



USER'S GUIDE

**2503AH –1, –2 & –3 Channel
Power Analysis System**

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Introduction

The 2503AH instrument family is a multifaceted analysis system. These instruments, consisting of one, two and three channel units, are designed to be highly versatile workhorses for production and engineering environments. They offer speedy, in depth and accurate analysis capabilities, as well as an unparalleled flexibility. Though the instruments provide a complex front panel user interface, the number of steps required to program a functioning configuration for an application is minimal. The variety of power-related details is broad. The kinds of power input/output devices they can test are extensive and include two and three phase power devices. Refer to Figure 1.



Figure 1. The 2503AH Power Analyzer

System Features

The following prominent characteristics allow you to evaluate the 2503AH analysis system.

- True 18-bit analog-to-digital resolution
- 500kHz data sampling rate
- 0.05% V & I accuracy
- Two 32MHz digital signal processors for each channel
- Harmonic and spectrum analysis of voltage and current
- Full stand-alone compliance with EN 61000-3-2¹ and EN 61000-3-3²

2503AH-1CH

The following characteristics are available with the one (single) channel power analyzer's capabilities.

- Can measure a voltage and a current input simultaneously.
- Can measure AC and DC signals.
- Can measure from DC to a fundamental frequency of 163kHz, a 500kHz bandwidth. This measurement includes the harmonic data contained within the frequency.

2503AH-2CH

The following characteristics are available with the two (dual) channel power analyzer's capabilities.

- Can measure 2 voltage and 2 current inputs simultaneously.
- Can measure AC and DC signals. For simultaneous measurements, use one channel for the DC signal and the remaining channel for high frequency AC.
- Can measure from DC to a fundamental frequency of 163kHz, a 500kHz bandwidth. This measurement includes the harmonic data contained within the frequency.

¹ The Harmonic standard as shown on this analyzer is IEC1000-3-2.

² The Flicker Level standard as shown on this analyzer is IEC1000-3-3.

- Can have its two channel inputs grouped to be synchronous, or asynchronous with respect to each other. Synchronous channel grouping allows for a 3-phase, 3-wire, 2-wattmeter method to be performed with the ability to measure the phase between channels. Refer to *Wiring Methods* on page 99.
- Can allow for added capacity to make efficiency measurements.

2503AH-3CH

The following characteristics are available with the three-channel power analyzer's capabilities.

- Can measure 3 voltage and 3 current inputs simultaneously.
- Can measure AC and DC signals. For simultaneous measurements, use one channel for the DC signal and a remaining channel for high frequency AC.
- Can measure from DC to a fundamental frequency of 163kHz, a 500kHz bandwidth. This measurement includes the harmonic data contained within the frequency.
- Can have two or all three-channel inputs asynchronous or grouped to be synchronous with respect to each other. Synchronous channel grouping allows for performing a 3-phase, 3-wire, 2-wattmeter method; a 3-phase, 3-wire 3-wattmeter method; and a 3-phase 4-wire method with the ability to measure the phase between channels. Refer to *Wiring Methods* on page 99.
- Can allow for added capacity to make efficiency measurements.

Interfaces

- Two RS232—Each of the ports may be used for control or for printer output. Rates can be set from 1,200 baud to 38,400 baud. Flow control is by way of the RTS/CTS handshake.
- One IEEE488—Full talk/listen capabilities
- Parallel Printer port—Standard Centronics interface cable compatible with IBM-PC. The interface option supports serial, RS-232, printers and GPIB, IEEE488, control.
- Serial ports for printing—Requires hardware RTS/ CTS handshaking.

Operational Concepts

We use the building block level to explain the power analysis system's operational concepts and explain its critical functions using specific measurements and application examples. A full description of the three-phase, three-channel power analyzer has been detailed. Note that the same basic theory applies to the one and two channel instruments. The following definitions are given within the context of the 2503AH instrument family:

- A phase is defined as:
Angular relationship between two waveforms. The phase of a wave is the position of any peak or trough compared to the same feature on a second wave.
- A channel is defined as:
A synchronized set of voltage and current inputs set up to take in power from a supplied source for the purpose of making power related measurements.
- A group is defined as:
One, two, or three, synchronously combined channels, set up to make multiple power related measurements. Note that a remaining channel can be set up in the display as a one-channel group. End measurement results must be calculated from multiple signals, such as the Total Power is the combined power from A and B, or A, B and C.

Channels

The block diagram, Figure 2, illustrates the power analysis system's operational concepts. Channels A, B, and C share one central processor. Each channel communicates its measurement and analysis results to this central processor via high-speed communication links. The central processor then updates the display, digital interfaces, and prints out data, as required. The central processor also manages data entered via the front panel keys, a computer interface and optional functions, such as, data logging and I/O interfacing. This entered data can be both analog and digital. Because the central processor is not required to perform any analysis functions, it services all interface and display functions efficiently.

Note: The input signal conditioning is omitted from the diagram for simplification.

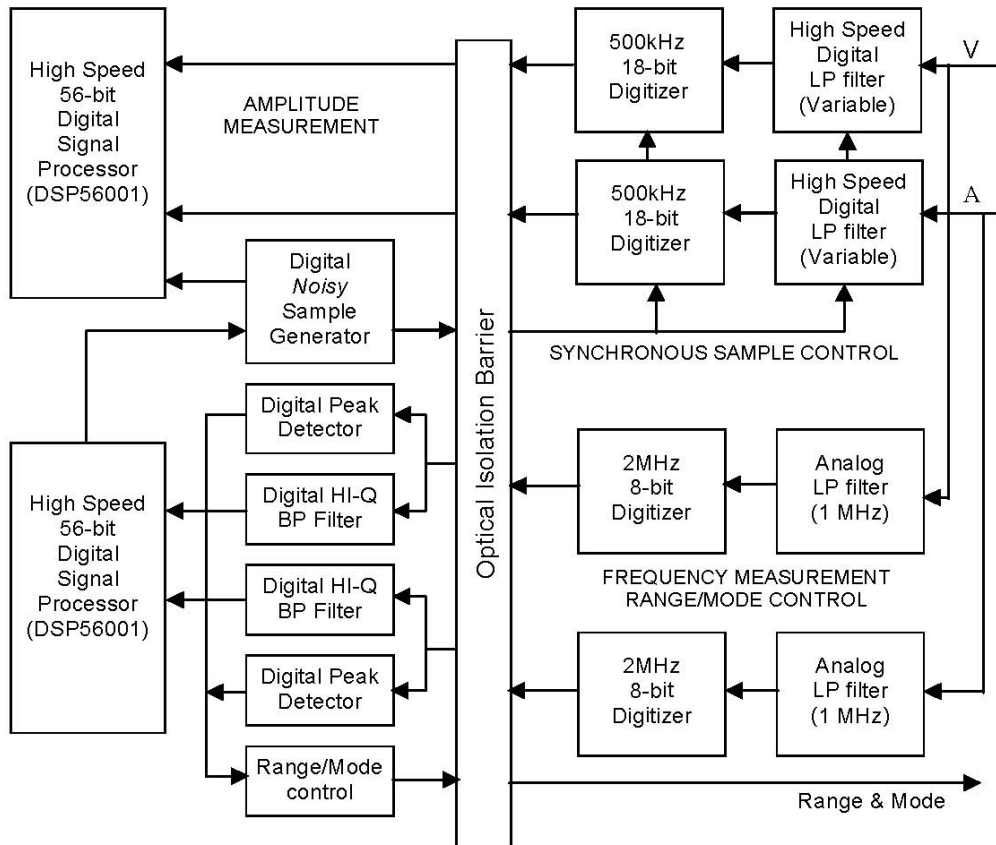


Figure 2. 2503AH Instrument Channel Block Diagram

Channel Functions

Key functions of each channel (phase) are signal conditioning, data sampling, and measurement analysis of the input signals. Signal conditioning includes scaling, ranging, attenuation and/or gain stages.

Each channel has dual high speed Digital Signal Processors (DSP) to measure frequency, to set sampling rates, and to perform a Fast Fourier Transform (FFT) implementation of the Discrete Fourier Transformer (DFT). Optocouplers and isolated supplies provide full galvanic isolation.

Each channel consists of three PC boards, which are attached to the analyzer's backplane. The "Input" board contains the shunts, attenuation and gain circuits. The "Supervisor" board contains the 8 bit, analog-to-digital converters (A/D), along with associated filtering circuits and the first DSP chip. The "Amplitude" board contains a second DSP chip used to perform all the harmonic analysis. See Figure 3.

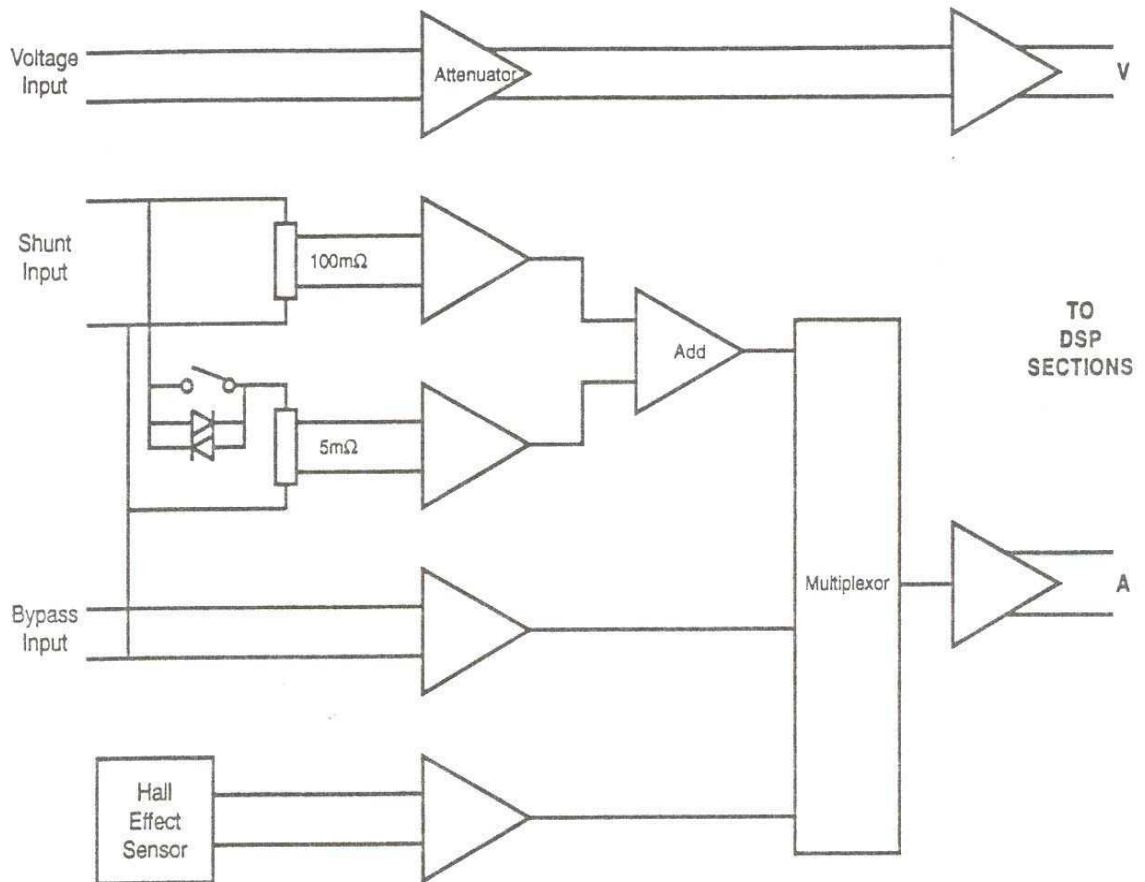


Figure 3. Channel Input Signals

Scaling and Sampling

The 18-bit A/Ds, which scale down the analog voltage and current input signals, have an input range of ± 2.75 volts. The voltage inputs are attenuated and the signals from the internal shunts are amplified to fit this input range, before they are converted.

The scaling and data sampling (synchronization) processes are controlled by the 8-bit A/D converters, which operate at a fixed 2MHz rate and yield a sample every 0.5 microsecond, ranging in milliseconds. Data is sampled with a rate from 250kHz - 500kHz.

A pair of time interleaved 250kHz converters allow for sampling up to 500kHz. Refer back to Figure 2, the Channel Block diagram.

Frequency Measurement

Each scaled input is also passed to a second sub-system for additional analysis. This second sub-system is internally named the “Supervisor DSP” board and consists of the following portions:

Filter and High Speed ADC—Each input passes through an analog 1MHz low pass filter, and is sampled at 2MHz by a pair of 8-bit analog-to-digital converters.

Supervisory Processor—The outputs of the pair of 8-bit converters is read by a Motorola DSP56001, which performs several asynchronous tasks using this data. This processor is linked to the central processor using the high speed RS485 data link.

Range

The ranging is selected in Vrms, but the instrument detects peak input voltages, and then selects the appropriate measurement range. The ranging is done on the basis of the 8-bit A/D output.

Mode Control

Processes that are continuous and independent between the inputs and other instruments or supervisory processor activities in progress are the sampling for overload status, underload status, and proprietary system tracking based on input samples.

Overload Detection—If an overload is detected, the DSP then changes the range presented to the input scaling circuitry (if able), and informs the central processor that a range change has occurred.

Underload Detection—If an underload condition remains for longer than a period provided by the central processor, which is set by the minimum-expected fundamental frequency, the DSP then changes the range presented to the input scaling circuitry (if able). The DSP also informs the central processor that a range change has occurred. You can also set a fixed range, rather than the above autorange process.

Bandpass Filtering and Frequency Measurement—Input samples are passed through a proprietary system, which tracks the bandpass filter function and the fundamental frequency reading within the set range. This tracked frequency reading is then used to measure the frequency of the remaining signal component.

Each input after scaling, is filtered by a high-speed digital low-pass filter and has its *corner* frequency controlled by one of three filter clocks common to all amplitude systems. After filtering, each input signal is then converted to 18-bit digital form by an A/D converter system, whose sample clock is taken from one of three sample clocks common to all amplitude systems.

The high speed RS485 data link passes the selections for its sample and filter clock signals and the measurement details to the DSP.

Sample Clock Generation

The central processor directs the supervisory DSP controls circuitry contained in an ASIC that generates a digital clock signal. The average frequency is settable with 20-bit resolution over a 2:1 range of frequencies. See Figure 4. This clock signal is available to all amplitude DSP systems on one of three such signal lines.

If directed by the central processor, the supervisory processor can *link* this frequency to that of either of its measured input frequencies. The frequency of the sample clock is such that the individual sample-to-sample clock period can vary by up to 1%, but the average over any 256 sample period is always within one ppm of the set value. This *jittered* sampling (also called *dithering*) prevents so called *aliasing* of high frequency signals. Without this jittered sampling, frequency components in excess of the 500kHz maximum sampling rate could *fold back* into the analysis range.

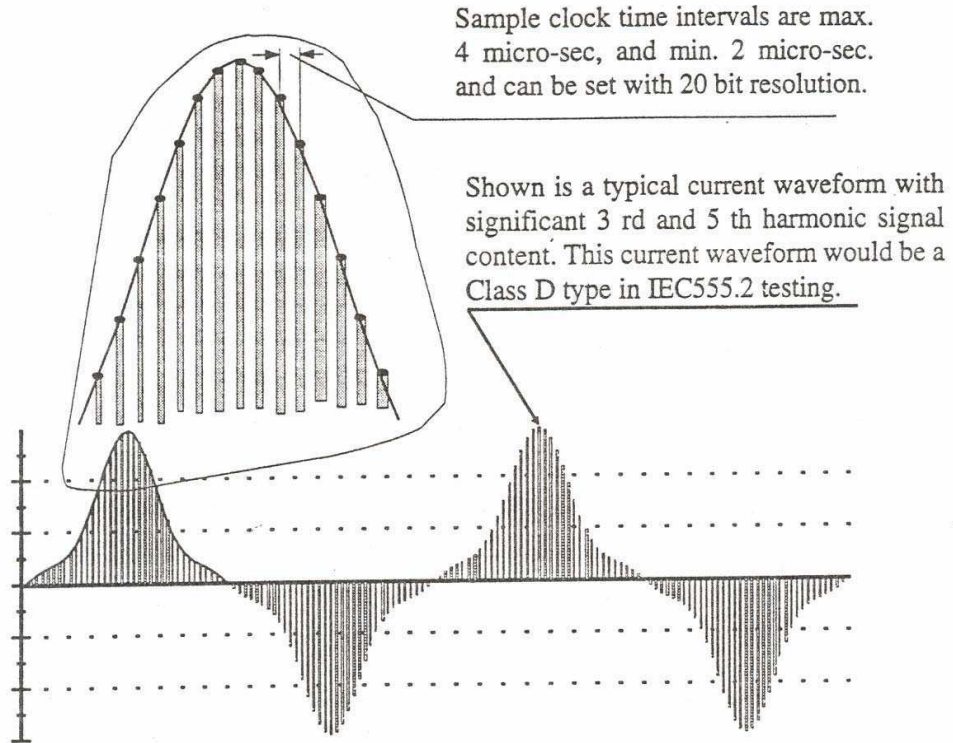


Figure 4. Sample Clock³

Note: Analyzers without the jittered sampling technique, require implementation of anti-aliasing low-pass filters. However, these filters are known to cause amplitude ripple and/or phase errors in the frequency range of interest. In the 400 - 500kHz range, anti-aliasing filters can cause amplitude errors in the 5% to 10 % range, and phase errors in excess of 45°.

The Crest Factor (CF) is 2.5 at full scale and signals with peaks up to 2.5 times the input range can be accurately analyzed. The jittered sampling also guarantees optimum crest factor measurements, because it has the same results as if the sampling rate would be an order of magnitude higher than 500kHz.

(3) IEC 555.2 testing displays on the 2503AH are now named IEC1000-3-2. Current specification now named EN61000-3-2.

Filter Clock Generation

Under the direction of the central processor, the supervisory DSP controls circuitry contained in an ASIC which generates a digital clock signal whose frequency is selectable in 1.2:1 steps over 4.5 decades of frequencies. This clock signal is available to all amplitude DSP systems on one of three such signal lines.

Amplitude Measurement Circuitry

Each input, after scaling, is filtered by a high speed digital low-pass filter having its corner frequency (filter clock frequency) controlled by one of three filter clocks common to all amplitude systems. After filtering, each input signal is then converted to 18-bit digital form by an 18-bit analog-to-digital converter system, whose sample clock is taken from one of three sample clocks common to all amplitude systems.

Independent DSPs measure and analyze the input signals. The analyzer accurately measures signals with an amplitude up to 2.5 times the full scale value allowing input signals to vary from 12Vdc, or 1200Vrms, to 3000Vpeak and current can range from a few milliamps to hundreds or even thousands of amperes.

Each converter consists of a pair of time interleaved 250kHz converters, allowing for sampling up to 500kHz. (Refer back to Figure 2, the Channel Block diagram.)

The output of all four converters (two per input) is read by Freescale's digital signal processor converter, DSP56001, at a rate controlled by the same sample clock used by the converters. This processor performs all amplitude and harmonic analysis required by the system, and maintains a database of the results of the latest such measurements for its channel. The central processor gains access to these results via the high speed RS485 data link. This same link is used to pass to the DSP the selections to use for its sample and filter clock signals, and details regarding the measurements to be made. The channel's circuit board with this harmonic analysis DSP is internally named the "Amplitude" circuitry.

Measurement Reference Point Considerations

As discussed above, the 2503AH inputs are isolated, or floating. Nevertheless, every measurement system must have a reference point. In the case of the 2503AH analyzers, the reference point is the **Current Low** terminal. Thus, both the **Voltage High** and **Voltage Low** terminals have an impedance of 600k Ω with respect to the **Current Low** terminal.

*When current measurements are made using an isolated CT, the **Current Low** terminal essentially floats because the CTs output floats. Even though the analyzer has superb common mode rejection, and the highest dynamic range available on the market, it is advisable to ground the **Current Low** terminal when using floating CTs. The ground terminal is located next to the **Current Low** terminal for this reason. Notice that each channel is individually isolated, hence this ground connection can be made on a channel by channel basis.*

Determining Channel Grouping

The decision to group channels is determined by the application for which the analyzer is being used. Potential applications that need channels grouped together might be:

Motor Testing (using the following methods)

- 3-phase, 3-wire, two meter
- 3-phase, 3-wire, three meter
- 3-phase, 4-wire

Fuel Cell Testing

- 3-phase inverter power testing

Input/Output Efficiency Testing

Two channels may be grouped together on the output or input of a unit under test. This is an application where you have both channels that are grouped together, and channels that are not grouped together.

Phased Power Measurements

A group of two channels can make two phase power measurements at the same time. A group of three channels can make three phase power measurements at the same time.

Each channel can be set to use its own input source, or use the input from the channel with which it's synchronized or grouped. Use the Channel Grouping menu to group channels. See *Grouping Channels* on page 53.

Channels are as grouped and synchronous when:

- A channel designator displays on the same line as another channel.
- Two or more channels are set to **3-phase** versus **norm** and therefore part of a *3-phase group*. This applies even when the channel designators are on separate display lines. Note that channels function asynchronously when the channel designators are on separate lines and set as **norm**.

Configuring Channel Group Feature

The three-channel power analyzer has the unique capacity of synchronously measuring amplitudes on one group, while independently measuring each input's frequency content and automatically selecting one of these frequency measurements as the synchronization source for the group's amplitude measurements. The process includes a step on selecting the inputs within a group that are allowed to measure the fundamental frequency, the instrument does the rest automatically. For more information review *Parameter and Equation Control Keys* on page 33.

Configure the 2503AH instrument family to perform a multitude of measurement tasks and to make independent measurements simultaneously on each of its channels. For example: Channel A can do line measurements, while Channels B and C can perform high frequency signal analysis.

Use **Advanced Setup** to modify the factory defaults; to build a totally new custom configuration; and to **Store** it in non-volatile memory. Review *Functional Configurations* on page 71.

Input Connections

The rear panel provides the connectors for attaching a low and a high voltage channel input and a low and a high current input. It also provides connectors for a current transformer, a Hall Effect transformer and a shunt bypass.

- Measure voltage and current input signals via one of the channel input connectors.
- Measure current input signals via the voltage drop across internal shunt(s), or via a voltage drop across the external shunt. See *Current Transformer Measurement Connections* on page 91.
- Use the internal HALL Effect sensor to measure currents up to 150 amps peak (60Arms). Refer to *HALL Effect Current Transformer* on page 97.
- Use the Bypass input connector to measure currents for high power applications, of any magnitude by using external shunts or current transformers, CTs. When using the Bypass mode, specify the transducer scale factors. This scale factor is entered via the front panel, permitting the analyzer to display the proper current values. For example, a 0.003Ω external shunt generates 3mV per ampere of current. Hence the input scaling needs to be setup accordingly.

Input Isolation

Many applications require that the input and A/D circuits of each channel to be isolated from other channels, as well as from the rest of the instrument. For example:


- In electronic ballast setups, the lamp power is isolated from the input power (110/220Vac).
- In “3-phase delta” connections, both voltage input terminals and both current input terminals are at high voltage levels.
- In electrical vehicles, one channel can be used to measure low voltage DC (battery) signals, while the other channel(s) are used to measure high voltage (3 phase motor) signals. The input channels are isolated via individual isolated supplies.


The system power supply provides 5V to each channel. This 5V supply is then converted by DC-DC converters to $\pm 15V$ and 5V for each channel. The DC-DC converters, rated for 3kW, are specially designed for power analysis and high voltage applications. The A/D converter circuit is also isolated via

these DC-DC converters. After the input signals are converted, they are transferred to the analysis section via optocouplers. The analysis section therefore does not require isolation and operates directly from the 5Vdc supplied by the system power supply.

Input Protection

The voltage input is inherently protected. Its high input impedance, 600k Ω , limits the current flow. The more vulnerable input is the Bypass circuit.

 **CAUTION:** Damage will occur, if the input wiring is mixed up and line voltage is applied across the Bypass input.

 **CAUTION:** The internal shunt can be damaged if line voltage is applied in a full short circuit across the shunt.

By its nature, the shunt has a very low impedance. (Refer back to Figure 3.) Even though the 5m Ω shunt becomes active as soon as the voltage across the 100m Ω shunt exceeds the forward voltage drop across the diodes, the line voltage circuit breakers are rather slow, and can not activate before the shunt has overheated. Full short circuit currents of 150A and higher have been observed, before the breaker reacts.

Some analyzers use an internal fast fuse to protect the shunt. This technique certainly works for line voltage type applications, where signals with maximum frequencies of 2kHz are considered. For high frequency (small amplitude) signals, such as found in many electronic ballasts and motor control circuits, the use of an internal fuse results in unwanted signal errors. For best results use an external (fast) 25A fuse in line with the measurement circuit.

Note: The external fuse has the same detrimental effect on frequency response.

For high frequency (500kHz) power analysis, even the smallest parasitic inductance in the input circuit can result in significant measurement errors. The input configuration of the 2503AH power analyzer is the best compromise between frequency response and reasonable protection, provided the line voltage is not short circuited via the shunt. The 2503AH analyzer's internal shunts can handle short duration, high peak currents.

Front Panel Interface

The following section addresses manual operation of the 2503AH power analyzer using the front panel interface consisting of keys and a display. Refer to Figure 5.

If you are interested in interfacing digitally refer to *Digital Control Interfacing* on page 135. Note that it is important to review this section, even if you are planning to control the instrument by computer. The features and functional characteristics of the 2503AH power analyzer are discussed in the context of operating the instrument via the front panel.

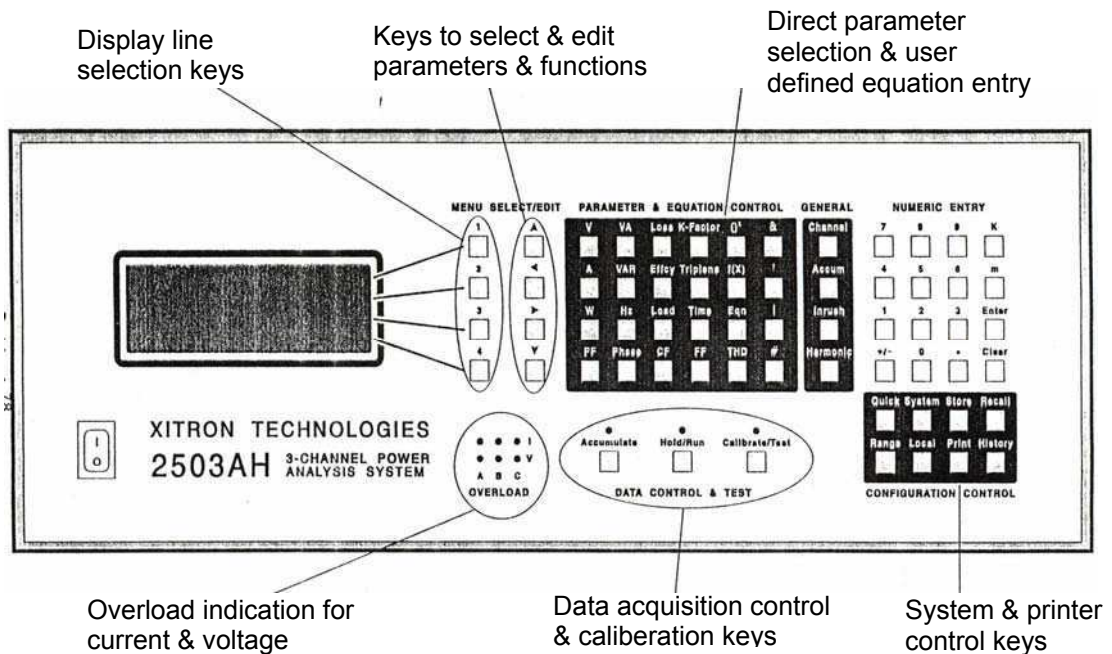


Figure 5. Front Panel

Basic operation involves configuring test parameters for your attached device and reading the results. Use the setup menu screens, labeled Standard and Advanced, to adapt the analyzer to your product's specialized needs.

Note: Additional screens, such as, the IEC1000-3-2 and IEC1000-3-3 setup menus allow you to configure the instrument for measurements in accordance with the standards now listed as EN 61000-3-2 and EN 61000-3-3.

You can use the pre-programmed **Quick Start** configurations, which are based on factory defaults. Multiple configurations can be set at one time to provide you with a full analysis of your equipment. The two and three channel units allow you to setup a number of applications or read multiple outputs on complex power equipment.

Power Switch

Powers the instrument on (|) and off (**O**).

Display Feature

The VFD* display is provided in an alphanumeric format. Although only four lines of textual information can be seen at any one time, associated display information can be viewed by scrolling up and down using the **▲** and **▼** keys.

The display enables you to review display lines of *results data* as shown in Figure 6. From here, you can access the various menus, define configuration details and edit measurement equations.

Σ rms	118.7 Vrms	Av
Σ rms	3.410 ArmsAi	
true	350.2 W	A
true	404.8 VA	A

Figure 6. Results Data

Configuration details are formatted in four columns of information as follows from left to right. To activate a line, press the **Menu** key next to it. See Figure 7.

* vacuum florescent display

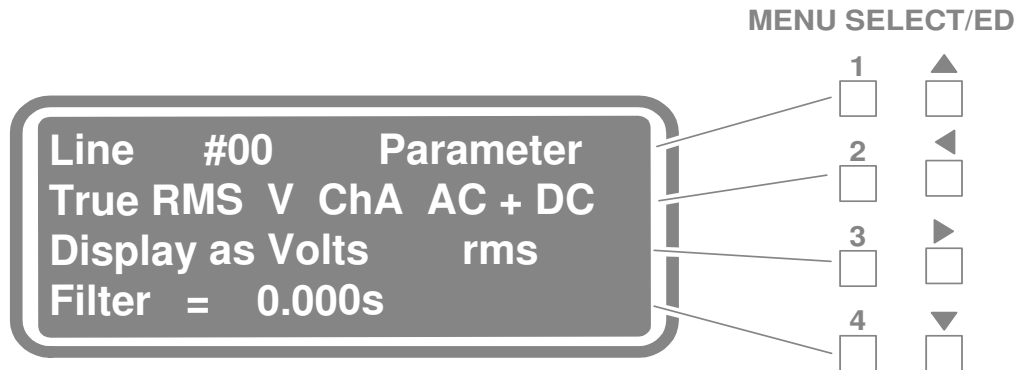


Figure 7. Configuration Menu Display with Keys

Menu Keys

Use the **Menu** keys and the **Select/Edit** keys to access all the available displays. These keys function as softkeys, working directly with the information shown in the display.

The four **Menu** keys are numbered 1 through 4 and correspond to the four lines of text shown at any one time in the display. Refer back to Figure 7. A key press moves a cursor to its associated line and flashes at the first selectable item.

- **Menu 1** key brings the cursor to the first line of the display. This key has an additional function in that it can bring up new configuration displays. For example: a repeated press on the **Menu 1** key moves you through the available **Parameter** displays as shown in Table 1, column 1 on page 41. The **Menu 1** key also moves you through alternate *Setup Submenus* as shown on page 55.
- **Menu 2, 3** and **4** keys bring the cursor to the second, third and fourth lines respectively.
- A repeated press on **Menu 2** key moves you through the options shown in Table 2, column 1 on page 45.

Select/Edit Keys

The four **Select/Edit** keys are the arrow keys: ▲ ▼ ▶ and ◀ (up, down, right and left). These keys are used to select and display the various options, effectively editing the default display.

The specific functions of these keys are:

1. Use the ▶ and ◀ keys (right and left arrows) to move a flashing cursor to selectable items on a display line, and;
2. Use the ▲ and ▼ keys (up and down arrows) to scroll through the available options for a selected item. Also use these keys to scroll down to access additional lines where a menu contains more than four lines.

Summary

- Use the **Menu** and **Select/Edit** keys to place the flashing cursor at the line item you wish to change.
- Access any additional lines in a configuration display by pressing the ▼ (down arrow) key.
- Access items within a line in a configuration display by pressing the ▶ (right arrow) key.

Specific Function Keys

























The following applies to keys labeled with a specific function. Note that the edit capacities of these keys is limited to the fitted available options. You may get a message on the display noting your instrument has not been fitted for the options you are requesting.

Note: First use the **Menu** and **Select/Edit** keys to place the flashing cursor at the item you wish to change. After pressing the key, notice other changes that may occur on the display that are defaults or limitations associated with your selection.

Parameter & Equation Control Keys

Once you are familiar with the power analyzer's display sequencing, you may use this group of keys as a direct selection in configuring measurements and equations.

PARAMETER & EQUATION CONTROL

V	VA	Loss	K-Factor	() ^x	*
					
A	VAR	Effcy	Triplens	f(x)	÷
					
W	Hz	Load	Time	Eqn	+
					
PF	Phase	CF	FF	THD	-
					

General Keys

There are four General keys:

- The **Channel** key allows you to select any of the three channels: A, B, and C. To group channels refer to the *Channel Grouping Submenu*. See page 53.
- Use the **Accum** key to configure the display with RMS Hr. in an existing setup.
- Use the **Inrush** key to configure or clear the display for Inrush measurements in an existing setup.
- The **Harmonic** key is used to enter Harmonic frequency range (NN-NN) values.

GENERAL

Channel



Accum



Inrush



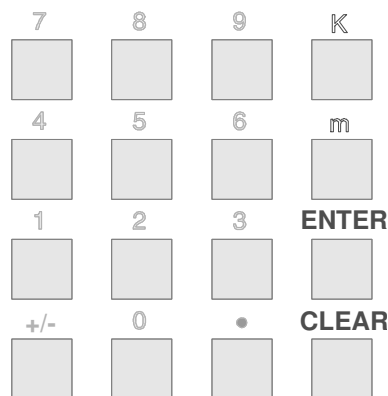
Harmonic



Numeric Entry Keys

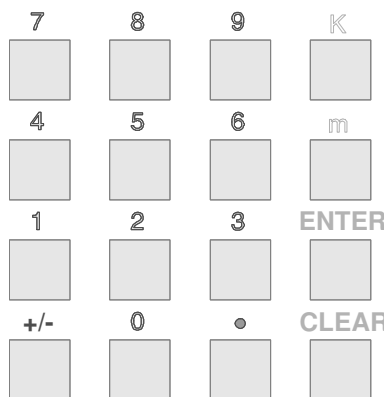
- Press the **Enter** key once to complete an edit. Note that the cursor stops flashing after pressing this key. To change the selection again press any of the **Menu** keys.
- Press the **Enter** key twice to display your measurement readings or results data.
- Use the **Clear** key to clear any entry or for specific settings.
- Use the **m** and **K** keys to designate micro and kilo. Note that these keys become disabled automatically when not applicable.

NUMERIC ENTRY



- Use the **0 through 9** keys for direct numeric entry where numeric values can be highlighted. (For example: in line 3 with the display of Ref =)
- The first numeric key press automatically clears the existing numeric entry in the display and accepts the newly entered number.
- Use the **+/-** key to change polarity where numeric values can be highlighted. (For example: in line 3 with the display of Ref =)
- Decimal values can be entered using the **Decimal point** key.

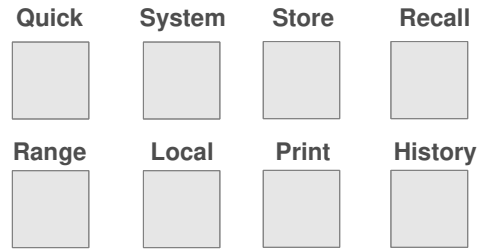
NUMERIC ENTRY



Configuration Control Keys

Use the eight Configuration Control keys to configure your analyzer's system.

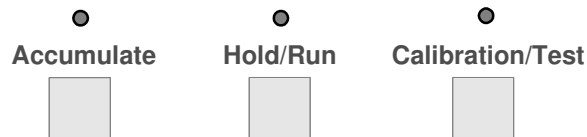
Refer to page 51 for more information on QUICK START, and **Store**, **Recall** and **Print** keys.



CONFIGURATION CONTROL

- Use the **Quick** key to set QUICK START configurations.
- Use the **System** key to provide access to the System menu.
- Use the **Store** and **Recall** keys to record and bring up reusable configurations.
- The **Range** key provides access to the SET RANGES menu.
- Use the **Print** key to print test results.
- Use the **Local** and **History** keys to select portions of test results.

Data Control & Test Keys



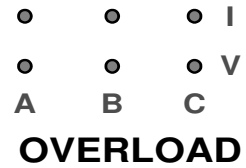
DATA CONTROL & TEST

The three Data Control & Test keys have unique functions. Each of these keys have an associated LED, to tell you this function is working.

- Pressing the **Accumulate** key begins an accumulation of data, which is shown on the display.
- Use the **Hold/Run** key to stop and restart a reading in process.
- The **Calibrate/Test** key starts the calibration sequence. See page 115.

Overload LEDs

These 6 red lights come on to indicate current and voltage overload conditions, specific to channel.



Starting the Power Analyzer

The following addresses the beginning steps when starting to use the 2503AH analyzer.

When the power switch is pressed on, the display rests momentarily on your instrument's serial number and any fitted options, such as AIO. Your display momentarily shows your configured channels and continues to display lines of data. These are the *results data* of whatever is presently being input on your rear panel connections in accordance with the defaults or a defined menu configuration for that line. You can review the full list of results data using the ▲ and ▼ keys (up and down arrows). Results data lines can be added, deleted and changed, as required by accessing the menus.

First Step

- Press the **Menu 1** key to configure a data display line appropriate for your testing needs. Refer to Table 1 and Table 2, for sequential lists of configurable displays. Press the **Enter** key twice to view the Results Data display lines.
- To quickly reconfigure your analyzer, press the **Quick** key. Refer to page 51.
- To update the operational setups on your analyzer, press the **System** key to access the interactive System menus. The display will read: SYSTEM CONFIGURATION. Refer to page 53.
- To recalibrate your analyzer, press the **Calibrate/Test** key. Refer to page 115.

Results Data

Each line of results data is based on a previously set configuration or on the factory default configuration. Refer back to Figure 7.

In this data display, you can:

- View the full list by pressing the **Select/Edit ▼** key.

Note: The first line of the configuration display tells you the line number (#) you have selected.

- Print the list, as required. See *Print Key* on page 67.
- Select a line to review and edit via its configuration setup: To select a line, press the **Menu 1** key while the data line item you want to review is at the top of the display. To return to the data display, press the **Enter** key twice if you have made a change, once if not.

Deleting a Results Data Display Line

- *To delete a results data display line:*
 1. While viewing the Results Data display, use the ▲ and ▼ keys to make the line to be deleted visible.
 2. Press the corresponding **Menu** key for the line containing the data to be deleted.
 3. Press the **Menu 1** key until the word Delete displays.
 4. Press the **Enter** key.

The selected display data line is deleted along with its associated configuration. Note that the next display line moves up numerically to take its place.

- *To erase all display lines:*
 1. Press the **Quick** key. The QUICK START menu displays.
 2. Press the **Menu 4** key. This selects Clear Display lines.

The instrument is now configured for the measurement of your selected application. Refer also to *Factory Defaults* on page 52.

Adding a Data Display Line

This can be initiated using any of the following methods while viewing the data display.

- *To add display lines:*
 1. Press the ▼ key until the display window has a blank data display line.
 2. Press the **Menu** key corresponding to a blank line.
A new Results Data display line will be started and will be numbered automatically. What you see is a new parameter configuration display for that new data line. Reconfigure this display, as required.
 3. Press the **Enter** key to read the Results Data.
 4. While viewing the data display, press any parameter key in the **Parameter & Equation Control** section of the front panel.
A new data display line will be started and will be numbered automatically. What you see is a new configuration display reflecting the new data line and the selected parameter as its starting parameter. Reconfigure this display, as required.

Reconfiguring a Results Data Display Line

- *To reconfigure display lines:*
 1. Press the **Menu** key for a presently used display line. The defined configuration for that display line will be *opened* for reconfiguring.
 2. Press the **Menu 2** key. The cursor will flash on the second display line.
 3. Move the cursor by using the ◀ and ▶ keys (left and right arrows) to stop at the item you would like to change.
 4. Press the ▲ and ▼ keys to toggle through the different choices that are available.
 5. Once you have configured the items, press the **Enter** key twice.
 6. Repeat the above for each individual display line to be configured.

Sequential Displays

The information provided here includes the sequence of the parameter displays in the first column and provides default details regarding the additional lines in the second, third and fourth columns. The Sequence tables help you anticipate possible setups using the **Menu** keys and **Select/Edit** keys.

The tables additionally give you an overall view of the testing possibilities and assist in development of test method documents. Also refer to the *Setup Submenus* on page 55.

Types of Setups

The **Menu** keys and **Select/Edit** keys enable you to move through the available parameter displays in a sequential manner. See Table 1. A repeated press of the **Menu 1** key displays the following types of setups:

- Parameters

- IEC1000-3-2 (EN61000-3-2)

- Time and Date setups

- Delete

The parameter descriptor displays on the first line. Table 2 sequentially lists the remaining three (plus) lines you can define. You can see that the parameter setups show a variety of measurements, calculations, and values calculated from a parameter in conjunction with a reference value. For example, you can define a display setup to show an individual harmonic current, a given harmonic as a percent of the fundamental current or a calculated parameter: THD, PF, CF, FF, Watts, VA, Loss, Efficiency, etc.

Parameters can be mixed and matched between channels. For example: the first 3 lines of the display can be setup to measure voltage in Channels A, B, and C, while the following lines can define the current or power for each channel.

When you store a complete instrument configuration, the defined display lines are also stored for later recall. You can give each stored setting a meaningful *Name* to easily remember its purpose.

Review Table 1, on next page, for the default sequences of the parameter displays.

Table 1. Parameter Display Sequence

First line reads:	Second line default reads:		Third line default reads:	Fourth line default reads:
Line #00 (→ 99) Parameter	Watts (see Table 2)		Display as Watts	Filter 1.000S
	ChA ChB ChC	AC+DC AC DC		
	ChA ChB ChC	Class A Class B Class C		
Line #00 (→ 99) IEC1000-3-2			Blank	
	Steady	Fluctuate		
Line #00 (→ 99) Accum. Time			Blank	
Line #00 (→ 99) Time & Date			Blank	
Line #00 (→ 99) Date			Blank	
Line #00 (→ 99) Time			Blank	
Line #00 (→ 99) Blank			Blank	
Line #00 (→ 99) Delete			Blank	
Line #00 (→ 99) Limit Param	Watts (see Table 2)		Ref = +0n	Display as Watts
	ChA ChB ChC	AC+DC AC DC		
	ChA ChB ChC	ChA ChB ChC		
Line #00 (→ 99) Param/Ref-1	Watts (see Table 2)		Ref = +0n	Display as Ratio
	ChA ChB ChC	ChA ChB ChC		
Line #00 (→ 99) Param/Ref	Watts (see Table 2)		Ref = +0n	Display as Ratio
	ChA ChB ChC	ChA ChB ChC		
	ChA ChB ChC	ChA ChB ChC		
Line #00 (→ 99) Param-Ref	Watts (see Table 2)		Ref = +0n	Display as Watts
	ChA ChB ChC	AC+DC AC DC		
	ChA ChB ChC	ChA ChB ChC		

Definitions

The following definitions relate to the selectable Parameter Setup displays.

A measured parameter:

The measured parameter may be filtered individually for each display line, and may have its basic unit converted into an alternative unit as desired. This is the normally used display data selection.

The difference between a parameter and another parameter or constant:

The instrument displays the difference between a measured parameter and a constant or the value of a measured parameter (either continuously updated or fixed to that measured at a particular time). The computed difference may be filtered individually for each display line, and may have its basic unit converted into an alternative unit as desired. This is useful for displaying the variance of a measured parameter from a *nominal* value.

The ratio, between a parameter and another parameter or constant:

The instrument displays the ratio between a measured parameter and a constant or the value of a measured parameter (either continuously updated or fixed to that measured at a particular time). The computed ratio may be filtered individually for each display line, and may have its basic unit converted into an alternative unit as desired. This is useful for displaying the ratio between a measured parameter and either a *nominal* value or the value of another parameter (e.g. ratio between power supply input and output voltages).

Ratio difference, between a parameter and a constant or another parameter:

The display line will show the difference between the ratio between a measured parameter and a constant or the value of a measured parameter (either continuously updated or fixed to that measured at a particular time) and unity. The computed ratio difference may be filtered individually for each display line, and may have its basic unit converted into an alternative unit as desired. This is useful for displaying the variance of the ratio between a measured parameter and either a *nominal* value or the value of another parameter.

A HIGH/PASS/LOW limits comparison comes with measured parameters and shows on the display against a (constant or variable) nominal value using a constant limit range. The measured parameter may be *filtered* individually for each display line and may have its basic unit converted into an alternative unit as desired. This is useful for production line *pass* and *fail* testing of power supplies, etc.

Harmonic Range frequency options, which are available with True RMS, are accessed by toggling the **Harmonic** key in the **General** section of the keyboard when the cursor flashes at the *Input Coupling* (i.e., DC, AC, and AC+DC). See Figure 8.

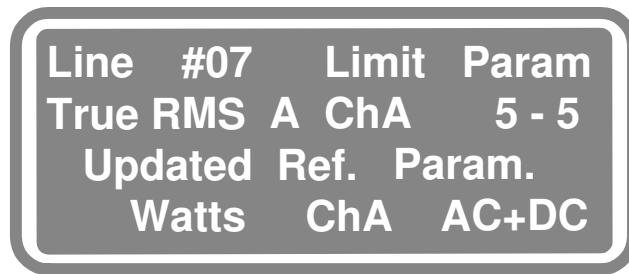


Figure 8. Harmonic Range

When entering a harmonic range:

- Set the second harmonic number the same as the first to yield results data at that harmonic only. Set the second harmonic number to (0) zero to yield results data measured over the entire measured range of harmonics starting at the first harmonic number.
- Set the second harmonic number to any other value to yield results data measured over the defined range of harmonics *inclusive*.

Note: Entering a range extending beyond that defined as the maximum measured harmonic for the particular channel may not yield reliable results.

Ref =

Indicates that the following numeric quantity has been selected as the reference or nominal value for the parameter defined on line 2. The ► and ◀ keys *toggle* between Ref = and numeric quantity selections. When the cursor is in the Ref = selection, the ▲ and ▼ keys toggle between the various reference or nominal value selections.

Updated Ref. Param.

Indicates that a continuously updated parameter value is to be used as the reference or nominal value.

Fixed Ref. Param.

Indicates that a previously measured parameter value is being used as the reference or nominal value. This value may be viewed by toggling to the **Ref =** selection.

Fix Ref. Param. Now

Indicates that the value of the reference/nominal parameter will be measured and *fixed* when the **Enter** key is pressed and this is being displayed. This selection is only available if a parameter has been previously defined for the reference or nominal value. If no parameter is presently defined then select the **Updated Ref. Param.** selection, press the **Enter** key, select the **Menu 4** key and edit the parameter to that desired as the reference, then press the **Menu 3** key to return to this line and make the desired selection.

Note: A reference parameter is available if the reference type selected in line 3 is either **Updated Ref. Param.** or **Fixed Ref. Param.**

Limit = Line

This is only available for the **Limit Param** data type. The user may enter any numeric value, which will be used to define the high (nominal + limit) and low (nominal - limit) levels of the PASS region.

Filter = Line

Enter any value between 0 (no filtering) up to 1000 seconds as the filter time constant. The filter is a single pole filter with an automatic filter bypass when the result changes by more than 10%. Even when not being displayed, this filter is active, maintaining the averaged result at all times. This is useful to display the *mean* line voltage or current when an unregulated power source is being used. (A filter period of 2 seconds is recommended for this purpose.)

Measurement Data

The power analyzer can hold a list of up to 50 different data to display. See Table 2. You can access the data line using the **Menu 2, 3, and 4** keys and scroll through the options using the **▲ ▼ ► ◀** keys (arrows). Each data display is associated with a *measurement* given in the first column.

Table 2. Display Data

Measurement*	Selectable Channel/ Channel Group		Slctble Power	Default Units	Optional Units	Full Loop of Options
Watts	ChA ChB ChC	GpA GpB GpC	AC+DC AC DC	Watts	dBW dBmW H.P. No Units	Percent dB Ratio +/-180° 0-360°
VAR		ChA ChB ChC	AC+DC AC	VAR	VAR (ac) H.P. No Units	
VA	ChA ChB ChC	GpA GpB GpC	GpA GpB GpC	VA	VA (ac) VA (dc) VA Peak H.P. No Units	grad (+/-) grad (+) rad (+/-)
PF	ChA ChB ChC	GpA GpB GpC	AC+DC AC	Ratio	Percent dB Ratio No Units	rad (+) Pirad
DPF		ChA ChB ChC	(none)	Ratio	Percent dB Ratio No Units	Pirad (+) Hertz
Eff.Phs.	ChA ChB ChC	GpA GpB GpC	AC+DC AC	+/- 180°	0-360° grad (+/-) grad (+) rad (+/-) rad (+) Pirad Pirad (+) No Units	cps rpm seconds hours Ohms
Pk VA		ChA ChB ChC	(none)	VA Peak	H.P. No Units dBW dBmW VA VA (ac) VA (dc)	Ohms (ac) Ohms (dc) Ohms (re)

* See glossary for measurement definitions and application.

Measurement*	Selectable Channel/ Channel Group		Slctble Power	Default Units	Optional Units	Full Loop of Options
W. Hr	ChA ChB ChC	GpA GpB GpC	AC+DC AC	Watt. hour	No Units	
VAR. Hr	ChA ChB ChC	GpA GpB GpC	AC+DC AC	VAR. hour	No Units	
VA.Hr	ChA ChB ChC	GpA GpB GpC	AC+DC AC DC	VA. hour	No Units	
Acc. Time	ChA ChB ChC		(none)	Hours	No Units Hertz cps rpm seconds	
Load Z	ChA ChB ChC		AC+DC AC DC	Ohms	Siemens No Units	
Load R	ChA ChB ChC		AC+DC AC DC	Ohms	Ohms (re) S (real) No Units	
Load X	ChA ChB ChC		AC+DC AC	Ohms	Ohms (im) S (imag) No Units	
Pwr Loss	(none)		(none)	Watts	Full Loop →	
Effcy	(none)		(none)	Percent	Full Loop →	
Spectrum A	ChA ChB ChC		1 (→ 99)	Amps rms	No Units	
Spect. Hz	ChA ChB ChC		1 (→ 99)	Hertz	Cps rpm seconds hours No Units	

* See glossary for measurement definitions and application.

Measurement*	Selectable Channel/ Channel Group	Selectable Power	Default Units	Optional Units	Full Loop of Options
Phs ChAi #1(→99) —Or— Phs ChAv #1(→99) —Or— Phs ChBi #1(→99) —Or— Phs ChBv #1(→99) —Or— Phs ChCi #1(→99) —Or— Phs ChCv #1(→99)	1(→99) ChAi #1(→99) —Or— 1(→99) ChAv #1(→99) —Or— 1(→99) ChBi #1(→99) —Or— 1(→99) ChBv #1(→99) —Or— 1(→99) ChCi #1(→99) —Or— 1(→99) ChCv #1(→99)	(none)	+/- 180°	0-360° grad (+/-) grad (+) rad (+/-) rad (+) Pirad Pirad (+) No Units	
True RMS A	ChA ChB ChC	AC+DC AC DC	Amps rms	dB Ratio	
Rectify A	ChA ChB ChC	(none)	Amps avs	+/-180°	
FF	ChA ChB ChC	(none)	Ratio	0-360°	
CF A	ChA ChB ChC	AC+DC AC DC	Ratio	grad (+/-)	
High Pk A	ChA	(none)	Amps peak	grad (+)	
Low Pk A	ChA	(none)	Amps peak	rad (+/-)	
Peak A	ChA ChB ChC	(none)	Amps peak	rad (+)	
Pk-Pk A	ChA ChB ChC	(none)	Amps pkpk	Pirad	

* See glossary for measurement definitions and application.

Measurement*	Selectable Channel/ Channel Group	Selectable Power	Default Units	Optional Units	Full Loop of Options
Inrush A	ChA ChB ChC	(none)	Amps peak	Pirad (+)	
Acc. Max A	ChA ChB ChC	(none)	Amps peak	Hertz	
Acc. Min A	ChA ChB ChC	(none)	Amps peak	cps	
Acc.Pk A	ChA ChB ChC	(none)	Amps peak	rpm	
RMS. Hr A	ChA ChB ChC	AC+DC AC DC	Ampere. Hr	seconds	
Σ Charge A	ChA ChB ChC	(none)	Ampere. Hr	hours	
Σ Dcharge A	ChA ChB ChC	(none)	Percent	No Units	
THD-Fund A	ChA ChB ChC	<2←<49 →<99	Percent	dB Ratio No Units Ratio	
THD-Harm A	ChA ChB ChC	<2←<49 →<99	Percent	dB Ratio No Units Ratio	
THD-Sig A	ChA ChB ChC	<2←<49 →<99	Percent	dB Ratio No Units Ratio	
K-Factor A	ChA ChB ChC	<2←<49 →<99	Ratio	No Units dB Ratio Percent	

* See glossary for measurement definitions and application.

Measurement*	Selectable Channel/ Channel Group		Slctble Power	Default Units	Optional Units	Full Loop of Options
Triplen A	ChA ChB ChC		<2←<49 →<99	Amps rms	No Units	
Odd Trip A	ChA ChB ChC		<2←<49 →<99	Amps rms	No Units	
Evn Trip A	ChA ChB ChC		<2←<49 →<99	Amps rms	No Units	
Wye-V A	ChA ChB ChC	GpA GpB GpC	(none)	Volts rms	Full Loop →	
Delta-V A	ChA ChB ChC	GpA GpB GpC	(none)	Volts rms	Full Loop →	
Frequency A and Frequency	ChA ChB ChC		(none)	Hertz	cps rpm seconds hours No Units	

Note: For descriptions matching by name and sequence to the measurements that show on the second display line with each of the Parameter setups refer to the glossary.

* See glossary for measurement definitions and application.

* See glossary for measurement definitions and application.

Configuration Control Keys

The following covers the functions associated with Configuration Control and the respective keys located on the front panel interface. Refer to *Configuration Control Keys* on page 35.

Operating the one, two and three channel power analyzers is easy, once you have grasped the key functions. Basic operation involves configuring test parameters for your attached device and reading the results. You can also use the pre-programmed QUICK START configurations, which are based on factory defaults. Multiple configurations can be set at one time to provide you with a full analysis of your equipment. The dual and three channels allow you to setup a number of applications or read multiple outputs on a complex device.

Quick Key

This key provides for QUICK START setups. The **Quick** key moves you into configuring the analyzer without selecting any application details. In order to use in QUICK START, enter the lowest frequency likely to be encountered (other than DC) and the general description of the application.

- *To select the QUICK START option:*
 1. Press the **Quick** key. The QUICK START submenu displays.
 2. Press the **Menu 2** key to select the second line.
 3. Press, or hold down, the **▲** key (up arrow) to scroll through a list of selectable settings, shown in Table 3 below.
 4. Press the **Enter** key twice. Once to select an option, a second time to view the data results.

Table 3. Standard Channel Use

Selections	Selectable only with . . .
(EN 61000-3-2) IEC1000-3-2 Channel Use	-----
(EN 61000-3-3) IEC1000-3-3 Channel Use	the Flicker Option is installed
AB 3Phase 3Wire	a 2 or 3 Channel Analyzer
ABC 3Phase 3Wire	a 3 Channel Analyzer
ABC 3Phase 4Wire	a 3 Channel Analyzer
A:Line In -> BC: HF Out	a 3 Channel Analyzer
A:Line In -> B: HF Out	a 2 or 3 Channel Analyzer

Setting Factory Defaults

The following procedures have been written around our Factory Default settings and apply to typical applications. If your unit-under-test requires settings other than what are defined by the default setup, please review *Starting the Power Analyzer* on page 37.

This procedure allows you to recall the factory default system settings for the various types of system configurations that the analyzer has when the **Quick** key is pressed.

- *To configure factory defaults using QUICK START:*
 1. Press the **Quick** key.
 2. Press the **Menu 2** key, once. The cursor will flash on **Standard Channel Use**.
 3. Press the **▲** key until the appropriate setup is located for your particular application.
 4. Press the **Enter** key, twice to action the selected setup.

Refer to the **Quick Key** list of selections in Table 3 above.

System Key

This key activates the System Menu. Once activated the words: SYSTEM CONFIGURATION show on the display, refer to Figure 9. Use the ▲ and ▼ keys to scroll through the list. Access the submenus by pressing the **Menu** key on the same line as the display's menu choice.

Note:

Some items are optional. Unaccessible items have not been installed on your instrument.

The 2503AH analyzer offers the ability to make adjustments to its operation in one area while changing another. Operation of most menus can be *suspended* and another menu *operated* by pressing the other menu's primary access key. When the second menu has been completed, you will be returned to the original menu.

SYSTEM CONFIGURATION

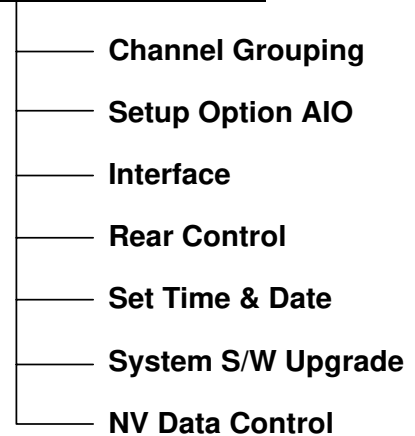


Figure 9. System Menu

Channel Grouping Submenu

The Channel Grouping submenu covers all applications of phase-related measurements. This display allows you to configure channels for asynchronous and synchronous measurements. Pressing the **Menu 2** key for Channel Grouping brings up the CHNL TYPE I/O display. See Figures 10a and 10b. Also see *Grouping Channels* on page 83.

Use this display to create groups containing one, two and three channels and efficiency setups.

The editable selections for the I/O CHNL display are:

norm

Applies where channels are to measure synchronously, but are not connected in a “3-phase delta” or “wye” configuration.

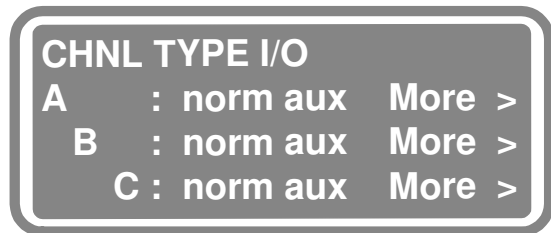


Figure 10a. Channel Selection

3 ϕ 4w

The channels are connected to measure a “3-phase 4-wire wye” system. Phase-to-Phase voltage is available for display from any channel contained in this group.

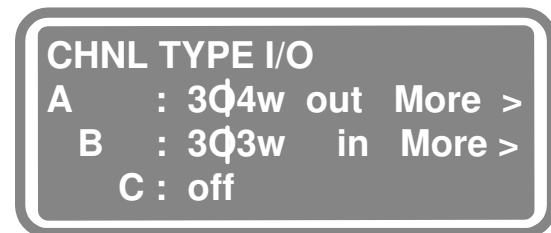


Figure 10b. Configuring Channels

Note: An error displays if the relative phase rotation between the channels cannot be determined.

3 ϕ 3w

The channels are connected to measure a “3-phase 3-wire delta” system.

Phase-to-Neutral voltage is available for display from any channel contained in this group. The settings are:

off

The selected channels are maintained in a safe state and no measurements are available.

aux

This channel’s power measurements are not included in either the *input*, or *output* totals.

in

The selected channel’s power measurements are included in the *input* total for the instrument’s power loss and efficiency calculations.

out

This channel’s power measurements are included in the *output* total for the instrument’s power loss and efficiency calculations.

More >

Moving the cursor into this field using the ► key (right arrow) jumps you to one of five possible setup menus. For more information on configuring this display, see *Functional Configurations* on page 71.

Setup Submenus

Access the Setup submenus from the CHNL TYPE I/O display. The five choices in setup displays pertain to each of the three channels and to channel groupings. Once in a setup display, press the **Menu 1** key to step the analyzer through the five available setups:

Standard Setup	See next paragraph.
IEC1000-3-2/J	(“J” represents the Japanese option.) Refer to page 108.
IEC1000-3-2	See Source Validity/Checking on page 76.
Advanced Setup	See page 56.
Spectrum Setup	See page 60.

Standard Setup

Within the Standard Setup display you can change the fundamental-frequency range for all channels, the Sync Source, Minimum (measurement) Period, aspects of the Filter, and you can initiate Analysis and Source Checking. See Figures 11 and 12.

A: Standard Setup

—	Fund: (Fixed) 40.0 - 5.12KHz
—	From: Synchronization source (example: ChA V or I)
—	Min. Period: Minimum measurement period in seconds
—	Filter: Low pass filter frequency applied to input signals
—	Analysis: Performed, None
—	Check Source Valid: N, Y

Figure 11. Standard Setup Menu Selections

Refer to *Functional Line Descriptions* on page 57 for explanations to menu choices. For additional selections when configuring your analyzer select the Advanced Setup menu.

Scroll down using the ▼ key.

Refer back to the full list of **Standard Setup** menu functions, illustrated in Figure 11.

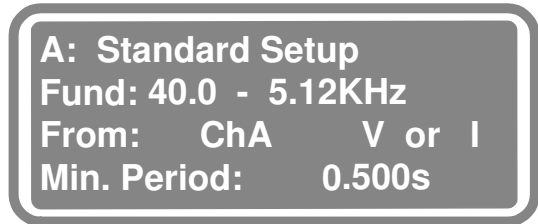


Figure 12. Standard Setup Display

Also see *Configuration Control Keys* on page 51.

If you want to set high and low synchronization limits, maximum harmonics, fundamental bin width of the FFT analysis, the synchronization averaging speed and synchronization's evaluation period, refer to **Advanced Setup**.

Advanced Setup

The **Advanced Setup** menu provides additional setup flexibility for each individual channel or group of channels. Figure 13, illustrates the **Advanced Setup** menu functions. This setup allows you to fully control all aspects of amplitude, frequency and harmonic signal measurements and analysis.

Note: We recommend that the **Standard Setup** menu items be performed first, and then an **Advanced Setup** started. This will set all parameters to the factory default values before being edited.

Access this menu via the Channel Grouping line in the System menu.

A: Advanced Setup

- **Fund: Sync Frequency**
 Sync x 1.0000 (ratio)
 Fixed (enter frequency)
- **Sync: (high - low frequency limits in KHz for**
 synchronization range)
- **From: Synchronization source**
 (example: ChA V or I)
- **Min. Period: Minimum measurement period in**
 seconds
- **Filter: Low pass filter frequency applied to**
 input signals
- **Analysis: None; Simple; Averaged; IEC1000-3-2**
- **Max. Harmonics: 1 to 99**
- **Fundamental ÷ BW: 0 to 999**
- **FFT Type: Windowed; Normal**
- **Sync Averaging: Slow; Med; Fast; None**
- **Sync Period: Sync signal evaluation period in**
 seconds

Figure 13. Advanced Setup Menu

To access the advanced functions, select the channel, and move the cursor to its **More >** field. Refer back to Figure 10b. The top display line shows one of four setups as described in Standard Setup.

To step the analyzer through the available setups, press the **Menu 1** key as required, until Advanced Setup displays. Use the ▼ (down arrow) key to view all the lines of this menu. You can change the options as described to the right of each function. More information on each function follows.

Note: The analyzer has a built-in QUICK START to configure the instrument for factory detailed measurements. See *Rear Panel Connections* on page 91.

Functional Line Descriptions

The descriptions here correlate to the Standard and Advanced setup submenus. Also see *Configuration Control* on page 51.

Fund—Determines the *measurement synchronization* and can be set to three choices:

Sync Frequency

This is the default and the first and most common choice. This sets the synchronization to the fundamental frequency. This directs the channel *Supervisor circuitry* to measure the fundamental frequency of the input signal, and then synchronizes the sampling rate to this frequency.

Sync by Ratio

This is the second choice. This is a measured “synchronization frequency” times a scale factor.

Fixed Fundamental

This is used for the most severe noise situations and functions as a channel grouping’s fundamental frequency.

Sync—The Supervisor will search for the fundamental frequency in the range specified on this line. For a line frequency measurement, set the **Sync**: line from 40-70Hz, as this covers both 50Hz and 60Hz applications. When you are making measurements on the lamp side of a high frequency electronic ballast, set the **Sync**: range from 5 through 200kHz. This covers the majority of electronic ballasts manufactured today.

From—Determines the *synchronization source*. Each channel can be synchronized to itself, or to other channels. The **From**: line allows you to define from where the subject channel gets its synchronization. Normally, for ChA, the sync source is ChA V or ChA I. With this setting, the Supervisor automatically selects the most stable *sync source*. For some applications, V only or I only produces better results. For example, a motor drive circuit (with PWM control) gives results with I only as the current is *filtered* by the motor.

Min Period—Determines the minimum *measurement period* over which the analyzer will calculate the various parameters. The smallest period you can set, is one cycle period or 1mS, whichever is bigger. If the above sync range is set from 40 – 70Hz, the minimum time is the period of 40Hz, or 0.025 second.

Filter—Determines the *corner frequency* of the low pass filter, which the input signals are passed through. You can set the filter as high as 5,000kHz (5MHz). The lowest value the instrument's filter accepts matches the upper sync range.

Example—Filter Settings

1) You can specify the 1dB corner frequency of an 8-pole elliptic filter applied to the input waveforms within the group.

2) To maintain high accuracy amplitude readings, you can set the **low pass filter** to at least 2 - 3 times the highest frequency of interest. The amplitude accuracy will be within 1% for frequencies below 0.8 x filter frequency.

Analysis—Determines the type of FFT **analysis** being performed. For more details refer to *Configuration Control Keys* on page 51. The choices are:

None

Disables all harmonic analysis for that channel or for the selected group of channels.

Simple

Enables harmonic analysis and is the fastest FFT analysis type. Simple means a single analysis is performed for each measurement period with the bandwidth, maximum number of harmonics, and FFT window type you have defined.

Averaged

Enables harmonic analysis. Multiple analyses are performed each measurement period with the bandwidth, maximum number of harmonics, and FFT window type you have defined, with the data results being averaged over the entire measurement period.

IEC1000-3-2

Enables harmonic analysis and is a compliant FFT over a sample size of 16 cycles of 50Hz (i.e. 320ms).

Note: Current based on EN 61000-3-2, which requires a high quality power source for harmonic current analysis purposes. Irrespective of how the unit under test behaves, maintain the power source's supply voltage within 2% of the nominal level and keep the voltage harmonic distortion to minimal. It is important to stabilize the frequency, maintain the phase accuracy for 3-phase systems within $\pm 1.5^\circ$ and maintain the voltage Crest Factor within a range of 1.40 - 1.42.

Max. Harmonics—Permits you to define the highest harmonic you are interested in. The instrument defaults to 49, however, you can select up to the 99th harmonic via the front panel or up to the 1000th via a computer interface.

Fundamental+BW—Gives you control over the individual *bin width* of the FFT. In software versions 3.0 and higher, this line is called “Number of Cycles.” You can control the sampling resolution by selecting the number-of-cycles. If a number of 16 cycles is entered, the analyzer sets its data acquisition such that the data samples are obtained over a total of 16 cycles of the fundamental frequency. The maximum number of samples remains 8192, but could be less. Given that the highest sampling rate is 500kHz, the 8192 samples can be maintained up to about 61Hz. For higher fundamental frequencies, the number of samples is smaller.

FFT Type—FFT determines the windowing method being used. The choices are **Normal**, meaning a rectangular window, or **Windowed**. When **Windowed** is selected, a modified Blackman-Harris windowing function is applied. In EN 61000-3-2 analysis mode, the rectangular window with no-overlap/no-gaps, is required.

Sync Averaging—Permits you to select **None**, **Slow**, **Med**, or **Fast** averaging of the frequency measurement. In case of varying fundamental frequencies, the results can be averaged over 2 measurements = **Fast** selection, 4 measurements = **Med** selection, and 8 measurements = **Slow** selection.

Sync Period—Determines the period over which the sync signal is evaluated. Note that this is just for the frequency measurement, and has no relationship to the measurement period for amplitude or harmonic analysis.

Spectrum Setup

Use **Spectrum Parameters** setup to display spectral content in a visual manner. This setup requires you to either define a *Spectrum* type measurement on the selected channel or define a relationship between a *spectrum point* and *harmonic number*. These setups allow you to perform a spectrum analysis of the input waveforms using a user-defined frequency step and maximum frequency for the *sweep*.

Note: Normal data results are still available during measurements defined by this setup mode, but no synchronization to a measured fundamental frequency is performed, and the amplitude measurement period is simply one period of the step frequency.

Rear Control Setup

The Rear Control submenu brings up REAR CONTROL SETUP. A sample display is shown in Figure 14. From this display you can configure and view the current rear panel control settings.

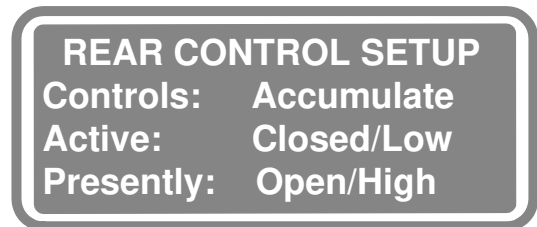


Figure 14. Rear Control

Refer to *Rear Panel Connections* on page 91.

Time & Date Setup

Figure 15 shows the Set Time & Date menu. You can enter the time and date and select a format. The four possible selections are illustrated.

To choose the time format, press **Menu 1** key and the hour format automatically toggles between 12 and 24. Set the time by pressing the **Menu 3** key, and entering the correct time in the 24 hour format using the **Numeric Entry** keys.

- *To setup time & date:*

1. Press the **Enter** key to set the entered time.
2. The Date format line has three selections, use the **▲** and **▼** keys to step through the three different date formats.
3. Push the key next to the format to activate it.

Note: The date and time can be read via the GPIB (IEEE488) and serial ports, for the purpose of time stamping any computer collected data.

Set Time & Date

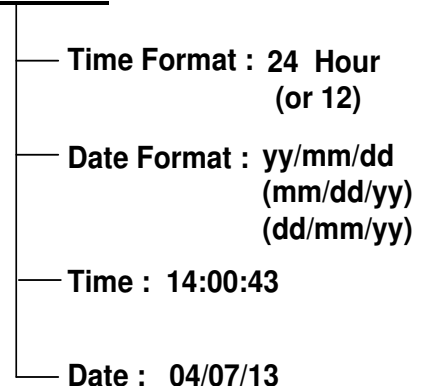


Figure 15. Time & Date Menu

Option AIO Setup

Refer to *AIO Configuration Setup* on page 129.

Interface Setup

The Interface menu permits you to change the IEEE488 interface address, using the **Numeric Entry** keys and change its printer port to control or off, using the ▲ and ▼ keys. See Figure 16.

The Baud-rate for the RS232 interface ports 1 and 2 can be set from 1200 to 48,400, the default is 9600.

The Parallel printer settings can be changed from printer to monitor, or off. To return to the normal parameter display, press the **Enter** key.

Interface

—	IEEE488	<i>Adrs no.</i>	:Control
—	RS232#1	<i>Baud rate</i>	:Printer
—	RS232#2	<i>Baud rate</i>	:Printer
—	Parallel		:Printer

Figure 16. Interface Menu

Store Key

If a setup will be used repeatedly, it can be stored in non-volatile memory. To store a setup, press the **Store** key and select a memory location. Pressing the **Store** key brings up a display similar to the one shown in Figure 17. In the display, the memory location followed by an asterisk indicates that setting which is currently active.

Note: The 2503AH power analyzers always power up in the active setting.

- *To store a configuration:*
 1. Press the **Store** key.
 2. Press the appropriate numbers using the **Numeric Entry** keys for the storage location.
- *To store in location #20—Example:*
 1. Press the **Store** key.
 2. Press the **Numeric Entry 2** key.
 3. Press the **Numeric Entry 0** key.

4. Press the **Enter** key.
5. The instrument will respond with the following messages if the storage was successful:

SETTINGS	followed	SETTINGS
STORED IN MEMORY	by	RECALLED FROM MEMORY

Overwriting Existing Storage Locations

The following are the two different ways to achieve overwriting existing storage locations. Procedure # 1 is the easier of the two procedures.

- *To overwrite a stored configuration—Procedure #1:*

1. Press the **Store** key.
2. Press the **▲** and **▼** keys to scroll to the storage location you wish to overwrite.
3. Press the **Menu** key that corresponds to the storage location you wish to overwrite. The instrument will respond with the following messages if the overwrite was successful:

SETTINGS	followed	SETTINGS
STORED IN MEMORY	by	RECALLED FROM MEMORY

- *To overwrite a stored configuration —Procedure #2:*

1. Press the **Store** key.
2. Press the appropriate numbers using the **Numeric Entry** keys for the storage location.

- *To overwrite storage location #09—Example:*

1. Press the **Store** key.
2. Press the **Numeric Entry 0** key.
3. Press the **Numeric Entry 9** key.
4. Press the **Enter** key.
5. The instrument will respond with the following messages if the overwrite was successful:

SETTINGS	followed	SETTINGS
STORED IN MEMORY	by	RECALLED FROM MEMORY

Assigning a Name to a Stored Setting

The analyzer can store up to 64K simple configurations in non-volatile memory. Assign a meaningful name to each stored setting to recall the correct setup later. To assign a name, select the “Edit Directory” line, and then press the key associated with the line showing “Name.” A flashing cursor indicates you can select the first character for the stored setting name. Press the ▲ and ▼ keys to step through the available character set. After selecting the character, press the ► key (right arrow) to move to the next character field, and repeat the process.

Recall Key

Recall complete instrument configurations by pressing the **Recall** key. The display shows the active setting, as well as the one following. Use the ▲ and ▼ keys to scroll through the list of available configurations. Pressing the key next to a given stored setting recalls this setting, and the instrument’s display briefly shows an appropriate message.

- *To recall a configuration—Procedure #1:*
 1. Press the **Recall** key.
 2. Press the ▲ and ▼ keys to scroll to the storage location you wish to recall.
 3. Press the **Menu** key that corresponds to that storage location.
 4. The instrument will respond with the following messages if the recall was successful:

**SETTINGS
RECALLED FROM MEMORY**

It is also possible to edit or delete a stored setting. If a stored setting is modified, and then stored under a new number, the old name is copied. Thus, you need to edit the name, as required to reflect the changes in the setup. See Figure 17.

- *To recall a configuration—Procedure #2:*

1. Press the **Recall** key.
2. Press the numbers for the recall location using the **Numeric Entry** keys.

- *To recall location #15—Example:*

1. Press the **Recall** key.
2. Press the **Numeric Entry 1** key.
3. Press the **Numeric Entry 5** key.
4. Press the **Enter** key.

The instrument will respond with the following messages if the recall was successful:

SETTINGS
RECALLED FROM MEMORY



Figure 17. Store, Recall, Edit Memory

Note: Stored settings can also be recalled by a computer via the IEEE488 interface. The fastest way to reconfigure the analyzer is to use speed sensitive applications. See *High Speed Operation* on page 181.

Range Key

The inputs for the 2503AH analyzer normally operate in autorange mode. However, you can manually change ranges, select the internal shunts and bypass inputs or bypass the Hall Effect CT. To accommodate any external shunt, CT or PT, enter the scale factors.

Notes:

- 1) The internal current shunts are in the 0.05A to 20Arms ranges;
- 2) The internal HALL Effect transducers are in the 5A to 40Arms ranges;

3) The external shunt/CT voltage inputs are in the 0.01V to 5Vrms ranges.

The three images depicted in Figure 18 show the displays giving access to the analyzer's ranging. The first display is called up by pressing the **Range** key. The second display shows the bottom 3 lines of the display accessed using the ▼ key.

Use the **Range** key to enter input ranges, select the appropriate channel (A, B or C). Modify the range when the cursor is in the auto **V** field by pressing the ▲ and ▼ keys.

In the case of the current measurement, you can select "Shunt," "Bypass" or "Hall." When selecting "Bypass", enter a scale factor.

To make a numeric entry: return to the display that gives access to the line showing Setup Input Scaling, (press the **Enter** key). Like other selections, the Input Scaling can be set for ChA, ChB or ChC. Select the channel on the first line.

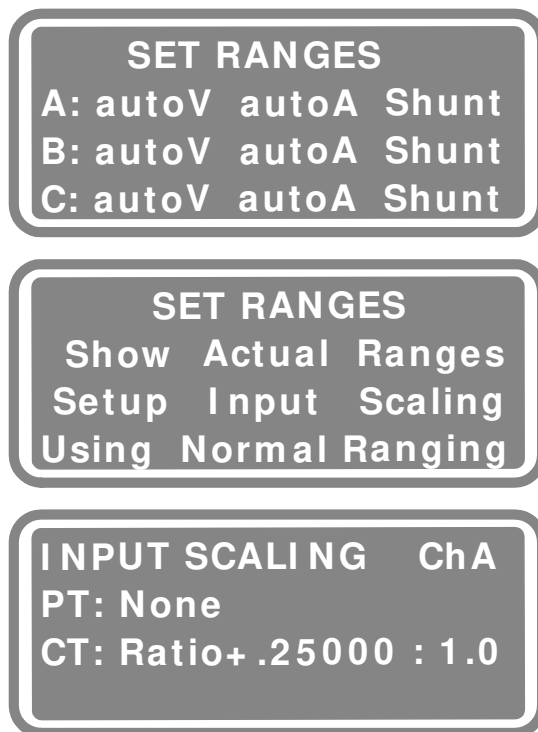


Figure 18. Setting Up Input Scaling

The third display can be accessed by selecting the Setup Input Scaling line. Press the respective **Menu** key to select which setup.

Notes:

- 1) The Input Scaling menu is also available by selection under the menu initiated by pressing the **Channel** key.
- 2) For higher sensitivity, the "Hall Effect CT" input can be configured for multiple turns. The last display shows the setting for 4 turns through the CT.
- 3) To show the active ranges for all three channels, press the **Menu** key next to the line with: Show Actual Ranges.

- 4) To limit autoranging, see *Preventing Autoranging for Inrush Measurements* on page 82.

Select the Ranging Technique

Under “normal” circumstances the analyzer automatically performs an autorange to provide enhanced input protection at all times, even when a fixed range is selected. In the rare circumstance that this is not the desired action, you can select for the “Strict” ranging mode, where the analyzer will “hold” a selected “fixed” range under all circumstances. The state of this flag is always volatile and defaults back to “normal” ranging following reset.

Local Key

Use when switching between **Remote** and **Local** commands when using the IEEE488 interface. See *Digital Control Interfacing* on page 135.

Print Key

To generate a data printout, press the **Print** key, and then select the appropriate port and report format. Figure 19 gives examples of print menu displays. Note that if the analyzer's serial ports are also set for Printer mode, the parallel port is moved down to the “fifth” display line.

Printout Display

Press the ▼ key, to select the Parallel Printer. After the parallel printer is selected, the PRINTOUT TO PARALLEL display appears. When selecting Harmonic print, you must select the channel and select whether you want *voltage* or *current* harmonics, otherwise, the instrument defaults to print the first 50 current harmonics for ChA.

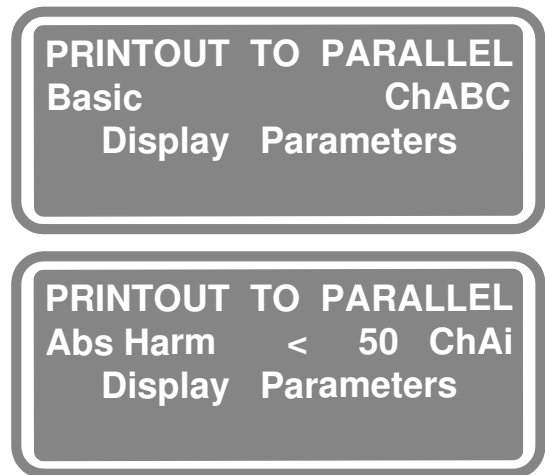


Figure 19. Printout Displays

Data Printout

The following Figure 20 shows a data printout at 50% reduced. Both, the Basic data, and the Harmonics data printout examples are shown. Even though many additional parameters may be needed for specific applications, the Basic and Harmonic printout includes all the data.

A number of application-specific print formats are available.

- Basic data
- Basic + Accum
- Absolute (harmonics in amps)
- Relative (harmonics as a % of fund)
- Current
- Presently defined display lines

Notes:

1) If a compatibility issue arises due to minor difference in printer control signals, attempt resolution by turning the connected printer off and back on again.

2) The 2503AH power analyzer uses the extended character set, as supported by IBM compatible, Proprinter, type printers. Set laser printers to a character set that includes the character 92 (Omega), which is frequently used in electrical applications. The character set that gives results on most printers is PC-8.

BASIC DATA PRINTOUT				CHANNEL A ABSOLUTE HARMONICS DATA			
Channel A				CURRENT			
Frequency				HARMONIC	AMPLITUDE	PHS-FundV	FREQUENCY
60.013 Hz				1	289.69mArms	+0.419°	60.004 Hz
DC Current				2	4.98mArms	-61.246°	120.01 Hz
AC Current				3	268.90mArms	+168.400°	180.01 Hz
AC+DC Current				4	6.64mArms	+127.054°	240.01 Hz
Rectified Current				5	228.80mArms	-13.414°	300.02 Hz
Peak Current				6	8.01mArms	-58.949°	360.02 Hz
224.7mAavg				7	177.34mArms	+153.070°	420.03 Hz
+1.6561 Apk				8	8.01mArms	+115.330°	480.03 Hz
Crest Factor				9	120.79mArms	-35.151°	540.03 Hz
Form Factor				10	7.63mArms	-78.772°	600.04 Hz
+2.253				11	66.12mArms	+138.447°	660.04 Hz
Current THD				12	5.91mArms	+86.372°	720.04 Hz
+145.36%				13	22.59mArms	-49.880°	780.05 Hz
DC Voltage				14	3.64mArms	-122.467°	840.05 Hz
+0.03 Vdc				15	9.08mArms	-82.544°	900.05 Hz
AC Voltage				16	2.46mArms	-3.110°	960.06 Hz
117.93 Vac				17	24.64mArms	+100.778°	1.0201KHz
AC+DC Voltage				18	2.71mArms	+118.298°	1.0801KHz
Rectified Voltage				19	28.75mArms	-92.031°	1.1401KHz
106.41 Vavg				20	3.11mArms	-105.870°	1.2001KHz
Peak Voltage				21	23.09mArms	+73.968°	1.2601KHz
+166.87 Vpk				22	3.10mArms	+41.886°	1.3201KHz
Crest Factor				23	14.96mArms	-131.431°	1.3801KHz
+1.415				24	3.34mArms	-178.308°	1.4401KHz
Form Factor				25	7.99mArms	-7.120°	1.5001KHz
+1.108				26	3.10mArms	-47.656°	1.5601KHz
Voltage THD				27	9.45mArms	+114.031°	1.6201KHz
+1.52%				28	2.77mArms	+78.992°	1.6801KHz
DC VA				29	11.21mArms	-104.847°	1.7401KHz
+0.00 Wdc				30	3.40mArms	-146.916°	1.8001KHz
AC VA				31	10.36mArms	+49.103°	1.8601KHz
59.70 VAR				32	3.66mArms	-8.796°	1.9201KHz
AC+DC VA				33	8.25mArms	-165.104°	1.9801KHz
59.70 VA				34	2.91mArms	+140.186°	2.0401KHz
DC Power				35	6.24mArms	-29.911°	2.1001KHz
+0.00 Wdc				36	2.85mArms	-86.726°	2.1601KHz
AC Power				37	7.28mArms	+98.795°	2.2201KHz
+33.48 Wac				38	2.59mArms	+30.630°	2.2801KHz
AC+DC Power				39	7.63mArms	-116.117°	2.3401KHz
+33.48 W				40	2.42mArms	+172.716°	2.4001KHz
Peak Power				41	7.60mArms	+37.415°	2.4601KHz
273.47 Vapk				42	2.13mArms	-64.160°	2.5202KHz
VAR				43	5.92mArms	+172.664°	2.5802KHz
+49.43 VARac				44	1.89mArms	+61.170°	2.6402KHz
AC PF				45	4.78mArms	-46.570°	2.7002KHz
+0.5608				46	1.58mArms	+83.804°	2.7602KHz
AC Phase				47	6.00mArms	-27.323°	2.8202KHz
+0.5608				48	1.09mArms	-141.218°	2.8802KHz
AC+DC Phase				49	6.00mArms		2.9402KHz
+55.888°							
Displacement PF							
+1.0000							
Fundamental Phase							
+0.339°							
Load Impedance							
232.97 Ω							
Load Resistance							
+130.65 Ω real							
Load Reactance							
-192.89 Ω imag							

Figure 20. A Basic Data Printout

Functional Configurations

The information provided here gives additional detail and examples to setting up configurations. Use the keys: **System**, **Quick**, **Menu**, and **Select/Edit** to access the various Configuration displays. Refer to *Setup Submenus* on page 55 and *Functional Line Descriptions* on page 58.

Notes:

- 1) To add a data line: from the Data (results) display, press the ▼ key to select a “blank line.” Edit the display to define the line by pressing the **Menu 4** key.
- 2) The analyzer is configured for checking the validity of the Voltage Source you are using to perform your test. Disable this feature only for engineering or pretest qualification on your devices being tested.

Fundamental Frequency

The power analyzers offer measurement capacity from 0.0001Hz to over 500kHz. However, low minimum fundamental frequency yields significantly slower autoranging and settling times upon signal application. Selecting high minimum fundamental frequency allows the analyzer to autorange within a single period of the applied waveform.

Fundamental Frequency Range

The maximum fundamental frequency range that can be entered is 100:1. This only affects the measurement of the sync frequency, and is only available if a fixed fundamental frequency was not selected. To support the analyzer in making *timely* decisions regarding signal detection, select a frequency range above where there is known to be little signal content. 40Hz is suitable for most line power measurements and 1kHz for high frequency signals saves

time during autoranging. A range of 10kHz to 500kHz is recommended for all high frequency measurements.

The following steps are for configuring the measurement range for the channels being used. See the next examples for channels A and B.

- *To configure ChA to measure signals 40Hz to 100Hz:*
 1. Press the **System** key.
 2. Press the **Menu 2** key. This selects “Channel Grouping.”
 3. Press the **Menu** key that corresponds to Channel A three times.
 4. Press the **Menu 1** key until the display line reads “Advanced Setup.”
 5. Press the **Menu 3** key twice.
 6. Enter in “100” by using the **Numeric Entry** keys.
 7. Press the **Enter** key once. The display line should read “Sync: 40 - 100Hz”.
 8. Press the ▼ key twice.
 9. Press the **Menu 4** key. This selects the Filter line.
 10. Enter in “5K” by using the **Numeric Entry** keys.
 11. Press the **Enter** key twice.
- *To measure a fundamental signals 20kHz to 80kHz:*
 1. In the Channel Grouping display, press the **Menu** key that corresponds to Channel B three times.
 2. Press the **Menu 1** key until the display line reads “Advanced Setup.”
 3. Press the **Menu 3** key once.
 4. Enter in “20K” by using the **Numeric Entry** keys.
 5. Press the **Enter** key once.
 6. Enter in “80K” by using the **Numeric Entry** keys.
 7. Press the **Enter** key once. The display line should read “Sync: 20K - 80kHz”.
 8. Press the ▼ key twice.
 9. Press the **Menu 4** key. This selects the Filter line.
 10. Enter in “500K” by using the **Numeric Entry** keys.
 11. Press the **Enter** key once.

12. Press the ▼ key once.

13. Press the **Menu 4** key to change the analysis to “none.”

Note: if you wish to perform harmonic analysis on the output of your device then ignore this step.

14. Press the **Enter** key twice.

- *To change the lowest fundamental frequency:*

1. If the “Lowest Freq:” is not in the range of 40Hz to 4kHz, press the **Menu 3** key and enter a new lowest fundamental frequency expected within range.

2. Press the **Enter** key to complete this selection.

Note: Under some circumstances autoranging forms an oscillation. In this case, you can reduce the lowest fundamental frequency to below the frequency of oscillation.

Input Filter

An input filter of approximately 1000 times the minimum fundamental frequency is automatically provided in this Setup method. Harmonic measurements of up to the 49th harmonic are provided by this setup, using a harmonic bandwidth of 25% of the fundamental frequency, and using a "windowed" Fast Fourier Transform (FFT) technique.

Fixed Fundamental Frequency

- *To configure the fixed fundamental / peak measurement:*

1. Press the **System** key.

2. Press the **Menu 2** key to select “Channel Grouping.”

3. Press the **Menu** key that corresponds to the Channel you are using three times.

4. Press the **Menu 1** key until the display line reads “Advanced Setup.”

5. Press the **Menu 2** key. The cursor will flash on “Sync Frequency.”

6. Press the ▲ key twice. “Fixed” will display.

7. Press the ► key (right arrow) once.

8. Enter in “100K” using the **Numeric Entry** keys. The “K” changes Hz to kHz.

9. Press the **Enter** key once.
10. Press the **Menu 4** key. to select the “Filter” line.
11. Enter in “200K” by using the **Numeric Entry** keys.
12. Press the **Enter** key twice.

To enter a Fixed frequency, applicable for Inrush measurements, pre-synchronize the instrument to 60Hz (50Hz) by fixing the synchronization frequency to 60.000Hz. Where heavily distorted line signals, or modulation frequencies are close to the fundamental frequency, a fixed synchronization ensures accurate measurements.

Frequency Sync Source

For synchronization purposes determine the Sync Source shown as “From:” on the display. Each channel can be synchronized to itself, or to another channel. The From: display line allows you to define from where the subject channel gets its synchronization. Normally, for ChA, the sync source is ChA V or ChA I. With this setting, the Supervisory automatically selects the most stable sync source. For some applications select, V only or I only to produce better results.

For example: A motor drive circuit (with PWM control) gives results with I only, as the current is *filtered* by the motor.

Sync Result Averaging

Normally the fundamental frequency is measured over the defined measurement period with no result averaging. This selection allows you to impose result averaging on the measured “synchronization frequency.” This is useful in situations where the synchronization frequency has poor stability.

Minimum Measurement Period

The minimum amplitude measurement period is typically within 10% + 10 ms of the entered period. The Sync Measurement Period sets the measurement period of the synchronization signal independent of the measurement period for amplitude.

Synchronizing the Source

For some applications, synchronizing to another channel may be necessary. For example, an HF electronic ballast efficiency measurement will produce optimum results when synchronizing the sampling rate on the line and HF side. So, the HF channels (B and C) can be configured to obtain their synchronization from ChA. This guarantees that samples on both sides are perfectly synchronous. Yet, to optimize for CF measurements on the HF side, it is better to let ChB and/or C be synchronized to the high frequency. Refer to From display line in *Functional Line Descriptions* on page 58.

Harmonics Analysis

You can select whether harmonic analysis is to be performed. Refer to Max. Harmonics display line in *Functional Line Descriptions* on page 58.

Note: If harmonic analysis is enabled, then IEC1000-3-2 (EN 61000-3-2) compliant analysis is always selected using the Standard Setup method.

For Simple and Averaged Analysis Types:

If the Analysis line has been set to Single or Averaged, you can:

- Enter a maximum harmonic.
- Set the maximum range for harmonic measurements.
The default value is 49, however values down to 2 and up to 2048 are allowed. Note that when large values are set, they can be overridden by the selection of the input-filter corner frequency.
- Enter an integer value to set the Fundamental Bandwidth for the measurement of each individual harmonic. Note that changing this value from the default of 4 may improve or severely worsen the accuracy and stability of harmonic measurements. It's best to set large figures when it is known that the signal has little frequency modulation, as it is desired to eliminate a high general noise content, and the fundamental frequency is below 10kHz. Only use lower than the default values when necessary due to significant frequency modulation.

Note: This setting also limits the minimum amplitude measurement period to the number of input cycle periods. High ratios yield long measurements, such as 1000:1 with a 0.0001Hz fundamental frequency means a measurement period of more than 100 days.

- Select the FFT Type window, where extremely accurate inter-harmonic phase measurements are required, choose from normal or square. By default, the 2503AH analyzer uses a modified Blackman-Harris type windowing technique to provide stable harmonic measurements throughout the frequency range and in most applications. If excessive instability is found in harmonic measurements then you can test both methods to determine which is best.

Note: In most cases the affects of the “Fundamental Bandwidth” ratio and “FFT Type” selections are interactive. Do not adjust these unless absolutely necessary, or requested to do so by Xitron Technologies customer support staff.

Source Validity/Checking

IEC1000-3-2 varies depending on the selected analysis. You can also select to have “Source Checking” performed here, or ignore the source quality. Values apply while the measurements are being made. Refer to Figure 21 for specifications.

This permits analysis without requiring access to an expensive source. If the analysis type is any choice other than IEC1000-3-2⁴, the Source Checking line does not appear.

- *To disable source checking*

1. Press the **System** key.
2. Press the **Menu 2** key.
This selects Channel Grouping.
3. Press the **Menu** key three times for the Channel you are performing the test on.
4. This brings you into the IEC1000-3-2 Setup submenu.

IEC1000-3-2 Source Checking

- Voltage accuracy/stability: +/- 2% of nominal
- Frequency stability: +/- 0.5% of nominal
- Phase accuracy (3-phases only): +/-1.5° of 120°
- Crest Factor: 1.40 – 1.42 and peak occurs between 87° – 93° after zero crossing.
- Maximum Harmonic Voltages (during test)
 - 3rd harmonic: 0.9%
 - 5th harmonic: 0.4%
 - 7th harmonic: 0.3%
 - 9th harmonic: 0.2%
 - Even harmonics from 2 – 10: 0.2%
 - All harmonics from 11 – 40: 0.1%

Figure 21. Source Checking Specification

⁴ Current standard is EN 61000-3-2

5. Press **Menu 1** key 2 times or until Check Source Valid appears.
6. Press the **Menu 2** key one time this will toggle Yes or No for Source Checking.
7. Press the **Enter** key twice.

Source Checking ON

Source Checking must be turned On when you are:

- Performing verification of EN 61000-3-2 compliance;
- Certifying a device in accordance with the EN 61000-3-2 specifications.

Source Checking OFF

In order to certify compliance the “Source Checking Analysis” is performed continuously. However, for engineering evaluations, you can operate the test with 230Vac line voltage and with Source Checking turned Off.

Displaying Harmonics

Harmonics data can be displayed in several ways. The most common is in absolute number harmonics, as amps or volts. Harmonics can also be displayed in dB and Percent. The standard is to show harmonic distortion for all harmonics; however, it's also possible to display a limited group of harmonics. For instance you can select to display the 3rd to 9th harmonic in percent of the overall RMS current.

Displaying THD

Because of demands from various application fields, you can even select from 3 different ways to display THD. The most common way is as a percent of the fundamental waveform amplitude. This parameter is called THD-Fund. THD can also be shown as a percent of the total RMS level (THD-Sig) or as a percent of the harmonic content in the signal (THD-Harm).

- *To define a harmonic analysis:*
 1. Select the display line.
 2. Press the **A** key in the PARAMETER & EQUATION CONTROL field to select a line for current harmonics. This causes the display line to be selected for overall (rms) current measurement.

- *To display voltage harmonics:*

1. Select the **V** key.
2. Press the **Harmonic** key in the front panel GENERAL field in order to change the AC+DC into Harmonics to be measured.

The display now shows the starting-and-ending harmonic, for which the current or voltage level will be displayed. To display the fundamental, the starting-and-ending harmonic is “1.” To display the level of harmonic content for a group of harmonics (i.e. from 3 – 9) modify the starting-and -ending number.

Harmonics Measurement Setup

The following Harmonic Display Line Configuration procedure is an example on how to configure a display line for measuring a single or a summation of either Voltage or Current Harmonics.

- *To measure current harmonics—Example:*

1. Press the **Menu 1** key. Display should read Line #00 Parameter.
2. Press the **Menu 2** key. The cursor will flash on the second display line.
3. Press the **A** key to select the True RMS Amps parameter, or Press the **V** key to select the True RMS Volts.
4. Press the **Channel** key.
5. Press the **▲** and **▼** keys to select ChA for example.
6. Press the **Harmonic** key. True RMS A CHA AC + DC will change to True RMS A CHA 1-1.
7. The cursor will flash on the first point of entry for the Harmonic value or Harmonic range.

The Harmonic value can be displayed as shown:

- If both numbers are the *same*, then the *value* at that Harmonic will display:
 - 1-1 = Fundamental value only
 - 2-2 = 2nd Harmonic only
 - 3-3 = 3rd Harmonic only
 - 9-9 = 9th Harmonic only
 - 35-35 = 35th Harmonic only

- If the numbers are *different*, then the value for the “summation” of the Harmonic will be displayed:
 - 1-3 = Fund. to the 3rd Includes the 1st, 2nd and 3rd Harmonics
 - 2-9 = 2nd to the 9th Includes the 2nd through the 9th Harmonics
 - 3-15 = 3rd to the 15th Includes the 3rd through the 15th Harmonics
 - 9-21 = 9th to the 21st Includes the 9th through the 21st Harmonics
- *To configure current harmonics—Example:*
 1. Use the **Numeric** keys to enter a number on the display or use the ▲ and ▼ keys to select a particular Harmonic number.
 2. Press the **Enter** key once to enter the selected number before the selection of the second number is made.
 3. When you have configured the Harmonic, press the **Enter** key to exit back to to view the data results display.
 4. Repeat the above for each individual display line to be configured.
- *To perform a harmonic analysis for ChA:*
 1. Select the parameter: “True RMS A ChA AC+DC” or another one.
 2. On Line 3 select the default units for harmonic levels as “Ratio” of the selected reference. See Figure 22.
 3. Choose a harmonic—It’s important to choose a harmonic as a percent of overall current. First change the starting number, then press the **Enter** key to accept the value. Next change the ending number and again press **Enter** to accept the entry.
 4. To return to the data display, press the **Enter** key a third time
 5. The final result is that the harmonic is displayed as a percent of the overall RMS display as Percent current. This procedure applies to individual voltage and current harmonics, as well as to a range of harmonics.

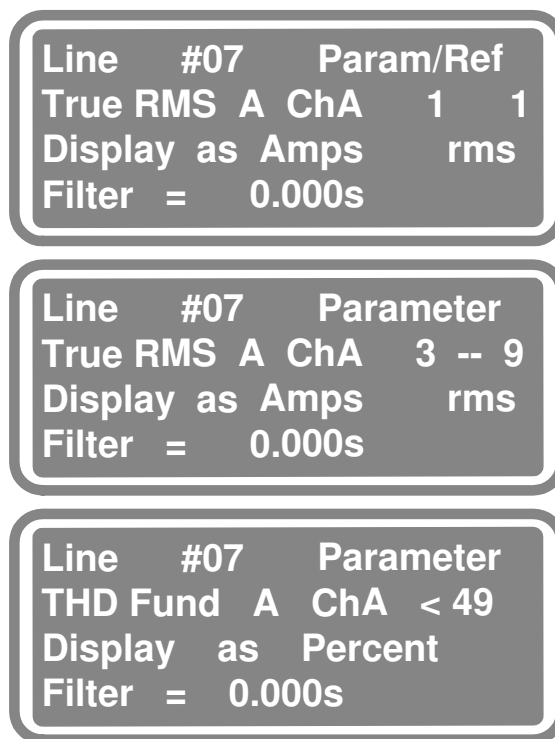


Figure 22. Displaying Harmonics as Percent

Multiple lines can be defined for individual harmonics. An individual harmonic can be displayed as a percent of another parameter.

- *To display harmonic percents of reference parameters:*
 1. Press the **Menu 1** key repeatedly until the display shows “Param/Ref” (or a related choice).
 2. Press the **Menu 4** key, to change the fourth line used as the reference parameter.
 3. Press the **Enter** key to accept the choice.
 4. Use the ▼ key to scroll to the fifth line, which allows the display to be defined in Percent, Ratio, Units, or dB. This allows you to change the display to be percentages of the selected reference. See Figure 23.

You can define another harmonic, such as the fundamental current as the reference, thus displaying the harmonic as a Ratio or Percent of the fundamental current level.

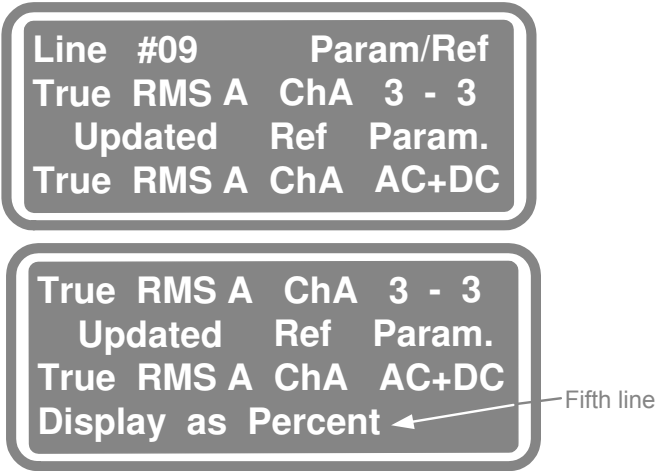


Figure 23. Choosing Harmonic Percent

THD can be displayed by selecting the line and pressing the **THD** key. Use the **▲** and **▼** keys to select the desired THD type. The instrument defaults to THD-Fund. While the cursor flashes on THD-Fund, press the **▲** key to select any of the THD parameters. Select the channel and whether the THD applies to voltage or current. The standard THD calculation is performed up to the 49th harmonic. See Figure 24.

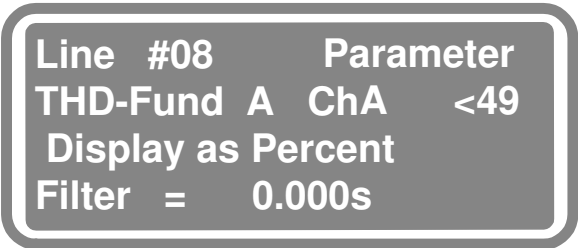


Figure 24. Displaying the 49th Harmonic

You can increase this to the 99th. harmonic, or decrease it to a smaller number. For numbers above 99, use the **Numeric Entry** keys.

As with other parameters, a first order display filter can be used to smooth fluctuating readings.

Configuring for Peak Parameters

“Peak” amperage readings are configurable from the Configuration displays listed in *Measurement Data* on page 44. Choose from these selections:

High Pk • Low Pk • Peak • Pk-Pk • Acc. Max • Acc. Min • Acc.Pk

Note: The Acc. Max/Min Parameters are controlled by the **Accumulate** key. The Start, Clear and Pause functions for the Accumulated Parameters are found in the menu that displays when the **Accumulate** key is pressed.

Preventing Autoranging for Inrush Measurements

The exception for Autorange as a normal mode occurs when making inrush current/voltage measurements, or when fluctuating levels are being measured, (i.e., EN 61000-3-2). In these cases, *freeze* the range to prevent the instrument from autoranging up-or-down. Even though you may have selected a fixed range, the instrument tends to range up if its input is overloaded by more than 250%. Change to Strict Ranging by pressing the key next to the “Using Normal Ranging” line. With “Strict Ranging,” the analyzer maintains the selected input range, even in overload conditions. The analyzer returns to Normal Ranging when reset or when turned off and on again.

Controlling Inrush Parameters

Inrush—Where voltage and current are continuously updated with the highest peak excursion from zero found. These parameters can be *cleared*” by pressing the **Inrush** key when no menu is being displayed.

Controlling Accumulated Parameters

“Accumulated” parameters (e.g. WHr etc.) can be started, paused, and cleared using the **Accumulate** key. These parameters are being updated when the ACCUMULATE LED annunciator is illuminated.

Pause—The accumulated parameters are held at their present values. This causes the ACCUMULATE LED to extinguish.

Start—Begins an accumulation process. Note that if Start is selected subsequent to Pause without clearing the results, the accumulation process restarts from the results at which it was paused.

Clear—Resets all accumulated parameters to their initial states. This can be performed at any time, including when an *accumulation* is in progress. This is the only available selection when the accumulation is configured as being controlled by the rear panel control input.

Holding Measurements

When input signals are only present for a limited period of time it is often desirable to *hold* the measured results and then display the measured results after the input has become inactive. Press the **RUN/HOLD** key. This key *toggles* between the RUN and the HOLD states. When the measurements are being held the LED illuminates.

When the rear panel control input is configured as controlling the HOLD state the **Hold** key accesses the Rear Panel's Control Input configuration menu.

Grouping Channels

The **System's** Channel Grouping submenu brings up the CHNL TYPE I/O display. See Figure 25. This display allows you to:

- Group channels for synchronous measurements;
- Set phase rotation relationships.
- Set efficiency calculation measurements.
- Jump to the Setup sub-menus. See *Channel Grouping Submenu* on page 53.

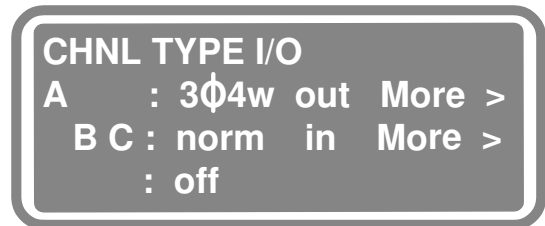


Figure 25. Grouping Channels

- *To group channels—Example:*
 1. Press the System key.
 2. Press the **Menu 2** key. This brings up CHNL TYPE I/O display where channels: A, B, and C have separate lines.
 3. With the objective to group ChB with ChA, press **Menu 3** key to select channel B line.

4. Press the ◀ key (left arrow) to highlight B and while the cursor is flashing on B, press the ▲ key. This visually and internally groups ChA and ChB.
5. Now configure ChA and ChB as one, selecting Input, Output or Aux in accordance with your needs. Note that the line for ChB automatically turns to Off.
6. When complete, press the **Enter** key. The channel grouping applies to all lines of Data (results). If ChA and ChB are grouped, you will see ΣA (sum of A) in the right column of the data display.
7. To view data press the **Enter** key again.

Notes:

- 1) ChC can be moved up following the same method as above, or you can configure it separately.
 - 2) To save steps, you can use the **Quick** key to configure a factory preset grouping, and then modify as required. (Press the **Quick** key, the **Enter** key and then press the **Menu 1** key.)
- *To ungroup channels—Example:*
 1. To access the CHNL TYPE I/O display, press the **Menu 2** key. The grouped channels display on the same line.
 2. With the objective to ungroup ChA and ChB, press **Menu 2** key.
 3. Next press the ◀ key (left arrow) to highlight B and while the cursor is flashing on B, press the ▼ key. This visually and internally ungroups ChA and ChB.
 4. To turn the line of configurable options for ChB back on, i.e. norm, press the ▶ key (right arrow) and then the ▲ key.

Note: ChC can be ungrouped following this same method as above.

Configuring Group Frequency Measurements

Inputs that are used as sync sources for one or more channel(s) are configured according to the fundamental frequency requirements of the group using that input as its sync source. These inputs can not otherwise be configured for independent frequency measurement.

Inputs, which are not configured as potential sources of a fundamental frequency, can be configured for independent frequency measurement. This

can be achieved by pressing the **Channel** key followed by the **Menu 3** key. You can then configure any inputs available for such measurements.

Measuring Delta Systems

When a group of channels are configured as measuring a 3-phase 3-wire, or “delta” system, then the analyzer needs to know the relative phasing of each channel to ensure the channels can be correctly combined to produce “total power.”

Example: ChA and ChB can be set to operate as a 2-Wattmeter instrument in a 60Hz, 3-phase, 3-wire configuration, with ChC operating by itself on a 400Hz line.

- If you are unsure as to the correct settings, try the following:
For a two-channel measurement of a “delta” configuration, set only one channel as being in-phase. For a three channel measurement set all channels as being in-phase.
- If the total power is correctly computed by the instrument, but the total power factor has the reverse lead/lag indication to that expected, then reverse all channels.
- If the total power is not correctly computed by the analyzer, or INVALID PHASE displays, then one or more (but not all) settings are incorrect.
- *To group channel using Quick key:*
 1. From a Data display, select a line using **Menu** and **Select/Edit** keys.
 2. From that Configuration display, press the **Quick** key.
 3. Press the **Menu 2** key to place cursor on the second line.
 4. Continue to press the **Menu 2** key until the line shows a setup appropriate for your use. Note that you can make additional configuring as required in a later display.
 5. Press the **Enter** key, twice. The message: “Selected Factory Defaults Have Been Set” displays momentarily and then the Configuration display reappears.
 6. Modify the parameters to match your needs and press the **Enter** key again.

Efficiency Measurement Setup for Two Channels

The following steps will configure the analyzer's ability to "calculate efficiency." These steps are based on a 2503AH-2Ch analyzer configuration for efficiency measurement.

- *To configure your analyzer to calculate efficiency:*
 1. Press the **System** key once.
 2. Press the **Menu 2** key. This selects Channel Grouping.
 3. Press the **Menu 2** key. This selects the line reading: A: norm aux More.
 4. Press the **▶** key (right arrow) once the cursor will flash on "aux."
 5. Press the **▲** key until this selection reads in.
 6. Press the **Enter** key once.
 7. Press the **Menu 3** key. This selects the line reading: B: norm aux More.
 8. Press the **▶** key (right arrow) once, the cursor will flash on "aux."
 9. Press the **▲** key until this selection reads out.
 10. Press the **Enter** key twice.

Note: If your analyzer has a third output that you would like to use in the calculation of efficiency then group channels B and C together. However, if channels B and C are grouped, with your device connected to only one of the grouped channels, the "efficiency parameter" does not work. To correct this situation, apply a signal to the unused channel or ungroup the two channels.

Rear Panel Control Input

The rear panel's Control Contact Closure/TTL Input can be configured as Inactive, Control, Accumulation, or Control RUN/HOLD.

- *To configure the TTL input:*
 1. Press the **System** key.
 2. Select the Rear Panel Control display menu line.
 3. Make the respective selections. You can inactivate, control accumulation or control RUN/HOLD. As a check feature, the menu displays the current state of this input in the lowest display line of this menu.

Saving an Instrument Configuration

Up to 65536 different configurations of channel groupings, group configurations, frequency measurement configuration, input range/terminal selections, CT and PT selections, and rear panel control selections can be stored in a non-volatile manner.

The instrument always restores the last recalled store when recovering from power application.

- *To store instrument configuration:*

1. Press the **Store** key.
2. Display and select the desired store number using the ▲ and ▼ keys and the respective **Menu** key,
—Or—
Enter the desired number directly using the number keys and press the **Enter** key. New stores can be created using this technique.

A presently valid store number can have a character string “attached” as its name by following the procedure below:

- *To recall a stored configuration:*

1. Press either the **Store** or **Recall** key.
2. Press the **Menu 2** key.
3. Select the required store number using the ▲ and ▼ keys and the corresponding **Menu** key,
—Or—
Enter the store number using the number keys.
4. Press the **Menu 2** key.
5. A “name” can then be entered using the ▲ and ▼ keys to change the character at the cursor position, and the ► and ◄ keys to move the cursor position.

Recalling a Previously Stored Instrument Configuration

- *To recall instrument configuration from memory:*

1. Press the **Recall** key to remove a Previously Stored Instrument Configuration.
2. Display and select the desired store number using the ▲ and ▼ keys and the respective **Menu** key.

—Or—

Enter the desired number directly using the number keys.

3. Press the **Enter** key.

A presently valid store number can have a character string *attached* as its name.

- *To attach a character string to a name:*

1. Press either the **Store** or **Recall** key.
2. Press the **Menu 2** key.
3. Select the required store number by using the ▲ and ▼ keys and the corresponding **Menu** key.

—Or—

Enter the Stored number using the **Numeric Entry** keys.

4. Press the **Menu 2** key.
5. A “name” can then be entered using the ▲ and ▼ keys to change the character at the cursor position, and the ► and ◀ keys to move the cursor position.

Removing a Previously Stored Instrument Configuration

A previous stored instrument configuration can be removed from the non-volatile memory.

- *To remove a previously stored configuration:*

1. Press either the **Store** or **Recall** key.
2. Press the **Menu 2** key.

3. Select the required store number by using the ▲ and ▼ keys and the corresponding **Menu** key.

—Or—

Enter the Store number using the **Numeric** keys.

4. Press the **Menu 3** key.

Note: Although many sets of configurations can be stored in the non-volatile memory, *unused* sets should always be deleted or reused to conserve memory.

Locking the Instrument's Configuration

A slide operated switch is located on the rear panel, just above the power receptacle. This switch can be used to disable any reconfiguration of the instrument by any front panel means other than recalling previously stored configurations.


This switch is recessed into the rear panel, allowing you to place a “paper seal” over the switch to prevent unauthorized reconfiguration.

The following are not permitted while this switch is in the “disabled” position.

- √ Changing any display line parameters or types.
- √ Storing instrument configurations.
- √ Changing channel groupings or group configurations.
- √ Changing range and terminal selections for any channel.
- √ Changing Input Frequency Measurement configurations.
- √ Performing “Input” or “External” Calibrations.

Rear Panel Connections

It is assumed that the power into a load is being measured. If the power drawn from a source is being measured, then replace *load* with *source* in each applicable text position when deciding which configuration/method to use.

 **CAUTION:** Damage will occur, if the input wiring is mixed up and line voltage is applied across the Bypass input. Additionally, the internal shunt can be damaged if line voltage is applied in a full short circuit across the shunt.

Current Transformer Measurement Connections

Measure current input signals via the voltage drop across internal shunt(s), or via a voltage drop across an external shunt. When using internal shunts, the voltage drop is limited to a maximum of several hundred millivolts. See Figure 26. See the *Range Key* on page 65.

The analyzer has a high sensitivity, 50mA range on one side, while also being able to measure up to 50A peak (20Arms) via the built-in shunts. In automated electronic ballast testing for example, use CTs to achieve acceptable measurements/analysis of high frequency signals. In automated test systems, a computer controlled switching system is used to connect the signals to the measuring/analyzing instruments.

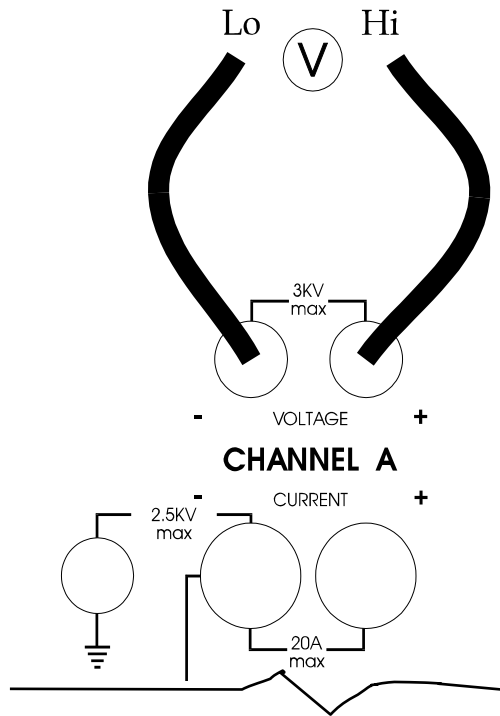


Figure 26. Typical Voltage Connection

External CTs and potential transformers (PTs) are effective in high power applications and where the analyzer's input circuitry would over burden the system. See Figures 27, 28 and 29.

Set the PT ratio to match the PT you are using.

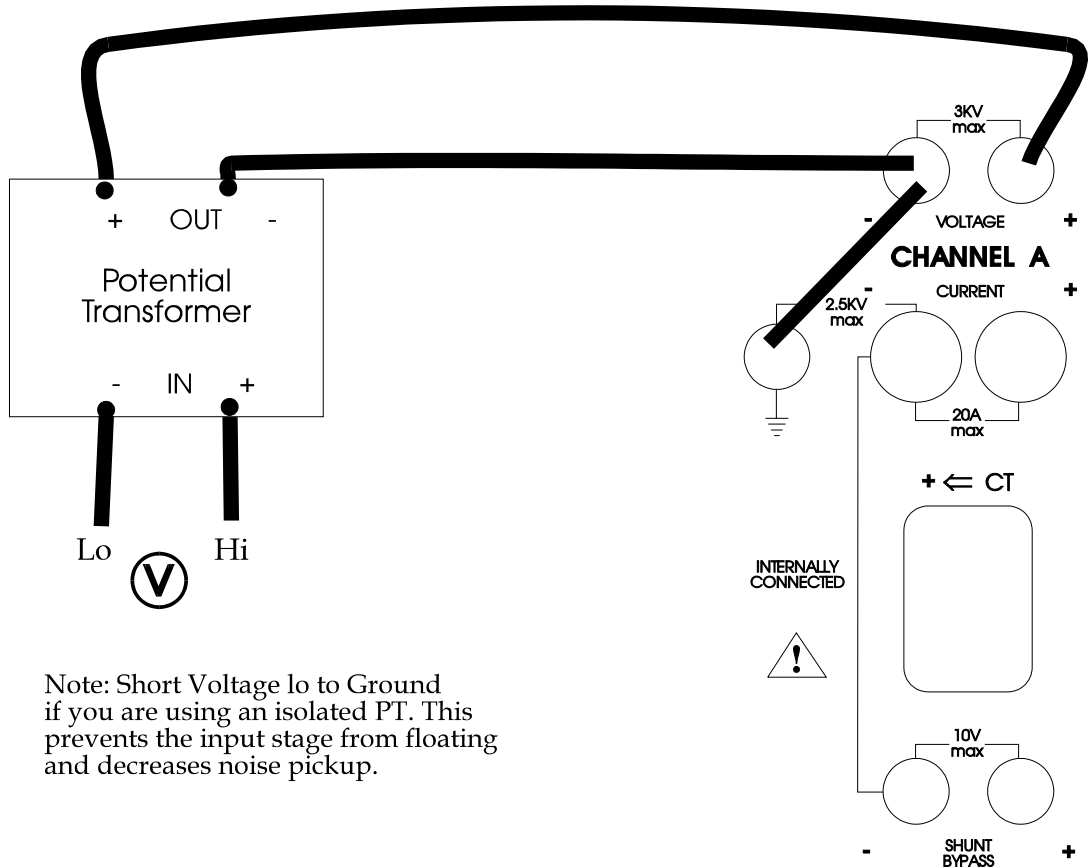


Figure 27. Ext Potential Transformer Connection

For electronic ballasts with typical signal frequencies from 20 – 80kHz, the combined capacitance and inductance of the cabling and signal switching system cause the ballast loading to be significantly different from its *normal* lamp load. A solution is to keep the ballast's wiring short and pick up the high frequency current with CTs.

Route the CT output via the computer controlled switching system without any problems. In this case, the Bypass input is used and ready for you to enter the scale factor for the particular CT model. See Figure 28.

Additionally, high power levels generally require CTs, and can also necessitate PTs. High current levels, in excess of 50 amps, make external shunts or CTs mandatory. Not only is it impractical to equip the analyzer with terminals capable of such high currents, the internal shunts and wiring would have to be equally suited. External shunt values in the low milliohm range are necessary for high current measurements.

Set the CT Ratio to match the CT you are using.

Note: Short Current Io to Ground if you are using an isolated CT. This prevents the input stage from floating and decreases noise pickup.

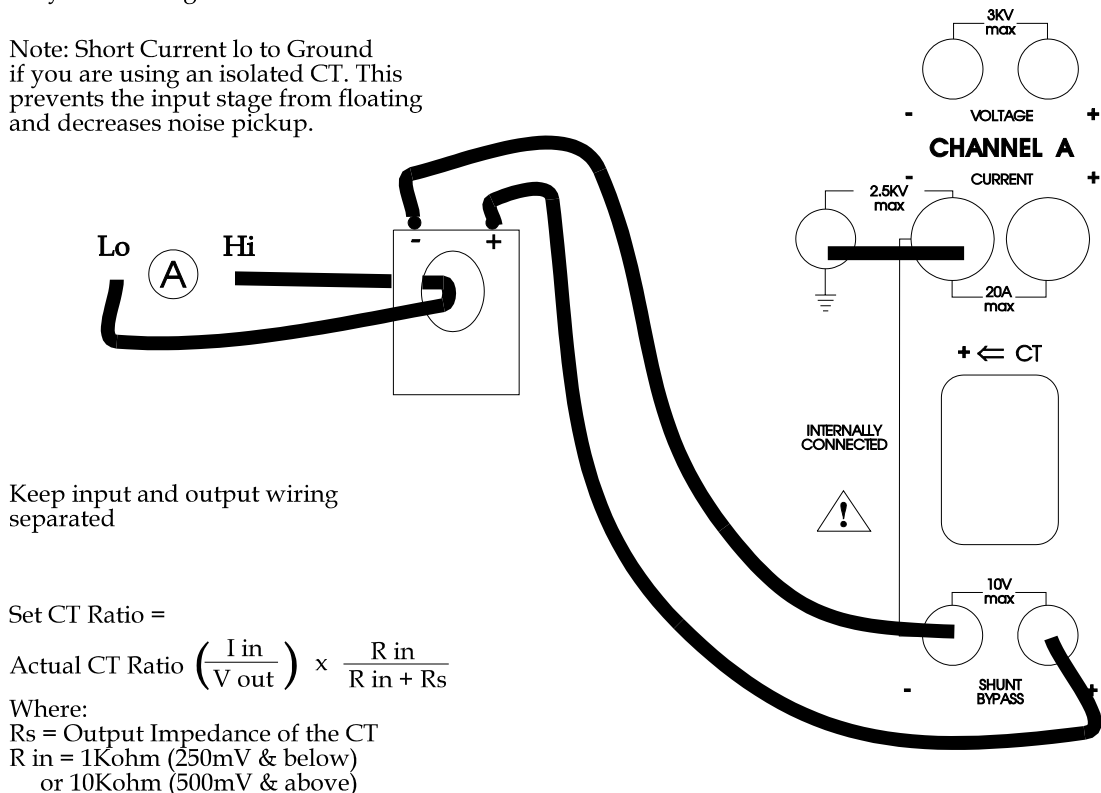


Figure 28. Ext Connection—Current/Voltage Transformer

Use the “Bypass” input to measure currents for high power applications, of any magnitude by using external shunts or current transformers, CT. When using the Bypass mode, specify the transducer scale factors. This scale factor is entered via the front panel, permitting the analyzer to display the proper current values. For example, a 0.003 ohm external shunt generates 3mV per amp of current. Hence the input scaling needs to be setup accordingly.

- 1) Problems that may occur in high frequency signal conditions with the CT.
- 2) The suitability of specific CT types for your analysis task. When using CTs, check the transformer's output impedance. High output impedance can require the scale factor to be adjusted to compensate for signal losses.

Set the CT Ratio to match the CT you are using.

Lo Hi

A

3kV max

- VOLTAGE +

CHANNEL A

- CURRENT +

2.5kV max

20A max

+ ← CT

INTERNALLY CONNECTED

10V max

- SHUNT BYPASS +

Note: Short Current lo to Ground if you are using an isolated CT. This prevents the input stage from floating and decreases noise pickup.

Keep input and output wiring separated

Note: Short Current I_o to Ground if you are using an isolated CT. This prevents the input stage from floating and decreases noise pickup.

Figure 29. Ext Connection—Current/Current Transformer

CT and PT Ratio Setups

This selection allows you to apply a PT scaling ratio to the voltage input, or a CT scaling ratio to any current input for any channel. Select the channel by pressing the **Menu 1** key and changing the channel that shows in the uppermost display line.

- *To select a PT ratio or CT ratio:*
 1. Press the **Channel** key and select the channel using the **Menu 1** key.
 2. Press the **Menu 3** key.
 3. Press the **Menu 2** key for PT or the **Menu 3** key for CT.
 4. Then press the **▲** key (up arrow) to select an active ratio.
 5. Press the **►** key (right arrow) to select the ratio.

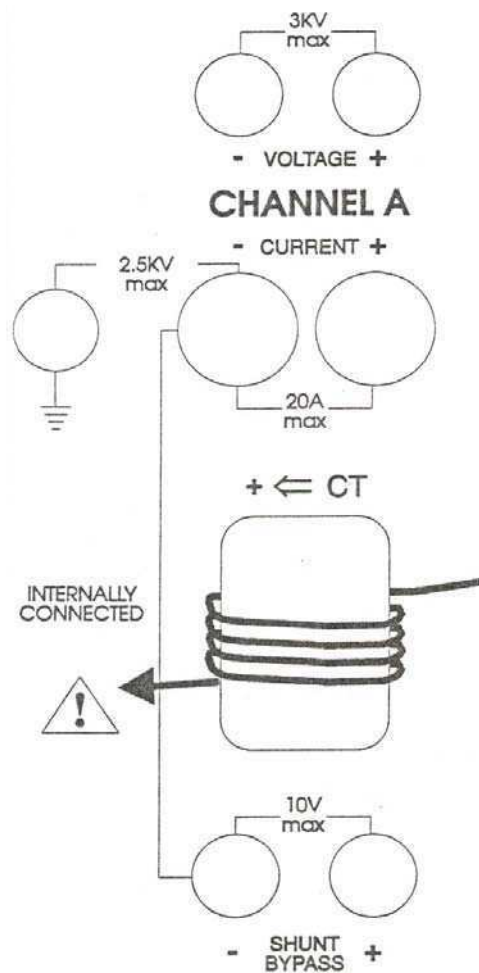
—OR—

Enter the required ratio.

Note: The ratio is maintained when not in use and the measured voltage at the terminals of the instrument is multiplied by the entered scale factor.

The selected CT ratio scale factor (if any) is applied to any current input. This allows for current output CTs, which use the internal shunt input terminals to have multiple passes through the internal Hall effect transducer. If you are using an external shunt/CT voltage input the capacity for multiple passes will be made through an external shunt or voltage output CT.

HALL Effect Current Transformer



Use the internal HALL Effect sensor to measure currents up to 150 amp peak (60Arms). See Figure 30.

In some cases, the internal shunt represents an undesirable burden. In these applications, the HALL Effect sensor can be used to measure current. The HALL Effect sensor provides accuracy for signals up to 100kHz. The sensor is configured for measurements from 1 – 60Arms. To measure smaller currents, use multiple turns, and set the scale factor accordingly.

A small current example—

When measuring a lamp current of 200 mA, in an electronic ballast application: loop the wire 5 times through the HALL Effect sensor, set the current transformer, CT, scale factor to 0.2, and the analyzer will accurately measure the lamp current.

Figure 30. Measuring Smaller Currents

A:Line In ->BC: HF Out

This configures the instrument for the measurement of HF output electronic lighting ballasts, switch-mode power supplies, motor drives etc. In this case, channel A is configured for measurement of line frequencies extending from the selected lowest frequency to 100:1 above this. Channels B and C are

configured for measurement of high frequency signals having a fundamental frequency in the range 5kHz to 640kHz. The line frequency channel is designated as an input measurement, and the high frequency channel(s) is/are designated as output measurements, thus measurements of power loss and efficiency are available following selection of the configuration. Usually there is no further configuration required following selection of this **Quick** key option. See Figure 31.

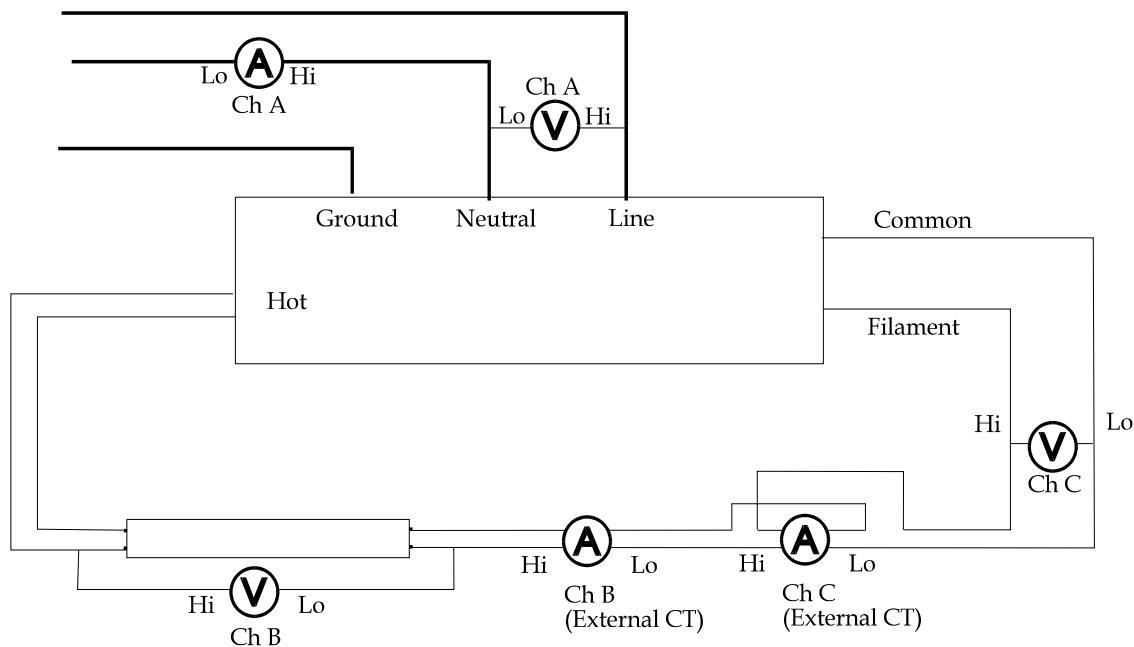


Figure 31. A: Line In ->BC: HF Out

To measure a ballast and lamp—

Example:

ChA gives ballast volts, current, power, power factor, harmonics etc.

ChB gives lamp voltage, total current, crest factor, etc.

ChC gives filament voltage, current, power etc.

The meter calculates total power (ChA) minus lamp power (ChB) plus filament power (ChC) to give total efficiency / loss for the ballast.

Wiring Methods

There are 4 basic methods of wiring the 2503AH-3CH for phase applications. For 3-phase, 3-wire, 3-meter hookups you must wire and configure the phase rotation properly to ensure the instrument correctly calculates the results. Refer to Figures 31, 32 and 33. For the “Wiring Methods” section the following abbreviations apply:

p = phase
w = wire
m = meter
c = channel

ABC 3-Phase 4-Wire Channel

This configures the instrument for the synchronous measurement of “3p wye” power having a fundamental frequency extending for the selected lowest frequency to 100:1 above this. Filtering of the input signal is automatically selected at 1000:1 above the selected lowest frequency. The QUICK START option covers line frequency, low frequency (e.g., low speed motor drivers) and high frequency “3p wye” applications. For *Setting Factory Defaults* refer to page 52. The synchronization source (i.e., the measurement of the fundamental frequency) is selected as any channels’ voltage or current input, the instrument will automatically select the most suitable input to act as the source of this data, and will automatically change this selection should a signal significantly change. This enables its use on switch-mode motor drives, where the voltage waveform is a composite of both low and high frequencies. See Figure 32.

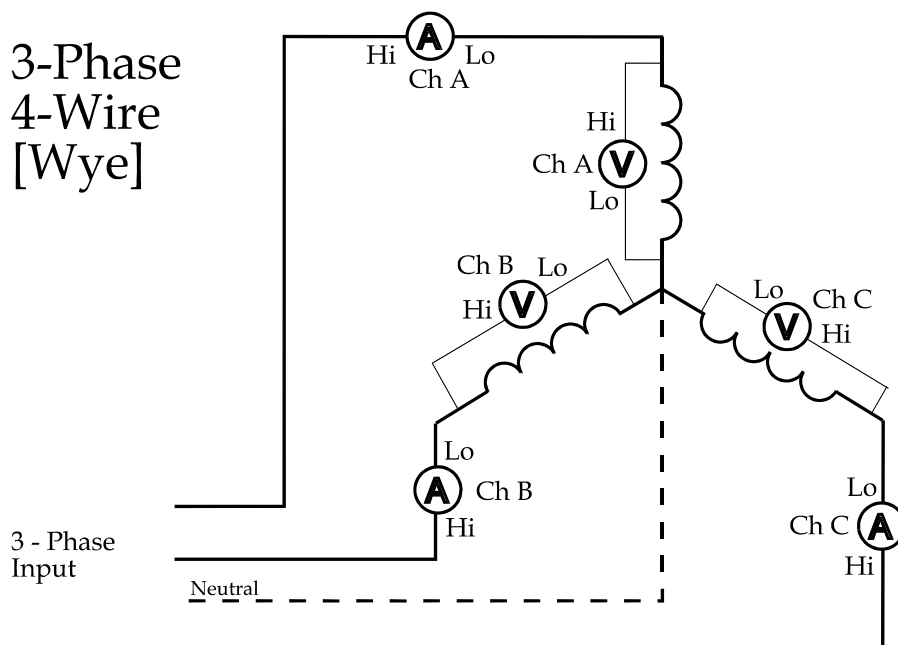


Figure 32. 3-Phase 4-Wire

3-Phase 4-Wire 3-Channel

In this case each channel has its “Voltage Hi” terminal connected to a phase of the supply, where the current terminals of the same channel are monitoring the current in that phase. The “Voltage Lo” terminals of all channels are connected together, and are connected to a neutral connection. This method is signified by configuring the group of three channels as “3p4w” in the Channel Grouping Menu.

ABC 3-Phase 3-Wire

This configures the instrument for the synchronous measurement of “3p delta” power having a fundamental frequency extending from the selected lowest frequency to 100:1 above this, using all three channels of a 2503AH. Filtering of the input signal is automatically selected at 1000:1 above the selected lowest frequency. Connect the channels as described in Figure 33 for optimum performance at low power factors and/or unbalanced loads. In all other respects this configuration is similar to the “3p4w” selection. Refer to Figure 32.

3-Phase 3-Wire 3-Meter [Delta]

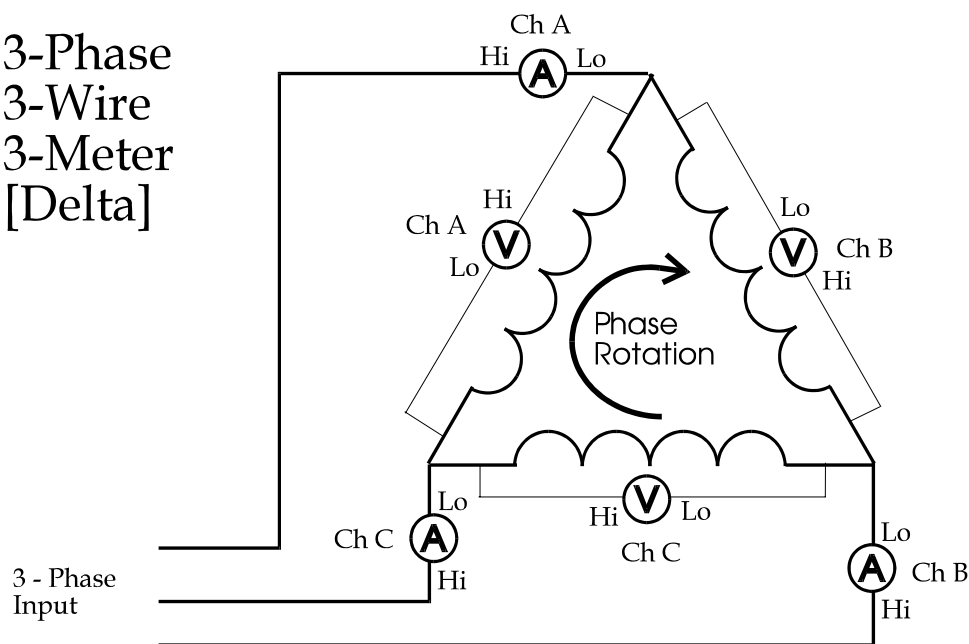


Figure 33. ABC 3-Phase 3-Wire

3-Phase 3-Wire 3-Channel

In this case each channel has its voltage terminals connected between consecutive pairs of phase voltages, with each channels' current monitoring the flow in the phase connected to its respective "Voltage Hi" terminal. This method is signified by configuring the group of three channels as 3p3w in the Channel Grouping menu, and setting all channels (or none) as being *in rotation* in the detailed menu for this group.

3-Phase 3-Wire 2-Channel

In this case the two channels are connected in the same manner as for the 3p4w3c method above, but only 2 channels are used, and the common "Voltage Lo" point is taken to the remaining phase voltage. This method is signified by configuring the group of two channels as "3p3w" in the Channel Grouping menu, and setting only one of these channels as being "in rotation" in the detailed menu for this group.

AB 3-Phase 3-Wire with 2-Meter Delta

This is similar to the 3-channel 3-phase 3-wire selection described above, but only uses two channels (A and B). Connect these two channels as described in Figure 34. Note that the phase rotation of the channels must be opposite each other and that each current measurement is made in the line phase connected to the corresponding voltage Hi terminal.

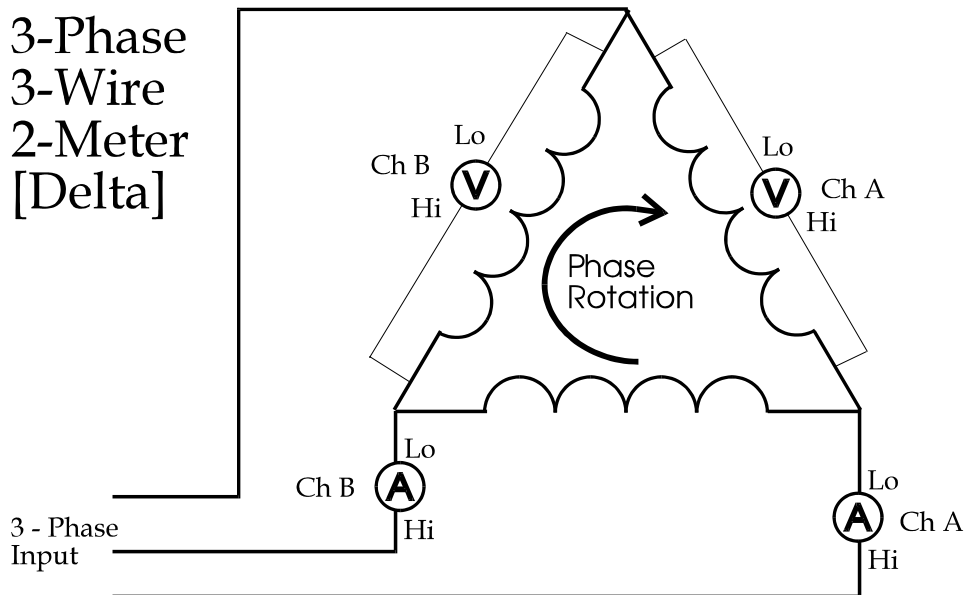


Figure 34. AB 3-Phase 3-Wire with 2-Meter Delta

An alternate to 3p3w3c can be used to achieve the advantages of 3p3w2c, while offering the actual current in the remaining phase and the remaining inter-phase voltage. Wire the third channel with its Voltage terminals between the phases being monitored by the first two channels, and with its current monitoring the third phase current. Ignore the power reading of this third channel. This method is signified by configuring the group of three channels as “3p3w” in Channel Grouping found in the SYSTEM CONFIGURATION menu, and setting only one or two of these channels as being *in rotation* in the detailed menu for this group.

IEEE Parameters

This section covers the connections, configurations and results of “IEEE Parameter” testing:

- √ IEC1000-3-2 (EN 61000-3-2) - Steady-state harmonic measurements
- √ IEC1000-3-2/J (EN 61000-3-2/J) - JEIDA and MITI
- √ IEC1000-3-3 (EN 61000-3-3) - Flicker measurements

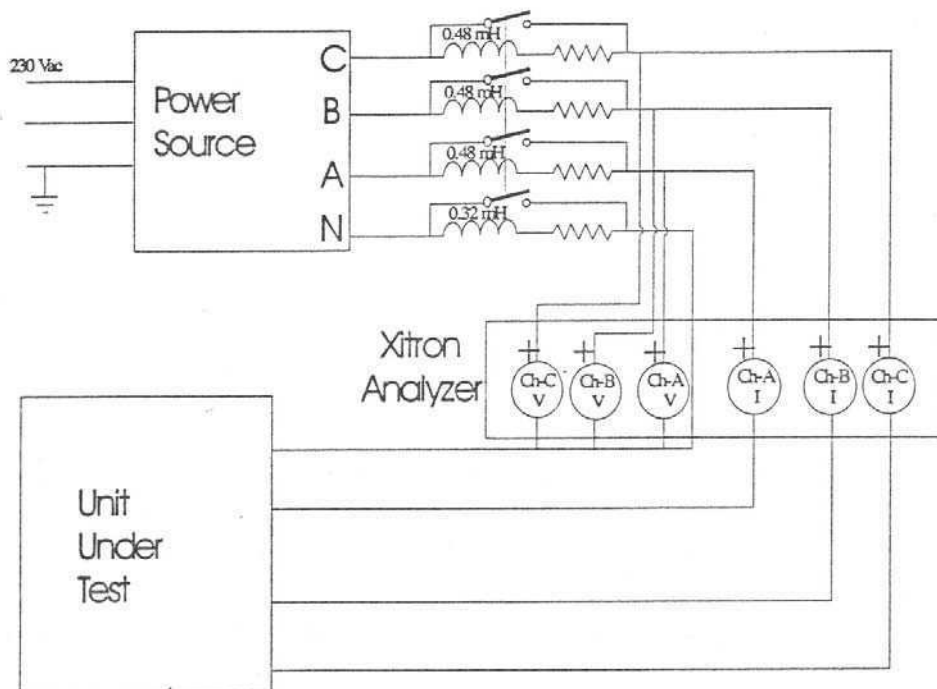
Note: All EN 61000 function interface commands are maintained as IEC1000 to preserve existing software.

When doing Steady-state harmonic testing, the instrument responds with a return value within 3 seconds. If fluctuating harmonics are being tested, the results will be available after 2 ½ minutes. When performing fluctuating-harmonics testing, note that the controlling computer can poll the 2503AH analyzer for status.

IEEE Parameter Test Wiring

Figure 35 shows the connection diagram for a “3-phase EN 61000” test setup. Notice that this setup satisfies both Steady-state measurements and Flicker-level measurement testing. Note that the standard impedance can be short circuited by relays for EN 61000-3-2 harmonics testing.

This configuration is only one of several ways the test can be setup. You can also build the standard impedance network, or purchase Xitron Technologies test equipment: Model 2520-1P, single phase, and 2502-3P, three-phase version.

Figure 35. IEC1000⁵ Test Wiring

Steady-State Harmonics Measurements

You can configure the 2503AH power analyzer for EN 61000-3-2 compliant harmonics analysis and measure all other parameters as well.

Configuring IEC1000-3-2 Display Line

The instrument setup for EN 61000 testing involves selecting your setup via the QUICK START menu and defining the display lines as required for the particular test. The following steps are only valid for a known configuration of the 2503AH power analyzer.

Note: If you attempt to set up a display line for either Steady state or Flicker level measurement status, while the analyzer is not configured for these tests, the instrument will display a message.

⁵ Current standard EN 61000

- *To configure a line using IEC1000-3-2 parameter:*
 1. Press the **Menu 1** key twice. The first line of the display reads “IEC1000-3-2”.
The second line reads CHA CLASSA STEADY.
 2. Press the **Menu 2** key. The cursor flashes on the second display line.
 3. Move the cursor using the ► and ◀ keys to the item you would like to change.
 4. Press the ▲ and ▼ keys to toggle through the different choices that are available.
 5. Once your desired option displays, press the **Enter** key twice.
 6. Repeat the above for each individual display item.
- *To configure for IEC1000-3-2 channel use:*
 1. Press the **Quick** key.
 2. Press the **Menu 4** key. This selects Clear Display lines.
 3. Press the **Quick** key.
 4. Press the **Menu 2** key once. The cursor flashes at “Standard Channel Use,” the default setting.
 5. Press the ▲ key until the display reads IEC1000-3-2 Chnl Use or IEC1000-3-3 Chnl Use, if fitted.
 6. Press the **Enter** key twice.

IEC1000-3-2 Data Readings

Pass	If the current measured by the specified channel passes the harmonics test for the specified class.
Fail	If the harmonic currents in the specified channel fail the test.
Running	If the test is running (up to 2.5 minutes).
Waiting	If the analyzer does not receive input.
Chksource	If the supply source exhibits excessive harmonics or invalidates the measurement.

Steady-State Measurement Testing

The connection diagram for a single phase Steady-state compliance test is shown in Figure 36. In this case, the use of the internal shunt is assumed. You can also select the HALL Effect CT, or the Shunt Bypass input. Although not mandatory for higher currents ($> 10\text{Arms}$), use the CT, in order to comply with the standard requirement that the instrument shall not cause a voltage drop of $> 0.15\text{V}$ -peak through its measurement circuit. The internal shunt of 5 milliohm provides compliant analysis up to currents of 30A of power. You can define a display line to show peak current to quickly verify existing conditions. A CT poses no burden at all, hence is ideal for higher current levels. For test setups where you have an external shunt, the voltage across this shunt is connected to the Shunt Bypass input.

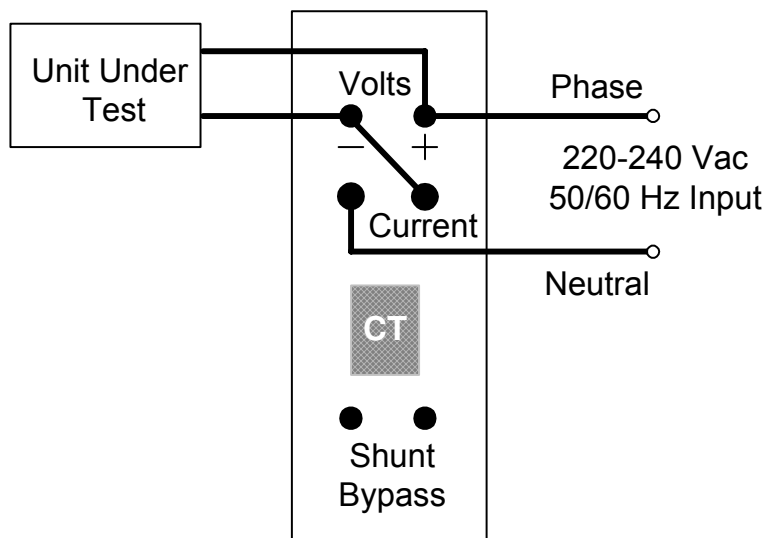


Figure 36. IEC1000-3-2⁶ Test Setup

Line Current Harmonic Measurements

In the case of Steady-state current harmonics, the main impact on analysis is that every data sample block is acquired over exactly 16 cycles of the fundamental frequency (320 ms for 50Hz systems). Since the instrument synchronizes its sampling to within 0.03 % of the fundamental frequency, a rectangular window is applied to the data samples. Thus a total of 8192 data

⁶ Current standard EN 61000

points for voltage, and for current are equally weighted for analysis purposes. The power level is calculated using the same 1.5-second time constant, which is applied to the calculation of individual harmonics.

Figure 37 shows an example of a Class A, Steady State test. You can configure the test class to: A, B, C, or D.

The analyzer compares all harmonics against the standard's limits for the selected Class, and decides on a “PASS” or “FAIL” status accordingly. Note that for Fluctuating tests, it can take 2.5 minutes before a status is generated.

Individual channels can be configured to acquire data in the Steady-state compliant method, or can be set up differently. The example given in figure shows the configuration selection, which can be accessed via the System key, and the Channel Grouping menu.

The Advanced Setup gives you additional flexibility to fine-tune the configuration. Notice that the Source Checking has to be turned On for full compliance testing. Refer to *Source Checking* on page 76. The standard calls for the source to meet stringent requirements while the test is in progress. This of course demands a compliant power source.

For precompliance testing, the test can be set up with “standard utility power” and with the Source Checking turned Off. Once the analyzer, or the selected channel, is configured for Steady-state harmonics measurement testing, a display line can be defined as shown in Figure 37. This line shows whether the unit-under-test passes or fails the test and which harmonic is the highest.

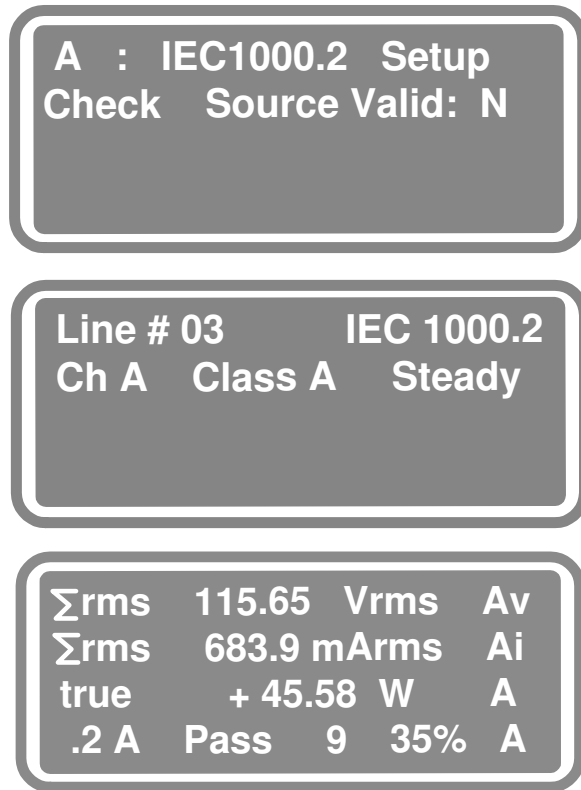


Figure 37. IEC1000-3-2⁷ Display Setup

In the example, the unit-under-test passes, with the 9th harmonic being the highest, at 35% of the standard's limit. If source checking is turned On, the analyzer can display a “Chk Srce [xx]” message, with “xx” identifying the problem the source voltage is having. If this occurs, you will be required to correct the source problem before a full compliance test can be completed.

Steady-State Harmonics Testing Variations

The “IEC1000-3-2/J” setup display supports JEIDA and MITI variations on Steady-state harmonics. In cases where no multiplier is desired, set both the multiplier and Vnom selections for the same nominal voltage. Refer to the following editable selections shown next.

⁷ Current standard EN 61000

“Multiplier 400/Vnom” or “Multiplier 230/Vnom”

Select either one using the **Menu 2** key. Use these choices to limit classes A, B and D. When applying this multiplier to the class A limits the result is rounded down to two significant decimal digits (i.e., 10 mA) as required by the MITI standard.

Notes:

- 1) Use 230/Vnom where the 400/Vnom is not appropriate.
- 2) For MITI standard, use 400/Vnom.

“Vnom 230V”

Manually edit this value using the Numeric Entry keys. Enter the nominal supply voltage of the device being tested in the range of 50 to 500 volts, with 1V resolution.

Note: Because this value is then used as the multiplier, be sure to enter 230V for nominal voltages of 220 through 240.

“Class A W adder? No” or “Class A W adder? Yes” selection

In both JEIDA and MITI standards an allowance is made for certain equipment with a power level exceeding 600W to be tested against limits which have an adder applied. This adder is the same in both standards and is only applied to class A and only when the power level is measured as being over 600W.

If selected, this (Class A) adder is also multiplied by the 230/Vnom or 400/Vnom multiplier described above.

“Min Class D: 75W” or “Min Class D: 50W” selection

At the time implemented, the minimum power limit for class D testing is 75W. However, it is intended that this limit will be reduced to 50W in the future. This selection allows the user to select the minimum power limit for class D compliance testing. This only has an affect if the load under test meets the waveshape criteria of the standard and has a power consumption of between 50W and 75W, affecting the automatic selection of class A or class D limits under these circumstances.

“Measure Class C Fund” or “Fixed Class C Fund” selection

Usually the limits for class C compliance testing is performed relative to the measured fundamental current. The MITI standard allows for the limits to be relative to the “fundamental wave current values achieved when dimming level is at its maximum.”

In this case the fundamental current at this *reference level* must be measured by the user and then entered into the analyzer as the reference for the class C limits table. When the fixed Class C Fund” selection is made an additional menu becomes available for this current to be entered with 1mA resolution.

Note that Xitron Technologies interprets this statement as meaning the fundamental current when dimming is minimized (i.e. the light is at its brightest) rather than when dimming is maximized. (This could lead to a zero current fundamental, thus low level limits on each harmonic current.)

Xitron Technologies recommends that:

- You seek advice from a certified competent body concerning all interpretations of standards; and
- The fixed fundamental current value be measured using the same mode used to measure the fundamental, and then be fixed by entering the measured value while the fixed fundamental selection is applied.

Flicker Level Testing

In the case of IEC1000-3-3 testing, the instrument is fully dedicated to performing all the analysis in accordance with the EN6-868 Flicker Meter specifications. However, these analysis are so demanding that only IEC1000-3-3 (EN 61000-3-3) parameters can be displayed.

Prior to beginning the Flicker test, be sure the instrument has established a steady-state condition. This process is set to 1 minute. Individual parameters can be read while the test is in progress.

The analyzer can display all IEC1000-3-3 (EN 61000) parameters instantaneous, as well as the maximum values that occurred while, the test progresses. At the end of the test, the analyzer displays a PASS or FAIL message.

Notes:

- 1) In the commands below “Ch” specifies the channel (i.e. ChA, ChB or ChC).
- 2) All *normal* parameters are *not* available for the selected channel while flicker measurements are in progress and after completion until the Off command is received.

Flicker tests can be done on single or three phase systems. For balanced three phase systems, the test on just one phase is acceptable. In unbalanced systems, three phase simultaneous testing is required. Since the Flicker test is demanding from a computational/analysis viewpoint, the analyzer will always set all three channels (if fitted) in Flicker configuration, even if only one channel is being used.

Note: You cannot configure channels for other tests, while Flicker level tests are being performed, unlike Steady state harmonics testing, where individual channels can be set to different configurations. However, channels can have different test times in IEC1000-3-3 mode.

Starting the Flicker Level Testing

Connect your device being tested to the analyzer at this time and ensure that it is turned on and functioning.

In the case of Flicker Level tests, only voltage is measured. The standard demands the use of a Cmelec standard impedance which simulates the impedance of the public supply system. This standard impedance is connected between the source and the device. The analyzer then measures the voltage at the input terminals of the device.

The standard defines parameters that need to be measured and then evaluated in accordance with IEC868, and Amendment I to this specification. Each of the parameters specified in Flicker level tests can be defined as a display line.

Because Flicker tests can vary from 10 minutes to over 2 hours, you must define a test time. The instrument defaults to 120 minutes, which is the time required to measure the long term flicker level. This parameter is called Plt. Figure 38a, b, and c show how the Flicker Level test is started and the associated displays.

- *To start the Flicker Level test:*
 1. Press the **System** key.
 2. Press the **Menu** key for the channel the test is to be performed on. The display line will change from saying Start to Abort. Do this for all channels to be tested.
 3. Press the **Enter** key. This brings you back to displaying the parameters.

4. The STATUS PARAMETER display line should now be saying Flicker Starting.
 5. After a few minutes the STATUS PARAMETER line will display the number of minutes left until the completion of the test as a count down.
- *To abort Flicker Level testing:*
 1. Press the **System** key
 2. Press the **Menu** key for the Channel the test is to be aborted. The display line will change from saying Abort to Start. Do this for all channels to be aborted.
 3. Press the **Enter** key to display the Parameters.
 - *Using the Quick key to start Flicker Level test:*
 1. Select the IEC1000-3-3 configuration via the **Quick** key.
 2. Press the display line **Menu 2** key to step through the various Quick configurations.
 3. When the display line shows IEC1000-3-3 Chnl Use, press the **Enter** key twice.
 4. Access System Configuration using the **System** key. Refer to Figure 38 for a sample of the display for a 3-channel instrument.
 5. After pressing the key associated with ChA, the display switches to Abort.
 6. Press the **Enter** key to commence the test. The display reports when the Flicker Level test starts.

Note: It can take several minutes before the test is actually in progress. The analyzer must first establish a steady-state condition.

The EN 61000-3-3 standard demands that the instrument evaluate the RMS level of every half cycle (every 10mS) against the steady state level. Since small voltage fluctuations of only 0.25% can represent a low Flicker level, it's important to accurately determine the nominal voltage against which the half cycle values are compared. Also, the instrument must measure changes in steady-state voltage (dc). Thus steady state must be established first, before analysis can commence.

Once the Flicker Level test has started, the display shows the time left to complete the test. You can define display parameters before the test starts, or while the test is in progress. All parameters are continuously calculated and updated.

Defining a display line merely determines which parameters are *pulled* from memory and shown on the display.

As in other tests, you can define up to 50 display lines, and scroll up and down to view the desired lines. The example shows the instantaneous value of the voltage at the devices under-test terminals, which is $U(t)$.

Also, the short term Flicker (P_{st}) is displayed, along with the maximum value that has been observed for the parameter $\Delta d(t)$.

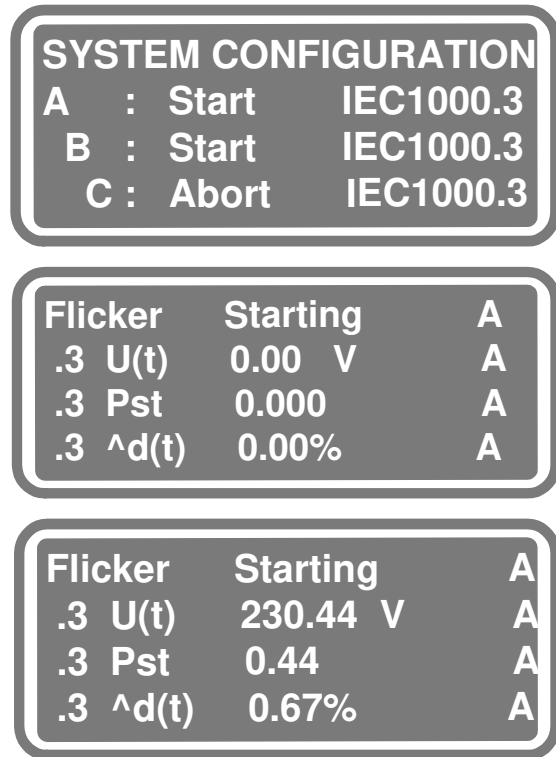


Figure 38. Flicker Level Testing

Automatic Class A/D and Waveform Output

Firmware version 3.95 and later replaces Class D with an automatic class A/D mode. If the signal meets the criteria required of class D, it will be tested to class D limits and Pass or Fail based upon these limits. If the signal fails to meet the Class D criteria, it will be tested to Class A limits and pass or fail based upon these limits. The front panel displays are as follows:

If your display is: .2Da Pass 9 %33 B

It means you are in (auto) class D and testing is being performed to the class A limits, on channel B.

If your display is: .2Dd Pass 9 %33 C

It means you are in (auto) class D and testing is being performed to class D limits, on channel C.

Flicker Level Testing Optional Setup

- *For Flicker Level optional setup:*

1. Press the **System** key. Select Channel Grouping.
2. Press the **Menu** key associated with the channel you are performing the test on, three times. This brings up the IEC1000-3-3 Setup menu.
3. Press the **Menu 2** key to select the RUN TIME for the test.

Note. The specification calls out for the test to be performed for 120 minutes (2 hours), For evaluation purposes or engineering tests a smaller run time can be entered.

4. Press the **Menu 2** key once. This will toggle Yes to No for Source Checking. Use Pst and Plt if you do not require this for your test.
5. Press the **Enter** key twice when you have completed your changes.

Calibration Procedures

The 2503AH power analyzer's **Calibrate/Test** key is used to perform calibrations of: the internal system; the input terminals; and the external outputs for voltage, bypass, shunt and HALL Effect. A frequency response check for individual channels can be preformed using the **Quick** and **System** keys.

Checking the Status of the Analyzer

The instrument performs many self-test procedures during recovery from power application. Any faults found during this testing are displayed at that time. Many of these faults are not "fatal," and the instrument can still be used. The status of the instrument with respect to power application fault detection, non-volatile and volatile memory usage, inter-processor communication noise and calibration data status can be viewed.

- *To view the power analyzer's status:*
 1. Press the **Calibrate/Test** key.
 2. Press the **Menu 1** key, which is next to System Status.
 3. The analyzer will sequentially display the following information:
 - The versions of each processor's software.
 - The *retry* rate of communications with each DSP, which is useful for finding *marginal* faults in digital circuitry.
 - The type and percentage used of the internal non-volatile *flash* memory. The highest percentage used of the internal central processors volatile memory (RAM) normally displays at 128Kb fitted. If 80% or greater of the instrument's processing capacity has been used, the usage displays with your next power up.

- If more than 75% of this memory is in use, then the analyzer automatically attempts to *reorganize* its contents to recover any unused memory.

Note: This reorganize process is similar to defragmenting a hard disk, but faster. If the analyzer does not recognize the device type, for example, it will display: *unknown device*. This indicates a marginal device that requires corrective action.

- The number of days since the last internal/input/external calibration was performed successfully on each channel. If data has been lost/become corrupted, then *req* displays instead of the last calibration date.
- The final message indicates that an Input Calibration is recommended if you wish to test the analog circuitry of the instrument.

Internal Calibration

Internal calibration is recommended at 10 day intervals or a 5% change in ambient temperature. An internal calibration is automatically performed prior to testing the inputs on each channel.

An internal calibration, requires no additional equipment and can be performed at any time, even when loads are present at the rear terminals. This fully automatic procedure calibrates and tests the Analog-to-Digital Converters, input filters and references on each channel.

- *To perform an internal calibration:*
 1. Press the **Calibrate/Test** key on the front panel.
 2. Press the **Menu** key that corresponds to Internal Calibration.
 3. The instrument will automatically sequence through the *internal calibration*.
 4. When all tests are complete the display shows the status of each channel.
 5. Press the **Enter** key to accept the internal calibration. If a failure is reported then rectify the fault condition before continuing.
 6. Otherwise, press any **Menu** key to return to normal operation.

Input Calibration

Input Calibration is recommended at 30 day intervals or a 5% change in ambient temperature. Note that an internal calibration is automatically performed prior to an input calibration.

An Input Calibration performs DC offset adjustments on each input, each mode, and each range. This procedure requires removal of all signals from the input terminals to the analyzer. If an external current shunt or CT is connected to a “bypass” current input, then keep this connection so that its DC offset can be automatically corrected. Note that if the DC offset adjustment is performed then repeat the Input Calibration if those same terminals are used with a different CT or shunt.

- *To perform an input calibration:*
 1. Ensure that there are no connections to any rear panel terminals or through the rear panel HALL Effect Current Transformers (CT).
 - If you are using an external Current Transformer (CT) or Shunt, leave them connected to the Bypass Terminals. This allows the instrument to adjust for any offsets.
 - If no CT or Shunt is used, short the Bypass Terminals each time the input calibration is performed.
 2. Press the **Calibrate/Test** key.
 3. Press the **Menu 3** key.
 4. The instrument performs the tests on each channel independently, during the same period of time.
 5. When all tests are complete the display shows the status of each channel and the instrument waits for you to press the **Enter** key to accept the calibration and then any **Menu** key to return to normal operation.
 6. Remove all shorts from the Bypass terminals if used. If a failure is reported then rectify the fault condition before continuing.

External Calibration

External calibration is recommended annually. Each external calibration can be performed on one channel at a time or several channels in parallel.

Required Calibration/Test Equipment:

- ✓ Fluke 5700A Multi-Function Calibrator or equivalent
- ✓ Fluke 5725A 10 amp Calibrator or equivalent

Note: The 5725 output is used for currents higher than 2A.

Voltage Calibration

Refer to Figure 39.

Single Channel Connections

Use Banana-to-Banana 36" long twisted pairs (Red & Black) or equivalent.

- ✓ 2503AH V-Hi - 5700 Output Hi (Red)
- ✓ 2503AH V-Lo - 5700 Output Lo (Black)

Parallel Channel Connections

For connection between channels—use Banana-to-Banana 6" long (Red & Black) or equivalent.

- ✓ Ch-A V-Hi to Ch-B V-Hi to Ch-C V-Hi
- ✓ Ch-A V-Lo to Ch-B V-Lo to Ch-C V-Lo

For connection between the 2503AH and the 5700—use Banana-to-Banana 36" long twisted pairs (Red & Black) or equivalent.

- ✓ 2503AH V-HI - 5700 Output Hi (Red)
- ✓ 2503AH V-Lo - 5700 Output Lo (Black)

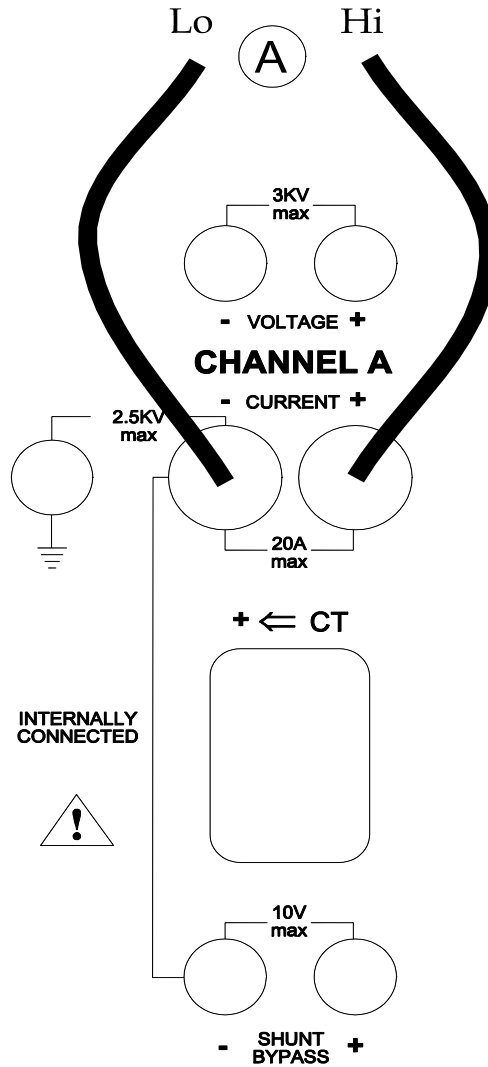


Figure 39. Typ Voltage and Shunt Calibration Connections

- *To perform a voltage calibration:*
 1. Press the **Calibrate/Test** key.
 2. Press the **Menu** key next to the External Calibration display line.
 3. Set the Fluke 5700's output voltage to the level requested in the upper display line of the instrument, at a frequency of 400Hz.

4. Select “OPERATE” on the Fluke.
5. Press the **Menu** key(s) for the channel(s) being calibrated.
6. The instrument now displays the amplitude measured, and the percentage deviation from the nominal level, for each channel. Allow the reading to settle for approximately 1 minute and press the **Menu** key(s) for the channel(s) being calibrated.
7. Press the **Menu 1** key. The instrument will increment to the next step.
8. Repeat steps 3 through 8 for each Voltage calibration step requested by the instrument.
9. Set the Fluke to “STANDBY.”

Shunt Calibration

Refer also to Figure 39.

Connections for Single Channel:

Use Banana-to-Banana 36" long twisted pairs (Red & Black) or equivalent.

- ✓ 2503AH I-HI - 5725 or 5700 Output Hi (Red)
- ✓ 2503AH I-Lo - 5725 or 5700 Output Lo (Black)

Connections for Parallel Channels:

Use Banana-to-Banana 6" long (Red & Black) or equivalent for connection between channels.

- ✓ Ch-A I-Lo to Ch-B I-HI
- ✓ Ch-B I-Lo to Ch-C I-HI

Use Banana-to-Banana 36" long twisted pairs (Red & Black) or equivalent for connection between the 2503AH power analyzer and the 5725 or 5700.

- ✓ 2503AH CH-A I-HI - 5725 or 5700 Output Hi (Red)
- ✓ 2503AH CH-C I-LO - 5725 or 5700 Output Lo (Black)

- *To perform a shunt calibration:*

1. Set the Fluke 5700's output current to the level requested in the upper display line of the instrument, at a frequency of 400Hz.
2. Select “OPERATE” on the Fluke.

3. Press the **Menu** key(s) for the channel(s) being calibrated. The analyzer now displays the amplitude measured, and the percentage deviation from the nominal level, for each channel.
4. Allow the reading to settle for approximately 2 minutes and press the **Menu** key(s) for the channel(s) being calibrated.
5. Press the **Menu 1** key. The instrument will increment to the next step.
6. Repeat steps 1 through 6 for each Shunt calibration step requested.
7. Set the Fluke to “STANDBY.”

Bypass Calibration

Refer to Figure 40.

Single Input Connections:

Use Banana-to-Banana 36 inch long twisted pairs (Red & Black) or equivalent

- ✓ 2503AH BYPASS-Hi - 5700 Output Hi (Red)
- ✓ 2503AH BYPASS-Lo - 5700 Output Lo (Black)

Parallel Connections:

For connection between channels—use Banana-to-Banana 6" long (Red & Black) or equivalent.

- ✓ Ch-A BYPASS-Hi to Ch-B BYPASS-Hi to Ch-C BYPASS-Hi
- ✓ Ch-A BYPASS-Lo to Ch-B BYPASS-Lo to Ch-C BYPASS-Lo

For connection between the 2503AH and the 5700—use Banana-to-Banana 36" long twisted pairs (Red & Black) or equivalent.

- ✓ 2503AH BYPASS-Hi - 5700 Output Hi (Red)
- ✓ 2503AH BYPASS-Lo - 5700 Output Lo (Black)
- *To perform a bypass calibration:*
 1. Set the Fluke 5700's output voltage to the level requested in the upper display line of the analyzer, at DC. For voltage levels below 1 volt, use the 2 volt range of the Fluke.
 2. Select “OPERATE” on the Fluke.

3. Press the **Menu** key(s) for the channel(s) being calibrated.
4. The analyzer now displays the amplitude measured, and the percentage deviation from the nominal level, for each channel.
5. Allow the reading to settle for approximately 1 minute and press the **Menu** key(s) for the channel(s) being calibrated.
6. Press the **Menu 1** key. The instrument will increment to the next step.
7. Repeat steps 1 through 6 for each Bypass calibration step requested by the instrument.
8. Set the Fluke to “STANDBY.”

HALL Effect Calibration

Figure 40 shows a Standard HALL Effect connection.

Connections for Single Channels:

Use Banana-to-Banana 10' long 18 AWG Teflon wire or equivalent.

Put four turns of the wire through the sensor and connect one end to the 5725's or 5700's Output Hi and the other end to the 5725's or 5700's Output Lo.

Connections for Parallel Channels:

Use Banana-to-Banana 10' long 18 AWG Teflon wire or equivalent.

Wrap four turns of the wire through all sensors and connect one end to the 5725 or 5700 Output Hi terminals and the other end to the Output Lo terminals.

Note: Short current Lo to Ground, if you are using a CT. This prevents the input stage from floating and decreases noise pickup.

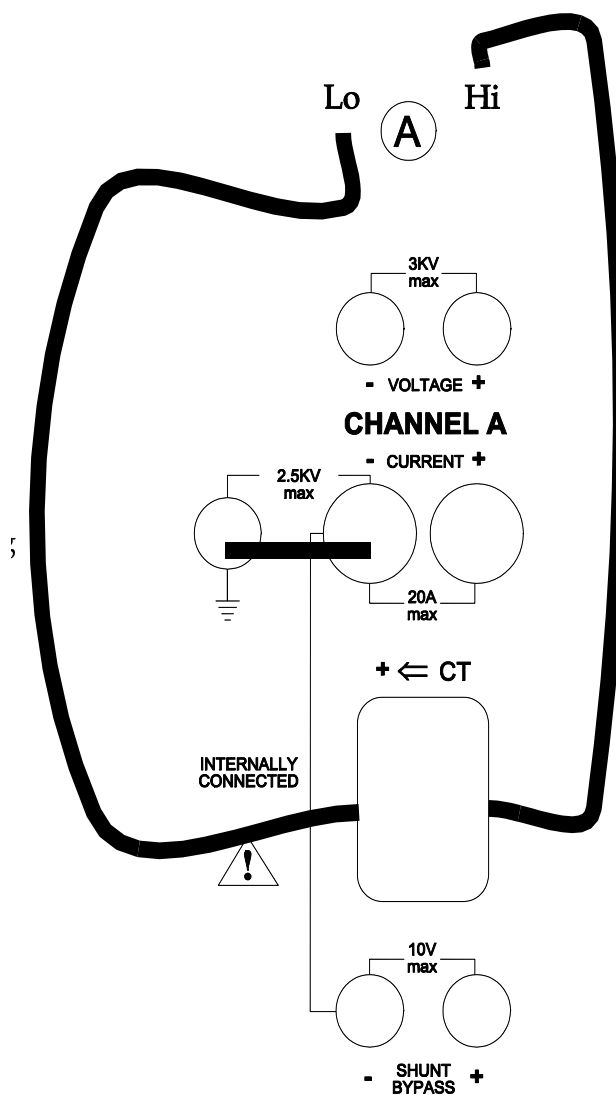


Figure 40. HALL Effect Calibration

- *To perform a HALL Effect calibration:*
 1. Set the Fluke 5700's output current to one quarter of the level requested in the upper display line of the instrument, at a frequency of 400Hz.
 2. Select "OPERATE" on the Fluke.

3. Press the **Menu** key(s) for the channel(s) being calibrated. The instrument now displays the amplitude measured, and the percentage deviation from the nominal level, for each channel.
4. Allow the reading to settle for approximately 1 minute and press the **Menu** key(s) for the channel(s) being calibrated.
5. Press the **Menu 1** key. The instrument will increment to the next step.
6. Repeat steps 1 through 6 for each HALL Effect calibration step requested by the instrument.
7. Set the Fluke to “STANDBY.”

Alternative HALL Effect Connection

Refer to Figure 41. Four passes through the device produces four times the current reading. Set your Shunt ratio for 0.225:1 to give correct readings. This technique works great for low currents. Just match the number of turns through the device with the Ratio.

Note: Short current Lo to Ground if your are using an isolated CT. This prevents the input stage from floating and decreases noise pickup.

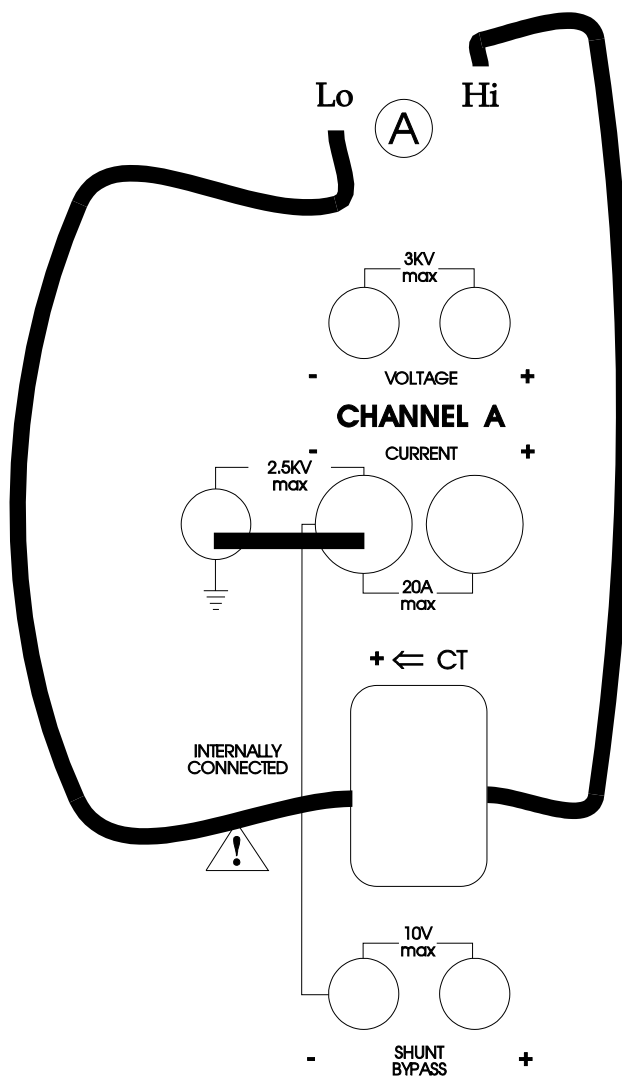


Figure 41. Alternative HALL Effect Connection

Completing the Calibration

1. Press any of the **Menu** keys to accept the calibration as being valid.
Remove all connections from the instrument.
2. Repeat the Internal and Input calibration procedures.

Frequency Response Check

√ Fluke 5700A Outputs to Voltage Inputs 2503AH

- *To configure a channel for a response check:*
 1. Press the key labeled **Quick** key.
 2. Press the corresponding **Menu** key to select the display line that reads: **Independent Channels**.
 3. Press the **Enter** key twice.
 4. Press the key labeled **System**.
 5. Select the display line that reads: **Channel Grouping**.
 6. Select the channel you wish to test.
 7. Move the cursor using the **▶** key (arrow) toward the: MORE >.
 8. Press **Menu 1** key, as required to bring up the Standard Setup submenu.
 9. Press the **▼** key twice.
 10. Select the line that reads: FILTER: "20kHz".
 11. Enter in a 500kHz filter using the **Numeric Entry** keys.
 12. Press the **Enter** key three times.
 13. Press the key labeled **Range**.
 14. Select the channel you wish to change.
 15. Make sure the cursor is flashing on **V-Auto**.
 16. Use the **▲** key to scroll up to the 150V range.
 17. Press the **Enter** key twice.

You have now configured the instrument for independent channels, a 500kHz filter and fixed it to the 150 volt range for the channel to be checked. Repeat above configuration for each channel to be checked.

Response Check Procedure

1. Apply 100VAC @ 400Hz to the channel to be checked.
2. Note reading. (The following specifications are referenced from this reading.)
3. Check the following points to the specifications provided below.

Frequency of Input	Voltage Reading	Testing Limits	Published Specification
1kHz		100.15 / 99.85	.15%
10kHz		100.15 / 99.85	.15%
20kHz		100.29 / 99.71	.29%
30kHz		100.43 / 99.57	.43%
40kHz		100.43 / 99.57	.43%
50kHz		100.43 / 99.57	.43%
60kHz		100.65 / 99.35	.65%
70kHz		100.65 / 99.35	.65%
80kHz		100.65 / 99.35	.65%
90kHz		100.65 / 99.35	.65%
100kHz		100.65 / 99.35	.65%
110kHz		101.15 / 98.85	1.15%
120kHz		101.15 / 98.85	1.15%
130kHz		101.15 / 98.85	1.15%
140kHz		101.15 / 98.85	1.15%
150kHz		101.15 / 98.85	1.15%
160kHz		101.15 / 98.85	1.15%
170kHz		101.15 / 98.85	1.15%
180kHz		101.15 / 98.85	1.15%
190kHz		101.15 / 98.85	1.15%
200kHz		101.15 / 98.85	1.15%

Analog Input/Output Option

The 2503AH analyzer family is available with several options. The analog input and output option, or AIO, provides the capability to interface with analog type inputs and outputs. This option applies to single and multi-unit systems that monitor, control, provide analysis and synchronize, etc.

Note: Your analyzer must be fitted for this option to function.

AIO Configuration Setup

- *To configure for AIO:*
 1. Press the **System** key.
 2. Press the **Menu 3** key. This selects Setup Option AIO.
 3. Press the **Menu 2** key. This selects Set Parameter.

AIO Display Line Parameter Configuration

The following is an example on how to configure an AIO Display Line for a measured parameter.

- *To configure an AIO display line—Example:*
 1. In the AIO Configuration display, press the **Menu 2** key. The cursor flashes on the second display line.
 2. Press the ▲ and ▼ keys until you locate True RMS.
Option: press the **V** key located in the Parameter & Equation Control section on the Front Panel. From this line in the display, the ► and ◀ keys can select the options: the parameter to be measured; the measurement channel; and the type of coupling for the signal.
 3. Press the **Enter** key once.
 4. Press the ▼ key three times.

AIO Characteristics

- The “Zero” is the start point reference for the AIO output.
- The “Ful Sc” is the stop point reference for the AIO output.
- The difference between the “Zero” and the “Ful Sc” is the “Resolution Span” for the AIO output.

AIO Examples—

- If your voltage range for your test is 0 to 200 volts and you want the output of the **AIO** to be at Full Scale when you reach 200Vrms, then set the Zero for 0mV and set the Full Scale to 200Vrms. This gives you a 25mV per volt changeout of the AIO Connector. See Figure 42.
- If you want the output of the AIO to be at the Mid Point when your voltage is at 200Vrms then set the Zero for 0mV and the Full Scale for 400Vrms. This gives you a 12.5 mV per volt changeout of the **AIO** connector.
- *To select output type:*
 1. From the AIO Parameter Configuration display, press the **Menu 4** key to select between volts or amps readout for the AIO Output being configured.
 2. When you have completed configuring the AIO Parameter, press the **Enter** key once. This brings you back to the beginning of the procedure.
 3. Press the **Menu 1** key. The AIO Output#01 advances to the next output #02, etc. You can also use this key to scroll through the individual AIO Outputs.
 4. Continue the above steps for each AIO output you wish to configure. When you have configured all of your AIO outputs, press the **Enter** key once to display your parameter.

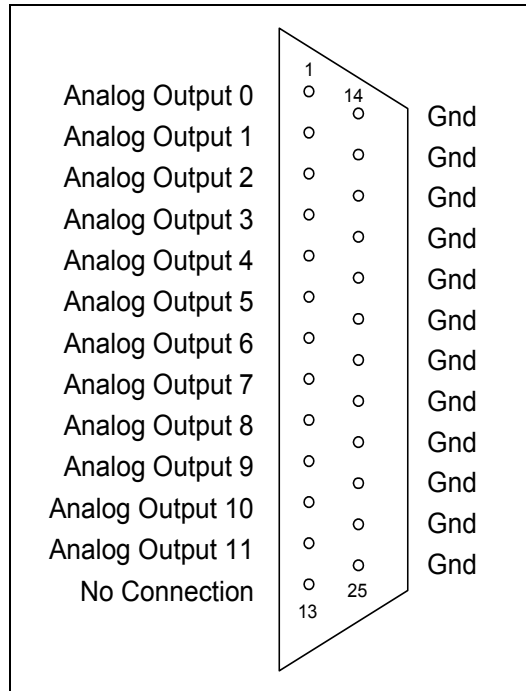


Figure 42. Analog Output Pinouts

- *To set starting point:*
 1. Press the **Menu 2** key. The cursor flashes on the second display line.
 2. Enter the value for your starting point using the **Numeric Entry** keys.
 3. Press the **Enter** key once.
- *To set FUL SC:*
 1. Press the **Menu 3** key. The Cursor flashes on the third display line.
 2. Enter the value for your starting point using the **Numeric Entry** keys.
 3. Press the **Enter** key once.

AIO Calibration

Required Test Equipment:

√ HP3458A or equivalent.

Analog Output	Positive Connection	Negative Connection
00	1	14
01	2	15
01	3	16
03	4	17
04	5	18
05	6	19
06	7	20
07	8	21
08	9	22
09	10	23
10	11	24
11	12	25

Configure the DMM—DC Measurements, NPLC of 30 and a NDIG of 6.

Configuring AIO for Calibration

- *To configure the AIO system for calibration:*
 1. Press the **System** key.
 2. Press the **Menu** key that corresponds to Setup Option AIO.
 3. Press **Menu 1** key to select which input to calibrate. (Note: it starts at #00.)
 4. Press the **Menu** key that corresponds to Calibrate Output.

Configuring AIO for Measuring

- *To configure DMM for measuring voltage:*

1. Press the **Menu** key that corresponds to 0V.
2. Adjust the reading on the DMM of Zero by using the ▲ and ▼ keys until an optimum point of Zero is found.

Note: Optimum adjustment is the transition point between the positive and negative readings on the DMM.

3. Press the **Menu** key that corresponds to 5V.
4. Adjust the reading on the DMM for 5,000 volts until an optimum point is achieved.

Note: These two adjustments interact with each other and require an oscillating adjustment technique until no further adjustment is possible.

5. Press the **Enter** key once.
6. Press the ▼ key once.

- *To configure the DMM for measuring current:*

1. Press the **Menu** key that corresponds to 0mA.
2. Adjust the reading on the DMM for Zero by using the ▲ and ▼ keys until an optimum point of 0 (zero) is found.

Note: Optimum adjustment is the transition point between the positive and negative readings on the DMM.

3. Press the **Menu** key that corresponds to 5mA.
4. Adjust the reading on the DMM for 5.000 mA using the ▲ and ▼ keys until an optimum point of 0 (zero) is achieved.

Note: These two adjustments interact with each other and require an oscillating adjustment technique until no further adjustment is possible.

5. Press the **Enter** key twice.
6. Press the **Menu** key that corresponds to 00 this will increment to the next AIO output to calibrate.

Note: You can continue to press this key to select which AIO Output you wish to calibrate.

7. Move the meter leads to the corresponding AIO output to be calibrated.
8. Repeat steps 1 through 6 until all of the AIO outputs have been calibrated.

Digital Control Interfacing

The 2503AH analyzers have optional RS232 and IEEE488 interfaces, which can be configured to allow the power analyzers to be controlled and interrogated by a computer.

Note: Throughout this chapter it is assumed that you are familiar with manual operation of the power analyzer, and with the methods of operating the controller for the particular interface being used.

Both interfaces operate in similar manners, using the same command set. The major difference between their operations is:

- The IEEE488 interface switches between remote and local command states, whereas the RS232 interface does not; and
- The controller can continuously read data from the IEEE488 interface, whereas the controller must prompt the analyzer to transmit the desired data from the RS232 interface.

Using RS232 Interfacing

Ensure your 8-bit card reliably operates in high-speed computers, such as 80386 based machines or faster.

The RS232 interface is configured to use the RS232 hardware *handshake* lines RTS and CTS to handshake data. The usage of these hardware handshake lines ensures that *no* data will be lost due to different speeds in the analyzers and the computer. If your computer is not able to use these handshake lines properly,* prevent *data overrun* by placing delays between sending individual command strings.

* Some computer systems continue to transmit a few characters after being *held off* from transmitting.

Note: In the RS232 interface there are no defined remote or local states, thus the instrument will respond to commands from either the front panel or the interface as applicable.

Data Format Selection

Ensure that the computer connected to the RS232 port is set to the same baud rate as the instrument's serial port, 8 bit data with no parity, 1 stop bit and 1 start bit. In normal operation, select the highest baud rate (38400 baud). Ensure that your computer operates correctly at this speed, particularly when multi-tasking.

Note: Decrease the selected baud rate to reduce data transfer error rates: when operating in environments having severe interference; when using long cable lengths, and if you are unsure whether the computer is capable of the highest baud rate.

Throughout this section of the manual, the use of a National Instruments AT-GPIB© IEEE488 controller board in an IBM AT (or compatible) is assumed. If you are using a different controller or a controller card from another vendor, then the exact methods used will differ from those shown. If you are using a computer with a built-in interface (such as the Hewlett-Packard series 300 and similar computers) then no configuration is usually required.

Using IEEE488 Interfacing

There are several differences between the IEEE488 and RS232 interface operation; these are all due to the extended capabilities of the hardware interface of the IEEE488 standard.

Bus Timing

Almost all of the timing requirements of the bus interface are handled by the hardware handshake system used by the IEEE488 interface. During decode of a command all further received data are held-off by this hardware handshake until the decode has been completed. Typically data transfer rates of up to 50,000 characters per second are attainable with the 2503AH-1CH, -2CH & -3CH.

Bus Commands

As previously mentioned, the IEEE488 interface can perform many tasks that the RS232 does not, those used by the 2503AH-1CH, -2CH & -3CH are as follows:

Remote/Local

The IEEE488 interface defines separate “remote” or “local” states for the power analyzer.

Device Clear

The IEEE488 defined Device Clear functions (both selective and global) force the 2503AH-1CH, -2CH & -3CH to perform a power-on reset function.

Interface Clear

The IEEE488 standard defines this command, which causes the interface portion of the 2503AH-1CH, -2CH & -3CH analyzers to be reset to the power on conditions, aborting any bus activity in progress.

Other IEEE488 Specific Items

If a handshake sequence is improperly completed during a transfer of data to or from the IEEE488 interface, then the 2503AH-1CH, -2CH & -3CH analyzers automatically powers on a reset sequence. This facility prevents the interface from becoming *locked out* if the interface cable is removed or becomes faulty during a data transfer.

Remote/Local Operation

When using the IEEE488 interface in the *local* state (e.g., following the initial application of power) the analyzer will only respond to commands from the front panel. After placing the instrument in the IEEE488 interface’s remote state via an interface command, the analyzer will only respond to commands received by way of the interface. This remote operation continues until released into the local state by the defined interface command, or by pressing the **Local** key on the front panel. In either state, the instrument can have its present status read by the interface.

The remote state is normally achieved automatically when the instrument is correctly addressed to *listen* to a command string defined by the IEEE488 interface bus.

Configuring the Instrument and Controller

Other than enabling the interface to act as a control interface, setting the desired address and connecting the IEEE488 cable, you need not perform any specific configurations on the instrument. As with all IEEE488 instruments and devices, you must ensure that the selected address does not conflict with any other devices in the system. When using the instrument with the National Instruments controller card (and with other cards for the IBM AT) do not select an instrument address of “0,” as this will conflict with the address of the card.

Configuring the Controller Card

Follow the manufacturers recommended installation procedure when installing the card in the computer. Where an IBM PC (i.e., 8-bit) card is to be installed into an IBM AT type machine (i.e. 16-bit or higher), take particular note of the hardware interrupt and DMA channel selected for the card.

Most manufacturers of these cards set these parameters to those compatible with the IBM PC, unfortunately these usually conflict with other cards normally found in the IBM AT class computers. In particular, be aware that the first parallel port in an IBM AT class computer uses interrupt IRQ7.

When a conflict occurs between interrupts and DMA channels, the problems cannot appear for some time, or can only cause intermittent operation. When any doubt occurs you are recommended to first deselect the DMA channel, and then (if the problem persists) deselect the IRQ. Although this will perform slightly slower than the published specifications for the card, this will ensure that no conflicts occur.

When operating using hardware interrupts and DMA channels, and the computer is operating under the control of multi-tasking software (such as Microsoft Windows), then there are many other issues that require attention. In these circumstances it is best to consult with the vendor of the controller card for specific configuration details.

Configuring the Controller Software

With the National Instruments AT-GPIB controller card, and with many other cards, there is a configured device driver installed in the computer. This driver must be correctly configured to ensure reliable operation with the 2503AH -1CH and -2CH analyzers. This section describes the settings that have been

tested with the National Instrument AT-GPIB driver revision 1.5 accessed with the “ibconf” program supplied with the controller card, other drivers and revisions can be similar to those shown below.

Controller Card Configuration

These settings can be varied dependent on other instrumentation using the IEEE488 bus.

Primary Address	0. ¹	Assert REN when SC	no. ^{1, 2}
Secondary Address	NONE. ¹	Enable Auto Serial Polling	yes. ³
Timeout Setting	T10S. ¹	Timing	500nS. ⁴
EOS	00H. ¹	Enable 488.2 Protocols	yes. ⁵
Terminate on EOS	no. ¹	CIC protocol	no. ²
Set EOI with EOS on Write	no. ¹	Interrupt Setting	11. ⁶
Type of Compare on EOS	7-bit. ¹	Base I/O Address	02COH. ⁶
Set EOI w/last byte of Write	yes. ¹	DMA Channel	5. ⁶
System Controller	yes. ²		

Notes:

- 1)** These selections are only for data transfers regarding the controller card itself. Thus other settings can be used, but have not been fully tested by Xitron Technologies Inc.
- 2)** These selections assume the use of a single controller. In configurations where a second controller exists these can be altered, other settings have not been fully tested by Xitron Technologies Inc.
- 3)** The Xitron Technologies 2503AH analyzers do not currently use the SRQ and Serial Poll capabilities of the IEEE488 bus. This setting will be dependent on other instruments.
- 4)** Timings of longer than this are also valid. The 350ns selection has been tested on shorter cable lengths by Xitron Technologies Inc. and can be used, however, in normal operation there is little overall performance gain by using it with the 2503AH analyzers. If other, very high speed devices exist in the system then this shorter time can be selected.

5) The 2503AH analyzers do not use the IEEE488.2 specifications, thus this setting has no affect on these instruments if you have otherwise ensured that no IEEE488.2 type transfers take place with 2503AH-1CH, -2CH & -3CH analyzer. If all of the other devices do not use the IEEE488.2 type transfers, then this setting should be set to No to ensure compatibility.

6) Although these settings have no affect on the 2503AH analyzers, ensure that no hardware conflicts exist with other installed devices in the computer. The settings shown above are highly recommended, as the probability of conflict is lowest with these settings.

Settings for the 2503AH Analyzers:

Note that as documented in the National Instruments manual, the name given for the device should not exist as a file, directory, or sub directory within the computer system. If this occurs then unreliable operation of both the bus and the computer can result. Especially when operating in a network environment, it is recommended that the name given is cryptic to reduce the probability of this occurring.

Primary Address	2. ¹	Set EOI with EOS on Write	no. ⁵
Secondary Address	NONE. ¹	Type of Compare on EOS	7-bit. ⁴ yes. ⁵
Timeout Setting	TIs. ²	Set EOI wAast byte of Write	no. ⁶
EOS Byte	OAH. ³	Repeat Addressing	
Terminate read on EOS	yes. ⁴		

Notes:

1) Configure the address in the instrument. The 2503AH analyzer does not use secondary addressing.

2) The only command that can hold the bus handshake for longer than 20mS is the device clear command. If this command is not used then even shorter timeout periods can be used to detect a failure. The device clear command can hold the bus handshake for up to one second. When using the command pass-through feature of the MIB (i.e. controlling another instrument via the MIB) then longer timeout periods are required.

3) The 2503AH analyzer always sends a carriage return (ODH) and a line feed (OAH) with EOI asserted at the end of each data transfer.

- 4) Terminating a data read with the defined EOS byte ensures that data transfers are correctly terminated. This ensures that you do not have to specify the exact number of characters for each transfer. Data transfers from the 2503AH analyzers are all 7-bit ASCII data with no parity.
- 5) The 2503AH analyzer will terminate a *data-receive* operation with either a line feed character (OAH), or any character with EOI asserted, or with a device trigger. Selecting the EOI with last byte of *Write* option ensures the shortest possible data transfer.
- 6) The 2503AH analyzer does not *unaddress* at the completion of a transfer. Thus, assuming no other device has been subsequently addressed, there is generally no requirement to readdress the instrument. However, if the instrument is reset to the LOCAL state then it must be readdressed to reenter the REMOTE state.

Reading Data From the Power Analyzer

With either interface you can interrogate the various data held by the instrument. This is achieved by sending a *data read* command string (see the next section), which defines which data is to be interrogated, and then reading the data from the instrument. Up to 1000 characters can be read from the instrument as a result of sending a *data read* command.

In the RS232 interface, this data is automatically transmitted from the instrument to the controller, the instrument will then wait for a further *data read* command before sending further data.

In the IEEE488 interface, the controller can immediately attempt to read the requested data, the controller will then be held for a short delay (typically less than 1mS) until the requested data is available, then the requested data will be read by the controller. This data can be read by the interface any number of times, the data transmitted will always be the latest available data (unless the instrument is in the HOLD state).

In either interface, the instrument typically responds by sending a single *space* character, followed by a numeric string (with a preceding polarity symbol), followed by the respective *engineering format* exponent data in the form “e+3,” and terminated by *carriage return* and *line feed* characters. Note that with the IEEE488 interface this last character is sent with the EOI line asserted.

Certain data do not follow this format, these are described in the following paragraphs. Refer to the READ= command description. You also can request more than one item of data is transmitted, here the individual items sent from the instrument are separated by means of the comma/V character.

Sending Data to the Power Analyzer

Both the RS232 and IEEE488 interfaces operate similarly with regards to sending data to the instrument. The only difference being the previously mentioned requirement to place the instrument in the REMOTE state with the IEEE488 interface. ASCII characters transmitted to the interface are stored in a *buffer* until either a *line feed* character is received, or a character with the EOI line asserted, or a “Group Execute Trigger” command is received. The received characters then are decoded and actioned.

Up to 1000 characters can be stored in the *receive buffer*, which can contain more than one complete command string type if desired. If you send conflicting commands within the same command string, then the last effective command will be used.

Separate individual commands within the same strings using the *comma* (,) or *semi-colon* (;) characters. For commands that require several items of data, separate with the *slash* (/) or *colon* (:) characters.

Notes:

- 1) Only the colon character can be used for the READ= command.
- 2) The 2503AH analyzers operate with the received ASCII characters, the command used to send these characters via the designated interface is dependent on the computer system and peripheral used.

Command Set

The various features of the 2503AH analyzer can be controlled by the controller sending certain command *strings* to the analyzer. You can freely distribute *space* and non-printing characters between commands throughout the command string, and can send more than one command before sending the termination character.

Notes:

- 1) Commands are terminated by the reception of a *line feed*, the reception of a character with the EOI line asserted, or by the reception of the “Group Execute Trigger” command.
- 2) You can freely use either lower or upper case characters, as desired.
- 3) The list of commands shown here are for software versions up to and including main software version 2.01. Future software revisions can include more capabilities.

Command Operator Portions

The uppercase portion of the commands listed below is the actual command operator.

ACCUM=STRING

These commands control the accumulation capabilities of the analyzer. These commands (with the exception of the ACCUM=CLEAR command) are only actioned when the analyzer has not been configured for rear panel control of accumulation.

ACCUM=ON

This command both initiates an accumulation and clears any prior accumulation results.

ACCUM=OFF

This command terminates an accumulation. Final results are available following a delay of one measurement period following the termination of the accumulation.

ACCUM=RESTART

This command restarts an accumulation. This is similar to the ACCUM=ON command shown above, but does not clear any previously taken accumulated results.

ACCUM=CLEAR

This command clears any accumulated results to their initial values (normally zero). This can be commanded during any phase of an accumulation, but is normally used while an accumulation is not being performed.

Command Optional Portions

The lower case portion(s) of the command represents the optional parameter(s) for the command. These optional portions of the commands are denoted as follows:

[c]

This shows that the command affects a specific channel. If this optional portion is not included, then channel A is affected. If [A], [B] or [C] is included then channel A, B or C respectively are affected. If the selected channel does not exist (e.g., specifying [c] to a 2503AH-1CH), then channel A is affected.

chl/parameter

This shows that you should place the required parameter descriptor in the specified position. Refer to the end of this section for a complete list of the available parameter descriptors and formats.

n

An integer number having the specified range. In cases where more than one digit is possible, you can optionally place the leading zero characters. This data can not have a preceding polarity sign character.

numeric

A floating point number having the specified units. This data can have an optional preceding polarity character. The decimal point is optional, and can be in any desired position. "e" format numbers are also accepted.

string

One of the specified possible character strings for the specific command.

Commands Available with IEC1000-3-2 Parameters

To enable the Steady-state testing, configure the instrument via the SET commands, prior to issuing a READ command as the READ command begins the test.

Note: Running a READ= xxxxxxxxxxxx loop, restarts the fluctuating harmonics measurement every time the 2503AH analyzer receives the READ command.

The 2503AH-1CH, -2CH & -3CH analyzers return a value (string) given below:

READ=IEC1000-2[chnl,class,trans]

chnl= CHA,CHB or CHC

class= A,B,C or D

trans= S(steady state) or F(luctuating)

Note: The instrument defaults to Steady, if not specified.

Examples: READ=IEC1000-2[CHA,D,F]
READ=IEC1000-2[CHB,B]

Upon receiving the above READ command, the instrument returns one of the values (strings) given below:

Pass	If the current measured by the specified channel passes the harmonics test for the specified class.
Fail	If the harmonic currents in the specified channel fail the test.
Running	If the test is running (up to 2.5 minutes).
Waiting	If the analyzer does not receive input.
Chksource	If the supply source exhibits excessive harmonics or invalidates the measurement.

Commands Available with IEC1000-3-3 Parameters

The 2503AH-1CH, -2CH & -3CH power analyzer requires two types of IEEE488 commands to control the instrument. One command is used to start or abort the “Flicker Measurement.” The second command serves to read the individual test results, or get the Run, Pass or Fail type response.

FLICKER[ch]=START[mins,N]

Starts the Flicker Level test, all previous test data is lost. Any flicker level measurement in progress on the specified channel is automatically aborted and then restarted. The test is run for mins (minutes integer only). If the N characters are present, then the Pst and Plt values are disregarded for the final pass/fail status check. The Plt value is automatically disregarded if the mitts figure is less than 120 minutes, and the Pst value is automatically disregarded if the mins figure is less than 10 minutes.

Examples: FLICKER[A]=START[120]
 FLICKER[B]=START[120/N]

Note: The various Pst and Plt parameters are available whether the N portion of this command is present or not.

FLICKER[ch]=ABORT
Aborts any flicker measurement in progress.

FLICKER[ch]=OFF
Disables flicker measurements on the selected channel.

PASS
A measurement has been completed and all checked parameters passed the IEC1000-3-3 limits.

FAIL[dc]
A measurement has been completed and the dc parameter failed to meet the IEC1000-3-3 limits.

FAIL[dmax]
A measurement has been completed and the dmax parameter failed to meet the IEC1000-3-3 limits.

FAIL[D(t)]
A measurement has been completed and the d(t) parameter failed to meet the IEC1000-3-3 limits.

FAIL[Pst]
A measurement has been completed and the Pst parameter failed to meet the IEC1000-3-3 limits.

FAIL[Plt]
A measurement has been completed and the Plt parameter failed to meet the IEC1000-3-3 limits.

All values are only updated while a measurement is in progress and only if flicker is enabled for the selected channel. The failure reported is that having the most excessive percentage of the EN 61000-3-3 specification.

Example: READ=IEC1000-3[CHA,Plt]
 READ=IEC1000-3[chnl,percentage]

If a numeric value is found for percentage, then this will return the “P” value, which is exceeded for the specified percentage of time. Although this is available while a measurement is in progress, this is not recommended.

Note: This data is recycled every 10 minutes (when Pst is computed). Interrogating this data following completion of a long-term measurement, will return the values pertaining to the final 10 minute period (or portion thereof).

Example: READ=IEC1000-3[CHA,80]

READ=IECHARMABS[chnl] or IECHARIVIPCT[chnl,class]

Returns the values of the 2nd through 40th harmonics as used for Flicker Level analysis. IECFLKRMABS returns the values in amperes, IECFIARIVIPCT returns the values in percentages of the applicable specification limits.

Examples: READ=IECHARMABS[CHA]
READ=IECHARMPCT[CHA,C]

SETIEC1000-2=[grp]/nosourcecheck

This provides a fast method of automatically configuring the group specified (grp, GRPA, GRPB or GRPC) to correctly perform Steady-state harmonic analysis. The no source check portion can be not specified nor (/N) can its voltage source be checked for conformance to EN 61000-3-2 specifications.

Examples: SETIEC1000-2=[GRPA]
SETIEC1000-2=[GRPB] /N

SETIEC1000-2=[grp]/J/400/W/50D/vnom/fundcurrent

where:

grp defines the group of channels to be configured for Steady-state measurements as previously described for this command: “J” indicates that these variants on this standard are to be used; “400” is optional and if not specified the entire field should not be present.

Do not use adjacent field separators. If present, this specifies that the limits for classes A, B and C are to be multiplied by 400/Vnom, rather than 230/Vnom.

Commands Available with Option AN12 Fitted

The following commands are only effective if option AN12 is fitted:

ANALOG[n]=DEFAULT,
ANALOG[n]=parameter,
ANALOG[n]=range/zero/span
ANALOG[n]=numeric

The function of these commands:

- Force the specified analog output to the specified output level yielding an output level of between -fullscale and +fullscale respectively:

Example: Output [n] between 0 and 11 inclusive yeilds output level: numeric, -1.0 to +1.0.

- Return the analog output to the parameter, zero offset and span specified by means of the front panel controlled configuration;

Example: Output [n] returned via ANALOG [n]=DEFAULT to specified parameter, zero offset and/or span.

- Configure the specified analog output to the indicated range, parameter zero offset and parameter span;

Example: Output [n] range configured as 5V, 10V, or 5mA for numeric value of offset and of span.

- Set the output level to be determined from the value of the passed parameter.

Note: After a *power-on* reset or a *device clear* (via the IEEE488 interface), all analog outputs are returned to their respective front panel configured parameters, channels, zero offsets and spans.

Analog Output Override and Control

These commands allow you to either override an analog output used to drive a plotter or alarm output, or allow you to control another instrument or power supply via this analog level.

CIT[c]=numeric

This command specifies that the selected channel is using a current output CT on its input that has an input to output ratio given in the numeric portion of the command. Note that the default is channel A if the optional [c] portion is not present. The equal (=) character is optional. If the specified channel was configured for voltage input measurement of current (i.e. an external CT or shunt) then this command deselects that mode, returning current measurement to the internal current shunt measurement mode.

CLRDISPLAY

This command clears all display lines.

CLRUPTIME

This command clears the timer which can be used to identify the exact time at which each channels' parametric data was last established.

See the READ= commands and UPTIME (c) parameter.

CVT[c]=numeric

This command specifies that the selected channel (channel A if the optional [c] portion is not present) is using a voltage output CT or current shunt on its current input that has an input (amps) to output (volts) ratio given in the numeric portion of the command. The equal (=) character is optional.

DISP[n]=chl/parameter

This command specifies that the selected display line (n, 0 through 49 inclusive) will display the specified parameter. If the optional [n] portion is not specified, or specifies a line beyond the last defined line, then the first undefined line is affected. The equal (=) character is optional. See the list at the end of this section for the available parameter descriptors.

EQN[n]=name/parameter

This command sets the specified equation number to the set name string and parameter definition, which can include an equation of up to 500 characters. The result of this equation can be used as a normal parameter by referring to it by its name. Using a standard parameter name does NOT override the standard definition, but renders this equation definition as being invisible.

Automated External Commands

These commands allow you to perform an automated external calibration of the instrument.

EXTCAL

This command initiates an external calibration sequence.

EXTSKIP

This command selects the next external calibration point without affecting the data for the point being measured, if any.

EXTUSE

This command shows that the instrument should compute the calibration data using the actual input level present and then select the next calibration point. The nominal input level required can be obtained by finding the current/voltage range in use for each channel using the READ=STATUS command. Also refer to *Check the Status of the Analyzer* on page 115.

FFT Based Harmonic Analysis

FFT[c]=maxharm/bandwidth/type

This command configures the FFT based harmonic analysis for the group containing the channel [c], as defined by maxharm/bandwidth/type. See the FUND and HARM commands.

MAXHARM

This integer defines the highest harmonic number, which is to be made available. This overrides any requests for higher harmonics by individual parameter requests. Setting this to 0 disables FFT based harmonic analysis for this group.

BANDWIDTH

This integer defines the ratio between the fundamental frequency and the bandwidth over which each harmonic is measured. Setting this to 0 disables FFT based harmonic analysis for this group.

TYPE

This string can be either NORMAL or WINDOWED.

Channel [c] Digital Filter

FILT[c]=n or FILT[c]=numeric

This command sets the group containing the channel [c] as using a digital filter. The = character is optional. The available formats are as follows—

- FILT[c]=0 No filtering.
- FILT[c]=1 20kHz Low Pass Filter
- FILT[c]=2 10kHz Low Pass Filter
- FILT[c]=3 5kHz Low Pass Filter
- FILT[c]=4 2kHz Low Pass Filter
- FILT[c]=5 1kHz Low Pass Filter

FILT[c]=numeric

Sets the low pass filter corner frequency to the passed numeric value, in Hz. A minimum value of 6Hz is allowed, a value in excess of 200kHz yields a 5MHz filter.

Input [i] Frequency Measurement

FMEAS[i]=min/max/period/filter

This command sets the measurement of frequency for the input [i] as being performed over the frequency range from min to max numeric value frequencies (in Hz), over the *period* numeric value (in seconds) and using optional result filtering (0 = none, 1 = fast, 2 = medium, 3 = slow). If the specified input is enabled as a synchronization source for establishing the fundamental frequency of one or more groups of channels then this sets all affected input measurements to these values, and sets the minimum expected frequency for these group(s) (for downranging purposes, see also the RANGETIME command) to the value specified by min. The input can be specified by the strings CHAV, CHAI, CHBV, etc.

Channel [c] Fundamental Frequency

FUND[c]=string

This command sets the group containing the channel [c] as having its fundamental frequency defined by a *string*. Valid *string* contents are as follows:

chlistlinlist/multiplier

Is the fundamental frequency is established from the channel(s) listed in the string chlist (e.g. ABC), using the input(s) listed in the string in list (e.g. VI), using an optional multiplier numeric quantity. The channels specified must either all be members of the group to which the [c] channel belongs, or a single non-member channel.

numeric

Means the fundamental frequency is set to the fixed value that is set by the numeric value (in Hz).

Setting Channel By Channel Letter

GROUPS=list,list,list

This command sets the channels indicated by their channel letter being included in the list string, as being contained in the three synchronous measurement groups respectively. Each channel **MUST BE** included in a list, and **CANNOT** be included in more than one list.

Input/Output Type Defined by String

GRPIO[c]=string

This command sets the group containing the channel [c] as having the input/output type defined by string. Valid string contents are as follows:

- IN—the group is measuring input power.
- OUT—the group is measuring output power.
- AUX—the group is measuring neither input or output power.

GRPTYPE[c]=string

This command sets the group containing the channel [c] as having the grouping type defined by string. Valid string contents are as follows:

- NORM—No special operations are performed when calculating the totals for this group.
- 3P3W or DELTA—The group is assumed to be measuring a 3-phase 3-wire power line and special calculations are performed for combining the measured data to produce total values.
- 3P4W or WYE—The group is assumed to be measuring a 3-phase 4-wire power line and special calculations are performed for combining the measured data to produce total values.
- OFF—All channels within the group are disabled.

Measuring Harmonics Signal Content

HARM[c]=string

This command sets the group containing the channel [c] as measuring harmonic signal content as defined by string. See also the FFT and FUND commands.

Valid string contents are as follows:

- **OFF**—no harmonic analysis is performed within the group. The FFT command has no affect with this setting.
- **SINGLE**—a single harmonic analysis is performed within the group during each amplitude measurement period.
- **NORM**—harmonic analysis is performed within the group, with multiple analyses being averaged during the measurement period as necessary to encompass the entire period.
- **IEC1000-3-2 (EN 61000-3-2)**—compliant harmonic analysis is performed within the group. The FFT command has no affect with this setting.

Entering Hold State

HOLD

This command specifies that the instrument is to enter the HOLD state. All database parameters are maintained at the values present at the time this command is received. These parameters can be subsequently released by the RUN command. This command is only effective if the rear panel control input has not been configured for control of this function.

Specifying Channels In-Phase

INPHASE=list

This command specifies which channels (defined by list) are connected in-phase when configured as measuring 3-phase 3-wire power. All channels should be within the same group, any remaining channels within the group, which are not contained within list, are assumed to be connected in anti-phase.

Sequencing Input Calibration

INPUTCAL

This command specifies that the instrument is to perform an automatically sequenced input calibration sequence. The input terminal pairs should each be shorted together prior to issuing this command.

INTCAL

This command specifies that the instrument is to perform an automatically sequenced internal calibration sequence.

Specifying Range

IRNG[c]=string

This command specifies that the instrument is to select the specified range for use on the specified channel. If the channel is not specified (i.e., the [c] portion is not included) then channel A is affected by this command. The equal (=) character is optional. The available strings are as shown below:

IRNG[c]=20A Selects the 20A (internal current shunt) range.

IRNG[c]=10A Selects the 10A (internal current shunt) range

IRNG[c]=5A Selects the 5A (internal current shunt) range.

IRNG[c]=2A Selects the 2A (internal current shunt) range.

IRNG[c]=1A Selects the 1A (internal current shunt) range.

IRNG[c]=0.5A Selects the 0.5A (internal current shunt) range.

IRNG[c]=0.2A Selects the 0.2A (internal current shunt) range.

IRNG[c]=0.1A Selects the 0.1A (internal current shunt) range.

IRNG[c]=0.05A Selects the 0.05A (internal current shunt) range.

IRNG[c]=AUTO Selects the current input, using internal current shunts, in autorange.

IRNG[c]=5V Selects the 5V (current bypass) range.

IRNG[c]=2.5V Selects the 2.5V (current bypass) range.

IRNG[c]=1V Selects the 1V (current bypass) range.

IRNG[c]=0.5V Selects the 0.5V (current bypass) range.

IRNG[c]=0.25V Selects the 0.25V (current bypass) range.

IRNG[c]=0.125V Selects the 0.125V (current bypass) range.

IRNG[c]=0.05V Selects the 0.05V (current bypass) range.

IRNG[c]=0.025V Selects the 0.025V (current bypass) range.

IRNG[c]=0.01V Selects the 0.01V (current bypass) range.

IRNG[c]=VAUTO Selects the current input, using current bypass input, in autorange.

IRNG[c]=40AH Selects the 40A (internal Hall Effect CT) range.

IRNG[c]=20AH Selects the 20A (internal Hall Effect CT) range.

IRNG[c]=10AH Selects the 10A (internal Hall Effect CT) range.

IRNG[c]=5AH Selects the 5A (internal Hall Effect CT) range.

IRNG[c]=HAUTO Selects the internal Hall Effect CT, in autorange.

Specifying Measurement Period

MEAS[c]=numeric

This command specifies that the selected channel should use the specified measurement period (in seconds). If the channel is not specified (i.e., the [c] portion is not included) then channel A is affected. The numeric portion can be between 0.001 and 10000.0 inclusive, values outside this range will be set to the closest allowable value. Setting any channel within a defined group will automatically change all channels within the defined group.

Specifying No CT Connection on Current Input

NOCT[c]

This command specifies that the selected channel does not have a CT connected on its current input. If the [c] portion is not present, then channel A is affected by this command. If the specified channel was configured for voltage input measurement of current (i.e. an external CT or shunt) then this command deselects that mode, returning current measurement to the internal current shunt measurement mode.

Specifying No PT Connection on Voltage Input

NOPT[c]

This command specifies that the selected channel does not have a PT connected on its voltage input. If the [c] portion is not present, then channel A is affected by this command.

Initiating Print Command

PRINT=n

This command initiates a printout, using the default printer device, having the

defined format number. Formats 0 through 9 are factory defined (see the printout section for details), while formats 10 through 19 are user defined. If the specified printout format is undefined, or no printer device is configured, then no action is taken.

Specifying Channel Using PT Input Connection

PT[c]=numeric

This command specifies that the selected channel (channel A if the optional [c] portion is not present) is using a PT on its input that has an input to output ratio given in the numeric portion of the command. The equal (=) character is optional.

Specifying Group Minimum Downrange Timing

RANGE TIME[c]=numeric

This command sets the group containing the channel [c] as having minimum downrange timing set by the numeric value (in seconds). This value is only utilized if it is more than 1/2 of a period of the minimum defined fundamental frequency for the group.

Determining Parameter Transmit to Controller

READ=parameter

This command determines which parameter(s) the instrument will next transmit to the controller. For the RS232 interface the requested data will be transmitted automatically following decode of this command, whereas the IEEE488 will simply store this request until the instrument is next interrogated by the controller (i.e. addressed as a talker).

Note: Several parameters (up to a maximum of 30) can be specified to be read simultaneously, if desired, with a maximum response string length of 1000 characters. Here, each parameter should be separated by the colon (:) character. If this is commanded, then each data item read will be separated by the comma (,) character in the received data string.

Specifying Reset to Stored Configuration

RECALL=n

This command specifies that the instrument should reset the configuration to that contained in the specified storage location. The number n should be between 0 and 65535. Note that this also sets, which saved configuration will

be retrieved, following a reset of the instrument. Attempting to recall a configuration from an undefined store location has no affect on the configuration of the instrument.

Resynchronizing Parameter Readings

RESYNC[c] and RESYNC

These commands allow you to resynchronize parameter readings to accommodate changes in the input waveforms. The RESYNC[c] form of this command affects only the specified channel, and those within the same synchronous group, while the RESYNC form affects all channels within the instrument. This command has no affect if the instrument is presently in the HOLD state.

The overall affect of implementing the RESYNC commands is as follows:

- Any attempts to read data from the instrument will be *unavailable* until the next measurement is completed.
- Any measurement in progress is aborted and a new measurement is initiated immediately following any settling delay imposed by input filtering requirements.

Flicker Test Commands

READ=IWAVEFORM[chnl]

Outputs a 256 point waveform representing one cycle of measured current signal. This is produced by an inverse FFT on the harmonic data. This command applies to firmware 3.95 and later.

READ=VWAVEFORM[chnl]

Outputs a 256 point waveform representing one cycle of measured voltage signal. This is produced by an inverse FFT on the harmonic data. This command applies to firmware 3.95 and later.

READ=IECCCLASS[chnl]

Outputs the class of the present IEC1000-3-2 test in progress. This command applies to firmware 3.95 and later.

FLICKER[ch]=SETUP[mins,N]

Similar to the START command above, but only configures the channel for flicker measurements. No measurement is started.

Example: FLICKER[A]=SETUP[120/N]

Data Access

READ=IEC1000-3[chnl,param]

chn 1=

ChA, ChB, or ChC

param =

Plt	Returns the current Plt value, updated every 10 minutes.
Psti	returns current Pst value, updated every 10 minutes.
Pst	returns current Pst level, updated continuously, reset when Psti is updated.
Pstm	the highest Psti value recorded during the measurement.
Tdt	the highest recorded length of time (in seconds) for which d(t) exceeds 3% (4% if running with no Pst or Plt check).
Dmax	the updated value of dmax (in %).
Dmaxm	the highest recorded value for dmax during the measurement.
dc	the updated value of do (in %).
Dcm	the highest recorded value of do during the measurement.
dt	the updated value of d(t) (in %).
dtm	the highest recorded value of dt during the measurement.
-Ut	the updated value of U(t) (in volts RMS).

Status

The present status of the measurement, the strings returned are as follows:

INVALID

A measurement has not been run, or the channel is not configured for flickermeasurements.

RUNNING

A measurement is in progress.

ABORTED

The last measurement was aborted (results can be invalid).

CHKSOURCE

A single half-cycled(t) measurement exceeded 50%, the measurement was aborted.

Run Command**RUN**

This command releases a previously received HOLD command. If the instrument is not presently in the HOLD state then this command has no effect. This command is only effective if the rear panel control input has not been configured for control of this function.

Save Command**SAVE=n/string**

This command specifies that the instrument should save the present configuration in the specified storage location. The number n should be between 0 and 65535. Note that this also sets which saved configuration will be retrieved following a reset of the instrument. The command can optionally contain a name string (up to 12 characters in length) which is used to name the specified storage location. In software versions prior to 2.00 the naming option is unavailable.

Rear Panel Control Input**SWITCH=string/string**

This command allows you to reconfigure the rear panel control input.

Note: This configuration is stored in the configuration storage areas of the instrument, thus reset and recall operations override this configuration.

The first string defines the operation to be controlled by the rear panel control input, the available options being as follows:

- **OFF**—This turns off the rear panel control input, leaving the accumulation and run/hold functions available for control by the interface or front panel.

- **ACCUM**—This configures the rear panel control input to control the accumulation function of the instrument. This stops this function being controlled by either the interface or front panel of the instrument.
- **RUN**—This configures the rear panel control input to control the run/hold function of the instrument. This stops this function being controlled by either the interface or front panel of the instrument.

The second string indicates the “active” state of the rear panel control input. If the first string indicated OFF, then this second string is optional (and is ignored if present). The separating slash “/” character is optional.

- **OPEN**—This configures the rear panel control input such that the desired operation is performed while the input is in the open or logic '1' state.
- **CLOSED**—This configures the rear panel control input such that the desired operation is performed while the input is in the closed or logic '0' state.

Specifying Channel’s Voltage Range

VRNG[c]=string

This command specifies that the selected channel (channel A if the [c] portion is omitted) sets its voltage range to that specified by the string portion of the command. The available options for the string portion are as follows:

VRNG[c]=1200V	Selects the 1200V range.
VRNG[c]=600V	Selects the 600V range.
VRNG[c]=300V	Selects the 300V range.
VRNG[c]=150V	Selects the 150V range.
VRNG[c]=60V	Selects the 60V range.
VRNG[c]=30V	Selects the 30V range.
VRNG[c]=15V	Selects the 15V range.
VRNG[c]=AUTO	Selects autorange.

Resending Data Requests Using RS232 Interface

At Symbol @

This character command is used in the RS232 interface to cause the results of a previously defined set of parameter data requests, such as READ=parameter command to be resent with the latest available data.

Available Parameter Strings for DISP & READ

The DISP and READ commands accept any of these strings as defining the data to be interrogated by these commands.

2503AH-1CH, -2CH, -3CH Compatibility Format (READ=only)

The general format for type of parameter definition is chl/lparameter. These format strings are converted to the *native* 2503AH-1CH, -2CH & -3CH analyzer format internally, with no units conversions, deviations or filtering.

Note: The chl/ portion of the string is optional, and specifies the source of the parameter. If this portion is omitted then channel A is used as the source.

The available options for this portion of the string are as follows:

CHA/	Channel A data is the source.
CHB/	Channel B data is the source. This option is not available in the 2503AH, if specified then the command has no affect.
CHC/	Channel C data is the source. This option is not available in the 2503AH—1CH and 2503AH—2CH, if specified then the command has no affect.
GROUP/	Total of all channels in the same group as channel A is the source.
INPUT/	Total of all channels defined as measuring the input.
OUTPUT/	Total of all channels defined as measuring the output.

The available parameter selections are as follows:

ACAHR	AC coupled Ampere-Hour accumulated data. Only channels A, B or C are valid sources for this parameter.
ACEPA	AC coupled computed Effective Phase Angle data [i.e., $\cos^{-1}(\text{ACPF})$].

ACI	AC coupled current data.
ACPF	AC coupled Power Factor data.
ACVAHR	AC coupled VA-Hour accumulated data.
ACVA	AC coupled VA data.
ACV	AC coupled voltage data.
ACWHR	AC coupled Watt-Hour accumulated data.
ACW	AC coupled power data.
AHR	AC+DC coupled Ampere-Hour accumulated data. Only channels A, B or C are valid sources for this parameter.
ATHD	Computed current total harmonic distortion. Only channels A, B or C are valid sources for this parameter.
DCAHR	DC coupled Ampere-Hour accumulated data. Only channels A, B or C are valid sources for this parameter.
DCI	DC coupled current data.
DCVAHR	DC coupled VA-Hour accumulated data.
DCVA	DC coupled VA data.
DCV	DC coupled voltage data.
DCWHR	DC coupled Watt-Hour accumulated data. It should be noted that this is the same as the DCVAHR parameter.
DCW	DC coupled power data. It should be noted that this is the same as the DCVA parameter.
EFF	Efficiency data. This data is the ratio of the OUTPUT/PWR and INPUT/PWR parameters expressed as a percentage. If a source is specified it will be ignored, as this parameter has no specific data source.
EPA	AC+DC coupled computed Effective Phase Angle data [i.e., $\cos I$ (PF)].

FREQ	Fundamental frequency of the voltage or current input (in Hz). Only channels A, B or C are valid sources for this parameter.
ICF	Current Crest Factor data. Only channels A, B or C are valid sources for this parameter.
IFF	The Current Form Factor data. Only channels A, B or C are valid sources for this parameter.
LOSS	The Power Loss data. This data is the result of subtracting the OUTPUT/PWR data from the INPUT/PWR data. If a source is specified it will be ignored, as this parameter has no specific data source.
MODI	The Mean Modulus Current data. This is only available in main software versions 2.00 and later.
MODV	The Mean Modulus Voltage data. This is only available in main software versions 2.00 and later.
PF	The AC+DC coupled Power Factor data.
PKI	The Peak current data. Only channels A, B or C are valid sources for this parameter.
PKV	The Peak voltage data. Only channels A, B or C are valid sources for this parameter.
PKW	The Peak power data. Only channels A, B or C are valid sources for this parameter.
PWR	The AC+DC coupled power data.
RMSI	The AC+DC coupled current data.
RMSV	The AC+DC coupled voltage data.
VAHR	The AC+DC coupled VA-Hour accumulated data.
VARHR	The VAR-Hour accumulated data.
VAR	The VAR data.
VA	The AC+DC coupled VA data.

VCF	The Voltage Crest Factor data. Only channels A, B or C are valid sources for this parameter.
VFF	The Voltage Form Factor data. Only channels A, B or C are valid sources for this parameter. This is only available in main software versions 2.00 and later.
VTHD	The computed voltage total harmonic distortion. Only channels A, B or C are valid sources for this parameter.
WHR	The AC+DC coupled Watt-Hour accumulated data.

Full Parameter Definition Format

This is the recommended format for defining parameters in the 2503AH analyzers where compatibility with earlier instruments is not required. This format allows for complete definition of parameters with optional units conversions, filtering and deviation computation and limits checking. This format also allows for access to “special” parameters, which have textual results rather than numerical.

The general format for this style is:

parameter[source and bandwidth][sub- definition string]

—Or—

special parameter

—Where—

parameter is a string defining the parameter

Source and Bandwidth

Is a series of strings or numeric data defining the source and bandwidth for the parameter, this string is surrounded by [] bracket characters.

Sub-definition String

Is an optional string containing optional additional operations to be performed on the parameter result. If no further processing is required, then the surrounding () parenthetical characters need not be present.

Special Parameter

Is a special parameter definition string defining the special (textual) data to be retrieved.

Parameter strings contain one of the following strings, defining the *base* parameter to be retrieved, the source and bandwidth of which is defined by the *source and bandwidth*.

The available formats for each portion is as follows:

AMPL

The RMS amplitude (i.e., volts or current). This parameter requires a single input source and either a string bandwidth or a pair of integers defining the harmonic range for the data. The default units for these results are Vrms or Arms, as applicable.

AMPLFR

The RMS amplitude (i.e. volts or current). This parameter requires a single input source and a pair of numeric frequencies defining the center frequency and half-bandwidth for the data (in Hz). (Note that this data is not available from the front panel). The default units for these results are Vrms or Arms, as applicable.

AMPLHR

The accumulated RMS amplitude (i.e. V_{Hr} or A_{Hr}). This parameter requires a single input source and a string bandwidth. The default units for these results are V_{Hr} or A_{Hr}, as applicable.

AVG

The average rectified amplitude (i.e. volts or current). This parameter requires a single input source. The default units for these results are V or A, as applicable.

CHARGE

The accumulated DC coupled positive RMS amplitude (i.e. V_{Hr} or A_{Hr}). This parameter requires a single input source. The default units for these results are V_{Hr} or A_{Hr}, as applicable. This parameter is only available from main software versions 2.00 and later.

CORREL

Power Factor or Correlation (i.e. W/VA). This parameter requires a channel or group of channels, and either a string bandwidth or a pair of integers defining the harmonic range for the data. The default units for this result is none.

CF

Crest Factor (i.e. Peak/RMS volts or current). This parameter requires a single input source and a string bandwidth. The default units for this result is none.

DISCHRG

The accumulated DC coupled negative RMS amplitude (i.e. V_{Hr} or A_{Hr}). This parameter requires a single input source. The default units for these results are V_{Hr} or A_{Hr}, as applicable. This parameter is only available from main software versions 2.00 and later.

DPF

Dissipation or Displacement Power Factor (i.e. W/VA at the fundamental frequency only). This parameter requires a channel or group of channels. The default units for this result is none.

DTOY

The Voltage between a calculated neutral and a phase of a Delta connected 3-phase supply. This parameter requires a channel. The default units for this result is V_{rms}.

EFF

Efficiency (i.e. W_{out}/W_{in}). This requires no further definition. The default units for this result is none (i.e. a pure ratio).

EPA

The inverse cosine of Power Factor. This parameter requires a channel or group of channels, and either a string bandwidth or a pair of integers defining the harmonic range for the data. The default units for this result is radians.

ETRIPL

Total even order triplens (Volts or current). This parameter requires a single input source and a single integer defining the highest harmonic to include in the summation. The default units for these results are V_{rms} or A_{rms}, as applicable.

FF

Form Factor (i.e. RMS/Average Rectified Voltage or Current). This parameter requires a single input source. The default units for this result is none.

FREQ

Frequency. This parameter requires either a single input source, or a single-channel source and an optional single integer harmonic number. The default units for this result is Hz.

GAIN

The Gain or ratio between any two signals. This parameter requires a single input source and single integer harmonic (dividend), and a single reference source and single integer harmonic (divisor). The default units for this result is none (i.e. a pure ratio).

GAINI

The imaginary portion of GAIN (see above, $GAIN = GAINR + j.GAINI$). Both inputs should belong to channels within the same group for the result to be meaningful. The default units for this result is none (i.e. a pure ratio).

GAINR

The real portion of GAIN (see above, $GAIN = GAINR + j.GAINI$). Both inputs should belong to channels within the same group for the result to be meaningful. The default units for this result is none (i.e. a pure ratio).

HIGH

The highest positive excursion of a signal (volts or current). This parameter requires a single input source. The default units for these results are Vpk or Apk, as applicable.

HIGHEST

The largest value for HIGH (see above) obtained during an accumulation. The default units for these results are Vpk or Apk, as applicable.

HZ

Frequency (alternative for FREQ above).

IMAG

The quadrature portion of a signal (volts or current). This parameter requires a single input source and single integer harmonic, and a single reference source and single integer harmonic. Both inputs should belong to channels within the same group for the result to be meaningful. The default units for these results are Vrms or Arms, as applicable.

IMP

The load impedance (i.e. volts/current). This parameter requires a channel and either a string bandwidth or a pair of integers defining the harmonic range for the data. The default units for this result is ohms.

INPHS

The In-Phase portion of a signal (volts or current). This parameter requires a single input source and single integer harmonic, and a single reference source and single integer harmonic. Both inputs should belong to channels within the same group for the result to be meaningful. The default units for these results are Vrms or Arms, as applicable.

INRUSH

The highest excursion from zero since last cleared (volts or current). This parameter requires a single input source. The default units for these results are Vpk or Apk, as applicable.

KFACT

The K-Factor (volts or current). This parameter requires a single input source and a single integer defining the highest harmonic to include in the summation. The default unit for this result is none.

KF

An alternate for KFACT (see above).

LOSS

Power Loss (i.e. Win - Wout). This requires no further definition. The default unit for this result is W.

LOW

The highest negative excursion of a signal (volts or current). This parameter requires a single input source. The default units for these results are Vpk or Apk, as applicable.

LOWEST

The largest value for LOW (see above) obtained during an accumulation. The default units for these results are Vpk or Apk, as applicable.

MAXPK

The largest absolute value of HIGHEST or LOWEST (see above).

OTRIPL

Total odd order triplens (volts or current). This parameter requires a single input source and a single integer defining the highest harmonic to include in the summation. The default units for these results are Vrms or Arms, as applicable.

PEAK +

The largest absolute value of HIGH or LOW (see above).

PF

An alternate for CORREL (see above).

PHASE

The Phase between two signals. This parameter requires a single input source and single integer harmonic, and a single reference source and single integer harmonic. Both inputs should belong to channels within the same group for the result to be meaningful. The default unit for this result is radians.

PHS

An alternate for PHASE (see above).

PKPK

The difference between HIGH and LOW (see above).

PKVA

The highest recorded absolute value of instantaneous VA. This parameter requires a single channel source. The default unit for this result is VApk.

PK

An alternate for PEAK (see above).

PWR

True Power. This parameter requires a channel or group of channels and either a string bandwidth or a pair of integers defining the harmonic range for the data. The default unit for this result is W.

QUAD

An alternate for IMAG (see above).

R

The load resistance (i.e. in-phase Volts/Current, $IMP = R + j.X$). This parameter requires a channel and either a string bandwidth or a pair of integers defining the harmonic range for the data. The default unit for this result is ohms.

RATIO

An alternate for GAIN (see above).

RATIOI

An alternate for GAINI (see above).

RATIOR

An alternate for GAINR (see above).

REAL

An alternate for INPHS (see above).

REA

The load reactance (i.e. quadrature volts/current, $IMP = R + j.REA$). This parameter requires a channel and either a string bandwidth or a pair of integers defining the harmonic range for the data. The default unit for this result is ohms.

RECTIFY

An alternate for AVG (see above).

RES

An alternate for R (see above).

RMS

An alternate for AMPL (see above).

SPAMPL

The signal amplitude measured at the specified spectrum point for the specified single input. The default units for these results are V_{rms} or A_{rms} , as applicable.

SPFREQ

The frequency associated with the specified spectrum point for the specified single input or channel. The default unit for this result is Hz.

THDF

The Total Harmonic Distortion of the selected signal (volts or current), relative to its fundamental component. This parameter requires a single input source and a single integer defining the highest harmonic to include in the summation. The default unit for this result is none (i.e. a pure ratio).

THDH

The Total Harmonic Distortion of the selected signal (volts or current), relative to its total harmonic content. This parameter requires a single input source and a single integer defining the highest harmonic to include in the summations. The default unit for this result is none (i.e. a pure ratio).

THDT

The Total Harmonic Distortion of the selected signal (volts or current), relative to its total RMS content. This parameter requires a single input source and a single integer defining the highest harmonic to include in the summation. The default unit for this result is none (i.e. a pure ratio).

TRIPL

Total triplens (volts or current). This parameter requires a single input source and a single integer defining the highest harmonic to include in the summation. The default units for these results are Vrms or Arms, as applicable.

VAHR

The accumulated VAHr. This parameter requires a channel or group of channels and a string bandwidth. The default unit for this result is VAHr.

VARHR

The accumulated VAR Hr. This parameter requires a channel or group of channels. The default unit for this result is VARHr.

VAR

Reactive or Imaginary Power. This parameter requires a channel or group of channels and either a string bandwidth or a pair of integers defining the harmonic range for the data. The default unit for this result is VAR.

VA

Apparent Power. This parameter requires a channel or group of channels and either a string bandwidth or a pair of integers defining the harmonic range for the data. The default unit for this result is VA.

WATTS

An alternate for PWR (see above).

WHR

The accumulated W Hr. This parameter requires a channel or group of channels and a string bandwidth. The default unit for this result is WHr.

X

An alternate for REA (see above).

YTOD

The Voltage between two phases of a Wye connected 3-phase supply. The default units for this result is Vrms. The computed phase-to-phase voltage for a 3-phase 4-wire “Wye” is available for both group and channel sources. When requested from a group source then the result is the average phase-phase voltage for the entire group.

When requested from an individual channel then the returned results are:

- ChA. The phase-phase voltage between channels A and B;
- ChB. The phase-phase voltage between channels B and C;
- ChC. The phase-phase voltage between channels C and A.

Z

An alternate for IMP (see above).

Note: If a requested channel is not configured for 3-phase 4-wire operation then “INVALID CHNL” is returned.

The following source and bandwidth strings are included for compatibility with future Xitron Technologies products and contain one or more of the following strings separated by commas:

A The Voltage input of channel A.

B The Current input of channel A.

C The Voltage input of channel B.

D The Current input of channel B.

E The Voltage input of channel C.

F The Current input of channel C.

R or S

Alternates for F (see above).

CHAV

The Voltage input of channel A.

CHAI

The Current input of channel A.

CHBV

The Voltage input of channel B.

CHBI

The Current input of channel B.

CHCV

The Voltage input of channel C.

CHCI

The Current input of channel C.

AB

Channel A (included for compatibility with future Xitron Technologies products).

CD

Channel B (included for compatibility with future Xitron Technologies products).

EF

Channel C (included for compatibility with future Xitron Technologies products).

CHA

Channel A.

CHB

Channel B.

CHC

Channel C.

G_GRP or GROUP

The group of channels including channel A.

GA_GRP or GROUPA

The group of channels including channel A.

GB_GRP or GROUP

The group of channels including channel B.

GC_GRP or GROUPC

The group of channels including channel C.

I_IN or INPUT

The total of all channels defined as measuring input power.

O_OUT or OUTPUT

The total of all channels defined as measuring output power.

DC

The DC component only of a parameter.

AC

The AC component only of a parameter.

ACDC or DCAC

The DC and AC components (i.e. the total) of a parameter.

AC+DC or DC+AC

The DC and AC components (i.e. the total) of a parameter.

integer

A harmonic in the range 0 through 2047.

Sub-Definition Strings with Semi-Colons

Sub-definition strings are separated by one or more semi-colons. Refer to following:

FILTER=numeric

Sets that this parameter result is to be filtered with the set numeric time constant (in seconds).

UNITS=string

Sets that the resultant units for the parameter are to be those specified by string. See a later section for available units strings.

NOMINAL=parameter [source and bandwidth]

Sets that the nominal or reference value of this parameter is the value of the set parameter with its associated source and bandwidth.

NOMINAL=numeric

Sets that the nominal or reference value of this parameter is the value of the *numeric*.

NOMINAL @ parameter[source and bandwidth]

Sets that the nominal or reference value of this parameter is the value of the set parameter with its associated source and bandwidth, this value being established at the time that this string is decoded.

DELTA

Sets that the difference between the parameter and the reference or nominal value is to be obtained. A *nominal* string must be present. Only one of DELTA, RATIO, DELTAR or LIMIT formats can be used for a single parameter.

RATIO

Sets that the ratio between the parameter and the reference or nominal value is to be obtained. A *nominal* string must be present. Only one of DELTA, RATIO, DELTAR or LIMIT formats can be used for a single parameter.

DELTAR

Sets that the ratio between the difference between the parameter and the reference or nominal value, and the nominal value, is to be obtained. A *nominal* string must be present. Only one of DELTA, RATIO, DELTAR or LIMIT formats can be used for a single parameter.

LIMIT=numeric

Sets the maximum allowable deviation from the reference or nominal value. The string HIGH, PASS or LOW is returned instead of the value of the parameter. Only one of DELTA, RATIO, DELTAR or LIMIT formats can be used for a single parameter.

Special Parameter Strings

Special-parameter strings are available as follows:

BLANK

(*DISP[n]* = only) defines a blank “—” display line. This parameter is only available from main software versions 2.00 and later.

DELETE

(*DISP[n]* = only) defines that the display line is to be deleted, the *gap* caused by this is “closed” up by shifting all lower display lines upwards. This parameter is only available from main software versions 2.00 and later.

STATUS[c]

Defines that a string indicating the range, mode and overload status of each input within the channel defined by c (A, B or C) will be returned. The format of the data returned is shown later in this document. This parameter is only available from main software versions 2.00 and later.

DATE

Defines that the date (in the format set by the **System** menu entry) will be returned.

TIMEDATE

Defines that the time and date (in the formats set by the **System** menu entry, separated by a single space character) will be returned.

TIME

Defines that the time (in the format set by the **System** menu entry) will be returned.

ACCTIME

Defines that the number of seconds (to within the nearest millisecond) which the accumulation has been running will be returned.

UPTIME[c]

Defines that the number of seconds (to within the nearest millisecond) at which the selected channels' measurement data was last updated will be returned. This data can be reset to zero at any time by the *CLRUPTIME* command. (This command clears all channel timers simultaneously.) This parameter is only available from main software versions 2.00 and later.

DUMP[n]

(*READ*=only) defines that the contents of the memory location defined by the numeric *[n]* are to be read from the instrument. The string returned consists of a series of command strings in a format suitable for sending back to the instrument to return it to the settings contained in the specified memory location. If no memory location is specified (i.e., *[n]* is not specified) then the present settings of the instrument are returned. This parameter is only available from main software versions 2.01 and later.

ID

(*READ*= only) defines that a string defining the instrument and software revisions are to be returned. The format of the data returned is shown later in this document. This parameter is only available from main software versions 2.00 and later.

Status Data Format

READ=*STATUS*[*c*] returns data having a format dependant on the channel specification. If no channel is specified (i.e. *READ*=*STATUS*) then the returned data is as follows:

1st character

The voltage range presently in use on channel A (0=1200V, 1=600V, 2=300V, 3=150V, 4=60V, 5=30V, 6=15V).

2nd & 3rd characters

The current input and range presently in use on channel A (00=20A shunt, 01=10A shunt, 02=5A shunt, 03=2A shunt, 04=1A shunt, 05=0.5A shunt, 06=0.2A shunt, 07=0.1A shunt, 08=0.05A shunt, 10=5V bypass, 11=2.5V bypass, 12=1V bypass, 13=0.5V bypass, 14=0.25V bypass, 15=0.125V bypass, 16=0.05V bypass, 17=0.025V bypass, 18=0.01V bypass, 20=40A hall, 21=20A hall, 22=10A hall, 23=5A hall).

4th character

The overload status of channel A voltage input (0=no overload, 1=overload).

5th character

The overload status of channel A current input (0=no overload, 1=overload).

6th through 10th characters

As the 1 st through 5th, but for channel B (all - characters if not fitted).

11th through 15th characters

As the 1st through 5th, but for channel C (all - characters if not fitted).

If a specific channel is specified (e.g. READ=STATUS[A]) then only the data for that channel is returned (i.e. only 5 characters).

ID Data Format Separated by Commas

READ=ID returns data having the following sub-strings, separated by comma characters (applies to 2503AH-1CH, -2CH & -3CH, as applicable):

- nn.nn main software revision.
- nn.nn channel A supervisor DSP software revision (00.00 if not fitted).
- nn.nn channel A amplitude DSP software revision (00.00 if not fitted).
- nn.nn channel B supervisor DSP software revision (00.00 if not fitted).
- nn.nn channel B amplitude DSP software revision (00.00 if not fitted).
- nn.nn channel C supervisor DSP software revision (00.00 if not fitted).
- nn.nn channel C amplitude DSP software revision (00.00 if not fitted).
- nn.nn history co-processor software revision (00.00 if not fitted).
- nn.nn analog I/O co-processor software revision (00.00 if not fitted).
- nn.nn video co-processor software revision (00.00 if not fitted).

Note: A special string is allocated to any customer-special software versions. This enables customer specific instruments to be recognized.

UNITS-string Format

UNITS=string within a sub-definition string should contain one of the following units definition strings available in the instrument. Not all parameters are comparable with all units strings, wherever possible the instrument will attempt to convert the base parameter to the desired final units. Setting a unit does NOT change the bandwidth of the parameter, nor change the parameter itself. The strings shown below are case-sensitive.

a blank string is no units

<i>A</i>	Amperes
<i>Aac</i>	AC Amperes
<i>Aavg</i>	Average, or Mean Rectified Amperes
<i>Adc</i>	DC Amperes
<i>Arms</i>	RMS Amperes
<i>Apk</i>	Peak Amperes
<i>Apkpk</i>	Peak to Peak Amperes
<i>Aimag</i>	Imaginary Amperes
<i>Areal</i>	Real Amperes
<i>V</i>	Volts
<i>Vac</i>	AC Volts
<i>Vavg</i>	Average, or Mean Rectified Volts
<i>Vdc</i>	DC Volts
<i>Vrms</i>	RMS Volts
<i>Vpk</i>	Peak Volts
<i>Vpkpk</i>	Peak to Peak Volts
<i>Vimag</i>	Imaginary Volts
<i>Vreal</i>	Real Volts
<i>dBV</i>	Voltage decibels relative to a 1V level
<i>dBuV</i>	Voltage decibels relative to a 1%V level
<i>AHr</i>	Ampere-Hours
<i>VHr</i>	Volt-Hours
<i>W</i>	Watts
<i>Wac</i>	AC Watts
<i>Wdc</i>	DC Watts

<i>dBW</i>	Power decibels relative to a 1W level
<i>dBmW</i>	Power decibels relative to a 1mW level
<i>VA</i>	Volt-Amperes
<i>VAac</i>	AC Volt-Amperes
<i>VAdc</i>	DC Volt-Amperes
<i>VApk</i>	Peak Volt-Amperes
<i>VAR</i>	Reactive Power
<i>VARac</i>	AC Reactive Power
<i>HP</i>	Horse Power
<i>WHr</i>	Watt-Hours
<i>VAHr</i>	VA-Hours <i>VARHr</i> VAR-Hours
<i>%</i>	Percentage (ratio)
<i>dB</i>	decibel (ratio)
<i>deg</i>	degrees (180° range)
<i>deg360</i>	degrees (0-360° range)
<i>grad</i>	grads
<i>rad</i>	radians
<i>pirad</i>	pi-radians (1 is equivalent to 180°)
<i>Hz</i>	Hertz
<i>cps</i>	Cycles-Per-Second
<i>rpm</i>	Revolutions-Per-Minute
<i>s</i>	seconds
<i>Hr</i>	Hours
<i>ohm</i>	Ohms
<i>S</i>	Siemens

Full Parameter Definition Format Usage

This section shows some examples of full format parameter definitions. These can be used to define individual items to be interrogated via the interface, such as in a READ= command or to define a display line as in a DISP[a]= command. In the case of the READ= command, multiple items can be defined for interrogation at the same time (up to 10 items) by separating each parameter definition by the colon (:) character.

AMPL[CHAV]

Defines AC+DC RMS voltage on channel A.

AMPL[CHAV,DC]

Defines DC only RMS voltage on channel A.

AMPL[CHAI,1,1]

Defines fundamental only (harmonic #1) RMS current on channel A.

AMPL[CHCI,2,1000]

Defines RMS current on channel C measured over the range of 2nd harmonic through the 1000th harmonic.

AMPLFR[CHAI,20e3,5e3]

Defines RMS current on channel A measured over a range centered on 20kHz with a 5kHz bandwidth (i.e., 15-25kHz).

RATIO[CHAV,1,CHBV,1]

Defines the ratio between the fundamental voltage of channel A and the fundamental voltage of channel B.

THDF[CHAI,49]{UNITS=%}

Defines THD current (relative to fundamental) on channel A, measured up to and including the 49th harmonic, expressed in percentage units.

PWR[INPUT,ACDC]{FILTER=2.5}

Defines the total input power, including both AC and DC components, with a 2.5 second single order filter applied to the result.

AMPL[CHAV,AC]{NOMINAL=AMPL[CHBV,AC];LIMIT=5.0;FILTER=2.00}

Defines a pass/fail check of the AC voltage of channel A, compared continuously against the AC voltage of channel B, allowing up to 5V difference before failing, and using a 2 second single order filter.

RATIO[CHAI,3,CHAI,1]{NOMINAL=0.0;LIMIT=0.2}

Defines a check of the ratio between 3rd harmonic and fundamental current of channel A, with a maximum limit of 20%.

High Speed Operation

The 2503AH-1CH, -2CH & -3CH power analyzers have the capability of operating at over 100 readings per second when correctly configured. This section covers some useful information regarding obtaining the highest possible speed from these instruments.

Measurement Periods

The highest possible reading rates are obtained when only those channels, which are required to be high speed are configured with short measurement periods. Channels, which are not required, should either be turned off, or set to an amplitude measurement period in excess of 0.25 seconds. See the MEAS command for details.

Frequency Measurement

Inputs, which are not configured for use for fundamental frequency determination, should have their frequency measurement turned off. There is a significant speed improvement when the fundamental frequency range covers a range of less than 2:1. If harmonic measurements are not needed or the fundamental frequency is well known (to within 1%, e.g. line voltage), then the use of a fixed frequency fundamental will achieve significant results. See *Automated External Commands* on page 149.

Harmonic Measurement

Enable Harmonic measurements only in groups of channels where required. Limit the maximum range of harmonics and keep the Fundamental:BW (bandwidth) ratio to the default values, if possible. If high frequencies are to be measured, then a significant improvement in speed can be realized by only allowing a single analysis per measurement period. See the *Harmonic Measurement Setup* on page 78.

Interrogating Results

Read as many parameters in the instrument at the same time, as possible. This saves time in reducing the transmission of new READ= commands and saves time in their decode.

Reduce the amount displayed on the front panel to as little as possible (less than four lines if possible) and eliminate any display line filters as these are continuously updated whether displayed or not.

Addendum—Performance Specifications

General

Unless otherwise indicated, all accuracy specifications given in this chapter are valid throughout the specified operating temperature range, for a period of 1 year, following a 30 minute warm-up period. To maintain accuracy, perform an Input Calibration sequence at 1 day intervals, and following temperature changes exceeding 5°C.

Charts show accuracies for either AC only or DC only parameters, for AC+DC, or Average Rectified parameters use the higher of the two relevant specifications.

High accuracy option specifications are for input frequencies between 40 and 450Hz, autoranging enabled, for crest factors less than 1.8, power factors greater than 0.9, 20kHz filter frequency. Signals other than meeting these requirements are specified as the standard accuracies.

Input accuracies for Voltage, Current Shunt, and Current Shunt Bypass are typically within 3dB to 5MHz.

Refer to the following graphic specifications—Figures 43 through 50.

Voltage Input on page 184.

Current Shunt Input on page 185.

Current Transducer Input on page 186.

Current (Shunt Bypass) Input on page 187.

Power Factor Accuracy on page 188.

Phase Accuracy on page 190.

Frequency Measurement on page 190.

Common Mode Rejection—Shunt Input on page 194.

Voltage and Bypass Inputs on page 195.

Voltage Input

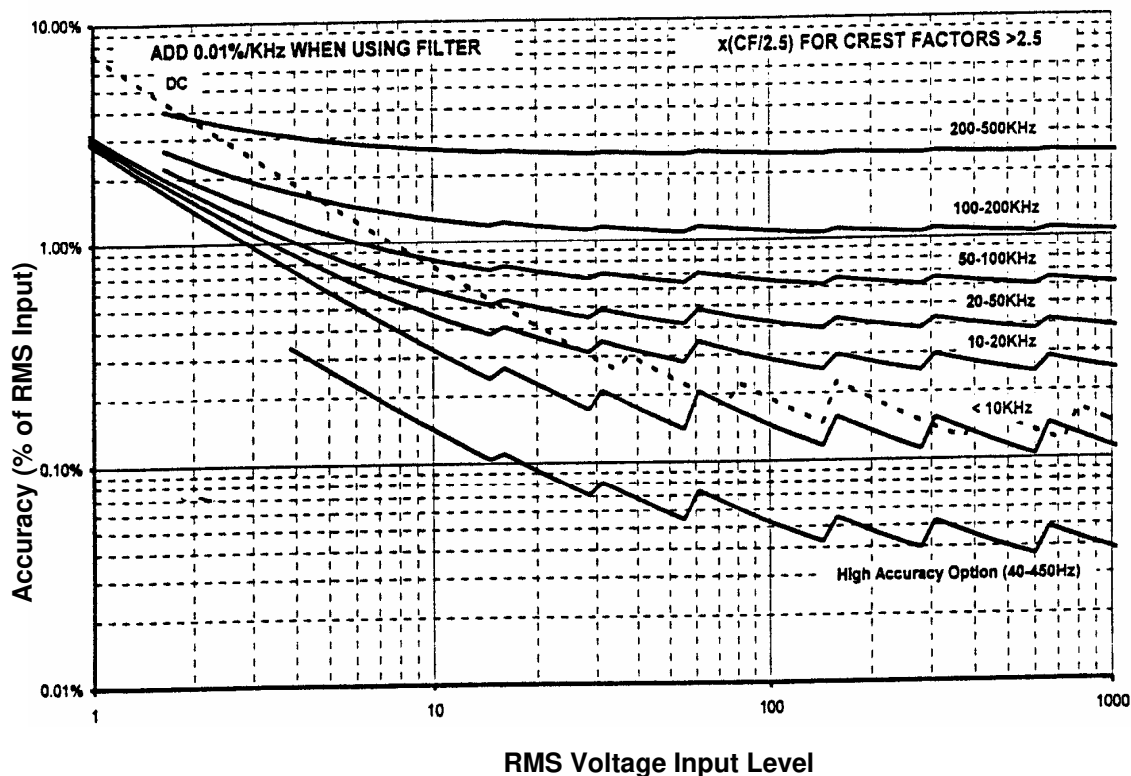


Figure 43. Voltage Input

Specification

- Ranges: 1200V, 600V, 300V, 150V, 60V, 30V and 15Vrms, autoranging or fixed.
- Max. Measurable Peak: > 2.5 times RMS range.
- Protection: Protected up to 3000V peak (2000VRMS) on any range.
- Input Impedance: $600k\Omega || 5pF$ from each voltage terminal to current shunt low terminal.
- Isolation: $1000M\Omega || 10pF$ from either terminal to chassis ground, 3000V peak max.
- Scaling: User scale factors from 1000000:1 to 0.0000001:1 may be used.

Current Shunt Input

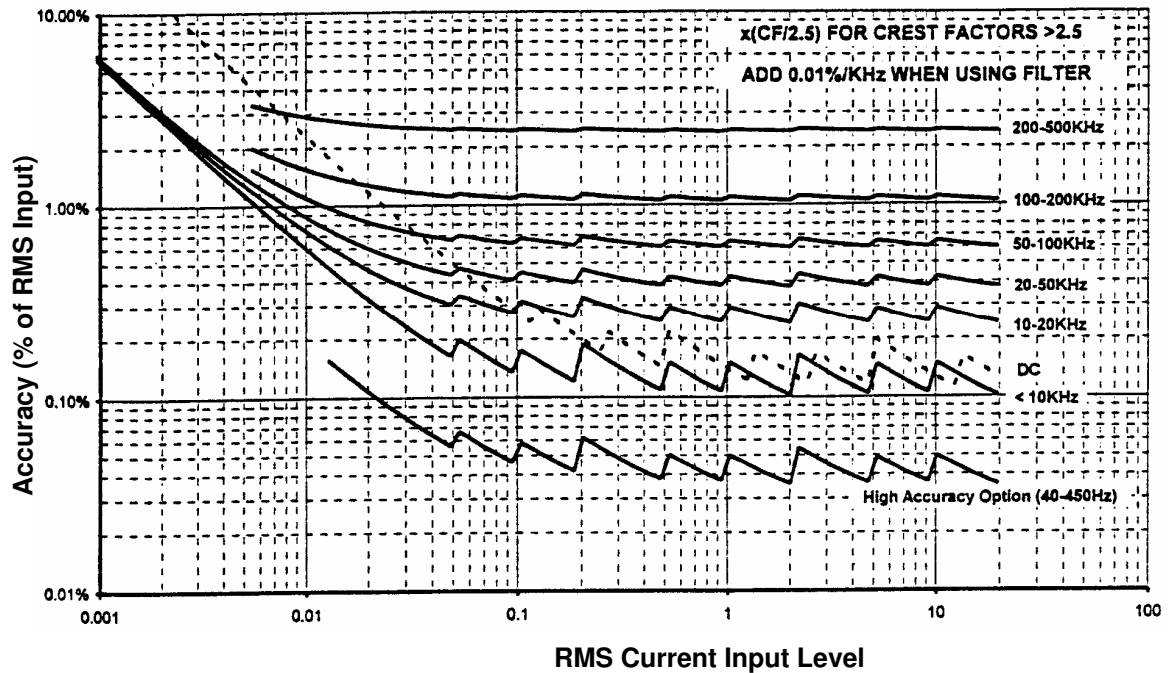


Figure 44. Current Shunt Input

Specification

Ranges: 20A, 10A, 5A, 2A, 1A, 500mA, 200mA, 100mA, or 50mA rms, autoranging or fixed.

Max. Measurable Peak: >2.5 times RMS range.

Protection: Protected up to 50A peak (25Arms) on any range.

Burden: <0.15Ω (below 2A range), <0.02Ω (2A range and above).

Isolation: 1000MΩ||200pF to chassis ground, 3000V peak max., <2500V/μs.

Scaling: User scale factors from 1000000:1 to 0.0000001:1 may be used.

Internal Hall Effect Current Transducer Input

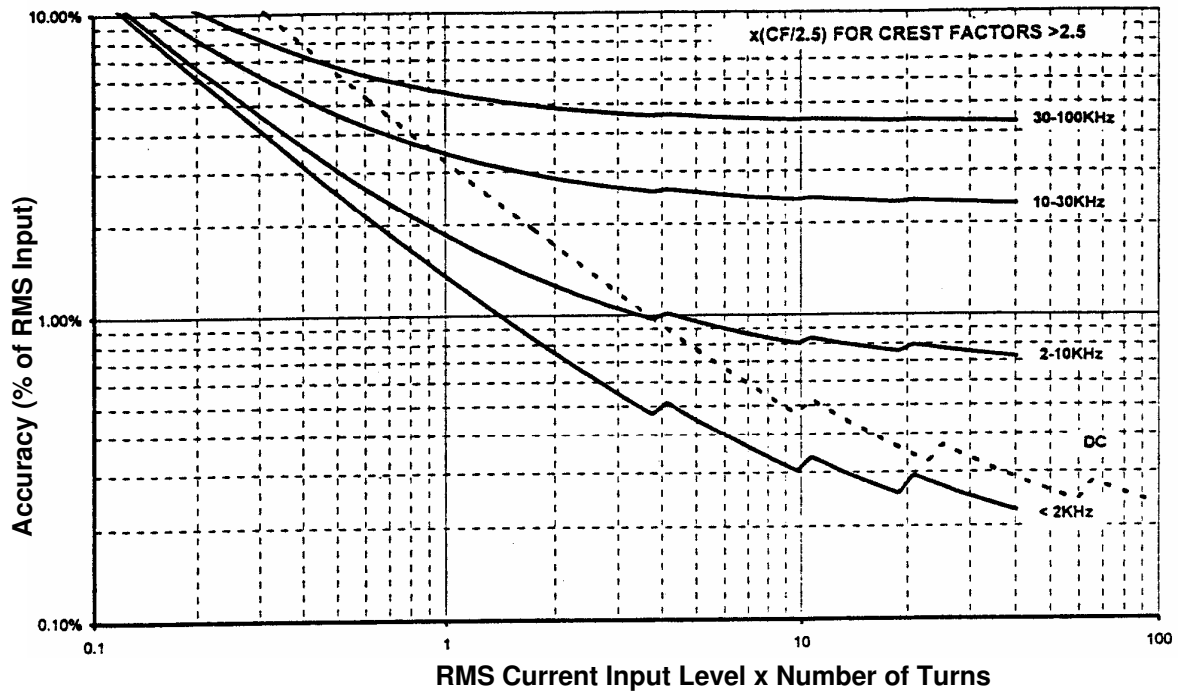


Figure 45. Current Transducer Input

Specification

- Ranges: 40A, 20A, 10A or 4Arms, autoranging or fixed.
- Max. Measurable Peak: >2.5 times RMS range.
- Protection: None required.
- Burden: Negligible.
- Scaling: User scale factors from 1000000:1 to 0.0000001:1 may be used.

Current (Shunt Bypass) Input

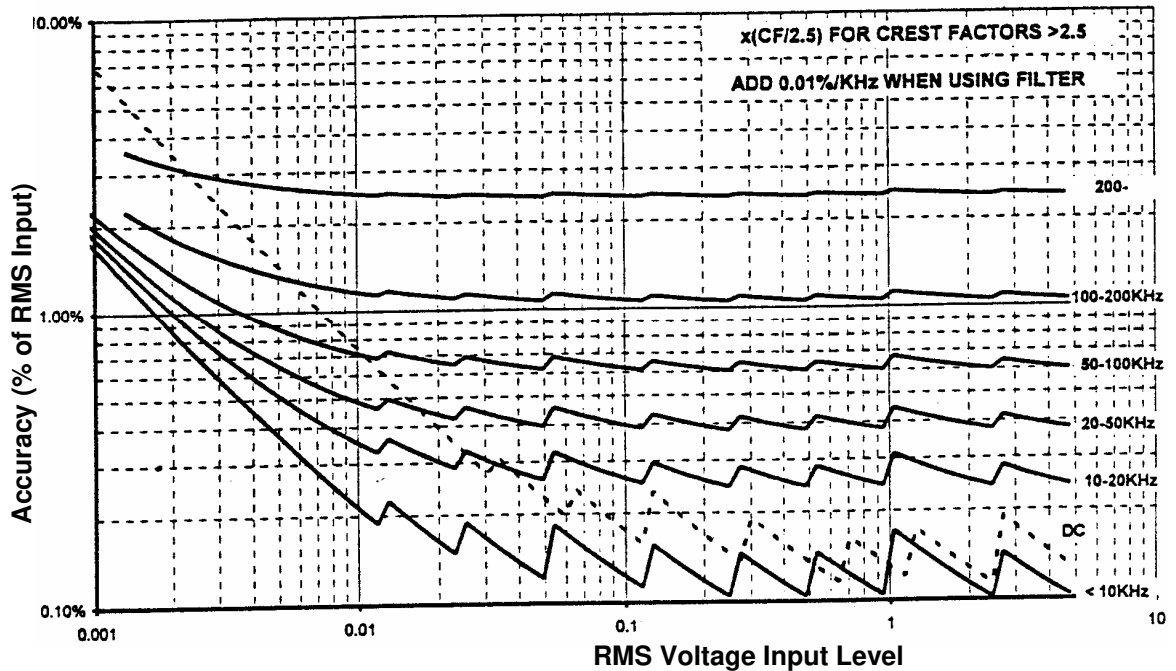


Figure 46. Current (Shunt Bypass) Input

Specification

Ranges: 5V, 2.5V, 1.25V, 500mV, 250mV, 125mV, 50mV, 25mV or 12.5mVrms, autoranging or fixed.

Max.Measurable Peak: >2.5 times RMS range.

Protection: Protected up to 100V peak (50Vrms) on any range.

Input Impedance: $1k\Omega$ (below 500 mV range), $10k\Omega$ (500 mV range and above).

Isolation: $1000M\Omega \parallel 200pF$ to chassis ground, 3000V peak max., $<2500V/\mu s$.

Scaling: User scale factors from 1000000:1 to 0.0000001:1 amps/volt may be used.

Input Filtering

Low Pass Filters: None or any 3 dB corner frequency (F_c) between 10Hz and 160kHz.

Attenuation: >40 dB at twice F_c .

VA Accuracy

VA accuracy is the addition of the relevant percentage accuracies for the voltage and current inputs from the preceding charts.

For the high accuracy option, the percentage VA accuracy is the higher of the relevant percentage accuracies for the voltage and current inputs from the preceding charts.

Power Factor Accuracy

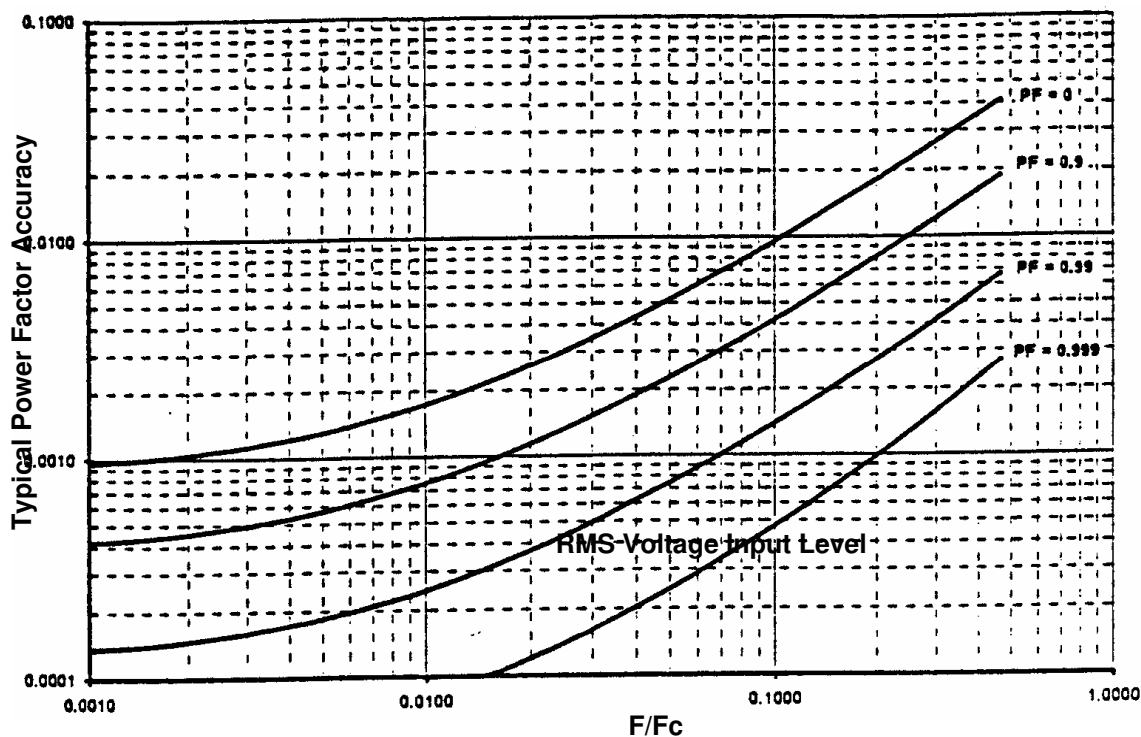


Figure 47. Power Factor Accuracy

Specification

In this graph, F_c is the filter corner frequency or 500kHz (100kHz if using the internal Hall Effect transducer), whichever is the lowest frequency. F is the fundamental power frequency. Extrapolate between curves for accuracy at other power factors.

Watts Accuracy

% Watts accuracy = % VA accuracy + (PF accuracy times 100/PF). At low power factors (less than 0.5) this is better expressed in terms of absolute Watts accuracy as follows:

Watts accuracy = (%VA accuracy times Watts/100) + (PF accuracy times VA)

VAR Accuracy

%VAR accuracy = %VA accuracy + [(1-PF) accuracy times 100/(-PF)]. At high power factors (greater than 0.5) this is better expressed in terms of absolute VAR accuracy as follows:

VAR accuracy = (%VA accuracy times VAR/100) + [(1-PF) accuracy times VA]

Phase Accuracy

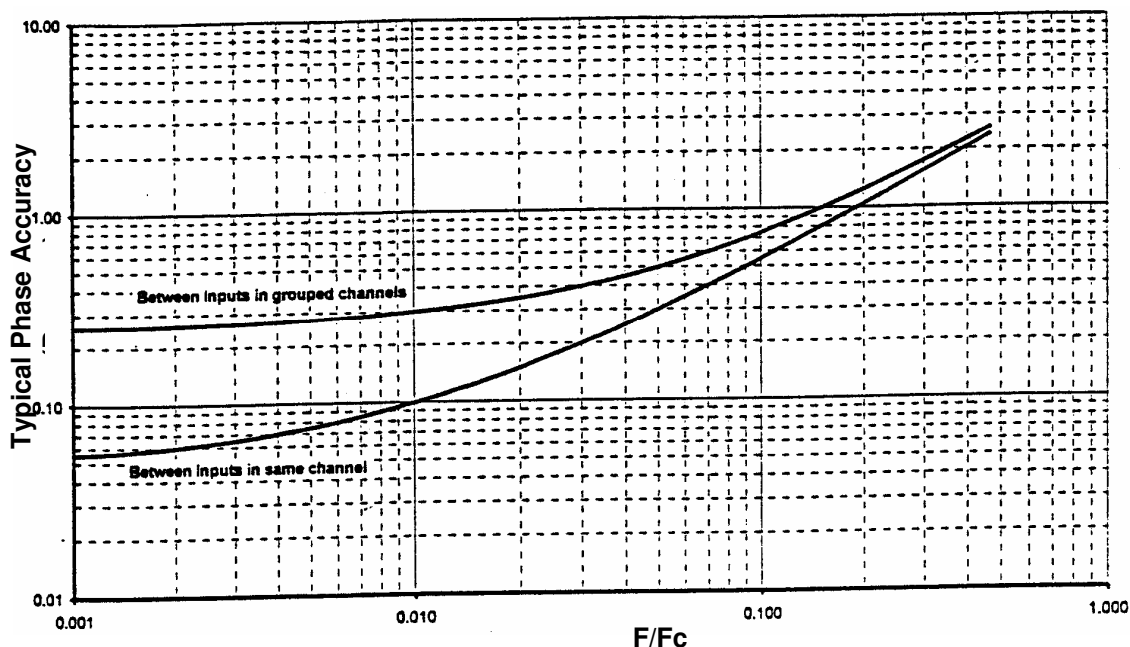


Figure 48. Frequency Measurement

Specification

In this graph, F_c is the filter corner frequency or 500kHz (100kHz if using the internal Hall Effect transducer), whichever is the lower frequency. F is the measurement frequency.

Frequency Measurement

Accuracy:	0.01% + (0.05% divided by measurement period in sec).
Min. Fundamental Signal:	5% of range.
Frequency Range:	0.0005Hz to 500kHz.
Technique:	Period measurement of filtered signal using a <i>tracking</i> bandpass filter having a bandwidth of 0.8 to 1.2 times the measured fundamental frequency.

Harmonic Rejection:	Detects fundamental component having an amplitude down to 30% of total signal.
Abnormal Cycle Rejection:	Rejects cycles having >20% deviation from the mean cycle period, a maximum of 10% of the cycles in the measurement period may be rejected.
Measurement Filtering:	Optional <i>moving average</i> filtering may be applied.
Response Time:	<1.5 measurement periods.

Harmonic Analysis

IEC1000-3-2 Analysis:	Uses 16 fundamental cycle window period, using rectangular window with no overlap and no gaps between window periods. Uses 4096 point Fast Fourier Transform with sampling frequency maintained within 0.01% of 256 times the fundamental frequency.
Standard Analysis:	User definable window period between 1 and 512 fundamental cycle periods, using rectangular window with no overlap and with no gaps for fundamental frequencies less than 100Hz. Uses automatically selected size (256 to 4096) Fast Fourier Transform with sampling frequency maintained within 0.01% of relevant ratio from the fundamental frequency.
Windowed Analysis:	User definable window period between 8 and 512 fundamental cycle periods, using a modified Blackman-Harris window with no overlap and with no gaps for fundamental frequencies less than 100Hz. Uses automatically selected size (256 to 4096) Fast Fourier Transform with sampling frequency maintained within 0.01% of relevant ration from the fundamental frequency.
Frequency Range:	0.0005Hz to 150kHz. Up to 2047 th harmonic.
Abs. Single Harmonic:	0.02% of total signal + (0.01% of total signal times frequency of harmonic in kHz) + (relevant percentage accuracy specification times the harmonic amplitude level) + (0.01% of input range).

Harmonic Analysis (continued)

Abs. Harmonic Range:	Square root of sum of squared accuracy at each harmonic. For low frequencies (<500Hz) and low harmonic content (<20% of signal) this approximates to (0.02% of total signal + 0.01% of input range) times the square root of the number of harmonics.
THD Accuracy:	Square root of number of harmonics times [(0.02% of total signal times frequency of fundamental in kHz) + (0.02% times input range/fundamental amplitude)].

Accumulated (Integrated) Parameters

Control:	Via front panel, IEEE488 or RS232 interface, or rear panel TTL/relay contract input. Rear panel input may be active high or active low and is debounced for circa 0.05s.
Accumulation Period:	0.1s to 100 years.
Timing Accuracy:	Front Panel Control: 0.02% + 0.1s. Rear Panel Control: 0.02% + 0.05s. Interface Control: 0.02% + 0.2s.

Peak Parameters

Min. Impulse Width:	Repetitive: 100ns (unfiltered), 500ns (filtered), minimum of 100 impulses per measurement period. Single: 4 μ s.
Accuracy:	As relevant input accuracy specifications at the frequency of the impulse (use 1/impulse period if unknown). Valid for impulse frequencies less than the filter corner frequency.

Date and Time

Accuracy:	0.005%.
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Analog Outputs (Option AIO)

Ranges:	User defined minimum and maximum outputs (for each output) in the range: -5V to $+5\text{V}$ or -5mA to $+5\text{mA}$.
Usage:	User defined parameter, difference between parameters or ratio of parameters, for each output.
Span:	User defined minimum and maximum parameter values corresponding to user minimum and maximum output levels for each output.
Settling Time:	$<10\text{ms}$. following change in parameter.
Accuracy:	Voltage: 0.02% of output level $+ 200\mu\text{V}$. Current: 0.05% of output level $+500\text{nA}$.
Output Impedance:	Voltage : $<0.5\Omega$ (5 mA_{max}). Current: $>100\text{k}\Omega$ (5V_{max}).

Common Mode Rejection Specifications

Shunt Input

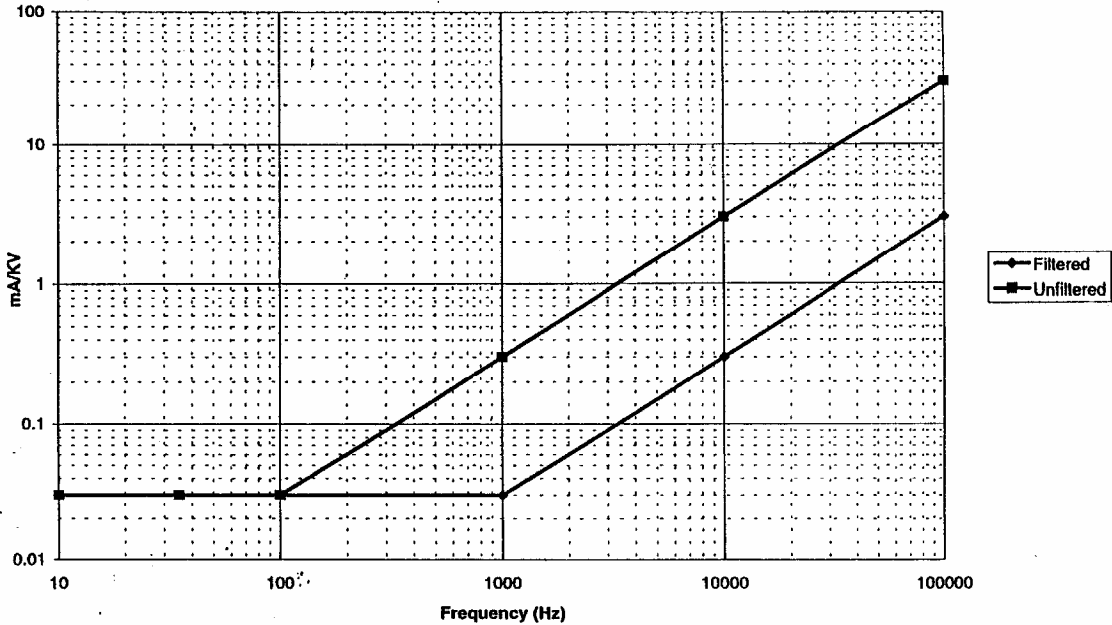


Figure 49. Common Mode Rejection for Shunt Input

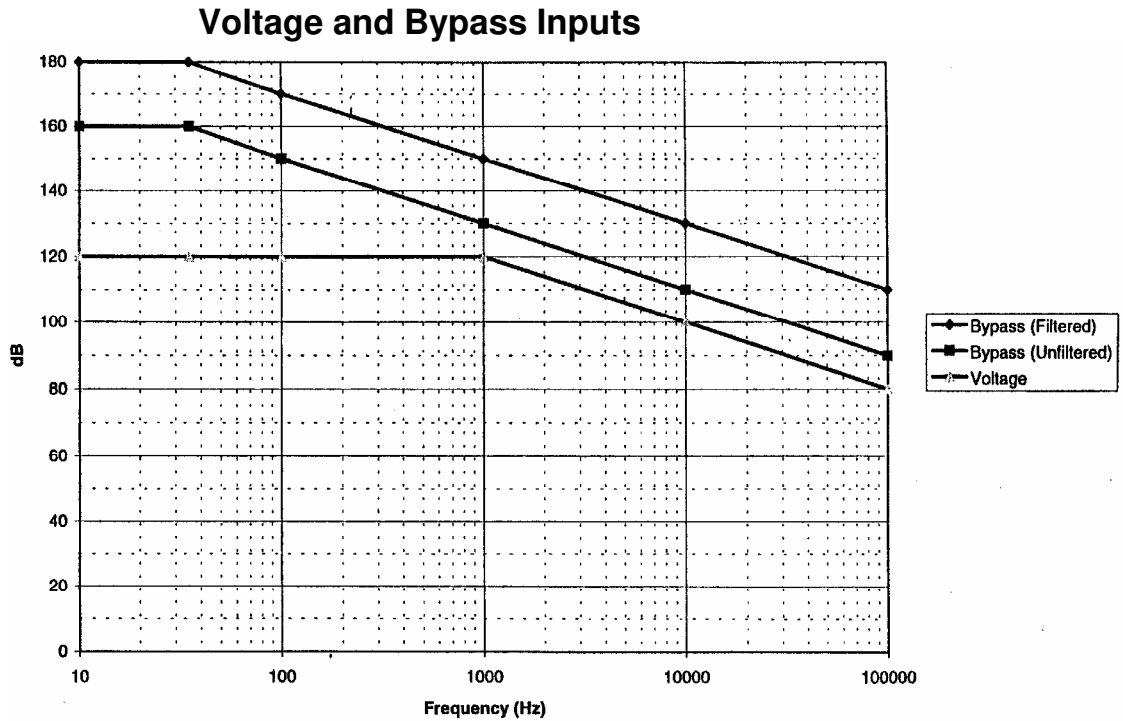


Figure 50. Voltage & Bypass Input Common Mode Rejection

Glossary

The following terms include those used to describe functions that are shown in the display's parameter screens and additional electronic terminology. Their definitions are given here. Some glossary items include notes relating to the term as used and specific ways that a term is used within the context of the 2503AH instruments.

Σ Charge

The summation of direct-current coupled, True root-mean-square (RMS) measurements recorded for the selected input having a positive polarity during any measurement period while accumulating.

Applies for the selected input having a positive polarity during any measurement period while accumulating. This data is available for any input of any channel. Use the V and A keys to select.

Σ Dcharge

The summation of direct-current coupled True RMS measurements recorded for the selected input having a negative polarity during any measurement period while accumulating.

Applies for the selected input having a negative polarity during any measurement period while accumulating. This data is available for any input of any channel. Use the V and A keys to select.

A; Ampere

Unit of electrical current.

AC

Alternating Current. An electrical current where the magnitude and direction of the current varies cyclically. The usual waveform of an AC circuit is a sine wave.

AC coupling

Circuit that passes an alternating current signal while blocking a direct current voltage.

Acc. Max.

Accumulation Maximum.

The highest peak signal of the High Peak measurements recorded for the selected input during any measurement period while accumulating.

This data is always measured using AC+DC bandwidth and is available for any input of any channel. Use the V and A keys to select.

Acc. Min.; Accumulation Minimum

The lowest peak signal of the Low Peak measurements recorded for the selected input during any measurement period while accumulating.

This data is always measured using AC+DC bandwidth and is available for any input of any channel. Use the V and A keys to select.

Acc. Pk.; Accumulated Peak

An accumulation of the highest Peak measurements recorded for a selected input during any measurement period.

This data is always measured using AC+DC bandwidth and is available for any input of any channel. Use the V and A keys to select, which input during any measurement period while accumulating.

Acc. Time; Accumulated Time

An accumulation of measurement data recorded for a selected input over a specified time. Selectable by channel.

Amplifier

A circuit that increases the voltage, current, or power of a signal.

Amplify

To increase the voltage, current, or power of a signal.

Amplitude

Magnitude or size of a signal voltage or current.

Apparent power

Power attained in an alternating current circuit as a product of effective voltage and current which reach their peak at different times.

Attenuate

To reduce the level of a signal. The opposite of amplification. Also to decrease the amplitude of an electronic signal.

Band-pass filter

A tuned circuit designed to pass a band of frequencies between a lower cut-off frequency (f_1) and a higher cut-off frequency (f_2). Frequencies above and below the pass band are heavily attenuated.

Bandwidth

Width of the band of frequencies between the half power points.

Buffer

An amplifier used to isolate a load from a source.

Bypass

A component, usually a capacitor, that provides a path for alternating current around a specified element in a circuit.

Calibration

To adjust the correct value of a reading by comparison to a standard.

Capacitance

Capacitance is a measure of the amount of electric charge stored for a given electric potential. Capacitance is defined as the total electric charge placed on an object divided by the potential of the object.

$$C = Q/V$$

The basic unit of capacitance is the Farad.

CF; Crest Factor

The crest factor of a waveform is equal to the peak amplitude divided by the root mean square value.

$$C = \frac{x_{\text{peak}}}{x_{\text{rms}}}$$

For a sine wave the crest factor is 1.414. Direct current voltages have a crest factor of 1 since the root mean square and the peak amplitude are equal.

CF; Crest Factor (continued)

CF applies to voltage or current. This data may be measured using AC only or AC+DC bandwidth and is available for any input of any channel. Use the V and A keys to select.

Coupling

To electronically connect two circuits so that the signal will pass from one to the other.

Current

Measured in amperes (A), current is the flow of electrons through a conductor. Also known as electron flow.

dB; Decibel

A measure of the ratio between two quantities and is used to express a wide variety of electronic measurements. A decibel is a dimensionless unit.

DC; Direct Current

Current that flows in a constant direction.

Delta-V

The computed phase-to-phase voltage for a 3-phase 4-wire wye.

This configuration is available for both channel and group sources. Note that when requested from a group source the result is the “average phase-phase voltage” for the entire group.

Dissipation

Release of electrical energy in the form of heat.

The inverse cosine of the measured true power factor for the selected channel, channel groups, and input/output group totals. A bandwidth of AC only, AC+DC or measurement over a range of harmonics can be specified.

Distortion

An undesired change in a waveform or signal.

DPF; Dissipation Power Factor

The measured dissipation power factor for the selected channel, channel groups, and input/output group totals. This is the same as specifying a measurement of the power factor (PF) for the fundamental only.

Eff. Pfs.; Efficiency Phase

The inverse cosine of the measured true power factor for the selected channel, group of channels, total of all input groups or total of all output groups.

A bandwidth of AC only, AC+DC or measurement over a range of harmonics, can be specified.

Effcy; Efficiency

The amount of useful power output divided by the total electrical power consumed (a fractional expression).

$$\text{Efficiency} = \frac{\text{Useful power out}}{\text{Total power consumed}}$$

The ratio of the total AC+DC output “Watts” and the total AC+DC input “Watts”.

FF; Form Factor

The form factor of an alternating current waveform (signal) is the ratio of the peak value to the RMS value.

This data is always measured using AC+DC bandwidth and is available for any input of any channel. Use the V and A keys to select.

Filter

Network consisting of capacitors, resistors and/or inductors used to pass certain frequencies and block others.

Freq; Frequency

Rate of recurrence of a periodic wave—Or—the measurement of the number of times that a repeated event occurs per unit time. To calculate the frequency, one fixes a time interval, counts the number of occurrences of the event within that interval, and then divides this count by the length of the time interval.

An alternative method to calculate frequency is to measure the time between two consecutive occurrences of the event (the period) and then compute the frequency as the reciprocal of this time.

$$f = \frac{1}{T}$$

where T is the period.

The result is measured in hertz (Hz) after the German physicist, Heinrich Rudolf Hertz.

1 Hz means that an event repeats once per second. Other units that have been used to measure frequency include: cycles per second, revolutions per minute (rpm).

Applies to the measured frequency (input specified), or harmonic frequency (channel specified).

Fundamental

The fundamental tone often referred to simply as the fundamental, is the lowest frequency in a harmonic series.

Gain

Increase in voltage, current and/or power. Gain is expressed as a ratio of amplifier output value to the corresponding amplifier input value.

Gain Bandwidth

A device parameter that indicates the maximum possible product of gain and bandwidth. The gain bandwidth product of a device is equal to the unity gain frequency (f_{unity}) of the device.

Harmonic

Sine wave that is smaller in amplitude and some multiple of a fundamental frequency. For example: 880 Hz. is the second harmonic of 440 Hz., 880 Hz. is the third harmonic of 220 Hz.

Harmonic settings of the 1st and 2nd numbers.

- Setting the 1st as any number and the 2nd as the same number, yields results for that harmonic only.
- Setting the 1st as any number and the 2nd as zero, yields the result measured over the entire measured harmonic range starting at the first harmonic, number.
- Setting the 1st as any number and the 2nd as any number, yields the result measured over the defined range of harmonics (inclusive).

Note that entering a range extending beyond a channel's maximum harmonic yields unreliable results.

High Pk; High Peak

The highest instantaneous level of the selected input signal during a single measurement period.

This data is always measured using AC+DC bandwidth and is available for any input of any channel. Use the V and A keys to select.

High-pass filter

A tuned circuit designed to pass all frequencies above a designated cut-off frequency. Frequencies below the cut-off are rejected or attenuated.

Hz; Hertz

Unit of frequency. One hertz is equal to one cycle per second.

Impedance; Z

A measurement in ohms of the opposition to current flow exhibited by a component when a given voltage is applied to the circuit. Impedance consists of the vector sum of resistance and reactance (X_L plus X_C). Impedance is the resistance found in all circuits where alternating current is used. Electrically, impedance is made up of three components- DC resistance, inductance and capacitance. Note that impedance differs from simple resistance in that it takes into account possible phase offset.

In phase

When two or more waves of the same frequency have their positive and negative peaks occurring at the same time.

Inductance

Property of a circuit to oppose a change in current. The moving magnetic field produced by a change in current causes an induced voltage to oppose the original change.

Inrush

Inrush current or input surge current refers to the maximum, instantaneous input *current* drawn by an electrical device when first turned on. The highest Peak measurement recorded for the selected input during any measurement period.

This data is always measured using AC+DC bandwidth and is available for any input of any channel. Additionally this data can be cleared at any time by pressing the **Inrush** key. Use the V and A keys to select.

Kfact; K-Factor

K-factor is a weighting of the harmonic load currents according to their effects on transformer heating, as determined from ANSI/IEEE C57.110. A k-factor of 1.0 indicates a linear load (no harmonics). The higher the k-factor, the greater the harmonic heating effects.

This parameter requires a single input source and a single integer defining the highest harmonic to include in the summation in volts or amps. The default units for this result are None. Use the V and A keys to select.

Kilo

Metric prefix for 1000. (10^3)

Load

Whatever component or piece of equipment that is connected to a source and draws current from a source is a load on that source. A source drives a load.

Load R: Real Load

The effective real resistive load for the selected channel.

Real load can be expressed in either resistance or conductance units.

You can specify bandwidths of DC only, AC only, AC+DC, or a range of harmonics for the measurement. The result assumes a load containing the series combination of a real and imaginary component.

Load X: Imaginary Load

The effective imaginary reactive load for the selected channel. Imaginary load can be expressed in either resistance or conductance units.

You can specify bandwidths of AC only, AC+DC, or a range of harmonics for the measurement. The result assumes a load containing the series combination of a real and imaginary component.

Load Z: Impedance Load

The effective impedance load for the selected channel. Impedance load can be expressed in either resistance or conductance units.

You can specify bandwidths of DC only, AC only, AC+DC, or a range of harmonics for the measurement.

Low pass filter

A tuned circuit designed to pass all frequencies below a designated cut-off frequency.

Low Pk; Low Peak

The lowest instantaneous level of the selected input signal during a single measurement period.

This data is always measured using AC+DC bandwidth and is available for any input of any channel. Use the V and A keys to select.

Negative feedback

A feedback signal 180° out of phase with an amplifier input signal.

Use to effectively increase amplifier stability, bandwidth and input impedance. Reduce distortion.

Out of phase

When the maximum and minimum points of two or more wave shapes do not occur at the same time.

Output

Terminal at which a component, circuit or piece of equipment delivers current, voltage or power.

Peak

The largest absolute value of High Peak or Low Peak.

The largest instantaneous excursion from zero of the selected input signal during a single measurement period.

This data is always measured using AC+DC bandwidth and is available for any input of any channel.

Use the V and A keys to select which input.

Period

Time to complete one full cycle of a cyclic or repeating waveform.

PF; Power Factor

Ratio of real or actual power to apparent power.

The measured true power factor for the selected channel, channel groups, and input/output group totals. A bandwidth of AC only, AC+DC or measurement over a range of harmonics can be specified.

Phs; Phase

Angular relationship between two waves. The *phase* of a waveform is the position of any peak or trough compared to the same feature on a second waveform.

Phase Shift

Change in phase of a waveform between two points, expressed as degrees of lead or lag.

Phase Angle

Phase difference between two or more waves, normally expressed in degrees. The phase difference between the first selected input/ harmonic and the second input/ harmonic assumes a load containing the series combination of a real and imaginary component.

Pk VA; Peak Volt-Ampere

The highest instantaneous excursion from zero of multiplication of the selected channels voltage and current waveforms during a single measurement period.

This data is always measured using AC+DC bandwidth and is available for any channel.

Pk-Pk

Peak to Peak

In an alternating current waveform, the difference between the maximum positive value, for example, high peak, and the lowest or most negative value, such as, low peak, for the selected input during a single measurement period.

Use the V and A keys to select.

This data is always measured using AC+DC bandwidth and is available for any input of any channel.

Power Loss

The difference between the total AC+DC input in watts and the total AC+DC output in watts.

Power Source

Electrical equipment used to deliver either alternating current or direct current voltage.

Reactance; X

The imaginary component of an impedance is called reactance, X . Reactance is the opposition to current flow without the dissipation of energy, provided by inductance or capacitance to alternating current.

$$Z = R + jX$$

Note that reactance depends on the frequency (f) of the applied voltage: the higher the frequency, the smaller the capacitive reactance (X_C) and the larger the inductive reactance (X_L).

Note that in purely resistive circuits, opposition to current flow is called resistance.

Reactive Power

Also called imaginary power, the power value in volt-amperes is obtained from the product of source voltage and source current in a reactive circuit.

Resistance; R

As measured in ohms, opposition to current flow and dissipation of energy in the form of heat.

Resistive power

Amount of power dissipated as heat in a circuit containing resistive and reactive components. True power as opposed to reactive power.

Resonance

Circuit condition that occurs at a frequency where the inductive reactance (X_L) and the capacitive reactance (X_C) are of equal magnitude. This causes electrical energy to oscillate between the magnetic field of the inductor and the electrical field of the capacitor.

Resonance occurs because the collapsing magnetic field of the inductor generates an electric current in its windings that charges the capacitor and the discharging capacitor provides an electric current that builds the magnetic field in the inductor, and the process is repeated. An analogy is a mechanical pendulum.

RMS; Root Mean Square

The effective value of an alternating current sine wave is 0.707 times the peak value. The root mean square value of a sine wave is the value of a direct current voltage that would produce the same amount of heat in a heating element.

RMS Hr.

The accumulation of True RMS measurements recorded for the selected input during any measurement period while accumulating.

This data can be measured using DC only, AC only or AC+DC bandwidth and is available for any input of any channel. Use the V and A keys to select.

Shunt

In many applications, current is measured using a current shunt. This device acts as a resistor that provides a precisely calibrated, constant and known resistance.

Source

Device that provides signal power or energy to a load.

Spect Hz; Spectrum Hertz

The frequency corresponding to the selected spectrum bin.

Spectrum

In electronics the frequency spectrum is a representation of a signal in terms of frequency . It is the projection of the function or signal onto a set of sinusoidal basic functions. It can be found from the result of a Fourier Transform. A frequency spectrum contains both amplitude and phase information. The power spectrum describes how much of the energy of the function or signal lies in any given frequency band, without regard for the phase.

Applies as the detected signal RMS amplitude at the frequency of the defined spectrum bin.

Spectrum Analyzer

Instrument used to display the frequency domain of a waveform plotting amplitude against frequency.

Sync Pulse

Pulse used as a reference for synchronization

Sync; Synchronization

Precise matching of two waves or functions.

Synchronous

Two or more signals in step or in phase.

THD; Total Harmonic Distortion

All the data results that are measured over the harmonic range from the lowest defined harmonic for that parameter up to and including highest harmonic defined.

The total harmonic distortion of a signal is a measurement of the harmonic distortion present, that is, any departure of the output signal waveform from that which should result from the input signal waveforms being operated on by the system's specified or ideal transfer function. In most cases, this ideal transfer function is linear and time-invariant. When a signal passes through a non-linear device, additional content is added at the harmonics of the original frequencies. This is a measurement of the extent of that distortion.

Note that total harmonic distortion has a maximum harmonic-frequency range type. Entering a range extending beyond that defined as the maximum measured harmonic for the particular channel may not yield reliable results.

THD; Total Harmonic Distortion (continued)

The measurement is most commonly the ratio of the sum of the *powers* (or RMS voltages/amplitudes, since the ratio is equivalent) of all harmonic frequencies above the fundamental frequency to the power of the fundamental.

THD-Fund

The total harmonic distortion that is recorded for the selected input, measured up to and including the selected harmonic, and expressed as a ratio to the signal content at the fundamental frequency.

Use the V and A keys to select.

THD-Harm

The total harmonic distortion that was recorded for the selected input, measured up to and including the selected harmonic and expressed as a ratio to the signal content at all harmonics from the fundamental up to and including the selected harmonic.

Use the V and A keys to select.

THD-Sig

The total harmonic distortion recorded for the selected input, measured up to and including the selected harmonic, expressed as a ratio to the AC+DC root mean square measurement of the signal.

Use the V and A keys to select.

Three phase

Three alternating current voltages 120° out of phase with each other.

Total

The measure true RMS voltage or current, plus the defined range of harmonics.

Trigger

Pulse used to initiate a circuit action.

Triggering

Initiation of an action in a circuit which then functions for a predetermined time. Example: The duration of one sweep in a cathode ray tube.

Triplen

The sum of all *third* order harmonics that are measured for the selected input up to and including the selected harmonic.

Triplens – 3, 6, 9, 12, 15, 18, 21, 24,...

Even Triplens – 6, 12, 18, 24,... The sum of all even third order harmonics

Odd Triplens – 3, 9, 15, 21,... The sum of all odd third order harmonics.

Note that Triplens also have a maximum harmonic frequency range type. In this case the result is measured over the harmonic range from the lowest defined for that parameter (e.g. 2nd for THD, 3rd for Triplens etc.) up to and including what is defined. Entering a range extending beyond that defined as the maximum measured harmonic for the particular channel may not yield reliable results.

Use the V and A keys to select.

True RMS

The measured true root mean square voltage or current.

Select either DC only, AC only, AC+DC or a range of harmonics for the bandwidth of the measurement. This data is available for any input of any channel. Use the V and A keys to select.

Two phase

Two repeating waveforms having a phase difference of 90°.

V; Volt

Unit of potential difference or electromotive force. One volt is the potential difference needed to produce one ampere of current through a resistance of one ohm.

VA: Volt-ampere

Unit of apparent power in an alternating current circuit containing capacitive or inductive reactance. Apparent power being the product of the measured source voltage and current.

Applies for the selected channel, channel groups, and input/output group totals. A bandwidth of DC only, AC only, AC+DC or measurement over a range of harmonics can be specified.

VA. Hr; Volt Ampere Hour

The summation measurements recorded for voltage and current.

Applies for the selected channel/group/group of groups during any measurement period while accumulating. This data can be measured using DC only, AC only or AC+DC bandwidth.

VAR; Volt-Ampere Reactive

The measured true volt-ampere reactive power.

A bandwidth of AC only, AC+DC or measurement over a range of harmonics can be specified. Applies for the selected channel, channel groups, and input/output group totals.

VAR.Hr

The summation of volt-ampere reactive measurements recorded.

Applies for the selected channel group/group of groups during any measurement period while accumulating. This data can be measured using DC only, AC only or AC+DC bandwidth.

Voltage

Voltage is the electrical potential difference between two points. Voltage is the energy required to move a unit of electrical charge from one point to the other against the electrostatic field that is present. Volts = joules per coulomb.

Voltage Gain

Ratio of amplifier output voltage to input voltage usually expressed in decibels. Also called voltage amplification.

Voltage Multiplier

Rectifier circuit using diodes and capacitors to produce a direct current output voltage that is some multiple of the peak value of alternating current input voltage.

Examples of cost effective ways of producing higher DC voltages are voltage doublers and triplers.

W Hr; Watt Hour

The summation of Watts measurements recorded.

Applies for the selected channel/group/group of groups during any measurement period while accumulating. This data can be measured using DC only, AC only or AC+DC bandwidth.

W; Watt

Unit of (electrical) power equal to the work done at the rate of one joule per second or to the power produced by a current of one ampere across a potential difference of one volt The mean voltage signal multiplied by the current signal equals watts. Note that one watt of power is expended when one ampere of direct current flows through a resistance of one ohm.

You can specify a bandwidth of DC only, AC only, AC+DC or measurement over a range of harmonics.

Wattage

The measured true power.

Applies to the selected channel, channel groups, and input/output group totals.

Wye-V

The computed phase-to-neutral voltage for a “3-phase 3-wire delta” connected group of channels.

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