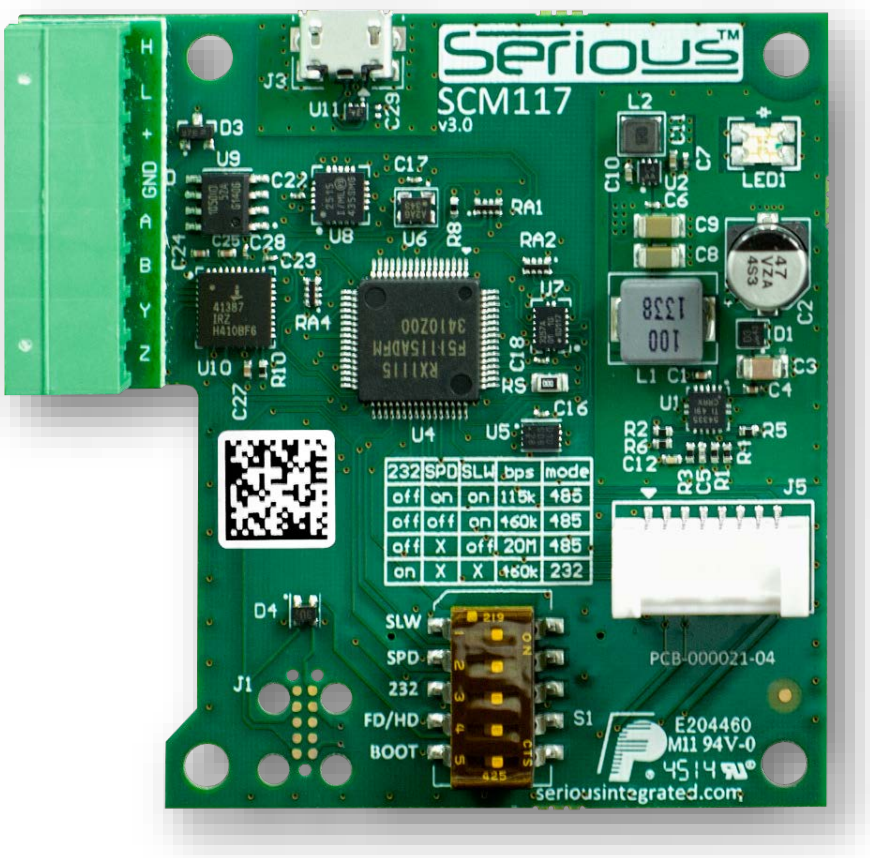
SCM117

Technical Reference Manual



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CONTENTS

DOCUMENT INFORMATION AND APPLICABLE PRODUCTS

CHANGE HISTORY AND APPLICABLE PRODUCTS

The following table summarizes major changes to this document and the applicable versions of the product corresponding to this document:

Doc Rev	Date	HW Rev	PCB Rev	Major Changes
A0	01 Oct 13	**1.0**	**01**	• Initial advance version
A1	05 Oct 13	**1.0**	**01**	• Added USB device, PCB edge sections • Internal review complete
B0	28 Feb 14	**2.0**	**02**	• PCB Edge replaced by TC2070 • Added SIM Pass-thru SHIP Programming Port (SPP) • RX111 48 to 64 pin version to get back missing UART • Removed **SIM_PWRDWN#** control • USB and JST16 now only on A00 variant (not A01/A02) • Noted 750kbps limit on CAN MCP2515 • Fixed **S1.4** half/full duplex polarity • Added **SIM_3V3_DOCK** and **SIM_3V3_DOCK** sensing
B1	31 Mar 14	**2.0**	**03**	• Updated with production photos
B2		**2.0**	**03**	• Added section describing how to reset the attached SIM

C0	20 JAN 15	**3.0**	**04**	• Updated content to reflect SCM117 v3.0
				  ◦ RSXXX & CAN connectors now Industrial Networking Connector
				  ◦ +VIN_CAN and +VIN_UART now +VIN
				  ◦ Debug connector now TC2050 and uses new RX FINE adapter
				• Expanded explanations of bypass mode
				• Expanded clarity of 2-wire RS4XX mode for PLC connections

DOCUMENT CONVENTIONS

This symbol indicates an advanced tip for hardware or software designers to extract interesting or unique value from the product.

Pay special attention to this note – items especially subject to change, or related to compatibility, functionality, and usage.

WARNING: You can damage your board, damage attached systems, overheat or cause things to catch fire if you do not heed these warnings.

Notes with this symbol are related to license and associated legal issues you need to understand to use this software. We're big believers in honoring license agreements, so please help the industry by respecting intellectual property ownership.

Some hardware features may be preconfigured or permanently reserved for use by the SHIPEngine software (the GUI management engine component of the Serious Human Interface™ Platform). Notes with this symbol indicate where the module comes pre-configured or uses these resources.

INTRODUCTION

The SCM117 Serious Communications/Power Module family is a series of flexible and production-worthy communications and power conversion accessory boards for use with Serious Integrated Modules (SIMs). The SCM117 can dock directly into newer SIMs such as the SIM115, SIM231, and SIM535 forming a low profile and cost effective combination. With other SIMs, such as the SIM110 and SIM225, a simple wire harness can interconnect the SCM117 with the SIM.

SCM117 v3.0 Docked into SIM231

The SCM117's most basic functionality is to provide network physical layer transceivers from the network cabling (RS232, RS485, RS422, or CAN) to the SIM, as well as network power conversion from whatever voltage (+9-25VDC) is available on the network cabling to the 5VDC required by the SIM.

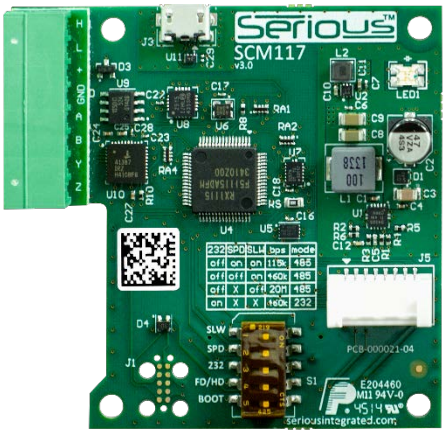
The SCM117 family has numerous members, or "variants", implementing all or a subset of the following hardware capabilities:

- Line transceivers for the RS232, RS422, RS485, and CAN protocols
- Renesas RX111 MCU for local protocol translation and control
- DC-DC converter for powering the SCM and attached SIM from most network-borne power

Variants without the RX111 MCU rely completely on the SIM to transmit and receive the specific protocol on the network, communicating directly through the network transceivers on the SCM117.

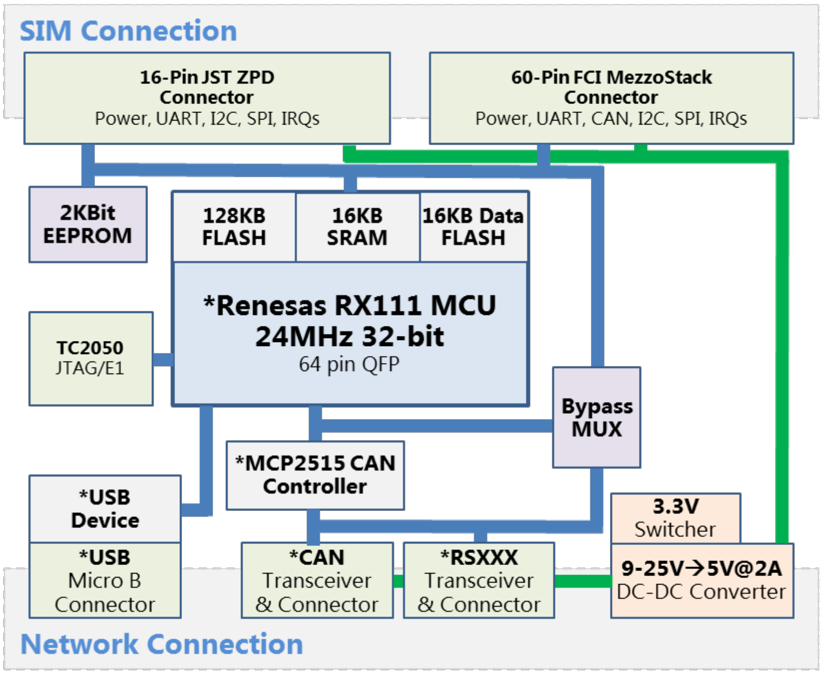
Variants with the RX111 MCU, in contrast, optionally place the RX111 in the middle of this conversation: the RX111 can communicate with the SIM using one protocol (for example, Modbus or SHIP Bridge) and another protocol on the network (for example, your own proprietary protocol).

HARDWARE OVERVIEW



The SCM117 family variants include some or all the following hardware features:

- Board-to-board direct attach to SIM115, SIM231, SIM535
- Wire-harness attach to all SIMs
- Installer-friendly, industrial connector
- Renesas RX111 MCU for protocol/network translation
- +9-25VDC to +5VDC @ 2A DC-DC converter
  - Powers both the SCM and attached host SIM
  - Accommodates Programmable Logic Controller (PLC) standard 24VDC power supplies
- Multi-mode RS232/RS422/RS485 transceiver
  - Half and full duplex
  - Differential and single ended operation
  - Switch selectable RS232 vs. RS4xx mode
  - Switch selectable slew rate control
- CAN transceiver
- MCP2515 CAN Controller (with RX111)
  - Up to 750kbps line rate
- -40 to +85C operating temperature



SCM117 Hardware Block Diagram
*options depend on variant

USAGE MODELS

The SCM117 is designed to operate in conjunction with, and as an accessory to, a Serious Integrated Module (SIM).

All SCM117 variants (family members) are designed to take 9-25V from an outside power source, often an industrial network, and convert it down to the 5V required by the SCM117 as well as the attached SIM.

The SCM117 also provides the appropriate network transceivers for CAN, RS485, RS422, and/or RS232, converting logic levels on the SIM/SCM to corresponding network levels.

SCM117 variants which have the Renesas RX111 MCU populated (e.g. variants A00, A01, and A02) are designed to act as intelligent protocol converters. This is the most common use of the SCM117. On one side of the RX111 MCU, the SCM117 communicates to the SIM using the Modbus or SHIPBridge protocol over SPI or UART. On the other side of the RX111 MCU, it communicates the appropriate messages to the OEM's proprietary protocol on a CAN, RS232, or RS485 network.

Less commonly, variants without the RX111 MCU are designed to have the SIM operate the protocols directly and the SCM117 act purely as a network interface and power supply.

SIMs running the SHIPEngine software (the GUI management engine component of the Serious Human Interface™ Platform) can communicate using the Modbus or SHIPBridge protocols over the SPI or UART connecting the SIM to SCM117. The SCM117 can then translate this protocol to an OEM custom network protocol over CAN/RS232/422/485 using OEM custom software on the RX111 MCU.

CONNECTING SCM117 TO SIMS

In the most compact and common configuration when used with newer SIMs (e.g. SIM115, SIM231, and SIM535) the SCM117 can dock directly into the back of the SIM using a low profile board-to-board connector on the SIM and requiring no cable harness or special tools. This dock connector carries UART, SPI, I2C, RESET#, and input 5V power to the SIM as well as several other signals.

Four screws (provided) fasten the SCM117 and the SIM together.

In some systems configurations, and with SIMs without this docking connector (e.g. SIM225), some SCM117 variants have a 16-pin wire-harness-friendly JST connector that can be used to connect a subset of these signals to the target SIM.

NETWORK TRANSCEIVER + POWER USAGE MODEL

When the SCM117 variant has no MCU on-board it acts as a simple power source adapter – taking in +9-25V from the network and supplying 5V to the SIM – as well as the transceivers for the physical layers of CAN, RS422, RS485, and/or RS232. In this configuration, the SIM's MCU is responsible for all network management including data and protocol generation/recognition.

On the network side, for example, you may have a standard RS485, half-duplex, 2-wire RS485 network driven by a Programmable Logic Controller (PLC) operating as a Modbus protocol master node. Typically, 24VDC will also be delivered from the PLC in order to power slave devices on the network. The SCM117-A03 variant has the RS422/485 transceivers available and can connect directly to this network configuration, converting the 24VDC on the network to the 5VDC required by the SCM as well as an attached SIM.

GUIs developed using the Serious Human Interface™ Platform can communicate directly from SIMs to Modbus networks, including a PLC, through an SCM117-A03 without RX111 MCU or an SCM117-A00 or A01 with the RX111 disabled in bypass mode.

INTELLIGENT PROTOCOL TRANSLATION + POWER USAGE MODEL

Nearly all network topologies require some sort of power and communications physical layer transceiver between the network and the device on the network. All SCM117 variants perform this basic functionality. Some variants of the SCM117 family also include a Renesas RX111 MCU. The RX111 is part of a new breed of powerful yet inexpensive 32-bit MCUs, and includes extensive I/O including SPI, I2C, UARTs, and USB device.

With the addition of this inexpensive MCU, these SCM117 variants can also perform protocol translation between the SIM and your unique network. You can leverage the off-the-shelf Serious Human Interface™ Platform (SHIP) binary software engine on the SIM, which communicates via Modbus (or, with SHIP v5, the full-featured Serious SHIPBridge protocol) and still interoperate with your proprietary CAN, RS232, RS422, or RS485 network. *You* control all the software on the SCM117's RX111 MCU – forwarding, translating, and filtering messages between the SIM and your network.

The Micriμm μC/OS-III kernel, μC/Modbus, and μC/CAN stacks have already been ported to the SIM117. Contact *Serious* for details.

There will be reference code available with the upcoming Serious Human Interface™ Platform version 5 release for the Serious Bridge Protocol.

The no-cost SHIPWare source code package downloadable from myserious.com includes the Micrium uC/OS-III kernel and a set of UART, SPI, I2C, and Modbus drivers you can use to write this protocol adaptation layer.

VARIANT OVERVIEW

The SCM117 is a family of communications/power modules. The family includes several standard members, or “variants”, with a specific subset of the family features. As of the time of this document’s date, the standard variants are:

Option	SCM117-	A00	A01	A02	A03	A04
SIM Connectivity						
60 pin board-to-board connector for power/I2C/SPI/UART connectivity		✓	✓	✓	✓	✓
16 pin wire harness connector for SIM Power/I2C/SPI/UART connectivity		✓				
Power						
+9-25VDC to 5V @ 1.5A DC-to-DC converter		✓	✓	✓	✓	✓
Local Processing						
Renesas RX111 MCU for protocol adaptation and management		✓	✓	✓		
MCP2515 CAN controller to 750kbps when RX111 is controlling the CAN transceiver		✓		✓		
Network Connectivity						
USB device circuitry		✓				
USB device micro-B connector		✓				
CAN transceiver with 4 pin connector		✓		✓		✓
RS232/485/422 multi-mode transceiver full/half duplex single/differential support slew rate control		✓	✓		✓	
Pluggable network connector size		8	6	4	6	4

APPLICABLE HOST PRODUCTS

The SCM117 does not operate in a stand-alone fashion; it must be physically attached to a Serious Integrated Module. All SCM117 variants have the following compatibility/features as follows:

SCM117 Feature	**SIM**					
	110	115	205	225	231	535
Board-to-Board compatible		✓			✓	✓
Wire-to-Board compatible	✓	✓	✓	✓	✓	✓
Can power SIM	✓	✓	✓	✓	✓	✓
CAN (direct from SIM)		✓			✓	✓
RS485/422/232 (from SIM)	✓	✓	✓	✓	✓	✓

SCM117 VARIANTS WITH MCU

When the SCM117 variant includes the on-board Renesas RX111 MCU, the RX111 is typically responsible for protocol translation and network connection management. The following compatibility matrix shows which SCM117 additional features for these MCU-equipped variants are available when used with various SIMs:

SCM117 Feature	**SIM**					
	110	115	205	225	231	535
SIM to SCM RX111 UART	✓	✓	✓	✓	✓	✓
SIM to SCM RX111 I2C		✓			✓	✓
SIM to SCM RX111 SPI		✓			✓	✓
CAN (from SCM RX111/MCP2515)	✓	✓	✓	✓	✓	✓
RS485/422/232 (from SCM RX111)	✓	✓	✓	✓	✓	✓

SOFTWARE

SOFTWARE ON THE SERIOUS INTEGRATED MODULE

The SCM117 is designed to operate as an accessory to a Serious Integrated Module running a graphical user interface (GUI).

For GUI development in as little as a few days, the Serious Human Interface™ Platform (SHIP) offers PC-based GUI design tools and rapid GUI prototyping, development, and deployment. With minimal coding, you can create attractive and functional GUIs in a fraction of the time of traditional C-based development. Included in SHIP are communications facilities that can be used with the SCM117.

In SHIP Version 5 (SHIPv5), the Modbus protocol is available over UART and SPI connections to the SCM117. In addition to Modbus, the SIM can also communicate using the new SHIPBridge protocol. SHIPBridge affords much greater communications and control capability than Modbus, including over-the-wire GUI and SIM firmware updates and over-the-wire access to on-SIM file systems such as a thumb drive plugged into a SIM’s USB port. See www.seriousintegrated.com/SHIP for details.

More traditional development of the SIM GUI, using graphics libraries in C in conjunction with an RTOS such as Micrium uCOS-III, Segger embOS or FreeRTOS, can enable more extensive use of the hardware features of the SIM and vast applications flexibility at the expense of significantly longer development time and higher R&D expense. *Serious* fully supports this development methodology with our partners: for more information see www.seriousintegrated.com/oob.

SOFTWARE ON THE SCM117

For SCM117 variants without an RX111 MCU, there is no software capability on the SCM117. For those variants with the RX111, development is easy and inexpensive using the no-cost Renesas e2Studio IDE and KPIT GNU compiler. For more information on setting up this environment see www.seriousintegrated.com/oob.

Developing for the RX111 requires both a debugger/programmer, such as the Renesas E1 or Segger J-Link as well as a Tag-Connect TC2050 Cable with RX111 FINE Adapter. The SCM117 Development Kits includes both these items.

⚠ Reference source code for the SCM117 is available from *Serious.* Check the community forums for registered hardware owners at mySerious.com or contact *Serious.*

ORDERING INFORMATION

DEVELOPMENT KITS

The SCM117-A00-SJL-01 development kit contains everything (except the graphic/touch SIM) needed to develop with SCM117 family.

The kit contains:

- SCM117-A00 module
  - Superset of all SCM117 features
  - Renesas RX111 MCU
  - MCP2515 CAN Controller, CAN Transceiver
  - RS232, RS485/422 Transceiver
  - +9-25V input power
- Debugging/Programming
  - Segger J-Link Lite RX JTAG debugger/programmer
  - Tag-Connect TC2050 Cable with RX111 FINE Adapter for connecting the J-Link or Renesas E1 debugger to the SCM117
- Lab use 12V power supply
  - 12V 10W wall power supply for lab use (EU/US voltage and plug compatibility)
  - Adapter has either stripped cable ends or includes barrel to screw terminal power jack adapter depending on availability
- Connectivity hardware
  - 16 pin wire harness (JST16 plug one end, tinned the other) for lab cable enabling
- Fasteners/Hardware
  - Board-to-board mounting screws (4x M3 Nylon) for docking SCM117 into a SIM or standalone use with standoffs
  - 10mm standoffs (4x 10mm M3 Nylon) for standalone use
  - Adhesive rubber feet (4) for standalone use

There is no specific kit that includes both a SIM and an SCM117, and you will want to order the SIM kit most appropriate for your application. For example, for 4.3" WQGA front panel applications, the SIM231-A01-R32ALM-01 (or the dev kit version SIM231-A01-DEV-01) may be a good choice.

STANDARD PRODUCTS

The SCM117-A00-SJL-01 development kit contains everything (except the graphic/touch SIM) needed to develop with SCM117 family and is available only in a single unit package.

For production and larger quantities, the following standard SCM117 products are available:

Variant	Ordering Code			Distributor Inventory	
	Individual Unit	10 Pack	50 Pack		
SCM117-A00		**SCM117-A00-10**	**SCM117-A00-50**	Arrow	Digi-Key
SCM117-A01		**SCM117-A01-10**	**SCM117-A01-50**	Arrow	Digi-Key
SCM117-A02		**SCM117-A02-10**	**SCM117-A02-50**	Arrow	Digi-Key
SCM117-A03		**SCM117-A03-10**	**SCM117-A03-50**	Arrow	Digi-Key
SCM117-A04		**SCM117-A04-10**	**SCM117-A04-50**	Arrow	Digi-Key

See the variant table for detailed information on features per variant.

SEMI-CUSTOM PRODUCTS

The Serious Custom Services team may be able to provide a customized version of the SCM117 for certain OEM designs, or even a product similar to the SCM117 that directly meets a unique interconnect need.

For example, the Services team could deliver an optimized dual RS485 over RJ45 version of the SCM117 under a customer-specific part number, but based on the SCM117 form factor and design, perhaps with a barrel jack power input.

Another example might be a semi-custom variant of the SCM117. Your design may require the SCM117-A02 feature-set but also need the USB device port. Serious could, for example, create an "SCM117-A06" or equivalent with this feature-set populated.

Contact your local *Serious* Manufacturers Representative or *Serious* directly for more information.

GETTING STARTED

CONNECTING THE SCM117 TO A SIM

There are two ways the SCM117 can connect to the SIM: through the direct board-to-board connector and using a connector with a wire harness.

Ensure power is not connected to the SIM or SCM when connecting them together.

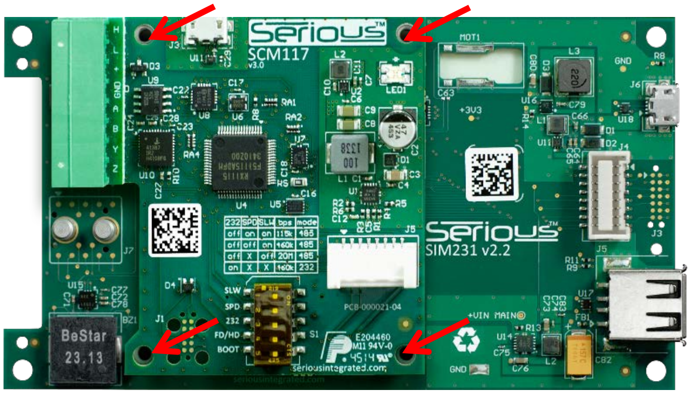
DOCKING: DIRECT BOARD-TO-BOARD ATTACH

For some SIMs (see the Applicable Host Products tables), for example the SIM231, the SCM117 can attach directly (both mechanically and electrically) to the SIM.

Orient the SCM117 such that the 60 pin connector on the back of the SCM aligns with the identical mating connector on the SIM. The connector can only be plugged in one way; it is polarized.

Some SIMs may have multiple 60-pin connectors.
Ensure you connect into the correct one or damage to the SIM and SCM may occur.
Consult the Technical Reference Manual of the specific SIM if you are unsure.

When correctly aligned, you should see the 4 stand-offs/mounting holes on the SIM align perfectly with the corresponding mounting holes of the SCM:

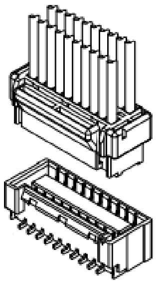


Using four machine screws gently fasten the SCM117 into the SIM’s standoffs. These M3-0.50 screws should be no more than 6mm in length.

Do not over tighten the screws or you may damage the SIM.

Using screws longer than 6mm can damage the LCD on the SIM.

ATTACHMENT USING A WIRE HARNESS



Most SIMs have some form of wire harness compatible connector. For example the SIM225-A03 has a 7 pin JST GH series connector on the board which exposes the primary SIM UART as well as can supply power to the SIM. SIMs released prior to 2014 contain this 7-pin connector – consult the applicable Technical Reference Manuals for details and signal diagrams. More recent SIMS, such as the SIM231, SIM115, and SIM535, have a slightly larger 16-pin JST ZPD series connector that goes beyond those signals present on the 7-pin version, adding I2C, SPI, interrupt signals, and more.

Both the 7-pin and 16-pin connectors are polarized and have a retention locking mechanism.

When using a wire harness to join the SCM to the SIM, the two boards are physically separated when mounted in your own enclosure. The four mounting holes on the SCM117 are designed for a M3 or #4 machine screws (see Physical Characteristics).

The SIM to SCM wire harness must be made to connect the appropriate signals between the two boards. See Power/SIM Wire-to-Board Connector for details and suggestions for this cable. SCM117 development kits contain a "JST16 to tinned-end" cable for experimentation in your lab.

Gently plug/unplug the wire harness connectors to avoid damage to the SIM/SCM.

POWERING THE SCM117+SIM

When the SCM117 is connected to the SIM (docked or via wire harness), the SCM is designed to power itself as well as the attached SIM.

Most SIMs have numerous ways to apply power; ensure the SCM is going to be the only power provider to avoid possible damage to the SCM, SIM, or attached power sources.

The simplest way to power the assembly is to wire the network supplied power (+9-25VDC 10W), such as a Programmable Logic Controller's 24VDC power supply, into the power input terminals of the SCM117's Industrial Networking Connector.

Pay careful attention to the polarity of the power input. It is not protected against reverse voltage and miswiring will damage your SCM117 and any attached SIM.

Development kits for the SCM117 may include a standard 110/220VAC wall power adapter to be used in the event that network power is unsuitable or unavailable in the lab environment. This standard wall adapter may have simple stripped ends for insertion into the Industrial Networking Connector.

In some kits, the power supply may terminate in a common barrel plug that has no direct means of connecting to the SCM117. Using the Barrel Power Jack Adapter included in these kits you can attach jumper wires from the adapter to the power inputs on the SCM117.

SPECIFICATIONS

MAXIMUM OPERATING LIMITS

The SCM117 maximum operating power limits are as follows:

Specification	Permissible Range			
	Min	**Typ**	**Max**	**Units**
Power				
Input Voltage **+VIN**	9*		25*	VDC
Input Power **+VIN**			12*	W
Output Voltage to SIM (**+5V**)	4.75	5.00	5.25	VDC
Output Current to SIM (**+5V**)			2000*	mA

*preliminary and subject to final production characterization.

For detailed limits on the RS232/422/485 interface, consult the Intersil ISL41387IRZ-T data sheet.

For detailed limits on the CAN interface, consult the Infineon IFX1050GVIO data sheet.

AC TIMING CHARACTERISTICS

The AC timing characteristics at the module level are governed by the underlying AC timing characteristics of the individual components. Consult the component data sheets for more information.

NETWORK BIT RATES

When operated from the RX111, the CAN port driven by the MCP2515 is limited to a maximum network bit rate of 750kbps. When driven directly by the CAN port on the SIM (where possible), the CAN network rate is supported up to 1mbps depending on the capabilities of the SIM's CAN controller.

In practice, construction of software drivers and MCU workload (either on the SCM or SIM's MCU depending on which is driving/monitor the port) will control (and often limit) the effective maximum throughput.

ENVIRONMENTAL CHARACTERISTICS

Specification	Permissible Range			
	Min	**Typical**	**Max**	**Units**
Operating Temperature	-40	25	+85	C
Storage Temperature	-40	25	+85	C
Humidity			90% (@60C) Non-condensing	RH

This information is preliminary and subject to final production characterization.

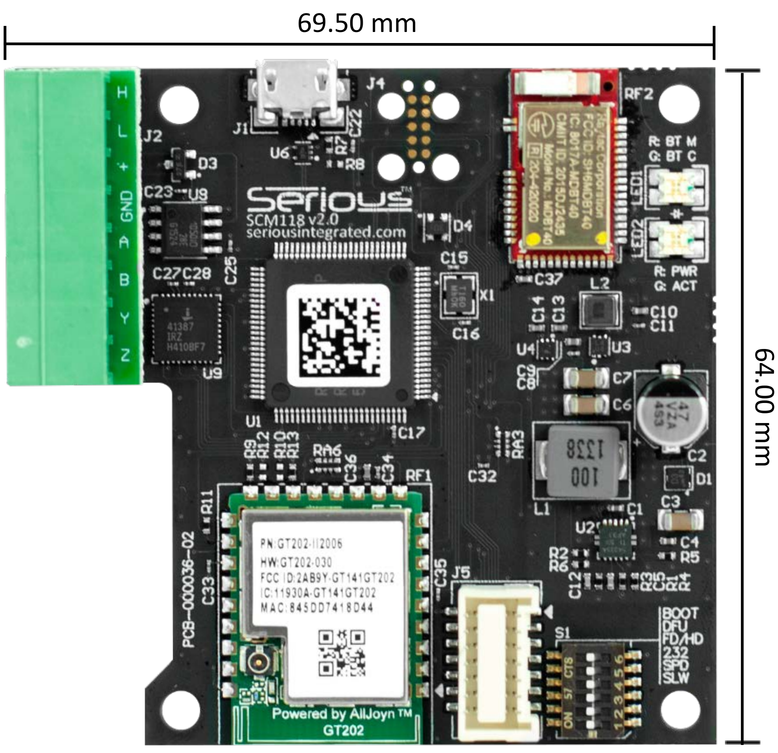
PHYSICAL CHARACTERISTICS

The following table summarizes the key physical characteristics of the SCM117.

Specification	Variant(s)	Typical	Tolerance	Units
Width	All	69.5	0.4	mm
Height	w/USB Micro B	66	0.4	mm
	no USB Micro B	64	0.4	mm
Thickness	A00		0.4	mm
	A01,A02,A03,A04		0.4	mm
Board-to-Board inner dimension when docked	All	4.0	0.2	mm
Weight	A00			g
	A01			g
	A02			g
	A03			g
	A04			g

This information is preliminary and subject to final production characterization.

Mechanical drawings and 3D CAD STEP models are available for most production-focused SIMs and SCMs. Visit www.seriousintegrated.com/docs for more information.



POWER

The SCM117 must be powered from an external +9-25VDC power supply. This supply is efficiently regulated from the 9-25VDC input down to the 5VDC required by both the SCM as well as attached SIM. Locally on the SCM and SIM respectively are further regulation systems from 5V to other required voltages.
The SCM117 **cannot be powered from the SIM**. When SCM117 +9-25VDC input power is not present the SIM may still be able to operate from an external 5V supply to the SIM directly (e.g. the USB device port on a SIM231), however the SCM117 will be held in shutdown mode without the explicit presence of 9-25V input power.

+9-25VDC INPUT POWER

The SCM can accept +9-25VDC from the Industrial Networking Connector, and on the schematics this power input is marked as **+VIN** and **GND**. The **GND** signal on the connector is common to the SIM/SCM system ground.
For current and voltage limits on this input, see Maximum Operating Limits.

+5V MAIN POWER RAIL

+VIN is delivered to the input of the main +9-25V buck DC-DC switching regulator capable of supplying up to 5.0V @ 2A (10W) to the **+5V** main power rail. This regulator typically operates at 90% efficiency and powers all the 5V needs on the SCM as well as supplies the main 5V power required to the attached SIM.

The network side of both the CAN Transceiver and the Multi-mode RS232/422/485 Transceiver are both powered by the +5V supply.

+3.3V REGULATION

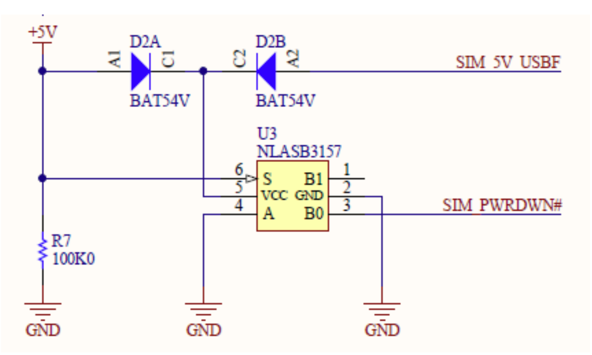
Several circuits on the SCM117 require 3.3V power. The SCM117 does not use the 3.3V supply generated and delivered from the SIM, but rather has its own independent regulator to convert **+5V** to the **+3V3** power signal on the SCM.

SIM USB DEVICE POWER

Some SIMs, for example the SIM231, can be powered exclusively through their USB device port since these SIMs, operating standalone, require less than the 500mA@5V normally available from PC USB ports and powered hubs. It is a common practice with these SIMs to develop their GUIs when they are connected and powered in this fashion. On other (typically larger) SIMs such as the SIM535, the USB device port cannot power the SIM and that input is only used to detect the presence of a USB initial connection.

When the SCM117 is connected, however, even for SIMs that may support stand-alone USB powering, the combined power needs of the SCM117 and SIM is too great for the USB 500mA limit. Therefore, in the absence of the external +9-25VDC on the SCM117 to power the combination, the SIM is held in powerdown mode and will not operate.

This simple circuit (or equivalent), ensures that the SIM is held in power down mode until the external 9-25VDC power input is present.



CONTROLLING AND MONITORING THE SIM (RX111 VARIANTS ONLY)

SIM-RESET#

All SIM's have an open-drain, active-low reset circuit with a pull-up resistor ensuring that, on power-up, the SIM is reset briefly and then allowed to run.

Since the SCM117 is designed to provide power and network connectivity to the SIM, it can also control this SIM RESET circuit from the RX111 (if present). When the RX111 software asserts **P26-SIM_RESET#** (low, active), this SCM signal holds the SIM in RESET until it is de-asserted (high, inactive).

Most SIMs (consult the respective Technical Reference Manual) have a minimum 50mS self-reset period, enabling the RX111 on boot to assert **P26-SIM_RESET#** and hold the SIM in RESET before it has a chance to start running. The SCM can perform any necessary pre-boot operations (such as reading the EEPROM in master mode before switching to slave mode) and then, when appropriate, release the SIM's RESET.

P26-SIM_RESET# can also be monitored by RX111 software to see if the SIM self-resets.

If you use this **P26-SIM_RESET#** capability, do not configure this pin as a push-pull output to avoid potential conflicts with the on-SIM reset circuitry.

The recommended process for resetting the SIM is as follows:

1. Write “1” to the Open Drain Register **PORT2.ODR1.B4** to make **P26-SIM_RESET#** an open drain pin (when made an output)
2. Write “0” to the Port Output Data Register **PORT2.PODR.B6**, so that when it is made an output it will reset the SIM
3. Write “1” to the Port Direction Register **PORT2.PDR.B6** to make it an output
4. Wait 1mS; the SIM will start the self-reset process
5. Write “0” to the Port Direction Register **PORT2.PDR.B6** to make it an input
6. The SIM, in the next 200mS, will come out of reset; you can monitor the Port Input Data Register (**PORT2.PIDR.B6**) to see when this happens

SIM POWER STATUS

The SIM is normally powered by the 5V supply from the SCM117.
The SIM then generates its internal 3.3V supply and makes a small portion of that 3.3V available on the 60 pin docking connector as well as the 16 pin JST wire-to-board connector.
The status of these two 3.3V signals can be read on the RX111 via the signals **SIM_3V3_DOCK** (**PH7**) and **SIM_3V3_JST16** (**P03**) respectively.
Normally, these signals will always read high since the SCM117 has no mechanism to directly control the SIM power. However, in some rare configurations the SIM power (or power-down) may be controlled from some other mechanism and these signals allow for detection of a power-down state.

SIM⇔SCM UART

The RX111 MCU's UART **SCI5** is connected to the SIM's UART present on the JST16 (**J4**) and 60 pin dock (**J1**) connectors with 3 signals:

JST16 J4 #	FCI60 J1 #	SIM UART Function
9	**35**	TXD Transmit Data
11	**37**	RXD Receive Data
13	**40**	TXE# Transmit Enable (half duplex only)

In bypass mode these signals are connected directly from the SIM to the SCM's RSXXX transceiver, completely bypassing the RX111 (if even present).

In non-bypass mode, this SIM UART is connected to the **SCI5** UART on the RX111 MCU and the RSXXX transceiver is connected to a different RX111 UART (**SCI12**).   The RX111 sits in between the two connections, able to provide protocol translation and other intermediary services. For example, the RX111 could talk UART to the SIM, and CAN to the network with a completely different protocol. Or the RX111 could talk one baud rate with Modbus to the SIM as a slave, and another baud rate as a Modbus Master to the network.

In this non-bypass mode, the SIM's UART is connected to the RX111 as follows:

SIM UART Function	RX111
TXD Transmit Data	**PC2/RXD5**
RXD Receive Data	**PC3/TXD5**
TXE# Transmit Enable	**PE4-SIM_TXE**

Note that the TXE# signal incoming from the SIM in this mode is only monitored (if desired) by RX111 software. The actual RSXXX transceiver drive enable is controlled by a different RX111 port (**PE3/RTS12#-RSXXX_DE**).

SIM⇔SCM SPI

Some SIMs (including SIM225, SIM115, SIM231, and SIM535) make an SPI port available for communication with external devices. Consult the specific SIM's TRM for availability and capabilities. When the SCM117 is put in bypass mode these signals are unused on the SCM117.

In non-bypass mode, these signals are connected to the RX111 MCU's SPI port "A". The 5 relevant signals from the SIM are as follows:

JST16 J4 #	FCI60 J1 #	Direction	SIM SPI Function	RX111
14	**22**	SCM⇦SIM	SPI Clock	**P15/RSPCKA-SIM_SPI_SCLK**
12	**24**	SCM⇦SIM	SPI Master Out, Slave In	**PA6/MOSOA-SIM_SPI_MOSI**
10	**26**	SCM⇨SIM	SPI Master In, Slave Out	**PA3/MISIA-SIM_SPI_MISO**
16	**19**	SCM⇦SIM	SPI Slave Select #	**PA4/SSLA0-SIM_SPI_SSEL**
15	**41**	SCM⇨SIM	SPI/I2C IRQ#	**PA1-SIM_IRQ#**

The SIM must be the SPI master and the SCM117 the SPI slave. The SCM117 must only respond to SPI communications when the Slave Select is asserted (active low).

The Serious Human Interface™ Platform v5 release contains built-in support for this SPI communications port using a robust and light framing protocol supporting both Modbus and the Serious SHIPBridge Protocol over SPI. Out of the box, you can communicate from your SIM-based GUI over SPI to your RX111 software, including updating your GUI or SHIPEngine from the network via the RX111!

SIM⇔SCM I2C

Some SIMs (including SIM225, SIM115, SIM231, and SIM535) make an I2C port available for communication with external devices. Consult the specific SIM's TRM for availability and capabilities. This I2C port is always connected to the SCM117's EEPROM. There are no I2C pull-up resistors on the SCM117 – these are provided on the SIM. Therefore the I2C bus (and EEPROM) cannot be used when the SCM117's I2C signals are not connected to a SIM.

These signals are connected to the RX111 MCU's I2C port "0". The 3 relevant signals from the SIM are as follows:

JST16 J4 #	FCI60 J1 #	Direction	SIM I2C Function	RX111
6	**39**	SCM⇦SIM	I2C Clock	**PB0/SCL0-SIM_I2C_SCL**
8	**42**	SCM⇔SIM	I2C Data	**P17/SDA0-SIM_I2C_SDA**
15	**41**	SCM⇨SIM	SPI/I2C IRQ#	**PA1-SIM_IRQ#**

When the SIM is not in reset, the SIM must be the I2C master and the SCM117's RX111 MCU the I2C slave.

⚠ The I2C bus may be shared on the SIM with many other devices; consult the specific SIM's TRM to ensure the slave address you use on the RX111 does not conflict with any other device on the SIM or the EEPROM on the SCM117.

The Serious Human Interface™ Platform (SHIP) does not currently use the I2C feature of the SCM117, however on most SIMs this I2C port is actively used for other devices from SHIP.

EEPROM

The SIM225 features a 2Kbit (256 byte) On Semiconductor CAT34C02 EEPROM. The EEPROM is an I2C device on the SIM's I2C port and shares an I2C connection with many other devices on the SIM. There are no on-board I2C pull-ups on the SCM117 – the EEPROM is *only* accessible when the SIM and SCM are connected as the SIM provides the needed I2C pull-ups.

Since the SCM's RX111's I2C port to the SIM is designed to be an I2C *slave* device (to the SIM's I2C Master), this EEPROM is inaccessible in normal operation to the RX111 as the RX111 cannot master the I2C bus when the SIM is performing that function. However the RX111 can be operated in master mode temporarily when the SIM is in RESET# in order for the RX111 to access the EEPROM. Since the RX111 can control the SIM's RESET# line, the RX111 can hold the SIM in RESET on boot, read/write the EEPROM in master mode, flip the I2C to slave mode, then release the SIM from RESET.

Consult each SIM Technical Reference Manual for a list of the on-SIM I2C devices and their addresses. The EEPROM's address bits are hard coded on the module to **`001`** yielding a 7-bit I2C address of **`0x51`** with write command **`0xA2`** and read command **`0xA3`**. Consult the CAT34C02 Data Sheet for programming and hardware information.

SERIALIZATION AND VARIANT/VERSION IDENTIFICATION

The EEPROM contains a small one-time programmable (OTP) region. This region may contain factory-programmed information including the serial number of the unit as well as variant/version information.

Do not write to the EEPROM's OTP region.
This region is reserved for manufacturing and configuration information by *Serious*.
Writing to this area will **void your warranty** with Serious and may render the module unusable.

BYPASS MODE

On variants without the RX111 MCU (e.g. –A03, -A04), the transceivers are always logically directly connected to the corresponding ports on the SIM's MCU. For example, the RSXXX transceiver on a SCM117-A03's receive and transmit are connected to the SIM's UART RxD and TxD pins respectively. In this model, the SIM's UART flows directly through the transceiver to the network and SIM-based software must communicate appropriately.

The Serious Human Interface™ Platform v5 release contains built-in support for this UART through the transceiver using RAW, Modbus and *Serious* SHIPBridge Protocols

GUIs developed using the Serious Human Interface™ Platform can communicate **directly** from SIMs to Modbus networks, including a PLC, through an SCM117-A03 without RX111 MCU or an SCM117-A00 or A01 with the RX111 disabled in bypass mode.

Where supported on the SIM, the CAN transceiver is directly connected to the SIM's MCU's CAN port.

(TBD DIAGRAM)

When the RX111 MCU is present on the variant, the SIM's SPI, UART, and I2C ports flow normally to matching dedicated ports on the RX111. An additional dedicated RX111 UART is connected to the RSXXX transceiver (on RSXXX-equipped variants), and an additional dedicated RX111 SPI port is connected through a CAN controller to a CAN transceiver (on CAN-equipped variants). In this model, the RX111 is the central "hub" managing all the various conversations (to the SIM and the external networks) via a users' custom software. This is the most powerful usage model of the SCM117 where, for example, two conversations can be happening simultaneously with the SIM (e.g. SHIPBridge over SPI and Modbus over UART) and two conversations can be happening simultaneously to the networks (e.g. Modbus over RS485 and a user's proprietary protocol over CAN) – with the RX111 software providing all interoperation and protocol/data translation and mapping.

(TBD DIAGRAM)

If the RX111 is present but you wish to experiment or use the SCM117 as if the RX111 were not (e.g. physically using a SCM117-A00 but wanting the RX111 disabled as if it were an SCM117-A03 or –A04), you can easily "bypass" the MCU and put the circuit in a configuration logically identical to the variants without the MCU.

Signals are routed in this "bypass mode" via a multiplexor controlled by the **P46-BYPASS#** signal. This signal is pulled low weakly, and when low the MCU is bypassed and the transceivers are logically directly connected to the SIM's corresponding ports.

When no software on the MCU configures port **P46**, the port pin floats, and the system is in bypass mode via the pull-down resistor. This is the reset state on variants with the MCU. RX111 software can then configure and assert high the port pin, taking the board out of bypass mode and putting the RX111 MCU in the middle of the conversation(s).

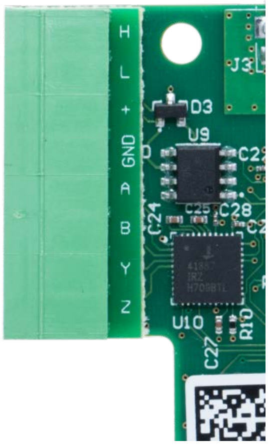
When no RX111 is present on a variant, there is no way on the SCM117 to assert the **P46-BYPASS#** signal high.

Note that DIP Switch S1.5, when in the "ON" position, puts the MCU (on reset) into a special boot mode. In this mode, **P46-BYPASS#** is not configured, and the SCM117 will remain post-reset in bypass mode.

When you are uncertain if the RX111 MCU software configures and takes the SCM117 out of bypass mode, but you need to use the SCM117 in bypass mode, turn S1.5 ON. This ensures the board will remain in bypass mode regardless of what software is currently installed in the RX111 MCU.

INDUSTRIAL NETWORKING CONNECTOR

All SCM117 variants have an industrial networking connector for attachment to an external CAN and/or RS232/422/485 network as well as the +9-25VDC Input Power source for the SCM+SIM combination.



The connector has at most 8 terminals, labeled on the silk screen and connected as follows:

J2#	Signal	Description
1	H	CAN Network "H"
2	L	CAN Network "L"
3	+VIN	Main +9-25V Power Input; see Power Supplies
4	GND	System Ground; see Power Supplies
5	A	Receive: RS232 or RS4xx inverting input
6	B	Receive: RS4xx non-inverting input
7	Y	Transmit: RS232 or RS4xx inverting output
8	Z	Transmit: RS4xx non-inverting output

For variants with both CAN and RSXXX connectivity, an 8 position connector will be populated. For variants with CAN but not RSXXX connectivity, a 4 position connector will be populated in pins 1 through 4, with pins 5 through 8 inaccessible. Similarly, for variants with RSXXX connectivity but not CAN, a 6 position connector will be populated in pins 3 through 8, with pins 1 and 2 inaccessible.

All variants and all package quantities (including single and multi-unit volume packaging) come with the corresponding plug supplied:

Pins	Connector	Plug	Variants	J2 Positions
4	FCI 20020107-C041A01LF*	FCI 20020004-C041B01LF*	CAN only (e.g. -A02/A04)	1-4
6	FCI 20020107-C061A01LF*	FCI 20020004-C061B01LF*	RSXXX only (e.g.-A01/A03)	3-8
8	FCI 20020107-C081A01LF*	FCI 20020004-C081B01LF*	CAN + RSXXX (e.g.-A00)	1-8

*or equivalent

This plug has screw terminals, and is designed to accept solid or stranded wires of 18 to 24 AWG. The entry areas for each terminal also support 2 or 3 wire insertion per terminal to facilitate multi-drop network chaining or termination resistors alongside the communications wires without requiring pigtails.

To fasten wires into the Industrial Networking Connector use a small jewler's flat screwdriver. Ensure the port you are entering the wire into has the screw loosened to allow the wire to enter completely. Simply push the untinned bare wire into the correct port. The wire should be pushed in far enough to the port that when the screw is tightened down it has a good connection and does not fall out. Take your screwdriver and turn the screw clockwise. Do not overtighten the screws, but make sure that each screw is snug and does not allow the wire to fall out.

To remove the wire, turn the screw counterclockwise. Once the screw has been backed off to the point where the wire has become loose you can remove the wire.

POWER CONNECTIONS

The main SCM's input power should be supplied on terminals 3 and 4 (**+VIN** and **GND** respectively). See the +9-25VDC Input Power chapter for details.

Pay careful attention to the polarity of the power input. It is not protected against reverse voltage and miswiring will damage your SCM117 and any attached SIM.

RS232/RS422/RS485

SCM117 variants with RS232/422/485 support employ an Intersil ISL41387IRZ-T multi-protocol transceiver, supporting selectable RS232 or RS485/RS422 (referenced generically as "RSXXX") modes.

On variants with the RX111 MCU, the MCU can control this transceiver and provide protocol translation from data exchanged with the SIM.

In bypass mode or on variants without the RX MCU, the transceiver must be directly be managed by the SIM.

MULTI-MODE RS232/RS422/RS485 TRANSCEIVER

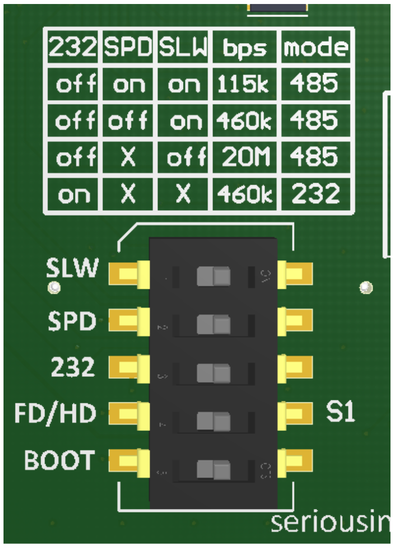
The Intersil ISL41387IRZ-T multi-protocol transceiver has the following key features:

- Selectable RS232 or RS485/RS422
- ±15kV (HBM) ESD protected
- Large (2.7V) differential V_{OUT} for improved noise immunity in RS485/RS422 networks
- Full failsafe (open/short) RX in RS485/RS422 mode
- RS232 transmit rates up to 650kbps, receive rates to 2mbps
- RS485/RS422 data rates up to 20Mbps
- RS485/RS422 slew rate limit options for 460kbps and 115kbps

It is well-suited for many point-to-point and multi-drop networks and works particularly well in many industrial PLC configurations. DIP switch **S1** configures the operational mode of the RS232/422/485 transceiver:

The position of these switches can be read from the RX111 MCU as follows:

Switch	RX111 Port	Schematic Net Name	Description
S1.1	PJ7	PJ7_RSXXX_SLEW	Slew Rate Control
S1.2	PJ6	PJ6-RSXXX_SPD	Speed Limit Control
S1.3	P41	P41-RS485/232#	RS485 or RS232 mode selection
S1.4	PB3	PB3-RXEN	Duplex selection



RS232 MODE SELECTION ("232")

DIP switch **S1.3** (marked **232**) controls the mode of the transceiver. In the **ON** position (**GND**) the transceiver operates in RS232 mode. In the **OFF** position, the control signal **P41-RS485/232#** has a weak pull-up and the transceiver operates in RS485/RS422 mode. The state of the switch is visible to the RX111 on port **P41**.

⚠ **P41** is not open-drain capable. Do not attempt to drive this signal high from the MCU as it may short to **GND** if the switch is **ON**. You may simulate open-drain behavior in software by only driving as an output low, but making the pin mode an input to allow the pull-up to pull the signal high.

SPEED AND SLEW RATE CONTROL (RS4XX MODE ONLY)

In RS4XX mode, DIP switches **S1.1** (marked **SLW**) and **S1.2** (marked **SPD**) control the slew rate and speed control of the transceiver respectively:

S1.1 SLW	S1.2 SPD	Description
OFF	**X**	20mbps max -- non slew rate controlled
ON	**OFF**	460kbps max – slew rate controlled
ON	**ON**	115kbps max – slew rate controlled

DIP switches **S1.1** and **S1.2** are ignored in RS232 mode. These switch positions can be read via ports **PJ7** and **PJ6** respectively, with "high" indicating **OFF** and "low" indicating **ON**.

⚠ **PJ6** and **PJ7** are not open-drain capable. Do not attempt to drive these signals high from the MCU as it may short to **GND** if a switch is in the **ON** position. You may simulate open-drain behavior in software by only driving as an output low, but making the pin mode an input to allow the pull-up to pull the signal high.

HALF/FULL DUPLEX SELECTION

The RSXXX port can operate in full duplex mode where data can independently and simultaneously flow in and out the receive and transmit pins respectively. It can also be configured to operate in half duplex mode where input/output data is often carried on the same wire(s) and the directionality takes turns.

The main difference between the modes lies in how the transmit and receive enable of the transceiver are configured and used. In full duplex mode, the transceiver receive data is always enabled and being processed by the appropriate MCU. In half duplex mode, the receive data is only valid when not transmitting – this avoids receive MCU algorithms from "seeing" the same data that they send if the network shares the same wires for transmit and receive. Full duplex mode always implies separate network wires for transmit and receive. Even then, you may not want to always have your transmitter enabled – there are many custom networks where the "master" in a network owns one network wire (or pair in differential mode) and can broadcast at any time to the "slaves" whereas the slaves must share the return line according to some convention to avoid collisions.

Given the many possible combinations on custom networks, there are two key elements that need to be addressed:

1. Is the receiver always on, delivering data to the SCM/SIM's UART all the time, or is it disabled during transmission to avoid "seeing your own packets"?
2. Is the transmitter always on, or must it be only turned on when the SCM/SIM transmits on the network?
3.

RECEIVE ENABLE: FULL AND HALF DUPLEX SELECTION

DIP switch **S1.4** controls how the RSXXX transceiver's *receiver* is enabled.

When **S1.4** is **OFF** (full duplex mode), a weak pull-up on the RSXXX transceiver's **RXEN** pin ensures that by default the RSXXX transceiver's receiver is always enabled and delivering data to the SIM and/or SCM's MCU (as determined by the Bypass Mode).

When **S1.4** is **ON** (half duplex mode), the RSXXX transceiver's **RXEN** pin is connected to GND. In this mode, the RSXXX transceiver's receive enable is controlled by its **RXEN#** which is connected to the opposite polarity **DEN** (drive enable) pin. In this configuration, whenever the transmitter is enabled, the receiver is disabled and the receive data "marks idle" with a pull-up.

The state of **S1.4** can be read by the RX111 MCU on port **PB3**. **PB3** is an open-drain capable pin, so it is possible to force half duplex mode (by driving **PB3** low in open drain mode) however it is not possible to force full duplex mode if the **S1.4** is **ON**.

⚠ **PB3** is open-drain capable; however it can be configured by software to also be push-pull CMOS. Do not attempt to drive this signal high from the MCU in push-pull mode as it may short to **GND** if the **S1.4** is **ON**.

TRANSMIT ENABLE

The transceiver's transmit drive enable (**DEN**) pin (when asserted/high) turns on the output drivers on the transceiver and presents UART transmit data onto the network. To avoid any network glitches on power-up, this is always held low (inactive) until either the SIM or SCM explicitly asserts this signal active/high. Either the SIM or SCM controls this signal as determined by the RSXXX Bypass Mode. On variants without the RX111, the SIM must manage this signal or no transmit data will be delivered to the network.

BYPASS AND NON-BYPASS MODES

There are five key signals related to sending and receiving data from the RSXXX transceiver:

ISL41387 Pin	Description	Schematic Signal
RA	Receive Data	**PE2/RXD12-RSXXX_RA**
DY	Transmit Data	**RSXXX_DY**
DEN	Drive Enable (active high)	**RSXXX_DEN**
RXEN#	Receive Enable (active low)	
RXEN	Receive Enable (active high)	**PB3-RXEN**[1]

[1]depending on **S1.4**, see Receive Enable

The RSXXX transceiver can managed by the RX111 (if present) for protocol translation and local network management. In this mode, the RX111 communicates to the SIM via a different UART (or I2C/SPI), translates and adapts messages, and communicates to the network from its **SCI12** UART.

Alternatively (and *always* when the RX111 is not present) the RX111 can be "bypassed" and these signals can be directly managed by the SIM's UART. See the Bypass Mode chapter for details.

The **P46_BYPASS#** signal controls this bypass mode: when asserted true/low, the three RSXXX transceiver signals are managed by the SIM. **P46_BYPASS#** signal is weakly pulled low on the SCM117, making bypass mode the default when the RX111 is not present, in **RESET**, or its **P46** pin not configured. The only way to de-assert the **P46_BYPASS#** signal so that the RX111 fully controls the transceiver is to have the RX111 software initialize/ configure its **P46** port pin to output drive a high signal.

The receive data signal (**PE2/RXD12-RSXXX_RA**) has a weak pull-up so that when transmitting and the receiver is disabled the receive data predictably "marks idle". This signal is delivered to directly to the SIM in bypass mode, but in both bypass *and* non-bypass mode it is always delivered to the RX111 MCU's **PE2/RXD12** pin so the RX111 can always receive the data on the network, even in bypass mode – the RX111 can still "snoop" the network receive data in bypass mode but not transmit.

The **P46_BYPASS#** signal specifically controls a set of multiplexers on the SCM117 as follows:

Transceiver Signal	Description	Bypass Mode (SIM Direct)		Non-Bypass Mode (RX111)	
		RX111	SIM	RX111	SIM
PE2/RXD12-RSXXX_RA	Receive Data	**PE2/RXD12**	**SIM_UART_RX**	**PE2/RXD12**	**PC3/TXD5**
RSXXX_DY	Transmit Data	**NC**	**SIM_UART_TX**	**PE1/TXD12**	**PC2/RXD5**
RSXXX_DEN	Drive/Receive# Enable	**PE4**	**SIM_TXE**	**PE3/RTS12#**	**NC**

INDUSTRIAL NETWORKING CONNECTOR – RSXXX TERMINALS

Positions 5 through 8 on the Industrial Networking Connector contain signals related to RS232 or RS422/485 network connectivity:

J2 #	Signal	Description
5	**A**	Receive: RS232 or RS4xx inverting input
6	**B**	Receive: RS4xx non-inverting input
7	**Y**	Transmit: RS232 or RS4xx inverting output
8	**Z**	Transmit: RS4xx non-inverting output

There is no termination facility on the SCM; external network termination must be provided if needed. Since the connector plug supports multi-wire insertion into a single terminal, the termination resistor lead may be collocated in the plug with the network wire.

USING RS232

In order to use the SCM117 in RS232 mode:

- Configure the DIP Switches
    - Ensure DIP switch **S1.3** is **ON** to ensure the transceiver operates in RS232 mode.
    - Set DIP switch **S1.4** for half (**ON**) or full (**OFF**) duplex mode.

Connect the RS232 receive/transmit data onto **J2** as follows:

J2 #	Signal	Description
5	**A**	RS232 data in to SCM
6	**B**	Do not connect
7	**Y**	RS232 data out from SCM
8	**Z**	Do not connect

- Set bypass or protocol translation mode:
    - Determine if you want the SIM to control/communicate directly with the RS232 network ("bypass" mode) or, if you have an SCM117 variant with RX111 MCU populated you may want to have the RX111 manage the RS232 connection and, in software, translate any needed protocol messages from the SIM and network to each other (non-bypass, or protocol translation mode). If you want to use protocol translation mode, ensure **P46_BYPASS#** is enabled and set high (de-asserted) by the RX111 software.

- Configure the appropriate UART to manage the transceiver
    - In bypass mode, configure the SIM to use the UART and transmit enable signal.
    - In protocol translation mode, configure the RX111's **PE2/RXD12**, **PE1/TXD12**, and **PE3/RTS12** pins appropriately and write the device driver/protocol necessary to manage the port.

The no-cost SHIPWare source code for SCM117 includes the Micrium uC/OS-III kernel and a set of UART, SPI, I2C, and Modbus drivers you can use to write this protocol adaptation layer.

There will be reference code available with the upcoming Serious Human Interface™ Platform v5 release for the Serious Bridge Protocol so you can write RX111 code to communicate with SHIP GUIs, including updating the SHIP GUI cargo and SHIPEngine from the network.

USING RS422/RS485

RS422 is a point-to-point protocol, and can be implemented on a network in differential or single-ended mode, with half or full duplex data flow. RS485 adds the concept to of a multi-drop network that can be used in one-master/multiple-slaves (with protocols like Modbus) or in custom protocol multi-master or peer-to-peer topologies. To use the SCM117 with an RS422/RS485 network:

- Configure the DIP Switches
    - Ensure DIP switch **S1.3** is **OFF** to ensure the transceiver operates in RS422/RS485 mode.
    - Set DIP switches **S1.1** and **S1.2** according to the desired maximum line rate chart.
    - Set DIP switch **S1.4** for half/full duplex receive/transmit enable control.

Connect the RS422/RS485 receive/transmit data onto **J2** as follows:

J2#	Signal	Description
5	A	RS4xx data in (inverting/single ended)
6	B	RS4xx data in (non-inverting differential) Connect to GND for single ended
7	Y	RS4xx data out (inverting/single ended)
8	Z	RS4xx data out (non-inverting differential) Do not connect for single ended

- Add termination if needed

- Set bypass or protocol translation mode:
    - Determine if you want the SIM to control/communicate directly with the RS422/RS485 network ("bypass" mode) or, if you have an SCM117 variant with RX111 MCU populated you may want to have the RX111 manage the RS422/RS485 connection and, in software, translate any needed protocol messages from the SIM and network to each other (non-bypass, or protocol translation mode). If you want to use protocol translation mode, ensure **P46_BYPASS#** is enabled and set high (de-asserted) by the RX111 software.

- Configure the appropriate UART to manage the transceiver:
    - In bypass mode, configure the SIM to use the UART and transmit enable signal.
    - In protocol translation mode, configure the RX111's **PE2/RXD12**, **PE1/TXD12**, and **PE3/RTS12** pins appropriately and write the device driver/protocol necessary to manage the port.

The no-cost SHIPWare source code for SCM117 includes the Micrium uC/OS-III kernel and a set of UART, SPI, I2C, and Modbus drivers you can use to write this protocol adaptation layer.

There will be reference code available with the upcoming Serious Human Interface™ Platform v5 release for the Serious Bridge Protocol so you can write RX111 code to communicate with SHIP GUIs, including updating the SHIP GUI cargo and SHIPEngine from the network.

PLC CONNECTIVITY

Many Programmable Logic Controllers have RS485 communications ports that can act as a Modbus Master or Slave. These ports are often "2-wire" ports which are differential lines run in half duplex.

The term "2-wire RS485" is a misnomer when it refers to differential half duplex RS485. You **must** also have a 3rd wire, the shared network ground. If you do not connect the ground, the RS485 differential signal can have a common mode offset that has the potential of physically damaging your SCM. See this article for a more detailed description of this issue.

When the Master is transmitting, the two wires are a differential transmit from the master to the slave(s). When a slave is responding, the two wires are a differential transmit in from the slave to the master.

To use the SCM117 in these topologies:

- Configure the DIP Switches
  - Ensure DIP switch **S1.3** is **OFF** to ensure the transceiver operates in RS422/RS485 mode.
  - Set DIP switches **S1.1** and **S1.2** according to the desired maximum line rate chart.
  - Ensure DIP switch **S1.4** is **ON** for half duplex receive/transmit enable control.

Connect the RS422/RS485 receive/transmit data onto **J2** as follows:

J2#	Signal	PLC Connection
5+7 bridged	A+Y	R- (inverting in/out)
6+8 bridged	B+Z	R+ (non-inverting in/out)
4	GND	GND

- Add termination if needed:
  - There is no termination facility on the SCM; if cable termination is required insert a termination resistor across pins 5 and 8 using the screw terminal version of the plug.

- Set bypass or protocol translation mode:
  - Determine if you want the SIM to control/communicate directly with the RS422/RS485 network (bypass mode) or, if you have an SCM117 variant with RX111 MCU populated you may want to have the RX111 manage the RS422/RS485 connection and, in software, translate any needed protocol messages from the SIM and network to each other (non-bypass, or protocol translation mode). If you want to use protocol translation mode, ensure **P46_BYPASS#** is enabled and set high (de-asserted) by the RX111 software.

- Configure the appropriate UART to manage the transceiver:
  - In bypass mode, configure the SIM to use the UART and transmit enable signal.
  - In protocol translation mode, configure the RX111's **PE2/RXD12**, **PE1/TXD12**, and **PE3/RTS12** pins appropriately and write the device driver/protocol necessary to manage the port.

An outstanding connection guide for dozens of common PLCs can be found at this web link.

CAN

CAN TRANSCEIVER

The CAN transceiver on the SCM117 is implemented with an Infineon IFX1050GVIO or similar device with the following specifications:

CAN data transmission rate up to 1 MBaud
- Suitable for 12V and 24V network applications
- EMC performance (high immunity and low emission)
- ISO/DIS 11898 compatible

The CAN transceiver is electrically routed to the CAN TX/RX signals on the MCP2515 CAN Controller (if present with the RX111 MCU) or the CAN TX/RX signals on the SIM (if supported by the SIM). When in Bypass Mode the CAN transceiver signals are expected to be supported directly by the SIM. Check the SCM117 Variants without MCU table to determine if a given SIM can perform this function, and over what interconnect mechanism.

CAN CONTROLLER

On variants with both RX111 MCU and CAN support, the MCP2515 CAN Controller is managed by, and connected to, the RX111 as follows:

RX111	MCP2515	Schematic Net Name	Description
PE0	**RESET#**	**PE0-MCP2515_RESET**	GPIO to reset the CAN controller, weakly pulled to reset until initialized and driven high.
P42	**CS#**	**P42-MCP2515_CS#**	SPI chip select
PC6/SMISO1	**SO**	**PC6/SMISO1-CAN_SO**	SPI master in, slave out data
PC7/SMOSI1	**SI**	**PC6/SMOSI1-CAN_SI**	SPI master out, slave in data
PC5/SCK1	**SCK**	**PC5/SCK1-CAN_SCLK**	SPI clock
PB1/IRQ4	**INT#**	**PB1/IRQ4-CANIRQ#**	CAN controller interrupt to MCU

The network side of the MCP2515 is connected to the transceiver. In this configuration, a CAN stack and protocol of your choosing must be implemented on the RX111 in conjunction with the MCP2515.

Micriµm's µC/CAN stack is available for the RX family along with the µC/CAN driver for the MCP2515 controller.

The no-cost SHIPWare source code release for the SCM117 available from mySerious.com contains a basic CAN stack that can be adapted for your use.

INDUSTRIAL NETWORK CONNECTOR - CAN TERMINALS

J2 has the following CAN-related signals:

J2#	Signal	Description
1	**CANH**	CAN Transmit/Receive H
2	**CANL**	CAN Transmit/Receive L

There is no termination facility on the SCM; external network termination must be provided if needed. Since the connector plug supports multi-wire insertion into a single terminal, the termination resistor lead may be collocated in the plug with the network wire.

USB DEVICE AND MICRO B CONNECTOR

The RX MCU populated on some variants of the SCM117, including the SIM117-A00 included in the development kits, has a USB device (or "function") port. This port is commonly plugged into a PC and, depending on your software, can act like any number of PC peripherals such as a serial port. When available, this USB port is available on the standard Micro B connector at location **J6**.

The USB port is a USB 2.0 Full Speed (12 mbps max) port. The USB Vendor ID (VID) and Product ID (PID) are software dependent. See www.seriousintegrated.com/docs/usb for information on *Serious* VID/PID combinations.

The power input from the USB device port is not sufficient to operate the SCM + attached SIM, and is not available for this purpose. This signal (**+5V_USB**) is only used to detect the presence of a USB connection with a PC or hub.

DEVICE IDS

USB devices are uniquely identified by a Vendor ID ("VID") and Product ID ("PID"). VIDs are assigned under license by the USB Implementers Forum. The *Serious* VID is **0x25D8**. *Serious*-delivered software for the SCM117 identifies all SCM117 variants as VID **0x25D8 and** PID **0x0117**.

You may use the *Serious* VID **only with software supplied from Serious for the module.** If you wish to write your own software for the SCM, you **must** obtain your own VID from the USB Implementers Forum.

SCM117 comes with the Renesas USB boot mode loader installed, however the USB ID may have been modified by Serious to identify the SCM as VID **0x25D8** and PIDs in the **0x0001…0x00FF** range. This modified version and the original Renesas loader are available for re-installation; see Additional Information.

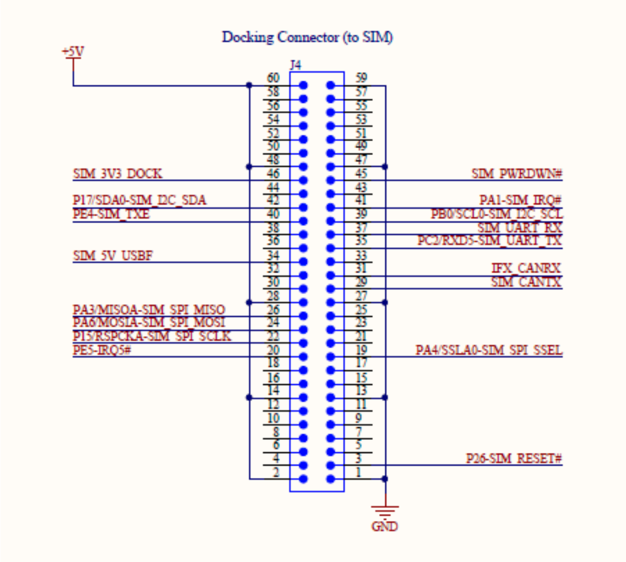
SOFTWARE

Renesas provides extensive documentation of the RX MCU as well as example software: consult the Renesas USB Driver software website.

Vendors such as Micriμm and Segger provide complete USB stacks pre-ported to RX MCUs.

60-PIN POWER/SERIAL SIM CONNECTOR

The best way to connect the SCM117 to a SIM is through the 60-pin board-to-board "docking" connector. Alternatively, where the attached SIM does not have this compatible connector, the 16-pin Power/Communications Connector can be used.



The 60-pin board-to-board connector is the FCI 10106813-061112LF, a 60-position, 0.5mm, gold plated, hermaphroditic board-to-board SMT connector. This connector is inexpensive, reliable, and widely carried at authorized distributors, including Digi-Key and Arrow Electronics.

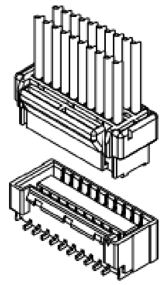
The pin numbering of this connector is the left-right mirror of the pin numbering on the SIM. Consult and compare with those in the applicable SIM Technical Reference Manual.

SCM117 J4 Pin	Schematic Net Name	Direction	Description
1,13,27, 47,59	GND	⇔	System Ground; see Power Supplies
2,14,28, 48,60	+5V	SCM⇨SIM	Outgoing +5VDC; see Power Supplies.
3	P26-SIM_RESET#	SCM⇨SIM	RESET# control to SIM.
19	PA4/SSLA0-SIM_SPI_SSEL	SCM⇦SIM	SPI slave select; SIM is master
20	PE5-IRQ5#	SCM⇨SIM	
22	P15/RSPCKA-SIM_SPI_SCLK	SCM⇦SIM	SPI clock; SIM is master
24	PA6/MOSOA-SIM_SPI_MOSI	SCM⇦SIM	SPI data; SIM is master
26	PA3/MISIA-SIM_SPI_MISO	SCM⇨SIM	SPI data; SIM is master
29	SIM_CANTX	SCM⇦SIM	CAN transmit data In bypass mode, this data SIM⇨CAN transceiver. Unused in protocol translation mode.
31	IFX_CANRX	SCM⇨SIM	CAN receive data In bypass mode, this data is from the CAN transceiver. Not available in protocol translation mode.
34	SIM_5V_USBF	SIM⇨SCM	Detects presence of power on SIM via its USB device port.
35	PC2/RXD5-SIM_UART_TX	SCM⇦SIM	UART transmit data In bypass mode delivered to the RSXXX transceiver. In protocol translation mode delivered to the RX111
37	SIM_UART_RX	SCM⇨SIM	UART receive data In bypass mode, this data is from the RSXXX transceiver. In protocol translation mode, this data is from the RX111
39	PB0/SCL0-SIM_I2C_SCL	SCM⇦SIM	I2C clock; SIM is master
40	PE4-SIM_TXE	SCM⇦SIM	UART Tx Enable for half duplex or multi-drop transceivers.
41	PA1-SIM_IRQ#	SCM⇨SIM	SPI and/or I2C IRQ to SIM
42	P17/SDA0-SIM_I2C_SDA	⇔	I2C data; SIM is master
46	SIM_3V3_DOCK		Used to detect state of the power on the dock connector.

16-PIN POWER/SERIAL SIM CONNECTOR

For SIMs without the 60-pin FCI board-to-board connector, almost any SIM can be connected to the SCM117 with a wire harness. On the SCM-end of the wire harness is a JST ZPD Series wire-to-board connector. Relevant part numbers are:

JST Part Number	Description
ZPDR-16V-S	Wire Housing
SZPD-002T-P0.3	Crimp pin for AWG#24 to AWG#28 stranded wire (see ⚠ below)



This connector is identical to that found on many *Serious* modules, including the SIM115, SIM231 and SIM535. Older SIMs had the 7 position JST GH series (SM07B-GHS-TB), and customer feedback indicated that more signals were desired, including **PWRDWN#** and the SPI port for higher speed communications. In addition, higher power handling capability was needed for larger modules including the SIM535 where the 1A limit of the JST GH series was insufficient. Both the JST ZPD and GH series are RoHS and UL94V-0 compliant.

Consult the specific SIM's Technical Reference Manual for the connector and signals available for wire harness connections. For example, the SIM225 has a JST GH series 7-pin wire-to-board connector that carries power, SIM reset, and a single UART Tx/Rx/TxEnable signals.

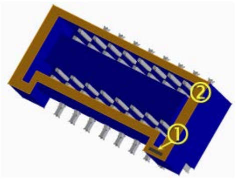
While operational to -40C, take care with insertion/removal outside normal room temperatures; the housing will be more susceptible to breakage at low temperatures.

The JST ZPD series data sheet indicates a minimum operational temperature of -25C. JST has provided *Serious* a quality and reliability certification for this connector down to -40C. Contact *Serious* for a copy of this certification.

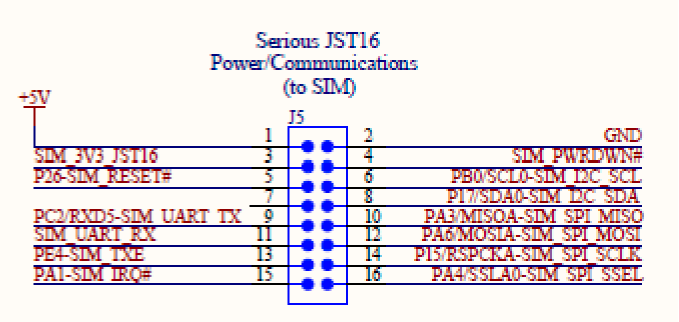
Ensure sufficient wire size for the SIM to avoid wire overheating and adequate power handling capability.

Several signals on this connector may be directly connected to signals on other connectors on the SIM. Ensure these connections are appropriate or you may damage your SIM or connected equipment.

SHIPEngine v4 uses the UART as the primary board-to-board communications mechanism. The upcoming SHIPv5 release expands this support to SPI as well.



While the signal wires of the connector can be any size between AWG#24 and AWG#28, the two main power connections (**+5V**, **GND**) should be sized according to the worst-case power requirements of the SIM, taking into account the anticipated maximum actual operating temperature. AWG#24 stranded high quality wire may be preferred for the **+5V** and **GND** power connections, and generally AWG#28 is acceptable for the remaining signals.



Pin	Schematic Net Name	Direction	Description
1	+5V	SCM⇨SIM	Outgoing +5VDC; see Power Supplies
2	GND	⇔	System Ground; see Power Supplies
3	SIM_3V3_JST16	SCM⇦SIM	Regulated +3.3VDC from SIM; see Power Supplies RX111 Port **P02** can be read to detect this from software.
4	SIM_PWRDN#	SCM⇨SIM	Puts SIM in power down mode.
5	P26-SIM_RESET#	SCM⇨SIM	RESET# control to SIM.
6	PB0/SCL0-SIM_I2C_SCL	SCM⇦SIM	I2C clock; SIM is master
7			do not connect
8	P17/SDA0-SIM_I2C_SDA	⇔	I2C data; SIM is master
9	PC2/RXD5-SIM_UART_TX	SCM⇦SIM	UART transmit data In bypass mode delivered to the RSXXX transceiver. In protocol translation mode delivered to the RX111
10	PA3/MISOA-SIM_SPI_MISO	SCM⇨SIM	SPI data; SIM is master
11	SIM_UART_RX	SCM⇨SIM	UART receive data In bypass mode, this data is from the RSXXX transceiver. In protocol translation mode, this data is from the RX111
12	PA6/MOSIA-SIM_SPI_MOSI	SCM⇦SIM	SPI data; SIM is master
13	PE4-SIM_TXE	SCM⇦SIM	UART Tx Enable for half duplex or multi-drop transceivers.
14	P15/RSPCKA-SIM_SPI_SCLK	SCM⇦SIM	SPI clock; SIM is master
15	PA1-SIM_IRQ#	SCM⇨SIM	SPI and/or I2C IRQ# to SIM.
16	PA4/SSLA0-SIM_SPI_SSEL	SCM⇦SIM	SPI slave select; SIM is master

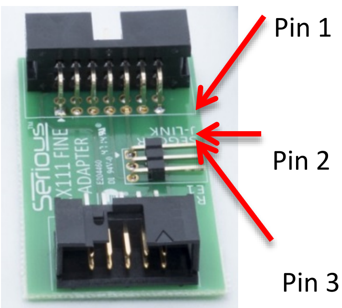
JST America offers a sample service for wire harnesses, and custom wire harness manufacturers such as TLC Electronics can assist in small to large volume harness development and production at reasonable cost. Various SIM development kits, such as the SIM115-A01-DEV-01, as well as the SCM117 development kits, include a sample single-ended wire harness for your use in prototyping.

TAG-CONNECT TC2050 CABLE WITH RX111 FINE ADAPTER

For variants that have the RX111 MCU populated, software developers will need access to the MCU's programming/debug port. Normally a Renesas E1 or one of the many models of Segger J-Link programmer/debugger devices will be used with Renesas or IAR tools for software development.

Connecting the programmer/debugger to the SCM117 is accomplished using a Tag-Connect TC2050-IDC cable, available separately from Tag-Connect or Digi-Key and included in all SCM117 Development Kits.

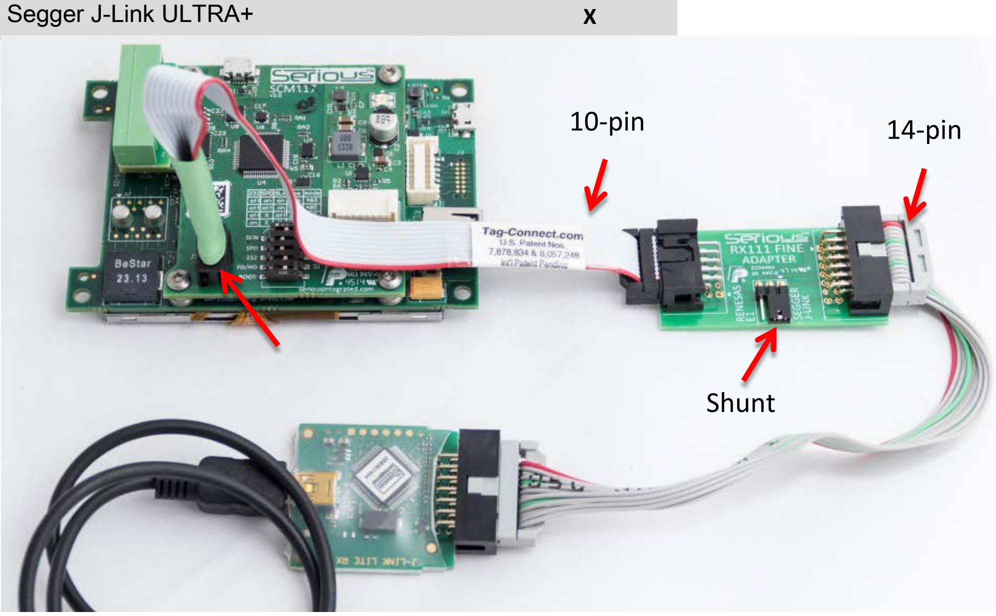
One end of the TC2050 has spring-loaded pogo pins such that when inserted into the SCM117 makes electrical contact between the cable and the PCB. Built-in retention "legs" hold the connector firmly in place during debugging. Gently squeeze the leg-housing to remove the connector from the board.



The other end of the TC2050 has a standard 0.1" female 10 pin IDC connector, unlike the 14-pin IDC connection on the Segger J-Link and Renesas E1 debuggers. Included in all SCM117 Development Kits is a small adapter board, the *Serious* RX111 FINE Adapter, which interconnects the 10 pin TC2050 cable to the 14-pin IDC connector. In addition to adapting the two connector types, it has an onboard shunt that is used to select between the Renesas E1 or Segger J-Link wiring configuration required for compatibility with certain Segger J-Link models (Specifically, the LITE RX model that is included in development kits). Below is a table detailing the position the shunt should be placed depending on what type of debugger is being used.

Debugger	Shunt on Pins 1-2	Shunt on Pins 2-3
Segger J-Link LITE RX	X	
Segger J-Link EDU		x
Segger J-Link BASE		x
Segger J-Link PLUS		x
Segger J-Link PRO		x
Segger J-Link ULTRA+		x

WARNING: Incorrect jumper placement on RX111 Fine Adapter shunt may damage your SCM117, debugger, and/or any other attached devices.



ADDITIONAL INFORMATION

The home page for SCM117 technical documentation is: http://www.seriousintegrated.com/w/index.php?title=SCM117

Further documentation, including schematics, STEP 3D CAD files, and more can be found there.

For more information on the SCM117:

- Visit www.seriousintegrated.com/SCM117
- Contact a Serious manufacturers' representative
- Contact a Serious authorized distributor
- Visit mySerious.com
- Contact Serious directly