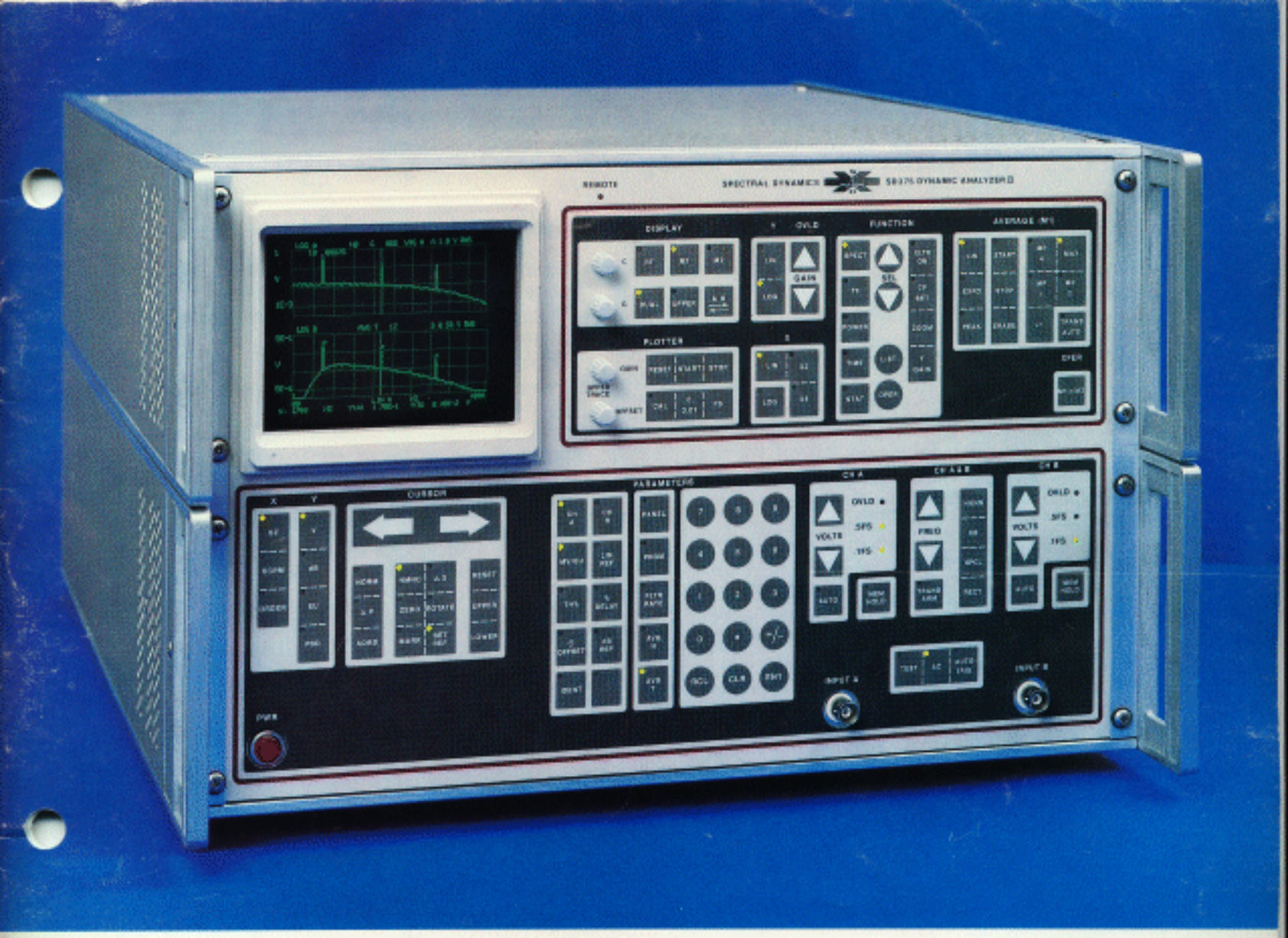


SD375 Dynamic Analyzer II

A powerful high-performance two-channel FFT Analyzer

Scientific Atlanta

Spectral Dynamics Division

The SD375 Dynamic Analyzer II

smart . . . versatile . . . easy to operate and easy to own

What is the SD375?

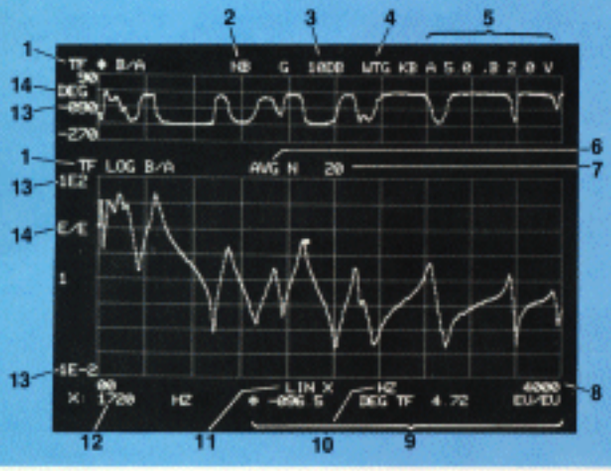
- A real time dual-channel spectrum analyzer with stable raster scan display
- A single, compact and portable instrument with touch control operation
- A signal correlator — time, amplitude, frequency up to 100 kHz
- A transfer function analyzer for mechanical, electrical, acoustic, hydraulic measurements
- A versatile transient recorder and waveform editor
- A signal averager in the frequency or time domain
- An acoustic analyzer for 1/3 and 1/1 octave analysis (optional)
- A post processor for data manipulation
- A signal source for external system or network excitation (optional)
- A completely controllable processor with IEEE 488 and RS 232C interfaces (optional)
- A frequency translator with up to 100 times zoom magnification (optional)

Why Two Channel Analysis?

- Establish true cause and effect in excitation/response measurements
- Measure phase relationships between continuous or transient signals
- Correlate two variables
- Measure system gain characteristics for any excitation level
- Process multi-channel data from operating systems
- Measure time delay between signals — establish directionality
- Trace and identify sources of noise and vibration
- Process microphone signals for acoustic intensity measurements

Displays . . .
a new standard of clarity, convenience and completeness

The SD375's display operates on the TV raster scan principle. Images are crisp, bright and absolutely flicker-free. Operating parameters and scaling factors are shown directly. No guesswork, codes or interpretations are required. What you see are processed results, not additional problems in diagnosing what the analyzer was doing.



1. Upper & lower trace identification
2. Spectrum mode
   NB—narrowband
   Z—zoom
3. Output display gain
4. Weighting selected:
   H—Hanning
   KB—Kaiser Bessel
   TR—transient
   R—rectangular
5. CH A & CH B selected full scale input level
6. Averager mode:
   AVG—linear sum
   EXPO—exponential
   PK—peak
7. Ensemble number N or average time T in seconds
8. Full scale analysis range or memory period
9. Y-axis cursor value for upper & lower trace in deg, γ^2, dB, V, V^2, EU, EU^2, EU^2/Hz
10. X-axis parameter in Hz, kcpm, order, sec
11. X-axis format in Lin or Log
12. X-axis cursor value in Hz, kcpm, order, msec
13. Scaled grid values of Y-axis display parameter
14. Y-axis parameter for upper & lower trace in deg, γ^2, dB, dBR, V, EU, PSD, V/V, EU/EU

Where to use the SD375

• Noise and vibration studies of vehicles and farm/construction equipment • Engineering instruction in vibration and signal analysis • Drive-by and fly-by tests of new vehicles and aircraft • Analysis of underwater sounds and sonar signals • Modal analysis of automotive engines, frames, and bodies • Vibration analysis of gas and steam turbines to define failure mechanisms • Medical and biological stimulus vs. reaction studies • Structural-integrity and tool-chatter investigations of machine tools • Aircraft flutter and vibration analysis • Stiffness/mobility measurements on operating bearings and machinery • Railway equipment noise-reduction programs • Household appliance development studies • Computer disc-drive design

SD375 Function Groups and Calculations

Simple Operation

The SD375 implements menu programming for fast familiarization and error-free operation and displays. Specific function selection is made by moving the asterisk up or down the menu list with the SEL controls. The OPER control initiates the selected function/display and presents a fully scaled and annotated display. The operator can focus on his data collection or analysis task without having to concentrate on analyzer operation.

①

```
SPECTRUM MENU

* 1.   SPECT A & B
  2.   GAA & GBB
  3.   RATIO
  4.   SPECT B÷A
  5.   GBB - GAA
  6.   SPECT B+A
  7.   GBB + GAA
  8.   SPECT A & ZOOM A
  9.   SPECT B & ZOOM B
  10   SYNC SPECT A & B
  11   SYNC SPECT A & Φ
  12   SYNC SPECT B/A & Φ
  13   EQUALIZED RATIO
```

1. RMS magnitude of CH A & CH B spectrum
2. Power spectrum (A^2 & B^2) of CH A & CH B
3. Transmissibility display of B/A or A/B
4. RMS spectrum difference, i.e. $\sqrt{B^2 - A^2}$
5. Power spectrum difference, i.e. $B^2 - A^2$
6. RMS Spectrum sum, i.e. $\sqrt{B^2 + A^2}$
7. Power spectrum sum, i.e. $B^2 + A^2$
8. Simultaneous baseband & zoom spectrum of CH A
9. Simultaneous baseband & zoom spectrum of CH B
10. Synchronous spectrum of CH A & CH B referenced to external trigger
11. Spectrum A & phase
12. Synchronous spectrum ratio & phase — "SYNC TF"
13. Compensating a ratio with a reference ratio, i.e. M1/M2

②

```
TRANSFER FUNCTION MENU

  1.   TF & Φ
  2.   TF & γ^2
  3.   TF RE AND IM
* 4.   TF CO/QD
  5.   EQUALIZED TF & Φ
```

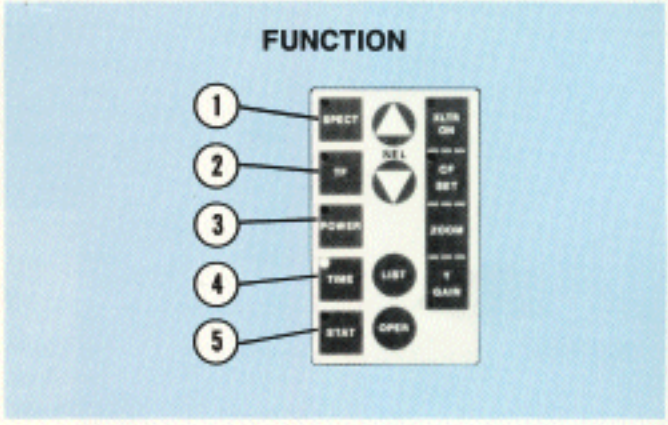
1. Transfer function gain of B/A & phase
2. Transfer function gain of B/A & coherence
3. Transfer function real & imaginary
4. Nyquist display of TF real vs. imaginary
5. Compensating a TF & phase measurement with reference TF & phase data, i.e. M1/M2

③

```
POWER MENU

  1.   COP & γ^2
* 2.   COP & GBB
  3.   GAA & GBB
  4.   GBB - GAA
  5.   GBB + GAA
  6.   CAB & Φ
  7.   CAB RE AND IM
  8.   CAB CO/QD
```

1. Coherent Output Power & coherence
2. Coherent Output Power & Total Power
3. Power Spectrum (A^2 & B^2) of CH A & CH B
4. Power Spectrum difference, i.e. $B^2 - A^2$
5. Power Spectrum sum, i.e. $B^2 + A^2$
6. Cross Spectrum & phase
7. Cross Spectrum real & imaginary
8. Cross Spectrum real vs. imaginary



④

```
TIME MENU

* 1.   TIME A & B
  2.   SYNC TIME A & B
  3.   TIME A & SPECT A
  4.   TIME B & SPECT B
  5.   RAA AND RBB
  6.   RBA
  7.   IMPULSE RESPONSE
```

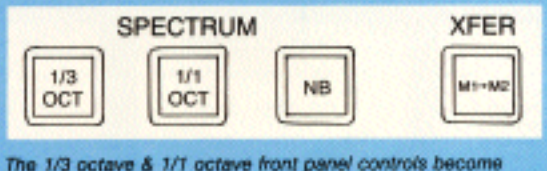
1. Filtered digitized time waveform of CH A & CH B
2. Synchronous time waveform of CH A & CH B referenced to external trigger
3. Simultaneous time waveform and spectrum of CH A
4. Simultaneous time waveform and spectrum of CH B
5. Normalized Auto Correlation of CH A & CH B
6. Normalized Cross Correlation
7. Inverse Fourier transform of transfer function

⑤

```
STATISTICAL MENU

* 1.   PDH A & B
  2.   PD A & B
```

1. Probability Density Histogram of CH A & CH B
2. Probability Distribution (cumulative) of CH A & CH B



The 1/3 octave & 1/1 octave front panel controls become operational when the -2 option is installed

```
OCTAVE MENU

1.   OCT A & B
2.   OCT B/A
3.   OCT B-A
4.   OCT B+A
5.   ACST WTG:  SELECT USING LIST
6.   SHAPING:  SELECT USING LIST
```

Data manipulation selection for 1/3 or 1/1 octave displays

```
SHAPING

* 1.   ON
  2.   OFF
```

1/3 octave filter shape selections: OFF for synthesized rectangular shape and ON for synthesized smooth shape

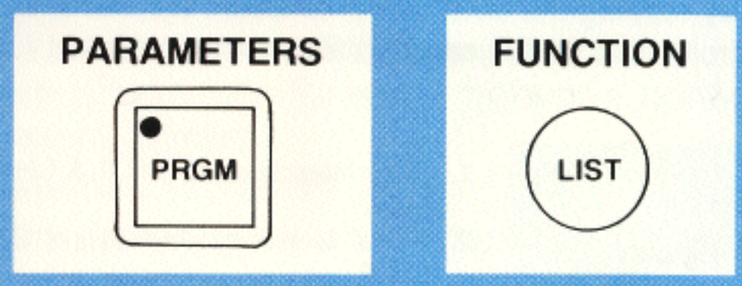
```
ACOUSTIC WTG

1.   FLAT
2.   A
3.   C
4.   A:  OVERALL ONLY
5.   C:  OVERALL ONLY
```

Acoustic weighting selections implemented as a post-processing operation

Programs

This menu, displayed when a PRGM/LIST is selected, provides those needed operator choices in signal source setup, post-processing manipulation, and I/O communication. Satisfactory functional performance of the SD375 is quickly verified with the SELF TEST program. Excitation source mode and output level are selected through the SIGNAL GENERATOR program. Post-processing integration and differentiation modes are easily selected in English or Metric scaling units with program NO. 1. Plotter operational modes are selected through the DIGITAL PLOTTER program. The I/O menu selections provide the interface configuration you need to communicate with most compatible digital peripherals.



PROGRAMS

1. ∫, ∫∫, ∮, ∀
2. DIGITAL PLOTTER
3. PRINTER INTERFACE
4. I/O MENU
5. SELF TEST
6. SIGNAL GENERATOR

ARTIFICIAL INTEGRATION MENU

* 1. NORMAL
2. ∫ UNITS
3. ∫∫ UNITS
4. ∫ MM/SEC
5. ∫∫ MM
6. ∫ IN/SEC
7. ∫∫ IN
8. ∮
9. ∀

DIGITAL PLOTTER MENU

1. ANALOG PLOT
* 2. DIGITAL PLOT
3. GRIDS
4. ANNOTATION
5. TRACE
6. TRACE OVERLAY, DASHED VECTOR

I/O MENU

* 1. MODIFY I/O PARAMETERS
2. SEND
3. RECEIVE
4. NO ACTION

SELF TEST

1. OFF
* 2. ON

SIGNAL GENERATOR

* 1. BAND LIMITED
2. BROAD BAND
3. SINGLE FREQ

USE CHA VOLTS SELECT.

OUTPUT LEVEL 0.05 V

I/O PARAMETERS

* 1.	CONTROLLING PORT:	PANEL CTL ONLY
2.	PRIMARY ADDRESS:	1
3.	IEEE MODE:	TALK ONLY
4.	DATA BUS:	STANDARD
5.	FLOATING PT:	DEC FORMAT
6.	BYTE CODING:	BINARY
7.	SERIAL HANDSHAKE:	HARDWARE
8.	DUPLEXING:	QUIET
9.	AUTO LINE FEED:	ON
10.	BAUD RATE:	19200
11.	BITS/SERIAL BYTE:	7
12.	PARITY:	NONE
13.	STOP BITS:	2

RECEIVE DATA PARAMETERS

* 1.	DATA GROUP:	5 TF COMP
2.	PORT:	IEEE
3.	BYTE CODING:	BINARY
4.	DATA BUS:	STANDARD
5.	DUPLEXING:	QUIET

SEND DATA PARAMETERS

1.	DATA GROUP:	9 CURSOR
* 2.	PORT:	IEEE
3.	BYTE CODING:	ASCII (ALWAYS)
4.	DATA BUS:	STANDARD
5.	DUPLEXING:	QUIET

Choose the Right Analyzer for Five Typical Applications

Application 1:

Using the SD375 for single and dual-channel signal processing and signal to noise enhancement.

Included in the standard SD375 are many important features and conveniences designed specifically to enhance signal analysis and recover the greatest possible amount of usable data from the signals available. For example, the extremely selective Kaiser-Bessel window, combined with real time operation and overlap processing assures optimum detection of low level signals and data masked by unwanted components. Completely normalized correlation analysis and probability displays give the SD375 the versatility to extract signal characteristics in the amplitude or time domain. Optional plug-in digital zoom can be used to augment the excellent 400-line frequency resolution and wide dynamic range characteristics of the standard analyzer.

How the SD375 Enhances Signal Processing

- Wide dynamic range front end from 2 μV to 20 V
- Aliasing protection on every range from 10 Hz to 100 kHz full scale
- Choice of four weighting windows including powerful Kaiser-Bessel
- Selectable overlap processing
- Real time (100% spectrum processing) operation to 4 kHz
- Averaged displays always normalized — any averaging time (T) or number of ensembles (N)
- Completely normalized and corrected correlation displays

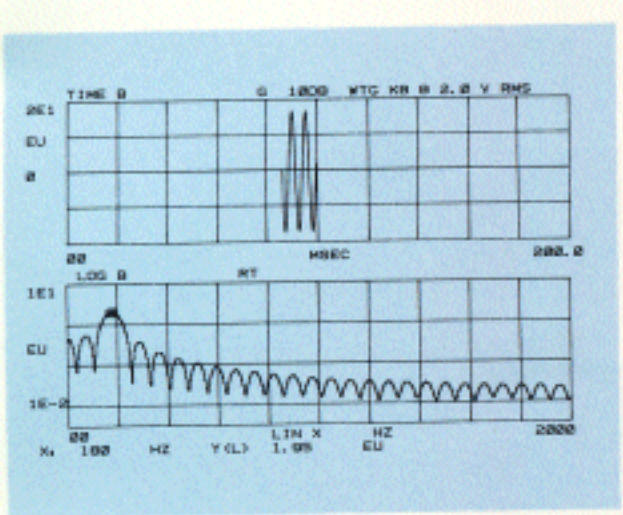


Figure 1: Time and spectrum display of an edited sine burst

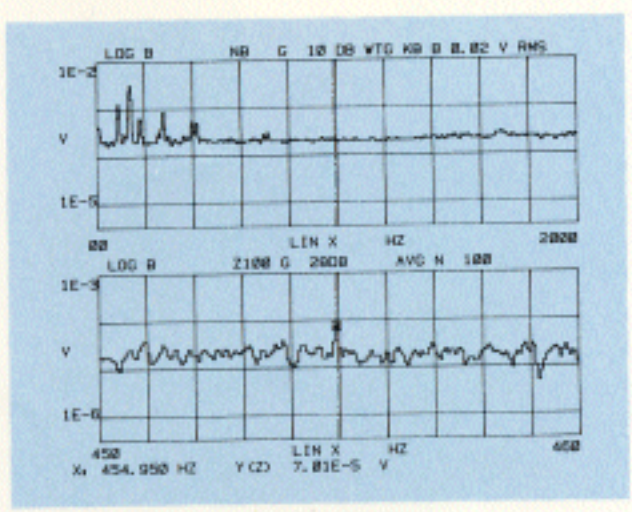


Figure 2: Simultaneous baseband and zoom display shows how 100 times improvement in resolution can uncover tone masked in noise

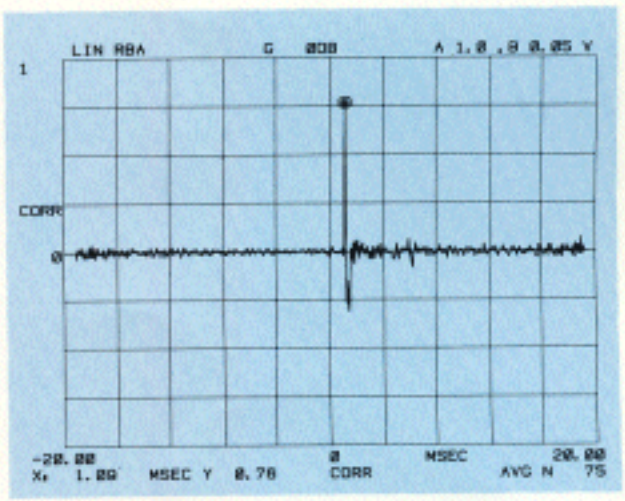


Figure 3: Normalized cross correlation measurement showing signal delay through filter network

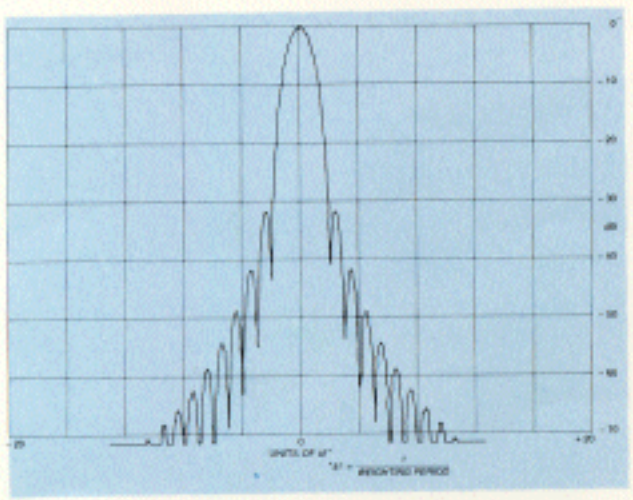


Figure 4: Typical HANNING WTG frequency characteristics. Most widely used weighting function. Offers good main lobe definition for separating closely spaced similar amplitude tonals.

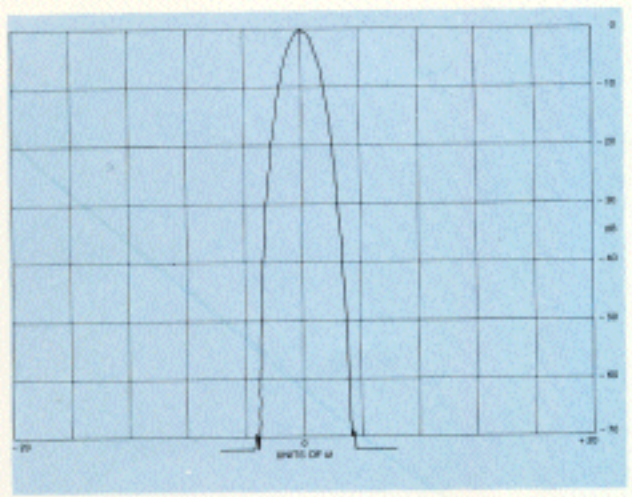


Figure 5: Typical KAISER-BESSEL WTG frequency characteristics. Offers optimum concentration of signal energy in main lobe without masking signal sideband terms.

Application 2:

Structural Transfer Function Measurements

Quality frequency response function measurements can be obtained using sinusoidal, random, pseudorandom or impact excitation methods. By offering four operator selectable weighting functions in conjunction with a continuously normalized averaging section which can select any integer number of ensembles or any desired averaging time in seconds, virtually any testing technique can be employed with confidence. Digitally adjustable threshold selection combines with auto transient averaging which automatically discards overloaded inputs and a special transient weighting function to make impact testing as simple as swinging a hammer. The completely annotated display can be used in conjunction with a unique Mark/List feature to display and hard copy precise resonant frequency and magnitude values from any selected frequency response function, phase, coherence, vector or power spectrum display. Add-on modal analysis packages permit the use of the SD375 for either real time structural measurements or for complete structural modeling to any level of sophistication desired by the user.

Why the SD375 Improves Structural Measurements

- Fast analysis speed eases use of sine sweep and random excitation
- Save data acquisition time with real time display for valid data verification
- Trigger during impact testing at pre-set force levels
- Automatically discard overloaded signals
- Display and list precise engineering unit values, e.g. at resonant frequencies
- Isolate a single mode in Nyquist displays
- Display results in any TF format in English or Metric units
- Add-on modal analysis packages for further analysis and complete modeling

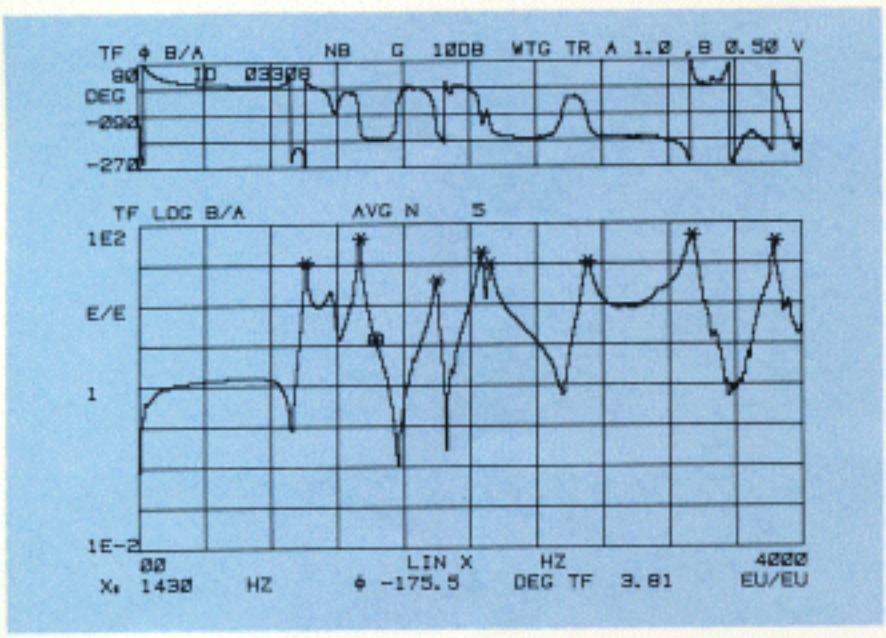


Figure 1: Transfer function and phase plot showing cursor MARK'ed structural resonant peaks. TF magnitude scaled in g's/lb (EU/EU).

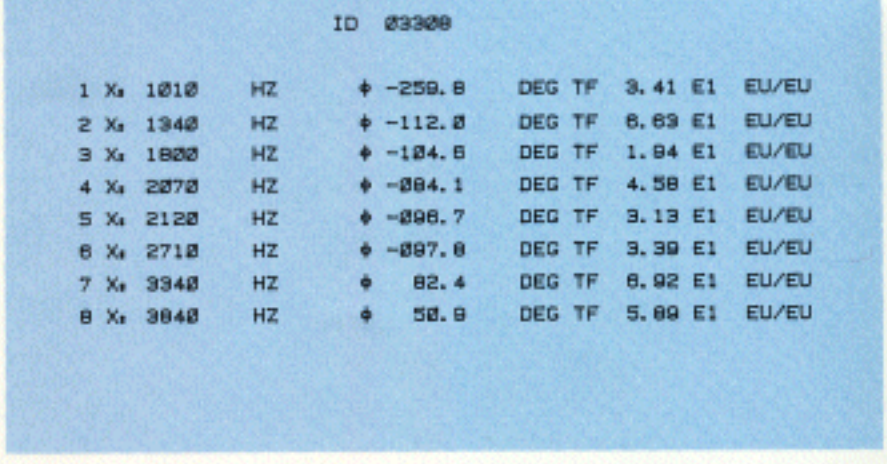


Figure 2: MARK/LIST plot of resonant peaks defined in Figure 1

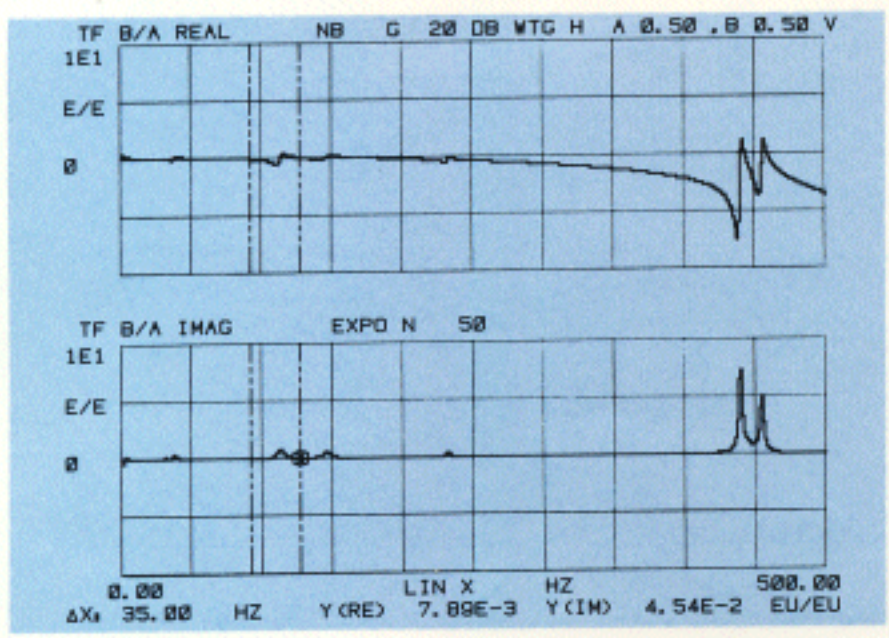


Figure 3: Typical structural TF real and imaginary display showing selected window of one mode

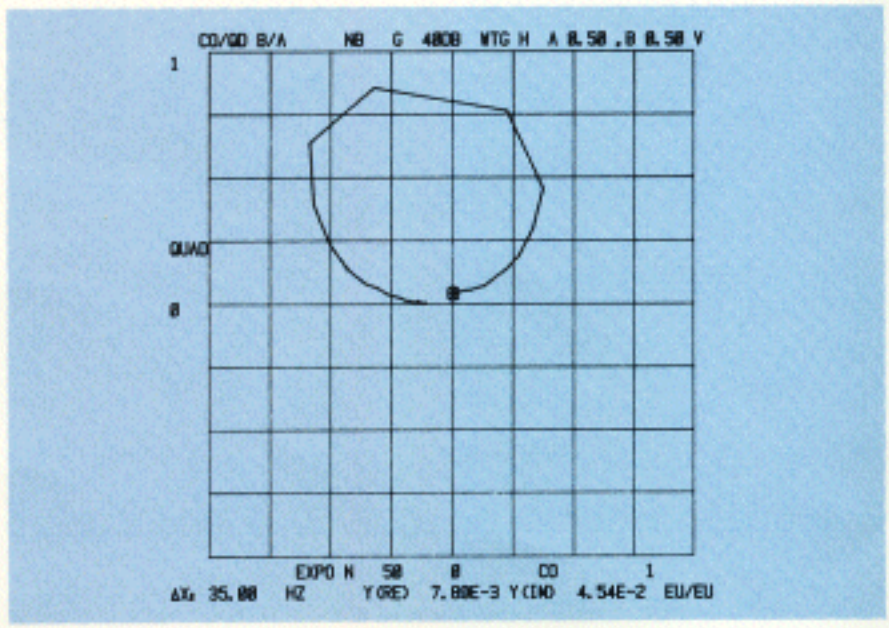


Figure 4: CO/QUAD plot of isolated mode identified in Figure 3

Application 3:

Noise Analysis and Acoustical Signal Processing

Direct readout and display in terms of absolute sound pressure level greatly simplifies the interpretation of narrowband noise measurements. Signal averaging and synchronous spectrum measurements permit the isolation of a single signal source in the presence of many sources where selected tach signals are available. Coherent output power (COP) and coherence function measurements give the percentage contribution of each source where several independent sources contribute to an overall noise problem. Optional 1/3 octave and 1/1 octave with acoustical weighting features provide spectrum displays in accepted constant percentage band levels.

How the SD375 Improves Noise Analysis

- Coherence function and coherent output power displays for isolating noise source contributions
- Spectrum ratio, addition and subtraction shows results of noise reduction efforts
- Signal averaging to clean up noisy machine signatures
- Optional 1/3 and 1/1 octave displays with selectable acoustic weighting

Synchronous Spectrum Displays for Machinery Analysis

When several machines are operating in proximity, analyzing the performance of any single machine is a problem. Each machine generates its own unique vibration pattern (signature), and the vibration of one affects the signatures of the others.

Using a tachometer signal from the machine to be analyzed as a sync pulse, its time-domain vibration signal is coherently averaged. The vibration signal and its harmonics are "averaged up" in the process, while broadband noise and non-synchronous periodic signals average to zero. A single FFT of the coherently-averaged time-domain signal produces a Synchronous Spectrum, containing only the tach related frequency and its harmonic orders.

Coherent Averaging/Synchronous Spectrum measurements are especially effective when background noise levels are extremely high, since it literally "lifts" harmonics above the broadband noise level, an impossible task with conventional baseband spectrum averaging.

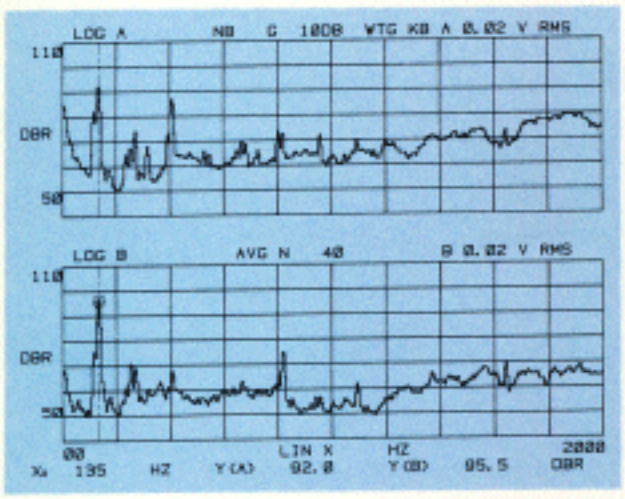


Figure 1: Averaged dual acoustic spectrums with DBR grid scaling and cursor readouts referenced to piston phone cal

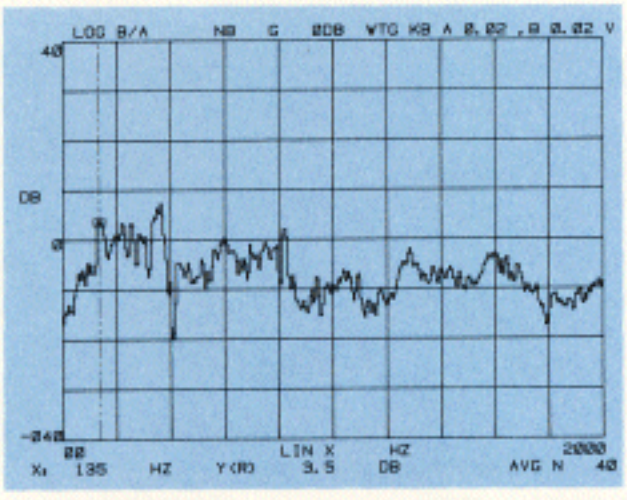


Figure 2: LOG ratio of the two spectrums presented in Figure 1. Signal gain or attenuation is easily identified about the 0 dB unity gain grid line.

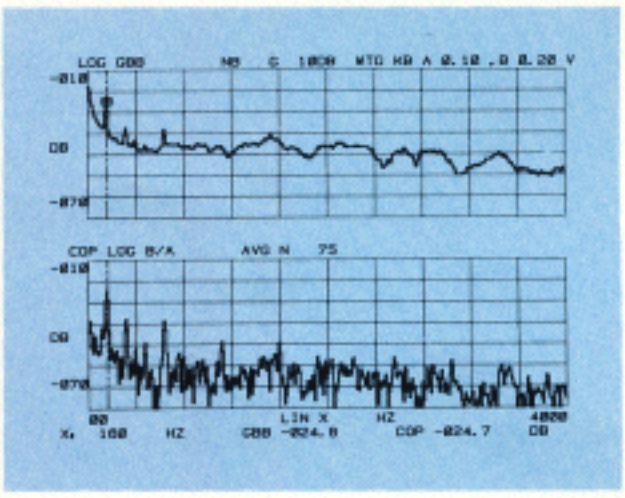


Figure 3: Composite GBB acoustic spectrum and the COP spectrum contributed by the noise source reference

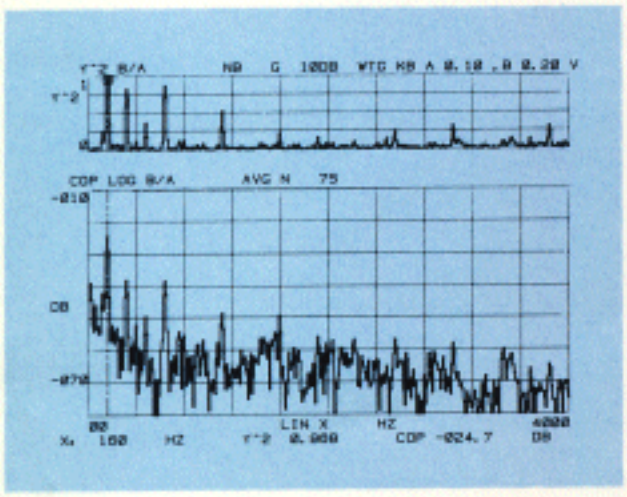


Figure 4: Coherence function identifies dominant frequencies in COP spectrum that are contributed by the noise source reference

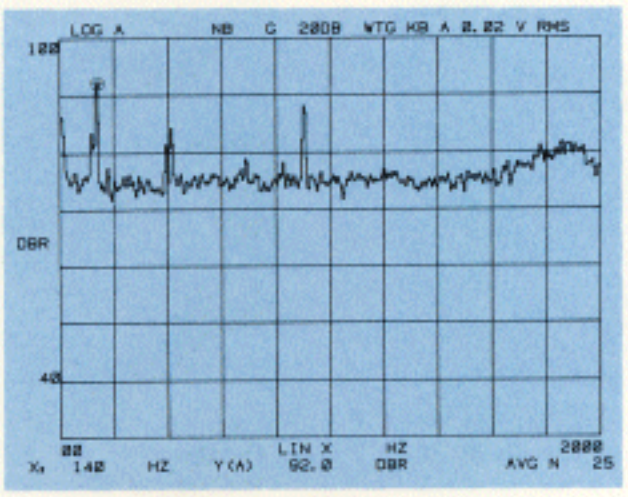


Figure 5: Acoustic signature of operating machine in high background noise environment

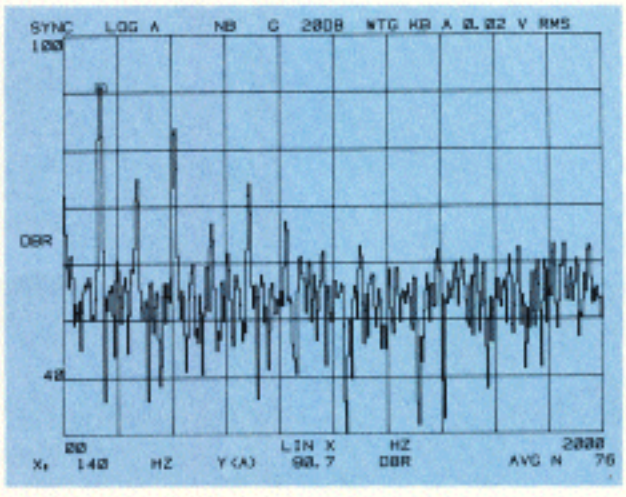


Figure 6: Acoustic synchronous spectrum related to the fundamental shaft speed of the same machine operating in high background noise environment

Application 4:

Audio Frequency Analysis—Filter Design and Parameter Studies

Real time analysis coupled with a new standard of display clarity and convenience makes many circuit measurements the simplest yet. Measurements can be calibrated and displayed in absolute voltage, dB, dBV and their ratios. Nyquist displays, Bode diagrams, vector components and expanded phase displays are as simple as the press of the touchpanel control. Adjustable phase offset simplifies interpretation of phase discontinuities. Versatile triggering, transient capturing and signal editing provides extra measures of convenience for both periodic and detailed transient analysis. Optional plug-in digital spectrum zoom improves baseband resolution for even finer detail in understanding both magnitude and phase characteristics.

How to Remove Test Instrumentation Errors

Equalized Transfer-Function measurements, selectable by touch control, easily compensate for differing filter characteristics or amplifier gain discrepancies. The SD375 measures and stores the broadband gain and response characteristics of the affected instrumentation channels, then automatically subtracts them from the system measurements on command. The result is a true picture of the system response, independent of instrumentation characteristics.

Better Audio Circuit Measurements with the SD375

- Real time measurements and display in V, dB and dBV
- Bode and Nyquist displays give sensitive and sensible results
- Adjustable phase offset and expanded annotated phase displays simplify interpretation
- Optional signal source speeds measurements and improves S/N
- Signal averaging removes unwanted hum components
- Convenient triggering on continuous and transient data ensures consistent acquisition
- Equalized TF & Φ correct for external instrumentation effects on frequency response measurements
- Signal editing enhances pulse waveform processing
- Optional zoom for better than millihertz resolution

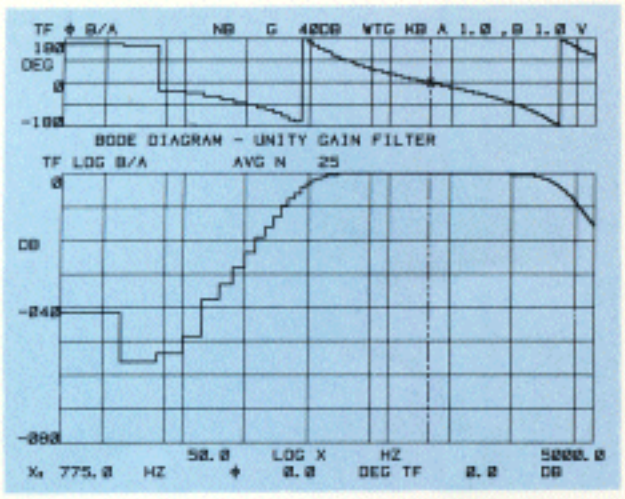


Figure 1: Gain and phase plot for unity gain bandpass filter *

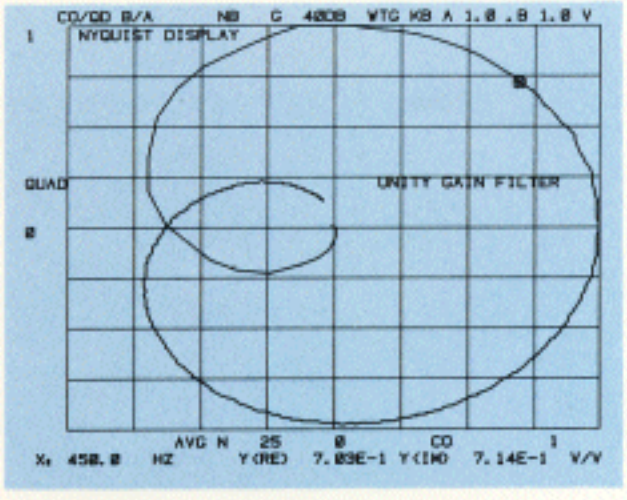


Figure 2: CO/QUAD (NYQUIST) plot of filter characteristics shown in Figure 1 *

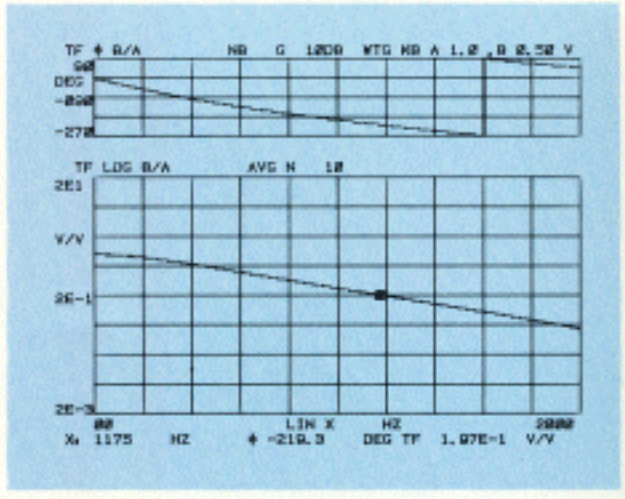


Figure 3: Measured external instrumentation characteristics stored in M2 memory

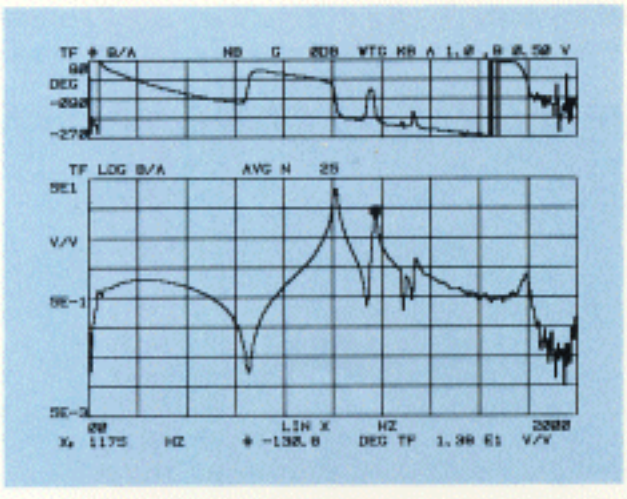


Figure 4: Measured composite transfer function, including unwanted instrumentation effects, stored in M1 memory

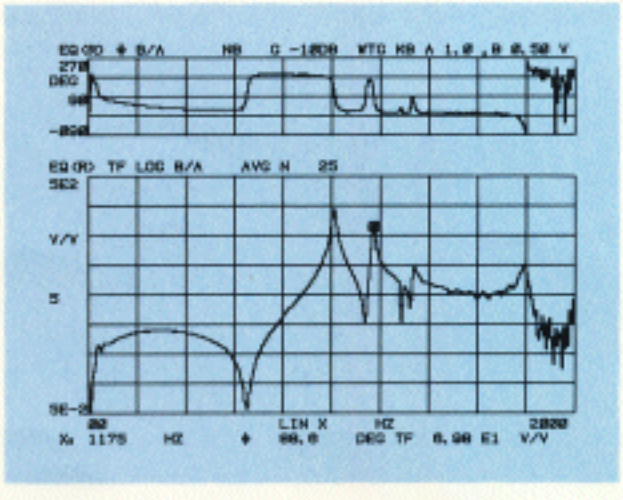


Figure 5: True system transfer characteristics (equalized TF and phase) obtained by removing unwanted characteristics of Figure 3. Note differences in magnitude and phase values at cursor from Figure 4.

* Operator defined annotation added via external text entry

Application 5:

Vibration Studies on Operating Systems

The SD375 can supply quick answers to machinery vibration problems, aid in product development of high-speed rotating devices or operate under remote control for continuous surveillance of critical performance machinery.

Why the SD375 Optimizes Most Machinery Measurements and Simplifies Interpretation of Machine Signatures

- Direct EU readout of signal peaks in the time domain
- Harmonic cursor with fine tuning for quick and accurate identification of true harmonics
- KCPM and ORDER displays simplify data interpretation
- Auto trigger for stable, convenient viewing of vibration time trace
- Single and double integration for direct EU display in in/sec, mm, etc.
- Sync TF permits stiffness measurements on operating machines
- Signal averaging and sync spectra isolate results to a selected tach input
- Coherence and Coherent Output Power help pinpoint sources of vibration and noise
- Magnitude and phase readout for direct balancing data

Simultaneous time and spectrum displays of a machine signature gives the test operator the needed information to quickly diagnose abnormal or changing performance conditions. Input AUTO TRIGgering from positive or negative thresholds, can be selected for stable, convenient viewing of time traces during continuous data acquisition modes.

Time traces or spectrum peaks are quickly identified with the cursor directly in EU (acceleration, velocity or displacement units) without the time consuming task and confusion of rescaling dB reference readouts to usable vibration numbers.

The SD375 provides a harmonic cursor with the added capability of fine tuning (accurately locating) higher harmonics or integer multiples of a fundamental frequency and identifying them with intensified cursor dots on the display.

Many machine signatures are derived from accelerometer signals but often the equivalent velocity or displacement spectrum is more descriptive of certain operating modes. The SD375 computes and displays the single and double integration spectrum of an accelerometer signal to get equivalent velocity or displacement and presents the integrated results in correct EU without further scaling adjustments. Differentiation is also provided.

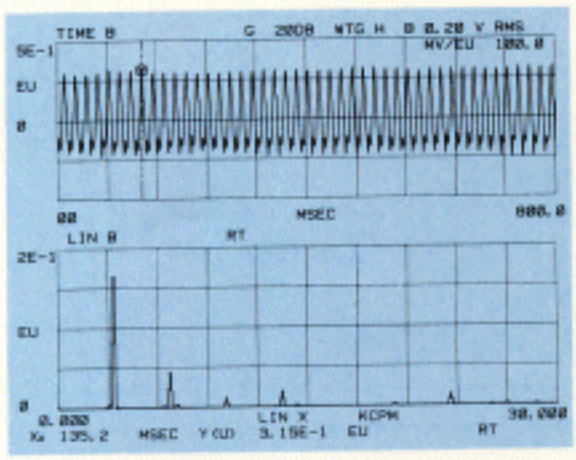


Figure 1: Time and spectrum plot of velocity signal with cursor identified time waveform peak

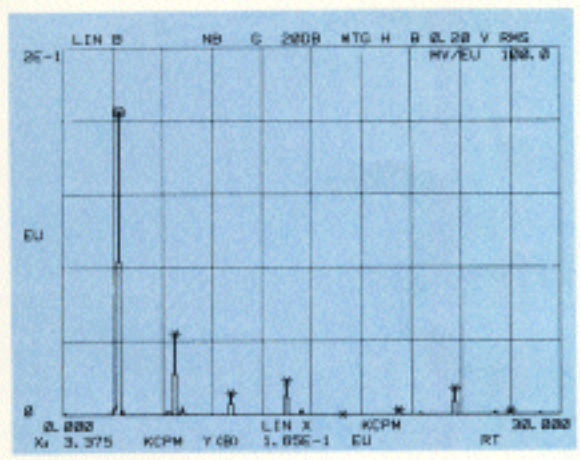


Figure 2: Linear amplitude velocity spectrum and multiple harmonics of the fundamental

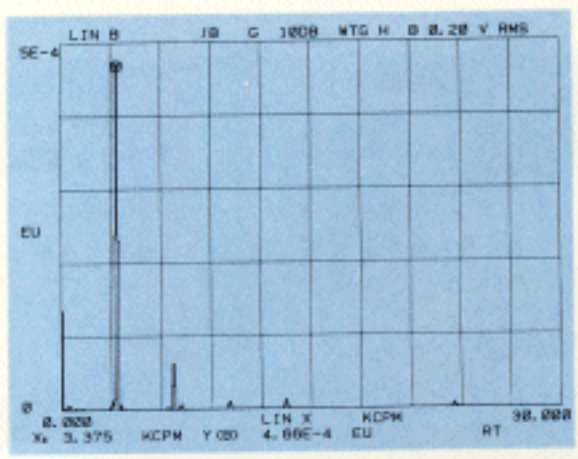


Figure 3: Displacement spectrum obtained by integrating velocity spectrum of Figure 2. Cursor readout is in direct displacement units.

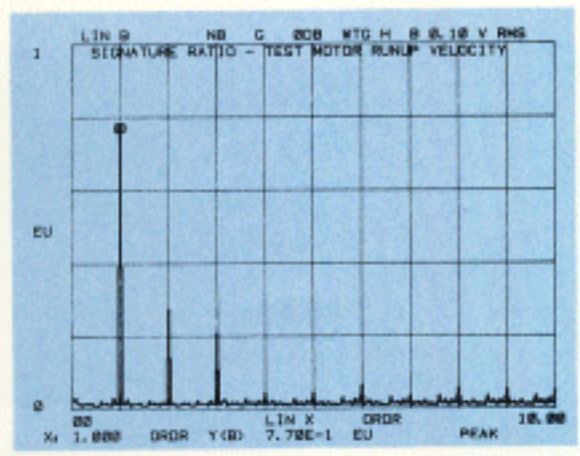


Figure 4: Peak Signature Ratio spectrum recorded from a test motor runup *

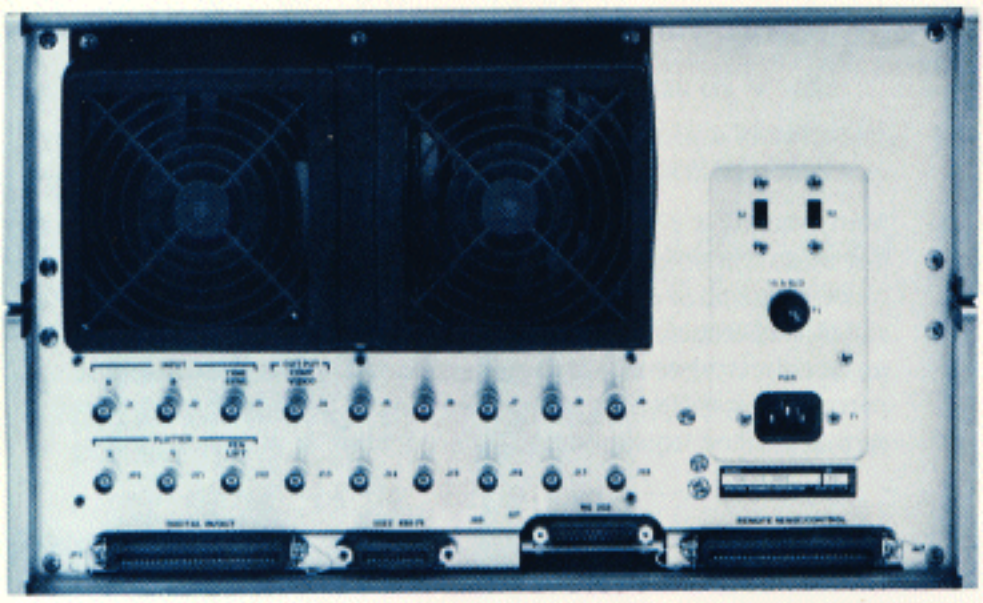
* Operator defined annotation added via external text entry

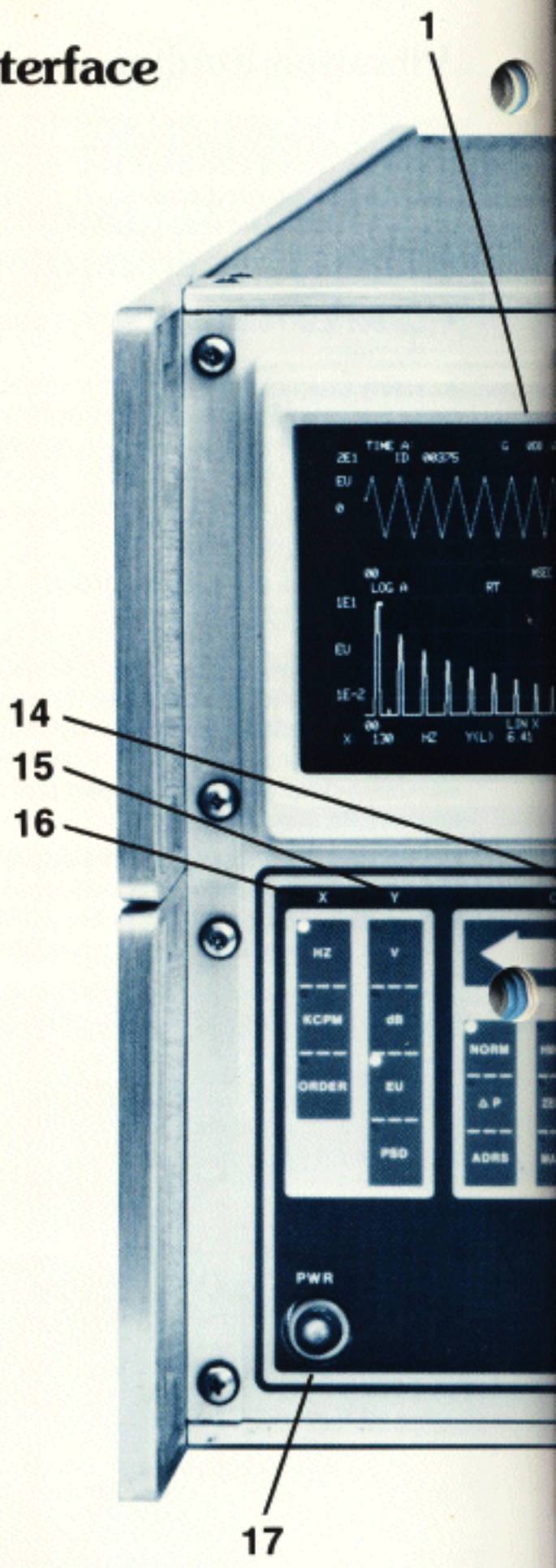
Efficient Touch Control...

the convenient, reliable operator / instrument interface

The SD375 meets the challenge of bringing high performance signal processing capability to its user through a well organized front panel that utilizes the touch control principle. Convenient and easy to operate, the panel incorporates sealed mechanical positive action switches impervious to contamination and corrosion. But more than just reliable, the panel is, above all, logically organized to provide fast and sure error-free interaction with the operator. A lighted LED and an audible tone acknowledge selection of each operating parameter and, as each control is changed, the new value appears immediately on the display screen.

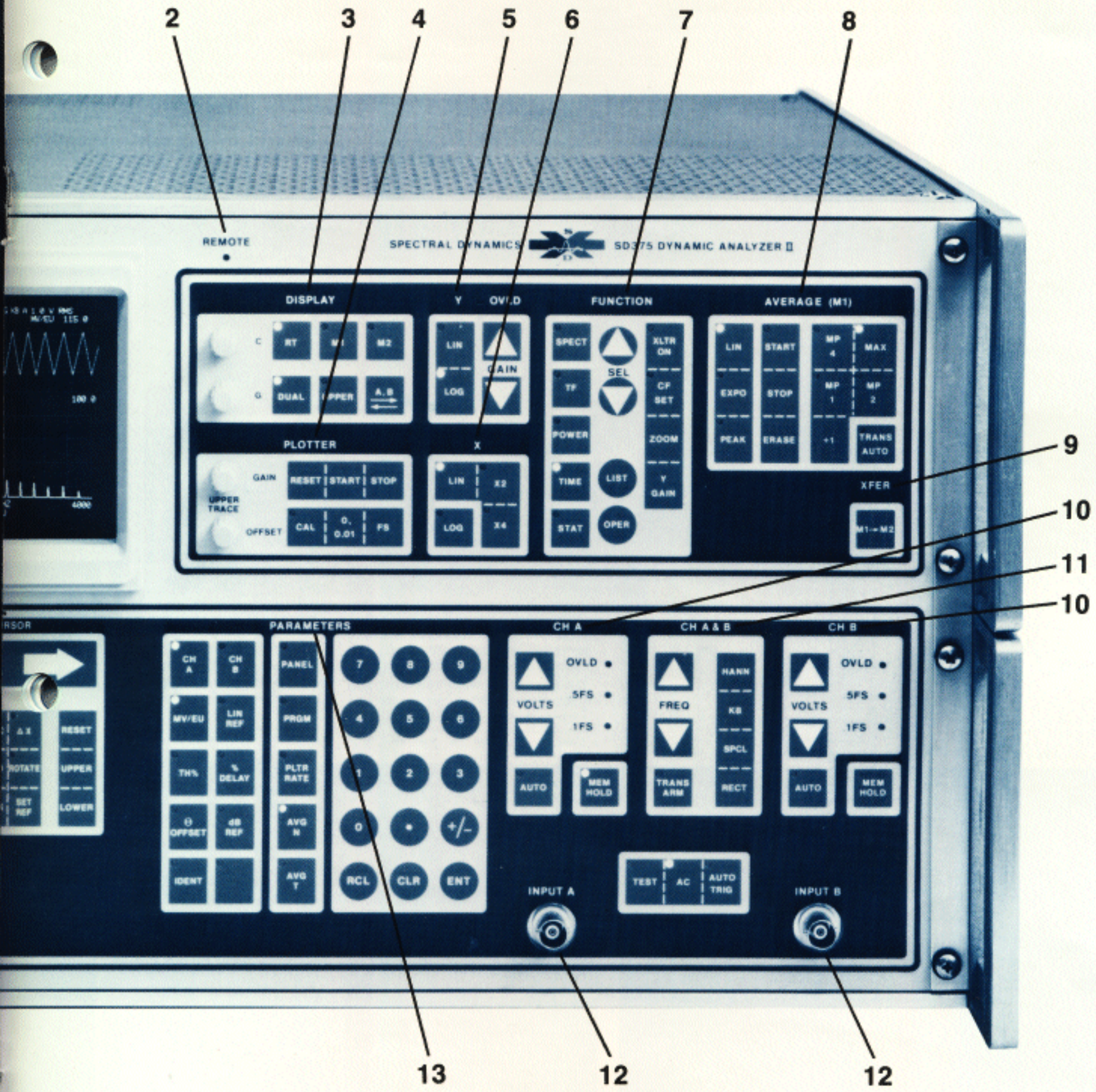
Equally convenient is the rear panel, with connectors which allow direct plug-in of digital or analog peripherals and accessories.





SD375 Front Panel Controls

1. Raster scan display
2. REMOTE — indicates when analyzer is under remote control
3. DISPLAY — adjusts contrast and gridline intensity. Controls memory selection and single or dual trace presentation.
4. PLOTTER — adjusts upper trace analog calibration. Controls plotter calibration and analog or digital plotter operation.
5. Y — selects Y-axis display format; indicates when output display overload occurs
6. X — selects X-axis display format
7. FUNCTION — selects function group and lists menu from which signal processing mode is selected. OPER executes selected mode. Provides control for optional translator operation.
8. AVERAGE (M1) — controls active averager memory operation, mode selection and overlap processing factor. Selects automatic transient averaging or +1 ensemble collection.
9. XFER — transfers averager M1 memory contents to M2



10. CH A/CH B — manual or autoranging selection of full scale input voltage ranges. Controls memory update or hold modes.
11. CH A & CH B — selects full scale frequency range, process weighting function and transient arm
12. INPUT — accepts CH A & B inputs, selects coupling mode, trigger condition or internal test signal
13. PARAMETERS — permits operator entered setup information for transducer sensitivities, data acquisition conditions, I.D. and averaging duration. Access PRGM directory menus and store or recall PANEL setups.
14. CURSOR — selects cursor mode, address location, editing of time domain waveform and executes mark feature. Also controls cursor position.
15. Y — selects vertical scaling units
16. X — selects horizontal scaling units
17. PWR — on/off power switch

Power Spectral Density

When measuring continuous signals with broadband spectrum content such as random vibration or acoustical noise, a standard spectrum analysis and display may not be optimum. Broadband signals often contain energy at all frequencies but, at any selected frequency, the actual amount of energy can be quite small. In these cases, it is the accumulation of energy or the summation of the spectrum contribution at many frequencies which add up to the total, potentially damaging signal level.

In the SD375, a very convenient measurement is provided in terms of widely accepted Power Spectral Density (PSD) units. For example, if a random vibration signal is being analyzed, the operator simply enters the signal sensitivity of the selected channel such as 31.6 mV/EU corresponding to 31.6 mV/g.

By pressing the PSD control, the display is automatically calibrated in terms of grms^2 per Hz with the correct bandwidth and selected weighting function characteristics automatically included in the display scaling. The spectrum contribution in terms of grms between any two selected frequencies can then be quickly calculated and displayed using the front panel ΔP controls.

Probability Measurements

Some waveform characteristics such as distortion and stress levels may be independent of absolute frequency and require a measurement which deals with amplitude values only. In the SD375, this measurement is made by segmenting the incoming waveform into 100 discrete amplitude intervals or "windows". The number of occurrences within each window is displayed as a distribution of amplitude values termed the probability density histogram (PDH).

If the probability density histogram function is integrated, a continuously increasing display is achieved which gives the probability that the sampled signal was less than the corresponding abscissa value. This display is called the probability distribution or cumulative probability distribution. It is automatically scaled from 0 to 100% to simplify the readout and interpretation of probability values.

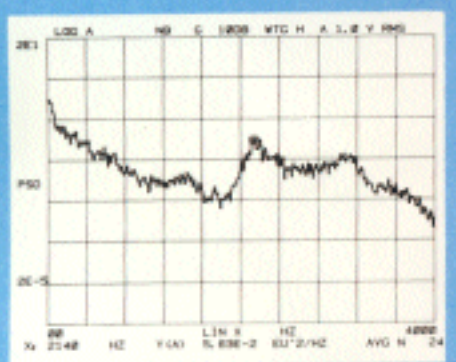


Figure 1: Broadband PSD measurement

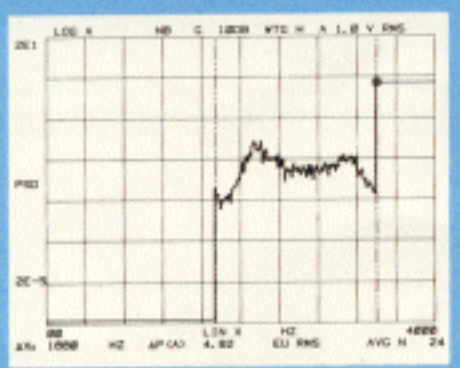


Figure 2: Signal power is computed between cursor limits and displayed as EU RMS

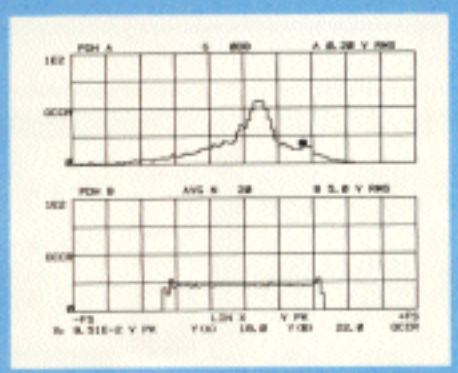


Figure 3: Dual channel probability density histogram display

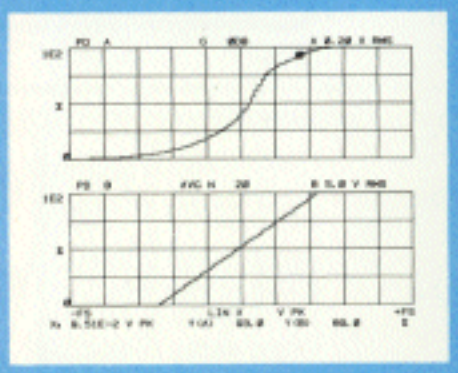


Figure 4: Dual channel cumulative probability distribution display

Input Data Editing

This feature provides selective ZEROing of parts of the input data record stored in memory A or B. Data position can be changed with the cursor ROTATE control. The operator can then select the desired FUNCTION to process the edited signals from input memory.

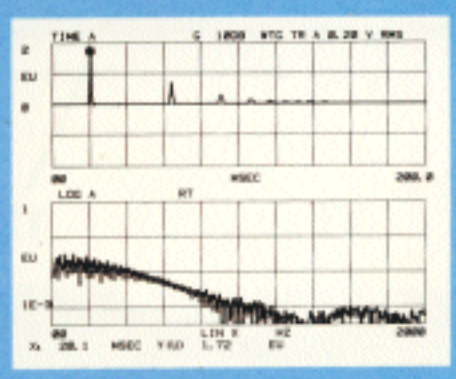


Figure 5: Transient signal captured with several secondary pulses which corrupt spectrum as shown.

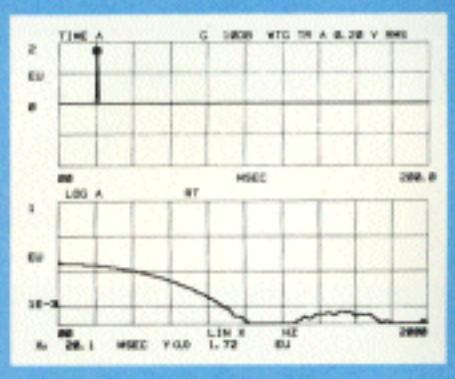


Figure 6: ZERO edit feature eliminates secondary pulses from input memory. Resultant smooth spectrum was processed with the TR (transient) WTG function.

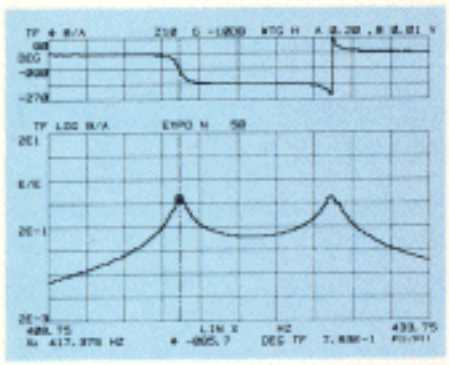
Standard Options for Extended Performance

The SD375 is configured to easily add these standard options initially or later as your signal processing and analysis requirements dictate. Front panel controls and main frame accommodations for the options are built into every analyzer.

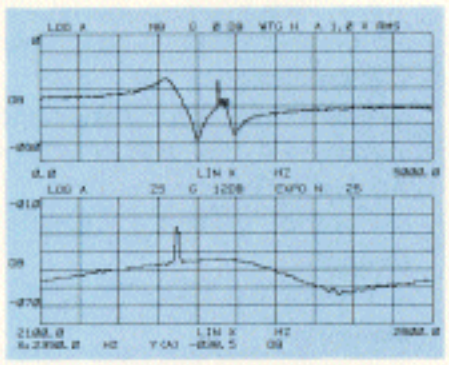
"-1" Zoom Option (Digital Translator)

. . . for accurate, expanded frequency resolution

The "-1" option provides six zoom (i.e. frequency magnification) factors — 2, 5, 10, 20, 50 and 100 for each analysis range. A zoom factor of 100, for example, increases the frequency resolution by 100 times the normal baseband resolution and, at the same time, improves the signal-to-noise ratio of the measurement. The factor best suited to the analysis task at hand can be instantly selected on the front panel for separating closely spaced frequency components.



Zoom factor of 10 separates closely spaced transfer function modes and defines smooth phase transition at resonance



Cursor control pinpoints the "action" area in this versatile baseband and zoom display without sacrificing visibility outside the zoom window

When the translator (XLTR) is turned on, the center position of the zoom window is automatically established by the cursor location. If the cursor is moved, the window is automatically relocated within the selected full-scale analysis range. The cursor always indicates the window's center frequency while the lower and upper window edge frequencies are annotated at the left and right ends of the X-axis grid as shown in the figures at the left.

The CF SET control locks the window position and enables the cursor to be moved to any point within the window for high resolution frequency readout. The ΔP cursor feature can be used to read the RMS level of the signal within the zoom window.

Translator gain of 1, 2, 4 or 8 recovers the dynamic range lost when zooming in with a narrow window on a portion of a broadband spectrum. This gain is inserted prior to spectrum analysis of the windowed signal and permits detection of signal amplitudes more than 80 dB down from full scale.

Specifications

Zoom Factors
2, 5, 10, 20, 50, 100; front panel selectable

Zoom Accuracy
±0.001% of full scale analysis range

Zoom Control
Established by cursor position. Cursor limits for each zoom factor are:

Zoom Factor	Cell Limits	
	Lower	Upper
2	50	350
5	20	380
10	10	390
20	5	395
50	2	398
100	1	399

Signal Gain
1, 2, 4 or 8 times; front panel selectable

Digital Output
200 digital words of floating point data transferred through -3B00 I/O option

Remote Control
All front panel XLTR controls plus cursor position can be remotely sensed and controlled through the -3B00 I/O option.

"-2" Option (1/3 and 1/1 Octave Analysis)

. . . noise studies, OSHA surveys, acoustic measurements

Adding the "-2" option to the SD375 combines 1/3 octave, 1/1 octave, and dual channel narrowband analysis capabilities into one instrument. Selection of the 1/3 or 1/1 octave display mode is provided from a menu through the LIST front panel control.

The "-2" utilizes a *single pass parallel process* data acquisition method for synthesizing 1/3 and 1/1 octave spectra. It offers three distinctive advantages over serial multiple-pass techniques. . .

First, the entire 1/3 or 1/1 octave spectrum is synthesized from the same segment of the data record, thus always assuring a valid spectrum.

Second, dual input buffer storage enables 1/3 or 1/1 octave processing of continuous impulsive signals.

Third, analysis time is reduced by utilizing overlap processing techniques on the lower frequency data group.

Thirty full 1/3 octave and ten full 1/1 octave bands of data plus the overall RMS level are displayed on each 1/3 and 1/1 octave full scale analysis range. Data signals can be processed independently on CH A or CH B and the 1/3 octave spectrum stored in their respective averager memory locations. Post data manipulation (+, −, ÷), selected through the menu, can be performed on stored A and B 1/3 octave spectra.

Specifications:

Center Frequency and Band Numbers

1/3 OCTAVE		1/1 OCTAVE	
Center Freq. (Hz)	Band No.	Center Freq. (Hz)	Band No.
1.6– 1,250	2–31	2 – 1,000	3–30
6.3– 5,000	8–37	8 – 4,000	9–36
12.5–10,000	11–40	16 – 8,000	12–39
25 –20,000	14–43	31.5–16,000	15–42
50 –40,000	17–46	63 –31,500	18–45
100 –80,000	20–49	125 –63,000	21–48

Filter Characteristics
Geometric mean frequency, effective bandwidth, and passband uniformity meet ANSI S1.11-1966 (R1975) Class III standards for 1/3 octave and Class II standards for 1/1 octave. These same parameters comply with IEC Publication 225.

Minimum Transmission Loss Variation
± 1 dB

Maximum Attenuation
70 dB

Display Range
1/3 Octave Mode — 30 full bands plus overall level
1/1 Octave Mode — 10 full bands plus overall level

Cursor Readout
X-Axis — center frequency and band number
Y-Axis — V, dB, dBR or Engineering Units (EU)

Analysis Time
0.4 sec for 1/3 or 1/1 octave

Linearity
± 1 dB or ± 0.1% of full scale, whichever is greater

Memories
Two memories available for storing averaged spectra plus a third memory for displaying a real time spectrum.

"-3B00" Option (Digital I/O with IEEE 488 and RS 232C)

- Direct menu access to I/O parameters
- Uninterrupted display during I/O operations
- Direct digital plotting without external controller
- I/O memory storage frees analyzer for next analysis while plotting
- Software selectable "SEND" and "RECEIVE" I/O configurations

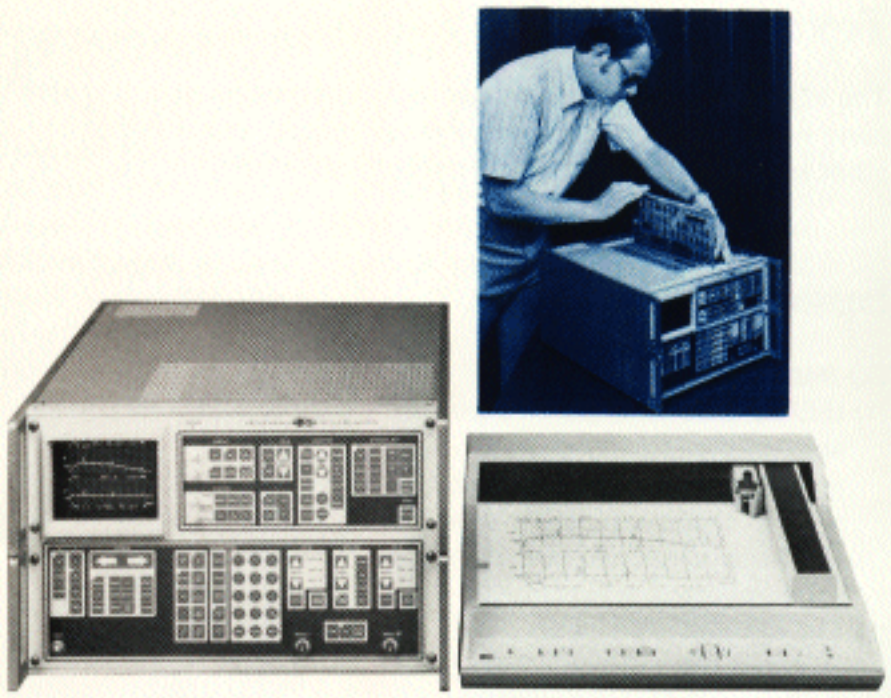
The SD375 unquestionably qualifies as an intelligent instrument with an I/O interface to match. Bi-directional communication with the SD375 is exceptionally convenient and flexible. It can "talk" and "listen" to its operator either through the front panel controls and display or via the optional digital I/O plug-in card, which includes both IEEE 488 and RS 232C interfaces.

The IEEE 488 bus provides a low-cost but very flexible means for interconnecting the analyzer and a variety of digital devices. It permits many bus compatible instruments to communicate directly with the SD375 or be addressed by a computing controller for direction and coordination of the overall system operation.

Remote Control and Data Transfer

All front panel controls are fully programmable through the I/O option by individual push button commands or a formatted "overlay" command. A front panel "overlay" can be read into a desk top calculator or computer memory and written back to the SD375 for controlled analyzer setups in repeated measurement sequences.

The SD375 function selection presents many data groups to talk about and listen to. These data groups are identified by secondary command group (SCG) numbers which accompany a primary command group (PCG) number on the IEEE 488 bus. Mnemonic codes on the RS 232C interface identify the same data groups. Also, serial RS 232C input commands can control data output through the IEEE port or vice versa.



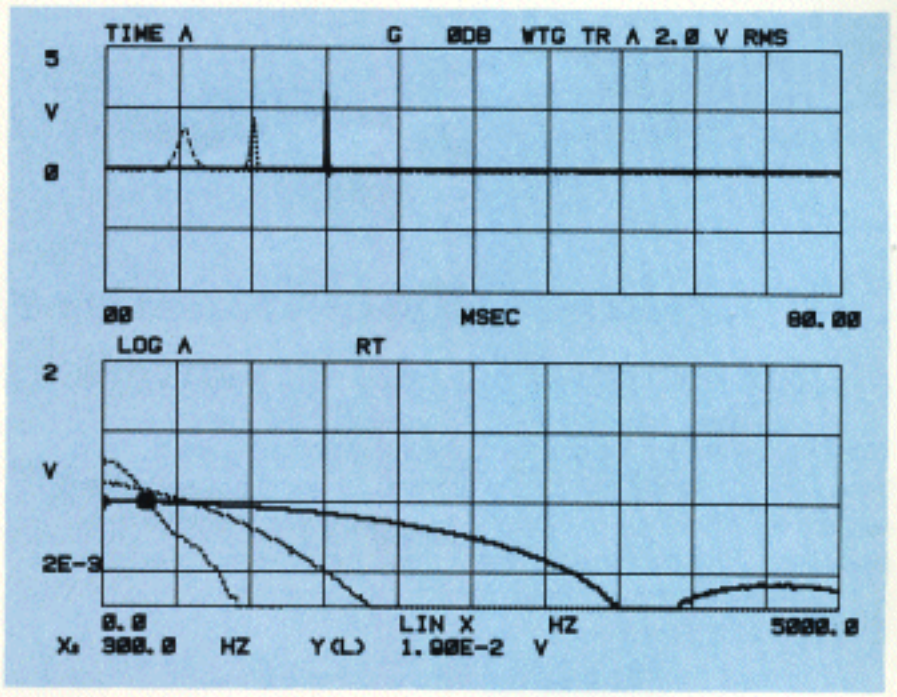
The SD375's Digital I/O "Option 3" plug-in board can be installed in seconds (inset photo) . . . permits direct communication with a broad selection of digital peripherals.

Data Formatting

Besides being friendly to almost any controller or computer, the SD375 I/O offers two digital data output formats to choose from. The DEC PDP 11 computer floating point data format provides a software programming convenience in handling data from the SD375. A selectable byte format is available to use with HP calculators and computers. Other mini-computers such as Data General, Honeywell and Tektronix calculators can receive data from the SD375, manipulate, store or postprocess it in the format most useful for each particular computer.

Direct Digital Plotting

Because the SD375 is a dual-port device, it's a simple operation to control certain IEEE 488 or RS 232C compatible digital plotters *directly* from the SD375 without the use of an external controller. The plotter menu permits operator selection of any desired combination of information on the hard copy; grids, annotation, data trace and trace overlays. Complete I/O buffering permits digital plotting while the SD375 is being setup from the front panel for another data acquisition and analysis task. Listings can also be plotted.



Trace overlays of TIME and SPECTRUM data captured from a force hammer with soft, medium and hard impact tips.

Text Entry

The I/O conveniently accepts text entry information from a simple hand held pocket terminal (requires -27 option), calculator or other keyboard device. Complementary information for the display or messages sent from a remote terminal to prompt operator action are transferred in a single keystroke operation.

Specifications

I/O Interfaces

(1) IEEE 488 1978: Eight-bit parallel, byte serial with 3-wire handshake
  (a) Programmed talk/listen mode
  (b) Talk or listen-only — hardware or software selected
  (c) Device clear and service request implemented
  (d) Port control assignment — hardware or software selected

(2) EIA RS 232C: Serial bit
  (a) Baud rate: 110, 300, 600, 1200, 2400, 4800, 9600, 19,200
  (b) Parity: Odd, even or none
  (c) Characters: 6, 7 or 8 bit with 1 or 2 stop bits
  (d) Format: ASCII or binary
  (e) Duplexing: Echo or quiet
  (f) Auto line feed: On or off
  (g) Handshake: Hardware or software
  (h) Port control assignment — hardware or software selected

Digital I/O Interface Compatibility Chart

I/O Designation	PDP-11 and Byte Format	IEEE 488	RS-232-C	HP – GL* Plotters	TEK 4662 Plotter•
-3B00	✓	✓	✓		
-3B01	✓	✓	✓	✓	
-3B02	✓	✓	✓		✓

* Includes:
HP 7225A or B with 17601A (IEEE) or 17603A (RS 232C) personality module;
HP 7220A (RS 232C only — automatic four-color pen selection);
HP 7245A or B (IEEE only);
HP 9872B or C (IEEE only — automatic four-color pen selection).

• IEEE only

IDAC (Interactive Dynamic Analyzer Control)

This hardware/software interface provides a user-oriented route for developing tailored remote control of the SD375 with a DEC PDP 11 computer and RT² operating system. IDAC includes a hardware IEEE 488 computer interface card and a set of approximately 100 mnemonics which will, via a keyboard, initiate SD375 action such as . . .

— push buttons
— read/write data
— store/retrieve data
— read/write annotation
— read/write front panel setups
— access mass storage device

Nearly 100 Fortran subroutines are included which can be called from a Fortran main program and utilized in data post-processing operations. This requires RT11 Fortran IV and RT11 system libraries for compiling and linking. The subroutines are available for the programmer/engineer who is familiar with Fortran and wishes to write a program to meet customized system signal processing needs.

"-4" Option (Signal Generator)

. . . for external system or network excitation

This convenient signal source provides broadband white noise, band limited pseudo-random noise and single sinewave analog outputs for excitation of systems or networks for performance evaluation. The signal generator output mode is established from a PRGM menu and its output amplitude selectable from 0.05 V to 10 V in a 1, 2, 5 sequence.

The pseudo-random noise is synced to the internal ADC clock and its sequence length matches the memory period of the analyzer. A trigger output, coincident with the start of each sequence, is provided. In zoom mode, the pseudo-random frequency output is concentrated within the zoom window.

Optional Modal Analysis Expansion

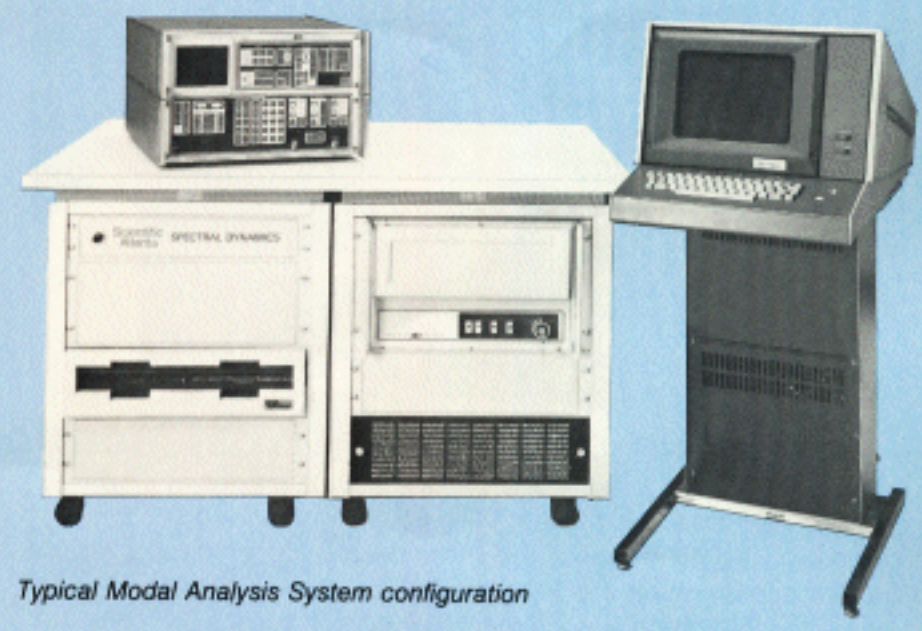
The standard SD375 can perform a wide variety of analysis functions. This includes accurate resonant frequency determination, precise amplitude and phase values between important structural points and directly measured values of structural stiffness, mobility and mass. Depending on the requirements of a test or of a suspected structural problem, it may be necessary to extend the analysis beyond simple measurements perhaps to include even a complete modeling task.

If detailed structural analysis becomes an important requirement for the SD375, the "modal accessory" add-on described below may be appropriate.

A full disc operating DEC CPU with 64 k bytes of memory forms the heart of the system. A high-speed graphics display terminal/keyboard is furnished and used for displaying animated mode shapes as well as other graphical data and facilitates the execution of user-defined programs. Software provided with the system includes a powerful SDRC written modal analysis package (MAP) and a set of signal processing routines (IDAC) authored by Spectral Dynamics to enhance the processing capabilities of the SD375.

Standard MAP software includes the following important features:

- Full project definition, file allocation and check point registration
- Project controlled data acquisition and transfer function file preparation
- Flexible single-degree-of-freedom (SDOF) curvefit for improved mode shape computation
- Powerful multi-degree-of-freedom (MDOF) curvefit algorithm for accurate damping and true resonant frequency determination
- Mass and stiffness computation and matrix determination
- Static and orthogonal views of either undeformed or deflected modal deformation
- Animated mode shape displays with normal or expanded views from any angle
- Frequency response function synthesis to verify measured data or create new transfer functions
- Automatic geometry generation
- Modal orthogonality checking
- NASTRAN compatible data file format



Typical Modal Analysis System configuration

The modal add-on option truly gives the SD375 user the best of both worlds: a stand-alone two-channel analyzer plus a completely user programmable disc operating CPU — a simple measurement or a computerized approach to creating a complete dynamic model — instant answers or expansion to dynamic modification and fatigue computations.

The modal expansion capabilities of the SD375 include the documentation and training necessary to make this an instantly usable structural dynamics tool. Please contact the factory or the nearest Scientific-Atlanta sales office for full details on the exact modal analysis configuration which is best for you.

Examples of on-site Modal Analysis of complex test objects.

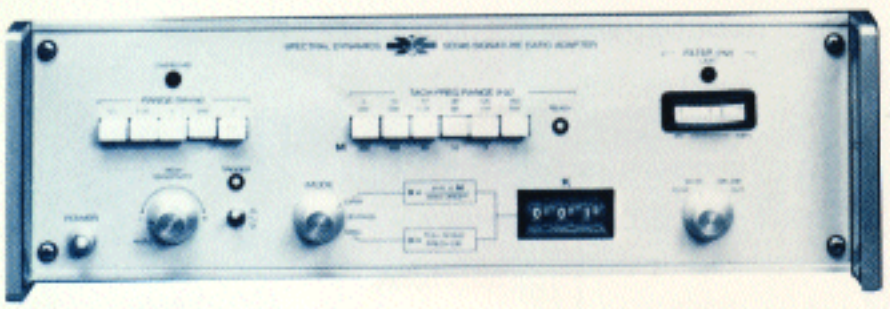
Accessories

...for remote display...hard copy...multiple channel analysis

A series of inexpensive accessories are available for the SD375 to meet specific application needs and provide convenient hard copy and data storage capabilities.

SD346 Signature Ratio® Adapter

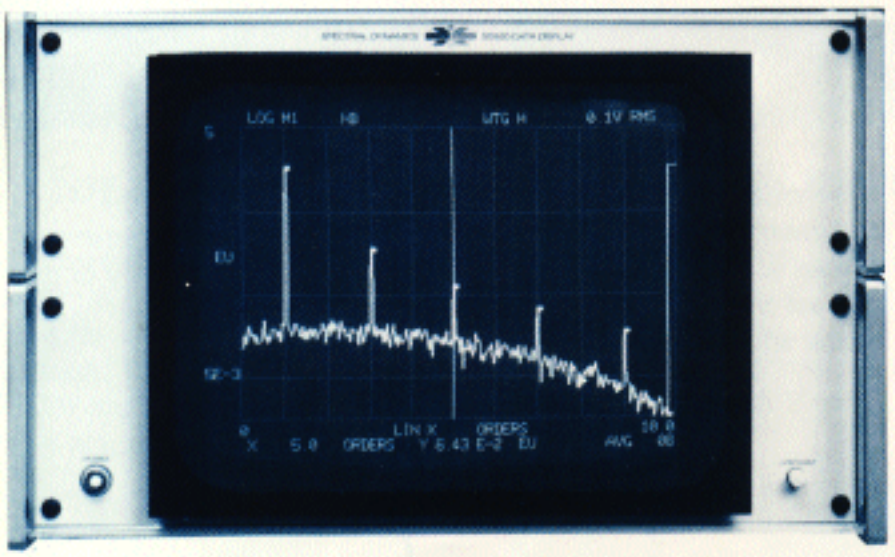
This accessory normalizes a spectrum display so that harmonic components related to a reference speed signal appear at constant locations in the display — regardless of speed variations — simplifying data interpretation and also permitting "rpm tracking" analysis.



SD346 Signature Ratio® Adapter

SD420 Large Screen External Monitor

The SD420 Raster Scan Data Display provides a large (12" diagonal) viewing image of the same data, annotation, and grid pattern appearing on the SD375's built-in display. Interconnect cable P/N 21369900 is required. If an SD346 Signature Ratio adapter is used in conjunction with an SD420, cable P/N 21381200 is required.



SD420 Raster Scan Data Display

SD422 Video Printer

A light, portable and inexpensive unit for producing dry-paper, permanent hard copies of all data, grids and annotation presented on the SD375 display. No hardware or software interfacing is needed; one BNC cable connects printer and analyzer.

SD422 Video Printer

Channel Selectors

The SD401A-2 is an IEEE controlled channel selector that can select one of 16 analog input channels for signal analysis by the SD375 or other analyzer.

The SD402 is a general purpose selector for scanning or switching up to 16 analog input channels for automatic or semi-automatic signal processing. The SD375's auto ranging feature allows processing of signals at different amplitude levels using the proper attenuator settings.

SD401A-2 Channel Selector

SD402 Channel Selector

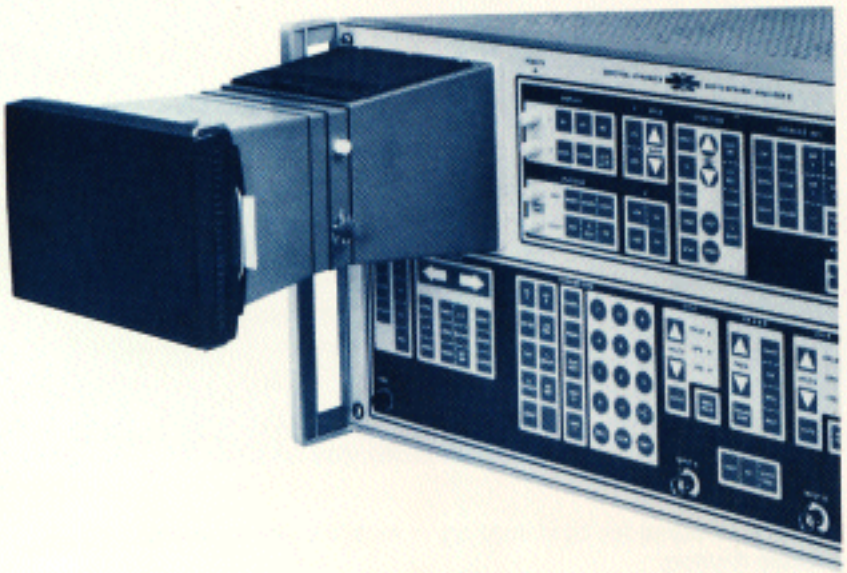
Analog X-Y Recorder

Any data trace, single or dual, time or spectrum, presented on the SD375 built-in display is available for recording on virtually any analog X-Y recorder.

Four different plotting speeds can be selected from the front panel. Sweep rate feedback is provided to automatically slow down the X-axis sweep while plotting spectrum peaks.

Polaroid Camera

The display bezel on the SD375 will accept the TEK C-5C-Polaroid scope camera directly if it is equipped with the option -2 hood.



TEK C-5C camera mounted on SD375

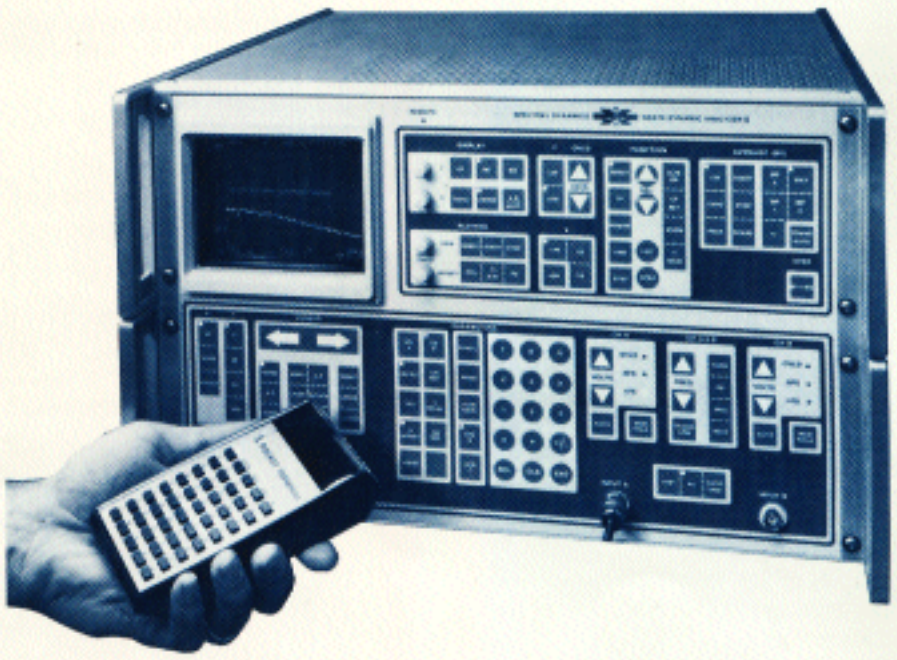
SD347 Tape Memory Unit

The SD347 digital data storage unit utilizes the RS 232C interface to communicate with the SD375. Time or spectrum information processed by the SD375 with its front panel setup are recorded on a cartridge tape. This mass storage capability preserves field recorded data files and corresponding front panel setups for play back into the SD375 for re-display, hard copy or use in a post-processing operation.

SD347 Tape Memory Unit

Hand-Held Pocket Terminal

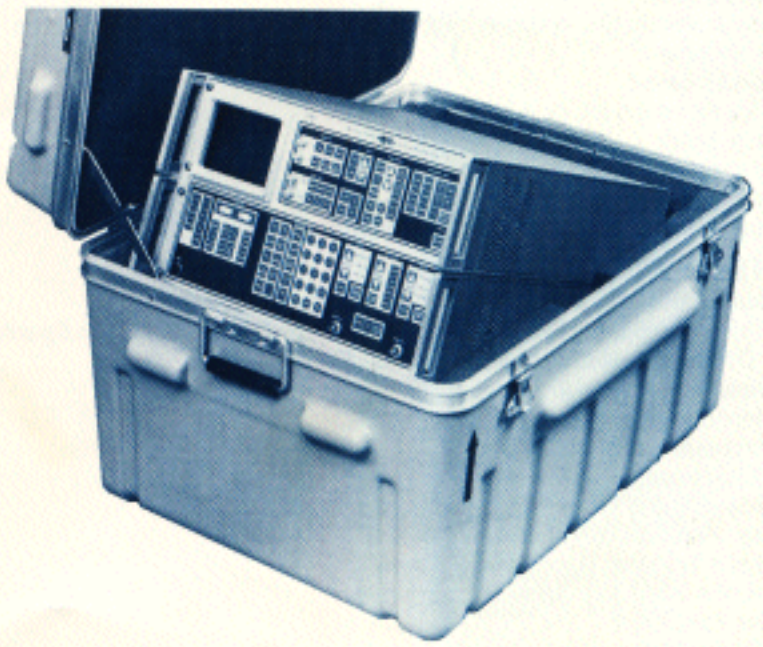
This operator convenience accessory enables pertinent information such as date, time, transducer number, location, and test condition to be entered, via RS 232C interface, on the SD375 display and become part of the video or digital hard copy record. It features a complete ASCII keyboard which provides remote control of the analyzer as well as text entry. Power for the terminal is provided with the "-27" mod to the SD375.



Pocket terminal interfaced to SD375

Carrying Case

The SD44-21 is a fiberglass carrying case with contoured foam padding to protect the SD375 during harsh shipping environments. Weight of padded case is 13,2 kg (29 lb).



Specifications

INPUT

Level:
0.01 Vrms to 20.0 Vrms; manual selection or autoranging, each channel
Digital (with I/O Option):
16-bits to each input memory
A/D Converter:
12 bits each channel
Sampling Rate:
Internally or externally controlled, up to 256,000 samples per second per channel
Anti-Aliasing Filter:
Automatically selected on each channel with initial 120 dB/octave rolloff and at least 70 dB rejection of aliasing terms
Synchronous Reference:
External trigger input for dual-channel coherent averaging/synchronous spectrum
Autotrigger:
Synchronizes input memory loading at keyboard defined threshold level
Test Signal:
Replaces input signal with internally generated periodic signal to check instrument operation

ANALYSIS

Resolution:
400-line spectrum, 1024 time-domain points, or 100 statistical windows per channel
Frequency Ranges:
1 Hz to 100 kHz full scale in a 1-2-4-5 sequence
Dynamic Range:
> 70 dB with averaging from full scale to minimum discernible signal
Real Time Frequency:
4 kHz (with full annotated display) for single channel forward transform and 2 kHz for dual channel forward transform
Weighting:
Selectable Rectangular, Special (transient), Kaiser-Bessel and Hanning weighting functions
Processing:
Overlap processing with selectable 1, 2, 4 or max transforms per memory period
Integration/Differentiation:
Single and double integration/differentiation with display and cursor readouts in EU's
Digital Zoom:
Plug-in option provides dual-channel zoom of 2, 5, 10, 20, 50 and 100 times baseband resolution with gain of 1, 2, 4 or 8 (cursor selected center frequency)
Remote Control:
Complete front-panel sense, control and lockout via I/O Option

AVERAGER

Domain:
Frequency or time on either channel
Ensembles:
Selectable from 1 to 2048 in integer steps
Seconds:
Selectable from 1 – 9,999 seconds
Modes:
Linear, exponential or peak
Control:
Start, stop, erase, +1, auto transient and transfer M1 to M2

TRANSIENT CAPTURE

Transient Arm:
Manual or automatic, enables triggering on incoming data signal from either channel
Threshold Level:
Entered via keyboard in ± %FS
Memory Hold:
Holds contents of either input memory
Transient Averaging:
Automatic, with over range signals discarded

SYSTEM FUNCTIONS

Computed and displayed for both channels:
Real Time Spectrum, Averaged rms Spectrum, Averaged Power Spectrum
Sum, Difference, Ratio of rms or Power Spectra
Equalized Ratio (M1/M2)
Synchronous Spectrum
Synchronous Ratio and Phase
Sync Spectrum A and Phase
Cross-Spectrum
Transfer Function & Phase
Equalized Transfer Function & Phase
Coherence and Coherence Output Power
Impulse Response
Input Time History
Normalized Auto-Correlation
Normalized Cross-Correlation
Probability Density Histogram
Cumulative Probability Distribution

DISPLAY

Type:
Built-in flicker-free raster scan, with all displays scaled and full annotation on each channel. Electronically-generated grid lines for non-parallax lin or log displays in single or dual display mode. Front-panel adjustable grid intensity and contrast.
Power Spectral Density:
Automatically normalized and displayed with 1 Hz effective noise bandwidth
Mode:
Touch selection of real-time, averager memory or auxiliary memory for single or dual-channel data. Simultaneously displays time and spectrum or broadband and zoom spectrum.
Gain:
X-axis display gain. X2 and X4 for cursor-selected segment in any time or spectrum display. Y-axis gain and attenuation in 10 dB steps. Data automatically scaled accordingly.

CURSOR

Modes:
Single cursor (either data trace) or harmonic cursor with multiples of cursor fundamental and true fine-tune alignment. ΔX values, PSD or ΔP (power) between cursor points.
Mark:
Intensifies up to 8 cursor-selected data points; stores indicated X and Y data values for listing
Edit:
Selectively rotates left, or right, the contents of either input memory. Selectively zeroes any part of either input memory with the cursor.

SETUP PARAMETERS

Panel Store:
Stores up to 7 operator-defined front panel setups for instant recall including channel parameters
Plotter Rate:
Front panel selection of up to 4 analog plotter rates
mV/EU:
Transducer sensitivity values from 0.001 to 9,999 for each channel can be entered for direct readout of engineering units
Linear Reference:
EU reference value represented by a selected display point can be entered
% Delay:
Delay Channel A and Channel B with respect to trigger point in 10% memory intervals up to 99 memory periods, also pretrigger up to 1 memory period in 10% memory intervals.
ϕ Offset:
Selectable phase offsets in 1° increments to a maximum of ± 180°

OUTPUT

Video:
Composite signal for hard copying or external video monitor
Plotter-Analog:
X, Y and pen lift signals for plotting input time waveform or any processed result from single or dual display. Simple two-point calibration.
SIMULPLOT:
Continuous video display during plot mode. Analog X-Y recorder output follows cursor at all times.
Digital:
Plug-in option providing IEEE 488 and RS 232C I/O interfaces. Outputs DEC PDP-11 floating-point data format or byte format.

MISCELLANEOUS

Operating Temperatures:
5°C to 45°C (41°F to 113°F)
Weight:
25 kg (55 lb)
Dimensions:
Rack-mount configuration:
Width — 43,2 cm (17")
Depth — 43,3 cm (19")
Height — 26,7 cm (10-1/2")
Power:
105-125/210-250 Vac @ 45-65 Hz. ≈ 350 W

Specifications subject to change without notice.

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