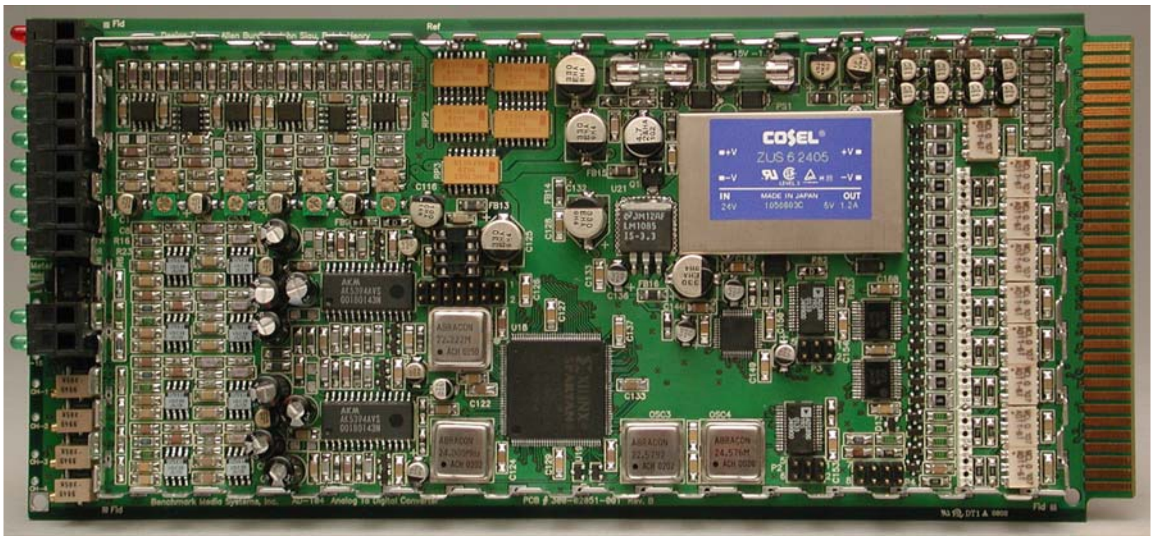
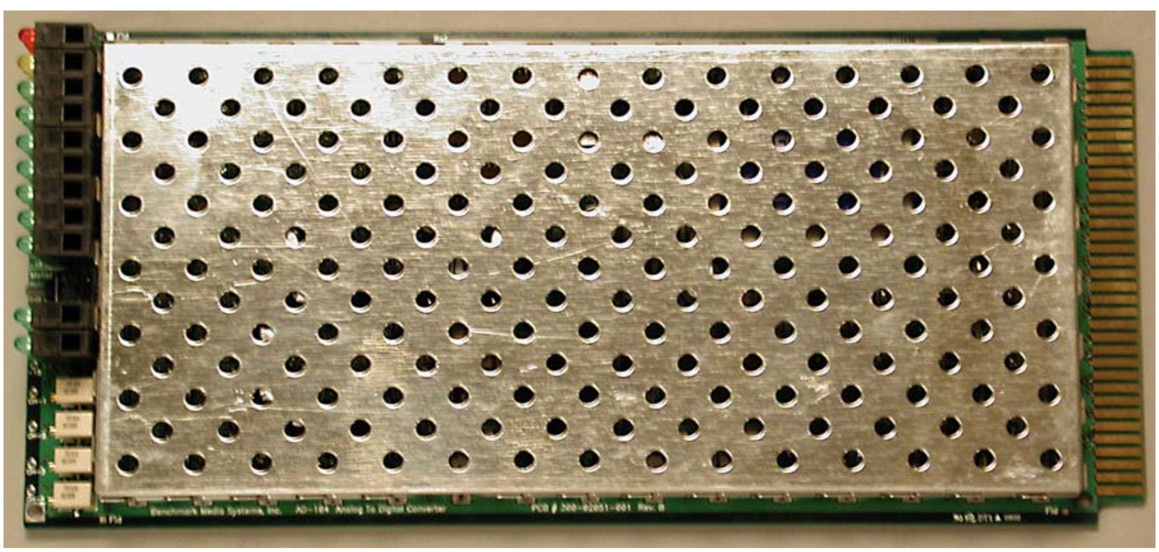
Benchmark Media Systems, Inc.

ADC-104
Instruction Manual

Part# 850-03000-000

(System1000™ 4-channel 24-bit 96-kHz Audio ADC)





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Revision History:

Revision	Filename	Date	Author
Revision A	ADC-104 – Rev A. Doc	06/18/03	John Siau

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SYSTEM OVERVIEW

The ADC-104 is a 4-channel 96-kHz 24-bit audio analog-to-digital converter for Benchmark System1000™ card frames. The card supports input sample rates from 28 kHz to 108 kHz, at word lengths of 16, 18, 20 and 24-bits. The performance of the ADC-104 is comparable to that of the highly respected Benchmark AD2408 converters.

Shielding

The ADC-104 card is double-shielded and is designed to operate adjacent to microphone preamplifier cards (or any other analog card) without interference or crosstalk. The card is a fully shielded EMI package by itself and easily passes all applicable emissions standards without the need for a shielded card frame.

Inputs and Outputs

The card has four analog audio inputs with individual front-panel level adjustments. In addition, the card has eight transformer-isolated digital audio outputs that are individually configurable for 110 or 75-Ohm operation.

Bi-directional Audio Reference Port

A bi-directional digital audio reference port provides a great deal of flexibility for system clocking. This reference port uses AES/EBU digital audio signals as a clock reference. Each ADC-104 card may be configured as either MASTER or SLAVE. In MASTER mode the reference port is an output and can be wired directly to the reference port of a slave card, or may be routed to other cards using the reference bus on the System1000™ card frame. In SLAVE mode the reference port is an input and may be configured for a 75, 110-Ohm, or high-Z input impedance.

UltraLock™ Jitter-Immune Technology

The ADC-104 uses Benchmark's UltraLock™ technology and is 100% immune to jitter on the clock reference signal. The A/D conversion clock is totally isolated from the AES/EBU digital audio clocks in a topology that outperforms two-stage PLL designs. No jitter-induced artifacts can be detected using an Audio Precision System 2 Cascade test set. Measurement limits include detection of artifacts as low as –140 dBFS, application of jitter amplitudes as high as 12.75 UI, and application of jitter over a frequency range of 2 Hz to 200 kHz. Jitter on the AES/EBU reference signal will have absolutely no effect on the quality of the analog to digital conversion.

Error Tolerance

The ADC-104 is designed to perform gracefully in the presence of errors or interruptions in the digital audio reference inputs. When reference is lost, the digital outputs fall back to a jumper-selected fallback frequency (44.1, 48, 88.2, or 96 kHz). A soft mute circuit eliminates pops when the card transitions between reference frequencies or between clock sources.

The ADC-104 is designed to avoid all unnecessary mute scenarios. Muting is only enabled upon loss of power or when transitioning between internal and external sync.

The ADC-104 will tolerate incorrectly set sample rate bits on the reference input. Sample rate is determined by measuring the incoming signal. Lack of sample rate status bits, or incorrectly set status bits will not cause loss of audio. The digital reference input automatically recognizes professional and consumer status bit formats. The digital audio outputs are professional format and include sample-rate indication.

Phase Accuracy in Multi-Channel Applications

The ADC-104 is phase accurate between channels, between cards, and between frames of cards. A fully populated MF-300 frame will provide 48 phase-accurate analog-to-digital conversion channels. An accurate stereo image can be reproduced using any two channels in the system.

Hot-Plug Power Management

Like all System1000™ cards, the ADC-104 is designed to allow insertion and removal from a powered frame. Power management circuitry controls the muting and resetting of all digital circuits upon removal and application of power. Audio is present at the outputs less than 5 seconds after hot-plugging the board.

SYSTEM1000™ Compatibility

The ADC-104 can be added to any existing System1000™ frame. It can coexist with any combination of digital or analog cards.

No special digital power supply rail is required. The ADC-104 is entirely powered from the +/-15V analog supplies and draws less than 263 mA.

All input and output pins are carefully filtered to eliminate any possible of interference with analog cards. The ADC-104 has exceptional shielding and will not interfere with any of the System1000™ cards (including microphone pre-amplifiers).

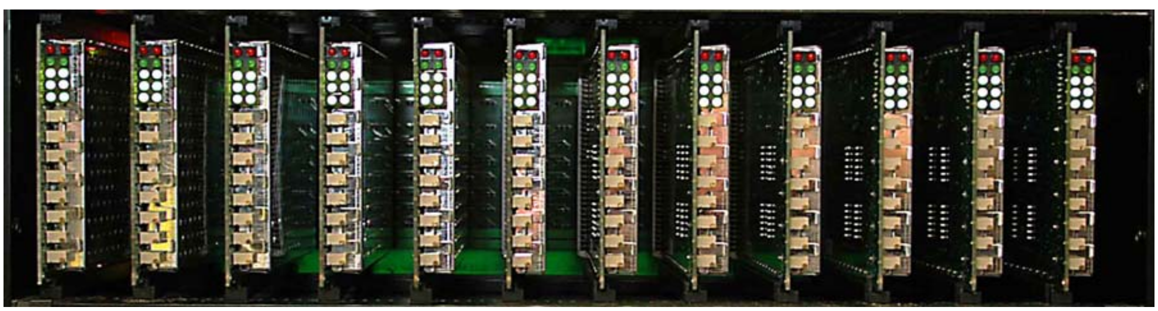


Photo 1 - 48 Channels of Conversion in a 3-RU System1000™ Card Frame

FEATURE SUMMARY

- Four analog inputs
- One digital audio reference input/output port
- 8 digital audio output ports (4 for each channel pair)
- Benchmark phase-accurate – jitter-immune – UltraLock™ technology
- Four Sample Rate Indicator LEDs
- Four 9-segment digital meters
- Three-position meter function switch
- Four power supply status LEDs
- Polarity Inversion – jumper selectable
- Adjustable Input Levels – Multi-turn trimmers – 1 trimmer per input – 20 dB Range, 2 dB/turn
- Powered from +/- 15 VDC
- Low Power Consumption (245 mA at +/- 15V typical, 265 mA peak, 7.3 Watts, 8 Watts peak)
- Full Hot-Plug Capability
- Reliable and consistent performance under all operating conditions
- Meets FCC and CE emissions requirements

I/O SUMMARY

Analog Inputs

- EMI filtered.
- Input Impedance is 200 kOhms.
- Input levels are adjustable with 10-turn trimmers (one trimmer per analog channel).
- At maximum gain, input level = +7.5 dBu at 0 dBFS.
- At minimum gain, input level = +27.5 dBu at 0 dBFS.

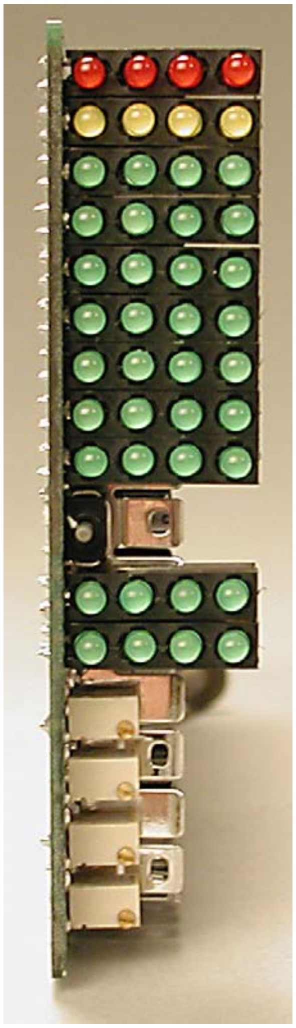
Digital Outputs

- Eight AES outputs
- Transformer Coupled
- DC blocking capacitors before and after transformers
- Diode ESD and overload protection
- Jumper selectable 75 Ohm, 110 Ohm

Digital Reference Input/Output Port

- Transformer Coupled
- DC blocking capacitors before and after transformers
- Diode ESD and overload protection
- Series resistor for protection and isolation of non-powered inputs
- Jumper selectable 75 Ohm, 110 Ohm, or High-Z loop through

FRONT PANEL



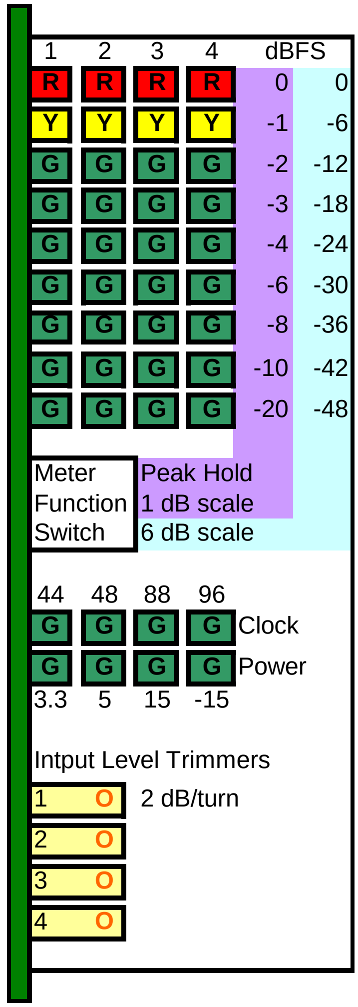


Photo 2 - Front Panel

Clock Status Display

- "44" – Green LED, On = Output sample rate is 44.1 kHz
- "48" – Green LED, On = Output sample rate is 48 kHz
- "88" – Green LED, On = Output sample rate is 88.2 kHz
- "96" – Green LED, On = Output sample rate is 96 kHz
- A single flashing LED = Slave mode reference error (fallback active)
- One flashing LED + 1 steady LED = fallback not equal to reference frequency, (output rate is indicated by steady LED, fallback rate is indicated by flashing LED).

Power Status Display

- "+15V" – Green LED, +15V supply is normal when lit
- "-15V" – Green LED, -15V supply is normal when lit
- "+5V" – Green LED, +5V supply is normal when lit
- "+3.3V" – Green LED, +3.3V supply is normal when lit

Input Level Trimmers

- One 10-turn trimmer per analog input (4 total)
- Trim Range: 20 dB, 2 dB/turn, +7.5 to +27.5 dBu at FSD
- Trimmers are located on front edge of card.

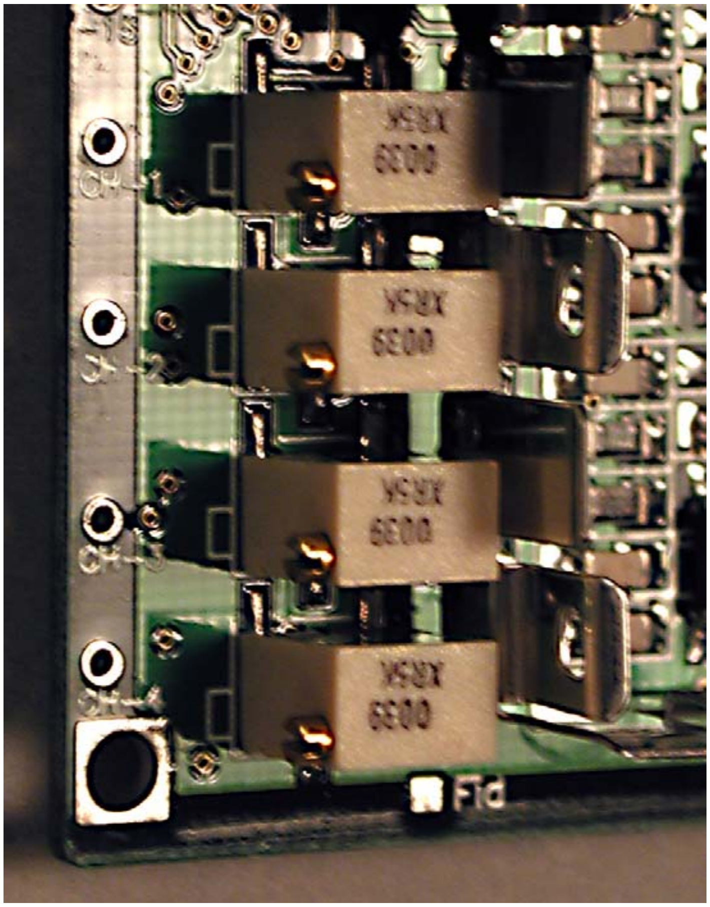


Photo 3 - Input Trimmers and Analog Audio Test Points

Analog Audio Test Points:

- One unbalanced analog test point per input (4 total).
- Test points are post gain control.
- Test points consist of large vias at front edge of PCB (adjacent to Input Level Trimmers).
- Vias are sized and located to provide convenient clip points for a scope or meter probe.
- One ground pad with a large hole is provided at the lower front corner of the card (to attach a scope or meter ground clip).
- Audio test points are unbalanced and will measure 0.78 dBu +/- .2 dB at 0 dBFS.

Power Supply Test Points

- One test point is provided for each of the 4 internal power rails.
- Test points consist of large vias at front edge of PCB.
- Vias are sized and located to provide convenient clip points for a scope or meter probe.
- One ground pad with a large hole is provided at the lower front corner of the card (to attach a scope or meter ground clip).
- Test points are adjacent to power status LEDs.

CLOCK SYNCHRONIZATION

One of the most important considerations in digital audio is clock synchronization. In most installations, audio analog to digital converters (such as the ADC-104) will need to be locked to an external clock reference.

AES/EBU Digital Audio Reference Signals

The ADC-104 uses AES/EBU digital audio signals for synchronization. The AES/EBU reference signals may be "Audio Black" (digital silence) or may contain an audio signal.

IMPORTANT: The ADC-104 does not use word clock for synchronization and will not lock to a word clock signal. Instead, the ADC-104 uses AES/EBU reference signals for synchronization. AES/EBU synchronization provides accurate framing of all AES/EBU outputs and eliminates some of the delay matching problems that can occur in a word-clock referenced system.

The Need for Synchronization

An external reference is usually required when any of the following conditions exist:

- Two or more digital source devices feed a common destination device.
- Phase accuracy must be maintained between two or more source devices.
- The destination device is configured as a master clock source.
- System sample rate needs to be changed frequently or easily.
- Digital audio must be synchronized to video.

Failure to synchronize two or more source devices can cause the following problems:

- Periodic clicks and pops.
- Muting of some or all of the audio channels.
- Phase errors.
- Random channel swapping on stereo pairs.
- Lock failures on downstream devices.

Slave Mode (Factory Default)

In most installations, the ADC-104 will need to operate in "**Slave Mode**". In this mode, the output clock on the ADC-104 locks to an externally supplied AES/EBU digital audio signal (when present). When a suitable reference signal is not present (or has errors), the ADC-104 will automatically switch to an internal crystal oscillator and continue operating at a sample rate determined by the "**Fallback Sample Rate**" jumpers.

Master Mode (Special Applications Only)

In **Master Mode,** the reference port is configured as an output, and the output impedance is 75 Ohms. This special mode of operation can be selected if one additional digital output is desired and then only if this card will be operating without an external reference.

Free-Running Mode (Special Applications Only)

In **Free-Running Mode** the reference port is disabled, and the input impedance is High-Z. Also, any signal on the reference input is ignored.

Terminating the High-Z Reference Input Port

Digital audio signals must be terminated in order to prevent reflections in the cables. Transmission errors may occur if a cable is not properly terminated. This is very important when cable lengths exceed 25 feet. Short cable runs may appear to work properly without a termination, but this is not good practice (errors may show up at the worst possible moment).

By default, the reference port has a High-Z input impedance (to allow loop-through and System1000™ bus applications). It is possible to enable a 75-Ohm termination on the ADC-104 but we recommend applying the termination on the backplane instead. This method has the following advantages:

- A reference signal may be looped through multiple cards.
- All cards can be configured identically and may be left in default configuration
- Termination locations are clearly visible on the backplane.
- The reference bus can be used without re-configuring the cards.

If looping is used, a termination must be applied at the end of the daisy chain. If a dedicated reference feed is connected to a single ADC-104 “Reference Input”, a terminating plug should be applied to the “Reference Loop” connector (see Photo 4).

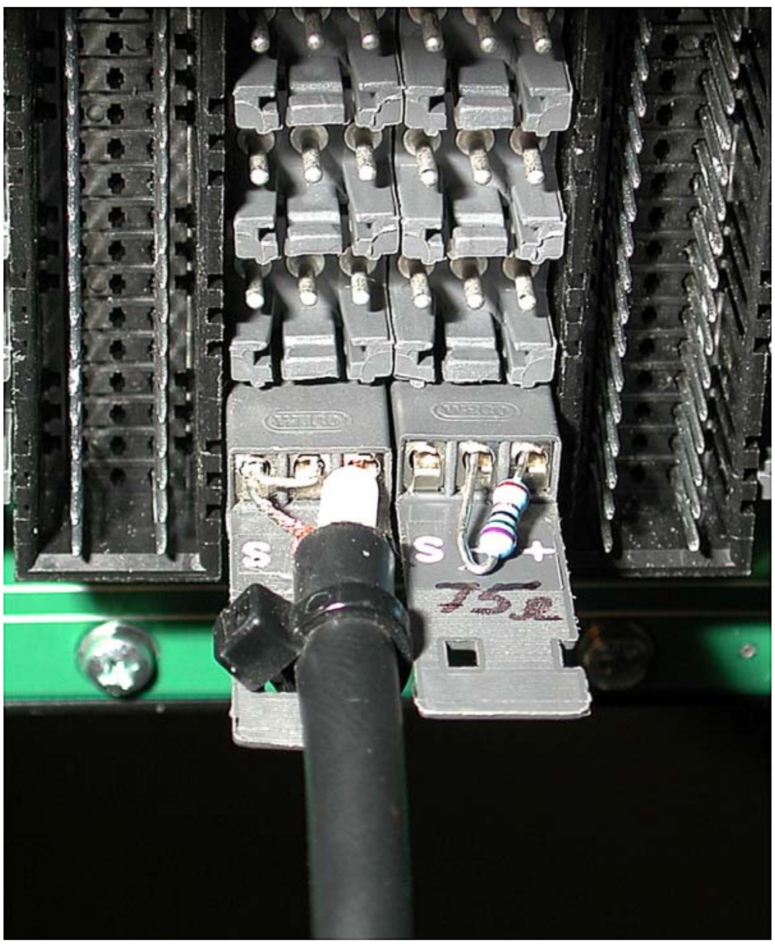


Photo 4 – 75 Ohm Terminating Plug on Reference Loop Connector

USING THE SYSTEM1000™ REFERENCE BUS

System1000™ WEC (WECO HSL) frames are equipped with a digital audio reference bus. This bus has a 75-Ohm BNC connector at one end, and a 110-Ohm balanced WECO connection at the other end (see Photo 5). A 110-Ohm to 75-Ohm balun transformer is located adjacent to the 75-Ohm BNC connector, and a jumper-selected 110-Ohm termination is located adjacent to the WECO connector. Each card slot has a 4-pin header that is used to connect the balanced 110-Ohm bus to pins 59 and 60 (see Photo 6). Two 2-pin jumper plugs must be installed (as shown in Photo 6) to enable the connection between a card slot and the bus. Both jumper plugs must be removed from any slots that will not be using the bus (this is the factory default).

The reference bus may be used as a card-to-card bus, or may be used to synchronize a System1000™ frames to another System1000™ frame. The reference bus may also be connected directly to other non-System1000™ devices, but cable lengths must be limited to 25 feet due to the bus loading. When synchronizing with external devices, the reference bus can act as either an input or output. The reference bus is equipped with a balanced 110-Ohm connector and a 75-Ohm unbalanced connector. Either connector may be used to interface with an external device, but only one connector can be used at a time.

The reference bus is balanced 110 Ohms, and can be connected to any or all of the 12 card slots in the frame. Two jumpers are provided below each card slot. Both jumpers must be connected in order to enable a card slot. Jumpers should not be enabled on any card slot that will be populated with an analog card. All cards receiving a signal from the reference bus must be placed in High-Z reference mode (factory default). The bus must be driven by only one device. The bus can be driven from any card slot, or from an external device.

If all of the card slot jumpers are disabled, the System1000™ reference bus can be used to convert signals between 75-Ohm unbalanced and 110-Ohm balanced.

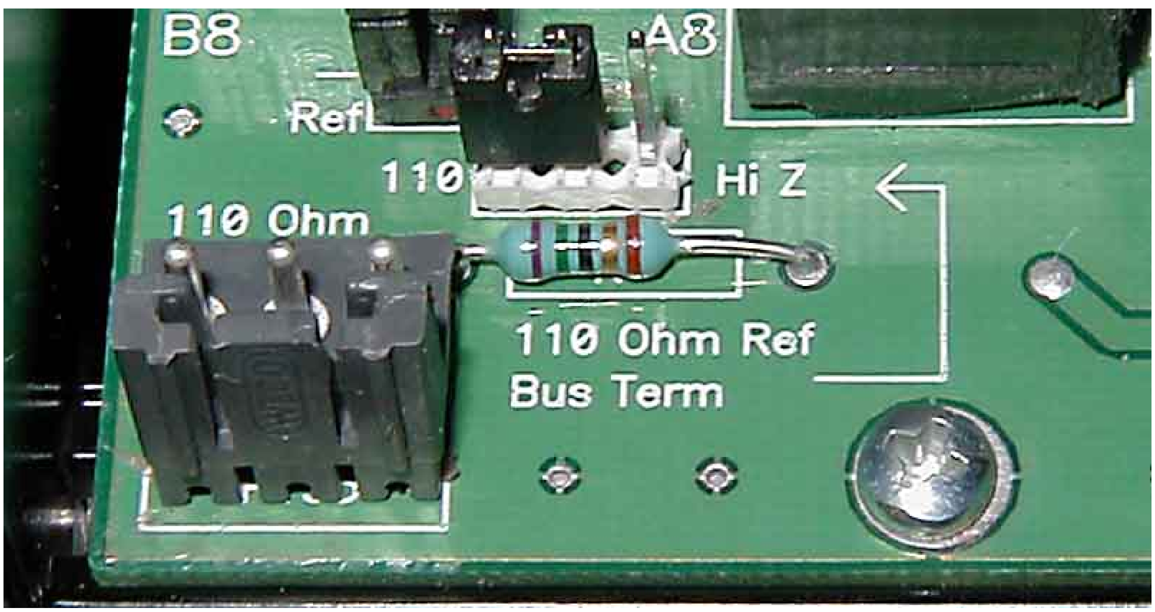


Photo 5 - Reference Bus - 110 Ohm Bus Connector and 110 Ohm Termination Header (shown with 110 Ohm termination enabled)

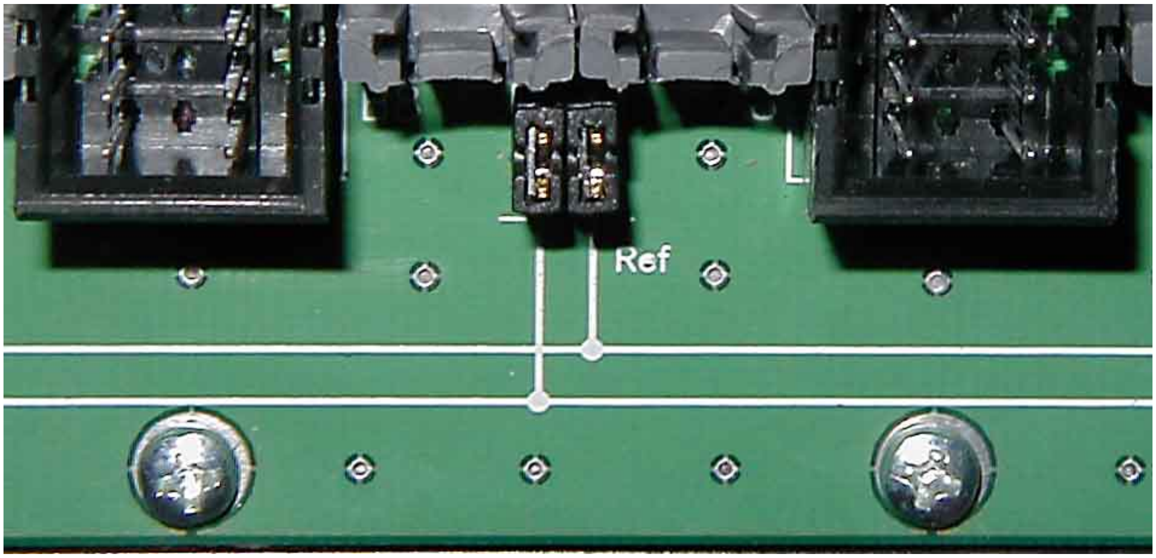


Photo 6 - Reference Bus - Card Slot Enable Header (shown with enable jumpers installed)

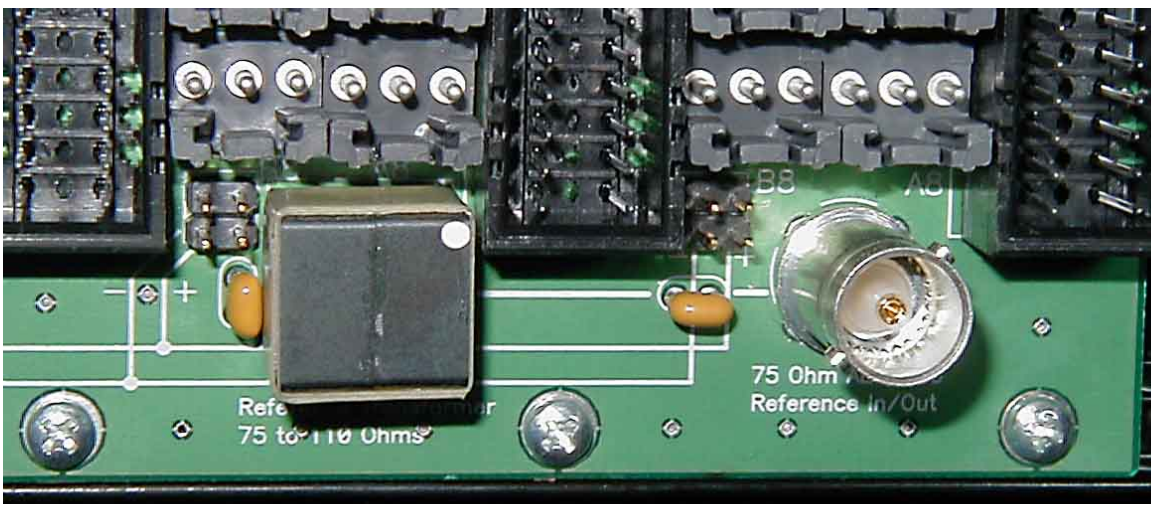


Photo 7 - Reference Bus - Balun and BNC Connector

Synchronization to an External Reference – Using a Buffered Connection to the Reference Bus (Preferred Method)

An AES/EBU or SP/DIF signal source may be buffered or even re-clocked by one of the cards in the System1000™ frame. One of the outputs from this card may be used to drive the reference bus. The advantage of this arrangement is that the external signal generator is isolated from the bus loading. This isolation eliminates the 25-foot cable length restriction that would be required if the reference bus were driven directly.

Using an ADC-104 card as a clock buffer

Suppose we have a frame of ADC-104 cards and we wish to synchronize all of them to an external reference. The best way to do this is as follows:
(In this example, card 1 is locked to the external reference, and the cards in slots 2-12 are locked to one of the digital audio outputs from card 1 using the reference bus).

- Set all ADC-104 cards to "Slave Mode" (factory default).
- Set reference input impedance to High-Z on all ADC-104 cards (factory default).
- Connect the external reference signal to the reference-input connector on slot 1 (see Photo 4).
- Insert a terminating plug in the reference loop connector for card 1 (see Photo 4).
- Enable the reference bus on all card slots except slot 1 (see Photo 6).
- Enable the 110-Ohm bus termination jumper (see Photo 5).
- Connect any digital audio output from card 1 to the reference-input connector (pins 59 and 60) on card slot 2 (this provides the connection to the reference bus).
- All cards will now follow card 1 and will maintain phase accuracy.
- If the external reference signal is removed, the ADC-104 in slot 1 will act as a master clock generator for the entire frame and all channels will maintain phase accuracy relative to each other.
- If the ADC-104 in card slot 1 is removed, all remaining cards will loose reference and will automatically switch to internal sync.

Using a DDA-205 card as a clock buffer

Suppose two or more ADC-104 cards in a frame that we wish to synchronize to an external reference. A digital distribution card such as the DDA-205 can be used for this purpose. The best way to do this is as follows:
(In this example, card 1 is populated with a DDA-205 and is fed from the external reference. Card slots 2-12 are populated with ADC-104 cards. The ADC-104 cards will be locked to one of the digital audio outputs from the DDA-205 in card 1 using the reference bus.

- Set all ADC-104 cards to "Slave Mode" (factory default).
- Set reference input impedance to High-Z on all ADC-104 cards (factory default).
- Connect the external reference signal to the digital input connector on slot 1.
- Insert a terminating plug in the digital loop connector for card 1.
- Enable the reference bus on all card slots except slot 1 (see Photo 6).
- Enable the 110-Ohm bus termination jumper (see Photo 5).
- Connect any digital audio output from card 1 to the reference-input connector (pins 59 and 60) on card slot 2 (this provides the connection to the reference bus).
- All cards will now follow card 1 and will maintain phase accuracy.
- If the external reference signal is removed, all ADC-104 cards will loose reference and will automatically switch to internal sync.
- If the DDA-205 card in slot 1 is removed, all ADC-104 cards will loose reference and will automatically switch to internal sync.

Synchronization to an External Reference – Using a Direct Connection to the Reference Bus (Alternate Method)

An AES/EBU or SP/DIF signal source may be connected directly to the reference bus. The bus connectors provide convenient connections to the reference bus, but it is important to understand that these connections are primarily intended for System1000™ frame-to-frame connections.

The reference bus connectors can be directly connected to a single external digital audio reference, but **certain precautions must be observed**:

- The reference signal source should be connected to one end of the bus and the other end of the bus must be terminated.
- All cards that are connected to the bus must be set to High-Z slave mode.
- Remove the reference bus enable jumpers from any card slot that will not be using the reference bus.
- The length of the reference cable must be limited to 25 feet.

To terminate the bus:

- Use the jumper-selected 110-Ohm termination to terminate the bus when feeding the bus from the 75-Ohm BNC connector.
- Use a 75-Ohm BNC terminating plug to terminate the bus when feeding the bus from a balanced 110-Ohm source (connected to the WECO connector).

The bus loading will vary according to the number of cards enabled, and consequently the termination will be less than ideal. Therefore the external reference must be located near the System1000™ frame whenever a reference signal will be connected directly to the reference bus. We recommend limiting the length of the reference cable to 25 feet when driving the reference bus directly from an external device.

If more than 25 feet of cable will be required, do one of the following:

- Use an output from one ADC-104 to drive the bus, see “Using an ADC-104 card as a clock buffer”.
- Install a distribution amplifier card in the System1000™ frame; see “Using a DDA-205 card as a clock buffer”.
- Insert a digital audio distribution amplifier within 25 feet of the System1000™ frame.

REMOVING TOP COVER (for access to jumpers)

The ADC-104 has a removable shield cover. This cover prevents crosstalk between System1000™ modules, provides supplementary EMI shielding, and greatly reduces the chances of damaging ESD sensitive components.

It is necessary to remove the cover for access to the configuration jumpers. See Photo 8

1. Starting at one of the corners, pry the cover up about 1/16”.
2. Proceed to an adjacent corner and pry it up about 1/16”.
3. Proceed to the other two corners.
4. Repeat the process if necessary.

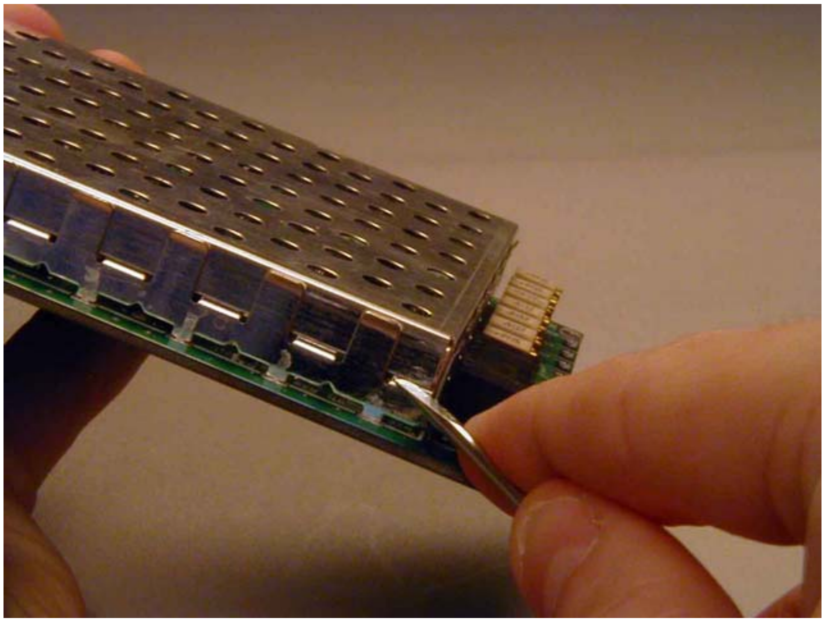


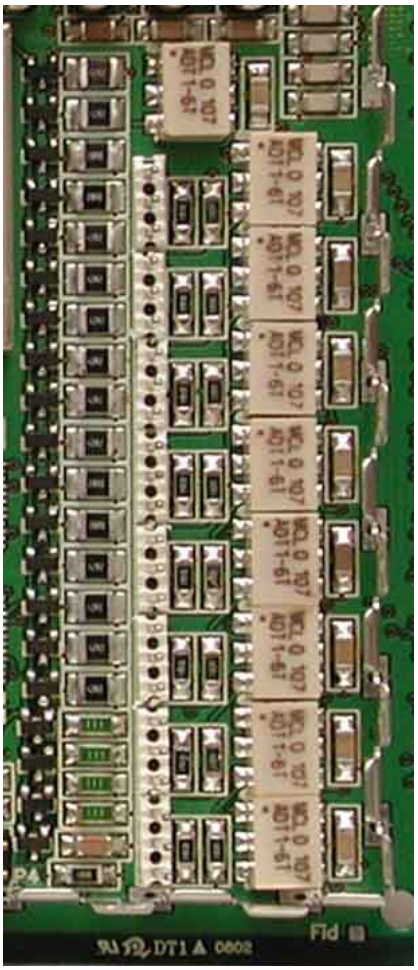
Photo 8 - Removing the Cover

JUMPERS

See Figure 1 for jumper locations.

Output Impedance Jumpers (Headers JP1 through JP8):

The 8 digital outputs on the ADC-104 can be configured for any combination of 110 and 75 Ohms. Each digital output has a 3-pin header and a 2-pin jumper plug for selection of the output impedance. The factory default is 110 Ohms.



JUMPER NUMBER		Pins	OUTPUT NUMBER
JP1	110 / 75	1 2 3	1,2A
JP2	110 / 75	1 2 3	1,2B
JP3	110 / 75	1 2 3	1,2C
JP4	110 / 75	1 2 3	1,2D
JP5	110 / 75	1 2 3	3,4A
JP6	110 / 75	1 2 3	3,4B
JP7	110 / 75	1 2 3	3,4C
JP8	110 / 75	1 2 3	3,4D

Photo 9 - Output Impedance Jumper Locations (shown in 110-Ohm default position)

Note: JP1 is closest to top of board, and JP8 is closest to bottom of board. On each header, pin 1 is closest to top of board. (See Photo 9).

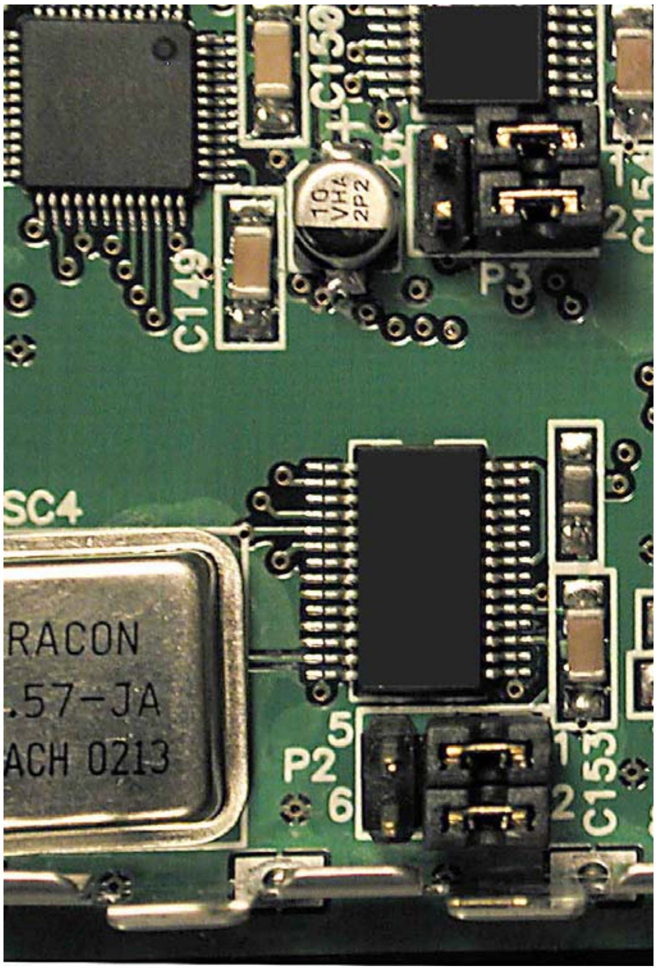
110 Ohms ***		**75 Ohms**	
110	1	**110**	1
	2		2
75	3	**75**	3

***** = Factory default output impedance is 110 Ohms.**

Output Word Length Jumpers (Headers P2, and P3)

Each of the two channel pairs has a 6-pin header that allows selection of 16, 18, 20, or 24-bit output word lengths. The word length for channel pair 1,2 may be set differently than that of channel pair 3,4 (if desired). Word lengths are reduced using TPDF (white noise) dither. Shorter word lengths will raise the noise floor of the ADC-104. The factory default setting is 24-bits for each channel pair.

Caution: Never feed a 24-bit output to a 16-bit device, this will cause distortion! Always match the output word length to the maximum word length supported by the rest of the system.



CHANNELS 1 AND 2

P3

5	3	1
6	4	2

CHANNELS 3 AND 4

P2

5	3	1
6	4	2

Photo 10 - Word Length Jumper Locations (shown in 24-bit default position)

24-BITS ***

5	3	1
6	4	2

20-BITS

5	3	1
6	4	2

18-BITS

5	3	1
6	4	2

16-BITS

5	3	1
6	4	2

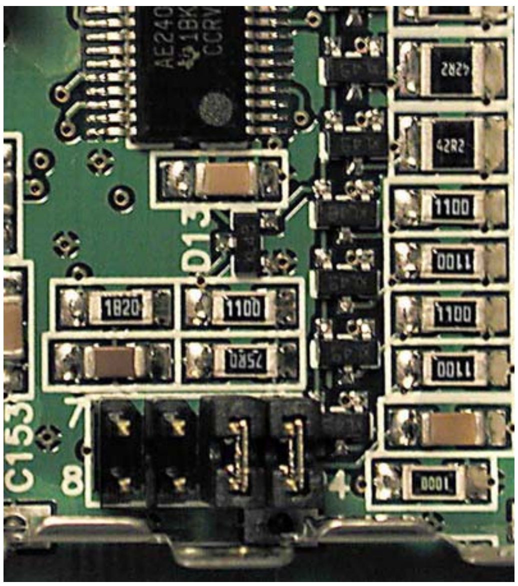
***** = Factory default word length is 24-bits.**

Reference Mode Jumpers (Header P4)

Default Reference-Mode Configuration (Slave, High-Z)

P4 is an 8-pin header that is used to configure the clock reference mode. The ADC-104 can be configured as a master clock generator, a slave device, or a free-running device. All of these functions can be enabled from the backplane if the jumpers are left in their default (Slave, High-Z) position.

In most installations, all cards should be configured identically, and should remain in the factory default reference mode (Slave, High-Z). Read "CLOCK SYNCHRONIZATION" before changing the reference mode jumpers.



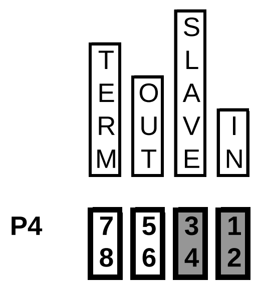
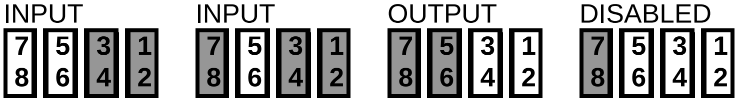


Photo 11 - Reference Mode Jumper Locations (shown in default position)

SLAVE ***	SLAVE	MASTER	FREE-RUN
HIGH-Z	75 OHM	75 OHM	HIGH-Z
INPUT	INPUT	OUTPUT	DISABLED



***** = Factory default reference mode is Slave with High-Z Input Impedance.**

Special Reference-Mode Configurations

The reference port on the ADC-104 is bi-directional. The reference port acts as an input in **Slave Mode**, and as an output in **Master Mode**. The ADC-104 ignores the reference port when **Free-Running Mode** is enabled. The factory default is Slave Mode with High-Z input impedance, and should be used for most applications.

Enabling the 75 Ohm Reference Termination (Special Applications Only)

When the reference port is configured as an input (**Slave Mode**), the input impedance can be set to 75 Ohms, or High-Z. The default input impedance setting is High-Z and is required whenever a reference signal will be delivered to the card using the System1000™ reference bus. If the reference input will be fed from an external 75-Ohm source, this termination could be applied. However, this setting usually does not need to be changed because terminations can be applied to the backplane. We recommend leaving all cards configured for High-Z input so that all of the cards in a frame can be configured identically. The High-Z setting is also required when BNC connector cards are plugged into the rear of the System1000™ card frame. Remember that a termination does still need to be applied at the end of a reference feed. We recommend placing the termination on the backplane instead of enabling the terminator on the card because this makes all of the cards in a system interchangeable.

Master Mode (Special Applications Only)

In **Master Mode,** the reference port is configured as an output, and the output impedance is 75 Ohms. This special mode of operation can be selected if one additional digital output is desired and then only if this card will be operating without an external reference.

Free-Running Mode (Special Applications Only)

In **Free-Running Mode** the reference port is disabled, and the input impedance is High-Z. Any signal on the reference input is ignored.

Fallback Sample-Rate Jumpers (Header P1 pins 11,12, 13, and 14)

P1 is a 14-pin header that is used to set the "**Fallback Sample Rate"**. This is the sample rate at which the ADC-104 card will operate at when no external clock reference is available. In **Slave Mode**, the **Reference Input** overrides the **Fallback Sample Rate**. In **Master Mode** and in **Free-Running Mode** the **Fallback Sample Rate** always determines the output sample rate.

The **Fallback Sample Rate** is active when:

- **Slave Mode** is enabled but the reference signal is absent.
- **Slave Mode** is enabled but the reference signal has an error condition.
- **Master Mode** is enabled (use this mode for special applications only).
- **Free-Running Mode** is enabled (use this mode for special applications only).

When **Slave Mode** is enabled, the **Fallback Sample Rate** should be set to match the sample rate that will be used most often. The factory preset for the **Fallback Sample Rate** is 48 kHz.

The ADC-104 is designed to prevent unnecessary muting of the audio signal when an error condition occurs. In slave mode, most A/D converters will mute when an error condition occurs on the reference input. In contrast, the ADC-104 will continue to operate, and will simply switch to an internal clock reference (at the **Fallback Sample Rate**) until the error condition is corrected. This can prevent dead air in a live application.

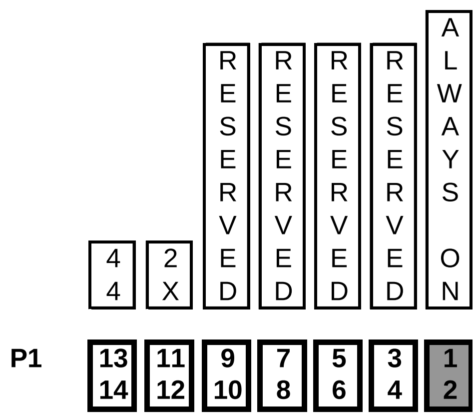
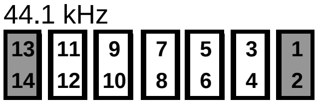
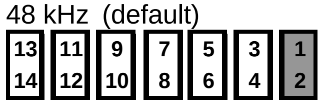


Photo 12 - Fallback Sample-Rate Jumper Locations (shown in default 48 kHz position)

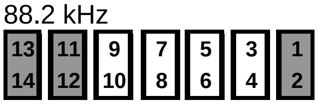
44.1 kHz



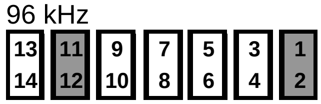
48 kHz (default)



88.2 kHz



96 kHz



PIN ASSIGNMENTS

ADC-104 Pin Assignments – MLX (Molex) Card Frame:

(As Seen from Rear of System1000™ MLX Card Frame)

MOLEX SL CONNECTORS

	19		23	13		17	
ANALOG IN - CH 3	+	S	-	+	S	-	ANALOG IN - CH 1
	27		28	25		26	
ANALOG IN - CH 4	+	S	-	+	S	-	ANALOG IN - CH 2
	30		34	29		33	
DIGITAL OUT 3,4A	+	S	-	+	S	-	DIGITAL OUT 1,2A
	36		40	35		39	
DIGITAL OUT 3,4B	+	G	-	+	S	-	DIGITAL OUT 1,2B
	42		46	41		45	
DIGITAL OUT 3,4C	+	S	-	+	S	-	DIGITAL OUT 1,2C
	48		52	47		51	
DIGITAL OUT 3,4D	+	S	-	+	S	-	DIGITAL OUT 1,2D
	54		58	53		57	
NC	+	S	-	+	S	-	NC
	59		60	61		62	
REFERENCE IN	+	S	-	+	S	-	REFERENCE LOOP

(S=Cable Shield)

CARD EDGE CONNECTOR

GND	2	1	GND
GND	4	3	GND
+15 Volts (Analog +V)	6	5	+15 Volts (Analog +V)
+15 Volts (Analog +V)	8	7	+15 Volts (Analog +V)
-15 Volts (Analog -V)	10	9	-15 Volts (Analog -V)
-15 Volts (Analog -V)	12	11	-15 Volts (Analog -V)
	14	13	ANALOG IN - CH 1
	16	15	GND
	18	17	ANALOG IN - CH 1
	20	19	ANALOG IN - CH 3
	22	21	GND
	24	23	ANALOG IN - CH 3
ANALOG IN - CH 2	26	25	ANALOG IN - CH 2
ANALOG IN - CH 4	28	27	ANALOG IN - CH 4
DIGITAL OUT 3,4A	30	29	DIGITAL OUT 1,2A
GND	32	31	GND
DIGITAL OUT 3,4A	34	33	DIGITAL OUT 1,2A
DIGITAL OUT 3,4B	36	35	DIGITAL OUT 1,2B
GND	38	37	GND
DIGITAL OUT 3,4B	40	39	DIGITAL OUT 1,2B
DIGITAL OUT 3,4C	42	41	DIGITAL OUT 1,2C
GND	44	43	GND
DIGITAL OUT 3,4C	46	45	DIGITAL OUT 1,2C
DIGITAL OUT 3,4D	48	47	DIGITAL OUT 1,2D
GND	50	49	GND
DIGITAL OUT 3,4D	52	51	DIGITAL OUT 1,2D
NC	54	53	NC
GND	56	55	GND
NC	58	57	NC
REFERENCE IN	60	59	REFERENCE IN
REFERENCE LOOP	62	61	REFERENCE LOOP
NC	64	63	NC
NC	66	65	NC
NC	68	67	NC
NC	70	69	NC

Notes:

- **Audio channels are identified numerically.** Channels 1 and 2 form the first stereo pair, and channels 3 and 4 form the second stereo pair.

- **Each audio channel pair has an "A", "B", "C", and "D" output.** For example, outputs "1,2A" and "1,2B" are driven from the same audio pair (channels 1 and 2). Outputs may be set to different output impedances if desired.

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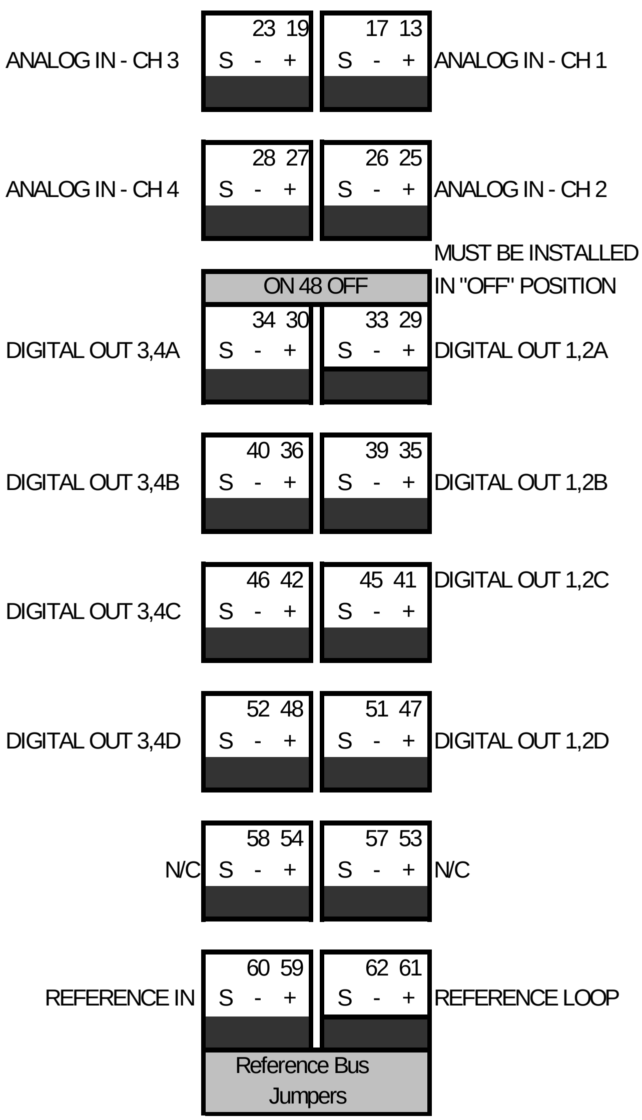
ADC-104 Pin Assignments – WEC (WECO HSL) Card Frame

(As Seen from Rear of System1000™ WEC Card Frame)

WECO HSL CONNECTORS

(S=Cable Shield)



CARD EDGE CONNECTOR

GND	2	1	GND
GND	4	3	GND
+15 Volts (Analog +V)	6	5	+15 Volts (Analog +V)
+15 Volts (Analog +V)	8	7	+15 Volts (Analog +V)
-15 Volts (Analog -V)	10	9	-15 Volts (Analog -V)
-15 Volts (Analog -V)	12	11	-15 Volts (Analog -V)
	14	13	ANALOG IN - CH 1
	16	15	GND
	18	17	ANALOG IN - CH 1
	20	19	ANALOG IN - CH 3
	22	21	GND
	24	23	ANALOG IN - CH 3
ANALOG IN - CH 2	26	25	ANALOG IN - CH 2
ANALOG IN - CH 4	28	27	ANALOG IN - CH 4
DIGITAL OUT 3,4A	30	29	DIGITAL OUT 1,2A
GND	32	31	GND
DIGITAL OUT 3,4A	34	33	DIGITAL OUT 1,2A
DIGITAL OUT 3,4B	36	35	DIGITAL OUT 1,2B
GND	38	37	GND
DIGITAL OUT 3,4B	40	39	DIGITAL OUT 1,2B
DIGITAL OUT 3,4C	42	41	DIGITAL OUT 1,2C
GND	44	43	GND
DIGITAL OUT 3,4C	46	45	DIGITAL OUT 1,2C
DIGITAL OUT 3,4D	48	47	DIGITAL OUT 1,2D
GND	50	49	GND
DIGITAL OUT 3,4D	52	51	DIGITAL OUT 1,2D
N/C	54	53	N/C
GND	56	55	GND
N/C	58	57	N/C
REFERENCE IN	60	59	REFERENCE IN
REFERENCE LOOP	62	61	REFERENCE LOOP
N/C	64	63	N/C
N/C	66	65	N/C
N/C	68	67	N/C
N/C	70	69	N/C

Notes:

- **Audio channels are identified numerically.** Channels 1 and 2 form the first stereo pair, and channels 3 and 4 form the second stereo pair.
- **Each audio channel pair has an "A", "B", "C", and "D" output.** For example, outputs "1,2A" and "1,2B" are driven from the same audio pair (channels 1 and 2). Outputs may be set to different output impedances if desired.
- **+48V Phantom jumper must be installed in "OFF" position.** Otherwise CH 2 Analog In will not work properly (input pin 26 is disabled unless phantom jumper is installed in "OFF" position).

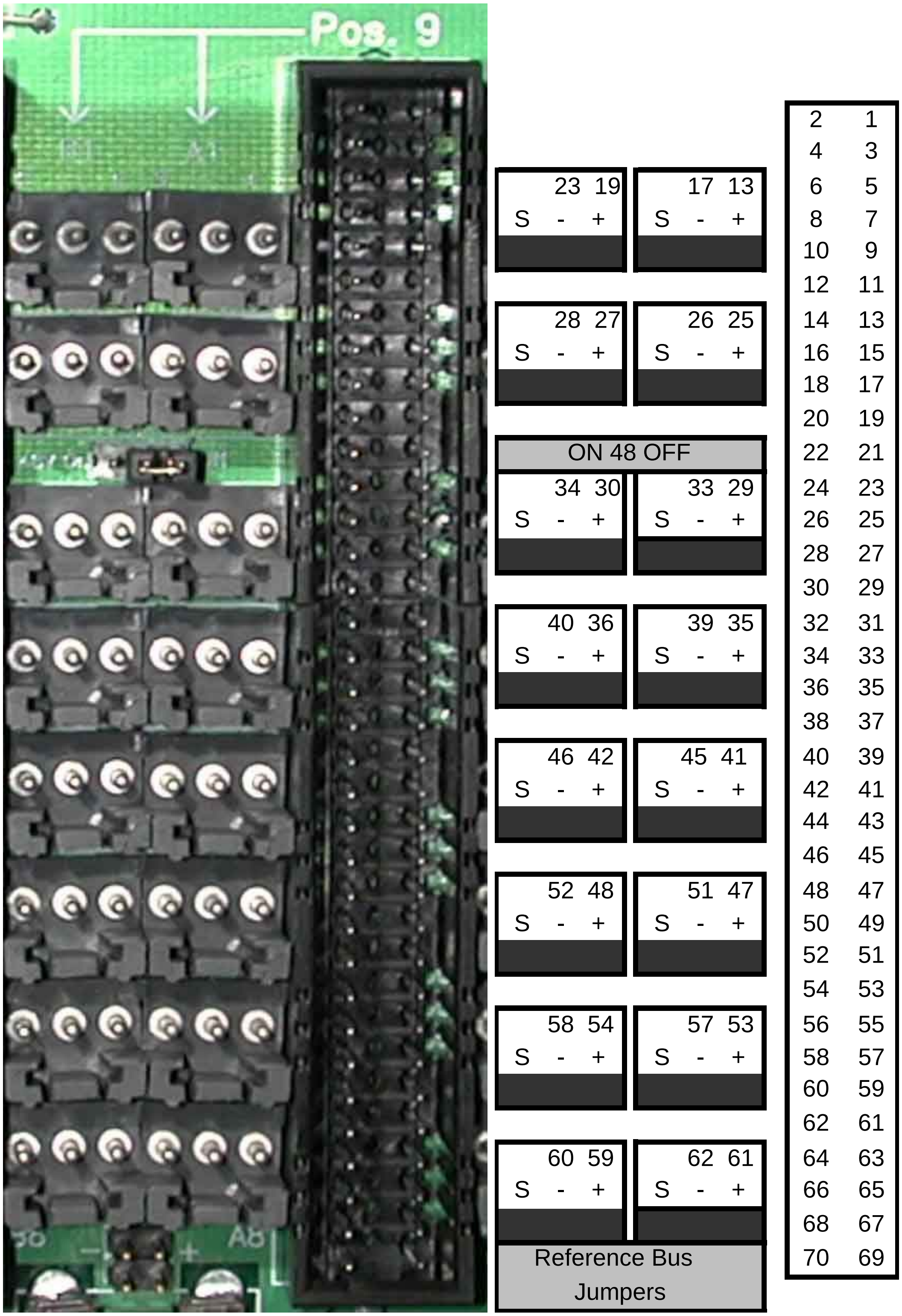


Photo 13 - Weco HSL Connectors and Associated Card Connector

Note the position of the 48V phantom jumper plug. This jumper plug must be installed in the position shown in order for the Channel 2 Analog Input to work correctly.

CONNECTOR WIRING INSTRUCTIONS

Wiring Example Photos:

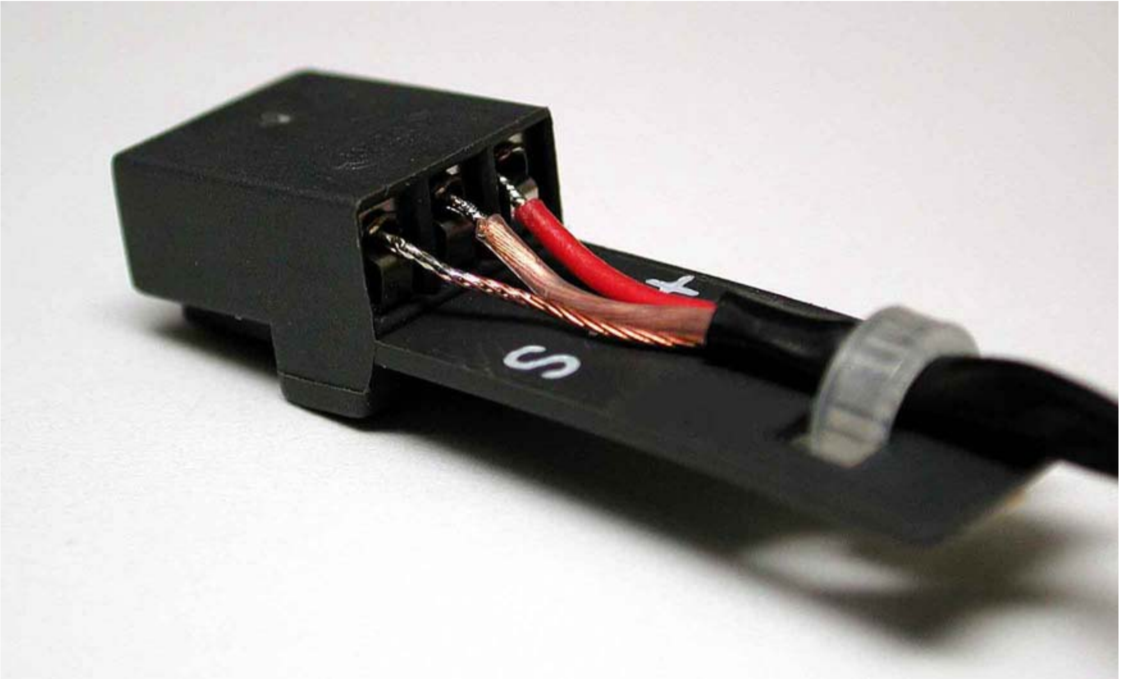


Photo 14 - Balanced (Analog or Digital) I/O using WECO HSL Connectors

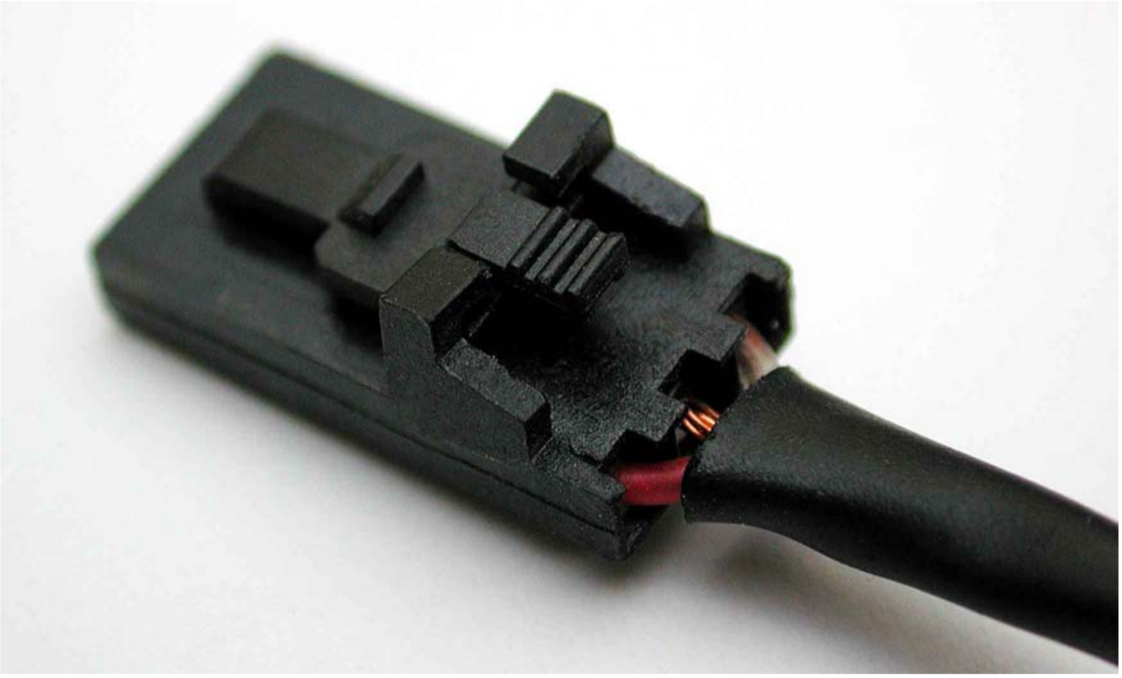


Photo 15 - Balanced (Analog or Digital) I/O using Molex SL Connectors

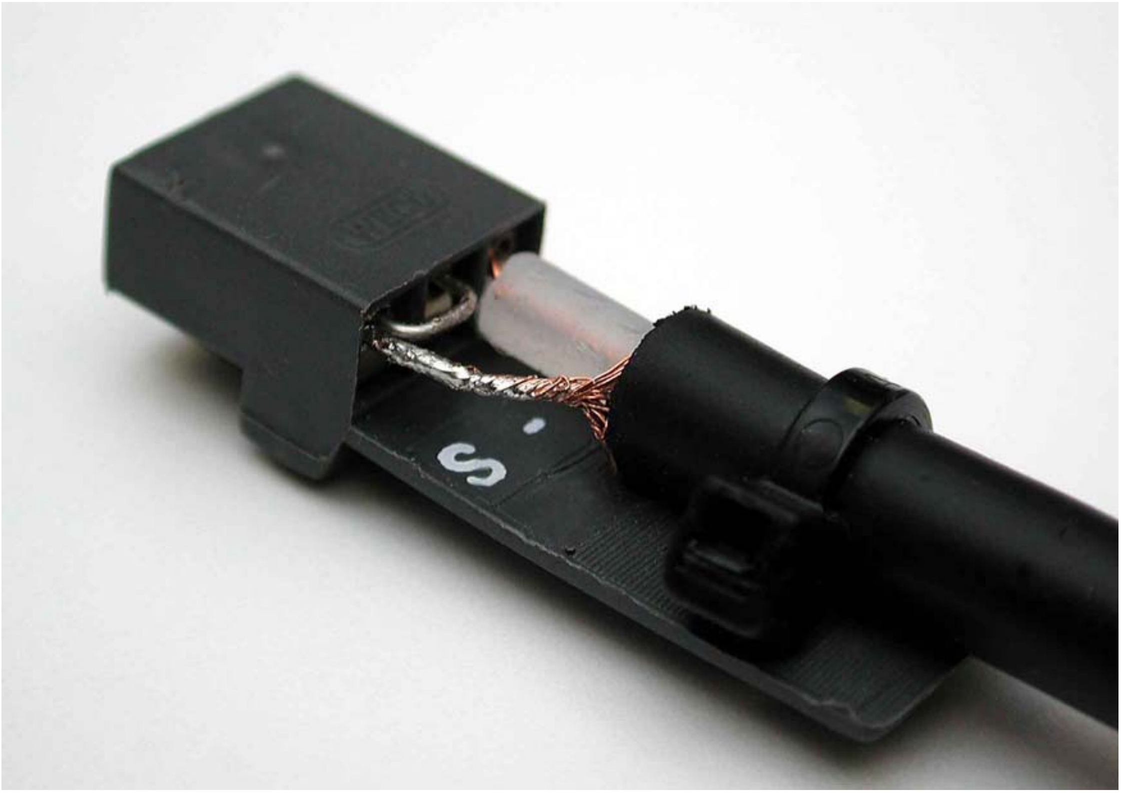


Photo 16 - Coaxial 75-Ohm Unbalanced Digital I/O using WECO HSLConnectors

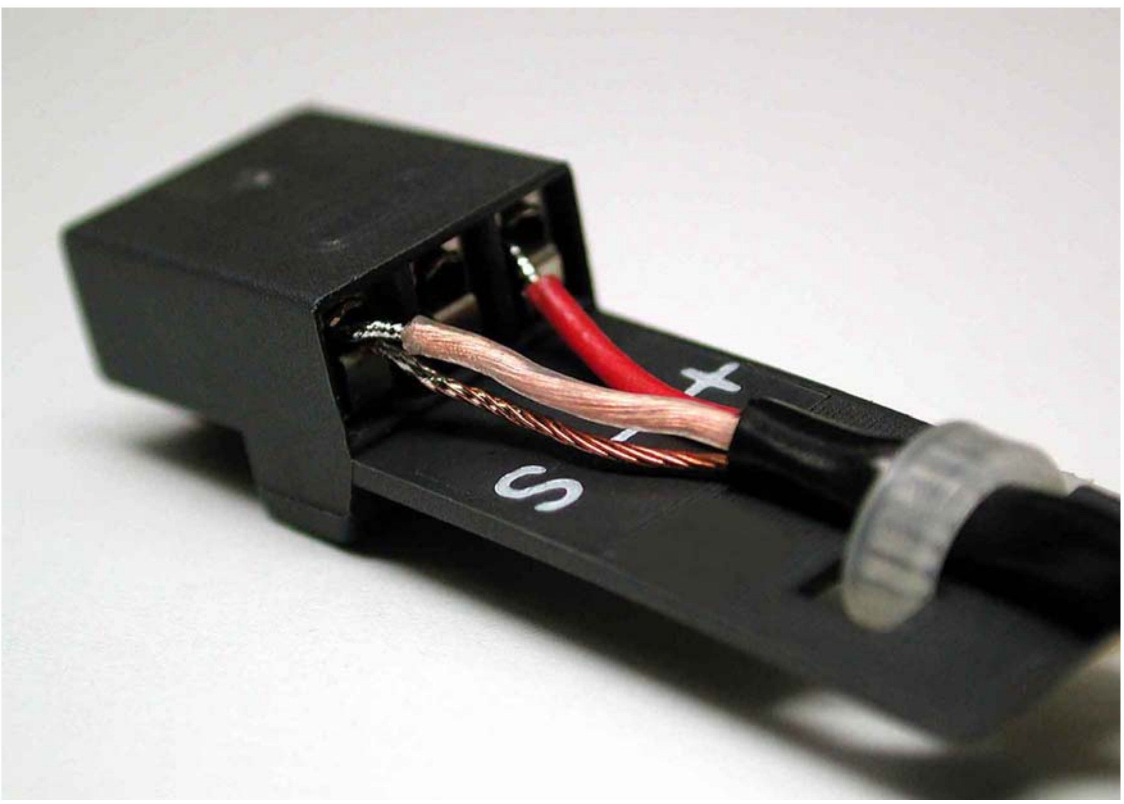


Photo 17 - Special Wiring - Balanced Analog Outputs Driving Unbalanced Devices

Wiring System1000™ Balanced Analog Audio I/O

See Photo 14 for WECO HSL connectors.
See Photo 15 for Molex SL connectors.

S = Shield * (connect to pin 1 on XLR connectors – do not connect to XLR shell)
+ = Positive Audio Out (connect to pin 2 on XLR connectors)
- = Negative Audio Out (connect to pin 3 on XLR connectors)

*** Never lift the shield at an audio output.**

Wiring System1000™ Balanced Analog Outputs to Unbalanced Inputs

See Photo 17 for WECO HSL connectors.

S = Shield* (connect to Sleeve on phone plug, or shield on RCA plug)
+ = Positive Audio Out (connect to Tip on phone plug, or center pin on RCA plug)
- = No Connection! **

** **Never tie the "-" analog output pin to ground.** The analog outputs on all System1000™ boards are actively balanced and, are driven with very low source impedances (typically 30 ohms per side). Unlike some transformer coupled outputs, the "-" pin should not be tied to ground when driving a device with an unbalanced input. If the "-" analog output pin is tied to ground, power consumption will increase dramatically. If many outputs are miss-wired in this fashion, power supply overloading may occur.

Wiring Unbalanced Analog Signals to System1000™ Balanced Inputs

For best results, back reference to the unbalanced source using balanced wiring as follows:

See Photo 14 for WECO HSL connectors.
See Photo 15 for Molex SL connectors.

S = Shield* (connect to Sleeve on phone plug, or shield on RCA plug)
+ = Positive Audio Out (connect to Tip on phone plug, or center pin on RCA plug)
- = Signal Reference * (connect to Sleeve on phone plug, or shield on RCA plug)

*** Never allow the "-" pin of a balanced input to float.**

If it is not practical to run balanced wiring from the unbalanced source, wire the System1000™ input connectors as follows:

S = Shield (connect to Sleeve on phone plug, or shield on RCA plug)
+ = Positive Audio Out (connect to Tip on phone plug, or center pin on RCA plug)
- = Shield (connect to Sleeve on phone plug, or shield on RCA plug)

Wiring System1000™ Digital I/O to 110 Ohm Balanced Digital I/O

See Photo 14 for WECO HSL connectors.
See Photo 15 for Molex SL connectors.

Set impedance jumper to 110 Ohms (located on ADC-104 card)
Use 110-Ohm digital audio cable.

S = Shield *** (connect to pin 1 on XLR connectors, and connect to XLR shell)
+ = Positive Digital Out (connect to pin 2 on XLR connectors)
- = Negative Digital Out (connect to pin 3 on XLR connectors)

***** Never lift ground on a digital input or output.** Digital shields should not be lifted at either end of a digital audio interconnect. Lifting a ground on a digital interconnect may produce EMI that exceeds allowable limits.

Wiring System1000™ Digital I/O to 75 Ohm Unbalanced Digital I/O

See Photo 16 for WECO HSL connectors.

Set output impedance jumper to 75 Ohms (located on ADC-104 card)
Use 75-Ohm coax.

S = Coax shield
+ = Coax center conductor
- = Coax shield ****

****** Note that both the "S" and the "-" pins must be connected to the shield of the coax.** A short piece of bus wire can be used to tie the "-" pin to the "S" pin (see Photo 5). The ADC-104 digital outputs are transformer coupled. If the "-" pin is left floating little or no signal will be transmitted.

SPECIFICATIONS

Digital Outputs

Number of Digital Outputs:	8 (4 per channel pair)
Number of Analog Audio Channels:	4
Output Sample Frequency Range:	28 to 108 kHz
Maximum Output Word Length	24-bits
Digital Output Impedance (Jumper Selected):	75, or 110 (default = 110)
Transformer Coupled Digital Outputs:	Yes
DC Blocking Capacitors in series with Transformer Outputs:	Yes
Transient and Over-Voltage Protection on Digital Outputs:	Yes

Digital Input

Minimum Digital Input Level:	300 mV
Digital Input Impedance (Jumper Selected):	75, 110, or Hi-Z
Transformer Coupled Digital Input:	Yes
DC Blocking Capacitor in series with Transformer Input:	Yes
Transient and Over-Voltage Protection on Digital Input:	Yes
Jitter Attenuation Method:	Benchmark UltraLock™
Jitter Tolerance (With no measurable change in performance):	>12.75 UI Sine, 100Hz-10 kHz > 3.5 UI Sine at 20 kHz > 1.2 UI Sine at 40 kHz > 0.4 UI Sine at 80 kHz > 0.29 UI Sine at 90 kHz > 0.25 UI Sine above 160 kHz

Analog Inputs

Number of Analog Inputs:	4
Input Type:	Transformerless Balanced
Input Impedance:	100 kOhms
Input Level Controls:	4 10-turn pots (1 per input)
Input Level Adjustment Range (at 0 dBFS):	+7.5 dBu to +27.5 dBu
Input Level Adjustability:	2 dB / turn
Input Level Variation with Sample Rate (44.1 kHz vs. 96 kHz):	< 0.006 dB

LED Status Indicators

LED Location:	Front Edge of Card
Meter LEDs	36 (9 per channel)
Status LEDs (indicate sample rate and lock status):	4 (44.1, 48, 88.2, 96)
Power LEDs (on = power normal):	4 (+15, -15, 5, 3.3)

Test Points

Test Point Location:	Front Edge of Card
Analog Inputs:	4 (one per analog input)
Power:	4 (one per voltage rail)
Ground:	1

Audio Performance

Fs = 44.1 to 96 kHz, 20 to 20 kHz BW, 1 kHz test tone, 0 dBFS = +24 dBu (unless noted):

SNR – A-Weighted, (0 dBFS = 20 to 27.5 dBu):	116 dB
SNR – Unweighted, (0 dBFS = 20 to 27.5 dBu):	114 dB
SNR at Higher Gain Settings:	
SNR – A-Weighted (0 dBFS = 10 to 18 dBu):	109 dB
SNR – A-Weighted (0 dBFS = 8 dBu):	108 dB
THD+N, 1 kHz at 0 dBFS:	-99 dBFS, -99 dB, 0.0011%
THD+N, 1 kHz at –1 dBFS:	-101 dBFS, -100 dB, 0.0010%
THD+N, 1 kHz at –3 dBFS:	-105 dBFS, -102 dB, 0.00079%
THD+N, 20 to 20 kHz test tone at –3 dBFS:	-104 dBFS, -101 dB, 0.0009%
Frequency Response at Fs=48,000:	+/- 0.1 dB (20 to 20 kHz) -0.02 dB at 10 Hz -0.20 dB at 20 kHz
Frequency Response at Fs=96,000:	+/- 0.1 dB (20 to 20 kHz) -0.02 dB at 10 Hz -0.20 dB at 20 kHz -0.86 dB at 40 kHz -2.7 dB at 45 kHz
Maximum Amplitude of Jitter Induced Sidebands: (10 kHz 0 dBFS test tone, 12.75 UI, sinusoidal jitter at 1 kHz)	< -141 dB
Maximum Amplitude of Spurious Tones with 0 dBFS test signal:	< -128 dB
Maximum Amplitude of Idle Tones:	< -128 dB
Interchannel Differential Phase (Stereo Pair):	+/- 0.5 degrees at 20 kHz
Interchannel Differential Phase (Channel 1 to Channel 3):	+/- 0.5 degrees at 20 kHz
Interchannel Differential Phase (Between Boards):	+/- 0.5 degrees at 20 kHz
Delay (Analog Input to Digital Output):	1.01 msec + (48/Fs) 2.10 msec at 44.1 kHz 2.02 msec at 48 kHz 1.53 msec at 88.2 kHz 1.49 msec at 96 kHz
Maximum Lock Time – after Fs change:	100 msec
Soft Mute Ramp Up/Down Time:	10 msec
Mute on Receive Error:	Yes
Mute on Lock Error:	Yes
Mute on Idle Channel:	No

System Group Delay

Delay from analog input to digital output is a function of sample rate:

2.72 msec at 28 kHz
2.51 msec at 32 kHz
2.10 msec at 44.1 kHz
2.01 msec at 48 kHz
1.55 msec at 88.2 kHz
1.51 msec at 96 kHz
1.45 msec at 108 kHz

The delay can be calculated using the following formula:

Delay = 1.01 msec + (48/Fs)

Where Fs = the sample rate in Hz.

Power Requirements

+/- 15 volts regulated
Minimum regulated input voltage = +/- 14 volts.
Maximum regulated input voltage = +/- 20 volts.
240 mA – Idle channel, digital outputs active and terminated, any sample rate.
263 mA – +24 dBu on all inputs, 0 dBFS, all meter LEDs on, digital outputs terminated, any sample rate.
Ground current < 4 mA (Loads are balanced to better than 2%).

Dimensions

(Standard System1000™ Card Dimensions)

220 mm x 100mm x 16mm
8.75” x 3.95” x 0.625”
(L x W x H)

Benchmark Media Systems, Inc.

COMPLIANCE and SAFETY INFORMATION

FCC Class B Compliance

This device complies with part 15 of the FCC Rules. Operation is subject to the following two conditions:
(1) This device may not cause harmful interference, and
(2) This device must accept any interference received, including interference that may cause undesired operation.

Safety Information

Do NOT service or repair this product unless properly qualified. Only a qualified technician or authorized Benchmark Media Systems, Inc. distributor should perform servicing.

For continued fire hazard protection, fuses should be replaced ONLY with the exact value and type as indicated on the rear panel and on this page below.

Do NOT substitute parts or make any modifications without the written approval of Benchmark Media Systems, Inc. Doing so may create safety hazards.

WARRANTY

The Benchmark 5 Year Warranty

Benchmark Media Systems, Inc. warrants its products to be free from defects in material and workmanship under normal use and service for a period of five years from the date of delivery. This warranty extends only to the original purchaser. This warranty does not apply to fuses, lamps, batteries, or any products or parts that have been subjected to misuse, neglect, accident, or abnormal operating conditions.

In the event of failure of a product under this warranty, Benchmark Media Systems, Inc. will repair, at no charge, the product returned to its factory. Benchmark Media Systems, Inc. may, at its option, replace the product in lieu of repair. If the failure has been caused by misuse, neglect, accident or abnormal operating conditions, repairs will be billed at the normal shop rate. In such cases, an estimate will be submitted before work is started, if requested by the customer.

The foregoing warranty is in lieu of all other warranties, expressed or implied, including but not limited to any implied warranty of merchantability, fitness or adequacy for any particular purpose or use. Benchmark Media Systems, Inc. shall not be liable for any special, incidental, or consequential damages. This limited warranty gives the consumer-owner specific legal rights, and there may also be other rights that vary from state to state.

A return authorization is required when sending products for repair. They must be shipped to Benchmark Media Systems, Inc. prepaid and preferably in their original shipping carton. A letter should be included addressed to the customer service department, giving full details of the difficulty.