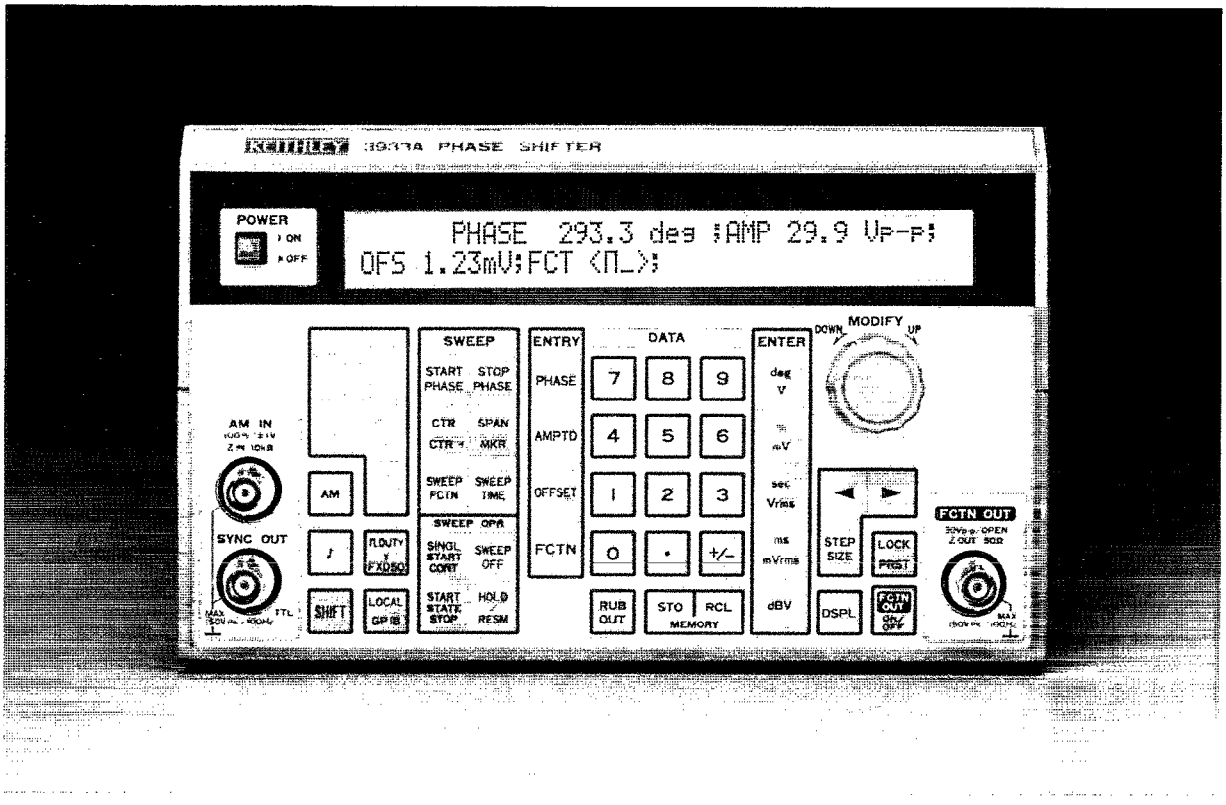
KEITHLEY INSTRUMENTS

Model 3933A Phase Shifter
Service Manual



Contains Servicing Information

Publication Date: August 1991
Document Number: 3933A-902-01 Rev. A

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.

To exercise this warranty, write or call your local Keithley representative, or contact Keithley headquarters in Cleveland, Ohio. You will be given prompt assistance and return instructions. Send the product, transportation prepaid, to the indicated service facility. Repairs will be made and the product returned, transportation prepaid. Repaired or replaced products are warranted for the balance of the original warranty period, or at least 90 days.

LIMITATION OF WARRANTY

This warranty does not apply to defects resulting from product modification without Keithley's express written consent, or misuse of any product or part. This warranty also does not apply to fuses, software, non-rechargeable batteries, damage from battery leakage, or problems arising from normal wear or failure to follow instructions.

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Service Manual
Model 3933A
Phase Shifter

Instruments Division
Cleveland, Ohio, U. S. A.
Document Number: 3933A-902-01

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.

Instrumentation and accessories should not be connected to humans.

HOW TO USE THIS MANUAL

Details procedures to verify that the instrument meets stated specifications.

SECTION 1
Performance Verification

Describes basic operating principles for the various circuits in the Model 3933A.

SECTION 2
Principles of Operation

Covers fuse replacement, calibration and repair of the instrument, and lists replacement parts.

SECTION 3
Service Information

WARNING

The information in this manual is intended for qualified service personnel who can recognize possible shock hazards. Do not attempt these procedures unless you are qualified to do so.

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SECTION 1
Performance Verification

1.1 INTRODUCTION

The procedures outlined in this section may be used to verify that the Model 3933A is operating within the limits stated in the specifications. Performance verification may be done when the instrument is first received to ensure that no damage or misadjustment has occurred during shipment. Verification may also be performed whenever there is a question of instrument accuracy, or following calibration, if desired.

NOTE
If the instrument is still under warranty (less than one year from the date of shipment), and its performance falls outside the specified range, contact your Keithley representative or the factory to determine the correct course of action.

1.2 ENVIRONMENTAL CONDITIONS

All measurements should be made at 18-28°C (65-82°F) and at less than 70% relative humidity.

1.3 INITIAL CONDITIONS

The Model 3933A must be turned on and allowed to warm up for at least one hour before beginning the verification procedures. If the instrument has been subjected to extremes of temperature (outside the range specified in the previous paragraph), additional time should be allowed for internal temperatures to reach normal operating temperature. Typically, it takes one additional hour to stabilize a unit that is 10°C (18°F) outside the specified temperature range.

1.4 LINE POWER

Be sure to set the line voltage switch for the correct voltage. The instrument should be operated at a voltage within ±10% of the line voltage setting and at a frequency from 48 to 62Hz.

1.5 RECOMMENDED TEST EQUIPMENT

Table 1-1 lists all the test equipment needed for verification. The procedure for performance verification is based on using this exact equipment.

NOTE
The verification limits reflect only the accuracy specifications of the Model 3933A. They do not include test equipment tolerance.

Alternate equipment may be used as long as the substitute equipment has specifications at least as good as

Table 1-1. Verification Equipment

Manufacturer	Model	Description	Specifications
Keithley	3930A	Multifunction Synthesizer	0.1mHz to 1.2MHz; ±5ppm
Keithley	197A	DMM (DC volts, AC volts) (5-1/2 digits)	20V range; ±(0.015% of rdg + 3 counts) ACV; ±(0.35% of rdg + 100 counts)
Fluke	8920A	DVM (AC volts) (3-1/2 digits)	20V range; 1kHz-200kHz (0.5% of rdg), 200kHz-1MHz (0.7%), 1-10MHz (3%), 10-20MHz (5%)
Philips	PM 6654C PM 9678	Timer/Counter TCXO option	0.01Hz-120MHz; time base aging <1×10^{-7}/month; Vp-p measurements
Panasonic	VP-7722A	Audio Analyzer	10Hz-110kHz; 0.001% at full scale; ±1dB harmonic distortion accuracy from 10Hz to 15.99kHz
Keithley	7051-2	BNC Interconnect Cable	50Ω coaxial cable (RG-58C), male BNC connectors, 2ft (0.6m)
Keithley	7755	50Ω Feed-through Terminator	BNC to BNC adapter, 50Ω termination, DC to 250MHz, VSWR of <1.1
Pomona	1468	BNC-banana Adapter	Female BNC connector to double banana plug

those listed in Table 1-1 (except for the Model 3930A Multifunction Synthesizer, which is required in all cases).

1.6 VERIFICATION PROCEDURES

The following paragraphs contain the detailed procedures for verifying the accuracy specifications of the Model 3933A using the equipment listed in Table 1-1. The allowable reading limits in these procedures do not include error that could be contributed by this equipment.

These procedures are intended for use only by qualified personnel using accurate and reliable test equipment. If the instrument is out of specifications and not under warranty, refer to the calibration information in Section 3.

1.6.1 Synthesizer Connections

The Model 3933A must be tested in conjunction with a Model 3930A Mutlifunction Synthesizer. Figure 1-1 shows DIGITAL OUT/DIGITAL IN connections using the CA-94 cable supplied with the Model 3933A. Note that frequency is set on the Model 3930A Synthesizer.

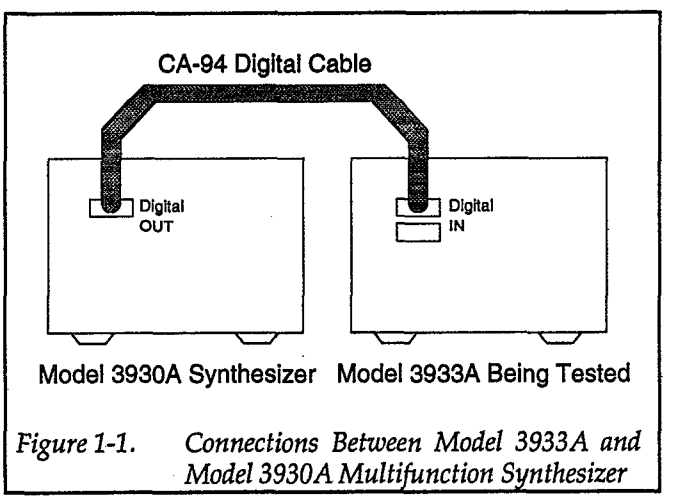


Figure 1-1. Connections Between Model 3933A and Model 3930A Multifunction Synthesizer

1.6.2 Frequency and Duty Cycle Accuracy

1. Connect the phase shifter to the Model 3930A and a timer/counter as shown in Figure 1-2. Turn on all instruments.
2. Restore factory defaults on the Model 3933A by pressing SHIFT PRST.
3. Program a frequency on the Model 3930A. Set the Model 3933A for the sine function with an amplitude of 20Vp-p.
4. Set the timer/counter to display the frequency at Channel A, and verify that the frequency reading is within the limits specified in Table 1-2.
5. Program a Model 3930A frequency of 100Hz. Set the Model 3933A for a square wave with 50% fixed duty cycle.
6. Set the timer/counter to display the pulse width of Channel A, and verify that the reading is within specifications shown in Table 1-2.
7. Modify the frequency and duty cycle settings of the phase shifter and synthesizer according to Table 1-2, and verify the pulse width readings.

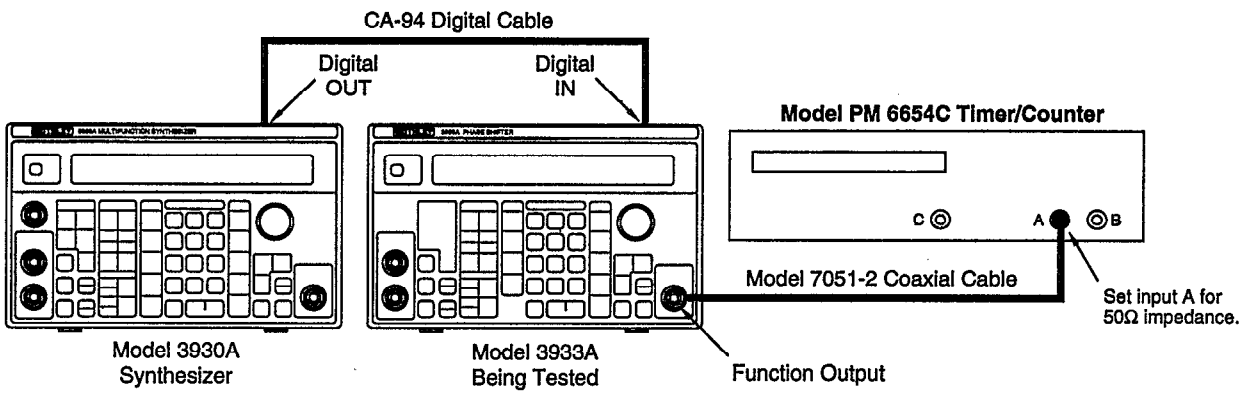


Figure 1-2. Connections to Timer/Counter

Table 1-2. Limits for Frequency and Duty Cycle Accuracy

3933A Function	3933A Amplitude	3930A Frequency	Allowable Timer/ Counter Reading (18°C to 28°C)		
Sine	20Vp-p	1MHz	999.995kHz	to	1.000005MHz
Square (FXD50)	20Vp-p	100Hz	4.97msec	to	5.03msec
		1kHz	497µsec	to	503µsec
		5kHz	99.4µsec	to	100.6µsec
		10kHz	49.7µsec	to	50.3µsec
Square (VAR50)	20Vp-p	100Hz	4.98msec	to	5.02msec
		1kHz	498µsec	to	502µsec
		5kHz	99.6µsec	to	100.4µsec
		10kHz	49.8µsec	to	50.2µsec

NOTE: Frequency accuracy is determined by the Model 3930A Multifunction Synthesizer.

1.6.3 Amplitude Accuracy

1. Connect the phase shifter to a DMM as shown in Figure 1-3. Turn on all instruments.
2. Restore factory defaults on the Model 3933A by pressing SHIFT PRST.
3. Program a 1kHz frequency on the Model 3930A. Set the Model 3933A for the sine function with an amplitude of 7.49Vp-p.
4. Set the DMM to measure AC volts with autoranging, and verify that the voltage reading is within the limits specified in Table 1-3.
5. Change the function, frequency, and amplitude settings of the phase shifter and synthesizer according to Table 1-3 and verify the voltage readings.

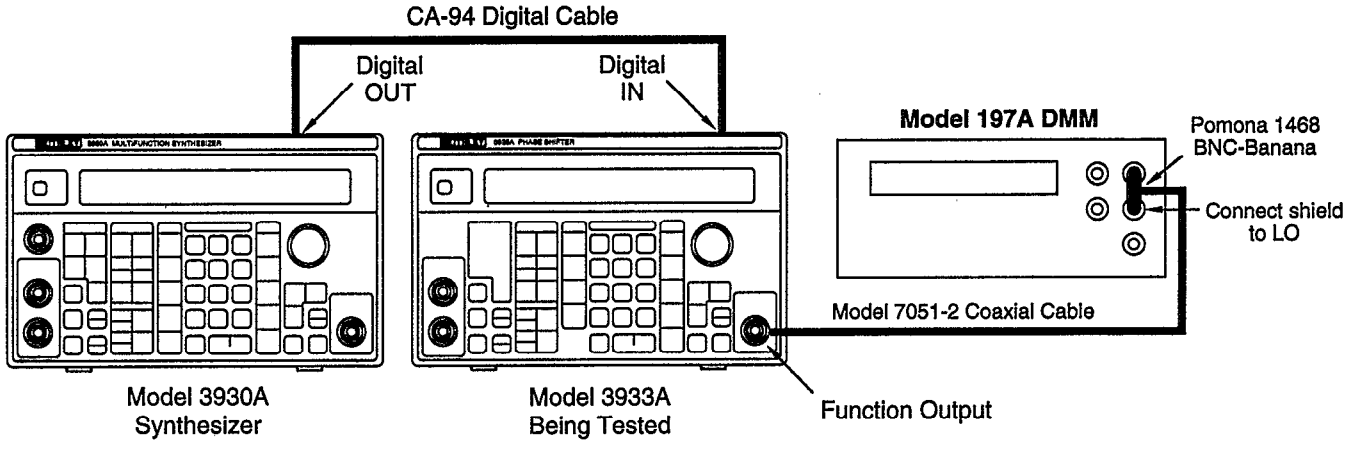


Figure 1-3. Connections to Model 197A DMM

Table 1-3. Limits for Amplitude Accuracy

3933A Function	3933A Amplitude	3930A Frequency	Allowable DMM Reading (18°C to 28°C)		
Sine	7.49Vp-p	1kHz	2.6349Vrms	to	2.6613Vrms
Square (FXD50)			3.558Vrms	to	3.782Vrms
Triangle			2.0541Vrms	to	2.1837Vrms
Sawtooth Up			2.0541Vrms	to	2.1837Vrms
Sawtooth Down			2.0541Vrms	to	2.1837Vrms
Sine	30Vp-p	1kHz	10.5536Vrms	to	10.6596Vrms
		10kHz	10.5536Vrms	to	10.6596Vrms
		20kHz	10.5536Vrms	to	10.6596Vrms
		50kHz	10.5536Vrms	to	10.6596Vrms
Sine	10Vp-p	1kHz	3.5179Vrms	to	3.5532Vrms
		10kHz	3.5179Vrms	to	3.5532Vrms
		20kHz	3.5179Vrms	to	3.5532Vrms
		50kHz	3.5179Vrms	to	3.5532Vrms
Sine	3Vp-p	1kHz	1.05536Vrms	to	1.06596Vrms
		10kHz	1.05536Vrms	to	1.06596Vrms
		20kHz	1.05536Vrms	to	1.06596Vrms
		50kHz	1.05536Vrms	to	1.06596Vrms
Triangle	30Vp-p	1kHz	8.6170Vrms	to	8.7468Vrms
Square			14.25Vrms	to	15.15Vrms
Sawtooth Up			8.6170Vrms	to	8.7468Vrms
Sawtooth Down			8.6170Vrms	to	8.7468Vrms

1.6.4 Frequency Response (Sine)

1. Connect the phase shifter to the Model 3930A and a wideband AC DVM as shown in Figure 1-4. Turn on all instruments.
2. Restore factory defaults on the Model 3933A by pressing SHIFT PRST.
3. Program a 1kHz Model 3930A frequency and a Model 3933A sine function of 30Vp-p.
4. Set the DVM to measure AC volts with autoranging, and verify that the voltage reading is within the limits specified in Table 1-4.
5. Set the DVM to measure dB, and select a 50Ω reference impedance. Press REL to establish the present voltage reading as the relative dB reference.
6. Change the frequency setting of the synthesizer according to Table 1-4, and verify the subsequent ±dB readings.
7. Program a 1kHz sine function of 3.75Vp-p, and verify that the voltage reading is within limits. Press REL to establish the reading as the relative dB reference. Verify the ±dB readings for the remaining frequencies.
8. Program a 1kHz sine function of 3.74Vp-p, and verify the reading. Establish the present reading as the relative dB reference. Verify the ±dB readings for the remaining frequencies.

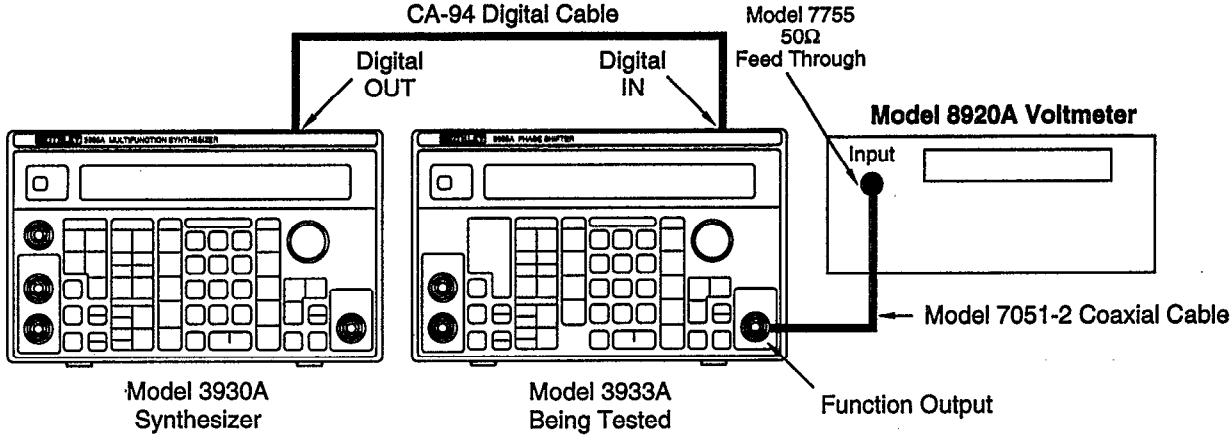


Figure 1-4. Connections to Wideband AC DVM

Table 1-4. Limits for Frequency Response (Sine)

3933A Function	3933A Amplitude	3930A Frequency	Allowable Voltmeter Reading (18°C to 28°C)		
Sine	30Vp-p	1kHz	5.2Vrms	to	5.4Vrms (=REF)
		10kHz	–0.1dB	to	+0.1dB
		100kHz	–0.1dB	to	+0.1dB
		200kHz	–0.3dB	to	+0.3dB
		350kHz	–0.3dB	to	+0.3dB
		500kHz	–0.3dB	to	+0.3dB
		700kHz	–0.3dB	to	+0.3dB
		800kHz	–0.5dB	to	+0.3dB
		900kHz	–0.5dB	to	+0.3dB
		1MHz	–0.5dB	to	+0.3dB
		1.2MHz	–1.0dB	to	+0.3dB
Sine	3.75Vp-p	1kHz	0.65Vrms	to	0.676Vrms (=REF)
		10kHz	–0.1dB	to	+0.1dB
		100kHz	–0.1dB	to	+0.1dB
		200kHz	–0.3dB	to	+0.3dB
		350kHz	–0.3dB	to	+0.3dB
		500kHz	–0.3dB	to	+0.3dB
		700kHz	–0.3dB	to	+0.3dB
		800kHz	–0.5dB	to	+0.3dB
		900kHz	–0.5dB	to	+0.3dB
		1MHz	–0.5dB	to	+0.3dB
		1.2MHz	–1.0dB	to	+0.3dB
Sine	3.74Vp-p	1kHz	0.648Vrms	to	0.674Vrms (=REF)
		10kHz	–0.1dB	to	+0.1dB
		100kHz	–0.1dB	to	+0.1dB
		200kHz	–0.3dB	to	+0.3dB
		350kHz	–0.3dB	to	+0.3dB
		500kHz	–0.3dB	to	+0.3dB
		700kHz	–0.3dB	to	+0.3dB
		800kHz	–0.5dB	to	+0.3dB
		900kHz	–0.5dB	to	+0.3dB
		1MHz	–0.5dB	to	+0.3dB
		1.2MHz	–1.0dB	to	+0.3dB

1.6.5 Frequency Response (Triangle, Sawtooth, Square)

1. Connect the phase shifter to the synthesizer and a timer/counter as shown in Figure 1-2. Turn on all instruments.
2. Restore factory defaults on the Model 3933A by pressing SHIFT PRST.
3. Program a 1kHz Model 3930A frequency and a Model 3933A triangle wave of 30Vp-p.
4. Set the timer/counter to display the peak-to-peak voltage at Channel A, and verify that the voltage reading is within the limits specified in Table 1-5. Call this reading REF.
5. Change the synthesizer frequency to 5kHz. The new reading should be between 0.97 times the REF reading and 1.03 times the REF reading.
6. Modify the frequency and function settings of the synthesizer and phase shifter according to Table 1-5, and verify that the corresponding readings are within the specified limits.

Table 1-5. Limits for Frequency Response (Triangle, Sawtooth, Square)

3933A Function	3933A Amplitude	3930A Frequency	Allowable Timer/Counter Reading (18°C to 28°C)		
Triangle	30Vp-p	1kHz	14.25Vp-p	to	15.75Vp-p (=REF)
		5kHz	0.97 × REF	to	1.03 × REF
		10kHz	0.97 × REF	to	1.03 × REF
Sawtooth Up	30Vp-p	1kHz	14.25Vp-p	to	15.75Vp-p (=REF)
		5kHz	0.95 × REF	to	1.05 × REF
		10kHz	0.95 × REF	to	1.05 × REF
Sawtooth Down	30Vp-p	1kHz	14.25Vp-p	to	15.75Vp-p (=REF)
		5kHz	0.95 × REF	to	1.05 × REF
		10kHz	0.95 × REF	to	1.05 × REF
Square	30Vp-p	1kHz	14.25Vp-p	to	15.75Vp-p (=REF)
		5kHz	0.98 × REF	to	1.02 × REF
		10kHz	0.98 × REF	to	1.02 × REF
		100kHz	0.98 × REF	to	1.02 × REF

1.6.6 Total Harmonic Distortion

1. Connect the phase shifter to the synthesizer and an audio analyzer as shown in Figure 1-5. Turn on all instruments.
2. Restore factory defaults on the Model 3933A by pressing SHIFT PRST.
3. Program a 1kHz Model 3930A frequency and a Model 3933A sine function of 30Vp-p.
4. Set the audio analyzer to measure distortion, and verify that the reading is within the limits specified in Table 1-6.
5. Change the frequency setting of the synthesizer according to Table 1-6, and verify the distortion readings.

Table 1-6. Limits for Total Harmonic Distortion

3933A Function	3933A Amplitude	3930A Frequency	Allowable Analyzer Reading (18°C to 28°C)
Sine	30Vp-p	1kHz	< 0.1%
		10kHz	< 0.1%
		20kHz	< 0.1%
		35kHz	< 0.1%
		50kHz	< 0.1%
		70kHz	< 0.1%
		100kHz	< 0.1%

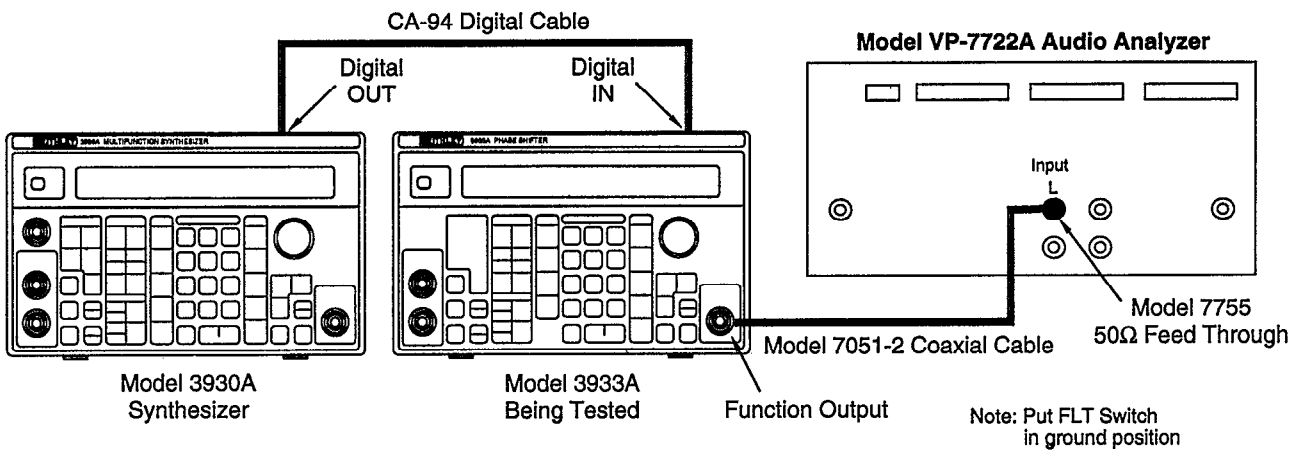


Figure 1-5. Connections to Audio Analyzer

1.6.7. DC Voltage Accuracy

1. Connect the phase shifter to the synthesizer and a DMM as shown in Figure 1-3. Turn on all instruments.
2. Restore factory defaults on the Model 3933A by pressing SHIFT PRST.
3. Program the Model 3933A for the DC function, 2.00mV amplitude, with +15V offset.
4. Set the DMM to measure DC volts with autoranging, and verify that the voltage reading is within the limits specified in Table 1-7.
5. Change the offset setting of the phase shifter according to Table 1-7, and verify the subsequent voltage readings.

Table 1-7. Limits for DC Voltage Accuracy

3933A Function	3933A Offset	Allowable DMM Reading (18°C to 28°C)
DC	+15V	+14.842V to +15.158V
	–15V	–14.842V to –15.158V
	+5V	+4.942V to +5.058V
	–5V	–4.942V to –5.058V
	+1.5V	+1.477V to +1.523V
	–1.5V	–1.477V to –1.523V

1.6.8 DC Level (Square) and DC Offset Error (Sine)

1. Connect the phase shifter to the synthesizer and a DMM as shown in Figure 1-3. Turn on all instruments.
2. Restore factory defaults on the Model 3933A by pressing SHIFT PRST.
3. Set the Model 3933A for a 7.49Vp-p square wave with a phase setting of +90°. Set the Model 3930A for gated mode and the EXT ⏚ trigger source.
4. Set the DMM to measure DC volts with autoranging, and verify that the voltage reading is within the limits specified in Table 1-8.
5. Change the function, amplitude, mode, trigger source, and phase settings of the phase shifter and synthesizer according to Table 1-8 and verify the voltage readings.

1.6.9 Rise and Fall Times

1. Connect the phase shifter to the synthesizer and a timer/counter as shown in Figure 1-1. Turn on all instruments.
2. Restore factory defaults on the Model 3933A by pressing SHIFT PRST.
3. Program a 100kHz square wave (FXD50) of 30Vp-p.
4. Set the timer/counter to measure rise/fall times of Channel A and verify that the rise time is within the limit specified in Table 1-9. Then change the slope to measure the fall time and verify the reading.
5. Change the amplitude setting of the phase shifter according to Table 1-9, and verify the remaining rise/fall times.

Table 1-8. Limits for DC Level (Square) and DC Offset Error (Sine)

3933A Function	3933A Amplitude	3930A Mode	3930A Trigger Source	3933A Phase	Allowable DMM Reading (18°C to 28°C)
Square	7.49Vp-p	Gate	Ext ⏚	+90°	3.715V to 3.774V
				–90°	–3.715V to –3.774V
Sine	30Vp-p	Gate	Ext ⏚	0°	±68mV
	3Vp-p				±14mV

Table 1-9. Limits for Rise/Fall Times

3933A Function	3930A Frequency	3933A Amplitude	Time	Allowable Timer/Counter Reading (18°C to 28°C)
Square (FXD50)	100kHz	30Vp-p	Rise	< 150nsec
			Fall	< 150nsec
		3.75Vp-p	Rise	< 150nsec
			Fall	< 150nsec
		3.74Vp-p	Rise	< 150nsec
			Fall	< 150nsec

SECTION 2
Principles of Operation

2.1 INTRODUCTION

This section covers basic operating principles of the Model 3933A.

2.2 BLOCK DIAGRAM

Figure 2-1 shows an overall block diagram of the Model 3933A. The various sections include the control section, display and keyboard section, phase shift section, digital I/O section, analog section, and the power supply and GPIB interface sections.

2.2.1 Control Section

The control section supervises all instrument operations. The control section includes the 68008 microprocessor, EPROM for program storage, and battery backed-up RAM for working storage and memory to store operating parameters.

2.2.2 Display and Keyboard Section

This section includes a 40-character X 2-line LCD (liquid crystal display) and a membrane keyboard. The LCD is backlit for better visibility.

2.2.3 Phase Shift Section

This section produces digital waveform data by phase shifting the signal from the Model 3930A Synthesizer or another Model 3933A Phase Shifter. Key parts of the phase shift section include the phase shift addition circuit, sine wave conversion ROM, sweep I/O circuits, and the digital output circuits to provide the necessary signals for any additional Model 3933A Phase Shifters.

2.2.4 Analog Section

The analog section includes a D/A converter to convert digital waveform data produced by the phase shift section into the analog output signal. The analog section also controls the amplitude of the output waveform and adds the DC offset to the output signal.

The analog section is isolated from other parts of the digital system by a pulse transformer and photo coupler.

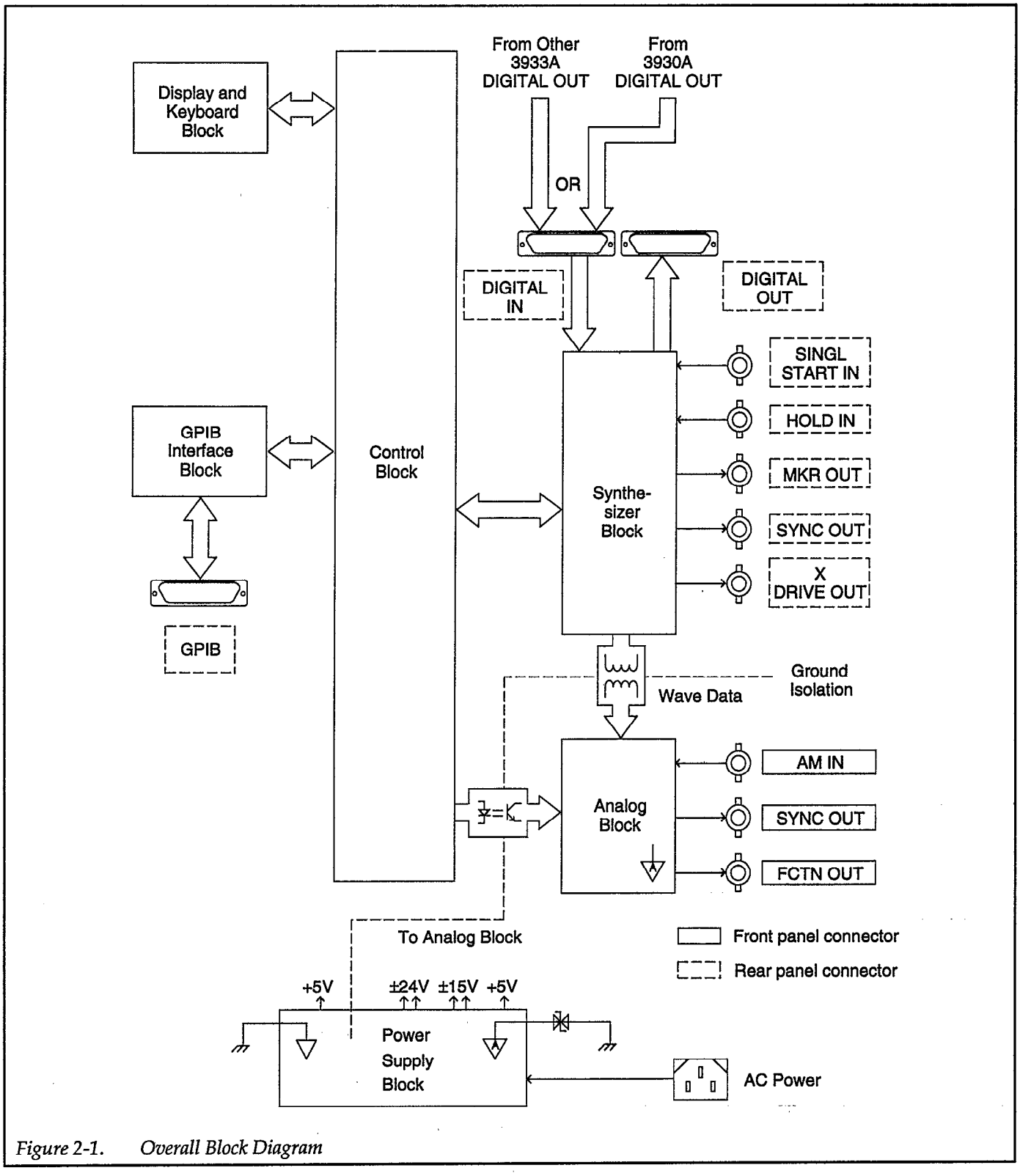


Figure 2-1. Overall Block Diagram

2.2.5 Power Supply Section

The power supply provides several DC operating voltages to various other sections in the instrument and is made up of a transformer and series regulators. Supply voltages include ±24V, ±15V, and two +5V DC supplies.

Note that power supply common for all circuits except the analog section is connected to chassis ground. Analog common is connected to chassis ground through a varistor.

2.3 ANALOG CIRCUIT DESCRIPTION

2.3.1 Analog Section Block Diagram

Figure 2-2 shows a block diagram of the analog section of the instrument. Key sections include the D/A converter, square wave generator, amplitude modulation circuits, and multiplying D/A and attenuator for amplitude and DC offset control.

2.3.2 D/A Converter

Digital waveform data is converted into an analog signal by the D/A converter. The converted signal is then passed through a low-pass filter to remove any spurious components. This conversion process is used to generate sine, triangular, and sawtooth waves.

2.3.3 Square Wave Generator

Square waves with fixed 50% duty cycle are generated by applying sine waves to an analog comparator. The analog comparator has a certain amount of hysteresis, which results in good-quality square waves at the output.

Variable duty cycle square waves are generated by a digital comparator. Digital sawtooth waveform information is used as the input signal to the digital comparator.

2.3.4 Amplitude Modulation

A signal applied to the AM IN jack can be used to amplitude modulate the output signal. This modulating signal is applied to the AM multiplier, which performs the modulating function.

2.3.5 Amplitude and DC Offset Control

Control of the AC amplitude and DC offset amplitude is performed the multiplying D/A section in conjunction with the output amplifier. Further amplitude control is provided by the output attenuator, which includes 1:10 and 1:100 attenuation ratios. Combining these two ratios yields overall attenuation ratios of 1:1, 1:10, 1:100, and 1:1000.

2.4 MULTIPHASE OSCILLATOR OPERATION

Figure 2-3 shows a block diagram of a multiphase oscillator made up of a Model 3930A Multifunction Synthesizer and two Model 3933A Phase Shifters. In this multiphase oscillator, the output of the Model 3930A is assigned as the first phase, while the second and third phase outputs are outputs from the two phase shifters as shown. In this manner, a multiphase oscillator up to a maximum of six phases can be configured. The oscillating frequency and oscillation mode for all units are determined by the main synthesizer signal, but the phase, amplitude, DC offset, and waveform type can be independently programmed for each unit.

Note that the main synthesizer signal, which provides a reference phase for each unit, is not directly output, and that the phase of each unit can be set independently of the others. Also note that the first phase signal (Model 3930 FCTN OUT) is determined by the programmed start/stop phase of the Model 3930A, while the second and third phase signals are determined by the phase settings of those units.

The phases of the various units can be determined from the programmed phase values (start/stop phase for the Model 3930A, phase setting for the Model 3933A). For example, if the Model 3930A start/stop phase is set to 0°, the Model 3933A phases are simply the programmed values. When the Model 3930A is set to the burst or gate oscillation modes, the start/stop phase of the synthesizer is 0°. Therefore, the Model 3933A signal phases will always be the same as the programmed phase values when the burst or gate oscillation mode is used.

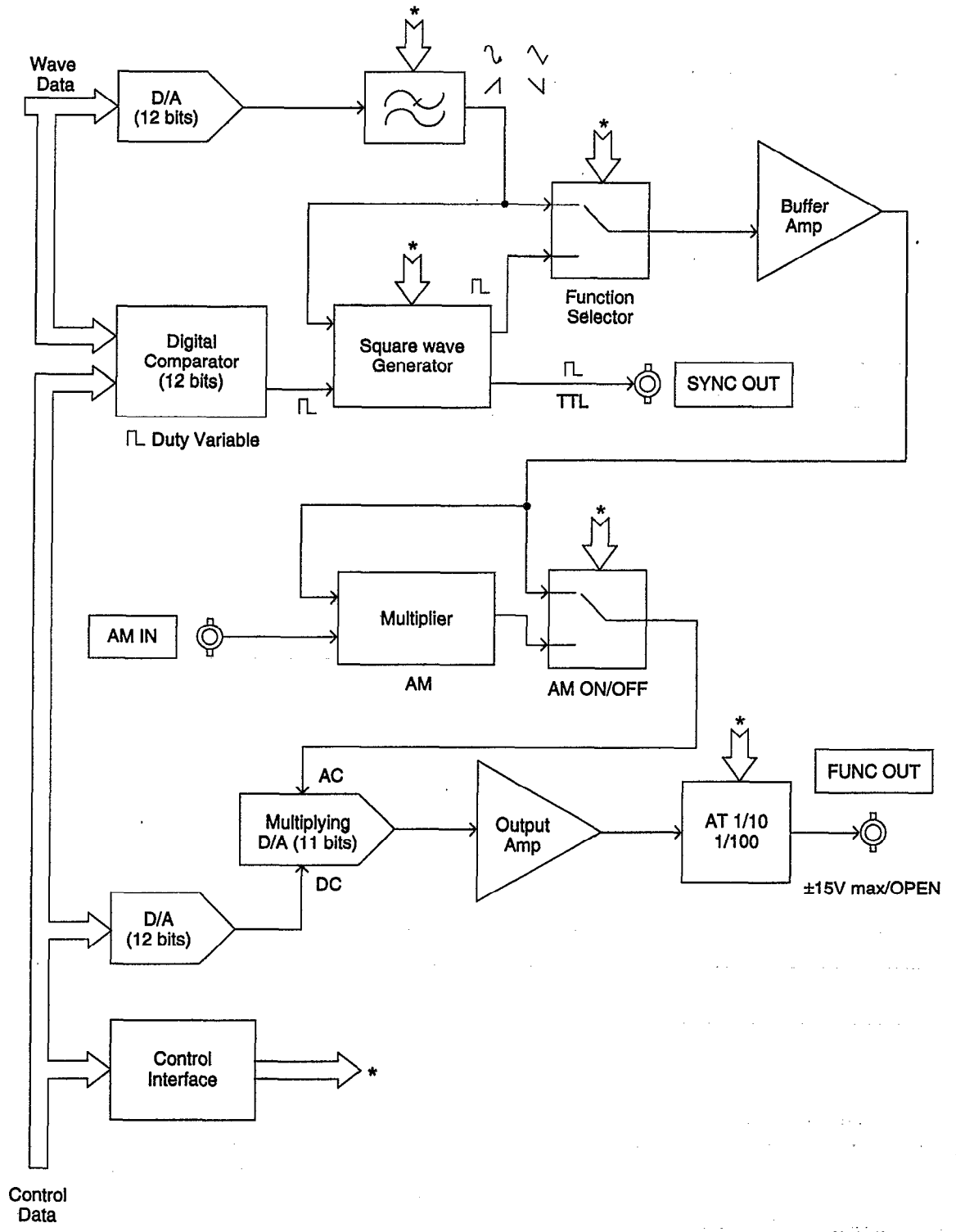


Figure 2-2. Analog Section Block Diagram

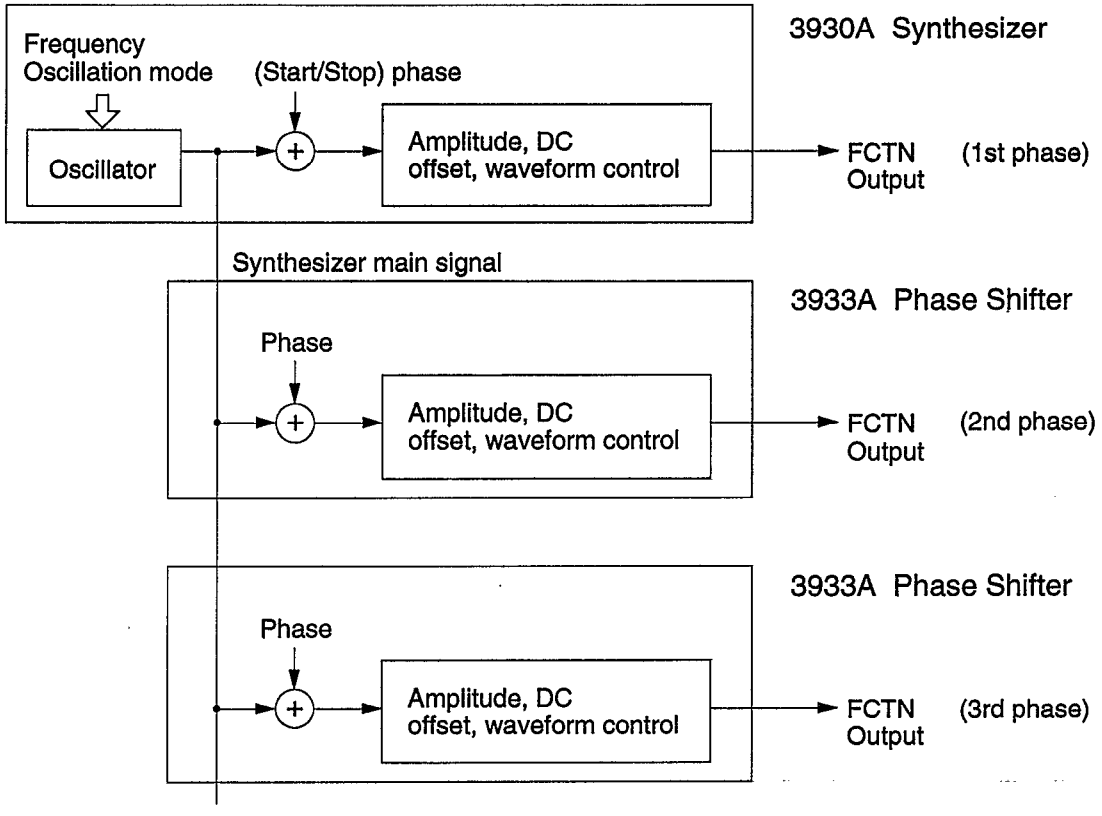


Figure 2-3. Multiphase Oscillator Block Diagram

SECTION 3
Service Information

3.1 INTRODUCTION

This section contains information on fuse replacement, instrument calibration and repair, and replacement parts for the Model 3933A.

3.2 LINE FUSE REPLACEMENT

WARNING

Disconnect the line cord and all other equipment from the instrument before replacing the line fuse.

The line fuse, which is located on the rear panel, protects the power line input from excessive current. To replace the fuse, first unplug the line cord, then unscrew the fuse from its fuse holder. Replace the fuse only with the type recommended in Table 3-1.

CAUTION

Using the wrong fuse type may result in instrument damage.

Table 3-1. Recommended Line Fuses

Line Voltage	Description	Keithley Part No.
100V/120V	1A, 250V, normal blow, 5mm x 20mm	FU-96-2
220V/240V	1/2A, 250V, normal blow, 5mm x 20mm	FU-96-1

3.3 CALIBRATION

The following paragraphs give step-by-step procedures for calibrating the Model 3933A. This calibration procedure can be performed at specified intervals, or if the performance verification procedures covered in Section 1 show that instrument performance is not within specifications.

NOTE

Calibration must be performed in the sequence covered below. If any of the calibration procedures cannot be performed successfully, refer to the repair information in paragraph 3.7 unless the unit is still under warranty. (Units still under warranty should be returned to the factory or authorized repair facility for repair.)

3.3.1 Environmental Conditions

Calibration should be performed at 18-28°C (65-82°F) and at less than 70% relative humidity.

3.3.2 Initial Conditions

The Model 3933A and the test equipment should be turned on and allowed to warm up for one hour before calibration. If the instrument has been subjected to extreme temperature or humidity, allow additional time for stabilization.

3.3.3 Line Power

Before calibrating the instrument, be sure the rear panel line voltage is set to the correct operating voltage. The Model 3933A should be calibrated while operating at a line voltage within ±10% of the line voltage switch setting and at a line frequency from 48Hz to 62Hz.

3.3.4 Recommended Calibration Equipment

Table 3-2 summarizes recommended equipment for calibrating the Model 3933A. Similar equipment may be used as long as corresponding specifications are comparable.

Table 3-2. Recommended Test Equipment for Calibration

Manufacturer	Model	Description	Specifications
Keithley	3930A	Multifunction Synthesizer (2 required)	0.1mHz to 1.2MHz; ±5ppm
Keithley	197A	DMM (DC volts, AC volts) (5-1/2 digits)	20V range; ±(0.015% of rdg + 3 counts) ACV; ±(0.35% of rdg + 100 counts)
Fluke	8920A	DVM (AC volts) (3-1/2 digits)	20V range; 1kHz-200kHz (0.5% of rdg), 200kHz-1MHz (0.7%), 1-10MHz (3%), 10-20MHz (5%)
Philips	PM6654C PM9678	Timer/Counter TCXO option	0.01Hz-120MHz; time base aging $<1 \times 10^{-7}$/month; Vp-p measurements
Keithley	7051-2	BNC Interconnect Cable (2 required)	50Ω coaxial cable (RG-58C), male BNC connectors, 2ft (0.6m)
Keithley	7755	50Ω Feed-through Terminator	BNC to BNC adapter, 50Ω termination, DC to 250MHz, VSWR of <1.1
Pomona	1468	BNC-banana Adapter	Female BNC connector to double banana plug

3.3.5 Cover Removal

Before calibration, the top and bottom covers must be removed as covered below (see Figure 3-1).

WARNING

Potentially hazardous voltages may be present inside the instrument. Use caution when performing calibration.

CAUTION

A conductive coating is applied to the inner surface of the covers. Be careful not to scratch the coating when removing the covers. Also be careful not the peel off the corners of the polyester film covering the front panel; the film can be peeled off relatively easily.

1. Place the instrument upside down on a soft cloth or rubber mat to avoid scratching the top cover.
2. Remove the four corner screws that secure the bottom cover, then remove the cover.
3. Place the instrument right side up.
4. Remove the top cover by separating it from the chassis.

3.3.6 Calibration Adjustments

Calibration adjustments are shown in Figure 3-2.

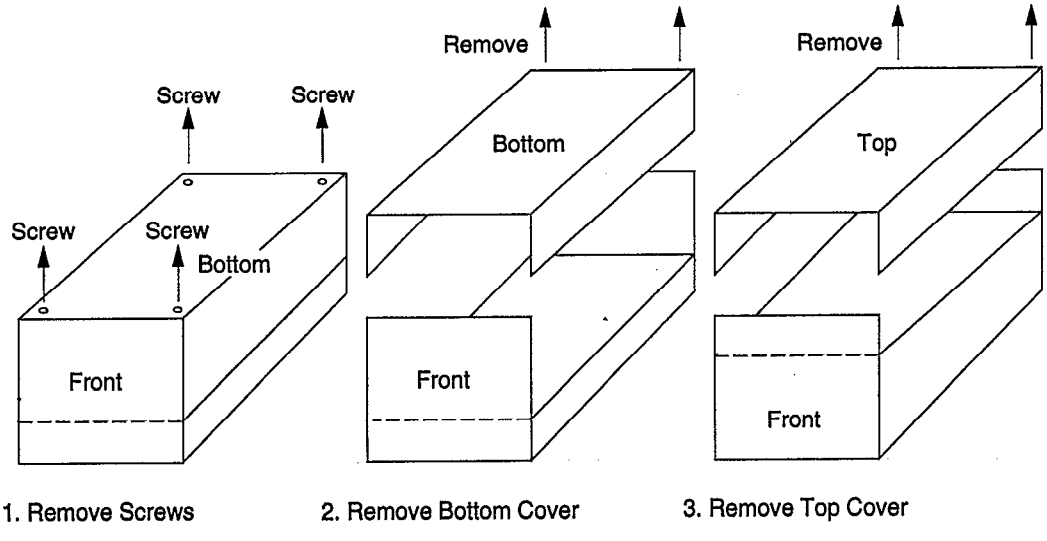


Figure 3-1. Cover Removal

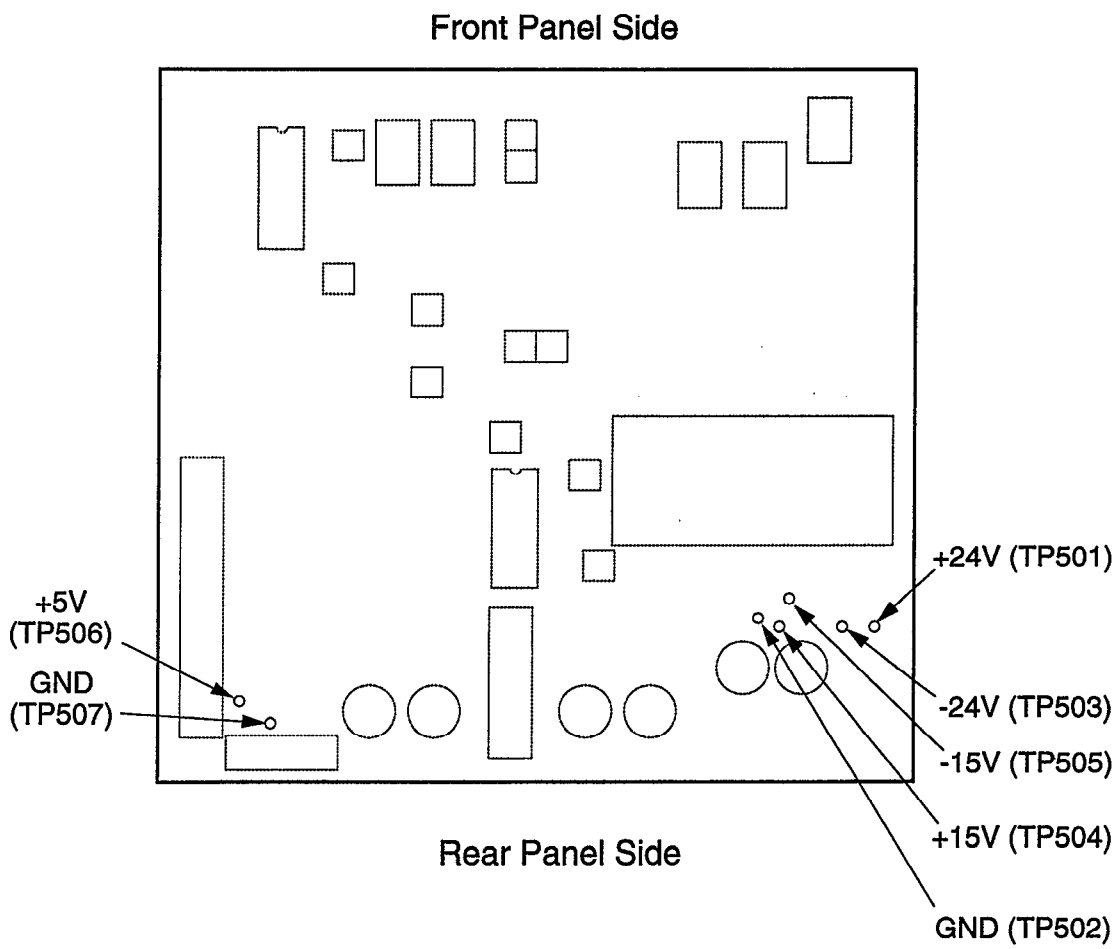


Figure 3-2. Analog Board (NP-21022) Calibration Adjustments

3.3.7 Function Synthesizer Connections

For all adjustment procedures, a Model 3930A Multifunction Synthesizer must be connected to the DIGITAL IN connector of the Model 3933A, as shown in Figure 3-3. Use the CA-94 digital cable supplied with the Model 3933A to make the connections.

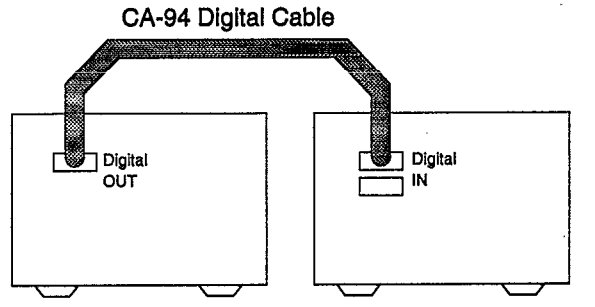


Figure 3-3. Function Synthesizer Connections

3.3.8 Calibration Procedures

NOTE
Calibration should be performed in the sequence presented.

DC Offset

1. Connect the Model 197A DMM to the Model 3933A FCTN OUT jack, as shown in Figure 3-4. Also make sure the Model 3930A is connected properly as indicated.
2. Set the Model 197A to the DCV function, and enable auto-ranging.
3. Setup the Models 3930A and 3933A as follows:

   Model 3933A: Factory Default (press SHIFT PRST)
   RANGE: FXD (press SHIFT 0)
   FCTN: DC

   Model 3930A: Factory Default (press SHIFT PRST)
   SOURCE: EXT V
   MODE: GATE
4. Adjust R213 (DC OFS) so that the DMM reads 0V ± 1mV.
5. Program a Model 3933A DC offset value of –15V (use OFFSET).
6. Adjust R211 (DC SPAN) for a DMM reading of –15V ± 0.002V.
7. Program a Model 3933A DC offset voltage of +15V.
8. Verify that the DMM reading is between 14.996V and 15.002V. If not, repeat the DC span adjustment (step 6) to minimize the errors in the –15V and +15V readings.
9. Program a DC offset voltage of 0V, and verify that the DMM reading is still 0V ± 1mV. If not, re-adjust R213 (DC OFS) for a reading within these limits.
10. Setup the Model 3933A as follows:
    FCTN: SIN
    OFFSET: 0V
    AMPTD: 30Vp-p
11. Adjust R101 (OFS) for a DMM reading of 0V ± 1mV.

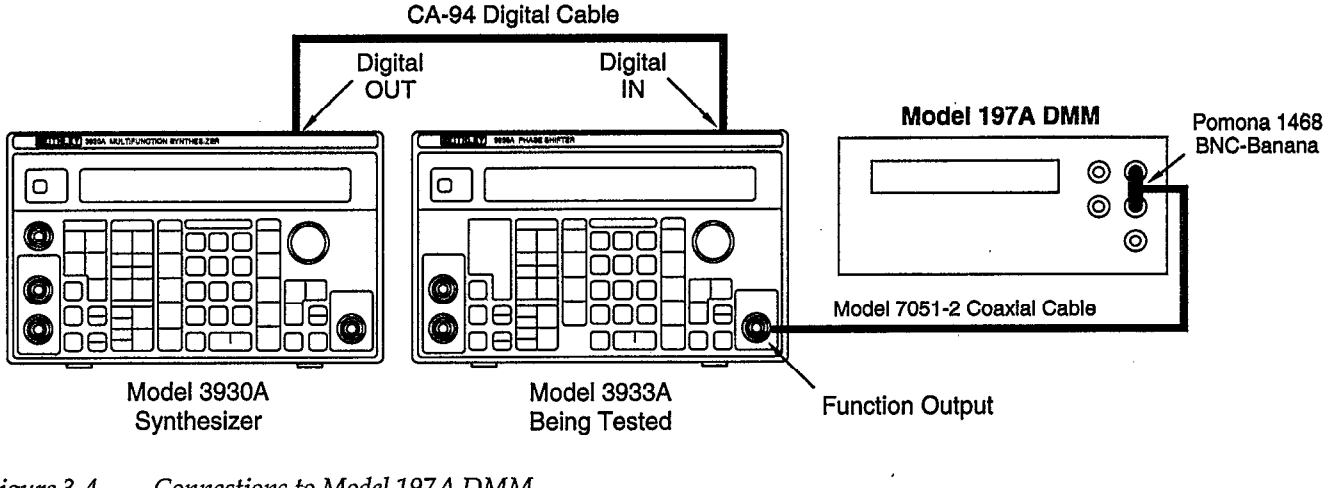


Figure 3-4. Connections to Model 197A DMM

SIN Level

1. Connect the Model 197A DMM to the FCTN OUT jack of the Model 3933A (Figure 3-4). Also make sure the Model 3930A is connected properly as indicated.
2. Set the Model 197A to the DCV function, and select auto-range.
3. Setup the Models 3930A and 3933A as follows:

   Model 3933A: Factory Default (press SHIFT PRST)
   PHASE: –90°
   AMPTD: 7.49Vp-p

   Model 3930A: Factory Default (press SHIFT PRST)
   SOURCE: EXT
   MODE: GATE
4. Adjust R109 (AMP) for a DMM reading of –3.745V ± 0.004V.

AM Balance

1. Connect a Model 197A DMM to FCTN OUT, and connect a second Model 3930A to the AM IN jack of the Model 3933A being calibrated (see Figure 3-5). The second Model 3930A will be used to provide an amplitude modulation signal.

NOTE
Connect an oscilloscope, if one is available, in parallel with the Model 197A input terminals in order to make adjustments easier.

2. Set the DMM to the ACV function, and select auto-ranging.
3. Setup the Model 3930A used for the AM signal as follows:

   Factory Default (press SHIFT PRST)
   AMPTD: 2Vp-p
4. Setup the first Model 3930A and the Model 3933A being calibrated as follows:

   Model 3933A: Factory Default (press SHIFT PRST)
   AMPTD: 7.49Vp-p
   AM: ON

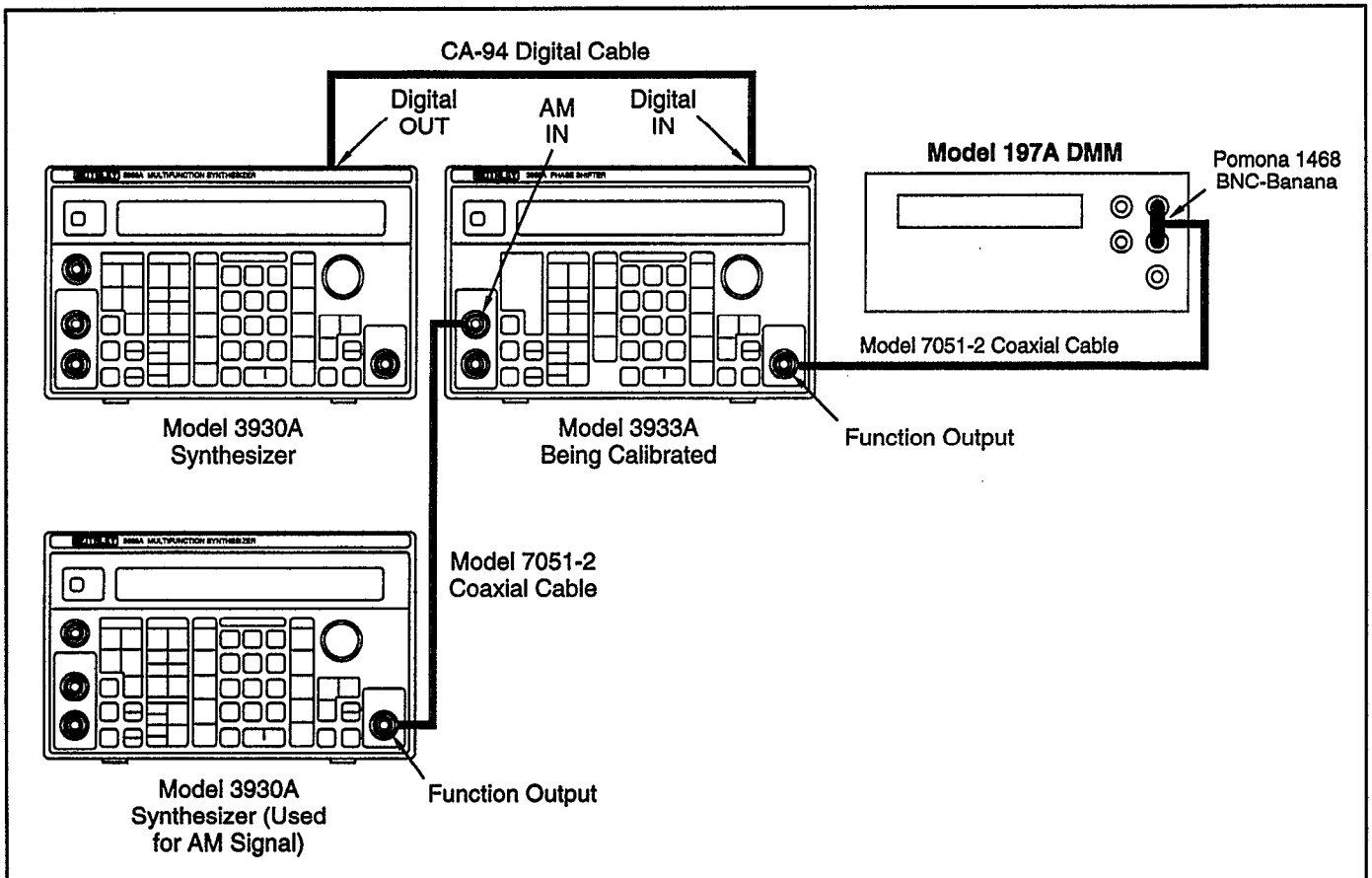


Figure 3-5. Second Model 3930A Connections

Model 3930A: Factory Default (press SHIFT PRST)
SOURCE: EXT
MODE: GATE

5. Adjust R207 (AM BAL) so that the multimeter indicates 10mV or less. (If an oscilloscope is being used, adjust for minimum signal amplitude.)
6. Select the DCV function on the DMM.
7. Adjust R208 (AM OFS) for a DMM reading of 0V ± 20mV.
8. Repeat steps 2 through 7 three or four times until both the AM balance and AM offset reading limits stated in steps 5 and 7 are satisfied.

AM Gain

1. Disconnect the second Model 3930A from the AM IN connector, and make sure the DMM is still connected to the FCTN OUT jack of the Model 3933A being calibrated (Figure 3-4).
2. Select the DCV function and auto-ranging on the DMM.
3. Setup the Model 3933A as follows:

   PHASE: –90°
4. Adjust R203 (AM GAIN) for a DMM reading of –1.872V ± 0.009V.

AM Offset

1. Connect the Model 197A DMM to FCTN OUT (Figure 3-4).
2. Select the DCV function and auto-ranging on the DMM.
3. Setup the Model 3933A as follows:

   PHASE: 0°
4. Adjust R208 (AM OFS) for a DMM reading of 0V ± 10mV.

Square Wave DC Level

1. Connect the Model 197A DMM to FCTN OUT (Figure 3-4).
2. Select the DCV function and auto-ranging on the DMM.
3. Setup the Model 3933A as follows:

   Factory Default (press SHIFT PRST)
   FCTN:
   AMPTD: 7.49Vp-p
   PHASE: +90°
4. Setup the Model 3933A as follows:

   PHASE: –90°
5. Adjust R316 (SQ–) for a DMM reading of –3.7445V ± 0.0055V.

Square Wave Duty Cycle

1. Connect the PM 6645C counter A input to the FCTN OUT jack, as shown in Figure 3-6.
2. Set the PM 6654C counter to the pulse width measurement mode.
3. Setup the Model 3933A as follows:

   Factory Default (press SHIFT PRST)
   FREQ: 100Hz
   AMPTD: 20Vp-p
   FCTN:
4. Adjust R308 (DUTY) for a counter reading of 5msec ± 0.005msec.

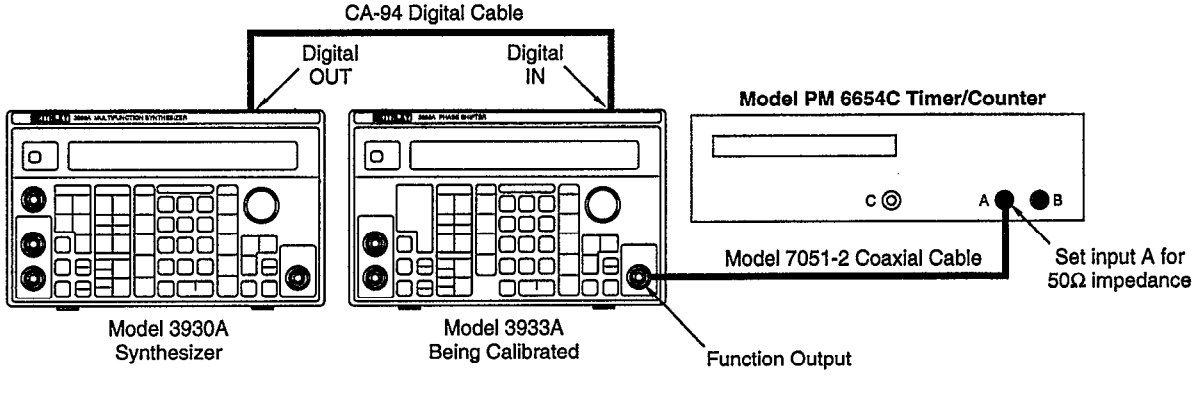


Figure 3-6. Connections to PM6654C Counter

Frequency Response

1. Connect the Model 8920A RMS Voltmeter to the FCTN OUT jack, as shown in Figure 3-7. Be sure to use the 50Ω feed-through terminator as indicated.
2. Make sure the voltmeter dB and REL modes are disabled.
3. Setup the Models 3930A and 3933A as follows:

   Model 3933A: Factory Default (press SHIFT PRST)
   AMPTD: 3.74Vp-p

   Model 3930A: FREQ: 1kHz
4. Allow the voltmeter reading to settle, then enable dB and REL in that order.
5. Setup the Model 3930A as follows:

   FREQ: 800kHz
6. Adjust C108′ for an RMS voltmeter reading of +0.04dB ± 0.03dB.

Display Contrast

7. Press the front panel DSPL key to return the display to normal.
8. Adjust R752 (CONTRAST) for the desired display contrast. (R752 is located on the control board (NP-10409) near the front panel.)

3.3.9 Cover Replacement

After calibration, replace the top and bottom covers, and secure them with the four screws removed earlier. Be careful not to scratch the conductive coating applied to the inside of the covers, and be sure not to peel off the front panel polyester film.

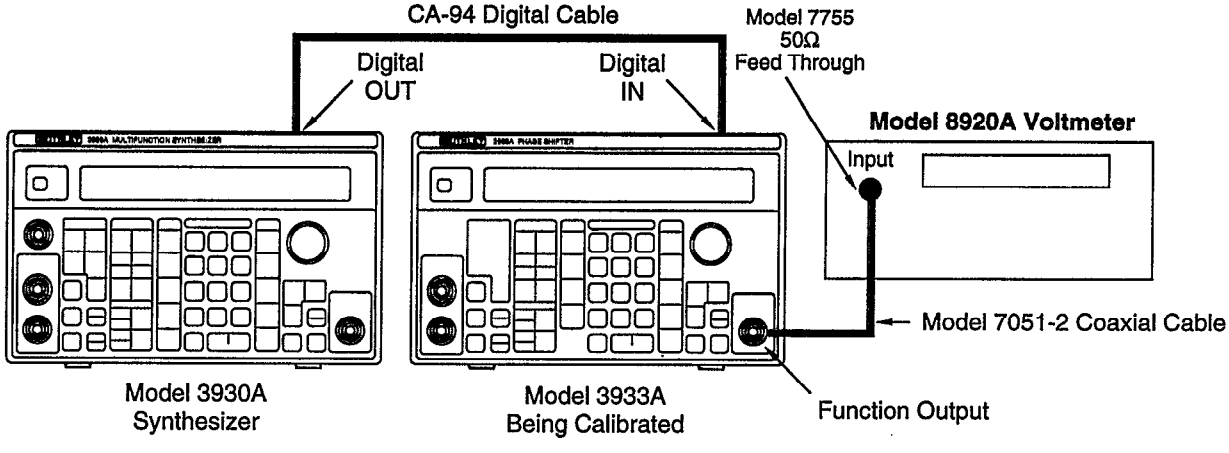


Figure 3-7. Connections to Wideband AC DVM

3.4 FAN FILTER CLEANING

The fan filter should be cleaned at least once every three months when the unit is operated in a clean environment or at least once a month when the unit is operated in a dirty environment. The fan filter element should be cleaned as follows:

1. Turn off the instrument power and disconnect the line cord.
2. Remove the filter cover on the rear panel.
3. Remove the filter element.
4. Soak the filter element in a solution of mild detergent and water until clean.
5. Rinse the filter element thoroughly in clean water, then allow the filter to dry thoroughly before replacement.
6. When the filter has dried completely, install the filter and cover.

CAUTION

The instrument should not be operated without the filter in place.

3.5 FCTN OUT JUMPER

The FCTN OUT jumper, which is located on the control board, allows you to select whether or not the output signal is turned on when power is first applied to the instrument. (As shipped, FCTN OUT is enabled when power is turned on). Use the procedure below to set the jumper position.

1. Disconnect the line cord and all other instruments from the Model 3933A.
2. Remove the top and bottom covers (see paragraph 3.3.5 for details).
3. Set J401 (FCTN OUT) to the desired position. (J401 is located on the control board, NP10409, near the rear panel.) Set the jumper to FCTN OUT ON to enable FCTN OUT at power on, or set it to FCTN OUT OFF to leave FCTN OUT disabled at power on.
4. Replace the top and bottom covers.

3.6 RECHARGEABLE BATTERY REPLACEMENT

The rechargeable battery (BT151), which backs up setup RAM, does not normally require field replacement. However, if you notice the instrument no longer stores setups even after charging the battery, the battery is probably defective and should be replaced. Follow the steps below to replace the battery.

CAUTION

Many parts on the internal circuit boards are static sensitive. To avoid possible damage, perform any repair operations only at a properly grounded workstation, and use only grounded-tip soldering irons and anti-static de-soldering tools.

1. Disconnect the line cord and all other instruments from the Model 3933A.
2. Remove the top and bottom covers (refer to paragraph 3.3.5 for procedure).
3. Note the positions of the various cables connected to the control board, then disconnect all cables from the board.
4. Remove the screws, and release the fasteners that secure the control board to the chassis.
5. Slide the control board towards the front panel until the jacks clear the rear panel.
6. Remove the control board.
7. Unsolder the battery leads, and cut the sealant that secures the battery. Remove the battery.
8. Install a new battery, taking care to observe polarity.
9. After soldering, secure the battery to the board using an electronics-approved silicone or RTV sealer.
10. Install the control board, and connect all cables to the board.
11. Replace the covers.
12. Turn on the power for 50 hours to fully charge the new battery.

3.7 REPAIR

Instrument repair may be necessary in cases where the unit cannot be properly calibrated.

3.7.1 Factory Service

If the Model 3933A is still under warranty, it is recommended that the unit be returned to the factory or Keithley authorized repair facility for repair or calibration. When returning the unit for service, include the following:

- Complete the service form at the back of this manual.
- Advise as to the warranty status of the instrument.

- Write the following on the shipping label: ATTENTION REPAIR DEPARTMENT.

3.7.2 Power Supply Test Points

Table 3-3 summarizes power supply test points, and Figure 3-8 shows the test point locations. Note that ±15V and ±24 supply voltages are reference to TP502, and the +5V supply is referenced to TP507.

Table 3-3. Power Supply Test Point Summary

Test Point	Description
TP501	+24V supply
TP502	GND (±15V, ±24V supplies)
TP503	–24V supply
TP504	+15V supply
TP505	–15V supply
TP506	+5V supply
TP507	GND (+5V supply)

3.7.3 Board-level Repair

Table 3-4 summarizes which circuit board is most likely at fault for various problems. Paragraph 3.8 below lists replacement boards and certain other parts. If board replacement fails to fix the problem, the most likely cause of the fault is the wiring between the boards.

Table 3-4. Board Level Repair Summary

Problem	Probable Cause
1. DC OFFSET VAR	B
2. OUTPUT ATT	B
3. FCTN OUT ON/OFF	B
4. PHASE VAR	A
5. WAVE FORM	A or B
6. AMPLITUDE VAR	B
7. AM	B
8. DUTY CYCLE VAR	A or B
9. DUTY CYCLE STABILITY	B
10. PHASE SWEEP	A
11. SYNC OUT	B
12. SWEEP MKR OUT	A
13. SWEEP SYNC OUT	A
14. X DRIVE OUT	A

A: Control circuit board (NP-10409)
B: Analog circuit board (NP-21022)

3.8 REPLACEABLE PARTS

3.8.1 Parts List

Table 3-5 summarizes available Model 3933A replacement parts. Figure 3-9 shows the location of mechanical parts.

3.8.2 Ordering Parts

To order a part, or to obtain information on replacement parts, contact your Keithley representative or the factory. When ordering parts, include the following information:

- Instrument model number
- Instrument serial number
- Keithley part number
- Part description

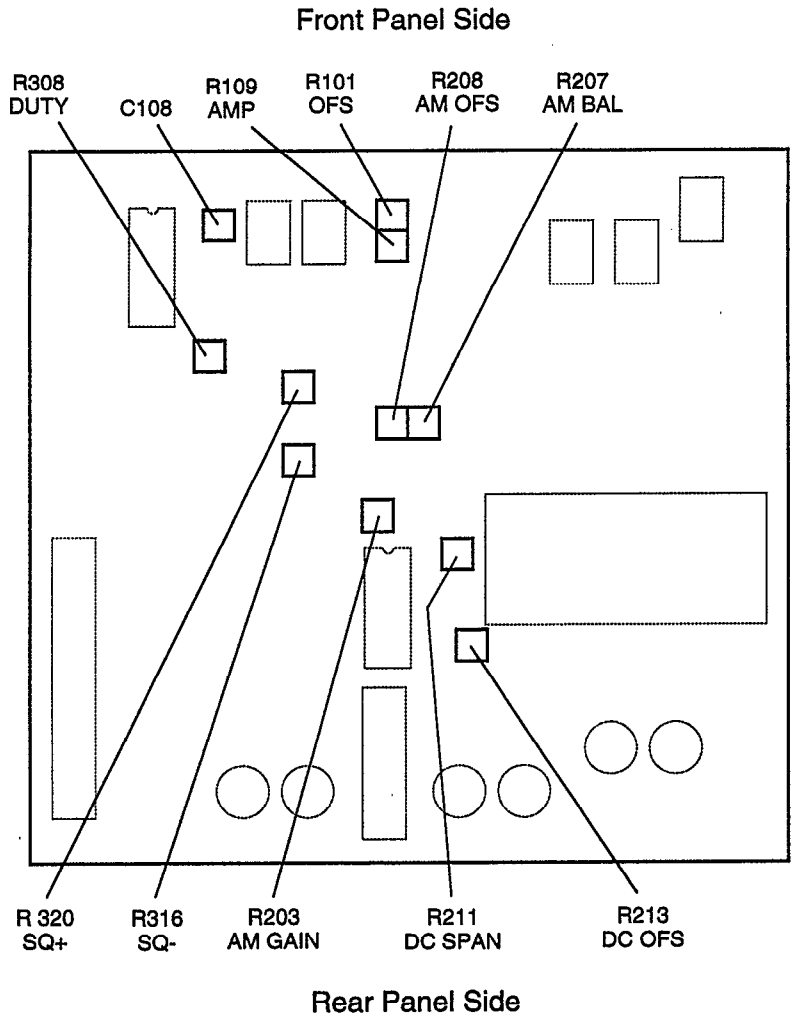


Figure 3-8. Power Supply Test Point Locations

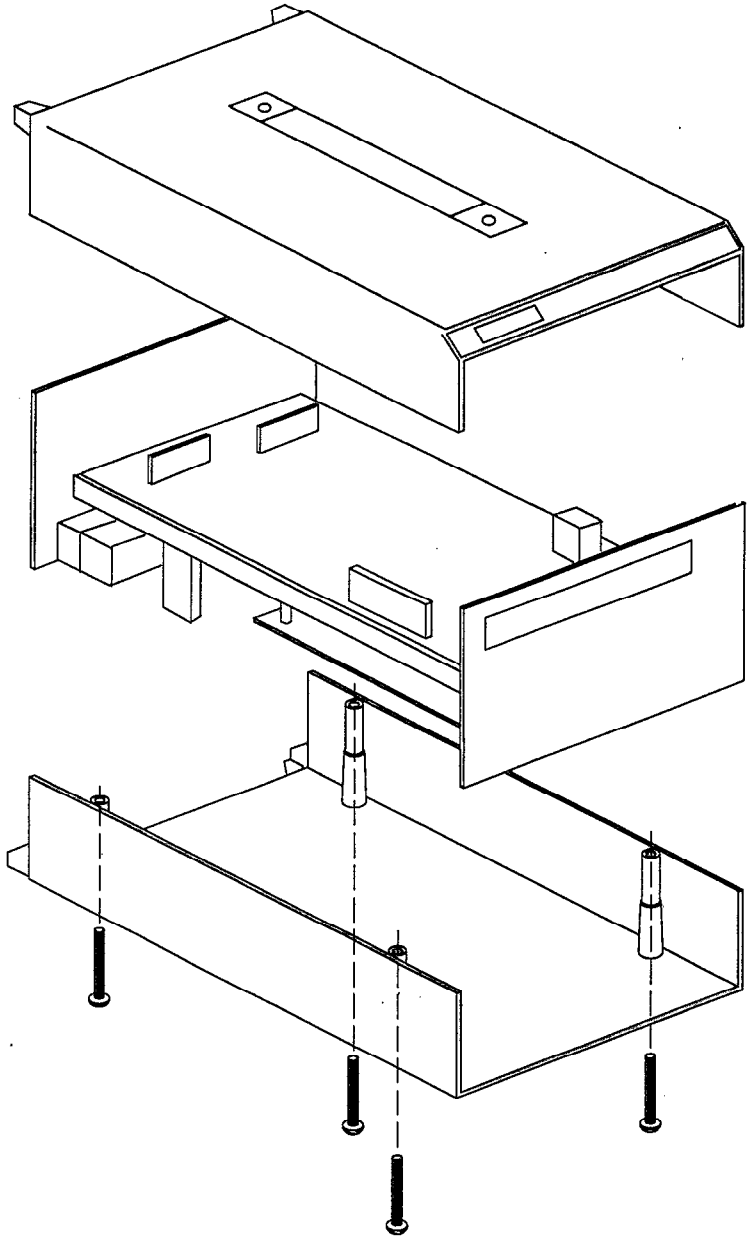


Figure 3-9. Model 3933A Exploded View

Table 3-5. Replaceable Parts

Description	Part Number	Qty.
Control board (NP-10409)	080-33641-00	1
Analog board (NP-21022)	080-33650-00	1
Fan	300-00718-00	1
Air filter	459-00205-00	1
Flat head screw (for air filter)	600-01241-00	4
Fuse holder	302-04054-00	1
Noise filter (AC receptacle)	240-03328-00	1
BNC connector	310-00347-00	3
Power switch (internal)	332-19141-00	1
Power switch (on front panel)	332-19133-00	1
Flexible wire (for power switch)	332-19150-00	1
Voltage selecting switch	332-50057-00	1
Rotary encoder	332-90041-00	1
Ground terminal	330-05389-00	1
LCD	304-10118-00	1
EL back light (for LCD)	100-70028-00	1
Power transformer	244-10890-00	1
Rear panel	400-11704-00	1
Hex. stud	606-00187-00	4
Grommet	546-00146-00	3
SW spacer (for power switch)	520-05356-00	1
Collar (for LCD)	606-02236-00	4
BNC bush	446-00046-00	4
BNC spacer	540-00157-00	4
Spacer (for rotary encoder)	520-05976-00	1
Hex. spacer (for power switch)	606-01892-00	2
Knob (for rotary encoder)	486-24060-00	1
Button (for power switch)	359-03554-00	1
Hex. stud (for NP-10409)	606-00101-00	2
Standoff (for NP-10409)	529-00185-00	4
Battery	*	1
Fuse (100V/120V)	FU-96-2	1
Fuse (220V/240V)	FU-96-1	1

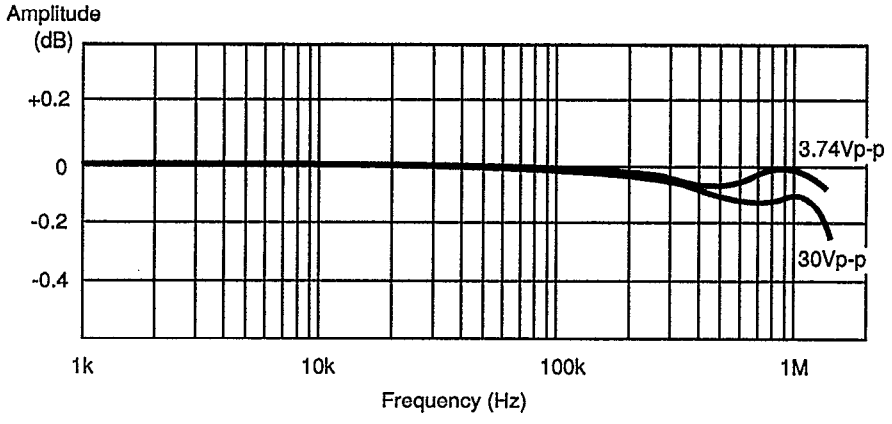
*Part number not available at time of printing; contact repair department.

APPENDIX A
Typical Data

INTRODUCTION

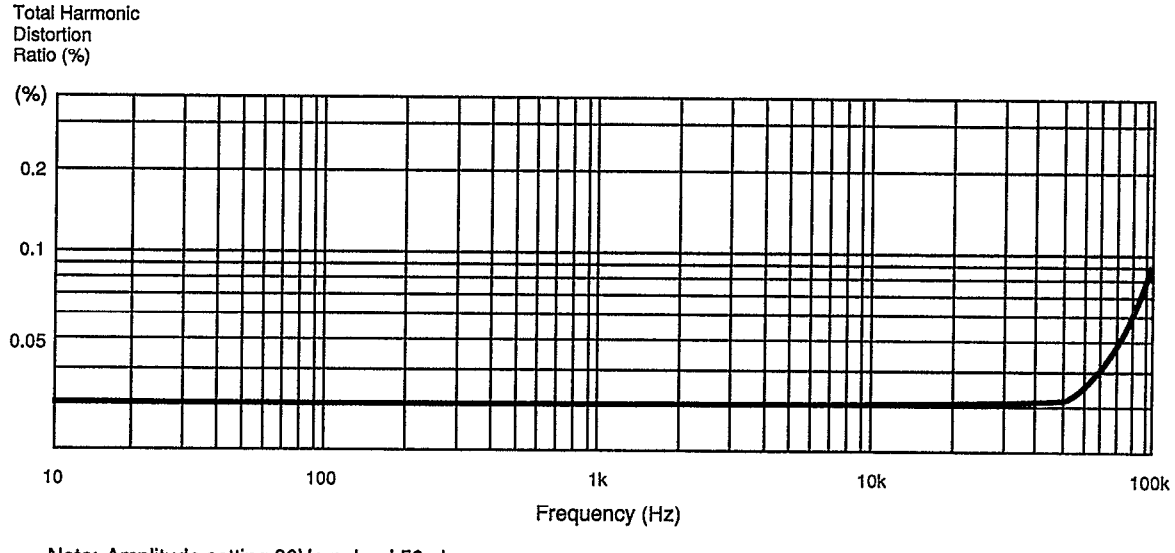
Appendix A provides the typical performance data for the Model 3933A.

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.



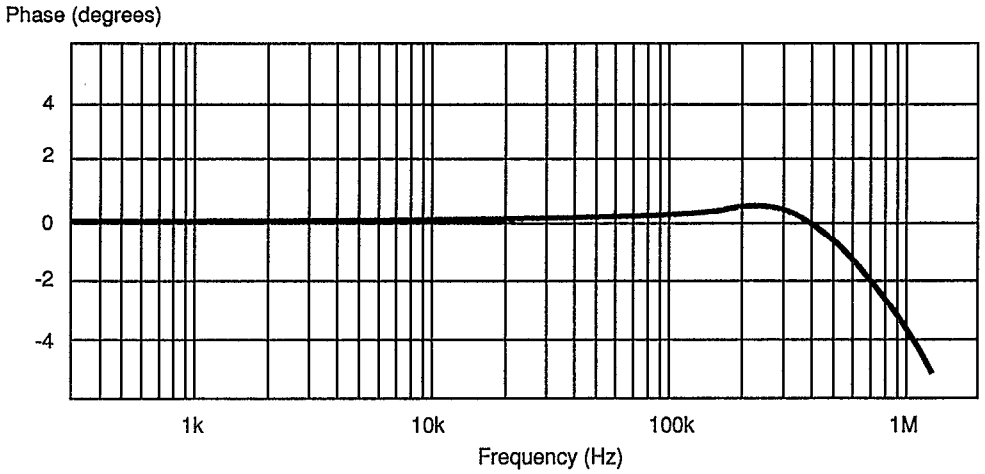
Note: Voltage is set voltage, load 50 ohms,
1 kHz base

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 from 30.0mVp-p to 30.0Vp-p (when output range is FXD, above 300Vp-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
		Vrms			0.01mVrms
		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) × 132.5 (H) × 350 (D) mm, 8.5 (W) × 5-1/4 (H) × 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)	∿ rms	∿ dBV	Hardware Resolution (p-p)	Output Attenuator (See note)
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)	∿ ⩘ ⩗ rms	∿ ⩘ ⩗ dBV	Hardware Resolution (p-p)	Output Attenuator (See note)
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)	⎍ rms	⎍ dBV	Hardware Resolution (p-p)	Output Attenuator (See note)
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.

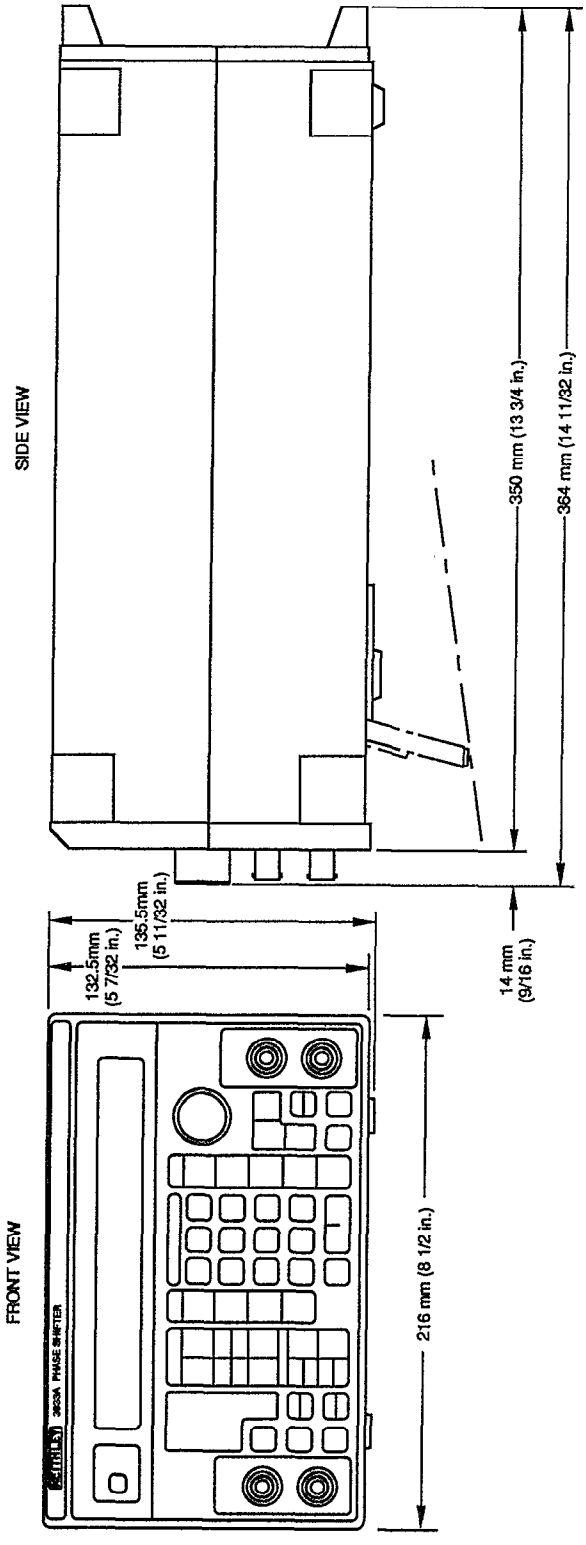


Figure B-1. Outer Dimensions of the Model 3933A

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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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