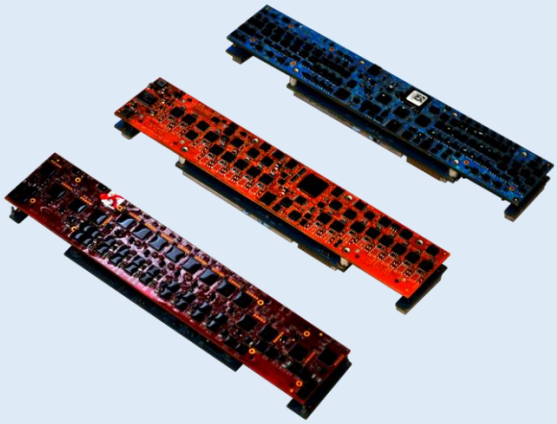
What are the Advantages of the NAI Function Modules?

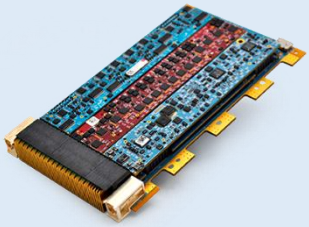
When Size, Weight and Power are critical NAI provides

- High funtional denisty
- Wide range of I/O, Commnication, Measurement and Simulation
- Programmable Channels
- Background Built in Test
- ARM processor and FPGA to offload system processor
- TurnKey Solution from one supplier



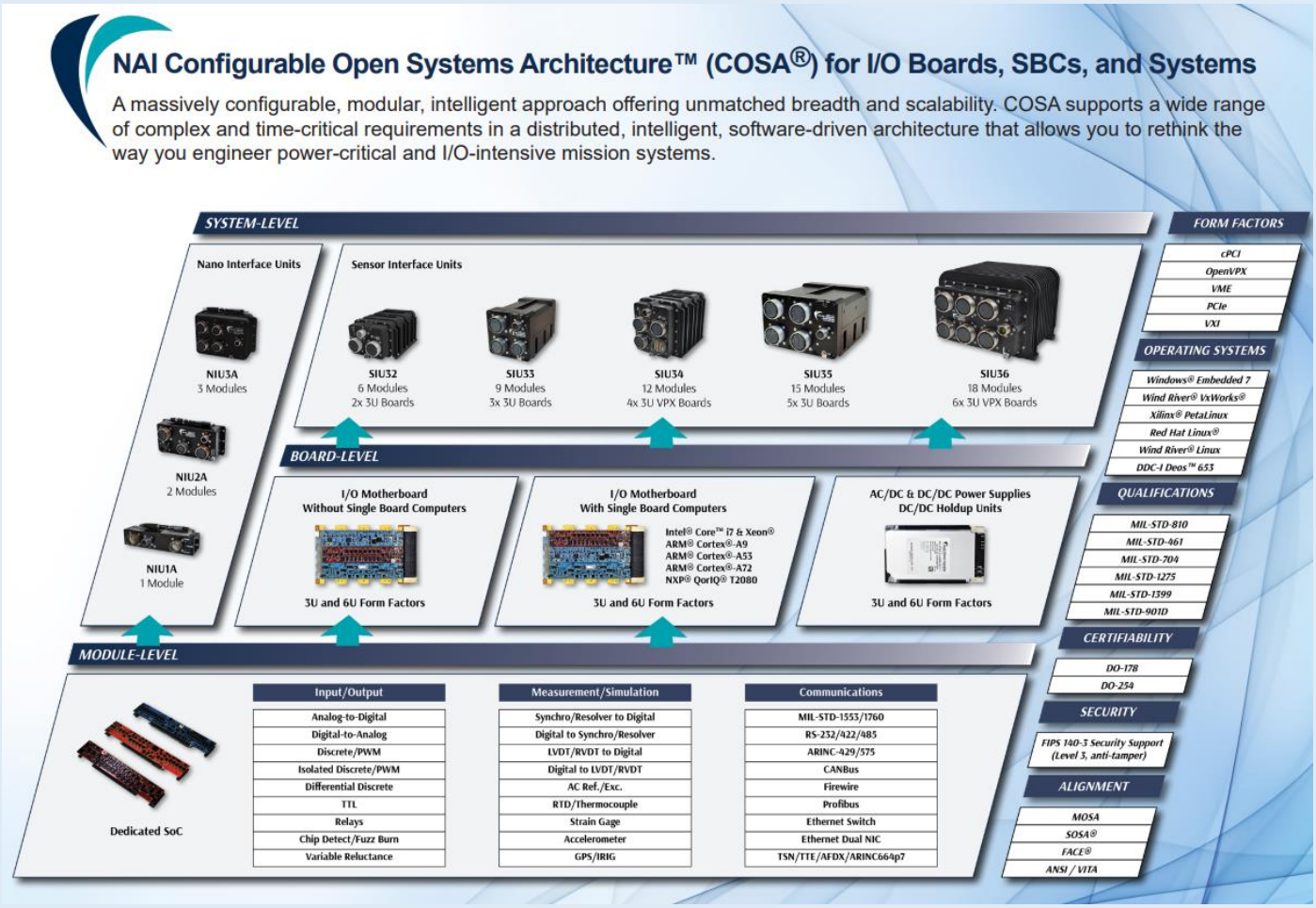
Over 90 Function Modules Available
Board level Products Supported – VPX, VME, cPCI and PCIe and Systems

6U VPX/VME – 6 Modules



3U VPX – 3 Modules

System (3) 3U VPX cards and Power Supply



90 Modules Available

I/O

- A/D 9 Modules
- D/A 5 Modules
- Discrete I/O 5 Modules
- Digital I/O 2 Modules
- Differntial Tranceivers 2 Modules

Measurement and Simulation

- LVDT/RVDT 15 Modules
- Synchro/Resolver 26 Modules
- AC Reference 2 Modules
- Thermocouple/RDT 3 Modules
- Variable Reluntance 1 Module
- Strain Guage 1 Module

Communication

- MIL-STD-1553 6 Modules
- ARINC 2 Modules
- Time Triggered Ethernet 1 Module
- IEEE 1394 (FireWire) 2 Modules
- CANBus 3 Modules
- Serial 4 Modules
- Ethernet 1 Module

Measurement and Simulation Modules

LVDT/RVDT - A linear variable differential transformer (LVDT) is a type of electrical transformer/transducer used for measuring linear displacement (position). A counterpart to this device used for measuring rotary displacement is called a rotary variable differential transformer (RVDT). The RVDT is like an LVDT in that it measures a positional displacement, however, the displacement, which is still a linear proportional function, is based on rotary instead of linear positional movement. Both deliver signals proportional to the linear displacement of the moveable core.

Simulation

Module	Description
DLA	2 Ch. Output (2-28 RMS), Output 1.5VA, Frequency 47 – 1,000 Hz
DLB	2 Ch. Output (2-28 RMS), Output 1.5VA, Frequency 1,000 – 5,000 Hz
DLC	2 Ch. Output (2-28 RMS), Output 1.5VA, Frequency 5,000 – 10,000 Hz
DLD	2 Ch. Output (2-28 RMS), Output 1.5VA, Frequency 10,000 – 20,000 Hz
DLE	2 Ch. Output (28 - 90 RMS), Output 1.5VA, Frequency 47 – 1000 Hz
DLJ	3 Ch. Output (2-28 RMS), Output 1.5VA, Frequency 47 – 1,000 Hz
DLK	3 Ch. Output (2-28 RMS), Output 1.5VA, Frequency 1,000 – 5,000 Hz
DLL	3 Ch. Output (2-28 RMS), Output 1.5VA, Frequency 5,000 – 10,000 Hz
DLM	3 Ch. Output (2-28 RMS), Output 1.5VA, Frequency 10,000 – 20,000 Hz
DLN	3 Ch. Output (28 – 90 RMS), Output 1.5VA, Frequency 47 – 1000 Hz

Key Features

NAI offers five smart function modules that convert these signals to a digital output corresponding to position in a variety of operating parameters. An LVDT/RVDT simulator is used to convert digital positional commands to corresponding AC signals.

Built-In Test (BIT)/Diagnostic Capability
The board supports three types of built-in tests: Power-On, Continuous Background and Initiated. The results of these tests are logically ORed together and stored in the BIT Dynamic Status and BIT Latched Status registers.

Power-On Self-Test (POST) / Power-on BIT (PBIT) / Start-up BIT(SBIT)
This board features a power-on self-test that will do an accuracy check of each channel and report the results in the BIT Status register when complete. After power-on, the Power-on BIT Complete register should be checked to ensure that POST/PBIT/SBIT test is complete before reading the BIT Latched Status.

Continuous Background Built-In Test
The background Built-In-Test or Continuous BIT (CBIT) (“D2”) runs in the background where each channel is checked to a test accuracy of 0.2% FS. The testing is totally transparent to the user, requires no external programming, and has no effect on the operation of the module or card. The technique used by the continuous background BIT (CBIT) test consists of an “add-2, subtract-1” counting scheme. The BIT counter is incremented by 2 when a BIT-fault is detected and decremented by 1 when there is no BIT fault detected and the BIT counter is greater than 0. When the BIT counter exceeds the (programmed) Background BIT Threshold value, the specific channel’s fault bit in the BIT status register will be set. Note, the interval at which BIT is performed is dependent and differs between module types. Rather than specifying the BIT Threshold as a “count”, the BIT Threshold is specified as a time in milliseconds. The module will convert the time specified to the BIT Threshold “count” based on the BIT interval for that module. The “add-2, subtract-1” counting scheme effectively filters momentary or intermittent anomalies by allowing them to “come and go“ before a BIT fault status or indication is flagged (e.g. BIT faults would register when sustained; i.e. at a ten second interval, not a 10-millisecond interval). This prevents spurious faults from registering valid such as those caused by EMI and/or dirty power causing false BIT faults. Putting more “weight” on errors (“add-2”) and less “weight” on subsequent passing results (subtract-1) will result in a BIT failure indication even if a channel “oscillates” between a pass and fail state.

Initiate Built-In Test

The DLx module supports an off-line Initiated Built-In Test (IBIT) ("D3"). IBIT test starts an initiated BIT test that utilizes an internal stimulus to generate and test the full-scale positional range to a default test accuracy of 0.1% full scale range. IBIT test cycle is completed within 30 seconds and the result can be read from the BIT status registers when IBIT bit changes from 1 to 0.

Measurement

Module	Description
LD1	4 Ch. Input (2-28 RMS), Frequency 47 – 1,000 Hz
LD2	4 Ch. Input (2-28 RMS), Frequency 1,000 – 5,000 Hz
LD3	4 Ch. Input (2-28 RMS), Frequency 5,000 – 10,000 Hz
LD4	4 Ch. Input (2-28 RMS), Frequency 10,000 – 20,000 Hz
LD5	4 Ch. Input (28 - 90 RMS), Frequency 47 – 1000 Hz

Key Features

- With isolated excitation and signal input covering 2, 3, or 4-wire transducer interfaces and a normalized digital position word based on a percentage of full-scale travel, the LVDT/RVDT modules are able to interface to virtually any type LVDT or RVDT transformer.
- The design has the capability to automatically shift to higher bandwidths when high acceleration events are encountered. There is no data latency. The shifting is smooth and continuous with no glitches.
- The channels include many other useful application features such as signal, reference and frequency measurements as well as signal under- and over-voltage detection, and reference under- and overvoltage detections.
- All channels have continuous background Built-In-Test (BIT).
- The modules also include extended LVDT FIFO buffering capabilities for greater storage/management of the incoming signal samples (data) for post processing applications. Programmable FIFO buffer thresholds maximize data flow control (in and out of the FIFO)

Built-In Test (BIT) / Diagnostic Capability

The board supports three types of built-in tests: Power-On, Continuous Background and Initiated. The results of these tests are logically ORed together and stored in the BIT Dynamic Status and BIT Latched Status registers.

Power-On Self-Test (POST) / Power-on BIT (PBIT) / Start-up BIT(SBIT)

- This board features a power-on self-test that will do an accuracy check of each channel and report the results in the BIT Status register when complete. After power-on, the Power-on BIT Complete register should be checked to ensure that POST/PBIT/SBIT test is complete before reading the BIT Latched Status.

Continuous Background Built-In Test

- All LVDT/RVDT measurement modules feature a background self-test capability or Continuous BIT (CBIT)("D2") test. The modules incorporate major diagnostics that ensure that the user is alerted to channel malfunction. This approach reduces bus traffic, because the Status Registers need not be constantly polled. In addition to specialized design algorithms, the modules include many other useful application features such signal voltage, reference voltage and frequency measurements, reference low/high (under-/over-voltage) fault detection, and signal low/high (under-/over-voltage) fault detection.
- The CBIT test enables reporting of automatic background BIT (accuracy) testing. Seamlessly and transparently, each channel is in the "background" while operating normally to a default accuracy tolerance of 0.1% full scale range. Any channel exceeding the tolerance flagged in BIT Status registers. The testing is totally transparent to the user, requires no external programming, and has no effect on the standard operation of the module. This test checks 72 unique positions for each channel sequentially and can take approximately 1 minute to complete. Each position cycles through all 4 channels within 3 seconds.

Synchro/Resolver - Synchros and Resolvers are transformer-type voltage/current transducers that convert a shaft or other rotating device's angular position and/or velocity to a multi-wire AC electrical signal. Both deliver signals proportional to the Sine and/or Cosine of the shaft angle. A Resolver-to-Digital or a Synchro-to-Digital simulator is used to convert digital angle/velocity commands to corresponding Synchro/Resolver AC signals.

Simulation

Module	Description
DS8	1 Ch. SYN Output (90 RMS), Output 8.0 VA, Frequency 400 Hz
DSA, DRA	2 Ch. SYN/RES Output (2-28 RMS), Output 1.5VA, Frequency 47 – 1,000 Hz
DSB, DRB	2 Ch. SYN/RES Output (2-28 RMS), Output 1.5VA, Frequency 1,000 – 5,000 Hz
DSC, DRC	2 Ch. SYN/RES Output (2-28 RMS), Output 1.5VA, Frequency 5,000 – 10,000 Hz
DSD, DRD	2 Ch. SYN/RES Output (2-28 RMS), Output 1.5VA, Frequency 10,000 – 20,000 Hz
DSE, DRE	2 Ch. SYN/RES Output (28-90 RMS), Output 1.5VA, Frequency 47 – 1,000 Hz
DSJ, DRJ	3 Ch. SYN/RES Output (2-28 RMS), Output 1.5VA, Frequency 47 – 1000 Hz
DSK, DRK	3 Ch. SYN/RES Output (2-28 RMS), Output 1.5VA, Frequency 1,000 – 5,000 Hz
DSL, DRL	3 Ch. SYN/RES Output (2-28 RMS), Output 1.5VA, Frequency 5,000 – 10,000 Hz
DSM, DRM	3 Ch. SYN/RES Output (2-28 RMS), Output 1.5VA, Frequency 10,000 – 20,000 Hz
DSN, DRN	3 Ch. SYN/RES Output (28 – 90 RMS), Output 1.5VA, Frequency 47 – 1,000 Hz

Key Features

A wide variety of DS and DR modules are available to cover the range of excitation voltages/frequency, include extensive field-parameter programmability, and provide a full operating envelope choice for simulating virtually any type Synchro or Resolver. By eliminating the need for external transformers and operating with lower AC reference frequencies, these solid-state designs offer huge space savings

Built-In Test (BIT) / Diagnostic Capability

Two different tests (one on-line and one off-line) can be selected.

The Online (D2) Test initiates automatic background BIT testing that checks the output accuracy of each channel by comparing the measured output angle to the commanded angle. Each channel is individually checked to an accuracy of 0.2° and each D/S Signal output is continually monitored. User can periodically clear to 00h and then read Test (D2) Verification register again, after 0.1 seconds, to verify that background bit testing is activated. Any failure triggers an Interrupt (if enabled) and the results are available in Status Registers. The testing is totally transparent to the user, requires no external programming, has no effect on the standard operation of the card, and can be enabled or disabled.

The (D3) Test initiates a BIT test that generates and tests 24 different angles to a test accuracy of 0.2 °. Results can be read from registers. External reference is required, and outputs must be on. Any failure triggers an Interrupt (if enabled). Testing requires no external programming and can be initiated or stopped at any time.

Measurement

Module	Description
SD1	4 Ch. Input (2-28 RMS), Frequency 47 – 1,000 Hz
SD2	4 Ch. Input (2-28 RMS), Frequency 1,000 – 5,000 Hz
SD3	4 Ch. Input (2-28 RMS), Frequency 5,000 – 10,000 Hz
SD4	4 Ch. Input (2-28 RMS), Frequency 10,000 – 20,000 Hz
SD5	4 Ch. Input (28 - 90 RMS), Frequency 47 – 1000 Hz

Key Features

NAI offers five smart function modules that cover the range of excitation voltages/frequency, include extensive field-parameter programmability, and provide a full operating envelope choice for interfacing to virtually any type of Synchro or Resolver. A Resolver-to-Digital or a Synchro-to-Digital converter is used to convert these signals to a digital output corresponding to the shaft angle and/or velocity.

Built-In Test (BIT) / Diagnostic Capability

SD1-SD5 incorporate major diagnostics that ensure that the user is alerted to channel malfunction. This approach reduces bus traffic, because the Status Registers need not be constantly polled. Three different tests (one on-line and two off-line) can be selected.

The Online **(D2)** Test initiates automatic background BIT testing. Each channel is checked every 5° to a testing accuracy of 0.05° and each Signal and Reference is always monitored. User can periodically clear to 00h and then read Test (D2) verification register again, after a minimum of 20.48 µs, to verify that background bit testing is activated. Any failure triggers an Interrupt (if enabled) and the results are available in status registers. The testing is totally transparent to the user, requires no external programming, has no effect on the standard operation of the card, and can be enabled or disabled.

The Offline **(D3)** Test initiates a BIT test that disconnects all channels from the outside world and connects them across an internal stimulus that generates and tests 36 different angles to a test accuracy of 0.1°. Results can be read from registers and external reference is not required. Any failure triggers an Interrupt (if enabled). The testing requires no external programming and can be initiated or stopped.

The Offline **(D0)** Test is used to check the card and the system interface. All channels are disconnected from the outside world, allowing the user to write any angle to all channels on the card and then to read the data from the interface. External reference is not required.

AC Reference - NAI's AC Reference smart function modules are used to provide an AC signal source for synchro, resolver LVDT and RVDT devices. All synchro, resolver, LVDT, and RVDT measurement and simulation smart function modules use transformers whose main primary-to-secondary coupling is varied by physically changing (or, in simulation, commanding) the relative orientation of the two windings. For operation, the primary winding of these transformers is excited by an alternating current, and electromagnetic induction causes current to flow in the secondary winding. Windings are fixed at certain characteristic electrical angles to each other on the stator. NAI offers three smart function modules that provide an AC signal source when a secondary reference source other than the optional on-board reference module is required. The modules are programmable for full range voltage outputs from 2 to 115 VAC, and frequency from 47 Hz to 10 kHz.

Module	Description
AC2	2 Channels, 2-28 Vrms, 47 Hz-20 kHz (max. range), programmable
AC3	2 Channels, 28-115 Vrms, 47 Hz-2.5 kHz (max. range) programmable

Key Features

- High accuracy reference or source AC voltages
- Variety of Vrms ranges
- Overcurrent protection
- All channels have continuous background Built-In-Test (BIT)

Built-In Test (BIT)/Diagnostic Capability

Automatic background BIT testing is provided. Each channel is checked for correct voltage, current and frequency. Any failure triggers an interrupt, if enabled, with the results available in the status registers. The testing is totally transparent to the user and has no effect on the operation of this module.

Thermocouple and RTD Measurement - NAI's thermal measurement smart function modules provide a thermocouple (TC) and/or resistance temperature detector (RTD)The TR1 provides eight channels which can be individually programmed as a Thermocouple (TC) or a Resistance Temperature Detector (RTD) measurement interface. NAI offers 3 thermal measurement smart function modules. Each are individually configurable for up to 8 isolated measurement channels. TC smart function modules can interface with virtually all thermocouple-type NIST temperature ranges. RTD smart function modules can interface to two, three and four-wire platinum RTD sensor configurations.

Function	Module	Description
RTD	RT1	8 Channels, RTD Measurement
Thermocouple	TC1	8 Channels Thermocouple, Independent 24-bit Sigma-Delta type
RTD or Thermocouple	TR1	8 Channels Independent 24-bit Sigma-Delta type (one for each channel)

Key Features

RT1

- 8 measurement channels
- Higher accuracy and repeatability as compared with thermocouples in applications below 600° C
- Two, three or four-wire mode
- Channels are calibrated at the factory

Built-In-Test (BIT) / Diagnostic Capability

Automatic background BIT testing is provided. Each channel is checked for correct A/D operation using an onboard 100 Ω nominal resistor. The open input detection test applies a 0.5 µA current to the A/D converter inputs. The FPGA then tests for a full-scale reading, indicating an open circuit. Any failure triggers an interrupt, if enabled, with the results available in the status registers. The testing is totally transparent to the user and has no effect on the operation of this module. It can be enabled or disabled. It is enabled by default

TC1

- Eight measurement channels
- Interfaces with virtually all NIST temperature ranges
- Self-powered
- Large temperature range; up to 2300° C
- Accuracy up to ±0.2° C

Automatic Background Built-In-Test (BIT) / Diagnostic Capability

Automatic background BIT testing is provided. Each channel is checked at periodic intervals for correct A/D operation using an internal measurement of an on-board resistor reference. The open input detection test applies a low-level current pulse to the A/D converter inputs and tests for a full-scale 3.3V limit, indicating an open sensor circuit. Any failure triggers an interrupt if enabled, with the results available in the status registers. The testing is transparent to the user and has no effect on the operation of this module. Enabled by default at power on, it may optionally be disabled

TR1

Thermocouple Features

- Interfaces with all standard NIST thermocouple types
- Self-powered
- Large temperature range; up to 2300° C
- Accuracy up to ±0.2° C (thermocouple type dependent)
- Measurement capability for low voltages, microvolt ranges

RTD Features

- Higher accuracy and repeatability as compared with thermocouples in applications below 600° C
- Two, three or four-wire mode
- Channels are calibrated at the factory for Pt100, Pt500, and Pt1000 RTDs

Automatic Background Built-In-Test (BIT) / Diagnostic Capability – Same as TC1

Variable Reluctance - NAI's variable reluctance (VR) and general-purpose pulse counters measure from a wide voltage input range variable reluctance (VR) signal or general-purpose pulse counter measurement. Channels can be programmed to operate individually or combined in pairs. NAI's VR smart function modules are ideal for speed sensing for aircraft, marine or automotive crankshafts, camshafts, brake or gear rotors, transmission shafts, etc. and is uniquely designed to process signals as a general-purpose counter, that can operate and process a wide variety of AC and DC input signals.

Function	Module	Description
Measurement	VR1	8 Channels, Differential Input. VR Pulse Timing & Count, GP Pulse Counter, Individual channel or in paired mode

Key Features

Variable Reluctance Interface
- 8 isolated, differential input channels, Monopole or Dipole Mode
- Large voltage range input, ±25 mV to ±100 V
- High-rate pulse train detection, 1 ns resolution

General Purpose Counter
- 32-bit
- Pulse Count
- Single channel: Increment
- Paired channel: Up/Down A, Up/Down B and Up/Down A-B (Quadrature)

Frequency
- 1 MHz (maximum, continuous; depending on some settings e.g. filtering, 4 Mbps is potentially achievable)
- 20 kHz with auto threshold and auto ranging modes enabled

Independent Channel Configuration
- Programmable parameters for interfacing with different sensor types
- Independent or paired mode

Isolated Channels
- Mitigates ‘noise’ false trigger count

Initiated Built-In Test
The initiated BIT test is initiated by the user, momentarily taking the specified test channels offline for a duration of 1ms. An internal reference signal is measured and verified for accuracy, with the test result displayed in the BIT status registers

Strain Gauge Measurement - While there are several methods of measuring mechanical strain, the most common is with a strain gage. The gage provides electrical resistance that varies in proportion to the amount of strain in the device. The most widely used gage is the bonded metallic strain gage. To measure such small changes in resistance, strain gages are almost always used in a bridge configuration with a voltage excitation source. The general Wheatstone bridge (conventional, 4-arm bridge) consists of four resistive arms with an excitation voltage, Vexc, that is applied across the bridge. NAI's strain gage smart function module uses four independent, isolated input A/Ds. This module is designed to read output signals from a completed Wheatstone bridge (i.e., it can be used with one or more strain gage elements as a completed 4-arm Wheatstone bridge) and is commonly used in applications requiring pressure, weight, and stress transducers interface/measurement.

Function	Module	Description
Measurement	SG1	4 Channels, Strain Gauge Measurement

Key Features

- Four independent, isolated input A/Ds
- Designed to read output signals from a completed Wheatstone bridge
- Used in applications requiring pressure, weight and stress transducers interface/measurement.
- On-chip digital filtering for wide dynamic range signal measurement
- DC excitation for load and accelerometer gauge interface (programmable from 2-12 VDC)
- Onboard management of A/D interface, register access and sample timing
- Internal and system calibration included

Automatic Background Built-In Test (BIT)/Diagnostic Capability

Automatic background BIT testing is provided. Each channel is checked at periodic intervals for correct A/D operation. Any failure triggers an interrupt if enabled, with the results available in the status registers. The testing is transparent to the user and has no effect on the operation of this module.

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Rev. A