SHELDON INSTRUMENTS

SI-100 User's Guide

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1.0 Introduction and Product Overview.

The Sheldon Instruments SI-100 Signal Conditioning, Data Acquisition and Control System is a fully featured stand-alone unit, ideal for any number of analog and digital input/output applications. Ideal because maximum performance is obtained by interfacing the SI-100 with any computer platform by means of an ultra high speed DSP accelerator.

The DSP accelerator resides inside of the computer where it operates in parallel with the host microprocessor. With this approach, the microprocessor is designed to exclusively service the graphical user interface software, thereby delegating all of the intensive number crunching tasks to the DSP. The performance of the DSP is not affected by the software nor the computer bus, since all of the low level bus drivers are virtually independent of the operating system. Full integration is possible with PCs, Macintoshes and Unix based Workstations.

All data is transmitted and received over a single high speed, RS-422 serial interface to the DSP at any rate, 0hz to 6Mhz, in one of the several standard IRIG pulse code modulation formats. As a stand-alone unit designed to fit in a standard 19 inch rack, any computer platform can be used to run a multitude of popular third party data analysis, processing, and control software packages.

Such software packages, with their extensive graphical features, are only further enhanced with their ability to display, analyze, and continuously acquire data directly to and from hard disks. The SI-100 is extremely well suited for aerospace, military, and automotive testing, industrial control and automation, as well as any other instrumentation applications.

The inputs are fully expandable to 32 modules or 255 channels. Each module contains 8 channels, complete with their own independent analog signal conditioning and processing components. Any input can be configured for differential or single ended operation, thereby accommodating any bridge or piezoelectric sensor type. All of the channels are digitized to a resolution of 12 bits, at an additive rate of up to 500khz with an accuracy of +/-1hz.

One of the more powerful features of the SI-100 is the ability to change sampling rates of each channel, within the range of 120hz to 62.5khz, and select the filter type (bessel, elliptic or none) without any hardware alterations to the anti-aliasing filters. Each filter automatically adjusts to its corresponding cutoff frequency, in the range of 48hz to 25khz. In addition, each channel has independent gains of +/-0.50 to +/-100 to improve dynamic range to within +/-10Vpp, and independent DC offsets of +/-250mVdc to +/-2.5Vdc.

The outputs are fully expandable to 16 modules or 128 channels. Each module contains 8 multiplying 12 bit digital to analog converters with voltage output, complete with variable internal or external referencing. A separate bus from the inputs allows outputs to be additively updated between 0hz to 500khz.

2.0 Hardware and Software Installation.

2.1 QuVIEW and SI-C3XDSP Software Installation for the PC.

The SI-100 communicates with the PC by means of an SI-C3xDSP card for either the PCI or ISA busses. Likewise, the DSP card must communicates with the host application LabVIEW through drivers and DLLs (dynamic link libraries). Therefore, the DSP card is to be installed and verified for proper operation before connecting the SI-100.

NOTE: LabVIEW must already be installed onto your computer before any Sheldon Instruments software is to be installed. QuVIEW is a set of DSP resident libraries that run under LabVIEW, and therefore is installed within the LabVIEW directory structure.

It is very important for certain procedures to take place in order for the SI-C30DSP card to operate correctly. A CD-ROM has been included that allow you to automatically install all of the necessary files for QuVIEW, as well as the remaining driver files. Proceed to install all files by invoking the "Setup" icon in the root directory of the CD-ROM. Remember, LabVIEW must already be installed on your system.

For a PCI card, follow these steps:

1) If you are installing a PCI DSP card, follow the installation procedure. The Windows 'Hardware Installation Wizard' will be invoked automatically. This wizard will install the drivers from the \DRIVERS subdirectory on the CD-ROM.

For an ISA DSP card, follow these steps:

1) When installing an ISA card, the appropriate files can be found in the CD-ROM's \SIC30DSP\ISA subdirectory. These files must be moved up by one level into the \SIC30DSP subdirectory.

2) For an ISA DSP card, the AUTOEXEC.BAT file must be altered so as to include the following lines:

   \SIC30DSP\C31LOAD -p 240 -D 100 -t \SIC30DSP\C31INI32.OUT

NOTE: In order for these lines to execute properly, they must be inserted before any batch files or the WIN command for invoking Windows.

3) Once inserted, reboot your computer so that the SI-C3xDSP card can be initialized. The following message will appear indicating whether or not the DSP loaded properly:

   Transfer test complete - No errors
   C31ini32.out loaded properly

2.2 SI-100 Installation.

The SI-100 is shipped with 1) a power cord, 2) an 9 pin to 9 pin DSUB molded cable for use with the RS-232 port, 3) a 9 pin to 9 pin DSUB molded cable for use with the high speed RS-422 signal level serial port, 4) an optional 15 pin to 15 pin DSUB molded cable for use with the second high speed RS-422 signal level serial port if octal analog outputs are used , 5) a CD-ROM containing all QuVIEW files, drivers and documentation.

NOTE: Be sure the power is OFF before plugging in the power cord.

The AC power supply is factory preset for 115Vac operation. If the line voltage is 220Vac, simply remove the power supply module and change the line voltage setting to 220Vac. The line voltage switch is located at the bottom of the module. A different fuse is also necessary for 220Vac operation.

2.3 RS-232 Serial Port Connection.

The 9 pin to 9 pin DSUB molded cable needs to be connected to the PC's RS-232 serial port and the RS-232 serial port of the SI-100.

2.4 RS-422 Signal Level Serial Port Connection.

The 9 pin and 15 pin DSUB molded cables needs to be connected to their respective RS-422 serial ports of the DSP interface card and the high speed RS-422 serial ports of the SI-100.

3.0 General Guidelines For LabVIEW Applications.

In the top left corner of the window, LabVIEW provides two buttons; first a FREE RUN button, and next to it a RUN button. A STOP button, in the shape of a stop sign, will also appear when either of the first two buttons are clicked.

The Free Run button will repeatedly execute the VI until the Stop button is pressed. The Run button will execute the VI only once or until the Stop button is pressed. All of the following descriptions assume that the Free Run button has been pressed.

3.1 LabVIEW VIs.

Several VIs integrating the C31 Real Time board with LabVIEW are useful for most instrumentation applications. These VIs are intended mainly as a guideline for building your own customized applications if desired.

All of the VIs integrate DSP accelerator cards for LSI's TMS320C31 Real Time card and the AT&T's WEDSP32C.

3.2 QuSCOPE: QuVIEW based Digital Oscilloscope.

The OSCILLOSCOPE VI allows converts your data acquisition system into a virtual desktop oscilloscope. Some of the controls and indicators operate as follows:

1) Single: Clicking this button will collect and display one screen of data for the selected channels, in accordance to the screen settings.

2) Continuous: The same as Single, but will constantly update the display, until it is pressed again or if the VI itself is stopped.

3) Error Message: This box will display a message if there are any errors in the setup or in the process of collecting data. The messages are intended to be self explanatory.

4) Calibrate/Uncalibrate: Asserting or pressing this button to a “true” state will enable the CAL.TBL file to be used for calibrating inputs and outputs. After calibration, all DC and magnitude errors will be removed from all subsequent Data Acquisition commands. Deasserting or unpressing this button to a “false” state will disable all calibration.

5) Channel Selector: Use these buttons to select the desired input channels for the analog inputs.

6) Samples: This value indicates the number of data points to be collected per channel.

NOTE: The number of samples is limited by the amount of available memory.

7) Sample Rate per Channel: The SAMPLE RATE/CHANNEL determines the actual frequency at which the input channels are to be sampled.

3.2.1. Trigger Conditions.

1) Trigger Channel: The TRIGCHANNEL determines the input channel where the trigger conditions are to be met, in order for data to be displayed for all the input channels. Not used if slope is set to none.

2) Trigger Slope: The TRIGGER SLOPE setting determines the direction or slope at which the specified trigger channel must cross the trigger level. Triggering can be set on a positive slope, negative slope, or be disabled if set to none.

3) Trigger Level: The TRIGLEVEL value determines the voltage level at which the specified trigger channel must intersect. The trigger voltage is specified in the range of ±5V. Triggering is ignored if the slope is disabled or set to none.

4) Hysteresis: The HYSTERESIS value determines a voltage window which the trigger channel must exceed before intersecting the trigger level. The hysteresis is an absolute value, ranging from 0V to 5V, whereby false triggers can be avoided.

For example, a hysteresis value of 1V means the signal must drop 1V below the trigger level, in order for a trigger to occur on a positive slope; or the signal must rise 1V above the trigger level for the negative slope case.

5) Pretrigger/Delay: The PRETRIG/DELAY specifies the number of samples to keep track of before or after a trigger event.

A negative entry for Pretrig/Delay specifies the number of data points to keep track of before a trigger event, thereby defining a starting point to collect and display any data specified in the Samples entry. A "0" entry or a positive entry for Pretrig/Delay specifies the number of data points to wait after a trigger event before collecting and displaying any data specified in the Samples entry.

6) Timeout: This entry specifies the number of samples to wait for the occurrence of a valid trigger condition before aborting.

3.3 Calibration VI.

The sole purpose of this VI is to calibrate (in software) the input and output channels of the C31 Real Time card.

In order to properly calibrate any errors, an accurate known external signal is fed into an input channel. This signal must be periodic and have an average value of 0Vdc (sine wave). The exact magnitude of the external signal is entered in the appropriate field. CAL.VI compares the known magnitude to the measured magnitude and also checks if the average value is centered about 0Vdc. Two compensation values are then generated, one for the magnitude and another for the offset. These values are stored in a default file named CAL.TBL, which can be altered by entering a different filename. This process is then repeated for every input channel.

NOTE: All input channels must be calibrated before any output channels can be calibrated. To do so, the output of a channel must be connected back into an input channel. The incoming signal is then compared to the outgoing signal and the corresponding compensation values are generated and stored in the specified CAL.TBL file. This process is then repeated for every output channel.

1) Active/Stop: Because of the DMA communications between the host and the DSP, this is the only way that execution can be "safely" terminated. If the VI is stopped any other way, LabVIEW may hang and the host PC may have to be reset.

2) Sample Rate: The frequency at which the input signals are being sampled.

3) Samples: This is the number of samples that will be considered in the calibration process. If the number of samples is too small, inaccurate calibration values may be generated. Typical values range from 100 to 1000 samples.

4) % Tolerance: This is the percent error which will be allowed in the calibration process.

5) Test Limit (V): This field determines the exact magnitude (in volts) of the external reference signal.

6) Create File: If the calibration file has not been previously created, then this button must be asserted (pressed).

7) Calibration Table File: The complete path name of the Calibration Table File must be entered. There are two default file names that are used by all Sheldon Instruments VIs: CAL.TBL and ZEROCAL.TBL. CAL.TBL contains the current calibration values. ZEROCAL.TBL is called by VIs when no calibration is desired. If another file name is used, then that same file name must replace CAL.TBL in each VI that uses the calibration table.

NOTE: Non-calibrated operations use ZEROCAL.TBL. This file must never be altered.

8) Conserve/Overwrite: These four large buttons are used to change the values in the calibration table file. When a desired value is obtained, the value can be written to the CAL.TBL file by pressing the corresponding button. No change will occur in the file if these buttons are never asserted.

9) Input Channel: The desired input channel to be calibrated.

10) Trigger Conditions: In order to make the signal display easier to read, trigger conditions

can be used. Change the SLOPE control to "Free Run" if no triggering is desired for the display.

11) Output Channel: The desired output channel to be calibrated.

12) Waveform Generation Parameters: These are the controls for the output signals to be generated by the C31 Real Time card.

13) Max Peak Value (V): Indicator for the maximum voltage peak measured on the specified input channel of the C31 Real Time card.

14) Min Peak Value (V): Indicator for the minimum voltage peak measured on the specified input channel of the C31 Real Time card.

15) Magnitude Error %: Display for the percent error between the known magnitude and the measured magnitude.

17) Offset Error (V): Display for the offset (in volts) between the known average value and the measured average value.

3.4 View: Time Data & Analysis VI.

The Time Data View VI provides the user with the ability to read most data files produced by Sheldon Instruments' data acquisition tools. Specifically, it will read 1) single and multichannel, time domain multiplexed stream files (such as those produced by QuView 1.x's Q_Display and Log to Disk.vi, 2) single channel QuView 1.x files, both with and without headers, 3) QuView 2.0 Beta files. In addition, it allows the user to export any of these file types as single channel QuView 1.x files, single channel QuView 1.x files with headers, or as ASCII text files in tab delimited form, for import into most spreadsheets and word processors. Export of files to QuView 2.0 format will be included once that format becomes fixed.

The VI has a single front panel and one pop-up dialog window. If no file is specified when run, the VI will active a file dialog box, prompting the user for an input file name. The user should select a file, then press the Windows OK button. Ideally, the file will immediately be opened and the first data in the file will be displayed. If, however, the source file type, number of channels, or frame size controls are not set correctly, the data will be displayed incorrectly.

The 'Frame Size' control, on the top center of the front panel, simply selects the number of points to be shown on the display. Since many files don't contain header information, such as the number of channels stored in the file, the 'Channels' control must be set. It can be changed dynamically (i.e. it immediately affects the data display, without requiring that the VI be stopped and re-run.)

Most importantly, the 'Source File Type' must be set. This is critical, because if a file without a header is read in "with header" mode, LabVIEW will attempt to read the beginning data in the file as the header, resulting in memory allocation errors. The VI will detect this problem and change the file type to “without headers” as soon as possible. It is therefore desirable to set these controls before running the VI, though all can be changed at any point during run time. If the data doesn’t look right, one of these controls is set incorrectly.

To change files while running, type in a new file name or press the ‘Browse’ button located directly over the ‘Source File Name’ control to select a file from a Windows file dialog box. Once the file is loaded, the user can move through the data using the large ‘Prev’ and ‘Next’ buttons on the bottom of the display. These buttons move one frame forward or backward. (Hint: To quickly move long distances, increase the frame size, move a few large frames, then return the frame size to its original size.) A red sliding indicator shows the position of the displayed data relative to the total file, while the slider width shows how much, relatively, of the file is being viewed on the display. These controls, and the obvious ‘STOP’ button, are all the user needs to view data files.

To export (convert) files to other formats, the ‘Export File Type’ control must be set. It can be set to ‘ASCII Text Files,’ ‘QuView 1.x with headers,’ and ‘QuView 1.x without headers.’ Note that if ASCII files are specified, the ‘Export File Path’ is a file name, but if either of the QuView 1.x formats is specified, the path should be to a directory. This allows the VI to generate unique file names for each channel that it extracts from a multichannel file. In ASCII mode, each channel is put into its own column within a single file, thus needing only a single file name. The ‘Browse’ button for export file path is aware of this difference, and will only allow the user to select the correct type of path from a Windows file dialog box. Once the path and export file type are specified, the ‘Export’ button is pressed. While the VI is exporting data, the button will remain depressed, and will read ‘Exporting.’ Upon completion, the button will return to its original upright position.

If the export process needs more information, a pop-up dialog window will open. The user should set all visible controls. This includes the event number in which the data was acquired, and the channel numbers of all the channels. If a multichannel file contains data from channels 0,1, 15, and 37, these numbers should be entered into the channel array. If the channels are linearly numbered, (0,1,2,...,n), the user can enter the channels manually, or simply press the ‘linear fill’ button, which fills the channel array with 0,1,2,...,n, where n is the number of channels specified on the main front panel. If a header is to be created, several more controls are displayed. These include the sample rate, acquisition data and time, test ID string, and channel ID strings. This information is optional, but will be copied into the headers if it is provided. When the data is entered, press the done button to continue with the export process.

3.5 Stream Data to Disk VI.

The Stream Data to Disk VI records a user specified list of channels to disk. To prepare for streaming, one must enter a number of Samples to display. Choosing zero if no graph is attached will increase streaming speeds. The sample rate is specified in Hz. A number of samples to save per channel is entered. To the right of these parameters, one selects channels to stream from an array of boolean buttons. Channel IDs may also be entered below this for each channel. Note that the ID array index on the channels numbers selected and not absolute channel number. Be sure the Slot

Number, Board, and Memory Options are correct for the board present. Trigger conditions may be specified as detailed in section 2.1.1. Again, note that Trigger channel refers to the Nth channel selected and not absolute channel number.

A Button in the bottom left toggles Between Logging To Disk/Display. A button in the lower right of the panel toggles between two possible formats. The data may be streamed without a header into a multiplexed channel file or may be stored into separate files which each contain a data header. The Event Number is only useful if separate headers are to be created. The Data File Path must be specified, this file will be created or overwritten.

Once the parameters above have been specified or at least confirmed correct, one should make sure the top most button is set to active. This button may also terminate the VI during an acquisition. The VI is run using the LabVIEW Run button. The Stream light will be blue while the data is being acquire, and then the VI will terminate after all files have been closed. The data may be viewed with the View.llb: Time Data View & Analysis.vi.

4.0 Overview of the SI-100.

The SI-100 is a data acquisition system that consists of four sections: octal analog input boards, an A-D conversion board, a personal computer controlled overall system processor control board, and finally D-A conversion boards.

4.1 Analog Input Section.

The first portion of the SI-100 consists of an octal analog input board, which provides all of the necessary analog signal processing components. All of the programmable configurations are uploaded from a personal computer, via the RS-232 serial port, to the SI-100.

The input to the system is a physical parameter such as temperature, pressure, acceleration, strain, displacement, flow, or position.

4.2 A-D Section.

The A-D converter has a resolution of 12 bits with a conversion rate ranging from 0hz to a maximum of 500khz, in increments of ±1hz.

All A-D converters have references to determine the quantization levels and corresponding digital codes. However, with extensive use, the operating temperatures cause them to become nonlinear with time. The references in the SI-100 are *periodically self calibrated.* So accurate referencing is not a worry, it is nearly constant with time and temperature!

4.3 Overall System Control Processing.

This section operates in the digital domain exclusively. It receives the 12 bits from the A-D section and transmits 12 bits to the D-A section. These ports are especially useful for interfacing to a multitude of computer platforms. A large number of third party vendors offer parallel interface cards, interface cards based on a high speed DSP math processor, as well as various digital signal processing and control software packages. Such software packages have the ability to acquire and *directly* store digital data to RAM disks and hard disks.

All configuration parameters such as gains, offsets, filtering options, overall system sampling rate, and data output formats are also performed in this section. These parameters are uploaded from the host computer to the SI-100's nonvolatile memory. Nonvolatile memory has indefinite reprogrammability, *without losing* system parameters when the power is shut off. The serial port of the SI-100 is only in use when these parameters are loaded.

4.4 D-A Section.

This section takes the digital code derived from the host computer and then performs the digital to analog conversion.

A total of 8 outputs per card are available for real time control and signal generation. Each output comes with all of the necessary analog signal processing components. All of the programmable configurations are uploaded from a personal computer, via the RS-232 serial port, to the SI-100.

5.0 Analog Input Parameters.

Several analog signal processing features for 8 input channels are accessed for editing in the LabVIEW environment. The parameters for editing are 1) input type, 2) preamp/coupling, 3) gain, 4) offset and 5) filter type as described below.

5.1 Input Type.

The INPUT TYPE determines whether the input is to be a single ended input or a differential ended input.

Transducers are available for a number of signal configurations. Most common is a single ended configuration, with a positive signal referenced to the system analog ground. Another is a differential ended configuration, where a positive signal is complemented with a negative signal, which is not necessarily grounded.

5.2 Preamp/Coupling.

The PREAMP/COUPLING determines AC or DC coupling for single ended inputs, or preamp gains of +1, +10, +100, or +1000 for differential ended inputs.

For single ended inputs, AC coupling will act as a first order high pass filter with a cutoff frequency or -3dB point at 1.6hz, along with the option to provide constant current with a nominal +24Vdc source. For differential ended inputs, the preamp gain is multiplied by one of the 32 post gain values.

5.3 Gain.

The GAIN specifies a value to amplify the input signal to obtain better signal integrity and resolution. A variable gain stage of ±0.50 to ±100, in 32 different increments is included on each channel. These gains are digitally controlled, thus emphasizing a precise and known gain value rather than "tweaking" with a noisy potentiometer.

5.4 Offset.

The OFFSET specifies a DC voltage to be added to an input signal. Because of imperfections in extensive analog circuitry, unwanted biases, or offsets may result. A full range of offsets are available within ±2.5Vdc, in 16 different increments. These offsets are digitally controlled for accuracy and reliability.

5.5 Filter Types.

The FILTER determines the antialiasing lowpass filter type, as well as a no filtering option. Either bessel or elliptic lowpass filters are available.

NOTE: Be aware that the sampling frequency ranges from 120hz to 62.5khz per channel when either bessel or elliptic filtering options are selected. Without any filtering options, each channel is capable of the entire sampling range of 0hz to 500khz, specified by the internal A-D converter.

In the Sheldon Instruments SI-100, the aforementioned antialiasing lowpass filters *automatically* adjust to a corner or cutoff frequency, when the sampling frequency is altered.

Elliptic filters are desirable when the magnitude response is required to have optimum passband and stopband characteristics. An 8 pole, 7 zero elliptic filter, with a ±0.5dB ripple in the passband and a -70dB stopband attenuation, closely resemble an ideal magnitude response (42dB/octave or 140dB/decade rolloff). However, the phase response is relatively poor. The elliptic filter cutoff frequency is determined automatically at 40% of the sampling rate; therefore, the -3dB cutoff frequency ranges from 48hz to 25khz.

Bessel filters are desirable when the phase characteristics are critical and must have a linear response, hence bessel filters are also called linear phase filters. However, the magnitude response has a -60dB stopband attenuation which is not as good as the elliptic filter. The bessel filter cutoff frequency is determined automatically at 27% of the sampling rate; therefore, the -3dB cutoff frequency ranges from 32hz to 16.67khz.

6.0 Analog Output Parameters.

Several analog signal processing features for 8 output channels are accessed for editing in the LabVIEW environment. The parameters for editing are 1) range, 2) reference, 3) signal type, 4) filter and 5) update mode.

6.1 Range.

The RANGE specifies the maximum and minimum voltage levels with which the multiplying DACs are to reference the outputs. Unipolar signals range from 0 to Vref and bipolar signals range from ±Vref.

6.2 Reference.

The REFERENCE specifies whether an internally generated or an external voltage reference are to determine the maximum levels of the multiplying DACs. The external references may vary within ±15Vpp, and the 7 internally generated references can be set at +1.25Vdc, ±2.5Vdc, ±5.0Vdc and ±10.0Vdc.

6.3 Update Mode.

The UPDATE MODE determines whether the DACs are to be updated simultaneously or in a time division multiplexed fashion. The internal DACs are double buffered, where the first latch holds the incoming digital data and the second latch holds the digital data for the DAC input.

7.0 External Connections.

7.1 Differential Ended Octal Analog Input Connection.

The 37 pin DSUB socket connector provides the signal inputs and excitation/power sources for differential ended transducers. The pinouts are as follows:

	19 GND0
-IN0 37	
	18 +IN0
+10VREF0 36	
	17 GND1
-IN1 35	
	16 +IN1
+10VREF1 34	
	15 GND2
-IN2 33	
	14 +IN2
+10VREF2 32	
	13 GND3
-IN3 31	
	12 +IN3
+10VREF3 30	
	11 GND4
-IN4 29	
	10 +IN4
+10VREF4 28	
	9 GND5
-IN5 27	
	8 +IN5
+10VREF5 26	
	7 GND6
-IN6 25	
	6 +IN6
+10VREF6 24	
	5 GND7
-IN7 23	
	4 +IN7
+10VREF7 22	
	3 none
none 21	
	2 none
none 20	
	1 none

7.2 Single Ended Octal Analog Input Connection.

The 37 pin DSUB socket connector provides the signal inputs and power sources for single ended transducers. The pinouts are as follows:

	19 GND0
-12Vdc0 37	
	18 IN0
+12Vdc0 36	
	17 GND1
-12Vdc1 35	
	16 IN1
+12Vdc1 34	
	15 GND2
-12Vdc2 33	
	14 IN2
+12Vdc2 32	
	13 GND3
-12Vdc3 31	
	12 IN3
+12Vdc3 30	
	11 GND4
-12Vdc4 29	
	10 IN4
+12Vdc4 28	
	9 GND5
-12Vdc5 27	
	8 IN5
+12Vdc5 26	
	7 GND6
-12Vdc6 25	
	6 IN6
+12Vdc6 24	
	5 GND7
-12Vdc7 23	
	4 IN7
+12Vdc7 22	
	3 none
none 21	
	2 none
none 20	
	1 none

7.3 Octal Analog Input DIP Switches.

The first of three DIP switches serves to assign the numbering range for the eight channels on each input card, and the other two serve to route the signals from the MUX to the Analog to Digital Conversion board. Their positions are as follows:

Base Range DIP Switch — Truth Table

ON OFF	SW-8	SW-7	SW-6	SW-5	SW-4	Channel Range
SW-8 (Always ON)	ON	ON	ON	ON	ON	0 thru 7
SW-7	ON	ON	ON	ON	OFF	8 thru 15
SW-6	ON	ON	ON	OFF	ON	16 thru 23
SW-5	ON	ON	ON	OFF	OFF	24 thru 31
SW-4	ON	ON	OFF	ON	ON	32 thru 39
SW-3 (Not Used)	ON	ON	OFF	ON	OFF	40 thru 47
SW-2 (Not Used)	ON	ON	OFF	OFF	ON	48 thru 55
SW-1 (Not Used)	ON	ON	OFF	OFF	OFF	56 thru 63
	ON	OFF	ON	ON	ON	64 thru 71
	ON	OFF	ON	ON	OFF	72 thru 79
	ON	OFF	ON	OFF	ON	80 thru 87
	ON	OFF	ON	OFF	OFF	88 thru 95
	ON	OFF	OFF	ON	ON	96 thru 103
	ON	OFF	OFF	ON	OFF	104 thru 111
	ON	OFF	OFF	OFF	ON	112 thru 119
	ON	OFF	OFF	OFF	OFF	120 thru 127

Routing DIP 1 (TOP Switch) Channel Range

OFF ON	SW-1	SW-2	SW-3	SW-4	SW-5	SW-6	SW-7	SW-8	
SW-1	ON	off	off	off	off	off	off	off	0 thru 7
SW-2	off	ON	off	off	off	off	off	off	8 thru 15
SW-3	off	off	ON	off	off	off	off	off	16 thru 23
SW-4	off	off	off	ON	off	off	off	off	24 thru 31
SW-5	off	off	off	off	ON	off	off	off	32 thru 39
SW-6	off	off	off	off	off	ON	off	off	40 thru 47
SW-7	off	off	off	off	off	off	ON	off	48 thru 55
SW-8	off	off	off	off	off	off	off	ON	56 thru 63

Routing DIP 2 (BOTTOM Switch) Channel Range

OFF	ON	SW-1	SW-2	SW-3	SW-4	SW-5	SW-6	SW-7	SW-8	
SW-1		ON	off	off	off	off	off	off	off	0 thru 7
SW-2		off	ON	off	off	off	off	off	off	8 thru 15
SW-3		off	off	ON	off	off	off	off	off	16 thru 23
SW-4		off	off	off	ON	off	off	off	off	24 thru 31
SW-5		off	off	off	off	ON	off	off	off	32 thru 39
SW-6		off	off	off	off	off	ON	off	off	40 thru 47
SW-7		off	off	off	off	off	off	ON	off	48 thru 55
SW-8		off	off	off	off	off	off	off	ON	56 thru 63

7.4 Octal Analog Output Connection for Outputs 0 through 3.

The 25 pin DSUB socket connectors provide the signal outputs and external reference inputs for output channels 0 through 3. The pinouts are as follows:

	13 SIGRTN0
VOUT0 25	
	12 none
none 24	
	11 REFRTN0
REFIN0 23	
	10 SIGRTN1
VOUT1 22	
	9 none
none 21	
	8 REFRTN1
REFIN1 20	
	7 SIGRTN2
VOUT2 19	
	6 none
none 18	
	5 REFRTN2
REFIN2 17	
	4 SIGRTN3
VOUT3 16	
	3 none
none 15	
	2 REFRTN3
REFIN3 14	
	1 none

7.5 Octal Analog Output Connection for Outputs 4 through 7.

The 25 pin DSUB socket connectors provide the signal outputs and external reference inputs for output channels 4 through 7. The pinouts are as follows:

	13 SIGRTN4
VOUT4 25	
	12 none
none 24	
	11 REFRTN4
REFIN4 23	
	10 SIGRTN5
VOUT5 22	
	9 none
none 21	
	8 REFRTN5
REFIN5 20	
	7 SIGRTN6
VOUT6 19	
	6 none
none 18	
	5 REFRTN6
REFIN6 17	
	4 SIGRTN7
VOUT7 16	
	3 none
none 15	
	2 REFRTN7
REFIN7 14	
	1 none

7.6 Octal Analog Output DIP Switches.

The DIP switch serves to assign the numbering range for the eight channels on each output card. Their positions are as follows:

Base Range DIP Switch		Truth Table				
ON	OFF	SW-8	SW-7	SW-6	SW-5	Channel Range
SW-1	(Not Used)	ON	ON	ON	ON	0 thru 7
SW-2	(Not Used)	ON	ON	ON	OFF	8 thru 15
SW-3	(Not Used)	ON	ON	OFF	ON	16 thru 23
SW-4		ON	ON	OFF	OFF	24 thru 31
SW-5		ON	OFF	ON	ON	32 thru 39
SW-6		ON	OFF	ON	OFF	40 thru 47
SW-7		ON	OFF	OFF	ON	48 thru 55
SW-8		ON	OFF	OFF	OFF	56 thru 63
		OFF	ON	ON	ON	64 thru 71
		OFF	ON	ON	OFF	72 thru 79
		OFF	ON	OFF	ON	80 thru 87
		OFF	ON	OFF	OFF	88 thru 95
		OFF	OFF	ON	ON	96 thru 103
		OFF	OFF	ON	OFF	104 thru 111
		OFF	OFF	OFF	ON	112 thru 119
		OFF	OFF	OFF	OFF	120 thru 127

7.7 RS-422 Pinout.

The 9 pin DSUB socket connector provides the high speed differential serial data that connects to the DSP card inside of the computer. The pinout is as follows:

	5 +Word Sync
-Word Sync 9	
	4 +Frame Sync
-Frame Sync8	
	3 none
-Bit Clock 7	
	2 +Bit Clock
-NRZ Data 6	
	1 +NRZ Data

If connected to a DSP's serial port, the following three signals must be used as follows:

+NRZ Data (pin 1) -> Data Receive (labeled as DR)
+Bit Clock (pin 2) -> Clock Receive (labeled as CLKR)
+Frame Sync (pin 4) -> Frame Sync Receive (labeled as FSR)

NOTE: *A series termination resistor of 33-100ohms must be used in order to help eliminate unwanted signal spikes.*

8.0 Overview of the SI-C3XDSP.

The SI-C30DSP and SI-C31DSP from Sheldon Instruments are powerful Digital Signal Processor (DSP) cards for your PC based on Texas Instruments' TMS320C30 and TMS320C31, 32 bit floating point DSPs respectively. They transform your PC into an ultra high performance development system and DSP accelerator. A full line of software development tools are available from TI which include compilers, assemblers, linkers, as well as a real-time source debugger.

One of the more powerful features of the SI-C3XDSP family is embedded emulation. Embedded emulation allows for emulation support to be provided within the target system. This ability is enabled by the TMS320C3X emulation port and the SN74ACT8990 Test Bus Controller, thereby eliminating any onboard boot PROM/EPROM or direct host access to the DSP.

All communication between the host and the DSP take place by means of a shared 16 bit bidirectional register. The expansion bus of the TMS320C30 can be used with the DMA channel to communicate with the host so that access to its primary bus goes undisturbed.

With the SI-C31DSP, the primary bus of the TMS320C31 is divided so that all communication between the host and the DSP take place over the exact same shared 16 bit bidirectional register.

8.1 Digital I/O Connection for the SIC3XDSP.

The 25 pin DSUB socket connector provides the buffered digital signals of the TMS320C3X processor. Their pinouts are as follows:

	13 none
none 25	
	12 none
none 24	
	11 none
GND 23	
	10 GND
GND 22	
	9 GND
CLKX1 (port 2) 21	
	8 CLKX0 (port
DX1 20	
	7 DX0
FSX1 19	
	6 FSX0
CLKR1 (port 3) 18	
	5 CLKR0 (port
DR1 17	
	4 DR0
FSR1 16	
	3 FSR0
XF1 15	
	2 XF0
TMCK1 14	
	1 TMCK0

TECHNICAL SPECIFICATIONS for the SI-100.

Octal analog input board:

Inputs	Any combination of single or differential ended with 8 minimum, 255 maximum channels.
Filter cutoff frequency	48hz to 25khz for elliptic filters, 37.5hz to 19.5khz for bessel filters (versions 01 & 02), 32hz to 16.7khz for bessel filters (version 03), (120hz to 62.5khz sampling rate).
Rolloff	7 pole (42dB/octave or 140dB/decade) rolloff slope.
Programmable gains	±0.50, ±1, ±1.33, ±1.66, ±2, ±3, ±4, ±5, ±8, ±10, ±15.38, ±20, ±25, ±40, ±50, and ±100.
Gain bandwidth	8Mhz
Programmable offsets in Vdc	-2.5, -2, -1.5, -1.25, -1, -0.75, -0.50, -0.25, 0, +0.25, +0.50, 0.75, +1, +1.5, +2.0, +2.5.
Input voltage range	±10.0V_p maximum input swing, or 20.0V_{p-p} full scale.
Maximum input voltage swing	±15V, will clip at ±10V with power on. ±35V with power off.

Single ended inputs:

Coupling	AC coupling with a highpass filter -3dB point at 1.6hz, or DC coupling.
Input impedance	10Mohm
Input capacitance	16pF
Accelerometer loading	2.5mA maximum

Differential ended inputs:

Programmable preamp gains	+1, +10, +100, or +1,000.
Preamp gain bandwidth	25Mhz
Differential and common mode input impedance	1Gohm (10^9 ohm)
Differential and common mode input capacitance	10pF
DC reference accuracy (worst case)	±30mV or 0.3% over 10Vdc for versions 01 and 02. 0.2% over 5V for version 03.
DC reference current supply	5mA to 10mA over 10Vdc for versions 01 and 02. 100mA over 5Vdc for version 03.

Analog to digital converter board:

Resolution	12 bits
Overall sample rate	0hz minimum, 500khz maximum additive sampling rate for the whole system.
Specified temperature range	0^oC to 70^oC
A-D references	Self calibrating upon power reset and during uploading and downloading over the RS-232 serial port.

Dynamic performance:

Total harmonic distortion	0.0125%
Peak harmonic or spurious nois	75dB minimum, 82dB typical for 100khz input signal. 70dB typical for 490khz input signal.

Signal to noise plus distortion	68dB minimum, 71dB typical for 0dB input. 32dB typical for -40dB input.

Static performance:

Linearity error	±3/4 LSB typical, ±1 LSB maximum.
Differential linearity	±1/2 LSB typical, ±0.9 LSB maximum.
Full scale error	±2 LSB typical, ±8 LSB maximum.
Offset error	±1.5 LSB typical, ±3 LSB maximum.

Timing and control board:

Sequencer memory	32,512 bytes of EEPROM. Each byte represents a sequencer channel to allow programmable timebase of independent sampling rates for different channels.
Parameter memory	512 bytes or 256 words of EEPROM per page; 4,096 bytes or 2048 words of EEPROM for all 8 pages.

Clock rates:

Internal serial data clock rate	0hz minimum, 6Mhz maximum.
Internal serial data clock accuracy	50ppm
External clock input signal level	Standard TTL level via BNC input.
External clock input rate	0hz minimum, 6Mhz maximum.

Data ports:

RS-422 serial port data resolution	8, 9, 10, 11 or 12 bits resolution per word.

RS-422 serial port data formats	NRZ-L, NRZ-M, NRZ-S and BIφ-L (bi-phase).
RS-422 serial port signal levels	0V to 5V differential signal levels.
Parallel port data resolution	12 bits
Parallel port signal levels	Standard TTL logic levels, using HCT244 output buffers.
DAC output board:	
Resolution	12 bits.
Sampling rate	0hz minimum, 500khz maximum.
Output voltage swing	$\pm 5V_p$ or $10V_{p-p}$ full scale.
Output channels	8 minimum, 128 maximum software selectable channels.
Short circuit current	25mA
Power supply:	
Input Voltage	90-132 VAC, 47-73 Hz; 180-264 VAC, 47-63 Hz.
Line Regulation	±0.2% or 10mV max, whichever is greater.
Load Regulation	±0.2% or 10mV max, whichever is greater (no load to full load; all other loads at 2/3 full load).
Cross regulation to Main Output	±0.1% or 10mV max, whichever is greater (at 50% test load, any other output varied from 50% to 100%).
Output Noise and Ripple	1% or 50mV peak to peak, whichever is greater, measured with a 20MHz bandwidth oscilloscope.

Output Voltage Adjustment Range	±5% min (single turn trimmer).
Operating Temperature	$0^{o}C$ to $+70^{o}C$ (derate 2.5% per ^{o}C over $50^{o}C$).
Storage Temperature	$-40^{o}C$ to $+85^{o}C$.
Outputs Temperature Coefficient	0.02% per ^{o}C max.
Efficiency	70% min at full load.
Overvoltage Protection	Set between 115% to 125% of nominal output voltage. Power must be manually recycled after OVP trip.
Current Limiting Protection	Automatic hiccup mode. Output will continue to restart until short is removed. Recovery adjusted to 105% to 125% of max rated current.
Remote Sensing	Eliminates the effect of output lead resistance on regulation, up to 0.5V lead drop. Open sense lead protection provided.
Undervoltage Protection	Undervoltage lockout provided.
Reverse Voltage Protection	Outputs protected against applied reverse voltages.
Brown-out Protection	Outputs maintained down to input line voltages of 85 or 160 VAC without shutdown or damage to the power supply.
Isolation	All outputs and chassis fully isolated up to 300 Vdc.
Cooling	Convection cooled.

TECHNICAL SPECIFICATIONS for the SI-C3XDSP.

Processor for SI-C30DSP:
* TMS320C30 27Mhz, 33Mhz or 40Mhz DSP.
* Single DMA channel.

Processor for SI-C31DSP:
* TMS320C31 27Mhz, 33Mhz, 40Mhz or 50Mhz DSP.
* Single DMA channel.

Memory:
* 64K x 32 bit words zero wait state SRAM, expandable to 1M x 32 bit words on primary bus.

Interface to Host:
* 16 bit, bidirectional I/O mapped communications between TMS320C30 expansion bus and host.
* Up to 1Mbyte/sec transfer rate.
* INT0, INT1 and INT2 used by host; INT2 and INT3 available on DIN expansion connectors.

Peripheral Expansion:
* Two 96 pin DIN connectors with all primary and expansion bus signals; host +5Vdc, -5Vdc, +12Vdc, -12Vdc and GND.
* Two 16 pin headers for access to both serial ports, timers, counters, and digital I/O.

Software:
* TI real time source debugger, C compilers, assemblers and linkers.
* Full compatibility with Hypersignal.
* Extensive LabVIEW libraries for real time acquisition, control and analysis.

Physical Dimensions & Electrical Requirements:
* Full size AT-bus card measuring 13.375"(L) x 4.625"(H) x
0.625"(D).
* 7 watts typical with 64K words SRAM.