User Manual

DA9318 Direct Charging Reference Board

UM-PM-022

Abstract

This document describes the hardware and software used to evaluate the DA9318 direct charging reference board.

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1 Terms and Definitions

GND	Ground
GUI	Graphical User Interface
IC	Integrated Circuit
JTAG	Joint Test Action Group
LED	Light Emitting Diode
LS	Level Shifter
OTG	On-The-Go
PC	Personal Computer
PD	Power Delivery
RCP	Reverse Current Protection
SAM3U	USB I^2C Interface
SCL	Serial CLock
SDA	Serial DAta
TA	Travel Adaptor
USB	Universal Serial Bus

2 References

[1] DA9318 Datasheet, Dialog Semiconductor

[2] 329-03-A_ SCH.pdf, Dialog Semiconductor

3 Introduction

The purpose of the reference board is to demonstrate DA9318 in a direct charging application.

The document covers a normal charging cycle, using an off-the-shelf charger IC and a charging cycle with the direct charging enabled. Direct charging means connecting the travel adaptor (TA) directly to the battery in the constant current charging phase. A block diagram of the DA9318 direct charging reference board is shown in Figure 1.

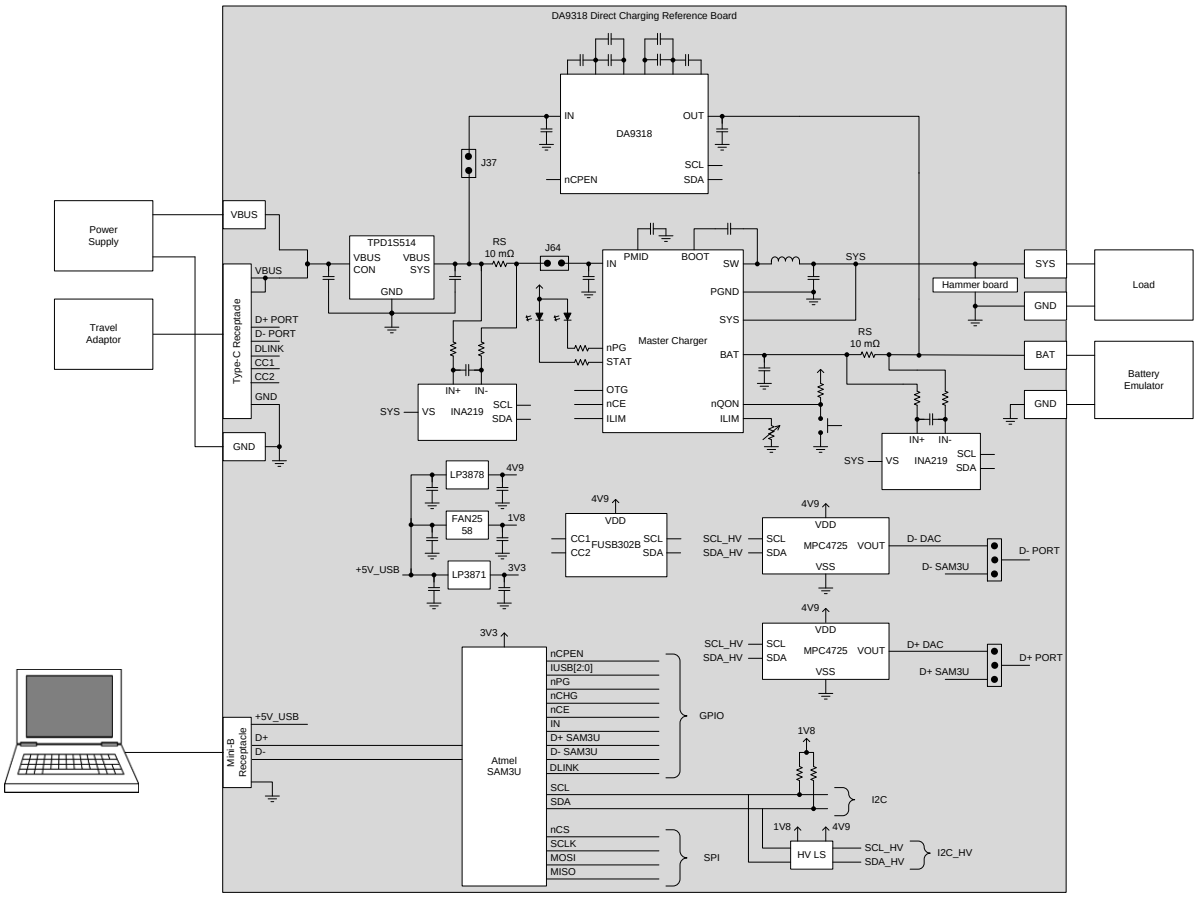

Figure 1: DA9318 Direct Charging Block Diagram

The DA9318 direct charging reference board, see Figure 2, facilitates the measurement, evaluation, and configuration of a battery charging cycle when connected to a TA that includes the iW1780H primary side controller and iW676 secondary side controller chip set.

Dialog's software package SmartCanvas™ uses a simple graphical user interface which enables DA9318 to be controlled via the USB port of a PC. The mini USB connection is visible on the left side of the board. When the cable is connected to the USB port of the PC the green LED (D1) is on.

The board contains jumper links, see Figure 6, to provide access to alternative configurations and measurement test points. Most standard operating modes are evaluated with minimal link changes.

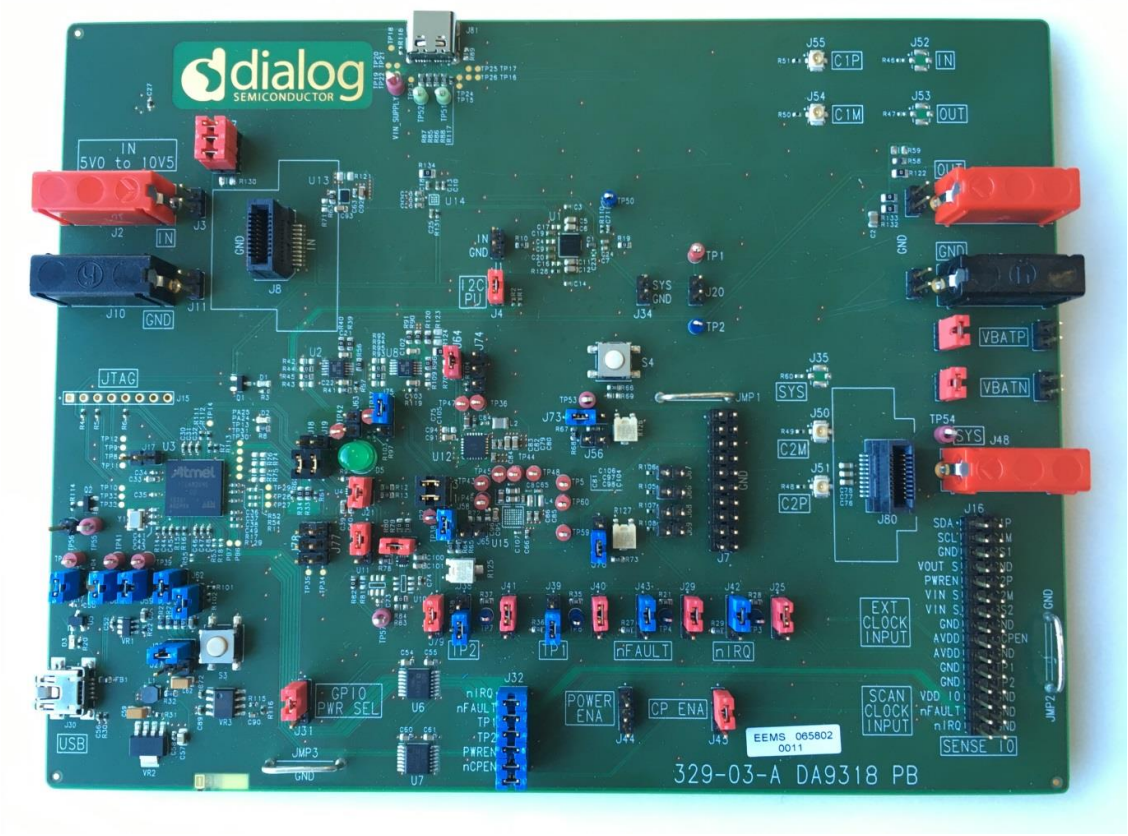

Figure 2: DA9318 Direct Charging Reference Board (329-03-A)

4 Functional Description

During direct charging the master charger of the battery operated device is bypassed and the TA is directly connected to the battery.

The difference between normal charging and direct charging is illustrated in Figure 3.

In order for the direct charging to work, the TA has to have a configurable output voltage and current limit.

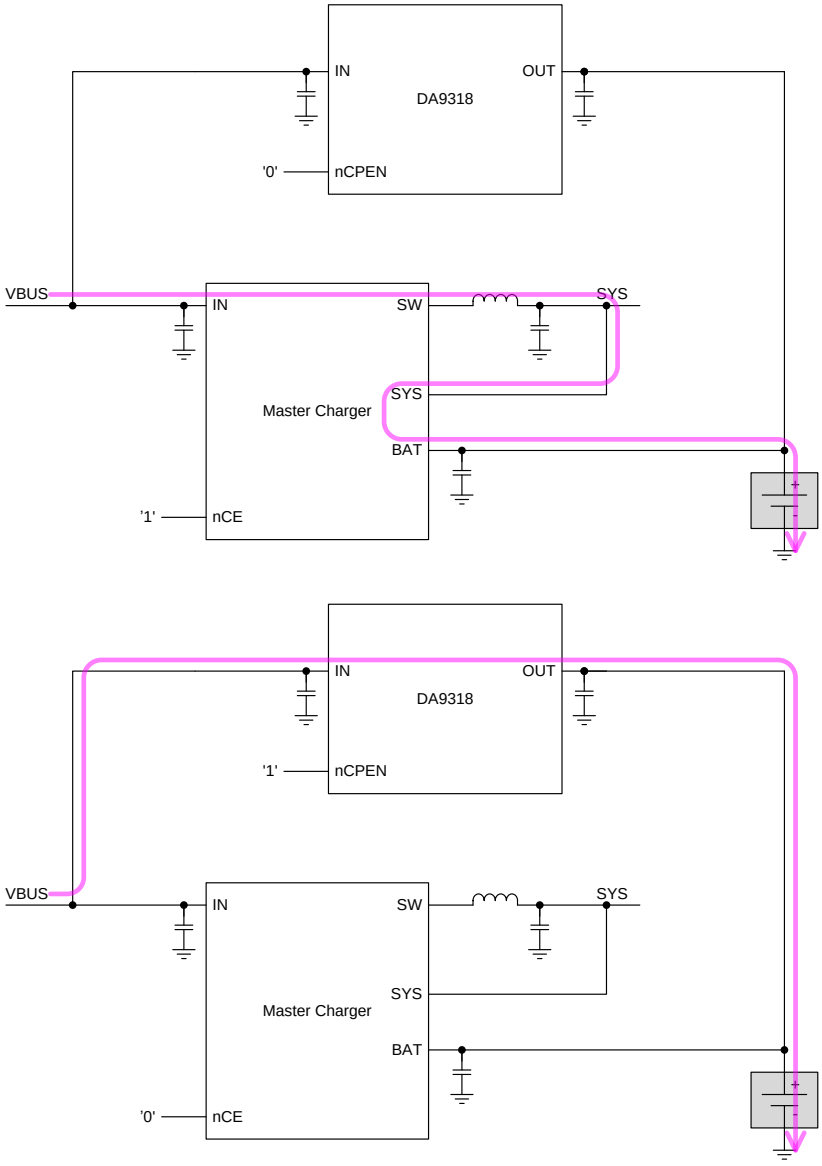

Figure 3: Normal Charging (Top) and Direct Charging (Bottom)

4.1 Master Charger

The master charger is capable of handling a complete charging cycle without host interaction.

The input current limit is set via GPIOs and the charging current and dynamic power management thresholds are set with external pull-down resistors.

The charging statuses are communicated via LEDs. The master charger can be enabled with the nCE signal driven from the microcontroller. During direct charging the master charger is disabled.

4.2 Power Monitor

Two power monitor ICs (INA226), fitted on the DA9318 direct charging reference board, allow for measurement of the master charger input voltage and input current, and for monitoring the battery current and voltage.

That information is read out via the I^2C interface and used in the control GUI software running on the PC.

When direct charging is enabled, the DA9318 internal ADC is monitoring the input/output current and input/output voltage.

Power monitoring is a safety feature associated with direct charging. The input power of the mobile device has to be compared to the output power of the TA. A mismatch indicates a fault condition and the charging has to be terminated.

4.3 Direct Charging

Reverse current protection (RCP) is enabled whenever DA9318 is not in the ACTIVE mode.

DA9318 is capable of starting up when V_{IN} is within the accepted range defined by V_{IN2OUT_MIN} and V_{IN2OUT_MAX}. If V_{IN} is not within the accepted range during start-up, the start-up is aborted.

When the above conditions are satisfied the DA9318 can be enabled by writing CP_EN to allow for direct charging. The TA voltage is set accordingly to allow an initial 6 A charge current into the battery.

During direct charging the master charger is disabled.

4.4 Over-Voltage Protection

Over-voltage protection (OVP) is needed for general protection of devices connected to VBUS.

TI TPD1S514, Fairchild FPF2280, and Kinetic KTS1682 can be used as they all are pinout compatible parts with very similar feature sets.

4.5 Direct Charging Sequence

A sequence diagram for direct charging is depicted in Figure 4.

NOTE

The DA9318 direct charging reference board communication to the TA is achieved using a Dialog proprietary secondary-side to primary-side digital link communication protocol. The sequence diagram in Figure 4 is provided for information only. Please contact ic-support@diasemi.com for more information.

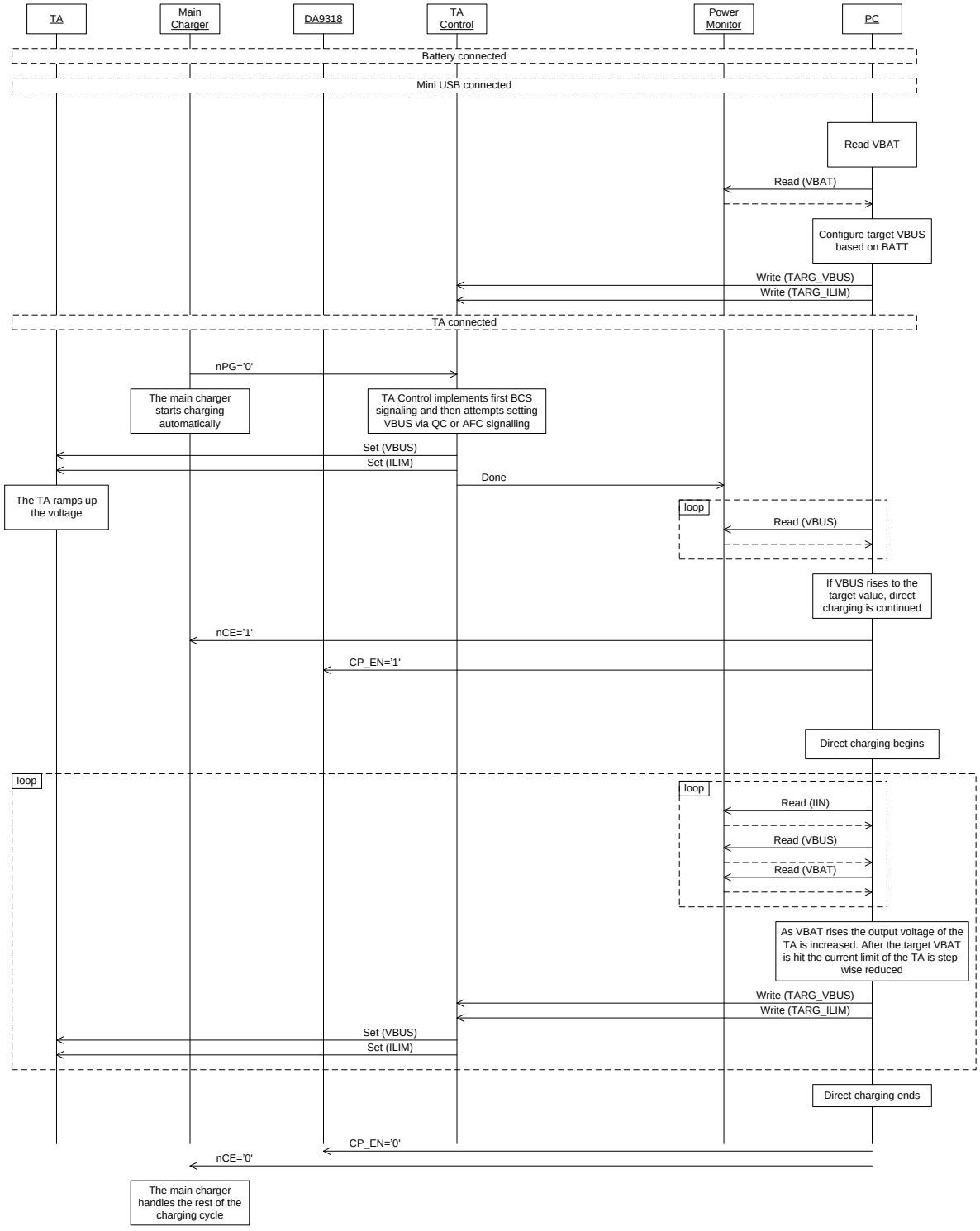

Figure 4: Sequence Diagram for Direct Charging

5 DA9318 Direct Charging Reference Board Hardware

The DA9318 direct charging reference board functionality can be broken down into sections, see Figure 5:

- USB Type-C™ cable input, OVP switch, input connector.
- Master charger / ADCs.
- DA9318 direct charging.
- USB interface (I^2C communication) and USB reset.
- Voltage monitoring connectors and IOs.
- Battery and system connectors.

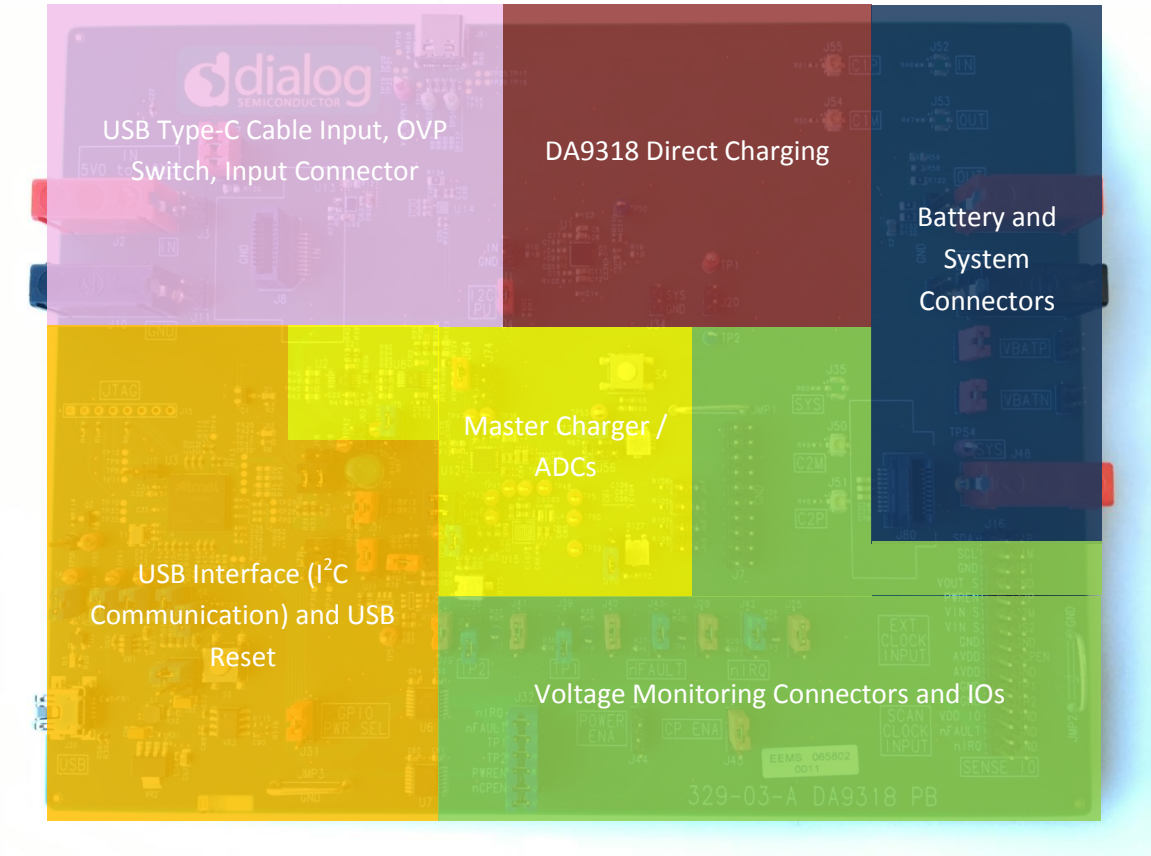

Figure 5: Functional Sections

5.1 Default Link Positions and Connector Definitions

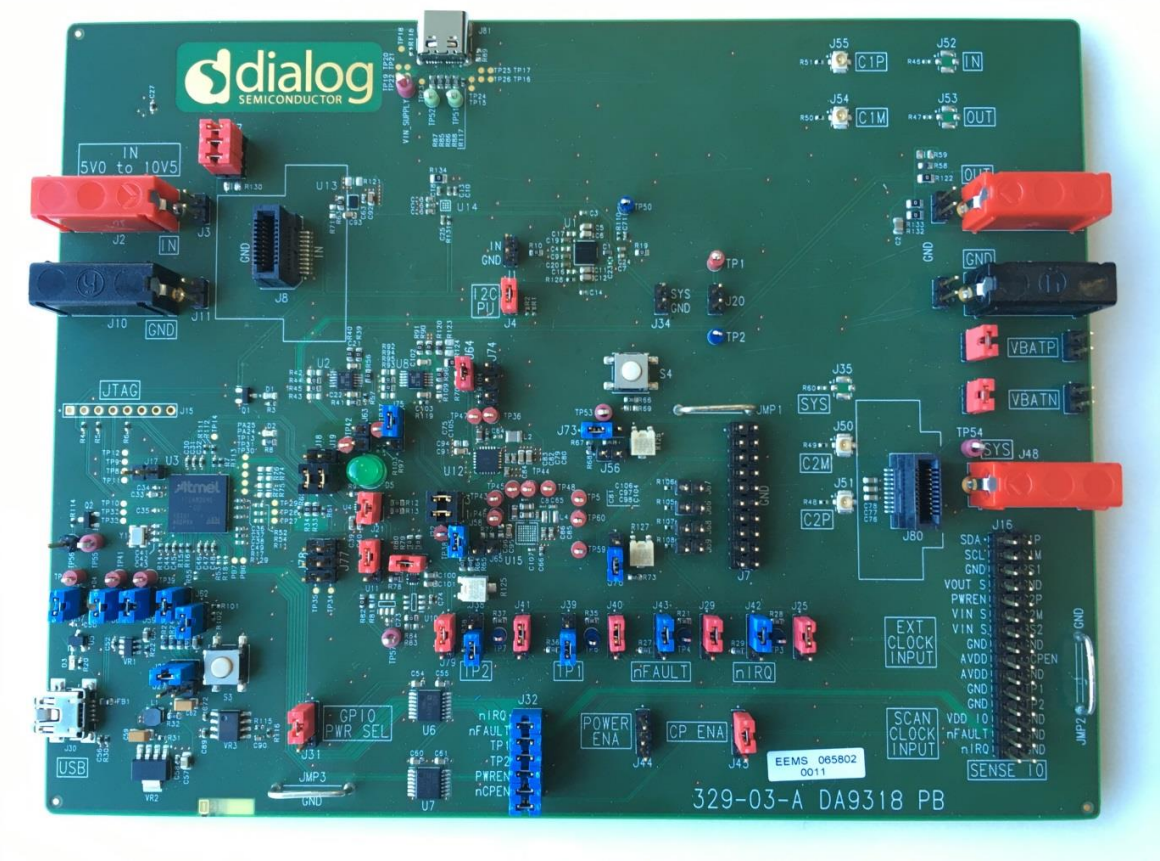

Figure 6: Default Link Positions

Table 1: Default Link Positions and Connector Definitions

Reference Designator	Position	Function
J1	1	IN sense point
	2	GND sense point
J2	NA	IN connector
J3	NA	IN connector
J4	1-2	I^2C pull-up to VDD_IO
J5	NA	OUT connector
J6	NA	OUT connector
J8	NA	Line transient connector
J9	NA	OUT load transient connector
J10	NA	GND connector (IN side of board)
J11	NA	GND connector (IN side of board)
J12	NA	GND connector (OUT side of board)
J13	NA	GND connector (OUT side of board)
J14	NA	NA
J15	NA	JTAG: reserved
J16	NA	Measurement header

Reference Designator	Position	Function
J17	1-2 **(Open)**	**Important: This erases the USB IC firmware. DO NOT SHORT**
J18	1-2 **(Close)**	I²C bypass: SAM3U SCL connected to LS input
	2-3	I²C bypass: SAM3U SCL connected to LS output (bypass)
J19	1-2 **(Close)**	I²C bypass: SAM3U SDA connected to LS input
	2-3	I²C bypass: SAM3U SDA connected to LS output (bypass)
J20	1-2 **(Open)**	PWREN shorted to SYS, DA9318 will immediately go from NO-POWER mode to SHUTDOWN mode when SYS power is supplied.
J21	1-2 **(Close)**	I²C level shifter IC enabled
J22	1-2 **(Close)**	SCL from SAM3U connected to DA9318
	3-4 **(Close)**	SDA from SAM3U connected to DA9318
J23	1-2 **(Close)**	I²C LS power selection: connected to VDD_IO
	2-3	I²C LS power selection: connected to AVDD
J24	NA	VBATN connector for cell sensing
J25	1-2 **(Close)**	nIRQ PU selection: VDD_IO
	2-3	nIRQ PU selection: AVDD
J26	1-2 **(Close)**	Sets VDD_IO to 1.8 V (if J27 open)
J27	1-2 **(Open)**	Sets VDD_IO to 2.8 V (if J26 open)
J28	NA	VBATP connector for cell sensing
J29	1-2 **(Close)**	nFAULT PU selection: VDD_IO
	2-3	nFAULT PU selection: AVDD
J30	NA	USB inlet
J31	1-2 **(Close)**	Both sides of level shifter set to VDD_IO
	2-3	Level shift from AVDD to VDD_IO
J32	1-2 **(Close)**	nIRQ connected to level shifter and SAM3U
	3-4 **(Close)**	nFAULT connected to level shifter and SAM3U
	5-6 **(Close)**	CC1 connected to level shifter and SAM3U
	7-8 **(Close)**	CC2 connected to level shifter and SAM3U
	9-10 **(Close)**	PWREN connected to level shifter and SAM3U
	11-12 **(Close)**	nCPEN connected to level shifter and SAM3U
J33	Close **(Default)**	Short GND to VBATN for a local pack sensing
	Open	GND and VBATN disconnected to allow cell sensing
J34	1	SYS sense point
	2	GND sense point
J35	NA	SMA connector for measuring SYS
J36	Close **(Default)**	Short VOUT_DA9318 to VBATP for a local pack sensing
	Open	VOUT_DA9318 and VBATP disconnected to allow cell sensing
J37	1-2, 3-4, 5-6 **(Close)**	IN connector shunt to IN of DA9318
J38	1-2	CC2 (labeled as TP7) pulled up to rail selected by J41
	2-3 **(Close)**	CC2 (labeled as TP7) pulled to ground

Reference Designator	Position	Function
J39	1-2	CC1 (labeled as TP6) pulled up to rail selected by J40
	2-3 **(Close)**	CC1 (labeled as TP6) pulled to ground
J40	1-2 **(Close)**	CC1 (labeled as TP6) PU selection: VDD_IO
	2-3	CC1 (labeled as TP6) PU selection: AVDD
J41	1-2 **(Close)**	CC2 (labeled as TP7) PU selection: VDD_IO
	2-3	CC2 (labeled as TP2) PU selection: AVDD
J42	1-2 **(Close)**	nIRQ pulled up to rail selected by J25
	2-3	nIRQ pulled to ground
J43	1-2 **(Close)**	nFAULT pulled up to rail selected by J29
	2-3	nFAULT pulled to ground
J44	1-2 **(Open)**	**Important: DO NOT SHORT**
	2-3 **(Open)**	Connect PWREN to GND to enter NO-POWER mode. Make sure J20 is open before installing a jumper in this position. **Note: J44 pin 2 is connected to AVDD by default**
J45	1-2 **(Close)**	nCPEN shorted to AVDD
	2-3	nCPEN shorted to GND
J47	NA	NA
J48	NA	SYS connector
J50	NA	SMA connector for measuring C2N (labeled as C2M)
J51	NA	SMA connector for measuring C2P
J52	NA	SMA connector for measuring IN
J53	NA	SMA connector for measuring OUT
J54	NA	SMA connector for measuring C1N (labeled as C1M)
J55	NA	SMA connector for measuring C1P
J56	1-2 **(Open)**	Master Charger thermistor sensor short to ground
J57	1-2 **(Close)**	Master Charger Status read connection to Atmel
J58	1-2 **(Close)**	Master Charger Current Limit settings
J59	1-2 **(Close)**	OTG to Ground
J60	1-2 **(Close)**	INTB GPIO connection to SAM3U
J61	1-2 **(Close)**	Master charger enable through GPIO
J62	1-2 **(Close)**	Master charger enable
J63	1-2 **(Open)**	PGB GPIO connection to SAM3U
J64	1-2 **(Close)**	DA9318 input disconnect
J65	1-2 **(Open)**	DA9156 input disconnect
J66	1-2 **(Open)**	DA9156 IRQ pull-up
J67	1-2 **(Open)**	DA9156 ISET pull-up
J68	1-2 **(Open)**	DA9156 GPIO0 pull-up
J69	1-2 **(Open)**	DA9156 GPIO1 pull-up
J70	NA	NA
J71	NA	NA

Reference Designator	Position	Function
J72	1-2 **(Close)**	I^2C high voltage level shifter enable
J73	1-2 **(Close)**	Master charger thermistor connection
	2-3	
J74	1-2 **(Open)**	Master charger DSEL settings
J75	1-2	Master charger PSEL settings
	2-3 **(Close)**	
J76	1-2	DA9156 battery ID connected to variable impedance
	2-3 **(Default)**	DA9156 battery ID connected to fixed impedance
J77	1-2 **(Open)**	Dplus connected to SAM3U PB11 port
	2-3 **(Open)**	Dplus connected to SAM3U PC15 port
J78	1-2 **(Open)**	Dplus connected to SAM3U PB12 port
	2-3 **(Open)**	Dplus connected to SAM3U PC16 port
J79	1-2 **(Close)**	Both sides of level shifter set to VDD_IO
	2-3	Level shift from AVDD to VDD_IO
J80	NA	Load transient connector
J81	NA	USB-C inlet
S3	NA	Push button to reset the USB IC

5.2 USB Interface

The DA9318 direct charging board uses an ATMEL® SAM3U® microcontroller as the USB transceiver, programmed to deliver the following functionalities:

- I²C control interfaces.
- Discrete digital IO control (General Purpose Input Output (GPIO) and dedicated functions).

5.2.1 USB Power and GUI Reset

The USB is powered by an on-board regulator (VR2), see Figure 7. Pressing the USB RESET switch S3 shuts down the on-board regulator VR2, powering down the supply for the SAM3U (USB I²C interface). This resets the GUI communication with the reference board.

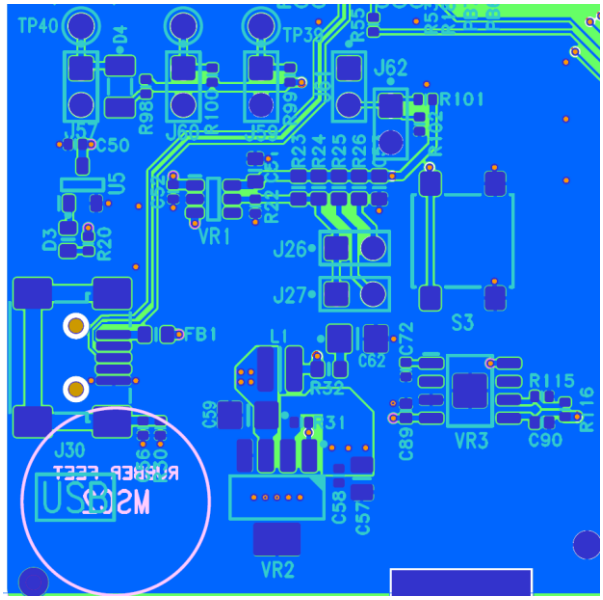

Figure 7: USB Interface Connector and Reset Switch

Table 2: Power Configuration Switch

Switch Name	Reference Designator	Type	Function
USB RESET	S3	Push button	Shuts down the on-board regulator that generates the interface supply

5.3 Power Supplies

The DA9318 direct charging board is powered up when a power source is connected to IN (J48). IN operating voltage range is +5.5 V to +10.5 V.

The VDD_IO voltage is generated by an on-board regulator (VR1) supplied from the +5 V USB. By default, the on-board generated VDD_IO is +1.8 V (J26 jumper is POP, J27 jumper is UNPOP):

- To change the on-board VDD_IO to +2.8 V, J27 must be fitted while J26 is UNPOP.
- To change the on-board VDD_IO to +3.3 V, J26 and J27 must be UNPOP.

NOTE
For correct operation, connect the reference board to a USB port capable of supplying 500 mA.

6 DA9318 Direct Charging Reference Board Software

The board is controlled using a graphical user interface (GUI), which requires a PC operating Windows® 2000/XP/Vista/Windows 7 with a USB1.1 or USB2 interface. The GUI allows the user to:

- Perform raw write and read operations to all control registers on Dialog and non-Dialog ICs.
- Monitor the charging status.
- Plot the DA9318 efficiency over time with saving and zoom feature.
- Plot the master charger efficiency over time with saving and zoom feature.
- Plot the DA9318 temperature over time with saving and zoom feature.
- Poll the DA9318 registers.
- Read ADC data from DA9318 (V_{IN}, V_{BAT}, I_{IN}, I_{OUT} and T_{JUNC}) when the DA9318 is enabled.
- Read ADC data from external ADC ICs (V_{IN}, V_{BAT}, I_{IN} and I_{OUT}) when the master charger is enabled.
- Control the TA voltage and current limit; and master charger voltage termination, charge current and current limit.
- Send default settings.
- Read all registers displayed.
- Clear faults.

6.1 GUI Installation

The files required to install the software are available on the supplied USB drive. To install the DA9318 reference board software:

1. Run **setup_DA9318_Reference_GUI.x.x.x.xx.exe**.
2. On completion, insert the USB cable and apply V_{SYS} and V_{IN}.
   a. For first time users Windows should detect the attached USB device. If this is not the case, it may be necessary to install the driver by navigating to the required driver file in the USB driver directory, see section 6.2. After installing the driver, reboot the PC to ensure correct operation.
3. Start the software by running **DA9318 Reference GUI.exe**.

6.1.1 GUI Installation Step By Step Guide

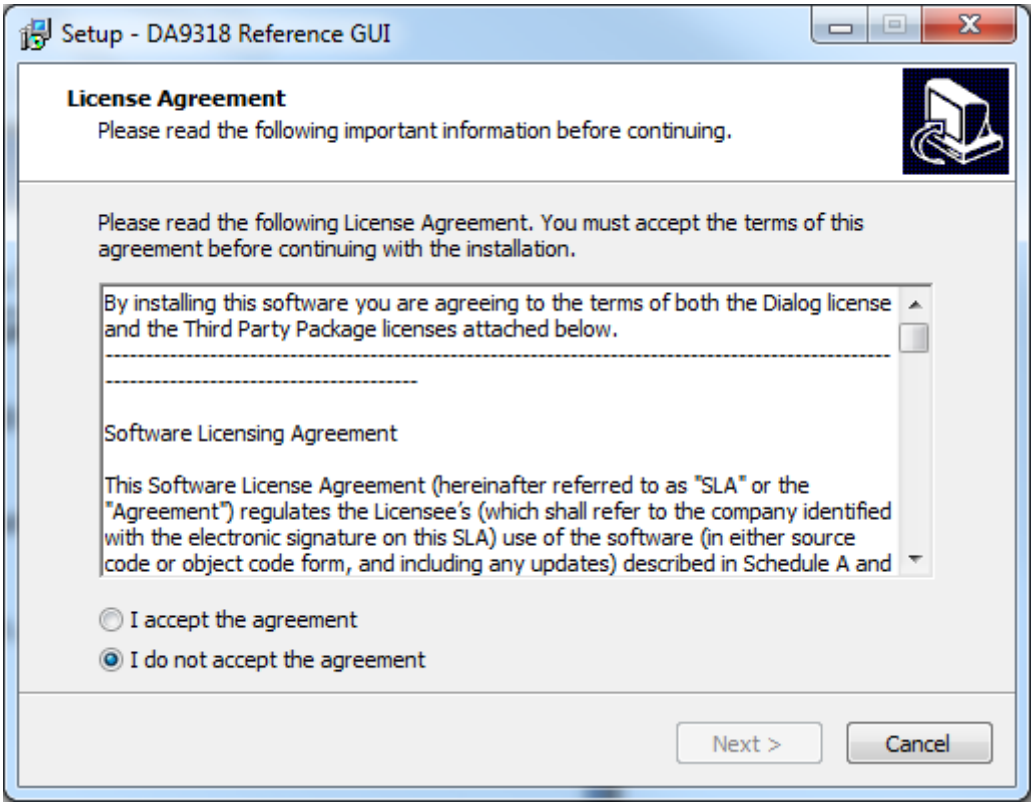

Figure 8: GUI Setup License Agreement

1. Select **I accept the agreement** then click **Next**.

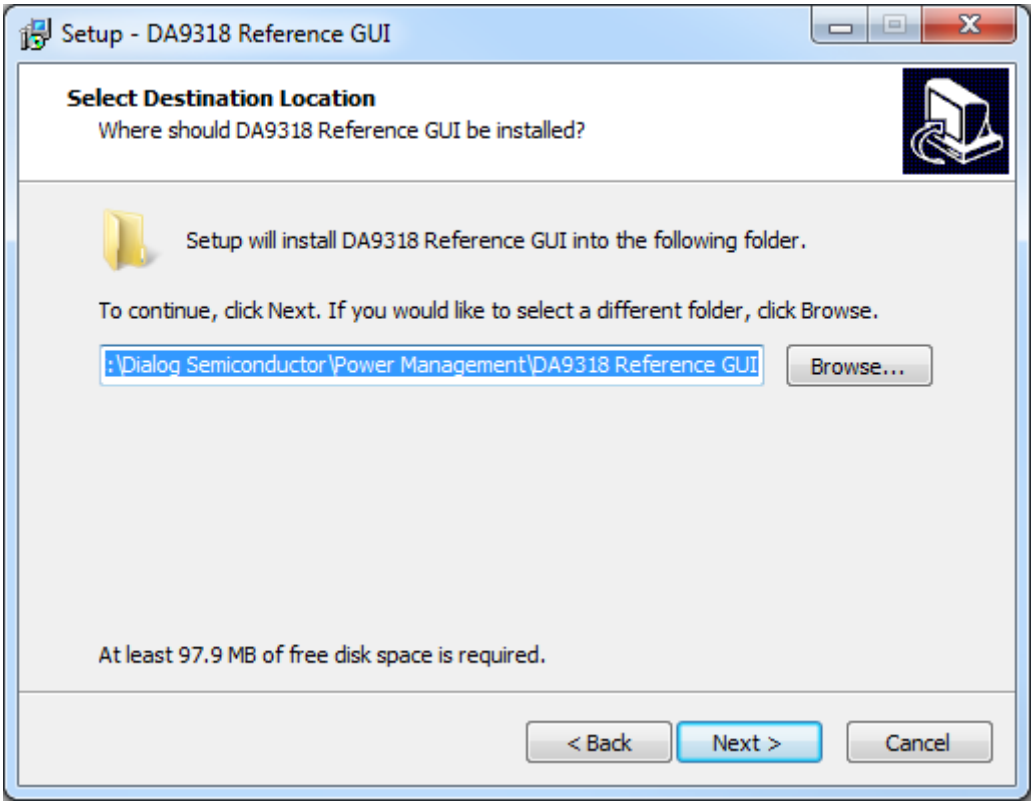

Figure 9: GUI Setup Destination Location

2. Click **Next**.

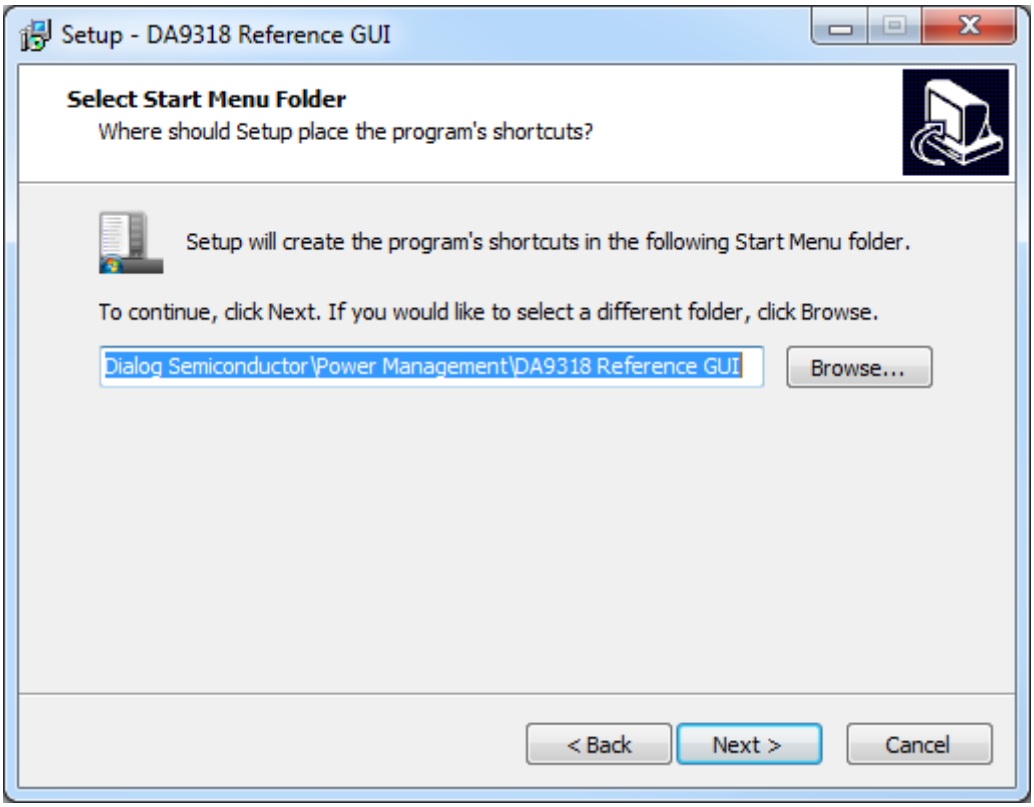

Figure 10: GUI Setup Start Menu Location

3. Click **Next**.

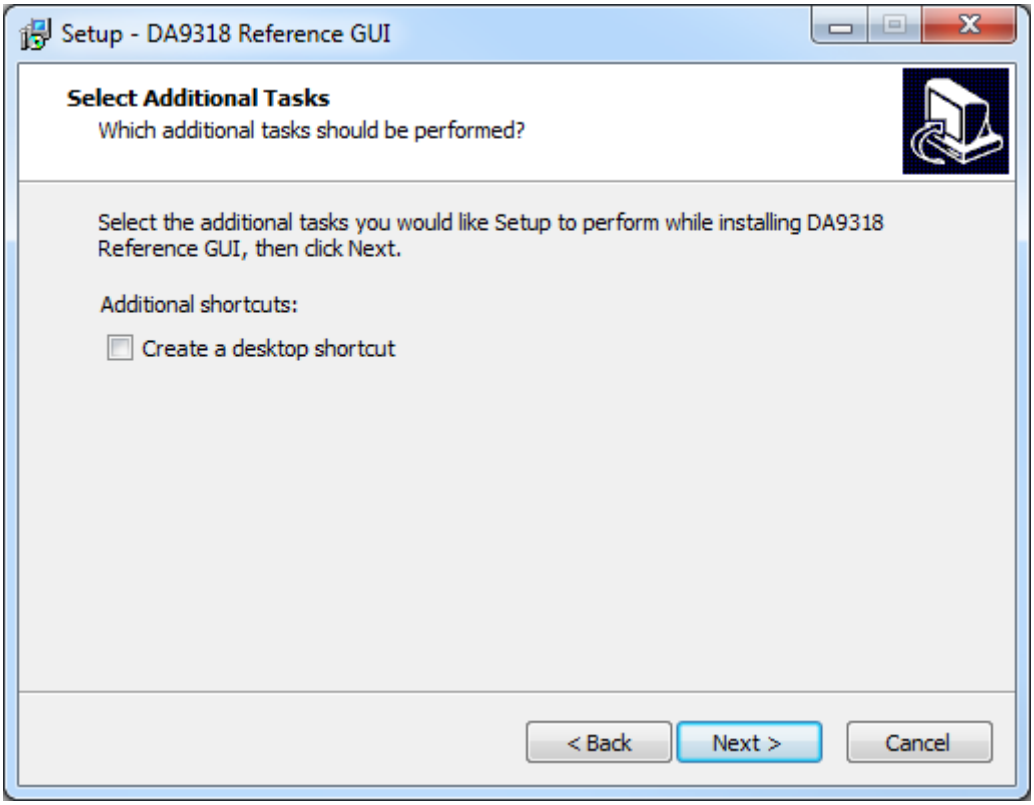

Figure 11: GUI Setup Additional Tasks

4. Select the **Create a desktop shortcut** check box (if required) and click **Next**.

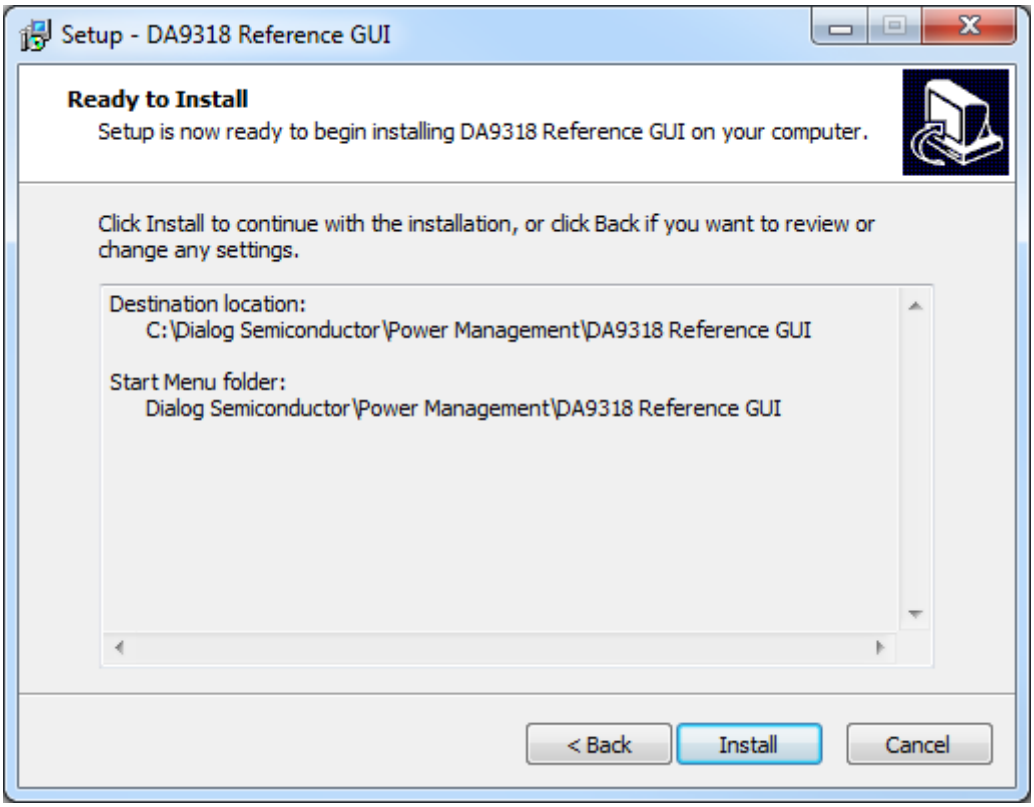

Figure 12: GUI Setup Start Installation

5. Click **Install**.

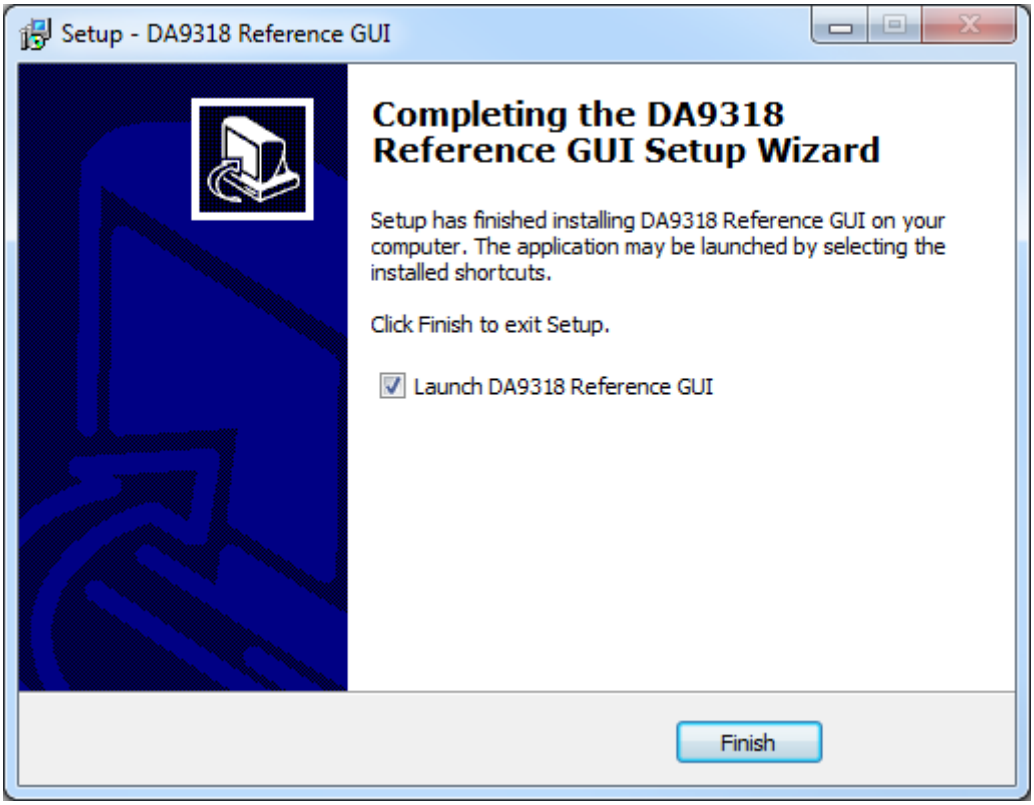

Figure 13: GUI Setup Finish and Launch

6. Click **Finish**.

Once the installation is completed, you may need to restart your computer.

When the software is installed, insert the USB cable before applying V_{SYS} and V_{IN}. The DA9318 SmartCanvas software can be started after power up.

6.2 Initial USB Connection

On connecting the USB to the PC for the first time, the SAM3U USB driver will request driver updating/installation from the Windows operating system. On Windows 7 (32-bit) operating systems (OS) the driver usually installs automatically. On Windows 7 (64-bit) machines it is common for the complete driver installation to fail. If this happens, install the driver manually by following these steps:

1. **Control Panel** → **Devices and Printers** (double-click device with yellow exclamation sign).
2. **Update Driver**.
3. **Browse my computer for driver software**.
4. Select the **Driver** folder location: **C:\Dialog Semiconductor\Power Management\DA9318 Reference GUI\Driver**.
5. If Windows warns about the driver, select **Install anyway**.
6. Remove the USB cable and then re-insert it into the reference board.

7 GUI Software

Run the DA9318 Reference Board GUI software by clicking the shortcut on the appropriate item in the Start menu (**All Programs → Dialog Semiconductor → Power Management → DA9318 Reference GUI**). The screen shown in Figure 14 is displayed.

The minimum recommended setting for the PC display size is 1024x768 pixels. Font size on the PC display should be Normal (95 dpi).

NOTE
A display size other than the recommended setting will affect the way in which the panels appear.

7.1 Controls

Figure 14 shows the main GUI interface.

Figure 14: Main GUI Interface

7.2 Control Widgets

7.2.1 Enable/Disable Polling

The polling switch enables or disables polling of the device registers and the refreshing of the registers' controls on the GUI interface.

Figure 15: Polling

7.2.2 Charging Status Indicators

The **Status Indicators** window, see Figure 16, displays the following information:

- **Pre-Charge**: When the battery voltage is below 3 V (V_{BATLOW}), the battery is pre-charged at a lower charge current of 128 mA.
- **Constant-Current**: When the battery voltage is above 3 V and below the constant voltage threshold; this indicator will light green. This indictor will also light green in conjunction with the **Slave Charging** indicator during direct charger.
- **Constant-Voltage**: When the battery voltage reaches the master charger constant voltage termination voltage threshold, this indicator will light green indicating charger is in constant voltage.
- **Slave Charging**: This indicator will light green when slave charging (DA9318) is enabled indicating direct charging.
- **DONE**: This indicator will light green when charge cycle is complete.

The update actions are as follows:

- **Read All Registers** – even if the hardware device is not being actively polled then all the registers can be polled once by pressing this button.

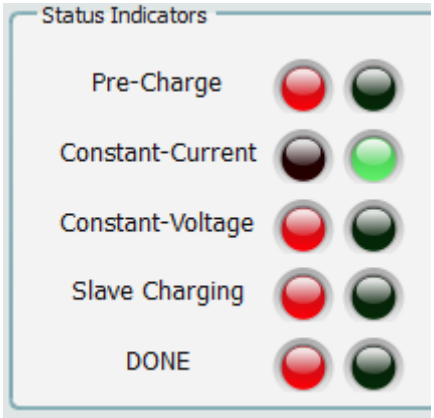

Figure 16: Board Status

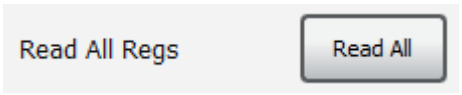

Figure 17: Read All Regs Button

7.2.3 Raw I/O

The **Raw I/O** control sends the entered device address, register address and data on the I²C communications interface. If the information sent is not valid then the I²C message will return NACK an error message will be displayed in the **Status** window.

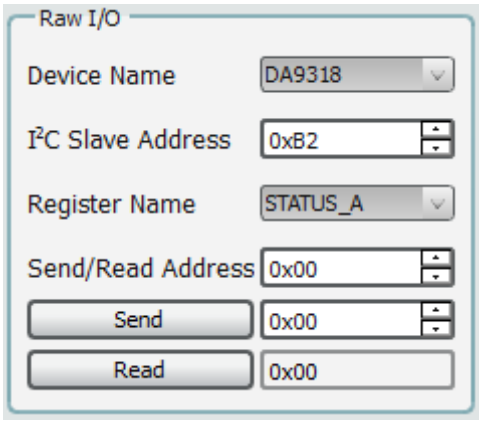

Figure 18: Raw I/O

7.2.4 Interface Control Information

In the **View** menu, click on **Status**, the **Status** window is displayed.

In the **Status** window, select the **Log** tab and **Log Level: Info**. This will display interface control information including: name, parent register and the bits to which this control corresponds, current value, whether it is read-only or R/W access, and finally a description of each possible setting.

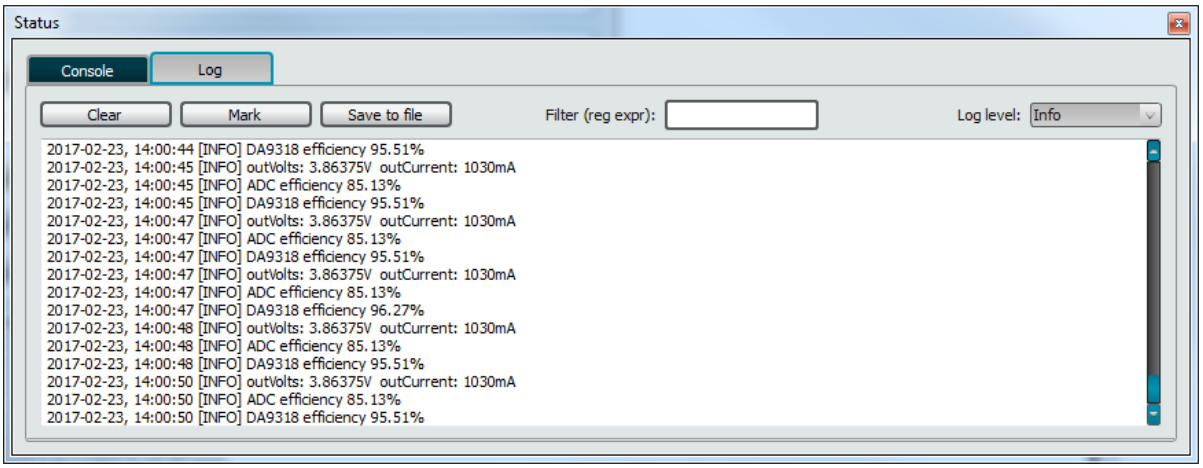

Figure 19: Interface Control Information

7.2.5 I²C Bus Scan

In the **Tools** menu, click on **Scan I2C**, the **I2C Bus Scan** window is displayed.

In the **I2C Bus Scan** window, selected **Scan**. Once the scan has completed, all I²C slave addresses will be displayed.

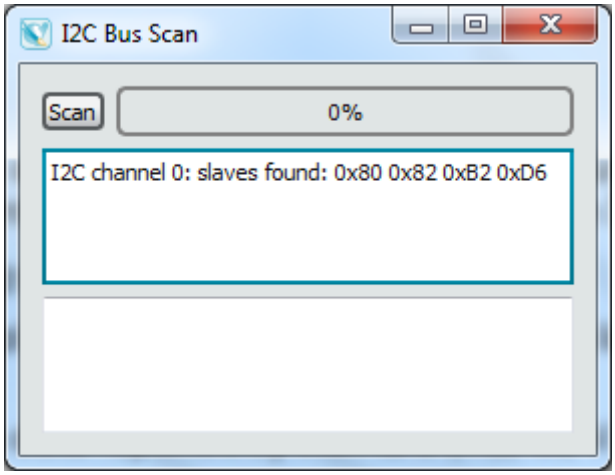

Figure 20: I2C Bus Scan

7.2.6 Settings

In the **Options** menu, click on **Settings**, the **Settings** window is displayed.

The U2 and U8 INE226 ADC ICs can be configured in the **Settings** window.

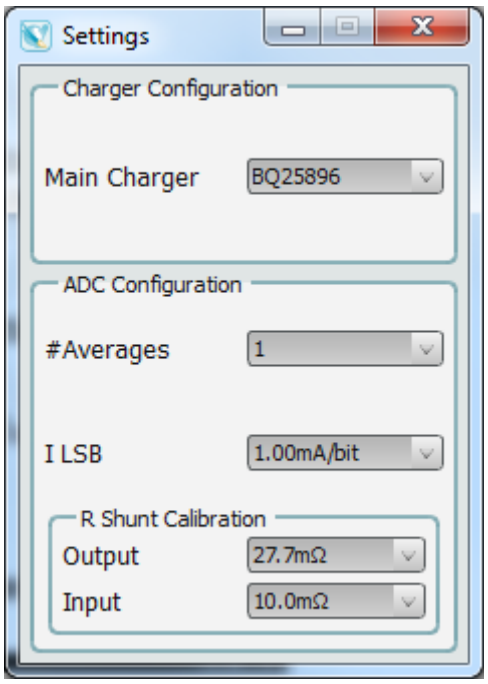

Figure 21: Settings

7.3 Quick Start Guide

The recommended steps to operate the DA9318 direct charging reference board are shown below.

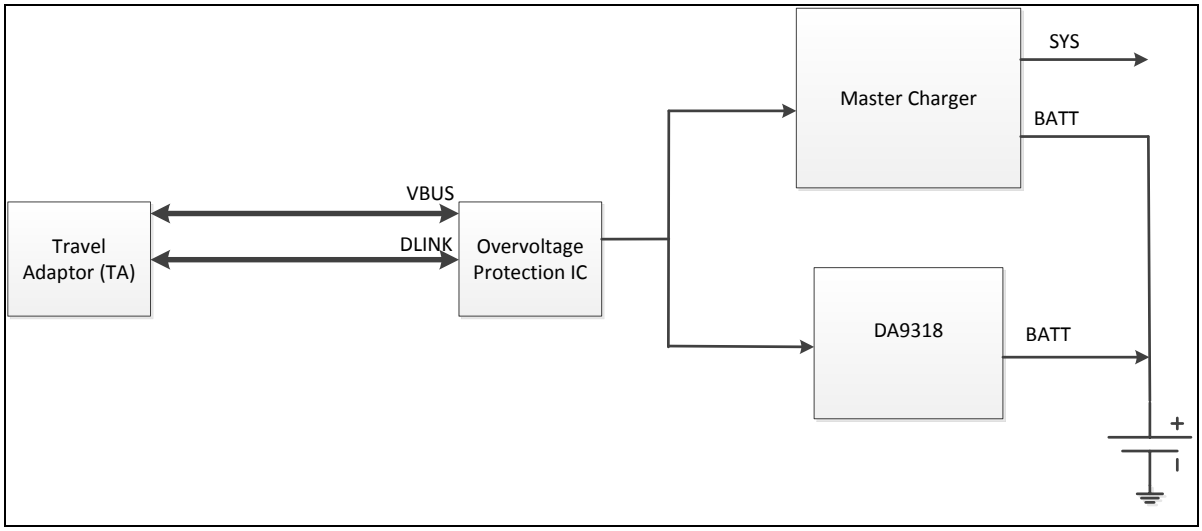

Figure 22: Test Setup

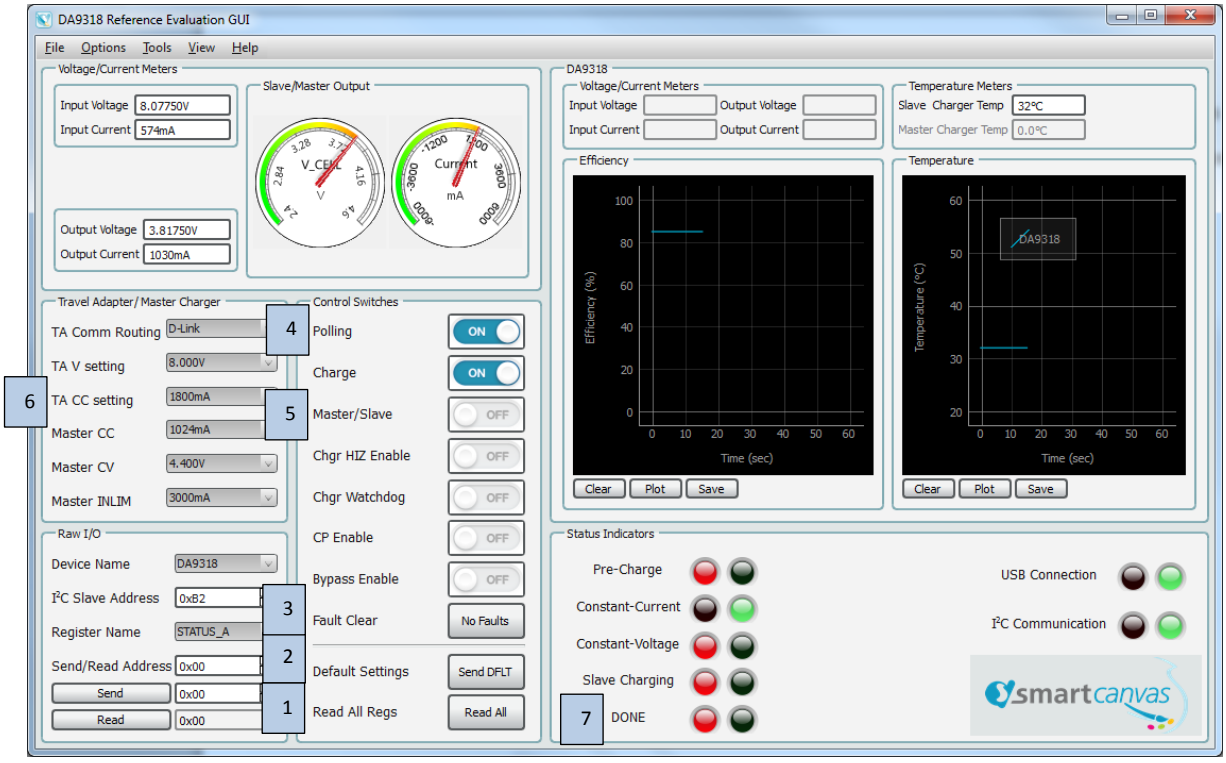

Figure 23: GUI Configuration

7.3.1 Operational Steps

The following operational steps assume that a battery is inserted initially and then the TA is inserted to J81. In addition, J30 must be connected to the USB port of a computer for I^2C communication using the DA9318 Reference Board SmartCanvas GUI software.

NOTE
The battery voltage should be less than 3.6 V to allow for a 6 A initial charge current.

The button or status indicator locations for each operational step are highlighted in Figure 23:

1. Click the **Read All** button, to read all registers to their current states.
2. Click the **Send DFLT** button, to send the default settings/
3. Click the **No Faults** button, to clear any faults.
4. Enable the **Polling** switch. The **Constant-Current** status indicator flags green, signaling that the master charger is enabled.
5. Enable the **Master/Slave** switch. Direct charging is enabled via DA9318 and the **Constant-Current** and **Slave Charging** status indicators flag green.
6. When the **Constant-Voltage** status indicator flags green, step down the **TA CC Setting** by 100 mA steps (or greater initially) until the minimum value is reached (400 mA). Note that for each step the **Constant-Voltage** status indicator will alternately flag red and green as the battery charges up.
7. When the **TA CC Setting** has reached the minimum value, disable the **Master/Slave** switch to return to master charger until the **DONE** status indicator flags green, signaling the end of the charge cycle.

NOTE
Unless the watchdog timer is serviced, it is recommended to disable it by disabling the **Chgr Watchdog** switch while the master charger is enabled. This is to ensure that the master charger does not initiate a power-on-reset when the watchdog timer has expired. Indeed, when the watchdog timer has expired, the device returns to default mode and all registers are reset to default values.

Revision History

Revision	Date	Description
1.0	01-Mar-2017	Initial version.

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.
APPROVED or unmarked	The content of this document has been approved for publication.

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