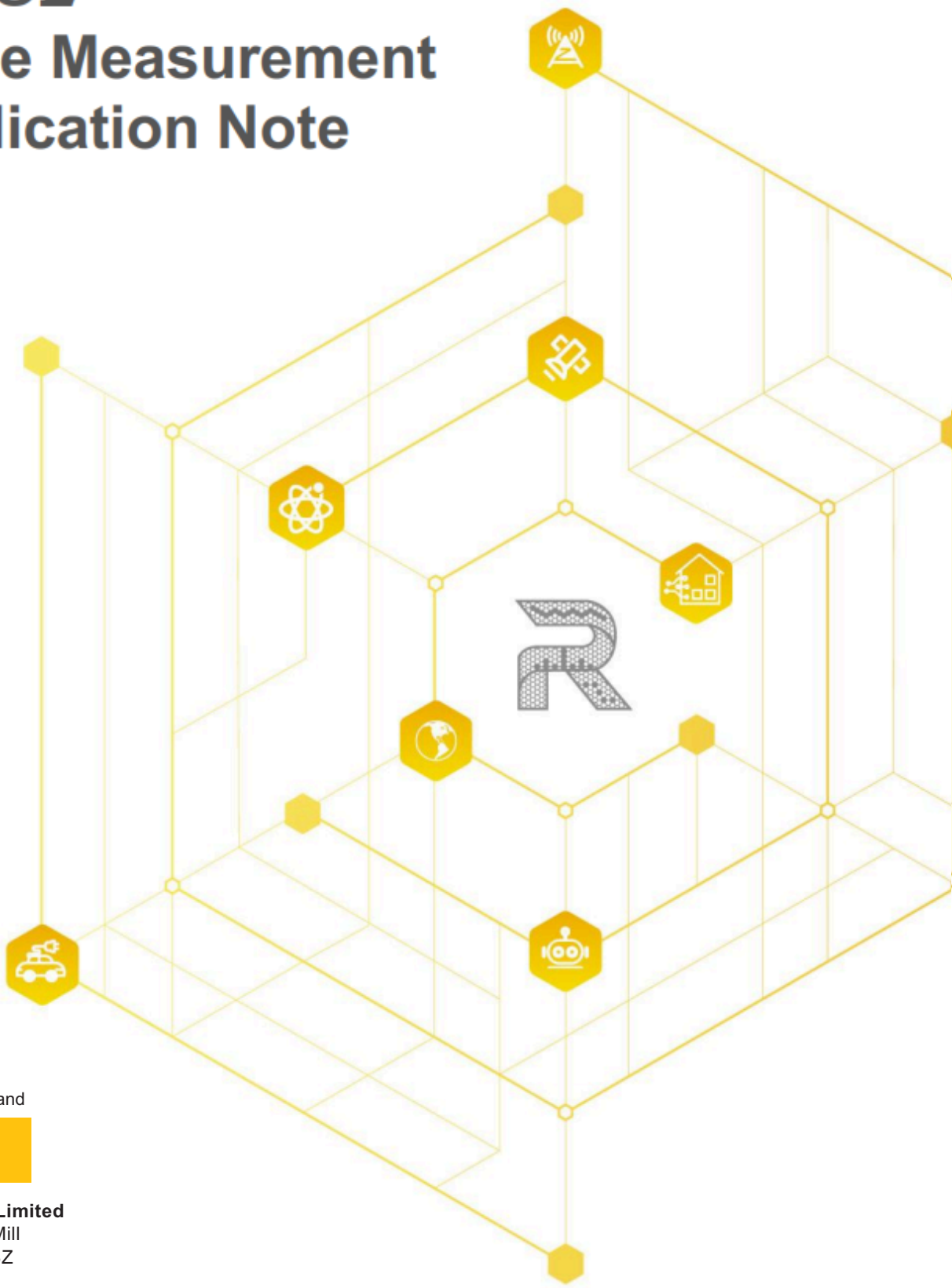
RIGOL
Pulse Measurement Application Note



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1 Document description

1.1 Content in this guide

The purpose of this application guide is to describe the following:

- Explain the basic definition of pulse measurement, the applicable prerequisites, the connection method and the basic setup process
- Authorization requirements for the pulse measurement analysis (PMA) option, as well as entering the pulse measurement mode, configuring the central frequency, range, Sample rate and measurement view.
- The concept, purpose and basic setup step of the pulse selection menu, which is used to specify the analysis object in the pulse sequence.
- Examples of typical parametric measurement operations, including methods for obtaining pulse meter readings such as pulse width, PRI, top power, etc.
- Ideas for troubleshooting common problems such as no pulses, unstable triggering, abnormal pulse width/edge/power/PRI readings, unclear multi-pulse objects, etc.
- Safety precautions regarding use of pulsed peak power, external trigger levels, and RF access.

1.2 Applicable instrument and software version

Category	Product information
Spectrum analyzers	RSA6000 series real-time spectrum analyzers
Analysis software options	Pulse Measurement Analysis Option (PMA)
Example signal source	DSG3000B Series
Downloader software version	Refer to the software installation package release notes
Instrument firmware version	Refer to the firmware release notes in the corresponding product manual

Note: Before using this software option, make sure that the instrument has correctly activated the corresponding authorization. Please refer to the RSA6000 product brochure or visit the RIGOL website for information on how to activate the license.

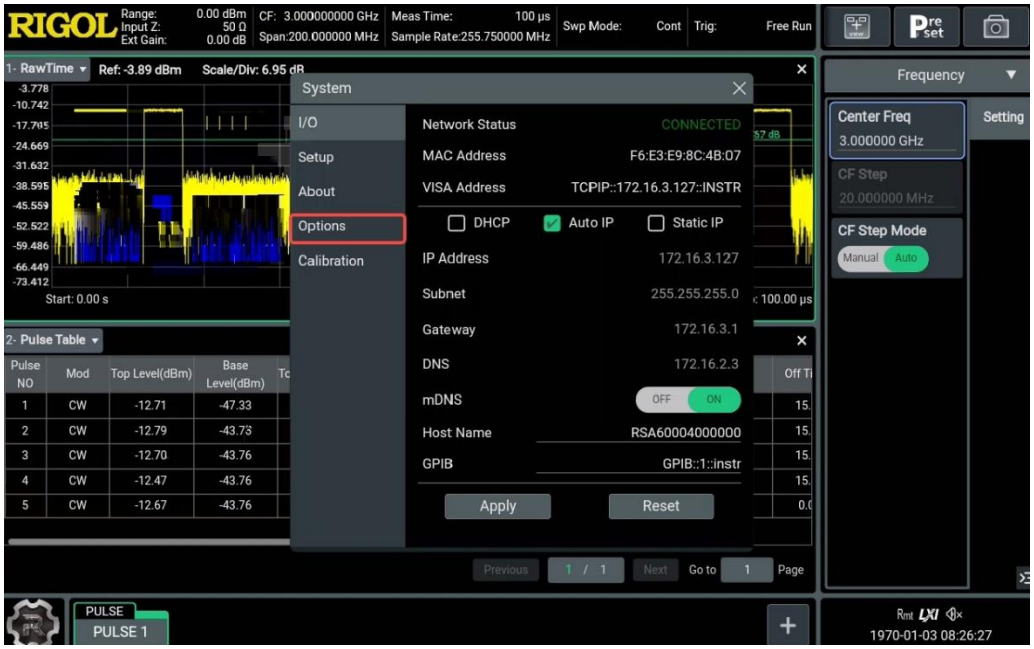
2 Caution

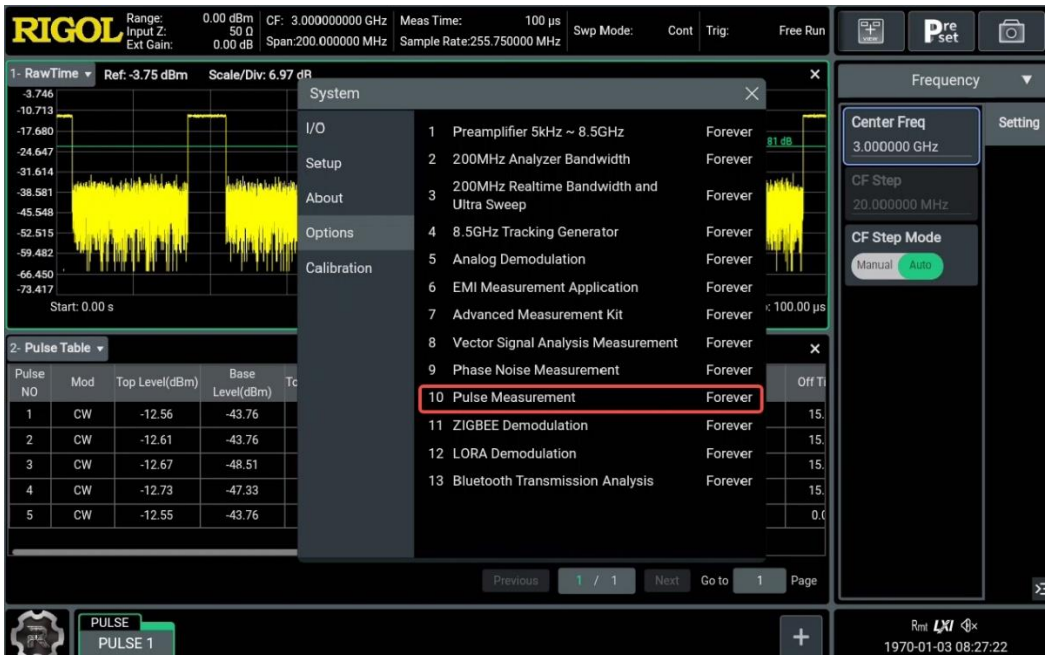
The following points typically need to be confirmed:

2.1 The instrument has relevant measurement applications/options

Pulse measurements for the RSA6000 generally rely on the **PMA option**. If the pulse measurement item is not found in the switch mode, check first if the pulse measurement analysis option is available in the options list and if the license period is normal.

How to view options:





2.2 The input signal meets the frequency and power range of the instrument

Guarantees are required that the input frequency does not exceed the instrument's upper limit, that the input power is not excessive, and that particular attention is paid to peak pulse power to prevent front-end overloading.

When power is not determined: Set the range parameter in the amplitude menu to maximum.

3 Description of the pulse measurement function

3.1 Feature Overview

In RF tests, the signal is not always transmitted continuously. Many systems are **pulsed**, meaning that the signal occurs only for some very short period of time, with the rest of the time off or low. For this type of signal, ordinary continuous spectrum observation often does not fully reflect its true characteristics, so the instrument needs to provide a specific pulse measurement mode.

Pulse measurement mode refers to the instrument in the analysis of RF signals, not only the frequency and power of the signal, but also the **time change pattern**, from the angle of time and frequency domain to the comprehensive analysis of the pulse signal.

Mode	The main answer question
Normal spectrum mode	At what frequency the signal is and how much power it is
Pulse measurement mode	When the signal appears, how long it lasts, whether the repetition is stable, and how it behaves during continuity

Pulse measurement mode is therefore an important function when analyzing the output signals of devices such as radar, pulse transmitters, T/R modules, etc.

3.2 Why pulse measurement mode is required

For continuous wave signals, the primary information is obtained by observing the spectrum distribution; however, the pulse signal has a distinct time structure in addition to the spectrum characteristics.
Example characteristics of a pulse signal:

Features	Description
Transmit timing	For example, every 100μs is transmitted for a short period of time and only 5 μs per pulse
Power characteristics	Power on is high and average power is not necessarily high
Edge and top	There is a rising/falling process on the front and rear edges; there may be sag, overshoot or fluctuations on the top

Limitations when using normal spectrum mode only:

Problem	Description
The results are averaged	The display power contains a large number of off times that do not accurately reflect the peak power at pulse on
Pulse width/PRI cannot be seen directly	The cross axis of the spectrum is frequency and does not allow easy observation of the switching rhythm in time
On/off is difficult to distinguish	Off segment noise and idle time can interfere with the measurement results
Edge characteristics are difficult to analyze	Rise/fall times, trace aberrations, etc. need to be observed in pulse measurement mode

3.3 Typical application scenario for pulse measurement mode

Pulse measurement mode is mainly used for the analysis of various types of pulsed RF signals, typical scenarios and test points are as follows:

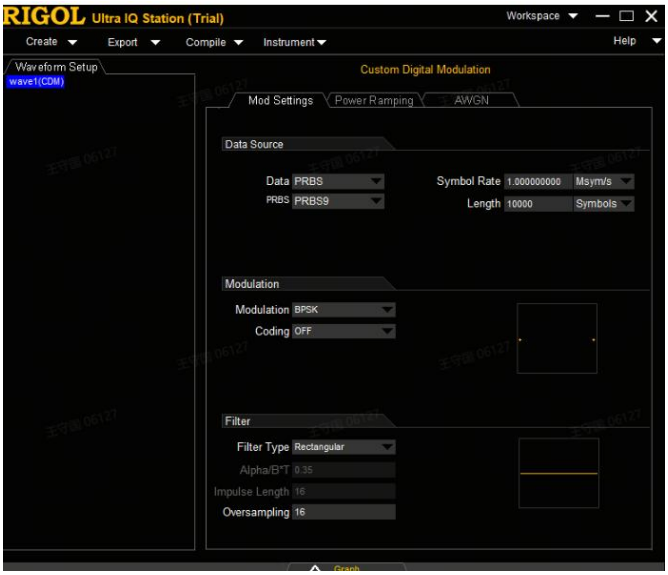
Scenario	Typical test/observation
Radar transmit signal test	Pulse width, PRI/PRF, top power, frequency stability, Pulsed trace quality
Pulse amplifier test	Continuity-up time, top power stability, sag, pulse-to-pulse consistency
T/R component test	Pulse response rate, output peak, trace shape, frequency characteristics
Pulse modulated source/gating source test	Pulses are scheduled to operate, continuity/shutdown is clean, residual output or trailing is present
Burst Signal Analysis	Burst slot behavior, pulse characteristics of non-continuous transmitting systems

4 Example of a parameter measurement operation

For example, "measures a 3 GHz pulse signal with parameters of approximately 5 μs pulse width, 20 μs pulse repetition period, and 10 dBm top power." Explain the basic flow of pulse measurements using the RIGOL RSA6000 Spectrum Analyzer.

4.1 Instrument connection

RIGOL 3000B Source + RSA6000 Spectrometer Combination



DSG3000B IQ Station BPSK modulation interface

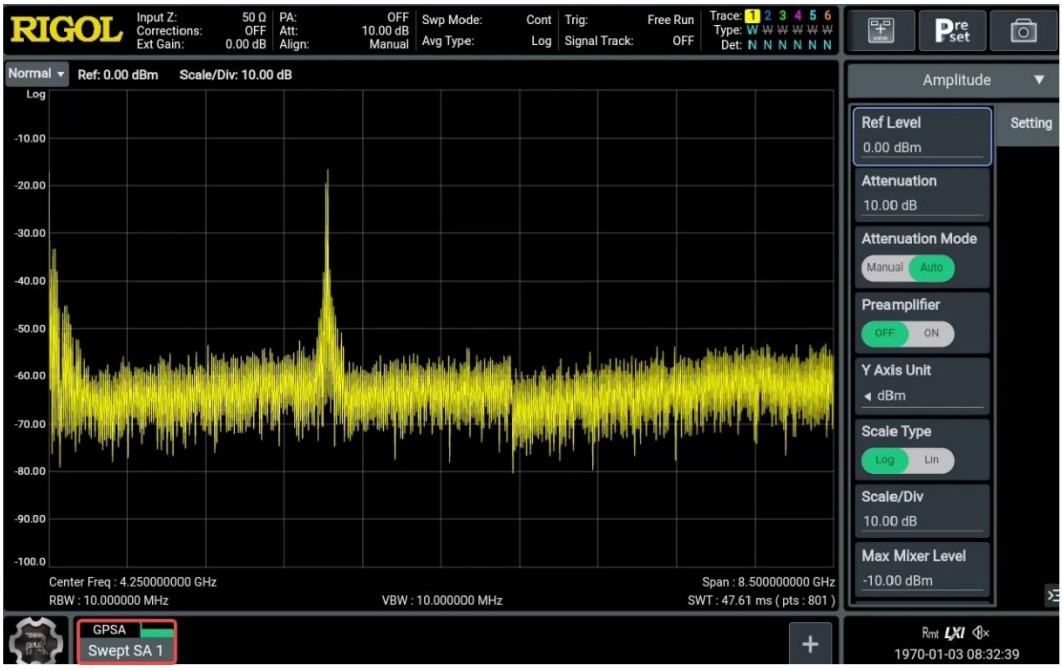
4.2 Instrument warm-up and reset

Recommendations:

1. Warm-up for 20 to 30 minutes
2. The System Reset (Preset) returns to the default state, avoiding previous settings affecting the current measurement

4.3 Enter pulse measurement mode

Lower Mode Bar:**General Spectral Analysis (GPSA) → Pulses (PULSE)**



4.4 Set basic parameters

4.4.1 Center frequency

The carrier frequency of the input pulse being measured is 3 GHz.

4.4.2 Range

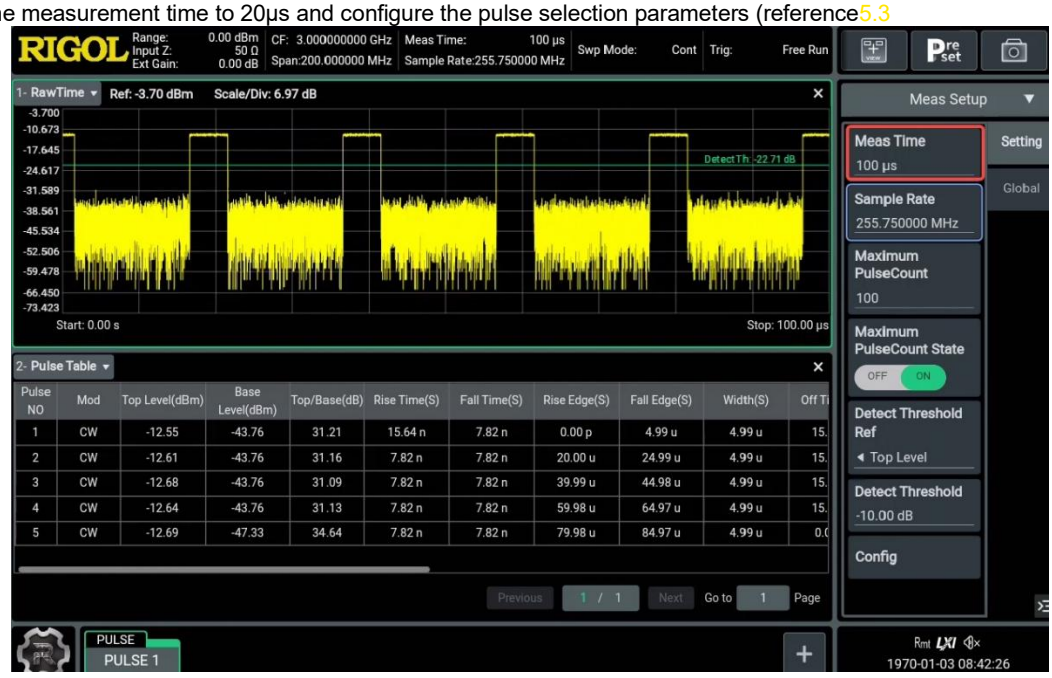
Initial recommendation: 0 dB (default). A weak signal can gradually decrease, and vice versa.

4.4.3 Sample rate

Accuracy is directly related to the refresh rate and the higher the sample rate the more accurate the refresh will be slower. Initial recommendation: 255.75 MHz.

4.4.4 Measurement time

1. Set the measurement time to 20µs and configure the pulse selection parameters (reference5.3



4.5 View the measurement results

Opens the pulse table, which is enabled in pulse table column editing via the Display menu: Pulse Width, PRI, Top Level (turned on by default).

5 Settings for the pulse selection menu

Gated measurement is a very important function in pulse analysis.

5.1 Concept

In pulse measurements, the instrument often acquires a series of repeated pulses. When the signal under test is present: Multiple pulses are present continuously, different pulse amplitude is inconsistent in the pulse sequence, there are primary and secondary pulses, pulses at different locations need to be analyzed separately. If you want to measure only one of the specified pulses, the instrument provides a **pulse selection verification**function to determine which pulse is currently being analyzed, whether all pulses are being analyzed or a specific pulse. By position or condition, which pulse is used to measure power/width/edge, etc. Simply put, pulse selection tells the instrument which one you want to focus on in a burst of pulses.

5.2 Role

The pulse selection menu makes the measurement more specific and can typically be used to:

- Select a single target pulse — such as the first, second, or a pulse at a fixed delay position after a trigger
- Differentiate between the different types of pulses – mix of primary and test pulses, different characteristics of pre- and post-pulses within the group, high/low level pulses, etc.
- Improve measurement stability — avoid multiple pulses processing together resulting in measurement fluctuations and average cloaking anomalies; select a fixed pulse to make the results more stable and repeatable
- Supports pulse sequence/pulse group analysis—the nth pulse in the group, a pulse in a specific location or time window

5.3 Basic steps

1. Allow multiple pulses to stabilize first

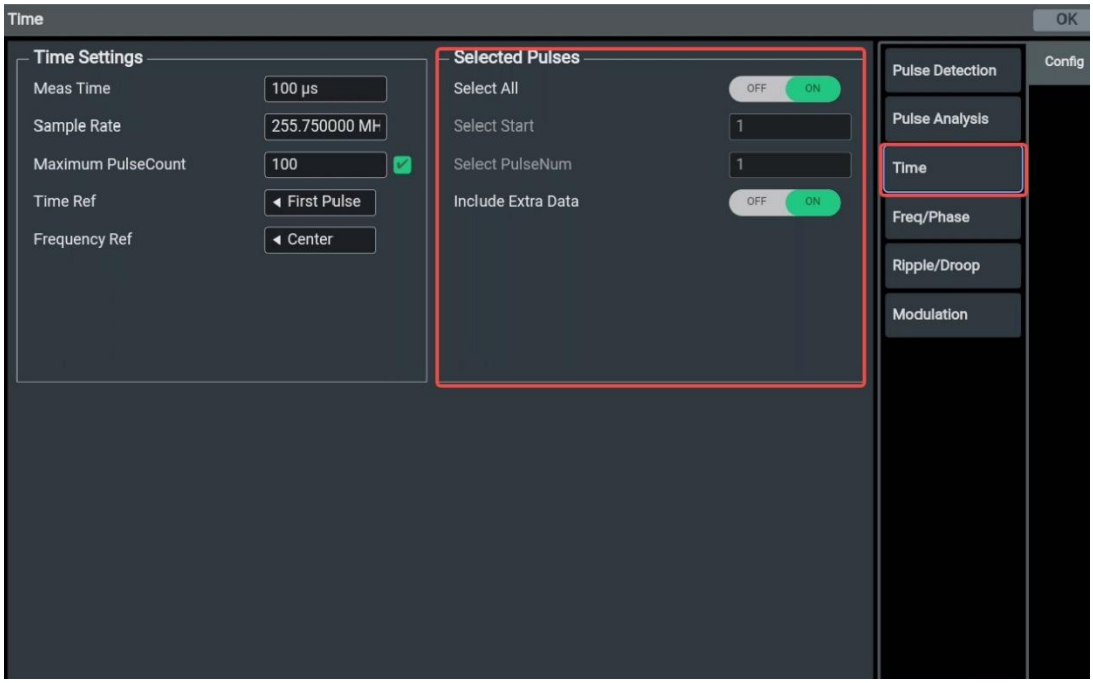
Before using pulse selection, ensure that the center frequency is set correctly, the trigger is stable, and the time window is sufficient to show multiple pulses. The waveform position is fixed and does not drift. Otherwise, the instrument cannot accurately distinguish between different pulses.

2. Sets the window X-axis auto-scale status

The default X-axis auto scale is on and can be skipped without modification. Action: Click the window you want to set → Display → X Scale → Set it to On.

3. Enter the pulse selection menu

In the menu, go to: Measure Setup → Setup → Configure → Time (corresponding to MeasSetup → Setting → Config → Time when the interface is in English) and you will see the settings for pulse selection.

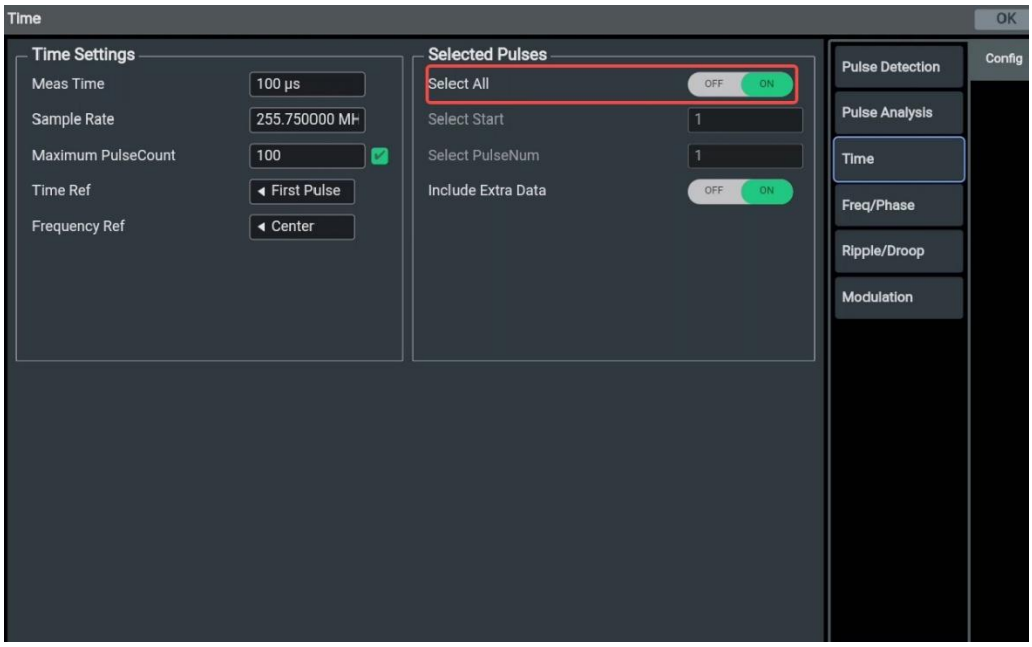


4. Determine the selection method

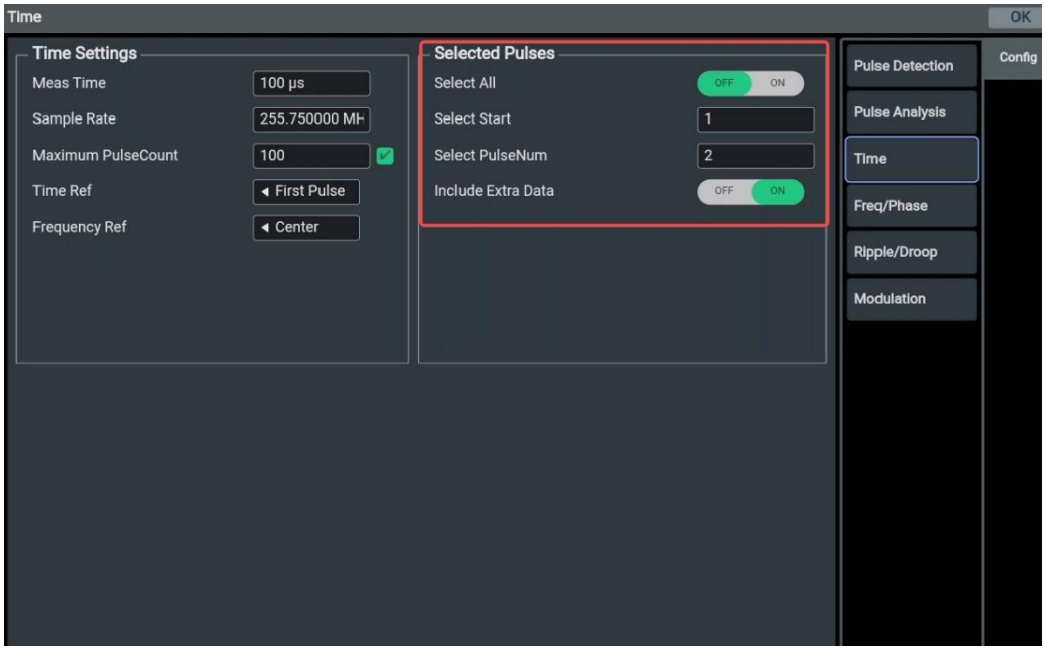
Determined by test target: Select all pulses or pulses for the specified condition.

5. Specifies the pulse sequence number or location

If all pulses are selected, select all is turned on.



If you select pulses for the specified condition, turn the All Selected Off and set the Select Start and the number of pulses (Select PulseNum).



6. Observe whether the trace results vary depending on the selection

Complete the post-selection check that the traces for the original time domain, amplitude, phase, frequency modulation are changed according to the parameter settings. to confirm that the pulse to be measured is selected by the instrument.

When Extra Data is on:

When Extra Data is Off:

6 Frequently asked questions and troubleshooting

6.1 No pulses

May behave	Possible causes	Troubleshooting suggestions
No apparent pulse trace on the screen; 2. Only the noise floor is visible; Irregular waveform unrecognizable; No valid results for parameter area	1.Center frequency error; 2. The input is not properly connected or has poor contact; 3.Y axis reference/scale is not appropriate; Excessive input attenuation; 5. Incorrect firing pattern; The measured piece does not deliver a pulse	Check the RF connection and carrier frequency; Turn on the Y-axis automatic scale; 3. Attenuation can be appropriately reduced (attention to overload); 4. Use of external/medium-frequency triggers; Switch back to the normal spectrum first to confirm the presence of the signal

6.2 The pulse waveform is unstable and drifts from side to side during external or medium frequency triggering

May behave	Possible causes	Troubleshooting suggestions
Pulse moves back and forth on the screen; Different location for each refresh; Difficulty in securing the edge of the observation; 4.The automatic measurement results are very jumpy	1.The trigger source/trigger level is not appropriate; 2. External triggers are not synchronized or amplitude is unstable; 3. There is jitter in the pulse repetition interval; Measurement time does not match trigger	1. Use of external triggers in preference; Check the trigger polarity and trigger level; 3. Adjust the trigger delay; Use an oscilloscope or synchronization source to confirm the measured piece timing, if necessary

6.3 Pulse width measured to large

May behave	Possible causes	Troubleshooting suggestions
Pulse width reading does not match theoretical value; 2. Manual and automatic difference; Pulse width varies significantly with different settings	Pulse width definitions vary (e.g., 50% threshold and fixed threshold); 2. Trigger an unstable edge to vaporize; 3. Noise threshold deviation; The measurement time is too short to cover the entire edge	Confirm the current pulse width definition; 2. Change to external/medium-frequency triggering; 3.Improve signal-to-noise ratio; Increase measurement time

6.4 Rise time or fall time measured slowly

May behave	Possible causes	Troubleshooting suggestions
1. The rise/fall time is significantly	1. Trigger unstable edge overlay to	1.Reduce the time window to view the single

May behave	Possible causes	Troubleshooting suggestions
greater than the theoretical value; 2. Edge is not too sharp; 3.The lower edge of the different bandwidth is significantly different	slow; The edge of the measured signal itself is slow	edge; 2. Place the edge in the screen with a trigger delay; 3.If still slow consider the signal itself or the instrument bandwidth limit

6.5 The top of the pulse is uneven, sag, ripple, or undulating

May behave	Possible causes	Troubleshooting suggestions
1. The top is gradually lowered; Cyclical fluctuations; Front high rear low or center bulging	1.Output is unstable during on-pass of the measured piece; 2.Power/Bias dynamic fluctuations; 3. Instrument bandwidth setting effect; The input link is slightly overloaded	1.Increase input attenuation to exclude front-end compression; Check for Overload prompt; Compare the top front and rear power difference with the markings; 4.If the optimization is still present, it is more likely to be a measured piece problem

6.6 Peak or top power readings are erratic

May behave	Possible causes	Troubleshooting suggestions
1.Different power values for each refresh; 2. Top power runout; 3.Peak is very different than expected	1.Trigger a change in the location of unstable samples; 2. Poor amplitude consistency between pulses; Input level too high or too low	1. Change to external/medium frequency triggering; 2.Adjust the input attenuation so that the signal falls within a reasonable range; 3.Observe multiple pulses to determine whether the instrument or the piece under test fluctuates

6.7 PRI / PRF measurement instability or result jumps

May behave	Possible causes	Troubleshooting suggestions
1. Adjacent Refresh PRI changes significantly; 2. PRF is not securely locked; 3. Sometimes can detect and sometimes cannot	1.Time window too short does not show multiple pulses; 2. Trigger changes in unstable reference points; 3. Repeated cycle jitter of the measured piece; The automatic algorithm does not recognize the starting point steadily	1.Increase the measurement time; 2. Use stable external triggering; 3. Manually measure the time difference between adjacent pulses with markers and compare; Check the automatic threshold setting; 5.If manual fluctuations also suspect that the item under test PRI is jittery

6.8 When multiple pulses are displayed, it is not known which one is currently being measured

May behave	Possible causes	Troubleshooting suggestions
1.Multiple pulses on the screen cannot confirm the measurement object; 2. Parameter values appear to vary with pulses; 3. Suspected anomaly is averaged	Improper use of pulse selection; Integrated treatment of all pulses by the instrument; Inconsistent pulse sequence amplitude or width	Enter the pulse selection to confirm the measurement object; Select the specified pulse instead of all; 3. To compare the first half or specific position pulses separately; Avoid only looking at average results when testing a burst/set

6.9 The instrument is set up correctly, but the results are still quite different from the theoretical values

May behave	Possible causes	Troubleshooting suggestions
1. Optimized frequency/bandwidth/trigger/time window, stable waveform but measurement deviates from specification; 2. Disparities with other instruments are obvious	1. The tested piece itself is abnormal; 2. The theoretical value and the test definition are not consistent; 3. Other machines adopt different thresholds/bandwidth/screening; Approaching instrument bandwidth or time resolution limits	1. Uniform test definition (pulse width threshold, edge definition, power type); 2. Record and compare the settings of each instrument; 3. Use standard signal source to verify the instrument; 4.Suspect item(s) first if consistent deviation at multiple settings

7 Summary

7.1 A summary of the functions of the pulse measurement analysis software

The pulse measurement analysis (PMA) option on the RSA6000 is a radar, pulse transmitter, T/R assembly, Specialized RF pulse analysis tools for pulse amplifiers and burst communication signals. Its core feature highlights include:

- **Combined time-frequency analysis capabilities:** Not only observation of carrier frequency, power, spectrum spread and stray, but also simultaneous analysis of pulse occurrence time. Duration, repetition period, edge, and envelope mass.
- **Complete pulse parameter measurements:** Auto output pulse width, PRI, PRF, duty cycle, Top Power, Average Power, Rise/Fall Time, Overshoot, Key indicators such as ripple, sag.
- **Flexible pulse detection and selection:** Supports detection thresholds, hysteresis levels, minimum/maximum pulse width, trigger linkage, Specified pulse selection and observation of additional data before and after for stable identification of target pulses.
- **Multidimensional views and statistical rendering:** Provides raw time domain, spectrum, amplitude, phase, Views such as FM graphs, pulse tables, current/cumulative statistics tables, scatter charts, Multi-window composite analysis is supported.
- **Deep Intra-Pulse Characterization:** Supports phase/frequency analysis, ripple/sag analysis, and CW, LFM, Modulated model analysis such as BPSK, QPSK, etc., used to locate intra-pulse frequency modulation, phase jump, and top stability issues.
- **Engineered testing and tracing:** Supports cursor measurement, peak search, trace comparison, SCPI remote control, and save raw data, pulse tables, and statistics tables for automated testing, report output, and off-line re-disk.

7.2 Summary of typical application value of pulse measurement

For radar, pulse transmitter, pulse amplifier, T/R assembly, The core value of pulse measurement software for pulse modulation sources and burst emission frequency system testing is to quantify "conduction moments, repeated beats, envelope mass and intra-pulse changes" that are difficult to observe directly in the common spectrum:

- **Accurate evaluation of pulse emission timing:** Pulse width can be measured directly, PRI, PRF, duty cycle, Turn-off time and other parameters, determine whether the pulse is transmitted according to the design beat, suitable for radar timing, pulse gating, Synchronous control and burst transmission behavior verification.
- **True reflection of power capability during on-**pass**:** Normal spectrum readings are susceptible to off-time averaging, pulse measurements focus on top power, peak power, average power and pulse-to-pulse consistency. Better suited for evaluating actual output capability of transmitters, amplifiers and T/R modules.
- **Quickly identify envelope quality problems:** Rising/falling edges, top flatness, overshoot, Ringing, trailing, sag, ripple, etc. Helps to position switch response, amplifier dynamics, supply stability and bias control issues.
- **Supports internal frequency and phase behavior analysis:** For pulse signals such as LFM, CW, BPSK, QPSK, Observation of frequency drift, FM linearity, phase jumps and edge transients during on-pass, suitable for radar FM pulses, Phase coded pulses and complex internal pulse modulated signal evaluation.
- **Increase reliability** with **low duty cycle and narrow pulse capture:** With external triggering, medium frequency triggering, trigger delay, measurement time and sample rate settings, Statically captures short bursts that are prone to miss or are evenly flooded in normal scans.
- **Enables targeted analysis of specific pulses and pulse groups:** Pulse selection allows only the target object in the N pulse, a set of pulses, or a primary/secondary pulse to be analyzed, avoiding multiple pulse average cloaking anomalies. Suitable for complex pulse string, group pulse and non-uniform pulse sequence testing.
- **Assisted system level fault location:** Constellation of time domain, spectrum, amplitude, phase, Combined observations of frequency modulation, pulse meter and statistics distinguish problems from trigger synchronization, input links, Instrument setup, amplifier power, modulated control, or the DUT itself, shortening the troubleshooting path.

7.3 Links to related products and resources

To get the latest firmware updates, complete user manuals or for professional technical support, please visit the official RIGOL channel:

- Official website: www.rigol.com
- RSA6000 Product Page: Search the "RSA6000" product flyer, data sheet, and list of the latest options.
- Technical Support & Service: If you have any questions regarding instrument usage or the automated test code (SCPI)

writing process, please contact your local RIGOL sales engineer or call the official technical support line.