LavryBlue Series

Model LE•4496
Modular Audio System

Operations Manual

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LavryBlue SYSTEM

The LavryBlue system is a 1U high (1.75 inches tall), 19 inch wide rack mount system, configurable to accommodate conversion functions, ranging from Digital to Analog conversion, Analog to Digital conversion, Single to Double wire, Double to Single wire interfaces and more. The hardware is designed to operate at 44.1, 48, 88 and 96KHz sampling including 32 – 100KHz Vari-speed mode.

The Chassis contains a power supply (equipped with significant output power noise filters). It provides room for up to 4 modules (printed circuit boards). Each module is a 2-channel unit, thus providing up to eight channels of conversion or processing.

The LavryBlue system can be configured to accommodate a single module for stereo conversion (ADC, DAC, Single - Double speed conversion), as well as four, six or eight channels. The chassis may be configured for any mix of functions, such as 2 channels of ADC and 2 Channels of DAC, 6 channels of ADC plus 2 channels of DAC and so on, within the 8 channels per chassis restriction.

The modules (printed circuit boards) are bolted into the chassis, and connected to each other in a daisy chain manner, enabling power distribution across the chassis. The interconnections also provide for communication between the units, much of which is user configurable.

Stand alone modes: Some functions can operate well in a stand-alone mode. A good example is the single - double wire interface unit. A digital to analog converter also functions well as a stand-alone unit, but there are cases where the user may want units to communicate. Crystallock™ jitter elimination mode is one such example requiring a master-slave relationship between units.

Shared clocks and settings: Operating ADC's with independent clocks violates proper sonic imaging. Multiple channels of Analog to Digital conversion require shared clocks. A Master Sync unit - an additional printed circuit board - controls the clocks of all ADC's simultaneously.

Communication between units has an additional purpose: It allows the settings of the various performance parameters on one ADC to be transferred to all other channels. With 20 possible settings per ADC, this feature simplifies setting of multiple channels. The possible settings include are output wordlength, Acoustic Bit Correction, display modes, reference meter bridge, analog soft saturation, digital soft saturation and so on.

Digital to Analog Converter model M•DA-824

This 3 inch wide (10.5 inch long) assembly is a plug-in module for the LavryBlue rack mount system.

This M•DA-824 unit is a two-channel digital to analog converter. The multi bit DAC converters accept up to 24 bits while accommodating 44.1 - 96KHz sample rates.
The DACs always operate at double-speed mode in narrow lock or CrystalLock™: normal speed data is first upsampled by the on board DSP to 88.2 or 96KHz. The digital to analog conversion utilizes two converters per channel, operating in a differential mode, thus providing cancellation of many artifacts and improving the noise performance by 3dB.

The unit features CrystalLock™ mode to ensure lowest jitter. The crystal lock circuitry utilizes a RAM data buffer and a DSP controlled pullable crystal oscillator, to overcome standard phase lock limitations. The clocks are made of custom pullable crystal and ECL voltage control oscillator circuitry (Emitter coupled logic), for lower jitter and improved sonic imaging.

Specifications:

Noise -110dBFS (20Hz – 22KHz unweighted)

Distortions
1kHz tone at -1dBFS: .002%FS
1kHz tone at -20dBFS: .0013%FS
1kHz tone at -60dBFS: .0006%FS

Sample rates
96kHz, 88.1kHz, 48kHz, 44.1kHz at +/- 150ppm lock range
(Front panel lamps indicate sample frequency)
32-100kHz wide lock mode (varispeed)
(Front panel-switch selection between CrystalLock™ and wide lock and narrow lock)

CrystalLock Master mode settings, ideally suited for single DAC (Stereo Channels), or Master-slave configurable suited for multiple DAC Channel operation. Crystal mode settings are done via a four position dip switch. Look for switch settings in the section “Clock Configurations”.

Crystal lock accuracy .1ppm / 10 sec maximum

Channel separation -100dBFs at 1KHz

Flatness response +/- .05dB (10Hz -20KHz)

Phase linearity 2 degrees (10Hz - 22 kHz)

Polarity Front panel switch selects “Pin 2 Hot” or “Pin 3 Hot”

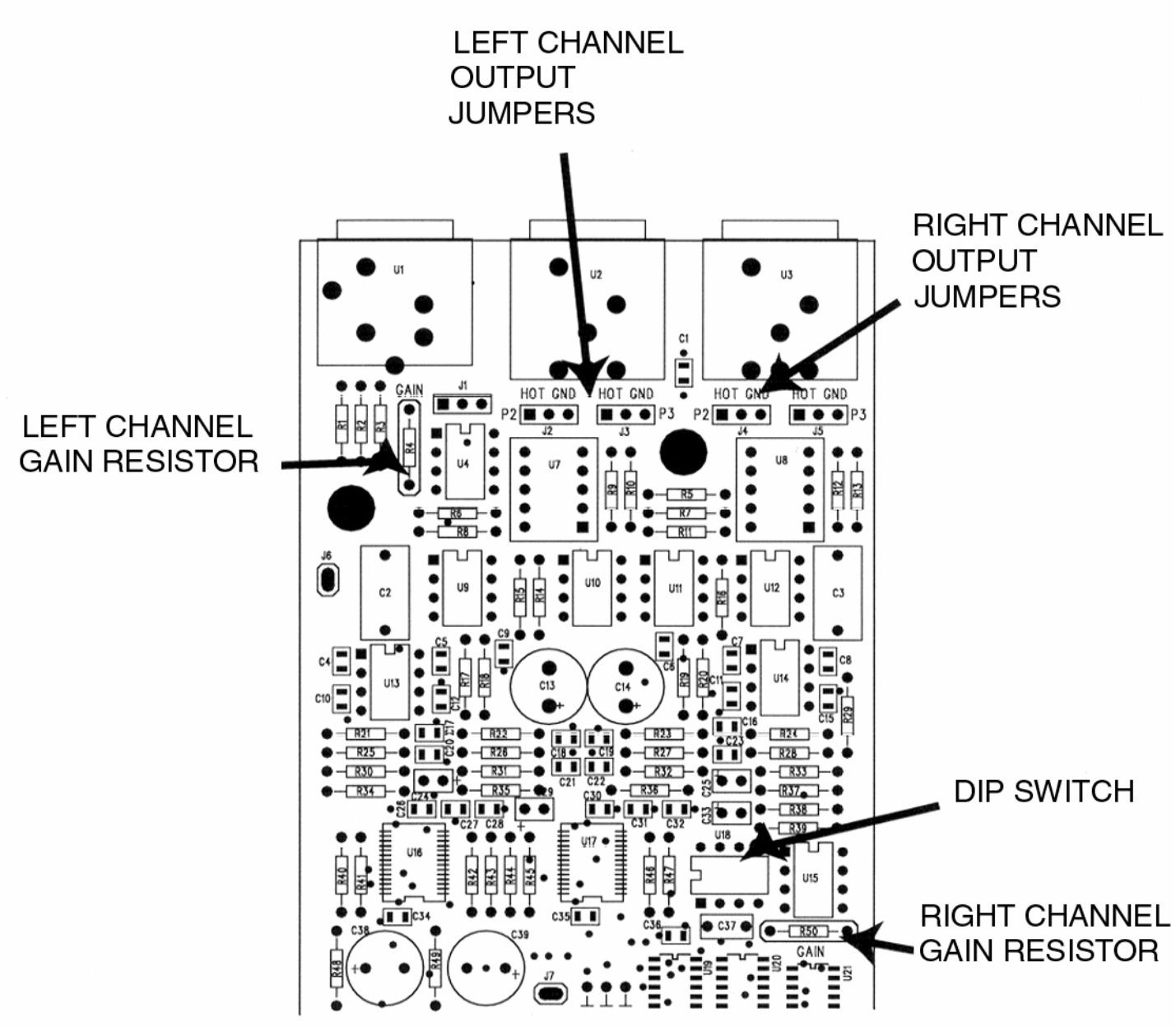
Analog Outputs

Balanced (maximum level of 27dBu +/-. 25dB) or Unbalanced (Maximum level of 21dBu +/-. 25dB). Balanced /unbalanced settings are user configurable via user-selectable jumpers. Unbalanced configuration can be made to drive pin 2 (with pin 3 grounded), or visa versa via the same user-selectable jumper configuration. Look for details in the table "Analog Output Mode".

Individual analog output front panel volume control adjustments (20 turn potentiometers for each channel) provide 0 to +24dBu range for balanced outputs, and –6dBu to +18dBu for unbalanced operation.

Digital input

AES/EBU, 110 Ohm, transformer isolated



Configuring the M•DA-824

Analog output configurations may be configured by user-selectable jumpers J2, J3, J4 and J5, located behind the analog XLR output connectors, to provide one of 3 modes. Jumper positions (left or right) are viewed from the front panel side of the board:

Analog Output Mode	**J2**	**J3**	**J4**	**J5**
Balanced output	Left	Left	Left	Left
Unbalanced Output – Pin 2 active, Pin3 to ground	Left	Right	Left	Right
Unbalanced Output – Pin 3 active, Pin2 to ground	Right	Left	Right	Left

Note: Pin 1 of each XLR is always grounded, to provide driver side shield ground. It is highly recommended to have the cable shield connected to Pin 1 for proper cable shield connection. Pin 1 should not be used as signal return for unbalanced configuration, thus all the jumpers J2-J5 should be on the board in their proper selected position. While it is possible to get sound out of

the unit by using the shield as a return path (missing jumpers), such practice is not recommended – keeping all the jumpers in the circuit ensures proper cable signal transmission.
Gain range configuration: The default settings are for 24dBu maximum level for balanced configuration (18dBu for unbalanced). The user can set the unit to provide 27dBu of balanced output (24 dBu unbalanced) by removing 2 resistors from the board. The resistors are clearly marked – surrounded by a white line with the word "GAIN" printed in copper next to each resistor. Remove the resistors with a pair of cutters. Such a change is only advisable when higher output levels are needed (the change is reversible but will require clearing solder pads and soldering new resistors).
Note: However tempting, setting the unit for 27dBu is for special cases only. Most gear can not handle 27dBu signals, and will require use of the front panel level adjust pots to bring the signal level down to acceptable operating range. The possible drawback of operating with too much output level is distortion of the signal peaks.

Clock Modes setup: a 4 position DIP switch (designated as U18) determines the clock settings as follows.

Mode description	Position 1 (left most)	Position 2	Position 3	Position 4 (right most)
Independent operation	OFF	OFF	OFF	ON
Master setting	TBD	TBD	TBD	TBD
Slave setting	TBD	TBD	TBD	TBD

Front Panel Controls and Display

The front panel provides the following controls:

Wide Lock for most normal applications including vari-speed (sampling rate between 40-50KHz or 80-100Kz double speed operation).

Narrow Lock reduces the sampling frequency input range to lock to signals within +/-100ppm (parts per million) around a fixed rate (44.1, 48, 88 or 96KHz). Narrow lock operation provides improved jitter rejection when operating with a known fixed frequency.

CrystalLock™ activates specialized hardware, including a temporary buffer memory and a DSP controlled instrumentation type digital to analog converter to provide almost total jitter elimination from the incoming digital signal. Note: Operating more then one M•DA-824 under CrystalLock™ requires proper setting of the clock modes as explained earlier (under "Clock Modes Setup").

Polarity Switch (2 positions) marked as **Pin 2 Hot** and **Pin 3 Hot** provides the ability to invert the signal polarity. When set to **Pin 2 Hot**, increasing the value of the digital input causes the voltage on Pin 2 of the analog output (at the XLR connectors) to increase, and the voltage on Pin 3 to decrease. The converse is true under "Pin 3 Hot" setting. Note: the polarity switch provides an electrical signal inversion, thus it should not be confused with the Balanced-Unbalanced configuration covered earlier (see Analog Output Configuration). For example, setting the unit to **Pin 3 Hot** and operating in unbalanced mode with Pin 3 active and Pin 2 grounded will yield an unbalanced inverted signal at Pin 3 (with Pin 2 grounded).

Gain control adjustment: the two front panel pots provide left and right level adjustments. The gain range spans from full scale to -14 dB below full scale. The default full scale setting is 24dBu Balanced (18dBu unbalanced). Note: as mentioned earlier, the full-scale value may be increased by 3dBu by removing the gain resistors (see "Gain range configuration" section.

Sampling Rate and Lock indicators: the converter automatically detects the incoming sample rate and displays it via one of the 4 LED indicators marked as 44.1, 48, 88.2 or 96KHz. Both the 44.1KHz and 48KHz being lit indicates special cases under wide lock (such as vary-speed, 47.95KHz sampling or similar "less standard rates").

The Lock LED indicates that the unit is locked to a digital input. When the Lock indicator is flashing, the unit indicates a signal not present or un locked condition, such as out-of-range frequency, or a missing signal or cable at the digital input.

Simplified Block Diagram Description

The Digital Audio Receiver circuit is isolated via a shielded transformer, to avoid ground loops. The signal path between the digital audio XLR connector and the receiver is off the board (3 wire cable connection – differential signal plus ground), to insure minimum coupling of the AES input signal into the analog section.

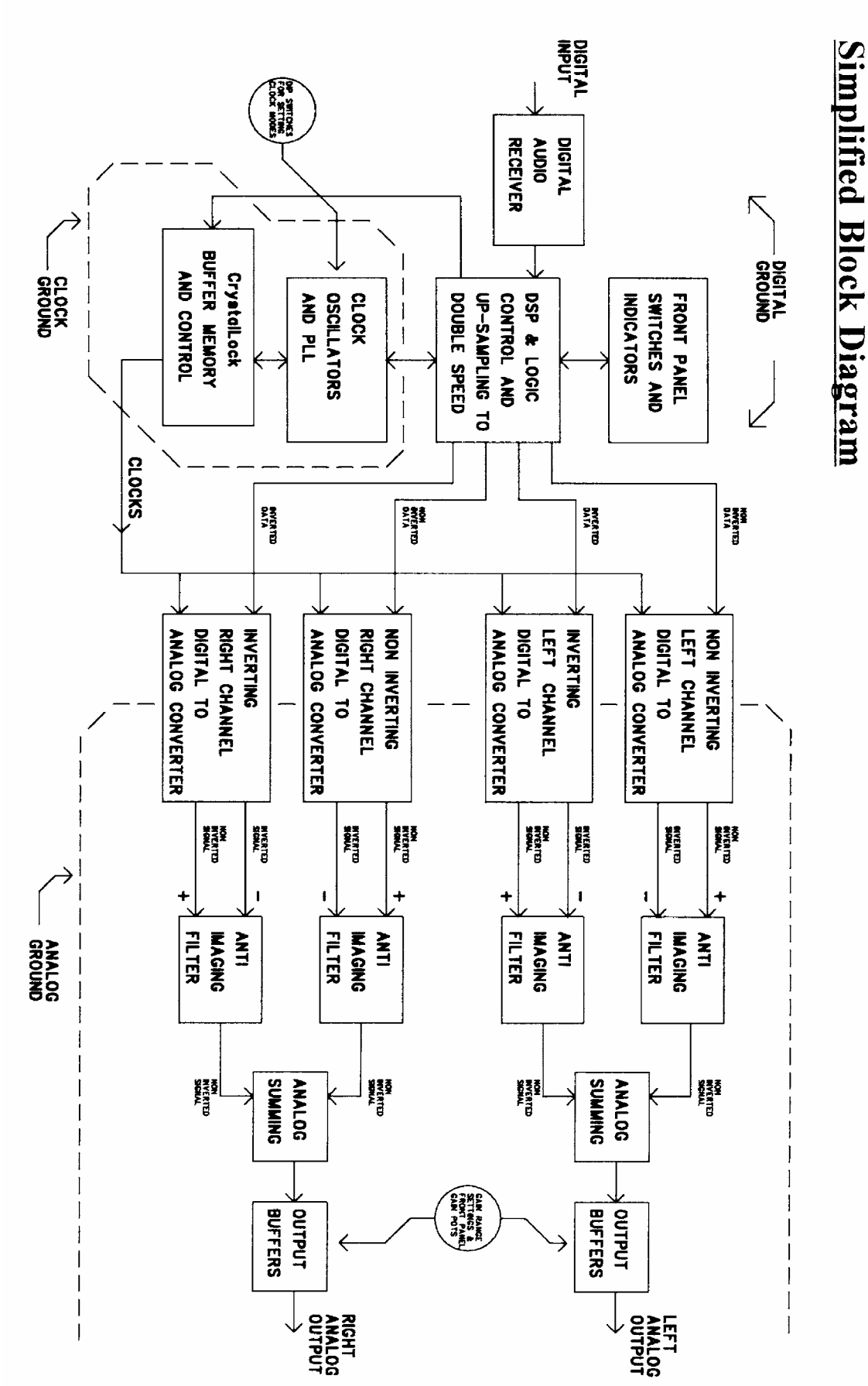
The DSP up-samples the data to double speed mode (unless the digital input is receiving double speed data) and sends it to the DAC converters. Each channel conversion utilizes two converters (inverting and non-inverting). The DSP pre-inverts the data sent to the inverting converter, thus the two converters operate out of phase. Also, each converter has both a non-inverting analog output and an inverting output. The same is true for each of the following anti-imaging filter inputs. By reverse-connecting the filter inputs, both filter outputs are in phase again.

The advantage of this architecture is three-fold. First, operating the converters in parallel provides an increased dynamic range. Second, some artifacts get canceled. Third, the addition of the two filter signals is accomplished by 2 resistors, filter 1 to the summing node and filter 2 to the summing node. Thus there is no need for an additional differential amplifier with its associated sonic degradation).

The output buffers drive each of the analog XLR pins with 2 buffers per pin (semi- parallel configuration). Such doubling of the drive capability arrangement provides significant freedom for selecting the best sounding devices. Many buffers provide a less than ideal compromise between current drive and other desirable characteristics such as noise, distortions and overall sonic quality. The output XLR connectors are shorted to ground during power-up, to avoid ear and speaker damage. During normal operation the shorting relays are out of the circuit; thus the signal does not pass through the relay, which would cause additional sonic degradation.

The clock oscillators are made out of ECL circuits (emitter coupled logic), to minimize jitter associated with lower speed devices. ECL provides a further advantage – operation under constant supply current; thus, the clock signals are very clean. The crystals themselves are custom-made for high frequency fundamental oscillations (around 25MHz). Operating at the

Simplified Block Diagram



fundamental (not harmonic) mode provides the lowest jitter. Avoiding the additional tuned circuits needed for harmonic operation provides more than cost savings; the additional inductor would be susceptible to environmental noise pickup, thus impacting the jitter performance.

The CrystalLock ™ mode eliminates jitter in the incoming data stream by having the DSP control the pull-able crystal oscillators. The incoming audio data is stored in a short buffer memory. With data already in memory, the crystal oscillator is free to transfer data to the DAC disregarding any jitter in the input frequency. A proprietary fast-lock high-accuracy DSP measurement compares the input frequency and oscillator frequency and makes appropriate adjustments. Such adjustments are made via a DSP-controlled instrumentation DAC. Controlling the clock oscillator pull range (+/- 100 parts per million) with 4096 steps of resolution enables Pico-second resolution. The pullable oscillator operates normally as an open loop device, driven by a fixed DC input voltage. Pico second corrections are not only very small, but they normally occur no faster then one step every few seconds (only when the long term **average** incoming data rate drifts away with respect to the clock rate).

Such jitter removal advantage requires some care in setting up multiple converters to ensure proper phase between all channels (see earlier description of DIP switch settings under “Clock Modes”).

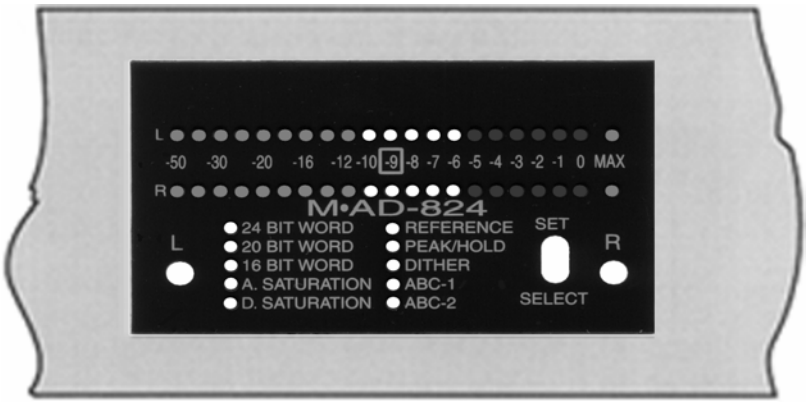
Analog to Digital Converter model M•AD-824

This 3 inch wide (10.5 inch long) assembly is a plug-in module for the LE•4496 rack mount system.

This M•AD-824 is a two channel unit, converting up to 24 bits. The unit receives its clocks (internal or external) from a plug-in board called MSYNC board (multi channel sync), which is controlled via a front panel board named SYNC-SB (Sync switching and Indication board).

Each chassis may contain up to 4 ADC units for 8 channels of conversion. One MSYNC board can drive up to 4 M•AD converters in one chassis. The MSYNC unit plugs in to the leftmost ADC (viewed from the front panel direction). The MSYNC is connected to the SYNC-SB (located behind the leftmost front panel window). All M•AD converters must be installed sequentially to the left of other modules.

The system may have up to 4 units all set up to slave mode. Alternatively, the left-most ADC (the one that has the MSYNC board plugged into it in slot 1) may be setup to be a master. In slave mode, each unit can be setup and programmed independently. In master mode, the parameters and modes set up on the master are transferred to the slave units (located to the right of the master).



The M•AD-824 front panel provides the following settings:

Wordlength selection between 24, 20 and 16 bits
Analog soft saturation, "rounding off signal peaks" to enable driving the ADC harder for extra hot recording
Digital soft saturation, emulates tape saturation – enabling 6dB hotter operation for signals under -12dBFS
Reference Meter Bridge with –10, -12, -14, -16, -18 and –20dBFS reference points
Peak-Hold, to hold and indicate the highest peak. It is reset when quickly operating the switch
Dither, for proper truncation to 20 or 16 bit word length.
ABC-1 and **ABC-2**, same as dither but with added noise-shaping processing.

Front panel operation

Settings of the M•AD-824 are accomplished by use of a single switch. The various parameters are retained in a non-volatile memory; thus, turning the power on will restore the last set of parameters programmed by the user

To set parameters, hold the switch up (**SET** position) or down (**SELECT** position) for about 2 seconds. This will activate the top 3 lamps (24, 20 and 16 bit word length). One of the available word length choices is lit solidly, while the other 2 unselected choices are blinking. Walk through the selection by quickly pressing the up (**SET** position), advancing the chosen outcome (solidly lit lamp) one position at a time.

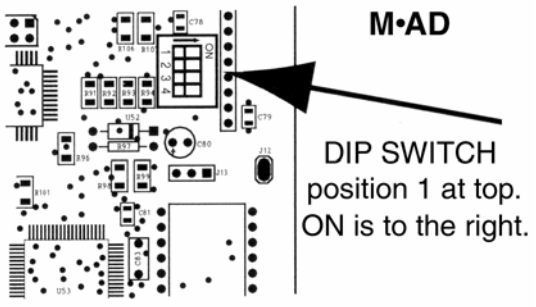
Advance to the next setting by activating the switch down to **SELECT**. The Analog soft saturation lamp is either lit solidly (indicating analog saturation ON), or blinking (indicating saturation OFF). The setting selection may be changed by pushing the switch quickly up (**SET** position).

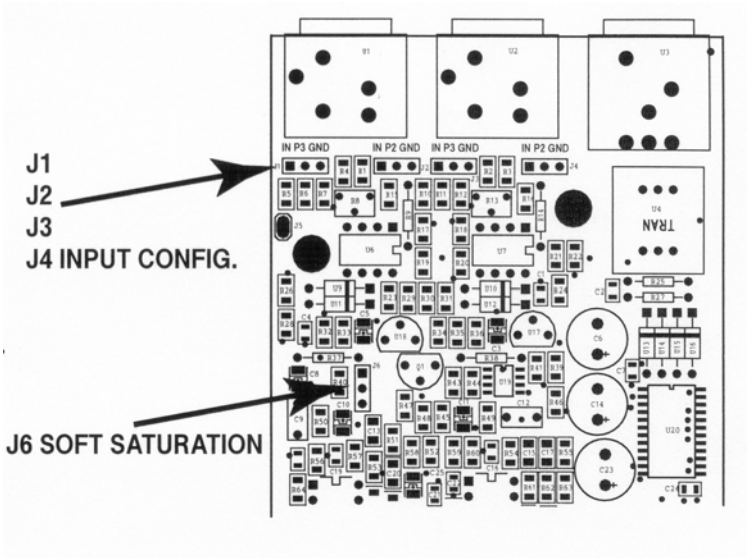
Advancing to the next function is always the same – push switch down quickly to **SELECT** and set the function to ON (solid lamp) or OFF (blinking lamp) by quickly pushing up to **SET** position. During reference meter bridge mode, moving the reference level selection is accomplished pushing the switch up to **SET**. The last 3 settings-- Dither, ABC-1 and ABC-2-- are grouped together (similar to word length). All 3 lamps blinking indicate no dither and no ABC. Otherwise, there is one solidly lit lamp (indicating the selection), and two blinking lamps. Always begin the programming by holding the switch up (**SET**) or down (**SELECT)** for 2 seconds (until the lamps blink). Advance to the next parameter by switching down (**SELECT**)

the required number of times. Exit the programming mode at any time by holding the switch up (**SET**) or down (**SELECT)** for about 2 seconds. A ten-second timer will automatically exit the program mode if left unattended, except in reference meter mode.

A chassis may be set to operate in master or slave mode. Setting parameters on a master is copied by all the slaves. A master unit must be located at the leftmost chassis position, and set to master via the on board DIP switch (position 1 set to ON). All the other units must be set to slave (DIP switch position 1 to OFF position). Master mode is indicated at power-up by blinking the –9dB lamps.

Slave unit parameters may be programmed independently via the slave unit's own front panel switch. However, the master-slave relationship will override such settings - the next time the master unit parameters are programmed or on power-up, the settings will change immediately on all the slaves as well.





DIP switch settings:

Position 1:	On – **Master**	Off - **Slave**
Position 2:	On – **Pin 2 hot**	Off- **Pin 3 hot**
Position 3:	On – gentle **ABC**	Off – aggressive **ABC**
Position 4:	future enhancements	

Configuration Jumpers:

INPUT CONFIGURATION: 4 sets of jumpers (J1, J2, J3 and J4) are located behind the analog input XLR connectors:

Pin 2 and/or pin 3 of the XLRs may be connected to analog ground. Alternatively, pin 2 or pin 3 (or both) can be fed into the converter's front end. The jumpers allow connecting both pin 2 and pin 3 to the converter for balanced input operation, or connecting one pin to ground for unbalanced operation.

For example, setting J1 to "P3 – IN" and J2 to "P2 – GND" sets J1 for unbalanced operation with Pin 3 active and pin 2 grounded.

SOFT SATURATION: A 3-position jumper, J6, enables the lowering of the threshold for the analog soft saturation feature. The default mode is a connection between the center pin to **HIGH, front position**. A more aggressive saturation curve occurs when lowering the saturation threshold (J6 connected to **LOW**, rear position).

M•AD-824 specifications

Dynamic range (22Hz – 22KHz unweighted) -114dBFS +/- 1dBFS

THD+N (1KHz unweighted), Internal clock or NARROW lock, typical and worst case:

-1dBFS	-98dBFS typical.	-96dBFS worst case.
-3dBFS	-102dBFS typical,	-98dBFS worst case.
-10dBF	-109dBFS typical,	-107dBFS worst case.
-20dBFS	-112dBFS typical,	-110dBFS worst case.

Analog input levels
24dBu balanced or unbalanced drive with no internal gain (front panel pots counter clockwise)
13dBu balanced or unbalanced drive with maximum internal gain (front panel pots clockwise)

Common mode rejection
Greater then 100dBFS for line frequencies (when applying 24dBU 100Hz common mode input signal, with no internal gain)

Analog inputs settings
Jumper selectable to balanced, Pin 2 active or Pin 3 active connections

Analog input Gain
11dB internal gain. Gain increases when turning Front Panel pots clockwise.

Output Word length
24, 20 or 16 bits selectable from the front panel.

Analog Soft Saturation
Default settings (High threshold) starts at –3dBFS
Optional settings (J6 jumper set to LOW threshold) starts at –6dBFS

Digital Soft Saturation
Provides 6dB more output level, while emulating an overdrive condition into magnetic tape.

Bar Graph display
21 lamps indication (color coded) for each channel, including MAX lamp (for overs), 0 to –10dBFS in 1 dB increments, -12 to –20dBFS in 2dB increments, followed by –25, -30, -40 and –50dBFS to indicate low level activity.

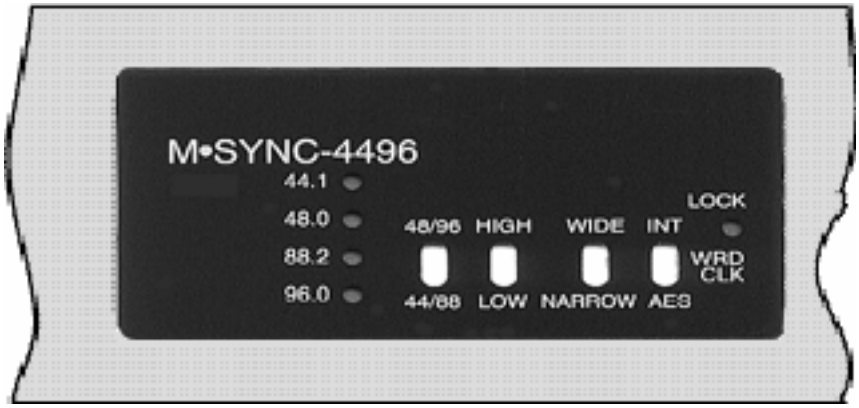
Reference Meter Bridge
Enables selection of reference points (indication lamps) on the bar graph display, to –10, -12, -14, -16, and -18 or –20dBFS levels. The magnified input signal is indicated in reference to the selected reference level in 0.2 dB steps, thus allowing for fine level adjustment (via the front panel gain pots, or externally to the unit).

Peak-Hold
To hold and indicate the highest peak level. The peak hold can be reinitialized by quickly activating the front panel switch.

Dither

Enables distortion and noise floor modulation free truncation to 20 or 16 bits word length.

Acoustic Bit Correction®
Dither plus psychoacoustic enhancement of the converter dynamic range for truncation to 20 or 16 bits.
ABC-1 provides a gentler enhancement curve. ABC-2 provides an aggressive enhancement curve.
Note that ABC-1 and ABC-2 may be replaced by less aggressive curves via position three of the DIP switch.



MSYNC Specifications:

Internal Clock operation: Set the right switch on LavryBlue M-SYNC to **INT.**
The 2 left switches set the sample frequency to 44.1, 48, 88.2 or 96KHz.

The **LOW/HIGH** switch is set to Low for 44.1 and 48KHz, and to High for 88.2 and 96KHz.

Internal clock accuracy is +/-25ppm (parts per million).

External Clock operation: Set the right switch to **WRD CLK** or **AES**.

The unit locks to a signal applied to the rear panel BNC connector Labeled **SYNC IN**. The signal should be externally terminated in 75-ohms.

WRD CLK locks the MSYNC unit to incoming word clock (sampling frequency rate), 2-5V amplitude. The lock condition is indicated when the lock lamp is on.

AES locks the MSYNC unit to an incoming AES signal, 2-5V amplitude.
The lock condition is indicated when the lock lamp is on.

Setting **WIDE/NARROW** switch to **NARROW** provides for +/- 150 PPM lock range.

Setting **WIDE/NARROW** switch to **WIDE** and **HIGH/LOW** to **LOW** provides 38-51KHZ range

Setting **WIDE/NARROW** switch to **WIDE**, and **HIGH/LOW** to **HIGH** provides 76-102KHZ

When in **NARROW** lock, the appropriate frequency indicator lamps show the selected output rate.

When in **WIDE** lock, the top lamps (44.1 and 48KHz) are lit simultaneously to indicate 38-51KHz range.

When in **WIDE** lock, the bottom lamps (88.2 and 96KHz) are lit simultaneously to indicate 76-102KHz range.

The unit provides an output sync signal at the rear panel BNC labeled SYNC OUT. The signal is useful for driving another dB4496 system (multi channel applications requiring more chassis). The output clock is a 75-ohm back terminated 3V signal (compatible with the BNC input of the next chassis).

The rear panel switch labeled **2x** enables receiving of standard sync rates (38-52KHz rate) and using them for conversion at double speed (76-102KHz) with the rear panel switch in the **ON** position. This feature is usable in both wide and narrow lock. The lamps indicate the output rate. This feature allows high-speed sampling in facilities wired for low-speed sync only. The **OFF** position requires sync and sample rate to match.