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PRELIMINARY OPERATOR'S AND
MAINTENANCE MANUAL

Model 1370

12 MHz VXI
Sweep/Function Generator

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SAFETY FIRST



PROTECT YOURSELF. Follow these precautions:

- Don't touch the outputs of the instrument or any exposed test wiring carrying the output signals. This instrument can generate hazardous voltages and currents.
- Don't bypass the VXI chassis' power cord's ground lead with two-wire extension cords or plug adaptors.
- Don't disconnect the green and yellow safety-earth-ground wire that connects the ground lug of the VXI chassis power receptacle to the chassis ground terminal (marked with ⏚ or ⚠).
- Don't hold your eyes extremely close to an rf output for a long time. The normally nonhazardous low-power rf energy generated by the instrument could possibly cause eye injury.
- Don't energize the VXI chassis until directed to by the installation instructions.
- Don't repair the instrument unless you are a qualified electronics technician and know how to work with hazardous voltages.
- Pay attention to the **WARNING** statements. They point out situations that can cause injury or death.
- Pay attention to the CAUTION statements. They point out situations that can cause equipment damage.

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Figure 1-1. Model 1375 12 MHz VXI Sweep/Function Generator

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SECTION 1
GENERAL

1.1 THE MODEL 1370

The MODEL 1370 is a three function (sine, triangle, square) 'C' size VXI Programmable Sweep/Function Generator. It can operate as a continuous, triggered, gated or burst signal source at output amplitudes up to 20 Vpp. Additionally, the Model 1370 can be programmed for dc and 'external width' (two level output determined by external signal and programmable trigger reference level). It has bi-directional frequency sweep capability within the frequency range of .01 Hz and 12 MHz, with either linear or logarithmic sweep characteristic. The output level is specified from 10 mV to 10 Vpp into 50Ω termination, and 20 mV to 20 Vpp into an open circuit with 3.5 digits of resolution. Offset can be programmed to vary the waveform's base line up to ± 10V, or in the dc function, vary the dc output. The function output is protected from external overvoltages up to 100V peak. Activation of the protection circuits sets error status bits monitored by the VXI controller.

Control of the sweep/function generator adheres to the SCPI (Standard Commands for Programmable Instruments) industry standard language for remote instrument programming.

1.2 SPECIFICATIONS

1.2.1 Functions

Programmable sine, triangle, square, square compiement, external width, or dc.

1.2.2 Operating Modes

Continuous:
Output continuous at programmed frequency. Frequency can be modified via the VCG IN.

Triggered:
Output quiescent until triggered by an external signal, a TTLTRG signal, or a VXI bus command, then generates one cycle of the programmed frequency.

Gated:
Similar to triggered mode except output continues for the duration of gate signal. The last cycle started is completed.

Burst:
Programmable number of waveform cycles in a burst. Burst length, initiated by the trigger signal, is programmable between 2 and 2^{30} cycles. Maximum burst rate is 12 MHz.

1.2.3 Frequency Range:
0.01 Hz to 12 MHz.

1.2.4 Outputs

Function Output:
Waveforms from 0.01 to 10 Vpp into 50Ω (0.02 to 20 Vpp into ≥50 kΩ). DC or offset programmable from -5V to +5V into 50Ω (-10V to +10V into ≥50 kΩ). Programmable on or off (Zoff >500 k Ω). Absolute peak amplitude plus offset may not exceed 5V into 50Ω (10V into ≥50 kΩ).

Source Impedance:	50Ω.
Protection:	Output protected to ± 100V peaks.

Sync Output:
TTL level square wave into 50Ω at programmed frequency. In addition, the Sync Output may be programmed to drive any of the eight TTLTRG* lines on the VXI backplane.

TTL Compatible:	≤0.4 to ≥2.4 V into 50Ω, ≤0.8 to ≥4.8 V into ≥50 kΩ.
Source Impedance:	50Ω.
Timing:	Concurrent with function output in square; lags sine and triangle by 90°.
Over/Undershoot:	<10% into 50Ω.
Protection:	Output protected to ± 15 V inputs.

Sweep Output:
Linear 0 V to +10 V (open circuit) ramp signal occurring during a frequency sweep. Instantaneous value of ramp voltage indicates percent time completion of frequency sweep.

Amplitude:	0 V ± 500 mV at start of sweep, increasing to +10 V ± 500 mV at sweep stop.

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Source Impedance: 2 kΩ.

Protection: Output protected to ± 15 V inputs.

1.2.5 Frequency Sweep

The SWEEP OUT BNC is active with a Sweep Mode selected, and inactive at other times.

Sweep Modes:

Continuous Sweep and Reset (CRESet):
Continuously sweeps from programmed start frequency to programmed stop frequency, resets to start frequency and begins a new sweep. Repeats continuously at the specified sweep time.

Continuous Sweep and Reverse (CREVerse):
Continuously sweeps from start frequency to stop frequency and back to start frequency. Repeats continuously at the specified sweep time.

Triggered Sweep and Reset (TRESet):
Programmed start frequency is generated continuously until the Model 1370 receives a trigger, which will initiate one sweep to the programmed stop frequency then a reset to the start frequency.

Triggered Sweep and Reverse (TREVerse):
Programmed start frequency is generated continuously until a trigger signal is received, which will initiate one sweep from the start frequency to the stop frequency. The generator immediately sweeps back to the start frequency and holds for another trigger.

Triggered Sweep and Hold (HRESet):
Programmed start frequency is generated continuously until a trigger signal is received, which will initiate one sweep from the start frequency to the stop frequency. The generator holds at the stop frequency until receipt of a second trigger which ramps it back to the start frequency, where it holds for another trigger cycle.

Triggered Sweep and Hold with Reverse (HREVerse):
Programmed start frequency is generated continuously until a trigger signal is received, which will initiate one sweep from the start frequency to the stop frequency. The generator holds at the stop frequency until receipt of a second trigger which sweeps it back to the start frequency, where it holds for another trigger cycle.

Manual Sweep (MANual):
Output frequency is programmed between start and stop frequencies. With the aid of the SWEEP OUT voltage, used for precisely setting up sweep characteristics.

Direction:
Sweep direction is programmable either up or down in all modes.

Lin/Log:
Frequency sweep characteristic programmable for either linear or logarithmic.

Time:
The duration of one swept transition between start/stop frequencies, programmed from 10 ms to 100s.

Flyback Time:
<1 ms.

Resolution:
A maximum of 4096 points per second (244 µs per point).

Accuracy:
±0.2% for sweep time, ±(2% of setting + 2% of range) for start/stop frequencies (see range definitions in Table 1-1).

Range:
Maximum calibrated range is 100:1 ratio of start/stop frequencies. Wider range accepted on a single range (see Table 1-1) with a device specific error generated. Ratio of start/stop values limited only by lowest practically achievable value; except for upper values ≥10 MHz, then lower value limited to ≥2 MHz. The greater of the start or stop frequencies determines the selected range.

Trigger Source:
May be from the external input, internal trigger source, the TTLTRG* lines, the *TRG command, or the Word Serial Trigger command.

Trigger Width:
Minimum of 0.5 ms for a sweep time ≤1s. For sweep time >1s, minimum width is (.0005*sweep time).

1.2.6 Inputs

VCG In:
± 12V into 10 kΩ, for up to 1200:1 frequency change. ± 10V gives the 1000:1 range maximum; ± 12V gives 20% overrange. The Model 1370 uses nine internally selected frequency ranges (FR), where:

FR = 10^{-2}, 10^{-1}, ... , or 10^{6} Hz, per Table 1-1:

An internal voltage (FRQ) between 1 and 12 volts is used as the multiplier of FR to set the output frequency. If the VCG input is used, it is summed with FRQ and the output frequency is:

Frequency = (FRQ + VCG) * FR Hz

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Table 1-1. Frequency Ranges

Range (FR)	Programmed CW or upper sweep value	1200:1 VCG range	Normal sweep range	Lowest practical value
10^6	1.00 MHz to 12.0 MHz	10.0 kHz to 12 MHz	100 kHz to 10.0 MHz	10.0 kHz
			2.00 MHz to 12.0 MHz	2.00 MHz
10^5	100 kHz to 999 kHz	1.00 kHz to 1.20 MHz	10.0 kHz to 999 kHz	1.00 kHz
10^4	10.0 kHz to 99.9 kHz	100 Hz to 120 kHz	1.00 kHz to 99.9 kHz	100 Hz
10^3	1.00 kHz to 9.99 kHz	10.0 Hz to 12.0 kHz	100 Hz to 9.99 kHz	10.0 Hz
10^2	100 Hz to 999 Hz	1.00 Hz to 1.20 kHz	10.0 Hz to 999 Hz	1.00 Hz
10^1	10.0 Hz to 99.9 Hz	100 mHz to 120 Hz	1.00 Hz to 99.9 Hz	100 mHz
10^0	1.00 Hz to 9.99 Hz	10.0 mHz to 12.0 Hz	100 mHz to 9.99 Hz	10.0 mHz
10^{-1}	100 mHz to 999 mHz	1.00 mHz to 1.20 Hz	10.0 mHz to 999 mHz	1.00 mHz
10^{-2}	10.0 mHz to 99.9 mHz	100 µHz to 120 mHz	1.00 mHz to 99.9 mHz	100 µHz

Where FRQ and VCG are in volts. A sum of 9.99 V gives maximum range, and 12V gives 20% overrange.

Slew Rate: 1.0 V/µs

VCG IN accuracy: ±4%

Trig In:
Fixed TTL compatible trigger level at 1.2 V. Trigger is programmable to either negative or positive slopes. In addition, any one of the eight TTLTRG* lines on the VXI backplane can be selected as the trigger input.

Maximum Rate: 12 MHz (24 MHz for External Width).

Minimum Width: 20 ns (except triggered sweep modes).

Input Protection:
Inputs protected against ±50V.

1.2.7 Precision

Frequency

Resolution: 3-1/2 digits.

Accuracy: ±2%.

Repeatability: ±1% for 24 hours.

Jitter: ≤0.1% ±100 ps.

Amplitude

Resolution: 3-1/2 digits or 2.5 mV when abs[peak amplitude + offset] >0.5V; 3-1/2 digits or 0.25 mV when abs[peak amplitude + offset] ≤0.5V.

Accuracy: ±(2% + 5mV) for 0.1 to 1Vpp (abs[peak amplitude + offset] ≤0.5V); ±(2% + 20 mV) for 1.01 to 10 Vpp, ± 40 mV for all other.

Repeatability (24 Hrs): ±(1% +10 mV).

Flatness: ±0.1 dB to 100 kHz, ±1.5 dB to 12 MHz for output at 5Vp-p. Reference is 1kHz.

Offset

Resolution: 3-1/2 digits or 2.5 mV when abs[peak amplitude + offset] >0.5V; 3 1/2 digits or 0.25 mV when abs[peak amplitude + offset] ≤0.5V.

Accuracy: ±40 mV in dc function.

Repeatability (24 Hrs): ±(1% + 20 mV).

1.2.8 Waveform Quality

Sine Distortion: (5 Vpp) Total Harmonic Distortion (THD) less than 0.5%, 10 mHz to 99.9 kHz.

No harmonics above: -40 dBc, 100 kHz to 999 kHz, -30 dBc, 1MHz to 12 MHz.

Time Symmetry: ±(1% + 8ns).

Square Transition: <15 ns for ≤5Vpp. <17 ns for > 5Vpp.

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Square (Over/Undershoot): <(5% + 20 mV) of peak-to-peak amplitude.

Triangle Linearity: 99% to 100 kHz.

1.3 GENERAL

1.3.1 SCPI Programming

Conforms to SCPI Version 1.0 and IEEE-488.2 standard mandatec commands. Rcot level commands include:

DIAGnostic	**MODE**	**OUTP**ut
SOURce	**STAT**us	**SYST**em
TRIGger		

1.3.2 VXI Interface

Message based, 256 byte input buffer. Supports the following subsets/protocols:

A16 D16 Master, A16 D16 Slave;
VXI bus Instrument Protocol (I);
VXI bus IEEE-488.2 Instrument Protocol (I4);
Event Generator, Response Generator;
DC (Dynamic Configuration) Device.

1.3.3 Environmental

Temperature Range: 25°C ±10°C for specified operation.

Operating: 0°C to 50°C within tolerances twice normal specifications.

Storage: -40°C to +71°C (RH not controlled).

Warm-up Time: 20 minutes for specified operation.

Altitude:

Operating: Sea level to 10,000 ft.

Storage: Sea level to 40,000 ft.

Relative Humidity (non-condensing):

0°C to +10°C: not controlled.

+11°C to +30°C: 95±5% RH max.

+31°C to +40°C: 75±5% RH max.

+41°C to +50°C: 45±5% RH max.

1.3.4 Size

Dimensions: Single slot, 'C' size VXI module. (30 x 260 x 350 mm).

Weight: <1.6 kg (3.5 lb).

1.3.5 Power

Total: < 24 Watts

Voltage	Peak Current	Dynamic Current
+24 Vdc	400 mA	150 mA
+5 Vdc	900 mA	100 mA
-2 Vdc	50 mA	5 mA
-5.2 Vdc	50 mA	5 mA
-24 Vdc	350 mA	100 mA

1.3.6 Reliability

>20,000 hours MTBF at 25°C, ground benign. MIL-HDBK-217 calculation at 50% component stress.

1.3.7 Normal Use

Within a VXI mainframe with cooling air. Maximum airflow requirement for 10°C rise is 0.06 mm (.0025 in) H_2O at 0.8 l/sec (1.7 CFM).

1.3.8 Safety

MIL-T-28800D, UL-1244, and the VXI System Speci-

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SECTION 2
PREPARATION

2.1 RECEIVING INSPECTION

Check the shipment at the time of delivery and inspect each box for damage. Describe any box damage and list any shortages on the delivery invoice.

2.1.1 Unpacking Instructions

1. **Unpack the boxes**. Unpack the boxes in a clean and dry environment. Save all the packing material in case the instrument must be returned for repair.
2. **Inspect the shipment for damage.** Inspect the equipment carefully for any signs of mechanical damage regardless of the condition of the shipping boxes.
3. **If necessary, file a claim.** In the case of mechanical damage, call the snipper immediately and start the claim process.
4. **Call Wavetek.** Call Wavetek's Customer Service representative (619 279-2200) to inform them that the shipment arrived damaged. Please be prepared to provide a detailed damage report.

2.1.2 Returning Equipment

Follow these steps when you return equipment to Wavetek:

1. **Save the packing material.** Always return equipment in its original packing material and boxes. If you use in-adequate material, you'll have to pay to repair any shipping damage as carriers won't pay claims on incorrectly packed equipment.
2. **Call Wavetek Customer Service and ask for a return authorization.** The Wavetek Customer Service representative (619 279-2200) will ask for your name, telephone number, company name, equipment type, model number, serial number, and a description of the problem.
3. **Pack and ship the equipment.**

2.2 PREPARATION FOR STORAGE OR SHIPMENT

2.2.1 Packaging

If at all possible, always use the original shipping container. However, when using packing materials other than the original, use the following guidelines:

1. Wrap the Model 1370 in ESD sensitive packing material.
2. Use a double-walled cardboard shipping container.

Protect all sides, including the top and bottom, with shock absorbing material (minimum of 2 inch thick material) to prevent movement of the Model 1370 within the container. Seal the shipping container with approved sealing tape. Mark "FRAGILE" on all sides, top, and bottom of the shipping container.

2.2.2 Storage

The Model 1370 should be stored in a clean, dry environment. In high humidity environments, protect the Model 1370 from temperature variations that could cause internal condensation. The following environmental conditions apply to both shipping and storage;

Temperature	–40°C to +71°C
Relative Humidity	not controlled, non-condensing
Altitude	<40000 ft (12192 m)
Vibration	< 2g
Shock	< 40g

2.3 PREPARATION FOR USE

Paragraph 2.3 covers the following topics:

Logical Address Selection
Data Transfer Bus Arbitration
Installation

2.3.1 Logical Address Selection

The VXI chassis Resource Manager identifies units in the system by the unit's logical address. The VXI logical address can range from 0 to 255. However,

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addresses 0 and 255 are reserved for special functions. Address 0 identifies the Resource Manager. Address 255 permits the Resource Manager to dynamically address the unit based on the units VXI chassis slot.

To change the Model 1370's logical address, use the eight position DIP switch (figure 2-1) accessible from the side panel. The Model 1370 uses binary values (2^0 to 2^7) to set the address using the active low address switch. This means the OFF position represents a logical 1. Conversely, an ON position represents a logical 0. Switch position number one is the least significant bit of the address. Insert A in figure 2-1 illustrates a switch set to a logical address of 3.

Wavetek ships the Model 1370 with a logical address of 255 for Dynamic Configuration. Refer to insert B in figure 2-1.

2.3.2 Data Transfer Bus Arbitration

The Model 1370 has VMEbus Mastership capability. This means the Sweep/Function Generator, when enabled, sends Responses and Events as signals to itsCommander. The Model 1370 cannot drive the interrupt lines.

The Model 1370 is configured as a level 3 requestor by the factory. The level 3 Bus Request and Bus Grant lines are used (BR3*, BG3IN*, and BG3OUT*). The other Bus Grant lines are daisy-chained by jumpers. The VMEbus specifications describe three priority schemes: Prioritized, Round-robin, and Single level. The Prioritized arbitration assigns the bus according to a fixed priority scheme where each of four bus lines has a priority from highest (BR3*) to lowest (BR0*). Round-robin arbitration assigns the bus on a rotating basis. Single level arbitration only accepts requests on BR3*.

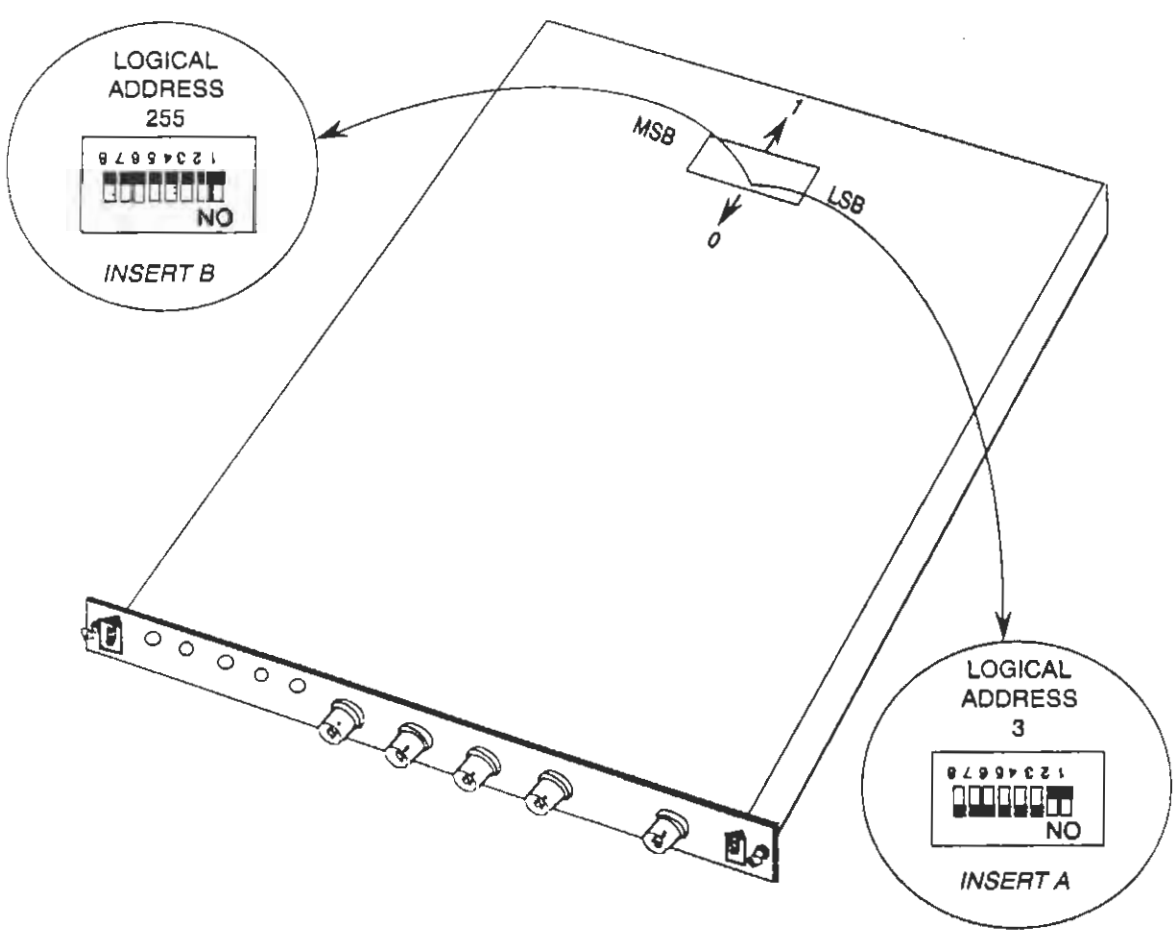


Figure 2-1. Set the Logical Address

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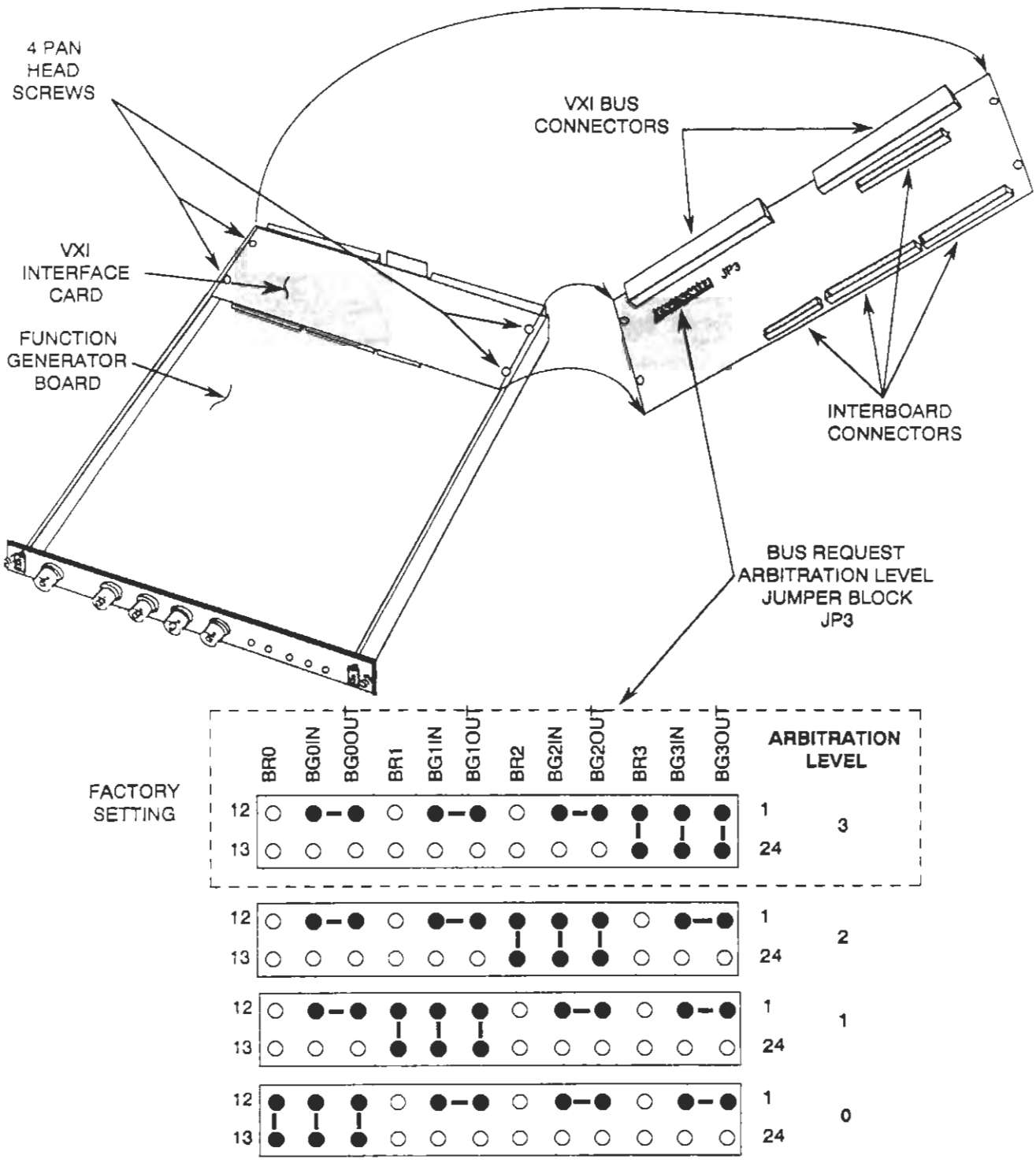


Figure 2-2. Bus Arbitration Level Jumpers

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If a different requestor level is required, the jumpers must be changed. The following instructions and figure 2-2 will aid in reconfiguring the Model 1370 to a new level. Refer to the VMEbus specification for more information on '*data transfer bus arbitration*'.

CAUTION

The Sweep/Function Generator contains CMOS devices which are sensitive to static electricity. When performing the bus arbitration level change, static electricity discharge straps should be worn.

1. Remove the four flat head screws on the Model 1370 left side panel, remove the panel.
2. Remove the four pan head screws holding the VXI Interface card to the main Sweep/Function Generator board.
3. Slowly and gently lift the VXI Interface card up from the Function Generator board. Considerable force may be required as there are four connectors between the two boards with a total of 136 pins. Do not use a metallic prying tool.
4. Change the data transfer bus arbitration jumpers to the desired level. Refer to figure 2-2.
5. Carefully install the VXI Interface card onto the Sweep/Function Generator board. Install the four pan head screws, the side panel and the four flat head screws.

2.4 INSTALLATION

The instrument will be installed in a VXI mainframe in any slot except slot 0 (zero). When inserting the instrument into the mainframe, it should be gently rocked back and forth to seat the connectors into the backplane receptacles. The ejectors will be at right angles to the front panel when the instrument is properly seated into the backplane. The two captive screws above and below the ejectors are used to secure the instrument into the chassis.

2.5 INITIAL CHECKOUT AND OPERATION VERIFICATION

This procedure provides the operator, service technician, receiving inspector, etc. with a quick method of verifying the functional operation of the Model 1370. This procedure does not test the unit's specifications. Connect the equipment as shown in figure 2-3 and perform the following procedure. This procedure assumes the Model 1370 is properly installed in a "C" size VXI chassis with a VXI controller in slot 0.

1 **Power On.** With the Model 1370 installed in the chassis and the scope connected, power on the VXI chassis:

Verify the RUN indicator is lit.

Verify the FAIL indicator is extinguished.

Verify the MODID indicator flashes.

2. **Default Settings.** Send the command:

```
OUTP:STAT ON
```

Verify the scope displays a 1kHz, 5Vpp sine wave.

3. **Frequency.** Change the frequency to 100 Hz by sending the command:

```
FREQ 100
```

Verify the scope displays a 100 Hz, 5Vpp sine wave. Change the frequency to 100 kHz by sending the command:

```
FREQ 1E5
```

MODEL 1370 OSCILLOSCOPE

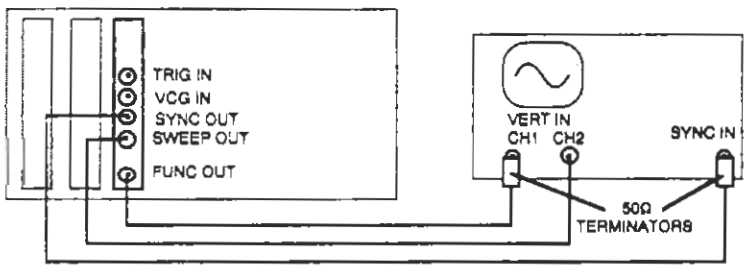


Figure 2-3. Test Setup

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Verify the scope displays a 100 kHz, 5Vpp sine wave.

4. **Sweep.** Change to the sweep mode by sending the command:

   ```
   FREQ:MODE SWE
   ```

   Verify the scope shows an output sine wave starting at 999 Hz and linearly sweeping up to 9.99 kHz in a 100 ms time span. Verify SWEEP OUT by displaying both CH1 and CH2. Change the sweep time to 10 seconds by sending the command:

   ```
   SWE:TIME 10
   ```

   Verify the scope shows an output sine wave starting at 999 Hz and linearly sweeping up to 9.99 kHz in a 10 second time span. Change the stop frequency to 2kHz by sending:

   ```
   FREQ:STOP 2E3
   ```

   Verify the frequency now sweeps from 999 Hz to 2kHz in 10 seconds. Change the start frequency to 200 Hz by sending the command:

   ```
   FREQ:STAR 200
   ```

   Verify the frequency is now sweeping from 200 Hz to 2kHz in 10 seconds. Change the sweep to down by sending:

   ```
   SWE:DIR DOWN
   ```

   Verify the frequency is sweeping from 2kHz to 200 Hz in 10 seconds. Change the sweep time to 1.0 seconds by sending the command:

   ```
   SWE:TIME 1
   ```

   Verify the frequency is sweeping from 2kHz to 200 Hz in 1 second. Change the spacing from linear to logarithmic by sending:

   ```
   SWE:SPAC LOG
   ```

   Verify an obvious change in sweep characteristics when switching to logarithmic sweep. Change the mode back to cw by sending the command:

   ```
   FREQ:MODE CW
   ```

   Verify the output signal returns to 100 kHz. Select CH1 scope display only.

5. **Function.** Change to the square waveform by sending the command:

   ```
   FUNC SQU
   ```

   Verify the scope displays a 100 kHz, 5Vpp square wave. Change to an inverted square waveform by sending the command:

   ```
   FUNC NSQ
   ```

   Verify the scope displays a 100 kHz, 5Vpp inverted square wave. Change to the triangle waveform by sending:

   ```
   FUNC TRI
   ```

   Verify the scope displays a 100 kHz, 5Vpp triangle wave.

6. **Amplitude.** Change the amplitude to 2.5 Vpp by sending the command:

   ```
   VOLT 2.5
   ```

   Verify the scope displays a 100 kHz, 2.5 Vpp triangle wave.

7. **Offset.** Offset the waveform -1.25 Vdc by sending the command:

   ```
   VOLT:OFFS -1.25
   ```

   Verify the scope displays a 100 kHz, 2.5 Vpp triangle offset by -1.25 Vdc.

8. **Trigger.** Select the trigger mode by sending:

   ```
   MODE TRIG
   ```

   Select the TRIG IN connector as the trigger source by sending the command:

   ```
   TRIG:SOUR EXT
   ```

   Connect a 1 kHz, TTL trigger source to the Model 1370 TRIG IN connector. The Model 1370's default trigger setting is positive slope, +1.2 V level. Verify the scope displays a single cycle of a 100 kHz, 2.5 Vpp triangle wave offset by -1.25 Vdc which repeats at 1 ms intervals.

9. **Gate.** Select the gated mode by sending the command:

   ```
   MODE GAT
   ```

   Verify the scope displays about 50 cycles of 100 kHz, 2.5 Vpp triangle waves offset by -1.25 Vdc which repeats at 1ms intervals.

10. **Burst.** Select the burst mode by sending the command:

    ```
    MODE BURS
    ```

    Change the burst count to 30 by sending the command:

    ```
    BURS 30
    ```

    Verify the scope displays 30 cycles of 100 kHz, 2.5 Vpp triangle waves offset by -1.25 Vdc which repeats at 1ms intervals.

This completes the Model 1370's initial checkout and operation verification procedure.

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SECTION 3
OPERATION

3.1 INTRODUCTION

This section provides the Operator/Programmer with the information needed to operate the Model 1370 Sweep/Function Generator in a VXI system. The unit resides in a VXI chassis and is subject to all of the restrictions and benefits of that environment.

Paragraph 3.2 describes the Model 1370 connectors and LED indicators. Paragraph 3.3 defines the Model 1370 programming messages. Paragraph 3.4 demonstrates how to operate the Model 1370 using the defined messages.

3.2 CONNECTORS AND LED INDICATORS

This paragraph describes the Model 1370 front panel connectors and LED indicators. Figure 3-1 illustrates the front panel; bold numbers identify the indicators and connectors. Table 3-1 describes the function of each item shown in figure 3-1.

3.3 MODEL 1370 PROGRAMMING

The Model 1370 communicates within the SCPI (Standard Commands for Programmable Instruments) and IEEE 488.2 standards. Therefore, the Model 1370 must respond to two types of commands: SCPI commands and IEEE 488.2 Common Commands. The IEEE 488.2 Common Commands support functions that are common to all instruments, such as reset, self test and status reporting. Common Commands are non-heirarchical (can be included within SCPI commands without disturbing their heirarchical relationships) and are easily identified by their leading asterisk (*). SCPI commands support functions that are specific to the instrument. This paragraph provides the following information:

SCPI Command Table - Paragraph 3.3.1.
Command Message Format- Paragraph 3.3.2.
Model 1370 SCPI Commands - Paragraph 3.3.3.
Self Test Query Response - Paragraph 3.3.4.
System Trigger-Paragraph 3.3.5.
IEEE 488.2 Common Commands - Paragraph 3.3.6.

3.3.1 SCPI Command Table

Table 3-2 lists the SCPI commands used in the Model 1370 and indicates their hierarchical relationships. The IEEE 488.2 Common Commands are listed in a separate table (Table 3-6). The SCPI Command Table is organized as follows:

Keyword	Parameter Form	Notes
[SOURce]		
:FREQuency		
[:CW]	<numeric_value>	
:MODE	<list>	
STARt	<numeric_value>	
STOP	<numeric_value>	

The indentations of *keywords* indicates their hierarchical relationships according to a tree system. The left-most edge is called the *root node*. Keywords closer to the root node are higher in hierarchy; lower nodes are to the right of their parent node. To program or query a settable parameter, the full path must be defined to reach the keyword appended with the required parameter form. A SCPI programming string typically starts at the root node and proceeds to the right through branch nodes to the *leaf node*. This string of keywords separated by colons and completely defining a single path is defined as a Program Header, and is commonly referred to as a "command" (see paragraph 3.3.2) or as a "query" (see paragraph 3.3.2.6). A Program Header followed by Program Data is defined as a Program Message Unit (paragraph 3.3.2.1).

In the example above the left-most keyword, [SOURce], is directly off the root node. Nodes in this position are called *Subsystems*, and all keywords indented under [SOURce] are part of the Source Subsystem. FREQuency is one of the main parameters under the Source Subsystem. The third level keywords under FREQuency set or query the

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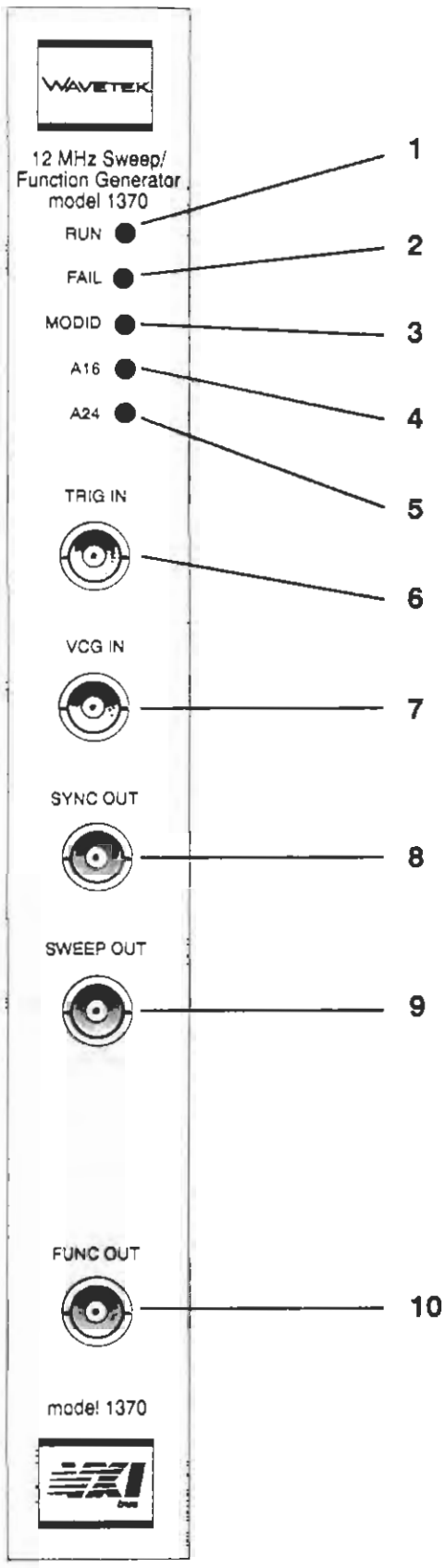


Figure 3-1. Model 1370 Front Panel

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Table 3-1. Model 1370 Front Panel

Item	Item Name	Function
1	RUN LED Indicator	When lit, indicates the VXIbus Interface Module microprocessor is running.
2	FAIL LED Indicator	When lit, indicates the VXIbus Interface Module registers are not initialized.
3	MODID LED Indicator	This indicator turns on momentarily indicating the Resource Manager has detected the presence of the function generator.
4	A16 LED Indicator	When lit, indicates that devices on the VXIbus are accessing the generator's A16 registers.
5	A24 LED Indicator	This indicator is not functional in the Model 1370 Sweep/Function Generator.
6	TRIG IN Connector	This connector receives the external trigger signal for the Model 1370's triggered, gated, and burst modes. See paragraphs 3.4.7.2, 3.4.8, 3.4.9, 3.4.10.
7	VCG IN Connector	This connector receives the external frequency control voltage. See paragraph 3.4.6.
8	SYNC OUT Connector	This connector supplies a synchronizing signal coincident with the FUNC OUT signal. The SYNC OUT signal lags the sine and triangle waveforms by 90°, and is in phase with the square waveform. Output level is TTL (=0 to >2.4V) into 50Ω.
9	SWEEP OUT Conn.	This connector supplies signal during frequency sweeps which is proportional to the instantaneous time position within the sweep. As such, it shows linear percent sweep completion whether the sweep selection is linear or log. Output level varies from 0 V at the start of the sweep to +10 V corresponding to stop of the sweep. Source impedance is 2 kΩ.
10	FUNC OUT Connector	This connector supplies the generator's waveform output. Output level is 10 mVpp to 10 Vpp into 50Ω

various frequency related parameters. The brackets around the SOURce and CW keywords indicate that they are *implied nodes*, and they may be included in or omitted from the message at the programmer's option. When included, do not use the brackets in the command. Referring to Table 3-2, `[SOURce]` is the only Model 1370 Subsystem which is in brackets. This is the default Subsystem, and is assumed unless another Subsystem is specified at the start of a command.

The root node itself is an implied node and is not directly programmed. A colon at the start of a command resets the SCPI parser (included in instrument firmware) to the root node. The leading colon is usually unnecessary (see paragraph 3.3.2.3).

3.3.1.1 Long and Short Form Keywords

The Model 1370 recognizes specific keywords that must be in the accepted long or short format. No other form of the keyword is accepted. For example, to send 'frequency' as part of a message, the short form keyword, shown in the table as upper case letters '`FREQ`', or the long form of the same keyword containing both upper and lower case characters '`FREQuency`' may be sent. Equal weight is given to upper and lower case characters when sending messages to the Model 1370.

3.3.1.2 SCPI Command Tree

Figure 3-2 shows an alternative method of illustrating the Model 1370 SCPI commands. This is an

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inverted tree with the root node along the top of the diagram and the various branches along the bottom.

3.3.2 Command Message Format

The following paragraphs provide the programmer/operator with an introduction to the general rules that must be followed when sending messages to the Model 1370. For an understanding beyond what is covered in this paragraph, refer to the appropriate SCPI and IEEE 488.2 documents.

Operating the Model 1370 is easy, provided the programmer/operator pays strict attention to the message format, as shown in this manual. Each character, including spaces, must be properly placed or the Model 1370 will record any unrecognized parts of the command string as an error.

Table 3-2 and Figure 3-2 show the Model 1370 message structure and message relationships. Refer to one of these while working within this paragraph.

Note

The Model 1370 records programming errors in its memory. The programmer/operator must use the 'SYSTEM:ERROR?' query to review these errors.

3.3.2.1 Program Message Unit

The Program Header (command or query) has been previously defined as a complete single path to a leaf node. It consists of one or more keywords separated by colons. It may also have a leading colon used to explicitly select the root node as the starting point. A Program Message Unit, <pmu>, consists of a Program Header followed (optionally) by Program Data.

3.3.2.2 Program Message

The Program Message (message) consists of one or more <pmu>'s deliminated by semicolons and followed by a Program Message Terminator, <pmt>.

3.3.2.3 Program Message Delimiters

To piece together the Program Message, the Model 1370 expects commands and parameters in the correct order (per Table 3-2), separated by defined delimiters: colons (:), semicolons (;), and spaces ( ).

Use the colon to separate keywords (nodes) within a Program Message Unit, for example,

```
VOLT:LEV:IMM:AMPL 5
```

Do not insert spaces between keywords and colons. Placing the optional colon at the beginning of a Program Message Unit ensures the parser starts from the "root" or top level. For example, a complete message with the leading colon is as follows:

```
:MODE CONT
```

The leading colon at the beginning of any new message is optional because the Program Message Terminator (<pmt>) at the end of the previous message sets the parser to the "root" level. The leading colon is not shown for most messages in this section.

The semicolon is used as a Program Message Unit Separator (<pms>). It permits the message units to be linked together in a single message. The colon may follow the semicolon to start the next message unit at the "root". For example,

```
SOUR:FREQ:CW 1E4;:MODE CONT
```

Without the colon following the semicolon, the message must start within the same subsystem as the previous message. For example:

```
SOUR:BURS 250;FREQ:CW 1E4
```

A space separates the Program Header from its data, as shown in the previous example.

3.3.2.4 Parameter Forms

For the Model 1370, parameters may be in the form of a decimal numeric value (numeric_data), alpha characters (character_data), or Boolean data. Examples of all three are:

```
FREQ 1000 (numeric_data)
MODE TRIG (character_data)
OUTP ON (Boolean_data)
```

Notice that in all cases, a space separates the header from data.

Numeric data values for most parameters may be in the form of an integer, a fixed or floating point value, or a special keyword as shown in the following examples:

integer;

```
FREQ 1000
```

fixed point;

```
FREQ 10.1
```

floating point;

```
FREQ 10E3
```

special form character;

```
FREQ MIN
```

When any of the three special form decimal <numeric_value> keywords, 'MINimum', 'MAXimum', or 'DEFault', are sent, the parameter being addressed is set to a predetermined

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<numeric_value>. The 'MAXimum' and 'MINimum' <numeric_values> are the upper and lower limit values of the parameter. The 'DEFault' <numeric_value> is within the limits of the parameter selected. Defaults values are listed in paragraph 3.4.3.

The Model 1370 uses several character data keywords. These are shown in figure 3-2 and in table 3-2.

Boolean data expresses an enabled ('on' or '1') or disabled ('off' or '0') state.

3.3.2.5 Program Message Terminators

The Model 1370 accepts any valid Program Message Terminator (<pmt>). Acceptable Program Message Terminators are New Line (NL), END, or NL with END (IEEE 488.2 - sect 7).

3.3.2.6 Queries

Unless otherwise indicated, each header with a parameter form also has a query form so that the current setting may be reported back. A query is programmed by following the leaf node keyword with a question mark (?), no space. For example, send:

```
SOUR:FREQ:CW?
```

or the reduced form:

```
FREQ?
```

to query the present frequency setting. The response for this query is a floating point numerical value representing the frequency in Hertz. For example, if the response is 1 kHz, the returned value is:

```
1.000000E+03
```

For queries that include parameters, the question mark and a space are inserted prior to the parameter; for example:

```
FREQ? MAX
```

Some commands may exist in query form only, for example:

```
SYSTEM:ERROR?
```

Some queries are mandated such as *ESE?, *SRE?, and *TST?; see paragraph 3.3.6.

3.3.3 Model 1370 SCPI Commands

This paragraph introduces the operator to the Model 1370 Program Message Units. Paragraph 3.4 covers the relationship between these units. For a description of message format, refer to paragraph 3.3.2. This paragraph uses only the short form keyword recognized by the Model 1370 (refer to Table 3-2). Program Message Terminators are assumed, and therefore not shown in the examples. However, most optional keywords are shown to document the program flow.

3.3.3.1 Frequency Messages

The Model 1370 accepts frequency messages while in either Continuous Wave (CW) or Sweep frequency mode. When in CW mode, a single operating frequency may be programmed. When in sweep mode, start and stop frequency messages may be sent. Sweep messages are described in paragraph 3.3.2.5. To change from one frequency mode to the other, send the command:

```
SOUR:FREQ:MODE <CW or SWEEP>
```

or the reduced form:

```
FREQ:MODE <CW or SWEEP>
```

To determine the current frequency mode, send the query:

```
SOUR:FREQ:MODE?
```

or the reduced form:

```
FREQ:MODE?
```

The response will be either 'CW' or 'SWE'.

To program the Model 1370 CW frequency in Hertz, send the command:

```
SOUR:FREQ:CW <numeric_value>
```

or the reduced form:

```
FREQ <numeric_value>
```

Numeric values are explained in paragraph 3.3.2.4. For CW frequency messages, numeric values may be in the form of an integer, a fixed or floating point value, or one of the special form character parameters, 'MAXimum', 'MINimum', or 'DEFault'.

Frequency resolution is 3-1/2 digits within the selected frequency range. Frequency capability of the instrument is 10 mHz to 12 MHz.

To determine the current CW frequency, send the query:

```
SOUR:FREQ:CW?
```

or the reduced form:

```
FREQ?
```

The response will be a floating point numeric value.

To determine the maximum, minimum or default CW frequency values, send the query:

```
SOUR:FREQ:CW? <special_form>
```

or the reduced form:

```
FREQ? <special_form>
```


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The special form keyword may be 'MAXimum', 'MINimum', or 'DEFault'. The response will be a floating point numeric value.

3.3.3.2 Function Messages

Function messages determine the generator's waveform. To select a function, send the command:

```
SOUR:FUNC:SHAP <keyword>
```

or the reduced form:

```
FUNC <keyword>
```

Function keywords are:

Sine wave:	SINe
Triangle:	TRIangle
Square wave:	SQUare
Square complement:	NSQuare
Dc function:	DC
External width function:	EXTWidth

To determine the current function selection, send the query:

```
SOUR:FUNC:SHAP?
```

or the reduced form:

```
FUNC?
```

The response will be the short form keyword representing the current setting.

3.3.3.3 Voltage (Amplitude) Messages

To program the generator's output voltage in Vpp, send the command:

```
SOUR:VOLT:LEV:IMM:AMPL
<numeric_value>
```

or the reduced form:

```
VOLT <numeric_value>
```

Numeric values are explained in paragraph 3.3.2.4. For voltage messages, numeric values may be in the form of an integer, a fixed or floating point value, or one of the special case character keywords, 'MAXimum', 'MINimum', or 'DEFault'.

Voltage resolution is 3-1/2 digits or 2.5 mV minimum. Amplitude range is 10 mVpp to 10 Vpp specified into a 50Ω load.

Amplitude and offset resolution is dependent upon the sum of the peak amplitude and offset voltage. When the peak amplitude plus the absolute offset voltage is greater than 0.5V, amplitude and offset resolution is limited to 2.5 mV. The amplitude and offset resolution is 0.5 mV when the peak amplitude plus absolute offset is less than 0.5V.

To determine the current amplitude, send the query:

```
SOUR:VOLT:LEV:IMM:AMPL?
```

or the reduced form:

```
VOLT?
```

The response will be a floating point numeric value.

To determine the maximum, minimum or default amplitude values, send the query:

```
SOUR:VOLT:LEV:IMM:AMPL? <special
keyword>
```

or the reduced form:

```
VOLT? <special keyword>
```

The special keyword may be 'MAXimum', 'MINimum', or 'DEFault'. The response will be a floating point numeric value.

3.3.3.4 Voltage (Offset) Messages

To program the generator's output offset in volts, send the command:

```
SOUR:VOLT:LEV:IMM:OFFS
<numeric_value>
```

or the reduced form:

```
VOLT:OFFS <numeric_value>
```

Numeric values are explained in paragraph 3.3.1.4. For offset messages, numeric values may be in the form of an integer, a fixed or floating point value, or one of the special case character keywords, 'MAXimum', 'MINimum', or 'DEFault'.

Offset resolution is 3 1/2 digits or 2.5 mV minimum. Offset range is -5V to +5V specified into a 50Ω load.

Amplitude and offset resolution depend on the sum of the peak amplitude and offset voltage. When this sum is greater than 0.5V, amplitude and offset resolution is limited to 2.5 mV. The resolution is 0.5 mV when the peak amplitude plus absolute offset is less than 0.5V.

To determine the current offset, send the query:

```
SOUR:VOLT:LEV:IMM:OFFS?
```

or the reduced form:

```
VOLT:OFFS?
```

The response will be a floating point numeric value.

To determine the maximum, minimum or default offset values for the Model 1370, send the query:

```
SOUR:VOLT:LEV:IMM:OFFS?
<special keyword>
```

or the reduced form:

```
VOLT:OFFS? <special keyword>
```

The special keyword may be 'MAXimum', 'MINimum', or 'DEFault'. The response will be a floating point numeric value.

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3.3.3.5 Frequency Sweep Messages

Frequency sweep commands are included under both the :FREQuency and the :SWEep subsystems (see Table 3-2). The :FREQuency subsystem enables or disables the sweep mode and sets the start/stop frequencies. The :SWEep subsystem sets the sweep mode, direction, spacing, and time. Sweep may be enabled in either continuous or triggered generator modes (see the MODE subsystem at the root level of Table 3-2). Burst and gated modes are disabled when using the sweep. Frequency sweep has seven sweep modes to choose from. The sweep frequencies range from .01 Hz to 12 MHz, with the start default at 999 Hz and the stop default at 99.9 kHz. The maximum calibrated frequency sweep ratio is 100:1, however ratios greater than 100:1 may be entered, generating a device specific error. If the high frequency setting is 10 MHz or greater, the low frequency minimum is 2 MHz. See Table 1-1 for frequency ranges and start/stop frequency limitations.

To change from one frequency mode to the other, send the command:

```
SOUR:FREQ:MODE <CW or SWEEP>
```

or the reduced form:

```
FREQ:MODE <CW or SWEEP>
```

To determine the currently programmed frequency mode, send the query:

```
SOUR:FREQ:MODE?
```

or the reduced form:

```
FREQ:MODE?
```

The response will be either 'CW' or 'SWE'.

Once sweep is enabled, to select one of the seven sweep modes, send the command:

```
SOUR:SWE:MODE <keyword>
```

or the reduced form:

```
SWE:MODE <keyword>
```

The keyword here is the list of sweep modes, as follows:

```
<AUTO | CRESet | TRESet |
HRESet | CREVerse | TREVerse |
HREVerse | MANual>
```

The default sweep mode, AUTO, is the continuous sweep with reset (CRESet) mode. For a complete description of each sweep mode, refer to the specifications in Section 1 of this manual.

To program the start and stop sweep frequencies, send the command:

```
SOUR:FREQ:<keyword>
<numeric_value>
```

or the reduced form:

```
FREQ:<keyword> <numeric_value>
```

In this case, the keyword is either 'STARt' or 'STOP'.

Numeric values are explained in paragraph 3.3.2.4. Start and stop frequency values may be in the form of an integer, a fixed or floating point value, or one of the special case character keywords, 'MAXimum', 'MINimum', or 'DEFault'.

To determine the current start or stop frequency, send the query:

```
SOUR:FREQ:<keyword>?
```

The keyword is either 'STARt' or 'STOP'. The response will be a floating point numeric value.

To determine the start or stop maximum, minimum or default values, send the query:

```
SOUR:FREQ:<keyword>? <special
keyword>
```

or the reduced form:

```
FREQ:<keyword>? <special keyword>
```

The keyword is either 'STARt' or 'STOP', and the special keyword is 'MAXimum', 'MINimum' or 'DEFault'. The response will be a floating point numeric value.

To direct the instrument to sweep up or down, enter:

```
SOUR:SWE:DIR <keyword>
```

or the reduced form:

```
SWE:DIR <keyword>
```

Here, the keyword is either 'UP' or 'DOWN'. To determine the sweep direction, send:

```
SOUR:SWE:DIR?
```

The response will be either 'UP' or 'DOWN'. Two sweep spacings are available, linear and logarithmic. To change from one sweep spacing to the other, send:

```
SOUR:SWE:SPAC <keyword>
```

or the reduced form:

```
SWE:SPAC <keyword>
```

The keyword here is either 'LINear' or 'LOGarithmic'. To determine the sweep space setting, enter the query:

```
SOUR:SWE:SPAC?
```

or the reduced form:

```
SWE:SPAC?
```


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The response will be either 'LIN' or 'LOG'.

To program the sweep time, send:

```
SOUR:SWE:TIME <numeric_value>
```

or the reduced form:

```
SWE:TIME <numeric_value>
```

Numeric values are explained in paragraph 3.3.2.4. Sweep time values may be in the form of an integer, a fixed or floating point value, or one of the special form numeric paramenters , 'MAXimum', 'MINimum', or 'DEFault'.

The sweep time has a range of from .01 seconds to 100 seconds, with a default of 100 ms.

To determine the current sweep time, enter the query:

```
SOUR:SWE:TIME?
```

or the reduced form:

```
SWE:TIME?
```

The response will be a floating point numeric value. To determine the sweep time maximum, minimum or default values, send the query:

```
SOUR:SWE:TIME? <special keyword>
```

or the reduced form:

```
SWE:TIME? <special keyword>
```

The special keyword may be 'MAXimum', 'MINimum', or 'DEFault'. The response will be a floating point numeric value.

3.3.3.6 Burst Count Value

To program the number of waveform cycles the Model 1370 will generate in the burst mode, send the command:

```
SOUR:BURS <numeric_value>
```

or the reduced form:

```
SOUR:BURS <numeric_value>
```

Numeric values are explained in paragraph 3.3.2.4. Burst values may be in the form of an integer or floating point value, or one of the special case character keywords, 'MAXimum', 'MINimum', or 'DEFault'.

The burst range is 2 to 2^{32} (or >1,000,000,000). Burst duration depends on the programmed frequency.

To determine the current burst count, send the query:

```
SOUR:BURS?
```

or the reduced form:

```
BURS?
```

The response will be an integer. To determine the maximum, minimum or default offset values for the Model 1370, send the query:

```
SOUR:BURS? <special keyword>
```

or the reduced form:

```
BURS? <special keyword>
```

The special keyword may be 'MAXimum', 'MINimum', or 'DEFault'. The response will be a floating point numeric value.

3.3.3.7 Mode Messages

Sending the command:

```
MODE <character_data>
```

selects the unit's operating mode. The mode command and mode parameter keywords must be separated by a space. There are no optional keywords in the mode subsystem.

To select continuous mode, send the command:

```
MODE CONT
```

In this mode, the Model 1370 produces a continuous output of the function selected at the frequency programmed.

To select the triggered mode, send:

```
MODE TRIG
```

When triggered, the generator starts from its quiescent state, produces one cycle, and returns to its quiescent state. The generator is triggered from the VXI TTL trigger bus, an external source, or the trigger command, *TRG.

To select the gated mode, send the command:

```
MODE GAT
```

When in the gated mode, the generator produces waveforms as long as the selected trigger source is active. The Model 1370 always completes the last waveform cycle after the trigger source becomes inactive before returning to the quiescent state.

To select the burst mode, send the command:

```
MODE BURS
```

When the unit receives a trigger, the generator produces a burst of waveform cycles equal in number to the burst count value (paragraph 3.3.2.6).

To determine the selected mode, send the query:

```
MODE?
```

The response will be the short form keyword for the current selection.

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3.3.3.8 Output State Command

Because the output state is Boolean in nature, the condition of the FUNC OUT connector is expressed by 'on' or '1' when enabled, 'off' or '0' when disabled. When sending any of the following messages, the 'STAT' keyword is optional.

To disconnect the signal from the FUNC OUT connector, send:

```
OUTP:STAT OFF
```

or

```
OUTP:STAT 0
```

To internally connect the signal to the FUNC OUT connector, send:

```
OUTP:STAT ON
```

or

```
OUTP:STAT 1
```

To find the output on/off state, send the query:

```
OUTP:STAT?
```

The response from the Model 1370 will be the Boolean numerical value '0' or '1'.

3.3.3.9 TTL Trigger Sync Output Messages

This command connects the Model 1370 sync output to one of the eight VXI backplane TTL trigger lines. These trigger lines can be used as a trigger source by other units in the system. Selecting and enabling the sync output to be placed on a trigger line is performed by two separate commands. To select one of the trigger lines, send the first command:

```
OUTP:TTLT<n>:SOUR SYNC
```

where <n> indicates the trigger line number. Valid numbers are 0 through 7. If a line number is not used, the Model 1370 defaults to line 0. Do not insert a space between the keyword 'TTLT' and <n>.

The second command, the trigger line state message, turns on or off the sync signal to the trigger bus. The on/off parameters are Boolean and may be represented by '1' or '0' (see paragraph 3.3.1.4). To turn on the trigger, send the command:

```
OUTP:TTLT<n>:STAT ON
```

or

```
OUTP:TTLT<n>:STAT 1
```

where <n> indicates the trigger line number. Do not insert a space between the keyword 'TTLT' and <n>. The command defaults to line 0 if a line number is not used. To turn off the trigger output, send the command:

```
OUTP:TTLT<n>:STAT OFF
```

or

```
OUTP:TTLT<n>:STAT 0
```

or the reduced form:

```
OUTP:TTLT<n> OFF
```

or

```
OUTP:TTLT<n> 0
```

To determine the output state of a trigger line, send the query:

```
OUTP:TTLT<n>:STAT?
```

or the reduced form:

```
OUTP:TTLT<n>?
```

The response will be a Boolean numerical value (1 or 0) indicating whether or not the sync is connected to the line represented by <n>. The command defaults to line 0 if a line number is not used. Do not insert a space between the keyword 'TTLT' and <n>.

3.3.3.10 Trigger Source Messages

The trigger source command selects the generator trigger source. Triggering edge programming is explained in paragraph 3.3.3.11.

The Model 1370 accepts three trigger sources: the unit's front panel TRIG IN connector, the VXI control interface, and one of eight VXI TTL trigger lines. The trigger on the selected VXI TTL trigger line must be from another source within the VXI chassis. There are no optional keywords in the trigger subsystem.

To select the Model 1370's front panel TRIG IN as the trigger source, send the command:

```
TRIG:SOUR EXT
```

To disable all trigger sources, send:

```
TRIG:SOUR TOFF
```

To select the control interface as the trigger input, send the command:

```
TRIG:SOUR BUS
```


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When BUS is selected, the Model 1370 accepts either the IEEE 488.2 *TRG or the VXIbus word serial Trigger command as a valid trigger.

To use the VXI backplane trigger bus as the trigger input, send the message:

```
TRIG:SOUR TTLT<n>
```

where <n> represents one of the eight TTL trigger bus lines, 0 through 7. The command defaults to line 0 if a number is not used. Do not insert a space between the keyword 'TTLT' and <n>. In this case, 'TTLT<n>' is a parameter keyword and must be separated by a space from the keyword 'SOUR'.

To determine the current trigger source, send the query:

```
TRIG:SOUR?
```

The response will be the short form keyword representing the selected trigger source.

Sending the command:

```
TRIG:SOUR TOFF
```

internally disables all trigger sources input to the Model 1370.

3.3.3.11 Trigger Slope Messages

The trigger slope command determines how the generator will respond to the trigger signal. To set the positive (rising edge) or negative (falling edge) slope of the trigger signal, send:

```
TRIG:SLOP <character_data>
```

Character data is either 'POSitive' or 'NEGative'. To determine the current trigger slope, send the query:

```
TRIG:SLOP?
```

The response will be either 'POS' or 'NEG'.

3.3.3.12 System Error Query

Sending:

```
SYST:ERR?
```

returns the programming errors held in the error queue. With each query, the unit returns a number followed by a brief description. The error queue holds up to eight errors, with one returned for each query sent, until the queue is empty. Table 3-4 describes the system error messages.

3.3.3.13 Model 1370 Calibration Query

The Model 1370's calibration procedure is contained in firmware. Sending the calibration query returns a message describing the calibration operation and setting the Model 1370 to the proper conditions for the step. To perform the calibration procedure, send:

```
DIAG:CAL? <numeric_value>
```

where the value represents a calibration step. The Model 1370 has 28 calibration steps, summarized in table 3-3. Section 5 of this manual describes the calibration procedure in detail.

Table 3-3. Calibration Steps

Numeric_Value	Item Calibrated
1	+15V Supply
2	-15V Supply
3	-10.24V reference
4	Node Balance
5	Triangle Balance
6	VCG Zero
7	High Symmetry
8	Low Symmetry
9	Low Frequency
10	High Frequency
11	1MHz
12	9.99 MHz
13	100 kHz
14	999 kHz
15	10 Hz Symmetry
16	0.999 Hz
17	99.9 Hz
18	Sine Distortion
19	Multiplier Balance
20	Offset 0V
21	Offset 5V
22	High Amplitude
23	Low Amplitude
24	Triangle Amplitude
25	Square Lower
26	Square Upper
27	Attenuator Adjustment
28	Waveform Quality

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Table 3-4. Error Messages

Error Number	Message	Error Number	Message
0	"No error"	-222	"Data out of range"
-100	"Command error"	-223	"Too much data"
-101	"Invalid character"	-224	"Illegal parameter value"
-102	"Syntax error"	-230	"Data corrupt or stale"
-103	"Invalid separator"	-231	"Data questionable"
-104	"Data type error"	-240	"Hardware error"
-105	"GET not allowed"	-241	"Hardware missing"
-108	"Parameter not allowed"	-250	"Mass storage error"
-110	"Command header error"	-251	"Missing mass storage"
-111	"Header separator error"	-252	"Missing media"
-112	"Program mnemonic too long"	-253	"Corrupt media"
-113	"Undefined header"	-254	"Media full"
-114	"Header suffix out of range	-255	"Directory full"
-120	"Numeric data error"	-257	"file name error"
-121	"Invalid character in number"	-258	"Media protected"
-123	"Exponent too large"	-260	"Expression error"
-124	"Too many digits"	-261	"Math error in expression"
-128	"Numeric data not allowed"	-270	"Macro error"
-130	"Suffix error"	-271	"Macro syntax error"
-131	"Invalid suffix"	-272	"Macro execution error"
-134	"Suffix too long"	-273	"Illegal macro label"
-140	"Character data error"	-274	"Macro parameter error"
-144	"Character data too long"	-275	"Macro definition too long"
-148	"Character data not allowed"	-276	"Macro recursion error"
-150	"String data error"	-277	"Macro redefinition not allowed"
-151	"Invalid string data"	-278	"Macro header not found"
-158	"String data not allowed"	-280	"Program error"
-160	"Block data error"	-281	"Cannot create program"
-161	"Invalid block data"	-282	"Illegal program name"
-168	"Block data not allowed"	-283	"Illegal variable name"
-170	"Expression error"	-284	"Program currently running"
-171	"Invalid expression	-285	"Program syntax error"
-178	"Expression data not allowed"	-286	"Program run time error"
-180	"Macro error"	-300	"Device specific error"
-181	"Invalid outside macro definition"	-310	"System error"
-183	"Invalid inside macro definition"	-311	"Memory error"
-184	"Macro parameter error"	-312	"PUD Memory lost"
-200	"Execution error"	-314	"Save/recall memory lost"
-201	"Invalid while in local	-315	"Configuration memory lost
-202	"Settings lost due to rtl	-330	"Self test failed"
-210	"Trigger error"	-350	"Queue overflow"
-211	"Trigger ignored"	-400	"Query error"
-212	"Arm ignored"	-410	"Query interrupted"
-213	"Init ignored"	-420	"Query unterminated"
-214	"Trigger deadlock"	-430	"Query deadlocked"
-215	"Arm deadlock"	-440	"Query unterminated after indefinite response"
-221	"Setting conflict"		

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Table 3-5 Self Test Response

Value	Conditions
0	Functioning correctly
1	Output Protection switched from 'ON' to 'OFF'
2	Output Protection is currently 'ON'
3	Output Protection switched from 'ON' to 'OFF' and is currently 'ON'
4	Power On fault detected

3.3.4 *TST? Self Test Query

This IEEE Common Command returns a number between 0 and 4 per the conditions of Table 3-5. If the response is 0 (zero), the generator is functioning correctly. If the response is 1, the output protection circuit was on, but is now off.

If the response is 2, the output protection is currently on. If the response is 3, the output protection circuit was on, went off, and is now on again. If the response is 4, the unit detected a generator fault at power on.

3.3.5 *TRG System Trigger

The *TRG is an IEEE Common Command used to provide a properly sequenced trigger and execute to an addressed 488.2 device. It triggers the Model 1370 via the VXI data bus ('BUS' must be selected as the trigger source in the Trigger subsystem).

3.3.6 IEEE 488.2 Common Commands

Table 3-6 briefly describes other messages mandated by the 488.2 standards.

3.4 MODEL 1370 OPERATION

The following paragraphs combine the previously described Program Message Units into groups of messages required to operate the Model 1370.

Continuous Operation	Paragraph 3.4.4
DC Output	Paragraph 3.4.5
VCG Operation	Paragraph 3.4.6
Triggered Operation	Paragraph 3.4.7
Gated Operation	Paragraph 3.4.8
Burst Operation	Paragraph 3.4.9
External Width	Paragraph 3.4.10
Internal Frequency Sweep	Paragraph 3.4.11

Before beginning, review output termination, input/output protection, and power on defaults described in paragraphs 3.4.1, 3.4.2, and 3.4.3.

3.4.1 Output Terminations

Each output connector must be properly terminated during its use to minimize signal reflection or power loss due to an impedance mismatch. Figure 3-3 shows proper 50Ω termination for the FUNC OUT connector, with R_S representing the Model 1370 source impedance, R_L representing the termination or load resistance, and R_{IN} representing the receiving instrument input impedance. Table 3-7 lists all the input and output impedances of the Model 1370.

Table 3-7 Input and Output Impedances

Connector	Impedance
FUNC OUT	50Ω
SYNC OUT	50Ω, TTL (0 to >2.4 V terminated)
VCG IN	10 kΩ
TRIG IN	10 kΩ

Table 3-6 IEEE 488.2 Common Commands

Command	Function	Description
*CLS	Clear Status Command	Clears Status Data Registers, forces OCIS/OQIS
*ESE	Standard Event Status Enable	Sets Event Status Enable Register bits
*ESE?	Standard Event Status Enable Query	Returns contents of Event Status Enable Register
*ESR?	Standard Event Status Register Query	Returns contents of Event Status Register
*IDN?	Identification Query	Identifies devices over the system interface
*OPC	Operation Complete Command	Requires oper. comp. message in Event Status Reg.
*OPC?	Operation Complete Query	ASCII '1' in dev. out. queue when operations complete
*RST	Reset Command	Resets the device
*SRE	Service Request Enable Command	Sets Service Request Enable Register bits
*SRE?	Service Request Enable Query	Returns contents of Service Request Enable Register
*STB?	Read Status Byte Query	Returns status and master summary status bytes
*TRG	Trigger Command	Initiates a properly sequenced trigger and execute
*TST?	Self Test Query	Starts self-test, places pass/fail response in output queue
*WAI	Wait - to - Continue Command	Blocks device commands until 'No-Op-Pend' flag is true

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3.4.2 Input/Output Protection

The Model 1370 provides protection for internal circuitry connected to input and output connectors. The FUNC OUT connector circuitry is protected from short circuits and external over voltages of up to ±100V peak. The SYNC OUT connector circuitry is protected to ±15V. Both VCG IN and TRIG IN connector circuits are protected from over voltages of up to ±50 V.

3.4.3 Power On/Reset Defaults

At power on, or as the result of sending *RST, the Model 1370 defaults to the following conditions:

Subsystem	Source
Frequency Mode	CW
Frequency value	1kHz
Amplitude	5Vpp
Offset	0Vdc
Sweep Start	999 Hz
Sweep Stop	9.99 kHz
Sweep Direction	Up
Sweep Spacing	Linear
Sweep Time	100 ms
Mode	Continuous
Function	Sine wave
Burst Value	2
Output	Off
Output TTL Trigger	Off
Trigger Slope	Positive
Trigger Source	External

3.4.4 Continuous Mode

This paragraph shows how to set up the Model 1370 for a continuous, 10 kHz, 1.5 Vpp sine wave, with −1.5 Vdc offset at the FUNC OUT connector. All of the parameters shown here are detailed in earlier paragraphs. Much of the information given here directly transfers to other modes.

Connect the Model 1370's output (terminated) to the device under test, as shown in figure 3-4. Use the SYNC OUT signal as a synchronizing source. Figure 3-5 illustrates the SYNC OUT and FUNC OUT relationships.

At power on, the Model 1370's FUNC OUT is always disconnected from the output amplifier. To enable the FUNC OUT connector, send the command:

```
OUTP:STAT ON
```

or the reduced form:

```
OUTP 1
```

Program Message Units may be linked together with semicolons and colons as explained in paragraph 3.3.2.3. To set up the instrument as described at the beginning of this paragraph, send the following linked command to the Model 1370 using short form keywords and without optional keywords:

```
FREQ 10E3;FUNC SIN;VOLT 1.5;
OFFS -1.5;:MODE CONT;:OUTP 1
```

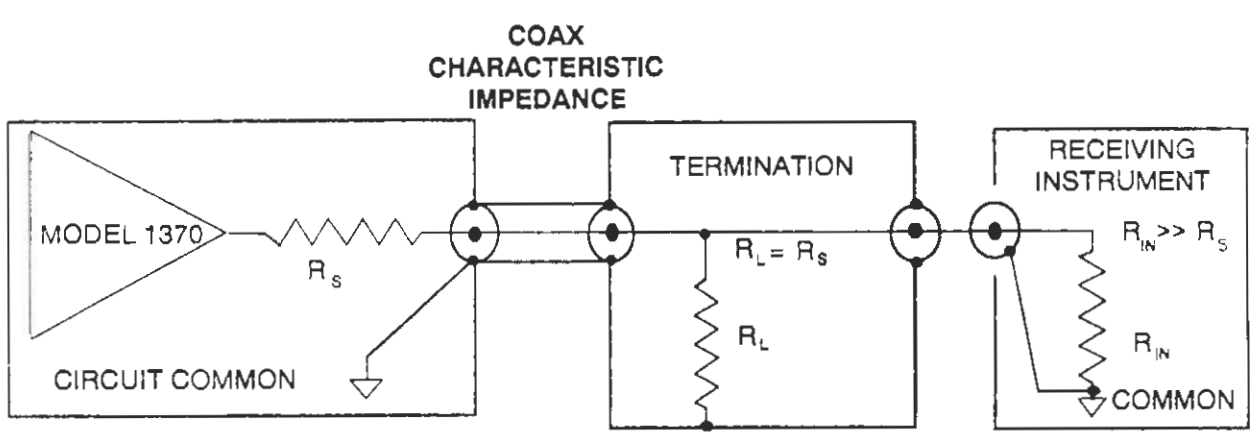


Figure 3-3. Output Termination

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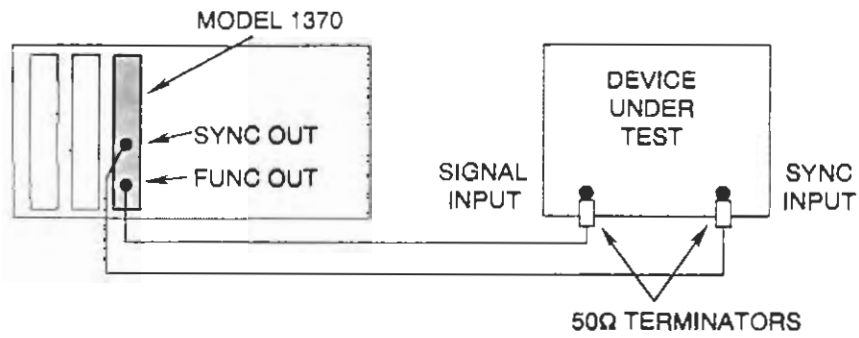


Figure 3-4. Model 1370 Basic Operation Setup

3.4.5 DC Output

In dc function, a fixed voltage determined by the offset setting is output from the FUNC OUT connector. To select the dc function, send the command:

```
SOUR:FUNC:SHAP DC
```

or the reduced form:

```
FUNC DC
```

To set the dc output voltage, send .

```
SOUR:VOLT:LEV:OFFS
<numeric_value>
```

or the reduced form:

```
VOLT:OFFS <numeric_value>
```

Numeric values are explained in paragraph 3.3.2.4. For dc offset messages, numeric values may be in the form of an integer, a fixed or floating point value, or one of the special case character keywords,

'MAXimum', 'MINimum', or 'DEFault'.

Dc output values range between -5 Vdc and +5 Vdc specified into a 50Ω load.

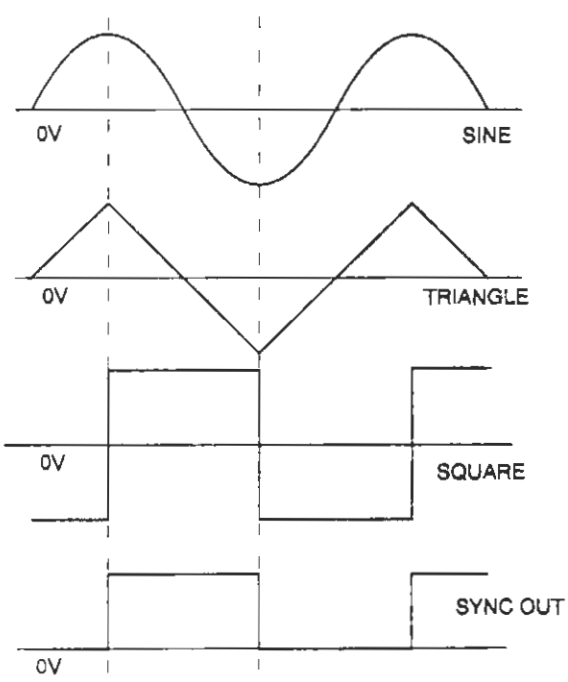


Figure 3-5. Continuous Waveform Characteristics

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3.4.6 VCG Operation

3.4.6.1 Introduction

Signals applied to the VCG IN connector control the frequency of the FUNC OUT signal within the selected range. Table 3-8 shows the nine frequency ranges internal to the Model 1370, and the limits for each range. An ac signal applied to the VCG IN connector provides modulation of the output frequency. A positive voltage applied to the VCG IN connector increases the generator's frequency, while a negative voltage decreases the frequency.

There are two methods of determining the required voltage at the VCG IN connector to produce the intended output frequency. They are the VCG nomograph shown in figure 3-6, and the equation:

Frequency = (FRQ + VCG) * FR.

For this example, suppose that the desired output frequency is 10 kHz, and the programmed frequency is 5 kHz. Using the nomograph, place one end of a straight edge on the "Frequency Mantissa of Output" (the programmed frequency) value, and the other end on the nomograph's "Frequency Mantissa of Program" (the desired output frequency) value. The nomograph shows that +5 Vdc applied to the VCG IN connector changes the output frequency to 10 kHz.

The output frequency may also be calculated from the equation:

Frequency = (FRQ + VCG) * FR

Where:

Frequency = The desired output frequency in Hz.

FRQ = The internal Model 1370 frequency control voltage between +1 and +12 Vdc. This value is equivalent to the Frequency Mantissa of Program in figure 3-6.

VCG = The external VCG IN control voltage, equivalent to the VCG IN voltage in figure 3-6.

FR = The Model 1370's frequency range, 10^{-2} through 10^{6} Hz. See table 3-8 under Range Name.

In this example:

FRQ = 5
VCG = +5Vdc
FR = 10^{3}

Therefore, the equation is:

Frequency = (5 + 5) * 10^{3}
= 10E3
= 10 kHz.

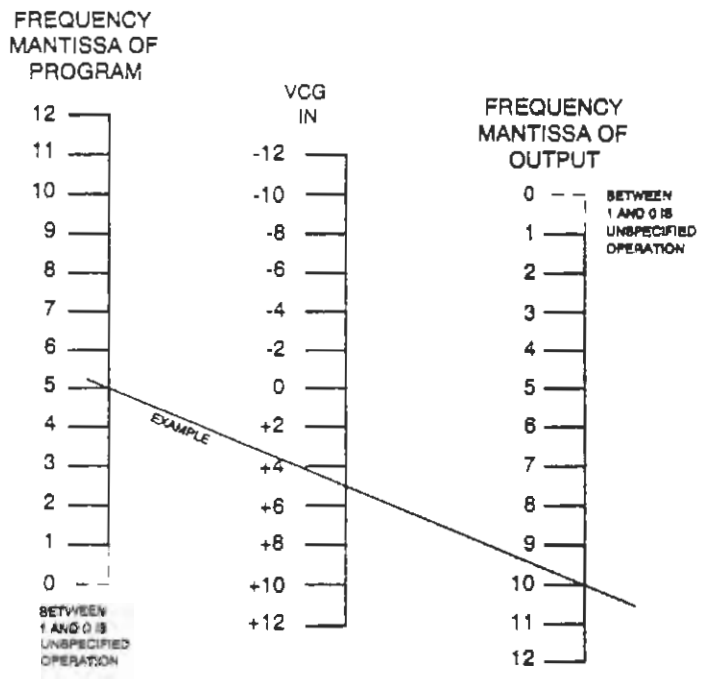


Figure 3-6 VCG Nomograph

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Table 3-8. Frequency Ranges

Range Name	Programmed Range	VCG Range
10^6	1.00 to 12.0 MHz	10.0 kHz to 12.0 MHz
10^5	100 to 999 kHz	1.00 kHz to 1.20 MHz
10^4	10.0 to 99.9 kHz	100 Hz to 120 kHz
10^3	1.00 to 9.99 kHz	10.0 Hz to 12.0 kHz
10^2	100 to 999 Hz	1.00 Hz to 1.20 kHz
10^1	10.0 to 99.9 Hz	100 mHz to 120 Hz
10^0	1.00 to 9.99 Hz	10.0 mHz to 12.0 Hz
10^{-1}	100 to 999 mHz	1.00 mHz to 1.20 Hz
10^{-2}	10.0 to 99.9 mHz	100 µHz to 120 mHz

3.4.6.2 Frequency Modulation (FM)

In the FM mode, an external signal connected to the VCG IN connector varies the frequency of the Model 1370's output about the programmed frequency. The magnitude of the modulating signal determines the frequency deviation, and the frequency of the modulating signal determines the rate of deviation. For frequency modulation, set up the unit as described in paragraph 3.4.4. The frequency selected sets the center frequency and range (table 3-8).

If an ac signal is applied to the VCG IN connector, the output will modulate about the programmed frequency. If a dc voltage is applied to the VCG IN connector, the output will be shifted by the magnitude and polarity of the voltage (see the example in figure 3-6).

A ramp at the VCG IN will cause the output frequency to sweep. A positive going ramp sweeps the frequency up, while a negative ramp sweeps the frequency down from the programmed frequency.

NOTE

Nonlinear operation may result when the VCG IN voltage is excessive; that is, when the attempted generator frequency exceeds the range limits.

3.4.6.3 External Frequency Sweep

By using the VCG input, and programming the Model 1370 frequency to the lowest possible value within a given range, frequency may be externally swept over a span of 1200:1. To accomplish this, program the unit as in paragraph 3.4.4, then set the frequency DAC to zero by sending the command:

```
DIAG:VCG
```

Finally, connect the VCG signal to the VCG IN connector. The programmed frequency (10 kHz for this example) determines the unit's VCG Range, shown in table 3-8 as 100 Hz to 120 kHz. Do not exceed these VCG Range limits.

3.4.7 Triggered Operation

3.4.7.1 Introduction

In the triggered mode, the Model 1370's output remains quiescent until triggered by the trigger source. All Model 1370 functions may be triggered. When triggered, the Model 1370 produces one complete waveform, then returns to the quiescent state. The quiescent state for sine and triangle waves is 0V. The quiescent state for the square wave is the negative peak voltage, and for the negative square wave is the positive peak voltage (see figure 3-7). The unit may be triggered by using the external TRIG IN, the trigger command, or the VXI trigger bus input.

To set the Model 1370 for the triggered mode, follow the instructions in paragraph 3.4.4, then change the mode to triggered by sending:

```
MODE TRIG
```

3.4.7.2 External Trigger Input

The trigger slope parameter affects how the instrument responds to the external trigger input signal. The slope determines whether the instrument triggers on the positive or negative going portion of the input signal. Before using the external trigger input, program the instrument as follows:

```
FREQ 10E3;FUNC SIN;VOLT 1.5;
OFFS -1.5;:MODE TRIG;:OUTP 1
```

The result will be a dc level of -1.5V. Next, select the external trigger input by sending the command:

```
TRIG:SOUR EXT
```

The maximum trigger rate is 12 MHz. The minimum amplitude is 500 mVpp up to 1 MHz, and 1Vpp from 1 MHz to 12 MHz.

To trigger on the positive going (rising edge) trigger slope, send the command:

```
TRIG:SLOP POS
```


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To trigger on the negative going (falling edge) trigger slope, send the command:

```
TRIG:SLOP NEG
```

For example, to enable the unit to trigger on the positive slope, send the following command:

```
TRIG:SOUR EXT;SLOP POS
```

3.4.7.3 BUS Trigger Commands

To trigger the generator using the IEEE 488 bus or the VXIbus, set up the generator in a triggered mode as described in paragraph 3.4.7.2, then select the bus trigger command by sending:

```
TRIG:SOUR BUS
```

Trigger the generator by sending either the 488.2 `*TRG` or 488.1 `GET` command over the 488 bus, or the word serial `Trigger` over the VXIbus. The `*TRG` command is mandated to be recognized by the Commander and by the Model 1370. The `GET` command causes the Commander to send the VXIbus word Serial `Trigger` command to addressed devices which support `Trigger` and do not have their DIR bit cleared to 0 (seee VXIbus System Specification). Trigger slope does not apply when using the `BUS` as the trigger source, and the bus commands only have effect when the Model 1370 is in a triggered mode of operation and the selected trigger source is `BUS`.

3.4.7.4 VXI TTL Trigger Bus Input

The Model 1370 may also be triggered from the VXI TTL backplane. The signal must be placed on the bus from another source within the VXI chassis.

To use the trigger bus as a trigger source, first set up the Model 1370 using the instructions in paragraph 3.4.7.2. Next, select one of the eight trigger lines by sending the message:

```
TRIG:SOUR TTLT<n>
```

Where `<n>` represents one of the eight TTL Trigger lines, 0 through 7.

The selected signal will trigger the Model 1370 on the leading (negative going) edge. Trigger slope does not apply when using one of the TTL Trigger lines as the trigger source.

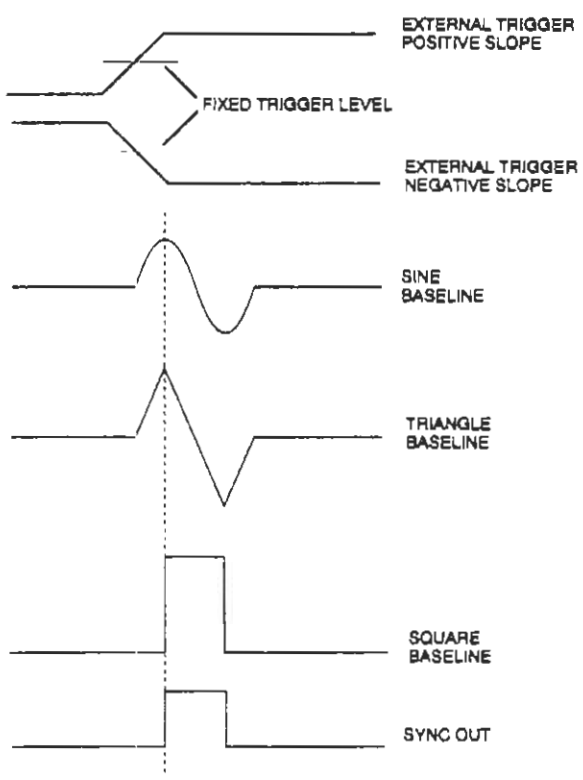


Figure 3-7. Triggered Waveform Characteristics

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3.4.8 Gated Operation

The gated mode is identical to the triggered mode, except the output from the Model 1370 starts from the quiescent state, produces continuous waveforms for the duration of the trigger signal, then returns to the quiescent state. All waveforms may be gated. The quiescent state for sine and triangle waves is 0V. The quiescent state for the square wave is the negative peak voltage, and for the negative square wave is the positive peak voltage, as shown in figure 3-8.

To view gated mode, set up the Model 1370 as described in paragraph 3.4.7.2, then send the mode command:

```
MODE GAT
```

Next select the trigger source. The unit may be triggered by the external TRIG IN as described in paragraph 3.4.7.2, or the VXI trigger bus input as described in paragraph 3.4.7.4. '*TRG' is not a valid command in gated mode.

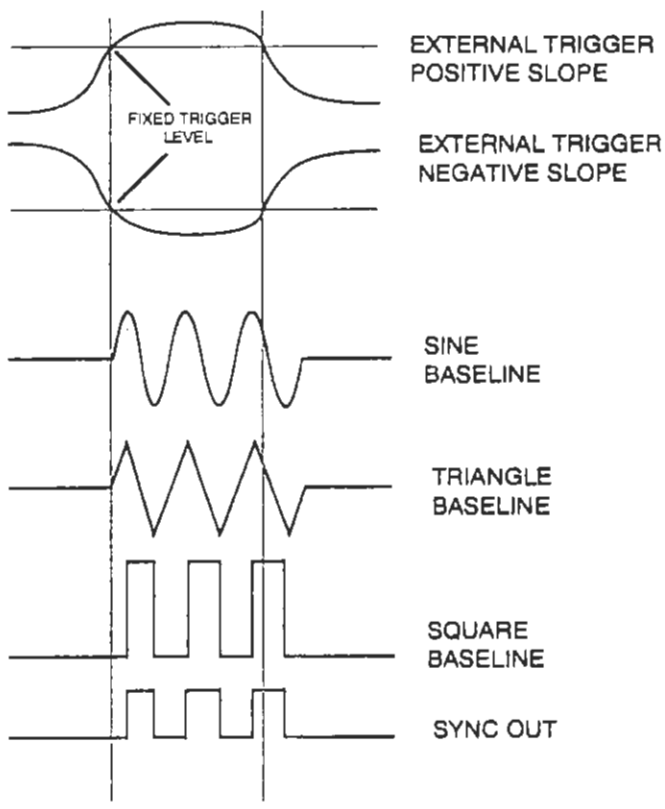


Figure 3-8. Gate Waveform Characteristics

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3.4.9 Burst Operation

The burst mode is identical to the triggered mode, except when a trigger is received, the Model 1370 leaves its quiescent state, produces a predefined number of cycles, then returns to its quiescent state. The quiescent state for sine and triangle waves is 0V. The quiescent state for the square wave is the negative peak voltage, and for the negative square wave is the positive peak voltage, as shown in figure 3-9.

To observe the burst mode, set up the Model 1370 as described in paragraph 3.4.4, then send the mode command:

```
MODE BURS
```

To change the burst count, send the command

```
BURS <numeric_value>
```

Numeric values are explained in paragraph 3.3.1.4. For burst count messages, numeric values may be any value between 2 and 2^{30} or >1,000,000,000, in the form of an integer or floating point value, or one of the special case character keywords, 'MAXimum', 'MINimum', or 'DEFault'. Burst duration depends on the frequency programmed.

A burst is initiated when the unit is triggered by the selected trigger source. The trigger source may be the external TRIG IN, as described in paragraph 3.4.7.2, the Trigger Command '*TRG' as described in paragraph 3.4.7.3, or the VXI trigger bus input as described in paragraph 3.4.7.4.

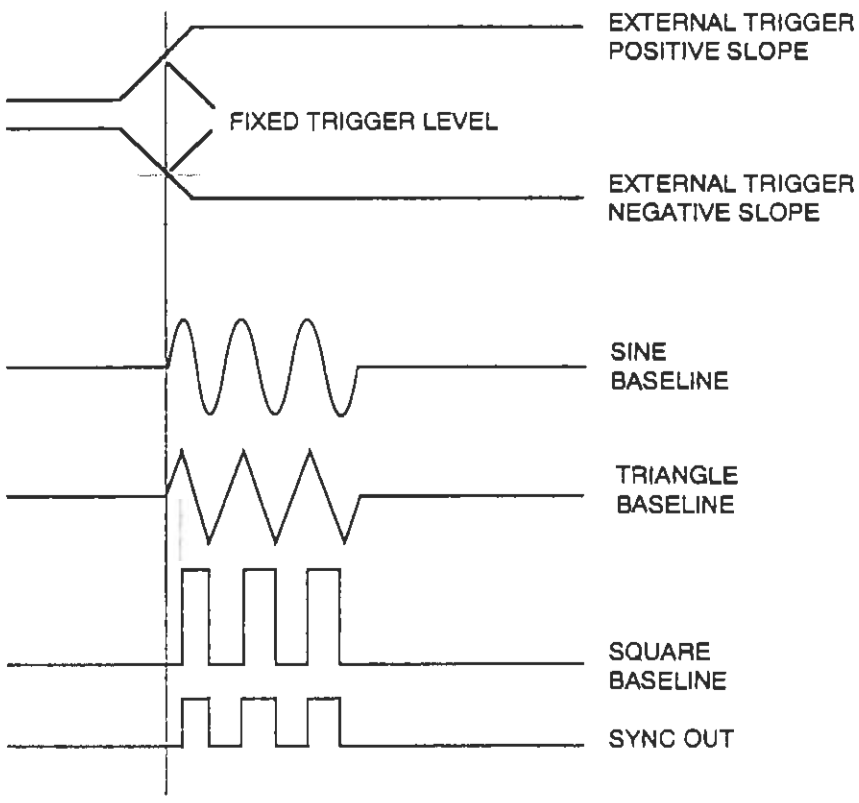


Figure 3-9. Burst Waveform Characteristics

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3.4.10 External Width

In external width, the Model 1370 produces an output pulse whose period and width are set by the external trigger signal as shown in figure 3-10. To select external width, send the command:

```
SOUR:FUNC EXTW
```

Frequency and mode commands are not required for external width. All other commands are as described in paragraph 3.4.4. The external width accepts trigger inputs from all three trigger sources: external TRIG IN, VXI Trigger Bus, and the Trigger command. However, the most useful trigger source for external width is the TRIG IN connector. This is because the trigger slope is adjustable as described in paragraph 3.4.7.2. To select the TRIG IN connector as the trigger source, send the command:

```
TRIG:SOUR EXT
```

A second trigger source for external width is the VXI backplane, described in paragraph 3.4.7.4. The period and width of the instrument output is dependent on the characteristics of the selected signal. A backplane signal is selected by sending the command:

```
TRIG:SOUR TTLT<n>
```

where <n> represents one of the eight TTL trigger lines.

The remaining trigger source available to the Model 1370, when in external width, is the trigger command '*TRG', described in paragraph 3.4.7.3. When using the trigger command, the period and width of the output signal is determined by the *TRG bit. To select the trigger command, send:

```
TRIG:SOUR BUS
```

3.4.11 Internal Frequency Sweep

When sweep is enabled, the output frequency may be swept within the range of .01 Hz to 12 MHz in continuous or triggered modes, and with linear (default) or logarithmic spacing. Sweep ratios greater than 100:1 may be achieved, but will generate a device specific error. If the high frequency setting is 10 MHz or greater, the minimum allowable frequency is 2 MHz. Sweep duration ranges from .01 seconds to 100 seconds, with a default of 100 ms.

The default start frequency is 999 Hz and the default stop frequency is 99.9 kHz. To enable sweep, enter:

```
FREQ:MODE SWE
```

To set the specific sweep mode, enter:

```
SWE:MODE <keyword>
```

To program the instrument to sweep up, enter:

```
SWE:DIR UP
```

or down, enter:

```
SWE:DIR DOWN
```

To enable log spacing, enter:

```
SWE:SPAC LOG
```

or linear spacing, enter:

```
SWE:SPAC LIN
```

To program the sweep time, enter:

```
SWE:TIME <numeric_value>
```

3.4.12 Status Command

This subsystem contains the Status reporting registers. Neither the Operation, nor the Questionable registers are implemented in the Model 1370. All queries will return a '0' (zero). The Enable subcommands for each register will be accepted, but will not perform any function. Preset may be exercised, but will perform no function.

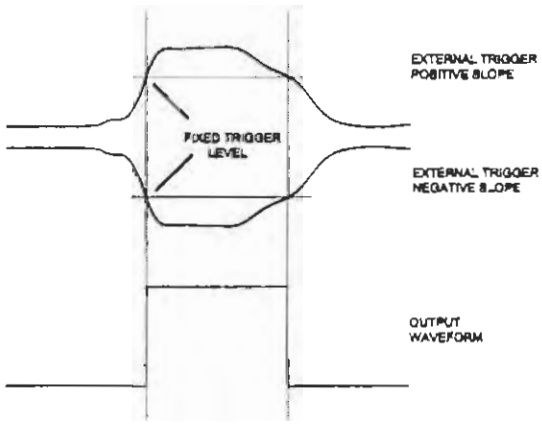


Figure 3-10. External Width Waveform Characteristics

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SECTION 4
CIRCUIT DESCRIPTION

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SECTION 5
CALIBRATION

5.1 FACTORY REPAIR

Wavetek maintains a factory repair department for those customers not possessing the necessary personnel or test equipment to maintain the instrument. If an instrument is returned to the factory for calibration or repair, a detailed description of the specific problem should be attached to minimize the turnaround time.

5.2 REQUIRED TEST EQUIPMENT

The test equipment required to perform the calibration procedure is listed in table 5-1.

Table 5-1. List of Test Equipment

Equipment	Quantity	Specifictions
VXI Requirements	1	VXI chassis
	1	VXI slot-0 controller
	1	VXI "C" size extender board (Optional-see text)
Multimeter	1	HP 3478A or equivalent
Oscilloscope	1	Tektronix 2465 or equivalent
Distortion Analyzer	1	HP 8903B Audio Analyzer
Freouency Counter	1	HP 5334A Universal Counter
Adaptor	1	BNC female to double banana jacks
Cable assembly	1	Dual clip/coax
Coaxial cable	1	BNC male connectors, RG58U cable
Probe	2	10 MΩ
50Ω Termination	1	Feedthrough, 0.1% accuracy, 2W

5.3 CALIBRATION

The following procedures require that the model 1370 be part of a VXI system as described in table 5-1. The model 1370 will be installed on a C-size VXI extender card and controlled by the Resource Manager. The computer/display device can be the Resource Manager (internal host in a Stand-Alone system) or an external host connected to the Resource Manager via the IEEE-488 (GPIB) programming bus.

WARNING

With the covers removed, low voltage dc power supplies are exposed. Do not be misled by the term "low voltage". Under adverse conditions, potentials as low as 50 volts can cause serious injury or death.

5.3.1 Semi-Automated Procedure

When the calibration procedure is initiated, the Model 1370 firmware returns an abbreviated description of the current calibration step to the system console, and instructs the Function Generator to modify its settings in preparation for making that adjustment. The abbreviated description identifies the parameter, calibration tolerance, and adjustment component. The procedure is initiated by sending '`DIAG:CAL?`', followed by the calibration step number, and a program message terminator.

NOTE

The completion of the calibration procedure returns the instrument to correct alignment.

Calibration limits and tolerances are not instrument specifications.

Instrument specifications are given in Section 1 of this Manual.

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5.3.2 Preparation

Obtain access to adjustable components by removing the side panel with the address switch cutout. Mount the module on an extender card, or plug it into a VXI chassis connector that will allow access to the adjustments during calibration. Allow at least a 15 minute warm-up.

5.3.3 Connector Termination

When used as test points, the SYNC OUT and FUNC OUT connectors must be terminated with 50Ω.

5.3.4 Calibration Procedure

To prepare the instrument for each step, send 'DIAG:CAL?', followed by the calibration step number, and a program message terminator (see paragraph 3.3.2.5). For steps that are identified as interacting with another step, all interacting steps must be within calibration tolerance before advancing to the next step. Figure 5-1 shows test point and adjustment locations.

Step 1. **Adjust +15 Vdc Supply**
- Reference TP-1
- Cal Point TP-2
- Adjust R314 for +15.000 ±.002 Vdc with DVM, dc mode, high Z in

Step 2. **Adjust -15 Vdc Supply**
- Reference TP-1
- Cal Point TP-3
- Adjust R318 for -15.000 ±.002 Vdc with DVM, dc mode, high Z in

Step 3. **Adjust -10.24 Reference Voltage**
- Reference TP-1
- Cal Point TP-4
- Adjust R300 for -10.240 ±.002 Vdc with DVM, dc mode, high Z in

Step 4. **Adjust Node Balance Voltage**
- Reference TP-1
- Cal Point TP-5
- Adjust R99 for triangle wave balanced about zero ±0.1 Vdc with oscilloscope

Step 5. **Adjust Triangle Balance**
- Reference TP-1
- Cal Point TP-6
- Adjust R60 for equal positive and negative peaks ±0.002 Vdc with oscilloscope

Step 6. **Null VCG** (Voltage Controlled Generator)
- Reference BNC Outer Shell
- Cal Point VCG Input BNC on Front Panel (Do NOT load with 50Ω)
- Adjust R11 for 0.0 ±0.001 Vdc with DVM, dc mode, high Z in

Step 7. **Adjust HF Waveform Symmetry** (Interacts with Step 8).
- Reference BNC Outer Shell
- Cal Point FUNC OUT BNC on Front Panel
- Adjust R23 for 0 ±0.5µs with oscilloscope, or 50 ±0.025% with frequency counter (Duty Cycle Mode)

Step 8. **Adjust LF Waveform Symmetry** (Interacts with Step 7).
- Reference BNC Outer Shell
- Cal Point FUNC OUT BNC on Front Panel
- Adjust R15 for 0 ±0.5 µs with oscilloscope, or 50 ±0.025% with frequency counter (Duty Cycle Mode). Allow 15 seconds for reading to settle.

Step 9. **Adjust Low Frequency** (Interacts with Step 10).
- Reference BNC Outer Shell
- Cal Point FUNC OUT BNC on Front Panel
- Adjust R12 for 10 ±0.1 Hz with frequency counter (Duty Cycle Mode).

Step 10. **Adjust High Frequency** (Interacts with Step 9).
- Reference BNC Outer Shell
- Cal Point FUNC OUT BNC on Front Panel
- Adjust R8 for 999 ±1.5 Hz with frequency counter.

Step 11. **Adjust 1MHz** (Interacts with Step 12).
- Reference BNC Outer Shell
- Cal Point FUNC OUT BNC on Front Panel
- Adjust C43 for 1 ±0.001 MHz with frequency counter.

NOTE

If the range of C43 is inadequate, change the nominal value of C44.

Step 12. **Adjust 9.99 MHz** (Interacts with Step 11).
- Reference BNC Outer Shell
- Cal Point FUNC OUT BNC on Front Panel
- Adjust R45 for 9.99 ±0.01 MHz with frequency counter.

Step 13. **Adjust 100 kHz** (Interacts with Step 14).
- Reference BNC Outer Shell
- Cal Point FUNC OUT BNC on Front Panel
- Adjust C45 for 100 ±0.1 kHz with frequency counter.

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Step 14. **Adjust 999 kHz** (Interacts with Step 13).
Reference BNC Outer Shell
Cal Point FUNC OUT BNC on Front Panel
Adjust R46 for 999 ±1kHz with frequency counter.

Step 15. **Adjust 10 Hz Symmetry** (Cap. Mult. Adj.).
Reference BNC Outer Shell
Cal Point FUNC OUT BNC on Front Panel
Adjust R117 for 50 ±0.1% with oscilloscope, or frequency counter (Duty Cycle Mode).

Step 16. **Adjust 0.999 Hz** (Cap. Mult. Adj.).
Reference BNC Outer Shell
Cal Point FUNC OUT BNC on Front Panel
Adjust R105 for .999 ±0.001 Hz with frequency counter.

Step 17. **Adjust 99.9 Hz** (Cap. Mult. Adj.).
Reference BNC Outer Shell
Cal Point FUNC OUT BNC on Front Panel
Adjust R112 for 99.9 ±0.1 Hz with frequency counter.

Step 18. **Adjust Sine Distortion** (Interacts with Step 19).
Reference BNC Outer Shell
Cal Point FUNC OUT BNC on Front Panel
Adjust R142, R154, R157, and R255 for <0.3% THD (Total Harmonic Distortion) with distortion analyzer (monitor analyzer output with oscilloscope).

NOTE

The initial adjustment in Step 18 is done at 999 Hz. Verify that distortion at the following frequencies is at minimum (below 0.42% THD) and somewhat equally balanced.

Frequency	*Program*
99.9 Hz	*freq 99.9*
999 Hz	*freq 999*
10 kHz	*freq 10E3*
99.9 kHz	*freq 99.9E3*

Step 19. **Adjust Mult. Balance** (Interacts with Step 18).
Reference BNC Outer Shell
Cal Point FUNC OUT BNC on Front Panel
Adjust R241 for <0.07 Vp-p with oscilloscope.

Step 20. **Adjust Offset at 0Vdc** (Interacts with Step 21).
Reference BNC Outer Shell
Cal Point FUNC OUT BNC on Front Panel
Adjust R237 for 0 ±0.005 Vdc with DVM, dc mode.

Step 21. **Adjust Offset at 5Vdc** (Interacts with Step 20).
Reference BNC Outer Shell
Cal Point FUNC OUT BNC on Front Panel
Adjust R208 for 5 ±0.005 Vdc with DVM, dc mode.

Step 22. **Adjust High Amplitude** (Interacts with Steps 23 and 24).
Reference BNC Outer Shell
Cal Point FUNC OUT BNC on Front Panel
Adjust R242 for 3.536 ±0.01 Vac with DVM, ac mode.

Step 23. **Adjust Low Amplitude** (Interacts with Steps 22 and 24).
Reference BNC Outer Shell
Cal Point FUNC OUT BNC on Front Panel
Adjust R251 for 0.357 ±0.002 Vac with DVM, ac mode.

Step 24. **Adjust Triangle Amplitude** (Interacts with Steps 22 and 23).
Reference BNC Outer Shell
Cal Point FUNC OUT BNC on Front Panel
Adjust R148 for 2.887 ±0.003 Vac with DVM, ac mode.

Step 25. **Adjust Negative Square Excursion.**
Reference BNC Outer Shell
Cal Point FUNC OUT BNC on Front Panel
Adjust R168 for -5 ±0.005 Vdc with DVM, dc mode.

Step 26. **Adjust Positive Square Excursion.**
Reference BNC Outer Shell
Cal Point FUNC OUT BNC on Front Panel
Adjust R164 for +5 ±0.005 Vdc with DVM, dc mode.

Step 27. **Adjust Output Attenuator.**
Reference BNC Outer Shell
Cal Point FUNC OUT BNC on Front Panel
Adjust R295 for 0.5 ±0.001 Vdc with DVM, dc mode.

Step 28. **Adjust Waveform Quality.**
Reference BNC Outer Shell
Cal Point FUNC OUT BNC on Front Panel
Adjust C122 and R96 for rise/fall <12ns, aberrations <(3.3% + 50 mV) with oscilloscope (wide bandwidth).

NOTE

For amplitudes of 1.01, 5 and 10V, balance aberration results. Verify rise/fall times for amplitudes of 1.01 and 5V are <12 ns, and 10V is <16 ns.

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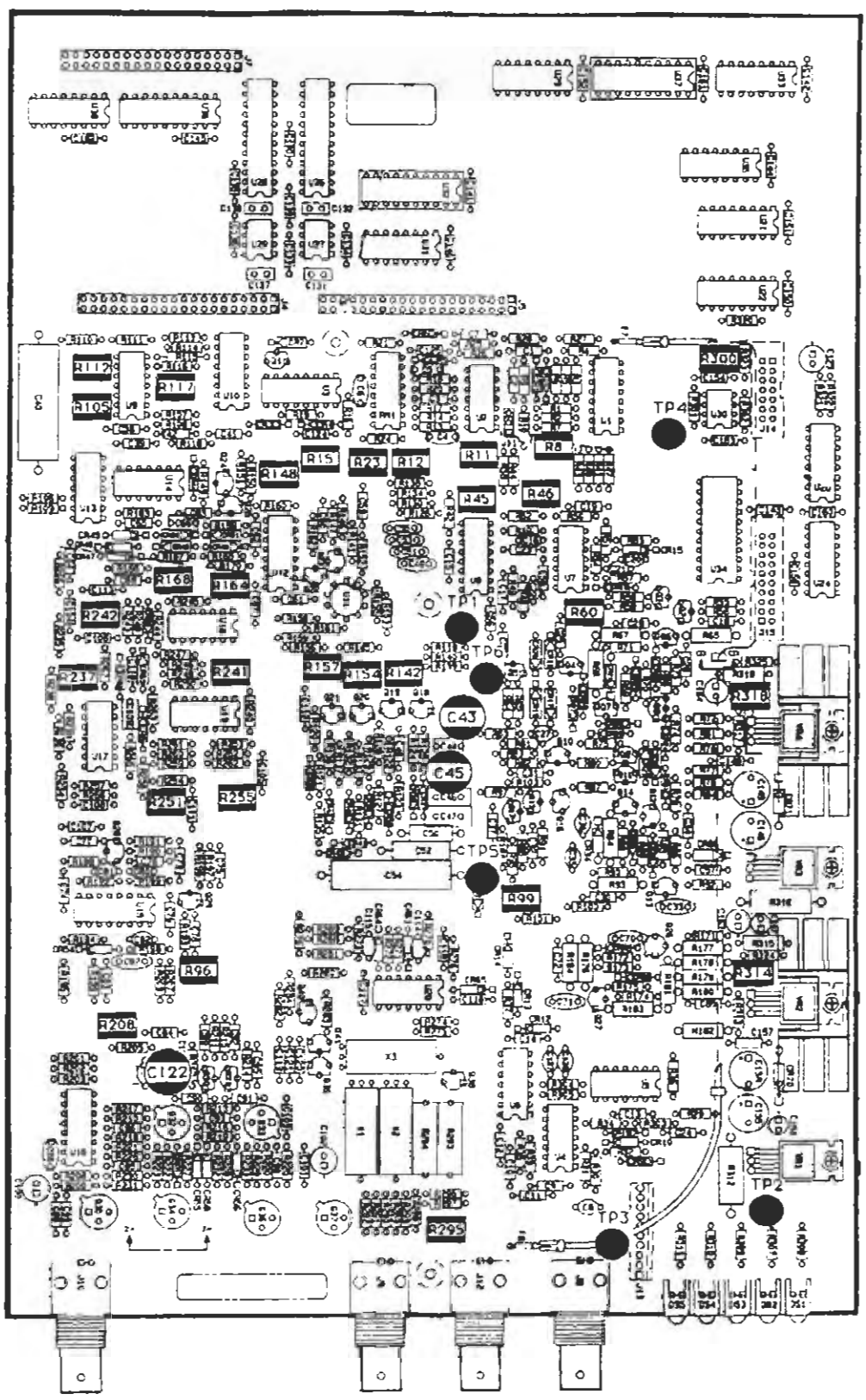


Figure 5-1. Test Points and Adjustments

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SECTION 6
TROUBLESHOOTING

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