# Model MT06000A

## Multi-Tone Test System
## Operating and Service Manual


**Part Number 10038070**

**Serial Number 0580795**

**Revision A**

rf/microwave instrumentation

**AR RF/Microwave Instrumentation**
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rf/microwave instrumentation

# Declaration of Conformity

**Issue Date:** April 2016
**Model #/s:** MT06000A
**Type of Equipment:** Multitone Test System
**Function:** Designed to be used in a RF immunity test system. The unit is intended to generate, amplify and monitor RF signals.

The equipment described above is declared to be in conformity with the following applicable national and international standards. The conformity is valid only when equipment is used in a manner consistent with the manufacturer's recommendations and the reference documents.

**EMC:**

**DIRECTIVE 2014/30/EU OF THE EUROPEAN PARLIAMENT** AND OF THE COUNCIL of 26 February 2014 on the harmonisation of the laws of the Member States relating to electromagnetic compatibility

**EN 61326-1:2013** Electrical equipment for measurement, control and laboratory use–EMC requirements–Part 1: General Requirements

**SAFETY:**

- **DIRECTIVE 2014/35/EU OF THE EUROPEAN PARLIAMENT** AND OF THE COUNCIL of 26 February 2014 on the harmonisation of the laws of the Member States relating to the making available on the market of electrical equipment designed for use within certain voltage limits

  **CENELEC EN 61010-1 Issued 2010/10/01 Ed: 3**
  Safety Requirements for Electrical Equipment for Measurement Control and Laboratory Use – Part 1: General Requirements

- **UL 61010-1 Issued 2012/05/11 Ed: 3**
  Safety Requirements for Electrical Equipment for Measurement Control and Laboratory Use – Part 1: General Requirements
- **CAN/CSA C22.2 #61010-1 Issued 2012/05/11 Ed: 3**
  Safety Requirements for Electrical Equipment for Measurement Control and Laboratory Use – Part 1: General Requirements

**HAZARDOUS SUBSTANCES (RoHS):**
DIRECTIVE 2011/65/EU OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL of 8 June 2011 on the restriction of the use of certain hazardous substances in electrical and electronic equipment (recast)

**RECYCLING (WEEE):**
DIRECTIVE 2012/19/EU OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL of 4 July 2012 on waste electrical and electronic equipment (WEEE) (recast)

Supporting documentation is held by AR RF/Microwave Instrumentation's quality department in Pennsylvania, United States.

**Place of issue:** AR RF/Microwave Instrumentation
160 School House Road
Souderton, Pennsylvania 18964 USA

**Authorized officer of the company:**

James M. Maginn
President

# INSTRUCTIONS FOR SAFE OPERATION

## BEFORE APPLYING POWER

Review this manual and become familiar with all safety markings and instructions.

Verify that the equipment line voltage selection is compatible with the main power source.

Protection provided by the equipment may be impaired if used in a manner not specified by Amplifier Research.

## INTENDED PURPOSES

This equipment is intended for general laboratory use in a wide variety of industrial and scientific applications. It is designed to be used in the process of generating, controlling, and measuring high levels of electromagnetic Radio Frequency (RF) energy. Therefore, the output of the amplifier must be connected to an appropriate load such as an antenna or field-generating device. It is the responsibility of the user to assure that the device is operated in a location which will control the radiated energy such that it will not cause injury and will not violate regulatory levels of electromagnetic interference.

## HAZARDOUS RF VOLTAGES

The RF voltages on the center pin of the RF output connector can be hazardous. The RF output connector should be connected to a load before AC power is applied to the amplifier. Do not come into contact with the center pin of the RF output connector or accessories connected to it. Place the equipment in a non-operating condition before disconnecting or connecting the load to the RF output connector.

## SAFETY GROUND

This equipment is provided with a protective earth terminal. The main power source to the equipment must supply an uninterrupted safety ground of sufficient size to the input wiring terminals, power cord, or supplied power cord set. The equipment MUST NOT BE USED if this protection is impaired.

## PHYSICAL DAMAGE

The RF amplifier should not be operated if there is physical damage, missing hardware, or missing panels.

## MAINTENANCE CAUTION

Adjustment, maintenance, or repair of the equipment must be performed only by qualified personnel. Hazardous energy may be present while protective covers are removed from the equipment even if disconnected from the power source. Contact may result in personal injury. Replacement fuses are required to be of specific type and current rating.

## SAFETY SYMBOLS

This symbol is marked on the equipment when it is necessary for the user to refer to the manual for important safety information.

Dangerous voltages are present. Use extreme care.

CAUTION: The caution symbol denotes a potential hazard. Attention must be given to the statement to prevent damage, destruction, or harm.

Indicates protective earth terminal.

## RANGE OF ENVIRONMENTAL CONDITIONS

This equipment is designed to be safe under the following environmental conditions:

- Indoor use
- Altitude up to 2000M
- Temperature of 5°C to 40°C
- Maximum relative humidity 80% for temperatures up to 31°C. Decreasing linearly to 50% at 40°C.
- Main supply voltage fluctuations not to exceed ± 10% of the nominal voltage or minimum and maximum autoranging values.
- Pollution degree 2: Normally non-conductive with occasional condensation. While the equipment will not cause hazardous condition over this environmental range, its performance may vary.

## COOLING AIR

Care should be exercised not to block the cooling air inlets or outlets. Cooling air blockage can result in damage to the RF amplifier or intermittent shut-downs.

# TABLE OF CONTENTS

# 1. GENERAL INFORMATION

## 1.1 GENERAL DESCRIPTION

This manual provides operating, interfacing and selected service information pertinent to the MT06000A Multi-tone Test System. Hardware and software are addressed in separate sections.

The Model MT06000A (Multistar™ Multi-tone tester) is a state-of-the-art system designed to test RF Radiated Immunity faster than ever before possible. By testing multiple frequencies (tones) at once, test times can be reduced by a factor equivalent to the number of tones selected. The number of tones is only limited by the signal generator bandwidth (200MHz) and the size of the amplifier used with the system.

The MT06000A contains all the instruments needed to perform radiated immunity testing for IEC 61000-4-3 specification except the required amplifiers, antennas and directional couplers.

Amplifiers can be sized and selected based on your required field levels and testing needs. Up to four RF amplifiers and directional couplers can be controlled and monitored and power can be delivered to up to four antennas to generate the desired fields. The system contains a vector signal transceiver, a RF pre-amplifier, a RF field probe and monitor, an RF switch matrix, and automated radiated immunity test software. Everything is contained in a single housing, which eliminates setup issues.

The software includes automated routines to calibrate the field and maximize the speed of test (most tones possible) while still meeting the Linearity and Harmonics requirements of the specification. In the event of a EUT failure, margin investigation (thresholding) and traditional single tone testing can be performed causing a slowing of the test only in the areas of concern. This system has the versatility needed for every test laboratory and equipment manufacturer while adding the benefit of reduced test times and greater throughput.

## 1.2 HARDWARE

The MT06000 hardware system components are as follows:

- 1pc. Model FL7006 Electric Field Probe
- 1pc. Model FM7004A Field Monitor
- 1pc. Model FI7000 Laser Probe Interface
- 1pc. Model SC1000 RF System Controller
- 1pc. Model 1078 PXIe chassis with the following:
  - Vector Signal Transceiver containing Vector Signal Generator and Vector Signal Analyzer
  - Pre-Amplifier
  - Embedded Controller (PC Computer)
- 1pc. AC Power Controller
- 1pc. Monitor 23″
- 1pc. Wireless Keyboard & Mouse
- Misc. RF & Power Interface Cables

These items are all housed in a 19 inch cabinet and are designed and tested to work together as a system under the control of the MT06000A control software.

## 1.3 ACCESSORIES

AR offers a number of accessories for use with this system:

- RF Amplifiers
- Directional Couplers
- Antenna(s)
- Antenna tripod
- Low Pass Filter
- Additional Field Probes
- Field Probe Stand
- Longer fiber optic cable for single length up to 100 meters
- Additional System Controller

Contact the Sales Department at AR for a full list of accessories.

Figure 1-1 provides a block diagram of the components of the system along with a sampling of accessories.

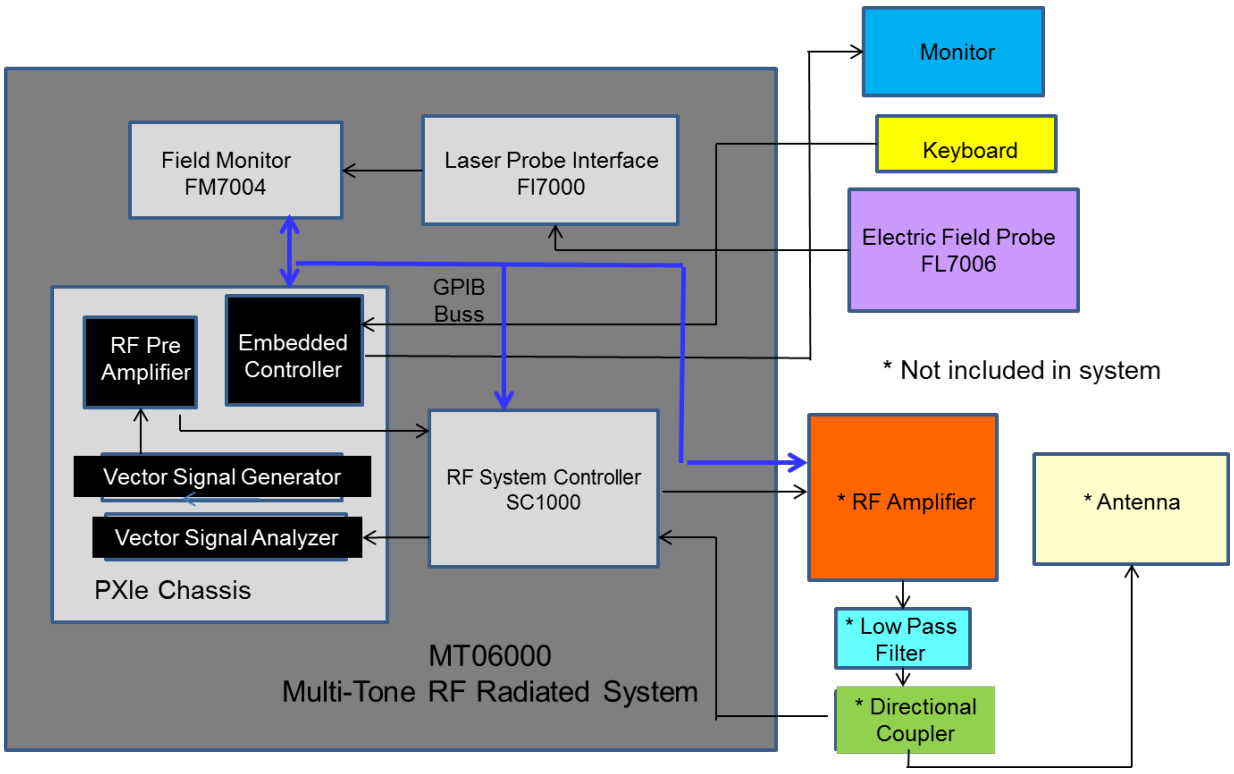



Figure 1-1

## 1.4 SUGGESTED APPLICATIONS

Radiated Immunity testing using the following standards:

- IEC/EN 61000-4-3
- MIL STD461D & E (CS114)
- DO160D & E
- EN/IEC 61000-4-3
- EN/IEC 60601-1-2
- EN 50130-4
- EN 61000-6-1/2
- EN 55024

## 1.5 FRONT PANEL

The front panel contains the following items:

- SC1000 System Controller – function is to use software to control the routing of the RF Signals to the amplifiers, directional couplers, and antennas. The user can manually control the switches via the front panel buttons.
- FM7004 Field Monitor – displays the field strength readings from the field probe thru the fiber optic cable. It has the capability to read 4 field probes manually by using the touch screen display
- FI-7000 Field Probe Interface – provides power and commands to operate the field probe (FL7006) thru the fiber optic cable. It also has a safety loopback connection to ensure proper connected cables prior to laser turn on.

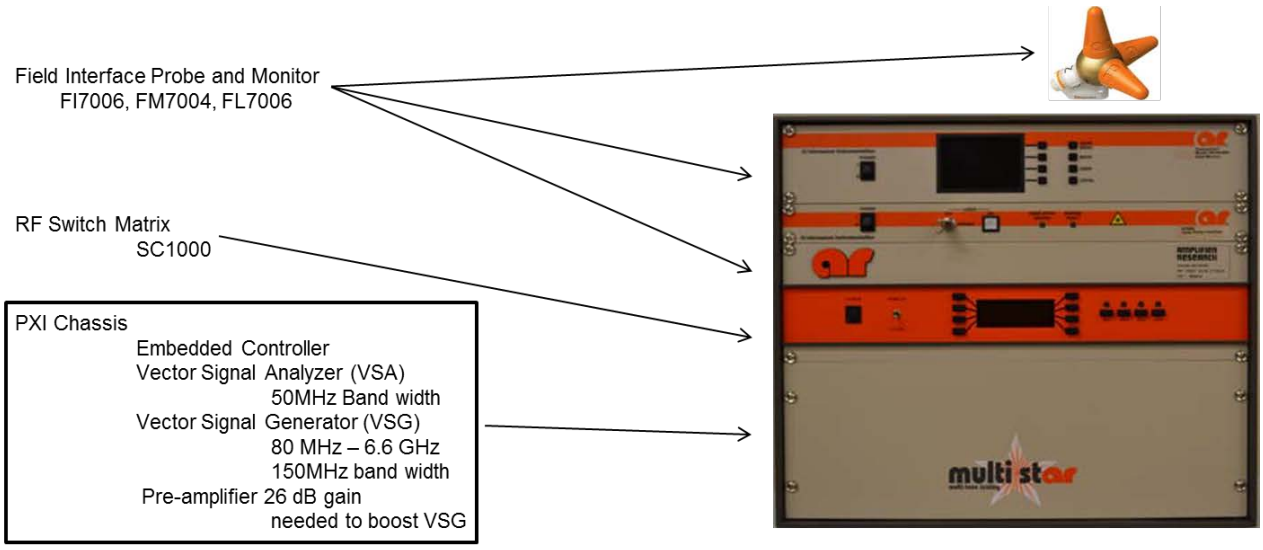



Figure 1-2. Front Panel View

## 1.6 REAR I/O PANEL

The rear panel contains the following items:

- Signal In – This is a Type N coaxial connector through which the external RF input signal can be routed. This connector can be used to connect an external signal source if so desired.
- Signal Out- This is a type N coaxial connector which is a RF output of the vector signal generator. The signal is connected to the input of the RF amplifier.
- Amplified Signal In – This is a Type N coaxial connector which provides a connection to the input of the internal power amp.
- Amplifier Signal Out (Load) – This is a Type N coaxial connector which provides a connection to the output of the power amp. This is connected to the desired antenna.

- **Forward Power Sense** – This is a Type N coaxial connector which provides RF input signal to the vector signal analyzer. This is connected to the directional coupler forward power port to monitor the amplifier's output power.
- **GPIB Interface Connector** – This is the remote control interface that is used to control the external amplifier (if required) and EUT monitoring devices.
- **Interlock/Aux**- Connections to the safety interlocks that will disable the amplifiers when a chamber door is opened.
- **AC Power Controller Panel (Circuit Breaker)**– This panel has 3 switched section indicator lamps, a circuit breaker, a local/remote switch, 3 interface jacks (J1, J2, J3) and a 115VAC present indicator lamp. During normal operation the 115VAC/240VAC present lamp will light when the circuit breaker is turned on. The three switched section lamps will light when the Local/Remote/Off switch is in the Local position. The power sequence interface connectors J1,J2 and J3 have no connections.

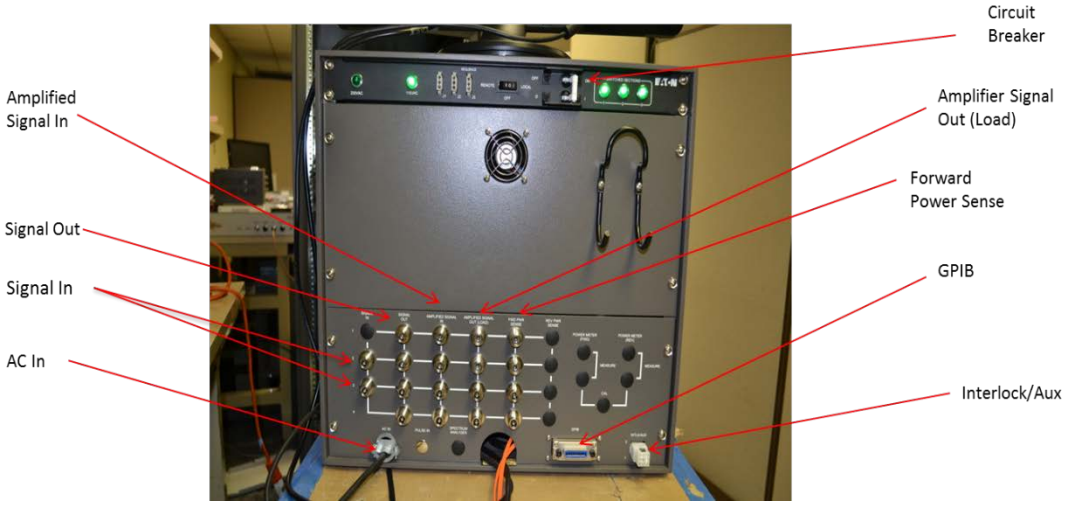



Figure 1-3. Rear panel view

## 1.7 PRODUCT SPECIFICATIONS

Refer to the AR Data Sheet at the end of this section for complete product specifications.

rf/microwave instrumentation

# Model MT06000A
# Multistar™
# Multi-tone RF Radiated Immunity System
# 65MHz–6GHz


Complete Testing Solutions to the following standards:

- EN/IEC 61000-4-3
- EN/IEC 60601-1-2
- EN 50130-4
- EN 61000-6-1/2
- EN 55024

The Model MT06000A (Multistar™ Multi-tone tester) is a state-of-the-art system designed to test RF Radiated Immunity faster than ever before possible. By testing multiple frequencies (tones) at once, test times can be reduced by a factor equivalent to the number of tones selected. The number of tones is only limited by the signal generator bandwidth (200MHz) and the size of the amplifier used with the system. The MT06000A contains all the instruments needed to perform radiated immunity testing for IEC 61000-4-3 specification except the required amplifiers, antennas and directional couplers. Amplifiers can be sized and selected based on your required field levels and testing needs. Up to 4 RF amplifiers and directional couplers can be controlled and monitored and power can be delivered to up to 4 antennas to generate the desired fields. The system contains a vector signal transceiver, a RF pre-amplifier, a RF field probe and monitor, an RF switch matrix, and automated radiated immunity test software. Everything is contained in a single housing, which eliminates setup issues. The software includes automated routines to calibrate the field and maximize the speed of test (most tones possible) while still meeting the Linearity and Harmonics requirements of the specification. In the event of a EUT failure, margin investigation (thresholding) and traditional single tone testing can be performed causing a slowing of the test only in the areas of concern. This system has the versatility needed for every test laboratory and equipment manufacturer while adding the benefit of reduced test times and greater throughput.

| Internal Test Specifications | |
|---|---|
| IEC/EN 60601-1-2<br>IEC/EN 50130-4<br>IEC/EN 61326<br>IEC/EN 61000-6-1<br>IEC/EN 61000-6-2<br>CISPR 24/EN 55024 | IEC 61000-4-3 procedure and levels |

| Vector Signal Transceiver (Generator) Specifications | |
|---|---|
| Frequency range | 65 MHz to 6.0 GHz |
| Resolution | 888 nHz |
| Power Out | +10 dBm |
| Modulation | AM, FM, Pulse, Phase |
| Bandwidth | 200MHz |
| Hardware Platform | PXIe |

| Vector Signal Transceiver (Analyzer) Specifications | |
|---|---|
| Frequency Range | 65MHz to 6.0GHz |
| Resolution | 888 nHz |
| Dynamic Range | 84dB |
| Bandwidth | 200MHz |
| Hardware Platform | PXIe |

| RF Preamplifier Specifications | |
|---|---|
| Frequency Range | 50MHz-8GHz |
| Gain | 26dB |
| Hardware Platform | PXIe |

| Field Monitor/Probe Spec | |
|---|---|
| Channels | 4 |
| Probe | 1 |
| Type | Isotropic, Laser powered |
| Frequency | 100kHz-6GHz |
| Range | 0.5–800 V/m |

| Connections | |
|---|---|
| RF signal input | 4- Type N Male (rear)<br>For optional signal generators |
| RF Signal Out | 4- Type N Male (rear) to RF amplifiers |
| High power RF in | 4- Type N Male (rear) from RF amplifiers |
| High power RF out | 4 Type N male (rear) to antennas/loads |
| Monitor port In | 4- Type N Male (rear)<br>For forward power |
| Serial Port | 2 – USB ports |

| Control PC | |
|---|---|
| Computer | Intel Core 2 Duo, 2.53GHz |
| Operating system | Windows 7 |
| RAM | 4GB DDR2 |
| Hardware Platform | PXIe |

| General | |
|---|---|
| Power | 115/230 VAC<br>50/60 Hz, single phase 16A |
| Breaker | 2 pole, 20A |
| Cooling | active cooling, air ventilation |
| Environmental conditions | 10°C - 40°C |
| Dimensions, | 50.3 x 47.2 x 61 cm<br>19.8 x 18.6 x 24 in |
| Weight | 22.7 kg (50.0 lb) |

| Accessories | |
|---|---|
| DAQ Module<br>(AR P/N 10025318) (NI USB-6212) | Data acquisition module is used to collect data, identify user defined failures, report user defined error messages, and reset EUT after failure |
| Low Pass Filter, 80MHz-1GHz | Absorptive filter used to remove harmonics |
| Low Pass Filter, 80MHz-4.2GHz | Absorptive filter used to remove harmonics |
| Low Pass Filter, 80MHz-6GHz | Absorptive filter used to remove harmonics |

# 2. THEORY OF OPERATION

## 2.1 DESIGN OF THE MULTI-TONE SYSTEM

Using the digital instrumentation under ARs proprietary software control, a Vector Signal Generator (VSG) digitally produces multiple tones and complex modulations while a Vector Signal Analyzer (VSA) facilitates frequency selective power measurement. Thus the multiple tones can be generated, measured and controlled.

## 2.2 VECTOR SIGNAL TRANSCEIVER

(A unit combining a vector signal generator and vector signal analyzer with FPGA-based real-time signal processing and control).

### 2.2.1 Vector Signal Generator (VSG)

The RF VSG is a wide-bandwidth from 65MHz to 6.6GHz vector signal generator which can generate different waveforms like, Amplitude modulation (AM), Pulse modulation (PM) and multitoned signals. The VSG is capable of providing 200 MHz of RF bandwidth. The VSG hardware platform is a PXIe platform and operating system is Windows 7. Using NI LabView or LabWindows you can generate a variety of modulated signals.

### 2.2.2 Vector Signal Analyzer (VSA)

The RF VSA is a wide instantaneous bandwidth coving from 10 MHz to 6.6GHz with a 80 dB typical Spurious Free Dynamic Range (SFDR). The RF VSA can perform fast and accurate RF measurements. You can perform common spectrum analysis measurements quietly due to the processing power of multicore CPU's. Using a 16 bit ADC with high-performance RF front end, the VSA offers up to 80 dB of SFDR. Using LabView you can perform common measurements such as power spectrum, peak power and frequency.

## 2.3 System Controller: SC1000

The AR Model SC1000 is an RF test system controller designed to facilitate broadband RF testing. The signal routing capabilities allow the concurrent use of up to two signal generators, four power amplifiers with forward and reverse power feedback from four directional couplers, and four different RF loads without the need to move cables. Additionally, the RF signal can be routed from an amplifier to a load for susceptibility testing, or from a load to a receiver for emissions testing. External switches can be controlled through the use of a switched +12V supply or through the use of the four open collector outputs and the un-switched +24V supply. Interlock protection is provided by interrupting the input signal if an external switch closure is not detected. The input signal is also interrupted prior to and during any RF signal re-routing to ensure "cold switching".

The Model SC1000 can be operated locally by using the unit's front panel controls, or remotely by using its built-in IEEE-488 or RS-232 interfaces.

*NOTE: Refer to the **SC1000 Operating and Service** manual for additional information.*

## 2.4 PXIe CHASSIS

The PXIe is a 8-slot chassis that provides a high-bandwidth backplane up to 1GB/s per-slot dedicated bandwidth. The chassis features a built-in 10MHz reference clock, PXI trigger bus, built-in 100 MHz clock, SYNC 100 and a PXI star trigger for PXI modules.

## 2.5 FIELD MONITOR: FM7004A

The FM7004A is a broadband electric and magnetic field monitor designed for use in radio frequency interference/electromagnetic compatibility (RFI/EMC) test system applications. If accepts inputs from up to four isotropic field probes then analyzes and displays that information on a user configurable color LCD touch display. It provides four digital interfaces (IEEE-488, RS-232, Ethernet and USB). The FM7004A is compatible with all AR7000 Series E and H Field Probes and Field Analyzers.

A complete FM7004A Field Monitor system consists of one to four field measurement probes, attached to the FM7004A through fiber optic cables. The FM7004A contains fiber optic receivers and transmitters to communicate with the probes, an I/O board for peripheral communication with a PC, a main processor board, and an LCD touch screen to display data and system status. USB, RS232, Ethernet and IEEE-488 ports are included for remote system operation. The FM7004A has a self-contained power supply with a universal input 110-230 VAC.

When a field strength reading is requested by the Field Monitor, the appropriate command is sent to the probe through fiber optic cable. The probe measures the signal level for all axes and transmits the data to the FM7004A. A vector addition is performed on these readings based on the enabled axes by the FM7004A processor. The main processor board then displays the data and, if desired, transmits the data to the I/O board for transmission to a remote PC.

*NOTE: Refer to the **FM7004A Operating and Service** manual for additional information.*

## 2.6 FIELD PROBE AND LASER PROBE INTERFACE: FL7006 & FI7000

The Model FL7006/FL7030/FL7218/FL7040/FL7060 Probe Kit consists of two principal functional units: the probe and the probe interface. The two units are connected by two pairs of fiber optic (F/O) cables. Power to operate the probe and commands to the probe are provided from the interface on one of the F/O cables. Responses from the probe to the interface are provided on a second F/O cable. The other F/O pair is a safety loopback connection ensuring properly connected cables prior to laser turn on.

Each probe has been calibrated at the factory in a CW field at a single frequency, and the resultant calibration tables have been loaded into probe non-volatile memory. The calibration tables provide the basis for the conversion of the digitized signal, from the sensor/detector/pre-amplifier/A to D converter path, to electric field measurements values for each axis. A composite field level is then derived by calculating the square root of the sum of the squares of the individual axis field values. This calculation method is generally quite precise relative to the extent to which

all the individual axis antenna patterns are those of very short electrical dipoles (sine function) at all frequencies.

In addition to the operating program and calibration tables (firmware), each probe's memory also contains the serial number of the probe, the revision of the probe's firmware, and the probe's most recent calibration date.

The probe interface sits between the probe and the host providing all of the specified communication protocols to the host.

*NOTE: Refer to the* ***FL7006/Kit Operating and Service*** *manual for additional information.*

## 2.7 EMBEDDED CONTROLLER

PXIe embedded controller provides a complete PC with integrated hard drive and two high speed USB and Gigabit Ethernet. Embedded controller hardware platform is PXIe with a Intel Core 2 Duo processor with memory of 4GB DDR2 RAM which operates of Windows 7.

## 2.8 RF PRE-AMP

Pre-Amplifier hardware platform is PXIe with frequency range of 50MHz to 8GHz with a gain of 26dB.

# 3. OPERATION

## 3.1 WARNINGS AND CAUTIONS

Throughout this manual, the symbol:

WARNING:

indicates that a hazard exists that may result in personal injury or loss of life.

CAUTION:

indicates that failure to follow procedures may result in damage to the equipment.

WARNING: DANGER - High Voltage Present:

The MT06000A operates from AC line voltages which may present a shock hazard.

WARNING: Safety Ground

Improper grounding of this equipment can result in electric shock. The unit must be operated only with a line cord with a safety ground wire. It is the user's responsibility to ascertain that the power connector is properly wired and that the power outlet is grounded.

WARNING: Explosive Atmosphere

To avoid explosion, never operate this unit in an explosive atmosphere. This equipment is not certified for operation in an explosive atmosphere.

## 3.2 INITIAL CONNECTIONS

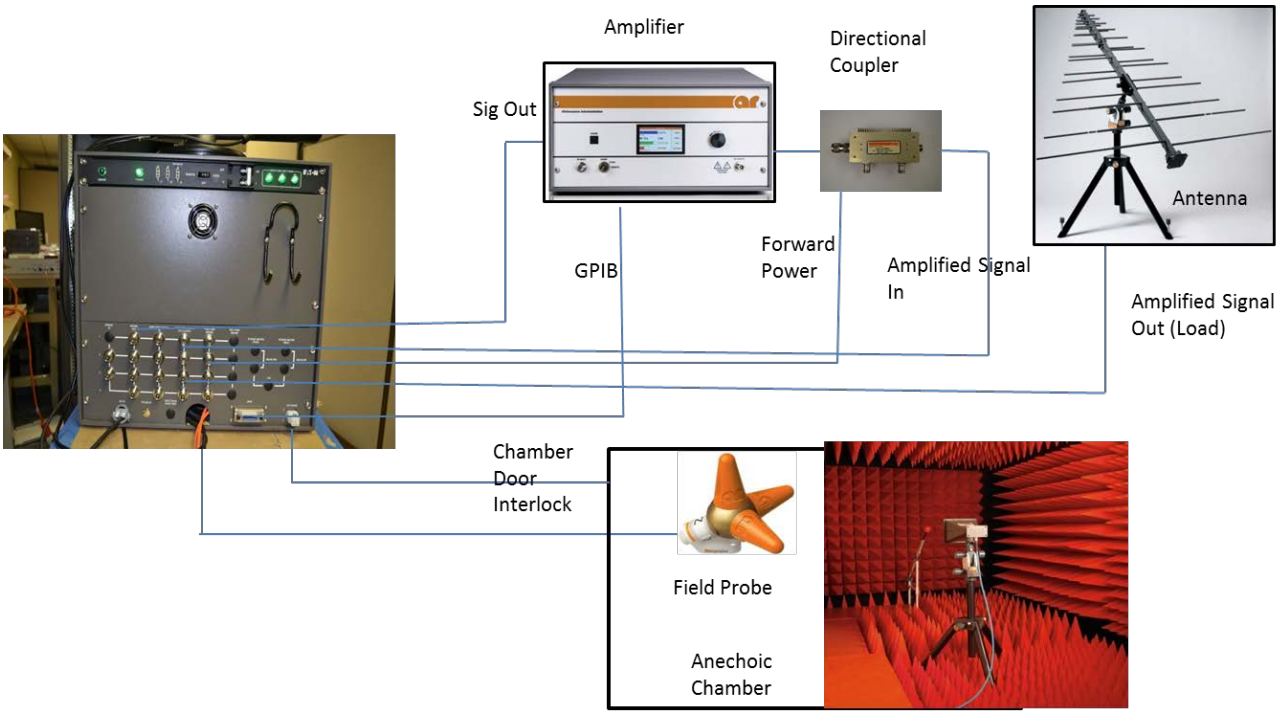



Figure 3-1 Example of Radiated Immunity test setup

### 3.2.1 AC Power

The MT06000A can be operated on AC voltages ranging from 90-264VAC. The system comes with an unterminated AC power cord. The AC power cord is located on the rear panel of the unit via a mouse hole. The other end of the power cord has 3 pre-stripped wire ends. The end user must provide and connect a properly rated AC power connector of their choosing to the unterminated end of the power cord.

### 3.2.2 Monitor Connections

Video Cable – Connect the display port cable located in the rear of the unit to the VGA monitor input.

Monitor Power Cable - Connect the monitor power cable located in the rear of the unit to the monitor input power connector.

### 3.2.3 RF Connections

The following RF connections can be configured in various setups depending on the equipment available (amplifier or antenna) and test parameters required. The user can set band breaks via the software Routing menu for each amplifier or antenna to accommodate the test parameter setup. Refer to Figure 3-1 for one example of a Radiated Immunity test setup.

Signal In – This is a RF input signal from an external signal generator. The system includes two N(M) connectors which are switched by the system controller. The routing of the switches are

controlled by the multi tone software or can be controlled manually from front buttons on the SC1000. The two N(M) connectors can be connected to separate external generators. Note: Sig In 1 is connected internal to the Transceiver.

Signal Out – This is a RF output signal from the transceiver that generates multiple tones. The system includes four N(M) connectors which are switched by the system controller. The routing of the switches are controlled by the multi tone software or can be controlled manually from front buttons on the SC1000. The four N(M) connectors can be connected to separate RF Input ports of different amplifiers.

Amplified Signal In – This is a RF Input signal from the output of the amplifier that amplifies multiple tones. The system includes four N(M) connectors which are switched by the system controller. The routing of the switches are controlled by the multi tone software or can be controlled manually from front buttons on the SC1000. The four N(M) connectors can be connected to separate directional couplers that connect to different amplifiers.

Forward Power – This is a RF Input signal from the output of the directional coupler forward power port that monitors amplifier output power of the multiple tones. The system includes four N(M) connectors which are switched by the system controller. The routing of the switches are controlled by the multi tone software or can be controlled manually from front buttons on the SC1000. The four N(M) connectors can be connected to separate directional couplers forward power port that monitor forward power of different amplifiers.

Amplified Signal Out (Load) – This is a RF Output signal from the output of the directional coupler forward power port that monitors amplifier output power of the multiple tones. The system includes four N(M) connectors which are switched by the system controller. The routing of the switches are controlled by the multi tone software or can be controlled manually from front buttons on the SC1000. The four N(M) connectors can be connected to separate antennas.

### 3.2.4 Field Probe Connections

Field Probe – The system includes one FL7006 field probe and with 10 meters of fiber optic cable located in rear of the unit. The field probe has two permanently attached short fiber optics cables. The fiber optic cables are keyed & color-coded to ensure safe & proper connections. Shuttered connectors are used to prevent accidental exposure to laser radiation. The field probe is design to be mounted on a non-conductive (dielectric) probe stand supplied with ¼-20 non-conductive screw with 1/8 to ¼ inch thread extending beyond the mounting surface.

### 3.2.5 Interlock/Auxiliary Connections

Interlock/Auxiliary connector – The system includes a 9-pin Int/Aux connector located on the rear panel. There are 4 independent open collector (current sinking) outputs and a switched +12VDC output. Which may be used to control external relays or switches on chamber doors. Note: A jumper cable is used if the Int/Aux connector is not being used. This is required to satisfy the interlock fault.

### 3.2.6 GPIB I/O Connections

GPIB Connector – The system includes a General-Purpose Interface Bus IEEE 488.1 located on the rear panel of the unit. This can be used to control an amplifier or connected to a EUT monitor equipment.

### 3.2.7 Ethernet

Ethernet Connector – The system includes a Gigabit 10/100/1000 Ethernet connector located on the rear panel of the unit.

### 3.2.8 Keyboard and Mouse

Keyboard – The system includes a wireless keyboard. Note: Insure the Receiver unit is connected to one of the USB ports located on the front panel. There is power switch on the keyboard to enable the keyboard.

Mouse – The system includes a wireless mouse. Note: Insure the Receiver unit is connected to one of the USB ports located on the front panel. On the bottom of the mouse insure the power switch is selected to the on position to enable the mouse.

*NOTE: One USB Receiver will control both the keyboard and mouse.*

### 3.2.9 Front Panel USB Connectors

USB Connector – The system includes two Hi-speed USB 2.0 (4 pin series A) connectors located on the lower right hand side of the front panel of the system.

## 3.3 POWER ON PROCEDURE

### 3.3.1 Rear Panel of the MT06000A unit:

1. Set circuit breaker on rear panel to OFF position.

2. Connect the AC power cable to the correct power source. All indicator lamps on rear panel should remain off.

3. Switch the circuit breaker to the ON position. The 120 VAC or 240 VAC lamp should light depending on what AC source voltage is being used. All other lamps should not be lit.

4. Switch the remote/local power switch on rear panel to the ON position. The three green Switched Section lamps on the rear panel should now be lit. The fan on the back panel should also start running.

### 3.3.2 Front Panel of the MT06000A unit:

SC1000 System Controller

1. On the front panel of the SC1000 set the Remote/Local switch to Local.

2. Press the power switch on front panel and switch information shall be displayed on the front panel.

3. Switch the Remote/Local switch to Remote and the display will be blank. Note: The unit is powered up when in Remote position, however there is no indication the SC1000 power in on.

### FI7000 Field Probe Interface

1. On the front panel of the FI7000 field probe interface turn on the power switch and shall illuminate to indicate that prime power is applied.

2. With the laser key turn the keyswitch to enable the laser power supply.

3. Press the Laser On switch, it will illuminate momentary switch to start laser on sequence. Laser is on when switch is illuminated. The Fiber Optic Status LED will illuminate Green when the fiber optic connections is sensed. It will illuminate Red if cable fault is present. The System Fault LED will illuminate Red if probe communications is terminated and the fiber optic cable is still sensed. A Off LED indicates safe condition (no faults).

### FM7004A

1. Press the power switch and the Main menu on the touch screen display will appear. *NOTE: The power switch controls power to the FM7004A only, it does not affect power at the field probe(s).*

2. Use the touch screen display for setup of field probe.

# 4. SYSTEM SOFTWARE SETUP

## 4.1 OVERVIEW

The test set-up begins with loading all of the test equipment into the software. Once the equipment has been loaded, it can be used for all future tests.

The steps basically flow with the headings found on the left side of the multi-tone software screen (Figure 4-1). They are:

1. Under **Equipment** you load all of your test laboratory equipment.
2. Under **Test Set-up** you load the test criteria
3. Under **Field Uniformity** you'll test field uniformity at single tone levels
4. Under **Multi-tone Configuration**, you'll test multi-tone calibration for forward power and field strength requirements while testing for linearity and harmonics
5. Under **Run Test**, you'll run the test.

Comprehensive online definitions and descriptions are available under the **Help** tab

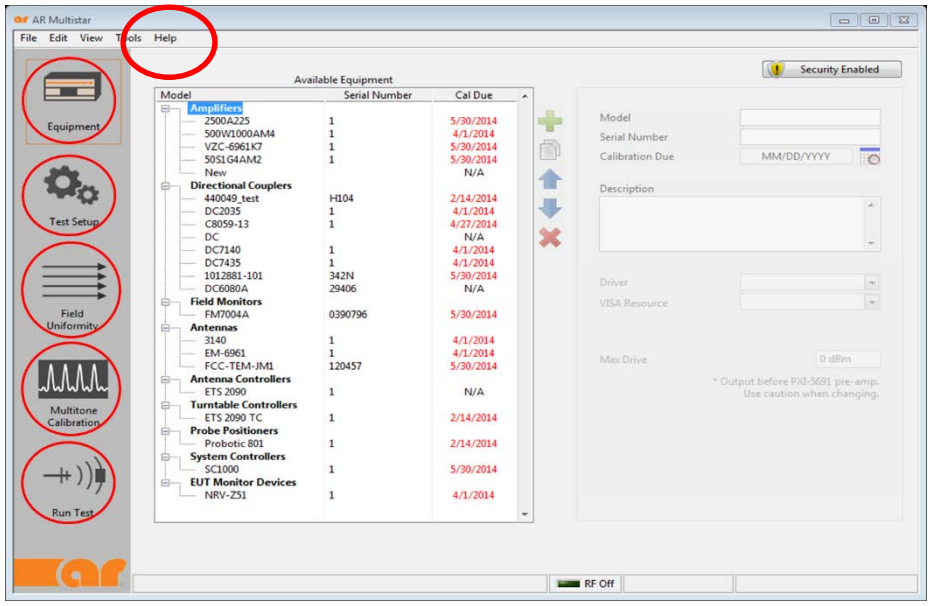



Figure 4-1

## 4.2 LOADING EQUIPMENT

The following pages are going to demonstrate how to load each type of equipment into the software. Note that with the exception of the directional couplers and antennas, the components need to be physically connected to the GPIB bus. This includes amplifiers, field monitors, antenna controllers, turn table controllers, probe positioners, system controllers and EUT monitoring devices.

Once the equipment is connected, look at the Main Menu of the software (Figure 4-1), highlight the type of equipment on the left side of the screen and then click on the green "plus sign' on the right side of the screen. From the main menu, select **Equipment**. The equipment list is categorized by type of equipment and then serial number and then calibration due date (Figure 4-2).

*Notice that if a piece of equipment is out of calibration, the 'Cal due date' is listed in red. Also please note that you can have identical equipment with different serial numbers.*

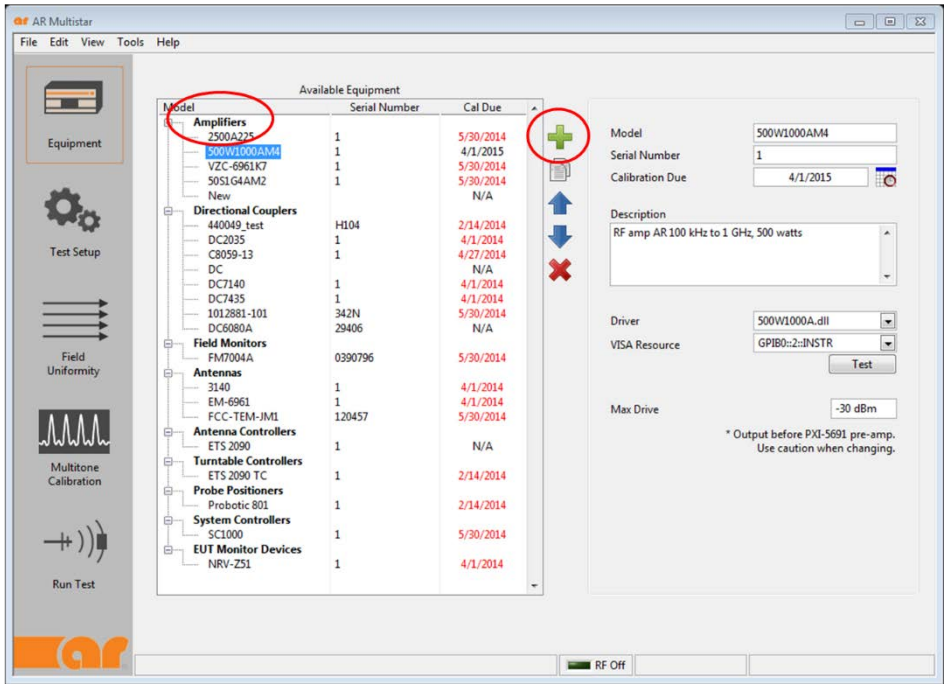



Figure 4-2

### 4.2.1 Loading Amplifiers

To add an amplifier, under available equipment, select **Amplifier** then the plus sign. From there you can input the model, serial number and calibration due date along with any special description. When adding an amplifier, there are some special considerations that you should keep in mind. If the amplifier can be remotely controlled for example, a driver needs to be selected. The amplifier GPIB address is selected by clicking the VISA Resource and finding the address on the bus. If amplifier is not remotely controlled then select **Manual** for the driver. Since the pre-amp has a gain of about 30 dB, the **Max Drive** should be set to -30 dBm which gives a max output power of 0 dBm at the **Signal Out** connection located in the back of the multi-tone system.

To test the amplifier remotely select the **Test** button and the **Amplifier Test Panel** (Figure 4-3) will be displayed.

With the amplifier test panel, you can turn the amplifier power on and turn the RF on by selecting the **Operate** mode.

You can also control the gain of the amplifier using the gain knob or enter the gain in percentage with the **Set** button. The **Check** button will check for interlock or amplifier faults. If everything checks out, then you can move on to the next piece of equipment.

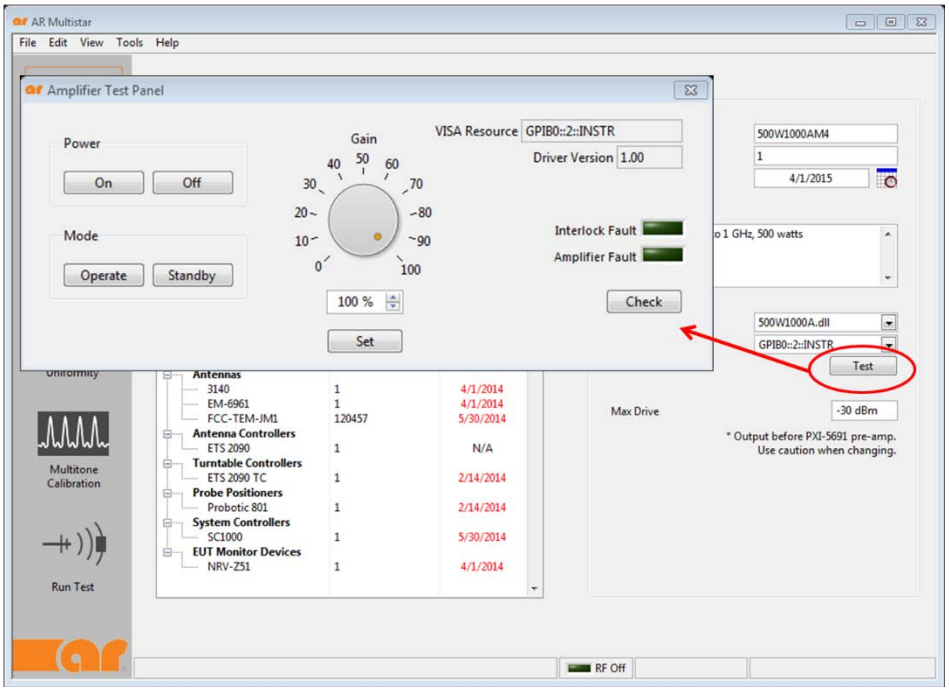



Figure 4-3

### 4.2.2 Loading Directional Couplers

You can load the directional coupler in a similar fashion to amplifiers (Figure 4-4). Again you can enter the model, serial number and calibration due date along with a brief description. This description will appear on the reports.

You can load the correction factors by selecting **Import Table** to import a csv table. If you need to save the loaded correction factors it can be saved by selecting the **Export Table** button.

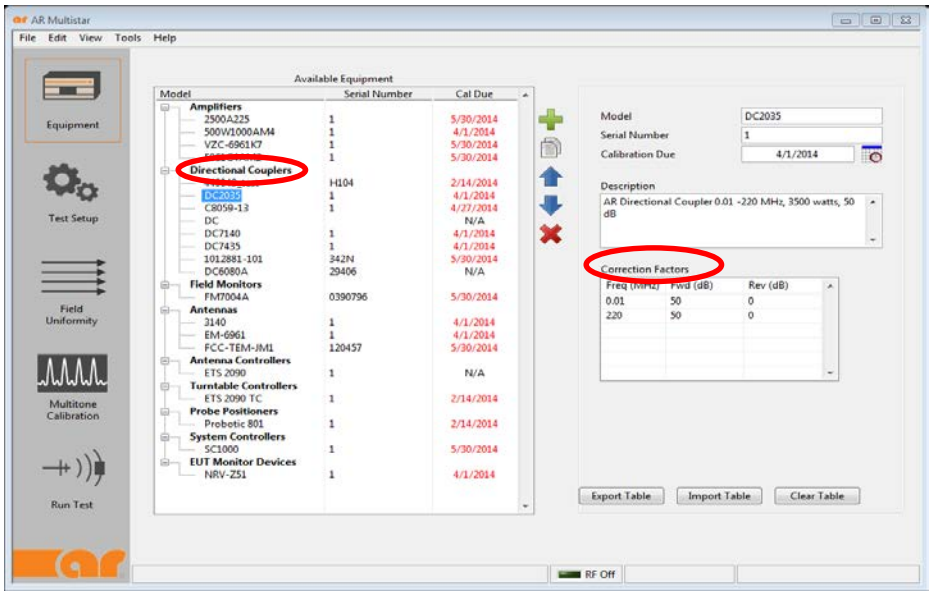



Figure 4-4

### 4.2.3 Loading Field Monitors

Adding the field monitor follows the same procedures as the amplifier (Figure 4-5).

Note that the driver and GBIB address need to be selected. The correction factors, composite, or x, y and z parameters can be entered manually or by importing a csv file by selecting import table. To save the correction factor table to a csv file select **Export Table** button. The **Clear Table** button will remove all the parameters in the correction factor table.

You have the option of selecting a check box titled **Use internal correction**, which uses the correction factors stored in the field monitor.

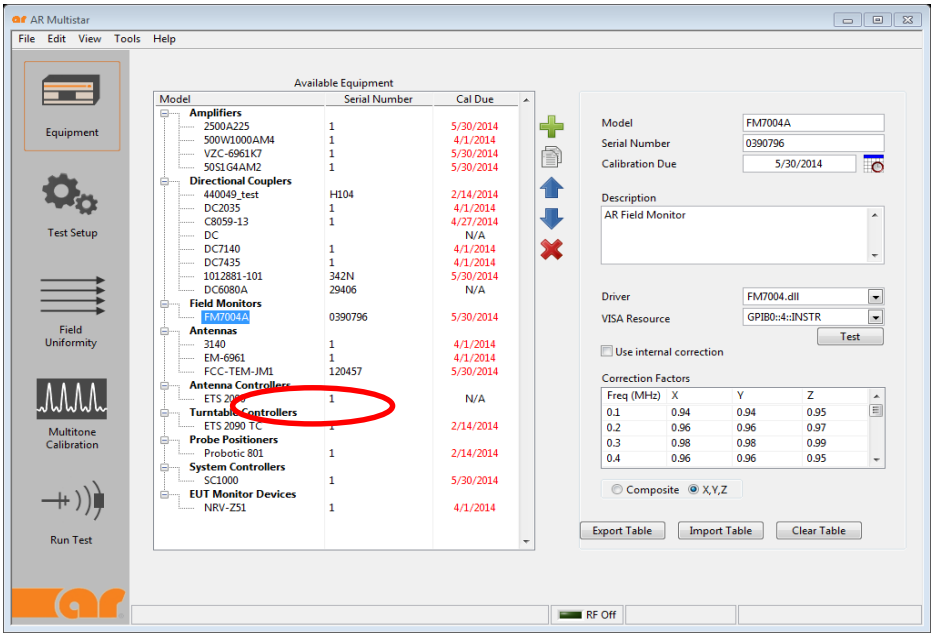



Figure 4-5

Like the amplifier, you can test the field monitor by selecting the **Test** button. This will display the **Field Monitor Test Panel** (Figure 4-6).

At this point, the user can type in the frequency of interest, and the software will display the field strength from the field monitor probe. This test demonstrates that the field monitor and field probe are communicating with the multi-tone software.

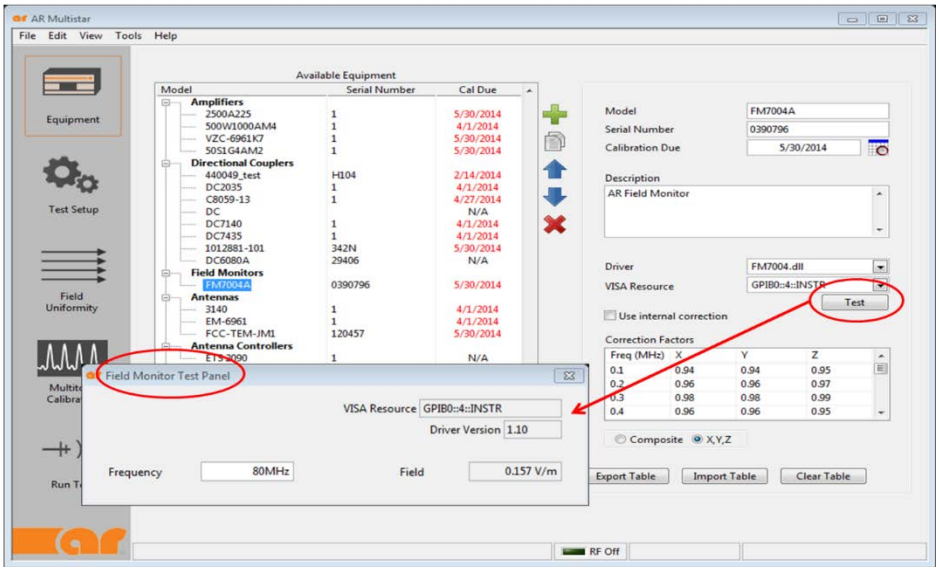



Figure 4-6

### 4.2.4 Loading Antennas and Antenna Controllers

Like the directional coupler, you can add all of the antennas in the lab (Figure 4-7). Again the user can manually enter the model, serial number, calibration due date and a brief description which will appear on the report.

The antenna gain factors can be entered manually or by selecting **Import Table** button to import a csv file. Antenna gain factors can be saved to a csv file via the **Export Table** button.

The horizontal and vertical height should be entered especially if an Antenna Controller is used. The antenna controller uses this information to set the antenna position when going between horizontal and vertical heights.

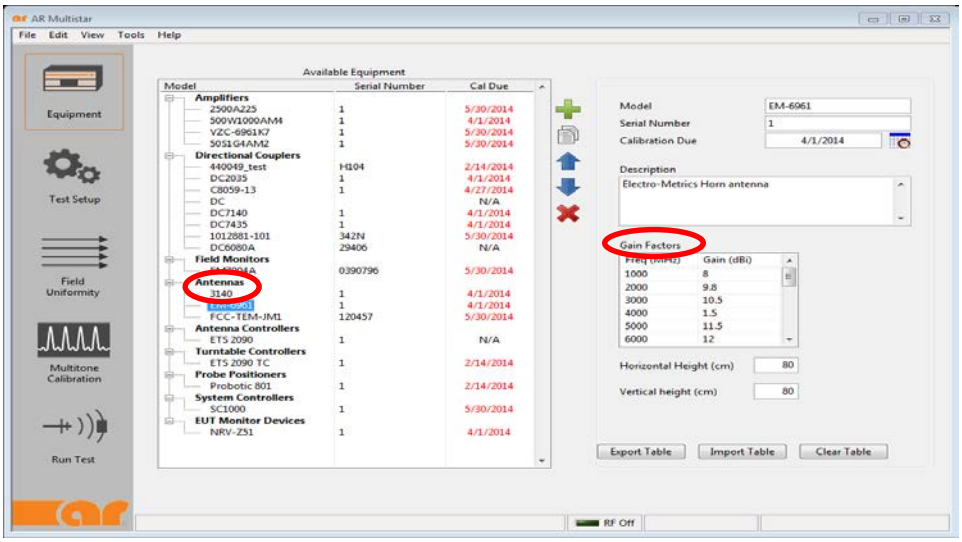



Figure 4-7

The antenna controllers can be added in the same fashion as the other equipment.

Like the amplifier, you can test the antenna controller by selecting the **Test** button. This will display the **Antenna Controller Test Panel** (Figure 4-8).

The user can set the **Polarization** and **Upper** & **Lower** limits plus the **Height** in centimeters.

Next select the **Set** button. The antenna should rotate to the entered polarization and height. The **Current Height** will display the antennas height in centimeters.

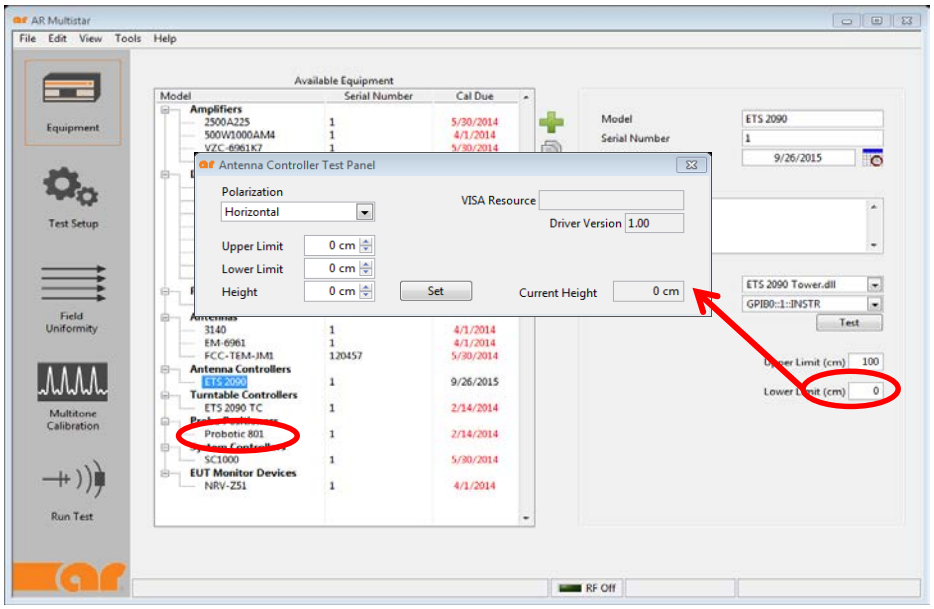

AR Multistar
File Edit View Tools Help
Equipment
Test Setup
Field Uniformity
Multitone Calibration
Run Test
Available Equipment
Model
Serial Number
Cal Due
Amplifiers
2500A225
500W1000AM4
Antenna Controller Test Panel
Polarization
Horizontal
VISA Resource
Driver Version 1.00
Upper Limit 0 cm
Lower Limit 0 cm
Height 0 cm
Set
Current Height 0 cm
Antennas
3140
EM-6961
FCC-TEM-JM1
Antenna Controllers
ETS 2090
Turntable Controllers
ETS 2090 TC
Probotic 801
SC1000
EUT Monitor Devices
NRV-Z51
Model ETS 2090
Serial Number 1
9/26/2015
ETS 2090 Tower.dll
GPIB0::1::INSTR
Test
Upper Limit (cm) 100
Lower Limit (cm) 0
RF Off

Figure 4-8

### 4.2.5 Loading the Turntable Controller

Again the user can manually enter the model, serial number, calibration due date and description of the turntable controller (Figure 4-9).

You'll need to select a driver for the turntable controller and the GPIB address. Then you are ready to test the turntable controller by selecting the **Test** button.

The turntable controller test panel will be displayed. The user can set the clockwise and counter clockwise limits plus the position in degrees.

Next select the **Set** button. The turntable should rotate to the entered position and should display the corresponding "set" position in degrees.

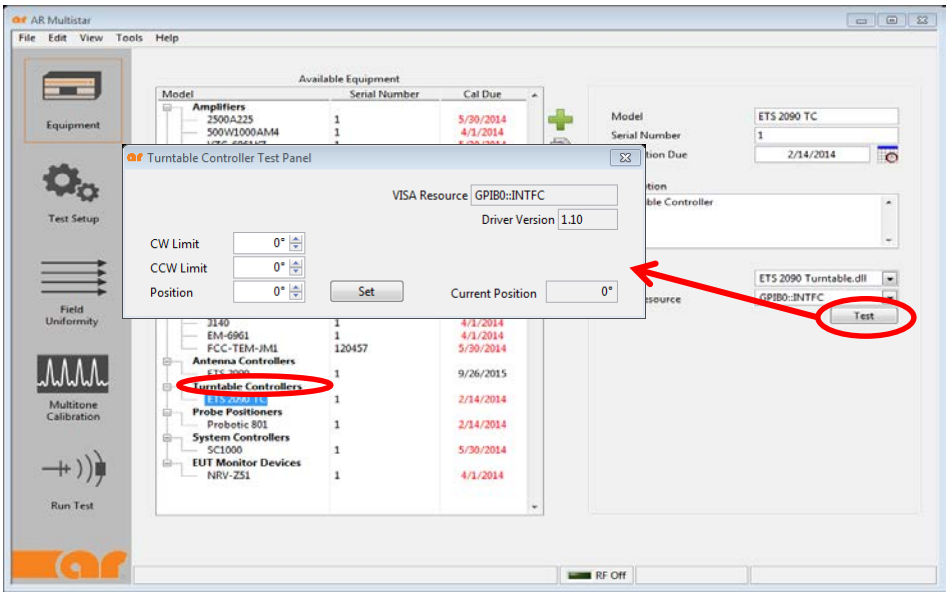



Figure 4-9

### 4.2.6 Loading the Probe Positioner

Moving on to the probe positioner, again, the user can manually enter the model, serial number, calibration due date and description, and select the probe positioner driver along with the GPIB address.

To test the setup, select the **Test** button and the **Probe Positioner Test Panel** will be displayed (Figure 4-10).

Enter the position information and select the **Move** command. The probe positioner should move to the entered position.

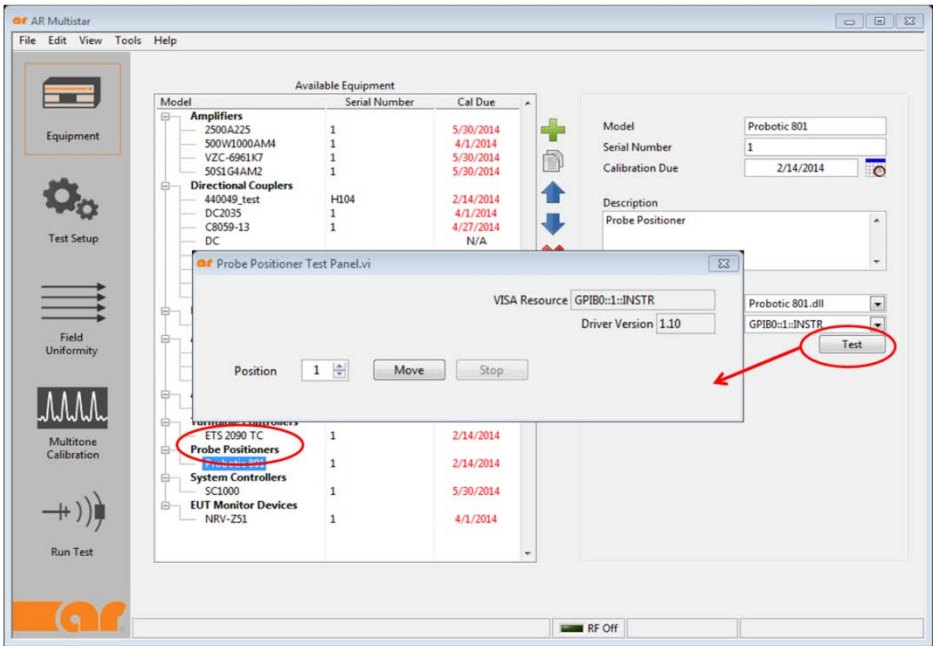



Figure 4-10

### 4.2.7 Loading System Controller

The system controller information can be entered under the system controller folder including the model, serial number, calibration due date and description (Figure 4-11). Like most other components, you'll need to select the driver and GPIB address, and test the setup. After selecting the **Test** button, the system controller test panel will be displayed.

Select a position for each switch (1 thru 7) and then select the **Set Switches** button.

If successful, you will hear the switches moving and the **Switches set successfully** status will appear.

The interlock can be checked by removing the interlock jumper plug located in the back of the multi-tone system. The status box should report an **interlock fault**.

Reinstall the interlock plug and check the status. The interlock fault should disappear. Use the **Reset** button to reset the switches to the default position.

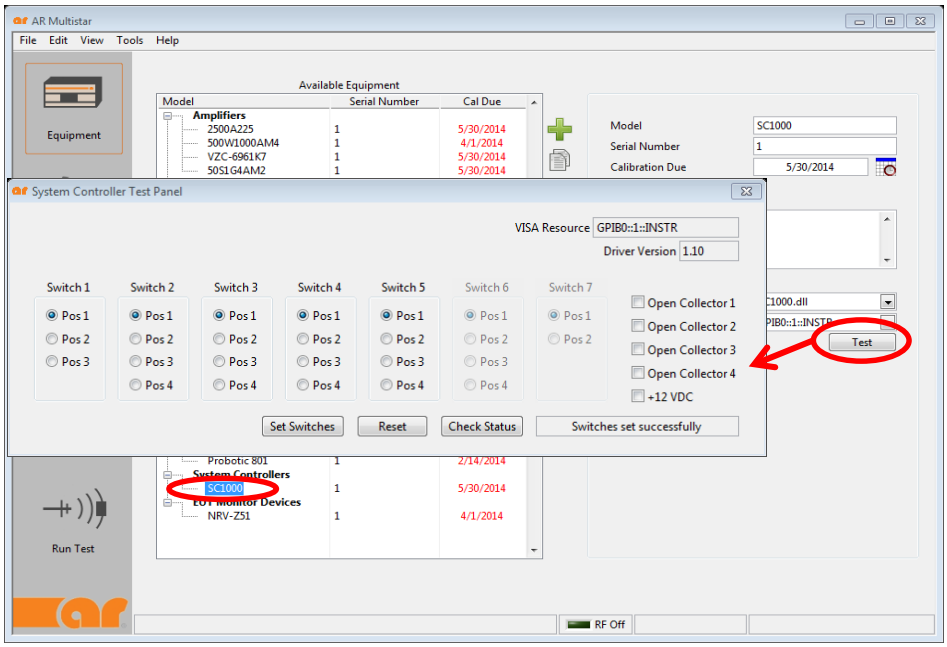



Figure 4-11

### 4.2.8 Loading End User Testing Monitoring Device

Add all of the remaining EUT test monitor equipment under the EUT Monitor Device folder entering the model, serial number, calibration due date and description (Figure 4-12).

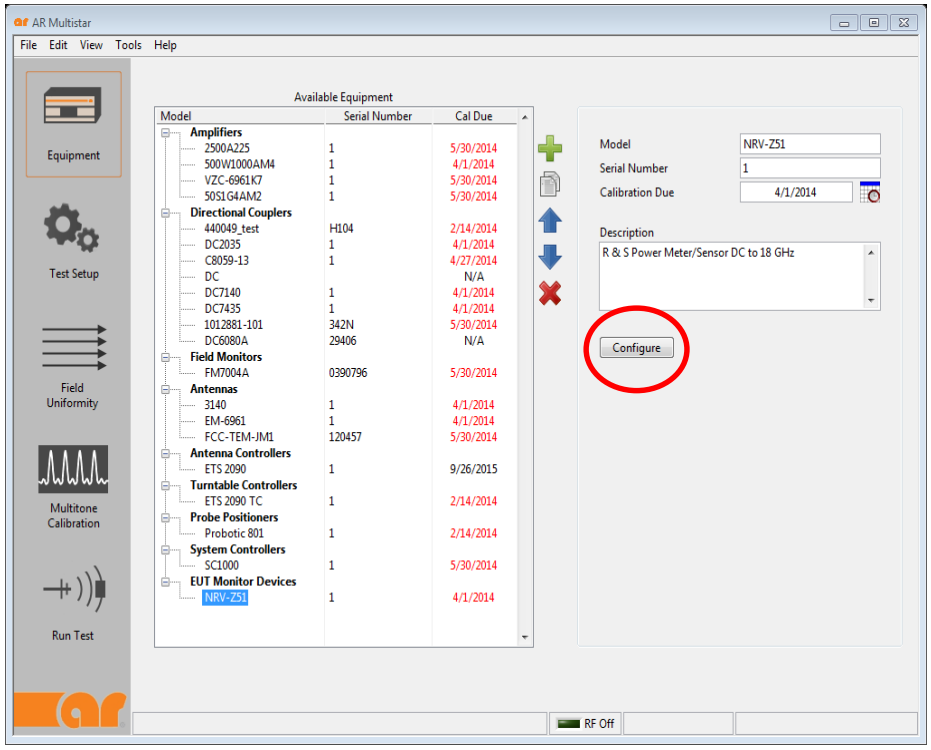



Figure 4-12

Select the **Configure** button. The **Edit EUT Monitor Device** display will be enabled (Figure 4-13).

Custom commands can be programmed to the EUT monitor equipment during various **Actions** listed on the left side of the screen. For example, a power meter initialization command could be sent during the **Start of Test** action, or a command to read the power meter could be sent during the **During the Dwell** action. You can even set the GPIB bus or serial port settings on the EUT Monitoring Devices. The flexibility gives the user unlimited customization options.

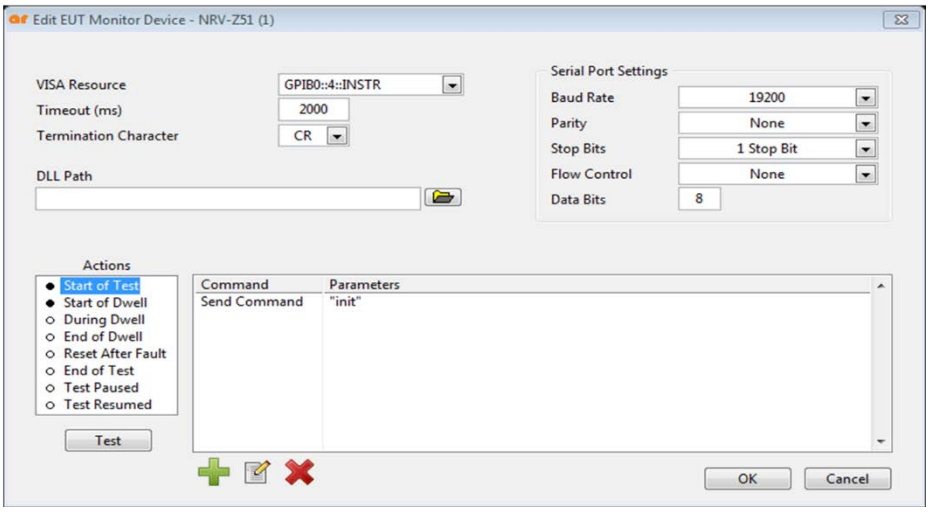



Figure 4-13

## 4.3 TEST SETUP

### 4.3.1 Load Test Parameters

Select **Test Setup** from the left side of the screen (Figure 4-14).

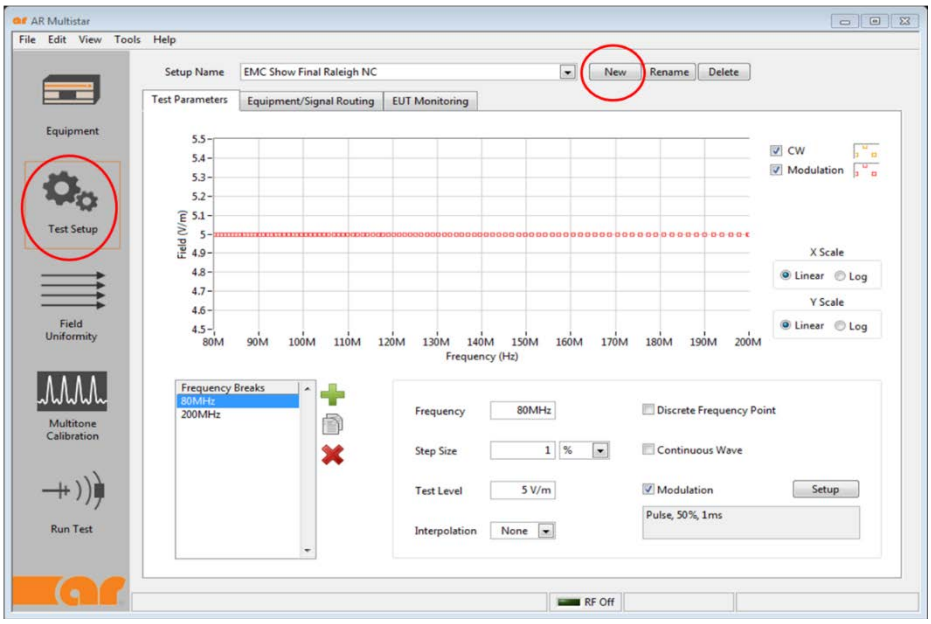



Figure 4-14

Using the green plus sign, you can set frequency breaks by entering the frequency in the frequency box. The step size can be set in either percent or fixed frequency step size.

Interpolation between frequency steps can be set as either **None**, **Linear** or **Log**. You can use the **Discrete Frequency Point** to set a custom clock frequency or any other frequency required for testing.

Select **Continuous Wave** for **CW**. The graph will plot each segment based on step sizes, field strength and interpolation between frequency steps.

The graph has selectable scales (linear or log).

Under **Test Set-up**, select **New** to display the **New Test Setup** menu.

### 4.3.2 Selecting Test Setup

The **New Test Setup** menu (Figure 4-15) has three options: first option is to **Use a predefined standard**, second **Copy an existing test setup**, or third to **Create a new, blank test setup**.

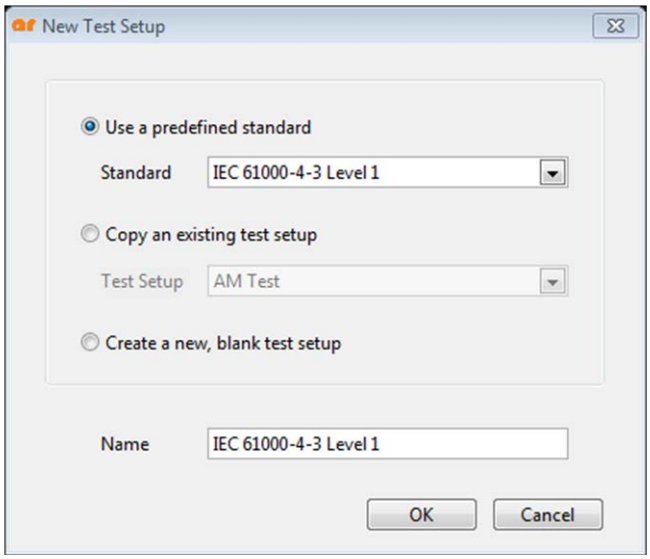



Figure 4-15

### 4.3.3 Modulation Setup

From the bottom right corner of the screen, select the **Modulation Setup** button (Figure 4-16). A pop-up titled **Edit Modulation** will appear. In this screen, you can select **AM** or **Pulse** Modulation.

Under AM Modulation, constant peak can be selected (Automotive). In addition, the modulation depth and frequency can be selected from drop down menus.

Under Pulse Modulation, the user needs to input both the Duty Cycle and Period.

*NOTE: the AM Modulation and Pulse Modulation can be selected concurrently.*

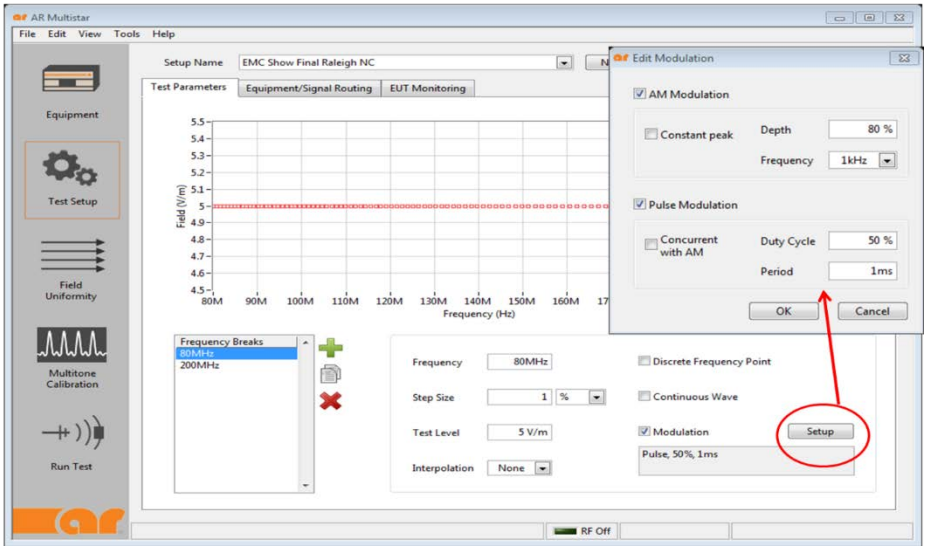



Figure 4-16

### 4.3.4 Defining Equipment and Signal Routing

Now that you've established the test parameters, it's time to select the equipment for the test. Under the **Equipment/Signal Routing** tab (Figure 4-17), select the system controller, field monitor, probe positioner, and turntable controller. Note that all of the equipment that you loaded earlier will prepopulate this table.

In addition, the system controller (SC1000) and field monitor (FM7004A) are part of the multi-tone system so these will be preloaded as well.

You can click on the plus sign to set up the connection for the antenna, amplifier, antenna controller and directional coupler.

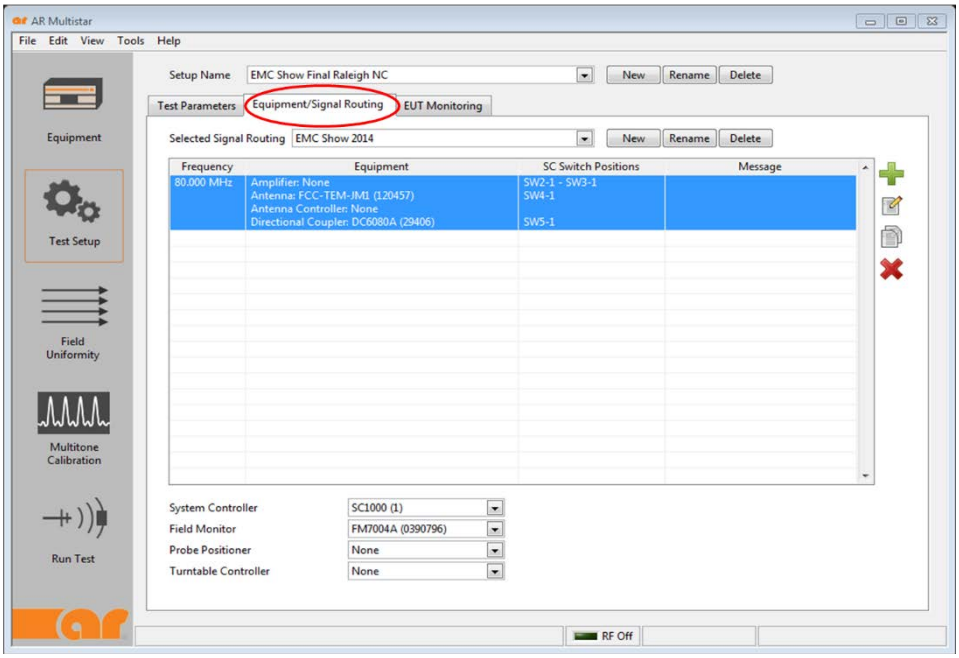



Figure 4-17

### 4.3.5 Setting Signal Routing Break

Under the Equipment/Signal Routing tab, when you click the plus sign, the **Edit Signal Routing Break** menu will be displayed (Figure 4-18).

From here, you'll: enter the start frequency; assign the appropriate amplifier signal out from the vector signal generator; direct the output of the amplifier to the appropriate antenna; select the antenna controller; and route the directional coupler (located on the output of the amplifier) forward power to the vector signal analyzer to measure amplifier output power.

The SC1000 has auxiliary inputs if custom monitoring is required.

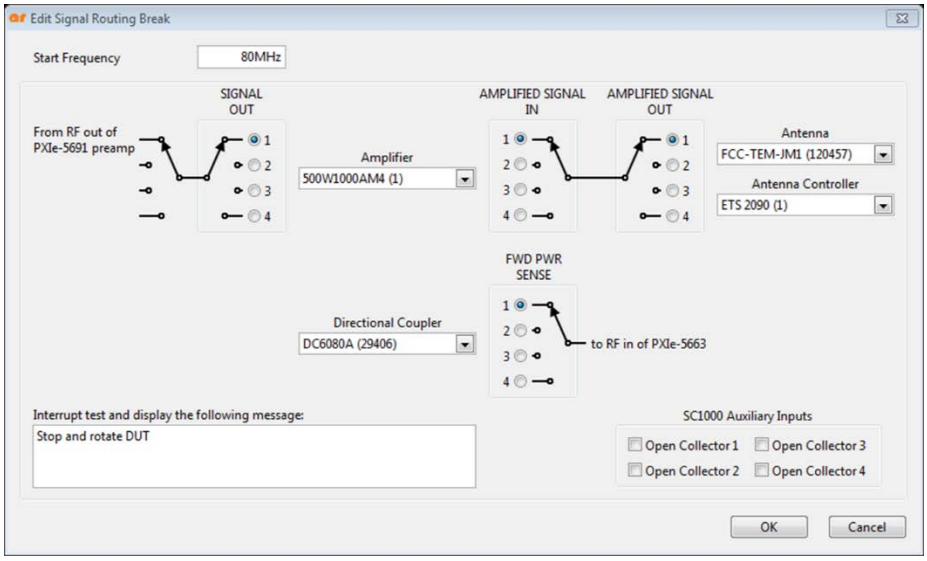



Figure 4-18

### 4.3.6 Selecting Dwell Settings

If EUT monitoring equipment is used, the user can customize any equipment that interfaces via the GPIB or serial buses. In addition, you can customize the EUT Reset by either sending a command or manually resetting the EUT (Figure 4-19).

Note that in the lower left portion of the screen, you have the option to preselect the behavior should a failure be detected during the dwell. Your choices are: to automatically switch to test individual tones; to pause the test and display the Report event window; or to mark the failure and continue with the next set of tones.

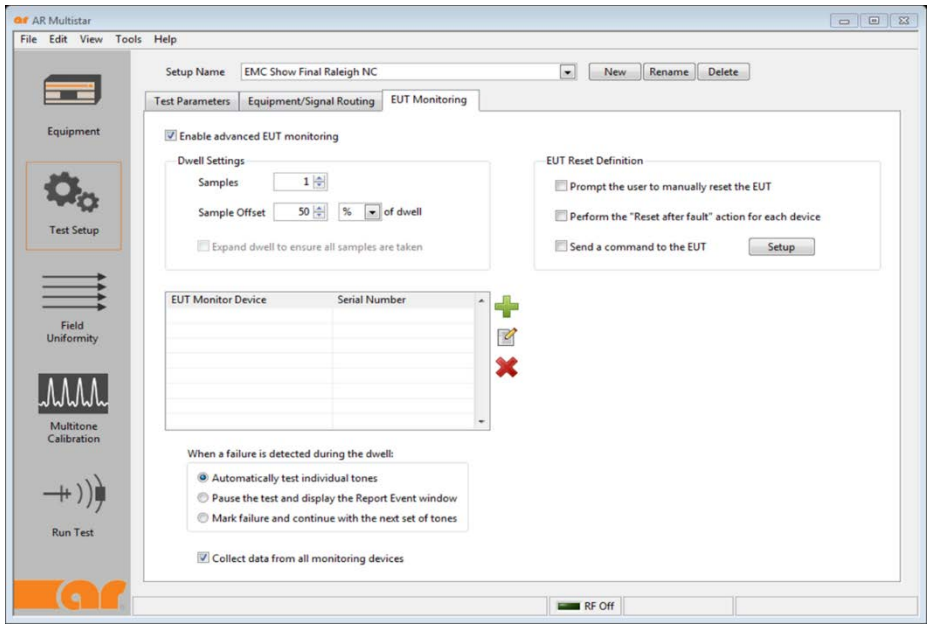



Figure 4-19

## 4.4 CALIBRATION OF FIELD UNIFORMITY

Select the **Field uniformity** option and then select the **Play** button. The field uniformity options menu will be displayed (Figure 4-20). The user has the option of leveling on constant field or constant power.

The number of positions is selectable from 1 to 16 positions. The power level between frequency steps can be **Unchanged**, or **Drop and Re-level** The drop and re-leveled power is reduced by the user selected level.

The starting drive level can be set, but this only applies to the first frequency step. At this point, the field leveling tolerance and power leveling tolerance can be set as well.

Select the **Next** button and additional field uniformity options will be displayed.

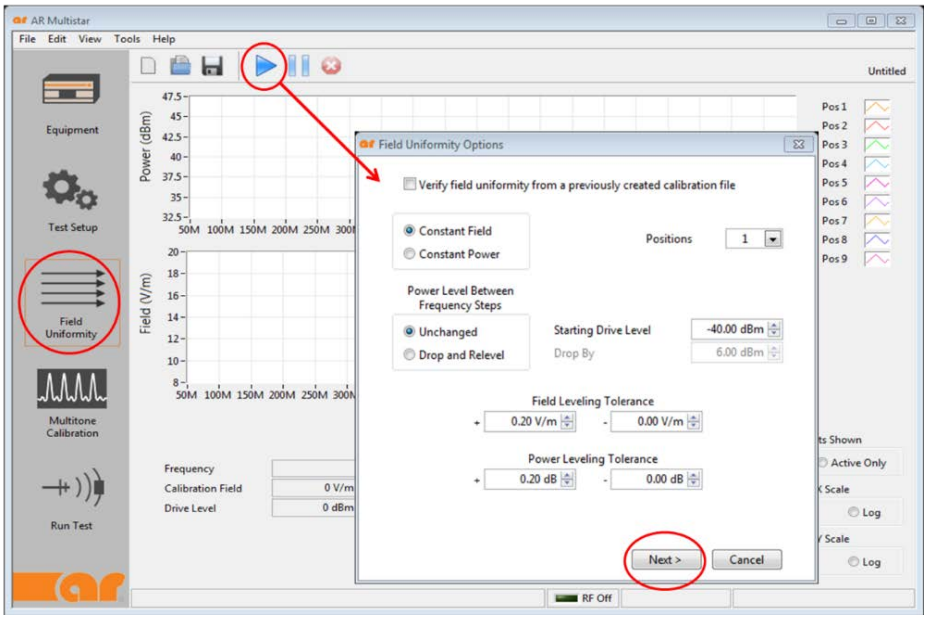



Figure 4-20

### 4.4.1 Select Antennas to Calibrate and Antenna Polarization

From here, you will select the antennas and associated polarization to be calibrated (Figure 4-21).

The antenna polarization is selected from the following options:

- vertical only
- horizontal only
- vertical then horizontal
- horizontal then vertical.

In this example the antenna's vertical position will be calibrated first then the horizontal position.

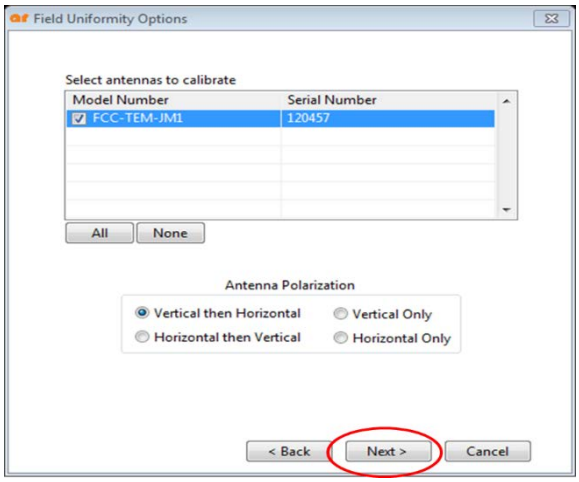



Figure 4-21

### 4.4.2 Loading EUT Test Information

On the Test Information screen (Figure 4-22), you will enter the test information that will appear on the calibration test report. Once you press **Run**, you will return to the Field Uniformity screen.

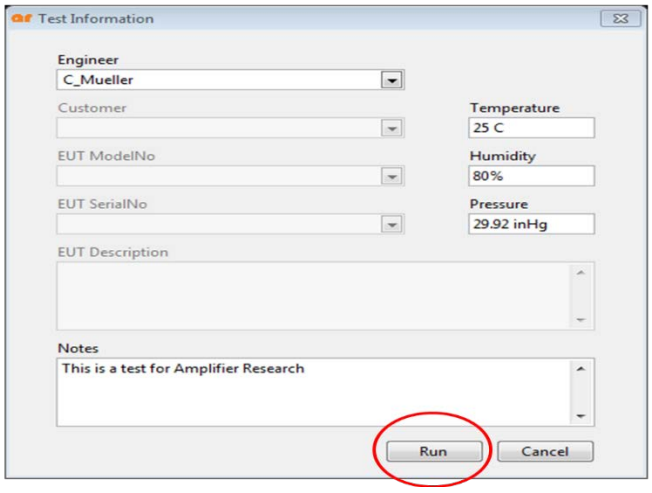



Figure 4-22

### 4.4.3 Running Field Uniformity Calibration

The calibration is now ready to run (Figure 4-23).

Since in this example, the field probe will be placed in four positions, you will be prompted to set the probe to **position 1**. After you set the field probe to position 1, press **Continue**.

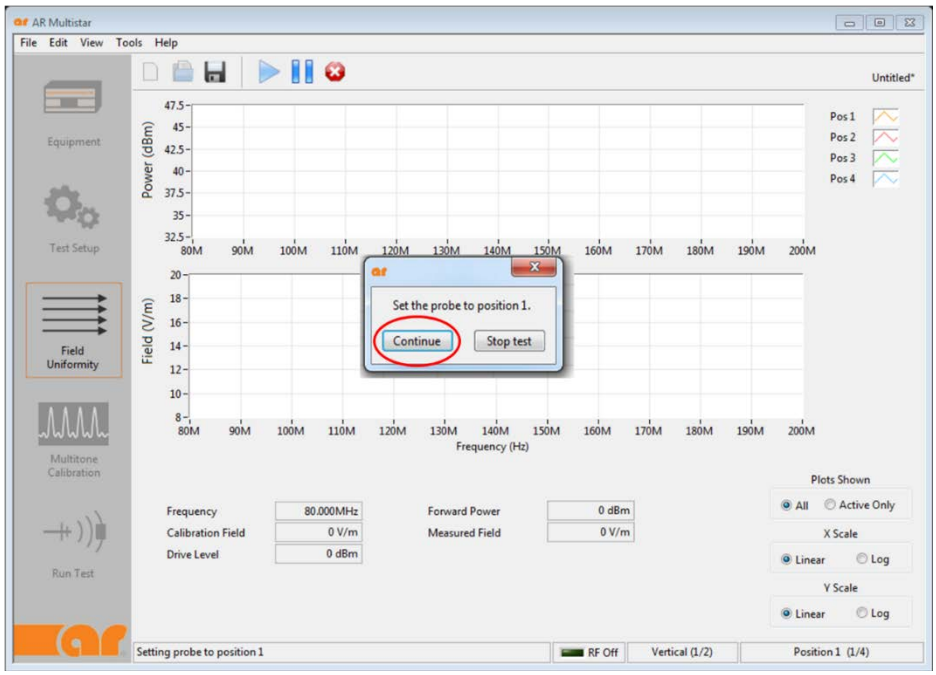



Figure 4-23

Once you press **Continue**, the field uniformity test will begin. Based on one tone, the objective is to level the field strength based on test setup calibration requirements within the field strength tolerances defined earlier.

The amplifier's forward power and the field probe's measured field strength are plotted.

In addition, the drive level from the VSG, amplifier forward power and field strength are measured and recorded in tabular form.

A series of status bars are listed across the bottom of the screen.

These displays indicate:

- what the software is doing (Measuring field and power)
- whether or not RF is On by the color of the LED being green or red
- the position of the field probe and
- the polarization of the antenna.

In this example vertical polarization was selected first (Figure 4-24).

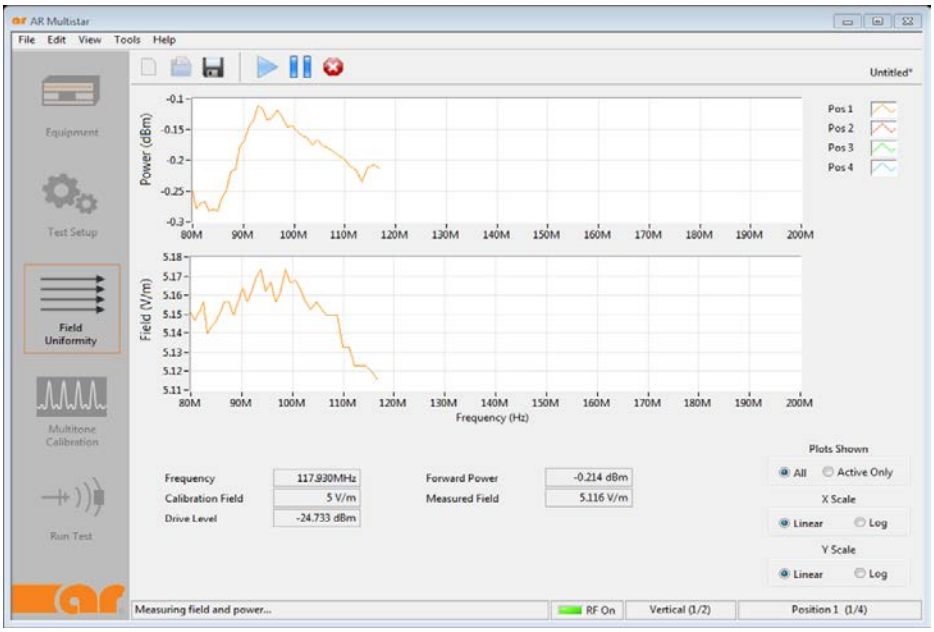



Figure 4-24

After completion of position 1 the software will prompt the user to move the field probe to the next position. (In this case positon 2) Click **Continue** and the software will repeat the measurements at **position 2.** (Figure 4-25)

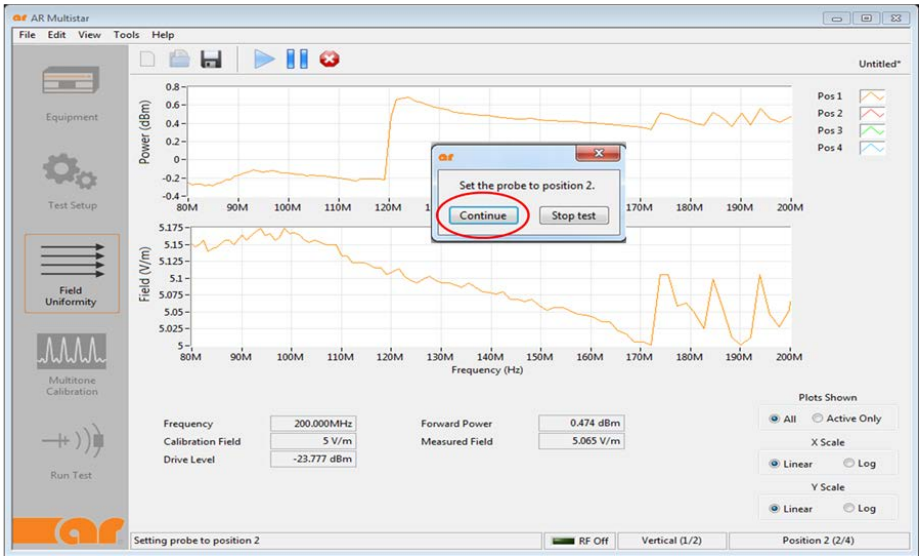



Figure 4-25

After completion, the software will prompt the user to move the field probe to **position 3** with the antenna in the vertical polarization. Click **Continue** and the software will repeat the measurements at **position 3** (Figure 4-26).

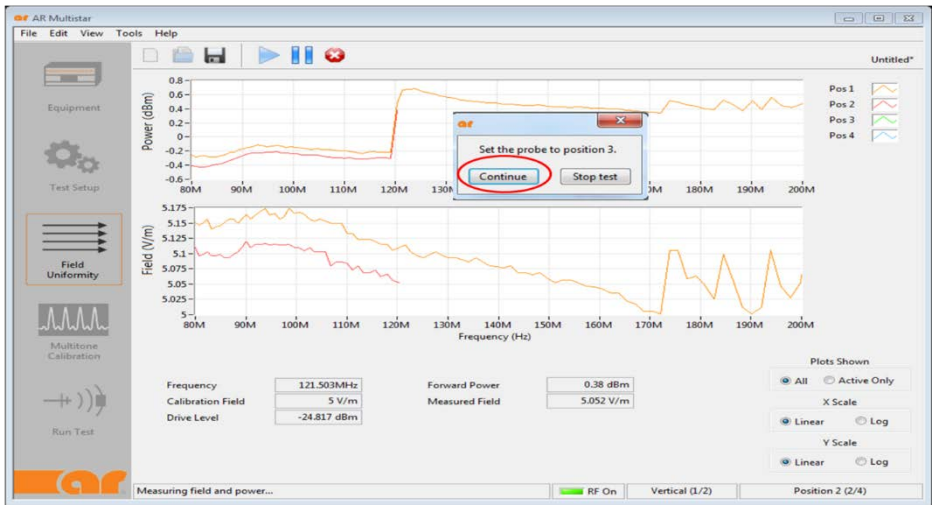



Figure 4-26

After completion of position 3 the software will prompt the user to move the field probe to **position 4**. Click Continue and software will collect data and graph data for position 4 with the antenna in the vertical polarization (Figure 4-27).

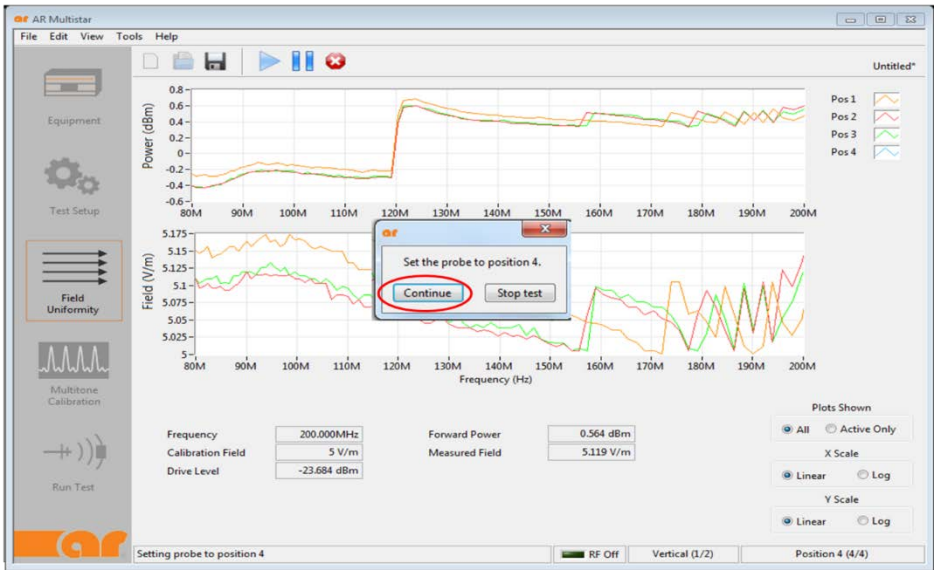



Figure 4-27

After measurement completion, the software will prompt the user to set the antenna polarization to horizontal and field probe to position 1 or 4 (Figure 4-28).

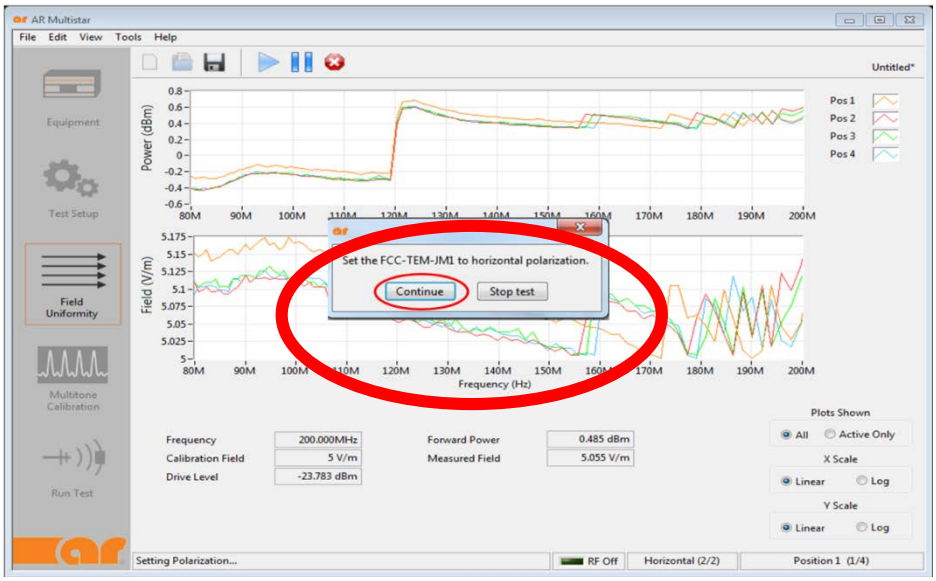



Figure 4-28

The software will prompt the user to set the field probe to position 1 (Figure 4-29). Click **Continue.**

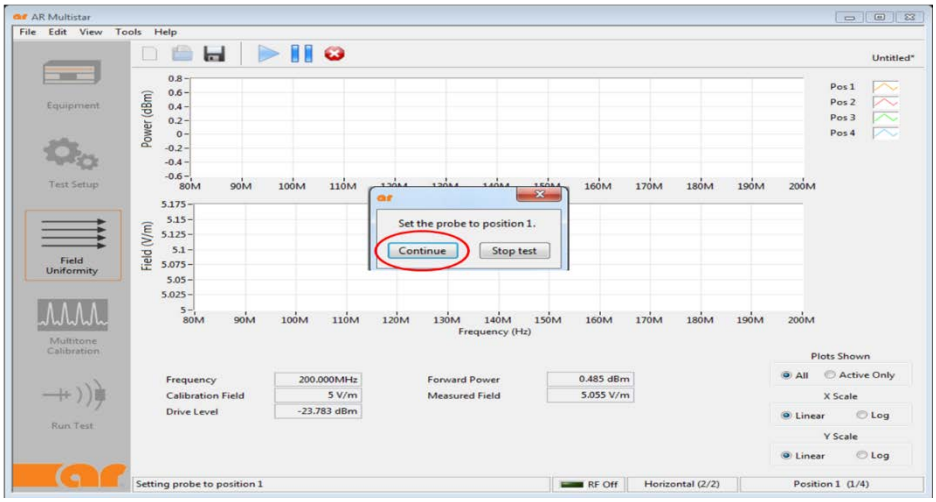



Figure 4-29

The software will repeat the steps for each position (1 thru 4) with the antenna in the horizontal position (Figure 4-30).


Figure 4-30

After the field uniformity test is completed a message at the bottom of the screen will display **Field uniformity check is finished** (Figure 4-31).

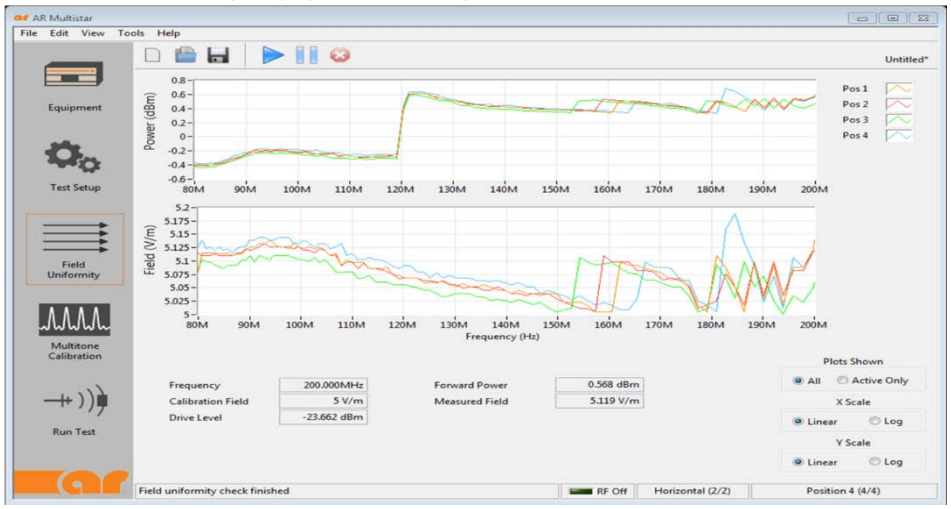



Figure 4-31

After the test is completed the software will prompt the user to select a file name to save the field uniformity calibration file (Figure 4-32).

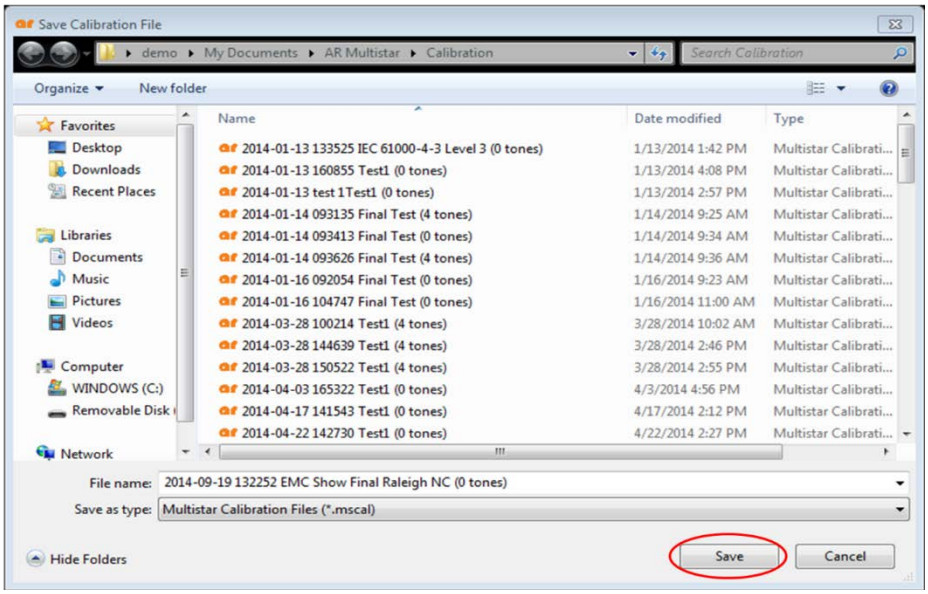



Figure 4-32

Up to now the calibration of Field Uniformity has been per the IEC Standard 61000-4-3. With the Multi-tone system, the Field Uniformity calibration will be faster than convention equipment because of the speed of the built in PXIe bus.

The second part of the calibration is to calibrate the tones as a set, which is the only step required above and beyond the IEC Standard.

## 4.5 MULTI-TONE CALIBRATION

It is important at this point to check the linearity at the 2dB compression point and checking the harmonics level.

To begin, from the left side of the screen, select **Multi-tone Calibration.**

Select the **Play** button and on the display **Multi-tone calibration** options will appear.

The user has the choice of how the calibration can run.

- One method is to start with 1 tone and increase the level, until the limit is exceeded.
- The second method is to start with multiple tones (based on what the user has selected) and decrease (if necessary) until within limits. This is the preferred way because it is faster because all the tones are tested at the same time instead of one at a time.

The user can select the number of tones per each set in addition to establishing the linearity and harmonic limits.

The default values are **3.1dB** for linearity and **6dBc** for harmonics.

Finally, the positive and negative power level tolerances can also be entered.

### 4.5.1 Selecting Calibration Options

Under **Multi-tone calibration**, set calibration option, input linearity, harmonic limits and input power leveling tolerance (Figure 4-33).

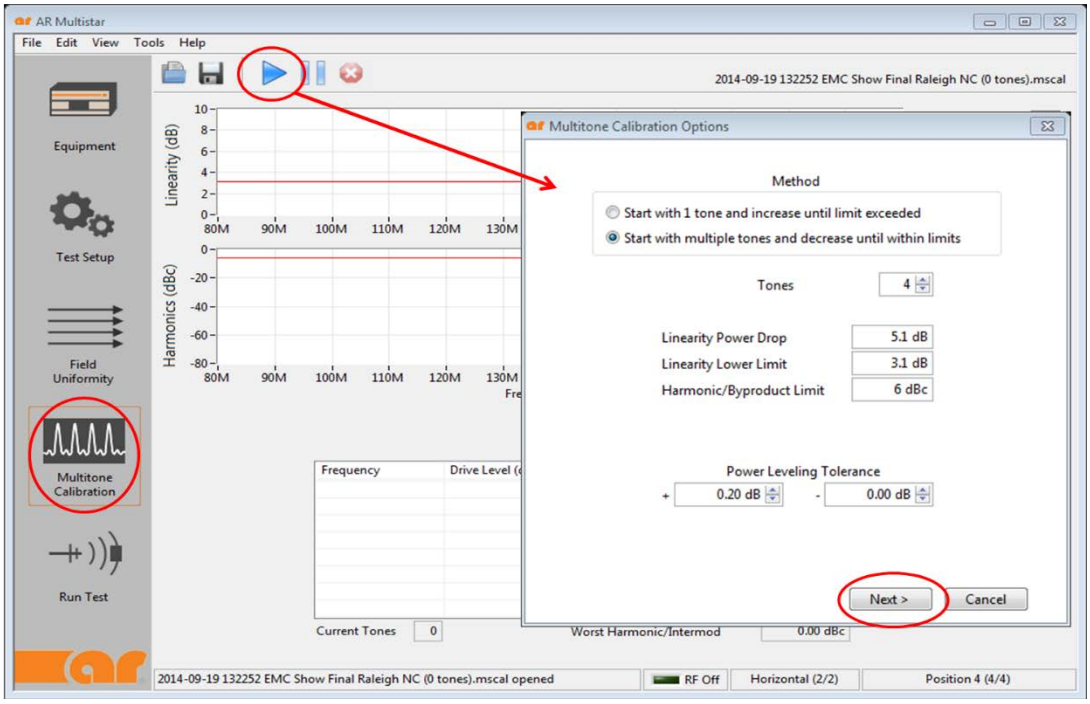



Figure 4-33

### 4.5.2 Selecting Antenna to be Calibrated and Antenna Polarization in Multi-Tone Environment

Click **Next** for additional calibration options. The user needs to select the antennas to be calibrated. (Figure 4-34)

In addition, the antenna polarization vertical or horizontal options need to be selected. Under **Multi-tone Calibration**, select the antenna to be calibrated and polarization type and sequence.

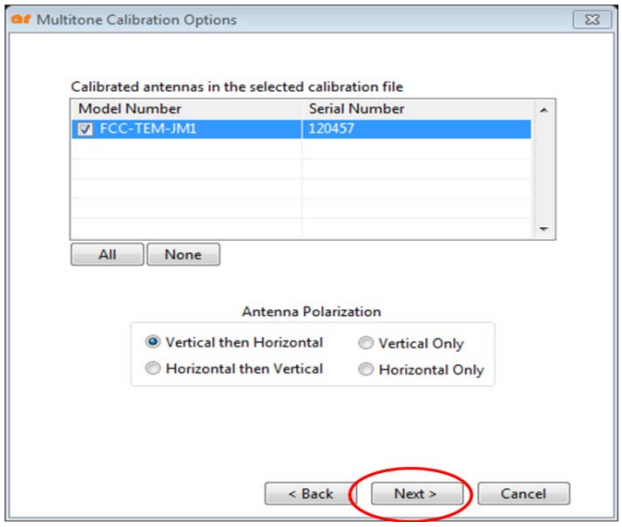



Figure 4-34

The test information needs to be filled out for the calibration test report (Figure 4-35). Then click **Run**

Under **Multi-tone Calibration**, complete test information for test report.

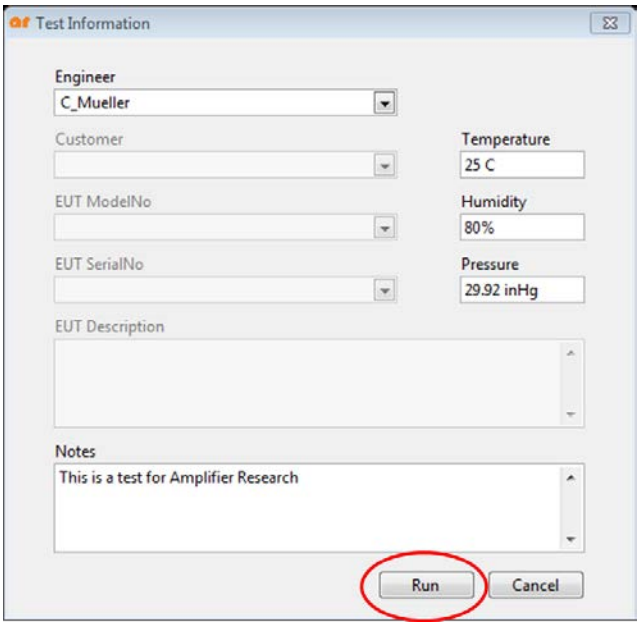



Figure 4-35

The software will prompt the user for the antenna polarization that needs to be setup (Figure 4-36). Select **Continue**.

Under **Multitone Calibration**, set up polarization type.

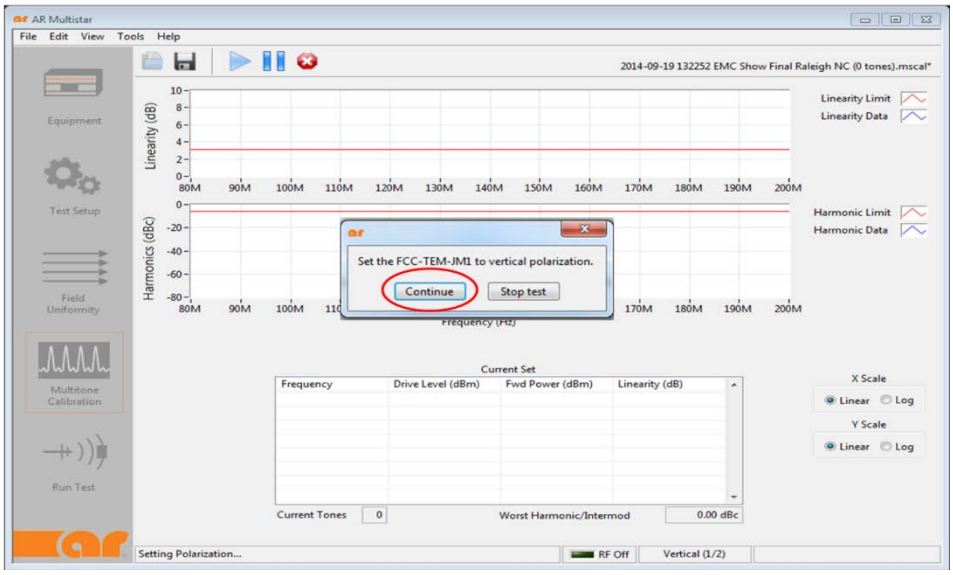



**Figure 4-36**

Based on the number of tones the user selected, the predefined linearity, harmonic criteria, and the testing method, the software will test for linearity and harmonics with as many tones as will pass.

Note that when you selected the multi-tone calibration options, you determined whether to start with one tone and add additional tones or start with multiple tones and eliminate one tone at a time.

The number of tones is based on two things: amplifier power and the tone spacing not larger than 150 MHz.

The software will record:

- the frequency in each set
- the VSG drive level
- the amplifier forward power
- the linearity
- the worst harmonic/intermod in that set of frequencies.

Under **Multitone Calibration**, under the first polarization type, test the linearity and harmonics (Figure 4-37).

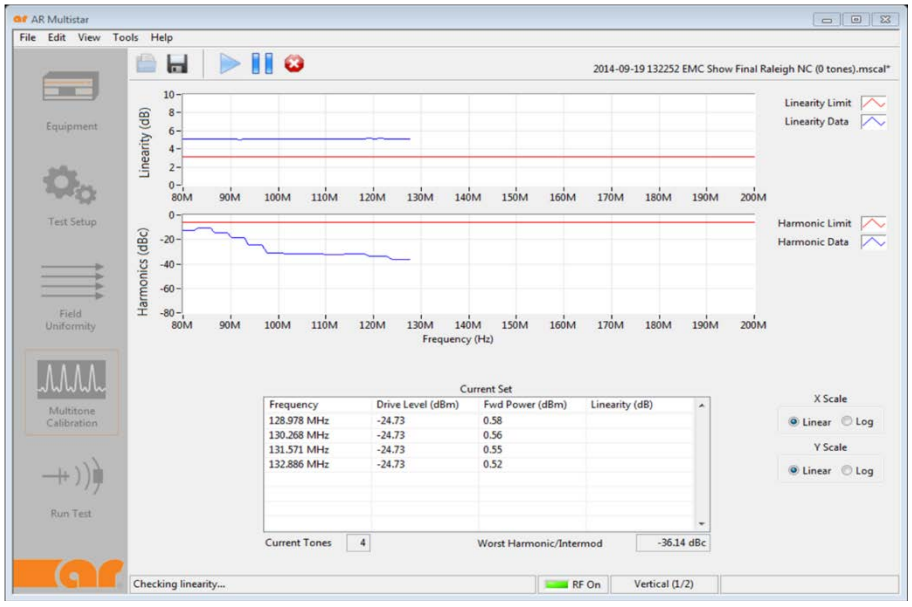



Figure 4-37

The linearity and harmonic will be recorded for each set of frequencies across the band.

After vertical polarization is completed the software will prompt you to setup the antenna to the horizontal position.

Click **Continue.**

Under **Multitone Calibration**, the software will record the linearity and harmonics and prompt for the antenna's second polarization type (Figure 4-38).

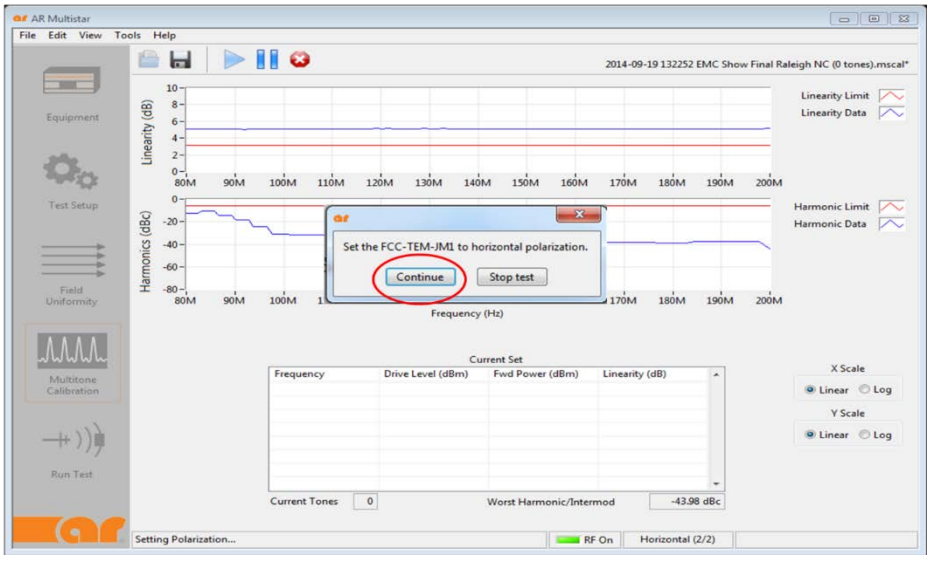



Figure 4-38

The software will repeat the linearity and harmonic measurement in the horizontal position.

Under **Multitone Calibration**, the software will prompt for the second polarization type, and measure the linearity and harmonics (Figure 4-39).

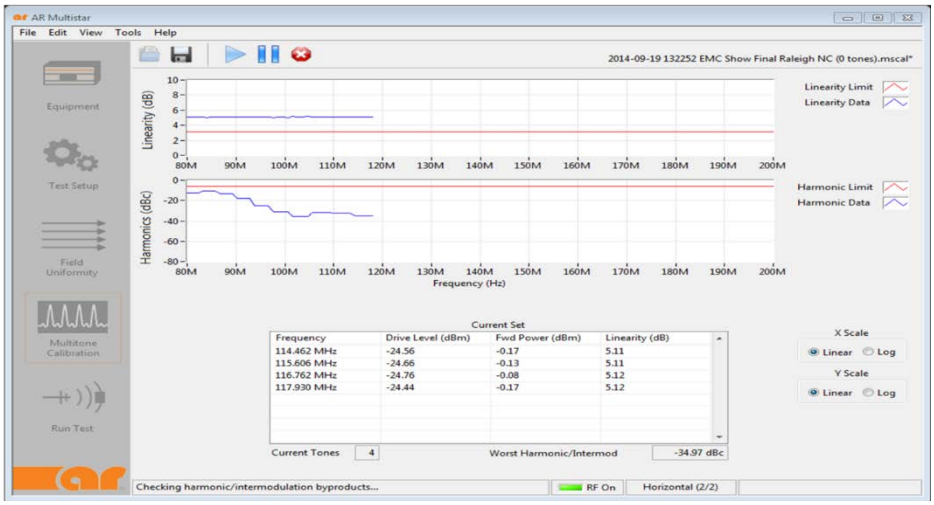



Figure 4-39

After calibration is completed, you are ready to save the multi-tone calibration by selecting the **Yes** button (Figure 4-40).

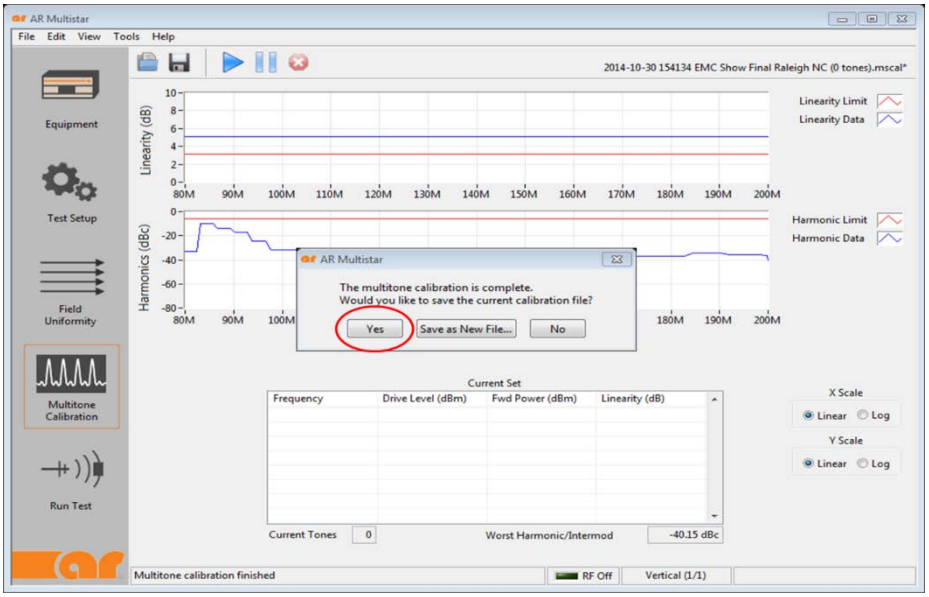



Figure 4-40

## 4.6 RUNNING A MULTI-TONE TEST

On the left side of the main screen, Select **Run Test** and then select **Play** button.

Under Run Test, we're ready to run the test. (Figure 4-41)

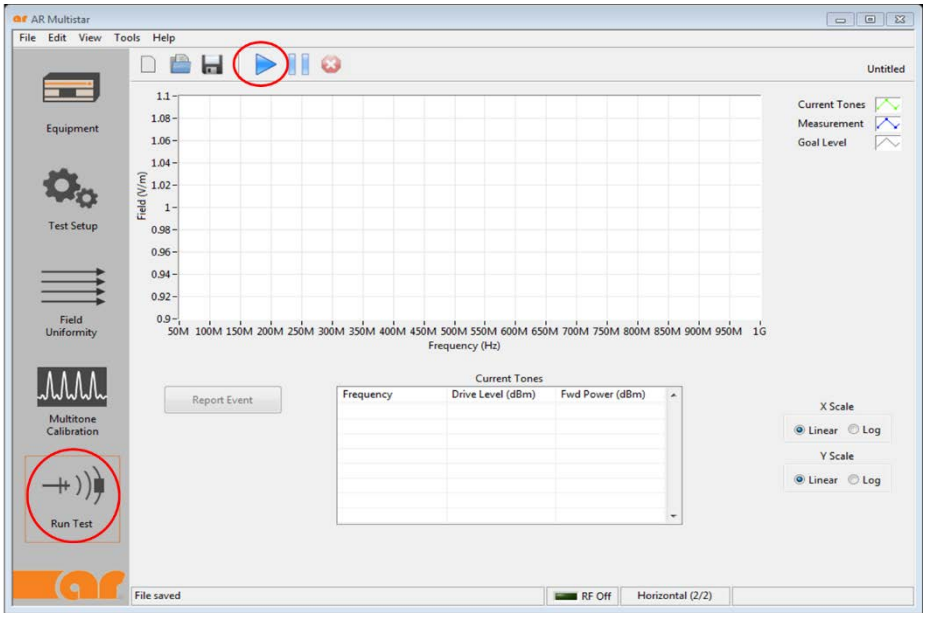



Figure 4-41

After selecting the play button, the final test options will be displayed.

### 4.6.1 Selecting Calibration File, Total Number of EUT Sides, and Entering Test Information

The **Calibration File** needs to be selected. The user chooses between the following two test options:

- either select EUT sides before changing antenna polarization
- or select polarization before changing EUT sides.

The **Total Number of EUT Sides** needs to be selected. A side is equivalent to an EUT surface. If all EUT sides are not requested, the user can specify the EUT sides that need to be tested. The dwell time and the power leveling tolerance are set here.

Click **Next.** (Figure 4-42)

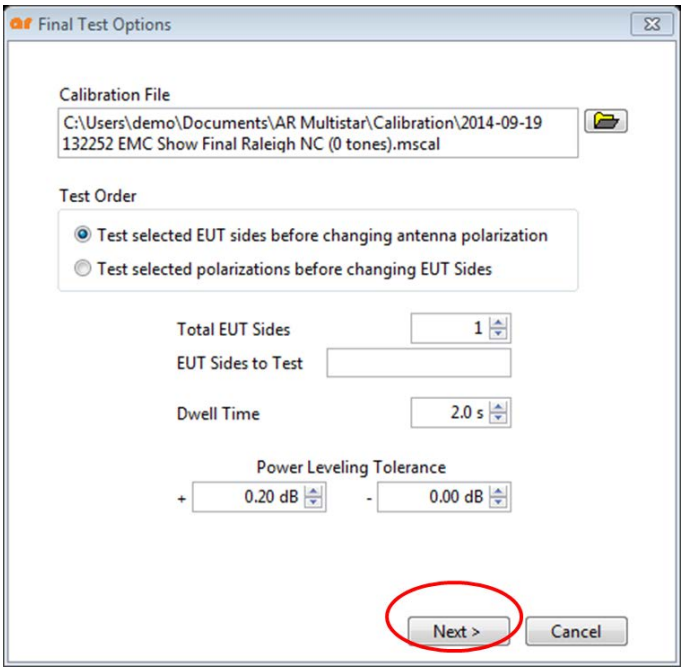



Figure 4-42

The test information for the test report can be entered here (Figure 4-43).

Click **Run.**

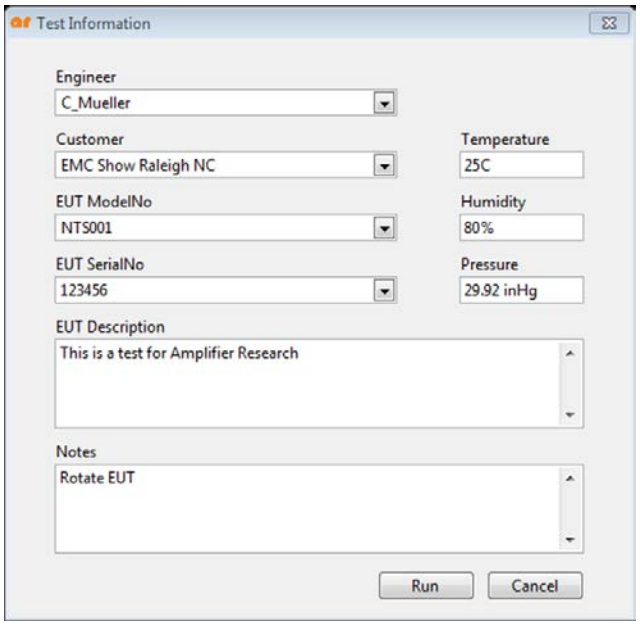



Figure 4-43

The software will set the number of tones per the calibration and re-level to the calibration level.

After the set of tones are re-leveled the software will dwell for the amount of time set by the user.

### 4.6.2 Running the Test and EUT Failure (Report Event)

Under Run Test, the test will begin (Figure 4-44).

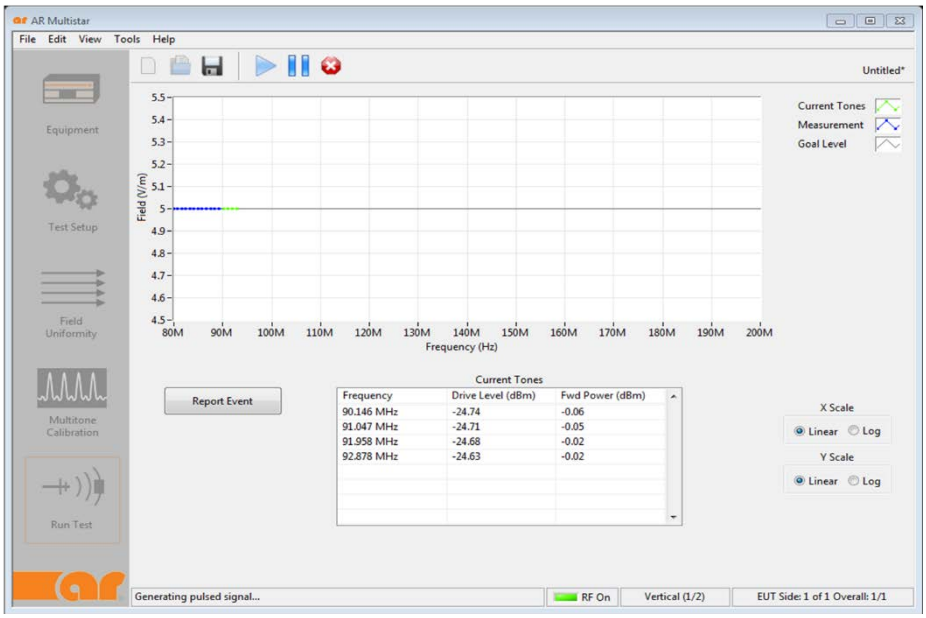



Figure 4-44

After each set of tones is completed, the software will plot the frequency coverage for that set in blue, and the number of current tones being generate in green.

If there is a EUT failure during these set of tones, the **Report Event** button can be selected to isolate which frequency is causing the problem.

Under **Run Test**, the software plots the frequency coverage and number of current tones (Figure 4-45).

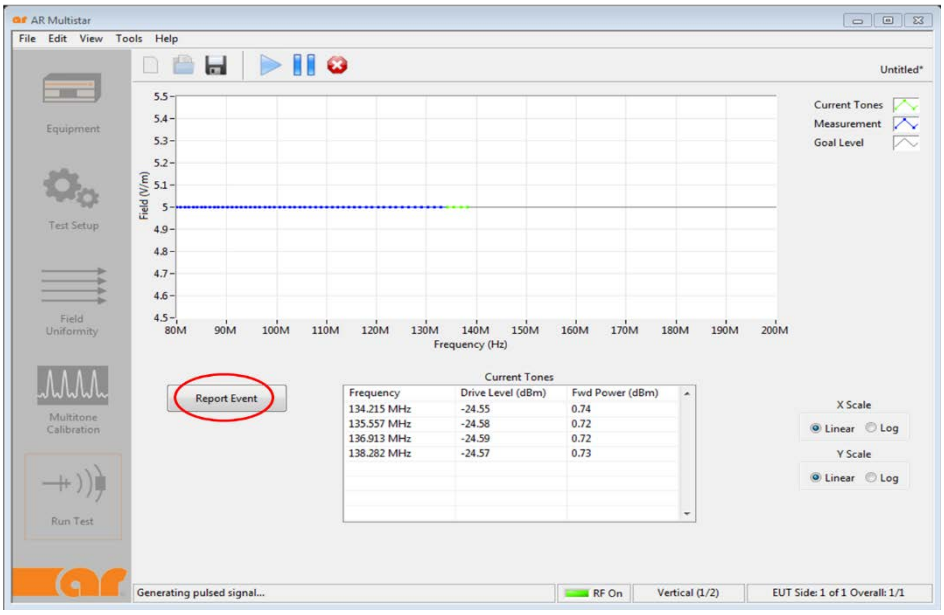



Figure 4-45

The **Report Event** menu will be displayed. The test is paused and the user can select a frequency from the set of tones displayed.

The test level and dwell setting can be adjusted if required. A pass or fail EUT status can be selected and event description can be entered.

Select the **Test** button. The test level and dwell will run the level and the amount of time selected.

Select the **Continue** button and the test will go to the next set of tones.

Under **Run Test**, select **Report Event** (Figure 4-46).

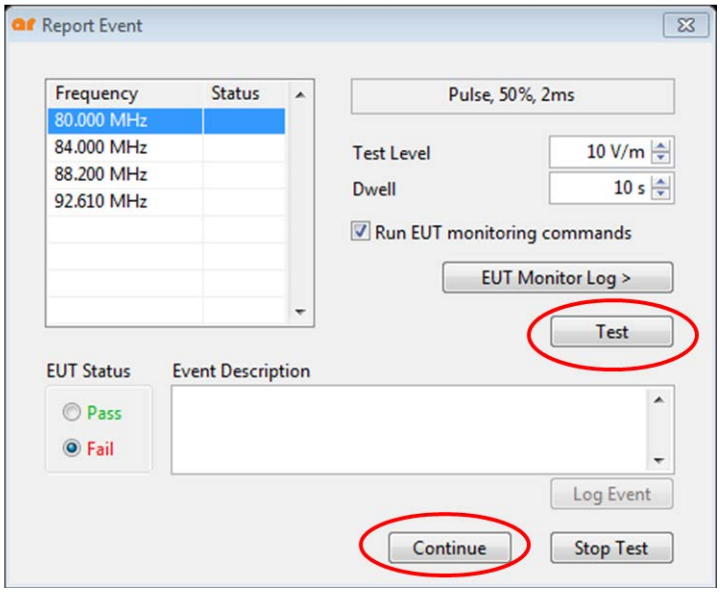



**Figure 4-46**

### 4.6.3 Saving the Test Results to a File

After the test is completed, select a file name to save the test.

Under **Run Test**, select of create the file name to save the test results (Figure 4-47).

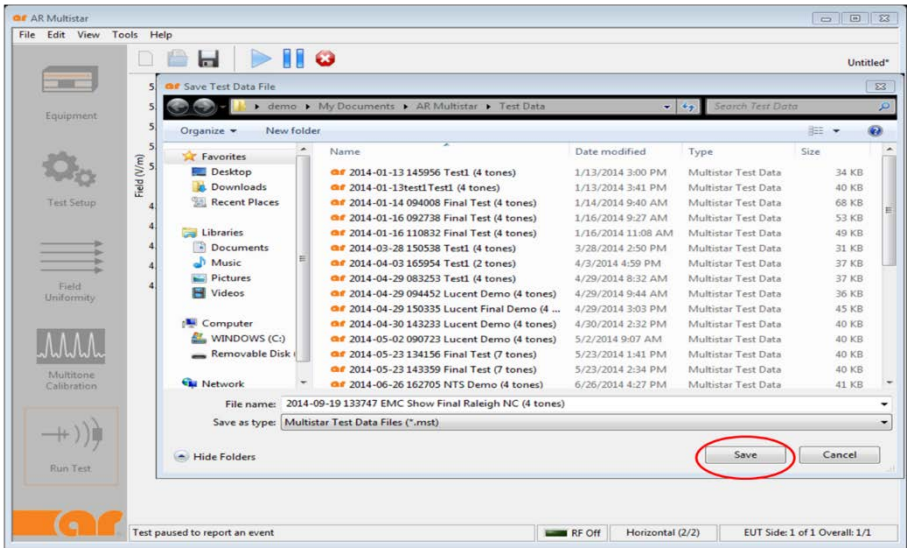



Figure 4-47

## 4.7 FIELD UNIFORMITY VERIFICATION

Once the calibration tests are completed, the user has the option to verify the field uniformity test at his or her leisure.

To verify field uniformity, check the box **Verify field uniformity from a previous created calibration file.**

Under the calibration file, select the calibration file that will be verified.

Set the field verification tolerance, specify the probe position, and then click **Next.**

Under **Field Uniformity**, select **Options**. (Figure 4-48)

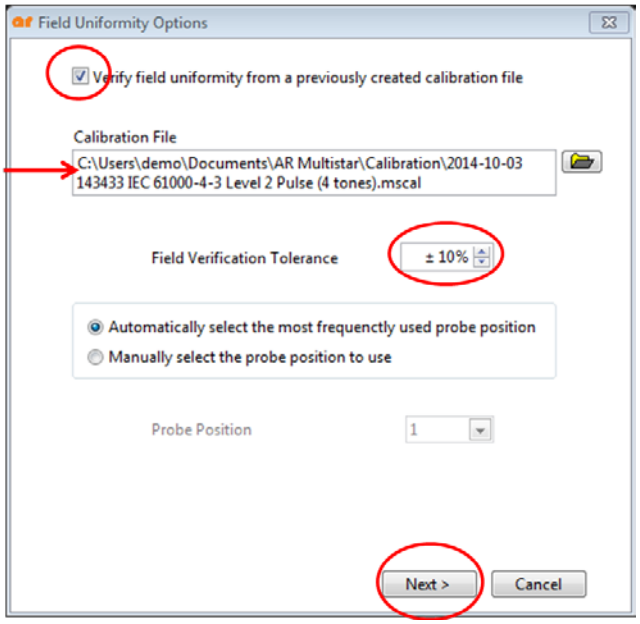



**Figure 4-48**

You now need to select the antenna to be verified under **select the antenna to be calibrate,** select the antenna polarization.

In this example antenna **FCC-TEM-JM1** and polarization **Vertical**

Select the **Next** button to continue.

Under **Field Uniformity**, select **Options**. (Figure 4-49)

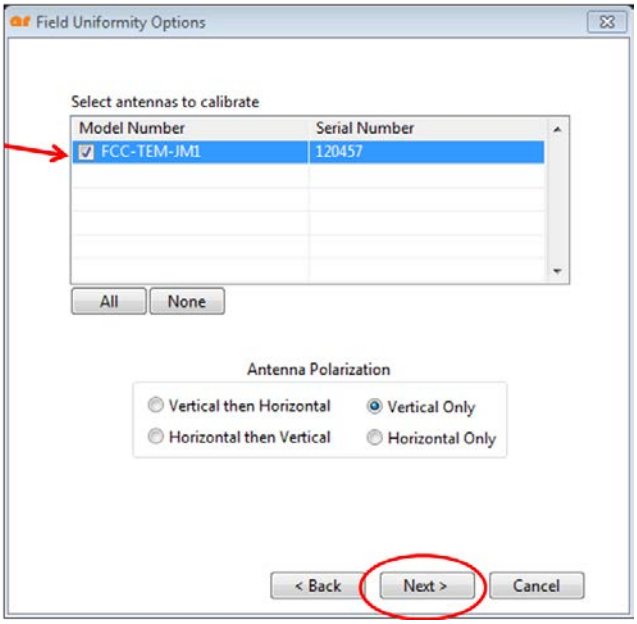



**Figure 4-49**

The test information entered on this screen will be used to populate the verification report.

Under **Field Uniformity**, select **Options** (Figure 4-50).

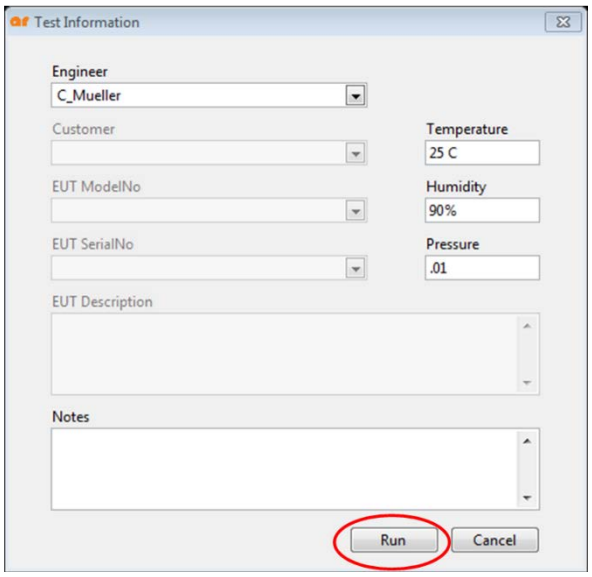



**Figure 4-50**

This next screen provides a great deal of information.

The top graph compares the power in dBm of the previous historical calibration (in gray) to the current verification power (in blue) across the frequency band.

The bottom graph displays the previous historical field strength (in gray) with upper and lower limit lines (in red). The measured field strength is then graphed in blue.

Under **Field Uniformity**, select **Options** (Figure 4-51).

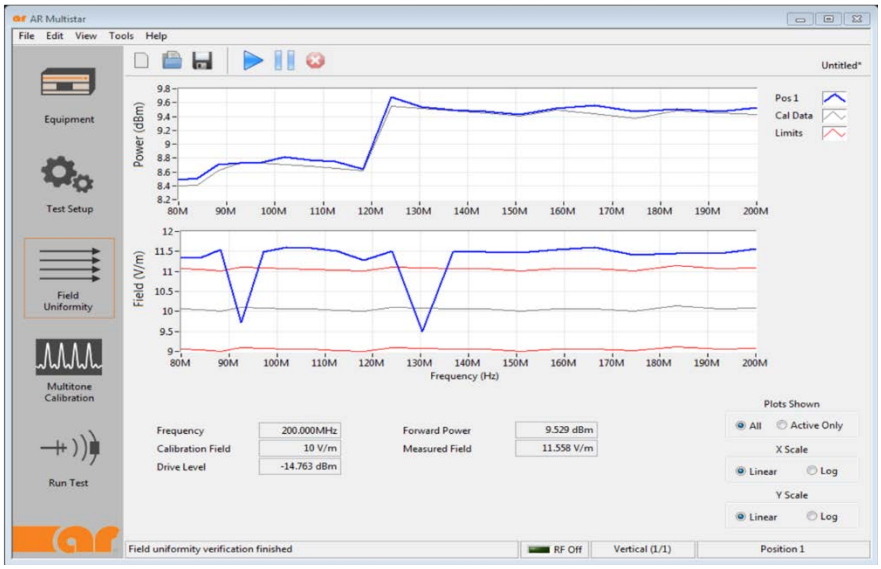



**Figure 4-51**

After verification is complete, if there are any failures, the verification data is displayed in a tabular form.

Select **Close**.

Under **Field Uniformity**, select **Options** (Figure 4-52).

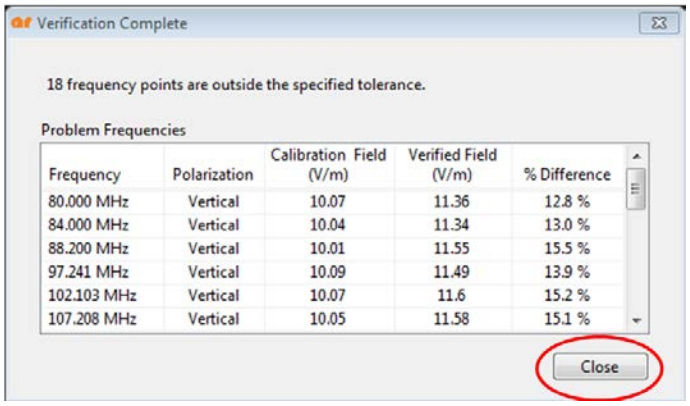



**Figure 4-52**

## 4.8 VIEWING CALIBRATION AND TEST DATA

Select **View** on the Tool Bar and then **Calibration** to view the calibration data (Figure 4-53).


Figure 4-53

The user can view the field strength calibration data measured with the field probe.

The graphs show the forward power and the field strengths at each position across the band.

The table below shows roughly the same data as the graphs with the addition of the VSG drive level just in tabular form.

Under **File**, select **Probe Data** (Figure 4-54).

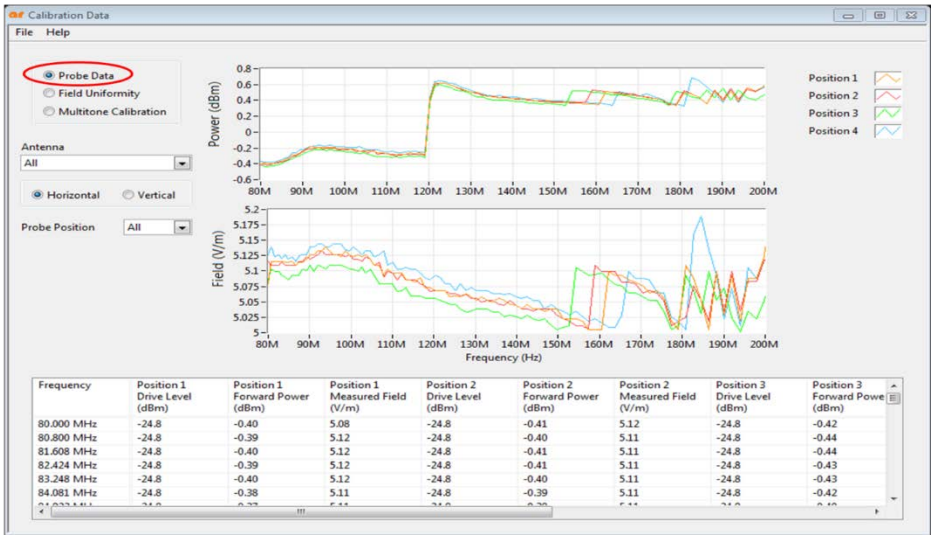



Figure 4-54

The field uniformity calibration data can be viewed in graphical and tabular forms including the frequency, VSG drive level, amplifier forward power, measured field strength for the probe position.

Note that the table will also include whether the field uniformity passed or failed.

Under **File**, select **Field Uniformity** (Figure 4-55).

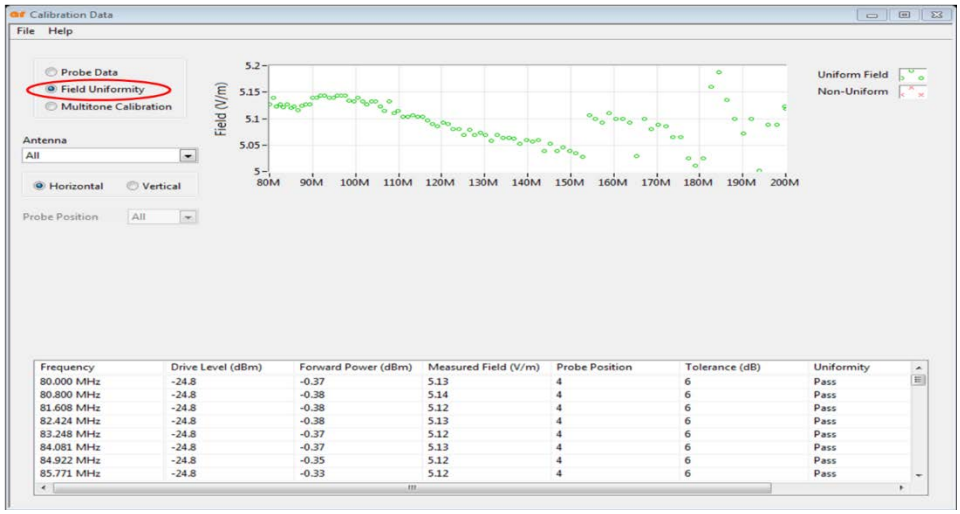



Figure 4-55

### 4.8.1 How the Multi-Tone Calculates the Field Uniformity

The Multi-tone system calculates the field uniformity based of the IEC 61000-4-3 standard

The field uniformity area is subdivided into grid points from 4 to 16 points. The number of grid points is determined by the following:

- The beam width of the antenna,
- The distance between the radiate antenna and EUT,
- The size of the EUT.

A grid of 16 points is illustrated.

There are two methods to calculate field uniformity: **Constant Power** and **Constant Field.**

- With the **Constant Power** method, the forward power is kept constant and the field strength is measured using a field probe.

- Whereas **Constant Field** method, the field strength is kept constant and the forward power is measured with a directional coupler.

The criteria for field uniformity is that at each frequency, a field is considered uniform if its magnitude measured at each of the grid points is within 6 dB of the nominal value. The total number of grid points (within the 6 dB window) has to be at least 75% or more.

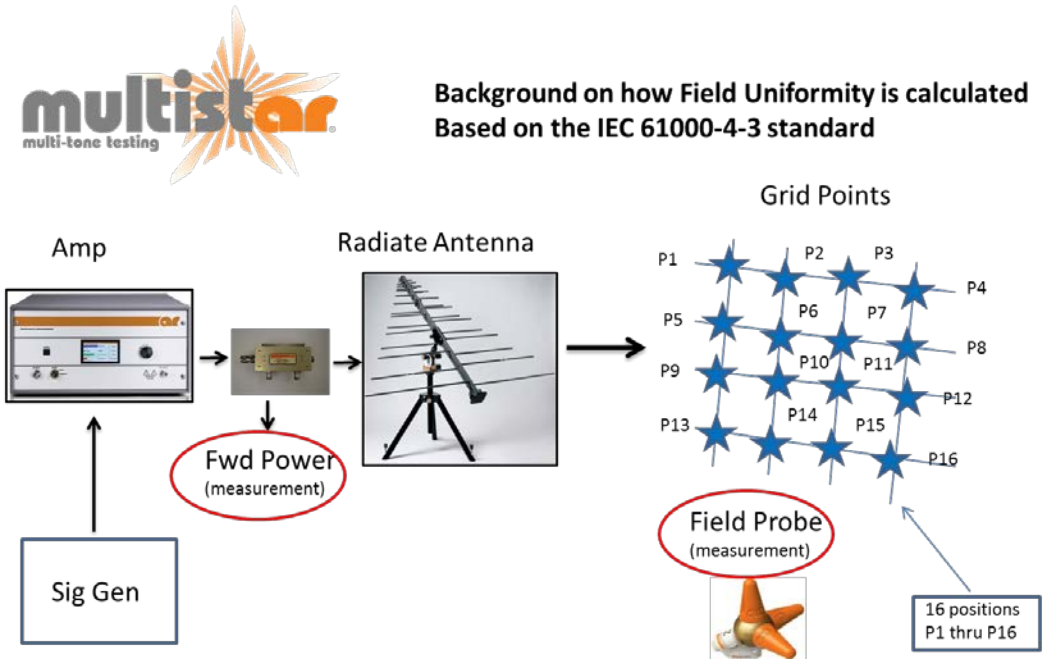



Figure 4-56

### 4.8.2 Calculating Field Uniformity using the Constant Field Method

The following shows an example of how field uniformity is calculated using the constant field method using a 16 point grid at one of the frequency steps (in this example 80 MHz).

- The IEC procedure is to level on a fixed-field strength for every grid point (in this example 16 points) and measure the forward power.
- Multi-tone software measures and records the forward power for each grid point and for each frequency step.
- Multi-tone software arranges the forward power for each grid point from highest to lowest. Starting with the highest forward power value, the software determines if at least 75 % of the grid points (in this example 12 out of 16) are within a 6 dB range. If not, then the software selects the next highest value. Software keeps repeating this until 75% of the grid points are in a 6 dB range. If not, then the field uniformity fails.
- In this example 40 dBm is the first highest forward power, and its 6 dB range is from 40 to 34 dBm (which is range 1). Of the 16 point samples, only 5 fall in this 6 dB range, which represents only 31.25%. Thus this does not meet the 75% criteria and software has to check the next highest power which is 37 dBm, range 2.
- The 6 dB forward power range is from 37 dBm to 31 dBm (Range 2). Of the 16 point samples, only 8 out of 16 points fall in this 6 dB window which represents 50%. This does not meet the 75% criteria and software has to check the next highest forward power which is 35 dBm (range 3).
- The 6 dB forward power range is from 35 dBm to 29 dBm(Range 3). Of the 16 point samples 12 out of 16 points fall in this 6 dB window, which represents 75%. This does meet the 75% criteria.

- Since this meets the 75% of the points are within 6 dB, use grid point 11 with forward power of 35 dBm to expose the EUT.
- The software will report a pass condition and record the grid point position and forward power.
- If 75% are not within 6 dB then the software will report fail.

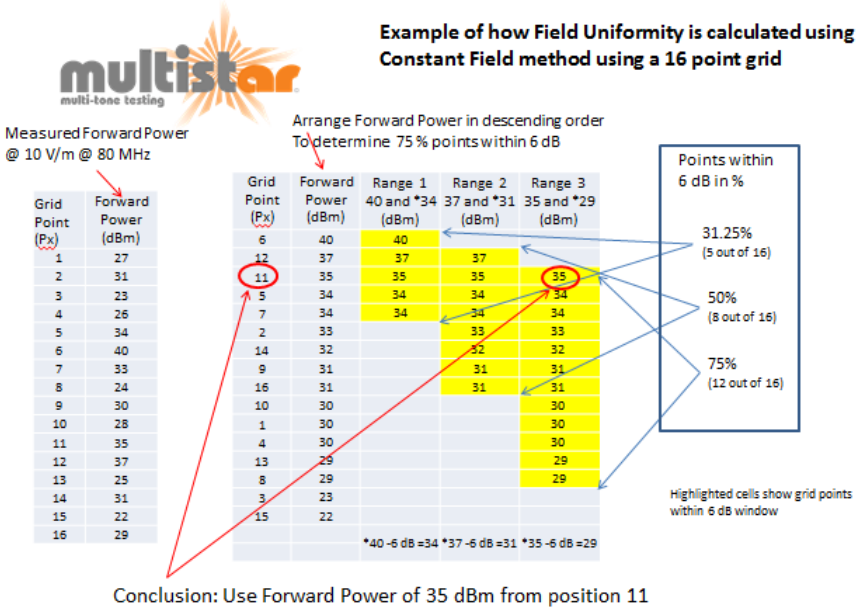
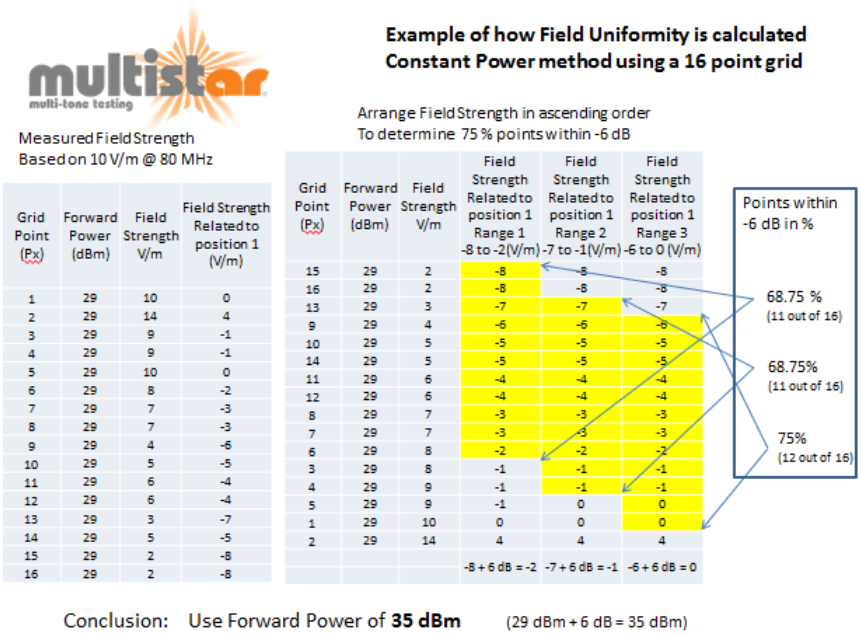



Figure 4-57

## 4.8.3 Calculating Field Uniformity using Constant Power Method

This example shows how the multi –tone system calculates field uniformity using the constant power method for a 16 point grid at one of the frequency steps (this example using 80 MHz with a field strength of 10 V/m).

- The IEC procedure is to level on a predetermined field strength (in this example 10 V/m) and measure the forward power at the first point (*NOTE: the user could select any point*). Record the forward power. The recorded forward power value is used to level the other grid points. After the forward power is achieved the field strength is measured and recorded.
- In this example forward power of 29 dBm is used to level all the other grid points. Using 29 dBm the software records the field strength for each of the grid points.
- The Multi-tone software uses the first grid point field strength as reference (0 dBm) and calculates the field strength delta for each grid point. In this example, grid point 2's field strength is 14 V/m and grid point 1's field strength is 10 V/m. The relative field strength delta is 4 dB.
- After the relative field strength of position 1 is calculated, the multi-tone software arranges each grid point field strength for each frequency step (80 MHz) from lowest to highest. In this example position 15 is the lowest (2V/m) and position 2 is the highest (14V/m).




| Grid Point (Px) | Forward Power (dBm) | Field Strength V/m | Field Strength Related to position 1 (V/m) |
|---|---|---|---|
| 1 | 29 | 10 | 0 |
| 2 | 29 | 14 | 4 |
| 3 | 29 | 9 | -1 |
| 4 | 29 | 9 | -1 |
| 5 | 29 | 10 | 0 |
| 6 | 29 | 8 | -2 |
| 7 | 29 | 7 | -3 |
| 8 | 29 | 7 | -3 |
| 9 | 29 | 4 | -6 |
| 10 | 29 | 5 | -5 |
| 11 | 29 | 6 | -4 |
| 12 | 29 | 6 | -4 |
| 13 | 29 | 3 | -7 |
| 14 | 29 | 5 | -5 |
| 15 | 29 | 2 | -8 |
| 16 | 29 | 2 | -8 |

| Grid Point (Px) | Forward Power (dBm) | Field Strength V/m | Field Strength Related to position 1 Range 1 -8 to -2 (V/m) | Field Strength Related to position 1 Range 2 -7 to -1 (V/m) | Field Strength Related to position 1 Range 3 -6 to 0 (V/m) |
|---|---|---|---|---|---|
| 15 | 29 | 2 | -8 | -8 | -8 |
| 16 | 29 | 2 | -8 | -8 | -8 |
| 13 | 29 | 3 | -7 | -7 | -7 |
| 9 | 29 | 4 | -6 | -6 | -6 |
| 10 | 29 | 5 | -5 | -5 | -5 |
| 14 | 29 | 5 | -5 | -5 | -5 |
| 11 | 29 | 6 | -4 | -4 | -4 |
| 12 | 29 | 6 | -4 | -4 | -4 |
| 8 | 29 | 7 | -3 | -3 | -3 |
| 7 | 29 | 7 | -3 | -3 | -3 |
| 6 | 29 | 8 | -2 | -2 | -2 |
| 3 | 29 | 8 | -1 | -1 | -1 |
| 4 | 29 | 9 | -1 | -1 | -1 |
| 5 | 29 | 9 | -1 | 0 | 0 |
| 1 | 29 | 10 | 0 | 0 | 0 |
| 2 | 29 | 14 | 4 | 4 | 4 |
| | | | -8 + 6 dB = -2 | -7 + 6 dB = -1 | -6 + 6 dB = 0 |

Figure 4-58

The multi-tone calibration can be viewed in graphical and tabular formats.

The linearity and harmonic data and limit lines are plotted in the graphs.

### 4.8.4 Viewing Calibration Data

The table shows the frequencies in sets, the recorded VSG drive level, amplifier forward power, linearity and worst harmonic in that frequency set.

On the tabular portion, please note that the shading depicts the breaks between the frequency groupings.

Under **File**, select **Calibration Data** (Figure 4-59).


Figure 4-59

### 4.8.5 Viewing Test Data

The test data can be viewed again in both graphical and tabular forms.

You can chose the view based on horizontal or vertical antenna position as well as EUT side and modulation.

The table also includes the drive level, forward power, field strength and Event status and description.

Under **File**, select **Test Data** (Figure 4-60).

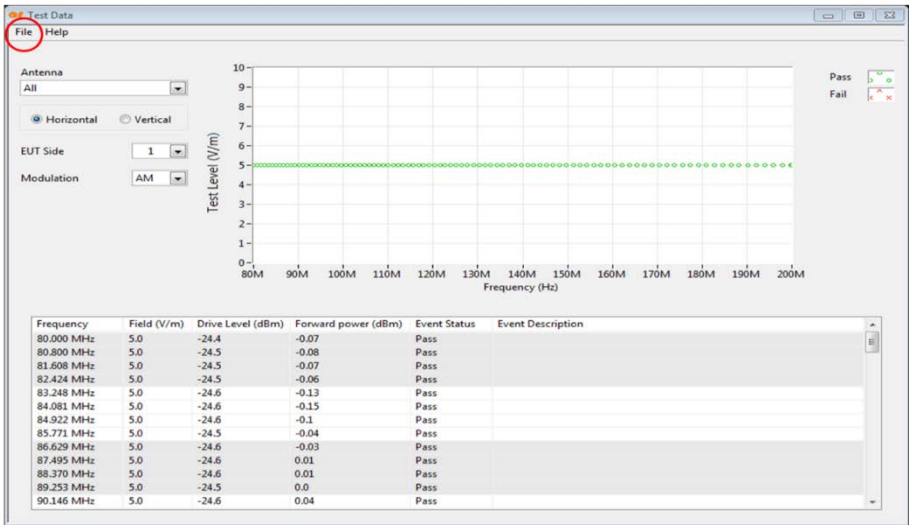



Figure 4-60

After you run a test you have the option to create a report based on your saved calibration and final test data.

From the Main Menu, **File** and then **Create Report** (Figure 4-61).

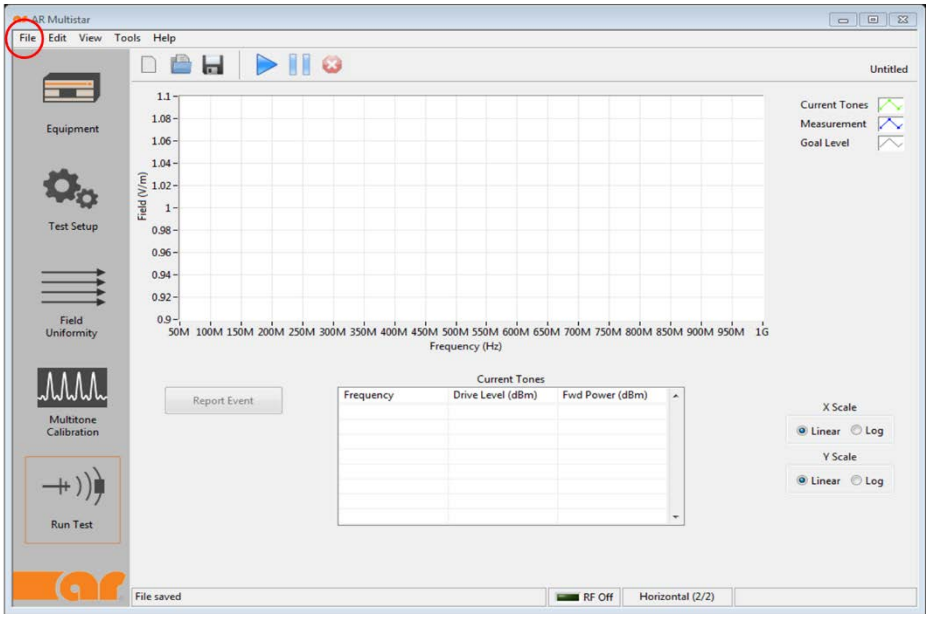



Figure 4-61

### 4.8.6 Creating Reports

After you run a test you have the option to create the following reports:

- Calibration
- Verification
- Final test

You can create a report based on your saved calibration and final test data.

You can also create a report based on a previously saved file.

From Main Menu, **Create Report** (Figure 4-62).

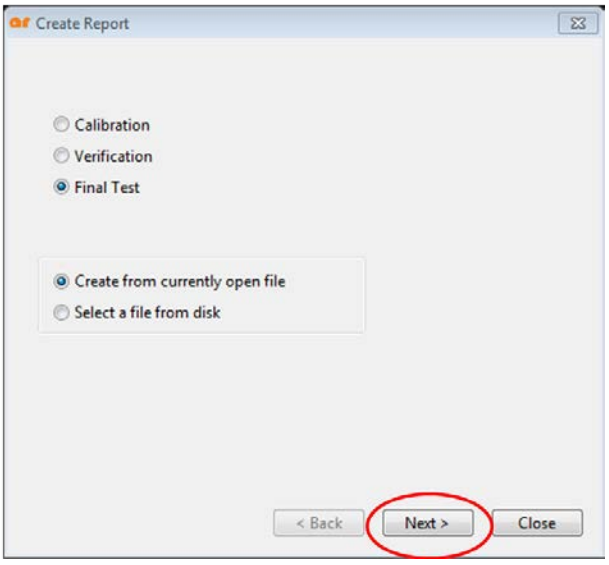



**Figure 4-62**

You can customize the content of your report.

You can choose to include:

- Vertical or horizontal antenna position
- EUT monitoring sides
- All data or only failures including the graph

Select **Next** button and choose addition report options.

Under **Create Report**, customizing your Report (Figure 4-63):

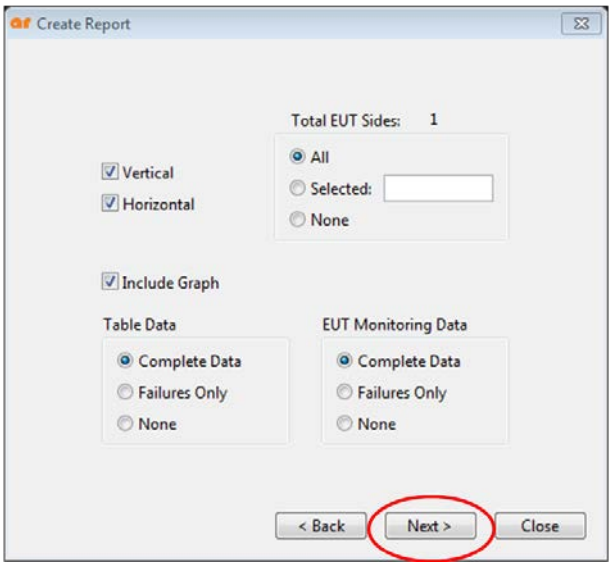



Figure 4-63

The options are to include test setup or equipment information as well as to select log or linear for the X and Y scales. Select the **Create** button (Figure 4-64).

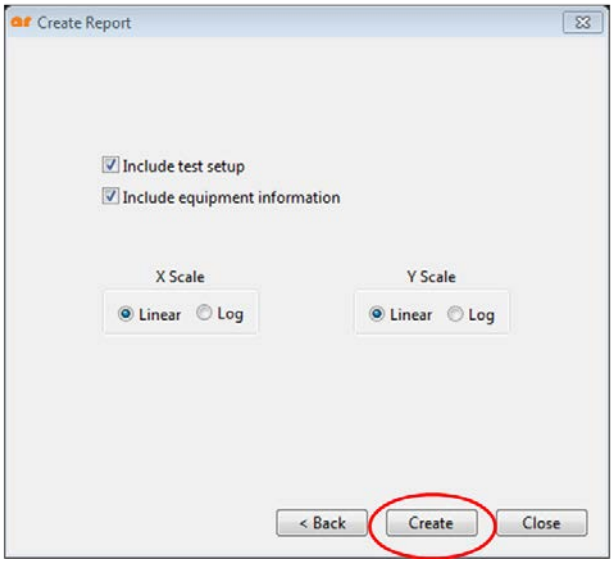



Figure 4-64

The **creating report** message will be displayed. Note this could take several minutes based on the size of the report.

Under **Create Report**, the **Final Report** is now being created (Figure 4-65).

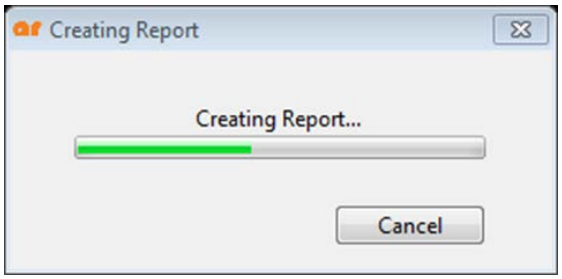



Figure 4-65

The report will be generated only in a Word document. This report can be edited like any other Word document.

The final report is ready and downloadable (Figure 4-66).

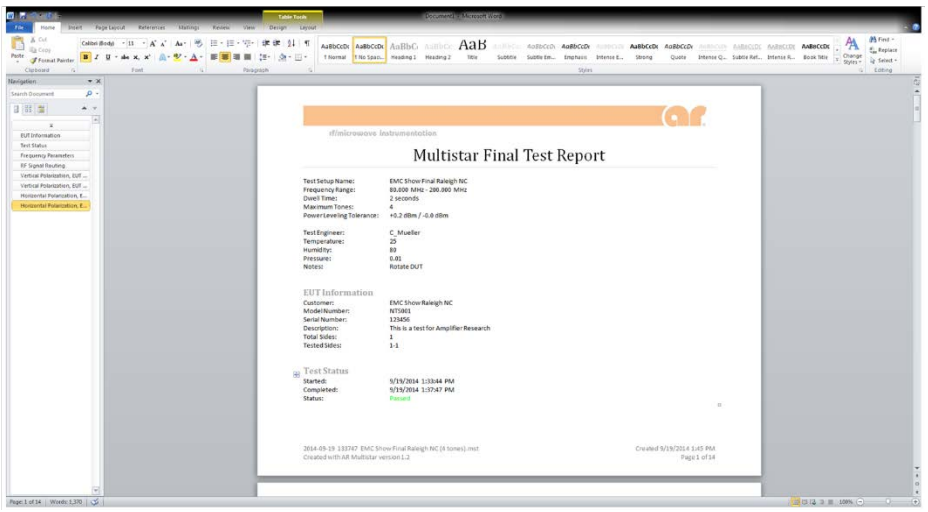



Figure 4-66

The report will generate test data in graph form (Figure 4-67).

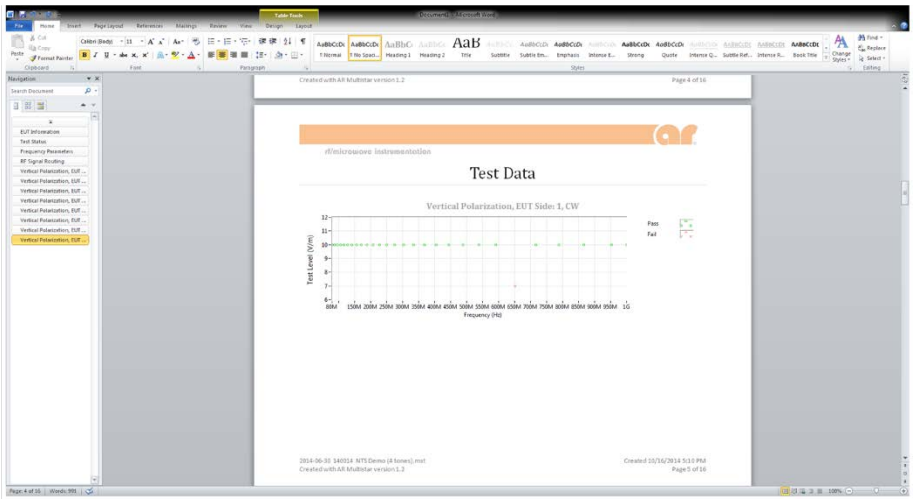



Figure 4-67

The test report will also generate test data in tabular form.

# 5. GENERAL INFORMATION

## 5.1 RETURN PROCEDURE

To return the MT06000A to AR, contact AR Customer Service for an RMA number and shipping instructions. Returns from outside the United States are not permitted without prior authorization. If shipping from outside of the United States, closely follow all directions on the RMA form for return shipping and marking. See warranty statement at rear of manual.

1. Contact the AR Customer Service Department and provide the following information. Briefly describe the problem in writing. Give details regarding the observed symptom(s), and whether the problem is constant or intermittent in nature. Include the serial number of the item being returned. An RMA number will be issued.

2. Package the system carefully. Use the original boxes and packing materials, if possible.

3. After obtaining an RMA #, ship the system to:

   AR RF/Microwave Instrumentation
   160 Schoolhouse Rd
   Souderton PA USA 18964
   Attn: Customer Service

   If the system is still under warranty, refer to the Limited Warranty for additional information about your return. The RMA # should be clearly visible on the outside of the package.

## 5.2 UPGRADE POLICIES

AR Software is periodically upgraded to enhance functionality. Contact AR Software Engineering department to check on the upgrade status for your software.

# WARRANTIES: LIMITATION OF LIABILITY

Seller warrants (i) that seller has title to the goods sold and (ii) that Amplifiers (all parts excluding traveling wave and vacuum tubes), Antennas, field monitors, field probes, field analyzers, field analyzer processor units, system controllers, system interlock, power meters, leak detectors, RF conducted probes, RF conducted clamps, Multi-tone, EMI receiver systems, RF down converters, RF conducted immunity systems, conducted immunity accessories, radiated immunity test systems, safety meters, safety sensor heads, tripods, directional couplers, waveguide adapters, termination loads, load attenuators, impedance stabilization networks, and coaxial cables will be free from defects in material and workmanship for a period of three (3) years from date of shipment shown on AR RF/Microwave Instrumentation invoice.

All modules, used in the amplifiers for the 1-6 GHz, 4-18 GHz, 6-18 GHz, all HPM products, and other applications, are hermetically-sealed. This sealing process protects the internal hybrid circuitry from humidity that could compromise the long term reliability of the product. These modules are not field-repairable and should *never* be opened outside of AR's Microelectronics Lab. The modules in these product lines have a security label on two sides of the modules between the housing and lid/cover. If the security label is removed and or cut, the warranty of the module will be voided.

Vacuum tubes in the 'L' series amplifiers, traveling-wave tubes in TWT amplifiers, and power heads will be free from defects in material and workmanship for a period of one (1) year.

Contact AR RF/Microwave Instrumentation for warranty information regarding items not listed.

Seller's sole responsibility in fulfilling these warranties shall be to repair or replace any goods which do not conform to the foregoing warranties or, at seller's option, to give buyer credit for defective goods. The warranty is valid only when used in the country specified at time of order. Warranty service must be obtained from the repair facility designated at that time. If warranty service is not available in the country where the equipment is to be used, it must be returned to AR RF/Microwave Instrumentation. Warranty service will be provided only for defective goods which are returned within the warranty period, freight costs prepaid to AR RF/Microwave Instrumentation or its designated repair facility.

There are no other warranties, express or implied, including any warranty of merchantability or fitness. Seller shall not be responsible for any incidental or consequential damages arising from any breach of warranty.

No person other than an officer of Amplifier Research Corporation, has any authority to bind seller to any affirmation, representation or warranty except as specifically included in the preceding terms and conditions.

Rev 1216