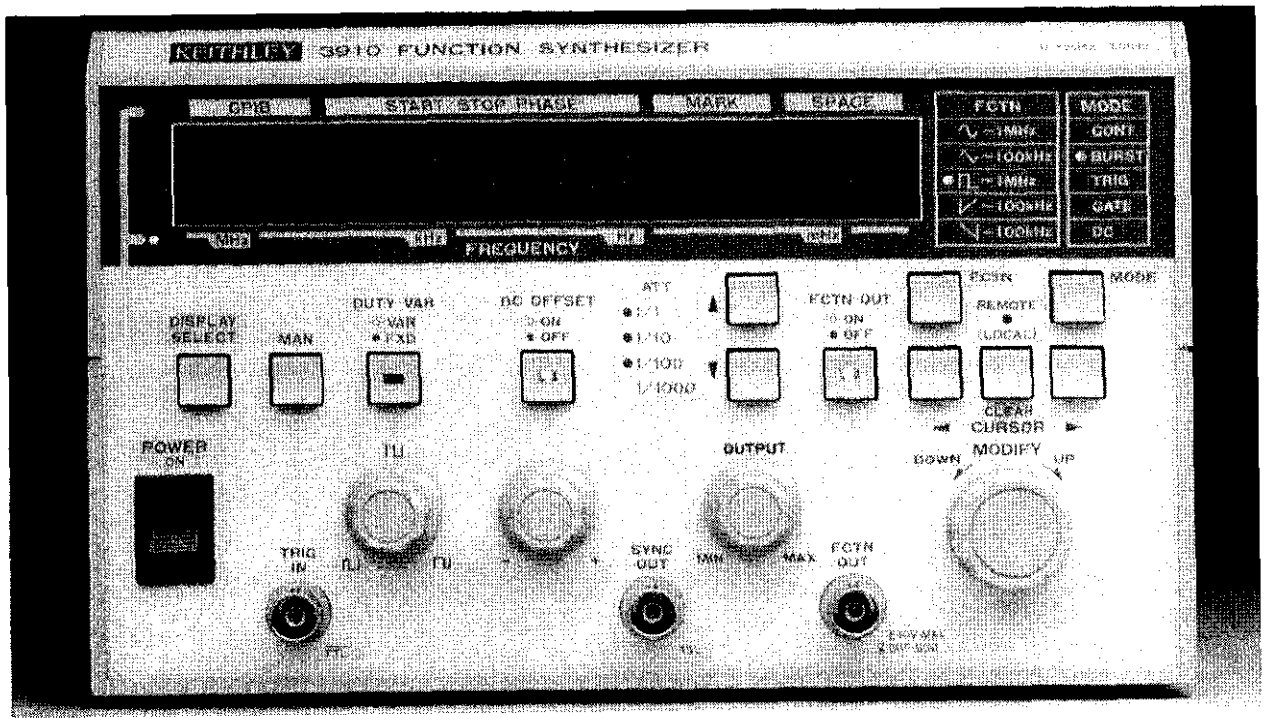
Model 3910
Function Synthesizer
Service Manual



Contains Operating and Servicing Information

KEITHLEY

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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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Model 3910 Function Synthesizer
Service Manual

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Manual Print History

The print history shown below lists the printing dates of all Revisions and Addenda created for this manual. The Revision Level letter increases alphabetically as the manual undergoes subsequent updates. Addenda, which are released between Revisions, contain important change information that the user should incorporate immediately into the manual. Addenda are numbered sequentially. When a new Revision is created, all Addenda associated with the previous Revision of the manual are incorporated into the new Revision of the manual. Each new Revision includes a revised copy of this print history page.

Revision A (Document Number 3910-902-01).....October 1991

Safety Precautions

The following safety precautions should be observed before using this product and any associated instrumentation. Although some instruments and accessories would normally be used with non-hazardous voltages, there are situations where hazardous conditions may be present.

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

Exercise extreme caution when a shock hazard is present. Lethal voltage may be present on cable connector jacks or test fixtures. The American National Standards Institute (ANSI) states that a shock hazard exists when voltage levels greater than 30V RMS, 42.4V peak, or 60VDC are present. **A good safety practice is to expect that hazardous voltage is present in any unknown circuit before measuring.**

Before operating an instrument, make sure the line cord is connected to a properly grounded power receptacle. Inspect the connecting cables, test leads, and jumpers for possible wear, cracks, or breaks before each use.

For maximum safety, do not touch the product, test cables, or any other instruments while power is applied to the circuit under test. ALWAYS remove power from the entire test system and discharge any capacitors before: connecting or disconnecting cables or jumpers, installing or removing switching cards, or making internal changes, such as installing or removing jumpers.

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

Do not exceed the maximum signal levels of the instruments and accessories, as defined in the specifications and operating information, and as shown on the instrument or test fixture rear panel, or switching card.

Do not connect switching cards directly to unlimited power circuits. They are intended to be used with impedance limited sources. NEVER connect switching cards directly to AC main. When connecting sources to switching cards, install protective devices to limit fault current and voltage to the card.

When fuses are used in a product, replace with same type and rating for continued protection against fire hazard.

Chassis connections must only be used as shield connections for measuring circuits, NOT as safety earth ground connections.

If you are using a test fixture, keep the lid closed while power is applied to the device under test. Safe operation requires the use of a lid interlock.

If a ⏚ screw is present on the test fixture, connect it to safety earth ground using #18 AWG or larger wire.

The ⚡ symbol on an instrument or accessory indicates that 1000V or more may be present on the terminals. Refer to the product manual for detailed operating information.

Instrumentation and accessories should not be connected to humans.

Maintenance should be performed by qualified service personnel. Before performing any maintenance, disconnect the line cord and all test cables.

HOW TO USE THIS MANUAL

Details procedures to verify that the Model 3910 Function Synthesizer meets stated specifications.

SECTION 1
Performance Verification

Describes basic operating principles for the various circuits in the Model 3910.

SECTION 2
Principles of Operation

Covers fuse replacement, battery 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

This section covers procedures to verify accuracy of the Model 3910. Verification can be performed when the instrument is first received to verify that the Model 3910 meets its stated accuracy specifications, and it can also be performed following calibration, if desired. If the instrument fails to meet stated specifications, refer to the calibration and repair information in Section 3 unless the unit is still under warranty (less than one year from the date of shipment).

NOTE
Instruments still under warranty should be returned to the factory for calibration or repair.

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 3910 and the test equipment should be turned on and allowed to warm up for one hour before making test measurements. If the instrument has been subjected to extreme temperature or humidity, allow additional time for stabilization. Typically, it take one additional hour to stabilize an instrument that is 10°C outside the allowed temperature range.

1.4 LINE POWER

Before testing, be sure the rear panel line voltage is set to the correct operating voltage. The Model 3910 should be tested while operating at a line voltage within ±10% of the line voltage switch setting and at a line frequency from 48Hz to 62Hz.

1.5 RECOMMENDED TEST EQUIPMENT

Table 1-1 summarizes recommended equipment for the verification procedures. Similar equipment may be used as long as corresponding specifications are comparable.

Table 1-1. Recommended Test Equipment for Performance Verification

Manufacturer	Model	Description	Specifications
Keithley	197A	DMM (DC volts, AC volts, 5-1/2 digits)	20V range; ±(0.015% of rdg + 3 counts) TRMS 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%)
Keithley	775A/51/52	Counter/Timer with TCXO option	0Hz-120MHz; time base aging <1 × 10^{-7}/month; frequency measurements, pulse width measurements.
Panasonic	VP-7722A	Audio analyzer	10Hz-110kHz; 0.001% accuracy 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

1.6 VERIFICATION LIMITS

The accuracy limits stated in the verification procedures are based only on Model 3910 accuracy specifications, and they do not include test equipment tolerance. If a particular measurement falls slightly outside the allowed range, calculate new limits based both on instrument accuracy specifications and test equipment accuracy specifications, then repeat the test.

1.7 VERIFICATION PROCEDURES

The following paragraphs cover the detailed procedures for verifying the accuracy specifications of the Model 3910 using the equipment listed in Table 1-1. These procedures are intended only for qualified personnel using accurate and reliable test equipment. If the instrument is out of specification and not under warranty, refer to the calibration information in Section 3, or call the factory for prompt servicing.

1.7.1 Frequency Accuracy

Procedure:

1. Connect the Model 3910 FCTN OUT jack to input A of the counter/timer, as shown in Figure 1-1. Be sure to use the 50Ω feed through.
2. Set the counter/timer to the frequency measurement mode.
3. Set Model 3910 operating modes as follows:
   AMPTD range: ~20Vp-p
   AMPTD level: MAX
   Frequency: 1MHz
   FCTN: square wave (⎍)
   MODE: CONT
   DC OFFSET: OFF
   DUTY VAR: FXD
4. Verify that the frequency reading is between 0.999970 and 1.000030MHz.

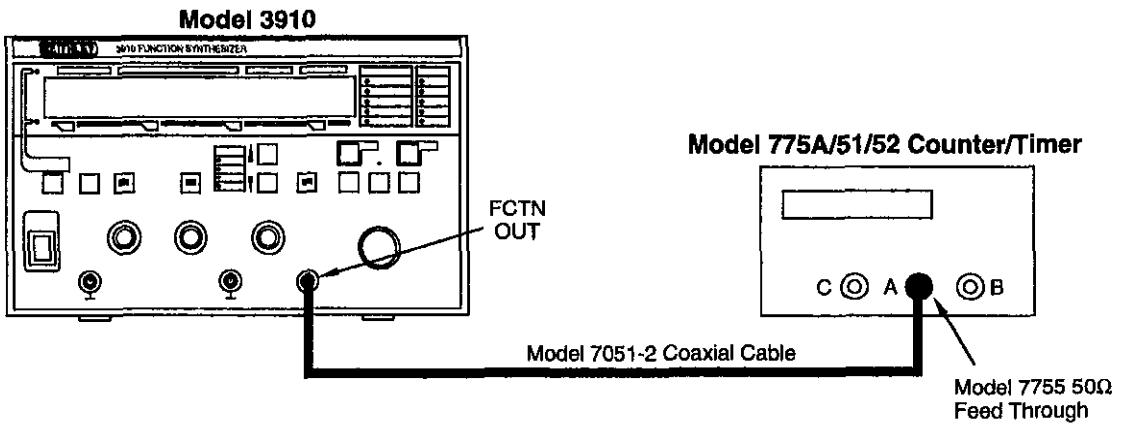

Figure 1-1. Connections for Frequency Accuracy Test

1.7.2 Maximum Output Amplitude

Procedure:

1. Connect the Model 3910 FCTN OUT jack to the Model 197A DMM, as shown in Figure 1-1. Do not use the 50Ω termination for this test.
2. Set the DMM for the ACV function, and select the 20V range.
3. Set Model 3910 operating modes as follows:
   AMPTD range: ~20Vp-p
   AMPTD level: MAX
   Frequency: 1kHz
   FCTN: sine (∿)
   MODE: CONT
   DC OFFSET: OFF
4. Verify that the DMM reading is at least 7.07Vrms, as summarized in the first line of Table 1-2.
5. Repeat step 4 for each of the remaining four functions listed in Table 1-2 (use the FCTN key to select functions). Verify that the output amplitude for each function is as stated in the table.

Table 1-2. Reading Limits for Output Amplitude Tests

Waveform	Measured Value	Equivalent p-p Value
Sine (∿)	≥7.07Vrms	≥20Vp-p
Triangle (∿)	≥5.774Vrms	≥20Vp-p
Square (⊓)	≥10.00Vrms	≥20Vp-p
Rising sawtooth (◿)	≥5.774Vrms	≥20Vp-p
Falling sawtooth (◺)	≥5.774Vrms	≥20Vp-p

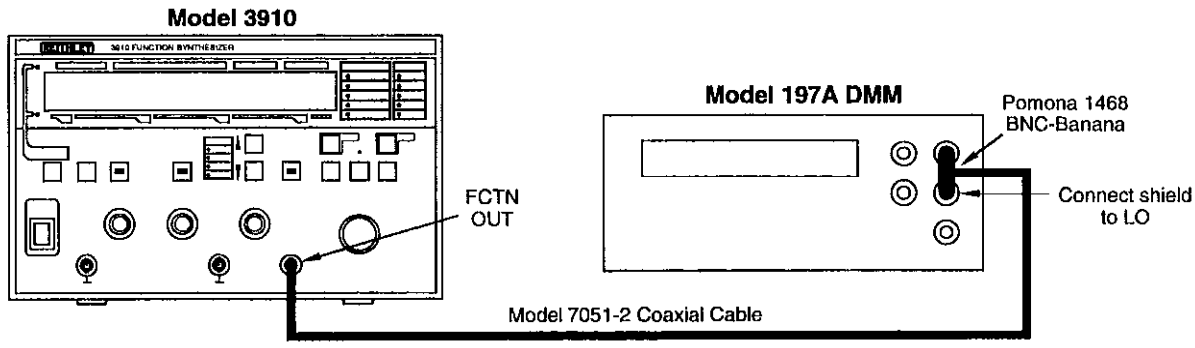

Figure 1-2. Connections for Output Amplitude and DC Offset Tests

1.7.3 DC Offset

Procedure:

1. Connect the Model 3910 FCTN OUT jack to the Model 197A DMM, as shown in Figure 1-1. Do not use the 50Ω termination for this test.
2. Set the DMM for the DCV function, and select the 20V range.
3. Set Model 3910 operating modes as follows:
   AMPTD range: ~20Vp-p
   AMPTD level: MAX
   Frequency: 1kHz
   FCTN: sine (∿)
   MODE: DC
   DC OFFSET: ON
   DC OFFSET setting: +Maximum
4. Verify that the DMM reads a minimum of +10VDC.
5. Set the DC OFFSET output setting to –Max.
6. Verify that the DMM reads a minimum of –10VDC.

1.7.4 Frequency Response

Procedure:

1. Connect the Model 3910 FCTN OUT jack to the wideband AC voltmeter, as shown in Figure 1-3. Be sure to connect the 50Ω feed-through terminator as shown.
2. Set the AC voltmeter to measure ACV using auto-ranging.
3. Set Model 3910 operating modes as follows:
   AMPTD range: ~20Vp-p
   AMPTD level: MAX
   MODE: CONT
   DC OFFSET: OFF
   FCTN: sine (∿)
   Frequency: 1kHz
4. Allow the voltmeter reading to stabilize, then enable the dB and REL modes in that order.
5. Change the Model 3910 frequency to 10kHz, and verify that the voltmeter reading is within ±0.1dB, as summarized in Table 1-3.
6. Change the Model 3910 frequency to 1MHz, and verify that the voltmeter is within +1, –3dB.
7. Disable the dB and REL modes on the voltmeter.
8. Set the function synthesizer frequency to 1kHz and the function (waveform) to triangle. Note and record the voltmeter reading.
9. Set the function synthesizer frequency to 10kHz, and verify that the voltmeter reading is within ±5% of the reading obtained in step 8.
10. Repeat steps 8 and 9 for the remaining functions listed in Table 1-3.

Table 1-3. Reading Limits for Frequency Response Tests

Waveform	Measured Value at 10kHz*	Measured Value at 1MHz*
Sine (∿)	Within ±0.1dB	Within +1, –3dB
Triangle (⩘)	Within ±5%	—
Square (⎍)	Within ±5%	—
Rising sawtooth (◿)	Within ±7%	—
Falling sawtooth (◺)	Within ±7%	—

*With reference to value at 1kHz; see procedure for details.

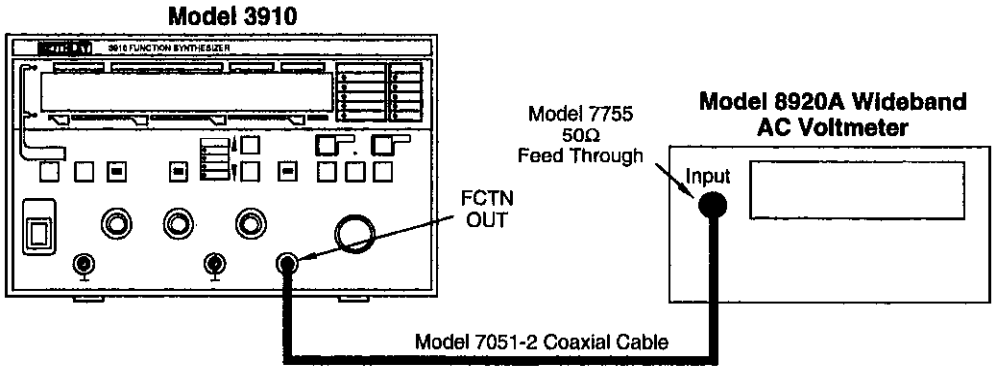

Figure 1-3. Connections for Frequency Response Tests

1.7.5 Total Harmonic Distortion

Procedure:

1. Connect the Model 3910 FCTN OUT jack to the input of the distortion analyzer as shown in Figure 1-1. Be sure to use the 50Ω terminator as shown.
2. Set Model 3910 operating modes as follows:
   AMPTD range: ~20Vp-p
   AMPTD level: MAX
   MODE: CONT
   DC OFFSET: OFF
   Frequency: 1kHz
   FCTN: sine wave (∿)
3. Verify that the distortion reading is less than 0.3%.
4. Measure the distortion at the following synthesizer frequencies:

   10Hz, 50Hz, 100Hz, 500Hz, 5kHz, 10kHz, 25kHz, 50kHz, and 100kHz.

Verify that the distortion is less than 0.3% for all the above frequencies.

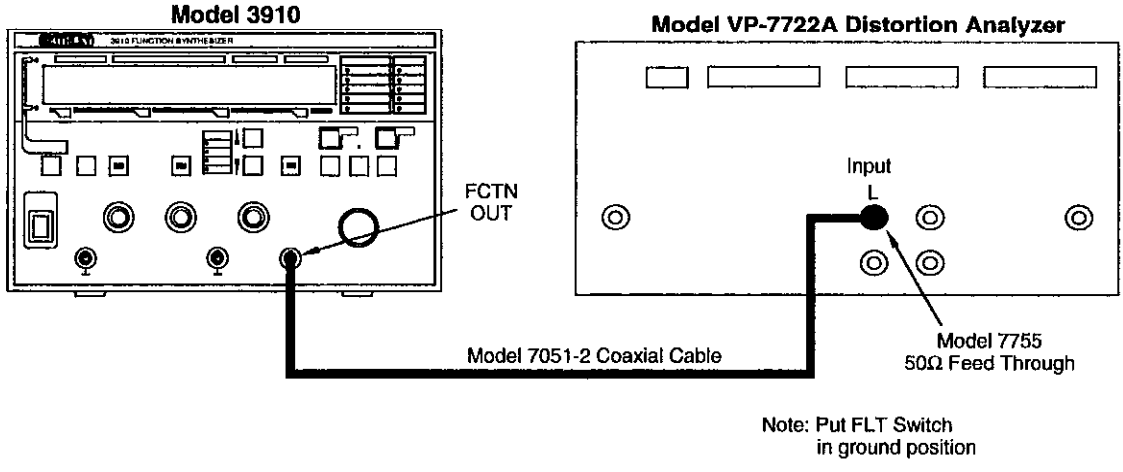

Figure 1-4. Connections for Distortion Tests

1.7.6 Duty Cycle Verification

1. Connect the Model 3910 FCTN OUT jack to input A of the counter/timer as shown in Figure 1-5.
2. Place the counter/timer in the pulse width measurement mode.
3. Set Model 3910 operating modes as follows:
   Frequency: 10kHz
   AMPTD range: ~20Vp-p
   AMPTD setting: MAX
   FCTN: square wave (⊓)
   MODE: CONT
   DUTY VAR: FXD
4. Verify that the pulse width is between 49.0µsec and 51.0µsec.

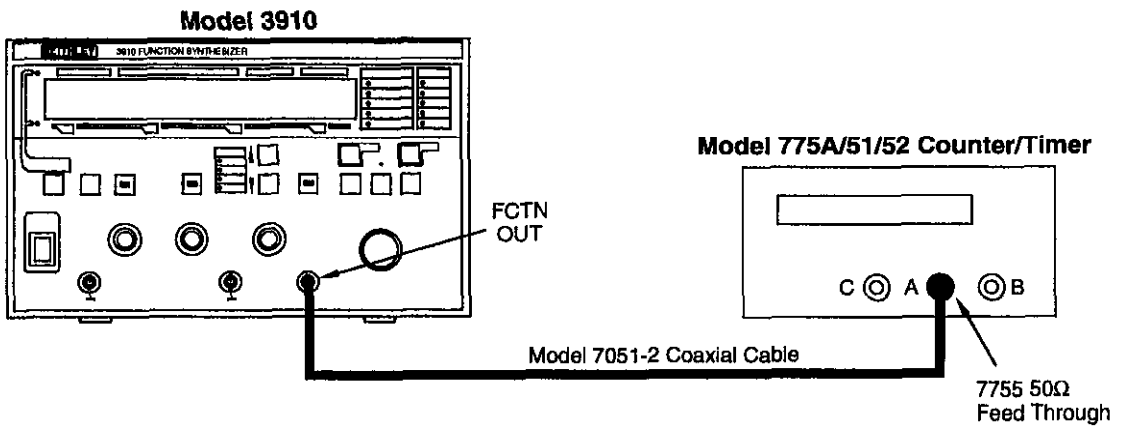

Figure 1-5. Connections for Square Wave Duty Cycle Verification

SECTION 2
Principles of Operation

2.1 INTRODUCTION

This section presents an overview of Model 3910 operating principles.

2.2 BLOCK DIAGRAM

Figure 2-1 shows an overall block diagram of the Model 3910. The various sections include the control block, display and keyboard unit, analog section, and the power supply and GPIB interface sections.

2.3 CIRCUIT OPERATION

2.3.1 Control Section

The control section supervises various instrument operations. The control section includes a single-chip CPU that houses ROM and RAM, a power-detection circuit, and various latches.

2.3.2 Display and Keyboard Section

The display includes 7-segment display units and various indicator LEDs. The keyboard is made up of a number of momentary-contact switches for the various control functions.

2.3.3 Synthesizer

The heart of the synthesizer is a custom LSI chip that performs direct digital synthesis of waveform data. Synthesizer data depends on the selected waveform and frequency.

2.3.4 Analog Section

The analog section converts digital waveform from the synthesizer into an analog signal. Parts of the analog section include circuits for DC offset, square wave duty cycle variation, and output amplifier, and the attenuator, which controls amplitude ranges.

2.3.5 Power Supply

The power supply converts the AC line power voltage into various DC voltages to power internal circuits. The power supply includes a transformer and series regulator. Note that power supply common is connected to chassis ground.

2.3.6 GPIB Interface

The optional GPIB interface allows the Model 3910 to be controlled over the GPIB by a computer. The interface performs many bus functions such as handshaking automatically, minmizing CPU time necessary to control the bus.

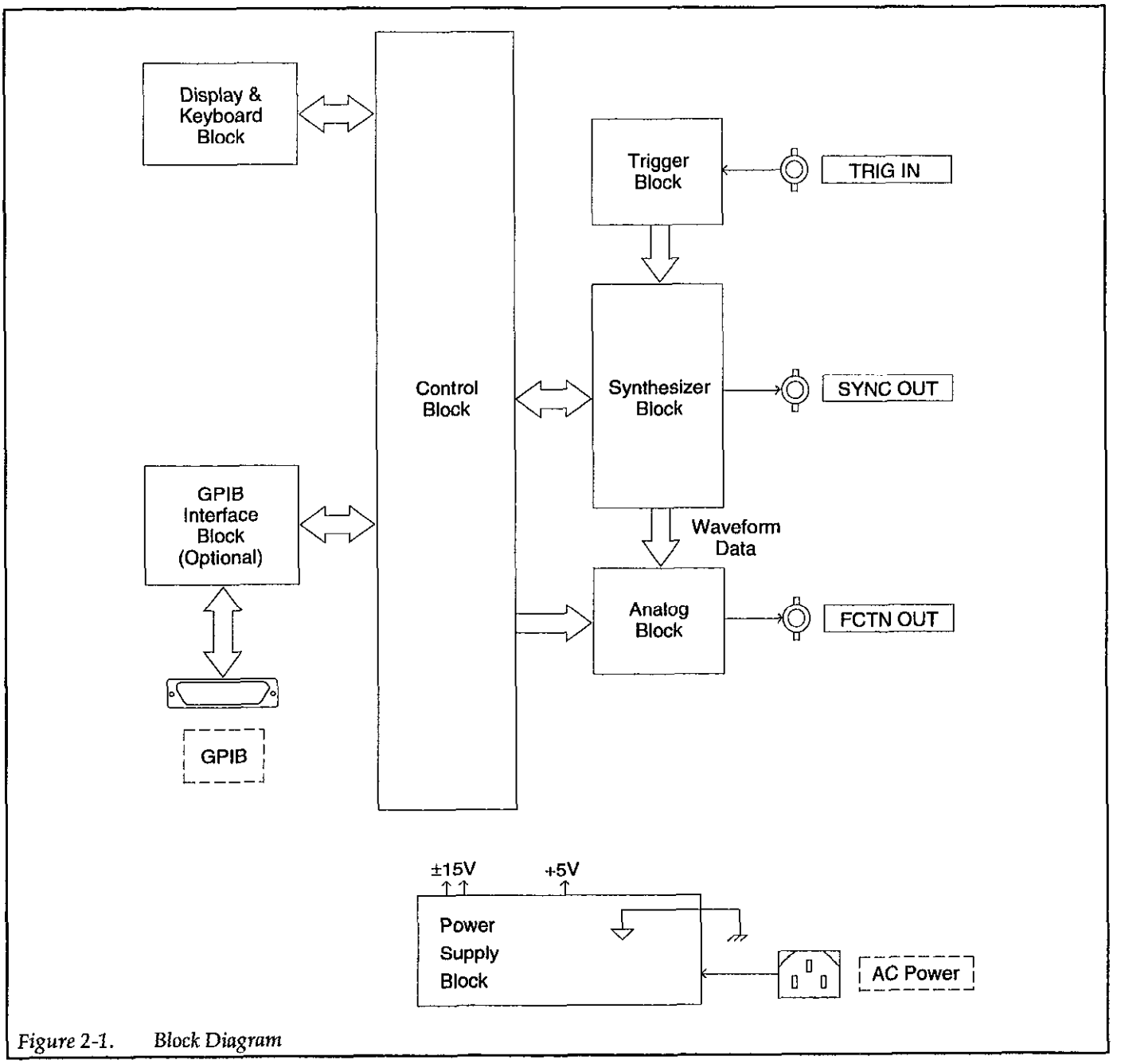

Figure 2-1. Block Diagram

SECTION 3
Service Information

3.1 INTRODUCTION

This section contains information on fuse and battery replacement, instrument calibration and repair, and replacement parts for the Model 3910.

3.2 LINE FUSE REPLACEMENT

The line fuse, which is located inside the line power receptacle on the rear panel, protects the power line input from excessive current. Follow the steps below to replace the fuse:

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

1. Using a flat-blade screwdriver, pry open the fuse drawer, as shown in Figure 3-1.
2. Remove the fuse from the fuse clip. Note that a spare fuse is located inside the fuse holder.
3. Replace the fuse with the type listed in Table 3-1.

CAUTION
Using the wrong fuse type may result in instrument damage.

4. Push the fuse drawer back into the receptacle.

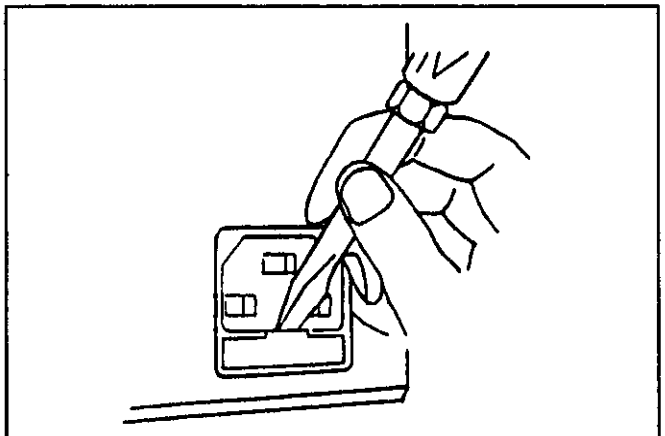

Figure 3-1. Fuse Replacement

Table 3-1. Recommended Line Fuses

Line Voltage	Description	Keithley Part Number
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 BATTERY REPLACEMENT

Two "AA" type batteries provide backup power for the setup RAM. If "Err 3" is displayed upon power-up, the batteries should be replaced.

The batteries should last for at least six months before requiring replacement but will typically last longer. The batteries should be replaced at least once a year regardless of their condition to avoid possible instrument damage due to battery leakage.

Refer to Figure 3-2 and the steps below to replace the batteries.

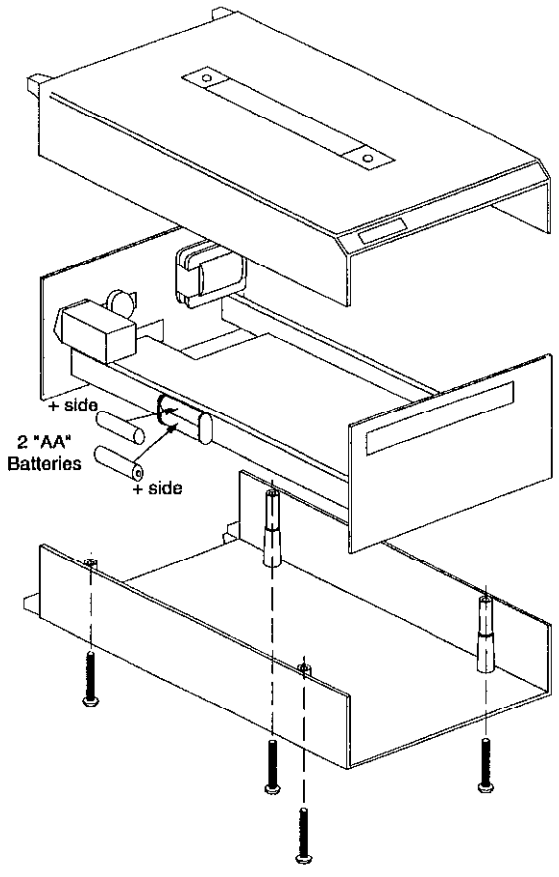

Figure 3-2. Battery Replacement

WARNING

Disconnect the line cord and all other equipment from the Model 3910 before removing the covers.

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.
2. Remove the four screws that secure the case bottom.
3. Remove the case bottom.
4. Turn the instrument right side up.
5. Remove the case top.
6. Remove the two batteries from the battery case.
7. Install two new "AA" alkaline batteries in the battery case, taking care to observe proper polarity.

CAUTION

Reversing battery polarity may result in instrument damage.

8. Install the top cover, then turn the instrument upside down.
9. Install the bottom cover, then replace the four screws that were removed earlier.
10. Plug in the instrument, then turn on the power.
11. Observe the display. If "Err 3" is displayed, press the CLEAR key to clear the error.

3.4 CALIBRATION

The following paragraphs give step-by-step procedures for calibrating the Model 3910. 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 should 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 for calibration or repair.) After calibration, performance verification procedures outlined in Section 1 can be used to verify that the instrument is operating properly.

3.4.1 Environmental Conditions

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

3.4.2 Initial Conditions

The Model 3910 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. Typically, it takes one additional hour to temperature stabilize a unit that is 10°C outside the allowed temperature range.

3.4.3 Line Power

Before calibrating the instrument, be sure the rear panel LINE VOLTAGE SELECTOR switch is set to the correct operating voltage. The Model 3910 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.

3.4.4 Recommended Calibration Equipment

Table 3-2 summarizes recommended equipment for calibrating the Model 3910. Similar equipment may be used as long as corresponding specifications are comparable.

3.4.5 Cover Removal

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

Table 3-2. Recommended Test Equipment for Calibration

Manufacturer	Model	Description	Specifications
Keithley	197A	DMM (DC volts, 5-1/2 digits)	200mV range; ±(0.016% of rdg+3 counts)
Keithley	775A/51/52	Counter/Timer with TCXO option	0Hz-120MHz; time base aging <1 × 10^{-7}/month; pulse width measurements
TEK	2225	Analog Oscilloscope	50MHz bandwidth; ±3% accuracy.
Keithley	7051-2	BNC interconnect Cable	50Ω coaxial cable (RG-58C), male BNC connectors, 2ft.(0.6m)
Keithley	7754-3	BNC to Alligator Cable	BNC/Alligator, 3 ft. (0.9m)
Pomona	1468	BNC-banana Adapter	Female BNC connector to double banana plug

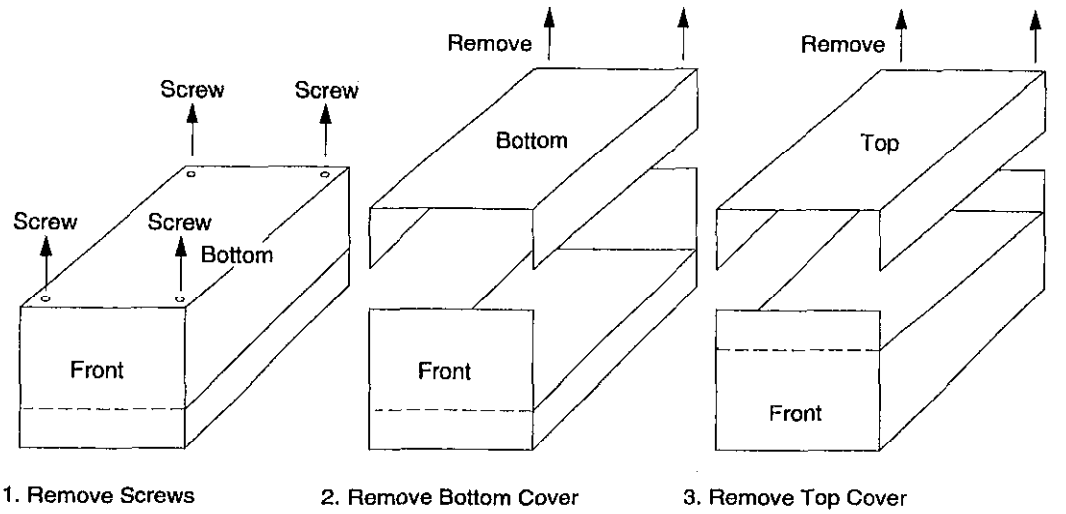

Figure 3-3. Cover Removal

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.

3.4.6 Calibration Adjustment Locations

Calibration adjustments are shown in Figure 3-4. Note that all calibration adjustments are located on the main circuit board. The display board (mounted to the front panel) has no calibration adjustments.

Some calibration adjustments are performed by turning a potentiometer while others are performed by replacing a fixed resistor.

3.4.7 DC Offset Calibration

TP2 Offset Calibration

1. Connect the DMM to TP2 and TP7, as shown in Figure 3-5.
2. Set the DMM to the DCV function, and select the 200mV range.
3. Place the Model 3910 in the DC MODE, and set DC OFFSET to the OFF position.
4. Adjust R64 for a DMM reading of 0mV ±1mV.

NOTE

The square wave duty cycle calibration (paragraph 3.4.9) must be performed if this adjustment is changed.

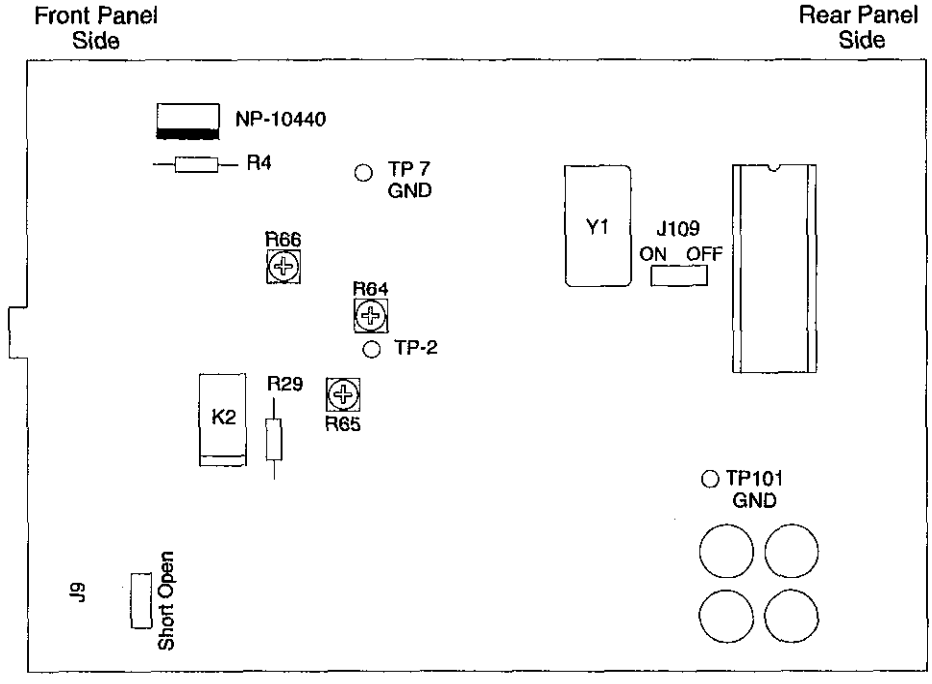

Figure 3-4. Calibration Adjustments (Main Board)

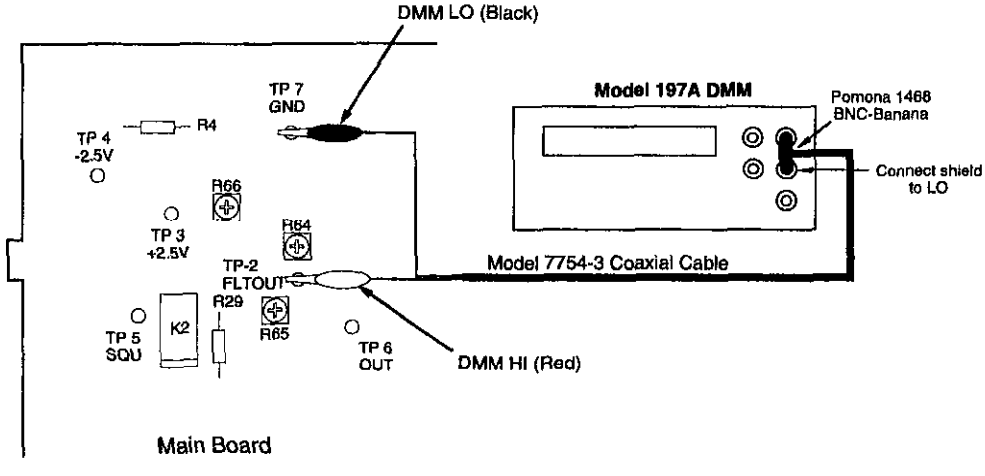

Figure 3-5. Connections for TP2 Offset Calibration

FCTN OUT Offset Calibration

1. Connect the DMM to the FCTN OUT jack, as shown in Figure 3-6.
2. Set the DMM to the DCV function, and select the 200mV range.
3. Place the Model 3910 in the DC MODE, and set DC OFFSET to the OFF position.
4. Adjust R65 for a DMM reading of 0mV ±1mV.

3.4.8 Amplitude Calibration

Amplitude Calibration for All Waveforms

1. Connect the Model 3910 FCTN OUT jack to the oscilloscope input, as shown in Figure 3-7.
2. Set the oscilloscope input mode for high-impedance and DC coupling.
3. Set Model 3910 operating modes as follows:
   MODE: CONT
   Frequency: 1kHz
   AMPTD range: ~20Vp-p
   AMPTD setting: MAX
4. Verify that the output voltage for all waveforms is within the range of 20Vp-p to 22Vp-p (change waveforms with the FCTN key). If the voltage amplitude is not within this range, proceed to steps 5 and 6 below. Otherwise, amplitude calibration is complete, and no further adjustments are necessary.

NOTE

If necessary, use the AMPTD setting control to set the maximum amplitude for any waveform to 22Vp-p. Clipping may occur if a waveform amplitude exceeds 22Vp-p.

5. If the voltage for all waveforms is lower than 20Vp-p, decrease the value of R29 using Table 3-3 as a guide. For example, if the output voltage is 19.8Vp-p, replace R29 with a 390Ω resistor. This change will result in an increase in amplitude of +1.4%.
6. If the voltage for all waveforms is higher than 22Vp-p, increase the value of R29, again using Table 3-3 as a guide. For example, if the output voltage is 22.2Vp-p, replace R29 with a 560Ω resistor. This change will decrease the output amplitude by about 1.6%
7. After replacing R29, check to see that the output amplitude for all waveforms is between 20Vp-p and 22Vp-p.

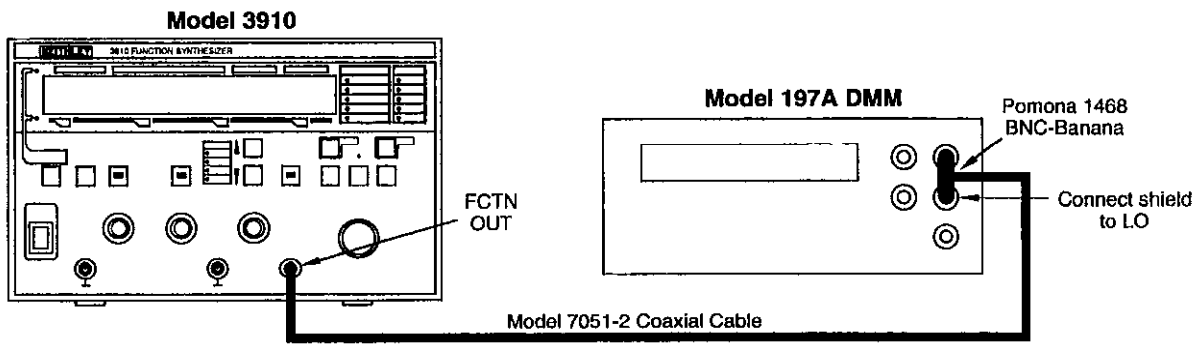

Figure 3-6. Connections for FCTN OUT Offset Calibration

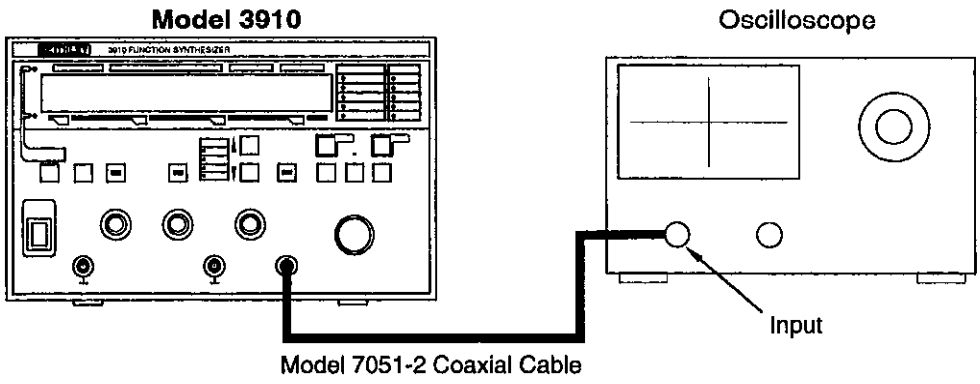

Figure 3-7. Connections for Amplitude Calibration

Table 3-3. Relationship Between R29 Value and Amplitude

R29 Value	Amplitude Change
360Ω	+2.0%
390Ω	+1.4%
430Ω	+0.7%
470Ω	0.0%
510Ω	–0.7%
560Ω	–1.6%
620Ω	–2.6%

Square Wave Amplitude Calibration

1. Connect the Model 3910 FCTN OUT jack to the oscilloscope input (see Figure 3-7).
2. Set the oscilloscope input mode for high impedance and DC coupling.
3. Set Model 3910 operating modes as follows:
   MODE: CONT
   Frequency: 1kHz
   AMPTD range: ~20Vp-p
   AMPTD setting: maximum
   FCTN: Square wave (⊓)
4. Check to see that the square wave amplitude differs by no more than ±0.5Vp-p from other waveforms. If the output amplitude is within these limits, no further calibration is required. Otherwise, go on to step 5.

NOTE
If necessary, use the AMPTD setting control to set the maximum amplitude for any waveform to 22Vp-p. Clipping may occur if a waveform amplitude exceeds 22Vp-p.

5. If the p-p output voltage for square waves is smaller than all other waveforms by 0.5Vp-p or more, change the amplitude by decreasing the value of R4, as summarized in Table 3-4. For example, if the square wave output is 0.6Vp-p less than other waveforms, replace R4 with a 14.3kΩ resistor. This change will increase the square wave amplitude by 1.4%.
6. If the square wave output voltage is higher by 0.5Vp-p than all other waveforms, increase the value of R4 using Table 3-4 as a guide. For example, if the square wave amplitude is 0.6Vp-p higher than other waveforms, replace R4 with a 15.8kΩ resistor.
7. After replacing R4, check to see that the square wave amplitude is within ±0.5Vp-p of all other waveforms.

Table 3-4. Relationship Between R4 Value and Square Wave Amplitude

R4 Value	Square Wave Amplitude Change
14.0kΩ	+2.0%
14.3kΩ	+1.4%
14.7kΩ	+0.6%
15.0kΩ	0.0%
15.4kΩ	–0.8%
15.8kΩ	–1.6%
16.2kΩ	–2.3%

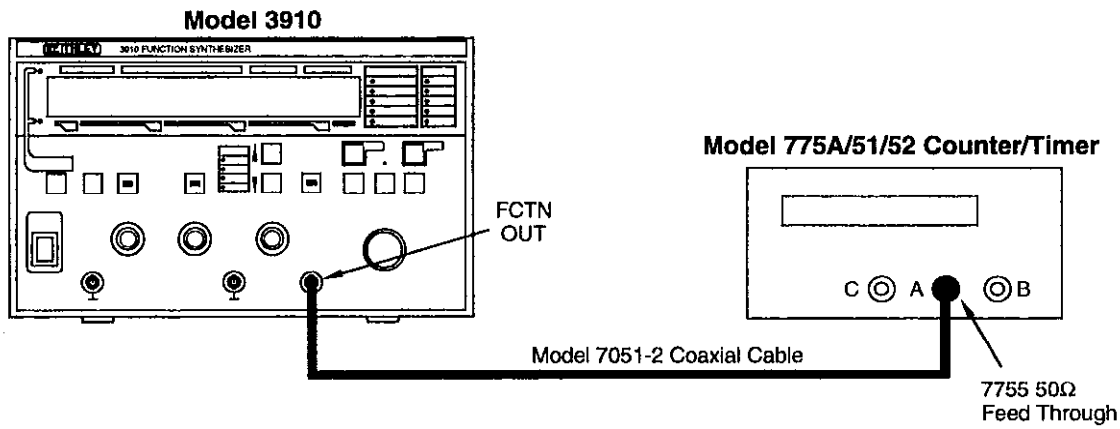

Figure 3-8. Connections for Square Wave Duty Cycle Calibration

3.4.9 Square Wave Duty Cycle Calibration

1. Connect the Model 3910 FCTN OUT jack to input A of the counter/timer, as shown in Figure 3-8.
2. Place the counter/timer in the pulse width measurement mode.
3. Set Model 3910 operating modes as follows:
   Frequency: 10kHz
   AMPTD range: ~20Vp-p
   AMPTD setting: MAX
   FCTN: square wave (⊓)
   MODE: CONT
   DUTY VAR: FXD
4. Adjust R66 for a square wave pulse width of 50.00µs ±0.01µs as read on the timer/counter.

3.4.10 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.

3.5 FCTN OUT JUMPERS

Two jumpers, which are located on the main circuit board, allow you to select whether or not the waveform output (FCTN OUT) is automatically turned on at power-on, and whether or not FCTN OUT is shorted when FCTN OUT is off.

Refer to Figure 3-4 for jumper locations.

NOTE
The covers must be removed to gain access to the jumpers. Refer to paragraph 3.4.5 for information on removing the covers.

3.5.1 Waveform Output On/Off Selection

As shipped from the factory, the Model 3910 is set up so that the waveform output (FCTN OUT) is automatically turned on when power is first turned on. You can change the setting of J109 on the main board so that FCTN OUT remains off at power on.

To change the waveform on/off selection, use a pair of tweezers to place the J109 jumper to the desired position as follows (see Figure 3-9):

- OFF: FCTN OUT remains off when power is turned on.
- ON: FCTN OUT turns on when power is turned on.

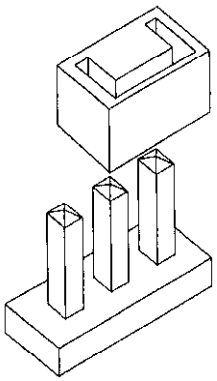

Figure 3-9. Jumper Installation

3.5.2 FCTN OUT Open/Short Selection

As shipped from the factory, the Model 3910 is set up so that FCTN OUT is open when FCTN OUT is turned off. You can change the setting of J9 on the main board so that FCTN OUT is shorted when turned off.

To change the waveform on/off selection, use a pair of tweezers to place the J9 jumper to the desired position as follows (see Figure 3-9):

- SHORT: FCTN OUT is connected to ground (shorted) when FCTN OUT is off.
- OPEN: FCTN OUT is open when FCTN OUT is off.

3.6 GPIB INTERFACE INSTALLATION

The Model 3911 is an optional IEEE-488 (GPIB interface) for the Model 3910. This paragraph covers interface installation. Refer to the Model 3910 Operator's Manual for details on GPIB programming and operation.

3.6.1 Installation Precautions

CAUTION

The Model 3911 Interface is static-sensitive. Observe the following precautions to prevent damage caused by static discharge when handling the interface:

1. **Keep the Model 3911 in its anti-static bag until ready for installation.**
2. **Remove the Model 3911 from its protective container only at a properly grounded work station. Also ground yourself with a suitable wrist strap.**
3. **Handle the interface only by the metal mounting plate. Do not touch the board surfaces or the connector pins.**
4. **Ground the Model 3910 Synthesizer to a bench or table before installing the Model 3911 Interface.**

3.6.2 Board Installation

1. Turn off Model 3910 power, and disconnect the line cord and all other equipment from the instrument.

CAUTION

Failure to disconnect the line cord and other equipment may result in damage to the GPIB interface board and the Model 3910.

2. Remove the two screws from the cover plate under the "GPIB" label on the rear panel.
3. Insert the GPIB board into the Model 3910, as shown in Figure 3-10. Carefully align the board so that it mates with the connector inside the instrument.

NOTE

If the board connector does not mate properly with the inside connector, continue with steps 4 through 7. Otherwise, skip to step 8.

4. Turn the Model 3910 upside down, and remove the four Phillips head screws shown in Figure 3-11.

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.

5. Turn the instrument right side up, and slide off the top cover.
6. Manually align the GPIB board connector and its mating connector, then seat the board in the connector.
7. Replace the top cover, and replace the four cover mounting screws.

8. Attach the GPIB board to the rear panel of the Model 3910 with the two screws that were previously removed.
9. Connect the power cord to the instrument and to a grounded AC receptacle.

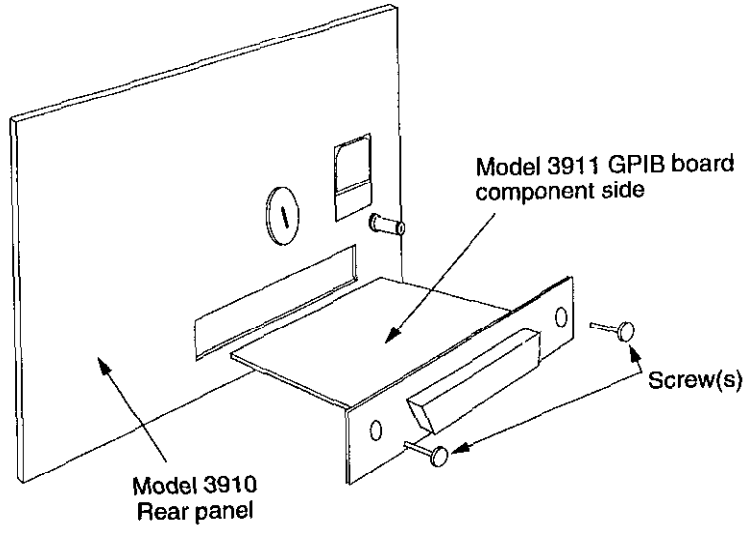

Figure 3-10. Model 3911 Interface Installation

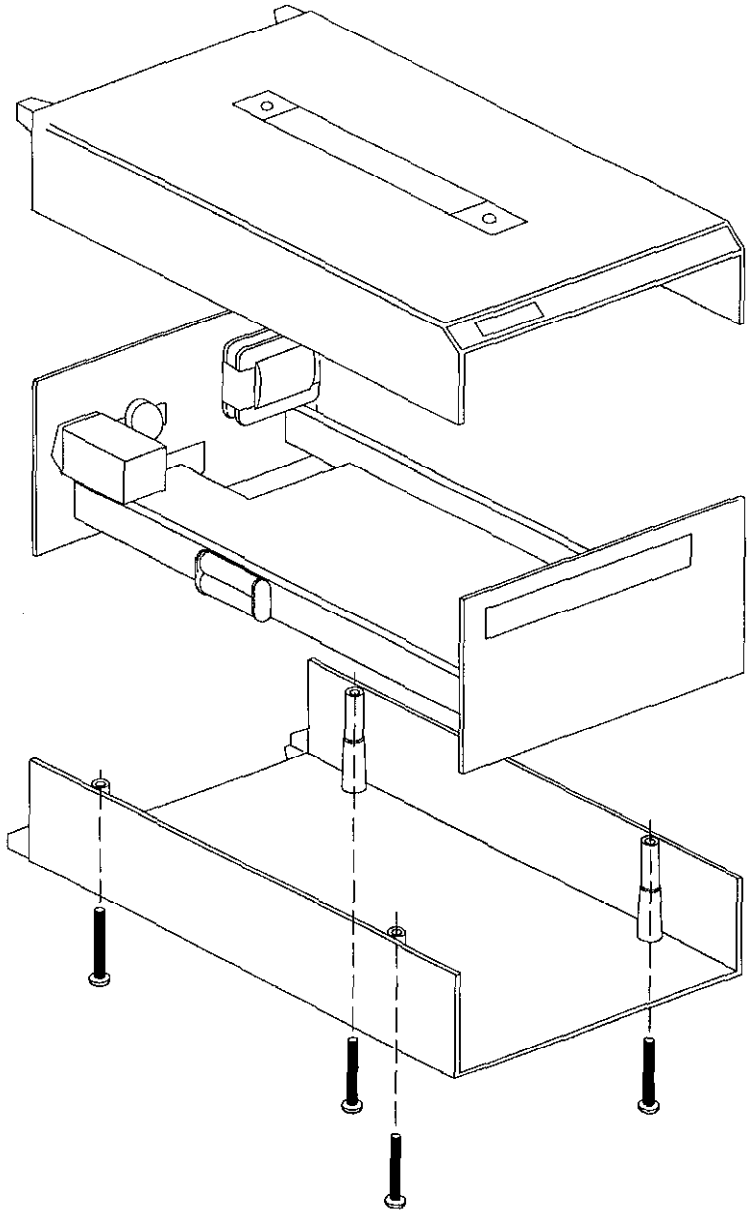

Figure 3-11. Cover Removal

3.7 REPAIR

3.7.1 Factory Service

If the Model 3910 is still under warranty, it is recommended that the unit be returned to the factory 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 Board Removal

Main Circuit Board Removal

Remove the main circuit board as follows:

1. Remove the three knobs shown in Figure 3-12 by loosening the set screws and then removing the knobs.

2. Disconnect the connectors J101, J106, J108, and J5 from the main board (see Figure 3-13).
3. Remove the 3-terminal regulator attaching screws (Figure 3-14).

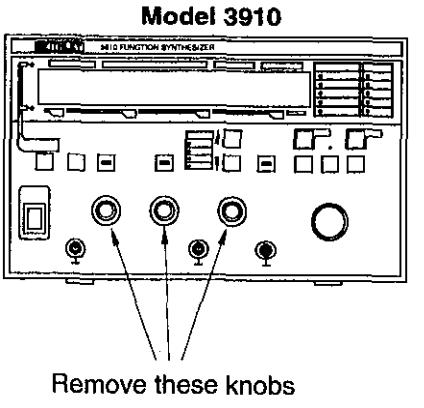

Figure 3-12. Knob Removal

4. Cut the connecting wires between the three BNC connectors (TRIG IN, SYNC OUT, and FCTN OUT) and the main board with diagonal cutters (see Figure 3-15).
5. Remove the six screws securing the main board (see Figure 3-16).

The main board can now be removed from the instrument. To install the board, simply reverse the above procedure.

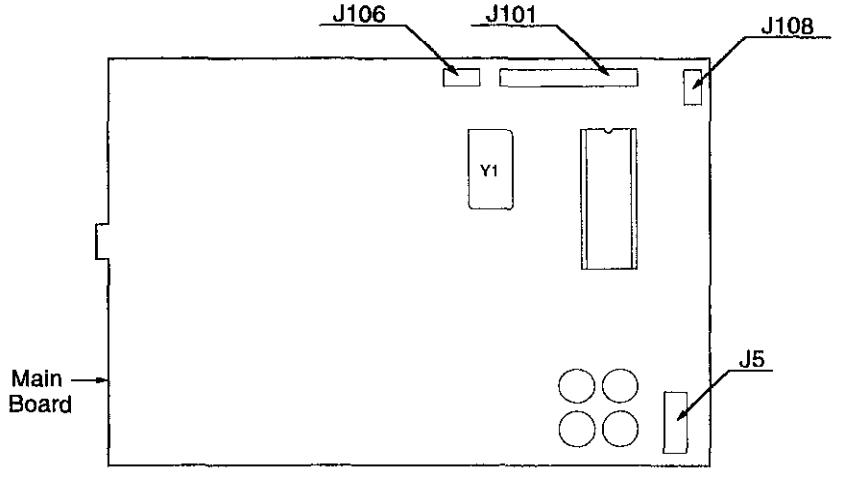

Figure 3-13. Connector Removal

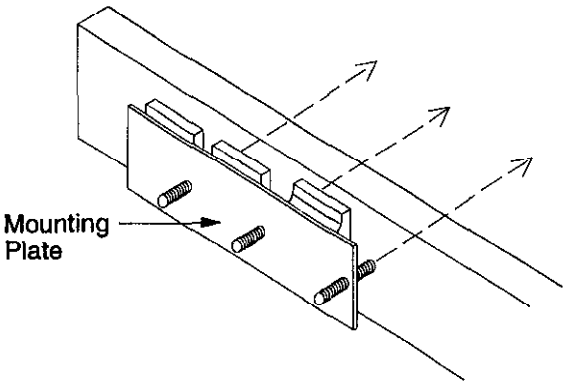

Figure 3-14. Removal of 3-Terminal Regulator Screws

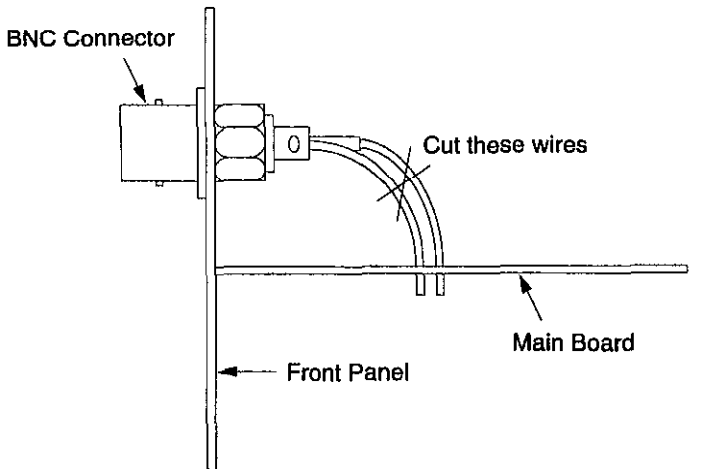

Figure 3-15. Connecting Wires

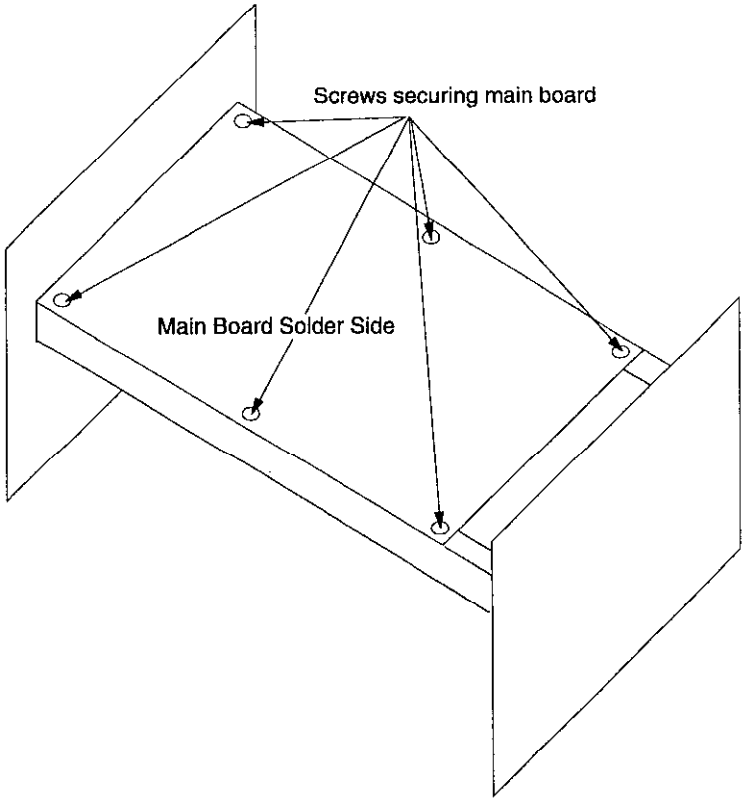

Figure 3-16. Main Board Mounting Screws

Display Board Removal

1. Disconnect the flat cable connector, J201 (see Figure 3-17).
2. Remove that five screws securing the display board to the front panel.
3. Remove the display board.

The display board can be installed by reversing the above procedure. When installing the board, be certain that none of the push buttons bind in the front panel holes.

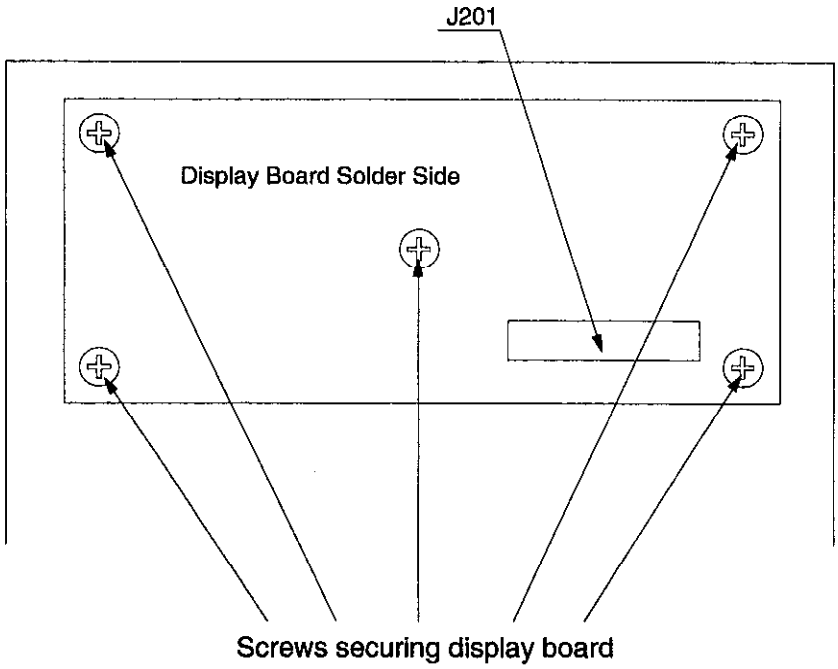

Figure 3-17. Display Board Connector and Screw Locations

3.8 REPLACEABLE PARTS

3.8.1 Parts List

Table 3-5 summarizes available Model 3910 replacement parts. Figure 3-18 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.
Top frame	426-01835-00	1
Handle cover	469-00527-00	1
Handle plate	469-00309-00	1
Handle adaptor-1	469-00489-00	2
Handle adaptor-2	526-07658-00	2
Bottom frame	426-01843-00	1
Foot	466-00469-00	1
Foot cushion	466-00485-00	2
Rubber cushion	466-00477-00	2
Side plate	456-00716-00	8
Top plate	400-11984-00	1
Power cord	352-02033-00	1
Cord band	352-04532-00	1
Fuse (1A/250V)	FU-96-2	1
Fuse (0.5A/250V)	FU-96-1	1
Front panel	406-04055-00	1
Power switch	332-06813-00	1
Rotary encoder	332-90041-00	1
Control (knob)	486-24060-00	1
Control (knob)	486-19660-00	3
BNC connector (BNC137)	310-00169-00	3
Rear panel	400-11992-00	1
Noise filter (inlet)	240-03212-00	1
Ground terminal	330-05389-00	1
Voltage selection switch	332-50057-00	1
IEEE cover	410-01664-00	1
Frame	526-14395-00	2
TR holder	520-06867-00	1
Power transformer	244-00068-00	1
Battery case	316-06075-00	1
Circuit board	080-34630-00	1
Display board	080-34648-00	1

APPENDIX A
Typical Data

INTRODUCTION

Appendix A provides the typical performance data for the Model 3910.

This instrument was thoroughly tested, 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 3910. Thus, measured performance of your Model 3910 may be different than that indicated by the typical data curves shown here.

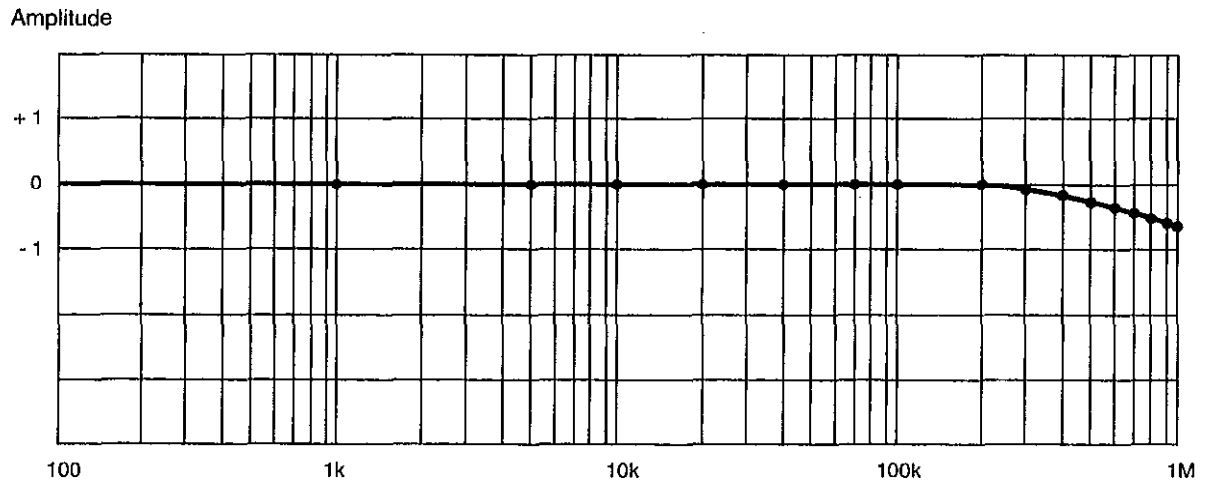

Figure A-1. Sine Wave Amplitude vs. Frequency Characteristics

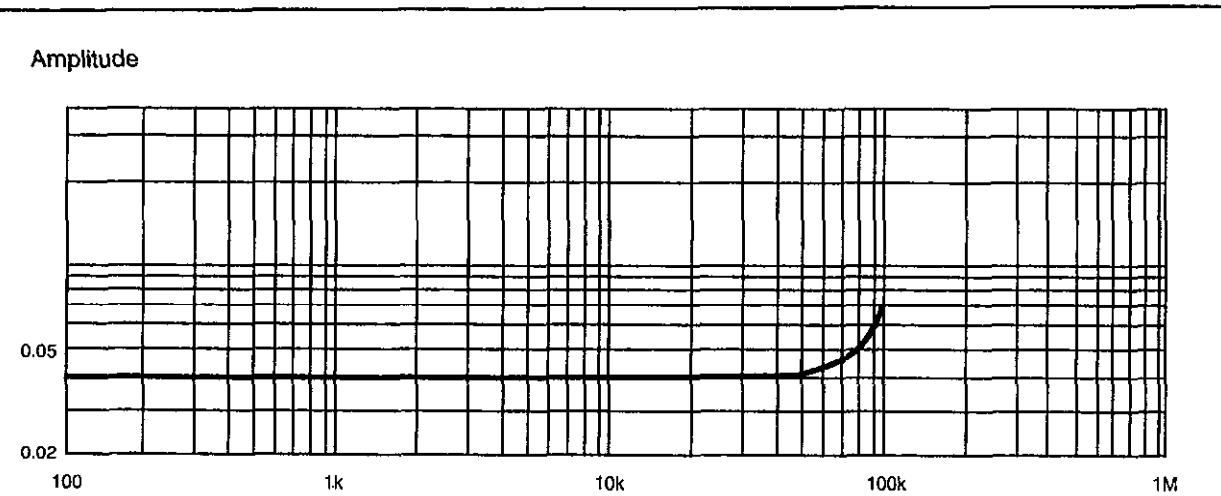

Figure A-2. Total Harmonic Distortion vs. Frequency Characteristics

APPENDIX B
Model 3910 and 3910/11 Specifications

B.1 ELECTRICAL SPECIFICATIONS

Waveforms
DC only, ∿ , ⎍ , ⟍ , ◿ , ⟍

Oscillation Modes		
Continuous	CONT	Continuous oscillation
Burst	BURST	Continually outputs an integer number of waveform cycles followed by an integer number of gaps.
Trigger	TRIG	Upon receiving a trigger, will output an integer number of waveform cycles.
Gate	GATE	N-cycles generated while trigger signal is on (i.e. Logic Low). N is an integer.
DC	DC	Outputs a DC level.

Frequency		
Waveform and Frequency Range	∿ , ⎍ (Duty fixed)	0.1mHz to 1MHz
	⟍ , ◿ , ⟍ , ⎍ (Duty variable)	0.1mHz to 100kHz
Display	Maximum 11 columns, resolution 0.1mHz (constant)	
Accuracy	$\pm 30 \times 10^{-6}$ (±30ppm)	

Output Characteristics			
Maximum Output	AC only	20Vp-p/open, 10Vp-p/50Ω load	
	DC only	±10V/open, ±5V/50Ω load	
Amplitude Frequency Characteristics	Amplitude accuracy referenced to amplitude at 1kHz, DC offset off, 50Ω load, 10Vp-p output		
	Sine wave	±0.1dB @ 10kHz	
		± 1dB, -3dB @ 1MHz	
	Triangle wave	±5% @ 10kHz	
	Square wave	±5% @ 10kHz	
	Rising sawtooth wave	±7% @ 10kHz	
	Falling Sawtooth wave	±7% @ 10kHz	
AMPTD Ranges	20Vp-p, 2Vp-p, 0.2Vp-p, 0.02Vp-p		
AMPTD Variable Adjustment	Max = 0dB, Min = –20dB		
Spectrum Purity	CONT mode, DC offset off, 50Ω load, 10Vp-p output		
	Total harmonic distortion	10Hz to 100kHz below 0.3%	
	Harmonics	100kHz to 500kHz	-45dBc typ.
		500kHz to 1MHz	-40dBc typ.
	Spurious	1MHz	-55dBc typ.
Square Wave Characteristics	DC offset off, 50Ω load, 10Vp-p output		
	Rise/Fall Time	120nsec typ.	
	Overshoot/Undershoot	Within 5% of output p-p value	
	Fixed duty ratio precision (in CONT mode)	1% of period @ 10kHz	
	Duty variable range	DC offset off, 50Ω load, 10Vp-p output	
		10kHz	5%-90%
		10kHz to 100kHz	10%-90%

Specifications subject to change without notice.

ELECTRICAL SPECIFICATIONS (Cont.)

Output Characteristics (Cont.)	
Power-up state	Function output turns on. Can be switched off by changing internal jumper.
Output Impedance	50Ω ±2%, unbalanced (open when function output is off, can be switched to short by changing jumper)
Connector	BNC plug, front panel

Sync Output	
Output Voltage	TTL level (51Ω in series with a 74LS00 output)
Connector	BNC plug, front panel

Trigger, Gate Oscillation		
Trigger Source	External trigger only. Front panel BNC plug or push-button switch.	
Input Voltage	TTL level (74HC14 input with 5.1kΩ pull-up resistor). Minimum pulse width 200ns.	
Start/Stop Phase	Setting range	+360.0° to -360.0°
	Display	Maximum 4 digits + negative display, resolution 0.1° (constant)
	Jitter	150ns

Memory	
Parameters Stored in Non-volatile Memory	Frequency, FCTN (function), Mode, AMPTD range, Duty var on/off, GPIB address, DC offset on/off. Start/Stop phase, Mark wave number, Space wave number.
Number of Sets	Stores 1 set of parameters.
Battery Backup	30 days or more after full charge (stored at room temperature)

Modify Method
Left/Right Cursor Button and Modify Dial

Display Functions	
7 Segment LED	Oscillation frequency, GPIB address (only when GPIB option is installed), start stop phase, mark wave number, space wave number.

Presets	
If the non-volatile memory fails and the 3910 is cleared, the parameters will be set as follows:	
Frequency	1.0000000kHz
FCTN OUT	On (can be set to off by switching internal short plug)
AMPTD range	-0.02Vp-p
DC offset	Off
Duty var	Fxd
Display select	Frequency display
FCTN (function)	Sine
GPIB Address	2 (3910/11 only)
Mark Wave Number	1
Space Wave Number	1
Mode	CONT
Start Stop Phase	0° (cursor is 0.1° column)

B.2 GPIB INTERFACE (3910/11 ONLY)

GPIB Interface			
Functions	SH1, AH1, T6, L4, SR1, RL1, PP0, DC1, DT0, C0		
Data	ASCII (7-bit)		
Delimiter	Transmission	CR or CR/LF (selectable from the front panel). EOI also sent simultaneously.	
	Reception	CR, CR/LF, CR + EOI, CR/LF + EOI, or EOI	
Address	0 - 30 (set by modify dial from panel face)		
Output Driver	DIO1 - DIO8, NDAC, NRFD, SRQ		Open collector
	DAV, EOI		Three-state
Local Key	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 Supply	Voltage	AC 100V, 120V, 220V, 240±10% switch, maximum voltage 250V.
	Frequency	48Hz - 62Hz
	Power Consumption	Approx. 25VA
Ambient Temperature and Humidity	Operating Range	0° - 40°C, 10 - 90% RH (no condensation)
	When Storage	-10° to 50°C, 10% to 80% RH (no condensation)
External Dimensions	Excluding Projections	216 (W) × 132.5 (H) × 350 (D) mm
Weight	Approx. 3.2kg., 6 lbs., 12 oz.	

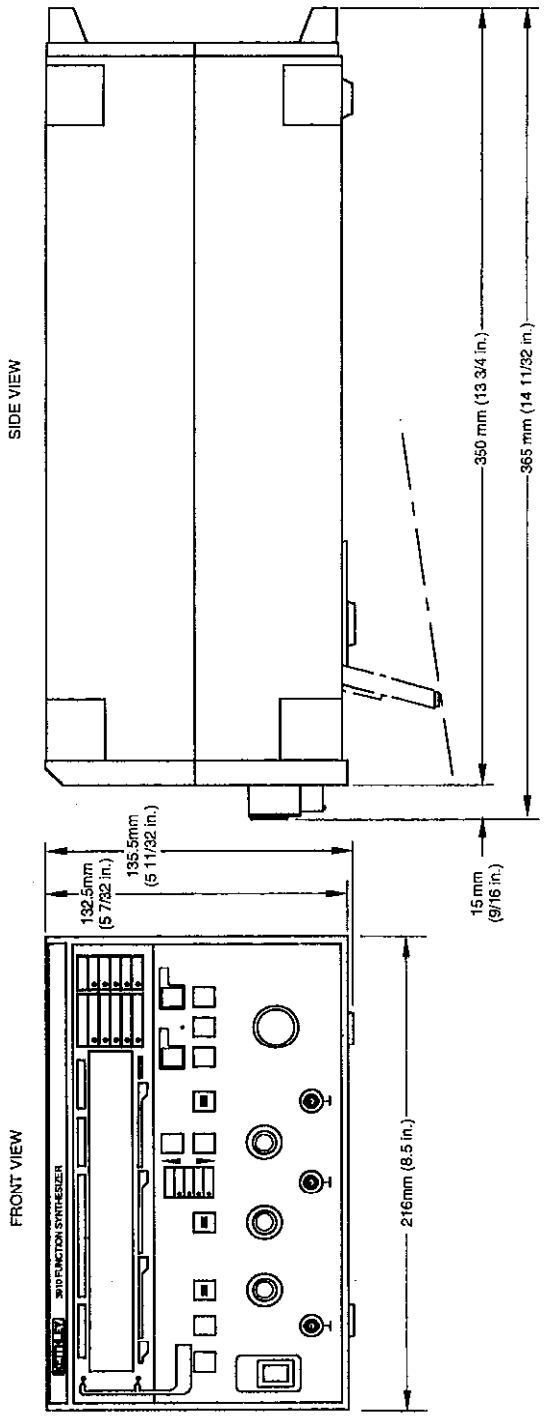

Figure B-1. Outer Dimensions of the Model 3910

Index

KEITHLEY

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 (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.