

# User manual

## DA9155M Getting Started with Evaluation Board

### UM-PM-010

#### **Abstract**

*This document describes the hardware and software used by Dialog Semiconductor to test and evaluate the DA9155M slave battery charger.*

*The hardware solution is based on PCB numbered 287-06-A.*

*The software uses a PC operating Windows 2000/XP/Vista/Windows 7™ with USB (1.1, 2.0 or 3.0) interface.*

*The software permits configuration of the device using one pre-defined templates, read and operations to all control registers while monitoring device status.*

*The section 'Quick Start Tutorial' provides an abbreviated quick start guide with a practical configuration example on how to run the evaluation kit.*

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## 1 Terms and definitions

DAI	Digital Audio Interface
DIO	Digital Input/Output
DUT	Device Under Test
GPIO	General Purpose Input Output
GUI	Graphical User Interface
I2C/SPI	Inter-Integrated Circuit/Serial Peripheral Interface
OS	Operating System
PCB	Printed Circuit Board
SPI	Serial Peripheral Interface
SMU	Source Meter Unit
USB	Universal Serial Bus
PCB	Printed Circuit Board

## 2 References

- [1] DA9155M, Data sheet, Dialog Semiconductor
- [2] UG-179-070-D, Digital I/O Board User Guide, Dialog Semiconductor
- [3] AN-PM-058 DA9155M PCB Layout Recommendation Application Note, Dialog Semiconductor
- [4] 287-06-A00\_SCH, DA9155M Performance Board Schematic, Dialog Semiconductor
- [5] 287-06-A\_PCB, DA9155M Performance Board Layout, Dialog Semiconductor

### 3 Introduction

The DA9155M Performance Board is designed evaluate the DA9155M slave battery charger. The optimised board layout enables testing at full-rated power and measurement of efficiency, current accuracy, transient response, and thermal performance.

The performance board includes an interface connector to the communication board referred as the Digital I/O (DIO) board. This DIO board connects the DA9155M to a computer via USB-to-I2C, for status monitoring and control using the DA9155M Graphical User Interface (GUI).

This document provides an overview of the development board, hardware configuration, and GUI installation process. The goal of this user manual is to provide the details required to get started with the evaluation of the DA9155M.

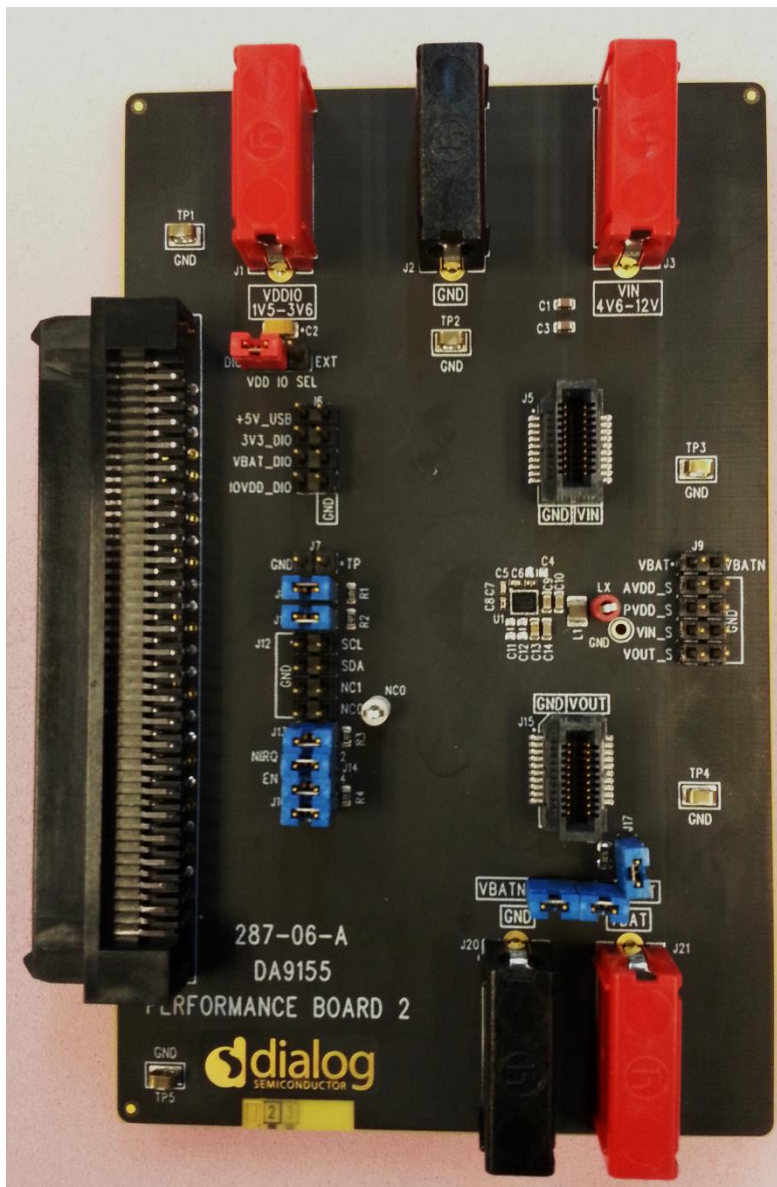


Figure 1: DA9155M Performance Board (top view)

## 4 Board recommended operating conditions

Table 1 lists the recommended operating conditions of the DA9155M Performance board. Stressing the board beyond these ratings may cause permanent damage to the board.

**Table 1: DA9155M Performance Board recommended operating conditions**

Parameter	Symbol	Min	Max	Unit
Storage temperature		-60	+150	°C
Operating temperature	T <sub>A</sub>	-40	+85	°C
Input voltage	V <sub>IN</sub>	4.3	13.4	V
Supply voltage IO	V <sub>DDIO</sub>	1.5	3.6	V
Battery voltage	V <sub>BAT</sub>	0	4.5	V
Battery current	I <sub>BAT</sub>	0	3	A
Digital I/O (EN, SCL, SDA, nIRQ)		0	0.7 x V <sub>DDIO</sub>	

## 5 DA9155M Performance Board Hardware

The DA9155M board functional overview is shown in Figure 2. The board functionality can be broken down into the following functions:

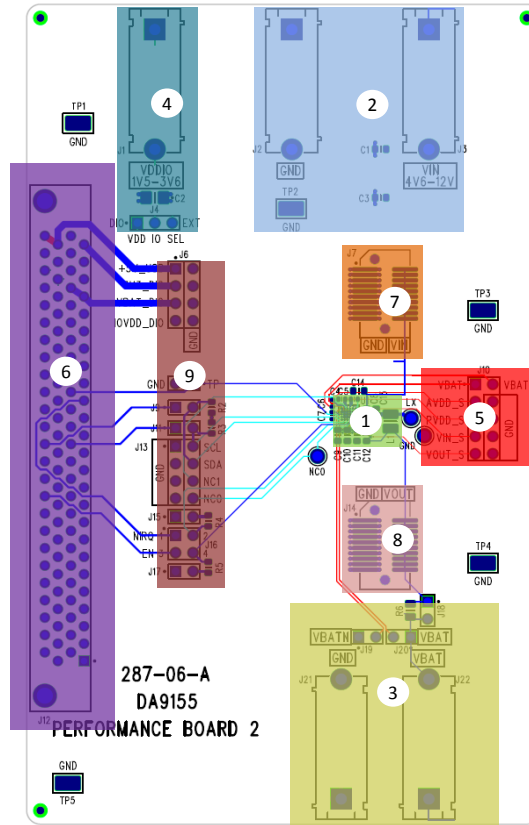


Figure 2: Functional overview

Table 2: DA9155M Performance Board overview and descriptions

Section No.	Function Description
1	Device Under Test (DUT) DA9155M slave charger
2	Input Voltage (VIN) terminals
3	Battery Output (VBAT) terminals and battery current sense resistor
4	VDDIO supply selector (DIO vs External)
5	DA9155M multi-test point J10 connector header
6	Digital I/O interface connector
7	Line transient injection point
8	Load transient injection point
9	Digital I/O board connectivity selector (signals SCL, SDA, Enable, nIRQ, TP)

### 5.1 DA9155M Slave charger layout

The placement guidelines for PCB layout and trace interconnectivity for the main power components are shown in the PCB layout section of the DA9155M Datasheet [Ref 1] and also shown in Figure 3 below. The same layout guidelines were followed and implemented for the DA9155M Performance Board, with the exception of the footprint for additional output capacitors are included in the board for experimentation purposes.

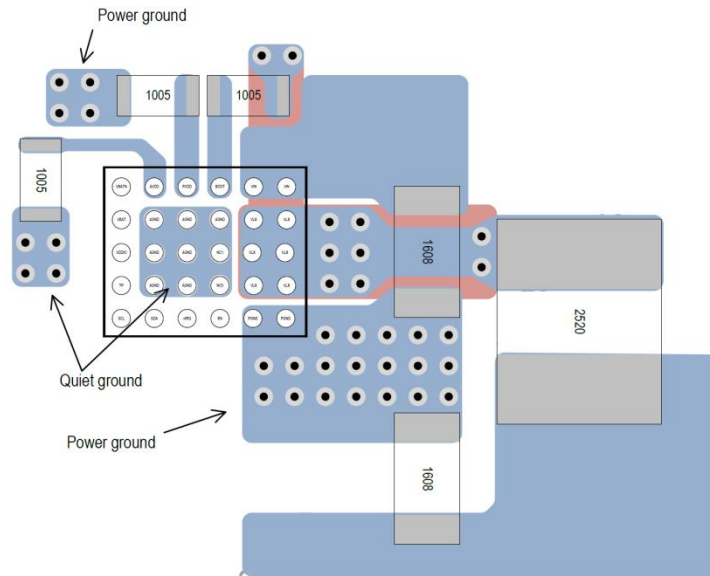


Figure 3: PCB Layout for DA9155M

It is important to follow the recommended layout guidelines in order to achieve the best efficiency performance and noise immunity. Particular attention should be paid to the layout of the input capacitor, inductor and output capacitors, highlighted in Figure 4. From this figure it can be seen that the Power Ground ensures that there is the minimal path impedance between the capacitors and the DA9155M PGND terminals. The layout engineer should review the DA9155M PCB Layout Recommendations Application Note, see [Ref 3]

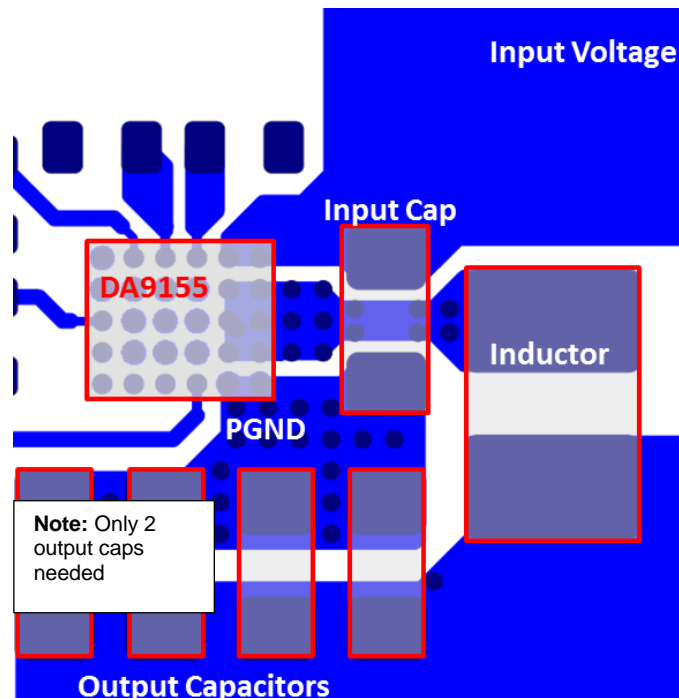


Figure 4: DA9155M Performance Board Layout

### 5.2 Slave charger multi-test point J10 connector

The multi-test point connector is shown in Figure 5. This connector provides the user access to the various nodes of the DUT. This connector is only capable of “sensing” voltages and should not be used for delivering current/voltage to and from the DUT, as the PCB traces can be fused by excessive current.

The signals available on this header are:

- Battery voltage VBAT sense (using battery Kelvin connection)
- Voltage of the AVDD supply
- Voltage of the PVDD supply
- Input voltage VIN sense
- Output voltage VOUT (measured at DA9155M output capacitor node)

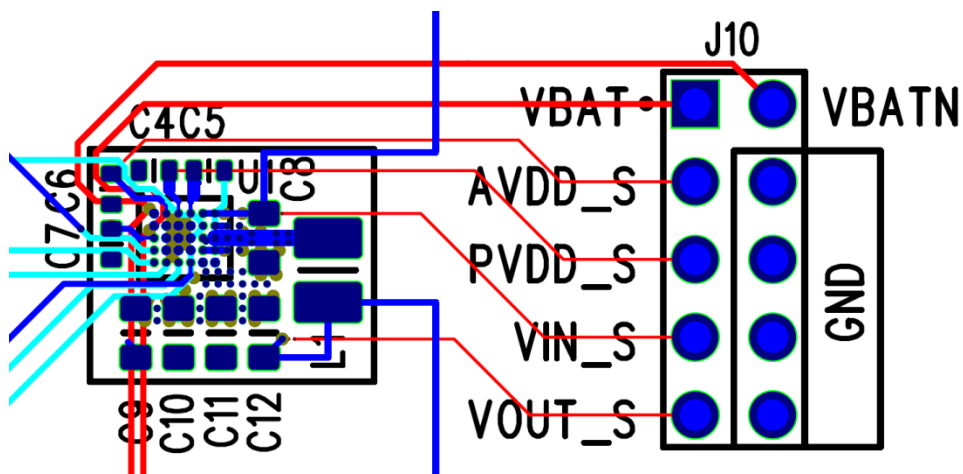


Figure 5: Test point J10 header

### 5.3 Digital I/O board connectivity headers

The DIO interface connectors select the signals from the DIO board to the DUT board and also provide test point terminals to monitor the different voltage rails of the DIO board. The jumpers shown in Figure 6 below indicate the default jumper selection for the digital signals SCL, SDA, Enable, nIRQ and TP.

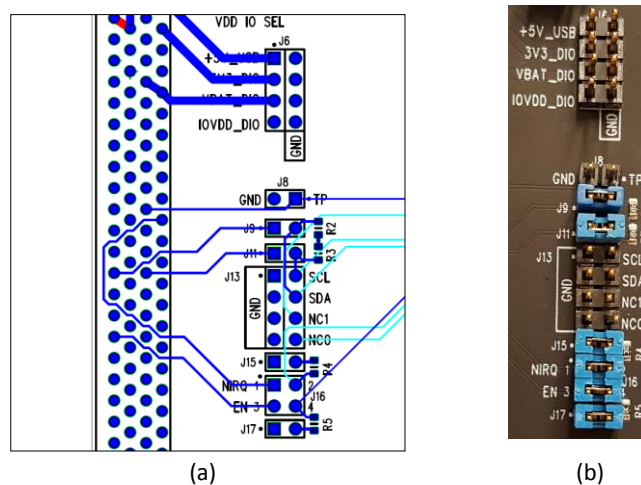


Figure 6: DIO connectivity headers (a) Layout view (b) Default jumper settings



### 5.4 Transient injection points

The two injection points are connected to the input voltage and output voltage (J5 and J15). These can be used to measure the line and load transient response of the DUT. Special transient injection boards are available (P/N 44-179-168-03-A and 44-179-168-03-B Hammer2 board), but these are not supplied as part of the standard DA9155M Performance Board kit. Please contact Dialog Semiconductor for more information on how to obtain one of the transient injection boards.

### 5.5 Connectivity

To evaluate the features of the DA9155M slave charger, it is necessary to connect the DUT to a computer to perform status monitoring and configure the device. The DA9155M Performance Board uses the DIO board as an interface to convert the USB datalink to I<sup>2</sup>C bus on the DUT.

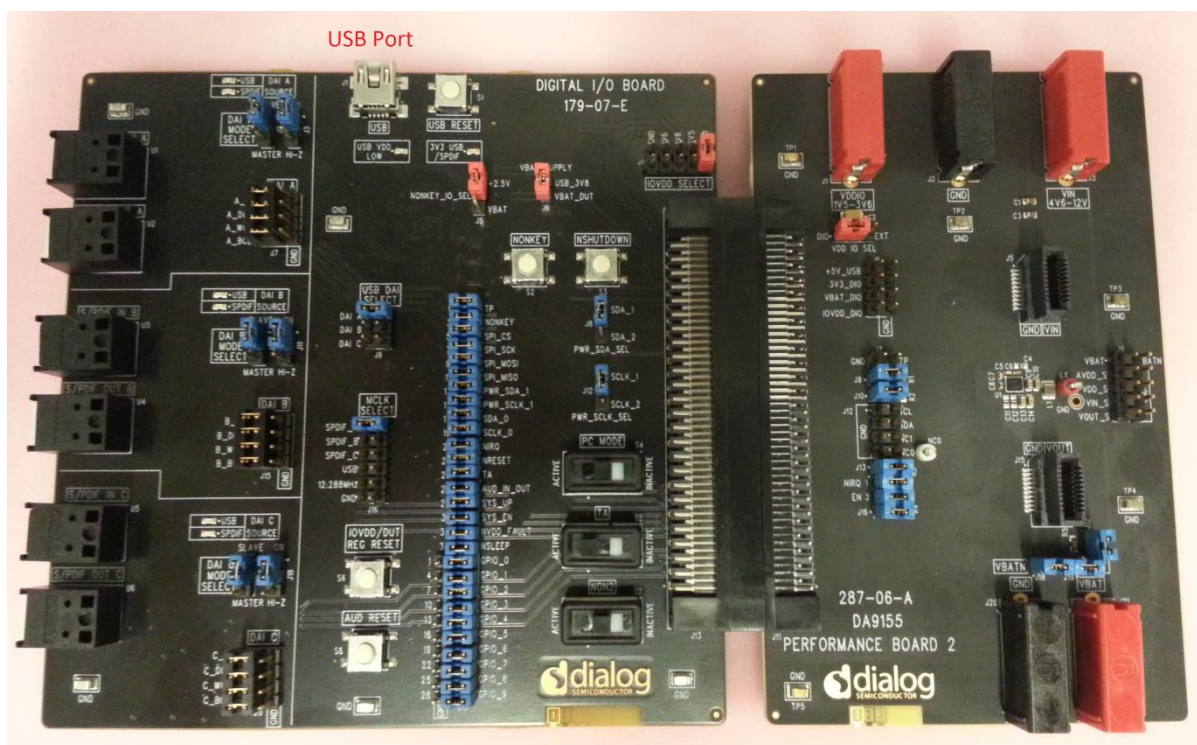


Figure 7: DIO and DA9155M Performance board

The configuration settings for the DIO board are shown in [Figure 7](#). Ensure these settings match the board under test. For additional information, schematics, and configuration, see the Digital I/O Board User guide [\[Ref 2\]](#)

## 6 Hardware requirements

The hardware included in the list below can be substituted by equivalent hardware.

**Table 3: List of hardware**

Item #	Description	Manufacturer	Comments
1	DA9155M Performance Board	Dialog Semiconductor	
2	Digital I/O Board	Dialog Semiconductor	
3	USB Cable	N/A	Type-A Male to Mini Type-B Male
4	Keithley 2308 Battery Emulator	Keithley	Dual output SMU, Output #1: Connected to VBAT (1) and Output #2: Connected to VIN

**Note 1** This SMU must be capable of sourcing and sinking current (simulate a battery).

### 6.1 Input voltage supply

The DA9155M Performance Board is a slave battery charger; this means that the input voltage must be present in order to enable the DUT. For the initial setup, and example in this document, this is set to 9 V DC and the current limited to 3 A.

### 6.2 Battery voltage

The VBAT terminals must be connected to a battery and the battery voltage must be within the DA9155M under- and overvoltage limits. Otherwise the DUT will enter into a fault condition and the charging mode will not be enabled until the fault is removed and the fault status registers (Event\_A and Event\_B) are cleared, see the DA9155M Datasheet [Ref 1] for more details on the DUT power modes and/or fault detection.

Before connecting a standard DC power supply to the VBAT terminals, ensure that the DC power supply is able to source and sink current. Once the DA9155M charger is enabled, current needs to flow into the VBAT supply. Failure to do so could damage the DC power supply and/or the DA9155M Performance Board.

In the hardware list [Table 3](#), the Keithley 2308 Battery Emulator Output #1 is connected to the VBAT terminals. The battery emulator was selected because it is able to sink/source up to 5 A of current and the input impedance can be programmed between 0  $\Omega$  and 1  $\Omega$ , in 10 m $\Omega$  steps.

There are three options that can be connected to the VBAT terminals:

- Li-Ion battery, the voltage must be within the under- and overvoltage limits as configured in DA9155M settings (VBAT\_UV and VBAT\_OV registers)
- Source Meter Unit capable of sourcing and sinking current, such as the Keithley 2308.
- Power supply connected in parallel to a resistive or electronic load. The user must ensure that the current load is greater than the current supplied by DA9155M, defined by the BUCK\_IOUT register. For example: Power supply output set to 4 V, electronic load set to 1 A and DA9155M set to 500 mA.

## 7 DA9155M Performance Board Graphical User Interface

The user can explore all the features of the DA9155M with the Graphical User Interface (GUI) using the I<sup>2</sup>C interface. This includes changing the control settings and monitoring the status/fault of the DUT.

The user must be aware that the GUI is non-invasive, meaning:

- It will not modify registers contents without user interaction
- I<sup>2</sup>C periodic communication stops when the “Polling Enabled” button is set to “Polling Disabled”

### 7.1 Software installation

When the supplied media is inserted into the computer the installation begins automatically. If the installation does not start automatically, run the program file ‘setup\_DA9155M\_Evaluation\_GUI\_AB.0\_0\_xx.exe’ from the ‘Software’ directory on the media. An automated script installs the program on your PC, and by default, the directory C:\Dialog Semiconductor\Power Management\DA9155M\_Evaluation GUI is used.

To install the software:

1. Run setup\_DA9155M\_Evaluation\_GUI\_AB.0\_0\_xx.exe and click the ‘Next’ button

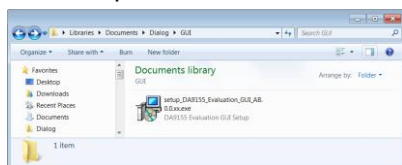


Figure 8: DA9155M Evaluation GUI Installation File

2. Accept the license agreement and click ‘Next’

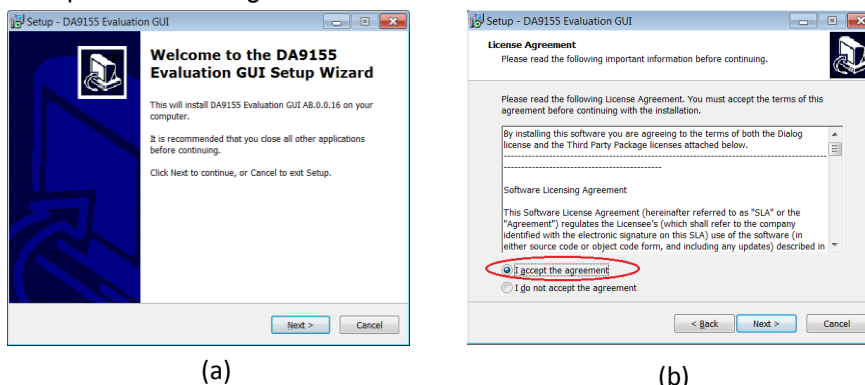


Figure 9: DA9155M GUI Software Licensing and Installation

3. Choose the installation path using ‘Browse’ or leave the default path and click ‘Next’

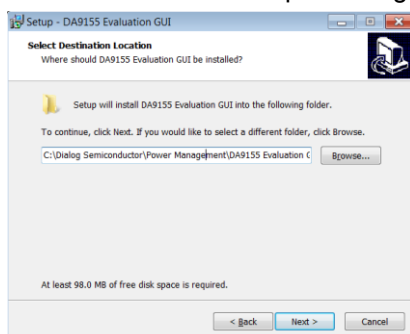


Figure 10: DA9155M GUI Installation Path

4. Choose the 'Start Menu Folder' using 'Browse...' or leave the default folder and click 'Next'
5. Check 'Create a desktop icon' to access the software directly from the desktop and click 'Next'
6. Review installation information and click 'Next'
7. Check 'Launch DA9155M GUI' to launch the GUI immediately after installation and click 'Finish'

Once connected, the hardware will be detected and the drivers will install automatically. In some operating systems the driver installer window may pop up: accept the recommended settings.

## 7.2 GUI overview

The GUI is laid out in a modular way, where the sections are grouped by functionality. This means that some sections or 'smartcanvas' modules are used to display device status (for example, VBAT Under Voltage) and other modules are used to control the behaviour of the DUT (for example, output current).

This section gives an overview of the GUI functions and references the GUI sections as shown in Figure 11.

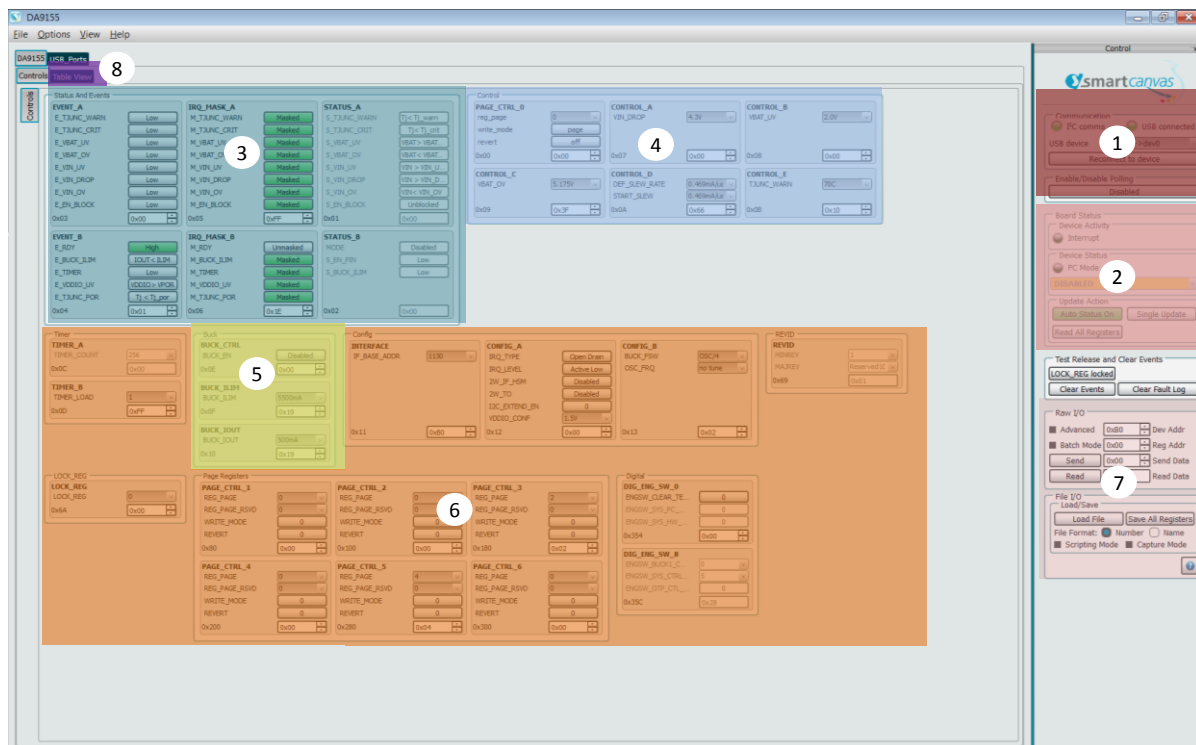


Figure 11: GUI Overview Screen

**Smartcanvas section 1:** Right after the GUI is initialized the "I2C comms" and "USB Connected" indicators should be shown in green, see Figure 12. If either one of these indicators is not green communication has not been established between the DA9155M and the GUI. It is possible to verify this by disabling the VBAT and the input voltage of the performance board, and then the green light should be disabled. Once power is re-enabled, press the "Reconnect to device" button to ensure the communication link is active.

The Enable/Disable Polling enables the GUI to perform periodic updates (once per second) of all the DUT registers and all the control/status registers will be updated with the read-back data.

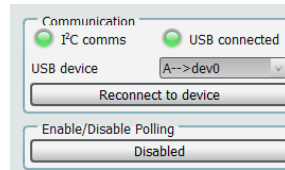


Figure 12: Active Communication Indicator

**Smartcanvas section 2:** This module will show the performance board status information and will define whether the GUI displayed registers are automatically or manually updated. In order to enable the automatic updates, enable the “Auto Status On” button, see Figure 13. Alternatively, the user might opt to perform a single GUI register refresh/read-back by pressing the “Single Update” button and keeping the “Auto Status Disabled”. The “Read All Registers” button will update all registers including those not displayed in the active GUI screen.

It is recommended to disable “Auto Status On” if other I<sup>2</sup>C devices in addition to the DIO and DA9155M are connected to the communication interface, particularly if another I<sup>2</sup>C master is connected, as this could create conflict in the communication link. If this is the case, the “Single Update” can be pressed whenever the GUI needs updating.

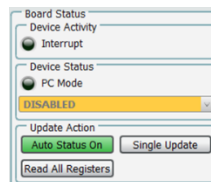


Figure 13: Board Status Indicator

**Smartcanvas section 3:** This section of the GUI provides the user with “Status and Events” information and can be used to “Mask” events from generating nIRQ flags or events. Figure 14 shows all events are masked or ignored as a default setting.

Event\_A and Event\_B registers display the status of all specific events, as described in the DA9155M datasheet [REF 1]. For example, if the battery voltage drops below the E\_VIN\_UV and the M\_VIN\_UV is unmasked, the S\_VIN\_UV bit is enabled and this will be displayed in the GUI, ensure the “Auto Status ON” button is active. When the event is “Unmasked” a nIRQ flag is generated and the nIRQ pin is set low after the event occurs.

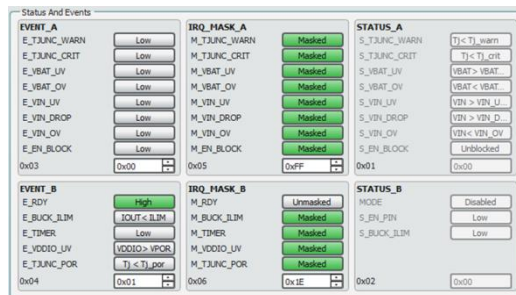


Figure 14: Status and Events shown in GUI

**Smartcanvas section 4:** This section of the GUI is used to modify specific control registers of the DA9155M as defined in the Datasheet [Ref 1]. For example, the user is able to change the under-voltage (VBAT\_UV) level or the specific DUT temperature for generating a warning.

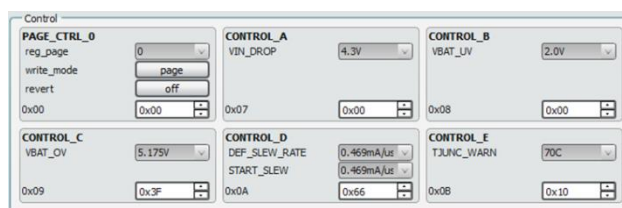
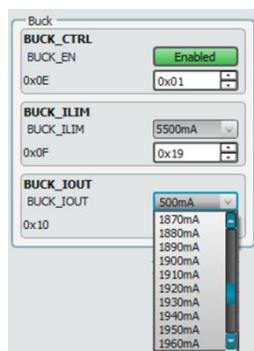


Figure 15: Control Registers in GUI

**Smartcanvas section 5:** This section of the GUI controls three of the most important registers of the DA9155M: These are the Buck Enable (BUCK\_EN), Buck Current Limit (BUCK\_ILIM), and Buck Output Current (BUCK\_IOUT) registers.

The BUCK\_EN will only enable the converter if there are no faults/events present, (EVENT\_A = EVENT\_B = 0x00). It is best practice to press the “Clear Events” button before enabling the Buck.

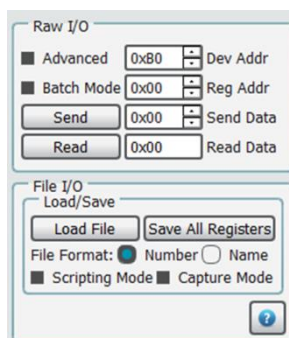


**Figure 16: Buck converter control registers**

**Smartcanvas section 6:** In this section of the GUI the following information about the DUT is displayed: I<sup>2</sup>C address, REVID, Oscillator Frequency, Timer\_A, Timer\_B, and page control registers. Review the DA9155M Datasheet for specific functionality of each of the registers in this section.

**Smartcanvas section 7:** This section of the GUI is used to manually Read/Write data to the I<sup>2</sup>C bus, by specifying the Device I<sup>2</sup>C address, Register Address, and the data package to read or write. The GUI will not perform any data manipulation or validation to the data written or read.

File I/O is used to save all DA9155M registers to a file. This feature is helpful when used after the “Read All Registers”, as it will capture a snap shot of the device under specific test conditions.



**Figure 17: Raw I/O and File I/O GUI Controls**

**Smartcanvas section 8:** The Table View tab displays the DA9155M Registers in a table format and captures the status of all the registers in a compact form. The register values are also editable in the Table View.

The screenshot shows the DA9155M GUI in the Table View tab. The interface includes a 'DA9155 USB\_Ports' header, a 'Controls Table View' sub-header, and a 'Register value' label with a red arrow pointing to the 'Data' column. The main table lists registers from 0x000 to 0x35C, with columns for Bit 7 through Bit 0. The 'Data' column shows the current value for each register, and the bit columns show the bit-level configuration, including fields like 'reg\_page\_[0]', 'START\_SLEW\_[4]', and 'DEF\_SLEW\_RATE\_[0]'. Some cells are highlighted in light blue or light green, indicating specific bit settings.

Register	Data	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0	
0x000: PAGE_CTRL_...	0x06	revert_[7]: 0x00	write_mode_[...]...	reg_page_[0]: 0x06						
0x001: STATUS_A	0x00	S_EN_BLOCK...	S_VIN_OV_[6]:...	S_VIN_DROP...	S_VIN_UV_[4]:...	S_VBAT_OV_[...]...	S_VBAT_UV_[...]...	S_TJUNC_CR...	S_TJUNC_WA...	
0x002: STATUS_B	0x01	unused						S_BUCK_ILIM...	S_EN_PIN_[1]...	MODE_[0]: 0x01
0x003: EVENT_A	0x00	E_EN_BLOCK...	E_VIN_OV_[6]:...	E_VIN_DROP...	E_VIN_UV_[4]:...	E_VBAT_OV_[...]...	E_VBAT_UV_[...]...	E_TJUNC_CR...	E_TJUNC_WA...	
0x004: EVENT_B	0x00	unused				E_TJUNC_PO...	E_VDDIO_UV...	E_TIMER_[2]: ...	E_BUCK_ILIM...	E_RDY_[0]: 0x00
0x005: IRQ_MASK_A	0xFF	M_EN_BLOCK...	M_VIN_OV_[6]...	M_VIN_DROP...	M_VIN_UV_[4]...	M_VBAT_OV_...	M_VBAT_UV_...	M_TJUNC_CR...	M_TJUNC_W...	
0x006: IRQ_MASK_B	0x1E	unused				M_TJUNC_PO...	M_VDDIO_UV...	M_TIMER_[2]: ...	M_BUCK_ILIM...	M_RDY_[0]: 0x00
0x007: CONTROL_A	0x00	VIN_DROP_[0]: 0x00								
0x008: CONTROL_B	0x00	unused			VBAT_UV_[0]: 0x00					
0x009: CONTROL_C	0x3F	unused			VBAT_OV_[0]: 0x3F					
0x00A: CONTROL_D	0x66	unused	START_SLEW_[4]: 0x06			unused	DEF_SLEW_RATE_[0]: 0x06			
0x00B: CONTROL_E	0x10	unused				TJUNC_WARN_[0]: 0x00				
0x00C: TIMER_A	0xFF	TIMER_COUNT_[0]: 0xFF								
0x00D: TIMER_B	0xFF	TIMER_LOAD_[0]: 0xFF								
0x00E: BUCK_CTRL	0x01	unused								
0x00F: BUCK_ILIM	0x19	unused	BUCK_ILIM_[0]: 0x19						BUCK_EN_[0]:...	
0x010: BUCK_IOUT	0x19	BUCK_IOUT_[0]: 0x19								
0x011: INTERFACE	0x80	IF_BASE_ADDR_[1]: 0x58							unused	
0x012: CONFIG_A	0x00	VDDIO_CONF_[6]: 0x00	I2C_EXTEND...	2W_TO_[4]: 0x00	2W_IF_HSM_[...]...	unused	IRQ_LEVEL_[...]...	IRQ_TYPE_[0]...		
0x013: CONFIG_B	0x02	OSC_FRQ_[4]: 0x00				unused	BUCK_FSW_[0]: 0x02			
0x069: REVID	0x01	MAJREV_[4]: 0x00				MINREV_[0]: 0x01				
0x06A: LOCK_REG	0x00	LOCK_REG_[0]: 0x00								
0x080: PAGE_CTRL_...	0x00	REVERT_[7]: ...	WRITE_MODE...	REG_PAGE_RSVD_[3]: 0x00			REG_PAGE_[0]: 0x00			
0x100: PAGE_CTRL_...	0x00	REVERT_[7]: ...	WRITE_MODE...	REG_PAGE_RSVD_[3]: 0x00			REG_PAGE_[0]: 0x00			
0x180: PAGE_CTRL_...	0x02	PAGE_CTRL_...	PAGE_CTRL_...	PAGE_CTRL_3_REG_PAGE_RSVD_[3]: 0x00			PAGE_CTRL_3_REG_PAGE_[0]: 0x02			
0x200: PAGE_CTRL_...	0x00	REVERT_[7]: ...	WRITE_MODE...	REG_PAGE_RSVD_[3]: 0x00			REG_PAGE_[0]: 0x00			
0x280: PAGE_CTRL_...	0x04	PAGE_CTRL_...	PAGE_CTRL_...	PAGE_CTRL_5_REG_PAGE_RSVD_[3]: 0x00			PAGE_CTRL_5_REG_PAGE_[0]: 0x04			
0x300: PAGE_CTRL_...	0x00	REVERT_[7]: ...	WRITE_MODE...	REG_PAGE_RSVD_[3]: 0x00			REG_PAGE_[0]: 0x00			
0x354: DIG_ENG_SV	0x00	unused	ENGSW_SYS...	ENGSW_SYS...	unused			ENGSW_CLE...		
0x35C: DIG_ENG_SV	0x24	unused	ENGSW_OTP...	ENGSW_SYS_CTRL_STATE_[3]: 0x04			ENGSW_BUCK1_CTL_STATE_[0]: 0x04			

Figure 18: DA9155M GUI using the Table View

## 8 Quick start tutorial guide

This section of the document provides the steps required to power up the board. Assumed that the GUI is installed and the DIO board is configured as in Figure 7.

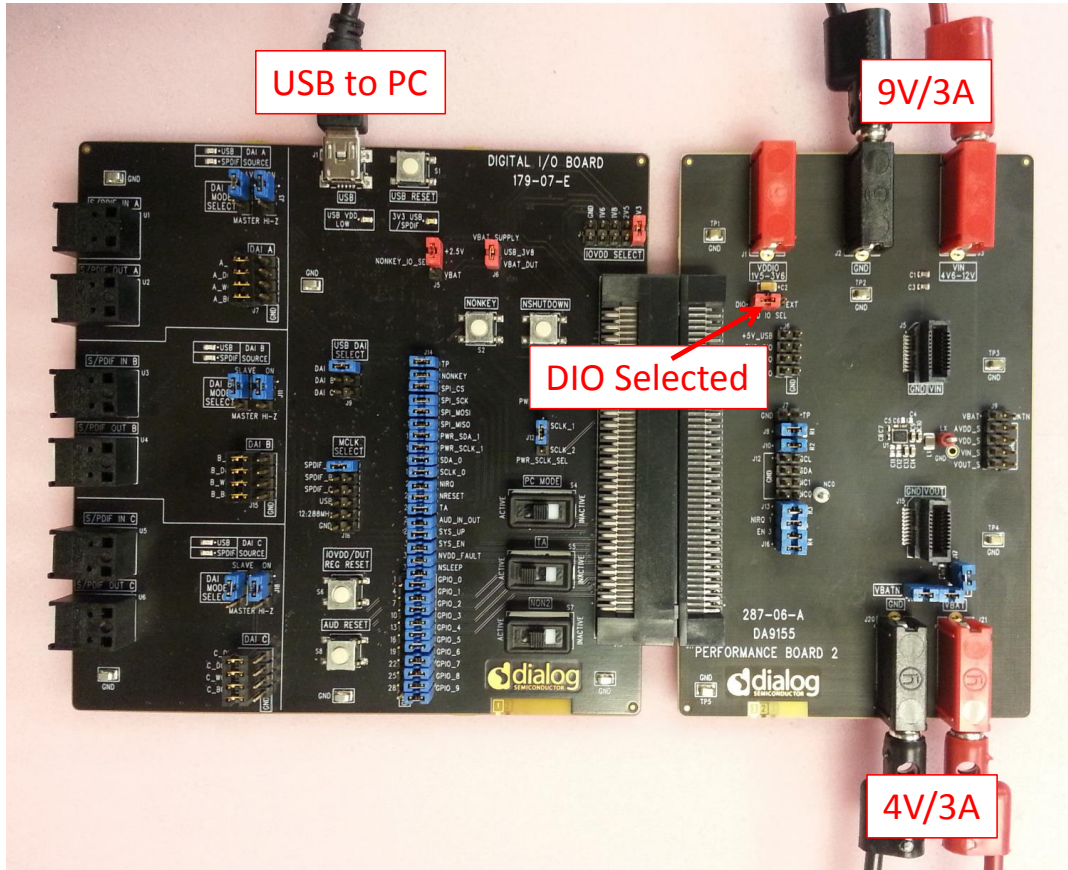


Figure 19: DA9155M Performance Board Full Setup

1. Set the Input Voltage: The input voltage is set to 9 V with a 3 A current limit, (the current limit can be changed later, and this is only a practical starting point). Also, since the Keithley 2308 is a dual output supply, Output #2 of this instrument can be connected to the input voltage terminals.
2. Set the VBAT Voltage: The VBAT terminals should be connected to the Keithley 2308 (battery emulator) Output #1 set to 4 V and current limited to 3 A. As mentioned in the “Battery voltage” section, if a real battery is to be connected, ensure the voltage is within the under- and overvoltage limits.
3. Set the VDDIO Voltage: The VDDIO voltage will be supplied by the DIO board, by selecting the VDDIO SEL jumper as shown in Figure 19, where header J4, is configured to short position pin 1 and 2 (the two closest to the interface connector).
4. Connect the USB cable: If not already so, connect the USB cable from the DIO port to the computer host computer.
5. Using the GUI: At this point the hardware setup is completed and the DA9155M GUI can be initialized. Once the GUI is done loading check the Active Communication Indicator, see Figure 12.
  - a. Before the Buck converter is enabled, press the ‘Clear Events’ button.

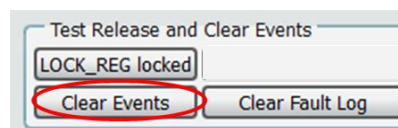


Figure 20: Clear Events button

- b. Select the desired Buck output current from the drop-down



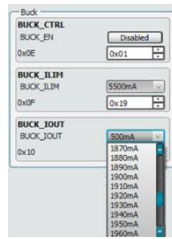


Figure 21: Configure the output current

- c. Click the BUCK\_EN 'Disabled' button to enable the converter

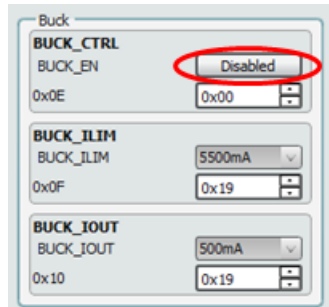


Figure 22: Enable Buck converter button

At this point the Buck converter should be enabled and performance evaluation can begin.

## Revision history

Revision	Date	Description
0.2	27-10-2015	Initial draft
1.0	10-11-2015	Initial release
Change details:		

### Status definitions

Status	Definition
DRAFT	The content of this document is under review and subject to formal approval, which may result in modifications or additions.
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