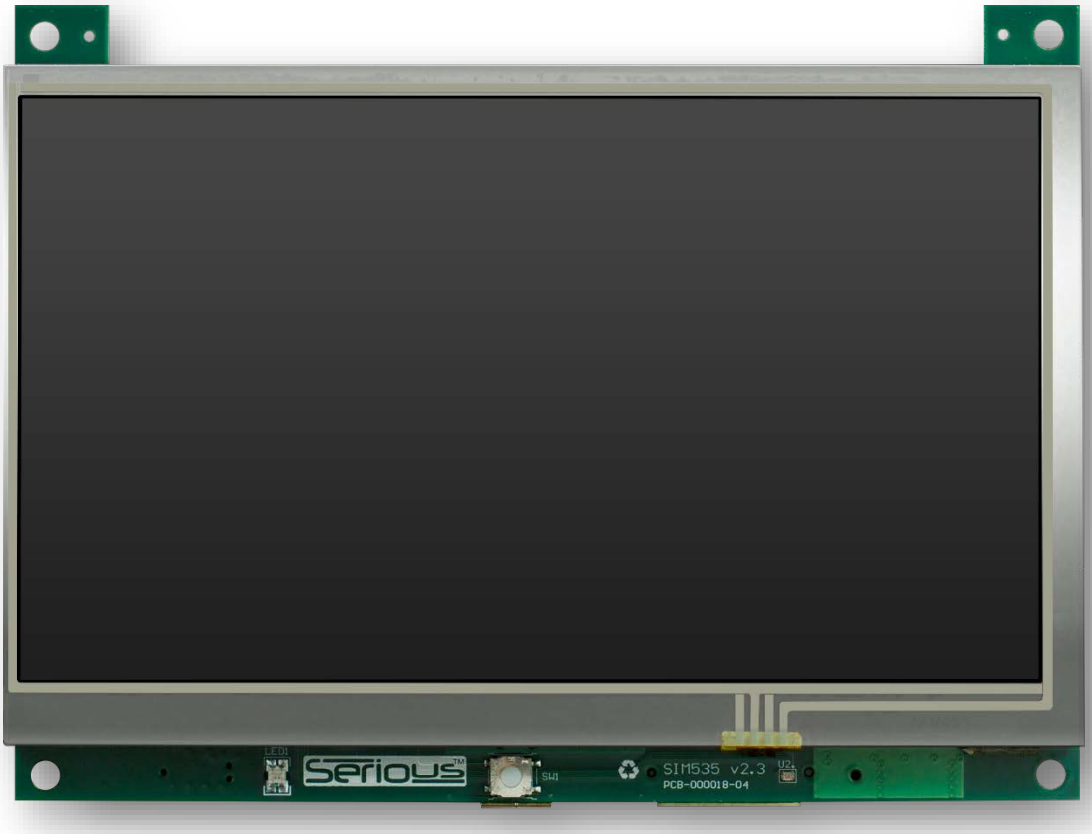
SIM535

Technical Reference Manual



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TRADEMARKS AND COPYRIGHTS

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 Version	Date	For HW Versions	Major Changes
A0	13 Dec 12	1.0	• Initial prerelease version
A1	15 Feb 13	1.0	• Updated based on near-final schematics

A2	9 Jul 13	1.x & 2.0	• Added preliminary estimated power tables
			• Revised based on final 1.x schematics
			  • Revised SDRAM max to 32MB
			  • Updated LCD display specifications (NITs and pixel sizes)
			  • Audio rewrite for PCM1774 and Serial FIFO mode
			  • Updated for IDT VersaClock® and switcher
			  • Various other typos and cleanup

A3			• Clarified boot mode table • Added Touch Controller and I2C Device Summary section
A4	05 Sep 13	2.0	• Updated variant table in with final values • Noted potential memory size changes (SDRAM, e-MMC) • Changed Touch controller, added proximity and ALS • Changed Serious Power/Comms Connector to 16 pin JST ZPD
B0	06 Mar 14	2.0	• Replaced PCB Edge Connector with SHIP Programming Port and Tag-Connect TC2070 • Replaced USB Mini-B with Micro B • Replaced IDT clock tree with Si5351, removed SSG option from 7269 • Boot mode fixed for Serial Flash • Added LCD Option Tables and SSN decoder for LCD options • Updated physical specs for final outline • Added daughter card and SCM117 sections
B1	20 May 14	2.0,2.1	• Added daughter card fastener and standoff electrical recommendations • Added handling and care section • Updated dev kit contents to (5VDC Wall Adapter)
B2	16 Sep 14	2.0-2.2	• Added block diagram • TBD add note on alignment holes

DOCUMENT CONVENTIONS

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

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 SIM535 family of Serious Integrated Modules is a series of complete intelligent 7.0" WVGA graphic front panels, some with touch capability.

These cost-effective modules are designed for use by Original Equipment Manufacturers (OEMs), custom design shops, and hobbyists to add sophisticated and user-friendly graphical user interfaces to their products.

USAGE MODELS

In most cases, you will be adding a SIM to a system that already has an MCU, I/O, power conditioning, and other custom interfaces. Perhaps your system already has a membrane keypad and a 2x16 character display or indicator LEDs. Your current MCU software in your existing system controller manages all aspects of your device, including (as applicable) belts, pumps, motors, servos, indicators, etc.

Rather than completely redesigning the hardware and software of your existing system to create a merged hardware/software architecture (LCD front panel plus system controller all-in-one), it is far more common to partition the problem by retaining your existing system controller and software and using the SIM as an intelligent stand-alone front panel.

Therefore SIMs typically most often used as stand-alone front panels responsible for managing just the Human Machine Interface (HMI) in a larger system. The existing, separate, device-specific system controller continues to manage the main functionality of the system. SIMs are equipped with several methods for simple interconnect to the external system controller, getting power from that external system, and communicating via a serial type link (SPI, UART, USB) to that controller to exchange data and commands.

Using the *Serious Human Interface™ Platform (SHIP)*, the software team can leverage the power of the *SHIPTide* rapid GUI development tools from *Serious*, developing a user interface in as little as a few hours and a few dozen lines of code. The *SHIPEngine* runtime firmware pre-installed on all SIMs takes care of all the drivers, rendering, communications, and event handling for the user interface, leaving the GUI development process to be focused on look and feel and differentiation of your device. You never need to write C code or use a JTAG debugger with a SIM to develop a modern-looking user interface.

SHIP software and development tools are available at no-cost for users of Serious Integrated Modules.
See www.seriousintegrated.com/SHIP for details.

Adding a simple software protocol driver to your system controller on the other end of the communications link allows your controller to communicate with the front panel. You can then architect inter-board messages such as "pump is on" which could be sent over the UART/SPI/etc. causing visual indicators to appear or change on the display. A GUI on the SIM535 could change user preferences, for instance, sending back messages such as "pump on days: MWF" which the system controller may store in its configuration EEPROM.

The possibilities are endless: the SIM535 module contains not only a powerful MCU but also a suite of hardware features that are commonly needed in many designs. An alarm panel, for example, could be as simple as a SIM535 connected to another PCB with a $0.20 MCU, a few relays and a battery.

HARDWARE

SIM535 family features include:

- 7” WQVGA 800x480 color TFT display
  - Various LCD features and touch panel options
- 240/266MHz 32-bit Renesas SH7269 MCU with FPU
  - 2.5MB RAM (frame buffer capable) with 2D Graphics Controller
- On Module Memory
  - 32MB SDRAM
  - 8MB boot serial FLASH + 2Kbit parameter EEPROM
  - Up to 4GB e-MMC FLASH memory for file systems, image data, executables, etc.
- Extensive I/O & Peripherals
  - Real Time Clock with coin cell battery backup option
  - PCB Temp Sensor
  - SD card socket
  - 60-Pin Board-to-Board Expansion Connector
  - 16-pin Power/Communications Connector
  - USB2.0 High-Speed Device Port
  - USB2.0 High Speed Embedded Host Port
  - Tag-Connect E10 Programming Port
  - SHIP Programming Port
- -20 to 70°C extended operating temperature
- -3.6 to 5.5V DC powered

Within the SIM535 are numerous family members, or “variants”. Each variant has a slightly different set of features and price points for an OEM to select the appropriate feature/cost point for their specific application.

Consult an authorized *Serious* representative for an up-to-date listing of order codes, family variants, and LCD options available.

This document version contains prerelease information prior to product introduction and is subject to change.

SOFTWARE

It is very difficult to know, as a designer selecting the hardware for a graphic/touch interface, if the result after many months of software and graphic design will have acceptable performance. Will the system be responsive? Will it be visually attractive? Will the look-and-feel be consistent with the company’s brand image? *Serious* addresses these OEM designer challenges by delivering video best-of-class GUI examples, fostering community demos and solutions, and providing software, tools, and consulting services.

The SIM535 is designed for use with the Serious Human Interface™ Platform tools and software. These PC-based tools offer rapid GUI prototyping, development, and deployment without the use of JTAG debuggers and low level coding. With minimal custom software you can create attractive and functional GUIs in a fraction of the time of C-based GUIs. See www.seriousintegrated.com/SHIP for details.

Renesas supports a limited set of customers for C-based development on the SH2 series of processors. For those applications requiring C-based development, contact *Serious*.

GETTING STARTED

The SIM535 comes pre-configured with a boot loader in the boot Serial FLASH and a demo program pre-installed in a FAT file system on the e-MMC FLASH. When initially powered, the demo will start running and displaying info on the LCD screen.

Many SIMs can be easily powered in the lab environment using the USB device connector from a PC/hub. However the SIM535's power needs exceed the capabilities of PC-based USB ports or hubs, so powering the SIM535 requires an external power supply. In addition, since the primary mechanism of communicating from the SHIPTide development tool to the SIM is through that same USB device port, you cannot use a higher-capacity tablet/phone power charger for this connection or you would obstruct the ability to communicate with the SIM. Therefore, powering the SIM535 requires delivering approximately 5V@1A to one of the ports that exposes the +VEXT signal:

- 16-pin Power/Communications Connector
- 60-Pin Board-to-Board Expansion Connector
- SHIP Programming Port

Powering from the 16-pin Power/Communications Connector

All SIM535 development kits come with a 16 pin wire harness for prototyping that can connect in to the 16-pin Power/Communications Connector. An AC power adapter with fixed 5VDC@1A output or similar lab power supply can be connected to the power pins of this harness to power the SIM535.

Powering from the 60-Pin Board-to-Board Expansion Connector

A variety of daughter-cards can be plugged into the 60-Pin Board-to-Board Expansion Connector and through this connector the SIM can be powered. For example, the off-the-shelf SCM117 Intelligent Power/Protocol Converter daughter card has an on-SCM DC-DC converter that can converter 9-25VDC to the 5VDC needed by both the SCM and the SIM. An AC power adapter or lab power supply with 9, 12, 15, or 24VDC at 5W or greater can be connected into the direct-wire-insert connectors on the SCM117.

Powering from the SHIP Programming Port

The SIM535 can be powered via the SHIP Programming Port (SPP). This port is commonly used for GUI development and connection with the SHIPTide development tool on the PC, since the SPP carries both USB and power to the SIM, and is a common port across many new SIMs including the SIM115, SIM231, and SIM535. Some SIM535 development kits include the SHIP Programming Connector 200 (SPC200), a small connector/cable adapter which plugs into the SPP on one end and on the other end plugs into a SHIP Programming Adapter 200 (SPA200). The SPA200 is connected to the PC via USB and provides intelligent programming services from SHIPTide and other PC-based software for development and volume programming. A stand-alone USB AC power adapter (1A minimum) connected to the SPA100 powers not only the SPA220, but also can power the attached SIM.

Be careful to connect the right power connections on the 16-pin wire harness to avoid damaging your SIM.

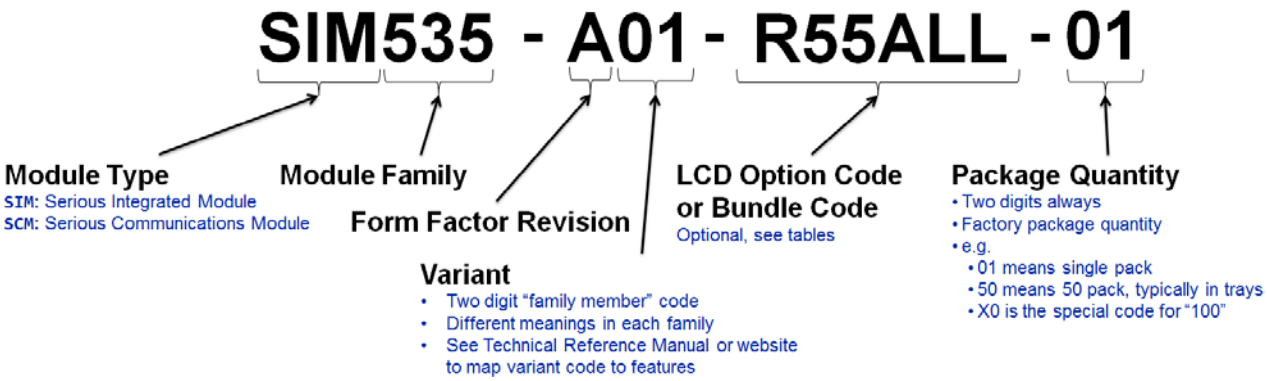
Several connectors may be used to power the SIM535. See Power Supplies.

For more getting started information and out-of-the-box tips, see www.seriousintegrated.com/oob.

ORDERING INFORMATION

ORDER CODES

SIM order codes are constructed as follows:



As of the time of this document's publish date, the current order codes are as follows:

Order Code	Description	Detail	Pkg Qty
SIM535-A01-DEV- 01	Dev Kit SIM115-A01-R45ALL w/SPA200-A00, Cables, Acrylic Case	Includes Serious SHIP Programming Adapter (SPA200-A00), no JTAG debugger/adapter included	1
SIM535-A01-R22ALL-01	Full Featured Color Graphic LCD Module 7.0" WVGA, Res Touch SH7269, 32MB RAM, 8MB FLASH, 4GB eMMC USB Host, USB Device, SD Card Prox, Ambient Light, RTCC	200+ NIT, 20k Hour Backlight, 24bit	1
SIM535-A01-R22ALL-05			5
SIM535-A01-R22ALL-25			25
SIM535-A01-R55ALL-01		500+ NIT, 50k Hour Backlight, 24bit	1
SIM115-A04-N55ALL-10			10
SIM115-A04-N55ALL-50			50
SIM535-A03-R22ALL-01	Low Cost Color Graphic LCD Module 7.0" WVGA, Res Touch SH7269, 32MB RAM, 8MB FLASH, 2GB eMMC Prox, Ambient Light, RTCC	200+ NIT, 20k Hour Backlight, 24bit	1
SIM535-A03-R22ALL-05			5
SIM535-A03-R22ALL-25			25
SIM535-A03-R55ALL-01		500+ NIT, 50k Hour Backlight, 24bit	1
SIM115-A03-N55ALL-10			10
SIM115-A03-N55ALL-50			50

SIM535 FAMILY MEMBER (VARIANT) OVERVIEW

As of the time of this document's publish date, the variants (aka family members) are:

Family Variant	A01	A02	A03	A04
MCU				
MCU	SH7269	SH7269	SH7269	SH7269
MCU Max MHz	266	266	266	266
MCU FLASH/RAM(kB)	0/2560	0/2560	0/2560	0/2560
JTAG E10 Debug	O ◎	O ◎	O ◎	O ◎
Memory				
SDRAM (MB)	32	32	32	32
eMMC (GB)	4	4	2	2
Boot Serial FLASH (MB)	8	8	8	8
EEPROM	✓	✓	✓	✓
LCD & Touch				
Touch	R4		R4	
Capacitive Proximity Sensor	✓		✓	
Ambient Light Sensor	✓	✓	✓	✓
Peripherals & GPIO				
User Red/Green/Orange LED	✓	✓		
PCB Temp Sensor	✓	✓		
Piezo Sounder	✓	✓		
32.768kHz Clock/Calendar	PCF8523	PCF8523	MCU	MCU
USB 2.0 HS device circuitry	S O ▭	S O ▭	S O	S O
USB 2.0 HS host circuitry	S O ▬	S O ▬		
Expansion Connectors				
USB2.0 High-Speed Device Port	✓	✓		
USB2.0 High Speed Embedded Host Port	✓	✓		
Full-sized SD Card Socket (SDIO)	✓	✓		
60-Pin Board-to-Board Expansion Connector Power, I2C, SPI, UART, DAC, I2S	✓	✓	✓	✓
16-pin Power/Communications Connector Power, I2C, SPI, UART	✓	✓	✓	✓
Power				
Power Input (5V typical)	O ⊙ S ▭	O ⊙ S ▭	O ⊙ S	O ⊙ S
CR1025 coin cell holder for RTCC backup	✓	✓		

⊙ on 16-pin Power/Communications Connector

O on 60-pin Expansion Connector

◎ on Tag-Connect JTAG Port

S on SHIP Programming Port

▬ on USB2.0 High Speed Embedded Host Port

▭ on USB Micro B Device Port

⚠ This table contains pre-release information prior to product introduction and is subject to change.

LCD OPTIONS

Consult the following table for available LCD Options on the SIM535 family at the time of this document release. Not all LCD options are available for all variants: for an up-to-date list, contact an authorized *Serious* representative. For a detailed explanation of LCD Option Codes, consult the Serious website.

LCD Option Code **Serial Number Byte[1]**	**R22ALL** **0x01**	**R43AEL** **0x00**	**R55ALL** **0x02**
Size (diagonal, active, inches)	7.0	7.0	7.0
Resolution	800x480	800x480	800x480
Touch	R4	R4	R4
NITs (mcd/m min typ)	200+	400+	500+
Backlight Life (min typ, hours)	20k	30k	50k
Viewing Technology	Landscape	Landscape	Landscape
Viewing Angles (min typ)			
Y+ (12o'clock)	65°	60°	65°
Y- (6o'clock)	55°	50°	55°
X+ (3o'clock)	70°	70°	70°
X- (9o'clock)	70°	70°	70°
Proximity Detect Capable	✓	✓	✓
Color Depth (bits)	24	18	24
Operating Temp Range	-20[2] to +70C[3]	-20[2] to +70C[3]	-20[2] to +70C[3]
Storage Temp Range	-30 to +80C	-30 to +80C	-30 to +80C
On-glass RAM	0	0	0
Active Area (W x W mm)	154.08 x 85.92	153.6 x 86.64	154.08 x 85.92
Pixel Pitch (W x H µm)	192.6x179	192 x180.5	192.6 x179
Backlight Power (min typ/max typ @100%, mW)	975/1025[4]	1400/1550[4]	1600/1699[4]

Notes: [1]See *Serious* Serial Number

[2]LCD will become slightly sluggish at low temperatures below -10C

[2]LCD will become darker near the high end of the temperature range

[4]LCD power at the backlight; SIM boost converter inefficiencies increase this at a module level; see DC Operating Characteristics

Note that the PCB, MCU, and associated components may be rated for a larger operating temperature range than the LCD. In this case, the MCU will operate correctly over the entire operating range however the LCD may not function or be visible outside its specified operating range. In all cases, the narrower of the two recommended storage temperature ranges (PCB and LCD) should not be exceeded.

DEVELOPMENT KITS

The SIM535-A01-DEV-01 development kit contains everything needed to develop with SIM535 family. The kit contains:

- SIM535-A01-R55ALL module
  - Superset of all SIM535 features
  - Bright 500+ NIT Resistive Touch LCD with proximity and ambient light detection
- SHIP Programming Adapter 200 (SPA200)
  - Includes SHIP Programming Connector 200 (SPC200)
  - Enables easy powering/connectivity from the PC
  - 5V 12W wall power supply for lab use (110/220VAC EU/US voltage and plug compatibility)
  - Barrel to screw terminal power jack adapter
- 16 pin wire harness (JST16 plug one end, tinned the other) for lab cable enabling
- Acrylic “enclosure” for safe handling and demonstration use

⚠ The SPA200 and SPC200 are set for release in Q3 2014; Development kits shipped prior to this release will include a mail-in coupon for these.

⚠ This is a preliminary table (prior to product release) and is subject to change.

⚠ The SIM535 is intended for GUI development with the Serious Human Interface™ Platform and has limited support from Renesas for C-level development, therefore the standard SIM535 development kit has no JTAG debugger included. Customers who which to do C/JTAG-level development will need a Tag-Connect TC2070 adapter cable and a Renesas E10 programmer/debugger.

SPECIFICATIONS

DC MAXIMUM RATINGS

The following are absolute maximum limits for the specified variants:

Specification	Variants	DC Limits			
		Min	Typ	Max	Units
Input Supply Voltage +VEXT	A01[1] A02[1]	4.50	5.00	5.25	V
	A01[2] A02[2]	3.60	5.00	5.25	V
	A03 A04	3.60	5.00	5.50	V

Notes: [1]USB Host circuit enabled
[2]USB Host circuit never enabled

DC OPERATING CHARACTERISTICS

MODULE LEVEL

The following DC characteristics apply to all variants of the SIM535, and ***do not include LCD backlight power*** which must be added to the total depending on the LCD option selected:

NOTE: All numbers in *colored italics* are pre-production estimates.

Specification	USB Host Boost	Range				
		Typ[1,2,5]	Typ[1,3,5]	Max[1,2]	Max[1,3]	Units
Input Supply Current +VEXT	RESET					mW
	off					mW
	on[4]				*3000*	mW

Notes: [1]Any additional external current draw from the module is in addition to this value
[2]At minimum voltage on supply
[3]At typical input supply voltage
[4]No device inserted; device power is in addition to this number plus typical conversion loss of 10%.
[5]Estimated (will be changed to "Measured" after characterization)

BY SUBSYSTEM

The amount of power necessary for SIM to function is highly dependent on how and which features of the module you use. This is especially true for major power consumers such as the LCD backlight and USB embedded host port. Depending how your application uses these features, the typical and maximum power numbers can be appropriately subtracted from the maximums for the SIM respectively. Assuming typical switching conversion efficiency, the power breakdown of the elements is as follows:

NOTE: All numbers in *colored italics* are pre-production estimates.

	Circuit-Local Power Required (mW)[1]			+VEXT to Local Conversion	+VEXT Power Required (mW)[1]		
Subsystem	Min	Typ	Max	Efficiency (typ)	Min	Typ	Max
LCD (backlight) – R22ALL		*975*	*1025*	*86%*		*1134*	*1192*
LCD (backlight) – R43AEL		*1400*	*1550*	*86%*		*1627*	*1802*
LCD (backlight) – R55ALL		*1600*	*1699*	*86%*		*1860*	*1976*
LCD (logic)		*561*	*700*	*92%*		*610*	*760*
Piezo w/Boost Enabled		3	12	*80%*		4	15
MCU (3.3V)		*521*	*616*	*92%*		*567*	*670*
MCU (1.25V)		*299*	*414*	*90%*		*332*	*460*
SDRAM		*165*	*495*	*92%*		*179*	*538*
SFLASH		33	83	*92%*		36	90
e-MMC		*10*	*264*	*92%*		*11*	*287*
SD card		0[2]	0[2]	*92%*		0[2]	0[2]
Resistive Touch		*33*	*56*	*92%*		*36*	*61*
USB Host		0[2]	0[2]	*90%*		0[2]	0[2]
USB Host (device inserted)			*750*	*90%*			*833*
Other logic and miscellaneous		*tbd*	*tbd*	*92%*			

Notes: [1]At typical input supply voltage
[2]No device inserted; device power is in addition to this number.
[3]50% white/50% black or 50% RGB pixel intensity
[4]100% white

MCU I/O

Many I/O signals on the SIM535 are directly and exclusively connected to SH7269 MCU pins. Consult the SH7269 data sheet for complete specifications of each pin.

There are specific power limitations on the MCU pins. Consult the SH7269 data sheet for more information. Exceeding these limits may damage your board, damage attached systems, overheat or cause things to catch fire.

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.

The no-cost Serious Human Interface™ Platform software initializes the MCU and SIM components for correct operation.

ENVIRONMENTAL CHARACTERISTICS

Specification	Variant	Permissible Range			
		Min	Typ	Max	Units
Operating Temperature	All	-20		+70	C
Storage Temperature	All	-30		+80	C
Humidity	All			90% (@60C)	RH

HANDLING AND CARE

Observe the following handling and care guidelines.

HANDLING

Be very careful when handling the edge of the SIM where the flexible cable from the LCD panel is exposed. This can be easily damaged or ripped if shear-force is applied in handling.

Do not attempt to disassemble the module or solder components or wires to the module; this may render your board non-functional and void your warranty.

As with all electronic subsystems and circuits, observe proper ESD handling procedures.

As with any glass product, use reasonable care when handling to avoid glass chips and cracks.

If the LCD glass breaks and the LCD liquid materials escape, avoid contact with bare skin. Wash exposed skin with soap and water immediately and dispose of the product according to local materials handling procedures.

If the SIM comes in factory packaging with a protective cover sheet on the LCD, it is advised to leave this protective film in place until the SIM is mounted in the final assembly to prevent scratches and fingerprints from marring the display surface. Do not expose to high temperature and/or high humidity testing with the protective sheet place. Slowly remove the protective sheet to minimize potential static electricity creation.

PRESSURE AND IMPACT

On non-touch variants apply no pressure, and ensure no impact can be made by end users, to the surface of the LCD display. There is no specification for pressure or impact on non-touch LCDs.

On touch variants, do not use sharp objects to activate the touch screen or the overlay material may be damaged.

Do not apply any bending/twisting force to the LCD or the SIM PCB or the unit may be permanently damaged.

STORAGE

Follow these basic precautions when storing un-installed SIMs for extended periods:

1. Store SIMs in the original factory packaging whenever possible. The sealed polyethylene antistatic bags or the antistatic trays are designed for long term storage.
2. Store the SIM sub-packs where they will not be subjected to high heat, sunlight, or high humidity conditions. Recommended storage temperatures should be kept between 0C and +40C, with relative humidity below 80%.
3. Desiccant should not be required if properly sealed and room temperature ambient temperatures are maintained.

CLEANING

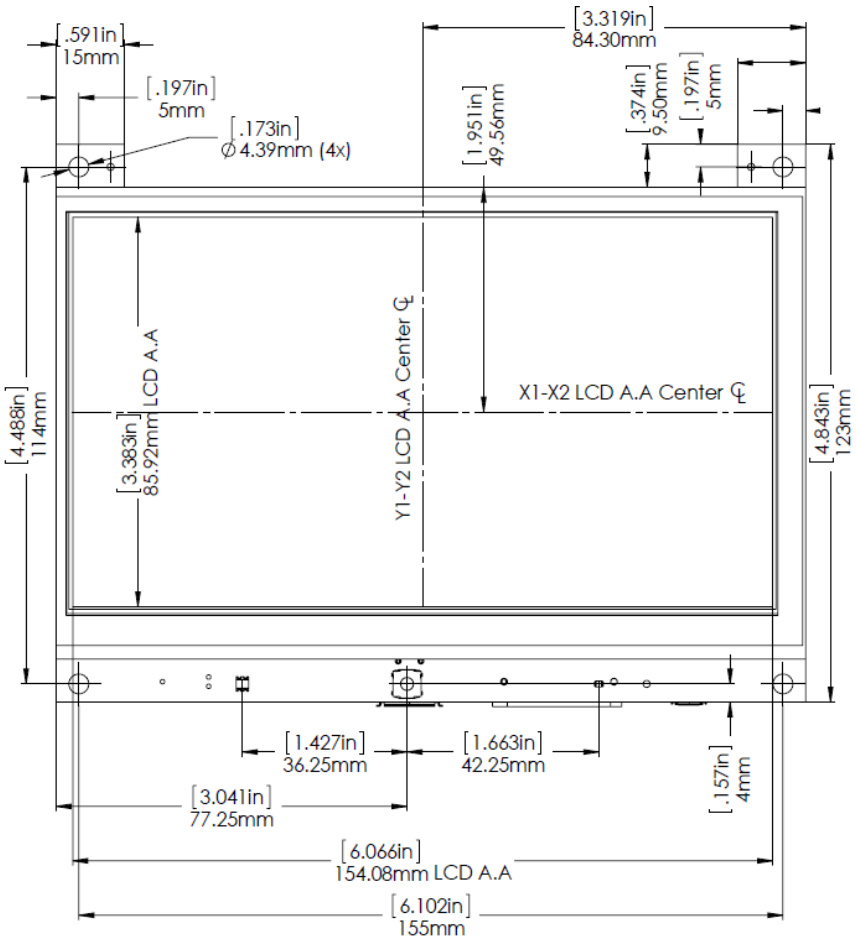
If cleaning of the LCD panel surface is necessary, Isopropyl or Ethyl alcohol, either 100% or mixed 50%/50% with distilled water, may be used on a moist clean soft cloth.

Do not use abrasive, ketone-containing, and aromatic solvents which will damage polarizer materials.

PHYSICAL CHARACTERISTICS

This section is provided as a helpful overview only.
The authoritative mechanical reference is the SIM535 Mechanical Design Package (MDP), which includes 2D drawings and STEP models, and is available for download at www.seriousintegrated.com/docs.

The outer dimensions of the SIM535 are 165mm x 123mm. Any connectors populated along the bottom edge may extend up to an additional 2mm beyond the 123mm of the PCB. The SIM is designed to be mounted using four M4 machine screws.



Example SIM535-A01-R22ALL Outline Dimensions

Each LCD option may be slightly different, and each variant may remove some features from the total possible. For example, the A03 variant has fewer connectors populated, affecting the maximum outer dimensions of the module.

DAUGHTER CARD PHYSICAL GUIDELINES

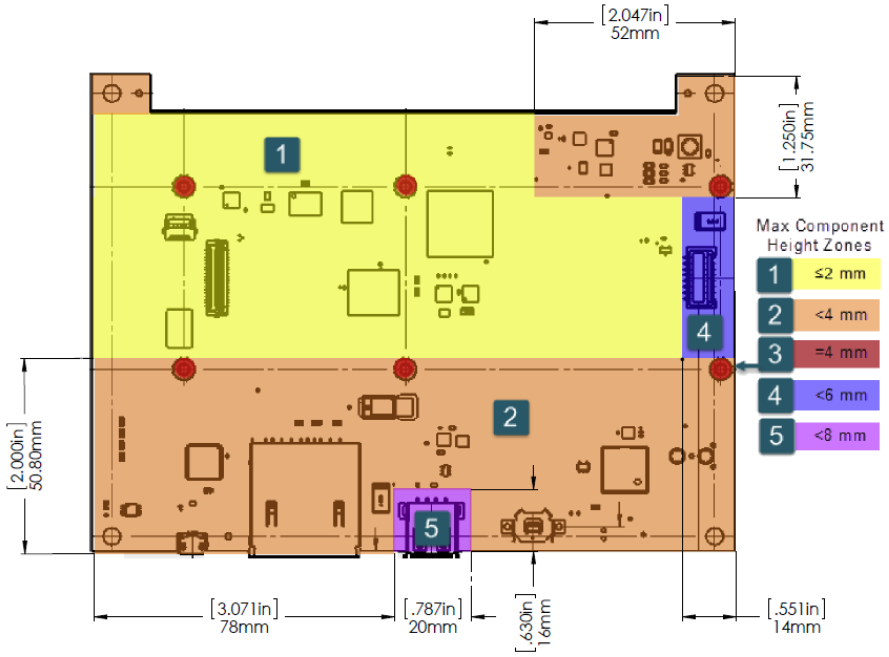
This section is provided as a helpful overview only.
The authoritative mechanical reference is the SIM535 Mechanical Design Package (MDP), which includes 2D drawings and STEP models, and is available for download at www.seriousintegrated.com/docs.

Most SIM535 variants include the 60-Pin Board-to-Board Expansion Connector. These variants also include six M3 threaded standoffs (PennEngineering® SMTSO-M3-4-ET or similar) to firmly support and attach a daughter card at the correct 4mm board-to-board distance.

Serious reserves the right to substitute components and/or change component layout on SIMs at any time without notice. Exceeding the height envelope described below with the assumption of specific SIM component used and/or placement so as to utilize the inner-stack-height for daughter card components may cause mechanical conflicts in future SIM revisions.

It is possible to create a single daughter card that can dock into numerous SIMs, including the SIM115, SIM231, and SIM535. Consult the respective Technical Reference Manuals (TRMs) to validate a compatible footprint: there are slight differences in the physical and electrical characteristic for daughter cards across different SIMs.

The board-to-board distance with this connector (when used with an identical mated connector) is only 4mm, enabling a daughter card to be developed with a very low overall combined profile. For components on the side of the daughter card facing the SIM, observe the maximum component height zones on the SIM – your components may extend only 4mm *less this distance* on the SIM-facing side of your PCB:



Example SIM535-A01-R22ALL Max Height Zone Map

For example, in the yellow shaded area above, the components on the SIM535 are less than 2mm total height, leaving (4mm board-to board) minus (2mm yellow height zone) = 2mm for components on the SIM-facing side of a daughter card.

Note that component data sheets typically indicate the physical height of the component which is not necessarily the same as the total height of the component after soldering, which may slightly raise (or even lower, in the case of some BGAs) the component.

For prototyping, any M3-0.5x6mm pan head or cap socket screw can be used to attach a daughter card to the SIM. For production units, the recommended screw and assembly torque specifications for attaching a daughter card are as follows:

Parameter	Recommendation		
Material	Stainless A1-50 or better		
Size	M3-0.5 x 6mm		
Head	Cap Socket (hex) or Pan Head 6-lobe/5-lobe/Torx®		
Patch	Nylon Patch per Specification IFI-524 2002 *Test Procedure for the Performance of Metric Nonmetallic Resistant Element Prevailing Torque Screws*		
	Specification	N·m	inch·lbs
	Maximum Prevailing Torque:	0.60	5.31
	Minimum First Removal Prevailing Torque	0.14	1.24
Insertion Torque	*Recommended: 0.60 N·m (5.3 inch·lbs)		
	*Maximum: 0.70 N·m (6.2 inch·lbs)		

**subject to final production characterization*

Small quantities of this type of screw can be readily purchased from McMaster-Carr (93705A813).

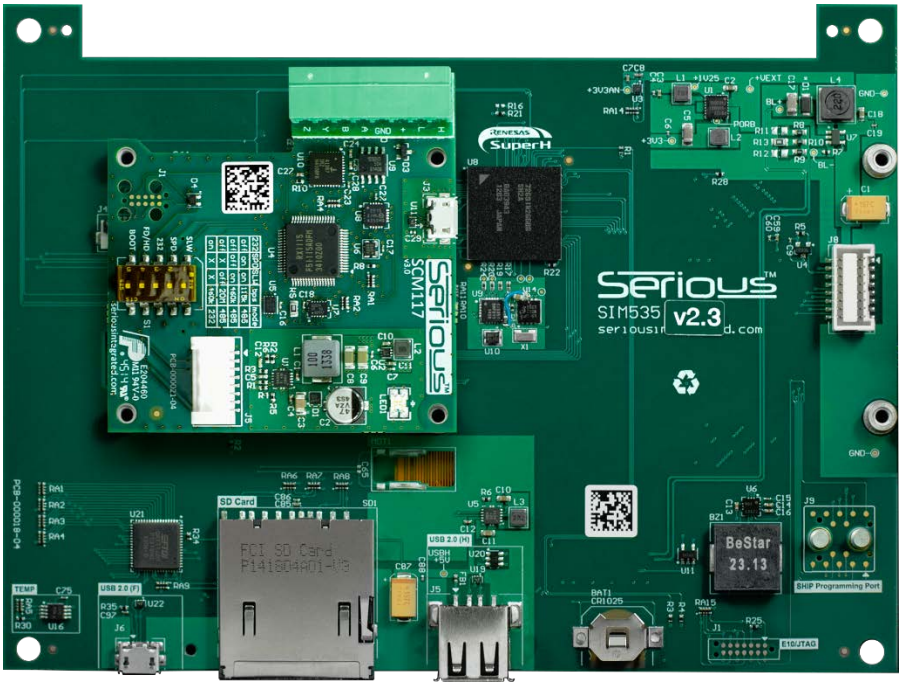
Do not apply excessive torque to daughter card screws into the threaded standoffs or they may tear from the PCB and permanently damage the SIM.

Do not use screws longer than recommended or the screw may apply force to the back side of the LCD panel and permanently damage it.

SERIOUS COMMUNICATIONS MODULES

Serious has several new communications daughter cards designed to dock into the back of the SIM115, SIM231, and SIM535 as well as some future SIMs.

The Serious Communications/Power Module 117 (SCM117) family, for example, 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.



Example SCM117 Docked into SIM535 v2.3

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

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

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 and SCM.

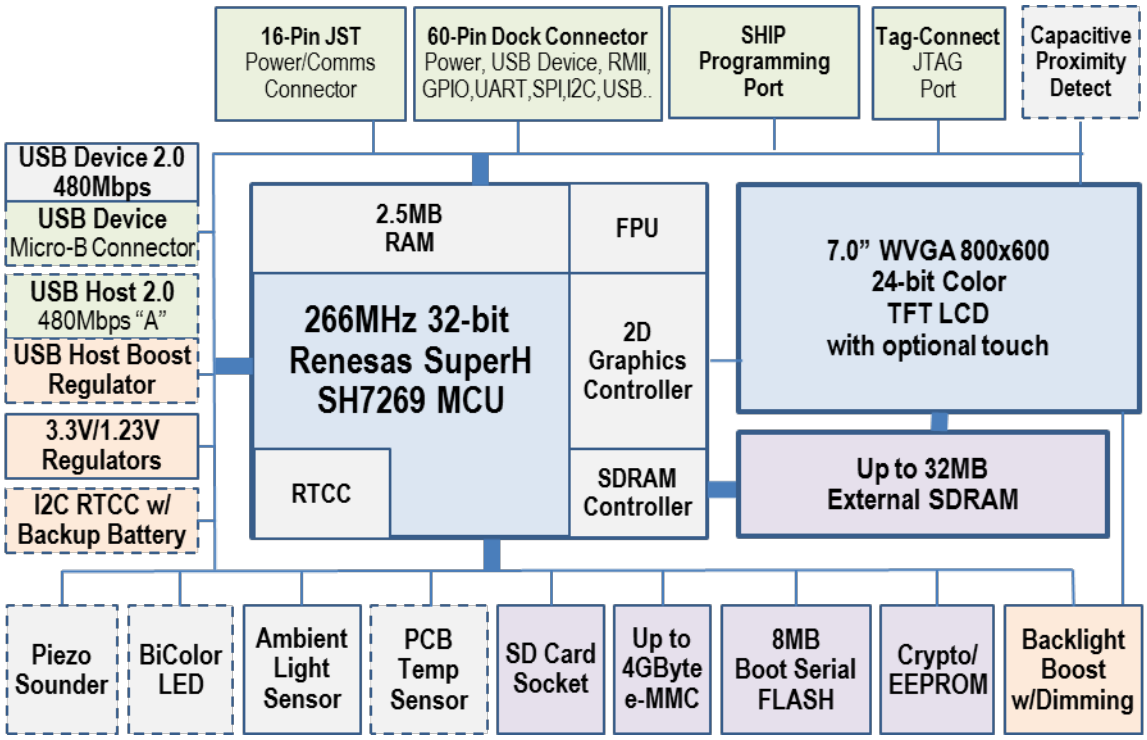
Variants with the RX111 MCU place the RX111 in the middle of this conversation: the RX111 can communicate with the SIM using one protocol (for example, Modbus or the new *SHIP Bridge* protocol) and another protocol on the network (for example, your own proprietary protocol).

For more information on the SCM117, see the *Serious* website.

HARDWARE OVERVIEW

HIGH PERFORMANCE RENESAS SH2 MCU

The heart of the SIM535 is the 32-bit Renesas SH7269 microcontroller (MCU) with up to 2.5MB of internal RAM, FPU, and integrated 2D Graphics Controller. This powerful MCU is equipped with extensive analog and digital peripherals and, with software, can deliver an excellent user interface experience. At a high level, the functional block diagram of the SIM535 is as follows:



SIM535 Hardware Block Diagram
options depend on variant selected

Not all features are available on all SIM5353 variants (family members).

GRAPHIC COLOR LCD DISPLAY AND TOUCH OPTION

The SIM535's Liquid Crystal Display ("LCD" or "glass") has an on-glass row-column driver chip for illuminating pixels but has no on-glass frame buffer or memory. The SH7269 MCU has an on-chip 2D graphics controller/accelerator for delivering pixel data at ~60 frames per second directly to the LCD over a 16, 18, or 24 bit LCD RGB interface. The MCU also has ~2.5MB of internal RAM capable of storing some or all of the pixel data that composes the image(s) to be delivered to the LCD plus other software program data. At 800x480 pixels and 16 bits per pixel, ~1.5MB of the RAM will be used for the graphic frame buffers and this data can fit inside the internal MCU RAM. When used in 24 bit color mode, one frame buffer will fit in internal RAM and the other must be placed in SIM's on-board DRAM.

Some SIM535 family members ("variants") include an integrated 4-wire resistive touch feature: a resistive film over the LCD returns an analog voltage in two dimensions which can be read by the MCU's analog-to-digital converter channels and translated with a simple algorithm into a pixel hit position. These touch-enabled variants may also include proximity detection where the proximity of a bare finger will be detectable by sensors which can be read by software.

ON-MODULE PERIPHERALS

The SIM535 contains numerous on-module peripherals – many common to a vast and diverse set of OEM applications, including a Real Time Clock/Calendar (RTCC) (battery-backed on some modules), temperature sensor, USB device, USB host, boot Serial FLASH, high speed UART(s), EEPROM, bi-color indicator LED, a user "select" switch, and more.

ON-MODULE MEMORY

The SIM535 module has a variety of memory for storage of program, data, images, parameters, etc.:

FLASH Memory:

- Up to 8Mbytes (64 Mbits) bootable serial FLASH memory attached via dedicated SPI
- Up to 4GB of e-MMC FLASH

EEPROM

- 2Kbits EEPROM

RAM

- 2.5MBytes RAM within the SH7269
- Up to 32MBytes of external DRAM

COMMUNICATIONS AND CONNECTORS

The SIM535 has numerous off-module communication ports and connectors. Some may or may not be available on specific SIM535 variants.

- 60-Pin Board-to-Board Expansion Connector with extensive I/O including:
  - SPI, I2C, CAN, and high-speed UART ports
  - USB device and host connections
  - Power input/output
  - GPIO
  - I2S and 10 bit mono 3.3V DAC
- Tag-Connect E10 Programming Port for JTAG MCU-level debugging, including:
  - Tag-Connect TC2070 adapter connection to 14-pin Renesas E10 and equivalent devices
- USB2.0 High-Speed Device Port
- USB2.0 High Speed Embedded Host Port with 150mA drive capability
- 16-pin Power/Communications Connector
  - Suitable for an inexpensive wire harness with latching plug connection
  - 3.3V Tx/Rx UART, SPI, +5V in, +3V3 out, RESET#, and DAC 3.3V (mono audio) output

POWER

The SIM535 module can be powered from 5VDC 1A typical supply applied to the **+VEXT** signal available on several connectors:

- Power and Communications Connector
- 60-Pin Board-to-Board Expansion Connector
- SHIP Programming Port

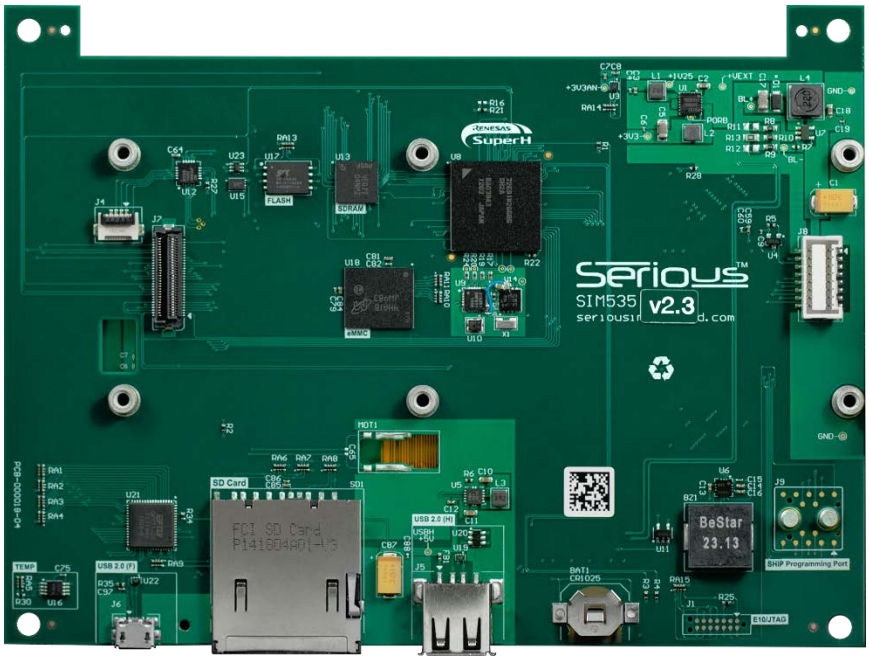
In the software development environment, the SHIP Programming Connector 200 (SPC200) plugged into the SHIP Programming Port and used with the SHIP Programming Adapter 200 (SPA200) is often the best choice.

See Getting Started for an overview of how to power the SIM535.

See DC Operating Characteristics for more information on input power supply parameters.

See Power Supplies for a detailed description of the power circuitry on the SIM.

MODULE FEATURE DETAIL



SIM535-A01 v2.0 Component Side View

RENESAS SH7269 MCU

At the heart of the SIM535 is a 266MHz 32-bit Renesas SH7269 MCU equipped with extensive analog and digital peripherals. Features include:

MCU Core & Memory

- 266MHz 32-bit core with 16KB cache
- 2,624 kB internal RAM
- Hardware Floating Point Unit (FPU)

Peripherals include:

- One USB 2.0 HS port
- SDRAM controller
- SD Card Controller
- Graphics controller with 2D acceleration (up to 800x600)
- 16-channel DMA controller
- 8 channel 10-bit A/D Converter
- Numerous SPI, I2C, CAN, I2S, and high-speed-capable serial ports

MCU BOOT MODES

The SIM535 is wired such that the SH7269 always boots from Serial FLASH. This chip comes factory programmed with a *Serious* boot loader program.

To use the full features of the Serious Human Interface™ Platform, you need to preserve the *Serious* firmware in the boot Serial FLASH.

The firmware in the boot Serial FLASH can be updated to new revisions over-the-wire from your attached system using the *Serious* SHIPBridge protocol over USB, UART, or SPI. It can also be updated over USB (via the SHIP Programming Port or USB Micro B Device Port) from a PC using the SHIPTide development tool or the SHIPCrane production programming tool.

LCD DISPLAY

The LCD display (or "glass") on the SIM535 is a 7" diagonal active area 800x480 TFT with optional 4-wire resistive touch layer. Various LCD options are available for the SIM535; see Ordering Information for more details.
The LCD display has no on-glass frame buffer or memory. The MCU is responsible for delivering pixel data at a specific frequency to the LCD display as well as various clock signals otherwise the display will not function correctly and will not display a stable image. No valid image is possible unless the MCU is operating and, under software control, the MCU is delivering pixel and timing data to the LCD display continuously. The LCD display, in absence of a valid signal from the MCU, may automatically enter self-test mode and display various cycling test patterns.

The LCD backlight is enabled when **PJ8/PWM2A-BLEN** is driven high, which turns on the backlight power boost circuit driving a constant current at approximately 9.6-18V (depending on the LCD) into the LCD's backlight LEDs. This **BLEN** signal has a weak pull-down, so the backlight is off until the MCU pin is initialized, including during and directly after system **RESET#**. This pin can be pulse-width-modulated ("PWM'd") to enable backlight dimming. A PWM driven by a typical 1 KHz clock with 16 PWM steps for a PWM net frequency of 64 Hz is generally sufficient and flicker free with duty cycles from 0 to 100%. In no circumstances should the PWM clock exceed 16 KHz.

The Serious Human Interface™ Platform has the backlight driver included; setting the platform glass backlight value to 0 to 100% automatically modulates the dimming circuit.

GRAPHICS CONTROLLER

Since the LCD display has no on-glass frame buffer, pixel data must be held in memory and streamed continuously to the display hardware. This memory must also be MCU accessible in order for software to "draw" into the frame buffers and transfer images and drawings to the screen.

On the SIM535, the SH7269 has sufficient internal RAM to contain two 16-bit frame buffers. One can be used as the currently displaying frame, the other as a hidden frame where updates and drawing can happen. Then the two can be swapped (the display controller pointed at the hidden buffer) to expose the new frame and allow the prior-displayed to be used as the new working buffer. When using 24 bit color modes, one frame buffer can held in internal RAM and the other in external RAM, or both can be in external RAM. External RAM has slower performance than internal RAM, so the location of these frame buffers is a matter of performance evaluation and tuning by the software designer.

The Serious Human Interface™ Platform software system has fully-integrated and optimized drivers and frame buffer management, making the graphics controller details transparent to the GUI designer.

TOUCH CONTROLLER

Some SIM535 family members include a resistive touch layer bonded to the LCD display. The layer can return an analog voltage in two dimensions to be read by analog-to-digital converters and translated with a software algorithm into a pixel hit position.

Resistive touch layers are made from a highly resilient Polyethylene Terephthalate (PET) film, and have the advantage of being robust and usable with a stylus, finger, or any blunt object. Unlike typical capacitive touch screens, resistive touch screens do not require the bare finger and can be used through gloves – important for certain medical, industrial, and automotive applications. They also work well in wet conditions, although appropriate caution must be taken to ensure liquids do not flow onto the SIM535 or other circuitry. *Serious* application note AN0201: Resistive Touch Bezel Guidelines is a good resource for understanding how to mount a touch screen behind a bezel.

Some chemicals including (but not limited to) Ketone-based products, harsh cleansers, and abrasive cleaning products can discolor and/or damage the PET film. To ensure long usable lifetime, make sure end-users are well-informed on how to clean and maintain the touch screen.

The SIM535 employs a stand-alone 4-wire resistive Semtech SX8656 touch controller with proximity sensing. The SX8656 provides sophisticated touch sensing/processing and delivers touch data back to the MCU via I2C. When touch data is available (for example, when the screen is pressed or a finger is dragged along the touch panel), the touch controller generates an interrupt on an MCU interrupt pin at which point software can read the device and determine the pixel coordinates and/or action.

See the I2C Device Summary for the complete table of I2C device addresses.

See the Interrupt Summary for the complete table of external peripheral interrupts.

The Serious Human Interface™ Platform has integrated touch drivers and algorithms that automatically map touch coordinates to GUI objects.

PROXIMITY SENSING

Most standard SIM535 variants include the SX8656 with proximity sensing capabilities which senses the presence of objects, like a bare finger, that alter a projected capacitive field above the touch screen surface. This enables, for example, software to "automatically" brighten the LCD backlight when a finger approaches the screen. This proximity sensing is a binary capability – the signal indicates either a finger is "near" or "not near", but does not indicate any relative positioning or indication of distance.

AMBIENT LIGHT SENSING

Some variants of the SIM535 include an Ambient Light Sensor ("ALS"), the Avago APDS-9002-021 or similar. Since the backlight on the SIM535's LCD display can be very bright, especially in low ambient light environments, software may want to modulate the backlight brightness to improve readability as well as backlight LED longevity. The ALS is connected to an MCU analog input (**PH3/AN3-ALS**) and the ambient light intensity can be derived from the ADC value.

HAPTIC FEEDBACK

Some custom variants of the SIM535 include a Haptic Feedback feature. When this feature is implemented, the Semtech SX8656 is replaced by the SX8654 (which adds the haptic driver capability) and a haptic motor is populated on the module.

Note the power consumption and heat issues related to haptic motor drive circuitry; see the Semtech data sheet for more information.

POWER SUPPLIES

POWER INPUT: +VEXT

The SIM535 is powered by the **+VEXT** signal available on the following connectors:

- 16-pin Power/Communications Connector
- 60-Pin Board-to-Board Expansion Connector
- SHIP Programming Port

There is no support for simultaneous power connectivity or dynamic power source switching. See the DC Characteristics for +VEXT limits.

Connecting more than one power source to the SIM simultaneously may damage your SIM or even connected equipment. Only one connector should drive the **+VEXT** signal. The remaining connectors can, within the limits of the SIM, receive power from this signal.

The external USB device supply is not routed to any power connections on the SIM, and is only used to detect an external host present.

Since the input voltage can have a fairly wide range, as low as 3.6V and as high as 5.5V depending on the variant, there are several switching power supplies attached to the **+VEXT** to generate the various voltages required on the SIM535:

Signal Name	Voltage	Circuits Powered

+3V3	3.3V	• MCU I/O
		• Memory
		  • SDRAM, e-MMC, SD card, Serial FLASH
		• LCD
		  • Logic, Touch
		• Peripherals
		  • USB Host, Temp Sensor, DAC/Audio

+1V25	1.25V	• MCU Core
USBH_VUSB	5.0V	• USB Host A Connector
USBH_AUX_5V	5.1V	• Piezo Driver
BL_LED+/-	9.6-18V	• LED Backlight Constant Current

TURNING SIM535 OFF: PWRDWN#

All regulators on the SIM535 can be turned off via the **PWRDWN#** signal, available on the following connectors:

- 16-pin Power/Communications Connector
- 60-Pin Board-to-Board Expansion Connector

PWRDWN# is weakly pulled high on the SIM to deliver the default powered-on behavior. Driving this signal to **GND** via logic (or connecting it to **GND** via a simple SPST switch) puts the SIM in power down mode.
The USB host, and LCD backlight are also powered off, so when **PWRDWN#** is asserted the SIM can consume only a few mA.

+3.3V (+3V3) AND +1.25V (+1V25) REGULATION

The **+VEXT** main power rail is converted to 3.3V (signal **+3V3**) and 1.25V (signal **+1V25**) through a switching power supply using the IDT P9122 or equivalent switching regulator. This regulator is capable of 90%+ efficiency and more than 1A per output.
The MCU is the only circuit on the SIM that requires 1.25V; it may draw up to 285mA at 1.25V maximum according to the SH7269 data sheet.

The 3.3V supply (**+3V3**) is far more broadly used throughout the module, powering most of the logic and peripherals. It is also delivered to the 60-Pin Board-to-Board Expansion Connector and the 16-pin Power/Communications Connector, but is only meant to supply a small amount of power to an attached system. The amount of 3.3V power available to these connectors is limited by (a) the total capacity of the regulator and (b) the excess power available on the **+3V3** signal after calculating the incoming available power minus that used on the SIM535. The DC Power Characteristics information in this manual can assist in this calculation: the actual amount available is highly dependent on the specific features used on the specific variant by the system designer.

USB DEVICE ("FUNCTION") POWER: USBF_VBUS

The **USBF_VBUS** signal is present on the following connectors:

- 60-Pin Board-to-Board Expansion Connector
- SHIP Programming Port
- USB2.0 High-Speed Device Port

The USB Micro B VBUS signal (**USBF_VBUS**) on various other connectors is directly connected to the USB Micro B power input: simultaneous connection may damage the SIM or connected devices such as a PC or USB Hub.

The SIM535 cannot be powered from the **USBF_VBUS** signal as the maximum power required by the SIM535 exceeds the ability of the USB specification. The **USBF_VBUS** signal is only used by logic on the SIM535 to determine if an external USB host has connected to the device port.

USB HOST POWER: USBH_VUSB

Some variants include a USB2.0 High Speed Embedded Host Port with USB A connector. This USB port can supply power to some USB devices, such as keyboard, mice, and thumb drives. A TI TPS2501 USB Host Power Boost Controller or equivalent ensures that even if **+VEXT** is below 4.75V, the USB Host A connector is still powered with 5.0V as required by the USB embedded host standard. The circuitry also provides overcurrent shutoff and controller notification if the device plugged into the connector draws more than 150mA.

This supply is enabled when the FTDI FT313HQ-R USB Host Controller's **PSW#** pin is asserted. This signal is delivered active-high into the boost controller's enable pin. The boost supply is disabled during **RESET#** and remains disabled until the FT313's port pin is configured by software explicitly to assert **PSW#.**

The circuit delivers up to 150 mA to the **USBH_VUSB** signal on the USB2.0 High Speed Embedded Host Port. This 150 mA will be sufficient for some powered devices, including USB thumb drives as well as some unpowered USB devices. However, it will not be sufficient for higher power devices such as USB powered printers and hard drives. When this power is exceeded, the **FAULT#** line is asserted and the circuit self-current-limits.

The USB Host power supply and any connected device can be a significant power load on the system. When initially turned on there is an inherent short term power drain as the boost controller is enabled and the **USBH_VUSB** power is generated and stabilized. If **+VEXT** is too low, the impedance of the external power supply too high, and/or the transient current support of the supply insufficient, then the SIM can self-reset. Observe the minimum recommended **+VEXT** DC Maximum Ratings carefully when the USB host feature is used.

LCD PANEL BACKLIGHT POWER: BLEN AND BL_LED+/BL_LED-

The LCD Panel has an array of LEDs creating the backlight. The LCD backlight is enabled when MCU signal **PJ8/PWM2A-BLEN** is driven high. This enable signal has a weak pull-down, so the backlight is off until the MCU pin is initialized, including during and directly after system **RESET#**.

The **PJ8/PWM2A-BLEN** signal drives the enable input of an On Semi CAT4139 or equivalent LED booster chip. The boost controller delivers a constant 45-160mA (dependent on the LCD option) to the LCD's LED array via signals **BL_LED+** and **BL_LED-**.

Backlight power is a significant portion of the SIM's power consumption. Software should carefully manage the backlight to be powered on as infrequently and for as short a time as possible – especially in battery powered systems, but also to ensure backlight longevity. Reducing the backlight power can significantly extend backlight lifetimes. Typically, operating the backlight at 50% brightness can more than double the backlight lifetime.

Software algorithms can enable the PWM capability of the **PJ8/PWM2A-BLEN** pin to enable backlight dimming. A PWM driven by a typical 1 KHz clock with 16 PWM steps for a PWM net frequency of 64 Hz is generally sufficient and flicker free with duty cycles from 0 to 100%. In no circumstances should the PWM clock exceed 16 KHz.

The proximity and ambient light sensing features (where available) can be used to assist in extending backlight longevity by dynamically adjusting the backlight power through software.

The display backlight is a significant power load on the system. When turned on there is an inherent short term power surge as well an overall power demand increase. If **+VEXT** is too low, the impedance of the external power supply too high, and/or the transient current support of the supply insufficient, then the SIM can reset. Observe the minimum recommended **+VEXT** DC Maximum Ratings carefully.

The Serious Human Interface™ Platform has the backlight driver included; setting the platform glass backlight value to 0 to 100% automatically modulates the dimming circuit.

BATTTERY BACKED REAL TIME CLOCK/CALENDAR (RTCC): +VBAT

Some SIM535 variants have an External RTCC with Optional Battery Backup chip with the battery holder option for a common CR1025-type 3V coin cell battery populated. This is not designed to be a rechargeable battery, nor does any circuit on the SIM535 supply power to charge this battery. The only purpose and connection of this coin cell battery is to provide the backup power signal +VBAT to the RTCC chip to keep the clock/calendar running in the event that all other power sources are removed. This battery can keep the clock keeping time for up to several years without replacement. The RTCC automatically switches to use the coin cell power only when main power is not available, so in a system that normally has main power applied the coin cell battery is rarely used. See External RTCC for more information.

MEMORY

SERIAL FLASH

All SIM535 family members include the SST SST25VF064C serial FLASH, a 64 megabit (8 megabyte) device with 2048 4KByte erasable blocks as well as a built-in 64-bit unique serial ID and 192 bits of OTP ID space.

The serial FLASH device is connected to SPI Channel 0 of the MCU:

Schematic Signal Name	Description	FLASH Name	MCU Name
PB19-MOSI0	SPI data MCU→FLASH	**SDI**	**PB19/MOSI0**
PB20-MISO0	SPI data FLASH→MCU	**SDO**	**PB20/MISO0**
PB17-RSPCK0	SPI FLASH clock	**SCK**	**PB17/RSPCK0**
PB18-SSL00	FLASH slave select	**CS#**	**PB18/SSL00#**
PF2-SFRST#	Serial FLASH RESET#	**HOLD#/RES#**	**PF2**

See the SST25VF064C data sheet for hardware specifications and programming details and the Renesas SH7269 datasheet for information on the SPI master port configuration. **PF2** is a generic I/O pin on the SH7269 and is wired (with a weak pull-up) to the FLASH's **RESET#** input. Left unprogrammed, the FLASH will self-reset on power-up and be in

the operational state by default. If desired, software can (by driving **PF2** low) reset the serial FLASH at will. The **PB14/SSL00#** slave select pin is also weakly pulled high, and until this port is appropriately programed the FLASH will not output data (or, see below, the Serial FLASH is driven from an external source).

The FLASH also contains factory-programmed information including the *Serious* Serial Number of the module which encodes the version, variant, and LCD option of the specific hardware. There are no "hardware identification bits" – the only way to determine what version/variant/LCD is to read this *Serious* Serial Number and decode it.

The Serious Human Interface™ Platform PC-based tools, including the SHIPTide development tool and the SHIPCrane programming tool, can read, display, and decode the *Serious* Serial Number for you through the USB2.0 High-Speed Device Port.

Using the *Serious* SHIPBridge protocol, you can fetch the *Serious* Serial Number over-the-wire (SPI, UART, USB, etc.) connecting your system ot the SIM.

The SIM535 is configured to boot from this Serial FLASH. The SH7269 automatically loads the first 8KB from the device and executes it. This boot firmware typically continues to load more of the serial FLASH into RAM (a second stage boot loader), which in turn bootstraps a file system driver for the e-MMC where the main operating program is stored.

The SPI bus and control signals for the Serial FLASH are available on the

- 16-pin Power/Communications Connector
- 60-Pin Board-to-Board Expansion Connector, and
- SHIP Programming Port.

Therefore, holding the SIM in **RESET#** and accessing the Serial FLASH through the SPI bus it is possible to reprogram the Serial FLASH directly without any prior software installed on the SIM. The SHIP Programming Port with the SHIP Programming Connector 200 (SPC200) connector and SHIP Programming Adapter 200 (SPA200) are able to access the Serial FLASH in this manner and can be used to re-install a boot loader.

Do not drive the SPI bus or Serial FLASH signals when the SIM is not in **RESET#** as this may damage the circuitry on the SIM and/or attached equipment.

SDRAM

The SIM535, depending on the variant, includes a Micron 32MB SDRAM or equivalent with a 16-bit data bus configuration. The SDRAM can operate at up to 133 MHz depending on the MCU core frequency. The MCU's built-in SDRAM controller can be configured to enable this memory in random access or burst modes.

SHIPEngine (the runtime engine of the Serious Human Interface™ Platform) automatically configures and manages the SDRAM

Serious makes every attempt to maintain 100% compatibility throughout the availibility lifetime of our devices. However components – especially memory – are subject to ongoing and sometimes frequent process, density, and availability changes. DRAM sizes and configuration for each variant are a minimum specification and vendors may vary. Software must be written to comprehend sizes beyond this minimum specification and various vendors and *Serious* reserves the right to substitute at any time multiple/different/larger devices than the specfied variant minimum.

EEPROM

The SIM535 features an Atmel ATSHA204 Cryptographic/Authentication device. Within this device is 4Kb (512 byte) EEPROM for storing security keys and/or parameter data. If the cryptographic and authentication features of the ATSHA204 are not used, the device can be used simply as a user EEPROM.

The 512 bit OTP area within the 4.5Kb EEPROM is pre-programmed by *Serious* and is unavailable for other uses. Modifying or writing to this area will void your warranty with *Serious* and render the module unusable.

The ATSHA204 is an I2C device on the SIM's main I2C control bus. This bus is shared by numerous devices: see the I2C Device Summary for more information including I2C addresses. Consult the Atmel ATSHA204 Data Sheet for programming and hardware information of the ATSHA204 device.

E-MMC FLASH MEMORY

The SIM535 module has, depending on the variant, 2GB or 4GB of embedded NAND FLASH with integrated MultiMedia Card (MMC) controller. These "e-MMC" devices eliminate the need for wear-leveling and bad-block management required by stand-alone NAND FLASH, and make bulk storage FLASH easy to manage as a linear or complex file system. The e-MMC software architecture is an industry standard, with numerous suppliers conforming to the v4 and v5 specification.

The specific e-MMC FLASH device used on a given SIM is SIM-variant specific and may be one of several devices including the Micron MTFC2G (2GB), MTFC4G (4GB), and MTFC8G (8GB) series.

Micron and other vendors have announced transitions from e-MMC v4 to e-MMC v5. SIM535s may contain either v4 or v5 devices depending on availability. Software should be written to comprehend both versions.

Serious makes every attempt to maintain 100% compatibility throughout the availibility lifetime of our devices. However components – especially memory – are subject to ongoing and sometimes frequent process, density, and availability changes. e-MMC sizes for each variant are a minimum specification and vendors may vary. Software must be written to comprehend sizes beyond this minimum specification and various vendors and *Serious* reserves the right to substitute at any time larger devices than the specfied variant minimum.

SHIPEngine (the runtime engine of the Serious Human Interface™ Platform) automatically configures and manages the e-MMC, including accomodating different sizes and versions of the e-MMC.

For programming information, consult the Micron e-MMC product website.

SD CARD SOCKET

The SIM535 module has a full sized SD Card socket, suitable for use with FLASH cards and other low power type devices. Writing software and implementing hardware for use with SD Cards may require a license from the SD Association.

SERIOUS SERIAL NUMBER

Beyond the 8MBytes of serial boot FLASH, the SST25VF064C device also has a 256 bit (32 byte) one-time programmable (OTP) region.

The Serial FLASH contains factory-programmed information including the serial number of the unit as well as variant/version information. Reading this information at run-time can enable software to dynamically adapt to the specific variant as well as accommodate any software-visible differences between versions of the specific module.

Do not write to the SST25VF064C's OTP region.
This region is reserved for manufacturing and configuration information by *Serious*.
Modifying or writing to this area will void your warranty with Serious and render the module unusable.

GUIs developed in SHIPTide can display this information at runtime.

The Serious Human Interface™ Platform PC-based tools, including the SHIPTide development tool and the SHIPCrane programming tool, can read, display, and decode the *Serious* Serial Number for you through the USB2.0 High-Speed Device Port.

Using the *Serious* SHIPBridge protocol, you can fetch the *Serious* Serial Number over-the-wire (SPI, UART, USB, etc.) connecting your system ot the SIM.

The 32-bit OTP area in the serial FLASH is structured as follows:

Location	Size (Bytes)	Contents		Example	
0x00..0x07	8	Unique SST25V064 Serial Number			
0x08..0x09	2	***Serious* Serial Number (SSN)**	ID	**0x0535**	means SIM535
0x0A	1		Version (major B7..4 + minor B3..0)	**0x21**	means v2.1
0x0B	1		Variant (see chart below)	**0x01**	means A01
0x0C	1		LCD option (see below)	**0x00**	means R43AEL
0x0D..0x0F	3		Sequence number of this unit	**0x000023**	
0x10..0x17	8	Reserved for custom OEM Serial Number			
0x18..0x1F	8	Reserved for *Serious* manufacturing information			

Locations **0x08**…**0x0F** form the unique *Serious* Serial Number (SSN) for the module. All values are stored in Big Endian order. Note that the SH7269 MCU on the SIM535 is also Big Endian.

The following table shows Variant and LCD Option maps, correlating the values at locations **0x0B** and **0x0C** respectively to the actual Variants and LCD options on the module:

Variant Byte	SIM535 Variant Name
0x01	-A01
0x02	-A02
0x03	-A03
0x04	-A04
0xFF	Invalid/Unknown
All others	Reserved

LCD Option Byte	LCD Option
0x00	R43AEL
0x01	R22ALL
0x02	R55ALL
0xFF	Invalid/Unknown
All others	Reserved

CRYPTOGRAPHIC/AUTHENTICATION DEVICE

The SIM535 features an Atmel ATSHA204 Cryptographic/Authentication device with built-in Random Number Generator (RNG) and EEPROM. The ATSHA204 is an I2C device on the SIM's main I2C control bus.

Within this device is 4Kb (512 byte) EEPROM for storing security keys and/or parameter data. If the cryptographic and authentication features of the ATSHA204 are not used, the device can be used simply as a user EEPROM.

The 512 bit OTP area within the 4.5Kb EEPROM is pre-programmed by *Serious* and is unavailable for other uses. Modifying or writing to this area **will void your warranty with *Serious*** and render the module unusable.

See the I2C Device Summary for the complete table of I2C device addresses.

Consult the Atmel ATSHA204 Data Sheet for programming and hardware information of the ATSHA204 device.

PCB TEMPERATURE SENSING

Some SIM535 variants also contain an On Semiconductor NCT75 or equivalent for measuring the system/PCB temperature. This sensor is excellent for keeping track of general system temperature, but is not an ambient air temperature sensor: accurate air temperature sensors require separation from the circuit board in order to isolate the sensor from heating sources on the board – especially the heating of the LCD backlight. As a result, the PCB Temperature Sensor will typically read a few degrees above that of the ambient temperature. The high level specifications for this device are:

Parameter	Value
Accuracy	
Maximum Sample Rate **(12 bit)**	50mS
Maximum Resolution	12 bit
Typical @ 25°C	±0.5°C
Worst Case @ 0°C to +70°C	±1.0°C
Supply Current	
Typical	440uA
Max	800uA
Shutdown Typical	3uA

The temperature sensor is an I2C device on the SIM's main I2C control bus.

See the I2C Device Summary for the complete table of I2C device addresses.

The temperature sensor can be programmed to interrupt the CPU when a temperature threshold has been exceeded. The **ALERT#** signal is connected to an MCU GPIO/Interrupt signal.

See the Interrupt Summary for the complete table of external peripheral interrupts.

See the NCT75 datasheet for more hardware specifications and programming information.

GUIs developed in SHIPTide can access the PCB Temperature Sensor's value at runtime.

CLOCKS, OSCILLATORS, AND TIME KEEPING

The following terms are important to understand theory of operation described herein:

Clock: A square-wave logic-level periodic signal (not a clock as in a timekeeping clock of time/date/minutes/hours, etc.)

Oscillator: A crystal or resonating oscillator circuit that creates a fixed-frequency sine wave used in a specific circuit to create a clock signal

RTCC: A real time clock/calendar which keeps track of the correct time/date as set by the end user or some other means.

There are many producers and consumers of stable clock signals (or "clocks") on the SIM535:

1) The SH7269 is driven a 13.33 MHz clock signal, which is internally in the MCU multiplied by 20 to yield a 266MHz CPU clock speed.
2) For variants with audio capability, the SH7269 and audio DACs require an audio sampling clock. This clock is typically 24.576MHz (48 KHz * 512), but can be changed based on the desired sampling rate.
3) Some variants have a 32.768 KHz crystal attached to an external RTCC chip. This RTCC chip, when correctly programmed via its I2C port, can deliver a 32.768 KHz clock to the SH7269's RTCC clock input.
4) Both the SH7269's USB Device port and the external USB Host port require a stable 12MHz clock to operate within USB specifications.

HIGH SPEED (MHZ) CLOCKS

The high speed clock system is driven by a 12MHz oscillator feeding a Silicon Labs Si5351C clock synthesis chip which turns the 12MHz input into 5 output clocks:

Schematic Signal Name	Programmed Frequency (MHz)	Clock Consumer
CLKMCU_13MHz	13.333	CPU Core
CLKVIDEO_27MHz	27.000	Video Input (CPU) – not used
CLKAUDIO_24MHz	24.576	Audio Sampling (CPU, D/A)
CLKUSBF_12MHz	12.000	USB Device (CPU)
CLKUSBH_12MHz	12.000	USB Host (FT313)

These frequencies can be changed at runtime via the I2C control port on the Si5351C. See the I2C Device Summary and the Silicon Labs Si5351 Data Sheet for details.

HIGH SPEED CLOCKS AND ELECTROMAGNETIC INTERFERENCE (EMI)

The SH7269 MCU is a high performance, high speed device and hence may (as compared to lower speed logic) create concerns on the part of the system design with regards to radiated electromagnetic interference (EMI). The EMI characteristics of a SIM will change as it is installed in a specific customer configuration, and there are two main tools available to the system designer to help manage EMI if issues do arise.

The Si5351C's output frequencies can be software-adjusted to help minimize certain EMI frequencies that may cause issues when mounted in a complete system, and the chip also provides for a spread-spectrum feature.

MCU REAL-TIME CLOCK/CALENDAR (RTCC)

The SH7269 MCU has an internal Real-Time Clock/Calendar (RTCC) peripheral, designed to be driven from an attached 32.768 KHz crystal or external 32.768 KHz clock source.

Some SIM535 variants have an External RTCC chip. This chip, when properly programmed, delivers from its **CLKOUT** pin output a clean 32.768 KHz output to the SH7269 RTCC external clock input **RTC_X1**. Other variants may have a simple 32.768 KHz crystal connected to the SH7269's RTCC crystal pins **RTC_X1/RTC_X2**. The SH7269 must be configured (via software and registers) to be enabled and use the correct RTC clock input mode.

The variant can be determined at runtime by reading the variant information from the Serial FLASH.

The MCU's RTCC is not battery-backed: when system power is lost from the SIM535 (or the PWRDWN# signal is asserted) the MCU's RTCC stops operation and timekeeping is lost. The MCU's RTCC must be re-loaded after every time power is restored to the SIM. In many system architectures, the time/date is available in another portion of the system, and over a communications link the remote time/date can be periodically retrieved and programmed in to the MCU's RTCC registers.

EXTERNAL RTCC WITH OPTIONAL BATTERY BACKUP

Some SIM535 variants have an external NXP PCF8523 RTCC chip. This RTCC is completely independent of the SH7269's RTCC, and some variants support a CR1025 backup lithium coin cell battery such that when main power is lost to the SIM, the coin cell ensures the external RTCC continues to run and keep time. With a quality battery, the clock/calendar could run for up to several years without replacement.

The NXP PCF8523 RTCC, if present, has a dedicated 32.768 KHz crystal. The RTCC's **CLKOUT** pin is connected to the MCU's RTCC clock input **RTC_X1**, and must be configured to output a 32.768 KHz input if the MCU's RTCC operation is required.

Schematic Signal Name	Description	RTCC Name	MCU Name
XRTC_CLKO	RTCC Clock Output	**CLKOUT**	**RTC_X1**

The external RTCC is an I2C device on the SIM's main I2C control bus.

See the I2C Device Summary for the complete table of I2C device addresses.

Consult the PCF8523 datasheet for more hardware specifications and programming information.

SHIPEngine has built-in support for the external RTCC chip and GUIs developed with SHIPTide can easily get/set the date and time in this chip.

AUDIO

Depending on the variant the SIM535 supports various audio options including:

- piezoelectric sounder for alarm and notification "beeps"
- I2S channel inputs/output on the 60-Pin Board-to-Board Expansion Connector for an external codec, and,
- the 10-bit Single Channel DAC used as a waveform output.

SHIPEngine has built-in audio support. With only a few lines of code you can, for instance, deliver an ADPCM .wav file to the DAC and I2S outputs or make the piezo sounder beep at a given frequency/volume.

Vendors such as Micrium and Segger provide software solutions that can deliver audio waveforms to the audio outputs. Renesas also has example code for this feature.

I2S INPUTS AND OUTPUTS

The SH7269's I2S Channel 0 is connected to the 60-Pin Board-to-Board Expansion Connector enabling many input/output audio combinations:

Schematic Signal/ MCU Name	Description
PF4/SSISCK0	I2S #0 Clock
PF5/SSIWS0	I2S #0
PF6/SSITXD0	I2S #0 Tx
PF7/SSIRXD0	I2S #0 Rx

I2S channel 0 is full duplex, and has 4 pins; these can be used as GPIO pins if the I2S functionality is not required.

SHIPEngine has built-in audio support. With only a few lines of code you can, for instance, deliver an ADPCM .wav file to the I2S outputs.

PIEZO SOUNDER

Some SIM535 variants include a piezoelectric sounder suitable for notifications, alarms, etc.

The sounder is activated by applying a frequency to the **PJ27/SGOUT_3** signal. The MCU can hardware-PWM this signal so software will typically be written to drive the sounder at a given frequency with 50% duty cycle for full volume output. The duty cycle can be reduced to lower the volume.

The sounder's resonant frequency is centered between 2400 and 4000 Hz. Waveforms in this frequency range will generate the loudest perceived sounds.

The voltage multipliers within the Piezo driver are controlled with two MCU GPIO pins, **PJ25-BZEN1** and **PJ26-BZEN2** as follows:

PJ25-BZEN1	PJ26-BZEN2	Voltage Vp-p Max	Volume
0	0	Off	Off
0	1	6.6V	Low
1	0	13.2V	Medium
1	1	19.8V	High

SHIPEngine has built-in support for the Piezo sounder. With only a few lines of code you can deliver a beep with a specified volume and frequency to the sounder.

10-BIT SINGLE CHANNEL DAC

Some SIM535 variants include an Analog Devices AD5611 single-channel 10-bit DAC connected to the SH7269's Serial I/O with FIFO peripheral. This 3.3Vp-p output can be used to drive speech-quality audio (via an off-module amplifier/speaker) or any other purpose requiring an analog output.

Consult Analog Devices AD5611 datasheet for more hardware specifications and programming information.

SHIPEngine has built-in audio support. With only a few lines of code you can, for instance, deliver an ADPCM .wav file to the DAC.

The SIM535 exposes this **DAC0_OUT** signal on the 16-pin Power/Communications Connector as well as the 60-Pin Board-to-Board Expansion Connector for inexpensive mono audio output or analog device control. For more sophisticated and higher quality audio output, the SH7269's I2S port is available to daughter cards on the 60-Pin Board-to-Board Expansion Connector.

The SH7269's Serial I/O with FIFO peripheral has an internal bit rate generator which can derive the bit-clock from the frequency supplied on the SH7269's **AUDIO_CLK** pin: divisors of ½ to 1/1024 are possible. Do not confuse the bit rate of the clock delivered to the DAC with the sample rate of data delivered to the DAC. They may or may not be related.

On SIM535 variants with the clock synthesizer the **AUDIO_CLK** pin is driven by default at 24.576MHz (which is 48 KHz * 512, a standard audio frequency) and this frequency can be changed at runtime via the clock synthesizer's I2C port.

On SIM535 variants with a single 12MHz input clock, the **AUDIO_CLK** pin is also driven by this frequency (along with the CPU and USB peripherals) and cannot be modified at runtime.

When the FIFO empty/watermark signals are programmed to drive DMA or ISRs, the bit clock is directly tied to the sample rate: the sample rate is the bit rate divided by the frame size. This mode has the advantage of leveraging the FIFO, minimizing interrupts/DMA cycles, and not requiring any other timing. The downside of this mode is the relative inflexibility of the sample rate. With VersaClock® enabled variants the **AUDIO_CLK** is very flexible, however in variants with a 12MHz fixed **AUDIO_CLK** the sample rate precision and options are limited.

A different sample rate generation mechanism with more 12MHz **AUDIO_CLK** flexibility can be used: The frame-to-frame timing can be independently driven by a Count Match Timer (CMT) module at whatever frequency the programmer desires. Upon match, the CMT can cause the DMA unit to deliver a new sample to the Serial I/O FIFO. In this mode, the FIFO is only used for a single sample at a time and the bitrate to the DAC must exceed the needs of the frame-to-frame rate or the timing will be violated and the FIFO will overflow.

Of course, if the DAC is being used as a non-timed output the FIFO can be loaded with the new set point value as desired.

USER PUSHBUTTON SWITCH AND LEDS

Some SIM535 variants have a single end-user-friendly pushbutton switch on the display-side of the module near the LCD panel. The switch is connected to an MCU input that is both a general purpose input and also an interrupt input that can wake the MCU from various sleep modes. A front panel captive button or plunger can be positioned to actuate this switch. There is no requirement for an end-system to use this switch; the enclosure may cover it completely and render it inaccessible if desired.

The pushbutton, on depression, can generate an interrupt to wake the CPU.

See the Interrupt Summary for the complete table of external peripheral interrupts.

Some SIM535 variants have a bi-color (red/green) LED located on front of the display-side of the module. A bi-color LED is actually two independent LEDs in one package: the LED on the SIM535 has red and green LEDs that, when both are on, have an amber hue. Typically, a plastic or metal front panel enclosure will expose this LED through a plastic light pipe; for example, the BiVar PLP1-125-F. There is no requirement for an end-system to expose this LED. The enclosure may cover it completely and render it un-viewable if desired.

Schematic Signal Name	Description	MCU Name
PF16/IRQ4-SW1#	Switch Input (active low)	**PF16/IRQ4**
PG26/LED_RED	LED Right Red	**PG26**
PG27/LED_GRN	LED Right Green	**PG27**

I2C DEVICE SUMMARY

Numerous devices on the SIM share the primary I2C bus:

Schematic Signal Name	Description	MCU Name
PE3/SDA1	I2C Serial Data	**PE3/SDA1**
PE2/SCL1	I2C Serial Clock	**PE2/SCL1**

Each device has a unique I2C address and maximum I2C frequency as follows:

Device	Description	Max Freq (KHz)	7-Bit Address	Read Byte	Write Byte
SX86XX	Touch Controller	**400**	**1001000**	**0x91**	**0x90**
PCF8523TK	RTCC	**1000**	**1101000**	**0xD1**	**0xD0**
SI5351	Clock Synthesizer	**400**	**1100000**	**0xC1**	**0xC0**
NCT75	Temperature Sensor	**400**	**1001001**	**0x93**	**0x92**
ATSHA204	Security/EEPROM	**1000**	**1100100**	**0xC9**	**0xC8**
CAT34C02	EEPROM on SCM117	**400**	**1010000**	**0xA1**	**0xA0**

INTERRUPT SUMMARY

The following devices external to the SH7269 are connected to interrupt inputs on the processor:

Device	Description	Interrupt Purpose	Interrupt
SW1	Pushbutton	When button pressed	**PF16/IRQ4-SW1#**
SX8656	Touch Controller	Touch event	**PF17/IRQ5-TOUCH_IRQ#**
NCT75	Temperature Sensor	Temperature threshold	**PH7/PINT7-TEMPALERT#**
FT313H	USB Host Controller	USB host event	**PJ21/IRQ1-USB_IRQ#**
J8.15	16-pin Power/Communications Connector	Host device SPI data ready*	**PJ22/IRQ2-PH5/AN5**
J7.42	60-Pin Board-to-Board Expansion Connector		
J7.19	60-Pin Board-to-Board Expansion Connector	TBD	**PJ23/IRQ3**

*The *Serious* SHIPBridge protocol, when used over the SPI port communicating between the SIM and the connected host, uses this interrupt to signal data ready by the host device.

CONNECTORS

The following table summarizes the signals available on the various connectors. Not all capabilities are available on all variants: consult the SIM535 Family Member (Variant) Overview.

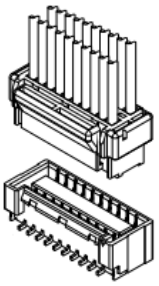
Signal(s)	JST 16[1]	FCI 60[2]	SPP [3]	TC[4]	USB F[5]	USB H[6]	Schematic Net Names	Notes
Power								
+VEXT	1	5	1				+VEXT	
+3V3	1	1		1			+3V3	
USBF_VBUS		1	1		1		USBF_VBUS	Only used to sense presence of external USB host
USBH_VUSB		1				1	USBH_VUSB	
GND	1	5	1	4	1	1	GND	
PWRDWN#	1	1					PWRDWN#	Open Drain; puts system is in shutdown/power-off mode
Reset & Debug								
E10	1	8	1	8			TMS, TMI, TDO, TCK, TRST# RESET#, ASEBRK#, ASEMD#	All JTAG-level debugging via Tag-Connect TC2070 RESET# only on JST16, SPP
USB								
USB Device		2	2		2		USBF_DM/USBF_DP	Also GND & USBF_VBUS
USB Host		2				2	USBH_DM/USBH_DP	Also GND & USBH_VUSB
Serial Communications								
UART Comm	3	3					PJ14/TXD6-UART0_TX PE6/RXD6-UART0_RX PJ31-TX_CONTROL	Main UART for attached host communications TX_CONTROL used for half duplex transmit enable.
UART/GPIO		2					PE7/RXD7-UART1_RX PJ15/TXD7-UART1_TX	Unused by most daughter cards, but available if needed.
CAN		2					PB21/A21/CRX2/IERXD PB22/A22/CTX2/IETXD/CS4#	
I2C Comm		2					PE4/SCL2 PE5/SDA2	Unused on SIM; available for Master/Slave daughter card uses. Must provide external pull-ups if used.
I2C Devices/Comm	2	2	2				PE2/SCL1 PE3/SDA1	This bus shares all the on-SIM I2C devices. Default comms device for SCM117. SIM always I2C Master and has pull-ups on both lines.
SPI (shared)	3	3	3				PB17/RSPCK0 PB19/MOSI0 PB20/MISO0	SIM always SPI Master; shared between on-board Serial FLASH and external daughter card or attached device
Comm CS#/IRQ#	2	2					PJ12-PH1/AN1 PJ22/IRQ2-PH5/AN5	SSL# for daughter card SPI slave Incoming IRQ# means daughter card has data Both signals require external pull-up if used
FLASH CS#		1	1				PB18/SSL00#	SSL# for on-SIM Serial FLASH; on-SIM pull-up
FLASH RST#		1					PF2-SFRST#	Enables overriding of boot Serial FLASH on daughter card
Other I/O								
DAC	1	1					DAC_OUT	From 10-bit DAC; rail-to-rail 3.3V output
I2S		5					PF4/SSISCK0 PF5/SSIWS0 PF6/SSITxD0 PF7/SSIRxD0 PE1/AUDIO_CLK	Full duplex; unused on SIM -- for external audio
GPIO/ADC		1					PJ13-PH2/AN2	Dual connected to MCU for ADC or GPIO usage
GPIO/IRQ		1					PJ23/IRQ3	
NC		8	2	1	1			
Total	**16**	**60**	**14**	**14**	**5**	**4**		

[1] J8: 16-pin Power/Communications Connector
[2] J7: 60-pin Expansion Connector
[3] J9: SHIP Programming Port
[4] J1: Tag-Connect JTAG Port
[5] J5: USB2.0 High Speed Embedded Host Port
[6] J6: USB Micro B Device Port

16-PIN POWER/COMMUNICATIONS CONNECTOR (J8)

A common way a SIM535 is connected to another system is via the JST ZPD Series wire-to-board connector. Relevant part numbers are:

JST Part Number	Description
BM16B-ZPDSS-TF(LF)(SN)	Shrouded Header, SMT, 16 position (2x8), Vertical
ZPDR-16V-S	Wire Housing
SZPD-002T-P0.3	Crimp pin for AWG#24 to 28 stranded wire (see ⚠ below)



This connector is identical to that found on all newer *Serious* modules, including the SIM115 and SIM231. 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 need for larger modules including the SIM535.

SHIPEngine v5 can use the UART or SPI on this connector with Modbus or the *Serious* SHIPBridge protocol to communicate between the GUI and the attached system.

Some Serious Communcations Modules (SCMs), for example the Serious Communications Module 117 (SCM117) include RS232, RS485, CAN transceivers and more, and dock into the back of the SIM535 directly.

Pin	Schematic Net Name	Description
1	**+VEXT**	Incoming +5VDC power pin; see Power Supplies.
2	**GND**	System Ground; see Power Supplies.
3	**+3V3**	Regulated +3.3VDC output from SIM; see Power Supplies.
4	**PWRDWN#**	Shutdown Input; see Power Supplies.
5	**RESET#**	System RESET# input and/or output; pulled high on the module.
6	**PE2/SCL1**	I2C Clock (shared with I2C SIM devices)
7	**DAC_OUT**	GPIO or 3.3V p-p DAC output
8	**PE3/SDA1**	I2C Data (shared with I2C SIM devices)
9	**PJ14/TXD6-UART0_TX**	UART TxD pin (3.3V).
10	**PB20/MISO0**	SPI Master In/Slave Out
11	**PE6/RXD6-UART0_RX**	UART RxD pin (3.3V).
12	**PB19/MOSI0**	SPI Master Out/Slave In
13	**PJ31-TX_CONTROL**	UART Tx Enable for half duplex or multi-drop transceivers.
14	**PB17/RSPCK0**	SPI Slave Clock
15	**PJ22/IRQ2-PH5/AN5**	IRQ input meaning “host SPI data ready”.
16	**PJ12-PH1/AN1**	SPI Slave Select

There is no legacy full-level RS232 port on the SIM535. However, a simple and very inexpensive adaptor (such as the CircuitMonkey.com USB-Serial TTL Adapter) can be easily attached to primary 3.3V UART Tx/Rx signals to enable full serial-over-USB communications to a PC. Alternatively, a common RS232 chip (like the venerable MAX232 or similar device) can boost the 3.3V UART levels to traditional RS232 voltages.

The JST ZPD series is fully RoHS and UL94V-0 compliant. In addition, it supports full -40 to 85C operation.

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

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.

While the signal wires of the connector can be any size between AWG#24 and AWG#28, the two main power connections (**+VEXT**, **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 is recommended for the **+VIN** and **GND** power connections, and generally AWG#28 is acceptable for the remaining signals.

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

Several signals on this connector are directly connected to signals on other connectors, including **+3V3, RESET#, +VEXT**.
Ensure these connections are appropriate or you may damage your SIM or connected equipment.

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. Most SIM535 Development Kits include a sample single-ended wire harness for your use in prototyping.

60-PIN BOARD-TO-BOARD EXPANSION CONNECTOR (J7)

While the 16-pin Power and Communications Connector is the a common way to connect an external system to the SIM535, the SIM535 Serial/Power Expansion Connector is one of the most flexible off-module connectors available and exposes many more signals. Often a simple daughter-card will be attached to the SIM535 using this connector to adapt the SIM535 to a particular system environment.

The Serial/Power Expansion Connector (if present) 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.
This connector exposes numerous serial, power, and GPIO signals from the MCU, including the same connections as the 16-pin Power/Communications Connector (J8). If desired, this connector can be the only external connection to the SIM535.

SHIPEngine v5 can use the UART, SPI, or USB signals on this connector as the main communications mechanism for communicating with external systems.

The RX63N/RX631 MCUs have extensive I/O multiplexers allowing one of many different peripheral functions to map to a given I/O pin: consult the RX63N/RX631 hardware manuals for the complete list of options.

Ensure you follow the recommended mechanical guidelines for custom daughter cards.

Several signals on this connector are directly connected to signals on other connectors, including **+3V3, RESET#, +VEXT**.
Ensure that common signal connections are appropriate or you may damage your SIM or connected equipment.

Signals on this connector are as follows:

Signal	Description	Pin
+VEXT	Main input power. See Power Supplies.	1
GND	Ground	2
TRST#	MCU JTAG TRST#	3
RESET#	SIM RESET# input (weakly pulled high on SIM)	4
TCK	MCU JTAG TCK	5
PJ15/TXD7-UART1_TX	Aux UART Tx	6
TMS	MCU JTAG TMS	7
PE7/RXD7-UART1_RX	Aux UART Rx	8
TDO	MCU JTAG/UART TDO	9
ASEBRK#	MCU JTAG ASEBRK#	10
TDI	MCU JTAG/UART TDI	11
ASEMD#	MCU JTAG ASEMD#	12
+VEXT	Main input power. See Power Supplies.	13
GND	Ground	14
	Do no connect	15
	Do not connect	16
PB18/SSL00	SPI Serial FLASH Slave Select	17
PF2-SFRST#	Serial FLASH RESET# (weakly pulled high)	18
PJ23/IRQ3		19
PJ12-PH1/AN1		20
PB17/RSPCK0	SPI RSPCK	21
PE5/SDA2	I2C Data Channel 0 (no on-SIM devices share this channel)	22
PB19/MOSI0	SPI MOSI	23
PE4/SCL2	I2C Clock Channel 0 (no on-SIM devices share this channel)	24
PB20/MISO0	SPI MISO	25
DAC_OUT	10 bit DAC output 0 to 3.3V	26
+VEXT	Main input power. See Power Supplies.	27
GND	Ground	28
USBF_DP	USB Device Data- (also connected to Micro B if present)	29
PB22/A22/CTX2/IETXD/CS4#	CAN Transmit	30
USBF_DM	USB Device Data- (also connected to Micro B if present)	31
PB21/A21/CRX2/IERXD	CAN Receive	32
USBF_VBUS	USB Device ("Function") Power status input to SIM	33
USBH_VUSB	USB Host Power output from SIM	34
USBH_DP	USB Host Data+ (also connected to USB A if present)	35
PJ14/TXD6-UART0_TX	Primary UART Transmit	36
USBH_DM	USB Host Data- (also connected to USB A if present)	37
PE6/RXD6-UART0_RX	Primary UART Receive	38
PJ31/TX_CONTROL	Primary UART Transmit Enable (for half duplex etc.)	39
PE2/SCL1	I2C Clock (shared with I2C SIM devices)	40
PE3/SDA1	I2C Data (shared with I2C SIM devices)	41
PJ22/IRQ2-PH5/AN5		42
PJ13-PH2/AN2	Connected to both MCU pins; do not drive both simultaneously.	43
	Do not connect	44
+3V3	SIM generated +3.3VDC output; see +3.3V Regulation	45
PWRDWN#	SIM Power Down, weakly pulled high; see Turning SIM535 Off: PWRDWN#	46
+VEXT	Main input power. See Power Supplies.	47
GND	Ground	48
PF4/SSISCK0	I2S Clock	49
PF7/SSIRXD0	I2S Rx	50
	Do not connect	51
PF5/SSIWS0	I2S	52
	Do not connect	53
	Do not connect	54
	Do not connect	55
PF6/SSITXD0	I2S Tx	56
PE1/AUDIO_CLK	Audio Input Clock	57
	Do not connect	58
+VEXT	Main input power. See Power Supplies.	59
GND	Ground	60

USB A HOST PORT

Some SIM535 variants include USB 2.0 High Speed embedded host circuitry along with the associated USB "A" Connector. See USB Embedded Host Port for details on the port functionality and USB Host Power for power enabling and limitations.

USB MICRO B DEVICE PORT

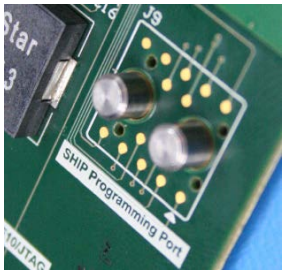
All SIM535 variants have the USB device (or "function" in USB nomenclature) circuitry populated and connected to the MCU's USB port. However, only some SIM535 variants (family members) have the USB Micro B connector present. The standard USB device signals are always present on the SHIP Programming Port and the 60-Pin Board-to-Board Expansion Connector.

The USB port is a USB 2.0 High Speed (480 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 USB Micro B Power input signal **USBF_VBUS** on various other connectors is directly connected to the USB Micro B power input: connecting any of these simultaneously may damage your SIM or even connected equipment such as a PC or USB Hub.

SHIPTide and SHIPEngine communicate over the USB Device port to download and update the SHIPEngine and GUI cargo during the development and manufacturing processes.

SHIP PROGRAMMING PORT



Programming the SIM115's GUI and SHIPEngine from the SHIPTide development tools is typically accomplished by connecting the PC running SHIPTide to the SIM using the USB Micro B connector on the SIM. The *SHIP Bridge* protocol within the *SHIPEngine* firmware as well as the *Tug* Boot Loader can operate over this USB link.

In some variants, the SIM will not have the USB Micro B Device Connector populated and some customer designed enclosures incorporating a SIM system may obstruct access to the USB Micro B Device Connector.
In these cases, the SHIP Programming Port on the SIM can be used to expose the USB device port when used with a SHIP Programming Connector SPC200 and SHIP Programming Adapter 200 (SPA200). This port replaces the PCB Edge Connector used on prior SIMs and offers many new features, including:

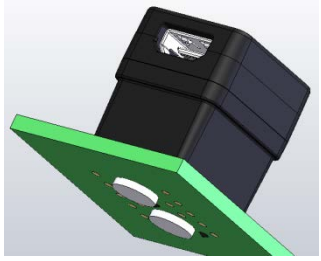
- Fast connect/disconnect
- Robust – up to 1,000,000 insertion cycles for the SPC200 cable-end
- More features – direct reprogramming capabilities of the Serial FLASH
- Supports USB 2.0 480mbps High Speed
- Small footprint
- Polarized to prevent connection if the connector is reversed

This new SHIP Programming Port is available and identical on the SIM115, SIM231, and SIM535.

In the case that a daughter card obstructs access to the SHIP Programming Port, this port may be mirrored up on the daughter card – all the signals are available on the 60-pin Expansion Connector. Contact *Serious* for details.

SHIP PROGRAMMING CONNECTOR 200 (SPC200)

Into the SHIP Programming Port is plugged a small connector – the SHIP Programming Connector 200, or SPC200.



This small connector is polarized – plugging it backwards into the SHIP Programming Port does not connect the pins to the SIM.

The SPC delivers the SHIP Programming Port signals to a small cable-friendly connector on one side. It leverages off-the-shelf HDMI cable/connector technology for this purpose, though the signals and power transmitted through the cable *are not compatible with the HDMI standard.*

Do not plug this cable into a normal HDMI port, for example on a laptop, DVD player, or TV.
The connector was chosen to leverage off-the-shelf cabling, but is not wired to the HDMI standard.
Connecting the SPC200/SPA200 with to any other device may damage the device or your SIM/SPA permanently.

Use a high quality HDMI version 1.4 cable less than 1.5 feet long, with a "Type D Micro" connector to plug into the SPC200. The other end of the cable should be the larger, more common "Type A" cable which plugs into the SHIP Programming Adapter 200 (SPA200).

SHIP PROGRAMMING ADAPTER 200 (SPA200)

The Serious Programming Adapter SPA200 is an inexpensive programming/USB intelligent adapter for use with the SIM115 and other Serious Integrated Modules. The SPA200 includes the following connectors:

- USB Micro B connector exposing (via an on-SPA hub) the USB device port of the SIM
- USB Micro B connector for powering the SPA and SIM from a USB AC power adapter
- HDMI Type A connector for connection to the SPC200

At its very simplest, the SPA200 enables connectivity between a PC USB port and the SIM's USB device circuitry, even if the SIMs USB Micro B connector is not populated or is obstructed. This is necessary for development and volume reprogramming/updating of the GUI and firmware from the SHIP environment.
The SPA200 has numerous other features beyond the scope of this document; contact Serious for more information or visit www.seriousintegrated.com/SPA200.

TAG-CONNECT E10 PROGRAMMING PORT

Tag-Connect is a rapid-connection system designed for in-situ reprogramming or connectivity. It adds no cost to the target hardware and is implemented on the PCB through a simple set of landing pads and guide holes. The SIM535 has a 14 pin pad-set designed to accommodate the TC2070-IDC-NL and associated TC-FRICTION retaining clip. The port is designed such that the (header) connector on the TC2070 ribbon cable can plug directly into a Renesas E10 programmer/debugger without any additional adapters or cables.

IDC

Plugging into incompatible devices may damage the SIM or connected device.

UNIVERSIAL SERIAL BUS (USB)

All SIM535 variants have a single USB 2.0 High Speed (480Mbit/s) device (or "function") capability, though not all variants have the associated Micro B connector. The USB Device signals are also available on other connectors (if present) including the 60-Pin Board-to-Board Expansion Connector and the SHIP Programming Port. Some SIM535 variants also have a USB 2.0 High Speed embedded host "A" connector and associated capability for (typically) support of USB thumb drives, keyboards, mice, etc.

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** and SHIPEngine software identifies all SIM535 family members as VID **0x25D8 and** PID **0x0535**.

You may use the *Serious* VID only with the Serious Human Interface™ Platform by using SHIPEngine on the module. If you wish to program your own software for the SIM, you must obtain your own VID from the USB Implementers Forum.

Many Serious Integrated Modules (SIMs) starting in late 2012 will come with a factory-installed boot loader program. This boot loader, when entering boot loader mode, will identify all SIMs (all families) with VID **0x25D8** and PIDs in the **0x0001…0x00FF** range.
This boot loader is available for re-installation; see Additional Information.

SOFTWARE

Renesas provides extensive documentation of the SH7269 MCU as well as example software: consult the Renesas USB Driver software website.

Vendors such as Micrium and Segger provide complete USB stacks pre-ported to SH2 MCUs.

USB2.0 HIGH-SPEED DEVICE PORT

The SH7269 MCU used on the SIM535 has a USB 2.0 High Speed (480Mbit/s) device (or "function") port. All SIM535 variants have the USB device port *circuitry* connected to this port. From a data-connectivity perspective, this port is commonly plugged into a PC and, depending on user-supplied software, can act like any number of PC peripherals such as a serial port. While all variants have the USB Device capability, only some variants have the USB Micro B connector.

SHIPEngine contains built-in USB device stacks and protocols that allow the SIM535 to communicate directly with SHIPTide (the rapid GUI development IDE) so GUIs can be downloaded quickly and simply from the PC to the SIM.

The SHIP Programming Port is available on all variants and makes these signals always available. The SHIP Programming Connector 200 (SPC200) plugs into this port, and with a suitable programming adapter such as the SHIP Programming Adapter 200 (SPA200) the SIM535 can be programmed and GUIs can be created from a PC.

USB2.0 HIGH SPEED EMBEDDED HOST PORT

Some SIM535 variants include a USB2.0 High Speed 480mbps Embedded Host Port. This port can (with the appropriate user-supplied software) drive a USB device such as a printer, Wi-Fi module, keyboard, or FLASH thumb drive. The port is managed by an FTDI FT313HQ-R USB Host Controller, connected to the 16-bit address/data bus of the SH7269 and accessed through chip select **PF3/CS2#-USBH_CS#**. For programming information, consult the FT313H data sheet.

This port can supply up to 150mA of power and has built-in current limiting and over-stress shutdown capabilities. The USB Host power supply system is described here. The USB host power is powered off at **RESET#** and must be enabled through software controlling the FT313H chip, which in turn controls the host power supply system.

ADDITIONAL INFORMATION

The home page for SIM535 technical documentation is:

www.seriousintegrated.com/docs/SIM535

Further documentation, including schematics, SolidWorks/STEP files, and more can be found there.

Information about the SHIP Programming Port, including the SHIP Programming Connector 200 (SPC200) and SHIP Programming Adapter 200 (SPA200) can be found at www.seriousintegrated.com/SPAs.

For more information on the SIM535:

- Visit www.seriousintegrated.com/SIM535
- Contact a Serious manufacturers' representative
- Contact a Serious authorized distributor
- Visit mySerious.com
- Contact Serious directly