GRASS VALLEY GROUP

Instruction Manual

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2020DAC

4-CHANNEL AUDIO D-TO-A CONVERTER

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Preface

About This Manual

This manual describes the features of a specific module of the 2000 Series Modular Products family. As part of this module family, it is subject to Safety and Regulatory Compliance described in the 2000 Series frame and power supply documentation (see the *2000 Frames Instruction Manual*).

2020DAC 4-Channel Audio Digital to Analog Converter

Introduction

The 2020DAC converts two AES stereo unbalanced or balanced digital audio inputs to two balanced analog audio output pairs. Output modes can be selected for channel swapping, channel summing, 1 kHz tone, or phase inversion. When used in a 2000 frame supporting network control, the 2020DAC supports remote mode selection and module monitoring.

The digital-to-analog converters (DACs) on the module use 24-bit delta-sigma with 128 times over-sampling and noise shaping. This offers superior performance with lower idle tones, excellent sonic performance and resolution, and true 20-bit performance.

Key features of the 2020DAC include:

- Inputs are jumper-selectable between unbalanced 75 Ω terminated AES-3id inputs or balanced 110 Ω terminated inputs,
- Two pairs of balanced analog outputs (four outputs),
- Support for 32 kHz, 44.1 kHz, and 48 kHz sampling rates,
- Output range selection from +14 dBu to +24 dBu with jumper selectable maximum level,
- Channel level control using on-board, multi-turn trim potentiometers,
- Auto detection of emphasis and engagement of de-emphasis to flatten frequency response,
- Interfaces with the 8900/2000 family of audio and video modules,
- Supports networked remote control and monitoring, and
- Remote control lockout using an on-board jumper.

Installation

Installation of the 2020DAC module is a process of:

- Placing the passive rear module in a frame slot,
- Placing the media module in the corresponding front slot, and
- Cabling and terminating signal ports.

The 2020DAC module can be plugged in and removed from a 2000 Series frame with power on. When power is applied to the module, LED indicators reflect the initialization process (see *Power Up on page 6*).

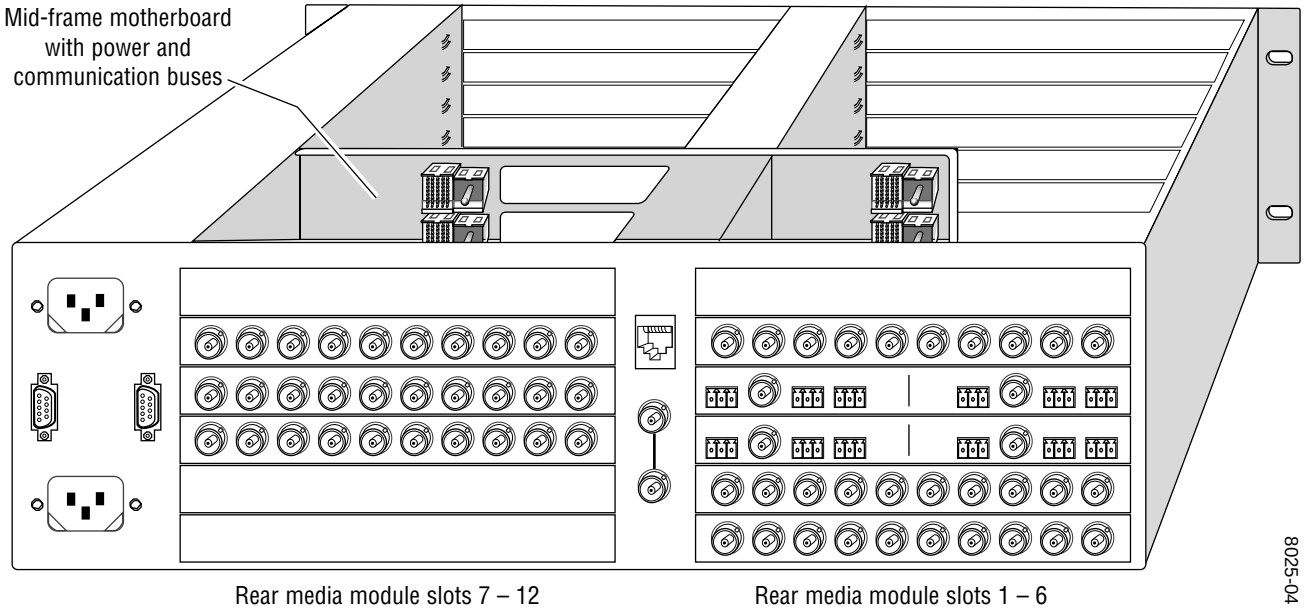
Module Placement in the 2000 Frame

There are twelve slot locations in both the front and rear of a 3RU frame to accommodate 2000 Series modules. The 2020DAC consists of a two module set with a front media module and a passive rear module that can be plugged into any of the 12 frame slots. Each 2020DAC front media module plugs into the front of the 2000 frame mid-plane. The passive rear module plugs into the corresponding rear slot to provide the input and output interface connectors.

To install a 2020DAC module set in the frame:

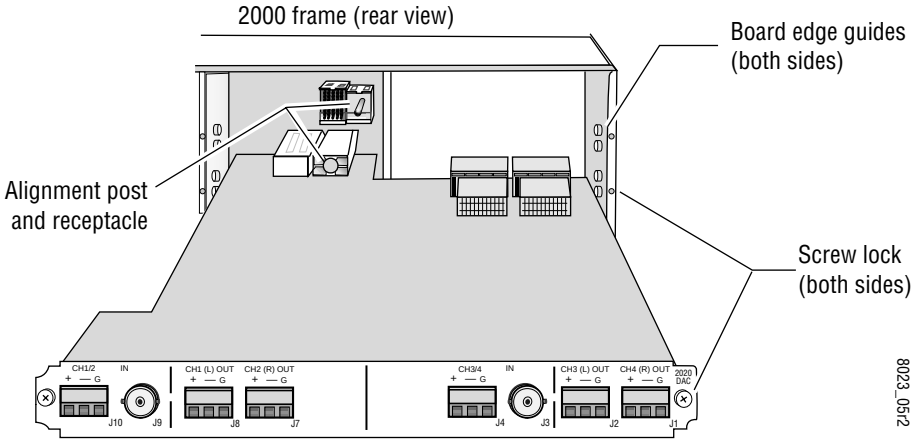
1. Locate a vacant slot in the rear of the 3 RU frame (Figure 1).

Figure 1. 3 RU Frame, Rear View



2. Insert the passive rear module into the vacant rear slot of the frame as illustrated in Figure 2.

Figure 2. Installing Passive Rear Module

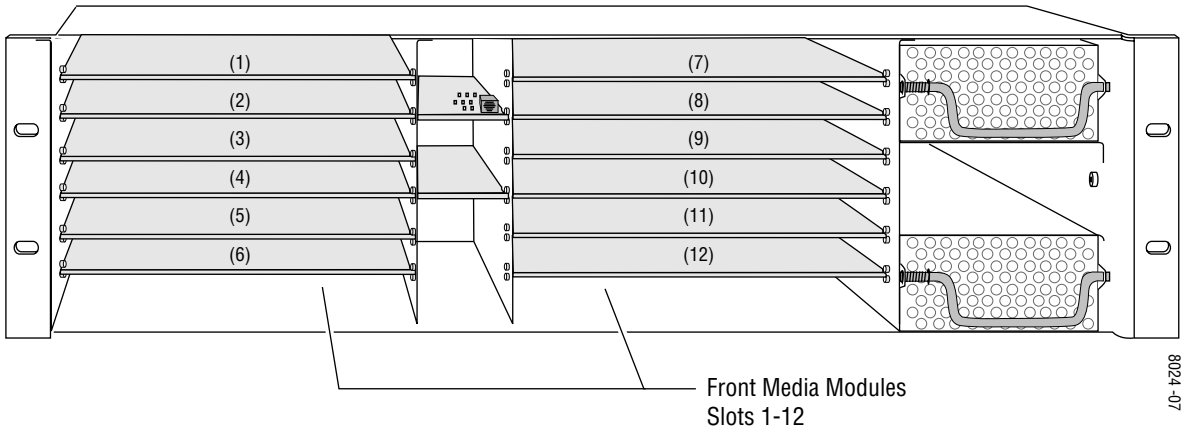


3. Verify that the module connector seats properly against the midplane.

4. Using a crossblade screwdriver, tighten the two screw locks to secure the module in the frame.

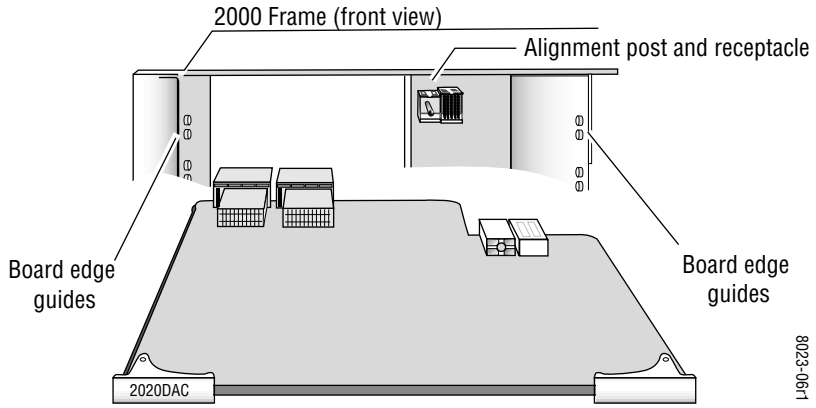
5. Locate the corresponding front slot in the frame. The 3 RU frame front view is illustrated in Figure 3.

Figure 3. 2000 Series 3 RU Frame, Front Slots



6. With the component side up, insert the front media module in the corresponding front slot (see Figure 4).
7. Verify that the module connector seats properly against the midplane and rear module connector.
8. Press firmly on both ejector tabs to seat the module.

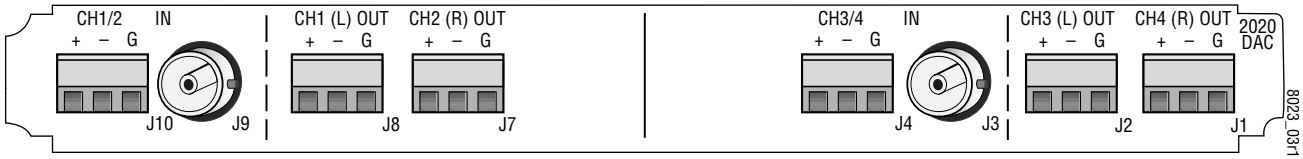
Figure 4. Installing Front Media Module



Cabling

The 2020DAC module provides two balanced 110 Ω inputs and two unbalanced 75 Ω inputs and four balanced analog, differential outputs shown in Figure 5. Set the module to use either balanced or unbalanced inputs using the local jumpers explained in *Local On-board Module Configuration on page 8*.

Figure 5. 2020DAC Input/Output Connectors



Balanced Inputs

For balanced inputs, connect audio inputs to the passive rear module +/– and G (ground) connections of the terminal blocks given in Table 1.

Table 1. Balanced Input Connections

Audio Channel	Terminal Block
CH 1/2	J10
CH 3/4	J4

Unbalanced Inputs

For unbalanced inputs, connect audio inputs to the passive rear module BNC connectors given in Table 2.

Table 2. Unbalanced Input Connections

Audio Channel	BNC Connectors
CH 1/2	J9
CH 3/4	J3

Outputs

Connect output destinations to the +/– and G (ground) connections on the terminal blocks given in Table 3.

Table 3. Audio Output Connections

Audio Channel	Terminal Block
CH1 (L) OUT	J8
CH2 (R) OUT	J7
CH3 (L) OUT	J2
CH4 (R) OUT	J1

Power Up

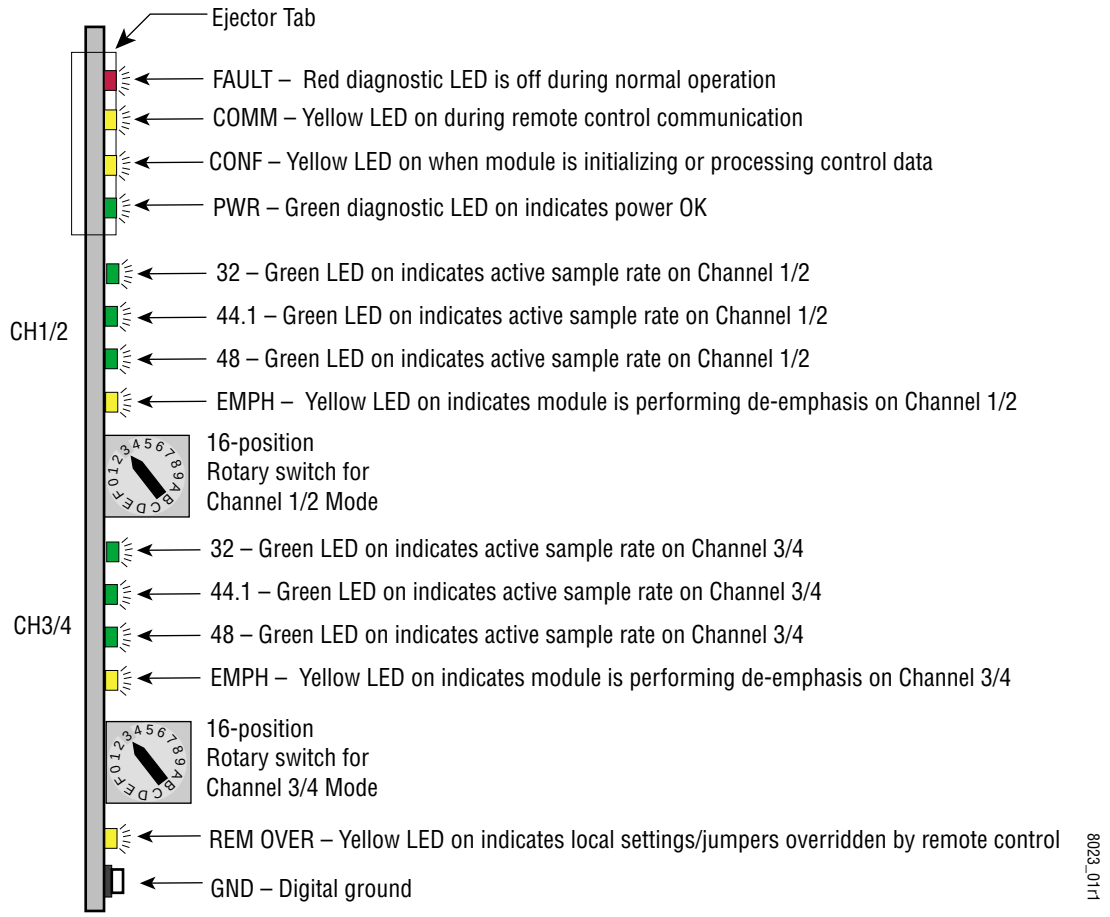
The front LED indicators and configuration switches are illustrated in Figure 6. Upon power-up, the green PWR LED should light and the yellow CONF LED should illuminate for the duration of module initialization.

Operation Indicator LEDs

With factory default configuration and a valid input signal connected, the green PWR LED should be on and the yellow REM OVER LED should be off (refer to Table 4 on page 7 to see a complete list of possible operating conditions and the resulting indicator status).

Audio input presence is indicated for both Channel 1/2 and Channel 3/4 by the 32, 44.1, or 48 green LEDs which indicate the corresponding input signal sample rate has been detected. Each channel also has a yellow EMPH LED to indicate when de-emphasis is being applied. The yellow REM OVER LED indicates that the on-board configuration jumpers and switch settings are being overridden by the remote control settings.

Figure 6. LEDs and Configuration Switches



A red FAULT LED indicates an error situation and, when noted with the other indicator LEDs, can indicate a specific problem area. Table 4 describes signal output and LED indications for the various input/reference combinations and user settings.

Table 4. Indicator LEDs and Conditions Indicated

LED	Indication	Condition
Fault (red)	Off	Normal operation
	On continuously	Module has detected internal fault
	Long flash	No input and the output is muted
	Short flash	Errors present in either or both received AES streams preventing reliable reception of data (including greater than 4% sample rate error)
COMM (yellow)	Off	No activity on frame communication bus
	Long flash	Location command received by the module from a remote control system
	Short flash	Activity present on the frame communication bus
CONF (yellow)	Off	Module is in normal operating mode
	On continuously	Module is initializing, changing operating modes or updating firmware. (When solid on along with Fault LED on, board has failed to load data.)
PWR (green)	Off	No power to module or module's DC/DC converter failed
	On continuously	Normal operation, module is powered
CH1/2 and CH3/4 32 (green)	Off	Sample rate is not near 32 kHz (off by more than 4%)
	On Continuously	Sample rate is 32 kHz ±400 ppm
	Flashing	Sample rate is 32 kHz ±4%
CH1/2 and CH3/4 44.1 (green)	Off	Sample rate is not near 44.1 kHz (off by more than 4%)
	On Continuously	Sample rate is 44.1 kHz ±400 ppm
	Flashing	Sample rate is 44.1 kHz ±4%
CH1/2 and CH3/4 48 (green)	Off	Sample rate is not near 48 kHz (off by more than 4%)
	On Continuously	Sample rate is 48 kHz ±400 ppm
	Flashing	Sample rate is 48 kHz ±4%
CH1/2 and CH3/4 EMPH (yellow)	Off	Module is not performing de-emphasis
	On continuously	Module is performing de-emphasis
REM OVR (yellow)	Off	Module configuration is through the module's on-board switches and jumpers
	On continuously	Module configuration is through remote control and on-board switches and jumpers are overridden

Note The 32, 44.1, and 48 kHz sample rate LEDs can all be out and the module can still output audio. The LEDs only show the three sample rates to within 4% of the nominal rate.

Configuration and Adjustments

Configuration and adjustment items for the 2020DAC include:

- Output mode – channel swapping, summing, or phase inversion,
- Control mode – Local/remote or local control only (remote lockout),
- Output gain levels– coarse and fine adjustment,
- 20-bit or 24-bit DAC mode, and
- Input select – balanced or unbalanced audio inputs.

The Control Mode, Output Gain, DAC modes and Input Select must be configured locally using onboard jumpers and switches. Output Mode can be set locally with the front rotary switch or can be configured remotely with the network interface.

Local On-board Module Configuration

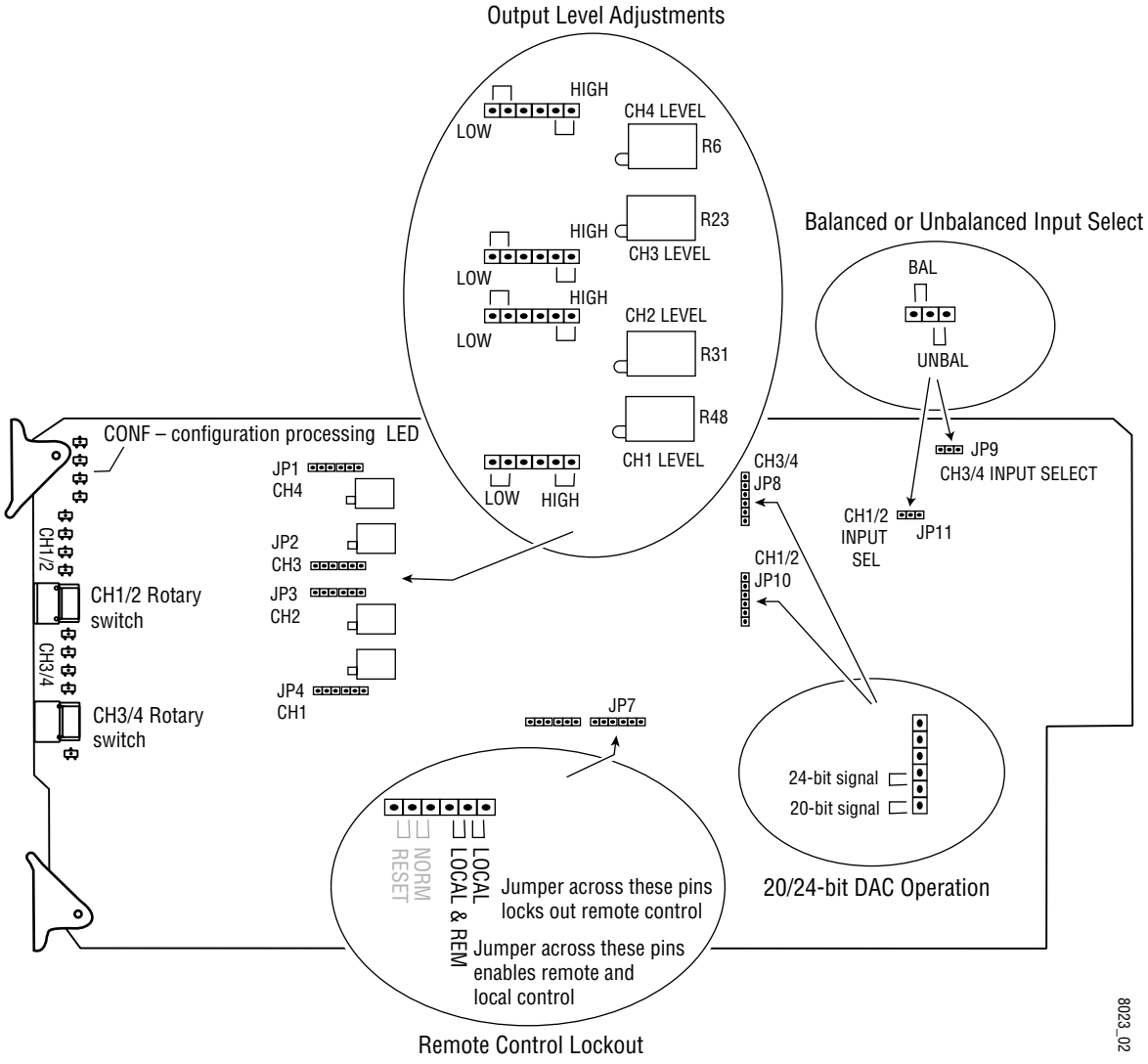
All 2020DAC module parameters can be configured locally using the jumpers and rotary switches described below and shown in Figure 7 on page 9. The CONF LED indicates status of the configuration process.

These components perform the following:

- Jumpers JP1 – JP4 set High/Low range of gain adjustment for each channel.
- Jumper JP7 sets control mode for Local only or Remote and Local.
- Jumpers JP8 and JP10 set the DAC mode to 20- or 24-bit.
- Jumpers JP9 and JP11 set the input selection of the module to balanced or unbalanced.
- Function (rotary) switches SW2 (CH1/2) and SW 2 (CH3/4) select the desired output configuration (0 through 9, A through F), although not all positions are used.
- CH1 – 4 LEVEL Potentiometers set the fine gain of each channel.
- CONF (configuring) LED, when on, indicates the module is initializing or processing configuration information.

Note Function switch positions 0 and F (Factory defaults) can be used to return the module configuration to the original factory settings.

Figure 7. 2020DAC Module Settings and Adjustments



Configuring Output Mode

The 2020DAC provides thirteen possible output configurations for each output channel, Channel 1/2 (L/R) and Channel 3/4 (L/R), as shown in Table 5. The module output channels can be configured using the corresponding rotary switches shown in Figure 7 on page 9. To make a configuration setting, simply rotate each switch to the desired output configuration. Each 16-position rotary switch selects one of 13 possible output modes. Positions B and C are not used and positions 0 and F select the same mode – Factory default.

Table 5. 2020DAC Output Mode Configurations

Switch Position	Mode Description
0	Factory default – No phase inversion, channel swapping or summing
1	Channel swap – Left and Right
2	Both channels phase inverted
3	Left channel phase inverted
4	Right channel phase inverted
5	Right channel to both channels
6	Left channel to both channels
7	Left + Right to both channels (-6dB mono sum)
8	Left - Right to both channels
9	Left + Right to Left channels and Left - Right to Right channel (-6dB, MS decode/encode)
A	Left + Right to both channels and both channels phase inverted
B	(not used, outputs digital silence)
C	(not used, outputs digital silence)
D	Tone 1 to all channels (Digital Silence)
E	Tone 2 to all channels (1 kHz, -20 dBFS)
F	Factory default – No phase inversion, channel swapping or summing

Table 6 provides the possible input and output conditions that result from different inputs and settings.

Table 6. Possible Operating Conditions

Audio Input Condition	Output Condition
Any AES-3id with sample rate between 32 kHz to 48 kHz	Audio will be present at any sample rate between the minimum and maximum rates
Any AES-3id with sample rate between 32 kHz to 48 kHz with Function Switch is set to E (1 kHz Tone)	1 kHz tone with frequency of tone accurate only at 32 kHz, 44.1 kHz or 48 kHz sample rates
No AES-3id input	Output muted, signal to noise level should be greater than or equal to maximum signal to noise level
No AES-3id input with Function Switch is set to E (1 kHz Tone)	No tone at output and output will be muted

Output Level Adjustments

The gain stage of each output channel CH1/2 (Left and Right) and CH3/4 (Left and Right) has two ranges of level adjustment—low and high (refer to Figure 7 on page 9).

The High/Low jumpers (J1 – 4) select the range of adjustment either:

- High range – 19 to 24 dBu, or
- Low range – 14 to 19 dBu.

Fine control within those ranges is set using the multi-turn potentiometers associated with each channel output providing ±3 dBu gain adjustment (do not exceed 24 dBu). This combination gives a maximum range for full-signal settings from +14 dBu to +24 dBu.

20/24-bit Operation

Jumper blocks JP8 (CH 3/4) and JP10 (CH1/2), pins 1 to 3, determine whether the DAC is in 24-bit or 20-bit mode (see Figure 7 on page 9).

- With the jumper across pins 1 and 2, the DAC is in 20-bit mode and will mask the lower four bits of information that are assumed to be non-audio data.
- With the jumper across pins 2 and 3, the DAC is in full 24-bit mode.

Input Select

Set jumper blocks JP11 (CH1/2 INPUT SEL) and JP9 (CH3/4 INPUT SEL) to unbalanced or balanced to match the type of audio being fed to the module.

- For unbalanced audio inputs (75 Ω BNC inputs), set each jumper block to UNBAL, pins 1 and 2 (see Figure 7 on page 9).
- For balanced audio inputs (110 Ω terminal blocks), set each jumper block to BAL, pins 2 and 3.

Remote Control Lockout

When a jumper is placed across pins 5 and 6 of jumper block JP7, module output mode settings are adjustable from the on-board switches only. To have both Local and Remote access, set the jumper across pins 4 and 5 (see Figure 7 on page 9).

Remote Configuration and Monitoring

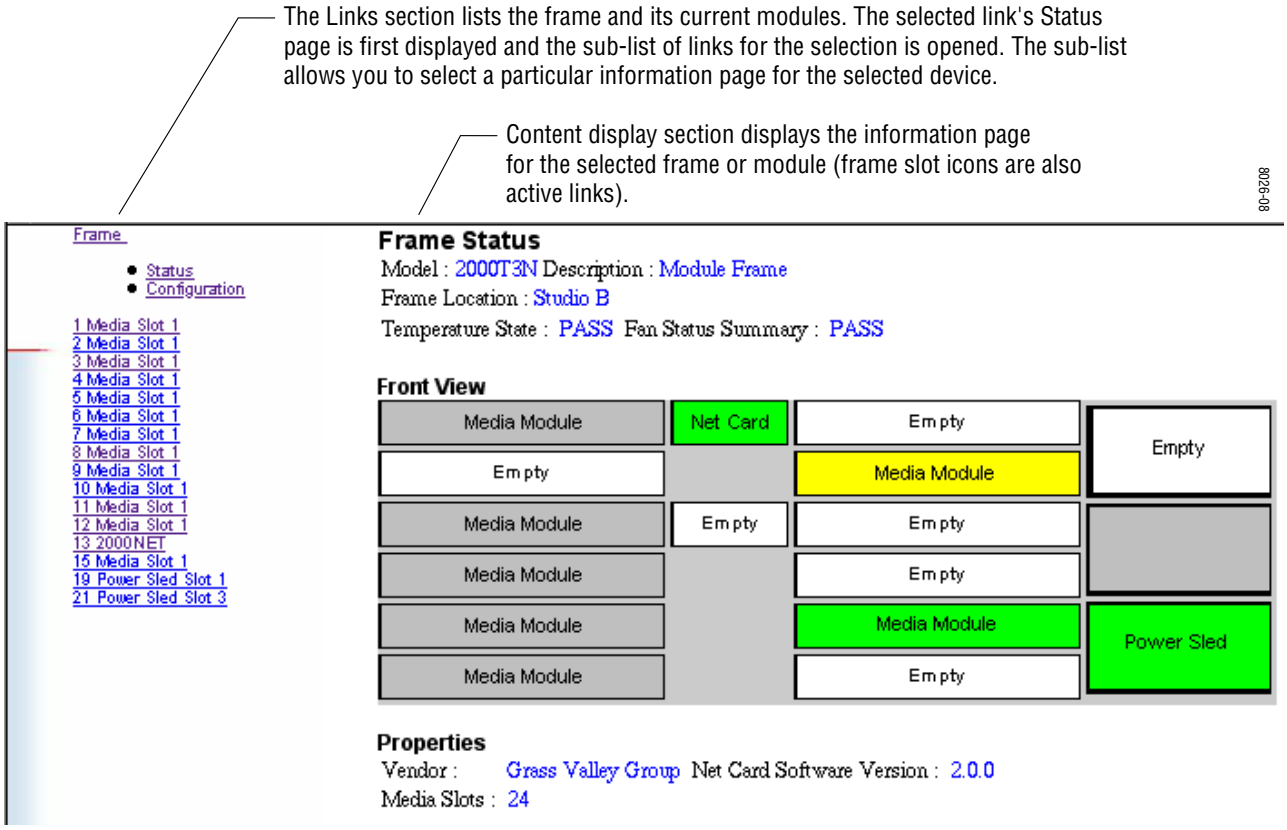
2020DAC configuration and monitoring can be performed remotely using the 2000NET interface (see Figure 8). This section describes the GUI access to the module configuration functions. Refer to the 2000NET Network Interface Module Instruction Manual for information on setting up and operating the 2000 frame network.

For remote access, make sure jumper block JP7 on the module is set for both Local and Remote access (Figure 7 on page 9).

Note The physical appearance of the menu displays shown in this manual represent the use of a particular platform, browser and version of 2000NET module software. They are provided for reference only. Displays will differ depending on the type of platform and browser you are using and the version of the 2000NET software installed in your system.

The 2000 modules can be addressed by clicking on a specific module icon in the frame status display or on a module name or slot number in the link list on the left.

Figure 8. 2000NET GUI



Module Configuration Displays

The 2000 GUI provides the following links and displays for the 2020DAC module (Figure 9):

- Module Configuration displays showing status and slot configuration information (location and user-assigned names),
- Ch 1/2 and Ch 3/4 Input Status/Output Mode displays, and
- Software Update display.

The Module Configuration displays operate in the same manner for all remote controllable 2000 modules. Refer to the 2000NET manual for more information on these displays. Some functions listed may not be supported by a particular module. These will be indicated as not supported.

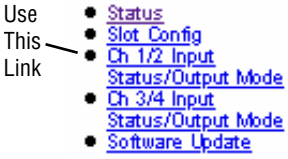
Figure 9. 2020DAC Display Links

Software Update Display

The Software Update display allows you to download new software versions for the module. Refer to the 2000NET manual and the Grass Valley Group web site at http://www.grassvalleygroup.com for complete details and new software versions.

Ch 1/2 and Ch 3/4 Input Status/Output Mode Displays

This section discusses the Ch 1/2 and Ch 3/4 Input Status /Output Mode displays available to set and monitor the 2020DAC module parameters remotely.



Ch 1/2 Input Status/Output Mode

The **CH 1/2 INPUT STATUS/OUTPUT MODE** display (Figure 10 on page 15) provides status reporting and output mode selection for Ch 1 and Ch 2.

Output level adjustments must be done using the on-board jumpers and gain controls described in *Output Level Adjustments on page 11*.

The following items will be reported under **CH 1/2 INPUT STATUS**:

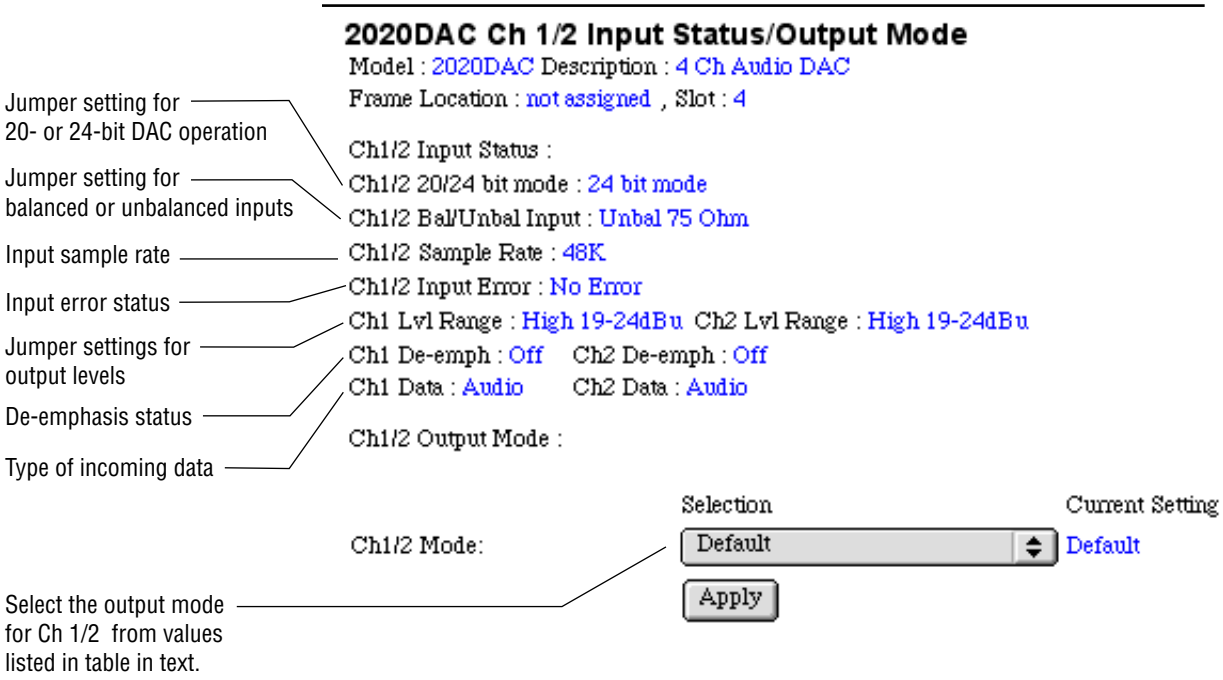
- **CH 1/2 20/24-BIT MODE** indicates whether Ch 1/2 are set for 20- or 24-bit operation at jumper J10 (CH 1/2) on the circuit board. (Refer to *20/24-bit Operation on page 11*.)
- **CH 1/2 BAL/UNBAL INPUT** indicates whether Ch 1/2 are set for balanced 110 Ω or unbalanced 75 Ω inputs at INPUT SEL jumper JP11 on the circuit board. (Refer to *Input Select on page 11*.)
- **CH 1/2 SAMPLE RATE** indicates the current input sample rate being detected by the module as one of the following: **OUT OF RANGE**, **32K**, **32K 4%**, **44.1K**, **44.1K 4%**, **44.056K**, **48K** or **48K 4%**.
- **CH 1/2 INPUT ERROR** indicates any input error conditions present as either **VALIDITY**, **CRC**, **PARITY**, **BI-PHASE**, **NO LOCK** or **NO ERROR.**
- **CH 1 AND CH 2 LVL RANGE** indicates whether Ch 1 and Ch 2 are set for **HIGH** (19-24 dBu) or **LOW** (14-19 dBu) level range at jumpers JP4 (CH 1) and JP3 (CH 2) on the circuit board. (Refer to *Output Level Adjustments on page 11*.)
- **CH 1 AND CH 2 DE-EMPH** indicates whether de-emphasis is being applied to Ch 1 or Ch 2 audio channel.
- **CH 1 AND CH 2 DATA** indicates type of incoming data (audio or non-audio) to Ch 1 and Ch 2 channels.

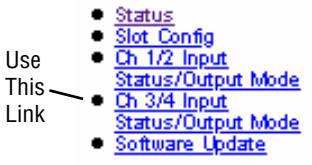
The **CH 1/2 OUTPUT MODE** display allows you to set the desired output mode of the module from the selections listed in Table 7. After making the selection, click the **APPLY** button to activate it.

Table 7. Ch 1/2 and Ch 3/4 Remote Control Output Modes

Mode Name	Mode Description
Default	Factory default with no phase inversion, channel swapping or summing.
L/R Swap	Swaps left and right channel outputs.
L/R Invert	Both left and right channel outputs phase inverted.
L Invert	Left channel output phase inverted.
R Invert	Right channel output phase inverted.
R Mono (R to L/R)	Right channel to both channel outputs.
L Mono (L to L/R)	Left channel to both channel outputs.
L plus R to L/R	Left plus right to both channel outputs.
L minus R to L/R	Left minus right to both channel outputs
L plus R, L minus R	Left plus right to left channel output and left minus right to right channel output.
(L plus R) Inv to L/R	Left plus right to both channel outputs with both channel outputs phase inverted.
AES Silence	AES silence on both left and right channel outputs.
1K@ -20dBFS	Tone to both channel outputs.

Figure 10. 2020ADC Ch1/2 Input Status/Output Mode





Ch 3/4 Input Status/Output Mode

The **CH 3/4 INPUT STATUS/OUTPUT MODE** display (Figure 11 on page 17) provides status reporting and output mode selection for Ch 3 and Ch 4.

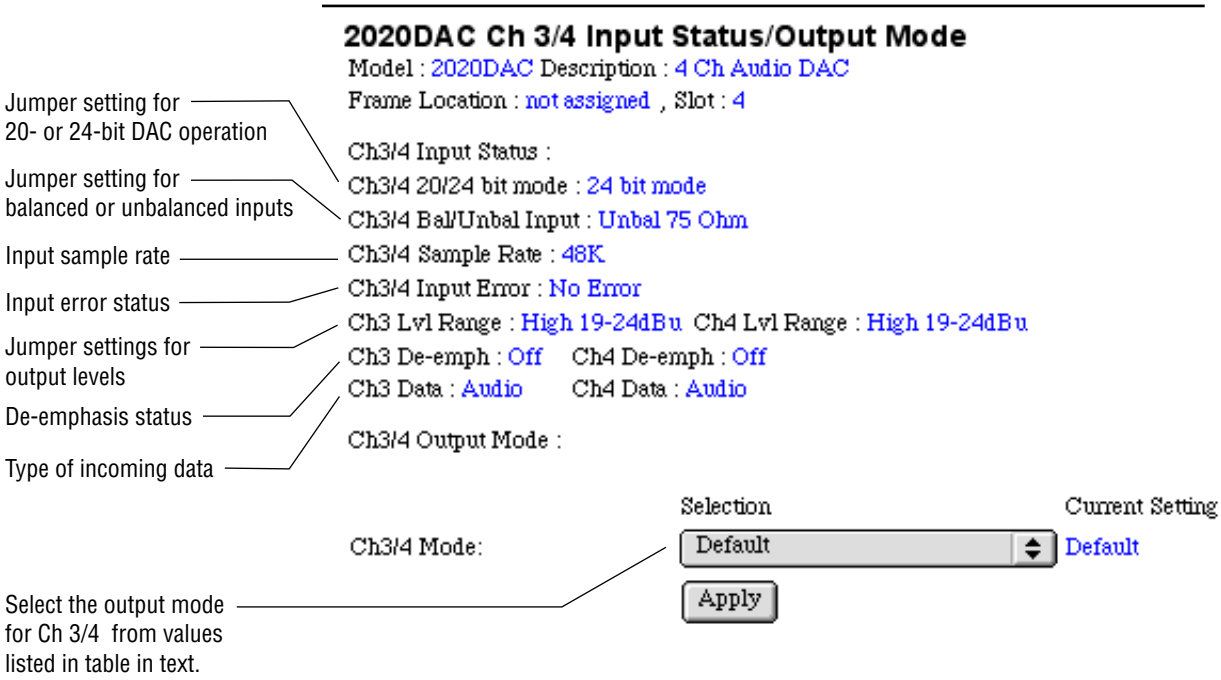
Output level adjustments must be done using the on-board jumpers and gain controls described in *Output Level Adjustments on page 11*.

The following items will be reported under **CH 3/4 INPUT STATUS**:

- **CH 3/4 20/24-BIT MODE** indicates whether Ch 3/4 are set for 20- or 24-bit operation at jumper J8 (Ch 3/4) on the circuit board. (Refer to *20/24-bit Operation on page 11*.)
- **CH 3/4 BAL/UNBAL INPUT** indicates whether Ch 3/4 are set for balanced 110 Ω or unbalanced 75 Ω inputs at the CH3/4 INPUT SEL jumper JP9 on the circuit board. (Refer to *Input Select on page 11*.)
- **CH 3/4 SAMPLE RATE** indicates the current input sample rate being detected by the module as one of the following: **OUT OF RANGE**, **32K**, **32K 4%**, **44.1K**, **44.1K 4%**, **44.056K**, **48K** or **48K 4%**.
- **CH 3/4 INPUT ERROR** indicates any input error conditions present as either **VALIDITY**, **CRC**, **PARITY**, **BI-PHASE**, **NO LOCK** or **NO ERROR**.
- **CH 3 AND CH 4 LVL RANGE** indicates whether Ch 3 and Ch 4 are set for **HIGH** (19-24 dBu) or **LOW** (14-19 dBu) level range at jumpers JP2 (CH 3) and JP1 (CH 4) on the circuit board. (Refer to *Output Level Adjustments on page 11*.)
- **CH 3 AND CH 4 DE-EMPH** indicates whether de-emphasis is being applied to Ch 3 or Ch 4 audio channel.
- **CH 3 AND CH 4 DATA** indicates type of incoming data (audio or non-audio) to Ch 3 and Ch 4 channels.

The **CH 3/4 OUTPUT MODE** display allows you to set the desired output mode of the module from the selections listed in Table 7 on page 15. After making the selection, click the **APPLY** button to activate it.

Figure 11. Ch 3/4 Input Status/Output Mode



Specifications

Table 8. 2020DAC Specifications

Parameter	Value
Digital Input	
Signal type	AES-3 ID (1992) 75 Ω and AES-3 balanced input 110 Ω (selectable)
Number of inputs	2 (CH 1/2 and CH 3/4)
Connector type	75 Ω BNC and 110 Ω terminal block
Common mode range	+20/-20V pk, DC–20 kHz
Differential voltage range	200 mV to 12 V p-p
Sampling rates	32 kHz, 44.1 kHz, 48 kHz
Input return loss	>15 dB (100 kHz to 10 MHz)
Maximum jitter	<200 ps RMS
Outputs	
Number of outputs	4 (CH 1-4 Left and Right)
Signal type	Balanced analog audio
Signal level for full-code input	+14 to +24 dBu max
Output impedance	50 Ω single-ended, 100 Ω differential
Connector type	Terminal block
Drive capability	+24 dBu into 10 k Ω
Performance (24 dBu into 10 kΩ load)	
Signal-to-noise ratio	>107 dB unweighted 22 kHz filter, >110 dB “A” weighted
THD+noise (20-22 kHz)	<0.005%, 22 kHz filter, +24 dBu/10 k Ω/7.5 nF
Interchannel crosstalk	<-100 dB, 20 Hz to 20 kHz
Intermodulation distortion	<0.006%, CCIF two-tone test, 19 kHz and 20 kHz tones
Frequency response	±0.1 dB, 20 Hz to 20 kHz
DC offset	<± 50 mV
De-emphasis	50/15 µsec, automatic
Electrical length	650 µS
Environmental	
Frame temperature range	0 to 45 ° C
Operating humidity range	10 to 90% non-condensing
Non-operating temperature	-10 to 70 ° C
Mechanical	
Frame type	2000 Series
Power Requirements	
Supply voltage	+24 V
Power consumption	< 6 Watts

Service

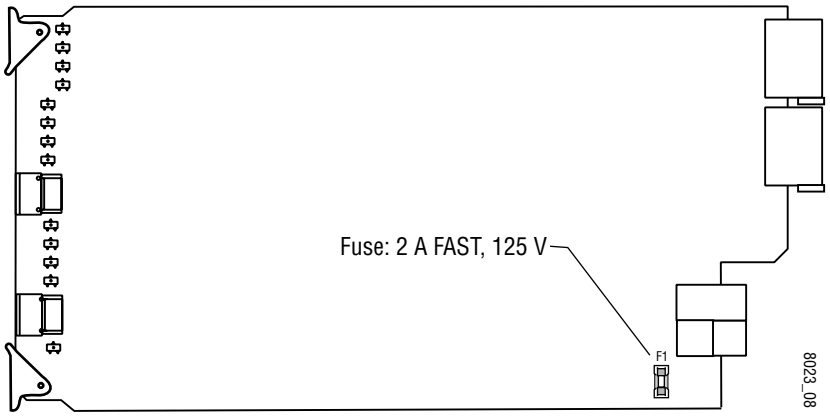
The 2020DAC modules make extensive use of surface-mount technology and programmed parts to achieve compact size and adherence to demanding technical specifications. Circuit modules should not be serviced in the field.

Troubleshooting

If your module is not operating correctly, proceed as follows:

- Check frame and module power. If power is not present, check the fuse on the +24 V input to the module as illustrated in Figure 12.
- Check for presence and quality of input signals.
- Verify that source equipment is operating correctly.
- Check cable connections.

Figure 12. Location of Module Fuse



Refer to Figure 6 on page 6 for the location of PWR LED and Table 4 on page 7 for proper LED indications.

If the module is still not operating correctly, replace it with a known good spare and return the faulty module to a designated Grass Valley repair depot. Call your Grass Valley representative for depot location.

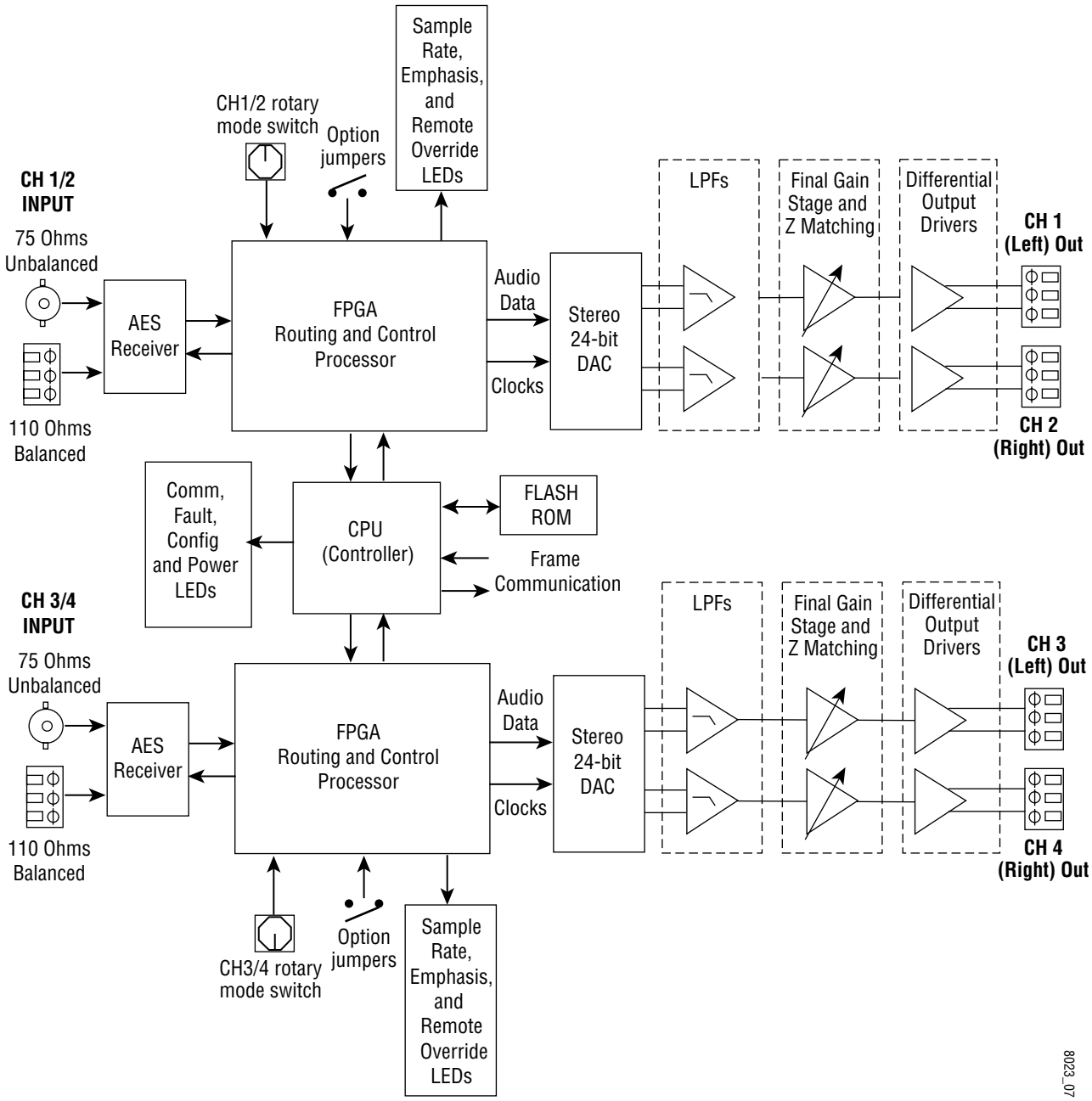
Refer to the *Contacting Grass Valley Group* at the front of this document for the Grass Valley Customer Support Information number. Check the Grass Valley Group web site at http://www.grassvalleygroup.com for further information on modular products.

Functional Description

Refer to the block diagram in Figure 13 while reading the following functional description.

Note As both CH 1/2 and CH 3/4 pairs are identical, only one channel description is provided.

Figure 13. 2020DAC Block Diagram



Digital Input

Either the balanced or unbalanced AES audio data is fed into the 2020DAC through an isolation transformer to the receiver. The receiver extracts the audio signal (left/right), as well as clock (bit clock, L/R clock and master clock), sample rate, emphasis and error information. The signal, clock and other decoded information is then passed to a FPGA (field-programmable gate array) for further decoding and routing.

Control and Routing FPGA

The FPGA receives its programming and control information from the CPU at power up. It also receives one of 16 output mode commands from a four-bit rotary switch and the jumper configuration information. (Currently only 13 of the settings are used.) The FPGA receives an AES stream from the receiver and sends its outputs to the output DAC. The FPGA also performs the following functions:

- Decodes and drives the front panel LEDs,
- Passes clock and audio information to the DAC for analog decoding,
- Enables the appropriate emphasis filter for both channels for the received sample rate on the DAC, and
- Enables a soft mute that ramps up/down in about 20 ms (depending on sample rate).

CPU (Controller)

The primary purpose of the CPU is to provide remote monitoring capability and local control for the 2020DAC. It receives information about:

- Sample rate,
- Emphasis,
- Error,
- Mode selection
- Digital signal present, and
- Output Level Range.

This information is passed through the frame controller to a remote monitoring location. A removable jumper is provided to allow disabling of remote control.

The CPU configures the FPGA during boot-up. It also downloads software updates as described in the 8900NET Module manual.

Digital/Analog Converter (DAC), Filter, Gain, and Output Stages

The DAC consists of a single, stereo, 24-bit, 128x over-sampling DAC. The outputs of the DACs are differential in nature. They are received by a differential receiver, which also serves as a Low Pass Filter (LPF). The signal then passes through to the gain stage, where gain can be adjusted per channel, then on to differential output drivers and then to terminal block outputs.

The output drivers provide precision signal balance and output common mode rejection.

Regulator

The 2020DAC's power is fed from +24 V from the frame's switching power supply. DC comes into the module, is fused, and then is converted into analog and digital voltage supplies.

Each stage of the DAC receives its own separate, highly regulated and filtered power source. The following power feeds are produced:

- Digital +5 V for microcontroller,
- Digital +3.3 V for FPGA, DAC and other digital sections,
- Analog ±10 V for filter and differential receiver stage, and
- Analog ±15 V for final gain and driver stage.

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