

User Manual DA9168 Performance Board UM-PM-051

Abstract

This document describes the hardware and software used to evaluate the DA9168. It is applicable to the DA9168-03-A1 performance board.



DA9168 Performance Board

Contents

Ab	stract			1						
1	Terms and Definitions4									
2	References 4									
3	Intro	Introduction								
4	DA91	DA9168 Performance Board Hardware								
	4.1	Default J	umper Positions and Connector Definitions	6						
	4.2	I ² C-USB	Module	9						
5	Basic	: Operatio	on	10						
	5.1	Starting I	Fast Charge Mode	10						
	5.2	Starting I	Reverse Boost Mode	10						
	5.3	Signal M	onitoring	11						
	5.4	Fault Ind	icators	11						
	5.5	Interrupt	Signals	12						
6	DA91	68 Perfor	mance Board Software	13						
	6.1	SmartCanvas GUI Installation1								
		6.1.1	SmartCanvas GUI Installation Step-by-Step Guide	13						
	6.2	Initial I ² C	-USB Connection	16						
7	Smar	tCanvas	Software	17						
	7.1	Register	Controls	17						
	7.2	Table Vie	ew Tab	18						
	7.3	Control V	Vindows	18						
		7.3.1	Communication	18						
		7.3.2	Enable/Disable Polling	19						
		7.3.3	I/O	19						
		7.3.4	Raw I/O	19						
		7.3.5	File I/O	19						
		7.3.6	Info	20						
	7.4	Menu Ite	ms	20						
		7.4.1	File -> Open Python Script	20						
		7.4.2	File -> Run Python Script	20						
		7.4.3	Tools -> Model IO	21						
		7.4.4	Tools -> Scan I2C	21						
		7.4.5	Tools -> Custom Tabs	22						
		7.4.6	Search -> Find Register	22						
		1.4.1	view	22						
8	Regis	ster Text	File	23						
	8.1	I ² C Regis	ster Text File Format	23						
Re	vision	History.		24						



Figures

Figure 1: DA9168 Performance Board Overview	. 5
Figure 2: DA9168 Performance Board Default Jumper Position	. 6
Figure 3: I ² C-USB Module	. 9
Figure 4: Enable Fast Charge Mode	10
Figure 5: Enable Reverse Boost Mode	10
Figure 6: System Events Tab	11
Figure 7: Interrupt Mask Tab	12
Figure 8: System Status Tab	12
Figure 9: GUI Setup License Agreement	13
Figure 10: GUI Setup Destination Location	14
Figure 11: GUI Setup Shortcuts Location	14
Figure 12: GUI Setup Create Shortcut	15
Figure 13: GUI Setup Installation	15
Figure 14: GUI Setup Finish and Launch	16
Figure 15: Main Interface	17
Figure 16: Table View	18
Figure 17: Communication Control	18
Figure 18: Polling	19
Figure 19: I/O	19
Figure 20: Raw I/O	19
Figure 21: File I/O	19
Figure 22: Info	20
Figure 23: Model IO	21
Figure 24: Scan I2C	21
Figure 25: Custom Tabs	22
Figure 26: Find Register	22
Figure 27: Register Dump (.txt File) Example	23

Tables

Table 1: Header and Switch Definitions	6
--	---



DA9168 Performance Board

1 Terms and Definitions

GPIO	General purpose input / output
GUI	Graphical user interface
IOs	Inputs / outputs
OTP	One time programmable
MUX	Multiplexer
PC	Personal computer
PCB	Printed circuit board
SAM3U	I ² C-USB interface (Microchip [®] Arm [®] -based ATSAM3U4E [®] microcontroller)
SCH	Schematic
GND	Ground
USB	Universal serial bus

2 References

- [1] DA9168, Datasheet, Dialog Semiconductor.
- [2] DA9168-03-A1_sch.pdf, Dialog Semiconductor.
- [3] DA9168-03-A1_pcb.pdf, Dialog Semiconductor.



3 Introduction

The DA9168 performance board enables the measurement, evaluation, and programming of the DA9168 device.

Dialog's control software SmartCanvas[™], uses a graphical user interface (GUI) to control DA9168 via the USB port of a PC. The I²C-USB connector is on the bottom side of the performance board.

The board has jumper links to provide access to alternative configurations and measurement test points.

4 DA9168 Performance Board Hardware

The DA9168 performance board functionality is organized in seven discrete sections, see Figure 1.

- 1. VBUS input section: Power supply and USB power supply connectors.
- 2. VSYS output section.
- 3. VBAT input/output section.
- 4. VOUT1 and VOUT2 outputs section.
- 5. REFLDO output section.
- 6. GPIOs network section.
- 7. GPIOs signal monitors section.



Figure 1: DA9168 Performance Board Overview

User Manual	Revision 3	03-Aug-2022



4.1 Default Jumper Positions and Connector Definitions

DA9168 performance board default jumper connections are shown as Figure 2.



Figure 2: DA9168 Performance Board Default Jumper Position

Table 1: Header and Switch Definitions

Note: Default jumper positions are indicated in **bold**.

Reference Designator	Position	Function	
J1	n/a	Micro USB-2.0 connector	
J2	n/a	VIN power	
J3	n/a	VSYS load	
J4	n/a	VOUT1 load	
J5	n/a	VOUT2 load	
J6	n/a	VREFLDO load	
J7	n/a	VMID load	
10	1	VSYS load voltage sense	
50	2	VSYS load GND sense	
J9 1-2 Connects VIN to VBI		Connects VIN to VBUS	
J10	1-2	VIN_USB to VBUS	

	Monuol
User	Manual



DA9168 Performance Board

Position	Function		
1	VIN power sense		
2	VIN GND sense		
1-2	Connects TMP_SNS network to TMP_SNS pin		
1-2	Reserved		
1-2	CHG_EN_N pull-down connector		
1-2	TMP_SNS pull-up connector		
1-2	Reserved		
1-2	Reserved		
n/a	VIN GND		
n/a	VSYS GND		
1-2/3	Connects VBAT_SNS and VBAT		
4	AGND		
n/a	VBUS line transient connector		
n/a	VSYS load transient connector		
n/a	VOUT1 load transient connector		
n/a	VOUT2 load transient connector		
n/a	VMID load transient connector		
1	VSYS output voltage sense		
2	VSYS GND voltage sense		
3	VSYS load		
4	VSYS GND		
1	VOUT1 output voltage sense		
2	VOUT1 GND voltage sense		
3	VOUT1 load		
4	VOUT1 GND		
1	VOUT2 output voltage sense		
2	VOUT2 GND voltage sense		
3	VOUT2 load		
4	VOUT2 GND		
1	REFLDO output voltage sense		
2	REFLDO GND voltage sense		
3	REFLDO load		
4	REFLDO GND		
1	VBAT voltage sense		
2	VBAT GND voltage sense		
3	VBAT load		
4	VBAT GND		
1	VMID output voltage sense		
2	VMID GND voltage sense		
	Position 1 2 1-2 1-2 1-2 1-2 1-2 1-2 1-2 1-2 1-2 1/2 n/a 1 2 3 4 1 2 3 4 1 2 3 4 1 2 3 4 1 2 3 4 1 2 3 4 1 2 3 4 1		

User Manual

Revision 3

03-Aug-2022



Reference Designator	Position	Function	
	3	VMID load	
	4	VMID GND	
	1	VBUS voltage sense	
J32	2	VBUS GND voltage sense	
(VBUS Kelvin sensing)	3	VBUS load	
	4	VBUS GND	
J33	n/a	I ² C-USB module connector	
J34	1-10	GPIOs signal monitor	
J35	1-10	GPIOs signal monitor	
120	1-2	ILIMIT pull-up connector	
330	2-3	ILIMIT pull-down connector	
107	1-2	ILIMIT pull-up connector	
337	3-4	ILIMIT weak pull-down connector	
120	1-2	EN pull-up connector	
336	2-3	EN pull-down connector	
120	1	Connects to real battery positive	
128	2	Connects to real battery GND	
J40	1-2	INT_N pull-up connector	
J41	1	Device C1 pin (VBAT) voltage sense	
	2	VBAT GND voltage sense	
J42	1	Device C2 pin (VSYS) voltage sense	
	2	VSYS GND voltage sense	
J43	1-2	CHG_EN_N pull-up connector	
S1	n/a	RIN_N reset push button	



4.2 I²C-USB Module

The DA9168 performance board uses an I²C-USB module (Figure 3) for the I²C communication. This I²C-USB module integrates a Microchip[®] Arm[®]-based ATSAM3U4E[®] (SAM3U) microcontroller.

Note: The SAM3U microcontroller VDDIO voltage is fixed at 3.3 V; therefore, the I²C-USB module only supports 3.3 V level I²C communication.



Figure 3: I²C-USB Module



5 Basic Operation

5.1 Starting Fast Charge Mode

Before starting Fast Charge mode, confirm the jumper connections are correct; VBUS and VBAT voltage level:

- VBUS voltage is higher than VINDPM, typical setting is 5.0 V
- VBAT voltage is higher than fast charge voltage threshold, typical setting is 3.7 V

Once power is applied, OTP registers are loaded and I²C communication is available.

Set register CHG_EN (0x16[0]) to high. DA9168 enters Fast Charge mode.

DA9168										
EURCTIONAL REGISTERS SYSTEM CHARGER LOO Table View										
arger	Charger Settings									
÷	PMC_CHG_00		PMC_CHG_01		PMC_CHG_02		PMC_CHG_03			
	CHG_VRCHG	100	CHG_TMR_SAFE	5 🗸	CHG_RANGE_TERM	5-20 mA, in 5	CHG_RANGE	Fast-charge 20 mA		
	CHG_TMR_HALF_EN	Enable	CHG_TMR_PRE	30 🗸	CHG_RANGE_PRE	5-15 mA, in 5	CHG_ICHG	CHG_RANGE = 0 : 🗸		
	CHG_TMR_EN	Enable	CHG_TOPOFF	Disable TOPOFF	CHG_ITERM	CHG_RANGE = 0 : V				
	CHG_TERM_EN	Enable			CHG_IPRE	CHG_RANGE = 0 : V				
	CHG_EN	Enable								
	0x0016	0x0F	0x0017	0x00	0x0018	0x0F ÷	0x0019	0x19		
	PMC_CHG_04		PMC_CHG_05		PMC_CHG_06					
	CHG_VBATREG	4.20 🗸	TS_VBATREG_SHIFT	100	TS_ICHG	CHG_RANGE = 0 : V				
			CHG_TS_WARM_V	Disable						
			CHG_TS_COOL_I	Disable						
	0x001A	0x17 *	0x001B	0x00 -	0x001C	0x0C				

Figure 4: Enable Fast Charge Mode

5.2 Starting Reverse Boost Mode

To enable DA9168 Reverse Boost mode, confirm the following conditions:

- VBUS power supply is disconnected
- VBAT voltage is higher than reverse boost voltage threshold, typical setting is 3.7 V
- Bits BOOST_VOUT(0x14[3:0]) setting is 0.5 V higher than VBAT

Set register BOOST_EN (0x13[0]) to high. DA9168 enters Reverse Boost mode.

DA9168								
EUNCTIO	NAL REGISTERS	CHARGER LDO	Table View					
ystem	System settings							
<u></u>	PMC_SYS_00		PMC_SYS_01		PMC_SYS_02		PMC_SYS_03	
	E_RD_CLR_DIS	Low	ILIMIT_EN	No IINDPM update	BTS_VBAT_RATE	50 ms	SYS_WAIT	1 🗸
	VSYS_MIN	3.7 🗸	IINDPM	0.1 🗸	BTS_VBAT_EN	Disable	WD_TMR	160 🗸
	VINDPM	4.2 🗸			BTS_VBUS_RATE	50 ms	WD_EN	No action
					BTS_VBUS_EN	Disable	RST_TMR	12 🗸
					VBAT_DEB	100 🗸	RST_REG	No action
					VBUS_DEB	100 🗸		
	0x000F	0x38	0x0010	0x00	0x0011	0x0A ÷	0x0012	0x34
	PMC_SYS_04	,	PMC_SYS_05		PMC_SYS_06			
	SEQ_BOOST	BOOST_EN is set w	BOOST_ILIM	1.0 🗸	RIN_N_SHIP_EXIT_TMR	20 ms		
	DLOAD_VMID_SEL	30 🗸	BOOST_VOUT	5.0 🗸	VBUS_OVSEL	5.8 🗸		
	DLOAD_VMID_EN	Disable			HIZ_MODE	VBUS when available		
	REV_VBUS_EN	Disable			SHIP_DLY	10 🗸		
	BOOST_EN	Enable			SHIP_MODE	No action		
	0x0013	0x39	0x0014	0x9A	0x0015	0x06		

Figure 5: Enable Reverse Boost Mode



DA9168 Performance Board

5.3 Signal Monitoring

The Kelvin sensing method is used on the DA9168 performance board to improve the measurement accuracy. On J26, J27, J28, J29, J30, J31, and J32, header pins 1 and 2 are used as voltage sensing pins, while pins 3 and 4 can be used for measuring the current flows.

- J41 monitors the DA9168 C1(VBAT) pin voltage directly
- J42 monitors the DA9168 C2(VSYS) pin voltage directly

🚹 CAUTION

Apply high current to J26, J27, J28, J29, J30, J31, J32, J41 and J42 headers pin 1 and 2 may cause the voltage sensing traces to burn out.

Other signals:

- switching node is monitored at TP4
- VBTS signal is monitored at TP3
- GPIO signals are monitored at J34 and J35 headers

5.4 Fault Indicators

Faults are indicated in the System Events tab in the SmartCanvas GUI.

DA9168								
EUNCTIC	NAL REGISTERS	CHARGER LDO	Table View					
tatus	System Events							
E S	PMC_EVENT_00		PMC_EVENT_01		PMC_EVENT_02		PMC_EVENT_03	
3, st	E_VBUS_VINDPM	VBUS not in VINDPM	E_VBUS_OV	VBUS not in OV	E_TSD_CRIT	Below	E_CHG_SLEEP	VBUS lower
2	E_VBUS_IINDPM	VBUS not in IINDPM	E_VMID_OV	VMID not in OV	E_TSD_WARN	Below	E_CHG_SPLMT	VBAT fet not
Ver	E_VMID_OC	VMID not in OC	E_VSYS_OV	VSYS not in OV	E_WD_TIMER	Watch-dog timer not	E_CHG_TIMER	Charge timer not
Ē	E_VBAT_OC	VBAT not in OC	E_VBAT_OV	VBAT not in OV	E_TS_HOT	Battery temp sens	E_CHG_TRICKLE	Charger not in trickle
Syst	E_VBUS_OK	VBUS not OK	E_VBUS_UV	VBUS not in UV	E_TS_WARM	Battery temp sens	E_CHG_PRE	Charger not
-×	E_VMID_OK	VMID not OK	E_VMID_UV	VMID not in UV	E_TS_COOL	Battery temp sens	E_CHG_CC	Charger not
ää	E_VSYS_OK	VSYS not OK	E_VSYS_UV	VSYS not in UV	E_TS_COLD	Battery temp sens	E_CHG_CV	Charger not
et	E_VBAT_OK	VBAT not OK	E_VBAT_UV	VBAT not in UV	E_TS_OFF	Battery temp sens	E_CHG_DONE	Charge termination
Inter	0x0005	0x00	0x0006	0x00	0x0007	0x00	0x0008	0x00 ÷
	PMC_EVENT_04	,						
	E_REF_OC	REF not in OC						
	E_LDO2_IMON1	LDO2 not in IMON1						
	E_LDO2_IMON2	LDO2 not in IMON2						
	E_LDO2_OC	LDO2 not in OC						
	E_LDO1_IMON1	LDO1 not in IMON1						
	E_LDO1_IMON2	LDO1 not in IMON2						
	E_LDO1_OC	LDO1 not in OC						
	0x0009	0x00						

Figure 6: System Events Tab

U	ser	M	an	ual	
U	301			uai	



5.5 Interrupt Signals

DA9168 interrupt signals are masked in the Interrupt Mask tab.

DA9168]							
EUNCTIO	Interrupt mask bits	CHARGER LDO	Table View					
rstem St	PMC_MASK_00	Masked	PMC_MASK_01 M VBUS OV	Masked	PMC_MASK_02	Masked	PMC_MASK_03 M CHG SLEEP	Masked
t mask System Events	M_VBUS_IINDPM M_VMID_OC M_VBAT_OC M_VBUS_OK M_VMID_OK M_VYID_OK	Masked Masked Masked Masked Masked Masked	M_VMID_OV M_VSYS_OV M_VBAT_OV M_VBUS_UV M_VBUS_UV M_VMID_UV M_VSYS_UV	Masked Masked Masked Masked Masked Masked	M_TSD_WARN M_WD_TIMER M_TS_HOT M_TS_WARM M_TS_COOL M_TS_COLD	Masked Masked Masked Masked Masked Masked	M_CHG_SPLMT M_CHG_TIMER M_CHG_TRICKLE M_CHG_PRE M_CHG_CC M_CHG_CV	Masked Masked Masked Masked Masked
Interru	0x000A	0xFF ÷	0x000B	0xFF ÷	0x000C	0xFF +	0x000D	0xFF ÷
	PMC_MASK_04 M_REF_OC M_LD02_IMON1 M_LD02_OC M_LD01_IMON1 M_LD01_IMON2 M_LD01_OC 0x000E	Masked Masked Masked Masked Masked Masked 0x7F						

Figure 7: Interrupt Mask Tab

Note: A masked fault is still indicated as high in the read-only registers 0x0000 to 0x0004 in the **System Status** tab.

DA9168		CHARGER LDO	Table View					
System Events System Status	System Status PMC_STATUS_00 S_VBUS_VINDPM S_VBUS_IINDPM S_VMID_OC S_VBAT_OC S_VBUS_OK S_VBUS_OK	VBUS not in VINDPM VBUS not in IINDPM VMID not in OC VBAT not in OC VBUS OK	PMC_STATUS_01 S_VBUS_OV S_VMID_OV S_VSYS_OV S_VBAT_OV S_VBUS_UV S_VBUS_UV	VBUS not in OV VMID not in OV VSYS not in OV VBAT not in OV VBUS not in UV	PMC_STATUS_02 S_TSD_CRIT S_TSD_WARN S_WD_TIMER S_TS_HOT S_TS_WARM S_TS_COOL	Below Below Watch-dog timer not Battery temp sens Battery temp sens	PMC_STATUS_03 S_CH6_SLEEP S_CH6_SPLMT S_CH6_TRIORLE S_CH6_TRIORLE S_CH6_PRE	VBUS lower VBAT fet not Charge timer not Charger not in trickle Charger not
Interrupt mask	S_VSYS_OK S_VSYS_OK S_VBAT_OK 0x0000	VSYS not OK VBAT OK 0x09	S_VSYS_UV S_VBAT_UV 0x0001	VSYS in UV VBAT not in UV 0x02	S_TS_COLD S_TS_OFF 0x0002	Battery temp sens Battery temp sens 0x00	S_CHG_CV S_CHG_DONE 0x0003	Charger not Charge termination
	PMC_SIAIUS_04 S_REF_0C S_LD02_IMON1 S_LD02_IMON2 S_LD02_0C S_LD01_IMON1 S_LD01_IMON2 S_LD01_0C 0x0004	REF not in OC LD02 not in IMON1 LD02 not in IMON2 LD01 not in IMON1 LD01 not in IMON2 LD01 not in OC Dx00						

Figure 8: System Status Tab

loor	Manual
USEL	Manual



6 DA9168 Performance Board Software

The board is controlled using the <u>SmartCanvas</u> software graphical user interface (GUI), which requires a PC operating Windows[®] 2000/XP/Vista/7/10 with a USB1.1 or USB2 interface. The GUI allows the user to:

- configure the DA9168 device
- perform write and read operations to all control registers
- monitor the device status, including faults

6.1 SmartCanvas GUI Installation

The files required to install the software are available on the supplied USB drive. To install the DA9168 SmartCanvas software:

- 1. Run setup_DA9168_GUI_0.0.0.3.exe. The program default install location is: C:\Dialog Semiconductor\Power Management\DA9168 GUI.
- On completion, plug in the performance board I²C-USB and apply power to VBUS or VBAT. The software must be started after the I²C-USB is plugged in, otherwise communication with the board may fail.
 - 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. For guaranteed operation, it is recommended that a PC reboot be carried out after installing the driver.
- 3. Once installation is complete, run the DA9168 SmartCanvas software: DA9168 GUI.exe.

6.1.1 SmartCanvas GUI Installation Step-by-Step Guide

🙀 Setup - DA9168 GUI 0.0.0.3 —	Х
License Agreement Please read the following important information before continuing.	
Please read the following License Agreement. You must accept the terms of this agreement before continuing with the installation.	
Dialog Smart Canvas Software Package Licensing Agreement	^
THIS LICENSING AGREEMENT REGULATES YOUR USE OF THE SOFTWARE PRODUCTS DESCRIBED HEREIN AND PROVIDED BY DIALOG SEMICONDUCTOR (UK) LTD (記LOG+ .	
IF YOU (INDIVIDUAL OR LEGAL ENTITY, ALSO REFERRED TO AS GIOENSEE- HEREIN) HAVE ALREADY SIGNED OR ASSENTED TO BE BOUND DV (NOTURE CONTINUES LIGHTIONIC) CONFIDENTIAL WITH DESCRIPTION TO THE	~
• <u>I accept the agreement</u>	
O I <u>d</u> o not accept the agreement	
Next >	ancel

Figure 9: GUI Setup License Agreement

4. Select I accept the agreement then click Next.





뤻 Setup - DA9168 GUI 0.0.0.3	-		×
Select Destination Location Where should DA9168 GUI be installed?			
Setup will install DA9168 GUI into the following folder.			
To continue, click Next. If you would like to select a different folder,	click Bro	owse.	
C:¥Dialog Semiconductor¥Power Management¥DA9168 GUI	B	owse	
At least 145.8 MB of free disk space is required.			
< <u>B</u> ack <u>N</u> ext	>	Ca	ncel

Figure 10: GUI Setup Destination Location

5. Click Next.

🛃 Setup - DA9168 GUI 0.0.0.3			—		×
Select Start Menu Folder Where should Setup place the	program's shortcut	s?		G	
Setup will create the	program's shortcuts	in the followi	ng Start Menu	ı folder.	
To continue, click Next. If you	would like to select	a different fo	der, click Bro	wse.	
Dialog Semiconductor¥Power	Management¥DA91	68 GUI	Bro	owse	
	<	(<u>B</u> ack	<u>N</u> ext >	Can	cel

Figure 11: GUI Setup Shortcuts Location

6. Click Next.

14 of 26





🔂 Setup - DA9168 GUI 0.0.0.3		_		×
Select Additional Tasks Which additional tasks should be performed?			Q	
Select the additional tasks you would like Setup then click Next.	o to perform v	vhile installing [0A9168 GU	Ι,
Additional shortcuts:				
Create a desktop shortcut				
	< <u>B</u> ack	<u>N</u> ext >	Car	icel

Figure 12: GUI Setup Create Shortcut

7. Select the Create a desktop shortcut check box and click Next.

🔀 Setup - DA9168 GUI 0.0.0.3	_		×						
Ready to Install Setup is now ready to begin installing DA9168 GUI on your computer									
Click Install to continue with the installation, or click Back if you want change any settings.	to reviev	v or							
Destination location: C:¥Dialog Semiconductor¥Power Management¥DA9168 GUI									
Start Menu folder: Dialog Semiconductor¥Power Management¥DA9168 GUI									
Additional tasks: Additional shortcuts: Create a desktop shortcut									
<		>	~						
< Back Inst	tall	Ca	incel						

Figure 13: GUI Setup Installation

8. Click Install.



🛃 Setup - DA9168 GUI 0.0.0.3	- 🗆 ×
	Completing the DA9168 GUI Setup Wizard
	Setup has finished installing DA9168 GUI on your computer. The application may be launched by selecting the installed shortcuts.
	Click Finish to exit Setup.
	Launch DA9168 GUI
R	
	Einish

Figure 14: GUI Setup Finish and Launch

9. Click Finish.

Once the installation is complete, a PC restart may be required.

When the software is installed, insert the I²C-USB cable before applying power. The DA9168 SmartCanvas software can be started after power up.

6.2 Initial I²C-USB Connection

On connecting the I²C-USB to the PC for the first time, the SAM3U USB driver requests driver updating/installation from the Windows operating system. On Windows 7/10 32-bit operating systems the driver usually installs automatically. On Windows 7/10 64-bit machines it is common for the complete driver installation to fail. If this happens you must install the driver manually by following these steps:

- 1. Control Panel \rightarrow 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\DA9168 GUI\driver.
- 5. If Windows warns about the driver, select **Install anyway**.
- 6. Remove the I²C-USB cable then reinsert it into the performance board.

7 SmartCanvas Software

Run the DA9168 SmartCanvas software by clicking the shortcut on the appropriate item in the Start menu (All Programs \rightarrow Dialog Semiconductor \rightarrow Power Management \rightarrow DA9168 GUI). The main GUI interface is displayed, see Figure 15.

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

NOTE

It is important to note that a display size other than the recommended setting affects the way in which the panels appear.

7.1 Register Controls

Device registers are displayed as a group of controls. Selected bit ranges within a register make up a control. Register data is always a standard bit width dictated by the device register map, but a control can be anything from 1-bit to the full register data width.

Registers are grouped together on tabs to assist with identification of device function or registers of the same type.

S DA916										- σ ×
Eile Ior	ls <u>S</u> earch ⊻iew <u>H</u> el	p								Cantal a
DA9168										CONUS A
EUNCTI	INAL REGISTERS	1 QHARGER LDO	Table View							Stemart canvas
8	- Charger Settings									Sinarccantas
ę	PMC_CHG_00		PMC_CHG_01		PMC_CHG_02		PMC_CHG_03			Communication
	CHG_VRCHG	100	CHG_TMR_SAFE	5 🗸	CHG_RANGE_TERM	5-20 mA, in 5	CHG_RANGE	Fast-charge	20 mA	US8 connection
	CHG_TMR_HALF_EN	Enable	CHG_TMR_PRE	30 V	CHG_RANGE_PRE	5-15 mA, in 5	CHE_TCHE	CHG_RANGE	-01 -	
	CHG TERM EN	Enable	CHS_TOPOPP	Usable TOPOPP	CHG_IPRE	CHG RANGE = 0 : V				DA9168 Device Communication
	CHG_EN	Disable				(Reconnect to device
	0x0016	CxOE 🗄	0x0017	0x00	0x0018	Ox0F	0x0019	0x19		Raw I/O
	PMC_CHG_04		PMC_CHG_05		PMC_CHG_06					Bus Interface DAVISB IZC
	CHG_VBATREG	4.20 🗸	TS_VBATREG_SHIFT	100	TS_JCHG	CHG_RANGE = 0 : V				Ren Address (1000
			CHG_TS_WARM_V	Disable						Send Data 0x00
	0x001A	0x17	0x0018	0x00	0x001C	Deac E				Read Data 0x00
										Advanced Mode
										Poling
										Poll All Registers Poll Visible Only
										C1/0
										Read All Registers (exd. Event)
										Read Event Registers
										File 10
										Save Load
										Read Chip ID
				Status				×	Info	USB Interface Info
Com								^	C Bitfield Info	ULI DI Version: 1.19
Coro									Bitfield: TS_VBATREG_SHIFT Review-PMC_CHG_DS(In:th)	SAM3U FW Version: 1.11
	Clear	Mark	Save to file	Filter (reg expr)	1º		Log level: Info	×	Bit: [2]	PPGA Version: 15.255
									POR: 0	
									Current Value: 0	
									Chierendel Blocks	
									PMC: TS_VBATREG_SHIPT	
									Description: Battery voltage regulation setting down-shift during TS event (mV).	

Figure 15: Main Interface



7.2 Table View Tab

The **Table View** tab shows the complete register map, see Figure 16. From this tab all the registers can be set or read back. Clicking on any of the bit groups on the map allows access to the full control settings. These controls read and write the same value elsewhere on the interface.

S DA9168										- o ×
Eile Jools Search View Help										L Control I
DA9168										Control ×
EUNCTIONAL REGISTERS SYSTEM CHARGER	L LDO Table View									Stsmart canvas
Data	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0		
0x0000: PMC_STATUS_00 0x09	S_VBUS_VINDPM: 0x00	S_VEUS_IINDPM: 0x00	S_VMID_OC: 0x00	S_VEAT_OC: 0x00	S_VBUS_OK: Gx01	S_VMID_OK: 0x00	S_VSYS_OK: 0x00	S_VEAT_OK: Ex01		Communication
0x0001: PMC_STATUS_01 0x02	S_VBUS_OV: 0x00	S_VMID_OV: 0x00	S_VSYS_OV: 0x00	S_VEAT_OV: 0x00	S_VEUS_UV: 0x00	S_VMID_UV: 0x00	S_VSYS_UV: @x01	S_VEAT_UV: 0x00		US8 connection
0x0002: PMC_STATUS_02 0x00	S_TSD_CRIT: 0x00	S_TSD_WARN: 0x00	S_WD_TIMER: 0x00	S_TS_HOT: 0x00	S_TS_WARM: 0x00	S_TS_COOL: 0x00	S_TS_COLD: 0x00	S_TS_OFF: 0x00		DA9168 Device Communication
0x0003: PMC_STATUS_03 0x00	S_CHO_SLEEP: 0x00	S_CHO_SPLMT: 0x00	S_CH3_TMER: 0x00	S_CHG_TRICKLE: 0x00	S_CHG_PRE: 0x00	S_CHG_CC: 0x00	S_CH0_CV: 0x00	S_CH3_DONE: Dx00		Reconnect to device
0x0004: PMC_STATUS_04 0x00	unused	S_REF_OC: 0x00	S_LD02_IMON1: 0x00	S_LDO2_IMON2: 0x00	\$_LD02_OC: 0x00	S_LDO1_IMON1: 0x00	S_LDO1_IMON2: 0x00	S_LD01_0C: 0x00		Raw I/O
0x0005: PMC_EVENT_00 0x00	E_VBUS_VINDPM: 0x00	E_VBUS_IINDPM: 0x00	E_VMID_OC: 0x00	E_VBAT_OC: 0x00	E_VBUS_OK: 0x00	E_VMID_OK: 0x00	E_VSYS_OK: 0x00	E_VBAT_OK: 0x00		Bus Interface DA9168 I2C V
0x0006: PMC_EVENT_01 0x00	E_VBUS_OV: 0x00	E_VMID_OV: 0x00	E_VSYS_OV: 0x00	E_VBAT_OV: 0x00	E_VBUS_UV: 0x00	E_VMID_UV: 0x00	E_VSYS_UV: 0x00	E_VBAT_UV: 0x00		Reg. Address 0x00
0x0007: PMC_EVENT_02 0x00	E_TSD_CRIT: 0x00	E_TSD_WARN: 0x00	E_WD_TIMER: 0x00	E_TS_HOT: 0x00	E_TS_WARM: 0x00	E_TS_COOL: 0x00	E_TS_COLD: 0x00	E_TS_OFF: Di00		Send Data 0x00
0x0008: PMC_EVENT_03 0x00	E_CHG_SLEEP: 0x00	E_CHG_SPLMT.	E_CHG_TIMER: 0x00	E_CHG_TRICKLE:	E_CHG_PRE: 0x00	E_CHG_CC: 0x00	E_CHG_CV: 0x00	E_CHG_DONE:		Read Data 0x00
0x0009: PMC_EVENT_04 0x00	unused	E_REF_OC:	E_LD02_MON1:	E_LD02_IM0N2:	E_LD02_0C:	E_LD01_IMON1:	E_LD01_IM0N2:	E_LD01_0C:		Paling
0x000A: PMC_MASK_00	M_VBUS_VINCPM:	M_VBUS_IINDPM:	M_VMD_OC:	M_VBAT_OC:	M_VBUS_OK:	M_VMID_OK:	M_VSYS_OK:	M_VEAT_OK:		Disabled
0x0008: PMC_MASK_01	M_VBUS_OV:	M_VMD_OV:	M_VSYS_OV:	M_VEAT_OV:	M_VBUS_UV:	M_VMID_UV:	M_VSYS_UV:	M_VEAT_UV:		Pol Al Registers Pol Visible Only
0x0000: PMC_MASK.02	M_TSD_CRIT	M_TSD_WARN:	M_WD_TIMER:	M_TS_HOT	M_TS_WARM:	M_TS_COOL:	M_TS_COLD:	M_TS_OFF:		Read All Registers (excl. Event)
0x0000: PMC MASK 03 0xFF	M_CHG_SLEEP:	M_CHG_SPLME	M_CHG_TIMER:	M_CHG_TRICKLE:	M_CHG_PRE:	M_CHG_CC:	M_CHG_CV:	M_CHG_DONE:		Read Event Registers
0x000E PMC MASK 04 0x7F	urused	M_REF_OC:	M_LD02_INON1:	M_LDO2_IMON2:	M_LD02_OC:	M_LDO1_INON1:	M_LDO1_IMON2	M_LDO1_OC:		File 10
0x000F: PMC: SYS:00 0x38	unused	E_RD_CLR_DIS:	VSY	UMIN:		VIN	OPM:			File Format: O Address Name
0x0010; PMC SYS 01 0x00	U7154	id	LIMT_EN:			IINDPM:				Chip ID
0x0011: PMC SYS 02 0x0A	BTS_VBAT_RATE:	BTS_VBAT_EN:	BTS_VBUS_RATE:	BTS_VBUS_EN:	VBA	LDEB:	VBL	IS_DEB:		
0x0012 PMC SYS 03 0x34	SYS W	IAIT.	WD.	TMR:	WO_EN	RST	TMR:	RST_REO:		
0x0012 PMC SVS 04 0x30		ed	SEQ_BOOST:	DLOAD_V	MID_SEL:	DLOAD_VMD_EN	REV_VBUS_EN:	BOOST_EN:	-	
			Cw01			0x00	0x00	0400		Kees Chip ID
			Status				×		Info	K. Interface: Dialog US8-IO
Console Log								Bitfield Info	980	USE Device: 0
Clear Mark	Save to file		Filter (reg.expr):			Log level: Info	~	Register: PMC_CHG Bits: (5:0)	1_04 (Dx1a)	VCS PW Dev. Version: 69888 PPGA Version: 15.255
								Access: R/W POR: 23		
								Current Value: 23	4.70	
								Chipmodel Blocks:	7.01	
								PMC: CHG_VBATR	REG	
								Description: Battery voltage regi	gulation setting (V).	
								10 mV step.		
Ľ										1

Figure 16: Table View

7.3 Control Windows

All dockable control windows, either on the right or bottom of the main window add additional functionality or monitoring to the GUI. The windows can be undocked by clicking on and dragging the title bar of that window and can be placed anywhere on the screen.

7.3.1 Communication

The **Communication** window has indicators to show when the SAM3U I²C-USB module is plugged in and when I²C communication is possible; the currently active I²C-USB device number is also shown, see Figure 17. Most of the time the communication link automatically connects if the I²C-USB is active and the device is powered up. On rare occasions, sequence of events may prevent recognition of the active communication link, pressing the **Reconnect to device** button recovers the link.

Control	×
Smart canvas	
Communication	n.
USB connection	
OA9168 Device Communication	
Reconnect to device]

Figure 17: Communication Control



DA9168 Performance Board

7.3.2 Enable/Disable Polling

The **Enable/Disable Polling** button enables or disables polling of the device registers and the refreshing of the registers controls on the GUI interface, see Figure 18.

Dis	abled
O Poll All Registers	Poll Visible Only

Figure 18: Polling

The **Enable/Disable Polling** button also allows the polling rate to be changed. There is an option to poll all or just the visible registers; however, selecting **Poll Visible Only** may have adverse effects on the functionality of the automation controls and is therefore not recommended.

7.3.3 I/O

The I/O update actions are as follows:

- Read All Register (excl. Event) even if the hardware device is not being actively polled then all the registers can be polled once by pressing this button.
- **Read Event Registers** all event registers can be polled once by pressing this button.

_I/0	
	Read All Registers (excl. Event)
	Read Event Registers

Figure 19: I/O

7.3.4 Raw I/O

The **Raw I/O** control sends the entered device address, register address and data on the I²C communications interface, see Figure 20. If the information sent is not valid then the I²C message returns NACK and an error message is displayed in the **Status** window. Data from an individual address can also be READ from this window.

Raw I/O	
Bus Interface	DA9168 I2C 🗸 🗸
Slave Address	0xD0
Reg. Address	0x00
Send Data	0x00 ÷
Read Data	0x00
Advanced Mode	

Figure 20: Raw I/O

The optional **Advanced Mode** allows control of the I²C frequency.

7.3.5 File I/O

The **File I/O** control **Load** button allows formatted text files to be loaded into the device registers, which is then be reflected on the **Registers** display of the GUI interface, see Figure 21.

1	File IO		
	Save		Load
	File Format:	O Addres	ss 🔘 Name

Figure 21: File I/O

	Manual	
User	manuai	



DA9168 Performance Board

The **Save** button saves the register values displayed on the GUI interface. If saving with the extension .txt or .csv, one of the **File Format** radio buttons can be selected to save by either register name or register address.

A predefined automated sequence is present in this window. This single-shot button allows a separate script to be loaded as required.

7.3.6 Info

The **Info** window displays a description of an interface control including: name, parent register and the bits to which this control corresponds, current value, whether it is read only or R/W, and finally a description of each possible setting, see Figure 22.

For long descriptions the window may either be undocked and made larger; or docked at the lefthand side of the main window.

nfo	x
Bitfield Info	h
Bitfield: S_REF_OC Register: PMC_STATUS_04 (0x4) Bit: [6] Access: R POR: 0	
Current Value: 0 Enumerated Value: REF not in OC	
Chipmodel Blocks: PMC: S_REF_OC	
Description: REF OC Status -	

Figure 22: Info

7.4 Menu Items

There are several menu items found on the top line of the interface, which allows the selection of enhanced functionality. These are not required in most cases of interface use.

7.4.1 File -> Open Python Script

The **Open Python script** option in the **File** menu opens a Python[®] script selected in the pop-up window.

7.4.2 File -> Run Python Script

The **Run Python script** option in the **File** menu runs the Python script selected in the pop-up window.

User Manual



7.4.3 Tools -> Model IO

The Model IO option in the Tools menu allows access to all registers at a glance, see Figure 23.

🐒 Model IO Viewer	– 🗆 X
ModelIO	
DA9168	V
PMC_STATUS_00	V
PMC_STATUS_00	
S_VBUS_VINDPM	VBUS not in VINDPM
S_VBUS_IINDPM	VBUS not in IINDPM
S_VMID_OC	VMID not in OC
S_VBAT_OC	VBAT not in OC
S_VBUS_OK	VBUS OK
S_VMID_OK	VMID not OK
S_VSYS_OK	VSYS not OK
S_VBAT_OK	VBAT not OK
0x0000	0x08

Figure 23: Model IO

7.4.4 **Tools -> Scan I2C**

The **Scan I2C** option in the **Tools** menu allows the scan of all slave devices on the I^2C bus, see Figure 24.

💟 I2C Bus Scan	_		×
Scan	52 %		
I2C channel 0: slaves found I2C channel 1: slaves found	: 0xD0 :		
Last Error: ('USB-Lab_IO ER LOW (extra info: I2C slave	ROR: 15 0xE)', 15)	SDA line	is

Figure 24: Scan I2C

U	ser	Manual
-	901	manaan



7.4.5 Tools -> Custom Tabs

The **Custom Tabs** option in the **Tools** menu allows customized tabs to be created by dragging register widgets to the **Custom Tabs** control window, see Figure 25.

Custom Tabs	- 🗆 X
Edi Taba (Import Taba) Export Taba (Import Taba) (Import Taba)	bTaks ⊃ Test ⊃ Test → □ Default → Test → □ Default → Test → □ Default → □
DA0165 Outom Tab Test Test Default PMC_SYS_00 E.O.O. VIDS/MN 3.7 VIDD/MN 4.2 Ox000F 0x.38	Test FMC_SVS_D4 SEQ.BOOT BOOT_BI set we DOAD_MED_SL 30 DOAD_MED_SL 30 DOAD_MED_SL 30 DOAD_MED_SL 30 DOAD_MED_SL 0 BOOT_PN Deable BOOT_SN Deable MOIOI3 0:38

Figure 25: Custom Tabs

7.4.6 Search -> Find Register

The **Find Register** option in the **Search** menu searches by name, or number, or by a particular text term contained within the GUI, see Figure 26. An entry made in the **Search Name** box searches register names and display the instances found in the right-hand side list box. If the **All Text** radio button is selected all entries containing the written text are identified and listed.

Search		х
Search Controls	Name	Address
PMC_CHG_00 Find	1 PMC_CHG_00	0x0016
Register Controls All Text		
Search Address		
0x Find		
Results		
Prev Next		
Advanced search		

Figure 26: Find Register

If the **Advanced Search** checkbox has been selected, selecting **Reg expr** allows a search based upon Python regular expression functions.

7.4.7 View

The View menu reopens the docking windows if they have been previously closed.

	cor	Manual	
U	301	manuai	



8 Register Text File

The DA9168 SmartCanvas software can save and load a text file containing command codes representing the register addresses and data. This file is principally used to save and load setup data but may also be used to perform a small degree of automation.

The use of the **Save** button in the **File I/O** control transfers register contents to the user's software. This is a register dump of the entire device. If the **Name** radial button is selected instead of **Address**, then register names rather than register addresses are saved in the text file.

8.1 I²C Register Text File Format

The following formats are used for both read and write in the text file:

- WRITE: writes to the device: WRITE [device name] [register address] [register data value].
- READ: reads from the device: READ [device name] [register address]. The result of the read is passed to a **File Readback Values** pop-up window.
- DELAY: implements a time delay specified in milliseconds: DELAY [time in milliseconds] no time suffix required.
- USBIO: controls the SAM3U USB device IOs: USBIO [USB IO pin index] [output value] USB device output value = 0 or 1.
- ACTION: pauses the file being loaded until the pop-up message dialogue has been acknowledged: ACTION [text message].

Numbers are always expressed in Hex, separated by tabs. The use of 0x in front of the hex value is mandatory. Inline comments (lines beginning with //) are permitted in the file. The data is processed in the order written and written directly to the specified device.

For example:

WRITE DA9168_I2C 0x0016 0x0E WRITE DA9168_I2C PMC_CHG_00 0x0E READ DA9168_I2C 0x0016 READ DA9168_I2C PMC_CHG_00 DELAY 1000 // delay is 1000 ms or 1 s USBIO 0 1 // "0" refers to the index number for the USB IO pin on the "USB_Ports" tab. ACTION Please press the OK button to continue.

DA9168 File IO 15-06-2020 15-54-12 - Notepad			-	×
<u>File Edit Format View Help</u>				
CONFIG DA9168_I2C slave=0xD0 bus=I2C addrBytes=1 dataBytes=1 freq=4000	000 chan=0			^
READ DA9168_I2C PMC_STATUS_00 0x00				
DELAY 1000				
WRITE DA9168_I2C PMC_STATUS_01 0x00				
WRITE DA9168_I2C PMC_STATUS_02 0x00				
WRITE DA9168_I2C PMC_STATUS_03 0x00				
WRITE DA9168_I2C PMC_STATUS_04 0x00				
WRITE DA9168_I2C PMC_EVENT_00 0x00				
WRITE DA9168_I2C PMC_EVENT_01 0x00				
ACTION				
WRITE DA9168_I2C PMC_EVENT_02 0x00				
WRITE DA9168_I2C PMC_EVENT_03 0x00				
WRITE DA9168_I2C PMC_EVENT_04 0x00				
WRITE DA9168_I2C PMC_MASK_00 0xFF				
WRITE DA9168_I2C PMC_MASK_01 0xFF				
WRITE DA9168_I2C PMC_MASK_02 0xFF				
WRITE DA9168_I2C PMC_MASK_03 0xFF				
WRITE DA9168_I2C PMC_MASK_04 0x7F				
WRITE DA9168_I2C PMC_SYS_00 0x38				
WRITE DA9168_I2C PMC_SYS_01 0x00				
WRITE DA9168_I2C PMC_SYS_02 0x0A				
WRITE DA9168_I2C PMC_SYS_03 0x34				
WRITE DA9168_I2C PMC_SYS_04 0x38				
WRITE DA9168_I2C PMC_SYS_05 0x9A				
WRITE DA9168_I2C PMC_SYS_06 0x06				
WRITE DA9168_I2C PMC_CHG_00 0x0E				
WRITE DA9168_12C PMC_CHG_01 0x00				
WRITE DA9168_12C PMC_CHG_02 0x0F				
WRITE DA9168_12C PMC_CHG_03 0x19				
WRITE DA9168_12C PMC_CHG_04 0x17				
WRITE DA9168_12C PMC_CHG_05 0x00				
WRITE DA9168_12C PMC_CHG_06 0X0C				
WRITE DA9100_12C PMC_LDU_00 0X44				~
<				>
	Windows (CRLF)	Ln 9, Col 35	100%	

Figure 27: Register Dump (.txt File) Example

lleor	Manual	
USCI	wanua	



Revision History

Revision	Date	Description	
3	03-Aug-2022	File was rebranded with new logo, copyright and disclaimer	
2	17-Aug-2020	Minor spelling corrections and clarification of Caution in Section 5.3.	
1	03-July-2020	Initial version	

User Manual



DA9168 Performance Board

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.

RoHS Compliance

Dialog Semiconductor's suppliers certify that its products are in compliance with the requirements of Directive 2011/65/EU of the European Parliament on the restriction of the use of certain hazardous substances in electrical and electronic equipment. RoHS certificates from our suppliers are available on request.



Important Notice and Disclaimer

RENESAS ELECTRONICS CORPORATION AND ITS SUBSIDIARIES ("RENESAS") PROVIDES TECHNICAL SPECIFICATIONS AND RELIABILITY DATA (INCLUDING DATASHEETS), DESIGN RESOURCES (INCLUDING REFERENCE DESIGNS), APPLICATION OR OTHER DESIGN ADVICE, WEB TOOLS, SAFETY INFORMATION, AND OTHER RESOURCES "AS IS" AND WITH ALL FAULTS, AND DISCLAIMS ALL WARRANTIES, EXPRESS OR IMPLIED, INCLUDING, WITHOUT LIMITATION, ANY IMPLIED WARRANTIES OF MERCHANTABILITY, FITNESS FOR A PARTICULAR PURPOSE, OR NON-INFRINGEMENT OF THIRD PARTY INTELLECTUAL PROPERTY RIGHTS.

These resources are intended for developers skilled in the art designing with Renesas products. You are solely responsible for (1) selecting the appropriate products for your application, (2) designing, validating, and testing your application, and (3) ensuring your application meets applicable standards, and any other safety, security, or other requirements. These resources are subject to change without notice. Renesas grants you permission to use these resources only for development of an application that uses Renesas products. Other reproduction or use of these resources is strictly prohibited. No license is granted to any other Renesas intellectual property or to any third party intellectual property. Renesas disclaims responsibility for, and you will fully indemnify Renesas and its representatives against, any claims, damages, costs, losses, or liabilities arising out of your use of these resources. Renesas' products are provided only subject to Renesas' Terms and Conditions of Sale or other applicable terms agreed to in writing. No use of any Renesas resources expands or otherwise alters any applicable warranties or warranty disclaimers for these products.

© 2022 Renesas Electronics Corporation. All rights reserved.

(Rev.1.0 Mar 2020)

Corporate Headquarters

TOYOSU FORESIA, 3-2-24 Toyosu

Koto-ku, Tokyo 135-0061, Japan

www.renesas.com

Contact Information

For further information on a product, technology, the most up-to-date version of a document, or your nearest sales office, please visit:

https://www.renesas.com/contact/

Trademarks

Renesas and the Renesas logo are trademarks of Renesas Electronics Corporation. All trademarks and registered trademarks are the property of their respective owners.

	Monuol
User	Manual

Revision 3

IMPORTANT NOTICE AND DISCLAIMER

RENESAS ELECTRONICS CORPORATION AND ITS SUBSIDIARIES ("RENESAS") PROVIDES TECHNICAL SPECIFICATIONS AND RELIABILITY DATA (INCLUDING DATASHEETS), DESIGN RESOURCES (INCLUDING REFERENCE DESIGNS), APPLICATION OR OTHER DESIGN ADVICE, WEB TOOLS, SAFETY INFORMATION, AND OTHER RESOURCES "AS IS" AND WITH ALL FAULTS, AND DISCLAIMS ALL WARRANTIES, EXPRESS OR IMPLIED, INCLUDING, WITHOUT LIMITATION, ANY IMPLIED WARRANTIES OF MERCHANTABILITY, FITNESS FOR A PARTICULAR PURPOSE, OR NON-INFRINGEMENT OF THIRD-PARTY INTELLECTUAL PROPERTY RIGHTS.

These resources are intended for developers who are designing with Renesas products. You are solely responsible for (1) selecting the appropriate products for your application, (2) designing, validating, and testing your application, and (3) ensuring your application meets applicable standards, and any other safety, security, or other requirements. These resources are subject to change without notice. Renesas grants you permission to use these resources only to develop an application that uses Renesas products. Other reproduction or use of these resources is strictly prohibited. No license is granted to any other Renesas intellectual property or to any third-party intellectual property. Renesas disclaims responsibility for, and you will fully indemnify Renesas and its representatives against, any claims, damages, costs, losses, or liabilities arising from your use of these resources. Renesas' products are provided only subject to Renesas' Terms and Conditions of Sale or other applicable terms agreed to in writing. No use of any Renesas resources expands or otherwise alters any applicable warranties or warranty disclaimers for these products.

(Disclaimer Rev.1.01)

Corporate Headquarters

TOYOSU FORESIA, 3-2-24 Toyosu, Koto-ku, Tokyo 135-0061, Japan www.renesas.com

Trademarks

Renesas and the Renesas logo are trademarks of Renesas Electronics Corporation. All trademarks and registered trademarks are the property of their respective owners.

Contact Information

For further information on a product, technology, the most up-to-date version of a document, or your nearest sales office, please visit <u>www.renesas.com/contact-us/</u>.