Keysight Technologies
Fast Power (Option FP2)

Programmer's Reference

KEYSIGHT TECHNOLOGIES

Notices

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Contents

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Introduction

The Fast Power option (FP2) enables fast channel power measurements for instruments with the prerequisite hardware (minimum DP2 and/or B40). This is done by performing real-time overlapped FFTs at the hardware layer, using software for post-processing before returning the result to the user. This leads to improved throughput for user applications that require many sequential power measurements.

Each Fast Power measurement can be predefined using an array index, and up to 1,000 measurements can be stored. This allows for power measurements to be defined one time in a batch, and then executed multiple times without having to redefine them, similar to “list mode” on other measurements.

In addition to basic channel power measurements, there are multiple measurement “functions” for each channel, such as peak power, peak frequency, and power spectral density. This reference guide contains a comprehensive list of the SCPI commands used to perform Fast Power measurements and adjust measurement parameters.

Measurement Configuration Commands for FPOW

The following commands are used to configure measurement settings:

CALC:FPOW:POW[n]:RES

CALC:FPOW:POW[n]:DEF

CALC:FPOW:POW[n]:DEF?

NOTE "n" is any integer value from 1 to 999 which denotes the measurement being specified.

CALCulate:FPOWer:POWer[n]:RESet

Description	The RESet command is used to return all variable parameters to their corresponding default values.
Remote Command	`CALC:FPOW:POW[n]:RES`

CALCulate:FPOWer:POWer[n]:DEFine

Description	The DEFine command is used to set the configurable parameters for measurements being performed. See "Appendix: CALCulate:FPOWer:POWer[n]:DEFine Parameters" to see all acceptable parameters and values.
Remote Command	`CALC:FPOW:POW[n]:DEF "configuration string"`
Example	`CALC:FPOW:POW1:DEF 'CenterFrequency = 1e9, Bandwidth = [1e6], DetectorType = Peak'`

CALCulate:FPOWer:POWer[n]:DEFine?

Description	The DEFine? command query is used to retrieve a list of all defined parameters in ASCII string format. The string begins and ends with quotation marks.
Remote Command	`CALC:FPOW:POW[n]:DEF?`
Default Return Result	"DCCoupled=False, ElecAttBypass=True, ElecAttenuation=0, IFGain=0, MechAttenuation=0, PreAmpMode=Off, PreSelectorOffset=0, UsePreSelector=False, ExternalReferenceFrequency=10000000, FrequencyReferenceSource=AutoExternalFrequencyReference, IFType=B40M, SignalInput=FpMainRf, AcquisitionTime=0.001, CenterFrequency=1000000000, ResolutionBW=0, ResolutionBWMode=BestSpeed, DetectorType=RmsAverage, Bandwidth=[1000000], OffsetFrequency=[0], Function=[BandPower], FilterType=[IBW], FilterAlpha=[0.22], IncludePowerSpectrum=False, TriggerDelay=0, TriggerLevel=1.2, TriggerSlope=Positive, TriggerSource=Free, TriggerTimeout=1"

List of CALCulate:FPOWer:POWer[n]:DEFine Parameters

AcquisitionTime

CenterFrequency

DCCoupled

DetectorType

DoNoiseCorrection

DoSpurSuppression

ElecAttBypass

ElecAttenuation

IFGain

IFType

IncludePowerSpectrum

MechAttenuation

PreAmpMode

ResolutionBWMode

ResolutionBW

TriggerDelay

TriggerLevel

TrigerSlope

TriggerSource

TriggerTimeout

SignalInput

UsePreSelector

[Bandwidth]

[FilterAlpha]

[FilterType]

[Function]

[OffsetFrequency]

NOTE For definitions and examples of the above parameters, see “Appendix: CALCulate:FPOWer:POWer[n]:DEFine Parameters” on page 12.

Measurement Commands for FPOW

The following commands are used to retrieve the measurement results:

```
CALC:FPOW:POW[n]:CONF
CALC:FPOW:POW[n]:INIT
CALC:FPOW:POW[n]:FETC?
CALC:FPOW:POW[n]:?
CALC:FPOW:POW[n]:READ?
CALC:FPOW:POW[n]:READ2?
```

NOTE "n" is any integer value from 1 to 999 which denotes the measurement being specified.

CALCulate:FPOWer:POWer[n]:CONFigure

Description	The CONFigure command begins hardware setup and returns immediately, with no acquisition made. This can be used in parallel with other hardware operations to effectively hide the hardware setup time.
Remote Command	`CALC:FPOW:POW[n]:CONF`

Example	`CALC:FPOW:POW1:CONF`
	`…(other operation ideally > 3ms)`
	`CLAC:FPOW:POW1?`

CALCulate:FPOWer:POWer[n]:INITiate

Description	The INITiate command begins an acquisition and returns immediately before it is complete.
Remote Command	`CALC:FPOW:POW[n]:INIT`

CALCulate:FPOWer:POWer[n]:FETCh?

Description	The FETCh command query is used to retrieve the results of an acquisition initiated by the INIT command. The returned results are in ASCII string format. The string begins and ends with quotation marks.
Remote Command	`CALC:FPOW:POW[n]:FETC?`
Return Result	Returns m comma-separated ASCII values, where m corresponds to the number of bandwidths defined.
Notes	The INIT and FETC? Command sequence performs the same functionality of a single `CALC:FPOW:POW[n]?` query. Units of the returned values are dependent on the ‘Function’ parameter.

CALCulate:FPOWer:POWer[n]:?

Description	This ? command query is used as short hand for both and INIT and FETC? command sequence. The returned results are in ASCII string format. The string begins and ends with quotation marks.
Remote Command	`CALC:FPOW:POW[n]?`
Return Result	Returns m comma-separated ASCII values, where m corresponds to the number of bandwidths defined.
Notes	The INIT and FETC? Command sequence performs the same functionality of a single `CALC:FPOW:POW[n]?` query. Units of the returned values are dependent on the ‘Function’ parameter.

CALCulate:FPOWer:POWer[n]:READ?

Description	The READ? Command is used to retrieve the results in a binary format.
Remote Command	`CALC:FPOW:POW[n]:READ?`
Return Result	Returns m 4 byte floating point binary values (Little-Endian), where m corresponds to the number of bandwidths defined.
Notes	Alternative syntax `CALC:FPOW:POW[n]:READ1?` can be used inter-changeably. Units of the returned values are dependent on the ‘Func-tion’ parameter.

CALCulate:FPOWer:POWer[n]:READ2?

Description	The READ2? command is used to retrieve additional debugging results in a binary format.
Remote Command	`CALC:FPOW:POW[n]:READ2?`
Return Result	Returns binary data (Little-Endian) that contains information on m amount of channels, along with ADC over range and full spectrum data. Bandwidth Return Value 1. Number of bandwidths defined [4 byte int] 2.Declared function return for the 1st specified channel [4 byte float] 3.Declared function return for the 2nd specified channel [4 byte float] ... m. Declared function return for the last specified channel [4 byte float] ADC Over Range 1.ADC over range occurred (1: true, 0 : false) [2 byte short] Spectrum Data 1.Number of Y-value points in the spectrum data k [4 byte int] 2.Start frequency of spectrum data (Hz) [8 byte double] 3.Step frequency of spectrum data (Hz) [8 byte double] 4.Spectrum data at 1st point (dBm) [4 byte float] 5.Spectrum data at 2nd point (dBm) [4 byte float] ... k. Spectrum data at kth point (dBm) [4 byte float]
Notes	Spectrum data is only returned if parameter ‘IncludePowerSpectrum’ is set to ‘True’. If set to ‘False’, the number of Y-value points (0) will be the final data returned. Units of the returned values are dependent on the ‘Function’ parameter.

Appendix: CALCulate:FPOWer:POWer[n]:DEFine Parameters

AcquisitionTime

Parameter	AcquisitionTime
Values	Time (s)
Default	0.001 (s)
Description	The acquisition time parameter sets the time in which the entire spectrum is measured. An increase in the acquisition time yields an improvement in repeatability.
Example	`CALC:FPOW:POW1:DEF ‘AcquisitionTime = 0.005’`

CenterFrequency

Parameter	CenterFrequency
Values	Frequency (Hz)
Default	1e9 (Hz)
Description	The center frequency parameter sets the frequency in which the measurement is centered around. This is the value that the offset frequency parameter is relative to.
Example	`CALC:FPOW:POW1:DEF ‘CenterFrequency = 2e9’`

DCCoupled

Parameter	DCCoupled
Values	True (DC coupled) False (AC coupled)
Default	False
Description	The DC coupled parameter allows the user to specify whether the DC blocking capacitor is utilized. Set parameter to true when measuring frequencies below 10 MHz.
Example	`CALC:FPOW:POW1:DEF ‘DCCoupled = True’`

DetectorType

Parameter	DetectorType
Values	RmsAverage Peak
Default	RmsAverage
Description	The detector type parameter allows the user to choose whether an RMS average or peak value is used during the measurement.
Example	`CALC:FPOW:POW1:DEF ‘DetectorType = Peak’`

DoNoiseCorrection

Parameter	DoNoiseCorrection
Values	True (Enable noise correction) False (Disable noise correction)
Default	False
Description	When noise correction is enabled, the linear noise power contributed by the analyzer is subtracted from all measurements. This effectively lowers the noise floor of the analyzer. When noise correction is enabled, the first measurement for a given set of input parameters will take extra time. This is because the analyzer takes an extra hidden initial acquisition with the RF input disconnected from the analyzer’s front end to measure the noise of just the analyzer. The measured noise floor is stored in a cache, so the extra hidden initial acquisition will occur only once for the same state settings. In other words, if noise correction was turned on and the analyzer made an acquisition at frequency A, then frequency B, and back again to frequency A, the hidden initial noise floor acquisition would only occur for the first acquisition at frequency A and the cached noise floor would be used the second time frequency A was measured.
Example	`CALC:FPOW:POW1:DEF ‘DoNoiseCorrection = True’`

DoSpurSuppression

Parameter	DoSpurSuppression
Values	True (Enable spur suppression) False (Disable spur suppression)
Default	False
Description	When measuring very low level signals, or when large out of band inputs are going into the analyzer, sometimes unwanted spurs and residuals can appear in the measured spectrum. Spur suppression is a method to help minimize the levels of these internally generated spurs and residuals. When spur suppression is enabled, the analyzer will automatically take two acquisitions using two different internal analog LO frequencies. The FFT spectrums from both acquisitions are combined by taking the minimum power between both traces on a per FFT bin basis. External signals will have the same amplitude for both traces and therefore will return the expected amplitudes. However, low level spurs and residuals generated internally to the analyzer tend to move to different FFT bins depending on the internal analog LO frequency used, and therefore tend to be suppressed using this spur suppression method. Because two acquisitions, rather than a single acquisition, are made when spur suppression is enabled, the measurement time will always be slower when spur suppression is enabled.
Example	`CALC:FPOW:POW1:DEF ‘DoSpurSuppression = True’`

ElecAttBypass

Parameter	ElecAttBypass
Values	True (electronic attenuator is bypassed) False (electronic attenuator is utilized)
Default	True
Description	The electronic attenuation bypass parameter allows the user to either utilize or bypass the electronic attenuator. The electronic attenuator is only available for frequencies up to 3.6 GHz. Set parameter to true when using frequencies above 3.6 GHz and set the parameter to false when using the preamp.
Example	`CALC:FPOW:POW1:DEF ‘ElecAttBypass = False’`

ElecAttenuation

Parameter	ElecAttenuation
Values	0 – 24 (dB)
Default	0 (dB)
Description	The electronic attenuation value parameter sets the amount of electrical attenuation from 0 to 24 dB (1 dB steps). Set ‘ElecAttBypass = False’ to set this parameter.
Example	`CALC:FPOW:POW1:DEF ‘ElecAttenuation = 10’`

IFGain

Parameter	IFGain
Values	-6 – 16 (dB)
Default	0 (dB)
Description	The IF gain parameter allows the user to specify the gain at the IF stage anywhere from -6 to 16 dB (1 dB steps). For most cases, set this gain to 0 dB.
Example	`CALC:FPOW:POW1:DEF ‘IFGain = 10’`

IFType

Parameter	IFType
Values	B10M (10 MHz path) B25M (25 MHz path) B40M (40 MHz path) WideBandIF
Default	B40M
Description	The IF type parameter allows the user to select between different IF paths.
Example	`CALC:FPOW:POW1:DEF ‘IFType = B25M’`

IncludePowerSpectrum

Parameter	IncludePowerSpectrum
Values	True False
Default	False
Description	The power spectrum parameter allows the user to read data on the en-tire spectrum for debugging purposes. See "CALCulate:FPOWer:POWer[n]:READ2?" for details.
Example	`CALC:FPOW:POW1:DEF 'IncludePowerSpectrum = True'`

MechAttenuation

Parameter	MechAttenuation
Values	0 – 70 (dB)
Default	0 (dB)
Description	The mechanical attenuation value parameter sets the amount of me-chanical attenuation anywhere from 0 to 70 dB (2 dB steps).
Example	`CALC:FPOW:POW1:DEF 'MechAttenuation = 10'`

PreAmpMode

Parameter	PreAmpMode
Values	Off Low Full
Default	Off
Description	The preamp mode parameter specifies whether the preamps are being utilized. Low allows any preamps up to 3.6 GHz, and Full allows all li-censed preamps. Set 'ElecAttBypass = True' to utilize any preamps.
Example	`CALC:FPOW:POW1:DEF 'PreAmpMode = Low'`

ResolutionBWMode

Parameter	ResolutionBWMode
Values	BestSpeed Narrowest Explicit
Default	BestSpeed
Description	The resolution bandwidth mode parameter allows the user to choose whether the IF filter is automatically or manually set. The BestSpeed value minimizes measurement time, while the Narrowest value minimizes RBW size. If this parameter is set to explicit, the ResolutionBW parameter must be set to the desired value.
Example	`CALC:FPOW:POW1:DEF ‘ResolutionBWMode = Explicit’`

ResolutionBW

Parameter	ResolutionBW
Values	RBW (Hz)
Default	0 (Hz)
Description	The resolution bandwidth parameter sets the (-3.01 dB) bandwidth of the IF filter. The ResolutionBWMode parameter must be set to explicit in order to manually set the RBW.
Example	`CALC:FPOW:POW1:DEF ‘ResolutionBW = 25e3’`

TriggerDelay

Parameter	TriggerDelay
Values	Time (s)
Default	0 (s)
Description	The trigger delay parameter sets the time after a trigger is detected until the measurement is performed.
Example	`CALC:FPOW:POW1:DEF ‘TriggerDelay = 0.1’`

TriggerLevel

Parameter	TriggerLevel
Values	-5 – +5 (V)
Default	1.2 (V)
Description	The trigger level parameter sets the voltage value at which an external trigger is detected.
Example	`CALC:FPOW:POW1:DEF ‘TriggerLevel = 2’`

TriggerSlope

Parameter	TriggerSlope
Values	Positive Negative
Default	Positive
Description	The trigger slope parameter indicates the direction of the trigger voltage for detection.
Example	`CALC:FPOW:POW1:DEF ‘TriggerSlope = Negative’`

TriggerSource

Parameter	TriggerSource
Values	Free Ext1 (Trigger 1 In) Ext2 (Trigger 2 In)
Default	Free
Description	The trigger source parameter allows the user to choose between measurements triggering freely or controlled by an external input.
Example	`CALC:FPOW:POW1:DEF ‘TriggerSource = Ext1’`

TriggerTimeout

Parameter	TriggerTimeout
Values	Time (s)
Default	1 (s)
Description	The trigger timeout parameter sets the time in which the analyzer will wait for a trigger before automatically performing the measurement.
Example	`CALC:FPOW:POW1:DEF ‘TriggerTimeout = 2’`

SignalInput

Parameter	SignalInput
Values	FpMainRf Fp50MhzCW
Default	FpMainRf
Description	The signal input parameter allows the user to select between using the main RF input or the internal analyzer reference signal of 50 MHz.
Example	`CALC:FPOW:POW1:DEF ‘SignalInput = Fp50MhzCW’`

UsePreSelector

Parameter	UsePreSelector
Values	True (preselector is utilized) False (preselector is bypassed)
Default	False
Description	The preselector parameter allows the user to either utilize or bypass the front-end tunable filter.
Example	`CALC:FPOW:POW1:DEF ‘UsePreSelector = True ’`

[Bandwidth]

Parameter	Bandwidth
Values	[Bandwidths] (Hz)
Default	[0] (Hz)
Description	The bandwidth parameter array defines the bandwidth of each channel that will be measured. All array parameters should have the same number of elements. Alternatively, if all the elements are the same value, a single number with no square brackets can be used to define the parameter.
Example	`CALC:FPOW:POW1:DEF ‘Bandwidth = [3.84e6, 3.84e6, 3.84e6, 3.84e6, 3.84e6]’`

[FilterAlpha]

Parameter	FilterAlpha
Values	[0.0 – 1.0]
Default	[0.22]
Description	The filter alpha parameter allows the user to adjust the alpha value associated with the root-raised-cosine filter type. Set ‘FilterType’ to RRC in order to utilize this parameter. All array parameters should have the same number of elements. Alternatively, if all the elements are the same value, a single number with no square brackets can be used to define the parameter.
Example	`CALC:FPOW:POW1:DEF ‘FilterAlpha = [0.5, 0.5, 0.5, 0.5, 0.5]’`

[FilterType]

Parameter	FilterType
Values	[IBW] (Integrated Bandwidth) [RRC] (Root Raised Cosine)
Default	[IBW]
Description	The filter type parameter allows the user to choose between an integration bandwidth filter or a root-raised-cosine filter. The integration band-width filter weighs all frequencies within the bandwidth equal. The root-raised-cosine filter has an associated alpha value, defined with the pa-rameter ‘FilterAlpha’. All array parameters should have the same number of elements. Alternatively, if all the elements are the same value, a single value with no square brackets can be used to define the parameter.
Example	`CALC:FPOW:POW1:DEF ‘FilterType = [RRC, RRC, RRC, RRC, RRC]’`

[Function]

Parameter	Function
Values	[BandPower] [BandDensity] [PeakPower] [PeakFrequency] [XdBBandwidth] [OccupiedBandwidth]
Default	[BandPower]
Description	This parameter array defines what measurement is being made for each individual specified parameter. All array parameters should have the same number of elements. Alternatively, if all the elements are the same value, a single value with no square brackets can be used to define the parameter. [BandPower]: Total power within the specified bandwidth of the channel (dBm) [BandDensity]: Total power density within the specified bandwidth of the channel (dBm/Hz) [PeakPower]: The peak power value within the specified bandwidth of the channel (dBm) [PeakFrequency]: The frequency which corresponds to the peak power value within the specified bandwidth of the channel. This frequency is relative to the center frequency (Hz) [XdBBandwidth]: The half power (-3.01 dB) bandwidth of the highest amplitude signal that resides within the channel (Hz) [OccupiedBandwidth]: The bandwidth at which 99% of the total power resides within the channel (Hz)
Example	`CALC:FPOW:POW1:DEF ‘Function = [BandDensity, BandDensity, Band-Density]’`

[OffsetFrequency]

Parameter	OffsetFrequency
Values	[Offsets] (Hz)
Default	[0] (Hz)
Description	The offset frequency parameter array defines the distance relative to the center frequency in which each bandwidth is offset. All array parameters should have the same number of elements.
Example	`CALC:FPOW:POW1:DEF ‘OffsetFrequency = [-10e6, -5e6, 0e6, 5e6, 10e6]’`

[OccupiedBandwidthPercent]

Parameter	OccupiedBandwidthPercent
Values	[0.0 – 1.0]
Default	[0.99]
Description	The occupied bandwidth percent parameter specifies the percent of total power in the channel that the returned bandwidth number represents when the Function for the channel is set to OccupiedBandwidth. The valid range for this parameter is 0.0 to 1.0, where 1.0 represents 100%. The default for this parameter is 0.99, which will return the band-width that contains 99% of the total channel power.
Example	`CALC:FPOW:POW1:DEF ‘OccupiedBandwidthPercent = [0.99, 0.90, 0.75]’`

[XdBBandwidth]

Parameter	XdBBandwidth
Values	[-200 to 0] (dB)
Default	[-3.01] (dB)
Description	The X dB bandwidth parameter is used to specify the power relative to the peak power that the bandwidth is measured in. This parameter only is used when the Function for the channel is set to XdBBandwidth. The parameter value must be a negative number.
Example	`CALC:FPOW:POW1:DEF ‘XdBBandwidth = [-3.01, -6.02]’`

Example: 5G NR Fast Power Measurement Using SCPI Commands

The following example demonstrates how to perform a 5G NR channel power measurement using SCPI commands. The waveform used in this example has the following parameters:

– FR1

– 100 MHz BW

– 30kHz SCS

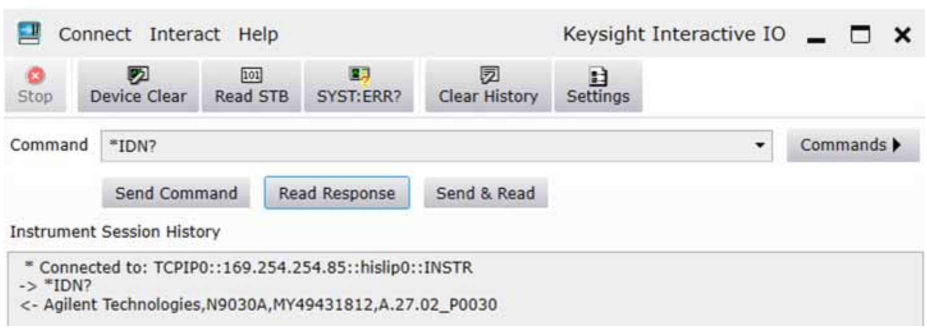
– 256 QAM

– TDD

1. Open the Keysight Interactive I/O program after connecting your Signal Analyzer to your computer.

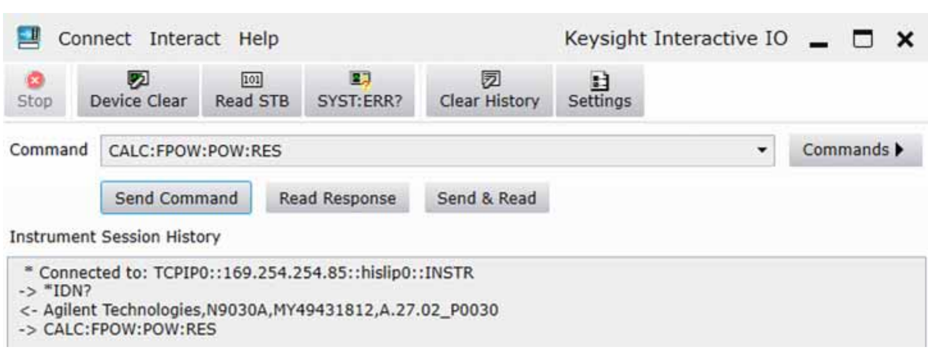
2. Confirm your device connection with the following command:

   `*IDN? → [Send Command]`



3. Use the reset command to prepare for a new Fast Power measurement.

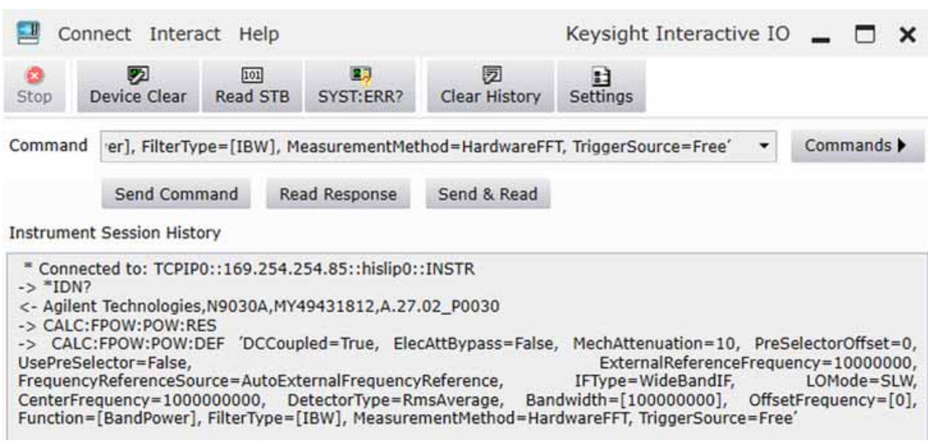
   `CALC:FPOW:POW:RES → [Send Command]`



4. Enter the following command to define the parameters for the Fast Power measurement:

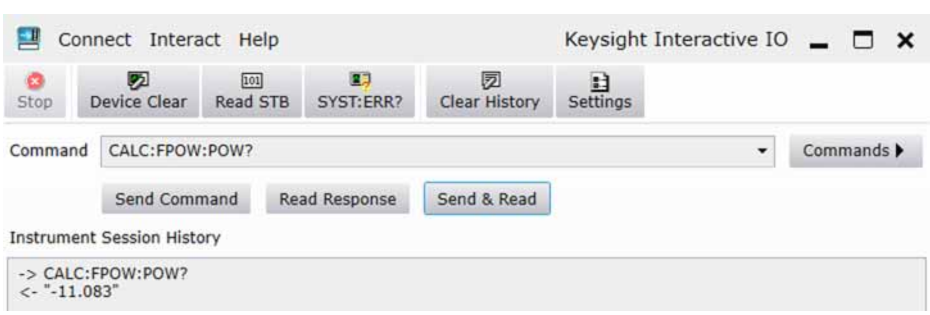
```
CALC:FPOW:POW:DEF ’

  DCCoupled=True,
  ElecAttBypass=False,
  MechAttenuation=10,
  PreSelectorOffset=0,
  UsePreSelector=False,
  ExternalReferenceFrequency=10000000,
  FrequencyReferenceSource=AutoExternalFrequencyReference,
  IFType=WideBandIF,
  LOMode=SLW,
  CenterFrequency=1000000000,
  DetectorType=RmsAverage,
  Bandwidth=[100000000],
  OffsetFrequency=[0],
  Function=[BandPower],
  FilterType=[IBW],
  MeasurementMethod=HardwareFFT,
  TriggerSource=Free’ → [Send Command]
```



5. Use the following command to execute a Fast Power measurement and read the result:

```
CALC:FPOW:POW? → [Send & Read]
```



Contacting Keysight

Assistance with test and measurement needs and information or finding a local Keysight office are available on the Web at:

http://www.keysight.com/find/assist

If you do not have access to the Internet, contact your field engineer.

NOTE

In any correspondence or telephone conversation, refer to the Keysight product by its model number and full serial number. With this information, the Keysight representative can determine the warranty status of your unit.

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