

# User Manual



**TSG 1001**  
**Programmable TV Generator**  
**Serial Number B040000 and Above**  
**070-7908-03**

This document supports software version 2.02



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# General Safety Summary

Review the following safety precautions to avoid injury and prevent damage to this product or any products connected to it. To avoid potential hazards, use this product only as specified.

*Only qualified personnel should perform service procedures.*

## To Avoid Fire or Personal Injury

**Use Proper Power Cord.** Use only the power cord specified for this product and certified for the country of use.

**Use Proper Voltage Setting.** Before applying power, ensure that the line selector is in the proper position for the power source being used.

**Ground the Product.** This product is grounded through the grounding conductor of the power cord. To avoid electric shock, the grounding conductor must be connected to earth ground. Before making connections to the input or output terminals of the product, ensure that the product is properly grounded.

**Observe All Terminal Ratings.** To avoid fire or shock hazard, observe all ratings and markings on the product. Consult the product manual for further ratings information before making connections to the product.

**Replace Batteries Properly.** Replace batteries only with the proper type and rating specified.

**Do Not Operate Without Covers.** Do not operate this product with covers or panels removed.

**Use Proper Fuse.** Use only the fuse type and rating specified for this product.

**Avoid Exposed Circuitry.** Do not touch exposed connections and components when power is present.

**Wear Eye Protection.** Wear eye protection if exposure to high-intensity rays or laser radiation exists.

**Do Not Operate With Suspected Failures.** If you suspect there is damage to this product, have it inspected by qualified service personnel.

**Do Not Operate in Wet/Damp Conditions.**

**Do Not Operate in an Explosive Atmosphere.**

**Keep Product Surfaces Clean and Dry.**

**Provide Proper Ventilation.** Refer to the manual's installation instructions for details on installing the product so it has proper ventilation.

**Symbols and Terms**

**Terms in this Manual.** These terms may appear in this manual:



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**WARNING.** *Warning statements identify conditions or practices that could result in injury or loss of life.*

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**CAUTION.** *Caution statements identify conditions or practices that could result in damage to this product or other property.*

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**Terms on the Product.** These terms may appear on the product:

DANGER indicates an injury hazard immediately accessible as you read the marking.

WARNING indicates an injury hazard not immediately accessible as you read the marking.

CAUTION indicates a hazard to property including the product.

**Symbols on the Product.** The following symbols may appear on the product:



WARNING  
High Voltage



Protective Ground  
(Earth) Terminal

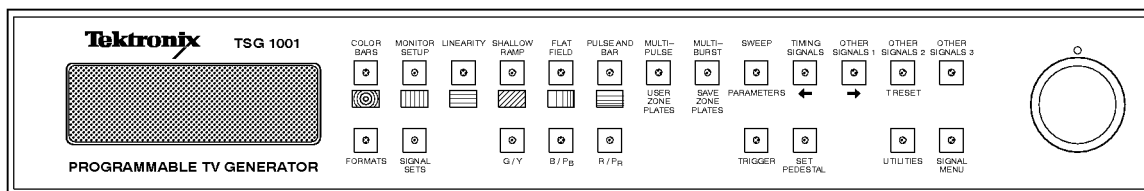


CAUTION  
Refer to Manual



Double  
Insulated

# Getting Started



## Introduction

The TSG 1001 Programmable Television Generator is a full-featured, multi-standard and multi-format test signal generator. With the included SDP1000 software package, it is capable of outputting pre-defined and user defined signals for testing both high-definition television (HDTV) and conventional television components and systems.

In addition to traditional test signals, the TSG 1001 can also output zone plate signals<sup>1</sup>, which can be modified to yield custom patterns. The custom zone plates may be named and stored in non-volatile RAM for later use.

## Standards and Formats

With three voltage-controlled oscillators and three output channels, the TSG 1001 can generate signals that conform to a number of scanning structure “standards” as well as a variety of chrominance and luminance encoding methods. In the TSG 1001, a unique combination of video scanning and encoding methods is called a **Format**. A list of the Formats supported by the TSG 1001 and SDP1000 at the time of this writing appears in Table 1. For the most up-to-date listing, see the SDP1000 documentation.

The TSG 1001 can also generate signals of other formats if an appropriate oscillator crystal is installed in place of a factory-installed crystal, or if the generator is driven—through the Clock input—by an external timing signal. Such a timing signal can be supplied by a Tektronix SPG 1000 HDTV Sync Generator. Driving the TSG 1001 with the encoded clock of an SPG 1000 will also allow “genlocking” the output of the TSG to another signal or sync source.

<sup>1</sup> Zone plate patterns can vary in the three dimensions of the signal spectrum — horizontal, vertical, and temporal; they have been found to be especially useful for determining the picture quality affects of sophisticated HDTV signal processing techniques. For more information, see Tektronix application note 20W-7056, “Broadening the Applications of Zone Plate Generators.”

**Additional Outputs**

Along with the three analog video channels (designated G/Y, B/P<sub>B</sub>, and R/P<sub>R</sub>), the TSG 1001 also has the following outputs:

- Parallel digital outputs (10-bit) of the three video channels.
- Full-time sync-only: Syncs that match the characteristics of the format being generated.

**Table 1: TSG 1001/SDP1000 formats**

Scanning Structure lines per frame/field rate/fields:frame	Sampling frequency (MHz)	Pre-defined formats
525/59.94 Hz/1:1	72.00	"525/59.94/1:1 GBR" "525/59.94/1:1 YPBPR"
525/59.94 Hz/2:1	72.00	"525/59.94/2:1 BETACAM" "525/59.94/2:1 GBR" "525/59.94/2:1 MII" "525/59.94/2:1 YPBPR" "NTSC"
	13.5	"525/59.94/2:1 D1" <sup>**</sup>
	14.318182	"D2 NTSC" <sup>**</sup>
	18	"525/59.94/2:1 D1 16:9" <sup>**</sup>
625/50 Hz/1:1	72.00	"625/50/1:1 GBR" "625/50/1:1 YPBPR"
625/50 Hz/2:1	13.5	"625/50/2:1 D1" <sup>**</sup>
	72.00	"625/50/2:1 GBR" "625/50/2:1 YPBPR" "625/50/2:1 YUV(PAL)" <sup>***</sup>
750/59.94/1:1	74.175824	"750/59.94/1:1 GBR" "750/59.94/1:1 YPBPR"
787-788/59.94 Hz/1:1*	75.335664	"787/59.94/1:1 GBR" <sup>**</sup> "787/59.94/1:1 YPBPR" <sup>**</sup>
1050/59.94 Hz/1:1	72.00	"1050/59.94/1:1 GBR" "1050/59.94/1:1 YPBPR"
1050/59.94 Hz/2:1	72.00	"1050/59.94/2:1 GBR" "1050/59.94/2:1 YPBPR"
1125/59.94/1:1	74.175824	"1125/59.94/1:1 GBR" "1125/59.94/1:1 YPBPR"
1125/59.94/2:1	74.175824	"1125/59.94/2:1 GBR" "1125/59.94/2:1 YPBPR"
1125/60 Hz/2:1	74.25	"1125/60/2:1 GBR" "1125/60/2:1 YPBPR"
1250/50 Hz/1:1	72.00	"1250/50/1:1 GBR" "1250/50/1:1 YPBPR"

Table 1: TSG 1001/SDP1000 formats (Cont.)

Scanning Structure lines per frame/field rate/fields:frame	Sampling frequency (MHz)	Pre-defined formats
1250/50 Hz/2:1	72.00	"1250/50/2:1 GBR" "1250/50/2:1 YPBPR"
User-defined	72.0, 74.25, 74.175824	"USER GBR" "USER YPBPR"

\* These formats require changing an oscillator crystal or using an external clock. Please contact a Tektronix representative for more information.

\*\* This format requires a Tektronix PE 1000 PAL Encoder.

- Programmable trigger: A trigger pulse is output at a point in the video frame selected with the TSG 1001 front panel controls. This pulse can trigger an oscilloscope or other test equipment. The trigger timing is shown on a picture monitor as the intersection of "cross hairs" visible in active video.
- H Drive, a TTL-compatible pulse at the Horizontal rate: H Drive may be active high or low, and pulse duration and position in the video line may be programmed with SDP1000 software tools.
- V Drive, a TTL-compatible pulse at the Vertical rate: As with H Drive, pulse type, duration, and position are programmed with SDP1000.

## Clock and Frame Inputs

The TSG 1001 Clock and Frame inputs gives the instrument additional capabilities.

**Clock input.** As mentioned above, the TSG 1001 has a clock input that permits the use of an external oscillator and sampling frequency. The external clock signal may be encoded—by an SPG 1000—with a frame reset pulse that enables synchronizing the output of the TSG with other signal sources.

**Frame input.** In addition to the clock input, the TSG 1001 has a frame input that accepts a separate frame reset pulse. This input is typically used when the instrument is slaved to a source other than an SPG 1000. Such sources are unlikely to have the frame pulse encoded with the clock signal.

## Remote Control

The TSG 1001 has provisions for both ground-closure and RS-232 (serial) remote control. All front panel functions of the instrument can be controlled from a remote location, either with a user-assembled ground closure switch device or with any device capable of transmitting ASCII characters following the RS-232 protocol (e.g., a PC running Procomm® software).

## Installation

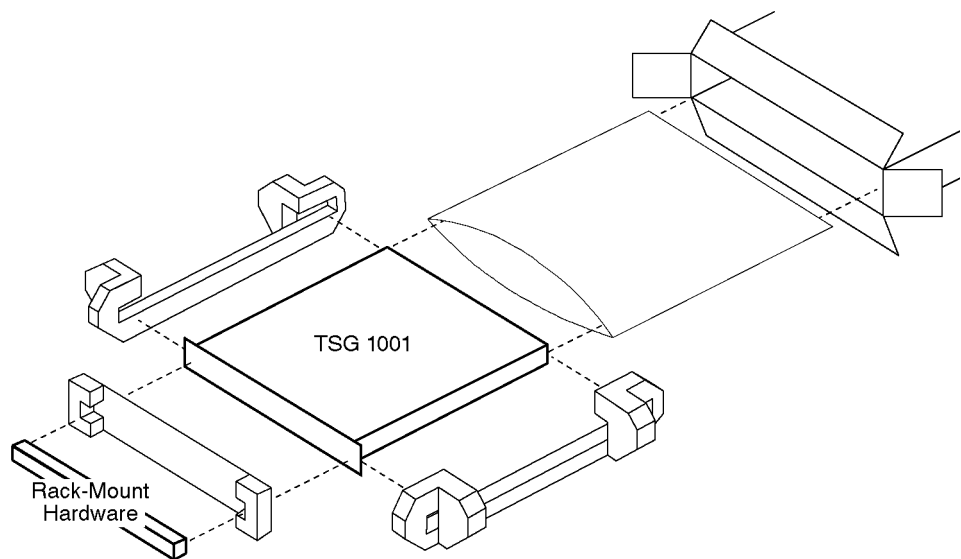
The TSG 1001 may be configured for operation world-wide and fits any standard 19 inch rack. It mounts in rack slides—which are provided with the instrument—for easy installation, removal, and transport. This section includes instructions for both electrical and mechanical installation.

### Unpacking

When unpacking the TSG 1001, confirm that the following items have been received (in addition to the TSG 1001 and this manual):

- The correct power cord.
- A cable for serial/parallel communications (Tektronix p/n 174-2344-00)
- Rack-mount hardware (Tektronix p/n 351-0751-01).
- An SDP1000 software development package.
- The TSG 1001 service manual (p/n 070-8625-XX)
- An envelope of accessory hardware.

Please save the shipping carton and all packaging materials (see Figure 1) in case reshipment becomes necessary.



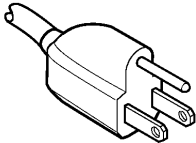
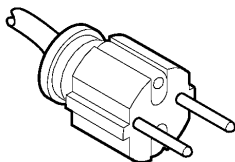
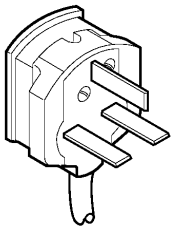
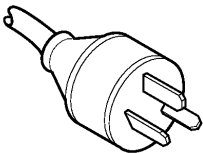
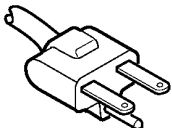
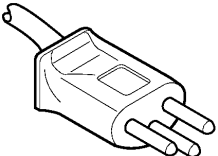
**Figure 1: Unpacking and re-packing the TSG 1001**

### Electrical Installation

This instrument is designed to operate over a line frequency range of 48 to 66 Hz, and a nominal line voltage of either 115 or 230 Volts. The position of the

voltage switch (S825 on the power supply board, accessible through the bottom of the instrument) and the value of the installed fuse are determined by the power cord option ordered with the instrument (see Tables 2 and 3) The fuse and voltage are indicated by the position of the black pan-head screw on the rear panel power supply information label. Before installing the generator, confirm that the indicated configuration is correct for the local power supply.

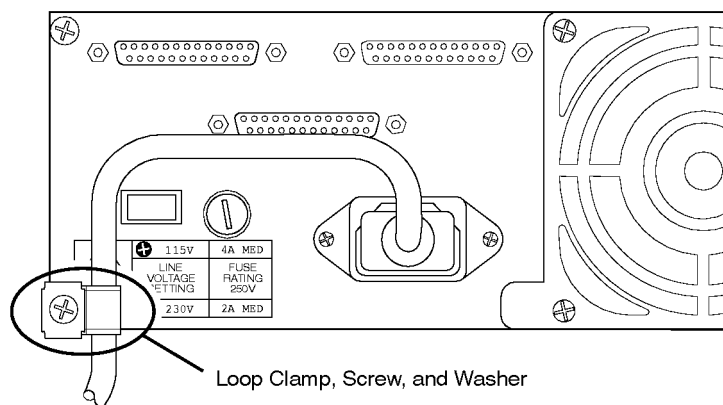
**Table 2: Power cord identification**

Plug Configuration	Normal Usage	Option Number
	North America 115 V	Standard
	Europe 230 V	A1
	United Kingdom 230 V	A2
	Australia 230 V	A3
	North America 230 V	A4
	Switzerland 230 V	A5

**Table 3: Possible power supply configurations**

Power Cord Option	S825 Position	Fuse
Standard (N. America, Japan)	115 V	4 A, medium blow
A1, A2, A3, A4, and A5	230 V	2 A, medium blow

**Securing the power cord.** Place the supplied (in the accessory envelope) loop clamp around the power cord and plug the cord into the rear panel receptacle. Remove the screw at the lower-left of the rear panel. Use the screw and washer supplied with the loop clamp to mount the clamp to the instrument (see Figure 2). This will minimize the chance of accidentally unplugging the TSG 1001 when sliding it in and out of the rack.



**Figure 2: Securing the power cord**

**Mechanical Installation**

The TSG 1001 is supplied with hardware for rack mounting. The instrument fits in a standard 19 inch rack. Spacing between the front rails of the rack must be at least 17.75 inches (45.1 cm) to allow clearance for the slide-mounts.

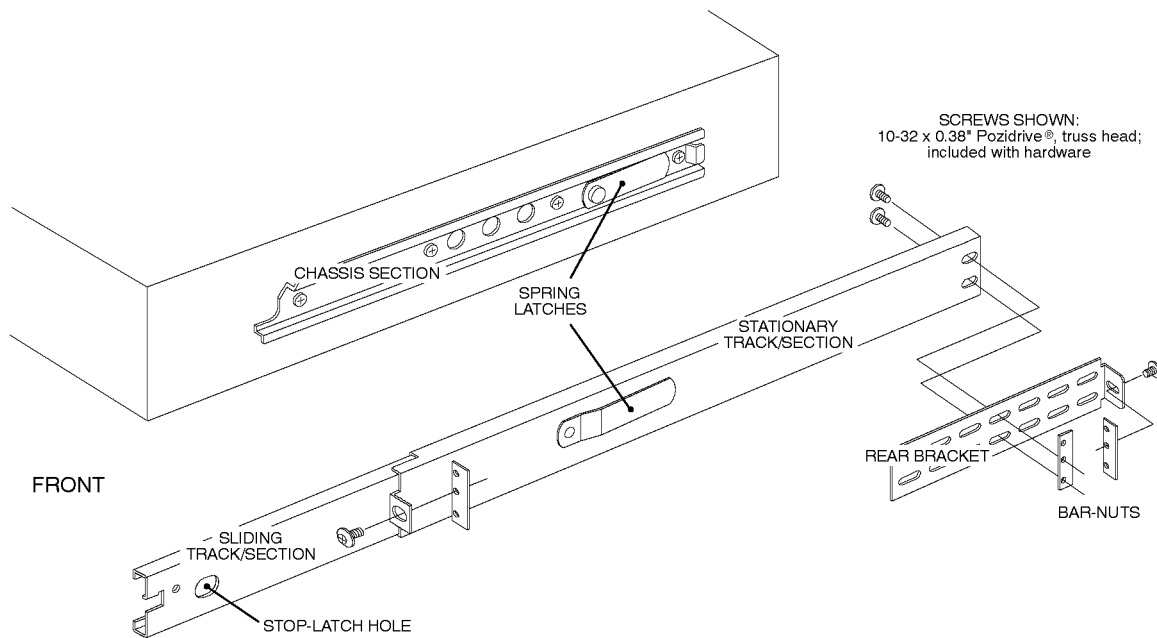
The provided rack slide-mount hardware is compatible with any rack that has front-to-rear rail spacing of between 15.5 and 28.0 inches (39.4 and 71.1 cm). Six inches (15.2 cm) of clearance are required between the rear panel of the instrument and any rear cabinet panel or wall. This is to provide adequate room for connectors and air circulation.

The slide-mount tracks are coated with a self-lubricating finish. They do not require any other lubrication or maintenance.

**Installing the slide-mount hardware.** Install the slide-mounts using the enclosed hardware as shown in Figures 3 and 4. Be sure that the stationary sections are



mounted at equal heights, and that they are level from front to back. For best results, do not fully tighten the screws until after the instrument has been installed



**Note:** Right and left hand slide-mounts are designated with RH and LH marked on the stationary sections. Stop-latch holes will be towards the bottom of the sliding sections when the slide-mounts are properly installed. (The right hand hardware is illustrated above.)

**Figure 3: Assembly of the rack-mounting hardware**

**Installing the TSG 1001.** Complete the rack installation of the TSG 1001 as follows:

1. Pull the sliding sections of the tracks to their fully-extended positions.
2. Insert the instrument into the extended sliding sections until the spring latches on the chassis sections begin pushing the sliding sections back into the stationary tracks.
3. Depress and hold the spring latches and push the generator into the slide-mounts until the spring latches snap in the stop-latch holes.
4. Press the latches again and push the instrument the rest of the way into the rack. Tighten the screws that hold the stationary tracks to the rear of the rack. Slide the instrument out and back in at least once to make sure the tracks do not bind.

5. Pull the TSG 1001 out far enough to tighten the screws at the front of the stationary tracks. Once the tracks are secure, push the instrument all of the way into the rack and use the instrument retaining screw to secure it in the “retracted” position.

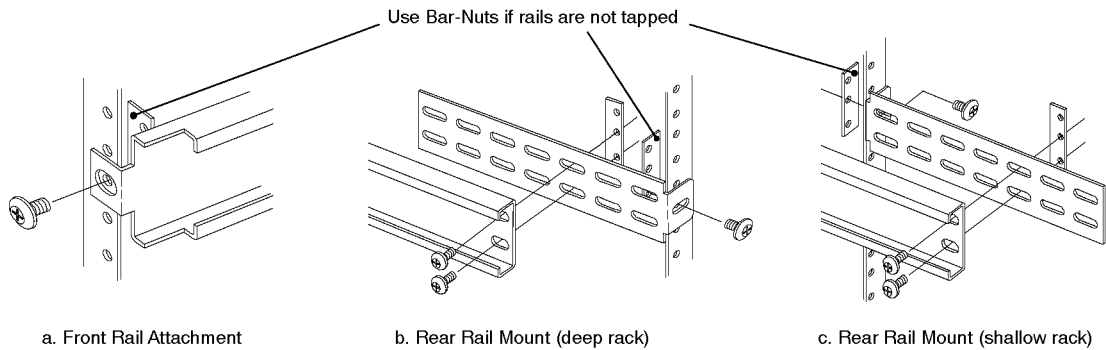


Figure 4: Installing the stationary slide-mount sections

**Removing the TSG 1001.** After all cables have been disconnected from the back of the instrument, the TSG 1001 may be removed from the rack as follows:

1. Loosen the retaining screw until it is completely disengaged from the rack.
2. Pull the instrument out until the chassis section spring latches snap into the stop-latch holes on both sides.
3. Press both spring latches to disengage them from the stop-latch holes and pull the TSG 1001 free of the slide tracks. For safety, push the sliding sections back into the stationary tracks (this may require pressing the spring latches on the stationary tracks out of the stop-latch holes at the rear of the sliding sections).

## Power-up/Checkout

Once the instrument has been installed, turn it on (the power switch is on the rear panel near the power receptacle) and confirm that the factory-loaded test signals remain in RAM. This is necessary because the rechargeable backup batteries discharge over time and, if several weeks have passed in shipping or storage, it is possible that all information stored in RAM has been lost.

Symptoms of “empty” RAM include:

- A lag between the press of a TSG 1001 front panel button and the responding “beep.”

- A press of any test signal (top row) button returns a “No Signals Defined” message.
- A press of the Formats button returns a “No Formats Stored” message.

If the TSG 1001 displays these symptoms on initial power-up, it will be necessary to reinitialize the instrument with the procedure described next.

## Reinitializing the Instrument

1. Turn the generator off and perform a “Power-up reset” by pressing and holding the Color Bars button while turning the instrument back on. Release the button when the display panel begins cycling through the Zone Plate names.
2. Select the Zone Plate Signal Set with the Signal Sets button. The first press will result in a blank display and, eventually, a beep. The second press will select the Signal Set and cause another belated beep.
3. If you haven’t already installed the SDP1000 on an IBM-compatible Personal Computer (PC) and connected the PC to the TSG 1001, do so now. See the software (SDP1000) manual for details.
4. Use the SDP1000/COM1000 utility to download one of the .dnl files from an SDP1000 signal library to the TSG 1001. Again, follow the procedures described in the software manual. Once the download is completed, the generator will be able to output test signals from RAM.
5. Leave the TSG 1001 switched on for 14 to 20 hours to recharge the RAM backup batteries.



# Operating Basics

This section contains an overview of the controls, indicators, connectors, and operation of the TSG 1001. The major topics are Controls and Connections, Outputting Test Signals, Using External Timing Signals, Remote Control, and Utilities. More detailed information for many of these topics is contained in the Reference section of this manual.

## Controls and Connections

All controls, except the power switch, are on the front panel; all connections are on the rear panel.

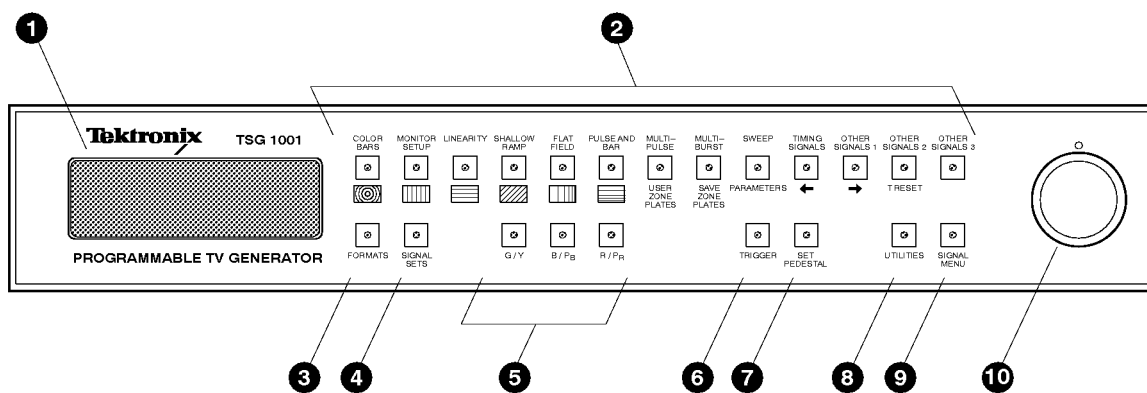


Figure 5: The TSG 1001 front panel

### The Front Panel

The front panel of the TSG 1001 is illustrated above. Please see the following numbered paragraphs for a brief explanation of each feature.

1. Front Panel Readout — A 2 line by 16 character vacuum-fluorescent display used to show TSG 1001 operating information.
2. Signal Select buttons — Used to select test signal categories or zone plate patterns. When the integral LED is lit, the button is “active,” and the associated signals will be output or available. When the RAM board signal set has been selected (with the Signal Sets button), repeated pressing of the active signal select button will scroll among alternate signals in the category, if any.
3. Formats Select button — Used to choose among signal formats if the RAM board signal set contains signals of more than one format. (A “format” is

characterized by both the picture scanning structure and the method of encoding chrominance and luminance information. Thus, “525/59.94/2:1 GBR” and “525/59.94/2:1 YPBPR” are unique formats. See the Getting Started section of this manual for more information.)

4. Signal Sets Select button — Used to select between the test signal set in RAM and the resident zone plates. The first press of the button will enable selection and cause the current signal set name to be displayed on the readout. Subsequent presses toggle between the two signal sets. Pressing most other front panel buttons will cancel the signal sets select mode.
5. Video Output Channel on/off buttons — Toggle the corresponding video channel on and off. A button’s LED will be lit when the channel is active.
6. Trigger button — Enables adjustment of the “location” in the video frame of the TTL trigger pulse. When the button’s LED is lit, the trigger location cross hairs will be added to the current test signal and the coordinates of the pulse will appear on the TSG 1001 readout. When the mode is first entered, turning the selector knob will change the horizontal position; after a second press of the button, the knob will control the vertical position. The generator will return to normal operation after a third press. The trigger output will be active at all times, whether the Trigger button is lighted or not.
7. Set Pedestal button — Enables adjustment of the active video pedestal of video output channels. When the button’s LED is lit, the pedestal (base voltage) level is displayed on the TSG readout, and the level may be adjusted with the selector knob. The pedestal will revert to 0 mV whenever this button is inactive.
8. Utilities button — Enables the utilities mode. When this button is lit, you may adjust basic instrument parameters (e.g., communications baud rate and beeper on/off) and check software version data.
9. Signal Menu button — Toggles the video output between test signals and the signal menu. When the LED is lit, a menu of the signals available through the active signal select button is shown on the attached video monitor. The menu entry of the current test signal is preceded by a “)” symbol.
10. Selector Knob — Works with the front panel buttons to select, adjust, and control various functions of the TSG 1001.

Selector Knob Indicator LED (above the knob) — Lights when the selector knob can be used for selection or parameter adjustment.

## The Rear Panel

The rear panel of the TSG 1001 is illustrated in Figure 6. Please see the following numbered paragraphs for a brief explanation of each feature.

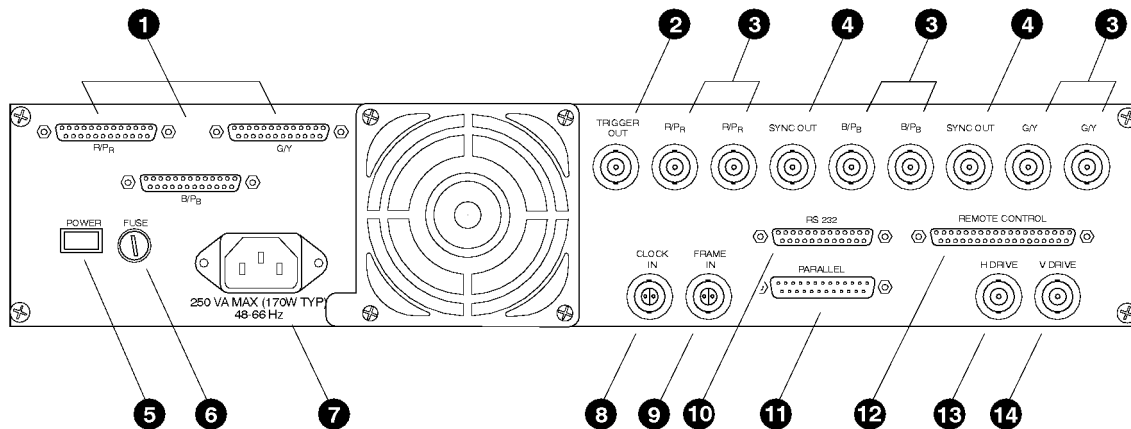


Figure 6: The TSG 1001 rear panel

1. Digital video channel outputs — Female DB25 connectors that provide parallel digital output of the three video channels. The output is balanced ECL with 10 data pair and one clock pair per channel.
2. Trigger output — A 75 $\Omega$  BNC connector that provides a frame-rate TTL pulse that can trigger an oscilloscope or other equipment.
3. Analog video channel outputs — 75 $\Omega$  BNCs, two for each component video channel. When the TSG 1001 is generating NTSC composite video, the composite signal will be available on one, two, or all three of the channels, depending on the source program; see the SDP1000 manual for more information.
4. Sync outputs — 75 $\Omega$  BNCs that provide only the bi-level or tri-level sync pulses of the active video format.
5. Power switch — Push-push on/off.
6. Fuse — Medium blow: 2A for 230V operation, 4A for 115V operation.
7. Power cord receptacle.
8. Clock input — A 78 $\Omega$  “BNO” connector for input of an external balanced ECL clock signal. The clock signal may be encoded with a frame-reset pulse. Permits the use of an external oscillator, typically in a Tektronix SPG 1000 HDTV Sync Generator.

9. Frame input — A  $78\Omega$  “BNO” connector for input of an external frame reset signal. The external frame reset pulse must be accompanied by a clock pulse present at the Clock input.
10. RS-232 (serial) communications port — A female DB25 connector for both data transfer into RAM and serial remote control.
11. Parallel communications port — A male DB25 connector for fast parallel downloads of test signal data into RAM.
12. Ground-closure remote control port — Allows the control of all front panel operations through ground-closure remote control, typically with a user-built interface.
13. H Drive output — A  $75\Omega$  BNC that can provide TTL-compatible (high or low) output. Intended for the output of a high or low pulse at the horizontal rate. The level of this output is determined by instructions in the signal-source program. See the SDP1000 manual for more information.
14. V Drive output — A  $75\Omega$  BNC that can provide TTL-compatible (high or low) output. Intended for the output of a high or low pulse at the vertical (frame) rate. The level of this output is determined by instructions in the signal-source program. See the SDP1000 manual for more information.

## Downloading Test Signals Into RAM

A mixed-format signal set is loaded into RAM when the TSG 1001 is assembled. This signal set is intended for test and demonstration purposes and should be replaced with one of the single-format signal sets supplied as part of the SDP1000 software, or with a signal or signal set created by the user. The procedures involved in creating (or modifying) and downloading signals and signal sets are detailed in the SDP1000 manual; the general techniques are outlined below. Note that downloading new information into RAM will over-write the previous contents of memory.

### Downloading a Single Test Signal

1. Install the SDP1000 software on an IBM-compatible PC running MS- or PC-DOS 3.0 or higher.
2. Connect the PC to the TSG 1001 through either the parallel (recommended) or serial port. Run COM1000, an SDP1000 utility, to set the communications parameters.
3. Run ED1000, the SDP1000 waveform editor. Open the appropriate waveform equation file and display the waveform of interest, or create a new waveform description.
4. When the desired waveform is displayed on the ED1000 screen, press the F3 key of the PC. The waveform will be sent to TSG RAM; when the download



is complete, the signal will be output by the TSG 1001. The TSG will also be able to generate zone plate patterns in the format of the downloaded signal.

### Downloading a Signal Set

The SDP1000 software includes signal set menu and download files in every supported format. The download files, designated with a .dnl or .dnz extension, may be sent to TSG RAM with COM1000, the SDP1000 communications utility. The following steps are for downloading an existing signal set from the SDP1000 signal libraries. See the SDP1000 manual for details of creating or modifying test signals and signal sets, and for procedures used in generating files for downloading to the TSG 1001.

1. Install the SDP1000 software on an IBM-compatible PC running MS- or PC-DOS 3.0 or higher.
2. Connect the PC to the TSG 1001 through either the parallel or serial port. (Use parallel communications if possible because downloads will be much faster.) Run COM1000, the SDP1000 communications utility, and set the communications port parameters.
3. Also use COM1000 to download the appropriate .dnl file. When the transfer is complete, a test signal from the signal set will be output by the TSG 1001, and other signals in the set may be chosen with the appropriate signal select buttons (see Outputting Test Signals, below). The TSG will also be able to generate zone plate patterns in any format contained in the signal set.

## Outputting Test Signals

You can output test signals from the RAM board or the zone plate patterns from the Zone Plate board.

### Outputting Test Signals from the RAM Board

When a signal set is loaded into the TSG 1001 RAM board, test signals can be selected and output with the following procedure:

1. Press the Signal Sets button. If the TSG display does not read "RAM Board Signal Set" as shown in Figure 7, press the button again to select the set.



Figure 7: TSG 1001 readout when the standard signal set is active

2. Press the Formats button. The name of a video format will be displayed. If more than one format is included in the signal set, the others may be selected with subsequent presses of the button or with the selection knob. The new format will be active as soon as the name is displayed.
3. Press one of the signal select buttons. The signal that is currently associated with the button will be output and its name will appear on the TSG readout. If the signal set has no signals defined for the button category, the message “No Signals Defined” will be displayed. If more than one test signal has been defined for the category, the remaining signals can be selected with subsequent presses of the signal select button or with the selection knob.

The full list of test signals available under the active button can be displayed on the attached video monitor (in place of a test signal) by pressing the Signal Menu button; the current test signal will be indicated with a leading “>” symbol. While the signal menu is displayed, the test signal may be changed only with the selection knob. Pressing the Signal Menu button a second time will return the TSG 1001 to normal operation; the current test signal will be output.

To change to another type of test signal, press the appropriate signal select button. In most cases, the last of a category’s signals to be output will be the first signal displayed when the category is selected again. However, after the instrument is turned off or the zone plate signal set has been used, the test signal listed at the top of the signal menu will be current when the signal category is next selected.

### Outputting Patterns from the Zone Plate Board

To select and modify a zone plate pattern, follow these steps:

1. Press the Signal Sets button. If the TSG display does not read “Zone Plate Signal Set” as shown in Figure 8, press the button again to select the set.



Figure 8: TSG 1001 readout when the zone plate signal set is active

2. Press the Formats button. The name of a video format will be displayed. If more than one format is included in the current RAM board signal set, they will also be available. Select the appropriate format by pressing the Formats button repeatedly or turning the selection knob.
3. Press one of the first six signal select buttons. The type of zone plate pattern associated with each button is shown graphically on the front panel below

the buttons. The pattern will be output and its name will appear on the TSG 1001 display panel.

4. Turn the selection knob to modify a fundamental characteristic or parameter of the pattern; the parameter values will be shown on the TSG display. To adjust other parameters of the active zone plate, press the Sweep/Parameters signal select button. Press the button repeatedly to choose among parameters—again, the numeric values will be shown on the readout. Turn the selector knob to change the value of the displayed parameter. The various parameters of the six basic zone plate patterns are explained in the Reference section of this manual. To return to the original configuration, press the signal select button for the zone plate again.
5. Several more pre-defined patterns are available through the seventh button, labeled Multipulse/User Zone Plates. To select one of these patterns, press the User Zone Plate button and then rotate the selector knob until the name of the desired zone plate appears on the TSG readout. Press the Sweep/Parameters button, as in the previous step, to modify these “standard” user zone plates.
6. To save a modified zone plate, press the Multiburst/Save Zone Plates button. The message “Rotate Knob to Store Location” will appear briefly, then be replaced with the name of a user zone plate. If necessary, rotate the selector knob until a message “Zone Plate Number #” appears (where # is an integer from 4 to 10). Press the Save Zone Plates button a second time. The message “Enter Zone Plate Name” will appear briefly, then the default name will return. Press the Save Zone Plates button again to accept the default name and save the pattern.

The procedure for entering a new name is explained in the Reference section of this manual. Note that the standard user zone plates mentioned in step 5 cannot be overwritten; an error message will appear if the user attempts to do so. To save a variation of any standard pattern, select one of the “Zone Plate Number #” locations.

(Note that all the “Zone Plate Number #” storage locations may eventually be used and renamed. If so, a previously saved pattern must be identified and overwritten to save a newly modified zone plate.)

7. To recall a user zone plate later, press the Multipulse/User Zone Plates signal select button. Rotate the selector knob until the name of the desired pattern appears on the readout. The TSG 1001 will output the selected pattern.

## H and V Drive Outputs

The H drive and V drive outputs are driven TTL high or low, depending on instructions in the test signal descriptions that are downloaded to TSG 1001 memory. These outputs are intended to be line-rate (H drive) and field- or

frame-rate (V drive) pulses; with the SDP1000 software, the TSG 1001 user can control when the pulses occur, their duration, and whether they are high or low.

Each test signal may have unique H and V drive instructions, but most users will find it more convenient to associate the same H and V output with all signals of a format. To do so, include H drive and V drive instructions in the menu file(s) that describe a format's vertical interval (usually `vertint.men`). In the signal sets provided with the SDP1000, H and V drive output depends on the format of the signal. Many formats have no H and V drive instructions, and the outputs will be indeterminate when those formats are active. (Lacking instructions, H drive and V drive will be constantly high or low depending on the last "active" state of the output.)

The user can set or change the characteristics of these outputs only by creating and sending a new download file to TSG 1001 RAM. The general procedure is as follows; for more information, see the Reference section of this manual or the software (SDP1000) manual.

1. Use a text editor to insert or modify the HDRIVE: and VDRIVE: instructions in the appropriate SDP1000 menu file. These instructions will usually appear or be referred to in the `vertint.men` file used by all test signals of a given format.
2. Use `Makerams`, an SDP1000 utility, to recompile the signal set menu file and create a new download file.
3. Use `COM1000`, the SDP1000 communications utility, to send the new download file to TSG 1001 RAM.

## Using External Timing Signals

The TSG 1001 can use external "balanced ECL" clock and frame timing signals, from either a Tektronix SPG 1000 HDTV Sync Generator or another—user supplied—source. This allows the TSG 1001 to be driven by an SPG 1000 and thus genlocked to another signal source. It also permits the use of an external clock to produce signals with "non-standard" sampling frequencies.

The source of the TSG 1001 sampling clock and frame reset is selected through the instrument's Utilities button (described later in this section). If Internal Reference is selected, both clock and frame reset are derived from one of the three internal oscillators. If External Reference is chosen, the user must also select one of three external timing modes (through another TSG utility):

- **External Clock Mode.** When in external clock mode, the TSG 1001 uses the signal connected to the Clock input as the system clock. The Clock input is a BNO connector and will accept a "10KH differential ECL" signal, typically over a "twin-ax" cable. The range of permissible frequencies for the external

clock in this mode is 13.5 to 78 MHz. When External Clock mode is selected, any signal at the Frame input is ignored.

For information about determining the clock frequency required for a given picture scanning structure, see the User Format Reference section of the SDP1000 manual.

- Encoded Mode.** Encoded mode is used by the SPG 1000 to control the TSG. In Encoded mode, both clock and frame information are contained in one signal present at the Clock input; the frame reset is indicated by a “missing pulse” in the clock signal. See Figure 9. The allowable range of clock frequencies in this mode is 68 to 78 MHz.

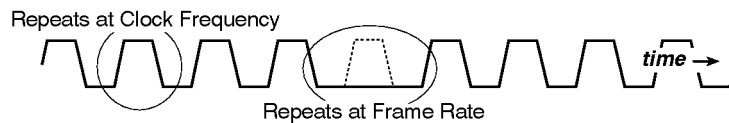


Figure 9: An encoded clock signal

The ability to time the TSG 1001 with an SPG 1000 can be valuable. Not only may the output of the TSG be synchronized with another signal source, but precise offsets—as small as a fraction of a nanosecond—can be introduced to compensate for timing delays caused by additional equipment and unequal-length cable runs throughout the video system. For more information about using the TSG 1001 with the SPG 1000, please contact a Tektronix representative, or see the SPG 1000 manual.

- Two Wire Mode.** In two wire mode, the TSG 1001 accepts information from both the Clock and Frame inputs. The clock signal is used as the system clock, and the TSG resets to the top of the video frame whenever a positive pulse is received at the Frame input. The frame signal must also be 10KH differential ECL. The range of permissible frequencies for the external clock in this mode is 13.5 to 78 MHz. The correct timing relationship for the clock and frame signals is shown in Figure 10.

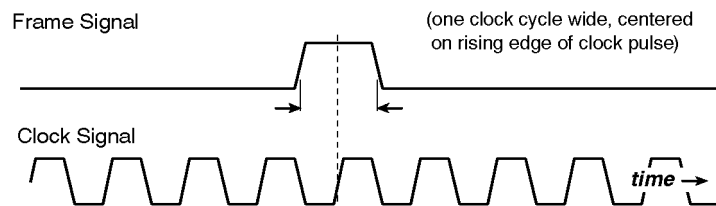


Figure 10: Clock and frame signal timing in two wire mode

### Using an SPG 1000 to Genlock a TSG 1001

1. Connect the genlock reference signal to the SPG 1000 as described in the SPG 1000 instruction manual.
2. Connect the BNO cable—supplied with the SPG 1000—between the SPG Clock Out and the TSG Clock In connectors.
3. Press the TSG 1001 UTILITIES button. Rotate the knob until the display reads “Int/Ext Ref Select.”
4. Press the OTHER SIGNALS/→ button to enter that utility selection.
5. Rotate the knob until the “External Ref Selected” message appears.
6. Press the TIMING SIGNALS/← button to confirm the selection and continue in the utilities mode.
7. Rotate the knob clockwise until the display reads “Set Ext Ref Mode.”
8. Press the OTHER SIGNALS/→ button to enter that utility selection.
9. Rotate the knob until the message “Encoded Mode Selected” appears.
10. Press the UTILITIES button to accept that entry and exit the utilities function.

### Returning the TSG 1001 to Normal Operation

1. Press the TSG 1001 UTILITIES button. Rotate the knob until the display reads “Int/Ext Ref Select.”
2. Press the OTHER SIGNALS/→ button to enter that utility selection.
3. Rotate the knob until the “Internal Ref Selected” message appears.
4. Press the UTILITIES button to accept that entry and exit the utilities function.

## Remote Control

Most functions available through the TSG 1001 front panel may also be controlled away from the instrument through RS-232 serial communications or ground closure remote control. Serial remote control is through the same female DB25 connector used for data downloads; a separate 37 pin female “D” connector is reserved for ground closure control. The techniques for both methods of remote control are outlined below. See the Reference section of this manual for more detail.

### Ground closure

Ground closure remote control is so named because functions are selected and actions initiated when an electrical connection to ground is closed momentarily.

In the TSG 1001, all of the front panel buttons are represented by a pin on the rear panel Remote Control connector and the selection knob is represented by a pin for each direction of rotation. Yet another pin is connected to ground. The pin assignments are listed in Table 4. The connector is illustrated in Figure 11.

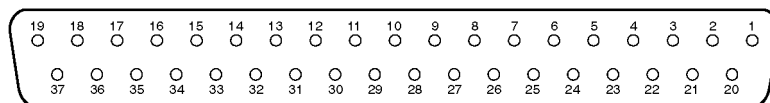


Figure 11: The remote control connector

Table 4: Functions of the ground closure pins

Pin	Function	Pin	Function
1	Color Bars	20	Monitor Setup
2	Linearity	21	Shallow Ramp
3	Flat Field	22	Pulse and Bar
4	Multipulse	23	Multiburst
5	Sweep	24	Timing Signals
6	Other Signals 1	25	Other Signals 2
7	Other Signals 3	26	Formats
8	Signal Sets	27	G/Y (on/off)
9	B/P <sub>B</sub> (on/off)	28	R/P <sub>R</sub> (on/off)
10	Trigger	29	Set Pedestal
11	Utilities	30	Signal Menu
12	Knob Left (CCW)	31	Knob Right (CW)
13–18	not used	32–37	not used
19	GROUND		

Momentarily connecting pin 1 to pin 19, for example, has the same affect as pressing the Color Bars signal select button, and shorting pin 31 to pin 19 is equivalent to turning the selector knob one “beep” clockwise.

Typically, ground closure control will be implemented with a user-assembled remote control box or panel. Such a panel for the TSG 1001 *could* have 24 momentary-contact switches—one for each function. Another possible approach is illustrated in Figure 12. This remote uses four momentary-contact push buttons and two rotary switches. Two of the buttons, when pressed, “turn” the selector knob, while each of the other two buttons “push” the front panel button

that has been selected with its associated rotary switch, S1 or S2. Note that the designer of this hypothetical solution has decided that video channel on/off is not an important remote operation.

There are countless ways to implement ground closure remote control—the only limit is the imagination of the user. The unique operating environment of the TSG 1001 will determine whether ground closure remote control is useful; it should also be considered in the design of the necessary control device(s).

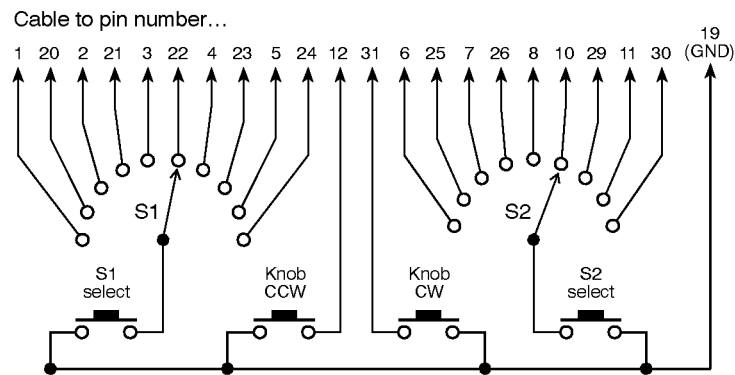


Figure 12: A possible ground-closure remote control circuit

**RS-232** The TSG 1001 may be controlled over a standard RS-232 interface by any device that can generate or transmit commands in ASCII characters. This makes it possible to control the TSG 1001 directly from an ASCII terminal or personal computer (PC).

Typically, serial remote control will be implemented with a PC that is running terminal-emulation or communication software, such as ProComm® or Smartcom®. Depending on the software used, commands that specify TSG 1001 settings may be entered directly through the keyboard or by transmitting text files that contain any number of commands. Many communications applications also allow the assignment of command “scripts” or “macros” to function keys or key combinations.

Serial remote control will permit the operator to learn the settings of the TSG 1001 and change them from a distance. New settings may be specified by name (e.g., “BLACK” test signal) or value (e.g., 9600 [baud]), which eliminates the need to scroll through a list of choices as with the front panel controls or ground-closure remote. In some cases, such as horizontal and vertical trigger location, the settings may also be changed “a step at a time.” Some of the ways to use serial remote control are:

- Enter commands directly through a PC or terminal keyboard. The value of this approach is limited, however, because typing commands such as



:FORMAT “1050/59.94/1:1 ypbpr” (to change the active signal format) will be tedious.

- Assign PC function keys or key combinations to certain settings or commands so the TSG 1001 can be controlled with a few key strokes. For example, if the script “:TRIGGER:VERTICAL Up;:TRIGGER:VERTICAL?” (followed by a carriage return) were to be associated with the Ctrl-Up arrow combination, pressing Ctrl-Up arrow would move the trigger up one line and would return the number of that line to the terminal screen. (Note that key assignment is not a standard feature of communication software; check the manual of your particular application.)
- Save a group of commands in the form of a text file. Such a file could be sent to the TSG 1001 to change several settings to predetermined values “all at once,” eliminating the need for much button-pushing and knob-turning.
- While running communication software, execute simple programs to “automate” adjustments or substitute short mnemonic strings for long commands. (Such programs can be compiled and executed with ProComm Plus®; other applications may also have this capability.)

RS-232 commands and command syntax are explained in “Serial RC Commands,” in the Reference section of this manual.

## Utilities

The TSG 1001 Utilities button provides access to:

- Software Version
- Test Signal Revision and Date
- Beeper enable/disable
- Internal/External Reference (clock) select
- Set External Reference Mode
- Set Baud Rate
- Set Zone Plate Amplitude

(The choice “Set Zone Plate Framing board” is also present, but has no meaning in the TSG 1001.)

Use the utilities mode as follows:

1. Press the Utilities button to enter the utilities mode (the button’s LED will be lit when the TSG is in utilities mode).

2. Use the selector knob to scroll through the list of utilities.
3. When the name of the desired utility is displayed on the TSG 1001 readout, select it by pressing the Other Signals 1/→ button. The version information or current setting will appear on the readout.
4. To change a utility's setting, press the "→" button repeatedly—or rotate the selector knob—until the desired setting is indicated on the TSG 1001 display. (The indicated setting is always "active"; there is no need to confirm the choice.)
5. Press the Timing Signals/← button to move back "up" to the utilities list. Repeat steps 2 through 4 to change another utility setting.
6. When all settings are correct, press the Utilities button to exit the utilities mode. The TSG 1001 will return to normal operation.

The utilities, their options, and the selection process are illustrated in Figure 13. The choices are explained briefly in the following paragraphs.

**Software Version** — Returns the version and date of the software in ROM.

**Test Signal Revision and Date** — Returns the date and time that the RAM download information was created with the SDP1000 Makerams utility.

**Beeper Enable/Disable** — Permits the user to turn the "audible feedback" off and on.

**Int/Ext Ref Select** — Used to choose between the internal oscillators and external timing signals present at the Clock and Frame inputs. If the user selects External Reference when no external timing signal is available, the TSG 1001 defaults to the internal oscillator and displays the message "Ext Ref Selected; Int Mode Enabled."

**Set Ext Ref Mode** — As explained in Using External Timing Signals, earlier in this section, the TSG 1001 can operate in three external timing modes: External clock only; clock encoded with a frame reset; and "2 wire" mode, where the clock and frame reset signals are separate. The TSG uses the specified mode only when external reference is selected through the Int/Ext Ref Select utility.

**Set Baud Rate** — Used to set the baud rate for RS-232 (serial) remote control and RAM file downloads. Choices are 1200, 2400, 4800, 9600, 19200, 38400, 57600, and 115200 bits per second. The baud rate setting *must* agree with that of the attached RS-232 device (usually a personal computer).

**Set Zone Plate Amplitude** — Permits the selection of full or half amplitude zone plates. This setting affects only the active video portion of the signal. The actual amplitudes will depend on the active video format.

**Set Zone Plate Framing Board** — Is not applicable to the TSG 1001, which can only take zone plate framing information from the RAM board. This option is relevant to other TSG1000 series instruments.

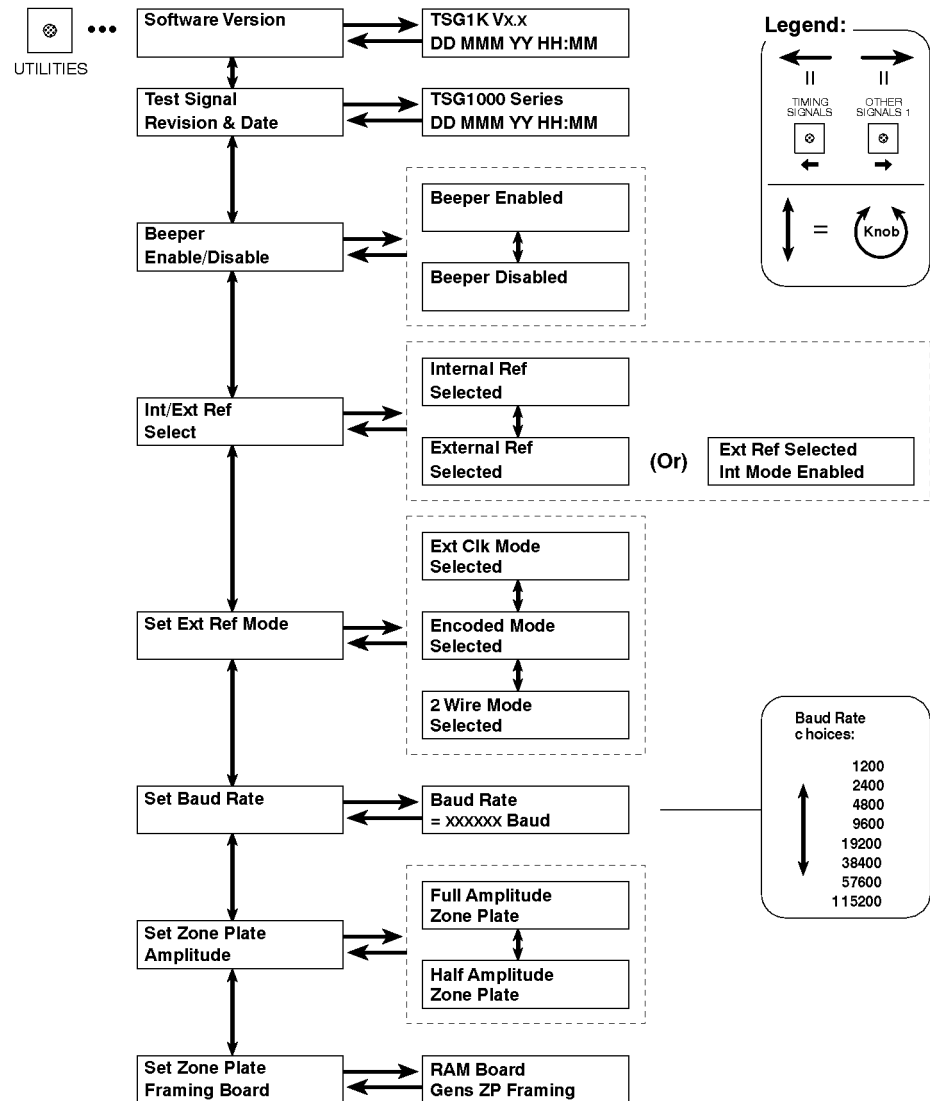


Figure 13: TSG 1001 utilities



## Reference

This section contains additional, detailed information you might need to operate the TSG 1001. See the service manual for schematics, parts lists, and procedures for performance verification and adjustment. See the SDP1000 manual for more information about creating, modifying, and downloading signals to User RAM or User ROM.

## Digital Video Output

The digital video output of the TSG 1001 is 10 bit linear PCM, balanced ECL (10KH series), compatible with D1 (4:2:2) and D2 video. Data transfer is at the sample frequency of the active video format. The pin-outs of the digital connectors are listed in Table 5.

**Table 5: Pin assignments for the TSG 1001 digital video output connectors**

Pin	Signal	Pin	Signal
1	Clock +	14	Clock –
2	System ground	15	System Ground
3	Data bit 9, +	16	Data bit 9, –
4	Data bit 8, +	17	Data bit 8, –
5	Data bit 7, +	18	Data bit 7, –
6	Data bit 6, +	19	Data bit 6, –
7	Data bit 5, +	20	Data bit 5, –
8	Data bit 4, +	21	Data bit 4, –
9	Data bit 3, +	22	Data bit 3, –
10	Data bit 2, +	23	Data bit 2, –
11	Data bit 1, +	24	Data bit 1, –
12	Data bit 0, +	25	Data bit 0, –
13	Cable Shield		

## H and V Drives

As discussed in the Operating Basics section of this manual, the H drive and V drive outputs are controlled by instructions in the test signal menu and download files that are created with the SDP1000 software. The general procedure for associating an H or V drive signal with the TSG 1001 test signals, or for changing its characteristics is:

1. Use a text editor to insert or modify the HDRIVE: and VDRIVE: instructions in the appropriate SDP1000 menu file. These instructions will usually appear or be referred to in the `vertint.men` file(s) used by all test signals of a given format.
2. Use Makerams, the RAM file generator, to recompile the signal set menu file and create a new download file.
3. Use the SDP1000 communications utility, COM1000, to send the new download file to TSG 1001 RAM.

The following explanations of the HDRIVE: and VDRIVE: menu file keywords are repeated from the SDP1000 manual. See that software manual for more information about menu files, keywords, download files, Makerams, or COM1000.

**HDRIVE:** HDRIVE: controls the H drive output of the TSG 1001. The H drive is a TTL-compatible output that is either low or high for each “packet” of eight contiguous samples on a video line. The H drive output can only make a low-to-high or high-to-low transition on the boundaries between sample packets. The HDRIVE: keyword is used to set the high and low packets on every line in the frame. For consistent behavior in all signals of a format, an HDRIVE: statement will typically appear early in the `vertint.men` file.

Syntax: HDRIVE: *sample specifications* [*sample specifications*]

where sample specifications can be

LO *samples*    or  
HI *samples*

Example: HDRIVE: LO 0–151 2224–2287  
                  HI 152–2223

This example specifies H drive for a 1050/59.94/2:1 format that uses 2288 samples per line. In this example, the H drive output will be at TTL low level during the first 19 packets (samples 0 through 151), at TTL high for the next 259 packets (samples 152 through 2223), and at low level again for the remainder of the line (8 packets; samples 2224 through 2287). The instruction will apply to every line defined *after* the HDRIVE: statement in the `.men` file. Thus, if the example lines are included before the frame description in a `lib1050i\gbr` menu file, the instructions will affect every line in the frame.

Note that because the first sample on a line is designated 0 (not 1), the transitions must occur just *before* a sample divisible by eight. The packets are made up of samples 0–7, 8–15, 16–23, ...240–247, and so on. The instruction “LO 0–16” would result in H drive at low level for the first three packets, or samples 0 through 23, because sample 16 is in the third packet.

**VDRIVE:** VDRIVE: controls the V drive output of the TSG 1001. V drive is a TTL-compatible output that is either low or high for each “packet” of eight contiguous samples on a video line. The V drive output can only make low-to-high or high-to-low transitions on the boundaries between sample packets. The VDRIVE: keyword is used to set the high and low packets. A VDRIVE: specification affects all following video lines (see the example below). For consistent behavior for all signals of a format, VDRIVE: statements will typically appear in the vertint.men file(s).

Syntax: VDRIVE: *sample specifications* [*sample specifications*]

where sample specifications can be

LO *samples*            or  
HI *samples*

```
Example: VDRIVE: HI 0–2223 LO 2224–2287
         “FSYNC B525” 525
         VDRIVE: LO 0–2287
         “FSYNC A525 V1” 1–15
         VDRIVE: HI 0–2287
         “FSYNC A525” 16–36 521–524
```

This example specifies V drive for a 525/59.94/1:1 format, which has 2288 samples per line. The result of these instructions will be a TTL low V drive “pulse” in every frame beginning at sample 2224 of line 525 and ending after sample 2287 of line 15. Note that each VDRIVE: instruction applies to all lines listed below it in the menu file—until the next VDRIVE: statement. Thus, if the example lines are included (as part of lib525i\gbr\vertint.men) before the listing of active video lines in a lib525i\gbr menu file, the VDRIVE: HI 0–2287 instruction will affect all the active video lines as well, leaving V drive at TTL high throughout the active video portion of the signal, as intended.

See the HDRIVE: example, above, for information on sample numbers and packets.

## RAM Capacity and Usage

The number of test signals that will fit into TSG 1001 RAM is a function of the video format(s) used and the complexity of the signals to be stored. A signal set will fit into RAM if: 1) the total “length” of the unique waveform descriptions is

262,144 samples or less; and 2) the frames described in the signal set total no more than 65,536 lines.

A unique waveform description is one that is referred to—either directly or in an “included” single-signal menu file—at least once in the signal set menu file. The waveform will be stored only once no matter how many times it is called for in the signal set. Vertical interval lines, for example, are referred to in nearly every test signal (or frame) description, yet will occupy no more RAM (“line memory”) than a waveform mentioned only once.

A frame description assigns the unique waveforms to the appropriate lines in a video frame. Each frame description of a given format occupies the same amount of TSG 1001 “frame memory.” Note, however, that some formats require more than one frame description per static test signal. For example, the NTSC color sequence requires two 525-line frames, so an NTSC test signal will occupy as much frame memory as one in a 1050 line HDTV format. (The PAL color sequence is four frames, so a 625/50/2:1 YUV test signal intended for the Tektronix PE1000 PAL encoder will take up *twice* as much frame memory as a 1250 line HDTV signal.)

### Line memory usage

Calculate the line memory requirements of a signal set by multiplying the number of unique waveform descriptions by the number of samples per line. For example, a signal set with 40 unique 625/50/2:1 waveforms and 50 unique 1250/50/1:1 waveforms will easily fit into line memory because fewer than 262,144 samples are used.

$$\begin{aligned}40 \times 4608 &= 184320 \\50 \times 1152 &= 57600 \\184320 + 57600 &= 241920\end{aligned}$$

Put another way, if all the waveforms to be stored are for the 1250/50/2:1 format (the lines of which are 2304 samples long), the number of unique descriptions that may be stored is

$$262144 \div 2304 = 113$$

including both vertical interval and active video lines.

### Frame memory usage

Calculate the frame memory requirements of a signal set by multiplying the number of frame descriptions by the number of lines per frame. For example, a



signal set with 30 1250/50/2:1 frames, and 40 625/50/1:1 frames will easily fit into line memory as fewer than 65,536 lines are used:

$$30 \times 1250 = 37500$$

$$40 \times 625 = 25000$$

$$37500 + 25000 = 62500$$

Put another way, if all the frames to be stored are in a 1250-line format, the number of frames that may be stored is:

$$65536 \div 1250 = 52$$

The line and frame lengths for the various scanning “standards” are listed in Table 6. For a quick check of whether the download file created from a given menu file will fit into RAM, run the SDP1000 Chkmnu utility with that file.

**Table 6: Frame and line lengths of the various scanning “standards”**

Standard	Lines/fram	Samples/line
525/59.94/2:1	525	4576
NTSC	525	4576
D2 NTSC	525	910
525/59.94/2:1 D1	525	858
525/59.94/2:1 D1 16:9	525	1144
525/59.94/1:1	525	2288
625/50/2:1	625	4608
625/50/2:1 D1	625	864
625/50/1:1	625	2304
750/59.94/1:1	750	1650
787/59.94/1:1	1575*	1596
1050/59.94/2:1	1050	2288
1050/59.94/1:1	1050	1144
1125/60/2:1	1125	2200
1125/59.94/2:1	1125	2200
1125/59.94/1:1	1125	1100
1250/50/2:1	1250	2304
1250/50/1:1	1250	1152

\* The 787/59.94/1:1 format uses alternating 787- and 788-line fields for a total of 1575 lines.

## Zone Plates

Zone plate video test patterns—or simply “zone plates”—have become important tools for the evaluation of modern video processing systems and techniques. They are called zone plates because the classical circular pattern looks like an optical zone plate, represented in Figure 14. Optical zone plates use the principles of Fresnel diffraction to focus and intensify light. Nowadays, however, the name has been applied to a near-infinite variety of stationary and “moving” monochrome test patterns.

### Introduction

Zone plate patterns are made up of sinusoidal variations in luminance, with the “peaks” of the sine waves resulting in white areas on the video screen and the wave “troughs” shown as gray or black. The cycles can occur in all three of the video dimensions: Horizontally, or along each line of the picture; vertically, or “down” the video frame; and temporally (with time). The three dimensions are often referred to by the shorthand designations of X, Y, and T.

The luminance of any point in the picture—physically on the screen *and* in time—is determined by the value of sine at that particular point; the value of sine follows from the phase of the cycle at that point; and (by the definition of a zone plate) the phase of any point is determined by the equation

$$\begin{aligned}\Phi_{xyt} = & k_{\phi} + k_X(x) + k_Y(y) + k_T(t) \\ & + k_{XT}(xt) + k_{YT}(yt) + k_{XY}(xy) \\ & + \frac{1}{2}k_{X^2}(x^2) + \frac{1}{2}k_{Y^2}(y^2) + \frac{1}{2}k_{T^2}(t^2)\end{aligned}$$

where  $x$ ,  $y$ , and  $t$  are the coordinates of the point in question and  $k_{\phi}$ ,  $k_X$ ,  $k_Y$ ,  $k_T$ ,  $k_{XT}$ ,  $k_{YT}$ ,  $k_{XY}$ ,  $k_{X^2}$ ,  $k_{Y^2}$ , and  $k_{T^2}$  are constants.

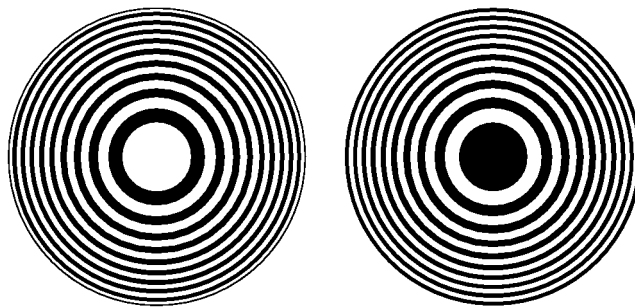


Figure 14: Optical zone plates (enlarged)<sup>1</sup>

<sup>1</sup> The white areas in the figure represent transparent regions; the black areas are opaque. The precise spacing of the rings serves to focus and intensify light that passes through the plate.

## Zone Plates in the TSG 1001

All zone plate patterns in the TSG 1000 series of generators are defined with coefficients of ten parameters that correspond to the constants in the above equation. Note that although the possibilities are virtually endless, most common zone plates are defined with only one or two parameters—while the coefficients of the remaining parameters are kept at zero. The ten parameters are explained under “Zone Plate Parameters,” later in this section. The use of the TSG 1001 to display, create and modify, and save zone plates is explained next.

To output zone plate patterns from the TSG 1001:

1. If more than one video format is included in the current RAM board signal set, select the appropriate one with the Formats button. The generator will output zone plate patterns in the active video format.
2. Press the Signal Sets button. If the TSG display does not read “Zone Plate Signal Set,” press the button repeatedly until it does.

The TSG 1001 is now in zone plate mode. In this operating mode, the top row of front panel buttons perform the secondary functions indicated by the graphics and nomenclature printed below them. See Fig. 15 and the following paragraphs for an explanation of the zone plate functions of the front panel controls.

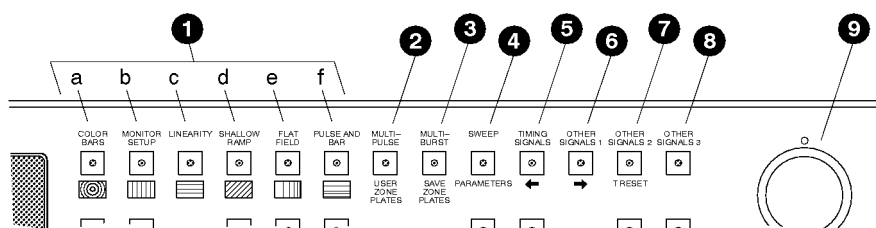


Figure 15: TSG 1001 zone plate controls

1. Zone Plate Select buttons — are used to select six standard patterns. The type of pattern is pictured below each button. Pressing a button will cause the TSG 1001 to output the corresponding zone plate; the button’s LED will light and the name of the pattern will appear on the instrument’s readout. Pressing any of these buttons a second time will change the readout to show the current value of the pattern’s “significant frequency,” which may then be adjusted by rotating the selector knob.

Table 7: Standard zone plates

Button	Pattern name	Significant frequency
1a	Circle	Circle (max c/aph)
1b	Horizontal Sine	Horizontal (MHz)

Table 7: Standard zone plates (Cont.)

Button	Pattern name	Significant frequency
1c	Vertical Sine	Vertical (c/aph)
1d	Diagonal Sine	Diagonal (equivalent c/aph)
1e	Horizontal Sweep	H Sweep (max MHz, or multiple)
1f	Vertical Sweep	V Sweep (max c/aph, or multiple)

2. User Zone Plates button — provides access to two additional pre-defined patterns, a “blank zone plate,” and seven storage locations for user-defined patterns. Pressing the button once will enter the user zone plates category and output the last active pattern; repeatedly pressing the button will scroll through the list of available patterns and locations, returning to the first choice when the end of the list is reached. The selector knob can also be used to scroll through the list—in both directions.
3. Save Zone Plates button — is used to place the active pattern in one of the seven user zone plate storage locations. The procedure is described later in this section under “Saving and Naming Zone Plate Patterns.”
4. Parameters button — permits adjustment of the ten defining zone plate parameter coefficients. Pressing the button once will “open” the list of parameters, and the last-adjusted parameter name and coefficient will appear on the readout. Pressing the button repeatedly will scroll through the list of parameters, returning to the first when the end of the list is reached. The ← (5) and → (6) buttons may also be used to scroll through the parameter list.

Turning the selector knob will *change the value* of the displayed coefficient; pressing the Other Signals 3 button (number 8 in Fig. 15) will reset the coefficient to 0.0.

---

**NOTE.** Beginning with kernel software version 2.02, coefficients can also be specified through RS-232 remote control. This may prove to be much more convenient for users who frequently define or modify TSG 1001 zone plates. For more information, see the discussion of Serial Remote Control, elsewhere in this Reference section of the manual.

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The Parameters button may also be used to cancel a Save Zone Plates operation without changing the displayed pattern.

5. The ← (left arrow) button may be used to “back up” in the list of parameters when the Parameters button is lit and a parameter and coefficient are listed on the readout.

6. The → (right arrow) button duplicates the scrolling function of the Parameters button.
7. T Reset button — is used to stop time (as it applies to TSG 1001 zone plates, anyway), and reset the time coordinate ( $t$  in the zone plate equation on page 32) of the pattern to zero. As long as the button is lighted, there will be no apparent motion in the zone plate, even if any of the time coefficients ( $K_{XT}$ ,  $K_{YT}$ ,  $K_T$ , or  $K_T^2$ —discussed later in this section) is non-zero. A second press of the button will restart zone plate time.
8. The Other Signals 3 button has the zone plate mode function of Parameter Reset. When the Parameters button is lit, pressing the Other Signals 3 button will reset the displayed parameter coefficient to zero.
9. Selector Knob.

To gain familiarity with zone plates and their parameters, select a blank zone plate through the User Zone Plates button. Then, using the Sweep/Parameters button and the selector knob, change coefficients and observe the results on both video and waveform monitors. At first, adjust only one parameter coefficient at a time. Once the effects of each parameter are understood, experiment with adjusting two or more coefficients at a time. To quickly return to a blank zone plate (and zero all the coefficients), press the Multipulse/User Zone Plates button again. To zero only the displayed coefficient, press the Other Signals 3 button.

## Zone Plate Parameters

The ten zone plate parameters are discussed here in the order that they appear when the Parameters (or →) button is pressed repeatedly. The adjustment range of most of the coefficients depends on the characteristics (sample frequency and lines per field) of the active video format.

<b>Parameter:</b>	$K_{\emptyset}$
TSG 1001 readout name:	K: PHASE
Units:	cycle
Range:	-0.5 to 0.5 (default = 0.00000)

$K_{\emptyset}$  is the initial phase of the pattern; it cannot create a pattern by itself. To see the effects of this adjustment, first set the  $K_X$  coefficient to approximately 0.75 and set a waveform monitor to view the line waveform. Then adjust  $K_{\emptyset}$ . The sine wave will begin on each line at the selected point in the cycle. Note that 0.25 cycle corresponds to a phase of 90 degrees (or  $\pi/2$  radians); recall that the sine of 90° is 1.0 and the sine of -90° is -1.0. When  $K_{\emptyset} = 0.25$ , the pattern will begin in the upper left corner of the screen as white; when  $K_{\emptyset} = -0.25$ , the beginning will be black.

<b>Parameter:</b>	$K_X$
TSG 1001 readout name:	KX: H FREQ
Units:	cycles/active picture height (c/aph)

$K_X$  denotes the initial constant horizontal frequency of the pattern. To see the effects of changing this coefficient, set a waveform monitor to view the video lines. Note that the units are cycles per active picture *height*. The number of cycles in a line will depend on the width-to-height aspect ratio of the active format. For example,  $K_X = 9.0$  will result in approximately 12 cycles per line in a format with a 4:3 aspect ratio; the same setting will yield about 16 cycles per line when the ratio is 16:9.

To estimate the equivalent absolute frequency of the sine wave (i.e., to convert from c/aph to c/s, or Hz), use the formula

$$f_{eq} \cong K_X \times R_{l:av} \times R_{aspect} \times N_{lines} \times f_{frame}$$

where

$R_{aspect}$  is the aspect ratio (width  $\div$  height),

$N_{lines}$  is the number of lines per frame,

$f_{frame}$  is the frame rate, and

$R_{l:av}$  is the ratio of line length to the length of the active video.

The maximum frequency is ( $\pm$ ) half of the active format's sampling frequency. In formats that use a 72.0 MHz clock, for example, the maximum value of  $K_X$  will correspond to a sine frequency of 36.0 MHz.

The Horizontal Sine zone plate selected with the Monitor Setup button is a "K<sub>X</sub>-only" zone plate (see Fig. 16).

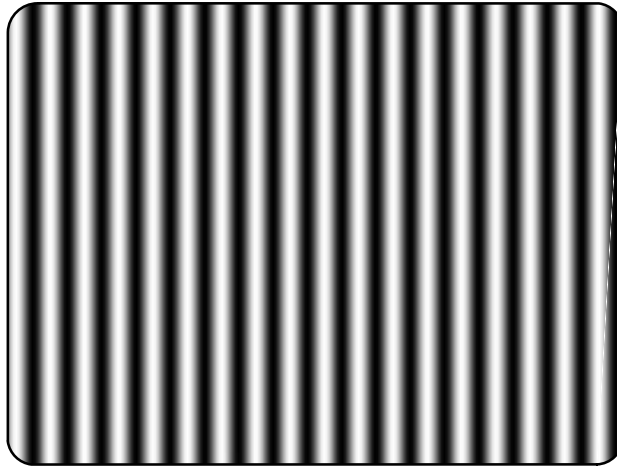


Figure 16: A “ $K_X$ -only” zone plate

Parameter:	$K_X^2$
TSG 1001 readout name:	$KX^2$ : H SWEEP
Units:	c/aph per active picture height (c/aph <sup>2</sup> )

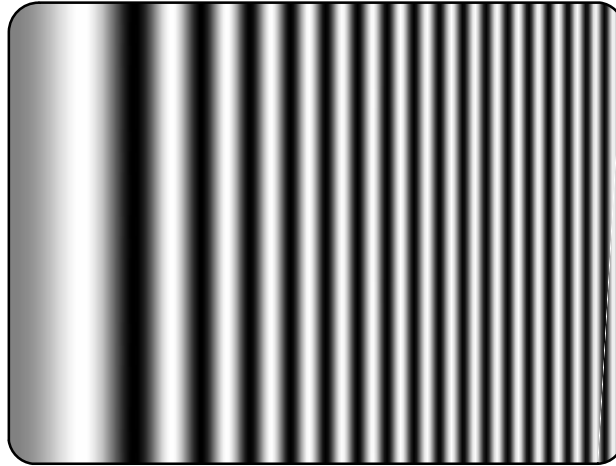
This parameter sets the increase (or decrease) in the horizontal frequency as a function of position along the video line. When  $K_X^2$  alone is applied, the result resembles a common sweep test signal. Again, use a waveform monitor to look at (all) the video lines to see the effects of  $K_X^2$ . When  $K_X$  is 0.0, setting  $K_X^2$  to 9 will result in the line waveform changing from DC to 9 c/aph in the width equal to one “active picture height.” As with  $K_X$ , the ending frequency will depend on the aspect ratio of the active video format. For example, in a 16:9 format with a  $K_X$  of -9.0, a  $K_X^2$  coefficient of 9.0 will cause the waveform to increase to DC in one “aph.” The frequency will continue to increase to approximately 7.0 c/aph by the end of the line.

Use this formula to calculate  $K_X$  and  $K_X^2$  terms for a sweep with the DC point at mid-screen:

$$K_X = \left(-\frac{1}{2}R_{aspect}\right) \times K_X^2$$

where  $R_{aspect}$  is the aspect ratio (width/height) of the active format.

The Horizontal Sweep zone plate selected with the Flat Field button is a “ $K_X^2$ -only” zone plate (see Fig. 17).



**Figure 17: A “ $K_x^2$ -only” zone plate**

<b>Parameter:</b>	$K_{XT}$
TSG 1001 readout name:	KXT: T CH H FREQ
Units:	c/aph per second (c/aph/s)

The  $K_{XT}$  parameter controls the change in horizontal sine frequency over time. Setting  $K_{XT}$  to 1.0, for example, will cause the horizontal frequency to increase by one c/aph each second. If  $K_X$  is 0.0, then the frequency will be 10 c/aph after ten seconds, 20 c/aph after twenty seconds, and so forth. The frequency will increase until it reaches the maximum for the active format; the phase of the signal will then “flip” by  $180^\circ$ —the sine wave will become “negative”—and the frequency will continue to “increase” through DC, when the cycle will begin again.

<b>Parameter:</b>	$K_{XY}$
TSG 1001 readout name:	KXY: V CH H FREQ
Units:	c/aph <sup>2</sup>

$K_{XY}$  sets the change in horizontal frequency as a function of the vertical position in the video frame. To see the effects of this parameter, set the waveform monitor to view one selected line only. Then, with  $K_{XY}$  set to approximately 25 (all other coefficients left at 0.0), look at line waveforms from top to bottom of the frame. The horizontal frequency increases slightly on each succeeding line, reaching 25 c/aph on the last line of active video. The result can be thought of as a vertically arranged “sweep” signal.



The Field Sweep zone plate selected with the User Zone Plates button is a “ $K_{XY}$ -only” zone plate.

<b>Parameter:</b>	$K_Y$
TSG 1001 readout name:	KY: VERT FREQ
Units:	c/aph

$K_Y$  sets the initial *vertical* frequency of the pattern (it is analogous to  $K_X$  rotated 90° clockwise). To see the effects of this parameter, set it to a low number and adjust a waveform monitor to view one or two *fields* of the TSG 1001 output. The variation in the (dc) voltage level from line to line will give the field waveform the appearance of a sampled sine wave, especially at a  $K_Y$  of around 5 to 10 c/aph (the sinusoid can become difficult to discern at higher frequencies). Note that in the Y (vertical) parameters, the c/aph units translate directly into visible cycles down the frame.

The Vertical Sine zone plate selected with the Linearity button is a “ $K_Y$ -only” zone plate (see Fig. 18)



Figure 18: A “ $K_Y$ -only” zone plate

<b>Parameter:</b>	$K_Y^2$
TSG 1001 readout name:	KY^2: VERT SWP
Units:	c/aph <sup>2</sup>

This parameter sets the increase (or decrease) in vertical frequency down the frame. ( $K_Y^2$  compares to  $K_X^2$  as  $K_Y$  compares to  $K_X$ .) Again, a good way to see the effect of  $K_Y^2$  is to view the field on a waveform monitor. With  $K_Y$  set to 0.0, a  $K_Y^2$  coefficient of 10 will result in the apparent vertical sine wave changing from DC to 10 c/aph from the top of the picture to the bottom.

To center the “DC point” at mid-screen, set  $K_Y^2$  to  $-2$  times  $K_Y$ .

The Vertical Sweep zone plate selected with the Pulse and Bar button is a “ $K_Y^2$ -only” zone plate (see Fig. 19).



Figure 19: A “ $K_Y^2$ -only” zone plate

Parameter:	$K_{YT}$
TSG 1001 readout name:	KYT: T CH V FREQ
Units:	c/aph/s

The  $K_{YT}$  parameter controls the change in vertical sine frequency over time. Setting  $K_{YT}$  to 1.0, for example, will cause the vertical frequency to increase by one c/aph each second. If  $K_Y$  is initially 0.0, then the frequency will be 10 c/aph after ten seconds, 20 c/aph after twenty seconds, and so forth. The frequency will increase until it reaches the maximum for the active format; the phase of the signal will then “flip” by  $180^\circ$ —the frequency will become “negative”—and the frequency will continue to increase through DC in a repetitive cycle.

**Parameter:**  $K_T$   
 TSG 1001 readout name: KT: TMPRL FREQ  
 Units: cycles per second (c/s)

The  $K_T$  parameter, if used alone, does not create a “pattern.” Rather, the entire screen will cycle (sinusoidally) between white and black. The effect will be similar on either line or field display of a waveform monitor.

Typically, a small  $K_T$  coefficient is set to add apparent motion to a standard circle, sine wave, or sweep pattern. To see the picture effects of this parameter, select any of the standard zone plates and vary  $K_T$ . Note that the  $K_T$  coefficient may be positive or negative; the sign will determine the direction of the pattern’s motion.

**Parameter:**  $K_T^2$   
 TSG 1001 readout name: KT^2: TMPRL SWP  
 Units: cycles per second per second (c/s<sup>2</sup>)

This parameter sets the change in temporal frequency over time. If  $K_T$  is initially 0.0, setting  $K_T^2$  to 1.0 will result in an apparent  $K_T$  of 10.0 after ten seconds, 20.0 after twenty seconds, and so forth. The temporal frequency will increase to maximum, return to 0.0, and repeat the cycle as long as the value of  $K_T^2$  remains greater than zero.

### Combining Zone Plate Parameters

Several mentions are made above regarding the combination of two or more “non-zero” zone plate parameters. Indeed, many useful zone plate patterns involve more than one parameter; the standard TSG 1001 signal set includes three: Diagonal Sine, Circle, and “Thousand Points of Light.”

The standard 45° **Diagonal Sine** pattern—selected with the SHALLOW RAMP button—is generated with equal coefficients for  $K_X$  and  $K_Y$ . In this special case, the diagonal frequency is  $\sqrt{2}$  times the vertical and horizontal frequencies.

The **Circle**—selected with the COLOR BARS button—is probably the best known zone plate pattern (see Fig. 20). Circular patterns have been found useful for their predictable color effects in composite (PAL and NTSC) systems and aliasing effects in digital systems. The stationary pattern is the result of non-zero

coefficients of  $K_X$ ,  $K_{X^2}$ ,  $K_Y$ , and  $K_{Y^2}$ . The apparent motion is created with a small  $K_T$ . Follow these “rules” to create new, centered circular zone plate patterns:

$$K_{X^2} = K_{Y^2}$$

$$K_Y = -\frac{1}{2}K_{Y^2}$$

$$K_X = R_{aspect} \times K_Y$$

where  $R_{aspect}$  is the aspect ratio (width/height) of the active video format..

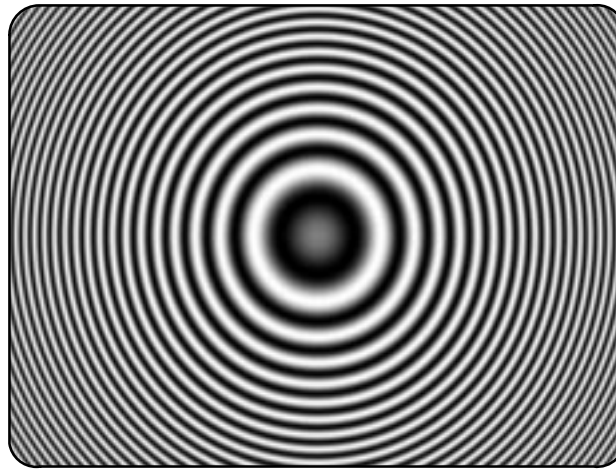


Figure 20: A Circular zone plate

The “**Thousand Points of Light**” pattern—one of the standard User Zone Plates—is an example of the more complex pattern possibilities. It is derived from the same parameters as the Circle zone plate, but the entire range of frequencies is swept several times in both horizontal and vertical axes. This pattern has been found useful in evaluating CODECs for analog-to-digital and digital-to-analog video encoding and decoding.

### Notes on the Standard Zone Plates

(The following notes apply to instruments with kernel software version 2.02 and later. Implementation of the “significant frequencies” was slightly different in earlier software versions.)

- **Circle:** The “Circle frequency” is actually the equivalent of the maximum vertical sinusoid frequency at the very top and bottom of the screen (see the discussion of the  $K_{Y^2}$  parameter earlier in this section). Adjusting the circle frequency has the simple effect of increasing or decreasing the maximum frequency at the outer edges of the pattern. However, this adjustment actually changes the coefficients of four of the ten zone plate parameters in order to keep the pattern round and centered on the screen.

- **Horizontal Sine:** The horizontal frequency reported on the readout is the “real time” frequency of the sine wave that causes the vertical bar pattern. The maximum frequency is half of the clock frequency used by the generator for the active video format (for example,  $72.0 \text{ MHz}/2 = 36.0 \text{ MHz}$ ).
- **Vertical Sine:** The vertical frequency is actually the  $K_Y$  coefficient. The maximum frequency (c/aph) corresponds to the number of active video lines in a field of the current format. For example, when a 525/59.94/1:1 format, which has 484 active lines per field, is output,  $K_Y$  can be any value between  $-484$  and  $484$ .
- **Diagonal Sine:** as mentioned above, the diagonal frequency is  $\sqrt{2}$  times the vertical and horizontal frequencies (c/aph). Adjusting the diagonal sine frequency changes both the  $K_X$  and  $K_Y$  coefficients.
- **Horizontal Sweep:** For “H Sweep” frequencies up to half of the format’s sampling frequency,  $f_s$ , the readout value is the maximum (or “swept to”) frequency of the sine wave. For numbers greater than  $f_s/2$ , dividing the readout value by the sampling frequency will give the number of complete DC–( $f_s/2$ )–DC cycles per line. For example, in a format with sampling frequency of  $72.0 \text{ MHz}$ , a “Horiz Swp Freq” of  $144 \text{ MHz}$  will result in approximately two complete frequency sweeps across the picture.
- **Vertical Sweep:** The Vertical Sweep frequency is actually the  $K_Y^2$  coefficient. For numbers greater than maximum, dividing the readout value by that maximum will give twice the number of complete DC-max-DC sweeps per field (sweeps =  $(K_Y^2/K_Y)/2$ ). For example, in a format with 484 lines per field, a “Vert Swp Freq” of  $968 \text{ c/aph}^2$  would result in one complete frequency sweep “down” the picture.
- **Field Sweep:** The Field Sweep pattern is available through the USER ZONE PLATES button. It is an example of a “ $K_{XY}$ -only” zone plate.

### Saving and Naming Zone Plate Patterns

User zone plate patterns that have actually been defined by the user (as opposed to “factory,” or standard user zone plates) can be named when first saved, and renamed later. The techniques for saving (and naming) and renaming such patterns are similar. **To cancel a save operation anytime, press the SWEEP/PARAMETERS button.**

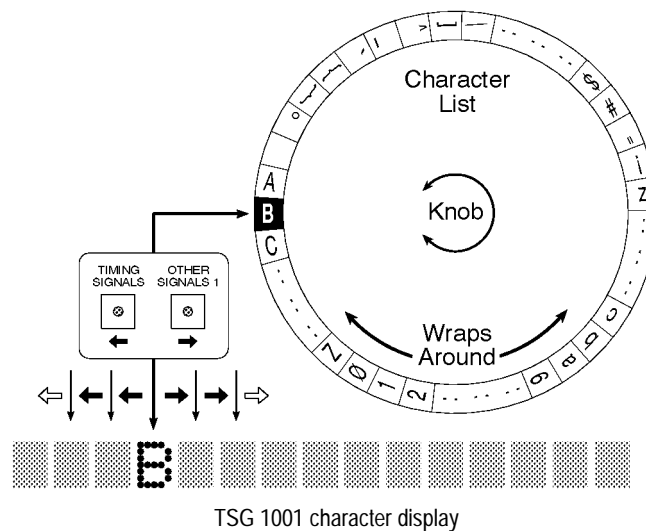
1. Once the generator is outputting the desired pattern, press the Multiburst/Save Zone Plates button. The message “Rotate Knob to Store Location” will appear on the TSG readout briefly, then be replaced with a user zone plate name. If necessary, turn the selector knob until the name of the desired storage location appears. When changing a pattern name, be sure its current name is displayed.

When the TSG 1001 is first put into service, the available storage locations are named “Zone Plate Number #” (where # is an integer from 4 to 10).

Eventually, all of the numbered storage locations may be used and renamed. If so, a previously saved pattern must be identified and overwritten in order to save a newly modified zone plate.

2. Press the Save Zone Plates button again. The message “Enter Zone Plate Name” appears briefly. When the original name returns, the first character position will alternate between the existing character (if any) and completely illuminated. The blinking pixels serve as the character position cursor. The character in the highlighted position may be changed by turning the selector knob. The possible characters, in the order they appear on the list are: A–Z; 0–9; a–z; ! " # \$ % & ' ( ) \* + , - . / [ \ ] ^ \_ ‘ { } °; and [space].

As Fig. 21 is intended to show, the list of characters wraps around at either end. Thus by turning the knob clockwise from the space, one may scroll through the uppercase alphabet, through the numerals 0–9, through the lowercase alphabet, “down” a list of punctuation marks, and back to the space. Continuing to rotate the knob repeats the process; turning the knob counterclockwise reverses it.



**Figure 21: Naming a zone plate pattern**

3. When the desired character occupies the cursor position, press the Timing Signals/← or the Other Signals 1/→ button to move the cursor one position to the left or right. (Pressing the ← button when at the beginning of a line will move the cursor to the end of the other line; pressing the → button when at the end of a line will move the cursor to the beginning of the other line.) Then use the selector knob to place the desired character in this location as well.

---

**NOTE.** *It is a good idea to use lowercase letters or some punctuation when naming new patterns. This will help differentiate locally-created patterns from the standard user zone plates, which are named with all capital letters.*

---

4. Repeat this procedure until all positions of both lines contain the desired character, then press the Multiburst/Save Zone Plates button. The message “Zone Plate stored” will appear on the readout momentarily.
5. To recall a user zone plate later, press the Multipulse/User Zone Plates signal-select button. Rotate the selector knob until the name of the desired pattern appears on the readout. The TSG 1001 will output the selected pattern.

## Serial Remote Control

---

**NOTE.** *RS-232 remote control as described in this section is possible with kernel software version 2.02 and later. Use the Utilities “Software Version” function to discover which version is installed in your TSG 1001.*

---

### Hardware Requirements

If the serial port is through a DB25 connector, use the cable supplied with the TSG 1001 or another straight-through cable as described in Table 8. Do not use a “null modem” cable. If the serial output is through a male DB9 connector (as on many IBM-compatible PCs), use a cable or adapter as described in Table 9.

**Table 8: RS-232 pin/conductor functions; DB25 connectors**

TSG 1001 female DB25	Pin/wire	PC/terminal male DB25
RxD	2	TxD
TxD	3	RxD
CTS	4	RTS
RTS	5	CTS
DTR	6	DSR
DSR	20	DTR
Signal GND	7	Signal GND
DCD	8	DCD

**Table 9: Connections in a 9-pin to 25-pin RS-232 adapter**

DB25 pin	RS-232 function	DB9 female pin
2	TxD	3
3	RxD	2
4	RTS	7
5	CTS	8
6	DSR	6
7	Signal GND	5
8	DCD	1
20	DTR	4

If the device has a non-standard connector, determine which pins perform the functions listed in the center column of Table 9 and connect them through to the appropriate pins of a DB25 connector as listed in the left column.

### Communications parameters

For best results, use these communications parameters for serial remote control of the TSG 1001:

- TTY or VT100 Terminal Emulation.
- Hardware Flow Control (RTS/CTS).
- 8 Data bits, no Parity, 1 Stop bit.
- Local Echo (or “Half Duplex”).

### Text Commands and Command Files

For best results, follow these guidelines when sending text to the TSG 1001:

- Lines may be up to 256 characters if hardware flow control is in effect.
- If hardware flow control is not possible, text should be limited to one command per line.
- End each line, including the last, with a carriage return.
- (Optional) Add a line feed to each carriage return sent.
- (Optional) Strip the line feed from each line received.

### Terminal Options Example

Many existing personal computer communications applications may be used for serial remote control of the TSG 1001. Because each application has slightly different capabilities and features, it is impossible to suggest “universal” settings and parameter choices.



The following Procomm Plus® (MS-DOS version 2.0) Terminal Options may be used as an example; they are known to work for RS-232 control of the TSG 1001 and may be helpful in configuring other communications software as well.

Terminal emulation	VT100 <i>or</i> ASCII
Duplex	HALF
Soft flow ctrl (XON/XOFF)	OFF
Hard flow ctrl (RTS/CTS)	ON
Line wrap	ON
Screen scroll	ON
CR translation	CR/LF
BS [back space] translation	n/a
Break length (ms)	350
Enquiry (ENQ)	n/a
EGA/VGA true underline	OFF (n/a)
Terminal width	80
ANSI 7 or 8 bit commands	8 BIT

Some PC communications packages may not be able to detect the TSG 1001 RTS (request to send) signal. In such cases, hardware flow control will not be possible; however, communication may still be possible at a lower baud rates (2400 baud or slower).

### Using the Remote Control Commands

Serial remote control commands may be used to set a particular TSG 1001 variable, or to prompt (“query”) the TSG 1001 for the current status of that variable. The basic syntax is:

```
:VARIABLE Parameter
or
:VARIABLE?
```

where the first form will set the variable and the second is a query. All commands are listed and explained under *Remote Control Commands* on page 49. When using the commands, remember the following conventions:

- Commands always begin with a colon (:) or an asterisk (\*).
- There is never a space between the variable name (also called a command **header**) and the question mark in a query.
- There is always a space between the header and the command parameter.
- Queries for on/off functions (for example, :BEEP?) will return 1 to indicate that the function is on and 0 to indicate that it is off.

- Commands are not case-sensitive; headers and parameters may be entered in either capitals or lowercase. In this manual, the short form of the header is capitalized; the remainder of the complete form is in lowercase. Parameters are shown in italics. To control the TSG, either the short or the complete form may be used. For example, entering `:EXT?` will have the same effect as entering `:EXTERNAL?`.
- Parameters can be numeric, Up/Down, On/Off, or a character string. String parameters—for example, “*white field*”—are always enclosed in double quotation marks.
- If a variable has a range of adjustment, the limits (minimum and maximum values) may be queried with the forms `:VARIABLE? Min` and `:VARIABLE? Max`. There must be a space between the question mark and the parameter.
- A variable with a range of adjustments may also be set to the minimum or maximum with the forms `:VARIABLE Min` and `:VARIABLE Max`.
- Most variables with numeric values are incremented in discrete steps. Therefore, the variable may not take on the exact value specified with the command parameter. For instance, the horizontal position of the Trigger pulse—set with `:TRIGger:HORizontal`—can only be a sample number that is an integer multiple of 4. Thus, specifying sample 1601, 1602, or 1603 (as in `:TRIG:HOR 1603`) will place the trigger pulse on sample 1600.
- Compound command headers (for example, `:TRIGger:VERTical`) are used to set or query lower-level, or “subordinate,” variables. The level of a command variable corresponds to its position in the compound header, as in

`:VAR_LEVEL1:VAR_LEVEL2:VAR_LEVEL3`

and so on. A convenient consequence of the serial RC command structure is that, once a command level is entered, it is not necessary to repeat higher-level variables to set or query other variables on the same level.

For example, the following sequence of commands is valid for querying various system parameters:

<code>:SYSTem:ERRor?</code>	<code>[:ERRor? is in level 2]</code>
<code>:VERSion?</code>	<code>[:VERSion? is also in level 2]</code>
<code>:VERSion:SRAM?</code>	<code>[:SRAM? is a level 3 variable]</code>
<code>:ZPLAte?</code>	<code>[:ZPLAte is also in level 3]</code>
<code>:SYSTem:ERRor?</code>	<code>[:ERR? is NOT in level 3; must repeat the entire compound header]</code>

- A line can contain several commands separated only by semicolons (`:VARIABLE1 Parameter1::VARIABLE2 Parameter2::...`). However, no line may exceed 256 characters.

## Remote Control Commands

The permissible command headers, their functions, and example parameters are summarized in Tables 10 through 12.

- Table 10 lists the remote control commands for front-panel functions in the order of the buttons emulated.
- Table 11 lists the remote control commands for utility functions.
- Table 12 lists the commands for zone plate functions.

All commands are explained, in alphabetical order, below Table 12.

**Table 10: Commands for front-panel functions**

Command header	Purpose	Parameter example
:BGRP?	List signal select button (or signal category) names, query only.	No Parameters
:SIGNal:BUtTon	Active signal select button, set or query.	"COLOR BARS"
:SGRP?	List signals in active (signal select button) category, query only.	No Parameters
:SIGNal	Test signal, select from current category or query.	"100% COLOR BARS"
:FGRP?	List available formats, query only.	No Parameters
:FORMat (or) :STANdard	Video format, select or query.	"1250/50/2:1 YPBPR"
:SSGRP?	List available signal sets, query only.	No Parameters
:SIGNal:SET	Active signal set, select or query.	"RAM BOARD"
:CH1	Channel 1 (G/Y) on, off, or query.	ON
:CH2	Channel 2 (B/P <sub>B</sub> ) on, off, or query.	OFF
:CH3	Channel 3 (R/P <sub>R</sub> ) on, off, or query.	ON
:TRIGger	Trigger cross hairs on, off, or query.	OFF
:TRIGger:VERTical	Vertical position of trigger pulse, set or query.	131 (line number)
:TRIGger:HORIZontal	Horizontal position of trigger pulse, set or query.	1232 (sample number)
:PEDestal	Active video pedestal, set or query.	UP
:SMENu	Signal menu on, off, or query.	OFF

**Table 11: Commands for utility functions**

Command header	Purpose	Parameter example
:BAUD	RS-232 baud rate, set or query.	4800
:BRGRP?	List possible baud rates, query only.	No parameters
:BEEP	Beeper, set or query.	OFF
:EXternal	External reference mode on, off, or query.	ON
:EXternal:MODE	External clock/frame mode, select or query.	"ENCODED MODE"
:SYSTem:ERRor?	Existing error conditions, query only.	No parameters
:SYSTem:VERSion?	SCPI compliance version, query only.	No parameters
:SYST:VERS:SOFTware?	Kernel ROM version, query only.	No parameters
:SYST:VERS:SRAM?	(Optional) User RAM version, query only.	No parameters
:SYST:VERS:ZPLate?	Zone plate version, query only.	No parameters
*RST	Reset all variables (except baud rate) to default.	No parameters
*IDN?	Identify device, query only.	No parameters

**Table 12: Commands for zone plate functions**

Command header	Purpose	Parameter example
:ZPREset:CIRClE	Select Circle zone plate; set or query freq.	199.96 (c/aph <sup>2</sup> )
:ZPREset:HSINe	Select Horizontal Sine ZP; set or query freq.	.6405 (MHz)
:ZPREset:HSWEep	Select Horizontal Sweep ZP; set or query freq.	.83 (MHz)
:ZPREset:VSINe	Select Vertical Sine ZP; set or query freq.	24.99 (c/aph)
:ZPREset:VSWEep	Select Vertical Sweep ZP; set or query freq.	35 (c/aph <sup>2</sup> )
:ZPREset:DSINe	Select Diagonal Sine ZP; set or query freq.	18.76 (c/aph)
:ZPREset:AMPLitude	Zone plate amplitude, set or query.	"HALF"
:ZPREset:RECall	Recall user zone plate. No query.	4 (storage location)
:ZPREset:SAVe	Save pattern to user ZP location and (optional) name location. No query.	8, "MY PATTERN"
:ZPARAmeter:K	K (phase) parameter, set or query.	MAX
:ZPARAmeter:KX	K <sub>x</sub> parameter, set or query.	98.6
:ZPARAmeter:KX2	K <sub>x2</sub> parameter, set or query.	-45

Table 12: Commands for zone plate functions (Cont.)

Command header	Purpose	Parameter example
:ZPARameter:KXT	$K_{XT}$ parameter, set or query.	.0
:ZPARameter:KXY	$K_{XY}$ parameter, set or query.	MIN
:ZPARameter:KY	$K_Y$ parameter, set or query.	-75
:ZPARameter:KY2	$K_{Y2}$ parameter, set or query.	UP
:ZPARameter:KYT	$K_{YT}$ parameter, set or query.	5207.5
:ZPARameter:KT	$K_T$ parameter, set or query.	DOWN
:ZPARameter:KT2	$K_{T2}$ parameter, set or query.	-0.245
:TRESet	On, off, or query.	ON

**:BAUD**

Parameters: *1200, 2400, 4800, 9600, 19200, 38400, 57600, or 115200;*  
*Min or Max*

The baud rate of the controlling device must also be changed immediately after using this command to continue communication. Remember to use 1200 or 2400 baud if hardware flow control is not possible.

**:BEEP**

Parameters: *On or Off*

:BEEP *On* and :BEEP *Off* will do the obvious. The query (:BEEP?) will return 1 when the beeper is active and 0 (zero) when it is inactive.

**:BGRP?**

Not applicable when Zone Plate signal set is active.

Parameters: None, query only

This query will return the list of signal select button names.

**:BRGRP?**

Parameters: None, query only

This query will return a list of the baud rates available for serial remote control and downloads to RAM.

**:CH1**

Parameters: *On or Off*

Used to turn video channel 1 (G/Y) on and off as with the front panel G/Y button. The query (CH1?) will return 1 when the channel is active and 0 (zero) when it is inactive.

**:CH2**

Parameters: *On or Off*

Used to turn video channel 2 (B/P<sub>B</sub>) on and off as with the front panel B/P<sub>B</sub> button. The query (CH2?) will return 1 when the channel is active and 0 (zero) when it is inactive.

**:CH3**

Parameters: *On or Off*

Used to turn video channel 3 (R/P<sub>R</sub>) on and off as with the front panel R/P<sub>R</sub> button. The query (CH3?) will return 1 when the channel is active and 0 (zero) when it is inactive.

**:EXternal**

Parameters: *On or Off*

Performs the functions of the “Int/Ext Ref Select” utility. *On* will place the TSG 1001 in external clock/frame reference mode; *Off* returns the instrument to internal mode. The query (:EXT?) will return two digits separated by a comma. The first will indicate mode status (1 for External Reference mode, 0 for internal); the second will reflect the requested status. The query, then, would return *0,1* if internal mode is active even though external mode has been requested.

**:EXternal:MODE**

Parameters: *“Mode Name”*

Selects one of the three external reference modes, as with the “Set Ext Ref Mode” utility. The mode name must be entered as one of the following:

- “ext clk mode”
- “encoded mode”
- “2 wire mode”

The query (:EXT:MOD?) returns the name of the current mode, or “*ext ref mode not set.*”

### **:FORMat (also :STANdard)**

Parameters:    “*Format Name*”;  
                  *Up* or *Down*

The correct parameter syntax is the format name as it is designated by the SDP1000 source file and appears on the TSG 1001 display. The entire string is enclosed in quotation marks. A query will return the current format using the same syntax.

The *Up/Down* parameters will select the next format “up” or “down” the list returned by the :FGRP? query.

### **:FGRP?**

Parameters:    None, query only

This command will return a list of the formats available in the currently loaded RAM board signal set.

### **\*IDN?**

Parameters:    None, query only

Used to verify which device is connected to the active serial port.

### **:PEDestal**

Parameters:    #### (mV);  
                  *Up* or *Down*  
                  *Min* or *Max*

A numeric parameter between –695 (Min) and 700 (Max) will set the active video pedestal voltage. If the parameter is not an exact “knob increment,” the pedestal level will be set to the closest increment that is more positive than the requested value. The *Up/Down* parameters increase/decrease the pedestal by one increment. The query (:PED?) will return the current pedestal voltage. (Pedestal increments are approximately 5.5 mV. A query will return the same whole number value as shown on the TSG front-panel readout.)

As with the front panel Pedestal button, selecting any other function will return the pedestal to 0 mV.

**\*RST**

Parameters: None

No parameters, no query. All settings except baud rate will be reset to their defaults. Use carefully.

**:SGRP?**

Parameters: None, query only

This command will return the list of signals associated with the active (currently selected) signal select button.

**:SIGNal**

Not applicable when Zone Plate signal set is active.

Parameters: *“Signal Name”*  
*Up or Down*

The signal name must be one of those that will be listed in response to an :SGRP? query; that is, available through the active signal select button. Entering a signal name will invoke the test signal. Enter the name as it appears on the TSG 1001 display or as returned by the :SGRP? query. Be sure to enclose the name in quotation marks.

Up and Down will scroll through the list of available signals. The query (:SIGN?) will return the name of the current test signal.

**:SIGNal:BUtTon**

Not applicable when Zone Plate signal set is active.

Parameters: *“Button Name”*

Used to activate a signal select button. The button name must be entered as one of the following:

- “color bars”*
- “monitor setup”*
- “linearity”*
- “shallow ramp”*
- “flat field”*
- “pulse and bar”*
- “multipulse”*
- “multiburst”*
- “sweep”*
- “timing signals”*



“other signals 1”  
 “other signals 2”  
 “other signals 3”

The query (:SIGN:BUtTon?) will return the name of the active button followed by that of the current test signal (for example, “LINEARITY”, “RAMP”).

The *Up/Down* parameters will select the next button “up” or “down” the list.

:SIGNal:BUtTon can also be used to select a particular test signal with the syntax:

```
:SIGNal:BUtTon "Button Name", "Signal Name"
```

which would replace the sequence:

```
:SIGNal:BUtTon "Button Name"  

:SIGNal "Signal Name"
```

A comma and space must appear between the button and signal names.

### **:SIGNal:SET**

Parameters:    "*Signal Set Name*";  
                   *Up* or *Down*

Used to perform the functions of the front panel Signal Sets button. In the TSG 1001, with only two possible signal sets, both the *Up* and *Down* parameters will cause the TSG to toggle between the sets. The query (:SIGNal:SET?) will return the name of the active signal set.

### **:SMENU**

Not applicable when Zone Plate signal set is active.

Parameters:    *On* or *Off*

Turns the video monitor signal menu on and off, as with the Signal Menu button. The query (:SMEN?) will return 1 if the signal menu is displayed, 0 if it is not.

### **:SSGRP?**

Parameters:    None, query only

This query will return a list of the available signal sets. In a standard TSG 1001, the signal sets are limited to “RAM Board” and “Zone Plate.”

**:SYSTem:ERRor?**

Parameters: None, query only

This query is used to check for possible error conditions. The serial remote control protocol will return error messages **only** in response to this query. Typically, :SYST:ERR? will be sent immediately after the failure of a command. The query will return a descriptive error message or “No Errors” when none has occurred.

**:SYSTem:VERSion?**

Parameters: None, query only

:SYSTem:VERSion? will return the version of SCPI (communications protocol) compliance used in the TSG 1001.

**:SYSTem:VERSion:SOFTware?**

Parameters: None, query only

:SYSTem:VERSion:SOFTware? will return the version and date of the software installed in the microprocessor kernel of the TSG 1001.

**:SYSTem:VERSion:SRAM?**

Parameters: None, query only

:SYSTem:VERSion:SRAM? will return the version and date of the test signals present in TSG 1001 RAM.

**:SYSTem:VERSion:ZPLAte?**

Parameters: None, query only

:SYSTem:VERSion:ZPLAte? will return the version and date of Zone Plate ROM software.

**:TRESet**

Applicable only when the Zone Plate signal set is active.

Parameters: *On* or *Off*

This command performs the function of the Other Signals 2/Treset button when the TSG 1001 is in zone plate mode. :TRES *On* stops “zone plate time” and resets it to zero; the effects of the time parameters— $K_{XT}$ ,  $K_{YT}$ ,  $K_T$ , and  $K_{T2}$ —on the active pattern are removed, and the apparent motion caused by non-zero time

parameters is suspended. Sending `:TRES Off` will restart the zone plate clock at  $t=0$ ; apparent motion will resume.

### **:TRIGger**

Parameters:     *On or Off*

This command turns the trigger cross hairs on and off. The query (`:TRIG?`) will return 1 when the cross hairs are superimposed on the current test signal and 0 (zero) when they are not. The trigger pulse will be present at the TSG 1001 Trigger Output in either case.

### **:TRIGger:VERTical**

Parameters:     #### (line number);  
                  *Down or Up*;  
                  *Max or Min*

A numeric parameter between 1 and Max will set the vertical location (i.e., the line number) of the Trigger output pulse. The value corresponding to *Max* will depend on the active video format. The query `:TRIG:VERT? Max` will return that value; the command `:TRIG:VERT Max` will move the pulse to the last line in the frame (*Min* will move it to the first). The trigger cross hairs (controlled with the `:TRIG` command) need not be active to move the pulse.

Note that the *Up* parameter will increase the line number of the trigger by one; because the lines are numbered from the top of the frame to the bottom, this will move the trigger location **down** the screen. *Down* will move the pulse down one line number, and **up** the screen. Also note that in interlaced (2:1) formats, the cross hair will move two lines on the screen for each *Down* or *Up* command.

The standard query (`:TRIG:VERT?`) will return the current vertical setting of the trigger pulse.

### **:TRIGger:HORizontal**

Parameters:     #### (sample number);  
                  *Down or Up*;  
                  *Max or Min*

A numeric parameter between zero and Max will set the horizontal location (i.e., the sample number) of the Trigger output pulse. The value corresponding to *Max* will depend on the active video format. The query `:TRIG:HOR? Max` will return that value; the command `:TRIG:HOR Max` will move the pulse to the last sample in the line (*Min* will move it to the first). The trigger cross hairs (controlled with the `:TRIG` command) need not be active to move the pulse.

The standard query (:TRIG:HOR?) will return the current horizontal location of the trigger pulse.

#### **:ZPARameter:K**

Applicable only when the Zone Plate signal set is active.

Parameters:   #.##### (cycles);  
                  *Down or Up*;  
                  *Max or Min*

A numeric value between  $-0.5000$  and  $0.5000$  will set the initial phase of the zone plate pattern ( $\pm 0.5$  corresponds to  $\pm 180^\circ$ ). The query will return the current value.

#### **:ZPARameter:KX**

Applicable only when the Zone Plate signal set is active.

Parameters:   #.##### (c/aph);  
                  *Down or Up*;  
                  *Max or Min*

A numeric parameter will set the value of the  $K_X$  zone plate parameter. Max, Min, and the Up and Down increments will depend on the active video format. The query will return the current value of  $K_X$ .

#### **:ZPARameter:KX2**

Applicable only when the Zone Plate signal set is active.

Parameters:   #.##### (c/aph<sup>2</sup>);  
                  *Down or Up*;  
                  *Max or Min*

A numeric parameter will set the value of the  $K_{X2}$  zone plate parameter. Max, Min, and the Up and Down increments will depend on the active video format. The query will return the current value of  $K_{X2}$ .

#### **:ZPARameter:KXT**

Applicable only when the Zone Plate signal set is active.

Parameters:   #.##### (c/aph/s);  
                  *Down or Up*;  
                  *Max or Min*

A numeric parameter will set the value of the  $K_{XT}$  zone plate parameter. Max, Min, and the Up and Down increments will depend on the active video format. The query will return the current value of  $K_{XT}$ .

**:ZPARAmeter:KXY**

Applicable only when the Zone Plate signal set is active.

Parameters:   #.##### (c/aph<sup>2</sup>);  
                  Down or Up;  
                  Max or Min

A numeric parameter will set the value of the  $K_{XY}$  zone plate parameter. Max, Min, and the Up and Down increments will depend on the active video format. The query will return the current value of  $K_{XY}$ .

**:ZPARAmeter:KY**

Applicable only when the Zone Plate signal set is active.

Parameters:   #.##### (c/aph);  
                  Down or Up;  
                  Max or Min

A numeric parameter will set the value of the  $K_Y$  zone plate parameter. Max, Min, and the Up and Down increments will depend on the active video format. The query will return the current value of  $K_Y$ .

**:ZPARAmeter:KY2**

Applicable only when the Zone Plate signal set is active.

Parameters:   #.##### (c/aph<sup>2</sup>);  
                  Down or Up;  
                  Max or Min

A numeric parameter will set the value of the  $K_{Y2}$  zone plate parameter. Max, Min, and the Up and Down increments will depend on the active video format. The query will return the current value of  $K_{Y2}$ .

**:ZPARAmeter:KYT**

Applicable only when the Zone Plate signal set is active.

Parameters:   #.##### (c/aph/s);  
                  Down or Up;  
                  Max or Min

A numeric parameter will set the value of the  $K_{YT}$  zone plate parameter. Max, Min, and the Up and Down increments will depend on the active video format. The query will return the current value of  $K_{YT}$ .

**:ZPARAmeter:KT**

Applicable only when the Zone Plate signal set is active.

Parameters:    #.##### (c/sec);  
                  Down or Up;  
                  Max or Min

A numeric parameter will set the value of the  $K_T$  zone plate parameter. Max, Min, and the Up and Down increments will depend on the active video format. The query will return the current value of  $K_T$ .

**:ZPARAmeter:KT2**

Applicable only when the Zone Plate signal set is active.

Parameters:    #.##### (c/sec<sup>2</sup>);  
                  Down or Up;  
                  Max or Min

A numeric parameter will set the value of the  $K_{T2}$  zone plate parameter. Max, Min, and the Up and Down increments will depend on the active video format. The query will return the current value of  $K_{T2}$ .

**:ZPREset:AMPLitude**

Applicable only when the Zone Plate signal set is active.

Parameters:    "Full" or "Half"

This command may be used to set the peak-to-peak amplitude of all zone plate patterns. Full amplitude patterns will contain white and black regions, while Half amplitude patterns will vary from light gray to dark gray. The actual peak amplitudes will depend on the active video format.

**:ZPREset:CIRClE**

Applicable only when the Zone Plate signal set is active.

Parameters:    #.##### (c/aph<sup>2</sup>);  
                  Down or Up;  
                  Max or Min

Used without a parameter, this command will activate the standard Circle zone plate pattern. The inclusion of a command parameter will also change all four of the spatial parameters ( $K_X$ ,  $K_Y$ ,  $K_{X2}$ , and  $K_{Y2}$ ) that define the pattern. The command parameter specifies  $K_{Y2}$ ; the remaining three are internally calculated from that value. Max, Min, and the Up/Down increments will depend on the active video format. The query—appropriate only when the Circle pattern is active—will return the current value of  $K_{Y2}$ .

#### **:ZPREset:DSINe**

Applicable only when the Zone Plate signal set is active.

Parameters:    #.##### (c/aph);  
                   Down or Up;  
                   Max or Min

Used without a parameter, this will select the standard Diagonal Sine zone plate pattern. The inclusion of a command parameter will change  $K_X$  and  $K_Y$ , which define the pattern and are calculated internally from the :DSINe frequency parameter ( $K_X = K_Y = f_{DSIN} \div \sqrt{2}$ ). Max, Min, and the Up/Down increments will

depend on the active video format. The query—appropriate only when the Diagonal Sine pattern is active—will return the current diagonal sine frequency.

#### **:ZPREset:HSINe**

Applicable only when the Zone Plate signal set is active.

Parameters:    #.##### (MHz);  
                   Down or Up;  
                   Max or Min

Used without a parameter, this will select the standard Horizontal Sine zone plate pattern. The inclusion of a command parameter will change  $K_X$ , which defines the pattern. Note that the :HSINe parameter is the real-time frequency of the luminance sine wave, in MHz, from which  $K_X$  is internally calculated. Max and the Up/Down increments will depend on the active video format. Min is zero. The query will return the current real-time frequency value of  $K_X$ .

#### **:ZPREset:HSWEp**

Applicable only when the Zone Plate signal set is active.

Parameters:    #.##### (MHz);  
                   Down or Up;  
                   Max or Min

Used without a parameter, this will select the standard Horizontal Sweep zone plate pattern. The inclusion of a command parameter will change  $K_X2$ , which defines the pattern. Note that the `:HSWEep` parameter is the real-time sweep frequency of the luminance sine wave, in MHz, from which  $K_X2$  is internally calculated. Max and the Up/Down increments will depend on the active video format. Min is zero. The query—appropriate only when the Horizontal Sweep pattern is active—will return the current real-time frequency value of  $K_X2$ .

#### **:ZPREset:RECall**

Applicable only when the Zone Plate signal set is active.

Parameters:   # (integer 1–10)

This command is used to recall User Zone Plates. The desired pattern must be specified by storage location, not by name. The command `:ZPRE:REC 1`, therefore, will recall the pre-defined Blank Zone Plate pattern. No query is possible.

#### **:ZPREset:SAVe**

Applicable only when the Zone Plate signal set is active.

Parameters:   #[, "string"]

Used to store user-defined zone plate patterns. The parameter must begin with an integer from 4 through 10 to identify the storage location. The optional character string will become the displayed name of the pattern. The integer and string must be separated by a comma and space. A “pipe” symbol (`|`) may be used in the string (for example, “My Zone Plate | Pattern”) to begin a second line on the TSG display. No query is possible with this command.

#### **:ZPREset:VSINe**

Applicable only when the Zone Plate signal set is active.

Parameters:   #.#### (c/aph);  
                  Down or Up;  
                  Max or Min

Used without a parameter, this will select the standard Vertical Sine zone plate pattern. The inclusion of a command parameter will change  $K_Y$ , which defines the pattern. Max and the Up/Down increments will depend on the active video format. Min is zero. The query—appropriate only when the Vertical Sine pattern is active—will return the current value of  $K_Y$ .



**:ZPREset:VSWEep**

Applicable only when the Zone Plate signal set is active.

Parameters:    #.#### (c/aph<sup>2</sup>);  
                  Down or Up;  
                  Max or Min

Used without a parameter, this will select the standard Vertical Sweep zone plate pattern. The inclusion of a command parameter will change  $K_Y2$ , which defines the pattern. Max and the Up/Down increments will depend on the active video format. Min is zero. The query—appropriate only when the Vertical Sweep pattern is active—will return the current value of  $K_Y2$ .

**GPIB control**

Because most of the commands follow GPIB (General Purpose Interface Bus) standard syntax, it is also possible—with the addition of a GPIB-to-RS-232 converter—to control the TSG 1001 over an IEEE-488 bus.

With a GPIB interface, the TSG 1001 can become part of an integrated video system that may be pre-programmed and controlled from one location. There is much highly developed GPIB control hardware and software. One approach involves the construction, on a PC display, of a “virtual instrument”—a graphical representation of the TSG 1001 front panel—that can be operated with mouse and keyboard commands. (An application that includes the ability to create virtual front panels on MS-DOS machines is LabWindows®, by National Instruments® and available from Tektronix. A similar application for the Apple Macintosh® is LabVIEW®, also by National Instruments.) GPIB standards and methods are well documented; check your technical library for more information—or contact your Tektronix representative.

**Hardware requirements.** GPIB control of the TSG 1001 will require the addition of a GPIB-to-Serial converter. Consult the converter manual for the serial cable specifications. A null modem or null modem cable may be required. If so, and if a null modem is used, be sure it connects the RTS pin of the converter to the CTS pin of the TSG 1001, and vice-versa. Baud rates above 9600 bps may not work in all installations.

**GPIB commands.** The following GPIB-only commands have been defined for the TSG 1001:

- \*CLS (Clear status)
- \*ESR? (Event status register—query only)
- \*STB? (Status byte—query only)

Discussion of these commands is outside the scope of this manual. For more information, see *IEEE 488.2–1987, Codes, Formats, Protocols and Common Commands for Use with IEEE 488.1–1987*, published by the IEEE (Institute of Electrical and Electronic Engineers).

# Appendix A: Specifications

**Table 13: General test signal characteristics**

Characteristic	Performance requirement	Supplemental information
Amplitude:		
accuracy	±1%	measured at 700 mV
channel match	±0.5%	channels 2 and 3 relative to channel 1
Frequency response	±1% to 20 MHz ±2% to 30 MHz	
Group delay distortion	≤3 ns to 20 MHz ≤5 ns to 25 MHz	
Channel-to-channel delay	±1 ns	channels 2 and 3 relative to channel 1
Field tilt	≤0.5%	
Line tilt	≤0.5%	
Sine squared pulses	HADs accurate within ±2 ns	
Pulse-to-bar ratio	1:1 ±1%	using 2T30 pulse and bar
Blanking level	0 V DC ±50 mV	
Spurious signals	<5 mV to 30 MHz <7 mV from 30 MHz to 100 MHz	
Output impedance	75Ω	
Return loss	≥35 dB down to 30 MHz	

**NOTE.** Specific characteristics (amplitudes, timings) of individual test signals are inherent in the SDP1000 definition of each signal. A graphic representation of each test signal waveform and the values of the defining parameters may be seen with the ED1000 waveform editor. Please see the SDP1000 manual for more information.

**Table 14: Tri-level sync outputs**

Characteristic	Performance requirement	Supplemental information
Blanking level	0 V $\pm$ 50 mV	
Spurious signals	<5 mV to 30 MHz <7 mV, 30 MHz to 100 MHz	
Output impedance	75 $\Omega$	

**Table 15: Digital outputs**

Characteristic	Information
Sampling frequency	72.000000, 74.25, or 74.175824 MHz (determined by active video format; see Table 1, on page 2), 1.0 ppm stability typical
Digital coding	10 bit linear PCM
Output format	balanced ECL (10KH series), 10 data pair, 1 clock pair
Connector	25 pin D female

**Table 16: Clock Input requirements**

Characteristic	Performance requirement	Supplemental information
Clock Input (external clock mode)		10KH differential ECL input.
Levels		high level: -1.18V min -0.98V max  low level: -1.72V min -1.52V max
Frequency	72.0, 74.25, and 74.175824 MHz	Measured at the Clock In connector from a reverse terminated source. Typically 8.0 to 78.0 MHz in external clock mode; 69.0–78.0 MHz, encoded mode.
Symmetry		Clock pulses must be $\geq$ 6 ns in both high and low states.
Noise		normal mode: >40 dB common mode: 500 mV p-p

**Table 16: Clock Input requirements (Cont.)**

Characteristic	Performance requirement	Supplemental information
Frame Input (2 wire mode)  Levels		10KH differential ECL input.  high level: -1.18V min -0.98V max  low level: -1.72V min -1.52V max  Measured at the Frame In connector from a reverse-terminated source.

**Table 17: Physical characteristics**

Characteristic	Information
Dimensions:	
Height	3.48 inches (8.84 cm)
Width	19.0 inches (48.26 cm)
Length	22.0 inches (55.88 cm)
Weight	25 lbs (10.4 kg)

**Table 18: Environmental characteristics**

Characteristic	Information
Temperature:	
operating	0° to 50°C           (32° to 122°F)
non-operating	-40° to 65°C       (-40° to 149°F)

**Table 19: Certifications and compliances**

EC Declaration of Conformity – EMC	Meets intent of Directive 89/336/EEC for Electromagnetic Compatibility. Compliance was demonstrated to the following specifications as listed in the Official Journal of the European Union: EN 50081-1 Emissions: EN 55011 Class A Radiated and Conducted Emissions EN 60555-2 AC Power Line Harmonic Emissions EN 50082-1 Immunity: IEC 801-2 Electrostatic Discharge Immunity IEC 801-3 RF Electromagnetic Field Immunity IEC 801-4 Electrical Fast Transient/Burst Immunity
Australia/New Zealand Declaration of Conformity – EMC	Complies with EMC provision of Radiocommunications Act per the following standard(s): AS/NZS 2064.1/2 Industrial, Scientific, and Medical Equipment: 1992
FCC Compliance	Emissions comply with FCC Code of Federal Regulations 47, Part 15, Subpart B, Class A Limits.
EC Declaration of Conformity – Low Voltage	Compliance was demonstrated to the following specification as listed in the Official Journal of the European Communities: Low Voltage Directive 73/23/EEC EN 61010-1:1993 Safety requirements for electrical equipment for measurement, control, and laboratory use
Safety Certification Compliance	
Temperature, Operating	+5 to +40° C
Altitude (maximum operating)	2000 meters
Equipment Type	Test and measuring
Safety Class	Class 1 (as defined in IEC 1010–1, Annex H) – grounded product
Overvoltage Category	Overvoltage Category II (as defined in IEC 1010–1, Annex J)
Pollution Degree	Pollution Degree 2 (as defined in IEC 1010–1). Note: Rated for indoor use only.
Approvals	UL1244 - Second Edition - Standard for Electrical and Electronic Measuring and Testing Equipment. CSA - Electrical Bulletin C22.2 No. 231.
Installation Category Descriptions	Terminals on this product may have different installation category designations. The installation categories are: CAT III Distribution-level mains (usually permanently connected). Equipment at this level is typically in a fixed industrial location CAT II Local-level mains (wall sockets). Equipment at this level includes appliances, portable tools, and similar products. Equipment is usually cord-connected CAT I Secondary (signal level) or battery operated circuits of electronic equipment

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