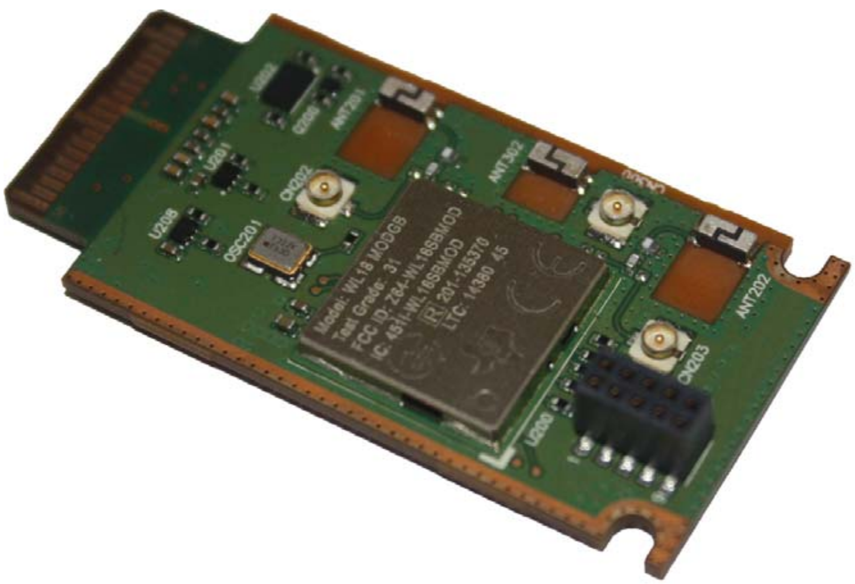
IoT Connector

Design Specification



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Revision History

Revision number	Release date	Changes
1	June 2015	Creation (limited release)
2	January 2016	Added power class and height class specifications Removed PWM Added ‘Class C’ temperature spec to Table 2-1 on page 12 Added Connector Power Category on page 13 Added Connector Height Category on page 23 Updated Figure 4-2 on page 24 (pad dimension 2.10 replaces 1.60) Added Figure 4-4 on page 26 Updated Table 4-2 on page 27 (board name field size; added example header columns; added ‘Additional fields’) Updated Figure 5-3 on page 35 (added Detail A and Detail B) Updated Figure 5-4 on page 36 (added Detail A and Detail B) Added Self-enclosed IoT Connector on page 37
3	February 2016	Changed terminology from ‘IoT Modules’ to ‘IoT Connectors’

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1: Introduction

1.1 Overview

The IoT Connector form factor represents an open hardware standard for sensors, network adapters, and other IoT technologies that can be "plugged" into host applications to provide new features and interfaces. As a family, IoT Connectors share a standardized footprint and pinout, with several interfaces to support various IoT technologies.

1.2 Rationale for the IoT Connector Form Factor

The IoT Connector form factor is designed to be a cost-competitive solution for several current and emerging market demands for host applications, including:

- On-demand hardware applications—The same host application can be used for different market segments by including unique IoT Connector solutions for each segment. For example, a Wi-Fi / Bluetooth solution for one segment and an environmental sensor for another segment.
- Electrical and feature compatibility across IoT technologies—Availability of several data interfaces allows support for various IoT solutions. For example, digital audio over PCM, application control and data transfer over USB, etc.
- Enables Configure/Built to Order
- Accommodates various PAN technologies, sensors, and other IoT applications

Using the IoT Connector’s modular design, all actors of the M2M value chain can benefit.

- Host applications can, without requiring redesign, inherit new features and interfaces for their products
- Technology specialists such as PAN, LPRF, Industrial Fieldbuses or sensors can bring their connectors to market
- System integrators and end customers can easily combine host applications and IoT Connectors to fit their specialized needs

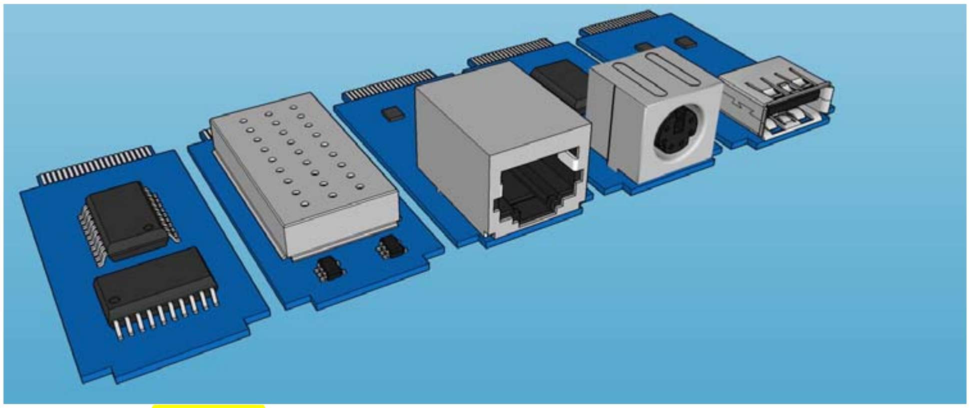

Figure 1-1: IoT Connectors—Common footprint, variable designs

1.3 Specification Objective

This document defines a standard open-hardware pluggable module form factor specification. The specification describes supported interfaces and the mechanical design requirements (device-side and host-side) for building IoT Connectors and integrating them into host applications.

1.4 Targeted Applications

The IoT Connector form factor provides a common platform for OEMs to make a wide range of technologies available for use with IoT Connector-compatible host applications. Some examples of technologies that could be implemented on IoT Connectors include:

- PAN (Personal Area Network): Wi-Fi, Bluetooth, Zigbee, etc.
- Common LAN/WAN: Ethernet, USB, Serial, etc.
- Low power and Low Power Long Range wireless technologies
- Industrial Fieldbuses: Modbus, Profibus, MPI, PPI
- Global Navigation Satellite Systems (GNSS)
- Specialized I/Os: Digital, Analog, Counting, PT1000, etc.
- Sensor networks
- Specialized sensors: Accelerometers, Temperature, Environment

1.5 IoT Connector Classes and Categories

The IoT Connector specification defines connector classes based on their power consumption categories and connector height categories. See Connector Power Category on page 13 and Connector Height Category on page 23 for details.

1.6 IoT Connector Characteristics

Key characteristics of the IoT Connector specification include:

- Standard footprint
- Support for wide connectors (up to 8 slots wide)
- Low-cost connectors
- Several available host interfaces:
  - ADC
  - GPIOs
  - I2C
  - I^2S
  - PCM
  - PPS Clock (Stratum 1)
  - SPI
  - UART
  - USB
  - SDIO

1.7 Document Organization

- Technical Specifications—Environmental, EMC/ESD, and power specifications
- Interfaces Specification—Host interface details for all supported interfaces
- Mechanical / Form factor—Operational specifications, and hardware design (host and IoT Connector) requirements
- Mounting methods—Mounting design details (host and IoT Connector)
- Pinout—Connector pin details

2: Technical Specifications

2.1 Overview

This chapter describes environmental, EMC/ESD, and power specifications for IoT Connectors.

2.2 Environmental Specifications

IoT Connectors must satisfy the operational and non-operational environmental specifications defined in Table 2-1.

Table 2-1: Environmental Specifications

Parameter	Range	Operating Class
Ambient Operating Temperature	-30°C to +70°C	Class A—The host application and IoT Connector remain fully functional across the specified temperature range, meeting the cellular performance requirements of ETSI or other appropriate wireless standards.
	-40°C to +85°C	Class B—The host application and IoT Connector remain fully functional across the specified temperature range. Some cellular parameters may deviate from the performance requirements of ETSI or other appropriate wireless standards.
	0°C to +50°C	Class C—Commodity Class. The host application and IoT Connector remain fully functional across the specified temperature range, meeting the cellular performance requirements of ETSI or other appropriate wireless standards.
Ambient Storage Temperature	-40°C to +85°C	

2.3 Power Requirement

IoT Connectors are powered by DC power provided by the host application via the pins (voltage rails) described in Table 2-2 on page 13.

Note: Hot-swapping (hot-plugging) of IoT Connectors is not supported.

Table 2-2: Power Supply Pins

Pin	Name	Function	Specification	Notes
1	VCC_5V0	USB power supply/5V power supply	5.0V ± 10%, 500 mA	
11	VCC_1V8	1.8V power supply	1.8V ± 10%, 500 mA	
28	VCC_3V3	3.3V power supply	3.3V ± 10%, 500 mA	Each pin must be capable of 500 mA. IoT Connectors may require up to 1 A total.
29	VCC_3V3	3.3V power supply	3.3V ± 10%, 500 mA	
Maximum combined power across all voltage rails (pins 1, 11, 28, 29)			3.3W	

2.3.1 Required Power-up Procedure

To prevent the possibility of latchup during the power-up sequence:

1. Host application must provide power rails (5V and 3.3V) first.
2. After power rails are provided, host application can provide I/O voltage (1.8V).

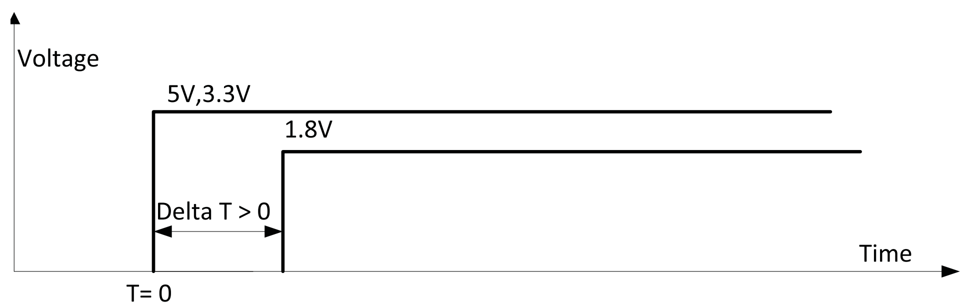

Figure 2-1: Power-up Sequence Timing

Note: Well-designed host applications will follow this procedure to make sure latchup will not occur. IoT Connector developers may also include, if desired, latchup-resistant chips and/or a latchup protection technology (LPT) circuit to prevent latchup during the power-up sequence.

2.3.2 Connector Power Category

IoT Connectors are assigned a power category based on their power consumption:

- Category 1: <2.5W
- Category 2: ≥2.5W to <3.3W
- Category 3: ≥3.3W

The power category is identified in the EEPROM header (see EEPROM Header on page 27).

2.4 EMC and ESD Recommendations

When designing an IoT Connector, make sure that potential EMC (Electromagnetic Compatibility) issues are considered, and appropriate ESD protection is incorporated in the design.

For example:

- Identify and mitigate possible spurious emissions radiated by the application to the host application's RF receiver in the receiver band.
- ESD protection is strongly recommended on the IoT Connector on all externally-accessible signals, such as:
    - Serial link
    - USB
    - Antenna port
    - Ethernet
- Perform EMC/ESD tests on IoT Connector board as soon as possible to detect potential issues
- Follow generic EMI mitigation philosophies
    - For high-speed buses, place decoupling capacitor close to IoT Connector port in case it is needed for signal speed reduction
    - Place bulk capacitors close to power rails. Ratings for these capacitors depend on the specific IoT Connector design.
- Provide ESD protection ground strips underneath the IoT Connector.
  Host applications should include ESD protection in the form of ground clips that engage with the IoT Connector's ground protection strips.
  For details, see Mounting methods on page 33.
- If appropriate, place series resistors inline with high speed traces to drop speed and eliminate ringing effects. For example, place 33 Ω resistors inline on SDIO traces.

Table 2-3: ESD Specifications [a]

Category	Connection	Specification
Operational	Externally-accessible signals	IEC-61000-4-2 - Level (Electrostatic Discharge Immunity Test). Contact and Air limits are specific to the end product in which the IoT Connector will be installed.

a. ESD protection is highly recommended at the point where the UIM contacts are exposed, and for any other signals that would be subjected to ESD by the user.

3: Interfaces Specification

3.1 Overview

This chapter describes the interfaces supported by IoT Connector form-factor devices and provides specific voltage, timing, and circuit recommendations for each interface.

3.2 IoT Connector Platform Features

The IoT Connector platform provides several interfaces for device control and data transfer:

- USB on page 15
- SDIO Interface on page 16
- UART on page 16
- SPI Bus on page 17
- Reset Signal (n_RESET) on page 18
- ADC on page 18
- I2C Interface on page 18
- General Purpose Input/Output (GPIO) on page 19
- n_CARD_DETECT on page 19
- Digital Audio on page 21
- Stratum Clock (PPS) on page 21

3.3 USB

The IoT Connector supports one high-speed USB2.0 Interface that conforms to *[3] Universal Serial Bus Specification, Revision 2.0*. The interface may be used for application control and data transfer between the IoT Connector and a host application.

Table 3-1: USB2.0 Interface Pins

Pin	Signal name	I/O[a]	Function	If unused	Voltage
1	VCC_5V0	I	USB power supply/5V power supply	No connect	5.0V
2	USB_D+	I/O	Differential data interface positive	No connect	
3	USB_D-	I/O	Differential data interface negative	No connect	
4	GND	-	Ground	No connect	

a. Direction with respect to IoT Connector

3.4 SDIO Interface

The IoT Connector supports an SDIO (Secure Digital Input/Output) interface that conforms to *[4] SD Specifications Part E1 SDIO Simplified Specification, Version 3.00*. The interface may be used for data communication between the IoT Connector and a host application.

The IoT Connector can incorporate an SDIO card or an embedded SDIO device, as identified in the EEPROM header (see EEPROM Header on page 27). The host application must identify the SDIO type and take appropriate steps to work with it (as described in the SDIO specification).

Table 3-2: SDIO Interface Pins

Pin	Signal name	I/O[a]	Function	If unused	Voltage
5	SDIO_CLK	I	SDIO clock	No connect	SDIO card: 2.7–3.6V Embedded SDIO device: 1.7–-1.95V or 2.7–3.6V See ([4] SD Specifications Part E1 SDIO Simplified Specification, Version 3.00 for details.
6	SDIO_CMD	I	Command/Response	No connect	
7	SDIO_DAT3/CD	I/O	Data 3/Card Detection	No connect	
8	SDIO_DAT2	I/O	Data 2	No connect	
9	SDIO_DAT1	I/O	Data 1	No connect	
10	SDIO_DAT0	I/O	Data 0	No connect	

a. Direction with respect to IoT Connector

3.5 UART

The IoT Connector supports a 4-wire UART interface. The interface may be used for data communication between the IoT Connector and a host application.

Flow control is managed using the RTS/CTS signals, or using software XON/XOFF.

For additional information, see Digital I/O Characteristics on page 22.

Table 3-3: UART Interface Pins

Pin	Signal name	I/O[a]	Function	If unused	Voltage
12	UART_TXD	O	UART Transmit Data	No connect	1.8V ± 10%
13	UART_RXD	I	UART Receive Data	No connect	
14	UART_CTS	I	UART Clear to Send	No connect	
15	UART_RTS	O	UART Ready to Send	No connect	

a. Direction with respect to IoT Connector

3.6 SPI Bus

The IoT Connector supports a 3/4/5-wire serial peripheral interface (SPI) that may be used for data communication between the IoT Connector and a host application.

The following features are available on the SPI bus:

- Mode: Slave (Master mode is not supported)
- 3/4/5-wire interface

Note: Although the IoT Connector supports 3, 4, and 5-wire implementations of the SPI bus, the connector will only work if the host application supports the same architecture (number of signals, bus speed, data length) as the connector.

Table 3-4: SPI Interface Pins

Pin	Signal name	I/O[a]	Function	If unused	Voltage
16	SPI_CLK	I	SPI serial clock	No connect	1.8V ± 10%
17	SPI_MISO	O	SPI2 Master Input/ Slave Output (Data transfer from IoT Connector to host application)	No connect	
18	SPI_MOSI	I	SPI Master Output/ Slave Input (Data transfer from host application to IoT Connector)	No connect	
19	SPI_SS/MRDY	I	SPI Slave Select	No connect	
26	SPI_SRDY (alternate function)	O	SPI Slave Ready	No connect	

a. Direction with respect to IoT Connector

3.6.1 SPI Configuration

Table 3-5: SPI Configuration

Operation	Max Speed	SPI-Mode	Duplex	4-wire Type
Slave	Host application-dependent	0,1,2,3	Full	SCLK (SPI_CLK) MOSI (SPI_MOSI) MISO (SPI_MISO) SS (SPI1_SS/MRDY)

3.7 Reset Signal (n_RESET)

The IoT Connector supports an interface that allows an external application to reset the device.

When the host application brings up the power rails for the IoT Connector, n_RESET is pulled high.

To reset the IoT Connector, the host must pulse n_RESET low.

Table 3-6: n_RESET Interface Pin

Pin	Signal name	I/O[a]	Function	If unused	Voltage
32	n_RESET	I	Active low reset from host application to IoT Connector	No connect	1.8V ± 10%

a. Direction with respect to IoT Connector

3.8 ADC

The IoT Connector supports one general purpose Analog to Digital Converter (ADC) output.

The interface may be used for one-way (output) communication from the IoT Connector to the host application. For example, ADC0 could be used as an indicator to the host application to notify when a specific analog event occurs (such as a sensor being triggered).

Table 3-7: ADC0 Interface Pin

Pin	Signal name	I/O[a]	Function	If unused	Voltage
20	ADC0	O	Analog to Digital Converter	No connect	1.8V ± 10%

a. Direction with respect to IoT Connector

3.9 I^{2}C Interface

The IoT Connector supports one I^{2}C (Inter-Integrated Circuit) interface. The interface may be used for data communication between the IoT Connector and a host application.

The I^{2}C bus implemented on the IoT Connector should support 100 kbps (standard mode) to be compatible with the widest variety of host applications. Higher speeds may also be implemented (for example, 400 kbps, 1 Mbps, etc.) but will only be attainable if also supported by the host application.

The I^{2}C interface has the following hardware requirements:

- Host application—All required pull-up resistors, including a weak pull-up for the I^{2}C bus, should be located on the host application, not on the IoT Connector. Resistor values are host-dependent. For pull-up details, see Pull-up Resistors on page 32.

- IoT Connector—A configuration EEPROM is required. For details, see n_CARD_DETECT on page 19 and EEPROM on page 26.

Table 3-8: I²C Interface Pins

Pin	Signal name	I/O[a]	Function	If unused	Voltage
22	I2C_SDA	I/O	I^2C Data (Tx/Rx)	No connect	1.8V ± 10%
23	I2C_SCL	I	I^2C Clock	No connect	1.8V ± 10%

a. Direction with respect to IoT Connector

3.10 General Purpose Input/Output (GPIO)

The IoT Connector supports four GPIOs that may be used for data communication between the IoT Connector and a host application.

For additional information, see Digital I/O Characteristics on page 22.

Table 3-9: GPIO Pins

Pin	Signal name[a]	I/O[b]	Function	If unused	Voltage
24	GPIO_1[c]	I/O	General purpose I/O	No connect	1.8V ± 10%
25	GPIO_2	I/O		No connect	1.8V ± 10%
26	GPIO_3	I/O		No connect	1.8V ± 10%
27	GPIO_4	I/O		No connect	1.8V ± 10%

a. Alternate functions available: pin 26: SPI_SRDY
b. Direction with respect to IoT Connector
c. May be used as an interrupt line if the connector has an IRQ line

Note: GPIOs are logic I/O signals that should not be used to directly drive electric loads.

3.11 n_CARD_DETECT

The IoT Connector provides a signal that is used by the host to detect when the IoT Connector is inserted or removed from a slot on the host application.

Table 3-10: n_CARD_DETECT Pin

Pin	Signal name	I/O	Function	Voltage
31	n_CARD_DETECT	I/O	Host monitors the signal for a state change that indicates the connector is inserted (active low), or removed (high)	1.8V ± 10%

Figure 4-6 on page 30 describes the process the host application uses to detect when IoT Connectors are inserted or removed from slots on the host application.

All IoT Connectors are assigned the same address (0x53) while they are inactive. When the host needs to work with a specific connector, it accesses the appropriate slot and activates the connector. When finished with a connector, it is deactivated, and the host can then access another connector if desired.

IoT Connectors can be inserted before the host application boots, or while the host application is running. The host application monitors the slots on the application board waiting for state changes on the n_CARD_DETECT pins, which indicate that a connector has been inserted or removed.

Note: IoT Connectors that occupy more than one slot must use the n_CARD_DETECT pin in the first slot.

Note: n_CARD_DETECT must have a pull-up (≥47k) on the host. For details, see *Recommended EEPROM Schematic on page 29* *and* *Pull-up Resistors on page 32**.*

Table 3-11: n_CARD_DETECT States

State[a]	Logic state	Address pin A0 (level)	EEPROM address	Comments
Input	High	High	0x53	No IoT Connector detected
Input	Low	High	0x53	IoT Connector is inactive
Output	High	Low	0x52	IoT Connector is active

a. Direction with respect to IoT Connector

3.12 Digital Audio

The IoT Connector supports a 4-wire digital audio interface that can be configured for either PCM (Pulse Code Modulation) or I^2S (Inter-IC Sound) audio.

Table 3-12: PCM / I^2S interface signals [a]

Pin	Signal name	I/O[b]	Function	If Unused
33	PCM_DIN	Output	PCM Data In The frame “data in” relies on the selected configuration mode.	Leave open
	I2S_IN		I2S Data In The frame “data in” relies on the selected configuration mode.	
34	PCM_DOUT	Input	PCM Data Out The frame “data out” relies on the selected configuration mode.	Leave open
	I2S_OUT		I2S Data Out The frame “data out” relies on the selected configuration mode.	
35	PCM_SYNC	Input	PCM Sync The frame synchronization signal delivers an 8 kHz frequency pulse that synchronizes the frame data in and the frame data out.	Leave open
	I2S_WS		I2S Word Select The word select clock indicates which channel is currently being transmitted (low cycle indicates left audio channel, high cycle indicates right audio channel).	
36	PCM_CLK	Input	PCM Clock The frame bit clock signal controls data transfer with the audio peripheral.	Leave open
	I2S_CLK		I2S Clock The frame bit clock signal controls data transfer with the audio peripheral.	

a. All values are preliminary and subject to change.
b. Direction with respect to IoT Connector

3.13 Stratum Clock (PPS)

The IoT Connector accepts a Stratum 1 clock input (PPS signal) from the host application. The host application should operate as a stratum 1 time source, connected to GPS (a stratum 0 source).

This signal can then be used to manage timing for sensor nodes (or other devices) that are attached to the IoT connector.

For additional information, see Digital I/O Characteristics on page 22.

Table 3-13: Clock interface pin descriptions

Pin	Signal name	I/O	I/O type	Description	If Unused
37	PPS	Input	1.8V	Stratum Clock 1 Pulse per second signal.	No connect

3.14 Digital I/O Characteristics

The I/O characteristics for supported 1.8V digital interfaces (GPIOs, UART, PPS) are described in the following table.

Table 3-14: Digital I/O Characteristics (V_{DD_PX} = 1.80 V (nominal)) [a]

Parameter		Comments	Min	Typ	Max	Units
V_{IH}	High level input voltage	CMOS/Schmitt	0.65 * V_{DD_PX}	-	V_{DD_PX} + 0.3	V
V_{IL}	Low level input voltage	CMOS/Schmitt	-0.3	-	0.35 * V_{DD_PX}	V
V_{SHYS}	Schmitt hysteresis voltage		100	-	-	mV
I_{IH}	Input high leakage current[b]	No pull-down	-		1	µA
I_{IL}	Input low leakage current[c]	No pull-up	-1		-	µA
R_P	Pull up/down resistance		55		390	kΩ
V_{OH}	High level output voltage	CMOS, at pin-rated drive strength	V_{DD_PX} - 0.45	-	V_{DD_PX}	V
V_{OL}	Low level output voltage	CMOS, at pin-rated drive strength	0	-	0.45	V
I_{OZH}	Tri-state leakage current[b]	Logic high output, no pull-down	-		1	µA
I_{OZL}	Tri-state leakage current[c]	Logic low output, no pull-up	-1		-	µA
R_K	Keeper resistance		30		150	kΩ
I_{ISL}	Sleep crystal input leakage		-0.15	-	0.15	µA
I_{IHVKP}	High-V tolerant input leakage	With keeper	-1	-	-	µA
C_{IN}	Input capacitance[d]		-	-	5	pF
I_{PIN}	Current per pin		-	-	16	mA

a. All values are preliminary and subject to change.
b. Pin voltage = V_{DD_PX} max. For keeper pins, pin voltage = V_{DD_PX} max - 0.45 V.
c. Pin voltage = GND and supply = V_{DD_PX} max. For keeper pins, pin voltage = 0.45 V and supply = V_{DD_PX} max.
d. Input capacitance is guaranteed by design, but is not 100% tested.

4: Mechanical / Form factor

4.1 Overview

This chapter describes mechanical specifications for the IoT Connector and host devices.

4.2 Mechanical Dimensions

4.2.1 Connector Height Category

IoT Connectors are assigned a height category based on the top height (distance from the top face of the PCB to the top of the tallest component on the PCB):

- Category 1: ≤14.00 mm
- Category 2: >14.00 mm

4.2.2 Required Top/Bottom Clearance

Figure 4-1 illustrates the space requirements between the IoT Connector and a host application.

Thus, maximum component heights on the connector's top and bottom face are:

- Top:
  - Category 1: ≤14.00 mm
  - Category 2: >14.00 mm
- Bottom—2.5 mm (0.5 mm clearance required to host PCB)

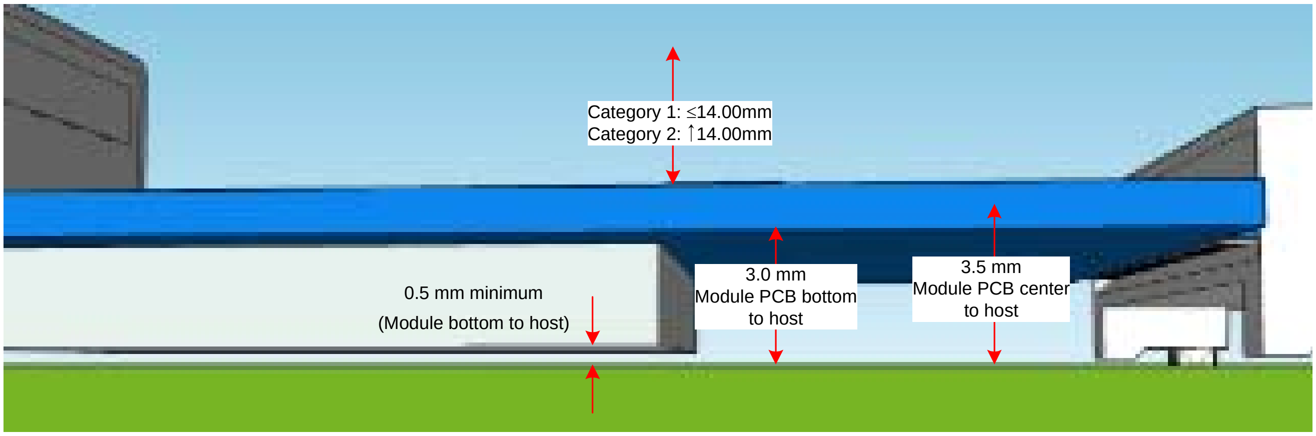

Figure 4-1: IoT Connector Height Limits

IoT Connectors may be designed to fit in 1–8 slots, depending on OEM design requirements. Figure 4-2 on page 24 and Figure 4-3 on page 25 describe the measurements for single-slot and double-slot IoT Connectors respectively.

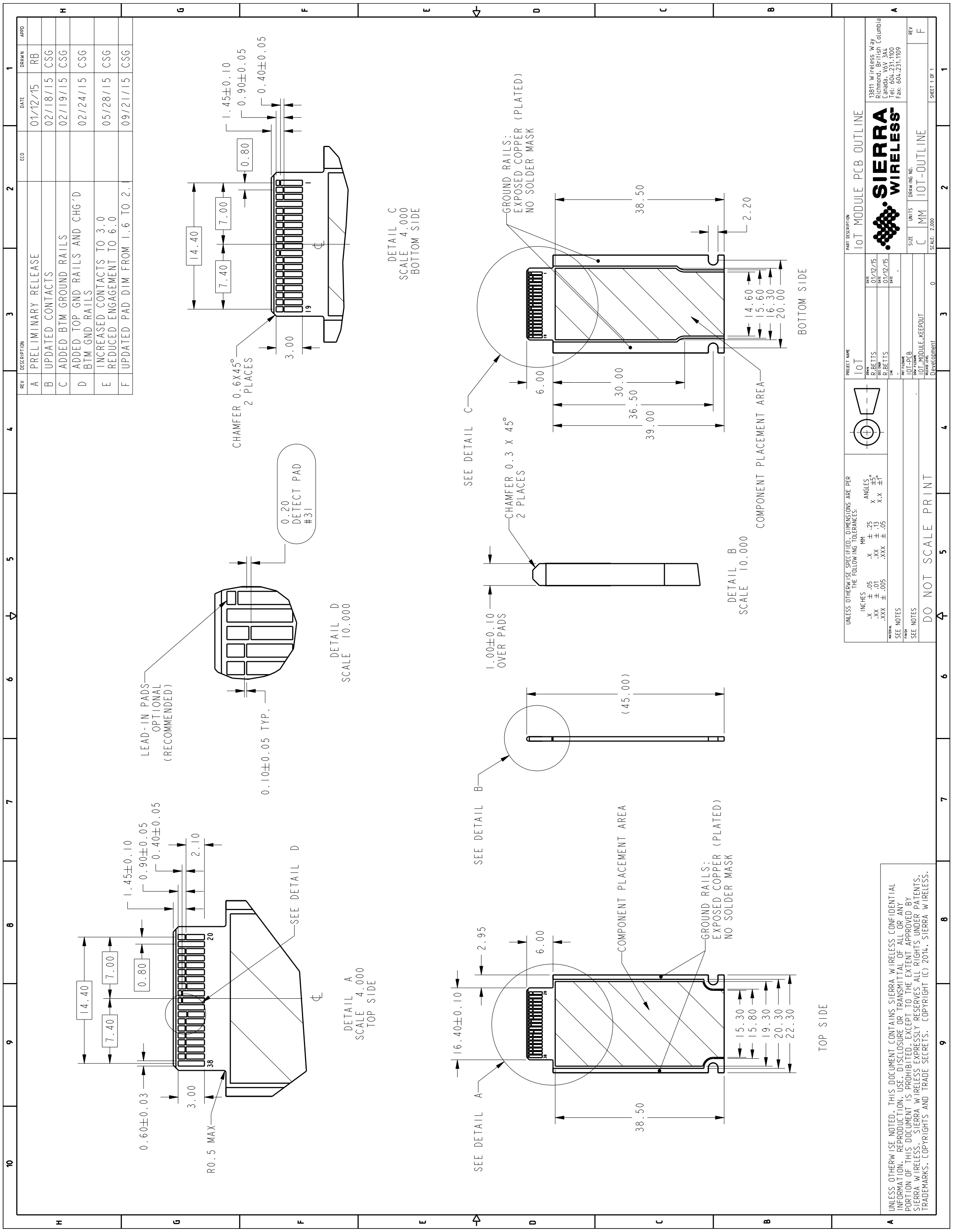

Figure 4-2: Single Slot Connector Port Details

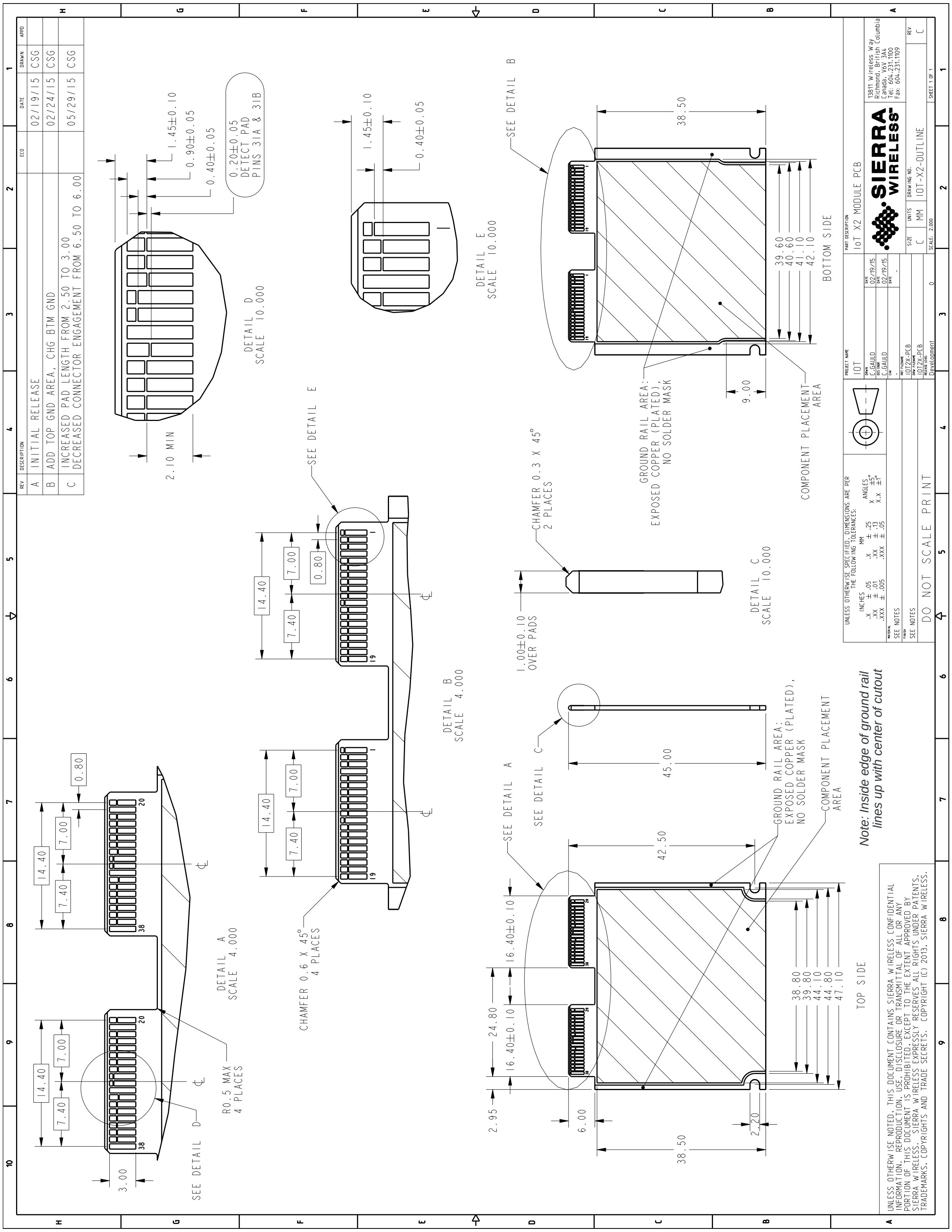

Figure 4-3: Double Slot Connector Port Details

4.3 Connector-side Requirements and Considerations

4.3.1 EEPROM

Each IoT Connector must use an I2C EEPROM that meets the following specifications:

Table 4-1: EEPROM Requirements

Attribute	Requirement	Options / Restrictions
Model	24Cxx type 1.8V I2C EEPROM	Other model types are not supported (for example, 3.3V or 5V)
Addressing	16-bit only	• 8-bit and 24-bit addressing are not supported • Address when device is inactive: 0x52 • Address when device is being scanned: 0x53
I2C mode support	100 kHz	OEM may also support higher speeds, which will only be usable if the host application also supports the higher speeds.
Memory paging	Not supported	Do not use paged type EEPROMs.
I2C clock stretching	Not supported	Do not use EEPROMs that perform I2C clock stretching
Write protect pin	Must be supported, and must protect the entire device memory	

EEPROMs that satisfy these requirements are available from several vendors. One example is ON Semiconductor part # CAT24C32.

Note: For double (or wider) connectors, the EEPROM is read via the first slot on the card.

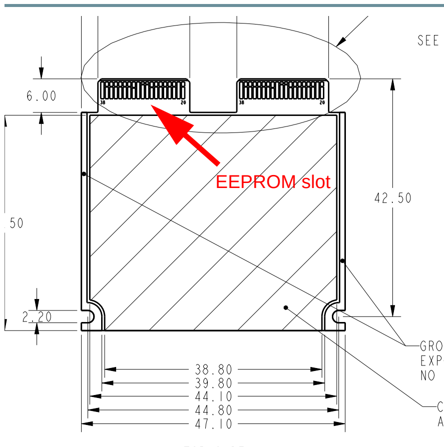

Figure 4-4: Slot location for EEPROM on wide IoT Connectors

4.3.2 EEPROM Header

All IoT Connectors must contain the following information in their EEPROMs.

Note: EEPROM data is stored in little-endian format.

Table 4-2: EEPROM Structure[a]

Field	Offset	Size (bytes)	Description	Example Header: Value	Example Header: Description
Header	0	2	0xAA, 0x55	0xAA, 0x55	Signature
Header Version	2	2	0x0001	0x0001	Version 1
Board Name	4	32	• OEM-defined board description • Null-terminated ASCII string—maximum 31 printable characters	“Laser module” + ‘\0’	Null-terminated connector name
Serial Number	36	10	IoT connector serial number Format: YYMMDDnnnn • YY = 2 digit year of production • MM = 2 digit month of production • DD = 2 digit day of production • nnnn = incrementing board number	“1504240001”	Year = 2015 Month = April Day = 24 Board number = 0001
Number of slots	46	1	Board width • 1–8 • Note: 0 is reserved	2	Double-width connector
Interfaces					
Slots used for I2C	47	1	• 0xNN bit mask of slots on which this interface is used • BitX = 0: Interface not used on slot X • BitX = 1: Interface used on slot X	0b00000010	I2C used on slot 2
Slots used for SPI	48	1	• 0xNN bit mask of slots on which this interface is used • BitX = 0: Interface not used on slot X • BitX = 1: Interface used on slot X	0b00000011	SPI used on slots 1 and 2
Slots used for UART	49	1	• 0xNN bit mask of slots on which this interface is used • BitX = 0: Interface not used on slot X • BitX = 1: Interface used on slot X	0b00000001	UART used on slot 1
Slots used for GPIO	50	1	• 0xNN bit mask of slots on which this interface is used • BitX = 0: Interface not used on slot X • BitX = 1: Interface used on slot X	0b00000011	GPIO used on slots 1 and 2

Table 4-2: EEPROM Structure[a] (Continued)

Field	Offset	Size (bytes)	Description	Example Header Value	Example Header Description
Slots used for SDIO	51	1	• 0xNN bit mask of slots on which this interface is used • BitX = 0: Interface not used on slot X • BitX = 1: Interface used on slot X	0b00000000	SDIO not used
Slots used for PCM	52	1	• 0xNN bit mask of slots on which this interface is used • BitX = 0: Interface not used on slot X • BitX = 1: Interface used on slot X	0b00000000	PCM not used
Slots used for ADC	53	1	• 0xNN bit mask of slots on which this interface is used • BitX = 0: Interface not used on slot X • BitX = 1: Interface used on slot X	0b00000011	Analog input used on slots 1 and 2
Additional fields					
Environmental Class	54	1	• Class letter in ASCII format • “A”, “B”, “C”	“A”	Class A temperature range
Power Category	55	1	• Power Class number (1 or 2)	2	Power Class 2
Connector Height Category	56	1	• Height Class number (1 or 2)	2	Connector Height Class 2
Application ID	57	64	• Null-terminated ASCII string	“Sierra Wireless Home App A” + ‘\0’	Null-terminated application name
Trusted ID	121	64	• Null-terminated ASCII string	“AzDffDHJFf12k” + “\0’	Null-terminated ID

a. Structure details are preliminary and subject to change.

4.3.2.1 Recommended EEPROM Schematic

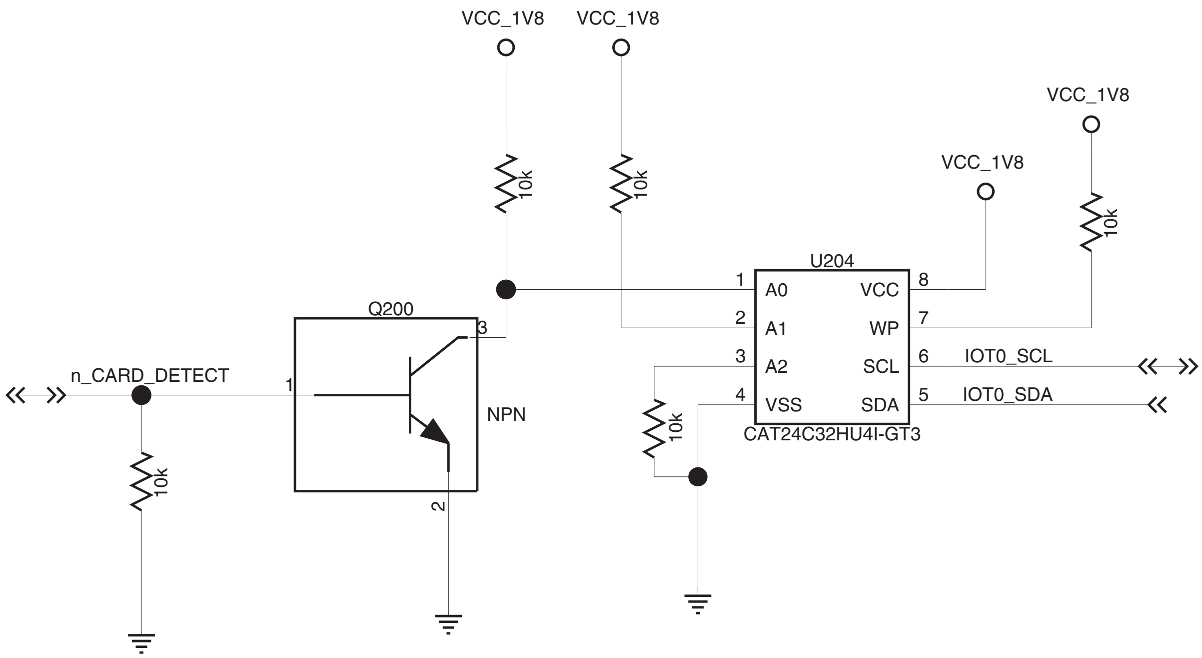

Figure 4-5: Schematic—Recommended EEPROM

Key EEPROM usage notes:

- Active device Address: 0x52
- Inactive Device Address: 0x53
- n_CARD_DETECT:
  - Tie to ground using a ≤10k pull-down resistor
  - Connect through the transistor to pin A0 on the EEPROM

4.4 Connector Boot Process

When an IoT Connector is detected, the host application reads the connector's EEPROM header information (see EEPROM Header on page 27.) This includes the connector's slot width (number of slots the connector occupies), which the host needs to determine each connector's location. For example, if a 2-slot wide connector is in slots 0–1, the host knows the next available slot is slot 2.

Figure 4-6 on page 30 illustrates the connector boot process.

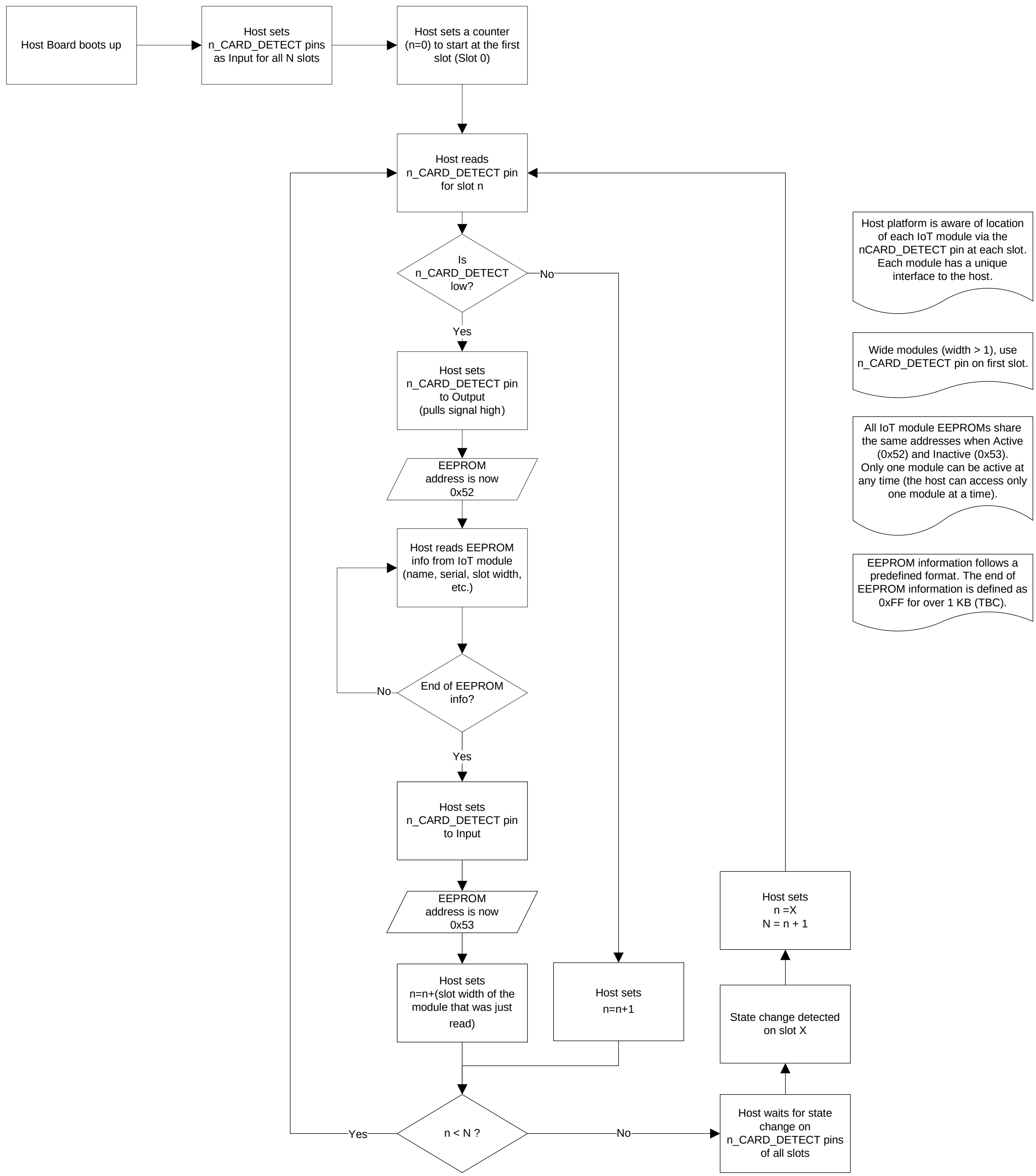

Figure 4-6: Host Process for IoT Connector Detection

4.5 Host-side Requirements and Considerations

4.5.1 IoT Connector Port

IoT Connectors connect to host applications via a QSFP+ port mounted on the host application. This port style was selected for ease of use, and wide commercial availability from multiple vendors.

The host application can be designed with as many ports as desired—there is no prescribed limitation on the number of IoT Connectors that a host application may support at one time.

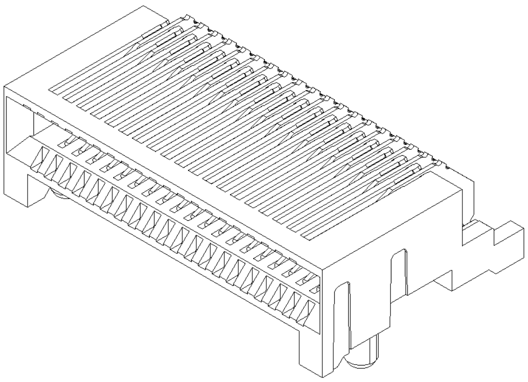

Figure 4-7: QSFP+ Port

The QSFP+ port standard is described in SFF-8436 Specification for QSFP+ 10 Gbs 4X Pluggable Transceiver (Standardized as EIA-964 at Rev 4.8 dated October 31, 2013)

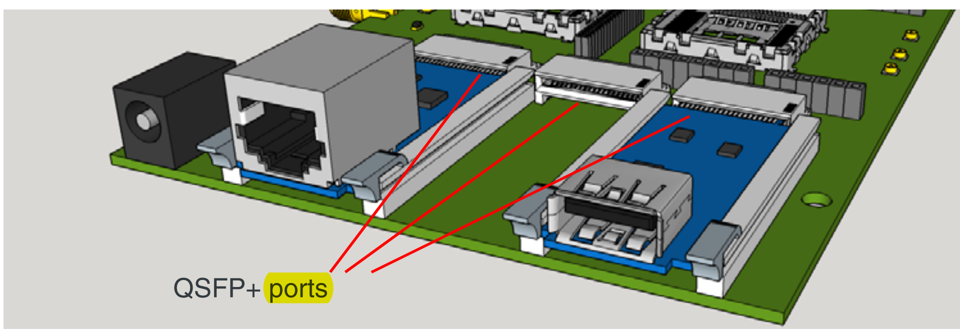

Figure 4-8: Installed QSFP+ Ports

4.5.2 IoT Connector Mounts

IoT Connectors are mounted on host applications using one of three methods:

- Screwed into spacers
- Screwed into soldered standoffs
- Plugged in via rails

For details, see Mounting methods on page 33.

4.6 Pull-up Resistors

All required pull-up resistors (for example, for the I2C interface and n_CARD_DETECT) should be located on the host application, not on the IoT Connector.

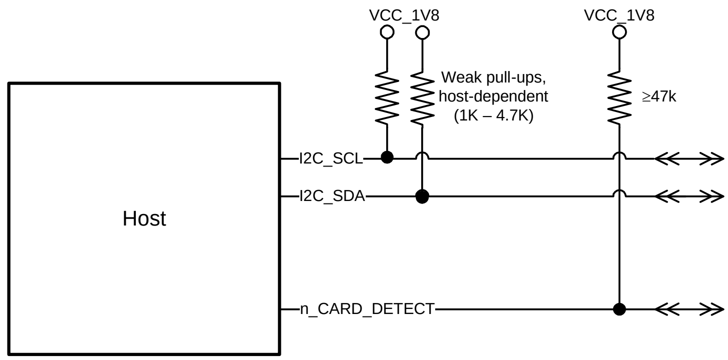

Figure 4-9: Host-side Pull-up Resistor Requirements

5: Mounting methods

5

5.1 Overview

This chapter describes methods and hardware specifications for mounting IoT Connectors in Host applications.

IoT Connectors are designed to be mounted in host applications via three methods to meet customer requirements:

- Plug in via IoT Connector rails. 3D-printing files are available at source.sierrawireless.com, and molded versions will be made available in future.
- Screwed into platform via spacers
- Screwed into platform via soldered standoffs

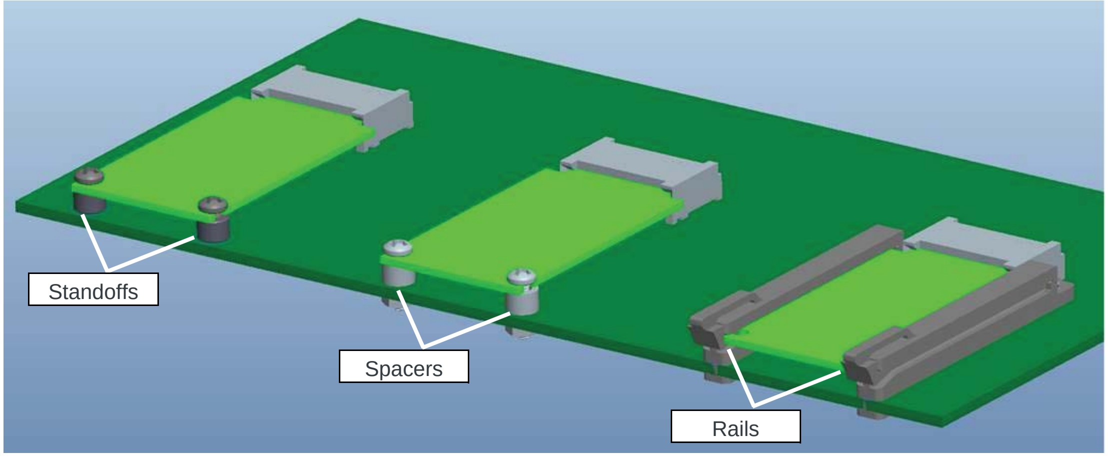

Figure 5-1: Connector Mounting Methods

Figure 5-1, Connector Mounting Methods, on page 33 and Figure 5-2, Host-side Mounting Types, on page 34 provide detailed specifications for the various mounting types.

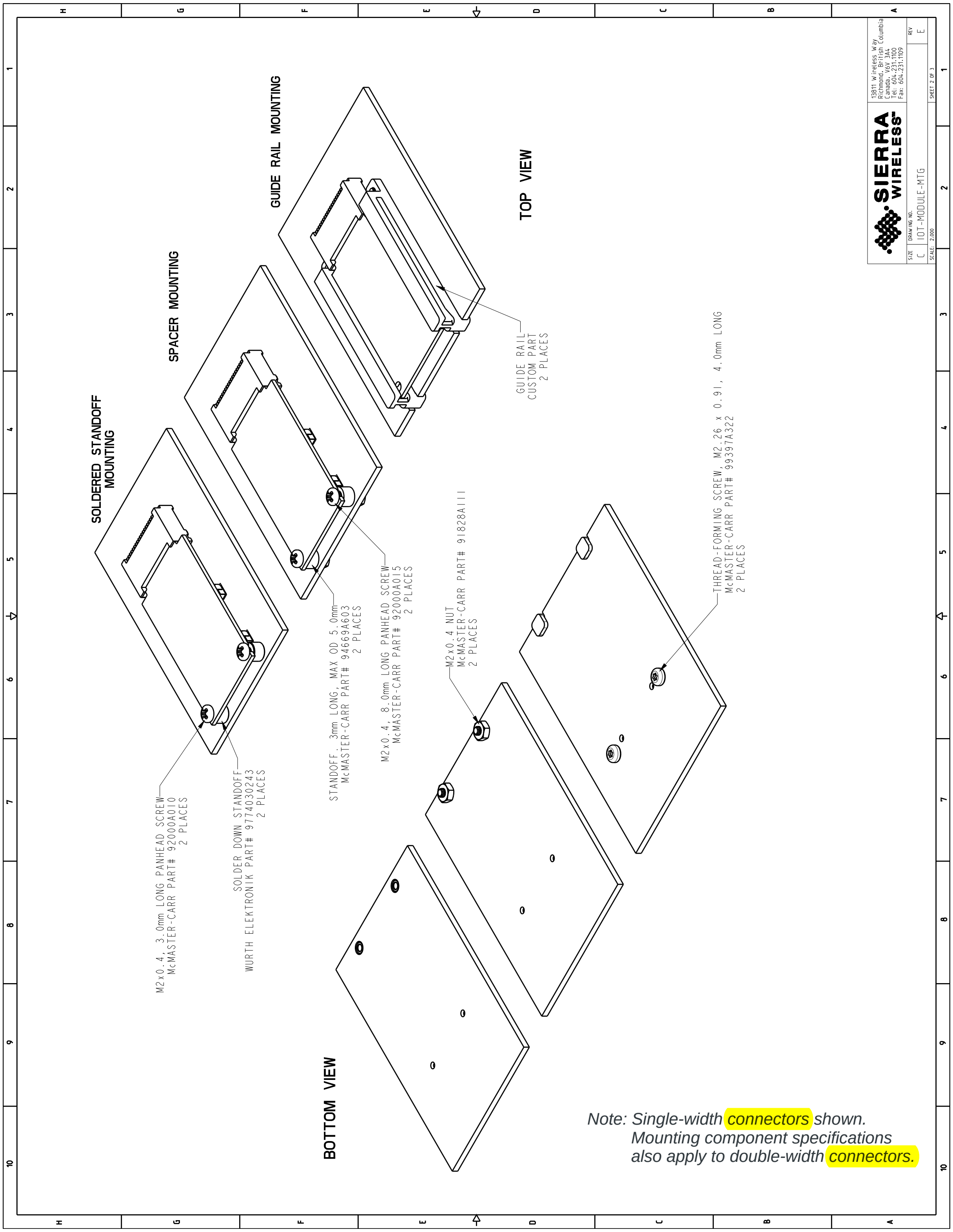

Figure 5-2: Host-side Mounting Types

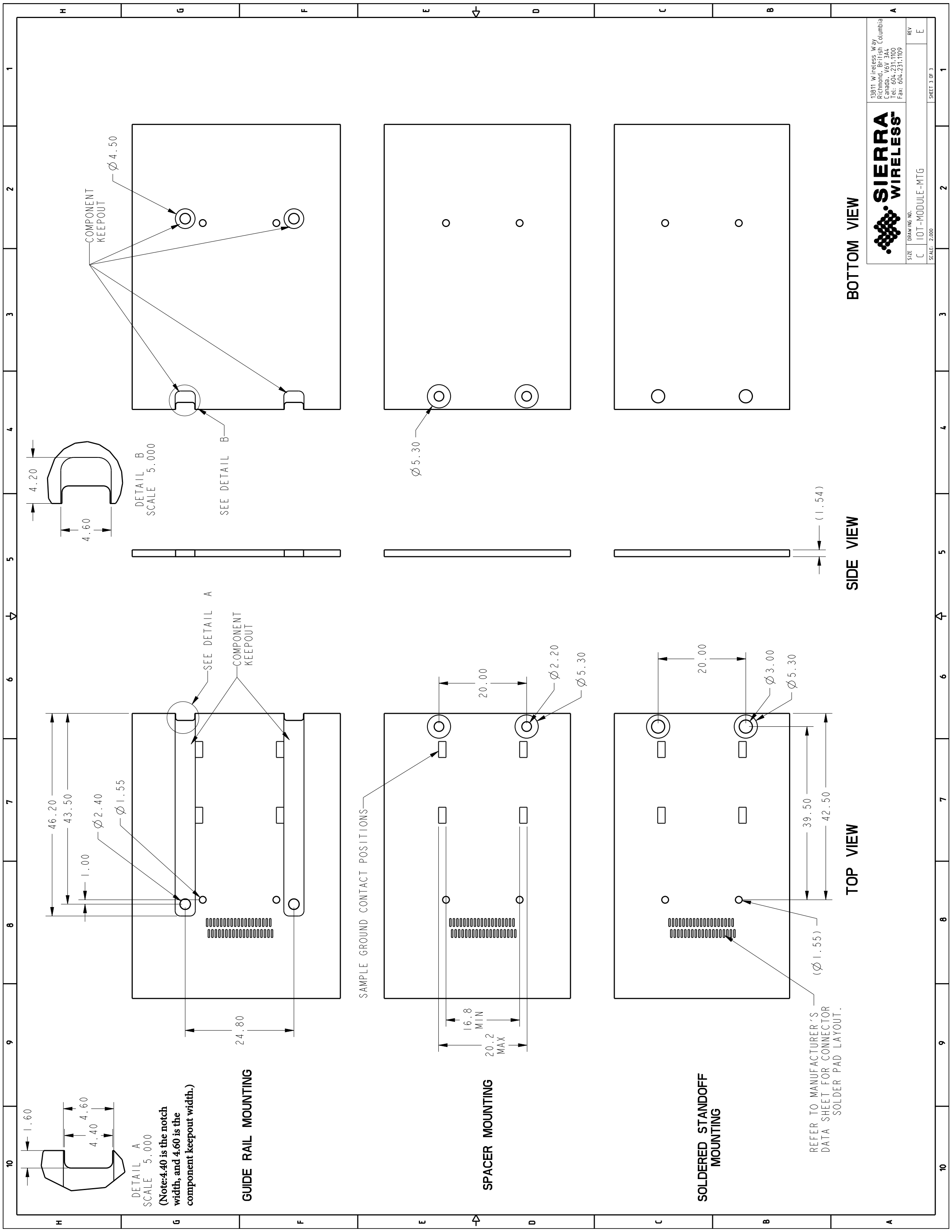

Figure 5-3: Connector-side Mounting Details (Single-width Connectors)

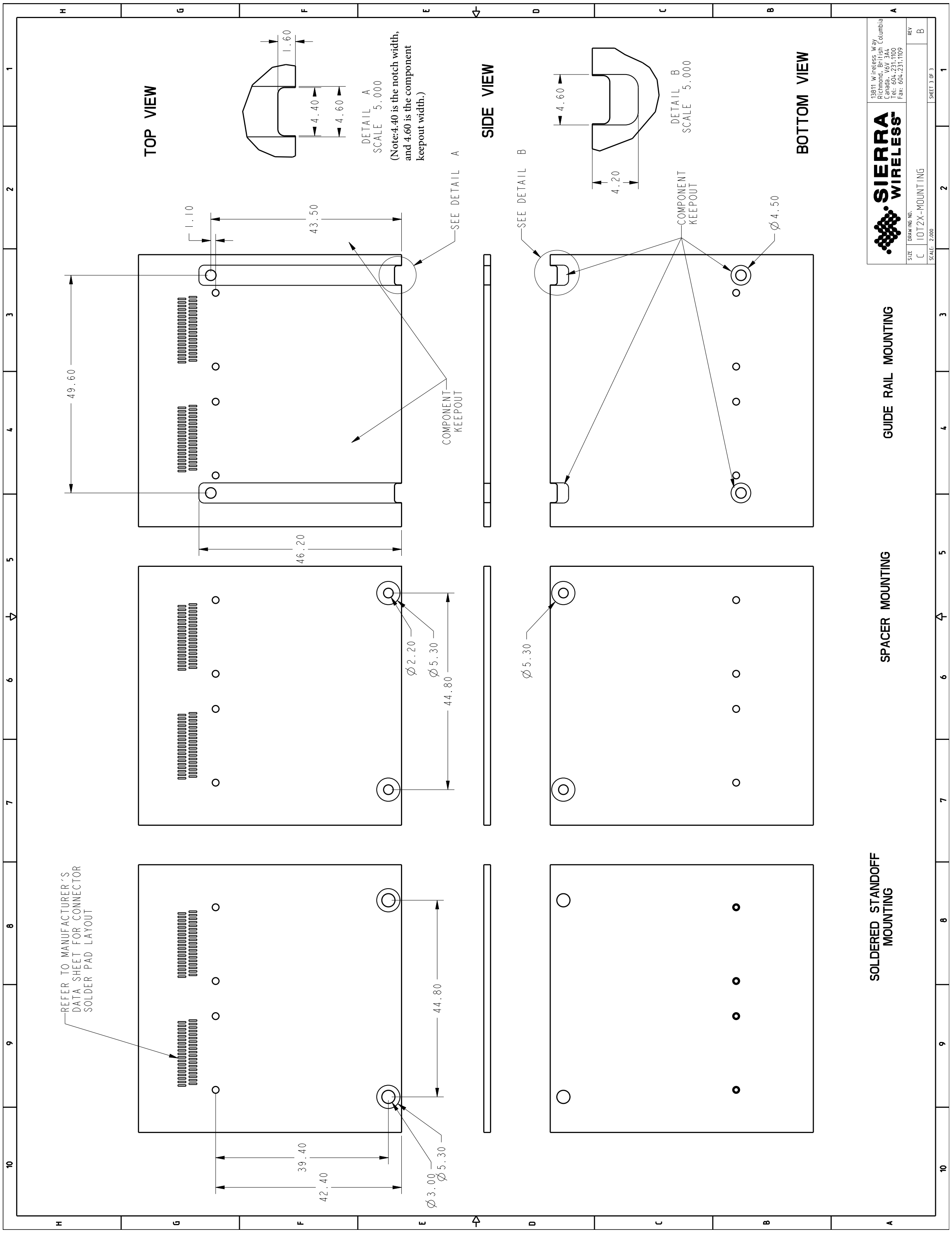

Figure 5-4: Connector-side Mounting Details (Double-width Connectors)

5.2 Self-enclosed IoT Connector

When designing an IoT Connector, you may want to consider enclosing the PCB in a 'box'. This would make the connector less susceptible to incidental damage while storing, handling, and installing.

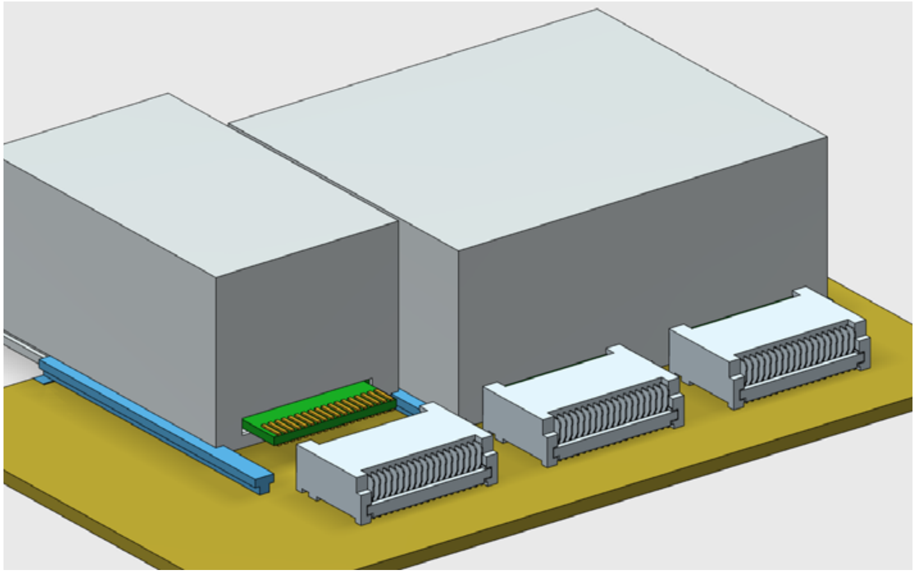

Figure 5-5: Enclosed ('Box') IoT Connector Concept—Rear View

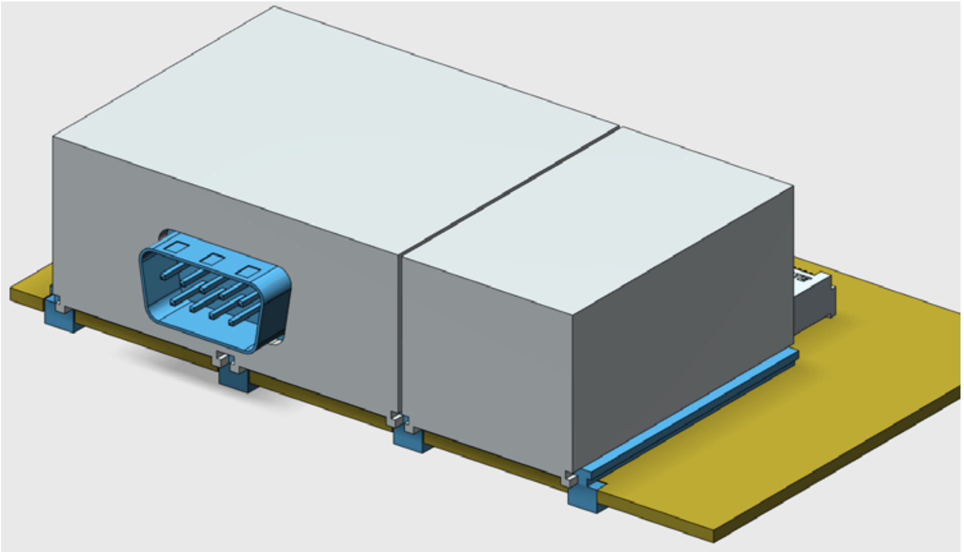

Figure 5-6: Enclosed ("Box") IoT Connector Concept—Front View

5.3 ESD Protection

IoT Connector mounts on the host application require ground protection appropriate to the mounting method:

- Mounting screws—Either ground the mounting screws, or install grounding clips as described below.
- IoT Connector rails—Install grounding clips as described below.

5.3.1 Grounding Clips

IoT Connectors are designed with copper strips on their bottom side as shown in Figure 5-8 on page 40. A host application can use these strips for grounding by installing grounding clips as shown in Figure 5-7 on page 39. (ITT Cannon Universal Contact, 4mm, part #120220-0206, or equivalent)

When the connector is connected to the host, the grounding clips are in contact with the connector's copper strips, thus providing protection against ESD zap.

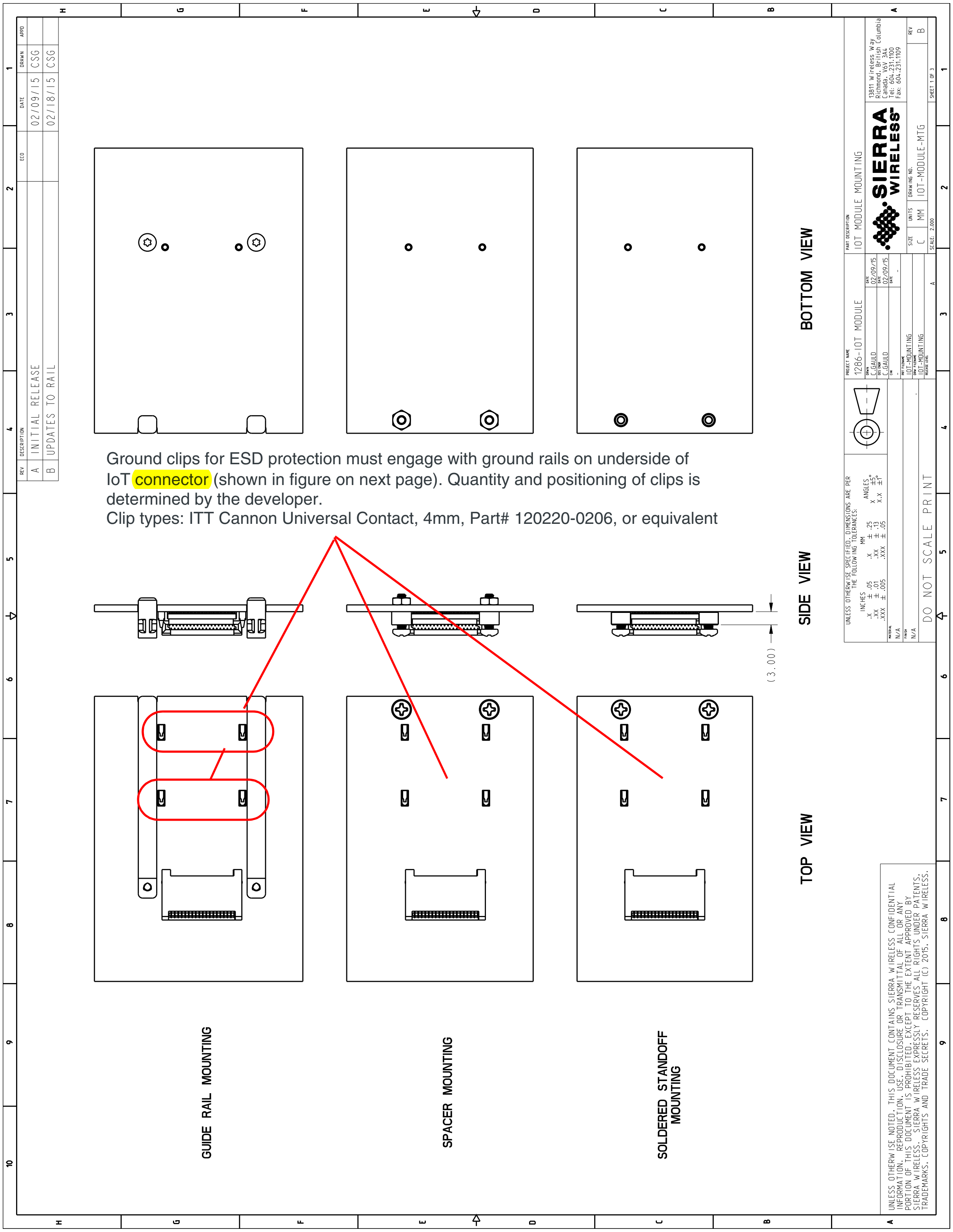

Figure 5-7: Host-side ESD Protection

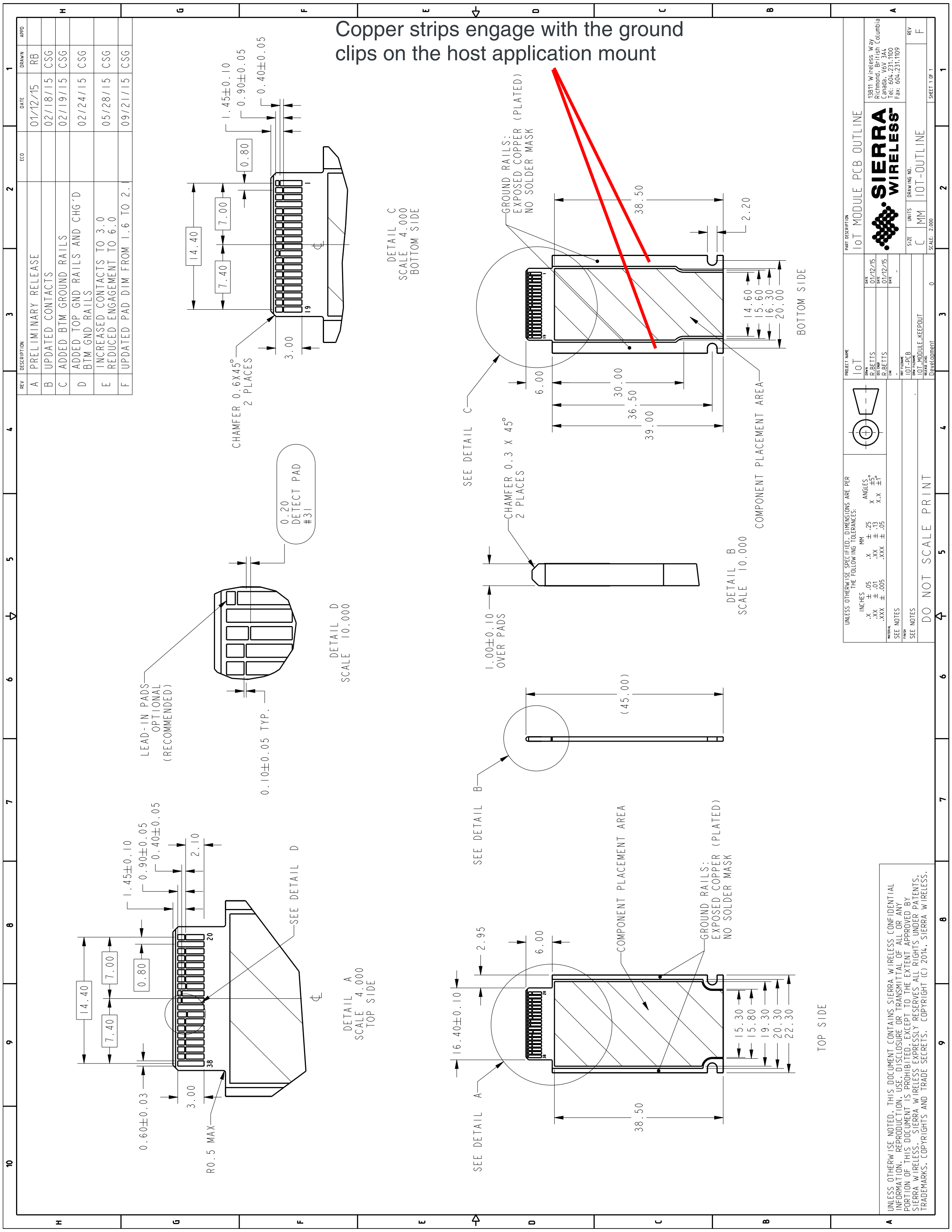

Figure 5-8: IoT Connector ESD Protection

6: Pinout

6.1 Overview

The system interface of the IoT Connector is through the gold-plated contacts on the end of the connector (19 on bottom, 19 on top).

6.2 Pin Configuration

Figure 6-1 illustrates the IoT Connector's edge connector pin locations.

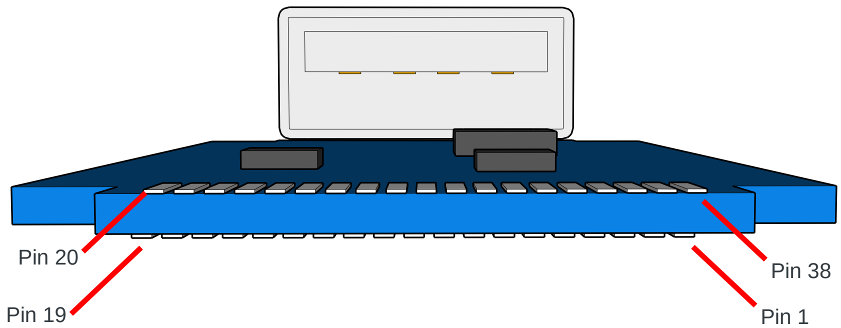

Figure 6-1: IoT Connector Edge Connector Pin Locations

Figure 6-2 illustrates the pin configuration.

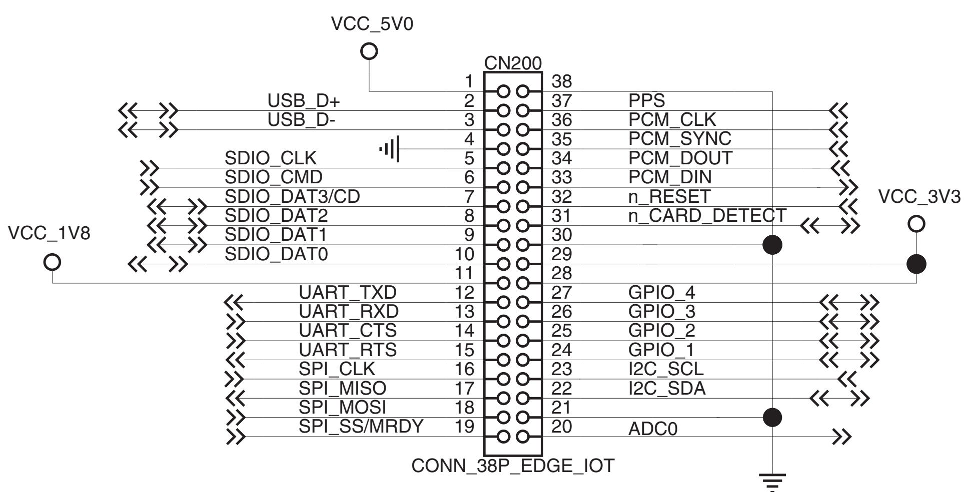

Figure 6-2: Edge Connector (USB/SDIO) Schematic—Connector View

6.3 Pin Definitions

Table 6-1 lists detailed information for the IoT Connector's pin connector.

Table 6-1: Pin Definitions

Pin	Group	Signal name	Function	Voltage/Current	I/O[a]
Connector bottom side					
1	Power	VCC_5V0	USB power supply/5V power supply	5.0V, 500mA	I
2	USB	USB_D+	USB Data positive	See ([3] Universal Serial Bus Specification, Revision 2.0)	I/O
3	USB	USB_D-	USB Data negative	See ([3] Universal Serial Bus Specification, Revision 2.0)	I/O
4	Power	GND	Ground		-
5	SDIO	SDIO_CLK	SDIO Clock	See footnote[b]	I
6	SDIO	SDIO_CMD	Command/Response	See footnote[b]	I
7	SDIO	SDIO_DAT3/CD	Data 3/Card Detection	See footnote[b]	I/O
8	SDIO	SDIO_DAT2	Data 2	See footnote[b]	I/O
9	SDIO	SDIO_DAT1	Data 1	See footnote[b]	I/O
10	SDIO	SDIO_DAT0	Data 0	See footnote[b]	I/O
11	Voltage reference	VCC_1V8	GPIO voltage output	1.8V ±10%	I
12	UART	UART_TXD	UART Transmit data	1.8V ±10%	O
13	UART	UART_RXD	UART Receive data	1.8V ±10%	I
14	UART	UART_CTS	UART Clear to Send	1.8V ±10%	I
15	UART	UART_RTS	UART Ready to Send	1.8V ±10%	O
16	SPI	SPI_CLK	SPI clock	1.8V ±10%	I
17	SPI	SPI_MISO	SPI master RX data	1.8V ±10%	O
18	SPI	SPI_MOSI	SPI master TX data	1.8V ±10%	I
19	SPI	SPI_SS/MRDY	SPI Slave Select/Master Ready	1.8V ±10%	I
Connector top side					
20	Analog	ADC0	Analog to Digital Converter	1.8V max	O
21	Power	GND	Ground		-
22	I2C	I2C_SDA	I2C Tx/Rx data	1.8V ±10%	I/O
23	I2C	I2C_SCL	I2C Clock	1.8V ±10%	I
24	GPIO	GPIO_1	General purpose I/O	1.8V ±10%	I/O

Table 6-1: Pin Definitions (Continued)

Pin	Group	Signal name	Function	Voltage / Current	I/O[a]
25	GPIO	GPIO_2	General purpose I/O	1.8V ±10%	I/O
26	GPIO	GPIO_3	General purpose I/O	1.8V ±10%	I/O
	SPI	SPI_SRDY	SPI Slave Ready		O
27	GPIO	GPIO_4	General purpose I/O	1.8V ±10%	I/O
28	Power	VCC_3V3	3.3V	3.3V ±10%, 500mA	I
29	Power	VCC_3V3	3.3V	3.3V ±10%, 500mA	I
30	Power	GND	Ground		-
31	DETECT	n_CARD_DETECT	Card detect: Active low detect	1.8V ±10%	I/O
32	Reset	n_RESET	Reset connector	1.8V ±10%	I
33	PCM	PCM_DIN	PCM Data IN (Input to Host)	1.8V ±10%	O
	I2S	I2S_IN	I2S Data In (Input to Host)		O
34	PCM	PCM_DOUT	PCM Data OUT (Output from Host)	1.8V ±10%	I
	I2S	I2S_OUT	I2S Data Out (Output from Host)		I
35	PCM	PCM_SYNC	PCM Synchronization	1.8V ±10%	I
	I2S	I2S_WS	I2S Word Select		I
36	PCM	PCM_CLK	PCM Clock	1.8V ±10%	I
	I2S	I2S_CLK	I2S Clock		I
37	Clock	PPS	Stratum Clock 1	1.8V ±10%	I
38	Power	GND	Ground		-

a. Direction with respect to IoT Connector
b. SDIO card: 2.7–3.6V; Embedded SDIO device: 1.7–-1.95V or 2.7–3.6V. See ([4] SD Specifications Part E1 SDIO Simplified Specification, Version 3.00 for details.

7: References

For more details, see the references listed below.

7.1 Web Site Support

Check the Sierra Wireless Developer Zone at source.sierrawireless.com for the latest documentation available for the IoT Connector.

7.2 Reference Documents

[1] High-Speed Inter-Chip USB Electrical Specification, Version 1.0 (a supplement to the USB 2.0 specification)

[2] Legato.io for Legato API details

[3] Universal Serial Bus Specification, Revision 2.0

[4] SD Specifications Part E1 SDIO Simplified Specification, Version 3.00

[5] RS232 Interface Specification

[6] I^{2}C Specification

[7] SFF-8436 Specification for QSFP+ 10 Gbs 4X Pluggable Transceiver (EIA-964 Rev 4.8, October 31, 2013)

A: Abbreviations

A

Table A-1: Acronyms and definitions

Acronym or term	Definition
3GPP	3rd Generation Partnership Project
ADC	Analog to Digital Converter
Bluetooth	Wireless protocol for data exchange over short distances
CLK	Clock
CPU	Central Processing Unit
CTS	Clear To Send
DC	Direct Current
DCD	Data Carrier Detect
EEPROM	Electrically Erasable Programmable Read-Only Memory
EMC	Electromagnetic Compatibility
ESD	Electrostatic Discharges
ETSI	European Telecommunications Standards Institute
GND	Ground
GNSS	Global Navigation Satellite Systems (GPS, GLONASS, BeiDou, and Galileo)
GPIO	General Purpose Input Output
Host	The device into which an IoT Connector is inserted
Hz	Hertz = 1 cycle/second
I/O	Input/Output
I2C	Inter-Integrated Circuit
I^2S	Inter-IC Sound
IoT	Internet of Things
kHz	Kilohertz = 10e3 Hz
LAN	Local Area Network
LPRF	Low-Power RF
LPT	Latchup Protection Technology
M2M	Machine to Machine
MHz	Megahertz = 10e6 Hz
OEM	Original Equipment Manufacturer—a company that manufactures a product and sells it to a reseller.

Table A-1: Acronyms and definitions (Continued)

Acronym or term	Definition
PAN	Personal Area Network
PCB	Printed Circuit Board
PCM	Pulse Code Modulation
PPS	Pulse Per Second
RTS	Request To Send
RX	Receive
SDIO	Secure Digital Input/Output
SPI	Serial Peripheral Interface
TBC	To Be Confirmed
TBD	To Be Determined
TX	Transmit
UART	Universal Asynchronous Receiver-Transmitter
USB	Universal Serial Bus
VCC	Supply voltage
WAN	Wide Area Network