MA24106A USB Power Sensor User Guide

True-RMS, 50 MHz to 6 GHz

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部件名称	有毒有害物质或元素					
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印刷线路板 (PCA)	✕	○	✕	✕	○	○
机壳、支架 (Chassis)	✕	○	✕	✕	○	○
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Table of Contents

Table of Contents (Continued)

Chapter 4—Remote Operation

Chapter 5—Sensor Operational Tests

Appendix A—Connector Care and Handling

Appendix B—Sample Visual Basic Code

Appendix C—Serial Port Compatibility

Appendix D—Upgrading the Firmware

Index

Chapter 1 — General Information

1-1   Scope of Manual

This manual provides general information, installation, and operating information for the Anritsu MA24106A USB power sensor. Throughout this manual, the terms MA24106A, USB power sensor, and power sensor will be used interchangeably to refer to the device. Manual organization is shown in the table of contents.

1-2   Introduction

This chapter contains general information about the MA24106A power sensor. It includes a general description of the device and information on its identification number, information on initial inspection, and preparation for storage and shipment.

1-3   Description

The MA24106A power sensor is a highly accurate, standalone instrument that communicates with a PC via USB. The power measurement capability of MA24106A is intended to mimic that of a traditional thermal (thermo-electric) power sensor. Therefore, it is ideal for measuring the average power of CW, modulated RF waveforms such as 3G, 4G, OFDM, and multi-tone signals. In other words, it measures true RMS power regardless of the type of input signal.

1-4   Initial Inspection

Inspect the shipping container for damage. If the shipping container is damaged, retain until the contents of the shipment have been checked against the packing list and the power sensor has been checked for mechanical and electrical operation. The following items are included with every MA24106A shipment:

- MA24106A, USB power sensor
- 3-200-1360, USB 2.0 A to Mini-B cable
- 2300-512, CD containing required software and manuals

If the shipment is incomplete or if the power sensor is damaged mechanically or electrically, notify your local sales representative or Anritsu Customer Service. If the shipping container is damaged or shows signs of stress, notify the carrier as well as Anritsu. Keep the shipping materials for the carrier's inspection.

1-5   Identification Number

All Anritsu power sensors are assigned a unique seven digit serial number, such as "0701012". The serial number is imprinted on a label that is affixed to the unit. When ordering parts or corresponding with Anritsu Customer Service, please use the correct serial number with reference to the specific instrument's model number (for example, model MA24106A power sensor, serial number: 0701012).

1-6   Preparation for Storage/Shipment

Preparing the power sensor for storage consists of cleaning the unit, packing the inside with moisture-absorbing desiccant crystals, and storing the unit in the recommended temperature environment. Please refer to the data sheet for storage temperature recommendations.

To provide maximum protection against damage in transit, the power sensor should be repackaged in the original shipping container. If this container is no longer available and the unit is being returned to Anritsu for repair, please advise Anritsu Customer Service; they will send a new shipping container free of charge. In the event neither of these two options is possible, instructions for packaging and shipment are given below:

- **Use a Suitable Container:** Obtain a corrugated cardboard carton. This carton should have inside dimensions of no less than 15 cm larger than the unit dimensions to allow for cushioning

- **Protect the Instrument:** Surround the unit with polyethylene sheeting to protect the finish.

- **Cushion the Instrument:** Cushion the instrument on all sides by tightly packing urethane foam between the carton and the unit. Provide at least three inches of dunnage on all sides.

- **Seal the Container:** Seal the carton by using either shipping tape or an industrial stapler.

- **Address the Container:** If the instrument is being returned to Anritsu for service, mark the address of the appropriate Anritsu service center and your return address on the carton in one or more prominent locations.

Chapter 2 — Installation

2-1   Introduction

This chapter provides information and instructions on operating the MA24106A power sensor. It contains the following:

- Hardware and Software Requirements for the Anritsu Power Meter Application
- Driver Installation procedure for properly installing the driver for the sensor

2-2   Hardware and Software Requirements

Please make sure that the following minimum requirements are met for installing and using the software:

- Intel® Pentium® III or equivalent processor
- Microsoft® Windows Vista® (32-bit only), Windows XP or Windows 2000
- 512 MB of RAM
- 100 MB of available hard-disk space
- 1024 × 768 display resolution
- PC or laptop with a USB port and CD-ROM drive

2-3   Driver Installation

The driver must be installed before the MA24106A power sensor can be used. Follow the steps below as a guide for proper installation:

1. Insert the installation CD in the drive of your computer. If the installation menu does not start automatically, open the file named **Startup.htm** located on the CD.
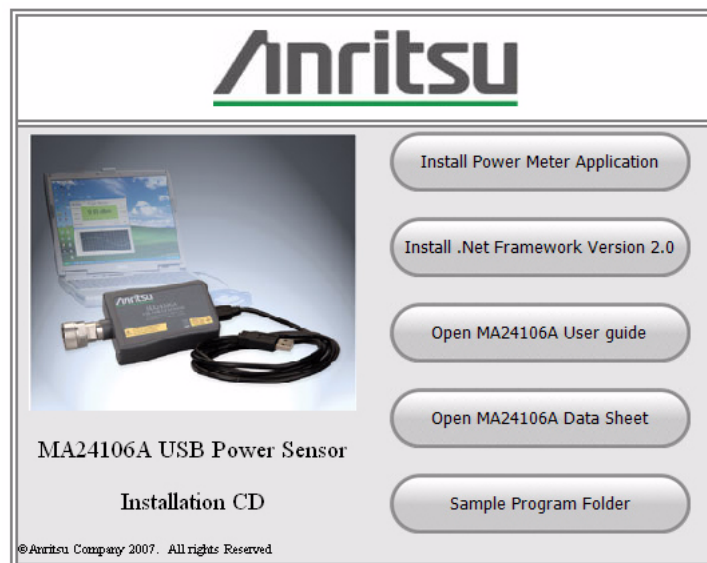
Figure 2-1.   Anritsu Power Meter Installation Menu

Note: If required, please install the Microsoft® .Net Framework, version 2.0.

2. Click **Install Power Meter Application** and select **Run** to start the installation.

3. Click **Next** in the following screen to begin the installation process.
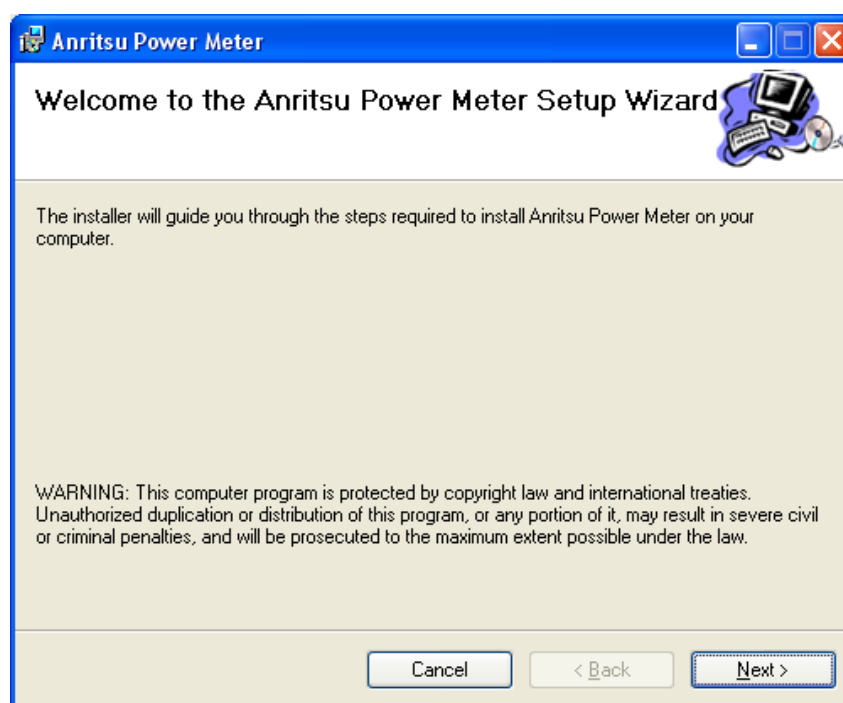
Figure 2-2. Anritsu Power Meter Installation

4. Browse for the installation folder, select the desired permissions, and then click **Next**. The default installation directory is: C:\Program Files\Anritsu\AnritsuPowerMeter
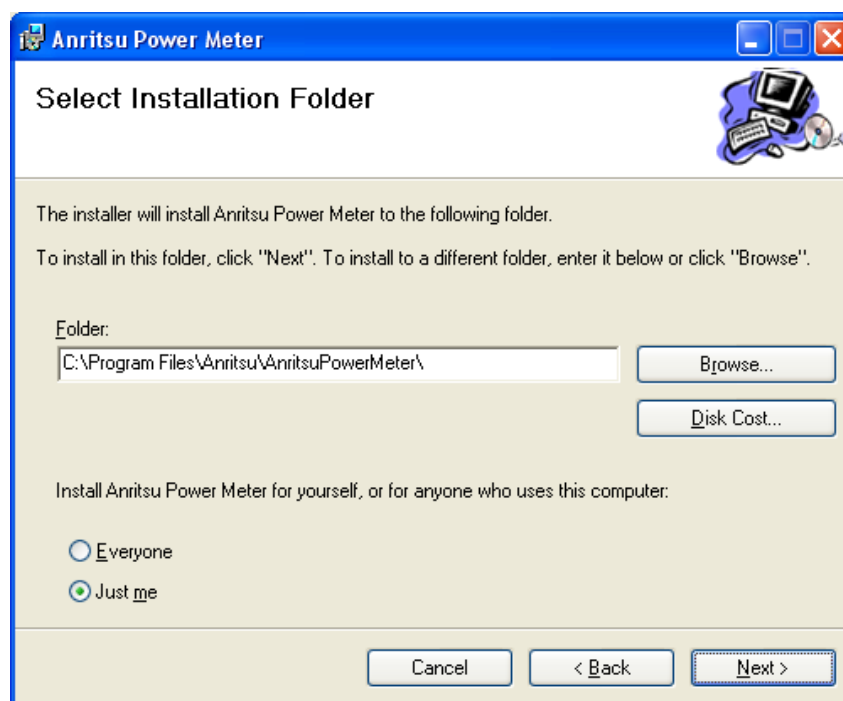
Figure 2-3. Anritsu Power Meter Installation

5. Select **I Agree** to the license agreement, and then click **Next**.
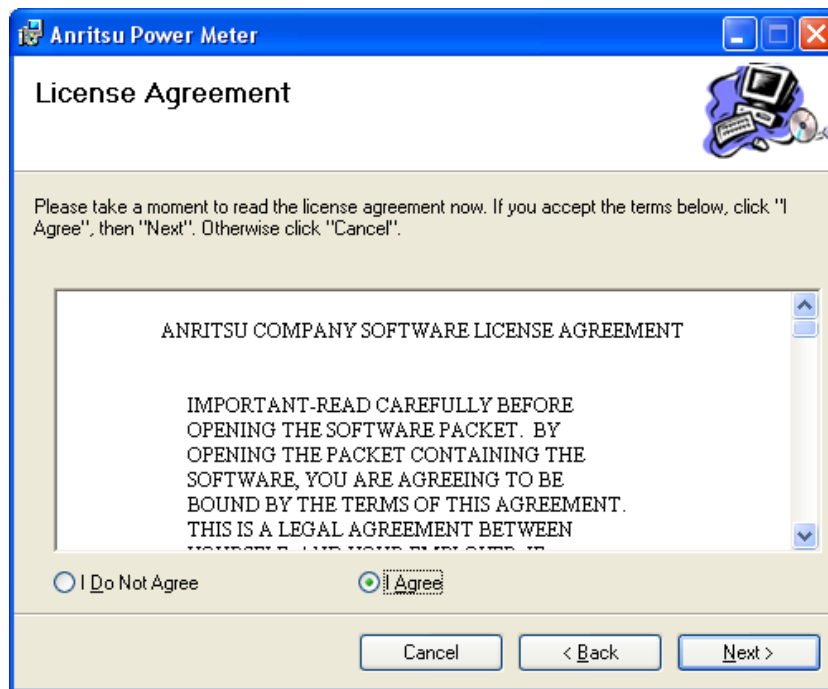
Figure 2-4.   License Agreement

6. Select **Next** to continue with the software installation.
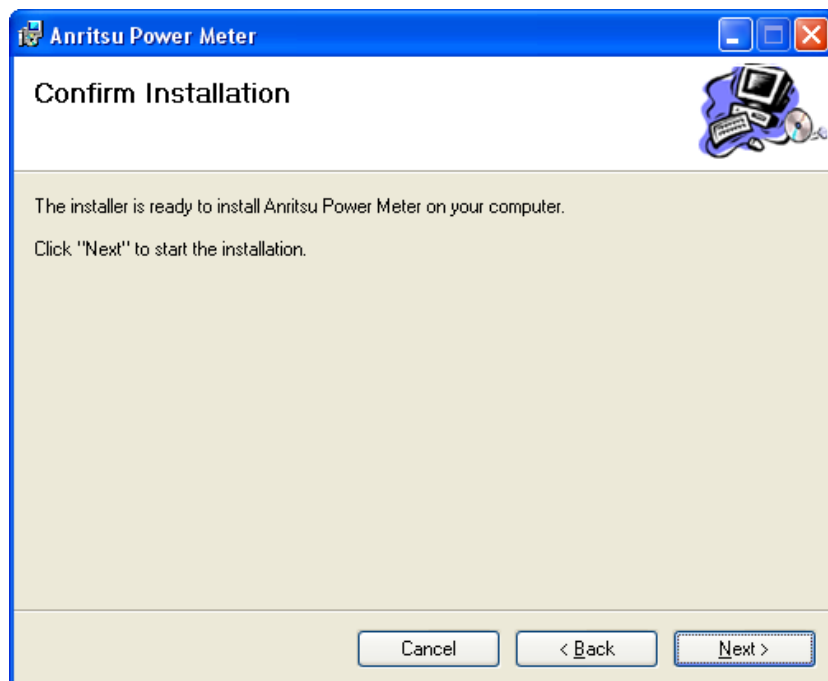
Figure 2-5.   Confirm Installation

The software will then install to the selected location.
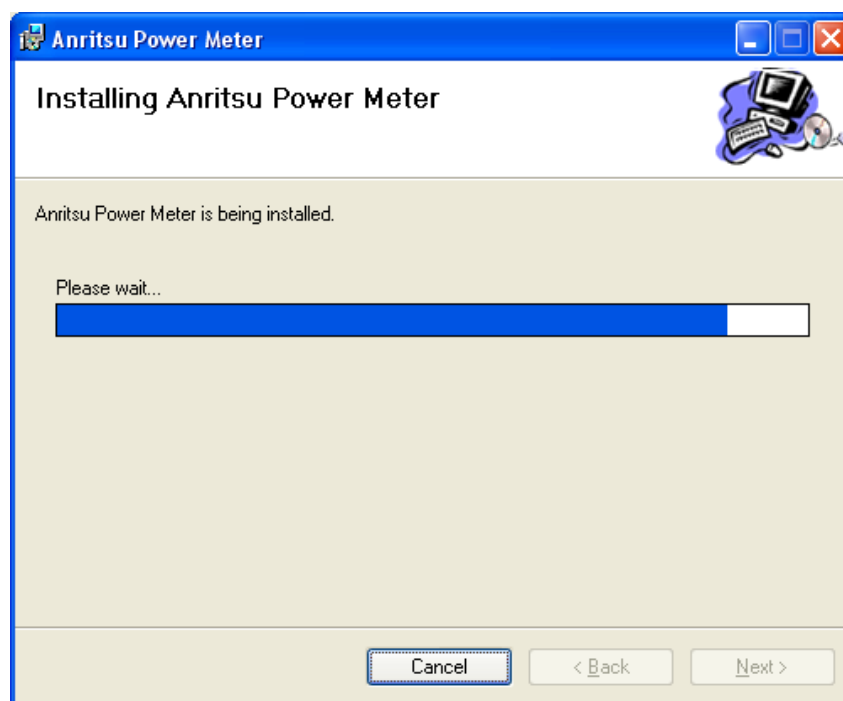
Figure 2-6.   Installing Anritsu Power Meter Application

   7. When the installation completes, click **Close**.
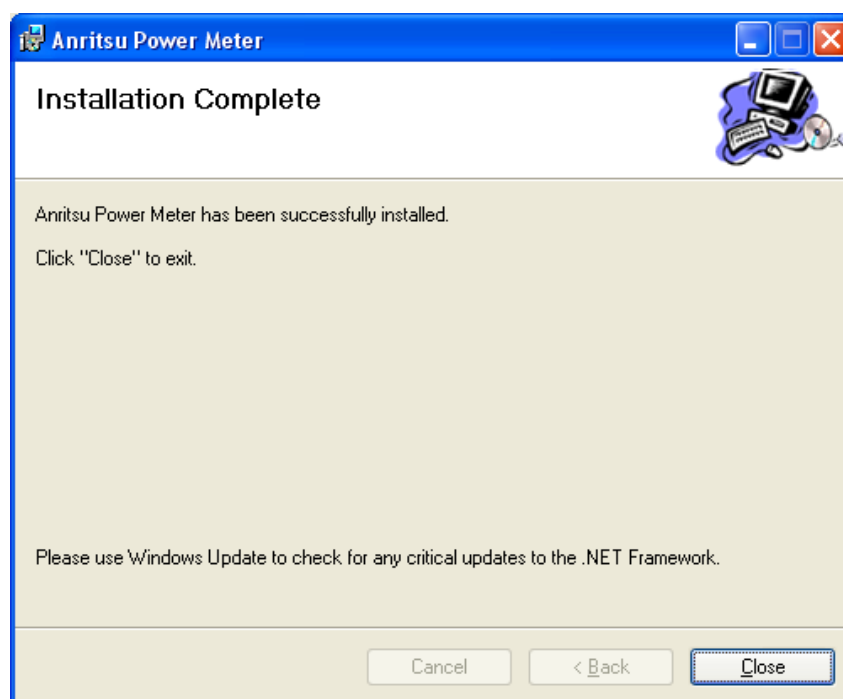
Figure 2-7.   Application Installation Complete

8. Connect the MA24106A power sensor to the USB port of the PC with the supplied USB cable. The status LED will light green indicating that the sensor is turned ON.

9. When the **Found New Hardware Wizard** installation screen appears, select **No, not this time** to search for software, and then click **Next**. If the Wizard does not start, refer to Appendix C, "Serial Port Compatibility" for troubleshooting information.

Figure 2-8. Found New Hardware Wizard

10. Select **Install from a list or specific location (Advanced)**, and then click **Next**.
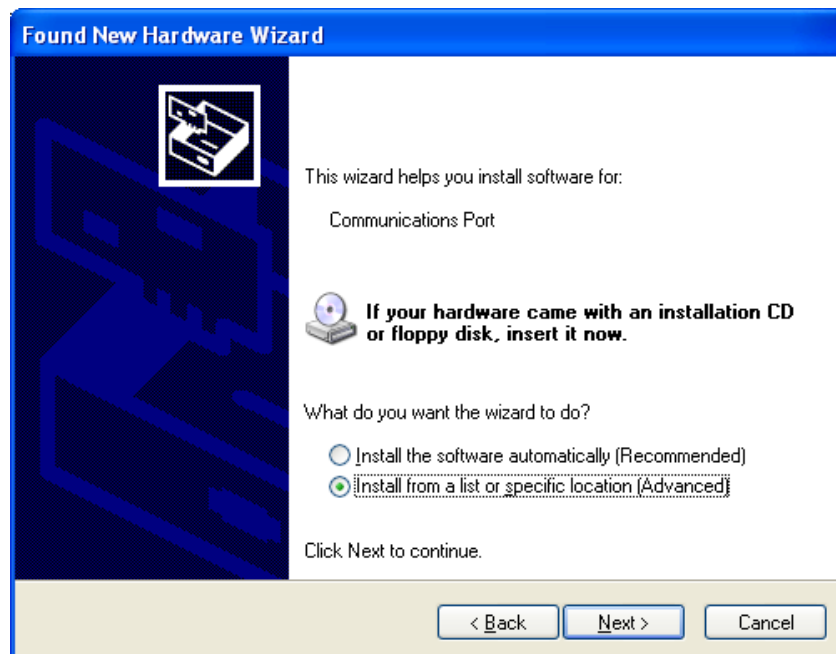
Figure 2-9. Found New Hardware Wizard

11. Select **Don't search. I will choose the driver to install**, and then click **Next**.
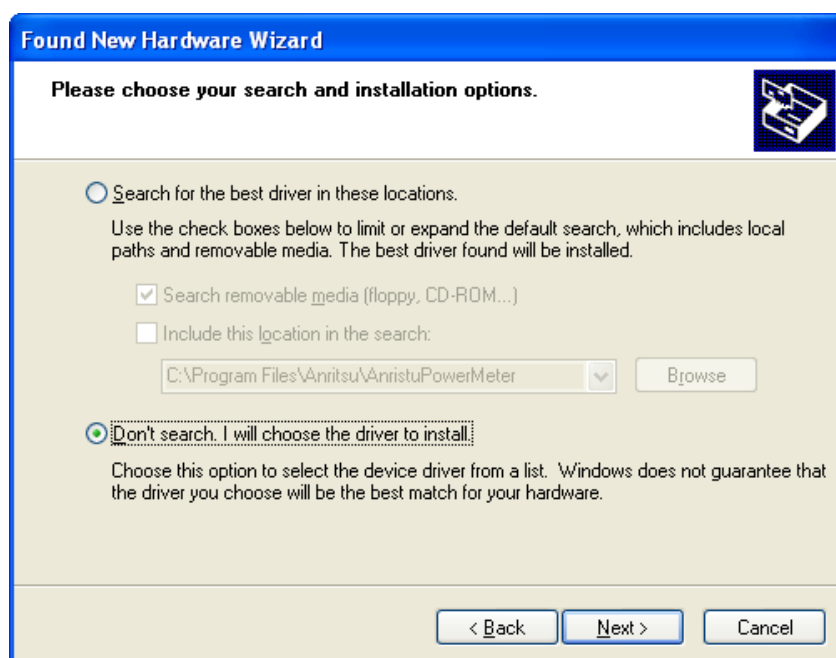
Figure 2-10. Found New Hardware Wizard

12. Select the hardware type **Computer**, and then click **Next**.
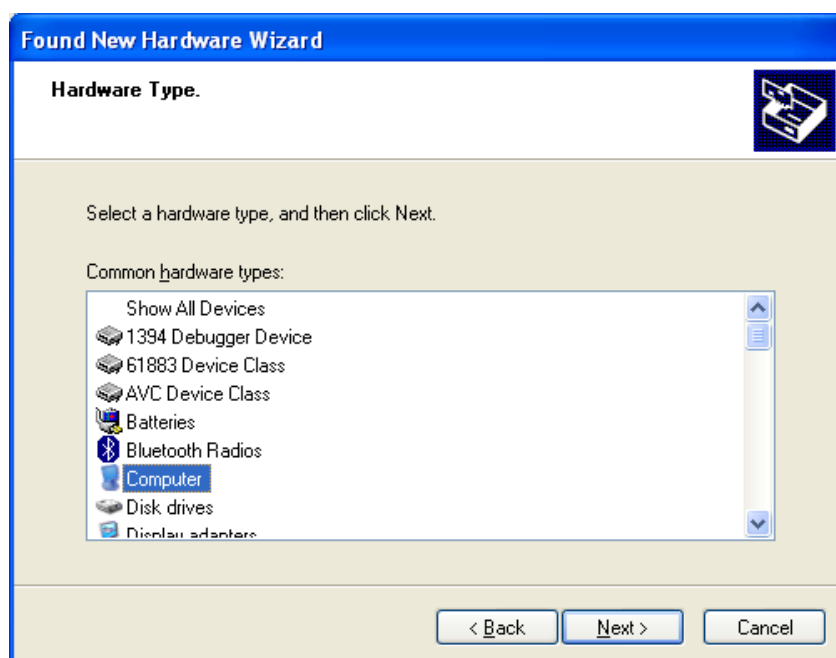
Figure 2-11. Found New Hardware Wizard

13. Click **Have Disk...**, and then click **Next**.

Figure 2-12. Found New Hardware Wizard

14. Browse to the location on your hard drive where you installed the program. If the default settings were chosen during the application installation, click **Browse...**, as shown below, and then select:

C:\Program Files\Anritsu\AnritsuPowerMeter\AnritsuMA24106A.inf

15. Click **OK**.
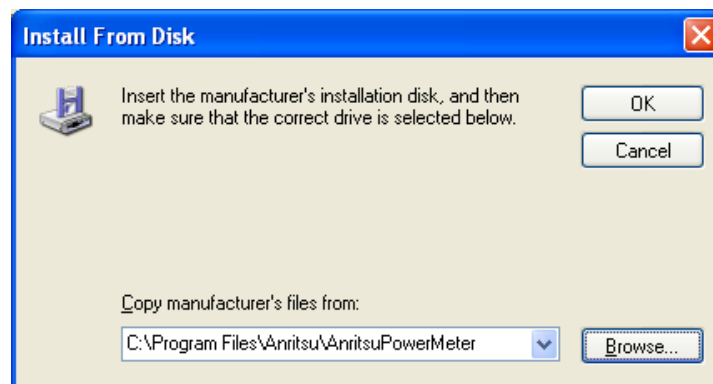
Figure 2-13. Install From Disk

16. Select **Anritsu MA24106A** from the list, and then click **Next** as shown below.
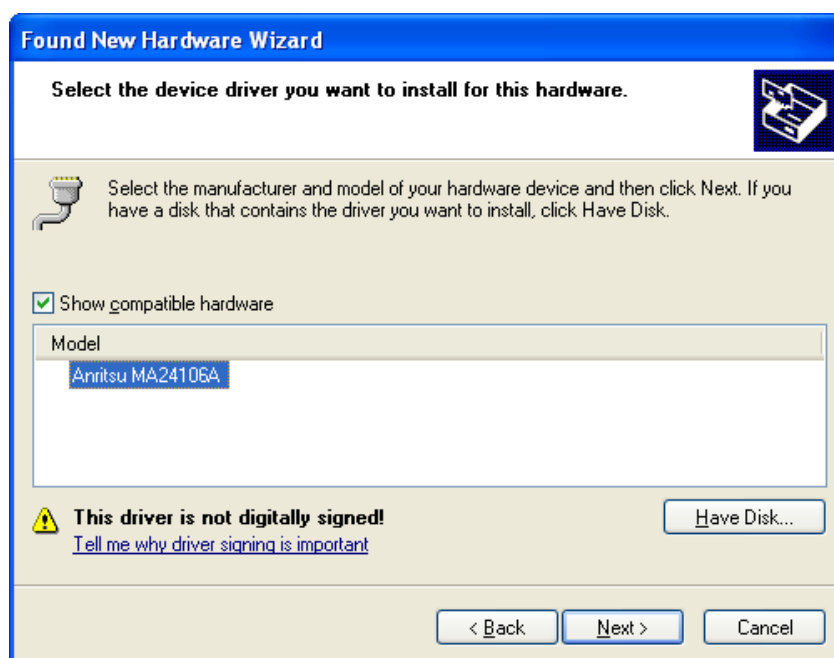
Figure 2-14. Found New Hardware Wizard

17. The Hardware Installation Warning dialog will appear as shown in Figure 2-15. Click **Continue Anyway**.

Figure 2-15. Hardware Installation

18. Click **Finish** to close the wizard.
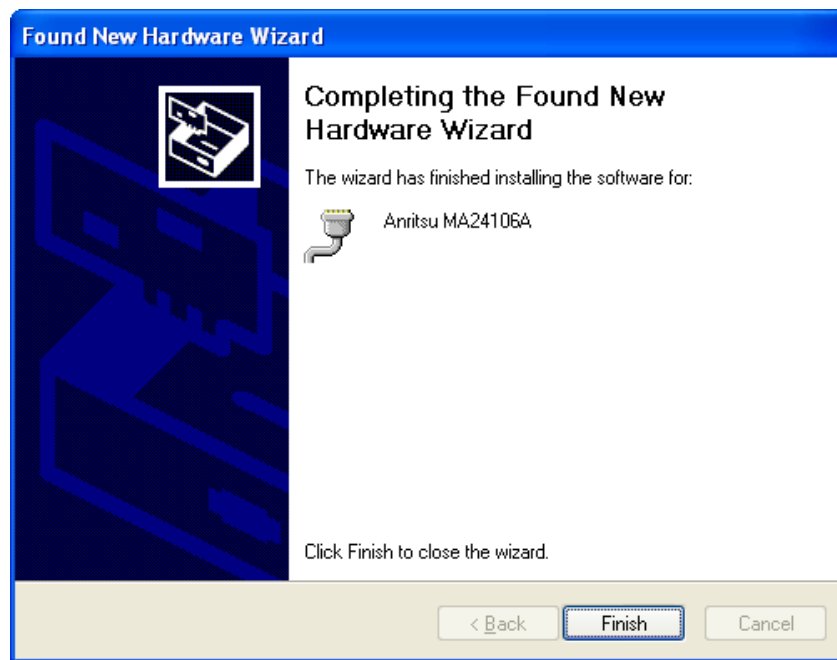
Figure 2-16. Found New Hardware Wizard

19. The MA24106A is now ready for use. Launch the Anritsu Power Meter application from the new desktop icon or from the Start | Programs menu. Refer to Chapter 3 for information about using the Anritsu Power Meter application.

Chapter 3 — Using the Power Sensor

3-1 Introduction

This chapter provides information on using the Anritsu Power Meter application with the MA24106A USB power sensor. It provides a description of the Graphical User Interface, various settings of the application, basic procedures for Making Measurements, as well as information about Uncertainty of a Measurement.

3-2 Graphical User Interface

The graphical user interface (Figure 3-1) layout is divided into five sections:

- Buttons
- Data Entry Fields
- Display Window
- Status Bar
- Menu Bar
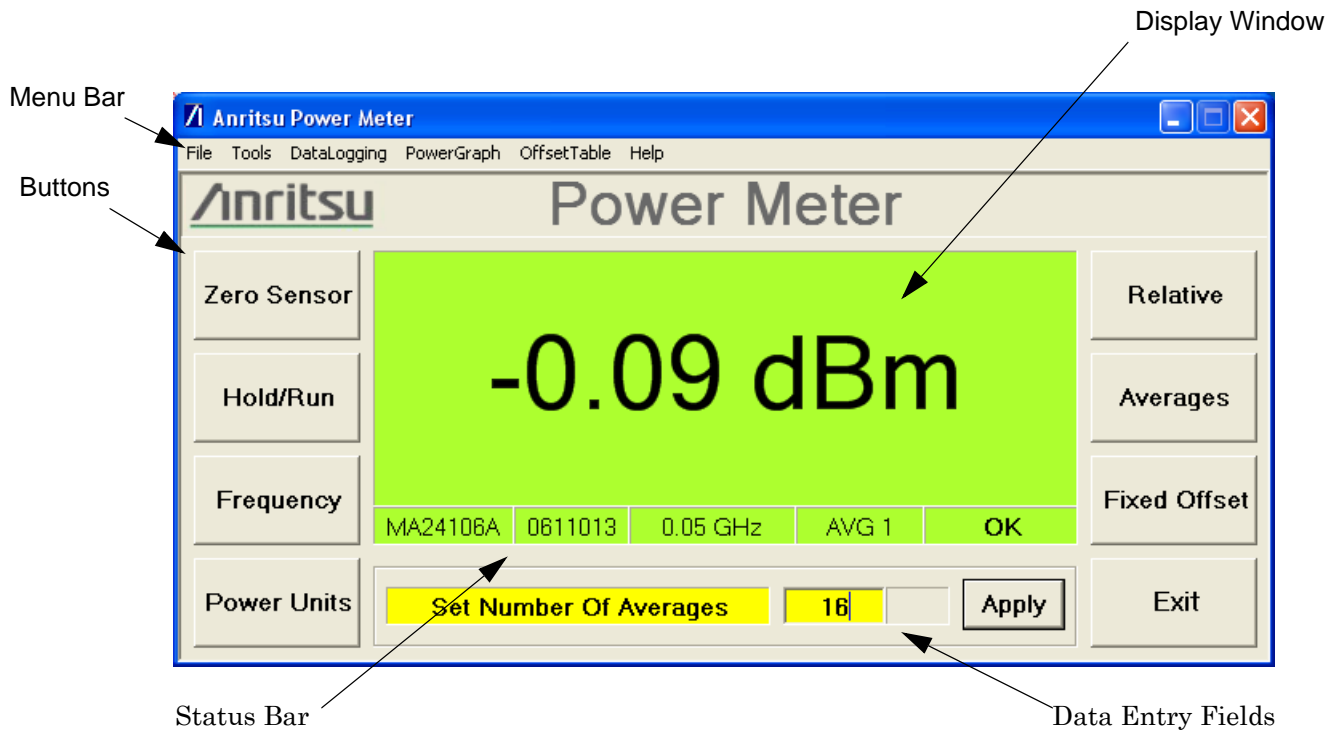
Figure 3-1. Graphical User Interface

The Anritsu Power Meter application always launches in the default state as described below:

- **Frequency:** 50 MHz
- **Power Units:** dBm
- **Averages:** 1
- **Fixed Offset:** 0 dB
- **Low Aperture Time:** Fast Mode

Communication with the sensor does not take place until the **Apply** button is clicked or the **Enter** key on the keyboard is pressed.

3-3   Buttons

There are nine buttons available on the user interface to perform the most common tasks as described below:

- **Zero:** Performs the Zero operation. Removes system noise.
- **Hold/Run:** Holds the last reading. Run releases the hold.
- **Frequency:** Applies frequency correction to the measured power.
- **Power Units:** Displays units of power in linear or log scale.
- **Normal/Relative:** Displays power changes with respect to desired reference value.
- **Averages:** Facilitates custom averaging number entry. The default number is 1.
- **Fixed Offset:** Facilitates an offset correction in dB. Input positive value for attenuation.
- **Apply:** Applies the current entry in the data entry field.
- **Exit:** Terminates the program.

3-4   Data Entry Fields

The data entry fields become active when clicking a button to accept an appropriate entry (see the example in Figure 3-2). Communication with the power sensor does not take place until the Apply button is clicked or the Enter key on the keyboard is pressed. The following list summarizes the entry fields:

- **Frequency Button:** Sets the Cal Factor Frequency in GHz
- **Power Units Button:** Sets the units of power to dBm, W, mW, or μW
- **Averages Button:** Sets the number of averages from 1 to 256
- **Fixed Offset Button:** Sets the attenuation from –100 dB to +100 dB Fixed Offset
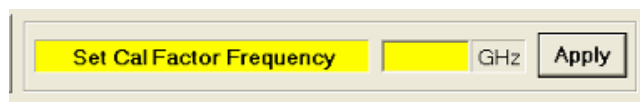
Figure 3-2.   Example of an Active Entry Field

3-5 Display Window

The display window contains the following information (see Figure 3-3 and Figure 3-4):

• Measured Power
• Relative Power
• Units of Power
• Fixed Offset
• Offset Table

Figure 3-3. Display Window (Relative Mode with Fixed Offset On)

Figure 3-4. Display Window (Normal mode with Offset Table On)

3-6 Status Bar

The status bar displays the model number, serial number, cal factor frequency, averaging number, and operational status of the sensor (see Figure 3-5).

Figure 3-5. Status Bar

3-7   Menu Bar

The Menu Bar contains the following menus:

File Menu

The File menu contains the Exit command, which terminates the application.
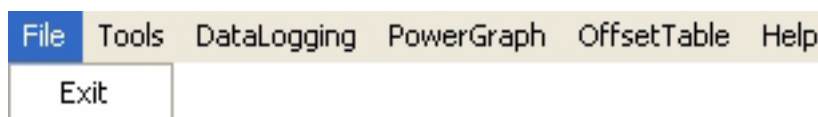
Figure 3-6.   File Menu

Tools Menu

The Tools menu contains:

- **Reset Averages:** Restarts the averaging
- **Clear Fixed Offset:** Removes the offset value and displays the absolute power being measured at the sensor RF port
- **High Aperture Time:** When High Aperture Time mode is selected, the sensor provides more accurate measurements of TDMA signals. In this mode, the ADC acquisition time is increased and the display update rate is decreased. This mode can be useful when measuring low power, modulated signals, and when changing between ranges.
- **Upgrade Firmware:** Launches the firmware upgrade sequence. Refer to Appendix D for a procedure on upgrading the firmware.
- **Connected to COM Port Number:** Displays the COM port number that is currently assigned to the power sensor.
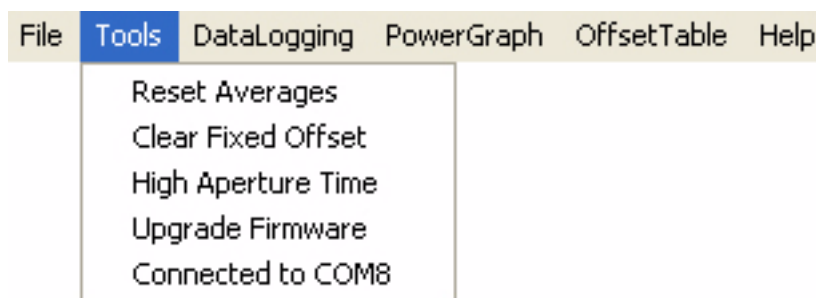
Figure 3-7.   Tools Menu

Data Logging Menu

The Data Logging menu provides choices between Data Logging On or Data Logging Off.
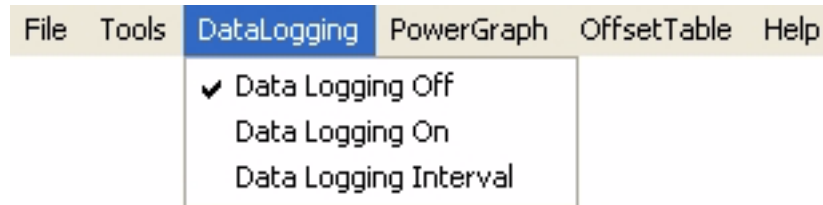
Figure 3-8.   DataLogging Menu

- **Data Logging On:** Data is stored as comma separated value (.csv) files that can be directly opened in Microsoft Excel. The filenames have the following format:

    xxxxxxx_yyyy_mm_dd_hhmmss.csv

    where:

    xxxxxxx: Serial number of the power sensor
    yyyy: Four-digit year
    mm: One- or two-digit month
    dd: One- or two-digit day
    hhmmss: Two digit hours (24-hour clock), minutes, and seconds

    The filename and location can be selected or changed as desired.
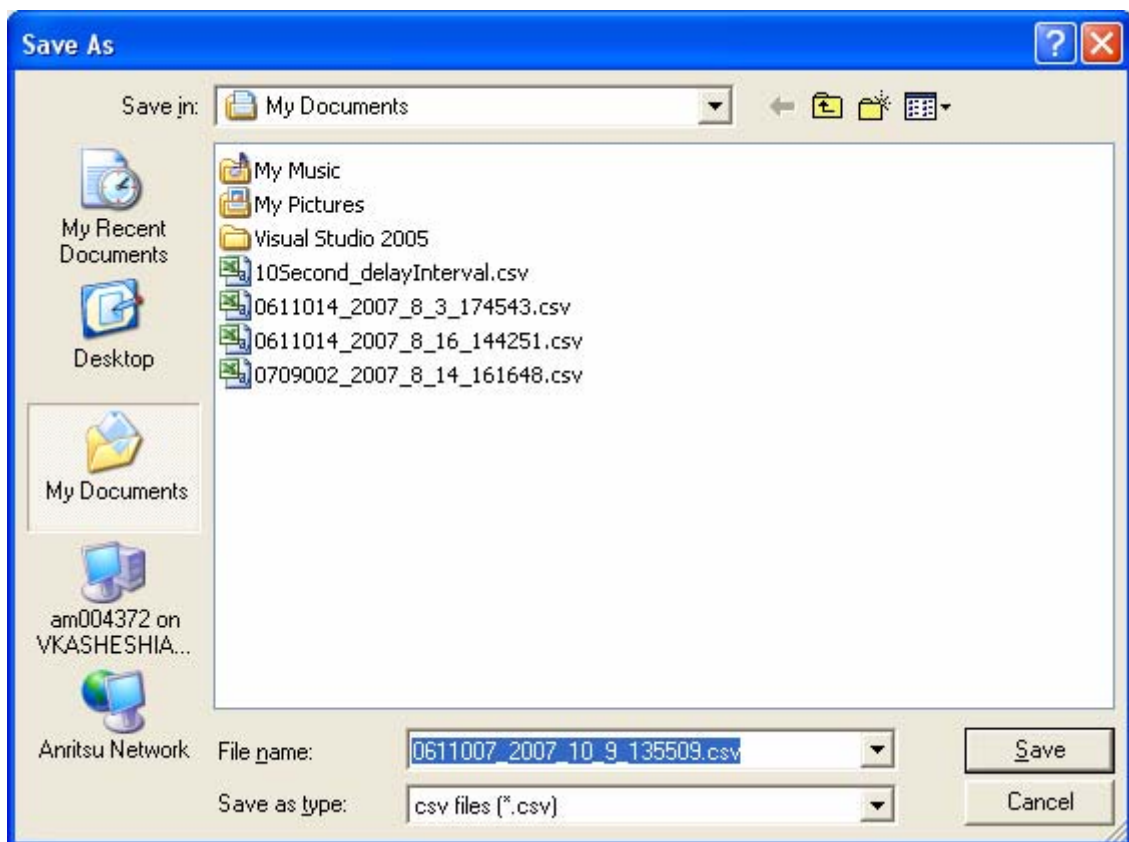
Figure 3-9.   DataLogging Save Dialog

- **Data Logging Interval:** Sets full speed data logging (approximately 10 measurements per second) or fixed interval data logging (user defined logging interval).
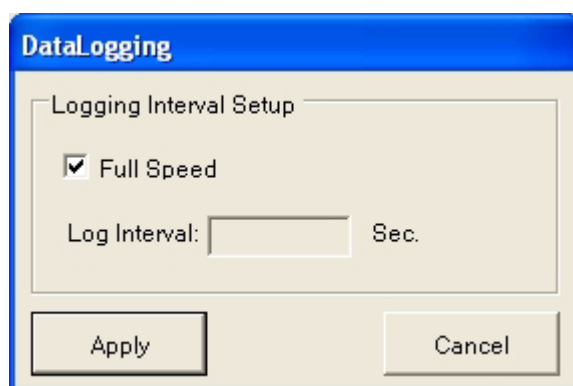
Figure 3-10. Data Logging

Power Graph

The Power Graph feature provides the ability to plot measured power with respect to time. This feature can be used for drift testing, tuning circuits, and for monitoring circuit behaviors to external stimuli, etc. The graph is continuously updated in real time.
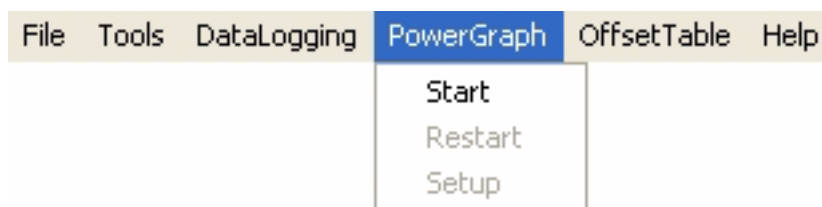
Figure 3-11. Power Graph Menu

Note: Unavailable selections become available after the Power Graph is started.

Clicking **Start** in the Power Graph menu opens the power versus time graph (Figure 3-12).
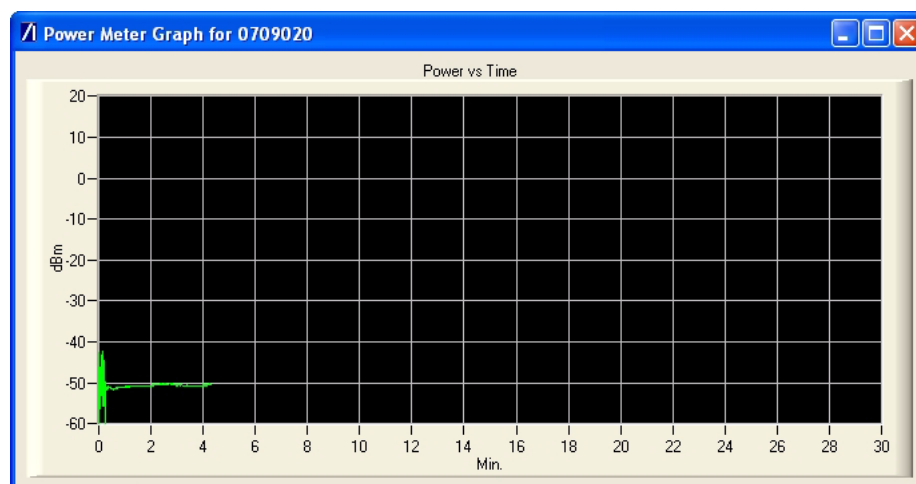
Figure 3-12. Power Graph Screen

The default settings of the graph are as follows:

- **Time, X-axis:** 30 minutes
- **Power, Y-axis:** +20 dBm to –60 dBm

Clicking **Setup** opens the Graph Setup dialog (below) where the scales of time and power axes can be changed. Power is in dBm and time is in minutes.

Figure 3-13. PowerGraph Setup Dialog

Offset Table

The Offset Table feature provides the ability to apply corrections to measurements in cases of RF devices being used between the sensor and DUT. Offset Table is different from Fixed Offset as it provides the ability to enter different offset values at different frequencies for an RF device. The frequency response of that device needs to be known before it can be entered. Offset Table employs linear interpolation to determine offset values for intermediate frequencies. In cases where the cal factor frequency is higher than the highest frequency in the offset table, then the offset for the highest frequency in the table is used. Similarly, when the cal factor frequency is lower than the lowest frequency in the offset table, then the offset for the lowest frequency in the offset table is used.

The procedure for setting, saving, recalling, and applying the offset table is as follows:

1. Click **OffsetTable** and select **Setup**.

2. In the resulting dialog (Figure 3-14), enter the frequency response of the RF device manually or by importing an S2P file used to measure the DUT. The example below is of a 10 dB attenuator where the values were manually entered.

> **Note:** Positive values in dB are used for attenuation.
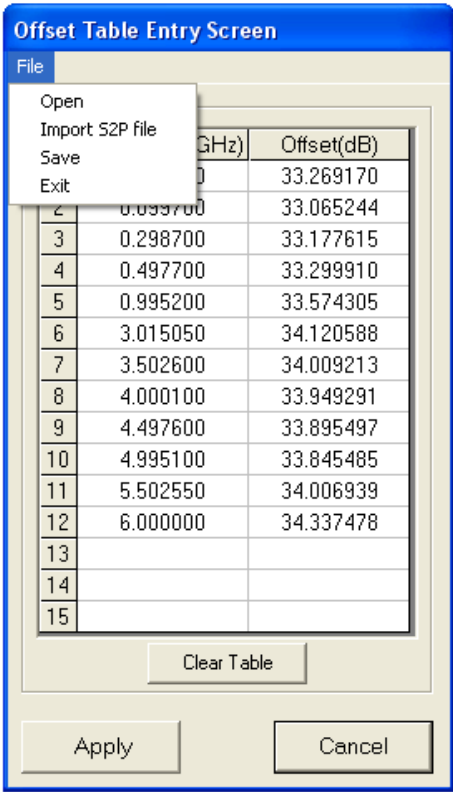
Figure 3-14. Offset Entry Screen

3. Click **Apply** in the Offset Entry screen to correct the measurement.

   The word Offset appears in the display window indicating that an offset table correction is applied to the current measurement. Also, a check mark is applied in front of the Offset Table On selection in the OffsetTable menu.

4. To clear all of the entries in the table, click the Clear Table button.

5. Save the response of the device by clicking **Save** from the Offset Entry Screen and save as a file in the directory of your choice (see Figure 3-15). Any number of device responses can be stored. The files are stored as comma separated value files (.csv).
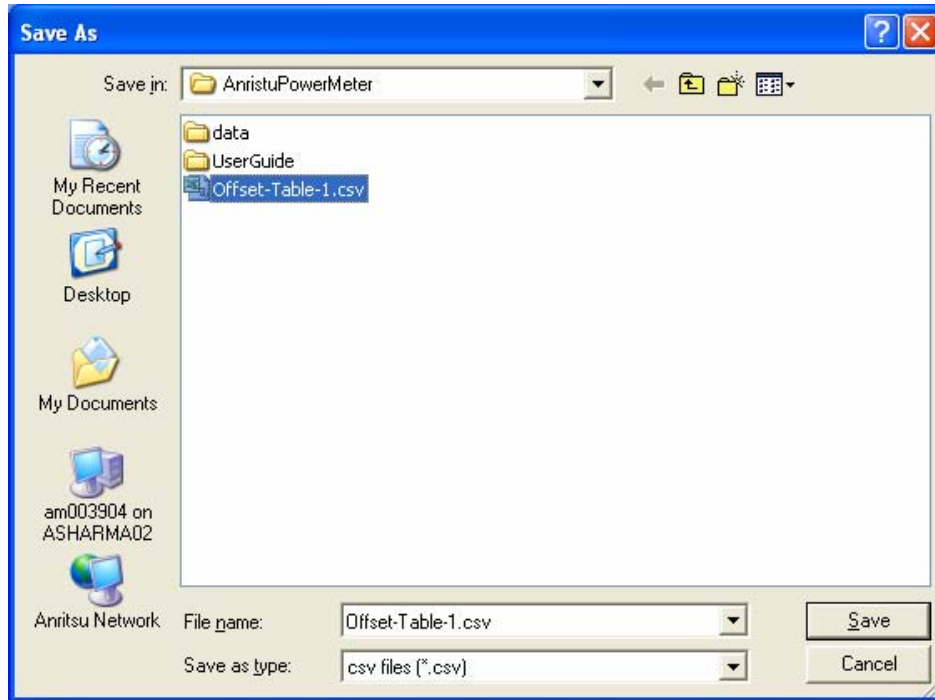
Figure 3-15. Save As Dialog

6. To recall a response, click **Open** in the Offset Entry screen, select the file, and then click **Apply**.

Similarly, S2P files can be imported as shown below:
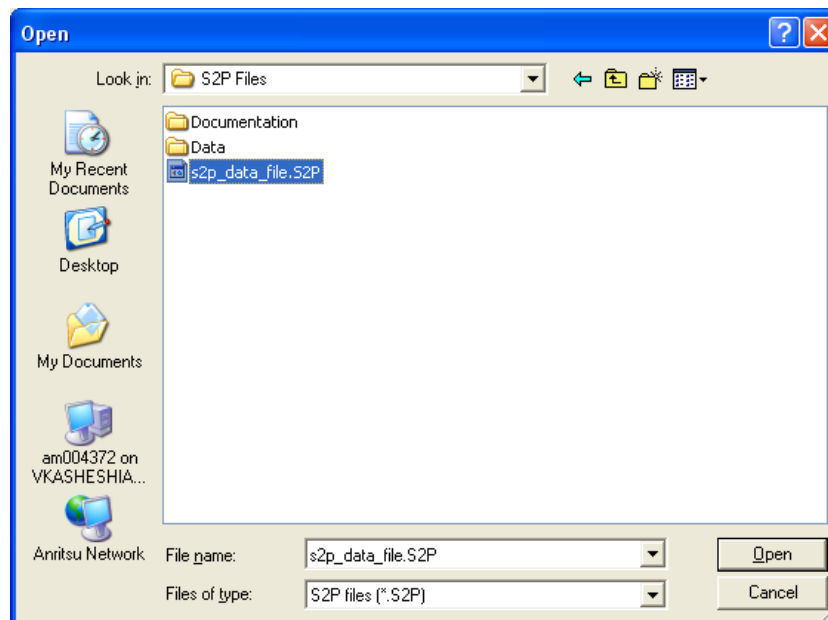
Figure 3-16. Open Dialog

7. To remove the Offset Table correction, click **Offset Table Off**. A check mark appears in front of Offset
Table Off and the word Offset does not appear in the display window (see Figure 3-17).
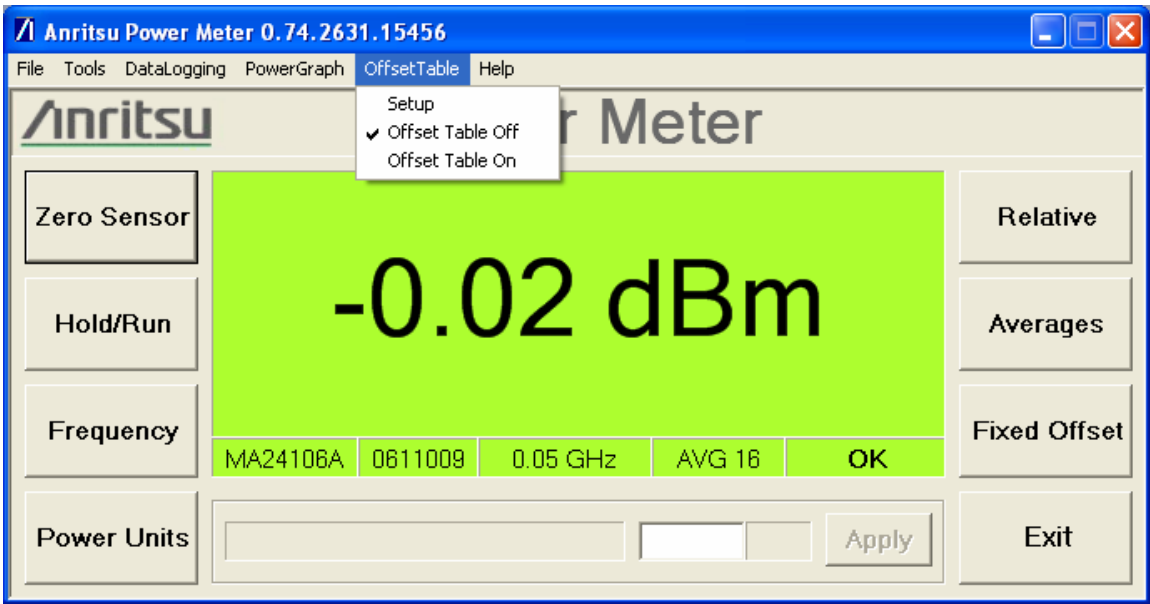
Figure 3-17. Offset Table Menu (Offset Table Off Status)

Session Restore

The Anritsu Power Meter application retains the set up information of a session, even if the USB power sensor
becomes disconnected from the PC. When the USB power sensor is reconnected, the changed properties (if
different from default) will be highlighted for five seconds as a reminder of the changed set up. The set up
information is lost once the application is closed.
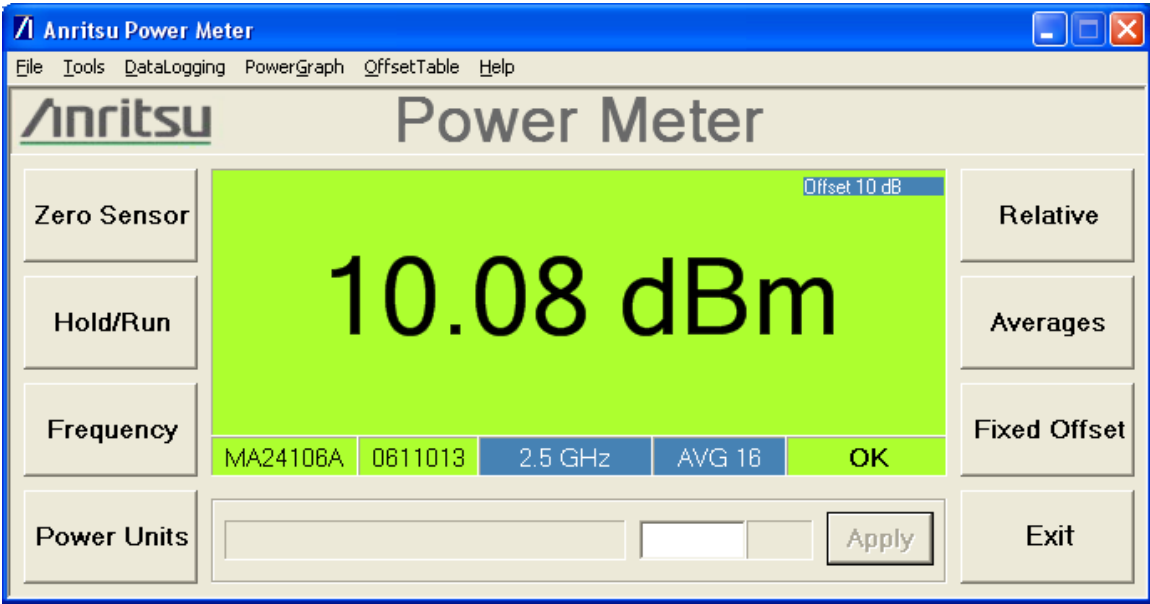
Figure 3-18. Session Restore

3-8 Making Measurements

This section presents common procedures for using the MA24106A power sensor. These procedures refer to the MA24106A buttons and menus that were previously described. You should be familiar with the Anritsu Power Meter PC application before attempting these procedures.

Basic Power Measurement

To perform a power measurement:

1. Connect the sensor to a computer as shown in Figure 3-19.

2. Open the Anritsu Power Meter application.

3. Zero the sensor as described below in Zeroing the Sensor.

4. Connect the power sensor to an RF source.

5. Read the power measurement from the Anritsu Power Meter application window (power readings are continuous with the default setting).
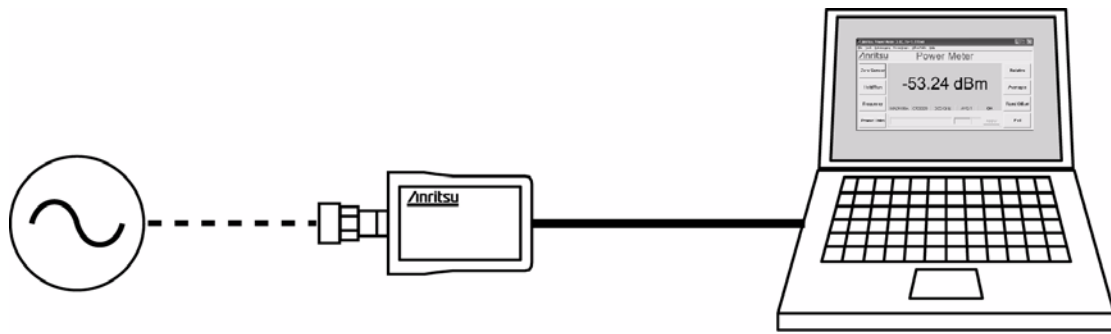
Figure 3-19. Measurement Setup

Connecting the DUT

RF signal connections are made to the Type N male RF connector, which has a 50 Ω characteristic impedance.

Warning: Do not connect or apply power outside of the MA24106A specifications or permanent damage may result.

When connecting to the Type N connector of the MA24106A to a Type N female connector, observe the following proper practice for tightening the connection:

1. While holding the body of the sensor in one hand, turn the Type N Male connector nut to finger tighten the connection. **Do not** turn the body of the MA24106A as this will cause excessive wear to the connector.

2. Back off the connection by turning the connector nut counter clockwise ¼ turn.

3. Tighten the connection (clockwise) using a 12 in-lb torque wrench (Anritsu part number: 01-200).

Note: The Sensor has a USB 2.0 interface with a USB Type Mini-B port. The MA24106A can be remotely programmed over this USB interface. In addition to programming, the MA24106A is powered by the USB. The interface is USB 2.0 compatible, but with an interface speed of 12 Mbps.

Zeroing the Sensor

Zero the sensor before making power measurements, particularly when operating within the lower 20 dB dynamic range of the power sensor. If frequent low-level measurements are being made, it is advised to check the sensor zeroing often and repeat as necessary. Before zeroing the sensor, connect it to the DUT (device under test) test port and remove RF power from the connection to a level 20 dB below the noise floor of the power sensor. For the MA24106A power sensor, this level is less than –60 dBm. It is preferable to leave the sensor connected to the DUT test port so that ground noise and thermal EMF (electro-magnetic fields) are zeroed out of the measurement. The sensor may also be connected to a grounded connector on the DUT or disconnected from any signal source.

To zero the sensor, press the **Zero** button on the application. If the sensor fails the zeroing operation, the message box states "Sensor zero failed" and "ZERO_ERROR" will be displayed on the application screen until the problem is corrected. If RF is detected, a reminder message will pop up asking to remove the RF source.

Calibrating the Sensor

The signal channel/analog signal acquisition hardware is integrated along with the RF front end of the power sensor. All of the necessary frequency and temperature corrections take place within the sensor. Therefore, there is no need for a reference calibration (at 50 MHz and 1 mW) with the MA24106A.

Applying a Calibration Factor Correction

The MA24106A power sensor has an internal EEPROM containing correction and calibration factors that were programmed into the sensor at the factory. The power sensor has an internal temperature sensor that reports its readings periodically to the microprocessor. The sensor makes all of the required calculations on the measurement once the measurement frequency has been entered by the user.

Optimizing the Readings

This section presents information on how to get the fastest readings from the MA24106A power sensor when using the Anritsu Power Meter application or operating under remote control (refer to Chapter 4 for specific remote programming command descriptions). Measurement speed depends greatly on the type of measurement, the power level, and stability of the signal. Stability of a measurement is influenced by noise and signal modulation. If high resolution is required, averaging must be increased.

Note: The values in the following tables are typical and should be used as a reference only.

Table 3-1, describes the number of averages needed to attain a certain noise level for a particular power level measurement with the Low Aperture Time mode setting.

Table 3-1.   MA24106A Averaging Table (Low Aperture Time, Default Mode)

Input Power (dBm)	Input Power (mW)	Number of Averages Needed for < ±0.20 dB Noise	Number of Averages Needed for < ±0.15 dB Noise	Number of Averages Needed for < ±0.10 dB Noise	Number of Averages Needed for < ±0.05 dB Noise	Number of Averages Needed for < ±0.01 dB Noise
20	100	1	1	1	1	1
15	31.6	1	1	1	1	1
10	10.0	1	1	1	1	1
5	3.16	1	1	1	1	2
0	1.00	1	1	1	4	16
-5	0.316	1	1	1	20	78
-10	0.100	1	1	1	1	1
-15	0.0316	1	1	1	1	1
-20	0.0100	1	1	1	1	7
-25	0.00316	1	1	1	3	61
-30	0.00100	2	3	7	25	–
-35	0.000316	16	28	62	245	–
-40	0.000100	158	–	–	–	–

Table 3-2, describes the number of averages needed to attain a certain noise level for a particular power level measurement with the High Aperture Time mode setting.

Table 3-2.   MA24106A Averaging Table (High Aperture Time)

Input Power (dBm)	Input Power (mW)	Number of Averages Needed for < ±0.20 dB Noise	Number of Averages Needed for < ±0.15 dB Noise	Number of Averages Needed for < ±0.10 dB Noise	Number of Averages Needed for < ±0.05 dB Noise	Number of Averages Needed for < ±0.01 dB Noise
20	100	1	1	1	1	1
15	31.6	1	1	1	1	1
10	10.0	1	1	1	1	1
5	3.16	1	1	1	1	1
0	1.00	1	1	1	1	1
-5	0.316	1	1	1	2	5
-10	0.100	1	1	1	1	1
-15	0.0316	1	1	1	1	1
-20	0.0100	1	1	1	1	1
-25	0.00316	1	1	1	1	4
-30	0.00100	1	1	1	2	38
-35	0.000316	1	2	4	16	–
-40	0.000100	10	18	39	153	–

Error States

This section details some of the error messages that may appear on the application screen. In most cases, the error condition can be easily corrected. The status LED will light yellow when an error state occurs. If not, note the error message and contact an Anritsu Service Center.

Table 3-3.   Error Messages

Message	Description	Resolution
Zero invalid as temperature changed by more than 10 Degrees C	The sensor's ambient temperature has changed by more than 10 ºC since the last zero operation.	Perform the zero operation again.
Temperature out of operating range	Operating range of the sensor is 0 ºC to 55 ºC.	Re-examine the ambient conditions.
Sensor zero failed	This message box appears if the zero operation is unsuccessful. The reason could be the presence of RF power at the input of the sensor.	Turn off the RF input to the sensor or disconnect the sensor from the RF source and try the zero operation again.
ZERO_ERROR	This message appears on the application screen if the zero operation is unsuccessful. The reason could be the presence of RF power at the input of the sensor.	Turn off the RF input to the sensor or disconnect the sensor from the RF source and try the zero operation again.
ADC_TEMP_OVERRNGE	This message appears on the application screen if the sensor is being operated in extremely high temperatures and has overheated.	Remove the sensor from the USB connection and allow to cool to the operating range of the sensor: 0 ºC to 55 ºC

3-9   Measurement Considerations

Time Varying Signals

Case 1: Modulated signals with pulse or pattern repetition times $\leq$ 1 ms (PRF $\geq$ 1 KHz)

If you obtain a steady power reading of a modulated signal (no significant fluctuations of the displayed power) with no averaging, then it is likely that the pulse or pattern repetition rate is greater than 1 KHz. In this case, most of the averaging of the envelope power is performed in the front end of the sensor (before being digitized). When this is the case, the MA24106A will provide an accurate indication of the average power with no special considerations.

Case 2: Modulated signals with pulse or pattern repetition times between 1 ms and 50 ms (100 Hz < PRF < 1 KHz)

In this case, the signal is varying too slowly to be averaged in the front end of the sensor, so averaging must be performed after digitalization by increasing the averaging number in the power meter application (or calculating the average of several measurements if controlling the sensor over the bus). A large amount of averaging must be used for some pulse/pattern repetition frequencies to get a steady reading. If Low Aperture Time (LAT) mode is selected, the maximum recommended pulse repetition time is about 10 ms. If High Aperture Time (HAT) mode is selected, signals with pulse repetition periods as long as 50 ms can usually be measured.

Case 3: Modulated signals with pulse or pattern repetition times greater than 50 ms

In this case, it can be difficult to get an accurate average power reading even by averaging many readings. The sample rate of the sensor and the pulse repetition rate of the signal may be close enough that they can "beat" together resulting in low frequency modulation of the power indication. If averages are not calculated over many of these beats, or an integer number of beats, errors can result. This is not unique to the MA24106A and can be an issue with any power sensor/meter and any sampled data system.

High Crest Factor Signals (peak to average ratio)

High crest factor signals, such as CDMA/WCDMA, may have crest factors as high as 10 dB. To ensure the most accurate power measurement, the statistically-low peak signals should not exceed +30 dBm.

For example, if a signal has an expected crest factor of 10 dB, then the highest average power measured should not exceed +20 dBm. A sensor's linearity graph of a WCDMA (TestModel_5_8HSPDSCH) signal with 10 dB crest factor is shown below:
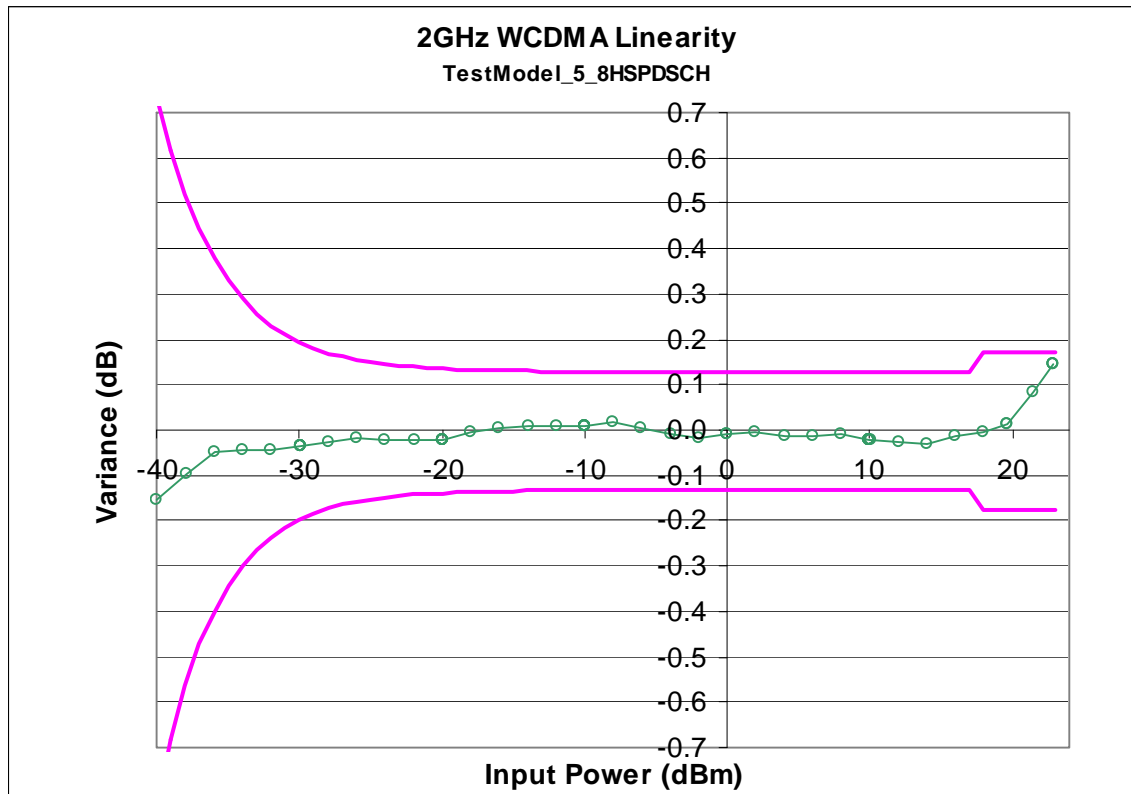
Figure 3-20. Sensor Linearity Graph

Multitone Signals

The MA24106A is a True-RMS sensor that can measure very wide bandwidth modulation without much restriction. The only limitation is the frequency flatness of the sensor. Because the sensor's sensitivity is not identical for all frequencies and when measuring multi-tone signals, the frequency entered into the sensor's application should be the average frequency of all significant tones. The MA24106A has an error of 0.01 dB for every 100 MHz bandwidth at frequencies below 3 GHz, and an error of 0.03 dB for every 100 MHz bandwidth at frequencies above 3 GHz.

For example, a dual tone signal of 2.0 GHz and 2.2 GHz may have an additional measurement error of 0.02 dB (0.01 dB × 2) when the application frequency is set to 2.1 GHz.

Noise and Averaging

When there is a need to achieve a required reading resolution, particularly at low power levels, averaging is often needed to reduce noise and steady the displayed power reading. Use the noise vs. resolution table in the sensor manual (Using the Power Sensor | Making Measurements | Optimizing the Readings) to determine the number of averages that will typically be required for a given resolution. Alternatively, determine the number of averages through calculation by using the noise specifications and the fact that noise will be proportional to the square root of N, where N is the number of averages.

For example, a CW tone at –30 dBm is to be measured to 0.01 dB resolution. Using the table in the sensor manual, the required number of averages is 38 averages using High Aperture Time mode (the same measurement would require more than 256 averages in Low Aperture Time mode).

Settling Time

The MA24106A samples power continuously every 70 ms in the Low Aperture Time (LAT) mode and 700 ms in the High Aperture Time (HAT) mode. The sensor's front end and digitizer settles completely to a step change in power in this amount of time. However, there is no way to synchronize the sensor's sampling to any other event, such as a power step or bus request for a measurement. Therefore, the first measurement requested from the sensor after a power step may not be fully settled. To ensure a fully settled measurement when operating the sensor over the bus, wait 70 ms (700 ms if in HAT) after a power step before requesting the measurement from the sensor. Alternatively, request two measurements from the sensor and discard the first.

If averaging is required as described above, settling time increases by N × sample period, where N is the number of averages and the sample period is the time is milliseconds. The measurement sample period is 70 ms for LAT and 700 ms for HAT. When operating the sensor over the bus, request N+1 measurements from the sensor, discard the first, and then average the subsequent readings. The settling time is approximately (N+1) × sample period.

3-10 Uncertainty of a Measurement

Power measurements have many component parts that affect overall measurement uncertainty when measuring power with the MA24106A sensor:

- **Sensor Linearity and Temperature Compensation:** Sensor Linearity and Temperature Compensation describe the relative power level response over the dynamic range of the sensor. Temperature Compensation should be considered when operating the sensor at other than room temperature.

- **Noise, Zero Set, and Zero Drift:** These are factors within the sensor that impact measurement accuracy at the bottom of the power sensor's dynamic range.

- **Mismatch Uncertainty:** Mismatch uncertainty is typically the largest component of measurement uncertainty. The error is caused by differing impedances between the power sensor and the device to which the power sensor is connected. Mismatch uncertainty can be calculated as follows:

  % Mismatch Uncertainty = $100[|1 + \Gamma_1\Gamma_2|^2 - 1]$

  dB Mismatch Uncertainty = $10\log|1 + \Gamma_1\Gamma_2|$

  where

  Γ_1 and Γ_2 are the reflection coefficients of the power sensor and the device under test

- **Sensor Calibration Factor Uncertainty:** Sensor Calibration Factor Uncertainty is defined as the accuracy of the sensor calibrated at a standard calibration condition. Anritsu follows the industry standard condition of calibration at a reference power of 0 dBm (1 mW) and an ambient temperature of 25 °C.

Uncertainty Example

An example of a measurement uncertainty calculation (for Low Aperture Time mode) is detailed for the MA24106A in Table 3-4 below. The MA24106A is used to measure the power of a 3 GHz, +12.0 dBm and −35 dBm CW signal from a signal source with 1.5:1 VSWR.

Table 3-4. Measurement Uncertainty Example

Uncertainty Term	Uncertainty Specification at +12 dBm (%)	Uncertainty Specification at −35 dBm (%)	Probability Distribution	Divisor	Adjusted Uncertainty at +12 dBm (%)	Adjusted Uncertainty at −35 dBm (%)
Sensor Linearity (<+18 dBm)	3.0	3.0	Rectangular	$\sqrt{3}$	1.8	1.8
Noise	0.0	0.8	Normal at 2σ	2	0.0	0.4
Zero Set	0.0	3.2	Rectangular	$\sqrt{3}$	0.0	1.8
Zero Drift	0.0	0.9	Normal at 2σ	2	0.0	0.5
Calibration Factor Uncertainty	1.4	1.4	Normal at 2σ	2	0.7	0.7
Mismatch Uncertainty	4.0	4.0	Rectangular	$\sqrt{3}$	2.3	2.3
Combined Uncertainty (RSS), Room Temperature					3.0	3.6
Expanded Uncertainty with K=2, Room Temperature					6.0	7.1
Temperature Compensation	1.4	1.4	Rectangular	$\sqrt{3}$	0.8	0.8
Combined Uncertainty (RSS, 0 to 50 °C)					3.1	3.6
Expanded Uncertainty with K=2 (RSS, 0 to 50 °C)					6.2	7.3

Table 3-5. Noise Measurement Uncertainty Calculations

Noise Calculations at 12 dBm (16 mW):

Noise	400 nW/16 mW = 0.0%
Zero Set	1700 nW/16 mW = 0.0%
Zero Drift	500 nW/16 mW = 0.0%

Noise Calculations at −35 dBm (316 nW):

Noise	2.5 nW/316 nW = 0.8%
Zero Set	10 nW/316 nW = 3.2%
Zero Drift	3 nW/316 nW = 0.9%

Chapter 4 — Remote Operation

4-1 Introduction

Once connected to a PC using a USB cable, the MA24106A shows up as an RS-232 Serial COM port on the PC. You can check the COM port number from the Tools drop-down menu or by using the Windows control panel. The COM port number and following settings are needed in order to control the sensor remotely:

- **Baud Rate:** 115200
- **Data Bits:** 8
- **Parity:** None
- **Stop Bits:** 1

When the power sensor is connected to a PC using a USB cable, it will be configured in idle mode. While in idle mode, the sensor is waiting for a **START** command from the host application. The application developer must send the **START** command to put the sensor in measurement mode. Once the sensor is in measurement mode, various commands can be sent to communicate with the power sensor. When the application is being closed, the **STOP** command should be sent to put sensor in idle mode.

> **Note:** In Low Aperture Time mode, the sensor takes about 70 milliseconds to respond to all commands with the exception of the **ZERO** command, which takes about 19 seconds.
>
> In High Aperture Time mode, the sensor takes about 700 milliseconds to respond to all commands with the exception of the **ZERO** command, which takes about 19 seconds.

4-2 Remote Operation Commands Summary

The following is a list of commands available to control the MA24106A:

Table 4-1. Remote Operation Commands

Command	Description
START	Puts the power sensor in measurement mode
STOP	Stops the measurement mode and puts the sensor in idle mode
IDN?	Gets identification information from the sensor
PWR?	Gets the power reading from the power sensor.
NPWR?	Gets a new power reading from the sensor
FREQ?	Gets the current cal factor frequency value from the sensor
FREQ	Sets the cal factor frequency value
ZERO	Zeros the power sensor
TMP?	Gets the current temperature from the sensor
STATUS?	Gets the error status byte from the sensor
HAT	Sets High Aperture Time mode
LAT	Sets Low Aperture Time mode

4-3   Remote Operation Command Details

Each command needs to be followed by a Line Feed (0x0A, ASCII 10) termination character. Response from the sensor will have a Line Feed (0x0A, ASCII 10) termination character attached at the end.

START

Description:	Puts the power sensor in measurement mode.
Syntax:	START + LF
Return Value:	None for the first time, OK for any subsequent command sent.
Remarks:	This command does not return anything when sent the first time. For any subsequent START commands, the sensor will return OK. This is helpful, if the user wants to know if the sensor is in measurement mode.

STOP

Description:	Stops the measurement mode and puts the sensor in idle mode.
Syntax:	STOP + LF
Return Value:	OK or ERR
Remarks:	This command should be sent before exiting the user application.

IDN?

Description:	Gets identification information from the sensor.
Syntax:	IDN? + LF
Return Value:	ANRITSU, Model #, Serial #, Module Serial #, firmware version

PWR?

Description:	Gets the power reading from the power sensor.
Syntax:	PWR? + LF
Return Value:	Power value in dBm
Remarks:	If an error condition exists, the returned power reading values are pre-tagged with the letter "E" and the sensor's LED turns yellow. The STATUS? command can then be issued to find details about the error.

NPWR?

Description:	Gets a new power reading from the power sensor.
Syntax:	NPWR? + LF
Return Value:	Current Power value in dBm
Remarks:	After receiving this command, the power sensor discards the existing data that is stored in the sensor's buffer. A new measurement of the current power is initiated to get a new power reading.
	If an error condition exists, the returned power reading values are pre-tagged with the letter "E" and the sensor's LED turns yellow. The STATUS? command can then be issued to find details about the error.

> **Note:** This command is only available in sensor firmware versions 1.01 and later.

FREQ?

Description: Gets the current cal factor frequency value from the sensor.

Syntax: FREQ? + LF

Return Value: Current cal factor frequency in GHz

FREQ

Description: Sets the current cal factor frequency value for the sensor.

Syntax: FREQ fghz + LF

Return Value: OK or ERR

Remarks: "fghz" is the cal factor frequency value in GHz. "fghz" must be between 0.05 GHz to 6 GHz. Available resolution is 3 digits after the decimal point.

ZERO

Description: Zeros the power sensor.

Syntax: ZERO + LF

Return Value: OK if successful and ERR if zeroing failed.

Remarks: In case of zero failure, the STATUS? command can be used to retrieve more detail about the error. See the STATUS? command for more detail. It takes 19 seconds to zero a sensor, please wait at least this long to get a response from the sensor.

TMP?

Description: Gets the current temperature reading from the sensor.

Syntax: TMP? + LF

Return Value: Current temperature in degrees C.

STATUS?

Description: Get error status byte from the sensor.

Syntax: STATUS? + LF

Return Value: Error status byte

Remarks: Error status byte information:

```
Status.b0 -> ZERO_TEMP_ERROR (Temperature changed more than
allowable limit after zeroing sensor)

Status.b1 -> Not Used

Status.b2 -> ADC_CH2_OR (Temperature over range)

Status.b3 -> ADC_CH3_OR (Detector A over ranged)

Status.b4 -> ZERO_ERROR_DET_A

Status.b5 -> ZERO_ERROR_DET_B

Status.b6 -> TEMP_ERROR (Temperature beyond operating range)

Status.b7 -> Not Used
```

HAT

Description: Sets the high aperture time mode.

Syntax: HAT + LF

Return Value: OK or ERR

Remarks: This command will put the sensor in high aperture time mode. In this mode, the A to D converter integration time is about 160 milliseconds.

LAT

Description: Sets the low aperture time mode.

Syntax: HAT + LF

Return Value: OK or ERR

Remarks: This command will put the sensor in low aperture time mode. In this mode, the A to D converter integration time is about 10 milliseconds. This mode is the default mode for the sensor when powered up.

Chapter 5 — Sensor Operational Tests

5-1 Introduction

The test methodology and equipment described herein can be used to gain some confidence in the measurement accuracy of the MA24106A Power Sensor. This is accomplished by comparing the sensor to another sensor with a specified cal factor and linearity performance or uncertainty. General commercially available equipment is used for these tests; however, these procedures are not sufficiently accurate to verify sensors to factory specification. Therefore, sensor test limits in these procedures are set appropriately to the specified comparison equipment. All tests should be performed at an ambient temperature of 20ºC to 25ºC.

> **Note:** Calibration and verification of high accuracy Power sensors requires substantial investment in both skill and equipment. For calibration, calibration verification, and to maintain the factory specifications of your power sensor, please send sensors to qualified Anritsu Customer Service Centers.

Refer to the following sections for required equipment and test procedures:

- Required Equipment
- VSWR Pretest
- Calibration Factor Test
- Linearity Test

5-2 Required Equipment

Table 5-1. Required Equipment

Equipment Description	Manufacturer and Model	Critical Specifications
Vector Network Analyzer (Pretest)	Anritsu MS4624B or equivalent	Reflection Coefficient Uncertainty ≤0.013 to 2 GHz Uncertainty ≤0.020 to 6 GHz
Synthesizer (Cal. Factor and Linearity Tests)	Anritsu MG3692 or equivalent	Output Power: >+20 dBm 0.05 to 6 GHz Output Power Setting Resolution: 0.01 dBm Harmonics: ≤–40 dBc Source VSWR ≤2
Reference Power Meter (Cal. Factor and Linearity Tests)	Anritsu ML2438 or equivalent	Instrumentation Accuracy ≤0.5%
Reference Power Sensor (Cal. Factor and Linearity Tests)	Anritsu MA2422B or equivalent	NIST Calibration or equivalent
10 dB K Attenuator (Linearity Test)	Anritsu 41KC-10	VSWR ≤1.15 to 6 GHz
6 dB K Attenuator (Cal. Factor Test)	Anritsu 41KC-6	VSWR ≤1.15 to 6 GHz
Adapter N(f) to K(f) (Cal. Factor and Linearity Tests)	Anritsu 34ANF50 and 34AS50	VSWR ≤1.05 to 6 GHz
Power Splitter (Linearity Tests)	Anritsu K241B	Effective Output VSWR <1.45 to 6 GHz
Power Sensor Under Test	MA24106A	See Datasheet, 11410-00424
Personal Computer	Any	See Chapter 2

5-3   VSWR Pretest

The most common cause of power sensor failure is excess input power. Applying power exceeding the damage level shown on the label will damage the sensor's sensing element resulting in impedance change. Input match will be degraded when element impedance is changed. If you suspect that a senor is damaged, you should start with an input match pretest.

The maximum VSWR values are listed in the Performance Specification section of this manual.   The uncertainty of the VSWR test equipment will affect actual measurement values. See the following Table 5-2 for an example of how measurement system uncertainty can affect the Expected Maximum Reflection Coefficient when using the Anritsu MS4624B Vector Network Analyzer.

Test Procedure

Follow the manufacturers S_{11} (or return loss) calibration procedure to perform calibration on a network analyzer. Connect the power sensor to the network analyzer test port and measure power sensor input match. Typically, matches are measured in terms of return loss in dB. Return loss and magnitude of the reflection coefficient conversion equations are as follows:

$\rho = 10^{-RL/20}$

$RL = -20\log\rho$

where

RL = Return Loss in dB

ρ = Magnitude of the Reflection Coefficient

VSWR and magnitude of the reflection coefficient conversion equations are as follows:

$VSWR = (1 + \rho) / (1 - \rho)$

$\rho = (VSWR - 1) / (VSWR + 1)$

where

VSWR = Voltage Standing Wave Ratio

ρ = Magnitude of the Reflection Coefficient

Record the measured data into Table 5-2 under the Actual Measurement column. The Actual Measurement should be smaller than the Maximum Reflection coefficient. The Maximum Reflection Coefficient is equal to the measurement system uncertainty added to the sensor's reflection coefficient specification. If the Actual Measurement reflection coefficient is larger than the Maximum Reflection Coefficient, then the power sensor may be defective. If the actual reflection coefficient is significantly larger than the maximum values in Table 5-2, then the sensor is damaged and it is not necessary to perform further testing.

Note: There are no user-serviceable parts inside the power sensors. Contact your local Anritsu Service Center and return defective sensors with a detailed description of the observed problem.

Table 5-2.   Pretest Measurement Result

Frequency	MS4624B Reflection Coefficient Uncertainty	Maximum Reflection Coefficient	Actual Measurement
50 MHz to 2 GHz	0.013	0.050 + 0.013 = 0.063	
2 GHz to 6 GHz	0.020	0.100 + 0.020 = 0.120	

5-4   Calibration Factor Test

In this test the calibration factors of the MA24106A are compared against another sensor (referred to in this procedure as the "reference sensor") with known calibration factor uncertainties. This reference sensor should be calibrated by a reputable standards laboratory which has low published measurement uncertainty. To perform the comparison, both sensors are used to measure the output power of a synthesizer with a high quality attenuator, such as the 41KC-6, on the output. The attenuator improves the source match of the synthesizer by lowering the mismatch ripples, thereby lowering the uncertainty in the comparison.

Test Procedure

1. Set up the equipment as follows (refer to Figure 5-1 for an illustration):

   a. Connect the reference power sensor to the reference power meter using the appropriate cables.

   b. Connect the MA24106A USB cable between the personal computer with the Power Meter application installed and the MA24106A power sensor under test.

   c. Launch the Power Meter application.

   d. Turn the power on to all of the instruments and allow them to warm up for the amount of time specified in their respective manuals.

   e. Reset or Preset all of the instruments.

   f. Configure the reference meter and sensor to measure a CW signal.

   g. Perform a sensor Zero and a 1 mW reference calibration on the reference sensor and meter per the manufacturer's instructions.

   h. Perform a low level Zero of the MA24106A as follows:

   With the MA24106A disconnected from the synthesizer, click the **Zero Sensor** button on the Power Meter application and wait for the Zeroing Sensor message to close.

   i. Connect the attenuator to the output of the synthesizer with the appropriate adapter to the output of the attenuator.

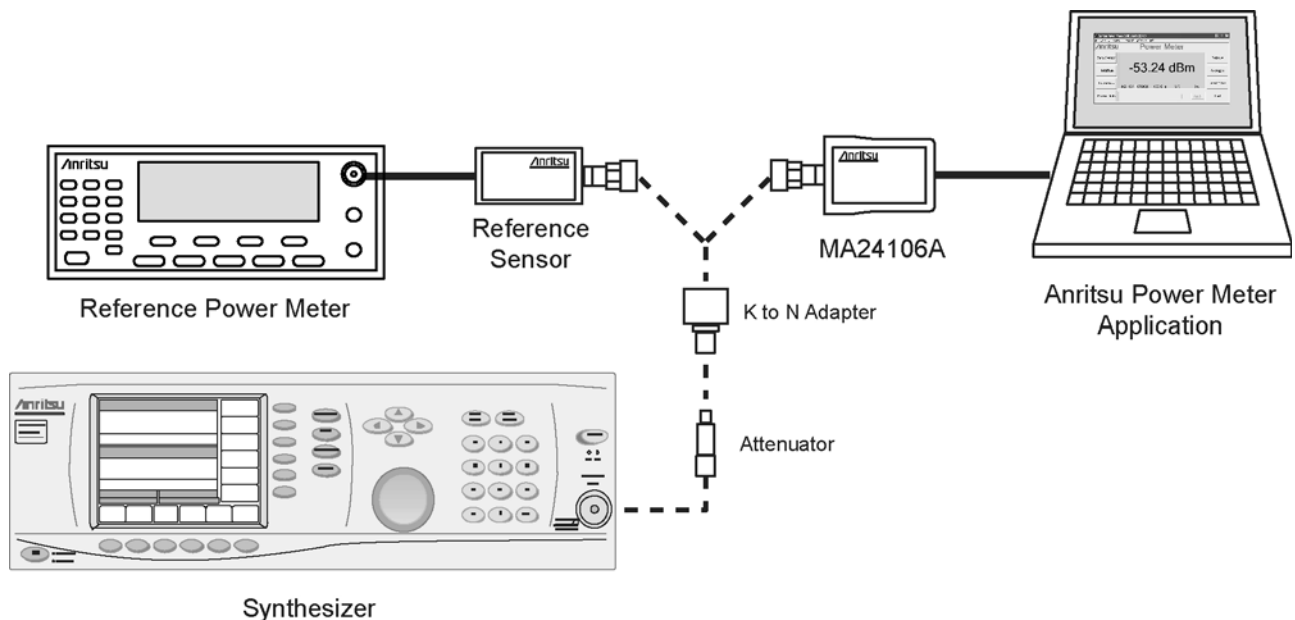   **j.** Set the synthesizer to +6 dBm and 50 MHz.

Figure 5-1.   Cal Factor Test Set Up

2. Connect the reference sensor to the synthesizer with the appropriate adapter and attenuator in-line (see Figure 5-1).

3. Apply the appropriate Cal factor to the reference sensor per the manufacturer's instruction.

4. Record the power indicated by the reference meter in the appropriate space in Table 5-3.

5. Disconnect the reference sensor from the synthesizer output and connect the MA24106A power sensor with the appropriate adapter and attenuator in-line (see Figure 5-1).

6. Apply the appropriate Cal factor to the MA24106A as follows:

   Press the **Frequency** button on the Power Meter application, and then enter the frequency of the measurement in GHz.

7. Record the power indicated by the MA24106A in the appropriate space in Table 5-3.

8. Set the synthesizer frequency to the next frequency in Table 5-3.

9. Repeat steps 2 through 8 until all of the frequencies in Table 5-3 have been measured.

10. For each row in Table 5-3, calculate the absolute value of the difference between the recorded Reference power measurement and the recorded MA24106A measurement, and record the result in the appropriate space in Table 5-3.

11. For each frequency, compare the power difference to the maximum allowed difference specified in Table 5-3. If the difference is higher than the maximum allowed difference, contact Anritsu customer service.

Table 5-3.   Calfactor Test Measurement Results

Frequency (GHz)	A Reference Power Measurement (dBm)	B MA24106A Measurement (dBm)	|A-B| Absolute Value of Difference in Power Measurements (dB)	Maximum Allowed Difference (dB)
0.05				0.26
0.1				0.26
0.3				0.26
0.5				0.26
1.0				0.26
2.0				0.31
3.0				0.31
4.0				0.31
5.0				0.33
6.0				0.33

5-5   Linearity Test

The linearity correction of the MA24106A is compared to a thermal power sensor, which has very good inherent linearity over a power range of about –20 to +10 dBm. For this reason, the MA24106A will be compared to the thermal sensor in two *ranges*, keeping the power levels to the thermal sensor in the range of –17 dBm to +5 dBm, while the power to the MA24106A will vary from about –26 dBm to about +14 dBm.

Test Procedure

1. Set up the equipment as follows (refer to Figure 5-2 for an illustration):

    a. Connect the reference power sensor to the reference power meter using the appropriate cables.

    b. Connect the MA24106A USB cable between the personal computer with the Power Meter application installed and the MA24106A power sensor under test.

    c. Launch the Power Meter application.

    d. Turn the power on to all of the instruments and allow them to warm up for the amount of time specified in the instrument's respective manuals.

    e. Reset or Preset all of the instruments.

    f. Configure the reference meter and sensor to measure a CW signal.

    g. Perform a sensor Zero and a 1 mW reference calibration on the reference sensor and meter per the manufacturer's instructions.

    h. Perform a low-level Zero of the MA24106A as follows:

        With the MA24106A disconnected from the synthesizer, click the **Zero Sensor** button on the Power Meter application and wait for the Zeroing Sensor message to close.

    i. Connect the power splitter to the output of the synthesizer and connect the 10 dB attenuator to one of the splitter outputs.

    j. Connect an N(f) to K adapter to each power sensor.

    k. Connect the reference sensor and adapter to the 10 dB attenuator.

    l. Connect the MA24106A and adapter to the other splitter output.

    m. Set the synthesizer to 50 MHz and +20 dBm.

n. Increase averaging on the MA24106A by clicking the **Averages** button, enter "16" and then click **Apply**.
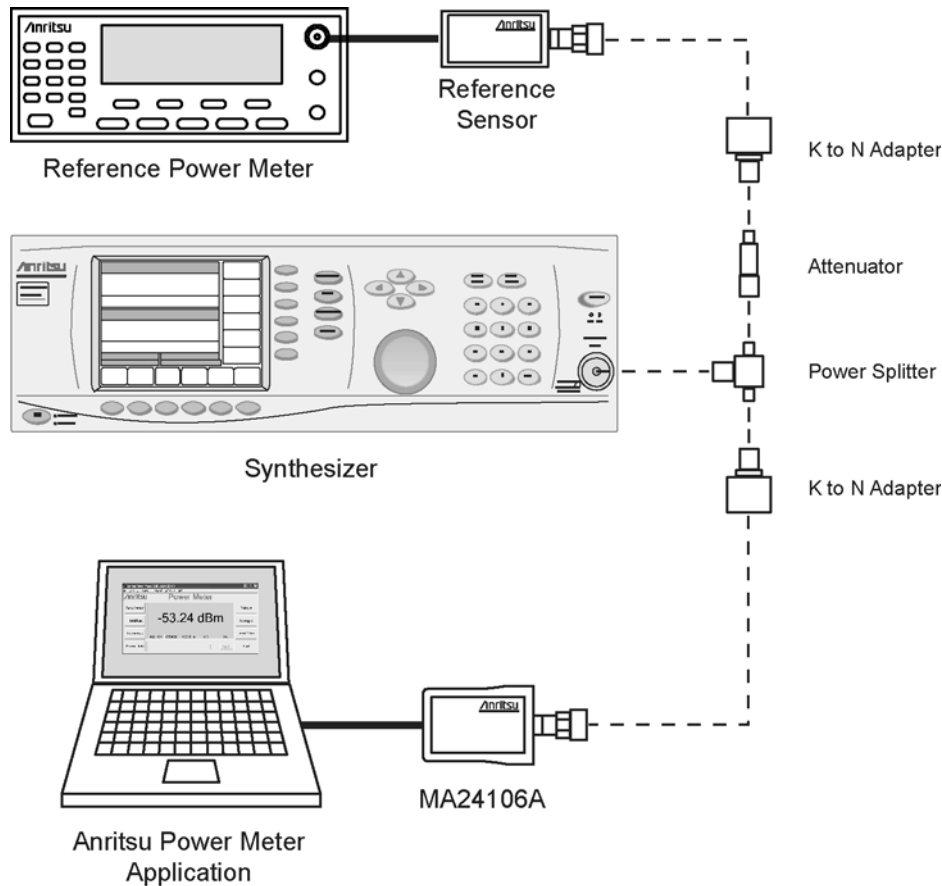

Figure 5-2. Linearity Test Setup

2. Apply the appropriate Cal factor to the reference sensor per the manufacturer's procedure.

3. Apply the appropriate Cal factor to the MA24106A as follows:

Click the **Frequency** button on the Power Meter application, and then enter the frequency of the measurement in GHz.

4. Turn Off the synthesizer's RF output and perform a low-level Zero of both the Reference sensor and the MA24106A.

5. Turn On the synthesizer's RF output.

6. Record data for the first 20 dB range as follows:

a. Record the power reading by the reference meter in the appropriate space in Table 5-4.

b. Record the power reading by the MA24106A in the appropriate space in Table 5-4.

c. Set the synthesizer power to +15 dBm.

d. Record the reference meter and the MA24106A power sensor readings in the appropriate places in Table 5-4.

e. Repeat the measurement for synthesizer output levels of +10, +5, and 0 dBm.

Note: The MA24106A power measured at 0 dBm will be used in step 7e, below.

7. Set up the test for the second 20 dB range as follows:

    a. Remove the 10 dB attenuator from in between the reference sensor and splitter and connect the reference sensor directly to the splitter.

    b. Remove the MA24106A from the splitter and connect the 10 dB attenuator between the splitter and the MA24106A power sensor (see Figure 5-3).

    c. Turn Off the synthesizer's RF output and perform a low-level Zero of both the Reference sensor and the MA24106A.

    d. Turn On the synthesizer's RF output.
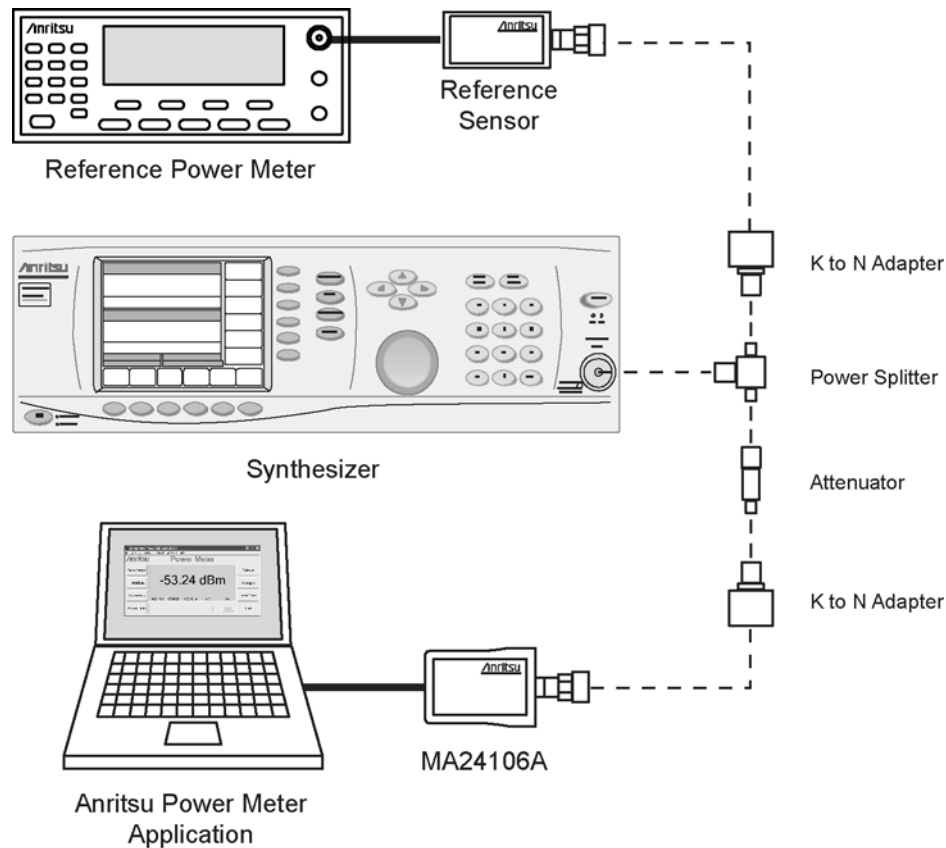
Figure 5-3.   Linearity Test Setup

    e. Set the synthesizer output level to +10 dBm and then adjust it until the sensor/meter under test reads as close as possible to the value obtained above in step 6e.

8. Record data for the next 20 dB range

    a. Read and record the power indicated by the reference meter in the appropriate place in Table 5-4.

    b. Lower the output power level of the synthesizer to +5 dBm.

    c. Record the reference meter and the MA24106A power sensor readings in the appropriate place in Table 5-4.

d. Repeat the measurement for synthesizer output levels of 0, –5, and –10 dBm.

Table 5-4. Measurement Results (50 MHz)

Row #	Synthesizer Power Level Setting (dBm)	Attenuation in Reference Arm (dB)	A Reference Power Measurement (dBm)	B = (A6–A5) Correction (dB)	C = (A+B) Corrected Reference Power Measurement (dB)	Attenuation in Test Arm (dB)	D MA24106A Measurement (dBm)	E = (C–D) Difference Calculation (dB)
1	+20	10				0		
2	+15	10				0		
3	+10	10				0		
4	+5	10				0		
5	0	10				0		
6	adjust per step 7e	0		0		10		
7	+5	0		0		10		
8	0	0		0		10		
9	-5	0		0		10		
10	-10	0		0		10		
11							Max:	
12							Min:	
13						Delta (E11 – E12):		

9. Perform the calculations and operation check as follows:

a. Subtract the Reference Power Measurement of row 5 from the Reference Power Measurement of row 6. Record this value in the Correction column of rows 1 through 5.

> **Note:** The Correction column of rows 1 through 5 should all have the same value.
> The Correction column of rows 6 through 10 have values of 0.

b. Add the Reference Power Measurement and Correction values of row 1 and record the result in the Corrected Reference Power Measurement column of row 1.

c. Repeat step 9b for rows 2 through 10.

d. Subtract the MA24106A Measurement of row 1 from the Corrected Reference Power Measurement of row 1 and record the result in the Difference Calculation column of row 1.

e. Repeat step 9d for rows 2 through 10.

f. Find the largest (most positive) value in the Difference Calculation column and record this value next to the word Max in row 11.

g. Find the smallest (least positive or most negative) value in the Difference Calculation column and record this value next to the word Min in row 12.

h. Subtract the Min value from step 9g from the Max value from step 9f and record the result next to the word Delta in row 13.

i. The Delta result should be less than 0.3 dB. If it is larger, contact Anritsu customer service.

10. Repeat the entire measurement and calculations with synthesizer frequency settings of 2 GHz, 4 GHz, and 6 GHz.

Table 5-5. Measurement Results (2 GHz)

Row #	Synthesizer Power Level Setting (dBm)	Attenuation in Reference Arm (dB)	A Reference Power Measurement (dBm)	B = (A6–A5) Correction (dB)	C = (A+B) Corrected Reference Power Measurement (dB)	Attenuation in Test Arm (dB)	D MA24106A Measurement (dBm)	C–D Difference Calculation (dB)
1	+20	10				0		
2	+15	10				0		
3	+10	10				0		
4	+5	10				0		
5	0	10				0		
6	adjust per step 7e	0		0		10		
7	+5	0		0		10		
8	0	0		0		10		
9	–5	0		0		10		
10	–10	0		0		10		
11							Max:	
12							Min:	
13							Delta (E11 – E12):	

Table 5-6. Measurement Results (4 GHz)

Row #	Synthesizer Power Level Setting (dBm)	Attenuation in Reference Arm (dB)	A Reference Power Measurement (dBm)	B = (A6–A5) Correction (dB)	C = (A+B) Corrected Reference Power Measurement (dB)	Attenuation in Test Arm (dB)	D MA24106A Measurement (dBm)	E = (C–D) Difference Calculation (dB)
1	+20	10				0		
2	+15	10				0		
3	+10	10				0		
4	+5	10				0		
5	0	10				0		
6	adjust per step 7e	0		0		10		
7	+5	0		0		10		
8	0	0		0		10		
9	–5	0		0		10		
10	–10	0		0		10		
11							Max:	
12							Min:	
13							Delta (E11 – E12):	

Table 5-7. Measurement Results (6 GHz)

Row #	Synthesizer Power Level Setting (dBm)	Attenuation in Reference Arm (dB)	A Reference Power Measurement (dBm)	B = (A6–A5) Correction (dB)	C = (A+B) Corrected Reference Power Measurement (dB)	Attenuation in Test Arm (dB)	D MA24106A Measurement (dBm)	E = (C–D) Difference Calculation (dB)
1	+20	10				0		
2	+15	10				0		
3	+10	10				0		
4	+5	10				0		
5	0	10				0		
6	adjust per step 7e	0		0		10		
7	+5	0		0		10		
8	0	0		0		10		
9	–5	0		0		10		
10	–10	0		0		10		
11							Max:	
12							Min:	
13						Delta (E11 – E12):		

Appendix A — Connector Care and Handling

Anritsu MA24106A Power Sensors are high-quality precision laboratory instruments and should receive the same care and respect afforded to such instruments. Follow the precautions listed below when handling or connecting these devices. Complying with these precautions will guarantee longer component life and less equipment down time due to connector or device failure. Also, such compliance will ensure that Power Sensor failures are not due to misuse or abuse – two failure modes not covered under the Anritsu warranty.

Beware of destructive pin depth mating connectors

Destructive pin depth of mating connectors is the major cause of failure in the field. When an RF component is mated with a connector having a destructive pin depth, damage will usually occur to the RF component connector. A destructive pin depth is one that is too long in respect to the reference plane of the connector (Figure A-1, left).

The center pin of a precision RF component connector has a precision tolerance. The mating connectors of various RF components may not be precision types. Consequently, the center pins of these devices may not have the proper pin depth. The pin depth of DUT connectors should be measured to assure compatibility before attempting to mate them with Power Sensor connectors. An Anritsu Pin Depth Gauge or equivalent can be used for this purpose (Figure A-1, right)
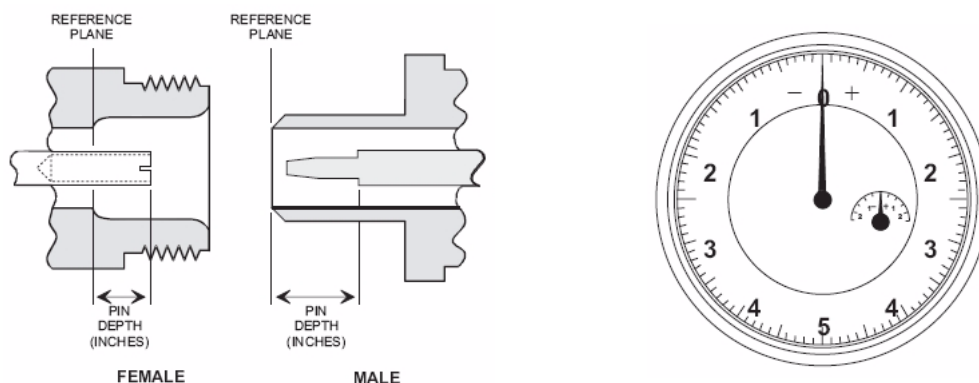
Figure A-1. Pin Depth

If the measured connector is out of tolerance in the "+" region, the center pin is too long (see Table A-1, below). Mating under this condition will likely damage the precision RF component connector. If the test device connector measures out of tolerance in the "−" region, the center pin is too short. This should not cause damage, but it will result in a poor connection and a consequent degradation in performance.

Table A-1. Allowable DUT connector pin depth

Connector Type	Pin Depth Gage Model #	Pin Depth (inches)	Pin Depth Gage Readout
N-Male	SC3825	0.207 +0.030 −0.000	0.207 +0.000 −0.030
N-Female	SC3825	0.207 +0.000 −0.030	0.207 +0.000 −0.030

Avoid over torquing connectors

Over torquing connectors is destructive; it may damage the connector center pin. Always use a connector torque wrench when tightening connectors. Never use pliers to tighten connectors.

Avoid mechanical shock

Precision connectors are designed to withstand years of normal bench handling. However, do not drop or otherwise treat them roughly. Mechanical shock will significantly reduce their service life.

Avoid applying excessive power

The MA24106A sensor is rated at +33 dBm maximum continuous input power. Exceeding the maximum input power level permanently damages the internal components, rendering the power sensor useless.

Cleaning connectors

The precise geometry that makes the RF component's high performance possible can easily be disturbed by dirt and other contamination adhering to the connector interfaces. When not in use, keep the connectors covered. To clean the connector interfaces, use a clean cotton swab that has been dampened with denatured alcohol.

Note: Most cotton swabs are too large to fit in the smaller connector types. In these cases, it is necessary to peel off most of the cotton and then twist the remaining cotton tight. Be sure that the remaining cotton does not get stuck in the connector. Cotton swabs of the appropriate size can be purchased through a medical laboratory-type supply center.

The following are some important tips on connector care:

- Use only isopropyl alcohol as a cleaning solvent. Do not use excessive amounts of alcohol as prolonged drying of the connector may be required.
- Never put lateral pressure on the center pin of the connector.
- Verify that no cotton or other foreign material remains in the connector after cleaning.
- If available, use compressed air to remove foreign particles and to dry the connector.
- After cleaning, verify that the center pin has not been bent or damaged.
- Avoid touching connector mating planes with bare hands. Natural skin oils and microscopic dirt particles and very hard to remove.
- Always check the pin depth of a connector before use to determine if they are out of spec. One bad connector can damage many.
- Always use an appropriate torque wrench.
- Put dust caps on the connector after use.

Appendix B — Sample Visual Basic Code

B-1 Demo Application

The MA24106A CD contains a demo application that allows you to interface with the power sensor using the remote programming protocol. The sample code is written in Microsoft® Visual Basic® 6.0 and is given at the end of this appendix. The complete project, DempApp.vbp, is available on the CD that shipped with the sensor. The Demo Application's main form is shown below:

Figure B-1. Demo Application

It is recommended to use the source code and project available on the CD that shipped with the sensor to minimize typing errors. You may need to add Microsoft® Comm Control 6.0 manually, which can be added from Visual Basic® 6.0 IDE by navigating to: Project | Components.

B-2 Using the Demo Application

Once connected to the PC using the USB cable, the MA24106A shows up as a Serial port device on the PC. You can check the COM port number using the device manager in the Windows® control panel.

Type the COM port number in the ComPortNo: text box and click **Initialize**. Once the COM port is initialized, you can type commands in the Command text box, and then click the **Send** button. Any responses from the sensor will be displayed in the Received text box. You can use the Functions group buttons to exercise the sensor for power readings, frequency readings and settings, and for zeroing sensor.

> **Note:** The Demo Application uses Microsoft Comm Control, which limits COM Port number usage to less than 16 (COM3 to COM16).

```
*************************************************************************
// This sample program shows how to control Anritsu MA24106A USB power sensor using
//Microsoft Visual basic 6.0
Option Explicit
Public gstrInputBuffer As String

'Event handler for InitializeComPort button
Private Sub btnInitializeComPort_Click()
    Call SetCommPort(Val(Trim(txtCOMPORTNo.Text)))
End Sub

'Subroutine to set the com port
Public Sub SetCommPort(portNo As Integer)
    On Error GoTo errHndler
        'Setup MSComm control
        MSComm1.Settings = "115200,n,8,1"
        MSComm1.CommPort = Trim(txtCOMPORTNo.Text)
        MSComm1.PortOpen = True
        MSComm1.RThreshold = 1
        MSComm1.SThreshold = 1
        '
        'Wait for half a second before sending START command
        Delay (0.5)
        'Arm sensor to start making measurements
        txtCommand.Text = "START"
        Call btnSend_Click
        '
        Exit Sub

errHndler:
        MsgBox ("ERROR: " & Err.Description)
End Sub

'Event handler for ResetComPort button
Private Sub btnResetComPort_Click()
    'Close com port
    If MSComm1.PortOpen = True Then
        MSComm1.PortOpen = False
    End If
End Sub

'Event handler for Send button
Private Sub btnSend_Click()
  Dim strResult As String
    'Clear buffer & receive text window before sending command
    gstrInputBuffer = ""
    txtReceived.Text = ""
    'Send command and appeand Termination character, 0x0A(10)with it.
    MSComm1.Output = UCase(txtCommand.Text) & Chr(10)
    'Display received result on the Received text box
    txtReceived.Text = strResult
    '
End Sub
```

```vb
'
'Event handler for MSComm1 event
Private Sub MSComm1_OnComm()
    'Get data from Input buffer
    gstrInputBuffer = MSComm1.Input
    'Display received result on the Received text box
    txtReceived.Text = gstrInputBuffer
End Sub

'Event handler for GetFreq button
Private Sub btnGetFreq_Click()
    txtCommand.Text = "FREQ?"
    Call btnSend_Click
End Sub

'Event handler for GetPower button
Private Sub btnGetPower_Click()
    txtCommand.Text = "PWR?"
    Call btnSend_Click
End Sub

'Event handler for SetFreq button
Private Sub btnSetFreq_Click()
    txtCommand.Text = "FREQ " & txtFreq.Text
    Call btnSend_Click
End Sub

'Event handler for ZeroSensor button
Private Sub btnZeroSensor_Click()
    txtCommand.Text = "ZERO"
    Call btnSend_Click
    'Sensor will return OK after about 19 Seconds
End Sub

'Event handler for Close button
Private Sub btnClose_Click()
'
    'Make sure we close the com port before we exit the app
    If MSComm1.PortOpen = True Then
        'Stop sensor from making measurements
        txtCommand.Text = "STOP"
        Call btnSend_Click
        '
        'Wait for half a second after sending START command
        Delay (0.5)
        '
        MSComm1.PortOpen = False
    End If
    'Close the app
    End
End Sub
```

```vb
'Delay routine
Public Sub Delay(ByVal Seconds As Single)
    '
    Dim fStartTimer As Single
    Dim fFinish     As Single
    '
    fStartTimer = Timer
    '
    Do
        DoEvents
        fFinish = Timer
        If Abs(fFinish - fStartTimer) > Seconds Then
            Exit Do
        End If
    Loop
    '
End Sub
**********************************************************************
```

Appendix C — Serial Port Compatibility

(For Anritsu Power Meter 1.0 Only)

The Anritsu Power Meter 1.0 application requires that the serial ports between COM1 and COM16 be used. You can find out the COM port number by going to **Start | Settings | Control Panel | System | Hardware | Device Manager | Ports (COM & LPT)**. Disconnect and reconnect the power sensor's USB cable from the computer and notice the new COM port number that appears in the Ports list.
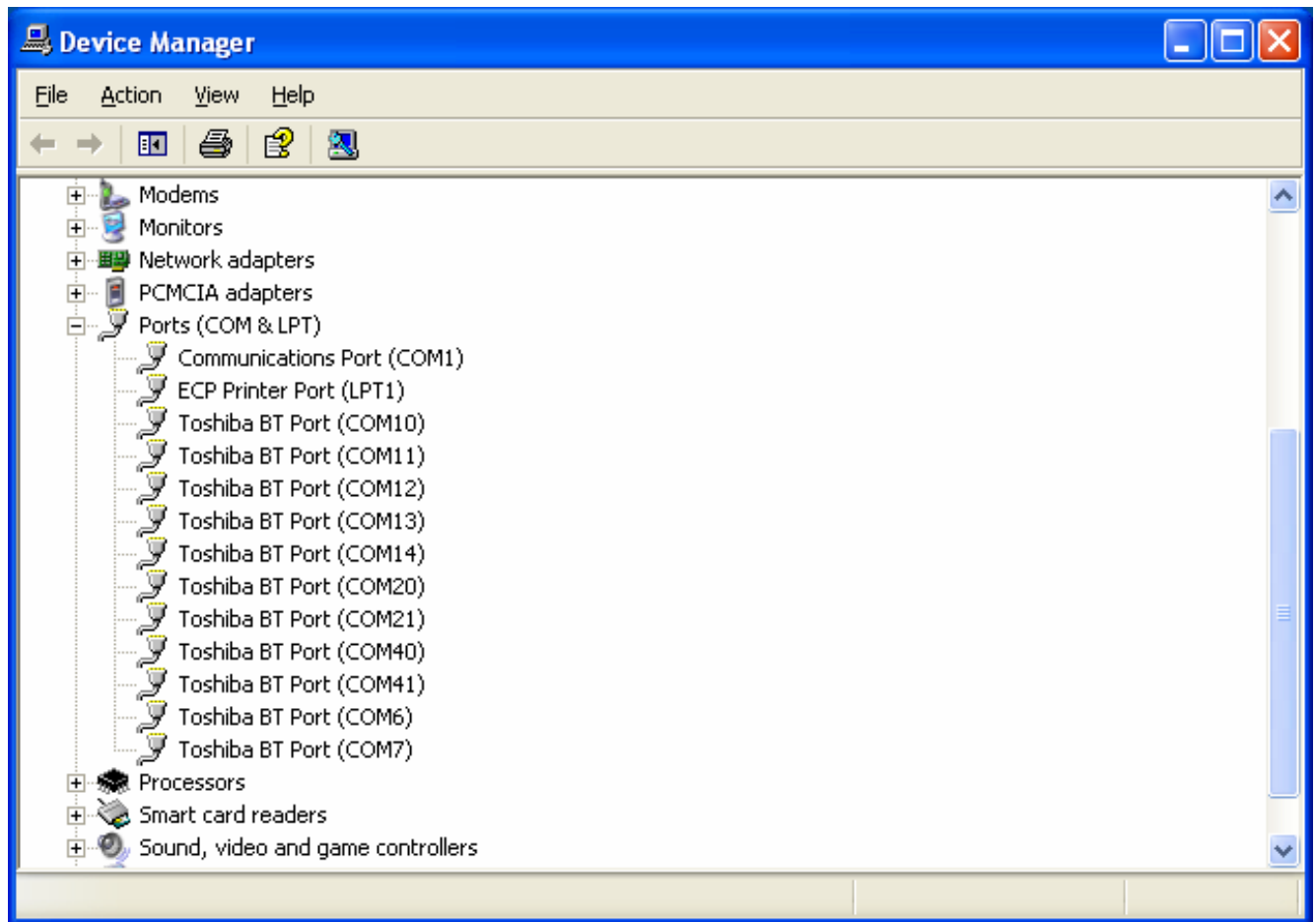
Figure C-1. Device Manager

If this number is less than 16, then the PC application will work fine. However, in some cases when the power sensor is connected, Windows may map your serial port to a port number greater than 16, such as COM17 or COM29 depending on which USB port that is being used. If you connect your power sensor and the Anritsu Power Meter application displays No Sensor, a port number above COM16 may be assigned. To correct this problem, you will need to follow one of the two steps outlined below. Whichever method you use, you should only need to perform the procedure once.

C-1   Method 1–Download Updated Software

The preferred method for resolving serial port compatibility issues is to download software updates for your product from www.us.anritsu.com.

C-2   Method 2–Trying a Different USB Port

1. Disconnect the USB end of your power sensor from your computer (or USB hub).

2. Connect the USB power sensor to a different USB port on your computer. Connecting to a USB hub tends to increase the port numbers, so connecting directly to the computer's USB port usually provides the best result.

3. Open the Device manager to see if the new port assignment is between COM1 and COM16. If it is NOT, return to step 1 and connect to a different USB port. If the port assignment is between COM1 and COM16, the problem has been resolved and no further action is required.

C-3   Method 3–Remapping a Serial Port

A serial port may be remapped to a different number, such as changing a serial port from COM19 to COM5. This may be needed if method 1 above does not result in a serial port assignment between COM1 and COM16 or if you prefer to use a USB hub or a specific USB port on your computer.

1. Open the System Properties by going to **Start | Settings | Control Panel | System**, or simultaneously pressing the **Windows** and **Pause** keys.

2. Select the **Hardware** tab and click the **Device Manager** button to open the Device Manager.
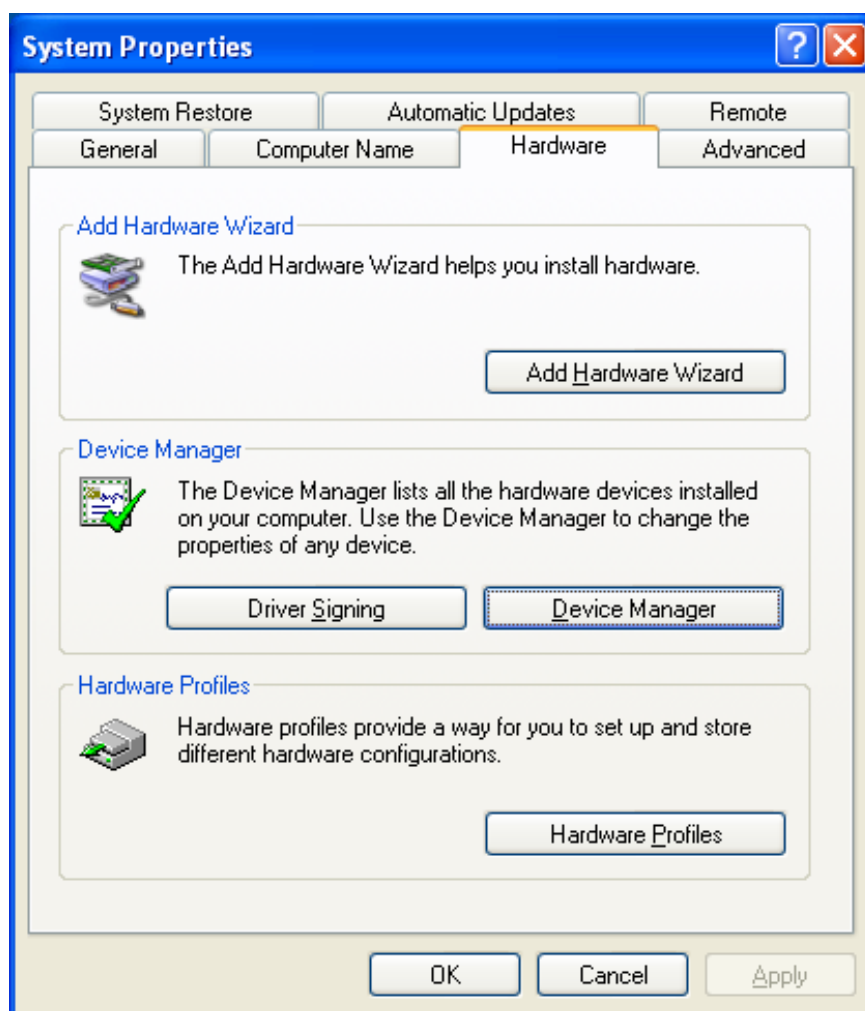
Figure C-2. System Properties

3. Click the **+** box next to Ports (COM & LPT) to expand the installed ports list.
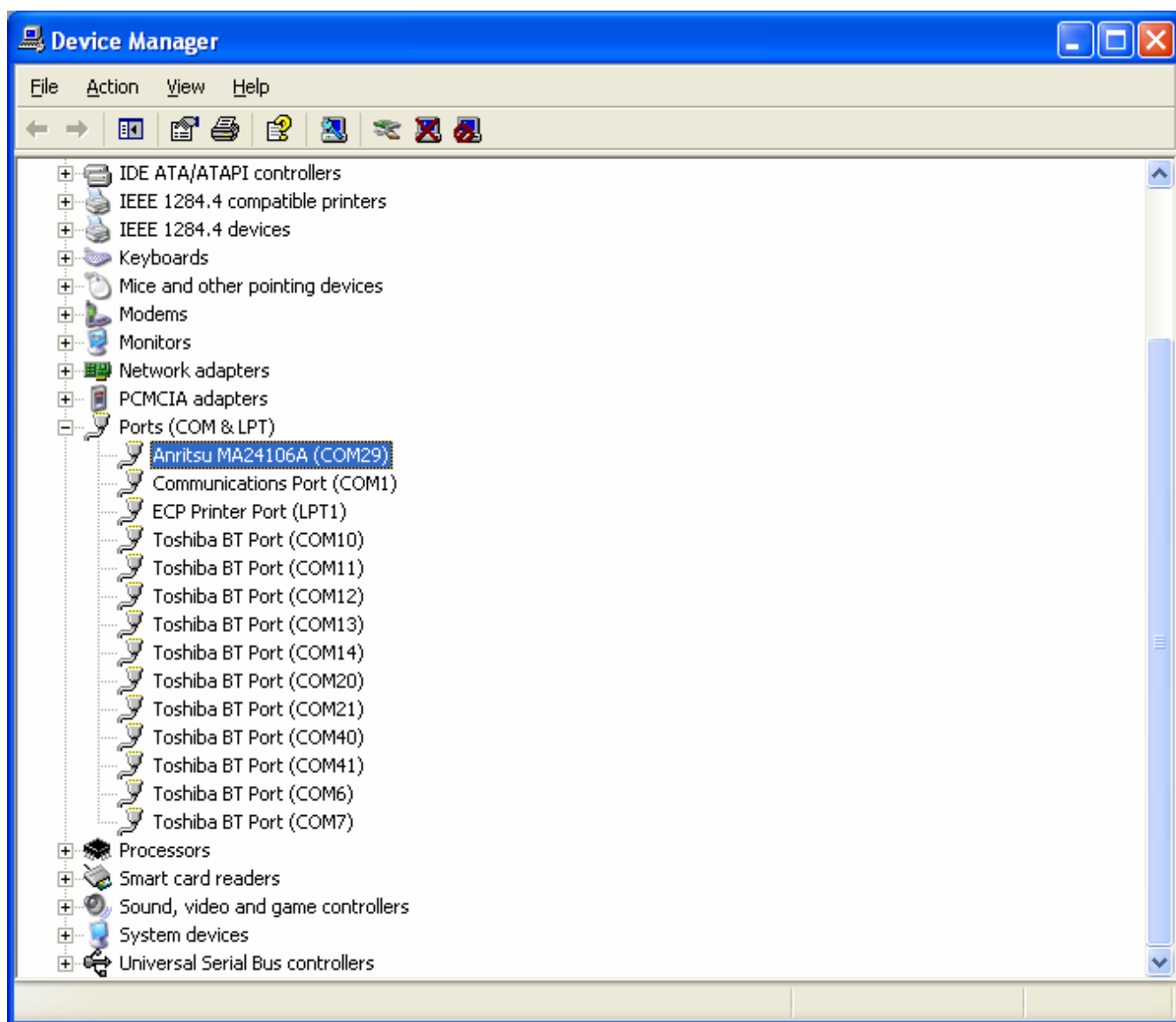
Figure C-3. Device Manager

4. Select the port that is assigned to the power sensor. Disconnect and reconnect the sensor and notice the new COM port number that appears. The new port is the current port assignment for the power sensor.

5. Right-click on the new port assigned in step 4 above and select **Properties** from the pop-up menu to display the properties for that port.

6. Click the **Port Settings** tab of the properties window.

7. Click the **Advanced** button to show the advanced property settings for the port.
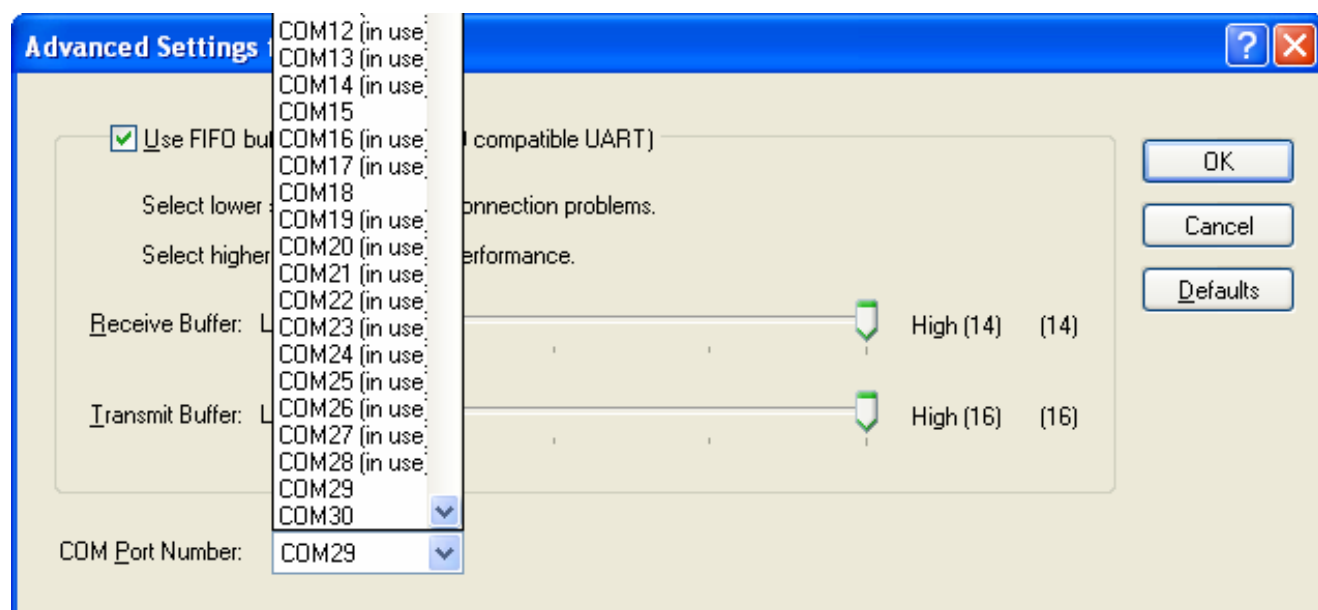
Figure C-4.   Advanced Settings for COM Port

8. Select a COM Port Number in the range of 1 through 16. If possible, select a port which is NOT marked as "in use" in the COM Port Number list. If all of the ports are marked as being in use, select port number 16 unless you know for sure that something is actually using COM16.

9. You will get an alert when you close the window telling you that the COM port number may be in use by another device and asking if you want to continue. Click **Yes** to continue.
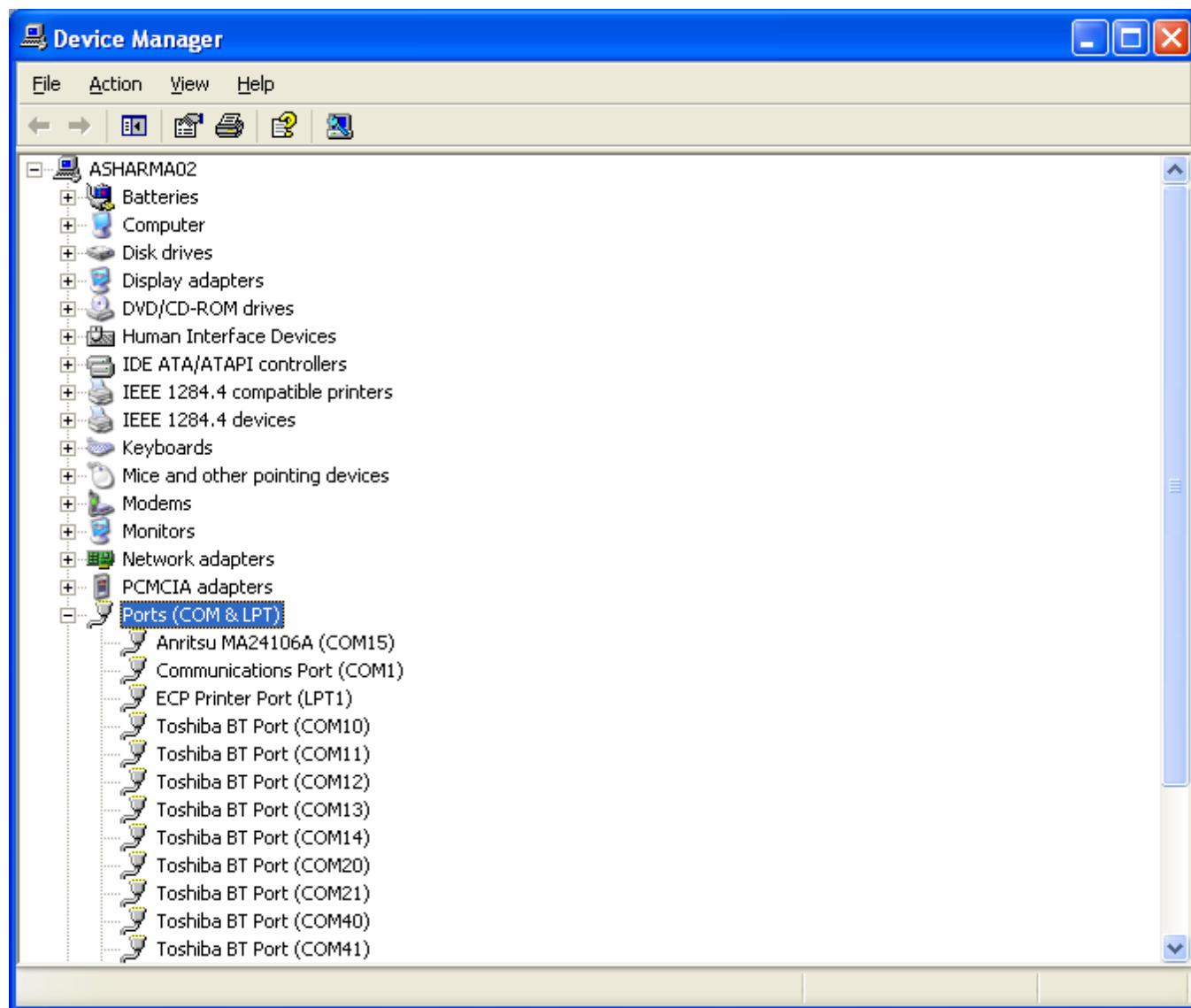
Figure C-5.   Device Manager

10. Close all windows that you have opened up to this point.

Appendix D — Upgrading the Firmware

D-1   Upgrading the Firmware

The Anritsu Power Meter application provides the necessary software to upgrade the MA24106A power sensor's firmware. The current sensor firmware can be determined from the Help | About menu in the Anritsu Power Meter application. To upgrade the firmware, proceed as follows:

1. Download the latest firmware upgrade files from http://www.us.anritsu.com and save them in a recoverable location.

2. Launch the firmware upgrade utility from the Tools menu in the Anritsu Power Meter application and follow the on-screen instructions.

3. Disconnect and reconnect the USB cable from the power sensor, and then click **OK**.
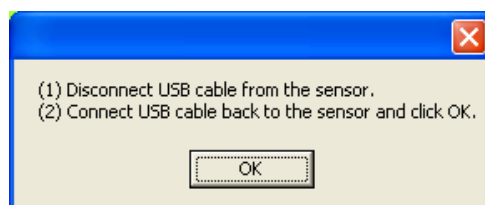
Figure D-1.   Firmware Upgrade Dialog

Note: If this is the first time that you are upgrading the sensor's firmware, you will need to install the MA24106A upgrade driver. Follow the driver installation procedure as outlined in Section 2-3, starting with step 9, and select the **MA24106A Upgrade Mode** driver when prompted from:
C:\Program Files\Anritsu\AnritsuPowerMeter\UpgradeModeDriver\AnritsuMA24106AUpgradeMode.inf

Figure D-2.   Upgrade Firmware Driver

4. Once the upgrade driver has been installed, click **OK** on the dialog below.
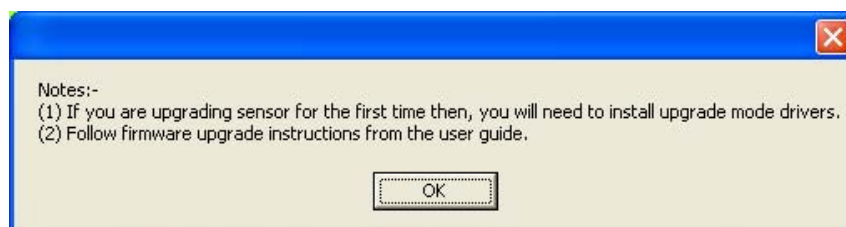
Figure D-3.   Firmware Upgrade Dialog

5. Select the power sensor that you intend to upgrade from the drop-down list box.
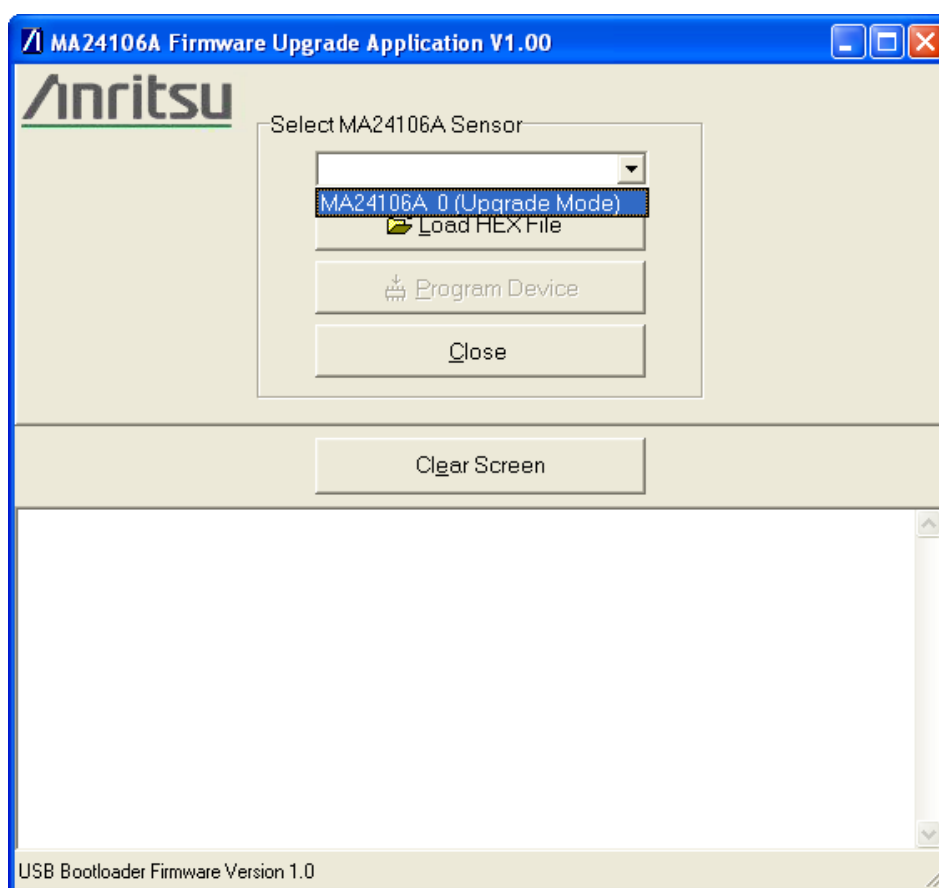
Figure D-4.   Firmware Upgrade Application

6. Click **Load Hex File** and select the HEX file from the directory in which it was saved.
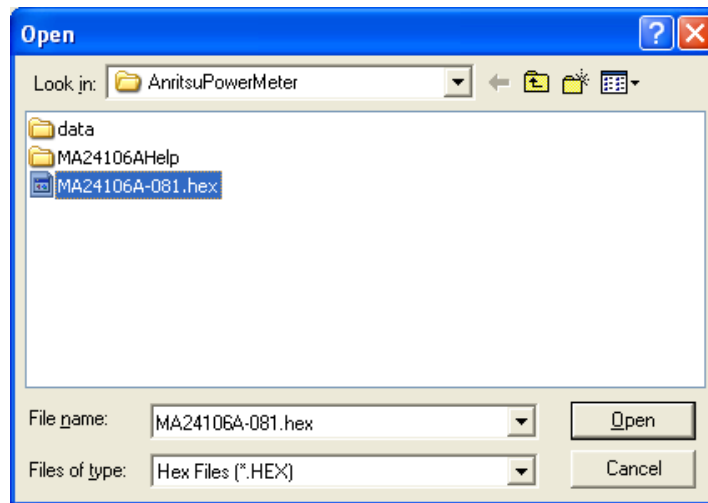
Figure D-5.   Open File Dialog

Warning: Do Not disconnect the MA24106A power sensor from the USB port or interrupt the firmware write sequence as this will cause an unrecoverable programming error.

7. Click **Program Device**. The following messages will be displayed during the program operation:

    MESSAGE - Programming FLASH Completed

    MESSAGE - Erasing and Programming FLASH...
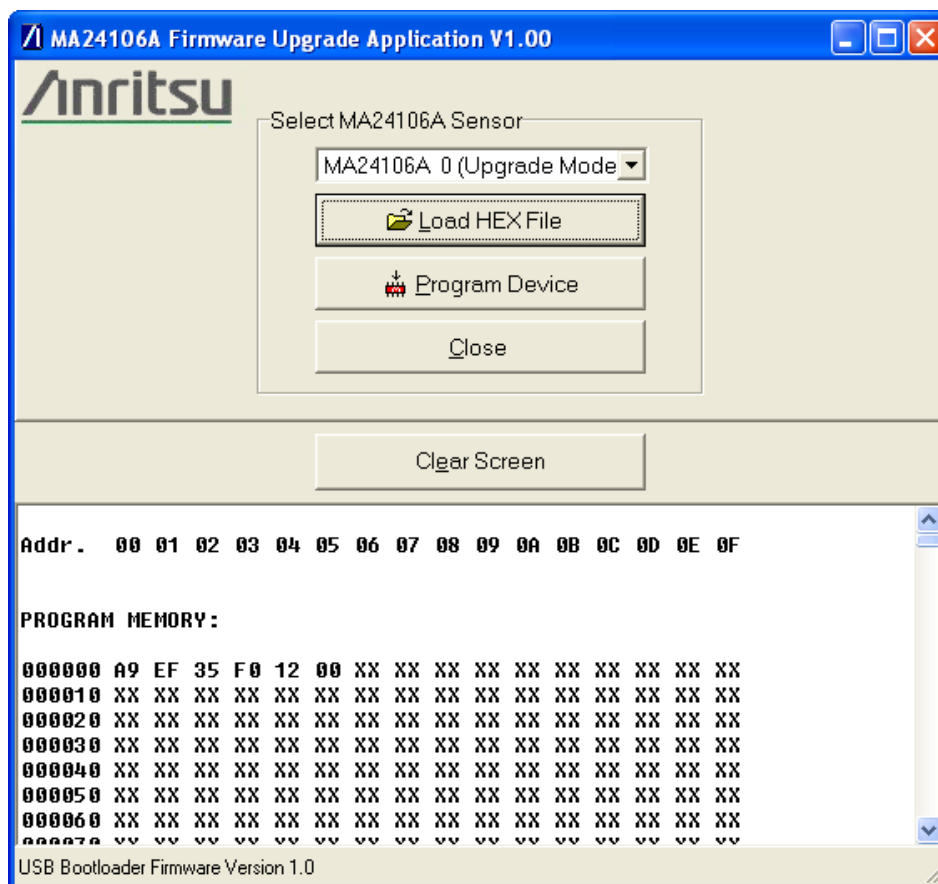
Figure D-6.   Firmware Upgrade Application

8. Disconnect and reconnect the USB cable from the power sensor, and then click **OK** to complete the firmware upgrade procedure.
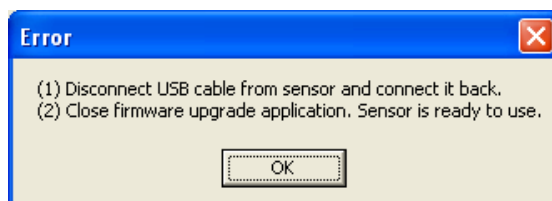
Figure D-7.

9. Launch the Anritsu Power Meter application to begin using the upgraded sensor.

Index