CIRRUS LOGIC
Leading the Digital Entertainment Revolution™

CS181xx

Digital Audio Networking Processor

CobraNet™
Silicon Series

CS18100, CS18101, CS18102, *and* CM-2

Hardware User's Manual

Version 2.1

Replaces DS651UM20

Preliminary Product Information

This document contains information for a new product.
Cirrus Logic reserves the right to modify this product without notice.

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DS651UM21

- NOTES -

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1.0 Introduction

This document is intended to help hardware designers integrate the CobraNet™ interface into an audio system design. It covers the CS18100, CS18101, and CS18102 members of the CobraNet™ Silicon Series of devices as well as the CM-2 module.

CobraNet is a combination of hardware (the CobraNet interface), network protocol, and firmware. CobraNet operates on a switched Ethernet network and provides the following additional communications services.

- Isochronous (Audio) Data Transport
- Sample Clock Distribution
- Control and Monitoring Data Transport

The CobraNet interface performs synchronous-to-isochronous and isochronous-to-synchronous conversions as well as the data formatting required for transporting real-time digital audio over the network.

The CobraNet interface has provisions for carrying and utilizing control and monitoring data such as *Simple Network Management Protocol* (SNMP) through the same network connection as the audio. Standard data transport capabilities of Ethernet are shown here as unregulated traffic. Since CobraNet is Ethernet based, in most cases, data communications and CobraNet applications can coexist on the same physical network. Figure 1 illustrates the different data services available through the CobraNet system.

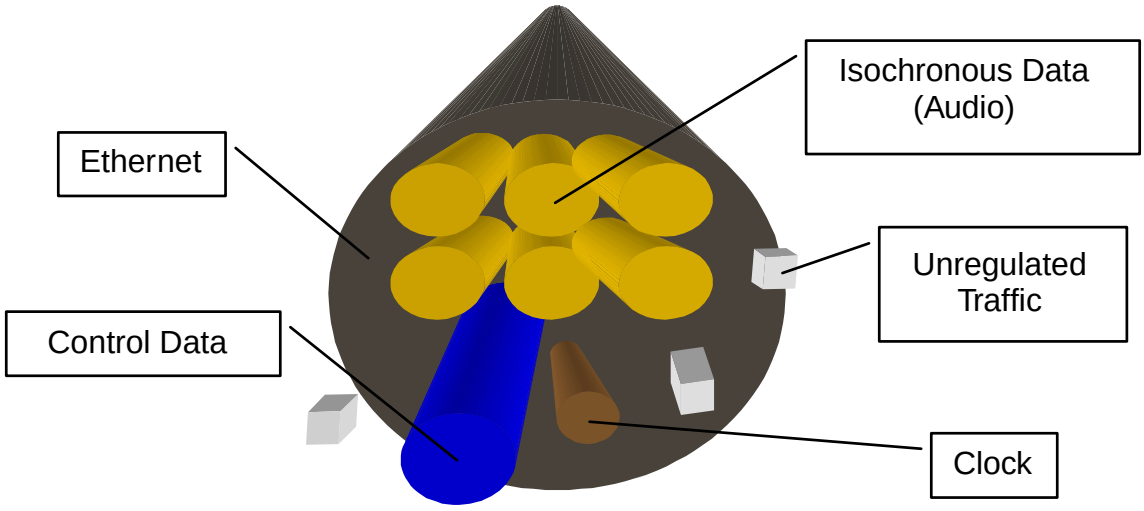


Figure 1. CobraNet Data Services

2.0 Features

2.1 CobraNet

- Real-time Digital Audio Distribution via Ethernet
- No Overall Limit on Network Channel Capacity
- Fully IEEE 802.3 Ethernet Standards Compliant
- Fiber optic and gigabit Ethernet variants are fully supported.
- Ethernet infrastructure can be used simultaneously for audio and data communications.
- Free *CobraCAD*™ Audio Network Design Tool
- High-quality Audio Sample Clock Delivery Over Ethernet
- Bit-transparent 16-, 20-, and 24-bit Audio Transport
- Professional 48kHz and 96kHz sample rate
- Select Latency as Low as 1.33ms
- Flexible Many-to-many Network Audio Routing Capabilities
- Reduced-cost, Improved-performance, Convergent Audio Distribution Infrastructure

2.2 CobraNet Interface

- Auto-negotiating 100Mbit Full-duplex Ethernet Connections
- 16-channel Audio I/O Capability
- Implements CobraNet Protocol for real-time transport of audio over Ethernet.
- Local Management via 8-bit Parallel Host Port
- UDP/IP Network Stack with Dynamic IP Address Assignment via BOOTP or RARP
- Remote Management via Simple Network Management Protocol (SNMP)
- Economical Three-chip Solution
- Available Module form factor allows for flexible integration into audio products.
- Non-volatile Storage of Configuration Parameters
- Safely Upgrade Firmware Over Ethernet Connection
- LED Indicators for Ethernet Link, Activity, Port Selection, and Conductor Status
- Watchdog Timer Output for System Integrity Assurance
- Comprehensive Power-on Self-test (POST)
- Error and Fault Reporting and Logging Mechanisms

2.3 Host Interface

- 8-bit Data, 4-bit Address
- Virtual 24-bit Addressing with 32-bit Data
- *Polled*, *Interrupt* and *DMA* Modes of Operation
- Configure and Monitor CobraNet Interface
- Transmit or Receive Ethernet Packets at *Near-100 Mbit* Wire Speed

2.4 Asynchronous Serial Interface

- Full-duplex Capable
- 8-bit Data Format
- Supports all Standard Baud Rates

2.5 Synchronous Serial Audio Interface

- Up to Four Bi-directional Interfaces Supporting up to 32 Channels of Audio I/O
- 64FS (3.072 MHz) Bit Rate for CS18100 and CS18101
- 128FS (6.144 MHz) Bit Rate for CS18102
- Accommodates Many Synchronous Serial Formats Including I^2S
- 32-bit Data Resolution on All Audio I/O

2.6 Audio Clock Interface

- 5 Host Audio-clocking Modes for Maximum Flexibility in Digital Audio Interface Design
- Low-jitter Master Audio Clock Oscillator (24.576 MHz)
- Synchronize to Supplied Master and/or Sample Clock
- Sophisticated jitter attenuation assures network perturbations do not affect audio performance.

2.7 Audio Routing and Processing

- Single-channel Granularity in Routing From Synchronous Serial Audio Interface to CobraNet Network
- Two levels of inward audio routing affords flexibility in audio I/O interface design in the host system.
- Local Audio Loopback and Output Duplication Capability
- Peak-read Audio Metering with Ballistics

3.0 Hardware

Figure 2 shows a high-level view of the CobraNet CM-2 interface hardware architecture.

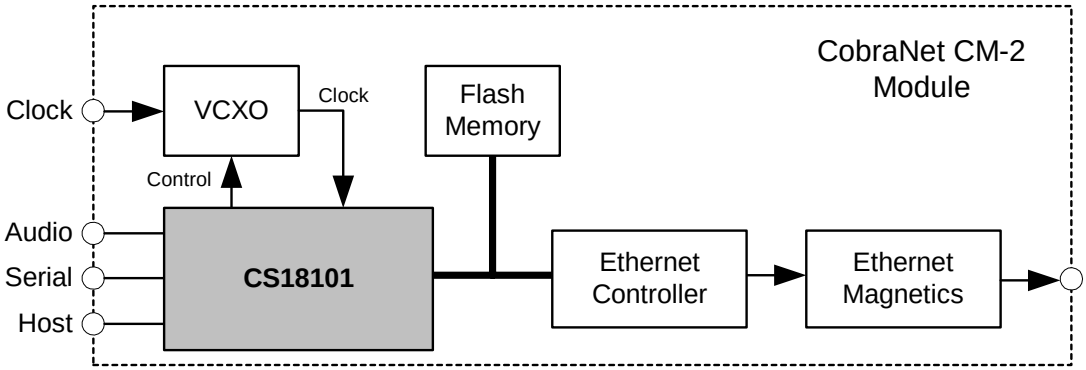


Figure 2. CobraNet Interface Hardware Block Diagram

Flash memory holds the CobraNet firmware and management interface variable settings.

The CS181xx is the heart of the CobraNet interface. It implements the network protocol stacks and performs the synchronous-to-isochronous and isochronous-to-synchronous conversions. The CS181xx has a role in sample clock regeneration and performs all interactions with the host system.

The sample clock is generated by a voltage-controlled crystal oscillator (VCXO) controlled by the CS181xx. The VCXO frequency is carefully adjusted to achieve lock with the network clock.

The Ethernet controller is a standard interface chip that implements the 100-Mbit Fast Ethernet standard. As per Ethernet requirements the interface is transformer isolated.

4.0 Pinout and Signal Descriptions

This section details the chip pinout and signal interfaces for each module and is divided as follows:

4.1 CS181xx Package Pinouts

4.1.1 CS181xx Pinout

Table 1 lists the pinout for the 144-pin LQFP CS181xx chip. The interfaces for these signals are expanded in the following sections.

Table 1. CS181xx Pin Assignments

Pin #	Pin Name	Pin #	Pin Name	Pin #	Pin Name	Pin #	Pin Name
1	VCXO_CTRL	37	DATA1	73	VDDIO	109	HADDR1
2	MCLK_SEL	38	$\overline{WE}$	74	ADDR10	110	HADDR0
3	DBDA	39	DATA0	75	ADDR14	111	HDATA7
4	DBCK	40	DATA15	76	GND	112	HDATA6
5	NC	41	DATA14	77	ADDR13	113	VDDIO
6	NC	42	DATA13	78	NC	114	HDATA5
7	NC	43	DATA12	79	NC	115	HDATA4
8	DAO_MCLK	44	VDDIO	80	NC	116	GND
9	TEST	45	DATA11	81	NC	117	HDATA3
10	VDDD	46	DATA10	82	ADDR15	118	HDATA2
11	HS3	47	GND	83	VDDD	119	VDDD
12	NC	48	DATA9	84	ADDR16	120	HDATA1
13	GND	49	DATA8	85	ADDR17	121	HDATA0
14	DAO2_LRCLK	50	NC	86	GND	122	GND
15	DAO1_DATA3	51	NC	87	ADDR18	123	XTAL_OUT
16	DAO1_DATA2/HS2	52	NC	88	ADDR19	124	XTO
17	DAO1_DATA1/HS1	53	NC	89	$\overline{OE}$	125	XTI
18	VDDIO	54	VDDD	90	$\overline{CS1}$	126	GND_a
19	DAO1_DATA0/HS0	55	ADDR12	91	VDDIO	127	FILT2
20	DAO1_SCLK	56	ADDR11	92	$\overline{MUTE}$	128	FILT1
21	GND	57	GND	93	$\overline{HRESET}$	129	VDD_A
22	DAO1_LRCLK	58	ADDR9	94	GND	130	VDDD
23	UART_TX_OE	59	ADDR8	95	WATCHDOG	131	DAI1_DATA3
24	VDDD	60	VDDIO	96	IOWAIT	132	DAI1_DATA2
25	UART_TXD	61	ADDR7	97	REFCLK_IN	133	GND
26	UART_RXD	62	ADDR6	98	VDDD	134	DAI1_DATA1
27	GND	63	GND	99	GPIO0	135	DAI1_DATA0
28	NC	64	ADDR5	100	GPIO1	136	VDDIO
29	DATA7	65	$\overline{CS2}$	101	GND	137	DAI1_SCLK
30	DATA6	66	VDDD	102	$\overline{HACK}$	138	DAI1_LRCLK
31	DATA5	67	ADDR4	103	$\overline{HDS}$	139	GND
32	DATA4	68	ADDR3	104	$\overline{HEN}$	140	$\overline{HREQ}$
33	VDDIO	69	GND	105	HADDR3	141	NC
34	DATA3	70	ADDR2	106	HADDR2	142	NC
35	DATA2	71	ADDR1	107	HR/$\overline{W}$	143	IRQ1
36	GND	72	ADDR0	108	GPIO2	144	IRQ2

4.1.2 CM-2 Connector Pinout

Table 1 lists the pinout for the four pinout connectors on the CM-2 board (J1-J4). The interfaces for these signals are expanded following the table.

Table 2. CM-2 Pin Assignments

Conn.	Pin #	Pin Name
J1/J2	A1	UART_RXD
J1/J2	A2	UART_TX_OE
J1/J2	A3	$\overline{\text{HACK}}$
J1/J2	A4	HR/$\overline{\text{W}}$
J1/J2	A5	$\overline{\text{HDS}}$
J1/J2	A6	$\overline{\text{HREQ}}$
J1/J2	A7	$\overline{\text{HEN}}$
J1/J2	A8	HADDR0
J1/J2	A9	HADDR1
J1/J2	A10	HADDR2
J1/J2	A11	HDATA0
J1/J2	A12	HDATA1
J1/J2	A13	HDATA2
J1/J2	A14	HDATA3
J1/J2	A15	HDATA4
J1/J2	A16	HDATA5
J1/J2	A17	HDATA6
J1/J2	A18	$\overline{\text{HRESET}}$
J1/J2	A19	HDATA7
J1/J2	A20	HADDR3
J1/J2	B1	UART_TXD
J1/J2	B2	GND
J1/J2	B3	VCC_+3.3V
J1/J2	B4	GND
J1/J2	B5	VCC_+3.3V
J1/J2	B6	GND
J1/J2	B7	VCC_+3.3V
J1/J2	B8	GND
J1/J2	B9	VCC_+3.3V
J1/J2	B10	GND
J1/J2	B11	VCC_+3.3V
J1/J2	B12	GND
J1/J2	B13	VCC_+3.3V
J1/J2	B14	GND
J1/J2	B15	VCC_+3.3V
J1/J2	B16	GND
J1/J2	B17	VCC_+3.3V
J1/J2	B18	RSVD1
J1/J2	B19	GND
J1/J2	B20	VCC_+3.3V
J3/J4	A1	RSVD2
J3/J4	A2	$\overline{\text{MUTE}}$
J3/J4	A3	FS1
J3/J4	A4	MCLK_OUT
J3/J4	A5	MCLK_IN
J3/J4	A6	REFCLK_IN
J3/J4	A7	DAO1_SCLK/DAI1_SCLK
J3/J4	A8	DAO1_DATA0
J3/J4	A9	DAO1_DATA1
J3/J4	A10	DAO1_DATA2
J3/J4	A11	DAO1_DATA3
J3/J4	A12	DAI1_DATA0
J3/J4	A13	DAI1_DATA1
J3/J4	A14	DAI1_DATA2
J3/J4	A15	DAI1_DATA3
J3/J4	A16	RSVD3
J3/J4	A17	WATCHDOG
J3/J4	A18	RSVD4
J3/J4	A19	AUX_POWER2
J3/J4	A20	AUX_POWER0
J3/J4	B1	GND
J3/J4	B2	VCC_+3.3V
J3/J4	B3	GND
J3/J4	B4	VCC_+3.3V
J3/J4	B5	GND
J3/J4	B6	VCC_+3.3V
J3/J4	B7	GND
J3/J4	B8	VCC_+3.3V
J3/J4	B9	GND
J3/J4	B10	VCC_+3.3V
J3/J4	B11	GND
J3/J4	B12	VCC_+3.3V
J3/J4	B13	GND
J3/J4	B14	VCC_+3.3V
J3/J4	B15	GND
J3/J4	B16	GND
J3/J4	B17	VCC_+5V
J3/J4	B18	VCC_+5V
J3/J4	B19	AUX_POWER3
J3/J4	B20	AUX_POWER1

4.2 Signal Descriptions

4.2.1 Host Port Signals

The host port is used to manage and monitor the CobraNet interface. Electrical operation and protocol is detailed in the "Host Management Interface (HMI)" on page 23 of this Manual.

Signal	Description	Direction	CM-2 Pin #	CS181xx Pin #	Notes
HDATA[7:0]	Host Data	In/Out	J1:A19, A[17:11]	111, 112, 114, 115, 117, 118, 102, 121	Host port data.
HADDR[3:0]	Host Address	In	J1:A20, A[10:8]	105, 106, 109,110	Host port address.
HRW	Host Direction	In	J1:A4	107	Host port transfer direction.
$\overline{\text{HREQ}}$	Host Request	Out	J1:A6	140	Host port data request.
$\overline{\text{HACK}}$	Host Alert	Out	J1:A3	102	Host port interrupt request.
$\overline{\text{HDS}}$	Host Strobe	In	J1:A5	103	Host port strobe.
$\overline{\text{HEN}}$	Host Enable	In	J1:A7	104	Host Port Enable.

4.2.2 Asynchronous Serial Port (UART Bridge) Signals

Level-shifting drive circuits are typically required between these signals and any external connections.

Signal	Description	Direction	CM-2 Pin #	CS181xx Pin #	Notes
UART_RXD	Asynchronous Serial Receive Data	In	J1:A1	26	Pull-up to VCC if unused.
UART_TXD	Asynchronous Serial Transmit Data	Out	J1:B1	25	
UART_TX_OE	Transmit Drive Enable	Out	J1:A2	23	Enable transmit (active high) drive for two wire multi-drop interface.

4.2.3 Synchronous Serial (Audio) Signals

The synchronous serial interfaces are used to bring digital audio into and out of the system. Typically the synchronous serial is wired to ADCs and/or DACs. Detailed timing and format is described in "Digital Audio Interface" on page 19.

Signal	Description	Direction	CM-2 Pin #	CS181xx Pin #	Notes
DAO1_SCLK	Audio Bit Clock	Out	J3:A7	20	Synchronous serial bit clock. 64 FS for CS18100 (2x1 channel) 64 FS for CS18101 (2x4 channels) 128 FS for CS18102 (4x4 channels) Typically tied to DAI1_SCLK.
DAO1_DATA[3:0]	Audio Output Data	Out	J3:A18, B18	15-17, 19	Output synchronous serial audio data DAO1_DATA[3:1] not used for CS18100.
DAI1_DATA[3:0]	Audio Input Data	In	J3: A[15:12]	131, 132, 134, 135	Input synchronous serial audio data DAI1_DATA[3:1] not used for CS18100.
DAI1_SCLK	Audio Bit Clock	In	J4:A7	137	Should be tied to DAO1_SCLK. Synchronous serial bit clock.

4.2.4 Audio Clock Signals

See "Synchronization" on page 16 for an overview of synchronization modes and issues.

Signal	Description	Direction	CM-2 Pin #	CS181xx Pin #	Notes
DAI1_LRCLK	Sample clock input	In		138	Should be tied to DAO1_LRCLK for all devices.
DAO1_LRCLK (FS1)	Sample clock output	Out	J3:A3	22	FS1 (word clock) for CS18100 and CS18101.
DAO2_LRCLK (FS1)	Sample clock output	Out	J3:A3	14	FS1 (word clock) for CS18102.
REFCLK_IN	Reference clock	In	J3:A6	97	Clock input for synchronizing network to an external clock source, for redundancy control and synchronization of FS divider chain to external source. See "Synchronization" on page 16 for more detail.
MCLK_IN	Master audio clock input	In	J3:A5	8*	For systems featuring multiple CobraNet interfaces operating off a common master clock. See "Synchronization" on page 16 for more detail.
MCLK_OUT	Master audio clock output	Out	J3:A4	8*	Low jitter 24.576 MHz master audio clock.

*An external multiplexor controlled by this pin is required for full MCLK_IN and MCLK out implementation.

4.2.5 Miscellaneous Signals

Signal	Description	Direction	CM-2 Pin #	CS181xx Pin #	Notes
$\overline{\text{HRESET}}$	Reset	In	J1:A18	93	System reset (active low). **10 ns** max rise time. **1 ms** min assertion time.
WATCHDOG	Watch Dog	Out	J3:A17	95	Toggles at 750 Hz nominal rate to indicate proper operation. Period duration in excess of 200 ms indicates hardware or software failure has occurred and the interface should be reset. Note that improper operation can also be indicated by short pulses (<100 ns).
$\overline{\text{MUTE}}$	Interface Ready	Out	J3:A2	92	Asserts (active low) during initialization and when a fault is detected or connection to the network is lost.
NC	No Connect	-	-	28, 50-53, 78-81, 141, 142	

4.2.6 Power and Ground Signals

Signal	Description	CM-2 Pin #	CS181xx Pin #	Specification
VCC_+3V	System Digital +3.3 v	J1:B20, B17, B15, B13, B11, B9, B7, B5, B3 J3:B14, B12, B10, B8, B6, B4, B2	N/A	3.3 ± 0.3v, 0.6A*
VCC_+5V		J3;B[18:17]	N/A	Backwards Compatibility
VDDD		N/A	10, 24, 54, 66, 83, 98, 119, 130	+1.8 V @ 500mA* for Core Logic
VDDIO		N/A	18, 33, 44, 60, 73, 91, 113, 136	+3.3 V @ 120mA* for I/O Logic
VDD_A		N/A	129	Filtered +1.8 V @ 10mA*
AUX_POWER [3-0]		J3:B[20:19], A[20:19]	N/A	
GND	Digital Ground	J1:B19, B16, B14, B12, B10, B8, B6, B4, B2 J3:B16, B15, B13, B11, B9, B7, B5, B3, B1	13, 21, 27, 36, 47, 57, 63, 69, 76, 86, 94, 101, 116, 122, 126, 133, 139	

* Indicates specifications are estimates.

4.2.7 System Signals

Use these CS181xx signals in the manner strictly described in the CS181xx reference design. Each signal is briefly described below.

Signal	Description	CS181xx Pin #
VCXO_CTRL	A Delta-sigma DAC Output for Controlling the On-board VCXO	1
MCLK_SEL	Control Signal for Selecting MCLK Sources	2
DBDA, DBCK	I2C Debugger Interface	3, 4
TEST	Used for testing during manufacturing. Keep grounded for normal operation.	9
DATA[15:0]	Data Bus for Flash & Ethernet Controller(s)	29-32, 34, 35, 37, 39-43, 45, 46, 48, 49
ADDR[19:0]	Address Bus for Flash & Ethernet Controller(s)	55, 56, 58, 59, 61, 62, 64, 67, 68, 70-72, 74, 75, 77, 82, 84, 85, 87, 88
$\overline{WE}$	Write Enable for Flash and Ethernet Controller(s)	38
$\overline{CS1}$	Chip Select for Flash Memory Device	90
$\overline{CS2}$	Chip Select for Ethernet Controller(s)	65
$\overline{OE}$	Output Enable	89
IOWAIT	Wait State Signal from Ethernet Controller(s)	96
GPIO[2:0]	General-purpose I/O Signals	99, 100, 108
XTI	Reference Clock Input / Crystal Oscillator Input	125
XTO	Crystal Oscillator Output	124
XTAL_OUT	A Buffered Version of XTI	123
FILT2, FILT1	PLL Loop Filter	127, 128
DAO_MCLK	MCLK Input	8
HS[3:0]	CS181xx Boot Mode Selection	11, 16, 17, 19

5.0 Synchronization

Figure 3 shows clock related circuits for the CS181xx and board design (CM-2). This circuitry allows the synchronization modes documented below to be achieved. Modes are distinguished by different settings of the multiplexors and software elements.

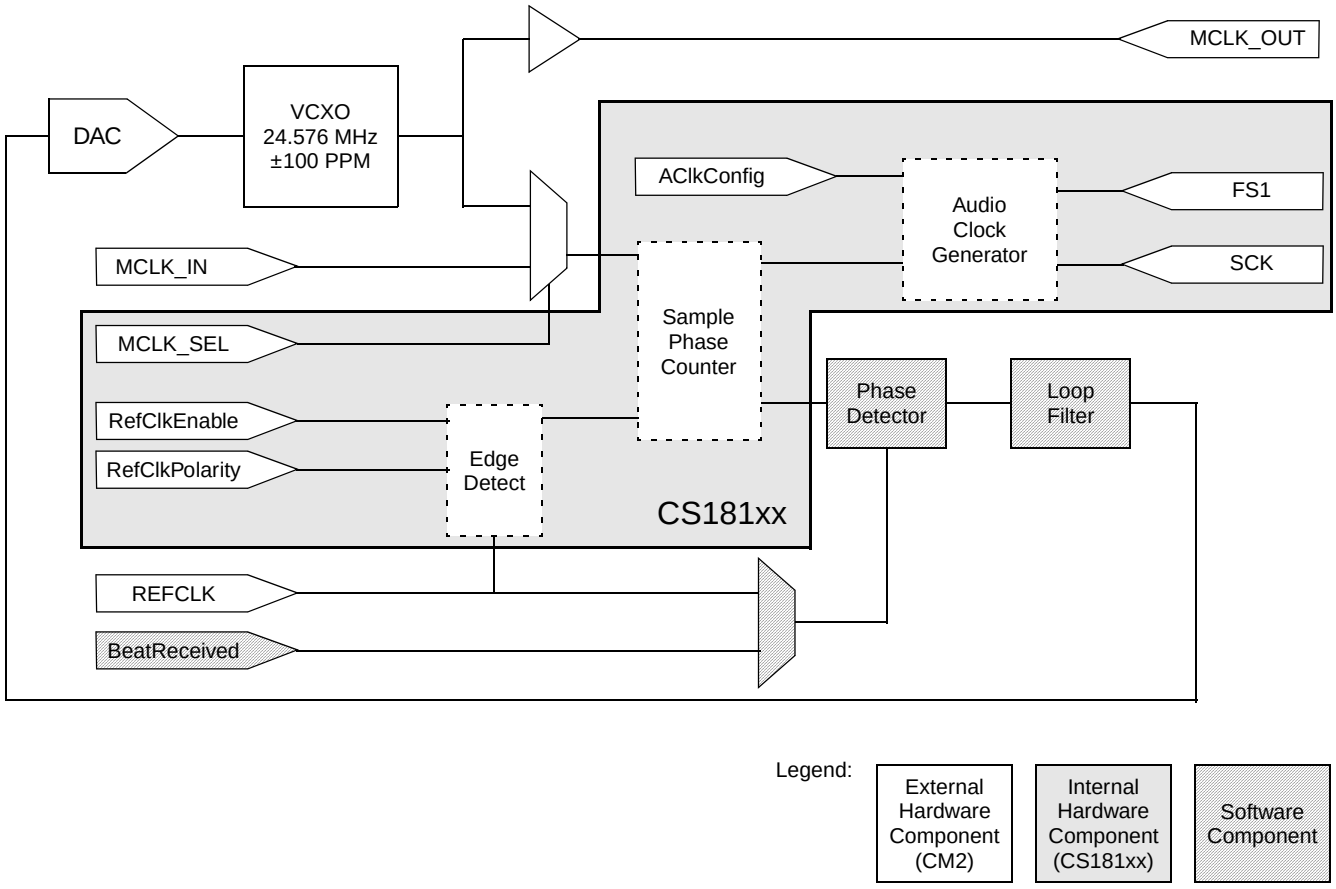


Figure 3. Audio Clock Sub-system

5.1 Synchronization Modes

Clock synchronization mode for conductor and performer roles is independently selectable via management interface variables *syncConductorClock* and *syncPerformerClock*. The role (conductor or performer) is determined by the network environment including the *conductor priority* setting of the device and the other devices on the network. It is possible to ensure you will never assume the conductor role by selecting a conductor priority of *zero*. However, it is not reasonable to assume that by setting a high conductor priority, you will always assume the conductor role. For more information, refer to CobraNet Programmer's Reference Manual.

The following synchronization modes are further described below:

5.1.1 Internal Mode

All CobraNet clocks are derived from the onboard VCXO. The master clock generated by the VCXO is available to external circuits via the master clock output.

Conductor—The VCXO is "parked" according to the *syncClockTrim* setting.

Performer—The VCXO is "steered" to match the clock transmitted by the Conductor.

5.1.2 Internal Mode with External Sample Synchronization

This mode is identical to internal mode except that it allows synchronization of derived clocks (sample clock, audio bit clock) to an external source via the reference clock input. This additional functionality is useful when adapting the CobraNet interface to a device that already has circuitry for generating those clocks.

Conductor—The VCXO is "parked" according to the *syncClockTrim* setting.

Performer—The VCXO is "steered" to match the clock transmitted by the conductor.

5.1.3 External Word Clock Mode

All CobraNet clocks are derived from the onboard VCXO. The VCXO is steered from an external clock supplied to the reference clock input. The clock supplied can be any integral division of the sample clock in the range of 750Hz to 48kHz.

External synchronization lock range: ±5 μs. This specification indicates drift or wander between the supplied clock and the generated network clock at the conductor. Absolute phase difference between the supplied reference clock and generated sample clock is dependant on network topology.

Conductor—This mode gives a means for synchronizing an entire CobraNet network to an external clock.

Performer—The interface disregards the fine timing information delivered over the network from the conductor. Coarse timing information from the conductor is still used; fine timing information is instead supplied by the reference clock. The external clock source must be synchronous with the network conductor. This mode is useful in installations where a house sync source is readily available.

5.1.4 External Master Clock Mode

The VCXO is disabled and MCLK_IN is used as the master clock for the node. This is a "hard" synchronization mode. The supplied clock is used directly by the CobraNet interface for all timing. This mode is primarily useful for devices with multiple CobraNet interfaces sharing a common master audio clock. The supplied clock must be 24.576 MHz. The supplied clock must have a ±37 ppm precision.

Conductor—The entire network is synchronized to the supplied master clock.

Performer—The node will initially lock to the network clock and will "jam sync" via the supplied master clock. The external clock source must be synchronous with the network conductor.

5.1.5 External Master Clock Mode with External Sample Synchronization

This mode is identical to *External Master Clock* mode except that it allows synchronization of the derived clocks (sample clock, audio bit clock) to an external source via the reference clock input. This additional functionality is useful when adapting the CobraNet interface to a device that already has circuitry for generating derived clocks of its own.

Conductor—The entire network is synchronized to the supplied master clock.

Performer—The node will initially lock to the network clock and will "jam sync" via the supplied master clock. The external clock source must be synchronous with the network conductor.

6.0 Digital Audio Interface

The CS18101, CS18102, and CM-2 support four bi-directional synchronous serial interfaces. The CS18100 supports one bi-directional synchronous serial interface. All interfaces operate in master mode with DAO1_SCLK as the bit clock and FS1 as the frame clock. A sample period worth of synchronous serial data includes two (or four) audio channels. CobraNet supports two synchronous serial bit rates: 48 Khz and 96 KHz. However, 96 kHz sample rate is not available when using CS18102 with 16X16 channels. Bit rate is selected by the *modeRateControl* variable. All synchronous serial interfaces operate from a common clock at the same bit rate.

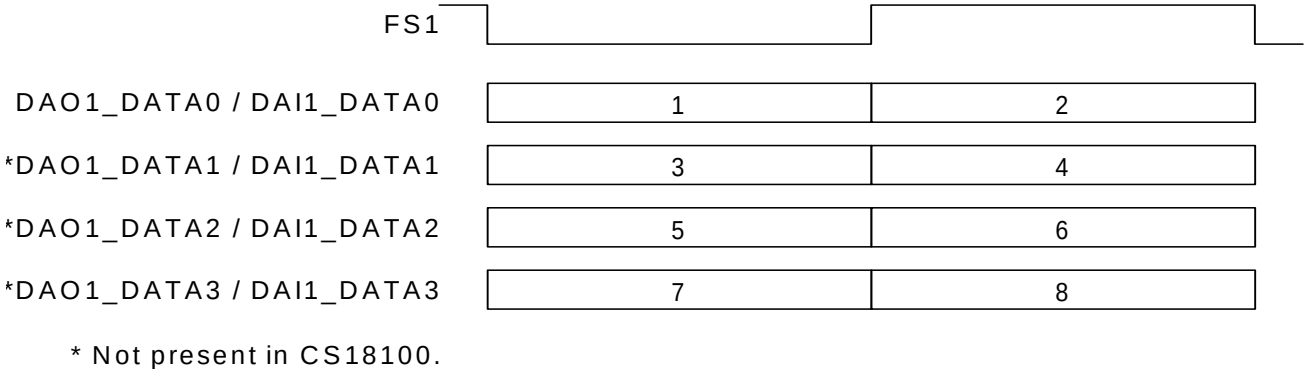


Figure 4. Channel Structure for Synchronous Serial Audio at 64FS (One Sample Period) - CS18100 & CS18101

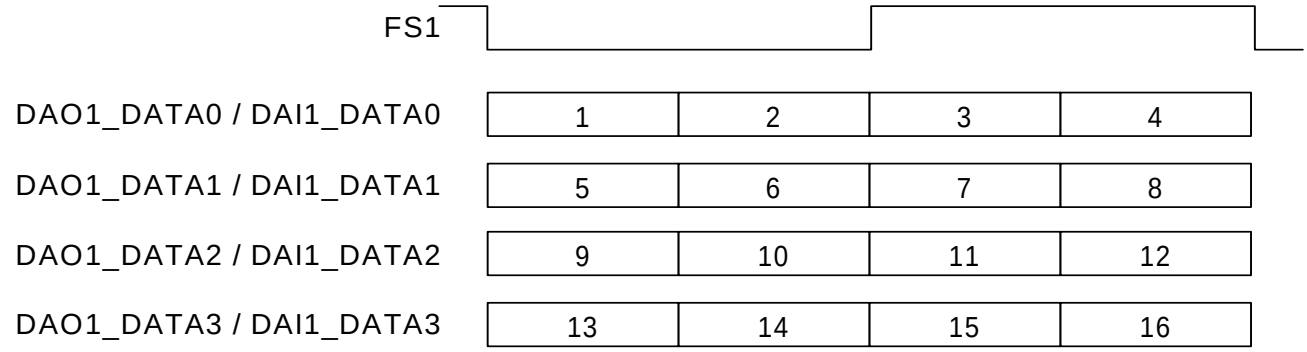


Figure 5. Channel Structure for Synchronous Serial Audio at 128FS (One Sample Period) - CS18102

Default channel ordering is shown above. Note that the first channel always begins after the rising or falling edge of FS1 (depending on the mode).

DAI1_SCLK period depends on the sample rate selected. Up to 32 significant bits are received and buffered by the DSP for synchronous inputs. Up to 32 significant bits are transmitted by the DSP for synchronous outputs. Bit 31 is always the most significant (sign) bit. A 16-bit audio source must drive to bit periods 31-16 with audio data and bits 15-0 should be actively driven with either a dither signal or zeros. Cirrus Logic recommends driving unused LS bits to zero.

Although data is always transmitted and received with a 32-bit resolution by the synchronous serial ports, the resolution of the data transferred to/from the Ethernet may be less. Incoming audio data is truncated to the selected resolution. Unused least significant bits on outgoing data is zero filled.

6.1 Digital Audio Interface Timing

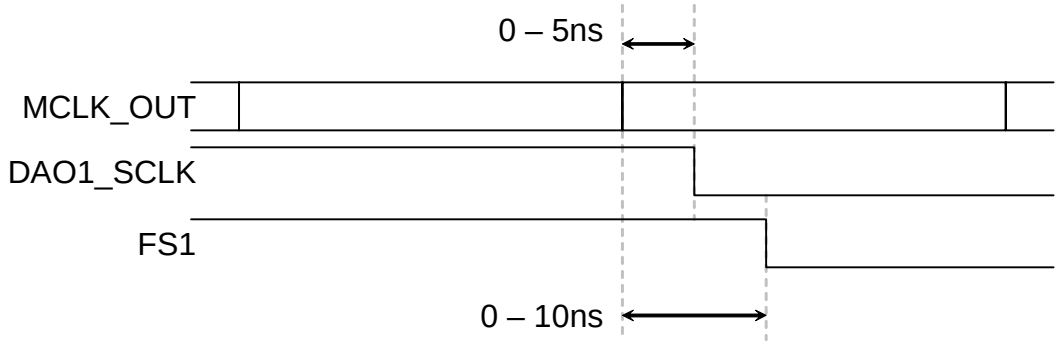


Figure 6. Timing Relationship between FS512_OUT, DAO1_SCLK and FS1

An DAO1_SCLK edge follows an MCLK_OUT edge by 0.0 to 5.0ns. An FS1 edge follows a MCLK_OUT edge by 0.0 to 10.0ns.

Note: The DAO1_SCLK and FS1 might be synchronized with the either the falling edge or the rising edge of MCLK_OUT. Which edge is impossible to predict since it depends on power up timing.

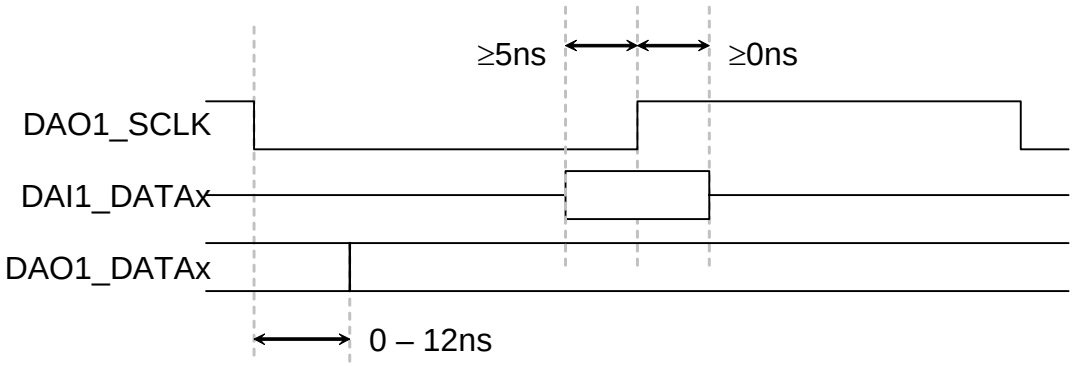


Figure 7. Serial Port Data Timing Overview

Setup times for DAI1_DATAx and FS1 are 5.0 ns with a hold time of 0.0 ns with respect to the DAI1_SCLK edge. Clock to output times for DAO1_DATAx is 0.0 to 12.0 ns from the edge of DAO1_SCLK.

6.1.1 Normal Mode Data Timing

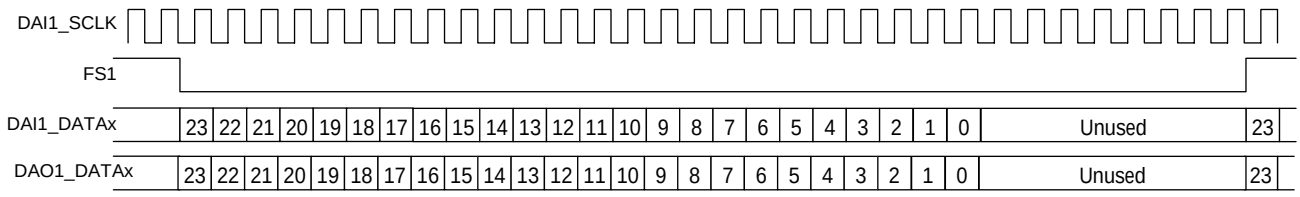


Figure 8. Audio Data Timing Detail - Normal Mode, 64FS - CS18100, CS18101

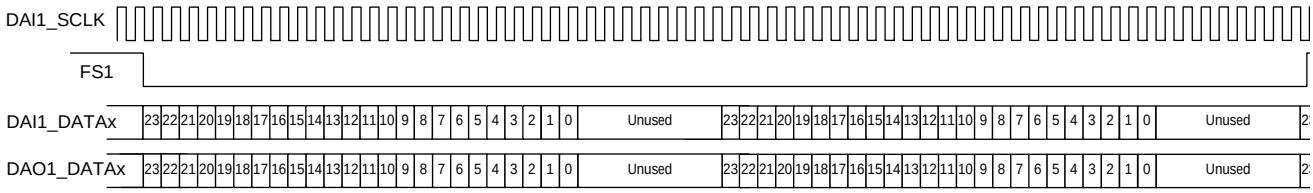


Figure 9. Audio Data Timing Detail - Normal Mode, 128FS - CS18102

Each audio channel is comprised of 32 bits of data, regardless of audio sample size. The figure above shows 24-bit audio data.

The MSB is left justified and is aligned with FS1. Data is sampled on the rising edge of DAI_SCLK and data changes on the falling edge.

6.1.2 I^2S Mode Data Timing

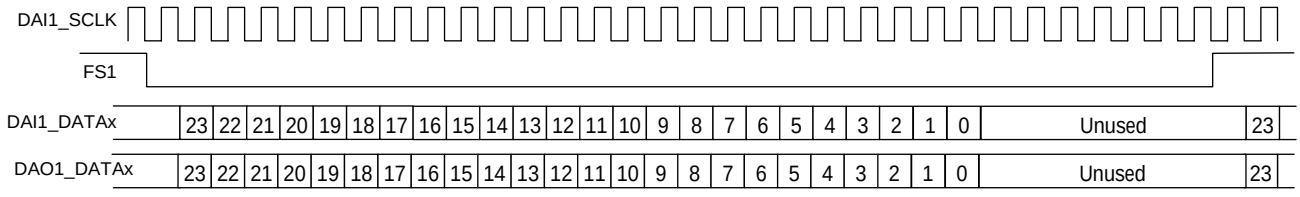


Figure 10. Audio Data Timing Detail - I^2S Mode, 64FS - CS18100, CS18101

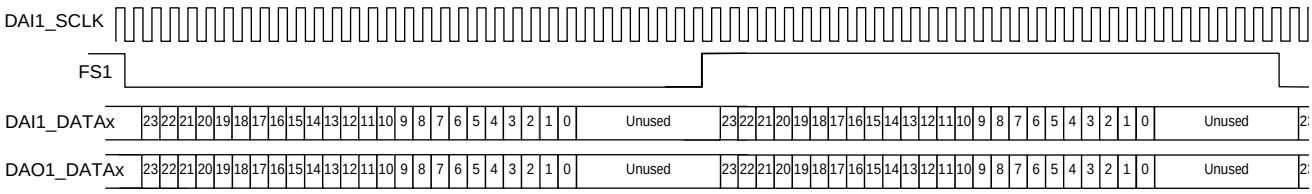


Figure 11. Audio Data Timing Detail - I^2S Mode, 128FS - CS18102

Each audio channel is comprised of 32 bits of data, regardless of audio sample size. The figure above shows 24-bit audio data.

The MSB is left justified and arrives one bit period following FS1. Data is sampled on the rising edge of DAI_SCLK and data changes on the falling edge.

6.1.3 Standard Mode Data Timing

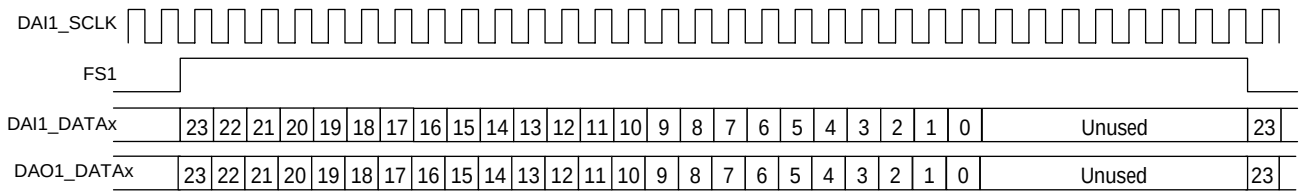


Figure 12. Audio Data Timing Detail - Standard Mode, 64FS - CS18100, CS18101

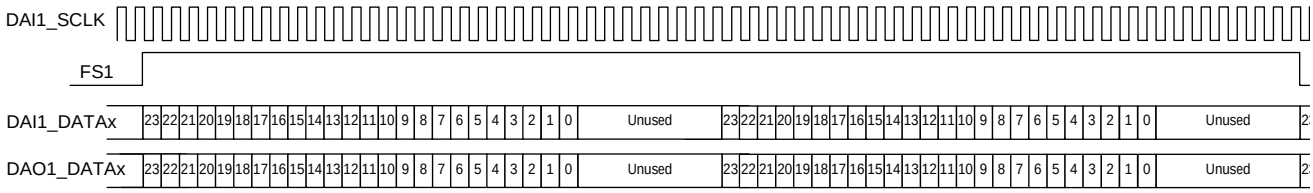


Figure 13. Audio Data Timing Detail - Standard Mode, 128FS - CS18102

Each audio channel is comprised of 32 bits of data, regardless of audio sample size. The figure above shows 24-bit audio data.

The MSB is left justified and is aligned with FS1. Data is sampled on the rising edge of DAI_SCLK and data changes on the falling edge.

7.0 Host Management Interface (HMI)

7.1 Hardware

The host port is 8 bits wide with 4 bits of addressing. Ten of the 16 addressable registers are implemented. The upper two registers can be used to configure and retrieve the status on the host port hardware. However, only the first 8 are essential for normal HMI communications. It is therefore feasible, in most applications, to utilize only the first 3 address bits and tie the most significant bit (A3) low.

Host port hardware supports Intel, Motorola, and Motorola multiplexed bus protocols in *big-endian* or *little-endian* modes. Standard CobraNet firmware configures the port in the Motorola, big-endian mode.

The host port memory map is shown in Table 3. Refer also to "HMI Definitions" on page 31 and "HMI Access Code" on page 32.

Host Address	Register
0	Message A (MS)
1	Message B
2	Message C
3	Message D (LS)
4	Data A (MS)
5	Data B
6	Data C
7	Data D (LS)
8	Control
9	Status

Table 3. Host port memory map

The message and data registers provide separate bi-directional data conduits between the host processor and the CS181xx. A 32-bit word of data is transferred to the CS181xx when the host writes the D message or data register after presumably previously writing the A, B, and C registers with valid data. Data is transferred from the CS181xx following a read of the D message or data register. Again, presumably the A, B, and C registers are read previously.

Two additional hardware signals are associated with the host port: $\overline{\text{HACK}}$ and $\overline{\text{HREQ}}$. Both are outputs to the host.

$\overline{\text{HACK}}$ may be wired to an interrupt request input on the host. $\overline{\text{HACK}}$ can be made to assert (logic 0) on specific events as specified by the *hackEnable MI* variable. $\overline{\text{HACK}}$ is deasserted (logic 1) by issuance of the *Acknowledge Interrupt* message (see *"Messages"* below).

$\overline{\text{HREQ}}$ may be wired to a host interrupt or DMA request input. $\overline{\text{HREQ}}$ is used to signal the host that data is available (read case, logic 0) or space is available in the host port data channel (write case, logic 1).

The read and write case are distinguished by the HMI based on the preceding message. *Identify, Goto Translation* (read), *Goto Packet* (read) and *Goto Counters* cause $\overline{\text{HREQ}}$ to represent read status. *Goto Translation* (write) and *Goto Packet* (write) switch $\overline{\text{HREQ}}$ to write mode. All other commands have no effect on $\overline{\text{HREQ}}$ operation.

In general, the host can read from the CS181xx when $\overline{\text{HREQ}}$ is low and can write data to CS181xx when $\overline{\text{HREQ}}$ is high.

7.2 Host Port Timing

(C_L = 20 pF)

Parameter	Symbol	Min	Max	Unit
Address setup before HEN# and HDS# low	t_{mas}	5	-	ns
Address hold time after HEN# and HDS# low	t_{mah}	5	-	ns
Read				
Delay between HDS# then HEN# low or HEN# then HDS# low	t_{mcdr}	0	-	ns
Data valid after HEN# and HDS# low with HR/W# high	t_{mdd}	-	19	ns
HEN# and HDS# low for read	t_{mrpw}	24	-	ns
Data hold time after HEN# or HDS# high after read	t_{mdhr}	8	-	ns
Data high-Z after HEN# or HDS# high after read	t_{mdis}	-	18	ns
HEN# or HDS# high to HEN# and HDS# low for next read	t_{mrd}	30	-	ns
HEN# or HDS# high toHEN# and HDS# low for next write	t_{mrdtw}	30	-	ns
HR/W# rising to HREQ# falling	$t_{mrwirqh}$	-	12	ns
Write				
Delay between HDS# then HEN# low or HEN# then HDS# low	t_{mcdw}	0	-	ns
Data setup before HEN# or HDS# high	t_{mdsu}	8	-	ns
HEN# and HDS# low for write	t_{mwpw}	24	-	ns
HR/W# setup before HEN# AND HDS# low	t_{mrwsu}	24	-	ns
HR/W# hold time after HEN# or HDS# high	t_{mrwhld}	8	-	ns
Data hold after HEN# or HDS# high	t_{mdhw}	8	-	ns
HEN# or HDS# high to HEN# and HDS# low with HR/W# high for next read	t_{mwtrd}	30	-	ns
HEN# or HDS# high to HEN# and HDS# low for next write	t_{mwd}	30	-	ns
HR/W# rising to HREQ# falling	$t_{mrwbsyl}$	-	12	ns

NOTES:1. The system designer should be aware that the actual maximum speed of the communication port may be limited by the firmware application. Hardware handshaking on the HREQ# pin/bit should be observed to prevent overflowing the input data buffer.

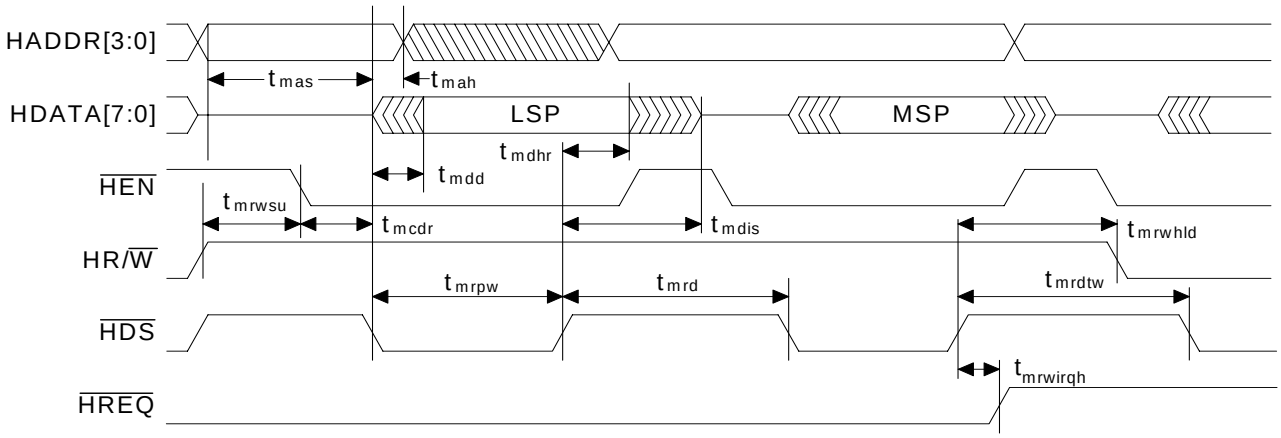


Figure 14. Host Port Read Cycle Timing

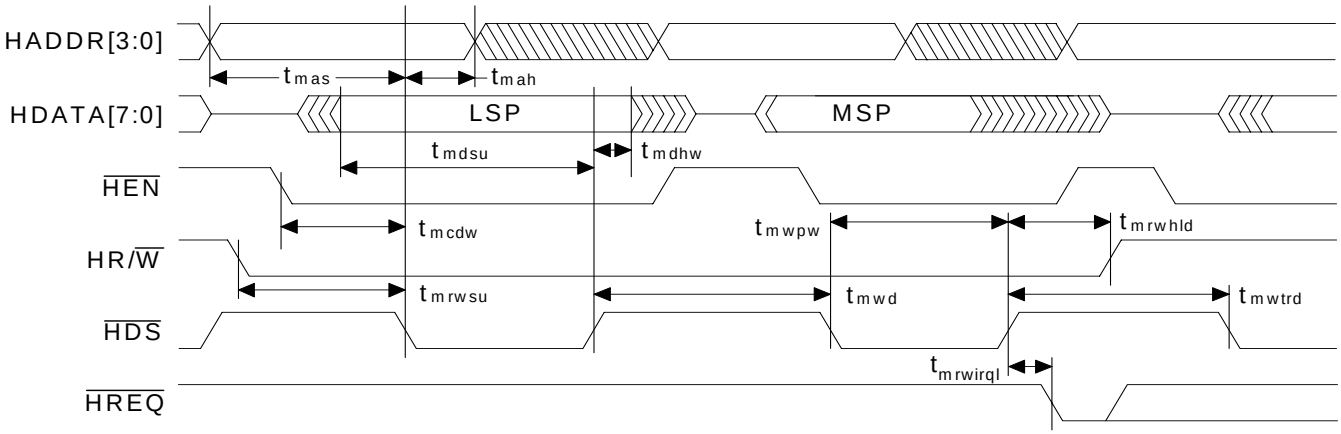


Figure 15. Host Port Write Cycle Timing

7.3 Protocol and Messages

The message conduit is used to issue commands to the CS181xx and retrieve HMI status. The data conduit is used to transfer data dependent on the HMI state as determined by commands issued by the host via the message conduit.

7.3.1 Messages

Messages are used to efficiently invoke action in the CS181xx. To send a message, the host optionally writes to the A, B, and C registers. Writing to the D register transmits the message to the CS181xx. A listing of all HMI messages is shown in Table 4. Refer also to "HMI Definitions" on page 31 and "HMI Access Code" on page 32.

Message	DRQ Handshake Mode	A	B	C	D
Translate Address	n/c	Address (MS)	Address	Address (LS)	0xB3
Acknowledge Interrupt	n/c	n/c	n/c	n/c	0xB4
Identify	read	n/c	n/c	7	0xB5
Goto Packet Transmit Buffer	write	n/c	n/c	6	0xB5
Goto Translation	write	n/c	n/c	5	0xB5
Acknowledge Packet Receipt	n/c	n/c	n/c	4	0xB5
Transmit Packet	n/c	n/c	n/c	3	0xB5
Goto Counters	read	n/c	n/c	2	0xB5
Goto Packet Receive Buffer	read	n/c	n/c	1	0xB5
Goto Translation	read	n/c	n/c	0	0xB5

Table 4. HMI messages

7.3.1.1. Translate Address

Translate Address does not actually update the address pointers but initiates the processing required to eventually move them. The host can accomplish other tasks, including HMI Reads and Writes while the address translation is being processed. A logical description of *Translate Address* is given below. A contextual use of the *Translate Address* operation is shown in the reference implementations. Refer also to "HMI Definitions" on page 31 and "HMI Access Code" on page 32.

```
void TranslateAddress(
   long address )
{
   int msgack = MSG_D;
   MSG_A = ( address & 0xff0000 ) >> 16;
   MSG_B = ( address & 0xff00 ) >> 8;
   MSG_C = address & 0xff;
   MSG_D = CVR_TRANSLATE_ADDRESS;
   while( !( ( msgack ^ MSG_D ) & ( 1 << MSG_TOGGLE_BO ) ) );
}
```

7.3.1.2. Interrupt Acknowledge

Causes HACK to be de-asserted.

```
void InterruptAck( void )
{
   int msgack = MSG_D;
   MSG_D = CVR_INTERRUPT_ACK;
   while( !( ( msgack ^ MSG_D ) & ( 1 << MSG_TOGGLE_BO ) ) );
}
```

7.3.1.3. Goto Packet

Moves HMI pointers to bridgeRxPktBuffer (write = 0) or bridgeTxPktBuffer (write = 1).

```
void GotoPacket(
   bool write )
{
   int msgack = MSG_D;
   MSG_C = write ? MOP_GOTO_PACKET_TRANSMIT : MOP_GOTO_PACKET_RECEIVE;
   MSG_D = CVR_MULTIPLEX_OP;
   while( !( ( msgack ^ MSG_D ) & ( 1 << MSG_TOGGLE_BO ) ) );
}
```

7.3.1.4. Goto Translation

Moves HMI data pointers to the results of the most recently completed translate address operation. The *write* parameter dictates the operation of the $\overline{\text{HREQ}}$ signal and only needs to be supplied for applications using hardware data handshaking via this signal.

```
void GotoTranslation(
   bool write = 0 )
{
   int msgack = MSG_D;
   MSG_C = write ? MOP_GOTO_TRANSLATION_WRITE : MOP_GOTO_TRANSLATION_READ;
   MSG_D = CVR_MULTIPLEX_OP;
   while( !( ( msgack ^ MSG_D ) & ( 1 << MSG_TOGGLE_BO ) ) );
}
```

7.3.1.5. Packet Received

Sets bridgeRxPkt = bridgeRxReady thus acknowledging receipt of the packet in bridgeRxPktBuffer.

```
void PacketReceive( void )
{
   int msgack = MSG_D;
   MSG_C = MOP_PACKET_RECEIVE;
   MSG_D = CVR_MULTIPLEX_OP;
   while( !( ( msgack ^ MSG_D ) & ( 1 << MSG_TOGGLE_BO ) ) );
}
```

7.3.1.6. Packet Transmit

Sets bridgeTxPkt = bridgeTxPktDone+1 thus initiating transmission of the contents of bridgeTxPktBuffer. Presumably bridgeTxPktBuffer has been previously written with valid packet data.

```
void PacketTransmit( void )
{
   int msgack = MSG_D;
   MSG_C = MOP_PACKET_TRANSMIT;
   MSG_D = CVR_MULTIPLEX_OP;
   while( !( ( msgack ^ MSG_D ) & ( 1 << MSG_TOGGLE_BO ) ) );
}
```

7.3.1.7. Goto Counters

Moves HMI data pointers to interrupt status variables (beginning at *hackStatus*).

```
void GotoCounters( void )
{
   int msgack = MSG_D;
   MSG_C = MOP_GOTO_COUNTERS;
   MSG_D = CVR_MULTIPLEX_OP;
   while( !( ( msgack ^ MSG_D ) & ( 1 << MSG_TOGGLE_BO ) ) );
}
```

7.3.2 Status

HMI status can always be retrieved by reading the message conduit. Status is updated in a pipelined manner whenever the D register is read. Reading the message conduit gives the current status as of the last time (the D register of) the conduit was read. Bitfields in the HMI Status Register are outlined in Table 5 below. Refer also to "HMI Definitions" on page 31 and "HMI Access Code" on page 32.

Status	Bit(s)
Reserved	[31:24]
Region Length	[23:8]
Reserved	[7:5]
Writable Region	4
Translation Complete	3
Packet Transmission Complete	2
Received Packet Available	1
Message Togglebit	0

Table 5. HMI status bits

7.3.3 Data

Before accessing data, address setup must be performed. Address setup consists of issuing a *Translate Address* request, waiting for the request to complete, then issuing a *Goto Translation*.

Pipelining requires that a *"garbage read"* be performed following an address change. The second word read contains the data for the address requested. No similar pipelining issue exists with respect to write operations.

7.3.3.1. Region length

Distance from the original pointer position (as per *Translate Address*) to the end of the instantiated region. A value of *0* indicates an invalid pointer.

7.3.3.2. Writable Region

When set, this bit indicates the address pointer is positioned within a writable region. *MI* variables may be modified in a writable region by writing data to the data conduit.

7.3.3.3. Translation Complete

When set, this bit indicates that the address translator is available (translation results are available and a new translation request may be submitted). This bit is cleared when a *Translate Address* message is issued and is set when the translation completes.

7.3.3.4. Packet Transmission Complete

This bit is cleared when transmission is initiated by issuance of the *Transmit Packet* message. The bit is set when the packet has been transmitted and the transmit buffer is ready to accept a new packet.

7.3.3.5. Received Packet Available

This bit is set when a packet is received into the packet bridge. It is cleared when the packet data is read and receipt is acknowledged by issuance of an *Acknowledge Packet Receipt* message. Note that *Received Packet Available* only goes low when there are no longer any pending received packets for the packet bridge. The packet bridge has the capacity to queue multiple packets in the receive direction.

7.3.3.6. Message Togglebit

This bit toggles on completion of processing of each message. A safe means for the host to acknowledge processing of messages is as follows:

```
void WaitToggle( void )
{
   int msgack = MSG_D; /* clean pipeline */
   msgack = MSG_D; /* record current state of togglebit */
   MSG_D = YOUR_COMMAND_HERE; /* issue command */
   /* wait for togglebit to flip */
   while( !( ( msgack ^ MSG_D ) & ( 1 << MSG_TOGGLE_BO ) ) );
}
```

8.0 HMI Reference Code

The following C code provides examples in using HMI messages, HMI status, and the HMI memory map.

8.1 HMI Definitions

```
/*============================================================================
** hmi.h
** CobraNet Host Management Interface example code
** Definitions
**----------------------------------------------------------------------------
** $Header$
** Copyright (c) 2004, Peak Audio, a division of Cirrus Logic, Inc.
**============================================================================*/
#define MSG_A 0
#define MSG_B 1
#define MSG_C 2
#define MSG_D 3
#define DATA_A 4
#define DATA_B 5
#define DATA_C 6
#define DATA_D 7
#define CONTROL 8
#define STATUS 9

#define CVR_SET_ADDRESS 0xb2   /* Not availbale on CS181xx/CM-2. */
                               /*CM-1 and Reference Design only. */
#define CVR_TRANSLATE_ADDRESS 0xb3
#define CVR_INTERRUPT_ACK 0xb4
#define CVR_MULTIPLEX_OP 0xb5

#define MOP_GOTO_TRANSLATION_READ 0
#define MOP_GOTO_TRANSLATION_WRITE 5
#define MOP_GOTO_PACKET_RECEIVE 1
#define MOP_GOTO_PACKET_TRANSMIT 6
#define MOP_GOTO_COUNTERS 2
#define MOP_PACKET_TRANSMIT 3
#define MOP_PACKET_RECEIPT 4
#define MOP_IDENTIFY 7

#define MSG_TOGGLE_BO 0
#define MSG_RXPACKET_BO 1
#define MSG_TXPACKET_BO 2
#define MSG_TRANSLATION_BO 3
#define MSG_WRITABLE_BO 4
#define MSG_LENGTH_BO 8
```

8.2 HMI Access Code

```
/*============================================================================
** hmi.c
** CobraNet Host Management Interface example code
** Simple edition
**----------------------------------------------------------------------------
** $Header$
** Copyright (c) 2004, Peak Audio, a division of Cirrus Logic, Inc.
**============================================================================*/
#include "hmi.h"

/* variables model HMI state */
long PeekLimit;
long PeekPointer = -1;
long PokeLimit;
long PokePointer = -1;

/* access host port hardware */
#define HMI_BASE 0

unsigned char ReadRegister(
   int hmiregister )
{
   return *(unsigned char volatile *const) ( hmiregister + HMI_BASE );
}

void WriteRegister(
   int hmiregister,
   unsigned char value )
{
   *(unsigned char volatile *const) ( hmiregister + HMI_BASE ) = value;
}

void SendMessage(
   unsigned char message )
{
   int msgack = ReadRegister( MSG_D );
   /* issue (last byte of) message */
   WriteRegister( MSG_D, message );
   /* wait for acceptance of message */
   while( !( ( msgack ^ ReadRegister( MSG_D ) ) & ( 1 << MSG_TOGGLE_BO ) ) );
}

void SetAddress(
   long address )
{
   /* translate address */
   WriteRegister( MSG_A, ( address & 0xff0000 ) >> 16 );
   WriteRegister( MSG_B, ( address & 0xff00 ) >> 8 );
   WriteRegister( MSG_C, address & 0xff );
   SendMessage( CVR_TRANSLATE_ADDRESS );
   /* wait for completion of translate address */
```

```
   while( !( ReadRegister( MSG_D ) & ( 1 << MSG_TRANSLATION_BO ) ) );
   /* goto translation */
   WriteRegister( MSG_C, MOP_GOTO_TRANSLATION_READ );
   SendMessage( CVR_MULTIPLEX_OP );
   /* "garbage" read clears data pipeline */
   ReadRegister( DATA_D );
   /* maintain local pointers */
   PeekPointer = PokePointer = address;
   PeekLimit = PokeLimit = PeekPointer +
      ReadRegister( MSG_C ) + ( ReadRegister( MSG_B ) << 8 );
   /* read-only region addressed */
   if( !( ReadRegister( MSG_A ) & ( 1 << MSG_WRITABLE_BO ) ) ) {
      PokeLimit = PokePointer;
   }
}

unsigned long Peek(
   long address )
{
   if( address != PeekPointer ) {
      SetAddress( address );
   }
   if( PeekPointer >= PeekLimit ) {
      throw "Peek addressing error!";
   }
   unsigned long value = ReadRegister( DATA_A ) << 24;
   value += ReadRegister( DATA_B ) << 16;
   value += ReadRegister( DATA_C ) << 8;
   value += ReadRegister( DATA_D );
   PeekPointer++; /* maintain local pointer */
   return value;
}

void Poke(
   long address,
   unsigned long value )
{
   if( address != PokePointer ) {
      SetAddress( address );
   }
   if( PokePointer >= PokeLimit ) {
      throw "Poke addressing error or read-only!";
   }
   WriteRegister( DATA_A, (unsigned char) ( ( value >> 24 ) & 0xff ) );
   WriteRegister( DATA_B, (unsigned char) ( ( value >> 16 ) & 0xff ) );
   WriteRegister( DATA_C, (unsigned char) ( ( value >> 8 ) & 0xff ) );
   WriteRegister( DATA_D, (unsigned char) ( value & 0xff ) );
   /* maintain local pointers */
   PokePointer++;
   PeekPointer = -1; /* force SetAddress()next Peek() to freshen data */
}
```

8.3 CM-1, CM-2 Auto-detection

The following function is useful for systems that support both the CM-1 and CM-2 or where a CobraNet interface is an optional add-in.

Detect() returns 0 if no CobraNet interface module is detected, 1 for CM-1 and 2 for CM-2.

```
int Detect( void ) {
   /* check for presence of CM-1 */
   MSG_B = 0x55; /* write to CM-1 CVR register */
   DATA_A = 0xaa; /* write to unused CM-1 register to flip data bus */
   if( MSG_B == 0x55 ) { /* read back CVR */
      /* redo same detection with different data */
      MSG_B = 0x3c;
      DATA_A = 0xc3;
      if( MSG_B == 0x3c ) {
         return 1; /* CM-1 detected */
      }
   }
   /* check for presence of CM-2 */
   /* issue identify command */
   MSG_C = MOP_IDENTIFY;
   MSG_D = CVR_MULTIPLEX_OP;
   int msgack = MSG_D; /* clean pipeline */
   msgack = MSG_D;
   /* wait for togglebit to flip in response to command */
   int tm0 = gettimeofday();
   while( !( ( MSG_D ^ toggle ) & ( 1 << MSG_TOGGLE_BO ) ) ) {
      int tm1 = gettimeofday();
      if( ( tm1 - tm0 ) > time_out ) {
         return 0; /* command timed out, no CobraNet interface present */
      }
   }
   int garbage = MSG_D; /* clean pipeline */
   /* verify identify results */
   if( DATA_A == 'C' ) if( DATA_B == 'S' )
         if( DATA_C == ( 18101 >> 8 ) ) if( DATA_D == ( 18101&0xff ) {
      return 2; /* CM-2 detected */
   }
   return 0; /* no interface or non-supported interface */
}
```

9.0 Mechanical Drawings and Schematics

The section contains detailed drawings of the CM-2 board and CS181xx device package design. The mechanical drawings are arranged as follows:

9.1 CM-2 Mechanical Drawings

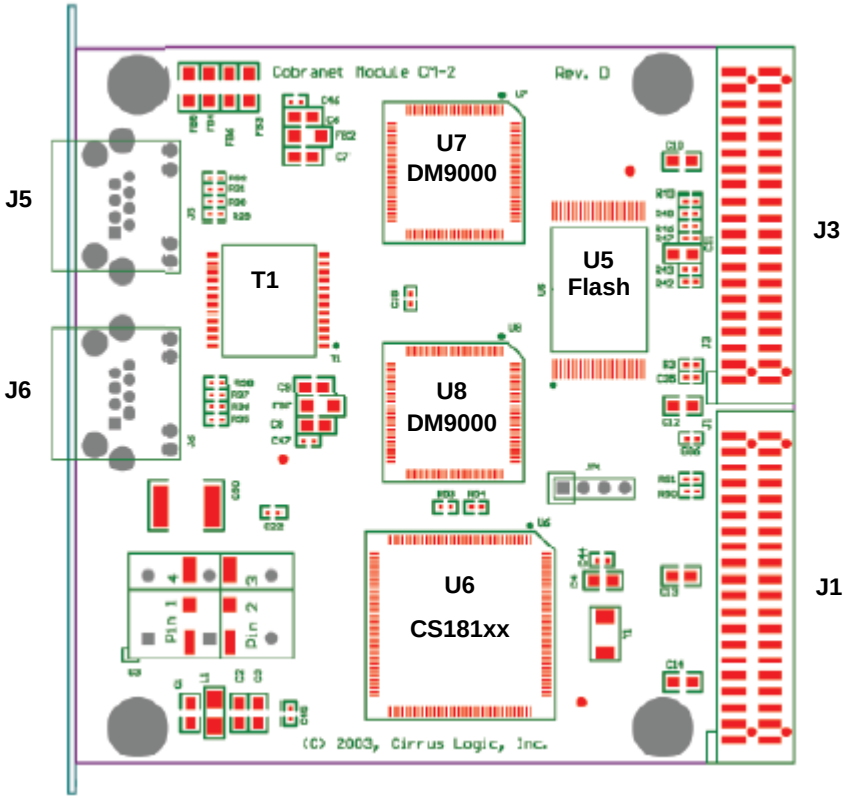


Figure 16. CM-2 Module Assembly Drawing

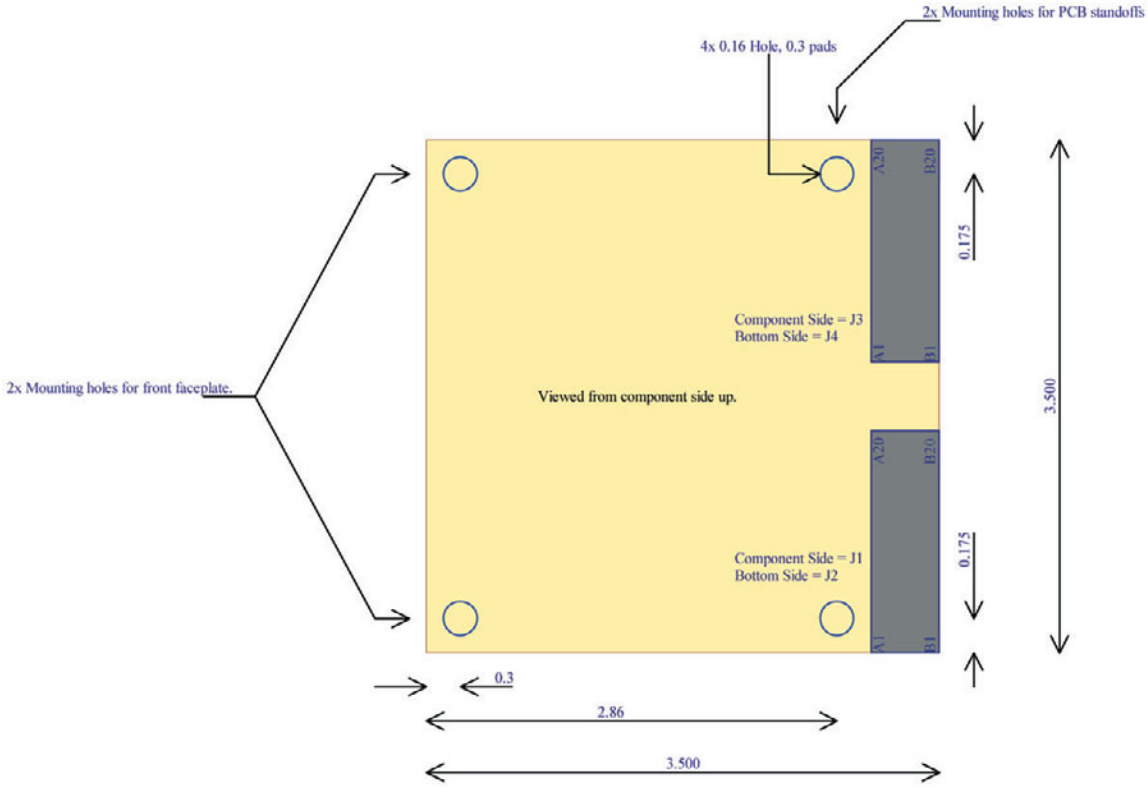


Figure 17. General PCB Dimensions

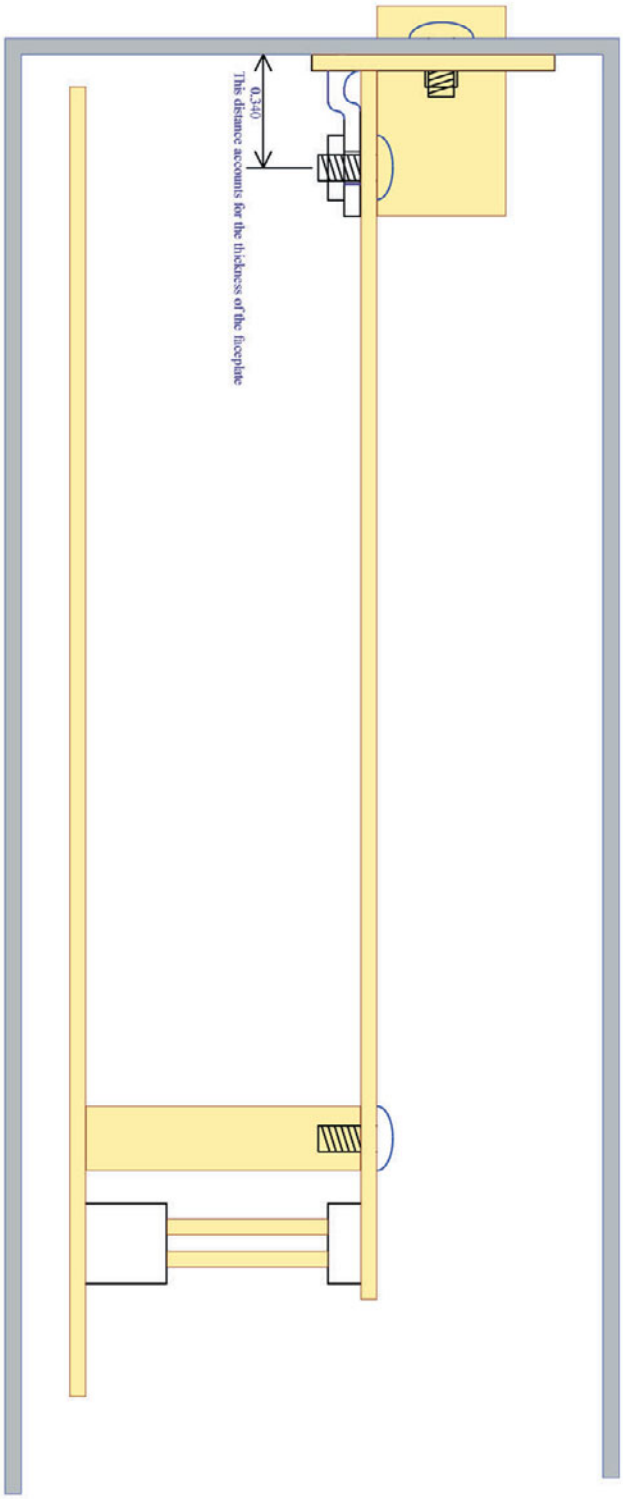


Figure 18. Example Configuration, Side View

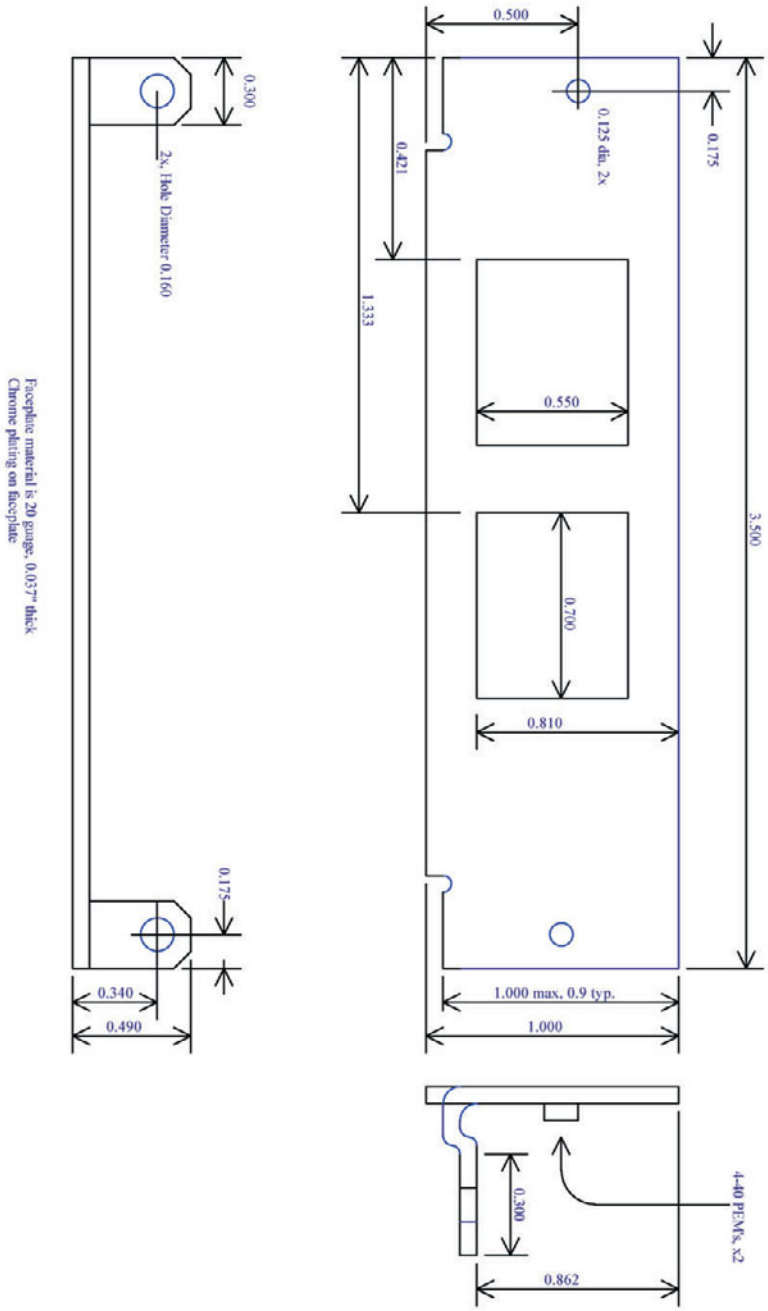


Figure 19. Faceplate Dimensions

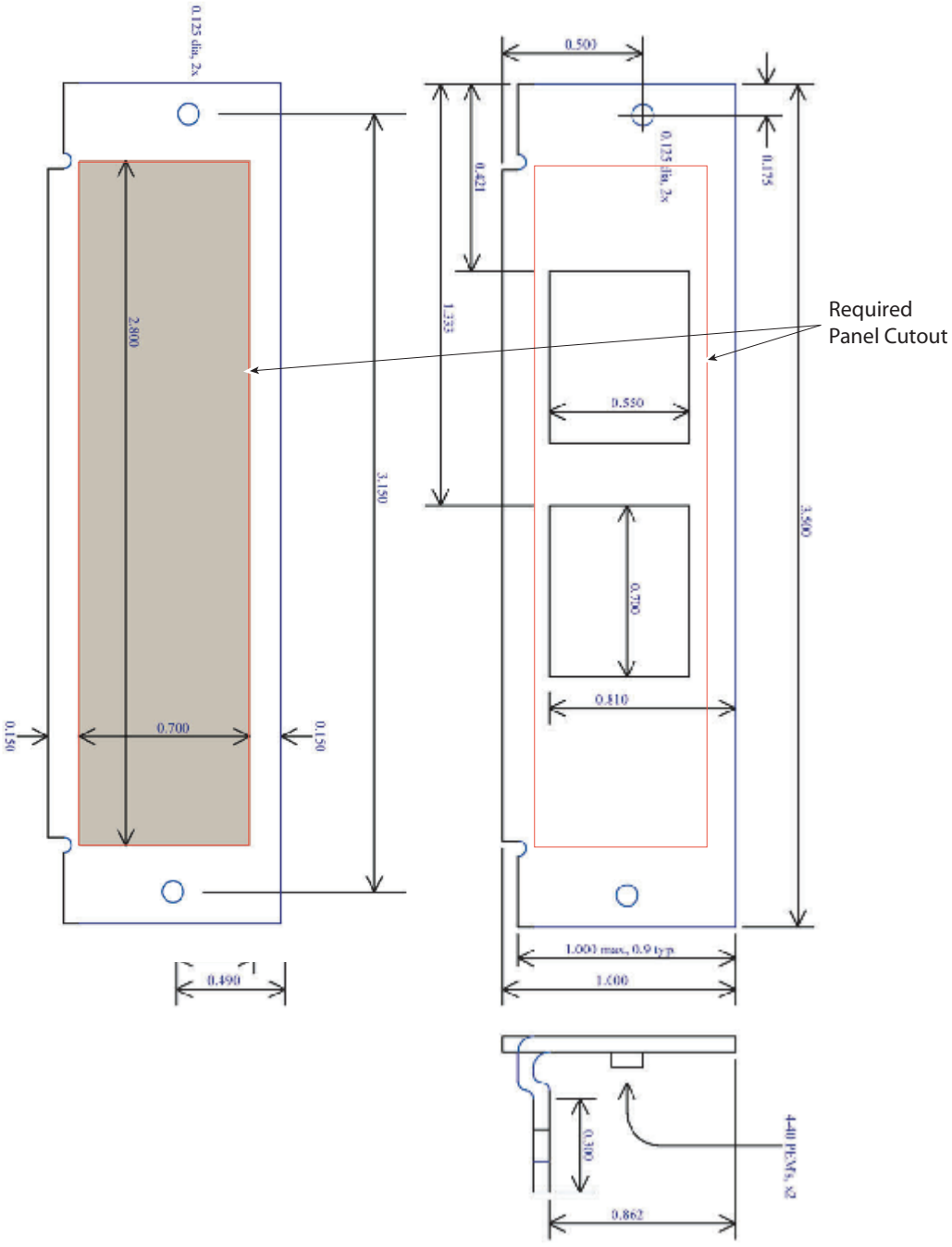


Figure 20. Case Cutout for Faceplate Mounting

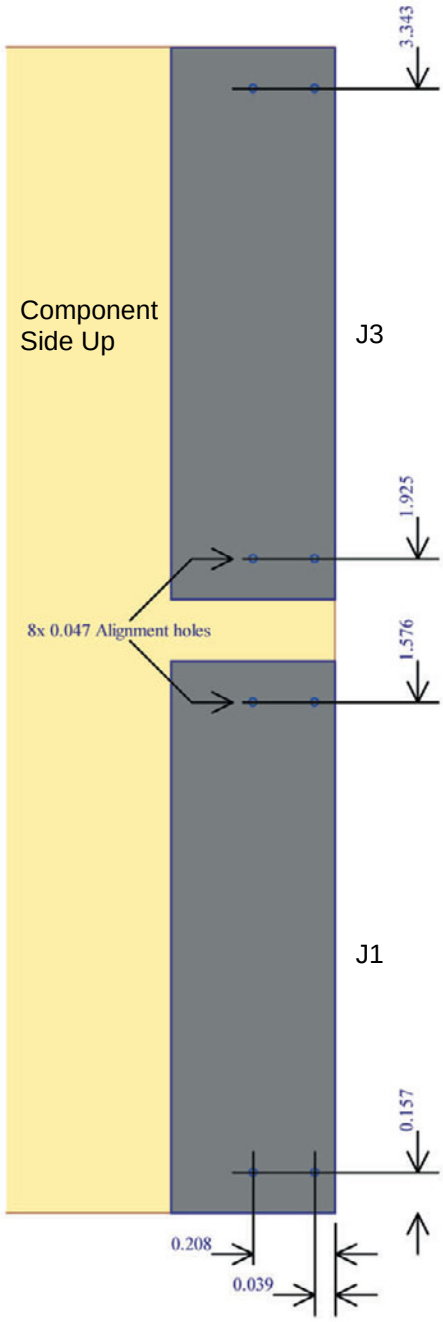
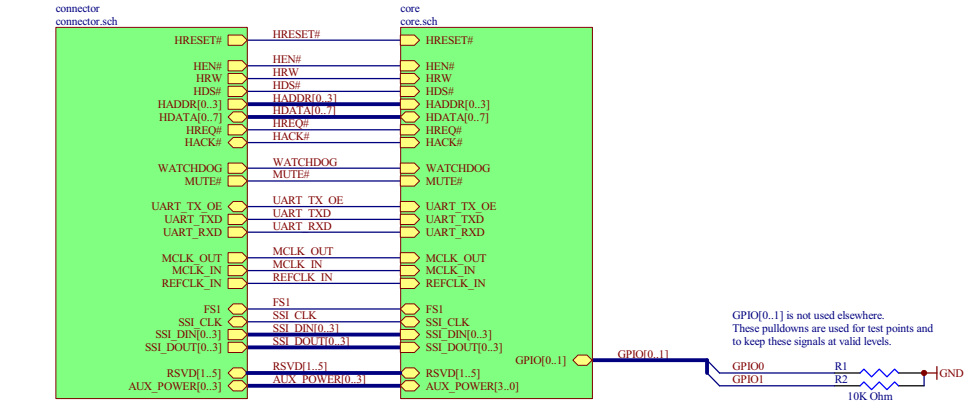


Figure 21. Connector Detail

9.2 CM-2 Schematics



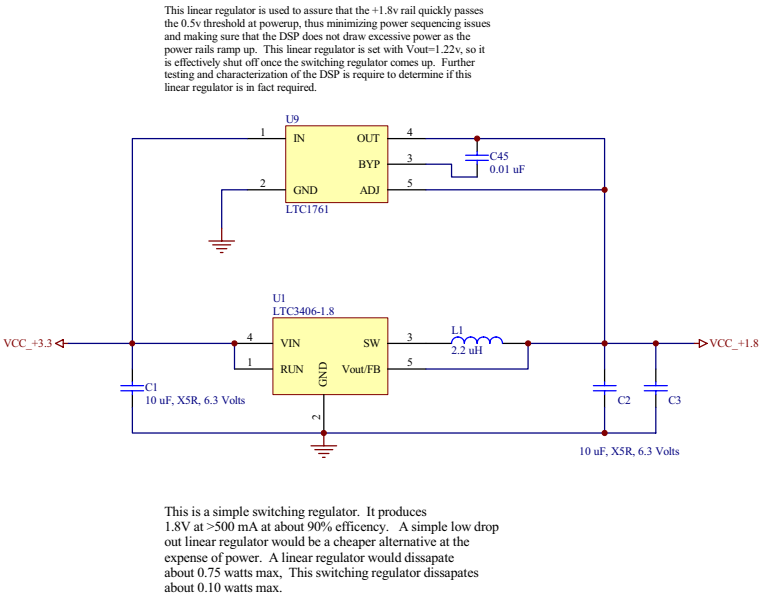


Figure 22. CM-2 RevE Schematic Page 1 of 7

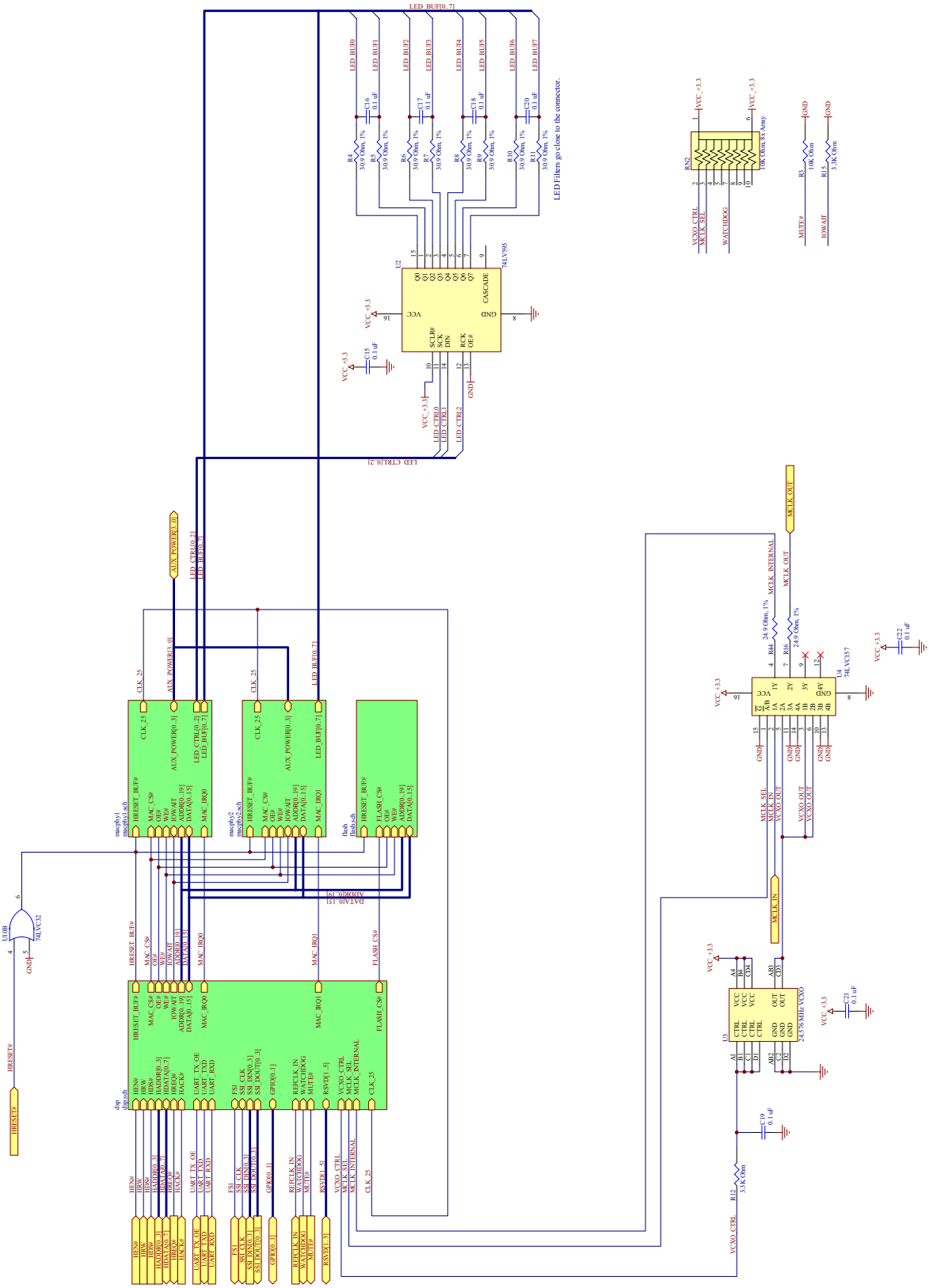


Figure 23. CM-2 RevE Schematic Page 2 of 7

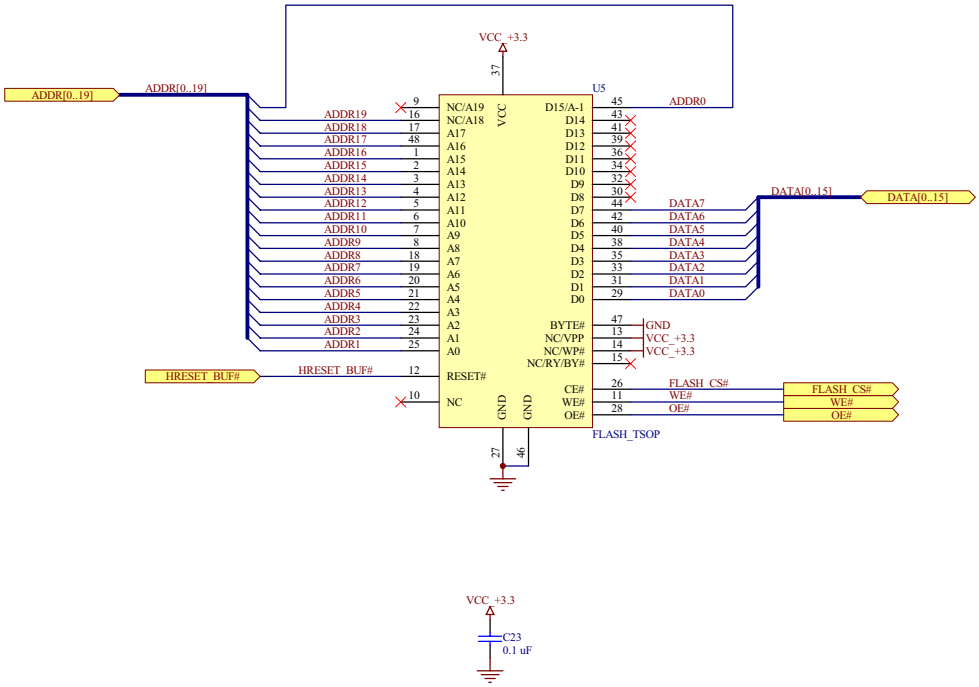


Figure 24. CM-2 RevE Schematic Page 3 of 7

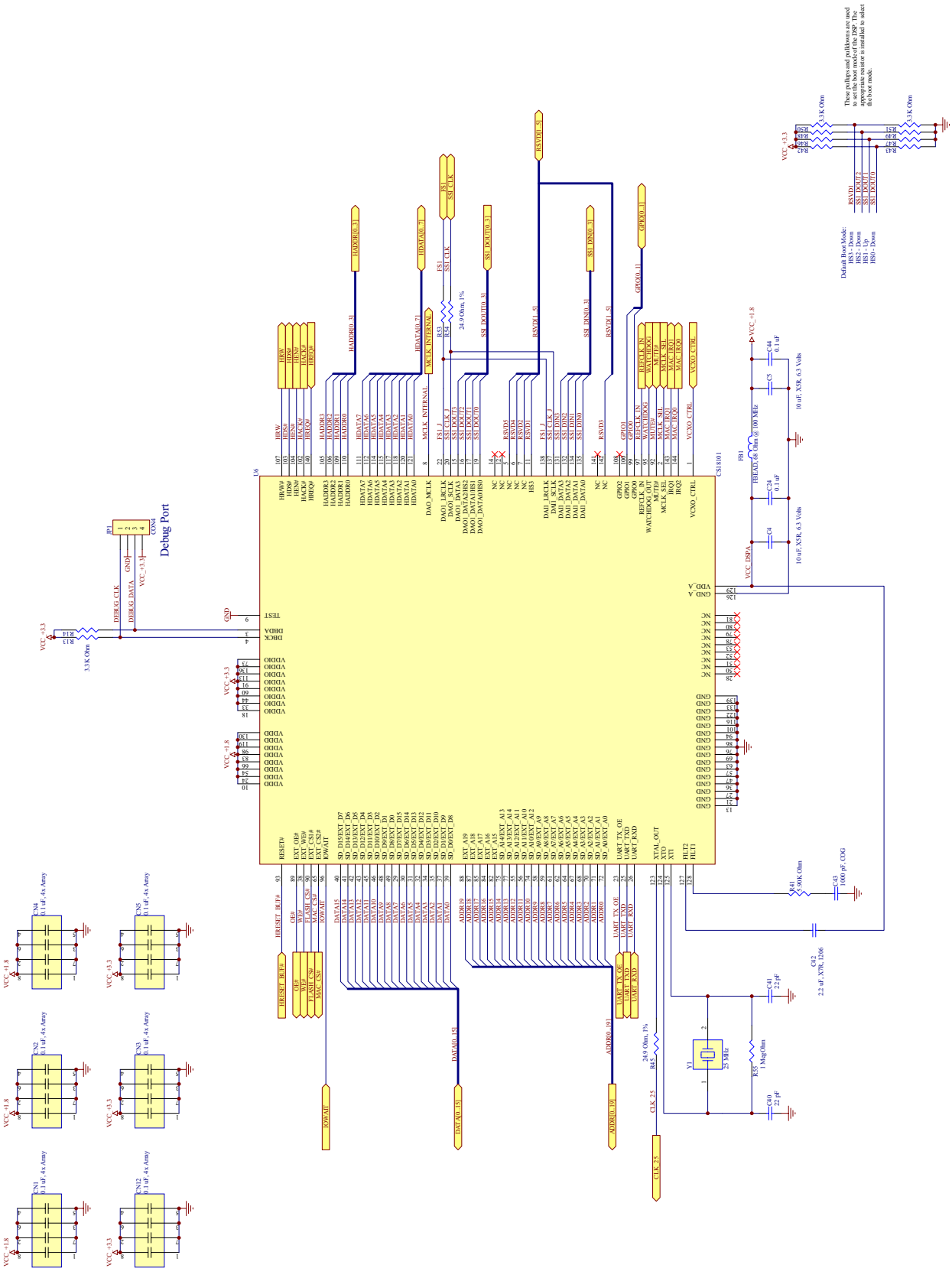


Figure 25. CM-2 RevE Schematic Page 4 of 7

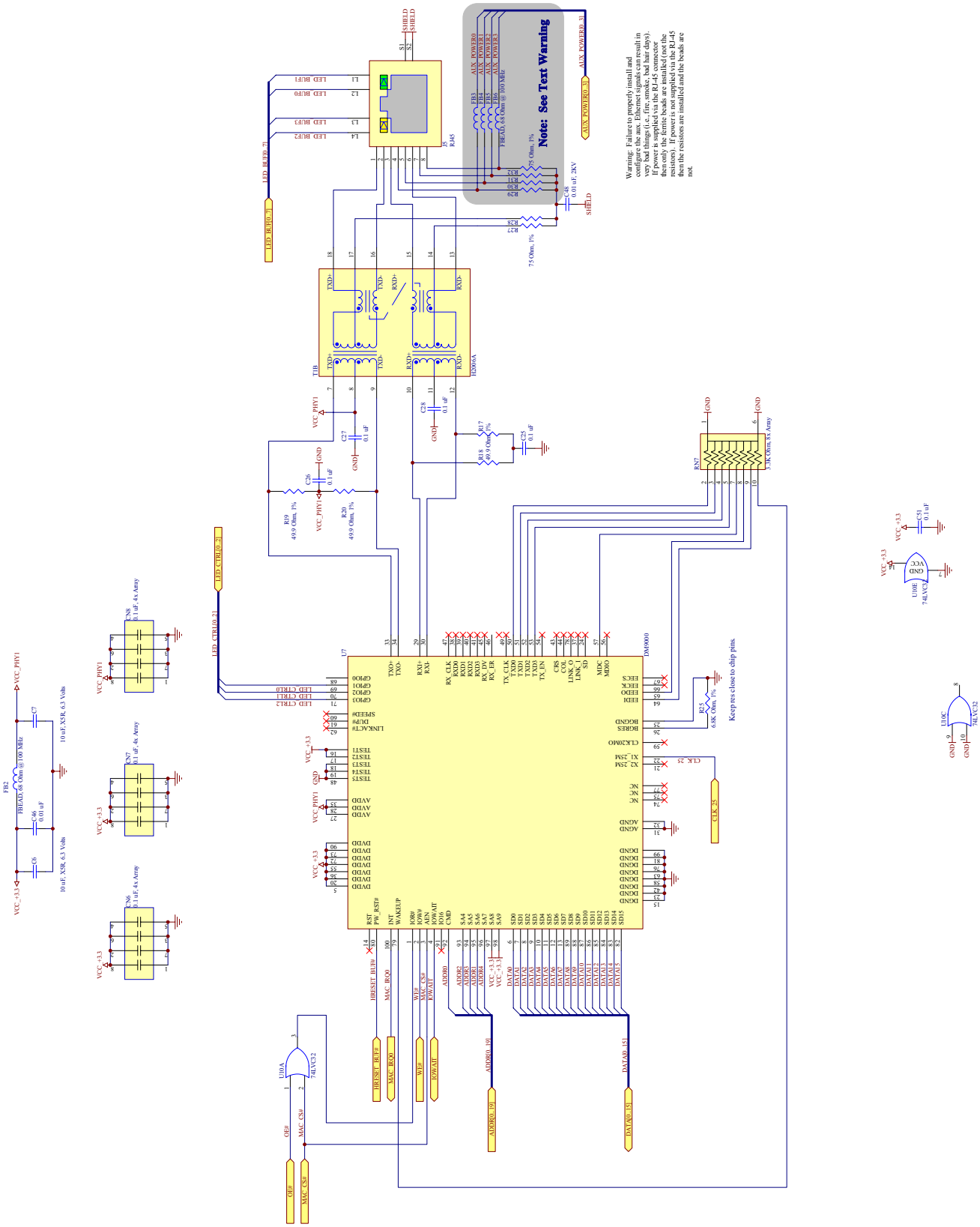


Figure 26. CM-2 RevE Schematic Page 5 of 7

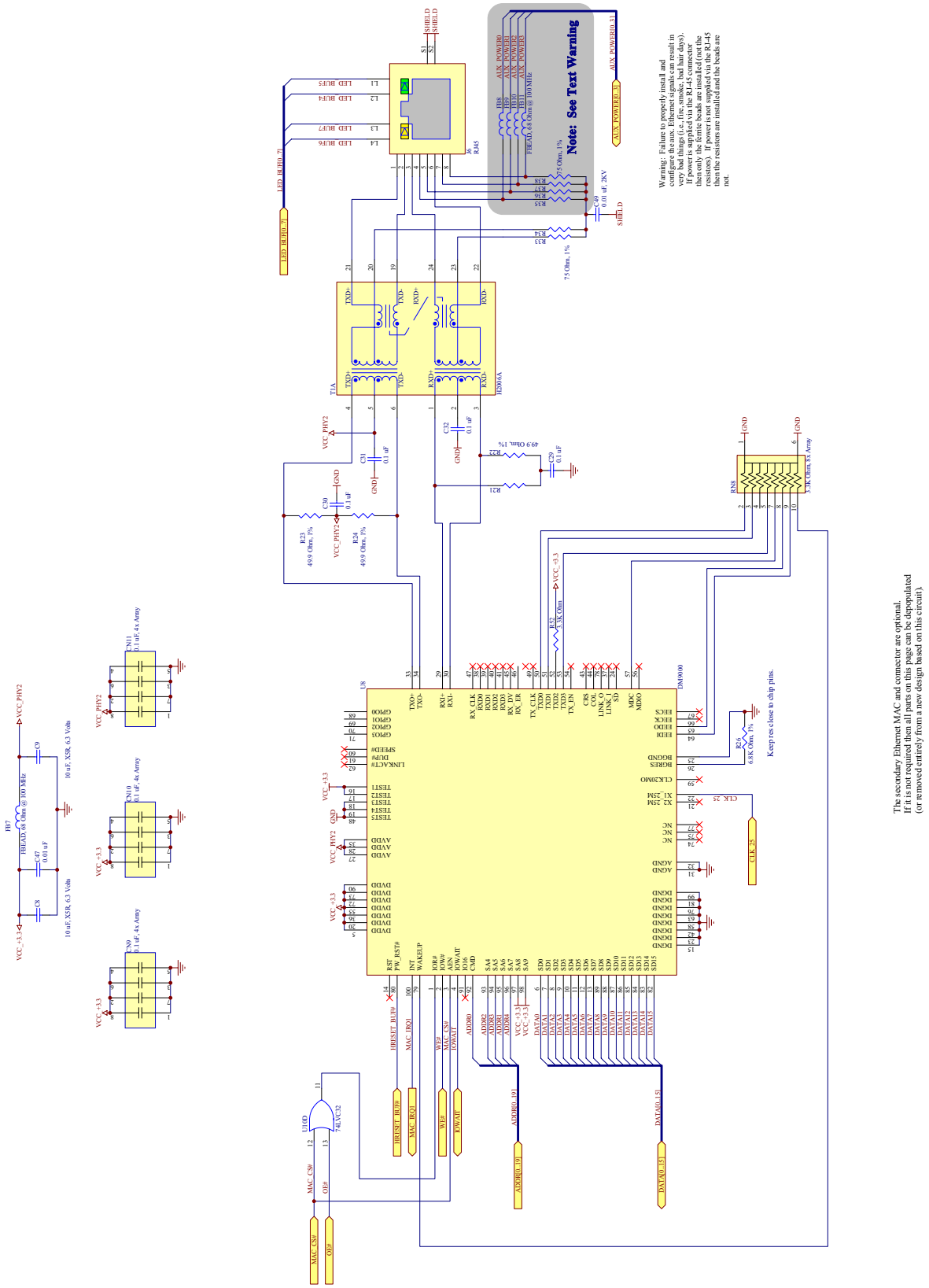


Figure 27. CM-2 RevE Schematic Page 6 of 7

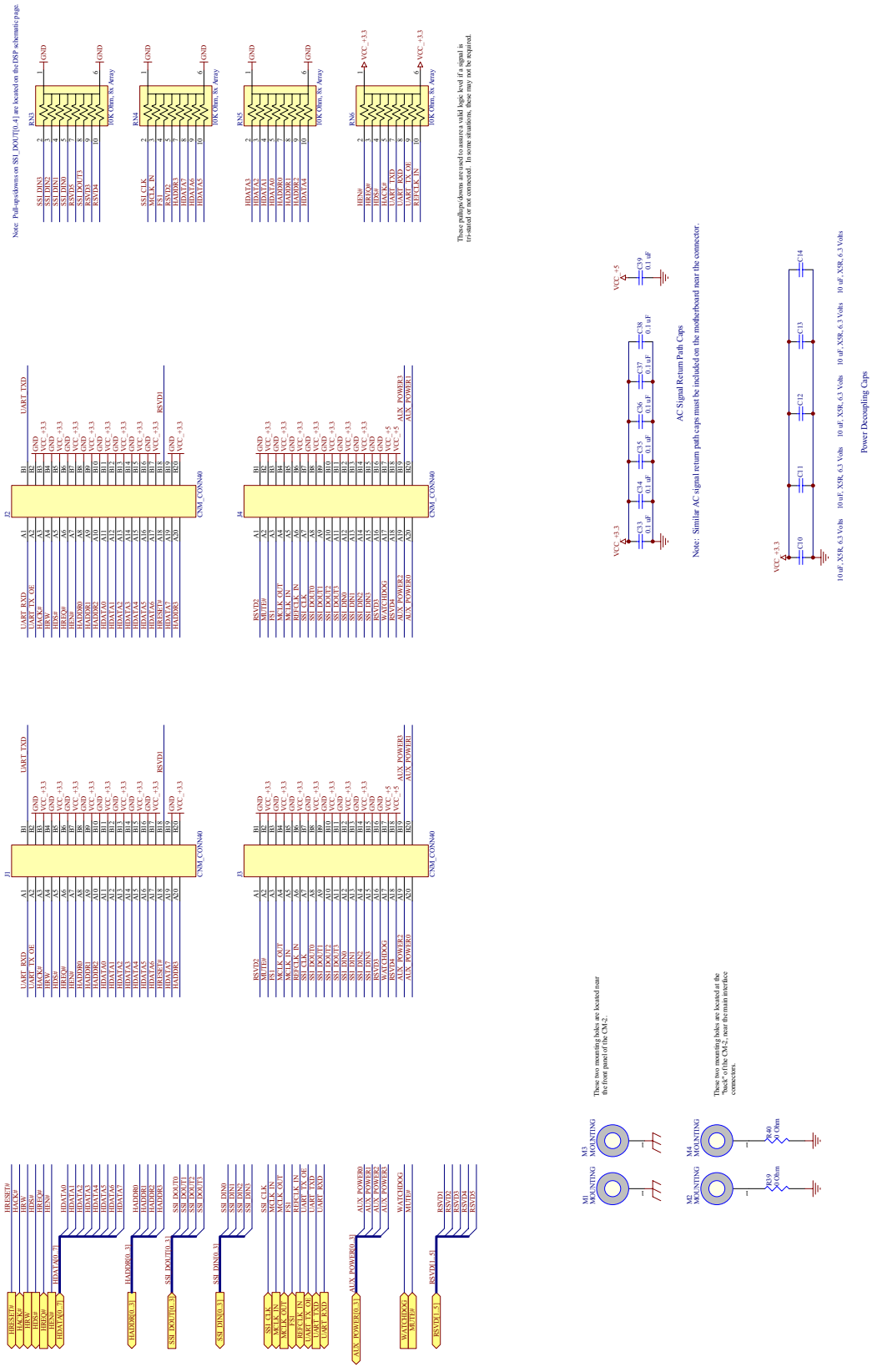
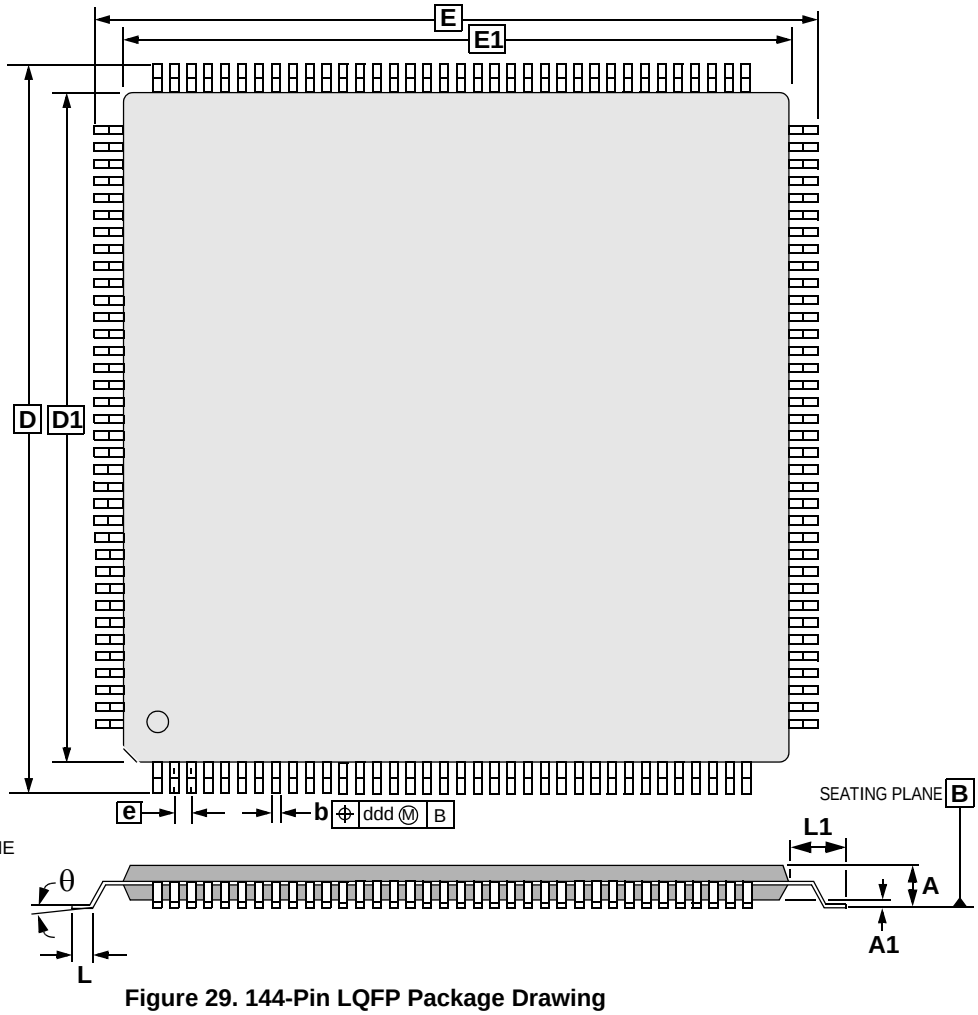


Figure 28. CM-2 RevE Schematic Page 7 of 7

9.3 CS181xx Package



Notes:

1. Controlling dimension is millimeter.
2. Dimensioning and tolerancing per ASME Y14.5M-1994.

Figure 29. 144-Pin LQFP Package Drawing

DIM	MILLIMETERS			INCHES		
	MIN	NOM	MAX	MIN	NOM	MAX
A	---	---	1.60	---	---	.063”
A1	0.05	---	0.15	.002”	---	.006”
b	0.17	0.22	0.27	.007”	.009”	.011”
D	22.00 BSC			.866”		
D1	20.00 BSC			.787”		
E	22.00 BSC			.866”		
E1	20.00 BSC			.787”		
e	0.50 BSC			.020”		
θ	0°	---	7°	0°	---	7°
L	0.45	0.60	0.75	.018”	.024”	.030”
L1	1.00 REF			.039” REF		
TOLERANCES OF FORM AND POSITION						
ddd	0.08			.003”		

9.4 Temperature Specifications

- Thermal Coefficient (junction-to-ambient): θ_{ja} - 38° C / Watt
- Ambient Temperature Range: 0-70 deg C
- Junction Temperature Range: 0-125 deg C

Contacting Cirrus Logic Support

For all product questions and inquiries contact a Cirrus Logic Sales Representative.
To find the one nearest to you go to **www.cirrus.com**