Option 100 Fault Location and Structural Return Loss Measurements

Agilent E5061A/E5062A
ENA Series RF Network Analyzers

User's Guide Supplement

Agilent Technologies

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Notice

Safety Information

Refer to your analyzer’s *User’s Guide* for safety, warranty, and assistance information.

Typeface Conventions

Sample (bold)	Boldface type is used when a term is defined or emphasis.
Sample (Italic)	Italic type is used for emphasis.
Sample key	Indicates a hardkey (key on the front panel or external keyboard) labeled “Sample.” “key” may be omitted.
Sample menu/button/box	Indicates a menu/button/box on the screen labeled “Sample” which can be selected/executed by clicking. “menu,” “button,” or “box” may be omitted.
Sample block/toolbar	Indicates a block (group of hardkeys) or a toolbar (setup toolbar) labeled “Sample.”
Sample 1 - Sample 2 - Sample 3	Indicates a sequential operation of Sample 1, Sample 2, and Sample 3 (menu, button, or box). “-” may be omitted.

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Book Overview

This book documents the use of Option 100 (fault location and structural return loss (SRL) measurement capability) with the following network analyzers:

- Agilent Technologies E5061A
- Agilent Technologies E5062A

Fault location and SRL measurements can help you test and troubleshoot 50 ohm or 75 ohm transmission lines. Both fault location and SRL measurements are used to identify damaged cables.

Fault location is best used to identify single faults greater than –40 dB.

SRL measurements are typically made before a cable has been installed and are best used to identify many small evenly-spaced imperfections that may be too small for a fault location measurement to detect.

Contents

1. **Introduction and Measurement Theory**

2. **Cable Preparation**

3. **Making Fault Location Measurements**

4. **Making SRL Measurements**

5. **Making Impedance Measurements**

1 Introduction and Measurement Theory

Fault Location Measurement Theory

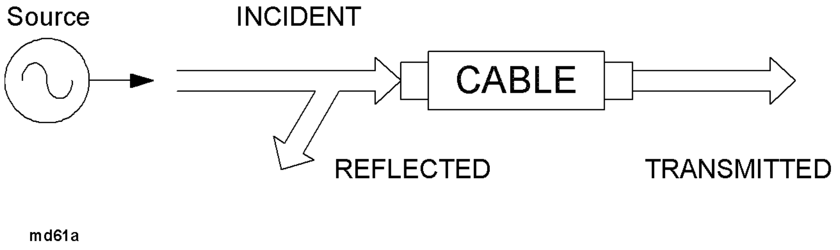
This section describes basic fault location measurement theory, how the analyzer converts frequency-domain data to distance-domain data, and the relationship between start distance, stop distance and frequency span.

Fault location measurements are designed to quickly and easily locate faults, or discontinuities, in either 50 ohm or 75 ohm transmission lines. Refer to Figure 1-1 for the following discussion.

The network analyzer has an RF signal source that produces an incident signal that is used as a stimulus to locate and measure discontinuities in your transmission line or cable. Each fault or discontinuity responds by reflecting a portion of the incident signal and transmitting the remaining signal.

The analyzer measures the frequency response of the cable and then transforms the frequency data to distance data.

Figure 1-1 **Fault Response to an RF Signal**



Typically, fault location measurement results are expressed in one of four ways:

Format	Description
Return Loss (RL)	The number of dB that the reflected signal is below the incident signal. Its relationship to the reflection coefficient (ρ) is described by the following formula: RL = –20 log ρ.
Reflection Coefficient (ρ)	The ratio of the reflected voltage wave to the incident voltage wave.
Standing Wave Ratio (SWR)	Any two waves traveling in opposite directions (the incident and reflected for example) cause a “standing wave” to be formed on the transmission line. SWR is defined as the maximum voltage over the minimum voltage of the standing wave. SWR can also be mathematically derived from the reflection coefficient (ρ) with the following formula: $\mathrm{SWR} = \frac{1+\rho}{1-\rho}$
Impedance Magnitude	The magnitude of the complex impedance at each measurement point. See “How to Display Impedance” on page 74 for information on making impedance measurements. $npedanceMagnitude = \lvert Z \rvert = \sqrt{Z_{\mathrm{real}}^2 + Z_{\mathrm{imaginary}}^2}$

How the Analyzer Converts Frequency Data to Distance Data

Fault-location measurements are single-ended measurements, meaning that only one end of a cable under test need be connected to the analyzer's RF OUT test port.

This type of measurement is generally called a reflection measurement and typically displays a response commonly known as return loss.

The analyzer performs swept-frequency measurements of return loss versus frequency, then uses the Fourier transform to convert the response-versus-frequency to a response-versus-distance. The analyzer's internal computer makes the calculation by using either the inverse discrete Fourier transform (inverse FFT) technique or the chirp-Z Fourier transform technique.

The Fourier transform technique is essentially a process of adding the signals measured by the analyzer in the frequency domain and combining them to create the fault-location response in the time domain.

The resulting measurement is an error-corrected fault-location response of the cable under test.

Start/Stop Distance and Frequency Span Explanation

When the analyzer is set up for a fault location measurement, you can determine the center frequency (when in band pass mode), and start and stop distances for the measurement. The distance range (start distance – stop distance) determines the frequency span, which in turn determines the start and stop frequencies.

NOTE In band pass mode (as opposed to low pass mode), you can select center frequency. Changes to distance range do not affect the user-chosen center frequency.

The analyzer will attempt to set the frequency span to the setting required for the distance range. The maximum setting for the frequency span cannot exceed the analyzer's frequency capability. For instance, the start frequency cannot be lower than the analyzer's low frequency limit, and the stop frequency cannot be higher than the analyzer's high frequency limit.

Cable Impedance and Structural Return Loss Measurement Theory

The SRL feature is designed to measure cable impedance and structural return loss. Cable impedance is the ratio of voltage to current of a signal traveling in one direction down the cable. Structural return loss is the ratio of incident signal to reflected signal in a cable, referenced to the cable's impedance.

The network analyzer uses a synthesized RF signal source to produce an incident signal as a stimulus. A reflection measurement is made and then used to compute the cable impedance. The structural return loss measurement is displayed referenced to the measured cable impedance.

For CATV cable, the cable is measured from 5 MHz to 1000 MHz at narrow frequency resolutions down to 125 kHz. The analyzer, with a furnished VBA utility program, will automatically scan the cable, then report the worst-case responses.

Cable Impedance

The analyzer automatically computes the cable impedance (Z). However, if you wish to turn off this “auto Z” function and input your own value of impedance, you can. See “Connector Model for Short Cables” on page 67.

In coaxial cable, the value of the impedance will depend upon the ratio of the inner and outer conductor diameters, and the dielectric constant of the material between the inner and outer conductors. The cable impedance will also be affected by changes in conductivity. These changes are a natural consequence of RF currents that flow near the surface of a conductor. This effect is known as the “skin effect.” Also, the construction of the cable can change along the length of the cable, with differences in conductor thickness, dielectric material and outer conductor diameter changing due to limitations in manufacturing. Thus the cable impedance may vary along the length of the cable.

The extent to which manufacturing imperfections degrade cable performance is characterized by a specification called structural return loss (SRL). SRL is the ratio of incident signal to reflected signal in a cable. This definition implies a known incident and reflected signal. In practice, the SRL is loosely defined as the reflection coefficient of a cable referenced to the cable's impedance. The reflection seen at the input of a cable, which contributes to SRL, is the sum of all the tiny reflections along the length of the cable. In terms of cable impedance, the SRL can be defined mathematically as:

Equation 1

$$Z_{SRL}(\omega) = \frac{Z_{in}(\omega) - Z_{cable}}{Z_{in}(\omega) + Z_{cable}}$$

Z_{in} is the impedance seen at the input of the cable, and Z_{cable} is the nominal cable impedance.

Cable impedance is a specification that is defined only at a discrete point along the cable, and at a discrete frequency. However, when commonly referred to, the impedance of the cable is some average of the impedance over the frequency of interest. Structural return loss, on the other hand, is the cumulative result of reflections along a cable as seen from the input of the cable. The above definitions need to be expressed in a more rigorous form in order to apply a measurement methodology.

Defining Cable Impedance

Following are three common methods of defining cable impedance. Although all three methods may be commonly used in your industry, your network analyzer uses the third method (Z-average normalization) to define cable impedance.

Method 1. One definition of cable impedance is that impedance which results in minimum measured values for SRL reflections over the frequency of interest. This is equivalent to measuring a cable with a return loss bridge that can vary its reference impedance. The value of reference impedance that results in minimum reflection, where minimum must now be defined in some sense, is the cable impedance. Mathematically, this is equivalent to finding a cable impedance such that:

Equation 2

$$\frac{\partial[\bar{\rho}(\omega, Z_{cable})]}{\partial(Z_{cable})} = 0$$

where ρ is some mean reflection coefficient. Thus, cable impedance and SRL are somewhat inter-related: the value of SRL depends upon the cable impedance, and the cable impedance is chosen to give a minimum SRL value.

Method 2. An alternate definition of cable impedance is the average impedance presented at the input of the cable over a desired span. This can be represented as:

Equation 3

$$Z_{avg} = \frac{\int_{F_{min}}^{F_{max}} Z_{in}(F)\, dF}{(F_{max} - F_{min})}$$

The value found for Z_{avg} would be substituted for Z_{cable} in Equation 1 to obtain the structural return loss from the cable impedance measurement.

Method 3 (Z-average normalization). The mathematics for the Z-average normalization as performed by the analyzer are shown below.

Equation 4

$$Z_{in}(\omega) = Z_0 \times \frac{(1 + \rho(\omega))}{(1 - \rho(\omega))}$$

Z_0 = system impedance, 50 or 75 Ω

Equation 5

$$Z_{cable} = \frac{\sum_{n=1}^{N} \left| Z_{in}(\omega_n) \right|}{N}$$

Equation 6

$$\rho_{SRL}(\omega) = \frac{Z_{in}(\omega) - Z_{cable}}{Z_{in}(\omega) + Z_{cable}}$$

In Equation 4, $\rho(\omega)$ is the reflection coefficient from the analyzer measured at each frequency and $Z_{in}(\omega)$ is the impedance of the cable for that measured reflection coefficient.

Step 1. The calculation of Z_{cable}, described in Equation 5, is the Z-average impedance of the cable over the number of frequency points (N). The default frequency range is approximately 5 MHz to 200 MHz. This frequency range is chosen because mismatch effects of the input connector are small. High quality connectors must be used if the average impedance is calculated over a wider span. The frequency range for this calculation can be modified by using the **Z Cutoff Freq.** softkey in the connector model menu to change the cable impedance cutoff frequency.

Equation 6 is the structural return loss for the cable. This calculation can be done by the analyzer or an external computer.

SRL and Periodic Cable Faults

SRL is the measure of the reflection of incident energy that is caused by imperfections or disturbances (bumps) in the cable which are distributed throughout the cable length. These bumps may take the form of a small dent, or a change in diameter of the cable. These bumps are caused by periodic effects on the cable while in the manufacturing process. For example, consider a turn-around wheel with a rough spot on a bearing. The rough spot can cause a slight tug for each rotation of the wheel. As the cable is passed around the wheel, a small imperfection can be created periodically corresponding to the tug from the bad bearing.

Each of these small variations within the cable causes a small amount of energy to reflect back to the source due to the non-uniformity of the cable diameter. Each bump reflects so little energy that it is too small to observe with fault location techniques. However, reflections from the individual bumps can sum up and reflect enough energy to be detected as SRL. As the bumps get larger and larger, or as more of them are present, the SRL values will also increase. The energy reflected by these bumps can appear in the return loss measurement as a reflection spike at the frequency that corresponds to the spacing of the bumps. The spacing between the bumps is one half the wavelength of the reflection spike and is described by equations 7 and 8.

Equation 7

$$wavelength \approx \frac{c}{f}$$

$$c = \text{speed of light} \qquad f = \text{frequency}$$

Equation 8

$$\frac{wavelength}{2} = \text{spacing between the bump}$$

The wavelength/2 spacing corresponds to the frequency at which down and back reflections will add coherently (in-phase). The reflections produce a very narrow response on the analyzer display that is directly related to the spacing of the bumps. The amount of reflected energy is observed as return loss. When this return loss measurement is normalized to the cable impedance, the return loss becomes structural return loss.

Figure 1-2 diagrams reflections from bumps in a cable. We can combine the energy reflected by each bump in a cable and make a few basic assumptions, to mathematically describe SRL by the series shown in Equation 9.

Equation 9

$$V_{ref} = [V_{in}L\Gamma L] + [V_{in}L(1-\Gamma)L\Gamma LL] + [V_{in}L(1-\Gamma)L(1-\Gamma)L\Gamma LLL] + \ldots$$

V_{ref} = reflected Voltage

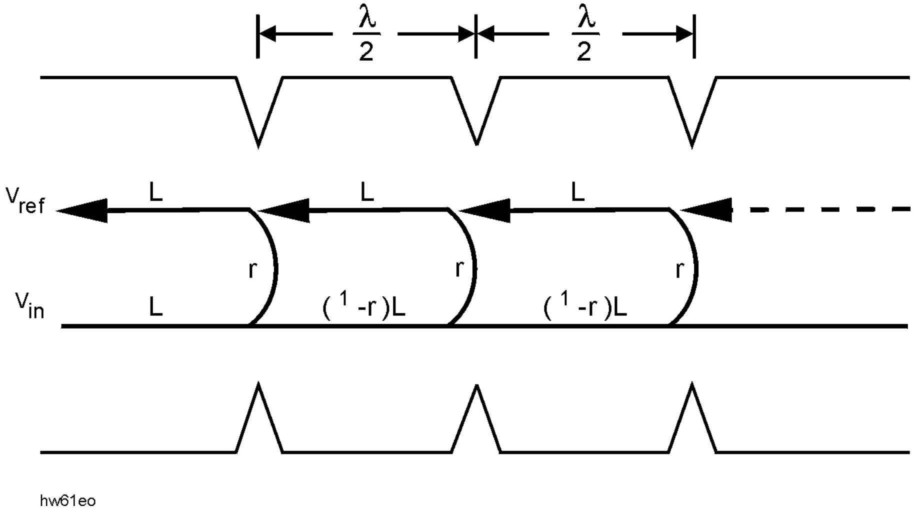
V_{in} = incident Voltage

L = cable loss

Γ = reflection coefficient of the bumps

The bumps are assumed to be uniform in reflection and spaced by a wavelength/2 separation.

Figure 1-2 **Periodic Bumps in a Cable**



The series may be reduced to a simple form to leave us with the relationship shown in Equation 10. The term L is a function of the loss of the cable at a specific frequency and the wavelength at that frequency.

Equation 10

$$\mathrm{SRL} = \frac{Vref}{Vin} = \Gamma\left(\frac{\mathrm{L}^2}{1-\mathrm{L}^2}\right)$$

The term $(L^2)/(1–L^2)$ can be thought of as the number of bumps that are contributing to SRL. It represents a balance between the contribution of loss in a single bump and further bumps in the cable for the specified frequency and cable loss. Calculate the distance into the cable by multiplying the term $(L^2)/(1–L^2)$ by the distance between bumps.

Table 1-1 illustrates some calculated values for a typical trunk cable. From the table, bumps spaced 1.5 meters apart out to 307 meters will contribute to SRL.

Table 1-1 **SRL Equation Constant**

Frequency	Spacing (λ/2)m	Loss (dB)/m	dB/bump	bumps $L^2/(1–L^2)$	Distance(m)
100 MHz	1.5	0.014	–0.02	205	307
500 MHz	0.3	0.033	–0.01	433	129
1 GHz	0.15	0.05	–0.0075	554	83

How to Use Table 1-1

Refer to Figure 1-2 and Equation 10 for the following discussion.

Γ = the reflection coefficient of each bump ($V_{reflected}/V_{incident}$)

L = the cable loss between bumps ($V_{transmitted}/V_{incident}$)

The distance between bumps equals λ/2 (1/2 wavelength).

Typical values:

$\Gamma << 1$

$L \leq 1$ for low loss cable

Derivation of L. In Equation 10, L is the cable loss for a 1/2 wavelength length of cable, expressed in linear.

1. Find the cable loss from a spec sheet. Cable loss is typically expressed in loss per foot.
2. Convert loss per foot to loss per meter.
3. Find the 1/2 wavelength in meters. This will be the spacing between bumps.
4. Multiply loss per meter × 1/2 wavelength to get dB loss per bump.
5. Convert dB loss per bump to linear.

Example.

1. A spec sheet states that the cable loss spec at 300 MHz is 1 dB per 100 feet.
2. Convert loss per foot to loss per meter:
   1 dB/100 ft ≈ 1 dB/30 m ≈ 0.033 dB/m
   This is the **Loss (dB)/m** *column in* Table 1-1.
3. Find the 1/2 wavelength in meters:
   1/2 wavelength at 300 MHz ≈ 0.5 meters
   This is the **Spacing (λ/2)m** *column in* Table 1-1.
4. Multiply loss/meter × 1/2 wavelength:
   0.033dB/meter × 0.5 meters = 0.0165 dB = L_{dB}
   This is the **dB/bump** *column in* Table 1-1.
5. Convert L_{dB} (loss) in dB to linear:
   $20 \log (L_{dB}) = -0.0165$ $L = 10^{(-0.016/20)} = 0.998$
6. $L^2/(1 - L^2) \approx 262$
7. There are approximately 262 bumps contributing to SRL at 300 MHz.
8. 262 × 0.5 = 131. The distance into the cable for 262 bumps is 131 meters.

In actual cables, the reflections from the bumps and the spacing of the bumps may vary widely. The best case for a minimum SRL, is that the bumps are totally random and very small. Real world examples are somewhere in between the uniform bumps and the scattered case. As the sizes of the bumps, their spacing, and the number of bumps vary within the manufacturing process, varying amounts of SRL are observed.

SRL and Discrete Cable Faults

In addition to a set of periodic bumps, a cable can also contain one or more discrete faults. For this discussion, discrete imperfections will be referred to as “faults,” and periodic imperfections will be referred to as “bumps.”

Reflections from discrete faults within the cable will also increase the level of SRL measured. The energy reflected from a fault will sum with the energy reflected from the individual bumps and provide a higher reflection level at the measurement interface. Examining the cable for faults before the SRL measurement is a worthwhile procedure. The time required to perform the fault location measurement is small compared to the time spent in performing an SRL measurement scan.

A fault within the cable will provide the same type of effect as a bad connector. If the fault is present within the end of the cable nearest to the analyzer, the effect will be noticed throughout the entire frequency range. As the fault is located further into the cable, the cable attenuation will reduce the effect at higher frequencies. The reflected energy travels further through the cable at lower frequencies where the cable attenuation per unit distance is lower.

Techniques for Removing Connector Effects

Connector Effects on SRL

To remove the unwanted effects of worn connectors, the SRL measurement uses a built-in connector model. The connector model consists of compensation for connector length and compensation for connector capacitance (connector C).

The “connector C” compensation emulates the C trim value of a variable impedance bridge.

The connector length is used to compensate for the effects of an electrically long connector and extends the calibration reference plane.

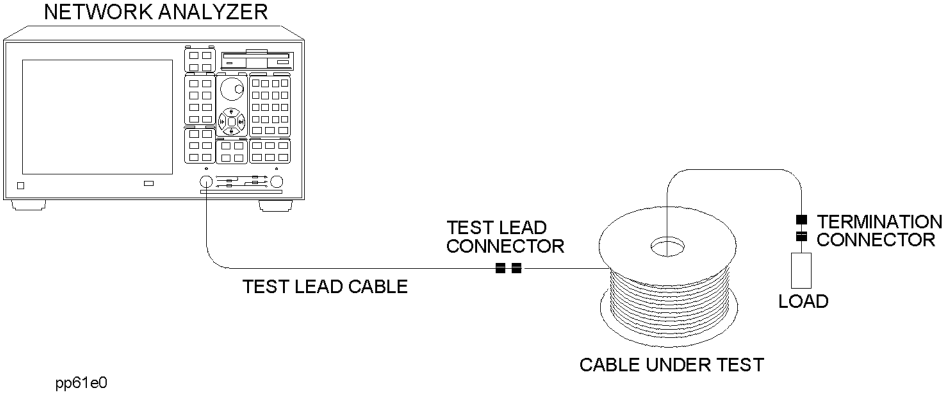
NOTE A calibration reference plane is established at the point where the short, open, and load standards have been measured.

The analyzer can automatically measure the optimum values for your connector model, or you may enter them manually.

The default values for the connector model are 0.00 mm length, and 0.00 pF capacitance (no compensation).

When measuring spools of cable, typically two connectors are used: the test-lead connector and the termination connector. (See Figure 1-3.) These connectors provide the cable interface and are measured as part of the cable data.

Figure 1-3 **Basic SRL Measurement Setup and Connections**



Often, slight changes in the test-lead connector can cause significant changes in the values of structural return loss measured at high frequencies. This is because the reflection from a connector increases for high frequencies. In fact, the return loss of a test-lead connector can dominate the SRL response at frequencies above 500 MHz. This is where training, good measurement practices, and precision cable connectors are needed, especially for measurements up to 1 GHz. Precision connectors are required to provide repeatability over multiple connections. Slip-on connectors are used to provide rapid connections to the cables, but require careful attention in obtaining good measurement data. Repeatability of measurement data is directly affected by the connector's ability to provide a consistently good connection. This is the major cause of repeatability problems in SRL measurements.

Effects of the test-lead connector at the measurement interface are observed as a slope in the noise floor at higher frequencies.
By observing the SRL measurement display and slightly moving the connector, the effects of the connection can be observed at the higher frequencies. The test-lead connector should be positioned to obtain the lowest possible signal level and the flattest display versus frequency. The mechanical interface typically provides an increasing slope with frequency and flattens out as the connection is made better.

The termination connector may also affect the SRL measurement if the cable termination connector and load provide a significant amount of reflection and the cable is short enough. As longer lengths of cable are measured, the cable attenuation provides isolation from the termination on the far end. Use a fault location measurement technique to observe the reflection from the termination at the far end of the cable. If the termination is shown as a fault, the reflection from the terminating connector is contributing to the reflection from the cable. A more suitable termination is required or a longer section of cable must be measured. The cable must provide sufficient attenuation to remove the effects of the connector and load for a good SRL measurement. Performing a good measurement on a short length of cable is quite difficult and requires connectors with very low reflections to be effective.

Fixed Bridge with Connector Compensation

The analyzer employs the fixed-bridge method and instrument software to emulate the traditional variable-bridge method. Vector error correction is used to provide the most accurate measurements up to the calibration plane defined by the calibration standards. Additional corrections can also be used to minimize the effects of the test-lead connector on the measured SRL response.

The error corrections done for a fixed bridge can also include connector compensation. The fixed bridge method with connector compensation technique mathematically removes the effects of the test-lead connector by compensating the predicted connector response given by a connector model.

Shunt C Connector Model

One model that can be used for the cable connector is the shunt C connector model. With this model, the adjustment of the C value given in a variable impedance bridge can be emulated. The shunt C connector model assumes the discontinuity at the interface is abrupt and much smaller than a half wavelength of the highest frequency of measurement. With this assumption, the discontinuity can be modeled as a single-shunt twisted pair, where $C = C_0$ + second and third order terms.

Intuitively this is the right model to choose because the effect of a typical poor connector on structural return loss measurement is an upward sloping response, typically worst at the high frequencies.

Using a shunt C to model the connector, a value of the susceptance, $-C$, may be chosen by the network analyzer to cancel the equivalent C of the connector and mathematically minimize the effect of the connector on the response measurement.

The equations for computing structural return loss and the average cable impedance with capacitive compensation are described next.

Equation 11

$$Z'_{in}(\omega) = \frac{Z_{in}(\omega) \cdot \frac{1}{jwC}}{Z_{in}(\omega) + \frac{1}{jwC}}$$

Equation 12

$$Z'_{cable} = \frac{\sum \left| Z'_{in}(\omega) \right|}{N}$$

Equation 13

$$\rho'_{SRL}(\omega) = \frac{Z'_{in}(\omega) - Z'_{cable}}{Z'_{in}(\omega) + Z'_{cable}}$$

In Equation 11, $Z_{in}(\omega)$ is calculated from the measured return loss as described in Equation 4, previously. The primed values are the new calculation values using the capacitive compensation. With these equations, the network analyzer can compute values for the cable impedance and mathematically compensate for the connector mismatch with a given value of C connector compensation.

Connector Length

The shunt C connector model can be improved with the addition of connector length. Connector length is used to compensate for the phase shift caused by the electrical length within the connector. The calibration plane can be moved from one side of the cable connector to the other side, so that the shunt C is placed exactly at the discontinuity of the connector and the cable under test.

Measurement Uncertainties

In any comparison of cable impedance or structural return loss data, it is important to understand the measurement uncertainty involved in each type of measurement. This is critical for manufacturers, who often use the most sophisticated techniques to reduce manufacturing guard bands. It is also important in field measurements that users choose the proper equipment for their needs, and understand the differences that can occur between manufacturers’ data and field data. Also, note that measurement uncertainty is usually quoted as the worst-case result if the sources of error are at some maximum value. This is not the same as error in the measurement, but rather a way to determine measurement guard band, and to understand how closely to expect measurements to compare on objects measured on different systems.

The errors that can occur in a reflection measurement are reflection tracking (or frequency response), T, source match, Γ_M, and directivity, D. The total error in a measurement can be shown to be

Equation 14

$$\Gamma_{MEAS} = T \cdot \left[D + \frac{(\Gamma_{DUT})}{(1 - \Gamma_M \Gamma_{DUT})} \right]$$

where Γ_{DUT} is the reflection response of the DUT.

Error correction techniques can effectively remove the effects of tracking. Also, source match effects are small if Γ_{DUT} is small. This leaves directivity as the largest error term in the reflection measurement. The causes and effects of these error terms will be described for each of the measurement methodologies.

For variable bridge measurements, the directivity of the bridge is the major error term. One-port vector error correction reduces the effects of tracking and source match, and improves directivity. The directivity after error correction is set by the return loss of the precision load, specified to be better than 49 dB at 1 GHz. However, the directivity is only well known at the nominal impedance of the system, and the directivity at other impedances should be assumed to be that specified by the manufacturer. For best performance, the bridge should be connected directly to the cable connector, with no intervening cable in between.

The directivity of the bridge could be determined at impedances other than 75 ohms, by changing the impedance and measuring the resulting values. This can be done by changing the reference impedance to the new value, say 76 ohms, changing the bridge to that value, and measuring the impedance on a Smith chart display. The difference from exactly 75 ohms represents the directivity at that impedance.

For fixed bridge methods, the reflection port is often connected to the cable connector through a length of test lead. A one-port calibration is performed at the end of the test lead. The directivity will again be set by the load, but any change in return loss of the test lead due to flexing will degrade the directivity of the measurement system. In both fixed and variable bridge measurements, the repeatability and noise floor of the analyzer may limit the system measurement. A convenient way to determine the limitation of the measurement system is to perform a calibration, make the desired measurement, then re-connect the load to check the effective directivity. A very good result will be better than –80 dB return loss of the load. Typically, flexure in the test leads, connector repeatability, or noise floor in the network analyzer will limit the result to between –60 to –40 dB. If the result is better than –49 dB, then the system repeats better than the load specification for the best available 75 ohm loads. Thus, the effective directivity should be taken to be the load spec of –49 dB. It is possible to reduce this limitation by having loads certified for better return loss.

Measurement Uncertainty for Impedance Measurements

The fixed bridge method calculates the cable impedance by averaging the impedance of the cable over frequency. The variable bridge uses a reading of the impedance from the dial on the bridge. The directivity at any impedance can be determined, as stated earlier, but only to the limit of the return loss of the load, and the system repeatability. Table 7-1 on page 89 shows the effect of directivity on cable impedance measurement uncertainty.

Any connectors and adapters used to connect the test-lead cable to the cable under test can have a significant effect on the impedance measurement. With the variable bridge method, the operator determines the appropriate setting, taking into account the capacitive tuning adjustment. With the fixed bridge method, it is also possible to compensate somewhat for the connector. However, it is often the case that the cable impedance is determined by the low frequency response, up to perhaps 200 MHz to 500 MHz, where the connector mismatch effects are still small. The choice of frequency span to measure cable impedance can itself affect the value obtained for cable impedance. In general, as the connector return loss becomes worse, it will have a greater effect on the resulting impedance measurement. The uncertainty caused by the connector is difficult to predict, but large errors could occur if the low frequency return loss is compromised to achieve better high frequency structural return loss.

Finally, note that since both methods average, in some way, the measurement over the entire frequency range, it is probable that the worst case error will never occur at all frequencies, and with the same phase. In fact, it is more likely that the errors will cancel to some extent in cable impedance measurements. Also, the loads that are used will invariably be somewhat better than specified, especially over the low frequency range. From this, it is reasonable to assume that the errors in impedance measurements are at least 50% less than listed in Table 7-1 on page 89.

Measurement Uncertainty for Structural Return Loss

The same factors that affect cable impedance — directivity, system and test lead stability, and cable connector mismatch — also affect structural return loss. However, since structural return loss is measured at all frequencies, it is much more likely that a worst case condition can occur at any one frequency. For that reason, the measurement uncertainty must include the full effect of the above listed errors.

Refer to Chapter 7 for further discussion on this subject.

2 Cable Preparation

Cable preparation (for slip-on connectors) can be critical for some SRL measurements, especially when measuring mainline cables with an SRL of –30 dB or lower. An improperly prepared cable can degrade the cable/connector response which may affect the measurement enough to make a “good” cable fail.

This chapter describes the most common cable preparation problems that should be avoided in order to obtain good measurements.

Cable Preparation Problems

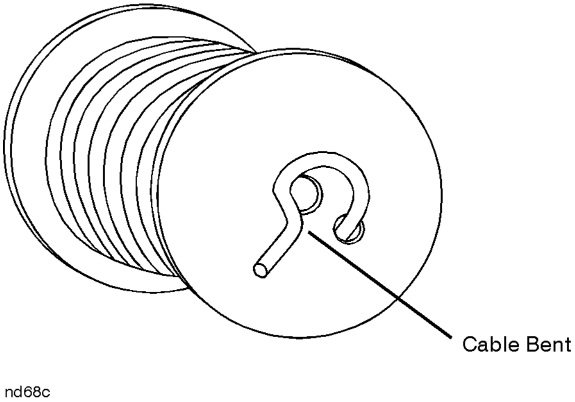
Follow the preparation instructions provided by the connector manufacturer and take great care to avoid the following cable preparation problems:

- bent cable
- deformed cable
- contaminated dielectric
- damaged outer conductor
- non-flush cut

Bent Cable

Poor measurement results can occur if the cable is bent or kinked near the end of the spool. The bend should be removed before proceeding with the SRL measurement.

Figure 2-1 **Bent/Kinked Cable**

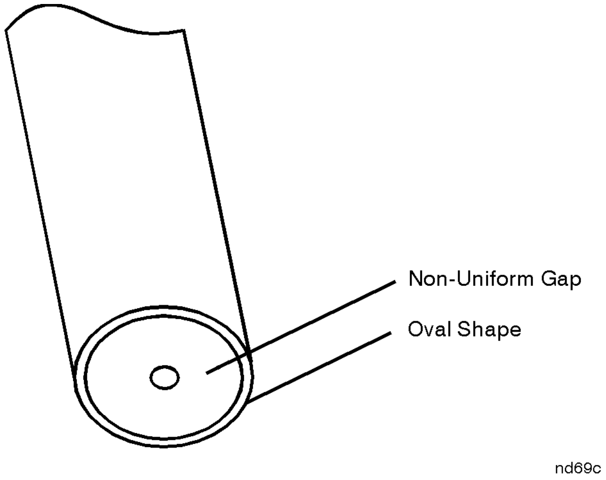


NOTE The built-in connector modeling will attempt to remove the effects of the connector. The connector response is shown at 0.0 ft. on the bottom trace. The extent to which the effects of the connector can be removed may depend on the quality of the cable preparation as well as the connector.

Deformed Cable

Compressing the dielectric (the gap) will produce egg-shaped or oval deformations which can cause impedance mismatches and affect the quality of the connector model compensation. See Figure 2-2. This can easily happen when using diagonal cutters to cut the cable.

Figure 2-2 **Deformed Cable (cut with diagonal cutters)**

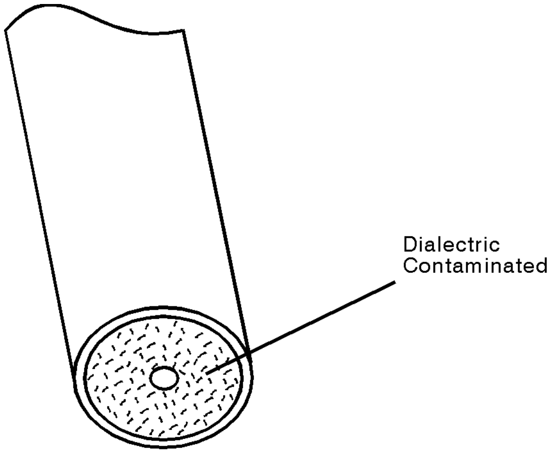


NOTE The built-in connector modeling will attempt to remove the effects of the connector. However, the modeling cannot remove the effects of the cable bend.

Contaminated Dielectric

When a cable is cut, contamination of the dielectric can occur from cuttings or shrapnel from the outer or inner conductor. This type of contamination can cause problems and change the connector model compensation needed.

Figure 2-3 **Contaminated Cable Dielectric**



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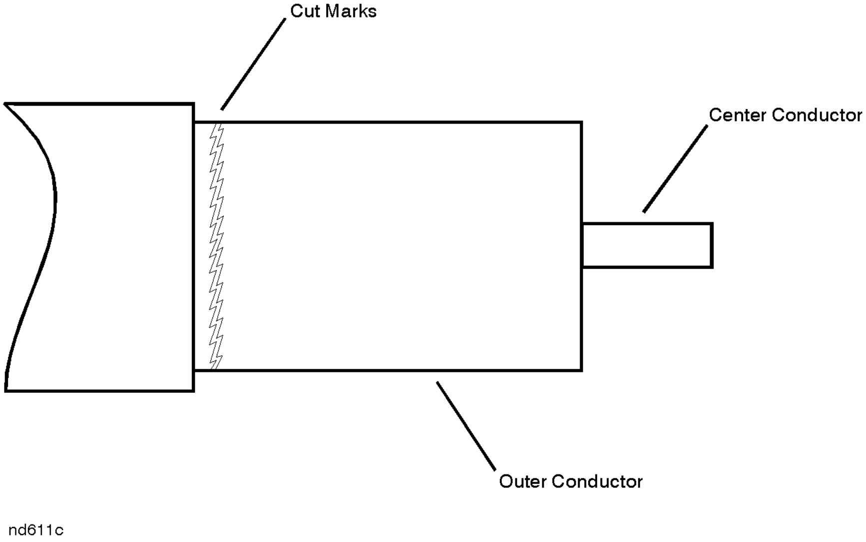
NOTE The built-in connector modeling will attempt to remove the effects of the connector. The extent to which the effects of the connector can be removed may depend on the quality of the cable preparation as well as the connector.

Damaged Outer Conductor

The outer conductor may be cut or dented when the outer insulation is removed. This can cause a close-in fault which cannot be compensated by the connector model.

Figure 2-4 **Scarred Outer Conductor of Cable**

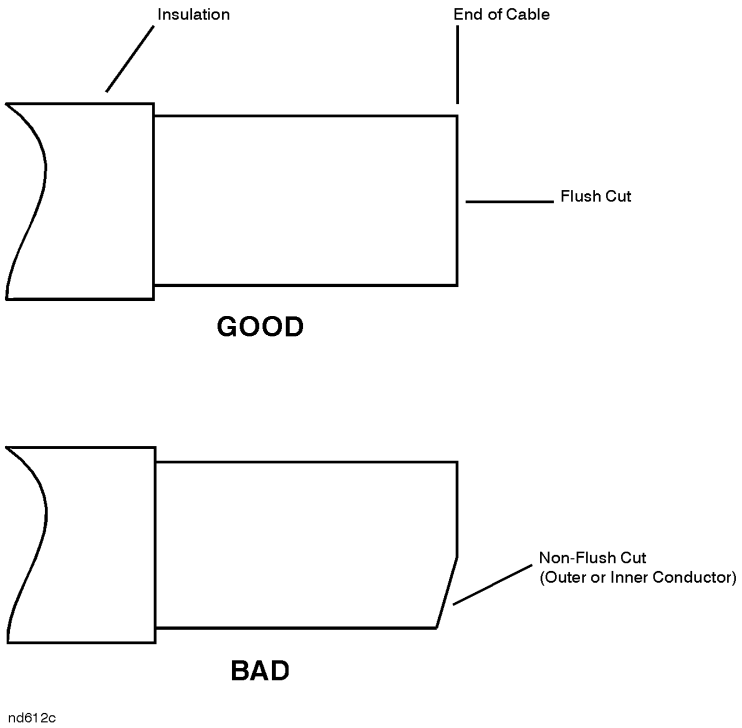


NOTE The built-in connector modeling will attempt to remove the effects of the connector at 0.0 ft. However, the modeling may not remove the effects of the outer conductor damage (which is a few inches into the cable).

Non-Flush Cut

Cables which require a flush cut, such as for GTC-XXX-TX-N (“Pogo”) connectors, might not actually be cut in such a way. This can cause an inconsistent connection or poor repeatability of the SRL measurement.

Figure 2-5 **Cable Cut Flush (good) and Non-Flush (bad)**



NOTE The built-in connector modeling will attempt to remove the effects of the connector. The extent to which the effects of the connector can be removed may depend on the quality of the cable preparation as well as the connector.

Recommended Tools and Cables

Recommended Tools

For connectors such as the GTC-XXX-TX-GHZ-N (“GHZ”) connector, cable prep tools similar to CableMatic Model SST-A (Ripley Company) are recommended.

Recommended Cables

The following table lists the recommended test lead cables for use in cable testing applications.

Table 2-1 **Recommended Test Lead Cables**

Cable Description	Part Number
75 Ohm Type-N 10 ft. (m-m)	8120-6737
75 Ohm Type-N 10 ft. (m-f)	8120-6740
75 Ohm Type-N 15 ft. (m-m)	8120-6738
75 Ohm Type-N 15 ft. (m-f)	8120-6741
75 Ohm Type-N 30 ft. (m-m)	8120-6739
75 Ohm Type-N 30 ft. (m-f)	8120-6742

3

Making Fault Location Measurements

This chapter explains how to make fault location measurements.

NOTE Refer to “Fault Location Measurement Theory” on page 10 for detailed information on how the analyzer measures fault location.

Basic Measurement Procedures

A typical fault location measurement consists of the following steps:

1. Enabling the fault location function
2. Selecting the transformation types
3. Calculating the measurement conditions
4. Setting the window
5. Setting the frequency range and the number of points
6. Setting the velocity factor
7. Setting the cable loss
8. Setting the display range
9. Calibrate the analyzer
10. Connect the cable under test

Each step is described on the following pages. The VBA utility program, which facilitates measurement setup, is explained at the end of this chapter.

Enabling the fault location function

Operation

Step 1. Press Channel Next (or Channel Prev) and Trace Next (or Trace Prev) to activate a trace for which you want to use the conversion type.

Step 2. Press Analysis - **Fault Location** to display the Fault Location menu.

Step 3. Press the **Fault Location** softkey to enable the conversion feature (**ON**).

NOTE To enable the conversion feature, the following conditions must be met. Otherwise, an error occurs.

- The sweep mode is linear sweep.
- The number of measurement points is 3 or more.

Selecting the transformation type.

Select the conversion type. The E5061A/62A simulates the response from the DUT of two types of stimulus signals: impulse signal and step signal. The impulse signal is a pulse-shaped signal in which the voltage rises from 0 to a certain value and returns to 0 again. The pulse width depends on the frequency sweep range. The step signal is a signal in which the voltage rises from 0 to a certain value. The rise time depends on the maximum frequency within the frequency sweep range.

Operation

Step 1. Press Channel Next (or Channel Prev) and Trace Next (or Trace Prev) to activate a trace for which you want to set the conversion type.

Step 2. Press Analysis - **Fault Location** to display the Fault Location menu.

Step 3. Press **Type** and then press one of the following softkeys to specify the type.

Softkey	Function
Bandpass	Sets the conversion type to "band pass."
Lowpass Step	Sets the conversion type to "low pass step."
Lowpass Imp.	Sets the conversion type to "low pass impulse."

Calculating Measurement Conditions

To use the transformation function efficiently, you need to make the following two settings appropriately.

- Window
- Sweep conditions: frequency range and number of points

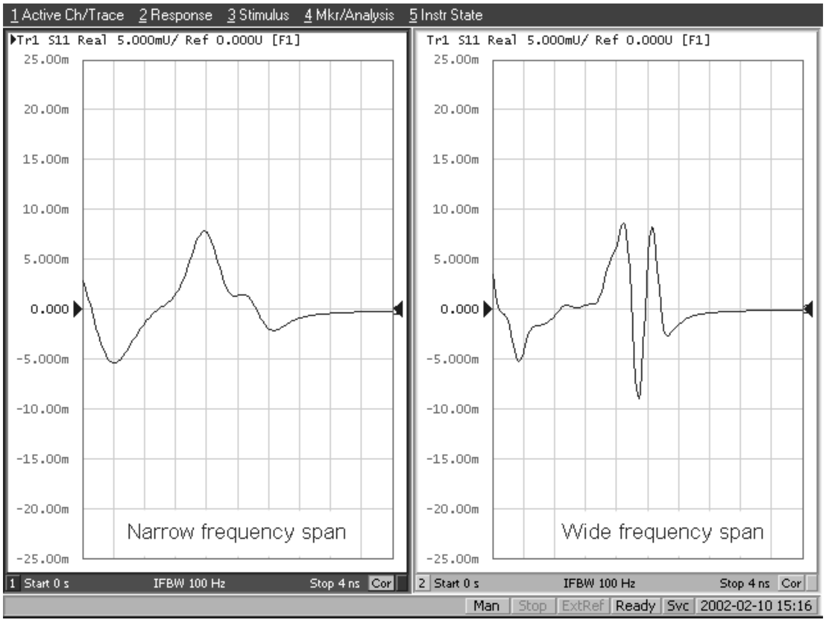
This section describes how to determine these conditions.

NOTE The VBA utility program for the fault location measurement, calculates and sets up frequency sweep range to get the highest resolution available for the required display distance range. See “Fault Location Measurement Setup using the VBA Utility Program” on page 55.

Effect of frequency sweep range on response resolution

Figure 3-1 shows an example when measuring the same cable while changing the sweep span. When measured in a narrower sweep range, the overlap between 2 peaks is larger than when measured in a wider sweep range. By performing measurement in a wider sweep range, adjacent peaks can be clearly separated, which means that the response resolution is smaller.

Figure 3-1 **Effect of frequency sweep range on resolution**



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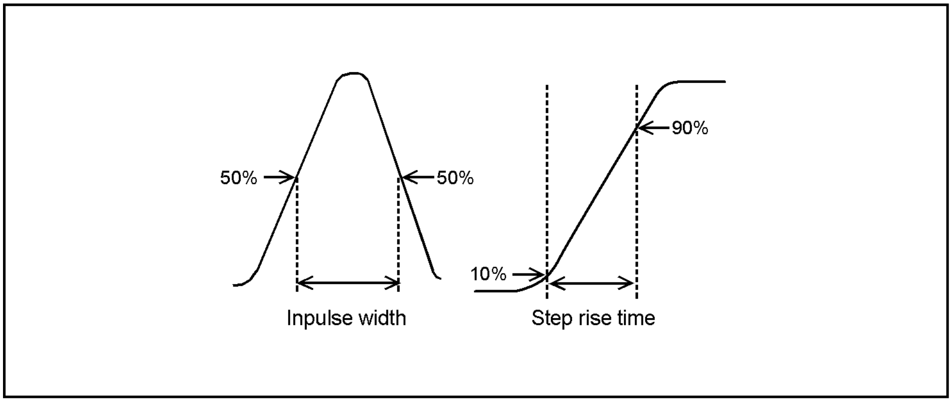
The sweep range affects the width of the impulse signal and the rise time of the step signal. The width of the impulse signal and the rise time of the step signal are inversely proportional to the sweep range. Therefore, the wider the sweep range is, the shorter these times are.

The resolution is equal to the width defined at the point of 50% of the impulse signal or the rise time defined at the points of 10% and 90% of the step signal. (Figure 3-2)

Figure 3-2 **Definition of the impulse width and the step rise time**



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Effect of the window function on the response resolution

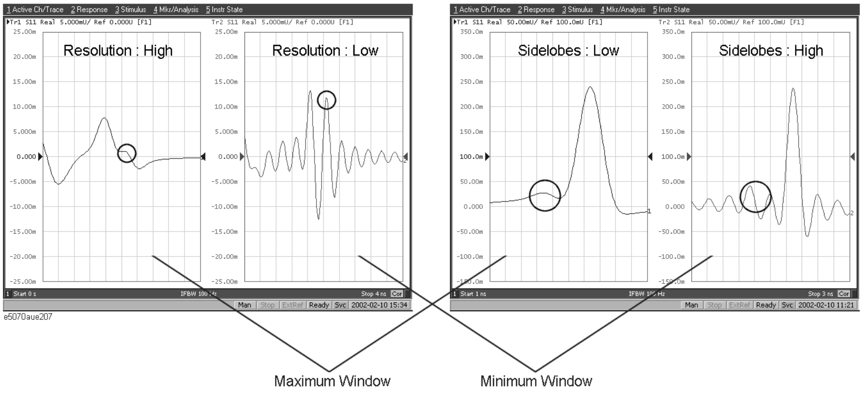
Lowering the sidelobe level with the window function elongates the width of the impulse signal and the rise time of the step signal. As described in “Effect of frequency sweep range on response resolution” on page 41, because the response resolution is equal to the width of the impulse signal and the rise time of the step signal, lowering the sidelobe level enlarges the response resolution. The following table shows the relation between the response resolution and the window setting.

Table 3-1 **The shape of window and response resolution**

Window	Low pass step	Low pass impulse	Band pass
Minimum	0.45/frequency span	0.60/frequency span	1.20/frequency span
Normal	0.99/frequency span	0.98/frequency span	1.95/frequency span
Maximum	1.48/frequency span	1.39/frequency span	2.77/frequency span

Figure 3-3 shows how the response changes when changing the window shape. You can see that, if the magnitudes of adjacent peaks are comparable, you need to make the resolution higher and, if they differ significantly, you need to set the window so that smaller peaks with lower sidelobes appear.

Figure 3-3 **Effect of window on response resolution**



Effect of the transformation type on the response resolution

Although both transformation types, band pass and low pass impulse, simulate the response of the impulse signal, the impulse width in the low pass impulse mode is half the width in the band pass mode. Therefore, the resolution is better in the low pass mode. If the DUT can be measured in the low pass mode, response data with better resolution is obtained in the low pass mode.

Measurement range

In the fault location function, the measurement range means the range within which the response can be measured without repetition. The repetition of the response occurs because measurement in frequency domain is performed discretely instead of continuously. The measurement range is inversely proportional to the frequency difference between adjacent measurement points. The frequency difference between measurement points

ΔF

is expressed as follows using the span of the sweep frequency

F_{span}

and the number of points

N_{meas}

.

$$\Delta F = \frac{F_{span}}{N_{meas} - 1}$$

Therefore, the measurement range is proportional to (the number of points- 1) and inversely proportional to the span of the sweep range. To enlarge the measurement range, use one of the following methods:

- Increase the number of points.
- Narrow the span of the sweep range.

NOTE When you change the above settings after performing calibration, you need to perform calibration again.

The sweep range is expressed as time or distance. The time of the measurement range

T_{span}

is as follows:

$$T_{span} = \frac{1}{\Delta F}$$

The distance of the measurement range

L_{span}

is expressed as follows using the velocity factor

V

and the speed of light in a vacuum

c

($3\text{x}10^8$ m/s).

$$L_{span} = \frac{Vc}{\Delta F}$$

NOTE The maximum length of the DUT that can be measured in the transmission measurement is

L_{span}

. On the other hand, in the reflection measurement, because the signal goes and returns, it is 1/2 of

L_{span}

.

The velocity factor varies depending on the material through which the signal propagates. For polyethylene, it is 0.66; for Teflon, 0.7.

The change of the setting and the change of the response

The following table shows the effect of the change of the measurement conditions on the response resolution and the measurement range.

Table 3-2 **Effect of setting changes**

Change of setting	Response resolution	Measurement range	Sidelobe
Widen the sweep range.	Becomes smaller.	Becomes narrower.	Does not change.
Sets the window type to maximum.	Becomes larger.	Does not change.	Becomes lower.
Increase the number of points.	Does not change.	Becomes wider.	Does not change.

Setting Window

Because the E5061A/E5062A transforms data within a finite frequency domain to data in distance or time domain, unnatural change of data at the end points within the frequency domain occurs. For this reason, the following phenomena occur.

- The width of the impulse signal and the rise time of the step signal

  The time width occurs in the impulse signal and the rise time occurs in the step signal.

- Sidelobe

  Sidelobes (small peaks around the maximum peak) occur in the impulse signal and the step signal. Ringing occurs on the trace due to sidelobes, which reduces the dynamic range.

By using the window function, you can lower the level of sidelobes. However, the width of the impulse and the rise time of the step become larger as a penalty. You can select from 3 types of windows: maximum, normal, and minimum. The following table shows the relation between the window and the sidelobe/impulse width.

Table 3-3 **Characteristics of window**

Window	Sidelobe level of the impulse signal	Width of the impulse (50% in low pass mode[a])	Sidelobe level of the step signal	Rise time of the step signal (10 – 90%)
Minimum	–13 dB	0.60/frequency span	–21 dB	0.45/frequency span
Normal	–44 dB	0.98/frequency span	–60 dB	0.99/frequency span
Maximum	–75 dB	1.39/frequency span	–70 dB	1.48/frequency span

[a] The value in the band pass mode is 2 times the value in the low pass mode.

The window function is available only when the response in time domain is displayed. It dose not have any effect when the response in frequency domain is displayed.

Operation

Step 1. Press Channel Next (or Channel Prev) and Trace Next (or Trace Prev) to activate a trace for which you want to set the window.

Step 2. Press Analysis - **Fault Location** to display the Fault Location menu.

Step 3. Press **Window** and then select a window type.

Softkey	Function
Maximum	Sets the window type to maximum. b of the Kaiser Bessel function is set to 13.
Normal	Sets the window type to normal. b of the Kaiser Bessel function is set to 6.
Minimum	Sets the window type to minimum. b of the Kaiser Bessel function is set to 0.
Impulse Width or **Step Rise**	Sets the window by specifying the impulse width or step rise time. The lower limit you can set is the value when the window is the minimum; the upper limit when the window is the maximum.
Kaiser Beta	Sets the window by specifying the b value of the Kaiser Bessel function. The Kaiser Bessel function is a function to determine the shape of the window. The allowable setting range is 0 to 13.

NOTE

By specifying **Kaiser Beta**, **Impulse Width**, or **Step Rise**, you can specify a window that is not classified into the three window types. When you specify a window type, these values are set automatically.

Setting Frequency Range and Number of Points

Set the sweep range and the number of points.

Operation

Step 1. Press Channel Next (or Channel Prev) to activate a channel you want to set.

NOTE The frequency range and the number of points are common to all the traces in the channel. If you want to use different settings, use another channel.

Step 2. Press Sweep Setup - **Sweep Type** - **Lin Freq** to set the sweep type to "linear sweep."

NOTE When the sweep type is set to other than the "linear sweep," the fault location feature is not available.

Step 3. Use the following keys to set the sweep range.

Key stroke	Function
Start	Sets the start frequency.
Stop	Sets the stop frequency.
Center	Sets the center frequency.
Span	Sets the frequency span.

Step 4. Press Sweep Setup - **Points** and enter the number of measurement points in the data entry bar in the upper part of the screen.

Step 5. When performing measurement in the low pass mode, press Analysis - **Fault Location** - **Set Freq Low Pass** to adjust the frequency range so that it is appropriate for the low pass mode. The frequency changes depending on the stop frequency as shown below.

Condition of the stop frequency	Frequency setting
> 300 kHz x the number of points	Start frequency = stop frequency/number of points
< 300 kHz x the number of points	Start frequency = 300 kHz Stop frequency = 300 kHz x number of points

NOTE If the above condition is met, the **Set Freq Low Pass** softkey is displayed in gray.

Setting the Velocity Factor

NOTE The velocity factor setting affects the cable loss setting and the display range setting. Thus it is recommended to set the velocity factor prior to the cable loss and display range.

Operation

Step 1. Press Channel Next (or Channel Prev) and Trace Next (or Trace Prev) to activate a trace for which you want to set the cable loss value.

Step 2. Press Cal, then scroll the softkey menu to display **Velocity Factor**.

Step 3. Press the **Velocity Factor** softkey and enter the value in the data entry bar in the upper part of the screen.

Setting the cable loss

Operation

Step 1. Press Channel Next (or Channel Prev) and Trace Next (or Trace Prev) to activate a trace for which you want to set the cable loss value.

Step 2. Press Analysis - **Fault Location** to display the Fault Location menu.

Step 3. Press the **Cable Loss** softkey and enter the cable loss value in the data entry bar in the upper part of the screen. The unit differs depending on the display unit: dB/us for the display unit of time (second), dB/100 m for distance (m), and dB/100 Ft for distance (Ft). If the display unit is changed after entry, the cable loss value also changes appropriate for the display unit.

Setting Display Range

Set the range displayed on the graph. The displayed range can be set not only by time but also by distance. The number of response points displayed on the graph is the same as the number of points regardless of the response resolution. Note that, for reflection measurement, the E5061A/62A lets you set the values on the horizontal axis for one-way data or round-trip data.

Operation

Step 1. Press Channel Next (or Channel Prev) and Trace Next (or Trace Prev) to activate a trace for which you want to set the display range.

Step 2. Press Analysis - **Fault Location** to display the Fault Location menu.

Step 3. Press **Unit** and select a unit to set the display range from the following. The unit selected here determines the type of display: in time or in distance.

Key stroke	Function
Seconds	Specifies (time) second.
Meters	Specifies meter (distance).
Feet	Specifies feet (distance).

Step 4. Press the following softkeys and enter the display range in the data entry bar in the upper part of the screen. The data entry bar displays the distance (time when setting distance) corresponding to the set time (or set distance) next to the setting value.

Key stroke	Function
Start	Sets the start value of the display range.
Stop	Sets the stop value of the display range.
Center	Sets the center value of the display range.
Span	Sets the span of the display range.

NOTE You cannot use the stimulus setting hardkeys to set the display range.

Step 5. Press **Reflection Type** to select the type of the values on the horizontal axis in reflection measurement from one-way or round-trip.

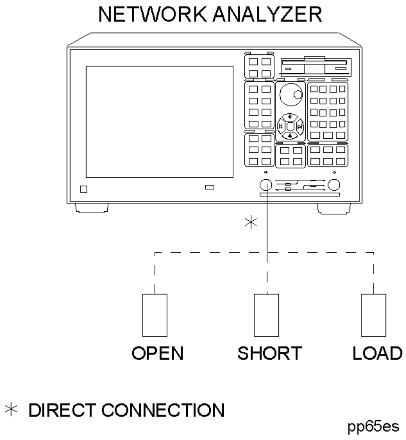
Key stroke	Function
One Way	Sets the values displayed on the horizontal axis to one-way.
Round Trip	Sets the values displayed on the horizontal axis to round-trip.

Calibrate the Analyzer

When practical, a calibration should be done at the measurement reference plane using open, short, and load calibration standards to correct the instrument and optimize accuracy. For calibration procedures, see the analyzer’s “User’s Guide”.

NOTE Most fault location measurements are made by connecting the cable under test directly to the analyzer's Port 1 test port. In this case the measurement reference plane would be the analyzer's port and you would connect calibration standards to the test port as shown in Figure 3-4. Fault location measurements may also be made using a test lead cable. If this is the case, the measurement reference plane would be the end of the test lead cable, and calibration standards would be connected to the end of the test lead cable.

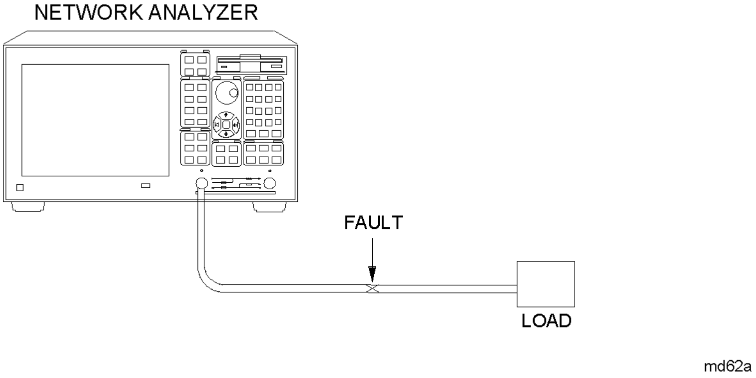
Figure 3-4 **Calibrate the Instrument**



Connect the Cable Under Test

The basic equipment setup for fault location measurements is illustrated in Figure 3-5.

Figure 3-5 **Basic Fault Location Measurement Setup**



Fault Location Measurement Setup using the VBA Utility Program

The E5061A/62A provides a macro program called flt_util.vba, which facilitates the measurement setup for fault location analysis. The utility program calculates and sets up frequency sweep range to get the highest resolution available for the required display distance range. (See “Calculating Measurement Conditions” on page 41 for more information on frequency range calculation.) The utility program sets up following measurement conditions as well as the frequency sweep range so that you can start fault location analysis from the preset condition by using the utility program:

- Sweep type - Linear Frequency
- Unit - meter
- Reflection Type - One Way
- Fault Location- ON

You need to set up the following parameters manually according to your measurement requirements:

- Number of points
- Cable loss
- Velocity factor
- Window

Operation

Step 1. Press Channel Next (or Channel Prev) and Trace Next (or Trace Prev) to activate a trace for which you want to perform fault location analysis.

Step 2. Insert the VBA utility program disk furnished with the analyzer (Agilent part number: E5061-180x8) in to the floppy disk drive of the analyzer.

NOTE The utility program can be copied into the analyzer’s hard disk drive to be used as a working file for easier operation.

Step 3. Press Macro Setup to display the softkey menu for macro processing.

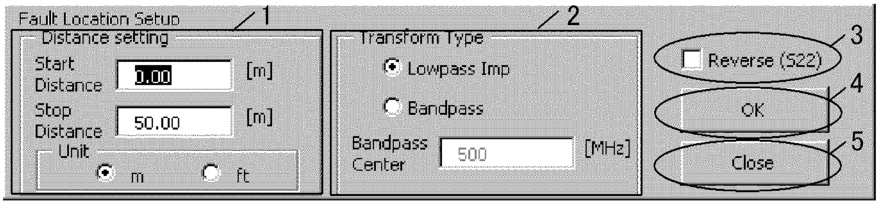
Step 4. Press **Load Project** to display the dialog box, select flt_util.vba in the floppy disk, and press **Open**.

NOTE You can load and run the utility program with fewer softkey operations using the load and run function. See Analyzer's User's Guide for details.

Step 5. Press **Select Macro - Module1 main** to execute the macro program.

Step 6. The Fault Location Setup window appears in the lower part of the screen. Following procedures will be performed with this setup window.

Fault Location Setup Window



Fault Location Setup

Distance setting

Start Distance: 0.00 [m]

Stop Distance: 50.00 [m]

Unit: ● m ○ ft

Transform Type: ● Lowpass Imp ○ Bandpass

Bandpass Center: 500 [MHz]

☐ Reverse (S22)

Step 7. Select the unit of distance (meter or feet), then enter the start and stop distance values.

NOTE The distance values can be between 0 m to 10000 m (32808.4ft).

Step 8. Select the transformation type: Lowpass impulse or Bandpass. In case of bandpass mode, enter the center frequency.

NOTE Center frequency can be from 1.3 MHz to the analyzer's highest frequency minus 1 MHz.

Step 9. If you measure S22 (instead of S11) check the Reverse (S22) check box.

Step 10. Press **OK** to setup the analyzer using the parameters entered in the setup window.

NOTE The velocity factor and number of points need to be properly set before this step because these parameters are used to calculate the frequency sweep range. If you change these values after this step, the analyzer setup can be invalid.

Step 11. Press **Close**, if you complete setup, to close the fault location setup window.

4 Making SRL Measurements

This chapter explains how to make SRL measurements.

NOTE

Refer to “Cable Impedance and Structural Return Loss Measurement Theory” on page 14 for detailed information on how the analyzer measures cable impedance and structural return loss.

How to Make SRL Measurements

A typical SRL measurement consists of the following steps:

1. Setting the sweep type, the sweep range, and the number of points
2. Enabling the SRL function.
3. Setting the average impedance.
4. Calibrate the analyzer.
5. Connect the cable under test
6. Determine the connector model.
7. Perform the SRL Cable Scan
8. Interpret the SRL Measurement

Each step is described on the following pages.

Setting Sweep Type, Sweep Range, and Number of Points

Set the sweep range and the number of points. If you perform the SRL cable scan, use the VBA utility program to set up the analyzer as described in “SRL Cable Scan Setup using the VBA Utility Program” on page 70 instead of the following manual procedures.

NOTE The SRL utility program not only sets sweep conditions but also enables the SRL function and sets the average impedance described in the following sections.

Operation

Step 1. Press Channel Next (or Channel Prev) to activate a channel you want to set.

NOTE The frequency range and the number of points are common to all the traces in the channel. If you want to use different settings, make them on another channel.

Step 2. Press Sweep Setup - **Sweep Type** and select a sweep type with the softkeys.

Step 3. Use the following keys to set the sweep range.

Key stroke	Function
Start	Sets the start frequency.
Stop	Sets the stop frequency.
Center	Sets the center frequency.
Span	Sets the frequency span.

Step 4. Press Sweep Setup - **Points** and enter the number of measurement points in the data entry bar in the upper part of the screen.

Enabling SRL Function

NOTE For channels for which SRL is enabled, it affects the calculation of the reflection coefficient and does not affect the transmission coefficient.

Operation

Step 1. Press Channel Next (or Channel Prev) to activate a channel for which you want to enable the SRL feature.

Step 2. Press Analysis - **SRL** to display the "SRL" menu.

Step 3. Press the **SRL** softkey to enable the SRL feature (**ON**).

Setting Average Impedance

The E5061A/62A lets you select manual entry or auto calculation for the average cable impedance.

Operation

Step 1. Press Channel Next (or Channel Prev) to activate a channel for which you want to set the average impedance.

Step 2. Press Analysis - **SRL** to display the "SRL" menu.

Step 3. When calculating the average impedance automatically (the preset value has been set automatically), press **Z Cutoff Freq.** to specify the cutoff frequency to calculate the average impedance. If **Z Cutoff Freq.** is not available, the instrument is in manual entry mode, so press **Auto Z** to turn it on and specify **Z Cutoff Freq.** again.

NOTE If you want to enter the average impedance value manually, set **Auto Z** to OFF to switch to manual entry mode, in which you can enter **Manual Z**. **Press Manual Z** and specify the average impedance value.

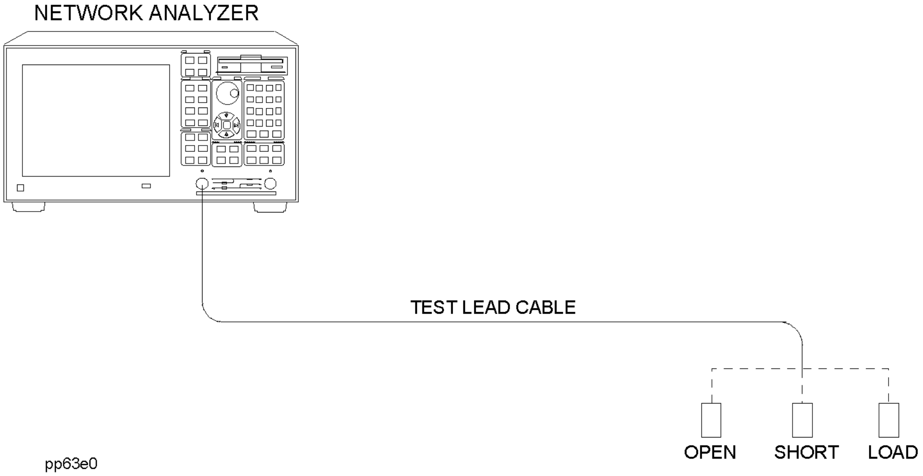
Note that, if there is no measurement value from the start frequency to the cutoff frequency, the value for manual entry is used as the average impedance value even in mode to calculate the average impedance automatically.

Calibrate the Analyzer

When practical, a calibration should be done at the measurement reference plane using open, short, and load calibration standards. For calibration procedures, see the analyzer’s “User’s Guide”.

NOTE Most SRL measurements are made using a test lead cable. If this is the case, the measurement reference plane would be the end of the test lead cable as shown in Figure 4-1. If you will be testing cables by connecting them directly to the analyzer's test port, you should perform the calibration at the analyzer's port.

Figure 4-1 **Calibrate the Instrument for an SRL Measurement**



Verifying the Calibration

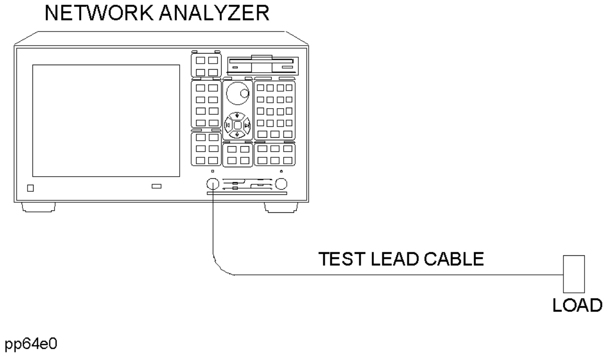
After calibrating, it is important to verify that the calibration is good. Always determine your system directivity and verify the quality of your test lead cable after performing a calibration.

When verifying the calibration and the quality of your test lead cable, you should look for a combination of good system directivity (<-50 dB, but acceptable up to -40 dB) and small variations in peak amplitudes (<10 dB) when the test lead cable is wiggled or moved.

Determine System Directivity.

1. Determine the system directivity by connecting the load standard to the end of the test lead cable as shown in Figure 4-2. (Or, if your reference plane is the analyzer's RF OUT (or PORT 1) test port, connect the load directly to that front panel connector.)

Figure 4-2 **Connect the Load**



2. Observe the magnitude of the response on measurement channel 1. The highest peak response on channel 1 is the system directivity. If the peak response on channel 1 is <-50 dB, the calibration is good. If the peak response is >-40 dB, you should recalibrate the analyzer.

NOTE Measurement quality is related to system directivity. For the highest quality measurements, system directivity should be <-50 dB, but measurement quality is acceptable up to -40 dB. See "SRL Measurement Uncertainty vs System Directivity" on page 88.

Also see "Measurement Uncertainties" on page 25.

Determine the Quality of the Test Lead Cable.

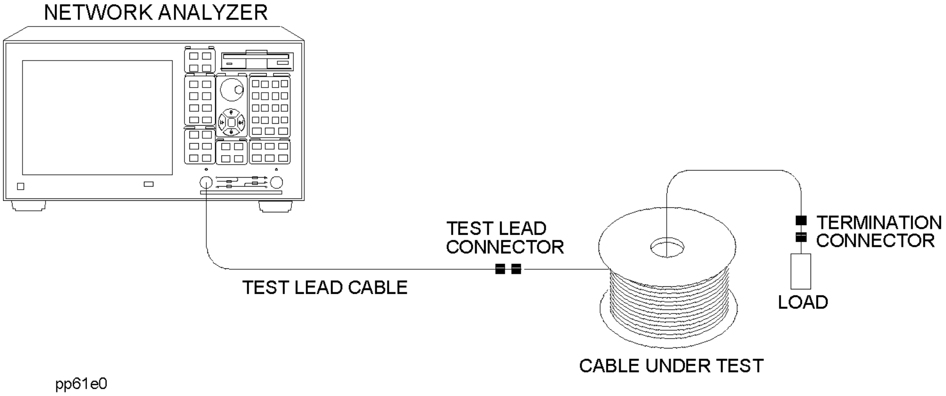
1. Leave the load connected to the end of the test lead cable and note the level of the peak response on measurement channel 1 (the system directivity).
2. Wiggle the test lead cable while observing the response on the analyzer's display.
    a. If the measurement trace is relatively stable, the test lead cable is of good quality.
    b. If you observe significant movement in the peaks of the measurement trace when wiggling the cable (>10 dB), the test lead cable may need to be replaced.

NOTE Variation in the system directivity that occurs as a result of test lead cable movement degrades the quality and repeatability of SRL measurements. Take precautions to protect your test lead cables from mishandling or abuse. Do not step on or drive vehicles over test lead cables.

Connect the Cable Under Test

The basic equipment setup for SRL measurements is illustrated in Figure 4-3.

Figure 4-3 **Basic SRL Measurement Setup**



Determine the Connector Model

After connecting the cable under test as shown in Figure 4-3, you should determine the connector model for the best response. The connector model may need to be determined each time a new cable is tested.

When using connectors that have very consistent interfaces, modeling the connector for each new connection to a cable may not be required. When using connectors that do not have a repeatable interface contact, modeling the connector for each new connection to a cable is necessary.

For some SRL measurements, the response of the connector can be critical for obtaining a true measurement of structural return loss. For example, a connector with a return loss of 30 dB will swamp out SRL responses less than about -20 dB. A connector with a 40 dB return loss will provide a more accurate measurement of the -20 dB responses.

Table 4-1 shows the effects of a connector mismatch on the measurement of a -35 dB SRL spike.

Table 4-1 **Measurement Results with Varying Connector Mismatches**

Corrected Connector Return Loss	SRL	Total Measured
-53 dB	-35 dB	-34 dB
-42 dB	-35 dB	-31.8 dB
-35 dB	-35 dB	-29 dB

As indicated by Table 4-1, the best true SRL measurement is made when the contribution of the connector is minimized by

- a good calibration
- a high-quality connector and connection (see Chapter 2, "Cable Preparation")
- a connector model which provides the lowest corrected connector response

The effects of the connector response can be minimized with the built-in connector model and the corrected connector response can be measured while the SRL measurement is being made. For some connectors, a response correction of up to 15 dB or more improvement is possible with the built-in connector model.

NOTE The maximum extent to which the effects of the connector response can be removed is to the accuracy and repeatability of the analyzer system (including the effects of test lead cable stability and quality). The accuracy of the system is given by the system directivity of the analyzer (which can be determined from the trace with a load connected after calibration).

For determining measurement uncertainty, use the value of the system directivity and the connector response. See “SRL Measurement Uncertainty vs Connector Fault” on page 92.

Connector Model for Long Cables

If a long cable is being measured, you can use the “Measure Connector” feature to automatically determine the L and C values. (A long cable is defined as approximately 300 m (1000 ft)).

3. Press Analysis - **SRL** to display the "SRL" menu.
4. Press **Portx Connector** (x is the port to which the cable is connected).
5. Connect the terminated cable, then press **Measure Connector** to set the L and C values automatically.

Connector Model for Short Cables

6. If you are measuring a short cable, or if you have very large mismatches in the cable under test, you may need to manually set the L and C values.
7. Press Analysis - **SRL** to display the "SRL" menu.
8. Press **Portx Connector** (x is the port to which the cable is connected), press the following softkeys, and specify the connector length and the connector capacitance.

Softkey	Function
Length	Specifies the connector length.
Capacitance	Specifies the connector capacitance.

9. Observe the SRL measurement trace while adjusting the connector length and C values for the best (lowest overall) response.
10. Some cables may be best measured by adjusting only the connector length, other cables may require a connector C adjustment, and some others may require a combination of connector length and C values.

NOTE When manually adjusting the connector length or connector C values, be sure to wait for the analyzer to complete a sweep and update the display before trying another value.

11. You may need to measure the connector using a Smith chart to get the best connector model:

    Press Format - **Smith - Real/Imag**

    Observe the display while adjusting the connector C and connector length parameters. The best response is obtained when the Smith chart response has been most compacted by the connector C and connector length adjustments.

NOTE If you cannot obtain a low enough response by adjusting the connector length and/or connector C values, you should perform a fault location measurement on the connector and the cable under test. (See Chapter 3, "Making Fault Location

Measurements") Be sure to determine the quality of the connector being used; some cable connectors degrade rapidly with use. The response of a bad connector is often large enough to swamp out the response from cable SRL.

Connector L and C Values

Table 4-2 shows some typical values for two types of slip-on connectors for mainline cable:

Table 4-2 **Typical L and C Values**

Connector	L Value	C Value
GTC-700-TX-GHZ-N (“GHz”)	40 to 80 mm	0 to 0.15 pF
GTC-700-TX-N (“Pogo”)	-12 to 12 mm	0 to 0.125 pF

For the connectors in Table 4-2, use of values within these ranges should be optimum for the best corrected connector fault response and lowest SRL spikes. Values far outside this range usually indicate a bad calibration, a poor connector or connection, or a close-in cable fault which cannot be compensated by the connector model.

NOTE The optimum calculated value for the connector lengths of “Gilbert Pogo” connectors may be slightly negative. This is a normal value and should not be a cause for concern.

For type-F connectors, which are typically used to measure 75 ohm drop cable, the range of connector L and C values will vary widely and will depend greatly on the quality of the type-F connector.

Perform the SRL Cable Scan

Once the connector model has been established for the best response, the cable should be scanned at narrow frequency resolution to look for narrow response spikes that are characteristic of periodic defects in the cable. The SRL cable scan is required to determine the cable's SRL with 125 kHz resolution.

By taking five sweeps of 1601 points each at slightly different frequency ranges (see Table 4-3), the analyzer can obtain 8005 distinct frequency points to achieve the desired frequency resolution of 125 kHz.

The resolution of the SRL measurement is determined by the following formula:

$$Resolution = \frac{F_{stop} - F_{start}}{N}$$

where N is the number of measurement points. See the table below.

	F_{start}	F_{stop}	N	Resolution
No Cable Scan	5 MHz	1000 MHz	201	4.95 MHz
	5 MHz	1000 MHz	1601	612 kHz
Using Cable Scan	5 MHz	1000 MHz	8005	125 kHz

Table 4-3 **SRL Cable Scan Frequency Sweeps**

Sweep Number	Start Frequency (MHz)	Stop Frequency (MHz)
1	5.000	999.500
2	5.125	999.625
3	5.250	999.750
4	5.375	999.875
5	5.500	1000.000

SRL Cable Scan Setup using the VBA Utility Program

The E5061A/62A provides a macro program called srl_util.vba, which facilitates the measurement setup for SRL cable scan.

Operation

Step 1. Press Channel Next (or Channel Prev) and Trace Next (or Trace Prev) to activate a trace for which you want to set up.

Step 2. Insert the VBA utility program disk furnished with the analyzer (Agilent part number: E5061-180x8) in to the floppy disk drive of the analyzer.

NOTE The utility program can be copied into the analyzer's hard disk drive to be used as a working file for easier operation.

Step 3. Press Macro Setup to display the softkey menu for macro processing.

Step 4. Press **Load Project** to display the dialog box, select srl_util.vba in the floppy disk, and press **Open**.

Step 5. Press **Select Macro - Module1 main** to execute the macro program.

Step 6. The SRL Setup window appears in the lower part of the screen. Click on the following 2 settings to check-mark them with the mouse as necessary and press OK.

- Connector Fault - Splits the screen vertically into 2 sections and displays trace 2 with fault location on. The display range of trace 2 is set to 0 to 5 m.
- Reverse(S22) - Sets the measurement parameter to S22.

NOTE Executing this macro program automatically makes the following settings in addition to the above.

Start frequency - 5 MHz, stop frequency - 1 GHz (the display range of trace 1)

Sweep type - Linear Frequency

Number of points - 1601

SRL - ON

Perform the SRL Cable Scan Using the VBA Utility Program

The E5061A/62A provides a macro program called srl_util.vba, which performs SRL cable scanning.

Operation

NOTE It is recommended to do calibration before scanning a cable.

NOTE You can skip the step 1 and 4 of the following procedures if you have already loaded the SRL utility program to setup the analyzer for the SRL Cable Scan

Step 1. Press Channel Next (or Channel Prev) and Trace Next (or Trace Prev) to activate a trace for which you want to perform the cable scan.

Step 2. Insert the VBA utility program disk furnished with the analyzer (Agilent part number: E5061-180x8) in to the floppy disk drive of the analyzer.

NOTE The utility program can be copied into the analyzer's hard disk drive to be used as a working file for easier operation.

Step 3. Press Macro Setup to display the softkey menu for macro processing.

Step 4. Press **Load Project** to display the dialog box, select srl_util.vba in the floppy disk, and press **Open**.

Step 5. Press **SelectMacro - CableScan main** to execute the macro program.

Step 6. The following processing is automatically performed.

- Makes the following settings: SRL - ON, sweep type - Linear Frequency, number of points - 1601, display format - LogMag.
- Sets the measurement parameter of the active trace to S22 (or S11) and enters into reflection measurement status.
- Sweep five times with the frequency settings listed in the Table 4-3.
- Performs the measurement again that gives the highest SRL value of the 5 sweeps.
- Moves the active marker to the maximum value.

Interpret the SRL Measurement

Periodically spaced SRL response bumps will cause frequency spikes at a frequency given by the following formulas:

$$wavelength \approx \frac{c}{f}$$

$c =$ speed of light $\quad f =$ frequency

$$\frac{wavelength}{2} = \text{spacing between the bumps}$$

The bumps may be located near one end of the cable or somewhere in the middle. Although the bumps from individual defects may be small, fault location measurements may be useful to determine the location(s) of the cable's defect(s).

See “SRL and Periodic Cable Faults” on page 18 for more information.

5

Making Impedance Measurements

The impedance of a cable under test can be displayed by using the parameter conversion function. The impedance can be displayed versus distance (for fault location measurements), or versus frequency (for reflection measurements).

How to Display Impedance

The following procedures show how to display impedance with the Linear Magnitude format.

Step 1. Press Analysis.

Step 2. Press **Conversion**.

Step 3. Press **Function**.

Step 4. Press **Z: Reflection** to select the conversion to impedance from reflection measurement.

Step 5. Press **Conversion** to turn ON the conversion function.

Step 6. Press Format.

Step 7. Press **Lin Mag** to select Linear Magnitude format.

The measured reflection coefficient is used to compute the impedance. The analyzer uses the formula

$$Z = Z_{sys} \cdot \left|\frac{(1+\Gamma)}{(1-\Gamma)}\right|$$

where Γ = measured complex reflection coefficient and
where Z_{sys} = 50 or 75 Ω

When the complex reflection coefficient, Γ, is zero, there are no reflections and the cable under test will be exactly the same impedance as the system impedance, Z_{sys}.

6

Characterizing and Verifying Antenna Systems

Fault location measurements are needed to verify and characterize antenna systems.

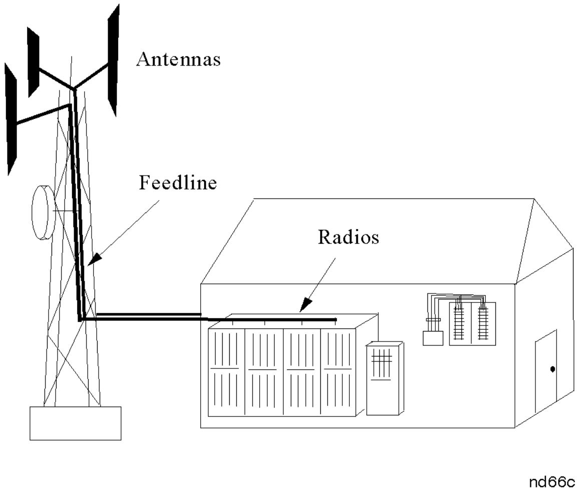
This chapter provides an introduction to the antenna feedline system, including the potential problems that may occur. Typical measurements used to characterize these antenna systems are also described. In conclusion, an installation and maintenance plan that can be used to verify the performance of the antenna system is presented.

This chapter contains the following information:

- antenna feedline system
- potential problems
- typical measurements
- installation and maintenance planning

Antenna Feedline System

Figure 6-1 **Typical Cell Site**



A typical cell site contains many pieces of hardware. These may include, but are not limited to:

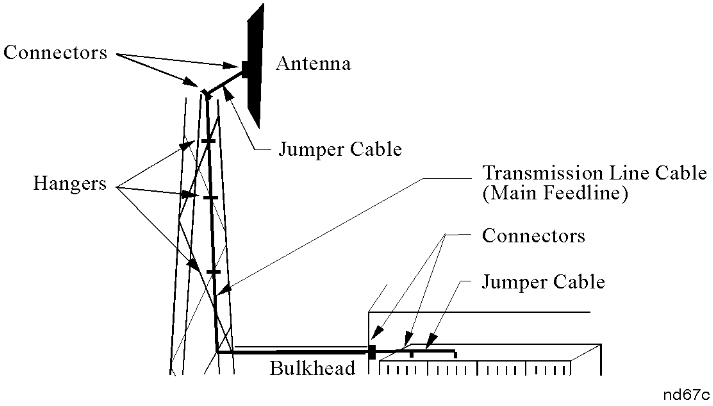
- racks of radios
- combiners
- coaxial feedline
- tower-mounted amplifiers
- lightning protection devices
- filters
- antennas

These may operate at multiple cellular, personal communication system (PCS), and microwave frequencies.

The components of the cell site that lie between the transmitting/receiving ports (radios) up to and including the antenna are commonly referred to as the “antenna system.” Those components between the antenna and the radio ports are referred to as the “antenna feedline system.”

Evaluating the quality of the components within the antenna feedline system is of utmost importance in today's communication systems. For example, the attenuation of the transmission lines, along with the insertion loss of the combiner, determines the majority of loss that occurs in the transmitting portion of the antenna system. Any imperfections or damage to this feedline can severely impact the transmission quality of the entire system.

Figure 6-2 **Antenna Feedline System**



The antenna system assembly consists of:

- main feedline and jumper cables (coaxial or waveguide)
- connectors or flanges
- hangers
- antenna

It is important to understand the effect the feedline assembly has on the entire system to help avoid intermittent problems and failures.

Knowing performance parameters such as feedline loss is especially critical when operating in the 800 to 900 MHz and 1.8 to 2.0 GHz frequency ranges. At these frequencies, the wavelength is very short and suffers greater propagation attenuation than the longer wavelength signals of lower frequencies. Thus, the system performance, in terms of the power transferred from the transmitter to the antenna, and from the antenna to the receiver, is characterized by the antenna feedline.

Potential Problems

Antenna feedline systems are typically the most common sources of failure in a communication system. The problems associated with these systems can be hard to identify and, once found, are usually located high on a tower. With the right test equipment, identifying and isolating problems becomes very easy, and can be done at ground level.

Transmission Lines/Antennas

The following problems may occur with transmission lines or antennas:

- weather damage
    - –lightning
    - –moisture
    - –corrosion
- vandalism
- cable discontinuities
- pinched cables

The transmission lines are exposed to all sorts of weather conditions which cause damage by mechanical stress, lightning, moisture, and corrosive atmospheres. Towers make good targets for vandals, as a very common cause of failure is created by bullet holes in the cables or antennas. Other common problems in the feedlines or antennas include discontinuities such as damaged junctions or support bends, and pinched cables caused by over-tightened hangers, or accidental denting by tower climbers.

Connectors

The following conditions may cause problems with connectors:

- low quality connectors
- poor connector contact
- moisture
- corrosion

Connectors present a great potential for problems, since moisture will invariably find its way inside. Normal atmospheric pressure changes will always equalize unless the system is deliberately pressurized. Low quality connectors, poor connector contact, corroded connectors, and improperly tightened or loose connectors are examples of critical fault conditions. Over time, these conditions can cause degradation or complete system failure.

Typical Measurements

The following typical measurements are used to characterize the antenna feedline system and help identify problems:

- Before installation—*incoming inspection*
    - –cable return loss
    - –characteristic impedance
    - –velocity factor
- Installation—*baseline tests*
    - –insertion loss
    - –antenna return loss (SWR)
    - –feedline system return loss (SWR)
    - –fault location
    - –length
- Maintenance—*compare to baseline*
    - –antenna return loss (SWR)
    - –feedline system return loss (SWR)
    - –fault location

NOTE To reduce interference when performing return loss and fault location measurements, reduce the system IF bandwidth . To further reduce interference when performing fault location measurements, use the bandpass mode.

Before Installation

Before installation, ensuring specified performance with incoming inspection can save hours of needless disassembly and reassembly of the cell site's antenna system. Important characteristics at this stage include cable return loss, characteristic impedance, and velocity factor.

Installation

At installation, it is necessary to do a complete set of tests on the antenna feedline system in order to fully characterize its initial performance. During assembly, return loss is usually measured after the addition of each component. Once assembly is complete, tests such as insertion loss, feedline system return loss, fault location and length are done. For characterization of the antenna, independent of the contributions made by the feed system, an important parameter is antenna return loss.

A significant property of an antenna is the propagation characteristics that result in antenna patterns. Many of the measured properties of the overall antenna system (which are determined at installation) are good indicators of whether or not the antenna pattern has been altered. Typically, this condition is confirmed from data collected by drive tests that define the cell site “foot print.”

The ability to save the measurement data taken at installation for a baseline is very important. This allows you to compare the original data with future measurement results, making problem detection and troubleshooting much easier.

Maintenance

Routine maintenance allows early detection of problems or trends, thus avoiding costly system shutdowns. However, when service must be interrupted, the outage can be minimized with rapid diagnostic procedures. The frequency with which routine maintenance is performed varies widely. But on average, it is done every six months. This is often done by the service provider, or may be contracted out to an independent group. Maintenance tests are typically limited to return loss and fault location, the two key indicators of the antenna feedline's integrity.

Installation and Maintenance Planning

Installation and maintenance planning is used to verify the performance of the antenna system. The following tables can be used to enter test results along with the specified limits and pass/fail margins. This allows for quick monitoring and recording of the antenna system's performance.

Table 6-1 Incoming Inspection

Characteristic	Limit/Spec	Test Result	Date/Time
Cable attenuation at 900 MHz (dB/100 ft.)			
Characteristic impedance			
Velocity factor			

Table 6-2 Installation

Characteristic	Limit/Spec	Test Result	Date/Time
Insertion loss			
Cable attenuation (dB/100 ft.)			
System return loss (dB)			
Cable length (ft.)			
Connector loss (fault loc., dB)			

Table 6-3 Maintenance

Characteristic	Pass/Fail Margin	Test Result	Date/Time
System return loss (dB)			
Connector loss (fault loc., dB)			

As described, the tests are typically divided into three categories:

1. *Incoming inspection*, which includes those tests done on the cable components before assembly to verify specified performance.
2. *Installation measurements*, which allow you to verify system integrity as well as record baseline data.
3. *Maintenance.*

The limits and pass/fail margins are useful for monitoring potential problems. A "fail" condition during maintenance may require immediate repair. By monitoring the "margin" of a pass condition, replacement before failure can be planned.

7

Characteristics

Overview of Characteristics

This chapter contains analyzer performance data for SRL and fault location measurements. For complete specification and characteristic information for your analyzer, see your analyzer's *User's Guide*.

Frequency Range Considerations

The higher frequency span available on the Agilent Technologies E5061A/E5062A can provide greater resolution when making fault location measurements. See the discussion in “Fault Location Distance Range and Resolution” on page 96.

However, when the analyzer has chosen a large frequency span (based on the user-defined start and stop distances), the performance of the system at high frequencies may become important.

Many coaxial cables perform poorly (or not at all) above 1500 MHz. If the cable or system you are measuring does not perform well at high frequencies, change the fault location frequency mode to band pass. Band pass mode may be used to limit the frequency range the analyzer will use when making fault location measurements.

Phase Considerations

In addition to using the connector capacitance and connector length functions to improve the connector model, you can use the electrical length and port extension features. Electrical length and port extension provide the same function as connector length, but these settings are entered in units of seconds, rather than length.

SRL data can also be observed in Smith chart format. The Smith chart can be used to verify the connector model for your SRL measurements.

See “Determine the Connector Model” on page 65 for more information.

General Performance Characteristics

SRL Measurement Mode	Structural Return Loss
Fault Location Measurement Mode	Return loss (dB) versus distance Reflection coefficient magnitude versus distance SWR versus distance
Dynamic Range	40 dB (based on system directivity after calibration)
Windowing	Minimum, medium and maximum windows are available for optimizing distance response data
Amplitude Accuracy[1]	±2.5 dB typical (minimum windowing) ±1.2 dB typical (medium windowing) ±0.4 dB typical (maximum windowing)
Data Correction	Data is normalized to the open/short/load response at the output port. Data correction for line losses and preceding mismatches is also available.
Measurement and Data Storage[2]	Use the internal disks to store and recall setups and data.
Markers	Ten independently controlled markers can be used to display return loss, reflection coefficient, SWR, or impedance versus distance.
Limit Lines	Limit lines may be entered for comparison to specification limits and pass/fail testing.
Remote Programming	The analyzer can be controlled from an external computer through the IEEE 488.2 GPIB port or the LAN interface. Use standard SCPI program subsystem commands to control the analyzer.
Hard Copy[2]	The analyzer can be configured to output print data to the parallel port, the USB port, or to a file. The data can be either a graph or a tabular listing of data points.
Fault Range	Up to 10000.00 meters. (See Table 7-10 and Table 7-11.)
Resolution	Down to 0.195% of range. (See Table 7-10 and Table 7-11.)

1. Inaccurate cable loss factor and/or multiple fault correction may introduce additional error uncertainties.
2. See your analyzer's *User's Guide* for information.

SRL Measurement Uncertainty vs System Directivity

System directivity, system and test lead stability, and cable connector mismatch all affect measurement uncertainty. Figure 7-1 shows a graph of measurement uncertainty curves for a –49 dB directivity system applied to various return loss values. The upper trace is return loss plus error, the bottom trace is return loss minus error, and the middle trace is the return loss with no error.

Figure 7-2 shows the same for a –40 dB directivity system.

Notice as the return loss gets larger (closer to 0 dB), the effect of the error is smaller. One use for this graph is to determine the measurement guard band needed to specify cable performance. For example, if a cable must meet a –30 dB return loss specification, and the system directivity is –49 dB, then the value of –32 dB must be measured to guarantee –30 dB.

To determine what the measured value must be, draw a line perpendicular to the x-axis at the specification value. Draw another line from the point at which it intersects the lower uncertainty trace to the y-axis. The y-axis value is the value that must be measured to guarantee the specification.

Conversely, if a cable is shipped with a measured value of –35 dB for structural return loss, the value that might be measured by a system other than the one it was originally tested on can be determined by drawing a vertical line through the x-axis at –35 dB. (Refer, still, to Figure 7-1). The upper and lower traces show, on the y-axis, the limits with which the cable SRL can be determined. For this example, the –35 dB cable could measure as bad as –33.5 dB, or as good as –37 dB. But there is more to consider. If the first measurement of the cable was performed on a similar system, it will have a similar uncertainty. For this example, a cable measured as –35 dB on the first system could be as bad as –31.5 dB. This could be measured on a second system as good as –35 dB (if the directivity error is exactly the same magnitude and phase as the first system), or as bad as –30.5 dB (if the directivity magnitude is the same, but the phase is opposite). Fortunately, as with impedance measurements, the directivities are unlikely to be worst case in magnitude at the same frequency and with opposite phase on two different systems.

Table 7-1 shows the effect of system directivity on cable impedance. A measured impedance of 74 ohms will have an uncertainty of ±1.5 Ω in a –40 dB system, and an uncertainty of ±0.6 Ω in a –48 dB directivity system.

Table 7-1 **Effect of Directivity on Cable Impedance for Z_{DUT} = 74 Ohms**

Directivity (Logarithmic)	**Refl. Coef. (Linear)**	**Measurement** Uncertainty	ρ_m	Z_m
40 dB	±0.01	±1.5 ohm	–0.0167	72.5
			+0.0032	75.5
45 dB	±0.00562	±0.8 ohm	–0.0123	73.2
			+0.0011	74.8
48 dB	±0.004	±0.6 ohm	–0.0107	73.4
			+0.0027	74.6

$$Z_m = 75\left(\frac{1 + p_m}{1 - p_m}\right)$$

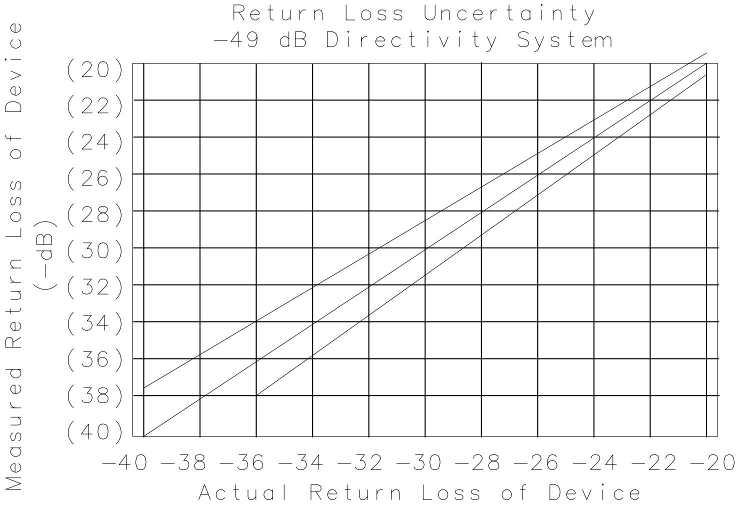
$$\rho_m = \rho_{DUT} \pm 0.01$$

$$\rho_{DUT} = \frac{Z_{DUT} - Z_0}{Z_{DUT} + Z_0}$$

$$\rho_m = \begin{cases} -0.0067 - 0.01 \text{ Min} \\ -0.0067 + 0.01 \text{ Max} \end{cases}$$

$$\rho_{DUT} = \frac{74 - 75}{74 + 75} = -0.0067$$

Figure 7-1 **Return Loss of Device Under Test: –49 dB Directivity**



pd66h21

Table 7-2 **Measurement Uncertainty Window for –49 dB Directivity System**

Return Loss of Cable Under Test		
Measured (Nominal)	**Minimum**	**Maximum**
–40.0	–43.7	–37.4
–32.0	–33.4	–30.9
–28.0	–28.8	–27.2
–25.2	–25.8	–24.7
–23.1	–23.5	–22.7
–21.4	–21.8	–21.1
–20.0	–20.3	–19.7

Figure 7-2 **Return Loss of Device Under Test: –40 dB Directivity**

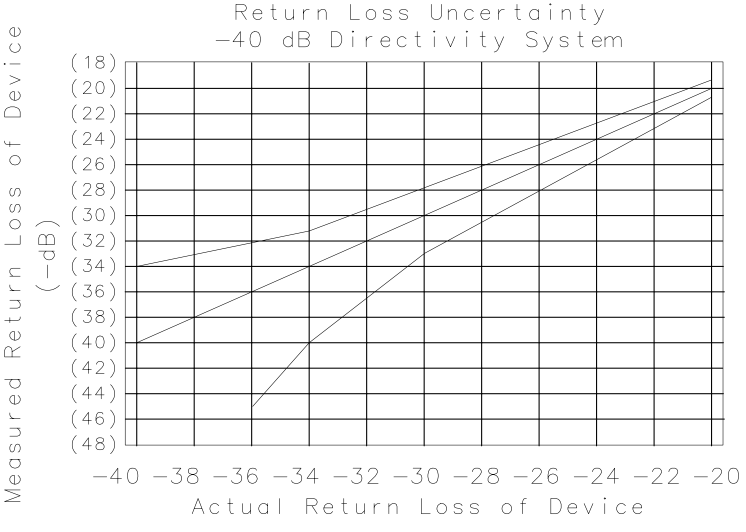


Table 7-3 **Measurement Uncertainty Window for –40 dB Directivity System**

Return Loss of Cable Under Test		
Measured (Nominal)	**Minimum**	**Maximum**
–40.0	—	–34.0
–33.5	–39.0	–30.1
–29.8	–33.0	–27.4
–27.2	–29.4	–25.4
–25.2	–26.9	–23.7
–23.6	–25.0	–22.4
–22.2	–23.4	–21.2
–21.0	–22.1	–20.1
–20.0	–20.9	–19.2

SRL Measurement Uncertainty vs Connector Fault

As discussed earlier, three factors affect the measurement uncertainty:

- system directivity
- system and test lead stability
- cable connector mismatch

System directivity can be measured by connecting the 75 or 50 ohm load standard to the test lead connector and observing the magnitude of the highest response. The highest response is the system directivity.
See “Calibrate the Analyzer” on page 62.

Test lead stability can be measured by connecting the 75 or 50 ohm load standard to the test lead connector, wiggling the cable and observing the response. See “Calibrate the Analyzer” on page 62.

The connector mismatch can be improved by the proper connector model. See “Determine the Connector Model” on page 65.

Minimizing Measurement Uncertainty

The best system performance can be attained by performing a good cal, taking proper care of a high quality test lead cable, and using the best connector model. When these three steps are taken, the optimized connector response can be measured using the “Connector Fault” feature.

You can now calculate the measurement uncertainty using the following procedure and worksheets. Note that the system directivity must also be included when computing measurement uncertainty.

1. Convert the system directivity, fault location, and SRL log (dB) responses to linear reflection coefficients using the following equation:

   Reflection Coefficient = $10^{(SRL(dB)/20)}$

2. Compute the sum and difference responses (assume the responses may have a plus or minus phase).
3. Convert from linear to log (dB) using the following equation:

   dB = $(20)(\mathrm{Log}_{10})$(Reflection Coefficient)

Example:

Table 7-4 Uncertainty Worksheet 1

Measurement	Log (dB)	Refl. Coef. (Linear)
SRL Response	–32 dB	0.0251
Connector Response	–50 dB	0.00316
System Directivity	–49 dB	0.00354

Table 7-5 Uncertainty Worksheet 2

Operation	SRL Response	Connector Response	System Directivity	Result (Linear)	Result (dB)
Max (add)	0.0251	0.00316	0.00354	0.0318	–29.97
Min (subtract)	0.0251	0.00316	0.00354	0.0184	–34.70

Measurement uncertainty = –32 dB +2.03/–2.7 dB

Measurement Uncertainty Tables

The following tables show the relationship between the corrected connector fault response, industry standard SRL cable specifications, and the maximum and minimum measured SRL responses. The tables also take into account the affects of system directivity (which can be determined from the trace with a load connected after calibration).

Table 7-6 Measurement Uncertainty with a –20 dB SRL Response

Corrected Connector	System Directivity	SRL (Actual)	SRL (Measured)	
			Max	Min
–20 dB	–49 dB	–20 dB	–13.83 dB	–49 dB
–25 dB	–49 dB	–20 dB	–15.93 dB	–27.91 dB
–30 dB	–49 dB	–20 dB	–17.38 dB	–23.76 dB
–35 dB	–49 dB	–20 dB	–18.32 dB	–22.08 dB
–40 dB	–49 dB	–20 dB	–18.9 dB	–21.26 dB

Corrected Connector	System Directivity	SRL (Actual)	SRL (Measured)	
			Max	Min
–45 dB	–49 dB	–20 dB	–19.24 dB	–20.84 dB
–50 dB	–49 dB	–20 dB	–19.44 dB	–20.6 dB
–55 dB	–49 dB	–20 dB	–19.55 dB	–20.48 dB
–60 dB	–49 dB	–20 dB	–19.61 dB	–20.4 dB
–65 dB	–49 dB	–20 dB	–19.65 dB	–20.36 dB

Table 7-7 **Measurement Uncertainty with a –26 dB SRL Response**

Corrected Connector	System Directivity	SRL (Actual)	SRL (Measured)	
			Max	Min
–30 dB	–49 dB	–26 dB	–21.38 dB	–36.51 dB
–35 dB	–49 dB	–26 dB	–22.92 dB	–30.82 dB
–40 dB	–49 dB	–26 dB	–23.92 dB	–28.74 dB
–45 dB	–49 dB	–26 dB	–24.54 dB	–27.76 dB
–50 dB	–49 dB	–26 dB	–24.91 dB	–27.25 dB
–55 dB	–49 dB	–26 dB	–25.12 dB	–26.98 dB
–60 dB	–49 dB	–26 dB	–25.25 dB	–26.83 dB
–65 dB	–49 dB	–26 dB	–25.32 dB	–26.74 dB

Table 7-8 **Measurement Uncertainty with a –30 dB SRL Response**

Corrected Connector	System Directivity	SRL (Actual)	SRL (Measured)	
			Max	Min
–30 dB	–49 dB	–30 dB	–23.51 dB	–49 dB
–35 dB	–49 dB	–30 dB	–25.52 dB	–39.75 dB
–40 dB	–49 dB	–30 dB	–26.9 dB	–34.86 dB
–45 dB	–49 dB	–30 dB	–27.79 dB	–32.98 dB
–50 dB	–49 dB	–30 dB	–28.33 dB	–32.07 dB
–55 dB	–49 dB	–30 dB	–28.65 dB	–31.6 dB
–60 dB	–49 dB	–30 dB	–28.83 dB	–31.35 dB
–65 dB	–49 dB	–30 dB	–28.94 dB	–31.21 dB

Table 7-9 **Measurement Uncertainty with a –32 dB SRL Response**

Corrected Connector	System Directivity	SRL (Actual)	SRL (Measured)	
			Max	Min
–35 dB	–49 dB	–32 dB	–26.66 dB	–48.43 dB
–40 dB	–49 dB	–32 dB	–28.25 dB	–38.73 dB
–45 dB	–49 dB	–32 dB	–29.3 dB	–35.95 dB
–50 dB	–49 dB	–32 dB	–29.94 dB	–34.7 dB
–55 dB	–49 dB	–32 dB	–30.33 dB	–34.07 dB
–60 dB	–49 dB	–32 dB	–30.55 dB	–33.74 dB
–65 dB	–49 dB	–32 dB	–30.68 dB	–33.55 dB

Fault Location Distance Range and Resolution

Resolution improves as the range is shortened and as the number of measurement points are increased. (See the following tables and graphs.) Distance is displayed in feet or meters. Typical range is limited by transmission line losses.

NOTE The following distance range discussion assumes that one way reflection measurement is selected.

Range

Maximum range is a function of the velocity factor (V_f), frequency span (F_s), the velocity of light in a vacuum (c = 2.99796 X 10^8 m/sec), and the number of measurement points (NP), and is determined (*in meters*) using the following formula:

$$Range = \frac{V_f(c)(NP-1)}{2(F_s)} = StopDis\tan ce$$

Resolution

Maximum resolution is a function of the velocity factor (V_f), frequency span (F_s), sampling factor (N_s: 128 for 101 points, 256 for 201 points, and 512 for 401 points), the velocity of light in a vacuum
(c = 2.99796 X 10^8 m/sec), and the number of measurement points (NP), and is determined (*in meters*) using the following formula:

$$Resolution = \frac{V_f(c)(NP-1)}{2(F_s)(N_s)} = \frac{Range}{N_s} = \frac{StopDis\tan ce}{N_s}$$

Typical Distance Data in Feet

Table 7-10 **Fault Location Distance Range or Maximum Distance (in feet) Versus Resolution at 201 Points**[1]

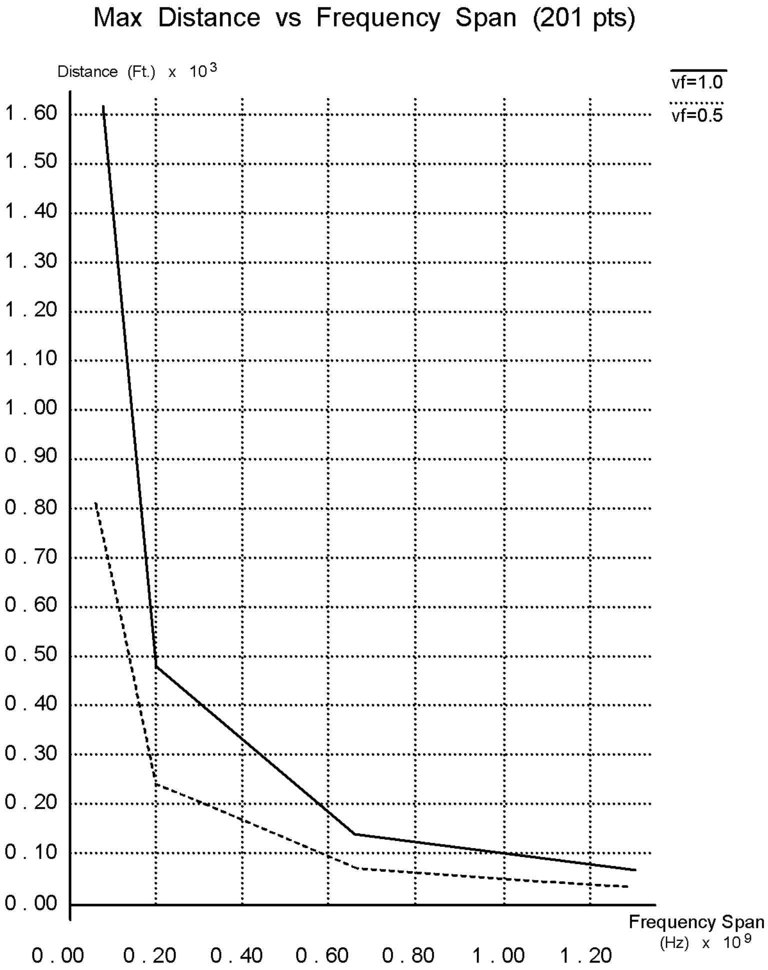
Frequency Span (MHz)	Distance Range (feet)	Resolution (feet)	Frequency Span (MHz)	Distance Range (feet)	Resolution (feet)
Velocity Factor = 0.5			**Velocity Factor = 0.8**		
1300	37.18	0.15	1300	59.49	0.23
650	74.36	0.29	650	118.97	0.46
200	241.67	0.94	200	386.67	1.51
60	805.55	3.15	60	1288.88	5.03
20	2416.66	9.44	20	3866.65	15.10
Velocity Factor = 0.6			**Velocity Factor = 0.9**		
1300	44.62	0.17	1300	66.92	0.26
650	89.23	0.35	650	133.85	0.52
200	290.00	1.13	200	435.00	1.70
60	966.66	3.78	60	1450.00	5.66
20	2899.99	11.33	20	4349.99	16.99
Velocity Factor = 0.7			**Velocity Factor = 1.0**		
1300	52.05	0.20	1300	74.36	0.29
650	104.10	0.41	650	148.72	0.58
200	338.33	1.32	200	483.33	1.89
60	1127.77	4.41	60	1611.11	6.29
20	3383.32	13.22	20	4833.32	18.88

---

[1] See Appendix A for typical coaxial cable characteristics including velocity factor.

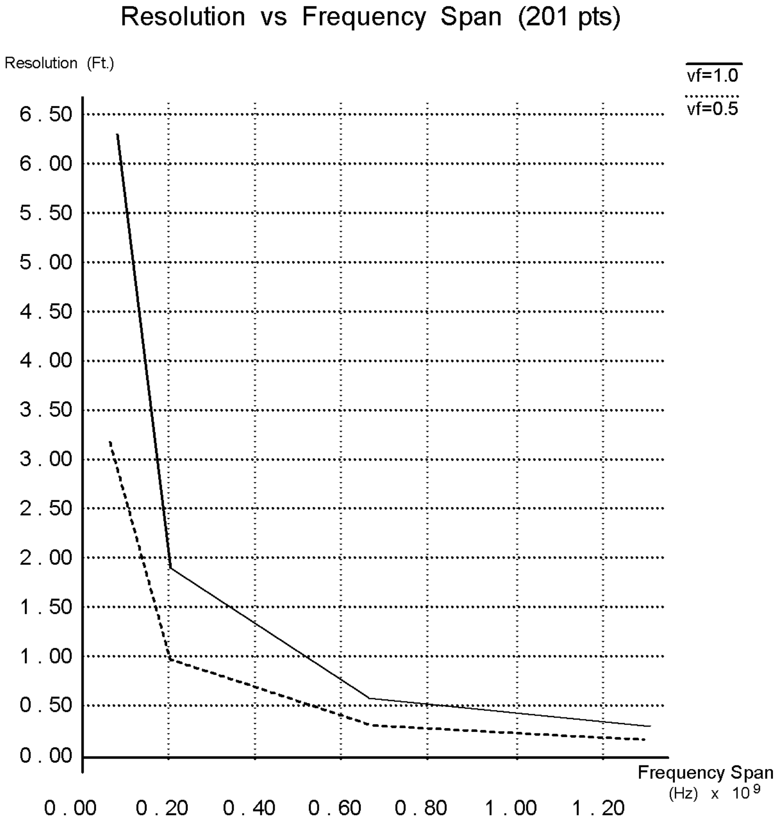
The following two graphs are plots of maximum distance versus frequency span and resolution versus frequency span using data from Table 7-10. Please note that data is plotted only for velocity factors of
0.5 and 1.0.

Figure 7-3



md67a

Figure 7-4



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Distance Data in Meters

Table 7-11 **Fault Location Distance Range or Maximum Distance (in meters) Versus Resolution at 201 Points**[1]

Frequency Span (MHz)	Distance Range (meters)	Resolution (meters)	Frequency Span (MHz)	Distance Range (meters)	Resolution (meters)
Velocity Factor = 0.5			**Velocity Factor = 0.8**		
1300	11.59	0.05	1300	18.54	0.07
650	23.18	0.09	650	37.08	0.14
200	75.32	0.29	200	120.52	0.47
60	251.08	0.98	60	401.72	1.57
20	753.23	2.94	20	1205.17	4.71
Velocity Factor = 0.6			**Velocity Factor = 0.9**		
1300	13.91	0.05	1300	20.86	0.08
650	27.81	0.11	650	41.72	0.16
200	90.39	0.35	200	135.58	0.53
60	301.29	1.18	60	451.94	1.77
20	903.87	3.53	20	1355.81	5.30
Velocity Factor = 0.7			**Velocity Factor = 1.0**		
1300	16.22	0.06	1300	23.18	0.09
650	32.45	0.13	650	46.35	0.18
200	105.45	0.41	200	150.65	0.59
60	351.51	1.37	60	502.15	1.96
20	1054.52	4.12	20	1506.46	5.88

---

[1] See Appendix A for typical coaxial cable characteristics including velocity factor.

The following two graphs are plots of maximum distance versus frequency span and resolution versus frequency span using data from Table 7-11. Please note that data is plotted only for velocity factors of 0.5 and 1.0.

Figure 7-5

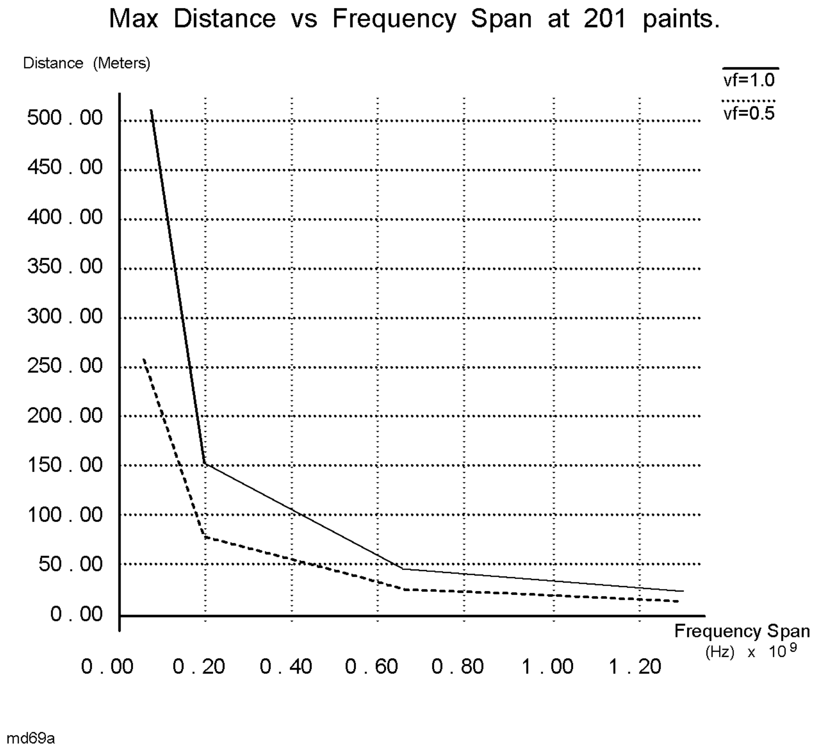
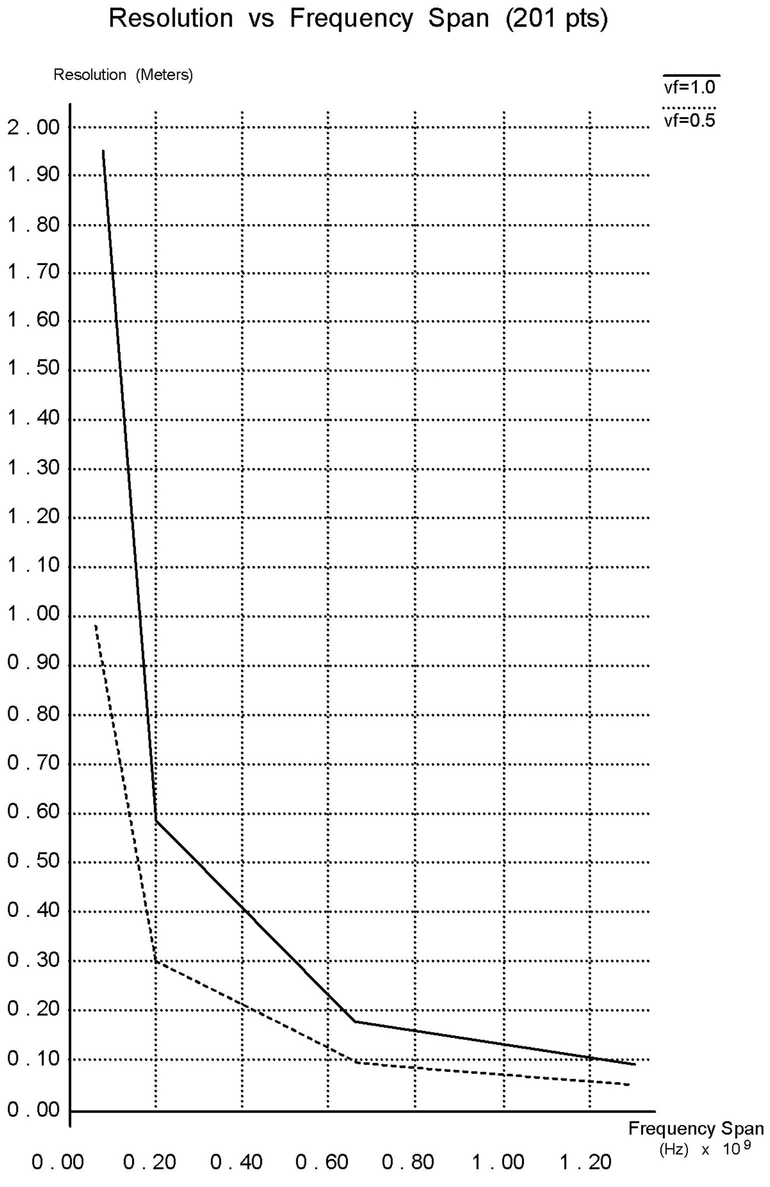


Figure 7-6



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A

Cable Loss and Velocity Factors

Cable Loss and Velocity Factors

The following table was reprinted from Times Wire and Cable, *RF Transmission Line Catalog and Handbook*. Catalog TL-6, 1972.

Table A-1 **Cable Loss and Velocity Factor Table**

Coaxial Cable Nominal Loss Characteristics dB per Hundred Feet, Frequency in GHz[1]										
RG/U	**Relative Velocity**	**.01**	**.05**	**.10**	**.20**	**.40**	**1**	**3**	**5**	**10**
5, 5A, 5B, 6A, 6B, 212	.659	.80	1.40	2.90	4.30	6.40	11.00	22.00	30.00	52.00
7	.659	.66	1.50	2.20	3.20	4.60	9.00	19.00	28.00	47.00
8, 8A, 10A, 70, 213, 215	.659	.66	1.50	2.20	3.20	4.60	9.00	19.00	28.00	47.00
9, 9A, 9B, 214	.659	.66	1.50	2.20	3.20	4.60	9.00	19.00	28.00	47.00
11, 11A, 12, 12A, 13, 13A, 216	.659	.66	1.50	2.20	3.20	4.60	9.00	19.00	28.00	–
14, 14A, 74, 74A, 217, 224, 293, 293A, 388	.659	.41	1.00	1.40	2.10	3.10	5.80	13.00	19.00	31.00
17, 17A, 18, 18A, 84A, 85A, 177, 218, 219, 295	.659	.23	.56	.81	1.20	1.90	3.80	9.00	13.50	–
19, 19A, 20, 20A, 147, 220, 221	.659	.17	.43	.63	.94	1.50	3.00	7.00	–	–
21, 21A, 222	.659	4.40	9.40	12.90	18.20	26.50	44.00	87.00	–	–
22, 22B, 111, 111A	.659	1.20	2.80	4.20	6.30	9.60	–	–	–	–

Coaxial Cable Nominal Loss Characteristics dB per Hundred Feet, Frequency in GHz[1]

RG/U	Relative Velocity	.01	.05	.10	.20	.40	1	3	5	10
29	.659	1.35	3.00	4.30	6.00	8.80	16.50	36.00	51.00	85.00
34, 34A, 34B	.659	.32	.90	1.40	2.10	3.30	5.80	16.00	28.00	
35, 35A, 35B, 164	.659	.24	.60	.90	1.30	2.00	3.70	8.90	15.00	–
54, 54A	.659	.90	2.20	3.30	4.60	6.90	13.10	26.20	35.00	–
55, 55A, 55B, 223	.659	1.35	3.00	4.30	6.00	8.80	16.50	36.00	51.00	85.00
57, 57A, 130, 131, 294, 294A	.659	.65	1.60	2.40	3.60	5.20	10.00	21.20	–	–
58, 58B	.659	1.20	3.10	4.60	7.00	10.00	17.50	38.00	–	–
58A, 58C	.659	1.40	3.30	4.90	7.30	11.00	20.00	41.00	–	–
59, 59A, 59B	.659	1.10	2.30	3.30	4.70	6.70	11.50	25.50	41.00	–
62, 62A, 71, 71A, 71B	.84	.90	1.90	2.80	3.70	5.20	8.50	18.40	29.50	–
63, 63B, 79, 79B	.84	.50	1.10	1.50	2.30	3.40	5.70	12.20	20.90	–
87A, 115, 115A, 116, 165, 166, 225, 227, 393, 397	.695	.60	1.40	2.10	3.10	4.50	7.50	14.00	21.00	35.00

Cable Loss and Velocity Factors

Coaxial Cable Nominal Loss Characteristics dB per Hundred Feet, Frequency in GHz[1]

RG/U	Relative Velocity	.01	.05	.10	.20	.40	1	3	5	10
94	.695	.60	1.30	2.00	2.90	4.20	7.10	13.00	19.00	33.00
94A, 226	.695	.40	1.00	1.50	2.10	3.00	5.00	10.00	15.00	27.00
108, 108A	.659	2.30	5.20	7.50	11.00	16.00	26.20	54.00	–	–
117, 117A, 118, 211, 211A, 228, 228A	.695	.25	.61	.90	1.40	2.00	3.40	7.50	11.50	–
119, 120	.695	.50	1.05	1.60	2.20	3.10	5.10	10.20	15.20	27.30
122	.659	1.60	4.40	6.90	11.00	16.60	29.20	57.20	89.00	–
140, 141, 141A, 142, 142B, 159, 302, 303, 400, 402	.695	1.20	2.70	3.90	5.50	8.00	13.00	26.00	36.00	62.00
143, 143A, 304, 401	.695	.85	1.80	2.50	3.80	5.70	9.70	18.10	26.10	40.70
144	.695	.38	1.00	1.60	2.30	3.80	7.00	15.10	–	–
161, 179, 179A, 179B, 187, 187A	.695	5.00	7.20	9.80	12.70	15.80	25.00	43.00	62.50	135.00
174, 174A	.659	3.80	6.50	8.90	12.00	17.50	31.00	64.30	97.00	185.00
178, 178A, 178B, 196, 196A, 403, 404	.695	5.30	10.00	13.30	20.00	27.50	45.00	78.00	115.00	172.00

Coaxial Cable Nominal Loss Characteristics dB per Hundred Feet, Frequency in GHz[1]

RG/U	Relative Velocity	.01	.05	.10	.20	.40	1	3	5	10
180, 180A, 180B, 195, 195A	.695	3.10	4.20	5.10	7.30	10.40	16.50	36.00	49.00	89.00
183	.91	.18	.38	.53	.78	1.20	1.90	3.70	5.00	–
188, 188A, 316	.695	3.80	7.90	11.50	15.00	20.00	30.00	58.00	79.00	133.00
235	.695	.60	1.40	2.10	3.10	4.50	7.50	14.00	21.00	35.00
306, 306A, 336	.80	.15	.33	.52	.80	1.30	2.30	5.20	7.80	–
307, 307A	.80	1.20	2.70	3.80	5.40	7.50	12.00	–	–	–
323, 324, 332, 333, 376	.80	.15	.32	.50	.75	1.20	2.10	4.70	6.50	–
334, 335	.80	.25	.60	.85	1.20	1.90	3.50	7.00	10.00	18.00
360	.80	.18	.40	.60	.90	1.50	2.50	5.30	7.50	

[1] Conditions: Ambient 20 °C

Cable Loss and Velocity Factors

B SCPI Command Reference

This chapter describes the SCPI command reference for the fault location and SRL function of the Agilent E5061A/E5062A. It describes the commands using their abbreviated format in alphabetical order. If you want to look up commands by their function, refer to SCPI command list by function.

Notational conventions in this command reference

This section describes the rules to read the description of the commands in this chapter.

Syntax

Part with heading “Syntax” describes the syntax to send a command from the external controller to the E5061A/E5062A. A syntax consists of a command part and a parameter part. The separator between the command part and the parameter part is a space.

If there are several parameters, the separator between adjacent parameters is a comma (,). 3 points (…) between commas indicate that parameters in that part are omitted. For example, <numeric 1>,…,<numeric 4> indicates that 4 parameters, <numeric 1>,<numeric 2>, <numeric 3>,<numeric 4>, are required.

String-type parameters, <string>, <string 1>, and so on, must be enclosed in double quotation marks ("). <block> shows block format data.

You can omit the lowercase letters in syntax. For example, ":CALibration:CABLe" can be shortened as ":CAL:CABL."

The definition of symbols used in the syntax is as follows:

<>	Characters enclosed in this pair of symbols are necessary parameters when sending the command.
[]	Part enclosed in this parenthesis pair can be omitted.
{}	Part enclosed in this parenthesis pair indicates that you must select one of the items in this part. Individual items are separated by a vertical bar (|).

For example, ":CALC:CORR:EDEL:TIME 0.1," ":CALCULATE1:SELECTED:CORR:EDEL:TIME 25E-3," and so on are valid for the syntax given below.

Syntax

```
:CALCulate{[1]|2|3|4}[:SELected]:CORRection:EDELay:TIME <numeric>
```

Description

Part with heading “Description” describes how to use the command or the operation when executed.

Parameters

Part with heading “Parameters” describes necessary parameters when sending the command. When a parameter is a value type or a string type enclosed with <>, its description, allowable setup range, preset (factory-set) value, and so on are given; when a parameter is a selection type enclosed with {}, the description of each selection item is given.

Query response

Part with heading “Query response” describes the data format read out when query (reading out data) is available with the command.

Each readout parameter is enclosed with {}. If there are several items within {} separated by the pipe (|), only one of them is read out.

When several parameters are read out, they are separated with a comma (,). Note that, 3 points (…) between commas indicate that the data of that part is omitted. For example, {numeric 1},…,{numeric 4} indicates that 4 data items, {numeric 1}, {numeric 2}, {numeric 3}, and {numeric 4}, are read out.

<newline><^END> after the parameters is the program message terminator.

Related commands

Part with heading “Related commands” describes the commands related to this command.

Equivalent key

Part with heading “Equivalent key” shows the operational procedure of the front panel keys that has the same effect as this command.

[Key]	Indicates that you press the key named Key.
[Key] - Item	Indicates a series of key operation in which you press the **[Key]** key, select (highlight) the item called **Item** on the displayed menu using the **[↓]** key and so on, and then press the **[Enter]** key.

Fault Location Commands

This section describes the commands specific to the fault location function of the E5061A/E5062A.

:CALC{1-4}:TRAN:DIST

Syntax

:CALCulate{[1]|2|3|4}[:SELected]:TRANsform:DISTance[:TYPE] {BPASs|LPASs}

:CALCulate{[1]|2|3|4}[:SELected]:TRANsform:DISTance[:TYPE]?

Description

For the active trace of channel 1 (:CALC1) to channel 4 (:CALC4), selects the transformation type used for the transformation function of the fault location function.

Parameters

	Description
BPASs (preset value)	Specifies the band-pass[*1].
LPASs	Specifies the low-pass[*2].

[*1] You do not need to select the stimulus type. Impulse is selected automatically.

[*2] You need to select the stimulus type (impulse or step) with the :CALC{1-4}:TRAN:DIST:STIM command.

Query response

{BPAS|LPAS}<newline><^END>

Example of use

```
10   OUTPUT 717;":CALC1:TRAN:DIST LPAS"
20   OUTPUT 717;":CALC1:TRAN:DIST?"
30   ENTER 717;A$
```

Related commands

:CALC{1-4}:TRAN:TIME on page 127

:CALC{1-4}:TRAN:DIST:STAT on page 121

:CALC{1-4}:TRAN:DIST:STIM on page 123

Equivalent key

[Analysis] - **Fault Location** - **Type** - **Bandpass**|**Lowpass Step**|**Lowpass Imp.**

NOTE

When performing this operation from the front panel, you select the stimulus type at the same time.

:CALC{1-4}:TRAN:DIST:CENT

Syntax

:CALCulate{[1]|2|3|4}[:SELected]:TRANsform:DISTance:CENTer <numeric>

:CALCulate{[1]|2|3|4}[:SELected]:TRANsform:DISTance:CENTer?

Description

For the active trace of channel 1 (:CALC1) to channel 4 (:CALC4), sets the center value used for the fault location display.

Parameters

	<numeric>
Description	Center value
Range	Varies depending on the frequency span, velocity factor, distance unit, and the number of points.
Preset value	0
Unit	Ft (feet) or m (meters)

If the specified parameter is out of the allowable setup range, the minimum value (if the lower limit of the range is not reached) or the maximum value (if the upper limit of the range is exceeded) is set.

Query response

{numeric}<newline><^END>

Example of use

```
10   OUTPUT 717;":CALC1:TRAN:DIST:CENT 1E-8"
20   OUTPUT 717;":CALC1:TRAN:DIST:CENT?"
30   ENTER 717;A
```

Related commands

:CALC{1-4}:TRAN:DIST:SPAN on page 119

:CALC{1-4}:TRAN:DIST:STAT on page 121

Equivalent key

[Analysis] - **Fault Location** - **Center**

:CALC{1-4}:TRAN:DIST:CLOS

Syntax

:CALCulate{[1]|2|3|4}[:SELected]:TRANsform:DISTance:CLOSs <numeric>

:CALCulate{[1]|2|3|4}[:SELected]:TRANsform:DISTance:CLOSs?

Description

For the active trace of channel 1 (:CALC1) to channel 4 (:CALC4), sets the cable loss value used for the transformation function of the fault location function.

Parameters

	<numeric>
Description	Cable Loss value
Range	Varies depending on the distance unit.
Preset value	0
Unit	dB/100Ft or dB/100m

If the specified parameter is out of the allowable setup range, the minimum value (if the lower limit of the range is not reached) or the maximum value (if the upper limit of the range is exceeded) is set.

Query response

{numeric}<newline><^END>

Example of use

```
10   OUTPUT 717;":CALC1:TRAN:DIST:CLOS 10"
20   OUTPUT 717;":CALC1:TRAN:DIST:CLOS?"
30   ENTER 717;A
```

Related commands

:CALC{1-4}:TRAN:TIME:CLOS on page 129

:CALC{1-4}:TRAN:DIST:UNIT on page 125

:CALC{1-4}:TRAN:METH on page 126

Equivalent key

[Analysis] - **Fault Location** - **Cable Loss**

:CALC{1-4}:TRAN:DIST:IMP:WIDT

Syntax

:CALCulate{[1]|2|3|4}[:SELected]:TRANsform:DISTance:IMPulse:WIDTh <numeric>

:CALCulate{[1]|2|3|4}[:SELected]:TRANsform:DISTance:IMPulse:WIDTh?

Description

For the active trace of channel 1 (:CALC1) to channel 4 (:CALC4), sets the shape of the Kayser Bessel window using the impulse width used for the transformation function of the fault location function.

Parameters

	<numeric>
Description	Impulse width
Range	Varies depending on the frequency span and the transformation type.
Preset value	Varies depending on the frequency span and the transformation type.
Unit	s (second)

If the specified parameter is out of the allowable setup range, the minimum value (if the lower limit of the range is not reached) or the maximum value (if the upper limit of the range is exceeded) is set.

Query response

{numeric}<newline><^END>

Example of use

```
10   OUTPUT 717;":CALC1:TRAN:TIME:IMP:WIDT 1E-10"
20   OUTPUT 717;":CALC1:TRAN:TIME:IMP:WIDT?"
30   ENTER 717;A
```

Related commands

:CALC{1-4}:TRAN:TIME:IMP:WIDT on page 130

:CALC{1-4}:TRAN:DIST:KBES on page 116

:CALC{1-4}:TRAN:DIST:STEP:RTIM on page 122

:CALC{1-4}:TRAN:DIST:STAT on page 121

Equivalent key

[Analysis] - **Fault Location** - **Window** - **Impulse Width**

:CALC{1-4}:TRAN:DIST:KBES

Syntax

:CALCulate{[1]|2|3|4}[:SELected]:TRANsform:DISTance:KBESsel <numeric>

:CALCulate{[1]|2|3|4}[:SELected]:TRANsform:DISTance:KBESsel?

Description

For the active trace of channel 1 (:CALC1) to channel 4 (:CALC4), sets the shape of the Kayser Bessel window using β used for the transformation function of the fault location function.

Parameters

	<numeric>
Description	The value of β.
Range	0 to 13
Preset value	6

If the specified parameter is out of the allowable setup range, the minimum value (if the lower limit of the range is not reached) or the maximum value (if the upper limit of the range is exceeded) is set.

Query response

{numeric}<newline><^END>

Example of use

```
10   OUTPUT 717;":CALC1:TRAN:DIST:KBES 3"
20   OUTPUT 717;":CALC1:TRAN:DIST:KBES?"
30   ENTER 717;A
```

Related commands

:CALC{1-4}:TRAN:TIME:KBES on page 131

:CALC{1-4}:TRAN:DIST:IMP:WIDT on page 115

:CALC{1-4}:TRAN:DIST:STEP:RTIM on page 122

:CALC{1-4}:TRAN:DIST:STAT on page 121

Equivalent key

[Analysis] - **Fault Location** - **Window** - **Kaiser Beta**

:CALC{1-4}:TRAN:DIST:LPFR

Syntax	:CALCulate{[1]|2|3|4}[:SELected]:TRANsform:DISTance:LPFRequency
Description	For the active trace of channel 1 (:CALC1) to channel 4 (:CALC4), changes the frequency range to match with the low-pass type transformation of the transformation function of the fault location function. (No query)
Related commands	:CALC{1-4}:TRAN:TIME:LPFR on page 132 :CALC{1-4}:TRAN:DIST:STAT on page 121 :CALC{1-4}:TRAN:DIST on page 112
Equivalent key	**[Analysis]** - **Fault Location** - **Set Freq Low pass**

:CALC{1-4}:TRAN:DIST:REFL:TYPE

Syntax

:CALCulate{[1]|2|3|4}[:SELected]:TRANsform:DISTance:REFLection:TYPE {OWAY|RTRip}

:CALCulate{[1]|2|3|4}[:SELected]:TRANsform:DISTance:REFLection:TYPE?

Description

For the active trace of channel 1 (:CALC1) to channel 4 (:CALC4), selects the reflection distance either one way or round trip.

Parameters

	Description
OWAY	Specifies the one way.
RTRip (preset value)	Specifies the round trip.

Query response

{OWAY|RTR}<newline><^END>

Example of use

```
10   OUTPUT 717;":CALC1:TRAN:DIST:REFL:TYPE RTR"
20   OUTPUT 717;":CALC1:TRAN:DIST:REFL:TYPE?"
30   ENTER 717;A$
```

Related commands

:CALC{1-4}:TRAN:TIME:REFL:TYPE on page 133

Equivalent key

[Analysis] - **Fault Location** - **Reflection Type** (**One Way**|**Round Trip**)

:CALC{1-4}:TRAN:DIST:SPAN

Syntax

:CALCulate{[1]|2|3|4}[:SELected]:TRANsform:DISTance:SPAN <numeric>

:CALCulate{[1]|2|3|4}[:SELected]:TRANsform:DISTance:SPAN?

Description

For the active trace of channel 1 (:CALC1) to channel 4 (:CALC4), sets the span value of the fault location display.

Parameters

	<numeric>
Description	Span value
Range	Varies depending on the frequency span, velocity factor, distance unit, and the number of points.
Preset value	19.671 Ft or 5.9958 m
Unit	Ft (feet) or m (meters)

If the specified parameter is out of the allowable setup range, the minimum value (if the lower limit of the range is not reached) or the maximum value (if the upper limit of the range is exceeded) is set.

Query response

{numeric}<newline><^END>

Example of use

```
10   OUTPUT 717;":CALC1:TRAN:DIST:SPAN 1E-8"
20   OUTPUT 717;":CALC1:TRAN:DIST:SPAN?"
30   ENTER 717;A
```

Related commands

:CALC{1-4}:TRAN:DIST:CENT on page 113

:CALC{1-4}:TRAN:DIST:STAT on page 121

Equivalent key

[Analysis] - **Fault Location** - **Span**

:CALC{1-4}:TRAN:DIST:STAR

Syntax

:CALCulate{[1]|2|3|4}[:SELected]:TRANsform:DISTance:STARt <numeric>

:CALCulate{[1]|2|3|4}[:SELected]:TRANsform:DISTance:STARt?

Description

For the active trace of channel 1 (:CALC1) to channel 4 (:CALC4), sets the start value of the fault location display.

Parameters

	<numeric>
Description	Start value
Range	Varies depending on the frequency span, velocity factor, distance unit, and the number of points.
Preset value	-9.8357Ft or -2.9979m
Unit	Ft (feet) or m (meters)

If the specified parameter is out of the allowable setup range, the minimum value (if the lower limit of the range is not reached) or the maximum value (if the upper limit of the range is exceeded) is set.

Query response

{numeric}<newline><^END>

Example of use

```
10   OUTPUT 717;":CALC1:TRAN:DIST:STAR 0"
20   OUTPUT 717;":CALC1:TRAN:DIST:STAR?"
30   ENTER 717;A
```

Related commands

:CALC{1-4}:TRAN:TIME:STAR on page 135

:CALC{1-4}:TRAN:DIST:STOP on page 124

:CALC{1-4}:TRAN:DIST:STAT on page 121

Equivalent key

[Analysis] - **Fault Location** - **Start**

:CALC{1-4}:TRAN:DIST:STAT

Syntax

:CALCulate{[1]|2|3|4}[:SELected]:TRANsform:DISTance:STATe {ON|OFF|1|0}

:CALCulate{[1]|2|3|4}[:SELected]:TRANsform:DISTance:STATe?

Description

For the active trace of channel 1 (:CALC1) to channel 4 (:CALC4), turns ON/OFF the transformation function of the fault location function.

You can enable the transformation function only when the sweep type is the linear sweep and the number of points is 3 or more. If you execute this command to try to enable the transformation function when the sweep type is other than the linear sweep or the number of points is less than 3, an error occurs and the command is ignored.

When the sweep type is the power sweep, you cannot turn on the transformation function. If you execute this command trying to turn on the transformation function during the power sweep, an error occurs and the command is ignored.

Parameters

	Description
ON or 1	Turns ON the transformation function.
OFF or 0 (preset value)	Turns OFF the transformation function.

Query response

{1|0}<newline><^END>

Example of use

```
10   OUTPUT 717;":CALC1:TRAN:DIST:STAT ON"
20   OUTPUT 717;":CALC1:TRAN:DIST:STAT?"
30   ENTER 717;A
```

Related commands

:CALC{1-4}:TRAN:TIME:STAT on page 136

Equivalent key

[Analysis] - **Fault Location** - **Fault Location**

:CALC{1-4}:TRAN:DIST:STEP:RTIM

Syntax

:CALCulate{[1]|2|3|4}[:SELected]:TRANsform:DISTance:STEP:RTIMe <numeric>

:CALCulate{[1]|2|3|4}[:SELected]:TRANsform:DISTance:STEP:RTIMe?

Description

For the active trace of channel 1 (:CALC1) to channel 4 (:CALC4), sets the shape of the Kayser Bessel window using the rise time of step signal used for the transformation function of the fault location function.

Parameters

	<numeric>
Description	The rise time of step signal
Range	Varies depending on the frequency span.
Preset value	Varies depending on the frequency span.
Unit	s (second)

If the specified parameter is out of the allowable setup range, the minimum value (if the lower limit of the range is not reached) or the maximum value (if the upper limit of the range is exceeded) is set.

Query response

{numeric}<newline><^END>

Example of use

```
10   OUTPUT 717;":CALC1:TRAN:DIST:STEP:RTIM 1E-10"
20   OUTPUT 717;":CALC1:TRAN:DIST:STEP:RTIM?"
30   ENTER 717;A
```

Related commands

:CALC{1-4}:TRAN:TIME:STEP:RTIM on page 137

:CALC{1-4}:TRAN:DIST:IMP:WIDT on page 115

:CALC{1-4}:TRAN:DIST:KBES on page 116

:CALC{1-4}:TRAN:DIST:STAT on page 121

Equivalent key

[Analysis] - **Fault Location** - **Window** - **Step Rise**

:CALC{1-4}:TRAN:DIST:STIM

Syntax

:CALCulate{[1]|2|3|4}[:SELected]:TRANsform:DISTance:STIMulus {IMPulse|STEP}

:CALCulate{[1]|2|3|4}[:SELected]:TRANsform:DISTance:STIMulus?

Description

For the active trace of channel 1 (:CALC1) to channel 4 (:CALC4), selects the stimulus type used for the transformation function of the fault location function.

Parameters

	Description
IMPulse (preset value)	Specifies the impulse[*1].
STEP	Specifies the step[*2].

[*1] You need to select the transformation type (band-pass or low-pass) with the :CALC{1-4}:TRAN:DIST command.

[*2] You do not need to select the transformation type. Low-pass is selected automatically.

Query response

{IMP|STEP}<newline><^END>

Example of use

```
10   OUTPUT 717;":CALC1:TRAN:DIST LPAS"
20   OUTPUT 717;":CALC1:TRAN:DIST:STIM STEP"
30   OUTPUT 717;":CALC1:TRAN:DIST:STIM?"
40   ENTER 717;A$
```

Related commands

:CALC{1-4}:TRAN:TIME:STIM on page 138

:CALC{1-4}:TRAN:DIST on page 112

:CALC{1-4}:TRAN:DIST:STAT on page 121

Equivalent key

[Analysis] - **Fault Location** - **Type** - **Bandpass**|**Lowpass Step**|**Lowpass Imp.**

NOTE

When performing this operation from the front panel, you select the transformation type at the same time.

:CALC{1-4}:TRAN:DIST:STOP

Syntax

:CALCulate{[1]|2|3|4}[:SELected]:TRANsform:DISTance:STOP <numeric>

:CALCulate{[1]|2|3|4}[:SELected]:TRANsform:DISTance:STOP?

Description

For the active trace of channel 1 (:CALC1) to channel 4 (:CALC4), sets the stop value of the fault location display.

Parameters

	<numeric>
Description	Stop value
Range	Varies depending on the frequency span, velocity factor, distance unit, and the number of points.
Preset value	9.8357Ft or 2.9979m
Unit	Ft (feet) or m (meters)

If the specified parameter is out of the allowable setup range, the minimum value (if the lower limit of the range is not reached) or the maximum value (if the upper limit of the range is exceeded) is set.

Query response

{numeric}<newline><^END>

Example of use

```
10   OUTPUT 717;":CALC1:TRAN:DIST:STOP 9.8357"
20   OUTPUT 717;":CALC1:TRAN:DIST:STOP?"
30   ENTER 717;A
```

Related commands

:CALC{1-4}:TRAN:TIME:STOP on page 139

:CALC{1-4}:TRAN:DIST:STAR on page 120

:CALC{1-4}:TRAN:DIST:STAT on page 121

Equivalent key

[Analysis] - **Fault Location** - **Stop**

:CALC{1-4}:TRAN:DIST:UNIT

Syntax

:CALCulate{[1]|2|3|4}[:SELected]:TRANsform:DISTance:UNIT {METers|FEET}

:CALCulate{[1]|2|3|4}[:SELected]:TRANsform:DISTance:UNIT?

Description

For the active trace of channel 1 (:CALC1) to channel 4 (:CALC4), selects the distance unit of the fault location display.

Parameters

	Description
METers	Specifies the meters.
FEET	Specifies the feet.

Query response

{MET|FEET}<newline><^END>

Example of use

```
10   OUTPUT 717;":CALC1:TRAN:DIST:UNIT MET"
20   OUTPUT 717;":CALC1:TRAN:DIST:UNIT?"
30   ENTER 717;A$
```

Related commands

:CALC{1-4}:TRAN:METH on page 126

Equivalent key

[Analysis] - **Fault Location** - **Unit** - **Seconds**|**Meters**|**Feet**

:CALC{1-4}:TRAN:METH

Syntax

:CALCulate{[1]|2|3|4}[:SELected]:TRANsform:METHod {TIME|DISTance}

:CALCulate{[1]|2|3|4}[:SELected]:TRANsform:METHod?

Description

For the active trace of channel 1 (:CALC1) to channel 4 (:CALC4), sets the horizontal axis of the fault location function either time or distance.

Parameters

	Description
TIME	Specifies the time.
DISTance	Specifies the distance.

Query response

{TIME|DIST}<newline><^END>

Example of use

```
10   OUTPUT 717;":CALC1:TRAN:METH DIST"
20   OUTPUT 717;":CALC1:TRAN:METH?"
30   ENTER 717;A$
```

Related commands

:CALC{1-4}:TRAN:DIST:UNIT on page 125

Equivalent key

[Analysis] - **Fault Location** - **Unit** - **Seconds**|**Meters**|**Feet**

:CALC{1-4}:TRAN:TIME

Syntax

:CALCulate{[1]|2|3|4}[:SELected]:TRANsform:TIME[:TYPE] {BPASs|LPASs}

:CALCulate{[1]|2|3|4}[:SELected]:TRANsform:TIME[:TYPE]?

Description

For the active trace of channel 1 (:CALC1) to channel 4 (:CALC4), selects the transformation type used for the transformation function of the fault location function.

Parameters

	Description
BPASs (preset value)	Specifies the band-pass*1.
LPASs	Specifies the low-pass*2.

*1. You do not need to select the stimulus type. Impulse is selected automatically.
*2. You need to select the stimulus type (impulse or step) with the :CALC{1-4}:TRAN:TIME:STIM command.

Query response

{BPAS|LPAS}<newline><^END>

Example of use

```
10   OUTPUT 717;":CALC1:TRAN:TIME LPAS"
20   OUTPUT 717;":CALC1:TRAN:TIME?"
30   ENTER 717;A$
```

Related commands

:CALC{1-4}:TRAN:TIME:STIM on page 138

:CALC{1-4}:TRAN:TIME:STAT on page 136

:CALC{1-4}:TRAN:DIST on page 112

Equivalent key

[Analysis] - **Fault Location** - **Type** - **Bandpass**|**Lowpass Step**|**Lowpass Imp.**

NOTE

When performing this operation from the front panel, you select the stimulus type at the same time.

:CALC{1-4}:TRAN:TIME:CENT

Syntax

:CALCulate{[1]|2|3|4}[:SELected]:TRANsform:TIME:CENTer <numeric>

:CALCulate{[1]|2|3|4}[:SELected]:TRANsform:TIME:CENTer?

Description

For the active trace of channel 1 (:CALC1) to channel 4 (:CALC4), sets the center value used for the transformation function of the fault location function.

Parameters

	<numeric>
Description	Center value
Range	Varies depending on the frequency span and the number of points.
Preset value	0
Unit	s (second)

If the specified parameter is out of the allowable setup range, the minimum value (if the lower limit of the range is not reached) or the maximum value (if the upper limit of the range is exceeded) is set.

Query response

{numeric}<newline><^END>

Example of use

```
10   OUTPUT 717;":CALC1:TRAN:TIME:CENT 1E-8"
20   OUTPUT 717;":CALC1:TRAN:TIME:CENT?"
30   ENTER 717;A
```

Related commands

:CALC{1-4}:TRAN:TIME:SPAN on page 134

:CALC{1-4}:TRAN:TIME:STAT on page 136

:CALC{1-4}:TRAN:DIST:CENT on page 113

Equivalent key

[Analysis] - **Fault Location** - **Center**

:CALC{1-4}:TRAN:TIME:CLOS

Syntax

:CALCulate{[1]|2|3|4}[:SELected]:TRANsform:TIME:CLOSs <numeric>

:CALCulate{[1]|2|3|4}[:SELected]:TRANsform:TIME:CLOSs?

Description

For the active trace of channel 1 (:CALC1) to channel 4 (:CALC4), sets the center value used for the transformation function of the fault location function.

Parameters

	<numeric>
Description	Cable Loss value
Range	Varies depending on the frequency span and the number of points.
Preset value	0
Unit	dB/usec

If the specified parameter is out of the allowable setup range, the minimum value (if the lower limit of the range is not reached) or the maximum value (if the upper limit of the range is exceeded) is set.

Query response

{numeric}<newline><^END>

Example of use

```
10   OUTPUT 717;":CALC1:TRAN:DIST:CLOS 100"
20   OUTPUT 717;":CALC1:TRAN:DIST:CLOS?"
30   ENTER 717;A
```

Related commands

:CALC{1-4}:TRAN:DIST:CLOS on page 114

:CALC{1-4}:TRAN:METH on page 126

Equivalent key

[Analysis] - **Fault Location** - **Cable Loss**

:CALC{1-4}:TRAN:TIME:IMP:WIDT

Syntax

:CALCulate{[1]|2|3|4}[:SELected]:TRANsform:TIME:IMPulse:WIDTh <numeric>

:CALCulate{[1]|2|3|4}[:SELected]:TRANsform:TIME:IMPulse:WIDTh?

Description

For the active trace of channel 1 (:CALC1) to channel 4 (:CALC4), sets the shape of the Kayser Bessel window using the impulse width used for the transformation function of the fault location function.

Parameters

	<numeric>
Description	Impulse width
Range	Varies depending on the frequency span and the transformation type.
Preset value	Varies depending on the frequency span and the transformation type.
Unit	s (second)

If the specified parameter is out of the allowable setup range, the minimum value (if the lower limit of the range is not reached) or the maximum value (if the upper limit of the range is exceeded) is set.

Query response

{numeric}<newline><^END>

Example of use

```
10   OUTPUT 717;":CALC1:TRAN:TIME:IMP:WIDT 1E-10"
20   OUTPUT 717;":CALC1:TRAN:TIME:IMP:WIDT?"
30   ENTER 717;A
```

Related commands

:CALC{1-4}:TRAN:TIME:KBES on page 131

:CALC{1-4}:TRAN:TIME:STEP:RTIM on page 137

:CALC{1-4}:TRAN:TIME:STAT on page 136

:CALC{1-4}:TRAN:DIST:IMP:WIDT on page 115

Equivalent key

[Analysis] - **Fault Location** - **Window** - **Impulse Width**

:CALC{1-4}:TRAN:TIME:KBES

Syntax

:CALCulate{[1]|2|3|4}[:SELected]:TRANsform:TIME:KBESsel <numeric>

:CALCulate{[1]|2|3|4}[:SELected]:TRANsform:TIME:KBESsel?

Description

For the active trace of channel 1 (:CALC1) to channel 4 (:CALC4), sets the shape of the Kayser Bessel window using β used for the transformation function of the fault location function.

Parameters

	<numeric>
Description	The value of β.
Range	0 to 13
Preset value	6

If the specified parameter is out of the allowable setup range, the minimum value (if the lower limit of the range is not reached) or the maximum value (if the upper limit of the range is exceeded) is set.

Query response

{numeric}<newline><^END>

Example of use

```
10   OUTPUT 717;":CALC1:TRAN:TIME:KBES 3"
20   OUTPUT 717;":CALC1:TRAN:TIME:KBES?"
30   ENTER 717;A
```

Related commands

:CALC{1-4}:TRAN:TIME:IMP:WIDT on page 130

:CALC{1-4}:TRAN:TIME:STEP:RTIM on page 137

:CALC{1-4}:TRAN:TIME:STAT on page 136

:CALC{1-4}:TRAN:DIST:KBES on page 116

Equivalent key

[Analysis] - **Fault Location** - **Window** - **Kaiser Beta**

:CALC{1-4}:TRAN:TIME:LPFR

Syntax	:CALCulate{[1]|2|3|4}[:SELected]:TRANsform:TIME:LPFRequency
Description	For the active trace of channel 1 (:CALC1) to channel 4 (:CALC4), changes the frequency range to match with the low-pass type transformation of the transformation function of the fault location function. (No query)
Related commands	:CALC{1-4}:TRAN:TIME on page 127 :CALC{1-4}:TRAN:TIME:STAT on page 136 :CALC{1-4}:TRAN:DIST:LPFR on page 117
Equivalent key	**[Analysis]** - **Fault Location** - **Set Freq Low pass**

:CALC{1-4}:TRAN:TIME:REFL:TYPE

Syntax

:CALCulate{[1]|2|3|4}[:SELected]:TRANsform:TIME:REFLection:TYPE {OWAY|RTRip}

:CALCulate{[1]|2|3|4}[:SELected]:TRANsform:TIME:REFLection:TYPE?

Description

For the active trace of channel 1 (:CALC1) to channel 4 (:CALC4), selects the reflection distance either one way or round trip.

Parameters

	Description
OWAY	Specifies the one way.
RTRip (preset value)	Specifies the round trip.

Query response

{OWAY|RTR}<newline><^END>

Example of use

```
10   OUTPUT 717;":CALC1:TRAN:TIME:REFL:TYPE RTR"
20   OUTPUT 717;":CALC1:TRAN:TIME:REFL:TYPE?"
30   ENTER 717;A$
```

Related commands

:CALC{1-4}:TRAN:DIST:REFL:TYPE on page 118

Equivalent key

[Analysis] - **Fault Location** - **Reflection Type** (**One Way**|**Round Trip**)

:CALC{1-4}:TRAN:TIME:SPAN

Syntax

:CALCulate{[1]|2|3|4}[:SELected]:TRANsform:TIME:SPAN <numeric>

:CALCulate{[1]|2|3|4}[:SELected]:TRANsform:TIME:SPAN?

Description

For the active trace of channel 1 (:CALC1) to channel 4 (:CALC4), sets the span value used for the transformation function of the fault location function.

Parameters

	<numeric>
Description	Span value
Range	Varies depending on the frequency span and the number of points.
Preset value	2E-8
Unit	s (second)

If the specified parameter is out of the allowable setup range, the minimum value (if the lower limit of the range is not reached) or the maximum value (if the upper limit of the range is exceeded) is set.

Query response

{numeric}<newline><^END>

Example of use

```
10   OUTPUT 717;":CALC1:TRAN:TIME:SPAN 1E-8"
20   OUTPUT 717;":CALC1:TRAN:TIME:SPAN?"
30   ENTER 717;A
```

Related commands

:CALC{1-4}:TRAN:TIME:CENT on page 128

:CALC{1-4}:TRAN:TIME:STAT on page 136

:CALC{1-4}:TRAN:DIST:SPAN on page 119

Equivalent key

[Analysis] - **Fault Location** - **Span**

:CALC{1-4}:TRAN:TIME:STAR

Syntax

:CALCulate{[1]|2|3|4}[:SELected]:TRANsform:TIME:STARt <numeric>

:CALCulate{[1]|2|3|4}[:SELected]:TRANsform:TIME:STARt?

Description

For the active trace of channel 1 (:CALC1) to channel 4 (:CALC4), sets the start value used for the transformation function of the fault location function.

Parameters

	<numeric>
Description	Start value
Range	Varies depending on the frequency span and the number of points.
Preset value	-1E-8
Unit	s (second)

If the specified parameter is out of the allowable setup range, the minimum value (if the lower limit of the range is not reached) or the maximum value (if the upper limit of the range is exceeded) is set.

Query response

{numeric}<newline><^END>

Example of use

```
10   OUTPUT 717;":CALC1:TRAN:TIME:STAR 0"
20   OUTPUT 717;":CALC1:TRAN:TIME:STAR?"
30   ENTER 717;A
```

Related commands

:CALC{1-4}:TRAN:TIME:STOP on page 139

:CALC{1-4}:TRAN:TIME:STAT on page 136

:CALC{1-4}:TRAN:DIST:STAR on page 120

Equivalent key

[Analysis] - **Fault Location** - **Start**

:CALC{1-4}:TRAN:TIME:STAT

Syntax

:CALCulate{[1]|2|3|4}[:SELected]:TRANsform:TIME:STATe {ON|OFF|1|0}

:CALCulate{[1]|2|3|4}[:SELected]:TRANsform:TIME:STATe?

Description

For the active trace of channel 1 (:CALC1) to channel 4 (:CALC4), turns ON/OFF the transformation function of the fault location function.

You can enable the transformation function only when the sweep type is the linear sweep and the number of points is 3 or more. If you execute this command to try to enable the transformation function when the sweep type is other than the linear sweep or the number of points is less than 3, an error occurs and the command is ignored.

When the sweep type is the power sweep, you cannot turn on the transformation function. If you execute this command trying to turn on the transformation function during the power sweep, an error occurs and the command is ignored.

Parameters

	Description
ON or 1	Turns ON the transformation function.
OFF or 0 (preset value)	Turns OFF the transformation function.

Query response

{1|0}<newline><^END>

Example of use

```
10   OUTPUT 717;":CALC1:TRAN:TIME:STAT ON"
20   OUTPUT 717;":CALC1:TRAN:TIME:STAT?"
30   ENTER 717;A
```

Related commands

:CALC{1-4}:TRAN:DIST:STAT on page 121

Equivalent key

[Analysis] - **Fault Location** - **Fault Location**

:CALC{1-4}:TRAN:TIME:STEP:RTIM

Syntax

:CALCulate{[1]|2|3|4}[:SELected]:TRANsform:TIME:STEP:RTIMe <numeric>

:CALCulate{[1]|2|3|4}[:SELected]:TRANsform:TIME:STEP:RTIMe?

Description

For the active trace of channel 1 (:CALC1) to channel 4 (:CALC4), sets the shape of the Kayser Bessel window using the rise time of step signal used for the transformation function of the fault location function.

Parameters

	<numeric>
Description	The rise time of step signal
Range	Varies depending on the frequency span.
Preset value	Varies depending on the frequency span.
Unit	s (second)

If the specified parameter is out of the allowable setup range, the minimum value (if the lower limit of the range is not reached) or the maximum value (if the upper limit of the range is exceeded) is set.

Query response

{numeric}<newline><^END>

Example of use

```
10   OUTPUT 717;":CALC1:TRAN:TIME:STEP:RTIM 1E-10"
20   OUTPUT 717;":CALC1:TRAN:TIME:STEP:RTIM?"
30   ENTER 717;A
```

Related commands

:CALC{1-4}:TRAN:TIME:IMP:WIDT on page 130

:CALC{1-4}:TRAN:TIME:KBES on page 131

:CALC{1-4}:TRAN:TIME:STAT on page 136

:CALC{1-4}:TRAN:DIST:STEP:RTIM on page 122

Equivalent key

[Analysis] - **Fault Location** - **Window** - **Step Rise**

:CALC{1-4}:TRAN:TIME:STIM

Syntax

:CALCulate{[1]|2|3|4}[:SELected]:TRANsform:TIME:STIMulus {IMPulse|STEP}

:CALCulate{[1]|2|3|4}[:SELected]:TRANsform:TIME:STIMulus?

Description

For the active trace of channel 1 (:CALC1) to channel 4 (:CALC4), selects the stimulus type used for the transformation function of the fault location function.

Parameters

	Description
IMPulse (preset value)	Specifies the impulse[*1].
STEP	Specifies the step[*2].

[*1] You need to select the transformation type (band-pass or low-pass) with the :CALC{1-4}:TRAN:TIME command.

[*2] You do not need to select the transformation type. Low-pass is selected automatically.

Query response

{IMP|STEP}<newline><^END>

Example of use

```
10   OUTPUT 717;":CALC1:TRAN:TIME LPAS"
20   OUTPUT 717;":CALC1:TRAN:TIME:STIM STEP"
30   OUTPUT 717;":CALC1:TRAN:TIME:STIM?"
40   ENTER 717;A$
```

Related commands

:CALC{1-4}:TRAN:TIME on page 127

:CALC{1-4}:TRAN:TIME:STAT on page 136

:CALC{1-4}:TRAN:DIST:STIM on page 123

Equivalent key

[Analysis] - **Fault Location** - **Type** - **Bandpass**|**Lowpass Step**|**Lowpass Imp.**

NOTE

When performing this operation from the front panel, you select the transformation type at the same time.

:CALC{1-4}:TRAN:TIME:STOP

Syntax

:CALCulate{[1]|2|3|4}[:SELected]:TRANsform:TIME:STOP <numeric>

:CALCulate{[1]|2|3|4}[:SELected]:TRANsform:TIME:STOP?

Description

For the active trace of channel 1 (:CALC1) to channel 4 (:CALC4), sets the stop value used for the transformation function of the fault location function.

Parameters

	<numeric>
Description	Stop value
Range	Varies depending on the frequency span and the number of points.
Preset value	1E-8
Unit	s (second)

If the specified parameter is out of the allowable setup range, the minimum value (if the lower limit of the range is not reached) or the maximum value (if the upper limit of the range is exceeded) is set.

Query response

{numeric}<newline><^END>

Example of use

```
10   OUTPUT 717;":CALC1:TRAN:TIME:STOP 2E-8"
20   OUTPUT 717;":CALC1:TRAN:TIME:STOP?"
30   ENTER 717;A
```

Related commands

:CALC{1-4}:TRAN:TIME:STAR on page 135

:CALC{1-4}:TRAN:TIME:STAT on page 136

:CALC{1-4}:TRAN:DIST:STOP on page 124

Equivalent key

[Analysis] - **Fault Location** - **Stop**

Fault Location Command list

List by function

Table B-1 shows the fault location SCPI command list by function.

Table B-1 Fault location SCPI command list by function

Function	Setting/execution item			Command
Fault Location	Transform	ON/OFF		:CALC{1-4}:TRAN:DIST:STAT on page 121 :CALC{1-4}:TRAN:TIME:STAT on page 136
		Transformation type		:CALC{1-4}:TRAN:DIST on page 112 :CALC{1-4}:TRAN:TIME on page 127
		Stimulus type		:CALC{1-4}:TRAN:DIST:STIM on page 123 :CALC{1-4}:TRAN:TIME:STIM on page 138
		Changing the frequency range to match with the low-pass type		:CALC{1-4}:TRAN:DIST:LPFR on page 117 :CALC{1-4}:TRAN:TIME:LPFR on page 132
		Reflection type		:CALC{1-4}:TRAN:DIST:REFL:TYPE on page 118 :CALC{1-4}:TRAN:TIME:REFL:TYPE on page 133
		Cable Loss		:CALC{1-4}:TRAN:DIST:CLOS on page 114 :CALC{1-4}:TRAN:TIME:CLOS on page 129
		Method, Distance unit		:CALC{1-4}:TRAN:METH on page 126 :CALC{1-4}:TRAN:DIST:UNIT on page 125
		Window setup	β	:CALC{1-4}:TRAN:DIST:KBES on page 116 :CALC{1-4}:TRAN:TIME:KBES on page 131
			Impulse width	:CALC{1-4}:TRAN:DIST:IMP:WIDT on page 115 :CALC{1-4}:TRAN:TIME:IMP:WIDT on page 130
			Rise time of step signal	:CALC{1-4}:TRAN:DIST:STEP:RTIM on page 122 :CALC{1-4}:TRAN:TIME:STEP:RTIM on page 137
		Display range after time domain transformation	Start value	:CALC{1-4}:TRAN:DIST:STAR on page 120 :CALC{1-4}:TRAN:TIME:STAR on page 135
			Stop value	:CALC{1-4}:TRAN:DIST:STOP on page 124 :CALC{1-4}:TRAN:TIME:STOP on page 139
			Center value	:CALC{1-4}:TRAN:DIST:CENT on page 113 :CALC{1-4}:TRAN:TIME:CENT on page 128
			Span value	:CALC{1-4}:TRAN:DIST:SPAN on page 119 :CALC{1-4}:TRAN:TIME:SPAN on page 134

List by front panel key

Table B-2 shows the fault location SCPI commands that correspond to the front panel keys (in alphabetical order).

Table B-2 Front panel key tree vs. fault location SCPI commands correspondence table

Key (operation)				Corresponding GPIB command
[Analysis]	**Fault Location**	**Cable Loss**		:CALC{1-4}:TRAN:DIST:CLOS on page 114 :CALC{1-4}:TRAN:TIME:CLOS on page 129
		Center		:CALC{1-4}:TRAN:DIST:CENT on page 113 :CALC{1-4}:TRAN:TIME:CENT on page 128
		Fault Location		:CALC{1-4}:TRAN:DIST:STAT on page 121 :CALC{1-4}:TRAN:TIME:STAT on page 136
		Reflection Type		:CALC{1-4}:TRAN:DIST:REFL:TYPE on page 118 :CALC{1-4}:TRAN:TIME:REFL:TYPE on page 133
		Set Freq Low Pass		:CALC{1-4}:TRAN:DIST:LPFR on page 117 :CALC{1-4}:TRAN:TIME:LPFR on page 132
		Span		:CALC{1-4}:TRAN:DIST:SPAN on page 119 :CALC{1-4}:TRAN:TIME:SPAN on page 134
		Start		:CALC{1-4}:TRAN:DIST:STAR on page 120 :CALC{1-4}:TRAN:TIME:STAR on page 135
		Stop		:CALC{1-4}:TRAN:DIST:STOP on page 124 :CALC{1-4}:TRAN:TIME:STOP on page 139
		Type		:CALC{1-4}:TRAN:DIST on page 112 :CALC{1-4}:TRAN:DIST:STIM on page 123 :CALC{1-4}:TRAN:TIME on page 127 :CALC{1-4}:TRAN:TIME:STIM on page 138
		Unit		:CALC{1-4}:TRAN:DIST:UNIT on page 125 :CALC{1-4}:TRAN:METH on page 126
		Window	**Impulse Width**	:CALC{1-4}:TRAN:DIST:IMP:WIDT on page 115 :CALC{1-4}:TRAN:TIME:IMP:WIDT on page 130
			Kaiser Beta	:CALC{1-4}:TRAN:DIST:KBES on page 116 :CALC{1-4}:TRAN:TIME:KBES on page 131
			Maximum	
			Minimum	
			Normal	
			Step Rise	:CALC{1-4}:TRAN:DIST:STEP:RTIM on page 122 :CALC{1-4}:TRAN:TIME:STEP:RTIM on page 137

Command tree

Table B-3 shows the fault location SCPI command tree of the E5061A/E5062A.

Table B-3 E5061A/E5062A SCPI command tree

Command	Parameters	Note
CALCulate{[1]|2|3|4}		
[:SELected]		
:TRANsform		
:DISTance		
:CENTer	<numeric>	
:CLOSs	<numeric>	
:IMPulse		
:WIDTh	<numeric>	
:KBESsel	<numeric>	
:LPFRequency		[No query]
:REFLection		
:TYPE	{OWAY|RTRip}	
:SPAN	<numeric>	
:STARt	<numeric>	
:STATe	{ON|OFF|1|0}	
:STEP		
:RTIMe	<numeric>	
:STIMulus	{IMPulse|STEP}	
:STOP	<numeric>	
[:TYPE]	{BPASs|LPASs}	
:TIME		
:CENTer	<numeric>	
:CLOSs	<numeric>	
:IMPulse		
:WIDTh	<numeric>	
:KBESsel	<numeric>	
:LPFRequency		[No query]
:REFLection		
:TYPE	{OWAY|RTRip}	
:SPAN	<numeric>	
:STARt	<numeric>	
:STATe	{ON|OFF|1|0}	
:STEP		
:RTIMe	<numeric>	
:STIMulus	{IMPulse|STEP}	
:STOP	<numeric>	
[:TYPE]	{BPASs|LPASs}	
:TRANsform		
:DISTance		
:UNIT	{METers|FEET}	
:METHod	{TIME|DISTance}	

SRL commands

This section describes the commands specific to the SRL function E5061A/E5062A.

:CALC{1-4}:SRL

Syntax

:CALCulate{[1]|2|3|4}:SRL[:STATe] {ON|OFF|1|0}

:CALCulate{[1]|2|3|4}:SRL[:STATe]?

Description

For the active trace of channel 1 (:CALC1) to channel 4 (:CALC4), turn ON/OFF SRL measurement function.

Parameters

	Description
ON or 1	Turns ON the srtuctural return loss function.
OFF or 0 (preset value)	Turns OFF the srtuctural return loss function.

Query response

{1|0}<newline><^END>

Example of use

```
10   OUTPUT 717;":CALC1:SRL ON"
20   OUTPUT 717;":CALC1:SRL?"
30   ENTER 717;A
```

Related commands

Equivalent key

[Analysis] - **SRL** - **SRL**

:CALC{1-4}:SRL:CONN{1-2}:CAP

Syntax

:CALCulate{[1]|2|3|4}:SRL:CONNector{[1]|2}:CAPacitance <numeric>

:CALCulate{[1]|2|3|4}:SRL:CONNector{[1]|2}:CAPacitance?

Description

For the active trace of channel 1 (:CALC1) to channel 4 (:CALC4), sets the connector capacitance value for the connector mismatch compensation.

Parameters

	<numeric>
Description	Connector capacitance value
Range	-2e-012 to 2e-012
Preset value	0
Unit	F

If the specified parameter is out of the allowable setup range, the minimum value (if the lower limit of the range is not reached) or the maximum value (if the upper limit of the range is exceeded) is set.

Query response

{numeric}<newline><^END>

Example of use

```
10   OUTPUT 717;":CALC1:SRL:CONN1:CAP 1e-1"
20   OUTPUT 717;":CALC1:SRL:CONN1:CAP?"
30   ENTER 717;A
```

Related commands

:CALC{1-4}:SRL:CONN{1-2}:IMM on page 145

:CALC{1-4}:SRL:CONN{1-2}:IMP? on page 145

:CALC{1-4}:SRL:CONN{1-2}:LENG on page 146

Equivalent key

[Analysis] - **SRL** - **Portx Connector** - **Capacitance**

:CALC{1-4}:SRL:CONN{1-2}:IMM

Syntax	:CALCulate{[1]|2|3|4}:SRL:CONNector{[1]|2}:IMMediate
Description	For the active trace of channel 1 (:CALC1) to channel 4 (:CALC4), measures the terminated cable connected to the specified port and automatically sets the connector length and capacitance values for connector mismatch compensation. (No query)
Related commands	:CALC{1-4}:TRAN:DIST on page 112 :CALC{1-4}:SRL:CONN{1-2}:IMP? on page 145 :CALC{1-4}:SRL:CONN{1-2}:LENG on page 146
Equivalent key	**[Analysis]** - **SRL** - **Portx Connector** - **Measure Connector**

:CALC{1-4}:SRL:CONN{1-2}:IMP?

Syntax	:CALCulate{[1]|2|3|4}:SRL:CONNector{[1]|2}:IMPedance?
Description	For the active trace of channel 1 (:CALC1) to channel 4 (:CALC4), reads out the average cable impedance used for the SRL calculation. (Query only)
Query response	{numeric}<newline><^END>

Example of use

```
10   OUTPUT 717;":CALC1:SRL:CONN1:IMP?"
20   ENTER 717;A
```

Related commands	:CALC{1-4}:TRAN:DIST on page 112 :CALC{1-4}:SRL:CONN{1-2}:IMM on page 145 :CALC{1-4}:SRL:CONN{1-2}:LENG on page 146
Equivalent key	None

:CALC{1-4}:SRL:CONN{1-2}:LENG

Syntax

:CALCulate{[1]|2|3|4}:SRL:CONNector{[1]|2}:LENGth <numeric>

:CALCulate{[1]|2|3|4}:SRL:CONNector{[1]|2}:LENGth?

Description

For the active trace of channel 1 (:CALC1) to channel 4 (:CALC4), sets the connector length value for the connector mismatch compensation.

Parameters

	<numeric>
Description	Cable length value
Range	-0.02 to 0.2
Preset value	0
Unit	m (meters)

If the specified parameter is out of the allowable setup range, the minimum value (if the lower limit of the range is not reached) or the maximum value (if the upper limit of the range is exceeded) is set.

Query response

{numeric}<newline><^END>

Example of use

```
10   OUTPUT 717;":CALC1:SRL:CONN1:LENG 0.01"
20   OUTPUT 717;":CALC1:SRL:CONN1:LENG?"
30   ENTER 717;A
```

Related commands

:CALC{1-4}:TRAN:DIST on page 112

:CALC{1-4}:SRL:CONN{1-2}:IMM on page 145

:CALC{1-4}:SRL:CONN{1-2}:IMP? on page 145

Equivalent key

[Analysis] - **SRL** - **Portx Connector** - **Length**

:CALC{1-4}:SRL:IMP:AUTO

Syntax

:CALCulate{[1]|2|3|4}:SRL:IMPedance:AUTO[:STATe] {ON|OFF|1|0}

:CALCulate{[1]|2|3|4}:SRL:IMPedance:AUTO[:STATe]?

Description

For the active trace of channel 1 (:CALC1) to channel 4 (:CALC4),turns ON/OFF the auto impedance calculation function of the SRL measurement.

Parameters

	Description
ON or 1 (preset value)	auto impedance calculation is ON.
OFF or 0	auto impedance calculation is OFF.

Query response

{1|0}<newline><^END>

Example of use

```
10   OUTPUT 717;":CALC1:SRL:IMP:AUTO ON"
20   OUTPUT 717;":CALC1:SRL:IMP:AUTO?"
30   ENTER 717;A
```

Related commands

:CALC{1-4}:SRL:IMP:AUTO:CUT on page 148

:CALC{1-4}:SRL:IMP:MAN on page 149

Equivalent key

[Analysis] - **SRL** - **Auto Z**

:CALC{1-4}:SRL:IMP:AUTO:CUT

Syntax

:CALCulate{[1]|2|3|4}:SRL:IMPedance:AUTO:CUToff <numeric>

:CALCulate{[1]|2|3|4}:SRL:IMPedance:AUTO:CUToff?

Description

For the active trace of channel 1 (:CALC1) to channel 4 (:CALC4), sets the cutoff frequency for the auto calculation for the average cable impedance.

Parameters

	<numeric>
Description	Maximum frequency value
Range	300000 to 3e+009
Preset value	2.1e+008
Unit	Hz

If the specified parameter is out of the allowable setup range, the minimum value (if the lower limit of the range is not reached) or the maximum value (if the upper limit of the range is exceeded) is set.

Query response

{numeric}<newline><^END>

Example of use

```
10   OUTPUT 717;":CALC1:SRL:IMP:AUTO:CUT 2.0e+008"
20   OUTPUT 717;":CALC1:SRL:IMP:AUTO:CUT?"
30   ENTER 717;A
```

Related commands

:CALC{1-4}:SRL:IMP:AUTO on page 147

:CALC{1-4}:SRL:IMP:MAN on page 149

Equivalent key

[Analysis] - **SRL** - **Z Cutoff Freq**

:CALC{1-4}:SRL:IMP:MAN

Syntax

:CALCulate{[1]|2|3|4}:SRL:IMPedance:MANual <numeric>

:CALCulate{[1]|2|3|4}:SRL:IMPedance:MANual?

Description

For the active trace of channel 1 (:CALC1) to channel 4 (:CALC4), sets the average cable impedance to be used in the SRL calculation.

Parameters

	<numeric>
Description	Averaging impedance value
Range	10 to 1000
Preset value	50 or 75
Unit	Ohm

If the specified parameter is out of the allowable setup range, the minimum value (if the lower limit of the range is not reached) or the maximum value (if the upper limit of the range is exceeded) is set.

Query response

{numeric}<newline><^END>

Example of use

```
10   OUTPUT 717;":CALC1:SRL:IMP:MAN 75"
20   OUTPUT 717;":CALC1:SRL:IMP:MAN?"
30   ENTER 717;A
```

Related commands

:CALC{1-4}:SRL:IMP:AUTO on page 147

:CALC{1-4}:SRL:IMP:AUTO:CUT on page 148

Equivalent key

[Analysis] - **SRL** - **Manual Z**

SRL Command list

List by function

Table B-1 shows the SRL SCPI command list by function.

Table B-4 SCPI command list by function

Function	Setting/execution item		Command
Structural Return Loss	ON/OFF		:CALC{1-4}:SRL on page 143
	Averaging impedance value automatic calculation / manual entry selection		:CALC{1-4}:SRL:IMP:AUTO on page 147
	Cutoff frequency		:CALC{1-4}:SRL:IMP:AUTO:CUT on page 148
	Averaging impedance value manual entry		:CALC{1-4}:SRL:IMP:MAN on page 149
	Port 1,2 connector configure	Connector Length	:CALC{1-4}:SRL:CONN{1-2}:LENG on page 146
		Capacitance	:CALC{1-4}:TRAN:DIST on page 112
		Connector length / capacitance automatic calculation	:CALC{1-4}:SRL:CONN{1-2}:IMM on page 145
		Read averaging impedance value	:CALC{1-4}:SRL:CONN{1-2}:IMP? on page 145

List by front panel key

Table B-2 shows the SRL SCPI commands that correspond to the front panel keys (in alphabetical order).

Table B-5 Front panel key tree vs. SCPI commands correspondence table

Key (operation)				Corresponding GPIB command
[Analysis]	**SRL**	**Auto Z**		:CALC{1-4}:SRL:IMP:AUTO on page 147
		Manual Z		:CALC{1-4}:SRL:IMP:MAN on page 149
		Port x Connector	**Capacitance**	:CALC{1-4}:TRAN:DIST on page 112
			Length	:CALC{1-4}:SRL:CONN{1-2}:LENG on page 146
			Measure Connector	:CALC{1-4}:SRL:CONN{1-2}:IMM on page 145
		SRL		:CALC{1-4}:SRL on page 143
		Z Cutoff Freq		:CALC{1-4}:SRL:IMP:AUTO:CUT on page 148

Command tree

Table B-3 shows the SRL SCPI command tree of the E5061A/E5062A.

Table B-6 E5061A/E5062A SCPI command tree

Command	Parameters	Note
CALCulate{[1]|2|3|4}		
:SRL		
:CONNector{[1]|2}		
:CAPacitance	<numeric>	
:IMMediate		[No query]
:IMPedance?	<numeric> (Return value)	[Query only]
:LENGth	<numeric>	
:IMPedance		
:AUTO		
:CUToff	<numeric>	
[:STATe]	{ON|OFF|1|0}	
:MANual	<numeric>	
[:STATe]	{ON|OFF|1|0}	

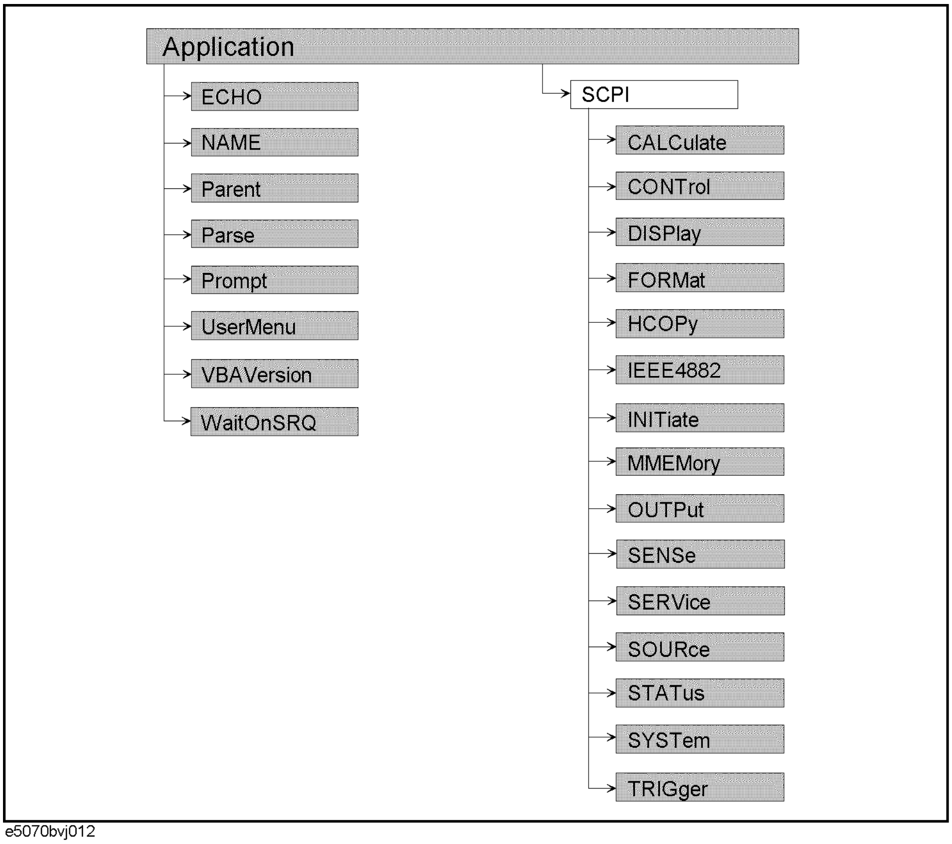
C COM Object Reference

This chapter describes the COM object model of the Agilent E5061A/E5062A and the COM object reference provided for the fault location and SRL function in alphabetical order.

COM Object Model

The COM objects provided for the E5061A/E5062A are structured hierarchically as shown in Figure C-1.

Figure C-1 **E5061A/E5062A COM object model**



Application Objects

The Application objects are at the top of the hierarchy of the E5061A/E5062A COM object model. They consist of 7 objects dedicated to the COM interface and SCPI objects corresponding to SCPI commands. For information on the basic use of the 7 objects dedicated to the COM interface, see “Application Objects” on page 154.

SCPI Objects

The SCPI objects are created to realize the SCPI commands of the E5061A/E5062A with the COM interface.

The conversion rules from the SCPI commands when writing SCPI object messages are as follows:

- SCPI. must be at the beginning. Notice that the IEEE common commands start with SCPI.IEEE4882. and "*" is omitted.
- Replace colons (:) used as the hierarchical separator symbol with dots (.).
- The number written in the object message is specified with ( ).
- You cannot omit the command message in the syntax.

SCPI command		COM object
OUTPUT 717;":SOUR1:POW -10"	→	SCPI.SOURce(1).POWer.LEVel.IMMediate.AMPLitude = -10
OUTPUT 717;":SENS1:CORR:COLL:METH:TYPE?" ENTER 717;A$	→	A = SCPI.SENSe(1).CORRection.COLLect.METHod:TYPE
OUTPUT 717;"*CLS"	→	SCPI.IEEE4882.CLS

Notational Rules of COM Objects

This section describes the rules for the description of the COM objects in this chapter.

Object Type

Part with heading “Object type” describes the type of the E5061A/E5062A COM object. The E5061A/E5062A provides properties and methods as the types of COM objects. In the E5061A/E5062A COM objects, COM objects to set (send)/read (return) the state of the E5061A/E5062A using variables are defined as property and ones to prompt some kind of processing as method.

Syntax

Part with heading “Syntax” describes the syntax to send a COM object from the E5061A/E5062A VBA to the E5061A/E5062A. The syntax consists of the object part and the set/read part, with an equal “=” inserted between them. Variables are indicated by italicized letters. Variables with () are indices. For indices with () having their preset values, you can omit “(*variable*),” and, if omitted, the preset values are automatically set.

There are the following 3 types of syntax for coding using objects.

"Object (property) = *variable*": to set the stat of the E5061A/E5062A.

variable=object (property): to read the stat of the E5061A/E5062A.

"Object (method)": to make the E5061A/E5062A perform some processing.

Description

Part with heading “Description” describes how to use the COM object or the operation when executed. COM objects used only to read the state of the E5061A/E5062A are indicated with “Read only” and ones used only to set the state of the E5061A/E5062A “No read.”

Variable

Part with heading “Variable” describes necessary variables when using the object. It gives the description, data type, allowable range, preset value, unit, resolution, and notes for *variable (italic)* shown in the syntax.

Variables declared as the string data type (String) are case insensitive. For variables of the string type that indicate arguments (written as *Param* in the syntax), you can omit lower-case letters.

The data types of the E5061A/E5062A COM objects include 5 types as shown in Table C-1. Before using variables, declare the data type of each variable. If you do not declare the data type of a variable, it is automatically dealt as the variant type.

Table C-1 Data type

Data type	**Name**	**Consumed memory**	**Range**
Long	Long integer type	4 bytes	-2,147,483,648 to 2,147,483,647
Double	Double precision floating point type	8 bytes	For a negative value: -1.79769313486232E+308 to -4.94065645841247E-324 For a positive value: -1.79769313486232E+308 to -4.94065645841247E-324
Boolean	Boolean type	2 bytes	-1 (True) or 0 (False)
String	Character string type [*1]	1 byte/alphanumeric character	Up to approximately 2 billion characters
Variant	Variant type	16 bytes	No limitation

[*1] For a fixed length string, declare the number of characters.

Examples

Part with heading “Examples” describes a simple example of how to use the object for coding with E5061A/E5062A VBA.

Related Objects

Part with heading “Related objects” describes related objects when using the object.

Equivalent Key

Part with heading “Equivalent key” shows the operational procedure of the front panel keys that has the same effect as this object.

[Key]	Indicates that you press the key named Key.
[Key] - **Item**	Indicates a series of key operation in which you press the **[Key]** key, move the focus to the button called Item on the displayed menu using

the **[←↓]** key and so on, and then press the **[Enter]** key.

Fault Location SCPI Objects

SCPI objects are a collection of the COM interface having one-on-one correspondence with the SCPI commands. This section describes the SCPI objects provided for the Fault Location function of the E5061A/E5062A.

SCPI.CALCulate(*Ch*).SELected.TRANsform.DISTance. CENTer

Object type

Property

Syntax

SCPI.CALCulate(*Ch*).SELected.TRANsform.DISTance.CENTer = *Value*

Value = SCPI.CALCulate(*Ch*).SELected.TRANsform.DISTance.CENTer

Description

For the active trace of channels 1 to 4 (*Ch*), sets the center value of the fault location display.

Variable

Table C-2 Variable (*Ch*)

	Ch
Description	Channel number
Data type	Long integer type (Long)
Range	1 to 4
Preset value	1
Note	If the specified variable is out of the allowable setup range, an error occurs when executed.

	Value
Description	Center value
Data type	Double precision floating point type (Double)
Range	Varies depending on the frequency span, velocity factor, distance unit, and the number of points.
Preset value	0
Unit	Ft (Feet) or m (Meters)
Note	If the specified variable is out of the allowable setup range, the minimum value (if the lower limit of the range is not reached) or the maximum value (if the upper limit of the range is exceeded) is set.

Examples

```
Dim Cent As Double
SCPI.CALCulate(1).PARameter(1).SELect
SCPI.CALCulate(1).SELected.TRANsform.DISTance.CENTer = 1E-8
Cent = SCPI.CALCulate(1).SELected.TRANsform.DISTance.CENTer
```

Related objects

SCPI.CALCulate(Ch).SELected.TRANsform.DISTance.SPAN on page 166

SCPI.CALCulate(Ch).SELected.TRANsform.DISTance.STATe on page 168

Equivalent key **[Analysis]** - **Fault Location** - **Center**

SCPI.CALCulate(*Ch*).SELected.TRANsform.DISTance. CLOSs

Object type

Property

Syntax

SCPI.CALCulate(*Ch*).SELected.TRANsform.DISTance.CLOSs = *Value*

Value = SCPI.CALCulate(*Ch*).SELected.TRANsform.DISTance.CLOSs

Description

For the active trace of channels 1 to 4 (*Ch*), sets the cable loss value used for the transformation function of the fault location function.

Variable

	Value
Description	Cable Loss value
Data type	Double precision floating point type (Double)
Range	Varies depending on the distance unit.
Preset value	0
Unit	dB/100m or dB/100Ft
Note	If the specified variable is out of the allowable setup range, the minimum value (if the lower limit of the range is not reached) or the maximum value (if the upper limit of the range is exceeded) is set.

For information on the variable (*Ch*), see Table C-2, “Variable (Ch),” on page 159.

Examples

```
Dim Cent As Double
SCPI.CALCulate(1).PARameter(1).SELect
SCPI.CALCulate(1).SELected.TRANsform.DISTance.CLOSs = 10
Cent = SCPI.CALCulate(1).SELected.TRANsform.DISTance.CLOSs
```

Related objects

Equivalent key

[Analysis] - **Fault Location** - **Cable Loss**

SCPI.CALCulate(*Ch*).SELected.TRANsform.DISTance. IMPulse.WIDTh

Object type

Property

Syntax

SCPI.CALCulate(*Ch*).SELected.TRANsform.DISTance.IMPulse.WIDTh = *Value*

Value = SCPI.CALCulate(*Ch*).SELected.TRANsform.DISTance.IMPulse.WIDTh

Description

For the active trace of channels 1 to 4 (*Ch*), sets the shape of the Kayser Bessel window using the impulse width used for the transformation function of the fault location function.

Variable

	Value
Description	Impulse width
Data type	Double precision floating point type (Double)
Range	Varies depending on the frequency span and transformation type.
Preset value	Varies depending on the frequency span and transformation type.
Unit	s (seconds)
Note	If the specified variable is out of the allowable setup range, the minimum value (if the lower limit of the range is not reached) or the maximum value (if the upper limit of the range is exceeded) is set.

For information on the variable (*Ch*), see Table C-2, “Variable (Ch),” on page 159.

Examples

```
Dim ImpWid As Double
SCPI.CALCulate(1).PARameter(1).SELect
SCPI.CALCulate(1).SELected.TRANsform.DISTance.IMPulse.WIDTh = 1E-10
ImpWid = SCPI.CALCulate(1).SELected.TRANsform.DISTance.IMPulse.WIDTh
```

Related objects

SCPI.CALCulate(Ch).SELected.TRANsform.DISTance. KBESsel on page 163

SCPI.CALCulate(Ch).SELected.TRANsform.DISTance.STEP.RTIMe on page 169

SCPI.CALCulate(Ch).SELected.TRANsform.DISTance.STATe on page 168

Equivalent key

[Analysis] - **Fault Location** - **Window** - **Impulse Width**

SCPI.CALCulate(*Ch*).SELected.TRANsform.DISTance. KBESsel

Object type

Property

Syntax

SCPI.CALCulate(*Ch*).SELected.TRANsform.DISTance.KBESsel = *Value*

Value = SCPI.CALCulate(*Ch*).SELected.TRANsform.DISTance.KBESsel

Description

For the active trace of channels 1 to 4 (*Ch*), sets the shape of the Kayser Bessel window using β used for the transformation function of the fault location function.

Variable

	Value
Description	The value of β
Data type	Double precision floating point type (Double)
Range	0 to13
Preset value	6
Note	If the specified variable is out of the allowable setup range, the minimum value (if the lower limit of the range is not reached) or the maximum value (if the upper limit of the range is exceeded) is set.

For information on the variable (*Ch*), see Table C-2, “Variable (Ch),” on page 159.

Examples

```
Dim Beta As Double
SCPI.CALCulate(1).PARameter(1).SELect
SCPI.CALCulate(1).SELected.TRANsform.DISTance.KBESsel = 3
Beta = SCPI.CALCulate(1).SELected.TRANsform.DISTance.KBESsel
```

Related objects

SCPI.CALCulate(Ch).SELected.TRANsform.DISTance. IMPulse.WIDTh on page 162

SCPI.CALCulate(Ch).SELected.TRANsform.DISTance.STEP.RTIMe on page 169

SCPI.CALCulate(Ch).SELected.TRANsform.DISTance.STATe on page 168

Equivalent key

[Analysis] - **Fault Location** - **Window** - **Kaiser Beta**

SCPI.CALCulate(*Ch*).SELected.TRANsform.DISTance. LPFRequency

Object type	Method
Syntax	SCPI.CALCulate(*Ch*).SELected.TRANsform.DISTance.LPFRequency = *Value*
Description	For the active trace of channels 1 to 4 (*Ch*), changes the frequency range to match with the low-pass type transformation of the transformation function of the fault location function. (No read)
Variable	For information on the variable (*Ch*), see Table C-2, “Variable (Ch),” on page 159.
Examples	`SCPI.CALCulate(1).PARameter(1).SELect` `SCPI.CALCulate(1).SELected.TRANsform.DISTance.LPFRequency`
Related objects	SCPI.CALCulate(Ch).SELected.TRANsform.DISTance.TYPE on page 172 SCPI.CALCulate(Ch).SELected.TRANsform.DISTance.STATe on page 168
Equivalent key	**[Analysis]** - **Fault Location** - **Set Freq Low pass**

SCPI.CALCulate(*Ch*).SELected.TRANsform.DISTance. REFLection.TYPE

Object type

Property

Syntax

SCPI.CALCulate(*Ch*).SELected.TRANsform.DISTance.REFLection.TYPE = *Param*

Param = SCPI.CALCulate(*Ch*).SELected.TRANsform.DISTance.REFLection.TYPE

Description

For the active trace of channels 1 to 4 (*Ch*), sets the reflection distance either one way or round trip.

Variable

	Param
Description	The stimulus type
Data type	Character string type (String)
Range	Select from the following. •"OWAY" Specifies the One Way. •"RTRip" Specifies the Round Trip.
Preset value	"RTRip"

For information on the variable (*Ch*), see Table C-2, “Variable (Ch),” on page 159.

Examples

```
Dim StimType As String
SCPI.CALCulate(1).PARameter(1).SELect
SCPI.CALCulate(1).SELected.TRANsform.DISTance.REFLection.TYPE =
"OWAY"
StimType =
SCPI.CALCulate(1).SELected.TRANsform.DISTance.REFLection.TYPE
```

Related objects

Equivalent key

[Analysis] - **Fault Location** - **Reflection Type**

SCPI.CALCulate(*Ch*).SELected.TRANsform.DISTance.SPAN

Object type

Property

Syntax

SCPI.CALCulate(*Ch*).SELected.TRANsform.DISTance.SPAN = *Value*

Value = SCPI.CALCulate(*Ch*).SELected.TRANsform.DISTance.SPAN

Description

For the active trace of channels 1 to 4 (*Ch*), sets the span value of the fault location display.

Variable

	Value
Description	Span value
Data type	Double precision floating point type (Double)
Range	Varies depending on the frequency span, velocity factor, distance unit, and the number of points.
Preset value	19.671 Ft or 5.9958 m
Unit	Ft (Feet) or m (Meters)
Note	If the specified variable is out of the allowable setup range, the minimum value (if the lower limit of the range is not reached) or the maximum value (if the upper limit of the range is exceeded) is set.

For information on the variable (*Ch*), see Table C-2, “Variable (Ch),” on page 159.

Examples

```
Dim Span As Double
SCPI.CALCulate(1).PARameter(1).SELect
SCPI.CALCulate(1).SELected.TRANsform.DISTance.SPAN = 1E-8
Cent = SCPI.CALCulate(1).SELected.TRANsform.DISTance.SPAN
```

Related objects

SCPI.CALCulate(Ch).SELected.TRANsform.DISTance. CENTer on page 159

SCPI.CALCulate(Ch).SELected.TRANsform.DISTance.STATe on page 168

Equivalent key

[Analysis] - **Fault Location** - **Span**

SCPI.CALCulate(*Ch*).SELected.TRANsform.DISTance.STARt

Object type

Property

Syntax

SCPI.CALCulate(*Ch*).SELected.TRANsform.DISTance.STARt = *Value*

Value = SCPI.CALCulate(*Ch*).SELected.TRANsform.DISTance.STARt

Description

For the active trace of channels 1 to 4 (*Ch*), sets the start value of the fault location display.

Variable

	Value
Description	Start value
Data type	Double precision floating point type (Double)
Range	Varies depending on the frequency span, velocity factor, distance unit, and the number of points.
Preset value	-9.8357Ft or -2.9979m
Unit	Ft (Feet) or m (Meters)
Note	If the specified variable is out of the allowable setup range, the minimum value (if the lower limit of the range is not reached) or the maximum value (if the upper limit of the range is exceeded) is set.

For information on the variable (*Ch*), see Table C-2, “Variable (Ch),” on page 159.

Examples

```
Dim Star As Double
SCPI.CALCulate(1).PARameter(1).SELect
SCPI.CALCulate(1).SELected.TRANsform.DISTance.STARt = 0
Star = SCPI.CALCulate(1).SELected.TRANsform.DISTance.STARt
```

Related objects

SCPI.CALCulate(Ch).SELected.TRANsform.DISTance.STOP on page 171

SCPI.CALCulate(Ch).SELected.TRANsform.DISTance.STATe on page 168

Equivalent key

[Analysis] - **Fault Location** - **Start**

SCPI.CALCulate(*Ch*).SELected.TRANsform.DISTance.STATe

Object type

Property

Syntax

SCPI.CALCulate(*Ch*).SELected.TRANsform.DISTance.STATe = *Status*

Status = SCPI.CALCulate(*Ch*).SELected.TRANsform.DISTance.STATe

Description

For the active trace of channels 1 to 4 (*Ch*), turns ON/OFF the transformation function of the fault location function.

You can enable the transformation function only when the sweep type is the linear sweep and the number of points is 3 or more. If you execute this object to try to enable the transformation function when the sweep type is other than the linear sweep or the number of points is less than 3, an error occurs and the object is ignored.

When the sweep type is the power sweep, you cannot turn on the transformation function. If you execute this object trying to turn on the transformation function during the power sweep, an error occurs and the object is ignored.

Variable

	Status	
Description	ON/OFF of the gating function	
Data type	Boolean type (Boolean)	
Range	Select from the following.	
	•True or -1	Turns ON the transformation function.
	•False or 0	Turns OFF the transformation function.
Preset value	False or 0	

For information on the variable (*Ch*), see Table C-2, “Variable (Ch),” on page 159.

Examples

```
Dim Trans As Boolean
SCPI.CALCulate(1).PARameter(1).SELect
SCPI.CALCulate(1).SELected.TRANsform.DISTance.STATe = True
Trans = SCPI.CALCulate(1).SELected.TRANsform.DISTance.STATe
```

Related objects

Equivalent key

[Analysis] - **Fault Location** - **Fault Location**

SCPI.CALCulate(*Ch*).SELected.TRANsform.DISTance.STEP.RTIMe

Object type

Property

Syntax

SCPI.CALCulate(*Ch*).SELected.TRANsform.DISTance.STEP.RTIMe = *Value*

Value = SCPI.CALCulate(*Ch*).SELected.TRANsform.DISTance.STEP.RTIMe

Description

For the active trace of channels 1 to 4 (*Ch*), sets the shape of the Kayser Bessel window using the rise time of step signal used for the transformation function of the fault location function.

Variable

	Value
Description	The rise time of step signal
Data type	Double precision floating point type (Double)
Range	Varies depending on the frequency span.
Preset value	Varies depending on the frequency span.
Unit	s
Note	If the specified variable is out of the allowable setup range, the minimum value (if the lower limit of the range is not reached) or the maximum value (if the upper limit of the range is exceeded) is set.

For information on the variable (*Ch*), see Table C-2, “Variable (Ch),” on page 159.

Examples

```
Dim RTime As Double
SCPI.CALCulate(1).PARameter(1).SELect
SCPI.CALCulate(1).SELected.TRANsform.DISTance.STEP.RTIMe = 1E-10
RTime = SCPI.CALCulate(1).SELected.TRANsform.DISTance.STEP.RTIMe
```

Related objects

SCPI.CALCulate(Ch).SELected.TRANsform.DISTance. IMPulse.WIDTh on page 162

SCPI.CALCulate(Ch).SELected.TRANsform.DISTance. KBESsel on page 163

SCPI.CALCulate(Ch).SELected.TRANsform.DISTance.STATe on page 168

Equivalent key

[Analysis] - **Fault Location** - **Window** - **Step Rise**

SCPI.CALCulate(*Ch*).SELected.TRANsform.DISTance. STIMulus

Object type

Property

Syntax

SCPI.CALCulate(*Ch*).SELected.TRANsform.DISTance.STIMulus = *Param*

Param = SCPI.CALCulate(*Ch*).SELected.TRANsform.DISTance.STIMulus

Description

For the active trace of channels 1 to 4 (*Ch*), sets the stimulus type used for the transformation function of the fault location function.

Variable

	Param
Description	The stimulus type
Data type	Character string type (String)
Range	Select from the following. •"IMPulse" Specifies the impulse[*1]. •"STEP" Specifies the step[*2].
Preset value	"IMPulse"

[*1] You need to select the transformation type (band-pass or low-pass) with the SCPI.CALCulate(Ch).SELected.TRANsform.DISTance.TYPE object.

[*2] You do not need to select the transformation type. Low-pass is selected automatically.

For information on the variable (*Ch*), see Table C-2, “Variable (Ch),” on page 159.

Examples

```
Dim StimType As String
SCPI.CALCulate(1).PARameter(1).SELect
SCPI.CALCulate(1).SELected.TRANsform.DISTance.STIMulus = "step"
StimType = SCPI.CALCulate(1).SELected.TRANsform.DISTance.STIMulus
```

Related objects

SCPI.CALCulate(Ch).SELected.TRANsform.DISTance.TYPE on page 172

SCPI.CALCulate(Ch).SELected.TRANsform.DISTance.STATe on page 168

Equivalent key

[Analysis] - **Fault Location** - **Type** - **Bandpass**|**Lowpass Step**|**Lowpass Imp.**

NOTE

When performing this operation from the front panel, you select the transformation type at the same time.

SCPI.CALCulate(*Ch*).SELected.TRANsform.DISTance.STOP

Object type

Property

Syntax

SCPI.CALCulate(*Ch*).SELected.TRANsform.DISTance.STOP = *Value*

Value = SCPI.CALCulate(*Ch*).SELected.TRANsform.DISTance.STOP

Description

For the active trace of channels 1 to 4 (*Ch*), sets the stop value of the fault location display.

Variable

	Value
Description	Stop value
Data type	Double precision floating point type (Double)
Range	Varies depending on the frequency span, velocity factor, distance unit, and the number of points.
Preset value	9.8357Ft or 2.9979m
Unit	Ft (Feet) or m (Meters)
Note	If the specified variable is out of the allowable setup range, the minimum value (if the lower limit of the range is not reached) or the maximum value (if the upper limit of the range is exceeded) is set.

For information on the variable (*Ch*), see Table C-2, “Variable (Ch),” on page 159.

Examples

```
Dim Span As Double
SCPI.CALCulate(1).PARameter(1).SELect
SCPI.CALCulate(1).SELected.TRANsform.DISTance.STOP = 2E-8
Cent = SCPI.CALCulate(1).SELected.TRANsform.DISTance.STOP
```

Related objects

SCPI.CALCulate(Ch).SELected.TRANsform.DISTance.STARt on page 167

SCPI.CALCulate(Ch).SELected.TRANsform.DISTance.STATe on page 168

Equivalent key

[Analysis] - **Fault Location** - **Stop**

SCPI.CALCulate(*Ch*).SELected.TRANsform.DISTance.TYPE

Object type Property

Syntax SCPI.CALCulate(*Ch*).SELected.TRANsform.DISTance.TYPE = *Param*

Param = SCPI.CALCulate(*Ch*).SELected.TRANsform.DISTance.TYPE

Description For the active trace of channels 1 to 4 (*Ch*), selects the transformation type used for the transformation function of the fault location function.

Variable

	Param
Description	The transformation type
Data type	Character string type (String)
Range	Select from the following. •"BPASs" Specifies the band-pass[*1]. •"LPASs" Specifies the low-pass[*2].
Preset value	"BPASs"

[*1] You do not need to select the stimulus type. Impulse is selected automatically.

[*2] You need to select the stimulus type (impulse or step) with the SCPI.CALCulate(Ch).SELected.TRANsform.DISTance. STIMulus object.

For information on the variable (*Ch*), see Table C-2, “Variable (Ch),” on page 159.

Examples

```
Dim Typ As String
SCPI.CALCulate(1).PARameter(1).SELect
SCPI.CALCulate(1).SELected.TRANsform.DISTance.TYPE = "LPAS"
Typ = SCPI.CALCulate(1).SELected.TRANsform.DISTance.TYPE
```

Related objects SCPI.CALCulate(Ch).SELected.TRANsform.DISTance. STIMulus on page 170

SCPI.CALCulate(Ch).SELected.TRANsform.DISTance.STATe on page 168

Equivalent key **[Analysis]** - **Fault Location** - **Type** - **Bandpass**|**Lowpass Step**|**Lowpass Imp.**

NOTE When performing this operation from the front panel, you select the stimulus type at the same time.

SCPI.CALCulate(*Ch*).SELected.TRANsform.TIME.CENTer

Object type

Property

Syntax

SCPI.CALCulate(*Ch*).SELected.TRANsform.TIME.CENTer = *Value*

Value = SCPI.CALCulate(*Ch*).SELected.TRANsform.TIME.CENTer

Description

For the active trace of channels 1 to 4 (*Ch*), sets the center value used for the transformation function of the fault location function.

Variable

	Value
Description	Center value
Data type	Double precision floating point type (Double)
Range	Varies depending on the frequency span and the number of points.
Preset value	0
Unit	s (second)
Note	If the specified variable is out of the allowable setup range, the minimum value (if the lower limit of the range is not reached) or the maximum value (if the upper limit of the range is exceeded) is set.

For information on the variable (*Ch*), see Table C-2, “Variable (Ch),” on page 159.

Examples

```
Dim Cent As Double
SCPI.CALCulate(1).PARameter(1).SELect
SCPI.CALCulate(1).SELected.TRANsform.TIME.CENTer = 1E-8
Cent = SCPI.CALCulate(1).SELected.TRANsform.TIME.CENTer
```

Related objects

SCPI.CALCulate(Ch).SELected.TRANsform.TIME.SPAN on page 179

SCPI.CALCulate(Ch).SELected.TRANsform.TIME.STATe on page 181

Equivalent key

[Analysis] - **Fault Location** - **Center**

SCPI.CALCulate(*Ch*).SELected.TRANsform.TIME. CLOSs

Object type

Property

Syntax

SCPI.CALCulate(*Ch*).SELected.TRANsform.TIME.CLOSs = *Value*

Value = SCPI.CALCulate(*Ch*).SELected.TRANsform.TIME.CLOSs

Description

For the active trace of channels 1 to 4 (*Ch*), sets the cable loss value used for the transformation function of the fault location function.

Variable

	Value
Description	Cable Loss value
Data type	Double precision floating point type (Double)
Range	0 to 1000
Preset value	0
Unit	dB/us
Note	If the specified variable is out of the allowable setup range, the minimum value (if the lower limit of the range is not reached) or the maximum value (if the upper limit of the range is exceeded) is set.

For information on the variable (*Ch*), see Table C-2, “Variable (Ch),” on page 159.

Examples

```
Dim Cent As Double
SCPI.CALCulate(1).PARameter(1).SELect
SCPI.CALCulate(1).SELected.TRANsform.TIME.CLOSs = 10
Cent = SCPI.CALCulate(1).SELected.TRANsform.TIME.CLOSs
```

Related objects

Equivalent key

[Analysis] - **Fault Location** - **Cable Loss**

SCPI.CALCulate(*Ch*).SELected.TRANsform.TIME. IMPulse.WIDTh

Object type

Property

Syntax

SCPI.CALCulate(*Ch*).SELected.TRANsform.TIME.IMPulse.WIDTh = *Value*

Value = SCPI.CALCulate(*Ch*).SELected.TRANsform.TIME.IMPulse.WIDTh

Description

For the active trace of channels 1 to 4 (*Ch*), sets the shape of the Kayser Bessel window using the impulse width used for the transformation function of the fault location function.

Variable

	Value
Description	Impulse width
Data type	Double precision floating point type (Double)
Range	Varies depending on the frequency span and transformation type.
Preset value	Varies depending on the frequency span and transformation type.
Unit	s (second)
Note	If the specified variable is out of the allowable setup range, the minimum value (if the lower limit of the range is not reached) or the maximum value (if the upper limit of the range is exceeded) is set.

For information on the variable (*Ch*), see Table C-2, “Variable (Ch),” on page 159.

Examples

```
Dim ImpWid As Double
SCPI.CALCulate(1).PARameter(1).SELect
SCPI.CALCulate(1).SELected.TRANsform.TIME.IMPulse.WIDTh = 1E-10
ImpWid = SCPI.CALCulate(1).SELected.TRANsform.TIME.IMPulse.WIDTh
```

Related objects

SCPI.CALCulate(Ch).SELected.TRANsform.TIME. KBESsel on page 176

SCPI.CALCulate(Ch).SELected.TRANsform.TIME.STEP.RTIMe on page 182

SCPI.CALCulate(Ch).SELected.TRANsform.TIME.STATe on page 181

Equivalent key

[Analysis] - **Fault Location** - **Window** - **Impulse Width**

SCPI.CALCulate(*Ch*).SELected.TRANsform.TIME. KBESsel

Object type

Property

Syntax

SCPI.CALCulate(*Ch*).SELected.TRANsform.TIME.KBESsel = *Value*

Value = SCPI.CALCulate(*Ch*).SELected.TRANsform.TIME.KBESsel

Description

For the active trace of channels 1 to 4 (*Ch*), sets the shape of the Kayser Bessel window using β used for the transformation function of the fault location function.

Variable

	Value
Description	The value of β
Data type	Double precision floating point type (Double)
Range	0 to13
Preset value	6
Note	If the specified variable is out of the allowable setup range, the minimum value (if the lower limit of the range is not reached) or the maximum value (if the upper limit of the range is exceeded) is set.

For information on the variable (*Ch*), see Table C-2, “Variable (Ch),” on page 159.

Examples

```
Dim Beta As Double
SCPI.CALCulate(1).PARameter(1).SELect
SCPI.CALCulate(1).SELected.TRANsform.TIME.KBESsel = 3
Beta = SCPI.CALCulate(1).SELected.TRANsform.TIME.KBESsel
```

Related objects

SCPI.CALCulate(Ch).SELected.TRANsform.TIME. IMPulse.WIDTh on page 175

SCPI.CALCulate(Ch).SELected.TRANsform.TIME.STEP.RTIMe on page 182

SCPI.CALCulate(Ch).SELected.TRANsform.TIME.STATe on page 181

Equivalent key

[Analysis] - **Fault Location** - **Window** - **Kaiser Beta**

SCPI.CALCulate(*Ch*).SELected.TRANsform.TIME. LPFRequency

Object type	Method
Syntax	SCPI.CALCulate(*Ch*).SELected.TRANsform.TIME.LPFRequency = *Value*
Description	For the active trace of channels 1 to 4 (*Ch*), changes the frequency range to match with the low-pass type transformation of the transformation function of the fault location function. (No read)
Variable	For information on the variable (*Ch*), see Table C-2, “Variable (Ch),” on page 159.
Examples	`SCPI.CALCulate(1).PARameter(1).SELect` `SCPI.CALCulate(1).SELected.TRANsform.TIME.LPFRequency`
Related objects	SCPI.CALCulate(Ch).SELected.TRANsform.TIME.TYPE on page 185 SCPI.CALCulate(Ch).SELected.TRANsform.TIME.STATe on page 181
Equivalent key	**[Analysis]** - **Fault Location** - **Set Freq Low pass**

SCPI.CALCulate(*Ch*).SELected.TRANsform.TIME. REFLection.TYPE

Object type

Property

Syntax

SCPI.CALCulate(*Ch*).SELected.TRANsform.TIME.REFLection.TYPE = *Param*

Param = SCPI.CALCulate(*Ch*).SELected.TRANsform.TIME.REFLection.TYPE

Description

For the active trace of channels 1 to 4 (*Ch*), selects the stimulus type used for the transformation function of the fault location function.

Variable

	Param
Description	The stimulus type
Data type	Character string type (String)
Range	Select from the following. •"OWAY" Specifies the One Way. •"RTRip" Specifies the Round Trip.
Preset value	"IMPulse"

For information on the variable (*Ch*), see Table C-2, “Variable (Ch),” on page 159.

Examples

```
Dim StimType As String
SCPI.CALCulate(1).PARameter(1).SELect
SCPI.CALCulate(1).SELected.TRANsform.TIME.REFLection.TYPE = "OWAY"
StimType =
SCPI.CALCulate(1).SELected.TRANsform.TIME.REFLection.TYPE
```

Related objects

Equivalent key

[Analysis] - **Fault Location** - **Reflection Type**

SCPI.CALCulate(*Ch*).SELected.TRANsform.TIME.SPAN

Object type

Property

Syntax

SCPI.CALCulate(*Ch*).SELected.TRANsform.TIME.SPAN = *Value*

Value = SCPI.CALCulate(*Ch*).SELected.TRANsform.TIME.SPAN

Description

For the active trace of channels 1 to 4 (*Ch*), sets the span value used for the transformation function of the fault location function.

Variable

	Value
Description	Span value
Data type	Double precision floating point type (Double)
Range	Varies depending on the frequency span and the number of points.
Preset value	2E-8
Unit	s (second)
Note	If the specified variable is out of the allowable setup range, the minimum value (if the lower limit of the range is not reached) or the maximum value (if the upper limit of the range is exceeded) is set.

For information on the variable (*Ch*), see Table C-2, “Variable (Ch),” on page 159.

Examples

```
Dim Span As Double
SCPI.CALCulate(1).PARameter(1).SELect
SCPI.CALCulate(1).SELected.TRANsform.TIME.SPAN = 1E-8
Cent = SCPI.CALCulate(1).SELected.TRANsform.TIME.SPAN
```

Related objects

SCPI.CALCulate(Ch).SELected.TRANsform.TIME. CENTer on page 173

SCPI.CALCulate(Ch).SELected.TRANsform.TIME.STATe on page 181

Equivalent key

[Analysis] - **Fault Location** - **Span**

SCPI.CALCulate(*Ch*).SELected.TRANsform.TIME.STARt

Object type

Property

Syntax

SCPI.CALCulate(*Ch*).SELected.TRANsform.TIME.STARt = *Value*

Value = SCPI.CALCulate(*Ch*).SELected.TRANsform.TIME.STARt

Description

For the active trace of channels 1 to 4 (*Ch*), sets the start value used for the transformation function of the fault location function.

Variable

	Value
Description	Start value
Data type	Double precision floating point type (Double)
Range	Varies depending on the frequency span and the number of points.
Preset value	-1E-8
Unit	s (second)
Note	If the specified variable is out of the allowable setup range, the minimum value (if the lower limit of the range is not reached) or the maximum value (if the upper limit of the range is exceeded) is set.

For information on the variable (*Ch*), see Table C-2, “Variable (Ch),” on page 159.

Examples

```
Dim Star As Double
SCPI.CALCulate(1).PARameter(1).SELect
SCPI.CALCulate(1).SELected.TRANsform.TIME.STARt = 0
Star = SCPI.CALCulate(1).SELected.TRANsform.TIME.STARt
```

Related objects

SCPI.CALCulate(Ch).SELected.TRANsform.TIME.STOP on page 184

SCPI.CALCulate(Ch).SELected.TRANsform.TIME.STATe on page 181

Equivalent key

[Analysis] - **Fault Location** - **Start**

SCPI.CALCulate(*Ch*).SELected.TRANsform.TIME.STATe

Object type

Property

Syntax

SCPI.CALCulate(*Ch*).SELected.TRANsform.TIME.STATe = *Status*

Status = SCPI.CALCulate(*Ch*).SELected.TRANsform.TIME.STATe

Description

For the active trace of channels 1 to 4 (*Ch*), turns ON/OFF the transformation function of the fault location function.

You can enable the transformation function only when the sweep type is the linear sweep and the number of points is 3 or more. If you execute this object to try to enable the transformation function when the sweep type is other than the linear sweep or the number of points is less than 3, an error occurs and the object is ignored.

When the sweep type is the power sweep, you cannot turn on the transformation function. If you execute this object trying to turn on the transformation function during the power sweep, an error occurs and the object is ignored.

Variable

	Status
Description	ON/OFF of the gating function
Data type	Boolean type (Boolean)
Range	Select from the following. •True or -1 Turns ON the transformation function. •False or 0 Turns OFF the transformation function.
Preset value	False or 0

For information on the variable (*Ch*), see Table C-2, “Variable (Ch),” on page 159.

Examples

```
Dim Trans As Boolean
SCPI.CALCulate(1).PARameter(1).SELect
SCPI.CALCulate(1).SELected.TRANsform.TIME.STATe = True
Trans = SCPI.CALCulate(1).SELected.TRANsform.TIME.STATe
```

Related objects

Equivalent key

[Analysis] - **Fault Location** - **Fault Location**

SCPI.CALCulate(*Ch*).SELected.TRANsform.TIME.STEP.RTIMe

Object type

Property

Syntax

SCPI.CALCulate(*Ch*).SELected.TRANsform.TIME.STEP.RTIMe = *Value*

Value = SCPI.CALCulate(*Ch*).SELected.TRANsform.TIME.STEP.RTIMe

Description

For the active trace of channels 1 to 4 (*Ch*), sets the shape of the Kayser Bessel window using the rise time of step signal used for the transformation function of the fault location function.

Variable

	Value
Description	The rise time of step signal
Data type	Double precision floating point type (Double)
Range	Varies depending on the frequency span.
Preset value	Varies depending on the frequency span.
Unit	s (second)
Note	If the specified variable is out of the allowable setup range, the minimum value (if the lower limit of the range is not reached) or the maximum value (if the upper limit of the range is exceeded) is set.

For information on the variable (*Ch*), see Table C-2, “Variable (Ch),” on page 159.

Examples

```
Dim RTime As Double
SCPI.CALCulate(1).PARameter(1).SELect
SCPI.CALCulate(1).SELected.TRANsform.TIME.STEP.RTIMe = 1E-10
RTime = SCPI.CALCulate(1).SELected.TRANsform.TIME.STEP.RTIMe
```

Related objects

SCPI.CALCulate(Ch).SELected.TRANsform.TIME. IMPulse.WIDTh on page 175

SCPI.CALCulate(Ch).SELected.TRANsform.TIME. KBESsel on page 176

SCPI.CALCulate(Ch).SELected.TRANsform.TIME.STATe on page 181

Equivalent key

[Analysis] - **Fault Location** - **Step Rise**

SCPI.CALCulate(*Ch*).SELected.TRANsform.TIME. STIMulus

Object type

Property

Syntax

SCPI.CALCulate(*Ch*).SELected.TRANsform.TIME.STIMulus = *Param*

Param = SCPI.CALCulate(*Ch*).SELected.TRANsform.TIME.STIMulus

Description

For the active trace of channels 1 to 4 (*Ch*), selects the stimulus type used for the transformation function of the fault location function.

Variable

	Param
Description	The stimulus type
Data type	Character string type (String)
Range	Select from the following. •"IMPulse" Specifies the impulse[*1]. •"STEP" Specifies the step[*2].
Preset value	"IMPulse"

[*1] You need to select the transformation type (band-pass or low-pass) with the SCPI.CALCulate(Ch).SELected.TRANsform.DISTance.TYPE object.

[*2] You do not need to select the transformation type. Low-pass is selected automatically.

For information on the variable (*Ch*), see Table C-2, “Variable (Ch),” on page 159.

Examples

```
Dim StimType As String
SCPI.CALCulate(1).PARameter(1).SELect
SCPI.CALCulate(1).SELected.TRANsform.TIME.STIMulus = "step"
StimType = SCPI.CALCulate(1).SELected.TRANsform.TIME.STIMulus
```

Related objects

SCPI.CALCulate(Ch).SELected.TRANsform.TIME.TYPE on page 185

SCPI.CALCulate(Ch).SELected.TRANsform.TIME.STATe on page 181

Equivalent key

[Analysis] - **Fault Location** - **Type** - **Bandpass**|**Lowpass Step**|**Lowpass Imp.**

NOTE

When performing this operation from the front panel, you select the transformation type at the same time.

SCPI.CALCulate(*Ch*).SELected.TRANsform.TIME.STOP

Object type

Property

Syntax

SCPI.CALCulate(*Ch*).SELected.TRANsform.TIME.STOP = *Value*

Value = SCPI.CALCulate(*Ch*).SELected.TRANsform.TIME.STOP

Description

For the active trace of channels 1 to 4 (*Ch*), sets the span value used for the transformation function of the fault location function.

Variable

	Value
Description	Stop value
Data type	Double precision floating point type (Double)
Range	Varies depending on the frequency span and the number of points.
Preset value	1E-8
Unit	s (second)
Note	If the specified variable is out of the allowable setup range, the minimum value (if the lower limit of the range is not reached) or the maximum value (if the upper limit of the range is exceeded) is set.

For information on the variable (*Ch*), see Table C-2, “Variable (Ch),” on page 159.

Examples

```
Dim Span As Double
SCPI.CALCulate(1).PARameter(1).SELect
SCPI.CALCulate(1).SELected.TRANsform.TIME.STOP = 2E-8
Cent = SCPI.CALCulate(1).SELected.TRANsform.TIME.STOP
```

Related objects

SCPI.CALCulate(Ch).SELected.TRANsform.TIME.STARt on page 180

SCPI.CALCulate(Ch).SELected.TRANsform.TIME.STATe on page 181

Equivalent key

[Analysis] - **Fault Location** - **Stop**

SCPI.CALCulate(*Ch*).SELected.TRANsform.TIME.TYPE

Object type

Property

Syntax

SCPI.CALCulate(*Ch*).SELected.TRANsform.TIME.TYPE = *Param*

Param = SCPI.CALCulate(*Ch*).SELected.TRANsform.TIME.TYPE

Description

For the active trace of channels 1 to 4 (*Ch*), selects the transformation type used for the transformation function of the fault location function.

Variable

	Param
Description	The transformation type
Data type	Character string type (String)
Range	Select from the following. •"BPASs" Specifies the band-pass[*1]. •"LPASs" Specifies the low-pass[*2].
Preset value	"BPASs"

*1. You do not need to select the stimulus type. Impulse is selected automatically.

*2. You need to select the stimulus type (impulse or step) with the SCPI.CALCulate(Ch).SELected.TRANsform.DISTance. STIMulus object.

For information on the variable (*Ch*), see Table C-2, “Variable (Ch),” on page 159.

Examples

```
Dim Typ As String
SCPI.CALCulate(1).PARameter(1).SELect
SCPI.CALCulate(1).SELected.TRANsform.TIME.SHAPe = "lpas"
Typ = SCPI.CALCulate(1).SELected.TRANsform.TIME.SHAPe
```

Related objects

SCPI.CALCulate(Ch).SELected.TRANsform.TIME. STIMulus on page 183

SCPI.CALCulate(Ch).SELected.TRANsform.TIME.STATe on page 181

Equivalent key

[Analysis] - **Fault Location** - **Type** - **Bandpass**|**Lowpass Step**|**Lowpass Imp.**

NOTE

When performing this operation from the front panel, you select the stimulus type at the same time.

SCPI.CALCulate(*Ch*).TRANsform.SELected.DISTance.UNIT

Object type

Property

Syntax

SCPI.CALCulate(*Ch*).TRANsform.SELected.DISTance.UNIT = *Param*

Param = SCPI.CALCulate(*Ch*).TRANsform.SELected.DISTance.UNIT

Description

For the active trace of channels 1 to 4 (*Ch*), selects the distance unit of the fault location display.

Variable

	Param
Description	The distance unit
Data type	Character string type (String)
Range	Select from the following. •"METers" Specifies meters. •"FEET" Specifies feets.
Preset value	None

For information on the variable (*Ch*), see Table C-2, “Variable (Ch),” on page 159.

Examples

```
Dim Typ As String
SCPI.CALCulate(1).PARameter(1).SELect
SCPI.CALCulate(1).TRANsform.SELected.DISTance.UNIT = "METers"
Typ = SCPI.CALCulate(1).TRANsform.SELected.DISTance.UNIT
```

Related objects

Equivalent key

[Analysis] - **Fault Location** - **UNIT** - **Seconds**|**Meters**|**Feet**

SCPI.CALCulate(*Ch*).TRANsform.SELected.METHod

Object type
Property

Syntax
SCPI.CALCulate(*Ch*).TRANsform.SELected.METHod = *Param*

Param = SCPI.CALCulate(*Ch*).TRANsform.SELected.METHod

Description
For the active trace of channels 1 to 4 (*Ch*), sets the horizontal axis of the fault location function either time or distance.

Variable

	Param
Description	The horizontal axis domain
Data type	Character string type (String)
Range	Select from the following. •"TIME" Specifies the time. •"DISTance" Specifies the distance.
Preset value	None (The default is Seconds of the TIME.)

For information on the variable (*Ch*), see Table C-2, “Variable (Ch),” on page 159.

Examples

```
Dim Typ As String
SCPI.CALCulate(1).PARameter(1).SELect
SCPI.CALCulate(1).TRANsform.SELected.METHod = "TIME"
Typ = SCPI.CALCulate(1).TRANsform.SELected.METHod
```

Related objects

Equivalent key
[Analysis] - **Fault Location** - **UNIT** - **Seconds**|**Meters**|**Feet**

SRL SCPI Objects

SCPI objects are a collection of the COM interface having one-on-one correspondence with the SCPI commands. This section describes the SCPI objects provided for the SRL function of the E5061A/E5062A.

SCPI.CALCulate(*Ch*).SRL.CONNector(*Pt*).CAPacitance

Object type

Property

Syntax

SCPI.CALCulate(*Ch*).SRL.CONNector(*Pt*).CAPacitance = *Value*

Value = SCPI.CALCulate(*Ch*).SRL.CONNector(*Pt*).CAPacitance

Description

For the active trace of channels 1 to 4 (*Ch*), sets the connector capacitance value for the connector mismatch compensation.

Variable

	Value
Description	Connector Capacitance for compensation
Data type	Double precision floating point type (Double)
Range	-2e-12 to 2e-12
Preset value	0
Unit	F
Note	If the specified variable is out of the allowable setup range, the minimum value (if the lower limit of the range is not reached) or the maximum value (if the upper limit of the range is exceeded) is set.

For information on the variable (*Ch*), see Table C-2, “Variable (Ch),” on page 159.

Examples

```
Dim Cent As Double
SCPI.CALCulate(1).PARameter(1).SELect
SCPI.CALCulate(1).SRL.CONNector(1).CAPacitance = 1E-2
Cent = SCPI.CALCulate(1).SRL.CONNector(1).CAPacitance
```

Related objects

SCPI.CALCulate(Ch).SRL.STATe on page 195

SCPI.CALCulate(Ch).SRL.CONNector(Pt).IMMediate on page 189

Equivalent key

[Analysis] - **SRL** - **Portx Connector** - **Capacitance**

SCPI.CALCulate(*Ch*).SRL.CONNector(*Pt*).IMMediate

Object type	Property
Syntax	SCPI.CALCulate(*Ch*).SRL.CONNector(*Pt*).IMMediate
Description	For the active trace of channels 1 to 4 (*Ch*), measures the terminated cable connected to the specified port and automatically sets the connector length and capacitance values for connector mismatch compensation.
Variable	For information on the variable (*Ch*), see Table C-2, “Variable (Ch),” on page 159.

Examples

```
Dim Cent As Double
SCPI.CALCulate(1).PARameter(1).SELect
SCPI.CALCulate(1).SRL.CONNector(1).IMMediate
```

Related objects	SCPI.CALCulate(Ch).SRL.STATe on page 195
Equivalent key	**[Analysis]** - **SRL** - **Portx Connector** - **Measure Connector**

SCPI.CALCulate(*Ch*).SRL.CONNector(*Pt*).IMPedance

Object type

Property

Syntax

Value = SCPI.CALCulate(*Ch*).SRL.CONNector(*Pt*).IMPedance

Description

For the active trace of channels 1 to 4 (*Ch*), read outs the averave cable impedance used for the SRL calculation.

Variable

	Value
Description	Impedance value
Data type	Double precision floating point type (Double)
Unit	Ohm
Note	This command is read only.

For information on the variable (*Ch*), see Table C-2, “Variable (Ch),” on page 159.

Examples

```
Dim ImpWid As Double
SCPI.CALCulate(1).PARameter(1).SELect
Imp = SCPI.CALCulate(1).SRL.CONNector(1).IMPedance
```

Related objects

SCPI.CALCulate(Ch).SRL.STATe on page 195

SCPI.CALCulate(Ch).SRL.CONNector(Pt).IMMediate on page 189

Equivalent key

None

SCPI.CALCulate(*Ch*).SRL.CONNector(*Pt*).LENGth

Object type

Property

Syntax

SCPI.CALCulate(*Ch*).SRL.CONNector(*Pt*).LENGth = *Value*

Value = SCPI.CALCulate(*Ch*).SRL.CONNector(*Pt*).LENGth

Description

For the active trace of channels 1 to 4 (*Ch*), sets the connector length value for the connector mismatch compensation.

Variable

	Value
Description	The connector length for compensation.
Data type	Double precision floating point type (Double)
Range	-0.02 to0.2
Preset value	0
Unit	m (Meters)

For information on the variable (*Ch*), see Table C-2, “Variable (Ch),” on page 159.

Examples

```
Dim Length As Double
SCPI.CALCulate(1).PARameter(1).SELect
SCPI.CALCulate(1).SRL.CONNector(1).LENGth = 0.1
Length = SCPI.CALCulate(1).SRL.CONNector.LENGth
```

Related objects

SCPI.CALCulate(Ch).SRL.STATe on page 195

SCPI.CALCulate(Ch).SRL.CONNector(Pt).IMMediate on page 189

Equivalent key

[Analysis] - **SRL** - **Portx Connector** - **Length**

SCPI.CALCulate(*Ch*).SRL.IMPedance.AUTO.CUToff

Object type	Property
Syntax	SCPI.CALCulate(*Ch*).SRL.IMPedance.AUTO.CUToff = *Value* *Value* = SCPI.CALCulate(*Ch*).SRL.IMPedance.AUTO.CUToff
Description	For the active trace of channels 1 to 4 (*Ch*), sets the cutoff frequency for the auto calculation for the average cable impedance.

Variable

	Value
Description	Maximum frequency.
Data type	Double precision floating point type (Double)
Range	300000 to 3e+009
Preset value	2.1e+008
Unit	Hz

For information on the variable (*Ch*), see Table C-2, “Variable (Ch),” on page 159.

Examples

```
Dim Length As Double
SCPI.CALCulate(1).PARameter(1).SELect
SCPI.CALCulate(1).SRL.IMPedance.AUTO.STATe = True
SCPI.CALCulate(1).SRL.IMPedance.AUTO.CUToff = 2.1e+008
Length = SCPI.CALCulate(1).SRL.IMPedance.AUTO.CUToff
```

Related objects

SCPI.CALCulate(Ch).SRL.STATe on page 195

SCPI.CALCulate(Ch).SRL.IMPedance.AUTO.STATe on page 193

SCPI.CALCulate(Ch).SRL.IMPedance.MANual on page 194

Equivalent key **[Analysis]** - **SRL** - **Z Cutoff Freq.**

SCPI.CALCulate(*Ch*).SRL.IMPedance.AUTO.STATe

Object type

Property

Syntax

SCPI.CALCulate(*Ch*).SRL.IMPedance.AUTO.STATe = *Status*

Status = SCPI.CALCulate(*Ch*).SRL.IMPedance.AUTO.STATe

Description

For the active trace of channels 1 to 4 (*Ch*), turns ON/OFF the auto impedance calculation function of the SRL measurement.

Variable

	Status
Description	Auto impedance calculation status
Data type	Boolean
Range	True (-1) or False (0)
Preset value	True

For information on the variable (*Ch*), see Table C-2, “Variable (Ch),” on page 159.

Examples

```
Dim Status As Boolean
SCPI.CALCulate(1).PARameter(1).SELect
SCPI.CALCulate(1).SRL.IMPedance.AUTO.STATe = True
Status = SCPI.CALCulate(1).SRL.IMPedance.AUTO.STATe
```

Related objects

SCPI.CALCulate(Ch).SRL.STATe on page 195

SCPI.CALCulate(Ch).SRL.IMPedance.AUTO.CUToff on page 192

SCPI.CALCulate(Ch).SRL.IMPedance.MANual on page 194

Equivalent key

[Analysis] - **SRL** - **AUTO Z**

SCPI.CALCulate(*Ch*).SRL.IMPedance.MANual

Object type

Property

Syntax

SCPI.CALCulate(*Ch*).SRL.IMPedance.MANual = *Value*

Value = SCPI.CALCulate(*Ch*).SRL.IMPedance.MANual

Description

For the active trace of channels 1 to 4 (*Ch*), sets the average cable impedance to be used in the SRL calculation.

Variable

	Value
Description	Average cable impedance value.
Data type	Double precision floating point type (Double)
Range	10 to 1000
Preset value	50 or 75
Unit	Ohm

For information on the variable (*Ch*), see Table C-2, “Variable (Ch),” on page 159.

Examples

```
Dim Imp As Double
SCPI.CALCulate(1).PARameter(1).SELect
SCPI.CALCulate(1).SRL.IMPedance.AUTO.STATe = False
SCPI.CALCulate(1).SRL.IMPedance.MANual = 75
Imp = SCPI.CALCulate(1).SRL.IMPedance.MANual
```

Related objects

SCPI.CALCulate(Ch).SRL.STATe on page 195

SCPI.CALCulate(Ch).SRL.IMPedance.AUTO.CUToff on page 192

SCPI.CALCulate(Ch).SRL.IMPedance.AUTO.STATe on page 193

Equivalent key

[Analysis] - **SRL** - **Manual Z**

SCPI.CALCulate(*Ch*).SRL.STATe

Object type

Property

Syntax

SCPI.CALCulate(*Ch*).SRL.STATe = *Status*

Status = SCPI.CALCulate(*Ch*).SRL.STATe

Description

For the active trace of channels 1 to 4 (*Ch*), turn ON/OFF SRL measurement function.

Variable

	Status
Description	SRL measurement function status
Data type	Boolean
Range	True (-1) or False (0)
Preset value	False

For information on the variable (*Ch*), see Table C-2, “Variable (Ch),” on page 159.

Examples

```
Dim Status As Double
SCPI.CALCulate(1).PARameter(1).SELect
SCPI.CALCulate(1).SRL.STATe = True
Status = SCPI.CALCulate(1).SRL.STATe
```

Related objects

Equivalent key

[Analysis] - **SRL** - **SRL**

Index

Index