Supplemental Operator's Guide
for the Agilent 35670A Dynamic Signal Analyzer

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AGILENT 35670A
Supplemental Operator's Guide

Section 1 : Turning On the AGILENT 35670A

The entire turn-on procedure for the AGILENT 35670A takes 40 seconds. In that time the analyzer completes a hardware self-test, boots its operating system, completes a front end self-calibration and autoranges all input channels. The default measurement state of the analyzer is a two-channel FFT measurement with a span of 51.2 kHz, front ends autoranging, input low floating, and DC coupled, averaging OFF and with a power spectrum display.
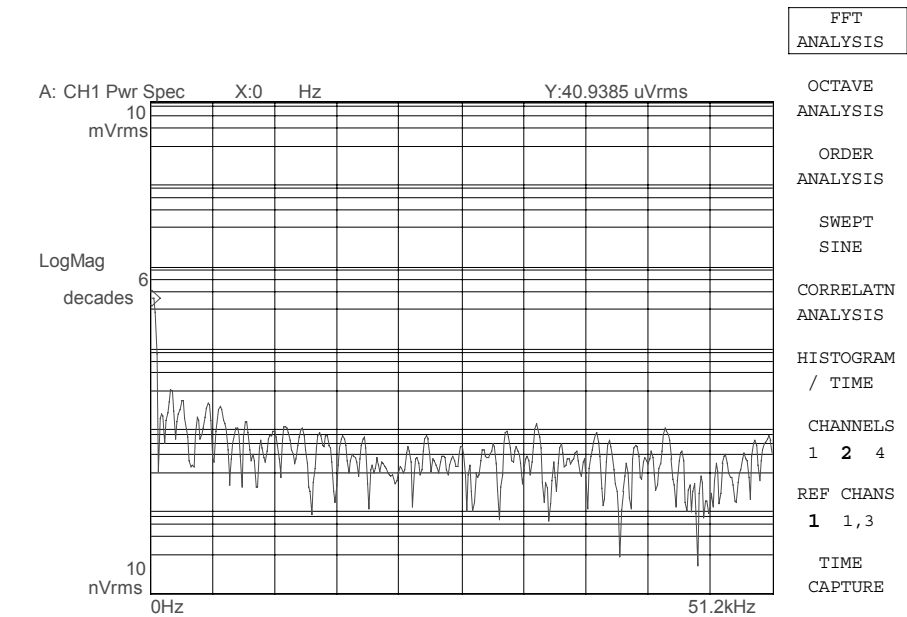
Typical Display After Turn-on Sequence

Section 2 :   Measurement State After Turn-on

```
Inst Mode  FFT                      Channels 2
           Measurement Source       INPUT

Meas Data  Data A    PWR SPEC1      Data B    PWR SPEC2
           Data C    TIME1          Data D    TIME2

Trac Coord Coord A   MAG-LOG        Coord B   MAG-LOG
           Coord C   REAL           Coord D   REAL

Freq       Start    0 Hz           Stop      51.2 kHz
           Center   25.6 kHz       Span      51.2 kHz
           Rec Len  7.8125 ms      Resoltn   400

Window     CH1 Type FLATTOP        BW        488.88 Hz
           CH2 Type FLATTOP        BW        488.88 Hz
           CH3 Type FLATTOP        BW        488.88 Hz
           CH4 Type FLATTOP        BW        488.88 Hz

Avg        Status   OFF            Type      RMS
           Number   10             Overlap   0 %
           Fast Avg OFF            Update    5
           Rept Avg FREEZE         Ovld Rej  OFF

Trigger    Type     FREE-RUN       Level     0 V
           Slope    POSITIVE
           Ext Lvl  1.48 V
           Ext Fltr OFF
           CH1 Dlay 0 s            CH2 Dlay 0 s
           CH3 Dlay 0 s            CH4 Dlay 0 s
           Arm      IMMEDIATE      Strt RPM 600 rpm
           RPM Step 60 rpm         Time Stp 500 ms
           Wtrfall  15             RPM Dir  UP

Source     Status   OFF
           Level    0 Vpk          DC Offst 0 V
           Type     SINUSOID       Sine Frq 10.24 kHz
           Arb Fltr OFF            Arb Reg  D1
           Arb Rept ON

Input      CHANNEL 1    CHANNEL 2    CHANNEL 3    CHANNEL 4
 Status    ON           ON           OFF          OFF
 Range     3.9858 mVp   3.9858 mVp   3.9858 mVp   3.9858 mVp
 Auto Rng  OFF          OFF          OFF          OFF
 Coupling  DC           DC           DC           DC
 InputLow  FLOAT        FLOAT        FLOAT        FLOAT
 AliasFlt  ON           ON           ON           ON
 A WtFltr  OFF          OFF          OFF          OFF
 ICP       OFF          OFF          OFF          OFF
 EngrUnit  OFF          OFF          OFF          OFF
 EU Label  USER         USER         USER         USER
 EU Mult   1 V/EU       1 V/EU       1 V/EU       1 V/EU

--- TACHOMETER ---
    Puls/Rev 1
    Level    0 V
    Range    LOW
    Slope    POSITIVE
    Holdoff  0 s
```

Section 3 :   Measuring with Transducers

The AGILENT 35670A can be used with a broad range of transducers. Transducers can use an external preamplifier to convert the raw signal into a voltage that is compatible with the AGILENT 35670A. Some transducers have internal circuitry which provides preamplification, however these internal circuits must be powered externally. The AGILENT 35670A can provide the necessary constant-current supply for transducers that are of type ICP, Isotron, Piezotron, DelaTron, Low Impedance, etc.

Using ICP-Type Transducers with the AGILENT 35670A

To set up Channel 1 for an ICP-type transducer:
- Press the **[Input]** hardkey
- Press [FRONT END CH1 SETUP] softkey *(F7)*.
- Press [ICP SUPLY **ON** OFF] softkey *(F8)* until **ON** is highlighted.

Note that the analyzer automatically switches the front end to AC Coupling in order to reject the large DC signal that is generated by the constant-current supply.

To set up Channel 2 for an ICP transducer:
- Press the **[Input]** hardkey
- Press [CHANNEL 1 **2** 3 4] softkey *(F1)* until **2** is highlighted.
- Press [FRONT END CH2 SETUP] softkey *(F7)*.
- Press [ICP SUPLY **ON** OFF] softkey *(F8)* until **ON** is highlighted.

For AGILENT 35670A analyzers with four channels, these same procedures can be repeated for Channels 3 and 4.

Using Transducers with External Preamplifiers

No special front end setup is required to use transducers with external preamplifiers except if the preamplifier's DC component is too high, resulting in a loss of dynamic range. This can be easily minimized by switching to AC coupling as follows:
- Press the **[Input]** hardkey
- Press [CHANNEL **1** 2 3 4] softkey *(F1)* until **1** is highlighted.
- Press [FRONT END CH1 SETUP] softkey *(F7)*.
- Press [COUPLING **AC** DC] softkey *(F5)* until **AC** is highlighted.

A transducer with an external preamplifier will convert mechanical units *(EU)* to volts. Care must be taken to observe gain settings on the external preamplifier, because these gain settings directly affect the resulting transducer sensitivity.

For example, if an accelerometer has am internal sensitivity of 25 pC/g, and a charge amplifier has a gain setting of 10 mV/pC, then the resulting transducer sensitivity is 250 mV/g. However is the gain setting on the charge amplifier is changed to 1 mV/pC, then the resulting sensitivity would then be 25 mV/g.

Specifying Transducer Sensitivity and Units

The AGILENT 35670A provides the ability to convert electrical signals into Engineering Units. Units can be specified as either conventional units or User units. Conventional units of motion available are:

acceleration:	g, m/s^2, inch/s^2
velocity:	m/s, inch/s
displacement:	m, inch, mil
force:	N, lb., dyne

To set up transducer properties for an accelerometer attached to Channel 2 with a sensitivity of 9.7 pC/g, follow these steps:

- Press **[Input]** hardkey.
- Press [CHANNEL 1 **2** 3 4] softkey *(F1)* until **2** is highlighted.
- Press [XDCR UNIT CH**2** SETUP] softkey *(F8)*
- Press the [XDCR SENSITVTY] softkey *(F6)*.
- Enter 9.7, then press the [mV/EU] softkey *(F2)*.
- Toggle the [XDCR UNIT **ON** OFF] softkey *(F4)* until **ON** is highlighted.
- Press the [XDCR UNIT LABEL] softkey *(F7)*.
- Select the [g] softkey *(F2)*.

Likewise if a force transducer is attached to Channel 1 with a sensitivity of 12.2 mV/lb., do the following:

- Press **[Input]** hardkey.
- Press [CHANNEL **1** 2 3 4] softkey *(F1)* until **1** is highlighted.
- Press [XDCR UNIT CH**1** SETUP] softkey *(F8)*
- Press the [XDCR SENSITVTY] softkey *(F6)*.
- Enter 12.2, then press the [mV/EU] softkey *(F2)*.
- Toggle the [XDCR UNIT **ON** OFF] softkey *(F4)* until **ON** is highlighted.
- Press the [XDCR UNIT LABEL] softkey *(F7)*.
- Press the [MORE CHOICES] softkey *(F9)*.
- Select the [lb] softkey *(F6)*.

Section 4 : **Measuring a Single Channel Power Spectrum - Displacement**

This section contains procedures for setting up and measuring a single channel power spectrum of displacement using an AGILENT 35670A Dynamic Signal Analyzer. Included are steps to select single channel operation, set up transducer parameters, frequency span, choose input range, select windowing, and turn on averaging in order to improve measurement accuracy. Instructions will also be presented to set up trace coordinates and trace scaling.

Selecting Single Channel Operation

Specify the single-channel instrument mode to measure one signal. However it should be noted that it is acceptable to measure a single channel in the *default* two-channel instrument mode and simply ignore the second channel. Nevertheless instructions will be given here to measure in single channel mode.

To measure a single-channel spectrum, turn on the AGILENT 35670A and then:
- Press the **[Inst Mode]** hardkey
- Press [CHANNELS 1 2 4] softkey *(F7)* until **1** is highlighted.

Setting Up Transducer Units for Displacement

To measure power spectrums using a displacement transducer with a sensitivity of 200 mV/mil, follow these steps:
- Press the **[Input]** hardkey.
- Enter 800 and then press the [Hz] softkey *(F2)*.

Any frequency below 51.2 kHz may of course be entered, however the analyzer will select the lowest span that contains the desired frequency. For example, if 1200 Hz is entered, the analyzer is switched to a span of 1600 Hz.

Selecting Frequency Span

The default frequency span after turn-on is 51.2 kHz, which is usually too high for most transducer measurements. To reduce the span to 800 Hz, perform the following steps:
- Press the **[Freq]** hardkey.
- Enter 800 and then press the [Hz] softkey *(F2)*.

Any frequency below 51.2 kHz may of course be entered, however the analyzer will select the lowest span that contains the desired frequency. For example, if 1200 Hz is entered, the analyzer is switched to a span of 1600 Hz.

Frequency Spans Available for the AGILENT 35670A	
102.4 kHz *	100 Hz
51.2 kHz	50 Hz
25.6 kHz	25 Hz
12.8 kHz	12.5 Hz
6.4 kHz	6.25 Hz
3.2 kHz	3.125 Hz
1.6 kHz	1.5625 Hz
800 Hz	0.78125 Hz
400 Hz	0.390625
200 Hz	0.1953125 Hz

* Available in single-channel mode when anti-alias filter is turned off.

To begin data acquisition,
- Press the **[Start]** hardkey.

To automatically scale the display to fit the data,
- Press the **[Scale]** hardkey.
- Toggle the [AUTOSCALE ON OFF] softkey *(F1)* until **ON** is highlighted.

Input   CH1 Rng: 501.7819 mVpk   CH2 Rng: 631.706 mVpk
               CH3 Rng: 2.5149 Vpk   CH4 Rng: 2.5149 Vpk
Date: 10-02-96 Time: 08:42:00 PM

A: CH1 Pwr Spec   X:160   Hz   Y:169.558 mVrms
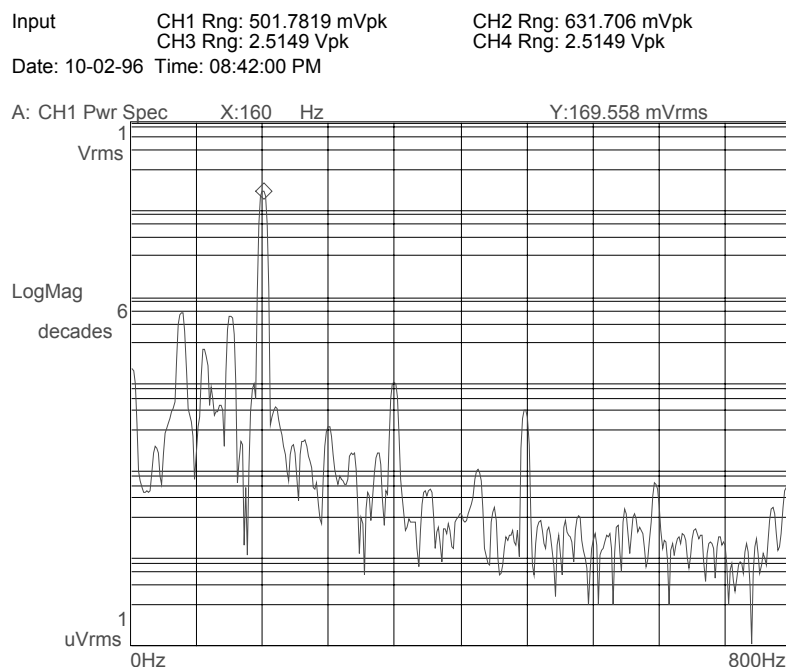
Quantifying Power Spectrum Results

Use the marker knob to read the amplitude at any measured frequency. Rotate the knob on the AGILENT 35670A front panel until the marker indicator (the small diamond following the spectral trace) is placed at the frequency of interest. The frequency and amplitude at this bin is presented as X and Y values at the top of the trace. Units of [Hz] and [Vrms] or [grms] identify the results.

Special marker features such as peak tracking can speed analysis. To always track the peak amplitude and frequency, follow these steps:

- Press the **[Marker]** hardkey.
- Press [PEAK TRK ON OFF] softkey *(F6)* until **ON** is highlighted.

The frequency and amplitude of the peak bin in every trace will be determined and displayed.

Section 5 :   Improving Measurement Results

Frequency Zooming to Increase Resolution

The AGILENT 35670A has the ability to zoom in on a signal to show detail with very fine resolution. After choosing a center frequency, it is possible to decrease the span and therefore increase the resolution all the way down to 61 µHz. To zoom in on a signal, move the marker to the desired center frequency, then:

- Press the **[Freq]** hardkey.
- Press the [CENTER] softkey *(F2)*.
- Press the **[Mkr Value]** hardkey.

To set a new, lower span,

- Press the **[Freq]** hardkey.
- Press the **[Down Arrow]** hardkey
- Press the yellow **[Start]** hardkey to begin the zoomed measurement.

To return to baseband measurements,

- Press the **[Freq]** hardkey.
- Press the [ZERO START] softkey *(F5)*.

Maximizing Dynamic Range

The default setting for input range is CH1 AUTO RANGE. For steady-state signals this works well because the front end will find the input range that just exceeds the signal level, and therefore maximize the dynamic range of the measurement. When a front end is set up to autorange and the signal either overloads or becomes too faint for the current range setting, the analyzer automatically searches for a new range and then re-starts the measurement. To select CH1 AUTO RANGE:

- Select the [CH1 AUTO RANGE] softkey *(F6)*

If a signal is not steady, but has periods of high and low levels, then CH1 AUTO RANGE may not set the front end at the most useful range. Instead, try CH1 AUTO UP ONLY. This causes the input range to ratchet up when an overload is detected, however when the signal is quiet, the front end range is not reduced. This prevents an overload if another high level signal is expected. CH1 AUTO UP ONLY works well with transient signals such as those expected during impact testing. To set up this condition:

- Press the **[Input]** hardkey.
- Select the [CH1 AUTO UP ONLY] softkey *(F5)*.

If continuous real-time measurements over a long duration are required, and absolutely no overload conditions are desired, then a fixed input range can be set that is greater than any signal expected. During periods of low signal level, dynamic range will not be optimal, however the entire measurement can be completed without overloads. To set up a fixed range of 1 volt:

- Press the **[Input]** hardkey.
- Select the [CHANNEL 1 RANGE] softkey *(F3),* enter 1, then press the [Vpk] softkey *(F1).*

If engineering units are turned on ([XDCR UNIT **ON** OFF]) then the range can be specified in EU. For example, if an accelerometer is connected to channel 1 with XDCR UNIT turned on and XDCR UNIT LABEL specified as [g], then the input range can be specified as 4 "g" as per the following:

- Press the **[Input]** hardkey.
- Select the [CHANNEL 1 RANGE] softkey *(F3)*
- Enter 4, then press the [EU] softkey *(F8).*

Averaging to Reduce Measurement Variance

Spectral measurements of steady signals give results which have a statistical variation over time. Averaging several results will help reduce this variation. The AGILENT 35670A has several averaging techniques available. For general spectrum measurements, RMS or *power* averaging is commonly used. To average a series of ten spectrum measurements using RMS averaging, follow these steps:

- Press the **[Avg]** hardkey.
- Press the [NUMBER AVERAGES] softkey *(F2),* enter 10, then press the [ENTER] softkey *(F1).*
- Press the [AVERAGE TYPE] softkey *(F3)*
- Press the [RMS] softkey *(F1)*
- Press the **[Avg]** hardkey.
- Turn on averaging by pressing the [AVERAGE **ON** OFF] softkey *(F1)* until **ON** is highlighted.

Systm Util   Date: 10-02-96
                  Time: 08:40 PM
Date: 01-02-04 Time: 12:44:00 PM

A: CH1 Pwr Spec   X:160   Hz   Y:174.015 mVrms

-
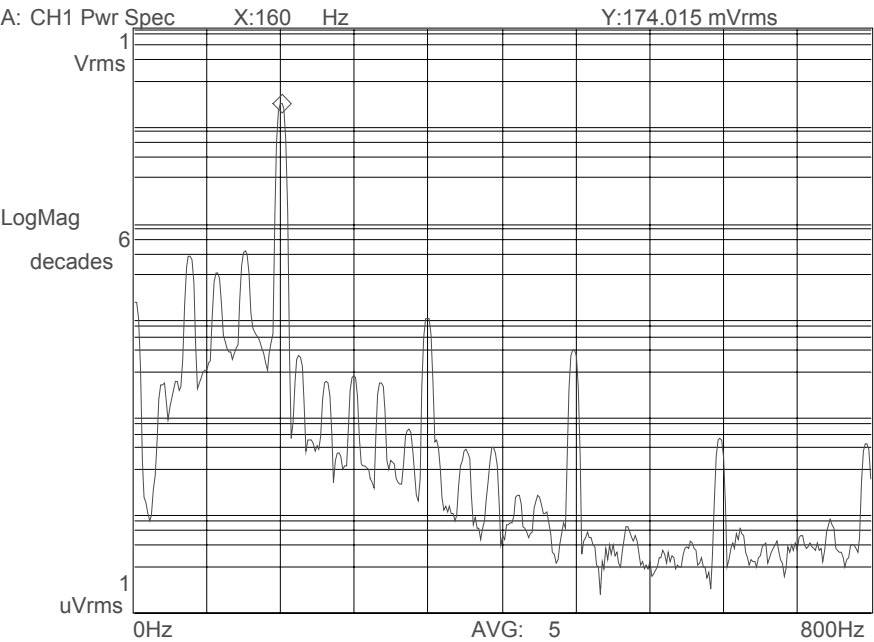
Section 6 :   Measuring a Single Channel Time Waveform

This section contains procedures for setting up and measuring a single channel time waveform using an AGILENT 35670A Dynamic Signal Analyzer. Included are steps to select single channel operation, set up the trace time length, and set up triggering to capture a transient event. Instructions will also be presented to scale the time trace.

Selecting Single Channel Operation

To measure a single-channel time waveform, turn on the AGILENT 35670A and then:

- Press the **[Inst Mode]** hardkey
- Press [CHANNELS **1** 2 4] softkey *(F7)* until **1** is highlighted.

Note: if the AGILENT 35670A was already turned on and in an unknown state, then preset the analyzer by doing the following:
- Press the green **[Preset]** hardkey
- Press [DO PRESET] softkey *(F1)*.

Then set the instrument mode to single channel as above.

Time Record Length in Seconds vs. Resolution					
Span - Hz	**100 lines**	**200 lines**	**400 lines**	**800 lines**	**1600 lines**
51200 Hz	0.001953 s	0.003906 s	0.007813 s	0.015625 s	0.03125 s
25600 Hz	0.003906 s	0.007813 s	0.015625 s	0.03125 s	0.0625 s
12800 Hz	0.007813 s	0.015625 s	0.03125 s	0.0625 s	0.125 s
6400 Hz	0.015625 s	0.03125 s	0.0625 s	0.125 s	0.25 s
3200 Hz	0.03125 s	0.0625 s	0.125 s	0.25 s	0.5 s
1600 Hz	0.0625 s	0.125 s	0.25 s	0.5 s	1 s
800 Hz	0.125 s	0.25 s	0.5 s	1 s	2 s
400 Hz	0.25 s	0.5 s	1 s	2 s	4 s
200 Hz	0.5 s	1 s	2 s	4 s	8 s
100 Hz	1 s	2 s	4 s	8 s	16 s
50 Hz	2 s	4 s	8 s	16 s	32 s
25 Hz	4 s	8 s	16 s	32 s	64 s
12.5 Hz	8 s	16 s	32 s	64 s	128 s
6.25 Hz	16 s	32 s	64 s	128 s	256 s
3.125 Hz	32 s	64 s	128 s	256 s	512 s
1.5625 Hz	64 s	128 s	256 s	512 s	1024 s
0.78125 Hz	128 s	256 s	512 s	1024 s	2048 s
0.390625 Hz	256 s	512 s	1024 s	2048 s	4096 s
0.1953125 Hz	512 s	1024 s	2048 s	4096 s	8192 s

Selecting Time Record Length

The default time record length at a frequency span of 51.2 kHz is only 7.8 ms, which is usually not enough time to capture a mechanical event or observe a transducer's time domain signal. To increase the time record length to 0.25 s, perform the following steps:
- Press the **[Freq]** hardkey
- Press the [RECORD LENGTH] softkey *(F8)*
- Enter 0.25 and then press the [S] softkey *(F1)*

The analyzer selects a new frequency span of 1.6 kHz, which at the default resolution of 400 lines, takes 0.25 seconds to capture. The following table outlines the time record lengths for all possible frequency spans and resolutions:

Displaying Time Waveforms

Time waveforms are displayed in a time trace. To set up the analyzer to display a single time trace of channel 1, follow these steps:
- Press the **[Disp Format]** hardkey.
- Press the [SINGLE] softkey *(F1)*
- Press the **[Active Trace]** hardkey.
- Press the [A] softkey *(F1)*
- Press the **[Meas Data]** hardkey.
- Press the [CHANNEL 1 2 3 4] softkey *(F1)* until **1** is highlighted.
- Press the [TIME CHANNEL 1] softkey *(F5)*
- Press the **[Scale]** hardkey.
- Toggle the [AUTOSCALE ON OFF] softkey *(F1)* until **ON** is highlighted.

Using Manual Arm to Capture a Single Time Waveform

Often it is desirable to observe just one time waveform in detail. To acquire just one record length at a time, follow these instructions:
- Press the **[Trigger]** hardkey.
- Select the [ARM SETUP] softkey *(F7)*
- Select the [MANUAL ARM] softkey *(F2)*
- Press the yellow **[Start]** hardkey to begin the measurement.
- Press the **[Trigger]** hardkey again.

Then to arm a single time record,
- Press the [ARM] softkey *(F9)*

One time record will be captured and displayed. To capture another time record,

- Press the [ARM] softkey *(F9) again.*

Event Triggering

The AGILENT 35670A has the ability to trigger the acquisition of a time waveform based on the slope and level of the measured signal. To set up triggering properly, the polarity of the measured pulse must be known in advance: will the event start with a negative slope or positive slope? Will the event be mostly positive or mostly negative? Use trial measurements to determine polarity if unknown.

Proper triggering is also affected by the input range. Fortunately the AGILENT 35670A has the ability to set the trigger point to be a percentage of the input range, so even with CH1 AUTO UP ONLY, successful triggering should be possible automatically.

To specify trigger parameters for a "positive" event on channel 1 where the trigger point should have a positive slope, follow these steps:
- Press the **[Trigger]** hardkey.
- Press the [CHANNEL **1** 2 3 4] softkey *(F3)* until **1** is highlighted.
- Press the [TRIGGER SETUP] softkey *(F6)*
- Press the [CHANNEL LEVEL] softkey *(F1)*
- Enter 5 then press the [PERCENT (%)] softkey *(F4)*
- Press the [SLOPE **POS** NEG] softkey *(F5)* until **POS** is highlighted.

Use pre-triggering to acquire some data before the trigger point. To set up a 0.01s pre-trigger condition, follow these steps:
- Press the **[Trigger]** hardkey.
- Press the [TRIGGER SETUP] softkey *(F6)*
- Press the [ALL CHANNELS] softkey *(F8)*
- Press the [CHANNEL * DELAY] softkey *(F9)*
- Enter -.01 then press the [S] softkey *(F1)*

To start the data acquisition,
- Press the yellow **[Start]** hardkey.

The analyzer should show in highlighted text above the trace:
        WAITING FOR CH 1 TRIGGER

Input   CH1 Rng: 1.0012 Vpk   CH2 Rng: 631.706 mVpk
             CH3 Rng: 2.5149 Vpk   CH4 Rng: 2.5149 Vpk
Date: 10-02-96 Time: 08:47:00 PM

A: CH1 Time   X:38.0859 ms   Y:1.06837 V
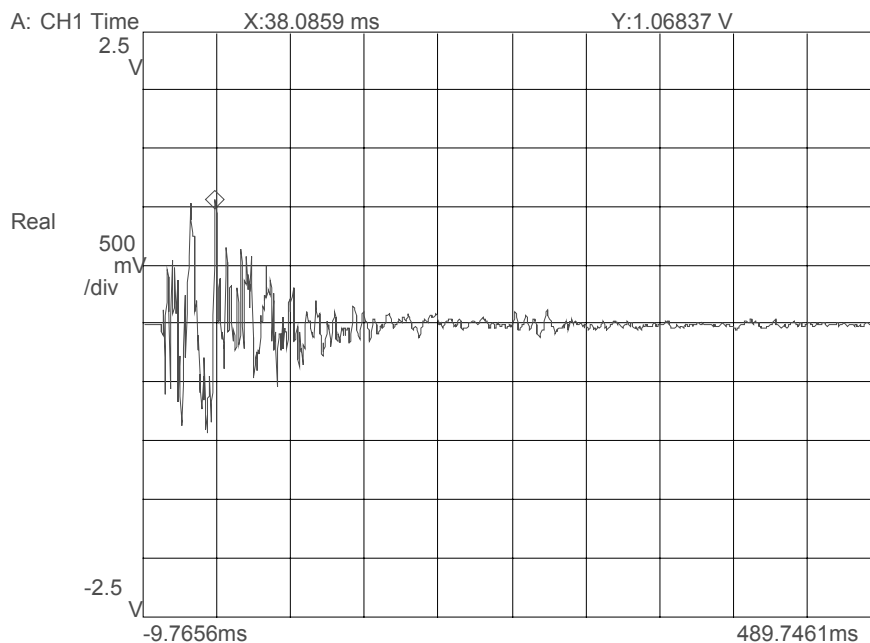
Quantifying Time Trace Results

Use the marker knob to read the amplitude at any time during the trace. Rotate the knob on the AGILENT 35670A front panel until the marker indicator (the small diamond following the spectral trace) is placed at the desired time. The time and amplitude at this bin is presented as X and Y values at the top of the trace. Units of [s] and [Vrms] or [grms] identify the results.

Peak tracking is very useful for determining maximum amplitude of positive peaks in the time domain:
- Press the **[Marker]** hardkey.
- Press [PEAK TRK ON OFF] softkey *(F6)* until **ON** is highlighted.

Care must be taken with negative peaks, however, because PEAK TRK ON only looks for the maximum value, and large negative peaks will be ignored.

Section 7 : Measuring Dual Channel Spectra

This section contains procedures for setting up and measuring a dual channel spectrum using an AGILENT 35670A Dynamic Signal Analyzer. Procedures are similar to those in the section "Measuring Single Channel Spectrum," however display setup and results are different and will be described here.

To set up the analyzer for a dual channel spectrum measurement, proceed as follows:

Presetting the Analyzer
- Press the green **[Preset]** hardkey
- Press [DO PRESET] softkey *(F1)*.
- Press the **[Pause/Cont]** hardkey if desired.

Selecting Dual Channel Operation
Measure two signals with the default two-channel instrument mode. If the analyzer has been changed to 1 or 4 channel operation, then follow these steps:
- Press the **[Inst Mode]** hardkey
- Press [CHANNELS 1 **2** 4] softkey (F7) until **2** is highlighted.

Selecting Frequency Span
Reduce the span to 800 Hz as follows:
- Press the **[Freq]** hardkey
- Enter 800 and then press the [Hz] softkey *(F2)*

Displaying Dual-Channel Power Spectrum Measurements
To see the results of a dual-channel measurement, the analyzer's display format must be changed to display two traces. Proceed as follows:
- Press the **[Disp Format]** hardkey.
- Press the [UPPER/LOWER] softkey *(F3)*
- Press the **[Active Trace]** hardkey.
- Press the [A] softkey *(F1)*.
- Press the **[Meas Data]** hardkey.
- Press the [CHANNEL **1** 2 3 4] softkey *(F1)* until **1** is highlighted.
- Press the [PWR SPEC CHANNEL 1] softkey *(F3)*
- Press the **[Scale]** hardkey.
- Toggle the [AUTOSCALE **ON** OFF] softkey *(F1)* until **ON** is highlighted.
- Press the **[Active Trace]** hardkey again.
- Press the [B] softkey *(F2)*.

- Press the **[Meas Data]** hardkey.
- Press the `[CHANNEL 1 2 3 4]` softkey *(F1)* until **2** is highlighted.
- Press the **[Scale]** hardkey.
- Toggle the `[AUTOSCALE ON OFF]` softkey *(F1)* until **ON** is highlighted.

Note: many of these keystrokes are not necessary if performed in the given order because the analyzer defaults to many of these settings.

To acquire dual channel spectra,
- Press the yellow **[Start]** hardkey.

Meas Data   A: CH1 Pwr Spec   B: CH2 Pwr Spec
[FFT]   C: CH1 Time   D: CH2 Time
Date: 10-02-96 Time: 08:49:00 PM

A: CH1 Pwr Spec   X:60   Hz   Y:147.382 mVrms

```
1
Vrms

LogMag
6
decades

1
uVrms
0Hz                                                           800Hz
```

B: CH2 Pwr Spec   X:60   Hz   Y:80.4887 mVrms

```
1
Vrms

LogMag
4
decades

100
uVrms
0Hz                                                           800Hz
```
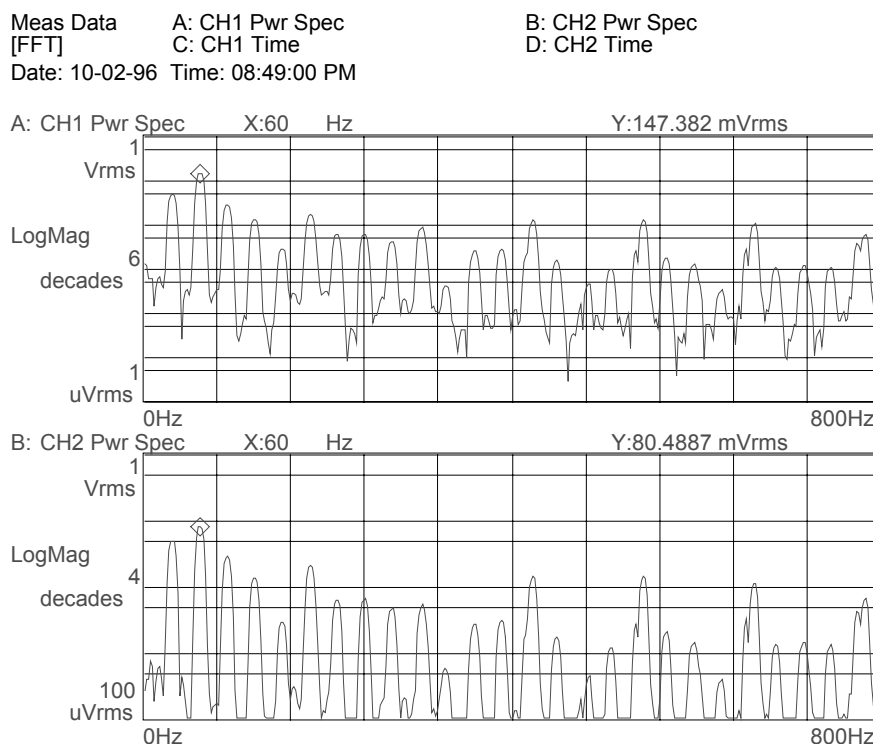
Using Markers with Dual Channel Measurements

Each trace has independent marker control. All functions available for a single marker are possible with both markers. To set up individual, independent markers on each channel, follow these steps:
- Press the **[Active Trace]** hardkey.
- Press the `[A]` softkey *(F1).*
- Press the **[Marker]** hardkey.
- Toggle the `[MARKER ON OFF]` softkey *(F1)* until **ON** is highlighted.

Use the marker knob to read the amplitude at any measured frequency for Channel 1 in Trace A.

To set up the marker for Channel 2 in Trace B,
- Press the **[Active Trace]** hardkey.
- Press the [B] softkey *(F2)*.
- Press the **[Marker]** hardkey.
- Toggle the [MARKER ON OFF] softkey *(F1)* until **ON** is highlighted.

The marker knob is now active for Trace B, which is Channel 2. To gain control of the marker on Trace A again, make it the active trace as follows:
- Press the **[Active Trace]** hardkey.
- Press the [A] softkey *(F1)*.

Coupled Markers

Markers on multiple traces can be coupled so that one marker will always track the frequency specified in another trace. This makes comparisons of level differences across channels simple. To set up coupled markers so that Trace B will follow the marker frequency specified in Trace A, do the following:
- Press the **[Active Trace]** hardkey.
- Press the [A] softkey *(F1)*.
- Press the **[Marker]** hardkey.
- Toggle the [COUPLED ON OFF] softkey *(F1)* until **ON** is highlighted.

Move the knob to move the marker in Trace A. Notice that the marker in Trace B moves to the same frequency.

Coupled Markers with Peak Tracking

Coupled markers can be further used to track a peak frequency in Trace A and determine the response amplitude at the peak frequency in Trace B. To do this, leave coupled markers on, as above, then set up peak tracking in Trace A as follows:
- Press the **[Active Trace]** hardkey.
- Press the [A] softkey *(F1)*.
- Press the **[Marker]** hardkey.
- Toggle the [PEAK TRK ON OFF] softkey *(F1)* until **ON** is highlighted.
- Press the yellow **[Start]** hardkey.

Notice that the marker in Trace A moves to the peak value, whereas the marker in Trace B moves to the same frequency as determined in Trace A.

Section 8 : Improving Dual Channel Measurement Results

Maximizing Dynamic Range

Autoranging to maximize the dynamic range of measurements in the AGILENT 35670A can function on all channels simultaneously. Therefore all capability previously mentioned for single-channel front-end ranging is available for dual-channel operation.

To set up autorange on all channels, follow these steps:
- Press the **[Input]** hardkey.
- Press [ALL CHANNELS] softkey *(F2)*.
- Select the `[CH* AUTO RANGE]` softkey *(F6)*

For signals that are not steady, use CH* AUTO UP ONLY. CH1 AUTO UP ONLY can be used for all channels to set up modal impact testing. To set up this condition:
- Press the **[Input]** hardkey.
- Select the `[CH* AUTO UP ONLY]` softkey *(F5)*.

To set up the same fixed range on all channels:
- Press the **[Input]** hardkey.
- Select the `[CHANNEL * RANGE]` softkey *(F3)*
- Enter the range, either in units of g or Volts.

Dual Channel Averaging

Averaging to reduce measurement variance applies to all channels being measured. Dual channel averaging is set up the same as single channel averaging:
- Press the **[Avg]** hardkey.
- Press the `[NUMBER AVERAGES]` softkey *(F2),* enter 10, then press the `[ENTER]` softkey *(F1).*
- Press the `[AVERAGE TYPE]` softkey *(F3)*
- Press the `[RMS]` softkey *(F1)*
- Press the **[Avg]** hardkey.
- Turn on averaging by pressing the `[AVERAGE ON OFF]` softkey *(F1)* until ON is highlighted.

Avg　　　　　Type: RMS　　　　　　Number: 10
[FFT]　　　　Update Rt: 5　　　　　Overlap: 0 %
Date: 10-02-96　Time: 08:51:00 PM

A: CH1 Pwr Spec　　　X:60　　Hz　　　　　　　Y:112.185 mVrms

1
Vrms

LogMag
5
decades

10
uVrms
　　　0Hz　　　　　　　　　　AVG:　10　　　　　800Hz

B: CH2 Pwr Spec　　　X:60　　Hz　　　　　　　Y:95.0385 mVrms

100
mVrms

LogMag
4
decades

10
uVrms
　　　0Hz　　　　　　　　　　AVG:　10　　　　　800Hz
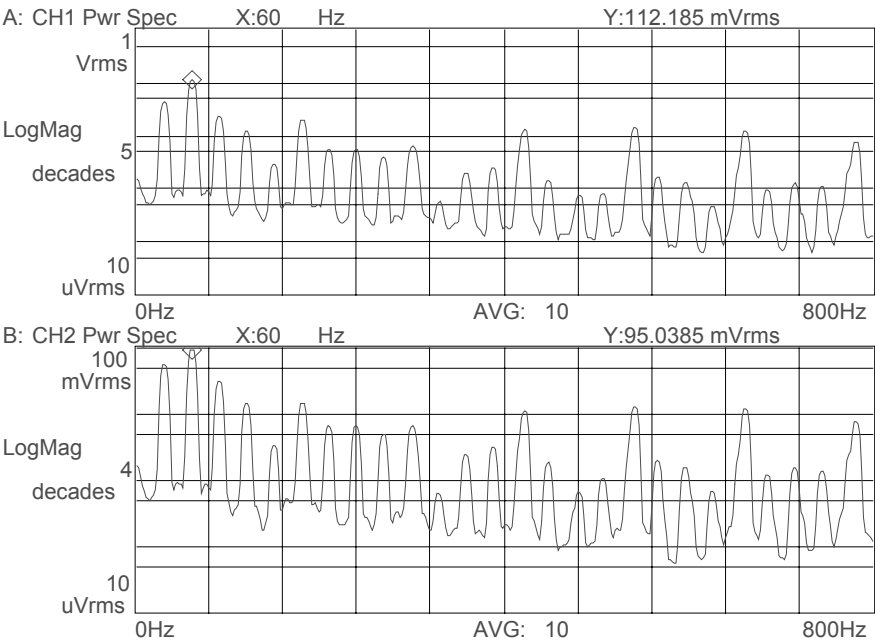
Section 9 : Measuring Dual Channel Time Waveforms

This section contains procedures for setting up and measuring a single channel time waveform using an AGILENT 35670A Dynamic Signal Analyzer. Included are steps to select single channel operation, set up the trace time length, and set up triggering to capture a transient event. Instructions will also be presented to scale the time trace.

Selecting Dual Channel Operation

To measure a single-channel spectrum, turn on the AGILENT 35670A. The default instrument mode is dual-channel operation.

> Note: if the AGILENT 35670A was already turned on and in an unknown state, then preset the analyzer by doing the following:
> * Press the green **[Preset]** hardkey.
> * Press [DO PRESET] softkey *(F1)*.

This always returns the analyzer to dual-channel operation.

Selecting Time Record Length

Time record length can be entered directly or indirectly. It is entered directly under the **[Freq]** hardkey as follows (this example sets up a 0.25 second time record):

* Press the **[Freq]** hardkey
* Press the [RECORD LENGTH] softkey *(F8)*
* Enter 0.25 and then press the [S] softkey *(F1)*

Time record length can also be specified indirectly by entering frequency and resolution in lines. The relationship between time record length (T), lines of resolution (N), and frequency (F) is:

$$T = {N}\big/{(1.024F)}$$

For 400 lines of resolution (default) and 1600 Hz span, the time record length should be $400/(1.024*1600) \approx 0.25$ seconds. The table showing the relationship between lines, span, and time record length can be found in the section on Single Channel Time Waveforms.

Displaying Dual Time Waveforms

Dual time waveforms can be shown in the UPPER/LOWER display format, with AUTO SCALE turned ON, as follows:

* Press the **[Disp Format]** hardkey.
* Press the [UPPER/LOWER] softkey *(F3)*.
* Press the **[Active Trace]** hardkey.
* Press the [A] softkey *(F1)*
* Press the **[Meas Data]** hardkey.

- Press the [CHANNEL **1** 2 3 4] softkey *(F1)* until **1** is highlighted.
- Press the [TIME CHANNEL 1] softkey *(F5)*
- Press the **[Scale]** hardkey.
- Toggle the [AUTOSCALE **ON** OFF] softkey *(F1)* until **ON** is highlighted.*.*
- Press the **[Active Trace]** hardkey.
- Press the [B] softkey *(F1)*
- Press the **[Meas Data]** hardkey.
- Press the [CHANNEL 1 **2** 3 4] softkey *(F1)* until **2** is highlighted.
- Press the [TIME CHANNEL 2] softkey *(F5)*
- Press the **[Scale]** hardkey.
- Toggle the [AUTOSCALE **ON** OFF] softkey *(F1)* until **ON** is highlighted.

Arming Dual Channel Time Measurements

To manually arm a dual channel time measurement, proceed the same as for the single channel case:

- Press the **[Trigger]** hardkey.
- Select the [ARM SETUP] softkey *(F7)*
- Select the [MANUAL ARM] softkey *(F2)*
- Press the yellow **[Start]** hardkey to begin the measurement.
- Press the **[Trigger]** hardkey.

Then to arm a single time record,

- Press the [ARM] softkey *(F9)*

One time record will be captured and displayed. To capture another time record,

- Press the [ARM] softkey *(F9) again.*

Triggering a Dual-Channel Time Measurement

Either channel may be monitored to initiate a trigger for a measurement. Setting up the trigger event is the same as for single channel time waveforms, except that channel 1 or channel 2 must be selected as the trigger. To specify the trigger channel, proceed as follows:

- Press the **[Trigger]** hardkey.
- Press the [CHANNEL **1** 2 3 4] softkey *(F3)* until **1** is highlighted.

This sets up the analyzer to trigger off an event on channel 1. To set up channel 2 as the trigger channel, do the following:

- Press the **[Trigger]** hardkey.
- Press the [CHANNEL 1 **2** 3 4] softkey *(F3)* until **2** is highlighted.

Then set up trigger parameters (for a positive event, positive slope) as follows:
- Press the [TRIGGER SETUP] softkey *(F6)*
- Press the [CHANNEL LEVEL] softkey *(F1)*
- Enter 5 then press the [PERCENT (%)] softkey *(F4)*
- Press the [SLOPE **POS** NEG] softkey *(F5)* until **POS** is highlighted.

Trigger Delay

Both channels should acquire data using the same pre-trigger delay. To set up a 0.01s pre-trigger condition, follow these steps:
- Press the **[Trigger]** hardkey.
- Press the [TRIGGER SETUP] softkey *(F6)*
- Press the [ALL CHANNELS] softkey *(F8)*
- Press the [CHANNEL * DELAY] softkey *(F9)*
- Enter -.01 then press the [S] softkey *(F1)*

To start the data acquisition,
- Press the yellow **[Start]** hardkey.

The analyzer should show in highlighted text above the trace:

WAITING FOR CH 1 TRIGGER

Trigger   Arm: Automatic   Waterfall Steps: 15
[FFT]   Chn Level: 5 %   Slope: Positive
Date: 10-03-96 Time: 05:23:00 PM

A: CH1 Time   X:472.168 ms   Y:371.577 mV

```
      500
      mV
Real
      100
      mV
      /div

      -500
      mV
     -9.7656ms                              489.7461ms
```

B: CH2 Time   X:472.168 ms   Y:-241.753 mV

```
      500
      mV
Real
      100
      mV
      /div

      -500
      mV
     -9.7656ms                              489.7461ms
```
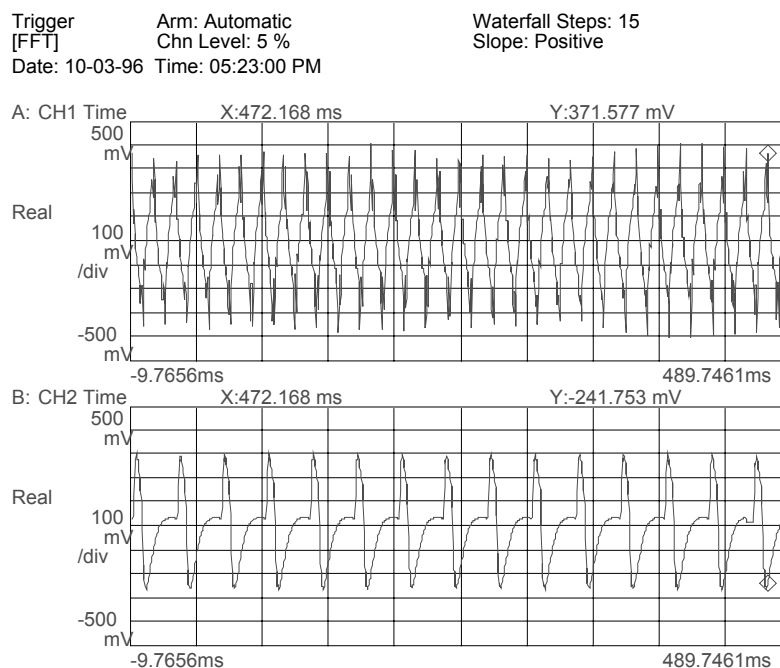
Using Markers with Dual Channel Time Measurements

Compare the time trace of Channel 1 with Channel 2 using two techniques: peak tracking and coupled markers. With peak tracking active on both channels, it is possible to measure an event with two channels and easily compare peak amplitudes. Set set up peak tracking for both channels, do the following:

- Press the **[Active Trace]** hardkey.
- Press the [A] softkey *(F1).*
- Press the **[Marker]** hardkey.
- Toggle the [PEAK TRK ON OFF] softkey *(F6)* until **ON** is highlighted.
- Press the **[Active Trace]** hardkey.
- Press the [B] softkey *(F2).*
- Press the **[Marker]** hardkey.
- Toggle the [PEAK TRK ON OFF] softkey *(F6)* until **ON** is highlighted.

Coupled markers can provide a quick comparison of relative levels during a transient event at a specific time. To set up peak tracking on Channel 1 and force the marker on Channel 2 to the time of Channel 1 peak, do the follow:

- Press the **[Active Trace]** hardkey.
- Press the [A] softkey *(F1).*
- Press the **[Marker]** hardkey.
- Toggle the [PEAK TRK ON OFF] softkey *(F6)* until **ON** is highlighted.
- Toggle the [COUPLED ON OFF] softkey *(F1)* until **ON** is highlighted.

Peak tracking looks for the maximum positive level in a trace. Therefore do not use peak tracking to determine the maximum absolute amplitude of negative pulses in a time trace.

Section 10 : Measuring Dual Channel Spectra and Time Waveforms

Two signals can be measured and examined in the time and frequency domains simultaneously. To accomplish this, a quad display format must be set up as follows:

First, preset the analyzer:

- Press the green **[Preset]** hardkey
- Press [DO PRESET] softkey *(F1).*

This places the analyzer into the default two channel mode. Set up the transducer parameters as described previously, if desired. Then, set up the display for four traces:

- Press the **[Disp Format]** hardkey.
- Press the [QUAD] softkey *(F6).*

- Press the **[Active Trace]** hardkey.
- Press the [A B C D] softkey *(F7)*.
- Press the **[Scale]** hardkey.
- Toggle the [AUTOSCALE ON OFF] softkey *(F1)* until **ON** is highlighted.*.*
- Press the **[Active Trace]** hardkey.
- Press the [A] softkey *(F1)*.

The default QUAD display shows Channel 1 power spectrum in Trace A, Channel 2 power spectrum in Trace B, Channel 1 time in Trace C, and Channel 2 time in Trace D.

Individual markers can be used on each trace, or peak tracking and coupled markers can be used as described for dual traces.

If averaging is applied to the power spectrum measurements, then the QUAD display will show the averaged power spectra in Trace A and B, and the previously acquired time traces in Trace C and D.

Scale	Trace: A	Ref Lvl: 1
	Per Div: 5	Ref Pos: Top
Date: 10-02-96	Time: 08:54:00 PM	

```
A: CH1 Pwr Spec      X:60    Hz                    Y:172.071 mVrms
    1
   Vrms
LogMag
    10
  uVrms
       0Hz                          AVG: 10                 800Hz
B: CH2 Pwr Spec      X:60    Hz                    Y:88.5405 mVrms
   100
  mVrms
LogMag
    10
  uVrms
       0Hz                          AVG: 10                 800Hz
C: CH1 Time          X:14.6484 ms              Y:427.266 mV
   500
    mV
Real
  -500
    mV
       0s                                          499.5117ms
D: CH2 Time          X:14.6484 ms              Y:279.515 mV
   500
    mV
Real
  -500
    mV
       0s                                          499.5117ms
```
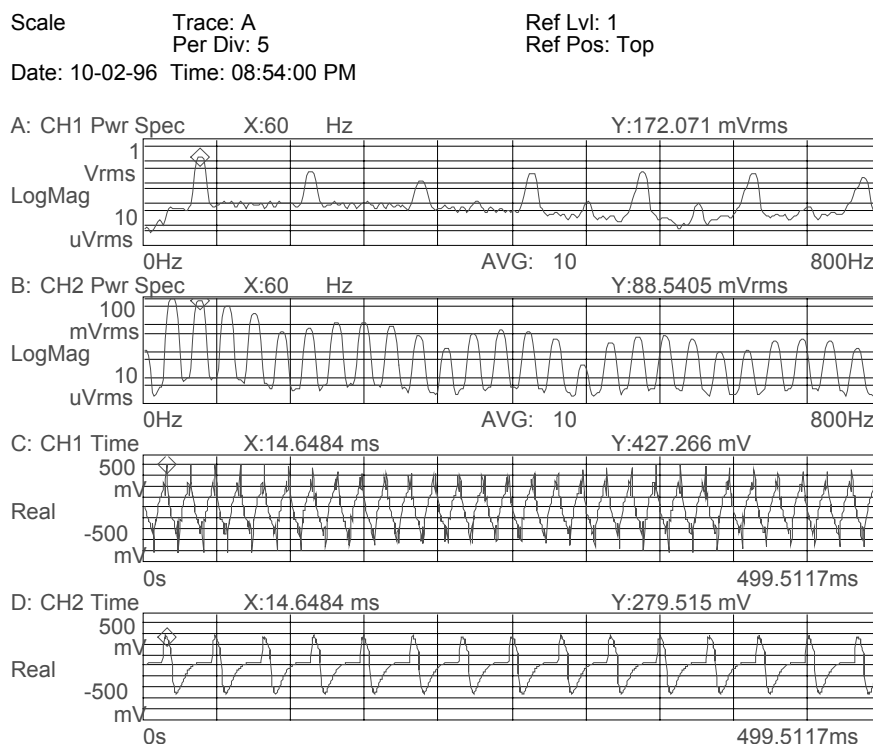
Section 11 : Modal Testing Using a Hammer and Accelerometer

Hammer testing is often the easiest and quickest technique for measuring frequency response functions used in modal analysis. Instructions for using a hammer with a force transducer and an accelerometer to measure frequency response functions are presented.

Setting Up the Transducer Parameters

Connect the force transducer on the hammer to Channel 1. Mount the response accelerometer to the desired location on the structure, and connect it (or its preamplifier) to Channel 2. Preset the analyzer and set up transducer parameters as follows, assuming an ICP accelerometer with a sensitivity of 11 mV/g and an ICP force transducer on the hammer with a sensitivity of 5 mV/lb:

- Press the green **[Preset]** hardkey
- Press `[DO PRESET]` softkey *(F1)*.

Wait for the analyzer to finish its preset routine.

- Press the **[Pause/Cont]** hardkey to pause the current measurement.

Set up the force transducer parameters as follows:

- Press the **[Input]** hardkey
- Press `[CHANNEL 1 2 3 4]` softkey *(F1)* until **1** is highlighted.
- Press `[FRONT END CH1 SETUP]` softkey *(F7)*.
- Press `[ICP SUPLY ON OFF]` softkey *(F8)* until **ON** is highlighted.
- Press the **[Input]** hardkey.
- Press the `[XDCR SENSITVTY]` softkey *(F6)*.
- Enter 5, then press the `[mV/EU]` softkey *(F2)*.
- Toggle the `[XDCR UNIT ON OFF]` softkey *(F4)* until **ON** is highlighted.
- Press the `[XDCR UNIT LABEL]` softkey *(F7)*.
- Press the `[MORE CHOICES]` softkey *(F9)*.
- Select the `[ lb ]` softkey *(F6)*.
- `[XDCR UNIT CH1 SETUP]` softkey *(F8)*

Set up the accelerometer parameters as follows:

- Press the **[Input]** hardkey.
- Press `[CHANNEL 1 2 3 4]` softkey *(F1)* until **2** is highlighted.
- Press `[FRONT END CH2 SETUP]` softkey *(F7)*.
- Press `[ICP SUPLY ON OFF]` softkey *(F8)* until **ON** is highlighted.
- Press the **[Input]** hardkey.
- Press `[XDCR UNIT CH2 SETUP]` softkey *(F8)*
- Press the `[XDCR SENSITVTY]` softkey *(F6)*.
- Enter 11, then press the `[mV/EU]` softkey *(F2)*.

- Toggle the `[XDCR UNIT ON OFF]` softkey *(F4)* until `ON` is highlighted.
- Press the `[XDCR UNIT LABEL]` softkey *(F7)*.
- Select the `[g]` softkey *(F2)*.

Setting Up Input Range

Use CH* AUTO UP ONLY as the autorange routine as follows:
- Press the **[Input]** hardkey.
- Press [ALL CHANNELS] softkey *(F2)*.
- Select the `[CH* AUTO UP ONLY]` softkey *(F5)*.

Then tap the structure with the hammer once. A yellow overload light by the input BNC connectors will indicate an overload, and the range will increase one step. Continue tapping on the structure, one tap at a time, allowing time for the input range to increase, until an overload is no longer indicated. This may take many hammer strikes. When an overload on either channel is no longer indicated, then the ranges are set correctly.

Choosing a Preliminary Frequency Span

Setting up a frequency response measurement is an interative process. A span is selected, a measurement is made, and the results are examined to determine if a narrower or wider span is required. To start measuring frequency response, you must select an initial span:
- Press the **[Freq]** hardkey.
- Enter 1600 and then press the [Hz] softkey *(F2)*.

Note: span should be any frequency that encompasses all modes of interest. If in doubt, start with a wider span.

Specifying Trigger Parameters

Hammer testing is triggered by the signal from the hammer. Without a force transducer, the trigger must come from the accelerometer that is attached to the hammer and connected to Channel 1. To set up a Channel 1 trigger, follow these steps:
- Press the **[Trigger]** hardkey.
- Press the `[CHANNEL 1 2 3 4]` softkey *(F3)* until **1** is highlighted.
- Press the `[TRIGGER SETUP]` softkey *(F6)*
- Press the `[CHANNEL LEVEL]` softkey *(F1)*
- Enter 5 then press the `[PERCENT (%)]` softkey *(F4)*
- Press the `[SLOPE POS NEG]` softkey *(F5)* until `POS` is highlighted.
- Press the **[Trigger]** hardkey.

- Press the [TRIGGER SETUP] softkey *(F6)*
- Press the [ALL CHANNELS] softkey *(F8)*
- Press the [CHANNEL * DELAY] softkey *(F9)*
- Enter -.01 then press the [S] softkey *(F1)*

Now to check that the trigger parameters are correct,

- Press the yellow **[Start]** hardkey.

The analyzer should show in highlighted text above the trace:

WAITING FOR CH 1 TRIGGER

Tap the hammer on the test structure to see if the measurement will trigger. If it will not, adjust the trigger level and slope until successful.

Setting Up Time Displays

View both the time trace and the windowed time trace for both channels using the QUAD display format as follows:

- Press the **[Disp Format]** hardkey.
- Press the [QUAD] softkey *(F6)*.
- Press the **[Active Trace]** hardkey.
- Press the [A] softkey *(F1)*
- Press the **[Meas Data]** hardkey.
- Press the [CHANNEL **1** 2 3 4] softkey *(F1)* until **1** is highlighted.
- Press the [TIME CHANNEL 1] softkey *(F5)*
- Press the **[Active Trace]** hardkey.
- Press the [B] softkey *(F1)*
- Press the [TIME CHANNEL 2] softkey *(F5)*
- Press the **[Active Trace]** hardkey.
- Press the [C] softkey *(F1)*
- Press the [CHANNEL **1** 2 3 4] softkey *(F1)* until **1** is highlighted.
- Press the [MORE CHOICES] softkey *(F9)*
- Press the [WINDOWED TIME CH 1] softkey *(F5)*
- Press the **[Active Trace]** hardkey.
- Press the [D] softkey *(F1)*
- Press the [WINDOWED TIME CH 2] softkey *(F5)*
- Press the **[Active Trace]** hardkey.
- Press the [A B C D] softkey *(F7)*.
- Press the **[Scale]** hardkey.
- Toggle the [AUTOSCALE **ON** OFF] softkey *(F1)* until **ON** is highlighted.

Window   Type: Force/Expo   Width: 15 ms
[FFT]   Decay: 30 ms
Date: 10-02-96 Time: 09:02:00 PM

A: CH1 Time   X:488.281 us   Y:67.1154 mV

```
  80 |
  mV |
     |
Real |
     |
 -20 |
  mV |
     -9.766ms                                        115.112ms
```

B: CH2 Time   X:488.281 us   Y:-74.925 mV

```
 300 |
  mV |
     |
Real |
     |
-200 |
  mV |
     -9.766ms                                        115.112ms
```

C: CH1 Win Time   X:488.281 us   Y:48.1237 mV

```
  70 |
  mV |
     |
Real |
     |
 -30 |
  mV |
     -9.766ms                                        115.112ms
```

D: CH2 Win Time   X:488.281 us   Y:-53.234 mV

```
 250 |
  mV |
     |
Real |
     |
-250 |
  mV |
     -9.766ms                                        115.112ms
```
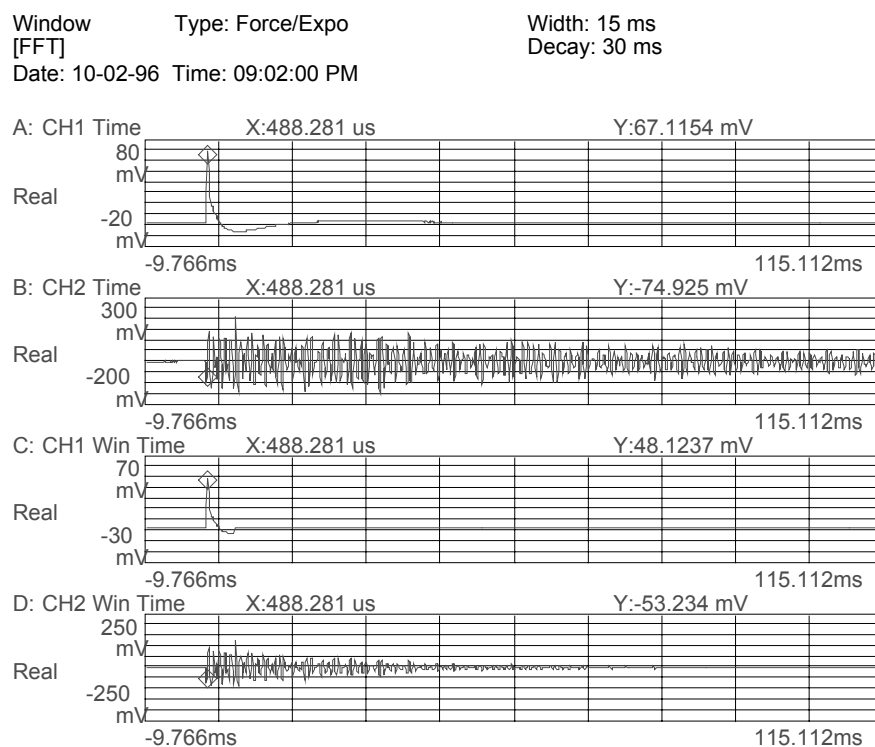
Using Force/Response Windows

Hammer measurements for modal analysis typically require special windows, named Force/Response windows, to maximize measurement quality. The force window merely zeros out the trace after a fixed time interval, so that noise or bumps from the hammer after the desired impact do not get interpreted as excitation applied to the structure. The fixed interval must be long enough to capture the whole pulse, so that measurement of the impact does not get zeroed out. A typical value for the length of a force window is T/7, where T is the record duration in seconds. For a 1600 Hz span and resolution of 400 lines, the record length is 250 ms, so a "conservative" force window might have a duration of 36 ms. Experience may show that a much shorter duration may work better.

Response windows prevent leakage by artificially decaying the response so that by the end of the record the signal is less than 5% of the peak. The artificial decay is specified by a time constant, with shorter time constants providing higher decay rates. A time constant that is guaranteed to decay a signal to less than 5% is T/4. For a span of 1600 Hz and resolution of 400 lines, this translates into a response

window time constant of 62.5 ms. To set up these Force/Response windows, follow
these steps:

- Press the **[Window]** hardkey.
- Press the [FORCE EXPO] softkey *(F4)*.
- Press the [FORCE EXPO SETUP] softkey *(F6)*.
- Press the [FORCE WIDTH] softkey *(F6)*.
- Enter 36 and then press the [mS] softkey *(F2)*.
- Press the [EXPO DECAY] softkey *(F7)*.
- Enter 62.5 and then press the [mS] softkey *(F2)*.

To view the effects of theForce/Response window,

- Press the yellow **[Start]** hardkey.
- Tap the structure with the hammer.

Observe the time trcaes. Compare them to their windowed time records. Determine
if the Force/Response windows met their object. Adjust windows if necessary. If it
appears that no window would be required, then it is possible to test with a
"UNIFORM" (meaning factor of 1) window instead of a force/response window. To
select a UNIFORM window,

- Press the **[Window]** hardkey.
- Press the [UNIFORM] softkey *(F3)*.

Displaying Hammer Test Results

The results of hammer testing are frequency response functions, and the indicator of
measurement quality is coherence. These traces can be set up as follows:

- Press the **[Disp Format]** hardkey.
- Press the [UPPER/LOWER] softkey *(F3)*.
- Press the **[Active Trace]** hardkey.
- Press the [A] softkey *(F1)*
- Press the **[Meas Data]** hardkey.
- Press the [FREQ RESP 2 / 1] softkey *(F6)*
- Press the **[Scale]** hardkey.
- Toggle the [AUTOSCALE ON OFF] softkey *(F1)* until **ON** is highlighted..
- Press the **[Active Trace]** hardkey.
- Press the [B] softkey *(F1)*
- Press the **[Meas Data]** hardkey.
- Press the [COHERENCE 2 / 1] softkey *(F7)*

Averaging

Averaging is a very effective technique for improving the quality of frequency
response measurements. A minimum of four averages reduces noise and variance

significantly. Ten averages may take longer, but may be necessary when testing difficult, non-linear structures. To set up five averages, follow these steps:
- Press the **[Avg]** hardkey.
- Toggle the [AVERAGE ON OFF] softkey *(F1)* until **ON** is highlighted.
- Press the [NUMBER AVERAGES] softkey *(F2).*
- Enter 5 and press the [ENTER] softkey *(F1).*

To avoid averaging overloaded data, turn on overload reject as follows:
- Press the **[Avg]** hardkey.
- Toggle the [OVLD REJ ON OFF] softkey *(F1)* until **ON** is highlighted.

To start taking measurements,
- Press the yellow **[Start]** hardkey.
-

Hammer the structure at one measurement point. After the data is acquired and displayed, hammer the structure again, and repeat 5 times until the average is complete.
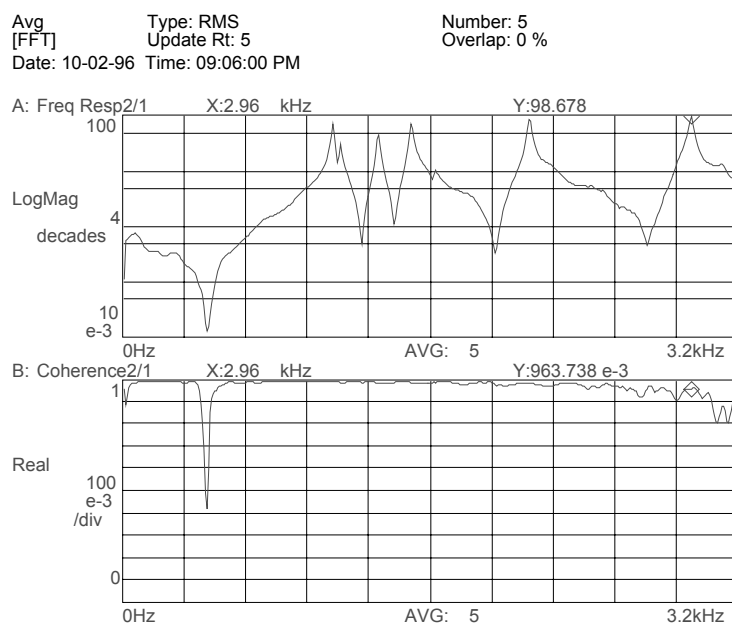
Changing Frequency Span

Changing frequency span or resolution affects three important parameters in hammer testing which must be changed to correspond to the new time record length: Trigger Delay, Force Window Width, and Response Window Decay Time. The following relationship between the parameters can be used as a guideline:

$$T = N \big/ (1.024F)$$

Where T is the time record length in seconds, N is the resolution in lines, and F is the frequency span in Hz.

$$Delay = 0.1(T)$$

$$ForceWidth = T \big/ 7$$

$$ExponentialDecay = T \big/ 4$$

When the frequency span is halved, the Time Record length doubles, as does the Delay time, Force Width, and Exponential Decay. All three parameters should change with the inverse of the change in frequency span.

Section 12 : Hammer Test Setup Without a Force Transducer

Hammer testing for modal analysis without a force transducer can yield usable results if an accelerometer is placed on the hammer and used to trigger the measurement. Although frequency response functions acquired with this technique will be affected by the dynamic characteristics of the hammer assembly and also its mass-loading effects, approximate mode frequencies and mode shapes can still be computed using modal analysis software.

On the other hand, power spectra obtained by measuring the single-channel response to a non-instrumented hammer strike may also provide information regarding modal frequencies and shapes, but success is too dependent on the consistency of the hammer strike, and therefore this technique is not recommended.

Setting Up the Hammer Test Without a Force Transducer

Attach an accelerometer to the hammer using cement or wax, and connect this transducer to Channel 1. Attach the response accelerometer to the desired location on the structure, and connect it to Channel 2. Preset the analyzer and set up transducer parameters as described in the section "Measuring with Transducers." Then proceed with the test in accordance with the proceeding section on "Modal Testing with a Hammer and Accelerometer."
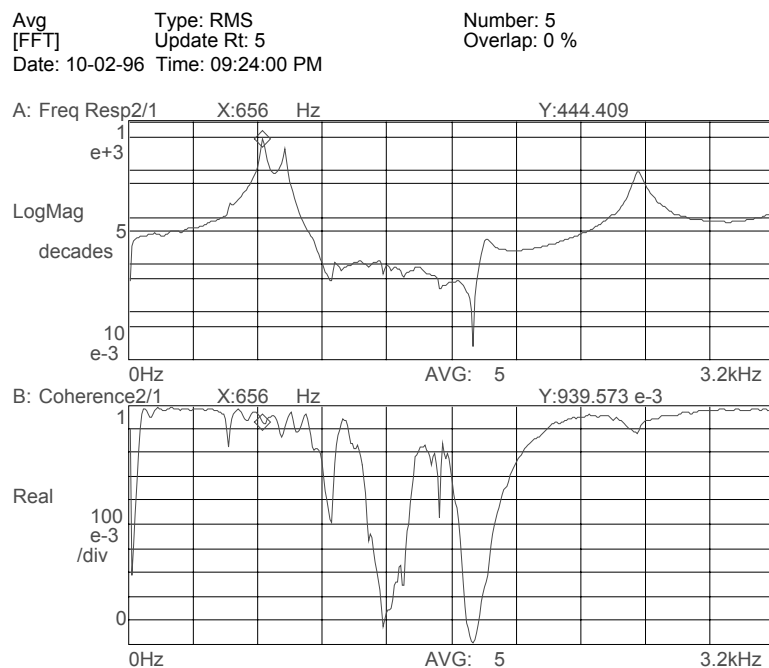
Section 13 : Order Domain Results in List Mode

Machinery run-ups and run-downs can be analyzed with order analysis, which is spectral analysis normalized to RPM. Results can be simplified by examining only a list of amplitude versus order, so that only desired results are examined.

To set up and measure a list of 10 orders for a machinery run-up, follow these steps:
- Press the green **[Preset]** hardkey
- Press [DO PRESET] softkey *(F1)*.
- Press the **[Pause/Cont]** hardkey if desired.
- Press the [ORDER ANALYSIS] softkey *(F3)*.
- Press [CHANNELS 1 2 4] softkey (F7) until 1 is highlighted.
- Press the **[Input]** hardkey
- Press the [CH1 AUTO UP ONLY] software *(F5)*.

Order analysis requires a tachometer signal connected to the TACH BNC at the back of the analyzer. To set up the AGILENT 35670A for the tachometer signal, follow these steps:
- Press the [TACHOMETR SETUP] softkey *(F9)*.
- Toggle the [TACH DISP ON OFF] softkey *(F6)* until **ON** is highlighted.
- Press the [TACH PULS PER REV] softkey *(F1)*.
- Enter the number of tachometer pulses per shaft revolution and press the [ENTER] softkey *(F1)*.
- Press the [LEVEL] softkey *(F3)*.
- Enter the tachometer level and press the [ENTER] softkey *(F1)*.
  If in doubt about the tachometer level, enter 0.5 V and experiment with level, slope, and trigger range until a tachometer display is shown.

Prepare the order display as follows:
- Press the **[Disp Format]** hardkey.
- Press the [UPPER/LOWER] softkey *(F3)*.
- Press the **[Active Trace]** hardkey.
- Press the [B] softkey *(F1)*

Prepare the order results list as follows:
- Press the **[Analys]** hardkey.
- Press the [DATA TABLE] softkey *(F5)*.
- Toggle the [TABLE ON OFF] softkey *(F1)* until **ON** is highlighted.
- Press the [INSERT X VALUE] softkey *(F4)*.
- Enter 1 and press the [ORDERS] softkey *(F1)*.
- Enter 2 and press the [ORDERS] softkey *(F1)*.
- Enter 3 and press the [ORDERS] softkey *(F1)*.

- Enter 4 and press the [ORDERS] softkey *(F1)*.
- Enter 5 and press the [ORDERS] softkey *(F1)*.
- Enter 6 and press the [ORDERS] softkey *(F1)*.
- Enter 7 and press the [ORDERS] softkey *(F1)*.
- Enter 8 and press the [ORDERS] softkey *(F1)*.
- Enter 9 and press the [ORDERS] softkey *(F1)*.
- Enter 10 and press the [ORDERS] softkey *(F1)*.

After the data table is built, it can be saved to disk with the following steps:

- Insert a 3.5" diskette into the AGILENT 35670A
- Press the **[Save/Recall]** hardkey.
- Press the [SAVE MORE] softkey *(F3)*.
- Press the [SAVE DATA TABL] softkey *(F4)*.
- Press the [ENTER] softkey *(F1)* to save the data table to the default filename "DATA1.TBL"
- "DATA1.TBL" can be recalled later to set up the structure of the data table.

To start taking measurements,

- Press the yellow **[Start]** hardkey.

Marker   Trace: A   X Ref: 0
                                               Y Ref: 100 u

Date: 10-02-96 Time: 09:36:00 PM

A: CH1 Pwr Spec   X:2   Order   Y:837.946 uVrms

Entry Label	Order	Vrms	
	1	4.797	u
	2	837.946	u
	3	21.182	u
	4	96.302	u
	5	21.047	u
	6	59.76	u
	7	21.843	u
LogMag	8	154.291	u
	9	58.746	u
	10	360.559	u

Section 14 : Comparing Two-Channel Real-Time Spectra with Recalled Data

Compare two channels of real-time data with spectra stored in registers using the UPPR/LOWR FRNT/BACK display format of the AGILENT 35670A. Note that the real-time data should be measured with the same frequency and resolution as the stored data if valid, direct comparisons are desired.

Preset the analyzer as follows:
- Press the green **[Preset]** hardkey
- Press [DO PRESET] softkey *(F1)*.
- Press the yellow **[Pause/Cont]** hardkey if desired.

Selecting Measurement Parameters

Refer to the section entitled "Measuring Dual Channel Spectra" to set up span, ranges, coupling, averaging, and windowing. Transducer parameters set up is described in the section "Measuring with Transducers."

Displaying Dual-Channel Spectra Compared with Recalled Data

The results of a dual-channel measurement are compared to recalled spectra in data registers via the following steps:
- Press the **[Disp Format]** hardkey.
- Press the [UPPR/LOWR FRNT/BACK] softkey *(F5)*.
- Press the **[Active Trace]** hardkey.
- Press the [A] softkey *(F1)*.
- Press the **[Meas Data]** hardkey.
- Press the [CHANNEL 1 2 3 4] softkey *(F1)* until **1** is highlighted.
- Press the [PWR SPEC CHANNEL 1] softkey *(F3)*
- Press the **[Active Trace]** hardkey again.
- Press the [B] softkey *(F2)*.
- Press the **[Meas Data]** hardkey.
- Press the [MORE CHOICES] softkey *(F9)*.
- Press the [DATA REGISTER] softkey *(F8)*.
- Press the [D1] softkey *(F1)*.
- Press the **[Active Trace]** hardkey.
- Press the [C] softkey *(F1)*.
- Press the **[Meas Data]** hardkey.
- Press the [CHANNEL 1 **2** 3 4] softkey *(F1)* until **2** is highlighted.
- Press the [PWR SPEC CHANNEL 2] softkey *(F3)*.
- Press the **[Active Trace]** hardkey again.
- Press the [D] softkey *(F2)*.
- Press the **[Meas Data]** hardkey.

- Press the [MORE CHOICES] softkey *(F9)*.
- Press the [DATA REGISTER] softkey *(F8)*.
- Press the [D2] softkey *(F2)*.

Recalling the Spectra from Disk

Use data registers D1 and D2 to contain the spectra used for comparison. D1 is compared to Channel 1 real-time data, and D2 is compared to Channel 2 real-time data. Comparison data must either be measured, then stored into data registers D1 and D2, or recalled into registers D1 and D2 from disk or non-volatile RAM. For instructions on how to store spectra to disk, see the section "Storing Data to a Disk File." For instructions on how to store spectra to data registers, see the section "Storing Data in Data Registers."

For this section, the comparison data is assumed to be stored in the disk file "COMPARE1.DAT" and "COMPARE2.DAT." To recall these spectra into D1 and D2, respectively, follow these steps:

- Insert the 3.5" disk containing the files "COMPARE1.DAT" and "COMPARE2.DAT."
- Press the **[Save/Recall]** hardkey.
- Press the [RECALL DATA] softkey *(F4)*.
- Press the [RCL TRACE AND SCALE] softkey *(F1)*.
- Press the [FROM FILE INTO D1] softkey *(F1)*.
- Press the [CLEAR ENTRY] softkey *(F9)*.
- Enter COMPARE1.DAT and press the [ENTER] softkey *(F1)*.

Data from the file "COMPARE1.DAT" now appears in data register D1. Next, recall "COMPARE2.DAT" into dataregister D2 as follows:

- Press the **[Save/Recall]** hardkey.
- Press the [RECALL DATA] softkey *(F4)*.
- Press the [RCL TRACE AND SCALE] softkey *(F1)*.
- Press the [FROM FILE INTO D2] softkey *(F2)*.
- Press the [CLEAR ENTRY] softkey *(F9)*.
- Enter COMPARE2.DAT and press the [ENTER] softkey *(F1)*.

Recalling the Spectra from Non-Volatile RAM

The comparison data files "COMPARE1.DAT" and "COMPARE2.DAT" are stored in the non-volatile RAM. To recall these spectra into D1 and D2, respectively, follow these steps:

- Press the **[Save/Recall]** hardkey.
- Press the [DEFAULT DISK] softkey *(F9)*.
- Press the [NON VOL RAM DISK] softkey *(F1)*.

- Press the **[Save/Recall]** hardkey.
- Press the [RECALL DATA] softkey *(F4)*.
- Press the [RCL TRACE AND SCALE] softkey *(F1)*.
- Press the [FROM FILE INTO D1] softkey *(F1)*.
- Press the [CLEAR ENTRY] softkey *(F9)*.
- Enter COMPARE1.DAT and press the [ENTER] softkey *(F1)*.

Data from the file "COMPARE1.DAT" now appears in data register D1. Next, recall "COMPARE2.DAT" into dataregister D2 as follows:

- Press the **[Save/Recall]** hardkey.
- Press the [RECALL DATA] softkey *(F4)*.
- Press the [RCL TRACE AND SCALE] softkey *(F1)*.
- Press the [FROM FILE INTO D2] softkey *(F2)*.
- Press the [CLEAR ENTRY] softkey *(F9)*.
- Enter COMPARE2.DAT and press the [ENTER] softkey *(F1)*.

The data registers now contain the comparison data. To make real-time measurements, start the measurement as follows:

- Press the yellow **[Start]** hardkey.

Scaling the Displays

Proper trace scaling of the FRONT/BACK displays provides a quick and clear visual comparison. Both traces should be set to the same scale, or at least use the same "Y PER DIV (DECADES)." This need to be set up for each pair of traces. After comparison data has been recalled into D1 and D2, and real-time measurements are complete on Channel 1 and Channel 2, set up scale as follows:

- Press the **[Active Trace]** hardkey.
- Press the [A B] softkey *(F1)*.
- Press the **[Scale]** hardkey.
- Toggle the [AUTOSCALE **ON** OFF] softkey *(F1)* until **ON** is highlighted.
- Press the [Y PER DIV (DECADES)] softkey *(F6)*.
- Enter 2 and press the [ENTER] softkey *(F1)*.

Note: Usually one, two, or three decades offers the best scale for comparison. If the scale is not identical, but the top reference is different, then the traces can be made identical. Assuming the maximum peak of both traces is about 8 mV, then the top reference can be set to 10 mV by the following:

- Press the [TOP REFERENCE] softkey *(F2)*.
- Enter 0.01 and press the [ENTER] softkey *(F1)*.

Scaling for traces A and B are now identical. To accomplish the same trace scaling
for C and D, follow these steps:

- Press the **[Active Trace]** hardkey.
- Press the `[C D]` softkey *(F1)*.
- Press the **[Scale]** hardkey.
- Toggle the `[AUTOSCALE ON OFF]` softkey *(F1)* until **ON** is highlighted.
- Press the `[Y PER DIV (DECADES)]` softkey *(F6)*.
- Enter 2 and press the [ENTER] softkey *(F1)*.

As with Traces A and B, if the top reference of C and D are not identical, set the top
reference level as shown above.

Using Markers to Compare

Coupled markers can be activated for all traces, but not independently for each pair
of traces. Use coupled markers to compare one set of traces at a time.

Section 15 : Waterfall Spectra at Time Intervals

Waterfalls on the AGILENT 35670A can be used to examine and compare spectra at fixed intervals of time. This is especially useful when measuring non-stationary signals from machinery, such as during run-ups and run-downs. To see a waterfall display of the vibration signature, follow these steps:

Preset the analyzer as follows:
- Press the green **[Preset]** hardkey
- Press [DO PRESET] softkey *(F1)*.
- Press the **[Pause/Cont]** hardkey if desired.

Selecting Single Channel Operation

Specify the single-channel instrument mode to measure one waterfall. Note that it is possible to measure and display waterfalls for two channels simultaneously. For single channel operation, however, the display performance will be better with only one channel active. To measure a single-channel waterfall, turn on the AGILENT 35670A and then:
- Press the **[Inst Mode]** hardkey
- Press [CHANNELS 1 2 4] softkey *(F7)* until **1** is highlighted.

Selecting Measurement Parameters

Refer to the section entitled "Measuring Single Channel Spectra" to set up span, ranges, coupling, averaging, and windowing. Transducer parameters set up is described in the section "Measuring with Transducers."

Setting Up the Waterfall Display

The best view of a waterfall includes the current power spectrum above the waterfall trace. In the AGILENT35670A this is implemented with the UPPER/BIG LOWER display format as follows:
- Press the **[Disp Format]** hardkey.
- Select the [UPPER/ BIG LOWER] softkey *(F4)*.
- Press the **[Active Trace]** hardkey.
- Select the [A] softkey *(F2)*.
- Press the **[Meas Data]** hardkey.
- Toggle the [CHANNEL 1 2 3 4] softkey until **1** is highlighted.
- Press the [PWR SPEC CHANNEL 1] softkey *(F3)*.

Continuing to set up a waterfall display,
- Press the **[Active Trace]** hardkey.
- Select the [B] softkey *(F2)*.

- Press the **[Disp Format]** hardkey.
- Press the [WATERFALL SETUP] softkey *(F8)*.
- Toggle the [WATERFALL ON OFF] softkey *(F1)* until ON is highlighted.

The default number of waterfall steps is 15, which means only 15 spectra are kept in memory and as new data is taken, the oldest spectra is discarded. The maximum number of waterfall steps which can be kept in memory depends on the RAM option installed in the AGILENT 35670A and the lines of resolution in each spectra. With standard memory and one channel active, 130 spectra can be stored with 400 lines of resolution. With maximum optional RAM, over 1000 spectra may be kept in memory.

The z-axis range describes how many spectra will be displayed in the waterfall simultaneously. The default number is 15.

Setting Up Time Step Arm

Waterfall spectra can be acquired at constant intervals of time by arming the measurement using TIME STEP ARM as follows:
- Press the **[Trigger]** hardkey.
- Select the [ARM SETUP] softkey *(F7)*.
- Select the [TIME STEP ARM] softkey *(F4)*.
- Select the [TIME STEP SIZE] softkey *(F8)*.
- Enter 1.5 and press the [S] softkey *(F1)*.

This sets up a 1.5 second time interval between spectra in the waterfall. Note that if the time record for a frequency span is too long, data cannot be acquired at the specified time interval. For example when the frequency span is 200 Hz and the resolution is 400 lines, the time record length is about 2 seconds. Waterfall spectra cannot be acquired any faster than a 2 second interval.

On the other hand if the time record length is equal to or shorter than the specified time interval, the measurement will be armed (and triggered, when FREE RUN TRIGGER is selected) exactly at the time interval increment.

To acquire a waterfall with 15 spectra at 1.5 second intervals, start the measurement:
- Press the yellow **[Start]** hardkey.

Using Slice Markers with Waterfall Data

Examine amplitude vs. time for a specified frequency using the AGILENT 35670A's waterfall slice marker. Select the frequency using the waterfall marker, then display the time history at that frequency as follows:
- Press the **[Active Trace]** hardkey.
- Select the [B] softkey *(F2)*.

This makes the waterfall trace active.

- Press the **[Marker Fctn]** hardkey.
- Press the [WATERFALL MARKERS] softkey *(F5).*

The SLICE SELECT softkey will be active. Use the marker knob to move the cursor to the frequency of interest.

- Press the [SAVE AND DISP DATA] softkey *(F5).*

This one keystroke saves the selected slice into data register D2 and changes the Meas Data of Trace A to display data register D2. Trace A will show the amplitude in the selected frequency band vs. time.

Collecting a Specified Number of Spectra During a Time Interval

Acquire a specified number of spectra into a waterfall during a fixed interval using time step arm. Divide the total measurement interval by the number of spectra desired during the interval to determine the desired TIME STEP SIZE. For example to measure 10 spectra during a one minute interval, select a 6 second TIME STEP SIZE as follows:

- Press the **[Trigger]** hardkey.
- Select the [ARM SETUP] softkey *(F7).*
- Select the [TIME STEP ARM] softkey *(F4).*
- Select the [TIME STEP SIZE] softkey *(F8).*
- Enter 6 and press the [S] softkey *(F1).*

Then specify the total number of spectra to be collected (10):

- Press the **[Active Trace]** hardkey.
- Select the [B] softkey *(F2).*
- Press the **[Disp Format]** hardkey.
- Select the [WATERFALL SETUP] softkey *(F8).*
- Select the [WATERFALL STEPS] softkey *(F8).*
- Enter 10 and then press the [ENTER] softkey *(F1).*

When Start is pressed, a new spectra will be acquired every six seconds.

Section 16 : Waterfall Spectra at RPM Intervals

Spectra can be acquired at fixed RPM intervals with RPM STEP ARM. This feature allows spectra to be taken at uniform RPM intervals even during erratic run-ups.

Setting Up the Tachometer

Connect the tachometer signal to the TACH BNC connector on the back of the AGILENT 35670A. Set up tachometer parameters as follows, assuming that the tachometer is a 1 V peak signal with 2 pulses per revolution:

- Press the **[Trigger]** hardkey.
- Press the [TACHOMTER SETUP] softkey *(F8)*.
- Press the [TACH PULS PER REV] softkey *(F8)*.
- Enter 2 then press the [ENTER] softkey *(F1)*.
- Toggle the [TACH DISP ON OFF] softkey *(F6)* until ON is highlighted.

Specifying the Start RPM

To set up RPM interval triggering, refer to the preceding section regarding Time Step Arm, then follow these instructions:

- Press the **[Trigger]** hardkey.
- Press the [ARM SETUP] softkey *(F7)*.
- Select the [RPM STEP ARM] softkey *(F3)*.
- Press the [START RPM] softkey *(F6)*.
- Press 1000 then the [RPM] softkey *(F1)*.

This starts the measurement when 1000 RPM.

- Press the [RPM STEP SIZE] softkey *(F7)*.
- Press 25 then the [RPM] softkey *(F1)*.

This arms the measurement every 25 RPM.

Collecting a Specified Number of Spectra During an RPM Interval

Acquire a specified number of spectra into a waterfall during an RPM run-up using RPM step arm. Divide the total RPM interval by the number of spectra desired during the interval to determine the desired RPM STEP SIZE. For example to measure 15 spectra during an RPM run-up from 1000 RPM to 1750 RPM, select an RPM STEP SIZE of 50 as follows:

- Press the **[Trigger]** hardkey.
- Select the [ARM SETUP] softkey *(F7)*.
- Select the [RPM STEP ARM] softkey *(F4)*.
- Press the [START RPM] softkey *(F6)*.
- Press 1000 then the [RPM] softkey *(F1)*.
- Press the [RPM STEP SIZE] softkey *(F7)*.

- Press 50 then the [RPM] softkey *(F1)*.

Then specify the total number of spectra to be collected (15):

- Press the **[Active Trace]** hardkey.
- Select the [B] softkey *(F2).*
- Press the **[Disp Format]** hardkey.
- Select the [WATERFALL SETUP] softkey *(F8).*
- Select the [WATERFALL STEPS] softkey *(F8).*
- Enter 15 and then press the [ENTER] softkey *(F1).*

When Start is pressed, spectra will be acquired as soon as the tachometer reaches 1000 RPM, and every 50 RPM thereafter until 15 spectra have been measured.

Starting and Pausing a Measurement

To start a waterfall measurement, press the yellow **[Start]** hardkey. To pause waterfall at any moment, press the yellow **[Pause/Cont]** hardkey. A measurement can be continued by pressing the yellow **[Pause/Cont]** hardkey again. The ability to pause a machinery run-up measurement allows the user to capture and observe critical data, such as a vibration resonance build-up over a certain rpm range.

Scaling the Display

Because a waterfall contains so much spectral information, it is often desirable to eliminate unwanted data from view, such as the noise floor, so that the critical data can be examined and compared. This is readily accomplished with display scaling. To scale the waterfall data acquired from Track 31 of the AGILENT Dynamic Signals II CD:

- Press the **[Active Trace]** hardkey.
- Press the [B] softkey *(F2).*
- Press the **[Scale]** hardkey.
- Press the [TOP REFERENCE] softkey *(F1).*
- Press 5 then [ENTER].
- Press the [Y PER DIV (DECADES)] softkey *(F6).*
- Press 4 then [ENTER].

Mechanical resonances at around 4170 RPM should become clearly visible with these scaling parameters.

Marker Fcn   Trace: B   Save Reg: D2
[Watrfall]   Base Supr: 0 %   Height: 57 %
Date: 07-24-96   Time: 11:31:00 PM

A: D2 Pwr Spec

B: CH1 Pwr Spec   Slice:122   Hz   Trace:4.311   kRPM
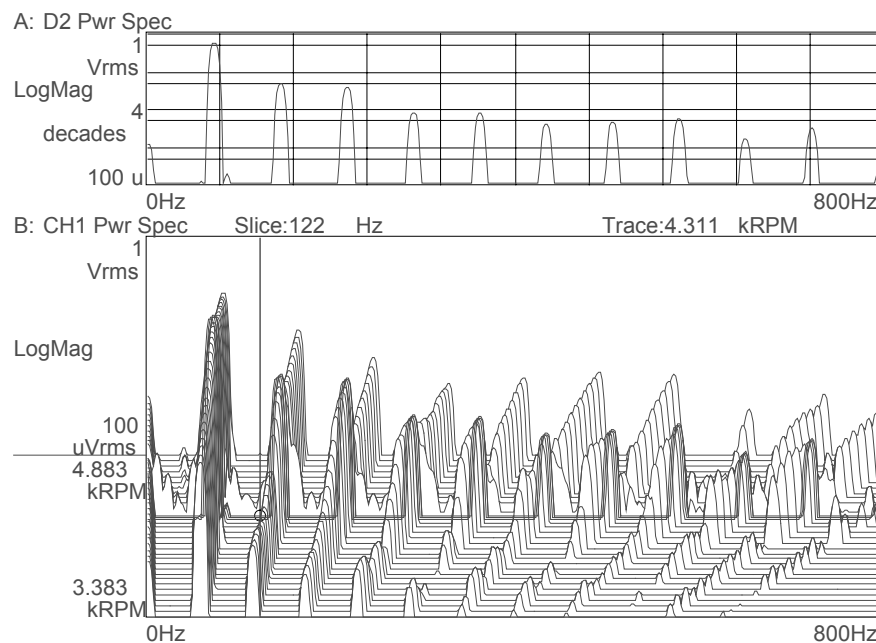
A Properly Scaled, RPM Triggered Waterfall Display

Section 17 : Two-Channel Absolute and Differential Amplitude Measurement

Measuring the relative motion between points on a machine can provide information regarding clearances and forces. These measurements may also demonstrate a susceptibility of a machine to a particular mode of vibration.

Absolute motion can be measured as a power spectrum, with units of peak-to-peak displacement in mils. Relative motion is measured as the vector difference between two channels. It also can be displayed with units of peak-to-peak displacement in mils.

When acquiring these measurements, it is very important to know the relative polarity of each transducer. If their polarity is opposite, then the signals must be added, not subtracted, to obtain differential motion.

The best technique is to use two identical accelerometers. If the transducers are not the same model, then it is best to determine their relative polarity.

Accelerometer Polarity

To determine the polarity of two accelerometers, follow these steps:
- Press the green **[Preset]** hardkey
- Press [DO PRESET] softkey *(F1)*.
- Press the **[Pause/Cont]** hardkey if desired.
- Press the **[Freq]** hardkey
- Enter 3200 and then press the [Hz] softkey *(F2)*.
- Press the **[Input]** hardkey.
- Press the [ALL CHANNELS] softkey *(F2)*.
- Select the [CH* AUTO UP ONLY] softkey *(F5)*.

Set up transducer parameters as described in the section "Measuring with Transducers." Then follow these steps to display a time trace of the two accelerometers:
- Press the **[Disp Format]** hardkey.
- Press the [UPPER/LOWER] softkey *(F3)*.
- Press the **[Active Trace]** hardkey.
- Press the [A] softkey *(F1)*
- Press the **[Meas Data]** hardkey.
- Press the [CHANNEL 1 2 3 4] softkey *(F1)* until **1** is highlighted.
- Press the [TIME CHANNEL 1] softkey *(F5)*
- Press the **[Scale]** hardkey.

- Toggle the `[AUTOSCALE ON OFF]` softkey *(F1)* until **ON** is highlighted.*.*
- Press the **[Active Trace]** hardkey.
- Press the `[B]` softkey *(F1)*
- Press the **[Meas Data]** hardkey.
- Press the `[CHANNEL 1 2 3 4]` softkey *(F1)* until **2** is highlighted.
- Press the `[TIME CHANNEL 2]` softkey *(F5)*
- Press the **[Scale]** hardkey.
- Toggle the `[AUTOSCALE ON OFF]` softkey *(F1)* until **ON** is highlighted.

Set up triggering on Channel 1 to 5% of range:
- Press the **[Trigger]** hardkey.
- Press the `[CHANNEL 1 2 3 4]` softkey *(F3)* until **1** is highlighted.
- Press the `[TRIGGER SETUP]` softkey *(F6)*
- Press the `[CHANNEL LEVEL]` softkey *(F1)*
- Enter 5 then press the `[PERCENT (%)]` softkey *(F4)*.
- Press the `[ALL CHANNELS]` softkey *(F8)*.
- Press the `[CHANNEL * DELAY]` softkey *(F9)*.
- Enter -0.01 then press the `[S]` softkey *(F1)*.

Mount the accelerometers on top of each other or very close together on a light test structure, then:
- Press the yellow **[Start]** hardkey.
- Tap the structure in the area around the two accelerometers to trigger a measurement.
- If the measurement overloaded, then tap again after the range has increased. Tap again until a trace is not overloaded.
- Press the **[Marker]** hardkey.
- Toggle the `[COUPLED ON OFF]` softkey *(F2)* until **ON** is highlighted.
- Examine the two time traces with the coupled markers to determine if the accelerometers are in phase or out of phase.

Note whether the accelerometers are in phase or out of phase. The function to determine differential amplitude depends on this relationship.

Measuring Amplitudes, Differential Amplitude, and Phase

For machinery motion measurements, one display setup can show:
- displacement of Channel 1 in mils peak-to-peak
- displacement of Channel 2 in mils peak-to-peak

- difference in motion between Channel 1 and Channel 2 in mils peak-to-peak
- phase angle between the two channels.

Set up the AGILENT 35670A
- Press the green **[Preset]** hardkey
- Press [DO PRESET] softkey *(F1)*.
- Press the **[Pause/Cont]** hardkey if desired.
- Press the **[Freq]** hardkey
- Enter 800 and then press the [Hz] softkey *(F2)*.
- Press the **[Input]** hardkey.
- Press the [ALL CHANNELS] softkey *(F2)*.
- Select the [CH* AUTO UP ONLY] softkey *(F5)*.

Set up transducer parameters on Channel 1 and Channel 2 as per the section "Measuring with Transducers." Mount the accelerometers to the machinery and connect them to Channel 1 and Channel 2. The following procedures assume that

Using a Math Function to Measure Differential Motion

For accelerometers with the same polarity
- Press the **[Analys]** hardkey.
- Press the [DEFINE FUNCTION] softkey *(F1)*.
- Press the [DEFINE F1] softkey *(F1)*.
- Press the [MEAS DATA] softkey *(F1)*.
- Press the [LIN SPEC CHANNEL 1] softkey *(F3)*.
- Press the [-] softkey *(F2)*.
- Press the [MEAS DATA] softkey *(F1)*.
- Toggle the [CHANNEL 1 **2** 3 4] softkey *(F1)* until **2** is highlighted.
- Press the [LIN SPEC CHANNEL 2] softkey *(F3)*.
- Press the [ENTER] softkey *(F7)*.

For accelerometers with opposite polarity
- Press the **[Analys]** hardkey.
- Press the [DEFINE FUNCTION] softkey *(F1)*.
- Press the [DEFINE F1] softkey *(F1)*.
- Press the [MEAS DATA] softkey *(F1)*.
- Press the [LIN SPEC CHANNEL 1] softkey *(F3)*.
- Press the [+] softkey *(F1)*.
- Press the [MEAS DATA] softkey *(F1)*.

- Toggle the [CHANNEL 1 **2** 3 4] softkey *(F1)* until **2** is highlighted.
- Press the [LIN SPEC CHANNEL 2] softkey *(F3)*.
- Press the [ENTER] softkey *(F7)*.

Set up display
- Press the **[Disp Format]** hardkey.
- Press the [QUAD] softkey *(F6).*

After a instrument preset the QUAD display format normally places PWR SPEC CHANNEL 1 in Trcae A and PWR SPEC CHANNEL 2 in Trace B. If this is not the case, then follow these steps:
- Press the **[Active Trace]** hardkey.
- Press the [A] softkey *(F1).*
- Press the **[Meas Data]** hardkey.
- Press the [CHANNEL **1** 2 3 4] softkey *(F1)* until **1** is highlighted.
- Press the [PWR SPEC CHANNEL 1] softkey *(F3)*
- Press the **[Active Trace]** hardkey again.
- Press the [B] softkey *(F2).*
- Press the [CHANNEL 1 **2** 3 4] softkey *(F1)* until **2** is highlighted.
- Press the [PWR SPEC CHANNEL 2] softkey *(F3).*

Put the math function of the differential motion in Trace c:
- Press the **[Active Trace]** hardkey.
- Press the [C] softkey *(F1).*
- Press the [MORE CHOICES] softkey *(F9).*
- Press the [MATH FUNCTION] softkey *(F7).*
- Press the [F1] softkey *(F1).*
- Press the **[Active Trace]** hardkey again.
- Press the [D] softkey *(F2).*
- Press the **[Meas Data]** hardkey.
- Press the [FREQ RESP 2 / 1]] softkey *(F6).*

Set up trace coordinates as peak-to-peak mil
- Press the **[Active Trace]** hardkey.
- Press the [A B C D] softkey *(F7).*
- Press the **[Trace Coord]** hardkey.
- Press the [Y UNITS] softkey *(F8).*
- Toggle the [AMPLITUDE PK **PP** RMS] softkey *(F1)* until **PP** is highlighted.
- Press the [XDCR UNIT CONVERT] softkey *(F4).*
- Press the [mil (DISP)] softkey *(F8).*

- Press the **[Active Trace]** hardkey again.
- Press the [D] softkey *(F2).*
- Press the **[Trace Coord]** hardkey.
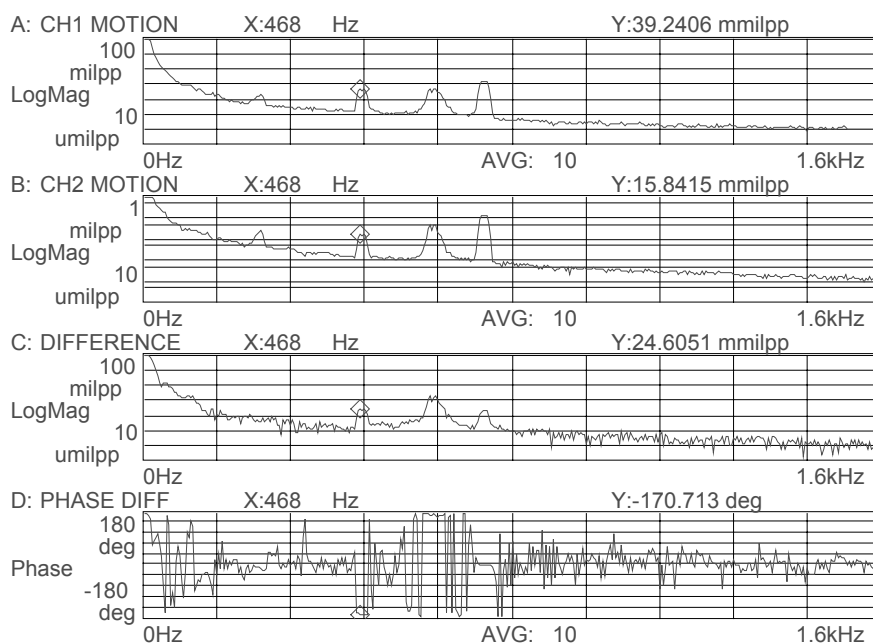- Press the [PHASE] softkey *(F4)*.

Start measurement
- Press the yellow **[Start]** hardkey.

The AGILENT 35670A will now measure motion of Channel 1 and 2 and show the results in Traces A and B. The difference in motion between Channel 1 and Channel 2 is shown in Trace C. The phase angle between channels is shown in Trace D.

Disp Frmat

Date: 01-01-04 Time: 08:35:00 AM

Section 18 : Measuring Frequency Response with the AGILENT 35670A

Frequency response functions characterize the behavior of systems to external stimuli. For mechanical systems, the stimulus can be a transient force such as an impact from a hammer, or a broadband stimulus, such as random excitation from an electrodynamic shaker. The response is usually motion of the system, measured with and accelerometer, velocity transducer, or displacement probe.

In either case the stimulus and the response measured with two channels of the AGILENT 35670A. The stimulus is usually measured on Channel 1, and the response is measured on Channel 2. The resulting frequency response is averaged to reduce noise and variance, and the result is displayed in a variety of formats that will be described in this section, including:

- Magnitude and phase
- Real and imaginary components (
- Nyquist Diagrams

The *quality* of the frequency response measurement is determined by how much of the response is due to the stimulus instead of being due to noise or other undesirable, unmeasured forces. Quality is described by coherence, which ranges from zero to one, where zero means none of the response is due to the stimulus. A coherence of one means that the response was entirely due to the stimulus

Measuring Frequency Response Using Impact Excitation

Refer to the section "Modal Testing Using a Hammer and Accelerometer" to measure frequency response using an impact as a stimulus. An impact provides broadband excitation, however the impact has a high peak to RMS ratio which tends to reduce measurement quality.

Measuring Frequency Response Using Broadband Excitation

Excite a system using the AGILENT 35670A built-in source to provide broadband excitation with low peak to RMS ratio and the best measurement quality. Use burst-random noise to eliminate window distortion and reduce leakage. The following instructions show how to set up a modal test with these example parameters:

electrodynamic shaker with amplifier
ICP force transducer with sensitivity of 8 mV/lb.
ICP accelerometer with sensitivity of 10.2 mV/G
wire sting to connect shaker to force transducer
burst random excitation, uniform window
frequency span of 800 Hz, 4 averages
results viewed as log magnitude and phase

Set up the shaker

- Attach force transducer to structure

- Attach one end of stinger to shaker and one end to force transducer
- Connect amplifier output to shaker
- Connect amplifier input to AGILENT 35670A source

Connect the transducers

- Connect force transducer to Channel 1
- Connect accelerometer to Channel 2

Preset the AGILENT 35670A

- Turn on the AGILENT 35670A, or
- Press the green **[Preset]** hardkey
- Press the yellow **[Pause/Cont]** hardkey if desired.

Enter Channel 1 input parameters

- Press the **[Input]** hardkey
- Press [CH1 AUTO UP ONLY] softkey *(F5)*.
- Press [FRONT END CH1 SETUP] softkey *(F7)*.
- Press [ICP SUPLY ON OFF] softkey *(F8)* until **ON** is highlighted.
- Press the **[Input]** hardkey
- Press [XDCR UNIT CH**1** SETUP] softkey *(F8)*
- Press the [XDCR SENSITVTY] softkey *(F6)*.
- Enter 8, then press the [mV/EU] softkey *(F2)*.
- Toggle the [XDCR UNIT **ON** OFF] softkey *(F4)* until **ON** is highlighted.
- Press the [XDCR UNIT LABEL] softkey *(F7)*.
- Press the [MORE CHOICES] softkey *(F9)*.
- Select the [lb] softkey *(F6)*.

Enter Channel 2 input parameters

- Press the **[Input]** hardkey
- Press [CHANNEL 1 **2** 3 4] softkey *(F1)* until **2** is highlighted.
- Press [CH2 AUTO UP ONLY] softkey *(F5)*.
- Press [FRONT END CH2 SETUP] softkey *(F7)*.
- Press [ICP SUPLY ON OFF] softkey *(F8)* until **ON** is highlighted.
- Press the **[Input]** hardkey
- Press [XDCR UNIT CH**2** SETUP] softkey *(F8)*
- Press the [XDCR SENSITVTY] softkey *(F6)*.
- Enter 10.2, then press the [mV/EU] softkey *(F2)*.
- Toggle the [XDCR UNIT **ON** OFF] softkey *(F4)* until **ON** is highlighted.
- Press the [XDCR UNIT LABEL] softkey *(F7)*.
- Select the [g] softkey *(F2)*.

Choose measurement parameters
- Press the **[Freq]** hardkey
- Enter 800 and then press the [Hz] softkey *(F2)*
- Press the **[Avg]** hardkey.
- Press the [NUMBER AVERAGES] softkey *(F2),* enter 4, then press the [ENTER] softkey *(F1).*
- Turn on averaging by pressing the [AVERAGE **ON** OFF] softkey *(F1)* until **ON** is highlighted.
- Press the **[Window]** hardkey
- Press the [UNIFORM] softkey *(F3).*

Set up display parameters
- Press the **[Disp Format]** hardkey.
- Press the [UPPER/LOWER] softkey *(F3)*
- Press the **[Active Trace]** hardkey.
- Press the [AB] softkey *(F5).*
- Press the **[Meas Data]** hardkey.
- Press the [FREQ RESP 2 / 1] softkey *(F6)*
- Press the **[Scale]** hardkey.
- Toggle the [AUTOSCALE **ON** OFF] softkey *(F1)* until **ON** is highlighted.
- Press the **[Active Trace]** hardkey.
- Press the [B] softkey *(F2).*
- Press the **[Trace Coord]** hardkey.
- Press the [PHASE] softkey *(F4).*

Set up the AGILENT 35670A source (if amplifier has level control)
- Check the following connections:
  AGILENT 35670A source connected to amplifier input
  amplifier plugged in
  amplifier output connected to shaker
  force transducer connected to Channel 1
- Reduce amplifier level control the lowest setting
- Turn on amplifier
- Press the **[Source]** hardkey.
- Press the [RANDOM NOISE] softkey *(F5)*
- Press the [LEVEL] softkey *(F2)*
- Enter 0.5, then press the [Vpk] softkey *(F1).*
- Toggle the [SOURCE **ON** OFF] softkey *(F1)* until **ON** is highlighted.

- Turn up the level control on the shaker amplifier until the excitation is noticeable, but does not buzz or rattle. If buzzing or rattling is heard, then either the level is too high or the structure is loose and must be quieted.
- Press the [MORE CHOICES] softkey *(F9)*
- Press the [BURST RANDOM] softkey *(F2)*

Set up the trigger
- Press the **[Trigger]** hardkey.
- Press the [SOURCE TRIGGER] softkey *(F4)*.

To acquire a burst random frequency response of the structure:
- Press the yellow **[Start]** hardkey.

```
Avg             Type: RMS                    Number: 10
[FFT]           Update Rt: 5                 Overlap: 0 %
Date: 10-02-96  Time: 09:49:00 PM
```

A: Freq Resp2/1   X:0   Hz   Y:84.6724 e-3

LogMag

decades

| 1 |
| 3 |
| 1 e-3 |

0Hz   AVG: 10   400Hz

B: Freq Resp2/1   X:0   Hz   Y:0   deg

180 deg

Phase

36 deg /div

-180 deg

0Hz   AVG: 10   400Hz
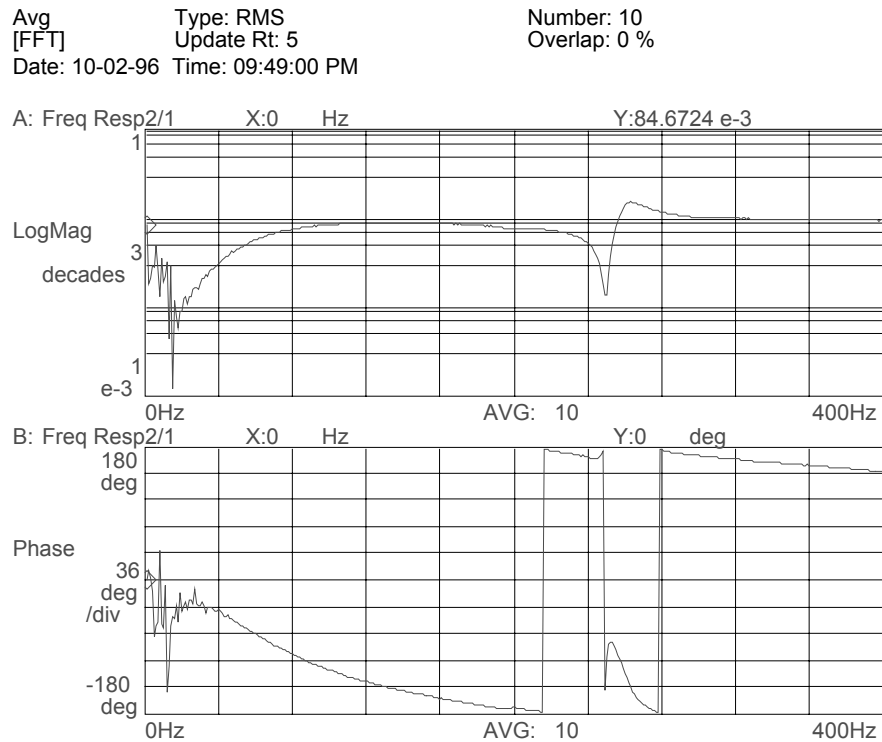
Viewing Frequency Response Results with a Nyquist Diagram

The previous display shows frequency response results with Log Magnitude and Phase traces. Other trace coordinates are available. To examine results in a Nyquist Diagram, proceed as follows:

- Press the **[Disp Format]** hardkey.
- Press the `[SINGLE]` softkey *(F1)*
- Press the **[Active Trace]** hardkey.
- Press the `[ A ]` softkey *(F1)*.
- Press the **[Trace Coord]** hardkey.
- Press the `[MORE CHOICES]` softkey *(F6)*.
- Press the `[NYQUIST DIAGRAM]` softkey *(F4)*.

Trac Coord   A: Nyquist   B: Phase
[FFT]   C: Real   D: Real
Date: 10-02-96 Time: 09:49:00 PM

A: Freq Resp2/1   R:-117.6 e-3   I:-101.3 e-3 +j   X:262   Hz
        200
        e-3

Imag
Nyquist
        50
        e-3   +1
        /div

        -300
        e-3
        -366.456e-3   Real   AVG: 10   266.456e-3
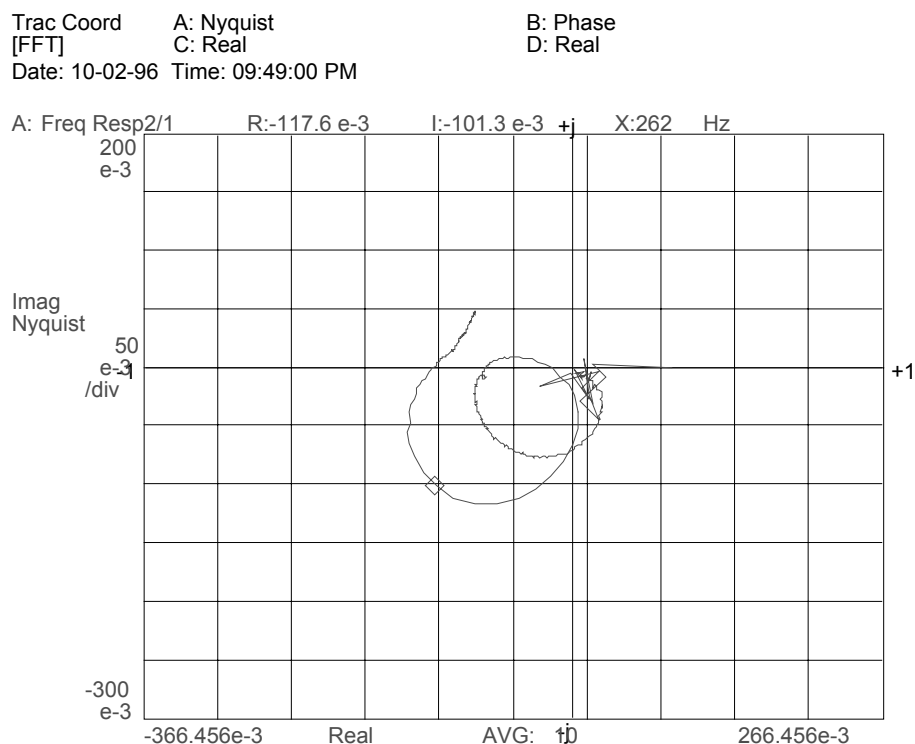
Viewing Results Using Real and Imaginary Traces

View frequency response measurements using real and imaginary coordinates as follows:

- Press the **[Disp Format]** hardkey.
- Press the `[UPPER/LOWER]` softkey *(F3)*.
- Press the **[Active Trace]** hardkey.
- Press the `[ AB ]` softkey *(F5)*.
- Press the **[Meas Data]** hardkey.
- Press the `[FREQ RESP 2 / 1]` softkey *(F6)*.
- Press the **[Scale]** hardkey.

- Toggle the [AUTOSCALE ON OFF] softkey *(F1)* until **ON** is highlighted.
- Press the **[Active Trace]** hardkey.
- Press the [A] softkey *(F2)*.
- Press the **[Trace Coord]** hardkey.
- Press the [MORE CHOICES] softkey *(F6)*.
- Press the [REAL PART] softkey *(F2)*.
- Press the **[Active Trace]** hardkey.
- Press the [B] softkey *(F2)*.
- Press the [IMAGINARY PART] softkey *(F3)*.

Assessing Measurement Quality

Measurement quality is described by coherence, which varies from 0 to 1. To set up a coherence display, follow these steps:

- Press the **[Meas Data]** hardkey.
- Press the [COHERENCE 2 / 1] softkey *(F7)*.

A coherence value of 1 means the response measured by Channel 2 was due to the excitation of Channel 1. A coherence of 0 means that none of the response of Channel 2 was due to the input measured by Channel 1.

Burst random excitation usually exhibits excellent coherence unless non-linearities are excited.

Section 19 : Two Spectral Traces Showing Mils and Ips while EU is G

Measure an accelerometer signal and display velocity and displacement spectra with the UPPER/LOWER display format in the AGILENT 35670A as follows:

Preset the AGILENT 35670A
- Turn on the AGILENT 35670A, or
- Press the green **[Preset]** hardkey
- Press the yellow **[Pause/Cont]** hardkey if desired.
- Press [CHANNELS **1** 2 4] softkey *(F7)* until **1** is highlighted.

Set up transducer parameters for a 10 mV/g accelerometer:
- Press the **[Input]** hardkey
- Press [FRONT END CH1 SETUP] softkey *(F7)*.
- Press [ICP SUPLY **ON** OFF] softkey *(F8)* until **ON** is highlighted.
- Press **[Input]** hardkey.
- Press [XDCR UNIT CH**1** SETUP] softkey *(F8)*
- Press the [XDCR SENSITVTY] softkey *(F6)*.
- Enter 10 (for an accelerometer with 10 mV/g sensitivity), then press the [mV/EU] softkey *(F2)*.
- Toggle the [XDCR UNIT **ON** OFF] softkey *(F4)* until **ON** is highlighted.
- Press the [XDCR UNIT LABEL] softkey *(F7)*.
- Select the [g] softkey *(F2)*.

Set up display format and Trace A to measure displacement in mil (0-pk):
- Press the **[Disp Format]** hardkey.
- Press the [UPPER/LOWER] softkey *(F3)*
- Press the **[Active Trace]** hardkey.
- Press the [A] softkey *(F5)*.
- Press the **[Trace Coord]** hardkey.
- Press the [Y UNITS] softkey *(F8)*
- Toggle the [AMPLITUDE **PK** PP RMS] softkey *(F4)* until **PK** is highlighted.
- Press the [XDCR UNIT CONVERT] softkey *(F4)*
- Press the [mil (DISP)] softkey *(F8)*
- Press the **[Scale]** hardkey.
- Toggle the [AUTOSCALE **ON** OFF] softkey *(F1)* until **ON** is highlighted.
- Press the yellow **[Start]** hardkey.

Set up Trace B to measure velocity in inch/s (0-pk):
- Press the **[Active Trace]** hardkey.
- Press the [B] softkey *(F2)*.

- Press the **[Trace Coord]** hardkey.
- Press the [Y UNITS] softkey *(F8)*
- Toggle the [AMPLITUDE **PK** PP RMS] softkey *(F4)* until **PK** is highlighted.
- Press the [XDCR UNIT CONVERT] softkey *(F4)*
- Press the [inch/s (VEL)] softkey *(F6)*
- Press the **[Scale]** hardkey.
- Toggle the [AUTOSCALE **ON** OFF] softkey *(F1)* until **ON** is highlighted.

Section 20 : Peak Hold During a Machine Run-up and Coast-Down

Peak amplitudes experienced during run-ups and coast-downs can be measured directly with the AGILENT 35670A using peak hold. Although the resulting spectra will indicate the maximum amplitude measured in each frequency bin during the course of the run-up and run-down, it is not possible to determine from this information whether the peak was due to the fundamental frequency or a harmonic.

To measure peak amplitudes, peak hold averaging is selected with enough averages specified so that peaks can be accumulated during the entire run-up and run-down, after which the measurement is paused and the results examined.

To set up a single-channel peak hold average for a run-up duration of 1 minute, proceed as follows:
- Select a frequency span and resolution, for example 800 Hz and 400 lines.
- Determine the time record length for this combination, T=N/F=400/800=0.5 s
- Determine how many averages are required to last for the measurement duration. Navg=Duration/T=60/.5=120 averages
- Specify number of averages to be greater than this number.

Preset the AGILENT 35670A
- Turn on the AGILENT 35670A, or
- Press the green **[Preset]** hardkey
- Press the yellow **[Pause/Cont]** hardkey if desired.
- Press [CHANNELS 1 2 4] softkey *(F7)* until **1** is highlighted.

Specify measurement parameters
- Press the **[Freq]** hardkey
- Enter 800 and then press the [Hz] softkey *(F2)*
- Press the **[Avg]** hardkey.
- Press the [NUMBER AVERAGES] softkey *(F2)*, enter 200, then press the [ENTER] softkey *(F1)*.
- Turn on averaging by pressing the [AVERAGE ON OFF] softkey *(F1)* until ON is highlighted.
- Press the [AVERAGE TYPE] softkey *(F3)*.
- Press the [PEAK HOLD] softkey *(F5)*.

Set up display format to measure peak amplitude
- Press the **[Disp Format]** hardkey.
- Press the [SINGLE] softkey *(F1)*

- Press the **[Active Trace]** hardkey.
- Press the `[ A ]` softkey *(F5).*
- Press the **[Scale]** hardkey.
- Toggle the `[AUTOSCALE ON OFF]` softkey *(F1)* until **ON** is highlighted.
- Press the yellow **[Start]** hardkey.

When the run-up and run-down is completed,
- Press the yellow **[Pause/Cont]** hardkey and examine results.

Avg   Type: Peak Hold   Number: 100
[FFT]   Update Rt: 5   Overlap: 0 %
Date: 10-02-96 Time: 09:55:00 PM

B: CH1 Pwr Spec   X:0   Hz   Y:994.858 uVrms
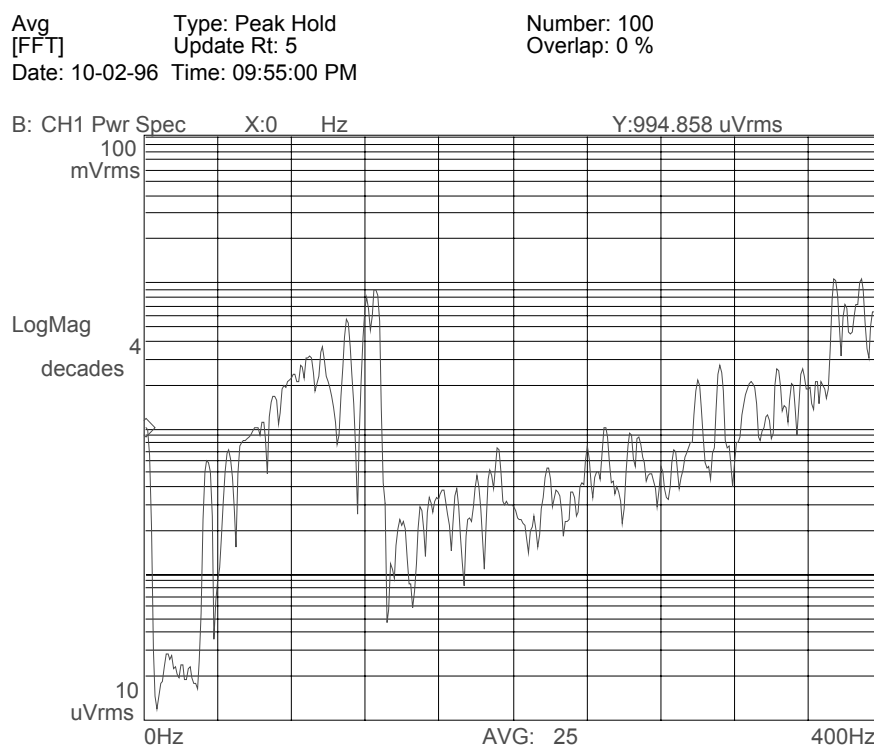
Section 21 : Using an External Trigger for Time Averaging

Use external triggering for synchronous averaging of linear spectra. With a reliable, consistent trigger, the resulting noise floor tends to be eliminated and the signal-to-noise ratio of the measurement can be optimal.

If the trigger is TTL, with little noise and jitter, then trigger setup is accomplished as follows:

- Press the **[Trigger]** hardkey.
- Select the [EXTERNAL TRIGGER] softkey *(F2)*.
- Press the [TRIGGER SETUP] softkey *(F6)*
- Toggle the [EXT LEVEL USER **TTL**] softkey *(F1)* until **TTL** is highlighted.

Other trigger parameters such as USER EXT LEVEL and EXT RANGE do not need to be specified when using a TTL trigger.

Specify User Levels for Triggering

When the external trigger is not a TTL signal, the trigger level, slope, and range can be specified to accommodate a broad range of external triggers. Successful triggering is easiest to obtain when the external trigger signal is well characterized. Trigger range, level, and slope must be determined.

Characterizing the External Trigger

External trigger pulses can be noisy and of an unknown shape and amplitude. Reliable use of an external trigger requires knowledge of trigger characteristics so that the AGILENT 35670A can be set up properly. This section provides guidance in capturing and analyzing trigger signals so that reliable external triggering is attained.

Connect the signal and preset the AGILENT 35670A

- Connect the external trigger signal to Channel 1.
- Turn on the AGILENT 35670A, or
- Press the green **[Preset]** hardkey
- Press the yellow **[Pause/Cont]** hardkey if desired.

Select the Histogram/Time measurement mode. This mode turns off the anti-alias filter so that the actual analog signal can be examined.

- Press the [HISTOGRAM / TIME] softkey *(F6)*.
- Press the **[Meas Data]** hardkey.
- Press the [UNFILTERD TIME CH 1] softkey *(F6)*.
- Press the **[Scale]** hardkey.
- Toggle the [AUTOSCALE **ON** OFF] softkey *(F1)* until **ON** is highlighted.

Acquire and Display the Trigger Signal
- Press the yellow **[Start]** hardkey.
- Press the **[Freq]** hardkey.
- Press the [UP ARROW] hardkey until only a few trigger pulses are visible.
- Press the yellow **[Pause/Cont]** hardkey to stop the measurement and characterize the trigger signal with the marker.

Characterize the Trigger Signal
- Use the market knob to determine the highest and lowest level of the trigger pulse.
- Note if the trigger level exceeds 2V. If it does not, then the external trigger range can be set to 2 V and the trigger level can be set with good resolution. If the trigger level exceeds 2 V, then set the trigger range to 10 V.
- Find a good trigger point on the trigger signal. Look for fast transitions or steep slopes, and locate the trigger point in the middle of or just before these areas. Note the trigger level in volts and the slope, either positive or negative, at the best transition point.
- Trigger range, level, and slope have now been determined.

Setting Up External Trigger

Set up a non-TTL trigger as follows:
- Press the **[Trigger]** hardkey.
- Select the [EXTERNAL TRIGGER] softkey *(F2)*.
- Press the [TRIGGER SETUP] softkey *(F6)*
- Toggle the [EXT LEVEL **USER** TTL] softkey *(F2)* until **USER** is highlighted.
- Press the [USER EXT LEVEL] softkey *(F3)*.
- Enter the trigger level in volts as determined above, and then press the [V] softkey *(F1)*.
- Toggle the [EXT RANGE +/- 10 **2**] softkey *(F4)* until **2** is highlighted, unless the trigger exceeded 2 V, then toggle the softkey to 10 V.
- Toggle the [SLOPE **POS** NEG] softkey *(F5)* until the slope at the selected trigger point is highlighted.

If the trigger appears noisy or erratic, try activating the 100 kHz external trigger noise filter as follows:
- Toggle the [EXT FILTER **ON** OFF] softkey *(F6)* until **ON** is highlighted.

Measuring Time Averaged Spectrums with External Triggering

Now that the external trigger has been set up, the analyzer is ready to measure a signal with time averaging as follows:

- Connect the external trigger signal to the EXT TRIG port on the back of the AGILENT 35670A.
- Turn on the AGILENT 35670A, or
- Press the green **[Preset]** hardkey
- Press the yellow **[Pause/Cont]** hardkey if desired.

Set up measurement parameters

- Press the **[Freq]** hardkey
- Enter 800 and then press the [Hz] softkey *(F2)*
- Press the **[Avg]** hardkey.
- Press the [AVERAGE TYPE] softkey *(F3).*
- Press the [TIME] softkey *(F3).*
- Turn on averaging by pressing the [AVERAGE ON OFF] softkey *(F1)* until ON is highlighted.
- Press the yellow **[Start]** hardkey.

Section 22 : Saving Trace Data to a 3.5" Disk or Non-Volatile RAM

Save trace data into non-volatile RAM or 3.5" disk using the AGILENT 35670A Save/Recall capabilities. All AGILENT 35670A data is stored as a Standard Data Format (SDF) file. This data format is compatible across Agilent Technologies's line of Dynamic Signal Analyzers. Utilities are available to view and plot SDF files from a PC and to access the data programmatically.

Saving Trace to 3.5" Disk

To store Trace A data as a file named "T1.DAT" on a 3.5" disk, insert a IBM-PC formatted disk into the AGILENT 35670A and follow these steps:
- Press the **[Active Trace]** hardkey.
- Press the [A] softkey *(F5)*.
- Press the **[Save/Recall]** hardkey.
- Press the [SAVE DATA] softkey *(F1)*.
- Press the [SAVE TRACE] softkey *(F1)*.
- Press the [INTO FILE] softkey *(F9)*.
- Press the [CLEAR ENTRY] softkey *(F9)*.
- Enter T1.DAT and then press the [ENTER] softkey *(F1)*

Note that the AGILENT 35670A automatically increments a numeric ending to a file name. To store Trace B data to a file named "T2.DAT":
- Press the **[Active Trace]** hardkey.
- Press the [B] softkey *(F5)*.
- Press the **[Save/Recall]** hardkey.
- Press the [SAVE DATA] softkey *(F1)*.
- Press the [SAVE TRACE] softkey *(F1)*.
- Press the [INTO FILE] softkey *(F9)*.
- *T2.DAT will be the default name*
- Press the [ENTER] softkey *(F1)*

Confirming Contents of 3.5" Disk File

To confirm that data was stored on disk successfully, view the contents of the disk with the catalog command:
- Press the **[Save/Recall]** hardkey.
- Toggle the [CATALOG **ON** OFF] softkey *(F8)* until **ON** is highlighted.

The entire contents and file details of the disk are displayed. To return to the trace view:
- Toggle the [CATALOG ON **OFF**] softkey *(F9)* until **OFF** is highlighted.

Saving Trace to Non-Volatile RAM (NV-RAM)

To store Trace A data as a file named "N1.DAT" into NV-RAM, follow these steps:

- Press the **[Active Trace]** hardkey.
- Press the `[ A ]` softkey *(F5).*
- Press the **[Save/Recall]** hardkey.
- Press the `[DEFAULT DISK]` softkey *(F9).*
- Press the `[NON-VOL RAM DISK]` softkey *(F9).*
- Press the **[Save/Recall]** hardkey.
- Press the `[SAVE DATA]` softkey *(F1).*
- Press the `[SAVE TRACE]` softkey *(F1).*
- Press the `[INTO FILE]` softkey *(F9).*
- Press the `[CLEAR ENTRY]` softkey *(F9).*
- Enter N1.DAT and then press the [ENTER] softkey *(F1)*

Confirming Contents of NV-RAM

To examine the contents of NV-RAM, turn on the catalog as follows:

- Press the **[Save/Recall]** hardkey.
- Toggle the `[CATALOG `**`ON`**` OFF]` softkey *(F8)* until **ON** is highlighted.

To return to the Trace view:

- Toggle the `[CATALOG ON `**`OFF`**`]` softkey *(F8)* until **OFF** is highlighted.

Section 23 : Recalling Trace Data From 3.5" Disk or Non-Volatile Memory

Recall trace data from a file in non-volatile RAM or 3.5" disk using the AGILENT 35670A Save/Recall capabilities. Recalled data is placed in a data register where it can be viewed, plotted, printed, analyzed, or used to compare.

Recall Trace From 3.5" Disk

To recall data from a file named "T1.DAT" on a 3.5" disk into data register D1, follow these steps:

- Insert the 3.5" disk containing the data file into the AGILENT 35670A.
- Press the **[Save/Recall]** hardkey.
- Press the [DEFAULT DISK] softkey *(F9)*.
- Press the [INTERNAL DISK] softkey *(F3)*.

View the contents of the 3.5" disk by turning on the catalog

- Toggle the [CATALOG **ON** OFF] softkey *(F9)* until **ON** is highlighted.

Return to the Trace view

- Toggle the [CATALOG ON **OFF**] softkey *(F9)* until **OFF** is highlighted.

Set up display format to view data register D1

- Press the **[Disp Format]** hardkey.
- Press the [SINGLE] softkey *(F1)*.
- Press the **[Active Trace]** hardkey.
- Press the [A] softkey *(F1)*.
- Press the **[Scale]** hardkey.
- Toggle the [AUTOSCALE **ON** OFF] softkey *(F1)* until **ON** is highlighted.*.*
- Press the **[Meas Data]** hardkey.
- Press the [MORE CHOICES] softkey *(F9)*.
- Press the [DATA REGISTER] softkey *(F8)*.
- Press the [D1] softkey *(F1)*.

Recall the Data into data register D1

- Press the **[Save/Recall]** hardkey.
- Press the [RECALL DATA] softkey *(F4)*.
- Press the [RCL TRACE AND SCALE] softkey *(F1)*.
- Press the [FROM FILE INTO D1] softkey *(F1)*.
- Press the [CLEAR ENTRY] softkey *(F9)*.
- Enter T1.DAT and then press the [ENTER] softkey *(F1)*

Recall Trace Data from Non-Volatile RAM (NV-RAM)

To recall data from a file stored in NV-RAM named "N1.DAT" into data register D2, follow these steps:

- Press the **[Meas Data]** hardkey.
- Press the [MORE CHOICES] softkey *(F9)*.

- Press the [DATA REGISTER] softkey *(F8)*.
- Press the [D2] softkey *(F2)*.
- Press the **[Save/Recall]** hardkey.
- Press the [DEFAULT DISK] softkey *(F9)*.
- Press the [NON-VOL RAM DISK] softkey *(F9)*.
- Press the **[Save/Recall]** hardkey.
- Press the [RECALL DATA] softkey *(F4)*.
- Press the [RCL TRACE AND SCALE] softkey *(F1)*.
- Press the [FROM FILE INTO D2] softkey *(F2)*.
- Press the [CLEAR ENTRY] softkey *(F9)*.
- Enter N1.DAT and then press the [ENTER] softkey *(F1)*

Section 24 : Plotting and Printing Trace Data

Use the plotting and printing capability of the AGILENT 35670A to generate hardcopy documentation of measurement results. Any trace can be documented, however to plot or print data stored on disk or in NV-RAM, the data must first be recalled into a Trace. To recall trace data from a file, see the section "Recalling Trace Data From 3.5" Disk or Non-Volatile Memory."

Generating Output with the AGILENT 35670A

All traces displayed on the screen are output to the printer, plotter, or file. Therefore if it is desired to plot one trace at a time, then the SINGLE display format should be used. Complete control over the plotting and printing parameters is available from the front panel of the AGILENT 35670A. For plotting, choose pen color for grids, annotation, each trace, and each marker. Traces can each have their own line type. Describe the test with two lines of plot titles that will appear at the top of the plot. A date stamp can be selected to show when the data was acquired.

Enter Trace A Title (if desired). Repeat for traces B, C, and D if displayed.
- Press the **[Active Trace]** hardkey.
- Press the [A] softkey *(F1).*
- Press the **[Disp Format]** hardkey.
- Press the [MORE] softkey *(F9).*
- Press the [TRACE TITLE] softkey *(F7).*
- Press the [CLEAR ENTRY] softkey *(F9).*
- Enter a description of the Trace, for example the accelerometer location, such as "MACH 1 - Y" and then press the [ENTER] softkey *(F1).* Note that trace titles can be up to 13 characters long.

Enter a plot title (if desired)
- Press the **[Plot/Print]** hardkey.
- Press the [MORE SETUP] softkey *(F9).*
- Press the [TITLE LINE 1] softkey *(F7).*
- Enter first line of test description, maximum 44 characters, then press the [ENTER] softkey *(F1)*
- Press the [TITLE LINE 2] softkey *(F8).*
- Enter second line of test description, maximum 44 characters, then press the [ENTER] softkey *(F1)*

Plotting the Display

To plot the current display, connect an GPIB plotter, with the plotter address set to 5, to the AGILENT 35670A. Then follow these steps:
- Press the **[Local/GPIB]** hardkey.

- Select the `[SYSTEM CONTROLLR]` softkey *(F2)*.

Check the Plot/Print Destination
- Press the **[Plot/Print]** hardkey.
- Press the `[PLOT/PRNT DESTINATN]` softkey *(F4)*.
- Select the `[OUTPUT TO GPIB]` softkey *(F1)*.

Plot the Trace
- Place a sheet of paper in the plotter and locate P1 and P2, if not done automatically.
- Press the **[Plot/Print]** hardkey.
- Press the `[START PLOT]` softkey *(F1)*.

Printing the Display

Results may be sent to a printer using the serial or parallel ports. The parallel port requires no setup. The serial port must be configured to match the parameters of the printer.

Print over Serial Interface to Raster Device
- Press the **[Plot/Print]** hardkey.
- Press the `[PLOT/PRNT DEVICE]` softkey *(F3)*.
- Select the `[RASTER PRINTER]` softkey *(F2)*.
- Press the **[Plot/Print]** hardkey.
- Press the `[PLOT/PRNT DESTINATN]` softkey *(F4)*.
- Select the `[OUTPUT TO SERIAL]` softkey *(F2)*.
- Press the **[Plot/Print]** hardkey.
- Press the `[MORE SETUP]` softkey *(F9)*.
- Press the `[SERIAL SETUP]` softkey *(F9)*.
- Choose serial setup parameters that match the printer. With luck the default choices will already match the printer.

Print over Parallel Interface to Raster Device
- Press the **[Plot/Print]** hardkey.
- Press the `[PLOT/PRNT DEVICE]` softkey *(F3)*.
- Select the `[RASTER PRINTER]` softkey *(F2)*.
- Press the **[Plot/Print]** hardkey.
- Press the `[PLOT/PRNT DESTINATN]` softkey *(F4)*.
- Select the `[OUTPUT TO PARALLEL]` softkey *(F4)*.

Print the Trace
- Press the **[Plot/Print]** hardkey.
- Press the `[START PLOT]` softkey *(F1)*.

Section 25 : Importing Plots into Microsoft Word

The plotter output of the AGILENT 35670A conforms to the HP-GL/2 Graphics Language. When the PLOT/PRINT output device is specified as a 3.5" disk file, not a printer or plotter, then the resulting graphics files can be imported directly into Microsoft Word using the Insert Picture command.

Determining if MS Word Has HP-GL Graphics Import Filter

Before importing a plot file, Word must have the HP-GL graphics import filter installed. To determine if it is, follow these steps:

- On a PC, start Microsoft Word or open a new document.
- Select Insert Picture
- In the "Insert Picture" dialog box, at the bottom, click on the arrow next to *"Files of Type".*
- Scroll up and down the list, looking for "HP Graphics Language."

If "HP Graphics Language" is present, then the HP-GL filter is installed. If it is not listed, then you must use the Word Setup program to install the HP-GL graphics import filter.

Installing the MS Word HP-GL Graphics Import Filter

Run Word Setup, by running "a:setup" from 3.5" disks, Word or Office CD-ROM, and proceed as follows:

- After setup has initialized, select "Add/Remove" (components).
- In the Maintenance Dialog Box, click on the "Converters, Filters and Data Access" option.
- Click on the "Change Option" button.
- Click on "Graphics Filters"
- Click on the "Change Option" button.
- Scroll down to the HP Graphics Language entry. The check box next to it should be empty.
- Click on the HP Graphics Language check box.
- Click on the "OK" button.
- Click on the "OK" button.
- Click on the "Continue" button.
- Click on the "OK" button.

The HP Graphics Language import filter has now been installed and activated. To make sure the filter has been installed,

- Return to Word.
- Select Insert Picture
- In the "Insert Picture" dialog box, at the bottom, click on the arrow next to *"Files of Type".*
- Scroll up and down the list, looking for "HP Graphics Language."

It should now be an import option.

Plot to a File Using the AGILENT 35670A

The AGILENT 35670A has the ability to route plotter output to a file. If the file is named with a ".HGL" file extension, then Word will recognize this file immediately as an HP Graphics Language file.

Set up plotter output to a file
- Press the **[Plot/Print]** hardkey.
- Press the `[PLOT/PRNT DESTINATN]` softkey *(F4)*.
- Select the `[OUTPUT TO FILE]` softkey *(F4)*.
- Press the `[OUTPUT FILENAME]` softkey *(F5)*.
- Press the `[CLEAR ENTRY]` softkey *(F9)*.
- Enter P1.HGL and then press the [ENTER] softkey *(F1)*

Insert a 3.5" Disk into the AGILENT 35670A and ensure DEFAULT DISK is INTERNAL DISK:
- Press the **[Save/Recall]** hardkey.
- Press the `[DEFAULT DISK]` softkey *(F9)*.
- Press the `[INTERNAL DISK]` softkey *(F3)*.

Plot to file "P1.HGL"
- Prepare Trace Titles and Plot Titles as described in the section "Plotting and Printing Trace Data."
- Press the **[Plot/Print]** hardkey.
- Press the `[START PLOT]` softkey *(F1)*.

Inserting Picture of an HP-GL Plot File Into a MS Word document.

To import the plot file into the Word document, follow these steps:
- Insert the 3.5" disk with the plot file "P1.HGL" into a PC.
- Open a Word document
- Select Insert Picture
- Click on the "Look in" arrow to change directories
- Select A: (3½ Disk)
- Double-Click on file "P1.HGL"
- Word will automatically detect that it is an HP-GL file, because of the .HGL file extension, and import the graphic directly.

Section 26 : Running a Single Calibration Test on Command

The AGILENT 35670A automatically runs periodic self-calibration tests which ensure that all measurements will meet published performance specifications. If a calibration is desired at a specific time, then a single caibration may be performed as follows:

- Press the **[System Utility]** hardkey.
- Press the `[CALIBRATION]` softkey *(F2)*.
- Press the `[SINGLE CAL]` softkey *(F3)*.

The calibration will start immediately and be completed in less than 15 seconds.

Section 27 : Returning the AGILENT 35670A to a Preset Condition

The AGILENT 35670A can generally return from an unknown state to a preset condition by using the following command:

- Press the green **[Preset]** hardkey
- Press `[DO PRESET]` softkey *(F1)*.

This does not turn off the analyzer, but it does stop data acquisition and reset most measurement parameters. If the AGILENT 35670A is locked up due to a software bug and no response can be generated by the Preset key, then a hard shutdown may be required.

Section 28 : Precautions to Prevent Loss of Data

The most important aspect of preventing data loss with the AGILENT 35670A is to avoid interrupting data acquisition. This can happen as easily as by tripping on the power cord, but can also occur by accidentally re-starting a long measurement, prematurely triggering an event, overloading the front ends, or unplugging connectors.

Two situations call for careful planning and precautions: the first is when frequencies are low and data acquisition times are very long, such as very low frequency seismic testing. An interruption may waste hours of data acquisition. The second situation worthy of precaution is when the test involves a one time event, like the initial run-up of large machine during a plant re-start, or like a crash test, where the test article is destroyed. In either case the data is valuable and care should be taken to save it to disk before the data is lost by another measurement.

Manual arming along with a Channel 1 trigger and pre-trigger delay is the preferred technique of acquiring transient crash tests. The pre-trigger delay ensures that the entire transient event is captured even if the trigger is a little late. Manual arming prevents re-triggering and loss of data if the transducer encounters a post-test bounce or hit. Of course manual arming REQUIRES that the measurement be manually armed before the test, otherwise the measurement will not be armed and data will be missed.

Section 29 : Transducer Unit Conversion with the AGILENT 35670A

Automatic conversion between acceleration, velocity, or displacement units is available with the Trace Coord capability in the AGILENT 35670A. Transducer sensitivity and transducer unit label is first specified for the input channel, then the desired unit is specified using XDCR UNIT CONVERSION.

Measuring Acceleration, Displaying Displacement

To set up and display a measurement of acceleration, proceed as follows:
- Press the green **[Preset]** hardkey
- Press [DO PRESET] softkey *(F1)*.
- Press the **[Input]** hardkey
- Press the [FRONT END CH1 SETUP] softkey *(F7)*.
- Press [ICP SUPLY **ON** OFF] softkey *(F8)* until **ON** is highlighted.
- Press the **[Input]** hardkey
- Press [XDCR UNIT CH**1** SETUP] softkey *(F8)*
- Press the [XDCR SENSITVTY] softkey *(F6)*.
- Enter 10.8, then press the [mV/EU] softkey *(F2)*.
- Toggle the [XDCR UNIT **ON** OFF] softkey *(F4)* until **ON** is highlighted.
- Press the [XDCR UNIT LABEL] softkey *(F7)*.
- Select the [g] softkey *(F2)*.

Specify an averaged measurement
- Press the **[Freq]** hardkey
- Enter 800 and then press the [Hz] softkey *(F2)*
- Press the **[Avg]** hardkey.
- Turn on averaging by pressing the [AVERAGE **ON** OFF] softkey *(F1)* until **ON** is highlighted.
- Press the yellow **[Start]** hardkey.

After the measurement is complete, set up the display to show acceleration and peak-to-peak displacement simultaneously. RMS acceleration is already displayed on Trace A. Set up Trace B to show peak-to-peak displacement as follows:
- Press the **[Active Trace]** hardkey again.
- Press the [B] softkey *(F2)*.
- Press the **[Meas Data]** hardkey.
- Press the [CHANNEL **1** 2 3 4] softkey *(F1)* until **1** is highlighted.
- Press the [PWR SPEC CHANNEL 1] softkey *(F3)*
- Press the **[Trace Coord]** hardkey.
- Press the [Y UNITS] softkey *(F8)*
- Toggle the [AMPLITUDE PK **PP** RMS] softkey *(F4)* until **PP** is highlighted.

- Press the [XDCR UNIT CONVERT] softkey *(F4)*
- Press the [inch (DISP)] softkey *(F7)*
- Press the **[Scale]** hardkey.
- Toggle the [AUTOSCALE ON OFF] softkey *(F1)* until **ON** is highlighted.

This accomplishes the equivalent of multiplying "g" by 386.4 to get "inches per second squared" (ips^2), and dividing by (jω)^2 to integrate twice in the frequency domain to get displacement.

Math Functions and XDCR UNIT CONVERT

When you have specified a "provided" transducer label using XDCR UNIT SETUP that is a "motion" engineering unit such as:

g
inch/s^2
inch/s
inch
mil
m/s^2
m/s
m

then do not try to convert acceleration to displacement using Analysis: Math Function and divide by (jω). Instead use the above example to convert directly using XDCR UNIT CONVERT in Trace Coord, Y UNITS. If this is attempted with Math Functions, the analyzer will sense that a power spectrum of a known unit "label" is being integrated or differentiated and will do it using trace coordinates anyway. It is easier to use the provided capability in XDCR UNIT CONVERT.

Converting Frequency Response Units to Compliance

Unlike power spectrum measurements, frequency response measurements cannot be automatically converted into other units. Howvere, it is often desired to express a frequency response result as the ratio of displacement to force, which are units of compliance, instead of acceleration to force, which are units of 1/mass. To convert a frequency response measured as "g/lb." into terms of "inch/lb.", then proceed as follows:

Converting "g" to "inch/s^2" requires multiplication by 386.4. This must be entered as a constant. Converting "inch/s^2" to "inch" requires double integration in the frequency domain by dividing by (jω) two times. These steps may be entered as follows

- Press the **[Analys]** hardkey.

- Press the `[DEFINE CONSTANT]` softkey *(F2).*
- Press the `[DEFINE K1]` softkey *(F1).*
- Enter 386.4 and press the `[ENTER]` softkey *(F1).*
- Press the **[Analys]** hardkey.
- Press the `[DEFINE FUNCTION]` softkey *(F1).*
- Press the `[DEFINE F1]` softkey *(F1).*
- Press the `[CONSTANT (K1-K5)]` softkey *(F3).*
- Press the `[CONSTANT K1]` softkey *(F1).*
- Press the `[ * ]` softkey *(F3).*
- Press the `[OPERATION]` softkey *(F5).*
- Press the `[MORE]` softkey *(F9).*
- Press the `[ /jOMEGA( ]` softkey *(F4).*
- Press the `[OPERATION]` softkey *(F5).*
- Press the `[MORE]` softkey *(F9).*
- Press the `[ /jOMEGA( ]` softkey *(F4).*
- Press the `[MEAS DATA]` softkey *(F1).*
- Press the `[FREQ RESP 2 / 1]` softkey *(F5).*
- Press the `[ ) ]` softkey *(F5).*
- Press the `[ ) ]` softkey *(F5).*
- Press the `[ENTER]` softkey *(F7).*

Now display the function F1 on Trace B
- Press the **[Active Trace]** hardkey.
- Press the `[B]` softkey *(F2).*
- Press the **[Meas Data]** hardkey.
- Press the `[MORE CHOICES]` softkey *(F9)*.
- Press the `[MATH FUNCTION]` softkey *(F7)*.
- Press the `[PWR SPEC CHANNEL 1]` softkey *(F3)*
- Press the `[F1]` softkey *(F1).*

Trace B will now convert "g/lb." into "inch/lb." This same technique could also be used to convert "g" into velocity terms, or to convert between metric and English units.

Section 30 : Using the Agilent Technologies Demostration Unit with the AGILENT 35670A

Several of the sections in this User's Guide are best explained with live data using transducers and machines. Because it is usually impractical to bring machinery into a laboratory for training purposes, the Agilent Technologies Demonstration Unit with the Dynamic Signals Test Disc #1 (The Red CD) provides a practical alternative.

This section describes the AGILENT Demonstration Unit and how to use it. The most important strating point is to MAKE SURE THE DEMONSTRATION UNIT IS GROUNDED TO THE AGILENT 35670A! This can be done via software by grounding Channel 1 via the Input, FRONT END CH1 SETUP. Alternatively a BNC can be connected from the AGILENT 35670A Source output to the Demo Unit's notch filter.
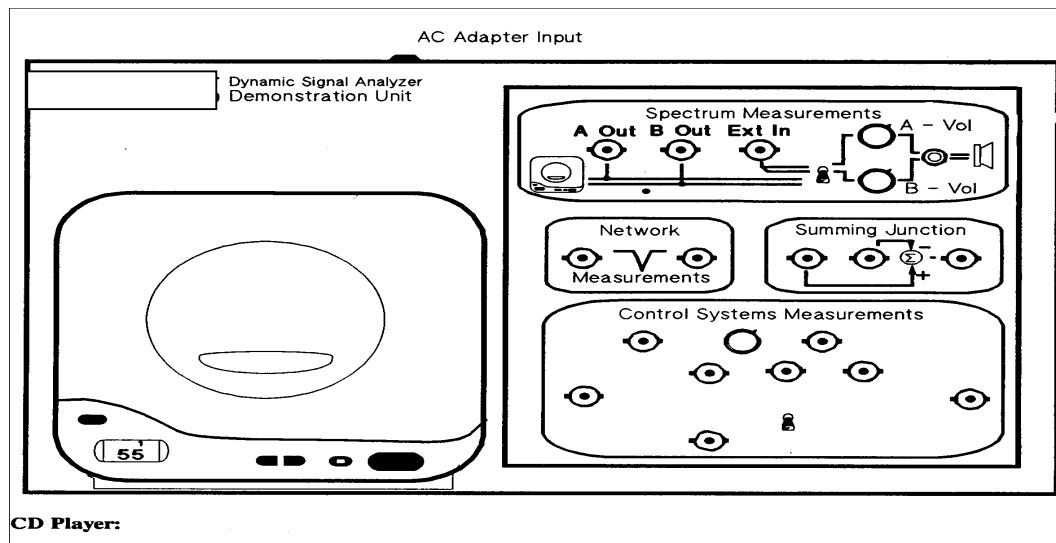

To set up the Demonstration Unit, follow these instructions:
1. Plug in the Discman power supply and insert the power connector in the receptacle on the back of the Demonstration Unit.
2. Insert the Dynamic Signals I CD in the Sony Discman, close the cover and press the play/pause button.
3. Refer to the summary below to determine, for each section of the User's Guide, the recommended track, port to connect the left CD output channel, and port to connect the right CD output channels.
4. Select track repeat mode (Play Mode 1) by pressing the PLAY MODE button on the front of the Discman twice until "1" appears in the Discman's LCD display

above the track number.

This diagram is provided as a quick reference of the key controls used in the
Dynamic Signals Demonstration unit.
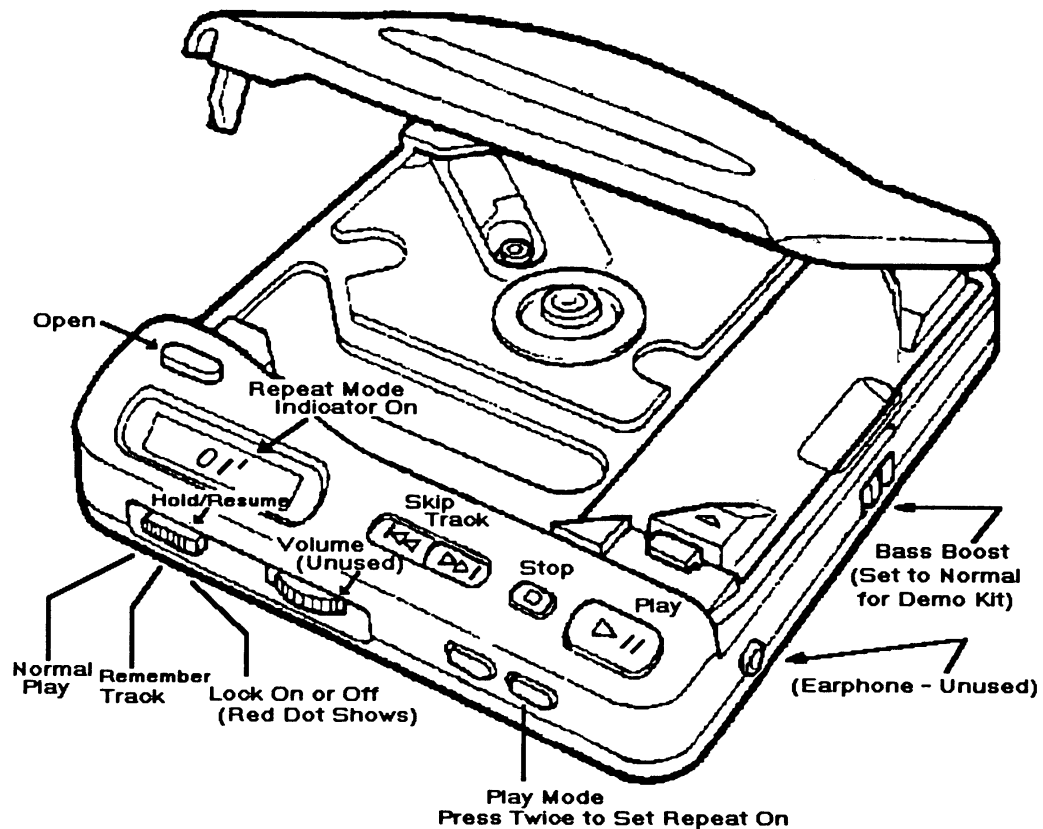
The following descriptions link the Section in this User's Guide to the appropriate
CD track. Also described herein is the recommended CD output channel connection
to the AGILENT 35670A. Finally any setup clues will be described to help utilize
the signals on the CD.

Section 4:   **Measuring a Single Channel Spectrum**
CD Track: 24
CD Track Desc.:   160 kHz Calibration Tone
Left Ch. (A Out):   N/A
Right Ch. (B Out):   Channel 1 of the AGILENT 35670A

Section 5:   **Improving Measurement Results**
CD Track: 24
CD Track Desc: 160 kHz Calibration Tone
Left Ch. (A Out):   N/A
Right Ch. (B Out):   Channel 1 of the AGILENT 35670A

Section 6:   **Measuring a Single Channel Time Waveform**
CD Track: 24
CD Track Desc.:   160 kHz Calibration Tone
Left Ch. (A Out):   N/A
Right Ch. (B Out):   Channel 1 of the AGILENT 35670A

Section 7:   **Measuring Dual Channel Spectra**
CD Track: 41
CD Track Desc.:   Current Probe, Tachometer
Left Ch. (A Out):   Channel 1 of the AGILENT 35670A
Right Ch. (B Out):   Channel 2 of the AGILENT 35670A

Section 8:   **Improving Dual Channel Measurement Results**
CD Track: 41
CD Track Desc.:   Current Probe, Tachometer
Left Ch. (A Out):   Channel 1 of the AGILENT 35670A
Right Ch. (B Out):   Channel 2 of the AGILENT 35670A

Section 9:   **Measuring Dual Channel Time Waveforms**
CD Track: 41
CD Track Desc.:   Current Probe, Tachometer
Left Ch. (A Out):   Channel 1 of the AGILENT 35670A
Right Ch. (B Out):   Channel 2 of the AGILENT 35670A

Section 10:	Measuring Dual Channel Spectra and Time Waveforms
CD Track:	41
CD Track Desc.:	Current Probe, Tachometer
Left Ch. (A Out):	Channel 1 of the AGILENT 35670A
Right Ch. (B Out):	Channel 2 of the AGILENT 35670A

Section 11:	Modal Testing Using a Hammer and Accelerometer
CD Track:	44
CD Track Desc.:	Hammer Measurements on a Brake Rotor
Left Ch. (A Out):	Channel 1 of the AGILENT 35670A
Right Ch. (B Out):	Channel 2 of the AGILENT 35670A

Section 13:	Order Domain Results in List Mode
CD Track:	28
CD Track Desc.:	Car Engine Run-up and Tachometer Signal
Left Ch. (A Out):	Channel 1 of the AGILENT 35670A
Right Ch. (B Out):	TACH input on the back of the AGILENT 35670A
Setup Hints:	Pulses per rev: 2
	Tach. Trigger level: 0.15 V

Section 16:	Waterfall Spectra at RPM Intervals
CD Track:	28
CD Track Desc.:	Car Engine Run-up and Tachometer Signal
Left Ch. (A Out):	Channel 1 of the AGILENT 35670A
Right Ch. (B Out):	TACH input on the back of the AGILENT 35670A
Setup Hints:	Pulses per rev: 2
	Tach. Trigger level: 0.15 V

Section 18:	Measuring Frequency Response with the AGILENT 35670A
CD Track:	58
CD Track Desc.:	Burst Random Frequency Response Measurement
Left Ch. (A Out):	Channel 1 of the AGILENT 35670A
Right Ch. (B Out):	Channel 2 of the AGILENT 35670A

Section 20:	Peak Hold During a Machine Run-up
CD Track:	28
CD Track Desc.:	Car Engine Run-up and Tachometer Signal
Left Ch. (A Out):	Channel 1 of the AGILENT 35670A
Right Ch. (B Out):	TACH input on the back of the AGILENT 35670A
Setup Hints:	Pulses per rev: 2