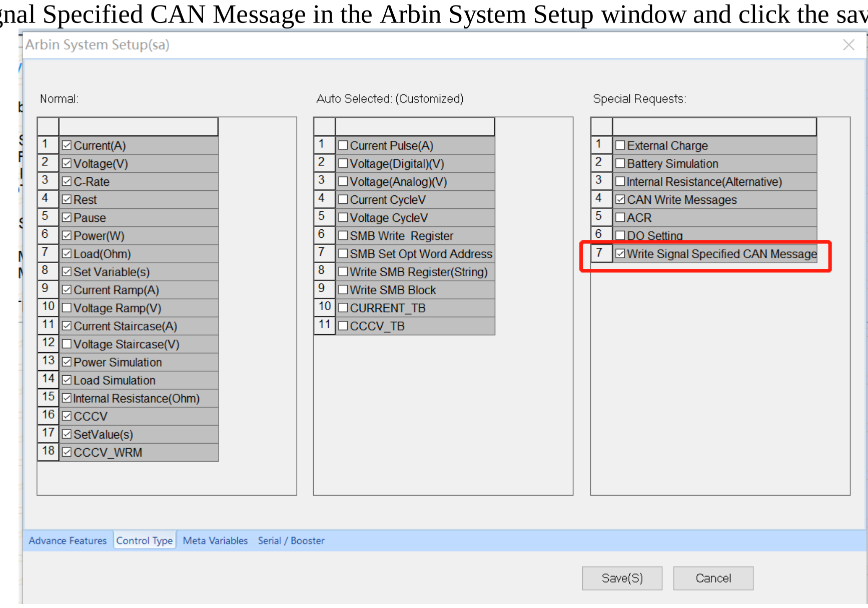


Fig 16 Enabling Write Signal Specified Message in the Advance Features of ArbinAdvSys.cfg file

2. Open the Outbound CAN Signal Configuration page in the CAN file, and then selects the variable to send in the Signal Value drop-down list.

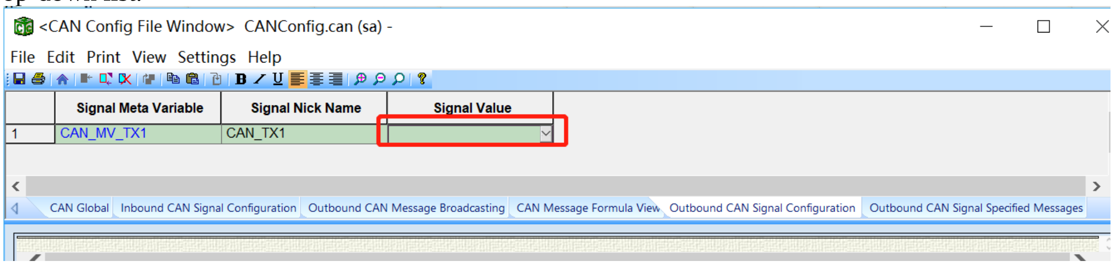


Fig 17 Outbound CAN Signal Configuration

3. In the Outbound CAN Signal Specified Messages page and select the CAN Signal to be sent.

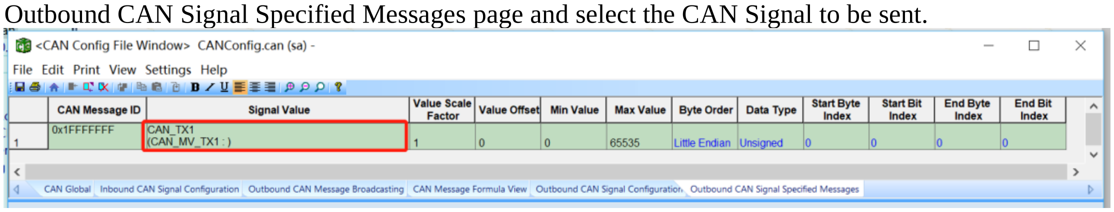


Fig 18 Outbound CAN Signal Specified Messages

4. Then select the Write Signal Specified CAN Message as the control type and fill some important contents, such as Period, MsgID and DFSS.

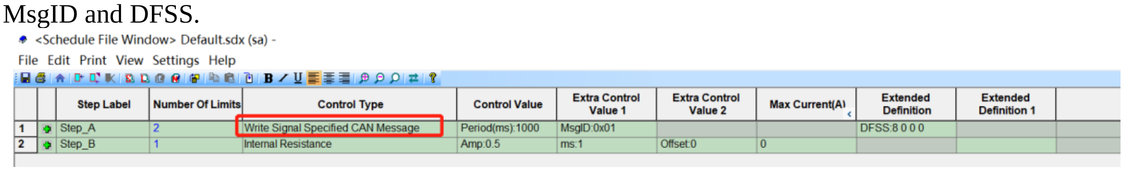


Fig 19 Write Signal Specified CAN Message in Schedule

Description of the fields in **Fig 18**

1. CAN Message ID: The ID of the CAN message that contains the signal.
2. Singal Value: The user can select the Singal Value available on the Outbound CAN Signal Configuration page.
3. Value Scale Factor: The Value of the Scale Factor.
4. Value Offset: The offset of the value.

Other references are described in this Appendix.

View Data Using Data Watcher Software

- Launch Data Watcher software, in Data Watcher Click **Add Tests**. Test Info window pops up, then select the test name, and click **Export Data** (see Fig. 20)

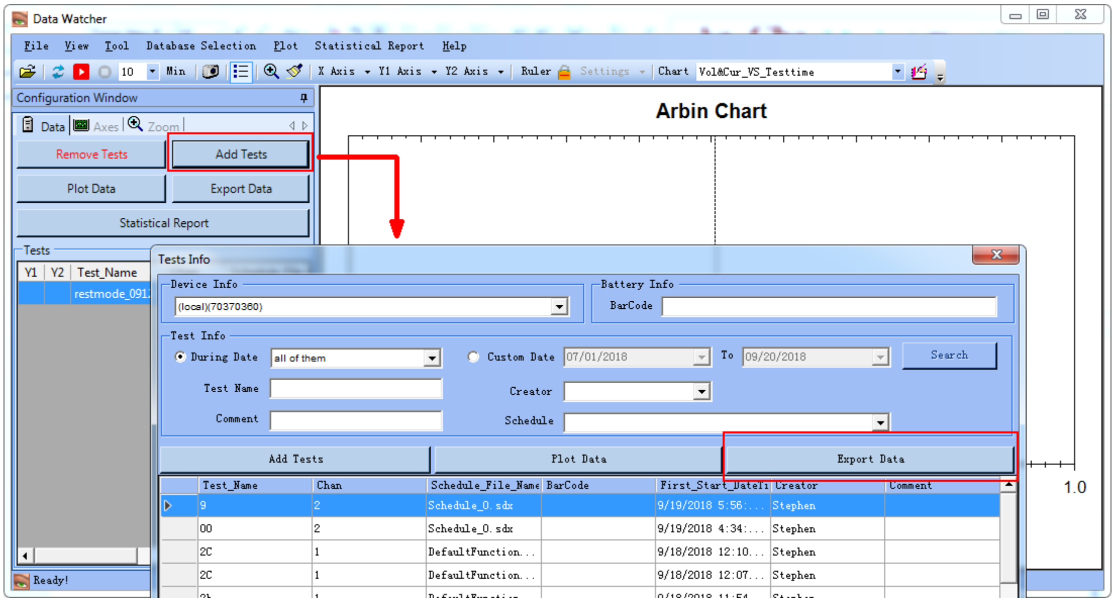


Fig 20 Export data in Data Watcher

- Then, Export Data window pops up. Check CAN Sheet box, and then click **Export to Files** (see Fig. 21)

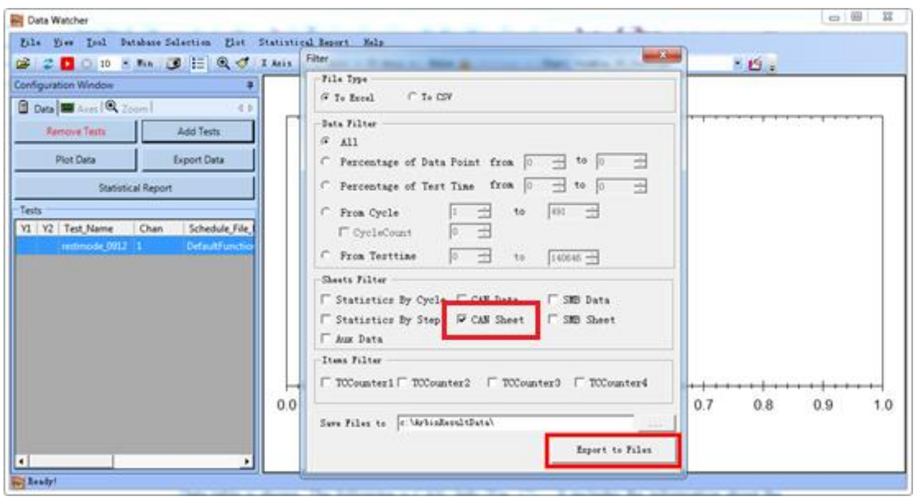
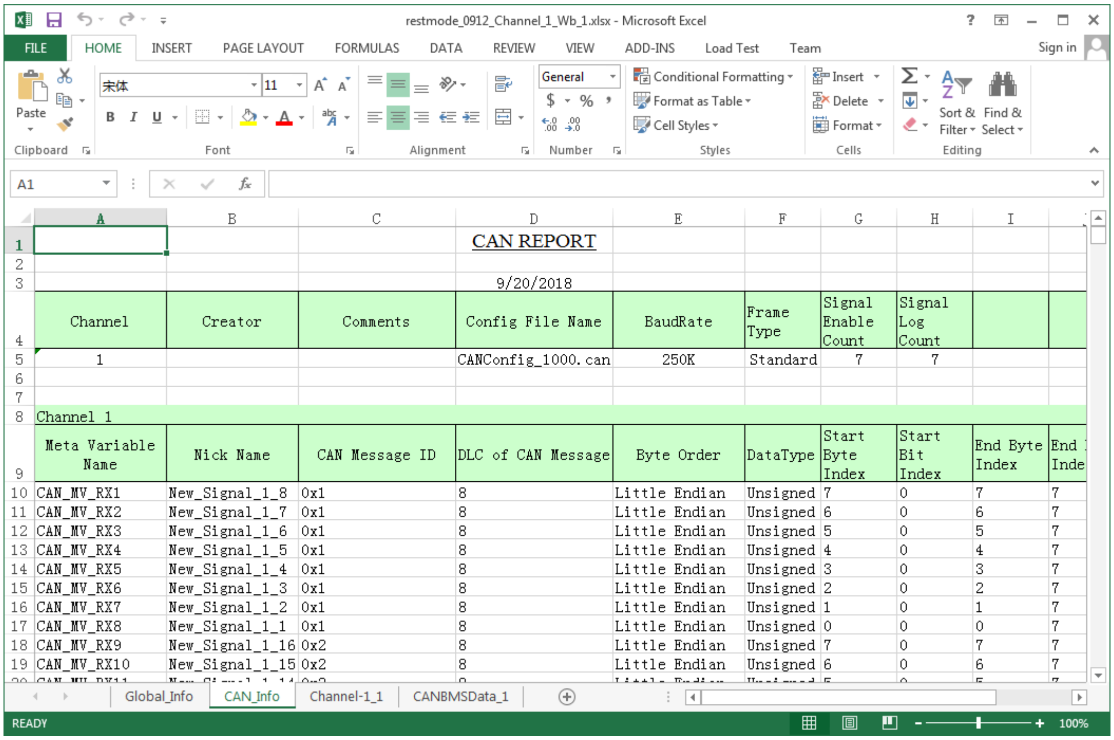


Fig 21 Export Data Window

- Then, CAN Info, and Can Data table are exported to Excel. Open the excel file, CAN Info, and Can Data table are shown. The following is CAN_Info (Fig. 22). It includes the information about the enabled CAN signals:



CAN REPORT

9/20/2018

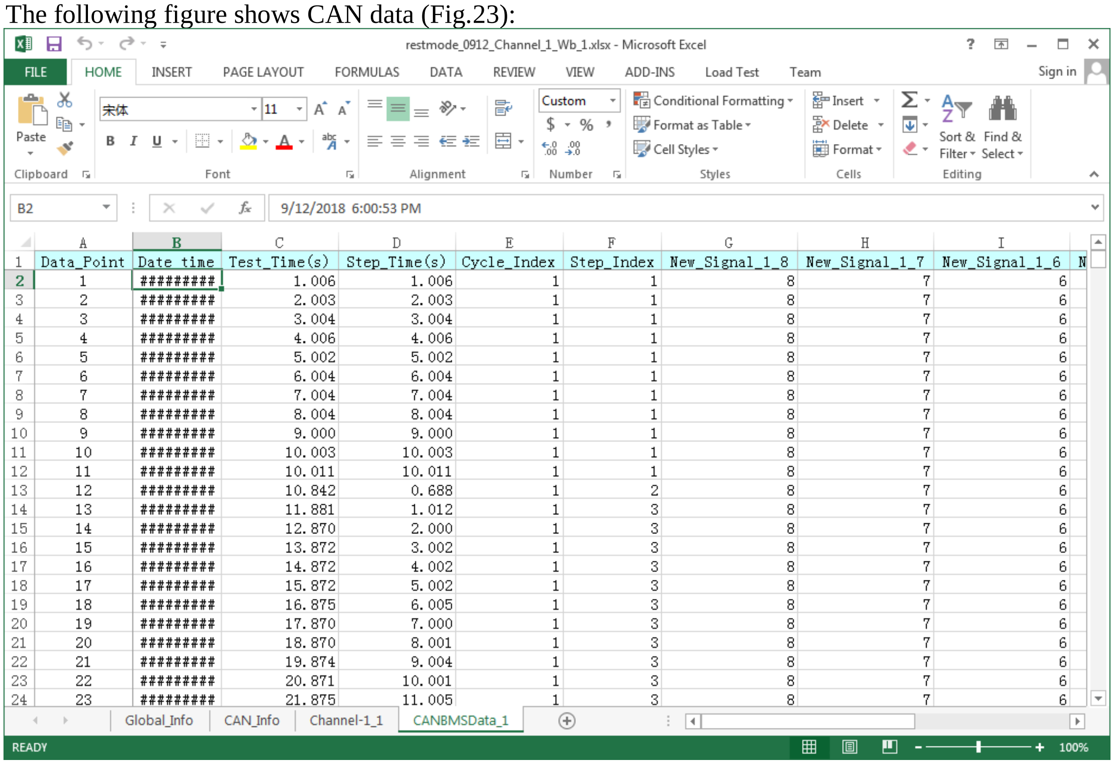
Channel	Creator	Comments	Config File Name	BaudRate	Frame Type	Signal Enable Count	Signal Log Count
1			CANConfig_1000.can	250K	Standard	7	7

Channel 1

Meta Variable Name	Nick Name	CAN Message ID	DLC of CAN Message	Byte Order	DataType	Start Byte Index	Start Bit Index	End Byte Index	End Inde
CAN_MV_RX1	New_Signal_1_8	0x1	8	Little Endian	Unsigned	7	0	7	7
CAN_MV_RX2	New_Signal_1_7	0x1	8	Little Endian	Unsigned	6	0	6	7
CAN_MV_RX3	New_Signal_1_6	0x1	8	Little Endian	Unsigned	5	0	5	7
CAN_MV_RX4	New_Signal_1_5	0x1	8	Little Endian	Unsigned	4	0	4	7
CAN_MV_RX5	New_Signal_1_4	0x1	8	Little Endian	Unsigned	3	0	3	7
CAN_MV_RX6	New_Signal_1_3	0x1	8	Little Endian	Unsigned	2	0	2	7
CAN_MV_RX7	New_Signal_1_2	0x1	8	Little Endian	Unsigned	1	0	1	7
CAN_MV_RX8	New_Signal_1_1	0x1	8	Little Endian	Unsigned	0	0	0	7
CAN_MV_RX9	New_Signal_1_16	0x2	8	Little Endian	Unsigned	7	0	7	7
CAN_MV_RX10	New_Signal_1_15	0x2	8	Little Endian	Unsigned	6	0	6	7

Fig 22 CAN Info Report

- The following figure shows CAN data (Fig.23):



Data_Point	Date time	Test_Time(s)	Step_Time(s)	Cycle_Index	Step_Index	New_Signal_1_8	New_Signal_1_7	New_Signal_1_6
1	#########	1.006	1.006	1	1	8	7	6
2	#########	2.003	2.003	1	1	8	7	6
3	#########	3.004	3.004	1	1	8	7	6
4	#########	4.006	4.006	1	1	8	7	6
5	#########	5.002	5.002	1	1	8	7	6
6	#########	6.004	6.004	1	1	8	7	6
7	#########	7.004	7.004	1	1	8	7	6
8	#########	8.004	8.004	1	1	8	7	6
9	#########	9.000	9.000	1	1	8	7	6
10	#########	10.003	10.003	1	1	8	7	6
11	#########	10.011	10.011	1	1	8	7	6
12	#########	10.842	0.688	1	2	8	7	6
13	#########	11.881	1.012	1	3	8	7	6
14	#########	12.870	2.000	1	3	8	7	6
15	#########	13.872	3.002	1	3	8	7	6
16	#########	14.872	4.002	1	3	8	7	6
17	#########	15.872	5.002	1	3	8	7	6
18	#########	16.875	6.005	1	3	8	7	6
19	#########	17.870	7.000	1	3	8	7	6
20	#########	18.870	8.001	1	3	8	7	6
21	#########	19.874	9.004	1	3	8	7	6
22	#########	20.871	10.001	1	3	8	7	6
23	#########	21.875	11.005	1	3	8	7	6

Fig 23 CAN Signal Data

Appendix H: Arbin Remote Database

Arbin Remote Database: The Arbin Battery Testing Systems can not only store the test data on the local computer, but also store the data of multiple test platforms in one database server, and even store it in a cloud database. This is a boon for most customers. Customers can better manage the data of each test platform, saving more time. When using a remote database, the customers should ensure that the local area network is in a relatively stable state.

SQLServer: Enable remote connection

1. Find SQL Server Management Studio in the desktop taskbar. (Fig1)

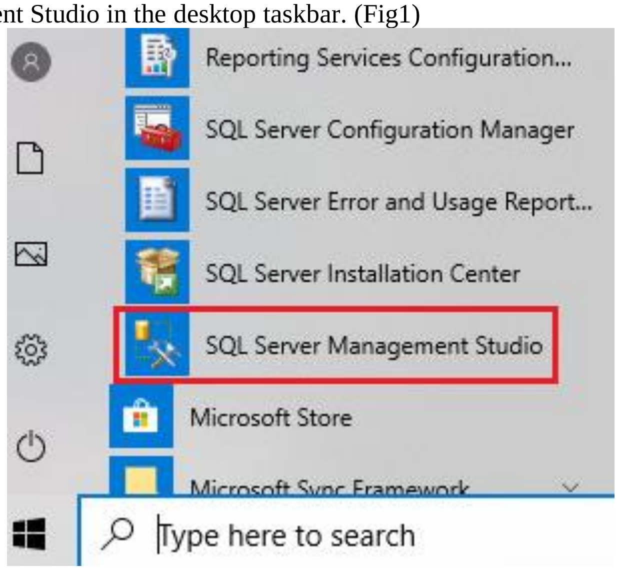


Fig1

2. Select hybrid login feature in the pop-up login dialog (See Fig2). Then click the "Connect" button.

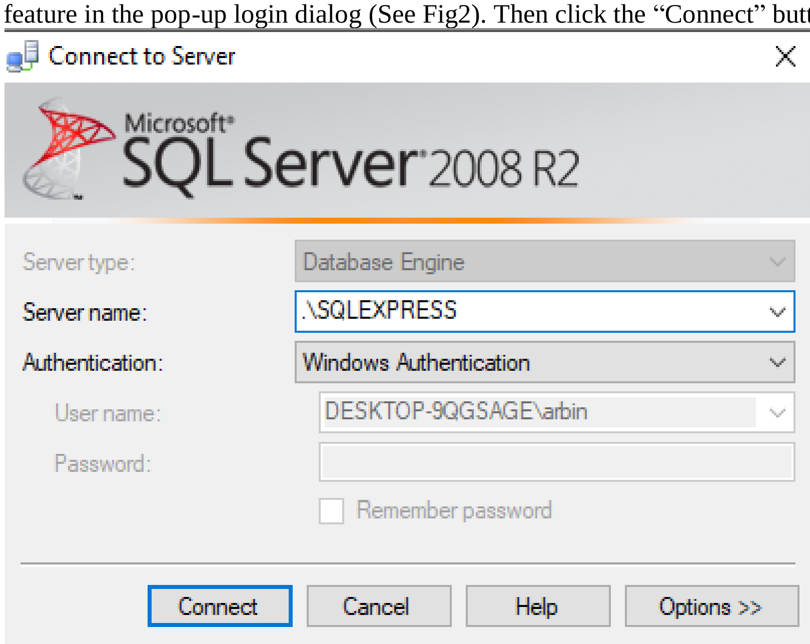


Fig 2

3. Right-click on the diagram and select "Properties".

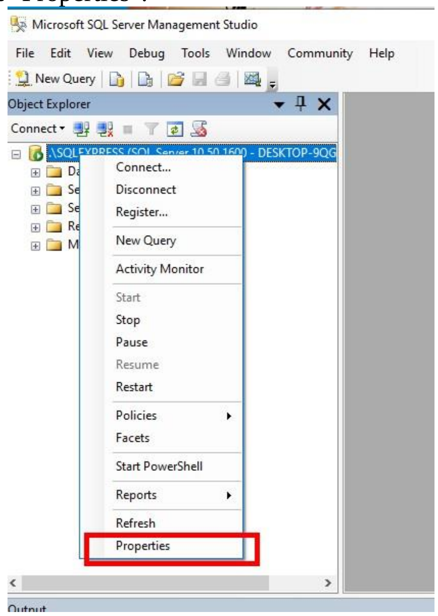


Fig 3

4. Select "SQL Server and Window Authentication mode" on Security page.

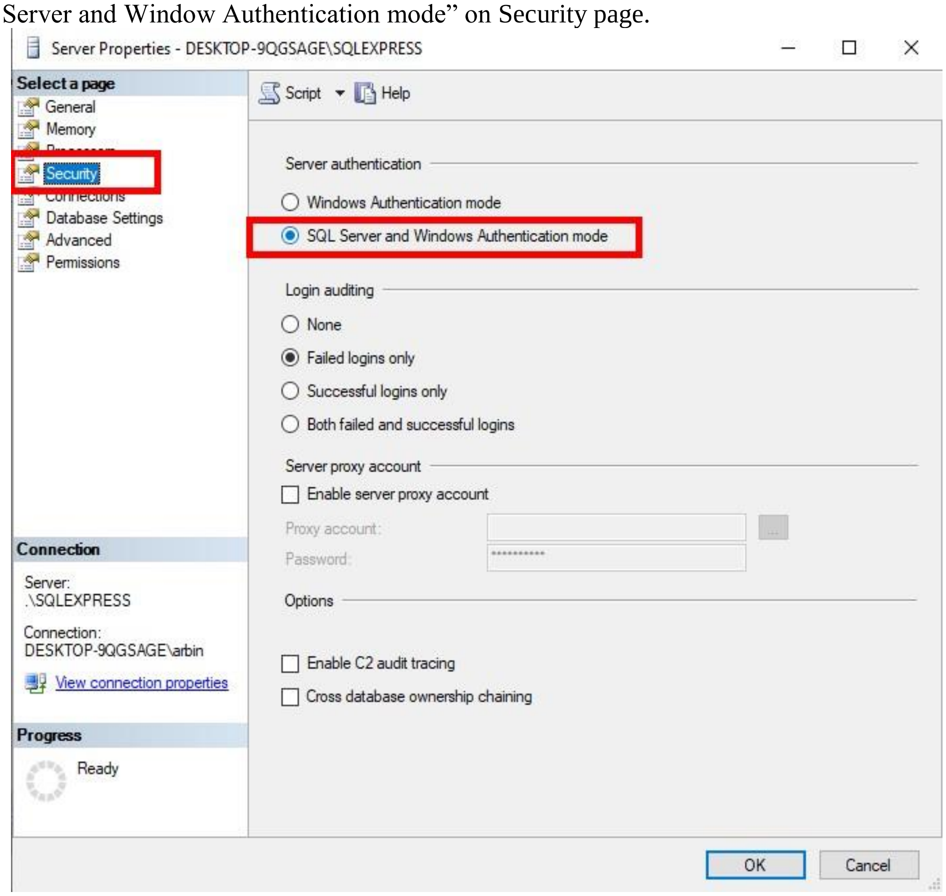


Fig 4

5. Setting allow remote connections
Right click on the diagram and select "facets".

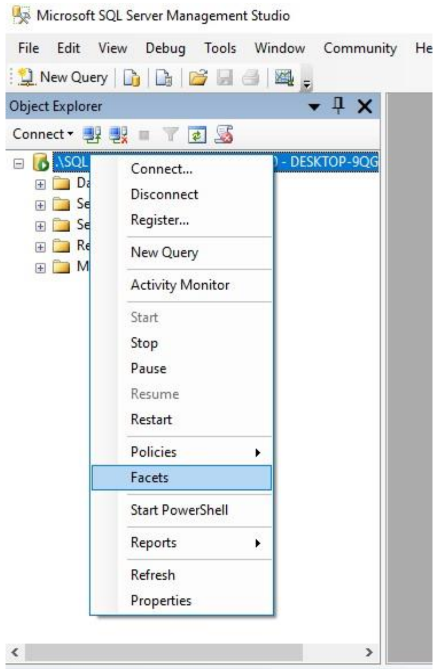


Fig 5

In View Facets page, choose the “Server Configuration” and set “Remote Access Enable” to be true. And then click “ok” to save it.

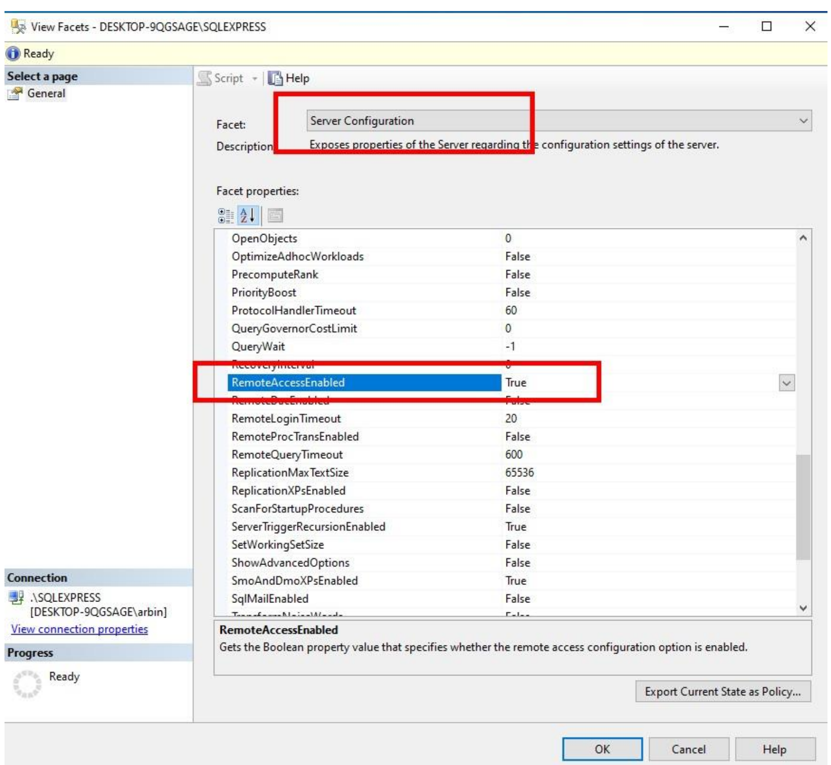


Fig 6

6. Enable sa account.
Right click “sa”, choose “properties”.

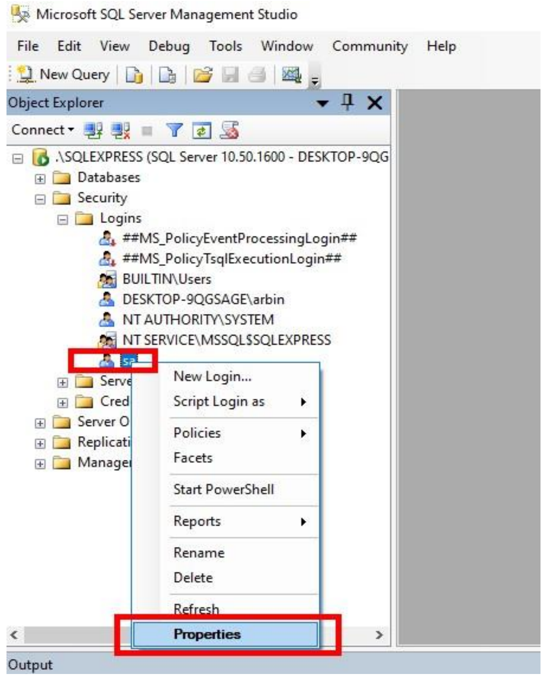


Fig 7

Open “status” set the function as shown below. And click “ok” to save it.

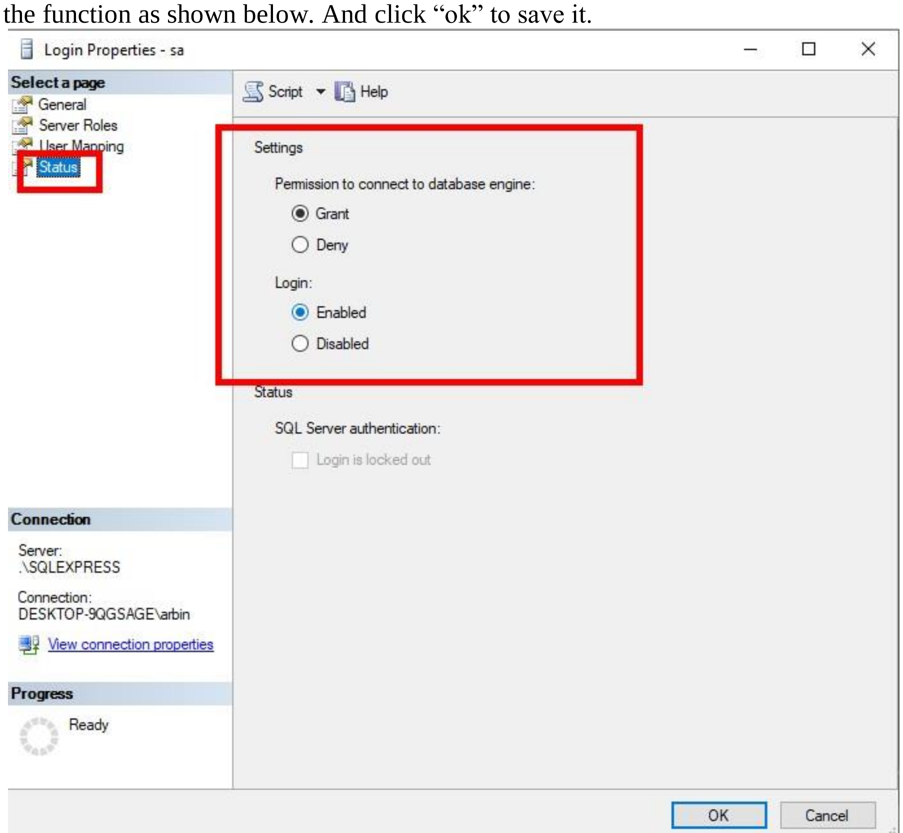


Fig 8

Open “General” page set the password for the “sa” account, the password “arbin”, and then click “ok” to save it.

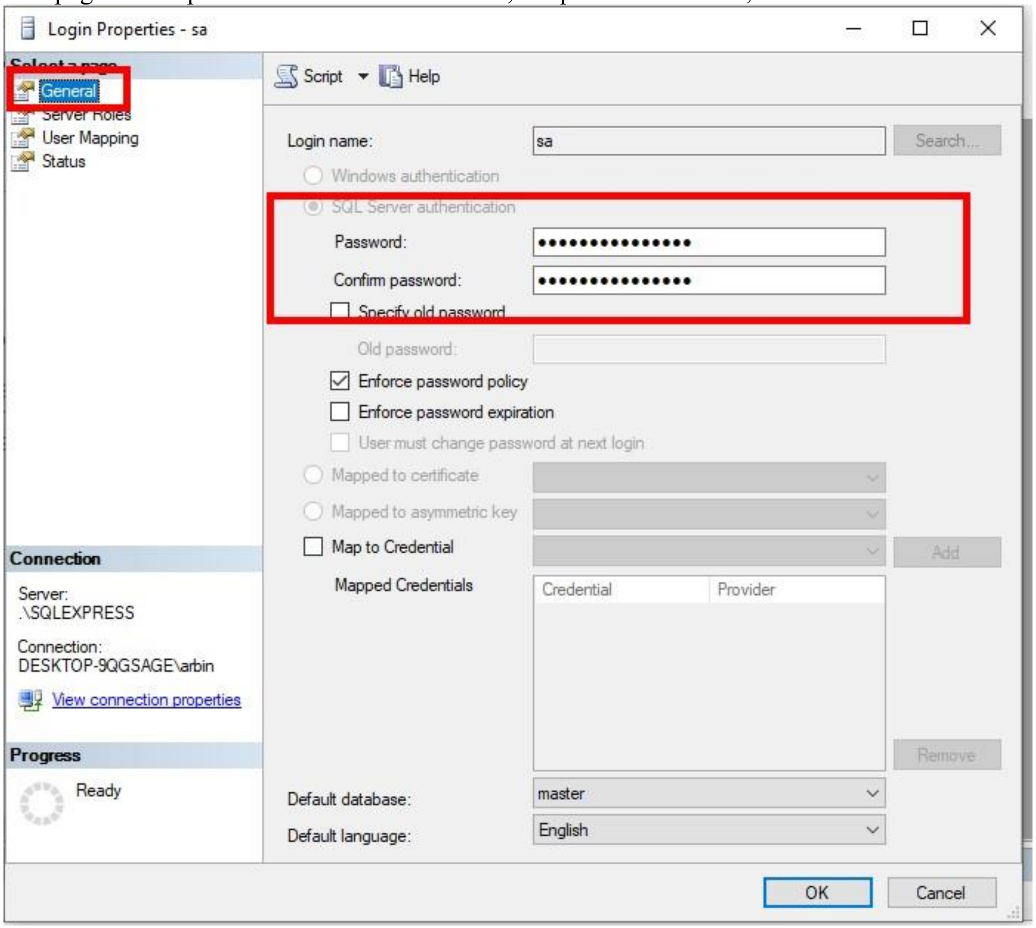


Fig 9

7. Open TCP/IP connection.

Open SQLServer Configuration manager in your computer.
If the start button is not found, please find the path at C:\Windows\SysWOW64 “SQLServerManager10.msc” or “SQLServerManager11.msc” or “SQLServerManager12.msc”and open it.

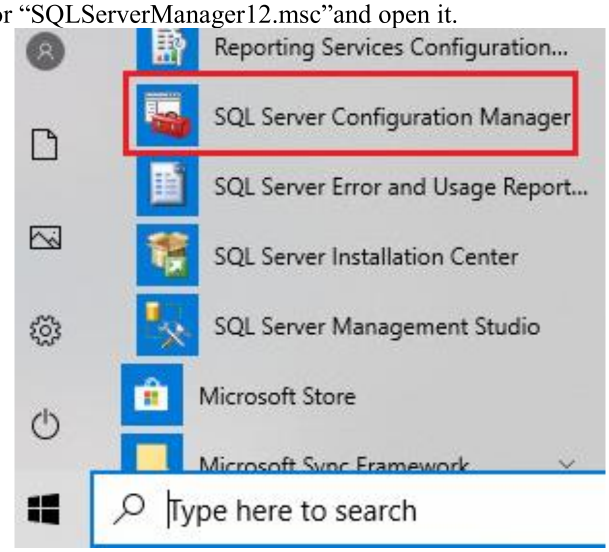


Fig 10

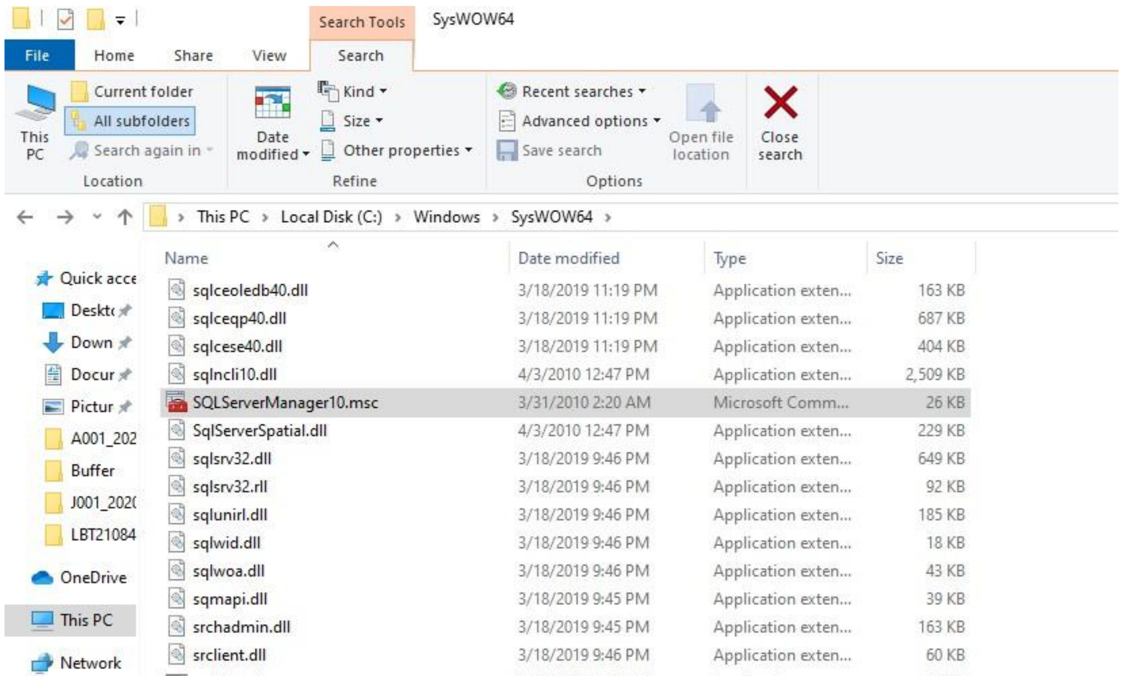


Fig 11

Set allow connection TCP/IP to be Enabled.

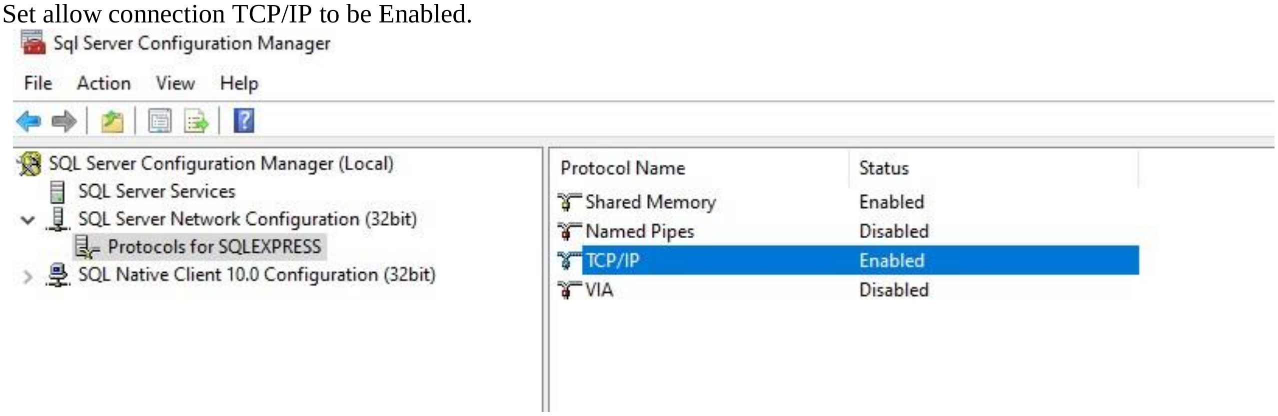


Fig 12

Double click TCP/IP to open the configuration. Find the LAN IP Settings, set “Active” and “Enabled” to be “yes”. TCP Dynamic Ports set as 1433.Click “ok” to save it.

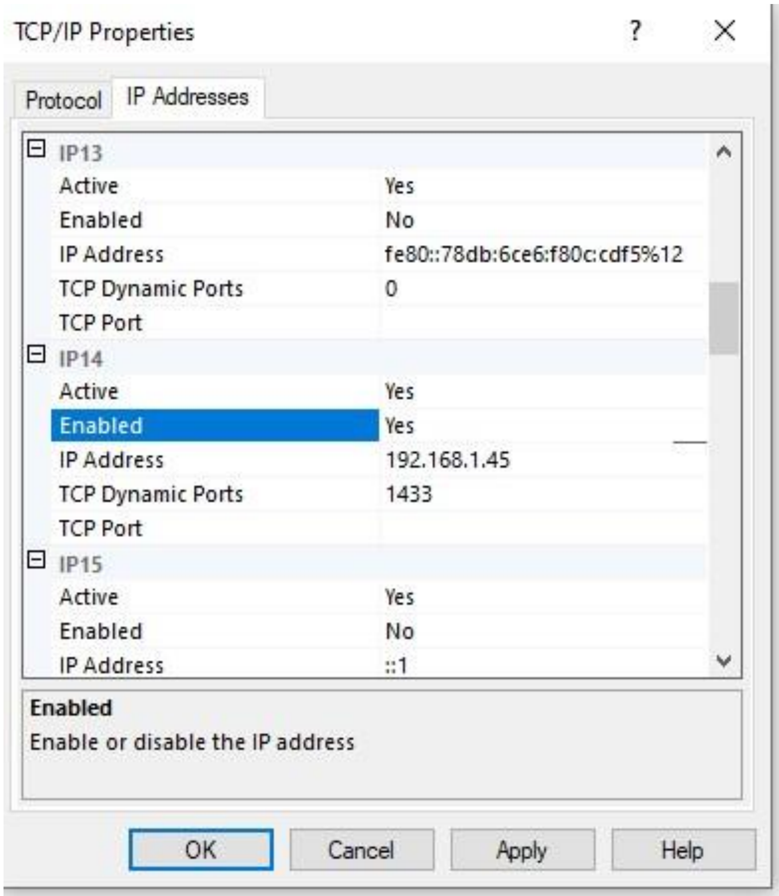


Fig 13

Note: When multiple SQL servers are installed locally and a TCP connection to port 1433 is opened, you need to close the original port connection before setting up a new port 1433 connection.

Finally, to restart SQLServer service.

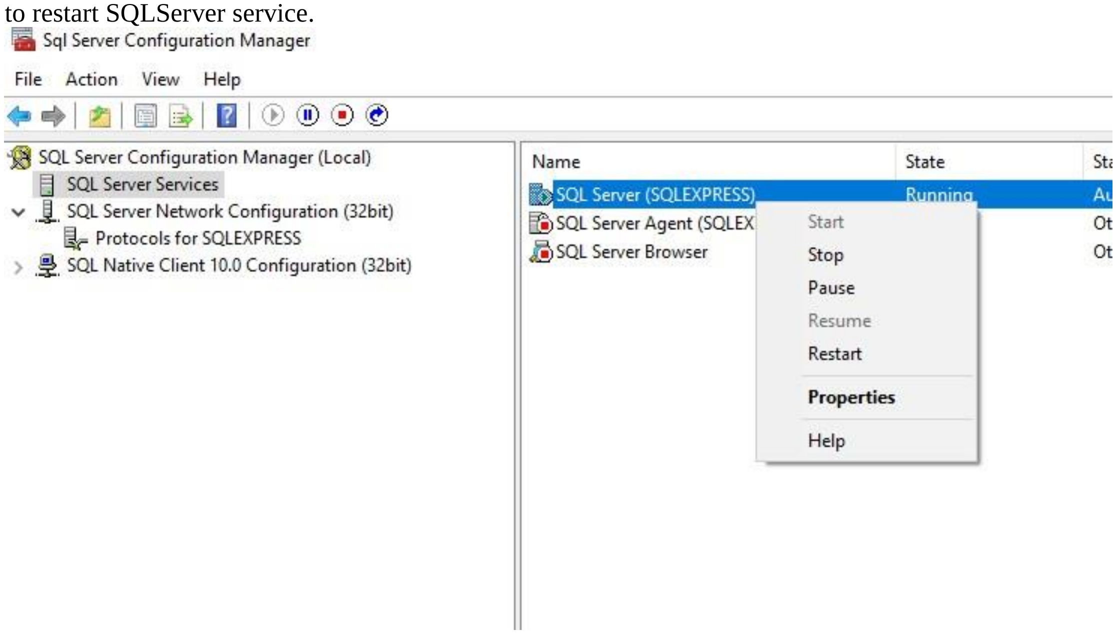


Fig 14

MitsPro8 Configuring the remote database

Open the "ArbinSys.DBCF" in system config directory.

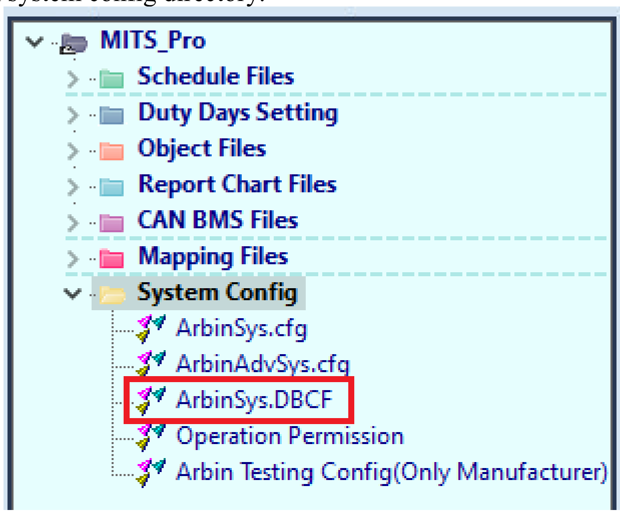


Fig 15

1. Choose "Remote and Local" in Connection Type.
2. The Cycle Name fill in sa.
3. Fill the remote computer IP in IP Address, port is 1433, Password is arbin.

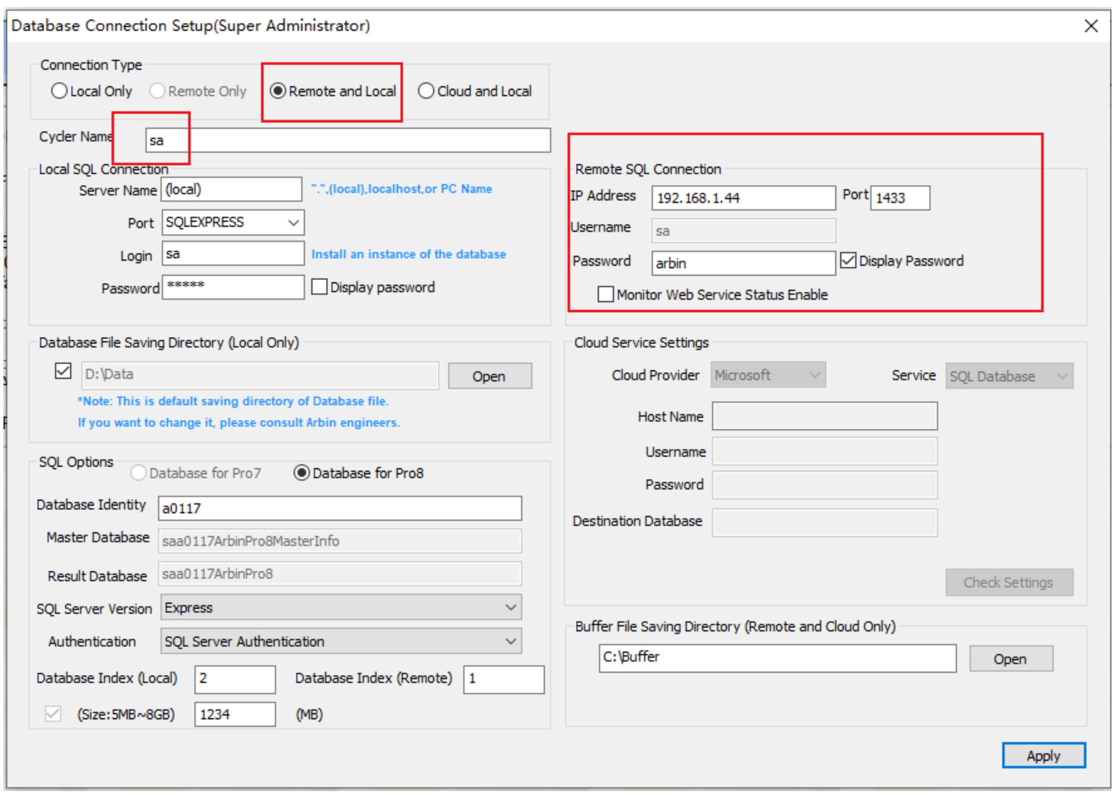


Fig 16

Click Apply to verified link.

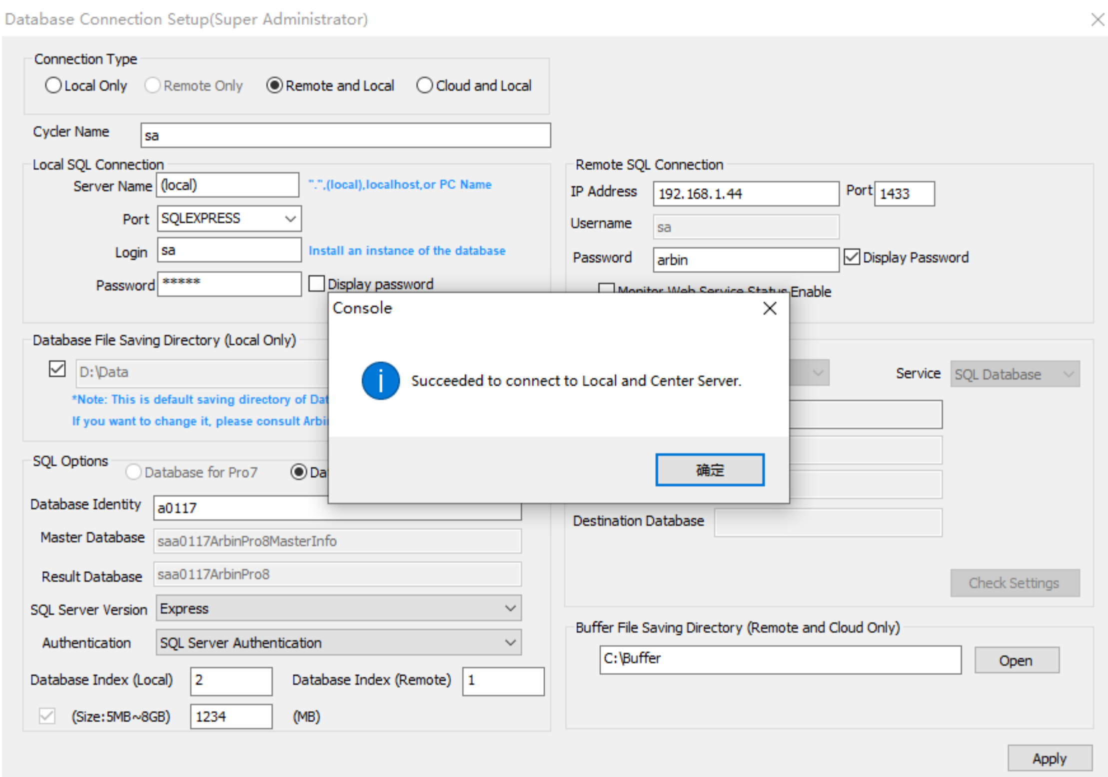


Fig 17

DataWatcher View the remote SQL database

Open “Server and Database Setting” in the data watcher.

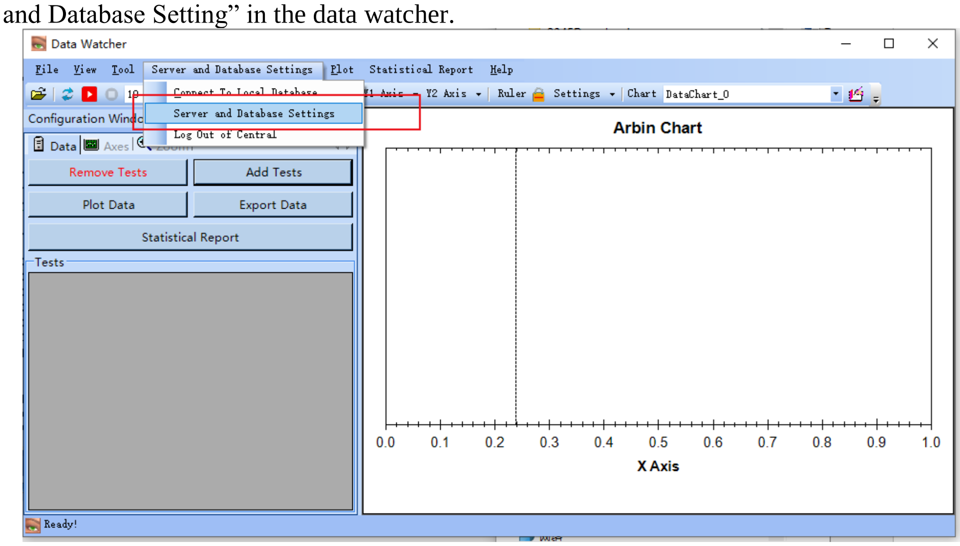


Fig 18

Click “Add New” to add a new server.

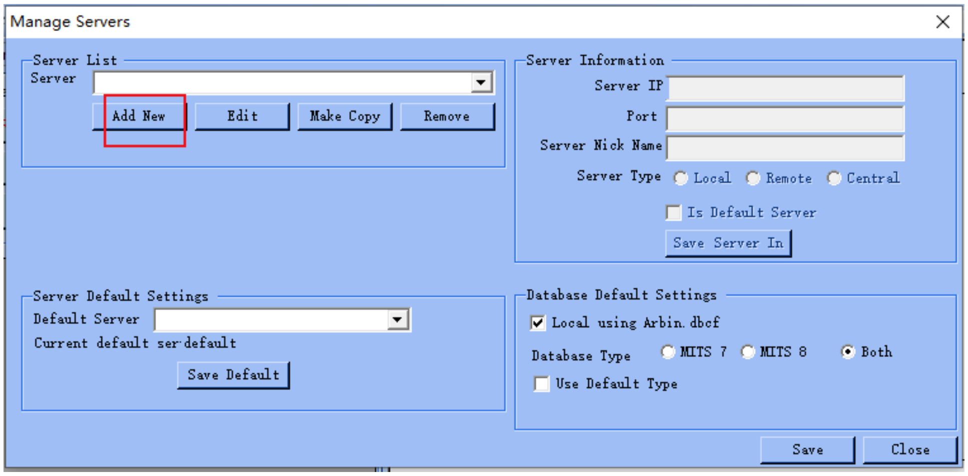


Fig 19

Fill in the LAN IP address of the Remote computer, port is1433, the Server Type select **Central** that need to input the login name and password of the Remote database, select **Remote** will use the default login name sa and password arbin to login.

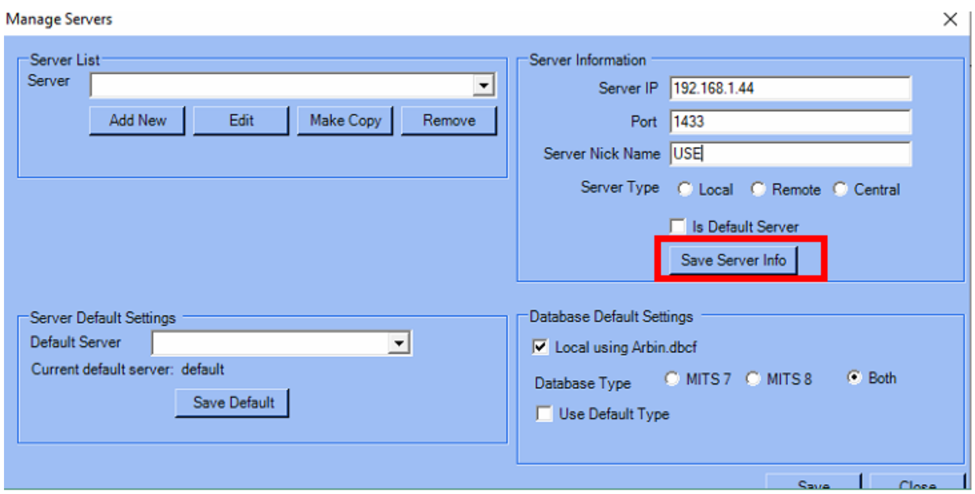


Fig 20

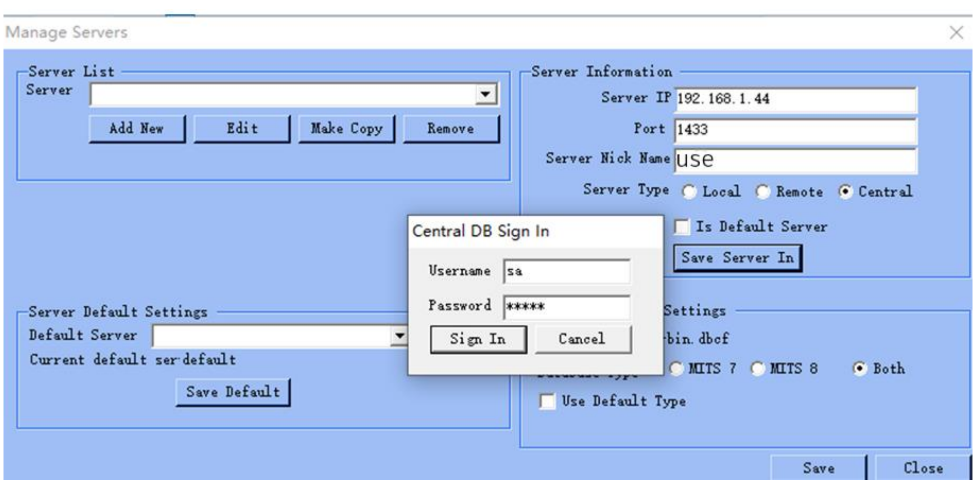


Fig 21

Enter the login name and password for the remote database, click Sign In.

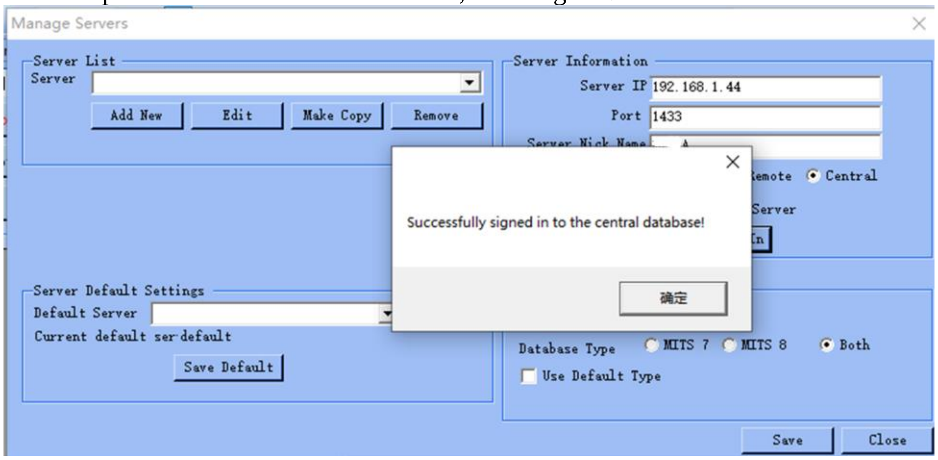


Fig 22

The connection will be prompted for success or failure.

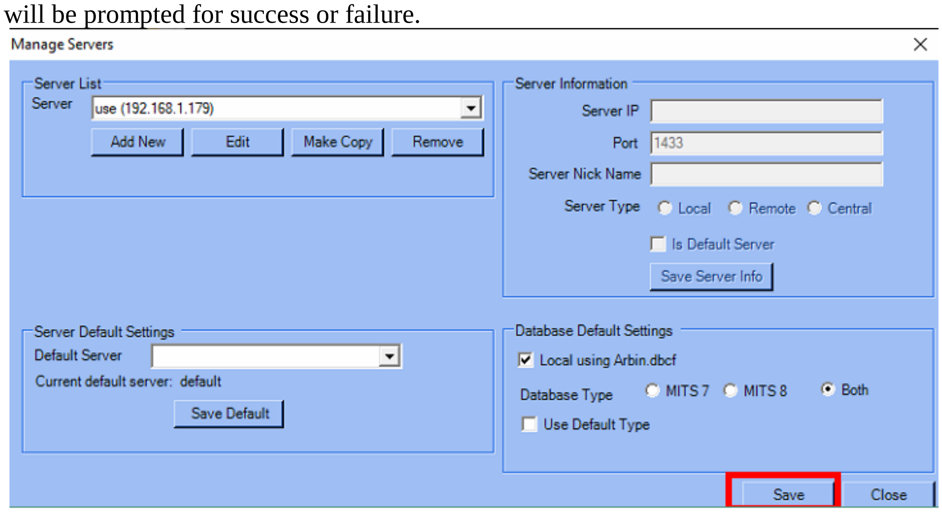


Fig 23

Click save button to exit after success.

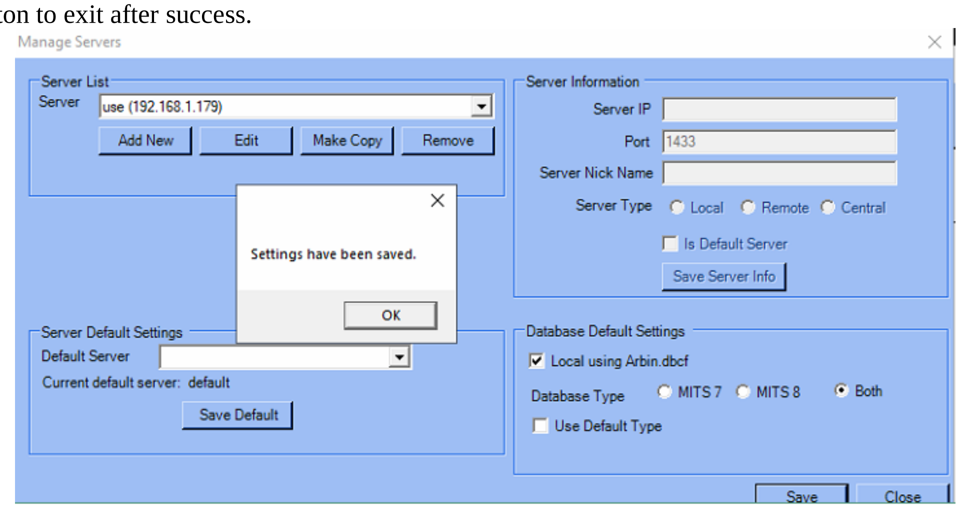


Fig 24

Click the “Add Test”.

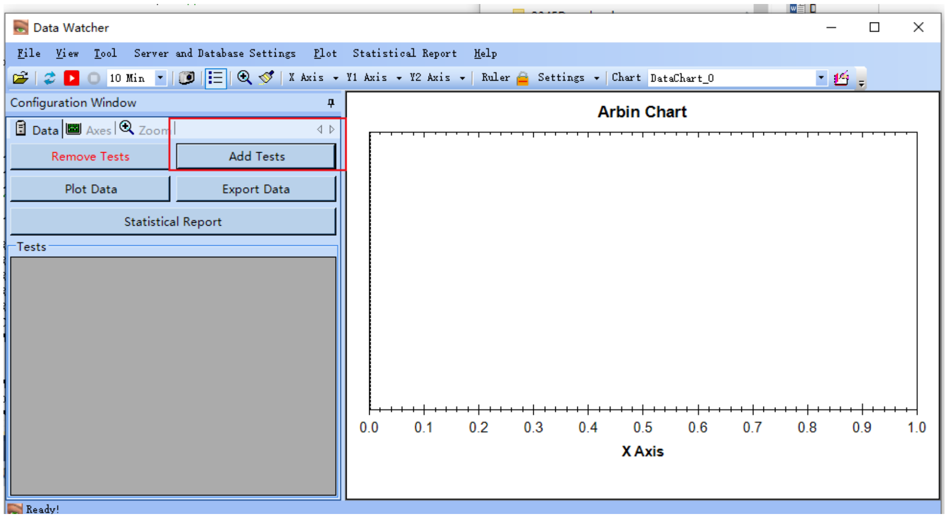


Fig 25

The Server drop-down list allows you to switch between databases with different IP addresses.

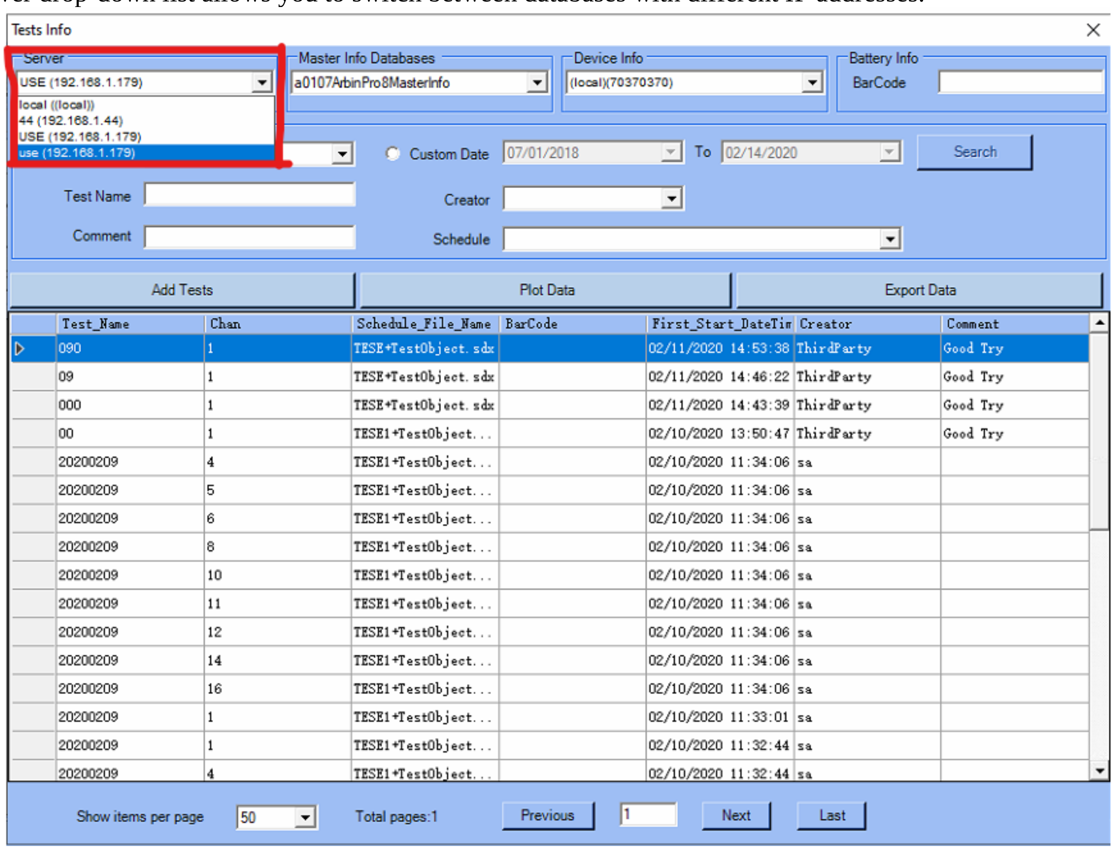


Fig 26

Master Info Database drop-down list allows user to switch between different databases.

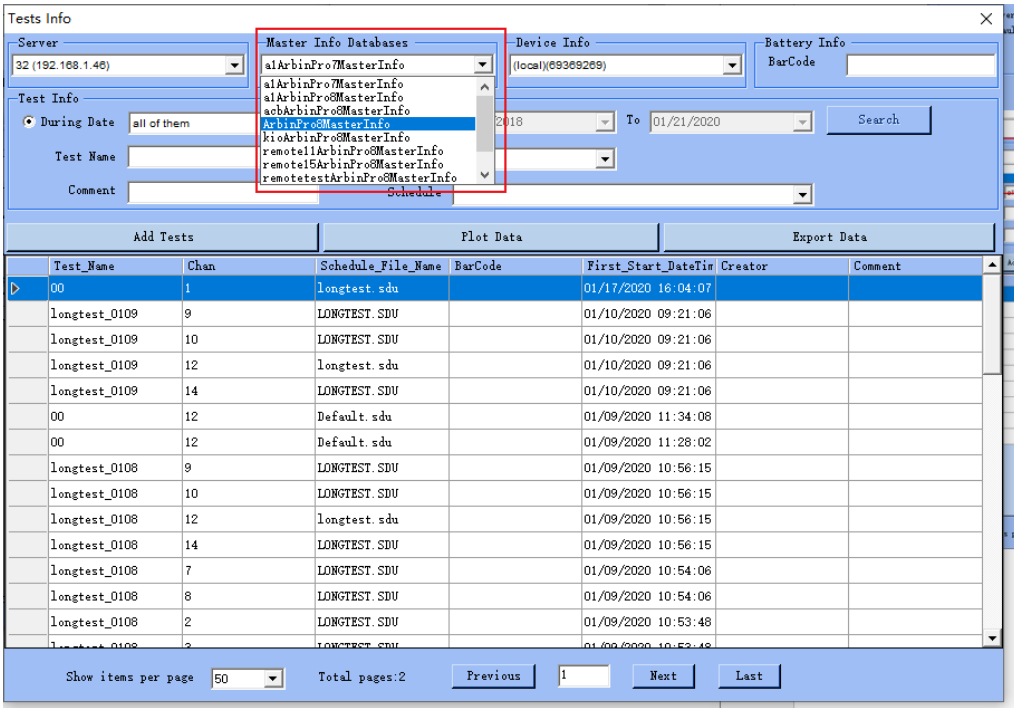


Fig 27

There may be more than one Device ID in the main database. You can switch to view it in the Device Info drop-down list to find your own experiment.

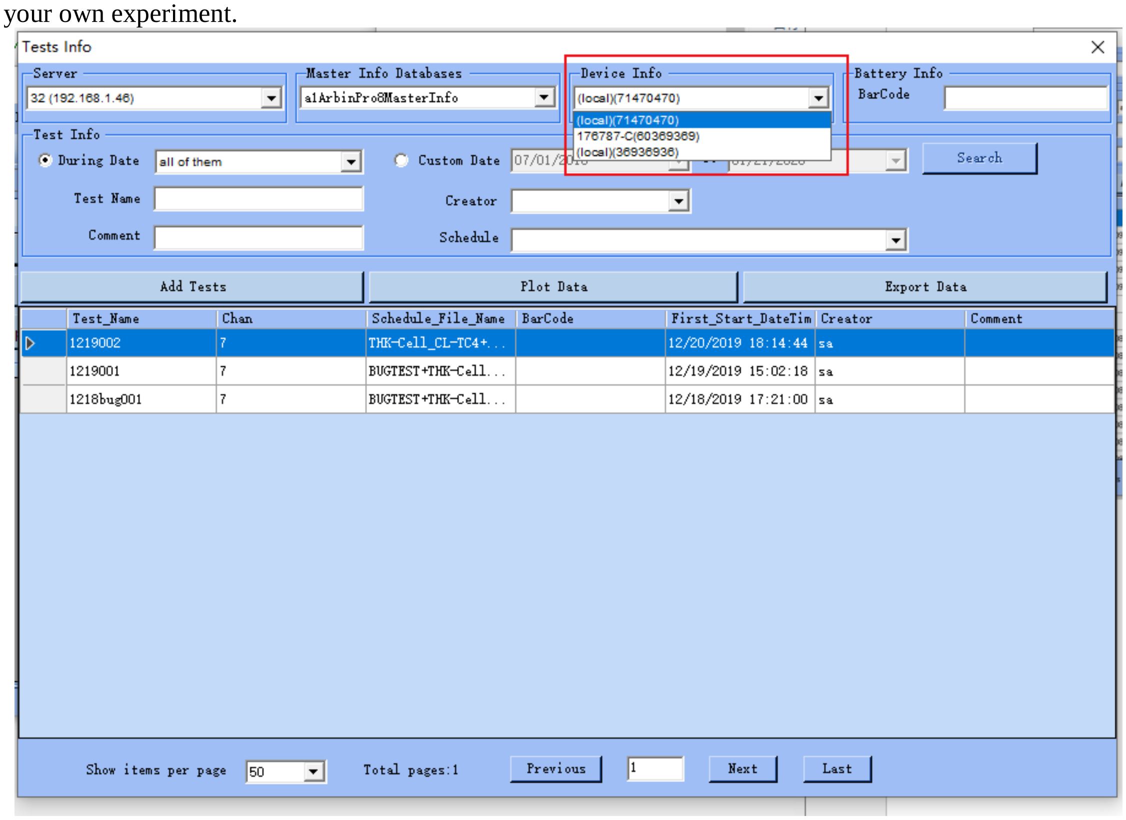


Fig 28

Appendix I: ACIM/EIS Testing

Arbin ACIM function supports Arbin ACIM board, Gamry and AutoLab device.

There are three different types of Gamry instruments sold by Arbin. The 1010E (replacing the 1000 series), the 5000E, and the 5000P:

1010E –
Capable of performing EIS from 10 µHz to 2 MHz
±12V Maximum Applied Potential
±1A Maximum Current: 9 current ranges

5000E/5000P

5000E –
Capable of performing EIS from 10 µHz to 1 MHz
±6V Maximum Applied Potential
±5A Maximum Current: 6 current ranges

5000P –
Capable of performing EIS from 10 µHz to 20 KHz
±6V Maximum Applied Potential
±5A Maximum Current: 6 current ranges

There is one main difference between the 5000E and the 5000P potentiostats, while both have a current AC amplitude maximum of 5A, the 5000E also has a voltage AC amplitude maximum of 3V (the 5000P does not).

Power and USB connections

First, connect the power cord to Power In port on the back of the Gamry. Next, connect the USB cable to the USB port on the back of the Gamry (Figure 1) and then connect the other end to a USB port on the PC that is running the Arbin, this is the communication connection.

Figure 1 – Gamry back with power and USB connected

Hardware Connection – 1010E Gamry

Figure 2 – Gamry 1010E with current connector

Plug the current connector into the front of the Gamry as seen in figure 2. Notice that their six colored plugs (green, red, blue, white, black, and orange) as seen in figure 3.

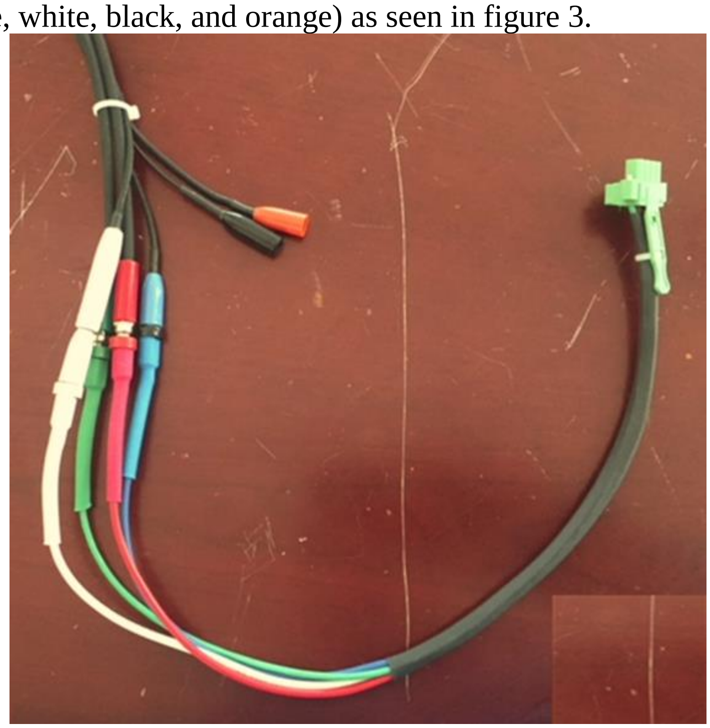


Figure 3 – Gamry connected to Arbin Gamry Cable

The Cable Pin out is as follows:
Green = Current Positive (I+)
Red = Current Negative (I-)
Blue = Voltage Positive (V+)
White = Voltage Negative (V-)
Next, connect the Arbin Gamry cable (4-pin ACIM cable) to the corresponding colored plugs as seen in Figure 3. Notice that the black and orange plugs are not used.

Hardware Connection – 5000E/5000P Gamry
On the front of the Gamry there is a current and a sense connector.

Figure 4 – Current connector plug

Figure 5 – Sense connector plug

Plug both the current and sense connectors into the front of the Gamry as seen in figure 6. Notice that the two cables are zip tied together with the current connector having two plugs (green and red), while the sense connector has four plugs (blue, white, black, and orange) as seen in figure 7.

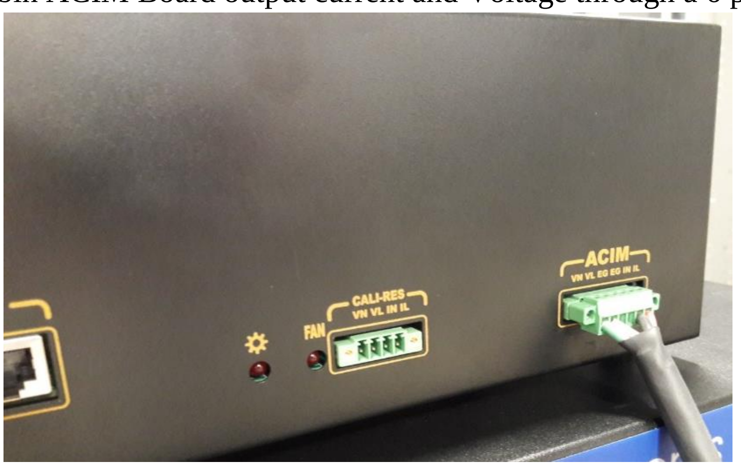
Figure 6 – Gamry connections

Figure 7 – Gamry connections with color plugs

Next, connect the Arbin Gamry cable (4-pin ACIM cable) to the corresponding colored plugs as seen in Figure 3. Notice that the black and orange plugs are not used.

Hardware Connection of Arbin ACIM Board:

Arbin ACIM Board output current and Voltage through a 6 pin to 5 pin ACIM cable:



Hardware Connection of Autolab Board:

AutoLab Board output current and Voltage through a 7 pin to 4 pin cables.

Connecting the Adaptor Cables to the Arbin

The front of the chassis (one ACIM port on each board):

Figure 9 – Connections on front of Arbin chassis

When connecting the Arbin ACIM/Gamry/autolab cable to the ACIM port, it will follow the V-, V+, I-, I+, pin out. For those ports with a fifth pin ("EG" – found on the front ports only), this pin is not used and will not affect the operation of the Gamry.

For chassis with multiple Gamry ports/connections, there is a system of cables that connect each board in a daisy chain fashion that allows them to run simultaneously, see Figure 10:

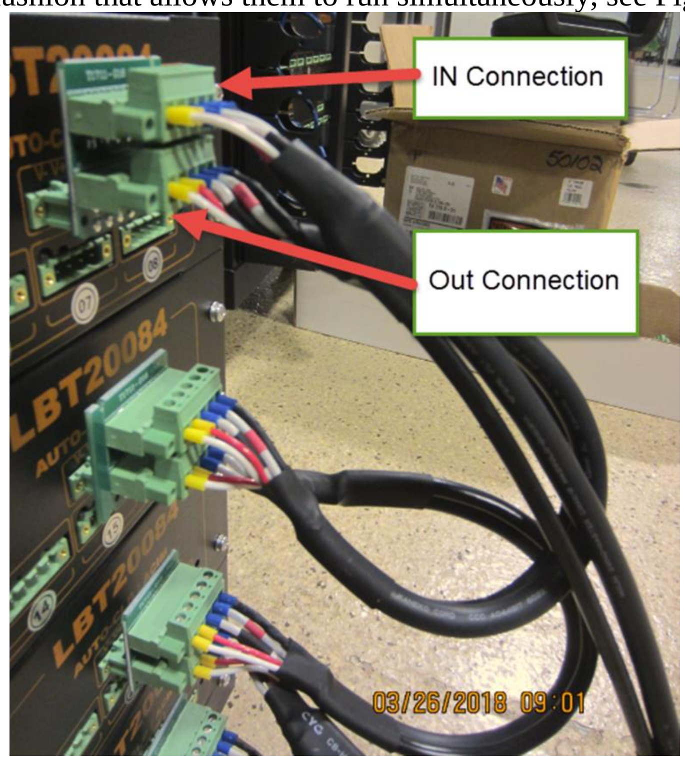


Figure 10: Multiple ACIM/Gamry connection plugs

Each small ACIM/Gamry board has two – five pin phoenix connectors, the top connector is for the IN connection and the bottom connector is for the out connection.

The end of the Arbin current connector cable has a 5-pin phoenix connector that plugs into the top/IN connector of the first board. Next, connect one of the smaller cables to the bottom/OUT connector that is on the first board and then connect the other end of that cable to the second boards IN connector. Repeat this step to set up the daisy chain effect mentioned earlier.

Software Setting

Gamry testing can be enabled/disabled in the Monitor and Control screen by clicking on the EIS icon in the tool bar

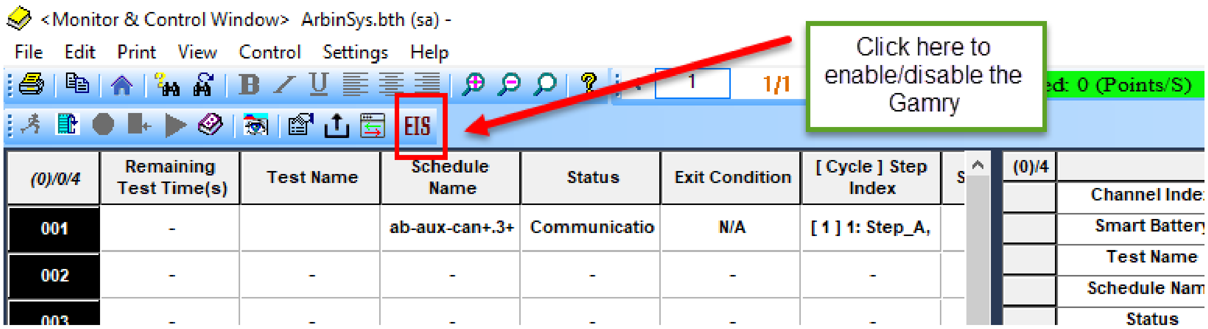


Figure 11 – Gamry disabled in the Monitor and Control Screen

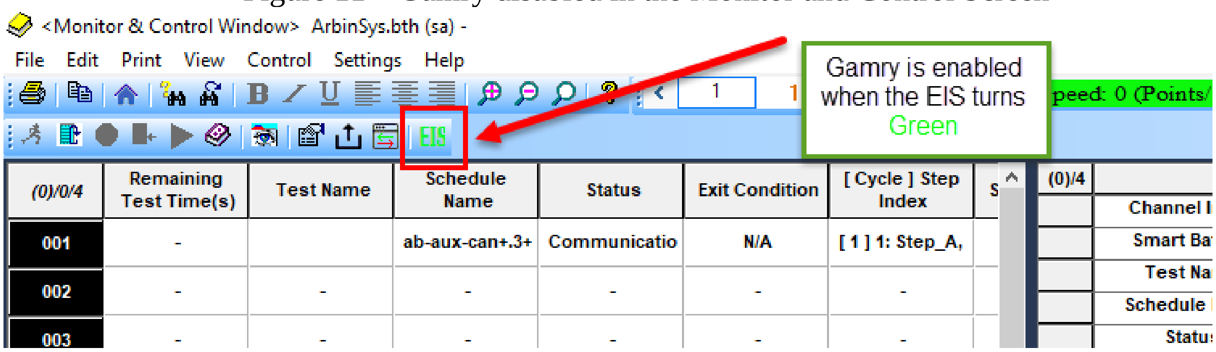


Figure 12 – Gamry enabled in the Monitor and Control Screen

Schedule Writing

First write a small rest step, 5 to 30 seconds long, and then insert the ACIM step into the schedule. Then, insert another small rest step, 5 to 30 seconds long after the ACIM step. Next, choose “Pause” in the Control Type drop box and “ACIM” in the Control Value drop box. The control parameters will appear automatically:

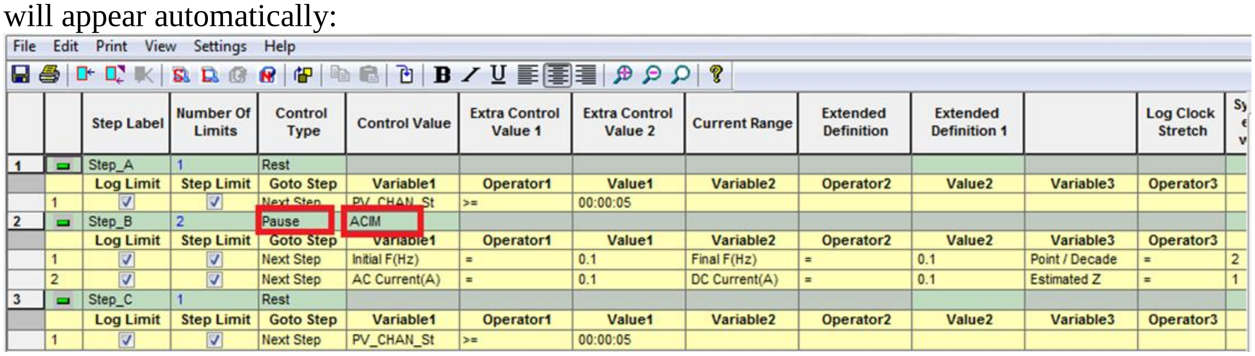


Figure 13 – ACIM step

Initial F(Hz): Initial frequency in ACIM test
Final F(Hz): Final frequency in ACIM test
Point/Decade: Number of testing points in each decade of frequency (2 – 20)

AC Current (A): AC RMS current
DC Current (A): DC current (-1A<DC + √2 X AC<1A)
Estimated Z: Estimation impedance, used as a start point of measurement (>0)
***To reduce the noise effect on an ACIM loop, Arbin recommends that you increase the AC current in the ACIM step. Also, the schedule limitation for ACIM tests is – (Iac*1.414+Idc < Gamry's max current)**

Results
In order to look at your ACIM data, you must open up the DataWatcher program and in EIS Plot box you can either plot the Gamry data or export it to Excel:
*Note, you cannot observe the Gamry while it is running in the DataWatcher program. The Gamry data can only be viewed in DataWatcher after the test has finished running.

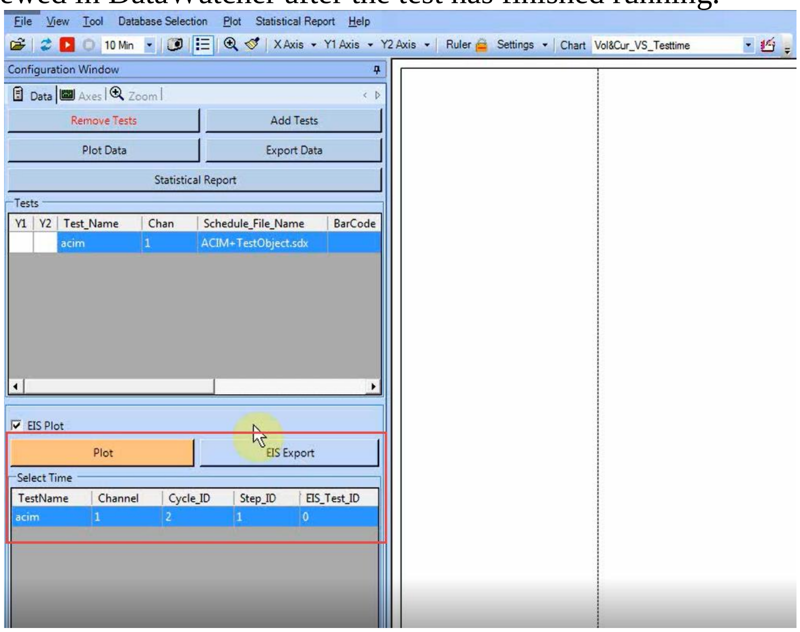


Figure 14 – DataWatcher Import screen

Once you click on the Export button, your ACIM data will appear in a CSV or text page:

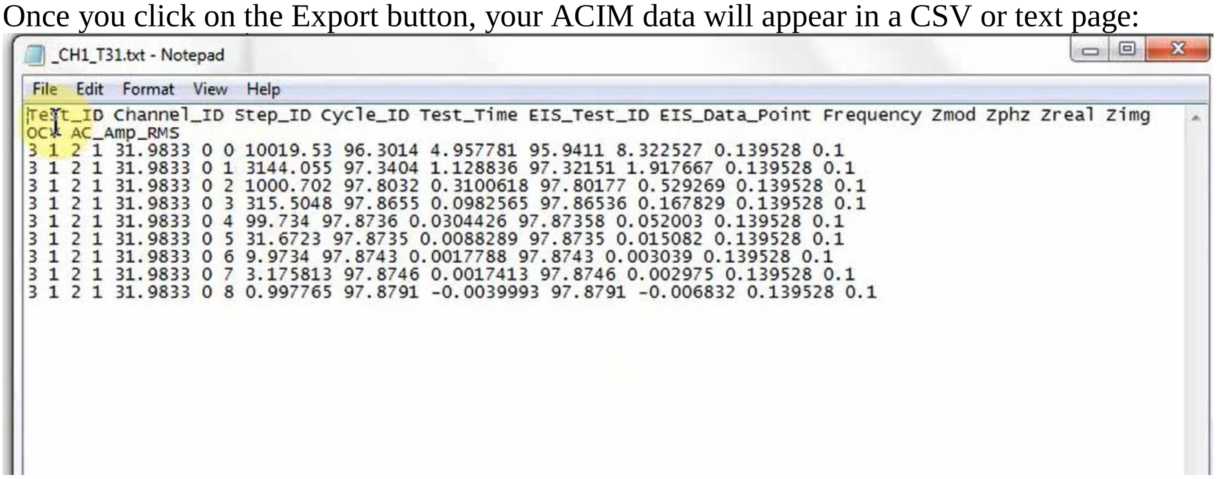


Figure 15 – ACIM Data in CSV format

Or you can click on the Export data button at the top and export your data into Excel:

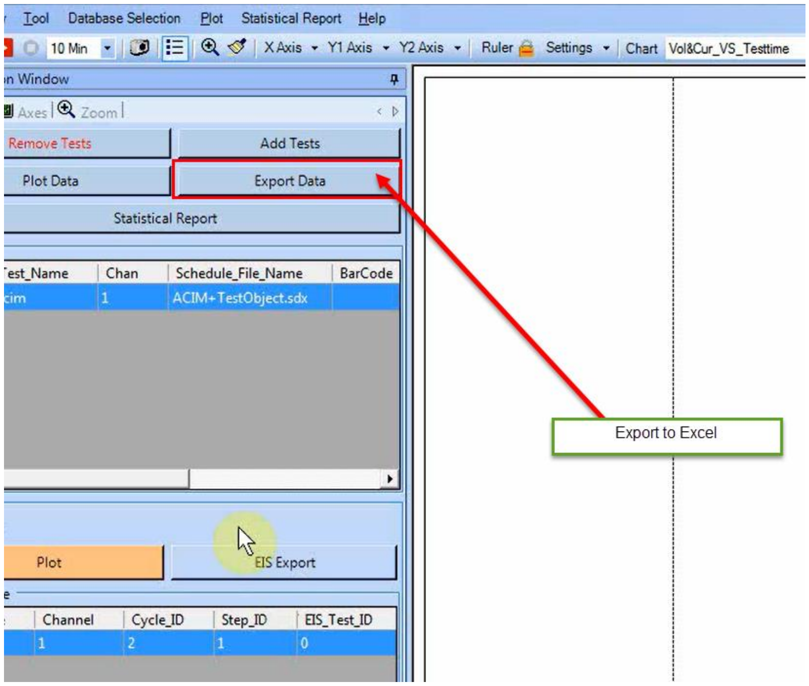


Figure 16 – ACIM data export to Excel

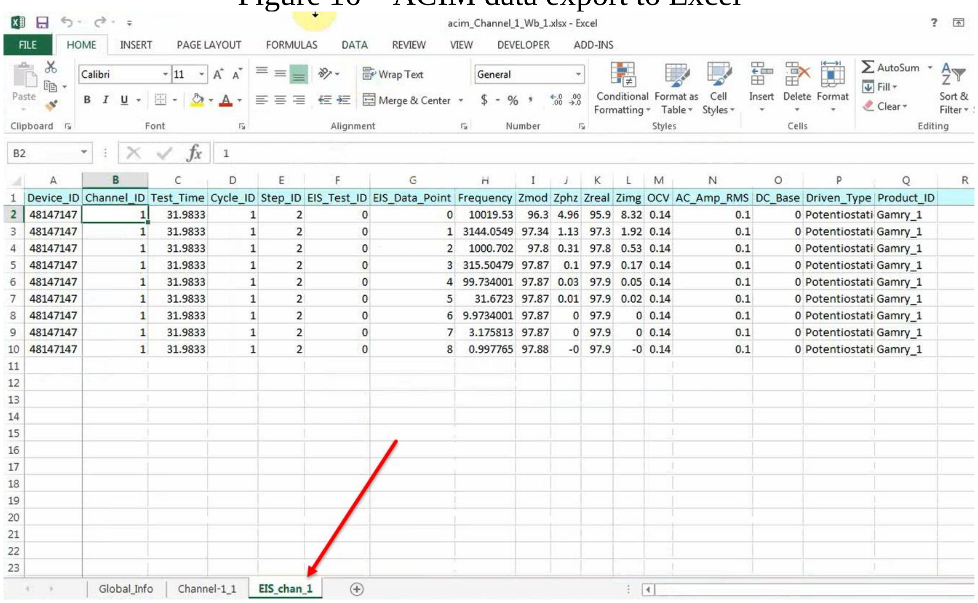


Figure 17 – ACIM Data in Excel on the EIS tab

Common Problems:

Overloads

During acquisition in the Framework software users will sometimes observe overloads (red or orange data points) indicating that the instrument is in an undesirable state. When an overload occurs one of 5 indicators will switch on, showing a red or orange box at the bottom of the experiment runner window with a message indicating which overload state has happened. At the same time the data points will turn red or orange for the overloaded points. Here is a basic explanation of the different types of overloads:

I OVLD Indicates a **current overload**. Sample area may be too big or the battery/supercap/fuel cell generates too much current for the potentiostat hardware.

V OVLD Indicates a **voltage overload**. The battery/supercap/fuel cell voltage is too high to measure, or the electrometer is disconnected and has drifted to the rails. Double-check that the white and blue leads are connected properly.

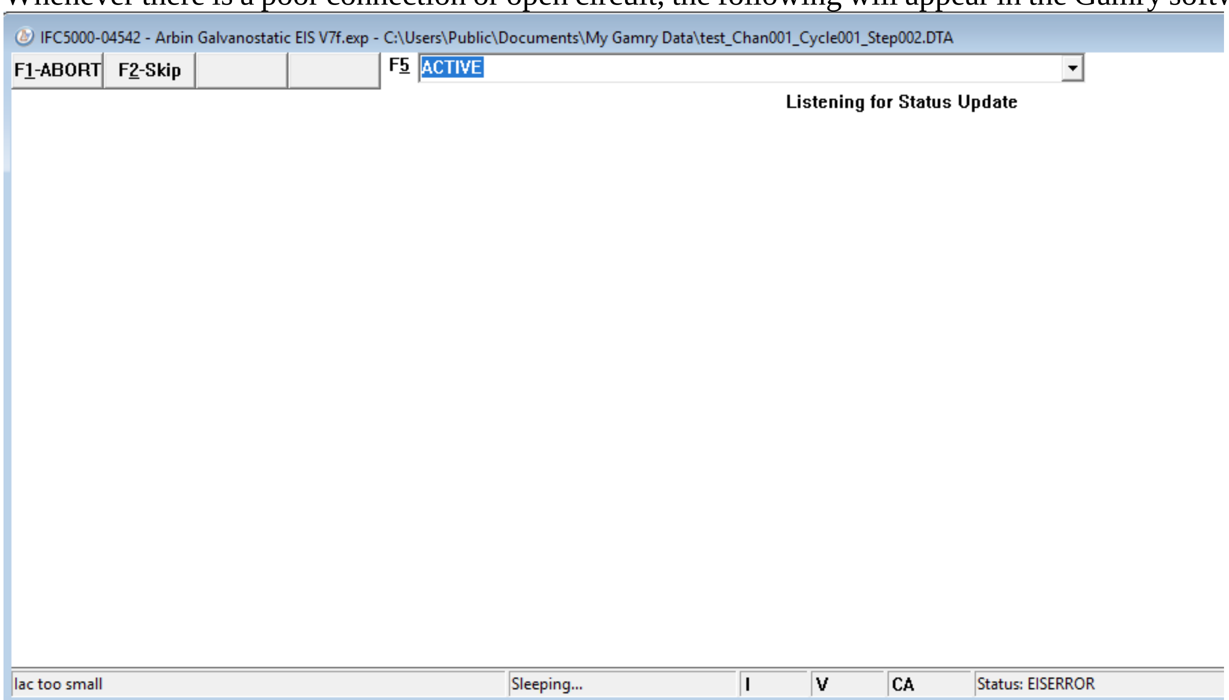
CA OVLD Indicates a **control amplifier overload**. The potentiostat cannot supply enough current between working and counter leads to reach the desired potential at the working electrode. The blue or white lead could be disconnected, or the cell's uncompensated resistance is so high that the instrument reaches its compliance voltage.

I ADC Indicates that the **current channel A/D converter is railed**. Incorrect instrument settings were used during an EIS scan. The state of the cell may be changing too much during the AC measurement to get a valid reading.

V ADC Indicates that the **voltage channel A/D converter is railed**. Incorrect instrument settings were used during an EIS scan. The state of the cell may be changing too much during the AC measurements to get a valid reading.

Poor Connection/Open Circuit

Whenever there is a poor connection or open circuit, the following will appear in the Gamry software:



To fix this problem, check the connect of the device under test (DUT) and restart then restart the test.

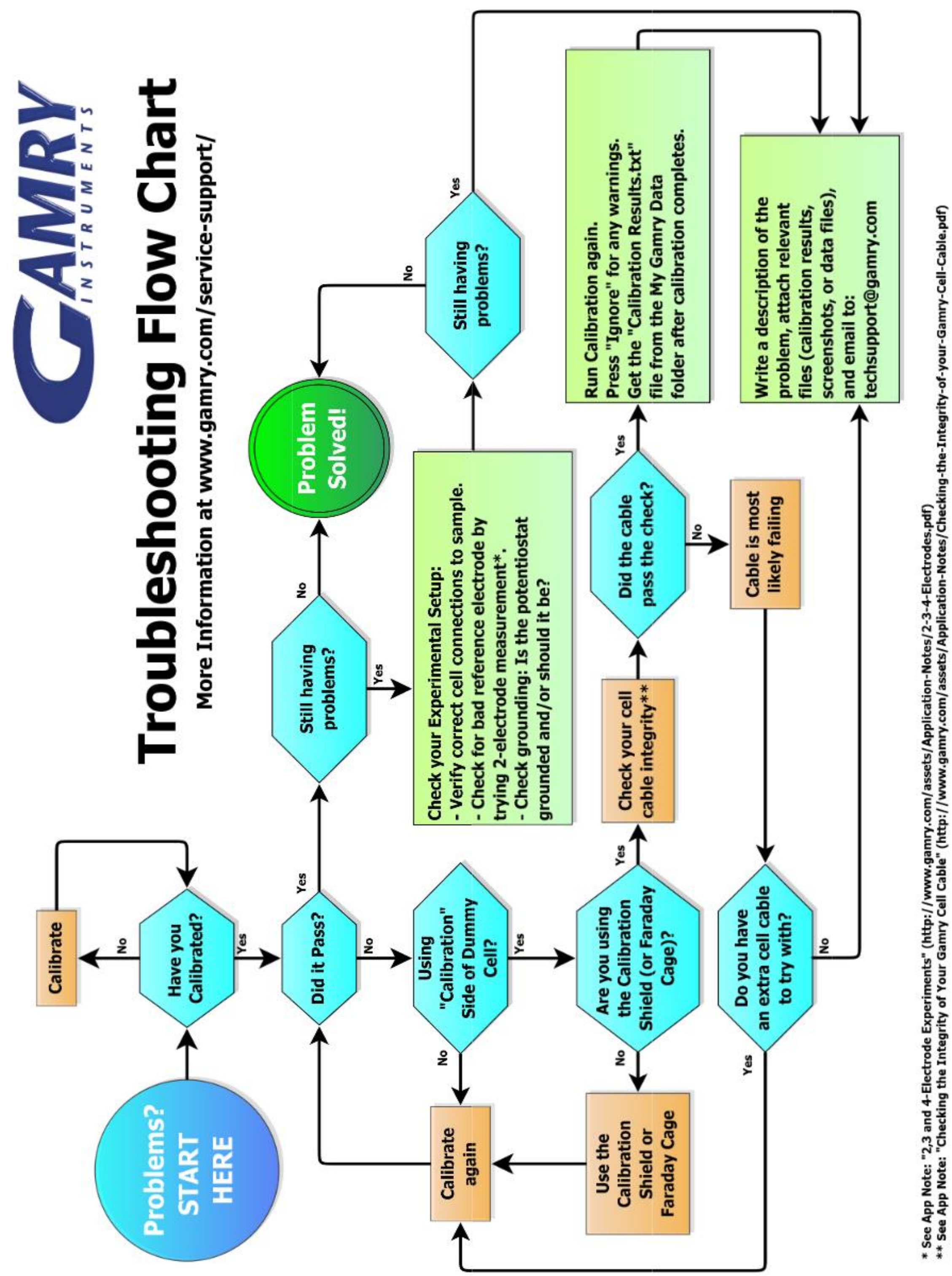
Framework:

- **Not authorized on this potentiostat**: the potentiostat is missing one or more Authorization Codes necessary to unlock the experiment
- **VRUPDN.New: Signal Invalid**: in the context of a CV experiment this means that the scan limits are in the wrong order. Initial cannot be equal to Scan Limit 1, Scan Limit 1 cannot be equal to Scan Limit 2, but Scan Limit 2 can be equal to Final.
- **Firmware mismatch**: the potentiostat has a firmware version that is not compatible with the installed Framework version. Either update to the latest version of the software and install firmware or contact us.
- **Mux: Not Open**: the software cannot establish communication with the ECM8 Multiplexer. This is generally caused by an incorrect COM port being utilized. Contact Gamry for assistance.
- **Mux: Error on COM65535:** the software cannot establish communication with the ECM8 Multiplexer. This is caused by incorrect settings for the COM port. Contact Gamry for assistance.
- **Vac too small**: the measured AC signal is too small, and, most likely culprit is an open connection between the sample or a faulty cell cable.
- **Pstat device list empty**: no instruments have been detected by the Framework software, and thus the experiment setup window cannot load.
- **Reply_timeout**: there has been a loss of communication between the host computer and the USB potentiostat. This can be caused by a bad USB cable or electrostatic shock in very dry conditions. Turn off the instrument and disconnect the USB cable for 10 seconds to establish communication again.

Echem Analyst:

- **No CURVE found in data file**: the data file is missing the section where data points are stored but has all other setup information. This can happen if the experiment ends unexpectedly or is aborted prematurely.
- **Unable to open specified Analysis Script**: before version 5.63 it was possible to install only some of the analysis scripts. You will receive this error if you try to view data files for which the analysis script is not installed. All versions: you can receive this error if viewing a data file that requires custom analysis scripts, but the scripts have not been properly assigned in the custom analysis script database file.
- **Not a valid Gamry Data file**: the data file is not in the Gamry format or is corrupted.

Troubleshooting:


GAMRY INSTRUMENTS
Troubleshooting Flow Chart
More Information at www.gamry.com/service-support/
Problems? START HERE
Have you Calibrated?
No
Calibrate
Yes
Did it Pass?
Yes
Still having problems?
No
Problem Solved!
Yes
Check your Experimental Setup:
- Verify correct cell connections to sample.
- Check for bad reference electrode by trying 2-electrode measurement*.
- Check grounding: Is the potentiostat grounded and/or should it be?
Still having problems?
No
Yes
No
Using "Calibration" Side of Dummy Cell?
No
Calibrate again
Yes
Are you using the Calibration Shield (or Faraday Cage)?
No
Use the Calibration Shield or Faraday Cage
Yes
Check your cell cable integrity**
Did the cable pass the check?
No
Cable is most likely failing
Yes
Run Calibration again.
Press "Ignore" for any warnings.
Get the "Calibration Results.txt" file from the My Gamry Data folder after calibration completes.
Do you have an extra cell cable to try with?
Yes
No
Write a description of the problem, attach relevant files (calibration results, screenshots, or data files), and email to: techsupport@gamry.com
* See App Note: "2,3 and 4-Electrode Experiments" (http://www.gamry.com/assets/Application-Notes/2-3-4-Electrodes.pdf)
** See App Note: "Checking the Integrity of Your Gamry Cell Cable" (http://www.gamry.com/assets/Application-Notes/Checking-the-Integrity-of-your-Gamry-Cell-Cable.pdf)

Appendix J: UPS Feature

1. Connecting the UPS:

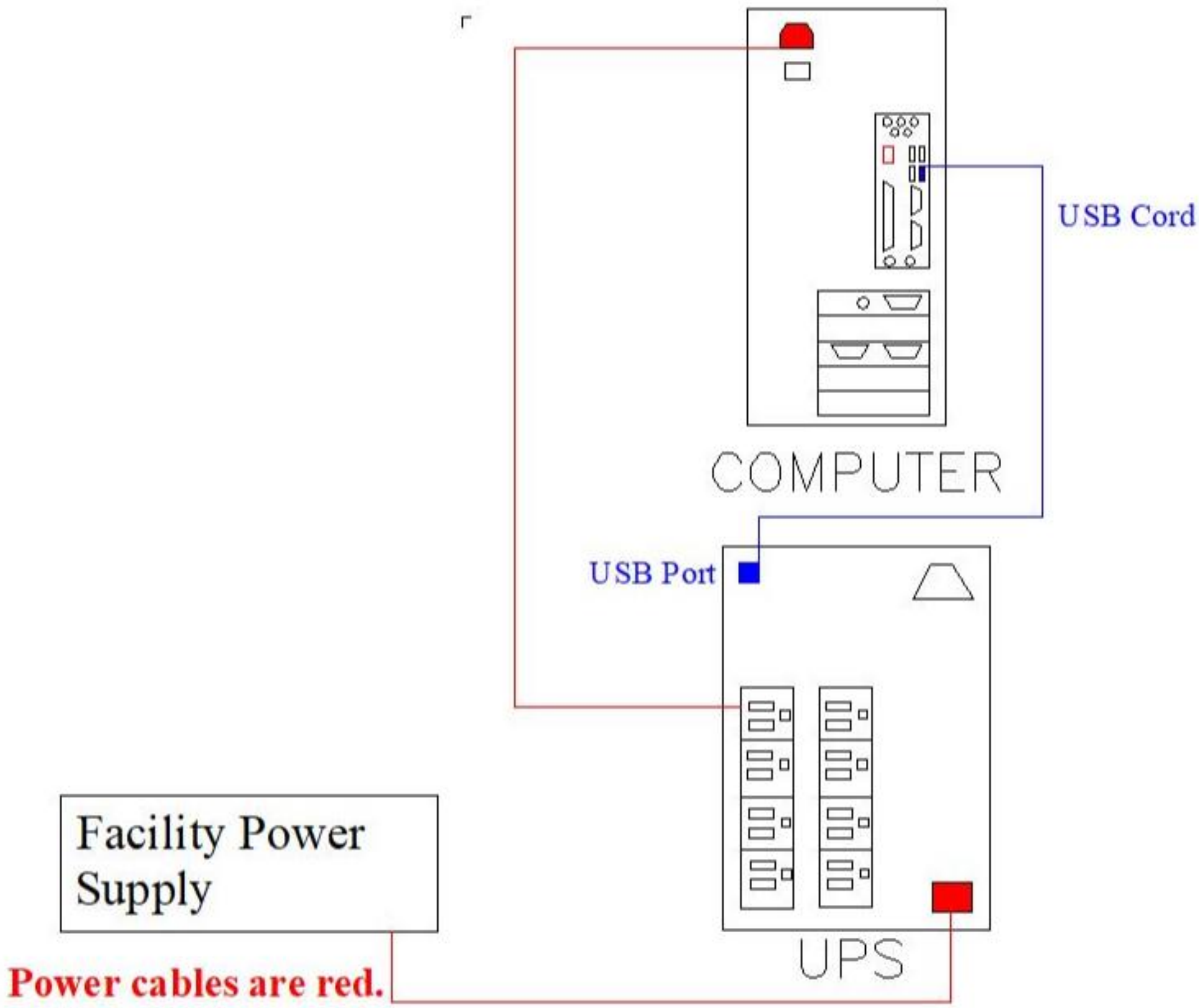


Figure 1. Connection

- ➢ Connect the PC and monitor to the UPS.
- ➢ Then connect the USB cable between the PC and the UPS.
  - o If the power goes off, the UPS will send the power off signal through the USB connection.

2. Software setup:

- ➢ Open the system config file and check the box next to Enable UPS
- ➢ The "Power down threshold time" is the time between when the power turns off and the PC will shut itself down. We use 5 minutes as the default setting.

➢ The “Resume channels if power is back within above time” means that channels will auto-resume if the power turns back on before the 20 minutes is over. Select this option to enable the auto-resume feature.

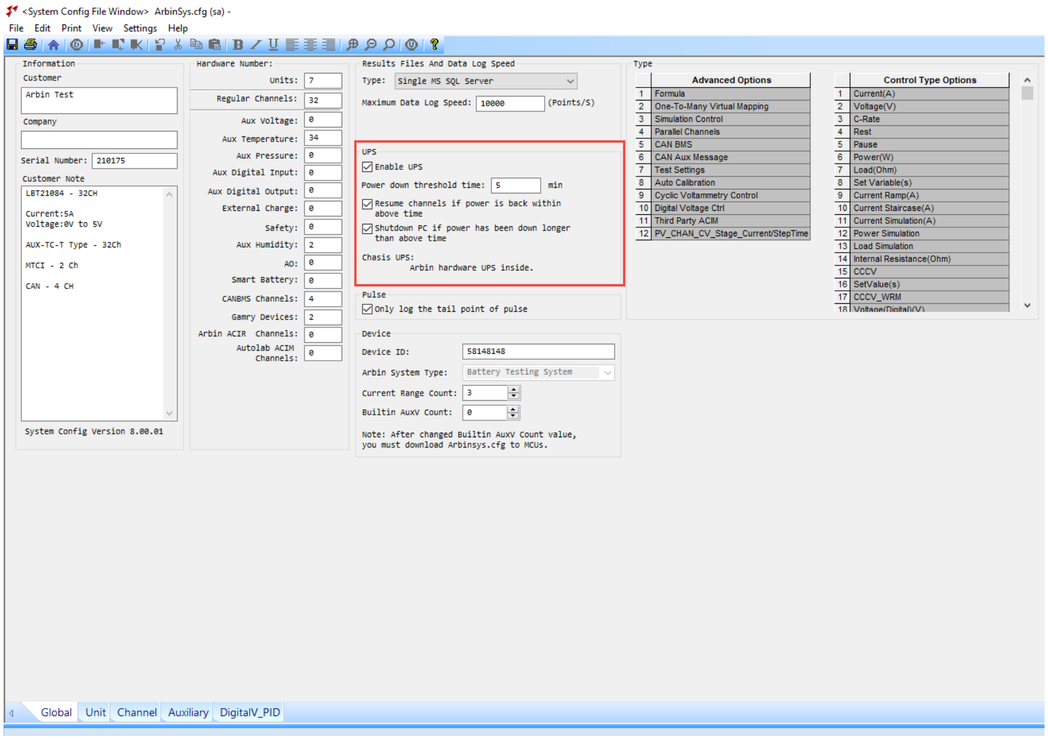


Figure 2. SysCfg Settings

3. How the UPS works:

➢ Only the UPS loses power
   - If only the UPS loses power while schedules are running, the channels will stop and the status will show ‘Go Pause” and the Exit condition will show ‘Power Down’. See Figure 3 below:

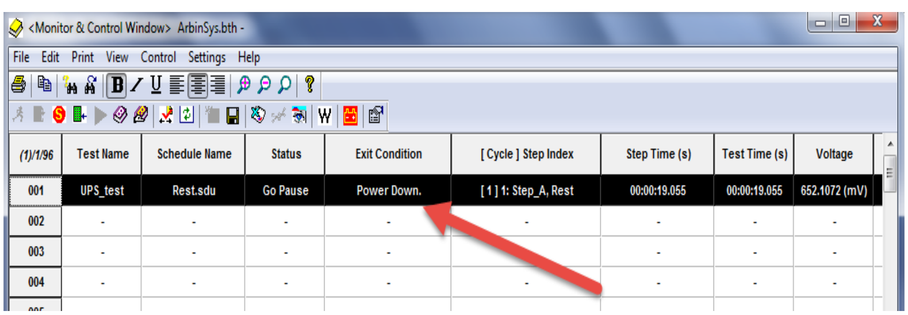


Figure 3, UPS loses power

- When the power turns back on within the threshold time (20 minutes in the System Config file), the channels which were running before will auto-resume as seen in Figure 4 below:

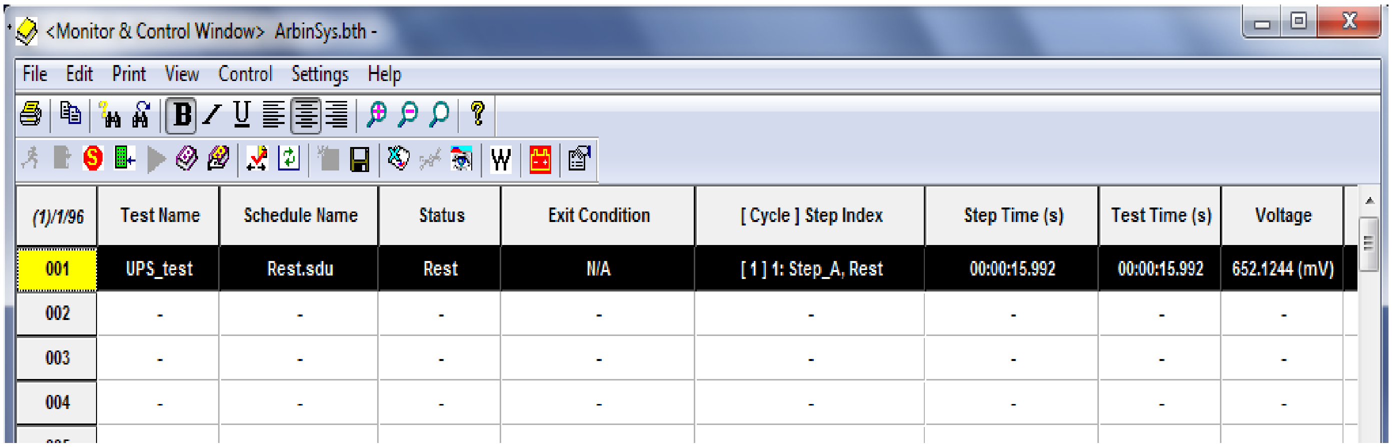


Figure 4, Auto-Resume

- Both the UPS and the Arbin lose power
  - If both the Arbin and UPS lose power while schedules are running, the active channels will stop, and their status will show 'Communication Failure' and the Exit Condition will show 'MCU Power Off'. See Figure 5 below:

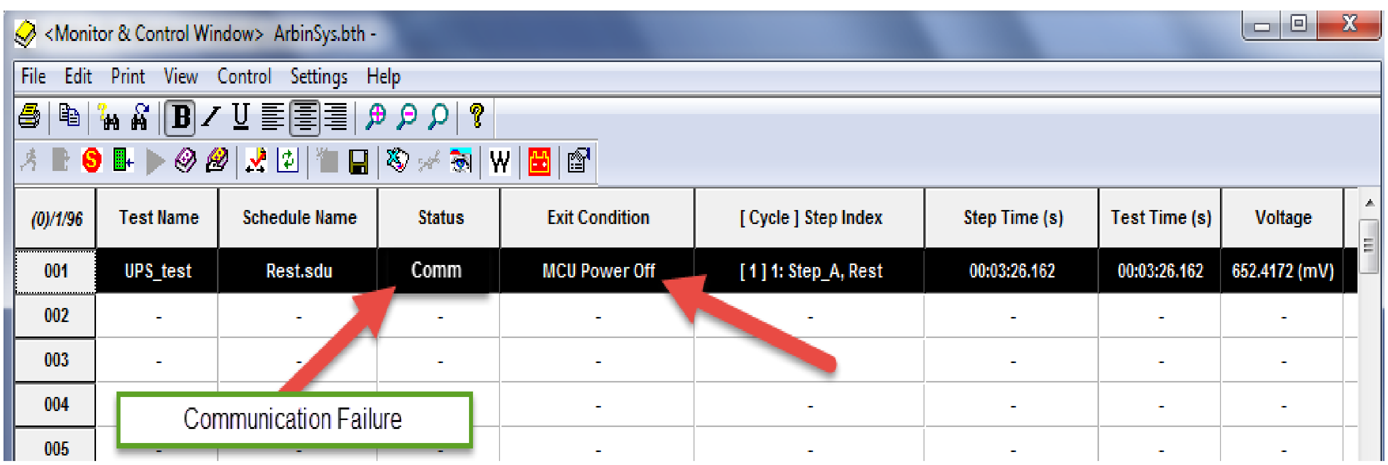


Figure 5, Stopped status

- When the power turns back on within the threshold time and the communication between the Arbin and the PC resumes, the channels that were running before, will auto-resume as in Figure 6 below:

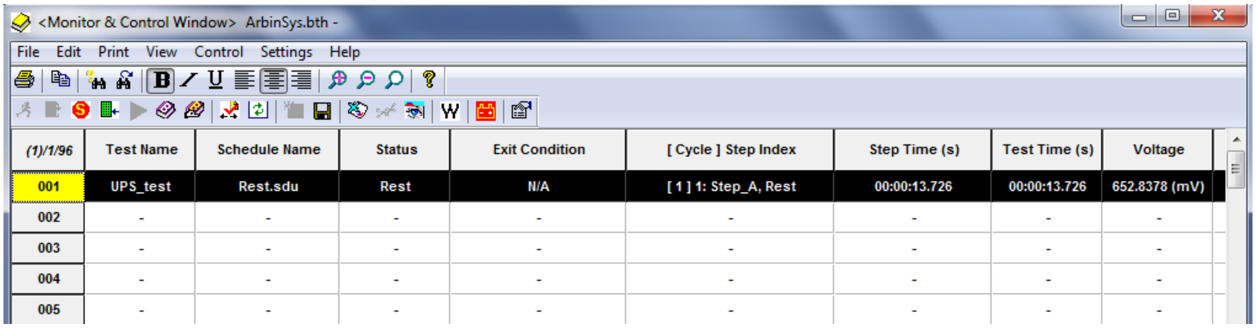


Figure 6, Auto-Resume

- It may take 30 seconds to 1 minute for all of the units to re-establish communication with the PC, but do not close DAQ during this process. Doing so will cause the test to be started over from the beginning and not resumed from the time the power went out.
- For some Arbin models, a Power Off will trigger “Power Off Unsafe” warning, and the auto-resume (see above) will not work. Operators need to check the causes of the Power Off message and manually resume tests, proving it is safe to do so.

Appendix K: Multi-Zone Temperature Chamber (MZTC) User Manual

The following is the User Manual for the Multi-Zone Temperature Chamber (MZTC) from Arbin Instruments. For more information regarding how to use the Mits Pro software or Arbin Testers please refer to the latest Mits Pro User Manual. In case of assistance contact Arbin support (support@arbin.com).

Table of Contents:

Version: 1
Revision: 1
Date: February 1st, 2019
Authors: Fernando Romo & Chang Zhong

Figure 5: Multi-Zone Temperature Chamber (MZTC) front view.

General Safety Information

Use the following safety guidelines to help ensure your own personal safety and to help protect your equipment and working environment from potential damage. Please refer to the manual in all cases where symbol ⚠ is marked, in order to find out the nature of the potential HAZARDS and any actions where have to be taken to avoid them.

⚠ **Warning:** Do not operate the Arbin Machine outside of its published power specifications.

⚠ **Warning:** Do not expose to moisture, liquid, heat, or corrosive vapor.

⚠ **Warning:** To prevent electrical shock, connect the power cord to an electrical outlet with appropriate facility grounding.

⚠ **Warning:** If the Arbin Machine is operated outside of its specified voltage and/or current ranges, the protection circuits for the device under test and the Arbin Machine may be impaired.

⚠ **Warning:** It is the responsibility of the end user to perform the appropriate tests for the specific device under test and to be fully aware of any characteristic and possible hazards (fire, explosion, burns, electrolyte exposure, etc.) the device under test may pose.

⚠ **Warning:** For safety reasons only use Arbin approved accessories.

⚠ **Warning:** Do not replace the power cord with an inadequately rated power cord.

⚠ **Warning:** Fans mounted to the sides of the Arbin Machine pull air into the chassis. Loose clothing or objects can be pulled into the fan assembly.

⚠ **Warning:** A two-person lift is required to move this Arbin Machine since its weight is 50 kg (110 lb).

⚠ **Warning:** Do not place a loaded Battery Tray on a conductive surface since it may short out the cell.

⚠ **Warning:** Do not touch a cell that has been warmed due to temperature setting or self-heating.

⚠ **Warning:** Switching between Local Mode and Remote Mode will reset the Safety Limits.

1. Introduction

The Multi-Zone Temperature Chamber (MZTC) is designed to maintain a battery's temperature constant while being tested on. The MZTC has 8 individually controlled temperature chambers. Depending on the battery tray used the MZTC can test up to 32 individual cells. The MZTC can be controlled over the temperature range of 10°C to 60°C. The MZTC can be controlled manually as a stand-alone temperature chamber (Local Mode) or controlled automatically with the Mits Pro software (Remote Mode).

The MZTC has two modes of operation: Local Mode and Remote Mode. The Local Mode allows the user to control the temperature of each chamber using the built-in touchscreen. The Remote Mode allows the user to control the temperature of each chamber using the Mits Pro software. The user assigns the temperature setting for each chamber in the test schedule they are running. To select the mode of operation, select the “Settings” tab in the MZTC touchscreen and select the desired mode of operation “Local” or “Remote”. The MZTC will display the current temperature and status of each chamber as long as it is being powered on regardless of the operating mode selected.

Figure 6: Temperature Monitor for the MZTC is highlighted.

2. General Operation

This section covers the general guidelines for proper operation of the MZTC. Please read the **General Safety Information** section on the beginning of this document!

2.1 Operating the Battery Trays

The battery trays have two rotating knobs which are used for opening or closing each individual chamber as shown in the figure below. Make sure to properly close each chamber before starting any test. Not rotating the knobs to the closing position will make the temperature chamber not to be thermally insulated.

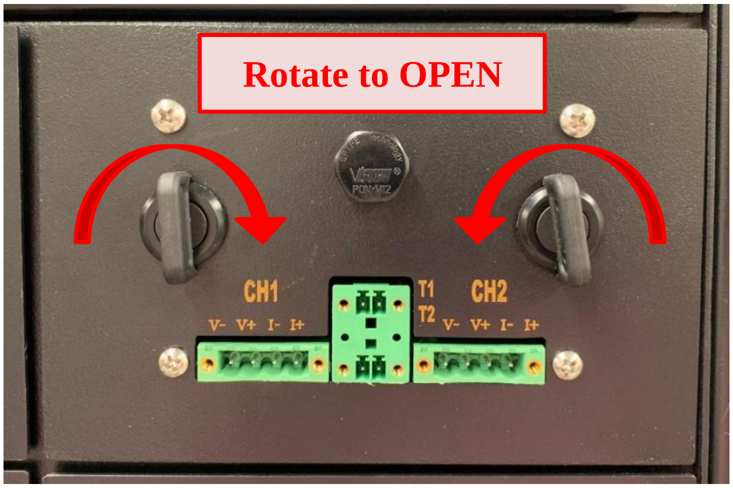


Figure 3: Rotate the handles towards the inside to remove the battery tray from the chamber.

Figure 4: Removing Chamber #1 battery board. Notice that the inside of the chamber is visible.

2.2 Loading a Cell to the Battery Tray

There are several types of battery trays for different type of cells. Please make sure that you do not charge or discharge the cell with a current greater than the rated current for the battery tray. When loading a cell to the battery tray, make sure to place the battery tray in a flat **non-conductive surface**. Also, connect the cell to the battery tray making sure to follow the appropriate voltage polarity. When unloading a cell from the battery tray be careful, since the cell might be extremely warm or cool to touch.

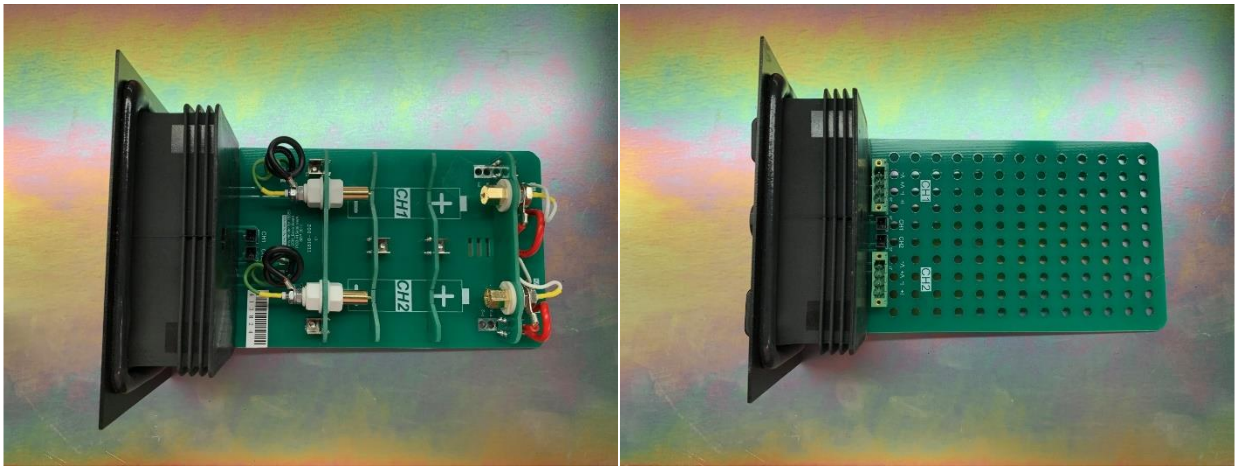


Figure 5: Cylindrical Cell battery tray (Left) and Universal Cell battery tray (Right) are shown.

2.3 Connecting IV Cables to the Battery Tray
When you have properly loaded a battery tray and placed it securely inside the MZTC, you can connect the IV cable from your Arbin Tester to the MZTC. Make sure to secure the IV cables to the battery tray by tightening the screws on the Phoenix connector. Make sure to use cables with appropriate current rating and that follow the appropriate wiring convention for Arbin (V-, V+, I-, I+).

2.4 Placement and Clearance for Air-flow
A two-person lift is required to move the MZTC since its weight is 50 kg (110 lb). The MZTC requires a clearance of 0.5m (1.6 ft) in every direction for proper air-flow. The MZTC air-flow direction is from right to left; make sure that no other machine/device is venting a warm air-flow into the cool air intake of the chamber.

2.5 Maintenance and Cleaning
The chamber is designed to require little maintenance, but when a component fails/breaks it is recommended to be serviced only by Arbin approved personnel. The chamber should be operated in a clean laboratory where no large dust particles or corrosive fumes are present. It is recommended to clean the outside and inside of the chamber in a yearly basis. Disconnect the chamber’s power cable and unload all battery trays before cleaning the chamber. The chamber can be cleaned gently using compressed-air to remove the dust, and with a microfiber cloth damped in isopropyl alcohol or ethyl alcohol. Make sure to properly dry the outside and inside parts of the MZTC before reconnecting its power cord. Note: that corrosive or toxic substances from cells/batteries might be present in the inside of the chamber. Make sure to safely and properly remove them.

3. Local Mode

The following sections show how to operate the MZTC with the Local Mode using the built-in touchscreen.

3.1 Selecting Local Mode
The first step of using the Local Mode is identifying which mode the MZTC is currently running on. The Temperature Monitor displays the mode of operation both in the Overview and Settings window. To change the mode of operation, select the Settings tab. The Settings window displays the Operating Mode and Version Information for the Temperature Monitor touchscreen program. Select the Local Mode button and the Local Mode will be highlighted in green. Note that if the MZTC is under Remote Mode and currently running a schedule with the Mits Pro software it will not allow you to change the mode of operation to Local Mode until the schedule has finished.

Figure 6: Select the Settings tab to switch between Local and Remote Mode.

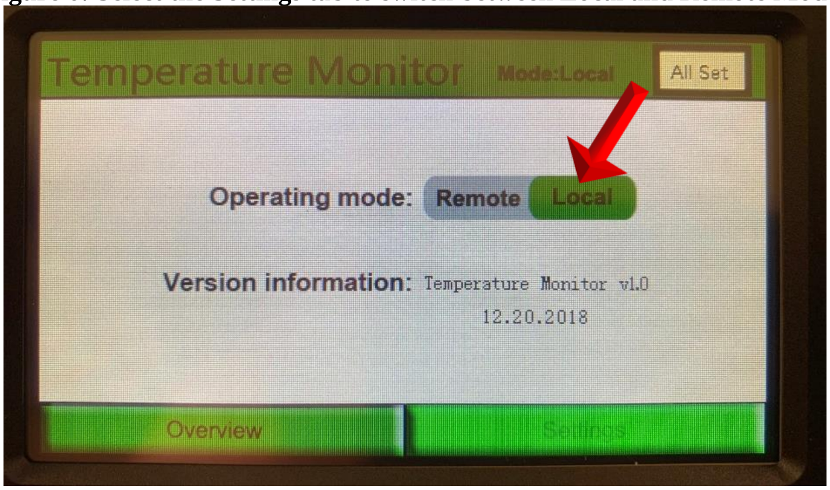


Figure 7: Select Local Mode in the Settings window.

3.2 Controlling Temperature Chambers Individually

First make sure that the MZTC is running on the Local Mode of operation. On the Overview window select the desired temperature chamber you want to control, chamber #1 on the figures below. A window will pop-up showing the current temperature, temperature set-point, and safety limits for that individual chamber. Select the chamber's Target Temperature box and a keyboard will pop-up in the display. Manually input a temperature set-point within the following range (10°C to 60°C), then select the Enter button. For any input larger than 60°C (Ex: 85°C) the MZTC will clamp the temperature set-point to 60°C, and for any input smaller than 10°C (Ex: 5°C) the MZTC will clamp set-point to 10°C. To return to the Overview window select the return arrow displayed on the top left corner of the "Set For Chamber" window, shown with a purple arrow on figure 9 below.

To turn ON or OFF an individual chamber select the Status button. A green circle means the chamber is ON, and a red circle means the chamber is OFF. A Status tab will pop-up asking you if you want to turn the temperature control box ON/OFF. Select the "Yes" button to turn the chamber either ON/OFF; select the "No" button to close the Status tab without performing any change to the chamber control.

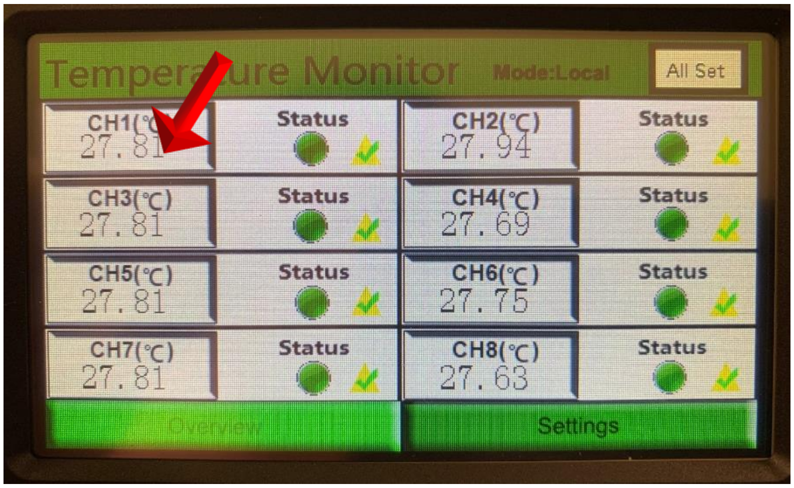


Figure 8: Overview window displays the current temperature, chamber status (ON/OFF), and safety status.

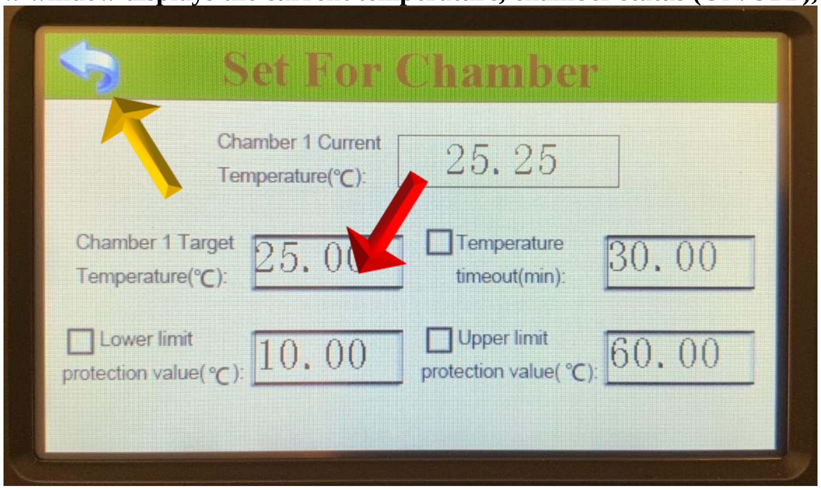


Figure 9: Set the target temperature for individual chamber.

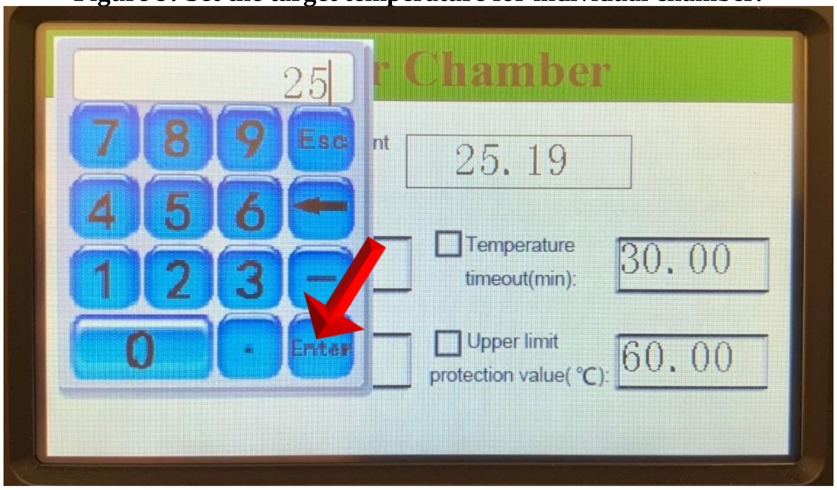


Figure 10: Manually input the target temperature set-point for an individual chamber.

Figure 11: Select the Status tab of the individual chamber you want to turn ON.

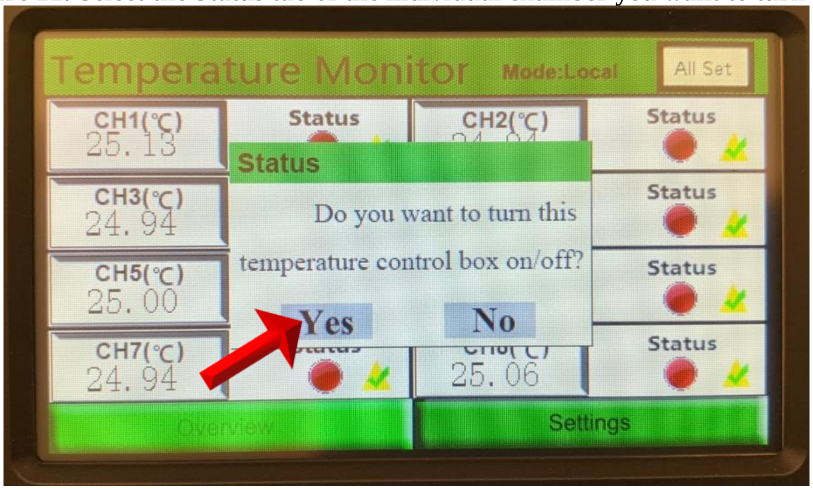


Figure 12: Select the Yes button to turn ON or OFF the individual chamber. Select the No button to close the Status tab.

3.3 Controlling Temperature Chambers Collectively

First make sure that the MZTC is running on the Local Mode of operation. On the Overview window select the “All Set” button, a window will pop-up showing the temperature set-point and safety limits that will be assigned to all temperature chambers. To make any change into these fields select their specific box and input the appropriate value using the keyboard that will pop-up. There are two buttons “Turn On” and “Turn Off” these are used to control all temperature chambers at the same time. Use the return arrow to return to the Overview window.

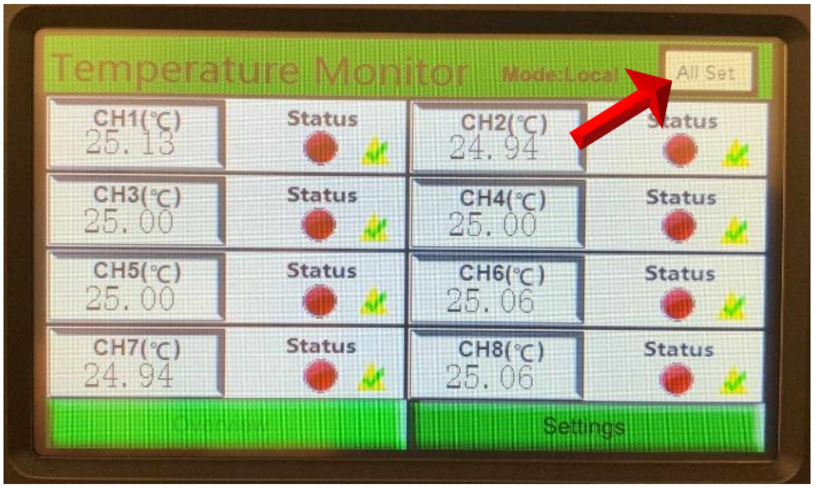


Figure 13: Select the All Set tab to control all the chambers collectively.

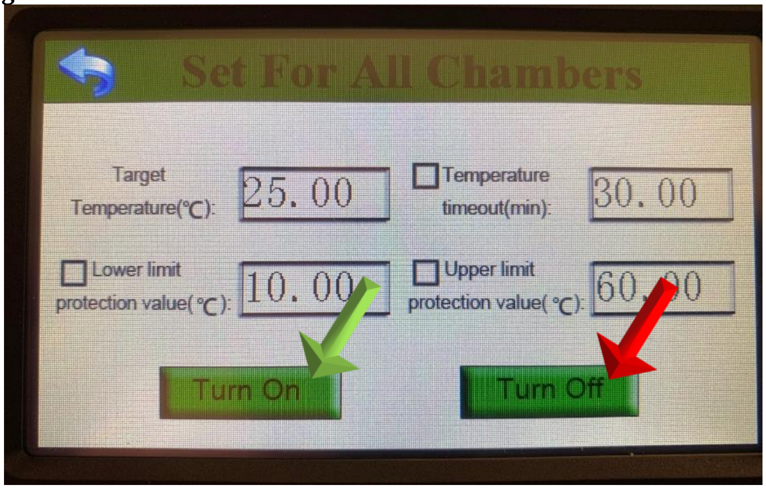


Figure 14: Manually input the desired temperature set-point for all chambers. The user can turn ON or OFF all the chambers.

Figure 15: Overview window showing all chambers ON (Left) and all chambers OFF (Right).

4. Remote Mode

The following sections show how to operate and configure the MZTC for Remote Mode operation which allows the chamber to be controlled by the Mits Pro software. These sections assume that the user has a good understanding in how to create schedules, modify the mapping, and run tests on the Mits Pro software. Refer to the ***Arbin Instruments MitsPro7.0 User's Manual*** for more information, or contact Arbin Support (support@arbin.com) if you have additional questions regarding the software or Remote Mode.

4.1 Selecting Remote Mode

The first step of using the Remote Mode is identifying which mode the MZTC is currently running on. The Temperature Monitor displays the mode of operation both in the Overview and Settings window. To change the mode of operation, select the Settings tab. The Settings window displays the Operating Mode and Version Information for the Temperature Monitor touchscreen program. Select the Remote Mode button and the Remote Mode will be highlighted in green. Note that the MZTC will be switched to Remote Mode automatically when controlled by Mits Pro; it cannot be switched to Local Mode until the tests are stopped or completed.

Figure 16: Select the Settings tab to switch between Local and Remote Mode.

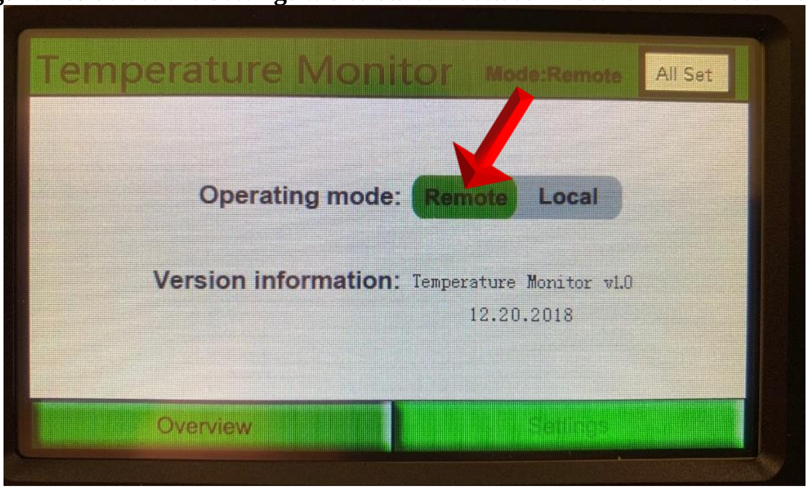


Figure 17: Select Remote Mode in the Settings window.

4.2 Making a Schedule to Control the MZTC

Before creating a schedule that will control the MZTC, it is important to verify that the Advanced Feature of Test Setting is available on your system. Create a new schedule or modify an existing one on the Mits Pro software. Go to the Test Settings tab, in here the temperature set-points are determined. Add a Test Setting element, you can modify its label, type, and control value. The figure below shows several test settings. As an example, there is the test setting labeled “10 DEG”, that its type is “temperature”, and its control value is 10 which in this context refers to 10°C. Also, its Auxiliary Virtual Index Nickname is 1.

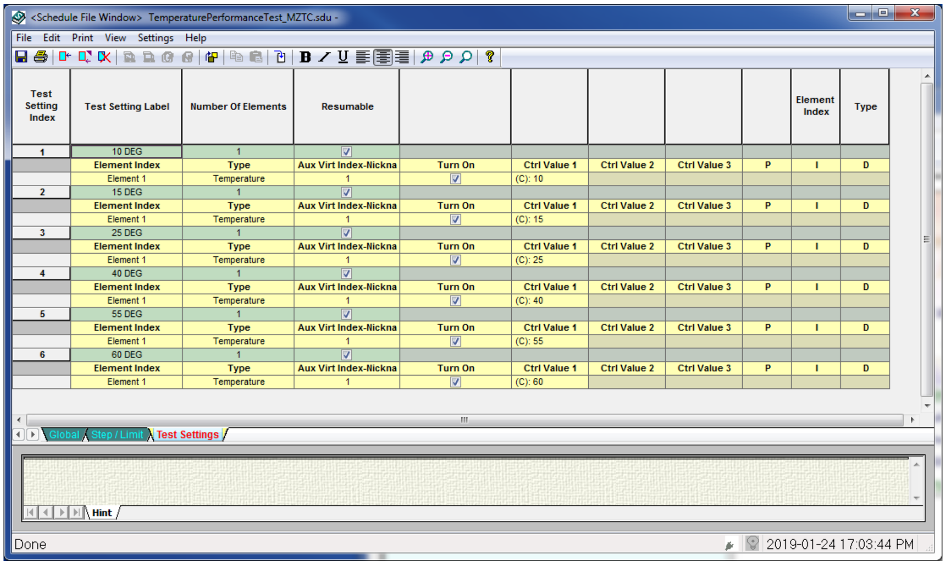


Figure 7: The temperature set-points are stored in the Test Settings tab.

After creating all the Test Settings elements that your schedule will require, go to the Step/Limit tab of the schedule. There will be a column labeled Test Settings; you can select the appropriate test setting you require for that particular step by selecting them from the drop-down menu. The figure below shows the first 7 steps from the schedule that produced the data for figure 25. Mits Pro allows a lot of flexibility in how to control and transition between steps. A step's completion can be determined by the channel's: step-time, test-time, voltage, current, capacity, temperature value, or other conditions.

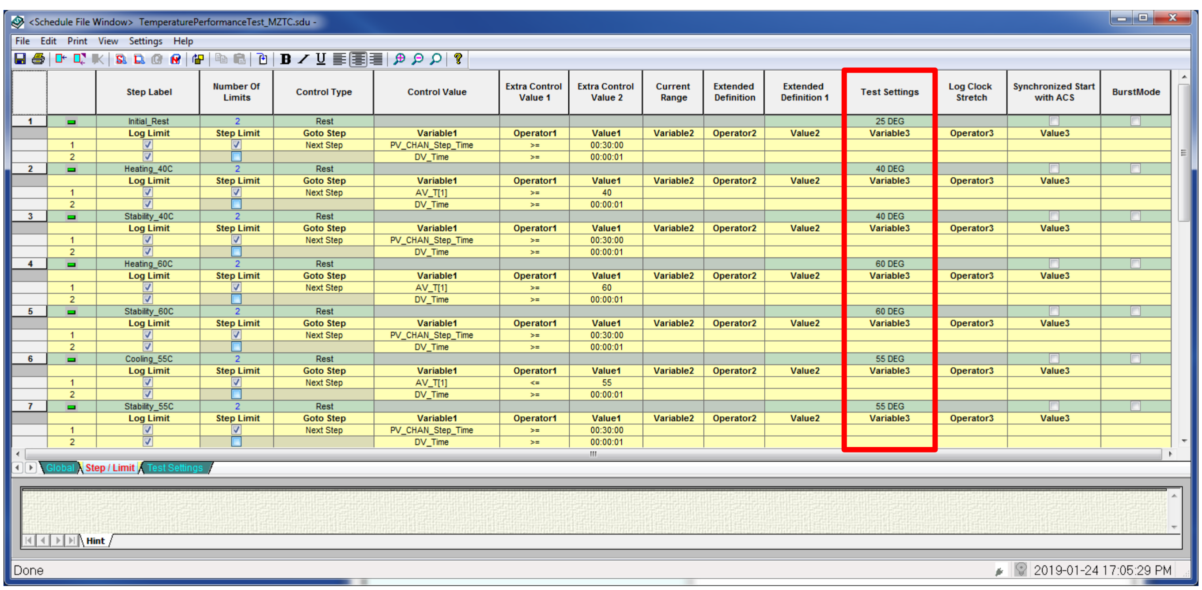


Figure 8: A sample schedule that uses Test Settings to control the temperature of the MZTC.

The schedule on the previous page has two different completion conditions used: one is when the temperature of the chamber reaches its temperature set-point (Steps 2, 4, and 6), and the other one is when a certain amount of time has elapsed between the start of that step (Steps 1, 3, 5, and 7).

Note that the control value for the exit condition for (Steps 2, 4, and 6) use the term "AV_T[1]". This term is making reference to the Auxiliary Virtual Index Nickname number 1. This does not mean it is temperature chamber #1. This means that when you assign this test to a specific IV channel, the temperature information will be coming from the temperature sensor mapped to that IV channel on the Batch file. It is possible to also utilize other temperature sensor data mapped to that IV channel; for example, if you have an additional PT100 sensor attached to your cell in a specific temperature chamber you can use that data to control a step's completion.

In this example, maybe you want to start charging or discharging your battery after its particular surface temperature reaches a specific value other than the set-point of the temperature chamber. During a temperature transition the surface temperature of a battery might take longer to reach the value of the temperature set-point for the chamber.

The final step in creating a schedule is determining the Safety Limits in the Global tab. Safety limits can be set for current (A), voltage (V), and temperature (°C). If the Advanced Feature of MTC Temperature Check is available in your system, you can determine how much time (in minutes) you allow an individual temperature chamber to reach its temperature set-point. You can decide if you want to Stop the Test or Make a Warning in the Monitor and Control Window when the MZTC takes longer than the allowed time. This timer will reset every time a different test setting is used.

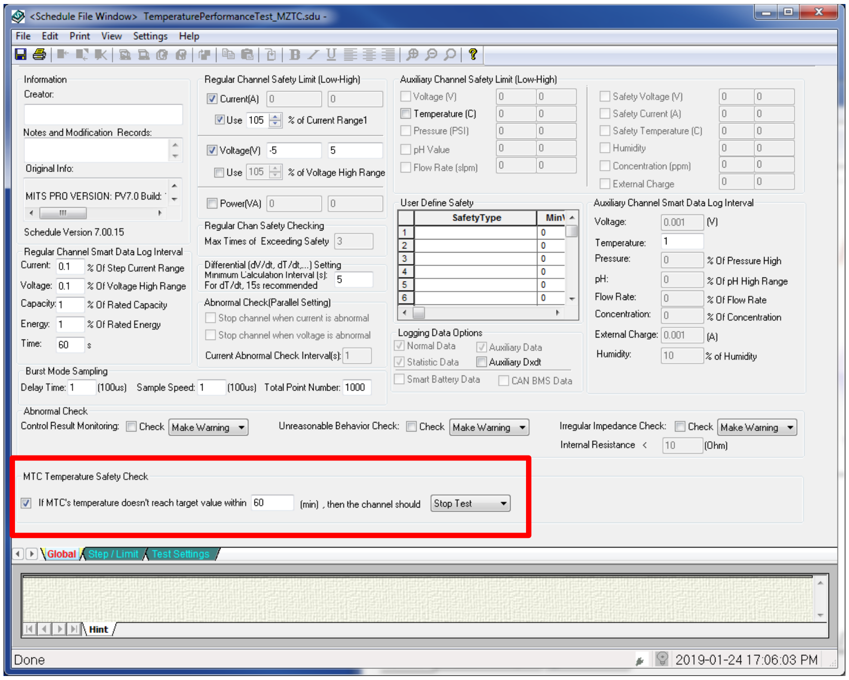


Figure 9: Safety limits can be determined on the Global tab of any schedule.

4.3 Modifying the Mapping on the Batch File

There are two main ways that the MZTC can be added to the Batch File. The first option is mapping one IV channel to one temperature chamber, as shown in figure 21. The second option is mapping two IV channels to one temperature chamber, as shown in figure 22. A third option is mapping additional PT100 sensors to a temperature chamber and IV channel; we recommend contacting Arbin Support (support@arbin.com) for supervision and guidance when making changes to the Batch File for safety.

Note that the Auxiliary Channel Virtual Index highlighted with a red box, on the figures shown in the next page, are related to the "AV_T[1]" term described in the previous section 3.3 talking about how to create a schedule to control the MZTC.

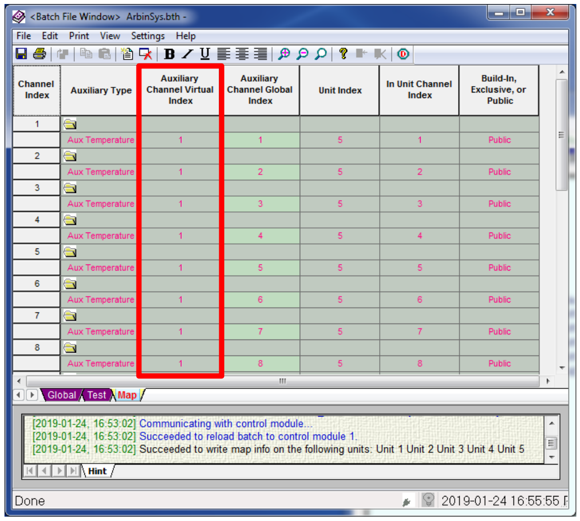


Figure 10: Map for one IV Channel one Temperature Chamber.

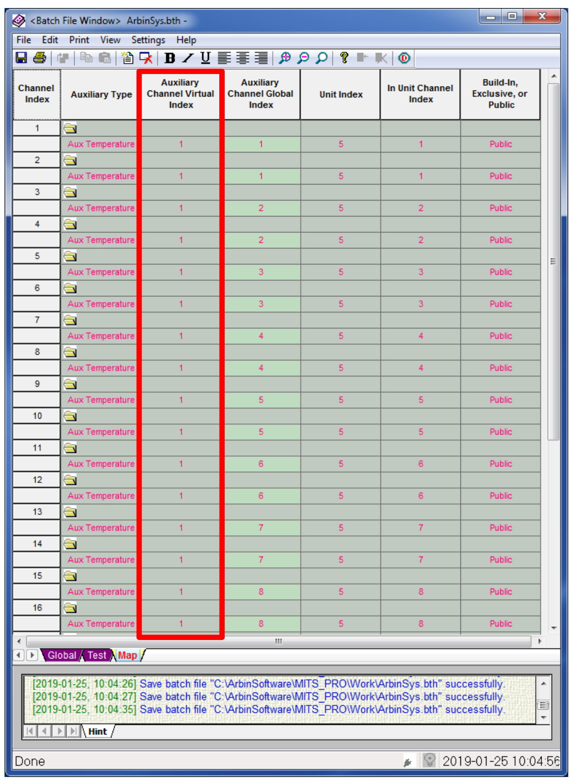


Figure 11: Map for two IV Channels one Temperature Chamber.

4.4 Running a Schedule on the Monitor and Control Window

In the Mits Pro software, launch the Monitor and Control Window. Select the desired IV channel that is properly connected to the temperature chamber, then assign a schedule that has the temperature set-points and control criteria for the test. If the MZTC is correctly configured and mapped, the current temperature will be displayed for that channel in the appropriate column. When ready to start the test, select the desired IV channel and start the test by clicking on the running man icon. The figure below shows selecting channel 1 on the Monitor and Control Window, and starting a new test under the name "Temperature_Control_Test". Note that when a schedule is started under Remote Mode the status of the temperature chamber will turn from red (OFF) to green (ON). Only the chambers running a schedule will be activated.

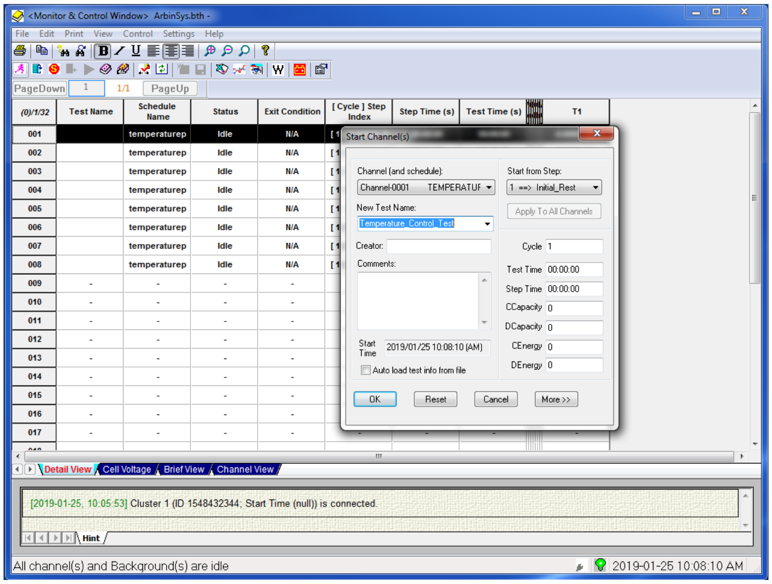


Figure 23: Starting a test on the Monitor and Control window.

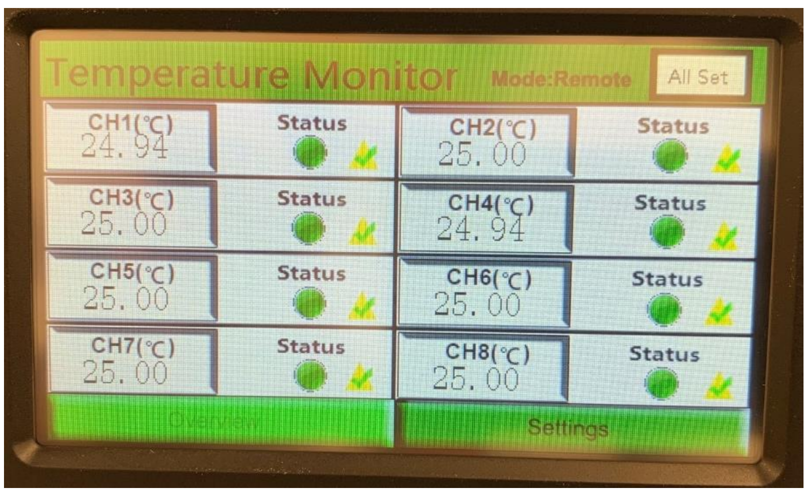


Figure 24: Overview window showing all chambers controlled remotely.

The temperature, voltage, and current data can also be monitored using the Data Watcher program in addition to the Monitor and Control window. Below the temperature reading of chamber #1 after running a schedule with different temperature set-points.

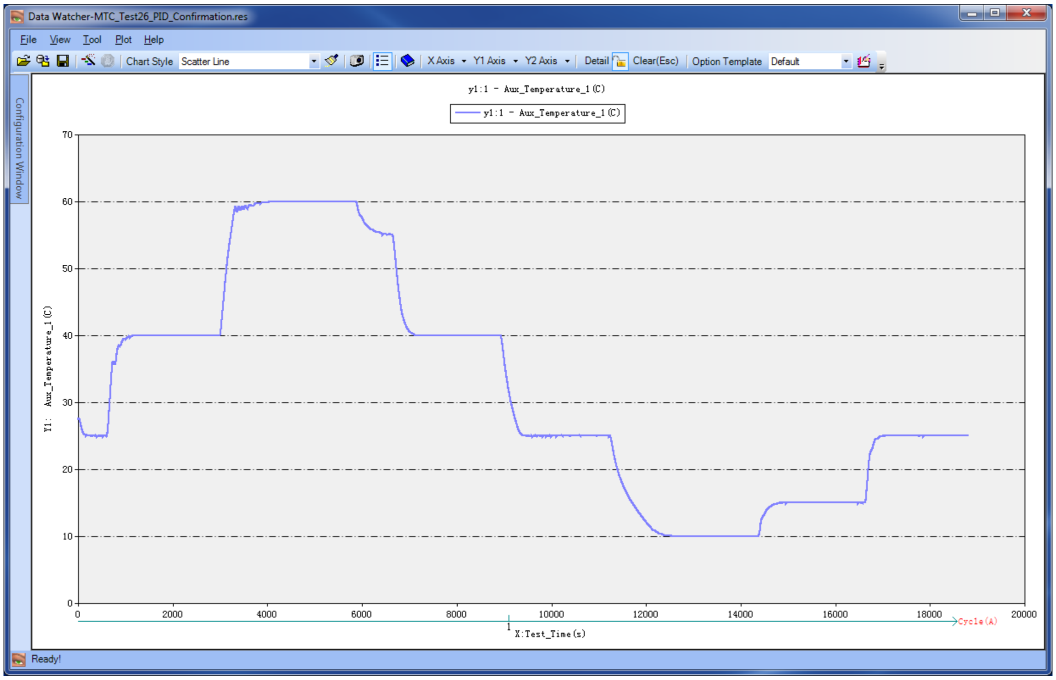


Figure 25: Temperature data from Chamber #1 being displayed in Data Watcher.

5. Safety

The MZTC was designed keeping safety in mind. There are several safety features both on the hardware and software that allows the user to better mitigate risk. Please read the **General Safety Information** section on the beginning of this document!

5.1 Hardware Protection

On the hardware side, in addition to its robust steel construction, each individual chamber of the MZTC has a pressure relief valve located in the front of the chamber that allows to vent gasses in case of battery thermal runaway.

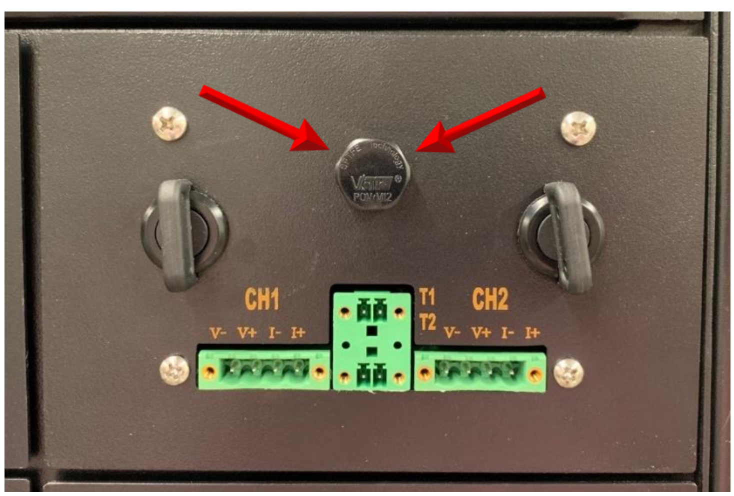


Figure 12: A pressure relief valve is located on every individual chamber's door.

5.2 Software Protection (Local Mode)

On the software side, the user can set several safety limits while on the Local Mode to prevent each individual chamber to be above or below a certain temperature "Upper/Lower Protection Value" in degrees Celsius. There is a special safety limit called "Temperature Timeout" this is the maximum time in minutes allowed for each individual chamber to reach its temperature set-point. These safety limits can be selected for each individual chamber or for all the chambers within the MZTC. The user can select which safety limit they want to be active: Temperature Timeout, Lower Limit Protection Value, and/or Upper Limit Protection Value, as shown in figure 27.

Each chamber counts with a status indicator that shows either Healthy or Unsafe condition. A Healthy condition is when the temperature chamber is operating within its safety limits and the status indicator displays a yellow triangle with a green check-mark. An Unsafe condition is when the temperature chamber is operating outside of its safety limits. When this happens the individual temperature chamber will be turned off, and a warming sign will be displayed in the status indicator, as shown in figure 28. Touching the warning sign will display the warming message as shown in figures 29 – 31. You need to manually clear the warning message before the temperature chamber can be controlled again.

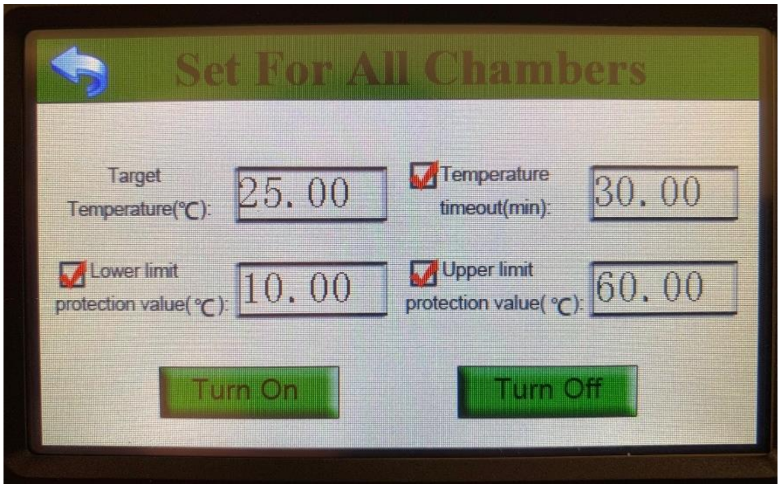


Figure 13: Safety Limits can be selected to maintain the temperature chamber within a specified temperature window, and a maximum amount of time can be determined for the chamber to reach its temperature set-point.

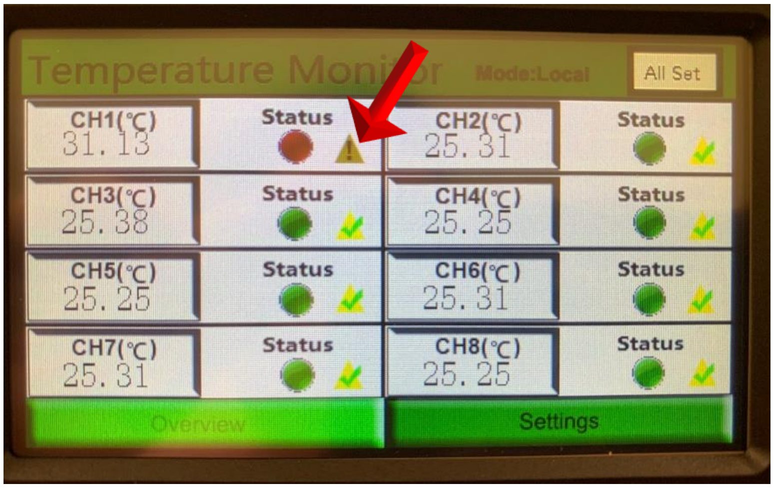


Figure 14: When a chamber goes to an UNSAFE condition, the chamber will turn OFF and the status indicator will show a warning sign. Touching the warning sign will display the warning message.

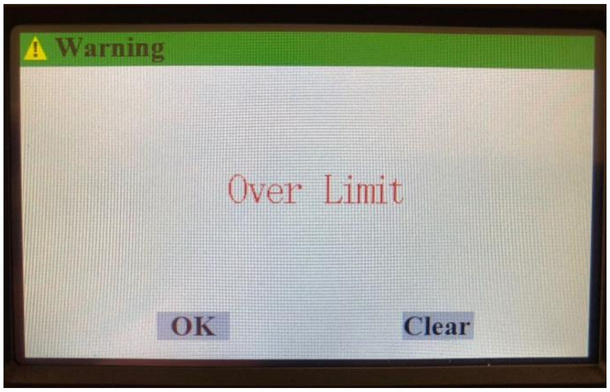


Figure 15: Warning message displayed when the temperature of the chamber is ABOVE the Upper Limit Protection Value, or BELOW the Lower Limit Protection Value.

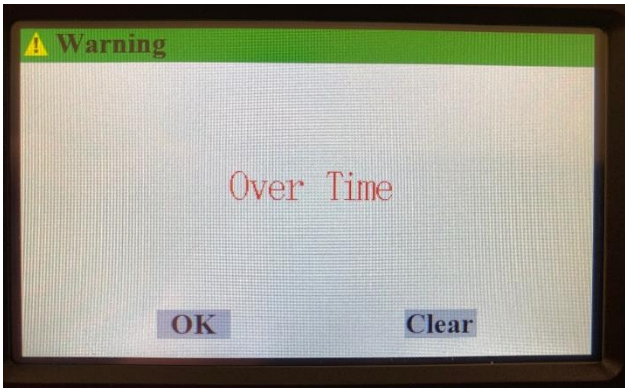


Figure 16: Warning message displayed when the chamber has not reached its temperature set-point and has taken more time than allowed in the Temperature Timeout safety limit.

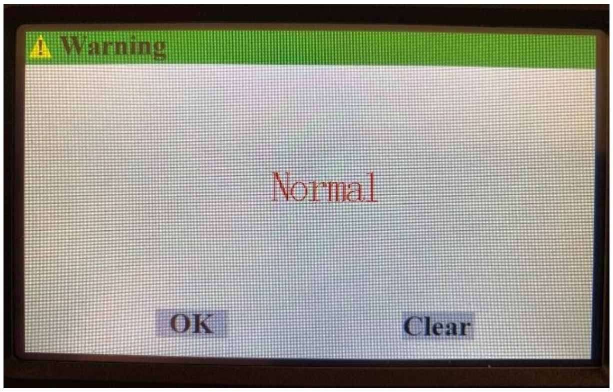


Figure 17: Warning message displayed when the chamber is on a normal/healthy state.

5.3 Software Protection (Remote Mode)

Mits Pro software allows you to add Safety Limits when creating a schedule in the Global tab. Safety limits can be set for current (A), voltage (V), and temperature (°C). If the Advanced Feature of MTC Temperature Check is available in your system, you can determine how much time (in minutes) you allow an individual temperature chamber to reach its temperature set-point. You can decide if you want to Stop the Test or Make a Warning in the Monitor and Control Window when the MZTC takes longer than the allowed time. This timer will reset every time a different test setting is used. This advanced feature is highlighted in a red box in the figure below.

Another safety feature is to set the Upper/Lower Temperature Limit for the chamber in the schedule using the Auxiliary Channel Safety Limit section. Select this feature by checking the box to the left of "Temperature [C]" and input the maximum/minimum temperature.

Another place to set the Upper/Lower Temperature Limit for the chamber in the schedule is to use the User Define Safety section. Select the Auxiliary Channel Virtual Index "AV_T[1]" that makes reference to the chamber's temperature sensor. Then, select the maximum and minimum value in degrees Celsius. The figure below shows a schedule that would allow the individual chamber to operate in the temperature range of 20°C to 40°C.

Warning messages cannot be selected or viewed in the touchscreen when the MZTC is being controlled by Mits Pro under the Remote Mode. All safety limits will be cleared when switching between modes.

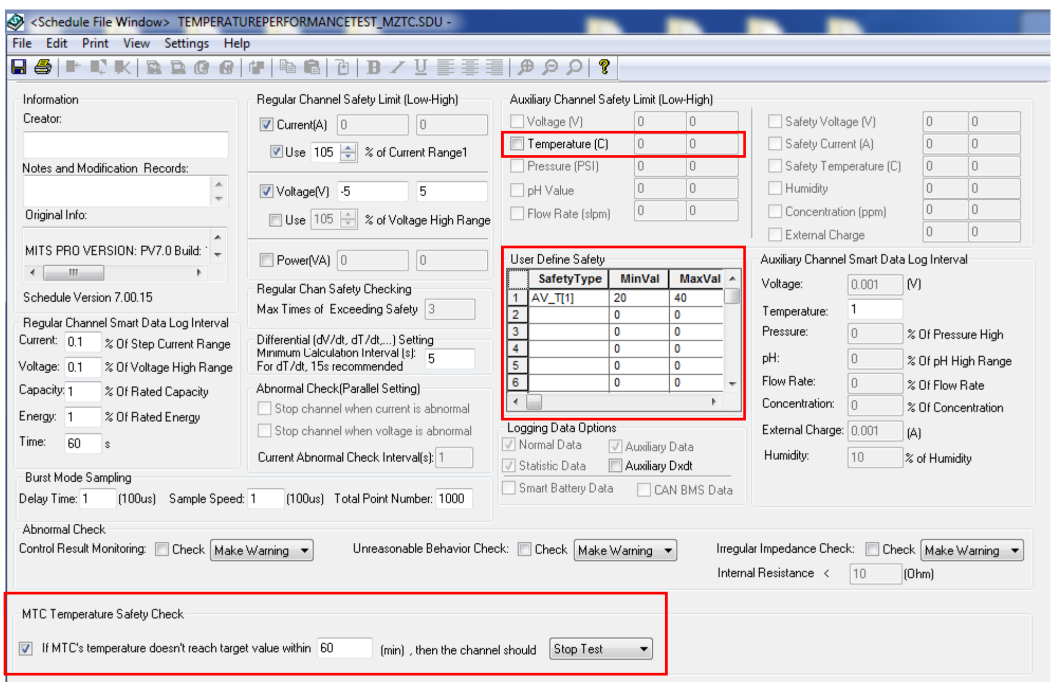


Figure 18: Safety features for the MZTC on the Global tab of the schedule.

6. Product Specifications

General

Individual Controlled Chambers	8 Chambers
Maximum Number of Cells	8 ~ 32 Cells*
Maximum Current per Battery Tray	See Table 1*

Dimensions

External

Height	5588 mm (22 in)
Width	3175 mm (12.5 in)
Depth	4064 mm (16 in)
Internal (Per Chamber)	
Height	762 mm (3 in)
Width	1143 mm (4.5 in)
Depth	1778 mm (7 in)
Weight	50 kg (110 lb)

Power

Voltage Range (Single-Phase)	90 ~ 264 V_{AC}
Frequency Range	47 ~ 63 Hz
Maximum Consumption	950 W
Maximum Current	10 A

Temperature Performance

Maximum Temperature	60 °C
Minimum Temperature	10 °C
Temperature Control Accuracy	± 0.5 °C
Temperature Control Precision	± 0.5 °C
Temperature Control Resolution	0.0625 °C
Temperature Stability Time (Unloaded)	30 minutes
Maximum Heating Capacity (Per Chamber)	TBD

Environment

Operating Ambient Temperature	18 °C ~ 28 °C
Storage Temperature	5 °C ~ 45 °C
Relative Humidity	< 90%
Altitude	2000 m (6500 ft)

*Refer to table 1: Battery trays for Multi-Zone Temperature Chamber.

Table 2: Battery trays for Multi-Zone Temperature Chamber. For more information see Battery Trays Table.

Battery Tray	Maximum Current	Number of Cells	PT100 Compatible	Arbin Part Number
Coin Cell	5A	2	Yes	#413820
	5A	4	No	#413822
Cylindrical Cell	10A	2	Yes	#413824
	30A	1	Yes	#413832
	60A	1	Yes	#413836
Universal Cell	10A	2	Yes	#413828
	10A	2	No	#413830
	60A	1	Yes	#413840

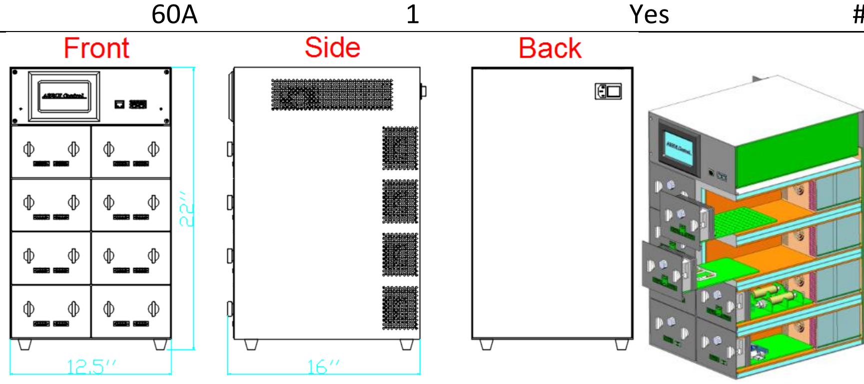


Figure 19: Mechanical drawings of the MZTC.

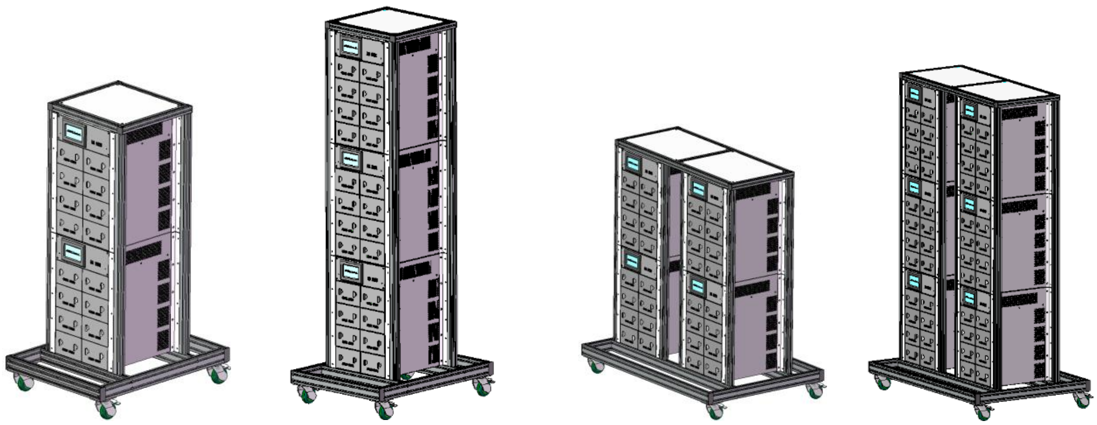


Figure 20: Multiple MZTC with different Rack configurations (2/3/4/6).

7. FAQ (Frequently-Asked-Questions)

1. How can I monitor the temperature of my cell directly?
    a. An additional Auxiliary PT100 board is required. Attach the PT100 temperature sensor to the cell, then connect the PT100 sensor to the battery tray. Finally, connect the Auxiliary PT100 board with the battery tray using the special phoenix-4-pin to phoenix-2-pin cable. Note that not all battery trays are compatible with the PT100 temperature sensor.
2. How many MZTC can I control using the Mits Pro software?
    a. Up to 32 MZTC (256 individual temperature chambers) can be controlled at the same time using one single computer.
3. Can I change the mode of operation from Remote Mode to Local Mode while the MZTC is being controlled by a schedule within the Mits Pro software?
    a. No, you cannot change the mode of operation from Remote Mode to Local Mode until the test schedule has been completed or stopped.
4. Can I have different battery trays in my MZTC?
    a. Yes, you can use different battery trays for the MZTC. Pay particular attention to the mapping on the Batch File and to the current ratings of the different battery trays.
    b. Below Battery Trays Table shows all the different battery trays available for the MZTC.

Battery Trays List

Table 3: MZTC Cylindrical Cell Battery Tray Holders.

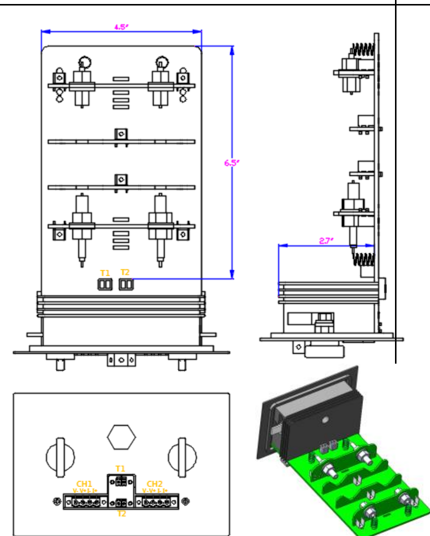
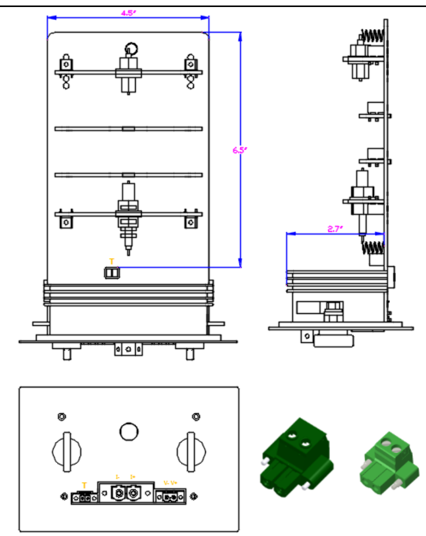
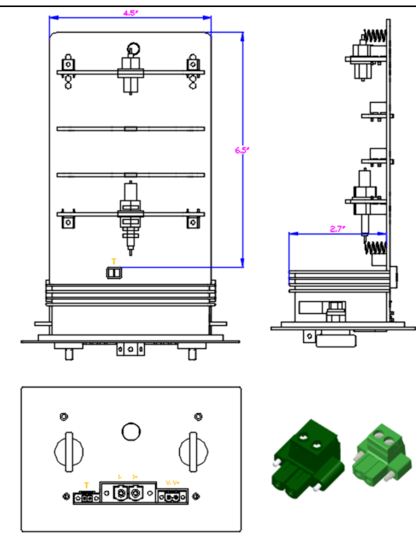
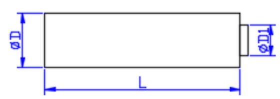
MZTC – Battery Tray Holder – Cylindrical Cell			
MZTC Battery Tray Holder	10A Cylindrical Cell 2CH	30A Cylindrical Cell 1CH	60A Cylindrical Cell 1CH
Arbin Part Number	#413824	#413832	#413836
Maximum Current	10 A	30 A	60 A
Maximum Number of Cells	2	1	1
Thermistor Port Number	2	1	1
Cell Dimensions	18mm≤ØD≤21mm ØD1≥8mm 55mm≤L≤75mm	18mm≤ØD≤21mm ØD1≥8mm 55mm≤L≤75mm	18mm≤ØD≤21mm ØD1≥8mm 55mm≤L≤75mm
Battery Tray Holder Dimensions	W: 4.5 in, D: 6.5 in, H: 2.7 in	W: 4.5 in, D: 6.5 in, H: 2.7 in	W: 4.5 in, D: 6.5 in, H: 2.7 in
Battery Tray Diagram			
Cell Diagram 			
IV Cable Connector	 Phoenix-4Pin_5.08-Female Arbin #194922 Phoenix #1810451	Phoenix-2Pin_10.16+2Pin_5.08-Female Arbin #388066 + #306130 Phoenix #1967456 + #1777989	Phoenix-2Pin_10.16+2Pin_5.08-Female Arbin #388066 + #306130 Phoenix #1967456 + #1777989
TC Cable Connector	 Phoenix-2Pin_3.81-Female Arbin #322466 Phoenix #1827703	 Phoenix-2Pin_3.81-Female Arbin #322466 Phoenix #1827703	 Phoenix-2Pin_3.81-Female Arbin #322466 Phoenix #1827703

Table 4: MZTC Universal Cell Battery Tray Holders.

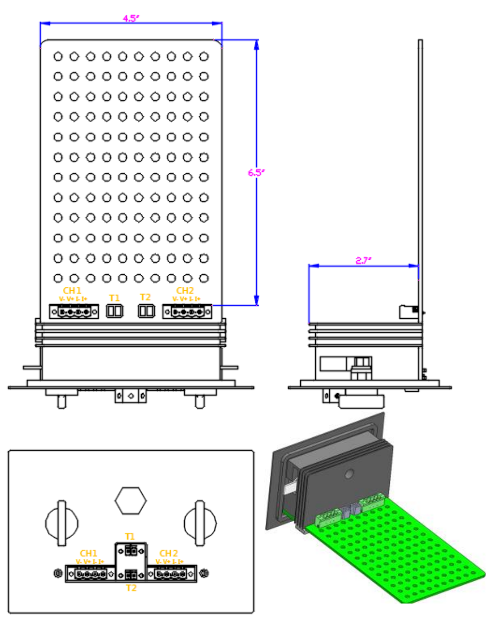
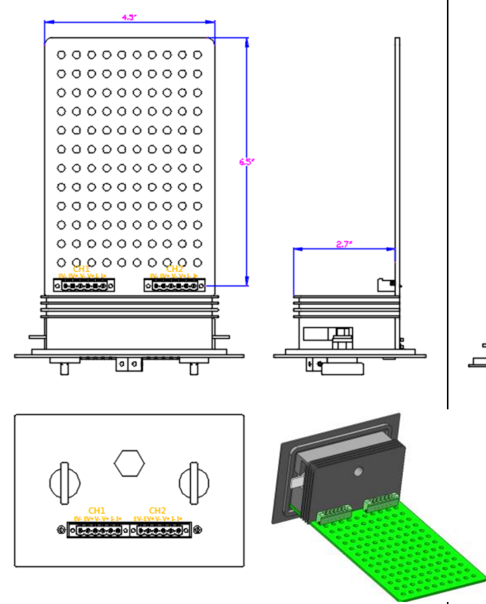
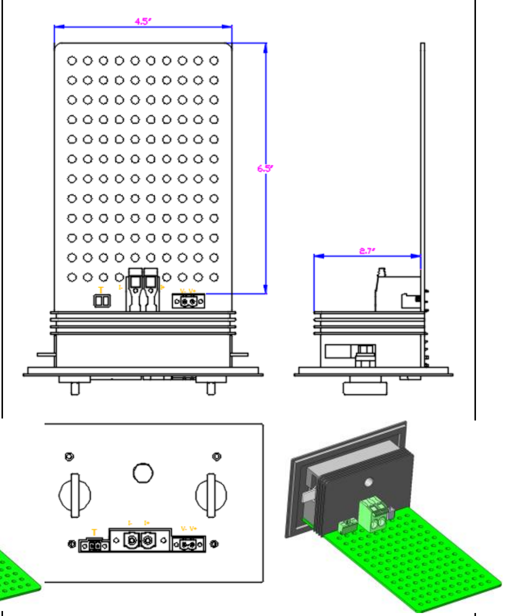
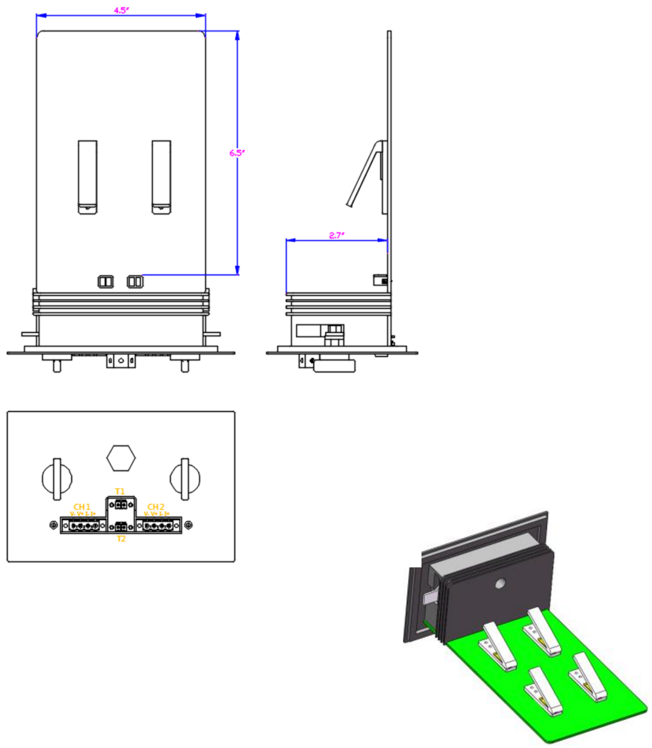
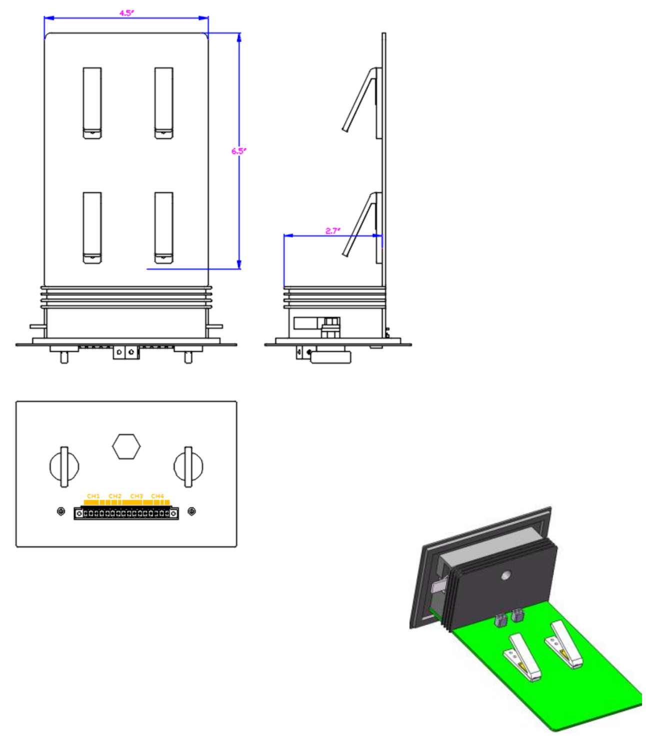
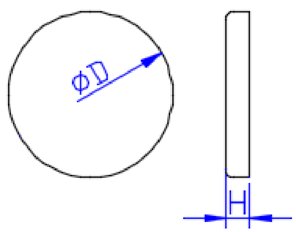
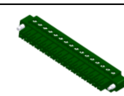
MZTC – Battery Tray Holder – Universal Cell			
MZTC Battery Tray Holder	10A Universal Cell 2CH	10A Universal Cell Three Poles 2CH	60A Universal Cell 1CH
Arbin Part Number	#413828	#413830	#413840
Maximum Current	10 A	10 A	60 A
Maximum Number of Cells	2	2	1
Thermistor Port Number	2	0	1
Cell Dimensions	W < 4 in, D < 6.5 in, H < 2.7 in	W < 4 in, D < 6.5 in, H < 2.7 in	W < 4 in, D < 6.5 in, H < 2.7 in
Battery Tray Holder Dimensions	W: 4.5 in, D: 6.5 in, H: 2.7 in	W: 4.5 in, D: 6.5 in, H: 2.7 in	W: 4.5 in, D: 6.5 in, H: 2.7 in
Battery Tray Diagram			
IV Cable Connector	 Phoenix-4Pin_5.08-Female Arbin #194922 Phoenix #1810451	 Phoenix-6Pin_5.08-Female Arbin #316538 Phoenix #1778027	Phoenix2Pin10.16+2Pin5.08Female Arbin #388066 + #306130 Phoenix #1967456 + #1777989
TC Cable Connector	 Phoenix-2Pin_3.81-Female Arbin #322466 Phoenix #1827703	None	 Phoenix-2Pin_3.81-Female Arbin #322466 Phoenix #1827703

Table 5: MZTC Coin Cell Battery Tray Holders.

MZTC – Battery Tray Holder – Coin Cell		
MZTC Battery Tray Holder	5A Coin Cell 2CH	5A Coin Cell 4CH
Arbin Part Number	#413820	#413822
Maximum Current	5 A	5 A
Maximum Number of Cells	2	4
Thermistor Port Number	2	0
Cell Dimensions	10mm⩽ØD⩽30mm H⩽7mm	10mm⩽ØD⩽30mm H⩽7mm
Battery Tray Holder Dimensions	W: 4.5 in, D: 6.5 in, H: 2.7 in	W: 4.5 in, D: 6.5 in, H: 2.7 in
Battery Tray Diagram		
Cell Diagram 		
IV Cable Connector	 Phoenix-4Pin_5.08-Female Arbin #194922 Phoenix #1810451	 Phoenix-16Pin_3.81-Female Arbin #381546 Phoenix #1827842
TC Cable Connector	 Phoenix-2Pin_3.81-Female Arbin #322466 Phoenix #1827703	None

Appendix L: Maintenance

This chapter describes several hardware maintenances best practices. Adhering to the below “best practices”, you will be doing your part to ensure your Arbin system performs its best.

Hardware maintenance

Arbin systems are air cooled and require proper airflow to cool on-board electronics. Arbin recommends allowing at least 3 feet of free space around the instrument.

Clean all labels on the Arbin chassis using a dry soft cloth whenever some dust builds up for clear visibility of any important labels.

Arbin systems must be set up in an area of your facility free from harmful chemical vapors or dust, such as corrosive solvent vapor or graphite powder. Chemical vapor or dust can cause internal circuit damage, or even electric shock. If the outside surface of the Arbin chassis requires cleaning, use a dry soft cloth to remove the particulate from the surface of the chassis.