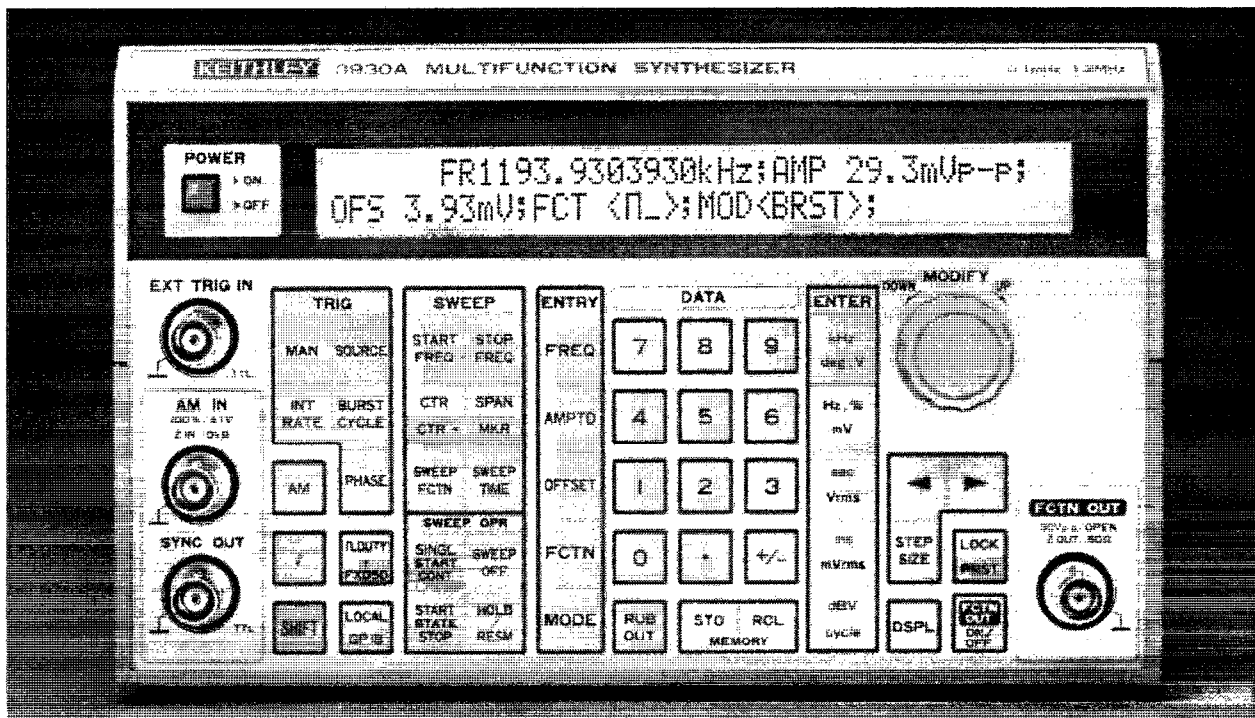


Model 3930A Multifunction Synthesizer

Service Manual



Contains Operating and Servicing Information

KEITHLEY

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.

THIS WARRANTY IS IN LIEU OF ALL OTHER WARRANTIES, EXPRESSED OR IMPLIED, INCLUDING ANY IMPLIED WARRANTY OF MERCHANTABILITY OR FITNESS FOR A PARTICULAR USE. THE REMEDIES PROVIDED HEREIN ARE BUYER'S SOLE AND EXCLUSIVE REMEDIES.

NEITHER KEITHLEY INSTRUMENTS, INC. NOR ANY OF ITS EMPLOYEES SHALL BE LIABLE FOR ANY DIRECT, INDIRECT, SPECIAL, INCIDENTAL OR CONSEQUENTIAL DAMAGES ARISING OUT OF THE USE OF ITS INSTRUMENTS AND SOFTWARE EVEN IF KEITHLEY INSTRUMENTS, INC., HAS BEEN ADVISED IN ADVANCE OF THE POSSIBILITY OF SUCH DAMAGES. SUCH EXCLUDED DAMAGES SHALL INCLUDE, BUT ARE NOT LIMITED TO: COSTS OF REMOVAL AND INSTALLATION, LOSSES SUSTAINED AS THE RESULT OF INJURY TO ANY PERSON, OR DAMAGE TO PROPERTY.

KEITHLEY

Keithley Instruments, Inc. • 28775 Aurora Road • Cleveland, OH 44139 • 216-248-0400 • Fax: 216-248-6168 • <http://www.keithley.com>

CHINA:	Keithley Instruments China • Holiday Inn Lido • Office Building 404C • Beijing, 100004 • 8610-4362871 • Fax: 8610-4366165
FRANCE:	Keithley Instruments SARL • BP 60 • 3 allée des Garays • 91122 Palaiseau Cédex • 31-6-0115155 • Fax: 31-6-0117726
GERMANY:	Keithley Instruments GmbH • Landsberger Straße 65 • 82110 Germering • 49-89-849307-0 • Fax: 49-89-84930759
GREAT BRITAIN:	Keithley Instruments, Ltd. • The Minster • 58 Portman Road • Reading, Berkshire RG30 1EA • 44-01734-575666 • Fax: 44-01734-596469
ITALY:	Keithley Instruments SRL • Viale S. Gimignano 38 • 20146 Milano • 39-2-48303008 • Fax: 39-2-48302274
JAPAN:	Keithley Instruments Far East KK • Aibido Bldg. • 7-20-2 Nishishinjuku • Shinjuku-ku, Tokyo 160 • 81-3-5389-1964 • Fax: 81-3-5389-2068
NETHERLANDS:	Keithley Instruments BV • Avelingen West 49 • 4202 MS Gorinchem • 31-(0)183-635333 • Fax: 31-(0)183-630821
SWITZERLAND:	Keithley Instruments SA • Kriesbachstrasse 4 • 8600 Dübendorf • 41-1-8219444 • Fax: 41-1-8203081
TAIWAN:	Keithley Instruments Taiwan • 1, Ming-Yu First Street • Hsinchu, Taiwan, R.O.C. • 886-35-778462 • Fax: 886-35-778455

Model 3930A Multifunction Synthesizer Service Manual

© 1991, Keithley Instruments, Inc.
Test Instrumentation Group
All rights reserved.
Cleveland, Ohio, U.S.A.
August 1991, First Printing
Document Number: 3930A-902-01 Rev. A

All Keithley product names are trademarks or registered trademarks of Keithley Instruments, Inc.

Other brand and product names are trademarks or registered trademarks of their respective holders.

Safety Precautions

The following safety precautions should be observed before using the Model 3930A Multifunction Synthesizer 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 3930A.

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.

Table of Contents

SECTION 1 — Performance Verification

1.1	INTRODUCTION	1-1
1.2	ENVIRONMENTAL CONDITIONS	1-1
1.3	INITIAL CONDITIONS	1-1
1.4	LINE POWER	1-1
1.5	RECOMMENDED TEST EQUIPMENT	1-1
1.6	VERIFICATION PROCEDURES	1-2
1.6.1	Frequency and Duty Cycle Accuracy	1-2
1.6.2	Amplitude Accuracy	1-4
1.6.3	Frequency Response (Sine)	1-5
1.6.4	Frequency Response (Triangle, Sawtooth, Square)	1-7
1.6.5	Total Harmonic Distortion	1-8
1.6.6	DC Voltage Accuracy	1-9
1.6.7	DC Level (Square) and DC Offset Error (Sine)	1-9
1.6.8	Rise and Fall Times	1-9

SECTION 2 — Principles of Operation

2.1	INTRODUCTION	2-1
2.2	BLOCK DIAGRAM	2-1
2.2.1	Control Section	2-1
2.2.2	Display and Keyboard Section	2-1
2.2.3	Trigger Section	2-1
2.2.4	Synthesizer Section	2-1
2.2.5	Analog Section	2-1
2.2.6	Power Supply Section	2-3
2.3	ANALOG CIRCUIT DESCRIPTION	2-3
2.3.1	Analog Section Block Diagram	2-3
2.3.2	D/A Converter	2-3
2.3.3	Square Wave Generator	2-3
2.3.4	Amplitude Modulation	2-3
2.3.5	Amplitude and DC Offset Control	2-3
2.4	SYNTHESIZER OPERATING PRINCIPLES	2-5

SECTION 3 — Service Information

3.1	INTRODUCTION	3-1
3.2	LINE FUSE REPLACEMENT	3-1
3.3	CALIBRATION	3-1
3.3.1	Environmental Conditions	3-2
3.3.2	Initial Conditions	3-2
3.3.3	Line Power	3-2

3.3.4	Recommended Calibration Equipment	3-2
3.3.5	Cover Removal	3-3
3.3.6	Calibration Adjustments	3-3
3.3.7	Calibration Procedures	3-6
3.3.8	Cover Replacement	3-9
3.4	FAN FILTER CLEANING	3-9
3.5	FCTN OUT JUMPER	3-9
3.6	RECHARGEABLE BATTERY REPLACEMENT	3-10
3.7	REPAIR	3-10
3.7.1	Factory Service	3-10
3.7.2	Power Supply Test Points	3-10
3.7.3	Board-Level Repair	3-12
3.8	REPLACEABLE PARTS	3-12
3.8.1	Parts List	3-12
3.8.2	Ordering Parts	3-12

APPENDICES

A	Typical Data	A-1
B	Model 3930A Specifications	B-1

List of Illustrations

SECTION 1 — Performance Verification

Figure 1-1	Connections to Timer/Counter	1-3
Figure 1-2	Connections to Model 197A DMM	1-4
Figure 1-3	Connections to Wideband AC DVM	1-5
Figure 1-4	Connections to Audio Analyzer	1-8

SECTION 2 — Principles of Operation

Figure 2-1	Overall Block Diagram	2-2
Figure 2-2	Analog Selection Block Diagram	2-4
Figure 2-3	Frequency Synthesizer Address Generator Diagram	2-5
Figure 2-4	Address Generator Waveform	2-6
Figure 2-5	Waveform Memory and D/A Converter	2-6

SECTION 3 — Service Information

Figure 3-1	Cover Removal	3-3
Figure 3-2	Analog Board (NP-21022) Calibration Adjustments	3-4
Figure 3-3	Control Board (NP-10408) Calibration Adjustments	3-5
Figure 3-4	Connections to Model 197A DMM	3-6
Figure 3-5	Second Model 3930A Connections	3-7
Figure 3-6	Connections to PM 6654C Counter	3-8
Figure 3-7	Connections to DVM	3-9
Figure 3-8	Power Supply Test Point Locations	3-11
Figure 3-9	Exploded View	3-13

List of Tables

SECTION 1 — Performance Verification

Table 1-1	Verification Equipment	1-2
Table 1-2	Limits for Frequency and Duty Cycle Accuracy	1-3
Table 1-3	Limits for Amplitude Accuracy	1-4
Table 1-4	Limits for Frequency Response (Sine)	1-6
Table 1-5	Limits for Frequency Response (Triangle, Sawtooth, Square)	1-7
Table 1-6	Limits for Total Harmonic Distortion	1-8
Table 1-7	Limits for DC Voltage Accuracy	1-9
Table 1-8	Limits for DC Level (Square) and DC Offset Error (Sine)	1-9
Table 1-9	Limits for Rise/Fall Times	1-10

SECTION 3 — Service Information

Table 3-1	Recommended Line Fuses	3-1
Table 3-2	Recommended Test Equipment for Calibration	3-2
Table 3-3	Power Supply Test Point Summary	3-10
Table 3-4	Board Level Repair Summary	3-12
Table 3-5	Replaceable Parts	3-12

SECTION 1

Performance Verification

1.1 INTRODUCTION

The procedures outlined in this section may be used to verify that the Model 3930A 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 3930A must be turned on and allowed to warm up for at least one hour before beginning the veri-

fication procedures. If the instrument has been subject 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 $\pm 10\%$ 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 3930A. 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 those listed in Table 1-1.

Table 1-1. Verification Equipment

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

1.6 VERIFICATION PROCEDURES

The following paragraphs contain the detailed procedures for verifying accuracy specifications of the Model 3930A 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 the service manual.

1.6.1 Frequency and Duty Cycle Accuracy

1. Connect the function synthesizer to a timer/counter as shown in Figure 1-1. Turn on both instruments.
2. Restore factory defaults on the Model 3930A by pressing SHIFT PRST.
3. Program a 1MHz sine function 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 100Hz square wave with a fixed 50% duty cycle.
6. Set the timer/counter to display the pulse width of Channel A, and verify that the reading is within specifications.
7. Modify the frequency and duty cycle settings of the synthesizer according to Table 1-2, and verify the pulse width readings.

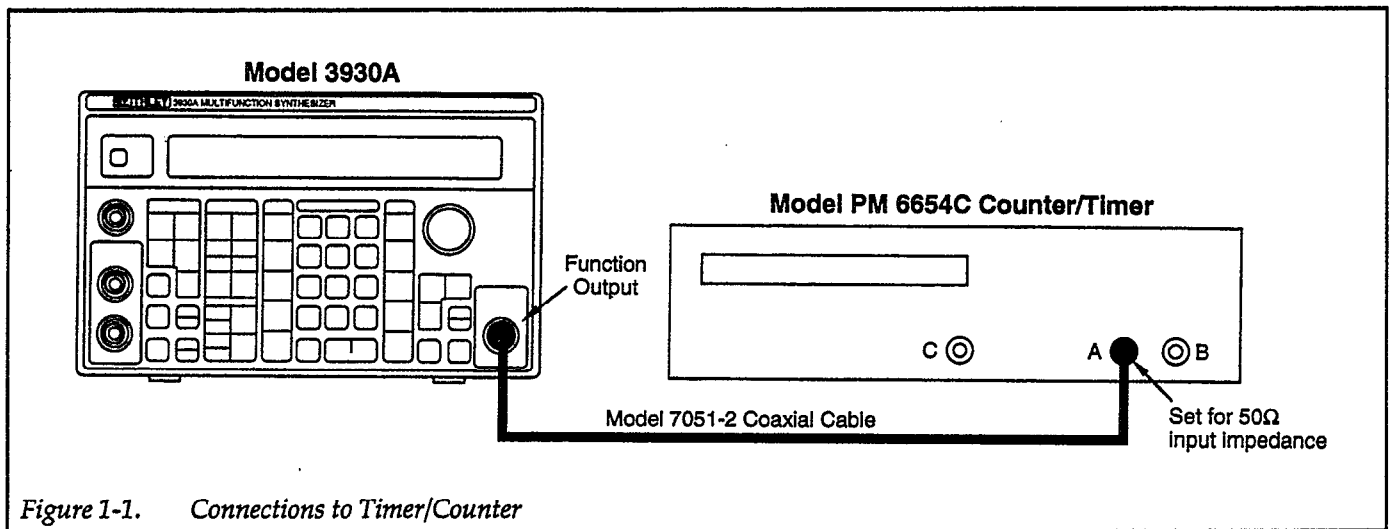


Figure 1-1. Connections to Timer/Counter

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

Function	Amplitude	Frequency	Allowable 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

1.6.2 Amplitude Accuracy

1. Connect the function synthesizer to a DMM as shown in Figure 1-2. Turn on both instruments.
2. Restore factory defaults on the Model 3930A by pressing SHIFT PRST.
3. Program a 1kHz sine function 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 synthesizer according to Table 1-3, and verify the voltage readings.

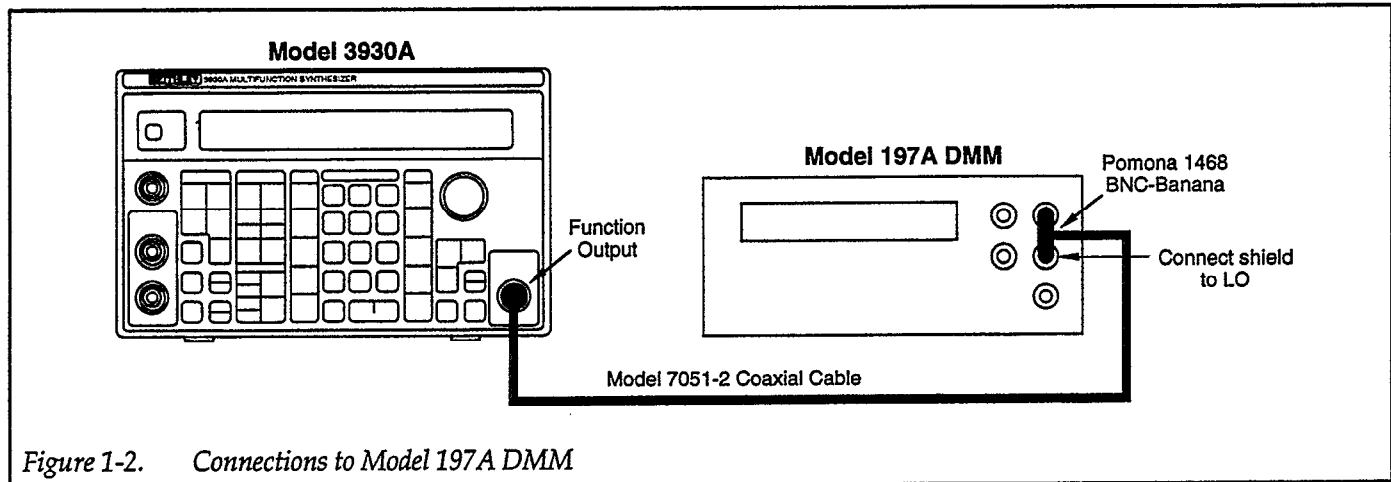


Figure 1-2. Connections to Model 197A DMM

Table 1-3. Limits for Amplitude Accuracy

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

1.6.3 Frequency Response (Sine)

1. Connect the function synthesizer to a wideband AC DVM as shown in Figure 1-3. Turn on both instruments.
2. Restore factory defaults on the Model 3930A by pressing SHIFT PRST.
3. Program a 1kHz 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.

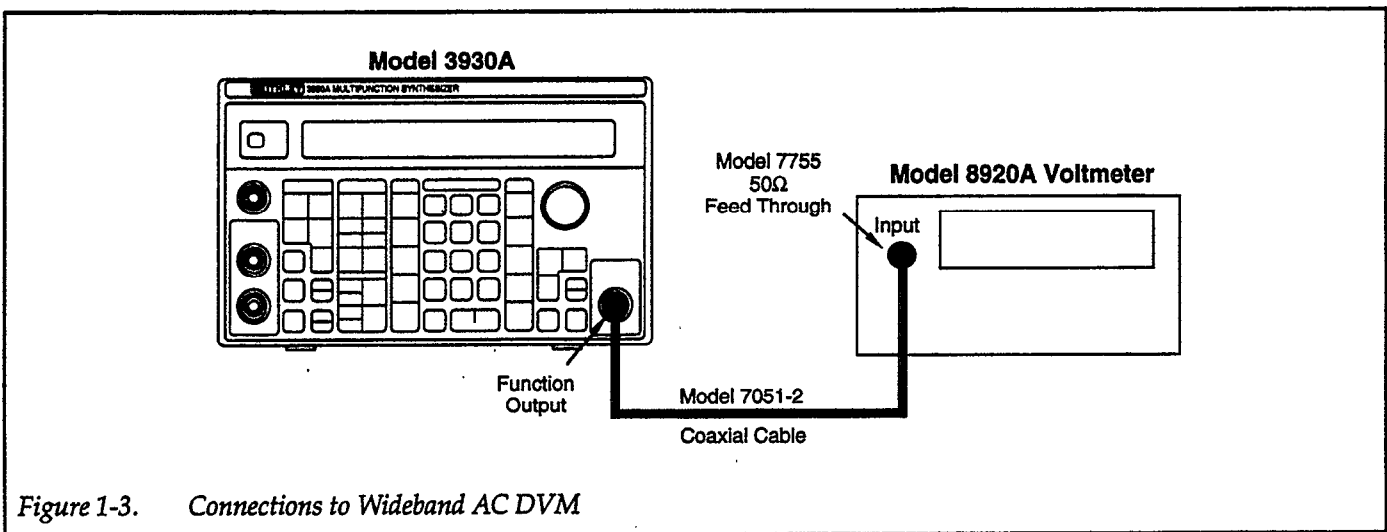


Figure 1-3. Connections to Wideband AC DVM

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

Function	Amplitude	Frequency	Allowable 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

1.6.4 Frequency Response (Triangle, Sawtooth, Square)

1. Connect the function synthesizer to a timer/counter as shown in Figure 1-1. Turn on both instruments.
2. Restore factory defaults on the Model 3930A by pressing SHIFT PRST.
3. Program a 1kHz 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 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 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)

Function	Amplitude	Frequency	Allowable 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

1.6.5 Total Harmonic Distortion

1. Connect the function synthesizer to an audio analyzer as shown in Figure 1-4. Turn on both instruments.
2. Restore factory defaults on the Model 3930A by pressing SHIFT PRST.
3. Program a 1kHz 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

Function	Amplitude	Frequency	Allowable 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%

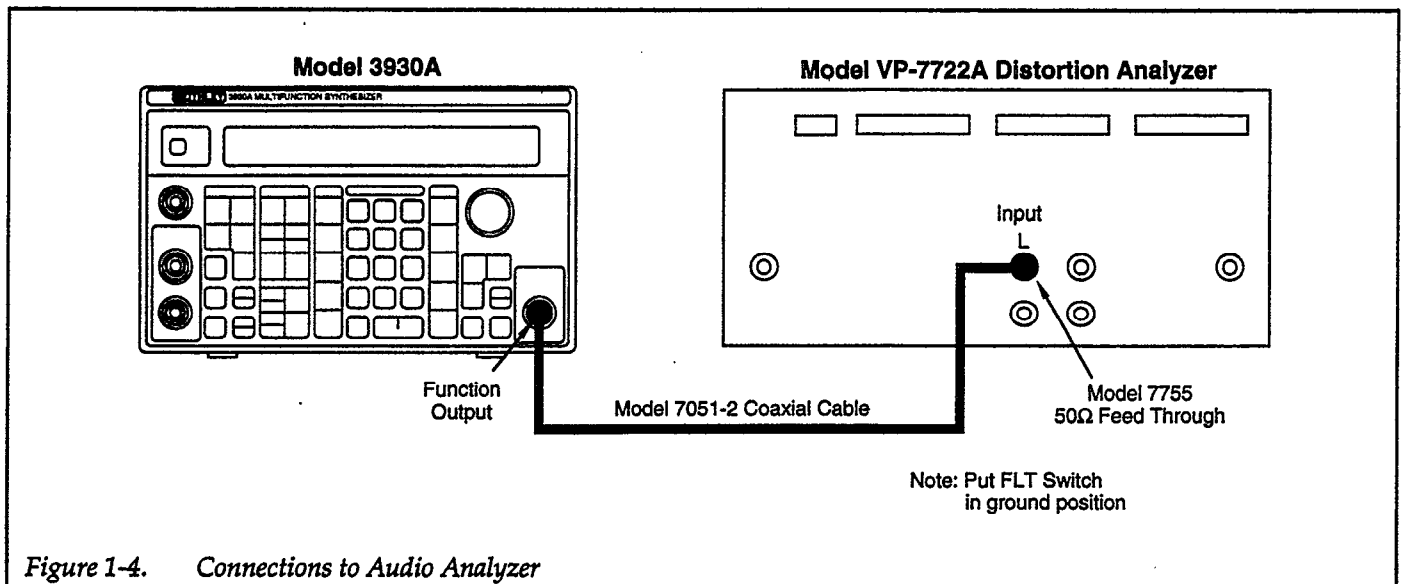


Figure 1-4. Connections to Audio Analyzer

1.6.6. DC Voltage Accuracy

1. Connect the function synthesizer to a DMM as shown in Figure 1-2. Turn on both instruments.
2. Restore factory defaults on the Model 3930A by pressing SHIFT PRST.
3. Program the DC function, 0Hz, 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 synthesizer according to Table 1-7, and verify the subsequent voltage readings.

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

1. Connect the function synthesizer to a DMM as shown in Figure 1-2. Turn on both instruments.
2. Restore factory defaults on the Model 3930A by pressing SHIFT PRST.
3. Program a 7.49Vp-p square wave, gated mode, Ext ∇ trigger source, and +90° of phase.
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 synthesizer according to Table 1-8 and verify the voltage readings.

Table 1-7. Limits for DC Voltage Accuracy

Function	Offset	Allowable 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 Rise and Fall Times

1. Connect the function synthesizer to a timer/counter as shown in Figure 1-1. Turn on both instruments.
2. Restore factory defaults on the Model 3930A 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 synthesizer 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)

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

Table 1-9. Limits for Rise/Fall Times

Function	Frequency	Amplitude	Time	Allowable 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 3930A.

2.2 BLOCK DIAGRAM

Figure 2-1 shows an overall block diagram of the Model 3930A. The various sections include the control section, display and keyboard section, trigger section, synthesizer 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 Trigger Section

The trigger section generates trigger signals for the burst and gate oscillation modes. Circuits in the trigger section include the internal trigger oscillator, counter for the burst oscillator, the I/O buffer, and various support circuits.

2.2.4 Synthesizer Section

This section is comprised of a custom LSI IC, which provides direct digital synthesis of the selected waveform. The digital waveform data is defined by the oscillation frequency and waveform type.

In addition to the custom LSI IC, the synthesizer section also includes a high-accuracy crystal oscillator, a sine wave conversion ROM, sweep I/O circuits, as well as circuits necessary to connect the Model 3930A to the optional Model 3933A Phase Shifter.

2.2.5 Analog Section

The analog section includes a D/A converter to convert digital waveform data produced by the synthesizer 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.

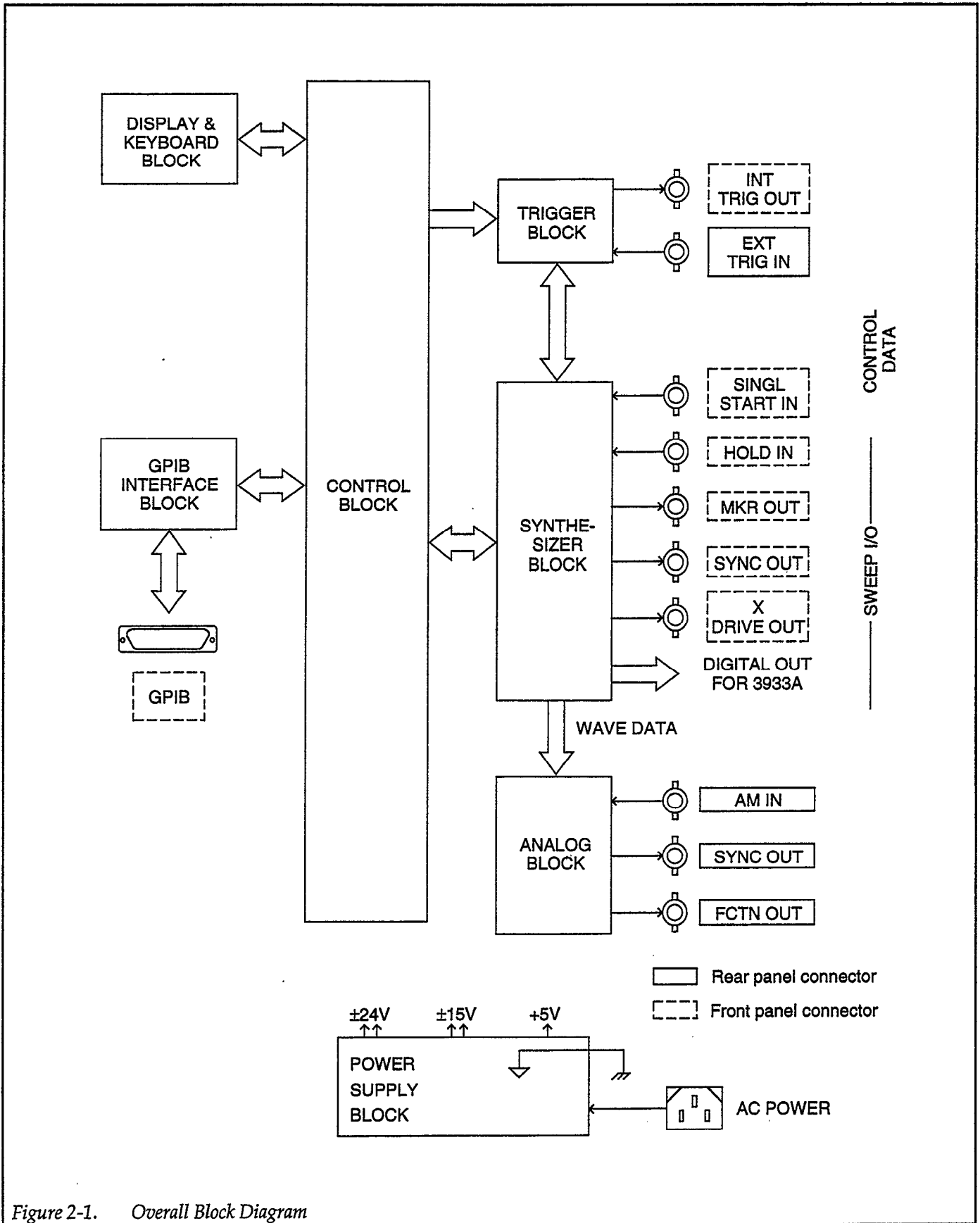


Figure 2-1. Overall Block Diagram

2.2.6 Power Supply Section

The power supply provides several DC operating voltages to various other sections in the instrument. Supply voltages include 24V, 15V, and +5V DC.

Note that power supply common is connected to chassis ground.

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 from the synthesizer 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.

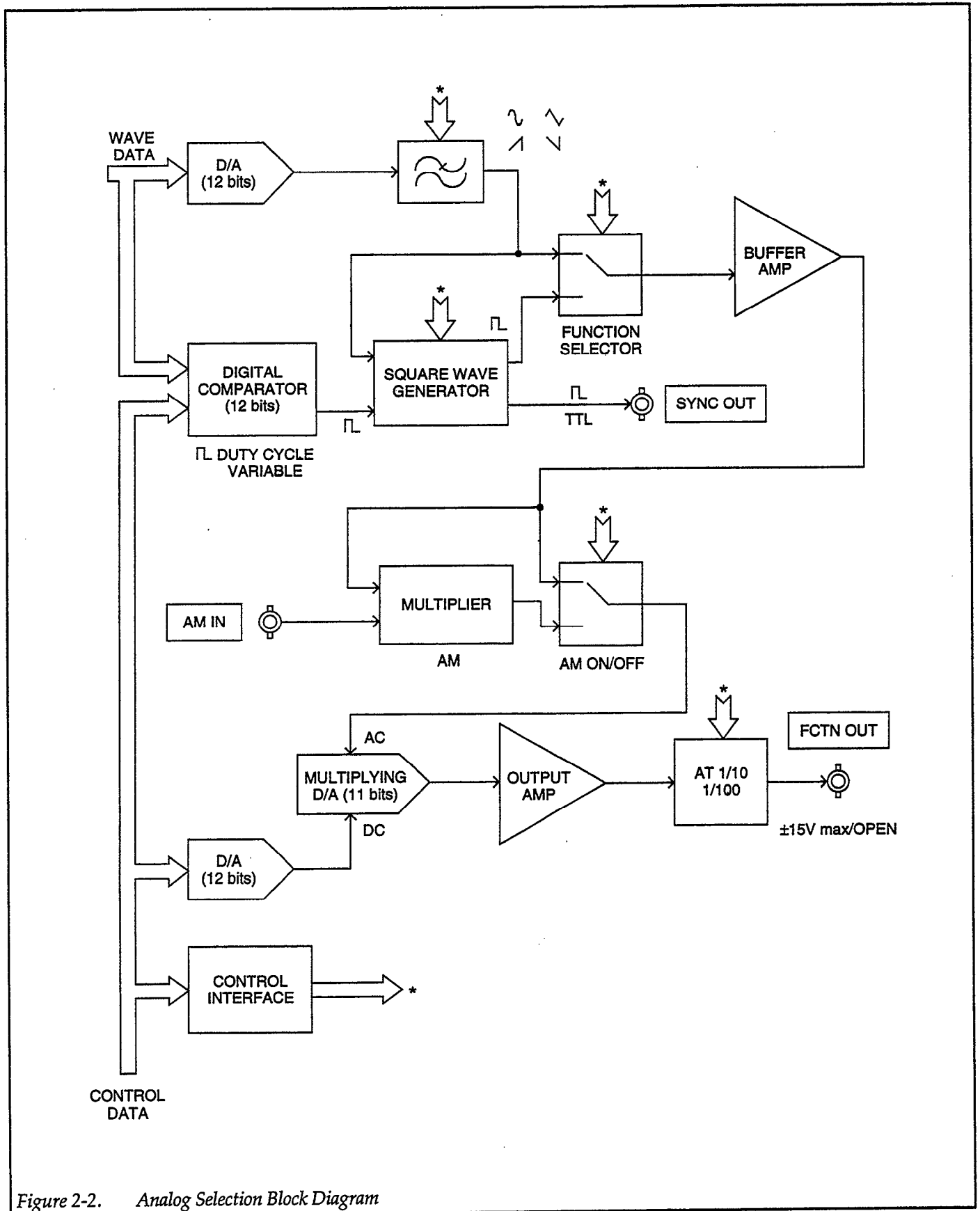


Figure 2-2. Analog Selection Block Diagram

2.4 SYNTHESIZER OPERATING PRINCIPLES

The Model 3930A uses a digital direct type of synthesizer. This configuration yields more accurate, stable waveforms than is possible with conventional oscillators.

Figure 2-3 shows a simplified block diagram of the digital synthesizer address generator. The address generator is made up of a clock register, a binary adder, and the frequency setting register. The clock register counts clock pulses, and the frequency setting register stores frequency setting information. The binary adder adds the outputs of the clock register and the frequency setting register.

Initially, the frequency setting register is programmed with the binary value representing the programmed operating frequency, and the clock register is cleared (set to all 0s). The clock register counts clock pulses, and the address output increases value with time until the register

overflows, at which point the register value returns to all 0s. The cycle starts again, and a ramp waveform shown in Figure 2-4 is generated. The slope of the ramp is directly proportional to the programmed frequency, and the repetition rate is inversely proportional to the set frequency.

The address output of the clock register is then applied to memory in which waveform data is stored, as shown in Figure 2-5. The output of the waveform memory is applied to the D/A converter, which converts the digital waveform data to an analog waveform.

In the Model 3930A, the clock and frequency setting registers are both 36 bits wide. The clock has a frequency resolution of $2^{36} \times 10^{-4}$ Hz. As a result, the minimum frequency setting (when 0 ... 001₂ is loaded into the frequency setting register) is $2^{36} \times 10^{-4} / 2^{36} = 0.1$ mHz. Note that the address output uses the most significant 12 bits out of the 36 bits available, and a 12-bit D/A converter is used.

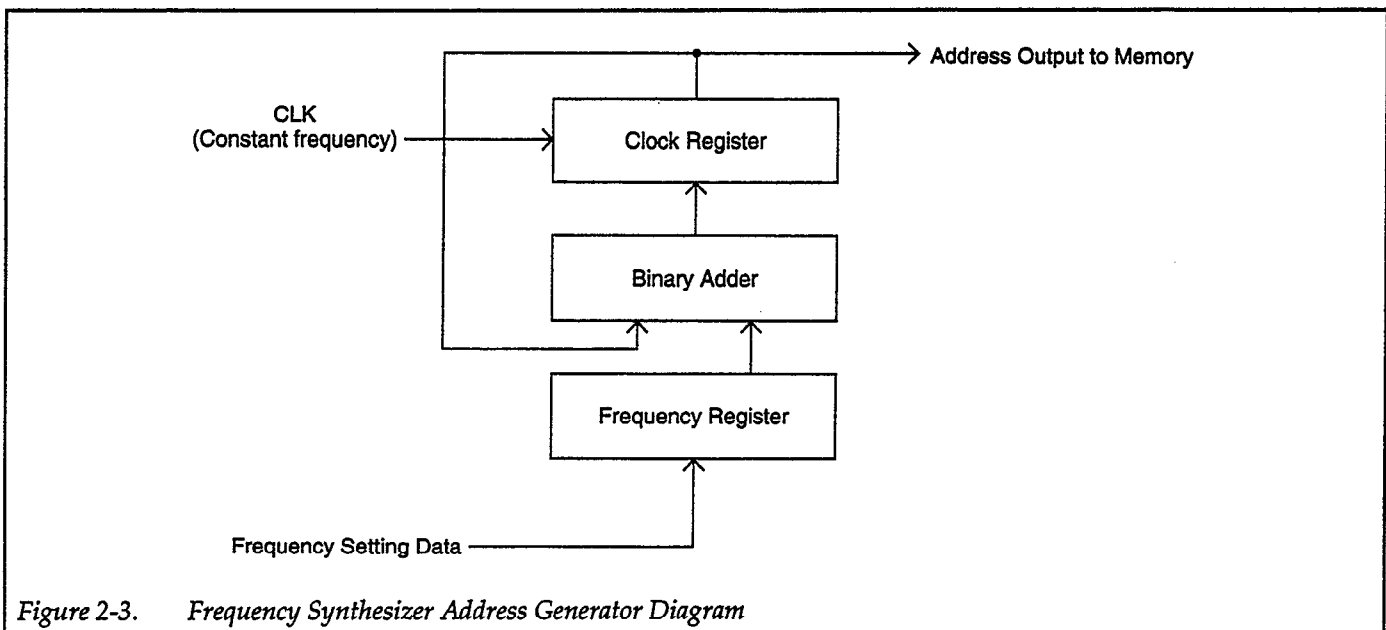
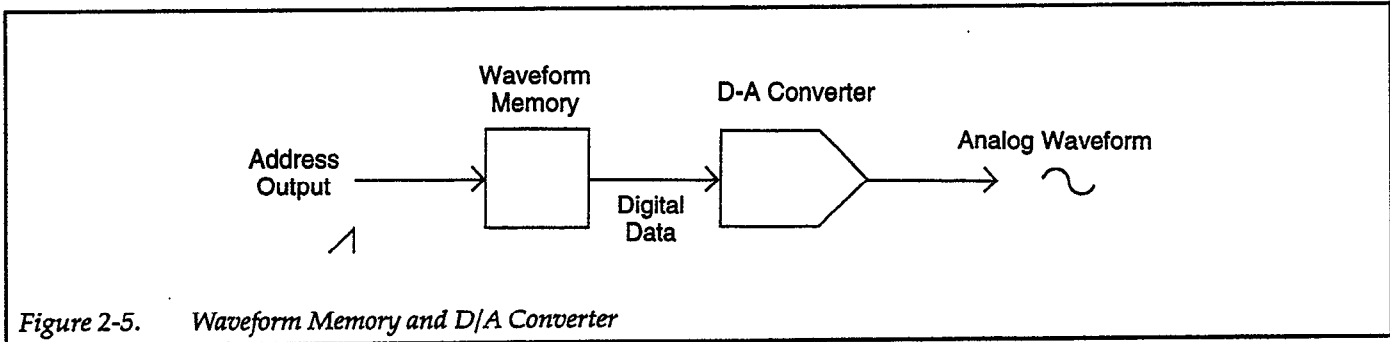
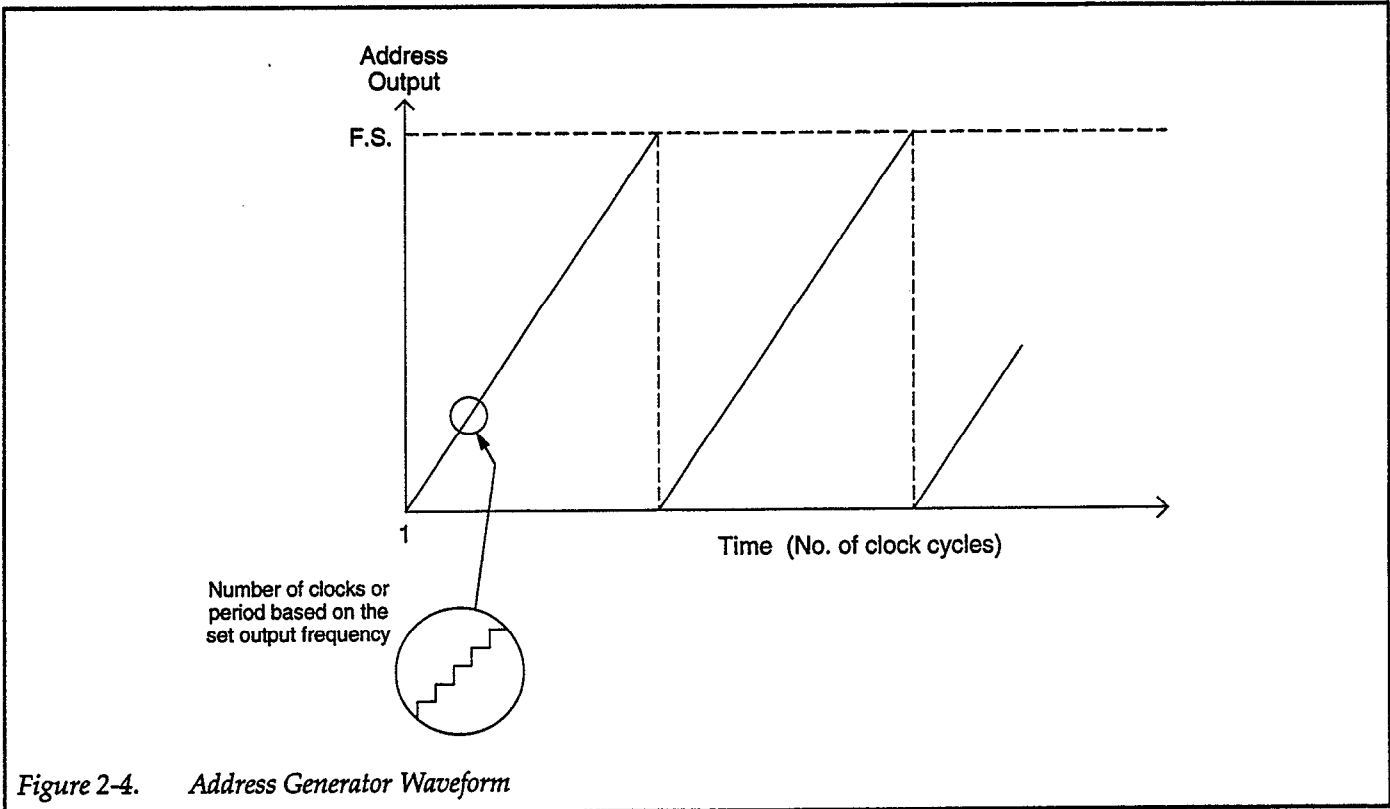


Figure 2-3. Frequency Synthesizer Address Generator Diagram



SECTION 3

Service Information

3.1 INTRODUCTION

This section contains information on fuse replacement, instrument calibration and repair, and replacement parts for the Model 3930A.

3.2 LINE FUSE REPLACEMENT

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.

WARNING

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

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 × 20mm	FU-96-2
200V/250V	1/2A, 250V, normal blow, 5mm × 20mm	FU-96-1

3.3 CALIBRATION

The following paragraphs give step-by-step procedures for calibrating the Model 3930A. 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.) After calibration, perform

the verification procedures outlined in Section 1 to verify that the instrument is operating properly.

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 3930A 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 3930A 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 3930A. 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	197A	DMM (DC volts, AC volts) (5-1/2 digits)	20V range; $\pm(0.015\%$ of rdg + 3 counts) ACV; $\pm(0.35\%$ 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	3930A	Multifunction Synthesizer	2Vp-p sine wave, $\pm 1\%$ amplitude accuracy
Keithley	7051-2	BNC Interconnect Cable	50 Ω coaxial cable (RG-58C), male BNC connectors, 2ft (0.6m)
Keithley	7755	50 Ω Feed-through Terminator	BNC to BNC adapter, 50 Ω 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

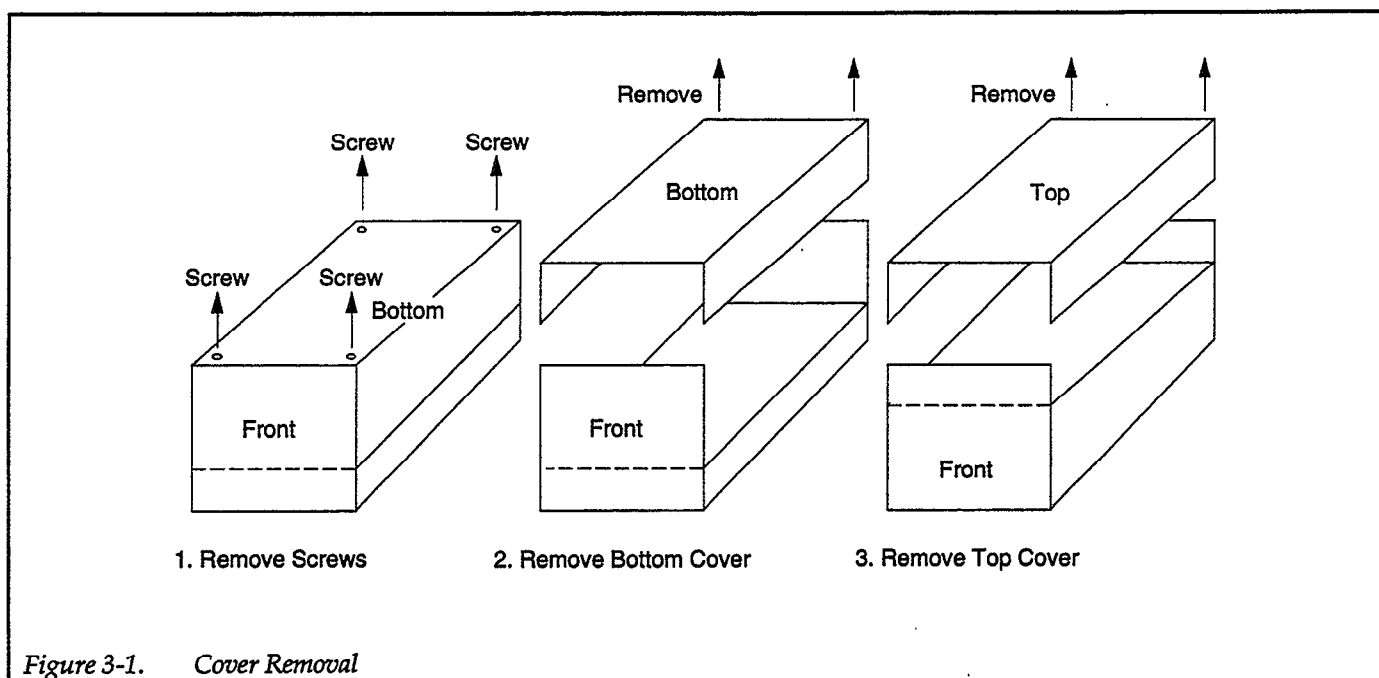
A conductive coating is applied to the inner surface of the covers. Be careful not to scratch the coating when removing the covers. Also be careful not to peel off the corners of the

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 and Figure 3-3.



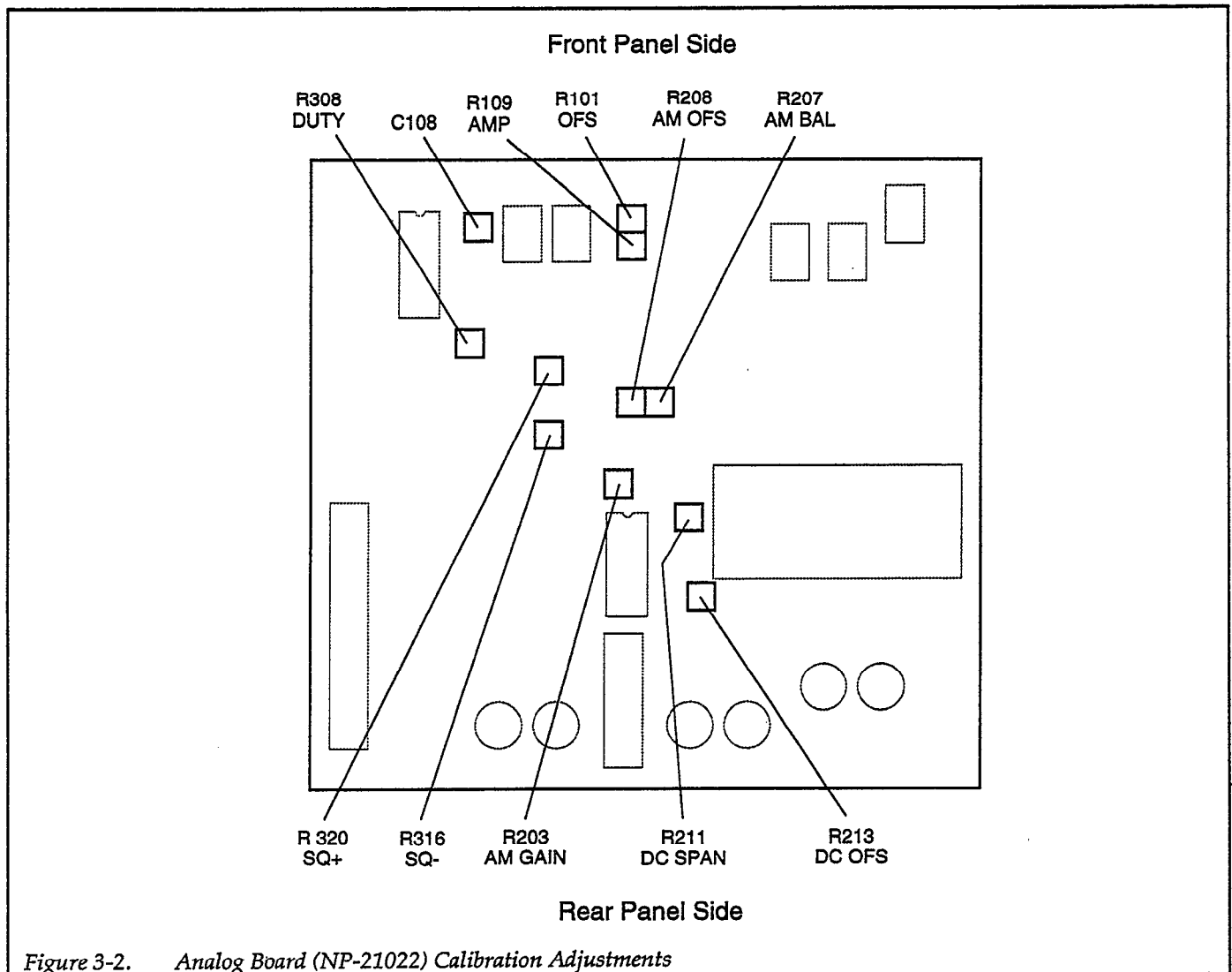


Figure 3-2. Analog Board (NP-21022) Calibration Adjustments

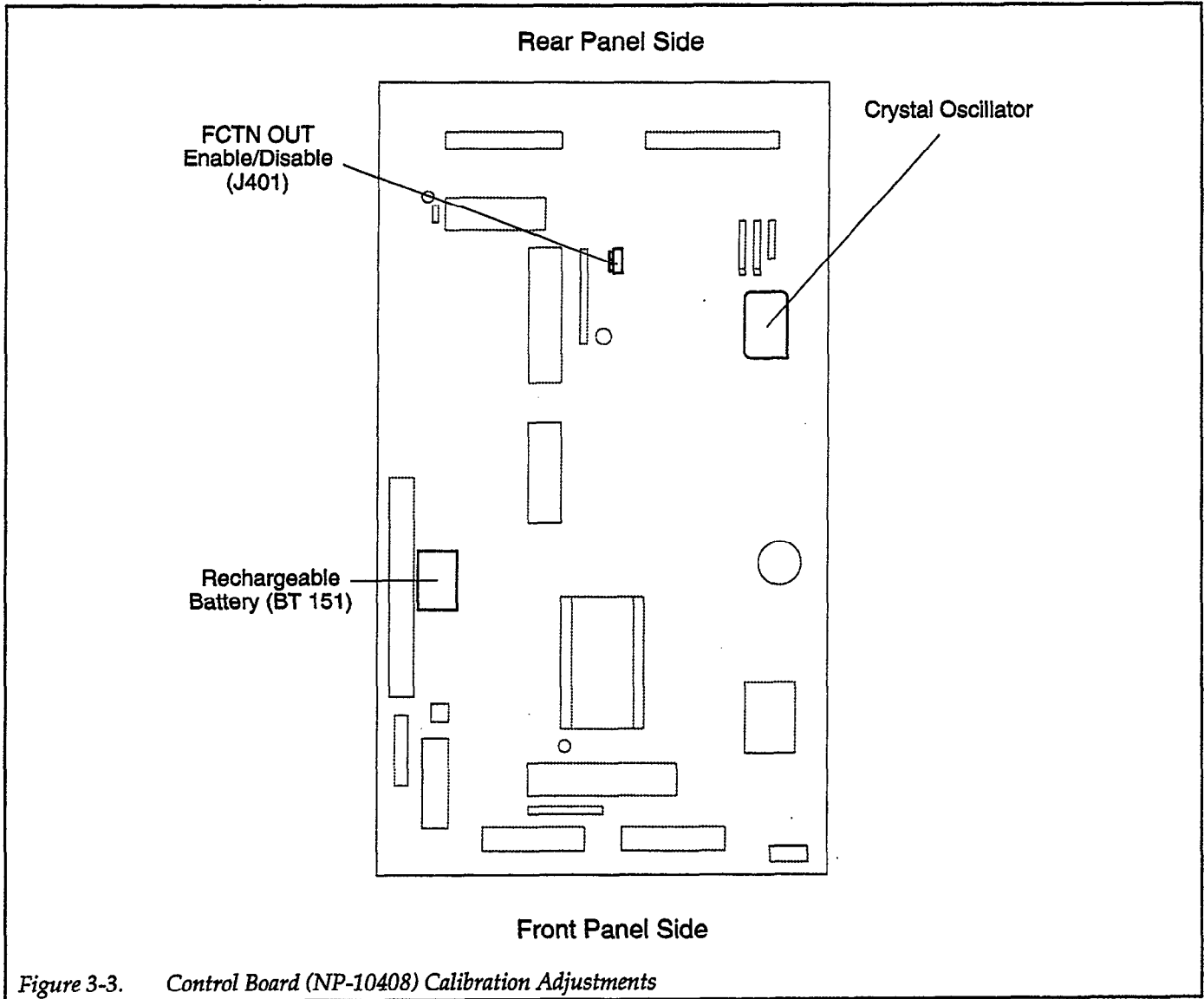


Figure 3-3. Control Board (NP-10408) Calibration Adjustments

3.3.7 Calibration Procedures

NOTE

Calibration should be performed in the sequence presented.

DC Offset

1. Connect the Model 197A DMM to the Model 3930A FCTN OUT jack, as shown in Figure 3-4.
2. Set the Model 197A to the DCV function, and enable auto-ranging.
3. Setup the Model 3930A as follows:
Factory Default (press SHIFT PRST)
SOURCE: EXT ∇
MODE: GATE
RANGE: FXD (press SHIFT 0)
FCTN: DC
4. Adjust R213 (DC OFS) so that the DMM reads $0V \pm 1mV$.
5. Program a Model 3930A DC offset value of $-15V$ (use OFFSET).
6. Adjust R211 (DC SPAN) for a DMM reading of $-15V \pm 0.002V$.
7. Program a 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 $0V \pm 1mV$. If not, re-adjust R213 (DC OFS) for a reading within these limits.
 10. Setup the Model 3930A as follows:
FCTN: SIN
OFFSET: $0V$
AMPTD: $30Vp-p$
 11. Adjust R101 (OFS) for a DMM reading of $0V \pm 1mV$.

SIN Level

1. Connect the Model 197A DMM to the FCTN OUT jack of the Model 3930A (Figure 3-4).
2. Set the Model 197A to the DCV function, and select auto-range.
3. Setup the Model 3930A as follows:
Factory Default (press SHIFT PRST)
SOURCE: EXT ∇
MODE: GATE
PHASE: -90°
AMPTD: $7.49Vp-p$
4. Adjust R109 (AMP) for a DMM reading of $-3.745V \pm 0.004V$.

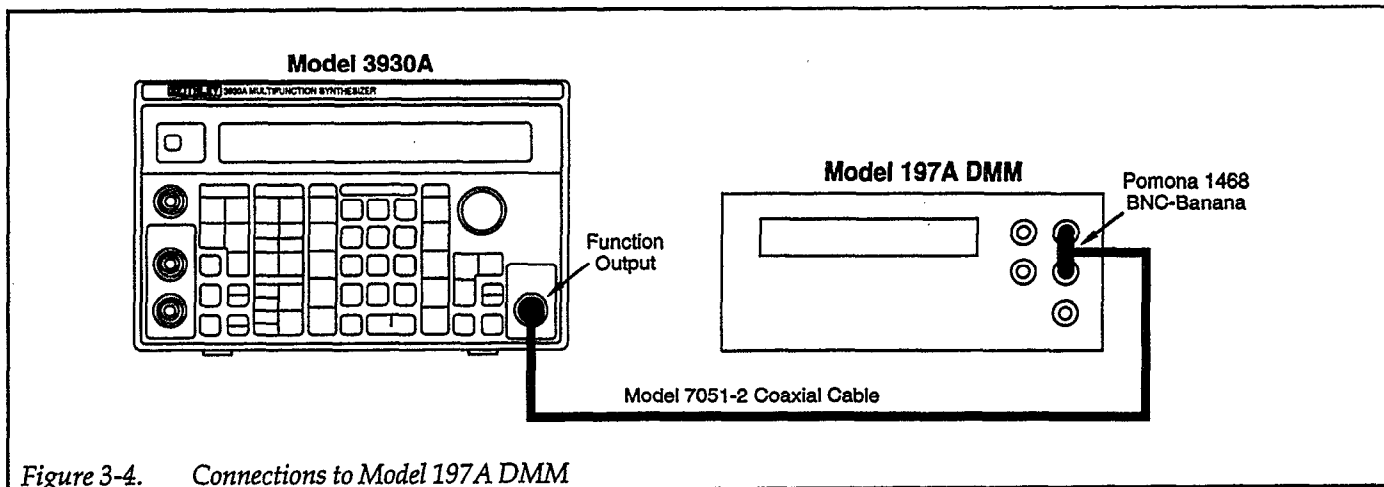


Figure 3-4. Connections to Model 197A DMM

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 3930A 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 Model 3930A being calibrated as follows:
Factory Default (press SHIFT PRST)
SOURCE: EXT ∇
MODE: GATE
AMPTD: 7.49Vp-p
AM: ON
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 $0V \pm 20mV$.

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 3930A being calibrated (Figure 3-4).
2. Select the DCV function and auto-ranging on the DMM.
3. Setup the Model 3930A as follows:
PHASE: -90°
4. Adjust R203 (AM GAIN) for a DMM reading of $-1.872V \pm 0.009V$.

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 3930A as follows:
PHASE: 0°
4. Adjust R208 (AM OFS) for a DMM reading of $0V \pm 10mV$.

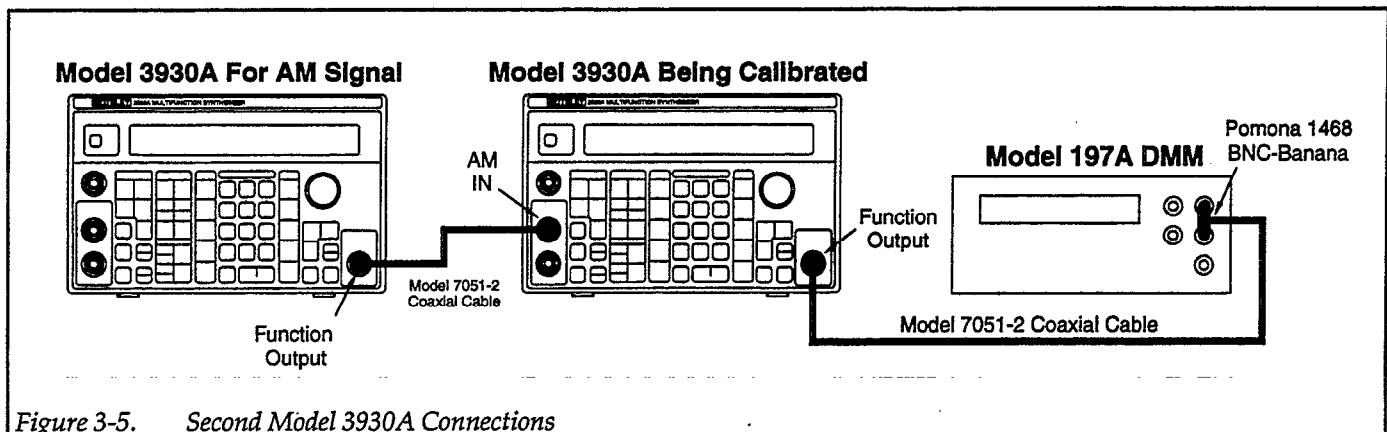


Figure 3-5. Second Model 3930A Connections

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 3930A as follows:
Factory Default (press SHIFT PRST)
SOURCE: EXT ∇
MODE: GATE
FCTN: \square
AMPTD: 7.49Vp-p
PHASE: +90°
4. Adjust R320 (SQ+) for a DMM reading of +3.7445V \pm 0.0055V.
5. Setup the Model 3930A as follows:
PHASE: -90°
6. Adjust R316 (SQ-) for a DMM reading of -3.7445V \pm 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 3930A as follows:
Factory Default (press SHIFT PRST)
FREQ: 100Hz
AMPTD: 20Vp-p
FCTN: \square

4. Adjust R308 (DUTY) for a counter reading of 5msec \pm 0.005msec.

Frequency Accuracy

1. Connect the PM 6654C counter A input to the FCTN OUT jack (Figure 3-6).
2. Set the counter to the frequency measurement mode.
3. Setup the Model 3930A as follows:
Factory Default (press SHIFT PRST)
FREQ: 1000kHz
AMPTD: 20Vp-p
FCTN: \square
4. Adjust the crystal oscillator trimmer for a counter reading of 1MHz \pm 5Hz.

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 50 Ω feed-through terminator as indicated.
2. Make sure the voltmeter dB and REL modes are disabled.
3. Setup the Model 3930A as follows:
Factory Default (press SHIFT PRST)
AMPTD: 3.74Vp-p
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 \pm 0.03dB.

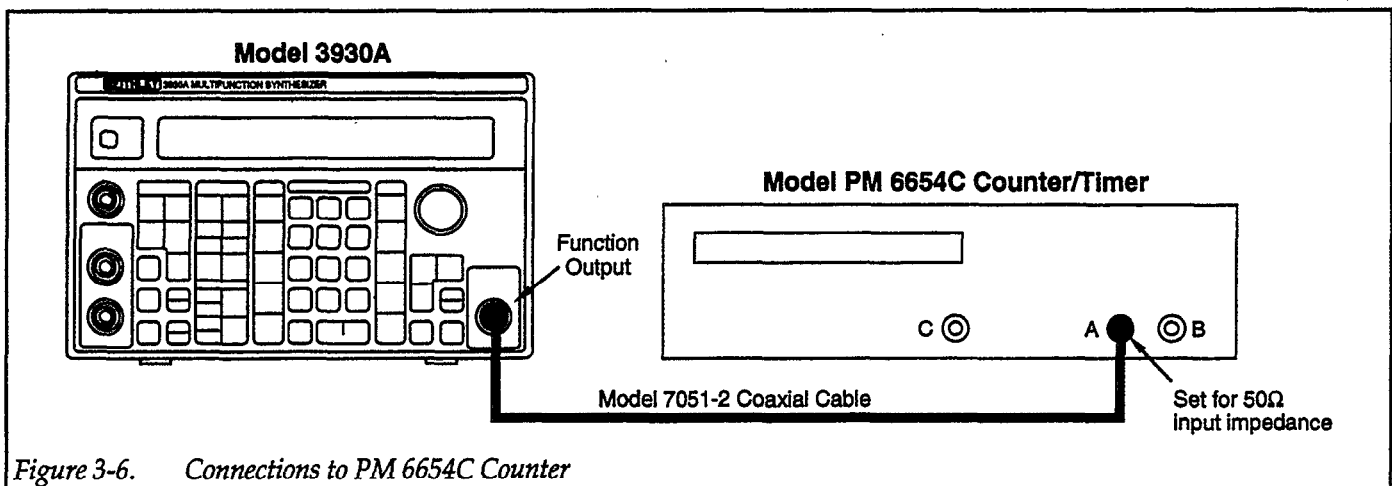


Figure 3-6. Connections to PM 6654C Counter

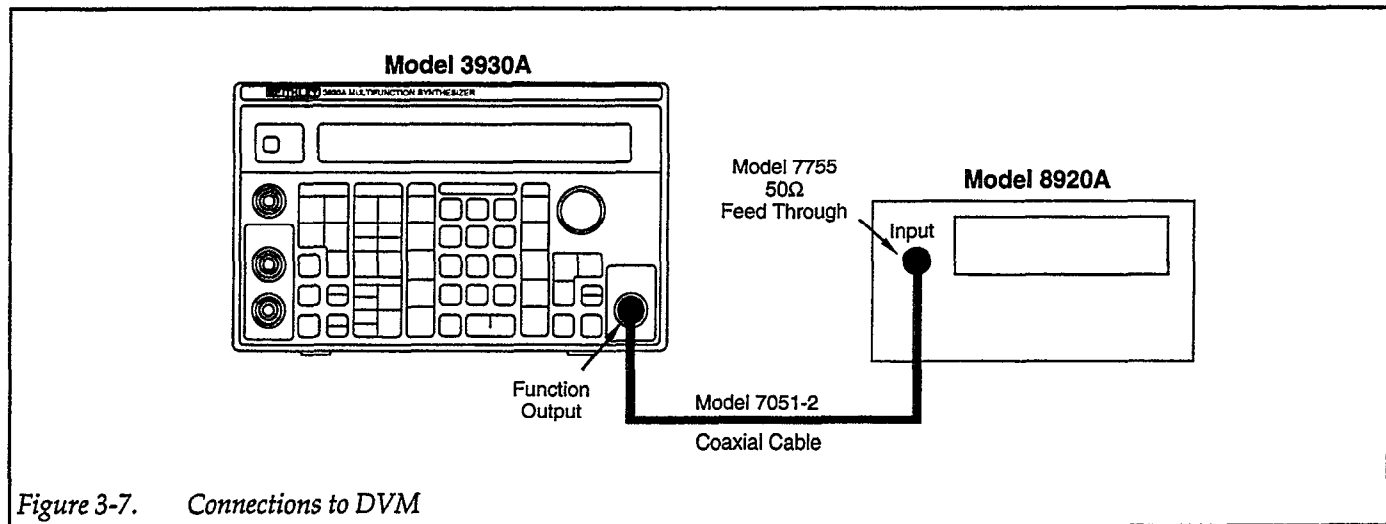


Figure 3-7. Connections to DVM

Display Contrast

1. Press the front panel DSPL key to return the display to normal.
2. Adjust R752 (CONTRAST) for the desired display contrast.

3.3.8 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.

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 from the filter cover.
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, replace the cover and filter assembly.

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 3930A.
2. Remove the top and bottom covers (see paragraph 3.3.5 for details).
3. Set J401 (FCTN OUT) to the desired position (see Figure 3-3 for location). 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, 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 3930A.
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 instrument does not meet the requirements of the operation check (Section 1) and is probably required if the unit cannot be properly calibrated.

3.7.1 Factory Service

If the Model 3930A 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 24V 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)

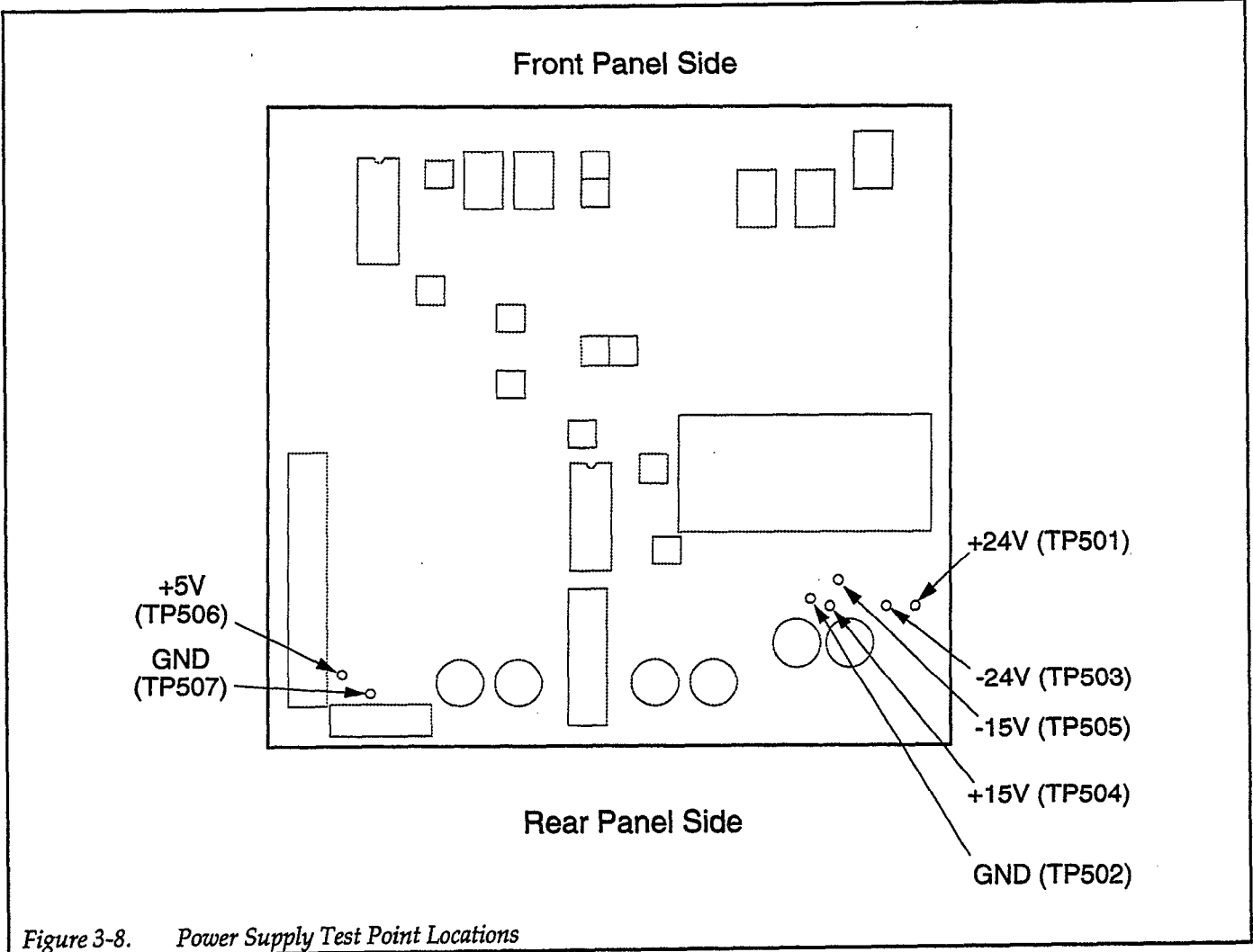


Figure 3-8. Power Supply Test Point Locations

3.7.3 Board-Level Repair

Table 3-4 summarizes which of circuit boards is most likely at fault for the various operating modes. 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. START/STOP PHASE VAR	A
5. WAVE FORM	A or B
6. AMPLITUDE VAR	B
7. CONT MODE	A
8. GATE MODE	A
9. AM	B
10. FREQUENCY VAR	A
11. DUTY CYCLE VAR	A or B
12. DUTY CYCLE STABILITY	B
13. BURST MODE	A
14. FREQUENCY SWEEP	A
15. SYNC OUT	B
16. INT TRIG OUT	A
17. SWEEP MKR OUT	A
18. SWEEP SYNC OUT	A
19. X DRIVE OUT	A

A: Control circuit board (NP-10408)
B: Analog circuit board (NP-21022)

3.8 REPLACEABLE PARTS

3.8.1 Parts List

Table 3-5 summarizes available Model 3930A 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

Table 3-5. Replaceable Parts

Description	Part Number	Qty.
Analog circuit board (NP-10408A)	080-33617-00	1
Control circuit board (NP-21022B)	080-33625-00	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	4
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	244-10896-00	1
Rear panel	400-11721-00	1
Hexagonal 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 bushing	446-00046-00	4
BNC spacer	540-00157-00	4
Spacer (for rotary encoder)	520-05976-00	1
Hexagonal spacer (for power switch)	606-01892-00	2
Knob (for rotary encoder)	486-24060-00	1
Button (for power switch)	359-03554-00	1
Hexagonal stud (for NP-10408)	606-00101-00	2
Standoffs (for NP-10408)	529-00185-00	4
Battery (rechargeable)	*	1
Fuse (100/120V)	FU-96-2	1
Fuse (220/240V)	FU-96-1	1

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

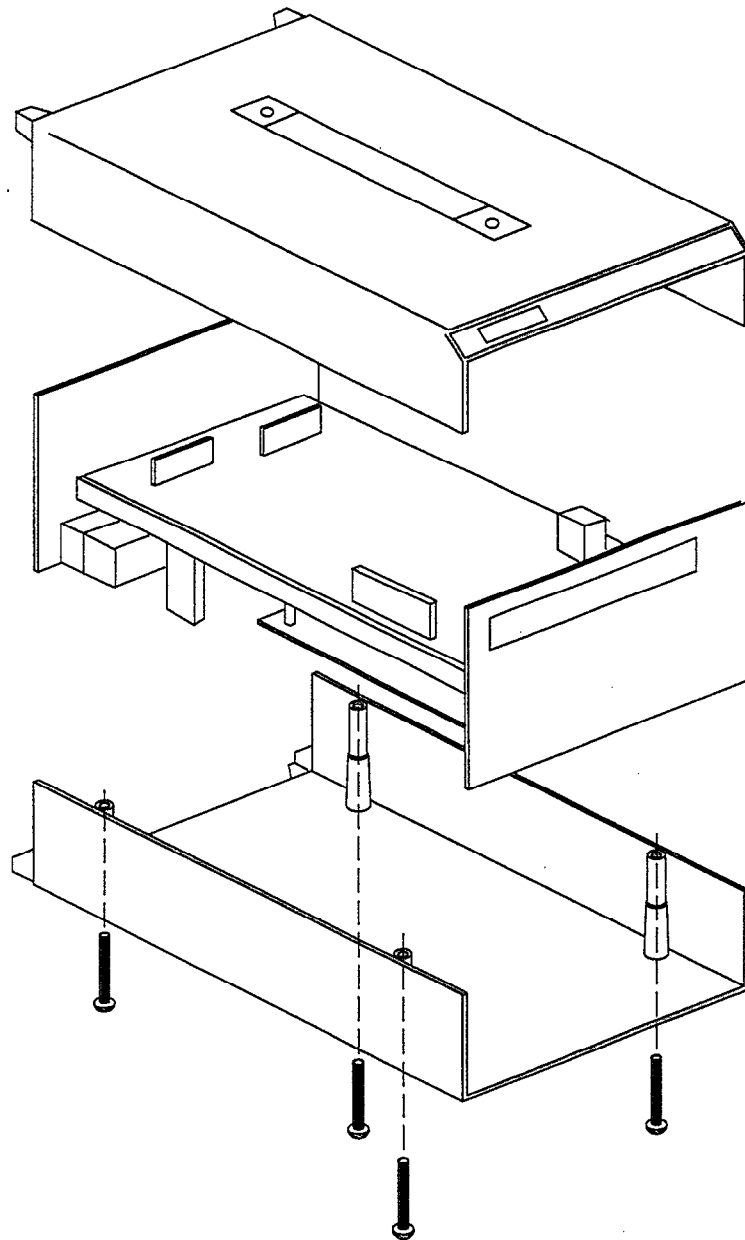


Figure 3-9. Exploded View

APPENDIX A

Typical Data

INTRODUCTION

Appendix A provides the typical performance data for the Model 3930A.

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 3930A. Thus, measured performance of your Model 3930A may be different than that indicated by the typical data curves shown here.

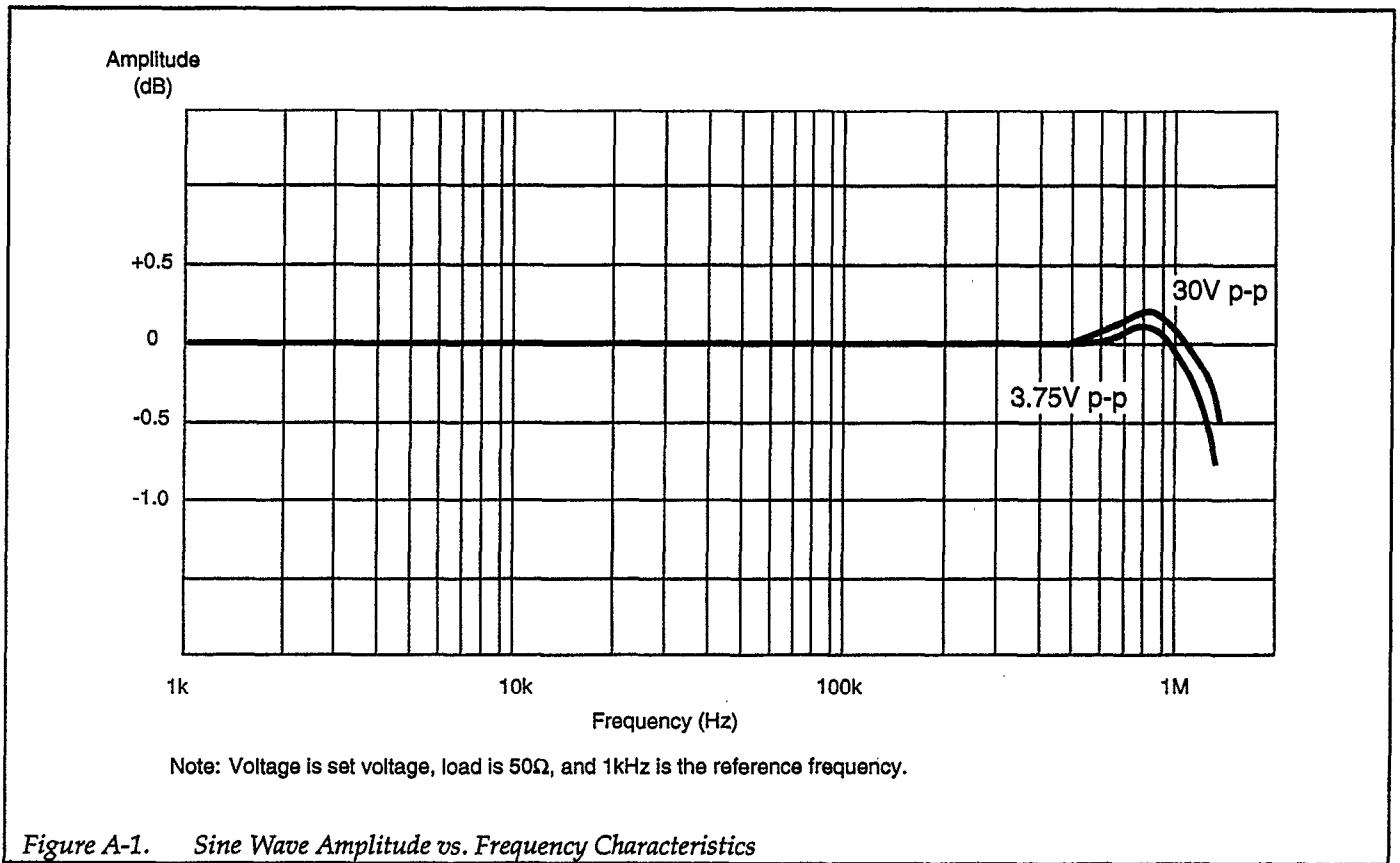


Figure A-1. Sine Wave Amplitude vs. Frequency Characteristics

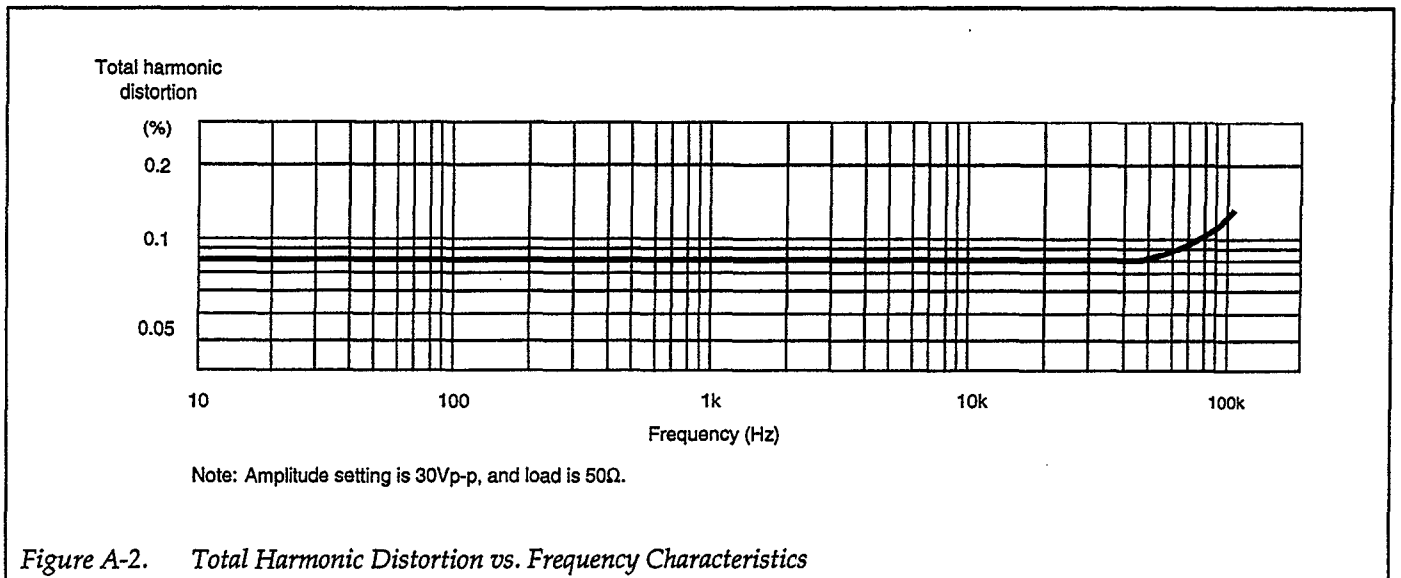


Figure A-2. Total Harmonic Distortion vs. Frequency Characteristics

APPENDIX B

Model 3930A Specifications

B.1 ELECTRICAL SPECIFICATIONS

Waveforms	
Types	DC only, \sim , \square , \sim , \wedge , ∇

Oscillation Modes		
Continuous	CONT	Continuous oscillation
Burst	BURST	N-cycles (N is an integer) generated by a trigger signal. N=1 to 65,536
Gate	GATE	N-cycles generated while trigger signal is on (N=integer).

Frequency		
Waveform and Frequency Range	\sim , \square (Duty cycle fixed at 50%)	0.1mHz to 1.2MHz
	\sim , \wedge , ∇ , \square (Duty cycle variable from 5% to 95%)	0.1mHz to 100kHz
Display	Maximum 11 digits, resolution 0.1mHz (fixed)	
Accuracy	$\pm 5 \times 10^{-6}$ (± 5 ppm)	
Stability	$\pm 2 \times 10^{-6}$ / year (± 2 ppm/year)	
Setting by period	Setting range	840ns to 10000s
	Display	Maximum 6 digits, minimum resolution 10ns
	Oscillation frequency is the reciprocal of the setting period (settings below 0.1mHz are truncated)	

Output Characteristics (Waveform Output)					
Maximum Output	AC only	30Vp-p/open, 15Vp-p/50 Ω load			
	DC only	± 15 V/open, ± 7.5 V/50 Ω load			
Display (Open Circuit Value)	When output range mode is automatic (AUTO)				
	AC	Vp-p	Max. 3 digits	Minimum Resolution	0.01mVp-p
		Vrms	Max. 3 places \pm		0.01mVrms
		dBV	display		0.1dBV (fixed)
	DC	Max. 3 digits + neg. display, 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 \pm display, minimum resolution 10mV (fixed)				
AC Amplitude Setting Range (at DC offset 0V)	Per Table B-1: AC Amplitude Setting Range for 0V DC offset				

Specifications subject to change without notice.

ELECTRICAL SPECIFICATIONS (CONT.)

Output Characteristics (Waveform Output) (Cont.)					
AC Amplitude Accuracy (in CONT mode)	Up to 50kHz frequency, 0V DC offset, 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 cycle fixed/variable)	When output 50%, 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 (in CONT mode)	1kHz reference frequency, 0V DC offset, AM off, 50Ω load, 30.0mVp-p to 30.0Vp-p amplitude setting (when output range is FXD, more than 3.00Vp-p), ~ is effective value measurement; other waveforms are 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 (in CONT mode)	0V DC offset, AM off, 50Ω load, 30.0mVp-p to 30.0Vp-p amplitude setting (when output range is FXD, and output is >3.00Vp-p)				
	Total harmonic distortion ratio	10Hz to 100kHz	< 0.1%		
	Harmonics (when amplitude setting is 30.0Vp-p)	100kHz to 500kHz	< -40dBc		
		500kHz to 1.2MHz	< -30dBc		
	Spurious (when amplitude setting is 30.0Vp-p)	Up to 500kHz	< -55dBc		
500kHz to 1.2MHz		< -40dBc			
⌋ Waveform Characteristics	0V DC offset, AM off, 50Ω load, 30.0mVp-p to 30.0Vp-p amplitude setting (when output range is FXD, and output is >3.00Vp-p)				
	Rise, fall time			150ns max	
	Over and undershoot			<5% of output p-p amplitude	
	Duty cycle (in CONT mode)	50% fixed accuracy			Period ±0.3% (up to 10kHz)
		When varied	Setting range	Accuracy	5.0% to 95.0% (resolution 0.1%)
					Period ±0.2% (up to 10kHz)
				Jitter <150ns	
Status at Power On	Output is on.				
Output Impedance	50Ω ±1%, unbalanced (open when output is off)				
Connector	BNC, front panel				

ELECTRICAL SPECIFICATIONS (CONT.)

Sync Output	
Output Voltage	TTL Level (50Ω in series with 74HC00 output)
Connector	BNC, front panel

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

Frequency Sweep				
Types		Sweep functions	CONT	SINGLE
		┘ (step)	┘ or ┘	┘ or ┘
LIN	Λ	Λ	Λ or V	/ or \
		Λ	Λ or V	Λ or V
LOG	Λ	λ	λ or γ	λ or λ
		λ	λ or γ	λ or γ
Sweep Range		Upper limit	Same as normal oscillation	
		Lower limit	┘/LIN	0.1mHz
		LOG	10mHz	
Minimum Sweep Width		┘, LIN	0.1mHz	
		LOG	1 decade	
Sweep Time		Setting range	5ms to 9999s	
		Display	Maximum 4 digits, minimum resolution 1ms	
		Note: Log sweep needs a minimum of 5.16ms per decade.		
Range of Settings		According to frequency of start and stop, or center and span		
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 (input to 74HC14 is pulled up by 4.7kΩ.)	
		Signal characteristics	Low	Holds sweep
			High	Resumes sweep
		Connector	BNC, rear panel	

ELECTRICAL SPECIFICATIONS (CONT.)

Frequency Sweep (Cont.)					
Output	Sweep Sync Output	Output voltage	TTL Level (56Ω in series with 74F04 output)		
		Signal characteristics	Low	While sweeping from start frequency toward stop frequency	
			High	Other cases	
	Connector	BNC, rear panel			
	Marker Output	Output voltage	TTL Level (56Ω in series with 74F04 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 circuit)		
		Signal characteristics	0V to +10V (Frequency increasing) +10V to 0V (Frequency decreasing)		
Output Impedance		600Ω, unbalanced			
Load impedance		10kΩ minimum			
Connector		BNC, rear panel			
Other Functions	Replace marker frequency with center frequency				

Burst/Gate Oscillation				
Trigger Source	Internal	Internal trigger oscillator (positive/negative logic)		
	External	External trigger signal (positive/negative logic), manual trigger		
Internal Trigger Oscillator	Rate Setting Range and Display (period setting)	0.001ms to 29.999ms		
		30.00ms to 299.99ms		
		0.3000s to 2.9999s		
		3.000s to 29.999s		
		30.00s to 299.99s		
	300.0s to 2999.9s			
	Accuracy	±5 × 10 ⁻⁵ (±50ppm)		
	Duty Cycle	50%		
Off/On	On only when oscillation mode is BURST or GATE, and the trigger source is internal			
Setting according to frequency	Setting range	0.4mHz to 1MHz		
	Display	Max. 5 digits, minimum resolution 0.1mHz		
	Oscillates at reciprocal period of set frequency (values below 0.4mHz are truncated)			
External Trigger Input	Input voltage	TTL level (input to 74HC14 is pulled up by 4.7kΩ)		
	Min. pulse width	200ns		
	Connector	BNC, front panel		
Internal Trigger Output	Output voltage	TTL level (56Ω in series with 74F04 output)		
	Signal Characteristics	Trigger source	Internal	Outputs internal trigger oscillation signal
		External	Outputs external trigger input signal	
Connector	BNC, rear panel			
Start/stop Phase	Set. range	-360° to 360°		
	Display	Max. 4 digits ± display, resolution 0.1° (fixed)		
Trigger Delay	Approx. 600ns (jitter 150 ns)			

Digital Out	
Output Voltage	TTL Level
Connector	36-pin, rear panel

ELECTRICAL SPECIFICATIONS (CONT.)

Memory	
Memory Contents	<p>Main Frequency*, amplitude*, DC offset*, waveform, oscillation mode</p> <p>Sweep-Related Start*, stop*, center*, span*, marker*, frequency, sweep time*, sweep function</p> <p>Trigger-Related Trigger source, internal trigger rate*, burst wave number*, start/stop phase*</p> <p>Other □ duty cycle*, AN on/off, beep sound (on/off), output range mode AUTO/FXD Modify</p> <p>Note: Parameters listed with * show cursor position and step size.</p>
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	
Functions	Parameters in effect prior to power-off are stored and become effective at next power on, (except for waveform output on/off).
Storage Contents	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 the cursor position value by 1.
	±5	Increases or decreases the cursor position value by 5.
	×÷2	Multiplies or divides entire value by 2.
	×÷10	Multiplies 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

Frequency	<u>1</u> .0000000kHz
Amplitude	<u>3</u> .00mVp-p (0.00Vp-p)
DC offset	<u>0</u> .00mV (0.00V)
Waveform	<u>~</u>
Oscillation mode	CONT

Sweep-Related

Start frequency	<u>1</u> .0000000kHz
Stop frequency	<u>10</u> .0000000kHz
Center frequency	<u>5</u> .5000000kHz
Span Frequency	<u>2</u> .0000000kHz
Marker frequency	<u>5</u> .0000000kHz
Sweep time	<u>1</u> .000s
Sweep function	LIN <u>^</u>

Trigger-Related

Trigger source	INT <u>√</u>
Internal trigger rate	<u>2</u> .000ms
Burst wave number	<u>1</u> cycle
Start/stop phase	<u>0</u> .0 deg

Others

AM	off
<input type="checkbox"/> Duty cycle	<u>50</u> .0% fixed
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, taken unaddressed if MLA
	L4	Basic listener, unaddressed if MTA
	SR1	Full service request capability
	RL1	Full remote and local operation capability
	PP0	No parallel-poll 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 (panel) EOI also sent simultaneously.
	Reception	CR, CR/LF, CR + EOI, CR/LF + EOI, or EOI
Address	0 - 30 (selected by numeric keys on the front 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 the chassis.	
Power Source	Voltage	100, 120, 220 or 240V AC $\pm 10\%$ (250V max.)
	Frequency	48 - 62Hz
	Power Consumption	Approx. 34VA
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) \times 132.5 (H) \times 350 (D) mm, 8.5 (W) \times 5-1/4 (H) \times 13-3/4 (D) in.
Weight	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	1865V 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 -76.2	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 output 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 output 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. DC V 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 instantaneous waveform output goes off.
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.

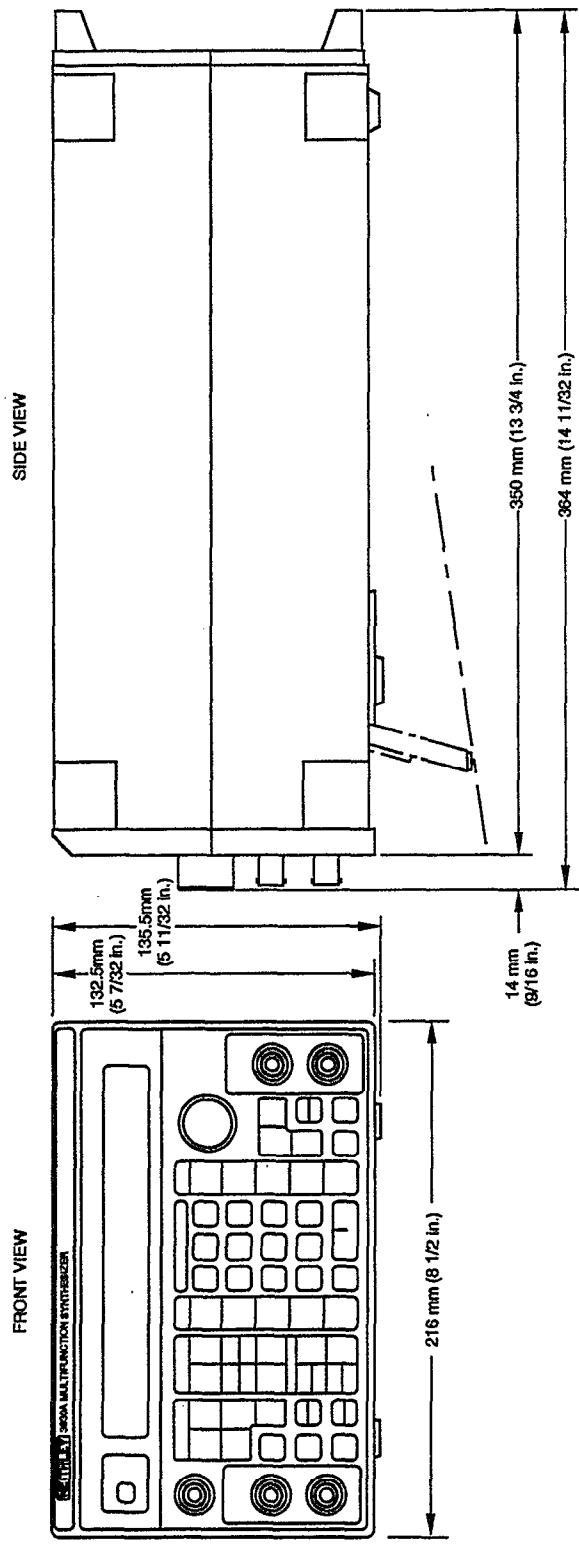


Figure B-1. Outer Dimensions of the Model 3930A

Index

A

AM Balance, 3-7
AM Gain, 3-7
AM Offset, 3-7
Amplitude Accuracy, 1-4
Amplitude and DC Offset Control, 2-3
Amplitude Modulation, 2-3
Analog Circuit Description, 2-3
Analog Section, 2-1

B

Block Diagram, 2-1
Board-Level Repair, 3-12

C

Calibration, 3-1
Calibration Adjustments, 3-3
Control Section, 2-1
Cover Removal, 3-3
Cover Replacement, 3-9

D

D/A Converter, 2-3

DC Level (Square) and DC Offset Error (Sine),
1-9

DC Offset, 3-6
DC Voltage Accuracy, 1-9
Display and Keyboard Section, 2-1
Display Contrast, 3-9

E

Environmental Conditions, 1-1, 3-2

F

Factory Service, 3-10
Fan Filter Cleaning, 3-9
FCTN Out Jumper, 3-9
Frequency Accuracy, 3-8
Frequency and Duty Cycle Accuracy, 1-2
Frequency Response, 3-8
Frequency Response (Sine), 1-5
Frequency Response (Triangle, Sawtooth,
Square), 1-7

I

Initial Conditions, 1-1, 3-2

L

Line Fuse Replacement, 3-1
Line Power, 1-1, 3-2

O

Ordering Parts, 3-12

P

Parts List, 3-12
Performance Verification, 1-1
Power Supply Section, 2-3
Power Supply Test Points, 3-10
Principles of Operation, 2-1

R

Rechargeable Battery Replacement, 3-10
Recommended Calibration Equipment, 3-2
Recommended Test Equipment, 1-1
Repair, 3-10
Replaceable Parts, 3-12
Rise and Fall Times, 1-9

S

Service Information, 3-1
SIN Level, 3-6
Square Wave DC Level, 3-8
Square Wave Duty Cycle, 3-8
Square Wave Generator, 2-3

Synthesizer Operating Principles, 2-5
Synthesizer Section, 2-1

Trigger Section, 2-1

T

Total Harmonic Distortion, 1-8

V

Verification Procedures, 1-2



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

Display or output (check one)

- Drifts
- Unstable
- Overload
- Unable to zero
- Will not read applied input
- Calibration only
- Data required
- Certificate of calibration 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.

KEITHLEY

Test Instrumentation Group
Keithley Instruments, Inc.
28775 Aurora Road
Cleveland, Ohio 44139

Printed in the U.S.A.