



Endevco's mixed-mode smart transducer system in multi channel vibration measurement

TP 315
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Endevco is an established world leader in the development of innovative sensor technology. Its list of “firsts” includes the first computer programmable charge amplifiers, the first automated calibration system, the first monolithic silicon piezoresistive accelerometer, the first “shear design” accelerometer, and the first smart accelerometer.

Endevco again leads the way by currently manufacturing “Plug & Play” i-TEDS accelerometers and SMART ISOTRON®/OASIS systems for mixed-mode applications. The Endevco SMART ISOTRON®/OASIS system fully complements the entire range of mixed mode sensor applications providing an exclusive range of features and benefits for the test community. This now gives end-users the capability to eliminate human documentation errors and substantially reduce set up time while working within a software-controlled network environment.

IEEE 1451 Standard

The IEEE 1451 standard provides a common communication interface for smart transducers. It is a cooperative development between industry and the National Institute of Standards and Technology, the governing body in this effort, to satisfy the requirements of industry to have an interchangeable transducer product. This standard is comprised of four sub-groups which detail how the smart transducer concept can be applied to various sensor types. The IEEE 1451 standard defines an object-oriented view of a networked smart transducer. This view incorporates a backplane with hardware and software blocks to enable desired functionality. Currently, there are four sub-groups in various stages of development.

IEEE 1451.1: Defines the software function blocks for the Network Capable Application Processor (NCAP) to interface a smart digital transducer to a network.

IEEE 1451.2: Defines a point-to-point serial interface between a transducer using a Smart Transducer Interface Module (STIM) and the NCAP. It also defines the Transducer Electronic Data Sheets (TEDS).

IEEE 1451.3: Defines the high speed multi-drop digital bus. This bus is intended for shortrun connections of multiple transducers using a Transducer Bus Interface Module (TBIM)

IEEE 1451.4: Defines the interface of a mixed-mode transducer which is able to transmit digital ID's (TEDS) over the same pair of point-to-point wire used for carrying power and high frequency analog output signals from the sensor.

Implementation of the 1451.4 standard has two primary goals:

- Eliminate the conventional “bookkeeping” practices of recording transducer model number, sensitivity, and mounting location. This lessens per-channel cost for test set up, minimizes paper work, reduces errors, and saves time.
- Enable users to implement TEDS, the essence of the standard, into existing measurement systems without system re-wiring.

Endevco's SMART ISOTRON System approach

Endevco offers a comprehensive smart system to provide more than just a sensor with digital ID. Our system approach consists of ISOTRON® accelerometers with Transducer Electronic Data Sheet (TEDS) capability, Smart Signal Conditioning with expert software, and dedicated hand-held programmers.

Our engineers believe that TEDS is only useful if it can be accessed easily by the engineer or technician making the measurement. In order to fully utilize the digital identification information in a practical sense, Endevco offers the Smart ISOTRON® system. This system provides:

- Instant transducer identification.
- Gain normalization of the system output which maximizes the signal to noise ratio of the A/D process.
- The capability to use a hand held programmer which allows on-the-spot programming, thereby minimizing transcription errors when working in large channel count environments.
- On-site transducer health check.
- OASIS software SW2000 which communicates the TEDS to the analysis software. This user friendly software package is designed to shorten set-up time and facilitate configuration management.
- In-line modules containing TEDS that provide upgrade path to non-Smart Sensors now held in inventory by end-users.

Use sensors you already have.

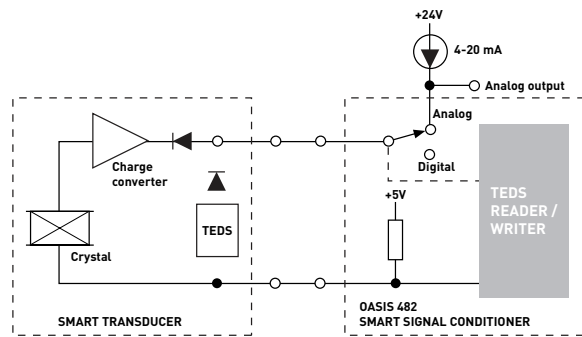
Transducer Operation

Endevco's i-TEDS (ISOTRON with TEDS) accelerometer incorporates the same two wire coaxial cabling used with standard ISOTRON® transducers. The standard supply voltage of +24V DC is routed through a constant current circuit (typically rated at +4 mA) from equipment such as Endevco's OASIS Smart Transducer Signal Conditioner. The i-TEDS incorporates a digital microcircuit chip between the transducer hybrid circuit output and the coaxial receptacle.

The digital memory chip stores the TEDS information for input/retrieval in the digital mode.

Sensors operate in analog or digital mode

During the analog mode, Endevco's OASIS conditioner is switched to act as a standard ISOTRON® conditioner. In the analog mode, the transducer's digital memory chip is inactive due to diodes restricting the positive current flow to the hybrid amplifier (see Diagram 1).



Connection diagram

BRAVO 400

When the OASIS conditioner is switched into the digital mode, the analog supply voltage is interrupted and a negative current flow is routed to the digital memory chip within the i-TEDS transducer for inputting or retrieving TEDS information. This is accomplished at a switch rate of 13.6k bits/second. Within the OASIS conditioner is a Transducer Independent Interface (TII) and a host computer. This ensures proper polarity and protocols to be used during the digital mode. Therefore Endevco's i-TEDS transducers may be operated in the analog mode as a typical ISOTRON® low impedance transducer or in the digital mode as an i-TEDS transducer with the added benefit of TEDS technology.

3.2 TEDS (Transducer Electronic Data Sheet)

The key feature of the mixed-mode Smart Sensor is its digital ID/TEDS. The 1451.4 TEDS includes the following sensor-specific data:

- Permanent memory (ROM)
 - Manufacturer
 - Model no.
 - Serial no.
 - Date manufactured
 - Type no.
- Programmable memory (EEPROM)
 - Calibration data
 - Sensitivity
 - Unit
 - Reference frequency
 - Calibration date
- Other information
 - Sensor location ID
 - High Pass (HP) and Low Pass (LP) cutoff frequency
 - Transfer function coefficients
 - Service history
 - Notes

Sensors have programmable memory for calibration and other information.

The permanent data is meant to be read only. This data is designed to be stored in the ROM portion of the digital chip. Other variables such as sensitivity, calibration date, sensor position ID, and other advanced coefficients are written to the EEPROM part of the memory chip as required (see Figure 4).

The ability to access TEDS sensor information on demand has many merits in the areas of configuration control and technical utility. Not only does TEDS provide for sensor “Plug-and-Play” functionality and enable seamless sensor/electronics interface, it permits the design and construction of test systems that allow for the acquisition of accurate, reliable, and repeatable measurements from which mathematical models can be established.

Benefits of Endevco’s SMART ISOTRON® system in multi-channel measurements

Measurements performed on large structures such as

aircraft fuselages and space booster launch pads require many channels of sensors. In most cases, over half of the time consumed in a multichannel testing installation is related to set up and configuration control—keeping track of sensor ID, cable ID, channel ID, and entering sensor database information into analysis software. With the Endevco Smart System, most of these time-consuming efforts will be minimized or eliminated entirely.

Smart sensors minimize or eliminate previously time-consuming setup activities.

The advantages of using Endevco’s SMART System approach are numerous:

- Elimination of sensor look-up tables. All up-to-date information about the sensor is stored in the TEDS memory chip. There is no need to generate a separate database for sensor sensitivity obtained from the manufacturer’s calibration certificates. Current calibration data is downloaded to the TEDS memory chip (EEPROM) at the time of recalibration.
- Elimination of cable connection errors. Built-in TEDS does away with manual connection tracking. The ID of the sensor is always available to the user regardless of how connections are made. In a typical multi-sensor test setup, a great deal of non-productive work is spent on matching sensor serial numbers to their connecting cables as well as keeping track of the subsequent connections throughout the system. This type of bookkeeping is prone to human errors as the number of channels increases. In large systems, where the tangle of cables is inevitable, distractions are bound to occur, creating the opportunity for additional mistakes.
- Location identification. Exact location of the sensor is of prime interest to the user during modal testing. Information such as position ID, orientation, coordinates, and polarity of the sensor is typically

recorded in a table and manually input into the analysis software. With Smart ISOTRON® sensors, these installation-specific parameters can be stored in TEDS along with all other parameters, then exported as required. In short, all information about the sensor and its whereabouts is known to the system once the location information has been entered into the TEDS chip. It is at this critical point where the Endeveco system excels. Endeveco's uniquely designed hand held programmer (model 36004) allows the user to enter location information (position ID, orientation, polarity) into the TEDS transducer in-situ. Without onlocation programming, a series of manual transcriptions of location information has to take place. An explanation of each of these tools is provided in a later section of this document.

- Instant transducer substitution. Real world tests dictate the need for accelerometer substitution on an emergency basis immediately before or during the test. With the use of i-TEDS accelerometers, this substitution can be quick, since TEDS data contains all device parameters required. Consequently, one can change sensors "on the fly" without worrying about system set up changes. Once the transducer has been substituted, all pertinent data is downloaded into the OASIS software database at the click of a mouse button. There is no lengthy "paper trail" before continuing a test – all adjustments are completed automatically. An intelligent signal conditioner at the receiving end will notice the sensor substitution and make up gain or transfer characteristic adjustments automatically ... a true "Plug-and-Play" scenario.
- Full scale output automatically matched to A/D converter. Endeveco's SMART ISOTRON® signal conditioner queries the sensors with regard to their sensitivities during the communication mode and automatically adjusts the gain of each channel to match the full scale input range of the A/D. This feature maximizes the signal-to-noise ratio of the digitization process.
- Improved product quality and shortened market timing. Competitive pressures have increased customer expectations for improved product quality. Modal testing with built-in TEDS not only will help many manufacturers shorten time to market for new products, but also will create an environment for improved quality control through increased accuracy and reliability of test data. OASIS SW2000 software provides a tab-delimited import feature to allow the user the ability to download this data directly into the software and be displayed directly to the applicable sensor channel. This benefits the user by storing all information in one convenient location for long-term storage, printing, and recall for repeating a test. This software database allows the use of non-smart sensors in a near smart sensor mode.

Software supports nonsmart sensors.

Components of Endeveco's smart ISOTRON® system

Endeveco provides Smart Sensor technology users a choice of options that completes all front-end, signal conditioning system needs and provides necessary Smart Sensor options for the calibration laboratory and installation purposes. The heart of the system is the OASIS 2000 eight-channel Smart Sensor amplifier card (model 482) which is combined with powerful, user-friendly software (SW2000) that has an integrated database to manipulate Smart Sensor data. The following is a detailed description of each component comprising the system.

Smart ISOTRON® amplifier card model 482

This eight-channel card is the new revolutionary signal conditioner used with I-TEDS accelerometers and other IEEE-1451.4 compliant sensors. Key features include:

- Used with IEEE 1451.4 compatible sensors and backwards compatibility with standard non-Smart ISOTRON® Sensors
- Extremely fast TEDS data retrieval
- Sensor open/short fault detection

- Computer-selected low-pass Butterworth filters
- Programmable gain 0 to 100
- Gain auto ranging
- 0.015 Hz to 100 kHz bandwidth (-3dB corners)
- Standard "D" input and output connectors
- BNC output connector for bank switching
- On-board microprocessor

OASIS 2000 eightchannel amplifier card is heart of system.

The model 482 [see Fig. 1 & Fig. 2] is an eight-channel amplifier card that communicates with newly developed i-TEDS accelerometers and provides backward compatibility for use with other Integral Electronic Piezo-Electric (IEPE) transducers and Remote Charge Converters (RCC). Each 482 card has an independent microprocessor, providing the fastest means of set up and transfer with increased reliability. Each channel has a built-in computer-selected, Butterworth low-pass filter with computer selected corner frequencies of 100 Hz, 1 kHz and 5 kHz and broadband. I-TEDS data retrieval is so fast, a 128 channel system can gather i-TEDS data, transmit and populate the computer software screen in less than 20 seconds! (Competitors take several minutes to accomplish the same simple task.) The features of programmable gain and gain auto ranging work together to provide the best possible signal to noise ratio by optimizing the range of the A/D converter for the amplifier.

Butterworth low-pass filter is built-in and computer-selected.

Model 482 support options include a 32 channel input breakout panel. Each breakout panel provides "D" connectors to mate with up to four model 482 amplifiers which convert card inputs and outputs to convenient BNC connectors.

Up to 16 model 482 cards can be housed in a single

rack (model 4990), providing a powerful 128 channels of flexible, intelligent signal conditioning for almost any testing needed. Up to 16 racks can be controlled from one computer to provide a maximum of 2048 Smart ISOTRON® channels.

Each 482 card supports 8 channels. Each rack houses 16 cards. 16 racks can be controlled from one computer to provide up to 2048 smart ISOTRON channels.

Ideally, a test lab would have one channel of data acquisition for each channel of vibration input. However, users may only have a 32-channel data acquisition system and be required to make multiple tests. With other instrumentation, it becomes labor intensive to connect/disconnect input cables to each amplifier channel one at a time. With the model 482, each card has a BNC output that is controlled via SW2000, the OASIS configuration software. The software allows the user to select one of the eight outputs at a time, allowing the user to perform what is called "bank switching". Bank switching gives the user the ability to perform multiple tests, utilizing a single 32-channel data acquisition system switching different channels for each test. It is possible to use two full racks of model 482's by switching each of the eight channels for eight different tests with eight different accelerometer inputs and one data acquisition system.

Bank switching allows multiple tests with a single 32-channel system



Figure 1 Model 482

Model 4990 OASIS system rack

The basic function of the OASIS rack is to provide a convenient, protective, cooling housing for the 4XX series amplifier cards. The rack provides the necessary power of ± 15 VDC, +5 VDC and +24 VDC, required for the 4XX series cards. The rack also provides the RS-232 or Ethernet communication interface, an external calibration input connector, and four ganged "D" amplifier card output connectors.

The 4XX series amplifier cards that can be used with the model 4990 rack include the model 428, a two channel PE/ISOTRON[®] amplifier, the model 436, a three-channel PR/DC amplifier card and the eight-channel Smart ISOTRON[®] amplifier. Any 4XX series card can be mixed in any combination in the rack and "hot" swapped without damage.

There are two communication options for OASIS System Rack: Ethernet or RS-232. Ethernet control is used when more than one rack is required. RS-232 is used only when one rack is required. The standard rack is designed for installation into 19" cabinet enclosures. The rack has removable mounting handles/brackets making it easy to reverse the front and rear when necessary. When bench-top use is desired, an optional, convenient outer shell with handles and angled feet (P/N EHM1616) is available. Shown below is the model 4990 with the added bench-top shell.

OASIS supports Ethernet or RS-232 communications.



Figure 2 Model 4990 with inserted cards

OASIS Software SW2000

OASIS SW2000 software was developed to configure and control model 4XX series signal conditioners and charge amplifiers. It is a simple to use, graphical interface that controls up to 2048 channels of Smart ISOTRON[®] sensors. Other significant, value-added enhancements provide user benefits beyond basic system configuration software. These key features include:

- Data import/export in a tab-delimited format
- Data entry verification functions—auto number, setting calibration due dates, checking sensor calibration due dates, and detection of duplicate entries
- Writing TEDS sensor location to Smart Sensors
- Capturing, reporting, and displaying amplifier channel signal levels
- Amplifier diagnostics
- PE sensor check
- Amplifier notes—storing and time logging
- Saving, copying, and printing configuration files
- Gain auto-ranging
- Off-line mode—used to configure a complete system test set-up without hardware attached

SW2000 is a proven, robust software developed to support each series 4XX amplifier card. This software provides complete set up, storage of each card's configuration, and retrieval of previous configuration files as well as configuration data file import and export capability. SW2000 software provides a user-friendly interface for easy configuration of any 4XX series card. Signal conditioner channel settings are selected from simple, context-sensitive or pull-down menus. Once selected, they can be sent to a single signal conditioner channel, all of the channels on a card, a selected group of cards, or globally to all cards of the same type at one time. After all amplifier settings are completed, a "save as" configuration file can be created to save these settings for recall and immediate use.

The OASIS software can easily be used to verify sensor calibration due dates, provide installation information,

setups, print reports and export amplifier data for other data acquisition instrumentation setups.

OASIS SW2000 gathers and displays the following TEDS data: Sensor position location, Sensor ID (make, model, serial number), and calibration date. Download of Smart Sensor TEDS data into the OASIS SW2000 application software database is nearly automatic. The user simply clicks the mouse to gather data from all Smart Sensors attached. Key features:

- Read TEDS into SW2000
- Import analysis software setup table
- Combine the setup table with TEDS data in SW2000
- Export finalized table back to analysis software in tab-delimited format
- Built-in error checking
- Auto gain—with a selectable limit window
- Off-line mode

One mouse-click downloads TEDS data into OASIS SW2000 software database.

TEDS data is read from an accelerometer into the OASIS software by clicking the “amplifier” icon, then selecting “Read TEDS”. This will cause each 482 board to retrieve TEDS from each sensor, with the result being displayed in the column for every channel that has a TEDS sensor attached. 128 channels of i-TEDS data retrieval is accomplished in less than 20 seconds!

Import software supports new “User Fields.”

The data import software feature allows use of external data files to selectively bring in data to supplement TEDS data read from sensors. This is helpful in three ways: first, “User Field” data can be imported from other databases into matching fields of SW2000. Import data fields are selected or identified from the Import Data menu. Second,

new “User Fields” can be added to SW2000 and this data can be imported in a similar manner. Third, data for non-smart sensors can be imported into each of the OASIS software data fields, creating a final test configuration database. Data imported must be in a tab-delimited format.

To permanently combine data that has been imported into SW2000, it must be saved as a configuration file. This is easily done by selecting the “File” icon from the menu, then saving it as a particular filename. Combining and saving the data allows permanent storage of a test configuration, which can be printed out or exported to another database or analysis software.

Exporting data in a tab-delimited format is accomplished by opening a previously saved filename and selecting the row and column data as required. This data is typically imported into follow on data acquisition instrumentation or analysis software to reduce set up time.

SW2000 software contains built-in error checking features to minimize manual data entry errors or inconsistent entries (e.g., duplicate sensor serial numbers, cable IDs, or measurement positions) in any of the configuration fields. Errors are automatically detected and flagged for resolution. Date and time are automatically stamped in any printed form for configuration control. System configuration information can be exported in comma or tab-delimited text file format for use with other software applications.

SW2000 Auto Gain allows the amplifier’s gain to auto range for a duration specified by the user. Auto range is accomplished by adjusting the “Full Scale Input Range” so that the maximum instantaneous absolute peak signal, detected at the output during the specified duration, is within 40% to 80% of the “Full Scale Output Range” setting. The auto gain duration is programmable from a minimum of 15 seconds to a maximum of 200 seconds in steps of 5 seconds. During auto gain, the vibration level is below the actual test level to ensure that each amplifier’s dynamic range is optimized. Auto gain optimizes the range of the

A/D converter to provide the amplifier the best range for accuracy and signal-to-noise ratio.

Programmable autogain optimizes each amplifier's dynamic range.

SW2000 software can operate in either "On-line" or "off-line" mode. On-line mode provides the user with instantaneous hardware control, displays actual settings, and provides status information of the OASIS hardware. Off-line mode allows the user to develop and store various measurement system configurations without requiring hardware to be present. Up to 16 racks containing any mixture of the 4XX series amplifiers can be controlled with this software. The OASIS software configuration window is depicted in Table 1.



Device ID	Device Name	Device Status
1	1000	OK
2	1001	OK
3	1002	OK
4	1003	OK
5	1004	OK
6	1005	OK
7	1006	OK
8	1007	OK
9	1008	OK
10	1009	OK
11	1010	OK
12	1011	OK
13	1012	OK
14	1013	OK
15	1014	OK
16	1015	OK

Table 1 OASIS SW2000 software configuration editor

Model 36004 hand held programmer

The model 36004 Smart hand held programmer is a portable, Read/Write, time-saving instrument designed specifically to interface with Smart Sensors. This system component allows the user to program Smart Sensor application-specific information regarding a sensor's mounting location, orientation, coordinates, and polarity.

The hand held programmer helps minimize data entry errors by allowing the user to enter measurement location

information (position ID, orientation, polarity) into a Smart ISOTRON® in-situ when installing a Smart ISOTRON® accelerometer. The unit comes complete and ready to use. Simply connect to any IEEE 1451.4 compatible Smart Sensor to Read/Write data for tremendous test set up time savings. The unit's key features include:

- LCD readout of sensor TEDS information
- Units displayed in $mV/m/s^2$ or mV/g
- Fault detection for Smart Sensors and standard ISOTRON® sensors
- Rechargeable battery power and automatic power-down
- Sensor location data written to sensors with TEDS



Figure 3 Model 36004

Model 36018 calibration software

The Endevco model 36018 software is an IEEE-1451.4 TEDS Editor providing a read and write capability for IEEE 1451.4 compliant sensors using 1-wire interface technology. This software was designed for use exclusively by Calibration Laboratories to over-write "All" TEDS data fields for Smart Sensors after calibration and to program fields not accessible with the hand held programmer. The software comes ready-to-use with the necessary RS-232 adapter and cable to connect to a Smart Sensor or TEDS compatible unit with a 10-32 style connector.

Ready-to-use software programs fields not accessible to hand-held programmer.

This program is compatible with IEEE 1451.4 sensors that use the accelerometer-transfer function template and employ a 256 bit 1-wire DS2430A (or compatible) memory device for data storage.

Additionally, this program requires the use of a Dallas Semiconductor Universal 1-wire com port adapter, P/N DS9097U-S09 (provided with the software). This adapter must be attached to the PCs, COM1, or COM2 serial port and the sensor connected to it. Note: It will not work with the DS9097U-009 adapter (The correct adapter is supplied). Shown in Figure 4 is the main screen of the TEDS programmer software.

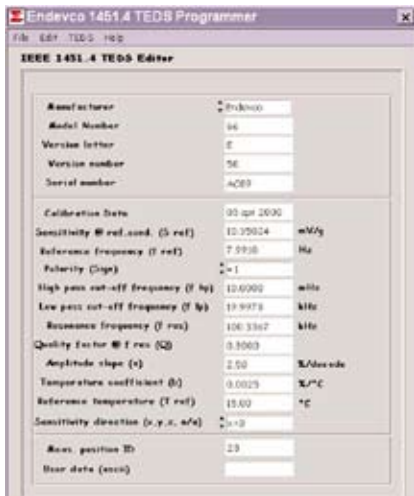


Figure 4 1451.4 TEDS programmer main screen

SMART ISOTRON® accelerometer family, i-TEDS line

The model 222A11 is a miniature accelerometer for vibration and shock measurements on printed circuit boards, lightweight structures, and automotive component testing. This 0.5 gram, electronically isolated device features adhesive mounting, 10 mV/g sensitivity, 500 g's F.S. and frequency response of 1 Hz-10 kHz ($\pm 5\%$).



The model 702A11 is a miniature i-TEDS accelerometer ideally suited for satellite vibration testing and lightweight structural tests. This 5.5 gram unit features a top connector, 10 mV/g sensitivity, 500 g's F.S. and frequency response of 1 Hz-6 kHz ($\pm 5\%$).



Endevco model 66A12 provides excellent sensitivity and resolution for low level measurements. The model 66 features Smart ISOTRON® capability with on-board TEDS circuitry. Sensitivities available are 5, 10, and 100 mV/g. Frequency response is 0.5Hz-10kHz ($\pm 5\%$). This unit consists of a welded titanium case with a single four pin connector.



The model 7752A13 is a very high sensitivity accelerometer for measuring extremely low vibration levels as found in bridge structures, isolation tables, and building motions. This 33 gram, hermetically sealed unit, features a 1000 mV/g sensitivity with 5 g's F.S. It is an electrically isolated device with a .5 Hz - 7 kHz ($\pm 5\%$) frequency response.



This model 63C12/63C13 Triaxial accelerometer is electrically isolated, hermetically sealed, and has a sensitivity of 1000 mV/g (C13) and 100 mV/g (C12) respectively. Frequency response is 0.5 Hz-3 kHz ($\pm 5\%$).

Model 2801M1 in-line Smart ISOTRON® convertor module

The 2801M1 in-line Smart ISOTRON® convertor module is used to add the intelligence of Smart Sensors to a customer's existing ISOTRON® inventory. This in-line module contains the value-added significance of TEDS and can be easily attached to non-Smart Sensors, providing the full timesaving, intelligent features of a Smart Sensor. The module has female 10-32 connectors on each end and is small enough to put in-line without interference. Key features include:

- Smart Sensor interface chip for TEDS IEEE1451.4 TEDS-compliant self-identification
- Wide frequency response
- Two-wire system
- Upgrade for customer's existing ISOTRON® accelerometer inventory for Smart Sensor use



Model 2801M1

Model 2771B/2801 Remote Charge Convertor (RCC)

The model 2771B and the model 2801 are in-line Remote Charge Convertors (RCC) with the addition of TEDS capability (an RCC is a low-noise, two-wire, single-ended device designed for use with Single-Ended Piezo-Electric (SEPE) transducers). This device transforms a transducer's high impedance charge output to a low impedance voltage proportional to the transducer's input charge signal. The 2771B is available with gain options of 0.1 mV/pC, 1.0 mV/pC and 10.0 mV/pC, and operates within a constant current range of 4 to 20 mA. The model 2771B has a 10-32 connector for sensor attachment and a BNC female connector for its output. The model 2801 has 10-32 connectors on each end making it an ideal in-line attachment. It has gain options of 1.0 mV/pC and 10.0 mV/pC. With the addition of the TEDS capability, each RCC can store and recall programmed sensor data pertinent

to the sensor attached. This gives the user the ability to employ SEPE sensors in an extreme environment yet make effective use of all TEDS features. Key features include:

- Low noise
- Smart Sensor interface chip for TEDS IEEE 1451.4 TEDS-compliant self-identification
- Wide frequency response
- Two-wire system
- Upgrade for customer's existing PE accelerometer inventory for Smart Sensor use



Model 2801

Conclusion

The IEEE 1451.4 standard is a reality. There is little doubt distributed data acquisition systems communicating via Ethernet, RS-232 or wireless schemes will dominate large, multi-channel test installations. There will also be a rapid evolution of smart sensors and accessory hardware. This will simplify dynamic test set up/analysis and make modal analysis faster and more accessible to industry. The challenge for manufacturers of sensors and test instrumentation equipment is to provide tools that will enable the test community to implement this new technology thereby increasing efficiencies.

Endevco is leading the way in this effort by currently manufacturing i-TEDS accelerometers and SMART ISOTRON®/OASIS systems for mixed-mode applications. The Endevco SMART ISOTRON®/OASIS system fully complements the entire range of mixed-mode sensor applications providing an exclusive range of features and benefits for the test community. Endevco's expertise in transducer development and manufacturing is unparalleled in the sensor industry. Endevco has been leading the way in sensor development for over fifty years and continues this effort with our unique SMART ISOTRON®/OASIS system.

Executive summary of Endevco's mixed-mode smart transducer system

Smart ISOTRON® accelerometer family:

- Model 222A11 for circuit board testing.
- Model 702A11 for satellite vibration testing.
- Model 66 for lightweight, triaxial measurements.
- Model 7752A13 for very low bridge vibration testing.
- Model 63C12/63C13 Triaxial for high sensitivity applications.

Key Concepts

- IEEE 1451 standard provides a common communication interface for smart transducers.
- IEEE1451 has four sub-groups that detail integration of smart transducers with specific sensor types.
- Two-wire coaxial cable is used to power and communicate with sensors.
- Sensors may operate in analog or digital mode.
- i-TEDS transducers are programmed by routing negative current flow to digital memory.
- Sensors have permanent memory containing factory information and programmable memory for calibration and other information.
- Smart ISOTRON® systems eliminate creation of lookup tables and cable connection errors. They allow instant transducer substitution, improved product quality, and automatic matching of full scale output to A/D converter.
- Model 482, 8-channel amplifier card is heart of OASIS system.
- Each rack houses 16 channels.
- One computer can control 16 racks.
- Bank switching gives users ability to perform multiple tests using a single 32-channel system.
- Function of model 4990 OASIS system rack is to provide protective housing for 4XX series amplifier cards.
- Any 4XX amplifier card can be mixed and hot-swapped in the model 4990 rack without damage.
- OASIS SW2000 graphical interface software can control up to 2048 channels of Smart ISOTRON® sensors.

- OASIS SW2000 features data import/export in tab-delimited format, data entry verification, writing TEDS sensor location, amplifier diagnostics, PE sensor check, saving/copying/printing configuration files, gain autoranging, and off-line mode.
- Download of TEDS data into OASIS database is achieved with one mouse click.
- Model 36004 hand held portable programmer writes measurement position location into a smart sensor.
- Model 36018 calibration software comes with ready to use RS-232 adapter.
- Convertor module 2801M1 is available to convert existing ISOTRON® inventory to smart sensors.
- Remote Charge Convertor 2771B/2801 changes sensor high impedance charge output to low impedance voltage.

Abbreviations

EEPROM	Electronically Erasable Programmable Memory
HP	High Pass
IEPE	Integral Electronic PiezoElectric
ISOTRON®	Piezoelectric accelerometer with built-in electronics, providing a low impedance voltage output
i-TEDS	ISOTRON® with TEDS (see abbreviation below)
LP	Low Pass
NCAP	Network Capable Application Processor
NIST	National Institute of Standards and Technology
OASIS	Optimal Architecture Sensor Interface System
RCC	Remote Charge Convertor
ROM	Read Only Memory
SEPE	Single Ended PiezoElectric
STIB	Smart Transducer Interface Bus
SW2000	Software 2000 for OASIS
TEDS	Transducer Electronic Data Sheet
TII	Transducer Independent Interfacev

