Anritsu

Application Note

Measuring Radar Pulsed Power

ML249XA Series
Power Meters

Understand how to set up and use the Wideband Peak Power Meter for Radar measurements

Measuring the Pulsed Power of a Radar Transmitter

Introduction

This application note shows how to set up and measure Pulsed Radar transmitters with the ML249XA series wideband peak power meter, MA2411B or MA2491A sensor

The ML249XA series power meter has a mainframe video bandwidth of 65MHz, coupled with an effective settable sample resolution of 1ns in a high resolution repetitive sample mode, which makes it ideal for peak and average power measurements on many Radar signals.

The power meter has a selection of trigger and measurement features to select precisely the section of the Radar signal under test. Multiple pulse radars pose a challenge for conventional power meters, as a conventional power meter cannot distinguish between the edges on the pulses in the sequence.

The ML249XA series incorporates a special synchronising feature, frame arming which allows the power meter to detect the off period in the transmission. This feature can be used to synchronise the power meter to the rising edge of the first pulse.
The power meter can display the results numerically or as a graph, enabling the design, manufacturing or service engineer to truly see the power profile of the Radar transmitter.

This application note shows how the ML249XA can be set up to measure single pulse and multi-pulse radar signals.

Overview

Many operational Radars are provided with special test ports that provide low power outputs suitable for monitoring the performance of the transmitter or transmitter modules. This test port can be used to measure the pulse power.

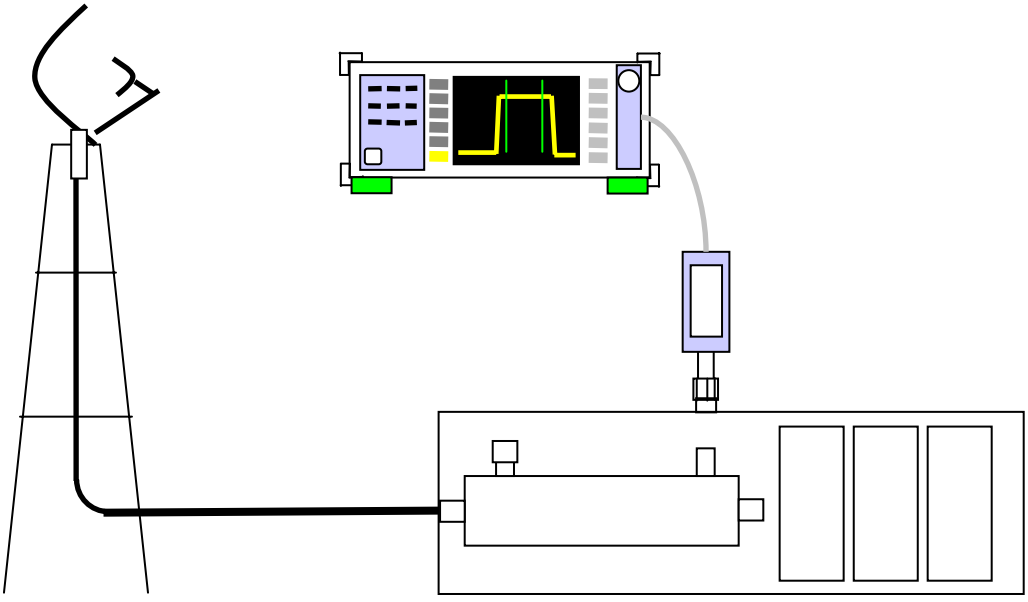

Figure 1. Typical Pulse Radar Measurement Set Up

Note: Two radar single pulse presets are available under the preset menu,

- No.15 which sets the power meter up for 200ns capture time using the Random Repetitive Sample Mode,
- No.16 which sets the power meter up for 5μs capture time using the continuous sample mode

Setting Up the Power Measurement

To make the measurement follow the sequence of actions below.

- Set the measurement mode
- Select the output parameter
- Calibrate and zero the sensor
- Set the cal factor for the sensor

- Set up the trigger
- Set up the timing

- Set up the gates
- Take the output data.

To start, press the yellow Preset key and select [Reset]

This will set Channel 1 to pulse modulated mode. Default input is set to A and the output set to Profile.

Selecting the Power Meter output parameter

The ML249XA can measure various combinations of output power parameters; the average power only, the average and the peak power or the average power, peak power and crest factor. To select which combination is required press Channel and then Set Up.

Use the down arrow to move the highlight to [Measurement] and select the appropriate softkey.

The ML249XA has two different ways of measuring the peak signal.

The first algorithm is designed to correctly measure the peak of pseudo random noise like signals such as WLAN and WCDMA, and the second is designed to reduce the effect of noise on a pulsed signal like radar.

The Avg, Peak and Avg, Peak & Crest selections automatically measure the peak of the raw data plotted on the profile display. When averaging is applied, the average of the peak value is calculated and measured.

The other selection, Average, Min & Max employs a different averaging algorithm which reduces the effect of peak impulse noise on measurements. In this case the max and minimum are calculated on the displayed averaged data, rather than the instantaneous peak data collected before display.

Select either Average or Average, Min and Max for the Radar pulse measurement.

Calibration and Zero

Connect the Sensor (either a MA2411B or a MA2490/1A) to the Calibrator and the sensor lead to input A.

Press Cal/Zero and then Zero & Cal

When the cal and zero has finished press Sensor and then Cal Factor
Use the down arrow to highlight the [Frequency] field.
To enter the frequency, press [Sel] on the numeric keypad and then enter the frequency e.g. 2.9 GHz.

Mistakes can be cleared with the [Clr] key. The cal factor for that frequency will be displayed on the upper portion of the screen.

Use [Exit] to close the dialog box.

Connect the power sensor to the test port.

Setting up the Trigger: Single Pulse Radars

To set up the trigger in a single pulse radar

Press Channel

Then press Trigger , Trigger Source

Change [Source] from Cont to Internal

The trigger arming can remain set to automatic.

The trigger level is set to auto by default. The trigger level can also be set manually. To change the level press Trigger , Trigger Source, Trigger Level , deselect Auto Trigger ,and then press Set Trig Level .Set the trigger level for the expected test port signal.

If the radar provides an external TTL synchronising test port signal then this can be connected to the external trigger socket on the rear panel. The trigger source then needs to be switched to External in the Trigger Source menu.

The trigger capture time and trigger delay can now be set. The capture time determines the overall time over which the data is taken. The trigger delay refers to the time at which the capture takes place with reference to the trigger event. The power meter supports pre-trigger operation, so set –ve values to events before the trigger.

So for example, we want to measure a 200ns pulse and see both the rising and falling edge of the signal. Set the trigger capture time to 300ns and set the trigger delay to –50ns. This should show 50ns of pre trigger information, and the pulse in the centre of the display.

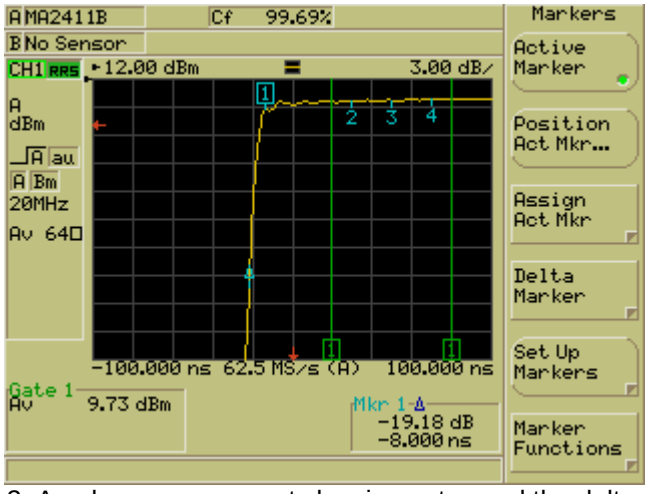

Figure 2. A pulse measurement showing gates and the delta marker

The ML249XA supports two different sampling methods. For capture periods of 3.2μs or longer the power meter directly samples the signal and displays the results on the screen. For capture periods of less than 3.2μs the power meter uses a repetitive sampling mode where the display is made up from several sweeps. The ADC samples at 16ns intervals and a 1GHz counter is used to count the time position of the samples relative to the trigger. The waveform is made up from a minimum of 16 sweeps. This method relies on a repetitive timing from a trigger event, so is not available when the trigger is set to continuous. It is for this reason that the trigger source needs to be set before setting the capture time on the power meter.

Other functions on the Trigger Menu

Trigger Bandwidth

The power meter is provided with four trigger bandwidth settings ranging from 20MHz to 20KHz. The 20MHz bandwidth setting is set by default. The lower bandwidth settings can be used for longer pulse lengths, either to increase the sensitivity of the trigger or to reduce the effect of superimposed noise or am on the signal.

Trigger Indication

The trigger event can be displayed in two different ways. The default setting shows two red arrows on the display. These show the trigger position in time and also the level. If external trigger is selected then only the time arrow is shown. All timings on the power meter such as Trigger capture time, trigger delay, gates and marker positions are determined from this trigger reference point.

The trigger event can also be displayed as a pseudo waveform on the display. To do this access the trigger menu, press More and then press Trigger Indication Lev and Pos display the arrows, Waveform depicts the trigger event waveform. The waveform can be moved up and down the display or set to one of the three preset positions.

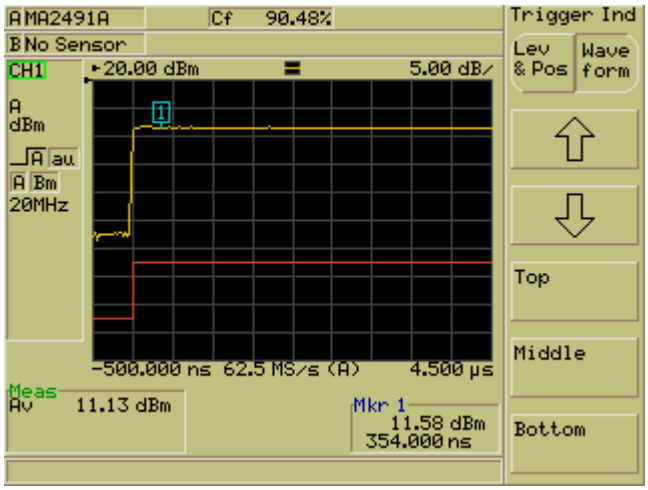

Figure 3. The trigger event waveform

Setting up the Trigger: Multi-Pulse Radars

Many Radars use multiple pulses. This sequence of pulses contains several rising edges that can fool the trigger settings on a conventional power meter. The ML249XA contains a special frame arming trigger setting which works as a two stage detection system to detect the off period of the frame signal.

1. The frame arming checks that the power level is below the set level for the test time. If this is true then the trigger is armed ready for the next rising edge. The test time and level are set by the user to suit the pulse conditions.
2. The trigger is activated on the next rising edge, which is the start of the Radar Pulse sequence.

The frame arming timing parameters are limited to a multiple of the trigger capture time. It's important therefore to set the trigger capture time and trigger delay before setting the frame arming duration. The frame arming duration is automatically reduced if the trigger capture time is reduced to the point where it needs adjusting.

Setting up the trigger and frame arming.

Press Channel

Then press Trigger , Set Capture Time

Set the Set Capture Time to a suitable value to display the pulses, the example below has been set to 20μs and the Trigger Delay time to -2μs. A –ve value for the delay time will show data before the trigger event and acts as pre-trigger information.

To set up frame arming

Press Channel

Then press Trigger , More, Arming

Change the Arming from Automatic to Frame

Select Frame Duration and after pressing [Sel] enter an appropriate time. For the waveform displayed in figure 3, the longest inter pulse off period is 4μs, so the minimum value for the frame arming test ought to be >4μs.

The frame duration value can be set to a larger value than the display time. For example supposing a radar pulse sequence consists of two 20μs pulses, with a 40μs interval between them and with a pulse repetition rate of 500Hz.

In this case setting the frame duration value to 50μs would ensure that the power meter always triggered on the first pulse. The trigger capture time could then be set to view the first pulse, eg a trigger capture time of 30μs and a trigger delay time of -5μs.

To view the second pulse, simply alter the trigger delay time to 55μs (20μs + 40μs, -5μs).

Close the dialog box by pressing [Exit].

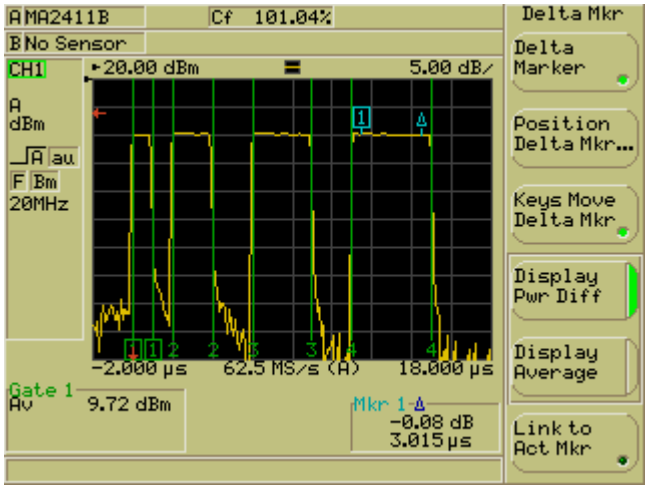

Figure 4. Multiple Pulses

If the Power Meter is not successfully triggering then the error message Chan 1 –No trigger is displayed.

The red arrows on the display show the trigger level and the trigger position. The trigger and frame arming test levels should be set to suit the output power of the device under test and the power meter range.

If the scaling factor on the display needs changing then use the scaling keys.
Press Channel , More, Scaling

Autoscale can be used to automatically scale the Y-axis of the display.

Marker Zoom
To access the marker zoom function, set the active marker to the pulse of interest, then press Marker Functions , Active Zoom In

The marker zoom provides a digital expansion of the 200 or 400 point display. To enhance the resolution of the trace, set the trigger capture time to a shorter interval.

To display the results in linear Units

Press Channel and then , Set Up . Scroll down to [Units] and select W or V

To set up a Gate to measure the power in the pulse

Press Channel and then Gating , Set Up .

The Gating Set Up dialog box appears, see figure 5. Use the up/down and left right keys to navigate in the fields of the gate dialog. Use [Sel] to enter the time values. Timing reference is set from the trigger point.

Press Enabled to switch the gate on. Press Set as Active to enable the display of the measurement on the screen. The Fence excludes a section of the frame from the calculation of the average and peak power. For Radar applications you do not need to set a fence.

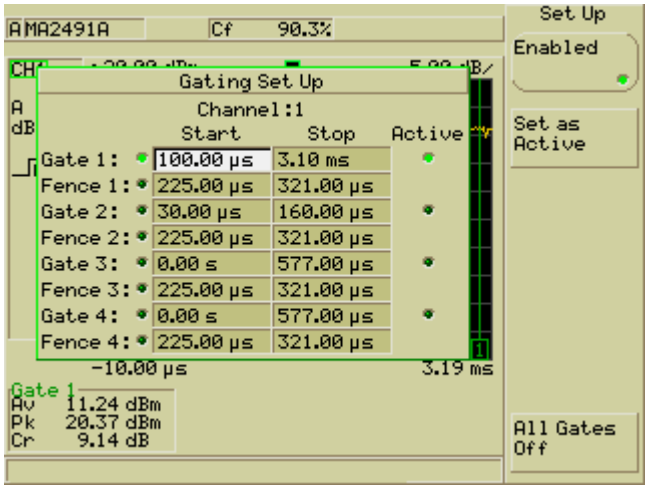

Figure 5. The Gating Set Up Dialog Box

As an alternative the average, peak and crest factor results can be displayed on their own without the graph.

To do this select Channel and then Set Up. Move down to [Meas Display] and select Readout.

Multiple Gates
To use more than one gate, set up the parameters for Gate 2, etc in the Gate Set up dialog box. All timings are from the trigger point, and not from the start of the second or third pulse.

To enable the gate, select Enabled.

The measurement values are always calculated for an enabled gate.

The Active Gate is the one selected for Display purposes, but all enabled gates are available for output over the GPIB or RS232 in one go using the GPMO command, or individual gates can be output using the active gate command GPAMO or the GPNMO command. See Chapter 5 of GPIB manual for more information.

To change the Gate output on the display, press Channel , Gating , Set Active Gate

Markers and Measuring Droop

The ML249XA supports 4 markers and a delta marker. The Active marker and the delta marker can be used to measure the droop on a radar pulse.

To access the marker functions press Channel, Markers .

Press Active Marker to set the active Marker on the display. By default marker 1 is the active marker, but this can be changed using Assign Act Mkr.

Positioning the Markers
1.The left and right arrow keys on the numeric keypad can be used to set the position of the active marker.

2.The position of the active marker and all the other markers can be explicitly set under the Set Up Markers key. All timings are with reference to the trigger point.

3. The active marker can be set to max or min automatically.
Press Channel, Markers , Marker Functions

To measure the droop of a pulse, set the active marker to the peak and then activate the delta marker. The active marker can then positioned at the other end of the pulse. The display will show the difference in the readings.

For more detail on the pulse droop, all 4 markers can be set to different positions on the pulse and the values read back over the GPIB interface.

Measuring the Rise Time
Set the active marker on the pulse to be measured. Then use the advanced marker functions.
Channel, Markers , Marker Functions , Advanced Marker Functions .

By default the rise time is calculated from 10% to 90% of the waveform in linear power. This can be changed under the search set up menu.
Channel, Markers , Marker Functions , Advanced Marker Functions , Search Set Up ,
The Reference Power Level for the rise time measurement can be either the active marker or

Dual Display Mode

Both versions of the ML249XA support a dual display mode. In this mode two display channels can be displayed on the screen, or the user can switch between them using Ch1/Ch2 . This has a number of uses for example Channel 1 could be set up to look at 1 pulse in detail, and Channel 2 set up to measure the time interval between pulses.

Another application is to set up the Channel1 and Channel 2 with the same measurement, but with different display modes, Ch1 with a profile display and Ch2 with a readout display.

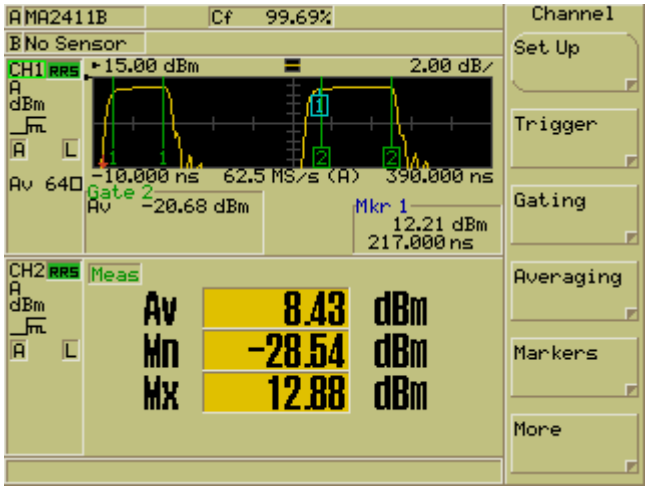

Figure 6. Dual Channel Display showing a pulse measurement

Setting an Offset

The reading on the power meter can be set to compensate for the splitter or the coupler used in the test port.

To set an offset press Sensor and then Offset . Select Fixed and use the down key to select [Offset]. Enter the value of the attenuator directly as a positive value. E.g. a 10.56dB attenuator should be entered directly as 10.56.

The power meter will now automatically correct for the value of the splitter or coupler, giving the true power reading at the test port.

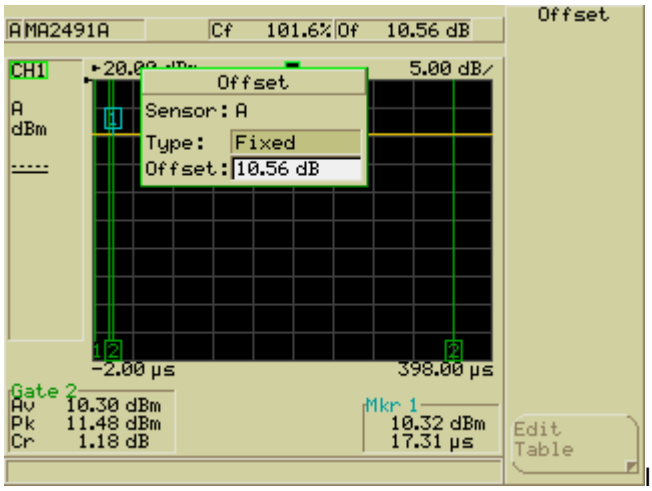

Figure 7. Entering the offset value

Saving Settings

Press System , Save/Recall and then Save Settings. Select the store and use Save as to save for the first time. The numeric keypad can be used to title the store settings. There is a timeout like a mobile phone text editor that enables the user to set consecutive letters that are on the same key. For example ‘adg’ can be set directly by pressing keys 8,9,4 , but to set ‘abc’ requires 8, pause, 8, pause, 8

Press Enter when finished, this will store the setting.

These settings can also be recalled from Preset

Power Meter Notation Conventions Used in this Application Note

The following conventions have been adopted in this Application Note.

Channel	Hard keys on the unit are enclosed in a box with a grey background.
Set Up	Soft keys that display on the screen are enclosed in a box with a white background. Pressing a soft key provides access to menu options, toggles selections and allows data entry.
[Exit]	The text that appears on or beneath the keys on the numeric keypad is enclosed in square brackets.
[Channel Set Up]	The titles of input dialogs that appear on the screen are enclosed in square brackets.
“Meas display”	Items or text that display within the main body of the screen are enclosed in quotation marks.
ML249xA	Used throughout this application note to refer to both the ML2495A and the ML2496A power meters.

ML249XA Peak Power Meter

There are two variants of the ML249XA Peak power meter:

- ML2495A single input unit
- ML2496A dual input unit.

Both units have a video bandwidth of 65MHz which means that the peak power on even the highest data rate signal can be measured correctly with out resorting to the manual corrections required by lower bandwidth power meters. The ADC uses a repetitive sample technique to sample at every ns when the capture time is set to <3.2μs. A variety of trigger facilities are available to ensure precise triggering. The power of the Radar pulse can be measured in a gate which defines precise time limits for the measurement. Up to 4 gates can be set on a single display channel set up. 4 Markers are available to measure features of the signal.

Both versions of the power meter support dual display channels. Each display channel can be thought of as a different measurement set-up and the power meter can toggle between them with the Ch1/Ch2 key or they can be displayed together on the screen. The measurement process will alternate between the two display channels.

The power meter supports 20 settings stores, which can be recalled either under the settings menu or under the preset menu.

MA2411B Pulse Sensor

- MA2411B 300MHz to 40GHz

This sensor has been designed for the most demanding rise time applications and displays a typical performance of 8ns rise time at +10dBm. Dynamic range is specified from –20dBm to +20dBm. This sensor does not have a CW mode and has been designed specifically for the pulse and OFDM applications. For multi-purpose CW and pulse applications use a MA2490A or MA2491A.

MA2490A and MA2491A Wideband Sensors

Two versions of the wideband sensor are available.

- MA2490A 50MHz to 8GHz
- MA2491A 50MHz to 18GHz

Both sensors have a 20MHz bandwidth and incorporate a CW mode switch for CW applications.

The sensors' dynamic range is –60dBm to +20dBm in CW mode and –26dBm to +20dBm in pulsed modulated mode.

The sensors are specified to handle 3dB over range to +23dBm. For signals with a high overshoot, the peak of the power should be kept below +20dBm for safe and accurate measurements. This may need the addition of an external attenuator and this application note describes how to automatically offset the reading for the value of the attenuator.

Further Information

For more information on the ML248XA Power Meter, the MA249XA sensor please contact your local Anritsu sales office or sales representative.

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