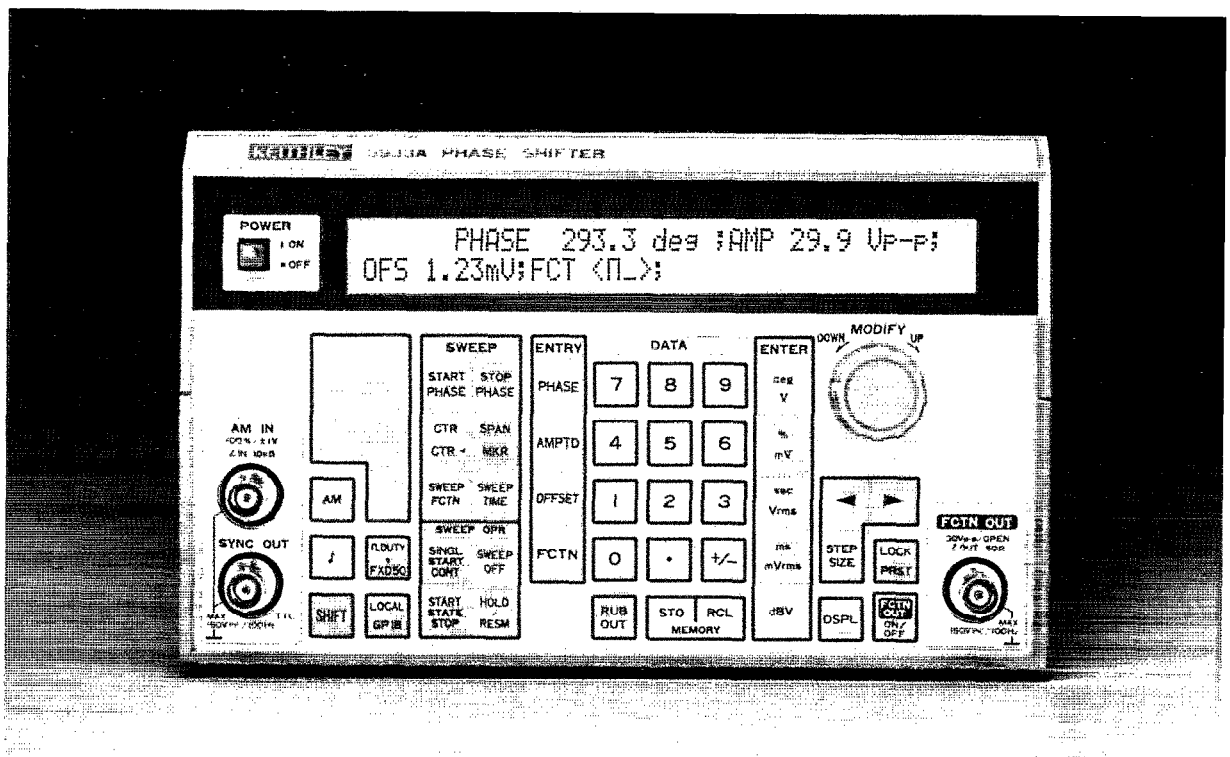
KEITHLEY INSTRUMENTS

Model 3933A Phase Shifter
Operator's Manual



Contains Operating Information

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WARRANTY

Keithley Instruments, Inc. warrants this product to be free from defects in material and workmanship for a period of 1 year from date of shipment.

Keithley Instruments, Inc. warrants the following items for 90 days from the date of shipment: probes, cables, rechargeable batteries, diskettes, and documentation.

During the warranty period, we will, at our option, either repair or replace any product that proves to be defective.

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Operator's Manual
Model 3933A
Phase Shifter

Instruments Division
Cleveland, Ohio, U. S. A.
Document Number: 3933A-900-01

Safety Precautions

The following safety precautions should be observed before using the Model 3933A Phase Shifter and any associated instruments.

This instrument is intended for use by qualified personnel who recognize shock hazards and are familiar with the safety precautions required to avoid possible injury. Read over this manual carefully before using the instrument.

Exercise extreme caution when a shock hazard is present at the test circuit. The American National Standards Institute (ANSI) states that a shock hazard exists when voltage levels greater than 30V rms or 42.4V peak are present. **A good safety practice is to expect that hazardous voltage is present in any unknown circuit before measuring.**

Inspect the connecting cables and test leads for possible wear, cracks, or breaks before each use.

For maximum safety, do not touch the test cables or any instruments while power is applied to the circuit under test. Turn off the power and discharge any capacitors before connecting or disconnecting cables from the instrument.

Do not touch any object which could provide a current path to the common side of the circuit under test or power line (earth) ground. Always make measurements with dry hands while standing on a dry, insulated surface capable of withstanding the voltage being measured.

Do not apply more than 42V peak between the outer shell of any BNC connector and chassis ground.

Instrumentation and accessories should not be connected to humans.

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SECTION 1
General Information

1.1 SUMMARY

The Model 3933A Phase Shifter is designed for use in conjunction with a Model 3930A Multifunction Synthesizer. Together, Model 3933A and Model 3930A form a variable phase, multi-phase oscillator with a phase setting range from –360 to 360°. Phase resolution is 0.1°. The frequency range is the same as the Model 3930A.

Five output waveforms, ∿, ⋀, ⎍, ◿, and ◺ are available. Each waveform has a maximum output of 30V p-p (no-load) and 15V p-p into 50Ω. Waveform and amplitude may be set independently of the Model 3930A or another Model 3933A. Waveform output is isolated from the Model 3930A, or another Model 3933A, allowing a wide range of applications. Multiple 3933A units may be combined with a single 3930A to create a multi-phase oscillator system.

Phase output is directly synthesized by a custom LSI digital IC, resulting in high accuracy and stability, and short phase switching time.

In addition to phase sweep and amplitude modulation (AM), variable square-wave duty cycle is also provided. Parameter settings are easily made using either the front panel keys and/or the modify knob.

The Model 3933A is equipped with a standard GPIB (IEEE-488) interface, and can be programmed over the bus to produce the same operating modes and parameters that can be controlled from the front panel.

The Model 3933A uses a two-line, 40-character liquid crystal display to indicate selected functions, parameters, and pertinent messages.

1.2 FEATURES

- Wide phase setting range: –360° to 360°, with resolution of 0.1°.
- High output and high AC voltage accuracy: 30V p-p (no load), 15V p-p into 50Ω, ±0.5% (~50kHz, sine wave, above 3V p-p).
- A total of 5 units of Model 3933A may be combined with a Model 3930A to provide up to a 6-phase oscillator system.
- Two-line, 40-character liquid crystal display.
- Five output waveforms: ∿, ⋀, ⎍, ◿, and ◺. Variable square wave duty cycle (5% to 95%, below 100 kHz).
- Multiple phase sweep functions. Each setting digitally synthesized according to input from the front panel numeric keypad or the modify dial.
- Low distortion ratio (<0.1%, 10Hz to 100kHz, above 30.0mV p-p, AUTO output range mode).
- Isolated waveform output.
- Battery backed-up memory can retain up to 10 groups of parameters. At power-on, it will automatically set

itself according to those parameters which were in effect immediately prior to the last power shut-off.
- GPIB interface included as standard equipment.
- Output mode switchable from automatic (AUTO) to fixed (FXD).
- A wide range of front and rear panel I/O interconnections to control or modify signal operations and parameters.

1.3 WARRANTY INFORMATION

Warranty information is located on the inside front cover of this instruction manual. Should your Model 3933A require warranty service, contact the Keithley representative or authorized repair facility in your area for further information. When returning the instrument for repair, be sure to fill out, and include, the service form at the back of this manual in order to provide the repair facility with the necessary information.

1.4 MANUAL ADDENDA

Any improvements or changes concerning the instrument or manual, will be explained in an addendum included with the unit. Be sure to note these changes and incorporate them into the manual before using or servicing the unit.

1.5 SAFETY TERMS AND SYMBOLS

The following safety terms and symbols are found on the instrument, or used in this manual.

The ⚠ symbol on the instrument indicates that the user should refer to the operating instructions.

The **WARNING** heading used in this manual explains dangers that might result in personal injury or death. Always read the associated information carefully before performing the indicated procedure.

The **CAUTION** heading used in this manual explains hazards that could damage the instrument card. Such damage may invalidate the warranty.

1.6 UNPACKING AND REPACKING

1.6.1 Unpacking

After carefully unpacking the instrument from its shipping carton, inspect it for obvious signs of physical damage. Report any such damage to the shipping agent immediately. Save the original packing carton for storage or possible reshipment.

1.6.2 Shipment Contents

The following items are included with every Model 3933A order:

- Model 3933A Phase Shifter
- Model 3933A Instruction Manual
- Power Cord
- Fuse 0.5A, 250V, 5.2 x 20mm (FU-96-2)
- Digital I/O interconnection cable (CA-94)
- BNC to BNC signal cable (Keithley Model 7051-2, -5, or -10)
- Additional accessories as ordered

1.6.3 Instruction Manual

If an additional instruction manual is required, order the manual package, Keithley part number 3933A-901-00. The manual package includes an instruction manual and any pertinent addenda.

1.6.4 Repacking For Shipment

Should it become necessary to return the Model 3933A for repair, carefully pack the unit in its original packing carton or the equivalent. Be sure to use a cardboard box of sufficient strength.

Include the following information:

- Advise as to the warranty status of the instrument.
- Write ATTENTION REPAIR DEPARTMENT on the shipping label.
- Fill out and include the service form located at the back of the manual.

1.7 OPTIONAL ACCESSORIES

The following accessories are available for use with the Model 3933A.

Models 3900-1 and 3900-2 Rack Mounting Kits: The Model 3900-1 mounts one Model 3933A in a standard 19 inch rack. The Model 3900-2 mounts two Model 3933A's, side by side, or one Model 3933A and one Model 3940A side by side. Both kits include all necessary hardware for proper rack mounting of the instruments.

Model 7007 Shielded IEEE-488 Cables: The Model 7007-1 (1m, 3.3ft.) and Model 7007-2 (2m, 6.6 ft.) can be used to interface the Model 3940 to the IEEE-488 bus.

Model 7051-2 BNC-to-BNC Cable: The Model 7051-2 is a 50 Ohm BNC-to-BNC cable (RG-58C), 2 feet (0.6m) in length. The Model 7951-2 is terminated with male BNC connectors at both ends.

Model 7051-5 BNC-to-BNC Cable: The Model 7051-5 is a 50 Ohm BNC-to-BNC cable (RG-58C), 5 feet (1.2m) in length. The Model 7951-5 is terminated with male BNC connectors at both ends.

Model 7051-10 BNC-to-BNC Cable: The Model 7051-10 is a 50 Ohm BNC-to-BNC cable (RG-58C), 10 feet (2.4m) in length. The Model 7951-10 is terminated with male BNC connectors at both ends.

1.8 SPECIFICATIONS

Detailed Model 3933A specifications may be found in Appendix A.

SECTION 2
Getting Started

2.1 INTRODUCTION

This section contains basic information on installation and power line connections. It also provides typical simple operating examples.

2.2 INSTALLATION

The following paragraphs discuss Model 3933A installation. Improper installation will adversely affect the life, reliability, and safety of the unit.

The Model 3933A weighs about 10 pounds. Be careful when carrying the unit or mounting it in a rack.

2.2.1 Installation Location

The allowable ambient temperature and humidity ranges for the Model 3933A are:

Operating: 0° to 40°C, 10 to 90%RH

Storage: –10° to 50°C, 10 to 80%RH.

Be sure to install the unit in a location that satisfies these temperature and humidity conditions. Also, the environment must be free of dust and vibration, and the Model 3933A must not be exposed to direct sunlight.

The Model 3933A uses an in-line electrical noise filter, but pulse noise or strong magnetic or electric fields may cause incorrect operation of the unit. Do not install the unit near a source of pulse noise or strong magnetic or electric fields.

WARNING

The guards on the rear panel of the unit are designed to protect rear panel connectors and should not be used as legs for installation. Do not stand the unit vertically on the rear guards, because it may fall over, causing instrument damage or personal injury.

2.2.2 Fan

The Model 3933A is air-cooled by a fan. Insufficient air flow may cause a component in the unit to fail. Follow the instructions given below.

CAUTION

Observe the following precautions to prevent damage to the unit:

An air intake port is provided on the rear panel of the unit. Allow a space of at least four inches between the rear panel and a wall or other obstruction.

An exhaust port is provided on the bottom panel of the unit. Install the unit on a rigid, flat surface, and avoid installing it on soft material, such as a cushion. Be careful not to insert foreign material between the bottom of the unit and the surface underneath. Another exhaust port is located on the top panel of the unit. Be careful not to block the top port by placing an object on top of the unit.

Avoid mounting two or more units vertically (for example, when using two or more units synchronously). Placing one unit on top of another will obstruct the exhaust port.

Dust collecting in the fan filter will prevent sufficient air flow. In a clean operating environment, wash the filter with a mild detergent every three months. When operating the unit in a dusty environment, wash the filter with a mild detergent at least once a month.

Immediately turn off the power to the unit if the fan ceases to operate. Operating the instrument with an inoperative fan may result in damage to the instrument.

2.3 LINE POWER SUPPLY AND GROUNDING

2.3.1 Line Power Supply

The Model 3933A operates with 100V, 120V, 220V, or 240V, ±10%, 48 to 62Hz, single-phase AC power supply. The power consumption is about 38 VA.

Line Voltage Selector Switch

The Line Voltage Selector switch on the rear panel allows you to change the operating voltage of the power supply. The standard setting of the switch is the same as the voltage in the country to which the unit is shipped.

To change the power supply voltage, first disconnect the line cord, and set the supply voltage switch in the correct position. Wait at least five seconds before turning the power back on after turning it off.

WARNING

Disconnect the power cord from the instrument before changing the supply voltage setting.

CAUTION

Be sure to set the line voltage switch to the correct position for the line power voltage to be used. Operating the instrument on an incorrect voltage may cause damage to the unit.

LINE Receptacle Connection

Connect the supplied power cord to the rear panel LINE receptacle and to a grounded AC power receptacle supplying the correct voltage.

WARNING

The Model 3933A is equipped with a 3-wire power cord that contains a separate ground wire and is designed to be used with grounded outlets. When proper connections are made, instrument chassis is connected to the power line ground. If the AC outlet is not grounded, the rear panel ground terminal must be connected to safety earth ground using #18AWG (or larger) wire before use.

Line Fuse

The line fuse protects the instrument from over-current situations. To replace the fuse, first disconnect the line cord, then unscrew the center cap with a small screwdriver. Replace the blown fuse only with the type listed in Table 2-1, then replace the fuse cap.

WARNING

Disconnect the line cord from the instrument before replacing the fuse.

CAUTION

Use only a fuse of the rating listed in Table 2-1, or instrument damage may occur.

Table 2-1. Fuse Replacement

Line Voltage	Fuse Current Rating	Keithley Part Number
110V, 120V	1A	FU-96-2
220, 240V	0.5A	FU-96-1

NOTE: Fuses are 5 x 20mm and have 250V, normal blow ratings.

2.3.2 Grounding

To prevent the possibility of electrical interference, ground the Model 3933A using the grounding terminal ⏚ on the rear panel.

WARNING
If the Model 3933A is not connected to a grounded AC outlet, be sure to connect the grounding terminal on the rear panel to safety earth ground using minimum #18AWG wire before use.

The Model 3933A uses the line filter circuit shown in Figure 2-1. The maximum leakage current at 250V/60Hz is 1mA rms. Touching the metallic part of the chassis of the unit may, therefore, cause an electric shock if the Model 3933A is not properly grounded.

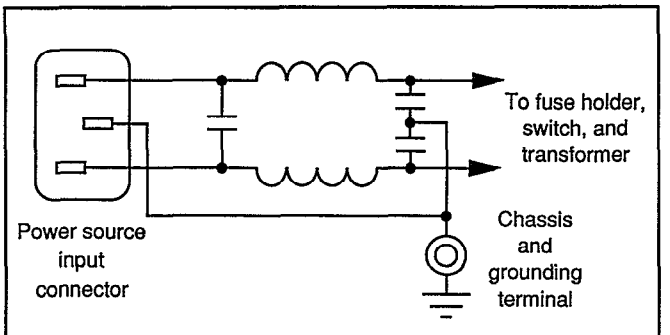


Figure 2-1. Line Filter

2.4 HANDLING PRECAUTIONS

A flat keyboard, coated with a polyester film, forms the control panel surface of the Model 3933A. Be careful not to damage the keyboard surface by cutting it with a sharp instrument or touching it with a hot object.

When the panel or case becomes dirty, clean it with a soft cloth. If the panel or case is too dirty for cleaning with a dry cloth, lightly dampen the cloth in mild detergent solution, and wipe the panel or case with the damp cloth. Never use solvents such as thinner or benzene, or chemical dust cloths, as these may damage the case or front panel surfaces.

2.5 BASIC OPERATION

The following paragraphs summarize front panel operating controls, give typical test connections, and discuss typical operating examples for the Model 3933A.

2.5.1 Front Panel Summary

Figure 2-2 summarizes each front panel feature. For detailed information on each operating feature, refer to Section 3.

2.5.2 Typical Test Connections

Figure 2-3 shows typical tests connections between the Model 3933A Phase Shifter and a device under test. Note that 50 ohm characteristic impedance cables, such as the Model 7051, should be used for all signal connections.

2.5.3 Operating Examples

The following examples give step-by-step instructions for setting basic Model 3933A operating parameters.

Example 1: Selecting the Waveform Type (Function)

The waveform type can be selected using the FCTN key, of the ENTRY group, as follows:

1. Press FCTN and note that the instrument displays the existing function and the available functions (sine, triangular, square, sawtooth, DC).
2. Press the number key corresponding to the desired function (0-5), or rotate the MODIFY knob until the desired function number is displayed. For example, press 3 to select the square wave function. The waveform will immediately change to the selected function.
3. Press DSPL to return to the normal display mode.

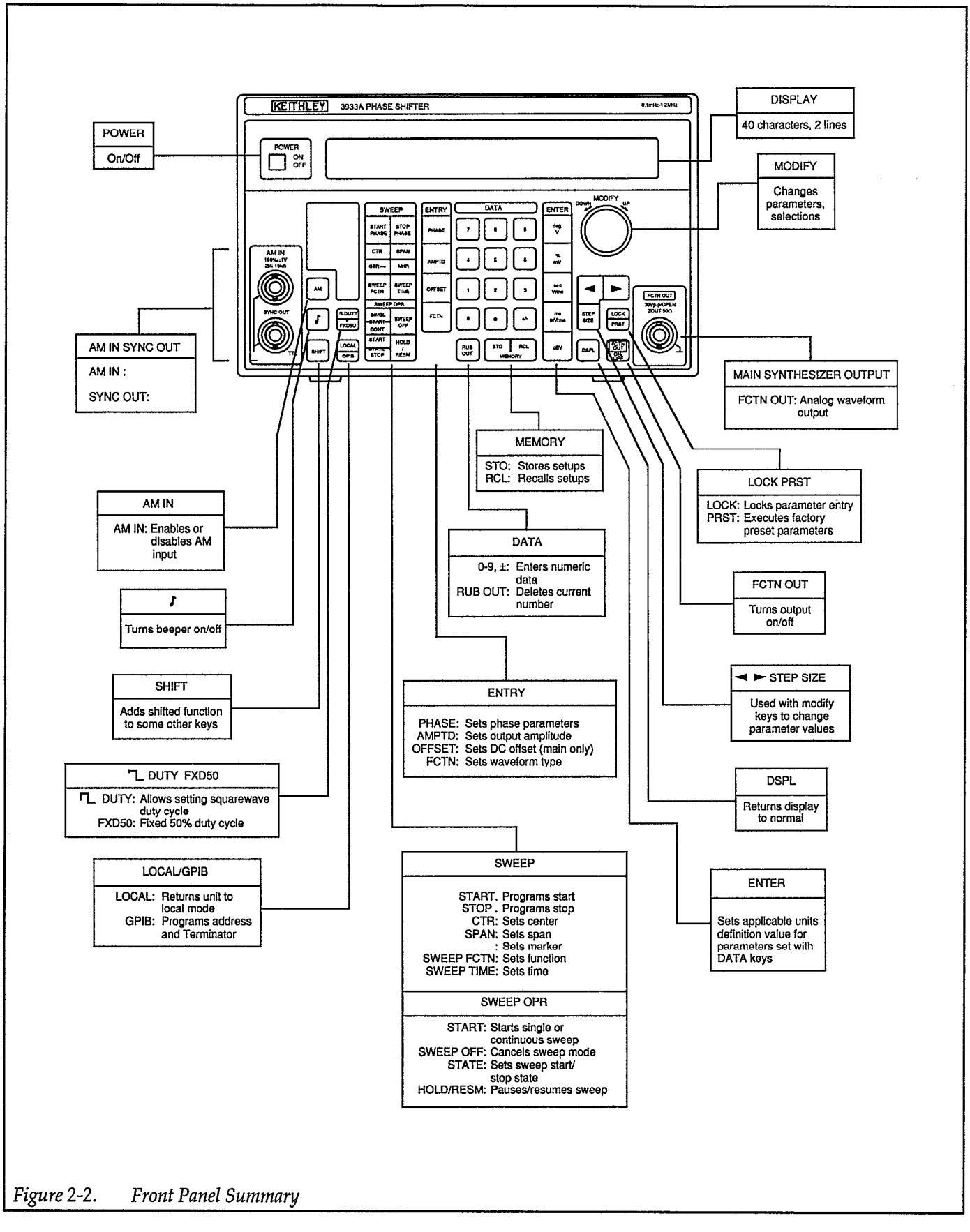


Figure 2-2. Front Panel Summary

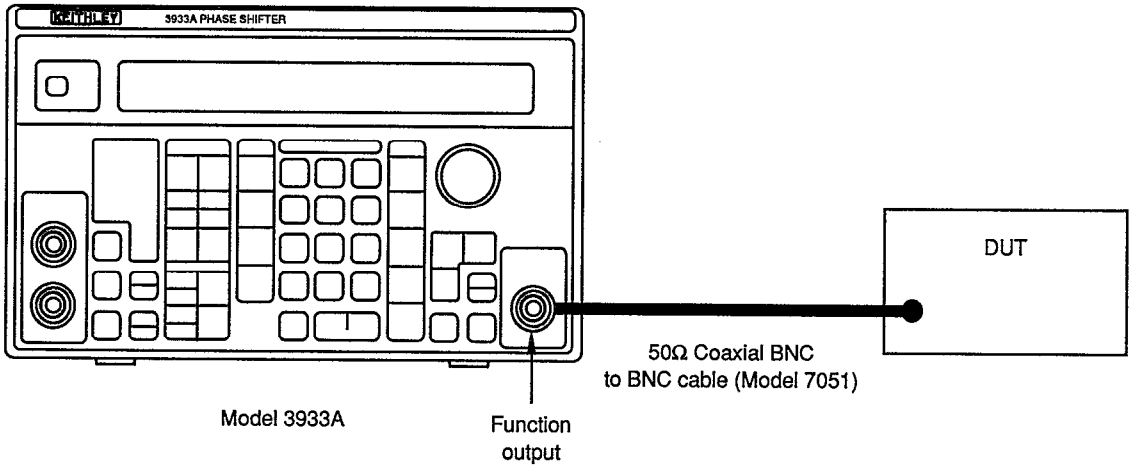


Figure 2-3. Typical Connections

Example 2: Setting the Output Amplitude.

Use the AMPTD key, of the ENTRY group, to set the output voltage amplitude as follows:

1. Press AMPTD, and note that the instrument displays the existing amplitude and allowed amplitude range.
2. To enter a completely new amplitude value in p-p units, press the keys for the desired numeric value, then press V or mV, as required. For example, to enter a 30mV p-p amplitude, press the following three keys: 3 0 mV.
3. To simply modify the existing amplitude value, use the cursor keys and the MODIFY knob to set the value as required.
4. Press DSPL to return to normal display.

Example 3: Programming the DC Offset

The OFFSET key allows you to set the DC or average level of the main synthesizer output waveform, as in the following example:

1. Press OFFSET and note that the instrument displays the existing offset value and allowed range.
2. Either press the numeric keys for the desired offset value, or use the MODIFY knob and/or cursor keys to change the value.
3. Press DSPL to return to normal display.

Example 4: Setting Phase Shift

The PHASE key allows you to set the amount of phase shift, in degrees, of the main synthesizer output waveform, as in the following example:

1. Press PHASE and note that the instrument displays the existing phase value and the allowed range.
2. Enter the desired phase shift value, or use the MODIFY KNOB and/or cursor keys to change the existing value.
3. Press DSPL to return to normal display.

SECTION 3
Operation

3.1 INTRODUCTION

This section contains detailed information on front panel and rear panel operation of the Model 3933A. For detailed GPIB (IEEE-488 bus) operation, refer to Section 4, GPIB Operation, in the manual for the Model 3930A Multifunction Synthesizer.

3.2 FRONT PANEL AND REAR PANEL DESCRIPTION

3.2.1 Input and Output Connections

CAUTION

Restrictions apply to input and output signal levels and signal types. Adhere to signal level and load characteristics as described below. or the instrument may be seriously damaged.

3.2.2 Input Connections

Two types of input signals may be applied through the front and rear panel BNC input connectors of the Model 3933A: LOGIC and ANALOG. The specifications of the input signals are given below.

BNC LOGIC INPUTS (Rear Panel)

Logic inputs include SWEEP SINGL START IN (single-sweep start input), and SWEEP HOLD IN (sweep hold input). Important specifications for these inputs include:

Input voltage: TTL level

Allowable maximum input voltage: 0V to +5V

Circuit: See Figure 3-1, Logic Input Circuits.

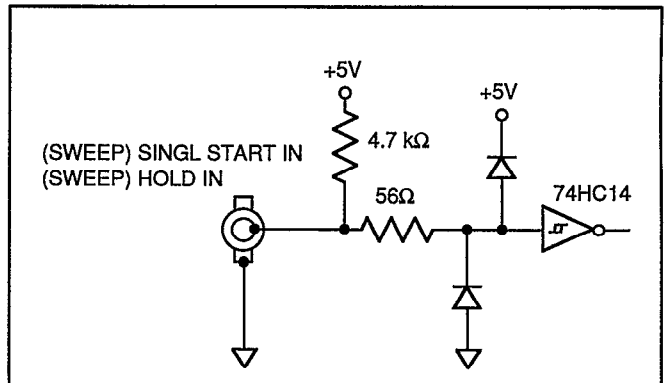


Figure 3-1. Logic Input Circuit

BNC ANALOG INPUT (Front Panel)

The AM IN BNC can be used to apply an external analog input signal which controls the amplitude of the waveform.

Input voltage range: –3V to +1V

Allowable maximum input voltage: ±15V.

Input phase range: DC to 100kHz.

Input impedance: Approximately 10kΩ.

Signal ground: insulated from ground.

Circuit: See Figure 3-2, Analog Input Circuit.

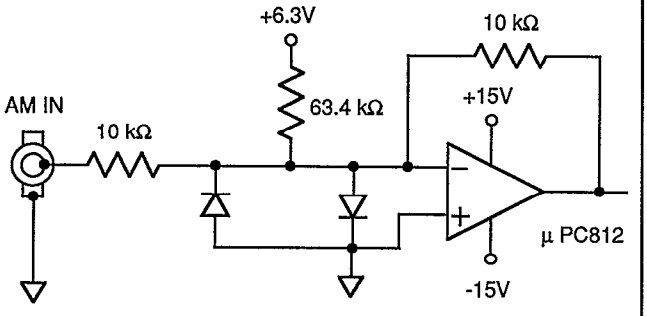


Figure 3-2. Analog Input Circuits

DIGITAL INPUT CONNECTOR (Rear Panel)

A third type of input is the DIGITAL INPUT. One digital, 36-pin, D-type input connector transfers MAIN SYNTHESIZER signals from a master Model 3930 to a Model 3933A slave unit, and between successive Model 3933A's in a chain of phase shifters. A jumper cable, CA-94 is required to interconnect units.

The main synthesizer signal from a Model 3930A (master unit) is applied to the DIGITAL IN connector on the rear panel of a Model 3933A (slave unit). If an additional phase shifter unit is chained to provide multiple phase operation, a second cable (CA-94) is connected from the DIGITAL OUT of the first slave, to the DIGITAL IN on the rear panel of the second slave unit. This may be repeated until a maximum of 5 (five) slave units are tied to a single master synthesizer. The DIGITAL IN and DIGITAL OUT signals at the rear panel of the slaves are identical to the master main synthesizer output signal.

Interconnection details are shown below, in Figure 3-3.

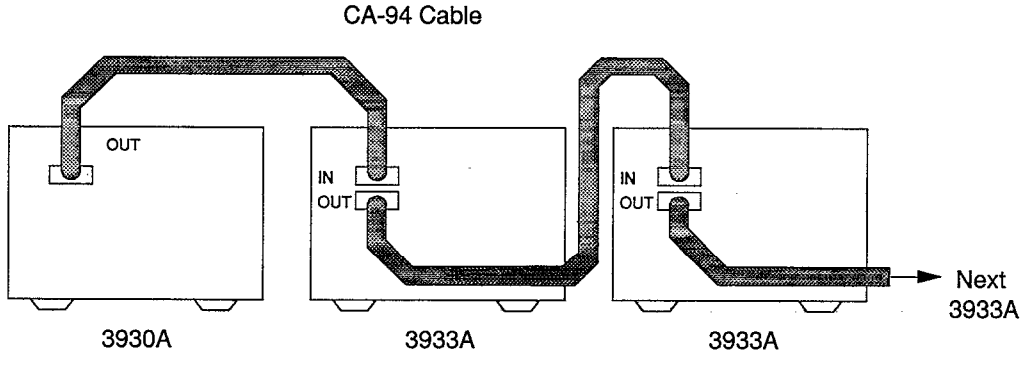


Figure 3-3. Typical Digital I/O Interconnections

3.2.3 Output Connections

Five output signals are available from various BNC connectors on the Model 3933A. The specifications for the output signals are given below.

CAUTION
Be careful not to connect an input signal to an output connector, or instrument damage may occur.

BNC LOGIC OUTPUTS (Rear Panel)

Logic outputs include the SWEEP SYNC OUT (sweep synchronous output) and SWEEP MKR OUT (sweep marker output). Specifications for these outputs are summarized below.

Output voltage: TTL level

Sweep MKR OUT and Sweep SYNC OUT are connected to ground.

Circuits: See Figure 3-4.

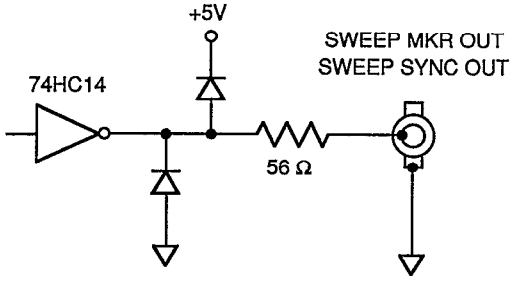


Figure 3-4. Sweep Marker and Sweep Synchronous Outputs

BNC LOGIC OUTPUT (Front Panel)

Waveform SYNC OUT (front panel synchronous output)

Output voltage: TTL level

Waveform SYNC OUT is electrically isolated from chassis ground.

Circuits: See Figure 3-5.

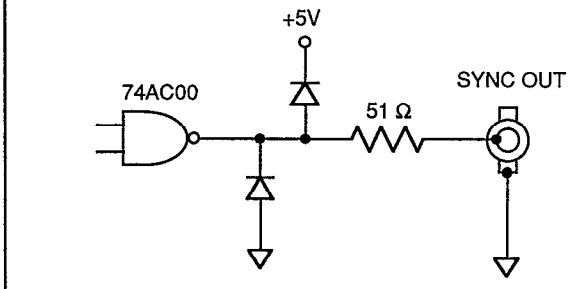


Figure 3-5. Waveform Synchronous Outputs

DIGITAL OUTPUT CONNECTOR (Rear Panel)

One digital, 36-pin, D-type input connector transfers signals among several Model 3933A's (up to 5) in a chain of phase shifters. A jumper cable, CA-94 is required to interconnect units.

BNC ANALOG OUTPUT (Rear Panel)

Sweep X Drive Out (Sweep X Axis Drive Output)

Output voltage: 0V to +10V/no load

Output impedance: 600Ω

Recommended load impedance: 10kΩ or more

BNC ANALOG OUTPUT (Front Panel)

Fctn Out (Waveform Output)

Maximum output voltage: ±15V/no load, ±7V/50Ω load

Output impedance: 50Ω

Recommended load impedance: 50Ω or more

OUTPUT CONSIDERATIONS

All logic outputs are driven by a 7400 family IC. Be careful not to connect a load that exceeds the drive capability of this TTL IC. Also, do not use excessively long connecting cables; the resulting capacitance may have detrimental effects on the output signals.

The interconnection between the Model 3930A Waveform Synthesizer (master), and the Model 3933A Phase

Shifter (slave), requires the special cable CA-94. Chaining multiple phase shifters requires the same cable.

The waveform synthesizer output impedance is 50Ω. To maintain maximum amplitude across the entire bandwidth, and for maximum square-wave quality, use a 50Ω coaxial cable for connections. Terminate the receiving end of the cable with a 50Ω impedance. The actual output voltage will be displayed by the Model 3933A if the output amplitude display is set for 50Ω loads.

3.2.4 GPIB Bus (Input/output Connector)

A GPIB connector on the rear panel permits remote control of all parameters which are normally accessed through phase shifter controls. The GPIB bus is both an input and an output system. See Section 4, GPIB Operation, in the Model 3930A Multifunction Synthesizer manual, for details.

3.2.5 Front Panel Description

The Model 3933A front panel, shown in Figure 3-6, contains the following:

- A two-line, 40-character liquid crystal display.
- A front panel with a built-in flat keyboard.
- 3 BNC I/O connectors.
- A rotary knob to modify certain parameters.
- A POWER ON/OFF button.

The liquid crystal display presents information useful for the operation of the Model 3933A, such as the value of each parameter and the range of permissible parameter values.

The flat keyboard includes a SHIFT key, which gives certain other keys a secondary function. Any key which is shaded with the same background color as the SHIFT key, requires that you press SHIFT first before accessing the function of that particular key.

Most settings are maintained in battery backed-up memory. As a result, on power-up, the Model 3933A automatically assumes the settings which were in effect immedi ately prior to the last power shut-down.

Key Representations

This section uses special representations such as [SHIFT], [MODIFY], or [SIZE] in the explanation of certain keys. For example, if [MODIFY] appears by itself, then it is the only one that applies. If both [MODIFY] and [SIZE] are shown, then both functions apply to that parameter. These representations indicate the following:

[SHIFT]	Press the SHIFT key, then press the applicable key to access the shifted key function. The liquid crystal display indicates "SHIFT" in the upper left corner when the Model 3933A is in the shift mode.
[MODIFY]	Enter the desired value using the DATA keys or change a given parameter value with the MODIFY knob. When [MODIFY] alone applies, the up/down step size, while incrementing or decrementing a value, is fixed at 1, and the cursor position is also fixed.
[MODIFY] [SIZE]	Both [MODIFY] and [SIZE] functions apply to this parameter. Specify the digit to be modified by placing the cursor under the desired digit, using ◀ or ▶. Then change the modify up/down increment using the STEP SIZE key.

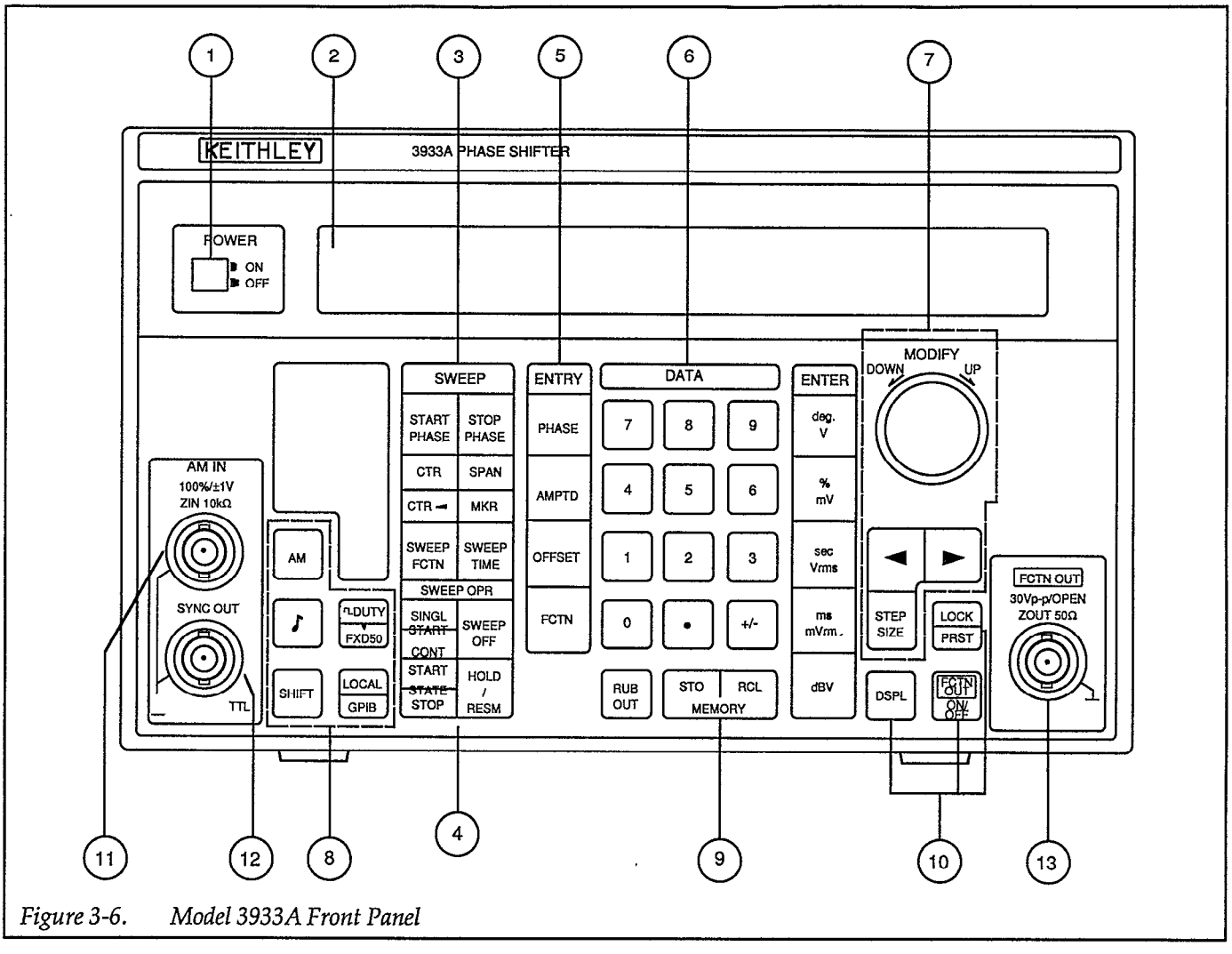


Figure 3-6. Model 3933A Front Panel

Detailed Descriptions

Each front panel feature is described below. The circled number to the left of each description corresponds to the appropriate number shown in Figure 3-6.

(1) POWER ON/OFF *(Power switch)*

POWER controls AC power to the Model 3933A. Press this switch once to turn power on. Press POWER a second time to turn the power off. An active display also indicates the instrument power is turned on.

(2) Display *(Power Indicator)*

The two-line, 40-character display shows parameter values and other important information during operation.

(3) SWEEP *(Phase sweep keys)*

The various SWEEP keys are used to program sweep functions such as start and stop phase, center, marker, span phase, sweep function and sweep time. The paragraphs below summarize the operation of these keys. Refer to the specifications located in Appendix A for details on the sweep range.

START PHASE *(Start phase)*
[MODIFY] [SIZE]

The START PHASE key allows you to set the sweep start phase. You can specify a start phase that is either higher or lower than the stop phase. The relationship between the start and stop phase values determines the sweep direction. If the start phase is higher than the stop phase, the sweep will be performed in a descending direction. If the start phase is lower than the stop phase, the sweep will be performed in the ascending direction.

STOP PHASE *(Stop phase)*
[MODIFY] [SIZE]

The STOP PHASE key allows you to set the stop phase of the phase sweep. You can specify a stop phase that is either higher or lower than the start phase. If the stop phase is higher than the start phase, the sweep will be performed in ascending order. If the stop phase is lower than the start phase, the sweep will be performed in descending order.

If the stop phase is changed, the sweep range will be determined by the new stop phase and the existing start phase.

CTR *(Center phase)*
[MODIFY] [SIZE]

The CTR key allows setting of the center phase of the sweep.

The relationship between the existing start and stop phase values determines the sweep direction. If the center phase is changed, the start and stop phase will be changed, but the span phase will remain constant.

CTR◀ *(Substitute center phase for marker phase)*
[SHIFT]

The CTR◀ key substitutes the center phase for the marker phase. The sweep direction and span phase are affected in the same manner as when using the center phase setting. If the substituted center phase is different than the marker phase, the start and stop phase will change accordingly.

SPAN *(phase span)*
[MODIFY] [SIZE]

This key allows you to set the phase span of the phase sweep. The relationship between the start and stop phase values determines the sweep direction. If the phase span is changed, the start and stop phase will be changed so that the sweep range is determined by the new phase span and the existing center phase. The existing center phase will not change.

MKR *(Marker phase)*
[SHIFT], [MODIFY] [SIZE]

This key allows you to set the marker phase of the phase sweep. Note that you can specify only one marker phase. While the oscillation frequency is higher than the programmed marker frequency during a sweep, the marker output signal available at the rear panel MKR OUT jack will be set low. The marker output signal at MKR OUT will be set high at all other times.

SWEEP FCTN *(Sweep function)*
[MODIFY]

The SWEEP FCTN key allows you to select the sweep function. Available sweep functions include: step (⌐¬), linear triangular wave and sawtooth wave (/\ or /|), and log triangular wave or sawtooth wave (/\ or /|).

With the step sweep function, the output phase simply changes between the start phase and stop phase at intervals determined by the sweep time. With the linear and log functions, the phase increases or decreases linearly or logarithmically, respectively.

SWEEP TIME *(Sweep time)*
[MODIFY] [SIZE]

The SWEEP TIME key allows you to set the sweep time, which is the time from the start phase to the stop phase. The allowed sweep time range is: 5msec to 9,999sec.

(4) SWEEP *OPR (Sweep Operation)*

SINGL START *(Single start: single-sweep start)*

This key starts a single sweep. Only one sweep will be generated per key press.

CONT START *(Continuous start: repeated sweep start)*
[SHIFT]

This key starts repeated sweeps, which will be generated continuously until halted with the HOLD/RESM or SWEEP OFF keys.

SWEEP OFF *(Sweep off)*

SWEEP OFF cancels the sweep mode. The phase will remain at the existing phase when this key is pressed, and the MKR OUT, SWEEP SYNC OUT, and X DRIVE OUT signals on the rear panel are set to high level, high level, and 0V, respectively.

START STATE *(Sweep start state: start phase output)*

This key resets the sweep and sets the output phase to the start phase.

When START STATE is pressed, the MKR OUT and SWEEP SYNC OUT signals on the rear panel will be set high. The X DRIVE OUT signal is set to 0V when the start phase is lower than the stop phase; the X DRIVE OUT signal is set to 10V when the start phase is higher than the stop phase. These signals can be used for scale adjustments of XY recorders.

STOP STATE (Sweep stop state: stop state)
[SHIFT]

STOP STATE performs the opposite function of the START STATE key in that it sets the output phase to the stop phase.

When STOP STATE is pressed, the MKR OUT and SWEEP SYNC OUT signals on the rear panel are set high. The X DRIVE OUT signal is set to 0V when the start phase is higher than the stop phase; it is set to 10V when the start phase is lower than the stop phase.

HOLD/RESM *(Hold/resume: temporary stop and resume)*

This key alternately stops and resumes the sweep.

Pressing HOLD/RESM while sweep is in progress will halt the sweep with the PHASE, MKR OUT, SWEEP SYNC OUT, and X DRIVE OUT signals present at that time maintained at their present values. Pressing HOLD/RESM with the sweep halted resumes the sweep, using the previous signal conditions.

(5) ENTRY *(Main parameter setting keys)*

PHASE *(Phase)*
[MODIFY] [SIZE]

Pressing PHASE allows you to set the output phase of the unit. The allowed phase range is from –360° to 360°. The amount of phase depends on the signal from the Model 3930A main synthesizer. The phase difference between the master Model 3930A signal and Model 3933A slave signal is:

(Model 3933A phase setting) – (Model 3930A start/stop phase setting)

If the Model 3930A's start/stop phase is anything other than 0°, the difference between the settings for both units does not change, regardless of the Model 3930A's oscillation mode.

AMPTD *(Amplitude)*
[MODIFY] [SIZE]

Pressing AMPTD allows you to set the output amplitude of the unit. The allowed amplitude ranges from 0.30mV p-p/no load to 30.0V p-p/no load when the DC offset is 0V and the output range mode is AUTO. The range becomes 0.00Vp-p to 30.0Vp-p in the FXD mode. In other cases, the upper and lower limits are restricted to the range specified in Table 3-1. The values for the amplitude setting are for no-load output conditions. The unit can be set to display either the no-load or 50Ω amplitude value (see below).

In the AUTO mode, amplitude setting may be set to rms or dBV value, as well as p-p.

You can specify the appropriate units by pressing the appropriate ENTER units key when entering the amplitude. Use mV or V for p-p values, mVrms or Vrms for rms values, and dBm for dB values.

OFFSET (DC offset)
[MODIFY] [SIZE]

The OFFSET key enables DC offset voltage programming. The allowed offset is between –15V/no load and 15V/no load for a DC waveform. For other waveform types, the offset range is restricted to the values specified in Table 3-1. All specified offset ranges are for no-load conditions.

FCTN (Function: waveform)
[MODIFY]

This key allows you to choose the output waveform of the phase shifter. Available waveforms include: DC, SIN ∿ (sine wave), ⩘ (triangular wave), ⎍ (square wave), ⩘ (ascending sawtooth wave), ⩘ (descending sawtooth wave).

If the output range is AUTO, and the waveform changes, p-p amplitude values are set automatically.

(6) **DATA** ***(Numeric keys for parameter entry)***

The DATA key set consists of numeric keys for entering a value and ENTER (units) keys for setting the units of the entered value. The . (decimal point) key and the +/– (sign inversion) key do not affect parameters for which they have no function.

Parameters which are selected with one numeric character, such as waveform and oscillation mode, do not require that any ENTER key be pressed. Such parameters are set simply by entering one numeric character (or by rotating the MODIFY knob as required).

For other parameters, enter the required value with the numeric keys, then press the appropriate ENTER units key to enter the units (deg, V, etc.).

The display will indicate the entered values and the cursor will flash beneath the least significant whole number. The MODIFY knob will allow you to change the value in the column indicated, while the cursor is flashing. After you have made any necessary modifications, press DSPL to return to the main parameter display and begin operation of the Model 3933A under the new settings.

If, while using the DATA numeric keypad, you enter an incorrect value, you will notice that the cursor is not visible. This indicates the MODIFY knob is not operational at this time.

For example, when changing PHASE, you want to set a new phase of 124 degrees, via the DATA keypad, but you erroneously enter "142". Since you haven't pressed the "deg" key on the ENTER pad, you have several options for changing the numeric input.

You can press the RUB OUT (delete) key. RUB OUT deletes the numeric character or decimal point from the rightmost position. Two strokes on the RUB OUT key will delete the "2", then the "4", leaving the "1" next to the decimal point. At this point, you simply enter "2", then "4", followed by the "deg" key. The display indicates "124 deg". Pressing DSPL completes the entry. Keep in mind, RUB OUT only works prior to entering the parameter units (V, deg, etc.).

If you have already pressed one of the ENTER keys, you will notice that the cursor is displayed and is blinking. You now have the option of using the MODIFY knob and the cursor movement keys (◀ and ▶). Place the cursor under the value to be changed and turn the MODIFY knob counter-clockwise to reduce the numeric value indicated by the cursor. A clockwise rotation will increase the value. The amount of increase or decrease depends on the setting of STEP SIZE (if applicable).

Another option is to simply press PHASE again (or any other appropriate ENTRY key), which will wipe out all your existing entries in the present display (other settings – AMPTD, OFFSET, FCTN – remain unaffected). Now, re-enter the proper numbers, plus "deg", then DSPL.

Pressing any appropriate ENTER key will enter the values for the MARK and SPAN waveform cycles and phase parameters, where only one type of unit is used. This also applies to the GPIB address, which does not contain parameter units. The Model 3933A will automatically select the appropriate unit value designation when two unit types are identified on one keypad face.

For amplitude, where parameters can be entered in different types of units, select the appropriate

units key from the ENTER key to complete entry of the value.

The units keys also have a units conversion function. This feature is available for unit conversions such as amplitude p-p/rms/dBV/dBm conversions. When the units key of the unit to be changed is pressed with the present setting displayed, the display will be changed to reflect the newly-selected units. Note, however, that the actual output remains unchanged.

0 *(Output Range Mode)*
[SHIFT] [MODIFY

The numeral "0" (zero) on the numeric key-pad has a second function when used in conjunction with the SHIFT key. An entry of [SHIFT] "0" brings up the output range mode display. The existing setting is displayed, with an option to toggle between AUTO and FXD. The display toggles between settings according to whether a "1" (one) or "0" (zero) is pressed. See section 3.5.2, Output Range Mode for details.

(7) **MODIFY *(Modify operation knob)***

In addition to using the numeric keys, you can set any parameter, except the GPIB address, delimiter, and memory number, by using the MODIFY knob.

The MODIFY knob is operational under the following two conditions:

The Model 3933A is in the appropriate parameter-entry mode.

And the displays indicates the present parameter value.

MODIFY *(Modify knob)*

When the step size is ±1, or ±5, you can select the digit to increase or decrease by placing the cursor under the appropriate digit (use ◀ or ▶) and turning the MODIFY knob to the right or left. Each knob increment increases or decreases the selected digit by a value of 1 (or 5).

When the step size is ×÷2, you can divide the selected parameter by 2 by turning knob counter-clockwise, or multiply the parameter by 2 by turning the knob clockwise.

Similarly, when the step size is ×÷10, you can divide or multiply the parameter by 10 by rotating the knob counter-clockwise or clockwise respectively. Note that the cursor will not be displayed when the step size is ×÷2 or ×÷10.

◀ *(Left cursor)*

This key moves the cursor to the left by one digit each time it is pressed.

▶ *(Right cursor)*

This key moves the cursor to the right by one digit each time it is pressed.

STEP SIZE *(UP/DOWN step size)*

STEP SIZE changes the MODIFY knob UP/DOWN step size value. For parameters with values that can be changed using variable step sizes, the step size will cycle in the following order each time this key is pressed: ±1 ×÷2 ×÷10 ... ±1.

(8) **MISCELLANEOUS KEYS**

LOCAL *(Return to local)*

LOCAL cancels remote, and returns the instrument to the local mode, when used over the GPIB.

GPIB *(GPIB Address: GPIB address, delimiter)*
[SHIFT]

The GPIB key allows you to program the GPIB primary address and the output delimiter used when the Model 3933A is acting as a GPIB talker. Only the numeric keys can be used for setting these parameters (the MODIFY knob cannot be used). The allowed range for the primary address is from 0 to 30, and the delimiter can be selected for CR/LF or CR (CR and LF or CR only).

The GPIB primary address is the integer part of this parameter, and the delimiter is defined by the fractional part. For example, a parameter of 2.0 indicates a primary address of 2 and defines CR/LF as the delimiter. Similarly, a parameter of

4.1 indicates a primary address of 4 with CR as the delimiter.

To change only the primary address, enter only the integer part of the number; the delimiter will remain unchanged. To change only the delimiter, enter the decimal point followed by the fraction (0 or 1); the primary address value will remain unchanged.

When programming the primary address and/or delimiter, remember that you must press any one of the ENTER keys to complete the entry process.

Note: when using multiple units in remote GPIB mode, it is necessary to program each unit with a unique address. The default is 2.0, which allows all units to acknowledge any GPIB command sent over the IEEE-488 bus.

This programming is achieved by pressing SHIFT, then pressing LOCAL/GPIB. When the display shows the 2.0 address, modify the parameter with the MODIFY knob or the DATA numeric keys to enter a unique address.

(Beep sound)
[SHIFT], [MODIFY]

This key controls the beep that sounds when you press front panel keys and when errors occur. You can turn the beep OFF (0) or ON (1).

DUTY *(Square-wave Duty Cycle)*
[MODIFY] [SIZE]

The DUTY key allows you to program the square-wave duty cycle. The allowed duty cycle ranges from 5.0% to 95.0%.

Two duty-cycle modes are available: 50% fixed and variable. In the variable mode, the upper frequency limit is restricted to 1MHz even if the duty cycle is set at 50%.

FXD50 *(Fixed 50% Duty Cycle)*
[SHIFT]

This key fixes the square-wave duty cycle at 50%.

SHIFT

The SHIFT key adds a secondary function to many other front panel keys. Those keys which have shifted functions are indicated by having a brown background color that matches the color of the SHIFT key. Keys with shifted functions include STOP STATE, CONT START, PRST, CTR ◀, MKR, GPIB, FXD50, and 0.

When the SHIFT key is first pressed, the unit enters the shift mode, and the liquid crystal display indicates "SHIFT" in the upper left corner. The shift mode is canceled when any key, including the SHIFT key, is pressed. If a key with a shift function is pressed, the unit enters that mode; otherwise, it returns to the mode it was in before SHIFT was pressed.

(9) MEMORY *(Memory operation keys)*

The MEMORY keys allow you to store and recall instrument setups. Ten groups of memory settings, numbered 0 through 9, are available for setup storage.

STO *(Store: store setup in memory)*

The STO key stores the displayed instrument setup parameters in the selected memory location (0-9). You can use only numeric keys to store setups (the MODIFY knob cannot be used). Pressing the numeric key will immediately store the existing parameter values in the selected memory location and erase the previous setup in that same memory location.

RCL *(Recall: read setup from memory)*

RCL reads instrument setups from the desired memory location (0-9) and displays them. Numeric keys are the only means of selecting memory locations to recall (the MODIFY knob cannot be used). Pressing RCL, followed by a single numeric key will immediately read the contents of the selected memory location into the display. Previous instrument settings will change accordingly.

(10) ADDITIONAL KEYS AND CONNECTORS

LOCK *(Lock out front panel keys)*

This key allows you to disable most front panel keys. Available modes are ON (1) and OFF (0).

When the lock is ON, most front panel keys are disabled, and the corresponding operating modes cannot be changed. However, both LOCK and FCTN OUT ON/OFF are still operational when the lock is ON. In addition, sweep control inputs from appropriate BNC connectors remain enabled.

Lock ON/OFF can also be programmed over the GPIB with the "LCK" command, and GPIB programming is not disabled when the lock is on. You can return the unit to local with the LOCAL key even when the lock is ON. However, you cannot return the instrument to local with the LOCAL key when the GPIB LLO (Local Lockout) command is in effect.

Existing parameter values, such as amplitude or phase, can be displayed by pressing appropriate keys when the lock is ON. The liquid crystal display will indicate "LOCK" in the position where the modification step size is normally indicated. Also, parameter names will not flash, and the cursor will not be displayed.

PRST (Preset)
[SHIFT]

The PRST key recalls the factory default preset operating parameters. Refer to the specifications in Appendix A for a summary of preset parameter settings.

DSPL *(Display: Phase Shifter main parameter display)*

DSPL displays the following Phase Shifter main parameters simultaneously:

Signal output ON/OFF (blank for ON)
Phase shift
Amplitude
DC offset
Waveform
Oscillation mode
Sweep mode (blank for normal oscillation)

Note that parameters cannot be programmed while the main parameter is displayed; you must press the appropriate parameter keys before setting parameters.

FCTN OUT ON/OFF *(Signal output ON/OFF)*

FCTN OUT turns the Phase Shifter output off or on. Each time this key is pressed, ON/OFF will toggle to the opposite state.

When FCTN OUT is OFF, the FCTN OUT signal will be open-circuited. The SYNC OUT signal will be identical to the output when FCTN OUT is set ON.

The liquid crystal display will indicate "OFF" in the upper left corner when the Model 3933A is in the FCTN OUT OFF mode (except in the SHIFT or REMOTE modes).

Note that the factory default setting for FCTN OUT is ON at power on.

(11) **AM IN** *(BNC Connector)*

This BNC plug is for the Amplitude Input signal. When the input signal is ±1 volt, the modulation factor is 100%.

(12) **SYNC OUT** *(BNC Connector)*

This BNC connector outputs the TTL level SYNC OUT waveform signal.

(13) **FCTN OUT Connector**

This BNC connector outputs an analog type signal from the waveform output. The maximum output voltage range from this connector is ±15 volts/no load. The output impedance is 50Ω.

3.2.6 Rear Panel Description

The Model 3933A rear panel contains five BNC connectors, two D-type connectors with 36 pins, and one D-type connector with 24 pins. Four BNC's are TTL level signals, one BNC is analog, and the three D-types are digital signals. All BNC signals are directly associated with SWEEP signals.

The following paragraphs describe, in detail, the connectors and other aspects of the Model 3933A rear panel, which is shown in Figure 3-7.

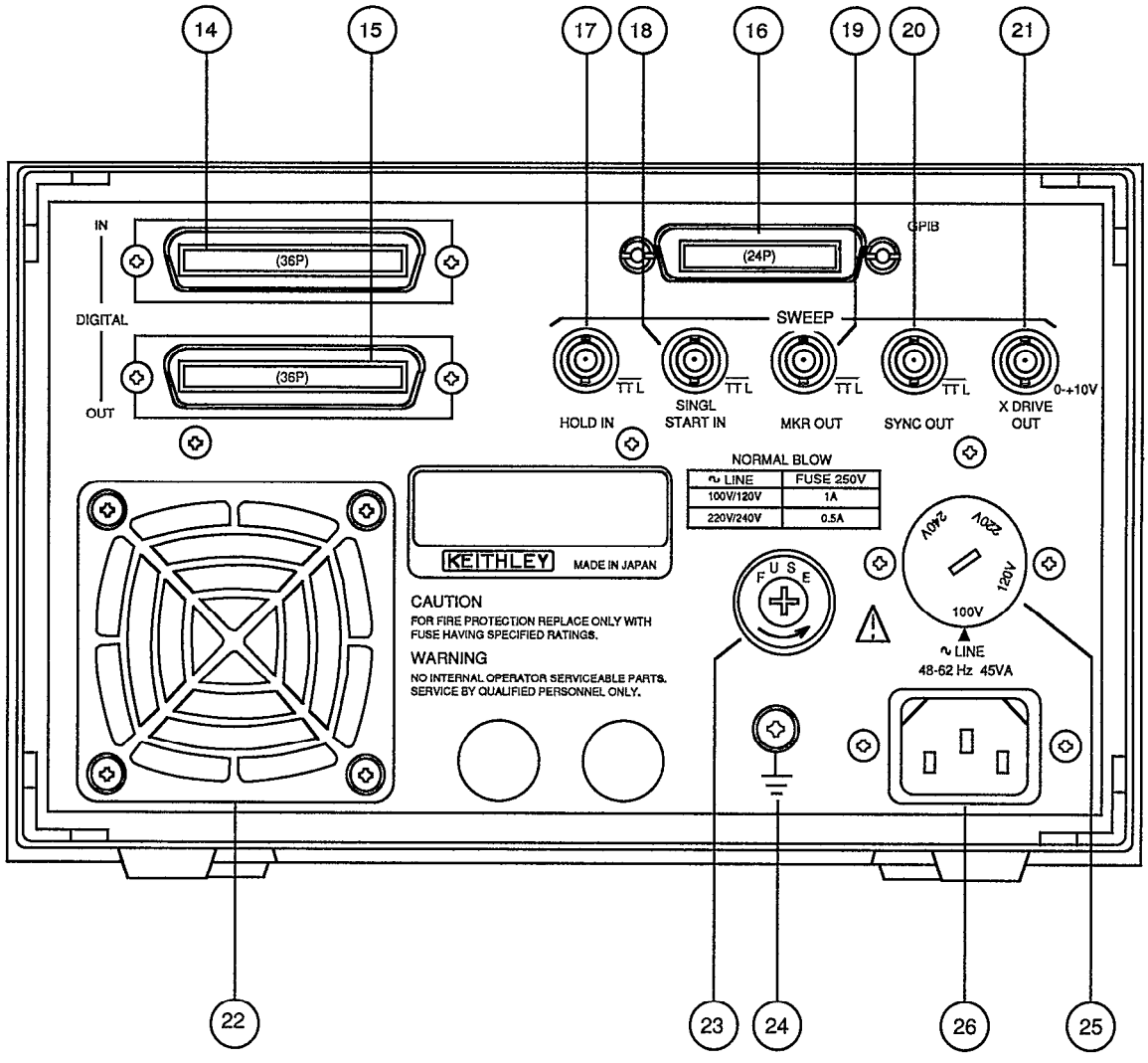


Figure 3-7. Model 3933A Rear Panel

(14) DIGITAL IN Connector

This 36-pin, D-type connector accepts the main synthesizer digital output signal from a master Model 3930A Multifunction Synthesizer unit.

(15) DIGITAL OUT Connector

This connector passes the signal from the DIGITAL IN connector to the next Model 3933A unit in the daisy-chain. These successive signals are identical to the original master main synthesizer signal.

(16) GPIB BUS Connector

This 24-pin, D-type connector accepts remote GPIB bus signals, allowing addressable codes to flow from a single remote station to selected master or slave units. The GPIB bus can change the same parameters and units that are accessed locally from the master or slave unit interfaces.

(17) (SWEEP) HOLD IN *(Sweep hold input)*

This BNC connector accepts a TTL-level signal used for sweep hold input. The sweep is halted as long as the input signal is at a low logic level.

(18) **(SWEEP) SINGL START IN** *(Single-sweep start input)*

This BNC connector accepts a TTL-level signal used to start a single sweep. A single sweep starts at the falling edge of the input signal.

(19) **(SWEEP) MKR OUT** *(Sweep marker output)*

This BNC connector provides a TTL-level signal used for sweep marker output. This signal goes low when the frequency rises above the marker frequency during a sweep. It remains high at all other times.

(20) **(SWEEP) SYNC OUT** *(Sweep synchronous output)*

This BNC connector provides a TTL-level signal for sweep synchronous output. This signal is at low level while a sweep is progressing from the start phase to the stop phase. It is at a high level at all other times.

(21) **(SWEEP) X DRIVE OUT** *(Sweep X-axis drive output)*

This BNC connector provides the signal for sweep X-axis drive output. The output voltage ranges from 0V to 10V, and it increases and decreases according to the sweep direction, as the sweep is generated. This output signal is intended for use as the X-axis drive for an oscilloscope or XY recorder.

(22) **AIR INTAKE PORT**

An air intake port is on the rear panel for cooling. Allow at least four inches of clearance behind the port and any obstruction.

When the air filter becomes dirty, pull out on the central plastic section of the air filter housing cover and remove the filter element. Clean the filter element with pressurized air or wash it with a mild detergent. Make sure that the filter is completely dry before re-installing it in the unit. The filter should be cleaned at least once every three months when used in a clean environment, or at least once a month in a dirty environment.

CAUTION

Immediately turn off the power to the unit if the fan ceases to operate. Be careful not to obstruct the exhaust ports on the upper and lower panels. Failure to observe these precautions may result in instrument damage.

(23) **FUSE** *(Line Fuse)*

The fuse holder cap can be removed with a Philips screwdriver. Turn the cap counterclockwise to access the fuse. Always use a fuse with an electrical rating that matches the input line voltage setting in use.

(24) ⏚ **(Grounding terminal)**

The grounding terminal is connected to the chassis of the Model 3933A. To prevent interference and for safety, be sure to ground this terminal.

WARNING

If the Model 3933A is connected to an ungrounded AC outlet, connect the grounding terminal to safety ground using #18AWG minimum wire before use.

(25) **LINE VOLTAGE SELECTOR** *(Supply voltage switch)*

This switch sets the Model 3933A for the correct line voltage. Using a flat-blade screwdriver, set the switch in the proper position for the supply voltage in your area.

WARNING

Disconnect the line cord before changing setting the switch position.

CAUTION

Operating the Model 3933A on an incorrect line voltage may result in instrument damage.

(26) **LINE** *(Power input connector)*

The LINE connector is used to connect the instrument to AC power.

WARNING
To avoid the possibility of electric shock, connect the Model 3933A to grounded AC outlet.

The fuse holder is located above, and to the left of, the LINE connector. The fuse can be replaced by disconnecting the line cord and unscrewing the fuse holder cap with a screwdriver. Replace only with the type indicated below.

Line Voltage	Fuse Current Rating	Keithley Part Number
110V, 120V	1A	FU-96-2
220, 240V	0.5A	FU-96-1

NOTE: Fuses are 5 x 20mm and have 250V, normal blow ratings.

3.3 STARTUP

1. Check that the supply voltage switch is set at the proper position for the supply voltage. The allowable supply voltage range is ±10% of the voltage at which the supply voltage switch is set.

CAUTION
Operating the Model 3933A in an incorrect line voltage may result in damage to the unit.

2. Make sure that the power is off, then plug the supplied power cable firmly into the LINE connector on the rear panel of the Model 3933A. Insert the power plug into a grounded AC power receptacle.

WARNING
To avoid the possibility of electric shock, use only a grounded AC receptacle for the power connection.

Turn on Model 3933A power by pressing in on the front panel POWER switch. Power is ON when the POWER switch button is depressed (in); power is OFF when the POWER switch button is released (out). When the power is turned on, the Model 3933A will begin normal operation, and the liquid crystal display backlight will turn on.

3. When the power is first turned on, the Model 3933A will return to the settings in effect prior to the last power-off, and the unit will display the phase shifter's main parameters.

If the previous settings were not stored correctly, the error code "Er MEMO11" message is displayed, factory preset parameters will be placed into effect and displayed. At this point, parameters in effect prior to the preceding power-off will be lost. This situation occurs when the memory backup battery has insufficient charge, and memory data cannot be maintained.

A fully-charged battery can retain memory for approximately 60 days. This period, however, varies slightly with ambient temperature and from one battery to another. Approximately 50 hours, with the unit connected to line power, are required to fully charge a dead battery.

When the battery no longer sustains sufficient charge for practical use, contact your Keithley representative or the factory for information on obtaining a replacement.

4. The backup battery may be discharged when the Model 3933A is used for the first time after being purchased, or if the unit has not been connected to line power for a considerable length of time. Connect the unit to line power for at least several hours to charge the battery.
5. Sweep operation mode parameters are not stored when the power is turned off. Therefore, turning the power off during sweep operation, sweep hold, end of single sweep, start phase output, or stop phase output, will result in a loss of sweep state information the next time power is turned on. At next power-up, the LCD will, however, indicate the output phase at the moment of previous shut-down.

Waveform output is not saved at shut-down and the Model 3933A is shipped with waveform output set to the "on" state during power-up sequencing. This can be set to "off" via an internal jumper pin. See the Model 3933A Service Manual for details.

6. If, at power-on, the phase shifter beeps and displays error code "Er NODT12" and the error message "NO SYNTH DATA COMING", there is a missing, or improper, digital signal at the rear panel of the slave Model 3933A.

This situation can arise under the following conditions:

- Master Model 3930A power switch is in the "OFF" position.

- A cable is not connected between the slave Model 3933A and a master Model 3930A.
- A digital cable is missing, or disconnected, between successive Model 3933A units in a phase shifter chain.

7. If, at power-on, the Model 3933A displays the error code "ER FRDT07", it indicates:

- The last time the power was turned off the waveform setting was "variable-duty-cycle" square wave.
- The master Model 3930's frequency exceeded 100kHz.
- In this case, the setting will automatically change to duty-cycle fixed 50%.

8. If, at power on, the Model 3933A fails to operate in one or more of the following conditions, contact your Keithley representative or the factory to determine the correct course of action.

- Unit does not power-up according to the mode and settings in effect immediately before last power-off.
- Unit does not power-up according to the preset operating modes.
- Main display does not appear.

Note: After turning off Model 3933A, wait at least five seconds before turning it on.

NOTE

For precise measurement applications, allow the Model 3933A to warm up for at least 30 minutes to allow internal circuits to stabilize.

3.4 OPERATING PROCEDURES

3.4.1 Setting Parameters Using Numeric Keys

When the appropriate parameter key such as FCTN, AMPTD, OFFSET, or PHASE is pressed, the parameter name and the present parameter value will be indicated in the upper part of the liquid crystal display. The allowed range of the parameter setting and useful help information will appear in the lower part of the liquid crystal display.

The parameter value can be changed when the parameter name indicated in the upper part of the liquid crystal display is flashing. The parameter name will not flash when the unit is in the GPIB remote mode, or when the front panel lock is enabled.

Some parameters, such as waveform, can be selected by pressing a single numeric character. Changes are made by simply pressing the numeric key corresponding to the desired setting, as shown in the display. An error message will be displayed if the entered value is outside the allowed range. Other displays and internal settings remain unchanged when an error occurs. Values may be changed as many times as desired, without leaving the present display. Pressing DSPL returns the display to the main settings and the final change will be indicated.

Example: Changing the waveform type from the present ∿ (sine wave) to ⊓ (square wave) or to ∧ (triangular wave).

Key Operation	Display Result
Press FCTN.	Existing waveform selection (<SIN>1) will be displayed.
Press 3	Waveform changes to <⊓ >3 (square wave).
Press 2	Waveform changes to < ∧ >2 (triangle wave).
Press 3	Waveform changes back to <⊓ >3 (square wave)
Press DSPL	Display indicates main settings, including final choice <⊓ >3 (square wave).

Parameters, such as amplitude and phase, which require units (deg, V, dbV, etc.) can be changed as follows:

- Press appropriate ENTRY key to select the desired parameter.
- Enter new numeric value (for phase or amplitude) with the numeric keys.
- Press appropriate ENTER key to add designator (V, deg, mV, etc.).

While entering the new value, the existing parameter value, unit display, and modification step size will disappear from the display, and the new value will be displayed. To correct an entered value during the entry process, press the RUB OUT key, which will delete one character at the units position (immediate left of decimal point) of the entered number. To re-enter the entire parameter value from the beginning, press the same parameter key to return to the corresponding parameter setting.

For amplitude, which has several unit value options, select and press the appropriate units key to complete the entry process. For phase and marker phase parameters, which have only single parameter units, press any one of the ENTER keys to complete entry.

Regardless of the number of digits for the entered value and the size of the units (sec, msec, V, mV, etc.), the predetermined number of digits, resolution, and units will be properly adjusted and displayed. When values below the display resolution are entered with the numeric keys, a beep tone will sound, an error message will be displayed. and the display will return to the previous value. Internal settings will remain unchanged when an error condition occurs.

Example: Change amplitude from a existing value of +178° to a new value, –98°, and then correct an erroneous entry of "95."

Key Operation	Display Presentation
Press PHASE	Existing parameter, "178 deg", will be displayed.
Press 9	The value of the key pressed, (9), will appear.
Press 5	The display now shows erroneous figure: "95".
Press Phase	The display again indicates the original setting of "178 deg".
Press ±	Display indicates "–". NOTE: This key is a character toggle between "+" and "–".
Press 9	The display indicates "–9".
Press 8	The display indicates the desired "–98".
Press deg	The display indicates the correct value "–98 deg".
Press DSPL	Entry is complete, and display shows main parameters, with desired phase values.

3.4.2 Setting Parameters with the MODIFY Controls

You can change parameter values with the MODIFY knob and cursor keys in the following cases:

1. The name of the parameter to be changed is blinking in the upper part of the liquid crystal display.

   The parameter name indicated in the upper part of the liquid crystal display will not flash when the unit is in the GPIB remote, or when the keyboard lock is on.

2. In the situation in step 1, the existing value specified is displayed and the modification step size is presented in the upper right corner of the liquid crystal display.

   Modification step size will not be displayed during numeric key input. Modification cannot be performed during numeric input.

For parameters which are selected with one numeric character, such as waveform and oscillation mode, the flashing cursor is fixed below the numeric character and cannot be moved. The step size is fixed to ±1 and cannot be changed.

For parameters that require units, such as amplitude, the step size can be changed by pressing the STEP SIZE key. It is not necessary to use a units key when changing the value with the MODIFY knob. When modifying an existing value, the modified value will automatically replace the old parameter value, and the existing units will remain unchanged.

When the step size is indicated in the right-most position of the liquid crystal display, each time the STEP SIZE key is pressed the step size will change in the following order ±1 ×÷2 ×÷10 ±1.

When the step size is ±1, you can specify the digit for UP/DOWN adjustment by placing the flashing underline cursor under the appropriate digit with the cursor keys, and turning the MODIFY knob to the right or left. When the step size is ×÷2 or ×÷10, the cursor will disappear, and you can multiply or divide the entire value by two or ten. Simply turn the MODIFY knob to the right or left. The step size and the existing cursor position will be stored with the respective parameters when those parameters are stored in memory.

Changing a value by modification will never result in an error because the modification process automatically limits parameter adjustments to the maximum allowed range for that particular parameter. The MODIFY keys cannot be used to store or recall memory locations, or to set the GPIB address and delimiter; only the numeric keys can be used to program these operating modes.

3.4.3 Error Codes

When an error occurs, the Model 3933A displays an error code in the upper right corner of the liquid crystal display, and the unit generates a long beep sound (if the beep sound setting is ON). The Model 3933A then displays the existing specified parameter value.

Displayed error codes and their meanings are summarized below. The error number at the end of each code name corresponds to the GPIB error code.

Er GPIB00

- The Model 3933A received a non-recognizable programming or inquiry command over the GPIB.

Examples:

"ABC 2" Non-recognizable programming command.
"?ABC": Non-recognizable inquiry command.
"123.4": Parameter values without headers.

- The Model 3933A received a command that is not recognized in the existing mode.

Example:

Phase setting command is given during sweep operation.

- The Model 3933A received a command string that is beyond the capacity of the GPIB input buffer.

Er UNIT01

- You attempted to specify an incorrect parameter unit.

Example:

You pressed the % or SEC key while setting the phase.

- You attempted to select an unacceptable unit for other settings.

Example:

You attempted to specify an amplitude value other than p-p for a DC waveform type.

Er PHASE03

- You attempted to set a phase value exceeding ±360°.
- You attempted to set values exceeding the allowable range for sweep start, sweep stop, center, or marker phase.
- You attempted to set a sweep center or span phase with a value exceeding the start or stop phase range.

Er AMPT04

- You attempted to specify an amplitude setting outside the range specified in Tables 3-1 and 3-2.

Er OFST05

- You attempted to specify a DC offset value greater than half the amplitude setting.

Table 3-1. Main Synthesizer Amplitude Range When DC Offset is 0 Volts

Output Range Mode	AC (p-p)	∿ rms	∿ dBV	Hardware Resolution (p-p)	Output Attenuator NOTE 3
AUTO	30.0V ~ 3.00V	10.6V ~ 1.06V	20.5 ~ 0.5	15mV	1/1
	2.99V ~ 300mV	1.05V ~ 106mV	0.4 ~ –19.5	1.5mV	1/10
	299mV ~ 30.0mV	105mV ~ 10.6mV	–19.6 ~ –39.5	150µV	1/100
	29.9mV ~ 0.30mV	10.5mV ~ 0.11mV	–39.6 ~ –79.2	15µV	1/1000
FXD	30.00V ~ 0.00V	(Vp-p only)	(Vp-p only)	15mV	1/1

Output Range Mode	AC (p-p)	∿ ◿ ◺ rms	∿ ◿ ◺ dBV	Hardware Resolution (p-p)	Output Attenuator NOTE 3
AUTO	30.0V ~ 3.00V	8.66V ~ 866mV	18.8 ~ 1.2	15mV	1/1
	2.99V ~ 300mV	865mV ~ 86.6mV	–1.3 ~ –21.2	1.5mV	1/10
	299mV ~ 30.0mV	86.5mV ~ 8.66mV	–21.3 ~ –41.2	150µV	1/100
	29.9mV ~ 0.30mV	8.65mV ~ 0.09mV	–41.3 ~ –80.9	15µV	1/1000
FXD	30.00V ~ 0.00V	(Vp-p only)	(Vp-p only)	15mV	1/1

Output Range Mode	AC (p-p)	⊓ rms	⊓ dBV	Hardware Resolution (p-p)	Output Attenuator NOTE 3
AUTO	30.0V ~ 3.00V	15.0V ~ 1.50V	23.5 ~ 3.5	15mV	1/1
	2.99V ~ 300mV	1.49V ~ 150mV	3.4 ~ 16.5	1.5mV	1/10
	299mV ~ 30.0mV	149mV ~ 15.0mV	–16.6 ~ –36.5	150µV	1/100
	29.9mV ~ 0.30mV	14.9mV ~ 0.15mV	–36.6 ~ –76.5	15µV	1/1000
FXD	30.00V ~ 0.00V	(Vp-p only)	(Vp-p only)	15mV	1/1

Table 3-2. DC-only Voltage Setting Range, Resolution, and Accuracy (open load, 18 to 28°C)

Output Range Mode	DC (+ or –)	Hardware Resolution	Accuracy	Output Attenuator NOTE 3
AUTO	15.0V ~ 1.50V	7.3mV	± (0.1% + 8mV)	1/1
	1.49V ~ 150mV	730µV	± (0.6% + 0.8mV)	1/10
	149mV ~ 15.0mV	73µV	± (1% + 80µV)	1/100
	14.9mV ~ 0.00mV	7.3µV	Not stipulated	1/1000
FXD	15.00V ~ 0.00V	7,3mV	± (0.1% + 8mV)	1/1

Er ACDC06

With a waveform other than DC and a non-zero DC offset (in other words, the DC offset was to be added to the AC waveform), you attempted to specify an invalid amplitude or DC offset value.

The following restrictions apply when adding DC offset to the AC waveform:

$$\frac{\text{AC amplitude setting [Vp-p]}}{2} + \text{DC offset voltage setting [Vp-p]} \leq 15 \text{ volts.}$$

- The amplitude setting must be equal to or larger than the minimum AC amplitude determined by the sum of the voltages above. In addition, the DC offset must not be added to limit the above restrictions. See Table 3-3 and paragraph 3.4.7 for more details on these restrictions.

Table 3-3. AC + DC Minimum Amplitude, Resolution, and Accuracy (open load)

Output Range Mode	Cumulative Voltage NOTE 4	Minimum AC Amplitude			Hardware AC Amplitude Resolution	Hardware DC Voltage Resolution	DC Voltage Accuracy	Output Attenuator NOTE 3
		p-p	∿ rms	∿ dbV				
AUTO	More than 1.5V	286mV	101mV	–19.9	15mVp-p	7.3mV	±(0.2% of AC amplitude setting (p-p) +0.1% of DC voltage setting +8mV)	1/1
	More than 150mV	28.6mV	10.1mV	–39.9	1.5mVp-p	730µV	±(0.2% of AC amplitude setting (p-p) +0.6% of DC voltage setting +0.8mV)	1/10
	More than 15mV	2.86mV	1.01mV	–59.9	150µVp-p	73µV	±(0.2% of AC amplitude setting (p-p) +1% of DC voltage setting +80µV)	1/100
	Less than 15mV	0.30mV	0.11mV	–79.2	15µVp-p	7.3µV	(Not stipulated)	1/1000
FXD	Not related to cumulative voltage	0.00V	(Vp-p only)		15mVp-p	7.3mV	±(0.2% of AC amplitude setting (p-p) +0.1% of DC voltage setting +8mV)	1/1

AC + DC Minimum Amplitude, Resolution, and Accuracy (open load) (Cont.)

Output Range Mode	Cumulative Voltage NOTE 4	Minimum AC Amplitude			Hardware AC Amplitude Resolution	Hardware DC Voltage Resolution	DC Voltage Accuracy	Output Attenuator NOTE 3
		p-p	∿ ⩘ ⩗ rms	dbV				
AUTO	More than 1.5V	286mV	82.5mV	–21.6	15mVp-p	7.3mV	±(0.2% of AC amplitude setting (p-p) +0.1% of DC voltage setting +8mV)	1/1
	More than 150mV	28.6mV	8.25mV	–41.6	1.5mVp-p	730µV	±(0.2% of AC amplitude setting (p-p) +0.6% of DC voltage setting +0.8mV)	1/10
	More than 15mV	2.86mV	0.83mV	–61.6	150µVp-p	73µV	±(0.2% of AC amplitude setting (p-p) +1% of DC voltage setting +80µV)	1/100
	Less than 15mV	0.30mV	0.09mV	–80.9	15µVp-p	7.3µV	(Not stipulated)	1/1000
FXD	Not related to cumulative voltage	0.00V	(Vp-p only)		15mVp-p	7.3mV	±(0.2% of AC amplitude setting (p-p) +0.1% of DC voltage setting +8mV)	1/1

AC + DC Minimum Amplitude, Resolution, and Accuracy (open load) (Cont.)

Output Range Mode	Cumulative Voltage NOTE 4	Minimum AC Amplitude			Hardware AC Amplitude Resolution	Hardware DC Voltage Resolution	DC Voltage Accuracy	Output Attenuator NOTE 3
		p-p	⊓ rms	dbV				
AUTO	More than 1.5V	286mV	143mV	–16.9	15mVp-p	7.3mV	±(0.2% of AC amplitude setting (p-p) +0.1% of DC voltage setting +8mV)	1/1
	More than 150mV	28.6mV	104.3mV	–69.9	1.5mVp-p	730µV	±(0.2% of AC amplitude setting (p-p) +0.6% of DC voltage setting +0.8mV)	1/10
	More than 15mV	2.86mV	1.43mV	–56.9	150µVp-p	73µV	±(0.2% of AC amplitude setting (p-p) +1% of DC voltage setting +80µV)	1/100
	Less than 15mV	0.30mV	0.15mV	–76.5	15µVp-p	7.3µV	(Not stipulated)	1/1000
FXD	Not related to cumulative voltage	0.00V	(Vp-p only)		15mVp-p	7.3mV	±(0.2% of AC amplitude setting (p-p) +0.1% of DC voltage setting +8mV)	1/1

NOTE 3: When switching the output attenuator, the waveform output goes off for a moment.
NOTE 4: Cumulative voltage = AC amplitude setting (p-p) divided by 2 plus DC voltage setting (V).
NOTE 5: DC voltage accuracy is when frequency is about 1kHz, ∿, AM off, open load, 18 to 28 degrees C.

Er FRDT07

- You tried to set the Model 3933A for a square wave with variable duty cycle while the Model 3930A was sweeping at, or set for, a frequency exceeding the square wave limit of 100kHz.

  The error is displayed and then the display indicates main parameters.

- The Model 3933A initiated a sweep exceeding the Model 3930A limit of 100kHz, or the Model 3933A was making a square wave of variable duty cycle, while the Model 3930A was set to a frequency value higher than 100kHz.

  Under these conditions, the duty cycle changes to fixed 50% and, following the error display, the duty cycle display appears.

- You tried to turn on the Model 3933A, and set it for a variable duty cycle square wave, while the Model 3930A was set for, or sweeping at, a frequency exceeding the square wave limit of 100kHz.

  In this case, the previous settings in memory are modified to produce a fixed 50% setting. Following the error display, the main parameters are displayed.

- When the Model 3930A is set beyond the 100kHz square wave limit, or it is sweeping beyond this limit, you tried to set a variable duty cycle by recalling a memory location containing that setting.

  Under these conditions, the recalled setting for square wave is changed to fixed 50%. Following the display of the error message, the main display is turned on. The actual data in that memory location is not altered.

Er SWP08

- You attempted to perform a sweep with a range of zero degrees.

Er RNGE09

- You attempted to specify a value outside the predetermined range, resulting in a condition other than errors 02 through 08.

Examples:

You entered a value of 6 during waveform selection.
You attempted to set the sweep time to 3msec.

Er CNVT10

- The result of the units conversion sequence is outside the allowed range of the given value.

Example:

You attempted to convert to an rms value when the waveform is set to sine wave with an amplitude of 0.30mVp-p. The Model 3933A automatically converts this to 0.10mVrms, which is below the lower limit of 0.11mVrms.

Er MEMO11

- A power-on error was found in the backup memory for one or more parameter settings. If this error occurs, preset values will be placed into effect, and you should make any new value settings using the front panel controls.
- An error was found in the contents of the memory while recalling parameters. Parameter settings will not be changed, and the Model 3933A will return to the prompt for the memory number to recall.

Er NODT12

- The Model 3933A (slave unit) has detected a problem between the Model 3930A (master unit) and itself, or a problem exists somewhere in the chain of master and slave units. A slave unit will not operate if the master unit is not powered-up or if there is a break in the communications link (Digital In/Out cables) from one slave to another, or between the master unit and a slave unit.
- If the slave unit detects that the power of the master unit is off, the signal output will be turned off, and the error display will appear. The Model 3933A slave unit will not recognize further parameter settings until the power of the master unit is turned on or the communications error condition is corrected.

3.4.4 Amplitude Units Conversion

Note that internal settings remain unchanged when the units conversion is performed. The Model 3933A automatically displays the result of units conversion as the existing specified value, and you can modify the value using the converted units, if desired.

p-p, rms to dBV: Press the dBV key when the Model 3933A displays the p-p or rms value.

p-p, dBV, to rms: Press the Vrms or mVrms key when the Model 3933A displays the p-p, or dBV value.

rms, dBV, to p-p: Press the V or mVrms key when the Model 3933A displays the rms or dBV value.

Note that amplitude conversion units do not correlate 1 to 1 with the original base unit. Therefore, following units conversion, rounding of units occurs with slight shift in display units caused by internal resolution limits. Thus, the system will never return to precisely the same settings following a conversion.

Phase

Pressing the PHASE key displays the present phase settings and allows you to modify that parameter. The allowed phase range is from –360.0° to 360.0°, with 0.1° resolution.

If the PHASE key is pressed during a sweep execution, the display indicates actual phase angle being executed at the instant the key is pressed. If the sweep is under HOLD control, the display indicates the phase being executed at the moment HOLD took effect. Under these conditions, the setting cannot be changed.

Under other conditions, where the system allows phase modification, the modifications can be made using either the numeric keypad and/or the MODIFY knob. The numeric position designated by the blinking cursor can be modified as follows:

- The indicated value can be increased or decreased by direct entry from the numeric keypad.
- The indicated value can be increased or decreased by the MODIFY knob, with each detent producing a specific stepped change in value.

  The step size change produced with the MODIFY knob is controlled by the STEP SIZE key. The value of the change is in four possible settings: ±1, ±5, ×÷2, and ×÷10.

  If the step size is ±1, a clockwise step of one detent of the MODIFY knob will produce a modification factor of +1 at the numeric position indicated by the blinking cursor. If the modification factor is ±5, the change will increase by five. A counterclockwise click will cause a corresponding decrease in value.

  A step size of ×÷2 or ×÷10 will react differently than the above modifications. In this case, a click clockwise will multiply by two or ten. A counterclockwise click will divide by two or ten. However, under these conditions, the entire numeric entry, not just the indicated numeric position, will be multiplied or divided. When changes are made with these step sizes, the first modified value will be rounded upward by the internal system and the results will not be a one-to-one correlation to the original value. However, each successive change will be mathematically correct.

  Modification via the MODIFY knob will have no further effect when the next increase or decrease operation will exceed the allowable limits. Thus, if the existing phase value is 240°, and you try to double that value via the MODIFY knob, while the step size is set at ×÷2, the operation of the knob has no effect on the numeric input.

  The Model 3933A's phase value is directly related to the signal output from the Model 3930A. The phase value is the offset from the master unit signal. The Model 3930A phase is considered phase one. The first Model 3933A, in any multiphase chain, is phase two. The second successive Model 3933A is designated as phase three, to the allowable maximum of six phases (one Model 3930A and five slaves). Phase, amplitude, offset and waveform may be set independently for each unit in the chain. See Figure 3.3 for details in setting up a multiphase system.

The primary basis for all phases is the 0° point of the first phase (master unit phase one). This is not sent directly to other units. This first phase is dependent on the start/stop settings of the master unit and that is directly dependent on the sweep trigger source. When a Model 3930A (master unit) is used alone, the phase settings work as start/stop parameters only when in burst and gate modes. However, when the master unit is hooked up to a Model 3933A slave unit, the master phase settings work the same way as those in a Model 3933A slave unit.

The phase difference between the master phase one and the Model 3933A phase is:

(Model 3933A phase) – (Model 3930A start/stop phase setting).

If the master phase is set to 0°, with no special limits, each unit's phase can be read directly.

Phase definitions for the available waveforms are illustrated in Figure 3-8.

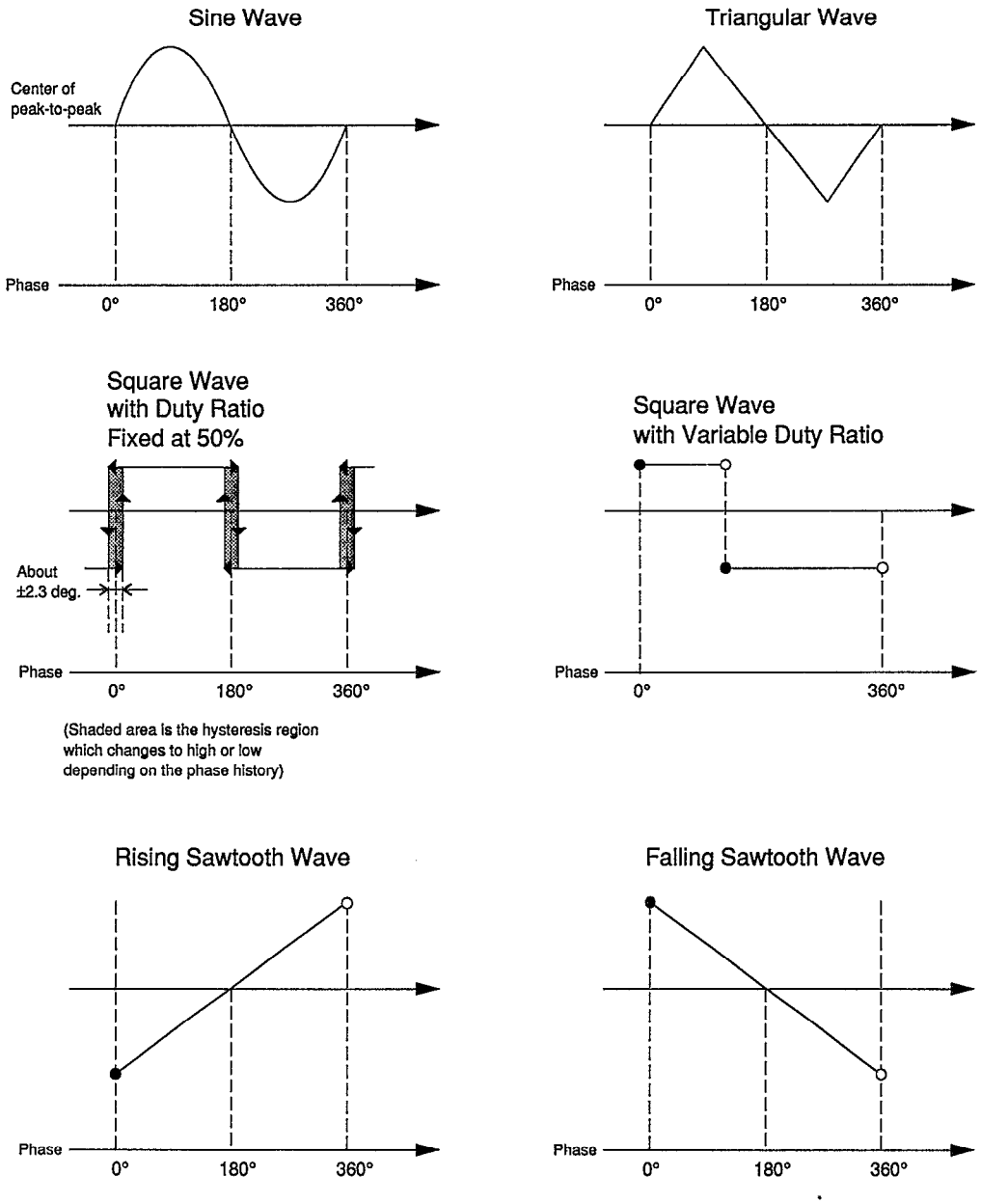


Figure 3-8. Waveforms and Their Phase Definitions

3.4.5 Amplitude Programming

Pressing AMPTD displays the existing amplitude setting and enables amplitude programming.

When using numeric keys to set the amplitude, press the appropriate units key to complete the entry process. Press V or mV to enter p-p units, use Vrms or mVrms for rms units, or press dBV for dB units.

The rms and dBV values are set on the assumption that the average, or center level, of the peak-to-peak amplitude of the waveform is 0V. Thus, these values do not depend on the DC offset value or square-wave duty cycle. You can use the MODIFY keys to change the amplitude.

The AMPTD key sets the amplitude for AC waveforms only; use the OFFSET key to set the DC output voltage of the DC waveform type. When the DC waveform is selected, you still can program the AC amplitude, but that value can be entered only in p-p units within the allowed amplitude ranges from 2.00mV p-p/no load to 20.0V p-p/no load. The specified value is stored, and it is used as the given amplitude for the next selected AC waveform.

For AC waveforms with 0V DC offset, you can specify any value within the maximum and minimum allowed amplitude limits without restrictions. If, however, the programmed DC offset is not 0V, certain restrictions concerning the maximum allowable amplitude apply. Paragraph 3.4.7 describes these restrictions in more detail.

When the main synthesizer amplitude is changed, an offset voltage may appear at the output jack for less than 1msec until the output stabilizes at its new value. In addition, an amplitude setting change, which causes output attenuator switching, may cause the output to be turned off for about 100msec during switching.

3.4.6 DC Offset Programming

Pressing the OFFSET key displays the existing DC offset value and enables offset programming.

When using the numeric keys to set the offset, press the V or mV key after entering the value to complete the entry process. As with other parameters, you can also use MODIFY key to change an existing offset value.

With a DC waveform, the programmed offset voltage is the DC voltage value that appears at the output jack. Valid offset values are within the range of +10V to –10V.

For all AC waveforms, the DC offset is added to the average value of the peak-to-peak amplitude of the AC waveform. Certain restrictions apply for amplitude-offset combinations, and some combinations of values may cause an error (Er ACDC07) to occur. See paragraph 3.4.8 below for more details.

When a DC offset setting that causes a change in output attenuators is programmed, the output may be turned off for approximately 100msec during the switching period.

3.4.7 AC Amplitude and DC Offset Relational Restrictions

AC amplitude and DC offset settings are subject to relational restrictions. See Table 3-3 (paragraph 3.4.3) and Figure 3-9 for more details on the interaction between these two parameters.

These restrictions are a result of the limitations in the maximum output voltage of the output amplifier. When the DC offset is added to the AC waveform, the output voltage peak will be the sum of the DC offset voltage and half of the AC waveform amplitude. This voltage is known as the total voltage and is related as follows:

$$\frac{\text{Set AC amplitude (Vp-p)}}{2} + \text{Set DC offset voltage (V)}$$

This voltage is limited by the maximum output voltage of the output amplifier.

Example:

An error will occur when you try to set the DC offset to 6V/no load when the amplitude is 10V p-p/no load. (The total voltage exceeds 10V/no load.)

Example:

An error will occur when you try to set the amplitude to 100mV p-p/no load when the DC offset is 5V/no load. (The minimum AC amplitude when the total voltage is over 1V/no load is 200mV p-p. The amplitude setting is below the minimum amplitude value.)

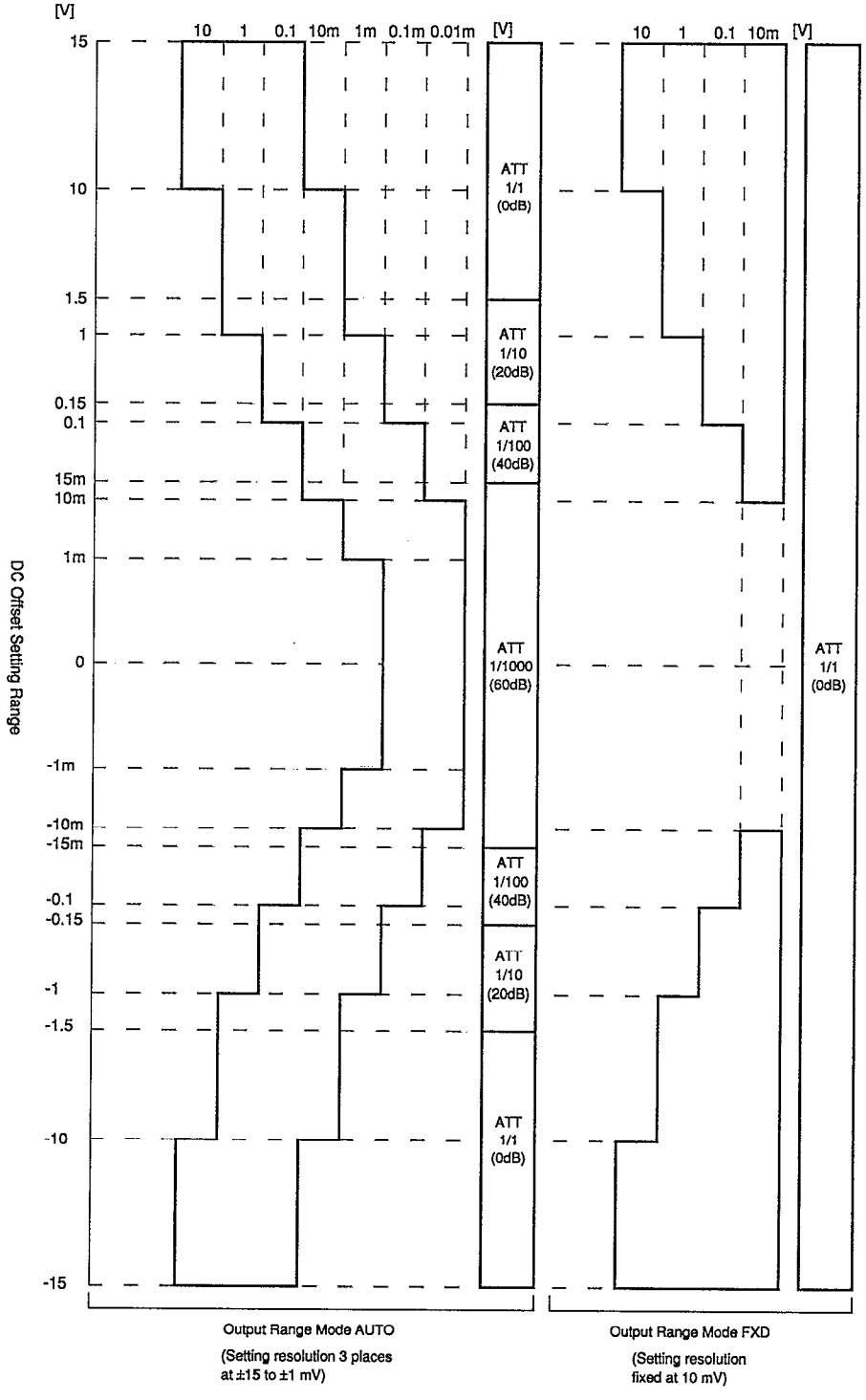


Figure 3-9A. Relational Range for Allowed AC Amplitude Voltage and DC Offset Voltage

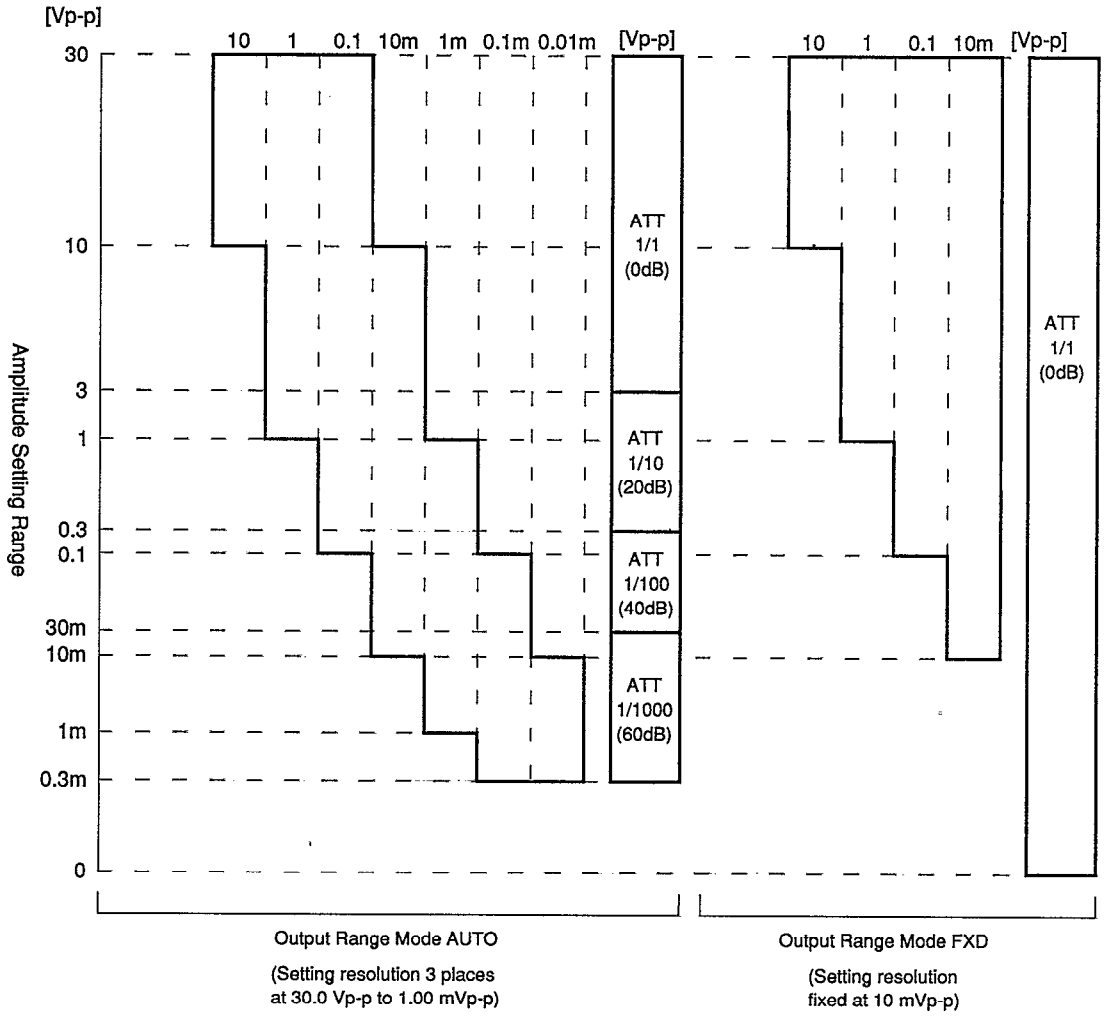


Figure 3-9B. Relational Range for Allowed AC Amplitude Voltage and DC Offset Voltage

Even valid combinations may cause errors in the process of setting up those combinations. To avoid such errors, reset the DC offset value to 0V before changing the amplitude, or change the setting specified in Figure 3-9 so that the values are within the range of allowed settings.

Example:

Suppose that the existing amplitude is 100mV p-p/no load and the DC offset is 500mV/no load. Assume that you want to use an amplitude of 500mV p-p/no load and a DC offset of 5V in combination. An error will occur if you set the DC offset to 5V before setting the amplitude. (The minimum AC amplitude when the total voltage is over 1.5V/no load is 286mV p-p. The existing amplitude setting is below the minimum amplitude value.) If you set the amplitude to 500mV p-p first, and then set the DC offset to 5V, you can obtain the desired amplitude and offset values without causing an error.

3.4.8 Waveform Selection, Square-Wave Duty Cycle, and Synchronous Output

Waveform Selection

Pressing the FCTN key displays the existing main synthesizer waveform along with its corresponding number and enables main synthesizer waveform selection. Available main synthesizer waveforms include: DC, SIN (∿) ⊓, ⋀, ◿, and ◺.

To select a waveform with the numeric keys, simply press the numeric key that corresponds to the desired waveform. For example, press 1 to select a sine wave. The waveform will change immediately when the corresponding key is pressed. It is not necessary to press a units key.

When the Model 3933A displays the existing waveform, and FUNCTION parameter selection is enabled, you can change the waveform by turning the MODIFY knob. Turning the knob clockwise increases waveform numbers, while turning the knob counterclockwise decreases waveform numbers. The number changes by a value of one for each detent. When the highest or lowest waveform numbers are reached, the number will wrap around to the lowest or highest selection. Allowable selections range from zero through five.

For all AC waveforms, the p-p value of the amplitude will remain unchanged when you change the waveform. If the output range mode is AUTO, and amplitude is either rms or dBV, the amplitude will be converted to p-p units when the waveform is changed.

Square-wave Duty Cycle

The duty cycle is the ratio of the waveform high-level duration to one complete cycle of the waveform. This ratio is expressed as a percentage. For example, a 10kHz square wave has a time period of 100µsec. If the high portion of the waveform has a period of 30µsec, the duty cycle is $30/100 \times 100 = 30\%$.

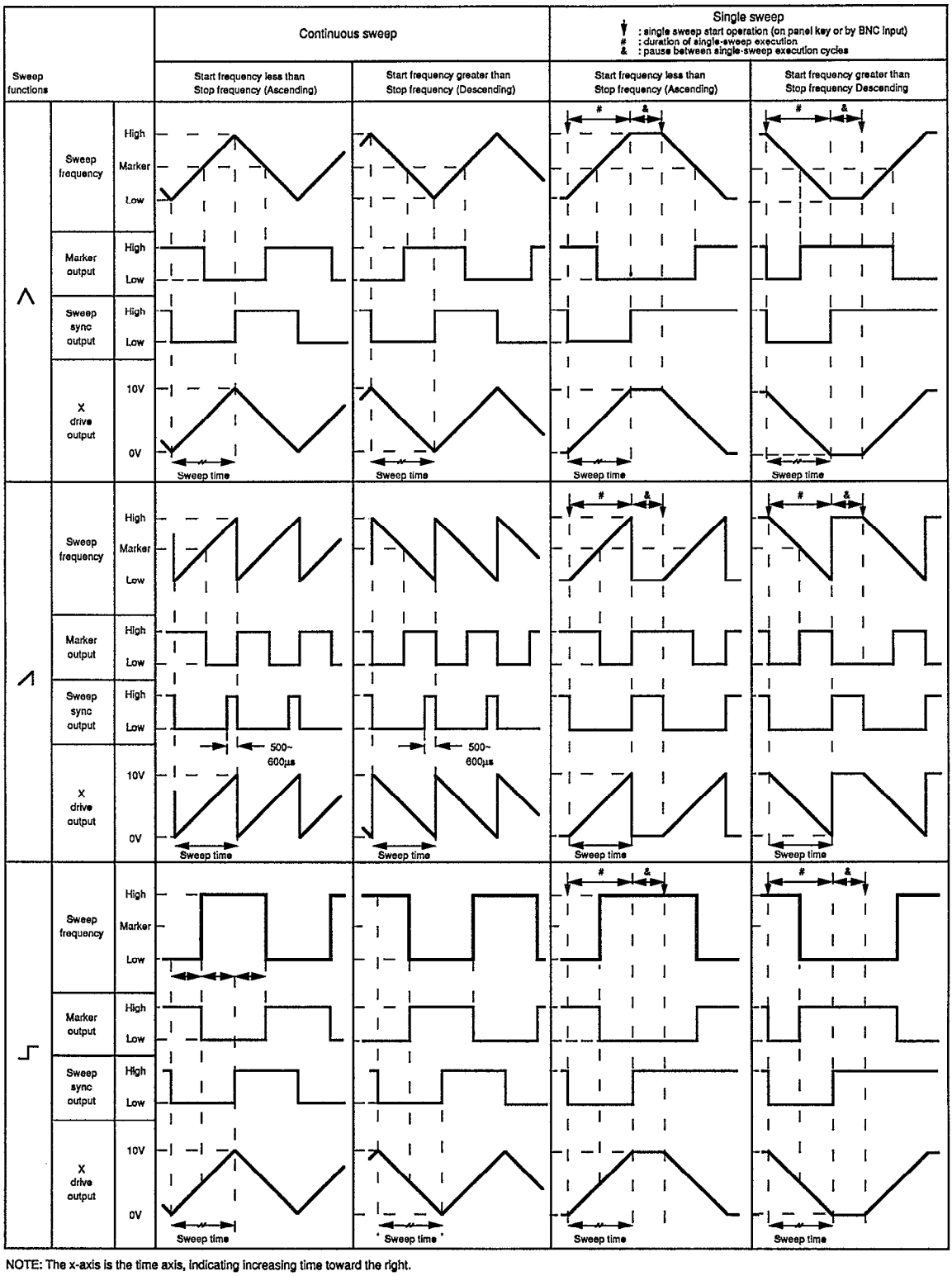
Two square-waveform duty cycle modes are available: a duty cycle fixed at 50%, and one with a variable-duty-cycle. The duty cycle applies only to the square-wave function (waveform 3), although the duty cycle can be programmed while other waveforms are selected.

To change the duty cycle, press the ⊓ DUTY key. When the display indicates duty cycle, enter the new value via the numeric keypad, or modify the duty cycle with the MODIFY knob. The allowable variable range is 5.0% to 95.0%. If the Model 3933A is set to variable duty cycle, it will remain in that mode even if you set the duty cycle to 50%. To select the fixed 50% duty cycle mode, press SHIFT FXD50. In the duty cycle display mode, the Model 3933A displays "FXD" for the 50% fixed mode or "VAR" for the variable duty cycle mode.

When the Model 3933A is in the variable duty cycle mode, the upper-frequency limit is 1MHz, and the maximum jitter is below 150nsec. The Model 3933A has a resolution of 0.1% for duty cycle display, but the hardware resolution is 0.4% (8 bits). As a result, if you make a duty cycle change lower than the hardware resolution factor, only the displayed value will change, not the duty cycle of the actual output.

Synchronous Output

Figure 3-10 illustrates the phase relationship between the waveform and outputs at frequencies below 1kHz. Typical jitter between the main synthesizer waveform output and the main synthesizer synchronous output is about 9.1nsec.



NOTE: The x-axis is the time axis, indicating increasing time toward the right.

Figure 3-10. Phase Relationship Between Waveform and Output

3.4.9 Mark, Span, and Phase Parameter Programming

Mark and Span Parameter Programming

Pressing the SPAN key displays the present span parameter and enables span parameter programming. Similarly, pressing the SHIFT MKR key displays the present marker parameter and enables marker parameter programming.

To program the MKR and SPAN parameters using the numeric keys, enter the desired value, and press the appropriate ENTER key to complete the entry process.

When the Model 3933A displays the existing MKR or SPAN value, and parameter entry is enabled, you can change the MKR or SPAN value with the MODIFY knob. When the step size is ±1, you can specify the digit to modify by placing the flashing cursor under the appropriate digit and turning the MODIFY knob to the right or left. When the step size is ×÷2 or ×÷10, you can divide or multiply the value by the step size by turning the MODIFY knob to the left or right.

The relationship between START PHASE, STOP PHASE, SPAN PHASE, CTR PHASE, and MKR PHASE is shown in the following example.

- You set the phase shifter to execute a START PHASE at 270°.
- You set STOP PHASE at 129.5°.
- The Model 3933A automatically sets the SPAN to 140.5°, and CTR becomes 199.7°.

The calculations are as follows:

- SPAN = start phase – stop phase (270 – 129.5 = 140.5)
- CTR = span phase – 2 + stop phase (140.5/2 = 70.25, 129.5 + 70.2 = 199.7; NOTE: 70.25 is rounded to 70.2)

Marker is not affected by this sequence.

SWEEP FUNCTION

There are three types of sweep functions available: (recipro), (repeat), and (step). The (recipro) type starts execution at the start phase, continuing through to the stop phase, where it then reverses direction to the start phase setting. The (repeat) type moves from the start phase through to the stop phase, instantly resets to the start phase and, if required, begins another sequence. The (step) type outputs the start phase signal, instantly changes to the stop phase signal, then repeats the entire cycle, as required.

Sweep time varies with the chosen sweep function. The actual sweep time is shown below.

- When chosen function is (recipro), actual sweep time is:
  1. Execution time from start phase to stop phase.
  2. Execution time from stop phase to start phase.
  3. Half the execution time of a repeated continuous sweep.
- When chosen function is (repeat), actual sweep time is:
  1. Execution time from start phase to stop phase.
  2. Execution time of one continuous sweep.
- When chosen function is (step), actual sweep time is:
  1. Execution time for start phase signal in continuous sweep.
  2. Execution time for stop phase signal in continuous sweep.
  3. Half the execution time for a continuous sweep.

3.5 SWEEP OPERATIONS

Starting a Continuous Sweep

Press SHIFT key, then CONT START key. The display indicates phase values as they are executing, and the message: CONT SWEEP EXEC (EXIT: SWP OFF). The phase parameters cannot be set during a continuous sweep operation.

Starting a Single Sweep

Press the SINGL START key to initiate a single sweep. During a single sweep, the Model 3933A displays the sweep phase, and the following message: "SINGL SWEEP EXEC (EXIT:SWEEP OFF)". You cannot set the phase with the PHASE key while the unit is generating a single sweep.

When the Model 3933A terminates a single sweep, it displays the terminated sweep phase, along with the following message: "SINGL SWEEP END". Once the sweep has terminated, you can program the output phase with the PHASE key. The MKR OUT and SWEEP SYNC OUT signals go high, and the X DRIVE OUT signal is set to 0V at the end of the sweep.

Holding/Resuming a Sweep from the Front Panel

To temporarily halt execution of a continuous or single sweep, press the HOLD/RESM key. The Model 3933A stops the sweep operation immediately, and displays the phase at which it stopped the sweep. The MKR OUT, SWEEP SYNC OUT, and X DRIVE OUT signals maintain their present values when the sweep is halted.

When a continuous sweep is paused, the Model 3933A displays "CONT SWEEP HOLD (EXIT:SWEEP OFF)"; similarly the unit displays "SINGL SWEEP HOLD (EXIT:SWEEP OFF)" when a single sweep is paused. When the Model 3933A is in the sweep hold mode, you cannot program the phase with the PHASE key.

To resume a sweep starting at the frequency at which you stopped sweep operation, press the HOLD/RESM key again.

Turning a Sweep Off to Enable Normal Phase Programming.

Press the SWEEP OFF key during a sweep or sweep hold to turn off a sweep and enable normal PHASE key programming. The MKR OUT and SWEEP SYNC OUT signals will be set high, and the X DRIVE OUT signal will be set to 0V.

When the SWEEP OFF or PHASE keys are pressed at the completion of a single sweep, during start phase output, or during stop phase output, normal phase programming will be enabled. In addition, the MKR OUT and SWEEP SYNC OUT signals will be set high, and the X DRIVE OUT signal will be set to 0V.

Setting the Output to the Start Phase

Press the START STATE key to set the output waveform to the programmed start phase. During this mode, the Model 3933A displays the start phase along with the following message: "SWEEP START STATE". The MKR OUT and SWEEP SYNC OUT signals also go high during the start phase mode. The X DRIVE OUT signal is set to 0V if the start phase is lower than the stop phase; it is set to 10V if the start phase is higher than the stop phase.

When the Model 3933A is in this mode, pressing the PHASE key enables normal phase programming and sets the X DRIVE OUT signal to 0V.

Setting the Output to the Stop Phase

Press SHIFT STOP STATE to set the output waveform to the programmed stop phase. While in this mode, the Model 3933A displays the stop phase along with the following message: "SWEEP STOP STATE". During the sweep stop state, the MKR OUT and SWEEP SYNC OUT signals are set high. X DRIVE OUT is set to 10V if the start phase is lower than the stop phase; it is set to 0V if the start phase is higher than the stop phase.

When the Model 3933A is in this mode, pressing the PHASE key enables normal phase programming and sets the X DRIVE OUT signal to 0V.

Stopping Sweep Output to Enable Setting of Phase Parameters

If the Model 3933A is executing a sweep, or is under HOLD control, you must press SWEEP OFF to enable phase parameter modification. At this time, MKR output and SWEEP SYNCHRONOUS output are set high, and X DRIVE output is set to 0V.

If SWEEP OFF or PHASE are pressed when single sweep has terminated, or start phase and stop phase are in the output state, phase programming is allowed. MKR and SWEEP SYNCH outputs will be set high and X DRIVE output is set to 0V.

Starting a Single Sweep Using an External Signal

A TTL-level, falling-edge signal(⩛), applied to the SINGL START IN BNC connector, starts a single sweep. This signal performs the same operation as pressing the SINGL START key.

SINGL START IN is internally pulled up to a high logic level, and sweep operation is not affected when the this connector is left disconnected from external signals.

Holding/Resuming a Sweep with an External Signal

A TTL low level signal, applied to the SWEEP HOLD IN BNC connector, places the Model 3933A in the sweep

hold mode. In the sweep execution mode, the Model 3933A halts the sweep as long as this input remains low. If you attempt to start a sweep when this input is low, the Model 3933A immediately enters the sweep hold mode. Note that pressing HOLD/RESM does not resume sweep operation with the hold signal held low; you must set SWEEP HOLD IN high to resume the sweep.

SWEEP HOLD IN is internally pulled up to a high logic level, and sweep operation is not affected when this connector is left disconnected from external signals.

3.5.1 Sweep Phase and Sweep Output Relationships

Figure 3-10 illustrates how sweep PHASE, MKR OUT, SWEEP SYNC OUT, and X DRIVE OUT signals change with time.

The MKR OUT signal is low when the sweep phase is higher than the marker phase. When the sweep function is or , the high signal level is maintained even after a single sweep is terminated.

The SWEEP SYNC OUT signal goes low during the transition from the start phase to stop phase. When the sweep function is, the phase changes at the center point of this output signal.

The X DRIVE OUT jack supplies a voltage that varies between 0V and 10V in proportion to the lapse of sweep time, and according to the direction of the sweep phase. The X DRIVE OUT signal also varies linearly with time. The X DRIVE OUT signal varies between 0V and 10V, corresponding directly to the change in direction of the phase sweep.

Substituting Marker Phase for Center Phase

Press SHIFT CTR to set the center phase to the present marker phase value. This operation produces the same result as programming an identical phase with the numeric keys. The marker phase is not affected by this operation.

Changing Settings During Sweep Operation

Because of processing execution time in the sweep execution mode, the Model 3933A may respond to the keys and GPIB commands more slowly than in other modes. If you change the sweep range, sweep time, or sweep function with MODIFY while the Model 3933A is in the sweep execution mode, the unit will recalculate the new parameters each time you change the setting, resulting in slower response.

If you set the sweep range based on center and span phases, an error may occur depending on the order of parameter selection, whether or not the Model 3933A is in the sweep execution mode.

Example:

Assume CTR is set to 0°, SPAN is set to 180° and you wish to change these values to 300 and 90, respectively. If you try to set the CTR to 300, then the SPAN to 90, an error will occur because the system sees this as an attempt to set CTR to 390, which is out of range. It is necessary to set SPAN to 90 first. Then set CTR to 300.

Number of Steps in a Sweep

Software controls the sweep in the Model 3933A. Therefore, instrument processing speed and phase shift resolution (12 bits) are the limiting factors in achieving a smooth sweep curve, except, of course, in the case of a stepped sweep operation.

The manner in which the sweep resolution is calculated is shown below. The definition of "step quantity" is the number of discrete steps between start phase and stop phase, for the two linear functions (recipro), and (repeat). Step width is derived from step quantity, as is shown in the following formula.

$$\text{Step Quantity} = \frac{\text{Sweep Width (deg)}}{2} \times 4096$$

or,

$$\text{Sweep Time (sec)} \times 2000$$

whichever results in better resolution.

$$\text{Step Width} = \frac{\text{Sweep Width (deg)}}{\text{Step Quantity (deg)}}$$

The MKR OUT signal is synchronous with the sweep steps. With an ascending sweep, the MKR OUT signal is low when the sweep phase is higher than the marker phase. With a descending sweep, the marker output is high when the sweep phase is lower than the marker phase. The deviation between the set marker phase value and the actual output in the MKR OUT signal is:

Marker Deviation (Maximum) = ±Step Width (deg)

The X DRIVE OUT signal will also change synchronously as the sweep progresses. Resolution of this output signal is 8 bits. Therefore, when the sweep step quantity is below 255, the sweep step quantity and the X DRIVE output step quantity are identical.

3.5.2 Output Range Mode

The Model 3933A amplitude control (waveform and DC offset) is handled by a multiplying D/A circuit and an output attenuator.

AUTO MODE

In AUTO mode, amplitude and DC offset values control the attenuator, while the output voltage is determined by the multiplying D/A device and the attenuator. These circuits allow a 3-place resolution for:

- Amplitude (Vp-p and Vrms setting)
- DC offset

A 0.1dBV resolution is provided for the dBV setting.

The use of an attenuator assures a quality waveform output (low distortion and noise, high precision) even when the output signal is low.

Amplitude and DC offset are combined such that the cummulative value does not exceed 15 volts. However, when these ratios become large, the one with the lower voltage loses quality.

FXD MODE

When the output range mode is FXD, the output attenuator is set to 0db. Thus, even if phase, amplitude and DC offset are changed, the output reflects a smooth transition. However, the output does pause briefly for waveform and AM on/off changes.

Amplituded and DC offset can be set independently, as long as the cummulative voltage does not exceed the range of ±15. Amplitude may be set to 0Vp-p, but Vrms and dBV units may not be used.

Keep in mind, the amplitude setting is controlled only by the D/A device, so the smaller the amplitude setting, the fewer the a number of digits and the worse the resolution. Also, even though amplitude can be set to 0Vp-p, the actual output is not truly zero. The greater the phase angle, the more this tends to happen.

WAVEFORM QUALITY

AUTO mode is most effective where precise, low level output is required, and in cases where changes involve a wide range in uniform steps.

FXD mode is most effective with continuous output (waveform and DC offset) or when large DC offsets are added to low level waveforms, and where uniform changes range from 0V to full scale.

See Figure 3-9 for details concerning DC offset setting range.

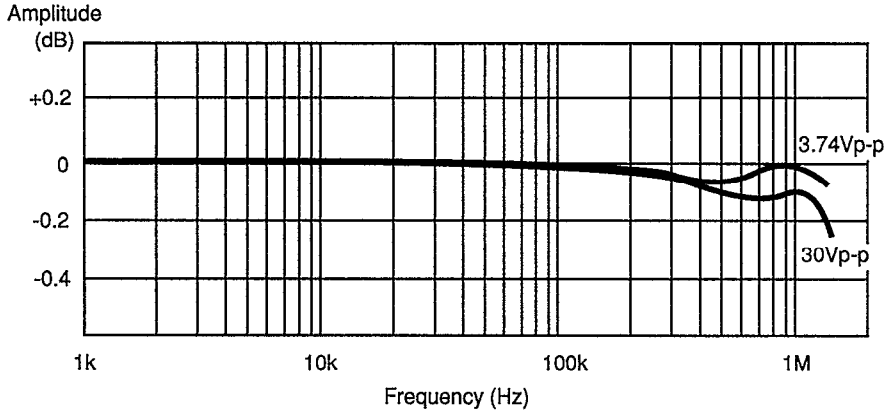
See Figure 3-9 for details concerning AC setting resolution.

APPENDIX A
Typical Data

INTRODUCTION

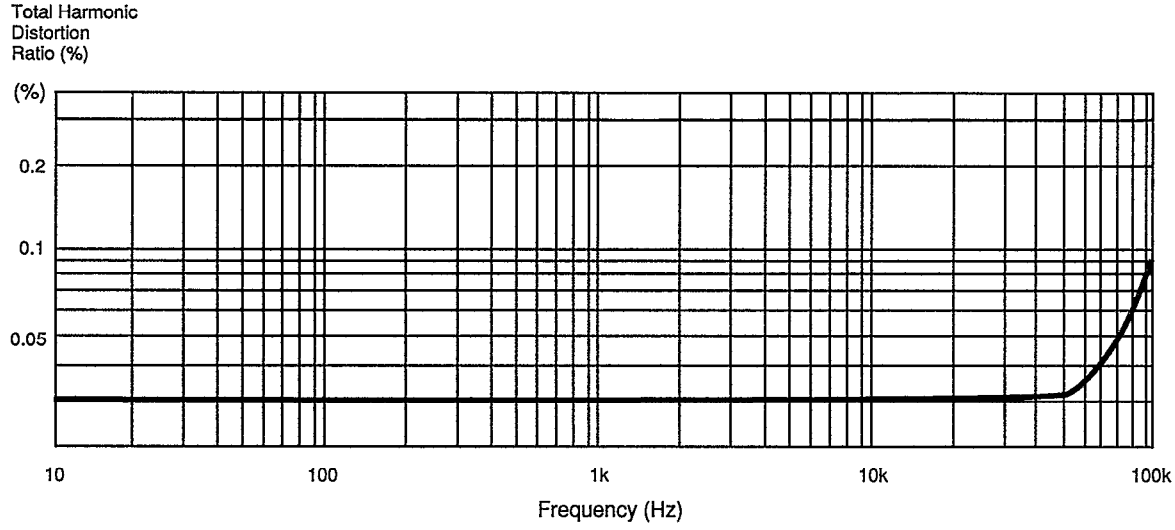
Appendix A provides the typical performance data for the Model 3933A.

This instrument was thoroughly tested and inspected and certified as meeting its published specifications when it was shipped from the factory. However, the typical data represents mean values of measurements for each Model 3933A. Thus, measured performance of your Model 3933A may be different than that indicated by the typical data curves shown here.



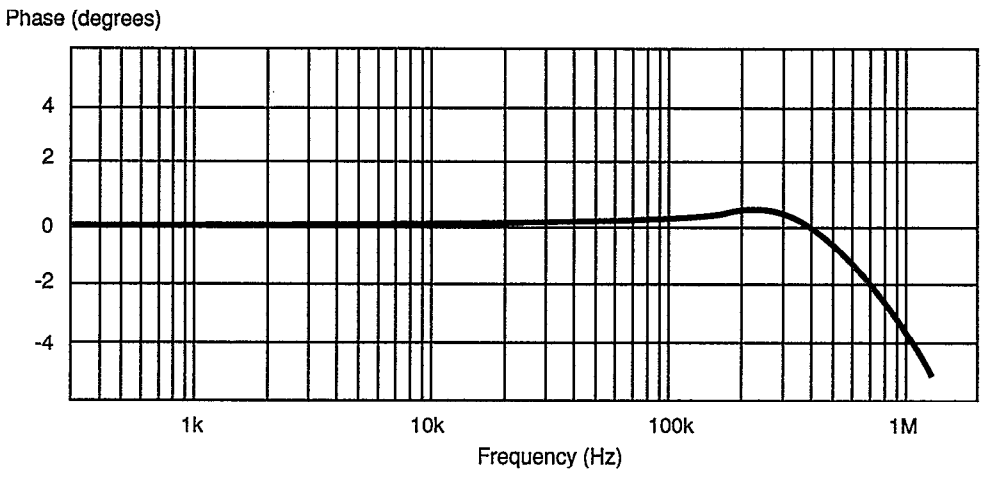
Note: Voltage is set voltage, load 50 ohms,
1 kHz base

Figure A-1. Sine Wave Amplitude – Frequency Characteristics



Note: Amplitude setting 30Vp-p, load 50 ohms

Figure A-2. Total Harmonic Distortion – Frequency Characteristics



Note: Phase re 1930A when it's two-phase

1930A's start/stop phase: 0 degrees
1933A's phase: 0 degrees
Both 1930A and 1933A have amplitude 30 Vp-p, waveform sine, load 50 ohms.

Figure A-3. Phase – Frequency Characteristics

APPENDIX B
Model 3933A Specifications

B.1 ELECTRICAL SPECIFICATIONS

Waveforms	
Types	DC only, ∿ , ⎍ , ⩘ , ◿ , ◺

Oscillation Modes
Set by 3930A mode.

Frequency		
Set by 3930A frequency.		
Waveform and Frequency Range	∿ , ⎍ (Duty cycle fixed at 50%)	0.1mHz to 1.2MHz
	∿ , ◿ , ◺ , ⎍ (Duty cycle varies from 5% to 95%)	0.1mHz to 100kHz

Phase			
Setting Range	–360° to 360° (Value corresponding to 0° at 3930A's start/stop phase)		
Display	Maximum 4 digits ± resolution 0.1° (fixed)		
Accuracy (when 3930A is in CONT mode)	° Set both 3930A and 3933A to these settings: DC offset 0V, AM off, 50Ω load, same waveform, 18°-28°C. ° Waveform duty cycle is fixed or variable on both devices. (cycle is optional) ° Amplitude setting is between 30.0mVp-p to 30.0Vp-p, and can be set independently. ° When connecting in sequence, phase number n is per this diagram: 3930A — 3933A — 3933A ... ... n = 1 n = 2 n = 3 However, n ≤ 6 (to max of 6 phases) ° Accuracy corresponds to: (3933A phase setting) - (3930A's start/stop phase setting) D = + 0, -(n–2) × 40ns		
	∿		±(0.1° + 120ns) + D
	⎍ (while rising)	When duty cycle is 50% (FXD)	±(0.5° + 120ns) + D
		When duty cycle is variable	±(0.1° + 220ns) + D
	⩘		±(0.1° + 90ns) + D
	◿ (while falling) ◺ (while rising)		±(0.1° + 240ns) + D

Specifications subject to change without notice.

ELECTRICAL SPECIFICATIONS (CONT.)

Output Characteristics (Waveform Output)					
Maximum Output	AC only	30Vp-p/open, 15Vp-p/50Ω			
	DC only	±15V/open, ±7.5V/50Ω			
Display (Open Circuit Value)	When output range mode is automatic (AUTO)				
	AC Vp-p	Max. 3 digits	Minimum Resolution	0.01mVp-p	
	AC Vrms			0.01mVrms	
	AC dBV			0.1dBV (fixed)	
	DC	Max. 3 digits, min. resolution 0.01mV when output range mode is fixed (FXD)			
	AC (Vp-p only)	Maximum 4 digits, minimum resolution 10mVp-p (fixed)			
	DC	Maximum 4 digits, minimum resolution 10mV (fixed)			
AC Oscillation Setting Range (at DC offset 0V)	Per Table B-1: AC Amplitude Setting Range for 0V DC Offset				
AC Amplitude Accuracy (when 3930A is in CONT mode)	Frequency up to 50kHz, DC offset 0V, AM off, open load, effective value measurement, 18°-28°C				
	∿	When output range is AUTO	3.00Vp-p to 30.0Vp-p	±0.5%	
			300mVp-p to 2.99Vp-p	±1.0%	
			30.0mVp-p to 299mVp-p	±1.5%	
		When output range is FXD	3.00Vp-p to 30.00Vp-p	±0.5%	
			0.30Vp-p to 2.99Vp-p	±1.0%	
	⊓ (duty ratio fixed/variable 50%	When output range is AUTO	3.00Vp-p to 30.0Vp-p	±1.0%	
			300mVp-p to 2.99Vp-p	±1.5%	
			30.0mVp-p to 299mVp-p	±2.0%	
	∿, ⩘, ⩗ (When frequency is 1kHz)	When output range is FXD	3.00Vp-p to 30.00Vp-p	±1.0%	
			0.30Vp-p to 2.99Vp-p	±1.5%	
DC Voltage Setting Range and Accuracy (when DC only)	Per Table B-2: DC-only Voltage Setting Range, Resolution, and Accuracy				
AC and DC Setting Range and DC Voltage Accuracy when AC + DC	Per Table B-3: AC + DC Minimum AC Amplitude, Resolution and Accuracy. The sum of AC amplitude's absolute peak and DC voltage's absolute value is less than 15V.				
Amplitude and Frequency Characteristics (when 3930A is in CONT mode)	1kHz reference frerquency, DC offset 0V, AM off, 50Ω load, amplitude setting 30.0mVp-p to 30.0Vp-p (when output range is FXD, more than 3.00Vp-p), ∿ is effective value measurement; otherwise measure p-p value.				
	∿	Up to 100kHz	±0.1dB		
		100kHz to 700kHz	±0.3dB		
		700kHz to 1MHz	+0.3dB, –0.5dB		
		1MHz to 1.2MHz	+0.3dB, –1.0dB		
	⩘	Up to 10kHz	±3%		
	⊓ (duty cycle fixed/50% variable)	Up to 100kHz	±2%		
	⩗ , ⩘	Up to 10kHz	±5%		
∿ Spectrum Purity (when 3930A is in CONT mode)	DC offset 0V, AM off, 50Ω load, amplitude setting from 30.0mVp-p to 30.0Vp-p (when output range is FXD, more than 3.00Vp-p)				
	Total harmonic distortion		10Hz to 100kHz	0.1% max	
	Harmonic (when amplitude setting is 30.0Vp-p)		100kHz to 500kHz	–40dBc max	
			500kHz to 1.2MHz	–30dBc max	
	Spurious (when amplitude setting is 30.0Vp-p		Up to 500kHz	–55dBc max	
			500kHz to 1.2MHz	–40dBc max	

ELECTRICAL SPECIFICATIONS (CONT.)

Output Characteristics (Waveform Output) (Cont.)				
⎍ Waveform Characteristics	DC offset 0V, AM off, 50Ω load, amplitude setting from 30.0mVp-p to 30.0Vp-p (when output range is FXD, more than 3.00Vp-p)			
	Rise, fall time			150ns max
	Over and undershoot			<5% of output p-p amplitude
	Duty cycle (when 3930A is in CONT mode)	50% fixed accuracy		Period ±0.3% (Up to 10kHz)
		When varied	Setting range	5.0% to 95.0% (resolution 0.1%)
			Accuracy	Period ±0.2% (Up to 10kHz) Jitter below 150ns
Status at Power On	Output is on.			
Output Impedance	50Ω ±1%, unbalanced (open when output is off)			
Signal Ground	Insulated from chassis (insulation breakdown voltage: below 150Vpeak/100Hz)			
Connector	BNC, front panel			

Sync Output	
Output Voltage	TTL Level (51Ω in series with 74AC00 output)
Signal Ground	Common with waveform output
Connector	BNC, front panel

AM Input	
Gain	At ±1V, 100% modulation. At 0V, output is half of displayed value. At −1V DC, carrier is suppressed.
Input Voltage Range	−3V to +1V
Modulation Range	≥100%
Modulation Signal Band	DC to 100kHz
Carrier Signal	Up to 100kHz (∿)
Input Impedance	10kΩ
Signal Ground	Common with waveform output
Connector	BNC, front panel

ELECTRICAL SPECIFICATIONS (CONT.)

Phase Sweep					
Types		Sweep functions	CONT		SINGL
		⎍	⎍ or ⏉		⎍ or ⎌
		⩓	⩓ or ⩔		⎍ or ⎌
		◿	◿ or ◹		◿ or ◹
Sweep Range		–360° to 360°			
Minimum Sweep Width		0.1°			
Sweep Time		Setting range	5ms to 9999s		
		Display	Maximum 4 digits, minimum resolution 1ms		
Range of Settings		According to start and stop, or center and span, phase setting			
Operation		CONT START	Starts continuous sweep		
		SINGL START	Starts single sweep		
		START STATE	Sets output to the start frequency output state		
		STOP STATE	Sets output to the stop frequency output state		
		HOLD/RESM	Holds and resumes sweep		
Input	Singl Start Input	Input voltage	TTL Level (input to 74HC14 is pulled up by 4.7kΩ.)		
		Signal characteristics	Single sweep starts at falling edge		
		Minimum pulse width	50ns		
		Connector	BNC, rear panel		
	Hold Input	Input voltage	TTL Level		
		Signal characteristics	Low	Holds sweep	
			High	Resumes sweep	
		Connector	BNC, rear panel		
Output	Sweep Sync Output	Output voltage	TTL Level (output to 74F404 is pulled up by 56Ω)		
		Signal characteristics	Low	While sweeping from start frequency toward stop phase	
			High	Other cases	
		Connector	BNC, rear panel		
	Marker Output	Output voltage	TTL Level (56Ω in series with 74HC14 output)		
		Signal characteristics	Low	While output signal is above marker frequency during sweep	
			High	Other cases	
		Connector	BNC, rear panel		
	X Drive Output	Output voltage	0V to +10V (±5%)/open		
		Signal characteristics	0V to +10V (phase increasing) +10V to 0V (phase decreasing)		
		Output Impedance	600Ω, unbalanced		
		Load impedance	10kΩ minimum		
		Connector	BNC, rear panel		
Other Functions	Replace marker phase with center phase				

Digital I/O for Multi-Phasing		
Digital In	Input Voltage	TTL level
	Connector	36-pin, rear panel
	Connection	Connect 3930A's or 3933A's digital out with this device's DIGITAL IN via a special cable.
Digital Out	Output Voltage	TTL level
	Connector	36-pin, rear panel

ELECTRICAL SPECIFICATIONS (CONT.)

Memory	
Memory Contents	Main Phase*, amplitude*, DC offset*, waveform Sweep-Related Start*, stop*, center*, span*, marker*, sweep time*, sweep function Other Square wave duty cycle*, AN on/off, beep sound (on/off), output range mode AUTO/FXD Modify Note: Parameters listed with * show cursor position and step size.
Number of Memory Units	10 units
Battery Backup	30 days or more after full charge (stored at room temperature)

Setting Protection When Power is Off	
Function	Parameters in effect prior to power-off are stored and become effective at next power-on (except for waveform output on/off).
Contents Protected	Same items as in Memory Contents, plus lock (on/off), GPIB address, delimiter.
Battery Backup	Identical to Memory

Modify		
Format	Per cursor movement and MODIFY knob.	
Up/Down Step Size	±1	Increases or decreases cursor position value by 1.
	±5	Increases or decreases cursor position value by 5.
	×÷2	Multiplies or divides entire value by 2.
	×÷10	Multiples or divides entire value by 10.
	Note: The above step sizes apply only to the parameters listed with * in Memory Contents. Others change step size by ±1 only, and cursor position is fixed.	
Parameters that can't be modified	Memory number, GPIB address, and delimiter	

Display Function
Synchronously displays waveform output on/off, frequency, amplitude, DC offset, waveform, oscillation mode, AM on/off, and sweep state.

Lock
Disables most front panel key entries and operating condition changes. Current parameter values can be displayed. GPIB input and certain BNC inputs are enabled.

ELECTRICAL SPECIFICATIONS (CONT.)

Preset

Sets the parameters listed below.
The modification step size is ±1. The underline indicates the cursor position.

Main

Phase	0.0 deg
Amplitude	3.00mVp-p (0.00Vp-p)
DC offset	0.00mV (0.00V)
Waveform	∿

Sweep-Related

Start phase	–180.0 deg
Stop phase	180.0 deg
Center phase	0.0 deg
Span phase	360.0 deg
Marker phase	0.0 deg
Sweep time	1.000s
Sweep function	⋀

Others

AM	off
⊓ Duty cycle	fixed 50.0%
Beep sound	on
Output range mode	AUTO

Display

Main parameter display status

B.2 GPIB INTERFACE

GPIB Interface

Functions	SH1	Full source handshake capability	
	AH1	Full acceptor handshake capability	
	T6	Basic talker, serial poll, talker unaddressed if MLA	
	L4	Basic listener, unaddressed if MTA	
	SR1	Full service request capability	
	RL1	Full remote local operation capability	
	PP0	No parallel-polling function capability	
	DC1	Full device clear capability	
	DT0	No controller function capability	
	C0	No controller function capability	
Data	ISO 7-bit code (ASCII code)		
Delimiter	Transmission	CR or CR/LF, EOI also sent simultaneously	
	Reception	CR, CR/LF, CR + EOI, CR/LF + EOI or EOI	
Address	0 - 30 (selected by numeric keys on the panel)		
Output Driver	DIO1 - DIO8, NDAC, NRFD, SRQ		Open collector
	DAV, EOI		Tri-state
Local Key	Switch for return-to-local function		
Connector	IEEE-488 24-pin GPIB connector, rear panel		

B.3 GENERAL

Signal Ground	The grounding pins of all input/output connectors are connected to chassis except for waveform output, synchronous output, and AM input.	
Power Source	Voltage	100, 120, 220 or 240V AC ±10% (250V max.)
	Frequency	48 to 62Hz
	Power Consumption	Approx. 38VA
Range of Ambient Temperature and Humidity	Operating	0°-40°C, 10-90% RH (without condensation)
	Storage	–10°-50°C, 10-80% RH (without condensation)
External Size	Excluding Projections	216 (W) x 132.5 (H) x 350 (D) mm, 8.5 (W) x 5-1/4 (H) x 13-3/4 (D) in.
Weigth	Approx. 4.6kg (10 lbs.)	

Table B-1. AC Amplitude Setting Range for 0V DC Offset

Output Range Mode	AC (p-p)	∿		Hardware Resolution (p-p)	Output Attenuator (See note)
		rms	dBV		
AUTO	30.0V to 3.00V	10.6V to 1.06V	20.5 to 0.5	15mV	1/1
	2.99V to 300mV	1.05V to 106mV	0.4 to 19.5	1.5mV	1/10
	299mV to 30.0mV	105mV to 10.6mV	–19.6 to –39.5	150µV	1/100
	29.9mV to 0.30mV	10.5mV to 0.11mV	–39.6 to –79.2	15µV	1/1000
FXD	30.00V to 0.00V	(Vp-p only)	(Vp-p only)	15mV	1/1

Output Range Mode	AC (p-p)	∿ ◿ ◺		Hardware Resolution (p-p)	Output Attenuator (See note)
		rms	dBV		
AUTO	30.0V to 3.00V	8.66V to 866V	18.8 to 1.2	15mV	1/1
	2.99V to 300mV	865V to 86.6mV	–1.3 to –21.2	1.5mV	1/10
	299mV to 30.0mV	86.5mV to 8.66mV	–21.3 to –41.2	150µV	1/100
	29.9mV to 0.30mV	8.65mV to 0.09mV	–41.3 to –80.9	15µV	1/1000
FXD	30.00V to 0.00V	(Vp-p only)	(Vp-p only)	15mV	1/1

Output Range Mode	AC (p-p)	⎍		Hardware Resolution (p-p)	Output Attenuator (See note)
		rms	dBV		
AUTO	30.0V to 3.00V	15.0V to 1.50V	23.5 to 3.5	15mV	1/1
	2.99V to 300mV	1.49V to 150mV	3.4 to –16.5	1.5mV	1/10
	299mV to 30.0mV	149mV to 15.0mV	–16.6 to –36.5	150µV	1/100
	29.9mV to 0.30mV	14.9mV to 0.15mV	–36.6 to –76.5	15µV	1/1000
FXD	30.00V to 0.00V	(Vp-p only)	(Vp-p only)	15mV	1/1

Note: When switching the output attenuator, the instantaneous waveform goes off.

Table B-2. DC Only Voltage Setting Range, Resolution, and Accuracy (open load, 18°-28°C)

Output Range Mode	DC (+ or –)	Hardware Resolution	Accuracy	Output Attenuator (See note)
AUTO	15.0V to 1.50V	7.3mV	±(0.1% + 8mV)	1/1
	1.49 to 150mV	730µV	±(0.6% + 0.8mV)	1/10
	149mV to 15.0mV	73µV	±(1% + 80µV)	1/100
	14.9mV to 0.00mV	7.3µV	(Not specified)	1/1000
FXD	15.00V to 0.00V	7.3mV	±(0.1% + 8mV)	1/1

Note: When switching the output attenuator, the instantaneous waveform ouptut goes off.

Table B-3. AC + DC Minimum AC Amplitude, Resolution, and Accuracy (open load)

Output Range Mode	Cumulative Voltage (See Note 2)	Minimum AC Amplitude							Hard. ACA Resl.	Hard. DCV Resl.	DC Voltage Accuracy	Output Atten. (See Note 1)
			∿		⩘ ◿ ◺		⎍					
		p-p	rms	dBV	rms	dBV	rms	dBV				
AUTO	More than 1.5V	286mV	101mV	–19.9	82.5mV	–21.6	143mV	–16.9	15mVp-p	7.3mV	±(0.2% of AC amplitude setting (p-p) +0.1% of DC voltage setting +8mV)	1/1
	More than 150mV	28.6mV	10.1mV	–39.9	8.25mV	–41.6	14.3mV	–36.9	1.5mVp-p	730µV	±(0.2% of AC amplitude setting (p-p) +0.6% of DC voltage setting +0.8mV)	1/10
	More than 15mV	2.86mV	1.01mV	–59.9	0.83mV	–61.6	1.43mV	–56.9	150µVp-p	73µV	±(0.2% of AC amplitude setting (p-p) +1% of DC voltage setting +80µV)	1/100
	Less than 15mV	0.30mV	0.11mV	–79.2	0.09mV	–80.9	0.15mV	–76.5	15µVp-p	7.3µV	(Not specified)	1/1000
FXD	Not related to cumulative voltage	0.00V	(Vp-p only)						15mVp-p	7.3mV	±(0.2% of AC amplitude setting (p-p) +0.1% of DC voltage setting +8mV)	1/1

Notes:

1. When switching the output attenuator, the waveform output goes off for a moment.
2. Cumulative voltage = AC amplitude setting (p-p) divided by 2 plus DC voltage setting (V).
3. DC voltage accuracy is when frequency is about 1kHz, ∿ , AM off, open load, 18°-28°C.

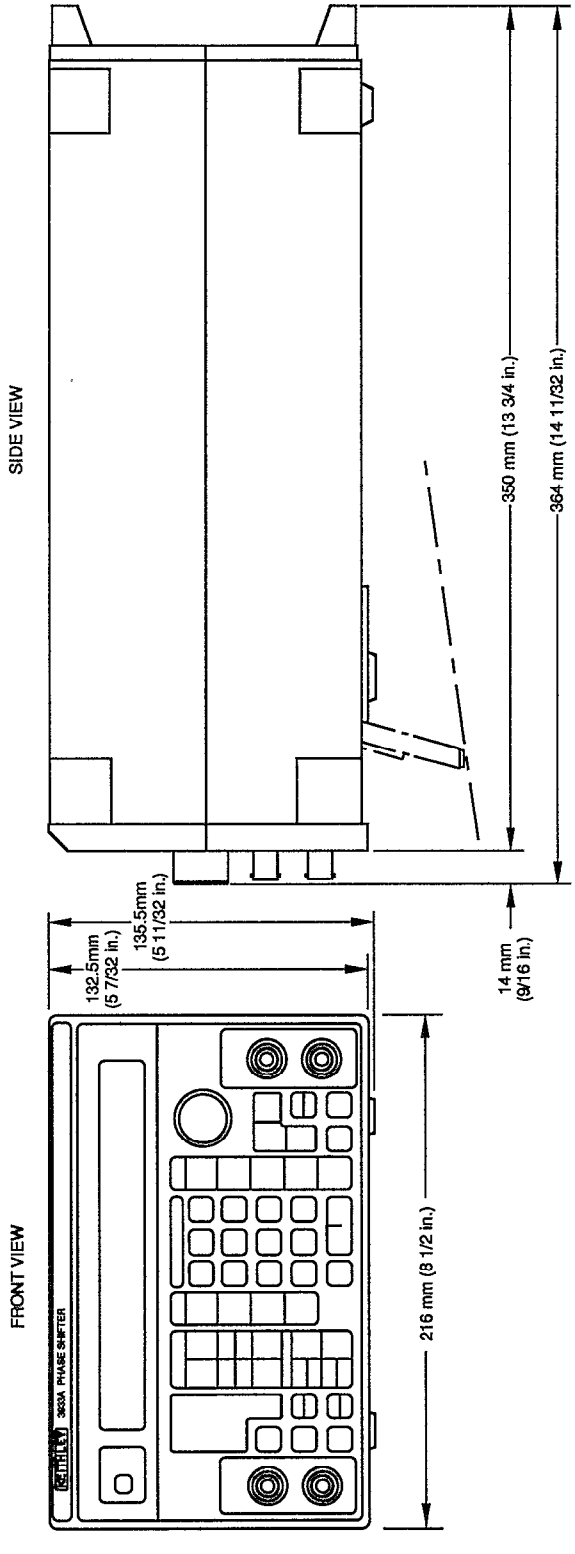


Figure B-1. Outer Dimensions of the Model 3933A

KEITHLEY INSTRUMENTS

SERVICE FORM

Model No. _____ **Serial No.** _____ **Date** _____

Name and Telephone No. _____

Company _____

List all control settings, describe problem and check boxes that apply to problem. _____

_____

_____

☐Intermittent ☐Analog output follows display ☐Particular range or function bad; specify _____
☐IEEE failure ☐Obvious problem on power-up ☐Batteries and fuses are OK
☐Front panel operational ☐All ranges or functions are bad ☐Checked all cables

Display or output (circle one)

☐Drifts ☐Unable to zero
☐Unstable ☐Will not read applied input
☐Overload

☐Calibration only ☐Certificate of Calibration required
☐Data required

(attach any additional sheets as necessary.)

Show a block diagram of your measurement system including all instruments connected (whether power is turned on or not). Also, describe signal source.

Where is the measurement being performed? (factory, controlled laboratory, out-of-doors, etc.)

_____

_____

What power line voltage is used? _____ Ambient Temperature? _____ °F

Relative humidity? _____ Other? _____

Any additional information. (If special modifications have been made by the user, please describe.) _____

_____

Be sure to include your name and phone number on this service form.

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