IOT-GATE-RPI

Reference Guide

Compulab

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Table 1   Document Revision Notes

Date	Description
May 2018	• First release
November 2018	• Added FCSD add-on side panel connector diagram – section 5.1.4 • Added RS485 connector pin-out – section 5.13.2

1 INTRODUCTION

1.1 About This Document

This document is part of a set of documents providing information necessary to operate and program Compulab IOT-GATE-RPI.

1.2 Related Documents

For additional information not covered in this manual, please refer to the documents listed in Table 2.

Table 2   Related Documents

Document	Location
IOT-GATE-RPI design resources	http://www.compulab.com/products/iot-gateways/iot-gate-rpi-industrial-raspberry-pi-iot-gateway/#devres

2 OVERVIEW

2.1 Highlights

- Powered by Raspberry Pi 3 Compute Module
- Broadcom BCM2837 CPU, quad-core Cortex-A53
- 1GB LPDDR2 and up-to 64GB eMMC
- 3G/LTE modem and WiFi b/g/n
- 2x Ethernet, 4x USB2, RS232, RS485, CAN
- Fanless design in aluminum, rugged housing
- Miniature size – 112 x 84 x 25 mm
- Designed for reliability and 24/7 operation
- Wide temperature range of -40C to 80C
- Wide input voltage range of 10V to 36V
- Supports DIN-rail and wall / VESA mounting
- Hardware protection against unauthorized boot from external storage
- Fully compatible with Raspberry Pi OS images

2.2 Specifications

Table 3   System

Feature	Specifications
CPU	Broadcom BCM2837 quad-core ARM Cortex A53 1.2GHz
GPU	Broadcom VideoCore IV
Memory	1GB LPDDR2
Storage	eMMC flash, 4GB - 64GB, soldered on-board
	Micro-SD socket * mutually exclusive with eMMC

Table 4   Display and Audio

Feature	Specifications
Display	HDMI 1.3, up-to 1920 x 1080 @60Hz
Analog Audio	Analog audio - stereo line-out, 3.5mm jack
Digital Audio	HDMI audio output

Table 5   Network

Feature	Specifications
Ethernet	2x 100Mbps Ethernet ports, RJ45 connectors
WiFi	802.11b/g/n WiFi interface Ralink RT3070 chipset
Cellular	3G/LTE cellular communication module (via mini-PCie socket, optional) On-board micro-SIM card socket

Table 6   I/O

Feature	Specifications
USB	4x USB2.0 host, type-A connectors
Serial	1x RS232 port, ultra-mini serial connector
	1x RS485 port, half-duplex 2-wire, RJ11 connector Optional, implemented with EB-RPI-FCSD HAT board * precludes RS232 port
	1x CAN BUS using MCP2515 CAN controller Optional, implemented with EB-RPI-FCSD HAT board
Digital I/O	6x DIO, 5V tolerant, 100-mil header Optional, implemented with EB-RPI-FCSD HAT board
Expansion	RPI HAT expansion interface

Table 7   Mechanical and Environmental

Supply Voltage	Unregulated 10V to 36V
Dimensions	112 x 84 x 25 mm
Enclosure Material	Aluminum housing
Cooling	Passive cooling, fanless design
Weight	450 grams
MTTF	> 200,000 hours
Operation temperature	Commercial: 0° to 60° C Extended: -20° to 60° C Industrial: -40° to 80° C

3 CORE SYSTEM COMPONENTS

3.1 Raspberry Pi 3 module

IOT-GATE-RPi is built around the Raspberry Pi 3 module (CM3) that provides the following key features:

- Broadcom BCM2837 quad-core ARM Cortex A53 1.2GHz
- Broadcom VideoCore IV GPU
- 1GB LPDDR2 SDRAM

3.2 System Memory

3.2.1 DRAM

IOT-GATE-RPI is available with 1GB of onboard LPDDR2 SDRAM memory.

3.2.2 Storage

IOT-GATE-RPI storage is used to store the bootloader, operating system (kernel and root filesystem) and user data. IOT-GATE-RPI supports the following storage options:

- eMMC storage of up-to 64GB soldered on-board
- Micro-DS socket

eMMC and micro-SD are functionaly mutually exclusive – only one can be used at the same time. IOT-GATE-RPI CPU features a single SD/eMMC interface which is routed to both eMMC storage and micro-SD socket via multiplexing logic.

eMMC / micro-SD multiplexing is controlled automatically by the micro-SD detection signal. When micro-SD card is inserted into the socket, the CPU interface is routed to the micro-SD socket and eMMC is not accessible. When micro-SD card is not present, the CPU interface is routed to the on-board eMMC. For additional details please refer to section 4.2.

3.3 HDMI Output

IOT-GATE-RPI features HDMI 1.3 interface routed to standard HDMI connector. HDMI interface support resolutions of up-to 1920 x 1080.

3.4 Audio

The IOT-GATE-RPI analog audio functionality is implemented by interfacing directly to the Raspberry Pi CM3 module. Analog stereo output is routed to 3.5mm audio jack (P13).

3.5 USB 2.0

IOT-GATE-RPI is equipped with two onboard USB2.0 hubs supporting four downstream USB2.0 host ports. The ports are routed to USB connectors P2, P3, P4 and P5. The USB hub supports the following main features:

- Fully compliant with Universal Serial Bus Specification Revision 2.0
- Four USB 2.0 High Speed (480Mbps) compatible downstream ports

3.6 Wireless interfaces

3.6.1 WLAN

IOT-GATE-RPI can be optionally assembled with the Ralink RT3070 802.11b/g/n WiFi module. WiFi antenna connection is available via an RP-SMA connector on IOT-GATE-RPi side panel.

3.6.2 Cellular

IOT-GATE-RPI cellular interface is implemented with a mini-PCIe modem module and a micro-SIM socket. In order to setup IOT-GATE-RPI for cellular functionality install an active SIM card into micro-SIM socket U9. The cellular module should be installed into mini-PCIe socket J4.

Modem antenna connection is available via an RP-SMA connector on IOT-GATE-RPi side panel.

CompuLab supplies IOT-GATE-RPi with the following cellular modem options:

- 3G cellular module, Simcom SIM5360 (EU bands)
- 4G/LTE cellular module, Simcom SIM7100E (EU bands)
- 4G/LTE cellular module, Simcom SIM7100A (US bands)

Figure 1   service bay - cellular modem

SIM socket   Mini-PCIe modem
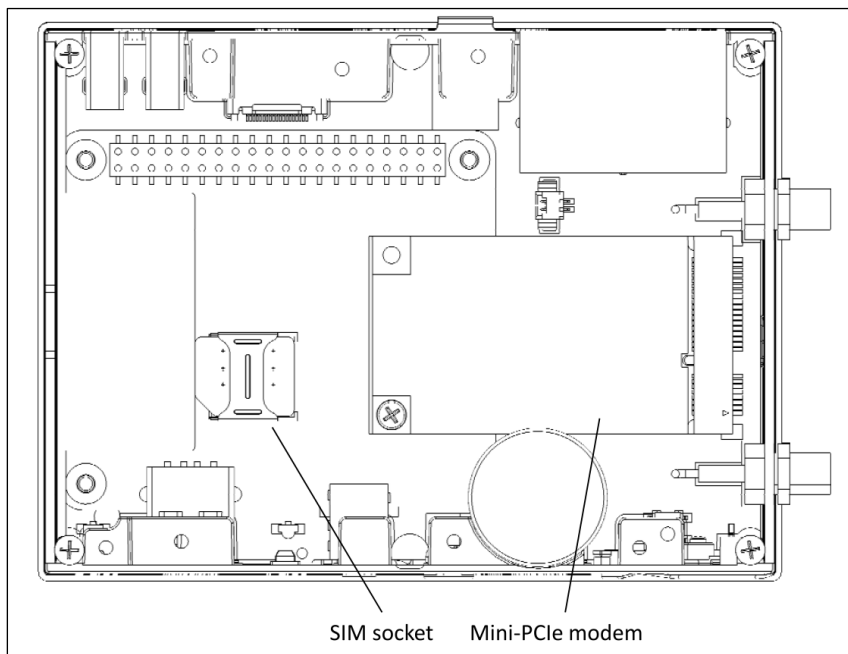
3.7 Ethernet

IOT-GATE-RPI incorporates two full-featured 100BASE-TX ports implemented with two Microchip LAN9514 10/100 Ethernet Controllers. The Ethernet ports are available on dual RJ45 connector P1.

3.8 RS-232

IOT-GATE-RPI. features a single RS232 port implemented with the MAX3243 transceiver connected to Raspberry Pi 3 module UART port. RS232 signals are routed to ultra mini serial connector P8.

3.9 USB programming port

IOT-GATE-RPI features a single micro USB type B connector P7 used only for re-programming IOT-GATE-RPI storage. This port is not functional during normal operation. For additional details please refer to chapter 4.3.

3.10 Expansion HAT interface

IOT-GATE-RPI HAT expansion interface is available on 100-mil header P9. The expansion connector provides the developer with a reach set of IOs, such as I2C, SPI, UART and more. All the interfaces are derived directly from a Raspberry Pi 3 module.

3.11 EB-RPI-FCSD add-on board

IOT-GATE-RPI can be optionally assembled with the EB-RPI-FCSD add-on board connected to the HAT expansion interface. EB-RPI-FCSD provides the following additional interfaces:

- 1x CAN bus via RJ11 connector
- 1x RS485 via RJ11 connector
- 6x 5V tolerant DIO signals via 100-mil header

For connector details please refer to section 5.13.

4 SYSTEM LOGIC

4.1 Power Subsystem

4.1.1 Power Rails

IOT-GATE-RPI is powered with a single power rail with input voltage range of 10-36V.

4.1.2 Power Modes

IOT-GATE-RPI supports two hardware power modes.

Table 8 Power modes

Power Mode	Description
ON	All internal power rails are enabled. Mode entered automatically when main power supply is connected.
OFF	Raspberry Pi 3 module is off

4.1.3 RTC Back-Up Battery

IOT-GATE-RPI features a 38mAh coin cell lithium battery, which maintains the IOT-GATE-RPI RTC whenever the main power supply is not present.

4.2 Boot Options

IOT-GATE-RPI supports the following boot modes:

- Booting from on-board eMMC storage
- Booting from micro-SD card
- USB programming mode

IOT-GATE-RPI boot mode is determined by the following factors:

- Position of the boot-protection switch SW4
- Presence of an micro-SD card in the micro-SD socket
- Connection of USB host to the USB programming port:

Table 9 IOT-GATE-RPI Boot options

Boot-protection switch SW4	USB host connected to micro-USB connector	Micro-SD card detection state	Active boot mode
ON	X	X	eMMC
OFF (default)	Not connected	Card present	Micro SD
	Not connected	Card not present	eMMC
	Connected	X	USB programming

4.3 USB programming mode

IOT-GATE-RPI USB programming mode can be used to re-flash on-board eMMC by connecting IOT-GATE-RPI to a USB host PC. For details please refer to:

http://mediawiki.compulab.com/w/index.php5/IOT-GATE-RPi:_Raspbian:_Manual_Installation

4.4 Boot protection switch

IOT-GATE-RPI boot protection switch SW4 allows to prevent unauthorized boot from external storage. When SW4 is in the "ON" position booting from micro-SD and USB programming mode are disabled and IOT-GATE-RPI will boot only from on-board eMMC.

4.5 Reset

IOT-GATE-RPI features push button SW1 which acts as a reset button. The system will perform reset if SW1 will stay pressed at least for 4sec and then released.

4.6 Real Time Clock

The IOT-GATE-RPI RTC is implemented with the Maxim DS1307 IC that provides clock and calendar information in BCD format. DS1307 is connected to the I2C port of Raspberry Pi 3 module. IOT-GATE-RPi backup battery keeps the RTC running to maintain clock and time information whenever the main power supply is not present.

5 INTERFACES AND CONNECTORS

5.1 Connector Locations

5.1.1 Front Panel
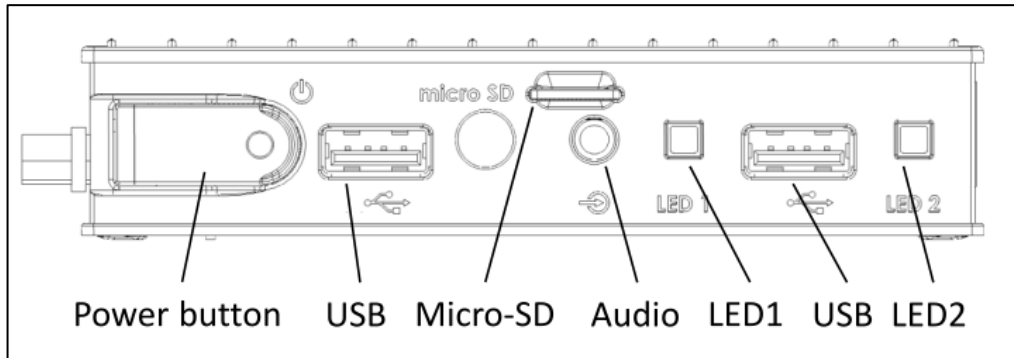
5.1.2 Back Panel
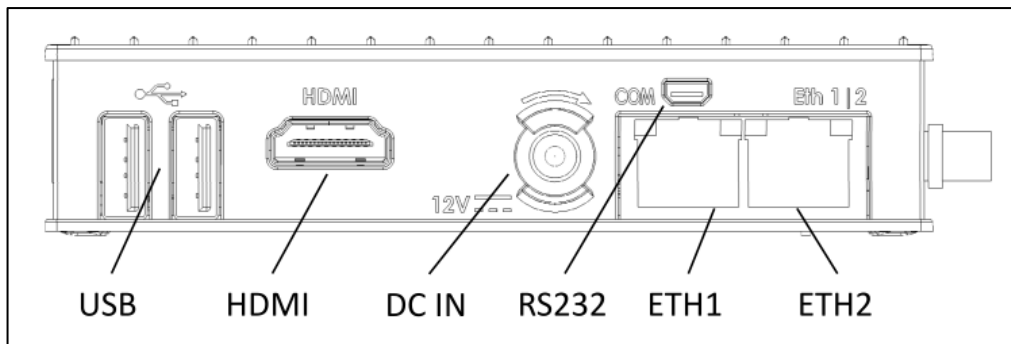
5.1.3 Antenna Side Panel

5.1.4 FCSD add-on Side Panel

CAN bus   GPIO cable opening   RS485
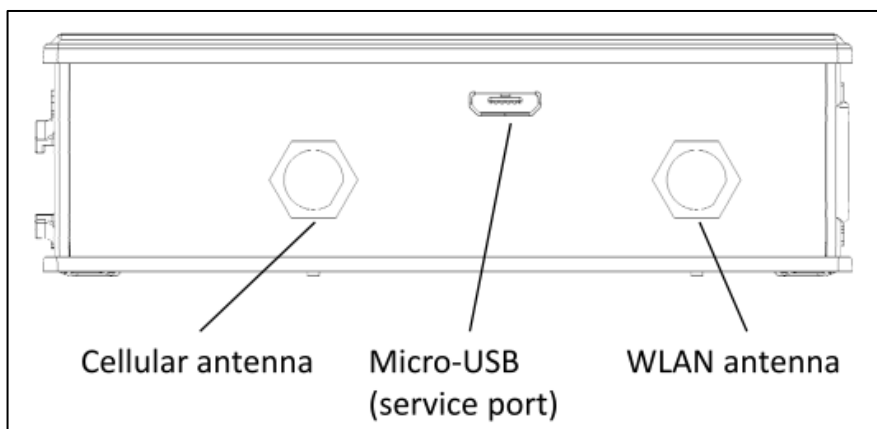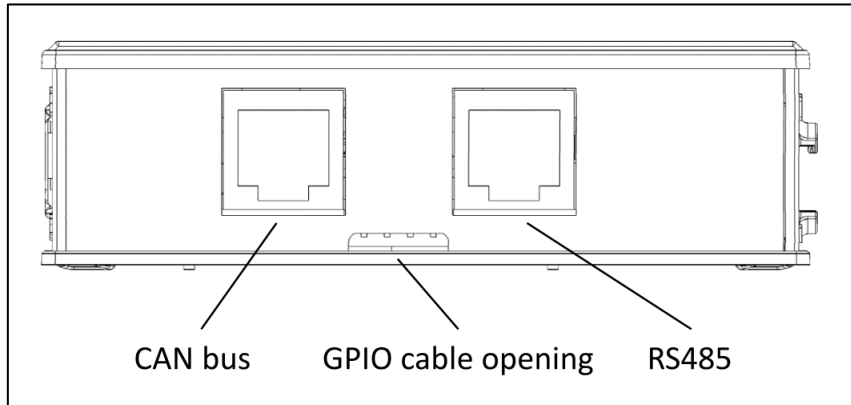
5.2 HDMI Connector (J3)

The HDMI display output is provided through the standard HDMI connector (J3).

5.3 DC Power Jack (J1)

DC power input connector.

Table 10   J1 connector pin-out

Pin	Signal Name	
1	DC IN	
2	GND	

Table 11   J1 connector data

Manufacturer	Mfg. P/N
Contact Technology	DC-081HS(-2.5)

The connector is compatible with the IOT-GATE-RPI power supply unit available from CompuLab.

5.4 Micro-SD Socket (P6)

The micro-SD socket (P6) is connected directly to the Raspberry Pi 3 module.

Table 12   P6 connector pin-out

Pin	Signal Name	Pin	Signal Name
1	SDIO_DAT2	5	SDIO_CLK
2	SDIO_DAT3	6	GND
3	SDIO_CMD	7	SDIO_DAT0
4	VDD_3V3	8	SDIO_DAT1
9	CD#		

5.5 uSIM socket (U9)

The uSIM socket (U9) is connected to mini-PCIe socket's (J4) pins 8, 10, 12, 14 and 16.

5.6 Audio Jack (P13)

IOT-GATE-RPI features one 3.5mm jack. Analog audio signal pinout is compatible with standard 3-pole audio cables.

Table 13   P13 connector pin-out

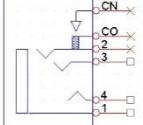| Pin	Signal Name	Jack pin-out	Mating plug
1	GND		
2	GND		
3	AUDIO_OUT_R		
4	AUDIO_OUT_L		

5.7   USB Host Connectors (P2, P3, P4 and P5)

The IOT-GATE-RPI external USB2.0 host ports are available through four standard type-A USB connectors (P2, P3, P4 and P5). For additional details, please refer to section 3.5 of this document.

5.8   Micro USB (P7)

IOT-GATE-RPI features a single micro USB type B connector P7. It is used for booting the IOT-GATE-RPI. For additional details please see chapter 4.3.

5.9   RJ45 Dual Ethernet Connector (P1)
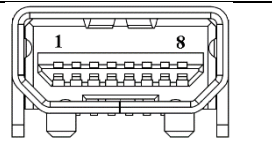
The IOT-GATE-RPI two 100BASE-TX ports routed to dual RJ45 connector P1. For additional details, please refer to section 3.7 of this document.

5.10   RS-232 connector (P8)

The IOT-GATE-RPI RS232 port is routed to the RS232 ultra-mini connector (P8). All signals are at RS232 levels. For more information refer to section 3.8.

Table 14   P8 connector pin-out

Pin	Signal Name	Pin	Signal Name	
1	RS232_TXD	5	GND	
2	NC	6	GND	
3	RS232_RXD	7	NC	
4	NC	8	GND	

Table 15   P8 connector data

Manufacturer	Mfg. P/N	Mating connector
Wieson	G3169-500001	Wieson, P/N: 4306-5000

The connector is compatible with the RS232 adapter cable (CompuLab P/N ACCENC-ADPUMSER) supplied by CompuLab.

5.11   Mini-PCIe Socket (J4)

USB2 hub downstream port #1 and uSIM signals are routed to mini-PCIe socket J4. The mini-PCIe connector can be used to host cellular data modem.

NOTE: Mini-PCIe socket J4 does not feature PCIe interface.

Table 16   P12 connector pin-out

Pin	Signal Name	Pin	Signal Name
1	NC	27	GND
2	3V3	28	NC
3	NC	29	GND
4	GND	30	TP
5	NC	31	NC
6	NC	32	TP
7	NC	33	NC
8	SIM_VCC	34	GND
9	GND	35	GND
10	SIM_IO	36	USB_DM
11	NC	37	GND
12	SIM_CLK	38	USB_DP
13	NC	39	3V3
14	SIM_RST	40	GND
15	GND	41	3V3
16	SIM_VPP	42	NC
17	NC	43	GND
18	GND	44	NC
19	NC	45	NC
20	W_DISABLE#	46	NC
21	GND	47	NC
22	PERST#	48	NC
23	NC	49	NC
24	3V3	50	GND
25	NC	51	NC
26	GND	52	3V3

5.12   HAT expansion connector

IOT-GATE-RPI HAT expansion connector P9 allows to connect HAT addons to IOT-GATE-RPi. The table below describes the connectors pinout.

Table 17   Embedded I/O Connector Interface Signals

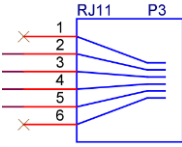| P9 Pin #	Signal Name	Signal Description	SoC GPIO#
1	3.3V	Power supply	NA
2	5V	Power supply	NA
3	SDA1	I2C Serial Data	GPIO2
4	5V	Power supply	NA
5	SCL1	I2C Serial Clock	GPIO3
6	GND	System Ground	NA
7			GPIO4
8			GPIO14
9	GND	System Ground	NA
10			GPIO15
11			GPIO17
12			GPIO18
13			GPIO27
14	GND	System Ground	NA
15			GPIO22
16			GPIO23
17	3.3V	Power supply	NA
18			GPIO24
19			GPIO10
20	GND	System Ground	NA
21			GPIO9
22			GPIO25
23			GPIO11
24			GPIO8
25	GND	System Ground	NA
26			GPIO7
27	SDA0	I2C Serial Data	GPIO0
28	SCL0	I2C Serial Clock	GPIO1
29			GPIO5
30	GND	System Ground	NA
31			GPIO6
32			GPIO12
33			GPIO13
34	GND	System Ground	NA
35			GPIO19
36			GPIO16
37			GPIO26
38			GPIO20
39	GND	System Ground	NA
40			GPIO21

5.13 EB-RPI-FCSD add-on board

5.13.1 CAN bus connector

EB-RPI-FCSD CAN bus interface is routed to RJ11 connector P3.

Table 18   P3 connector pin-out

Pin	Signal Name
1	NC
2	CAN_VCC
3	CAN_H
4	CAN_L
5	CAN_GND
6	NC

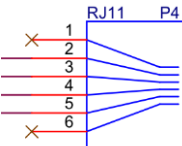## 5.13.2 RS485 connector

EB-RPI-FCSD RS485 interface is routed to RJ11 connector P4.

Table 19   P4 connector pin-out

Pin	Signal Name
1	NC
2	GND
3	RS485_A
4	RS485_B
5	GND
6	NC

5.13.3 DIO connector

EB-RPI-FCSD digital I/O signals are implemented with SoC GPIOs routed to 100-mil header connector P2. Direction of digital I/O signals is controlled by two on-board switches SW1 and SW2.

Table 20   P3 connector pin-out

Pin	Signal Name	Direction Control
1	SOC GPIO 17	SW1
2	SOC GPIO 23	SW2
3	SOC GPIO 18	SW1
4	SOC GPIO 24	SW2
5	SOC GPIO 27	SW1
6	SOC GPIO 25	SW2
7	GND	N/A
8	VCC_5V	N/A

5.14 Indicator LEDs (DS1, DS2, and DS3)

The tables below describes IOT-GATE-RPI indicator LEDs.

Table 21   Power LED (DS1)

Main power connected	SD1 LED
Yes	On
No	Off

Table 22   General purpose LED #1 (DS2)

General purpose LED #1 (DS2) is controlled by SoC GPIO45.

GPIO45 state	DS2 LED
High	On
Low	Off

Table 23   DS3 LED description

General purpose LED #1 (DS3) is controlled by SoC GPIO42.

GPIO42 state	DS3 LED
High	On
Low	Off

6   MECHANICAL DRAWINGS

IOT-GATE-RPI 3D model is available for download at:

http://www.compulab.com/products/iot-gateways/iot-gate-rpi-industrial-raspberry-pi-iot-gateway/#devres

7 OPERATIONAL CHARACTERISTICS

7.1 Absolute Maximum Ratings

Table 24   Absolute Maximum Ratings

Parameter	Min	Max	Unit
Main power supply voltage	-0.3	40	V

NOTE: Stress beyond Absolute Maximum Ratings may cause permanent damage to the device.

7.2 Recommended Operating Conditions

Table 25   Recommended Operating Conditions

Parameter	Min	Typ.	Max	Unit
Main power supply voltage	10	12	36	V