

S3603D Vector Network Analyzer

Frequency range: 300kHz - 20GHz

CONTENTS

1. Reducing Accessory Influence
2. Increasing Reflection Measure Precision of the Low Loss Two-port Device
3. Increasing Dynamic Range
4. Increasing Measure Precision of the Long Electrical Delay Devices
5. Increasing Phase Measure Precision
6. Reducing Trace Noise
7. Reducing Receiver Crosstalk
8. Increasing Sweep Points
9. Increasing Measure Stability
10. Increasing Sweep Speed
11. Increasing Multistate Measure Efficiency
12. Transmitting Data Quickly
13. Using Macro

S3603D Vector Network Analyzer

Frequency range: 300kHz - 20GHz

1. Reducing Accessory Influence

The accessories used during the test such as cables may affect the Measure precision of the tested device. Proper methods can be selected according to actual situation during the test.

Removal of unnecessary response by time domain gate

The time domain gate is an important function of time domain transformation, which makes the analyzer be able to remove some responses through mathematical operation. The time domain gate function can be used to remove unnecessary responses in both reflection and transmission measures.

a) Time domain gate function in reflection measure

Utilization of time domain gate function in reflection measure can be used to separate required response (like return loss of filter) and useless response (like adaptor reflection or connector mismatch).

b) Time domain gate function in transmission measure

Utilization of time domain gate function in transmission measure can separate the responses of designated route in the multiple-pass unit. If the gate function is used in the time domain transformation, the time domain gate can be closed and the gate function can be kept effective to research the frequency response of measured piece. The time domain gate filter has the following two types:

- **Band-pass**: to filter the response outside the pass band
- **Band-stop**: to filter the response inside the stop band

2. Increasing Reflection Measure Precision of Low Loss Two-port Device

The tow-port calibration modifies all system errors of the analyzer, while the one-port calibration only modifies the direction, source match and response error but not the positive load match error. Therefore, under the condition of one-port calibration, in order to increase the reflection measure precision of the two-port device, the non-measure port of the measured piece shall be connected with high quality load to reduce the load match error, and this method is particularly applicable to reflection measure of the low loss two-way device, such

S3603D Vector Network Analyzer

Frequency range: 300kHz - 20GHz

as the filter pass band and cable. When measure is carried out on the device with high reverse isolation, it is unnecessary to consider the problem of load match, and the following method can be taken to terminate the non-Measure port of the two-port device during the one-port calibration.

- Connect a match load (like load in calibration parts) with high performance to the non-Measure port of the measured piece, and the Measure precision of this method is close to that of the absolute two-port calibration.
- Connect a precision attenuator of 10dB to the non-Measure port of the measured piece and connect the attenuator output to the non-activation port of the Analyzer, this can nearly double the attenuation value of the attenuator by matching with effective loads of the analyzer, namely 20dB. When the return loss of the low loss two-port device such as filter is measured, the direction and load match of the Analyzer will greatly affect measure precision, and the following calculation indicates that: during the one-port calibration, for example, adding a high quality attenuator between the non-measure port of the measured piece and the non-activation port of the Analyzer can improve the load match of the Analyzer, so that the Measure precision of one-port calibration is increased. Set the analyzer, filter and attenuator's specifications as follows (corresponding linear values given in the bracket);

Analyzer: Original load match (NALM)=18dB(0.126)

Direction (NAD)=40dB(0.01)

Filter: Insertion loss (FIL)=1dB(0.891)

Return loss (FRL)=16dB(0.158)

Attenuator: Insertion loss(FIL)=1dB(0.316)

Return loss (ARL)=32.26dB(0.024)

a) Measure result without attenuator:

At this moment, the output port of the filter is directly connected with the non-activation port of the analyzer, and the measure error caused by load match is:

S3603D Vector Network Analyzer

Frequency range: 300kHz - 20GHz

$$LME1 = FIL \times NALM \times FIL = 0.891 \times 0.126 \times 0.891 = 0.1$$

The directional error is:

$$NAD = 0.01$$

If the error signal and return signal of the filter are absolutely in the same direction, the measure result of return loss is

$$FIL_{+} = -20 \log(| FRL + LME1 + NAD |) = 11.4 \text{dB}$$

If the error signal and return signal of the filter are absolutely in opposite directions, the measure result of return loss is

$$FIL_{-} = -20 \log(| FRL - LME1 - NAD |) = 26.4 \text{dB}$$

Namely, if the actual return loss of the filter is 16dB, the measure result may be any value from 11.4dB to 26.4dB.

b) Measure result with attenuator:

After the attenuator is added, the direction of the Analyzer, load match and reflection of the attenuator may cause the Measure error, and the Measure error caused by the load is:

$$LME2 = FIL \times AIL \times NALM \times AIL \times FIL = 0.01$$

The Measure error caused by the attenuator reflection is:

$$RLE = FIL \times ARL \times FIL = 0.019$$

The directional error is:

$$NAD = 0.01$$

If the error signal and return signal of the filter are absolutely in the same direction, the measure result of return loss is:

$$FIL_{+} = -20 \lg(| FRL + LME2 + RLE + NAD |) = 14.1 \text{dB}$$

If the error signal and return signal of the filter are absolutely in opposite directions, the measure result of return loss is:

$$FIL_{-} = -20 \lg(| FRL - LME2 - RLE - NAD |) = 18.5 \text{dB}$$

Namely, if the return loss of the filter is 16dB, the Measure result may be any value from 14.1dB to 18.5dB. Thus, adding the attenuator can reduce uncertainty of measure and increase measure precision.

When the reflection measure is carried out on the low loss two-port device, taking any one of the following measures can get the precise measure result:

S3603D Vector Network Analyzer

Frequency range: 300kHz - 20GHz

- Carry out the one-port calibration, and connect a high quality load to the output port of the measured piece during the measure.
- Carry out the one-port calibration, and insert a 10dB attenuator with high quality between the output port of the measured piece and the non-activation port of the Analyzer during the measure.
- Carry out the complete two-port calibration, and directly connect the output port of the measured piece to the receiving port of the analyzer.

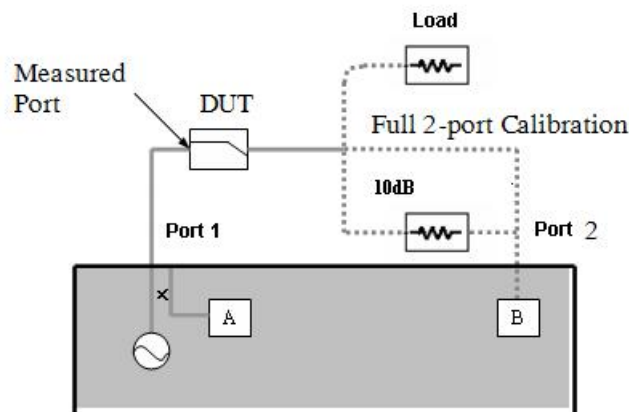


Fig.1 Precise reflection measure of two-port device

3. Increasing Dynamic Range

The dynamic range refers to the difference between the maximum power that analyzer allows to input and the minimum measurable power (noise background). In order to make the Measure correct and effective, the input signal must in this range. If the amplitude of the measured signal varies greatly, for example, the measure of out-of-band suppression of the filter, it is quite necessary to increase the dynamic range of measure. The following Fig.2 is a typical dynamic range during the measure.

S3603D Vector Network Analyzer

Frequency range: 300kHz - 20GHz

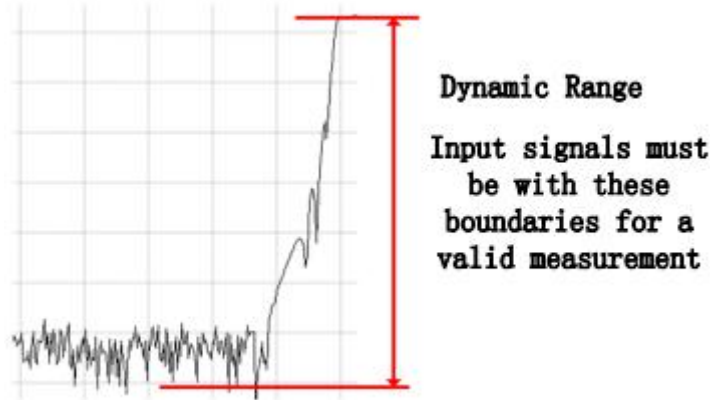


Fig.2 Dynamic range

In order to reduce the uncertainty of measure, the dynamic range of the analyzer shall be larger than the response range of the measured piece. When the tested signal is at least 10dB higher than the noise background, the precision can be increased effectively. The following methods are helpful for increasing the dynamic range.

3.1 Increasing input power of the measured piece

Increasing input power of the measured piece can make the analyzer much more precisely measure the input power of the measured piece, however, attention shall be paid to that it may cause compression distortion if the input of analyzer's receiver is too high and the receiver may break down if the input is high to a certain extent.

3.2 Reducing noise background of the receiver

The following methods can be used to reduce the noise background and to increase the dynamic range of the analyzer:

- Reduce the crosstalk of analyzer's receiver.
- Reduce the intermediate-frequency bandwidth.
- Set the sweep average.

S3603D Vector Network Analyzer

Frequency range: 300kHz - 20GHz

4. Increasing Measure Precision of Long Electrical Delay Device

In the given instant, the frequency of signal output by the measured piece may strictly equal to the frequency of the signal entering into the measured piece. For instance, when the analyzer measures a long cable by swift Sweep, frequency of the cable terminal signal will fall behind the source frequency of the analyzer. If the frequency deviation is quite obviously when compared with the intermediate-frequency detector bandwidth, the measure result will have errors due to filtering of the intermediate-frequency filter. During the measure, it is feasible to remove this kind of measure error by reducing the sweep frequency speed, and there are three methods to reduce the sweep frequency speed of the analyzer.

4.1 Increasing sweep time

Increasing sweep time reduces the speed of frequency change and increases dwell time at every spot of data measure, it can effectively reduce the frequency difference input and output by the measured piece.

4.2 Increasing sweep points

Increasing sweep spot number can reduce the speed of frequency changes.

4.3 Setting dwell time by averages of step-sweep

In the way of step-sweep (default mode of the analyzer), do not take samples of measure until the phase lock of a frequency spot is finished. Measure sampling time can be controlled by setting dwell time. Make sure that the input and output frequencies of the measured piece are the same during the measure.

5. Increasing Phase Measure Precision

The following functions of the analyzer can be used to increase the phase measure precision.

5.1 Electric time delay

Electrical delay simulates the length change of the nondestructive transmission line by averages of mathematical operation, it can remove linear phase shift component of the measured piece so as to measure the linear phase offset of the measured piece better, and the

S3603D Vector Network Analyzer

Frequency range: 300kHz - 20GHz

analyzer supports setting electrical delays respectively for each Measure Trace.

1.1 Setting of Electrical delay

1.1.1 By mouse or touch screen

- Click [**Response**] to display the sub-menu, and click [**Electrical delay...**] on [**Scale**] submenu to display Electrical delay dialog box.
- Set the delay value in the [**Electrical delay**] box.
- Set the speed factor in the [**Velocity Factor**] box.
- In the Medium area, click the option button to select the medium type of [**Coaxial**] or [**Waveguide**].
- If Waveguide medium type is selected, input low-frequency cut-off frequency in [**Cutoff Freq**].
- After the setting is finished, click [**OK**] button to close the dialog box.

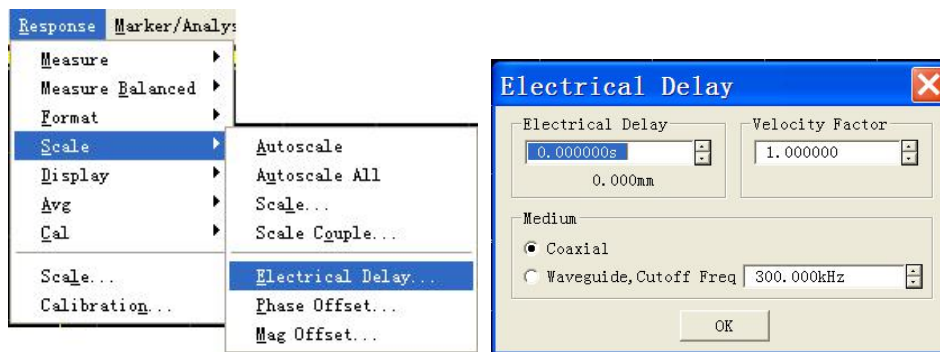


Fig.3 Setting of electrical delay

1.1.2 By front panel keys

- Press [**Scale**] key in RESPONSE area, and press the soft-key corresponding to [**Electrical delay**] on the emergent soft-key menu.
- Set the value of Electrical delay in the displayed Electrical delay dialog box.
- Press the soft-key corresponding to [**More**] to display the subordinate soft-key menu, and press the soft-key corresponding to [**Velocity Factor**] to set the speed factor.
- Press the soft-key corresponding to [**Media COAX |Wave**] to select the medium type.
- If Waveguide medium type is selected, press the soft-key corresponding to [**Waveguide Cutoff Freq**] to set up the low frequency cut-off frequency of waveguide.

S3603D Vector Network Analyzer

Frequency range: 300kHz - 20GHz

1.1.3 Electrical delay dialog box

[Electrical delay]

Set the delay value of increase or removal, the delay unit is time, and it is used to compensate for the linear phase shift of the measured piece.

[Velocity Factor]

Set the relative speed of the measured piece medium, the vacuum speed factor is 1, the speed factor of PVC cable medium is 0.66, and the speed factor of PTEF medium is 0.7.

Medium area

a) [Coaxial]

During the selection, the remission line which indicates increase is a coaxial line, and the speed factor must be set up at the same time.

b) [Waveguide]

During the selection, the transmission line which indicates increase is the waveguide, and the low frequency cut-off frequency of waveguide must be set up.

c) [Cutoff Freq]

Set the low frequency cut-off frequency of waveguide.

5.2 Port extensions and loss

After the calibration, it is feasible to move measure reference plane by port extension, and that can avoid carrying out calibration once more. For example, the following two conditions need to use port extension function.

- After the calibration, it is found that a piece of cable needs to be added into the measure configuration, and the port extension function is used to define the cable length added to the specific port of the analyzer.
- The DUT need to be tested on the clamp, so calibration can not be carried out directly. Utilizing port extension can compensate for the delay (phase shift) caused by the clamp, and the port extension can automatically apply the Electrical delay to all Measures relevant to a specific port. In addition to port extension, you can also set the loss value, and you can get more accurate results by correcting the loss caused by port extension. Loss value can be set in two ways: directly set a DC loss value, or specify the loss value at two frequency points. It can be set for each port at the same time.

S3603D Vector Network Analyzer

Frequency range: 300kHz - 20GHz

2.1 Setting of port extensions and loss

The Analyzer is set with two ways to set up port extension and loss values:

- When the extended electrical length and phase length of cable or clamp are already known, delay parameter and loss parameters such as time and distance, etc. can be manually set.
- Measure through the Short or Open standards connected to the port by automatic port extension function, and automatically calculate the port extension and loss value for each port.

2.1.1 Setting manually

2.1.1.1 By mouse touch screen

- a) Click [**Response**], and point at [**Cal**] in the **Response** menu to display **Calibration** submenu.
- b) Click [**Port Extensions...**] to display **Port Extensions** dialog box, select **Port 1** or **Port 2** from the drop-down box of port selection; and click [**Port Extension ON**] to tick the check box.
- c) Set the value of [**Dist.**] and [**Time**] in the **Delay** zone, select the distance unit from the drop-down box of [**Meters**]; set the speed factor in the [**Velocity Factor**] box
- d) Tick [**Loss 1**] and [**Loss 2**] in the **Loss** zone, input the loss value in the loss input box; set the frequency value in [**@Freq 1**] and [**@Freq 2**].

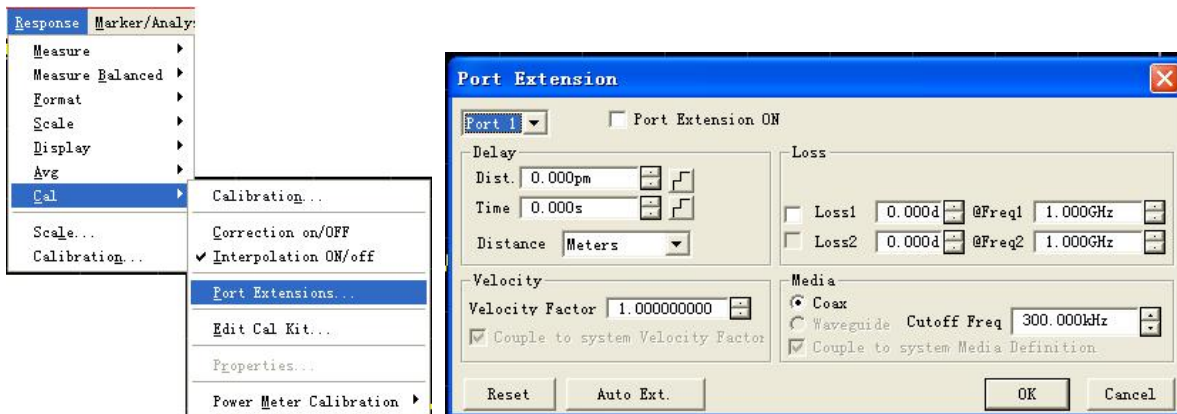


Fig.4 Setting of port extensions

2.1.2 By front panel keys

- a) Press [**Cal**] key in RESPONSE zone, and press the soft-key corresponding to [**More**] in the emergent soft-key menu.

S3603D Vector Network Analyzer

Frequency range: 300kHz - 20GHz

- b) Press the soft-key corresponding to **[Velocity Factor]** to set the speed factor.
- c) Press the soft-key corresponding to **[Port Extensions]** to display the submenu, and press the soft-key corresponding to **[Extensions on|OFF]** to enable the port extension function.
- d) Press the soft-key corresponding to **[Manual Extensions Port1]** to display the submenu, and press the soft-key corresponding to **[Port1 Loss]** to enable the loss setting function of port 1.
- e) Press the soft-key corresponding to **[Loss1 Swich on | OFF]** to enable the function of loss 1, and press the soft-key o **[Loss1]** to input the loss value in the input box, then press the soft-key of **[Freq1]** to input the frequency value in theinput box; press the soft-key corresponding to **[Loss2 Swich on | OFF]** to enable the function of loss 2, and press the soft-key o **[Loss2]** to input the loss value in the input box, then press the soft-key of **[Freq2]** to input the frequency value in theinput box.
- f) Press the soft-key corresponding to **[Manual Extentions Port2]** to display the submenu, and press the soft-key corresponding to **[Port2 Loss]** to enable the loss setting function of port 2.
- g) Press the soft-key corresponding to **[Loss1 Swich on | OFF]** to enable the function of loss1, and press the soft-key o **[Loss1]** to input the loss value in the input box, then press the soft-key of **[Freq1]** to input the frequency value in theinput box; press the soft-key corresponding to **[Loss2 Swich on | OFF]** to enable the function of loss 2, and press the soft-key o **[Loss2]** to input the loss value in the input box, then press the soft-key of **[Freq2]** to input the frequency value in the input box.

2.1.2 Setting automatically

2.1.2.1 By mouse or touch screen

- a) Single click **[Response]** and point to**[Cal]** to display the calibration submenu.
- b) Click **[Port Extensions...]** to display the **Port Extensions** dialog box, and select the operating port from the drop-down box of port selection; click **[Port Extensions]** and tick the check box.
- c) Click the **[Auto Ext.]** button to display the **Automatic PortExtension** dialog box.

S3603D Vector Network Analyzer

Frequency range: 300kHz - 20GHz

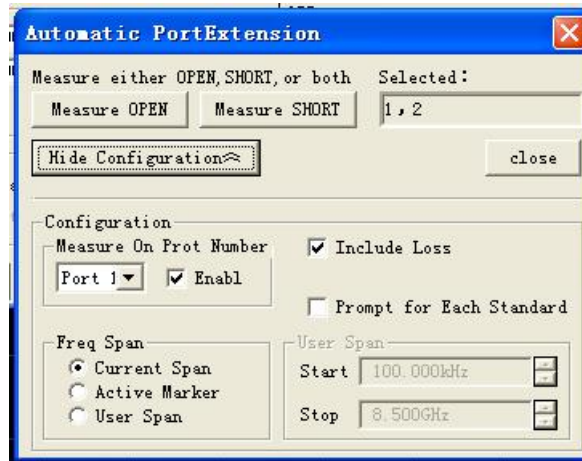


Fig.5 Automaticport extensions & losses

- d) Tick [**Include Loss**] in the **Configuration** area, select the port to be operated from the drop-down box and tick [**Enable**].
- e) If prompts are needed in connecting calibration criterion, it may tick [**Prompt for Each Standard**].
- f) It may select the [**Current Span**], [**Active Marker**] or [**User Span**] in the **Preq Span** area as required.
- g) Click [**close**] to complete the automatic port extension function, and the analyzer will automatically calculate the port extension and loss values and update data.

2.1.2.2 By front panel keys

- a) Press the key[**CAL**]in RESPONSE zone, and press the soft-key corresponding to [**More**] on the soft-key menu appeared.
- b) Press the soft-key corresponding to [**Port Extensions**] to display the submenu, press the soft-key corresponding to [**Extensions on | OFF**] to enable port extension function.
- c) Press the [**Auto Port Extension**] to display the submenu, and press the soft-key corresponding to [**Select Port Port 1, 2**] to select a port.
- d) Press the soft-key corresponding to [**Select Port Measure Open**] to display the submenu, and it may select [**ALL**] ports or a specific port for measurement as required.
- e) Press the soft-key corresponding to [**Select Port Measure Short**] to display the

S3603D Vector Network Analyzer

Frequency range: 300kHz - 20GHz

submenu, and it may select **[ALL]** ports or a specific port for measurement as required.

f) Press the soft-key corresponding to **[Method]** to display the submenu, and it may select the **[Current Span]**, **[Active marker]** or **[User Span]** as required.

g) Press the soft-key corresponding to **[Include Loss on | OFF]** to enable the function of automatic calculation of losses.

2.1.2.3 Auto port extensions dialog box

Configuration zone

a) Drop-down box of measurement port

Select port 1 or port 2.

b) [Enable] check box

Display the Enable state of currently selected port, and both ports of the analyzer are ON by default.

c) [Include Loss]check box

Automatically calculate losses if it is ticked.

d) [Prompt for each Standard] check box

Prompt is available when connecting calibration kit.

Freq Span zone

a) [Current Span] radio

Set the frequency range to full band.

b) [Active marker] radio

Set the frequency range to that between start frequency and stimulus marker frequency.

c) [User Span] radio

It is possible to set the start and stop frequency in the **User Define** zone if this box is checked.

[Open]

Port is connected with Open for Open measure.

[Short]

Port is connected with Short for Short measure.

[Hide Configuration]

Hide the dialog box display of the whole **ConFig. Zone**.

S3603D Vector Network Analyzer

Frequency range: 300kHz - 20GHz

[close]

Turn off the automatic port extension dialog box.

5.3 Phase offset

The phase offset adjusts the phase Measure result by averages of mathematical operation, and the modification range is $0^\circ - 360^\circ$. For example, there are two conditions as follows where phase offset function is used:

- Improve the display of the phase Measure result to locate the display value in the screen center or the designated position. It is similar with changing reference electrical level in the amplitude measure.
- Simulate the preconceived phase shift in the Measure. For example, a piece of cable need to be added in the measure, and the phase shift due to it is known. At this moment, the phase offset function can be used to add that phase shift value and to simulate the whole Measure composition.

3.1 Setting of phase offset

3.1.1 By mouse or touch screen

- a) Click [**Response**], click [**Scale**] on the submenu, and Click [**Phase offset ...**] on the **Scale** menu to display **Phase offset** dialog box.
- b) Set the corresponding phase offset value in the [**Phase offset**] box.
- c) Click [**OK**] button to close the dialog box.

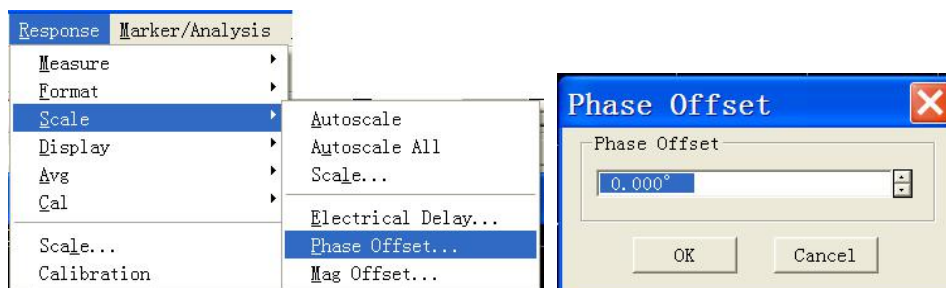


Fig.6 Setting of phase offset

3.1.2 By front panel keys

- a) Press [**Scale**] key in RESPONSE area, and corresponding soft-key menu turns up.
- b) Press the soft-key corresponding to [**Phase Offset**], and set the phase offset value in the emergent **Phase Offset** box.

S3603D Vector Network Analyzer

Frequency range: 300kHz - 20GHz

5.4 Interval between frequency spots

When the analyzer measures, it takes sample data on discrete frequency spots, and then it links all measure spots and forms a Trace on the screen. If the phase shift of the two contiguous frequency spots of the measured piece is more than 180° , the lack of data sampling will result in aliasing so that the phase gradient displayed at this moment is wrong. If such a condition takes place during the group delay measure, the measure result of group delay may be a negative value which is apparently wrong, as the measure result of the surface acoustic wave filter shown below:

- The 1st Fig. shows the measure results of 51 spots and the group delay is a negative value. Actually, it is impossible that the group delay of the measured piece is a negative value, which means that the Measure values of group delay cannot be below the 0 second reference line.
- The 2nd Fig. shows the measure results of 201 spots, and the group delay is a positive value, namely the Measure values are above the 0 second reference line.

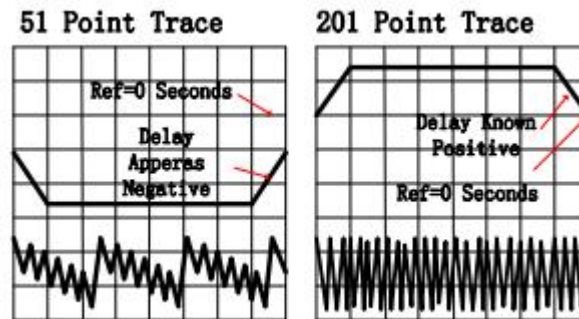


Fig.7 Influence of frequency interval on phase measure

The following two methods can be taken to set the change of the front and rear phase Traces and to check whether there is aliasing during the Measure.

- Add Measure spots.
- Reduce the frequency span.

S3603D Vector Network Analyzer

Frequency range: 300kHz - 20GHz

6. Noise Reduction Techniques

The analyzer receives the random noise from the channel, which would reduce the Measure precision. Several functions of the Analyzer introduced below can be used to reduce trace noise, decrease noise background, and get more precise Measure result and larger dynamic range.

6.1 Sweep average

The Sweep average can reduce the influence on Measure from random noise, and the Analyzer takes average at a point via constant Sweep to calculate each Measure value. Setting of the average factor determines times of constant Sweep. The bigger the speed factor is, the more possible it is to reduce the influence on Measure from noise.

- The Trace average is applied to all Measure Traces in the channel, and all channels whose average functions are enabled will display an average counter.
- When the Sweep average is enabled, the average counter displays times of Sweep average carried out, and observing Trace changes and times of average carried out is good for selecting the best average factor.
- Although Sweep average can be carried out during non-ratio Measure, the desired result can not be got.
 - * When the phase Measure for non-ratio Measure is averaged, the Measure result is still random, because the phase Measure is realized by averages of relative Measure and result of absolute phase Measure for a single receiver is random. Therefore, the certain result can not be got by averaging.
 - * When the amplitude Measure for non-ratio Measure is averaged, the noise background would not fall down.
- Both the Sweep average and reduction of intermediate-frequency bandwidth can be carried out to reduce noise. If the quite low noise is required, it will be better to take Sweep average. Usually, the Sweep average takes longer time to reduce noise than reduction of intermediate-frequency bandwidth, because the required averaging times are much more. The influence on noise of Sweep average is shown in the following Figure.:

S3603D Vector Network Analyzer

Frequency range: 300kHz - 20GHz

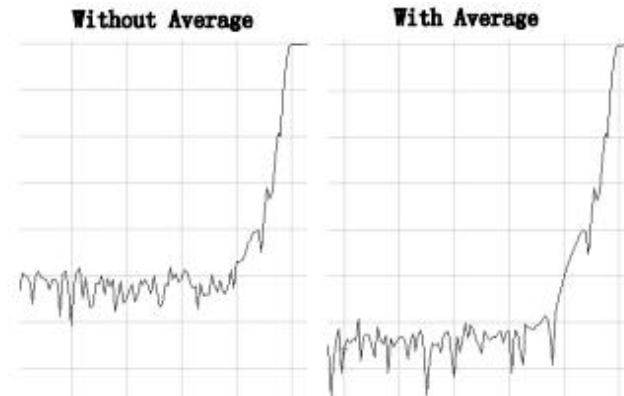


Fig.8 Influence on measure result from sweep average

1.1 Setting of Sweep Average

1.1.1 By mouse or touch screen

- Click [**Response**], point at [**Avg**] on the submenu, and click [**Average...**] on **Avg** submenu to display [**Average**] dialog box.
- Click [**Average on/OFF**] to tick the check box.
- Click [**Average Factor**] box to set the average factor.
- If the Sweep average needs to start again, click [**Restart**] button.
- Click [**OK**] button to close the dialog box.

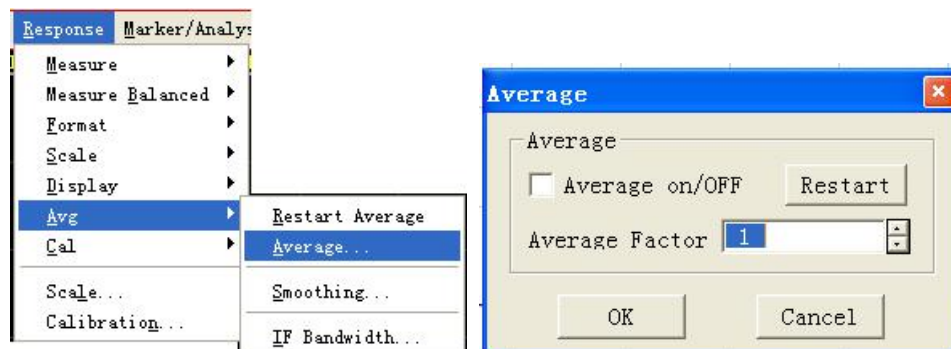


Fig. 9 Setting of Sweep Average

1.1.2 By front panel keys

- Press [**Avg**] key in RESPONSE area.
- Press the soft-key corresponding to [**Averaging Factor**], and input the average factor in **Average Factor** box.

S3603D Vector Network Analyzer

Frequency range: 300kHz - 20GHz

- c) Press the soft-key corresponding to [**Averaging on|OFF**] to enable average function.
- d) If the Sweep average needs to start again, press the soft-key corresponding to [**Averaging Restart**].

6.2 Trace smoothing

The trace smoothing smooths the Trace display by taking the average of contiguous data spots. Contiguous data spots averaged are called the smoothing aperture, and the analyzer defines the aperture size by two methods: designating the spots to take the average and designating the percentage of value range. The smoothing function may reduce the peak value of noise on the measure data Trace, but it would not increase the sweep time.

The influence of the trace smoothing is shown in the following Figure:

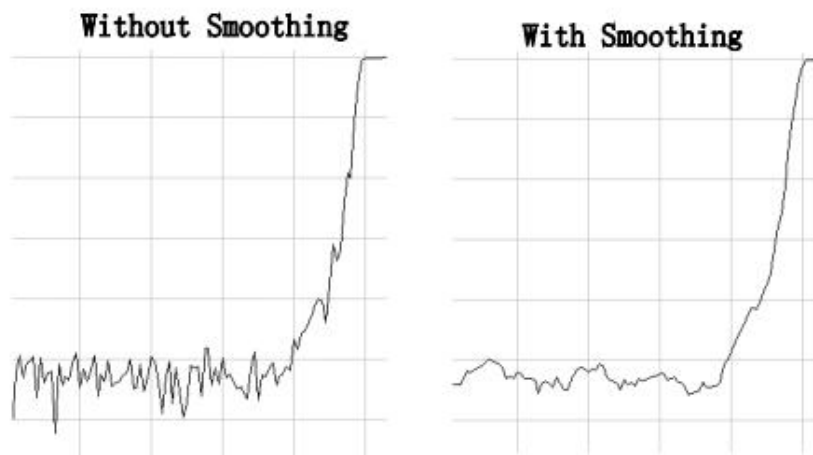


Fig.10 Influence on measure result of smoothing

2.1 Setting Smoothing

2.1.1 By mouse or touch screen

- a) Click [**Response**], point at [**Avg**] on the submenu, and click [**Smoothing...**] on **Average** submenu to display **Smoothing** dialog box.
- b) Click [**Smoothing on/OFF**] to tick the check box and Stimulus the smoothing function.
- c) Take one of the following methods to set smoothing aperture.
 - Set smoothing percent (the maximum value is 25%) in [**Percent**] box
 - Input the Points of smoothing aperture (the maximum value is 25% of total Sweep

S3603D Vector Network Analyzer

Frequency range: 300kHz - 20GHz

spot number) in the **[Points]** box.

d) Click **[OK]** button to close the dialog box.

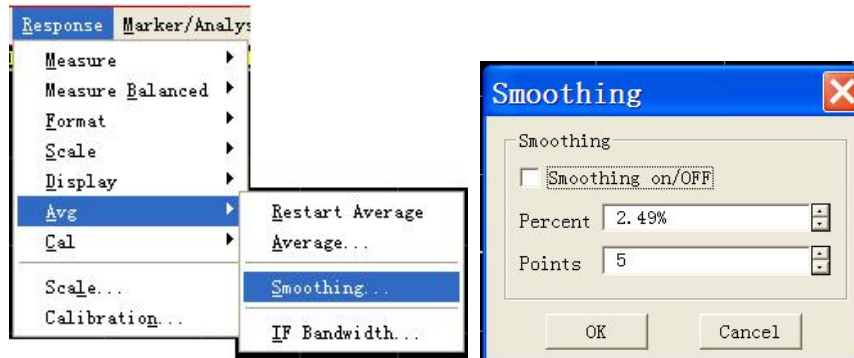


Fig.11 Setting smoothing

2.1.2 By front panel keys

a) Press **[Avg]** key in **Response** keys area.

b) Press the soft-key corresponding to **[Smoothing]** to display the corresponding soft-key menu.

c) Press the soft-key corresponding to **[Smoothing on|OFF]** to enable smoothing function.

d) Take one of the following methods to set smoothing aperture.

- Press the soft-key corresponding to **[Smoothing Percent]** to set smoothing percentage (maximum value is 25%).
- Press the soft-key corresponding to **[Smoothing Points]**, and input the spots of smoothing (the maximum spot number is 25% of Sweep spot number).

6.3 Reducing IF bandwidth

S3603D vector network analyzer convert the frequency of the received response signal to intermediate-frequency signal whose frequency is relatively lower. Bandwidth of the intermediate-frequency filter (IF bandwidth) can set downwards from 30kHz to the minimum 1Hz. Reducing the IF bandwidth can decrease the influence on the Measure result of random noise. Every 10 times the IF bandwidth is reduced, the noise background decreases 10dB, however, setting the intermediate-frequency bandwidth would make the Sweep time longer. The analyzer supports setting the intermediate-frequency bandwidth for each channel and

S3603D Vector Network Analyzer

Frequency range: 300kHz - 20GHz

segment sweep, and the influence on measure from the intermediate-frequency bandwidth is as shown in the following Figure.:



Fig.12 Influence on measure result from intermediate-frequency bandwidth

3.1 Setting of the intermediate-frequency bandwidth

3.1.1 By mouse or touch screen

- Click [**Response**], point at [**Avg**] on the submenu, and click [**IF Bandwidth...**] on **Average** submenu to display **IF Bandwidth** dialog box.
- Click **IF Bandwidth** box, and set the intermediate-frequency bandwidth.
- Click [**OK**] button to close the dialog box.

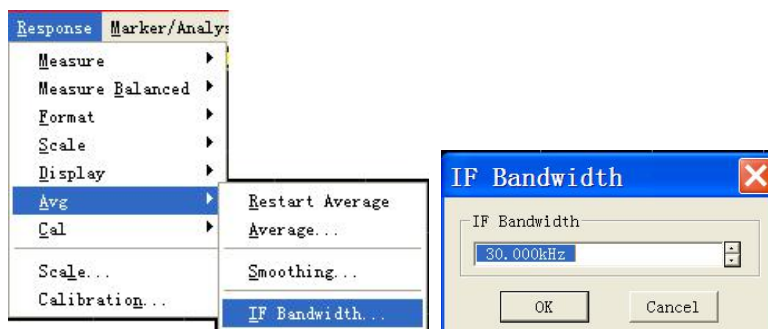


Fig.13 Setting of Intermediate-frequency Bandwidth

3.1.2 By front panel keys

- a) Press [**Avg**] key in **Response** keys area.
- b) Press the soft-key corresponding to [**IF Bandwidth**], and set the intermediate-frequency bandwidth value in **IF Bandwidth** dialog box.

S3603D Vector Network Analyzer

Frequency range: 300kHz - 20GHz

7. Reducing Receiver Crosstalk

Crosstalk refers to the energy leakage between analyzer signal paths, which is a difficult problem high-loss transmission measure is facing. Effects of crosstalk can be reduced through selecting alternate sweep and carrying out isolation calibration.

- Energy leakage between signal paths leads to errors in transmission measure.
- Crosstalk affects the precision of the following measures:
 - * Measures of high-loss devices, such as isolation measure of the switch in cut-off status.
 - * Measures of devices with wide dynamic ranges, such as measure of filter.

7.1 Using alternate sweep mode

Alternate Sweep only measures one receiver in A and B at a time, with the other one turned off, which helps to reduce crosstalk.

1.1 Setting alternate sweep

1.1.1 By mouse or touch screen

- a) Click [**Stimulus**], and click [**Sweep Setup...**] on the **Sweep** submenu, to display the dialog box of **Sweep Setup**.
- b) If multiple channels have been enabled, click the [**Channel**] box to select the channel for which the alternate Sweep Setup is required.
- c) Click [**Alternate Sweeps**] and tick the check box.
- d) Click [**OK**] button to close the dialog box.

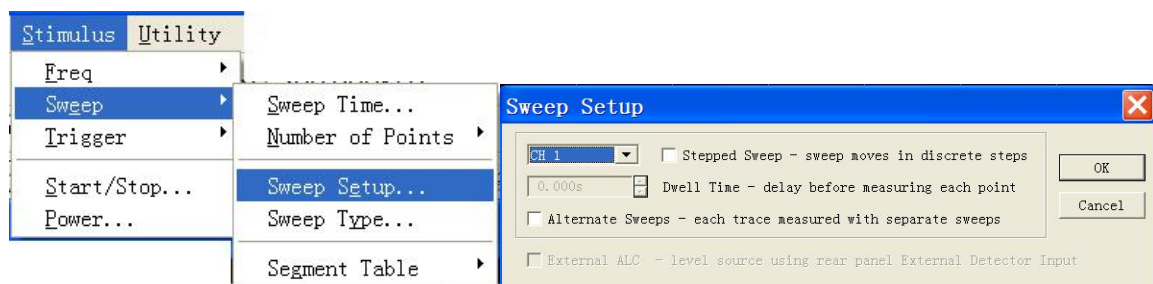


Fig.14 Setting alternate sweep

1.1.2 By front panel keys

- a) Press [**Sweep**] key in the STIMULUS area to display the corresponding software menu.

S3603D Vector Network Analyzer

Frequency range: 300kHz - 20GHz

- b) Press the soft-key corresponding to [**Sweep Setup...**], to display the dialog box of **Sweep Setup**.
- c) If multiple Measure channels are enabled, press [], [] keys in the ADJUST area to switch to the [**Channel**] box, and press [△], [▽]keys or rotate the knob in the ADJUST area to select the channel for which the alternate Sweep Setup is required.
- d) Press [], []keys to switch to the check box of [**Alternate Sweeps**], and press **the knob key** in the ADJUST area to tick the check box.
- e) Press [**OK**] key in the **Entry** keys to close the dialog box.

7.2 Perform an isolation calibration

For transmission measure, a response and isolation calibration helps to reduce crosstalk. This is because the analyzer measures and subtracts the leakage signals during the measurement calibration. The calibration improves isolation so that it is limited only by the noise floor. If a higher measure precision is wanted, full dual-port calibration without ignoring isolation shall be conducted. Crosstalk signal is generally below the noise background, so isolation calibration is necessary only when crosstalk signal is visible after the noise background is lowered.

8. Increasing Sweep Points

8.1 Sweep points

One data point represents the measure result under one activation. Sweep points number of the analyzer's single sweep can be defined, and the sweep time varies with sweep points number. Sweep points number in default settings is 201, and the maximum configurable points is 16001.

1.1 Setting sweep points

1.1.1 By mouse or touch screen

- a) Click [**Stimulus**], and click [**Number of Points**] in the [**Sweep**] menu, to display the dialog box of Number of Points.
- b) Click to select sweep point number on submenu.
- c) If custom point number is required, click [**Custom...**] on submenu to display the

S3603D Vector Network Analyzer

Frequency range: 300kHz - 20GHz

dialog box of **Sweep Points**, and set sweep point number in Number of Points box.

d) Click **[OK]** button to close the dialog box after setting is completed.

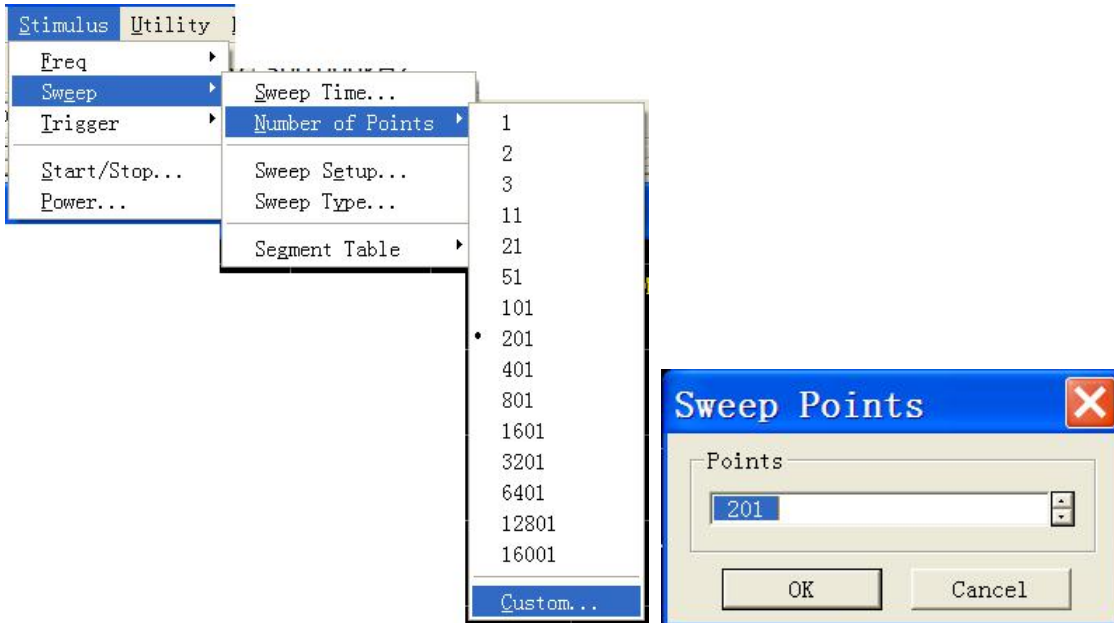


Fig.15 Setting sweep points

1.1.2 By front panel keys

a) Press **[Sweep]**key in STIMULUS area.

b) Press the soft-key corresponding to **[Number of Points]**, and set the Sweep point in Number of Points box.

9. Measurement Stability

Unstable measure result can be caused by several situations. In order to carry out repeatable measures, a stable measure environment is required. Factors affecting measure stability mainly include:

9.1 Frequency drift

Frequency precision of the Analyzer depends on its internal constant-temperature crystal oscillator of 10MHz. If the Measure application requires higher frequency precision and stability, we can drop the internal frequency standard, but provide a high-stable external

S3603D Vector Network Analyzer

Frequency range: 300kHz - 20GHz

frequency standard instead through a connector of **10MHz reference input** on the rear panel.

9.2 Temperature drift

Temperature change and its consequent expansion or contraction can change properties of the following elements:

- Internal devices of Analyzer
- Calibration standards in calibration kit
- Measured piece
- Test cable
- Adapter

In order to reduce the effects of temperature drift in Measure, the following measures can be taken:

- Warming up the Analyzer for 30min before calibration and measurement.
- Open the calibration kit box 1 hour before calibration, and take calibration kit out of the protection foam.
- Measure in an environment with controllable temperature. In the temperature environment of $23^{\circ}\text{C}\pm 3^{\circ}\text{C}$, it can be ensured that all the technical Specifications of the Analyzer meet the requirements.
- Ensure the temperature stability of calibration kit, and avoid unnecessary touch of calibration kit during calibration process.
- Ensure that the difference between ambient temperature and temperature during calibration is within $\pm 1^{\circ}\text{C}$.

9.3 Imprecise calibration

If calibration is imprecise and correct response of the measured piece can not be obtained during measure, in order to guarantee calibration precision, the following shall be taken into consideration:

- Calibration shall be conducted at the point connecting the measured piece, namely on the measure plane, to ensure that Measure plane is the same as calibration plane.
- After calibration, in case that any additional accessory (such as cable, adapter or attenuator) is inserted into the Measure assembly, port extension function is used to compensate additional electrical length and delay, and if a higher precision is wanted,

S3603D Vector Network Analyzer

Frequency range: 300kHz - 20GHz

calibration shall be conducted again.

- Use calibration kit in accordance with the definition in calibration process for calibration.

9.4 Measure connection

Correct connection is essential for obtaining repeatable measure results. The following measures shall be taken during measure connection:

- Regularly check and clean connectors for all components in measure assembly.
- Use correct connecting method.
- Avoid moving cable during measure.

10. Increasing Sweep Speed

Adopting maximum Sweep speed can improve Measure efficiency. The following settings shall be optimized during Measure to achieve the maximum sweep speed.

10.1 Sweep setup

The maximum sweep speed is obtained by making the following settings carefully:

- **Frequency span:** only the frequency range concerning the measured piece shall be measured.
- **Segment sweep:** use segment sweep to measure the most concerned frequency band.
- **Turnoff step sweep:** if measure allows, do not use the step sweep mode, so as to achieve the minimum sweep time.
- **Automatic sweep time:** the fastest sweep can be obtained by using the default sweep time for the current settings.
- **Sweep point number:** the minimum sweep points required for measure shall be used.

10.2 Reducing noise settings

Reasonable conduction of the following two settings can reduce Sweep time while acceptable measure results can still be obtained:

- **Intermediate-frequency bandwidth:** use the widest intermediate-frequency bandwidth that can give acceptable tack noise and dynamic range.
- **Average:** Reduce average factors as much as possible or turn off average function.

S3603D Vector Network Analyzer

Frequency range: 300kHz - 20GHz

10.3 Selecting calibration type

Select the fastest calibration measure meeting the measure precision requirement. The time required for sweep measure without error correction is approximately the same as that for response of calibration correction, while forward and reverse sweep measures are required for error correction of full dual-port calibration measure to update measure parameters, even if only one S parameter is displayed, so the required measure time is the longest.

10.4 Closing unnecessary functions

Analyzer must update information on all Stimulus functions. In order to accelerate sweep, turn off all the following analyzer functions not necessary for measure application:

- Undesired Trace
- Unused marker
- Smoothing
- Limit test
- Trace computation
- Display

The Sweep speed of analyzer depends on various measure settings. Try more settings to achieve the maximum Sweep speed and to meet the required measure result.

4.1 Deleting undesired Trace

4.1.1 By mouse or touch screen

- a) Click the right mouse button on Status Bar key of the Trace to be deleted, to display the context menu.
- b) Click [**Delete Trace**] in the context menu.

S3603D Vector Network Analyzer

Frequency range: 300kHz - 20GHz



Fig.16 Delete undesired trace

4.1.2 By front panel keys

- Press [**Trace**] key in TRACE/CHAN area, and press the soft-key corresponding to [**Delete Traces**] on the corresponding soft-key menu.
- Press the soft-key corresponding to the Trace to be deleted, then such Trace can be deleted.

4.2 Closing unused markers

4.2.1 By mouse or touch screen

- Click [**Marker/Analysis**], and click [**Marker...**] on [**Marker**] menu, to display **Marker** dialog box.
- Select the markers to be closed in **Marker** Box.
- Click [**On**] to clear the check box. If all markers are to be closed, click [**Close All**].
- Click [**OK**] button to close the dialog box.

S3603D Vector Network Analyzer

Frequency range: 300kHz - 20GHz

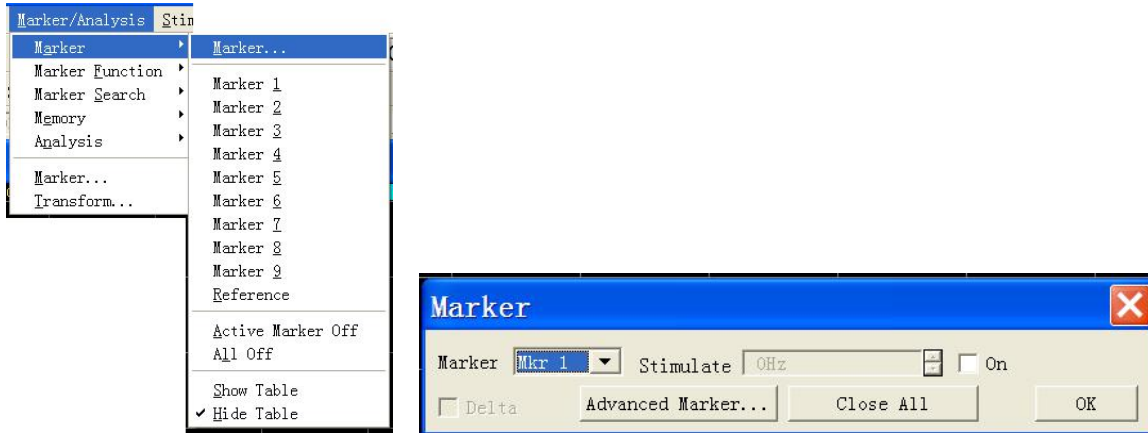


Fig.17 Close of the unused marker

4.2.2 By front panel keys

- Click [**Marker**] in MKR/ANALYSIS area to display the corresponding soft-key menu.
- Click the soft-key corresponding to [**Turn Off Markers**] to display the submenu, and click the soft-keys corresponding to the markers to be closed.
- If all markers are to be closed, click the soft-key corresponding to [**All Off**].

4.3 Closing smoothing function

4.3.1 By mouse or touch screen

- Click [**Response**], and click [**Smoothing...**] on [**Avg**] menu, to display the **Smoothing** dialog box.
- Click [**Smoothing on/OFF**] to clear the check box and turn off smoothing function.
- Click [**OK**] button to close the dialog box.

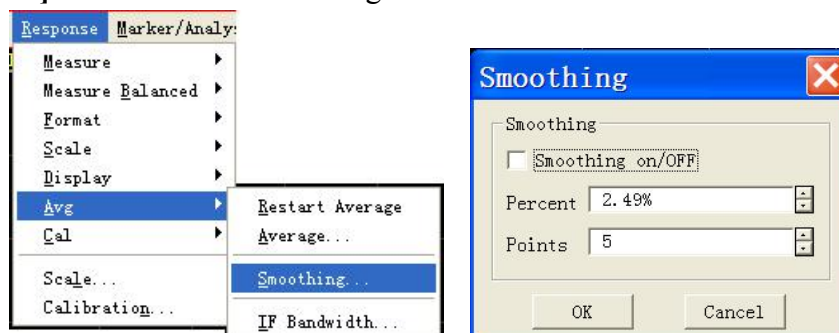


Fig.18 Closing smoothing function

S3603D Vector Network Analyzer

Frequency range: 300kHz - 20GHz

4.3.2 By front panel keys

- Press [**Avg**] key in RESPONSE area to display the corresponding soft-key menu.
- Press the soft-key corresponding to [**Smoothing**] menu item.
- Click the soft-key corresponding to [**Smoothing on/OFF**] menu item to turn off smoothing function.

4.4 Closing limit test

4.4.1 By mouse or touch screen

- Click [**Marker/Analysis**], and click [**Limit Test...**] on [**Analysis**] menu, to display **Limit Test** dialog box.
- Click [**Limit Test on/OFF**] to clear the check box and turn off limit test function.
- Click [**OK**] button to close the dialog box.

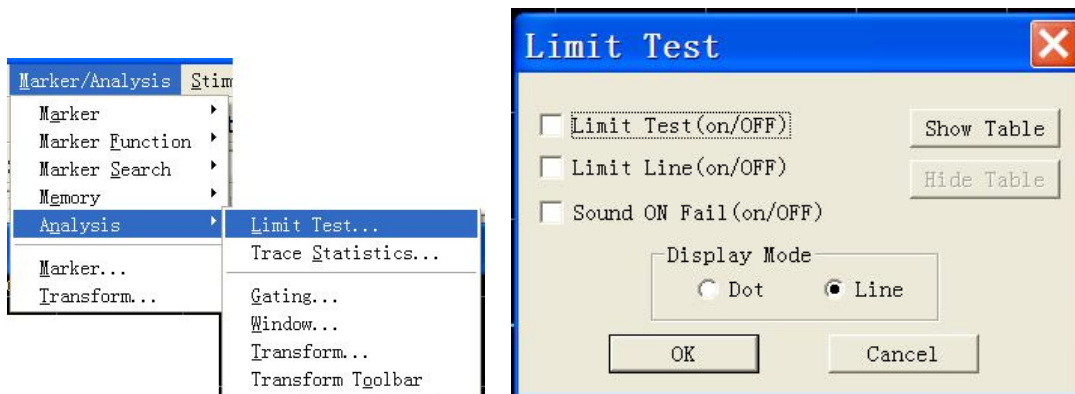


Fig.19 Closing limit test

4.4.2 By front panel keys

- Press [**Analysis**] key in MKR/ANALYSIS area to display the corresponding soft-key menu, and press the soft-key corresponding to [**Limits**] to display the submenu.
- Press the soft-key corresponding to [**Limit Test on/OFF**] menu to turn off limit test function.

4.5 Turning off Trace computation function

4.5.1 By mouse or touch screen

- Click [**Marker/Analysis**], and click [**Math/Memory...**] on [**Memory**] menu, to

S3603D Vector Network Analyzer

Frequency range: 300kHz - 20GHz

- display **Math/Memory** dialog box.
- b) Select Data in [**Data Math**] box.
- c) Click [**OK**] button to close the dialog box

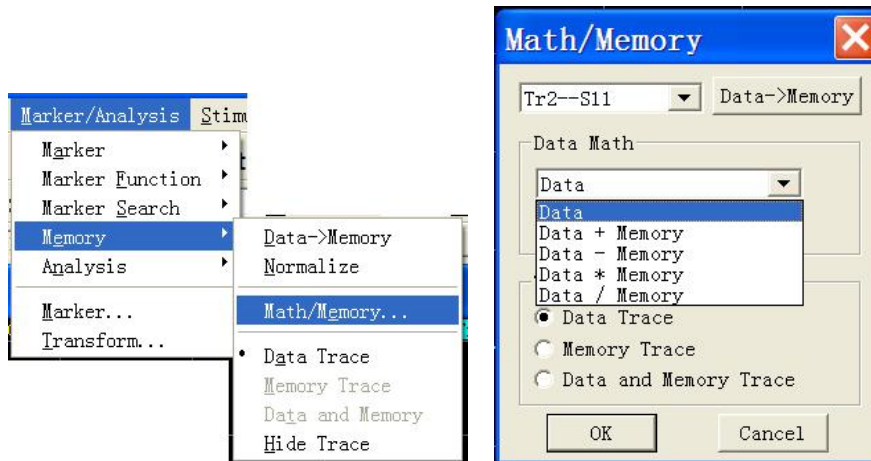


Fig.20 Turning off trace computation function

4.5.2 By front panel keys

- a) Click [**Memory**] in MKR/ANALYSIS area to display the corresponding soft-key menu.
- b) Press the soft-key corresponding to [**Data Math**].
- c) Press the soft-key corresponding to [**Data Math Off**] to turn off Trace computation function.

11. Increasing Multistate Measure Efficiency

If multi-parameter measure is required to characterize the property of a device, various methods can be used to improve the measure efficiency. Try the following methods to find the most suitable measure application scheme for you.

11.1 Increasing measure efficiency through measure settings

In order to improve the measure efficiency of the measured piece for which multiple parameters must be measured, it is very helpful to be familiar with Analyzer operation, which helps to establish the optimum measure application scheme.

S3603D Vector Network Analyzer

Frequency range: 300kHz - 20GHz

1.1 Arranging a set of measures reasonably

Arrange a set of measures of the measured piece under one instrument status, and conduct such measure via call-back function when the status of storage instrument is convenient. The pre-conFig.d measure setting function can also be used to conduct a set of measures.

1.2 Using segment sweep

Segment sweep is very convenient when the following settings need to be changed while characterizing the multi-parameters Measure of a device.

- Frequency range
- Power level
- Intermediate-frequency bandwidth
- Sweep spot number

Segment sweep allows defining a set of frequency ranges with respective attributes, so that measures of the measured piece requiring various Measure settings can be completed through a single sweep.

1.3 Selective trigger measure

Measures shall be set as follows by using trigger function:

- Continuously updating those Measures with data of quick changes
- Occasionally updating those Measures with data of few changes

For example, tuning measure of a filter can be set as:

- Passband response of a channel Measure filter is used for tuning.
- A channel is used for out-of-band response of the Measure filter.

Then tuning Measure of the filter can be observed consecutively. Continuously updating all channels will lead to reduction of response speed of the analyzer, causing that the filter can not be tuned quickly. How to establish the following measure settings is discussed below:

- Measure data in Channel 1 will be updated continuously.
- Measure data in Channel 2 will be updated as needed.

1.3.1 By mouse or touch screen

a) Establish a two-channel Measure.

Click [**Response**], click [**Meas Setups**] on [**Display**] submenu, and click [**Set D**] in the pop-up dialog box.

S3603D Vector Network Analyzer

Frequency range: 300kHz - 20GHz

- b) Set trigger of Channel 1: update Measure data continuously.
 - 1) Click [**Stimulus**], point to [**Trigger**] on **Stimulus** menu, and click [**Trigger...**] on **Trigger** submenu, to display the **Trigger** dialog box.
 - 2) Select [**Internal**] option button in **Trigger Source** zone.
 - 3) Click [**Channel**] box in **Trigger Settings** zone and select **Channel 1**.
 - 4) Click to select [**Continuous**] option button in **Trigger Settings** zone.
- c) Set trigger of Channel 2: update Measure data as needed.
 - 1) Click [**Channel**] box in **Trigger Settings** zone and select **Channel 2**.
 - 2) Click to select [**Single**] or [**Group**] option button in **Trigger Settings** zone. If **group** trigger mode is selected, enter the number of groups in [**Group**] input box.
 - 3) Click [**OK**] button to close the dialog box.
- d) Click [**Utility**], and click [**KEYs**] on [**System**] menu, to display **Soft Keyboard** dialog box. Click [**Trigger**], to display the soft-key toolbar corresponding to **Trigger**.
- e) Click the window below to make Channel 2 the current Stimulus channel.
- f) Update the Measure data in Channel 2. Click [**Single**], [**Group**] or [**Restart**] button on the soft-key toolbar corresponding to **Trigger**, to update the measure data in Channel 2.

1.3.2 By front panel keys

- a) Establish a two-channel Measure.

Press [**Display**] key in RESPONSE area, press the soft-key corresponding to [**Meas Setups**] on the displayed soft-key menu, and press the soft-key corresponding to [**Setup D**] on the submenu.
- b) Set trigger of Channel 1: update Measure data continuously.
 - 1) Press [**Display**] key in RESPONSE area, press the soft-key corresponding to [**Windows**], and press [**Window 1**] on the displayed submenu to make Window 1 the current stimulus window, and Channel 1 the current stimulus channel.
 - 2) Press [**Trigger**] key in STIMULUSE area, and press the soft-key corresponding to [**Continuous**] on the displayed soft-key menu.
- c) Set trigger of Channel 2: update Measure data as needed.

S3603D Vector Network Analyzer

Frequency range: 300kHz - 20GHz

- 1) Press **[Display]** key in RESPONSE area, press the soft-key corresponding to **[Windows]**, and press **[Window 2]** on the displayed submenu to make Window 2 the current Stimulus window, and Channel 2 the current Stimulus channel.
- 2) Press **[Trigger]** key in STIMULUSE area, and press the soft-key corresponding to **[Single]** or **[Group]** on the displayed soft-key menu.
- d) Update the Measure data in Channel 2. Press **[Trigger]** key in STIMULUSE area, and press the soft-key corresponding to **[Single]**, **[Group]** or **[Restart]** on the displayed soft-key menu.

11.2 Automatically changing measure settings

Automatically changing measure settings through programming can improve the efficiency of multistate multi-parameters measure effectively.

11.3 Quick call measure

The most effective method of call measure is to save a set of measures as an instrument status.

- The time difference between calling an instrument status including multiple measures and calling an instrument status with only one measure is very small.
- Each call requires corresponding time, and the calling time can be saved by calling in groups through establishing a set of measures.

12. Transmitting Data Quickly

Use of the fastest data transmission helps to improve measure efficiency, and the following methods can be used to improve data transmission speed.

12.1 Using single trigger mode

Using single trigger mode guarantees that measure has been completed before data transmission.

1.1 Setting single trigger

1.1.1 By mouse or touch screen

- a) Click **[Stimulus]**, point to **[Trigger]** on **Stimulus** menu, and click **[Trigger...]** on

S3603D Vector Network Analyzer

Frequency range: 300kHz - 20GHz

Trigger submenu, to display the **Trigger** dialog box.

- b) Select [**Internal**] option button in **Trigger Source** zone.
- c) Click [**Channel**] in **Trigger Settings** zone to select the Measure channel for data transmission.
- d) Click to select [**Continuous**] option button in **Trigger Settings** zone, and click [**OK**] button to close the dialog box.
- e) Update Measure results:
 - 1) Click the corresponding Trace status button so that the Trace and Channel to be updated will become Stimulus Trace and Channel.
 - 2) Click [**Utility**], click [**keys**] on [**System**] submenu, and click [**Trigger**] in **Soft Keys** dialog box.
 - 3) Click [**Single**] in **Trigger** soft-key toolbar.

1.1.2 By front panel keys

- a) Press [**Trigger**] key in STIMULUSE area, and press the soft-key corresponding to [**Trigger...**] on soft-key menu, to display the **Trigger** dialog box.
- b) Press []、[**I**] keys in ADJUST area to enter **Trigger Source** zone, and press [**Δ**], [**∇**]keys or rotate the knob to select [**Internal**] option button.
- c) Press []、[]keys in ADJUST area to enter [**Channel**] box in **Trigger Settings** zone, and press [**Δ**], [**∇**]keys or rotate the knob to select the Measure channel for data transmission.
- d) Press []、[]keys in ADJUST area to select [**Continuous**] option button, and press [**OK**] key in **Enter** keys to close the dialog box.
- e) Update Measure results:
 - 1) Press [**Channel**] key in TRACE/CHAN area, and press the soft-key corresponding to the channel to be updated, to make it the channel to be Stimulus.
 - 2) Press [**Trigger**] key in STIMULUSE area, and press the soft-key corresponding to [**Single**] on the soft-key menu.

12.2 Transmitting as little data as possible

For instance, use segment sweep to reduce Trace spot, rather than transmitting the whole trace with many linear points.

S3603D Vector Network Analyzer

Frequency range: 300kHz - 20GHz

12.3 Using real number format

The highest transmission speed can be obtained by selecting real number format in automatic measure using SCPI.

12.4 Using LAN

The speed of data transmission by SCPI automatic Measure applications can be increased via LAN.

12.5 Using COM program

The fastest data transmission speed can be realized by using COM in automatic measure applications.

13. Using Macro

Macro is an executable file loaded into and operated on the analyzer. 3S3603D Vector Network Analyzer supports maximum 10 macros.

13.1 New Macro

- a) Click [**Utility**], point to [**Macro**] on Utility menu, and click [**Macro Setup...**] on the submenu, to display the Macro Setup dialog box.

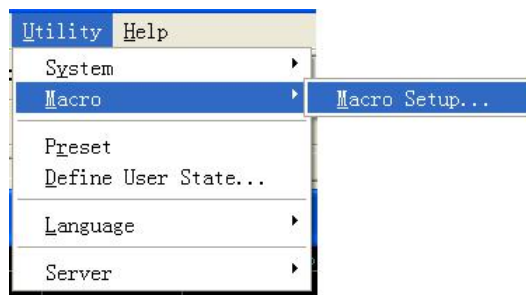


Fig.21 Macro setup

- b) Click to Stimulus the blank line below the existing macro settings in the Macro Settings dialog box, and click [**Edit**] button, to display the Macro Edit Window dialog box.

S3603D Vector Network Analyzer

Frequency range: 300kHz - 20GHz

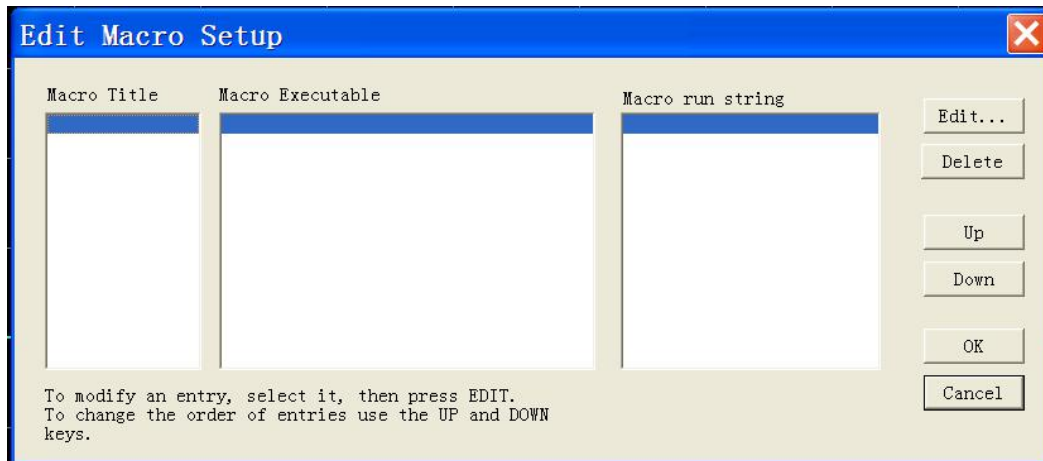


Fig.22 Macro setup dialog box

- c) Enter the caption text describing macro in **[Macro Name]** box.
- d) Enter the detailed path of executable file in **[Executable File]** box, or click **[...]** button to find the executable file.
- e) Enter the string parameters transmitted to the executable file in **[Parameter]** box.
- f) Click **[OK]** button to close the Macro Edit Window dialog box.
- g) Click **[OK]** button to close the Macro Setup dialog box.

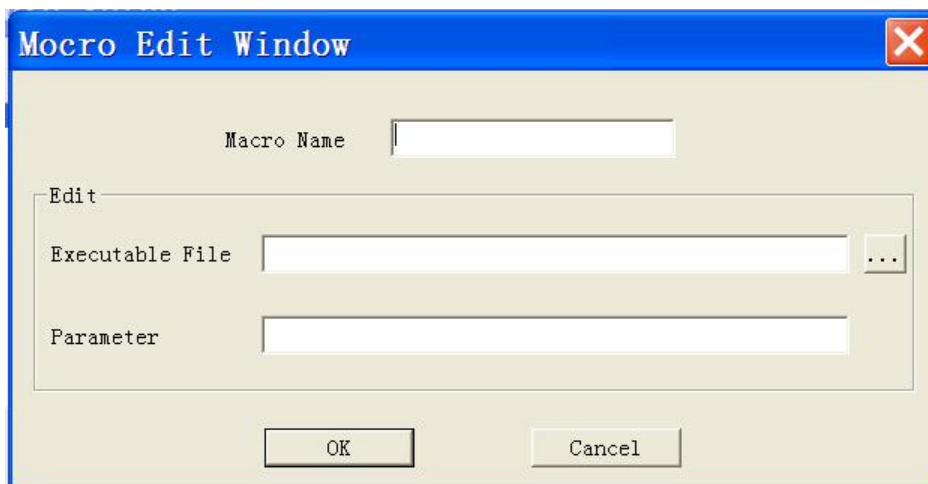


Fig.23 Macro edit window dialog box

S3603D Vector Network Analyzer

Frequency range: 300kHz - 20GHz

13.2 Macro settings dialog box

[Macro Title]

To display the macro title, when **[Macro/Local]** key is pressed, the name of macro title is displayed in the active item toolbar button of Macro. When **[Macro]** is clicked in system menu, the name of macro title is displayed in the submenu item of Macro. In order to display the complete macro title in the active item toolbar button, the title should not exceed 14 characters. Macro title is associated with the executable file, so macro functions should be described so as to distinguish different macros. For instance, for a macro having access to 41st institute homepages, its title can be named “41st Institute Homepages”.

[Macro Executable]

To display the full path of the executable file, e.g. macro with access to 41st institute homepages, path of the executable file is: C:\Program Files\Internet Explorer\IEXPLORE.EXE.

[Macro Run String]

To display the parameters transmitted to the executable file and quoted by the executable file. For instance, for macro with access to the homepages, parameters required for macro run are: <http://www.salukitec.com>.

[Edit]

Macro Edit Window dialog box is displayed when it is clicked, to set and modify the selected macro.

[Delete]

The selected macro is deleted when it is clicked.

[Up]

Click **[Up]** button to move the selected macro one line up, which is used to rearrange macro sequence. Macro sequence in dialog box is consistent with the sequence appearing in the active item toolbar of Macro. Four macros are displayed in toolbar at a time, and the next four macros are displayed when press **[Macro/Local]** key again.

[Down]

Click **[Down]** button to move the selected macro one line down.

S3603D Vector Network Analyzer

Frequency range: 300kHz - 20GHz

13.3 Macro edit window dialog box

[Macro Name]

It is used to set the name of macro title.

Edit Zone

a) [Executable File]

It is used to set the full path of the executable file.

b) [...]

It is used to browse drive and directory, locate the executable file, and create the full path of the executable file.

c) [Parameter]

It is used to set the string parameter transmitted to the executable file for quotation.

Note: Information will conduct the necessary updates, the contents of this document are subject to change without notice.