AFG31000 Series Arbitrary Function Generator

Service Manual

tek.com

077179600

Contacting Tektronix, Inc.

Tektronix, Inc.
14150 SW Karl Braun Drive
P.O. Box 500
Beaverton, OR 97077
USA

For product information, sales, service, and technical support:
- In North America, call 1-800-833-9200.
- Worldwide, visit tek.com to find contacts in your area.

Warranty

Tektronix warrants that the product will be free from defects in materials and workmanship for a period of three (3) years from the date of original purchase from an authorized Tektronix distributor. If the product proves defective during this warranty period, Tektronix, at its option, either will repair the defective product without charge for parts and labor or will provide a replacement in exchange for the defective product. Batteries are excluded from this warranty. Parts, modules, and replacement products used by Tektronix for warranty work may be new or reconditioned to like new performance. All replaced parts, modules and products become the property of Tektronix.

In order to obtain service under this warranty, Customer must notify Tektronix of the defect before the expiration of the warranty period and make suitable arrangements for the performance of service. Customer shall be responsible for packaging and shipping the defective product to the service center designated by Tektronix, shipping charges prepaid, and with a copy of customer proof of purchase. Tektronix shall pay for the return of the product to Customer if the shipment is to a location within the country in which the Tektronix service center is located. Customer shall be responsible for paying all shipping charges, duties, taxes, and any other charges for products returned to any other locations.

This warranty shall not apply to any defect, failure or damage caused by improper use or improper or inadequate maintenance and care. Tektronix shall not be obligated to furnish service under this warranty a) to repair damage resulting from attempts by personnel other than Tektronix representatives to install, repair or service the product; b) to repair damage resulting from improper use or connection to incompatible equipment; c) to repair any damage or malfunction caused by the use of non-Tektronix supplies; or d) to service a product that has been modified or integrated with other products when the effect of such modification or integration increases the time or difficulty of servicing the product.

THIS WARRANTY IS GIVEN BY TEKTRONIX WITH RESPECT TO THE PRODUCT IN LIEU OF ANY OTHER WARRANTIES, EXPRESS OR IMPLIED. TEKTRONIX AND ITS VENDORS DISCLAIM ANY IMPLIED WARRANTIES OF MERCHANTABILITY OR FITNESS FOR A PARTICULAR PURPOSE.

TEKTRONIX' RESPONSIBILITY TO REPAIR OR REPLACE DEFECTIVE PRODUCTS IS THE SOLE AND EXCLUSIVE REMEDY PROVIDED TO THE CUSTOMER FOR BREACH OF THIS WARRANTY. TEKTRONIX AND ITS VENDORS WILL NOT BE LIABLE FOR ANY INDIRECT, SPECIAL, INCIDENTAL, OR CONSEQUENTIAL DAMAGES IRRESPECTIVE OF WHETHER TEKTRONIX OR THE VENDOR HAS ADVANCE NOTICE OF THE POSSIBILITY OF SUCH DAMAGES.

[W16 – 15AUG04]

Table of Contents

Important safety information

Important safety information

This manual contains information and warnings that must be followed by the user for safe operation and to keep the product in a safe condition.

To safely perform service on this product, additional information is provided at the end of this section. See Service safety summary.

General safety summary

Use the product only as specified. Review the following safety precautions to avoid injury and prevent damage to this product or any products connected to it. Carefully read all instructions. Retain these instructions for future reference.

Comply with local and national safety codes.

For correct and safe operation of the product, it is essential that you follow generally accepted safety procedures in addition to the safety precautions specified in this manual.

The product is designed to be used by trained personnel only.

Only qualified personnel who are aware of the hazards involved should remove the cover for repair, maintenance, or adjustment.

Before use, always check the product with a known source to be sure it is operating correctly.

This product is not intended for detection of hazardous voltages.

Use personal protective equipment to prevent shock and arc blast injury where hazardous live conductors are exposed.

While using this product, you may need to access other parts of a larger system. Read the safety sections of the other component manuals for warnings and cautions related to operating the system.

When incorporating this equipment into a system, the safety of that system is the responsibility of the assembler of the system.

To avoid fire or personal injury

Use proper power cord. Use only the power cord specified for this product and certified for the country of use. Do not use the provided power cord for other products.

Use proper voltage setting. Before applying power, make sure that the line selector is in the proper position for the source being used or make sure the line voltage is corrected based on the published specifications.

Ground the product. This product is grounded through the grounding conductor of the power cord. To avoid electric shock, the grounding conductor must be connected to earth ground. Before making connections to the input or output terminals of the product, make sure that the product is properly grounded.

Do not disable the power cord grounding connection.

Power disconnect. The power cord disconnects the product from the power source. See instructions for the location. Do not position the equipment so that it is difficult to operate the power cord; it must remain accessible to the user at all times to allow for quick disconnection if needed.

Connect and disconnect properly. Do not connect or disconnect instruments while is connected to a voltage source and. the instrument is powered on. Use only connectors and adapters supplied with the product or indicated by Tektronix to be suitable for the product.

Observe all terminal ratings. To avoid fire or shock hazard, observe all ratings and markings on the product. Consult the product manual for further ratings information before making connections to the product. Do not exceed the Measurement Category (CAT) rating and voltage or current rating of the lowest rated individual component.

Do not apply a potential to any terminal, including the common terminal, that exceeds the maximum rating of that terminal.

Do not float the common terminal above the rated voltage for that terminal.

Do not operate without covers. Do not operate this product with covers or panels removed, or with the case open. Hazardous voltage exposure is possible.

Avoid exposed circuitry. Do not touch exposed connections and components when power is present.

Do not operate with suspected failures. If you suspect that there is damage to this product, have it inspected by qualified service personnel before using this product.

Disable the product if it is damaged. Do not use the product if it is damaged or operates incorrectly. If in doubt about the safety of the product, turn it off and disconnect the power cord. Clearly mark the product to prevent its further operation.

Examine the exterior of the product before you use it. Look for cracks or missing pieces.

Use only specified replacement parts.

Wear eye protection. Wear eye protection if exposure to high-intensity rays or laser radiation exists.

Do not operate in wet or damp conditions. Be aware that condensation may occur if a unit is moved from a cold environment to a warm environment.

Do not operate in an explosive atmosphere.

Provide proper ventilation. Refer to the installation instructions in the manual for details on installing the product so it has proper ventilation.

Slots and openings are provided for ventilation and should never be covered or otherwise obstructed. Do not push objects into any of the openings.

Provide a safe working environment. Always place the product in a location convenient for viewing the display and indicators.

Avoid improper or prolonged use of keyboards, pointers, and button pads. Improper or prolonged keyboard or pointer use may result in serious injury.

Be sure your work area meets applicable ergonomic standards. Consult with an ergonomics professional to avoid stress injuries.

Use care when lifting and carrying the product. This product is provided with handles for lifting and carrying.

Use only the Tektronix rack-mount hardware specified for this product.

Keep product surfaces clean and dry. Remove the input signals before you clean the product. Inspect the instrument as often as operating conditions require. To clean the exterior surface, perform the following steps:

1. Remove loose dust on the outside of the instrument with a lint-free cloth. Use care to avoid scratching the clear glass display filter.
2. Use a soft cloth dampened with water to clean the instrument. Use an aqueous solution of 75% isopropyl alcohol for more efficient cleaning.

CAUTION. Avoid getting moisture inside the unit during external cleaning. Use only enough cleaning solution to dampen the cloth or swab. To avoid damage to the instrument, do not expose it to sprays, liquids, or solvents, and do not use any abrasive or chemical cleaning agents.

Terms in this manual

These terms may appear in this manual:

WARNING. Warning statements identify conditions or practices that could result in injury or loss of life.

CAUTION. Caution statements identify conditions or practices that could result in damage to this product or other property.

Service safety summary

This section contains additional information required to safely perform service on the product. Only qualified personnel should perform service procedures. Read this *Service safety summary* and the General safety summary before performing any service procedures.

To avoid electric shock. Do not touch exposed connections.

Do not service alone. Do not perform internal service or adjustments of this product unless another person capable of rendering first aid and resuscitation is present.

Disconnect power. To avoid electric shock, switch off the product power and disconnect the power cord from the mains power before removing any covers or panels, or opening the case for servicing.

Use care when servicing with power on. Dangerous voltages or currents may exist in this product. Disconnect power, remove battery (if applicable), and disconnect test leads before removing protective panels, soldering, or replacing components.

Verify safety after repair. Always recheck ground continuity and mains dielectric strength after performing a repair.

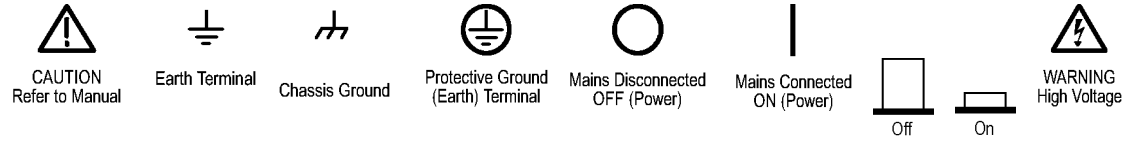
Symbols and terms on the product

These terms may appear on the product:

- DANGER indicates an injury hazard immediately accessible as you read the marking.
- WARNING indicates an injury hazard not immediately accessible as you read the marking.
- CAUTION indicates a hazard to property including the product.

When this symbol is marked on the product, be sure to consult the manual to find out the nature of the potential hazards and any actions which must be taken to avoid them. (This symbol may also be used to refer the user to ratings in the manual.)

The following symbol(s) may appear on the product:



Service introduction

Getting started

Thank you for choosing a Tektronix product. The AFG31000 Series Arbitrary Function Generator (AFG) instruments are high-performance instruments with built-in waveform generation applications, real-time waveform monitoring called InstaView™, and an improved user interface for higher test efficiency.

Contact information

If you have any questions after you review the information in this documentation, please contact your local Tektronix office, sales partner, or distributor. You can also call the corporate headquarters of Tektronix in North America at 1-800-833-9200. Visit tek.com to find contacts in your area.

General model information

This manual provides operation information for the following products. Unless otherwise noted, *AFG31000 Series* refers to the models in the following table.

Table 1: AFG31000 models

Model	Bandwidth	Sample rate	Channel	Waveform memory size	Optional
AFG31021	25 MHz	250 MS/s	1	16 MS/CH	128 MS/CH
AFG31022	25 MHz	250 MS/s	2	16 MS/CH	128 MS/CH
AFG31051	50 MHz	1 GS/s	1	16 MS/CH	128 MS/CH
AFG31052	50 MHz	1 GS/s	2	16 MS/CH	128 MS/CH
AFG31101	100 MHz	1 GS/s	1	16 MS/CH	128 MS/CH
AFG31102	100 MHz	1 GS/s	2	16 MS/CH	128 MS/CH
AFG31151	150 MHz	2 GS/s	1	16 MS/CH	128 MS/CH
AFG31152	150 MHz	2 GS/s	2	16 MS/CH	128 MS/CH
AFG31251	250 MHz	2 GS/s	1	16 MS/CH	128 MS/CH
AFG31252	250 MHz	2 GS/s	2	16 MS/CH	128 MS/CH

Each AFG31000 Series provides:

- 25 MHz to 250 MHz function signal generator
- 20 MHz to 160 MHz pulse generator

The AFG31000 Series also provides 14-bit vertical resolution.

AFG31000 Series documentation

Complete documentation for the instruments is available at tek.com. The following table is a complete list of available documentation.

Table 2: AFG31000 documentation

Document name	Available languages	Document number	Document description
Instructions Compliance and Safety Instructions	English	0713606xx	This document contains compliance and safety information for the AFG31000 Series Arbitrary Function Generator.
	French	0713613xx	
	German	0713615xx	
	Italian	0713614xx	
	Japanese	0713617xx	
	Korean	0713621xx	
	Portuguese	0713618xx	
	Russian	0713622xx	
	Simplified Chinese	0713619xx	
	Spanish	0713616xx	
	Traditional Chinese	0713620xx	
AFG31000 Series Arbitrary Function Generator User's Manual	English	0771473xx	This document describes operation and installation procedures for all models of the AFG31000 Series Arbitrary Function Generator. It includes information about features, functions, and accessories.
	Japanese	0771478xx	
	Simplified Chinese	0771479xx	
	Traditional Chinese	0771480xx	
	German	0771481xx	
	French	0771482xx	
	Russian	0771486xx	
	Korean	0771487xx	
AFG31000 Series Arbitrary Function Generator Programmer's Manual	English	0771488xx	This document provides information required to use programmable interface commands for the AFG31000 Series Arbitrary Function Generator.
AFG31000 Series Arbitrary Function Generator Specification and Performance Verification Technical Reference	English	0771489xx	This document describes specifications and performance verification procedures for the AFG31000 Series Arbitrary Function Generator.
AFG31000 Series Arbitrary Function Generator Declassification & Security Instructions	English	0771491xx	This document includes information that is necessary to clear or sanitize the product so it can be removed from a secured area, such as when returning the product for repair.
Series 31000 ArbExpress Printable Help	English	0771492xx	This online help provides information on how to create, edit, and transfer standard waveforms to an arbitrary waveform generator, an arbitrary function generator, or an oscilloscope.
AFG31000 Series Arbitrary Function Generator Release Notes	English	0771493xx	Release notes

NOTE: XX in a part number replaces the document revision number.

Strategy for servicing

This manual contains information for periodic maintenance of your arbitrary function generator. Further, it contains information for corrective maintenance down to the module level:

- To isolate a failure of a module, use the troubleshooting procedures found in the Maintenance section.
- To remove and replace a failed module, follow the instructions in the Removal and installation procedures section.
- After isolating a faulty module, replace it with a fully-tested module obtained from the factory. The Replaceable parts and modules list section contains part numbers and ordering information for all replaceable modules.

Performance verification procedures

The performance verification procedures are provided in the *AFG31000 Series Specifications and Performance Verification Technical Reference* and should be performed every 12 months.

If the instrument does not meet the performance criteria, repair is necessary (refer to Contact information for information regarding how to contact the appropriate personnel).

Extended warranty

Additional years of warranty coverage are available on many products. These valuable contracts protect you from unbudgeted service expenses and provide additional years of protection at a fraction of the price of a repair. Extended warranties are available on new and existing products. Contact your local Tektronix office, sales partner, or distributor for details (refer to Contact information for details).

Operating basics

Operating requirements

Use the following information to safely install your instrument.

To operate your instrument:

1. Place the instrument on a cart or bench, observing clearance requirements of 50 mm (2 in.) from the sides and rear.
2. Before operating, make sure that the ambient temperature is between 0 °C to +50 °C (+32 °F to +122 °F).

CAUTION. To make sure that the instrument has the appropriate cooling, keep both sides of the instrument clear of obstructions.

Check and protect connectors

The source voltage and frequency should be between 100 V to 240 V and 47 Hz to 63 Hz.

The instrument will also support 115V, 360-440Hz.

WARNING. *To reduce the risk of fire and shock that may cause personal injury or death, make sure that the mains supply voltage fluctuations do not exceed 10% of the operating voltage range.*

To check input and output connectors:

1. Locate the output connectors on the front panel.
2. Locate the input connectors on the front panel.

NOTE: When connecting a cable, make sure to distinguish the input connector from the output connectors to avoid making the wrong connection.

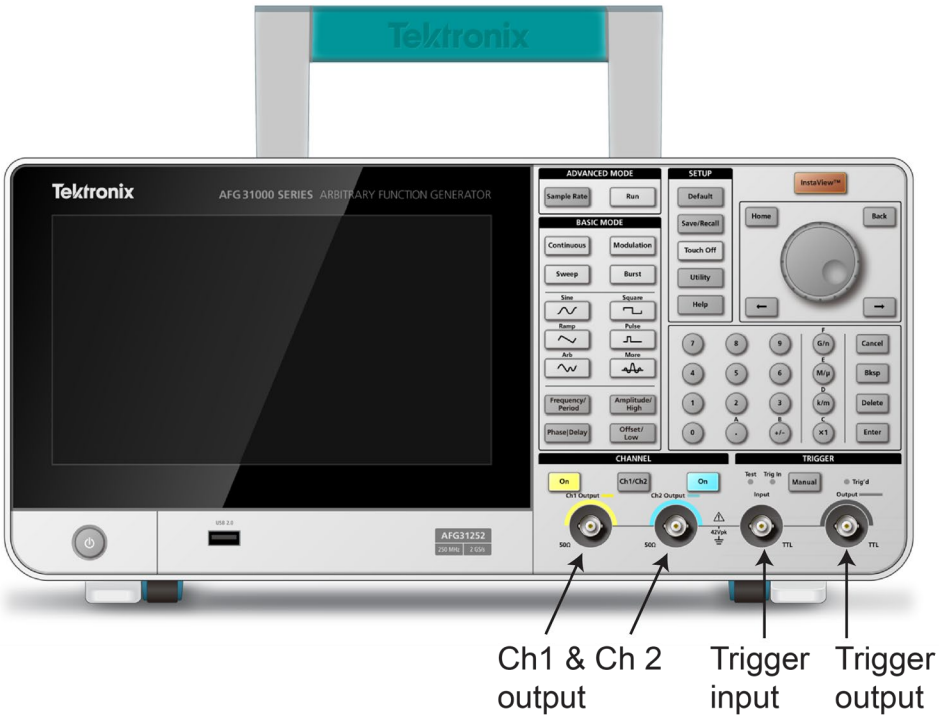


Figure 1: AFG31000 Series front-panel inputs and outputs

The instrument input and output connectors are floating inputs and outputs (see Floating ground for more information).

WARNING. *To avoid personal injury or death due to electric shock, do not apply voltages in excess of 42 V_{pk} to any BNC connector ground or to the chassis ground.*

CAUTION. Do not short output pins or apply external voltages to output connectors, because this will cause damage to your instrument. Also, do not apply more than +5 V to the Trigger Input connector, which may cause damage to your instrument.

Floating ground

Because the common ground (input and output channel common) of the AFG31000 Series is electrically isolated from the chassis ground (the instrument chassis and ground line of the ac connector), you can make a floating connection between the instrument and other equipment.

All the signal output connectors are connected to the common ground, and the remote interface connector is connected to the chassis ground.

WARNING. *To avoid personal injury due to electric shock, use this product so that the sum of the floating voltage and the output voltage of the instrument does not exceed 42 V_{pk}. Do not touch the center of the BNC connector while the equipment and instrument are in use.*

CAUTION. The maximum rated voltage between the chassis ground and common ground is 42 V_{pp} (dc + peak ac). When the potential voltage between the chassis ground and common ground goes over 42 V_{pp}, the internal protective circuit is activated to protect the circuits. However, voltages continuously exceeding 42 V_{pp} may cause the internal circuits in the instrument to be damaged. When a potential voltage exists between the chassis ground and common ground, a short circuit from output to ground causes the instrument internal fuse to open and the output is stopped. If the fuse opens, you need to contact your local Tektronix Service Support. When a potential voltage exists between the common ground and chassis ground, short-circuiting between them may lead to excessive current flow and the internal or external circuits may be damaged.

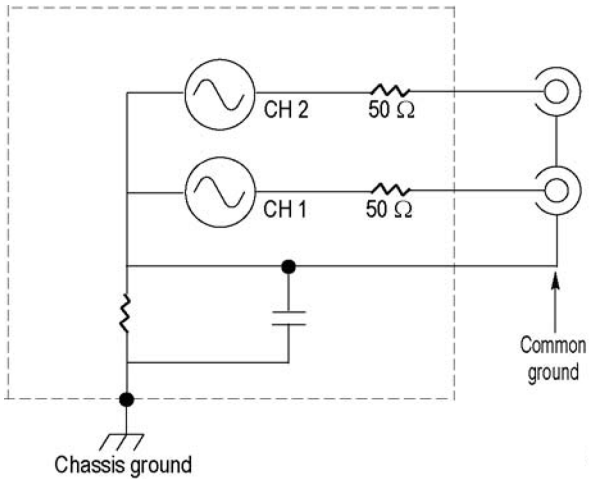


Figure 2: AFG31000 Series floating ground

Front-panel overview

The following figure shows the front panel of a dual-channel model.

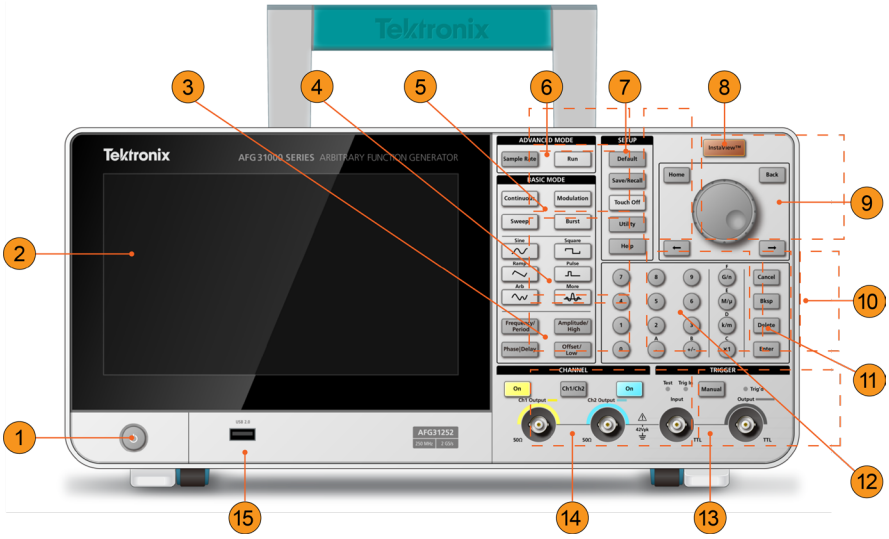


Figure 3: AFG31000 Series front-panel overview

1. Power switch
2. Touchscreen
3. Shortcut buttons: Frequency/Period, Amplitude/High, Phase/Delay, Offset/Low
4. Waveform function keys: Sine, Ramp, Arb, Square, Pulse, and More
5. Basic Mode buttons: Continuous, Sweep, Modulation, and Burst
6. Advanced Mode keys: Sample, Rate, and Run
7. Setup buttons: Default, Save/Recall, Touch Off, Utility, and Help
8. InstaView (real-time waveform measurement) button
9. Navigation area: Navigation control (turn the control to change the number of parameter that is selected); Home key (takes you to the initial power on screen); Back key (use to switch between AFG, Advanced Mode, ArbBuilder, Help, and Utility); left and right arrow keys (when editing a setting, moves the cursor to the left or the right)
10. Cancel, Bksp (backspace), Delete, and Enter buttons (use with the numeric keypad)
11. Settings edit buttons: G/n, M/µ, k/m, and x1 buttons (use when editing a setting)
12. Numeric keypad
13. Trigger button, LEDs, and connectors
14. Channel buttons and connectors
15. USB input (Type A connector)

NOTE: Shortcut keys are provided for advanced users. The shortcut keys allow you to select a setting and enter a numeric value using the front-panel controls or the touchscreen.

Power the instrument

The following procedure shows you how to connect the instrument to power and turn it on and off.

Connect the power cord:

1. Make sure the front-panel power switch is in the off position.
2. Connect the female end of the supplied power cord to the ac receptacle on the rear panel.
3. Connect the male end of the power cord to a grounded ac outlet.

To power on the instrument:

Press the front-panel power switch to turn on the instrument.

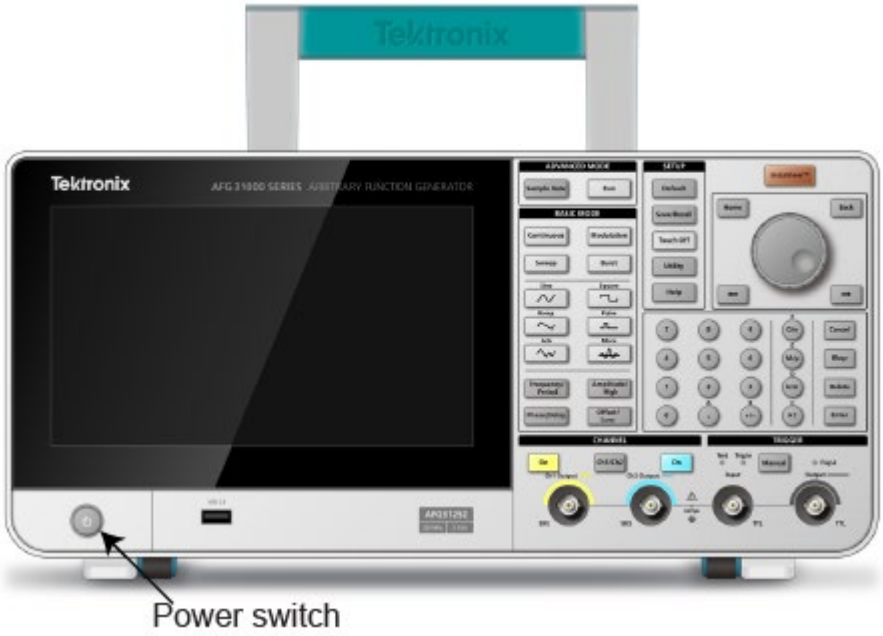


Figure 4: AFG31000 Series two-channel front view

NOTE: Wait until the front-panel display shows that the instrument has passed all power-on self-tests before using the instrument.

Touchscreen interface

The following figures describe the touchscreen main display.

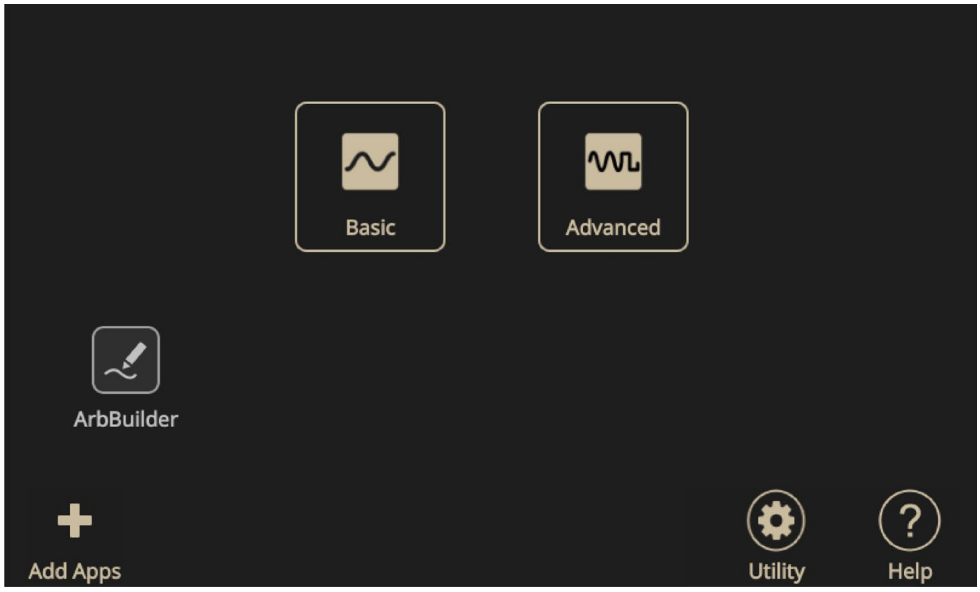


Figure 5: Touchscreen main display

Protect your DUT

Use caution when you connect the instrument channel output to your device under test (DUT). To avoid damage to your DUT, follow the steps below to set the limit values for high level and low level.

To protect your DUT:

1. Make note of the CH1 or CH2 high voltage and low voltage.
2. Swipe the bottom area up and select **Ch1** or **Ch2**.
3. Make sure that the limits are set appropriately for the device under test (DUT).
   - Default high limit: 500 mV
   - Default low limit: –500 mV

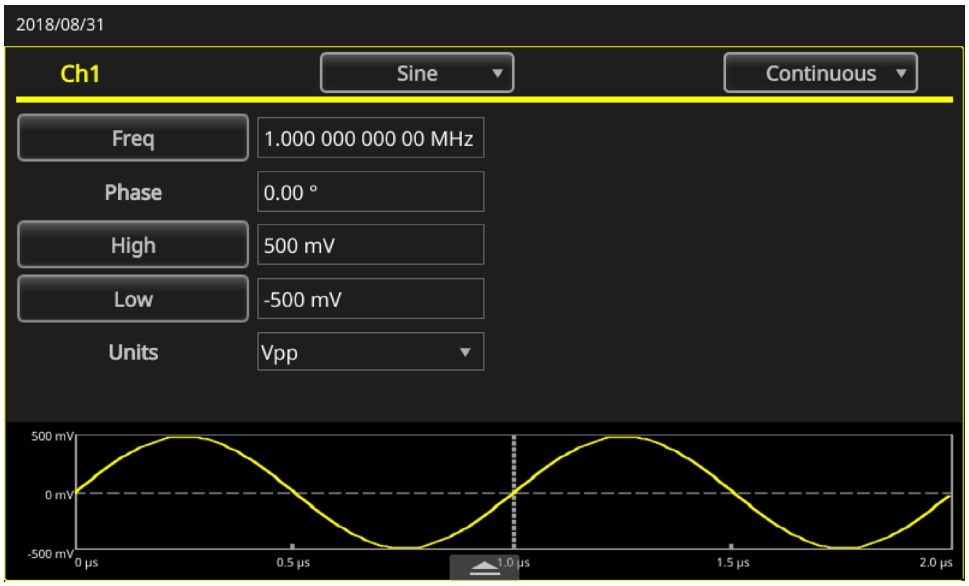


Figure 6: High and low voltage limits

Perform diagnostics and calibration

When powering on the instrument, it performs a limited set of hardware tests. You can also run the following manual diagnostic and calibration functions from the Utility menu (see Utility menu options for more detail). This procedure uses internal routines to verify that the instrument is operating correctly.

- **Diagnostics (self-test):** Perform diagnostics to verify that your instrument is operating correctly.
- **Calibration (self-calibration):** The calibration function checks dc accuracy using the internal calibration routines.

Figure 7: Diagnostics and calibration

NOTE: If you need to verify that the instrument meets the warranted specifications, do the complete set of performance verification procedures provided in the S*pecifications and Performance Verification Manual.*

To perform diagnostics and calibration:

CAUTION. Do not remove power from the instrument while performing calibration. If the power is turned off during calibration, data stored in the internal memory may be lost.

NOTE: Disconnect all cables from the instrument when you perform diagnostics or calibration (do not remove the power cord).

1. Select **Utility** on the touchscreen.
2. Select **Diagnostics/Calibration** in the menu.
3. To perform diagnostics, select **Run**.
4. Select **OK** to perform diagnostics or **Cancel** to exit.

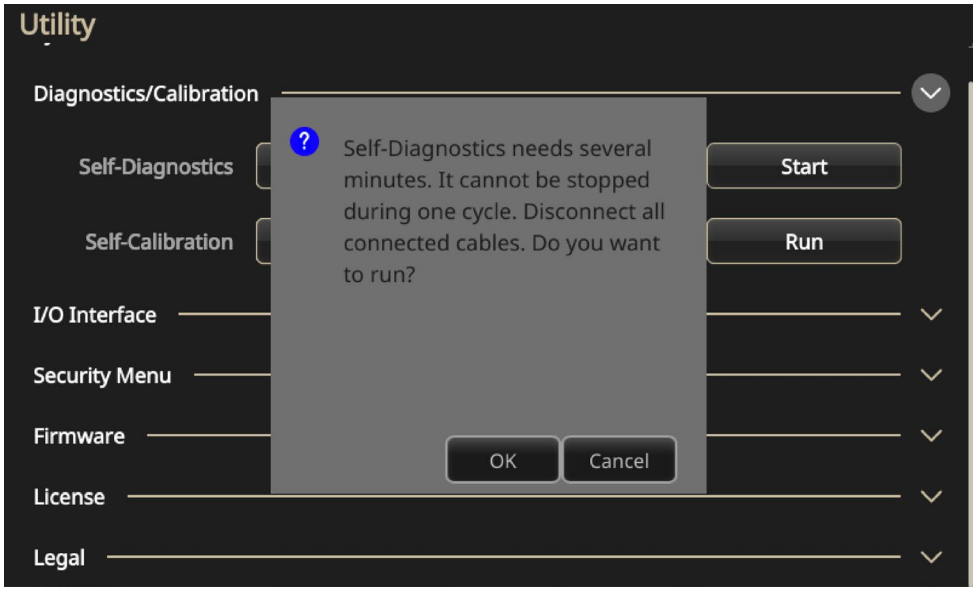


Figure 8: Run system diagnostics

5. Wait until the test is completed. The diagnostics test takes eight minutes to complete.
6. To perform calibration, select **Run**.

7. Select **OK** to perform calibration or **Cancel** to exit.

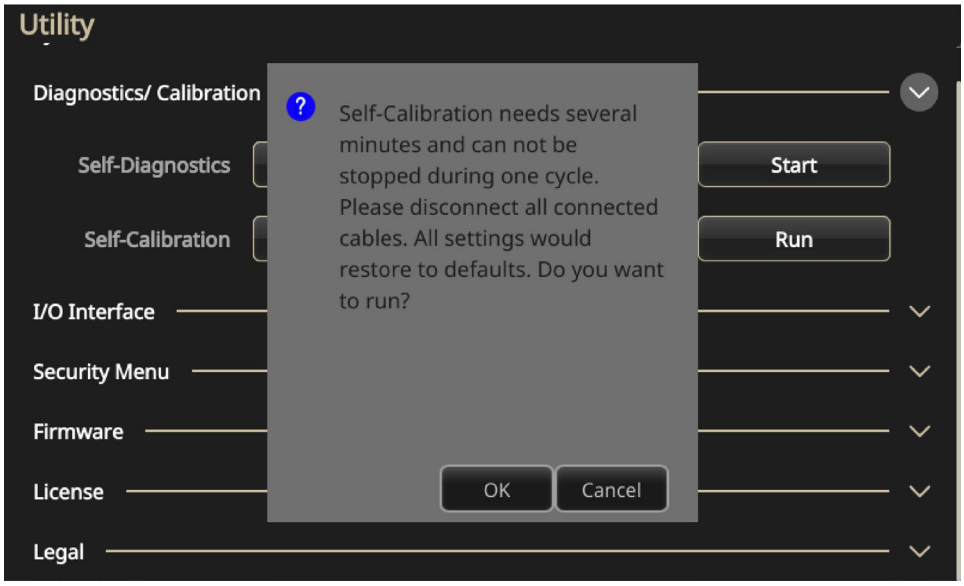


Figure 9: Run self-calibration

8. Wait until the test is completed. The diagnostics test takes eight minutes to complete.
9. Once calibration or diagnostics is executed, a dialog box displays the results including any errors.

Protection from overheating

The internal temperature of the AFG31000 Series instrument is monitored. A warning message is displayed if the internal temperature reaches a specified level and signal output is automatically turned off.

If the warning message appears, check for the following conditions:

- The ambient temperature requirement is correct.
- The required cooling clearance has been provided.
- The instrument fan is working properly.

Theory of operation

Overview

The AFG31000 Series instruments offer multiple models with different frequencies and channels. Each model consists of two major sections: the platform section and the generator section. This overview describes the electrical operation of the instruments down to the module level. It describes the basic operation of each functional circuit block as shown in the following block diagram.

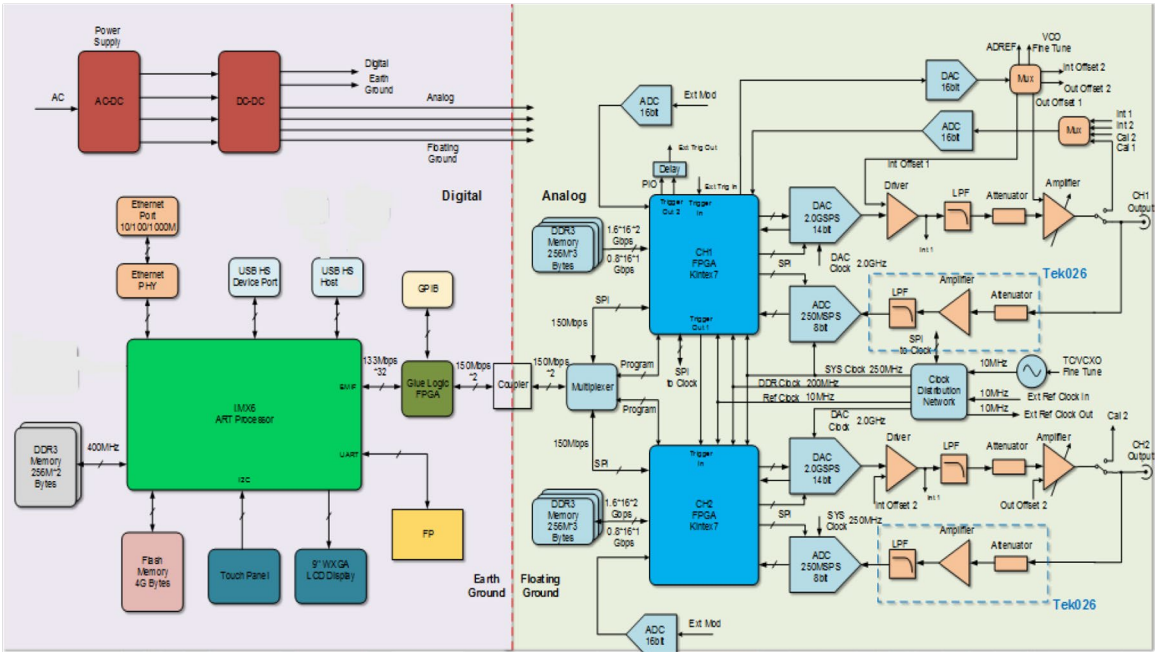


Figure 10: AFG31000 Series Theory of operation

Platform section

Instrument area	Description
Primary circuit	Contains the power switch, one ac line voltage (100~240 V ac) out to Artesyn power supply and another ac line voltage (100~240 V ac) pass rectifier and filter circuit out (120 V~370 V dc) to TDK-Lambda power supply.
CPU circuit	Contains an MPU, EMMC, and SDRAM to control the instrument. The liquid crystal display controller and the USB circuit are included in the MPU.
Local regulators	Stabilizes and supplies +3.3 V and +5.0 V for the logic circuit. 4.2 V for CPU Power Management Integrated Circuit.
Remote interface	The CPU board contains a GPIB and LAN driver circuit.
SG board communication interface	Use a FPGA for CPU board and SG board communication.
SG Signal I/O circuit	The Reference Clock Input/output, the Modulation Input and Add in signals are transmitted from SG board to this board.
Front panel board	Contains an MPU to address keypad input and transition to CPU board response.
LCD	The display is a TFT LCD, 9.0 Inches with 800 x 480 resolution, controlled by CPU board LCD with RGB mode.
Fan	A 92 mm by 92 mm size, dc 12 V type fan. It is driven by fan controller on the SG board and be transmitted to CPU board output to Fan.

Generator section

This section provides information on the components that ensure the functionality and performance of the AFG31000 Series instruments.

Instrument area	Description
Isolator	Transmits the serial control signal from the CPU board to the following circuits with electrical insulation.
Clock circuit	Generates a 2 GHz high-speed clock necessary for the signal generation from a 10 MHz reference clock by PLL. This circuit has a function of selecting the reference signal source as well.
FPGA	The field-programmable gate array (FPGA) is the key IC to achieve Direct Digital Synthesis, waveform SRAM 128 K, x8 MUX, Modulation, Burst and Sweep. The FPGA manages most of the generator section.
DDR	Three pieces * 16 bits width * 128 M depth for each channel Stores user-defined waveform data in advance mode.
DAC	14-bit 2.5 GSPS update rate digital to analog converter. Receives digital signal from FPGA and generate corresponding analog signal.
Trigger circuit	Receives an External Trigger input signal, executes the level conversion, then supplies the level converted trigger signal to the FPGA.
Pre-amplifier circuit	Converts the differential output signal of the DAC to single ended output, then supplies the single ended output to the Output Amplifier through the Attenuator.
Output amplifier	The output of the pre-amplifier is amplified and output. A low-pass filter (LPF) is used when a sine wave is output.
Trigger out	The Sync Out signal from the FPGA is level converted to Trigger Out.
ADC	Modulation by an external source is performed by digitally sampling the external input from the Ext Modulation Input connector.
Local regulator	Supplies the necessary ±15 V, ±5 V,1 V, 1.5 V, 1.8 V, 3.3 V power.
On/Off relay	On or Off of the output signal.
Calibration circuit	DC Calibration of the output signal is done by a 24-bit AD Converter.
Output amplifier	The output of the pre-amplifier is amplified and output. LPF is used when a sine wave is output.
Output filter	LPF is used when a sine wave is output.
InstaView circuit	Tek026 as the key part of InstaView circuit to provide the waveform of the DUT input.

Adjustment procedures

Adjustment procedures

This section describes the procedures necessary to manually adjust the AFG31000 Series Arbitrary Function Generators. Perform each adjustment when you remove and replace a circuit board.

Purpose

This procedure returns the arbitrary function generator to compliance with its warranted characteristics as listed in the *AFG31000 Series Specifications and Performance Verification Technical Reference Manual*. It can also be used to optimize the performance of the instrument.

After the removal and replacement of an SG board or CPU board due to electrical failure, perform the adjustment procedure in this section.

NOTE: These adjustments should be performed every 12 months.

Equipment required

The next table lists the equipment that is required to complete the adjustment procedures.

Description	Minimum requirements	Recommended equipment	Purpose
Digital multi meter (DMM)	AC volts, true RMS, ac coupled, Accuracy: ± 0.02% to 1 MHz, dc volts Accuracy: 50 ppm, resolution 100 µV Resistance accuracy: ± 0.05 Ω	Keithley 2002	Measures voltage; Used in multiple procedures
Power meter	100 kHz to 250 MHz 1 µW to 100 mW (-30 dBm to +20 dBm) Accuracy: 0.02 dB Resolution: 0.01 dB	R&S NRP2	Measures voltage; Used in multiple procedures
Power head	100 kHz to 250 MHz 1 µW to 100 mW (-30 dBm to +20 dBm)	R&S NRP6A	Measures voltage; Used in multiple procedures
Frequency counter	50 kHz to 5 GHz, Accuracy: 0.01ppm Phase measurement	Tektronix FCA3103	Checks clock frequency
Oscilloscope	1 GHz bandwidth 50 Ω input termination	Tektronix DPO7104C	Checks output signals; Used in multiple procedures
Spectrum analyzer	20 kHz to 1.25 GHz	Tektronix RSA5103	Checks output signals; Harmonics Spurious
BNC coaxial cable (2 required)	50 Ω, male to male BNC connector, 91 cm	Tektronix part number 012-0482-00	Signal interconnection
BNC terminator	50 Ω , ±1Ω , 2 W, dc to 1 GHz, BNC	Tektronix part number 011-0049-02	Signal termination
Adapter dual-banana plug	BNC (female) to dual banana	Tektronix part number 103-0090-00	Signal interconnection to a DMM
Adapter BNC(fe)-N(ma)	BNC (female) to N (male)	Tektronix part number 103-0045-00	Signal interconnection to a Spectrum Analyzer

Performance conditions

The adjustments in this section are an extensive, valid confirmation of performance and functionality when the following requirements are met:

- The instrument covers must be on the AFG31000 Series.
- The instrument must have been calibrated/adjusted at an ambient temperature between +20 °C and +30 °C.
- The instrument must have had a warm-up period of at least 20 minutes.

Enable Service mode

You must enable the service mode to perform the adjustment procedure. Do the following steps to enter the service mode.

To enable Service mode

1. Push the **Power** button to power on the arbitrary function generator.
2. Press the front-panel number keys to input the password **"62218**."
3. Press the **Utility** button on the front-panel.
4. Check if Service is in the last position of **Utility** menu on the touchscreen.

Save Cal

To adjust the Reference Clock, Flatness, and Trigger Delay parameters, select **Service > Manual Calibration**.

Each parameter is stored in the memory of the arbitrary function generator after you select the **Save Cal** on the Manual Calibration options.

Previous adjustment parameters will be recalled after a power cycle, unless you select the **Save Cal.**

CAL Clear

The **Cal Clear** procedure is in **Service > Manual Calibration**. It clears all the current adjustment parameters and sets them to the default value. The previous adjustment parameters will be recalled after a power cycle unless you select **Save Cal**.

Reference clock

This procedure adjusts the frequency accuracy of the arbitrary function generator. For any model, only channel one of the frequency point is adjusted.

To adjust the reference clock:

1. Connect the instrument to a frequency counter using the AFG CH1 Output and the frequency counter input using a 50 Ω BNC coaxial cable.

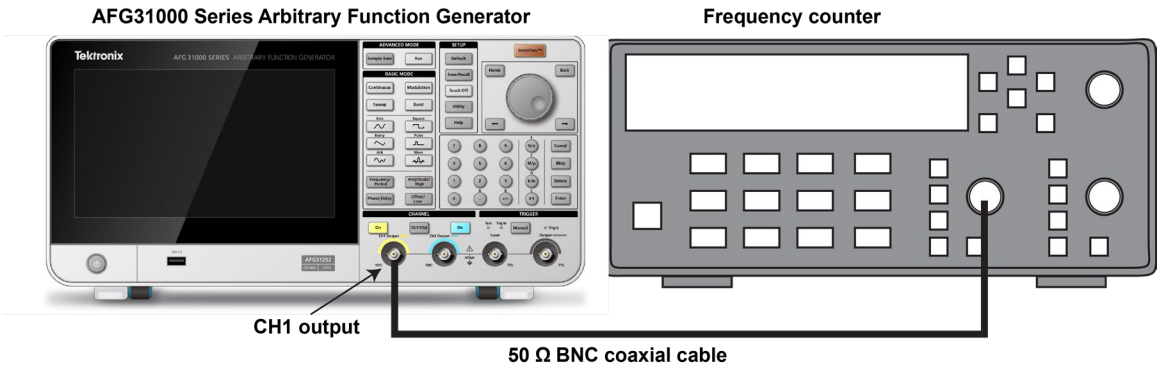


Figure 11: Reference clock adjustment

2. Push the **Default** front-panel button to recall the AFG default setup.
3. Set up your arbitrary function generator as shown in the next table:

Select menu	Setting	Front panel operation
Function	Sine	Sine (front)
Frequency	1.000000 MHz	Frequency/Period (front)
Amplitude	1.00 V_{pp}	Amplitude/High (front)
Channel 1 Output	On	On (front)

4. Press the Utility button.
5. Select **Service > Manual Calibration > Reference Clock Cal**.
6. Adjust the Ref Clock value with the rotary knob so that the frequency counter reading is between 0.999999 MHz and 1.000001 MHz.
7. Select the **Save Cal** to save the adjusted value.

Flatness adjustment

To obtain a flat sine wave relative to a 1 kHz sine wave, compensate the output level of the sine waveform at a 100 kHz and 5 MHz interval with a power meter.

To obtain a flat sine wave with a 1 kHz reference:

1. Connect the arbitrary function generator to a 50 Ω terminator to a power meter with a power head.

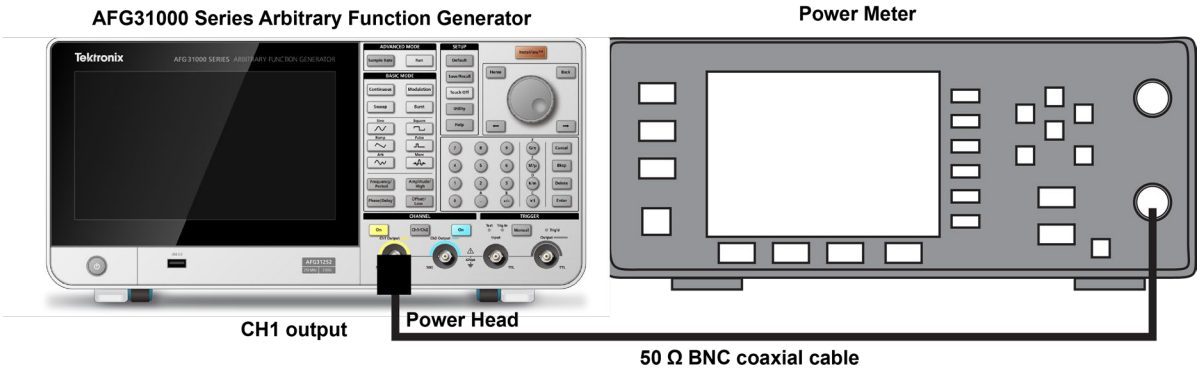


Figure 12: Flatness adjustment

2. Set up the arbitrary function generator using the following steps:

Select menu	Setting	Operation
Amplitude units	V_{PP}	On the touchscreen select the Basic icon > Units > V_{PP}
Amplitude	1.0 V_{PP}	Amplitude/High (front)
Offset	0 V	Offset/Low (front)
Channel 1 output	On	On (front)

3. Press the Utility button.
4. Select **Service > Manual Calibration**. Press the arrow of the spin box to set the first frequency of the arbitrary function generator to 1 kHz.
5. Set the frequency parameter of the power meter to 1 kHz and compensate the power meter so that the reading value at 1 kHz may become 0 dB with the frequency dependent offset function. Then set up the power meter to the relative measurement mode.
6. Press the upwards arrow of the spin box. The setting of the next frequency of the arbitrary function generator becomes 100 k.
7. Change the frequency of the power meter setting to 100 k (same as the arbitrary function generator frequency).
8. The power meter shows the value difference from the reference value. Set this value to the Flatness field of the arbitrary function generator.
9. Press the upwards arrow of the spin box. The setting of the next frequency of the arbitrary function generator becomes 5 MHz.
10. Change the frequency of the power meter setting to 5 MHz (same as the arbitrary function generator frequency).
11. The power meter shows the value difference from the reference value. Set this value to the Flatness field of the arbitrary function generator.
12. Repeat steps 9 through 11 until the setting of the arbitrary function generator is: 25 MHz; AFG3102x, 50 MHz; AFG3105x, 100 MHz; AFG3110x, 150 MHz; AFG3115x, or 250 MHz; AFG3125x.

    The frequency of the output signal of the arbitrary function generator increases 5 MHz increments every time you push the upwards arrow of the spin box. Set the frequency of the power meter to the same frequency of the arbitrary function generator in step 8. Pushing the downwards arrow of the spin box decreases the output frequency of the arbitrary function generator.
13. Select the **Flatness Cal Apply** to enable the input data for flatness correction.
14. **(AFG31xx2 only)** Repeat steps 2 through 13 for the channel 2 output.
15. Select **Save Cal** to save the adjusted value.

Trigger delay adjustment

This procedure adjusts trigger timing of two channels.

NOTE: This adjustment is not necessary in the AFG31021, AFG31051, AFG31101, AFG31151 and AFG31251.

To adjust the trigger timing of two channels:

1. Connect the arbitrary function generator to the oscilloscope using a 50 Ω BNC coaxial cable.

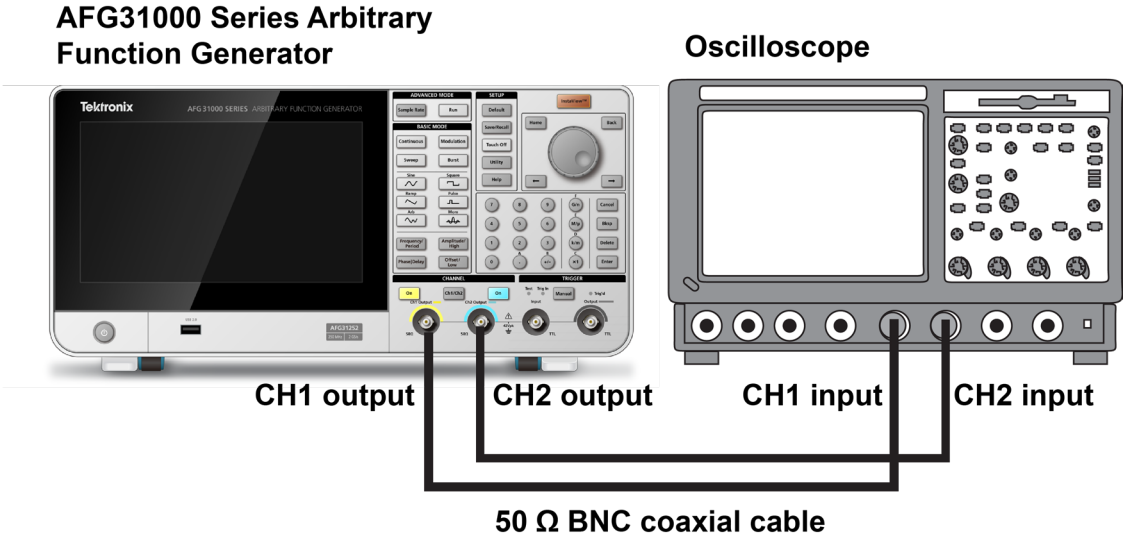


Figure 13: Trigger delay adjustment

2. Push the **Default** front-panel button and the **OK** menu button to recall the arbitrary function generator default setup.
3. Set up the arbitrary function generator using the following steps.

Select menu	Setting	Operation
Function (CH1)	Pulse	Pulse (front)
Leading (CH1)	AFG31021/31022: 8.0 ns AFG31051/31052: 6.0 ns AFG31101/31102: 4.0 ns AFG31151/31152: 3.0 ns AFG31251/31252: 2.0 ns	Select **leading** (on the touchscreen)
Lead Delay (CH1)	0.00 ns	Delay (front)
Function (CH2)	Pulse	CH1/CH2 > Pulse (front)
Leading (CH2)	AFG31021/31022: 8.0 ns AFG31051/31052: 6.0 ns AFG31101/31102: 4.0 ns AFG31151/31152: 3.0 ns AFG31251/31252: 2.0 ns	Select **leading** (on the touchscreen)
Lead Delay (CH2)	0.00 ns	Delay (front)
Run Mode (CH2)	Burst	Burst (front)
Trigger Delay	0.0 ns	Select **TrigDelay** (on the touchscreen)
Run Mode (CH2)	Continuous	Continuous (front)
Channel 1 Output	On	On (front)
Channel 2 Output	On	On (front)

4. Set up the oscilloscope using the following steps

Select option	Setting	Operation
Horizontal	200 ns/div	Sec/div knob
Vertical (CH1 and CH2)	200 mV/div	Volts/div knob
Vertical position	Align the baseline of each channel	CH1 and CH2 Vertical position knob

5. Select the Utility button. Select **Service > Manual Calibration > Trigger Delay Cal.**
6. Change the value of the Trigger Delay in the service menu to a value other than 0.0 ns, then return it to 0.0 ns.
7. Press the **Home** button.
8. Select **Basic** on the touchscreen. Push the CH1/CH2 button to activate the CH1 screen.
9. Select **Burst** to change the CH1 Run mode to Burst mode.
10. Change the value of the Trigger Delay in the Burst menu to a value other than 0.0 ns, then return it to 0.0 ns.
11. Select **Continuous** to change the CH1 Run mode to Continuous mode.
12. On the touchscreen, swipe the arrow at the bottom up, go to the InterChannel tab and select **Align Phase**.
13. Change the Horizontal setting of the oscilloscope to 1 ns/div.
14. Write down the skew time of two signals from the oscilloscope screen.
15. Select **Utility**. Select **Service > Manual Calibration > Trigger Delay Cal**.
16. Set the **Trigger Delay** to the value written down in step 14.
17. Select **Save Cal**.
18. Press **Home**. Select **Basic**. Press the CH1/CH2 button to activate the CH1 screen. Press **Burst** to change the CH1 Run mode to Burst mode.
19. Change the value of the Trigger Delay in the Burst menu to a value other than 0.0 ns, then return it to 0.0 ns.
20. Select **Continuous** to change the CH1 Run mode to Continuous mode.
21. Swipe the arrow at the bottom of the touchscreen up, go to the **InterChannel** tab and select **Align Phase.**
22. Check that the skew time of the two signals on the oscilloscope screen is less than 1 ns.

NOTE: Do not reboot the AFG31000.

Burst external trigger adjustment

NOTE: Make sure you have accomplished the Trigger delay adjustment procedure before accomplishing this procedure. Also, do not reboot the AFG31000 until this procedure is completed.

This procedure adjusts trigger timing of two channels in burst external trigger mode.

NOTE: This adjustment is not necessary in the AFG31021, AFG31051, AFG31101, AFG31151 and AFG31251.

Connect the arbitrary function generator to the oscilloscope and another AFG31000, as shown in the following figure. The AFG31000 is the external trigger source.

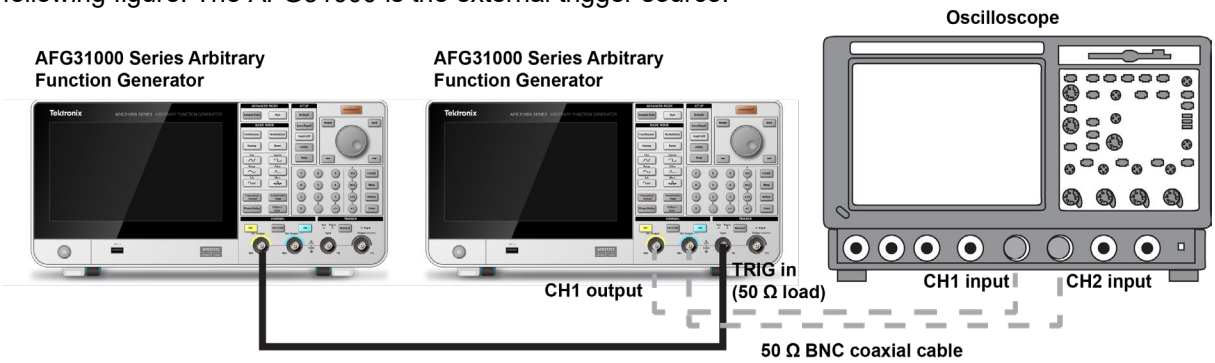


Figure 14: Instrument setup: burst external trigger adjustment

23. Select **Default** and **OK** on the AFG31000 to recall the arbitrary function generator default setup.
24. Select **Default** and **OK** to recall the arbitrary function generator default setup.

25. Set up the arbitrary function generator the AFG31000 using the following steps:

Select menu	Setting	Operation
Function (CH1)	Pulse	Pulse (front)
Leading (CH1)	AFG31022: 8 ns AFG31052: 6 ns AFG31102: 4 ns AFG31152: 3 ns AFG31252: 2 ns	
Run Mode (CH1)	Burst	Burst (front)
Trigger Delay (CH1)	0.00 ns	Delay (front)
Trigger source	External	Select Trigger Source (on the touchscreen)
Trigger Slope	Positive	Select Trigger Slope (on the touchscreen)
Clock source	Internal	Utility(front), select System > Clock Ref
Function (CH2)	Pulse	Pulse (front)
Leading (CH2)	AFG31022: 8 ns AFG31052: 6 ns AFG31102: 4 ns AFG31152: 3 ns AFG31252: 2 ns	
Run Mode (CH2)	Burst	Burst (front)
Trigger Delay (CH2)	0.00 ns	Delay (front)
Channel 1 Output	On	On (front)
Channel 2 Output	On	On (front)

26. Set up the arbitrary function generator AFG31000 using the following steps:

Select menu	Setting	Operation
Function (CH1)	Square	Square (front)
Run Mode (CH1)	Continuous	Continuous (front)
Amplitude	6.6Vpp	Amplitude(front)
Offset	0V	Offset (front)
Frequency	100kHz	Frequency(front)
Clock source	External	Utility(front) > System > Clock Ref
Channel 1 Output	On	On (front)

27. Set up the oscilloscope using the following steps:

Select menu	Setting	Operation
Horizontal	200 ns/div	Sec/div knob
Vertical (CH1 and CH2)	200 mV/div	Volts/div knob
Vertical position	Align the baseline of each channel	CH1 and CH2 Vertical position knob

28. Change the horizontal setting of the oscilloscope to 1 ns/div.

29. Connect the PC to the AFG31000 through USB, Ethernet, or GPIB. Access the AFG31000 through Visa.
30. Send the following PI commands to set the skews to 0.0ns.
    - `MSERvice:BURSt:SKEw 0.`
    - `MSERvice:BURSt:NEGSkew 0.`
31. Write down the skew time of two signals from the oscilloscope screen.
32. Send the PI command: `MSERvice:BURSt:SKEw x.xxns` to the DUT. x.xxns is the value written down in step 10.
33. Check that the skew time of the two signals on the oscilloscope screen is less than 1 ns.
34. Change Trigger Slope to Negative.
35. Write down the skew time of two signals from the oscilloscope screen.
36. Send the PI command: `MSERvice:BURSt: NEGSkew x.xxns` to the DUT. x.xxns is the value written down in step 14.
37. Send the PI command: `MSERvice:CALibration:SAVE`
38. Check that the skew time of the two signals on the oscilloscope screen is less than 1 ns.

Delay IC adjustment

This procedure adjusts the value of each bit of delay IC.

1. Connect the AFG31000 to the oscilloscope DPO70k as shown as in the following figure.

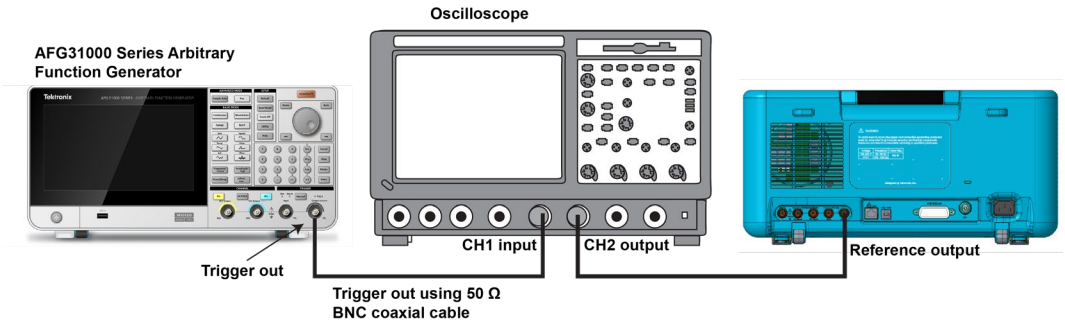


Figure 15: Delay IC adjustment

2. Push **Default** and **OK** to recall the arbitrary function generator default setup.
3. Push **CH1->square->1MHz**.
4. Push **Default** to recall the oscilloscope to the default setup.
5. Set up the oscilloscope using the following steps:

Select menu	Setting	Operation
Horizontal	10.0 ns/div	Sec/div knob
Vertical (CH1 and CH2)	200 mV/div	Volts/div knob
Horizontal position	Align the baseline of each channel	CH1 and CH2 Horizontal position knob

6. Select **Horiz/Acq->Horizontal/Acquisition Setup-> Acquisition->64** to set sample mode as 64 times/Average as well as Sampling Models as ET.
7. Select **Measure>Measurement Setup->Time->Delay**, to set source1 Ch1 and source2 Ch2 to Rising edge.
8. Select **Vertical>Vertical Setup>Channel>deskew** to adjust the Ch2 Deskew time to positive edge align.
9. Change the Horizontal Resolution to 1.0TS/s.
10. Connect to the DUT through Visa.
11. Send the PI command: `MSERvice:DELYchip:BIT BITREF` to the DUT.
12. Write down the skew time of two signals from the oscilloscope screen, BITREF Trefp.
13. Send the PI command: `MSERvice:DELYchip:BIT BIT0` to the DUT.
14. Write down the skew time of two signals from the oscilloscope screen, as the first bit value BIT0 T0p.

15. Repeat steps 11 and 12, record the value from BIT1 to BIT9; each bit of the PI Command is described below:

Bit	PI command	Adjust value
BITREF	MSERvice:DELYchip:BIT BITREF	Trefp
BIT0	MSERvice:DELYchip:BIT BIT0	T0p
BIT1	MSERvice:DELYchip:BIT BIT0	T1p
BIT2	MSERvice:DELYchip:BIT BIT0	T2p
BIT3	MSERvice:DELYchip:BIT BIT0	T3p
BIT4	MSERvice:DELYchip:BIT BIT0	T4p
BIT5	MSERvice:DELYchip:BIT BIT0	T5p
BIT6	MSERvice:DELYchip:BIT BIT0	T6p
BIT7	MSERvice:DELYchip:BIT BIT0	T7p
BIT8	MSERvice:DELYchip:BIT BIT0	T8p
BIT9	MSERvice:DELYchip:BIT BIT0	T9p

16. Send all the following PI commands to the DUT.
    - MSERvice:DELYchip:VALUe BITREF,Trefp
    - MSERvice:DELYchip:VALUe BIT0,T0p
    - MSERvice:DELYchip:VALUe BIT1,T1p
    - MSERvice:DELYchip:VALUe BIT2,T2p
    - MSERvice:DELYchip:VALUe BIT3,T3p
    - MSERvice:DELYchip:VALUe BIT4,T4p
    - MSERvice:DELYchip:VALUe BIT5,T5p
    - MSERvice:DELYchip:VALUe BIT6,T6p
    - MSERvice:DELYchip:VALUe BIT7,T7p
    - MSERvice:DELYchip:VALUe BIT8,T8p
    - MSERvice:DELYchip:VALUe BIT9,T9p
    - MSERvice:DELYchip:VALUe:APPLy
    - MSERvice:CALibration:SAVE

Resetting the serial number

When you replace the CPU board, you must set the serial number. Perform the following procedure to set the serial number.

To reset the serial number

1. Connect the PC to the AFG31000 through USB, Ethernet, or GPIB interface. Access the instrument through Visa.
2. Send the following PI command to the instrument to set the serial number to "xxxxxxx".
   `MSERvice:SNUMber "xxxxxxx".`
3. Send the query PI command to confirm the serial number is set successfully.
   `MSERvice:SNUMber?`

NOTE: The installed license is bound with the serial number and MAC address. If the serial number is changed, the installed license is invalid.

Resetting the MAC address

The MAC address is set at the factory and usually does not need to be reset. When a new MAC address setup is required, perform the following procedure.

To reset a MAC address

1. Connect the PC to the AFG31000 through USB, Ethernet, or GPIB interface. Access the instrument through Visa.
2. Send the following PI command to the instrument to set the MAC address to "xx-xx-xx-xx-xx-xx".
   `MSERvice:MADDress "xx-xx-xx-xx-xx-xx".`
3. Send the query PI command to confirm the serial number is set successfully.
   `MSERvice:MADDress?`

NOTE: The installed license is bound with the serial number and MAC address. If the MAC address number is changed, the installed license is invalid.

Maintenance

Maintenance

This section contains information needed to do periodic, preventative, and corrective maintenance on your AFG.

Service preparation

This product is intended for use by personnel who recognize shock hazards and are familiar with the safety precautions required to avoid injury. Read and follow all installation, operation, and maintenance information carefully before using the product.

If the product is used in a manner not specified, the protection provided by the product warranty may be impaired. Operators of this product must always be protected from electric shock at all times. The responsible body must ensure that operators are prevented access and/or insulated from every connection point.

Refer to the Operating basics section of this manual for information.

Preventing ESD

When performing any service that requires internal access to the AFG31000 Series, follow the precautions below. These precautions prevent damage to internal modules and components due to electrostatic discharge (ESD).

CAUTION. Static discharge can damage any semiconductor component in the AFG31000 Series.

- Minimize handling of static-sensitive modules.
- Transport and store static-sensitive modules in their static-protected containers or on a metal rail. Label any package that contains static-sensitive modules.
- Discharge the static voltage from your body by wearing a grounded antistatic wrist strap while handling the modules. Service static-sensitive modules only at a static-free workstation.
- Do not allow anything capable of generating or holding a static charge on the workstation surface.
- Handle circuit boards by the edges when possible.
- Do not slide the modules over any surface.
- Avoid handling modules in areas that have a floor or work-surface covering that will generate a static charge.

Preventative maintenance

Preventative maintenance consists of visually inspecting and cleaning your AFG and using general care when operating it. Perform preventative maintenance more often if you operate your AFG in a severe environment.

General care

For optimum performance, follow these recommendations:

- Protect your instrument from adverse weather conditions. It is not waterproof.
- Do not store or leave your instrument where the liquid crystal display (LCD) will be exposed to direct sunlight or high humidity for more than four hours.
- The front and rear cases keep dust out of your instrument and must be in place during normal operation.
- To avoid damage to your instrument, do not expose them to any sprays, liquids, or solvents.

Inspection and cleaning

This section describes how to inspect for dirt and damage, and how to clean the exterior and interior of your instrument. Inspecting and cleaning are done as preventative maintenance. When done regularly, preventative maintenance, may prevent malfunctions and enhance reliability.

The collection of dirt on internal components can cause your instrument to overheat and fail. Dirt also provides an electrical conduction path that could cause instrument failure, especially under high-humidity conditions. Inspect your instrument as often as operating conditions require.

CAUTION. Avoid the use of chemical cleaning agents which might damage the plastics used your AFG. Use only deionized water when cleaning the front panel buttons. Use an ethyl alcohol solution as a cleaner and rinse with deionized water.

Exterior inspection

Inspect the outside of your AFG for damage, wear, and missing parts, using the following checklist as a guide. If your AFG appears to have been dropped or damaged, it should be checked thoroughly to verify correct operation and performance. Immediately repair defects that could cause personal injury or cause further damage to your AFG.

External inspection checklist

Item	Inspect for	Repair action
Cabinet, front panel, and cover	Cracks, scratches, deformations, damaged hardware, or gaskets.	Repair or replace the defective module.
Front-panel knobs	Missing, damaged, or loose knobs.	Repair or replace missing or defective knobs.
Connectors	Broken shells, cracked insulation, and deformed contacts. Dirt in connectors.	Repair or replace the defective modules. Clear or wash out dirt.
Carrying handle, bail, cabinet feet	Correct operation.	Repair or replace the defective module.

Exterior cleaning

To clean the AFG exterior:

1. Remove loose dust on the outside of the arbitrary function generator (AFG) with a lint-free cloth. Use care to avoid scratching the clear glass display shield.
2. Remove remaining dirt with a lint free cloth dampened in a general-purpose detergent-and-water solution. Do not use abrasive cleaners.

CAUTION. To prevent getting moisture inside your AFG during external cleaning, use only enough liquid to dampen the cloth or applicator.

To avoid damage to the surface of your AFG, do not use any abrasive or chemical cleaning agents.

Flat panel display cleaning

The display is a soft plastic display and must be treated with care during cleaning.

CAUTION. Imported cleaning agents or methods can damage the flat panel display.
Avoid using abrasive cleaners or commercial cleaners to clean the display surface.
Avoid scrubbing the display with excessive force.
Avoid spraying liquids on the display surface.

To clean the front panel

1. Clean the flat panel display surface by gently rubbing the display with a clean-room wipe (such as Wypall Medium Duty Wipes, #05701, available from Kimberly-Clark Corporation).
2. If the display is very dirty, moisten the wipe with distilled water or a 75% isopropyl alcohol solution and gently rub the display surface. Avoid using excess force or you may damage the plastic display surface.

CAUTION. To prevent getting moisture inside your AFG during external cleaning, use only enough liquid to dampen the cloth or applicator.

Interior inspection

Inspect and clean the interior of your AFG if it may have been damaged or exposed to an unusually dirty environment.

To access the inside of your AFG for inspection and cleaning, refer to the Removal and installation procedures.

Inspect the internal portions of your AFG for damage and wear, using the check list below as a guide. Defects should be repaired immediately.

CAUTION. To prevent damage from electrical arcing, make sure that circuit boards and components are dry before applying power your AFG.

Internal inspection checklist

Item	Inspect for	Repair action
Front and rear case	Cracks or deformations; scratched lettering or display filter; loose connectors or labels	Repair or replace defective hardware
Circuit boards	Loose, broken, or corroded solder connections; burned circuit boards; burned, broken, or cracked circuit-run plating	Remove failed module and replace with a new module
Solder connections	Cold solder or rosin joints	Re-solder joint and clean with ethyl alcohol
Wiring and cables	Loose plugs or connectors; burned, broken, or frayed wiring	Firmly seat connectors. Repair or replace modules with defective wires or cables
Chassis	Dents, deformations, and damaged hardware	Straighten, repair, or replace defective hardware

Interior cleaning

To clean the interior of your AFG

1. Remove dust with dry, low-pressure, deionized air (approximately 9 psi).
2. Remove any remaining dust with a lint-free cloth dampened in isopropyl alcohol (75% solution) and rinse with warm deionized water (cotton-tipped applicator is useful for cleaning in narrow spaces and on circuit boards).

NOTE: If these steps do not remove all the dust or dirt, please contact your local Keithley Instruments office for assistance (see Contact information).

Lubrication

There is no periodic lubrication required for this instrument.

Removal and installation

Removal and installation procedures

This section describes how to remove and install the major mechanical and electrical modules. Any electrical or mechanical module, assembly, or part listed in the parts list is referred to as a module.

See the Replaceable parts and modules section for a list of all the replaceable modules and diagrams showing their location in the instrument.

WARNING. The information in this section is intended only for qualified personnel. Make sure that you turn the instrument off and disconnect the power line cord and any other cables connected to the front and rear panel. Do not perform these procedures unless you are qualified. Failure to recognize and observe standard safety precautions could result in personal injury or death due to electric shock.

After repair adjustments

After the removal and replacement of a module due to electrical failure, perform the Adjustment procedures.

Before disassembly

Before you disassemble the instrument, do the following:

- Review Preventing ESD.
- Review the exploded view diagrams in the Replaceable parts and modules section for an overview of how the entire AFG is assembled.
- Review the Order of instrument disassembly diagram to understand which procedure must be performed to access a given module.
- Review the Equipment required for disassembly to verify that you have the necessary tools to remove and install modules in your AFG.

Equipment required for disassembly

Use the following tools to remove and replace all modules:

- Torque-limiting screwdriver, long shank, 8 lb.-in (0.85 N m) range with Torx T-8, T-10, and T-15 tips
- 16 mm (5/8 inch) deep socket with wide center hole
- 7 mm (9/32 inch) socket
- 8 mm socket
- Torque wrench to 18 in-lb. (2.0 N m)
- Pliers (all-purpose and needle-nose)
- Tweezers

Order of instrument disassembly

Disassembly for replacement is best achieved by removing and replacing the modules in a specific order. Complete disassembly is best achieved by performing the removal procedures in the order shown in the next diagram.

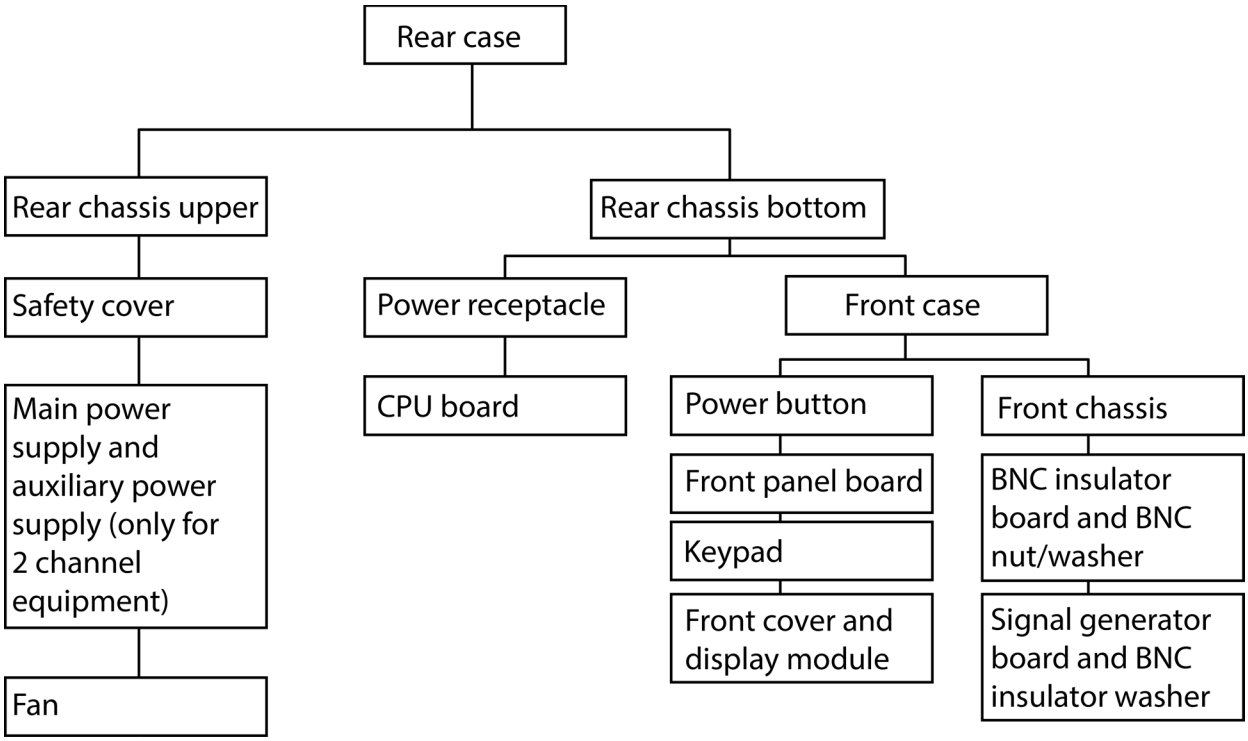


Figure 16: Order of disassembly

Module rear case removal and installation

You will need a torque-limiting Torx T-15 and T-10 screwdriver. Refer to the following figure, and follow the steps below, to remove the rear cover.

To remove the module rear case:

1. Place your AFG top down on a soft surface, such as an antistatic mat.
2. Remove the two screws located on the bottom by using a Torx T-10 screwdriver.
3. Remove the two screws located behind the handle by using a Torx T-15 screwdriver.
4. Lift the rear case off.

To install the module rear case, perform the removal procedure in reverse order.

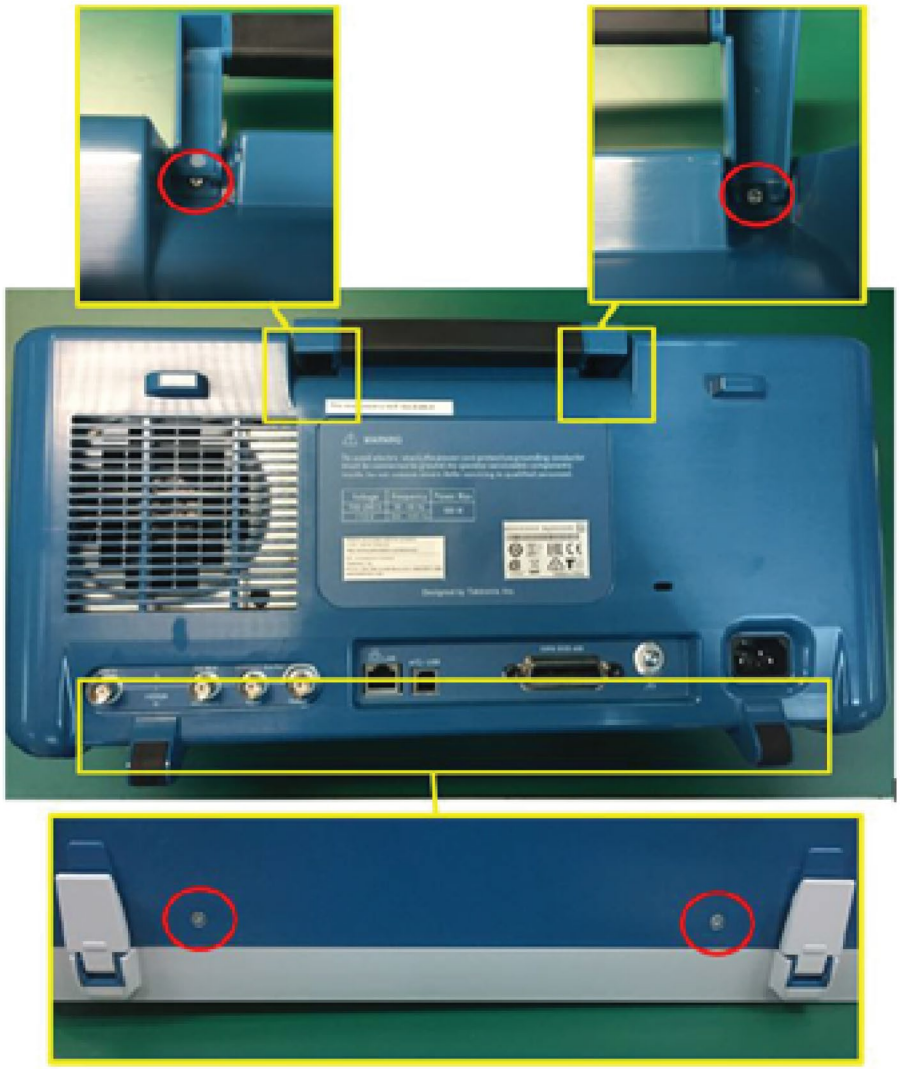


Figure 17: Module rear case

Module rear chassis upper removal and installation

You will need a torque-limiting Torx T-15 screwdriver for this procedure. Refer to the following figure and follow the steps below to remove the module rear chassis upper.

To remove the module rear chassis upper:

1. Remove the ten screws attaching the module rear chassis upper to the front chassis and the module rear chassis-bottom. Eight screws are on the front chassis. Two screws are on the module rear chassis-bottom.
2. Disconnect the following cables:
   a. Two (2) pin fan cable from fan
   b. Four (4) pin power cable (from main power supply to CPU board)
   c. Seven (7) pin power cable (from main power supply to signal generator board)
   d. Four (4) pin power cable (from auxiliary power supply to signal generator board)
   e. Three (3) pin power cable (from main power supply to CPU board)
   f. Three (3) pin cable (from auxiliary power supply to CPU board)
3. Lift the module rear chassis upper off.

To install the module rear chassis upper, perform the removal procedure in reverse order.

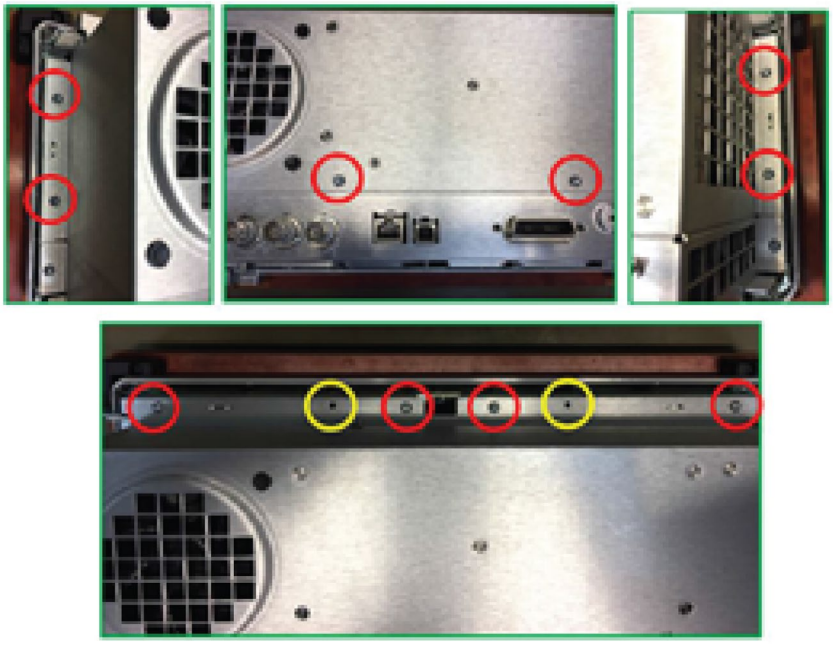


Figure 18: Module rear upper chassis upper

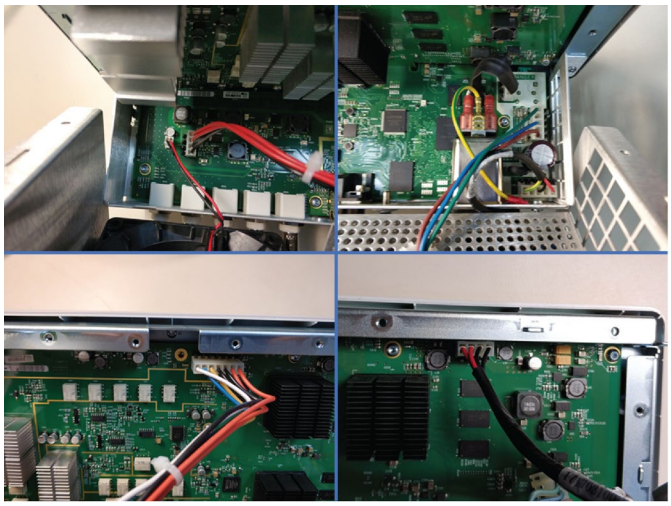


Figure 19: Module rear chassis, upper cables

Module rear chassis bottom removal and installation

You will need a torque-limiting Torx T-15 and T-10 screwdriver for this procedure. Refer to the following figure and follow the steps below to remove the module rear chassis-bottom.

To remove the module rear chassis-bottom:

1. Remove two screws attaching the rear chassis-bottom to front chassis by using T-15 screwdriver.
2. Remove five screws attaching the rear chassis-bottom to front chassis by using T-10 screwdriver.
3. Disconnect the following cables:
   a. Front panel cable
   b. Display module flexible flat cable (FFC); (to disconnect the display module FFC, flip up the brown connector cover and pull out the FFC)
4. Lift the module rear chassis-bottom off.

To install the module rear chassis-bottom, perform the removal procedure in reverse order.

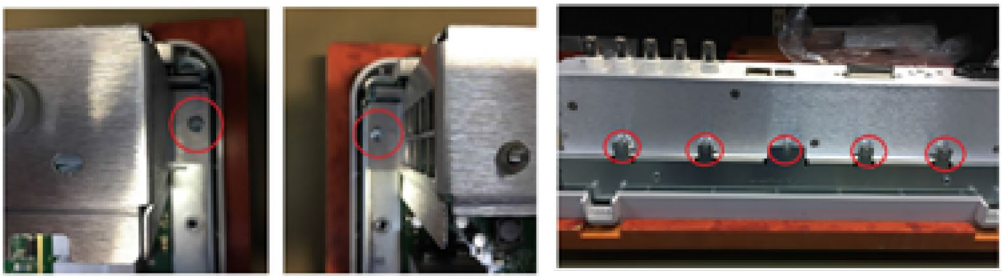


Figure 20: Module rear chassis, bottom

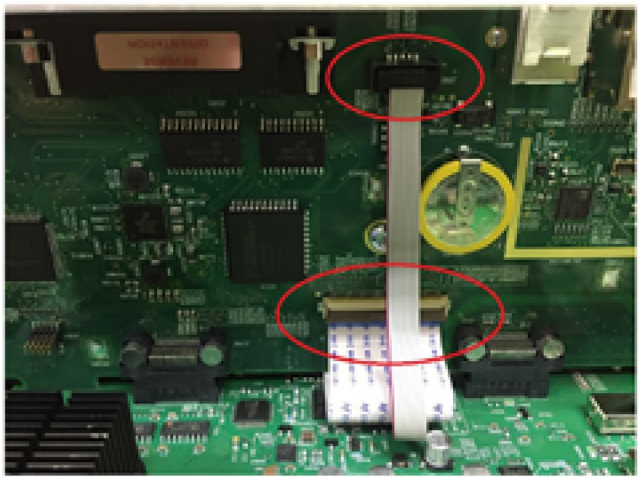


Figure 21: Module rear chassis, bottom, cables

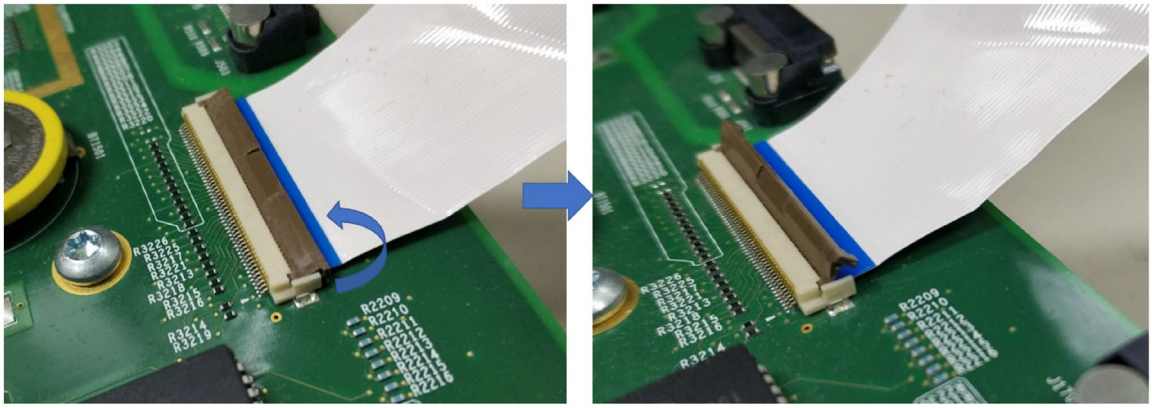


Figure 22: Disconnecting the display module

Module front chassis removal and installation

You will need a torque-limiting Torx T-15 screwdriver for this procedure. Refer to the following figure and follow the steps below to remove the module front chassis.

To remove the module front chassis:

1. Remove six screws attaching the front chassis to front cover by using T-15 screwdriver.
2. Disconnect the following cables:
   a. Front panel cable
   b. Display module flexible flat cable (FFC); (to disconnect the FFC, you should pull outward on the two brown ears of the FFC connector on the display and pull out the FFC)
3. Pull the module front chassis out.

NOTE: To install the module front chassis, perform the removal procedure in reverse order.

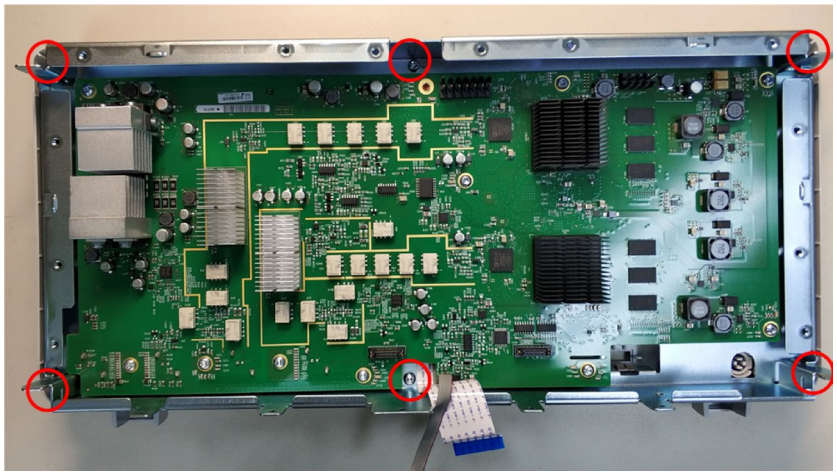


Figure 23: Module front chassis

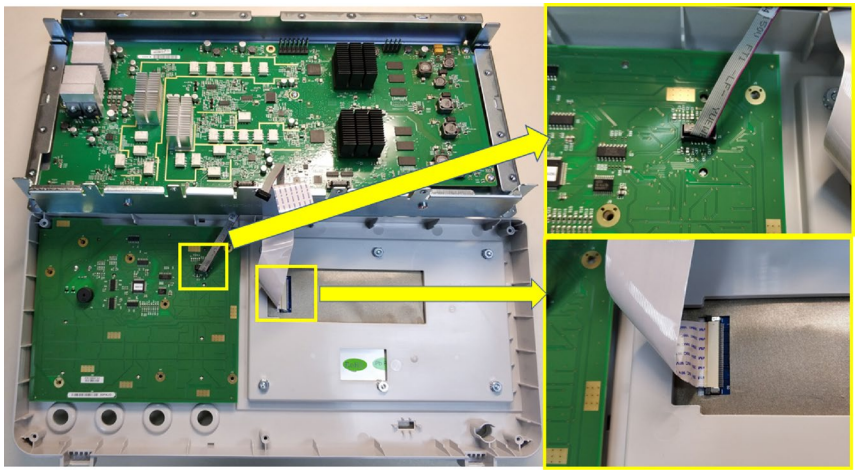


Figure 24: Module front chassis cables

Front-panel board: Power button, keypad, and LCD module removal and installation

You will need a torque-limiting Torx T-15 screwdriver, pliers, and tweezers for this procedure. Refer to the following figure and follow the steps below to remove the front panel board and keypad.

To remove the front panel board and keypad:

1. Use tweezers to grasp the springs; remove the eight screws attaching the front panel board to the front cover (refer to the following figure).
2. Remove the encoder plastic cover.
3. Reverse the whole module to be the other side.
4. Remove the front panel board and keypad.
5. Remove the power button.
6. Use an 8 mm socket driver to remove the six locknuts attaching the LCD module to the front cover.
7. Remove the LCD module

NOTE: To install all the parts, perform the removal procedure in reverse order.

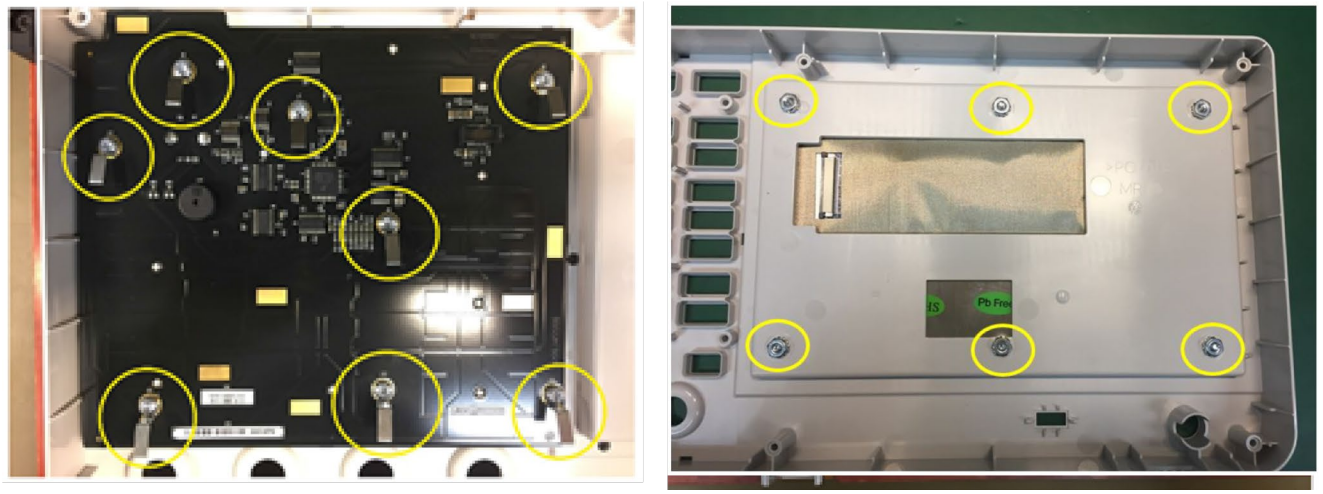


Figure 25: Front panel board and keyboard

BNC insulator board and signal generator board removal and installation

You will need a torque-limiting Torx T-15 screwdriver and a 16 mm (5/8 inch) deep socket with a wide center hole to remove the BNC insulator board (or BNC insulator sheet) and the generator board. Refer to the following figure and follow the steps below to remove the boards.

To remove the insulator board:

1. Remove the four hex nuts attaching the BNC insulator board (or three hex nuts for the BNC insulator sheet) to the front chassis by using a 16 mm (5/8 inch) socket. Remove the three screws attaching the BNC insulator board to the front chassis by using T-15 screwdriver.
2. Remove the BNC insulator board (or sheet).
3. Remove the three screws near the BNC connectors using a T-15 screwdriver.
4. Remove the eight screws attaching the signal generator board to the front chassis using a T-15 screwdriver.
5. Gently pull out the signal board toward the rear.
6. Remove the BNC insulator washer.

NOTE: To install all the parts, perform the removal procedure in reverse order.

Figure 26: BNC insulator board (or sheet)

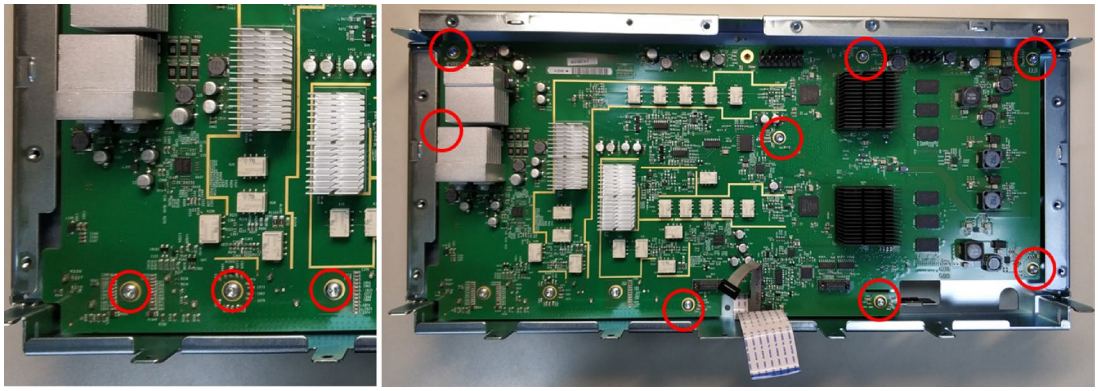


Figure 27: Signal generator board

Figure 28: BNC insulator washer

CPU board and power receptacle removal and installation

You will need torque-limiting Torx T-15, T-10, and T-8 screwdrivers for this procedure. Refer to the following figure and steps below to remove the front panel board and keypad.

To remove the CPU board and power receptacle:

1. Disconnect the cables.
2. Remove one screw attaching the grounding cable to the chassis by using the T-10 screwdriver. Remove the two screws attaching the power receptacle to the chassis using the T-8 screwdriver.
3. Remove the power receptacle.
4. Remove the four screws attaching the CPU board to the rear bottom-chassis using the T-15 screwdriver.
5. Remove the five BNC nuts and washers using the 16 mm socket driver.
6. Remove the two black GPIB hex screws using the 7 mm socket driver.
7. Pull out the CPU board.

NOTE: To reconnect all the parts, perform the removal procedure in reverse order.

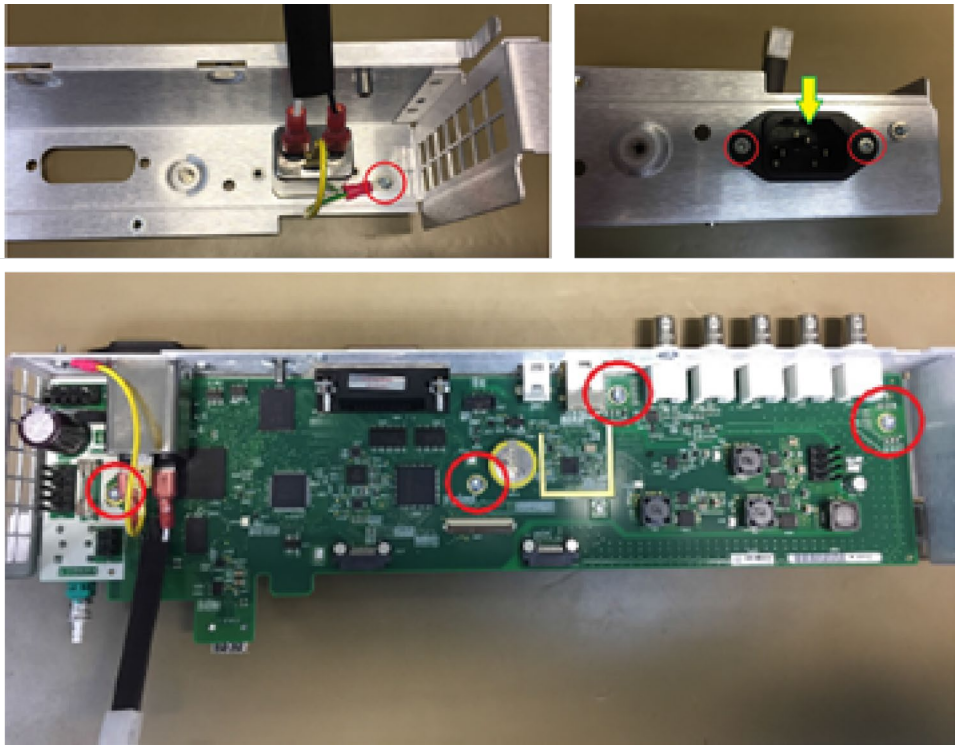


Figure 29: Power receptacle

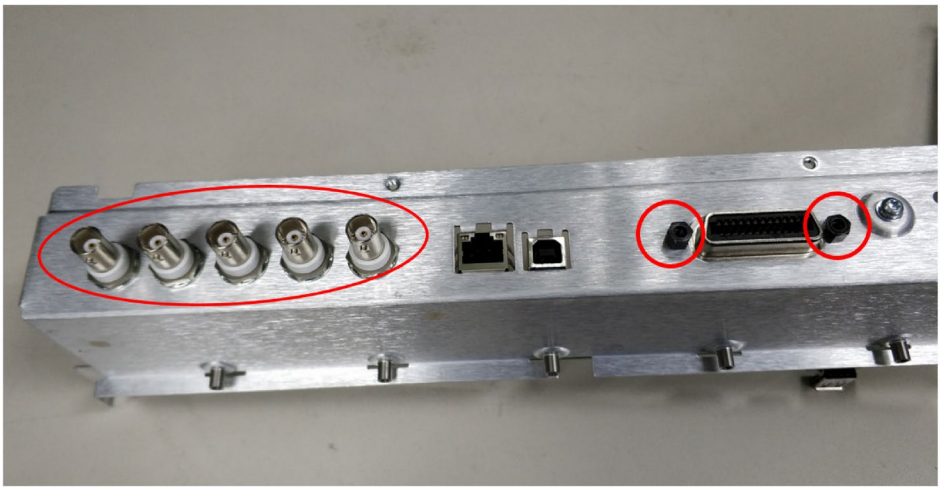


Figure 30: Remove the BNC nuts and GPIB hex screws.

Power supply and fan removal and installation

You will need needle-nose pliers and a torque-limiting Torx T-15 screwdriver for this procedure. Refer to the following figure and follow the steps below to remove or install all the parts.

To remove the power supply and fan:

1. Remove the four screws attaching the safety cover to the chassis by using a T-15 screwdriver.
2. Remove the safety cover.
3. Remove the four screws attaching the auxiliary power supply to the chassis using a T-15 screwdriver. Remove the four screws attaching the main power supply to the chassis using a T-15 screwdriver. The auxiliary power supply is only applicable for the two-channel unit.
4. Remove the main power supply (and auxiliary power supply, if applicable).
5. Remove the four grommets attaching the fan to the chassis using needle-nose pliers.
6. Remove fan.

NOTE: To reconnect all the parts, perform the removal procedure in reverse order.

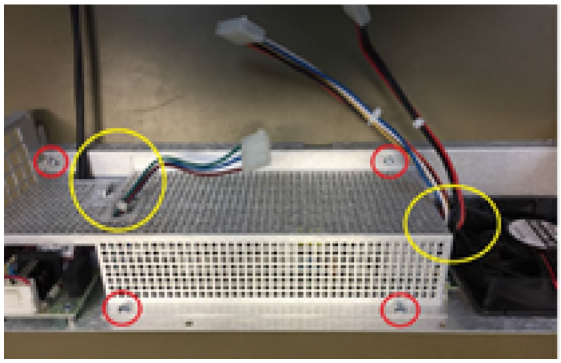


Figure 31: Safety cover

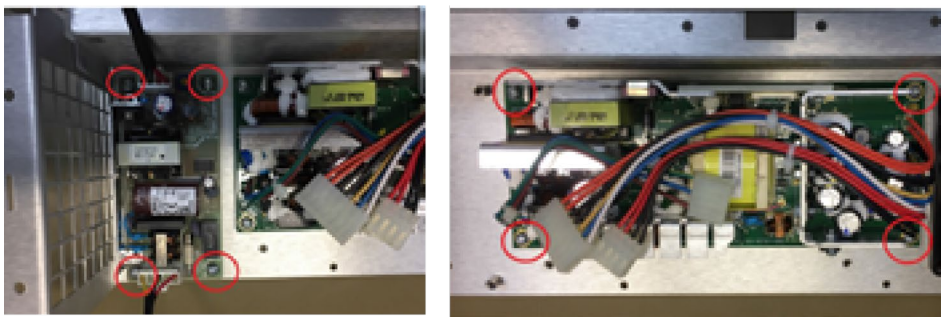


Figure 32: Power supply: Removal and distribution

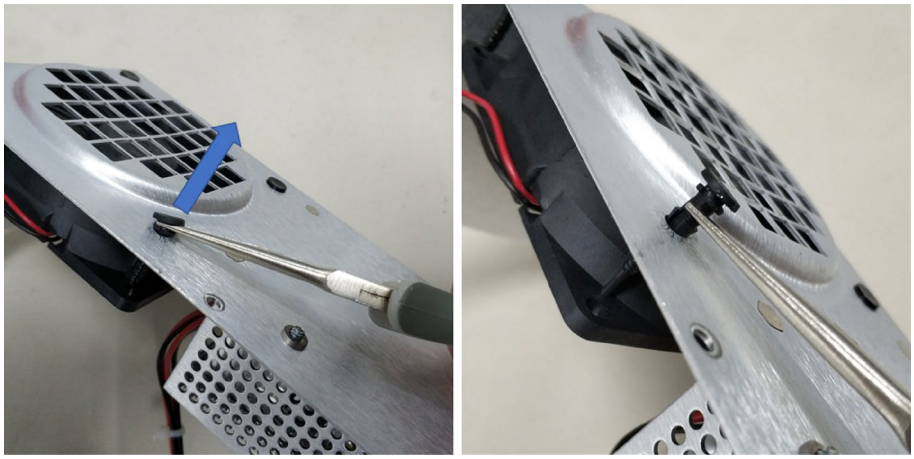


Figure 33: Fan: Removal and installation

Diagrams

The diagrams in this section show how the modules in the different models of the AFG are connected.

AFG 3xxx2 connection diagram

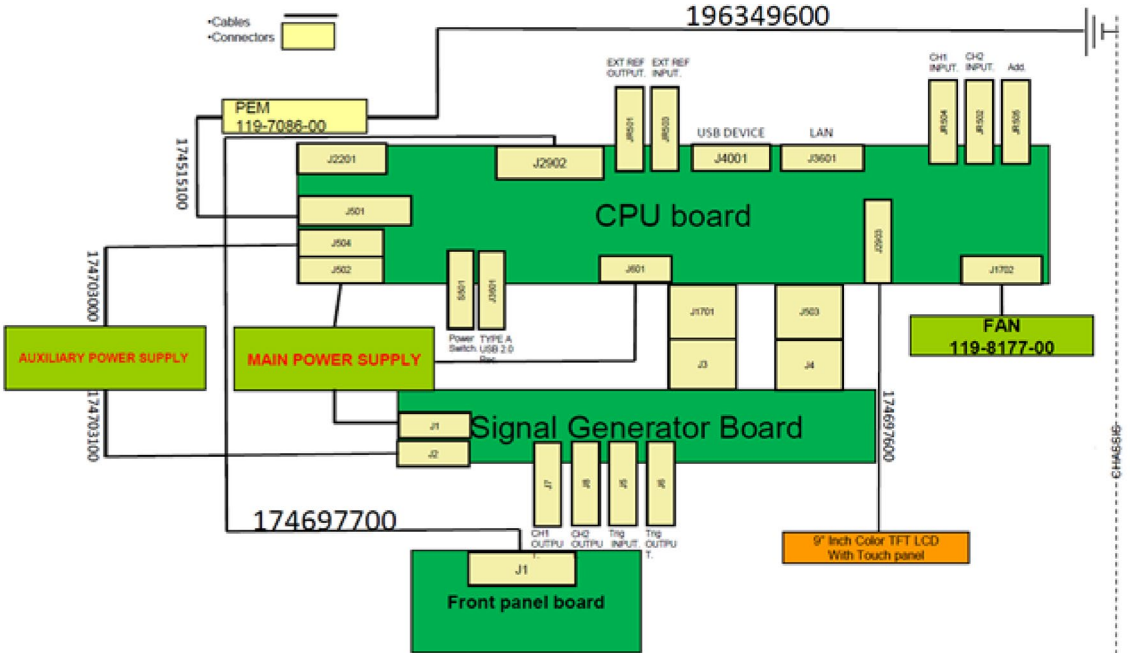


Figure 34: AFG31000 Series 2 channels unit interconnection diagram

AFG 3xxx1 connection diagram

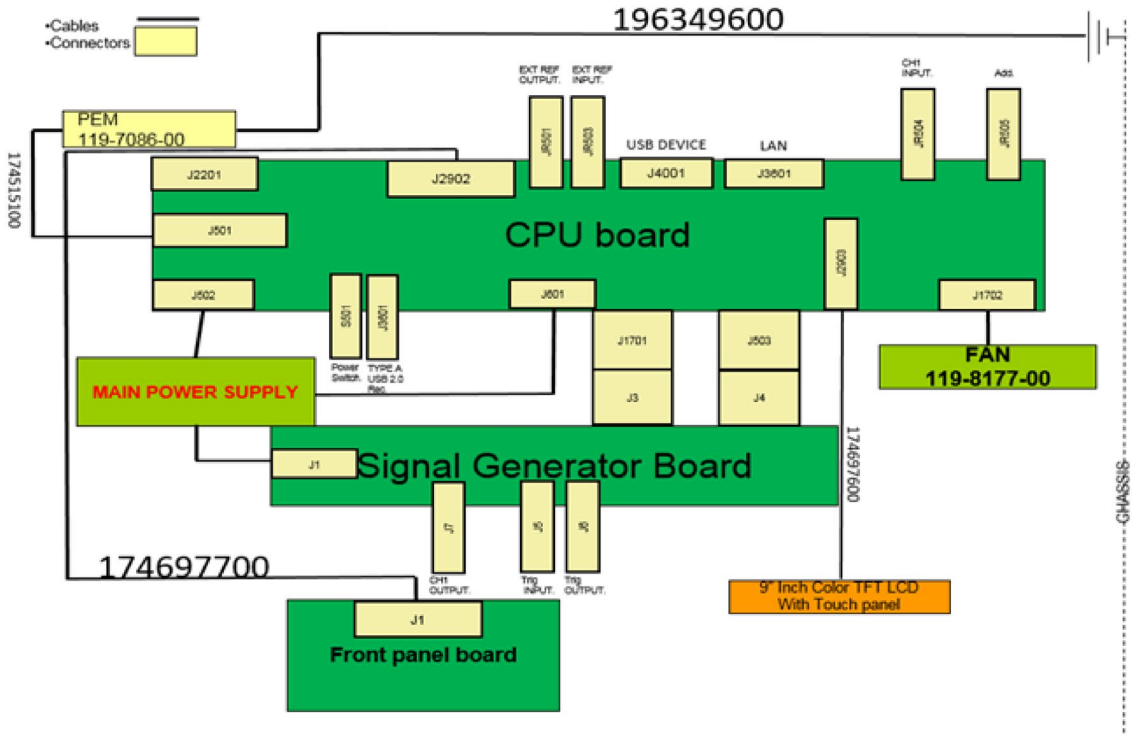


Figure 35: AFG31000 Series 1 channel unit interconnection diagram

Replaceable parts and modules

This section contains a list of the replaceable parts and modules for the AFG 31000 Series.

Parts ordering information

Replacement parts and modules are available through your local Tektronix field office or representative (see Contact information).

Changes to Tektronix instruments are sometimes made to accommodate improved components as they become available and to give you the benefit of the latest circuit improvements. Therefore, when ordering parts, it is important to include the following information in your order.

- Part number
- Instrument type or model number
- Instrument serial number
- Instrument modification number, if applicable

If you order a part that has been replaced with a different or improved part, your local Tektronix field office or representative will contact you concerning any change in part number.

Using the replaceable parts list

This section contains a list of the mechanical and electrical components that are replaceable for the arbitrary function generator. Use this list to identify and order replacement parts and modules. The following table describes each column in the parts list.

Column	Column name	Description
1	Figure and index number	Items in this section are referenced by component number.
2	Tektronix part number	Use this part number when ordering replacement parts from Tektronix.
3	Instrument model	This indicates the model of instrument that uses this item.
4 and 5	Serial number	Column four indicates the serial number at which the part was first effective. Column five indicates the serial number at which the part was discontinued. No entries indicate the part is good for all serial numbers.
6	Quantity	This indicates the quantity of parts used.
7	Name and description	An item name is separated from the description by a colon (:). Because of space limitations, an item name may sometimes appear as incomplete. Use the U.S. Federal Catalog handbook H6-1 for further item name identification.

NOTE: Abbreviations conform to the American National Standard ANSI Y1.1-1972.

Exploded diagram replaceable parts - AFG top level modules

Use the following table and figure to determine the replaceable parts and modules in your AFG top level modules.

Index number	Tektronix part number	Instrument model	Quantity	Name and description
-1	N/A	AFG31021 AFG31051 AFG31101 AFG31151 AFG31251 AFG31022 AFG31052 AFG31102 AFG31152 AFG31252	1	Module front case
-2	N/A	AFG31021 AFG31051 AFG31101 AFG31151 AFG31251 AFG31022 AFG31052 AFG31102 AFG31152 AFG31252	1	Module front chassis
-3	211-1273-xx	AFG31021 AFG31051 AFG31101 AFG31151 AFG31251 AFG31022 AFG31052 AFG31102 AFG31152 AFG31252	6	Screw, PT; K35-1.57, pan-head, STL, ZNPL, T-15 Torx; exact (nonexpensed) duplicate of 211114300
-4	N/A	AFG31021 AFG31051 AFG31101 AFG31151 AFG31251 AFG31022 AFG31052 AFG31102 AFG31152 AFG31252	1	Module rear chassis bottom

Index number	Tektronix part number	Instrument model	Quantity	Name and description
-5	211-0538-00	AFG31021 AFG31051 AFG31101 AFG31151 AFG31251 AFG31022 AFG31052 AFG31102 AFG31152 AFG31252	7	Screw, machine; 6-32 x 0.312, FLH, 100 DEG, STL, ZNPL, T-10 Torx
-6	211-1272-00	AFG31021 AFG31051 AFG31101 AFG31151 AFG31251 AFG31022 AFG31052 AFG31102 AFG31152 AFG31252	12	Screw, machine; 6-32 X 0.250, PNH, STL, ZNPL, T-15 Torx
-7	N/A	AFG31021 AFG31051 AFG31101 AFG31151 AFG31251 AFG31022 AFG31052 AFG31102 AFG31152 AFG31252	1	Module rear chassis upper
-8	N/A	AFG31021 AFG31051 AFG31101 AFG31151 AFG31251 AFG31022 AFG31052 AFG31102 AFG31152 AFG31252	1	Module rear case
-9	211-0935-00	AFG31021 AFG31051 AFG31101 AFG31151 AFG31251 AFG31022 AFG31052 AFG31102 AFG31152 AFG31252	2	Screw, machine; 6-32 x 0.50, PNH, T-15 Torx

Exploded diagram - AFG top level modules

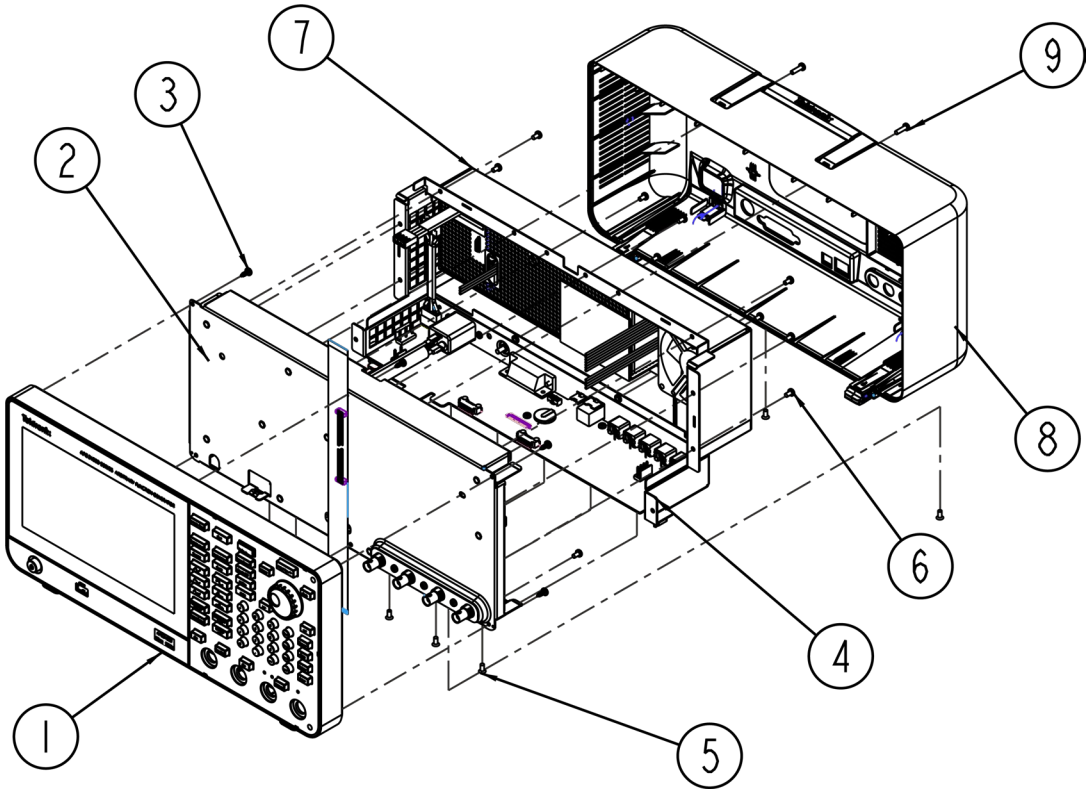


Figure 36: AFG31000 top level modules exploded view

Exploded diagram replaceable parts - module front case

Use the following table and figure to determine the replaceable parts and modules in your AFG module front case.

Index number	Tektronix part number	Instrument model	Quantity	Name and description
-01	202-0551-00	AFG31021 AFG31051 AFG31101 AFG31151 AFG31251 AFG31022 AFG31052 AFG31102 AFG31152 AFG31252	1	Front case
-02	119-8852-00	AFG31021 AFG31051 AFG31101 AFG31151 AFG31251 AFG31022 AFG31052 AFG31102 AFG31152 AFG31252	1	Display module with projected capacitance touchscreen; 9-inch, TFT LCD, 800 X 480, RGB interface, CTP 5-point touch, custom cover glass with custom silk screen, safety controlled
-03	348-2304-00	AFG31021 AFG31051 AFG31101 AFG31151 AFG31251 AFG31022 AFG31052 AFG31102 AFG31152 AFG31252	4	Gasket, conductive foam
-04	260-3074-00	AFG31021 AFG31051 AFG31101 AFG31151 AFG31251 AFG31022 AFG31052 AFG31102 AFG31152 AFG31252	1	Keypad

Index number	Tektronix part number	Instrument model	Quantity	Name and description
-05	878-1398-00	AFG31021 AFG31051 AFG31101 AFG31151 AFG31251 AFG31022 AFG31052 AFG31102 AFG31152 AFG31252		
-06	211-1273-00	AFG31021 AFG31051 AFG31101 AFG31151 AFG31251 AFG31022 AFG31052 AFG31102 AFG31152 AFG31252	8	Screw, PT; K35-1.57, Pan head, STL, ZNPL, T-15 Torx; Exact (Non-expensed) duplicate of 211114300
-07	366-0938-00	AFG31021 AFG31051 AFG31101 AFG31151 AFG31251 AFG31022 AFG31052 AFG31102 AFG31152 AFG31252	1	Button power
-08	335-3773-00	AFG31022 AFG31052 AFG31102 AFG31152 AFG31252	1	Label front
	335-3965-00	AFG31021 AFG31051 AFG31101 AFG31151 AFG31251	1	Label front
-09	335-3774-00	AFG31252	1	Marker, identification, label, front, USB
	335-3963-00	AFG31021	1	Marker, identification, label, front, USB
	335-3962-00	AFG31051	1	Marker, identification, label, front, USB
	335-3961-00	AFG31101	1	Marker, identification, label, front, USB
	335-3960-00	AFG31151	1	Marker, identification, label, front, USB
	335-3959-00	AFG31251	1	Marker, identification, label, front, USB

Index number	Tektronix part number	Instrument model	Quantity	Name and description
	335-3958-00	AFG31022	1	Marker, identification, label, front, USB
	335-3957-00	AFG31052	1	Marker, identification, label, front, USB
	335-3956-00	AFG31102	1	Marker, identification, label, front, USB
	335-3955-00	AFG31152	1	Marker, identification, label, front, USB
-10	366-0937-00	AFG31021 AFG31051 AFG31101 AFG31151 AFG31251 AFG31022 AFG31052 AFG31102 AFG31152 AFG31252	1	Knob, grip
-11	253-0583-00	AFG31021 AFG31051 AFG31101 AFG31151 AFG31251 AFG31022 AFG31052 AFG31102 AFG31152 AFG31252	1	Conductive fabric tape for shielding 87580-STD
-12	131-8139-00	AFG31021 AFG31051 AFG31101 AFG31151 AFG31251 AFG31022 AFG31052 AFG31102 AFG31152 AFG31252	1	Contact, spring; front panel elect.

Exploded diagram - module front case

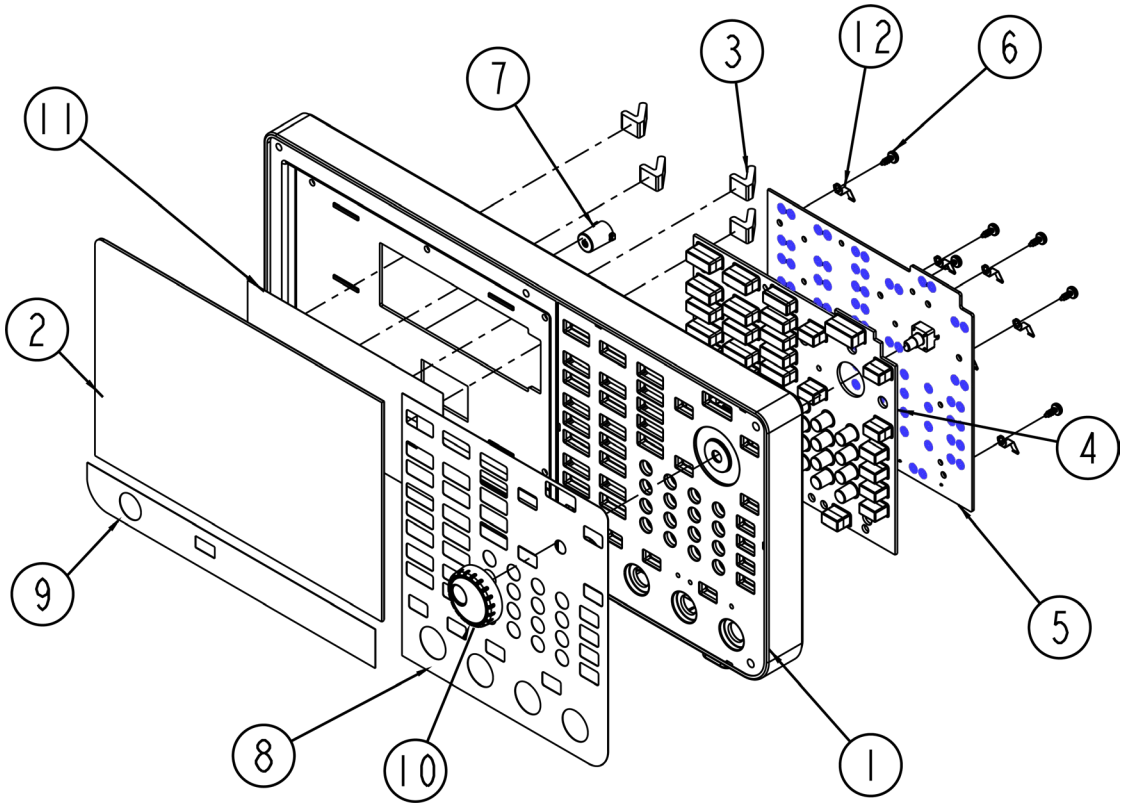


Figure 37: AFG31000 front case exploded view

Exploded diagram replaceable parts - module front chassis

Use the following table and figure to determine the replaceable parts and modules in your AFG module front-chassis.

Index number	Tektronix part number	Instrument model	Quantity	Name and description
-01	441-2877-00	AFG31021 AFG31051 AFG31101 AFG31151 AFG31251 AFG31022 AFG31052 AFG31102 AFG31152 AFG31252	1	Chassis front
-02	878-1680-00	AFG31152 AFG31252	1	Circuit board assembly; generator board; 2 CH; 389-5449-00 wired; AFG31152/AFG31252
	878-1487-00	AFG31021 AFG31051 AFG31101	1	Circuit board assembly; generator board; 1 CH; 389-5224-00 wired, low-end models
	878-1679-00	AFG31151 AFG31251	1	Circuit board assembly; generator board; 1 CH; 389-5449-00 wired; AFG31151/AFG31251
	878-1490-00	AFG31022 AFG31052 AFG31102	1	Circuit board assembly; generator board; 2 CH; 389-5224-00 wired; low-end models
-03	210-1700-00	AFG31021 AFG31051 AFG31101 AFG31151 AFG31251 AFG31022 AFG31052 AFG31102 AFG31152 AFG31252	1	BNC insulate washer

Index number	Tektronix part number	Instrument model	Quantity	Name and description
-04	174-6976-00	AFG31021 AFG31051 AFG31101 AFG31151 AFG31251 AFG31022 AFG31052 AFG31102 AFG31152 AFG31252	1	FFC display 50 POS 0.5 mm pitch
-05	174-6977-00	AFG31021 AFG31051 AFG31101 AFG31151 AFG31251 AFG31022 AFG31052 AFG31102 AFG31152 AFG31252	1	Cable, ribbon, 2 x 5 pin front panel board to CPU board
-06	878-1600-00	AFG31151 AFG31251 AFG31022 AFG31052 AFG31102 AFG31152 AFG31252	1	Circuit board assembly; BNC board 389-5386-00 wired
	337-4828-00	AFG31021 AFG31051 AFG31101	1	Insulation sheet
-07	211-0935-00	AFG31021 AFG31051 AFG31101 AFG31151 AFG31251 AFG31022 AFG31052 AFG31102 AFG31152 AFG31252	3	Screw, machine; 6-32 x 0.50, PNH, T-15 Torx
-08	211-1272-00	AFG31021 AFG31051 AFG31101 AFG31151 AFG31251 AFG31022 AFG31052 AFG31102 AFG31152 AFG31252	13	Screw, machine; 6-32 x 0.250, PNH, STL, ZNPL, T-15 Torx

Index number	Tektronix part number	Instrument model	Quantity	Name and description
-09	220-0497-00	AFG31022 AFG31052 AFG31102 AFG31152 AFG31252	4	Nut, plain hex; .5-28 x .562 hex, BRS, NI (nickel) plated
	220-0497-00	AFG31021 AFG31051 AFG31101 AFG31151 AFG31251	3	Nut, plain hex; .5-28 x .562 hex, BRS, NI (nickel) plated

Exploded diagram - module front chassis

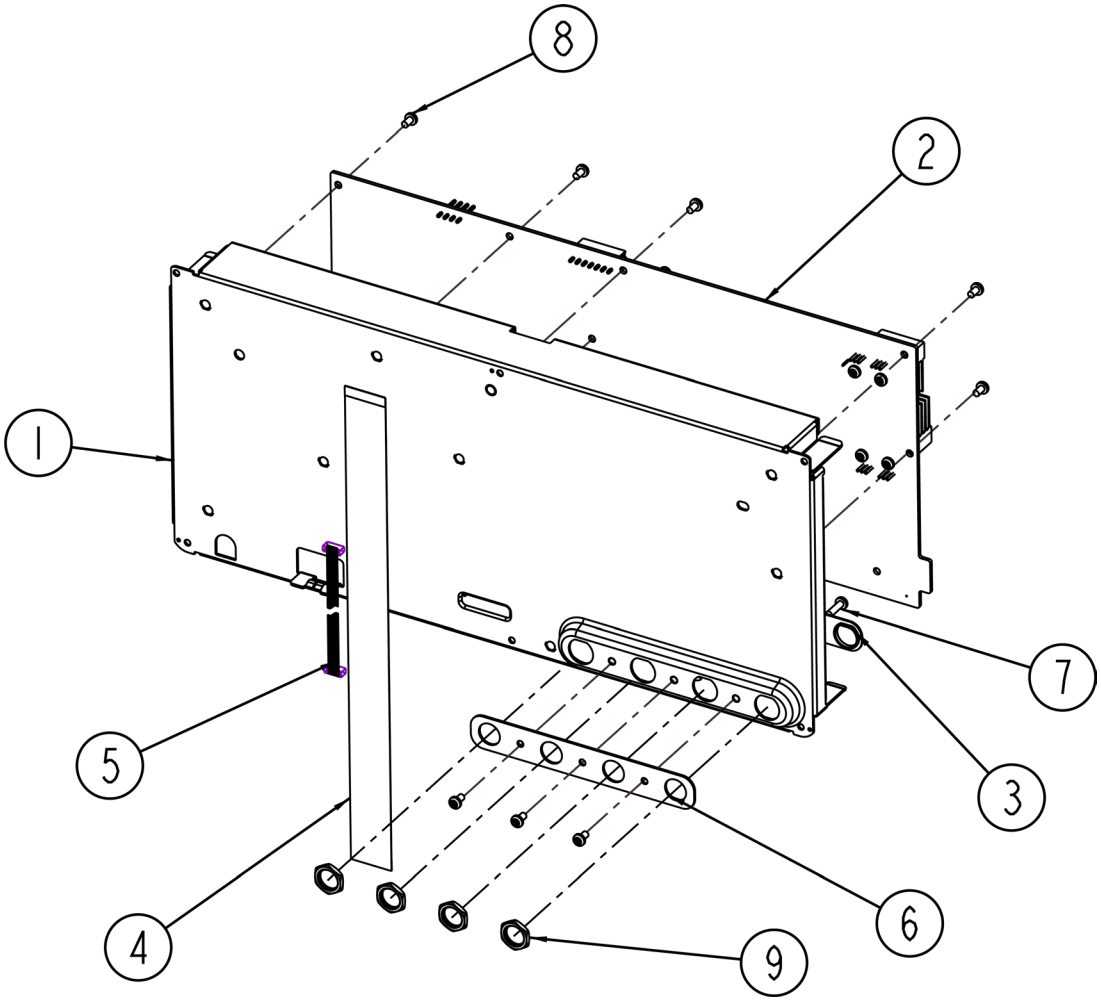


Figure 38: AFG31000 front chassis exploded view

Exploded diagram replaceable parts - module rear chassis bottom

Use the following table and figure to determine the replaceable parts and modules in your AFG module rear chassis-bottom.

Index number	Tektronix part number	Instrument model	Quantity	Name and description
-01	441-2879-00	AFG31021 AFG31051 AFG31101 AFG31151 AFG31251 AFG31022 AFG31052 AFG31102 AFG31152	1	Chassis rear bottom side
	441-2918-00	AFG31252	1	Chassis rear bottom side FIP
-02	878-1399-00	AFG31022 AFG31052 AFG31102 AFG31152 AFG31252	1	Circuit board assembly, CPU board, 2CH
	878-1491-00	AFG31021 AFG31051 AFG31101 AFG31151 AFG31251	1	Circuit board assembly, CPU board, 1CH
-03	211-1272-00	AFG31021 AFG31051 AFG31101 AFG31151 AFG31251 AFG31022 AFG31052 AFG31102 AFG31152 AFG31252	4	Screw, machine; 6-32 x 0.250, PNH, STL, ZNPL, T-15 Torx
-04	210-1039-00	AFG31022 AFG31052 AFG31102 AFG31152 AFG31252	5	Washer, lock internal tooth
	210-1039-00	AFG31021 AFG31051 AFG31101 AFG31151 AFG31251	4	Washer, lock internal tooth

Index number	Tektronix part number	Instrument model	Quantity	Name and description
-05	220-0497-00	AFG31022 AFG31052 AFG31102 AFG31152 AFG31252	5	Nut, plain, hex; 5-28 x .562 hex, BRS, NI (nickel) plated
	220-0497-00	AFG31021 AFG31051 AFG31101 AFG31151 AFG31251	4	Nut, plain, hex; 5-28 x .562 hex, BRS, NI (nickel) plated
-06	119-7086-00	AFG31021 AFG31051 AFG31101 AFG31151 AFG31251 AFG31022 AFG31052 AFG31102 AFG31152 AFG31252	1	Filter, EMI; ac line connector/input filter; 6.0A, 120-250 V ac, dc-400 HZ,2.2 NF CY, 100 NF CX, IEC input, Fast-on/solder lug output, chassis mount, safety controlled; FN9222-6-06
-07	211-0303-00	AFG31021 AFG31051 AFG31101 AFG31151 AFG31251 AFG31022 AFG31052 AFG31102 AFG31152 AFG31252	2	Screw, machine; 4-40 x 0.25, FLH 100 DEG, steel, zinc finish, T-8 Torx
-08	210-0056-00	AFG31021 AFG31051 AFG31101 AFG31151 AFG31251 AFG31022 AFG31052 AFG31102 AFG31152 AFG31252	2	Washer, lock; #10 split, 0.047 THK, SI BRZ NP
-09	213-0610-00	AFG31021 AFG31051 AFG31101 AFG31151 AFG31251 AFG31022 AFG31052 AFG31102 AFG31152 AFG31252	2	Screw machine; 4BA x 1.0, OVH, STL CRPL, POZ telequipment

Index number	Tektronix part number	Instrument model	Quantity	Name and description
-10	211-0711-00	AFG31021 AFG31051 AFG31101 AFG31151 AFG31251 AFG31022 AFG31052 AFG31102 AFG31152 AFG31252	1	Screw, with washer, 6-32 x .250 panhead, T-15 Torx
-11	174-7030-00	AFG31021 AFG31051 AFG31101 AFG31151 AFG31251 AFG31022 AFG31052 AFG31102 AFG31152 AFG31252	1	Cable, power auxiliary power supply to CPU board
-12	196-3496-00	AFG31021 AFG31051 AFG31101 AFG31151 AFG31251 AFG31022 AFG31052 AFG31102 AFG31152 AFG31252	1	Lead, elect (rear sub-panel to inlet), safety controlled
-13	174-5151-00	AFG31021 AFG31051 AFG31101 AFG31151 AFG31251 AFG31022 AFG31052 AFG31102 AFG31152 AFG31252	1	CA assembly, SP, elect; 2, 18 AWG, 7 CML, with holder, 09050-3031 & faston

Exploded diagram - module rear chassis bottom

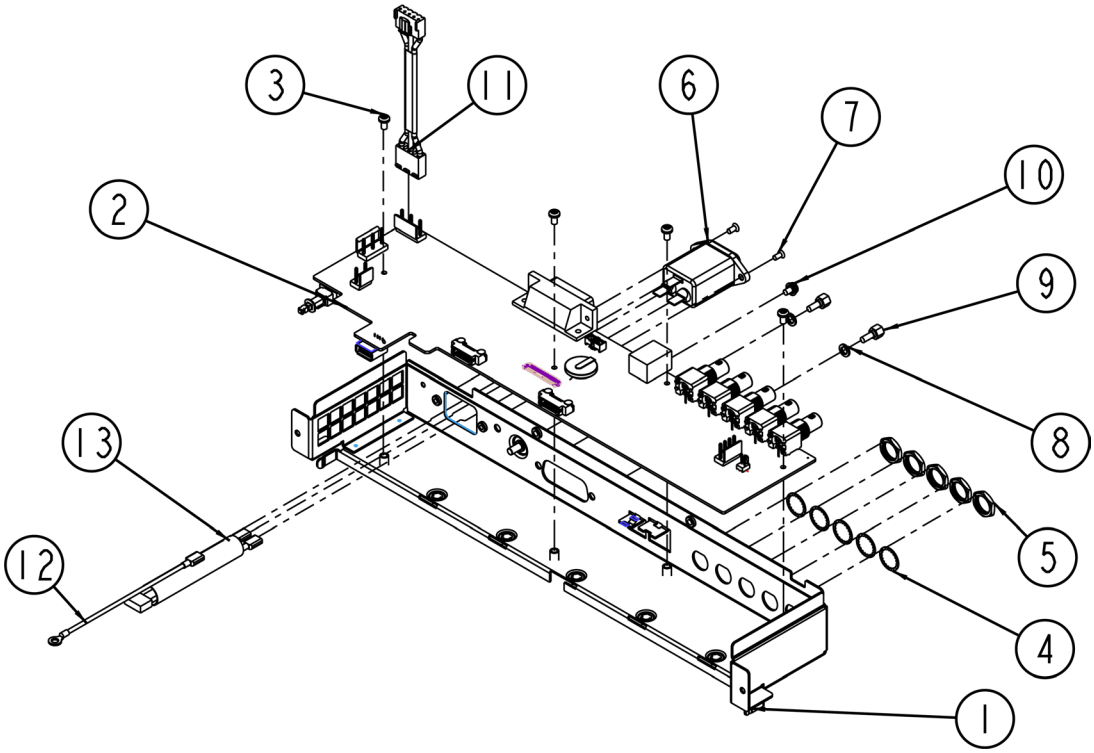


Figure 39: AFG31000 rear chassis bottom exploded view

Exploded diagram replaceable parts - module rear chassis upper

Use the following table and figure to determine the replaceable parts and modules in your AFG module rear chassis upper.

Index number	Tektronix part number	Instrument model	Quantity	Name and description
-01	441-2878-00	AFG31021 AFG31051 AFG31101 AFG31151 AFG31251 AFG31022 AFG31052 AFG31102 AFG31152	1	Chassis rear top side
	441-2919-00	AFG31252	1	Chassis rear top side FIP
-02	119-7271-04	AFG31021 AFG31051 AFG31101 AFG31151 AFG31251 AFG31022 AFG31052 AFG31102 AFG31152 AFG31252	1	Power supply; ac-dc; 150 W max in; 87-264 V ac, 47-63 HZ, 100-127 V ac, 360-440 HZ in; +4.3V @ 2.3A, +7.5V @ 3.2A, +18V @ 2A, -18V @ 2A out; safety controlled
-03	119-8853-00	AFG31022 AFG31052 AFG31102 AFG31152 AFG31252	1	Power supply; ac-dc; internal; 85 - 265 V ac, 47-63 HZ, means input; 30-watt, single output 12 V dc, 2.5A; no case; safety controlled
-04	441-2880-00	AFG31021 AFG31051 AFG31101 AFG31151 AFG31251 AFG31022 AFG31052 AFG31102 AFG31152 AFG31252	1	Cover, protection power supply cover

Index number	Tektronix part number	Instrument model	Quantity	Name and description
-05	211-1272-00	AFG31021 AFG31051 AFG31101 AFG31151 AFG31251 AFG31022 AFG31052 AFG31102 AFG31152 AFG31252	12	Screw, machine; 6-32 X 0.250, PNH, STL, ZNPL, T-15 Torx
-06	119-8177-00	AFG31021 AFG31051 AFG31101 AFG31151 AFG31251 AFG31022 AFG31052 AFG31102 AFG31152 AFG31252	1	Fan, tube axial (92 MM, dc, assembly), safety controlled
-07	348-2082-00	AFG31021 AFG31051 AFG31101 AFG31151 AFG31251 AFG31022 AFG31052 AFG31102 AFG31152 AFG31252	4	Grommet, fan mount, noise damping
-08	174-7031-00	AFG31021 AFG31051 AFG31101 AFG31151 AFG31251 AFG31022 AFG31052 AFG31102 AFG31152 AFG31252	1	Cable, power auxiliary supply to SG board
-09	337-4850-00	AFG31252	1	Absorber NFS40100
-10	253-0583-00	AFG31252	1	Conductive fabric tape for shielding 87580-STD
-11	346-0299-00	AFG31021 AFG31051 AFG31101 AFG31151 AFG31251 AFG31022 AFG31052 AFG31102 AFG31152 AFG31252	1	Cable ties

Exploded diagram - module rear chassis upper

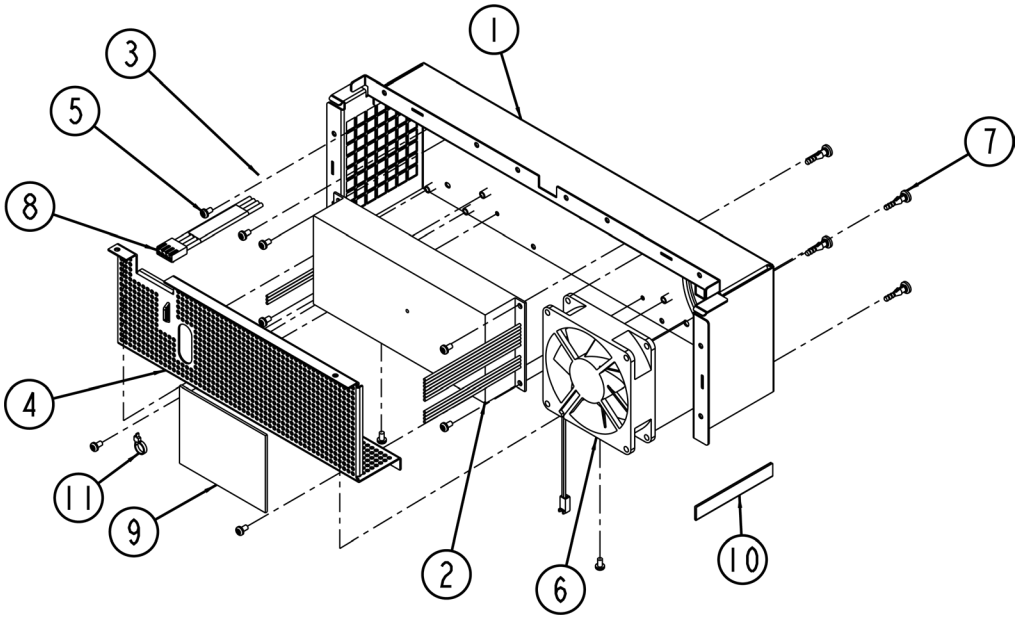


Figure 40: AFG31000 rear chassis-upper exploded view

Exploded diagram replaceable parts - module rear case

Use the following table and figure to determine the replaceable parts and modules in your AFG module rear-case.

Index number	Tektronix part number	Instrument model	Quantity	Name and description
-01	348-1909-00	AFG31021 AFG31051 AFG31101 AFG31151 AFG31251 AFG31022 AFG31052 AFG31102 AFG31152 AFG31252	2	Foot, rear; safety controlled
-02	348-1910-00	AFG31021 AFG31051 AFG31101 AFG31151 AFG31251 AFG31022 AFG31052 AFG31102 AFG31152 AFG31252	2	Foot, front cabinet, hinged
-03	214-5148-00	AFG31021 AFG31051 AFG31101 AFG31151 AFG31251 AFG31022 AFG31052 AFG31102 AFG31152 AFG31252	2	Spring front foot
-04	202-0552-00	AFG31021 AFG31051 AFG31101 AFG31151 AFG31251 AFG31022 AFG31052 AFG31102 AFG31152 AFG31252	1	Case, rear

Index number	Tektronix part number	Instrument model	Quantity	Name and description
-05	367-0598-00	AFG31021 AFG31051 AFG31101 AFG31151 AFG31251 AFG31022 AFG31052 AFG31102 AFG31152 AFG31252	1	Handle, carrying over molded, safety controlled
-06	335-3776-00	AFG31021 AFG31051 AFG31101 AFG31151 AFG31251 AFG31022 AFG31052 AFG31102 AFG31152 AFG31252	1	Marker identification, label, rear, safety
-07	335-3878-00	AFG31022 AFG31052 AFG31102 AFG31152 AFG31252	1	Marker identification, label rear cover analog I/O
	335-3964-00	AFG31021 AFG31051 AFG31101 AFG31151 AFG31251	1	Marker identification, label analog I/O, 1CH
-08	335-3879-00	AFG31021 AFG31051 AFG31101 AFG31151 AFG31251 AFG31022 AFG31052 AFG31102 AFG31152 AFG31252	1	Marker identification, label rear digital I/O

Exploded diagram - module rear case

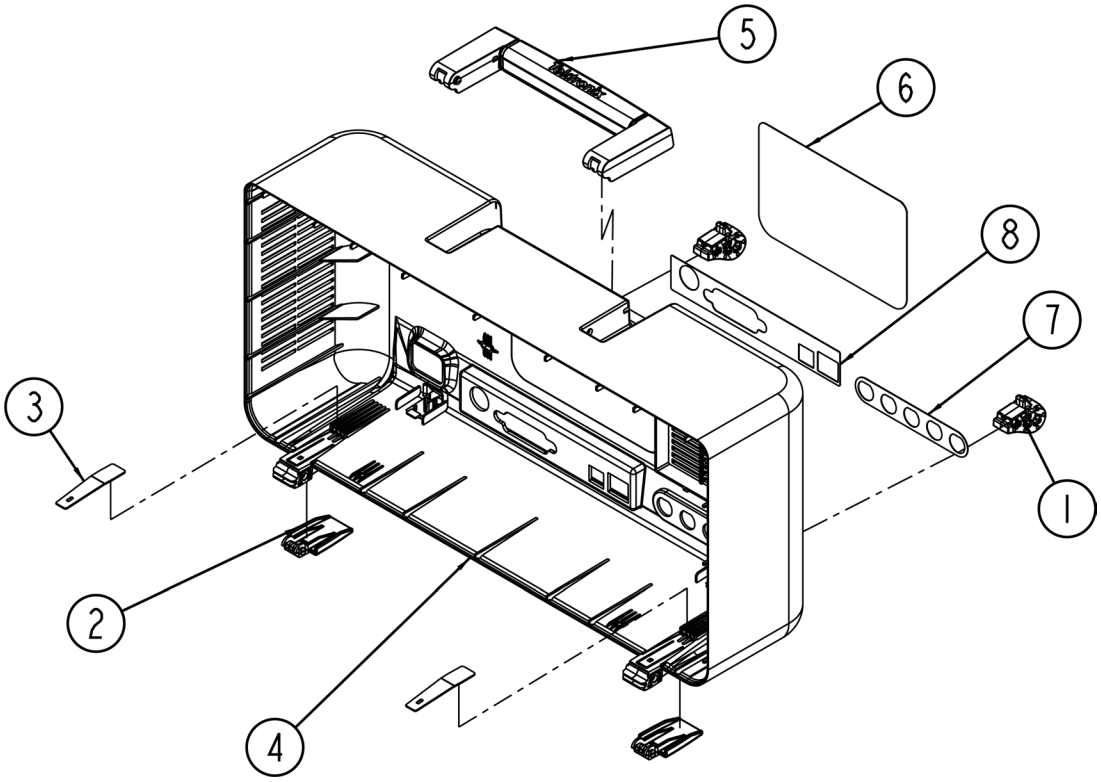


Figure 41: AFG31000 rear case exploded view

Troubleshooting

Troubleshooting

This section contains the following information to help you isolate faulty modules in the AFG31000 Series Arbitrary Function generators.

- Troubleshooting trees – Show how to find and isolate faulty modules.
- Diagnostics – Describes the diagnostics supplied with the AFG, operation, and status messages.

After you troubleshoot and identify a faulty part, use the Removal and installation procedures to replace a module.

Troubleshooting tools and equipment

You may need the following tools and equipment to troubleshoot your AFG:

Tools and equipment	Example
Digital multimeter (DMM)	3.5 inch or greater digit DMM
Oscilloscope with probe	Tektronix TDS 1000 or TDS 2000 series oscilloscope

Troubleshooting trees

To isolate a problem to a specific troubleshooting procedure, use the following troubleshooting trees. The trees make use of internal diagnostic routines to speed fault isolation to a module.

WARNING. Connection and wiring procedures in this document are intended for use by qualified personnel only. To prevent electrical shock, do not touch the heat sink of the power supply module. There are potentially dangerous voltages present on the heat sink of the power supply module. Do not perform these procedures unless qualified to do so. Failure to recognize and observe normal safety precautions could result in personal injury or death.

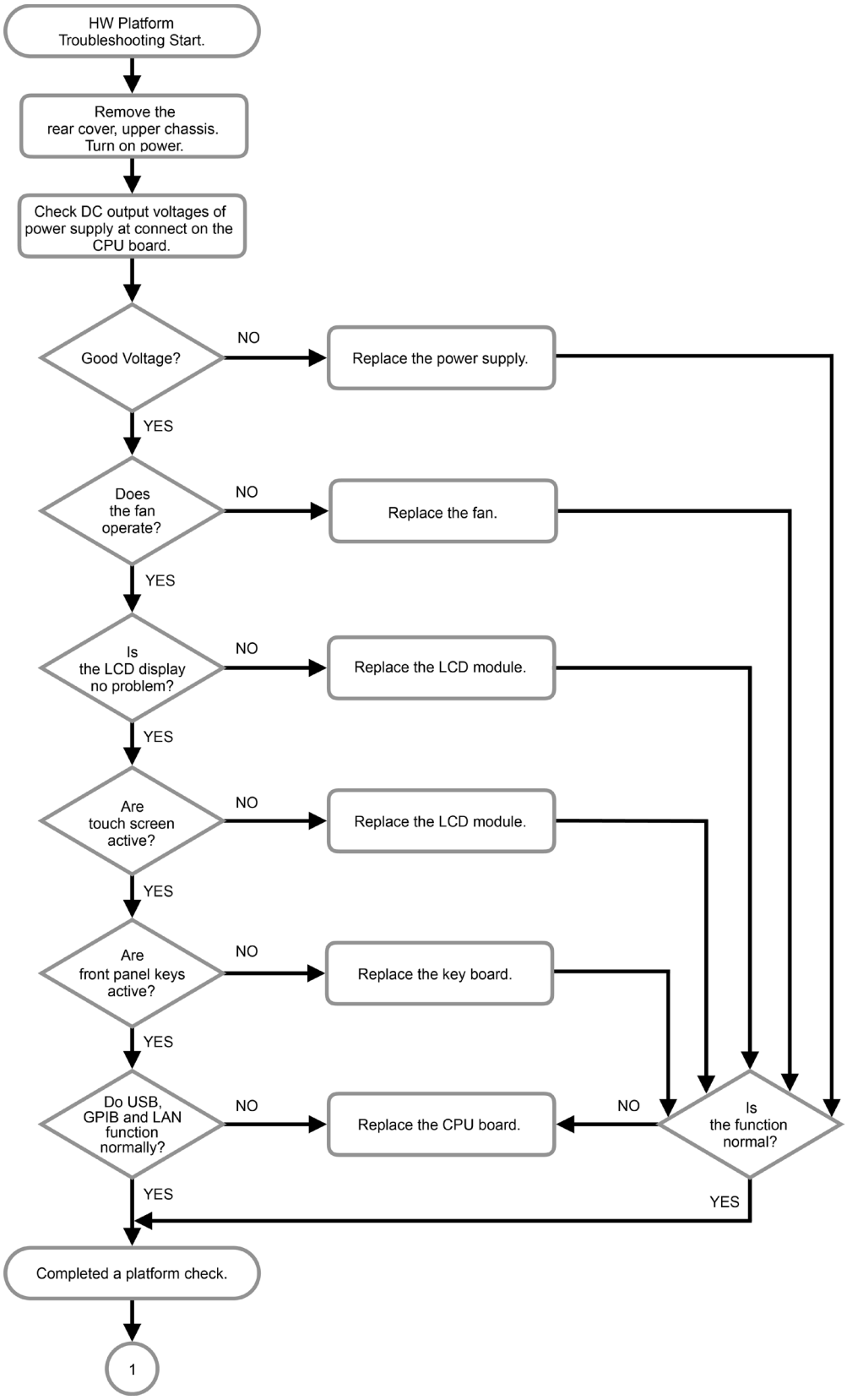


Figure 42: Platform troubleshooting tree

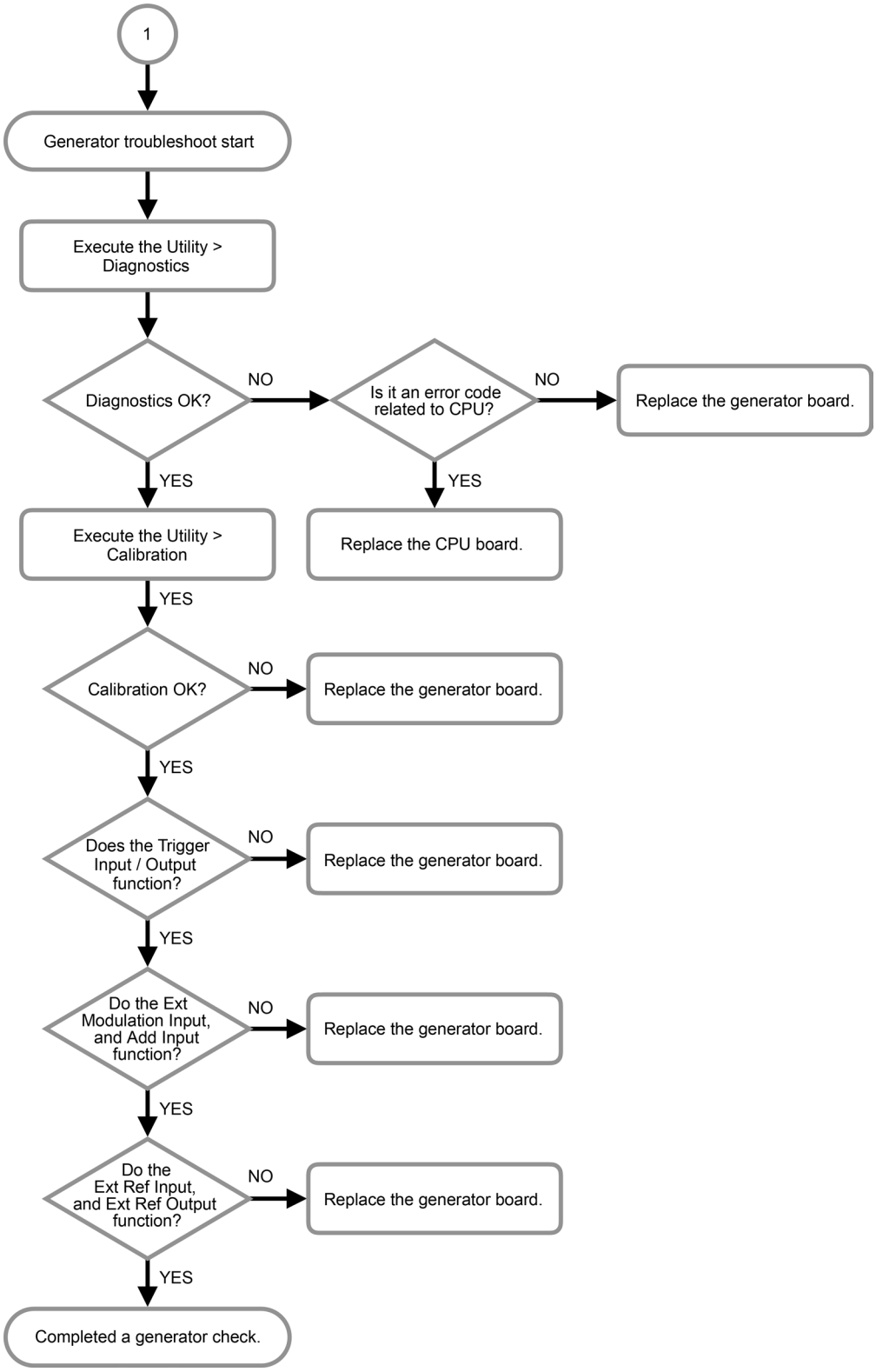


Figure 43: Generator troubleshooting tree

Diagnostics

When the arbitrary function generator is powered up, the instrument automatically executes a diagnostic test for all diagnostic items before the startup screen appears.

If an error is detected, the diagnostic test displays an error message. If you see an error message, select **OK** to proceed with the next step. The arbitrary function generator software starts. If the instrument contains an unresolved error, the test will not execute.

See Diagnostic error codes for more information.

Perform diagnostics and calibration

When powering on the instrument, it performs a limited set of hardware tests. You can also run the following manual diagnostic and calibration functions from the Utility menu (see Utility menu options for more detail). This procedure uses internal routines to verify that the instrument is operating correctly.

- **Diagnostics (self-test):** Perform diagnostics to verify that your instrument is operating correctly.
- **Calibration (self-calibration):** The calibration function checks dc accuracy using the internal calibration routines.

Figure 44: Diagnostics and calibration

NOTE: If you need to verify that the instrument meets the warranted specifications, do the complete set of performance verification procedures provided in the S*pecifications and Performance Verification Manual.*

To perform diagnostics and calibration:

CAUTION. Do not remove power from the instrument while performing calibration. If the power is turned off during calibration, data stored in the internal memory may be lost.

NOTE: Disconnect all cables from the instrument when you perform diagnostics or calibration (do not remove the power cord).

1. Select **Utility** on the touchscreen.
2. Select **Diagnostics/Calibration** in the menu.
3. To perform diagnostics, select **Run**.
4. Select **OK** to perform diagnostics or **Cancel** to exit.

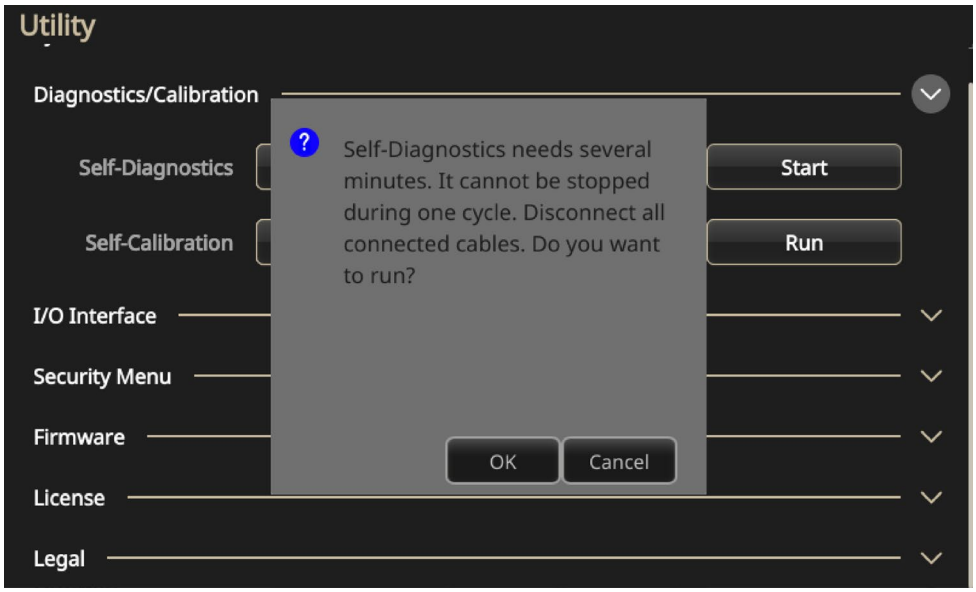


Figure 45: Run system diagnostics

5. Wait until the test is completed. The diagnostics test takes eight minutes to complete.
6. To perform calibration, select **Run**.
7. Select **OK** to perform calibration or **Cancel** to exit.

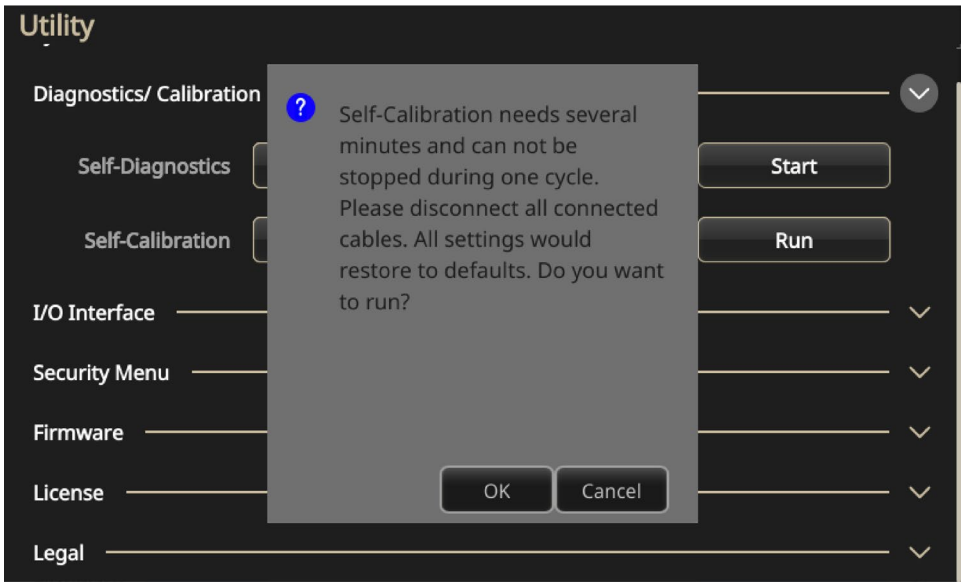


Figure 46: Run self-calibration

8. Wait until the test is completed. The diagnostics test takes eight minutes to complete.
9. Once calibration or diagnostics is executed, a dialog box displays the results including any errors.

Self-test error codes

If the self-tests detect a malfunction, the AFG31000 Series displays `[name of the test] failed!` and the error code. The following table lists the error codes with a description of the error and modules related to the error.

Table 3: Output diagnostics error codes

Error code	Description
2101	Calibration data checksum failure
2301	CH1 internal offset failure
2302	CH2 internal offset failure
2303	CH1 output offset failure
2304	CH2 output offset failure
2305	CH1 output gain failure
2306	CH2 output gain failure
2401	CH1 x12 dB K12 attenuator failure
2402	CH2 x12 dB K22 attenuator failure
2403	CH1 x20 dB K13 attenuator failure
2404	CH2 x20 dB K23 attenuator failure
2405	CH1 x20 dB K14 attenuator failure
2406	CH2 x20 dB K24 attenuator failure
2407	CH1 x14 dB/20 dB K15 attenuator failure (14 dB for AFG31151, AFG31152, AFG31251, AFG31252; 20 dB for AFG31021, AFG31022, AFG31051, AFG31052, AFG31101, AFG31102)
2408	CH2 x14 dB/20 dB K25 attenuator failure
2409	CH1 x20 dB K18 attenuator failure
2410	CH2 x20 dB K28 attenuator failure
2411	CH1 filter failure
2412	CH2 filter failure
2415	U51 failure
2501	CH1 ASIC failure
2502	Ch2 ASIC failure
2503	Ch1 ADC failure
2504	Ch2 ADC failure

Table 4: Calibration error codes

Error code	Description
1101	CH1 internal offset calibration failure
1102	CH2 internal offset calibration failure
1103	CH1 output offset calibration failure
1104	CH2 output offset calibration failure
1105	CH1 output gain calibration failure
1106	CH2 output gain calibration failure
1201	CH1 x12 dB K12 attenuator calibration failure
1202	CH2 x12 dB K22 attenuator calibration failure
1203	CH1 x20 dB K13 attenuator calibration failure
1204	CH2 x20 dB K23 attenuator calibration failure
1205	CH1 x20 dB K14attenuator calibration failure
1206	CH2 x20 dB K24attenuator calibration failure
1207	CH1 x14 dB/20dB K15 attenuator calibration failure
1208	CH2 x14 dB/20dB K25 attenuator calibration failure
1209	CH1 x20 dB K18 attenuator calibration failure
1210	CH2 x20 dB K28 attenuator calibration failure
1211	CH1 filter calibration failure
1212	CH2 filter calibration failure
1215	U51 calibration failure
1216	Saving calibration file failure
3001	Error code of Offset_DAC correction for CH1 about X4 attenuation
3002	Error code of Offset_DAC correction for CH2 about X4 attenuation
3003	Error code of Offset_DAC correction for CH1 about X16 attenuation
3004	Error code of Offset_DAC correction for CH2 about X16 attenuation
3005	Error code of variable gain correction for CH1 about X4 attenuation
3006	Error code of variable gain correction for CH2 about X4 attenuation
3007	Error code of variable gain correction for CH1 about X16 attenuation
3008	Error code of variable gain correction for CH2 about X16 attenuation
3009	Error code of attenuation circuit coefficient's correction for CH1 about X4 attenuation
3010	Error code of attenuation circuit coefficient's correction for CH2 about X4 attenuation
3011	Error code of attenuation circuit coefficient's correction for CH1 about X16 attenuation
3012	Error code of attenuation circuit coefficient's correction for CH2 about X16 attenuation