Momentum Data Systems DAE-8 series modules provide a high performance off-the-shelf audio processing solution for OEMs and system integrators needing a low cost, quick time to market solution.

The DAE-82 module offers up to 20 I\(^2\)S ports, allowing the mixed signal portions to be selected to meet the exact system requirements. The DAE-82 is based on Texas Instruments (TI) DA810, which is functionally similar to TI's C674x floating point DSP devices.

The DAE-82 can also be used with MDS HDMI switcher/repeater products, which range from a 1:1 repeater with OSD through a 8:2 switch.

By using MDS' audio and HDMI modules system designers can quickly implement the common functions needed of all AV Receivers and focus on the unique aspects of their products.

A key aspect of any complex system is the software. All of MDS' HDMI and DAE audio modules use a simple messaging interface to control their operation. The DAE-82 module include a host-side API that simplifies the setup of common AVR operations.

For OEMs and integrators needing assistance with analog, system or software design, MDS' Audio Services Group can provide design services ranging from consulting through complete product design.

**AVR decoder firmware**

Combined with that hardware platform is firmware that enables certain specific processing features that are common to AV Receivers (AVRs, which for these products also includes Pre-Processor or Pre-Pro applications).

In the nomenclature of the TI DSP devices used on the DAE-82, the overall software environment is called the Performance Audio Framework (PA/F). This environment creates a framework for using functional modules (decoders, filters, etc.) in a flow graph style connection, with support for the control and exception processing needed in AVR applications.

The individual functions - audio signal processor (ASP) blocks - are configured together into standard inter-connections. MDS offers specific configurations of ASPs, both standard ones like Dolby or DTS decoders or custom ones like the Clip/Level Indicator.

A common set of core functionality is built up from a unique topology of available decoders and ASPs. Not all functions are available in all configurations and the topology may have different features.

There are a number of optional ASPs that offer functionality from 3rd parties, for example THX or Dolby Volume.

When an DAE-82 is ordered, it is assigned a 4 digit order code that both defines the hardware and the firmware configuration (i.e. the decoder, ASPs and their topology) that go with it. Unless noted otherwise, the descriptions in this datasheet refers to the firmware in a generic sense and not a specific combination of features.

**Decoder and post processing firmware**

The following standard TI audio signal processing (ASP) functions are provided in the DAE-82's firmware. Note that patent holder license agreements are required for access and/or use of many of these ASPs.

The next two figures illustrate a common configuration of the ASPs on DAE-8 systems. Not shown in these diagrams are the control paths from the host and the automatic actions that can occur. For example a system that is receiving a stereo DTS encoded data stream and using Neo for creating a multichannel output will by default start using PLIIx if the input stream switches to Dolby.

On single DSP systems a SRC (Sample Rate Conversion) function is used to keep the decoded output, which can be up to 192 kHz sample rate, to 48 kHz or less in the primary path.

On single DSP systems the back-end processing is 7.1 (at up to 48 kHz), though this does include traditional 5.1 plus two height channels when using PLIIz.

Note that the GEQ, and LOU use the same ASP block, it is instantiated with different parameters. On single DSP systems only one of GEQ or PEQ would typically be used.

The tone control (TC) has selectable frequencies for low and high and wide range of cut or boost levels.
Standard TI provided decoders and matrixing
- Dolby® TrueHD, Dolby® Digital Plus, Dolby® Digital EX, Dolby® Pro Logic® IIxz
- DTS-HD™, DTS-ES 96/24™, DTS Neo:6™, DTS® 5.1
- AAC decode (ISO/IEC 13818-7:1997 5.1.0.0)

Standard TI ASPs
- BM - Bass Management II (per speaker bass management, 0, 1, or 2 subs) (1 sub on DAE-82 standard configurations).
- RVB - TI Room Simulator Library
- GEQ - TI Filter Library (configured for 8 bands/chan, common coefficient)
- TI processor loading
- Audio stream split
- SRC - Sample rate conversion
- DEL - Speaker delay
- SNG - Signal/Noise generator
- DM - Downmix
- MTX - Matrix (stereo to multichannel)

TI ASPs from 3rd parties
Subject to availability; may require additional fees including algorithm porting charges.

- Advanced NIC - provides additional status and control capability
- INF - Infrasonic filter (non-standard)
- SM - Support for 3 subwoofer channels (standard on dual DSP)
- TC - Tone controls
- CLI - Clip/level indicator
- ASC - Active Crossover (non-standard)
- MST - Multi-channel stereo
- PEQ - Parametric Eq allows up to 32 different bands of eq per channel (actual number of bands depends on system configuration)
- AAS/AAT - Audio Analysis Source/Tool (used for HDMI testing)

The DAE-82 module uses Texas Instruments’ DA810 (part of TI’s TMS320C674x+™ processor line) VLIW processor.
Creating the audio system

In addition to the typical power supply and front and rear panel hardware and associated control processor(s), signal switching/muxing, and (optional) balanced I/O, some additional hardware is needed to create a complete system with the DAE-8 modules. A single zone system is assumed, as well as the use of MDS’ HDMI solutions.

With the DAE-82 an external SPDIF receiver is needed, specifically a CS8416 connected to the appropriate pins of the DAE-82 module. Depending on the desired (analog) performance level and HDMI subsystem a clock cleanup circuit will be needed to reduce clock jitter from digital sources.

Also required are external volume controls that have an artifact free MUTE (for example the CS3308) as well as circuitry to prevent power on/off transients on analog outputs.

An external ADC for analog input capability is supported. Up to 8 ADC channels (7.1) are supported, though from a practical aspect 6 channels (5.1) is generally all that is needed.

MDS offers reference designs for purchase to provide a design as a starting point for your own system. Alternately MDS engineering services can be used to create custom versions specific to your requirements.

DAE-82 module details

As described on the prior pages, what is ordered is a specific hardware plus firmware product and the price and capabilities vary depending on the feature set included.

The remainder of this section provides details on the hardware.

Common Features - DSP

While most features of the DSP are brought out to the digital connector, some features are not supported (for example, USB). Some signal lines may only be used on certain firmware versions - for example the I2S lines for multiple sub woofers are only used on the dual DSP boards.

Common Features - connector

All boards use the same 140 pin connector for digital signals and power, a Hirose FX8C-140S-SV5 receptacle. This allows mating heights of 10 to 16mm to allow circuitry to be placed under the board if desired; do not place any analog circuitry under the DAE module.

The DAE-82 uses 3.3 and 5V power from the digital connector with a peak current of 2A on the 3.3V supply. About 100 mA is used on the 5V supply.

Common Features - booting

All DAE-8 modules are intended to boot from a local SPI serial flash. The host can write to this flash directly for field updates.

A UART is available on the DSP and access to that on the host board (either to a connector via the appropriate level shifter or into your host processor for external access) should be provided for access to diagnostics during development.

While shown in the diagrams, production boards do not have the JTAG connector populated.

Common Features - control

The board is controlled through an I2C port on the DSP. A messaging protocol developed by TI (Alpha Messaging) is used to interact with the board. (Higher level libraries are provided for common AVR functions to isolate the complexity of the low level messaging.)

A second I2C port is available for control of external peripherals. In standard releases this is just for an external SPDIF receiver for the DAE-82.
Common Features - I2S ports

With the exception of a few I2S data lines, the three McASP ports on the DA8xx device are brought out to the connector. From the raw hardware perspective this provides up to 20 I2S data lines in three clock domains.

However the AVR firmware makes specific use of certain ports. 4 data lines of McASP0 are used for audio input. McASP1 is always used for the primary output. McASP2 is always used for secondary (downmix) output and an optional stereo input mix.

SPDIF/clock generation
The DAE-82 model is more basic and requires the main board design to convert SPDIF input to I2S as well as provide the correct output clocks derived from a stabilized version of the input clock to the DAC section.

The DAE-82 can be used for applications for HD audio decode with post processing at 48 kHz in up to a 7.1 configuration.

The DAE-82 is pin compatible with the DAE-88, though it is not functionally the same as the DAE-88 includes the SPDIF receiver.

Evaluation systems
For those wishing to better understand how to use the DAE-82 module MDS offers an evaluation system for purchase.

Customers combining MDS’ DAE-82 with one of MDS’ HDMI repeater/switcher/audio extractor systems should contact MDS for guidance on the evaluation system choices.

The EVM’s ARM Cortex M3 microprocessor runs a simple menu based interface to allow the DAE-8 modules to be controlled and monitored via the EVM’s serial port.

Included with the system is a host side API source code library (suitable for use on any 32 bit microprocessor with a C++ compiler) that is used to control the DAE-8 functions.

At a low level this library abstracts the physical communications method. As the DAE-8 is controlled over I2C the customer created system will need to replace the generic driver code with the specific method used to communicate with the board from your host processor.

MDS provides a layer on top of the lower level driver to provide a simple and robust interface for the common functions of an AVR. Access to the lower level interface is available to allow complete customization of the system’s functions.

### DAE-8 standard firmware/ASP features.

<table>
<thead>
<tr>
<th>Version (hardware)</th>
<th>DSP*</th>
<th>SPDIF in &amp; ASRC</th>
<th>Std Dec. a</th>
<th>HD Dec.</th>
<th>Post proc.</th>
<th>Post proc. max Fs</th>
<th>Block A b</th>
<th>SM for 3 subs?</th>
<th>GEO / PEQ</th>
<th>TC</th>
<th>Dolby Volume</th>
<th>Primary out</th>
<th>Secondary out</th>
</tr>
</thead>
<tbody>
<tr>
<td>DAE-8202 (DAE-82)</td>
<td>DA810 456 MHz</td>
<td>External</td>
<td>Yes</td>
<td>Yes</td>
<td>PLLixz, NEO, MST, Matrix</td>
<td>48 kHz</td>
<td>Yes</td>
<td>No</td>
<td>one, &lt; 8 bands/ch</td>
<td>Single</td>
<td>No</td>
<td>7.1</td>
<td>2.0 mixdown</td>
</tr>
<tr>
<td>DAE-8212 (DAE-82)</td>
<td>DA810 456 MHz</td>
<td>External</td>
<td>Yes</td>
<td>Yes</td>
<td>PLLixz, NEO, MST, Matrix, DVL (Dolby Volume)</td>
<td>48 kHz</td>
<td>Yes</td>
<td>No</td>
<td>one, &lt; 5 bands/ch</td>
<td>Single</td>
<td>Yes</td>
<td>7.1</td>
<td>2.0 mixdown</td>
</tr>
</tbody>
</table>

a. Dolby Digital, DTS, AAC
b. Block A : RVB (room), DM (downmix), LOU (loudness), BM (bass management), DEL (delay)
DAE-82 Digital Audio module

These boards provide volume control on input and output since these are features of a typical AVR and the EVM software provides an example of how to integrate that with the DAE-82.

HDMI input/output
MDS offers a number of different HDMI repeater/switching solutions to provide access to the audio carried by HDMI interconnects.

Typically the downstream HDMI device will be a TV or similar display device which does not decode audio. In that case the DAE-8 is configured to provide the stereo downmix as 2 channel PCM for the HDMI output of the AVR.

USB support:
Developers familiar with TI’s DA8xx devices will know the hardware supports a USB interface. On MDS’ DAE-8 modules that interface is not used, but can be provided as a hardware build option subject to certain restrictions.

The standard DAE-8 software environment does not use/support USB.
DAE-82 Digital Audio modules

Ordering information (order code is in *italics*)

Shipment of DAE-8 products with decoder capability requires appropriate license information from Dolby Labs and Digital Theater Systems.

Modules orders are subject to minimum quantities, please contact MDS sales department for a quotation.

Ordering codes consist of the hardware model followed by 2 or more alpha-numeric code that indicates a specific combination of firmware modules (standard and optional).

Some features may incur additional charges for porting or per unit license fees.

**EVM-DAE-82xx**: DAE development system.
- DAE MotherBoard (includes 7.1 analog I/O and SPDIF in) for DAE-82
- DAE-82xx module
- Power supply
- HSR-41 HDMI repeater module

Supported ADC/DACs/Volume controls

Different parts have different control requirements. While in most cases the host processor can take responsibility, there are some direct hardware level interactions that the DAE board needs to be involved with (for example the MUTE signals).

Please contact MDS to discuss hardware choices and to determine if specific hardware might require modification to the DAE’s drivers.

Some options require MDS to create a customer specific firmware release and incur a porting charge. These charges do not include the license fee from the algorithm vendor. Adding additional processing options will reduce CPU availability for other features.

**DAE-8-DV**: Dolby Volume option.

**DAE-8-DH**: Dolby Headphone option.

**DAE-8-THX**: THX option.

Available on DAE-82 only:

**DAE-8-D0**: Dolby only (no DTS). (typical for ATSC and similar applications where only AC3 will be encountered)

**DDE-STD**: 90 Day Startup Support
- Help with installation of hardware/software.
- Problems in installation.
- How to use/run hardware or software that comes with the system. This excludes example programs because they are provided as-is, without support.
- Assistance with integration of the DAE-8 modules into your own system is provided under an hourly support contract
- Excludes MDS required system testing

Consulting services are also available from Momentum Data Systems.

Related items

Please visit [http://www.mds.com](http://www.mds.com) for more information on these and other products to speed your design to market.

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DTS is a trademark of Digital Theater Systems, Inc.

THX is a trademark of THX Ltd.

Dirac Live is a trademark of Dirac Research AB

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