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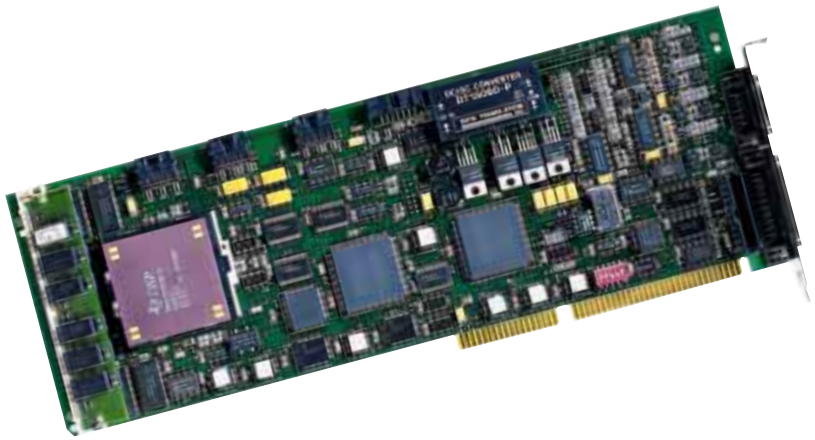
Find the *Measurement Computing / Data Translation DT3818-UH-40-4* at our website: *Click HERE*

Fulcrum Delta Sigma

DSP-Based

Data Acquisition System

Fulcrum™ Delta Sigma is an intelligent data acquisition system optimized for the highest performance, real-time data acquisition and digital signal processing applications. A unique architecture that tightly couples delta-sigma A/D and D/A converters to a Texas Instruments TMS320C40 (C40) DSP engine allows simultaneous data collection and analysis, A/D, D/A, and host communications. Applications that require high throughput and computationally-intensive measurement, control, or analysis are now straightforward and easy. Fulcrum Delta Sigma models feature interconnection to other boards for synchronization and data sharing.



M-5783

Delta Sigma A/D & D/A Data Converters

Analog input and output circuits feature advanced delta sigma converters for improved ac performance. Delta-sigma A/D converters offer the following advantages:

- Simultaneous sampling by independent A/D converters on each input (equivalent to Simultaneous Sample and Hold)
- Reduced noise and improved accuracy result from 64x oversampling on each input
- Elimination of errors due to aliasing and high frequency noise using the built-in "brick wall" digital filtering system (External anti-aliasing filters are not needed)
- Excellent low-level signal-to-noise performance improves accuracy on low-level signals
- Excellent differential linearity assures consistently accurate data conversion across the full input range

Delta-sigma D/A converters provide automatic interpolation between data points, for smoother output. Signal reconstruction is performed by an 8x digital interpolation filter followed by 64x oversampling.

High-Performance Data Acquisition and DSP

Fulcrum Delta Sigma's efficient hardware architecture lets you perform analog input, analog output, and signal processing simultaneously. The memory is shared by the analog I/O and C40 (and interboard communications). Each subsystem on the board has its own high-speed pathway in and out of memory, and each pathway has its own independent DMA controller. This allows A/D and D/A subsystems to operate

Compatible Windows Software

DSP LAB	DSP-EZ
✔	✔

Free:

- SPOX Run-Time License

Analog Inputs

All specifications are typical at 25°C and rated voltage unless otherwise specified.

	DT3818, DT3818-50	DT3814, DT3814-2
Resolution (bits)	**16** (0.0015% FSR)	**16** (0.0015% FSR)
Throughput	1–52kHz/channel 416kHz aggregate (8 channels)	1–52kHz/channel 104kHz aggregate (2 channels)
Inputs	8 differential inputs; 8 separate delta sigma converters	2 differential inputs; 2 separate delta sigma converters
Gain	1	1
Range (V)	±10	±10
Digital Anti-Aliasing Filters **Passband (–3dB)** **Stopband (–80dB)**	 24kHz 28kHz	 24kHz 28kHz
Channel-to-Channel Aperture Match (ns)	±5	±5
Channel-to-Channel Phase Match (°)	±0.1	±0.1
Group Delay	18/throughput	18/throughput
Channel-List (entries)	8	2
System Error (% of FSR)	±0.05 max	±0.05 max
Signal/(Noise+Distortion) Ratio (dB) @ f_{in}	89 @ 1kHz in, 48kHz sampling	89 @ 1kHz in, 48kHz sampling
Total Harmonic Distortion (dB) @ f_{in}	–96 @ 1kHz in, 48kHz sampling	–96 @ 1kHz in, 48kHz sampling
Input Impedance	100MΩ/100pF	100MΩ/100pF
CMRR (dB @ 60Hz)	80 min	80 min
Maximum Input Voltage Protection (On/Off)	±25/±15	±25/±15
ESD Protection	To 1.5kV, Mil 38510 class 2	To 1.5kV, Mil 38510 class 2

Analog Outputs* (not available on DT3814)

	DACs	Resolution (bits)	Throughput (kHz)	Range (V @ ±5mA min)	Total Harmonic Distortion	Reconstruction Filter	Error (% of FSR)	Drift (ppm of FSR/°C)	Group Delay
DT3818, DT3818-50, DT3814-2	2	16 (0.0015% FSR)	**1–52kHz/DAC**, full-scale change	±10	–82dB @ 48kHz w/reconstruction filter	16kHz low-pass (4-pole), software enabled	±.05	±50	33/ throughput

*All specifications are typical at 25°C and rated voltage, unless otherwise specified.
**Digital anti-aliasing filters automatically operate at the Nyquest frequency (half the sampling rate).

Typical DRAM SIMMs

MEMORY CAPACITY	MANUFACTURER	MODEL
1M x 32 (4Mbytes)*	Micron Toshiba	MT8D132M-7 THM321000AS-70
2M x 32 (8Mbytes)*	Toshiba	THM322020AS-70
4M x 32 (16 Mbytes)*	Micron Toshiba	MT8D432-7 THM324000S-70

Fulcrum Delta Sigma Models

Model	A/D Converters	D/A Converters	SRAM	C40 Speed
DT3818	8	2	1032 Kbytes	40 MHz
DT3818-50	8	2	1032 Kbytes	50 MHz
DT3814	2	—	520 Kbytes	40 MHz
DT3814-2	2	2	520 Kbytes	40 MHz

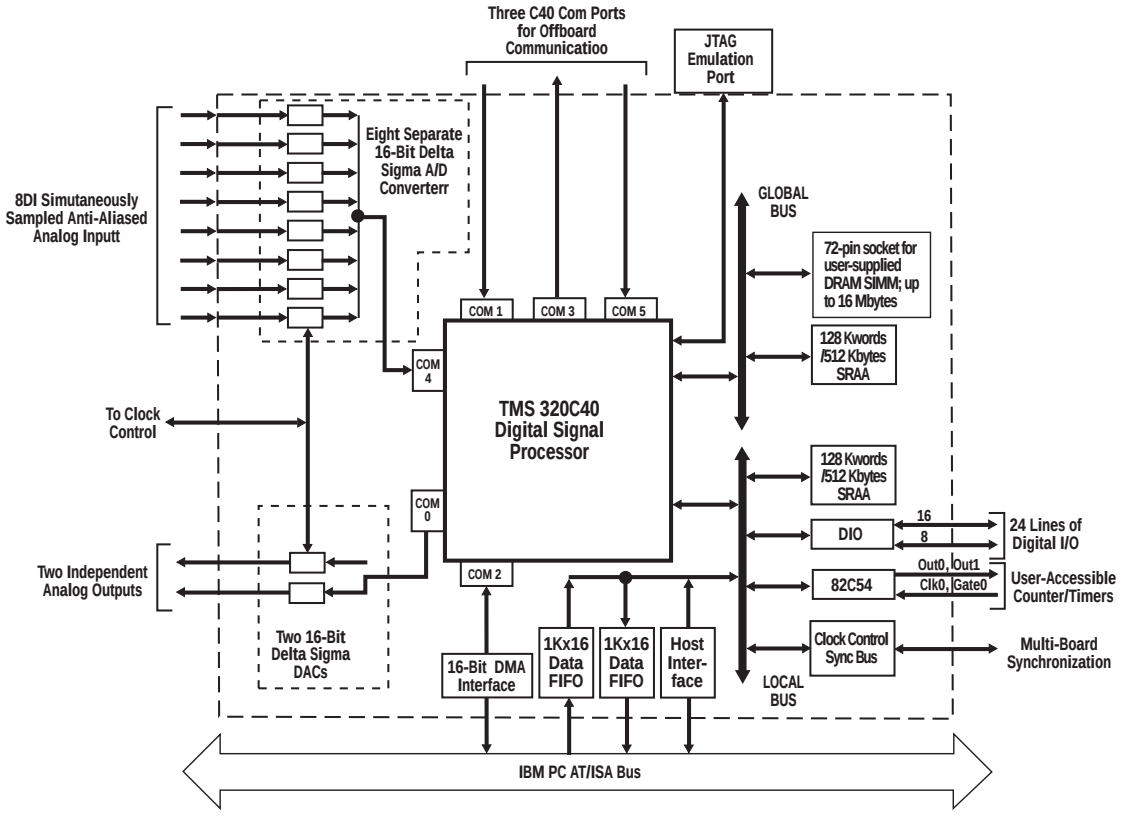
DSP LAB™

Fulcrum Delta Sigma applications may be developed with the DSP LAB™ Developer's Kit. This includes the industry-standard SPOX™ operating system as ported to the Fulcrum Delta Sigma board, SPOX device drivers for the board subsystems and the SPOX DSP and math libraries. Texas Instruments cross-platform C40 development tools are also included. A version without the TI compiler is also available for developers who already own an up-to-date version of the TI compiler or other TI-compatible C40 compiler. Communication drivers to the host PC support DOS and Windows development.

Example programs include a Windows® FFT analysis program that displays data on the PC using Visual Basic. ® A program running on Fulcrum collects and analyzes the data before sending it to the PC. This leaves the PC free for display and user interface. Full source code for the PC and Fulcrum programs is provided with this example.

DSP-EZ™

DSP-EZ™ is by far the easiest way to develop a powerful, efficient DSP application using Fulcrum™ boards. DSP-EZ consists of DSP Basic™ that performs DSP and data acquisition on the Fulcrum board, and custom controls that perform board setup and display data on the host PC. All tools operate in the uncomplicated Visual Basic® programming environment.



DT3818 and DT3818-50 Block Diagram

M-0414

simultaneously at **full rated throughput**, and leaves the C40 completely free for processing. A digital I/O subsystem is also provided that can be used to set up or control external circuitry.

Expandable DSP, Data Acquisition

Fulcrum Delta Sigma is designed for easy expansion of both its DSP and data acquisition capabilities. Up to three data paths on each board are available for sharing data and processing power with up to three additional boards. Multiple Fulcrum Delta Sigma boards can be interconnected to provide high-performance distributed processing for demanding DSP applications. Additionally the A/D and D/A channels on different boards can be synchronized using a built-in Multi-Board Sync Bus.

Analog Input and Output: Two or eight delta-sigma 16-bit A/D converters with differential inputs collect data simultaneously. Each A/D can sample data from 1kHz to 52kHz, for an aggregate throughput to 416kHz (104kHz on DT3814 models). When the A/D subsystem is enabled, a DMA controller moves data from the converter to C40 memory. Simultaneous sampling and anti-aliasing filters are built-in to the A/D design, eliminating the need for external filters.

Two delta-sigma 16-bit D/A converters output data simultaneously or singly on some models. The delta-sigma D/A converters provide a reconstruction filter and digital interpolation. Each converter has a throughput of 1kHz to 52kHz. Software enables an additional 16kHz reconstruction filter on each D/A and a DMA controller sends data from C40 memory to the converter.

The A/D and D/A subsystems can be operated simultaneously at full throughput rates. The internal clock for A/D and D/A is shared and programmable over the operating range of 1kHz to 52kHz. Two external hardware and 2 programmable software triggers are available to start the A/D and D/A subsystems.

Host Communications: Data is transferred to and from the host PC through the ISA Bus. DMA is used both on the Fulcrum Delta Sigma and in the PC host to move data in either direction, from board to host or from host to board.

Expansion: Additional high-speed hardware data paths allow the Fulcrum board to communicate with other boards. These data paths allow data and processing power to be shared across multiple boards. Additionally, a Multi-Board Sync Bus synchronizes A/D and D/A subsystems across multiple boards.

Digital I/O: Three 8-bit static digital ports are independently programmable for input or output. These 24 lines (bits) of TTL compatible input or output are used to measure input signals or control outputs.

Counter/Timers: Two counter/timers are available to the developer. One is fully accessible to the user (with external I/O) and may be programmed for various functions. The other is available for counting the sample clock.



The Delta-Sigma Converter

Analog-to-digital conversion can be accomplished through many different technologies. Delta-sigma converters demonstrate exceptional noise, linearity, and resolution characteristics.

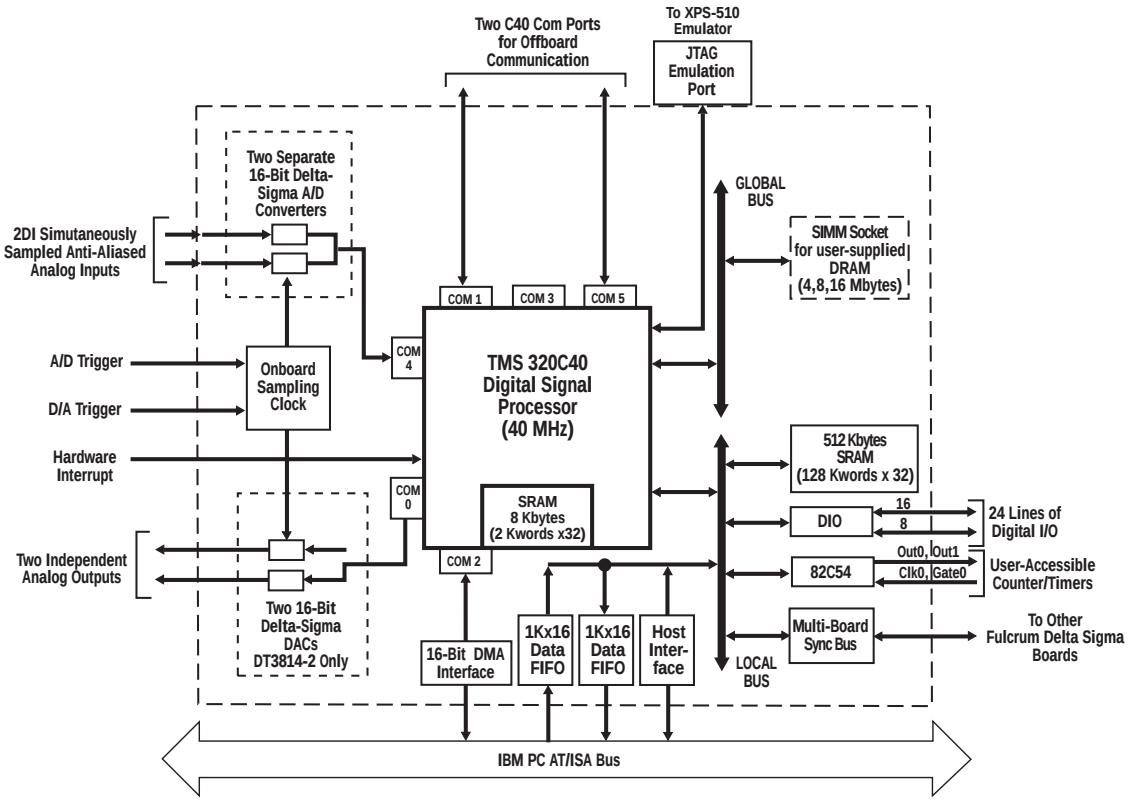
Delta-sigma converters are fundamentally different from other converter technologies. Traditional designs are based on high-accuracy analog components like resistors and comparators to provide reliable conversions. This analog circuitry is harder both to design and to manufacture. Delta-sigma converters are mostly digital and use a 1-bit converter that oversamples the signal many times. Digital circuits won't drift with time and temperature.

Output from the 1-bit converter is a continuous stream of 1s and 0s which are fed into a digital filter that minimizes noise and removes aliased signals. (This digital filter is an integral part of the A/D converter chip). The data is then decimated to provide the correct sampling rate.

This architecture is inherently monotonic* and provides very high accuracy.

Delta-sigma converters are also characterized by a lag or group delay from the time an analog sample is grabbed till the digital value is output. Each sample is integrated in the 1-bit converter and then passed through the digital filter. The digital filter combines previously sampled inputs with the current sample. This causes a lag between the sampled signal and the digital output of 18 samples. In most signal processing and analysis applications this lag is insignificant. However, in real-time control applications, the A/D lag and the D/A lag should be carefully considered and analyzed.

* Monotonic: if the input signal voltage goes higher the converter is guaranteed to output the same or a higher conversion value.



DT3814 and DT3814-2 Block Diagram

M-0418

Specifications

All specifications are typical at 25°C and rated voltage, unless otherwise specified.

PROCESSOR

Texas Instruments TMS320C40 32-bit floating-point Digital Signal Processor; performs all onboard device configuration and control, data management, and data processing; 40 or 50 MHz clock; 40 or 50 MFLOPS (million floating-point operations per second)

Interrupt to C40—Subsystem error, external interrupt line, host

MEMORY

Factory-Supplied SRAM—DT3818 Models: 1032 Kbytes total: 2 Kwords x 32 bits C40 onchip SRAM (160 Mbytes/s, DT3818; 200 Mbytes/s, DT3818-50); 256 Kwords x 32 (80 Mbytes/s) onboard SRAM

DT3814 Models: 520 Kbytes total: 2 Kwords x 32 bits C40 onchip SRAM (160 Mbytes/s); 128 Kwords x 32 (80 Mbytes/s) onboard SRAM

Used for program execution space and scratchpad memory

User-Supplied DRAM—Fulcrum Delta Sigma can accommodate one 72-pin DRAM SIMM (single inline memory module), user-supplied memory capacity can be 4, 8, or 16 Mbytes, memory speed should be 70ns or less; DRAM is accessed at 20 or 25* Mbytes/s (3 wait states), and is typically used to store output waveforms or acquired samples.

* DT3818-50 Only

STATIC DIGITAL I/O

Number of Lines

24, organized as three 8-bit ports; each port is separately configurable for input or output

Outputs

Drive 10 LSTTL loads

Inputs

1 LSTTL load; level-sensitive; unused inputs float

CLOCKS AND TRIGGERS

The A/D and D/A subsystems are clocked by an onboard programmable oscillator. Both subsystems are driven by the same clock to allow synchronous input/output operations.

Each subsystem (A/D, D/A) has separate external hardware and internal software triggers. Polarity is software-selectable on hardware triggers.

COUNTER/TIMERS

Two 16-bit counter/timers, 82C54-based; counter 0 is fully user-accessible (for external gate & clock input, output brought to board connector); other divides down sampling clock (output to user connector).

OPERATION

A/D

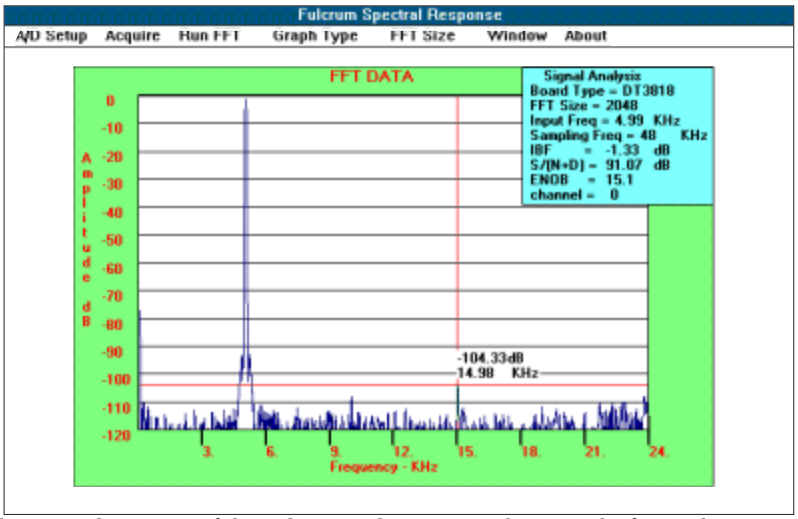
Channel Selection—Channel selection is accomplished by an 8-element (DT3818 models) or 2-element (DT3814 models) read list. Each input has its own A/D converter; multiple converters can be triggered at once for simultaneous sampling of input channels. Data values on each channel in the channel list are sequentially transferred into memory.

Data Transfer—single channel DMA via dedicated C40 DMA channel and communication port to onboard memory

D/A

Channel Selection—either channel singly or both channels simultaneously

Data Transfer—single channel DMA via dedicated C40 DMA channel and communication port from onboard memory



The spectral response of the Fulcrum Delta Sigma is shown in the figure above. A very pure sine wave is presented to the board's analog input and FFT analysis is performed on the collected data. Notice the low noise floor and extremely low level of harmonic distortion. The Signal to Noise + Distortion (S/(N+D)) ratio is a measure of the power of the signal in relation to noise and distortion introduced during the A/D conversion or in other words the overall quality of the conversion. In this case an S/(N+D) of 91.07dB gives us an effective number of bits (ENOB) equal to 15.1 bits.

Specifications *(continued)*

Digital Input, Digital Output
Operation—8, 16, or 24 bits in or out; or any combination of in and out simultaneously
Data Transfer—uses C40 local bus to transfer values in and out of onboard memory, or to and from host bus

Simultaneous Operation
A/D, D/A, host, and interboard communication subsystems can be operated simultaneously at full or near full rated throughput

Data Collection Mode
Fulcrum Delta Sigma acquires analog signals in a continuous stream of data buffers. C40 DMA channels have an auto-initializing feature that allows automatic transfer of multiple buffers. Software allows data collection to start and stop under program control or be delayed by a specific number of samples.

GENERAL

Host Interface
ISA (IBM PC AT) bus or EISA Bus; I/O mapped, 10-bit I/O address; 16-bit data path; one DMA channel; connects to C40 via dedicated DMA channel and communication port
Data Transfer—single-channel DMA via dedicated C40 DMA channel and communication port from onboard memory
Interrupt to Host—one line, software-selected level; source: DMA done (to or from host); two additional C40 interrupts, used to pass messages and data between host and C40

Power Requirements
+5V @ 3.5A typical; low-noise ±15V generated by onboard DC/DC converter

Physical/ Environmental
Dimensions—full-size PC AT board mechanically compatible with ISA system slots only; 12.7 x 35.6 x 1.9 cm (5.0" x 14.0" x .75") overall
Connectors—26-pin shielded mini-D connector for analog signals (3M #10226-52B2 VE); separate 50-pin shielded mini-D connector (3M #10250-52B2 VE) for digital signals
Temperature—operating: 0 to 50°C; storage: –25 to 85°C
Relative Humidity—to 95%, non-condensing

Ordering Summary

All Data Translation products are covered by a 1-year warranty.

Fulcrum Delta Sigma

Fulcrum Delta Sigma includes a SPOX run-time license, and is shipped with a comprehensive hardware manual. DSP LAB or DSP-EZ is required for board operation.

- DT3818—8 A/Ds, 2 DACs; 40 MHz C40; 1032 Kbytes SRAM
- DT3818-50—8 A/Ds, 2 DACs; 50 MHz C40; 1032 Kbytes SRAM
- DT3814—2 A/Ds, no DACs; 40 MHz C40; 520 Kbytes SRAM
- DT3814-2—2 A/Ds, 2 DACs; 40 MHz C40; 520 Kbytes SRAM

DSP LAB Developer's Kit

Includes utilities (program loader, diagnostics, installation utility, demo program and sources) SPOX development tools, and the Texas Instruments TMS320C40 Cross Platform Development Tools required to build Fulcrum/ C40 applications. All products are supplied on 3.5" 1.4 Mbyte media. Comprehensive documentation is supplied.

- DSP LAB Developer's Kit SP0312-CL

DSP-EZ

Easy-to-use DSP development environment for Fulcrum. Contains DSP Basic to control DSP and data acquisition on the Fulcrum board, and Visual Basic custom controls that perform board setup and display data on the host PC. Single-user package. Includes a copy of the software on 1.4 Mbyte 3.5" diskette media, a comprehensive user manual, application development tools with sources, and a hardware driver.

- SP0950-CL

Accessories

- EP254—EMI/RFI shielded enclosure for Fulcrum Delta Sigma screw terminal panel
- EP227/EP250 Bundle—Shielded cable set for all user signals; .91m (3')
- DT748—Screw terminal panel and cable assemblies; accommodates all user signals
- EP281/284—Multiboard cable set for interconnecting two Fulcrum Delta Sigma boards

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