

KA49701A Reference Platform PC GUI Software User Manual

The information described in this document is the exclusive intellectual property of Nuvoton Technology Corporation Japan and shall not be reproduced without permission from Nuvoton.

Nuvoton is providing document only for reference purposes of KA49701A PC GUI Software based system design. Nuvoton assumes no responsibility for errors or omissions.

All data and specifications are subject to change without notice.

For additional information or question, please contact Nuvoton Technology Corporation Japan.

www.nuvoton.co.jp

TABLE OF CONTENTS

<u>1. OVERVIEW OF THE KA49701A PC GUI SOFTWARE</u>	<u>3</u>
<u>1.1 Overview</u>	<u>3</u>
<u>2. CONNECTION SETUP.....</u>	<u>4</u>
<u>2.1 Components.....</u>	<u>4</u>
<u>2.2 Software Installation.....</u>	<u>4</u>
<u>2.3 Hardware Connection.....</u>	<u>5</u>
<u>2.3.1 Board Verification for Supplying Power to MCU Board.....</u>	<u>5</u>
<u>2.3.2 Connection of USB-UART Cable.....</u>	<u>5</u>
<u>2.3.3 Connection of AFE Board and MCU Board.....</u>	<u>6</u>
<u>2.3.4 Power Connection of the AFE Board.....</u>	<u>6</u>
<u>2.3.5 Power Up the Boards.....</u>	<u>7</u>
<u>3. PC GUI SOFTWARE DESCRIPTION.....</u>	<u>8</u>
<u>3.1 Main Window.....</u>	<u>8</u>
<u>3.2 Sub Window.....</u>	<u>22</u>
<u>3.2.1 Functions – Register R/W.....</u>	<u>22</u>
<u>3.2.2 Functions – Continuous R/W.....</u>	<u>24</u>
<u>3.2.3 Functions – Cell Balance.....</u>	<u>25</u>
<u>3.2.4 Functions – Diagnostic.....</u>	<u>27</u>
<u>3.2.5 Functions – Protection.....</u>	<u>29</u>
<u>3.2.6 Functions – Graph.....</u>	<u>31</u>
<u>4. LED DEFINITION FOR OPERATION MODE AND ERROR FACTOR.....</u>	<u>34</u>
<u>REVISION HISTORY.....</u>	<u>35</u>

1. OVERVIEW OF THE KA49701A PC GUI SOFTWARE

1.1 Overview



Figure 1.1 KA49701A PC GUI Software Main Window version 2.00

The PC GUI software for the KA49701A Reference Software Platform is tailored to interface with the Nuvoton Battery Monitoring IC (KA49701A) through the Nuvoton MCU (M483SGCAE) Board, featuring dedicated firmware integration. Upon launching the software, it automatically detects the MCU's firmware version to ensure compatibility.

The MCU board houses the essential firmware components of the BMIC, including device drivers, middleware, and demonstration applications. These core firmware elements empower the PC GUI to execute its high-level functions.

This Manual provides a comprehensive overview of the PC GUI Software's functional operations. For detailed information on the MCU Board Firmware, please refer to "KA49701A Reference Platform Software User Manual".

The PC GUI software establishes communication with the MCU via a USB-UART interface, enabling it to issue commands to the BMIC. The MCU, in turn, communicates with the BMIC through an SPI interface. The software retrieves data from the MCU at 0.5 seconds intervals and can also control BMIC registers upon request. Importantly, this PC GUI software is fully compatible with the Windows 10 operating system.

The PC GUI software offers a wide range of features, such as displaying converted BMIC ADC data, real-time monitoring of register, data logging capabilities, graphical data representation, and full BMIC register map control, including the management of Charge & Discharge FETs.

In addition, this PC GUI software presents users two primary operating modes: Demo Mode and Evaluation Mode, along with the ability to manage operation modes and conduct demonstrations of cell balancing, diagnostics, and protection functions.

2. CONNECTION SETUP

2.1 Components

To demonstrate the KA49701A Reference Platform using PC GUI, users must configure the setup as depicted in Figure 2.1.

The setup comprises five components:

- 1> AFE Board – BMIC KA49701A Evaluation Board.
- 2> Board Connection Wires – Two sets of ribbon cables (6-pin x1 and 9-pin x1) to connect AFE board and MCU board.
- 3> MCU Board – M483SGCAE MCU Board, contains dedicated firmware such as BMIC Device Driver, Middleware, sample demo application etc.
- 4> USB-UART Cable - TTL-232R-3V3 USB-UART interface cable, establish a connection between the PC USB port and the MCU board.
- 5> PC GUI – KA49701A PC GUI Ver 2.00, for communication with MCU.

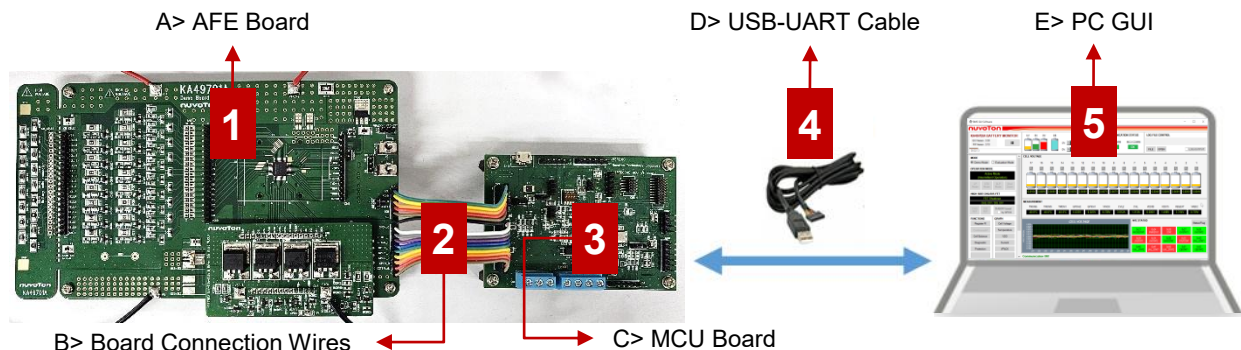


Figure 2.1 Setup for demonstration of KA49701A Reference Platform

Note

The PC GUI Software has been tested with Microsoft Windows 10. Its compatibility with earlier version of Windows has not been fully evaluated and, therefore, cannot be guaranteed.

2.2 Software Installation

The FTDI driver for USB-UART Cable is required to be installed before setup.

Open the link <https://ftdichip.com/drivers/d2xx-drivers/> and click “setup executable” link to download the driver and install the driver accordingly.

Currently Supported D2XX Drivers:							
Subscribe to Our Driver Updates							
Operating System	Release Date	Processor Architecture					Comments
		X86 (32-Bit)	X64 (64-Bit)	ARM	MIPS	SH4	
Windows (Desktop)*	2021-07-15	2.12.36.4	2.12.36.4	2.12.36.4A*****	–	–	WHQL Certified, Includes VCP and D2XX. Available as a setup executable . Please see the Release Notes and Installation Guides .

“setup executable” link

Figure 2.2 Web link for FTDI driver download

2.3 Hardware Connection

2.3.1 Board verification for supplying power to MCU Board

To supply the REGEXT voltage (3.3V) from AFE Board to MCU Board, users must ensure following connections:

- 1> Jumper JREGEXT of AFE Board (top) is SHORT
- 2> Jumper JVDD50 of AFE Board (top) is OPEN
- 3> Jumper J1 of MCU Board (top) is SHORT

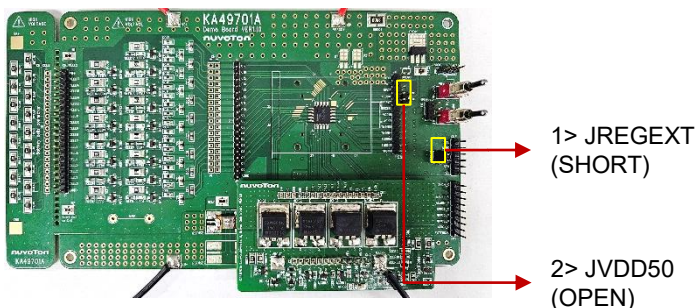


Figure 2.3.1 AFE Board Top View

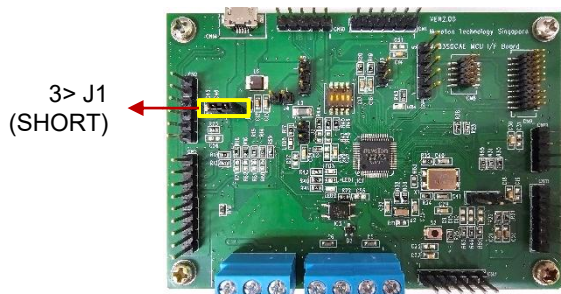


Figure 2.3.2 MCU Board Top View

REMINd:

Make sure ALL connections above are correct before connecting the MCU Board to it, otherwise it might cause permanent damage to MCU board.

2.3.2 Connection of USB-UART Cable

Connect the USB-UART Cable (TTL-232R-3V3) to CN1 of MCU Board as below, and then connect it to PC USB port.

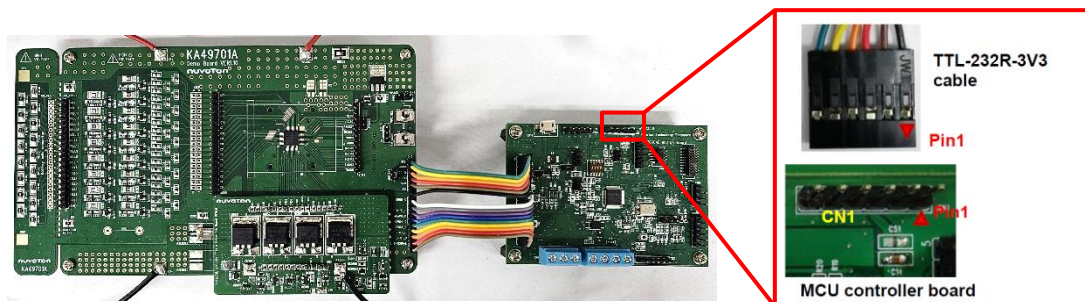


Figure 2.3.3 Connection of USB-UART Cable

2.3.3 Connection of AFE Board and MCU Board

Connect AFE board to MCU board using 2 sets of ribbon cables as shown in Figure below.

Two ribbon cables provided in standard package:

- 1> 6pin cable – to connect CN2 of AFE Board to CN2 of MCU Board
- 2> 9pin cable – to connect CN5 of AFE Board to CN5 of MCU Board

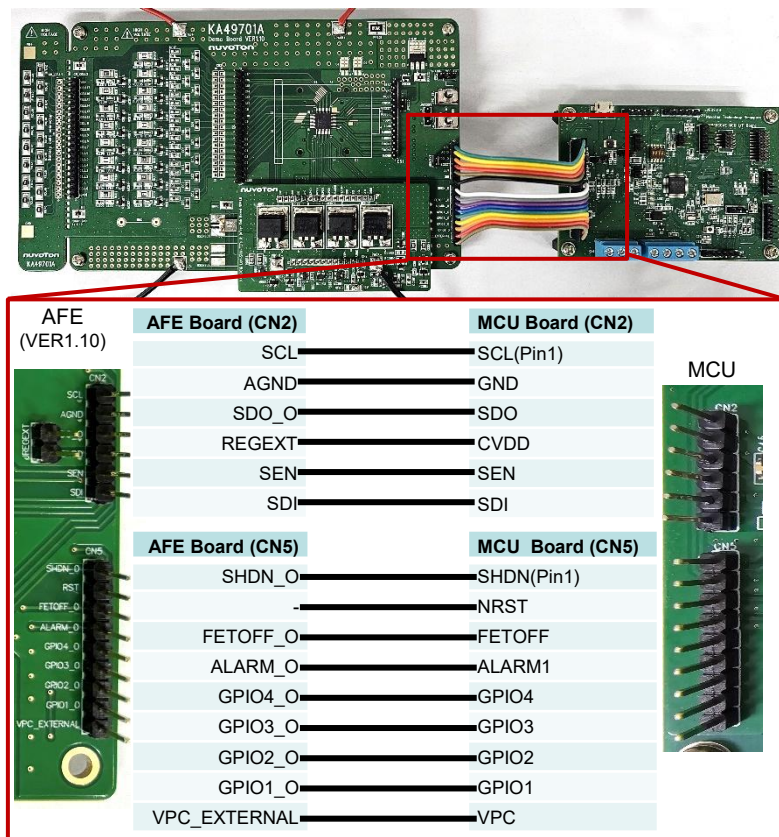


Figure 2.3.4 Connection of AFE board to MCU Board

2.3.4 Power Connection of the AFE Board

Connect the power supply across VB+ to VB- of AFE Board.

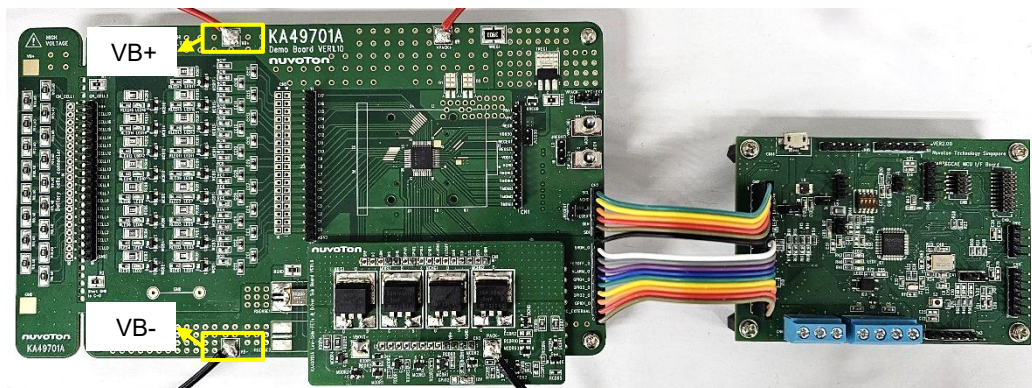


Figure 2.3.5 Power Connection of the AFE Board

2.3.5 Power Up the Boards

Procedure to power up the boards:

- 1) Before connecting the MCU Board to AFE Board, apply 12V across VB+ and VB- of AFE Board and switch VPC_SEL to LEFT position (direction towards BMIC), and then check if the REGEXT (pin4) of CN2 of AFE Board is 3.3V.

Note

Exceeding 3.3V on the CVDD pin of the board can result in permanent damage to the MCU board.

- 2) Power OFF and switch back the VPC_SEL to MIDDLE position. Then connect the MCU Board to AFE Board and connect the USB-UART Cable from MCU Board to PC USB port.
- 3) Power on the supply across the VBAT of the AFE board (about 12.5V~85V). Then switch the VPC_SEL to the LEFT position (direction towards BMIC) and then switch back to MIDDLE position. This will wake up AFE and MCU boards.
- 4) The LED indicator LED4 (Green) on MCU board will flash to indicate that the BMIC and MCU has been waken up and the boards are working in normal operation. Refer to Chapter 4 for details on the LED indicators' status on the MCU Board.
- 5) Execute the PC GUI software, the Main Window of PC GUI will be displayed as shown in Figure 2.3.8 below. Users have the option to verify the setup's connections or restart the PC GUI in case the Main Window displays abnormalities.

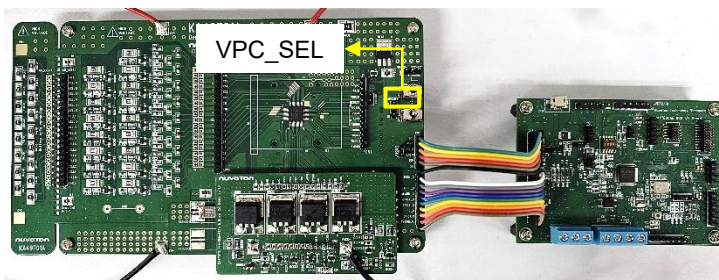


Figure 2.3.6 Switch VPC_SEL position of AFE board

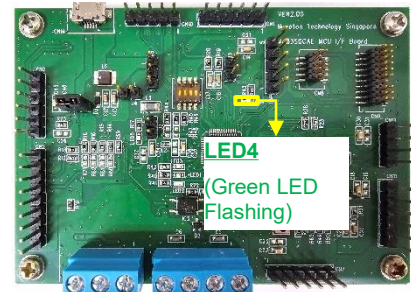


Figure 2.3.7 LED4 position of MCU board

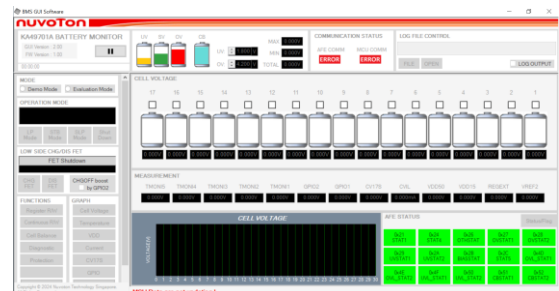
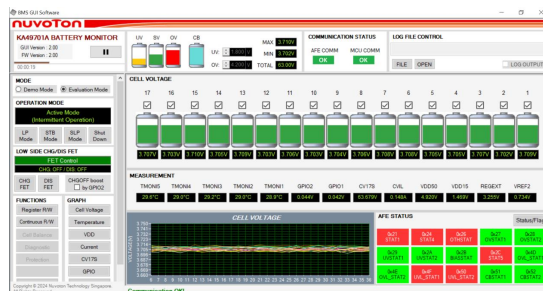


Figure 2.3.8 Example of Normal and Abnormal of PC GUI

3. PC GUI SOFTWARE DESCRIPTION

3.1 Main Window

The Main Window of the PC GUI software, which appears upon starting the application, is illustrated in Figure 3.1.1.

The PC GUI software establishes communication with the MCU via a USB-UART interface. It facilitates the transmission and reception of data to and from the BMIC through the MCU. Following data retrieval, the PC GUI software undertakes data conversion and presents it in both graphical and text formats. Additionally, it serves as a reference guide for users, detailing the available functions and operations at the system level.

This interface is segmented into several sections labeled A through N, each designated for specific functionalities. Further information regarding the purpose and operation of these sections will be elaborated on in the subsequent pages.

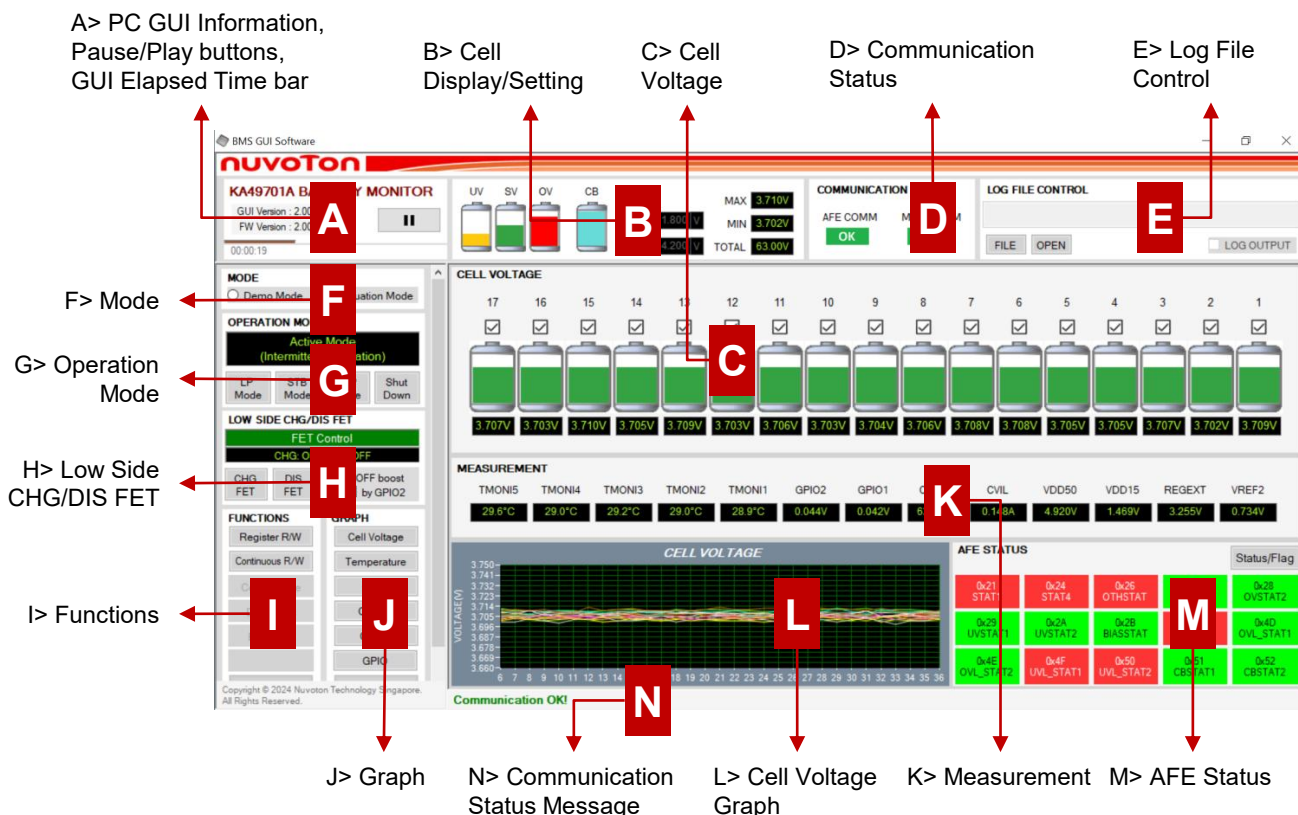


Figure 3.1.1 Main window

Note

The pause button is intended to pause the PC GUI data retrieval from the MCU, presenting a static data for convenient browsing. We do not guarantee the functionality of any operations during the pause state. When engaging in other activities, please click the "Pause/Play" button first to resume PC GUI data retrieval.

A> PC GUI Information, Pause/Play Button, GUI Elapsed Time bar

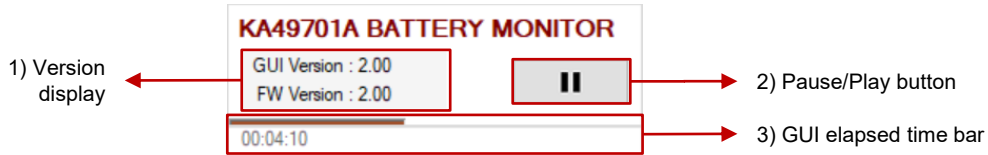


Figure 3.1.2 Main window - PC GUI information, pause/play button, GUI elapsed time bar

- 1) **Version display** – to display the PC GUI & MCU Firmware (FW) software version.
- 2) **Pause/Play button** – the button alternates between displaying “||” and “▶”.

 - Click “||” to pause data acquisition of PC GUI from BMIC via MCU.
 - Click “▶” to play or resume data acquisition of PC GUI from BMIC via MCU when stopped.

When clicking “||”, some controls on the PC GUI will become greyed out, disabled or invalid. To click “▶” to re-enable these controls when needed.

- 3) **GUI elapsed time bar** – A progress bar that corresponds to the elapsed time when the PC GUI is opening and show the time in seconds.

B> Cell Display/Setting

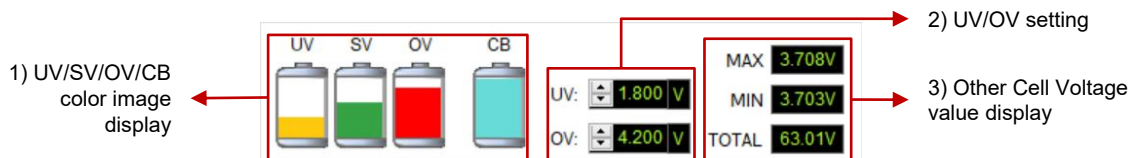


Figure 3.1.3 Main window - Cell Display/Setting

- 1) **UV/SV/OV/CB color image display** – to indicate the cell color image for under-voltage (UV) (orange), standard-voltage (SV) (green), over-voltage (OV) (red) and cell balance (CB) (light blue).
- 2) **UV/OV setting** – to set under-voltage (UV) & over-voltage (OV) value (same as HUV/HOV setting in protection function)
 - HUV/HOV are voltage protection items of protection function, UV in main window and HUV in Protection sub window controls each other, as do OV and HOV.
- 3) **Other Cell Voltage value display** – to display the calculation result of cells' voltage in volt (V):
 - MAX – the maximum cell voltage among all cells.
 - MIN – the minimum cell voltage among all cells.
 - TOTAL – the voltage accumulated from all cells.

C> Cell Voltage

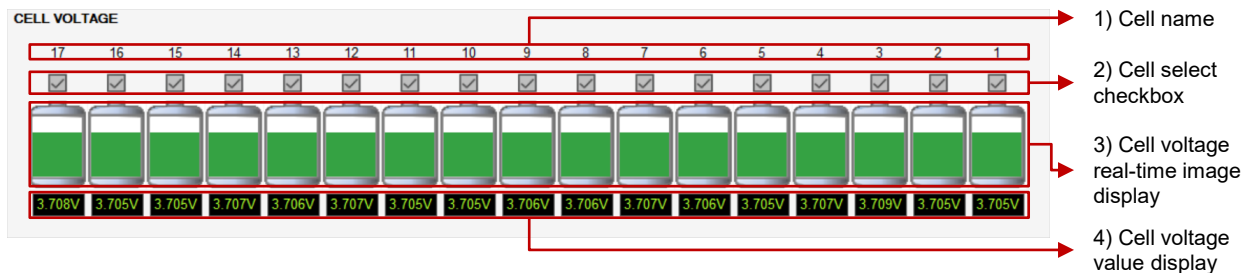


Figure 3.1.4 Main window – Cell Voltage

- 1) **Cell name** – Cell name of cell 1 to 17.
- 2) **Cell select checkbox** – to switch ON/OFF of cell voltage measurement individually:
 - Switch ON: checked (set corresponding bit of BMIC register 0x05 & 0x06 to “1”) .
 - Switch OFF: unchecked (set corresponding bit of BMIC register 0x05 & 0x06 to “0”).
- 3) **Cell voltage real-time image display** – to display timely visualization of dynamic cell voltage data retrieved from the BMIC via the MCU. Simultaneously, the statuses of UV, SV, OV and CB for the cells will be reflected.
- 4) **Cell voltage value display** – to display timely voltage value of cell voltage in volt (V) which is retrieved and converted from BMIC via MCU.
 - The cell voltage value displayed is conversion data from readout data of KA49701A BMIC Register 0x2D ~ 0x3D.
 - The PC GUI will regularly retrieve data from the BMIC through the MCU, ensuring that all the information displayed above is kept up-to-date.

D> Communication Status

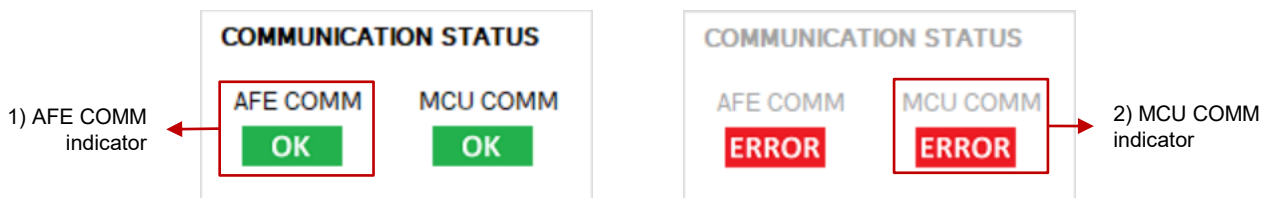


Figure 3.1.5 Main window - Communication Status

- 1) **AFE COMM indicator** – to indicate the status of AFE communication between MCU and BMIC.
 - Green indicator – “OK” means no AFE communication error
 - Red indicator – “ERROR” means AFE communication error
- 2) **MCU COMM indicator** – to indicate the status of MCU communication between PC GUI software and MCU.
 - Green indicator – “OK” means no MCU communication error
 - Red indicator – “ERROR” means MCU communication error

E> Log File Control



Figure 3.1.6 Main window - Log File Control

- 1) **Logfile Path display** – to display the log file path and file name.
- 2) **FILE button** – to set the log file location to store the data. The default location is in the 'LogFile' folder within the PC GUI software. There are two groups of data will be saved:
 - All log data – represents converted/unconverted data retrieved from the BMIC through the MCU at regular intervals, every 0.5 seconds. The data includes cell voltage (cell 1~17), CV17S voltage, VDD50 voltage, VREGEXT voltage, VDD15 voltage, VREF2 voltage, CVIL current, GPIO1&2 voltage and temperature (TMONI1~5). The following figure is an example of the data log output file, and the formatted default name of the file is “logAll-<yyMMdd-HHmm>.csv”.

Time	CV01(V)	...	CV17(V)	CV17S(V)	...	CVIL(A)	GPIO1(V)	...	TMONI5(deg)	CV01_AD	...	CV17_AD	CV17S_AD	...	CVIL_AD	GPIO1_AD	...	TMONI5_AD
14:45:25	3.703	...	3.699	63.534	...	0.1593	0.043	...	29.3	0x2f6e	...	0x2f60	0x2088	...	0x001d	0x008d	...	0x1cf6
14:45:25	3.703	...	3.699	63.542	...	0.1593	0.044	...	29.4	0x2f6d	...	0x2f5f	0x2089	...	0x001d	0x008f	...	0x1cf4
14:45:26	3.703	...	3.7	63.466	...	0.1593	0.041	...	29.4	0x2f6c	...	0x2f62	0x207f	...	0x001d	0x0087	...	0x1cf6
14:45:26	3.705	...	3.701	63.527	...	0.1593	0.041	...	29.3	0x2f74	...	0x2f65	0x2087	...	0x001d	0x0087	...	0x1cf8
14:45:27	3.702	...	3.699	63.55	...	0.1593	0.041	...	29.3	0x2f6b	...	0x2f60	0x208a	...	0x001d	0x0087	...	0x1cf6
14:45:27	3.704	...	3.705	63.542	...	0.1593	0.041	...	29.3	0x2f71	...	0x2f65	0x2088	...	0x001d	0x008f	...	0x1cf7
14:45:28	3.705	...	3.705	63.542	...	0.1593	0.041	...	29.3	0x2f73	...	0x2f65	0x2088	...	0x001d	0x008f	...	0x1cf6
14:45:28	3.703	...	3.703	63.542	...	0.1593	0.041	...	29.3	0x2f6d	...	0x2f65	0x2084	...	0x001e	0x008b	...	0x1cf6
14:45:29	3.702	...	3.701	63.504	...	0.1648	0.042	...	29.3	0x2f6b	...	0x2f65	0x2084	...	0x001d	0x008f	...	0x1cf9
14:45:29	3.704	...	3.699	63.481	...	0.1593	0.044	...	29.3	0x2f71	...	0x2f61	0x2081	...	0x001d	0x008f	...	0x1cf9
14:45:30	3.704	...	3.701	63.511	...	0.1593	0.042	...	29.3	0x2f6f	...	0x2f65	0x2085	...	0x001d	0x008b	...	0x1cf9
14:45:30	3.704	...	3.702	63.542	...	0.1593	0.042	...	29.3	0x2f6f	...	0x2f6a	0x2089	...	0x001d	0x008b	...	0x1cf9
14:45:31	3.705	...	3.701	63.481	...	0.1538	0.043	...	29.3	0x2f75	...	0x2f67	0x2081	...	0x001c	0x008c	...	0x1cf9
14:45:31	3.703	...	3.7	63.504	...	0.1593	0.044	...	29.3	0x2f6d	...	0x2f63	0x2084	...	0x001d	0x008f	...	0x1cf8

Figure 3.1.7 Example of the data log output file – All log data

- CVIL log data – represents converted low speed current (CVIL) data from the BMIC through the MCU at intervals of 250/62.5/31.25 msec, depending on the configured conversion time (by setting b13~b14 of BMIC register 0x1E). The logged data will be presented in the formats shown in the following figures. The default file name format is “logCVIL-<yyMMdd-HHmm>.csv”.

250ms

CVIL_AD conversion time is 250 ms:

Time	CVIL01(A)	CVIL02(A)	CVIL03(A)	CVIL04(A)	CVIL05(A)	CVIL06(A)	CVIL07(A)	CVIL08(A)
9:44:04	0.1703	0.1703						
9:44:04	0.1703	0.1703	0.1703					
9:44:05	0.1648	0.1648						
9:44:05	0.1703	0.1648						
9:44:06	0.1758	0.1703						
9:44:06	0.1703	0.1703						
9:44:07	0.1703	0.1703						
9:44:07	0.1703	0.1703						

CVIL_AD conversion time is 62.5 ms:

Time	CVIL01(A)	CVIL02(A)	CVIL03(A)	CVIL04(A)	CVIL05(A)	CVIL06(A)	CVIL07(A)	CVIL08(A)
9:51:57	0.1703	0.1593	0.1703	0.1758	0.1703	0.1703	0.1703	0.1648
9:51:57	0.1703	0.1703	0.1703	0.1703	0.1648	0.1703	0.1703	0.1703
9:51:58	0.1648	0.1703	0.1703	0.1648	0.1648	0.1648	0.1648	0.1758
9:51:58	0.1703	0.1648	0.1648	0.1703	0.1703	0.1703	0.1648	0.1703
9:51:59	0.1703	0.1648	0.1758	0.1758	0.1703	0.1703	0.1703	0.1703
9:51:59	0.1703	0.1648	0.1648	0.1758	0.1648	0.1703	0.1703	0.1703
9:52:00	0.1648	0.1648	0.1703	0.1648	0.1648	0.1703	0.1703	0.1703
9:52:00	0.1703	0.1703	0.1703	0.1703	0.1648	0.1703	0.1703	0.1758

62.5ms

31.25ms

CVIL_AD conversion time is 31.25 ms:

Time	CVIL01(A)	CVIL02(A)	CVIL03(A)	CVIL04(A)	CVIL05(A)	CVIL06(A)	CVIL07(A)	CVIL08(A)	CVIL09(A)	CVIL10(A)	CVIL11(A)	CVIL12(A)	CVIL13(A)	CVIL14(A)	CVIL15(A)	CVIL16(A)
9:50:30	0.1703	0.1648	0.1703	0.1648	0.1648	0.1758	0.1703	0.1648	0.1593	0.1703	0.1703	0.1703	0.1648	0.1703	0.1648	0.1703
9:50:30	0.1648	0.1703	0.1648	0.1648	0.1593	0.1703	0.1648	0.1648	0.1648	0.1648	0.1593	0.1703	0.1703	0.1703	0.1703	0.1703
9:50:31	0.1648	0.1648	0.1648	0.1648	0.1703	0.1648	0.1648	0.1648	0.1648	0.1648	0.1648	0.1648	0.1648	0.1648	0.1648	0.1538
9:50:31	0.1648	0.1648	0.1703	0.1593	0.1703	0.1648	0.1703	0.1703	0.1648	0.1593	0.1758	0.1648	0.1758	0.1648	0.1758	0.1648
9:50:32	0.1648	0.1703	0.1758	0.1758	0.1758	0.1648	0.1648	0.1593	0.1648	0.1703	0.1703	0.1758	0.1648	0.1758	0.1648	0.1703
9:50:32	0.1593	0.1703	0.1758	0.1648	0.1703	0.1758	0.1593	0.1703	0.1648	0.1703	0.1648	0.1648	0.1703	0.1703	0.1648	0.1648
9:50:33	0.1703	0.1703	0.1593	0.1758	0.1703	0.1758	0.1758	0.1648	0.1648	0.1758	0.1703	0.1758	0.1648	0.1703	0.1593	0.1648
9:50:33	0.1703	0.1593	0.1703	0.1703	0.1703	0.1648	0.1538	0.1703	0.1648	0.1703	0.1758	0.1758	0.1703	0.1593	0.1593	0.1703
9:50:34	0.1648	0.1648	0.1648	0.1758	0.1758	0.1593	0.1593	0.1648	0.1648	0.1648	0.1703	0.1593	0.1758	0.1813	0.1648	0.1648
9:50:34	0.1703	0.1703	0.1648	0.1648	0.1648	0.1593	0.1593	0.1648	0.1703	0.1758	0.1648	0.1703	0.1648	0.1648	0.1648	0.1648

Figure 3.1.8 Example of the data log output file – CVIL log data

- 3) **OPEN button** – to open the default location and select the log file (.csv). It's important to note that using this button to open the currently logged file is not recommended when the LOG OUTPUT is selected, as data cannot be logged while the log file is open.
- 4) **LOG OUTPUT select** – to start or stop the data log function, it can only be activated when a logfile location is chosen.

F> Mode

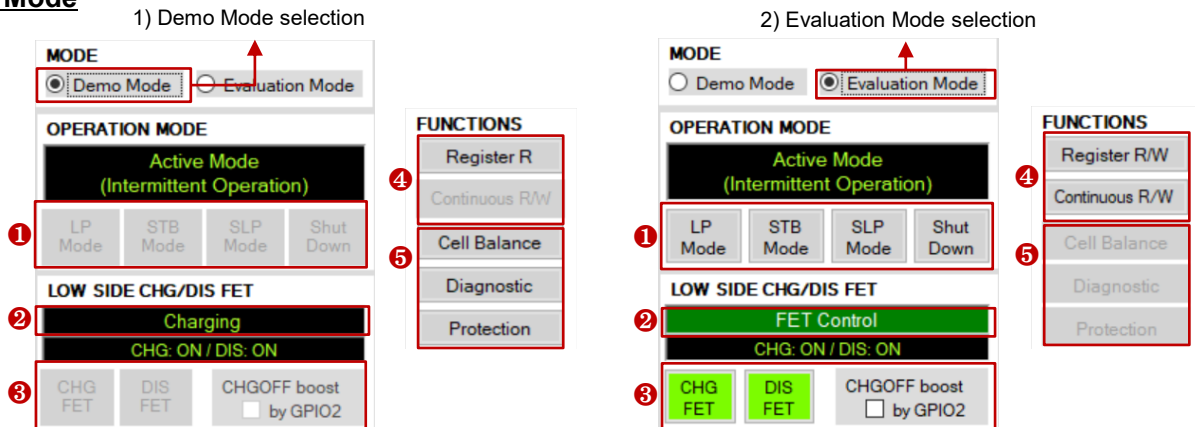


Figure 3.1.9 PC GUI appearance when Demo Mode & Evaluation Mode

- 1) **Demo Mode** – To restrict users from directly modifying registers through the Register R/W sub window and Continuous R/W sub window, and to limit their access to operation mode and manual FET ON/OFF control.
- 2) **Evaluation Mode** – to open-up register write features, continuous read/write function and provide access to operation mode and manual FET ON/OFF control. However, to mitigate the risk of potential malicious IC control, some demonstration functions such as Cell Balance, Diagnostic and Protection have been deactivated.

Table 3.1.1 provides a summary of the PC GUI appearance changes when either demo mode or evaluation mode is selected.

	Demo Mode	Evaluation Mode
① Operation Mode buttons	<ul style="list-style-type: none"> Buttons are greyed and disabled. LP Mode/STB Mode/SLP Mode/Shutdown functions are deactivated. 	<ul style="list-style-type: none"> Buttons are enabled. LP Mode/STB Mode/SLP Mode/Shutdown functions are activated.
② CHG/DIS FET status display	<ul style="list-style-type: none"> Status displays the MCU CHG/DIS FET status (e.g pre-charge, charging, discharging etc.) Black background. 	<ul style="list-style-type: none"> No more display about MCU CHG/DIS FET Status. Text changes to “FET Control”. Means allow user to turn ON/OFF FET manually. Green background.
③ CHG/DIS FET ON/OFF & CHGOFF boost selection	<ul style="list-style-type: none"> Buttons are greyed and disabled. CHG/DIS FET ON/OFF control functions are deactivated. CHGOFF boost selection is deactivated 	<ul style="list-style-type: none"> Buttons are enabled. CHG/DIS FET on/off control functions are activated. CHGOFF boost selection is activated
④ Register function button	<ul style="list-style-type: none"> Text on button: “Register R” - allow user to read registers only. Text on button: “Continuous R/W” – greyed and disabled 	<ul style="list-style-type: none"> Text on button: “Register R/W” - allow user to both read or write registers. Text on button: “Continuous R/W” - allow user to continuously read/write multiples register with time interval
⑤ Other functions buttons	<ul style="list-style-type: none"> Buttons are enabled. Cell Balance /Diagnostic/ Protection functions are activated. 	<ul style="list-style-type: none"> Buttons are greyed and disabled. Cell Balance/Diagnostic/Protection functions are deactivated.

Table 3.1.1 PC GUI appearance changes for Demo/Evaluation Mode

CHGOFF boost selection – to select the control method for the CHGOFF boost circuit.

CHGOFF boost circuits	Checkbox status	Description
Using GPIO2 pin	<div> <div>CHG FET</div> <div>DIS FET</div> <div>CHGOFF boost <input checked="" type="checkbox"/> by GPIO2</div> </div>	Set b1 of BMIC register 0x13 to “0” Set b11~b8 of BMIC register 0x13 to “1110”.
By CHG itself	<div> <div>CHG FET</div> <div>DIS FET</div> <div>CHGOFF boost <input type="checkbox"/> by GPIO2</div> </div>	Set b11~b8 of BMIC register 0x13 to “0000” (default).

Table 3.1.4 Charge/Discharge status display

G> Operation Mode

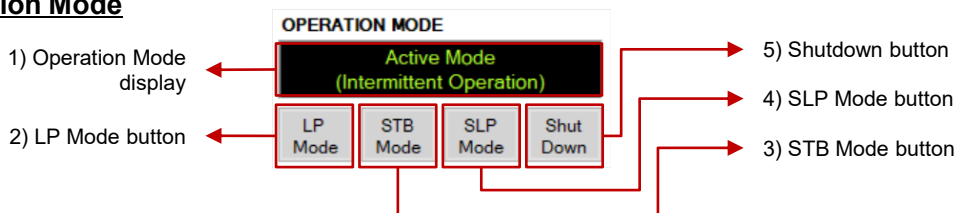


Figure 3.1.10 Main window – Operation Mode

1) Operation Mode display – to display the presently operation modes.

Operation Mode display	Description
“Active Mode (Intermittent Operation)”	b4~b1 of BMIC register 0x01 is “0000”.
“Low Power Mode (Intermittent Operation)”	b3 of BMIC register 0x01 is “1” .
“Standby Mode (Intermittent Operation)”	b4 of BMIC register 0x01 to “1”.
NO display when “Sleep”	b2 of BMIC register 0x01 is “1”.
NO display after “Shutdown”	b1 of BMIC register 0x01 is “1”.

Table 3.1.2 Description of Operation Mode display

- LP Mode button*** – to click and light ON button to transit BMIC to low power mode (set b3 of BMIC register 0x01 to “1”), clicking it again and light OFF button to transit BMIC back to Active mode (set b3 of BMIC register 0x01 to “0”). The same functionality applies to the other three buttons listed below.
- STB Mode button*** – to click and light ON button to transit BMIC to standby mode (set b4 of BMIC register 0x01 to “1”)
- SLP Mode button*** – to transit BMIC to sleep mode (set b2 of BMIC register 0x01 to “1”). The action will terminate the communication between MCU and AFE. Reset MCU is required to re-activate the PC GUI.

Note*: If either the VPC_H_F flag (0x2C[9]) or VPC_L_F flag (0x2C[8]) is detected when clicking the LP Mode, STB Mode, or SLP Mode button, the detected flag will be cleared first before entering the respective mode.

- Shutdown button** – to shutdown AFE (set b1 of BMIC register 0x01 to “1”). The action will shut down AFE board at first, it will result in the subsequent powering OFF of the MCU board as well. Reset MCU is required to re-activate the PC GUI.

The “Operation Mode” buttons are only enabled when in Evaluation Mode.

The “Operation Mode” buttons are only enabled when in Evaluation Mode.

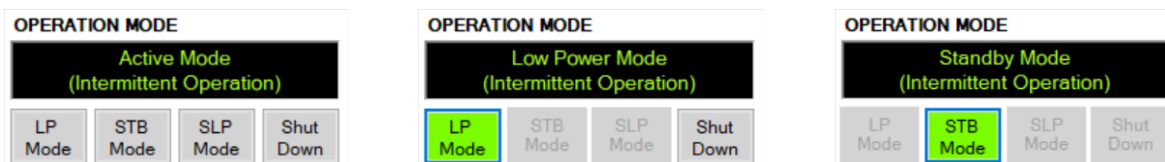


Figure 3.1.11 PC GUI appearance when Active/Low Power Mode/Standby Mode

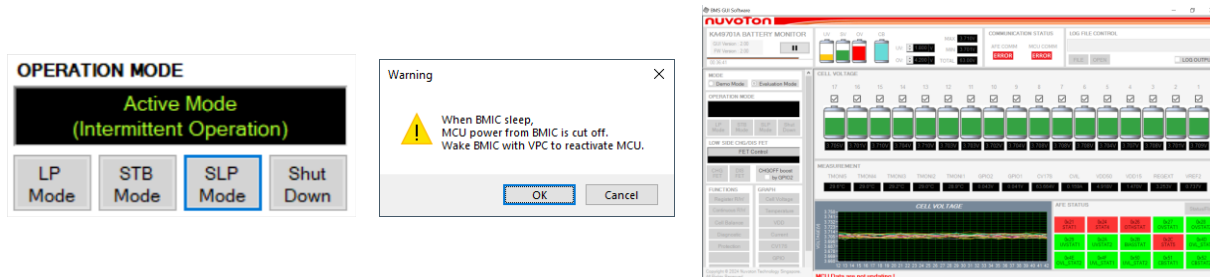


Figure 3.1.12 PC GUI appearance when Sleep

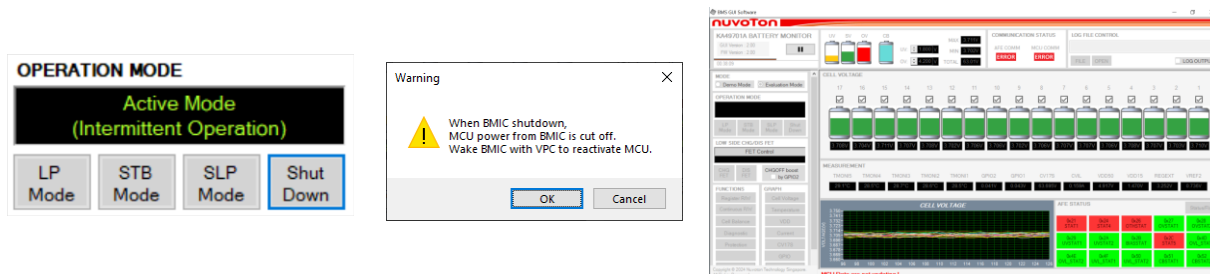


Figure 3.1.13 PC GUI appearance after Shutdown

H> Low Side CHG/DIS FET

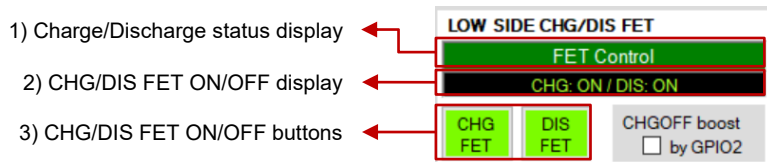


Figure 3.1.14 Main window – Low Side CHG/DIS FET (Evaluation Mode)

- 1) **Charge/Discharge status display** – to display status of Charge/Discharge feedback from MCU.
- 2) **CHG/DIS FET ON/OFF display** – to display the ON/OFF status of Charge/Discharge FET.
- 3) **CHG/DIS FET ON/OFF buttons** – to turn ON/OFF Charge/Discharge FET manually when in Evaluation Mode. To click and light ON button to turn ON FET, clicking it again and light OFF button to turn OFF FET.

The details of the Charge/Discharge status and FET status are described as table on next page.

Mode	Charge/Discharge Status		FET ON/OFF Status		Description
	State	Display	CHG	DIS	
Demo	Shutdown	"Shutdown"	OFF	OFF	Cell voltage < Shutdown Voltage Threshold (SVT).
	Starting	"Standby"	OFF	OFF	MCU start or recover from Shutdown / Failure.
	Normal	"Precharge"	ON	OFF	Cell voltage > Shutdown Voltage Threshold (SVT) and Cell voltage < Discharge Start Voltage (DSV).
		"Discharging"	ON	ON	Cell voltage > Discharge Start Voltage (DSV).
		"Charging"	ON	ON	Depend on Current is charge current (+) or discharge current (-).
		"Charging Complete"	OFF	ON	Cell voltage > Full Charge Voltage (FCV) and current is between Discharge Current at Full Charge and Charge Current at Full Charge.
	Failure	"Temporary Failure 1" (Orange text)	ON	OFF	Discharging Errors only such as Over Current Discharge (OCD) error, Short-Circuit Discharge (SCD) error, Under Voltage (UV) error, Over Temperature Discharge (OTD) or Under Temperature Discharge (UTD)
		"Temporary Failure 2" (Orange text)	OFF	ON	Charging Errors only such as Over Current Charge (OCC) error or Over Voltage (OV) error or Over Temperature Charge (OTC) or Under Temperature Charge (UTC)
		"Temporary Failure 3" (Orange text)	OFF	OFF	Both Charging and Discharging Errors occurred such OCC&UV error, or OCD/SCD & OV error, or OV&OTD or OV&UTD or UV&OTC or UV&UTC
		"Permanent Failure" (Red text)	OFF	OFF	Permanent Fail Over Voltage (PF OV)
Evaluation	Manual	"FET control" (Green)	-	-	CHG/DIS FET ON/OFF controlled by PC GUI manually.

Table 3.1.3 Description about status of Low Side Charge/Discharge FET

I> Functions

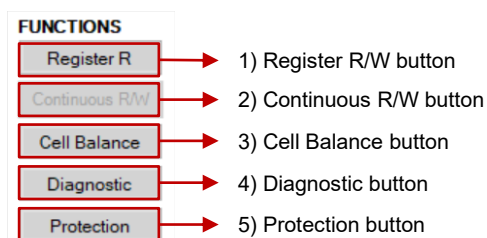


Figure 3.1.15 Main window – Functions

- 1) **Register R/W button** – to open the Register window for reading or writing BMIC registers, and viewing the register map of BMIC. The text on Register button displays “Register R” when in Demo Mode, but “Register R/W” when in Evaluation Mode.
- 2) **Continuous R/W button** – to open the Continuous Register Read/Write window for reading or writing BMIC registers continuously. The button is disabled when in Demo Mode.
- 2) **Cell Balance button** – to open the Cell Balance window for cell balancing setting. The button is disabled when in Evaluation Mode.
- 3) **Diagnostic button** – to open the Diagnostic window for diagnostic checking. The button is disabled when in Evaluation Mode.
- 4) **Protection button** – to open the Protection window for protection setting. The button is disabled when in Evaluation Mode.

The details of sub windows are described in following Chapter3.2.

J> Graph

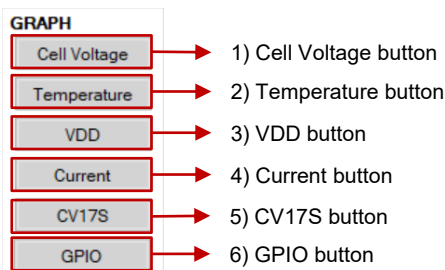


Figure 3.1.16 Main window – Graph

- 1) **Cell Voltage button** – to open the graph window of Cells Voltage.
- 2) **Temperature button** – to open the graph window of Temperature (TMONI1~5).
- 3) **VDD button** – to open the graph window of VDD50, VDD15, VREGEXT & VREF2 voltage.
- 4) **Current button** – to open the graph window of Low Speed current CVIL.
- 5) **CV17S button** – to open the graph window of CV17S voltage.
- 6) **GPIO button** – to open the graph window of GPIO1 & GPIO2 voltage.

The details of sub windows are described in following Chapter3.2.

K> Measurement



Figure 3.1.17 Main window – Measurement

- 1) **TMONI5 reading** – Read data from BMIC Register 0x43 via MCU and convert it to degree (°C).
- 2) **TMONI4 reading** – Read data from BMIC Register 0x42 via MCU and convert it to degree (°C).
- 3) **TMONI3 reading** – Read data from BMIC Register 0x41 via MCU and convert it to degree (°C).
- 4) **TMONI2 reading** – Read data from BMIC Register 0x40 via MCU and convert it to degree (°C).
- 5) **TMONI1 reading** – Read data from BMIC Register 0x3F via MCU and convert it to degree (°C).
- 6) **GPIO2 reading** – Read data from BMIC Register 0x46 via MCU and convert it to voltage (V).
- 7) **GPIO1 reading** – Read data from BMIC Register 0x45 via MCU and convert it to voltage (V).
- 8) **CV17S reading** – read data from BMIC Register 0x3E via MCU and convert it to voltage (V).
- 9) **CVIL reading** – Read data from BMIC Register 0x47 via MCU and convert it to ampere (A).
- 10) **VDD50 reading** – Read data from BMIC Register 0x44 via MCU and convert it to voltage (V).
- 11) **VDD15 reading** – Read data from BMIC Register 0x49 via MCU and convert it to voltage (V).
- 12) **REGEXT reading** – Read data from BMIC Register 0x4A via MCU and convert it to voltage (V).
- 13) **VREF2 reading** – Read data from BMIC Register 0x4B via MCU and convert it to voltage (V).

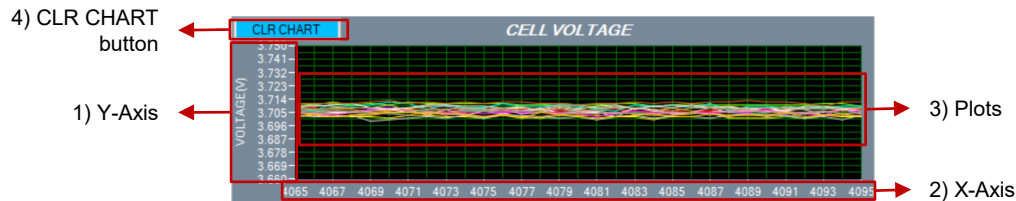
The voltage conversion is based on BMIC product standards.

The current conversion is based on current ADC register on BMIC product standards divided by shunt resistor on the AFE board, which is 1mΩ.

The temperature conversion depends on VDD50 voltage, internal pull up resistor of TMONI1~5 pin, TMONI1~5_AD voltage and thermistor characteristic.

The PC GUI will regularly retrieve data from the BMIC through the MCU, ensuring that all the information displayed above is kept up-to-date.

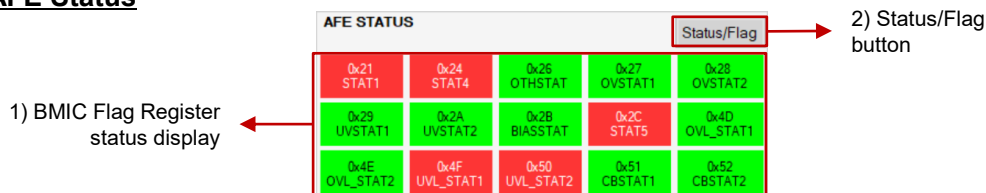
L> Cell Voltage Graph



- 1) **Y-Axis** – to represent the cell voltage value in Volts (V). The Y-axis ranges from 0V to 5V.
- 2) **X-Axis** – to represents the elapsed time with interval of 0.5 seconds between consecutive points. The maximum number of consecutive point is 4096.
- 3) **Plot** – to plot the 17 sets of cell voltage data acquired from the BMIC via MCU at intervals of 0.5 seconds for visualization. The data sets used consist of the same cell voltage measurements mentioned earlier in section “C> Cell Voltage”.
- 4) **CLR CHART button** – to reset the chart by clearing the existing data sets and re-plotting them. This action is particularly helpful when the chart reaches its maximum capacity of consecutive points (4096).

This cell voltage graph is the same with the CELL graph mentioned in Chapter 3.2’s sub-window, with the distinction that sub window offers more control over the graph.

M> AFE Status



- 1) **BMIC Flag Register status display** – to display the overview of status of BMIC Status/Flag Registers: 0x21, 0x24, 0x26, 0x27, 0x28, 0x29, 0x2A, 0x2B, 0x2C, 0x4D, 0x4E, 0x4F, 0x50, 0x51, 0x52.
 - Green – means all bits in status/flag register are “0”.
 - Red - means any bit in status/flag register turns to “1”.
- 2) **Status/Flag button** – to open the Status window for viewing the status of BMIC operation, fault status and Cells status.

The status sub-window retrieves data from the BMIC status register via the MCU and presenting information related to cell status, ongoing operations, and any detected faults.

The PC GUI will regularly retrieve data from the BMIC through the MCU, ensuring that all the information displayed above is kept up-to-date.

- i. **Status of AFE Operation & Fault page** – To display the status of status register which are grouped by functions. The table below presents the corresponding register addresses for each group of functions.

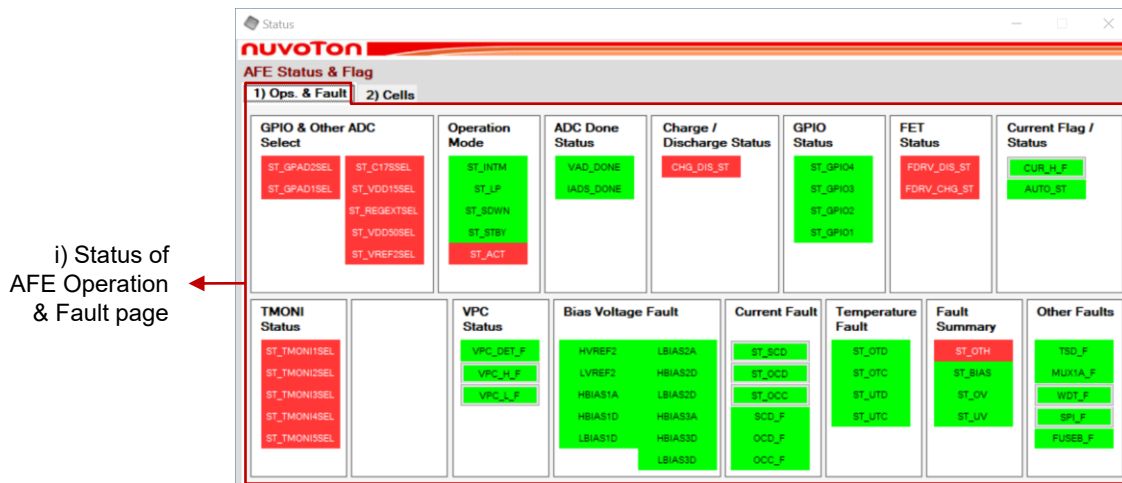


Figure 3.1.20 Sub Window – Status Function Status of AFE Operation & Fault page

Group by functions	Registers Address
GPIO & Other ADC Select	0x24 (b0, b2 ~ b4, b6 ~ b7, b13)
Operation Mode	0x21 (b0 ~ b4)
ADC Done Status	0x21 (b5, b7)
Charge/Discharge Status	0x26 (b12)
GPIO Status	0x21 (b12 ~ b15)
FET Status	0x21 (b10, b11)
Current Flag/Status	0x21 (b6) 0x2C (b12)
TMONI Status	0x24 (b8 ~ b12)
-	-
VPC Status	0x2C (b8, b9, b14)
Bias Voltage Fault	0x2B (b0 ~ b10)
Current Fault	0x26 (b5 ~ b7, b13 ~ b15)
Temperature Fault	0x2C (b4 ~ b7)
Fault Summary	0x2C (b0 ~ b3)
Other Faults	0x26 (b4, b8 ~ b10) 0x2C (b13)

Table 3.1.4 Corresponding register addresses for each group of function in Status of AFE Operation & Fault page

When hover mouse over the register labels, user can view the individual address of each register. Green indicates that the status of bit is "0", while red indicates that the status of bit is "1".

For example, in "TMONI Status" group, when hover mouse over the register label "ST_TMONI2SEL", there is a tip "Reg 0x24 b9" displayed for few seconds, which means this register refers to the bit 9 of register address 0x24 of BMIC, the status of current bit is "1".

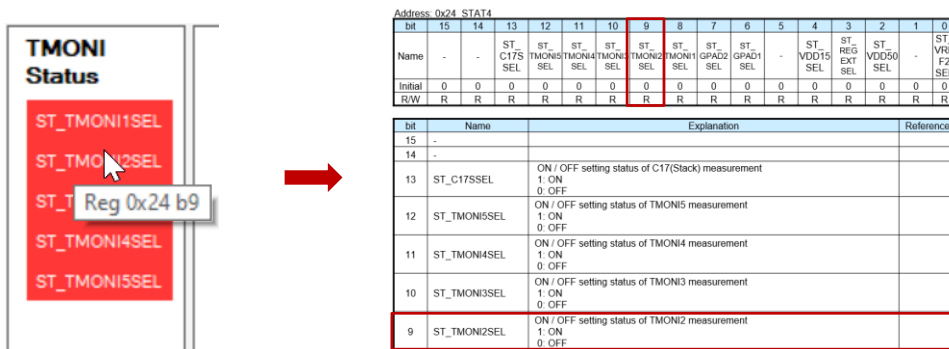


Figure 3.1.21 Example of status display and corresponding registers in BMIC Register Map

ii. **Status of Cells page** – To display the status of cell-related status register. The table below presents the corresponding register addresses for each group of functions.



Figure 3.1.22 Sub Window – Status Function Status of Cells page

When hover mouse over the register labels, user can view the individual addresses of each register. Green indicates that the status of bit is "0", while red indicates that the status of bit is "1".

Group by functions	Registers Address
Cell Select Status	0x22 (b0 ~ b15) & 0x23 (b0)
OV/OTD/OTC Flag	0x27 (b0 ~ b15) & 0x28 (b0 ~ b10)
UV/UTD/UTC Flag	0x29 (b0 ~ b15) & 0x2A (b0 ~ b10)
OV/OTD/OTC History	0x4D (b0 ~ b15) & 0x4E (b0 ~ b10)
UV/UTD/UTC History	0x4F (b0 ~ b15) & 0x50 (b0 ~ b10)

Table 3.1.5 Corresponding register addresses for each group of function in Status of Cells page

Error Flag Buttons

There are 8x Error Flag Buttons in Status of Operation & Fault page and 2x Error Flag Buttons in Status of Cells page, which are used to manually clear flag by writing “1” to the specific bit of register.

Red button indicates that the status of the bit is “1,” meaning the flag is up. After clicking the button to set the bit to “1” in the register to clear the flag, the button will turn green, indicating that the flag has been cleared.

Below tables describe the details of error flag buttons.

Error Flag Buttons (in Ops.& Fault page)		Error Flag Buttons (in Cells page)																																																															
ST_SCD 0x26 (b15)	Current Fault <div><div>ST_SCD</div><div>ST_OCD</div><div>ST_OCC</div><div>SCD_F</div><div>OCD_F</div><div>OCC_F</div></div>	WTD_F 0x26 (b13)	Other Faults <div><div>TSD_F</div><div>MUX1A_F</div><div>WDT_F</div><div>SPI_F</div><div>FUSEB_F</div></div>	OV/OTD/OTC History 0x4D (b0 ~ b15) & 0x4E (b0 ~ b10)	<div><div>OV/OTD/OTC History<table><tr><td>OV15_F</td><td>-</td></tr><tr><td>OV14_F</td><td>-</td></tr><tr><td>OV13_F</td><td>-</td></tr><tr><td>OV12_F</td><td>-</td></tr><tr><td>OV11_F</td><td>OTD3_F</td></tr><tr><td>OV10_F</td><td>OTD4_F</td></tr><tr><td>OV9_F</td><td>OTD3_F</td></tr><tr><td>OV8_F</td><td>OTD3_F</td></tr><tr><td>OV7_F</td><td>OTD3_F</td></tr><tr><td>OV6_F</td><td>OTD3_F</td></tr><tr><td>OV5_F</td><td>OTD3_F</td></tr><tr><td>OV4_F</td><td>OTD3_F</td></tr><tr><td>OV3_F</td><td>OTD3_F</td></tr><tr><td>OV2_F</td><td>OTD3_F</td></tr><tr><td>OV1_F</td><td>OTD3_F</td></tr></table></div><div>UV/UTD/UTC History<table><tr><td>UV15_F</td><td>-</td></tr><tr><td>UV14_F</td><td>-</td></tr><tr><td>UV13_F</td><td>-</td></tr><tr><td>UV12_F</td><td>-</td></tr><tr><td>UV11_F</td><td>UTD3_F</td></tr><tr><td>UV10_F</td><td>UTD4_F</td></tr><tr><td>UV9_F</td><td>UTD3_F</td></tr><tr><td>UV8_F</td><td>UTD3_F</td></tr><tr><td>UV7_F</td><td>UTD3_F</td></tr><tr><td>UV6_F</td><td>UTD3_F</td></tr><tr><td>UV5_F</td><td>UTD3_F</td></tr><tr><td>UV4_F</td><td>UTD3_F</td></tr><tr><td>UV3_F</td><td>UTD3_F</td></tr><tr><td>UV2_F</td><td>UTD3_F</td></tr><tr><td>UV1_F</td><td>UTD3_F</td></tr></table></div></div>	OV15_F	-	OV14_F	-	OV13_F	-	OV12_F	-	OV11_F	OTD3_F	OV10_F	OTD4_F	OV9_F	OTD3_F	OV8_F	OTD3_F	OV7_F	OTD3_F	OV6_F	OTD3_F	OV5_F	OTD3_F	OV4_F	OTD3_F	OV3_F	OTD3_F	OV2_F	OTD3_F	OV1_F	OTD3_F	UV15_F	-	UV14_F	-	UV13_F	-	UV12_F	-	UV11_F	UTD3_F	UV10_F	UTD4_F	UV9_F	UTD3_F	UV8_F	UTD3_F	UV7_F	UTD3_F	UV6_F	UTD3_F	UV5_F	UTD3_F	UV4_F	UTD3_F	UV3_F	UTD3_F	UV2_F	UTD3_F	UV1_F	UTD3_F
OV15_F		-																																																															
OV14_F		-																																																															
OV13_F	-																																																																
OV12_F	-																																																																
OV11_F	OTD3_F																																																																
OV10_F	OTD4_F																																																																
OV9_F	OTD3_F																																																																
OV8_F	OTD3_F																																																																
OV7_F	OTD3_F																																																																
OV6_F	OTD3_F																																																																
OV5_F	OTD3_F																																																																
OV4_F	OTD3_F																																																																
OV3_F	OTD3_F																																																																
OV2_F	OTD3_F																																																																
OV1_F	OTD3_F																																																																
UV15_F	-																																																																
UV14_F	-																																																																
UV13_F	-																																																																
UV12_F	-																																																																
UV11_F	UTD3_F																																																																
UV10_F	UTD4_F																																																																
UV9_F	UTD3_F																																																																
UV8_F	UTD3_F																																																																
UV7_F	UTD3_F																																																																
UV6_F	UTD3_F																																																																
UV5_F	UTD3_F																																																																
UV4_F	UTD3_F																																																																
UV3_F	UTD3_F																																																																
UV2_F	UTD3_F																																																																
UV1_F	UTD3_F																																																																
ST_OCD 0x26 (b14)	SPI_F 0x26 (b8)	Set “FFFF” to 0x4D & 0x4E to clear flags																																																															
ST_OCC 0x26 (b13)																																																																	
CUR_H_F 0x26 (b12)	Current Flag / Status <div><div>CUR_H_F</div><div>AUTO_ST</div></div>	VPC_H_F 0x26 (b8)	VPC Status <div><div>VPC_DET_F</div><div>VPC_H_F</div><div>VPC_L_F</div></div>	UV/UTD/UTC History 0x4F (b0 ~ b15) & 0x50 (b0 ~ b10)	<div><div>OV/OTD/OTC History<table><tr><td>OV15_F</td><td>-</td></tr><tr><td>OV14_F</td><td>-</td></tr><tr><td>OV13_F</td><td>-</td></tr><tr><td>OV12_F</td><td>-</td></tr><tr><td>OV11_F</td><td>OTD3_F</td></tr><tr><td>OV10_F</td><td>OTD4_F</td></tr><tr><td>OV9_F</td><td>OTD3_F</td></tr><tr><td>OV8_F</td><td>OTD3_F</td></tr><tr><td>OV7_F</td><td>OTD3_F</td></tr><tr><td>OV6_F</td><td>OTD3_F</td></tr><tr><td>OV5_F</td><td>OTD3_F</td></tr><tr><td>OV4_F</td><td>OTD3_F</td></tr><tr><td>OV3_F</td><td>OTD3_F</td></tr><tr><td>OV2_F</td><td>OTD3_F</td></tr><tr><td>OV1_F</td><td>OTD3_F</td></tr></table></div><div>UV/UTD/UTC History<table><tr><td>UV15_F</td><td>-</td></tr><tr><td>UV14_F</td><td>-</td></tr><tr><td>UV13_F</td><td>-</td></tr><tr><td>UV12_F</td><td>-</td></tr><tr><td>UV11_F</td><td>UTD3_F</td></tr><tr><td>UV10_F</td><td>UTD4_F</td></tr><tr><td>UV9_F</td><td>UTD3_F</td></tr><tr><td>UV8_F</td><td>UTD3_F</td></tr><tr><td>UV7_F</td><td>UTD3_F</td></tr><tr><td>UV6_F</td><td>UTD3_F</td></tr><tr><td>UV5_F</td><td>UTD3_F</td></tr><tr><td>UV4_F</td><td>UTD3_F</td></tr><tr><td>UV3_F</td><td>UTD3_F</td></tr><tr><td>UV2_F</td><td>UTD3_F</td></tr><tr><td>UV1_F</td><td>UTD3_F</td></tr></table></div></div>	OV15_F	-	OV14_F	-	OV13_F	-	OV12_F	-	OV11_F	OTD3_F	OV10_F	OTD4_F	OV9_F	OTD3_F	OV8_F	OTD3_F	OV7_F	OTD3_F	OV6_F	OTD3_F	OV5_F	OTD3_F	OV4_F	OTD3_F	OV3_F	OTD3_F	OV2_F	OTD3_F	OV1_F	OTD3_F	UV15_F	-	UV14_F	-	UV13_F	-	UV12_F	-	UV11_F	UTD3_F	UV10_F	UTD4_F	UV9_F	UTD3_F	UV8_F	UTD3_F	UV7_F	UTD3_F	UV6_F	UTD3_F	UV5_F	UTD3_F	UV4_F	UTD3_F	UV3_F	UTD3_F	UV2_F	UTD3_F	UV1_F	UTD3_F
OV15_F		-																																																															
OV14_F		-																																																															
OV13_F	-																																																																
OV12_F	-																																																																
OV11_F	OTD3_F																																																																
OV10_F	OTD4_F																																																																
OV9_F	OTD3_F																																																																
OV8_F	OTD3_F																																																																
OV7_F	OTD3_F																																																																
OV6_F	OTD3_F																																																																
OV5_F	OTD3_F																																																																
OV4_F	OTD3_F																																																																
OV3_F	OTD3_F																																																																
OV2_F	OTD3_F																																																																
OV1_F	OTD3_F																																																																
UV15_F	-																																																																
UV14_F	-																																																																
UV13_F	-																																																																
UV12_F	-																																																																
UV11_F	UTD3_F																																																																
UV10_F	UTD4_F																																																																
UV9_F	UTD3_F																																																																
UV8_F	UTD3_F																																																																
UV7_F	UTD3_F																																																																
UV6_F	UTD3_F																																																																
UV5_F	UTD3_F																																																																
UV4_F	UTD3_F																																																																
UV3_F	UTD3_F																																																																
UV2_F	UTD3_F																																																																
UV1_F	UTD3_F																																																																
	VPC_L_F 0x26 (b13)	Set “FFFF” to 0x4F & 0x50 to clear flags																																																															
Set individual bit to “1” to clear flag																																																																	

Table 3.1.6 Error flag buttons in Status of Operation & Fault page

Table 3.1.7 Error flag buttons in Status of Cells page

N> Communication Status Message



Figure 3.1.23 Main window – Communication Status Message

Communication Status Message – To display text message regarding the AFE and MCU communication status in the BMS PC GUI Software.

3.2 Sub Window

In addition to the main window, there are subsidiary windows integrated to facilitate specific functions.

The sub windows like Register Read/Write function, Continuous Read/Write function, Status display function, Cell balance setting function, Diagnostic check function and protection function and Graphs.

3.2.1 Functions – Register R/W

The sub window for Functions can be accessed from main window through the following buttons.

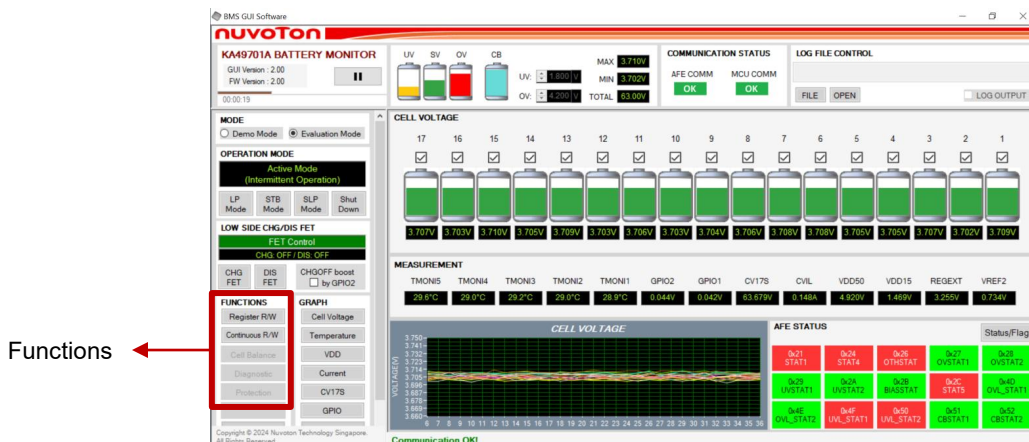


Figure 3.2.1 Functions buttons

The Register R/W sub window consists of 2 main parts:

- Register R/W - used to read data from or write data to BMIC registers via MCU.
- Register Map – used to display the most up-to-date readout data for each bit for reference.

Refer to the details of each part on the following page.

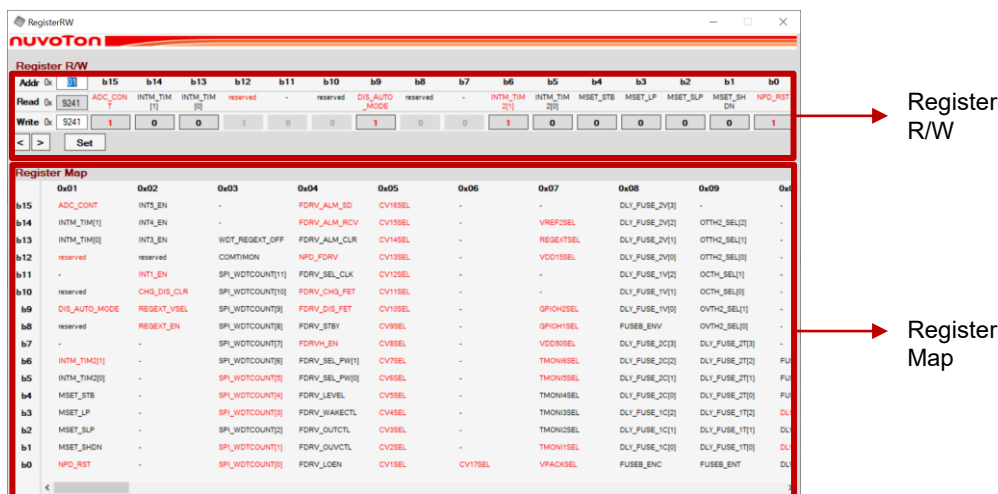


Figure 3.2.2 Sub Window – Register R/W Function

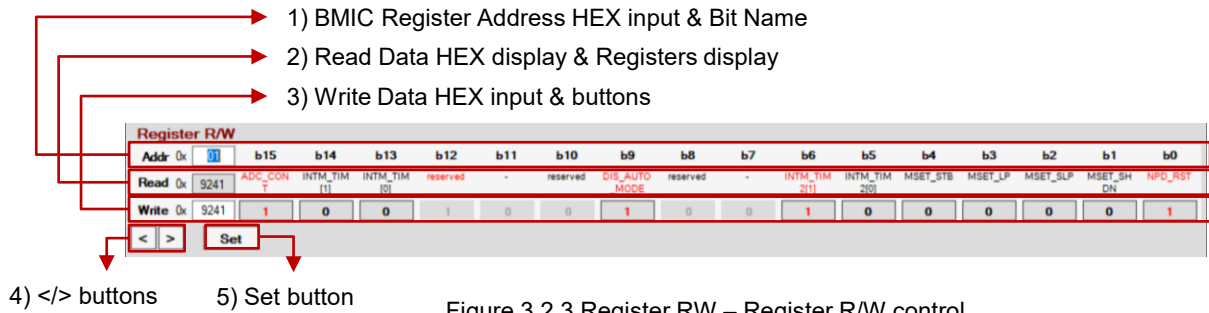


Figure 3.2.3 Register RW – Register R/W control

- 1) **BMIC Register Address HEX input & Bit Name** – to input a 1-byte hexadecimal number as the BMIC register address to read back BMIC data via the MCU. The bit names for the register address are designated as "b15~b0".
- 2) **Read Data HEX display & Registers display** – to display the readout data from BMIC via MCU. The readout data format is a 2-bytes hexadecimal number. BMIC registers and their status under the specified Register Address are shown accordingly. The color of the text corresponds to the high (H) or low (L) bit of a specific register (Black : "0" & Red : "1").
- 3) **Write Data HEX input & Buttons** – to input a 2-byte hexadecimal number to write data to the specified BMIC register address via the MCU. The buttons allow the setting of individual bits in the BMIC registers to '0' or '1.' Disabled buttons indicate that the corresponding registers are read-only. The control of the Write Data HEX input and buttons is interdependent.
- 4) **</> buttons** – are used to navigate the previous/next BMIC register.
- 5) **Set button** – to write the current data into specific BMIC register via MCU.

When data acquisition of PC GUI from BMIC via MCU is paused (Pause/Play button - "▶"), clicking the Set button by the user will resume the data acquisition.

Please be aware that items 3) and 5) are visible and functional exclusively in Evaluation Mode, while they remain hidden and inactive in Demo Mode.

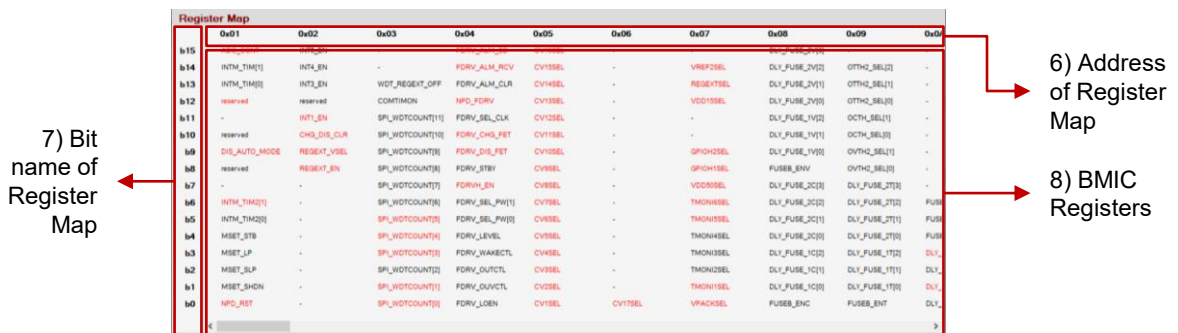


Figure 3.2.4 Register RW – Register Map

- 6) **Address of Register Map** – Register address of KA49701A register map (0x01 to 0x5B).
- 7) **Bit name of Register Map** – Bit name of each register address (for 16 bits).
- 8) **BMIC Registers** – Registers of KA49701A BMIC. The color of the text corresponds to the high (H) or low (L) bit of a specific register (Black : "0" & Red : "1").

The PC GUI will regularly retrieve data from the BMIC through the MCU, ensuring that all the information displayed above is kept up-to-date.

3.2.3 Functions – Continuous R/W

The Continuous R/W sub window is used to read/write data continuously to BMIC registers via MCU.

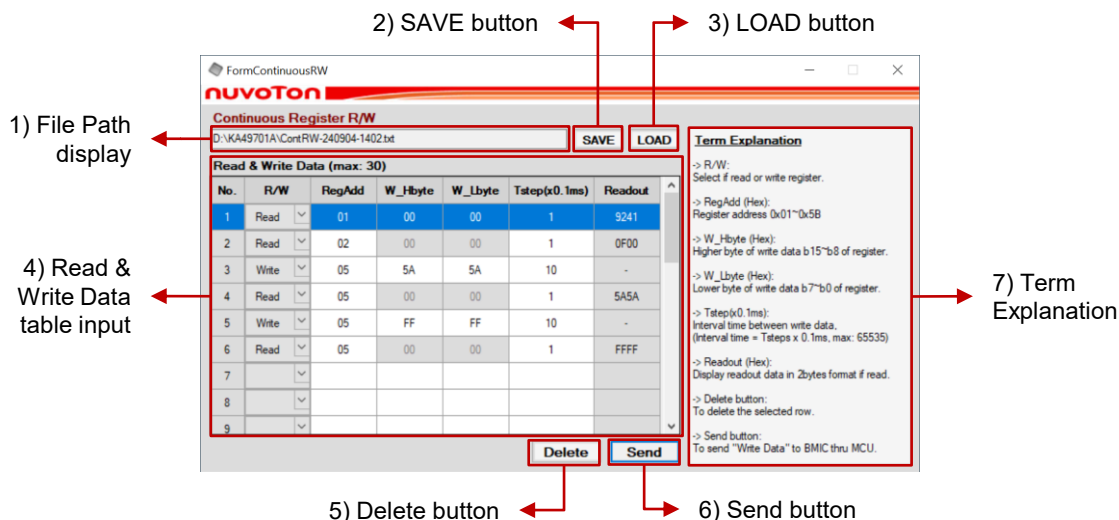


Figure 3.2.5 Sub Window – Continuous Register Read/Write Function

- 1) **File Path display** – to display the path/file name of the setting file.
- 2) **SAVE button** – to set the location to store the read/write data file and save the current read/write data into data file. The default location is in “ContRWData” folder within PC GUI software and the default name is “ContRW-<yyMMDD-HHmm>.txt”.

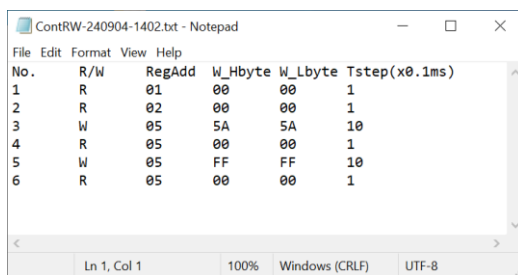


Figure 3.2.6 Example of read/write data file (.txt)

- 3) **LOAD button** – to open the read/write data file and load the read/write data.
- The format of the text file should remain the same as the example above, adhering to the fixed formatting requirements.
- 4) **Read & Write Data table input** – to input sets of read/write data. Each set includes data number, read or write selection, the register address, higher byte and lower byte of write data, the interval time, and the readout data if read. The maximum sets of write data is 30.
 - 5) **Delete button** – to delete the selected row in Read & Write Data table.
 - 6) **Send button** – to send data of Read & Write Data table to BMIC via MCU.
 - 7) **Term Explanation** – To explain the meaning of the terms that appear in the Read & Write Data table and provide guidance.

When data acquisition of PC GUI from BMIC via MCU is paused (Pause/Play button - “▶”), clicking the Send button by the user will resume the data acquisition.

3.2.3 Functions – Cell Balance

The Cell Balance sub window is used to demonstrate the cell balance function of the BMIC. Users have the capability to configure Cell Balance ON/OFF settings with timing sequence control and send commands to the BMIC via MCU. This interaction results in the visual representation of cell performance in main window.

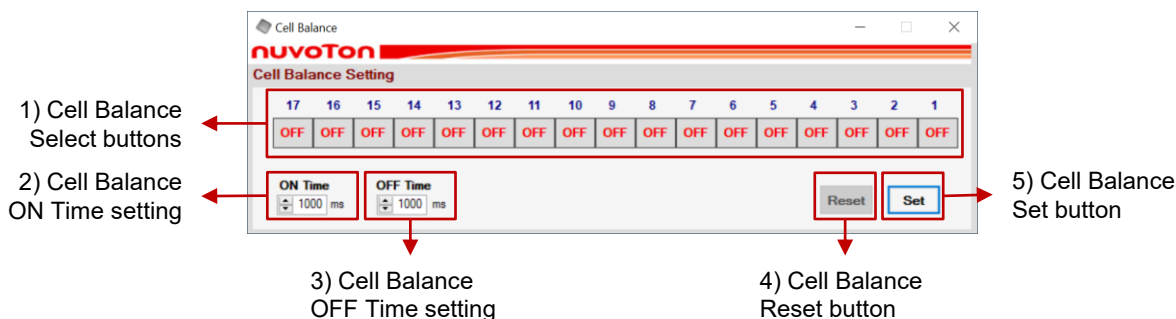


Figure 3.2.7 Sub Window – Cell Balance Function

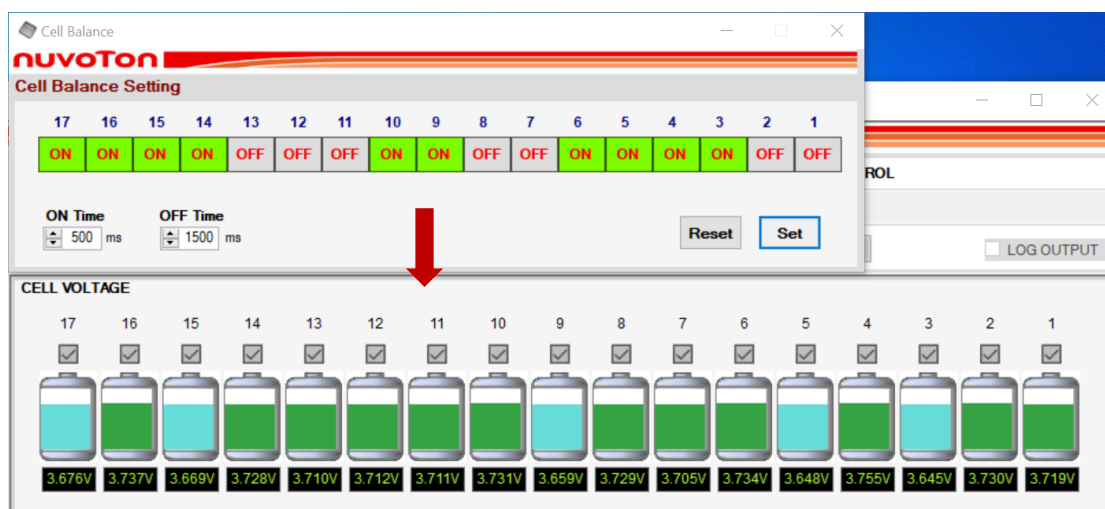


Figure 3.2.8 Example of visual representation of Cell Balance Function

- 1) Cell Balance Select buttons** – consists of 17 buttons to set ON/OFF for individual channel during cell balancing. This setting corresponds to the DI_CBSEL register of BMIC.
 - “OFF”(grey) means specific channel not selected for cell balancing, to set DI_CBSEL[x] bit to “0”. (default setting)
 - “ON” (green) means specific channel selected for cell balancing, to set DI_CBSEL[x] bit to “1”.
- 2) Cell Balance ON Time setting** – to set the ON time of cell balancing.
- 3) Cell Balance OFF Time setting** – to set the OFF time of cell balancing.

Both default ON/OFF time is 1000ms (minimum: 500ms, maximum: 1500ms, step: 100ms)

4) **Cell Balance Reset button** – the reset button is enabled only after cell balance is set. Click the button to reset the cell balance settings and send data to BMIC via MCU.

5) **Cell Balance Set button** – to send the cell balance settings to BMIC via MCU.

When data acquisition of PC GUI from BMIC via MCU is paused (Pause/Play button - “▶”), clicking the Reset or Set button by the user will resume the data acquisition.

The sequence to do Cell Balance setting is:

- 1> Set the channel ON/OFF for cell balance
- 2> Set the ON/OFF time
- 3> Click “Set” button to send command

The PC GUI will pop-up error message to the user in case of incorrect actions or other faults. The error messages and their explanation are illustrated in following table.

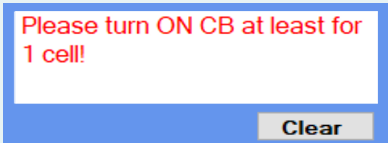
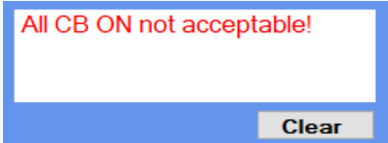
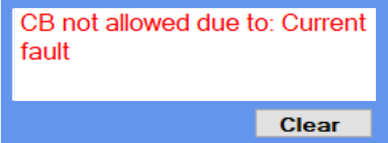
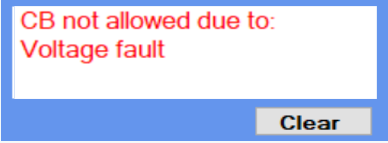
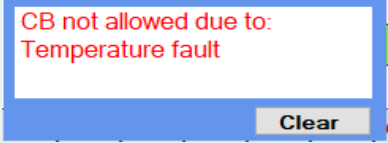
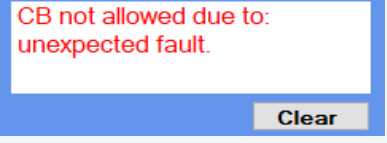
Pop-up alert message	Explanation
	If click “Set” button when NO cell selected for cell balance.
	If click “Set” button when All cells selected for cell balance.
	If current fault occurs (OCC / OCD / SCD).
	If voltage fault occurs (UV / OV).
	If temperature fault occurs (UTC / UTD / OTC / OTD).
	If other unexpected faults occur.

Table 3.2.1 Pop-up error message of Cell Balance Function

3.2.4 Functions – Diagnostic

The Diagnostic sub window is used to demonstrate the safety diagnostic function of the BMIC. Users have the capability to do diagnostic check on BMIC which is described in datasheet of KA49701A. The results of diagnostic check will be displayed after checking for a particular item.

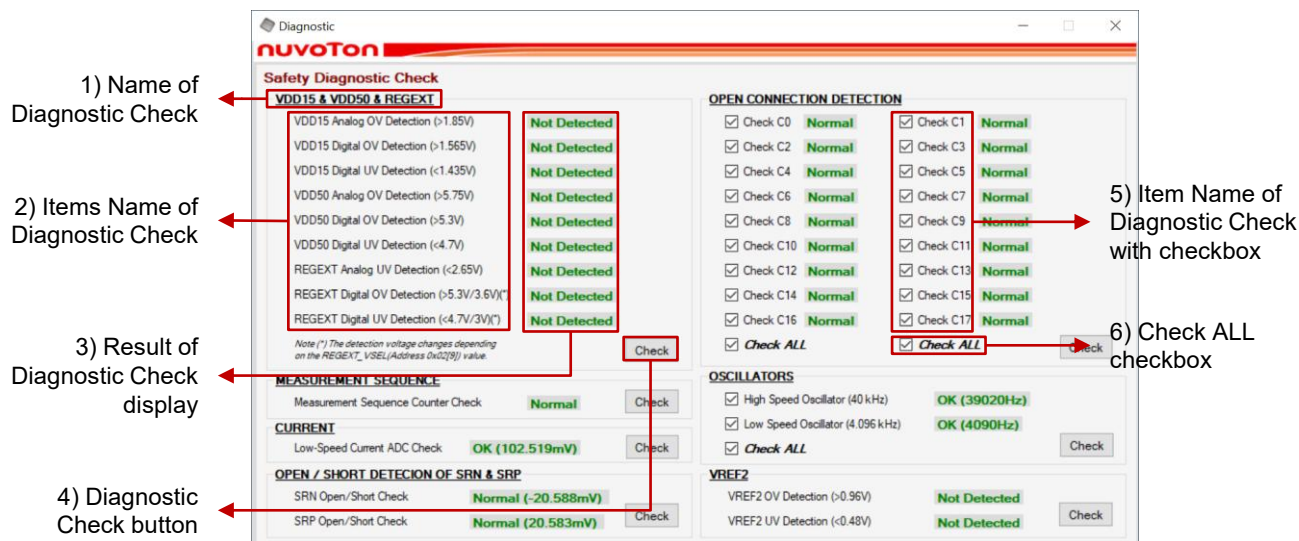


Figure 3.2.9 Sub Window – Diagnostic Function

- 1) **Name of Diagnostic Check** – to specify the name of Safety Diagnostic Check. There are a total of 7 types of Safety Diagnostic Check included in Diagnostic sub window.
- 2) **Item Name of Diagnostic Check** – to specify the item name of Safety Diagnostic Check.
- 3) **Result of Diagnostic Check display** – to display result of Diagnostic Check for each item. The result is displayed using colored text.
 - Green – means OK, no abnormality detected
 - Red – means NG, abnormal detected
- 4) **Diagnostic Check button** – to send the command to MCU for specific diagnostic checking. Only one type of Diagnostic Check is allowed at one time.
- 5) **Item Name of Diagnostic Check with checkbox** – to specify the item name of Safety Diagnostic Check and to select the item for checking.
- 6) **Check ALL checkbox** – to select all items above the checkbox for specific type of Safety Diagnostic Check for checking.

Each type of Safety Diagnostic Check includes one or more checking items. The details of Diagnostic Check are illustrated in following table.

Diagnose Items		Result Display	
		OK (Green)	NG (Red)
VDD15 & VDD50 & REGEXT			
	VDD15 Analog OV Detection (>1.85V)	Not Detected	Detected
	VDD15 Digital OV Detection (>1.565V)		
	VDD15 Digital UV Detection (<1.435V)		
	VDD50 Analog OV Detection (>5.75V)		
	VDD50 Digital OV Detection (>5.3V)		
	VDD50 Digital UV Detection (<4.7V)		
	REGEXT Analog UV Detection (<2.65V)(*)		
	REGEXT Digital OV Detection (>5.3V/3.6V)(*)		
	REGEXT Digital UV Detection (<4.7V/3V)(*)		
MEASUREMENT SEQUENCE			
	Measurement Sequence Counter Check	Normal	Abnormal
CURRENT			
	Low-speed Current ADC Check	OK + CVIL_AD reading <Within range of 100mV (+/-10mV)>	NG + CVIL_AD reading <Out of range of 100mV (+/-10mV)>
OPEN/SHORT DETECTION OF SRN & SRP			
	SRN Open/Short Check	Normal + CVIL_AD reading <Within range of CVIL_AD (+/-2mV)>	Open + CVIL_AD reading <Within range of CVIL_AD (+/-10mV) > OR: Short + CVIL_AD reading <Within range of CVIL_AD (+/-2mV)>
	SRP Open/Short Check		
OPEN CONNECTION DETECTION			
	Check C0~C17	Normal	Opened
OSCILLATORS			
	High Speed Oscillator (40kHz)	OK + Frequency <Within range of Frequency (+/- 5%)>	NG + Frequency <Out of range of Frequency (+/- 5%)>
	Low Speed Oscillator (4.096kHz)		
VREF2			
	VREF2 OV Detection (>0.96V)	Not Detected	Detected
	VREF2 UV Detection (<0.48V)		

Note (*) : The detection voltage changes depending on the REGEXT_VSEL (Address 0x02[9]) value.

Table 3.2.2 The details of Diagnostic Check

3.2.5 Functions – Protection

The Protection sub window is used to demonstrate the protection function of our reference BMS solution. MCU firmware sets multiple parameters in three aspects (voltage/current/temperature) to enhance the protection of BMS. For example, when configuring voltage protection, a range of threshold values is defined for system protection. This progression begins with the lowest shutdown voltage threshold (SVT), proceeds to the Hard Under Voltage threshold (HUV), and culminates at the highest Permanent Fail Over Voltage (PFOV). Users can read and write protection value settings from and to the MCU as per their requirement. Additionally, users can save and load these settings for future use.

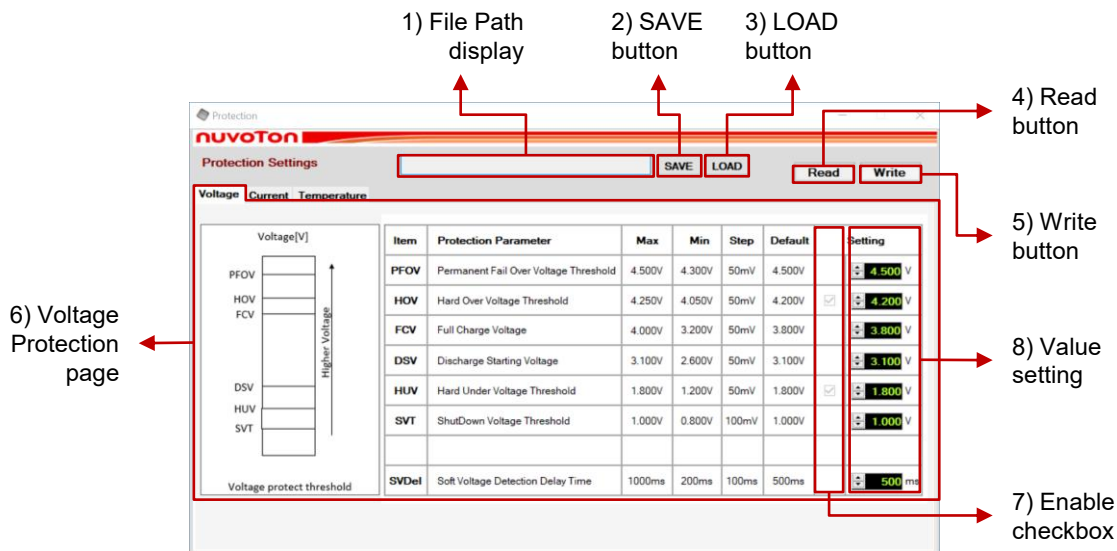


Figure 3.2.10 Sub Window – Protection Function Voltage Protection page

- 1) **File Path display** – to display the path/file name of the setting file.
 - 2) **SAVE button** – to set the location to store the setting file and save the current setting into setting file. The default location is in “SettingsFile” folder within PC GUI software and the default name is “pro-<yyMMDD-HHmm>.csv”.
 - 3) **LOAD button** – to open the setting file and load the settings.
 - 4) **READ button** – to read the settings from MCU.
 - 5) **Write button** – to write the settings to MCU.
- Setting file refers to the .csv file to store all protection settings which includes voltage/current/temperature setting value and enable status.
- When data acquisition of PC GUI from BMIC via MCU is paused (Pause/Play button - “▶”), clicking the Write button by the user will resume the data acquisition.
- 6) **Voltage Protection page** – contains voltage-related protection parameters and their detailed explanations for quick reference.
 - 7) **Enable checkbox** – to enable/disable the specific parameter in MCU FW.
 - 8) **Value setting** – to set the value for specific item.

9) Current Protection page

The screenshot shows the 'Protection Settings' window with the 'Current' tab selected. On the left, a graph shows 'Current[A]' on the y-axis and 'Charge' (upward arrow) and 'Discharge' (downward arrow) on the x-axis. Three horizontal lines represent thresholds: HOCC (top), HOCD (middle), and HSCD (bottom). A label 'Current protect threshold' points to the HOCD line. On the right, a table lists the parameters:

Item	Protection Parameter	Max	Min	Step	Default	Setting
HOCC	Hard Over Current Charge Threshold	20A	5A	5A	10A	10 A
HOCD	Hard Over Current Discharge Threshold	40A	10A	10A	20A	20 A
HSCD	Hard Short Circuit Detection at DischargeThreshold	100A	20A	20A	40A	40 A
OTUT_ITH	Current Threshold to switch between Charging and Discharging	3500mA	0mA	175mA	1400mA	1400 mA

At the bottom, 'Current Sensing Resistor' is set to 1.000mΩ. A note states: 'Shunt Resistor fixed 1mOhm. If system going to use different value of shunt resistor, both MCU FW and GUI SW need to change.'

Figure 3.2.11 Sub Window – Protection Function Current Protection page

10) Temperature Protection page

The screenshot shows the 'Protection Settings' window with the 'Temperature' tab selected. On the left, a graph shows 'Temperature[degree.C]' on the y-axis and 'Higher Temperature' (upward arrow) on the x-axis. Two horizontal lines represent thresholds: HOTD1, HOTD2 (top) and HUTC1, HUTC2 (bottom). A label 'Temperature protect threshold' points to the HUTC1, HUTC2 line. On the right, a table lists the parameters:

Item	Protection Parameter	Max	Min	Step	Default	Setting
HOTD1	Hard Over Temperature Discharge Threshold for (Grp1)	90°C	60°C	1°C	80°C	80 °C
HOTD2	Hard Over Temperature Discharge Threshold (Grp2)	90°C	60°C	1°C	80°C	80 °C
HOTC1	Hard Over Temperature Charge Threshold (Grp1)	90°C	60°C	1°C	80°C	80 °C
HOTC2	Hard Over Temperature Charge Threshold (Grp2)	90°C	60°C	1°C	80°C	80 °C
HUTC1	Hard Under Temperature Charge Threshold for (Grp1)	0°C	-20°C	1°C	-10°C	-10 °C
HUTC2	Hard Under Temperature Charge Threshold (Grp2)	0°C	-20°C	1°C	-10°C	-10 °C
HUTD1	Hard Under Temperature Discharge Threshold (Grp1)	0°C	-20°C	1°C	-10°C	-10 °C
HUTD2	Hard Under Temperature Discharge Threshold (Grp2)	0°C	-20°C	1°C	-10°C	-10 °C

At the bottom, a note states: 'TMONI grouping depends on Register GP_MODE(addr 0x11) b14 - TMONISEL setting: 0: Group1 TMONI 1~4, Group2 TMONI 5 1: Group1 TMONI 1~3, Group2 TMONI 4~5'

Figure 3.2.12 Sub Window – Protection Function Temperature Protection page

9) **Current Protection page** – contains current-related protection parameters and their detailed explanations for quick reference.

10) **Temperature Protection page** – contains temperature-related protection parameters and their detailed explanations for quick reference.

The explanation includes image, item name, the Max/Min/Step value, the default value and the unit.

3.2.6 Graphs

The sub window for Graphs can be accessed from main window through the following buttons.

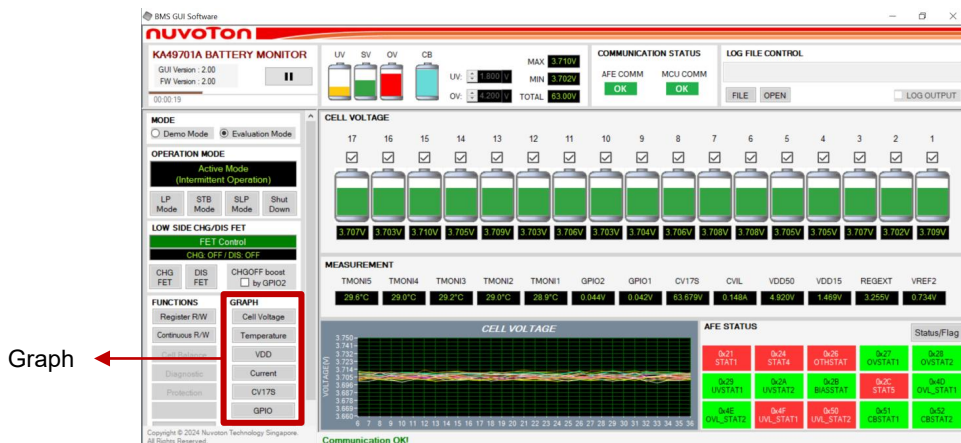


Figure 3.2.13 Graph buttons

Next, users can find explanations for each of the sub-windows.

CELL VOLTAGE graph – to display the graph of Cells Voltage timely.

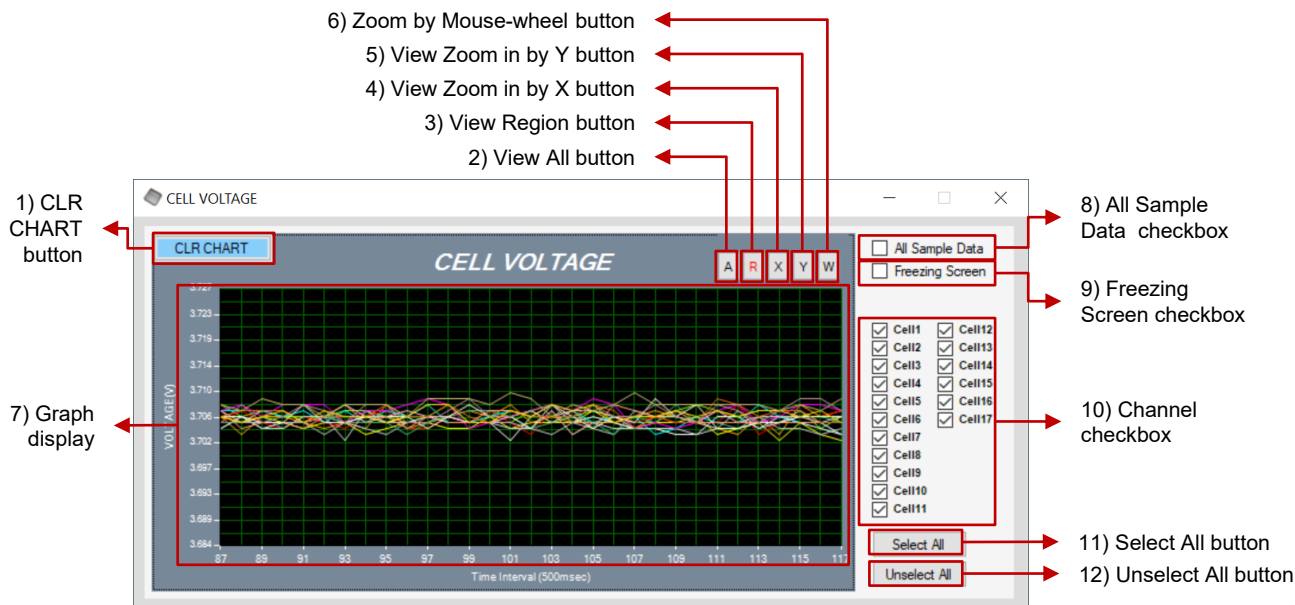


Figure 3.2.14 Sub Window – Cell Voltage Graph

- 1) **CLR CHART button** – to clear the current chart.
- 2) **View All button** – to view all data (Y axis).
- 3) **View Region button** – to view by region.
- 4) **View Zoom by X button** – to view zoom by X axis.
- 5) **View Zoom by Y button** – to view zoom by Y axis.
- 6) **View Zoom by Mouse-wheel button** – to zoom in/out by mouse wheel

- 7) **Graph display** – to display the chart timely.
- 8) **All Sample Data checkbox** – to select whether the chart displays the most recent 30x sample data points or shows all sample data along the X-axis.
- 9) **Freezing Screen checkbox** – to select whether the chart displays real-time updates or remains static at a specific moment.
- 10) **Channel checkbox** – to select the displayed channels individually (17 channels).
- 11) **Select All button** – to select all channels.
- 12) **Unselect All button** – to clear all selection of channels.

Note

The chart depicts data plotted over time, where each data point corresponds to the main window data updating interval of every 0.5s. The layout of all Graphs sub window are the same.

TEMPERATURE graph – to display the graph of temperature (TMONI1~5) timely.

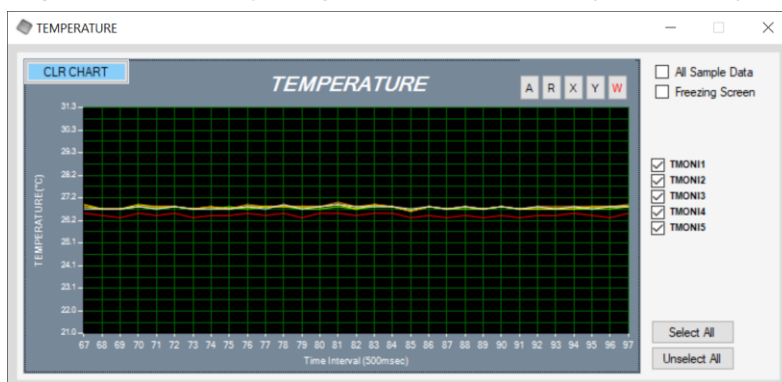


Figure 3.2.15 Sub Window – Temperature Graph

Note

There are a total of Five channels (TMONI1~5) for BMIC temperature measurement. However, it's important to note that the number of temperature sensor (thermistor) used may vary depending on customization. In default configuration, our AFE board is equipped with 5 pcs of thermistors (NCU18XH103F60RB) for channel TMONI1~5. The temperature measurement within the PC GUI software is dependent on the characteristics of this standard thermistor component on our AFE board.

VDD graph – to display the graph of VDD50, VREGEXT, VDD15, & VREF2 voltage timely.

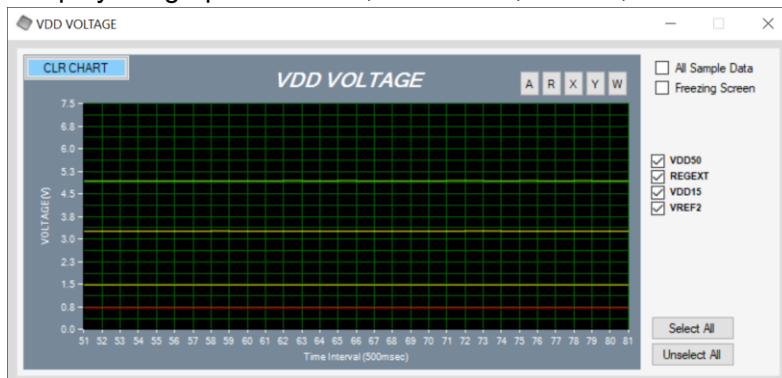


Figure 3.2.16 Sub Window – VDD Voltage Graph

CURRENT graph– to display the graph of ADC current timely.

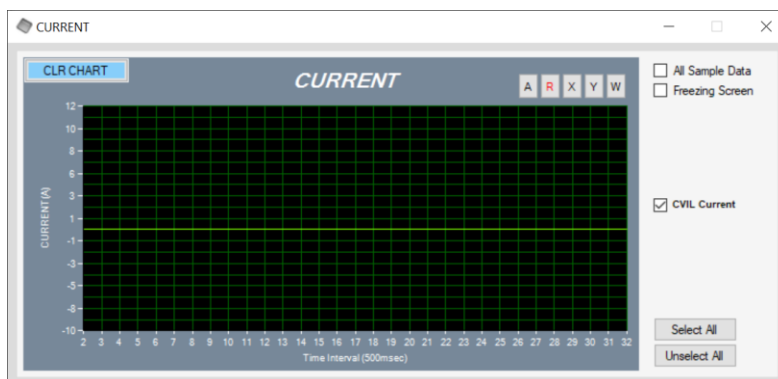


Figure 3.2.17 Sub Window – Current Graph

CV17S graph– to display the graph of CV17S voltage timely.

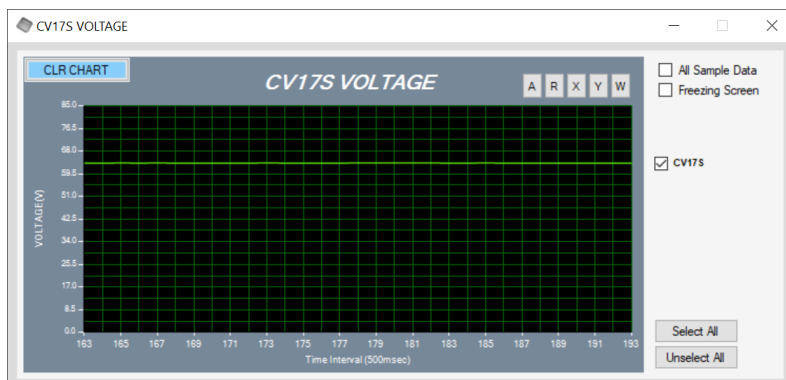


Figure 3.2.18 Sub Window – CV17S Voltage Graph

GPIO graph– to display the graph of GPIO1 & GPIO2 voltage timely.

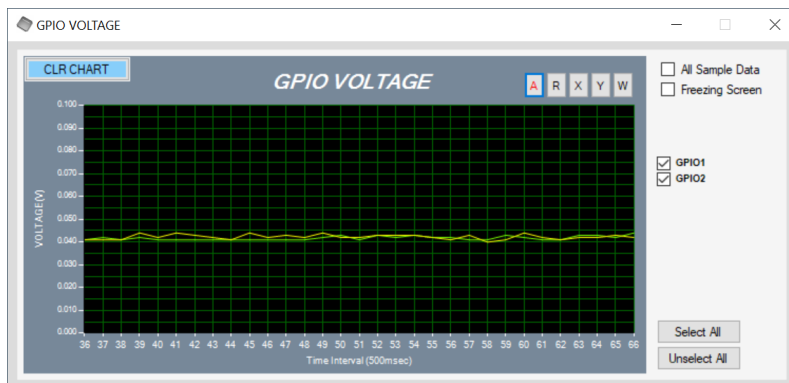


Figure 3.2.19 Sub Window – GPIO Voltage Graph

4. LED DEFINITION FOR OPERATION MODE AND ERROR FACTOR

The MCU board features four LEDs, namely LED1 (Red), LED2 (Amber), LED3 (Blue), and LED4 (Green), which are used to indicate the LED Mode status. The LED Mode status is categorized into error, normal, operating mode, and diagnostic. Various combinations of LED illumination correspond to distinct scenarios. The following table provides a detailed explanation of the LED status.

X: OFF; O: ON; B: Blinking (1Hz), B*: Blinking depend on CB ON/OFF set timing

LED MODE		LED STATUS				ITEM	EXPLANATION
		4	3	2	1		
Status	Error	X	X	X	O	Register write error	SDO is Low
		X	X	O	X	Register read error	SDO is Low or CRC error
		O	O	O	O	Wake Up error	SDO is not HI after 10 times of startup attempts
	Normal	B	X	X	X	Normal operation	CHG = OFF / DIS = OFF
		B	X	X	O		CHG = ON / DIS = OFF
		B	X	O	X		CHG = OFF / DIS = ON
		B	X	O	O		CHG = ON / DIS = ON
		B	B*	X	X	Cell Balancing	CHG = OFF / DIS = OFF
		B	B*	X	O		CHG = ON / DIS = OFF
		B	B*	O	X		CHG = OFF / DIS = ON
		B	B*	O	O		CHG = ON / DIS = ON
	Operating mode	X	B	X	X	Low Power operation	CHG = OFF / DIS = OFF
		X	B	X	O		CHG = ON / DIS = OFF
		X	B	O	X		CHG = OFF / DIS = ON
		X	B	O	O		CHG = ON / DIS = ON
		X	X	B	B	Standby operation	CHG = NA / DIS = NA
		X	X	B1*	B1*	Sleep operation	CHG = NA / DIS = NA
	Diagnostic	X	X	X	X	Shutdown operation	CHG = NA / DIS = NA
		X	B	B	B	Safety Diagnostic operation	CHG = NA / DIS = NA

1*) If the MCU board is powered by an external supply, the LED blinks; otherwise, it remains OFF

Table 4.1 Detailed explanation of the LED status

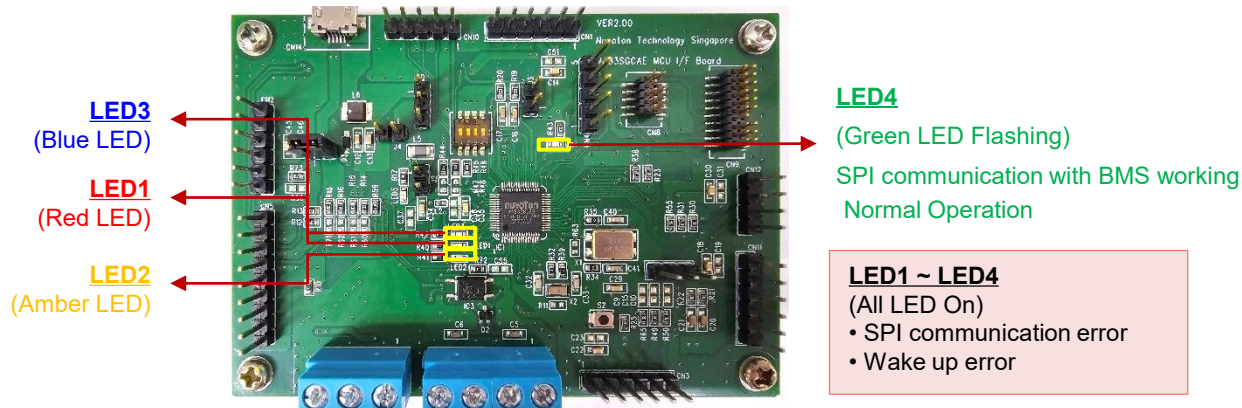


Figure 4.1 LED allocations and indications

REVISION HISTORY

Ver.	Date	Revised Contents
V1.00	8 th Feb 2024	1. Initially issued.
V2.00	18 th Oct 2024	<ol style="list-style-type: none"> 1. Changed IC part name from "KA49701A(ES)" to "KA49701A". 2. Changed figure of new AFE board. 3. Changed the contents of Chapter 3.1 Main Window due to updated layout of Main Window. <ul style="list-style-type: none"> - Added new Function: Continuous R/W - Added new Graph: CV17S & GPIO - Added new Measurement items : GPIO1, GPIO2, CV17S - Added new Cell Voltage Graph - Added new Status/Flag register display: 0x21, 0x24, 0x51, 0x52 - Expanded the range of data log: <ul style="list-style-type: none"> o previous log only converted data (e.g 3.703V), o now log both converted data(e.g 3.703V) and unconverted data (e.g 0x2f6e). - Added "Error Flag Buttons" in Status/Flag sub window. 4. Added Chapter 3.2.2 Continuous R/W. 5. Expanded the range of Diagnostic Check: <ul style="list-style-type: none"> - Added "Open Connection Detection" - Added "Open/Short Detection of SRN&SRP" 6. Added "OTUT ITH" for Current protection
V2.10	15 th Jul 2025	1. Content page: "2.2.5 Power Up the Boards" → "2.3.5 Power Up the Boards"

Important Notice

Nuvoton Products are neither intended nor warranted for usage in systems or equipment, any malfunction or failure of which may cause loss of human life, bodily injury or severe property damage. Such applications are deemed, "Insecure Usage".

Insecure usage includes, but is not limited to: equipment for surgical implementation, atomic energy control instruments, airplane or spaceship instruments, the control or operation of dynamic, brake or safety systems designed for vehicular use, traffic signal instruments, all types of safety devices, and other applications intended to support or sustain life.

All Insecure Usage shall be made at customer's risk, and in the event that third parties lay claims to Nuvoton as a result of customer's Insecure Usage, customer shall indemnify the damages and liabilities thus incurred by Nuvoton.

*Please note that all data and specifications are subject to change without notice.
All the trademarks of products and companies mentioned in this datasheet belong to their respective owners.*