Operator's Manual SD222 Portable 2-Ch Analyzer (Part Two)

Legacy Manual

COGNITIVE VISION, INC.
7220 Trade Street, Suite 101
San Diego, CA 92121-2325 USA

analyzers@cognitivevision.com
www.cognitivevision.com

Tel: 1.858.578.3778 / Fax: 1.858.578.2778
In USA: 1.800.VIB.TEST (842.8378)

LEGACY MANUAL POLICY

Cognitive Vision Legacy manuals are those product manuals and documentation that accompanied earlier products and product lines which have since been discontinued ("Legacy Products"). Over the past thirty years, these include products that were sold by Spectral Dynamics, Scientific Atlanta and Smiths Industries.

Cognitive Vision, Inc. provides downloadable copies of these manuals strictly as a courtesy to its customers who continue to use Legacy Products. IMPORTANT: Please read the following Disclaimer carefully. Any use of this manual indicates your express agreement with this policy.

If you have any questions regarding this policy, or for additional information regarding the serviceability of any Legacy Product(s), please call our service department.

DISCLAIMER

IN DOWNLOADING THIS MANUAL, THE USER UNDERSTANDS AND EXPRESSLY AGREES THAT COGNITIVE VISION MAKES NO WARRANTIES WHATSOEVER, EITHER EXPRESS OR IMPLIED, INCLUDING ANY WARRANTY OF MERCHANTABILITY OR FITNESS FOR A PARTICULAR PURPOSE. IN USING THIS MANUAL, THE USER ACKNOWLEDGES THAT ALL PREVIOUS PRODUCT WARRANTIES ISSUED BY SPECTRAL DYNAMICS, SCIENTIFIC ATLANTA AND SMITHS INDUSTRIES FOR LEGACY PRODUCTS HAVE SINCE EXPIRED.

IN PROVIDING THIS MANUAL, COGNITIVE VISION ASSUMES NO LIABILITY OR RESPONSIBILITY WHATSOEVER TO THE USER OF THIS MANUAL, THE USER'S AGENTS AND/OR CUSTOMERS, OR ANY OTHER PARTY, FOR ANY CLAIMED INACCURACY IN THIS MANUAL, OR FOR DAMAGE CAUSED OR ALLEGED TO BE CAUSED DIRECTLY OR INDIRECTLY BY ANY USE OF THIS MANUAL, REGARDLESS OF WHETHER COGNITIVE VISION WAS INFORMED ABOUT THE POSSIBIILITY OF SUCH DAMAGES, OR FOR ANY CLAIM MADE AGAINST THE USER'S ORIGINAL PRODUCT WARRANTY.

FURTHER, COGNITIVE VISION SHALL NOT BE RESPONSIBLE FOR ANY INTERRUPTION OF SERVICE, LOSS OF BUSINESS, ANTICIPATORY PROFITS, CONSEQUENTIAL DAMAGES, OR INDIRECT OR SPECIAL DAMAGES ARISING UNDER ANY CIRCUMSTANCES, OR FROM ANY CAUSE OF ACTION WHATSOEVER INCLUDING CONTRACT, WARRANTY, STRICT LIABILITY OR NEGLIGENCE.

NOTWITHSTANDING THE ABOVE, IN NO EVENT SHALL COGNITIVE VISION'S LIABILITY TO THE USER EXCEED AN AMOUNT EQUAL TO THE REPLACEMENT COST OF THIS MANUAL.

COGNITIVE VISION, INC.
7220 Trade Street, Suite 101
San Diego, CA 92121-2325 USA

analyzers@cognitivevision.com
www.cognitivevision.com

Telephone: 1.858.578.3778 / Fax: 1.858.578.2778
IN USA: 1.800.VIB.TEST (842.8378)

Processing

Process and Averaging Overview

Press **UP ARROW** and **DOWN ARROW** to move between the 2 PROC screens. There are four option columns on the screens. The first column selects the desired process. The titles are self-explanatory and are described in detail later in this section.

PROCESS	WINDOW	TIME AV	PROC AV
CH DATA	RECT	1	1
CHA-CHB	HANNING		LINEAR
DIFF	HAMMING		EXPON
INT	FLAT-TOP		PEAK
ASPECT			
DSPECT			
XSPECT			
ACORR			
XCORR			
COHER			
RMS			
TRANS			
more			OK >

PROC (Process) Screen – 1st part

Note

PROCESS	WINDOW	TIME AV	PROC AV
more			
MOTOR			
OCT/3 S	RECT	1	1
OCT/3 L	HANNING		LINEAR
OCT/1 S	HAMMING		EXPON
OCT/1 L	FLATTOP		PEAK
OCT CAL			
			OK >

PROC (Process) Screen – 2nd part

The MOTOR option appears only in SD221-M models.

The first four options in the column CH DATA, CHA-CHB, DIFF and INT are time domain processes and the others from ASPECT to TRANS, are in the process domain.Processes in the second screen are for octave analysis and calibration only.

The second column selects the type of window (RECTANGULAR, HANNING, HAMMING, or FLAT-TOP) for the process domain (ASPECT, DSPECT, XSPECT, ACORR, XCORR COHER, RMS and TRANS). Windowing of a data record reduces the amount of energy in that record and so the result of a spectral computation could appear to be reduced if a window function is applied. The instrument compensates for this and adjusts the spectral output for this loss. Thus the peak values produced by spectrum and correlation processes are the same regardless of the window applied.

Averaging can be carried out in the time domain or in the process domain. The number of averages is selected by numerical entry from the keypad up to a maximum of 4096. For example, setting the number of time averages to 3 and the number of process averages to 4 will result in 3 blocks of data being averaged and then being processed - this is repeated 4 times to give the final result. Interim results during PROC AV are displayed on the screen. Although there is a time penalty to pay for the additional processing required, the operator is able to see the accumulated average developing on the screen. In addition, the number of averages computed is displayed on the screen at each update.

The acquisition and averaging process can be stopped by pressing any key on the instrument. One useful technique is to define a large number of averages for the process, and then simply press any key when the display has stabilized. The averaged process will then freeze at this point for inspection using the cursor.

Averaging

Most signals in the real world consist of a composition of two types of signal, namely a "deterministic" portion which is usually the signal of interest and a "random" portion which is generally considered as noise.

Examples of deterministic signals are speech, mechanical vibrations or a sine wave, whereas the sound of hissing air could be termed entirely random. TIME AV and PROCESS AV can be used to enhance the two different parts of the signal, as the following explanation will reveal.

Time Domain Averaging

A Time Domain Average means that data is averaged as it is acquired by the instrument and before it is presented to the selected algorithm for processing. Time averaging should only be used when the signal to be examined is repetitive and a consistent trigger point is available. Correct triggering can be achieved from INTERNAL source using NORMAL triggering mode, or by use of an external trigger using EXT TR. The signal to noise ratio (SNR) of the signal to be analyzed can be improved using time averaging which has been correctly triggered. Time averaging on randomly triggered data will have the opposite effect making the eventual result meaningless.

Summary of Time Averaging Properties

- Time averaging is useful only when a signal contains a deterministic component
- Time averaging increases the signal to noise ratio (SNR) of the signal being analyzed (i.e. it increases the ratio of the deterministic part to the random part).
- A trigger point synchronized to the deterministic part of the signal must be available.

Process Domain Averaging

Averaging in the Process Domain will provide a statistically more accurate estimate of the process being executed. It will not improve the signal to noise ratio (i.e. the deterministic portion of the signal is unaffected).

Each time a process is executed, the individual values of the output can vary to some degree. For example, the value in each line of a spectral output will show some variation in amplitude, although tending to a mean value. Averaging will provide a better estimate of this mean value. Putting this another way, averaging will smooth the estimate of the random portion off a signal – it will not uncover a deterministic signal which is buried in noise.

Summary of Process Averaging Properties

- Process averaging produces a statistically more accurate estimate of the true process.
- Signal to noise ratio is not improved.
- Synchronized data acquisition with a known trigger point is not usually required unless an absolute phase measurement (relative to a fixed point) is desired.

A Linear Average is simply an accumulated sum of the records divided by the number of sample records. When this is selected, processing ceases after the number of averages have been acquired and processed. EXPON (Exponential) average is a "moving" average with each record being weighted according to the time at which it was acquired – the earlier the record, the less significance it has in the resulting average. Exponential averaging proceeds indefinitely until interrupted by pressing any key on the instrument.

PEAK averaging is not so much an average but more a "peak hold". The number of data records specified is acquired and the peak at each point is held.

Oscilloscope Mode (CHDATA and CHA-CHB)

The instrument acts as a 100 kHz sampling rate Digital Storage Oscilloscope when operating in time domain mode. This is selected via the PROC (Process) screen by choosing CH DATA for normal single or two channel operation or by choosing CHA–CHB for pseudo differential input (the difference between the two channels).

CH DATA always records data on two channels according to the record length, sensitivity and trigger conditions specified on the appropriate screens. Either or both channels can be displayed as selected by the DISP (Display) screen. The cursor is used in the usual way to give high resolution read-out of amplitude and time, and the display can be horizontally panned to show the full record length recorded.

It should be noted that the sampling rate of the data acquisition process is 2.56 times the bandwidth selected in the SAMPLE screen. For example, a selection of 20 kHz with the filters ON will band limit the incoming signals to 20 kHz while sampling them at 51.2 kHz. The filters can, of course, be switched off and this is probably most desirable in oscilloscope mode.

All time domain displays are linearly interpolated to improve the visual representation of the sampled signals and to prevent perceptual aliasing effects.

The CHA-CHB process is a signed arithmetic subtraction of channel B from channel A with any out of range results being clipped.

Differentiation

Differentiation is selected by DIFF in the PROC screen. The process differentiates the input data record with respect to time and adjusts the amplitude range of the display to accommodate the differentiated signal. The calculation is such that the differential of Vsinwt is wVcoswt. The differential of a signal in volts is volts/second.

Differentiation can be carried out on channel A, channel B or both channels simultaneously as selected in the DISP (Display) screen.

Integration

Integration is selected by INT in the PROC screen. The process integrates the input data record with respect to time and adjusts the amplitude range of the display to accommodate the integrated signal. The calculation is such that the integral of Vsinwt is – Vcoswt/w. The integral of a signal in volts is volt-seconds.

Integration can be carried out on channel A, channel B or both channels simultaneously as selected in the DISP (Display) screen.

Autospectrum

The Autospectrum Process is selected by ASPECT in the PROC screen.

Setting up the Autospectrum

Always apply the input to channel A. Its output is an amplitude and phase spectrum where the number of lines of resolution is the number of time samples divided by 2.56. The following table shows the record length with the corresponding number of spectral lines. The amplitude information is output on the upper trace and the phase information on the lower trace. Amplitude and/or phase display can be selected via the DISP (Display) screen.

Record Length vs. Spectral Lines

Time Record Length	No of Spectral Lines
256	100
512	200
1024	400
2048	800
4096	1600

Note that the Dual Autospectrum Process provides simultaneous amplitude spectrums of channels A and B.

Window types RECTANGULAR, HANNING, HAMMING and FLAT-TOP can be applied as selected in the PROC (Process) screen.

To prevent aliasing problems, execute Autospectrum option with the internal filters ON. (The 40 kHz selection always operates with the anti-aliasing filter OFF). For a given bandwidth, the spectral resolution is defined by the record length. A longer record length will give greater frequency solution at the expense of longer data acquisition and processing time. A 256-point spectrum takes approximately 0.5 seconds while a 1024-point spectrum takes about 2 seconds. This includes all display processing.

The Autospectrum can be displayed in linear or logarithmic scale. This is selected in the DISP (Display) screen. In linear scaling, the amplitude is displayed as Volts (or Engineering Units) where 1 volt in the vertical axis is equivalent to a sine wave of 1 volt rms. In logarithmic scaling 0 dBV is equivalent to a 1 volt rms sine wave. The dBV values are calculated according to the formula 20log(Vrms).

In linear display mode, the range displayed is from 0 to the sensitivity selected in the INPUT screen. In logarithmic display, the display range is 80 dB where the top of the vertical axis is the logarithm of the sensitivity selected in the INPUT menu and the bottom of the screen is 80 dB less. For example, a sensitivity of 5V results in 23 dBV at the top of the vertical axis and –57 dBV at the bottom.

Amplitude Magnification

In both linear and logarithmic display mode, it is often necessary to examine more closely frequency components of small value at the bottom of the screen. The vertical axis can be expanded from the bottom of the screen by pressing the **UP ARROW** cursor key. This can be repeated until the required magnification is achieved. Magnification can be reduced by pressing the **DOWN ARROW** cursor key. The chosen magnification is maintained until the main display is deselected.

The screen cursor provides a read-out of amplitude and/or phase versus frequency according to the sensitivity and record length selected.

Harmonic Cursors

Twenty harmonic cursors (10 even and 10 odd) can be displayed which are multiples of the fundamental frequency defined by the main cursor. The action is to position the main cursor (using the cursor keys) over the fundamental component of the signal being analyzed. Pressing the decimal point "." will then display up to twenty dotted cursors at the odd and even harmonics of the fundamental. The main cursor can be moved if desired to read the frequencies of the harmonics. The action of moving the main cursor and pressing the decimal point for harmonic cursors can be repeated as often as desired.

Windowing the Spectrum

Higher frequency resolution is achieved by increasing the record length and windowing the desired part of the spectrum using the pan control keys on the function keypads. This is equivalent to a "ZOOM" feature but with less "number crunching" and executes more quickly overall. The technique is that a long FFT is calculated and only the section of interest is displayed on the screen, by use of the pan keys. At a frequency range of 100 Hz and a record length of 4096, a resolution of 100/1600 or 0.0625 Hz can be achieved. Spectrum averaging is selected as normal in the PROC screen.

Dual Autospectrum

Dual Autospectrum is similar to the single Autospectrum process except that data is gathered simultaneously on channels A and B and the resulting spectra displayed together on the screen. Dual Autospectrum is selected by DSPECT in the PROC screen.

All aspect functions are available in DSPECT (i.e. window types, harmonic cursors, display modes etc.) except that DSPECT always displays the amplitude spectra of channels A and B for comparative purposes. Phase information is not displayed. Y magnification and Autoscale operate simultaneously on both displays.

Cross-Spectrum

The Cross-Spectrum process is selected by XSPECT in the PROC screen and computes the cross-spectrum of the data inputs on channel A and channel B. Control features are identical to those for Autospectrum and reference should be made to this section for detailed information. The phase output is the case of Cross-Spectrum is the difference in phase between the two channels.

Auto-Correlation

Auto-Correlation is a single-channel function obtained by comparing a signal with itself and displaying it in terms of plus and minus time with respect to a zero time delay.

Setting up the Autocorrelation

The Autocorrelation process is selected by ACORR in the PROC screen. Its input is a data record as defined in the SAMPLE screen and is applied via channel A. Its output is the standard time domain Autocorrelation option giving units proportional to input squared in the vertical axis and time in the horizontal axis. The standard function leads to "tapering" of the correlated output, i.e. for an input sine wave the output is a cosine wave reducing in amplitude with increasing time. This is due to the effect of the window on the sampled data record. To reduce this effect, circular correlation is implemented with HANNING, HAMMING and FLAT-TOP windows. The reasons are as follows.

The Autocorrelation option implies that a data record is passed over itself with each point being multiplied and the sum of the products being computed. Zero padding of data points is required in this process which leads to tapering of the output. One way round this is to loop the record back on itself, i.e. make it circular, which avoids zero padding. To avoid error, however, circular correlation can only be done when the amplitude at the beginning of the input record is equal to the amplitude at the end. This is the case for all windows except, of course, RECTANGULAR. For this reason, the instrument carries out linear correlation for a Rectangular window and a circular correlation for Hanning, Hamming and Flat-Top windows.

Amplitude Magnification

As with spectral processes, Y-axis magnification can be applied to x256 on the correlation output.

Cross-Correlation

The Cross-Correlation process is selected by XCORR in the PROC screen. It is identical to Autocorrelation except that input data from channel A and channel B are correlated with each other. It should be noted that the same signal applied to channels A and B will provide the same output as the Autocorrelation function on channel A only.

In keeping with recognized cross-correlation techniques, both negative and positive time results are displayed by this process. This ensures that meaningful results can be obtained regardless of which input signal is applied to which channel. If the input signals are swapped between channel A and channel B, then the result of the Cross-Correlation, will be reversed about the zero time axis.

Coherence

The Coherence process is selected by COHER in the PROC screen. It is the standard coherence function for measuring the interaction between the signal input on channel A and channel B. It is a normalized measure of the coefficient of correlation between two signals, but output in the frequency domain. The output range is dimensionless in the range 0 to 1. Two fully coherent signals will give an output of 1, implying that they are related by a linear transfer function. A coherence of 0 means that the signals have nothing to do with each other.

Due to the large amount of internal memory used by the coherence process, the maximum record length is limited to 2048 points resulting in an output of 800 lines. If an attempt is made to process 4096 points a message MAX RECORD 2048 appears on the screen.

RMS Calculation

The RMS value of the band of a spectrum can be obtained using the RMS process. The process is single channel and displays the spectrum similar to Autospectrum on the screen. The cursor is moved to the low frequency end of the band to be measured and the decimal point "." key is then pressed. As the cursor is moved to the right (i.e. increasing frequency) the RMS output value of the intervening band is displayed in the center of the screen.

Transfer Function

The Transfer Function process is selected by TRANS in the PROC screen. It is a two channel process in which the input to a system is applied to channel A and the output of the system is applied to channel B. The output of the process is a dimensionless amplitude trace (Vout/Vin) versus frequency and a plot of phase versus frequency. The number of lines in the output is similar to spectral processes (RECORD LENGTH/2.56).

All window types and averaging can be applied to the Transfer Function process. Linear and logarithmic displays are available.

The Transfer Function process is capable of handling gains up to 32. This is to prevent the gain of the system from exceeding the dynamic range of the instrument. Gains of greater than 32 will saturate at the top of the display.

Windowing of Time Domain Data

Four window types are available on the SD222, RECTANGULAR, HANNING, HAMMING and FLAT-TOP. Different windows are used in different circumstances,but the operator should be clear as to why windows are required at all.

The various processes in the analyzer assume that the time domain data record received is repeated to infinity. However, due to the finite record length, discontinuities are apparent between the end of a record and its assumed repetitions. This means that, for example, a continuous sine wave will be sampled for a period of time according to record length and then re-sampled again according to the trigger condition. It is extremely unlikely that the end of one record will continue into the next record without a discontinuity. The result of this discontinuity on the FFT algorithm is to produce large amounts of leakage into the spectral lines on either side of the signal frequency, thus swamping any signals of interest close to the fundamental. The application of windows eliminates this problem by reducing signal amplitude at the beginning and end of data records so that they "match" better.

The first window type, Rectangular, is in fact no window at all and would produce the effect described above on periodic waveforms. It is, however, useful when processing transient waveforms as the signal is usually zero at the beginning and end of the record.

The Hanning window produces narrow spectral lines and so is useful for accurate frequency measurement. Conversely, the Flat-Top window provides the best amplitude accuracy of the window types. The Hamming window is a general-purpose window and provides the advantages of Hanning and Flat-Top but to a lesser degree than using them individually.

Some experimentation may be required with window types depending on the type of signal, but in general most periodic signals will benefit from use with a Hanning window and most transient signals with a Rectangular window.

MOTOR – Motor Process For Entek's Motormonitor

Use the following procedure to enable the SD221 to communicate with an IBM-PC or compatible.

1. Connect SD221 to PC via cable CA-2 (see section 5 for pin assignments).
2. Execute MOTORMONITOR.
3. Select MOTOR on the PROC screen and press OK twice.

Control of the SD221 is not handled entirely by the PC. To abort from the communication sequence, press any key on the SD221.

Octave Analysis

Octave and 1/3 octave analysis are selectable in the PROC screen.

Octave Analysis Processes

Octave bands (OCT/1) or 1/3 octave bands (OCT/3) can be selected according to the following table. They are all single channel processes with data input being applied via channel A.

Octave and 1/3 Octave Bands

Process	Number of Bands Computed
OCT/3 S	15
OCT/3 L	31
OCT/1 S	5
OCT/1 L	10

The bands are calculated from narrow band spectral lines. In the long processes (OCT/3 L and OCT/1 L) two spectrums are computed to produce the number of bands. In the short processes (OCT/3 S and OCT/1 S) only one spectrum is calculated. This produces fewer bands but the processing time is halved.

The processes always require that a Record Length of 2048 is selected. If this is not selected, a warning message will appear on the screen.

The range of bands calculated is determined by the frequency selected in the FREQ column of the SAMPLE screen. The frequency selected represents the highest band of the range which will be computed. For example, a setting of 10 kHz with OCT/3 L will calculate 31 1/3 octave bands downwards from 10 kHz according to ANSI standard S1.11. This will give a range of 10 Hz to 10 kHz. In the FREQ selection, only the 5 kHz, 10 kHz and 20 kHz values are valid.

The following table summarizes the ranges available. Filter bands according to ANSI Standard S1.11 are shown in section 7.

The cursor can be used in the usual way to provide numerical read-out at the top of the screen.

Octave and 1/3 Octave Ranges

Process	Freq	Range Band (Center Frequencies)	No. of Bands
OCT/3 S	20 kHz	800 Hz – 20 kHz	15
	10 kHz	400 Hz – 10 kHz	15
	5 kHz	200 Hz – 5 kHz	15
OCT/3 L	20 kHz	20 Hz – 20 kHz	31
	10 kHz	10 Hz – 10 kHz	31
	5 kHz	5 Hz – 5 kHz	31
OCT/1 S	20 kHz	1 kHz – 16 kHz	5
	10 kHz	500 Hz – 8 kHz	5
	5 kHz	250 Hz – 4 kHz	5
OCT/1 L	20 kHz	31.5 Hz – 10 kHz	10
	10 kHz	16 Hz – 8 kHz	10
	5 kHz	8 Hz – 4 kHz	10

Octave Analysis Calibration

Calibration of octave analysis can be carried out either statically or dynamically. In static calibration, a scale factor is entered via the keypad. In dynamic calibration, a signal of known value is measured by the instrument and the value entered via the keypad.

Static calibration is carried out by entering a scale factor in the DISPLAY screen. EU is selected in the UNITS column and a floating point number entered as the SCALE factor in the usual way.

To calibrate the instrument dynamically, the process OCT CAL is selected in the PROC screen. VOLTS should be selected in the UNITS column of the DISP (Display) screen. A signal is input via channel A to produce an octave or 1/3 octave display in the usual way. The prompt PRESS TO CALIBRATE will appear at the end of the computation. The cursor should be positioned on the band corresponding to the calibration signal and the decimal point pressed. The calibration value can now be entered via the keypad. Use the following procedure for Octave Analysis Calibration.

1. Select OCT CAL process.
2. Input calibration signal and press GO.
3. Move cursor to band corresponding to calibration signal.
4. Press decimal point ".".
5. Enter calibration value via keypad.

The instrument will use the static calibration value if EU is selected in the DISP (Display) screen. Units are then DBE. If VOLTS is selected in the DISP screen, then the dynamic calibration value is used and the display is in DB.

The instrument can retain both a static and dynamic calibration value. Dynamic calibration on octave analysis can therefore be "carried over" to narrow band analysis (Autospectrum) by adjusting the scale factor in static calibration to produce the same value as the dynamic signal.

Post-processing (using the M-GO) function to narrow band (Autospectrum) can be carried out, but this will only compute 15 bands in 1/3 octave analysis and 5 bands in octave analysis since only one spectrum can be computed.

Technical Description

Overview

The SD222 uses the latest developments in micro-technology to produce, in truly portable form, a powerful two-channel spectrum analyzer equivalent in performance and accuracy to instruments many times its size and weight.

The case is of extremely rugged construction to allow sophisticated measurement and analysis to be carried out in the most hostile environments. The menu driven set-up procedures enable the operator to quickly master all control measurement and display features of the SD222. Indeed, it is intended that reference to this manual should rarely be necessary.

The display is a high-contrast LCD dot matrix type allowing alphanumeric and graphic representation on its 256 x 128 pixel format. The display is protected by a watertight anti-glare scratch resistant window which provides high impact resilience. All keypads are of rubber mat construction which can also tolerate high impacts without damage, and provide tactile feedback even when operated with a gloved hand. The case is moisture- and dust-resistant. Clean with a damp cloth.

The neckstrap attached to the base of the SD222 allows easy support and operation of the instrument, as well as providing hands-free transportation.

All measurement and processing is carried out by a true 16-bit processor allowing rapid manipulation of data and calculation of complex mathematical processes. The memory includes 250 kbytes of non-volatile static RAM. All switching of the internal measurement circuitry is performed electronically by menu prompted entry from the front panel keypads. This technique provides greater reliability and accuracy than the mechanical switches found on more conventional instruments, and the clearly annotated prompts make operation of the SD222 much easier.

As well as incorporating sophisticated processing algorithms, the large memory area of the SD222 enables numbers of measurements to be stored and recalled for later inspection, or downloaded via the built-in RS232 interface to a graphics printer for hardcopy filing. All stored data is retained when the instrument is switched off.

The SD222 is powered from an internal battery pack that allows approximately 6 hours operation when fully charged. Recharging of the batteries is achieved by simply connecting the charger provided to the charging socket. The instrument can be powered from the charger when battery charge is low.

Electrical

The SD222 uses a purely static CMOS design throughout to achieve reliable and low power consumption operation.

Inputs via channel A or channel B are switched via DC, AC, accelerometer or ground coupling to an electronically programmable gain amplifier covering 3 decades. The output of the gain amplifier passes through one of a bank of pre-filters, and then into the main anti-aliasing filter. When the filters are switched OFF, the output of the programmable gain amplifier is switched directly to the input of the sample-and-hold amplifier. Output of the S/H amplifier drives a 12-bit A/D converter, the output of which is available to the main processor.

Trigger source can be routed either internally from channel A or channel B, externally, or allowed to free-run under control of the processor. Internal triggering is entirely analog, so that when a trigger is sensed the data acquisition process of the A/D converters always begins at the same point. This technique is more precise than digital triggering which can be in error by up to one sample period. The only exception is pre-trigger mode, where data is being acquired prior to a legitimate trigger. Trigger level is resolved to one part in 256 which is scaled to one point in 100 for easier operator control.

The CPU section uses 16-bit processing and data transfer throughout. The processor varies its clock speed depending on the process being executed to minimize power consumption. Likewise, the RS232 interface is shut down unless data is being transferred. The real-time clock has its own battery which will power the clock for at least 15 years. Back-up of the static memory is achieved by a second battery allowing around 10 years data retention. Both batteries are protected against fault current discharge caused by internal component failure.

Primary instrument power is provided by high efficiency linear regulators as opposed to switching regulators to avoid noise problems. Battery charge is monitored at two levels, the first causing a warning message to be displayed on the screen, and the second shutting down the instrument to prevent an over-discharge condition on the internal batteries. If the instrument is inadvertently left on, it will switch itself off 5 minutes after the last key was pressed. The only exception is if the machine is waiting for a trigger or the auto shutdown has been disabled.

The instrument casing is cast aluminum which provides excellent RFI protection. As well as being sealed to IP65 standard, the casing and keypads are resistant to most industrial chemicals and can withstand high temperatures.

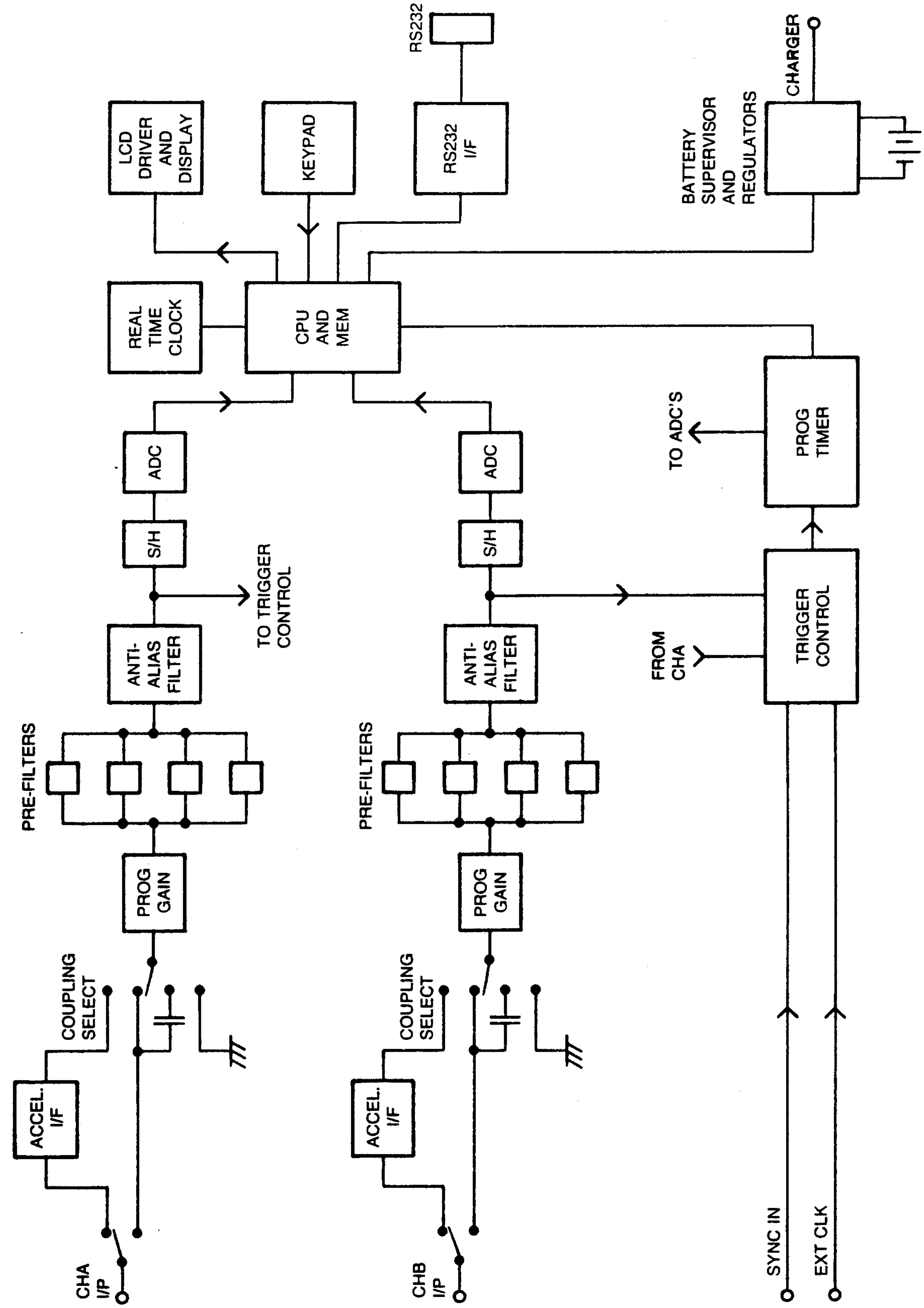
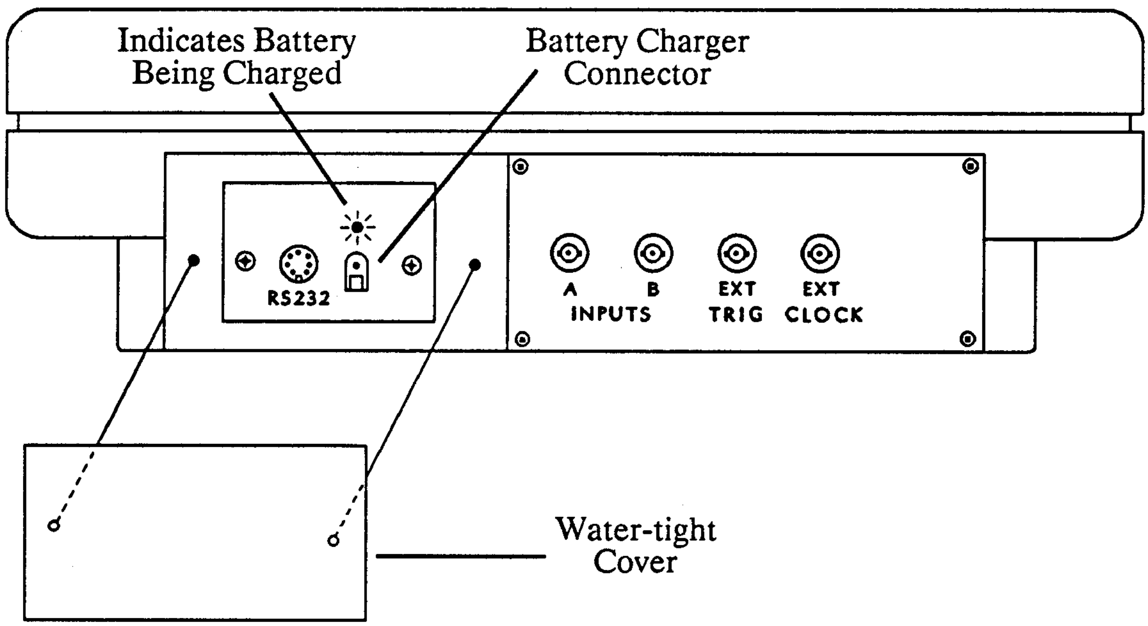


Figure 4-1. SD222 Block Diagram

External Connections

The following figure shows the SD222 rear panel. Remove the water-tight cover to expose the RS232 and battery charger connectors. When operating in adverse environments, replace the cover.



SD222 Rear Panel Showing External Connections

Analog Inputs

BNC connectors A (for channel A) and B (for channel B) receive input signals in the range ±5 V to ±5 mV according to the sensitivity selected. The input impedance at each input is 1 MΩ, except when the accelerometer interface is selected. When the amplitude of the input signal exceeds the sensitivity range selected, a warning message is displayed on the screen.

Maximum Input Voltage

Maximum input voltage is defined by the voltage which induces a forward current flowing through the output impedance of the signal source in series with a 100 Ω resistor. (This resistor is fitted on each channel input). This voltage, −15 V, should not induce a current of more than 30 mA. The maximum input voltage is dependent on the output impedance of the source. Any voltage between ±15V is acceptable, thereafter account should be taken of the output current capability or output impedance of the signal source. If the signal source cannot drive or sink more than 30 mA, then the maximum input voltage can be as high as 100 V. The maximum input voltage is defined in this way as the input to each channel passes through a 100 Ω resistor and the signal is then diode clamped to ±15 V.

Accelerometer Inputs

The accelerometer interface is selected as a coupling option in the INPUT screen. The interface takes a standard ICP accelerometer and generates 4 mA at up to 15 V. The accelerometer is AC coupled with a –3 dB cutoff of 0.1 Hz. The interface is overvoltage protected.

External Trigger and Clock Inputs

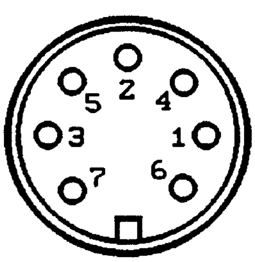
The **EXT TRIG** and **EXT CLOCK** inputs enable external trigger and clock signals to control the data acquisition functions of the instrument. Both inputs contain Schmitt triggers to ensure noise-free generation and can be driven by a TTL or CMOS logic level, or an open-collector drive. The inputs are fitted with overvoltage diode protection and with 100 kΩ pull-up resistors to +5 V.

Both inputs trigger on the positive going edge of the signal. Any duty cycle can be accepted provided that the input level is at logic low level for at least 30 nsec. Do not exceed the maximum sampling rate of 102.4 kHz on EXT CLK or spurious data will result.

RS232 Interface

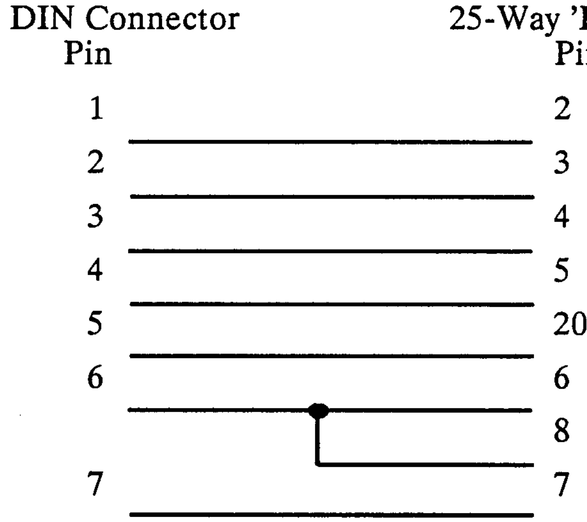
The RS232 interface is via a 7-way DIN socket on the connector panel. The interface operates with a hardware handshake, and does not support XON/XOFF.

Connector Shown As Viewed From Rear of SD222.



RS-232-C Pin Assignments

To connect to an IBM-PC computer or compatible, use a cable wired as in the following figure. This ensures correct enabling and handshaking between the devices.



IBM PC RS-232-C Cabling

Battery Charging Socket

A standard battery charger with a maximum output of 450 mA can be connected to the charger socket on the connector panel to charge the internal NiCad batteries. The center pole of the socket is negative. Connecting a charger in reverse polarity will not damage the instrument. The red LED illuminates to indicate that charging is taking place.

If an attempt is made to charge the batteries with a low impedance power supply or a charger set at a charging current of more than 500 mA, the internal circuit will isolate the charging source, indicated by the LED turning off. In severe cases, an internal fuse will blow to protect the instrument.

If the internal batteries are discharged, the instrument can be powered from a charger providing 450 mA of current. Continuous charging should not be allowed to exceed the maximum duration.

Charge	Current	Charging Time	Max Duration
Boost	450 mA	6 hours	6 hours
Normal	220 mA	16 hours	Indefinite

Use of boost charging should be kept to a minimum as constant recharging in this mode will, as with any NiCad cell, shorten the life of the internal batteries.

Using the Battery Charger

The instrument is supplied with a battery charger for charging the internal battery pack. The output current is fixed at approximately 220 mA. The charger can be used to charge the internal batteries indefinitely, but battery life will be preserved if the batteries are cycled between charge and discharge. Ideally, the batteries should be charged at night and then discharged during the day with use of the instrument.

Data Format For Download

Overview

Records stored in the MEM (Memory) screen can be downloaded via the RS-232-C interface by simply selecting `HEXDUMP` in the `MEM` screen and pressing `ENTER`. Records with a valid ID NO only are transmitted. Vacant ID NO's are not transmitted. Records can be of variable length as defined by `LENGTH` when they were stored. Each record is accompanied by status, time and date and settings information.

Once initiated, the transmission of records continues in sequence until all valid records have been transmitted. Transmission can be interrupted by pressing any key on the instrument. The parameters of the RS-232-C interface can be modified in the `UTIL` (Utilities) screen.

Data Structure

A record associated with an ID NO consists of a 64 byte header which contains all status and settings information followed by the data where length can vary according to the length of the data record. To observe the format of a record, it is suggested that the RS-232-C is connected to a standard printer and the `HEXDUMP` option activated. All valid records (ID NO's in which data has been stored) will be transmitted. End of transmission is signified by a double slash (//).

Format of 64-Byte Header

Parameter	No of Bytes	Comments
Machine Identification	2	
Software Revision	2	
ID NO	2	
Channel B Delay	2	Range 0-4095
Post-trigger Delay	2	Range 0-4095
Pre-trigger Delay	2	Range 0-4095
Trigger Level	2	Range 0-100
Count 2	2	
Count 1	2	
Count 0	2	
Trigger Latch	2	
Input Latch	2	
Input Flag	2	Auto Flag
Process Averages	2	Range 0-4095
Time Averages	2	Range 0-4095

Format of 64-Byte Header (cont.)

Parameter	No Of Bytes	Comments
Log/Linear Flag	2	
Trigger Source Flag	1	
Trigger Delay Flag	1	
Trigger Mode Flag	1	
Process Flag	1	Process Selected
Window Flag	1	Window Selected
Average Type Flag	1	
Display Flag	1	ChA, ChB or Both
Integrate Flag	1	No. of Integrations
EU Flag	1	
Spare	1	
EU Factor	4	Floating Point Number
Time, Seconds	1	
Time, Minutes	1	
Time, Hours	1	
Date, Day	1	
Date, Month	1	
Date, Year	1	
Channel Display	1	1 or 2 Channels Stored
Spare	1	
Address Of Data Record	4	Start Address In RAM
Length Of Data Record	2	Length In Bytes
Spare	4	Set To FF
	64	

If you wish to write a software driver for a particular host computer, please contact Spectral Dynamics for full information on the format and definitions of the individual parameters in the header.

The header is followed by data of length specified in the Length of Data Record parameter.

Filter Bands According To ANSI S1.11 - 1986

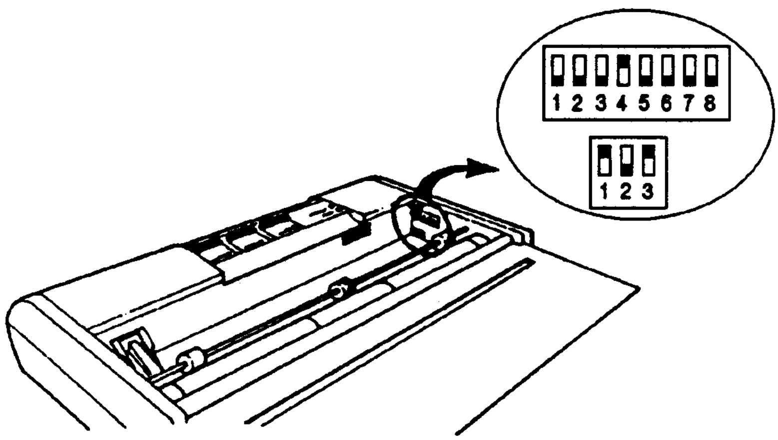
ANSI Band No.	1/3 Octave Center Freq (Hz)	Octave Center Freq (Hz)
7	5	
8	6.3	
9	8	8
10	10	
11	12.5	
12	16	16
13	20	
14	25	
15	31.5	31.5
16	40	
17	50	
18	63	63
19	80	
20	100	
21	125	125
22	160	
23	200	
24	250	250
25	315	
26	400	
27	500	500
28	630	
29	800	
30	1000	1000
31	1250	
32	1600	
33	2000	2000

Filter Bands According to ANSI S1.11 (cont.)

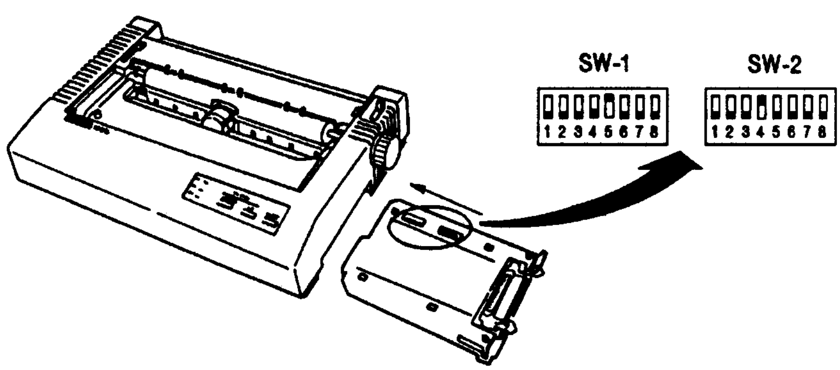
ANSI Band No.	1/3 Octave Center Freq (Hz)	Octave Center Freq (Hz)
34	2500	
35	3150	
36	4000	4000
37	5000	
38	6300	
39	8000	8000
40	10000	
41	12500	
42	16000	16000
43	20000	

Hardcopy Printers

The following figures show how to connect your printer to the SD222 for a hardcopy plot.

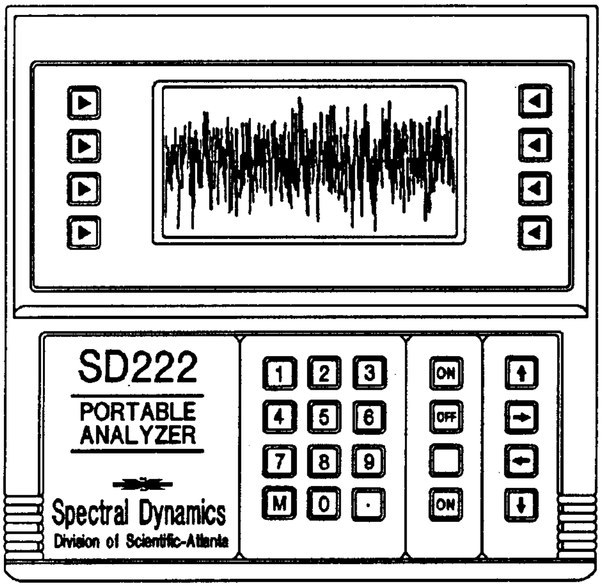


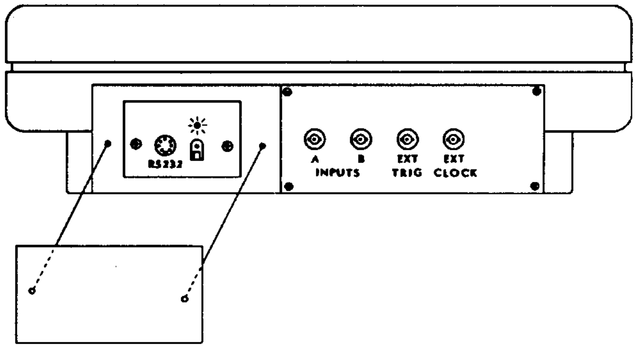
Switch Settings For Diconis Semas Model 150 Printer



Switch Settings For Citizen Model 120D Printer

SD222
2-Channel Analyzer
Specifications





Input

Number of Channels
2

Voltage Ranges
5 mV to 5 Vpk-pk (autoranged or selectable in 1, 2, 5 sequence)

Input Voltage (max)
±18 volts

Transducer Interface
4 mA current source built-in on each channel for standard accelerometer (15 volt source)

Scaling
Engineering Units (EUs) available

Frequency Ranges
0 – 100 Hz to 0 – 20 kHz in 8 ranges (1,2,5 sequence) with anti-aliasing filter or 0 – 40 kHz without anti-aliasing filter.

Input Sensitivity Range
130 dB

Input Dynamic Range
70 dB (12-bit A/D converter)

Input Filter
100 Hz to 20 kHz low pass per channel (selectable in 1, 2, 5 sequence or off) > 130 dB/octave roll-off

Input Impedance
1 MΩ

Input Coupling
DC, AC, accelerometer or ground

Sampling Rate
102.4 kHz per channel max (coupled to frequency range)

Sampling Rate/Bandwidth Ratio
2.56:1

Processor

Memory Size
256 kbytes of non-volatile SRAM

Data Record Length
256 to 4096 points selectable in binary steps

No. of Set-Up and Storage Memories
Up to 500, user-defineable

Process
Selectable by menu

Post-Processing
On last record acquired or any store time domain record

User Interface
8-way function keypad with menu interface to screen

Cursor keypad
Numeric input keypad

Real-Time Clock
Indication of seconds, minutes, hours, and date on stored readings

Display

Resolution
256 x 128 pixels

Type
High contrast LCD alphanumeric/graphic

Display Format
1 or 2 channel graphic display, continuous scan of displayed data by cursor

Vertical Magnification
By cursor control on processes

Horizontal Scroll
Keypad control

Text Information
Channel X-Y data displayed to full resolution at cursor position

Harmonic Cursors
20 available

Trigger

Control Modes
All menu-selectable — Normal, Free-Run, Single-Shot

Trigger Point
Normal, pre- or post-trigger
Set by no. of points after/before trigger point
Channel B delayed

Level
Variable with resolution of 1 part in 100, + or – slope

Trigger Source
Internal or external

Sample Clock Source
Internal or external

Time Domain Processing

Channel Data
CH A, CH B, or CHA & CHB

CHA – CHB
Differential Input

Differentiation
CHA or CHA & CHB

Integration
CHA or CHA &CHB

Spectrum Analysis

Autospectrum
100 to 1600 lines resolution
Log or linear amplitude display
Amplitude or amplitude & phase display

Cross Spectrum
100 to 1600 lines resolution
Log or linear amplitude display
Amplitude or amplitude & phase display

1/3 Octave Analysis
15 or 31 band selectable display

1/1 Octave Analysis
5 or 10 band display

Correlation

Auto-Correlation
See Table 1.

Cross-Correlation
See Table 1.

Other Processes

Coherence
100 — 800, window - see Table 1.

Transfer Function

100 – 800, window - see Table 1.

RMS Calculation
Variable over frequency band selected

Interfaces

RS232
Dump display to graphics printer (Epson type)
Transfer file to host computer (variable baud rate to 192000

General

Battery Type
NiCad recharageable (internal)

Time Between Charges
5-6 hours continuous running, auto shut-down

Memory Back-Up
By lithium cell up to 10 years

Weight
4 kg (8.8 lbs)

Size
256 (W) x 250 (H) x 92 (D) mm
10 x 9.8 x 3.6 inches

Operating Temperature
0° – 50° C (32° – 122°F)

Environment
Sealed to IP65 standard (U.K.)

Table 1. Windows vs. Process

Process	Rect.	Flat-Top	Hanning	Hamming
Auto-Spectrum	x	x	x	x
Dual Auto-Spectrum	x	x	x	x
Cross-Spectrum	x	x	x	x
Auto-Correlation	x	x	x	x
Cross-Correlation	x	x	x	x
Coherence	x	x	x	x
Transfer Function	x	x	x	x
RMS	x	x	x	x
Octave Analysis	x	x	x	x

Table 2. Averaging (Number Selectable Between 2 and 4096

Process	Linear	Exponential	Peak Hold
Time	x		
Auto-Spectrum	x	x	x
Dual Auto-Spectrum	x	x	x
Cross-Spectrum	x	x	x
Correlation	x	x	x
Coherence	x	x	x
Transfer Function	x	x	x
RMS	x	x	x
Octave Analysis	x	x	x

Specifications Subject to Change Without Notice.

Spectral Dynamics
A Division of Scientific-Atlanta

United States: P.O. Box 23575 • San Diego, CA 92123-0575 • (619) 496-3400 • TWX 910-335-2022 • FAX (619) 496-3546
Europe: Home Park Estate • Kings Langley, Herts, WD4 8LZ, England • Telephone: 09.277-66133 • Telex: 912044