WinSystems®

The Embedded Systems Authority

# SYS-C398

## ARM® Industrial Computer in Aluminum Enclosure with NXP's i.MX 6 Processor

# Product Manual


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# Revision History

| Document Version | Last Updated Date | Brief Description of Change |
|---|---|---|
| v1.0 | 12/2016 | Initial release |

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## Trademark Acknowledgments

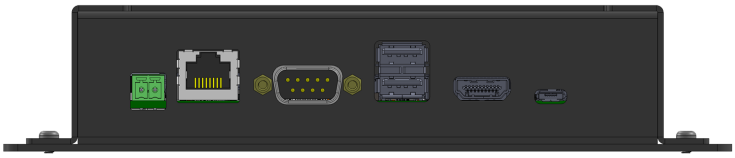
# Table of Contents

# 1. System Overview

The WinSystems SYS-C398 is a Single Board Computer (SBC) enclosed in a custom anodized aluminum enclosure. The SYS-C398 is durable and ready for the most rugged environments. See “Introduction” on page 2 for details about this manual. For details about the SYS-C398, see “Functionality” on page 2 and “Features” on page 3.

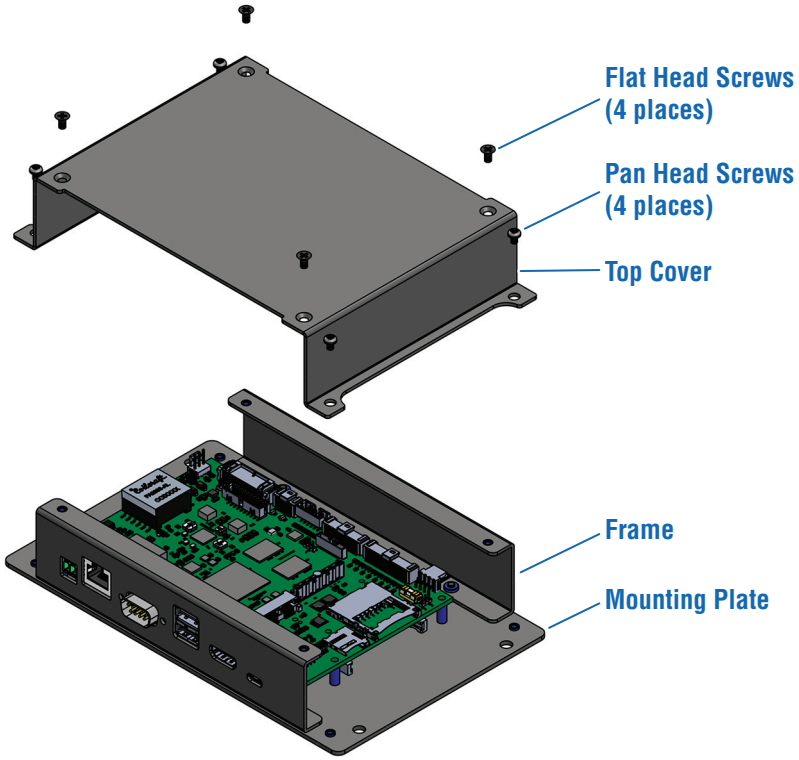
## 1.1 External Connectors, Ports, and Inputs

All external connectors, ports, and inputs are on the SYS-C398 faceplate. See “Edge Connections” on page 15 for details.



## 1.2 Access the Enclosure

Use a #2 Phillips head screwdriver to remove the eight screws (four #6-32 Flat Head screws and four #6-32 Pan Head screws) that secure the enclosure top cover to the frame and mounting plate (see the following figure). After all screws are out, lift the cover and set it aside. See “Mechanical Drawing” on page 45 for dimensions.



# 2. Introduction

This manual provides configuration and usage information for the SYS-C398. If you still have questions, contact Technical Support at (817) 274-7553, Monday through Friday, between 8 AM and 5 PM Central Standard Time (CST).

Refer to the WinSystems website for other accessories (including cable drawings and pinouts) that can be used with your SYS-C398.

# 3. Functionality

The WinSystems SYS-C398 Single Board Computer (SBC) enables customers to use the full capabilities of the NXP i.MX6 CPU, which WinSystems has integrated into a compact, rugged, industrial form factor. This design features the following:

- **High-Performance Computer:** With Single, Dual, or Quad core ARM Cortex A9 options, the SYS-C398 product family provides a high-performance, scalable, multi-core platform.
- **Multiple Displays with video acceleration:** Supporting from two to four active displays, Camera, MIPI capture and display, and power efficient accelerators for 2D, 3D, HD Video, and multimedia applications.
- **Robust I/O Platform:** Each system supports the full range of available integrated I/O, including Storage, Networking, GPIO, COM, CAN, $I^2C$, SPI, WDT, RTC, and MiniPCIe expansion.
- **Reliable in extreme environments:** WinSystems specifically designed the SYS-C398 family for the rugged and wide operating range required of modern industry. Passive Cooling operation from -40 °C to +85 °C and a wide power input range of +10 V DC to +50 V DC.

**NOTE** WinSystems can provide custom configurations for Original Equipment Manufacturer (OEM) clients. Please contact an Application Engineer through technical support for details (see “Introduction” on page 2).

# 4. Features

The different models of SYS-C398 provide the following features:

| Product Number | SYS-C398Q-2-0 | SYS-C398DL-2-0 | SYS-C398S-1-0 |
|---|---|---|---|
| **Processor** | NXP i.MX 6Q | NXP i.MX 6DL | NXP i.MX 6S |
| Cores | 4x ARM Cortex A9 | 2x ARM Cortex A9 | ARM Cortex A9 |
| Frequency | 800MHz | 800MHz | 800MHz |
| Cache | 32KB/32KB L1, 1MB L2 | 32KB/32KB L1, 512KB L2 | 32KB/32KB L1, 512KB L2 |
| **Memory** | 2GB 64bit DDR3 | 2GB 64bit DDR3 | 1GB 32bit DDR3 |
| Embedded SRAM | 256KB | 128KB | 128KB |
| **Hardware Display Accelerators** | NEON Media Processor Engine | NEON Media Processor Engine | NEON Media Processor Engine |
| 3D Graphics Core | Open GL ES 3.0, Open CL | Open GL ES 3.0 | Open GL ES 3.0 |
| 2D Graphics Core | Dual BitBlt | BitBlt | BitBlt |
| Vector Graphics Core | OpenVG 1.1 | - | - |
| **Video Interfaces** | Up to Four Active Displays | Up to Two Active Displays | Up to Two Active Displays |
| HDMI 1.4 Type A | HD1080p60 | HD1080p30 | HD1080p30 |
| LVDS Interface | 2x (2048x1536) or 2x (1280x720) | 2x (1366x768) | 2x (1366x768) |
| MIPI/DSI | Capture + Display | - | - |
| **MIPI** | Display Port + Camera Input | - | - |
| **Camera Interface** | CMOS 8 bit | CMOS 8 bit | - |
| **Ethernet*** | 1 Gbps | 1 Gbps | 1 Gbps |
| | Wake on LAN (WOL) IEEE 1588 | Wake on LAN (WOL) IEEE 1588 | Wake on LAN (WOL) IEEE 1588 |
| **Serial** | | | |
| RS 232/422/485 | 2x up to 1 Mbps | 1x up to 1 Mbps | 1x up to 1 Mbps |
| RS 422/485 | 3x up to 5 Mbps | - | - |
| **CAN Ports** | Two | Two | - |
| **USB Ports with Over Current Protection** | 6x USB 2.0 + On The Go | 6x USB 2.0 + On The Go | 6x USB 2.0 + On The Go |
| **Audio Interfaces** | HDMI + Line In/Out, Mic, Head | HDMI + Line In/Out, Mic, Head | HDMI |
| **General Purpose I/O** | 24 Lines Tolerant to 30V | 24 Lines Tolerant to 30V | 24 Lines Tolerant to 30V |
| **Mass Storage** | CFast + SD/SDIO + MicroSD | SD/SDIO + MicroSD | SD/SDIO + MicroSD |
| **Expansion Bus Connectors** | | | |
| Mini PCIe | One Half Size | One Half Size | - |
| IO60 | I2C, SPI, TTL & PWM | I2C, SPI, TTL & PWM | I2C, SPI, TTL & PWM |
| **Operating Temperature** | -40 °C to +85 °C | -40 °C to +85 °C | -40 °C to +85 °C |
| **Timers** | Three | Three | Three |
| **Real Time Clock** | Secure RTC | Secure RTC | Secure RTC |
| **Battery** | Optional External | Optional External | Optional External |
| **Watchdog Timer** | Programmable + TrustZone | Programmable + TrustZone | Programmable + TrustZone |
| **Electrical** | | | |
| PoE PD | IEEE802.3at (Up to 25W) | IEEE802.3at (Up to 25W) | IEEE802.3at (Up to 25W) |
| Aux. Input | 10–50VDC | 10–50VDC | 10–50VDC |
| **Mechanical Enclosure** | | | |
| Dimensions | 8 x 5 in (203.2 x 127 mm) | 8 x 5 in (203.2 x 127 mm) | 8 x 5 in (203.2 x 127 mm) |
| Weight | 1.2 lb (545 gm) | 1.2 lb (545 gm) | 1.2 lb (545 gm) |
| System Thickness | 1.6” (40.6 mm) | 1.6” (40.6 mm) | 1.6” (40.6 mm) |

* The theoretical maximum performance of 1 Gbps ENET is limited to 470 Mbps (total for Tx and Rx). The actual measured performance in an optimized environment is up to 400 Mbps. Per NXP IMX6DQCE Rev. 2, 5/2013/ERR004512/ ”ENET: 1 Gb Ethernet MAC (ENET) system limitation.”

# 5. Before You Begin

Review the warnings in this section and the best practice recommendations (see “Best Practices” on page 43) when using and handling the WinSystems SYS-C398. Adherence to these recommendations provides an optimal user experience and prevents damage. Read through this document and become familiar with the SYS-C398 before proceeding.


FAILING TO COMPLY WITH THESE BEST PRACTICES MAY DAMAGE THE SYS-C398 AND VOID YOUR WARRANTY.

## 5.1 Warnings

Only qualified personnel should configure and install the SYS-C398. While observing the best practices, pay particular attention to the following:

**Avoid Electrostatic Discharge (ESD)**
Only handle the circuit board and other bare electronics when electrostatic discharge (ESD) protection is in place. Having a wrist strap and a fully grounded workstation is the minimum ESD protection required before the ESD seal on the product bag is broken.

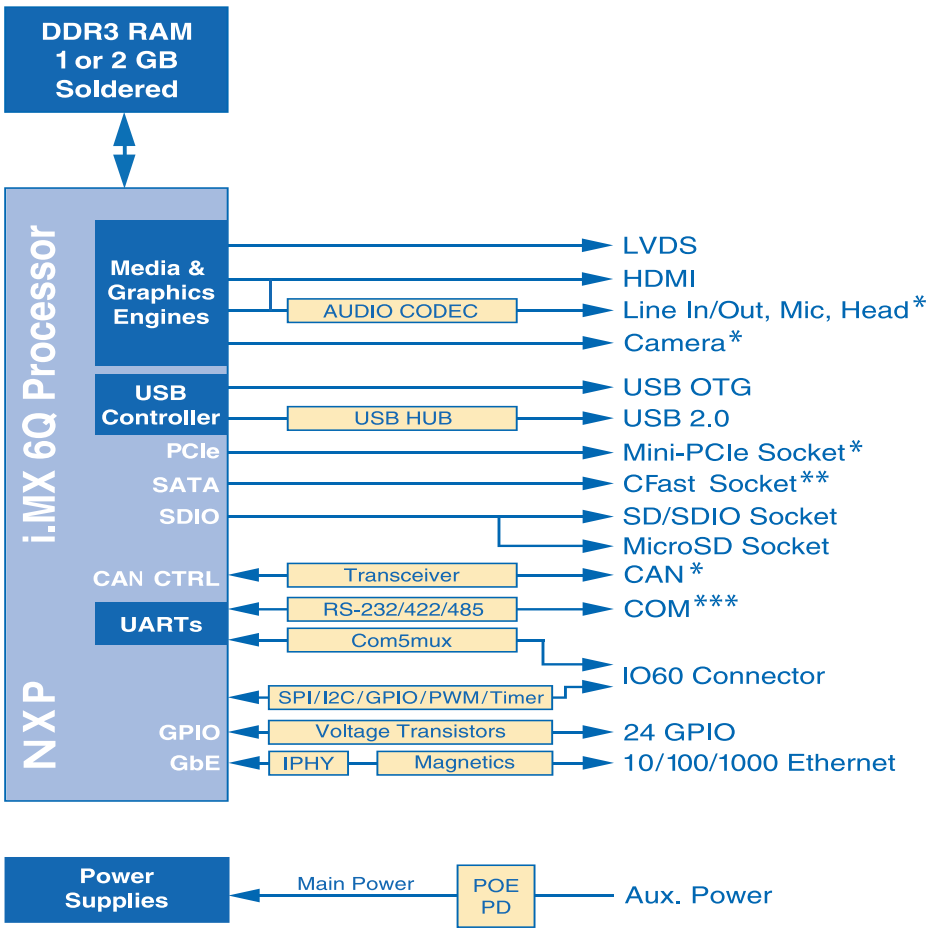

Before supplying voltage to pin 49 of J5, remove any jumper installed on JP1. Damage to the board may occur if you apply a voltage to pin 49 of J1 while a jumper is installed on JP1.

# 6. General Operation

## 6.1 System Block Diagrams

The SYS-C398 is a single-board computer (SBC). It is a full-featured embedded system with a variety of on-board I/O options. The following figure is a simplified system block of the SYS-C398:

**Figure 6–2:** Simplified Block Diagram




* Not available on SYS-C398S (SYS-C398DL and SYS-C398Q only)

** Model SYS-C398Q only

*** Available COM numbers are model specific. Refer to your model's Serial interface specifications for details.

# 7. System Board Specifications

The SYS-C398 system board adheres to the following specifications and requirements:

**SYS-C398 Specifications**

| Electrical | |
|---|---|
| $V_{CC}$ or Power | +10 V DC to + 50 V DC or Power over Ethernet (PoE IEEE802.3) at up to 25W |
| MTBF | 16.25 years |
| Models / Processor | **SYS-C398S:** NXP i.MX 6S, Single core ARM Cortex A9, 800MHz, 32KB/32KB L1, 512KB L2 (Cache), 1GB 32-bit DDR3 (Soldered), 128KB (Embedded)<br>**SYS-C398DL:** NXP i.MX 6DL, Dual core ARM Cortex A9, 800MHz, 32 KB/32 KB L1, 512 KB L2 (Cache), 2 GB 64-bit DDR3 (Soldered), 128KB (Embedded)<br>**SYS-C398Q:** NXP i.MX 6Q, Quad core ARM Cortex A9, 800MHz, 32 KB/32 KB L1, 1 MB L2 (Cache), 2 GB 64-bit DDR3 (Soldered), 256 KB (Embedded) |
| **Mechanical** | |
| Dimensions | 4 x 5.75 in (102 x 146 mm) |
| Weight | SYS-C398Q-2-0 (Quad): 5.0 oz (142.2 gm)<br>SYS-C398DL-2-0 (Dual Lite): 4.8 oz (136.1 gm)<br>SYS-C398S-1-0 (Solo): 4.2 oz (113.4 gm) |
| PCB thickness | 0.078 inch (1.98 mm) |
| **Environmental** | |
| Temperature | -40 °C and +85 °C (-40 °F and +185 °F) |
| Humidity (RH) | 5% to 95% non-condensing |
| Mechanical Shock Testing | MIL-STD-202G, Method 213B, Condition A 50g half-sine, 11 ms duration per axis, 3 axis |
| Random Vibration Testing | MIL-STD-202G, Method 214A, Condition D .1g/Hz (11.95g rms), 20 minutes per axis, 3 axis |
| RoHS Compliant | Yes |
| **Operating Systems** | |
| Runs Linux and other compatible operating systems. | |

# 8. Setup

## 8.1 Power Setup

**Use Proper Power Connections (Voltage)**—When verifying the voltage, measure it at the power connector on the SYS-C398. Measuring it at the power supply does not account for voltage drop through the wire and connectors.
Power the SYS-C398 using Power over Ethernet (J16 RJ45, PoE IEEE802.3) or Auxiliary Input (J17, +10 V DC to + 50 V DC). Verify the power connections. Incorrect voltages can cause catastrophic damage.

Power can be provided to the SYS-C398 through either of two inputs:

1. +10 V DC to +50 V DC power supply connected to the green power connector at J17.
2. IEEE 802.3 at compliant Power over Ethernet (PoE).

See “Power up” on page 8 for additional information.

## 8.2 Serial Console Setup

A serial cable connected to the SBC and a secondary system with a terminal emulator program is required to view the serial console output of the SYS-C398 SBC and to configure the SBC through the U-Boot boot loader interface. The default serial port settings are:

- Baud rate = 115200
- Data width = 8 bits
- Parity = None
- Stop = 1 bit
- Flow Control = Off

See “Console” on page 12 for additional information.

## 8.3 Keyboard and Mouse

Connect a keyboard and mouse to the SYS-C398 through the USB connectors.

## 8.4 Audio and Video Display Setup

The SYS-C398 can provide three separate video outputs, one HDMI and two LVDS. See “Video Output” on page 12 for additional information.

An audio cable bundle is available from WinSystems for the SYS-C398Q board (P/N CBL-AUDIO2-202-12D). It attaches to **J12** and brings the analog audio signals out to

1/8” phone jacks. The signals available on the cable are Line Out, Headphone, Line In, and Microphone In. In addition to the analog audio outputs & inputs, the SYS-C398Q also supports digital audio on the HDMI video connector. Plugging this connector into a device with HDMI audio capability allows the board to play audio through the device.

## 8.5 Startup

As shipped from the factory, the SYS-C398Q uses the **JP5** jumpers to signal the i.MX6 ARM processor which device loads the initial boot application. The default device is on-board SPI-NOR flash, but boot-up can be loaded from the SD card or the microSD card if desired.

U-Boot is the default boot loader installed on the SYS-C398. U-Boot has been ported to the board, and all of the board’s boot peripherals are available for use from within U-Boot. The boot loader uses environment variables to specify configuration of the board during startup; the variables also specify the operating system boot device, and any variables that pass on to the operating system during startup. As shipped from the factory, U-Boot environment variables are stored in a partition of the SPI-NOR flash.

## 8.6 Power up

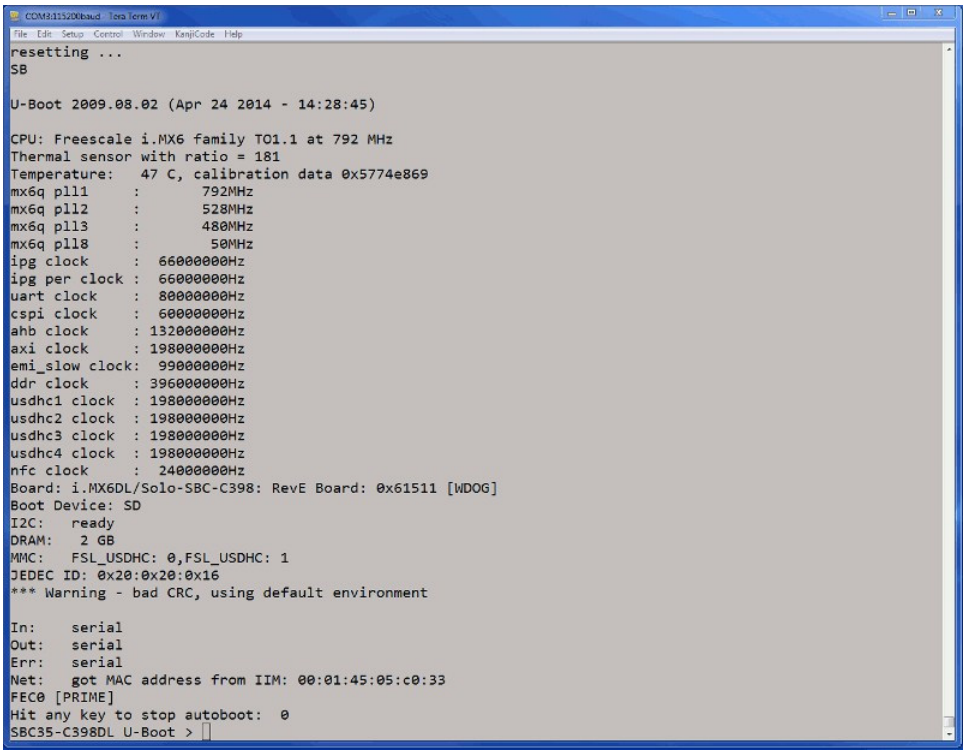
Once the SYS-C398 powers up, the boot loader starts. U-Boot pauses for three seconds to allow for aborting the OS boot. If you do not abort the OS boot during the three-second window, the system loads the WinSystems Linaro distribution of Linux. The U-Boot OS abort period is programmable - it can be changed by aborting an OS boot and changing the bootdelay parameters. Please remember to save the changes to the SPI-NOR flash device after modifying the parameters. If you abort the U-Boot OS boot by pressing any key during the three-second pause, the U-Boot command prompt displays as shown in the screen snapshot on the next page.

**NOTE** The open source U-Boot project is hosted at http://www.denx.de/wiki/U-Boot. Extensive U-Boot documentation is available for download from this site.

The image depicted in the figure titled “U-Boot Screen During Startup” on page 36 shows the U-Boot startup screen and OS boot countdown boot screen from an SYS-C398 Dual Core or Single Core board.

**NOTE** The **“*** Warning - bad CRC…”** message is an indicator that U-Boot is using the built-in environment variables and not a local copy from SPI-NOR flash. If a variable were added or modified and the environment saved with the U-Boot **saveenv** command, this message would not be present.

U-Boot Screen During Startup




## 8.7 U-Boot Commands

U-Boot supports commands that are executable from the U-Boot command prompt. This manual focuses on commands used to display and change the boot configuration.

**NOTE** Use single quotes for argument strings that require spaces and environment variables, as depicted in the following examples:

| Example | Command string |
|---|---|
| Single quote requirement for argument strings with spaces. | `setenv bootcmd 'run bootcmd_mmc'`<br>`setenv ipaddr '192.16.1.104'` |
| Single quote requirement for environment variables. | `setenv bootdelay '10'` |
| Alternate single quote requirement for environment variables. | `setenv fastboot_dev 'mmc1'` |

The U-Boot commands, formats, and functions table provides U-Boot commands to display and change the boot configuration, an example of syntax in context, and command definitions.

**U-Boot commands, Formats, and Functions**.

| Command | Example Format in Context | Command Definition |
|---|---|---|
| printenv | printenv | Prints a list with all variables in the environment and their values, plus some statistics about the current usage and the total size of the memory available for the environment |
| setenv | setenv <variable name><br><variable settings> | Used to define the value of environment variables, and if no argument is given (used alone), it displays all environment valuables. |
| saveenv | saveenv | This command saves environment variables to persistent storage; saving is required after making changes to any variable; without doing so, changes are lost when the system is reset |
| destroyenv | destroyenv | Erases entire contents of the U-Boot environment and restores variables to default values; it will not save the default environment to persistent storage, such as with saveenv |
| help<br>*or*<br>? | help<br>*or*<br>? | Lists all of the available U-Boot commands, and when used with an argument, such as "help run" it will list all the run commands under the help environment variable |
| reset | reset | Resets the system and restarts the boot process |
| run | run <executable> | Executes (Runs) the selected executable |
| boot | boot = run bootcmd | Executes default boot command |

## 8.8 U-Boot Environment Variables

U-Boot parameters configure the SYS-C398 during OS boot. Many should remain unchanged, but others can be modified to reflect a board's hardware specific configuration. Each U-Boot variable is stored as a character array (a string) in the board's memory. As shipped from the factory, the U-Boot parameters are stored in the same SPI flash device as U-Boot. When used in U-Boot commands, parameter names are replaced with the contents of the string associated with the variable. If you enter the U-Boot command 'printenv' on the U-Boot command line, all of the parameters will be printed followed by their string contents.

The use of an environment variable is indicated to U-Boot by surrounding the variable name with the U-Boot variable '${' and '}'. For example, to use the environment variable 'serverip' in a U-Boot command, it must be specified as follows:

```
${serverip}
```

The environment variables depicted below are the defaults for the SYS-C398Q (Quad Core).

**NOTE** Since the environment variables depicted below are not part of a command line (they are a screen printout of global environment variables), there are no single line quotes required; it is merely a list.

```
bootdelay=3
baudrate=115200
ipaddr=192.168.1.103
serverip=192.168.1.101
netmask=255.255.255.0
loadaddr=0x10800000
rd_loadaddr=0x11000000
netdev=eth0
ethprime=FEC0
kernel=uImage
cpu_count=maxcpus=4
video1=video=mxcfb0:dev=hdmi,1280x720M@60,if=RGB24
video2=video=mxcfb1:dev=ldb,1024x600M@60,if=RGB666
video3=video=mxcfb2:off
bootargs=console=ttymxc0,115200n8 ${video1} ${video2} ${video3}
bootargs_mmc=setenv bootargs ${bootargs} root=/dev/mmcblk0p2 rootwait rw ip=none ${cpu_count} bootcmd_mmc=run
bootargs_mmc; fatload ${mmc_bootdevice} ${loadaddr} ${kernel}; bootm ${loadaddr} bootcmd=run bootcmd_mmc
mmc_bootdevice=mmc 1:1
stdin=serial
stdout=serial
stderr=serial
ethact=FEC0
```

Environment variables may be composed of other variables. All of the text in a U-Boot environment variable preceded by a '`$`' and enclosed between the braces '`{`' and '`}`' are themselves environment variables. When U-Boot encounters this markup notation during variable processing, it replaces the markup characters and variable name with the variable's string contents. In the list above, the environment variable '`bootargs`' is comprised of the following string:

```
console=ttymxc0,115200n8 ${video1} ${video2} ${video3}
```

When used internally by U-Boot, `${video1}` is expanded to become:

```
video=mxcfb0:dev=hdmi,1280x720M@60,if=RGB24
```

`${video2}` will be expanded to become:

```
video=mxcfb1:dev=ldb,1024x600M@60,if=RGB666
```

and `${video3}` will expand to become:

```
video=mxcfb2: off
```

The complete expansion of the environment variable '`bootargs`' will become:

```
console=ttymxc0,115200n8
video=mxcfb0:dev=hdmi,1280x720M@60,if=RGB24
video=mxcfb1:dev=ldb,1024x600M@60,if=RGB666 video=mxcfb2: off
```

By using U-Boot's variable expansion capability, complex U-Boot environment strings can be assembled from simple strings. The following sections illustrate important U-Boot devices and their environment variables.

### 8.8.1 Console

The console argument (`console=ttymxc0,115200n8`) selects the serial device and protocol for the console output. This variable should not be changed if a console is desired, and it can be deleted if no console is used.

### 8.8.2 Video Output

There are three video outputs on the SYS-C398; one HDMI and two LVDS (Flat Panel). The two LVDS sources also provide back light support. The desired video sources and resolutions must be configured using U-Boot environment variables. The default settings enable the HDMI port with a resolution of 1280x720; the default settings also enable a single LVDS port with resolution of 1024x600.

**Setting the primary display mode:**

To set the primary display to HDMI with 1080P60 mode, and the secondary display on LVDS with XGA mode enter the following:

```
video=mxcfb0:dev=hdmi, 1920x1080M@60,if=RGB24
   video=mxcfb1:dev=ldb,LDB-XGA,if=RGB666
```

To set the primary display to LVDS with XGA mode, and the secondary display on HDMI with 1080P60 mode, enter the following:

```
video=mxcfb0:dev=ldb,LDB-XGA,if=RGB666
   video=mxcfb1:dev=hdmi,1920x1080M@60,if=RGB24
```

### 8.8.3 Specifying Active Cores

The SYS-C398Q utilizes the NXP i.MX6Q processor, which has four ARM processor cores. By default, all four cores are active. You can specify the maximum number of cores with the environment variable '`cpu_count`'.

Normally, Linux will use all available CPU cores. Changing this variable can make kernel and device driver debugging easier to accomplish. To change the number of CPU cores in use, enter the following series of commands from the U-Boot command line, substituting the number of CPUs for ***X***:

```
setenv cpu_count 'maxcpus=X'
saveenv
```

### 8.8.4 Boot Command and Boot Device

As shipped from the factory, the board is set to boot the Operating System (OS) image from an SD card. By changing certain U-Boot environment variables, the board can be directed to boot the OS image from a microSD card, an attached SATA/CFast device, or over the Ethernet. On startup, U-Boot will look in the environment for a variable named '`bootcmd`'. Typically, '`bootcmd`' directs U-Boot to execute commands contained in another environment variable. For instance, the default '`bootcmd`', which is

'run bootcmd_mmc', simply directs U-Boot to execute, as a command, the contents of environment variable 'bootcmd_mmc', which are reflected in the following table.

**Executing Boot Command Environment Variable**

| Command | Format in Context | Function |
|---|---|---|
| bootcmd | run bootcmd_mmc | On startup, U-Boot will look in the environment for a variable named 'bootcmd'. For instance, the default 'bootcmd', which is 'run bootcmd_mmc', simply directs U-Boot to execute, as a command, the contents of environment variable 'bootcmd_mmc'.The contents of 'bootcmd_mmc' are:<br>run 'bootargs_mmc'; fatload {mmc_bootdevice} ${loadaddr}${kernel}; bootm ${loadaddr}<br>The contents of environmental variable bootargs_mmc are:<br>setenv bootargs ${bootargs} root=/dev/mmcblk0p2 'rootwait' 'rw' 'ip=none'<br>This command causes UBoot to set bootargs to be the same value as the environment variable bootargs; it then specifies the root device. Further definitions of variables are as follows:<br>'rootwait' – tells U-Boot to wiat for the mount of the root file system to complete<br>'rw' – specifies that the file system is to be mounted<br>'ip=none' – directs U-Boot not to initialize the Ethernet device |

Parameters referenced in the prior table expand so the variable is replaced by the value specified in the environment. The following are options of each.

${kernel} *becomes* 'uImage '

${loadaddr} *becomes* '0x10800000'

${mmc_bootdevice} *becomes* 'mmc 1:1'

When all are completed and the variables expanded, the above commands instruct U-Boot to execute a FAT file system copy from device 'mmc 1:1' of the 'uImage' file. The file will be copied to RAM address '01080000', and then execution will begin at address '01080000'.

To use the microSD card instead of the SD card as the OS image source device, modify the environment variable 'mmc_bootdevice' so that its value becomes 'mmc 0:1' instead of 'mmc 1:1'.

To boot from a CFast/SATA device attached to the SYS-C398 board's SATA interface, modify bootcmd so that its value becomes 'run bootcmd_sata'. Changes to variable 'bootcmd_sata' and 'bootargs_sata' may also be required to boot from the desired partition of a SATA/CFast device.

It is also possible to use U-Boot to boot the kernel 'uImage' file from a network server using the TFTP protocol. This is convenient for rapid kernel debug/testing kernel configuration. It is also a great way to speed up the debug process for kernel device drivers. However this requires knowledge of the TFTP server's file system, and the correct U-Boot configuration will vary from development environment to development environment. You must install and configure a TFTP server, and copy the 'uImage' file

into the file system so that the TFTP server is configured for use. Contact your WinSystems Applications Engineer for additional information on configuring U-Boot.

### 8.8.5 Root File System

The root file system arguments (`root=/dev/mmcblk0p2 rootwait rw`) specify the device and partition where the Linux file system resides. For each device, this will be the second partition that contains a Linux ext3 file system.

### 8.8.6 U-Boot Delay

This is the amount of time after power-up during which you can press a key to abort the OS boot; if the OS boot is aborted, the U-Boot command prompt will appear and the various U-Boot commands can be executed. This delay can be changed by modifying the environment variable '`bootdelay`'. The default value is three (3 seconds). To change the value to 10 seconds enter:

```
setenv bootdelay '10'
```

# 9. Configuration

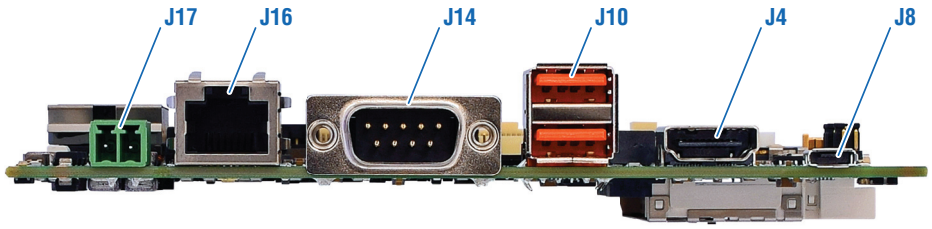
This section describes the SYS-C398 components and configuration.

## 9.1 Component Layout

The SYS-C398 provides components on the edge, top, and bottom of the board.

### 9.1.1 Edge Connections

Edge connections provide common external connections.

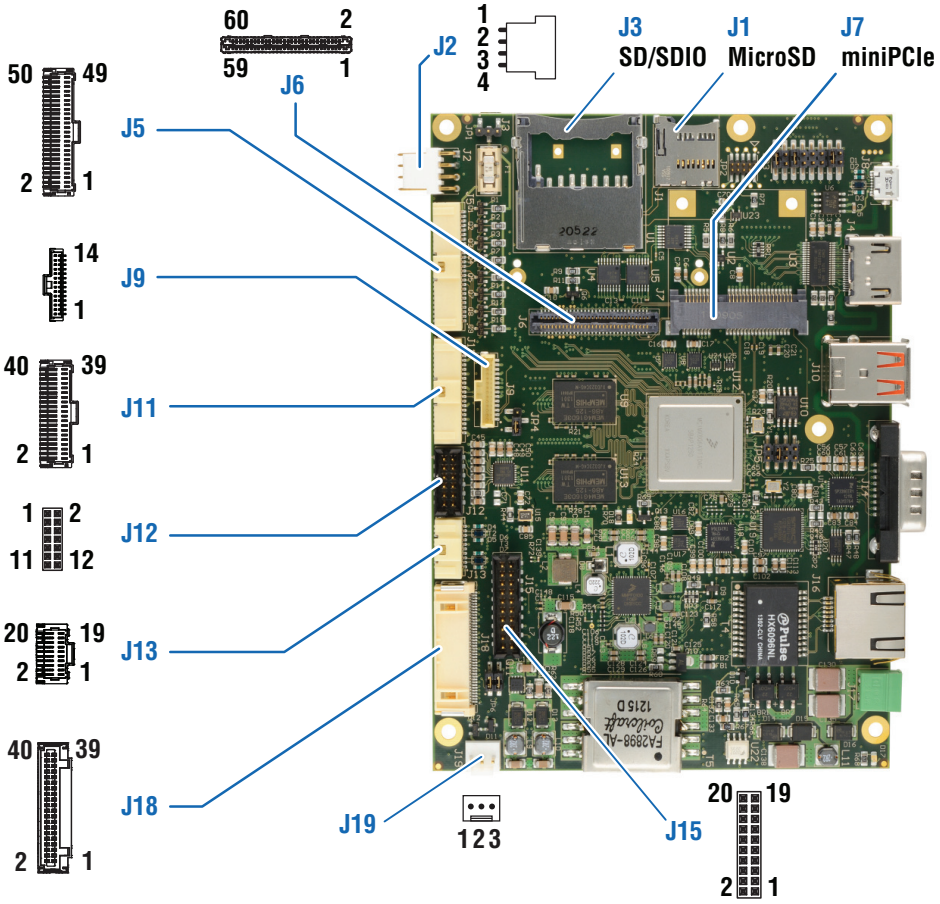



**Edge Connections**

| Item | Description | Reference |
|---|---|---|
| J4 | HDMI | page 21 |
| J8 | Micro USB (USB OTG) | page 25 |
| J10 | USB 2.0 | page 27 |
| J14 | COM 1 | page 30 |
| J16 | Ethernet Port | page 32 |
| J17 | Power Connector | page 32 |

### 9.1.2 Top View Connections

The connectors in this view connect the SYS-C398 to peripherals. Refer to “Edge Connections” on page 15 and “Bottom View Connections” on page 17 for other connections.

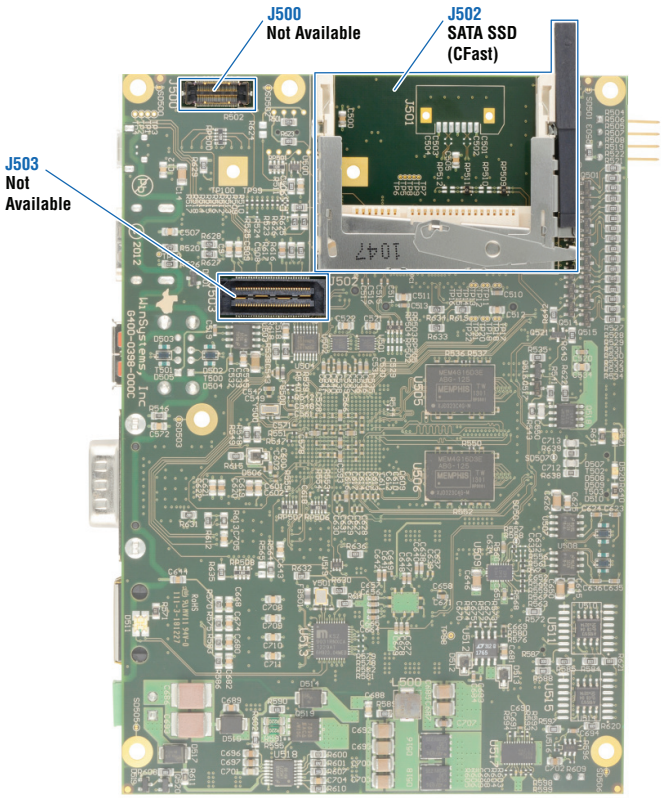



**Top View Connections**

| Item | Description | Reference |
|---|---|---|
| J1 | Micro SD | page 19 |
| J2 | Power Controls | page 20 |
| J3 | SD/SDIO | page 20 |
| J5 | GPIO | page 21 |
| J6 | IO60 Expansion Bus | page 23 |
| J7 | MiniPCIe (SYS-C398DL and SYS-C398Q Only) | page 24 |
| J9 | Backlight Power | page 26 |
| J11 | LVDS | page 28 |
| J12 | Analog Audio | page 29 |
| J13 | Four USB Ports (SYS-C398DL and SYS-C398Q Only) | page 29 |
| J15 | Controller Area Network (CAN) BUS Connector (SYS-C398DL and SYS-C398Q Only) | page 31 |
| J18 | COM 2, 3, 4, & 5 (SYS-C398Q Only) | page 33 |
| J19 | External Battery Connection | page 36 |

### 9.1.3 Bottom View Connections

The connectors in this view connect the SYS-C398 to peripherals. Refer to “Edge Connections” on page 15 and “Top View Connections” on page 16 for other connections.

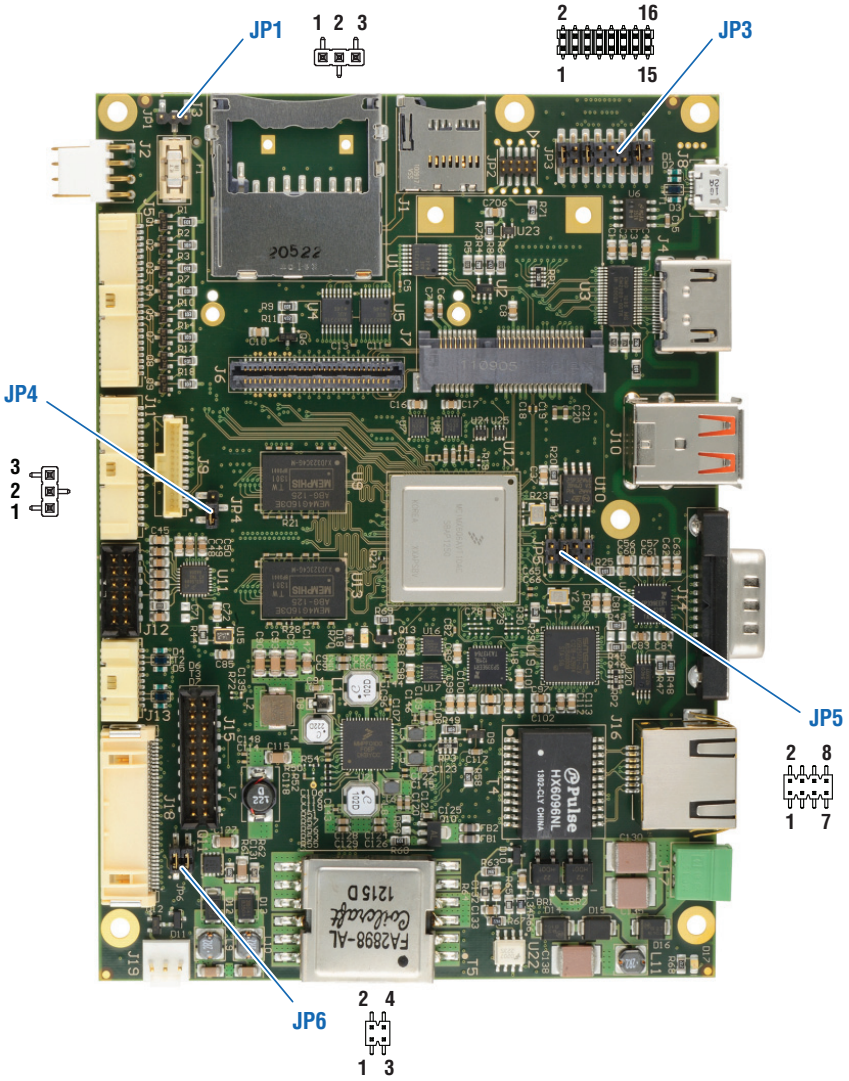



**Bottom View Connections**

| Item | Description | Reference |
|---|---|---|
| J500 | Not Available | Not Available |
| J502 | SATA SSD (CFast)(SYS-C398Q Only) | page 37 |
| J503 | Not Available | Not Available |

### 9.1.4 Jumpers

Jumpers configure the settings for the SYS-C398.




| Item | Description | Reference |
|---|---|---|
| JP1 | Digital I/O Power Jumper | page 38 |
| JP3 | Boot Configuration Jumper | page 39 |
| JP4 | Panel Power Jumper | page 40 |
| JP5 | Boot Mode Jumper | page 41 |
| JP6 | CAN Termination Jumper Block | page 41 |

## 9.2 Watchdog Timer

The SYS-C398 features the watchdog timer built into the i.MX6. This advanced watchdog timer can be used to guard against software lockups (Programmable + TrustZone).

## 9.3 Secure Real-time Clock/Calendar

A secure real-time clock is used as the clock/calendar. It supports a number of features including periodic and alarm interrupt capabilities. In addition to the time and date keeping functions, the system configuration is kept in CMOS RAM contained within the clock section. A battery must be connected to J19 for the real-time clock to retain time and date during a power down. See “External Battery Connection (J19)” on page 36.

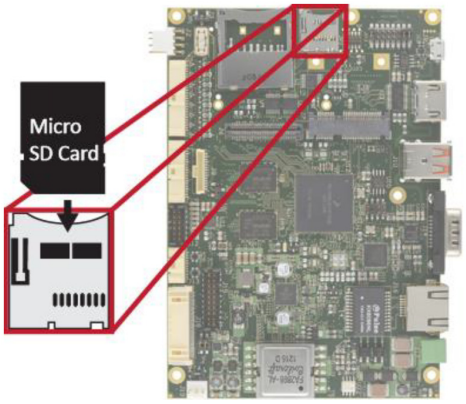
## 9.4 Power

The SYS-C398 draws power through the J17 connector (see “Power Connector (J17)” on page 32). Alternately, power can be supplied by PoE (see “Ethernet Port (J16)” on page 32).

## 9.5 Connectors

### 9.5.1 Micro SD (J1)

Orient the micro SD card as depicted in the following illustration. The card should be positioned so that the beveled edge is on the right front.





Do not insert or remove the Micro SD card while the SYS-C398 is powered up or in the process of powering up or down. This could corrupt the file system on the removable media. Always power down the board completely, then remove or insert media.

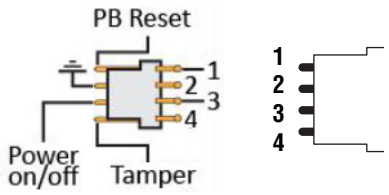
**Additional Information**

This micro SD card connector is a Molex 47352-1001.

### 9.5.2 Power Controls (J2)

J2 provides inputs for Pushbutton (PB) Reset, Power ON/OFF, and Tamper detection. The Power On/Off and Tamper circuits (pins 3 and 4, respectively) connect directly to the i.MX6 processor. PB Reset connects to the Master Reset input of a voltage supervisor and reset control circuit.

**Layout and Pin Reference:**




| Pin | Name |
|---|---|
| 1 | PB Reset |
| 2 | Ground |
| 3 | Power On/Off |
| 4 | Tamper |

**Additional Information**

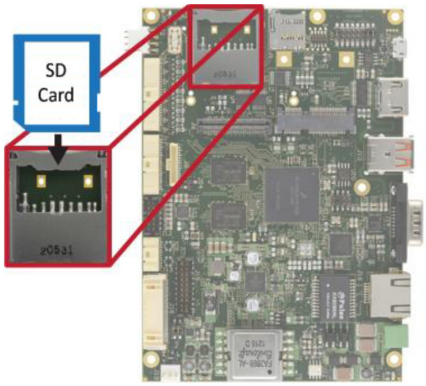
This power connection is a Molex 22-12-2044.

Matching connector: Molex 22-01-2045

Mating Crimp Connector: Molex 08-55-0110/Molex 08-55-0111

### 9.5.3 SD/SDIO (J3)

Make sure the SD/SDIO card is oriented properly, as depicted in the following illustration. The card should be positioned so that the beveled edge is on the right front.





Do not insert or remove the SD/SDIO card while the SYS-C398 is powered up or in the process of powering up or down. This could corrupt the file system on the removable media. Always power down the board completely, then remove or insert media.

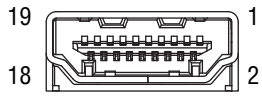
### Additional Information

This connection is a Molex G650-0009-0K0.

## 9.5.4 HDMI (J4)

The High Definition Multimedia Interface (HDMI) provides crisp, clear audio and video.

### Layout and Pin Reference:




| Pin | Name | Pin | Name |
|---|---|---|---|
| 1 | D2+ | 2 | D1_Shield |
| 3 | D2- | 4 | D1+ |
| 5 | D1-_Shield | 6 | D1- |
| 7 | D0+ | 8 | D0_Shield |
| 9 | D0- | 10 | CK+ |
| 11 | CK_Shield | 12 | CK- |
| 13 | CEC | 14 | HEC |
| 15 | I2C_CLK | 16 | I2C _DAT |
| 17 | GND | 18 | +5V |
| 19 | HOT_PLUG_DET | | |

### Additional Information

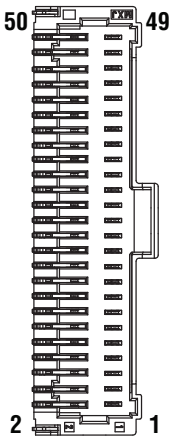
This connector is a Molex 47151-10010.

## 9.5.5 GPIO (J5)

The SYS-C398 supports 24 lines of digital input/output (DIO). All signals are 30 V tolerant.


Before supplying voltage to pin 49 of J5, remove any jumper installed on JP1. Damage to the board may occur if you apply a voltage to pin 49 of J1 while a jumper is installed on JP1.

### Layout and Pin Reference:




| Pin | Name | Pin | Name |
|---|---|---|---|
| 1 | DIO[0] | 2 | GND |
| 3 | DIO[1] | 4 | GND |
| 5 | DIO[2] | 6 | GND |
| 7 | DIO[3] | 8 | GND |
| 9 | DIO[4] | 10 | GND |
| 11 | DIO[5] | 12 | GND |
| 13 | DIO[6] | 14 | GND |
| 15 | DIO[7] | 16 | GND |
| 17 | DIO[8] | 18 | GND |
| 19 | DIO[9] | 20 | GND |
| 21 | DIO[10] | 22 | GND |
| 23 | DIO[11] | 24 | GND |
| 25 | DIO[12] | 26 | GND |
| 27 | DIO[13] | 28 | GND |
| 29 | DIO[14] | 30 | GND |
| 31 | DIO[15] | 32 | GND |
| 33 | DIO[16] | 34 | GND |
| 35 | DIO[17] | 36 | GND |
| 37 | DIO[18] | 38 | GND |
| 39 | DIO[19] | 40 | GND |
| 41 | DIO[20] | 42 | GND |
| 43 | DIO[21] | 44 | GND |
| 45 | DIO[22] | 46 | GND |
| 47 | DIO[23] | 48 | GND |
| 49 | Power* | 50 | GND |

* Power sourced to pin49 from the SBC is configured using JP1:

JP1: 1-2 = 3.3 V

JP1: 2-3 = 5 V

Remove jumper from JP1 if applying external power source to pin 49. See “Digital I/O Power Jumper (JP1)” on page 38.

### Additional Information

The I/O is terminated at a Molex 501571-5007, 2x25, 1mm pitch (Pico-Clasp™) right angle locking header connector (WS G650-2050-7HB).

Matching connector: The mate is the Molex 501189-5010 housing with Molex 501193-2000 crimp pins.

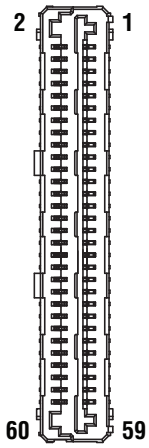
WinSystems cables simplify connections to the board:

- CBL-DIO24-000-14: Pico-Clasp to unterminated
- CBL-DIO24-001-12: Pico-Clasp to Pico-Clasp
- CBL-DIO24-002-12: Pico-Clasp to 2x25, 0.1" pitch housing

### 9.5.6 IO60 Expansion Bus (J6)

IO60 includes I$^2$C, SPI, (1) TTL Serial Port, (8) GPIO and (1) PWM line. IO60 provides developers with easy access to these popular buses so they can add special functionality to a system. Go to www.winsystems.com for predefined expansion options and the IO60 design guide or contact an Application Engineer through technical support (see “Introduction” on page 2 for details).

**Layout and Pin Reference:**




| Pin | Name | Pin | Name |
|---|---|---|---|
| 1 | +5 V (VCC5) | 2 | +5 V (VCC5) |
| 3 | +5 V (VCC5) | 4 | +5 V (VCC5) |
| 5 | TX | 6 | RX |
| 7 | RTS | 8 | CTS |
| 9 | GND | 10 | UART_MUX_CTL |
| 11 | SPI_CLK | 12 | SPI_MISO |
| 13 | SPI_CS0 | 14 | SPI_MOSI |
| 15 | SPI_CS1 | 16 | SPI_CS2 |
| 17 | SPI_CS3 | 18 | SPI_RDY |
| 19 | GND | 20 | GND |
| 21 | SMB/I²C_SCLK | 22 | SMB/I²C_SCLK |
| 23 | GND | 24 | GND |
| 25 | PWM0 | 26 | EPIT |
| 27 | GND | 28 | GND |
| 29 | POR | 30 | GPIO_0 |
| 31 | GPIO_1 | 32 | GPIO_2 |
| 33 | GPIO_3 | 34 | GPIO_4 |
| 35 | GPIO_5 | 36 | GPIO_6 |
| 37 | GPIO_7 | 38 | GPIO_8 |
| 39 | GND | 40 | GND |
| 41 | RSVD | 42 | RSVD |
| 43 | RSVD | 44 | RSVD |
| 45 | GND | 46 | GND |
| 47 | RSVD | 48 | RSVD |
| 49 | RSVD | 50 | RSVD |
| 51 | GND | 52 | GND |
| 53 | RSVD | 54 | RSVD |
| 55 | RSVD | 56 | RSVD |
| 57 | +3.3 V (VCC3) | 58 | +3.3 V (VCC3) |
| 59 | +3.3 V (VCC3) | 60 | +3.3 V (VCC3) |

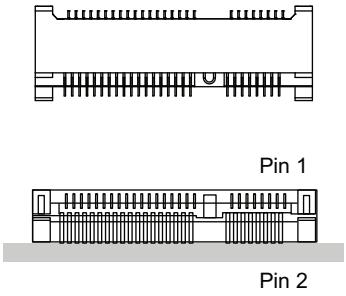
**Additional Information**

This connection is a Samtec LSEM-130-06.0-L-DV-A-N-K-TR.

### 9.5.7 MiniPCIe (J7)

The SYS-C398Q and SYS-C398DL (not available on the SYS-C398S) provide a half-length mini-PCIe socket to support a variety of peripherals available in this format.

**Layout and Pin Reference:**



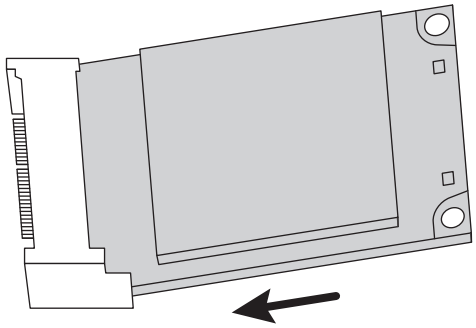

| Pin | Name | Pin | Name |
|---|---|---|---|
| 1 | Mechanical Key | 2 | Mechanical Key |
| 3 | NC | 4 | GND |
| 5 | NC | 6 | 1.5V |
| 7 | CLKREQ# | 8 | NC |
| 9 | GND | 10 | NC |
| 11 | REFCLK- | 12 | NC |
| 13 | REFCLK+ | 14 | NC |
| 15 | GND | 16 | NC |
| 17 | NC | 18 | GND |
| 19 | NC | 20 | W_DISABLE# |
| 21 | GND | 22 | PERST# |
| 23 | PERn0 | 24 | +3.3Vaux |
| 25 | PERp0 | 26 | GND |
| 27 | GND | 28 | +1.5V |
| 29 | GND | 30 | SMB_CLK |
| 31 | PERn0 | 32 | SMB_DATA |
| 33 | PERp0 | 34 | GND |
| 35 | GND | 36 | NC |
| 37 | GND | 38 | NC |
| 39 | +3.3Vaux | 40 | GND |
| 41 | | 42 | |
| 43 | GND | 44 | LED_WLAN# |
| 45 | NC | 46 | LED_WPAN# |
| 47 | NC | 48 | 1.5V |
| 49 | NC | 50 | GND |
| 51 | mSATA DET | 52 | +3.3Vaux |
| Shaded cells indicate Mechanical Key or other no pin/no connection. | | | |

**Additional Information**

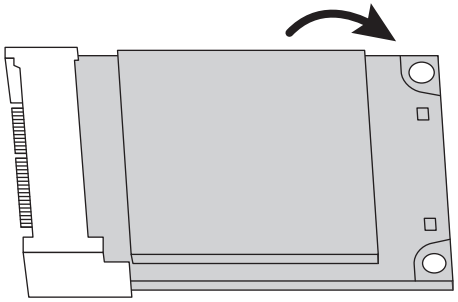
This connection is a Molex 0679105700.

To install a miniPCIe into J7:

1. Insert the miniPCIe.



2. Push the free end of the card toward the circuit board and then secure it with two (2 mm) screws (WinSystems P/N: G527-0000-400).



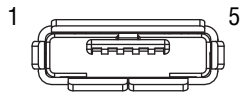
### 9.5.8 Micro USB (USB OTG) (J8)

The USB on-the-go (OTG) connector enables the SYS-C398 to be connected to a USB host (such as a desktop PC), allowing the SYS-C398 to appear as a USB flash drive, digital audio device, camera, etc. The USB OTG port can also be used as a debug interface to the SYS-C398 when it runs certain operating systems such as Android.

**Host or Client**

If the cable assembly that is plugged into J8 grounds pin four (4), the SYS-C398 is the host. If the cable assembly plugged into J8 does not ground pin four (4), the SYS-C398 is the client.

**Layout and Pin Reference:**




| Pin | Function |
|---|---|
| 1 | USB_OTG_VCC5 |
| 2 | USB_OTG_CON_D- |
| 3 | USB_OTG_CON_D+ |
| 4 | USB_OTG_ID_SENSE |
| 5 | GND |

**Additional Information**

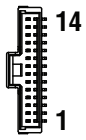
This connection is a Molex 47589-0001.

Mating Connector: Molex Cable Assembly 68784-0001

### 9.5.9 Backlight Power (J9)

J9 supplies power for up to two backlights.

**Layout and Pin Reference:**

| | Backlight Control 0 | | Backlight Control 1 | |
|---|---|---|---|---|
| | Pin | Name | Pin | Name |
|   | 1 | +5 V DC | 8 | +5 V DC |
| | 2 | Enable (Low) | 9 | Enable (LOW) |
| | 3 | Enable (High) | 10 | Enable (High) |
| | 4 | GND | 11 | GND |
| | 5 | +12 V DC | 12 | +12 V DC |
| | 6 | GND | 13 | GND |
| | 7 | PWM | 14 | PWM |

**Additional Information**

This connection is a Molex/501331-1407.

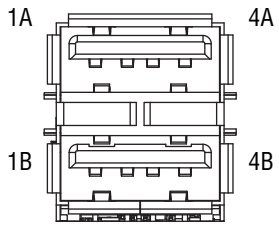
Mating Connector: Molex 501330-1400

Mating Crimp Connector: Molex 501334-0000

### 9.5.10 USB 2.0 (J10)

J10 provides two USB ports (USB port 5 and USB port 6).

**Layout and Pin Reference:**




| Port | Pin | Function |
|---|---|---|
| **USB Port 5 (upper)** | 1A | USB_PWR5 |
| | 2A | USB_D-5 |
| | 3A | USB_D+5 |
| | 4A | GND |
| **USB Port 6 (lower)** | 1B | USB_PWR6 |
| | 2B | USB_D-6 |
| | 3B | USB_D+6 |
| | 4B | GND |

**Additional Information**

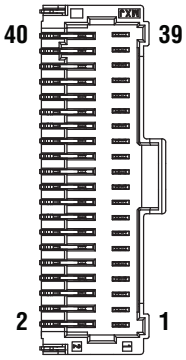
This connection is a Samtec USBR-A-D-S-W-TH.

Mating Connector: Standard USB 2.0 Connector.

### 9.5.11 LVDS (J11)

The Low Voltage Differential Interface (LVDS) interface works in conjunction with Panel Power at JP4 and Backlight Power at J9 to provide flat panel display video.

**Layout and Pin Reference:**




| LVDS | Pin | Name | Pin | Name |
|---|---|---|---|---|
| **LVDS 0** | 1 | SWVDD | 2 | GND |
| | 3 | D0- | 4 | D0+ |
| | 5 | D1- | 6 | D1+ |
| | 7 | SWVDD | 8 | GND |
| | 9 | D2- | 10 | D2+ |
| | 11 | D3- | 12 | D3+ |
| | 13 | SWVDD | 14 | GND |
| | 15 | CLK- | 16 | CLK+ |
| | 17 | DDC_CLK | 18 | GND |
| | 19 | DDC_DATA | 20 | GND |
| **LVDS 1** | 21 | SWVDD | 22 | GND |
| | 23 | D0- | 24 | D0+ |
| | 25 | D1- | 26 | D1+ |
| | 27 | SWVDD | 28 | GND |
| | 39 | D2- | 30 | D2+ |
| | 31 | D3- | 32 | D3+ |
| | 33 | SWVDD | 34 | GND |
| | 35 | CLK- | 36 | CLK+ |
| | 37 | NC | 38 | GND |
| | 39 | NC | 40 | GND |

**Additional Information**

This connector is a Molex 501571-4007.

Mating Connector: Molex 501189-4010

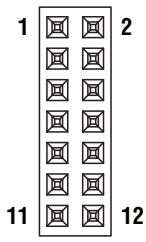
Mating Crimp Connector: Molex 501193-3000

WinSystems cables simplify connections to the board:

- CBL-LVDS24-000-14: Video – (LVDS) Unterminated, 14”
- CBL-LVDSB-009-12: Video – (LVDS) Dual – Ampire AM800480R3TMQWA1H, 12”
- CBL-LVDSB-012-18: Video – (LVDS) Single – Ampire AM800480R3TMQWA1H, 18”

### 9.5.12 Analog Audio (J12)

**Layout and Pin Reference:**




| Pin | Name | Pin | Name |
|---|---|---|---|
| 1 | OUT_R | 2 | LINE_R |
| 3 | OUT_L | 4 | LINE_L |
| 5 | ADGND | 6 | ADGND |
| 7 | HEADPHONE_R | 8 | MIC_IN |
| 9 | HEADPHONE_L | 10 | ADGND |
| 11 | HEADPHONE_GND | 12 | ADGND |

**Additional Information**

This connection is a Molex 087832-1206.

Mating Connector: Molex 51110-1250

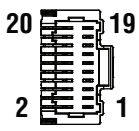
Crimp Connector: Molex 50394-8051

Cable Assembly WinSystems: CBL-AUDIO2-202-12D

### 9.5.13 Four USB Ports (J13)

The SYS-C398Q and SYS-C398DL (not available on the SYS-C398S) provide four USB ports. Cable Assembly CBL-USB4-002-12 can be attached to the 20 pin connector at J13 to provide four USB 2.0 ports (with ADP-IO-USB-001).

**Layout and Pin Reference:**

| | Pin | Function | Pin | Function |
|---|---|---|---|---|
|  | 1 | USB1_PWR | 2 | USB2_PWR |
| | 3 | USB1_D- | 4 | USB2_D- |
| | 5 | USB1_D+ | 6 | USB2_D+ |
| | 7 | GND | 8 | GND |
| | 9 | GND | 10 | GND |
| | 11 | GND | 12 | GND |
| | 13 | USB3_PWR | 14 | USB4_PWR |
| | 15 | USB3_D- | 16 | USB4_D- |
| | 17 | USB3_D+ | 18 | USB4_D+ |
| | 19 | GND | 20 | GND |

**Additional Information**

This connection is a Molex 501571-2007.

Cable Assembly: WinSystems CBL-USB4-002-12

Termination Adapter: WinSystems ADP-IO-USB-002

## 9.5.14 COM 1 (J14)

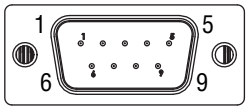
COM1 uses the advanced EXAR SP339E multi-protocol transceiver and supports Loopback, RS-232, RS-485 half-duplex), and RS-422 (full-duplex). RS-232 can transmit and receive data up to 1 Mbps, while the RS-422/485 ports support data transmission speeds up to 5 Mbps. The SP339E transceiver includes programmable line termination for the RS-422/485, loopback mode, and slew rate.

A termination resister may be necessary for accurate RS-485/422 communication, but must be removed when the lines are used for RS-232.

WinSystems provides scripts that configure selected modes for each UART with the example operating systems. The settings used by the scripts to configure different communication protocols are shown in the table below.

| | M0 | M1 | SLEW* | Termination** |
|---|---|---|---|---|
| Loopback | 0 | 0 | 0 | 0 |
| RS232 | 1 | 0 | 0 | 0 |
| RS485 (half duplex) | 0 | 1 | 0 | 1 |
| RS485 (full duplex)/RS422 | 1 | 1 | 0 | 1 |
| *SLEW = VCC enables 250 kbps slew limiting<br>**TERM = VCC enables 120 Ω (ohm) differential termination to the receive inputs | | | | |

**Layout and Pin Reference:**




| Pin | RS-232 | RS-422 | RS-485 |
|---|---|---|---|
| 1 | DCD | - | - |
| 2 | RX | TX+ | TX/RX+ |
| 3 | TX | RX+ | - |
| 4 | DTR | - | - |
| 5 | GND | - | - |
| 6 | DSR | TX- | TX/RX- |
| 7 | RTS | RX- | - |
| 8 | CTS | - | - |
| 9 | RI | - | - |

**Additional Information**

This connection is a Norcomp 190-009-163R001.

Mating Connector: Norcomp 9T190-009-263R001

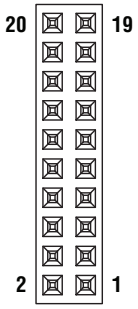
### 9.5.15 Controller Area Network (CAN) BUS Connector (J15)

The SYS-C398Q and SYS-C398DL (not available on the SYS-C398S) provide access to two FlexCAN channels through J15. The module is a full implementation of the CAN protocol specification, which supports both standard and extended message frames.

The FLEXCAN module has four functional modes: Normal Mode (User and Supervisor), Freeze Mode, Listen-Only Mode and Loop-Back Mode. There are also two low power modes: Disable Mode and Stop Mode.

For more information on FLEXCAN, see chapter 26 of the NXP (formerly Freescale) i.MX 6Dual_6Quad Reference Manual at http://www.nxp.com/files/32bit/doc/ref_manual/IMX6DQRM.pdf.

**Layout and Pin Reference:**




| Pin | Function | Pin | Function |
|---|---|---|---|
| 1 | VCC5 | 2 | GND |
| 3 | CAN1L | 4 | CAN1H |
| 5 | GND | 6 | N/C |
| 7 | N/C | 8 | VCC5 |
| 9 | N/C | 10 | N/C |
| 11 | VCC5 | 12 | GND |
| 13 | CAN2L | 14 | CAN2H |
| 15 | GND | 16 | N/C |
| 17 | N/C | 18 | VCC5 |
| 19 | N/C | 20 | N/C |

**Additional Information**

This connection is a Molex 87832-2020.

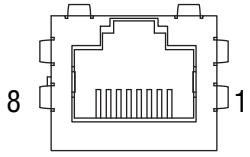
Mating Connector: Molex 51110-2050

Crimp Terminal: Molex 50394-8051

### 9.5.16 Ethernet Port (J16)

J16 is a Gigabit (10/100/1000) Ethernet port that complies with the Precision Time Protocol standard IEEE-1588. The SYS-C398 is a POE PD (powered device).

**Layout and Pin Reference:**

| | Pin | Function | Description |
|---|---|---|---|
|  | 1 | BI_D1+ | Bi-Directional Data + |
| | 2 | BI_D1- | Bi-Directional Data - |
| | 3 | BI_D2+ | Bi-Directional Data + |
| | 4 | BI_D3+ | Bi-Directional Data + |
| | 5 | BI_D3- | Bi-Directional Data - |
| | 6 | BI_D2- | Bi-Directional Data - |
| | 7 | BI_D4+ | Bi-Directional Data + |
| | 8 | BI_D4- | Bi-Directional Data - |

**Additional Information**

This connection is a Amphenol RJCSE538001.

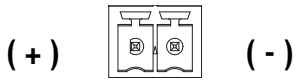
Mating Connector: Amphenol RJ45

### 9.5.17 Power Connector (J17)

Use this connection to supply power to the SYS-C398. The SYS-C398 can operate from a +10 V DC to +50 V DC (+/- 5%) power source.


**Warning**
Do not reverse the positive and negative terminals when you connect power to the unit. This will void the warranty and damage the board.

**Layout and Pin Reference:**




| Pin | Name | Notes |
|---|---|---|
| 1 | + Positive | Power Input: +10 V DC to +50 V DC |
| 2 | - Negative | |

**Additional Information**

This connection is a Phoenix 1803277.

Matching connector: Phoenix 1803578

### 9.5.18 COM 2, 3, 4, & 5 (J18)

The SYS-C398Q (not available on the SYS-C398S and SYS-C398DL) provides a COM Interface at J18. COM 2 uses the EXAR SP339E multi-protocol transceiver and supports RS-232, RS-422, and RS-485 modes. RS-232 can transmit and receive data up to 1 Mbps, while RS-422/485 modes are capable of data transmission speeds up to 5 Mbps. The SP339E transceiver includes programmable line termination for the RS-422/485, loopback mode, and slew rate.

COMS 3, 4, & 5 use Linear Tech LTC2854 RS-422/485 transceivers with programmable 120 ohm termination. All three COM ports are capable of transmitting and receiving data up to 5 Mbps.

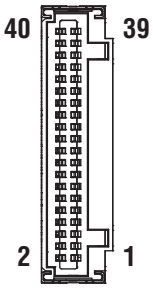
COM5 is multiplexed with the IO60 UART signals. If a module with UART support is plugged into the IO60 connector, the COM5 UART signals will be routed to the IO60 expansion bus, not J18.

**Linear Tech Transceiver (COMS 3, 4, & 5) table**

| | Rx485EN | RX422EN | HD3_TE | FD3_TE |
|---|---|---|---|---|
| RS485 W/Term | 0 | 1 | 1 | 0 |
| RS485 W/O Term | 0 | 1 | 0 | 0 |
| RS422 W/RCVR Term | 1 | 0 | 0 | 1 |
| RS422 W/O RCVR Term | 1 | 0 | 0 | 0 |

WinSystems provides scripts that configure selected modes for each UART with the example operating systems. The settings used by the scripts to configure different communication protocols are shown in the Linear Tech Transceiver (COMS 3, 4, & 5) table. A termination resister may be necessary for accurate RS-485/422 communication, but must be removed when the lines are used for RS-232.

## Layout and Pin Reference:

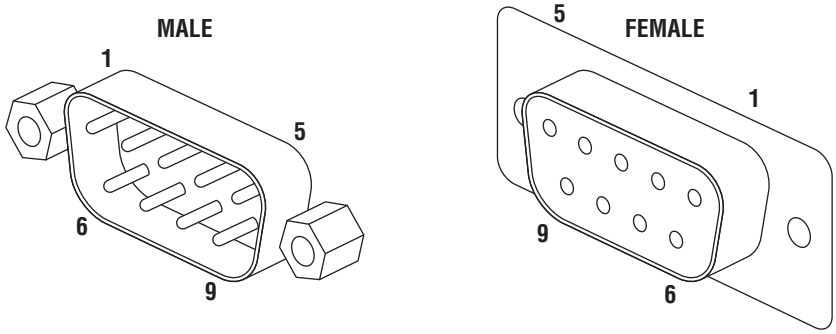



| Pin | Name | Interface | | | Pin | Name | Interface | | |
|---|---|---|---|---|---|---|---|---|---|
| | | RS-232 | RS-422 | RS-485 | | | RS-232 | RS-422 | RS-485 |
| 1 | COM2 | - | - | - | 21 | COM4 | - | - | - |
| 2 | COM2 | - | TX- | TX/RX- | 22 | COM4 | - | TX- | TX/RX- |
| 3 | COM2 | RX | TX+ | TX/RX+ | 23 | COM4 | - | TX+ | TX/RX+ |
| 4 | COM2 | RTS | RX- | - | 24 | COM4 | - | RX- | - |
| 5 | COM2 | TX | RX+ | - | 25 | COM4 | - | RX+ | - |
| 6 | COM2 | CTS | - | - | 26 | COM4 | - | - | - |
| 7 | COM2 | - | - | - | 27 | COM4 | - | - | - |
| 8 | COM2 | - | - | - | 28 | COM4 | - | - | - |
| 9 | COM2 | GND | GND | GND | 29 | COM4 | - | GND | GND |
| 10 | COM2 | GND | GND | GND | 30 | COM4 | - | GND | GND |
| 11 | COM3 | - | - | - | 31 | COM5 | - | - | - |
| 12 | COM3 | - | TX- | TX/RX- | 32 | COM5 | - | TX- | TX/RX- |
| 13 | COM3 | - | TX+ | TX/RX+ | 33 | COM5 | - | TX+ | TX/RX+ |
| 14 | COM3 | - | RX- | - | 34 | COM5 | - | RX- | - |
| 15 | COM3 | - | RX+ | - | 35 | COM5 | - | RX+ | - |
| 16 | COM3 | - | - | - | 36 | COM5 | - | - | - |
| 17 | COM3 | - | - | - | 37 | COM5 | - | - | - |
| 18 | COM3 | - | - | - | 38 | COM5 | - | - | - |
| 19 | COM3 | - | GND | GND | 39 | COM5 | - | GND | GND |
| 20 | COM3 | - | GND | GND | 40 | COM5 | - | GND | GND |

## DB9 Pinout using CBL-SER4-002-12

| Pin | Interface | | |
|---|---|---|---|
| | RS-232 | RS-422 | RS-485 |
| 1 | - | - | - |
| 2 | RX | TX+ | TX/RX+ |
| 3 | TX | RX+ | |
| 4 | - | - | - |
| 5 | GND | GND | GND |
| 6 | - | TX- | TX/RX- |
| 7 | RTS | RX- | - |
| 8 | CTS | - | - |
| 9 | - | - | - |

### DB-9 Male and Female




### Additional Information

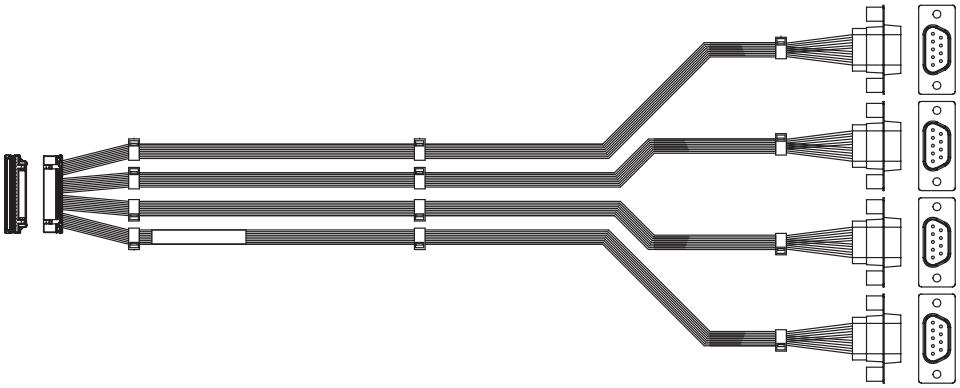
This connection is a Molex 502046-4070.

Mating Connector: Molex 9T503110-4000

Crimp Terminal: Molex 501930-1100

WinSystems cables simplify connections to the board:

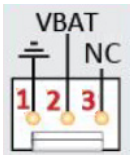
- CBL-SER4-000-14: Duo-Clasp to unterminated
- CBL-SER4-001-12: Duo-Clasp to Duo-Clasp
- CBL-SER4-002-12: Duo-Clasp to 4xDB9 (shown)



### 9.5.19 External Battery Connection (J19)

When connected to one of the External Batteries provided in the table below, J19 supplies standby power for the secure real-time clock. External Batteries are available from WinSystems.

**Layout and Pin Reference:**




| Pin | Name |
|---|---|
| 1 | Ground |
| 2 | $V_{BAT}$ |
| 3 | No connection |

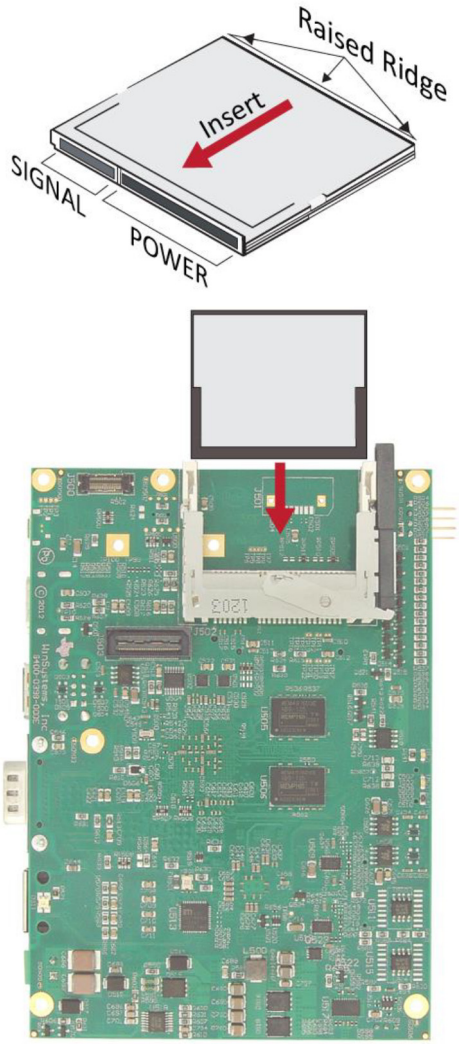
**Additional Information**

This connection is described in the following table.

| Description | MFR Part Number | WinSystems Part Number |
|---|---|---|
| PCB Connector | Molex 22-11-2032 | - |
| Mating Connector | Molex 22-01-2035 | - |
| Battery with Connector 3.6 V DC, 2700 mAh | - | BAT-LTC-E-36-27-1 |
| Battery with Connector 3.6 V DC, 1650 mAh | - | BAT-LTC-E-36-16-1 |

### 9.5.20 SATA SSD (CFast) (J502)

The SYS-C398 supports CFast high performance storage at J502, which is located on the bottom of the board. The SATA compatible data card consists of 24 pins. The raised ridge along the back top of the card is useful for making sure the card is oriented properly.




**NOTE** The CFast connector can be depopulated to support a SATA connection.

**Pin Reference (Signal):**

| Pin | CFast | Description |
|---|---|---|
| S1 | GND | Signal Ground |
| S2 | A+ | Differential Signal A+ |
| S3 | A- | Differential Signal A- |
| S4 | GND | Ground |
| S5 | B- | Differential Signal B- |
| S6 | B+ | Differential Signal B+ |
| S7 | GND | Ground |

**Pin Reference (Power):**

| Pin | CFast | Description |
|---|---|---|
| P1 | CDI | Card Detect In P15 PGND Device Ground |
| P2 | GND | Device Ground P16 PGND Device Ground |
| P3 | NC | Not Connected P17 CDO Card Detect Out |
| P4 | NC | Not Connected |
| P5 | NC | Not Connected |
| P6 | NC | Not Connected |
| P7 | GND | Device Ground |
| P8 | LED1 | LED Output |
| P9 | LED2 | LED Output |
| P10 | IO1 Reserved | Input/Output |
| P11 | IO2 Reserved | Input/Output |
| P12 | IO4 Reserved | Input/Output |
| P13 | PWR 3.3V | Device Power |
| P14 | PWR 3.3V | Device Power |
| P15 | PGND | Device Ground |
| P16 | PGND | Device Ground |
| P17 | CDO | Card Detect Out |

**Additional Information**

This connection is a Molex 0679105700.

## 9.6 Jumpers

Jumper Part Number SAMTEC 2SN-BK-G applies to all jumpers. These are available in a ten piece kit from WinSystems (Part# KIT-JMP-G-200).

### 9.6.1 Digital I/O Power Jumper (JP1)

**Purpose:** The jumper configuration at JP1 allows you to provide power for supporting additional I/O devices at J5. See “GPIO (J5)” on page 21.


Before supplying voltage to pin 49 of J5, remove any jumper installed on JP1. Damage to the board may occur if you apply a voltage to pin 49 of J1 while a jumper is installed on JP1.

**Jumper Pin Reference**:


| Jumpered Pins | Name |
|---|---|
| 1-2 | +3.3 V to pin 49 of J5 (default) |
| 2-3 | +5 V to pin 49 of J5 |
| No jumper installed | 0 V DSV to J5. With no jumper installed, up to +30 V external power source can be used. |

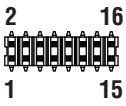
**Additional Information**

Jumper Kit: KIT-JMP-G-200

## 9.6.2 Boot Configuration Jumper (JP3)

**Purpose:** Jumper JP3 controls SYS-C398 Boot Configuration. Reference the NXP (formerly Freescale) manual for more in depth information on boot configurations. See http://www.nxp.com/files/32bit/doc/ref_manual/IMX6DQRM.pdf.

**Jumper Pin Reference**:




| Option | Jumper Configuration | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| **Jumper Block PINS** | **1-2** | **3-4** | **5-6** | **7-8** | **9-10** | **11-12** | **13-14** | **15-16** |
| SATA (CFAST/HARD DRIVE) | 0 | 1 | 0 | X | X | X | X | 1 |
| SERIAL ROM (SPI-NOR) | 0 | 1 | 1 | 0 | X | X | X | X |
| **SD/MicroSD Options** | | | | | | | | |
| - Normal Boot | 1 | 0 | 0 | * | * | * | * | * |
| - Fast Boot | 1 | 0 | 1 | * | * | * | * | * |
| - Bus/High Speed 25 MB/s (SDR25) | 1 | 0 | * | 0 | 0 | * | * | * |
| - Bus/Normal Speed 12.5MB/s (SDR12) | 1 | 0 | * | 0 | 1 | * | * | * |
| - Bus - UHS-I 50MB/s (SDR50) | 1 | 0 | * | 1 | 0 | * | * | * |
| - Bus - UHS-I 104MB/s (SDR104) | 1 | 0 | * | 1 | 1 | * | * | * |
| - Bus Width - 1-Bit with 1 Delay Cell | 1 | 0 | * | * | * | 0 | 0 | * |
| - Bus Width - 4-Bit with 1 Delay Cell | 1 | 0 | * | * | * | 0 | 1 | * |
| - Bus Width - 1-Bit with 2 Delay Cell | 1 | 0 | * | * | * | 1 | 0 | * |
| - Bus Width - 4-Bit with 2 Delay Cell | 1 | 0 | * | * | * | 1 | 1 | * |
| - Port Select - J1 - uSD | 1 | 0 | * | * | * | * | * | 0 |
| - Port Select - J3 - SD | 1 | 0 | * | * | * | * | * | 1 |

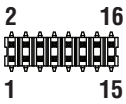
**Legend:**

1 – Jumper Installed

0 – Jumper Removed

X – Does not matter

* – Options




| Option | Jumper Configuration | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| MMC Options | | | | | | | | |
| - Normal Boot | 1 | 1 | 0 | * | * | * | * | * |
| - Fast Boot | 1 | 1 | 1 | * | * | * | * | * |
| - Bus - High Speed Mode | 1 | 1 | * | 0 | X | * | * | * |
| - Bus - Normal Speed Mode | 1 | 1 | * | 1 | X | * | * | * |
| - Bus Width - 1-Bit | 1 | 1 | * | * | * | 0 | 0 | * |
| - Bus Width - 4-Bit | 1 | 1 | * | * | * | 0 | 1 | * |
| - Bus Width - Reserved | 1 | 1 | * | * | * | 1 | 0 | * |
| - Bus Width - 4-Bit DDR (MMC 4.4) | 1 | 1 | * | * | * | 1 | 1 | * |
| - Port Select - J1 - uSD | 1 | 1 | * | * | * | * | * | 0 |
| - Port Select - J3 - SD | 1 | 1 | * | * | * | * | * | 1 |

**Legend:**

1 – Jumper Installed

0 – Jumper Removed

X – Does not matter

* – Options

### Additional Information

This connection is a Samtec TMM-108-01-L-D-SM-P.
Jumper Kit: KIT-JMP-G-200

## 9.6.3 Panel Power Jumper (JP4)

**Purpose:** JP4 provides 3.3 V DC (Default) or 5 V DC for panel power to connector J11.

**Jumper Pin Reference**:


| Jumpered Pins | Name |
|---|---|
| 1-2 | +3.3 V DC (J11)(default) |
| 2-3 | +5 V DC (J11)(default) |

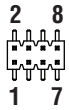
### Additional Information

Jumper Kit: KIT-JMP-G-200

### 9.6.4 Boot Mode Jumper (JP5)

**Purpose:** JP5 selects the boot mode for the SYS-C398. The default JP5 set for Internal Boot mode (jumper installed on Pins 3-4).

**Jumper Pin Reference**:




| Description | Boot Mode | Jumper Pins |
|---|---|---|
| Boot from fuses | 0 0 | No Jumpers |
| Serial downloader (USB OTG) | 1 0 | 1 – 2 |
| Internal boot | 0 1 | 3 – 4 |
| Reserved | 1 1 | 1 – 2, 3 – 4 |

**Additional Information**

This connection is a Samtec TMM-104-01-G-D-SM-P-TR.

Jumper Kit: KIT-JMP-G-200

### 9.6.5 CAN Termination Jumper Block (JP6)

**Purpose:** For high speed Controller Area Network (CAN), both ends of the pair of signal wires (CANH and CANL) must be terminated. JP6 allows the user to add 120 Ω (ohm) differential termination to the signal pairs when necessary. If you place multiple devices along the cable, only devices on the ends of the cable need termination resistors.

**Jumper Pin Reference**:


| Pin | Function |
|---|---|
| 1 | CAN1L |
| 2 | CANH (120 Ohm Termination) |
| 3 | CAN2L |
| 4 | CANH (120 Ohm Termination) |

**Additional Information**

Jumper Kit: KIT-JMP-G-200

# 10. Cables and Accessories

WinSystems cables and batteries simplify connection to the SYS-C398. The following table lists available items.

| Item | Part Number | Connection | Description |
|---|---|---|---|
| Cables | CBL-DIO24-000-14 | See “GPIO (J5)” on page 21 | Pico-Clasp to unterminated |
| | CBL-DIO24-001-12 | | Pico-Clasp to Pico-Clasp |
| | CBL-DIO24-002-12 | | Pico-Clasp to 2x25, 0.1“ pitch housing |
| | CBL-LVDS24-000-14 | See “LVDS (J11)” on page 28 | Video – (LVDS) Unterminated, 14” |
| | CBL-LVDSB-009-12 | | Video – (LVDS) Dual – Ampire AM800480R3TMQWA1H, 12” |
| | CBL-LVDSB-012-18 | | Video – (LVDS) Single – Ampire AM800480R3TMQWA1H, 18” |
| | CBL-AUDIO2-202-12D | See “Analog Audio (J12)” on page 29 | Cable Assembly WinSystems |
| | CBL-USB4-002-12 | See “Four USB Ports (J13)” on page 29 | USB Cable Assembly WinSystems |
| | CBL-SER4-000-14 | See “COM 2, 3, 4, & 5 (J18)” on page 33 | Duo-Clasp to unterminated |
| | CBL-SER4-001-12 | | Duo-Clasp to Duo-Clasp |
| | CBL-SER4-002-12 | | Duo-Clasp to 4xDB9 |
| Batteries | 3.6 V DC, 2700 mAh | See “External Battery Connection (J19)” on page 36 | BAT-LTC-E-36-27-1 |
| | 3.6 V DC, 1650 mAh | | BAT-LTC-E-36-16-1 |
| Screws | G527-0000-400 | See “MiniPCIe (J7)” on page 24 | 2 mm |
| Jumpers | KIT-JMP-G-200 | See “Jumpers” on page 38<br>See “Boot Configuration Jumper (JP3)” on page 39 | Jumper Kit (10 jumpers) |

# 11. Software Drivers

Go to www.winsystems.com for information on available software drivers.

# Appendix A. Best Practices

This section outlines the best practices for operating the SYS-C398 in a safe and effective manner that does not damage the board. Please read this section carefully.

**Avoid Electrostatic Discharge (ESD)**—Only handle the circuit board and other bare electronics when electrostatic discharge (ESD) protection is in place. Having a wrist strap and a fully grounded workstation is the minimum ESD protection required before the ESD seal on the product bag is broken.

## Power Supply

### Power Supply Budget

Evaluate your power supply budget. It is usually good practice to budget twice the typical power requirement for all of your devices.

### Zero-Load Power Supply

Use a zero-load power supply whenever possible. A zero-load power supply does not require a minimum power load to regulate. If a zero-load power supply is not appropriate for your application, then verify that the single board computer's typical load is not lower than the power supply's minimum load. If the single board computer does not draw enough power to meet the power supply's minimum load, then the power supply will not regulate properly and can cause damage to the SYS-C398.

**Use Proper Power Connections (Voltage)**—When verifying the voltage, measure it at the power connector on the SYS-C398. Measuring it at the power supply does not account for voltage drop through the wire and connectors.
Power the SYS-C398 using Power over Ethernet (J16 RJ45, PoE IEEE802.3) or Auxiliary Input (J17, +10 V DC to + 50 V DC). Verify the power connections. Incorrect voltages can cause catastrophic damage.

### Power Harness

Minimize the length of the power harness. This will reduce the amount of voltage drop between the power supply and the SYS-C398.

### Gauge Wire

Use the largest gauge wire available for your application and connector. Most connector manufacturers have a maximum gauge wire they recommend for their pins.

### Contact Points

For maximum reliability, WinSystems' boards typically use connectors with gold finish contacts. It is critical that the contact material in the mating connectors is matched properly (gold to gold and tin to tin). Contact areas made with dissimilar metals can cause oxidation/corrosion, resulting in unreliable connections.

### Pin Contacts

Often the pin contacts used in cabling are not given enough attention. The ideal choice for a pin contact uses a design similar to Molex's or Trifurcon's design that provides three distinct points to maximize the contact area and improve connection integrity in high shock and vibration applications.

## Power Down

Make sure that power has been removed from the system before making or breaking any connections.

**Power Supply OFF**—The power supply should always be off before it is connected to the I/O Module. Do not hot-plug the SYS-C398 on a host platform that is already powered.

**I/O Connections OFF**—I/O Connections should also be off before connecting them to the embedded computer modules or any I/O cards. Connecting hot signals can cause damage whether the embedded system is powered or not.

## Conformal Coating

Applying conformal coating to a WinSystems product will not in itself void the product warranty, if it is properly removed prior to return. Coating may change thermal characteristics and impedes our ability to test, diagnose, and repair products. Any coated product sent to WinSystems for repair will be returned at customer expense and no service will be performed.

## Operations/Product Manuals

Every single board computer has an Operations manual or Product manual.

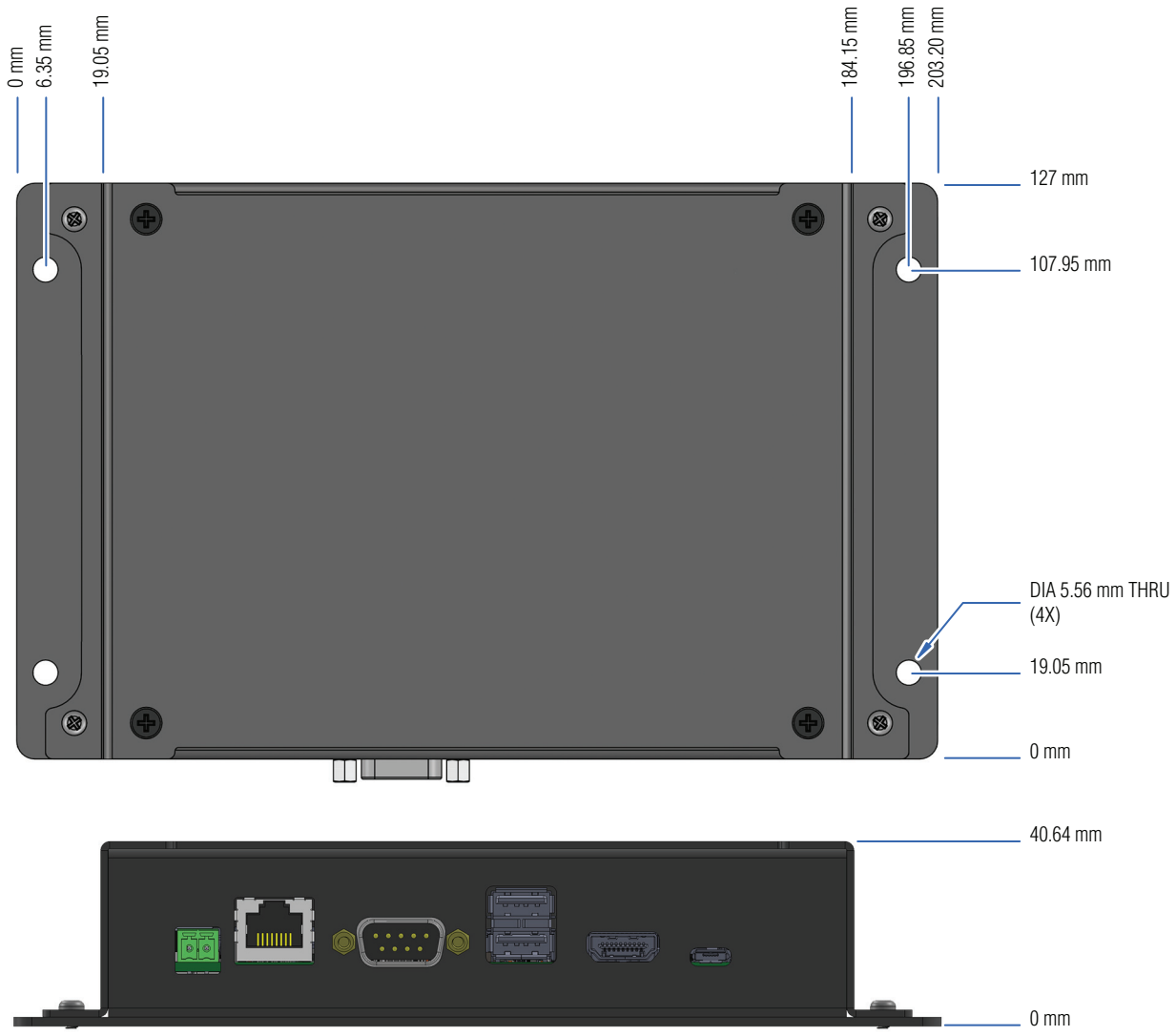
**Periodic Updates**—Operations/Product manuals are updated often. Periodically check the WinSystems website (http://www.winsystems.com) for revisions.

**Check Pinouts**—Always check the pinout and connector locations in the manual before plugging in a cable. Many I/O modules will have identical headers for different functions and plugging a cable into the wrong header can have disastrous results.

**Contact an Applications Engineer**—If a diagram or chart in a manual does not seem to match your board, or if you have additional questions, contact a WinSystems Applications Engineer at: +1-817-274-7553.

# Appendix B. Mechanical Drawing

**Figure B–1:** SYS-C398 Dimensions



# Appendix C. Warranty Information

WinSystems warrants that for a period of two (2) years from the date of shipment, any Products and Software purchased or licensed hereunder which have been developed or manufactured by WinSystems shall be free of any defects and shall perform substantially in accordance with WinSystems' specifications therefor. With respect to any Products or Software purchased or licensed hereunder which have been developed or manufactured by others, WinSystems shall transfer and assign to Customer any warranty of such manufacturer or developer held by WinSystems, provided that the warranty, if any, may be assigned. The sole obligation of WinSystems for any breach of warranty contained herein shall be, at its option, either (i) to repair or replace at its expense any materially defective Products or Software, or (ii) to take back such Products and Software and refund the Customer the purchase price and any license fees paid for the same. Customer shall pay all freight, duty, broker's fees, insurance, charges and other fees and charges for the return of any Products or Software to WinSystems under this warranty. WinSystems shall pay freight and insurance charges for any repaired or replaced Products or Software thereafter delivered to Customer within the United States. All fees and costs for shipment outside of the United States shall be paid by Customer. The foregoing warranty shall not apply to any Products or Software which have been subject to abuse, misuse, vandalism, accident, alteration, neglect, unauthorized repair or improper installation.

THERE ARE NO WARRANTIES BY WINSYSTEMS EXCEPT AS STATED HEREIN. THERE ARE NO OTHER WARRANTIES EXPRESS OR IMPLIED INCLUDING, BUT NOT LIMITED TO, THE IMPLIED WARRANTIES OF MERCHANTABILITY AND FITNESS FOR A PARTICULAR PURPOSE. IN NO EVENT SHALL WINSYSTEMS BE LIABLE FOR CONSEQUENTIAL, INCIDENTAL OR SPECIAL DAMAGES FOR LOSS OF DATA, PROFITS OR GOODWILL. WINSYSTEMS' MAXIMUM LIABILITY FOR ANY BREACH OF THIS AGREEMENT OR OTHER CLAIM RELATED TO ANY PRODUCTS, SOFTWARE, OR THE SUBJECT MATTER HEREOF, SHALL NOT EXCEED THE PURCHASE PRICE OR LICENSE FEE PAID BY CUSTOMER TO WINSYSTEMS FOR THE PRODUCTS OR SOFTWARE OR PORTION THEREOF TO WHICH SUCH BREACH OR CLAIM PERTAINS.

Title to the Products shall remain vested in WinSystems until complete payment is made by Customer. Title to any Software shall remain vested in WinSystems, or WinSystems' licensor from whom WinSystems has obtained marketing rights, both before, during and after the term of the License. Nonpayment when due of the purchase price for any Products or the License fees for any Software, or, if applicable, taxes and/or the cost of any freight and insurance for any Products and/or Software, shall entitle WinSystems to take possession of the Products and/or Software without notice to Customer or prejudice to WinSystems' rights under contract or any other legal remedy.

Until title to the Products pass in accordance with the provision set out above, except with the prior written approval of WinSystems, no Products shall be modified, altered, moved or in any way assigned, sublet, mortgaged or charged nor may Customer part with possession of all or part of the same.

There are no understandings, agreements or representations, express or implied, other than those set forth herein. This Order embodies the entire agreement between the parties and may be waived, amended or supplemented only by a written instrument executed jointly by WinSystems and Customer as evidenced only by the signature of duly authorized officers of each party. The foregoing terms and conditions of any order which may be issued by Customer for the purchase of Products or licensing of Software hereunder.

In the event this Order is placed in the hands of an attorney or collection agency by WinSystems to collect any sums due hereunder to WinSystems, Customer shall pay all reasonable attorney's fees, expenses, collection and court costs incurred by WinSystems.

THIS AGREEMENT SHALL BE GOVERNED AND CONSTRUED UNDER THE TEXAS UNIFORM COMMERCIAL CODE AND THE APPLICABLE LAWS OF THE STATE OF TEXAS. THE PARTIES ACKNOWLEDGE THAT ANY ACTION BROUGHT HEREUNDER SHALL ONLY BE BROUGHT IN A COURT OF COMPETENT JURISDICTION IN TARRANT COUNTY, TEXAS.

## Warranty Service

1. To obtain service under this warranty, obtain a return authorization number. In the United States, contact the WinSystems Service Center for a return authorization number. Outside the United States, contact your local sales agent for a return authorization number.
2. You must send the product postage prepaid and insured. You must enclose the products in an anti-static bag to protect from damage by static electricity. WinSystems is not responsible for damage to the product due to static electricity.