

AKDAC-3 Audio Evaluation Board

Features

- Audio Evaluation for AKDesign Audio DAC Module.
- Digital audio inputs: AES/EBU, S/PDIF, TOSLink, USB, I2S.
- DSD support up to 11.2MHz on USB input, up to 5.6MHz on all other inputs
- USB and I2S inputs support PCM sample rates up to 384kHz.
- Balanced and un-balanced connectors for analog line-stage audio outputs from DAC module.
- Independent connectors for pre-line stage outputs from DAC module.
- Simple local user interface to allow standalone operation.
- Customizable connectors for front panel.
- External control via I2C.
- Digital Supply: 7-9V
- Analog supply: +/- 12V or +/- 15V
- A unique feature allows any external audio file player to update the firmware of the AKDAC-3 or ADM by simply playing a specially formatted wave file into the USB port.

General Description

The AKDAC-3 is designed as a motherboard for the AKDesign Audio DAC Module (ADM). It provides all the necessary I/O connectors, interface receivers and control processing to either integrate it into existing designs or use it as a complete standalone DAC solution.

Balanced and unbalanced connectors are provided for the analog line stage outputs. Internal connectors are provided for the pre-line stage outputs from the DAC module.

Additional multi-pin connectors with programmable signals are provided for integration into larger systems that require custom software adaptations.

The AKDAC-3 board incorporates additional power conditioners for improved ripple rejection before supplying the analog section of the ADM.

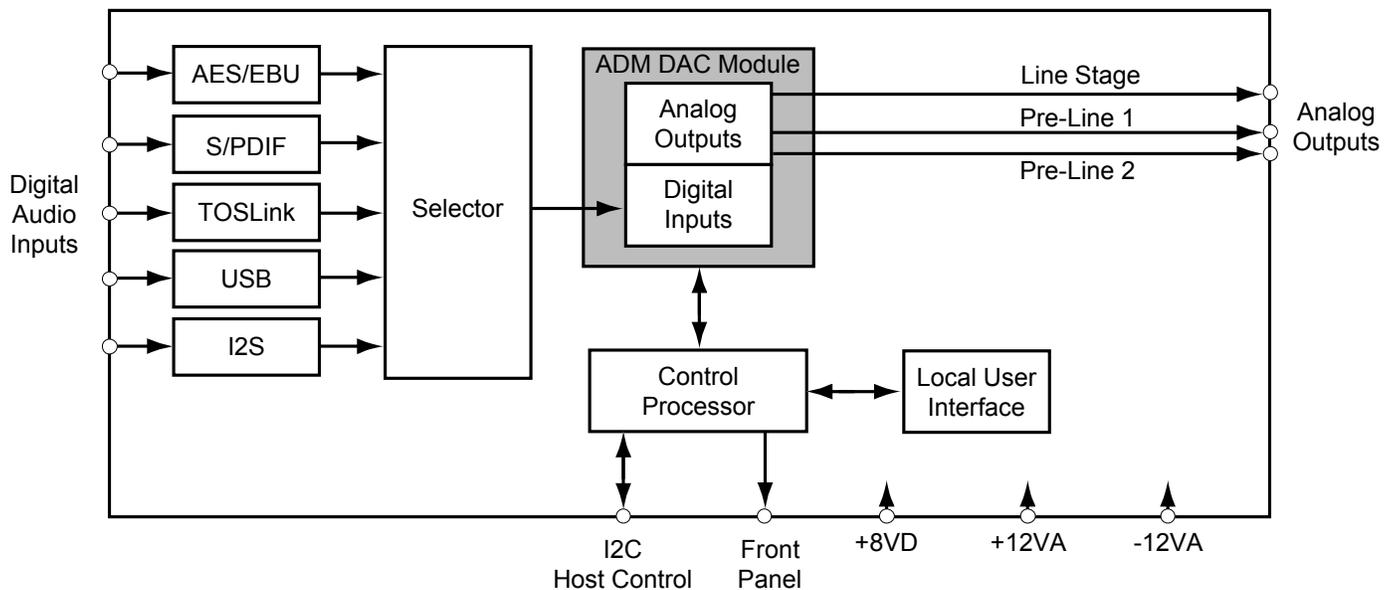


Figure 1

Connectors

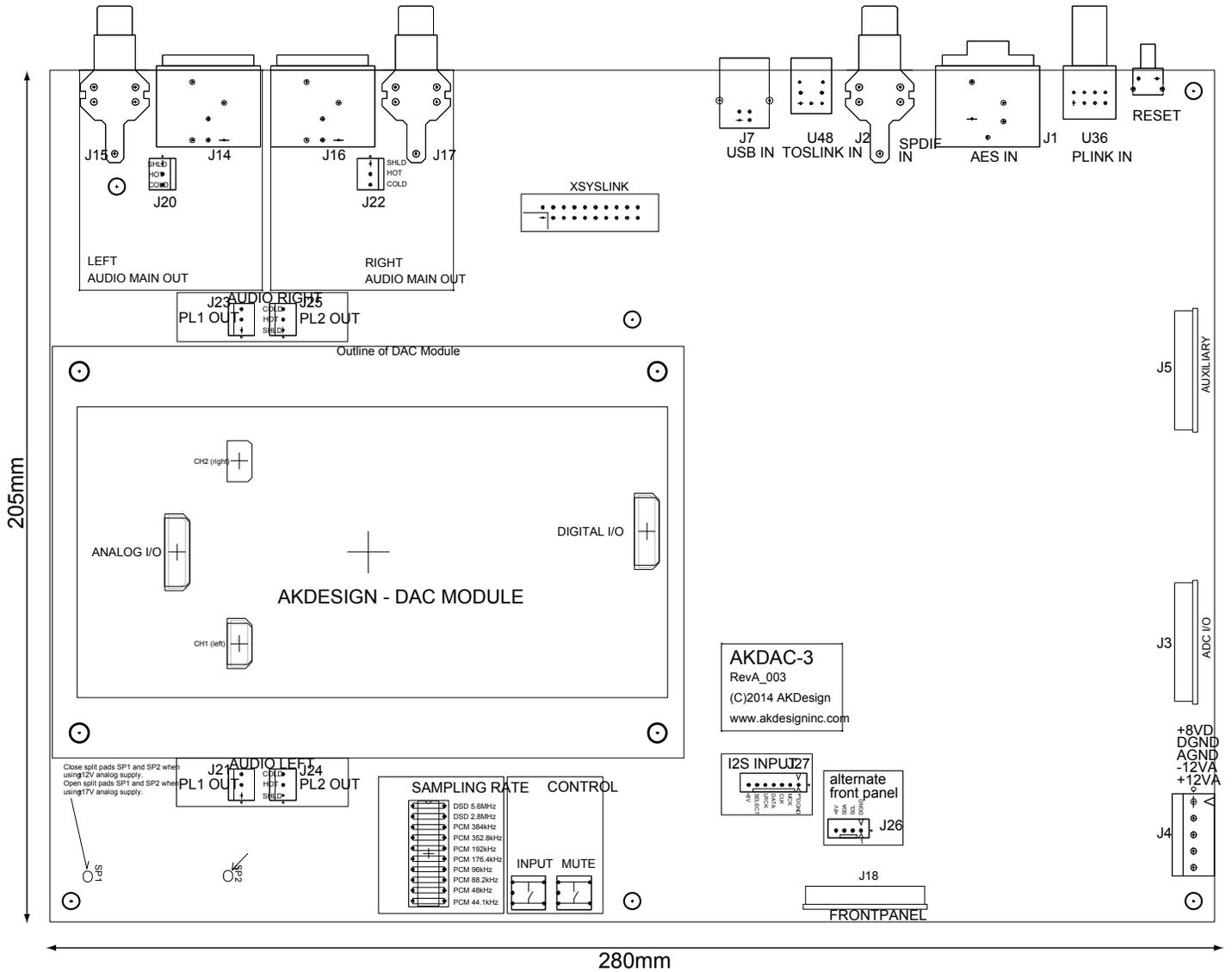


Figure 2

J4 Power Connector

Connector type: Molex 26-60-4050
 Mating connector type: Molex 09-50-7051
 Pins: Molex 08-50-0106

Pin	Signal	Direction	Description
1	VD		+8Volt digital supply, 1A max.
2	DGND		Digital Ground
3	AGND		Analog Ground
4	VA_N		-12Volt analog supply, 200mA max. (-15V when using additional on-board regulators)
5	VA_P		+12Volt analog supply, 200mA max. (+15V when using additional on-board regulators)

J27 I2S connector

Connector type: JST B7B-PH-K-S
 Mating connector type: JST PHR-7
 Pins: JST SPH-002T-P0.5S
 All signal levels are TTL compatible, referenced to 3.3V and **no signal input is 5V tolerant.**

Pin	Signal	Direction	Description
1	VD		
2	MCK_OUT	out	512FS master clock output
3	BCK	in	I2S bit clock
4	PCMLR	in	I2S data (PCM left / right)
5	LRCK	in	I2S L/R word clock
6	SEL_44_I2S	in	44/48 base frequency select (high selects 44.1kHz oscillator)
7	GND		Ground

J26 I2C Front Panel Host Bus Connector

Connector type: JST B4B-PH-K-S
 Mating connector type: JST PHR-4
 Pins: JST SPH-002T-P0.5S
 All signal levels are TTL compatible, referenced to 3.3V and **no signal input is 5V tolerant.**

Pin	Signal	Direction	Description
1	GND		Ground
2	FP_HOST_SCL	in	I2C Clock (pulled up to 3V3 on board)
3	FP_HOST_SDA	inout	I2C Data (pulled up to 3V3 on board)
4	VD	out	+8V digital supply

J21 Pre-Line 1 Analog Output (PL1) Connector for Left Channel

Connector type: Molex 22-11-2032
 This connector provides the direct pre-line stage 1 outputs from the ADM.

Pin	Signal	Direction	Description
1	AGND		Analog GND
2	PL1_AUDIO_L+	out	Analog audio output after 1 st filter before line stage, left channel +, (voltage source)

3	PL1_AUDIO_L-	out	Analog audio output after 1 st filter before line stage, left channel -, (voltage source)
---	--------------	-----	--

J23 Pre-Line 1 Analog Output (PL1) Connector for Right Channel

Connector type: Molex 22-11-2032

This connector provides the direct pre-line stage 1 outputs from the ADM.

Pin	Signal	Direction	Description
1	AGND		Analog GND
2	PL1_AUDIO_R+	out	Analog audio output after 1 st filter before line stage, right channel +, (voltage source)
3	PL1_AUDIO_R-	out	Analog audio output after 1 st filter before line stage, right channel -, (voltage source)

J24 Pre-Line 2 Analog Output (PL2) Connector for Left Channel

Connector type: Molex 22-11-2032

This connector provides the direct pre-line stage 2 outputs from the ADM.

Pin	Signal	Direction	Description
1	AGND		Analog GND
2	PL2_AUDIO_L+	out	Analog audio output after 2 nd filter before line stage, left channel +, (voltage source)
3	PL2_AUDIO_L-	out	Analog audio output after 2 nd filter before line stage, left channel -, (voltage source)

J25 Pre-Line 2 Analog Output (PL2) Connector for Right Channel

Connector type: Molex 22-11-2032

This connector provides the direct pre-line stage 2 outputs from the ADM.

Pin	Signal	Direction	Description
1	AGND		Analog GND
2	PL2_AUDIO_R+	out	Analog audio output after 2 nd filter before line stage, right channel +, (voltage source)
3	PL2_AUDIO_R-	out	Analog audio output after 2 nd filter before line stage, right channel -, (voltage source)

J18 Front Panel Connector

Connector type: FCI SFW24R-2STE1LF, 1mm 24 position FFC

Pin	Signal	Direction	Description
1	VD	out	Digital supply voltage
2	VD	out	Digital supply voltage
3	VD	out	Digital supply voltage
4	GND		
5	FP_INT	in	Interrupt signal from key decoder (customizable)
6	GND		
7	FP_HOST_SDA	inout	I2C Data (pulled up to 3V3 on board)
8	GND		
9	FP_HOST_SCL	in	I2C Clock (pulled up to 3V3 on board)
10	GND		
11	FP_IROUT	in	Infrared remote receiver output signal (customizable)

12	GND		
13	CUSTOM_0	inout	Customizable signal
14	GND		
15	CUSTOM_1	inout	Customizable signal
16	GND		
17	CUSTOM_2	inout	Customizable signal
18	GND		
19	CUSTOM_3	inout	Customizable signal
20	GND		
21	CUSTOM_4	inout	Customizable signal
22	CUSTOM_5	inout	Customizable signal
23	CUSTOM_6	inout	Customizable signal
24	xINIT	out	Reset signal (active low)

J3 General Purpose Customizable Connector

Connector type: FCI SFW24R-1STE1LF, 1mm 24 position FFC

Pin	Signal	Direction	Description
1,3,5,7,9,11,13,15,17,19,21,23	GND		
2,4,6,8,10,12,14,16,18,20,22,24	BRD_INTCON	inout	Customizable signals

J5 General Purpose Customizable Connector

Connector type: FCI SFW24R-2STE1LF, 1mm 24 position FFC

Pin	Signal	Direction	Description
1,7,13,18,24	GND		
2-6, 8-10, 14-17, 19-23	ADC_INTCON	inout	Customizable signals
11,12	ADC_INTCON	in	Customizable signals

Digital and Analog Audio Connectors

Loc.	Type	Direction	Description
J15	RCA	out	Unbalanced left analog audio output after line stage
J14	XLR	out	Balanced left analog audio output after line stage
J17	RCA	out	Unbalanced right analog audio output after line stage
J16	XLR	out	Balanced right analog audio output after line stage
J7	USB Type B	in	Digital audio input, PCM up to 24 bits / 384kHz, DSD up to 12.2MHz
U48	TOSLink	in	Digital audio input, up to 24 bits / 96kHz
J1	XLR	in	AES/EBU digital audio input, up to 24 bits / 192kHz, DSD via DoP
J2	RCA	in	S/PDIF (coax) digital audio input, up to 24 bits / 192kHz, DSD via DoP
U36	ST Optical	in	PLINK receiver

RECOMMENDED OPERATING CONDITIONS

Description	Symbol	Min.	Typ.	Max.	Units
Digital power supply	VD	+7	+8	+10	V
Ramp up time from GND to VD	VD			100	ms
Positive analog power supply (12V operation SP1, SP2 closed)	VA_P	+11	+12	13	V
Negative analog power supply (12V operation SP1, SP2 closed)	VA_N	-11	-12	-13	V
Positive analog power supply (15V operation SP1, SP2 open)	VA_P	+14	+15	16	V
Negative analog power supply (15V operation SP1, SP2 open)	VA_N	-14	-15	-16	V
Digital supply current	I _{VD}		600	900	mA
Analog supply current VA_P	I _{VA_P}		150	200	mA
Analog supply current VA_N	I _{VA_N}		150	200	mA
Ambient temperature	T _A	-10		+45	°C

SWITCHING CHARACTERISTICS

Description	Min.	Typ.	Max.	Units
Duty cycle of digital audio input signals (AES/EBU formatted only)		50/50		%
Front Panel Host I2C Bus				
SCL Clock Frequency			100	kHz
SDA setup time before postive edge of SCL	100			ns
SDA hold time after negative edge of SCL		0		ns

GENERAL DESCRIPTION

The AEB provides several digital inputs for PCM and DSD sources, such as USB, AES/EBU, I2S etc. An on-board processor selects these signals, communicates with the host, provides a local user interface for stand-alone operation and controls the ADM module.

Analog outputs

The ADM module generates 3 different analog output signals which can all be accessed on the AKDAC-3 via dedicated connectors (see data sheet of ADM for more details):

1. after line stage of ADM, accessible via XLR and RCA connectors. These signals can directly drive a cable into a standard pre-amplifier.
2. PL1 signals, after first output filter and before line stage of ADM module for external amplification to line level. These signals are accessible via the internal J21, J23 connectors.
3. PL2 signals, after second output filter and before line stage of ADM module for external amplification to line. These signals are accessible via the internal J24, J25 connectors.

The ADM module must be configured according to the intended analog output (see data sheet for ADM).

All line stage outputs are muted directly by the ADM via relays on the AKDAC-3 when necessary. No output muting is provided for the pre-line stage outputs.

Digital audio inputs

There are 5 digital audio inputs:

1. AES/EBU for up to 24 bits / 192kHz
2. S/PDIF for up to 24 bits / 192kHz
3. Toslink for up to 24 bits / 96kHz
4. I2S for 24 bits PCM up to 384kHz and DSD up to 11.2MHz. This interface is designed to operate in clock master mode and, therefore, provides a 512FS master clock output on the connector J27. The external digital source can control the fundamental sample rate (44.1 or 48kHz base frequency) with the SEL_44_I2S signal.
This input can also be configured to operate in clock slave mode. Please inquire at AKDesign directly for customization options.
5. USB for 24 bits PCM up to 384kHz and DSD up to 5.6MHz. This interface conforms to USB Audio Specification 2.0 and does not require

driver software for Mac OS or Linux. For Windows a driver is supplied by AKDesign.

DSD is supported on USB via 2 mechanisms:

1. DoP for all platforms (DoP stands for DSD-over-PCM and uses standard PCM frames that are filled with raw DSD data)
2. ASIO on Windows platforms

Custom PID, VID numbers and corresponding strings can be programmed into the firmware of the AKDAC-3 for those clients who wish to use their own company branded product name and driver software.

All input interfaces support PCM sample rates up to 192kHz and DSD up to 2.8MHz. Higher sample rates are supported for USB and I2S interfaces, but only in clock master mode (see ADM data sheet for more details).

The AKDAC-3 can be customized with additional inputs via its auxiliary and ADC inputs and outputs. Please inquire at AKDesign directly for customization options.

Local User Interface

For standalone operation a simple user interface is provided right on the AKDAC-3 board. The digital audio input can be selected with the INPUT toggle button. Only the USB and I2S inputs support 8FS PCM and DSD 2x inputs, and they can only be used in clock master mode (see data sheet for ADM for more details). The detected sample rate on the selected digital audio input is displayed on a bar graph. The following sample rates are indicated:

- 10 bars lit: DSD 2x
- 9 bars lit: DSD 1x
- 8 bars lit: 384kHz
- 7 bars lit: 352.8kHz
- 6 bars lit: 192kHz
- 5 bars lit: 176.4kHz
- 4 bars lit: 96kHz
- 3 bars lit: 88.2kHz
- 2 bars lit: 48kHz
- 1 bar lit: 44.1kHz
- No bar lit: no lock, no valid signal detected

The MUTE toggle button can be used to mute all audio outputs. The blue LED indicating the selected input will blink when audio is muted.

The RESET button serves to reset the USB interface and the main control processor.

Firmware update

From time to time AKDesign may make a special wave file available that contains a firmware update for the AKDAC-3 or the ADM. It can be played into the AKDAC-3 as a regular audio file via its USB interface. Update files for the ADM can be played into the AKDAC-3 via any digital input. No audio will be audible during this operation. A power cycle will be necessary after completion of this operation in order to load the new program into active memory.

While playing this special wave file into the AKDAC-3 or ADM the internal flash memory is erased, reprogrammed and verified. It is therefore vital that the process is not interrupted once it is started until the very end. The PrgrStat signals (see I2C bus definitions) indicate the status during programming. If the status signals indicate an error at the end the process can be restarted by first applying a reset to the AKDAC-3 (RESET button) and then restarting the process again from the beginning. Under no circumstances should the power be turned off after an error occurred during programming or else the AKDAC-3 or ADM will not be able to boot.

See section I2C bus definitions for more information.

For applications that do not provide an external user interface via I2C, the local on-board bar graph display indicates the status during flash programming:

- running bars indicate flash programming in progress
- all 10 bars flashing indicate that an error occurred. Reset and board and start the programming sequence again. Do not power cycle!

Connectors with customizable signals

Connectors J3, J5, J18 carry signals that can be fully customized according to customer's application. Standard configuration for J18 is to carry the same I2C bus as already implemented on J26. In addition on J18 there is a signal input for a IR receiver - standard format implementation is RC6, and an input for a signal as it is typically used for key decoders.

If any of these signals on these connectors is not used it should be left unconnected and floating.

Power for analog section

While the ADM has built-in voltage regulators with very good ripple rejection, the AKDAC-3 board features an additional set of voltage regulators that can be used in series. In order to make use of this additional step in regulation the VA input voltage needs to be raised from +/-12V to +/-15V and split pads SP1 and SP2 need to be open. When operating with the nominal VA supply

voltage for the ADM (+/-12V), then SP1 and SP2 need to be closed.

On-board LED indicators

LED20: on when clock circuitry is operating properly.

LED21: currently not used.

LED22: currently not used.

LED23: currently not used.

Driver Software for USB interface

No driver software is required for the Mac OS and Linux platforms as the USB implementation is USB Audio Class 2.0 compliant. For the Windows platform AKDesign offers a free driver software. For a fee it can be customized with your company name, product name and VID/PID.

I2C HOST BUS DEFINITIONS

The AKDAC-3 can be controlled by an external host processor via I2C. The address of the board on the bus is: b0001101 and the AKDAC-3 is a bus slave.

Register write transfers always consist of 2 bytes: the first byte selects the register address and the second byte will be written into the data register pointed out by the first byte.

In order to read a register, a 1-byte write transfer has to be done first to set the register address. A second 1-byte read transfer will then read the register contents. If the same register is read multiple times no repeated write transfer will be necessary as the register address is memorized until changed.

Register Descriptions

Input Selection (address 00000001)

7	6	5	4	3	2	1	0
reserved	reserved	reserved	reserved	SEL_In(3)	SEL_In(2)	SEL_In(1)	SEL_In(0)
				read/write	read/write	read/write	read/write

SEL_In: These 4 bits select 1 of the 8 possible digital inputs on the evaluation board:

- 0000 0000: USB input
- 0000 0001: TosLink input (optical connector)
- 0000 0010: S/PDIF input (RCA connector)
- 0000 0011: AES input (XLR connector)
- 0000 0100: PLink input
- 0000 0101: Aux input
- 0000 0110: A/D input
- 0000 0111: I2S input

The last selection before power-down is memorized and activated after the next power-up.

Audio Status (address 00000010)

7	6	5	4	3	2	1	0
STATE(3)	STATE(2)	STATE (1)	STATE (0)	reserved	MUTE	PrgrStat1	PrgrStat0
read-only	read-only	read-only	read-only		read/write	read-only	read-only

The 4-bit STATE word indicates the detected sample rate:

- 0000: no lock, no signal
- 0001: 44.1kHz
- 0010: 48kHz
- 0011: 88.2kHz
- 0100: 96kHz
- 0101: 176.4kHz
- 0110: 192kHz
- 1001: 352.8kHz
- 1010: 384kHz
- 0111: DSD
- 1000: DSD 2X
- 1011: DSD 4X

MUTE: This bit can be set to 1 by the host to mute all analog audio outputs.
A zero unmutes the outputs.

The 2 PgrStat bits indicate the status of the flash during programming, either for the AKDAC-3 or the ADM depending on what update file is being played into the DAC:

00: normal operation

01: flash is being programmed (do not attempt any setup change or communication while this mode is active). From time to time AKDesign may make a special wave file available that contains a firmware update for either the ADM or AKDAC-3. These files can be played as regular audio files. The update file for the AKDAC-3 can only be played into it via its USB interface while update files for the ADM can be played into the AKDAC-3 via any of its audio inputs. No audio will be audible during this operation. A power cycle will be necessary after completion of this operation in order to load the new program into active memory.

1x: an error occurred during the flash verification cycle. This condition can only be cleared with the RESET button. If the power supply to the AKDAC-3 is not turned off the old firmware is still active at this point. Therefore, a new firmware programming cycle should be started immediately after first asserting RESET without turning off the power.

Software Revision of AKDAC-3 Module (address 00000100)

7	6	5	4	3	2	1	0
bit7	bit6	bit5	bit4	bit3	bit2	bit1	bit0
read-only							

Indicates software revision of AKDAC-3 board in binary.

Software Revision of ADM Module (address 00000101)

7	6	5	4	3	2	1	0
bit7	bit6	bit5	bit4	bit3	bit2	bit1	bit0
read-only							

Indicates software revision of ADM module in binary.

Temperature (address 00000110)

7	6	5	4	3	2	1	0
bit7	bit6	bit5	bit4	bit3	bit2	bit1	bit0
read-only							

Indicates temperature of ADM module in Celsius. Format is 2's complement ranging from -128 to +127 degrees.

Grounding Considerations

Three different grounds exist on the AKDAC-3:

- Digital ground for all digital circuitry
- Analog ground for all analog circuitry
- Chassis ground for mounting holes and case of analog XLR output connectors

By default none of the grounds are connected to each other, but split pads exist to connect them easily. Depending on the external power supply used it may be necessary to close the split pad SP16 (bottom side of PCB) which connects analog and digital grounds, rather than connecting them near the power supply. A separate split pad SP3 to connect analog and chassis grounds is located on the bottom side of the PCB right below the power connector J4.

REVISION HISTORY

2014/07/18	Release of document