Chipsmall Limited consists of a professional team with an average of over 10 year of expertise in the distribution of electronic components. Based in Hongkong, we have already established firm and mutual-benefit business relationships with customers from,Europe,America and south Asia,supplying obsolete and hard-to-find components to meet their specific needs.

With the principle of “Quality Parts,Customers Priority,Honest Operation,and Considerate Service”,our business mainly focus on the distribution of electronic components. Line cards we deal with include Microchip,ALPS,ROHM,Xilinx,Pulse,ON,Everlight and Freescale. Main products comprise IC,Modules,Potentiometer,IC Socket,Relay,Connector.Our parts cover such applications as commercial,industrial, and automotives areas.

We are looking forward to setting up business relationship with you and hope to provide you with the best service and solution. Let us make a better world for our industry!

Contact us

Tel: +86-755-8981 8866 Fax: +86-755-8427 6832
Email & Skype: info@chipsmall.com Web: www.chipsmall.com
Address: A1208, Overseas Decoration Building, #122 Zhenhua RD., Futian, Shenzhen, China

SIM115

Technical Reference Manual

IMPORTANT LEGAL NOTICE

See the latest and complete warranty, licensing and legal information at www.seriousintegrated.com/legal.

Information herein is provided in connection with Serious Integrated, Inc. ("SERIOUS") products.

The products may comprise components designed and manufactured by SERIOUS as well as other vendors. This information may refer to a variety of specifications related to those non-SERIOUS components for informational purposes only, and the user is strongly urged to consult the original manufacturers' data sheets and other documentation for authoritative specifications.

No license, express or implied, by estoppel or otherwise, to any intellectual property rights is granted by this information.

SERIOUS assumes no liability whatsoever, and SERIOUS disclaims any warranties whether express or implied, written, oral, statutory or otherwise relating to the information and its use, including any liability for warranties relating to fitness for a particular purpose, performance, quality, merchantability, or noninfringement of any patent, copyright or other intellectual property right. The user is responsible for determining the suitability of SERIOUS products for the intended application and that applicable specifications are met.

SERIOUS makes no representations or warranties with respect to the accuracy or completeness of the information and may make changes to the information, specifications and product descriptions at any time without notice. Designers should not rely on the absence or characteristics of any features or instructions marked "reserved" or "undefined." SERIOUS reserves these for future definition and shall have no responsibility whatsoever for conflicts or incompatibilities arising from future changes to such features or instructions. SERIOUS products may contain design defects or errors known as errata which may cause the product to deviate from published specifications. Current characterized errata are available upon request.

Use of SERIOUS products in automotive, military, aircraft, space, life-saving or life-sustaining applications or in any systems where failure or malfunction may result in personal injury, death or severe property or environmental damage is entirely at the buyer's risk and the buyer agrees to defend, indemnify and hold harmless SERIOUS from any and all damages, claims, suits or expenses resulting from such use.

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	23 Sep 13	1.0	• Initial prerelease version
A1	27 Sep 13	1.0	• First internal scrub; alpha customer ready

B0	20 Jan 14	2.0	• Updated for pre-production v2.0 units
			  • Removed PCB Edge connector
			  • Added Tag-Connect for JTAG
			  • Added new SHIP Programming Port
			  • Removed haptic option
			  • Finalized LCD specification for R45ALL/N55ALL versions
			  • Added LCD 24-bit support notes
			  • USB device connector changed from mini to micro
			• Added references to SCM117

B1	tbd	2.0	• Backlight enable (BLEN) moved from P11 to P24 for production • Added daughter card screw and standoff electrical recommendations • Added handling and care section

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 SIM115 family of *Serious Integrated Modules* is a series of complete intelligent 3.5" QVGA graphic front panels, some with resistive touch capability.

The SIM115 family incorporates *Serious Gatling™ Technology* for rapid-fire delivery of pixels to the display with minimal CPU overhead while retaining the cost-effective elements of a solution without a dedicated hardware graphics controller. Using this technology, the SIM115 can deliver 16 or 24 bit color frames to the LCD with little CPU and SDRAM bandwidth required.

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 SIM115 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 SIM115 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 SIM115 connected to another PCB with a $0.20 MCU, a few relays and a battery.

HARDWARE

SIM115 family features include:

- 3.5" QVGA 320x240 color TFT display
  - Various touch panel options, including 4-wire resistive with proximity detection
  - Color depths from 16 to 24-bit
  - *Serious* Gatling™ Technology for rapid-fire pixel delivery to the LCD with minimal CPU intervention
- 100MHz 32-bit Renesas RX631/RX63N MCU
  - 128KB RAM, 512KB-2MB FLASH
  - Integrated temp sensor & RTCC
  - Ethernet RMII available on expansion connector on some variants
- On Module Memory
  - 8-16MB SDRAM
  - 8-16MB serial FLASH + 4kbit EEPROM
- Extensive I/O
  - 60-pin Expansion Connector (GPIO, +5V, RESET#, I2C, SPI, UART; RMII on 63N-based units)
  - *Serious* system-to-system 16-pin Power/Communications Connector
  - SHIP Programming Port for rapid GUI/Firmware programming
  - USB Micro B Device Connector
  - USB A Host Connector
  - Tag-Connect JTAG Port
- PCB operating temperatures as wide as -40 to 85°C; LCD option may restrict operating range.

Within the SIM115 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 the Variant Table for more information. In addition to these different functional variants, various LCD options are available.

SOFTWARE

Developing a complete graphic user interface (GUI) can be a complex, time consuming, and expensive endeavor. Often tens of thousands of lines of custom C code need to be developed in conjunction with custom hardware drivers and off-the-shelf libraries. For rapid GUI development, the Serious Human Interface™ Platform offers PC-based GUI design tools and rapid GUI prototyping, development, and deployment. With minimal coding you can create attractive and functional GUIs in a fraction of the time of C-based development.

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

The SIM115 is also supported by a growing collection of Renesas, open source, as well as *Serious* proprietary software, allowing designers to gain confidence that their essential software can not only get it done, but perform to the needed end result. Available at mySerious.com for download, SIM115 programmers can obtain an out-of-the-box experience with pre-ported versions of the Micriμm uCOS-III, Segger embOS and FreeRTOS operating systems. The SIM115 includes full single-unit production licenses of the Micriμm and Segger kernels for use with each module.

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.

GETTING STARTED

The SIM115 comes pre-configured with a SHIP demo loaded into the in the RX MCU and serial FLASH.

If your SIM variant has a USB Micro B connector present, your SIM can be powered from any PC's USB port or USB hub with 500mA power capability.

Alternatively if you have purchased a development kit containing a SHIP Programming Adapter 200 (SPA200) and SHIP Programming Connector SPC200, you can plug the SPA200/SPC200 combination into the SHIP Programming Port with the SPA200 powered from a PC USB port, hub, or even a stand-alone USB AC power adapter.

Several connectors may be used to power the SIM115. See Power Supplies.

The demo will start running and displaying info on the LCD screen. For more getting started information and out-of-the-box tips, see www.seriousintegrated.com/oob.

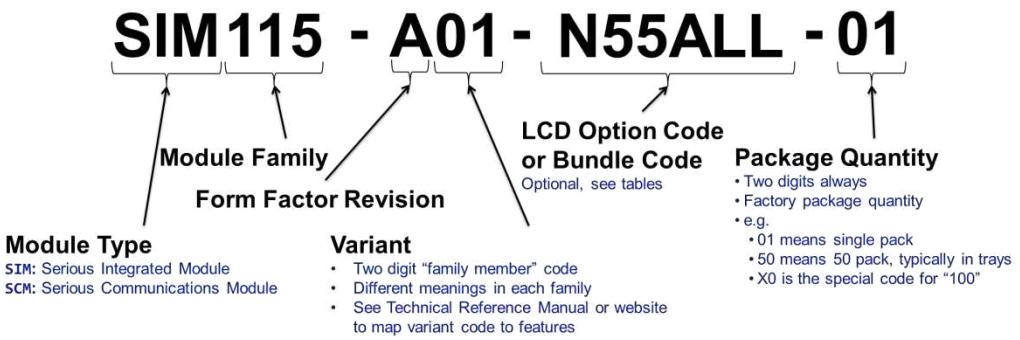
ORDERING INFORMATION

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.

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
SIM115-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
SIM115-A01-R45ALL-01	Color Graphic LCD Module 3.5" QVGA w/Serious Gatling™ Technology Res Touch, Full Featured	RX63N 768/128, 16MB DRAM, 16MB SFLASH, USB Device+Host, Piezo, RTCC, Prox, AmbLight	1
SIM115-A01-R45ALL-10			10
SIM115-A01-R45ALL-50			50
SIM115-A02-N55ALL-01	Color Graphic LCD Module 3.5" QVGA w/Serious Gatling™ Technology No Touch, Full Featured	RX63N 768/128, 16MB DRAM, 16MB SFLASH, USB Device+Host, Piezo, RTCC, AmbLight	1
SIM115-A02-N55ALL-10			10
SIM115-A02-N55ALL-50			50
SIM115-A03-R45ALL-01	Color Graphic LCD Module 3.5" QVGA w/Serious Gatling™ Technology Res Touch, Low Cost	RX631 512/128, 8MB DRAM, 8MB SFLASH, Prox, AmbLight	1
SIM115-A03-R45ALL-10			10
SIM115-A03-R45ALL-50			50
SIM115-A04-N55ALL-01	Color Graphic LCD Module 3.5" QVGA w/Serious Gatling™ Technology No Touch, Low Cost	RX631 512/128, 8MB DRAM, 8MB SFLASH, AmbLight	1
SIM115-A04-N55ALL-10			10
SIM115-A04-N55ALL-50			50

For a detailed explanation of LCD Option Codes, consult the Serious website.

VARIANT OPTIONS

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

Family Variant	A01	A02	A03	A04
MCU				
MCU	RX63N	RX63N	RX631	RX631
MCU Max MHz	100	100	100	100
MCU FLASH/RAM(kB)	768/128	768/128	512/128	512/128
JTAG E1 Debug	○◎	○◎	○◎	○◎
Memory				
SDRAM (MB)	16	16	8	8
Serial FLASH (MB)	2x8	2x8	8	8
EEPROM	✓	✓	✓	✓
LCD & Touch				
Serious Gatling™ Technology	✓	✓	✓	✓
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 FS device circuitry	S ○ ▭	S ○ ▭	S ○	S ○
USB 2.0 FS host circuitry	S ○ ▭	S ○ ▭		
Connectors				
USB 2.0 FS device Micro-B connector	✓	✓		
USB 2.0 FS host A connector	✓	✓		
60-pin Board-to-Board Expansion Connector Power, I2C, SPI, UART, DAC, RMII (w/RX63N)	✓	✓	✓	✓
16-pin *Serious* Power/Comms Connector Power, I2C, SPI, UART	✓	✓	✓	✓
Power				
Power Input (5V typical)	○ ⊙ S ▭	○ ⊙ S ▭	○⊙S	○⊙S
CR1025 coin cell holder for RTCC backup	✓	✓		

⊙ on 16-pin Power/Communications Connector
○ on 60-pin Expansion Connector
◎ on Tag-Connect JTAG Port
S on SHIP Programming Port
▭ on USB A Host Connector
▭ on USB Micro B Device Connector

⚠ This table contains prerelease information prior to product introduction and is subject to change.

LCD OPTIONS

Consult the following table for available LCD Options on the SIM115 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	R45ALL	N55ALL
Size (diagonal, active, inches)	3.5	3.5
Resolution	320x240	320x240
Touch	R4	
NITs (min typ)	400+	500+
Backlight Life (min typ, hours)	50k	50k
Viewing Technology	Landscape	Landscape
Viewing Angles (min typ)		
Y+ (12o'clock)	60°	60°
Y- (6o'clock)	40°	40°
X+ (3o'clock)	60°	60°
X- (9o'clock)	60°	60°
Proximity Detect Capable	✓	
Color Depth (bits)	16/24	16/24
Operating Temp Range	-20[1] to +70C[2]	-20[1] to +70[2]C
Storage Temp Range	-30 to +80C	-30 to +80C
On-glass RAM	0	0
Active Area (mm W x mm W)	70.08x52.56	70.08x52.56
Pixel Pitch (µm W x µm H)	219 x 219	219 x 219

Notes: [1]LCD will become slightly sluggish at low temperatures below -10C
[2]LCD will become darker near the high end of the temperature range

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.

SPECIFICATIONS

DC MAXIMUM RATINGS

The following are absolute maximum limits for the specified variants:

Specification	Variant	DC Limits			
		Min	Typ	Max	Units
Input Supply Voltage +VEXT	A01	4.50[1]	5.00	5.25	V
	A02	4.50[1]	5.00	5.25	V
	A01	3.60[2]	5.00	5.25	V
	A02	3.60[2]	5.00	5.25	V
	A03	3.60	5.00	5.50	V
	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 SIM115.

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

Specification	LCD Backlight State	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	off					mW
	100%	off					mW
	100%	on[4]	*1000*	*3000*	*1300*	*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 10-20%.
[5]Estimated (will be changed to "Measured" after characterization)

BY SUBSYSTEM

The amount of power necessary for SIM115 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. If your application does not enable 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:

Subsystem	Circuit-Local Power Required (mW)[1]			+VEXT to Local Conversion Efficiency (typ)	+VEXT Power Required (mW)[1]		
	Min	Typ	Max		Min	Typ	Max
LCD Backlight							
N55ALL LCD option		*452*	*530*	*80%*		*565*	*663*
R45ALL LCD option		*452*	*530*	*80%*		*565*	*663*
LCD Logic		*83*[3]	*120*[4]	92%		*90*[3]	*131*[4]
Serious Gatling™ Technology		*66*	*100*	92%		*72*	*108*
Piezo		*3*	*10*	92%		*4*	*11*
MCU		*178*	*370*	92%		*194*	*402*
DRAM 8MB or 16MB		200	594	92%		217	645
SFLASH 8MB or 16MB		33	83	92%		36	90
Resistive Touch		*33*	*56*	92%		*36*	*61*
USB Host		0[2]	750	*85%*		0[2]	883
Other logic and miscellaneous		*tbd*	*tbd*	*92%*		*tbd*	*tbd*

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 SIM115 are directly and exclusively connected to RX63N/631 MCU pins. Consult the RX63N/631 data sheet for complete specifications of each pin.

There are specific power limitations on the MCU pins. Consult the RX63N/631 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 SHIPWare source code as well as the full-featured Serious Human Interface™ Platform software initializes the MCU and other SIM components for correct operation.

ENVIRONMENTAL CHARACTERISTICS

The following table describes the absolute maximum environmental conditions for the SIM115:

Specification	Variant	Permissible Range			
		Min	Typ	Max	Units
Operating Temperature (not including LCD)	All	-40		+85	C
Storage Temperature (not including LCD)	All	-40		+85	C
Humidity	All			90% below 50C 60% above 50C	RH

Note that these limits do not include the LCD environmental limits. For example, while the SIM may be able to function over its full operating temperature range, often the LCD temperature range is more restrictive and the LCD may become difficult to read, sluggish, or non-functional outside its limits.

Consult the LCD Options to determine the operating and storage temperature limits for the LCD selected. In no case should the unit be stored outside the narrower of the Storage Temperature ranges of the SIM and its LCD.

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.

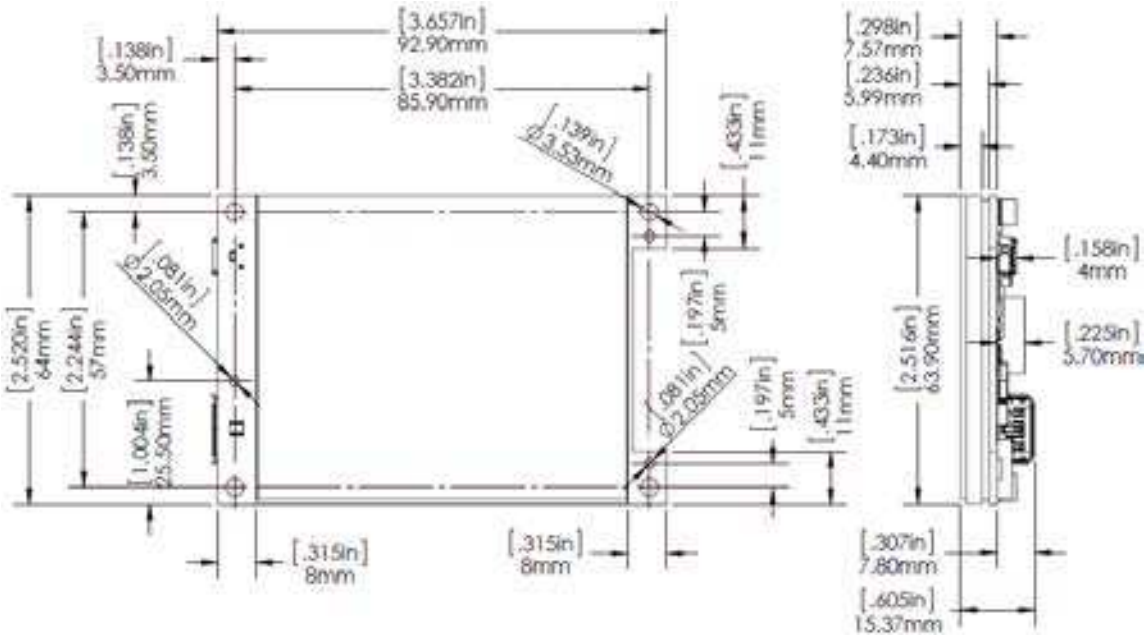
CLEANING

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

The outer dimensions of the SIM115 are approximately 93mm x 64mm. Note that for those variants with USB Micro B and/or USB A connectors populated, these connectors do extend approximately 2mm from the edge of this width. The depth of the module depends on the variant. For example, variants with resistive touch screens have the cover glass and touch layer on the LCD that increase depth by over 1mm. Also, various connectors such as the USB A connector, if populated, change the mechanical dimensions.



Example SIM115-A01-R45ALL Outline Dimensions

Mechanical drawings and SolidWorks/STEP models are available for most SIMs.
Visit www.seriousintegrated.com/docs for more information.

The weight of the module is as follows, excluding any external cable harnesses, daughter cards, or batteries:

Variant	Permissible Range	
	Typ	Units
A01	*Tbd*	g
A02	*Tbd*	g
A03	*tbd*	g
A04	59	g

DAUGHTER CARD MECHANICAL RECOMMENDATIONS

This section is provided as a helpful overview only. The authoritative mechanical reference is the SIM115 Mechanical Design Package (MDP), which includes 2D drawings and STEP models, and is available for download at www.seriousintegrated.com/docs.

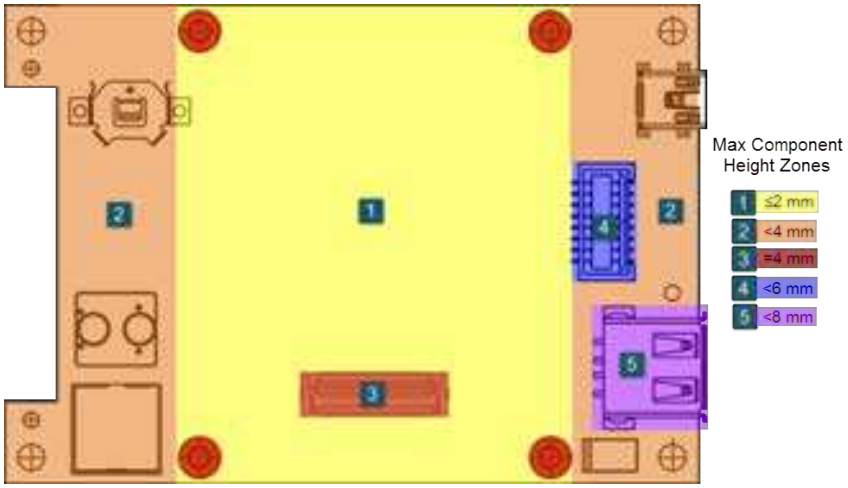
Most SIM115 variants include the 60-Pin Board-to-Board Expansion Connector. These variants also include four M3x0.5 threaded standoffs (PennEngineering® SMTSO-M3-4-ET or similar) to firmly support and attach a daughter card at the correct 4mm board-to-board distance.

These standoffs are not electrically connected on the SIM. It is not recommended that you connect the standoffs to ground, power, or any other signal via the daughter card, for example with a grounded pad the screw head mates to).

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:



SIM535-A01-R22ALL Max Height Zone Map

For example, in the yellow shaded area above, the components on the SIM 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 is in the process of releasing several new communications daughter cards designed to dock into the back of the SIM115, SIM231, and SIM535 as well as some future SIMs.

SCM117 Docked into the SIM115

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.

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

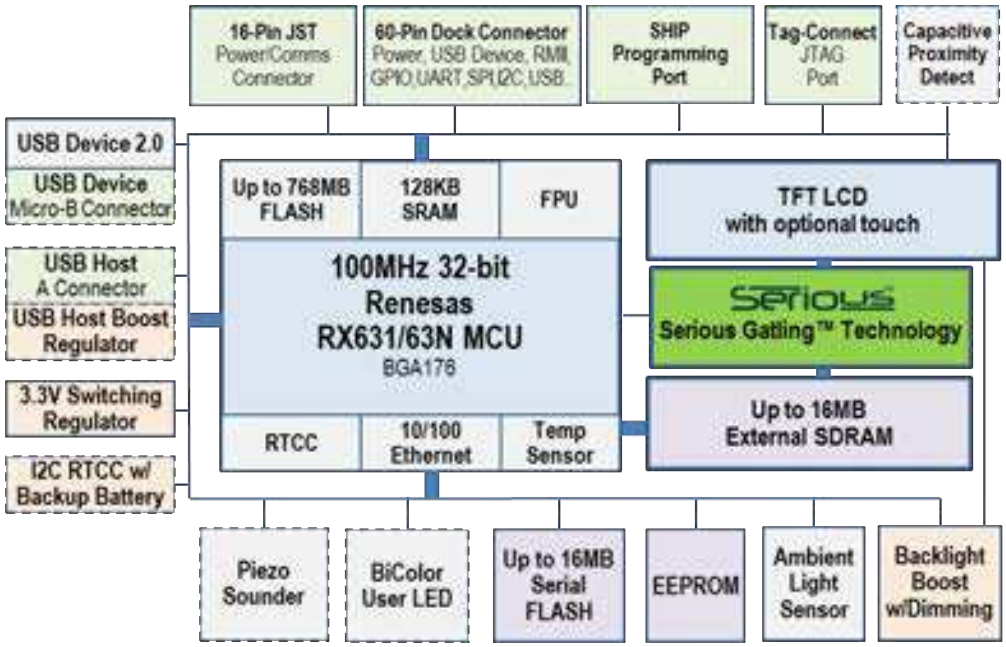
- RS232, RS422, RS485, and CAN transceivers
- Renesas RX111 MCU for local protocol translation and control
- DC-DC converter for powering the SCM and attached SIM from network-borne power

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



SIM115 Hardware Block Diagram
options depend on variant selected

Not all features are available on all SIM115 variants (family members).

HIGH PERFORMANCE RENESAS RX63N/631 MCU

The heart of the SIM115 is the 32-bit Renesas RX63N/631 microcontroller (MCU) with 128kB of internal RAM, and zero wait-state internal execution FLASH. This powerful MCU is equipped with extensive analog and digital peripherals and, with software, can deliver an excellent user interface experience.

GRAPHIC COLOR LCD DISPLAY AND TOUCH OPTION

The SIM115'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 pixel data must be delivered at approximately 60Hz per complete frame by the MCU, and stored and managed in system DRAM.

The RX63N/631 MCU does not include an on-board graphics controller; however the raw horsepower of this MCU family, when combined with its peripherals and *Serious Gatling™ Technology* on the SIM115 can deliver impressive user interfaces, including multi-layer alpha blending, animation, and more.

With a 320x240 pixel resolution at 16 bits of color information per pixel (in RGB565 format), each frame requires 153,600 bytes of RAM. For a double-buffered system, 307,200 bytes for the two frame buffers are required. *Serious* Gatling Technology delivers excellent performance in this mode: less than 10% of the SDRAM bandwidth is required to deliver the frame buffer to the LCD at 60Hz.

For color-sensitive applications, such as those with extensive gradients, the SIM115 also supports 24 bit color mode. When 24-bit color mode is enabled, twice as much DRAM is required per frame buffer, and SDRAM bandwidth required to deliver the frame buffer to the LCD at 60Hz is less than 20%.

Some SIM115 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 touch controller and translated with a ratio into a pixel hit position. These touch-enabled variants also include a capacitive proximity detection feature where the proximity of a bare finger will be detectable by sensors which can be read by software.

SERIOUS GATLING™ TECHNOLOGY

Designed to assist the MCU's existing pixel to LCD connectivity, *Serious Gatling™ Technology* enables lower CPU overhead, increased throughput, and improved efficiency of rapid-fire pixel delivery from the CPU-Memory subsystem to the LCD display.

On the SIM115, the technology is implemented in an FPGA. The FPGA chip accommodates a fly-by-burst-mode DMA from the MCU into its internal pixel FIFO and delivers a fixed rate pixel stream to the LCD. It also manages all the timing to the LCD screen, delivering pixels at a rate determined by the FPGA configuration. This configuration (available from *Serious*) is downloaded at boot time through the RX MCU's SPI port.

The DMA unit on the RX MCU must be programmed to continuously deliver the current frame buffer as requested by the chip in a DREQ#/DACK# cycle using SDRAM continuous access single cycle mode.

The no-cost Serious Human Interface™ Platform software automatically initializes the FPGA and includes the correct driver for the SIM115's implementation of Serious Gatling Technology.

ON-MODULE PERIPHERALS

The SIM115 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), USB device, USB host, serial FLASH, high speed UART(s), EEPROM, bi-color indicator LED, and more.

ON-MODULE MEMORY

The SIM115 module has a variety of memory for storage of program, data, images, parameters, etc.:

FLASH Memory:

- Up to 16MB serial FLASH memory attached via dedicated SPI (either 1 or 2 8MB chips)

EEPROM

- Up to 4kbits EEPROM

RAM

- 128kB RAM within the RX63N/RX631 MCU
- Up to 16MBytes of SDRAM

COMMUNICATIONS AND CONNECTORS

The SIM115 has numerous off-module communication ports and connectors. Some may or may not be available on specific SIM115 variants.

- 60-pin Board-to-Board Expansion Connector with extensive I/O including:
  - DAC, SPI, I2C, CAN, and high-speed UART ports
  - USB device and host connections
  - Power input/output
  - GPIO
  - JTAG
  - RMII (on variants with RX63N)
- Tag-Connect JTAG Port for MCU-level programming/debugging
- SHIP Programming Port for easy reprogramming of your *Serious Human Interface™ Platform* (SHIP) GUI or SHIPEngine during development or in an high-throughput production environment
- USB Micro B Device Connector
  - USB 2.0 full speed device port
- USB Host Port
  - USB 2.0 full speed embedded host port capable of supplying up to 150mA
- 16-pin Power/Communications Connector
  - Suitable for an inexpensive wire harness with latching plug connection
  - 3.3V Tx/Rx UART, SPI, I2C, +5V in, +3V3 out, RESET#, and DAC output

POWER

The SIM115 module can be powered from the **+V_EXT** signal (typically 5V) available on several connectors:

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

The SIM115 can also be powered via the **+5V_USBF** signal on the USB device port. Commonly during GUI development with SHIPTide the USB Micro B connector can be connected to an adequately powered USB port.

Alternatively, and especially for those variants without the USB Micro B connector, the SHIP Programming Port can supply 5V from a suitable USB port on a powered hub, PC port, or USB AC Adapter when used with a SHIP Programming Adapter 200 (SPA200) and the SHIP Programming Connector SPC200.

The permissible input voltage range, by variant, is detailed in the DC Maximum Ratings section.

MODULE FEATURE DETAIL

SIM115 v2.0

RENESAS RX63N/RX631 MCU

At the heart of the SIM115 is a 100MHz 32-bit Renesas RX63N/RX631 MCU equipped with extensive analog and digital peripherals. Features include:

MCU Core & Memory

- 100MHz 32-bit core, typically operating at 96MHz on the SIM115
- 128kB zero wait state internal RAM
- Hardware Floating Point Unit (FPU)

Peripherals include:

- One USB 2.0 FS embedded host port and one USB 2.0 FS device port
- SDRAM controller
- DMA controller and Data Transfer Controller
- Multi-channel 10- and 12-bit A/D Converters
- Numerous SPI, I2C, CAN, and high-speed-capable serial ports

MCU BOOT MODES AND THE USB BOOT FLASH

Three separate FLASH memory areas are available inside the RX MCU: Program FLASH, Data FLASH, and USB Boot Mode FLASH as well as one Boot Mode ROM. Three "boot modes" are available on the RX631/RX63N MCU family based on the state of the MD and PC7 pins when the RESET# signal is released. Depending on which of the three boot modes is determined at reset, the MCU jumps to a corresponding start address for code execution.

MD	PC7	Boot Mode	Execution start after RESET#
High	X	Normal Program Boot Mode	Program FLASH reset vector
Low	Low	ROM Boot Mode	Start of Boot Mode ROM
Low	High	USB Boot Mode	Start of USB Boot Mode FLASH

In normal Program boot mode, the PC7 signal is completely available for program and system use. However, in the two special boot modes, PC7 must remain fixed throughout the operation of the mode until the subsequent RESET# and is not available for general program and system use during these special modes.

The MD1 and PC7 signals are weakly pulled high on the SIM115, ensuring that for normal operation the MCU will boot in Normal Program Boot Mode, starting execution at the main RX MCU Program FLASH reset vector. The Program FLASH can be (re)programmed in a variety of ways, including the JTAG port exposed on the Tag-Connect JTAG Port and 60-pin Expansion Connector.

The Serious Human Interface™ Platform v5 can update the RX MCU program FLASH over many different connections including USB, SPI, and UART using the built-in ***Tug*** bootloader and the ***SHIP Bridge*** protocol. This update can be performed from within the SHIPTide development environment: no JTAG debugger or C programming tools are required.

Because the PC7 and MD1 signals are available on the Tag-Connect JTAG Port and 60-pin Expansion Connector, they can be pulled low externally to the SIM forcing the SIM to go into one of the two special boot modes. Consult the Renesas RX63N/RX631 MCU Hardware Manual for additional boot mode details.
In USB Boot Mode, the processor begins execution in the 16KB USB Boot FLASH rather than the normal program FLASH. ***Serious*** programs the USB boot area with special firmware designed to function with the Serious Human Interface™ Platform tools, enabling reprogramming of the SHIPEngine and Serial FLASH with new GUI cargo files. The algorithm in this firmware is proprietary, and when the SIM115 boots in USB Boot mode the USB port will identify itself as requiring up to 500mA of bus power and having USB Vendor ID 0x25D8 (registered exclusively to *Serious*) and USB Product ID in the 0x0001 to 0x0099 range depending on the version of the protocol contained in the area.

FIRMWARE SHIPPED ON THE SIM115

The SIM115 comes with a pre-installed version of SHIPEngine v5.x, the runtime binary component of the Serious Human Interface™ Platform (SHIP).

SHIPEngine v5.x includes a complete boot loader (*Tug*) which includes upgrade and communications capabilities using the *SHIP Bridge* protocol. The boot loader and off-line upgrade system is installed in the top 8kB of the RX program FLASH as well as in the primary serial FLASH. The SHIPEngine v5 is contained in the remainder of the RX program FLASH. The GUI and configuration data, as in SHIP v4, is also contained in the remainder of the serial FLASH(s).

To use the full features of the Serious Human Interface™ Platform, you need to preserve the *Serious* firmware in the RX program FLASH and serial FLASH(s). Modifying/erasing either the serial FLASH(s) or RX program FLASH will render the SHIPEngine and boot loader unusable. Restoring these images can be accomplished using USB Boot mode and SHIPTide/SHIPCrane tools available at www.seriousintegrated.com.

REPROGRAMMING THE SERIAL FLASH

The on-SIM serial FLASH chip(s) can be re-programmed via software or with custom hardware by externally holding the SIM in RESET# and accessing the serial FLASH through the SPI bus present on these connectors:

- 60-pin Expansion Connector
- SHIP Programming Port

The Serious Human Interface™ Platform v5 can update the serial FLASH(s) over many different connections including USB, SPI, and UART.

REPROGRAMMING THE RX MCU PROGRAM FLASH

The RX MCU program FLASH can be re-programmed from a JTAG debuggger (such as the Renesas E1 or Segger L-Link) via the Tag-Connect JTAG Port using a Tag Connect TC2070 cable, available directly from Tag-Connect.com or Digi-Key.

The Serious Human Interface™ Platform v5 can update the RX MCU program FLASH over many different connections including USB, SPI, and UART.

LCD DISPLAY

The LCD display (or "glass") on the SIM115 is a 3.5" diagonal active area 320x240 TFT with optional 4-wire resistive touch layer. The LCD display has no on-glass frame buffer or memory. The MCU, with the Serious Gatling Technology assistance, 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 **P24/ MTIOC4A- BLEN** is driven high, which turns on the backlight power boost circuit driving a constant current to flow through the backlight LEDs on the LCD. 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 MCU pin has hardware pulse-width-modulation ("PWM") capability and the duty-cycle can be varied to enable backlight dimming. A typical 1kHz clock with 16 PWM steps for a PWM net frequency of 64 Hz is generally sufficient and flicker free with duty cycles from 0-100%. The PWM frequency should not exceed 16kHz.

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 SIM115, the RX63N/631 has insufficient internal RAM to contain frame buffers: multiple frame buffers can be created in the external SDRAM. Typically, two frame buffers are used: one 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 DMA channel pointed at the hidden buffer) to expose the new frame and allow the prior-displayed frame to be used as the new working buffer.

The RX63N/631 is a high performance general purpose MCU capable of driving an LCD display with very little external logic. The SIM115 implements *Serious* Gatling™ Technology: a combination of MCU-supported burst DMA and SDRAM with external logic delivering rapid-fire pixels to the LCD display with minimal MCU overhead. Depending on the configuration of the technology and the associated driver, the LCD can be operated in 16 bit or 24 bit color modes.

The no-cost SHIPWare software at mySerious.com includes all initialization code, drivers, and utilities to enable the basic functions of the graphics controller, including portrait and landscape modes and adjustable frame rates. This software is available after account sign-up and registration of your SIM115 serial number.

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 SIM115 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 in the touch controller 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