Application Note

Anritsu
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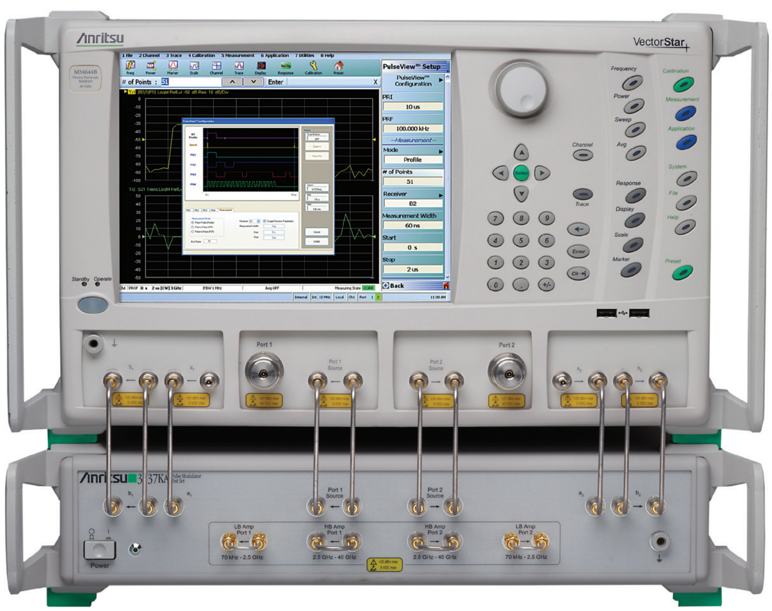
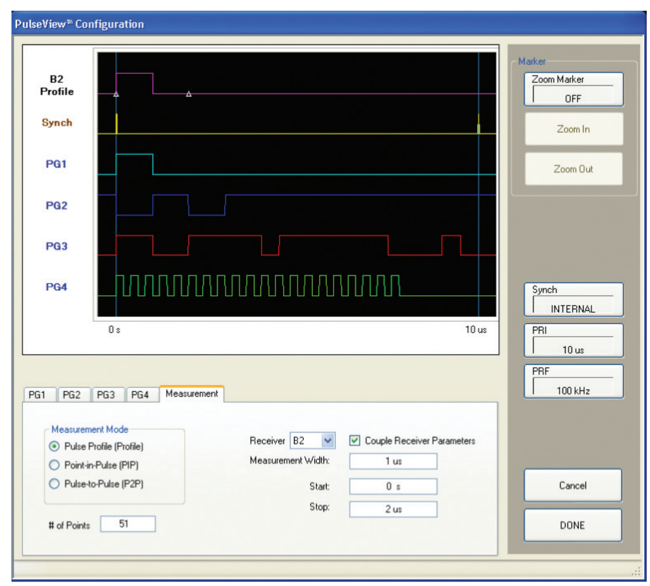
Understanding PulseView™ Measurements

MS4640B Series Vector Network Analyzer





1 Introduction

This document will give a basic introduction to the Anritsu VectorStar™ PulseView application. It will explain how the three measurement modes (Pulse Profiling (PP), Point-In-Pulse (PIP), and Pulse-To-Pulse (PTP)) work and contains some measurement examples for each mode. For more detailed information, see chapter 23 – PulseView in the VectorStar Measurement Guide (Anritsu Document # 10410-00318).

2 Measurement Modes

2.1 Point-In-Pulse (PIP)

This measurement quantifies S-parameter data somewhere within a pulse. One may want to avoid edge effects or just measure the pulse as a whole, but the structure within the pulse is not of great interest, nor is the variation from pulse to pulse.

A point-in-pulse measurement is illustrated in Figure 1. Data is acquired over a requisite length of time, and the user specifies the interval of interest relative to a synch pulse T_0. This interval is usually quantified in terms of a delay and a desired measurement width or aperture. In addition, a level of averaging can be specified so this same interval is analyzed on multiple pulses and the results combined. Pulses are sampled with the same coherent clock so that phase information is maintained.

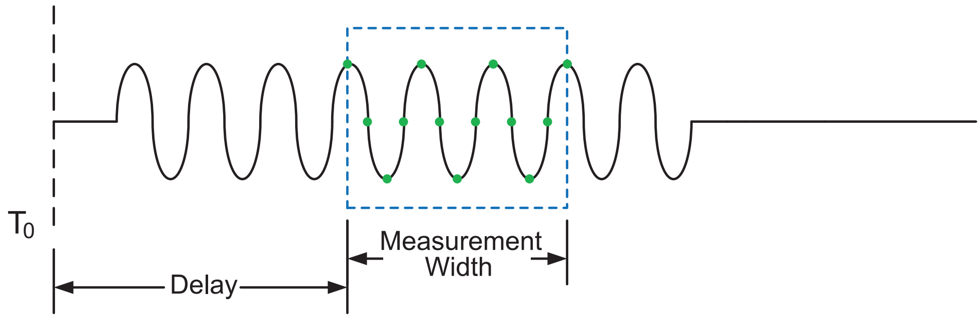


Figure 1. Figure 1: Point-In-Pulse Measurement

The diagram in Figure 1 illustrates an example where the width of interest is 13 samples. While only a single sample is required for measurement, about four hundred million samples are possible (limited only by the record length of the instrument). Point-in-pulse measurements are often made with swept frequency or power, and are plotted as such. In these cases, the above process is simply repeated for multiple frequencies and power levels.

2.1.1 Point-In-Pulse Parameters

Measurement Width: The measurement width (in time) per point displayed on the VNA.

Delay: Determines when the measurement starts relative to T_0.

Number of Points: Number of points (swept Frequency, swept Power, or CW) to plot in the VectorStar display. Each point represents a single measurement of a pulse.

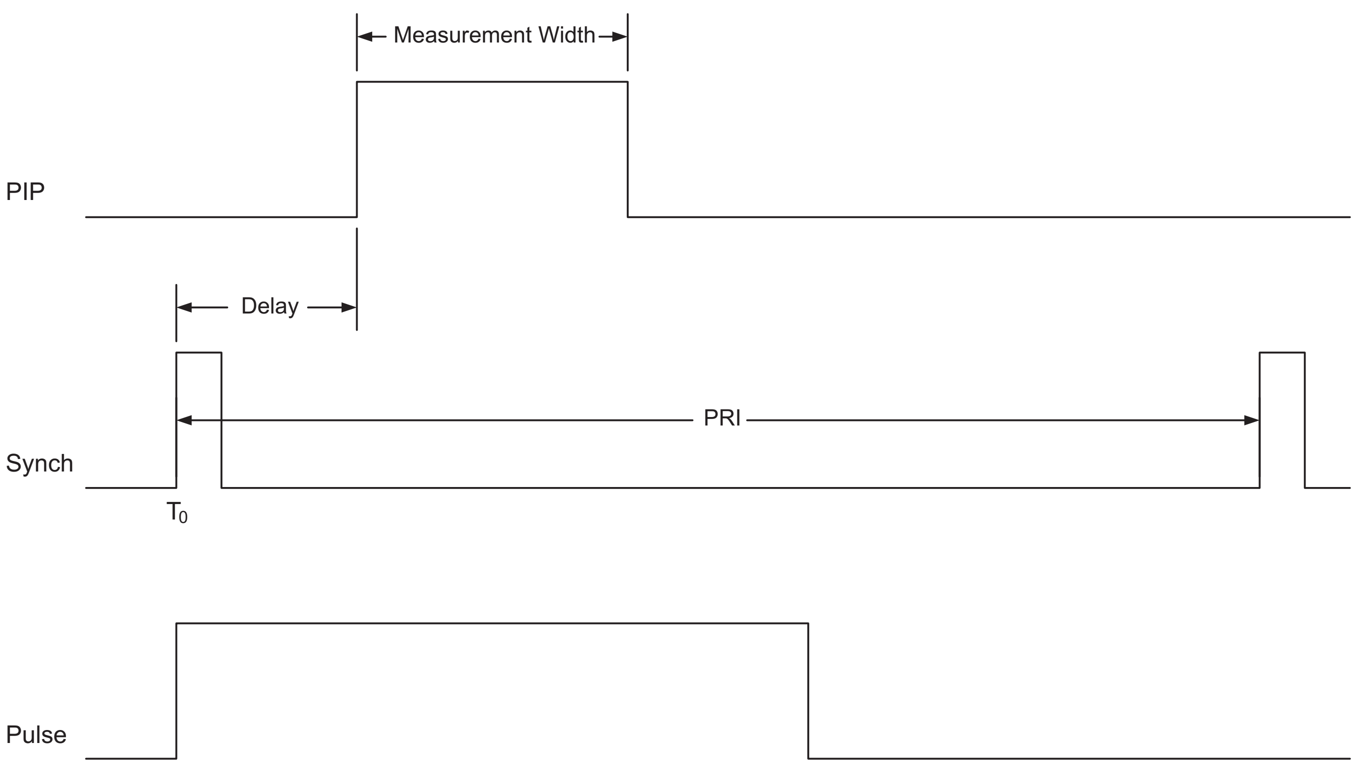


Figure 2. Point-In-Pulse Parameters

2.1.2 Point-In-Pulse Measurement Examples

Case 1: CW PIP measurement with no Averaging

In this case, every point in the measurement represents a single measurement of a pulse at a fixed frequency. After every measurement, there will be a small break for the VNA to configure itself to take the next measurement.

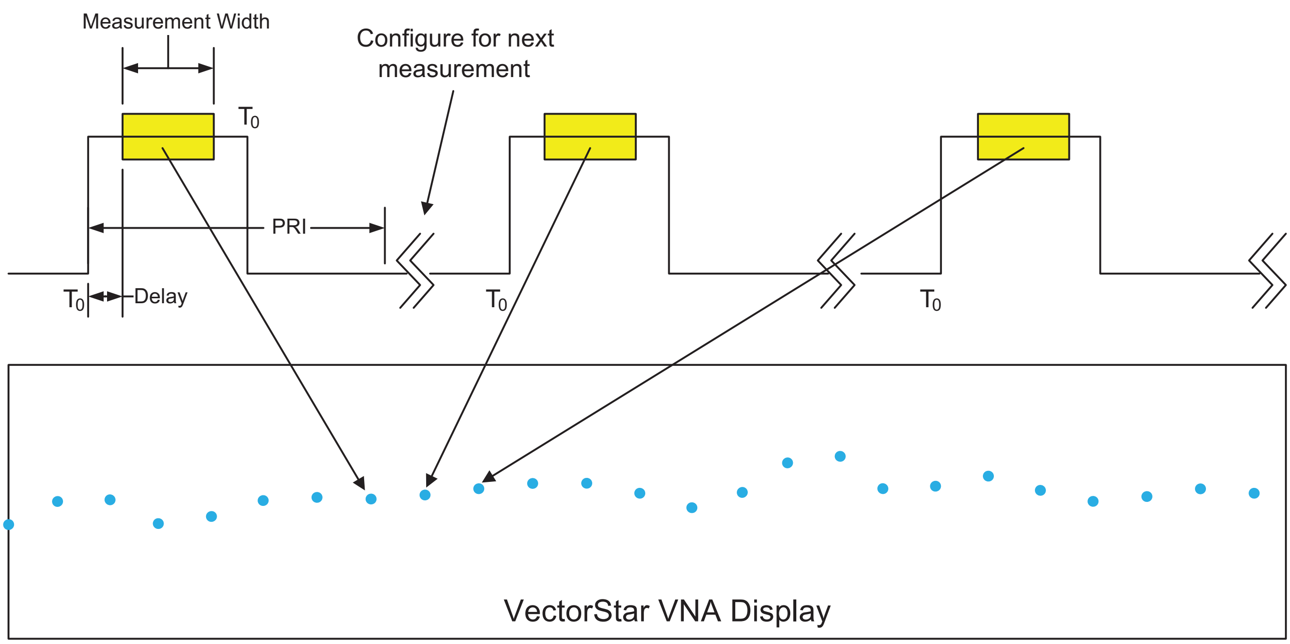


Figure 3. PIP Measurement Case 1

Case 2: CW PIP measurement with 3 Averages

In this case, every point in the measurement represents an average of x number of measurements of pulses at a fixed frequency. After every average measurement, there will be a small break for the VNA to configure itself to take the next average measurement.

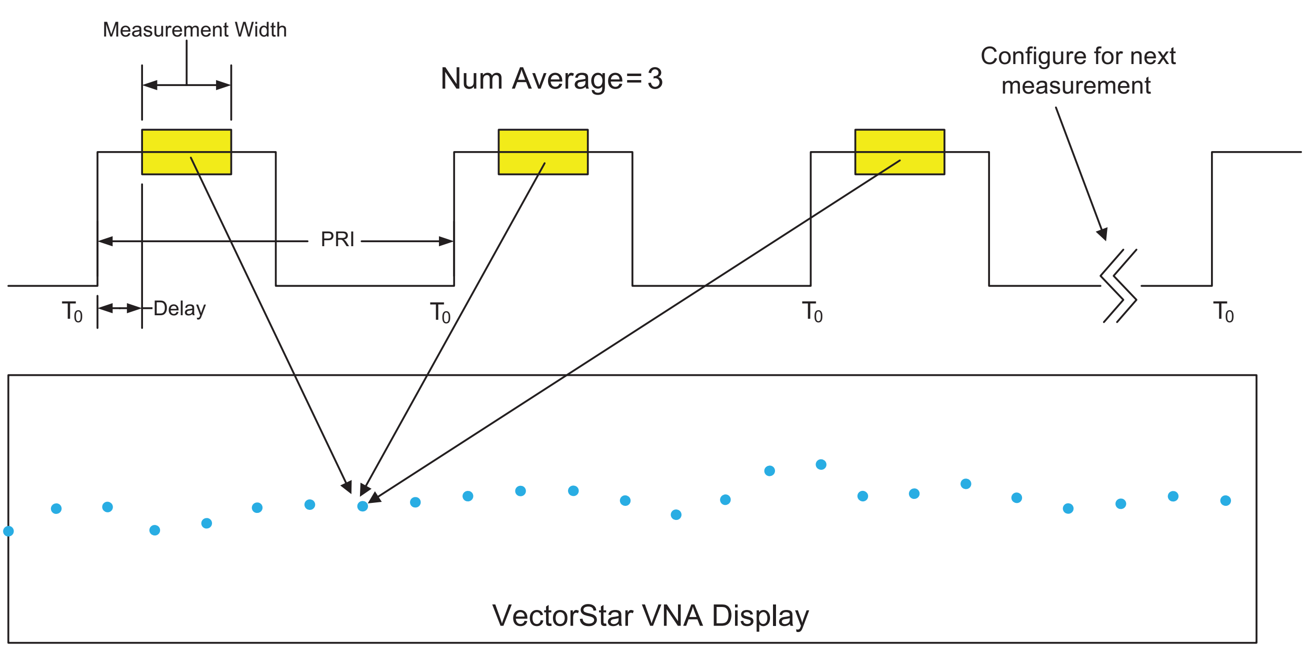


Figure 4. PIP Measurement Case 2

Case 3: Swept Frequency PIP measurement with no Averaging
In this case, every point in the measurement represents a single measurement of a pulse at a specific frequency. The next measurement will be a single pulse at the next frequency in the sweep determined by the Start and Stop Frequencies and the number of points. The frequency delta can be calculated with the following formula:

$$Frequency\ Delta\ = \left(\frac{(Stop\ Frequency - Start\ Frequency)}{Number\ of\ Points - 1}\right)$$

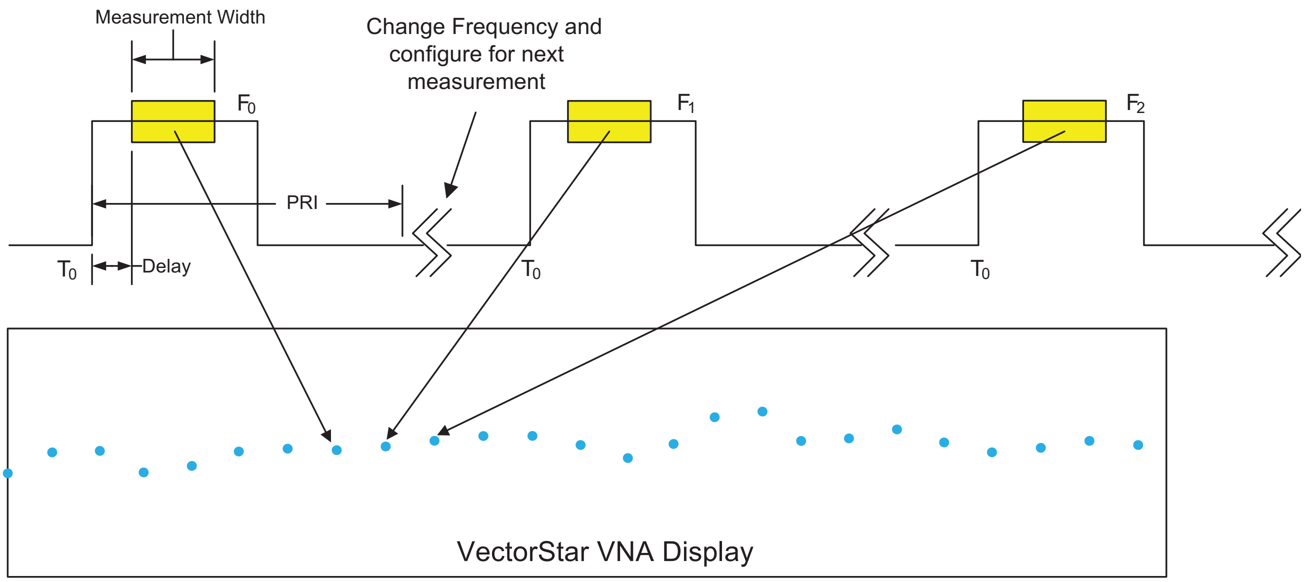


Figure 5. PIP Measurement Case 3

Case 4: Swept Frequency PIP measurement with Averaging
This case is the same as case 3 with the difference being that each point in the trace is an average of x number of measurements at a specific frequency.

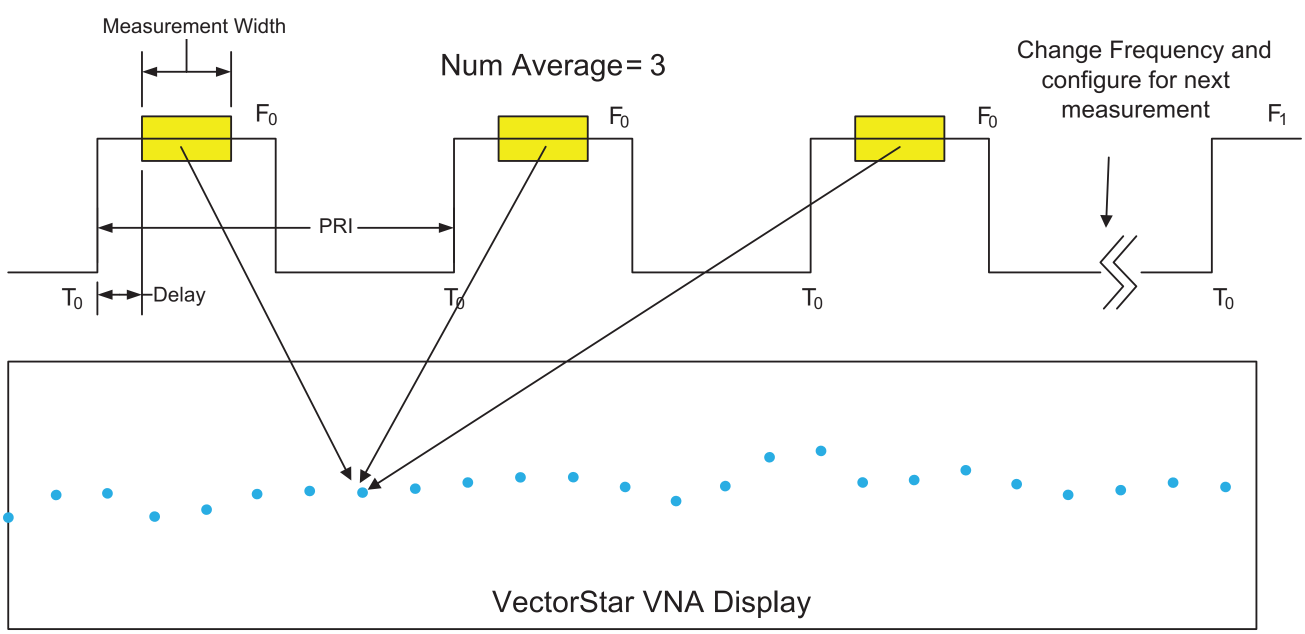


Figure 6. PIP Measurement Case 4

Case 5: Swept Power PIP measurement with no Averaging
In this case, every point in the measurement represents a single measurement of a pulse at a fixed frequency with the power being swept. Each successive measurement will be a single pulse at the next power level in the sweep determined by the Start and Stop Power levels and the number of points. The power delta can be calculated with the following formula:

$$Power\ Delta\ = \left(\frac{(Stop\ Power - Start\ Power)}{Number\ of\ Points - 1}\right)$$

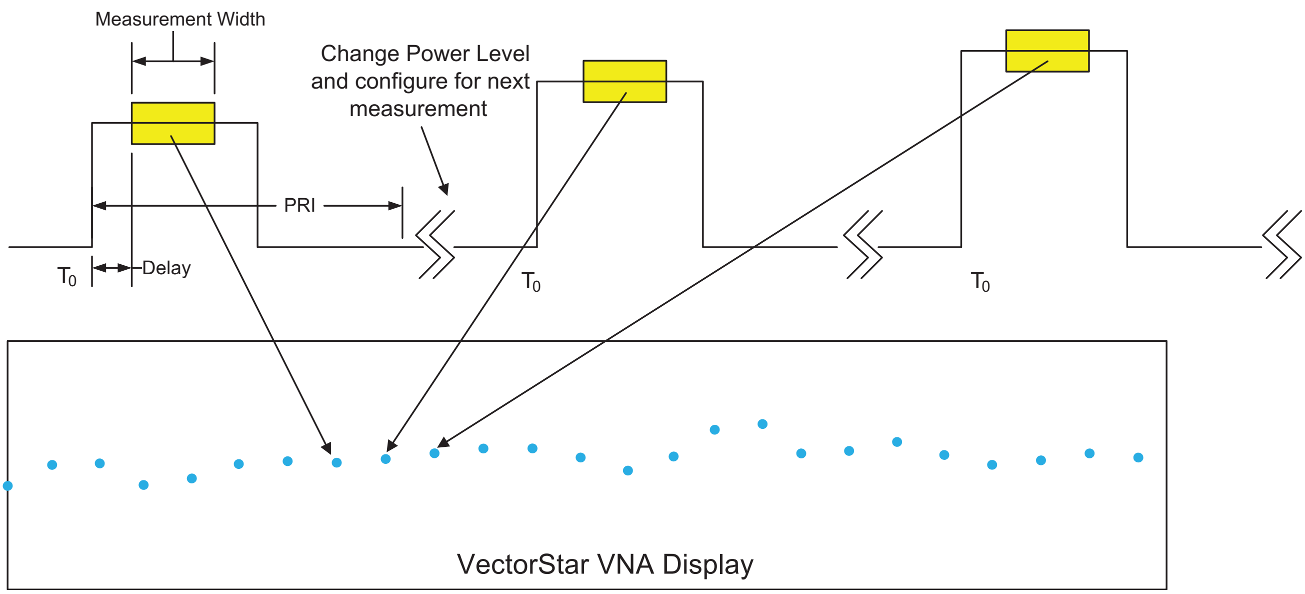


Figure 7. PIP Measurement Case 5

Case 6: Swept Frequency PIP measurement with Averaging
This case is the same as case 5 with the difference being that each point in the trace is an average of x number of measurements at a specific power level.

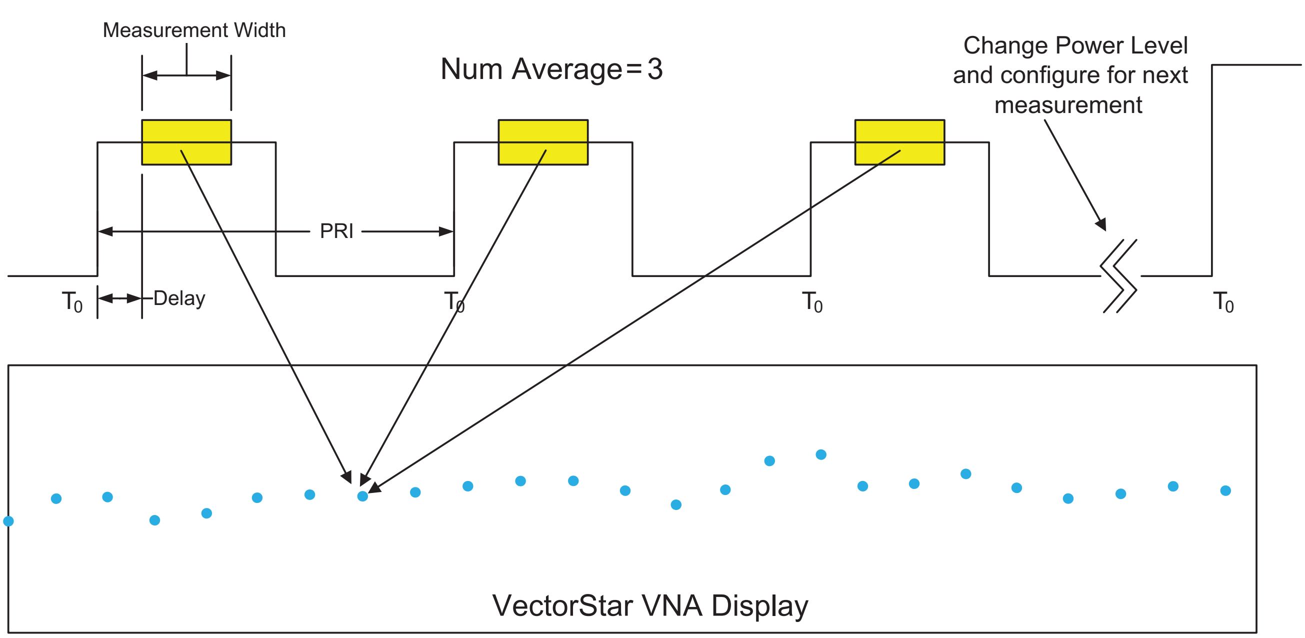


Figure 8. PIP Measurement Case 6

2.2 Pulse Profiling (PP)

The pulse profiling measurement focusses on the structure of data within the pulse. Characteristics like overshoot or undershoot, droop, and edge response are measured while the frequency and power are kept constant (although they can be varied between acquisitions).

This data is normally plotted vs. time to indicate position within the pulse (measurement normally is setup as constant frequency (CW) and constant power, but more complex measurements can be orchestrated using multiple channels or setups).

Variation between pulses is often not observable in this measurement, which may represent an average over a number of pulses. One can structure the measurement, however, to look at behavior from an absolute start time with no averaging in order to look at the complete evolution over multiple pulses.

A start time and a stop time (T_{start} and T_{stop}) are specified relative to the synch pulse (T_0) along with a number of time points to describe the portion of the pulse to be profiled. The measurement may begin before the physical pulse is at the DUT and end after the pulse is no longer being applied to the DUT, but the data must be interpreted appropriately in all cases. A measurement width is also specified. Additional averaging can be imposed across multiple pulses. As with point-in-pulse, the range of allowed widths is large.

The measurement windows are allowed to overlap (and will if $(T_{stop} - T_{start}) / (\text{NumTimePoints} - 1) < \text{Width}$), which performs a variety of time-based smoothing operations on the data. A common setup is 10 to 20 non-overlapping (or slightly overlapping) profiling time points within a pulse, but application requirements may dictate very different parameter choices.

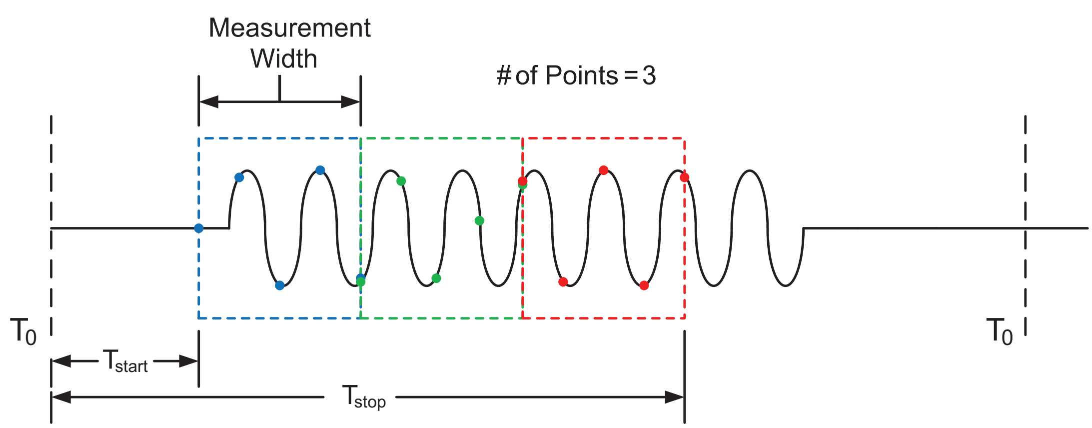


Figure 9. Pulse Profiling Measurement

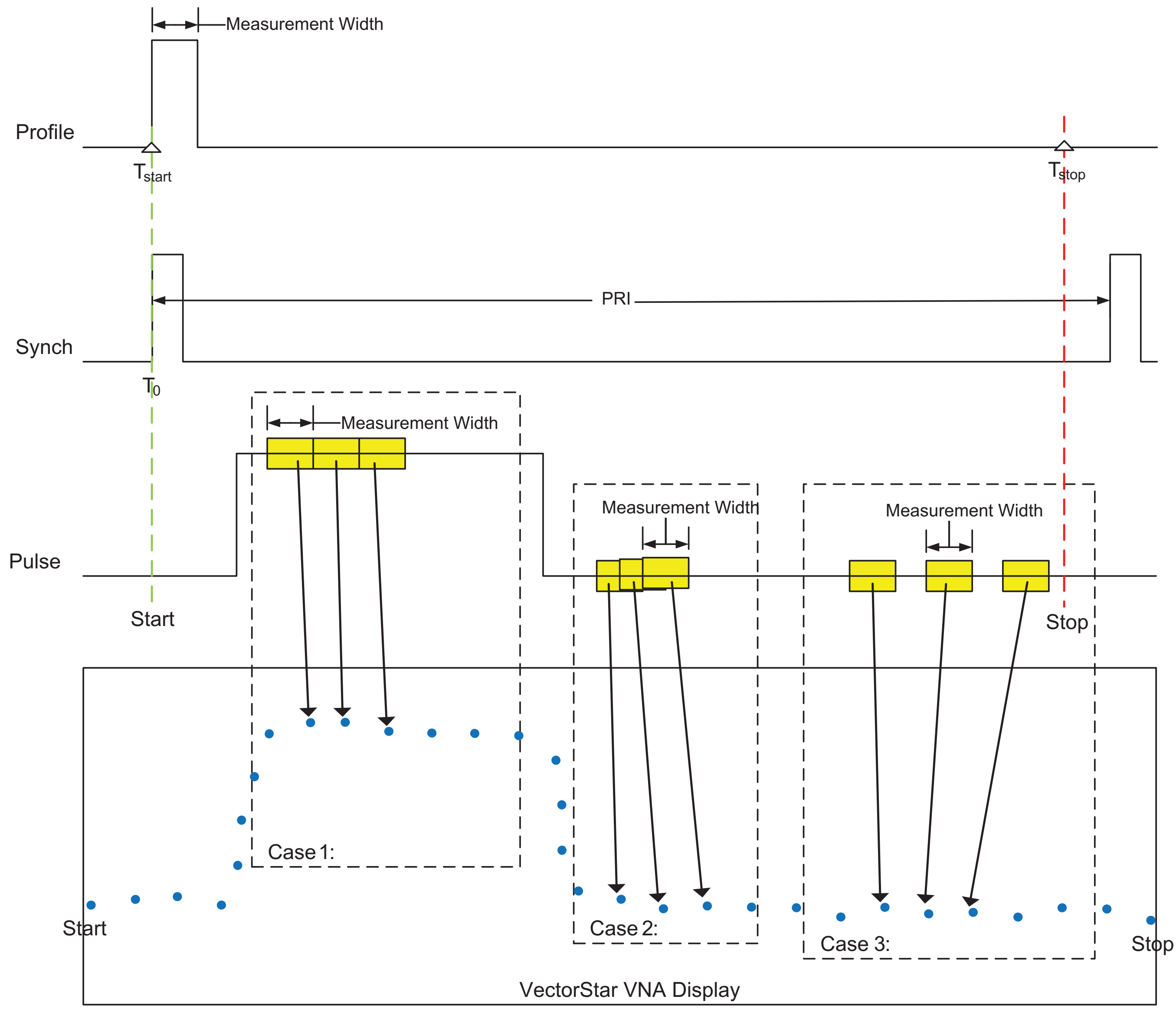


Figure 10: Pulse Profiling Measurement Examples

2.2.1 Pulse Profiling Parameters

Measurement Width: is the measurement time per point displayed on the VNA. It determines the time resolution.

Start and Stop: determines where the measurement is to take place relative to the Synch Time reference

Number of Points: Number of points to plot in VectorStar display

2.2.2 Pulse Profile Measurement Examples

Case 1: Non-overlapping contiguous measurement
In this case, there is no overlap of data and no data is skipped for all data points that are plotted. To setup a measurement with this characteristic, you will need to set up the following:

$$Number\ of\ Points\ = \left(\frac{(Stop - Start)}{Measurement\ Width}\right) + 1$$

For instance:

Start = 0 s
Stop = 300 ns
Measurement Width = 10 ns

$$Number\ of\ Points\ = \left(\frac{(300 - 0)}{10}\right) + 1$$
$$= 31$$

Case 2: Overlapping measurement
In this case, every data point that is plotted consists of data that is overlapped. To setup a measurement with this characteristic, you will need to set up the following:

$$Number\ of\ Points\ = \left(\frac{(Stop - Start)}{Measurement\ Width}\right) * \left(\frac{1}{\%\ Overlap}\right) + 1$$

For instance:

Start = 0 s
Stop = 300 ns
Measurement Width = 10 ns
% Overlap = 0.50 (as a decimal)

$$Number\ of\ Points\ = \left(\frac{(300 - 0)}{10}\right) * \left(\frac{1}{.5}\right) + 1$$
$$= 61$$

Case 3: Non-overlapping non-contiguous measurement
In this case, there is no overlap of data, but data is skipped for successive data points that are plotted. To setup a measurement with this characteristic, you will need to set up the following:

$$Number\ of\ Points < \left(\frac{(Stop - Start)}{Measurement\ Width}\right) + 1$$

For instance:

Start = 0 s
Stop = 300 ns
Measurement Width = 10 ns

$$Number\ of\ Points < \left(\frac{(300 - 0)}{10}\right) + 1$$
$$< 31$$

If Number of Points is < 31, some data will be ignored.

2.3 Pulse-To-Pulse (PTP)

This type of measurement can be described as a hybrid of the first two methods. Normally, one will pick a section of the pulse to measure, and then the progression over a number of pulses is plotted (versus time or index).

This process is illustrated in Figure 11, where the first three pulses are shown. The delay from T_0 is the same for each measurement window of interest and the window in each pulse is processed separately.

Pulses are treated in an absolute fashion, so averaging of multiple pulses is not useful and is not available. As with pulse profiling, this measurement is performed at constant frequency (CW) and constant power. One could orchestrate measurements that cycled through a variety of frequencies and power levels using multiple channels or setups.

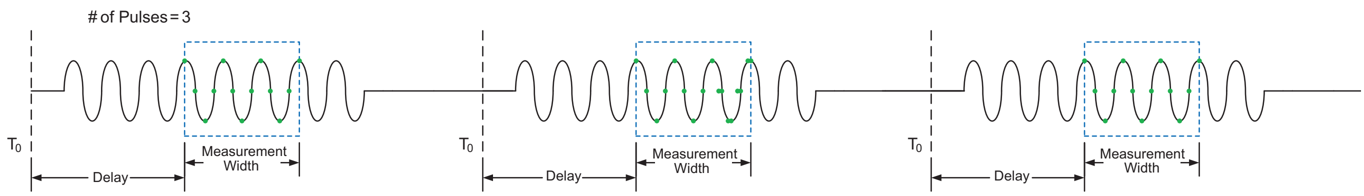


Figure 11: Pulse-To-Pulse Measurement

2.3.1 Pulse-To-Pulse Parameters

Measurement Width: The measurement width (in time) per point displayed on the VNA.

Delay: Determines when the measurement starts relative to T_0.

Number of Pulses: Number of pulses to plot in VectorStar display. Each point represents a single measurement of a pulse.

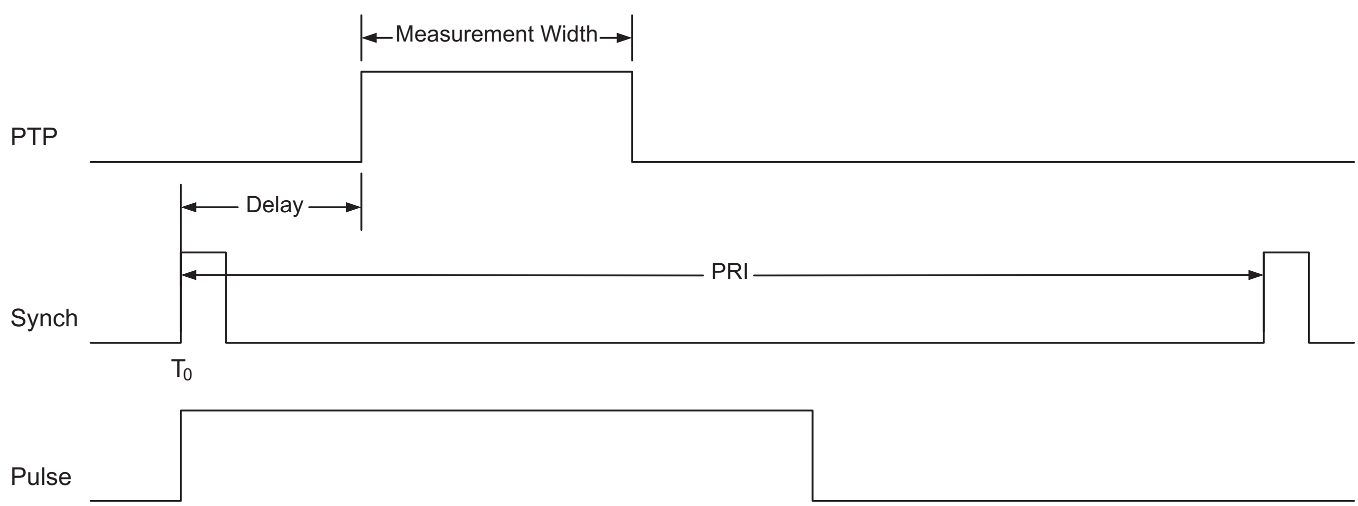


Figure 12: Pulse-To-Pulse Parameters

2.3.2 Pulse-To-Pulse Measurement Example

Case 1: Typical Pulse-to-Pulse Measurement
In this example, a user wants to measure changes in amplitude and phase of a pulse train for 1000 pulses. They are not interested in edge effects and want to take the measurement in the center of the pulse where it is stable. The following example will show how to set up this measurement.

Pulse Width = 1 us

PRI = 2.1 us

Number of pulses to measure: 1000

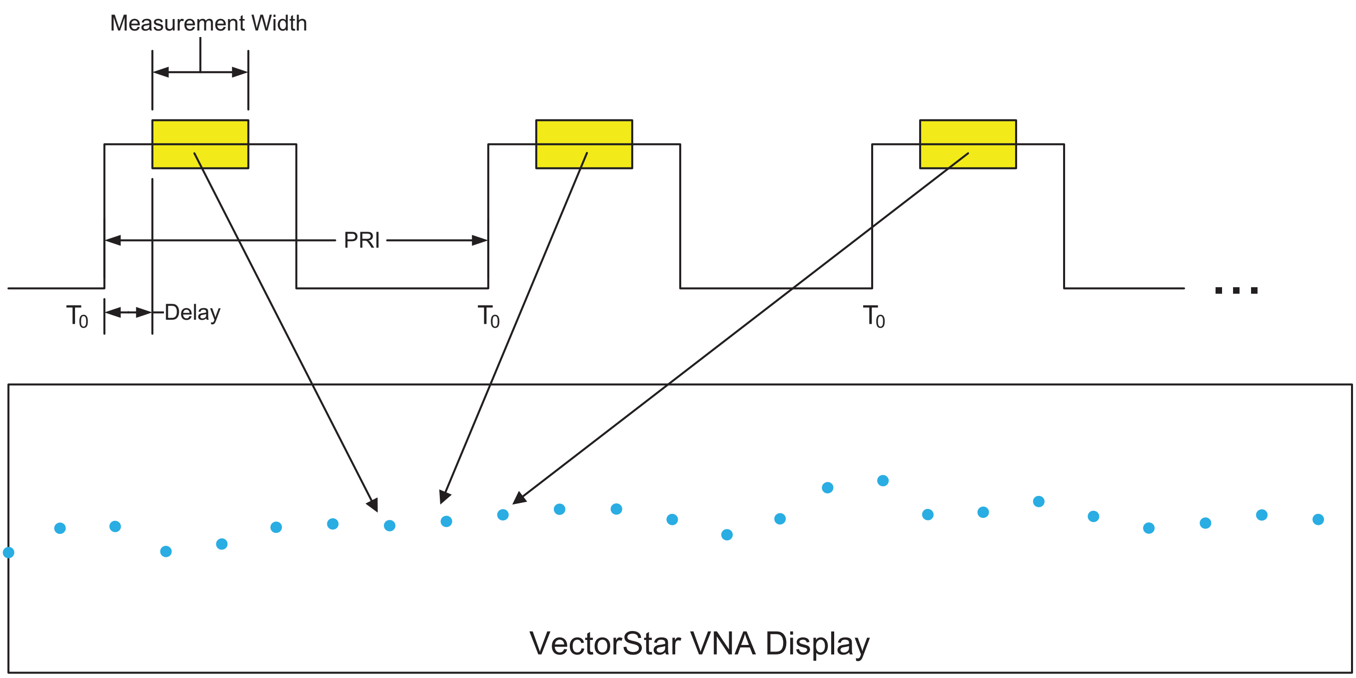


Figure 13: Pulse-To-Pulse Measurement Example

Setup the PulseView measurement as shown in Figure 14.

Measurement Width: 800ns – Take measurement for 800ns within the pulse

Delay: 100 ns – Delay far enough from T_0 so that we ignore the rising edge effects (i.e. overshoot and ringing).

# of pulses: 1000 – Number of pulses to measure and display.

PRI: 2.1 us

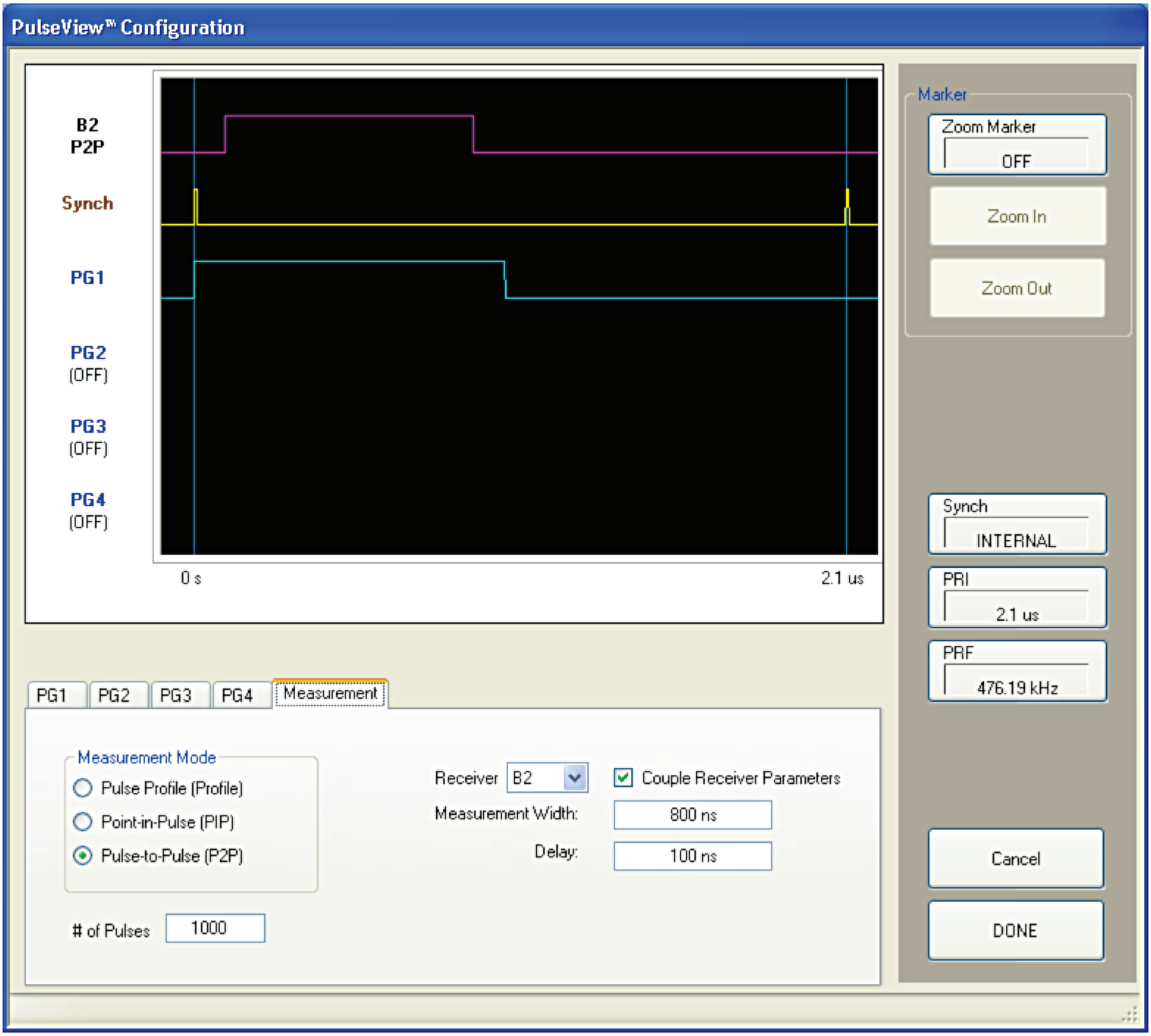


Figure 14: PulseView Setup for Pulse-To-Pulse measurement

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11410-00805, Rev. A Printed in United States 2014-04