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Measurement Reference Manual

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Revision History

REV	DESCRIPTION	DATE	OWNER	VERIFIED
A	Initial transfer from Agilent documentation	Sept 2006	David Del Sontro	Dave Savage
B	Updated post CDR to reflect changes in measurements	Oct 2006	David Del Sontro	Dave Savage
C	Update calibrations and measurements to reflect amplifiers and attenuator switch philosophy	Apr 2006	David Del Sontro	Dave Savage
D	Updated to reflect customer comments	June 2006	David Del Sontro	Dave Savage
E	Updated to add drawings and correct measurement descriptions.	July 2006	David Del Sontro	Dave Savage
F	Updated to add W-CDMA and Ported Measurements	November 2006	David Del Sontro	
G	Updated	April 2008	RLTechnical	

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1. Acronyms

Table 1 Acronyms

Acronym	Definition
API	Application Programming Interface
ATE	Automatic Test Equipment
CISS	Configurable Integrated Surveillance System
COTS	Commercial Off The Shelf
DCE	Data Communications Equipment (ie modem)
DTE	Data Terminal Equipment (ie computer, printer)
GUI	Graphical User Interface
HW	Hardware
I/O	Input/Output
ICD	Inter-Connect Drawing
LAN	Local Area Network
LED	Light Emitting Diode
MHz	Mega-Hertz
PC	Personal Computer
SCB	RF Interface Unit
SPDT	Single Throw Double Pole
USB	Universal Serial Bus
UUT	Unit Under Test
VAC	Volts, Alternating Current
VDC	Volts, Direct Current

2. Introduction

This Measurement Reference addresses Revision G of the PTS measurement software.

2.1 TEST CONFIDENCE CHECKS

The test confidence checks are intended to provide the user assurance that the PTS will provide meaningful data upon test completion. This requirement will be met by standardized path checks, standard telemetry requests, and PTS local test procedure displays.

2.2 SCOPE

The measurements and calibrations described in this documentation pertain to the Symtx N1891A-2 Payload Test System (PTS) for use in testing communications satellite payloads.

2.3 TEST TYPES

The tests that can be run on the PTS are divided into two types, Measurements and Calibrations.

2.3.1 Measurements

Measurements are tests that are used to measure the performance of the Unit Under Test (UUT). Measurements may require data from Calibrations in order to supply corrected results.

2.3.2 Calibrations

Calibrations are tests that provide system calibration data. The calibration data is stored on the PTS controller for access by Measurements.

2.4 COMMAND, TELEMETRY AND CONTROL MESSAGES

During a test, the PTS may be required to send or receive messages from the Sequence Controller over the remote interface. These messages fall into three categories: Command, Telemetry, and Control.

2.4.1 Command Messages

During a test, the PTS may require a change in the state of the UUT. The test pauses and sends a Command Request to the sequence controller. After the PTS receives a Command Resume message, the test resumes.

2.4.2 Telemetry Messages

During a test, the PTS may be configured to record UUT telemetry values. The test pauses and sends a Telemetry Request to the sequence controller. After the PTS receives a Telemetry Resume message, the test resumes. The telemetry data is recorded in the test results file.

2.4.3 Control Message

During a test, the PTS may require user/sequencer input before it can proceed. The test pauses and sends a Control Request to the sequence controller. After the PTS receives a Control Resume message, the test resumes.

2.5 TEST PARAMETER INPUTS

Input parameters are required to configure the PTS tests for a specific application. There are two sources of parameter input, the Program Schedule Message and the Local Parameter File. In addition, the Rules File determines the units and multipliers of parameters contained in the Program Schedule Message.

2.5.1 Program Schedule Message

The Program Schedule Message (PSM) is intended to provide tests with the parameters necessary to configure the test for a specific UUT. The parameters in the PSM include UUT-specific values such as frequency range, power range, and number of measurement points. The PSM is passed to the PTS over the remote interface prior to the start of a test.

2.5.2 Local Parameter File

The Local Parameter File (LPF) is intended to provide Measurements and Calibrations with the parameters necessary for specific test conditions or test environments. The parameters in the LPF include instrument-specific values such as Resolution Bandwidth or Averaging Factor. At the beginning of a test, the PTS retrieves the default LPF parameters from the system server hard drive. The LPF parameters can alternatively be sent to the PTS over the remote interface, which overrides the default LPF values by adding the parameters to the Program Schedule Message.

2.5.3 Rules File

The Rules File has three functions:

1. It converts the test conductor-passed units of measure (via the PSM) to the fundamental unit of measure required by the test.
2. It sets the units annotation (MHz, for example) shown in the test control window for each PSM parameter.

3. It determines if the operator can make changes to values in the test control window.

For more information on the Rules File, consult the *System User's Guide.*

2.6 TEST RESULTS

Each test records data in a results file upon test completion. The results are stored in CITI file format (see *PTS System User's Guide* for format details). Test results are stored in individual datasets as described in the Measurements and Calibrations sections of this document. A common dataset called Parameters is located at the beginning of every result file.

2.6.1 Parameters Dataset

The Parameters dataset is located at the beginning of the results file. It contains a copy of all the parameters in the Program Schedule Message, Local Parameter File, and Test Limits File that were used by the test during its execution. In addition, the following system level parameters are recorded:

Name	**Type**	**Description**
STOPTIME	String	System time at completion of test. Format is mmddyy_hh:mm:ss
TestVersion	String	Not used
DownlinkHost	String	Measurement computer name for the cabinet containing the measurement receiver
UplinkHost	String	Measurement computer name for the cabinet containing the measurement stimulus source
DownlinkUUT	String array	Array of system port names for downlink port sequencing.
UplinkUUT	String array	Array of system port names for uplink port sequencing.
UUTOutputPort	String array	Array of user port names for downlink port sequencing.
UUTInputPort	String array	Array of user port names for uplink port sequencing.
SpacecraftIdentifier	String	Test article name
EnvironmentIdentifier	String	Test phase name
TestName	String	Test Identifier name

Name	Type	Description
ActiveTest	String	Not user configurable
OperatorID	String	Test Operator name
TimeStamp	String	System time stamp at start of test. Format is mmddyy_hhmmss
StartTime	String	System time stamp at start of test. Format is mmddyy_hh:mm:ss
WildSuffix	String	Data services configuration parameter (not user configurable)
TestID	String	Test Identifier name
UseTag	String	Data services configuration parameter (not user configurable)
ConfigFileName	String	Local Parameter File name, including .tlf extension
RefSignal	String array	Array of standard telemetry mnemonics for the telemetry request performed at "Ref" (InputReferencePower) (See Section 5.2.8)
MeasSignal	String array	Array of standard telemetry mnemonics for the telemetry request performed at "Meas" (InputReferencePower+ StdTelemetryPowerOffset) (See Section 5.2.8)
SYSTEM_VERSION	String	Version of PTS system software used during the test.
TestLib_VERSION	String	Version of VEE measurement library used during the test.
Supervisor_VERSION	String	Version of VEE software library used during the test.
ParmUtils_VERSION	String	Version of VEE software library used during the test.

Name	Type	Description
CalUtils_VERSION	String	Version of VEE software library used during the test.
DataServicesUtils_VERSION	String	Version of VEE software library used during the test.
GenUtils_VERSION	String	Version of VEE software library used during the test.
InstrUtils_VERSION	String	Version of VEE software library used during the test.
ResultUtils_VERSION	String	Version of VEE software library used during the test.
IOUtils_VERSION	String	Version of VEE software library used during the test.
LocalVar_VERSION	String	Version of VEE software library used during the test.
MatrixFunctions_VERSION	String	Version of VEE software library used during the test.
MeasurementAlgorithms_VERSION	String	Version of VEE software library used during the test.
Toolbox_VERSION	String	Version of VEE software library used during the test.
CurrentInputPort	String	User uplink port name for current sequence index.
CurrentOutputPort	String	User downlink port name for current sequence index.
CurrentSeqIndex	String	Port sequence index number for this test. Note: the index number for the first test in a sequence is 0.
CurrentInputRefPower	String	InputReference for current sequence index.
CurrentUUTCFG	String	UUTCFG for current sequence index.

2.6.2 Path Check

The first way in which Test Confidence Checks will be provided is through standardized path checks. All transmission measurements will start with a path check which provides calibrated power to the specified UUT input ports and looks for a signal at an appropriate frequency and with an appropriate signal-to-noise ratio (SNR). Using the VSA, the power level of the RF source that is used in the measurement is set to provide a corrected power level at the UUT interface. The VSA measures the UUT output signal and limit checks the measured SNR. If the signal passes the limit check, the test proceeds without pausing. If the signal fails, the user is prompted to re-check the connection. The user can chose to resume which will re-try the path check or abort the test.

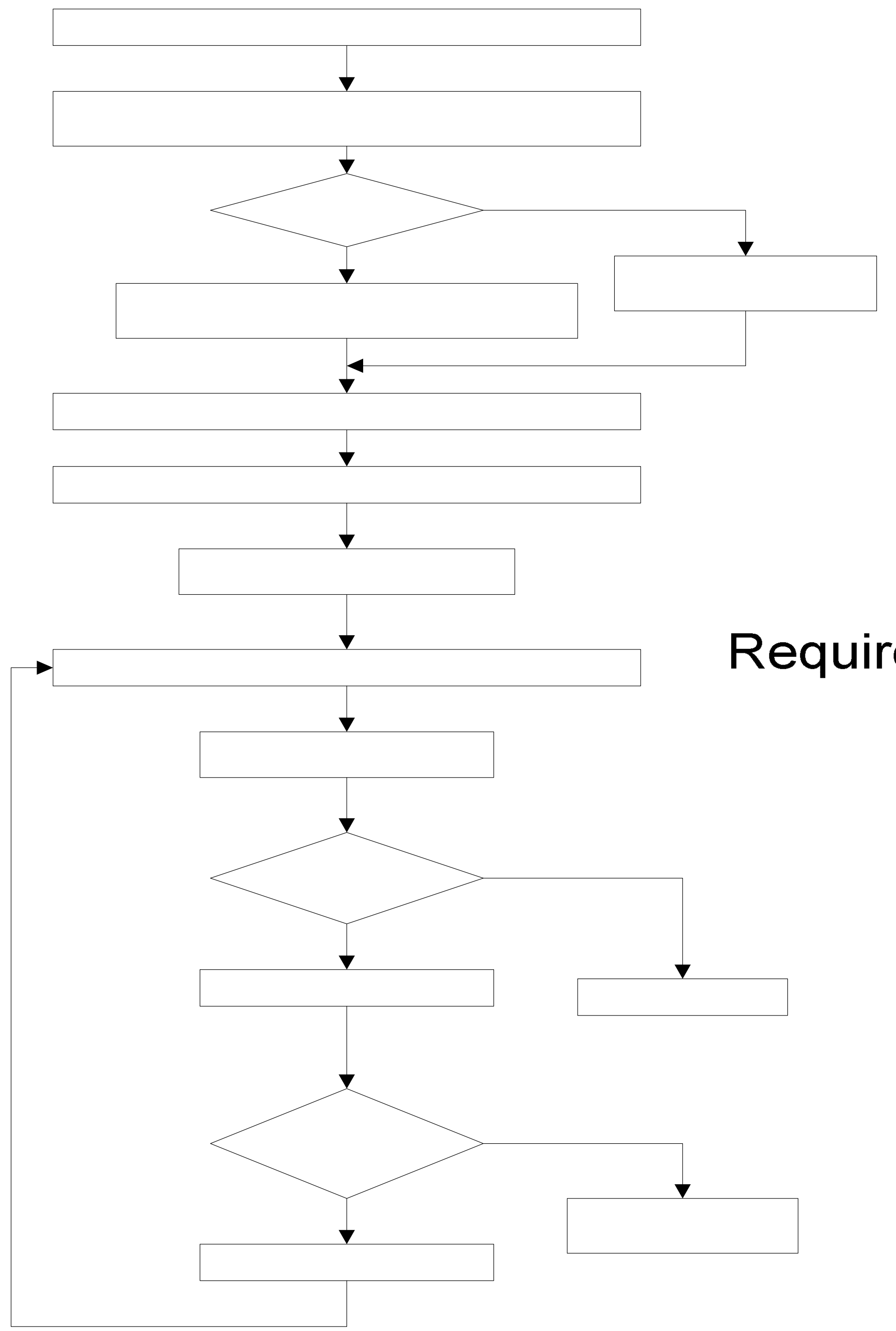


Figure 1 Path Check Flow Diagram

2.6.3 Standard Telemetry

The second way in which Test Confidence Checks will be supported is through Standard Telemetry requests. This function occurs immediately after the path check, while the uplink signal is applied to the UUT. If the parameter, PTEConfiguration (See Section 5.1.2), is set to YES Standard Telemetry (YST), the test will pause and send a configurable telemetry request to the test conductor computer (for remote operation) or to the system server GUI (for local operation). The configuration of the telemetry request is set by mnemonics stored in the Standard Telemetry File. The telemetry values are limit tested against ranges stored in the Standard Telemetry File. The limit testing can be configured to check for either reference or measurement input power levels (See Section 5.2.8).

2.6.4 Test Procedure Displays

The third way in which Test Confidence Checks will be supported is through PTS test display screens. While the PTS is executing a test procedure, the test procedure will display intermediate data on the PTS measurement computer screen inside the VEE Supervisor window. This displayed data is meant to fulfill three purposes which are: 1) the user can quickly determine if the test is collecting valid data, 2) the user can determine what step the test procedure is currently executing, 3) the user can determine that the PTS software is operating correctly.

Test progress can also be monitored on the measurement computer screen in the VSA window. When evaluating VSA displays, it is necessary to understand the relationship between the center frequency of the RF signals and the center frequency of the display. The InputCenterFrequency and TranslationFrequency parameters in the measurement Program Schedule Message definitions below identify the signal frequency going into the receiver section of the PTS, that is, into the Dual Downconverter. The first LO of the Dual Downconverter is set to convert the received RF signal to a nominal 22 MHz center frequency at the Vector Signal Analyzer input using the algorithm:

LO Frequency = RF Center Frequency + 478 MHz + Offset

The Offset is used to maximize the accuracy of the measurement. The Offset term is zero (0) for those cases where a narrow frequency range is being measured; this is the case for most CW measurements, placing the specified signal at the 22 MHz point on the VSA display. For measurements needing wideband calibration, the offset will be the difference between the signal center frequency and the nearest IF Calibration center frequency point. This causes the signal center to be shifted on the display by the offset frequency. Since the offset is determined individually for the uplink and downlink signals, the measured signals on the two VSA channel displays may not line up.

2.7 LIMIT CHECKING

Each measurement and calibration in the PTS architecture provides the ability to limit-check any test result parameter. Measured values are compared to limit values that are either stored in the Test Limit Files (TLF) for each test, or passed in the program schedule message. At the completion of a test, a PASS or FAIL response is issued to the test sequencer.

The limit-checking feature of the PTS can be turned off or on using a flag in the Program Schedule message. For any parameter to be limit tested, either or both of the following limit parameters can be passed:

ParamName_LoLimit

ParamName_HiLimit

where “ParamName” is the output parameter name to be limit tested.

If ParamName is a scalar parameter, the ParamName_LoLimit and

ParamName_HiLimit parameters should also be scalars.

If ParamName is an array (part of an array dataset), the ParamName_LoLimit and ParamName_HiLimit parameters should be passed as 1D arrays, with an EVEN number of elements specifying a mask consisting of XY pairs. The first and subsequent odd numbered elements specify the “X” or “independent” values of the mask. The second and subsequent even numbered elements specify the “Y” or “dependent” values of the mask.

If only one of ParamName_LoLimit and ParamName_HiLimit is defined, a one-sided limit test will be performed, with the other limit set to –1E150 or 1E150 as appropriate.

If a mask specifies limits for only a subset of the “X” values that actually appear within a result array, the limit (Lo or Hi) becomes inactive (wide open) for the result values with “X” values outside the declared mask “X” values. Result values appearing within the mask “X” values are checked as normal against the mask.

An example of LoLimit and HiLimit definitions, for a result parameter called “Gain”, first for a scalar and then for an array result.

```
doubleGain_LoLimit 80

doubleGain_HiLimit 87

doubleGain_LoLimit {

-10   82

0     81
```

```
5     80
}
doubleGain_HiLimit {
-10   87
0     86
5     85
}
```

The software will record a PASS or FAIL indication for each limit tested item at the end of the results file for ease of determining which items have caused the overall test failure.

3. MEASUREMENTS

3.1 ADJACENT CHANNEL LEAKAGE POWER

3.1.1 Test Purpose

The purpose of this test is to measure the ratio of the transmitted power of the main channel to adjacent channels within a beam.

This test will fulfill the following test requirements of a typical payload test plan:

- Adjacent Channel Leakage Power

3.1.2 Test Diagram

W-CDMA STIMULUS VSA MEASUREMENT

3.1.3 Test Description

This test will measure the power leaking into the adjacent channels relative to the total power of the W-CDMA signal on the output of the transponder. The user will specify the adjacent channels to be measured and the input waveform file from a list of predefined configurations of multiple W-CDMA signals. The spectrum analyzer (SA) measures the applied input reference signal and the VSA CH2 measures the resulting test stimulus on the output of the transponder. The test will report the primary channel power and the leakage power in the adjacent channels.

The stimulus for this measurement is a W-CDMA signal based on the test model 1, placed at a specified input frequency. The user has the ability to specify fading on the input signal. The switch matrix is set to connect the SA to the source uplink coupler and VSA CH2 to the specified UUT output port. The SA is used to measure the stimulus signal and the signal is adjusted for the specified power level. The W-CDMA reference signal is measured on and verified. If the beacon mode parameter is set, the system will use Source 2 to provide the specified beacon signal. The switch matrix is set to verify the uplink beacon signal frequency and amplitude on VSA channel 1. Once the beacon signal is verified, the switch matrix is set to connect the beacon signal to the specified uplink port. At this point, an intermediate telemetry request will be made to verify that the beacon signal is present. Once verified, the switch matrix is then set to apply the W-CDMA stimulus signal to the specified UUT input port.

The repeater output signal is then measured using VSA CH2 to determine the primary channel power. The measurement will then measure the leakage power for the specified adjacent channels. VSA power readings will be corrected for system internal and external path losses using calibration data measured prior to the test. See Section 4.1 for details on corrected uplink and downlink power calculations.

3.1.4 Program Schedule Message

Name	Type	Units	Description
PTEConfiguration	Parameter		See Section 5.1.2
UUTCFG	Parameter		See Section 5.1.3
Ports	Group		See Section 5.1.4
InputSpotFreq	Group		See Section 5.1.5
TranslationFreq	Group		See Section 5.1.7
InputSpotPower	Group		See Section 5.1.12
ChannelBW	Parameter		See section 5.1.14
OutputOffsetFrequency	Group		See section 5.1.19
WaveformModel	Group		See Section 5.1.22
BeaconMode	Group		See Section 5.1.21
Fading	Group		See Section 5.1.23

3.1.5 Local Parameter File

Name	Type	Units	Description
SimulateTest	Parameter		See Section 5.2.2
85121A Compatibility Mode	Parameter		See Section 5.2.14
InputSignal	Group		See Section 5.2.3
Receiver	Group		See Section 5.2.4
UUTDelay	Group		See Section 5.2.5
TimeBase	Group		See Section 5.2.6
PathCheck	Group		See Section 5.2.7
StdTelemetry	Group		See Section 5.2.8
SNROrResBW	Group		See Section 5.2.9

3.1.6 Command, Telemetry & Control Messages

Standard telemetry as defined in the “stf” file is (optionally, depending on the PTEConfiguration flag YST/NST) carried out at the same time and signal conditions as the path check. Each defined standard telemetry mnemonic defined will appear as a result variable of that name in the STDTLM data package in the result Citifile. The values returned by the UUT for each mnemonic sent will be recorded as the values of those result variables in the STDTLM data package.

Intermediate telemetry communications, as defined in the LPF string-array parameter IntTelemetry, are (optionally, depending on the PTEConfiguration flag YIT/NIT) sent and the responses recorded at specific time in the measurement. The intermediate telemetry data is stored in the Intermediate Telemetry data package INTTLM inside the results Citifile. Each telemetry mnemonic becomes the name of a variable parameter within the INTTLM data package.

The dependent variable of the package is, in this measurement, InputPower. The values that the telemetry records at each power level will appear in the dependent data arrays of the package.

3.1.7 Results

The results file consists of the following datasets:

- PathCheckResults Dataset
- Scalar Dataset
- Secondary Scalar Dataset
- Adjacent Channel Array Dataset

Note that these datasets are in addition to the standard datasets provided by all measurements.

3.1.7.1 PathCheckResults Dataset

Name	Units	Description
PathCheckResults	Various	See Section 5.3.1

3.1.7.2 Scalar Dataset

Name	Units	Description
ULExtHWGain	dB	Insertion gain of uplink external hardware, between the PTS calibration plane and the UUT input.
DLExtHWGain	dB	Insertion gain of downlink external hardware, between the UUT output and the PTS calibration plane.
MeasResBW	Hz	The receiver resolution bandwidth that was used during the measurement.
ULTVAmplitudeOffset	dB	Offset gain of the uplink portion of the test system due to thermal vacuum temperature shifts
DLTVAmplitudeOffset	dB	Offset gain of the downlink portion of the test system due to thermal vacuum temperature shifts

InputPowerCorr	dB	Input power measured within the WaveformSignal Bw corrected for path and external hardware gain/loss
InputPowerUncorr	dB	Uncorrected PSA band power reading

3.1.7.3 Secondary Scalar Dataset

Name	Units	Description
PrimeChannelMag	dBm	Measured primary channel power in absolute dBm
OutputPathCal	dB	Output signal path cal. This is the insertion gain between the VSA CH2 input and the PTS calibration plane
VSACH2Power	dBm	Uncorrected VSA CH2 reading
PrimeChannelFreq	Hz	Frequency of the primary channel

3.1.7.4 Adjacent Channel Array Dataset

Name	Units	Description
AdjacentChannelRelFreq	Hz	Measured frequency relative to the primary channel in Hz
AdjacentChannelRelMag	dBm	Measured leakage power relative to main channel total power in dB
OutputPathCal	dB	Output signal path cal. This is the insertion gain between the VSA CH2 input and the PTS calibration plane
VSACH2Power	dBm	Uncorrected VSA CH2 reading
AdjacentChannelBW	Hz	Bandwidth of the adjacent channel
AdjacntChannelMag	dB	Measured channel power in absolute dBm

3.1.8 Calibrations Required

- Uplink Port Gain Calibration
- Downlink Port Gain Calibration
- Downconverter RF Gain Calibration

- Receiver Amp/Pad Gain Calibration
- External Hardware Calibrations
- Thermal Vacuum Amplitude Calibration

3.1.9 VEE Library Name

WCDMA.lib

3.1.10 Pseudo Measurement Code

1. Initialize test parameters. Read and process values from the .lpf and .psm. Store a copy of the test parameters in the data file.

2. Initialize instruments to a preset condition. Instruments initialized are:

ULMatrix

DLMatrix

RFSource1

RFSource2

ULPowerMeter

DLPowerMeter

LOSource1

LOSource2

VSA

IFReceiver

SpectrumAnalyzer

Awg1

FunctionGenerator

FadingAttenuator

Perform chore functions (for example, Cal, zero, etc.) related to each instrument if the timer indicates a need.

3. If BeaconMode=0;

    a. Perform the standard path check. Request standard telemetry data from the host computer if this parameter is set. Store path check and telemetry results in the data file.

    b. Determine maximum expected port power from input parameters. Set UL path (amp and pad state) and receiver path (amp, pad or thru state) based on this power.

4. If BeaconMode=1 set up the beacon.

    a. Turn RFSource1 off.

    b. Connect matrix path to use source1&2 combiner.

    c. Connect matrix path for uplink and downlink ports.

    d. Set up VSA for uplink power measurements.

    e. Determine maximum expected port power from input parameters. Set UL path (amp and pad state) and receiver path (amp, pad or thru state) based on this power.

    f. Turn on RFSource2 and adjust the power until desired beacon power is achieved. Use the VSA CW marker and calibration data for the power readings.

    f. Request beacon verification telemetry from the host computer.

    g. Check telemetry data against limits. If fail, log message and abort test.

5. Set up the AWG for the W-CDMA waveform.

    a. If RF frequency > 3.2 GHz, set AWG output to single ended, amplifier in.

    b. If RF frequency <= 3.2 GHz, set AWG output to differential, amplifier out.

    c. Download specified waveform files to AWG Channel 1 and Channel 2.

    d. Command AWG to play out waveforms. Set AWG output (ch1 and ch2) to ON.

6. Set up the RFSource1 for I/Q mode.

    a. if RF frequency > 3.2 GHz, set source to use wideband I/Q inputs.

    b. if RF frequency <= 3.2 GHz, set source to use narrowband I/Q inputs.

    c. turn modulation on, set RF output to ON.

7. If FadingOn=1, connect path to include fader. Preset function generator.

8. Set up the PSA for uplink power measurements.

    a. Connect matrix path to use PSA for power monitoring.

    b. Set up PSA frequency and span (span=sigbw*1.4)

    c. Set up PSA averaging and band power markers (marker spacing=sigbw*1.2)

9. Set the uplink power level.

    a. Set uplink power

        -set RF source1 frequency to InputFrequency-WaveformOffsetFrequency

        -read and correct power level from PSA band power marker measurement centered at InputFrequency

        -calculate delta power from desired

        -adjust source power level by delta

        -repeat steps until delta power is less than input power tolerance

    b. Perform the I/Q DC calibration on RFSource1.

10. Set up the VSA for downlink power measurements.

    a. Connect matrix path to use VSA Ch2 for downlink signal measurement.

    b. Set up VSA and downconverter/LO's frequencies for downlink signal at:

        DL Frequency = OutputFrequency + DLFreqErr + ChannelOffsetFrequency

    DLFreqErr is measured during the path check.

    c. Set up VSA band power markers to downlink frequency +- ChannelBw/2.

    d. Set paths for appropriate receiver amp or pad as needed.

11. Measure adjacent channel power.

    a. if FadingOn=1 then

        -set up function generator, waveform type, frequency, amplitude. Fading is now on.

        repeat for number of FadingSamples:

meas ref channel power

set receiver frequency

measure and correct VSA band power marker reading

for each OutputOffsetFrequency (each channel)

set receiver frequency

measure and correct VSA band power marker reading

if delay>0, wait delay seconds

repeat until done

preset function generator

calculate the average of collected results

reference channel power

adjacent channel power

b. if FadingOn=0 then

meas ref channel power

set receiver frequency

measure and correct VSA band power marker reading

-for each OutputOffsetFrequency (each channel)

set receiver frequency

measure and correct VSA band power marker reading

12. If FadingOn=1, switch fader out of the uplink path.
13. Request intermediate telemetry data from host computer if parameter is set.
14. Perform limit check and store results to data file.

3.2 AMPLITUDE ISOLATION

3.2.1 Test Purpose

The purpose of this test is to determine the isolation between the expected signal path and the unattended ports on the output of the transponder.

This test will fulfill the following test requirements of a typical payload test plan:

- Amplitude Isolation

3.2.2 Test Diagram

SINGLE SOURCE VSA MEASUREMENT

3.2.3 Test Description

This test will measure the amplitude relationship between ports of the transponder at a specified power level. The measurement can choose between single CW or a pre-stored W-CDMA waveforms based on parameters specified in the program schedule message.

The test begins by generating a CW or W-CDMA modulated carrier at a specified frequency using RF Source 1. If a W-CDMA signal, the stimulus signal is based on the test model 1 waveform. The stimulus for this measurement is then placed at a specified input frequency and power level. The switch matrix is set to connect either the VSA Channel 1 for CW stimulus or the SA for W-CDMA stimulus to the source uplink coupler. The power of the stimulus signal is measured and the signal is adjusted for the specified power level. The switch matrix is then set to apply the stimulus signal to the specified UUT input port. The switch matrix is then set to connect the "stimulus" downlink to VSA CH2. If CW stimulus, the downconverter CH2 is tuned to the specified downlink frequencies so that the VSA can be used to make a directed measurement of the signal. If W-CDMA, the VSA CH2 is used to determine peak envelope power. Depending on the type of signal used, CW or W-CDMA modulated, the appropriate signal characteristics, and average noise level are measured and recorded.

Then the switch matrix is configured to connect to the secondary or "repeater" output to VSA CH2. If CW stimulus, the downconverter CH2 is tuned to the specified downlink frequencies so that the VSA can be used to make a directed measurement of any signals that exceed the specified spur level for the response transponder. If W-CDMA signal, the VSA CH2 is used to determine peak envelope power. Depending on the type of signal used, CW or W-CDMA modulated, the appropriate signal characteristics, and average noise level are measured and recorded. The amplitude measurement is recorded and compared relative to the amplitude measured previously on the primary stimulus downlink. The test continues to measure the relative amplitude for all secondary repeater outputs specified. VSA power readings will be corrected for system internal and external path losses using calibration data measured prior to the test. See Section 4.1 for details on corrected uplink and downlink power calculations.”

3.2.4 Program Schedule Message

Name	Type	Units	Description
PTEConfiguration	Parameter		See Section 5.1.2
UUTCFG	Parameter		See Section 5.1.3
Ports	Group		See Section 5.1.4
“Response”+OutputPorts	Group with prefix		See Section 5.1.5 This is/are the OutputPort(s) of the response channels(s).
InputSpotFreq	Group		See Section 5.1.5 for stimulus port
TranslationFreq	Group		See Section 5.1.7 for stimulus port
InputSpotPower	Group		See Section 5.1.12 for stimulus port
OutputFrequency	Group		See Section 4.1.19 on page 187 These are the frequencies for the directed search at the response repeater output.
ChannelBW	Parameter		See Section 5.1.14
SpurAmpSpec	Parameter		See Section 5.1.20 If specified in dBc, this value is relative to the downlink carrier measured at the UUT stimulus repeater output.
OutputOffsetFrequency	Group		See Section 5.1.19
Waveform Model	Group		See Section 5.1.22

3.2.5 Local Parameter File

Name	Type	Units	Description
SimulateTest	Parameter		See Section 5.2.2
InputSignal	Group		See Section 5.2.3
Receiver	Group		See Section 5.2.4
UUTDelay	Group		See Section 5.2.5
TimeBase	Group		See Section 5.2.6
PathCheck	Group		See Section 5.2.7
StdTelemetry	Group		See Section 5.2.8
SNROrResBW	Group		See Section 5.2.9
Spurious	Group		See Section 5.2.10

```
double   InputPowerTolerance                    3
int      Averages                               1
string   DoDownConverterCal                     "AUTO"
string   DoVSACalibrate                         "AUTO"
string   ULPowerMeter_DoSetRefPathAndCalibrate  "AUTO"
string   ULPowerMeter_DoSetRefPathAndZero       "AUTO"
string   DLPowerMeter_DoSetRefPathAndCalibrate  "AUTO"
string   DLPowerMeter_DoSetRefPathAndZero       "AUTO"
string   TimeBaseSource                         "INT"
double   UUTTimebaseAccuracy                    1e-8
double   ExtTimebaseAccuracy                    1e-9
double   PathCheckSNRThreshold                  25
#double   MaxResBW                              1e3
double   MaxAcquisitionTime                     60
double   NoiseGuardBand                         13
double   StdTelemetryPowerOffset                -15
string   StdTelemetryLevel                      "Ref"
string   IntTelemetry                           {"MDUTMEAS4"
                                                "MDUTMEAS5" "MDUTMEAS6"}
```

```
double   MinSNR                                    30
double   InputPowerTolerance                       0.5
int  MaxSpurTableSize                              5
```

3.2.6 Command, Telemetry & Control Messages

Standard telemetry as defined in the “stf” file is (optionally, depending on the PTEConfiguration flag YST/NST) carried out at the same time and signal conditions as the path check. Each defined standard telemetry mnemonic defined will appear as a result variable of that name in the STDTLM data package in the result Citifile. The values returned by the UUT for each mnemonic sent will be recorded as the values of those result variables in the STDTLM data package.

There is no intermediate telemetry for this test.

3.2.7 Results

The results file consists of the following datasets:

- PathCheckResults Dataset
- Scalar Dataset
- Secondary Scalar Dataset
- AmplitudeIsolation Array Dataset

Note that these datasets are in addition to the standard datasets provided by all measurements.

3.2.7.1 PathCheckResults Dataset

Name	Units	Description
PathCheckResults	Various	See Section 5.3.1

3.2.7.2 Scalar Dataset

Name	Units	Description
StimulusCarrierFreq	Hz	StimulusCarrierUplinkFrequency
ULPowerCorr	dBm	Corrected Uplink Power
ULPowerUnCorr	dBm	Un-corrected uplink power
ULPowerCal	dB	Uplink path insertion gain, between VSA CH1 and PTS uplink calibration plane
ULExtrHWCal	dB	Uplink external hardware insertion gain, between the PTS uplink calibration plane and the UUT input.
ResponseCarrierFreq	Hz	Response Carrier Downlink Frequency
DLPowerCorr	dBm	Corrected downlink power
DLPowerUnCorr	dBm	Un-corrected downlink power on VSA Channel 2
DLPowerCal	dB	Downlink path insertion gain, between VSA CH2 and PTS downlink calibration plane.
DLExtHWCal	dB	Downlink external hardware insertion

3.2.7.3 Secondary Scalar Dataset

Name	Units	Description
PrimeChannelMag	dBm	If W-CDMA, measured primary channel power in absolute dBm.
OutputPathCal	dB	If W-CDMA, Output signal path cal. This is the insertion gain Between the VSA CH2 input and the PTS Calibration plane.

Name	Units	Description
VSACh2Power	dBm	If W-CDMA, Uncorrected VSA CH2 reading.

3.2.7.4 AmplitudeIsolation Array Dataset

Name	Units	Description
SpurFrequency	Hz	If CW, Measured spur frequency at the Response Repeater output
SpurIndex	N/A	If CW, Index for found spurs
RepeaterIsolation	dBc	IF CW, Stimulus to Response Repeater Isolation defined as the difference between the Stimulus repeater output carrier level and the Response repeater output spur level, expressed in dBc.
SpurResBW	Hz	If CW, Receiver Resolution Bandwidth during the spur measurement
SpurSNR	dBc	IF CW, Ratio of spur power to noise power in the receiver Resolution BW, measured at the Response repeater output
SpurRelPower	dBc	If CW, Measured power of Response repeater output spur relative to the Stimulus repeater output carrier
W-CDMA RelMag	dBc	If W-CMDA, measured channel power relative to Stimulus input
SpurAbsPowerCorr	dBm	If CW, Measured power of spur (absolute level) at the Response repeater output
W-CDMA AbsPowerCorr	dBm	If W-CDMA, measured channel power (absolute level) at the Response repeater output
SpurAbsPowerUnCorr	dBm	If CW, Un-corrected measured power of spur
SpurPathCal	dB	If CW, Downlink path insertion gain, between receiver input and PTS downlink calibration plane, at the spur frequency
SpurExtHWCal	dB	If CW, Downlink external hardware insertion gain, between the PTS downlink calibration plane and the UUT input, at the spur frequency

Name	Units	Description
SpurTVAmpCal	dB	If CW, Thermal vacuum amplitude offset of the downlink, at the spur frequency
SpurRelPower	dBc	If CW, Measured power of Response repeater output spur relative to the Stimulus repeater output carrier.
RptSpurAmpSpecdBc Or RptSpurAmpSpecdBm	dB Or dBm	If CW, Reported value of SpurAmpSpecdBc or SpurAmpSpecdBm from Program Schedule Message

3.2.8 Calibrations Required

- Uplink Port Gain Calibration
- Downlink Port Gain Calibration
- Downconverter RF Gain Calibration
- Receiver Amp/Pad Gain Calibration
- External Hardware Calibrations
- Thermal Vacuum Amplitude Calibration

3.2.9 VEE Library Name

AmplitudeIsolation.lib

3.2.10 Pseudo Measurement Code

1. Initialize test parameters. Read and process values from the .lpf and .psm. Store a copy of the test parameters in the data file.
2. Initialize instruments to a preset condition. Instruments initialized are:

ULMatrix

DLMatrix

RFSource1

ULPowerMeter

DLPowerMeter

LOSource1

LOSource2

VSA

IFReceiver

SpectrumAnalyzer

Awg1

Perform chore functions (for example, Cal, zero, etc.) related to each instrument if timer indicates a need.

If this is the first time through the port sequence, (for example, first input port and first output port) perform the standard path check, configure the VSA and perform the standard telemetry request.

Store path check and telemetry results in the data file.

Determine maximum expected port power from the input parameters. Set UL path (amp and pad state) and receiver path (amp, pad, or thru state) based on this power.

Check to see if modulation is W-CDMA or just CW. If W-CMDA

Set up the AWG for the W-CDMA waveform.

If RF frequency > 3.2 GHz, set AWG output to single ended and amplifier in.

If RF frequency <= 3.2 GHz, set AWG output to differential and amplifier out.

Download specified waveform files to AWG Channel 1 and Channel 2.

Command AWG to play out waveforms. Set AWG output (ch1 and ch2) to ON.

Set up the RFSource1 for I/Q mode.

If RF frequency > 3.2 GHz, set source to use wideband I/Q inputs.

If RF frequency <= 3.2 GHz, set source to use narrowband I/Q inputs.

Turn modulation on, set RF output to ON.

Set up the PSA for uplink power measurements.

Connect matrix path to use PSA for power monitoring.

Set up PSA frequency and span (span=sigbw*1.4)

Set up PSA averaging and band power markers (marker spacing=sigbw*1.2)

Set up the VSA for downlink power measurements.

Connect matrix path to use VSA Ch2 for downlink signal measurement.

Set up VSA and downconverter/LO’s frequencies for downlink signal at:

DL Frequency= OutputFrequency + DLFreqErr + ChannelOffsetFrequency

DLFreqErr is measured during the standard path check.

Set VSA band power markers to VSA center freq +- ChannelBw/2.

No matter if W-CDMA or not, set Response Port (if it is a different response port then the last response port)

If W-CDMA, perform a spur search with spectrum analyzer.

Store Data

Do next iteration for different stim, response, and amplitude isolation ports.

3.3 AM TO PM CONVERSION

3.3.1 Test Purpose

The purpose of this test is to measure the conversion of amplitude modulation to phase modulation on a carrier that has passed through the repeater channel.

This test will fulfill the following test requirements of a typical payload test plan:

- AM/PM Conversion
- Phase vs. Drive

3.3.2 Test Diagram

SINGLE SOURCE VSA MEASUREMENT

3.3.3 Test Description

This test will measure the AM to PM conversion in the repeater channel as a function of drive level at a single uplink frequency. An amplitude-modulated carrier is applied to the uplink channel. The two-channel vector signal analyzer measures the residual phase modulation of the test stimulus and the total PM on the repeater output. The test stimulus amplitude is adjusted over a specified range. The test will report the AM to PM conversion and the deviation from linear phase versus input power level.

The stimulus for this measurement is a single carrier with amplitude modulation, placed at a specified input frequency. The switch matrix is set to connect the VSA CH1 to the source uplink coupler and VSA CH2 to the specified UUT output port. VSA CH1 is used to measure the stimulus signal and the signal is adjusted for the specified starting power level. The AM peak-to-peak excursion of the signal is set equal to the input power step value (up to a maximum AM depth of 10 dB). The switch matrix is then set to apply the stimulus signal to the specified UUT input port.

As the stimulus source level is stepped through the input power range, the source residual PM is measured using VSA CH1 and the repeater output PM is measured using VSA CH2.

The phase measurements of the stimulus residual PM and the repeater output PM are used to calculate the sign of the PM with respect to the original AM tone. The repeater's PM is calculated by subtracting the residual input signed PM from the repeater output signed PM.

The AM to PM conversion coefficient is calculated by dividing the result PM in degrees by the input AM in dB. The phase shift versus drive characteristic is obtained by integrating the signed AM to PM conversion versus drive data.

VSA power readings will be corrected for system internal and external path losses using calibration data measured prior to the test. See Section 4.1 for details on corrected uplink and downlink power calculations.

3.3.4 Program Schedule Message

Name	Type	Units	Description
PTEConfiguration	Parameter		See Section 5.1.2
UUTCFG	Parameter		See Section 5.1.3
Ports	Group		See Section 5.1.4
InputSpotFreq	Group		See Section 5.1.5
TranslationFreq	Group		See Section 5.1.7
InputSweptPower	Group		See Section 5.1.13
AMModFrequency	Parameter		See Section 5.1.17

3.3.5 Local Parameter File

Name	Type	Units	Description
SimulateTest	Parameter		See Section 5.2.2
85121A Compatibility Mode	Parameter		See Section 5.2.14
InputSignal	Group		See Section 5.2.3
Receiver	Group		See Section 5.2.4
UUTDelay	Group		See Section 5.2.5
TimeBase	Group		See Section 5.2.6
PathCheck	Group		See Section 5.2.7
StdTelemetry	Group		See Section 5.2.8
SNROrResBW	Group		See Section 5.2.9
AMToneGen	Group		See Section 5.2.12

3.3.6 Command, Telemetry & Control Messages

Standard telemetry as defined in the "stf" file is (optionally, depending on the PTEConfiguration flag YST/NST) carried out at the same time and signal conditions as the path check. Each defined standard telemetry mnemonic defined will appear as a result variable of that name in the STDTLM data package in the result Citifile. The values returned by the UUT for each mnemonic sent will be recorded as the values of those result variables in the STDTLM data package.

There is no intermediate telemetry for this test.

3.3.7 Results

The results file consists of the following datasets:

- PathCheckResults Dataset
- Scalar Dataset
- PowerSweep Array Dataset
- SecondaryPowerSweep Array Dataset

Note that these datasets are in addition to the standard datasets provided by all measurements.

3.3.7.1 PathCheckResults Dataset

Name	Units	Description
PathCheckResults	Various	See Section 5.3.1

3.3.7.2 Scalar Dataset

Name	Units	Description
ULExtHWGain	dB	Insertion gain of uplink external hardware, between the PTS calibration plane and the UUT input
DLExtHWGain	dB	Insertion gain of downlink external hardware, between the UUT output and the PTS calibration plane
MeasResBW	Hz	Receiver resolution bandwidth that was used during the measurement
ULTVAmplitudeOffset	dB	Offset gain of the uplink portion of the test system due to thermal vacuum temperature shifts
DLTVAmplitudeOffset	dB	Offset gain of the downlink portion of the test system due to thermal vacuum temperature shifts

3.3.7.3 PowerSweep Array Dataset

Name	Units	Description
InputPowerRelNOP This is the independent variable for this dataset and is the "X" value for plots and limit testing.	dB	Specified input power relative to NOP
InputPower	dBm	Measured input power, in absolute dBm
AMToPMConv	degrees/ dB	AM to PM Conversion of the UUT
PhaseVsDrive	degrees	Phase Shift vs. Input Power for the UUT
InputPMMag	degrees	Uplink Phase Modulation Magnitude
InputPMPhase	degrees	Uplink Phase Modulation Phase
OutputPMMag	degrees	Downlink Phase Modulation Magnitude
OutputPMPhase	degrees	Downlink Phase Modulation Phase
InputAMDepth	dB	Uplink Amplitude Modulation Depth

3.3.7.4 SecondaryPowerSweep Array Dataset

Name	Units	Description
InputPowerRelNOP This is the independent variable for this dataset and is the "X" value for plots and limit testing.	dB	Input power relative to NOP
InputPathCal	dB	Input signal path calibration; this is the insertion gain between the VSA CH1 input and the PTS calibration plane.
VSACH1Power	dBm	Uncorrected VSA CH1 reading

3.3.8 Calibrations Required

- Uplink Port Gain Calibration
- Downlink Port Gain Calibration
- Downconverter RF Gain Calibration
- Receiver Amp/Pad Gain Calibration
- External Hardware Calibrations
- Thermal Vacuum Amplitude Calibration

3.3.9 VEE Library Name

AM2PMConv.lib

3.4 AM TO PM TRANSFER

3.4.1 Test Purpose

The purpose of this test is to measure the transfer of amplitude modulation on one carrier to phase modulation on another carrier that has passed through the repeater channel.

This test will fulfill the following test requirements of a typical payload test plan:

- AM/PM Transfer

3.4.2 Test Diagram

TWO-SOURCE VSA MEASUREMENT

3.4.3 Test Description

This test will measure the AM to PM transfer in the repeater channel as a function of drive level. An amplitude-modulated carrier and a "clean" carrier are applied to the uplink channel. The two-channel vector signal analyzer measures the AM level of the test stimulus and the PM level on the "clean" carrier at the repeater output. The test stimulus amplitude is adjusted over a user-defined range. The test will report the AM to PM transfer vs. input power level.

The stimulus for this measurement consists of two signals. An un-modulated "clean" carrier is generated by RF Source #2 at a specified (higher) input frequency. An amplitude-modulated carrier is generated by RF Source #1 at a specified (lower) input frequency. The AM peak-to-peak excursion of this signal is set equal to the input power step value (up to a maximum AM depth of 10 dB).

The switch matrix is set to combine the two RF source signals, connect the VSA CH1 to the source uplink coupler, and connect VSA CH2 to the specified UUT output port. VSA CH1 is used to measure the stimulus signals and the signals are adjusted for the specified starting power level. The switch matrix is then set to apply the stimulus signals to the specified UUT input port.

As the stimulus source level is stepped through the input power range, the source power levels are measured using VSA CH1 and the repeater output PM is measured using VSA CH2. The AM to PM transfer coefficient is calculated by dividing the measured PM in degrees by the input AM in dB. The input power levels are stepped over the specified power range using one of the following two methods.

1. Both modulated and clean carriers are stepped through the specified input power range.

Or,

2. The clean carrier is held at the start power level while the modulated carrier is stepped through the specified range.

VSA power readings will be corrected for system internal and external path losses using calibration data measured prior to the test. See Section 4.1 for details on corrected uplink and downlink power calculations.

3.4.4 Program Schedule Message

AM to PM Transfer PSM parameters consist of the PSM parameters for AM to PM Conversion (See Section 3.3.4) PLUS:

Name	Type	Units	Description
InputTwoToneCW	Group		See Section 5.1.6

3.4.5 Local Parameter File

AM to PM Transfer LPF parameters are the same as the LPF parameters for AM to PM Conversion. (See Section 3.3.5)

3.4.6 Command, Telemetry & Control Messages

Standard telemetry as defined in the “stf” file is (optionally, depending on the PTEConfiguration flag YST/NST) carried out at the same time and signal conditions as the path check. Each defined standard telemetry mnemonic defined will appear as a result variable of that name in the STDTLM data package in the result Citifile. The values returned by the UUT for each mnemonic sent will be recorded as the values of those result variables in the STDTLM data package.

There is no intermediate telemetry for this test.

3.4.7 Results

The results file consists of the following datasets:

- PathCheckResults Dataset
- Scalar Dataset
- PowerSweep Array Dataset
- SecondaryPowerSweep Array Dataset

Note that these datasets are in addition to the standard datasets provided by all measurements.

3.4.7.1 PathCheckResults Dataset

Name	Units	Description
PathCheckResults	Various	See Section 5.3.1

3.4.7.2 Scalar Dataset

Name	Units	Description
ULExtHWGain	dB	Insertion gain of the uplink external hardware, between the PTS calibration plane and the UUT input
DLExtHWGain	dB	Insertion gain of the downlink external hardware, between the UUT output and the PTS calibration plane
MeasResBW	Hz	Receiver resolution bandwidth that was used during the measurement
ULTVAmplitudeOffset	dB	Offset gain of the uplink portion of the test system due to thermal vacuum temperature shifts
DLTVAmplitudeOffset	dB	Offset gain of the downlink portion of the test system due to thermal vacuum temperature shifts

3.4.7.3 PowerSweep Array Dataset

Name	Units	Description
InputPowerRelNOP This is the independent variable for this dataset, and is the "X" value for plots and limit testing.	dB	Specified input power relative to NOP
InputPower	dBm	Measured input power of the lower frequency (AM modulated), in absolute dBm
InputPowerCleanCarrier	dBm	Measured input power of the upper frequency carrier (no AM), in absolute dBm
AMToPMTrans	degrees/ dB	AM to PM Transfer of the UUT
OutputPMMag	degrees	Downlink Phase Modulation Magnitude
InputAMDepth	dB	Uplink Amplitude Modulation Depth

3.4.7.4 SecondaryPowerSweep Array Dataset

Name	Units	Description
InputPowerRelNOP This is the independent variable for this dataset, and is the "X" value for plots and limit testing.	dB	Input power relative to NOP
InputPathCal	dB	Input signal path calibration for the modulated carrier; this is the insertion gain between the VSA CH1 input and the PTS calibration plane.
VSACH1Power	dBm	Uncorrected VSA CH1 reading for the modulated carrier
InputPathCalCleanCarrier	dB	Input signal path calibration for the unmodulated carrier; this is the insertion gain between the VSA CH1 input and the PTS calibration plane.
VSACH1PowerCleanCarrier	dBm	Uncorrected VSA CH1 reading for the unmodulated carrier

3.4.8 Calibrations Required

- Uplink Port Gain Calibration
- Downlink Port Gain Calibration
- Downconverter RF Gain Calibration
- Receiver Amp/Pad Gain Calibration
- External Hardware Calibrations
- Thermal Vacuum Amplitude Calibrations

3.4.9 VEE Library Name

AM2PMTrans.lib

3.5 COMPOSITE ERROR VECTOR MAGNITUDE

3.5.1 Test Purpose

The purpose of this test is to measure the modulation quality of the W-CDMA signal after the signal has passed through the repeater channel.

This test will fulfill the following test requirements of a typical payload test plan:

- Composite Error Vector Magnitude
- Peak Code Domain Error

3.5.2 Test Diagram

W-CDMA STIMULUS VSA MEASUREMENT

3.5.3 Test Description

This test will measure the quality of the W-CDMA signal after the signal has passed through the repeater channel over a user specified drive level. The user will choose a waveform type from a list of predefined configurations of multiple W-CDMA signals to be applied to the uplink channel. The spectrum analyzer measures the applied reference signal and VSA CH2 is used to measure the test stimulus on the output of the transponder. The test will report the percent error vector magnitude versus power level and the peak domain error code.

The stimulus for this measurement is a W-CDMA signal based on the test model 4, placed at a specified input frequency. The user has the ability to specify fading on the input signal. If the beacon mode parameter is set, the system uses Source 2 to provide the specified beacon signal. The switch matrix is set to verify the uplink beacon signal frequency and amplitude on VSA channel 1. Once the beacon signal is verified, the switch matrix is set to connect the beacon signal to the specified uplink port. At this point an intermediate telemetry request is made to verify the beacon signal is present. Once verified, the switch matrix is set to apply the W-CDMA stimulus signal to the specified UUT input port. The switch matrix is then set to connect the PSA to the source uplink coupler and VSA CH2 to the specified UUT output port. The PSA is used to measure the stimulus signal and the signal is adjusted for the specified starting power level.

As the stimulus source level is set to the specified level, the EVM of the repeater output signal is measured using VSA CH2. The output signal is demodulated and measured for composite EVM and peak code domain error. The vector magnitude and phase errors are also measured and recorded. The measured signals are compared to the ideal signal in order to determine the errors between the ideal signal and the transponder output signal. The vector magnitude and phase errors are then recorded. These measurements are repeated over the user specified power range. SA and VSA power readings will be corrected for system internal and external path losses using calibration data measured prior to the test. See Section 4.1 for details on corrected uplink and downlink power calculations.

3.5.4 Program Schedule Message

Name	Type	Units	Description
PTEConfiguration	Parameter		See Section 5.1.2
UUTCFG	Parameter		See Section 5.1.3
Ports	Group		See Section 5.1.4
InputSpotFreq	Group		See Section 5.1.5
TranslationFreq	Group		See Section 5.1.7
InputSweptPower	Group		See Section 5.1.12 Note, input power sweep
BeaconMode	Group		See Section 5.1.21
WaveformModel	Group		See Section 5.1.22
Fading	Group		See Section 5.1.23
ChannelBW	Parameter		See Section 5.1.14

3.5.5 Local Parameter File

Name	Type	Units	Description
SimulateTest	Parameter		See Section 5.2.2
85121A Compatibility Mode	Parameter		See Section 5.2.14
InputSignal	Group		See Section 5.2.3
Receiver	Group		See Section 5.2.4
UUTDelay	Group		See Section 5.2.5
TimeBase	Group		See Section 5.2.6
PathCheck	Group		See Section 5.2.7
StdTelemetry	Group		See Section 5.2.8
SNROrResBW	Group		See Section 5.2.9

3.5.6 Command, Telemetry & Control Messages

Standard telemetry as defined in the “stf” file is (optionally, depending on the PTEConfiguration flag YST/NST) carried out at the same time and signal conditions as the path check. Each defined standard telemetry mnemonic defined will appear as a result variable of that name in the STDTLM data package in the result Citifile. The values returned by the UUT for each mnemonic sent will be recorded as the values of those result variables in the STDTLM data package.

Intermediate telemetry communications, as defined in the LPF string-array parameter IntTelemetry, are (optionally, depending on the PTEConfiguration flag YIT/NIT) sent and the responses recorded at specific times in the measurement. The intermediate telemetry data is stored in the Intermediate Telemetry data package INTTLM inside the results Citifile. Each telemetry mnemonic becomes the name of a variable parameter within the INTTLM data package.

The dependent variable of the package is, in this measurement, InputPower. The values that the telemetry records at each power level will appear in the dependent data arrays of the package.

3.5.7 Results

The results file consists of the following datasets:

- PathCheckResults Dataset
- Scalar Dataset
- PowerSweep Array Dataset
- SecondaryPowerSweep Array Dataset

Note that these datasets are in addition to the standard datasets provided by all measurements.

3.5.7.1 PathCheckResults Dataset

Name	Units	Description
PathCheckResults	Various	See Section 5.3.1

3.5.7.2 Scalar Dataset

Name	Units	Description
ULExtHWGain	dB	Insertion gain of uplink external hardware, between the PTS calibration plane and the UUT input
DLExtHWGain	dB	Insertion gain of downlink external hardware, between the UUT output and the PTS calibration plane
MeasResBW	Hz	Receiver resolution bandwidth that was used during the measurement
ULTVAmplitudeOffset	dB	Offset gain of the uplink portion of the test system due to thermal vacuum temperature shifts
DLTVAmplitudeOffset	dB	Offset gain of the downlink portion of the test system due to thermal vacuum temperature shifts

3.5.7.3 PowerSweep Array Dataset

Name	Units	Description
InputPowerRelNOP This is the independent variable for this dataset and is the "X" value for plots and limit testing.	dB	Specified input power relative to NOP
InputPower	dBm	Measured input power, in absolute dBm
EVM	%	Measured Error Vector Magnitude
VectorErrorMag	dBm	Measured Vector Error Magnitude
VectorErrorPhase	degrees	Measured Vector Error Phase
PkCodeDomainError	dBc	Measured Peak Code Domain Error
CodeId	N/A	Code Identifier at which the peak code domain error occurred
Channel_Id	N/A	Channel identifier at which the peak code domain error occurred

3.5.7.4 SecondaryPowerSweep Array Dataset

Name	Units	Description
InputPowerRelNOP This is the independent variable for this dataset and is the "X" value for plots and limit testing.	dB	Input power relative to NOP
InputPathCal	dB	Input signal path calibration; this is the insertion gain between the VSA CH1 input and the PTS calibration plane.

InputPowerRaw	dBm	Uncorrected PSA reading
OutputPathCal	dB	The output signal path calibration factor; this value is the insertion gain between the VSA CH2 input and the PTS calibration plane.
OutputPowerRaw		Uncorrected VSA channel 2 reading

3.5.8 Calibrations Required

- Uplink Port Gain Calibration
- Downlink Port Gain Calibration
- Downconverter RF Gain Calibration
- Receiver Amp/Pad Gain Calibration
- External Hardware Calibrations
- Thermal Vacuum Amplitude Calibrations

3.5.9 VEE Library Name

WCDMA.lib

3.5.10 Pseudo Measurement Code

1. Initialize test parameters. Read and process values from the .lpf,.psm. Store a copy of the test parameters in the data file.

2. Initialize instruments to a preset condition. Instruments initialized are:

ULMatrix

DLMatrix

RFSource1

RFSource2

ULPowerMeter

DLPowerMeter

LOSource1

LOSource2

VSA

IFReceiver

SpectrumAnalyzer

Awg1

FunctionGenerator

FadingAttenuator

Perform chore functions (for example. Cal, zero, etc.) related to each instrument if timer indicates a need.

3. If BeaconMode=0;

a. Perform the standard path check and request standard telemetry data from the host computer if this parameter is set. Store path check and telemetry results in the data file.

b. Determine the maximum expected port power from input parameters. Set UL path (amp and pad state) and receiver path (amp, pad or thru state) based on this power.

4. If BeaconMode=1 set up the beacon.

a. Turn RFSource1 off.

b. Connect matrix path to use source1&2 combiner.

c. Connect matrix path for uplink and downlink ports.

d. Set up VSA for uplink power measurements.

e. Determine maximum expected port power from input parameters. Set UL path (amp and pad state) and receiver path (amp, pad or thru state) based on this power.

f. Turn on RFSource2 and adjust power until desired beacon power is achieved. Use the VSA CW marker and calibration data for the power readings.

g. Request beacon verification telemetry from the host computer.

h. Check telemetry data against limits. If fail, log message and abort test.

5. Set up the AWG for the W-CDMA waveform.

a. If RF frequency > 3.2 GHz, set AWG output to single ended, amplifier in.

b. If RF frequency <= 3.2 GHz, set AWG output to differential, amplifier out.

c. Download specified waveform files to AWG Channel 1 and Channel 2.

d. Command AWG to play out waveforms. Set AWG output (ch1 and ch2) to ON.

6. Set up the RFSource1 for I/Q mode.

a. if RF frequency > 3.2 GHz, set source to use wideband I/Q inputs.

b. if RF frequency <= 3.2 GHz, set source to use narrowband I/Q inputs.

c. turn modulation on, set RF output to ON.

7. Set up the PSA for uplink power measurements.

a. Connect the matrix path to use the PSA for power monitoring.

b. Set up the PSA frequency and span (span=sigbw*1.4)

c. Set up the PSA averaging and band power markers (marker spacing=sigbw*1.2)

8. Set up the VSA for downlink power measurements.

a. Connect the matrix path to use VSA Ch2 for downlink signal measurement.

b. Set up the VSA and downconverter/LO's frequencies for downlink signal at:

DL Frequency= OutputFrequency + DLFreqErr + ChannelOffsetFrequency

DLFreqErr is measured during the path check.

c. Swap hardware channels on the VSA so Channel 1 is now using ADC2. This is to allow a digital demod using the downlink signal on ADC2.

d. Set up the VSA to perform 3GPP W-CDMA demod on Channel 1 (ADC2).

e. Set up the VSA band power markers to downlink frequency +- ChannelBw/2.

9. Measure EVM/Peak code domain error over a range of input power levels.

a. if FadingOn=1, connect path to include fader. Preset function generator.

b. Set input power using the PSA.

-set RF1 source frequency to InputFrequency-WaveformOffsetFrequency

-measure band power on PSA centered at InputFrequency, adjust RFSource1 power until:

measured power - desired power < input power tolerance

-perform the I/Q dc calibration on RFSource1

c. If first time through the loop: autorange the VSA input level.

d. Measure output power using VSA band power markers.

- if NextPointDelay>0 wait delay seconds
- set paths for appropriate receiver amp or pad as needed
- autorange VSA input level
- read VSA band power marker and correct using downlink cal data

e. Measure EVM/PCDE

- if FadingOn=1 then
    - set up fading function generator, turn fading on
    - for the number of FadingSamples, measure in a loop
    - retrieve VSA error summary for digital demod
    - collect values
    - wait delay, then repeat loop
    - calculate average of each type collected:
        - composite EVM, % rms
        - EVM mag, % rms
        - EVM phase, deg
        - Pk CDE, dBc
        - CDE code (don't average)
        - CDE channel (don't average)
    - preset function generator
- if FadingOn=0 then
    - retrieve VSA error summary for digital demod
    - record values

f. Update live graph

g. Request intermediate telemetry values from host computer if set.

h. Loop to step b until all powers are measured.

i. If FadingOn=1, switch fader out of the uplink path.

10. Perform limit check and store results to data file.

3.6 DELAY VS. FREQUENCY

3.6.1 Test Purpose

The purpose of this test is to determine the group delay and frequency response (gain) across the channel bandwidth of the repeater. The test also calculates slope and ripple of the delay and gain measurements in the channel pass-band. This test will fulfill the following test requirements of a typical payload test plan:

- Group Delay/Group Delay Slope/Group Delay Ripple
- Repeater Turn Around Delay
- In-Band Frequency Response

3.6.2 Test Diagram

SINGLE SOURCE VSA MEASUREMENT

3.6.3 Test Description

Because the unit under test is frequency translating, the uplink stimulus for this test is a frequency-modulated carrier. The modulation frequency is set to be one- half of the measurement's frequency step size, and the VSA is used to demodulate the FM and measure the delay of the signal through the repeater. The test also measures uplink and downlink carrier power so that the UUT gain can be calculated.

The test configures the switch matrix for the specified uplink and downlink ports. The uplink signal is set to the specified input start frequency. The input power level is set to either a user specified power level or the value stored for the reference power determined by the gain transfer test. The carrier is frequency- modulated at a fixed modulation index of 1. The VSA is used to demodulate the uplink and downlink signals. Channel 1 of the VSA is connected through the matrix to the uplink stimulus and the reference phase of the demodulated FM signal is measured. Channel 2 of the VSA is connected to the output of the repeater and the demodulated phase of the downlink signal is measured. The delay (seconds) is calculated from the VSA phase readings (degrees) and the modulation frequency (Hz) by the formula:

$$Delay = \frac{VSAPhase}{360 \times f_{MOD}}$$

Where f_{MOD} is the modulation frequency. The absolute delay through the repeater is calculated from:

UUT_Delay (s) = UL Corrected Delay (s) - DL Corrected Delay (s)

See Section 3.1 on page on page 126 for details on corrected delay calculations. The stimulus signal will be stepped across the input frequency range, and the VSA will repeat this measurement at each point. Absolute delay, relative delay, delay slope, and delay ripple are calculated and displayed vs. input frequency.

Deviation from linear phase is calculated by taking the integral of the relative delay vs. frequency measurement. The test will also calculate the maximum peak-to-peak ripple of phase linearity in a specified sliding window within the specified channel bandwidth.

The test also records uplink and downlink carrier power in order to calculate UUT gain. VSA readings are corrected for system internal and external path losses using calibration data measured prior to the test. See Section 4.1 for details on corrected uplink and downlink power calculations.

3.6.4 Program Schedule Message

Name	Type	Units	Description
PTEConfiguration	Parameter		See Section 5.1.2
UUTCFG	Parameter		See Section 5.1.3
Ports	Group		See Section 5.1.4
InputSweptFreq	Group		See Section 5.1.8 Note that the input frequency sweep must have equally spaced frequency steps, and that the FM Modulation Frequency is always set to be half of the frequency step.
TranslationFreq	Group		See Section 5.1.7
InputSweptPower	Group		See Section 5.1.13
ChannelBW	Parameter		See Section 5.1.14
RippleWindow	Parameter		See Section 5.1.15

3.6.5 Local Parameter File

Name	Type	Units	Description
SimulateTest	Parameter		See Section 5.2.2
85121A Compatibility Mode	Parameter		See Section 5.2.14
InputSignal	Group		See Section 5.2.3
Receiver	Group		See Section 5.2.4
UUTDelay	Group		See Section 5.2.5
TimeBase	Group		See Section 5.2.6
PathCheck	Group		See Section 5.2.7
StdTelemetry	Group		See Section 5.2.8
SNROrResBW	Group		See Section 5.2.9
SmoothingPoints	Integer	N/A	For the GainSlope and DelaySlope calculations, the derivative of the gain or delay measurement is averaged over the number of adjacent points specified by SmoothingPoints. Increasing this parameter tends to smooth out the Slope results.

3.6.6 Command, Telemetry & Control Messages

Standard telemetry as defined in the “stf” file is (optionally, depending on the PTEConfiguration flag YST/NST) carried out at the same time and signal conditions as the path check. Each defined standard telemetry mnemonic defined will appear as a result variable of that name in the STDTLM data package in the result Citifile. The values returned by the UUT for each mnemonic sent will be recorded as the values of those result variables in the STDTLM data package.

There is no intermediate telemetry for this test.

3.6.7 Results

The results file consists of the following datasets:

- PathCheckResults Dataset
- Scalar Dataset
- FrequencySweep Array Dataset
- SecondaryFrequencySweep Array Dataset

Note that these datasets are in addition to the standard datasets provided by all measurements.

3.6.7.1 PathCheckResults Dataset

Name	Units	Description
PathCheckResults	Various	See Section 5.3.1

3.6.7.2 Scalar Dataset

Name	Units	Description
All ScalarResults from Gain Vs Frequency	Various	See Section 3.11.7.2
MinDelay	seconds	The minimum group delay value in the measured frequency range
CenterDelay	seconds	The group delay measured at InputCenterFrequency
MaxDelayRipple	seconds	The maximum peak-to-peak ripple of measured group delay in any window of width RippleWindowBW as the sliding window is moved within ChannelBW around the InputCenterFrequency
MaxPhaseRipple	degrees	The maximum peak-to-peak ripple of measured phase in any window of width RippleWindowBW as the sliding window is moved within ChannelBW around the InputCenterFrequency

3.6.7.3 FrequencySweep Array Dataset

Name	Units	Description
All FrequencySweep results from Gain Vs Frequency	Various	See Section 3.11.7.3
InputCarrierPower	dBm	Input carrier power to the UUT. This is the center tone of the FM spectrum, which is used to calculate the UUT gain.
OutputCarrierPower	dBm	Output carrier power from the UUT. This is the center tone of the FM spectrum, which is used to calculate the UUT gain.

Name	Units	Description
Delay	seconds	Absolute group delay of the UUT
DelayRelMin	seconds	Group delay of the UUT, normalized to 0 at the minimum delay frequency
DelayRelCenter	seconds	Group delay of the UUT, normalized to 0 at the center frequency
PhaseRelCenter	degrees	Phase, calculated by integrating the DelayRelCenter and normalizing to 0 at the center frequency
DelaySymmetry	seconds	Symmetry of the measured group delay, calculated by taking the midpoint of the frequency sweep (not the defined center frequency) and calculating the absolute value of the delta between the left and right halves
DelaySlope	sec/Hz	Slope of the group delay at each frequency point, calculated from the derivative of a 2nd order polynomial fitted to the three closest frequency points
DelayRipple	seconds	Peak-to-peak ripple of measured group delay in the window of width RippleWindowBW as the sliding window is moved within ChannelBW around the InputCenterFrequency
PhaseRipple	degrees	Peak-to-peak ripple of calculated phase (relative to the phase at center) in the window of width RippleWindowBW as the sliding window is moved within ChannelBW around the InputCenterFrequency

3.6.7.4 SecondaryFrequencySweep Array Dataset

Name	Units	Description
All SecondaryFrequencySweep results from Gain Vs Frequency	Various	See Section 3.11.7.4
InputPathDelayCal	seconds	Group delay calibration of the input signal path between the VSA CH1 input and the PTS calibration plane

Name	Units	Description
OutputPathDelayCal	seconds	Group delay calibration of the output signal path between the VSA CH2 input and the PTS calibration plane
InputExtHWDelay	seconds	Delay of external hardware between the PTS uplink calibration plane and the UUT input
OutputExtHWlDelay	seconds	Delay of external hardware between the UUT output and the PTS downlink calibration plane
ULTVPhaseOffset	seconds	Thermal vacuum phase offset of the uplink
DLTVPhaseOffset	seconds	Thermal vacuum phase offset of the downlink
DelayRaw	seconds	The measured group delay, before correction with Path and ExtHW cal data

3.6.8 Calibrations Required

- Uplink Port Gain Calibration
- Downlink Port Gain Calibration
- Downconverter RF Gain Calibration
- Receiver Amp/Pad Gain Calibration
- External Hardware Gain & Delay Calibrations
- Uplink Port Delay Calibration
- Downlink Port Delay Calibration
- Thermal Vacuum Amplitude Calibration
- Thermal Vacuum Phase Calibration

3.6.9 VEE Library Name

DelayVsFreq.lib

3.7 DYNAMIC RANGE

3.7.1 Test Purpose

The purpose of this test is to stimulate the repeater channel with a two-tone signal and measure the distortion and noise impairments appearing on the output as the input power is stepped over a specified range.

This test will fulfill the following test requirements of a typical payload test plan:

- Amplitude Linearity/Two-Tone IMD
- Carrier to Noise/Noise Figure
- Output Power vs. Input Power

3.7.2 Test Diagram

TWO-SOURCE VSA MEASUREMENT

3.7.3 Test Description

This test will measure the noise and inter-modulation products at the repeater output. A two-tone signal is applied to the UUT input. The two-channel vector signal analyzer measures the carrier levels, intermodulation product levels, and noise power as the input power is stepped over a specified range.

The stimulus for this measurement consists of a two-tone signal, generated by the combined carriers from RF Source #1 and RF Source #2, at a specified input frequency and tone separation. The carrier powers can be specified for equal level or with a fixed offset power between them. The switch matrix is set to connect the VSA CH1 to the source uplink coupler and VSA CH2 to the specified UUT output port. VSA CH1 is used to measure the stimulus signals and the signals are adjusted for the specified starting power level. The switch matrix is then set to apply the stimulus signals to the specified UUT input port.

As the stimulus source level is stepped through the input power range, the source output spectrum is measured using VSA CH1 and the repeater output spectrum is measured using VSA CH2. The following information is derived from the measured signals:

1. Input and output carrier power levels in dBm.

2. Input and output intermodulation product levels in dBc, up to 7th order. The results may be normalized to either input or output power levels.

3. Input and output noise levels in dBc/Hz. Noise within a specified bandwidth of the carrier will be excluded. UUT noise figure will be calculated as the ratio of the carrier to noise in versus the carrier to noise out of the transponder. Where input noise will be assumed to be the kTB.

VSA power readings will be corrected for system internal and external path losses using calibration data measured prior to the test. See Section 4.1 for details on corrected uplink and downlink power calculations.

3.7.4 Program Schedule Message

Name	Type	Units	Description
PTEConfiguration	Parameter		See Section 5.1.2
UUTCFG	Parameter		See Section 5.1.3
Ports	Group		See Section 5.1.4
InputSpotFreq	Group		See Section 5.1.5
InputTwoToneCW	Group		See Section 5.1.6
TranslationFreq	Group		See Section 5.1.7
InputSweptPower	Group		See Section 5.1.13
PhaseNoiseExclusion	Real	Hz	Defines the frequency range next to the lower tone to exclude from the noise measurement. Valid entries are 0 to 40% of the tone spacing frequency.

3.7.5 Local Parameter File

Name	Type	Units	Description
SimulateTest	Parameter		See Section 5.2.2
85121A Compatibility Mode	Parameter		See Section 5.2.14
InputSignal	Group		See Section 5.2.3
Receiver	Group		See Section 5.2.4
UUTDelay	Group		See Section 5.2.5
TimeBase	Group		See Section 5.2.6
PathCheck	Group		See Section 5.2.7
StdTelemetry	Group		See Section 5.2.8
SNROrResBW	Group		See Section 5.2.9
IntTelemetry	Group		See Section 5.2.13
InputNoiseTemperature	Real	Celsius	The equivalent temperature of the input signal to the UUT. This is the thermal temperature of the attenuator (or coupler) at the input of the UUT, assuming that the attenuation is great enough to lower the excess noise of the PTS RF source to kTB.
HighestIMDOrder (3, 5 or 7)	Integer	NA	Highest order intermodulation product to be measured
InOutSelect	Integer	NA	InOutSelect determines whether the IMOD results are displayed versus input or output power. A value of 1 will plot IMOD results versus output power and a value of 0 will plot the results versus input power.

3.7.6 Command, Telemetry & Control Messages

Standard telemetry as defined in the "stf" file is (optionally, depending on the PTEConfiguration flag YST/NST) carried out at the same time and signal conditions as the path check. Each defined standard telemetry mnemonic defined will appear as a result variable of that name in the STDTLM data package in the result Citifile. The values returned by the UUT for each mnemonic sent will be recorded as the values of those result variables in the STDTLM data package.

Intermediate telemetry communications, as defined in the LPF string-array parameter IntTelemetry, are (optionally, depending on the PTEConfiguration flag YIT/NIT) sent and the responses recorded at each power level during the power sweep. The intermediate telemetry data is stored in the Intermediate Telemetry data package INTTLM inside the results Citifile. Each telemetry mnemonic becomes the name of a variable parameter within the INTTLM data package.

The dependent variable of the package is, in this measurement, InputPower. The values that the telemetry records at each power level will appear in the dependent data arrays of the package.

3.7.7 Results

The results file consists of the following datasets:

- PathCheckResults Dataset
- Scalar Dataset
- Scalar2 Dataset
- RelativePower Array Dataset
- CorrectedPower Array Dataset
- UncorrectedPower Array Dataset
- PathCal Array Dataset

Note that these datasets are in addition to the standard datasets provided by all measurements.

3.7.7.1 PathCheckResults Dataset

Name	Units	Description
PathCheckResults	Various	See Section 5.3.1

3.7.7.2 Scalar Dataset

Name	Units	Description
ULExtHWGainFlo	dB	Insertion gain of uplink external hardware, between the PTS calibration plane and the UUT input, at the lower tone frequency
ULExtHWGainFup	dB	Insertion gain of uplink external hardware, between the PTS calibration plane and the UUT input, at the upper tone frequency
ULExtHWGainFlo3	dB	Insertion gain of uplink external hardware, between the PTS calibration plane and the UUT input, at the lower tone 3rd order frequency
ULExtHWGainFlo5	dB	Insertion gain of uplink external hardware, between the PTS calibration plane and the UUT input, at the lower tone 5th order frequency
ULExtHWGainFlo7	dB	Insertion gain of uplink external hardware, between the PTS calibration plane and the UUT input, at the lower tone 7th order frequency
ULExtHWGainFup3	dB	Insertion gain of uplink external hardware, between the PTS calibration plane and the UUT input, at the upper tone 3rd order frequency

Name	Units	Description
ULExtHWGainFup5	dB	Insertion gain of uplink external hardware, between the PTS calibration plane and the UUT input, at the upper tone 5th order frequency
ULExtHWGainFup7	dB	Insertion gain of uplink external hardware, between the PTS calibration plane and the UUT input, at the upper tone 7th order frequency
ULExtHWGainNoise	dB	Insertion gain of uplink external hardware, between the PTS calibration plane and the UUT input, at the noise measurement frequency
DLExtHWGainFlo	dB	Insertion gain of downlink external hardware, between the UUT output and the PTS calibration plane, at the lower tone frequency
DLExtHWGainFup	dB	Insertion gain of downlink external hardware, between the UUT output and the PTS calibration plane, at the upper tone frequency
DLExtHWGainFlo3	dB	Insertion gain of downlink external hardware, between the UUT output and the PTS calibration plane, at the lower tone 3rd order frequency
DLExtHWGainFlo5	dB	Insertion gain of downlink external hardware, between the UUT output and the PTS calibration plane, at the lower tone 5th order frequency
DLExtHWGainFlo7	dB	Insertion gain of downlink external hardware, between the UUT output and the PTS calibration plane, at the lower tone 7th order frequency
DLExtHWGainFup3	dB	Insertion gain of downlink external hardware, between the UUT output and the PTS calibration plane, at the upper tone 3rd order frequency
DLExtHWGainFup5	dB	Insertion gain of downlink external hardware, between the UUT output and the PTS calibration plane, at the upper tone 5th order frequency
DLExtHWGainFup7	dB	Insertion gain of downlink external hardware, between the UUT output and the PTS calibration plane, at the upper tone 7th order frequency

Name	Units	Description
DLExtHWGainNoise	dB	Insertion gain of downlink external hardware, between the UUT output and the PTS calibration plane, at the noise measurement frequency
MeasResBW	Hz	Receiver resolution bandwidth that was used during the measurement

3.7.7.3 Scalar2 Dataset

Name	Units	Description
ULTVAmplitudeOffsetFlo	dB	Thermal vacuum amplitude offset of the uplink, at the lower tone frequency
ULTVAmplitudeOffsetFup	dB	Thermal vacuum amplitude offset of the uplink, at the upper tone frequency
ULTVAmplitudeOffsetFlo3	dB	Thermal vacuum amplitude offset of the uplink, at the lower tone 3rd order frequency
ULTVAmpliudeOffsetFlo5	dB	Thermal vacuum amplitude offset of the uplink, at the lower tone 5th order frequency
ULTVAmplitudeOffsetFlo7	dB	Thermal vacuum amplitude offset of the uplink, at the lower tone 7th order frequency
ULTVAmplitudeOffsetFup3	dB	Thermal vacuum amplitude offset of the uplink, at the upper tone 3rd order frequency

Name	Units	Description
ULTVAmplitudeOffsetFup5	dB	Thermal vacuum amplitude offset of the uplink, at the upper tone 5th order frequency
ULTVAmplitudeOffsetFup7	dB	Thermal vacuum amplitude offset of the uplink, at the upper tone 7th order frequency
ULTVAmplitudeOffsetNoise	dB	Thermal vacuum amplitude offset of the uplink, at the noise measurement frequency
DLTVAmplitudeOffsetFlo	dB	Thermal vacuum amplitude offset of the downlink, at the lower tone frequency
DLTVAmplitudeOffsetFup	dB	Thermal vacuum amplitude offset of the downlink, at the upper tone frequency
DLTVAmplitudeOffsetFlo3	dB	Thermal vacuum amplitude offset of the downlink, at the lower tone 3rd order frequency
DLTVAmplitudeOffsetFlo5	dB	Thermal vacuum amplitude offset of the downlink, at the lower tone 5th order frequency
DLTVAmplitudeOffsetFlo7	dB	Thermal vacuum amplitude offset of the downlink, at the lower tone 7th order frequency
DLTVAmplitudeOffsetFup3	dB	Thermal vacuum amplitude offset of the downlink, at the upper tone 3rd order frequency
DLTVAmplitudeOffsetFup5	dB	Thermal vacuum amplitude offset of the downlink, at the upper tone 5th order frequency
DLTVAmplitudeOffsetFup7	dB	Thermal vacuum amplitude offset of the downlink, at the upper tone 7th order frequency
DLTVAmplitudeOffsetNoise	dB	Thermal vacuum amplitude offset of the downlink, at the noise measurement frequency

3.7.7.4 RelativePower Array Dataset

Name	Units	Description
InputTonePowerRelNOP This is the independent variable for this dataset, and is the "X" value for plots and limit testing.	dB	Specified input power per tone, relative to NOP
RelOutputPowerFlo3	dBc	Relative output power of lower 3rd order product
RelOutputPowerFup3	dBc	Relative output power of upper 3rd order product
RelOutputPowerFlo5	dBc	Relative output power of lower 5th order product
RelOutputPowerFup5	dBc	Relative output power of upper 5th order product
RelOutputPowerFlo7	dBc	Relative output power of lower 7th order product
RelOutputPowerFup7	dBc	Relative output power of upper 7th order product
InputCarrierToNoise	dBc/Hz	Input carrier to noise ratio, assuming input noise is kTB
OutputCarrierToNoise	dBc/Hz	Output carrier to noise ratio, using measured output carrier and noise values
UUTNoiseFigure	dB	UUT Noise Figure, calculated as InputCarrierToNoise – OutputCarrierToNoise

3.7.7.5 CorrectedPower Array Dataset

Name	Units	Description
InputTonePowerRelNOP This is the independent variable for this dataset, and is the "X" value for plots and limit testing.	dB	Specified input power per tone, relative to NOP
InputPowerFlo	dBm	Corrected input power of lower tone
InputPowerFup	dBm	Corrected input power of upper tone
InputPowerNoise	dBm/Hz	Corrected input noise power density
InputPowerFlo3	dBm	Corrected input power of lower 3rd order product
InputPowerFup3	dBm	Corrected input power of upper 3rd order product
InputPowerFlo5	dBm	Corrected input power of lower 5th order product
InputPowerFup5	dBm	Corrected input power of upper 5th order product
InputPowerFlo7	dBm	Corrected input power of lower 7th order product
InputPowerFup7	dBm	Corrected input power of upper 7th order product
OutputPowerFlo	dBm	Corrected output power of lower tone
OutputPowerFup	dBm	Corrected output power of upper tone
OutputPowerNoise	dBm/Hz	Corrected output noise power density
OutputPowerFlo3	dBm	Corrected output power of lower 3rd order product
OutputPowerFup3	dBm	Corrected output power of upper 3rd order product

Name	Units	Description
OutputPowerFlo5	dBm	Corrected output power of lower 5th order product
OutputPowerFup5	dBm	Corrected output power of upper 5th order product
OutputPowerFlo7	dBm	Corrected output power of lower 7th order product
OutputPowerFup7	dBm	Corrected output power of upper 7th order product

3.7.7.6 UncorrectedPower Array Dataset

Name	Units	Description
InputTonePowerRelNOP This is the independent variable for this dataset, and is the "X" value for plots and limit testing.	dB	Specified input power per tone, relative to NOP
UncorrInputPowerFlo	dBm	Uncorrected input power of lower tone
UncorrInputPowerFup	dBm	Uncorrected input power of upper tone
UncorrInputPowerNoise	dBm/Hz	Uncorrected input noise power density
UncorrInputPowerFlo3	dBm	Uncorrected input power of lower 3rd order product
UncorrInputPowerFup3	dBm	Uncorrected input power of upper 3rd order product
UncorrInputPowerFlo5	dBm	Uncorrected input power of lower 5th order product
UncorrInputPowerFup5	dBm	Uncorrected input power of upper 5th order product
UncorrInputPowerFlo7	dBm	Uncorrected input power of lower 7th order product
UncorrInputPowerFup7	dBm	Uncorrected input power of upper 7th order product

Name	Units	Description
UncorrOutputPowerNoise	dBm/Hz	Uncorrected output noise power density
UncorrOutputPowerFlo	dBm	Uncorrected output power of lower tone
UncorrOutputPowerFup	dBm	Uncorrected output power of upper tone
UncorrOutputPowerFlo3	dBm	Uncorrected output power of lower 3rd order product
UncorrOutputPowerFup3	dBm	Uncorrected output power of upper 3rd order product
UncorrOutputPowerFlo5	dBm	Uncorrected output power of lower 5th order product
UncorrOutputPowerFup5	dBm	Uncorrected output power of upper 5th order product
UncorrOutputPowerFlo7	dBm	Uncorrected output power of lower 7th order product
UncorrOutputPowerFup7	dBm	Uncorrected output power of upper 7th order product

3.7.7.7 PathCal Array Dataset

Name	Units	Description
InputTonePowerRelNOP This is the independent variable for this dataset, and is the "X" value for plots and limit testing.	dB	Specified input power per tone, relative to NOP
InputPathCalFlo	dB	Input path calibration of lower tone
InputPathCalFup	dB	Input path calibration of upper tone
InputPathNoise	dB	Input path calibration of noise power density

Name	Units	Description
InputPathCalFlo3	dB	Input path calibration of lower 3rd order product
InputPathCalFup3	dB	Input path calibration of upper 3rd order product
InputPathCalFlo5	dB	Input path calibration of lower 5th order product
InputPathCalFup5	dB	Input path calibration of upper 5th order product
InputPathCalFlo7	dB	Input path calibration of lower 7th order product
InputPathCalFup7	dB	Input path calibration of upper 7th order product
OutputPathCalFlo	dB	Output path calibration of lower tone
OutputPathCalFup	dB	Output path calibration of upper tone
OutputPathNoise	dB	Output path calibration of noise power density
OutputPathCalFlo3	dB	Output path calibration of lower 3rd order product
OutputPathCalFup3	dB	Output path calibration of upper 3rd order product
OutputPathCalFlo5	dB	Output path calibration of lower 5th order product
OutputPathCalFup5	dB	Output path calibration of upper 5th order product
OutputPathCalFlo7	dB	Output path calibration of lower 7th order product
OutputPathCalFup7	dB	Output path calibration of upper 7th order product

3.7.8 Calibrations Required

- Uplink Port Gain Calibration
- Downlink Port Gain Calibration
- Downconverter RF Gain Calibration
- Receiver Amp/Pad Gain Calibration
- External Hardware Calibrations
- Thermal Vacuum Amplitude Calibrations

3.7.9 VEE Library Name

DynamicRange.lib

3.8 GAIN ADJUSTMENT

3.8.1 Test Purpose

The purpose of this measurement is to measure the adjustable gain/attenuation steps of a repeater.

This test will fulfill the following test requirements of a typical payload test plan:

- Gain Adjustment, Fixed Gain Mode
- Gain Adjustment, ALC Mode

3.8.2 Test Diagram

SINGLE SOURCE VSA MEASUREMENT

3.8.3 Test Description

The stimulus for this measurement is a single CW carrier, placed at a specified input frequency. The switch matrix is set to connect the VSA CH1 to the source uplink coupler and VSA CH2 to the specified UUT output port. VSA CH1 is used to measure the stimulus signal and the signal is adjusted for the specified input power level. The switch matrix is then set to apply the stimulus signal to the specified UUT input port.

The test can be selected to measure fixed gain or ALC type repeaters. For the fixed gain mode, the repeater is commanded to a reference gain setting. The VSA is used to measure repeater input and output power, and repeater intermediate telemetry is recorded. The repeater is then commanded to change to a new gain setting, and the input power is adjusted to maintain the original output power level so that gain compression in the UUT does not affect the measured gain. Input and output power levels are measured and the new UUT gain is calculated. This process is repeated over the specified gain range of the repeater, and the measured gain vs. gain setting is calculated, as well as measured deviation from gain setting vs. gain setting.

For the ALC mode, the same method is used except that the input power is held constant as the repeater is commanded over its specified gain range. The test will request that the ALC mode be turned on and the repeater ALC attenuator be set to a specified start value before beginning the gain sweep. UUT output power is measured at each point and the output power vs. gain setting is recorded. VSA power readings will be corrected for system internal and external path losses using calibration data measured prior to the test. See Section 4.1 for details on corrected uplink and downlink power calculations.

3.8.4 Program Schedule Message

Name	Type	Units	Description
PTEConfiguration	Parameter		See Section 5.1.2
UUTCFG	Parameter		See Section 5.1.3
Ports	Group		See Section 5.1.4
InputSpotFreq	Group		See Section 5.1.5
TranslationFreq	Group		See Section 5.1.7
InputSpotPower	Group		See Section 5.1.12
RefControlState or RefAttenuatorStep(*)	Real	dB	Reference control state. All subsequent measurements of control states are referenced to an initial measurement at this reference state.
{ControlState} or ControlStateStart ControlStateStop ControlStateStep	Real array Triplet of Reals	dB	This is a list of attenuator or gain control states to measure. and can be specified as an array or a start/stop/step triplet.
ControlStateSafe(opt)	Real	dB	If specified, the test system will request this control state at the end of the test, when the sweep is complete. This can be used to leave the UUT in a known safe state if the last setting required for the sweep leaves the UUT in a vulnerable condition.

3.8.5 Local Parameter File

Name	Type	Units	Description
SimulateTest	Parameter		See Section 5.2.2
85121A Compatibility Mode	Parameter		See Section 5.2.14
InputSignal	Group		See Section 5.2.3
Receiver	Group		See Section 5.2.4
UUTDelay	Group		See Section 5.2.5
TimeBase	Group		See Section 5.2.6
PathCheck	Group		See Section 5.2.7

Name	Type	Units	Description
StdTelemetry	Group		See Section 5.2.8
SNROrResBW	Group		See Section 5.2.9
IntTelemetry	Group		See Section 5.2.13
ControlStateRequest	String	NA	String mnemonic for the UUT control state command. The command will be formed by: ControlRequest(string)+Control State(real)
OutputPowerToleranceF actor (opt) Defaults to 2 if not specified	Real	NA	This parameter specifies how close the measured output power must be to the reference output power when the source power level is adjusted after an attenuator step. The output power tolerance is calculated as: OutputPowerToleranceFactor * InputPowerTolerance.
AttenOrGain “ATTEN” or ”GAIN”	String	NA	Specifies whether the control state request is in terms of attenuation or gain. This parameter is used to determine the sign of the control state so that the gain adjustment error can be calculated.

3.8.6 Command, Telemetry & Control Messages

Intermediate telemetry communications, as defined in the LPF string-array parameter IntTelemetry, are (optionally, depending on the PTEConfiguration flag YIT/NIT) sent and the responses recorded at each power level during the power sweep. The intermediate telemetry data is stored in the Intermediate Telemetry data package INTTLM inside the results Citifile. Each telemetry mnemonic becomes the name of a variable parameter within the INTTLM data package. The dependent variable of the package is, in this measurement, InputPower. The values that the telemetry records at each power level will appear in the dependent data arrays of the package.

Standard telemetry as defined in the “stf” file is (optionally, depending on the PTEConfiguration flag YST/NST) carried out at the input reference level. Each defined standard telemetry mnemonic will appear as a result variable of that name in the STDTLM data package in the result Citifile. The values returned by the UUT for each mnemonic sent will be recorded as the values of those result variables in the STDTLM data package.

3.8.7 Results

The results file consists of the following datasets:

- PathChecklResults Dataset
- Scalar Dataset
- GainSweep Array Dataset
- GainSweepPlot Array Dataset

Note that these datasets are in addition to the standard datasets provided by all measurements.

3.8.7.1 PathCheckResults Dataset

Name	Units	Description
PathCheckResults	Various	See Section 5.3.1

3.8.7.2 Scalar Dataset

Name	Units	Description
InputExtHwCal	dB	Insertion gain of uplink external hardware, between the PTS calibration plane and the UUT input
OutputExtHwCal	dB	Insertion gain of downlink external hardware, between the UUT output and the PTS calibration plane
MeasResBW	Hz	Receiver resolution bandwidth that was used during the measurement
ULTVAmplitudeOffset	dB	Offset gain of the uplink portion of the test system due to thermal vacuum temperature shifts
DLTVAmplitudeOffset	dB	Offset gain of the downlink portion of the test system due to thermal vacuum temperature shifts

3.8.7.3 GainSweep Array Dataset

Note: The first element in this array corresponds to the RefControlState.

Name	Units	Description
ControlState This is the independent variable for this dataset, and is the "X" value for plots and limit testing.	dB	Attenuator or gain control states that were measured
InputPower	dBm	Input power to UUT, absolute dBm, corrected for PTS internal and external calibration
OutputPower	dBm	Output power to UUT, absolute dBm, corrected for PTS internal and external calibration
Gain	dB	Measured UUT gain Calculated as [OutputPower(i) – InputPower(i)]
GainNormalized	dB	Gain normalized to gain of reference state Calculated as [Gain(i) – Gain(ref)]

GainError	dB	Difference between measured normalized gain and the set gain Calculated as [Gain(i) – Gain(ref)] – Sign * [ControlState(i) – ControlState(ref)], where Sign = +1 for gain steps and -1 for attenuator steps.
InputPowerRaw	dBm	Uncorrected UUT input receiver reading
OutputPowerRaw	dBm	Uncorrected UUT output receiver reading
InputPathCal	dB	Input signal path calibration
OutputPathCal	dB	Output signal path calibration

3.8.7.4 GainSweepPlot Array Dataset

Note: This dataset is similar to the GainSweep dataset, but does not include the RefControlState element; it is used for plotting all other array results.

Name	Units	Description
PlotCntrlState This is the independent variable and is the "X" value for plots and limit testing for this dataset, and is the "X" value for plots and limit testing.	dB	Attenuator or gain control states that were measured
PlotInputPower	dBm	Input power to UUT, absolute dBm, corrected for PTS internal and external calibration
PlotOutputPower	dBm	Output power to UUT, absolute dBm, corrected for PTS internal and external calibration
PlotGain	dB	Measured UUT gain Calculated as [OutputPower(i) – InputPower(i)].
PlotGainNormalized	dB	Gain normalized to gain of reference state Calculated as [Gain(i) – Gain(ref)]

PlotGainError	dB	Difference between measured normalized gain and the set gain Calculated as [Gain(i) – Gain(ref)] – Sign * [ControlState(i) – ControlState(ref)], where Sign = +1 for gain steps and -1 for attenuator steps

3.8.8 Calibrations Required

- Uplink Port Gain Calibration
- Downlink Port Gain Calibration
- Downconverter RF Gain Calibration
- Receiver Amp/Pad Gain Calibration
- External Hardware Calibrations
- Thermal Vacuum Amplitude Calibration

3.8.9 VEE Library Name

GainAdjustment.lib

3.9 GAIN TRANSFER

3.9.1 Test Purpose

The purpose of this test is to measure the gain transfer (power out vs. power in) curve of the repeater under test and to determine the input reference power required to saturate the repeater output. The input reference power is stored by the system to be used by other repeater measurements. This test can be performed on a repeater in either fixed gain or ALC mode.

This test will fulfill the following test requirements of a typical payload test plan:

- Gain Transfer, Fixed Gain Mode
- Gain Transfer, ALC Mode

3.9.2 Test Diagram

SINGLE SOURCE VSA MEASUREMENT

3.9.3 Test Description

The gain transfer curve will be measured over a specified input power range, referenced to a target saturation point. The switch matrix is configured for the appropriate uplink and downlink ports. A CW signal is applied to the repeater input at a specified starting level. The input and output power are measured with the VSA, using a resolution bandwidth narrow enough to minimize the error due to high repeater output noise. Repeater output power will be measured simultaneously with the input power, or following the input reading by a specified output settling delay. As the RF source level is increased, the input power, single carrier output power and optional spacecraft telemetry are recorded. This process continues until the specified final input power level is achieved or the measurement measures a specified decrease in output power, indicating a TWTA helix overload condition.

Once the gain transfer curve has been measured, the test will use one of the following saturation definitions to determine the Nominal Operating Point: (NOP):

- **Compression Point** – Nominal Operating Point (NOP) is defined as the point at which repeater gain is decreased by *GainCompression* dB, compared to the small-signal (linear) gain region.

- **Output Power Back Off** – The maximum output power *PoutMax* is determined from the gain transfer curve. Input power *Pin* is reduced until output power *Pout* = *PoutMax* + *OutputBackoff.* Nominal Operating Point

(NOP) is then defined as *Pin* + *InputBackoff.* This method is recommended only for traveling wave tube amplifiers that have gain transfer curves with a well-defined maximum power point.

- **X/Y** – Input power is increased until the AM/AM gain slope is less than or equal to *GainSlope* dB/dB, defining the saturation point. Next, input power is reduced until output power changes by *OutputBackoff* dB. Finally, input power is increased by *InputBackoff* dB, defining the Nominal Operating Point (NOP) level.

- **AM Null** – Input power is increased until the AM modulated on the carrier is null, defining the saturation point and for this case will also define the Nominal Operating Point (NOP) level.

Once the saturation search has been completed, the Nominal Operating Point (NOP) will be recorded for use by other repeater measurements. The test will then perform input power, output power, gain, and telemetry measurements at the input reference power and at user-specified inputs or output offset levels in the linear region of the gain transfer curve, defined by the input NOP power plus StdTelemetryPowerOffsets.

If configured to test an ALC repeater, the test will request that the ALC mode be turned on and the repeater ALC attenuator be set to a specified start value before beginning the gain transfer sweep. The power sweep will be performed with the PTS RF source attenuators held constant to prevent “glitching” the repeater’s ALC circuitry. At the end of the gain transfer measurement, the test will request that the repeater ALC attenuator be set to a specified stop value and that the repeater be returned to the fixed gain mode before turning the RF source off.

The test can be configured to skip the saturation search routine altogether. In this case, only the gain transfer sweep over the specified start to stop input power range will be performed.

VSA readings will be corrected for system internal and external path losses using calibration data measured prior to the test. See Section 4.1 for details on corrected uplink and downlink power calculations.

3.9.4 Program Schedule Message

Name	Type	Units	Description
PTEConfiguration	Parameter		See Section 5.1.2
UUTCFG	Parameter		See Section 5.1.3
Ports	Group		See Section 5.1.4
InputSpotFreq	Group		See Section 5.1.5
TranslationFreq	Group		See Section 5.1.7
InputSweptPower	Group		See Section 5.1.13
ControlState or ALCAttenLevelStart(*) (required if ALCMode)	Real	dB	ALC attenuation or gain state for the test to set the UUT to, prior to the gain transfer search and sweep
ControlStateSafe(opt) or ALCAttenLevelStop(*) (only for ALCMode)	Real	dB	If specified, the test system will request this control state at the end of the test, when the sweep is complete. This can be used to leave the UUT in a known safe state if the last setting required for the sweep leaves the UUT in a vulnerable condition.
AMModFrequency	Parameter		See Section 5.1.17

3.9.5 Local Parameter File

Name	Type	Units	Description
SimulateTest	Parameter		See Section 5.2.2
85121A Compatibility Mode	Parameter		See Section 5.2.14
InputSignal	Group		See Section 5.2.3

Receiver	Group		See Section 5.2.4
UUTDelay	Group		See Section 5.2.5
TimeBase	Group		See Section 5.2.6
PathCheck	Group		See Section 5.2.7
StdTelemetry	Group		See Section 5.2.8
SNROrResBW	Group		See Section 5.2.9
IntTelemetry	Group		See Section 5.2.13
Algorithm	String	NA	Describes the algorithm to be used. “CompPoint”, “OPBO”, “AM_Null” or “X/Y”
HelixOverload	Real	dB	If the test system detects that the UUT output power has dropped off by this amount from the peak output power, as input power is raised, the test will be halted and the test system will be left in a safe state (no RF power at the UUT input).
EnableNOPSearch(opt) 1 or 0 Defaults to 1 if not set	Integer	NA	If set to 1, the test will perform a search for NOP. The search will use the supplied value of InputReferencePower and related input power parameters to start the search. The search will start from the lowest part of the power sweep and will move upwards. The NOP search criteria should be met BEFORE the upper defined end of the defined power sweep

Name	Type	Units	Description
ALCMode “ON” or “OFF” 1 or 0	String or Integer	NA	When the ALCMode is enabled, the RF source output attenuator is locked to prevent power from momentarily dropping out as the uplink power level is adjusted.
EnableALCRequests 1 or 0 (Required if ALCMode)	Integer	NA	If 0, the UUT is already in the ALC mode at the start of the test and the ALC ON request does not need to be made. The ALC will be left ON at the end of the test. If 1, the UUT will be switched to ALC mode during the test, and will be switched out of ALC mode at the end of the test.
ControlStateRequest (Required if ALCMode)	String	NA	The Mnemonic to set ALC attenuation or gain control state. The request will be formed with ControlStateRequest+Value
GainCompression (Required for “CompPoint” algorithm only)	Real	dB	Nominal Operating Point (NOP) is defined as the point at which repeater gain is decreased by *GainCompression* dB, compared to the small-signal (linear) gain region.
LinearSlopeTol (Required for “CompPoint” algorithm only)	Real	NA	The first 10 points in the defined power sweep will input into a linear regression algorithm (X=Input Power dBm to Y=Output Power dBm). If the slope of this part of the UUT response curve is not in the range of 1 ± LinearSlopeTol, the test will generate an error message and abort.
OutputBackoff	Real	dB	After determining the defined saturation point, input power *Pin* is

Name	Type	Units	Description
(Required for “OPBO” and “X/Y” algorithms)			reduced until output power *Pout* = *PoutSat* + *OutputBackoff.*
InputBackoff (Required for “OPBO” and “X/Y” algorithms)	Real	dB	After applying the *OutputBackoff*, input power *Pin* is increased by *InputBackoff* dB, defining the Nominal Operating Point (NOP) level.
GainSlope (Required for “X/Y” algorithm only)	Real	dB/dB	For the X/Y algorithm, the saturation point is defined as the input power value where the slope of the gain transfer curve becomes less than *GainSlope (dB/dB).*
AMToneGen	Group		See Section 5.2.12

3.9.6 Command, Telemetry & Control Messages

Intermediate telemetry communications, as defined in the LPF string-array parameter IntTelemetry, are (optionally, depending on the PTEConfiguration flag YIT/NIT) sent and the responses recorded at each power level during the power sweep. The intermediate telemetry data is stored in the Intermediate Telemetry data package INTTLM inside the results Citifile. Each telemetry mnemonic becomes the name of a variable parameter within the INTTLM data package.

The dependent variable of the package is, in this measurement, InputPower. The values that the telemetry records at each power level will appear in the dependent data arrays of the package.

Standard telemetry as defined in the “stf” file is (optionally, depending on the PTEConfiguration flag YST/NST) carried out after the NOP has been found. Standard telemetry is measured and recorded for both the NOP and a defined point in the linear operating region of the UUT. Each defined standard telemetry mnemonic defined will appear as a result variable of that name in the STDTLM data package in the result Citifile. The values returned by the UUT for each mnemonic sent will be recorded as the values of those result variables in the STDTLM data package.

3.9.7 Results

The results file consists of the following datasets:

- PathCheckResults Dataset
- Scalar Dataset
- Scalar2 Dataset
- PowerSweep Array Dataset
- PowerSweep2 Array Dataset
- NOPSweep Array Dataset
- Output Power Offset Array Dataset

Note that these datasets are in addition to the standard datasets provided by all measurements.

3.9.7.1 PathCheckResults Dataset

Name	Units	Description
PathCheckResults	Various	See Section 5.3.1

3.9.7.2 Scalar Dataset

Name	Units	Description
NOPInputPower	dBm	Input power at Nominal Operating Point (NOP)
NOPOutputPower	dBm	Output power at Nominal Operating Point (NOP)
NOPGain	dB	Overall gain of the UUT at the Nominal Operating Point (NOP)
SmallSignalInputPower	dBm	Input power, in the condition of input power at NOP+InputPathCheckOffsetPower
SmallSignalOutputPower	dBm	Output power, in the condition of input power at NOP+InputPathCheckOffsetPower
SmallSignalGain	dB	Overall gain of the UUT, in the condition of input power at NOP+InputPathCheckOffsetPower
MeasResBW	Hz	Receiver resolution bandwidth used during the measurement

3.9.7.3 Scalar2 Dataset

Name	Units	Description
NOPInputPathCal NOPInputExtHwCal NOPULTVAmpOffset NOPInputPowerRaw	dB dB dB dBm	Input signal path cal, external hardware cal, thermal vacuum offset, and uncorrected receiver reading, in the condition of input power at NOP
NOPOutputPathCal NOPOutputExtHwCal NOPDLTVAmpOffset NOPOutputPowerRaw	dB dB dB dBm	Output signal path cal, external hardware cal, thermal vacuum offset, and uncorrected receiver reading, in the condition of input power at NOP
SmallSignalInputPathCal SmallSignalInputExtHwCal SmallSignalULTVAmpOffset SmallSignalInputPowerRaw	dB dB dB dBm	Input signal path cal, external hardware cal, thermal vacuum offset, and uncorrected receiver reading, in the condition of input power at NOP+InputPathCheckOffsetPower
SmallSignalOutputPathCal SmallSignalOutputExtHwCal SmallSignalDLTVAmpOffset SmallSignalOutputPowerRaw	dB dB dB dBm	Output signal path cal, external hardware cal, thermal vacuum offset, and uncorrected receiver reading, in the condition of input power at NOP+InputPathCheckOffsetPower

3.9.7.4 PowerSweep Array Dataset

Name	Units	Description
InputPowerRelNOP This is the independent variable for this dataset, and is the "X" value for plots and limit testing.	dB	Input power relative to NOP
InputPower	dBm	Input power, absolute dBm
OutputPower	dBm	Output power, absolute dBm
Gain	dB	Overall gain of the UUT

3.9.7.5 PowerSweep2 Array Dataset

Name	Units	Description
InputPowerRelNOP This is the independent variable for this dataset, and is the "X" value for plots and limit testing.	dB	Input power relative to NOP
InputPathCal InputExtHwCal InputTVAmpOffset InputPowerRaw	dB dB dB dBm	Input signal path cal, external hardware cal, thermal vacuum offset, and uncorrected receiver reading
OutputPathCal OutputExtHwCal OutputTVAmpOffset OutputPowerRaw	dB dB dB dBm	Output signal path cal, external hardware cal, thermal vacuum offset, and uncorrected receiver reading

3.9.7.6 NOPSweep Array Dataset

Name	Units	Description
NOPInputPower This is the independent variable for this dataset, and is the "X" value for plots and limit testing.	dBm	Corrected absolute input power for final NOP sweep
NOPInputPowerRaw	dBm	Uncorrected absolute input power for final NOP sweep
NOPOutputPower	dBm	Corrected absolute output power for final NOP sweep
NOPOutputPowerRaw	dBm	Uncorrected absolute output power for final NOP sweep
NOPGain	dB	Calculated gain of the UUT during the final NOP sweep

3.9.8 Calibrations Required

- Uplink Port Gain Calibration
- Downlink Port Gain Calibration
- Downconverter RF Gain Calibration
- Receiver Amp/Pad Gain Calibration
- External Hardware Calibrations
- Thermal Vacuum Amplitude Calibration

3.9.9 VEE Library Name

GainTransfer.lib

3.10 GAIN TRANSFER – W-CDMA

3.10.1 Test Purpose

The purpose of this test is to measure the gain transfer (power out vs. power in) curve of the repeater under test with a stimulus condition that utilizes multiple W-CDMA signals and to determine the input reference power required to saturate the repeater output. The input reference power is stored by the system to be used by other repeater measurements. This test can be performed on a repeater in either fixed gain or ALC mode.

This test will fulfill the following test requirements of a typical payload test plan:

- Gain Transfer, Fixed Gain Mode
- Gain Transfer, ALC Mode

3.10.2 Test Diagram

W-CDMA STIMULUS SA MEASUREMENT

3.10.3 Test Description

The gain transfer curve will be measured over a specified input power range, referenced to a target saturation point. The user will choose a waveform type consisting of predefined configurations of multiple W-CDMA signals to be applied to the uplink channel. If the beacon mode parameter is set, the second RF source is used to create the specified beacon signal. The switch matrix is set to verify the beacon signal level on VSA channel 1. Once the beacon signal is verified, the switch matrix is set to connect the beacon signal to the specified uplink port. At this point, an intermediate telemetry request is made to verify the beacon signal is present. Once verified, the switch matrix is set to apply the stimulus signal to the specified UUT input port.

The switch matrix is set to connect the PSA to the source uplink coupler and VSA CH2 to the specified UUT output port. The PSA is used to measure the stimulus signal and the signal is adjusted for the specified starting power level. The W-CDMA output signal is measured on VSA channel 2.

The signal is applied to the repeater input at a specified starting level. The input and output power are measured with the PSA and VSA respectively using band power markers so that the entire signal bandwidths are captured. Repeater output power is measured simultaneously with the input power, or following the input reading by a specified output settling delay. As the RF source level is increased, the input power, output power, and optional spacecraft telemetry are recorded. The beacon signal must be placed outside the input signal bandwidth or the power adjustment algorithm will fail. This is because beacon power is not adjusted during the measurement except when it was initially set up.

Once the gain transfer curve has been measured, the test will use one of the following saturation definitions to determine the Nominal Operating Point: (NOP):

- **Output Power Back Off** – The maximum output power *PoutMax* is determined from the gain transfer curve. Input power *Pin* is reduced until output power *Pout* = *PoutMax* + *OutputBackoff.* Nominal Operating Point (NOP) is then defined as *Pin* + *InputBackoff.* This method is recommended only for traveling wave tube amplifiers that have gain transfer curves with a well-defined maximum power point.

- **X/Y** – Input power is increased until the AM/AM gain slope is less than or equal to *GainSlope* dB/dB, defining the saturation point. Next, input power is reduced until output power changes by *OutputBackoff* dB. Finally, input power is increased by *InputBackoff* dB, defining the Nominal Operating Point (NOP) level.

Once the saturation search has been completed, the Nominal Operating Point (NOP) will be recorded for use by other repeater measurements. The test will then perform input power, output power, gain, and telemetry measurements at the input reference power and at user-specified offset input and output levels in the linear region of the gain transfer curve, defined by the input NOP power plus StdTelemetryPowerOffsets.

If configured to test an ALC repeater, the test will request that the ALC mode be turned on and the repeater ALC attenuator be set to a specified start value before beginning the gain transfer sweep. The power sweep will be performed with the PTS RF source attenuators held constant to prevent “glitching” the repeater’s ALC circuitry. At the end of the gain transfer measurement, the test will request that the repeater ALC attenuator be set to a specified stop value and that the repeater be returned to the fixed gain mode before turning the RF source off.

The test can be configured to skip the saturation search routine altogether. In this case, only the gain transfer sweep over the specified start to stop input power range will be performed.

SA readings will be corrected for system internal and external path losses using calibration data measured prior to the test. See Section 4.1 for details on corrected uplink and downlink power calculations.

3.10.4 Program Schedule Message

Name	Type	Units	Description
PTEConfiguration	Parameter		See Section 5.1.2
UUTCFG	Parameter		See Section 5.1.3
Ports	Group		See Section 5.1.4
InputSpotFreq	Group		See Section 5.1.5
TranslationFreq	Group		See Section 5.1.7
InputSweptPower	Group		See Section 5.1.13
ControlState or ALCAttenLevelStart(*) (required if ALCMode)	Real	dB	ALC attenuation or gain state for the test to set the UUT to, prior to the gain transfer search and sweep
ControlStateSafe(opt) or ALCAttenLevelStop(*) (only for ALCMode)	Real	dB	If specified, the test system will request this control state at the end of the test, when the sweep is complete. This can be used to leave the UUT in a known safe state if the last setting required for the sweep leaves the UUT in a vulnerable condition.
ChannelBW	Parameter		Bandwidth of the output W-CDMA signal
BeaconMode	Group		See Section 5.1.21
WaveformModel	Group		See Section 5.1.22

3.10.5 Local Parameter File

Name	Type	Units	Description
SimulateTest	Parameter		See Section 5.2.2
85121A Compatibility Mode	Parameter		See Section 5.2.14
InputSignal	Group		See Section 5.2.3
Receiver	Group		See Section 5.2.4
UUTDelay	Group		See Section 5.2.5
TimeBase	Group		See Section 5.2.6
PathCheck	Group		See Section 5.2.7
StdTelemetry	Group		See Section 5.2.8
SNROrResBW	Group		See Section 5.2.9
IntTelemetry	Group		See Section 5.2.13
Algorithm	String	NA	Describes the algorithm to be used. "OPBO", or "X/Y"
HelixOverload	Real	dB	If the test system detects that the UUT output power has dropped off by this amount from the peak output power, as input power is raised, the test will be halted and the test system will be left in a safe state (no RF power at the UUT input).
EnableNOPSearch(opt) 1 or 0 Defaults to 1 if not set	Integer	NA	If set to 1, the test will perform a search for NOP. The search will use the supplied value of InputReferencePower and related input power parameters to start the search. The search will start from the lowest

Name	Type	Units	Description
			part of the power sweep and will move upwards. The NOP search criteria should be met before the upper defined end of the defined power sweep.
ALCMode “ON” or “OFF” 1 or 0	String or Integer	NA	When the ALCMode is enabled, the RF source output attenuator is locked to prevent power from momentarily dropping out as the uplink power level is adjusted.
EnableALCRequests 1 or 0 (Required if ALCMode)	Integer	NA	If 0, the UUT is already in the ALC mode at the start of the test and the ALC ON request does not need to be made. The ALC will be left ON at the end of the test. If 1, the UUT will be switched to ALC mode during the test, and will be switched out of ALC mode at the end of the test.
ControlStateRequest (Required if ALCMode)	String	NA	Mnemonic to set ALC attenuation or gain control state. The request will be formed with ControlStateRequest+Value
OutputBackoff (Required for “OPBO” and “X/Y” algorithms)	Real	dB	After determining the defined saturation point, input power *Pin* is reduced until output power *Pout = PoutSat + OutputBackoff*
InputBackoff (Required for “OPBO” and “X/Y” algorithms)	Real	dB	After applying the *OutputBackoff*, input power *Pin* is increased by *InputBackoff* dB, defining the Nominal Operating Point (NOP) level.
GainSlope (Required for “X/Y” algorithm only)	Real	dB/dB	For the X/Y algorithm, the saturation point is defined as the input power value where the slope of the gain transfer curve becomes less than *GainSlope (dB/dB).*
Name	Type	Units	Description

BeaconTelemetry	String	N/A	Mnemonic to send for beacon telemetry request
BeaconTelemetry	Real	N/A	Lower and upper limit for beacon telemetry value

3.10.6 Command, Telemetry & Control Messages

Intermediate telemetry communications, as defined in the LPF string-array parameter IntTelemetry, are (optionally, depending on the PTEConfiguration flag YIT/NIT) sent and the responses recorded at each power level during the power sweep. The intermediate telemetry data is stored in the Intermediate Telemetry data package INTTLM inside the results Citifile. Each telemetry mnemonic becomes the name of a variable parameter within the INTTLM data package.

The dependent variable of the package is, in this measurement, InputPower. The values that the telemetry records at each power level will appear in the dependent data arrays of the package.

Standard telemetry as defined in the "stf" file is (optionally, depending on the PTEConfiguration flag YST/NST) carried out after the NOP has been found. Standard telemetry is measured and recorded for both the NOP and a defined point in the linear operating region of the UUT. Each defined standard telemetry mnemonic defined will appear as a result variable of that name in the STDTLM data package in the result Citifile. The values returned by the UUT for each mnemonic sent will be recorded as the values of those result variables in the STDTLM data package.

3.10.7 Results

The results file consists of the following datasets:

- PathCheckResults Dataset
- Scalar Dataset
- Scalar2 Dataset
- PowerSweep Array Dataset
- PowerSweep2 Array Dataset

- NOPSweep Array Dataset
- Output Power Offset Array Dataset

Note that these datasets are in addition to the standard datasets provided by all measurements.

3.10.7.1 PathCheckResults Dataset

Name	Units	Description
PathCheckResults	Various	See Section 5.3.1

3.10.7.2 Scalar Dataset

Name	Units	Description
NOPInputPower	dBm	Input power at Nominal Operating Point (NOP)
NOPOutputPower	dBm	Output power at NOP
NOPGain	dB	Overall gain of the UUT at the NOP
SmallSignalInputPower	dBm	Input power, in the condition of input power at NOP+InputPathCheckOffsetPower
SmallSignalOutputPower	dBm	Output power, in the condition of input power at NOP+InputPathCheckOffsetPower
SmallSignalGain	dB	Overall gain of the UUT, in the condition of input power at NOP+InputPathCheckOffsetPower
MeasResBW	Hz	Receiver resolution bandwidth that was used during the measurement

3.10.7.3 Scalar2 Dataset

3.10.7.4 PowerSweep Array Dataset

Name	Units	Description
NOPInputPathCal NOPInputExtHwCal NOPULTVAmpOffest NOPInputPowerRaw	dB dB dB dBm	Input signal path cal, external hardware cal, thermal vacuum offset, and uncorrected receiver reading, in the condition of input power at NOP
NOPOutputPathCal NOPOutputExtHwCal NOPDLTVAmpOffset NOPOutputPowerRaw	dB dB dB dBm	Output signal path cal, external hardware cal, thermal vacuum offset, and uncorrected receiver reading, in the condition of input power at NOP
SmallSignalInputPathCal SmallSignalInputExtHwCal SmallSignalULTVAmpOffset SmallSignalInputPowerRaw	dB dB dB dBm	Input signal path cal, external hardware cal, thermal vacuum offset, and uncorrected receiver reading, in the condition of input power at NOP+InputPathCheckOffsetPower
SmallSignalOutputPathCal SmallSignalOutputExtHwCal SmallSignalDLTVAmpOffset SmallSignalOutputPowerRaw	dB dB dB dBm	Output signal path cal, external hardware cal, thermal vacuum offset, and uncorrected receiver reading, in the condition of input power at NOP+InputPathCheckOffsetPower

Name	Units	Description
InputPowerRelNOP This is the independent variable for this dataset, and is the "X" value for plots and limit testing.	dB	Input power relative to NOP
InputPower	dBm	Input power, absolute dBm
OutputPower	dBm	Output power, absolute dBm
Gain	dB	Overall gain of the UUT

3.10.7.5 PowerSweep2 Array Dataset

Name	Units	Description
InputPowerRelNOP This is the independent variable for this dataset, and is the "X" value for plots and limit testing.	dB	Input power relative to NOP
InputPathCal InputExtHwCal InputTVAmpOffset InputPowerRaw	dB dB dB dBm	Input signal path cal, external hardware cal, thermal vacuum offset, and uncorrected receiver reading
OutputPathCal OutputExtHwCal OutputTVAmpOffset OutputPowerRaw	dB dB dB dBm	Output signal path cal, external hardware cal, thermal vacuum offset, and uncorrected receiver reading

3.10.7.6 NOPSweep Array Dataset

Name	Units	Description
NOPInputPower This is the independent variable for this dataset, and is the "X" value for plots and limit testing.	dBm	Corrected absolute input power for final NOP sweep
NOPInputPowerRaw	dBm	Uncorrected absolute input power for final NOP sweep
NOPOutputPower	dBm	Corrected absolute output power for final NOP sweep
NOPOutputPowerRaw	dBm	Uncorrected absolute output power for final NOP sweep
NOPGain	dB	Calculated gain of the UUT during the final NOP sweep

3.10.8 Calibrations Required

- Uplink Port Gain Calibration
- Downlink Port Gain Calibration
- Downconverter RF Gain Calibration
- Receiver Amp/Pad Gain Calibration
- External Hardware Calibrations
- Thermal Vacuum Amplitude Calibration

3.10.9 VEE Library Name

GainTransfer.lib

3.10.10 Pseudo Measurement Code

1. Initialize test parameters. Read and process values from the .lpf,.psm. Store a copy of the test parameters in the data file.

2. Initialize instruments to a preset condition. Instruments initialized are:

ULMatrix

DLMatrix

RFSource1

RFSource2

ULPowerMeter

DLPowerMeter

LOSource1

LOSource2

VSA

IFReceiver

SpectrumAnalyzer

Awg1

Perform chore functions (for example. Cal, zero, etc.) related to each instrument if timer indicates a need.

3. If BeaconMode=0 ;

a. perform the standard path check

b. If EnableNOPSearch=0 also perform the standard telemetry request.

c. Store path check and telemetry results in the data file.

d. Determine maximum expected port power from input parameters. Set UL path (amp and pad state) and receiver path (amp, pad or thru state) based on this power.

4. If BeaconMode=1 set up the beacon.

a. Turn RFSource1 off.

b. Connect matrix path to use source1&2 combiner.

c. Connect matrix path for uplink and downlink ports.

d. Set up VSA for uplink power measurements.

e. Determine maximum expected port power from input parameters. Set UL path (amp and pad state) and receiver path (amp, pad or thru state) based on this power.

f. Turn on RFSource2 and adjust power until desired beacon power is achieved. Use the VSA CW marker and calibration data for the power readings.

g. Request beacon verification telemetry from the host computer.

h. Check telemetry data against limits. If fail, log message and abort test.

5. Set up the AWG for the W-CDMA waveform.

    a. If RF frequency > 3.2 GHz, set AWG output to single ended, amplifier in.

    b. If RF frequency <= 3.2 GHz, set AWG output to differential, amplifier out.

    c. Download specified waveform files to AWG Channel 1 and Channel 2.

    d. Command AWG to play out waveforms. Set AWG output (ch1 and ch2) to ON.

6. Set up the RFSource1 for I/Q mode.

    a. If RF frequency >3.2 GHz, set source to use wideband I/Q inputs.

    b. If RF frequency <= 3.2 GHz, set source to use narrowband I/Q inputs.

    c. Turn modulation on, set RF output to ON.

7. Set up the PSA for uplink power measurements.

    a. Connect matrix path to use PSA for power monitoring.

    b. Set up PSA frequency and span (span=sigbw*1.4)

    c. Set up PSA averaging and band power markers (marker spacing=sigbw*1.2)

8. Set up the VSA for downlink power measurements.

    a. Connect matrix path to use VSA Ch2 for downlink signal measurement.

    b. Set up VSA and downconverter/LO's frequencies for downlink signal at:

DL Frequency= OutputFrequency + DLFreqErr + ChannelOffsetFrequency

DLFreqErr is measured during the standard path check.

c. Set VSA band power markers to VSA center freq +- ChannelBw/2.

9. Perform command pause for ALCRequest ON.

10. Measure GainTransfer Pout vs. Pin curve.

a. Loop for each power level:

b. Set source frequency to InputFrequency-WaveformOffsetFrequency

c. Set uplink power level

-read and correct power level from PSA band power marker measurement centered at InputFrequency

-calculate delta power from desired

-adjust source power level by delta

-repeat steps until delta power is less than input power tolerance

d. If first time through the loop: autorange the VSA input level. Also switch in appropriate receiver amp and pad.

e. Read output power level

-if NextPointDelay>0 wait delay seconds

-if VSA has overload, auto range VSA level

-read VSA band power marker result

-correct VSA reading with downlink cal data

f. Update GainTransfer live graph

g. If set, request Intermediate Telemetry values from host computer.

h. Check for helix overload

-if algorithm type is OPBO

-compare current Pout to previous Pmax, if greater save as Pmax, continue measurement

-compare current Pout to Pmax+HelixOverload, if less than, then power has caused helix overload.

Log message and abort test.

i. Increment to next desired power level and repeat steps.

11. Find the normal operating point.

a. If EnableNOPSearch=0 exit this step.

b. If algorithm type= OPBO

-using Pout max from Pout vs. Pin curve calculate output power backoff as Pout max + output backoff

-find the Pin that produces this output power

-set the input power

-measure the output power

-step the input power in finer steps until step size=input power tolerance

- use Pin that produces the closest Pout backoff

-set Pin to the Pin(at output backoff) + input backoff.

-measure and record Pin, Pout, cal data used, this is the NOP point

c. If algorithm type=X/Y

-calculate gain slope from Pout vs. Pin curve

-find point where calculated gain slope < GainSlope(parameter value)

-use this calculation to bracket pin/pout measurements

-set input power, measure output power until step size= input power tolerance, this is pin,pout sat

-calculate output power backoff as Pout sat+ output backoff

-set input power, measure output power to find input power that produces Pout sat + output backoff

-using this Pin, calculate Pin+input backoff

-set Pin to Pin+input backoff

-measure and record Pin, Pout, cal data used, this is the NOP point

d. If algorithm type = anything else, log error message, abort test.

12. If set, request NOP telemetry values from host computer. Note: power is still set at the NOP point.

13.. Measure small signal parameters.

    -set input power to NOP input power + StdTelemetryPowerOffset

    -measure and record pin, pout, cal data used

14. Perform command pause for ALCRequest OFF.

15. Limit check measured values as required.

16. Store results in data file.

3.11 GAIN VS. FREQUENCY

3.11.1 Test Purpose

The purpose of this test is to measure the frequency response (gain vs. frequency) of the repeater. The test also calculates gain slope and gain ripple in the channel pass-band.

This test will fulfill the following test requirements of a typical payload test plan:

- In-Band Frequency Response/Gain Slope
- Out-of-Band Rejection

3.11.2 Test Diagram

SINGLE SOURCE VSA MEASUREMENT

3.11.3 Test Description

This test will measure the repeater gain within a specified frequency range. The switch matrix is configured for the appropriate uplink and downlink ports. A CW carrier is applied to the repeater input at a specified channel start frequency and power level. The input power level is set to either a user specified power level or the value stored for the input reference power previously determined by the gain transfer test. The two-channel vector signal analyzer measures the input and the output power levels of the carrier, as the carrier is stepped across the frequency range. Gain, gain slope, and gain ripple are calculated and displayed vs. input frequency.

VSA readings will be corrected for system internal and external path losses using calibration data measured prior to the test. See Section 4.1 for details on corrected uplink and downlink power calculations.

3.11.4 Program Schedule Message

Name	Type	Units	Description
PTEConfiguration	Parameter		See Section 5.1.2
UUTCFG	Parameter		See Section 5.1.3
Ports	Group		See Section 5.1.4
InputSweptFreq	Group		See Section 5.1.8
TranslationFreq	Group		See Section 5.1.7
InputSweptPower	Group		See Section 5.1.13
ChannelBW	Parameter		See Section 5.1.14
RippleWindow	Parameter		See Section 5.1.15

3.11.5 Local Parameter File

Name	Type	Units	Description
SimulateTest	Parameter		See Section 5.2.2
85121A Compatibility Mode	Parameter		See Section 5.2.14

Name	Type	Units	Description
InputSignal	Group		See Section 5.2.3
Receiver	Group		See Section 5.2.4
UUTDelay	Group		See Section 5.2.5
TimeBase	Group		See Section 5.2.6
PathCheck	Group		See Section 5.2.7
StdTelemetry	Group		See Section 5.2.8
SNROrResBW	Group		See Section 5.2.9
ServoInputPowerOnlyAtCenter (opt) Defaults to 0 if not specified	Integer	N/A	If set to 1, the input power will be set within InputPowerTolerance only at the InputCenterFrequency. The RF source power will not be adjusted for other frequencies, in order to speed up the measurement. If set to 0, the input power will be set within InputPowerTolerance at all frequencies. This is recommended if the UUT is being tested at saturated power levels.
SmoothingPoints	Integer	N/A	For the GainSlope calculation, the derivative of the gain measurement is averaged over the number of adjacent points specified by SmoothingPoints. Increasing this parameter tends to smooth out the GainSlope results.

3.11.6 Command, Telemetry & Control Messages

Standard telemetry as defined in the "stf" file is (optionally, depending on the PTEConfiguration flag YST/NST) carried out at the same time and signal conditions as the path check. Each defined standard telemetry mnemonic defined will appear as a result variable of that name in the STDTLM data package in the result Citifile. The values returned by the UUT for each mnemonic sent will be recorded as the values of those result variables in the STDTLM data package.

There is no intermediate telemetry for this test.

3.11.7 Results

The results file consists of the following datasets:

- PathCheckResults Dataset
- Scalar Dataset
- FrequencySweep Array Dataset
- SecondaryFrequencySweep Array Dataset

Note that these datasets are in addition to the standard datasets provided by all measurements.

3.11.7.1 PathCheckResults Dataset

Name	Units	Description
PathCheckResults	Various	See Section 5.3.1

3.11.7.2 Scalar Dataset

Name	Units	Description
MaxGain	dB	The peak gain measured
CenterGain	dB	The gain measured at InputCenterFrequency

MaxGainRipple	dB	Maximum peak-to-peak ripple of measured gain in any window of width RippleWindowBW as the sliding window is moved within ChannelBW around the InputCenterFrequency
MeasResBW	Hz	Receiver resolution bandwidth that was used during the measurement

3.11.7.3 FrequencySweep Array Dataset

Name	Units	Description
FrequencyRelCenter This is the independent variable for this dataset, and is the “X” value for plots and limit testing.	Hz	Input frequency relative to InputCenterFrequency
Frequency	Hz	Input frequency (absolute)
InputPower	dBm	Input power to the UUT
OutputPower	dBm	Output power from the UUT
Gain	dB	UUT gain
GainRelMax	dB	Gain relative to the maximum gain MaxGain
GainRelCenter	dB	Gain relative to the gain at InputCenterFrequency
GainSlope	dB/Hz	Slope of the gain at each frequency point within the ChannelBW. Calculated from the derivative of a 2nd order polynomial fitted to the point and the two closest frequency points.
GainRipple	dB	Peak-to-peak ripple of measured gain in the window of width RippleWindowBW as the sliding window is moved within ChannelBW around the InputCenterFrequency
GainSymmetry	dB	Symmetry of the measured gain, calculated by taking the midpoint of the frequency sweep (not the defined center frequency) and calculating the absolute value of the delta between the left and right halves

3.11.7.4 SecondaryFrequencySweep Array Dataset

Name	Units	Description
FrequencyRelCenter This is the independent variable for this dataset, and is the "X" value for plots and limit testing.	Hz	Input frequency relative to InputCenterFrequency
Frequency	Hz	Input frequency (absolute)
InputPathCal InputExtHwCal InputTVAmpOffset InputPowerRaw	dB dB dB dBm	Input signal path cal, external hardware cal, thermal vacuum offset, and uncorrected receiver reading
OutputPathCal OutputExtHwCal OutputTVAmpOffset OutputPowerRaw	dB dB dB dBm	Output signal path cal, external hardware cal, thermal vacuum offset, and uncorrected receiver reading

3.11.8 Calibrations Required

- Uplink Port Gain Calibration
- Downlink Port Gain Calibration
- Downconverter RF Gain Calibration
- Receiver Amp/Pad Gain Calibration
- External Hardware Calibrations
- Thermal Vacuum Amplitude Calibration

3.11.9 VEE Library Name

GainVsFreq.lib

3.12 INPUT POWER SET

3.12.1 Test Purpose

The purpose of this test is to allow for adjustment of the uplink power level under control of the test conductor computer. This test may be a single action or run in a loop. This test can be used to perform threshold testing of the command receiver.

This test will fulfill the following test requirements of a typical payload test plan:

- Command Receiver Threshold
- Ranging Threshold
- W-CDMA Loading

3.12.2 Test Diagram

SINGLE SOURCE UPLINK MEASUREMENT

3.12.3 Test Description

The test begins by generating either a CW, frequency-modulated carrier, or a predefined W-CDMA waveform at a specified frequency using RF Source 1. The switch matrix is set to connect the VSA CH1 or the PSA (IF W-CDMA signal being applied) to the source uplink coupler. The FM is created by a user-supplied tone applied to the RF source modulation input or is internally generated by the source. The deviation of the uplink FM signal is measured with CH1 of the VSA.

If the deviation is not within specified limits, the user is requested to adjust the amplitude of the user-supplied tone. The RF source output power is adjusted to the specified UUT input power.

If the stimulus is a W-CDMA signal and the beacon mode parameter is set, the system will use Source 2 to provide the specified beacon signal. The switch matrix is set to verify the uplink beacon signal frequency and amplitude on VSA CH1. Once the beacon signal is verified, the switch matrix is set to connect the beacon signal to the specified uplink port. At this point, an intermediate telemetry request will be made to verify the beacon signal is present. Once verified, the switch matrix is then set to apply the W-CDMA stimulus and the beacon signal to the specified UUT input port.

The stimulus signal is routed to the UUT uplink input. Once the uplink power has settled, a configurable telemetry request command is sent to the test conductor computer. The received telemetry data and measured uplink power level are recorded.

For non W-CDMA signals, the specified UUT downlink port is routed to the spectrum analyzer input. This allows the operator to manually observe downlink signals while the uplink signal is present.

To set the uplink power to a new level, the test conductor computer sends a new input power value to the PTS. Telemetry data and uplink power are recorded at each level.

The test completes by removing the uplink RF power after receiving an “end” command from the test conductor.

VSA readings will be corrected for system internal and external path losses using calibration data measured prior to the test. See Section 4.1 for details on corrected uplink and downlink power calculations.

3.12.4 Program Schedule Message

Name	Type	Units	Description
PTEConfiguration	Parameter		See Section 5.1.2
UUTCFG	Parameter		See Section 5.1.3
Ports	Group		See Section 5.1.4
InputSpotFreq	Group		See Section 5.1.5
InputSpotPower	Group		See Section 5.1.12
InputFMTone	Group		See Section 5.1.16 Note: If FMModFrequency is set to zero, the test will use a CW uplink signal.
WaveformModel	Group		See Section 5.1.22
BeaconMode	Group		See Section 5.1.21

3.12.5 Local Parameter File

Name	Type	Units	Description
SimulateTest	Parameter		See Section 5.2.2
85121A Compatibility Mode	Parameter		See Section 5.2.14
InputSignal	Group		See Section 5.2.3
Receiver	Group		See Section 5.2.4
FMToneGen	Group		See Section 5.2.11
IntTelemetry	Group		See Section 5.2.13
SNROrResBW	Group		See Section 5.2.9 Note: MaxResBW applies to this test, but not MinSNR.
BeaconTelemetry	String	N/A	Mnemonic to send for beacon telemetry request
BeaconTelemetryLimit	Real	N/A	Lower and upper limit for beacon telemetry value

3.12.6 Command, Telemetry & Control Messages

Intermediate telemetry communications, as defined in the LPF string-array parameter IntTelemetry, are (optionally, depending on the PTEConfiguration flag YIT/NIT) sent and the responses recorded at each power level during the power sweep. The intermediate telemetry data is stored in the Intermediate Telemetry data package INTTLM inside the results Citifile. Each telemetry mnemonic becomes the name of a variable parameter within the INTTLM data package.

The dependent variable of the package is, in this measurement, InputPower. The values that the telemetry records at each power level will appear in the dependent data arrays of the package.

Standard telemetry as defined in the “stf” file is (optionally, depending on the PTEConfiguration flag YST/NST) carried out at the input reference level. Each defined standard telemetry mnemonic will appear as a result variable of that name in the STDTLM data package in the result Citifile. The values returned by the UUT for each mnemonic sent will be recorded as the values of those result variables in the STDTLM data package.

3.12.7 Results

The results file consists of the following datasets:

- Scalar Dataset
- PowerSweep Array Dataset

Note that these datasets are in addition to the standard datasets provided by all measurements.

3.12.7.1 Scalar Dataset

Name	Units	Description
MeasuredFMDeviation	Hz	Measured command FM deviation
MeasResBW	Hz	Receiver resolution bandwidth used during the measurement

3.12.7.2 PowerSweep Array Dataset

Name	Units	Description
InputPowerRelRef This is the independent variable for this dataset, and is the "X" value for plots and limit testing.	dB	Input power relative to InputReferencePower
InputPower	dBm	Input power to UUT, absolute dBm, corrected for PTS internal and external calibration
InputPathCal InputExtHwCal InputTVAmpOffset InputPowerRaw	dB dB dB dBm	Input signal path cal, external hardware cal, thermal vacuum offset, and uncorrected receiver reading

3.12.8 Calibrations Required

- Uplink Port Gain Calibration
- Downconverter RF Gain Calibration
- Receiver Amp/Pad Gain Calibration
- External Hardware Calibrations
- Thermal Vacuum Amplitude Calibration

3.12.9 VEE Library Name

InputPowerSet.lib

3.13 MODULATION INDEX

3.13.1 Test Purpose

The purpose of this test is to measure the PM modulation index or AM depth of a downlink beacon signal.

This test will fulfill the following test requirements of a typical payload test plan:

- Beacon Modulation Index
- Beacon Power and Frequency

3.13.2 Test Diagram

SINGLE SOURCE VSA MEASUREMENT

3.13.3 Test Description

The test can be selected to operate with an uplink frequency-modulated carrier present (Drive) or absent (No-Drive). For the Drive version, the FM is created by a user-supplied tone applied to the RF source modulation input or is internally generated by the source. The deviation of the uplink FM signal is measured with VSA CH1. If the deviation is not within specified limits, the user is requested to adjust the amplitude of the user-supplied tone.

The test uses the VSA CH2 input to measure the total beacon downlink power and carrier frequency. VSA CH2 is then set to demodulate the beacon downlink signal. The test can be configured to measure AM or PM modulation. The VSA band power marker function is used to measure the total modulation and the modulation of individual specified sub-bands. A configurable intermediate telemetry request can be made by the test at this point.

VSA readings will be corrected for system internal and external path losses using calibration data measured prior to the test. See Section 4.1 for details on corrected uplink and downlink power calculations.

3.13.4 Program Schedule Message

Name	Type	Units	Description
PTEConfiguration	Parameter		See Section 5.1.2
UUTCFG	Parameter		See Section 5.1.3
Ports	Group		See Section 5.1.4
InputSpotFreq	Group		See Section 5.1.5
TranslationFreq	Group		See Section 5.1.7
InputSpotPower	Group		See Section 5.1.12
InputFMTone	Group		See Section 5.1.16
OutputFrequencyRange	Group		See Section 5.1.18 Note: OutputFrequencyRange is used in this test to specify the modulation sideband frequencies to be measured.

3.13.5 Local Parameter File

Name	Type	Units	Description
SimulateTest	Parameter		See Section 5.2.2
85121A Compatibility Mode	Parameter		See Section 5.2.14
InputSignal	Group		See Section 5.2.3
Receiver	Group		See Section 5.2.4
UUTDelay	Group		See Section 5.2.5
TimeBase	Group		See Section 5.2.6
PathCheck	Group		See Section 5.2.7
StdTelemetry	Group		See Section 5.2.8
SNROrResBW	Group		See Section 5.2.9
FMToneGen	Group		See Section 5.2.11
IntTelemetry	Group		See Section 5.2.13
DemodType AM or PM	String	NA	Configures the VSA to demodulate AM or PM on the downlink beacon output.

3.13.6 Command, Telemetry & Control Messages

Standard telemetry as defined in the “stf” file is (optionally, depending on the PTEConfiguration flag YST/NST) carried out at the same time and signal conditions as the path check. Each defined standard telemetry mnemonic defined will appear as a result variable of that name in the STDTLM data package in the result Citifile. The values returned by the UUT for each mnemonic sent will be recorded as the values of those result variables in the STDTLM data package.

Note that Standard Telemetry is not performed for the “NoDrive” version of the test.

Intermediate telemetry communications, as defined in the LPF string-array parameter IntTelemetry, are (optionally, depending on the PTEConfiguration flag YIT/NIT) sent and the responses recorded upon completion of the VSA measurement and before the uplink signal is removed. The intermediate telemetry data is stored in the Intermediate Telemetry scalar data package INTTLM inside the results Citifile. Each telemetry mnemonic becomes the name of a variable parameter within the INTTLM data package.

3.13.7 Results

The results file consists of the following datasets:

- PathCheckResults Dataset
- Scalar Dataset
- Subcarrier Array Dataset
- SecondaryFrequencySweep Dataset
- BeaconSpectrum Array Dataset
- BeaconDemod Array Dataset

Note that these datasets are in addition to the standard datasets provided by all measurements.

3.13.7.1 PathCheckResults Dataset

Name	Units	Description
PathCheckResults	Various	See Section 5.3.1

3.13.7.2 Scalar Dataset

Name	Units	Description
ULPowerCorr	dBm	Corrected uplink power
ULPowerUncorr	dBm	Uncorrected uplink power reading

Name	Units	Description
ULPathCal	dB	Uplink path insertion gain, between VSA CH1 and PTS uplink calibration plane
ULExtHWCal	dB	Uplink external hardware insertion gain, between the PTS uplink calibration plane and the UUT input
ULTVAmplitudeOffset	dB	Thermal vacuum amplitude offset of the uplink
DLPowerCorr	dBm	Corrected downlink power
DLPowerUncorr	dBm	Uncorrected downlink power reading
DLPathCal	dB	Downlink path insertion gain, between VSA CH2 and PTS downlink calibration plane
DLExtHWCal	dB	Downlink external hardware insertion gain, between the PTS downlink calibration plane and the UUT input
DLTVAmplitudeOffset	dB	Thermal vacuum amplitude offset of the downlink
ULFMDeviation	Hz	Measured uplink FM deviation
ULFMDeviationError	%	Percent error in the measured uplink FM deviation compared to the specified value
DLModIndexTotal	RadRMS Or %RMS	Measured Total Modulation Index of the downlink signal. If DemodType = "PM", units are Radians root-mean-square. If DemodType = "AM", units are Percent root-mean-square.
DLMeasCF	Hz	Measured downlink carrier center frequency
MeasResBW	Hz	Receiver resolution bandwidth used during the measurement

3.13.7.3 Subcarrier Array Dataset

Name	Units	Description
SubcarrierFrequency	Hz	Individual measured offset frequencies from the carrier for each subcarrier
SubcarrierModIndex	RadRMS Or %RMS	The individual measured modulation index for each subcarrier. If DemodType = “PM”, units are Radians root-mean-square. If DemodType = “AM”, units are Percent root-mean-square.
SubcarrierNumber	NA	Integer representing the beacon subcarrier number, with 1 being the subcarrier closest to the main carrier

3.13.7.4 BeaconSpectrum Array Dataset

Name	Units	Description
DLFrequency	Hz	Downlink frequency for the beacon spectrum measurement trace, relative to the measured downlink carrier frequency DLMeasCF
BeaconPower	dBm	Beacon spectrum power trace as measured by VSA CH2

3.13.7.5 BeaconDemod Array Dataset

Name	Units	Description
DemodFrequency	Hz	Frequency for the demodulated beacon measurement trace, relative to downlink carrier frequency
BeaconDemod	dBRadR MS Or dBRMS	Beacon demod power trace as measured by VSA CH2. If DemodType = “PM”, units are dBRadRMS. If DemodType = “AM”, units are dBRMS.

3.13.8 Calibrations Required

- Uplink Port Gain Calibration
- Downlink Port Gain Calibration
- Downconverter RF Gain Calibration
- Receiver Amp/Pad Gain Calibration
- External Hardware Calibrations
- Thermal Vacuum Amplitude Calibration

3.13.9 VEE Library Name

ModIndex.lib

3.14 NOISE FIGURE

3.14.1 Test Purpose

The purpose of this test is to measure the noise figure of a repeater channel.

This test will fulfill the following test requirements of a typical payload test plan:

- Noise Figure

3.14.2 Test Diagram

SINGLE SOURCE SA MEASUREMENT

3.14.3 Test Description

This test uses a noise source as the stimulus and calculates repeater noise figure using the y-factor technique. Note that this method is suitable only for repeater paths that have noise figure values less than the noise source Excess Noise Ratio (ENR). In addition, the gain-bandwidth product of the repeater must be low enough to prevent output compression when the noise source is turned on.

The test begins by performing a signal path check through the UUT (if specified by the Program Schedule Message). The path check is made through the coupled input and output ports of the repeater. Path check results are not used in the noise figure calculation. VSA path check readings will be corrected for system internal and external path losses using calibration data measured prior to the test. See Section 4.1 for details on corrected uplink and downlink power calculations.

The test then configures the switch matrix to route the downlink output of the repeater to the spectrum analyzer input. The operator is prompted to connect the noise source to the LNA input of the repeater. The spectrum analyzer is tuned to the specified downlink frequency. The switch matrix CH2 attenuator is adjusted to prevent input overload or the switch matrix CH2 amplifier is inserted if the UUT output noise is too low compared to the receiver noise figure.

The spectrum analyzer is used to measure the downlink noise density with the noise source turned off and then on. The ratio of the two measurements is the y- factor, which is used to calculate the system noise figure. Because it is assumed that the receiver noise figure is low enough to be neglected, no second-stage noise correction is performed.

3.14.4 Program Schedule Message

Name	Type	Units	Description
PTEConfiguration	Parameter		See Section 5.1.2
UUTCFG	Parameter		See Section 5.1.3
Ports	Group		See Section 5.1.4
InputSpotFreq	Group		See Section 5.1.5
TranslationFreq	Group		See Section 5.1.7
InputSpotPower	Group		See Section 5.1.12

3.14.5 Local Parameter File

Name	Type	Units	Description
SimulateTest	Parameter		See Section 5.2.2
85121A Compatibility Mode	Parameter		See Section 5.2.14
InputSignal	Group		See Section 5.2.3
Receiver	Group		See Section 5.2.4
UUTDelay	Group		See Section 5.2.5
TimeBase	Group		See Section 5.2.6
PathCheck	Group		See Section 5.2.7
StdTelemetry	Group		See Section 5.2.8
SNROrResBW	Group		See Section 5.2.9
TCold	Real	Kelvin	Noise source OFF temperature
NFResBW	Real	Hz	Specified resolution bandwidth of the noise figure measurement receiver
Verbose(opt) "ON" or "OFF" 1 or 0	String or Integer	NA	If set to "ON" or 1, the test will pause and prompt the operator to make the manual connection of the noise source.
PromptString(opt) Defaults to a general connection prompt if not specified.	String	NA	Allows for customization of the prompt that is given when Verbose is "ON" or 1.
NSSerialNumber	String	N/A	A string representing the serial number of the noise source used in this test. This string will be used to locate the correct noise source ENR table to be used by the test.

3.14.6 Command, Telemetry & Control Messages

Standard telemetry as defined in the "stf" file is (optionally, depending on the PTEConfiguration flag YST/NST) carried out at the same time and signal conditions as the path check. Each defined standard telemetry mnemonic defined will appear as a result variable of that name in the STDTLM data package in the result Citifile. The values returned by the UUT for each mnemonic sent will be recorded as the values of those result variables in the STDTLM data package.

There is no intermediate telemetry for this test.

3.14.7 Results

The following results files are available:

- PathCheckResults Dataset
- Scalar Dataset

3.14.7.1 PathCheckResults Dataset

Name	Units	Description
PathCheckResults	Various	See Section 5.3.1

3.14.7.2 Scalar Dataset

Name	Units	Description
NoiseSourceENR	N/A	Noise Source Excess Noise Ratio
NoiseSourceOFFTemp	deg. K	Temperature at Noise Source OFF
UUTNoiseFigure	dB	Noise Figure of UUT
UUTNoiseTemperature	deg. K	Equivalent noise temperature of UUT
PwrCold	dB/Hz	Receiver power density reading with Noise Source OFF
PwrHot	dB/Hz	Receiver power density reading with Noise Source ON

3.14.8 Calibrations Required

- Uplink Port Gain Calibration
- Downlink Port Gain Calibration
- Downconverter RF Gain Calibration
- Receiver Amp/Pad Gain Calibration
- Spectrum Analyzer Gain Calibration
- External Hardware Calibrations
- Noise Source ENR Calibration Factors
- Thermal Vacuum Amplitude Calibration

3.14.9 VEE File Name

NoiseFigure.LIB

3.15 NOISE POWER RATIO

3.15.1 Test Purpose

The purpose of this test is to stimulate the repeater channel with a multi-tone signal and measure the distortion and noise impairments appearing on the output as the input power is stepped over a specified range.

This test will fulfill the following test requirements of a typical payload test plan:

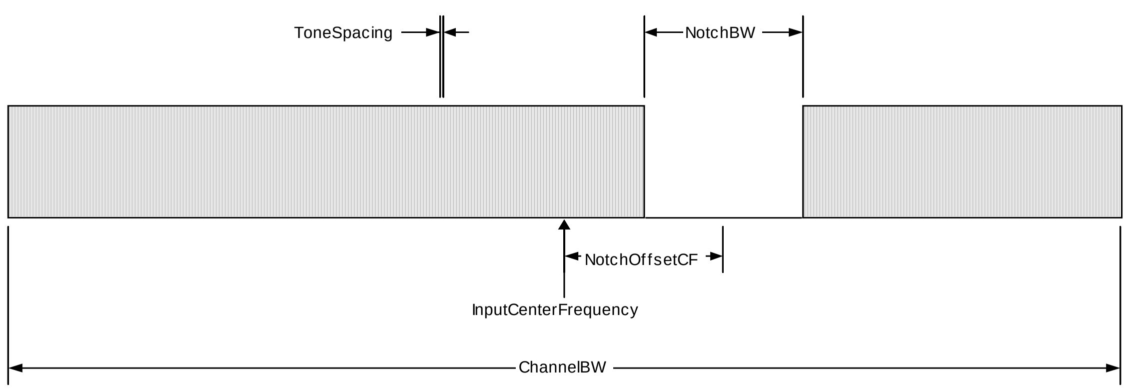
- Noise Power Ratio
- Carrier to Noise and Noise Figure
- Multi-Tone Output Power versus Input Power

3.15.2 Test Diagram

SINGLE SOURCE VSA MEASUREMENT

3.15.3 Test Description

The stimulus for this test consists of a multi-tone signal with equally spaced tones. The stimulus spectrum will include a notched-out region that is free of tones. Relative frequency and bandwidth of the notch can be specified. A typical stimulus spectrum is shown below:



This test will measure the noise and inter-modulation products appearing at the repeater output. The multi-tone stimulus is applied to the UUT input. The two-channel vector signal analyzer measures total input and output power levels as well as noise and intermodulation products that fall in the notched region as the input power is stepped over a specified range.

The test begins by performing a single-carrier path check through the specified UUT input and output ports. This is the same path check procedure used in CW tests (see Section 2.1). At the completion of the path check, the CW stimulus is removed.

The test then proceeds to generate the multi-tone stimulus. The switch matrix is set to connect the VSA CH1 to the source uplink coupler and VSA CH2 to the specified UUT output port. VSA CH1 is used to measure the stimulus signal and the signal is adjusted for the specified starting power level. The switch matrix is then set to apply the stimulus signals to the specified UUT input port.

As the stimulus source level is stepped through the input power range, the source output spectrum is measured using VSA CH1 and the repeater output spectrum is measured using VSA CH2. The following information is derived from the measured signals:

1. Input and output total power levels in the specified *ChannelBW*.
2. Input and output noise and intermodulation power in the notched region. The power is measured using VSA band power markers placed to include the center *NotchMeasPercent* of the notched region.
3. Input and output tone power in the un-notched region. The power is measured using VSA band power markers placed adjacent to the notched region. The bandwidth of the markers is the same as used in part 2.

Noise Power Ratio will be based on output tone and noise power in the notched region. NPR is calculated as:

$$NPR = \left(\frac{OutputTonePower}{OutputNoisePower} \right)$$

and converted to dB.

The noise figure calculation will be based on carrier to noise ratio in the notched region. The UUT input noise density in dBm/Hz is assumed to be kT. The UUT noise figure is calculated as:

$$NF = \frac{\left(\frac{C}{N} \right)_{IN}}{\left(\frac{C}{N} \right)_{OUT}} = \frac{\left(\frac{InputTonePower - InputNoisePower}{kT(NotchMeasPercent/100)NotchBW} \right)}{\left(\frac{OutputTonePower - OutputNoisePower}{OutputNoisePower} \right)}$$

and converted to dB. Note that the noise in the notched region is subtracted from the measured tone power, thus removing the background noise power that is included in the band power marker measurement of the tones.

VSA power readings will be corrected for system internal and external path losses using calibration data measured prior to the test. See Section 5.1 for details on corrected uplink and downlink power calculations.

3.15.4 Program Schedule Message

Name	Type	Units	Description
PTEConfiguration	Parameter		See Section 5.1.2
UUTCFG	Parameter		See Section 5.1.3
Ports	Group		See Section 5.1.4
InputSpotFreq	Group		See Section 5.1.5
TranslationFreq	Group		See Section 5.1.7
InputSweptPower	Group		See Section 5.1.13
ChannelBW	Parameter		See Section 5.1.14 Bandwidth of the input NPR signal. The outer tones of the stimulus signal will be placed at InputCenterFrequency±(ChannelBW -ToneSpacing)/2.
NPR	Group		See Section 5.1.11

3.15.5 Local Parameter File

Name	Type	Units	Description
SimulateTest	Parameter		See Section 5.2.2
85121A Compatibility Mode	Parameter		See Section 5.2.14
InputSignal	Group		See Section 5.2.3
Receiver	Group		See Section 5.2.4
UUTDelay	Group		See Section 5.2.5
TimeBase	Group		See Section 5.2.6
PathCheck	Group		See Section 5.2.7

Name	Type	Units	Description
StdTelemetry	Group		See Section 5.2.8
SNROrResBW	Group		See Section 5.2.9
IntTelemetry	Group		See Section 5.2.13
InputNoiseTemperature	Real	Celsius	The equivalent temperature of the input signal to the UUT. This is the thermal temperature of the attenuator (or coupler) at the input of the UUT, assuming that the attenuation is great enough to lower the excess noise of the PTS RF source to kTB.
NotchMeasPercent	Real	%	The percentage of the NPR spectrum's *NotchBW* that will be measured by the bandpower markers. Setting this parameter to less than 100% will prevent the measurement of intermodulation products that fall near the notch edges.

3.15.6 Command, Telemetry & Control Messages

Standard telemetry as defined in the "stf" file is (optionally, depending on the PTEConfiguration flag YST/NST) carried out at the same time and signal conditions as the path check. Each defined standard telemetry mnemonic defined will appear as a result variable of that name in the STDTLM data package in the result Citifile. The values returned by the UUT for each mnemonic sent will be recorded as the values of those result variables in the STDTLM data package.

Intermediate telemetry communications, as defined in the LPF string-array parameter IntTelemetry, are (optionally, depending on the PTEConfiguration flag YIT/NIT) sent and the responses recorded at each power level during the power sweep. The intermediate telemetry data is stored in the Intermediate Telemetry data package INTTLM inside the results Citifile. Each telemetry mnemonic becomes the name of a variable parameter within the INTTLM data package. The dependent variable of the package is, in this measurement, InputPower. The values that the telemetry records at each power level will appear in the dependent data arrays of the package.

3.15.7 Results

The results file consists of the following datasets:

- PathCheckResults Dataset
- Scalar Dataset
- NPR Array Dataset
- SecondaryNPR Array Dataset

Note that these datasets are in addition to the standard datasets provided by all measurements.

3.15.7.1 PathCheckResults Dataset

Name	Units	Description
PathCheckResults	Various	See Section 5.3.1

3.15.7.2 Scalar Dataset

Name	Units	Description
ULExtHWCal	dB	Insertion gain of uplink external hardware, between the PTS calibration plane and the UUT input, at the *InputCenterFrequency*
DLExtHWCal	dB	Insertion gain of downlink external hardware, between the UUT output and the PTS calibration plane, at the *OutputCenterFrequenc*
ULTVAmplitudeOffset	dB	Thermal vacuum amplitude offset of the uplink, at the *InputCenterFrequency*.
DLTVAmplitudeOffset	dB	Thermal vacuum amplitude offset of the downlink, at the *OutputCenterFrequency*
WideMeasResBW	Hz	Receiver resolution bandwidth used during the input and output total power measurement
NarrowMeasResBW	Hz	Receiver resolution bandwidth used during the input and output tone and noise power measurement

3.15.7.3 NPR Array Dataset

Name	Units	Description
InputTotalPowerRelNOP This is the independent variable for this dataset, and is the "X" value for plots and limit testing.	dB	Specified input total power, relative to NOP
InputNoisePowerRatio	dB	Input Noise Power Ratio, calculated linearly as (InputTonePower/InputNoisePower), then converted to dB
OutputNoisePowerRatio	dB	Output Noise Power Ratio, calculated linearly as (OutputTonePower/OutputNoisePower), then converted to dB
UUTNoiseFigure	dB	UUT Noise Figure, calculated as InputCarrierToNoise – OutputCarrierToNoise, in dB
InputCarrierToNoise	dB	Input carrier to noise ratio, assuming input noise is kTB. Calculated linearly as (InputTonePower-InputNoisePower)/[k*T*(NotchMeasPercent/100)* NotchBW], then converted to dB
OutputCarrierToNoise	dB	Output carrier to noise ratio. Calculated linearly as (OutputTonePower-OutputNoisePower)/(OutputNoisePower), then converted to dB

3.15.7.4 SecondaryNPR Array Dataset

Name	Units	Description
InputTotalPowerRelNOP This is the independent variable for this dataset, and is the "X" value for plots and limit testing.	dB	Specified input total power, relative to NOP
InputTotalPower	dBm	Corrected input total multi-tone power within the ChannelBW
InputTotalPowerUncorr	dBm	Uncorrected input total multi-tone power within the ChannelBW
InputTotalPowerPathCal	dB	Input Path Cal of the total power measurement
InputTonePower	dBm	Corrected input tone power in the un-notched region
InputTonePowerUncorr	dBm	Uncorrected input tone power in the un-notched region
InputTonePowerPathCal	dB	Input Path Cal of the tone power in the un-notched region.
InputNoisePower	dBm	Corrected input noise power in the notched region
InputNoisePowerUncorr	dBm	Uncorrected input noise power in the notched region
InputNoisePowerPathCal	dB	Input Path Cal of the noise power in the notched region
OutputTotalPower	dBm	Corrected output total multi-tone power within the ChannelBW
OutputTotalPowerUncorr	dBm	Uncorrected output total multi-tone power within the ChannelBW
OutputTotalPowerPathCal	dB	Output Path Cal of the total power measurement
OutputTonePower	dBm	Corrected output tone power in the un-notched region
OutputTonePowerUncorr	dBm	Uncorrected output tone power in the un-notched region

Name	Units	Description
OutputTonePowerPathCal	dB	Output Path Cal of the tone power in the un-notched region
OutputNoisePower	dBm	Corrected output noise power in the notched region
OutputNoisePowerUncorr	dBm	Uncorrected output noise power in the notched region
OutputNoisePowerPathCal	dB	Output Path Cal of the noise power in the notched region

3.15.8 Calibrations Required

- Uplink Port Gain Calibration
- Downlink Port Gain Calibration
- Downconverter RF Gain Calibration
- Receiver Amp/Pad Gain Calibration
- External Hardware Calibrations
- Thermal Vacuum Amplitude Calibration

3.15.9 VEE Library Name

NPR.lib

3.16 NOMINAL GAIN AND FREQUENCY

3.16.1 Test Purpose

The purpose of this test is to provide a quick measurement of repeater gain and translation frequency using a single CW carrier.

This test will fulfill the following test requirements of a typical payload test plan:

- Nominal Channel Gain
- Translation Frequency
- DC Power Efficiency
- Radiated Emissions or Susceptibility

3.16.2 Test Diagram

SINGLE SOURCE VSA MEASUREMENT

3.16.3 Test Description

This test can be used to measure the repeater gain and translation frequency. The source and receiver instruments will use the PTS internal or external frequency reference instead of the spacecraft reference to allow measurement of payload frequency error.

The test begins by generating a single CW carrier at a specified frequency using RF Source 1. The switch matrix is set to connect the VSA CH1 to the source uplink coupler and VSA CH2 to the specified UUT output port. Using VSA CH1 to measure source output power, the RF source output power is adjusted to the specified UUT input power.

The stimulus signal is routed to the specified UUT uplink port. The VSA measures power level and frequency for both the uplink and downlink signals. Gain is calculated as the ratio of output to input power. Translation frequency is calculated as the difference between the measured input and output frequency. Frequency error is calculated as the difference between the measured translation frequency and the specified frequency.

At completion of the VSA measurement, a configurable telemetry request is sent to the test conductor computer and the received telemetry data is recorded. The test is then in a command pause state with power applied to the uplink. When a resume message is received from the test conductor computer, the test removes uplink power and the test ends.

VSA readings will be corrected for system internal and external path losses using calibration data measured prior to the test. See Section 4.1 for details on corrected uplink and downlink power calculations.

3.16.4 Program Schedule Message

Name	Type	Units	Description
PTEConfiguration	Parameter		See Section 5.1.2
UUTCFG	Parameter		See Section 5.1.3
Ports	Group		See Section 5.1.4
InputSpotFreq	Group		See Section 5.1.5
TranslationFreq	Group		See Section 5.1.7
InputSpotPower	Group		See Section 5.1.12

3.16.5 Local Parameter File

Name	Type	Units	Description
SimulateTest	Parameter		See Section 5.2.2
85121A Compatibility Mode	Parameter		See Section 5.2.14
InputSignal	Group		See Section 5.2.3
Receiver	Group		See Section 5.2.4
UUTDelay	Group		See Section 5.2.5
TimeBase	Group		See Section 5.2.6
PathCheck	Group		See Section 5.2.7
StdTelemetry	Group		See Section 5.2.8
SNROrResBW	Group		See Section 5.2.9
IntTelemetry	Group		See Section 5.2.13

3.16.6 Command, Telemetry & Control Messages

Intermediate telemetry communications, as defined in the LPF string-array parameter IntTelemetry, are (optionally, depending on the PTEConfiguration flag YIT/NIT) sent and the responses recorded upon completion of the VSA measurement and before the uplink signal is removed. The intermediate telemetry data is stored in the Intermediate Telemetry scalar data package INTTLM inside the results Citifile. Each telemetry mnemonic becomes the name of a variable parameter within the INTTLM data package.

Standard telemetry as defined in the “stf” file is (optionally, depending on the PTEConfiguration flag YST/NST) carried out at the input reference level. Each defined standard telemetry mnemonic will appear as a result variable of that name in the STDTLM data package in the result Citifile. The values returned by the UUT for each mnemonic sent will be recorded as the values of those result variables in the STDTLM data package.

3.16.7 Results

The results file consists of the following datasets:

- PathCheckResults Dataset
- Scalar Dataset
- SecondaryScalar Dataset

Note that these datasets are in addition to the standard datasets provided by all measurements.

3.16.7.1 PathCheckResults Dataset

Name	Units	Description
PathCheckResults	Various	See Section 5.3.1

3.16.7.2 Scalar Dataset

Name	Units	Description
InputPower	dBm	Input power to UUT, absolute dBm, corrected for PTS path and external calibration
OutputPower	dBm	Output power from UUT, absolute dBm, corrected for PTS path and external calibration
Gain	dB	Overall UUT gain, calculated as (OutputPower – InputPower)
InputFrequency	Hz	Measured input carrier frequency to UUT
OutputFrequency	Hz	Measured output carrier frequency from UUT

Name	Units	Description
MeasTransFreq	Hz	Measured translation frequency calculated as (InputFrequency – OutputFrequency)
TranslationOffset	Hz	Offset in measured translation frequency compared to nominal, calculated as (MeasTransFreq – TranslationFrequency)
TranslationError	ppb	TranslationOffset expressed in parts per billion of nominal translation frequency, calculated as [1E9 * (TranslationOffset) / abs(TranslationFrequency)]
MeasResBW	Hz	The receiver resolution bandwidth that was used during the measurement

3.16.7.3 SecondaryScalar Dataset

Name	Units	Description
InputPathCal	dB	Input signal path cal
InputExtHwCal	dB	External hardware cal
InputTVAmpOffset	dB	Thermal vacuum amplitude offset
InputPowerRaw	dBm	Uncorrected receiver reading
OutputPathCal	dB	Output signal path cal
OutputExtHwCal	dB	External hardware cal
OutputTVAmpOffset	dB	Thermal vacuum amplitude offset
OutputPowerRaw	dBm	Uncorrected receiver reading

3.16.8 Calibrations Required

- Uplink Port Gain Calibration
- Downlink Port Gain Calibration
- Downconverter RF Gain Calibration
- Receiver Amp/Pad Gain Calibration
- External Hardware Calibrations
- Thermal Vacuum Amplitude Calibration

3.16.9 VEE Library Name

NomGainAndFrequency.lib

3.17 PASSIVE INTERMODULATION

3.17.1 Test Purpose

The purpose of this test is to measure the level of passive intermodulation (PIM) signals that transfer between two repeaters.

This test will fulfill the following test requirements of a typical payload test plan:

- Passive Intermodulation

3.17.2 Test Diagram

TWO-SOURCE VSA MEASUREMENT

3.17.3 Test Description

This test involves two repeaters, one designated “stimulus” and the other “response”. To measure passive intermodulation, the test applies two carriers to the stimulus repeater input, with signal separations in the hundreds of MHz. The VSA is used to measure uplink and downlink carrier powers for the stimulus repeater. The VSA is then connected to the downlink output of a “response” repeater, whose uplink input is not stimulated. The VSA is used to measure the downlink intermodulation product levels on the response repeater output.

The stimulus for this measurement consists of two CW signals. Since the signals can be separated by hundreds of MHz, two signal generators are required to create the stimulus. The switch matrix is set to combine the two RF source signals, connect the VSA CH1 to the source uplink coupler, and connect VSA CH2 to the specified UUT output port. VSA CH1 is used to measure the stimulus signals and the signals are adjusted for the specified starting power level. The switch matrix is then set to apply the stimulus signals to the specified UUT input port. The VSA is used to measure the uplink and downlink power levels through the stimulus repeater.

The switch matrix is then set to connect VSA CH2 to the response repeater downlink output. The test calculates the possible intermodulation product frequencies that could fall within the specified start/stop output frequency search range. CH2 of the downconverter is tuned to those calculated frequencies so that the VSA can be used to make a directed search for any signals that exceed the specified spur level for the response transponder. If signals are found that are above the specification level, the signal frequency, peak signal amplitude, and average noise level are measured and recorded.

VSA readings will be corrected for system internal and external path losses using calibration data measured prior to the test. See Section 4.1 for details on corrected uplink and downlink power calculations.

3.17.4 Program Schedule Message

Name	Type	Units	Description
PTEConfiguration	Parameter		See Section 5.1.2
UUTCFG	Parameter		See Section 5.1.3 (for stimulus repeater)
Ports	Group		See Section 5.1.4 (for stimulus repeater)
“Response”+OutputPort	Group with prefix		See Section 5.1.4 This is the OutputPort of the response repeater.
InputSpotFreq	Group		See Section 5.1.5 (for stimulus repeater)

Name	Type	Units	Description
TranslationFreq	Group		See Section 5.1.7 (for stimulus repeater)
InputTwoToneCW	Group		See Section 5.1.6 (for stimulus repeater)
InputSpotPower	Group		See Section 5.1.12 (for stimulus repeater)
OutputFrequencyRange	Group		See Section 5.1.18 This is the search frequency range of the stimulus repeater output and response repeater input.
ResponseTranslationFrequency or ReturnTransFreq(*)	Real	Hz	This is the translation frequency caused by the response repeater that is picking up the intermodulation products. Note: For down-converting repeaters, this value must be negative.
SpurAmpSpec	Parameter		See Section 5.1.20 If specified in dBc, this value is relative to the downlink carrier measured at the UUT stimulus repeater output.

3.17.5 Local Parameter File

Name	Type	Units	Description
SimulateTest	Parameter		See Section 5.2.2
85121A Compatibility Mode	Parameter		See Section 5.2.14
InputSignal	Group		See Section 5.2.3
Receiver	Group		See Section 5.2.4
TimeBase	Group		See Section 5.2.6
PathCheck	Group		See Section 5.2.7
StdTelemetry	Group		See Section 5.2.8
Spurious	Group		See Section 5.2.10
HighestIMDOrder 3, 5, 7 etc.	Integer	NA	Highest odd integer order of intermodulation products to search for, within the supplied OutputFrequencyStart and OutputFrequencyStop bounds

3.17.6 Command, Telemetry & Control Messages

Standard telemetry as defined in the "stf" file is (optionally, depending on the PTEConfiguration flag YST/NST) carried out at the same time and signal conditions as the path check. Each defined standard telemetry mnemonic defined will appear as a result variable of that name in the STDTLM data package in the result Citifile. The values returned by the UUT for each mnemonic sent will be recorded as the values of those result variables in the STDTLM data package.

There is no intermediate telemetry for this test.

3.17.7 Results

The following results files are available:

- PathCheckResults Dataset
- Scalar Dataset
- StimulusCarrierLevel Array Dataset
- SpursFound Array Dataset

Note that these datasets are in addition to the standard datasets provided by all measurements.

3.17.7.1 PathCheckResults Dataset

Name	Units	Description
PathCheckResults	Various	See Section 5.3.1

3.17.7.2 Scalar Dataset

Name	Units	Description
NumSpurs	NA	Number of PIM products found at the Response repeater output that exceeded SpurAmpSpecdBm

3.17.7.3 StimulusCarrierLevel Array Dataset

Name	Units	Description
ULFrequency	Hz	Uplink carrier frequencies for Stimulus repeater
DLFrequency	Hz	Measured downlink carrier frequencies for Stimulus repeater
ULPowerCorr	dBm	Corrected uplink power
ULPowerUncorr	dBm	Uncorrected uplink power reading
ULPathCal	dB	Uplink path insertion gain, between VSA CH1 and PTS uplink calibration plane
ULExtHWCal	dB	Uplink external hardware insertion gain, between the PTS uplink calibration plane and the UUT input
ULTVAmplitudeOffset	dB	Thermal vacuum amplitude offset of the uplink
DLPowerCorr	dBm	Corrected downlink power
DLPowerUncorr	dBm	Uncorrected downlink power reading
DLPathCal	dB	Downlink path insertion gain, between VSA CH2 and PTS downlink calibration plane
DLExtHWCal	dB	Downlink external hardware insertion gain, between the PTS downlink calibration plane and the UUT input
DLTVAmplitudeOffset	dB	Thermal vacuum amplitude offset of the downlink

3.17.7.4 SpursFound Array Dataset

Name	Units	Description
SpurFrequency	Hz	Measured spur frequency at the Response repeater output
SpurIndex	NA	An integer index for the list of found spurs, starting with 1
SpurOrder	NA	An odd integer representing the IMD order of the distortion product found
SpurHarmLower	NA	An integer representing the harmonic number of the lower frequency carrier that caused this spur
SpurHarmUpper	NA	An integer representing the harmonic number of the upper frequency carrier that caused this spur
SpurFreqPredict	Hz	Predicted spur frequency at the Response repeater output
SpurResBW	Hz	Receiver Resolution Bandwidth during the spur measurement
SpurSNR	dBc	Ratio of spur power to noise power in the receiver Resolution BW, measured at the Response repeater output
SpurRelPower	dBc	Measured power of Response repeater output spur relative to the Stimulus repeater output carrier. (The lower frequency carrier is used as the reference.)
SpurAbsPowerCorr	dBm	Measured power of spur (absolute level) at the Response repeater output
SpurAbsPowerUnCorr	dBm	Un-corrected measured power of spur
SpurPathCal	dB	Downlink path insertion gain, between receiver input and PTS downlink calibration plane, at the spur frequency
SpurExtHWCal	dB	Downlink external hardware insertion gain, between the PTS downlink calibration plane and the UUT input, at the spur frequency
SpurTVAmpOffset	dB	Thermal vacuum amplitude offset of the downlink
RptSpurAmpSpecdBc Or RptSpurAmpSpecdBm	dB Or dBm	Reported value of SpurAmpSpecdBc or SpurAmpSpecdBm from Program Schedule Message

3.17.8 Calibrations Required

- Uplink Port Gain Calibration
- Downlink Port Gain Calibration
- Downconverter RF Gain Calibration
- Receiver Amp/Pad Gain Calibration
- External Hardware Calibrations
- Thermal Vacuum Amplitude Calibration

3.17.9 VEE File Name

PIM.LIB

3.18 PHASE NOISE

3.18.1 Test Purpose

The purpose of this measurement is to determine the level of spurious sidebands and phase noise associated with local oscillators in the payload.

This test will fulfill the following test requirements of a typical payload test plan:

- Spurious Phase Modulation
- Local Oscillator Sidebands

3.18.2 Test Diagram

SINGLE SOURCE VSA MEASUREMENT

3.18.3 Test Description

This test applies a single CW carrier to the repeater under test and uses the VSA to measure the single sideband phase noise of the RF source and UUT output signals. Note that the RF source measurement is not used to correct the UUT output measurement, and that the noise floor of the test will be limited by the phase noise performance of the RF source and measurement receiver. The PTS instruments will use the PTS internal or external frequency reference instead of the spacecraft reference to allow measurement of payload phase noise.

The test begins by generating a single CW carrier at a specified frequency using RF Source 1. The switch matrix is set to connect the VSA CH1 to the source uplink coupler and VSA CH2 to the specified UUT output port. Using VSA CH1 to measure source output power, the RF source output power is adjusted to the specified UUT input power. The stimulus signal is routed to the specified UUT uplink port. The VSA measures power level and frequency for both the uplink and downlink signals.

VSA CH1 will be used to measure the residual phase noise of the stimulus signal in the channel of interest and CH2 will measure the phase noise of the repeater output signal. The measurement is made over a specified start to stop output frequency range with respect to the carrier center frequency. Measured phase noise is recorded in dBc/Hz, relative to the carrier amplitude. Discrete side-band modulation signals are determined from the average noise floor and removed from the corrected phase noise data. The side-band levels in dBc relative to the carrier are listed in a table.

VSA readings will be corrected for system internal and external path losses using calibration data measured prior to the test. See Section 4.1 for details on corrected uplink and downlink power calculations

3.18.4 Program Schedule Message

Name	Type	Units	Description
PTEConfiguration	Parameter		See Section 5.1.2
UUTCFG	Parameter		See Section 5.1.3
Ports	Group		See Section 5.1.4
InputSpotFreq	Group		See Section 5.1.5
TranslationFreq	Group		See Section 5.1.7
InputSpotPower	Group		See Section 5.1.12
OutputFrequencyRange	Group		See Section 5.1.18

3.18.5 Local Parameter File

Name	Type	Units	Description
SimulateTest	Parameter		See Section 5.2.2
85121A Compatibility Mode	Parameter		See Section 5.2.14
InputSignal	Group		See Section 5.2.3
Receiver	Group		See Section 5.2.4
TimeBase	Group		See Section 5.2.6
PathCheck	Group		See Section 5.2.7
StdTelemetry	Group		See Section 5.2.8
SNROrResBW	Group		See Section 5.2.9
VSASamplePoints (opt) Defaults to 101 if not specified.	Integer	N/A	VSASamplePoints is the number of sample points to be used when measuring each octave of the phase noise measurement. Valid values are 51,101,201,401,801,1601,3201,6401,12801,25601,51201,102401.
DiscreteSidebandAmpDelta (opt) Defaults to 13 dB if not	Real	dB	This parameter is the amount of dB a signal must rise above the noise floor to be identified as a discrete sideband.
ExcludeOffsetFreq (opt) Defaults to 0 if not specified.	Real	Hz	This parameter specifies the frequency offset region with respect to the carrier that will be excluded from the discrete sideband signal search.

3.18.6 Command, Telemetry & Control Messages

Standard telemetry as defined in the “stf” file is (optionally, depending on the PTEConfiguration flag YST/NST) carried out at the same time and signal conditions as the path check. Each defined standard telemetry mnemonic defined will appear as a result variable of that name in the STDTLM data package in the result Citifile. The values returned by the UUT for each mnemonic sent will be recorded as the values of those result variables in the STDTLM data package.

There is no intermediate telemetry for this test.

3.18.7 Results

The following results files are available:

- PathCheckResults Dataset
- Scalar Dataset
- PhaseNoise Array Dataset
- DiscreteSignals Array Dataset

3.18.7.1 PathCheckResults Dataset

Name	Units	Description
PathCheckResults	Various	See Section 5.3.1

3.18.7.2 Scalar Dataset

Name	Units	Description
ULPowerCorr	dBm	Corrected uplink power
ULPowerUnCorr	dBm	Un-corrected uplink power
ULPathCal	dB	Uplink path insertion gain, between VSA CH1 and PTS uplink calibration plane
ULExtHWCal	dB	Uplink external hardware insertion gain, between the PTS uplink calibration plane and the UUT input

ULTVAmplitudeOffset	dB	Thermal vacuum amplitude offset of the uplink
DLPowerCorr	dBm	Corrected downlink power
DLPowerUnCorr	dBm	Un-corrected downlink power
DLPathCal	dB	Downlink path insertion gain, between VSA CH2 and PTS downlink calibration plane
DLExtHWCal	dB	Downlink external hardware insertion gain, between the PTS downlink calibration plane and the UUT input
DLTVAmplitude Offset	dB	Thermal vacuum amplitude offset of the downlink
DLMeasCarrierFreq	Hz	Measured downlink carrier frequency

3.18.7.3 PhaseNoise Array Dataset

Name	Units	Description
OffsetFrequency This is the independent variable for this dataset, and is the "X" value for plots and limit testing.	Hz	Offset frequency of measured phase noise, relative to DLMeasCarrierFreq
InputNoise	dBc/Hz	Measured residual phase noise of the input CW signal
OutputNoise	dBc/Hz	Measured UUT phase noise with discrete signals removed
OutputNoiseWithDiscrete	dBc/Hz	Measured UUT phase noise with discrete signals included
VSAResBWActual	Hz	The actual VSA resolution BW used for each measurement point

3.18.7.4 DiscreteSignals Array Dataset

Name	Units	Description
DiscreteOffsetFreq	Hz	Offset frequency of found discrete signals, relative to DLMeasCarrierFreq
DiscreteAbsFreq	Hz	Absolute output frequency of found discrete signals
DiscreteRelPower	dBc	Measured output power of the discrete signal relative to the test carrier power
DiscreteAbsPower	dBm	Measured output power of the discrete signal (absolute power level.)

3.18.8 Calibrations Required

- Uplink Port Gain Calibration
- Downlink Port Gain Calibration
- Downconverter RF Gain Calibration
- Receiver Amp/Pad Gain Calibration
- External Hardware Calibrations
- Thermal Vacuum Amplitude Calibration

3.18.9 VEE File Name

PhaseNoise.LIB

3.19 RANGING DELAY

3.19.1 Test Purpose

The purpose of this test is to measure the delay of a ranging signal through the command receiver and telemetry beacon.

This test will fulfill the following test requirements of a typical payload test plan:

- Ranging Delay

3.19.2 Test Diagram

SINGLE SOURCE VSA MEASUREMENT

3.19.3 Test Description

The test begins by generating a frequency-modulated carrier at a specified uplink frequency using RF Source #1. The FM is created by a user-supplied tone applied to the RF source modulation input or is internally generated by the source. The switch matrix is set to connect the VSA CH1 to the source uplink coupler and VSA CH2 to the specified UUT output port. The deviation of the generated FM signal is measured using the CH1 FM demodulation function of the VSA. If the deviation is not within specified limits, the user is requested to adjust the amplitude of the user-supplied tone.

Using VSA CH1 to measure source output power, the RF source output power is adjusted to the specified UUT input power. The stimulus signal is routed to the specified UUT uplink port. The VSA measures power level and frequency for both the uplink and downlink signals.

The VSA is used to FM demodulate both the uplink and downlink signals. Channel 1 of the VSA is connected through the matrix to the uplink stimulus and the reference phase of the demodulated FM signal is measured. Channel 2 of the VSA is connected to the beacon output and the demodulated phase of the downlink signal is measured. The delay (seconds) is calculated from the VSA phase readings (degrees) and the modulation frequency (Hz) by the formula:

$$Delay = \frac{VSAPhase}{360 \times f_{MOD}}$$

Where f_{MOD} is the modulation frequency. The absolute delay through the UUT is calculated from:

UUT_Delay (s) = UL Corrected Delay (s) - DL Corrected Delay (s) – FM2PMCorrection

The FM2PMCorrection term is necessary to account for the phase shift that occurs when the uplink FM signal is converted to the PM beacon downlink signal. Its value is given by:

$$FM2PMCorrection = \frac{\pm 90^{o}}{360 \times f_{MOD}}$$

See Section 5.1 for details on corrected delay calculations. VSA power readings will be corrected for system internal and external path losses using calibration data measured prior to the test. See Section 5.1 on page for details on corrected uplink and downlink power calculations.

3.19.4 Program Schedule Message

Name	Type	Units	Description
PTEConfiguration	Parameter		See Section 5.1.2
UUTCFG	Parameter		See Section 5.1.3
Ports	Group		See Section 5.1.4
InputSpotFreq	Group		See Section 5.1.5
TranslationFreq	Group		See Section 5.1.7
InputSpotPower	Group		See Section 5.1.12
InputFMTone	Group		See Section 5.1.16

3.19.5 Local Parameter File

Name	Type	Units	Description
SimulateTest	Parameter		See Section 5.2.2
85121A Compatibility Mode	Parameter		See Section 5.2.14
InputSignal	Group		See Section 5.2.3
Receiver	Group		See Section 5.2.4
UUTDelay	Group		See Section 5.2.5
TimeBase	Group		See Section 5.2.6
PathCheck	Group		See Section 5.2.7
StdTelemetry	Group		See Section 5.2.8
SNROrResBW	Group		See Section 5.2.9
FMToneGen	Group		See Section 5.2.11
PhaseShift	Real	Deg	Value of the phase shift due to the change in modulation from FM to PM inside the UUT. The value should be ±90 degrees, UUT dependent. For a non-regenerative repeater, the value should be 0 degrees.

3.19.6 Command, Telemetry & Control Messages

Standard telemetry as defined in the “stf” file is (optionally, depending on the PTEConfiguration flag YST/NST) carried out at the same time and signal conditions as the path check. Each defined standard telemetry mnemonic defined will appear as a result variable of that name in the STDTLM data package in the result Citifile. The values returned by the UUT for each mnemonic sent will be recorded as the values of those result variables in the STDTLM data package.

There is no intermediate telemetry for this test.

3.19.7 Results

The results file consists of the following datasets:

- PathCheckResults Dataset
- Scalar Dataset

Note that these datasets are in addition to the standard datasets provided by all measurements.

3.19.7.1 PathCheckResults Dataset

Name	Units	Description
PathCheckResults	Various	See Section 5.3.1

3.19.7.2 Scalar Dataset

Name	Units	Description
ULPowerCorr	dBm	Corrected uplink power
ULPowerUncorr	dBm	Uncorrected uplink power reading
ULPathCal	dB	Uplink path insertion gain, between VSA CH1 and PTS uplink calibration plane
ULExtHWCal	dB	Uplink external hardware insertion gain, between the PTS uplink calibration plane and the UUT input
ULTVAmplitudeOffset	dB	Thermal vacuum amplitude offset of the uplink
DLPowerCorr	dBm	Corrected downlink power
DLPowerUncorr	dBm	Uncorrected downlink power reading
DLPathCal	dB	Downlink path insertion gain, between VSA CH2 and PTS downlink calibration plane
DLExtHWCal	dB	Downlink external hardware insertion gain, between the PTS downlink calibration plane and the UUT input
DLTVAmplitudeOffset	dB	Thermal vacuum amplitude offset of the downlink
ULFMDeviation	Hz	Measured uplink FM deviation
ULFMDeviationError	%	Percent error in the measured uplink FM deviation compared to the specified value
RangingDelay	Sec	Corrected UUT Ranging Delay
ULDelayCorr	Sec	Corrected Uplink delay measurement. ULDelayCorr = ULDelayUncorr + ULPathDelay + ULExtHWDelay + ULTVPhaseOffset
ULDelayUncorr	Sec	Uncorrected Uplink delay as measured at VSA CH1
ULPathDelay	Sec	Uplink path delay, VSA CH1 to PTS uplink calibration plane
ULExtHWDelay	Sec	Uplink external hardware delay, PTS uplink calibration plane to UUT input
ULTVPhaseOffset	Sec	Thermal vacuum phase offset of the uplink
DLDelayCorr	Sec	Corrected Downlink delay measurement. DLDelayCorr = DLDelayUncorr + DLPathDelay + DLExtHWDelay + DLTVPhaseOffset

Name	Units	Description
DLDelayUncorr	Sec	Uncorrected Downlink delay as measured at VSA CH2
DLPathDelay	Sec	Downlink path delay, VSA CH2 to PTS downlink calibration plane
DLExtHWDelay	Sec	Downlink external hardware delay, PTS downlink calibration plane to UUT output
DLTVPhaseOffset	Sec	Thermal vacuum phase offset of the downlink
FM2PMCorr	Sec	The FM2PMCorrection term is necessary to account for the phase shift that occurs when the uplink FM signal is converted to the PM beacon downlink signal. Its value is given by: $FM2PMCorrection = \frac{\pm 90^{O}}{360 \times f_{MOD}}$

3.19.8 Calibrations Required

- Uplink Port Gain Calibration
- Downlink Port Gain Calibration
- Downconverter RF Gain Calibration
- Receiver Amp/Pad Gain Calibration
- Uplink Port Delay Calibration
- Downlink Port Delay Calibration
- External Hardware Calibrations
- Thermal Vacuum Amplitude Calibration
- Thermal Vacuum Phase Calibration

3.19.9 VEE Library Name

RangingDelay.lib

3.20 Repeater Isolation

3.20.1 Test Purpose

The purpose of this test is to measure the level of leakage signals that transfer between two repeaters.

This test will fulfill the following test requirements of a typical payload test plan:

- Repeater Isolation

3.20.2 Test Diagram

SINGLE SOURCE VSA MEASUREMENT

3.20.3 Test Description

This test involves two repeaters, one designated “stimulus” and the other “response”. To measure isolation, the test applies a single CW carrier to the stimulus repeater input. The VSA is used to measure uplink and downlink carrier powers for the stimulus repeater. The VSA is then connected to the downlink output of a “response” repeater, whose uplink input is not stimulated. The VSA is used to measure the downlink signal levels on the response repeater output.

The test begins by generating a single CW carrier at a specified frequency using RF Source 1. The switch matrix is set to connect the VSA CH1 to the source uplink coupler and VSA CH2 to the specified UUT output port. Using VSA CH1 to measure source output power, the RF source output power is adjusted to the specified UUT input power. The switch matrix is then set to apply the stimulus signal to the specified UUT input port. The VSA is used to measure the uplink and downlink power levels through the stimulus repeater.

The switch matrix is then set to connect VSA CH2 to the response repeater downlink output. CH2 of the downconverter is tuned to the specified downlink frequencies so that the VSA can be used to make a directed search for any signals that exceed the specified spur level for the response transponder. If signals are found that are above the specification level the signal frequency, peak signal amplitude, and average noise level are measured and recorded. VSA readings will be corrected for system internal and external path losses using calibration data measured prior to the test. See Section 4.1 for details on corrected uplink and downlink power calculations.

3.20.4 Program Schedule Message

Name	Type	Units	Description
PTEConfiguration	Parameter		See Section 5.1.2
UUTCFG	Parameter		See Section 5.1.3 (for stimulus repeater)
Ports	Group		See Section 5.1.4 (for stimulus repeater)
“Response”+OutputPorts	Group with prefix		See Section 5.1.4 This is the OutputPort of the response repeater.
InputSpotFreq	Group		See Section 5.1.5 (for stimulus repeater)
TranslationFreq	Group		See Section 5.1.7 (for stimulus repeater)
InputSpotPower	Group		See Section 5.1.12 (for stimulus repeater)
OutputFrequency	Group		See Section 5.1.19 These are the frequencies for the directed search at the response repeater output.
SpurAmpSpec	Parameter		See Section 5.1.20 If specified in dBc, this value is relative to the downlink carrier measured at the UUT stimulus repeater output.

3.20.5 Local Parameter File

Name	Type	Units	Description
SimulateTest	Parameter		See Section 5.2.2
85121A Compatibility Mode	Parameter		See Section 5.2.14
InputSignal	Group		See Section 5.2.3
Receiver	Group		See Section 5.2.4
TimeBase	Group		See Section 5.2.6
PathCheck	Group		See Section 5.2.7
StdTelemetry	Group		See Section 5.2.8
Spurious	Group		See Section 5.2.10

3.20.6 Command, Telemetry & Control Messages

Standard telemetry as defined in the “stf” file is (optionally, depending on the PTEConfiguration flag YST/NST) carried out at the same time and signal conditions as the path check. Each defined standard telemetry mnemonic defined will appear as a result variable of that name in the STDTLM data package in the result Citifile. The values returned by the UUT for each mnemonic sent will be recorded as the values of those result variables in the STDTLM data package.

There is no intermediate telemetry for this test.

3.20.7 Results

The following results files are available:

- PathCheckResults Dataset
- Scalar Dataset
- RepeaterIsolation Array Dataset

3.20.7.1 PathCheckResults Dataset

Name	Units	Description
PathCheckResults	Various	See Section 5.3.1

3.20.7.2 Scalar Dataset

Name	Units	Description
StimulusCarrierFreq	Hz	Stimulus carrier uplink frequency
ULPowerCorr	dBm	Corrected uplink power
ULPowerUnCorr	dBm	Un-corrected uplink power
ULPowerCal	dB	Uplink path insertion gain, between VSA CH1 and PTS uplink calibration plane
ULExtHWCal	dB	Uplink external hardware insertion gain, between the PTS uplink calibration plane and the UUT input
ULTVAmplitudeOffset	dB	Thermal vacuum amplitude offset of the uplink
ResponseCarrierFreq	Hz	Response carrier downlink frequency
DLPowerCorr	dBm	Corrected downlink power
DLPowerUnCorr	dBm	Un-corrected downlink power
DLPowerCal	dB	Downlink path insertion gain, between VSA CH2 and PTS downlink calibration plane
DLExtHWCal	dB	Downlink external hardware insertion gain, between the PTS downlink calibration plane and the UUT input
DLTVAmplitudeOffset	dB	Thermal vacuum amplitude offset of the downlink
NumSpurs	N/A	Number of found spurs

3.20.7.3 RepeaterIsolation Array Dataset

Name	Units	Description
SpurFrequency	Hz	Measured spur frequency at the Response repeater output
SpurIndex	N/A	Index for found spurs
RepeaterIsolation	dBc	Stimulus to Response Repeater Isolation, defined as the difference between the Stimulus repeater output carrier level and the Response repeater output spur level, expressed in dBc
SpurResBW	Hz	Receiver Resolution Bandwidth during the spur measurement
SpurSNR	dBc	Ratio of spur power to noise power in the receiver Resolution BW, measured at the Response repeater output
SpurRelPower	dBc	Measured power of Response repeater output spur relative to the Stimulus repeater output carrier
SpurAbsPowerCorr	dBm	Measured power of spur (absolute level) at the Response repeater output
SpurAbsPowerUnCorr	dBm	Un-corrected measured power of spur
SpurPathCal	dB	Downlink path insertion gain, between receiver input and PTS downlink calibration plane, at the spur frequency
SpurExtHWCal	dB	Downlink external hardware insertion gain, between the PTS downlink calibration plane and the UUT input, at the spur frequency
SpurTVAmpCal	dB	Thermal vacuum amplitude offset of the downlink, at the spur frequency
SpurRelPower	dBc	Measured power of Response repeater output spur relative to the Stimulus repeater output carrier
RptSpurAmpSpecdBc Or RptSpurAmpSpecdBm	dB Or dBm	Reported value of SpurAmpSpecdBc or SpurAmpSpecdBm from Program Schedule Message

3.20.8 Calibrations Required

- Uplink Port Gain Calibration
- Downlink Port Gain Calibration
- Downconverter RF Gain Calibration
- Receiver Amp/Pad Gain Calibration
- External Hardware Calibrations
- Thermal Vacuum Amplitude Calibration

3.20.9 VEE File Name

RepeaterIsolation.LIB

3.21 Spurious Response

3.21.1 Test Purpose

The purpose of this measurement is to determine the level and frequency of spurious output signals generated by the repeater. The test can be configured to operate with a single CW carrier present, dual CW carrier present, or no carrier present.

This test will fulfill the following test requirements of a typical payload test plan:

- Spurious Outputs, Carrier Related (Single or Two-Tone)
- Spurious Outputs, Non-Carrier Related

3.21.2 Test Diagram

TWO SOURCE SPECTRUM ANALYZER

3.21.3 Test Description

The spurious response test can be selected to operate with a single or dual CW carrier present ("Drive") or no carrier present (No-Drive). Note that for either case, the standard path check routine using the VSA as the receiver will be performed at the beginning of the test. The spectrum analyzer is used as the spur search receiver because its preselected input is necessary for image-free measurement of out-of-band spurious signals.

For the carrier-related measurement, the test begins by generating the specified single or dual CW carrier at a specified frequency using RF Source 1 and 2 respectively. The switch matrix is set to connect the VSA CH1 to the source uplink coupler and spectrum analyzer to the specified UUT output port. Using VSA CH1 to measure source output power, the RF source output power is adjusted to the specified UUT input power. The stimulus signal is routed to the specified UUT uplink port.

For the non-carrier related measurement, no uplink signal is generated.

The spectrum analyzer spur search is performed over a specified UUT output start-to-stop frequency range. The search begins by measuring the carrier power (if present) and a specified list of known signals (such as beacon transmitters). Measured power and frequency of the carrier and known signals are recorded. The SA then searches the remaining sections of the specified start/stop range. The frequencies of any spurious signals that are higher than a specified level are stored for final examination. A record of the wide-span SA trace is recorded for each measured frequency range.

The final spur examination is optionally performed by zooming in on the identified spur frequencies until the SA span is narrowed to a specified bandwidth. A record of this final SA trace is recorded. Total power in the specified bandwidth is recorded and compared to the specified spur power limit. A table of spur frequencies and power levels is generated.

VSA readings will be corrected for system internal and external path losses using calibration data measured prior to the test. See Section 4.1 for details on corrected uplink and downlink power calculations.

3.21.4 Program Schedule Message

Name	Type	Units	Description
PTEConfiguration	Parameter		See Section 5.1.2
UUTCFG	Parameter		See Section 5.1.3
Ports	Group		See Section 5.1.4
InputSpotFreq	Group		See Section 5.1.5
TranslationFreq	Group		See Section 5.1.7
InputSpotPower	Group		See Section 5.1.12
InputTwoToneCW	Group		See Section 5.1.6 Note: Only required Spurious Two Tone
OutputFrequencyRange	Group		See Section 5.1.18 Note: For spurious searches that include large variations in noise floor, this parameter should be broken up into start/stop frequency segments. Each segment should span a region in which the noise floor varies by less than the NoiseGuardBand.
SpurAmpSpec	Parameter		See Section 5.1.20

3.21.5 Local Parameter File

Name	Type	Units	Description
SimulateTest	Parameter		See Section 5.2.2
85121A Compatibility Mode	Parameter		See Section 5.2.14
InputSignal	Group		See Section 5.2.3
Receiver	Group		See Section 5.2.4
UUTDelay	Group		See Section 5.2.5
TimeBase	Group		See Section 5.2.6
PathCheck	Group		See Section 5.2.7
StdTelemetry	Group		See Section 5.2.8
Spurious	Group		See Section 5.2.10
CenterExcludeBW	Real	Hz	A bandwidth around the carrier that will not be searched for spurs
{KnownSignalFrequency} {KnownSignalBW}	Real arrays, same size	Hz Hz	Arrays describing the center frequencies and bandwidths of known signals that are excluded from the spur search. Instead, the band powers within these bandwidths are measured and recorded in a separate output dataset.
Imdproducts	Integer	Array	Will measure and record all IMD products from the list
ImdSignalBW	Real	Hz	Specifies the span to use during measurement of ImdProducts and to exclude from the spur search

3.21.6 Command, Telemetry & Control Messages

Standard telemetry as defined in the “stf” file is (optionally, depending on the PTEConfiguration flag YST/NST) carried out at the same time and signal conditions as the path check. Each defined standard telemetry mnemonic defined will appear as a result variable of that name in the STDTLM data package in the result Citifile. The values returned by the UUT for each mnemonic sent will be recorded as the values of those result variables in the STDTLM data package.

There is no intermediate telemetry for this test.

3.21.7 Results

The following results files are available:

- PathCheckResults Dataset
- CarrierTrace Dataset
- WideBandN Trace Dataset
- SpurN Trace Dataset
- Scalar Dataset
- SpuriousResponse Array Dataset
- KnownSignalsResponses Array Dataset
- IMDResponses Array Dataset

3.21.7.1 PathCheckResults Dataset

Name	Units	Description
PathCheckResults	Various	See Section 5.3.1

3.21.7.2 CarrierTrace Dataset

This is a plot of the output carrier sweep. This dataset is recorded only for the “Drive” version of the test.

Name	Units	Description
CarrierTraceX	Hz	Horizontal trace frequency, normalized to 0 at the marker frequency (array)

Name	Units	Description
CarrierTraceY	dBm	Vertical trace amplitude, corrected to the UUT output (array)
CarrierFrequency	Hz	Marker absolute frequency (single value)

3.21.7.3 WideBandN Trace Dataset

This is a plot of the Nth wideband sweep, where N is the number of OutputFrequency ranges to be searched.

Name	Units	Description
WideBandTraceX	Hz	Horizontal trace frequency, normalized to 0 at the marker frequency (array)
WideBandTraceY	dBm	Vertical trace amplitude, corrected to the UUT output (array)
WideBandFrequency	Hz	Marker absolute frequency (single value)

3.21.7.4 SpurN Trace Dataset

This is a plot of the final narrowband sweep for the Nth spur found. If no spurs are found, this dataset will not be recorded.

Name	Units	Description
SpurTraceX	Hz	Horizontal trace frequency, normalized to 0 at the marker frequency (array)
SpurTraceY	dBm	Vertical trace amplitude, corrected to the UUT output (array)
SpurFrequency	Hz	Marker absolute frequency (single value)

3.21.7.5 Scalar Dataset

Name	Units	Description
ULPowerCorr	dBm	Corrected uplink carrier power (may be –999 if test is “No-Drive”)

Name	Units	Description
ULPowerUnCorr	dBm	Uncorrected uplink power (may be –999 if test is “No-Drive”)
ULPathCal	dB	Uplink path insertion gain, between VSA CH1 and PTS uplink calibration plane.
ULExtHWCal	dB	Uplink external hardware insertion gain, between the PTS uplink calibration plane and the UUT input.
ULTVAmpCal	dB	Thermal vacuum amplitude offset for the uplink.
DLPowerCorr	dBm	Corrected downlink power (may be –999 if test is “No-Drive”.)
DLPowerUnCorr	dBm	Un-corrected downlink power (may be –999 if test is “No-Drive”.)
DLPathCal	dB	Downlink path insertion gain, between VSA CH2 and PTS downlink calibration plane.
DLExtHWCal	dB	Downlink external hardware insertion gain, between the PTS downlink calibration plane and the UUT input.
DLTVAmpCal	dB	Thermal vacuum amplitude offset for the downlink.
NumSpurs	N/A	Number of found spurs
OutputCenterFrequency	Hz	Same as OutputCenterFrequency in Program Schedule Message

3.21.7.6 SpuriousResponse Array Dataset

Name	Units	Description
SpurFrequency	Hz	Frequency of found spur
SpurIndex	N/A	Integer indicating order in which spur was found during search
SpurBandPower	dBm	Measured spur power in the specified SpurBWSpec bandwidth at the UUT output
SpurRelPower	dBc	Measured power of spur relative to measured downlink carrier level
SpurAbsPowerCorr	dBm	Measured power of spur (absolute level) at the UUT output

SpurAbsPowerUnCorr	dBm	Un-corrected measured power of spur
SpurPathCal	dB	Downlink path insertion gain, between receiver input and PTS downlink calibration plane, at the spur frequency
SpurExtHWCal	dB	Downlink external hardware insertion gain, between the PTS downlink calibration plane and the UUT input, at the spur frequency
SpurTVAmpCal	dB	Thermal vacuum amplitude offset of the downlink, at the spur frequency
NarrowBandScanStatus	N/A	Pass/Fail status of the final narrow band scan. If spur is higher than SpurSpec, =0 (Fail). If spur is less than or equal to SpurSpec, =1 (Pass)
RptSpurAmpSpecdBc Or RptSpurAmpSpecdBm	dB Or dBm	Reported value of SpurAmpSpecdBc or SpurAmpSpecdBm from Program Schedule Message

3.21.7.7 KnownSignalResponses Array Dataset

This array is recorded only if parameter KnownSignalFrequency is specified.

Name	Units	Description
KnownIndex	N/A	Integer of known signal array index
KnownFrequency	Hz	Frequency of known signal
KnownRelPower	dBc	Measured power of known signal relative to DLPowerCorr
KnownAbsPowerCorr	dBm	Measured power of known signal (absolute level)
KnownAbsPowerUnCorr	dBm	Measured uncorrected power of known signal
KnownPathCal	dB	Downlink path insertion gain, between receiver input and PTS downlink calibration plane, at the known signal frequency

Name	Units	Description
KnownExtHWCal	dB	Downlink external hardware insertion gain, between the PTS downlink calibration plane and the UUT input, at the known signal frequency.
KnownTVAmpCal	dB	Thermal vacuum amplitude offset of the downlink, at the known signal frequency.

3.21.7.8 IMDResponses Array Dataset

This array is recorded only if parameter IMDProducts is specified.

Name	Units	Description
ImdIndex	N/A	Integer of Imd response index
ImdOrder	N/A	Order of the Imd Response
ImdFrequency	Hz	Frequency of the measured intermodulation product
ImdRelPower	dBc	Measured power of intermodulation product relative to the measured carrier power
ImdAbsPowerCorr	dBm	Measured corrected power of the intermodulation product absolute value
ImdAbsPowerUnCorr	dBm	Measured uncorrected power of the intermodulation product absolute value
ImdPathCal	dB	Downlink path insertion gain, between receiver input and PTS downlink calibration plane, at the intermod signal frequency
ImdExtHWCal	dB	Downlink external hardware insertion gain, between the PTS downlink calibration plane and the UUT input, at the intermod signal frequency
ImdTVAmpCal	dB	Thermal vacuum amplitude offset of the downlink, at the intermod signal frequency

3.21.8 Calibrations Required

- Uplink Port Gain Calibration
- Downlink Port Gain Calibration
- Downconverter RF Gain Calibration
- Receiver Amp/Pad Gain Calibration
- External Hardware Calibrations
- Thermal Vacuum Amplitude Calibration

3.21.9 VEE File Names

Spurious.LIB

3.22 Threshold Measurement - Command

3.22.1 Test Purpose

The purpose of this test is to determine the power level in which is the command receiver can no longer demodulate the spacecraft configuration request.

This test will fulfill the following test requirements of a typical payload test plan:

- Command Receiver Threshold

3.22.2 Test Diagram

SINGLE SOURCE VSA MEASUREMENT

3.22.3 Test Description

The test begins by generating either a CW or a frequency-modulated carrier at a specified frequency using RF Source 1. The switch matrix is set to connect the VSA CH1 to the source uplink coupler. The FM is created by a user-supplied tone applied to the RF source modulation input or is internally generated by the source. The deviation of the uplink FM signal is measured with CH1 of the VSA.

If the deviation is not within specified limits, the user is requested to adjust the amplitude of the user-supplied tone. The RF source output power is adjusted to the specified UUT input power and the stimulus signal is routed to the UUT uplink input.

The test determines the threshold point by stepping input power and issuing a command and telemetry request at each power level. The host computer will respond with corresponding telemetry response and a command resume message indicating CV or No CV. If CV response is received the measurement will step power to the next level and once again pause to send the host computer the appropriate request. This process is repeated until a No CV is received. Once the No CV is received the power level is recorded as the threshold point. The measurement will then increase the uplink power by the specified level and repeat the CV process again until a No CV is recorded. This process will repeat until the number of tries is reached and the average threshold level is recorded.

VSA readings will be corrected for system internal and external path losses using calibration data measured prior to the test. See Section 4.1 for details on corrected uplink and downlink power calculations.

3.22.4 Program Schedule Message

Name	Type	Units	Description
PTEConfiguration	Parameter		See Section 5.1.2
UUTCFG	Parameter		See Section 5.1.3
Ports	Group		See Section 5.1.4
InputSpotFreq	Group		See Section 5.1.5
InputSweptPower	Group		See Section 5.1.12
InputFMTone	Group		See Section 5.1.16 Note: If FMModFrequency is set to zero, the test will use a CW uplink signal.

3.22.5 Local Parameter File

Name	Type	Units	Description
SimulateTest	Parameter		See Section 5.2.2
85121A Compatibility Mode	Parameter		See Section 5.2.14
Command Request	String		Command Mnemonic sent to the test conductor in the command pause message
InputSignal	Group		See Section 5.2.3
Receiver	Group		See Section 5.2.4
FMToneGen	Group		See Section 5.2.11
IntTelemetry	Group		See Section 5.2.13
SNROrResBW	Group		See Section 5.2.9 Note: MaxResBW applies to this test, but not MinSNR.
ThresholdSequence	Group		See Section 5.2.15

3.22.6 Command, Telemetry & Control Messages

Intermediate telemetry communications, as defined in the LPF string-array parameter IntTelemetry, are (optionally, depending on the PTEConfiguration flag YIT/NIT) sent and the responses recorded at each power level during the power sweep. The intermediate telemetry data is stored in the Intermediate Telemetry data package INTTLM inside the results Citifile. Each telemetry mnemonic becomes the name of a variable parameter within the INTTLM data package.

The dependent variable of the package is, in this measurement, InputPower. The values that the telemetry records at each power level will appear in the dependent data arrays of the package.

Standard telemetry as defined in the “stf” file is (optionally, depending on the PTEConfiguration flag YST/NST) carried out at the input reference level. Each defined standard telemetry mnemonic will appear as a result variable of that name in the STDTLM data package in the result Citifile. The values returned by the UUT for each mnemonic sent will be recorded as the values of those result variables in the STDTLM data package.

3.22.7 Results

The results file consists of the following datasets:

- Scalar Dataset
- PowerSweep Array Dataset
- SweepSummary Array Dataset

Note that these datasets are in addition to the standard datasets provided by all measurements.

3.22.7.1 Scalar Dataset

Name	Units	Description
MeasuredFMDeviation	Hz	Measured command FM deviation
MeasResBW	Hz	Receiver resolution bandwidth that was used during the measurement
FMDeviationError	Hz	Error from desired FM deviation
MeasRefPhase	Deg	Measured phase difference between uplink and downlink at starting power level
InitialInputPower	dBm	Measured input starting power level, corrected for internal and external path losses
InitialVSACH1Power	dBm	VSA Ch1 marker reading
ThresholdAverage		Calculated average of all the threshold readings

3.22.7.2 PowerSweep Array Dataset

Name	Units	Description
InputPowerRelRef This is the independent variable for this dataset, and is the “X” value for plots and limit testing.	dB	Input power relative to InputReferencePower
InputPower	dBm	Input power to UUT, absolute dBm, corrected for PTS internal and external calibration
InputPathCal InputExtHwCal InputTVAmpOffset InputPowerRaw	dB dB dB dBm	Input signal path cal External hardware cal Thermal vacuum amplitude offset Uncorrected receiver reading
AGC Telemetry	N/A	Value returned from host computer in response to a telemetry request

3.22.7.3 SweepSummary Array Dataset

Name	Units	Description
SweepNumber This is the independent variable for this dataset, and is the “X” value for plots and limit testing.	Real	Index for each loop of the threshold sweep
InputThreshold	dBm	Input power to UUT, absolute dBm, corrected for PTS internal and external calibration for the point that the threshold limit was met
InputThresholdUn Corr	dBm	Uncorrected input power level at the threshold point

3.22.8 Calibrations Required

- Uplink Port Gain Calibration
- Downconverter RF Gain Calibration
- Receiver Amp/Pad Gain Calibration
- External Hardware Calibrations
- Thermal Vacuum Amplitude Calibration

3.22.9 VEE Library Name

Threshold.lib

3.23 Threshold Measurement - Ranging

3.23.1 Test Purpose

The purpose of this test is to determine the power level in which the command receiver can no longer demodulate the spacecraft range tone.

This test will fulfill the following test requirements of a typical payload test plan:

- Ranging Threshold

3.23.2 Test Diagram

SINGLE SOURCE VSA MEASUREMENT

3.23.3 Test Description

The test begins by generating either a CW or a frequency-modulated carrier at a specified frequency using RF Source 1. The switch matrix is set to connect the VSA CH1 to the source uplink coupler. The FM is created by a user-supplied tone applied to the RF source modulation input or is internally generated by the source. The deviation of the uplink FM signal is measured with CH1 of the VSA.

If the deviation is not within specified limits, the user is requested to adjust the amplitude of the user-supplied tone. The RF source output power is adjusted to the specified UUT input power and the stimulus signal is routed to the UUT uplink input.

The measurement will measure the phase of the uplink signal on channel 1 of the VSA versus the phase of the signal on the downlink on channel 2 of the VSA. This value is stored as reference phase. The uplink power will then be stepped down as specified. At each power step, the phase difference between the baseband ranging tone on the input and the demodulated signal on the output of the transponder. The power level is stepped down in amplitude until the reference phase and the measured phase is greater and then the specified phase “delta phase” is reached. The power level is recorded as the threshold level. The test repeats the threshold sequence for the user specified number of passes. The average of the threshold readings is calculated and recorded.

VSA readings will be corrected for system internal and external path losses using calibration data measured prior to the test. See Section 4.1 for details on corrected uplink and downlink power calculations.

3.23.4 Program Schedule Message

Name	Type	Units	Description
PTEConfiguration	Parameter		See Section 5.1.2
UUTCFG	Parameter		See Section 5.1.3
Ports	Group		See Section 5.1.4
InputSpotFreq	Group		See Section 5.1.5
InputSweptPower	Group		See Section 5.1.12
InputFMTone	Group		See Section 5.1.16 Note: If FMModFrequency is set to zero, the test will use a CW uplink signal.

3.23.5 Local Parameter File

Name	Type	Units	Description
SimulateTest	Parameter		See Section 5.2.2
85121A Compatibility Mode	Parameter		See Section 5.2.14
ATPSimMode	Integer		If equal to 1, use the ATP simulated threshold level. (Use for ATP only.)
ATPSimModeThreshold	Double		Defines the threshold for the simulated mode during ATP
InputSignal	Group		See Section 5.2.3
Receiver	Group		See Section 5.2.4
FMToneGen	Group		See Section 5.2.11
IntTelemetry	Group		See Section 5.2.13
SNROrResBW	Group		See Section 5.2.9 Note: MaxResBW applies to this test, but not MinSNR.
ThresholdSequence	Group		See Section 5.2.15

3.23.6 Command, Telemetry & Control Messages

Intermediate telemetry communications, as defined in the LPF string-array parameter IntTelemetry, are (optionally, depending on the PTEConfiguration flag YIT/NIT) sent and the responses recorded at each power level during the power sweep. The intermediate telemetry data is stored in the Intermediate Telemetry data package INTTLM inside the results Citifile. Each telemetry mnemonic becomes the name of a variable parameter within the INTTLM data package.

The dependent variable of the package is, in this measurement, InputPower. The values that the telemetry records at each power level will appear in the dependent data arrays of the package.

Standard telemetry as defined in the "stf" file is (optionally, depending on the PTEConfiguration flag YST/NST) carried out at the input reference level. Each defined standard telemetry mnemonic will appear as a result variable of that name in the STDTLM data package in the result Citifile. The values returned by the UUT for each mnemonic sent will be recorded as the values of those result variables in the STDTLM data package.

3.23.7 Results

The results file consists of the following datasets:

- Scalar Dataset
- PowerSweep Array Dataset
- SweepSummary Array Dataset

Note that these datasets are in addition to the standard datasets provided by all measurements.

3.23.7.1 Scalar Dataset

Name	Units	Description
MeasuredFMDeviation	Hz	Measured command FM deviation
MeasResBW	Hz	Receiver resolution bandwidth that was used during the measurement
FMDeviationError	Hz	Error from desired FM deviation
MeasRefPhase	Deg	Measured phase difference between uplink and downlink at starting power level
InitialInputPower	dBm	Measured input starting power level, corrected for internal and external path losses
InitialVSACH1Power	dBm	VSA Ch1 marker reading
ThresholdAverage		Calculated average of all the threshold readings

3.23.7.2 PowerSweep Array Dataset

Name	Units	Description
InputPowerRelRef This is the independent variable for this dataset, and is the "X" value for plots and limit testing.	dB	Input power relative to InputReferencePower
InputPower	dBm	Input power to UUT, absolute dBm, corrected for PTS internal and external calibration
InputPathCal InputExtHwCal InputTVAmpOffset InputPowerRaw	dB dB dB dBm	Input signal path cal external hardware cal thermal vacuum amplitude offset uncorrected receiver reading
PhaseDelta	deg	Phase delta between the input and out for each power step

3.23.7.3 SweepSummary Array Dataset

Name	Units	Description
SweepNumber This is the independent variable for this dataset, and is the "X" value for plots and limit testing.	Real	Index for each loop of the threshold sweep
InputThreshold	dBm	Input power to UUT, absolute dBm, corrected for PTS internal and external calibration for the point that the threshold limit was met
InputThresholdUn Corr	dBm	Uncorrected input power level at the threshold point
MeasThresholdPhase	deg	Measured difference in phase between the input and the output at the threshold point

Calibrations Required

- Uplink Port Gain Calibration
- Downconverter RF Gain Calibration
- Receiver Amp/Pad Gain Calibration
- External Hardware Calibrations
- Thermal Vacuum Amplitude Calibration

3.23.8 VEE Library Name

Threshold.lib

4. CALIBRATIONS

4.1 SYSTEM POWER AND DELAY CORRECTIONS

The PTS calibrations are designed to provide corrections that can be used by the measurements to calculate accurate power and delay at the Unit Under Test (UUT). The calibration interface for the PTS is defined as the point at which the user attaches the calibration reference devices to the test system.

4.1.1 Uplink Power Corrections

Uplink power is measured using CH1 of the VSA. The corrected uplink power at the UUT is calculated as:

UL Corrected Power (dBm) = VSA CH1 Power Reading (dBm)

+ DC_CH1Gain (dB)

+ DC_CH1GainDelta (dB)

- CH1Pad/AmpRelGain (dB)

+ ULPortGain (dB)

+ ULPortPadRelGain (dB)

+ External UL Hardware Gain (dB)

+ ULThermal Vacuum Amplitude Offsett (dB) (if applicable)

External Hardware Gain is defined as gain that exists beyond the calibration interface and is contained in gain files supplied by the operator. All other terms are defined in the following calibration sections. For any given measurement frequency, the PTS software will provide interpolated values for the individual terms.

Uplink power can also be measured using the spectrum analyzer. The corrected uplink power at the calibration interface is calculated as:

UL Corrected Power (dBm) = SA Power Reading (dBm)

+ SA_ULGain (dB)

- CH1Pad/AmpRelGain (dB)

+ ULPortGain (dB)

+ External UL Hardware Gain (dB)

+ ULThermal Vacuum Amplitude Offsett (dB) (if applicable)

4.1.2 Downlink Power Corrections

Downlink power can be measured using CH2 of the VSA. The corrected downlink power at the UUT is calculated as:

DL Corrected Power (dBm) = VSA CH2 Power Reading (dBm)

+ DC_CH2Gain (dB)

+ DC_CH2GainDelta (dB)

- CH2Pad/AmpRelGain (dB)

+ DLPortGain (dB)

- External DL Hardware Gain (dB)

+ DLThermal Vacuum Amplitude Offsett (dB) (if applicable)

External Hardware Gain is defined as gain that exists beyond the calibration interface and is contained in gain files supplied by the operator. All other terms are defined in the following calibration sections. For any given measurement frequency, the PTS software will provide interpolated values for the individual terms.

Downlink power can also be measured using the spectrum analyzer. The corrected downlink power at the calibration interface is calculated as:

DL Corrected Power (dBm) = SA Power Reading (dBm)

+ SA_DLGain (dB)

- CH2Pad/AmpRelGain (dB)

+ DLPortGain (dB)

+ External DL Hardware Gain (dB)

+ DLThermal Vacuum Amplitude Offsett (dB) (if applicable)

4.1.3 Uplink Delay Corrections

Uplink delay is measured using CH1 of the VSA. The corrected uplink delay at the UUT is calculated as:

UL Corrected Delay (s) = VSA CH1 Delay Reading (s)

+ ULPortDelay (s)

- CH1_PadRelDelay (s)

+ ULPadRelDelay (s)

+ External UL Hardware Delay (s)

+ ULThermal Vacuum Delay Offsett (s) (if applicable)

External Hardware Delay is defined as delay that exists beyond the calibration interface and is contained in delay files supplied by the operator. All other terms are defined in the following calibration sections. For any given measurement frequency, the PTS software will provide interpolated values for the individual terms.

4.1.4 Downlink Delay Corrections

Downlink delay is measured using CH2 of the VSA. The corrected downlink delay at the UUT is calculated as:

DL Corrected Delay (s) = VSA CH2 Delay Reading (s)

+ DLPortDelay (s)

- CH2_Pad/AmpRelDelay (s)

+ External DL Hardware Delay (s)

+ DLThermal Vacuum Delay Offsett (s) (if applicable)

External Hardware Delay is defined as delay that exists beyond the calibration interface and is contained in delay files supplied by the operator. For any given measurement frequency, the PTS software will provide interpolated values for the individual terms.

4.1.5 Cal Frequency Specification

Because measurements can require corrections from multiple calibrations, the frequency ranges of the cals must be coordinated. The PTS software provides this functionality through the use of two common cal frequency configuration files: ULCalFreqConf.prm for uplink calibration frequencies and DLCalFreqConf.prm for downlink calibration frequencies. These files are used to link calibration frequency ranges to each of the PTS uplink and downlink ports.

4.1.5.1 ULCalFreqConf.prm Frequency Band Parameters

The following parameters define the common uplink calibration frequencies:

Name	Type	Units	Description
{ULFreqBands}	String array	N/A	ULFreqBands defines the frequency band names. These names are user-defined (C-Band-UP, etc.)
{ULFreqBandStart} {ULFreqBandStop}	Real Arrays	Hz	Corresponding start, stop and step frequencies for each ULFreqBand

4.1.5.2 ULCalFreqConf.prm Port Definitions

The following parameters describe bands and frequencies that apply to a port. Each Port is configured to include one or more bands. The port names used in the system reflect the internal port names and not the user-defined labels.

Name	Type	Units	Description
{*PortName*_Amplitude_Bands}	String array	N/A	Amplitude_Bands define the calibration bands for the gain calibrations. The *PortName* is the internal system port name (not user-defined). Note: For general non-port calibrations such as internal Rcvr Pad Amp and Downconverter gain cals, a pseudo-port name can be used.
{*PortName*_Delay_Bands }	String array	N/A	Delay_Bands define the calibration bands for the delay calibrations. The *PortName* is the internal system port name (not user-defined).

Name	Type	Units	Description
{*PortName*_CenterFreqs}	Real array	Hz	CenterFreqs define discrete frequencies of interest for which a calibration point is desired. The *PortName* is the internal system port name (not user-defined). Note: For general non-port calibrations such as internal Rcvr Pad Amp and Downconverter gain cals, a pseudo-port name can be used.

4.1.5.3 DLCalFreqConf.prm Frequency Band Parameters

The following parameters define the common downlink calibration frequencies:

Name	Type	Units	Description
{DLFreqBands}	String array	N/A	DLFreqBands defines the frequency band names. These names are user-defined (C-Band-DOWN, etc.)
{DLFreqBandStart} {DLFreqBandStop}	Real Arrays	Hz	Corresponding start, stop and step frequencies for each DLFreqBand

4.1.5.4 DLCalFreqConf.prm Port Definitions

The following parameters describe bands and frequencies that apply to a port. Each Port is configured to include one or more bands. The port names used in the system reflect the internal port names and not the user-defined labels.

Name	Type	Units	Description
{*PortName*_Amplitude_Bands}	String array	N/A	Amplitude_Bands define the calibration bands for the gain calibrations. The *PortName* is the internal system port name (not user-defined). Note: For general non-port calibrations such as internal Rcvr Pad Amp and Downconverter gain cals, a pseudo-port name can be used.
{*PortName*_Delay_Bands }	String array	N/A	Delay_Bands define the calibration bands for the delay calibrations. The *PortName* is the internal system port name (not user-defined).

Name	Type	Units	Description
{*PortName*_Delay_Bands }	String array	N/A	Delay_Bands define the calibration bands for the delay calibrations. The *PortName* is the internal system port name (not user-defined).

{*PortName*_CenterFreqs}	Real array	Hz	CenterFreqs define discrete frequencies of interest for which a calibration point is desired. The *PortName* is the internal system port name (not user-defined). Note: For general non-port calibrations such as internal Rcvr Pad Amp and Downconverter gain cals, a pseudo-port name can be used.

4.1.6 Calibration Assets Specification

System users have the ability to define the assets that will be used for calibration. The PTS software provides this functionality through the calibration configuration file: calassets.prm for the definition to use the calibration cart assets or the rack assets for uplink and downlink calibrations.

4.1.6.1 CalAsset.prm

The following parameters describe the hardware equipment to be used for calibration.

Name	Type	Units	Description
CalSourceAssetCH1	String	N/A	Defines the source to be used for calibration. The user selects between RFSource1 Rf Source2 CalSource1 or CalSource2
CalPMAssetCH1	String	N/A	Defines the power meter to be used for calibration. The user selects between PM1, PM2, PM3, PM4, CalPM1, or CalPM2
CalSourceAssetCH2	String	N/A	Defines the source to be used for calibration. The user selects between RFSource1 Rf Source2 CalSource1 or CalSource2
CalPMAssetCH2	String	N/A	Defines the power meter to be used for calibration. The user selects between PM1, PM2, PM3, PM4, CalPM1, or CalPM2

4.2 Antenna Port Gain Calibration

4.2.1 Test Purpose

The purpose of the Antenna Port Gain Calibration is to measure the insertion gain between the antenna test port and the antenna interface.

4.2.2 Test Diagram

ANTENNA TEST PORT CALIBRATION SET-UP

4.2.3 Test Description

The Antenna Port Gain Calibration measures the insertion gain between the antenna port and the antenna interface. The operator is directed to zero and calibrate the calibration power meters (if a specified time since last done has elapsed), and then connects the CALPM sensor to one arm of a calibration power splitter and the CALPM2 to the antenna side of the spacecraft coupler. The other arm of the splitter is connected to the coupled port of the spacecraft coupler. All other ports on the spacecraft coupler must be terminated. The common port of the splitter is supplied with an RF signal via a cable connected to a specified uplink port. The switch matrix is set to connect the RF source to the specified uplink port. The RF source is set to the start frequency. The calibration power meter CALPM serves as the system absolute power standard and is programmed to the source frequency so that it reads and applies the calibration sensor's cal factor to its measurement. The RF source output power is adjusted to keep both power sensors in their optimum measurement range. The two calibration sensor values are read and the antenna loss is calculated as:

AntPortGain (dB) = Cal PM2 Reading (dBm) – CAL PM Reading (dBm)

The RF source is stepped across the specified frequency range, with the power meter readings recorded at each point.

The test can be configured to run over multiple start/stop/step frequency ranges. In addition, specific channel center frequencies can be added to the list of measured frequencies to eliminate interpolation error at channel centers. (See Section 4.1.5)

4.2.4 Program Schedule Message

Name	Type	Units	Description
PTEConfiguration	Parameter		See Section 5.1.2
Ports	Group		See Section 5.1.4
CalTrendMode	Parameter		See Section 5.1.9
InputSweptFrequency	Group		See Section 5.1.8

4.2.5 Local Parameter File

Name	Type	Units	Description
SimulateTest	Parameter		See Section 5.2.2
Receiver	Group		See Section 5.2.4
PortTypeForCalFile	String		Should be either “uplink” or “downlink” to designate the port name to be used as part of the calibration file name to be created

4.2.6 Results

The results file consists of the following datasets:

- FrequencySweep Array Dataset
- CalTrend Array Dataset

Note that these datasets are in addition to the standard datasets provided by all measurements.

4.2.6.1 FrequencySweep Array Dataset

Name	Units	Description
Frequency This is the independent variable for this dataset, and is the “X” value for plots and limit testing.	Hz	Calibration (absolute) frequencies
AntPortGain	dB	Measured insertion gain between the calibration power sensors

4.2.6.2 CalTrend Array Dataset

Name	Units	Description
Frequency This is the independent variable for this dataset, and is the “X” value for plots and limit testing.	Hz	Calibration (absolute) frequencies
AntPortGainPrevious	dB	Measured insertion Gain between the calibration power sensors for the previous calibration that has been stored
AntPortGainDelta	dB	Variation from previous calibration, equals AntPortGain - AntPortGainPrevious

4.2.7 Calibrations Created

The following files are created by this calibration for use by other tests:

File Name	Units	Description
AntPortGain _*x*	dB	Measured insertion gain between the calibration power sensors on the spacecraft coupler located at Port *x*

4.2.8 VEE Library Name

CouplerCal.lib

4.3 Payload Port Gain Calibration

4.3.1 Test Purpose

The purpose of the Payload Port Gain Calibration is to measure the insertion gain between the Payload test port and the payload interface.

4.3.2 Test Diagram

PAYLOAD TEST PORT CALIBRATION SET-UP

4.3.3 Test Description

The Payload Port Gain Calibration measures the insertion loss between the payload port and the payload interface. The operator is directed to zero and calibrate the calibration power meters (if a specified time since last done has elapsed), and then connects the CALPM to the antenna interface of the spacecraft coupler sensor and the CALPM2 to the payload coupled arm side of the spacecraft coupler. The payload interface side of the spacecraft coupler is connected to the RF signal via a cable connected to a specified uplink port. All other ports on the spacecraft coupler must be terminated. The switch matrix is set to connect the RF source to the specified uplink port. The RF source is set to the start frequency. The calibration power meter CALPM serves as the system absolute power standard and is programmed to the source frequency so that it reads and applies the calibration sensor's cal factor to its measurement. The RF source output power is adjusted to keep both power sensors in their optimum measurement range. The two calibration sensor values are read and the payload port loss is calculated as:

PayloadPortGain (dB) = Cal PM2 Reading(dBm) – CAL PM Reading (dBm)

The RF source is stepped across the specified frequency range, with the power meter readings recorded at each point.

The test can be configured to run over multiple start/stop/step frequency ranges. In addition, specific channel center frequencies can be added to the list of measured frequencies to eliminate interpolation error at channel centers. (See Section 4.1.5)

4.3.4 Program Schedule Message

Name	Type	Units	Description
PTEConfiguration	Parameter		See Section 5.1.2
Ports	Group		See Section 5.1.4
CalTrendMode	Parameter		See Section 5.1.9
InputSweptfrequency	Group		See Section 5.1.8

4.3.5 Local Parameter File

Name	Type	Units	Description
SimulateTest	Parameter		See Section 5.2.2
Receiver	Group		See Section 5.2.4
PortTypeForCalFile	String		Should be either “uplink” or “downlink” to designate the port name to be used as part of the calibration file name to be created

4.3.6 Results

The results file consists of the following datasets:

- FrequencySweep Array Dataset
- CalTrend Array Dataset

Note that these datasets are in addition to the standard datasets provided by all measurements.

4.3.6.1 FrequencySweep Array Dataset

Name	Units	Description
Frequency This is the independent variable for this dataset, and is the “X” value for plots and limit testing.	Hz	Calibration (absolute) frequencies
PayloadPortGain	dB	Measured insertion gain between the calibration power sensors

4.3.6.2 CalTrend Array Dataset

Name	Units	Description
Frequency This is the independent variable for this dataset, and is the “X” value for plots and limit testing.	Hz	Calibration (absolute) frequencies
PayloadPortGainPrevious	dB	Measured insertion gain between the calibration power sensors for the previous calibration that has been stored
PayloadPortGainDelta	dB	Variation from previous calibration, equals PayloadPortGain - PayloadPortGainPrevious

4.3.7 Calibrations Created

The following files are created by this calibration for use by other tests:

File Name	Units	Description
PayloadPortGain _*x*	dB	Measured insertion gain between the calibration power sensors on the spacecraft coupler located at Port *x*

4.3.8 VEE Library Name

CouplerCal.lib

4.4 Uplink Port Gain Calibration

4.4.1 Test Purpose

The purpose of the Uplink Port Gain Calibration is to measure the insertion gain of the uplink path between the PTS rack and the UUT interface for a specified uplink port.

4.4.2 Test Diagram

UPLINK PORT GAIN CAL

4.4.3 Test Description

The Uplink Port Gain Calibration measures the insertion gain between the uplink power sensor in the PTS and the calibration power sensor at the UUT interface. The operator is directed to zero and calibrate the calibration power meter (if a specified time since last done has elapsed), and then connects the sensor to the uplink UUT interface port to be tested. The switch matrix is set to connect the RF source to the specified uplink port. The RF source is set to the uplink start frequency. The calibration power meter serves as the system absolute power standard and is programmed to the source frequency so that it reads and applies the calibration sensor's cal factor to its measurement. The uplink power meter is set to a cal factor of 100%, since it is to be referenced to the calibration sensor. The RF source output power is adjusted to keep both power sensors in their optimum measurement range. The uplink sensor and calibration sensor values are read and the uplink gain is calculated as:

ULPortGain (dB) = Cal PM Reading(dBm) – UL PM Reading (dBm)

The RF source is stepped across the specified frequency range, with the power meter readings recorded at each point.

The test has the optional ability to measure the uplink insertion gain with the uplink attenuator in the path. The uplink attenuator is used in measurements requiring low UUT input power levels. The frequency sweep described above is repeated with the uplink pad in. The uplink sensor and calibration sensor values are read and the uplink gain is calculated as:

ULPortPadRelGain (dB) =
[Cal PM Reading(dBm) – UL PM Reading (dBm)] – ULPortGain (dB)

Note that ULPortPadRelGain is expressed as gain relative to the measured uplink thru path in dB.

The test can be configured to run over multiple start/stop/step frequency ranges. In addition, specific channel center frequencies can be added to the list of measured frequencies to eliminate interpolation error at channel centers. (See Section 4.1.5)

4.4.4 Program Schedule Message

Name	Type	Units	Description
PTEConfiguration	Parameter		See Section 5.1.2
Ports Note: For this calibration, OutputPort will be ignored.	Group		See Section 5.1.4
CalTrendMode	Parameter		See Section 5.1.9

4.4.5 Local Parameter File

Name	Type	Units	Description
Simulate Test	Parameter		See Section 5.2.2
Receiver	Group		See Section 5.2.4

4.4.6 Results

The results file consists of the following datasets:

- FrequencySweep Array Dataset
- CalTrend Array Dataset

Note that these datasets are in addition to the standard datasets provided by all measurements.

4.4.6.1 FrequencySweep Array Dataset

Name	Units	Description
Frequency This is the independent variable for this dataset, and is the "X" value for plots and limit testing.	Hz	Calibration (absolute) frequencies
ULPortGain	dB	Measured insertion gain between the uplink power sensor in the PTS and the calibration power sensor at the uplink port
ULPortPadRelGain	dB	Insertion gain of the uplink attenuator, measured at the uplink port
ULSourceToPortGain	dB	Measured insertion gain between the uplink RF source in the PTS and the calibration power sensor at the uplink port

4.4.6.2 CalTrend Array Dataset

Name	Units	Description
Frequency This is the independent variable for this dataset, and is the "X" value for plots and limit testing.	Hz	Calibration (absolute) frequencies
ULPortGainPrevious	dB	Measured insertion gain between the uplink power sensor in the PTS and the calibration power sensor at the uplink port, for the previous calibration that has been stored
ULPortGainDelta	dB	Variation from previous calibration, equals ULPortGain - ULPortGainPrevious
ULPortPadRelGainPrevious	dB	Insertion gain of the uplink attenuator, measured at the uplink port, for the previous calibration that has been stored
ULPortPadRelGainDelta	dB	Variation from previous calibration, equals ULPortPadRelGain - ULPortPadRelGainPrevious

4.4.7 Calibrations Created

The following files are created by this calibration for use by other tests:

File Name	Units	Description
ULPortGain _*x*	dB	Measured insertion gain between the uplink power sensor in the PTS and the calibration power sensor at Uplink Port *x*
ULPortPadRelGain_*x*	dB	Insertion gain of the uplink attenuator, measured at Uplink Port *x*

4.4.8 VEE Library Name

ULPortGainCal.lib

4.5 Downlink Port Gain Calibration

4.5.1 Test Purpose

The purpose of the Downlink Port Gain Calibration is to measure the insertion gain of the downlink path between the PTS rack and the UUT interface for a specified downlink port.

4.5.2 Test Diagram

DOWNLINK PORT GAIN CAL

4.5.3 Test Description

The Downlink Port Gain Calibration measures the insertion gain between the downlink power sensor in the PTS and the calibration power sensor at the UUT interface. The operator is directed to zero and calibrate the calibration power meter (if a specified time since last done has elapsed), and then connects the sensor to one arm of a calibration power splitter. The other arm of the splitter is connected to the downlink UUT interface port to be tested. The common port of the splitter is supplied with RF signal via a cable connected to a specified uplink port. The switch matrix is set to connect the RF source to the specified uplink port and connect the downlink power sensor to the specified downlink port, as shown in the test diagram. The RF source is set to the downlink start frequency. The calibration power meter serves as the system absolute power standard and is programmed to the source frequency so that it reads and applies the calibration sensor's cal factor to its measurement. The downlink power meter is set to a cal factor of 100%, since it is to be referenced to the calibration sensor. The RF source output power is adjusted to keep both power sensors in their optimum measurement range. The downlink sensor and calibration sensor values are read and the downlink gain is calculated as:

DLPortGain (dB) = Cal PM Reading (dBm) – DL PM Reading (dBm)

The RF source is stepped across the specified frequency range, with the power meter readings recorded at each point.

The test can be configured to run over multiple start/stop/step frequency ranges. In addition, specific channel center frequencies can be added to the list of measured frequencies to eliminate interpolation error at channel centers. (See Section 4.1.5)

4.5.4 Program Schedule Message

Name	Type	Units	Description
PTEConfiguration	Parameter		See Section 5.1.2
Ports	Group		See Section 5.1.4
CalTrendMode	Parameter		See Section 5.1.9

4.5.5 Local Parameter File

Name	Type	Units	Description
SimulateTest	Parameter		See Section 5.2.2
Receiver	Group		See Section 5.2.4

4.5.6 Results

The results file consists of the following datasets:

- FrequencySweep Array Dataset
- CalTrend Array Dataset

Note that these datasets are in addition to the standard datasets provided by all measurements.

4.5.6.1 FrequencySweep Array Dataset

Name	Units	Description
Frequency This is the independent variable for this dataset, and is the "X" value for plots and limit testing.	Hz	Calibration (absolute) frequencies
DLPortGain	dB	Measured insertion gain between the downlink power sensor in the PTS and the calibration power sensor at the downlink port

4.5.6.2 CalTrend Array Dataset

Name	Units	Description
Frequency This is the independent variable for this dataset, and is the "X" value for plots and limit testing.	Hz	Calibration (absolute) frequencies
DLPortGainPrevious	dB	Measured insertion gain between the downlink power sensor in the PTS and the calibration power sensor at the downlink port, for the previous calibration that has been stored
DLPortGainDelta	dB	Variation from previous calibration, equals DLPortGain - DLPortGainPrevious

4.5.7 Calibrations Created

The following files are created by this calibration for use by other tests:

File Name	Units	Description
DLPortGain _*x*	dB	Measured insertion gain between the downlink power sensor in the PTS and the calibration power sensor at Downlink Port *x*

4.5.8 VEE Library Name

DLPortGainCal.lib

4.6 Downconverter RF Gain Calibration

4.6.1 Test Purpose

The purpose of the Downconverter RF Gain Calibration is to measure the insertion gain of the downconverter path between the uplink/downlink power sensors and the Vector Signal Analyzer (VSA) for specified uplink/downlink frequency ranges.

4.6.2 Test Diagram

DOWNCONVERTER RF GAIN CAL

4.6.3 Test Description

The Downconverter RF Gain Calibration measures the insertion gain between the uplink or downlink power sensors through the dual downconverter to the VSA inputs. This is an internal calibration, but requires the remote unit to be connected to the main rack.

The test begins by running the power meter zero and cal and the VSA internal cal if the specified times since these have last been performed has elapsed. The switch matrix is set to route the RF source output through the uplink "coupled" path to the uplink power sensor and the VSA CH1 input, and to route the RF source output through the remote unit downlink "passthru" path to the downlink power sensor and VSA CH2 input (see test diagram).

To measure the uplink RF gain, the RF source is set to a specified uplink start frequency and its output power level is adjusted to achieve a target power level at the uplink power sensor. The downconverter CH1 input frequency is tuned to convert the RF signal to the IF output center frequency. The VSA CH1 power level and the uplink power sensor level are read and the gain is calculated as:

DC_CH1Gain (dB) = UL PM Reading (dBm) – VSA CH1 Reading (dBm)

The RF source is stepped across the specified frequency range, with the VSA and power meter readings recorded at each point. The test can be configured to run over multiple start/stop/step frequency ranges, and specific channel center frequencies can be added to the list of measured frequencies to eliminate interpolation error at channel centers.

The calibration also includes "spot" frequencies in the downconverter band that can be used to perform periodic re-calibrations and eliminate downconverter IF gain drift. The PTS measurements can call for the Downconverter RF Gain Calibration at the spot frequency as a subroutine prior to the beginning of a test. The downconverter RF gain delta at the spot frequencies are then calculated as:

DC_CH1GainDelta (dB) =
DC_CH1Gain (dB) – [UL PM Reading (dBm) – VSA CH1 Reading (dBm)]

This gain delta value will be used by the measurements to correct for small drifts in the downconverter gain that have occurred since execution of the wide frequency range calibration.

To measure the downlink RF gain, the above steps are repeated, setting the RF source to frequencies in the downlink frequency range. The VSA CH2 power level and the downlink power sensor level are read, and the gain is calculated as:

DC_CH2Gain (dB) = DL PM Reading (dBm) – VSA CH2 Reading (dBm)

This routine can also be called by a measurement to execute the Downconverter RF Gain Calibration at the spot frequencies as a subroutine prior to the beginning of test. The downconverter RF gain delta at the spot frequencies are then calculated as:

DC_CH2_GainDelta (dB) =
DC_CH2Gain (dB) – [DL PM Reading (dBm) – VSA CH2 Reading (dBm)]

4.6.4 Program Schedule Message

Name	Type	Units	Description
PTEConfiguration	Parameter		See Section 5.1.2
Ports	Group		See Section 5.1.4
CalTrendMode	Parameter		See Section 5.1.9

4.6.5 Local Parameter File

Name	Type	Units	Description
SimulateTest	Parameter		See Section 5.2.2
Receiver	Group		See Section 5.2.4

4.6.6 Results

The results file consists of the following datasets:

- FrequencySweep_CH1 Array Dataset
- FrequencySweep_CH2 Array Dataset
- CalTrend_CH1 Array Dataset
- CalTrend_CH2 Array Dataset

Note that these datasets are in addition to the standard datasets provided by all measurements.

4.6.6.1 FrequencySweep_CH1 Array Dataset

Name	Units	Description
Frequency This is the independent variable for this dataset, and is the "X" value for plots and limit testing.	Hz	Calibration (absolute) frequencies
DC_CH1Gain	dB	Measured insertion gain from the uplink power sensor through the dual downconverter to the VSA CH1 input

4.6.6.2 FrequencySweep_CH2 Array Dataset

Name	Units	Description
Frequency This is the independent variable for this dataset, and is the "X" value for plots and limit testing.	Hz	Calibration (absolute) frequencies
DC_CH2Gain	dB	Measured insertion gain from the downlink power sensor through the dual downconverter to the VSA CH2 input

4.6.6.3 CalTrend_CH1 Array Dataset

Name	**Units**	**Description**
Frequency This is the independent variable for this dataset, and is the “X” value for plots and limit testing.	Hz	Calibration (absolute) frequencies
DC_CH1GainPrevious	dB	Measured insertion gain from the uplink power sensor through the dual downconverter to the VSA CH1 input, for the previous calibration that has been stored
DC_CH1GainDelta	dB	Variation from previous calibration, equals DC_CH1Gain - DC_CH1GainPrevious

4.6.6.4 CalTrend_CH2 Array Dataset

Name	**Units**	**Description**
Frequency This is the independent variable for this dataset, and is the “X” value for plots and limit testing.	Hz	Calibration (absolute) frequencies
DC_CH2GainPrevious	dB	Measured insertion gain from the downlink power sensor through the dual downconverter to the VSA CH2 input, for the previous calibration that has been stored
DC_CH2GainDelta	dB	Variation from previous calibration, equals DC_CH2Gain - DC_CH2GainPrevious

4.6.7 Calibrations Created

The following files are created by this calibration for use by other tests:

File Name	Units	Description
DC_CH1Gain	dB	Measured insertion gain from the uplink power sensor through the dual downconverter to the VSA CH1 input
DC_CH1GainDelta	dB	Measured delta change in DC_CH1Gain at the spot calibration frequencies
DC_CH2Gain	dB	Measured insertion gain from the downlink power sensor through the dual downconverter to the VSA CH2 input
DC_CH2GainDelta	dB	Measured delta change in DC_CH2Gain at the spot calibration frequencies

4.6.8 VEE Library Name

DownconverterRFGainCal.lib

4.7 Source Amp/Pad Gain Calibration

4.7.1 Test Purpose

The purpose of the Source Amp/Pad Gain Calibration is to measure the insertion gain of the source switched amplifiers and attenuators (pads) relative to the thru path for specified uplink frequency ranges.

4.7.2 Test Diagram

SOURCE AMP/PAD GAIN CAL

4.7.3 Test Description

The Source Amp/Pad Gain Calibration measures the insertion gain of the source switched 20 dB attenuator (pad) in the remote unit relative to the thru path for specified uplink frequency ranges. This is an internal calibration, but requires the remote unit to be connected to the main rack.

The test begins by running the VSA internal cal, if the specified time since this have last been performed has elapsed. The switch matrix is set to route the RF source output through the uplink “coupled” path to the VSA CH1 input, and to route the RF source output through the downlink “passthru” path to the VSA CH2 input (see test diagram).

To measure the source CH1 paths, the test begins by setting the CH1 path to the “thru” setting. The RF source is set to a specified uplink start frequency and its output power level is adjusted to achieve a target power level at the VSA CH1 input. The downconverter input frequency (CH1 and CH2) is tuned to convert the RF signal to the IF output center frequency. The VSA CH1 and CH2 power levels are read and the gain relative to the CH2 path is calculated as:

CH1ThruGain (dB) = VSA CH1 Reading (dBm) – VSA CH2 Reading (dBm)

The RF source is stepped across the specified frequency range, with the VSA readings recorded at each point.

The switch matrix is then set to the Source “pad” setting. The measurement is repeated over the same frequency range, this time calculating the gain of the “pad” path relative to the CH2 path as:

SourcePadGain (dB) = VSA CH1 Reading (dBm) – VSA CH2 Reading (dBm)

The gain of the pad path relative to the thru path can then be calculated as:

SourcePadRelGain (dB) = SourcePadGain (dB) - CH1ThruGain (dB)

The test can be configured to run over multiple start/stop/step frequency ranges, and specific channel center frequencies can be added to the list of measured frequencies to eliminate interpolation error at channel centers. (See Section 4.1.5)

4.7.4 Program Schedule Message

Since this is an internal calibration, no system ports need to be specified.

Name	Type	Units	Description
PTEConfiguration	Parameter		See Section 5.1.2
Ports	Group		See Section 5.1.4
CalTrendMode	Parameter		See Section 5.1.9

4.7.5 Local Parameter File

Name	Type	Units	Description
SimulateTest	Parameter		See Section 5.2.2
Receiver	Group		See Section 5.2.4
ULThru_DLThru_SrcPower ULPad_DLThru_SrcPower ULAmp_DLThru_SrcPower	Real	dBm	RF Source Power Parameters set the RF source power settings for the SourceAmpPadGainCal. The values listed have been selected for the losses of the System Switching Unit used in this test system. These values should not be changed for this hardware configuration.

4.7.6 Results

The results file consists of the following datasets:

- FrequencySweep_CH1 Array Dataset
- CalTrend_CH1 Array Dataset

Note that these datasets are in addition to the standard datasets provided by all measurements.

4.7.6.1 FrequencySweep_CH1 Array Dataset

Name	Units	Description
Frequency This is the independent variable for this dataset, and is the "X" value for plots and limit testing.	Hz	Calibration (absolute) frequencies
CH1PadRelGain	dB	Measured insertion gain of the source attenuator

4.7.6.2 CalTrend_CH1 Array Dataset

Name	Units	Description
Frequency This is the independent variable for this dataset, and is the "X" value for plots and limit testing.	Hz	Calibration (absolute) frequencies
SourcePadRelGainPrevious	dB	Measured insertion gain of the source attenuator, for the previous calibration that has been stored
SourcePadRelGainDelta	dB	Variation from previous calibration, equals SourcePadRelGain - SourcePadRelGainPrevious

4.7.7 Calibrations Created

The following files are created by this calibration for use by other tests:

File Name	Units	Description
SourcePadRelGain	dB	Measured insertion gain of the source attenuator

4.7.8 VEE Library Name

SourceAmpPadGainCal.lib

4.8 Receiver Amp/Pad Gain Calibration

4.8.1 Test Purpose

The purpose of the Receiver Amp/Pad Gain Calibration is to measure the insertion gain of the receiver switched amplifiers and attenuators (pads) relative to the thru path for specified uplink/downlink frequency ranges.

4.8.2 Test Diagram

RECEIVER AMP/PAD GAIN CAL

4.8.3 Test Description

The Receiver Amp/Pad Gain Calibration measures the insertion gain of the receiver switched 15 dB amplifier, 30 dB amplifier, and 15 dB attenuator (pad) in the PTE unit and 30 dB amplifier in the remote unit relative to the thru path for specified uplink/downlink frequency ranges. This is an internal calibration, but requires the remote unit to be connected to the main rack.

The test begins by running the VSA internal cal, if the specified time since this have last been performed has elapsed. The switch matrix is set to route the RF source output through the uplink “coupled” path to the VSA CH1 input, and to route the RF source output through the downlink “passthru” path to the VSA CH2 input (see test diagram).

To measure the receiver CH1 paths, the test begins by setting the CH1 path to the “thru” setting. The RF source is set to a specified uplink start frequency and its output power level is adjusted to achieve a target power level at the VSA CH1 input. The downconverter input frequency (CH1 and CH2) is tuned to convert the RF signal to the IF output center frequency. The VSA CH1 and CH2 power levels are read and the gain relative to the CH2 path is calculated as:

CH1ThruGain (dB) = VSA CH1 Reading (dBm) – VSA CH2 Reading (dBm)

The RF source is stepped across the specified frequency range, with the VSA readings recorded at each point.

The switch matrix is then set to the CH1 “pad” setting. The measurement is repeated over the same frequency range, this time calculating the gain of the “pad” path relative to the CH2 path as:

CH1PadGain (dB) = VSA CH1 Reading (dBm) – VSA CH2 Reading (dBm)

Finally, the switch matrix is then set to the CH1 “amp” setting. The RF source power will need to be lowered to achieve the target power level at the VSA CH1 input. The measurement is repeated over the same frequency range, this time calculating the gain of the “amp” path relative to the CH2 path as:

CH115dBAmpGain (dB) = VSA CH1 Reading (dBm) – VSA CH2 Reading (dBm)

CH130dBAmpGain (dB) = VSA CH1 Reading (dBm) – VSA CH2 Reading (dBm)

The gain of the pad path relative to the thru path can then be calculated as:

CH1PadRelGain (dB) = CH1PadGain (dB) - CH1ThruGain (dB)

The gain of each of the amplifier paths relative to the thru path can then be calculated as:

CH115dBAmpRelGain (dB) = CH115dBAmpGain (dB) – CH1ThruGain (dB)

CH130dBAmpRelGain (dB) = CH130dBAmpGain (dB) – CH1ThruGain (dB)

The test can be configured to run over multiple start/stop/step frequency ranges, and specific channel center frequencies can be added to the list of measured frequencies to eliminate interpolation error at channel centers. (See Section 4.1.5)

To measure the receiver CH2 amplifier and pad paths, the measurements above are repeated over the downlink frequency ranges, substituting CH2 for CH1 and vice versa. The path gains are calculated as:

CH2ThruGain (dB) = VSA CH2 Reading (dBm) – VSA CH1 Reading (dBm)

CH2PadGain (dB) = VSA CH2 Reading (dBm) – VSA CH1 Reading (dBm)

CH215dBAmpGain (dB) = VSA CH2 Reading (dBm) – VSA CH1 Reading (dBm)

CH230dBAmpGain (dB) = VSA CH2 Reading (dBm) – VSA CH1 Reading (dBm)

CH2REM30dbGain (dB) = VSA CH2 Reading (dBm) – VSA CH1 Reading (dBm)

And the relative path gains are:

CH2PadRelGain (dB) = CH2PadGain (dB) - CH2ThruGain (dB)

CH215dBAmpRelGain (dB) = CH215dBAmpGain (dB) – CH2ThruGain (dB)

CH230dBAmpRelGain (dB) = CH230dBAmpGain (dB) – CH2ThruGain (dB)

CH2REM30dBAmpRelGain (dB) = CH2REM30dBAmpGain (dB) – CH2ThruGain (dB)

4.8.4 Program Schedule Message

Since this is an internal calibration, no system ports need to be specified.

Name	Type	Units	Description
PTEConfiguration	Parameter		See Section 5.1.2
Ports	Group		See Section 5.1.4
CalTrendMode	Parameter		See Section 5.1.9

4.8.5 Local Parameter File

Name	Type	Units	Description
SimulateTest	Parameter		See Section 5.2.2
Receiver	Group		See Section 5.2.4
ULThru_DLThru_SrcPower ULPad_DLThru_SrcPower UL15dbAmp_DLThru_Src Power UL30dbAmp_DLThru_Src Power ULThru_DLPad_SrcPower ULThru_DL15dBAmp_Src Power ULThru_DL30dBAmp_Src Power ULThru_DLREM30dBAmp _SRCPower	Real	dBm	RF Source Power Parameters set the RF source power settings for the RcvrAmpPadGainCal. The values listed have been selected for the losses of the System Switching Unit used in this test system. These values should not be changed for this hardware configuration.

4.8.6 Results

The results file consists of the following datasets:

- FrequencySweep_CH1 Array Dataset
- FrequencySweep_CH2 Array Dataset
- CalTrend_CH1 Array Dataset
- CalTrend_CH2 Array Dataset

Note that these datasets are in addition to the standard datasets provided by all measurements.

4.8.6.1 FrequencySweep_CH1 Array Dataset

Name	Units	Description
Frequency This is the independent variable for this dataset, and is the "X" value for plots and limit testing.	Hz	Calibration (absolute) frequencies
CH1PadRelGain	dB	Measured insertion gain of the CH1 receiver attenuator
CH115dBAmpRelGain	dB	Measured insertion gain of the CH1 receiver 15 dB amplifiers
CH130dBAmpRelGain	dB	Measured insertion gain of the CH1 receiver 30 db amplifiers

4.8.6.2 FrequencySweep_CH2 Array Dataset

Name	Units	Description
Frequency This is the independent variable for this dataset, and is the "X" value for plots and limit testing.	Hz	Calibration (absolute) frequencies

Name	Units	Description
CH2PadRelGain	dB	Measured insertion gain of the CH2 receiver attenuator
CH215dBAmpRelGain	dB	Measured insertion gain of the CH2 receiver 15 dB amplifier
CH230dBAmpRelGain	dB	Measured insertion gain of the CH2 receiver 30 dB amplifier
CH2REM30dBAmpRelGain	dB	Measured insertion gain of the CH2 remote unit 30 dB amplifier

4.8.6.3 CalTrend_CH1 Array Dataset

Name	Units	Description
Frequency This is the independent variable for this dataset, and is the "X" value for plots and limit testing.	Hz	Calibration (absolute) frequencies
CH1PadRelGainPrevious	dB	Measured insertion gain of the CH1 receiver attenuator, for the previous calibration that has been stored
CH1PadRelGainDelta	dB	Variation from previous calibration, equals CH1PadRelGain – CH1PadRelGainPrevious
CH115dBAmpRelGainPrevious	dB	Measured insertion gain of the CH1 receiver 15 dB amplifiers, for the previous calibration that has been stored
CH115dBAmpRelGainDelta	dB	Variation from previous calibration, equals CH115dBAmpRelGain – CH115dBAmpRelGainPrevious
CH130dBAmpRelGainPrevious	dB	Measured insertion gain of the CH1 receiver 30 dB amplifiers, for the previous calibration that has been stored.
CH130dBAmpRelGainDelta	dB	Variation from previous calibration, equals CH130dBAmpRelGain – CH130dBAmpRelGainPrevious

4.8.6.4 CalTrend_CH2 Array Dataset

Name	Units	Description
Frequency This is the independent variable for this dataset, and is the "X" value for plots and limit testing.	Hz	Calibration (absolute) frequencies
CH2PadRelGainPrevious	dB	Measured insertion gain of the CH2 receiver attenuator, for the previous calibration that has been stored
CH2PadRelGainDelta	dB	Variation from previous calibration, equals CH2PadRelGain – CH2PadRelGainPrevious
CH215dBAmpRelGainPrevious	dB	Measured insertion gain of the CH2 receiver 15 dB amplifiers, for the previous calibration that has been stored
CH215dBAmpRelGainDelta	dB	Variation from previous calibration, equals CH215dBAmpRelGain – CH215dBAmpRelGainPrevious
CH230dBAmpRelGainPrevious	dB	Measured insertion gain of the CH2 receiver 30 dB amplifiers, for the previous calibration that has been stored
CH230dBAmpRelGainDelta	dB	Variation from previous calibration, equals CH230dBAmpRelGain – CH230dBAmpRelGainPrevious
CH2REM30dBAmpRelGainPrevious	dB	Measured insertion gain of the CH2 remote unit 30 dB amplifier, for the previous calibration that has been stored
CH2REM30dBAmpRelGainDelta	dB	Variation from previous calibration, equals CH2REM30dBAmpRelGain – CH2REM30dBAmpRelGainPrevious

4.8.7 Calibrations Created

The following files are created by this calibration for use by other tests:

File Name	Units	Description
CH1PadRelGain	dB	Measured insertion gain of the CH1 receiver attenuator
CH115dBAmpRelGain	dB	Measured insertion gain of the CH1 receiver 15 dB amplifiers
CH130dBAmpRelGain	dB	Measured insertion gain of the CH1 receiver 30 dB amplifiers
CH2PadRelGain	dB	Measured insertion gain of the CH2 receiver attenuator
CH215dBAmpRelGain	dB	Measured insertion gain of the CH2 receiver 15 dB amplifiers
CH230dBAmpRelGain	dB	Measured insertion gain of the CH2 receiver 30 dB amplifiers
CH2REM30dBAmpRelGain	dB	Measured insertion gain of the CH2 remote unit 30 dB amplifier

4.8.8 VEE Library Name

ReceiverAmpPadGainCal.lib

4.9 Spectrum Analyzer Gain Calibration

4.9.1 Test Purpose

The purpose of the Spectrum Analyzer Gain Calibration is to measure the insertion gain of the uplink and downlink path between the power sensors and the spectrum analyzer (SA) for specified frequency ranges.

4.9.2 Test Diagram

SPECTRUM ANALYZER GAIN CAL

4.9.3 Test Description

The Spectrum Analyzer Gain Calibration measures the insertion gain between the uplink and downlink power sensors and the spectrum analyzer input. This is an internal calibration, but requires the remote unit to be connected to the main rack.

The test begins by running the power meter zero and cal and the SA internal cal if the specified time since these have last been performed has elapsed. The switch matrix is set to route the RF source output through the downlink “passthru” path to the downlink power sensor and SA RF input (see test diagram).

To measure the downlink SA gain, the RF source is set to a specified downlink start frequency and its output power level is adjusted to achieve a target power level at the downlink power sensor. The SA is tuned to the test frequency. The SA power level and the downlink power sensor level are read and the gain is calculated as:

SA_Gain (dB) = DL PM Reading (dBm) – SA Reading (dBm)

The RF source is stepped across the specified frequency range, with the SA and power meter readings recorded at each point.

The test can be configured to run over multiple start/stop/step frequency ranges. (See Section 4.1.5)

4.9.4 Program Schedule Message

Since this is an internal calibration, no system ports need to be specified.

Name	Type	Units	Description
PTEConfiguration	Parameter		See Section 5.1.2
Ports	Group		See Section 5.1.4
CalTrendMode	Parameter		See Section 5.1.9

4.9.5 Local Parameter File

Name	Type	Units	Description
SimulateTest	Parameter		See Section 5.2.2
Receiver	Group		See Section 5.2.4

4.9.6 Results

The results file consists of the following datasets:

- FrequencySweep Array Dataset
- CalTrend Array Dataset

Note that these datasets are in addition to the standard datasets provided by all measurements.

4.9.6.1 FrequencySweep Array Dataset

Name	Units	Description
DLFrequency This is the independent variable for this dataset, and is the "X" value for plots and limit testing.	Hz	Calibration (absolute) frequencies for the downlink path
DLSA_Gain	dB	Measured insertion gain from the downlink power sensor through the system switch unit to the spectrum analyzer input

4.9.6.2 CalTrend Array Dataset

Name	Units	Description
DLFrequency This is the independent variable for this dataset, and is the "X" value for plots and limit testing.	Hz	Calibration (absolute) frequencies used to measure the downlink path
DLSA_GainPrevious	dB	Measured insertion gain from the downlink power sensor through the system switch unit to the spectrum analyzer input, for the previous calibration that has been stored
DLSA_GainDelta	dB	Variation from previous calibration, equals SA_Gain - SA_GainPrevious

4.9.7 Calibrations Created

The following files are created by this calibration for use by other tests:

File Name	Units	Description
DLSA_Gain	dB	Measured insertion gain from the downlink power sensor through the system switch unit to the spectrum analyzer input, for the previous calibration that has been stored

4.9.8 VEE Library Name

SpectrumAnalyzerGainCal.lib

4.10 Uplink Spectrum Analyzer RF Gain Calibration

4.10.1 Test Purpose

The purpose of the Uplink Spectrum Analyzer RF Gain Calibration is to measure the insertion gain of the path between the uplink power sensor and the spectrum analyzer (SA) for specified uplink/downlink frequency ranges.

4.10.2 Test Diagram

Uplink Spectrum Analyzer RF Gain Calibration

4.10.3 Test Description

The Uplink Spectrum Analyzer RF Gain Calibration measures the insertion gain between the uplink power sensor to the SA. This is an internal calibration, but requires the remote unit to be connected to the main rack. The test begins by running the power meter zero and cal and the SA internal cal if the specified times since these have last been performed has elapsed. The switch matrix is set to route the RF source output through the uplink “coupled” path to the SA to measure the uplink RF gain. The RF source is set to a specified uplink start frequency and its output power level is adjusted to achieve a target power level at the uplink power sensor. The SA power level and the uplink power sensor level are read and the gain is calculated as:

Uplink Spectrum Analyzer Gain (dB) = UL PM Reading (dBm) – Spectrum Analyzer Reading (dBm).

The RF source is stepped across the specified frequency range, with the SA and power meter readings recorded at each point. The test can be configured to run over multiple start/stop/step frequency ranges. (See Section 4.1.5)

4.10.4 Program Schedule Message

Since this is an internal calibration, no system ports need to be specified.

Name	Type	Description
PTEConfiguration	Parameter	See Section 5.1.2
Ports	Group	See Section 5.1.4
CalTrendMode	Parameter	See Section 5.1.9

4.10.5 Local Parameter File

Name	Type	Description
Simulate Test	Parameter	See Section 5.2.2
Receiver	Group	See Section 5.2.4

4.10.5.1 Results

The results file consists of the following datasets:

- FrequencySweep Array Dataset
- CalTrend Array Dataset

Note that these datasets are in addition to the standard datasets provided by all measurements.

4.10.5.2 FrequencySweep Array Dataset

Name	Units	Description
ULFrequency This is the independent variable for this dataset, and is the "X" value for plots and limit testing.	Hz	Calibration (absolute) frequencies for the uplink path
ULSA_GainPrevious	dB	Variation from previous calibration, equals ULSA_Gain – ULSA_GainPrevious

Name	Units	Description
ULSA_GainData	dB	Measured insertion gain from the uplink power sensor through the system switch unit to the spectrum analyzer input, for the previous calibration that has been stored.

4.10.5.3 CalTrend Array Dataset

Name	Units	Description
ULFrequency This is the independent variable for this dataset, and is the "X" value for plots and limit testing.	Hz	Calibration (absolute) frequencies used to measure the uplink path
ULSA_GainPrevious	dB	Measured insertion gain from the uplink power sensor through the system switch unit to the spectrum analyzer input, for the previous calibration that has been stored

4.10.5.4 Calibrations Created

Name	Units	Description
ULSA_Gain	dB	Measured insertion gain from the uplink power sensor through the system switch unit to the spectrum analyzer input, for the previous calibration that has been stored

4.10.6 VEE Library Name

SpectrumAnalyzerGainCal.lib

4.11 Uplink Delay Calibration

4.11.1 Test Purpose

The purpose of the Uplink Delay Calibration is to measure the delay of the uplink path between the PTS rack and the UUT interface for a specified uplink port.

4.11.2 Test Diagram

UPLINK DELAY CAL

4.11.3 Test Description

The Uplink Delay Calibration measures the delay between the VSA CH1 input in the PTS and the calibration diode detector at the UUT interface. The diode detector has a known flat group delay response to amplitude-modulated signals and is therefore the group delay reference for the calibration.

The test begins by running the VSA internal cal if the specified time since this have last been performed has elapsed. The operator is directed to connect the input of the diode detector to the uplink UUT interface port to be tested.

The switch matrix is set to route the RF source output through the uplink “coupled” path to the VSA CH1 input, and to the specified uplink port. The stimulus signal is a two-tone RF signal with a carrier separation equal to the specified measurement step size F_{STEP} and a constant phase relationship between the two carriers. The phase of the detector’s video output (at F_{STEP}) is proportional to the group delay of the RF signal.

The RF source is set to the uplink start frequency. The RF source output power is adjusted to achieve a target power level at the detector RF input. CH2 of the VSA is used to measure the phase of the detector video output. CH1 of the VSA is used to measure the delta-phase between the two-uplink carriers as they are stepped across the uplink frequency range. The uplink delay calibration can then be derived from:

ULPortDelay (s) = Detector Delay (s) – VSA CH1 Delta Delay (s)

Where delay is calculated as:

$$Delay = \frac{VSAPhase\,\mathrm{Re}\,ading}{360 \times f_{STEP}}$$

The RF source is stepped across the specified frequency range, with the calculated delay recorded at each point. The test can be configured to run over multiple start/stop/step frequency ranges (see section 4.1.5).

4.11.4 Program Schedule Message

Name	Type	Units	Description
PTEConfiguration	Parameter		See Section 5.1.2
Ports Note: For this calibration, Outputport will be ignored	Group		See Section 5.1.4
CalTrendMode	Parameter		See Section 5.1.9

4.11.5 Local Parameter File

Name	Type	Units	Description
SimulateTest	Parameter		See Section 5.2.2
Receiver	Group		See Section 5.2.4
TwoToneAverages DetectorAverages	Int	N/A	The delay calibration uses different averaging when measuring the 2-tone signal than when measuring the detector signal. This is due to the fact that the detector signal has higher signal to noise ratio and therefore requires less averaging. Using two different averaging values speeds up the calibration.
SpanToRBWRatio	Real	N/A	The VSA measurement resolution bandwidth can be set with this parameter. VSA Res BW = VSA Span * SpanToResBWRatio. The VSA Span is set proportional to the Tone Spacing. Note: This value must match the value for the uplink cal.

Name	Type	Units	Description
minToneSpacing maxToneSpacing	Real	Hz	Tone Spacing is generally set equal to the measurement step size, with a minimum value of minToneSpacing and a maximum value of maxToneSpacing. The lower limit prevents repeatability problems caused by low modulation rates. The upper limit prevents the signal from exceeding the receiver bandwidth. Note: These values must match the values for the uplink cal.
DetTargetPower	Real	dBm	The calibration attempts to level the power at the output of the detector to ensure constant delay through the detector. This parameter value should be set as high as possible to ensure good SNR, but not so high that the RF source maximum power limit is exceeded. Note: This value must match the value for the uplink cal.
detPowerWindow	Real	dB	The RF source power will be adjusted until the output of the detector is equal to detTargetPower +/- detPowerWindow

4.11.6 Results

The results file consists of the following datasets:

- FrequencySweep Array Dataset
- CalTrend Array Dataset

Note that these datasets are in addition to the standard datasets provided by all measurements.

4.11.6.1 FrequencySweep Array Dataset

Name	Units	Description
Frequency This is the independent variable for this dataset, and is the "X" value for plots and limit testing.	Hz	Calibration (absolute) frequencies
ULPortDelay	Sec	Measured delay between the VSA CH1 input and the calibration diode detector at the uplink port

4.11.6.2 CalTrend Array Dataset

Name	Units	Description
Frequency This is the independent variable for this dataset, and is the "X" value for plots and limit testing.	Hz	Calibration (absolute) frequencies
ULPortDelayPrevious	Sec	Measured delay between the VSA CH1 input and the calibration diode detector at the uplink port, for the previous calibration that has been stored
ULPortDelayDelta	Sec	Variation from previous calibration, equals ULPortDelay - ULPortDelayPrevious

4.11.7 Calibrations Created

The following files are created by this calibration for use by other tests:

File Name	Units	Description
ULPortDelay _*x*	Sec	Measured delay between the VSA CH1 input and the calibration diode detector at Uplink Port *x*

4.11.8 VEE Library Name

ULPortDelayCal.lib

4.12 Downlink Delay Calibration

4.12.1 Test Purpose

The purpose of the Downlink Delay Calibration is to measure the delay of the downlink path between the PTS rack and the UUT interface for a specified downlink port.

4.12.2 Test Diagram

DOWNLINK DELAY CAL

4.12.3 Test Description

The Downlink Delay Calibration measures the delay between the VSA CH2 input in the PTS and the calibration diode detector at the UUT interface. The diode detector has a known flat group delay response to amplitude-modulated signals and is therefore the group delay reference for the calibration.

The test begins by running the VSA internal cal, if the specified time since this have last been performed has elapsed. The operator is directed to connect the RF input of the diode detector to one arm of a calibration power splitter. The other arm of the splitter is connected to the downlink UUT interface port to be tested. The common port of the splitter is supplied with RF signal via a cable connected to a specified uplink port.

The switch matrix is set to connect the RF source to the specified uplink port and connect the VSA CH2 input to the specified downlink port, as shown in the test diagram. The stimulus signal is a two-tone RF signal with a carrier separation equal to the specified measurement step size F_{STEP} and a constant phase relationship between the two carriers. The phase of the detector's video output (at F_{STEP}) is proportional to the group delay of the RF signal.

The RF source is set to the downlink start frequency. The RF source output power is adjusted to achieve a target power level at the detector RF input CH1 of the VSA is used to measure the phase of the detector video output. CH2 of the VSA is used to measure the delta-phase between the two-downlink carriers as they are stepped across the downlink frequency range. The downlink delay calibration can then be derived from:

DLPortDelay (s) = Detector Delay (s) – VSA CH2 Delta Delay (s)

Where delay is calculated as:

$$Delay = \frac{VSAPhase\mathrm{Re}ading}{360 \times f_{STEP}}$$

The RF source is stepped across the specified frequency range, with the calculated delay recorded at each point. The test can be configured to run over multiple start/stop/step frequency ranges. (See Section 4.1.5)

4.12.4 Program Schedule Message

Name	Type	Units	Description
PTEConfiguration	Parameter		See Section 5.1.2
Ports	Group		See Section 5.1.4
CalTrendMode	Parameter		See Section 5.1.9

4.12.5 Local Parameter File

Name	Type	Units	Description
SimulateTest	Parameter		See Section 5.2.2
Receiver	Group		See Section 5.2.4
TwoToneAverages DetectorAverages	Int	N/A	The delay calibration uses different averaging when measuring the 2-tone signal than when measuring the detector signal. This is due to the fact that the detector signal has higher signal to noise ratio and therefore requires less averaging. Using two different averaging values speeds up the calibration.
SpanToRBWRatio	Real	N/A	The VSA measurement resolution bandwidth can be set with this parameter. VSA Res BW = VSA Span * SpanToResBWRatio. The VSA Span is set proportional to the Tone Spacing. Note: This value must match the value for the uplink cal.
minToneSpacing maxToneSpacing	Real	Hz	Tone Spacing is generally set equal to the measurement step size, with a minimum value of minToneSpacing

Name	Type	Units	Description
			and a maximum value of maxToneSpacing. The lower limit prevents repeatability problems caused by low modulation rates. The upper limit prevents the signal from exceeding the receiver bandwidth. Note: These values must match the values for the uplink cal.
DetTargetPower	Real	dBm	The calibration attempts to level the power at the output of the detector to ensure constant delay through the detector. This parameter value should be set as high as possible to ensure good SNR, but not so high that the RF source maximum power limit is exceeded. Note: This value must match the value for the uplink cal.
detPowerWindow	Real	dB	The RF source power will be adjusted until the output of the detector is equal to detTargetPower +/- detPowerWindow

4.12.6 Results

The results file consists of the following datasets:

- FrequencySweep Array Dataset
- CalTrend Array Dataset

Note that these datasets are in addition to the standard datasets provided by all measurements.

4.12.6.1 FrequencySweep Array Dataset

Name	Units	Description
Frequency This is the independent	Hz	Calibration (absolute) frequencies

Name	Units	Description
variable for this dataset, and is the "X" value for plots and limit testing.		
DLPortDelay	Sec	Measured delay between the VSA CH2 input and the calibration diode detector at the downlink port

4.12.6.2 CalTrend Array Dataset

Name	Units	Description
Frequency This is the independent variable for this dataset, and is the "X" value for plots and limit testing.	Hz	Calibration (absolute) frequencies
DLPortDelayPrevious	Sec	Measured delay between the VSA CH2 input and the calibration diode detector at the downlink port, for the previous calibration that has been stored
DLPortDelayDelta	Sec	Variation from previous calibration, equals DLPortDelay - DLPortDelayPrevious

4.12.7 Calibrations Created

The following files are created by this calibration for use by other tests:

File Name	Units	Description
DLPortDelay _*x*	Sec	Measured delay between the VSA CH2 input and the calibration diode detector at Downlink Port *x*

4.12.8 VEE Library Name

DLPortDelayCal.lib

4.13 THERMAL VACUUM CALIBRATION

4.13.1 Test Purpose

The purpose of the Thermal Vacuum Calibration (TVAC Cal) is to measure, calculate, and correct the test system for effects of amplitude and phase changes or drift of the test system and cabling with time and temperature. This drift must be known to determine if the system must be recalibrated or so that the known drift can be incorporated into the measured results by offsetting the results by the amount of drift.

There are three levels of RF signal loop paths provided in this system. Each loop enables the measurement and calculation of amplitude and phase drift in each path. See the RF ICD for block diagram showing the three loops.

4.13.2 Test Diagram

THERMAL VACUUM CALIBRATION SETUP

4.13.3 Test Description

The Thermal Vacuum Calibration measures the amplitude and phase through one or all three loop-back paths in the test system. The routine uses a three-equation and three-unknown algorithm to derive a drift measurement for the uplink and downlink.

The Uplink Path gain transfer (loss and phase transfer) is represented as A. The Uplink/Downlink Path gain transfer is represented as B. The Downlink Path gain transfer is represented as C.

A, B, and C are the unknowns that are to be solved. These quantities represent the magnitude and phase gain transfer for the associated path.

The solution is started by measuring the following:

$$Xmeas=A+C$$

$$Ymeas=A+B$$

$$Zmeas=B+C$$

In each case above, the quantities recorded are vectors. For example, they have magnitude and phase. The values X, Y, and Z are the amplitude and phase difference between the measured coupled signal from the uplink and the measured signal on the downlink. For example, X is the amplitude and phase transfer across the uplink (A) and back through the downlink (C).

TVAC Cal loops

There are three possible loop levels in this system: Loop1, Loop2, and Loop 3. Within each one of these levels, there is a set of A, B, and C that is derived from measurements. Thus, it is possible to isolate a drift effect to a loop level. For example, if Loop 1 and Loop 2 did not show any drift in their A, B, and C values, yet Loop 3 did, one can attribute the drift to only Loop 3. For Loop 1 and Loop 2, internal loop back cables are built into the chassis. For loop 3, an external loop back cable is required to be connected for the measurement to be valid.

Since there are three different loops, the following measurements are available:

For Loop 1:

$$Xmeas1=A1+C1$$

$$Ymeas1=A1+B1$$

$$Zmeas1=B1+C1$$

For Loop 2:

$$Xmeas2=A2+C2$$

$$Ymeas2=A2+B2$$

$$Zmeas2=B2+C2$$

For Loop 3:

$$Xmeas3=A3+C3$$

$$Ymeas3=A3+B3$$

$$Zmeas3=B3+C3$$

Reference Plane and Relative Measurements

The requirement for the TVAC Cal is to determine the relative drift of Ax, Bx, Cx (x=loop index) relative to the Loop 1 A1, B1, C1. The Loop 1 measurements set the reference plane to the output of the remote unit. Therefore, Ax, Bx, and Cx are the losses (dB) and phase transfer(degrees) to the end point of the loop.

The two loops of interest are: Loop 2 relative to Loop 1 and Loop 3 relative to Loop 1.

The A, B, C measurement routine will store results as a reference or as an offset to a reference as specified. A reference measurement run will measure the loops and store all the measurements and calculated values, Ax1ref, Bx1ref, and Cx1ref where Axref is the A of loop x relative to Loop 1.

The measurements may be performed using the VSA or the internal power meters. In the power meter case, phase will not be measured. The TVAC Cal descriptions herein are based on the VSA method. The power meter method operates the same way but the power meters are used to measure the amplitude, and a phase of 0 recorded when the power measurements are taken.

Measurement Procedure:

Loop 1 must be measured first

Then either Loop 2 or Loop 3 as specified

For Loop 2:

Xmeas2-Xmeas1 = X21

Ymeas2-Ymeas1 = Y21

Zmeas2-Zmeas1 = Z21

Where

X21 = A21+C21

Y21 = A21+B21

Z21 = B21+C21

Then solve for A21, B21, C21 using the following:

$$A = \frac{X + Y - Z}{2} \qquad B = \frac{-X + Y + Z}{2} \qquad C = \frac{X - Y + Z}{2}$$

Where:

A21 is	A of Loop2 relative to Loop 1
B21 is	B of Loop2 relative to Loop 1
C21 is	C of Loop2 relative to Loop 1

<u>For Loop 3:</u>

Xmeas3-Xmeas1	=	X31
Ymeas3-Ymeas1	=	Y31
Zmeas3-Zmeas1	=	Z31

Where

X31	=	A31+C31
Y31	=	A31+B31
Z31	=	B31+C31

Then solve for A31, B31, and C31 which are:

$$A = \frac{X + Y - Z}{2} \qquad B = \frac{-X + Y + Z}{2} \qquad C = \frac{X - Y + Z}{2}$$

Where:

A31 is	A of Loop 3 relative to Loop 1
B31 is	B of Loop 3 relative to Loop 1
C31 is	C of Loop 3 relative to Loop 1

Reference Measurements and Offset Measurement

During the reference run, the loops of interest must be measured and the related results of these calculated:

A21ref	A of Loop 2 relative to Loop 1
B21ref	B of Loop 2 relative to Loop 1
C21ref	C of Loop 2 relative to Loop 1
A31ref	A of Loop 3 relative to Loop 1
B31ref	B of Loop 3 relative to Loop 1
C31ref	C of Loop 3 relative to Loop 1

Offset Measurement

During the offset run, the same loops of interest must be measured and the following are calculated; Note: If Loop 1 was measured recently, the operator has the choice to always use the most recent Loop 1 data, instead of re-running Loop 1.

A21off	A of Loop 2 relative to Loop 1
B21off	B of Loop 2 relative to Loop 1
C21off	C of Loop 2 relative to Loop 1
A31off	A of Loop 3 relative to Loop 1
B31off	B of Loop 3 relative to Loop 1
C31off	C of Loop 3 relative to Loop 1

Then, the loop drifts can be calculated:

A21drift = A21off - A21ref

B21drift	=	B21off	-	B21ref
C21drift	=	C21off	-	C21ref

A31drift	=	A31off	-	A31ref
B31drift	=	B31off	-	B31ref
C31drift	=	C31off	-	C31ref

A31drift	This is the relative drift of the uplink
B31drift	This is the relative drift of the up/down link
C31drift	This is the relative drift of the downlink

Measurement of X (Xmeas)

If the wrap around cable "measure" parameter is set, for Loop 3, the user is prompted to ensure that the external wrap around cable is connected to the thermal vacuum unit on the ports specified. For Loop 1 and Loop 2, an external cable is not required and the measurement procedure proceeds.

Upon receiving a correct response, the switch matrix is set to connect the RF source through primary uplink path (A) to the uplink loop port on the Uplink. The switch matrix is then set for the return path through primary downlink path (C) by connecting external wrap around cable "in port" through downlink to the input of VSA CH2. The RF source is set to the uplink start frequency and the amplitude and phase is measured. The RF source is stepped across the specified frequency range while the VSA is used to measure amplitude and phase on Ch1 and Ch2. Ch1 is an amplitude and phase sample of the uplink and Ch2 is an amplitude and phase sample of the downlink.

An "X" value is obtained for each frequency point by performing the following calculation:

Amplitude of X = Ch1 (dB) – Ch2 (dB)

Phase of X = Ch1 (degrees) – Ch2 (degrees)

These readings are stored as value "X".

If specified, Y and Z are also measured. If not specified, the value for X is compared to the previous value of X and half of the difference is given to A and half to C.

Measurement of Y

This routine is the same as the measurement of X, except that the measurement is of loop A+B.

Measurement of Z

This routine is the same as the measurement of X, except that the measurement is of loop B+C.

Once the results are calculated, the results will be written to a file based on the results parameter. If the results parameter is set to “reference”, the amplitude and phase results will be stored and uplink and downlink reference files will be created to be used by this calibration in the future. If the results parameter is set to “offset”, the amplitude and phase results will be stored and an additional calculation will be performed to subtract the current results from the uplink and downlink reference files, to determine the amplitude and phase offsets.

The user is then prompted to decide if the offset calibration files should be written. If the operator gives a positive response, the measurement will store the appropriate offset calibration files that will then be used by all future measurements.

The calibration results are stored based on the environment parameter. If the results parameter is set to “test”, the amplitude and phase results will be stored and no calibration or reference files are created.

The test can be configured to run over multiple start/stop/step frequency ranges. In addition, specific channel center frequencies can be added to the list of measured frequencies to eliminate interpolation error at channel centers. (See Section 4.1.5)

4.13.4 Program Schedule Message

Name	Type	Units	Description
PTEConfiguration	Parameter		See Section 5.1.2
Ports	Group		See Section 5.1.4
CalTrendMode	Parameter		See Section 5.1.9

4.13.5 Local Parameter File

Name	Type	Units	Description
Simulate Test	Parameter		See Section 5.2.2
ReceiverType	String		Set to VSA or PM to determine receiver to be used
Receiver	Group		See Section 5.2.4
Remote Unit	Parameter		If 0, do not measure the remote unit. If 1, measure the remote unit.
Thermal Vacuum Unit	Parameter		If 0, do not measure thermal vacuum unit. If 1, measure the thermal vacuum unit (Loop 2).
Wrap Around Cable	Parameter		If 0, do not measure the wrap around cable. If 1, measure the wrap around cable (Loop 3).
TestMode	String		Set to “reference”, “offset”, or “test”
Path Tested	String		Set to AC, BC, AB, or All
Cal Factors Ports	String		Saves cal factors for uplink and downlink to the specified port numbers
Frequencies	String		Set to uplink, downlink, or both
Uplink Port	String		Specifies uplink port to use for the external loopback
Downlink Port	String		Specifies downlink port to use for the external loopback
Offset Prompt	String		If set to “on”, a prompt will appear asking the user to save calibration data if the “Offset Limit” is exceeded for any of the measurements, ONLY IN THE OFFSET MODE. If set to “off”, no prompt will appear, regardless of the value.
Offset Limit	Real		Maximum limit of all offset values

4.13.6 Results

The results file consists of the following datasets:

- FrequencySweep Array Dataset
- CalTrend Amplitude Array Dataset
- CalTrend Phase Array Dataset
- Offset Amplitude Array Dataset
- Offset Phase Array Dataset

Note that these datasets are in addition to the standard datasets provided by all measurements.

4.13.6.1 FrequencySweep Array Dataset

Name	Units	Description
Frequency This is the independent variable for this dataset, and is the "X" value for plots and limit testing.	Hz	Calibration (absolute) frequencies
RemoteULAmplitude	dB	Calculated uplink amplitude for the remote unit
RemoteDLAmplitude	dB	Calculated downlink amplitude for the remote unit
TVULAmplitude	dB	Calculated uplink amplitude for the thermal vacuum unit
TVDLAmplitude	dB	Calculated downlink amplitude for the thermal vacuum unit
CableULAmplitude	dB	Calculated uplink amplitude for the wrap around cable
CableDLAmplitude	dB	Calculated downlink amplitude for the wrap around cable

Name	Units	Description
RemoteULPhase	Sec	Calculated uplink phase for remote the unit
RemoteDLPhase	Sec	Calculated downlink phase for the remote unit
TVULPhase	Sec	Calculated uplink phase for the thermal vacuum unit
TVDLPhase	Sec	Calculated downlink phase for the thermal vacuum unit
CableULPhase	Sec	Calculated uplink phase for the wrap around cable
CableDLPhase	Sec	Calculated downlink phase for the wrap around cable

4.13.6.2 CalTrend Amplitude Array Dataset

Name	Units	Description
Frequency This is the independent variable for this dataset, and is the "X" value for plots and limit testing.	Hz	Calibration (absolute) frequencies
CableULAmplitudePrevious	dB	Calculated amplitude for the wrap around cable, for the previous calibration that has been stored
CableULAmplitudeDelta	dB	Variation from previous calibration, equals CableULAmplitude - CableULAmplitudePrevious
CableDLAmplitudePrevious	dB	Calculated amplitude for the wrap around cable, for the previous calibration that has been stored
CableDLAmplitudeDelta	dB	Variation from previous calibration, equals CableDLAmplitude - CableDLAmplitudePrevious

4.13.6.3 CalTrend Phase Array Dataset

Name	Units	Description
Frequency This is the independent variable for this dataset, and is the “X” value for plots and limit testing.	Hz	Calibration (absolute) frequencies
CableULPhasePrevious	Sec	Calculated phase for the wrap around cable, for the previous calibration that has been stored
CableULPhaseDelta	Sec	Variation from previous calibration, equals CableULPhase - CableULPhasePrevious
CableDLPhasePrevious	Sec	Calculated phase for the wrap around cable, for the previous calibration that has been stored
CableDLPhaseDelta	Sec	Variation from previous calibration, equals CableDLPhase - CableDLPhasePrevious

4.13.6.4 Offset Amplitude Array Dataset

Name	Units	Description
Frequency This is the independent variable for this dataset, and is the “X” value for plots and limit testing.	Hz	Calibration (absolute) frequencies
CableULAmplitudeReference	dB	Calculated amplitude for the wrap around cable, from the previous calibration designated reference run
CableULAmplitudeOffset	dB	Variation from the reference calibration, equals CableULAmplitude - CableULAmplitudePrevious
CableDLAmplitudePrevious	dB	Calculated amplitude for the wrap around cable, from the previous calibration designated reference run
CableDLAmplitudeDelta	dB	Variation from reference calibration, equals CableDLAmplitude - CableDLAmplitudePrevious

4.13.6.5 Offset Phase Array Dataset

Name	Units	Description
Frequency This is the independent variable for this dataset, and is the "X" value for plots and limit testing.	Hz	Calibration (absolute) frequencies
CableULPhasePrevious	Sec	Calculated phase for the wrap around cable, from the previous calibration designated reference run
CableULPhaseDelta	Sec	Variation from reference calibration, equals CableULPhase - CableULPhasePrevious
CableDLPhasePrevious	Sec	Calculated phase for the wrap around cable, from the previous calibration designated as reference run
CableDLPhaseDelta	Sec	Variation from reference calibration, equals CableDLPhase - CableDLPhasePrevious

4.13.7 Calibrations Created

The following files are created by this calibration for use by other tests whenever generated:

File Name	Units	Description
ULCableAmplitudeOffset_x	dB	Calculated uplink (A) amplitude offset from the reference run for port_x
DLCableAmplitudeOffset_x	dB	Calculated downlink (C) amplitude offset from the reference run for port_x
DLULCableAmplitudeOffset_x	dB	Calculated uplink/downlink (B) amplitude offset from the reference run for port_x
ULCablePhaseOffset_x	dB	Calculated uplink (A) phase offset from the reference run for port_x
DLCablePhaseOffset_x	dB	Calculated downlink (C) phase offset from the reference run for port_x
DLULCablePhaseOffset_x	dB	Calculated uplink/downlink (B) phase offset from the reference run for port_x

4.13.8 VEE Library Name

ThermalVacuumCal.lib

4.13.9 Pseudo Measurement Code

4.13.9.1 Loopback Level 1 Procedure (Remote Unit)

NOTE: If the "Remote Unit" parameter is set to 1, Loopback Level 1 will always be run before any other loopback levels selected.

1. Perform for all frequency steps.
2. Set sources.
3. For the following steps, make AC, AB, and BC measurements based on "Path Tested" parameter. If a path is not measured, the parameters will be set to zero in the results file.
4. Set paths and measure AC by making differential measurement using VSA channels 1 and 2. (For power meter, only amplitude is measured.)

   AMP_{X1}, $PHASE_{X1}$

5. Set paths and measure AB by making differential measurement using VSA channels 1 and 2.

   AMP_{Y1}, $PHASE_{Y1}$

6. Set paths and measure BC by making differential measurement using VSA channels 1 and 2.

   AMP_{Z1}, $PHASE_{Z1}$

7. Create dataset {Frequency Step, AMP_{X1}, $PHASE_{X1}$, AMP_{Y1}, $PHASE_{Y1}$, AMP_{Z1}, $PHASE_{Z1}$, } for each frequency. Write to file RemoteResults in the results directory.
8. If "Test Mode" in the Local Parameter File is set to "reference", create dataset {Frequency Step, AMP_{X1}, $PHASE_{X1}$, AMP_{Y1}, $PHASE_{Y1}$, AMP_{Z1}, $PHASE_{Z1}$} for each frequency. Write to file RemoteReference in the calibration directory. Step 8 says what happens if test mode is reference. Need what happens for other test modes or say why other modes are not allowed.

4.13.9.2 Loopback Level 2 Procedure (Thermal Vacuum Unit)

1. Perform for all frequency steps.
2. Set sources.

3. For the following steps, make AC, AB, and BC measurements based on “Path Tested” parameter. If a path is not measured, the parameters will be set to zero in the results file.

4. Set paths and measure AC by making differential measurement using VSA channels 1 and 2. (For power meter, only amplitude is measured.)

$$AMP_{X2},\ PHASE_{X2}$$

5. Set paths and measure AB by making differential measurement using VSA channels 1 and 2. (For power meter, only amplitude is measured.)

$$AMP_{Y2},\ PHASE_{Y2}$$

6. Set paths and measure BC by making differential measurement using VSA channels 1 and 2. (For power meter, only amplitude is measured.)

$$AMP_{Z2},\ PHASE_{Z2}$$

7. Calculate delta values using Loopback Level 1 Reference data.

$$AMP_{X21} = AMP_{X2} - AMP_{X1}$$

$$PHASE_{X21} = PHASE_{X2} - PHASE_{X1}$$

$$AMP_{Y21} = AMP_{Y2} - AMP_{Y1}$$

$$PHASE_{Y21} = PHASE_{Y2} - PHASE_{Y1}$$

$$AMP_{Z21} = AMP_{Z2} - AMP_{Z1}$$

$$PHASE_{Z21} = PHASE_{Z2} - PHASE_{Z1}$$

8. Calculate uplink and downlink datasets:

   a. If “Path Tested” is set to “All”:

$$AMP_{A21} = (AMP_{X21} + AMP_{Y21} - AMP_{Z21}) / 2$$

$$AMP_{B21} = (-AMP_{X21} + AMP_{Y21} + AMP_{Z21}) / 2$$

$$AMP_{C21} = (AMP_{X21} - AMP_{Y21} + AMP_{Z21}) / 2$$

$$PHASE_{A21} = (PHASE_{X21} + PHASE_{Y21} - PHASE_{Z21}) / 2$$

$$PHASE_{B21} = (-PHASE_{X21} + PHASE_{Y21} + PHASE_{Z21}) / 2$$

$$PHASE_{C21} = (PHASE_{X21} - PHASE_{Y21} + PHASE_{Z21}) / 2$$

   b. If “Path Tested is set to “AC”:

$$AMP_{A21} = (AMP_{X21}) / 2$$

$$AMP_{B21} = 0$$

$$AMP_{C21} = (AMP_{X21}) / 2$$

$$PHASE_{A21} = (PHASE_{X21}) / 2$$

$$PHASE_{B21} = 0$$

$$PHASE_{C21} = (PHASE_{X21}) / 2$$

c. If "Path Tested is set to "AB":

$$AMP_{A21} = (AMP_{Y21}) / 2$$

$$AMP_{B21} = (AMP_{Y21}) / 2$$

$$AMP_{C21} = 0$$

$$PHASE_{A21} = (PHASE_{Y21}) / 2$$

$$PHASE_{B21} = (PHASE_{Y21}) / 2$$

$$PHASE_{C21} = 0$$

d. If "Path Tested is set to "BC":

$$AMP_{A21} = 0$$

$$AMP_{B21} = (AMP_{Z21}) / 2$$

$$AMP_{C21} = (AMP_{Z21}) / 2$$

$$PHASE_{A21} = 0$$

$$PHASE_{B21} = (PHASE_{Z21}) / 2$$

$$PHASE_{C21} = (PHASE_{Z21}) / 2$$

9. Create dataset {Frequency Step, AMP_{X1}, $PHASE_{X1}$, AMP_{Y1}, $PHASE_{Y1}$, AMP_{Z1}, $PHASE_{Z1}$, AMP_{X2}, $PHASE_{X2}$, AMP_{Y2}, $PHASE_{Y2}$, AMP_{Z2}, $PHASE_{Z2}$, AMP_{X21}, $PHASE_{X21}$, AMP_{Y21}, $PHASE_{Y21}$, AMP_{Z21}, $PHASE_{Z21}$, AMP_{A21}, $PHASE_{A21}$, AMP_{B21}, $PHASE_{B21}$, AMP_{C21}, $PHASE_{C21}$} for each frequency. Write to file TVResults in the results directory.

10. If "Test Mode" in the Local Parameter File is set to "reference":
    a. Create reference files using all frequencies:
        - {Frequency, AMP_{A21}} to file ULCableReferenceAmp
        - {Frequency, $PHASE_{A21}$} to file ULCableReferencePhase
    b. Create reference files using all frequencies:
        - {Frequency, AMP_{C21}} to file DLCableReferenceAmp
        - {Frequency, $PHASE_{C21}$} to file DLCableReferencePhase
    c. Create reference files using all frequencies:
        - {Frequency, AMP_{B21}} to file ULDLCableReferenceAmp
        - {Frequency, $PHASE_{B21}$} to file ULDLCableReferencePhase

11. If "Test Mode" in the Local Parameter File is set to "offset":

a. Calculate the offset values using parameters from the Cable reference files:

$$AMP_{A21,OFFSET} = AMP_{A21,REF} - AMP_{A21}$$

$$AMP_{B21,OFFSET} = AMP_{B21,REF} - AMP_{B21}$$

$$AMP_{C21,OFFSET} = AMP_{C21,REF} – AMP_{C21}$$

$$PHASE_{A21,OFFSET} = PHASE_{A21,REF} - PHASE_{A21}$$

$$PHASE_{B21,OFFSET} = PHASE_{B21,REF} – PHASE_{B21}$$

$$PHASE_{C21,OFFSET} = PHASE_{C21,REF} – PHASE_{C21}$$

b. Prompt the user based on offset values and values of “Offset Limit” and “Offset Prompt” in the Local Parameter File. If the user doesn’t want to save offset values, skip the following steps.
c. Create calibration files using all frequencies:
    - {Frequency, $AMP_{A21,OFFSET}$} to file ULCableAmplitudeOffset_x
    - {Frequency, $PHASE_{A21,OFFSET}$} to file ULCablePhaseOffset_x
    - A calibration file is created for each port specified in the program schedule message.
d. Create calibration files using all frequencies:
    - {Frequency, $AMP_{C21,OFFSET}$} to file DLCableAmplitudeOffset_x
    - {Frequency, $PHASE_{C21,OFFSET}$} to file DLCablePhaseOffset_x
    - A calibration file is created for each port specified in the program schedule message.
e. Create calibration files using all frequencies:
    - {Frequency, $AMP_{B21,OFFSET}$} to file ULDLCableAmplitudeOffset_x
    - {Frequency, $PHASE_{B21,OFFSET}$} to file ULDLCablePhaseOffset_x
    - A calibration file is created for each port specified in the program schedule message.

4.13.9.3 Loopback Level 3 Procedure (Wrap Around Cable)

1. Perform for all frequency steps.
2. Set Sources
3. For the following steps, make AC, AB and BC measurements based on “Path Tested” parameter. If a path is not measured, the parameters will be set to zero in the results file.
4. Set paths and measure AC by making differential measurement using VSA channels 1 and 2. (For power meter, only amplitude is measured.)

    $$AMP_{X3}, PHASE_{X3}$$

5. Set paths and measure AB by making differential measurement using VSA channels 1 and 2. (For power meter, only amplitude is measured.)

    $$AMP_{Y3}, PHASE_{Y3}$$

6. Set paths and measure BC by making differential measurement using VSA channels 1 and 2. (For power meter, only amplitude is measured.)

$$AMP_{Z3}, PHASE_{Z3}$$

7. Calculate delta values using Loopback Level 1 Reference data.

$$AMP_{X31} = AMP_{X3} - AMP_{X1}$$

$$PHASE_{X31} = PHASE_{X3} - PHASE_{X1}$$

$$AMP_{Y31} = AMP_{Y3} - AMP_{Y1}$$

$$PHASE_{Y31} = PHASE_{Y3} - PHASE_{Y1}$$

$$AMP_{Z31} = AMP_{Z3} - AMP_{Z1}$$

$$PHASE_{Z31} = PHASE_{Z3} - PHASE_{Z1}$$

8. Calculate uplink and downlink datasets:
   a. If “Path Tested” is set to “All”:

$$AMP_{A31} = (AMP_{X31} + AMP_{Y31} - AMP_{Z31}) / 2$$

$$AMP_{B31} = (-AMP_{X31} + AMP_{Y31} + AMP_{Z31}) / 2$$

$$AMP_{C31} = (AMP_{X31} - AMP_{Y31} + AMP_{Z31}) / 2$$

$$PHASE_{A31} = (PHASE_{X31} + PHASE_{Y31} - PHASE_{Z31}) / 2$$

$$PHASE_{B31} = (-PHASE_{X31} + PHASE_{Y31} + PHASE_{Z31}) / 2$$

$$PHASE_{C31} = (PHASE_{X31} - PHASE_{Y31} + PHASE_{Z31}) / 2$$

   b. If “Path Tested” is set to “AC”:

$$AMP_{A31} = (AMP_{X31}) / 2$$

$$AMP_{B31} = 0$$

$$AMP_{C31} = (AMP_{X31}) / 2$$

$$PHASE_{A31} = (PHASE_{X31}) / 2$$

$$PHASE_{B31} = 0$$

$$PHASE_{C31} = (PHASE_{X31}) / 2$$

   c. If “Path Tested” is set to “AB”:

$$AMP_{A31} = (AMP_{Y31}) / 2$$

$$AMP_{B31} = (AMP_{Y31}) / 2$$

$$AMP_{C31} = 0$$

$$PHASE_{A31} = (PHASE_{Y31}) / 2$$

$$PHASE_{B31} = (PHASE_{Y31}) / 2$$

$$PHASE_{C31} = 0$$

   d. If “Path Tested” is set to “BC”:

$$AMP_{A31} = 0$$

$$AMP_{B31} = (AMP_{Z31}) / 2$$

$$AMP_{C31} = (AMP_{Z31}) / 2$$

$$PHASE_{A31} = 0$$

$$PHASE_{B31} = (PHASE_{Z31}) / 2$$

$$PHASE_{C31} = (PHASE_{Z31}) / 2$$

9. Create dataset {Frequency Step, AMP_{X1}, $PHASE_{X1}$, AMP_{Y1}, $PHASE_{Y1}$, AMP_{Z1}, $PHASE_{Z1}$, AMP_{X3}, $PHASE_{X3}$, AMP_{Y3}, $PHASE_{Y3}$, AMP_{Z3}, $PHASE_{Z3}$, AMP_{X31}, $PHASE_{X31}$, AMP_{Y31}, $PHASE_{Y31}$, AMP_{Z31}, $PHASE_{Z31}$, AMP_{A31}, $PHASE_{A31}$, AMP_{B31}, $PHASE_{B31}$, AMP_{C31}, $PHASE_{C31}$} for each frequency. Write to file CableResults in the results directory.
10. If "Test Mode" in the Local Parameter File is set to "reference":
    a. Create reference files using all frequencies:
        - {Frequency, AMP_{A31}} to file ULCableReferenceAmp
        - {Frequency, $PHASE_{A31}$} to file ULCableReferencePhase
    b. Create reference files using all frequencies:
        - {Frequency, AMP_{C31}} to file DLCableReferenceAmp
        - {Frequency, $PHASE_{C31}$} to file DLCableReferencePhase
    c. Create reference files using all frequencies:
        - {Frequency, AMP_{B31}} to file ULDLCableReferenceAmp
        - {Frequency, $PHASE_{B31}$} to file ULDLCableReferencePhase
11. If "Test Mode" in the Local Parameter File is set to "offset":
    a. Calculate the offset values using parameters from the Cable reference files:

$$AMP_{A31,OFFSET} = AMP_{A31,REF} - AMP_{A31}$$

$$AMP_{B31,OFFSET} = AMP_{B31,REF} - AMP_{B31}$$

$$AMP_{C31,OFFSET} = AMP_{C31,REF} – AMP_{C31}$$

$$PHASE_{A31,OFFSET} = PHASE_{A31,REF} - PHASE_{A31}$$

$$PHASE_{B31,OFFSET} = PHASE_{B31,REF} – PHASE_{B31}$$

$$PHASE_{C31,OFFSET} = PHASE_{C31,REF} – PHASE_{C31}$$

    b. Prompt the user based on offset values and values of "Offset Limit" and "Offset Prompt" in the Local Parameter File. If the user doesn't want to save offset values, skip the following steps.
    c. Create calibration files using all frequencies:
        - {Frequency, $AMP_{A31,OFFSET}$} to file ULCableAmplitudeOffset_x
        - {Frequency, $PHASE_{A31,OFFSET}$} to file ULCablePhaseOffset_x
        - A calibration file is created for each port specified in the program schedule message.
    d. Create calibration files using all frequencies:

- {Frequency, $AMP_{C31,OFFSET}$} to file DLCableAmplitudeOffset_x
- {Frequency, $PHASE_{C31,OFFSET}$} to file DLCablePhaseOffset_x
- A calibration file is created for each port specified in the program schedule message.

e. Create calibration files using all frequencies:

- {Frequency, $AMP_{B31,OFFSET}$} to file ULDLCableAmplitudeOffset_x
- {Frequency, $PHASE_{B31,OFFSET}$} to file ULDLCablePhaseOffset_x
- A calibration file is created for each port specified in the program schedule message.

5. Common Parameters

5.1 Shared Program Schedule Message (PSM) Parameters

5.1.1 Notes

(*) Signifies parameters that are included only for 85121A backwards compatibility. Parameters not marked with * should be used in preference if possible. To activate the 85121A backwards compatibility mode, the LPF parameter Compatibility_85121_PSM must be set to 1. (See Section 5.2.14)

(+) Signifies parameters that are 85121A backwards compatible and also used in the N1891A PTS.

The (opt) tag indicates that a variable is optional. In relevant cases, a default setting that is adopted in the case of non-definition is described.

5.1.2 PTEConfiguration

Name	Type	Units	Description
PTEConfiguration(+)	String	N/A	Sets flags that control test system operation. A string variable, with each 2-character flag name preceded with Y or N (Yes/No) and each flag setting separated by underscore (_) characters, e.g. NSR_NDL_NLC_NST_NIT: YSR/NSR Send results (Yes/No) YDL/NDL Display local (Yes/No) YLC/NLC Limit check (Yes/No) YST/NST Standard Telemetry (Yes/No) YIT/NIT Intermediate Telemetry (Yes/No) For more details of this parameter, see the *System User's Guide.*

5.1.3 UUTCFG

Name	Type	Units	Description
UUTCFG Or SpacecraftPath(*)	String array	N/A	Tag(s) used to describe the UUT configuration. The tag(s) is/are written in the result file. If UUTCFG is a single string, InputPort and OutputPort must also be single strings. If UUTCFG is an array of strings, InputPort, OutputPort, and InputReferencePower must also be equal-sized arrays of strings. The measurement will be sequenced through the list of UUTCFG(), InputPort(), OutputPort(), and InputReferencePower() conditions, with a separate output file for each case.

5.1.4 Ports Group

Name	Type	Units	Description
{InputPort} or SpacecraftUplinkPort(*) (Allow prefix in front of these parameter names, for some tests that have multiple signals defined)	String array	N/A	InputPort, or a list of InputPorts for the stimulus repeater UUT To allow port sequencing, this parameter must be an array. See UUTCFG description for important sizing constraints.
{OutputPort} or SpacecraftDownlinkPort(*) (Allow prefix in front of these parameter names, for some tests that have multiple signals defined)	String array	N/A	OutputPort, or a list of OutputPorts for the stimulus repeater UUT To allow port sequencing, this parameter must be an array. See UUTCFG description for important sizing constraints.

5.1.5 InputSpotFreq Group

Name	Type	Units	Description
InputFrequency or CWTestFrequency(*) (Allow prefix in front of these parameter names, for some tests that have multiple signals defined)	Real Real	Hz Hz	The input frequency for the test

5.1.6 InputTwoToneCW Group

Name	Type	Units	Description
ToneSpacing Or {TwoToneFrequencies} or LowerFrequency(*) UpperFrequency(*)	Real Real Array size 2 Pair of Reals	Hz	The spacing between the two tones that are centered on InputFrequency Or The absolute frequencies of two input carriers
TwoTonePowerOffset (opt)	Real	dBc	Input offset power level between the two stimulus tones This parameter must be 0 or a positive value. During a power sweep, the upper frequency tone will be lower in level than the lower frequency tone by this value. Note: If this parameter is not specified, the upper frequency tone will remain constant at the first power level of a power sweep.

5.1.7 TranslationFreq Group

Name	Type	Units	Description
TranslationFrequency or OutputCenterFrequency or ChannelLOFrequency(*) (Allow prefex in front of these parameter names, for some tests that have multiple signals defined)	Real	Hz	The frequency translation that occurs between input and output signals in the UUT OutputCentrerFrequency specifies the absolute output frequency that is produced by the UUT from InputCenterFrequency.

5.1.8 InputSweptFreq Group

Name	Type	Units	Description
InputCenterFrequency With one of the next 4 parameters:	Real	Hz	The “center” of the input channel to be analyzed Banded measurements can be referenced to and centered about this frequency point.
{InputFrequency} or	Real array	Hz	A list of absolute input frequencies to sweep through Some measurements may require equally spaced frequencies.
{InputFreqStart} {InputFreqStop} {InputFreqStep} or	Triplet of Reals or Real arrays	Hz	Defines an absolute frequency sweep If these values are arrays, specifying multiple swept bands within the same test, the arrays must all be the same size.
{InputOffsetFreq} or	Real	Hz	A list of offset frequencies to sweep through, relative to InputCenterFrequency Some measurements may require equally spaced frequencies.
{InputOffsetFreqStart} {InputOffsetFreqStop} {InputOffsetFreqStep}	Triplet of Reals or Real arrays	Hz	Defines a frequency sweep, relative to InputCenterFrequency If these values are arrays, specifying multiple swept bands within the same test, the arrays must all be the same size.

85121 backwards compatibility is provided by the following alternate definition mechanism:

Name	Type	Units	Description
CWTestFrequency(*) With one of the two following parameter sets	Real	Hz	The "center" of the input channel to be analyzed Banded measurements can be referenced to and centered about this frequency point.
StartFrequency(*) StopFrequency(*) StepFrequency(*)	Triplet of Reals	Hz	Defines an absolute frequency sweep
{StartFreqArray}(*) {StopFreqArray}(*) {StepFreqArray}(*)	Triplet of Real Arrays	Hz	Defines an absolute frequency sweep If these values are arrays, specifying multiple swept bands within the same test, the arrays must all be the same size.

5.1.9 CalTrendMode

Name	Type	Units	Description
CalTrendMode 0 or 1 Defaults to 0 if not specified	Integer	N/A	The trend-checking feature of the PTS calibrations can be turned on by setting this parameter to 1, or turned off by setting it to 0. If CalTrendMode is set to 1, the test compares the new measured data with previously stored calibration data for trend-checking purposes. Existing cal data on the system is subtracted from measured calibration values and the calculated trend (delta) values are compared against the trend limits. The pass/fail results of the cal and trend limit checking are passed back to the user as a telemetry message. The

Name	Type	Units	Description
			user then decides whether or not the existing cal data should be replaced with the new measured data. If CalTrendMode is set to 0, no comparison is made between the measured values and the existing cal data. The new measured data automatically overwrites the existing cal data.

5.1.10 MultitoneWithRouting Group

Name	Type	Units	Description
InputStartChannelCF {InputChannel} {OutputChannel} or InputFirstToneFreq {InputTones} {OutputTones}	Real Integer array Integer array	Hz NA NA	The frequency of the first channel (or tone) The first channel or tone is number 1 by definition. InputChannel/InputTones is a list of active input channel/tone numbers. OutputChannel/OutputTones is a list of active output channel/tone numbers.
ChannelSpacing or ToneSpacing	Real	Hz	The spacing between the channels/tones: F(n) = InputStartChannelCF + [InputChannel(n) – 1] * ChannelSpacing
{ChannelRouting} or {ToneRouting}	Integer array	NA	The ChannelRouting/ToneRouting array describes the mapping of the input channels to the output channels. ChannelRouting/ToneRouting must be the same size as the OutputChannel/Tones array. Each element of ChannelRouting/ToneRouting is a value found in the InputChannel/Tones array. Note that more than one element in ChannelRouting/ToneRouting can

Name	Type	Units	Description
With one of the next two parameters:			contain the same value from the InputChannel/Tones. This means that an input channel/tone can map to multiple output channels/tones).
TranslationFrequency OR	Real	Hz	The frequency translation that occurs between input and output signals in the UUT
OutputStartChannelCF or OutputFirstToneFreq	Real	Hz	The frequency of the first channel (or tone) at the UUT output

5.1.11 NPR Group

Name	Type	Units	Description
ToneSpacing	Real	Hz	Frequency spacing between tones in the NPR signal spectrum
NotchOffsetCF	Real	Hz	Offset of the notch center frequency relative to the InputCenterFrequency of the NPR spectrum If equal to zero, the notch will be placed at the center of the spectrum. Note that offsetting from the center frequency may reduce notch depth in the generated spectrum due to the limited image rejection of the I/Q modulator in the RF source.
NotchBW	Real	Hz	Bandwidth of the notch to be removed from within the input NPR signal spectrum. NotchBW must be >= ToneSpacing and <= (ChannelBW – ToneSpacing)

5.1.12 InputSpotPower Group

Name	Type	Units	Description
{InputReferencePower}(+) (Allow prefix in front of this parameter name, for some tests that have multiple signals defined)	Real array	dBm	Reference power level for the input to the UUT If set to -999 or less, the Nominal Operating Point (NOP) value from a prior Gain Transfer test for the same UUT UUTCFG condition will be substituted. To allow port sequencing, this parameter must be an array. See UUTCFG description for important sizing constraints.
InputOffsetPower(opt) or OffsetPower(opt)(*) Defaults to 0 if not set.	Real	dB	Offset from the input reference power level The main measurement will be made at a power level of InputReferencePower+InputOffsetPower
OuputOffsetPower(opt) Defaults to 0 if not set.	Real	dB	Offset from the output reference power level The main measurement will be made at a power level of OutputReferencePower+OutputOffsetPower

5.1.13 InputSweptPower Group

Special note on swept power measurements: the signal source used inside the test system has a minimum settable resolution. This is normally 0.01 dB (for E8267C and similar instruments). It is highly recommended that any measurements which are sensitive to input and output power changes, in the order of hundredths of a dB, use only power steps that are integer multiples of this minimum settable resolution.

So, in Gain Transfer and similar power-sweep measurements, use power steps that are multiples of 0.01 dB only.

This is consistent with the note accompanying the InputPowerTolerance LPF parameter.

Name	Type	Units	Description
{InputReferencePower}(+) (Allow prefix in front of this parameter name, for some tests that have multiple signals defined)	Real array	dBm	Reference power level for the input to the UUT If set to -999 or less, the Nominal Operating Point (NOP) value from a prior Gain Transfer test for the same UUT UUTCFG condition will be substituted. To allow port sequencing, this parameter must be an array. See UUTCFG description for important sizing constraints.
InputOffsetPowerStart InputOffsetPowerStop InputOffsetPowerStep or ULPowerStartLevel(*) ULPowerStopLevel(*) ULPowerStepLevel(*) Or, alternately as an array: {InputOffsetPower} or {OffsetPower}(*)	Triplet of Reals Real array	dB	Defines offset from the input reference power level for measurements using power sweeps Can be specified as a start/stop/step triplet of reals defining a range of equally spaced offset steps or as an array of arbitrarily spaced steps. The main measurement will be made at power levels of InputReferencePower+InputOffsetPower() where the InputOffsetPower() array is defined by the Start, Stop, Step range or the arbitrary array.
OutputOffsetPowerStart OutputOffsetPowerStop OutputOffsetPowerStep Or, alternately as an array: {IOutputOffsetPower}	Triplet of Reals Real array	dB	Defines offset from the output reference power level for measurements using power sweeps The main measurement will be made at power levels of OutputReferencePower+OutputOffsetPower(), where the OutputOffsetPower() array is defined by the Start, Stop, Step range or the arbitrary array.

5.1.14 ChannelBW

Name	Type	Units	Description
ChannelBW(+)(opt) If omitted, the value of this parameter will default to twice the smallest frequency delta between the OutputCenterFrequency and the lowest or highest frequencies defined by the frequency sweep.	Real	Hz	This defines the bandwidth of the channel of interest In swept frequency measurements, it defines the channel width to analyze the swept data over. The measurement will still sweep over the full user-defined frequency range, but the data analysis (peak gain, etc.) will only be performed over the range defined by the OutputCenterFrequency) ±ChannelBW/2 (or InputCenterFrequency +TranslationFrequency ±ChannelBW/2). In spot-frequency or multitone measurements, this parameter can be used to define channel bandwidth. This is so that frequency spans and band power markers can be set up to include all wanted, or exclude all unwanted, signals.

5.1.15 RippleWindow

Name	Type	Units	Description
RippleWindow(+) or FreqWindow(*)	Real	Hz	For swept frequency measurements that calculate ripple of gain, phase, or group delay, this parameter specifies the width of the sliding window that is used to calculate peak-to-peak ripple. It does not affect the measured sweep, only the data processing. The reported maximum gain, phase or group delay ripple will be the greatest ripple within any single RippleWindow anywhere within the ChannelBW.

5.1.16 InputFMTone Group

Name	Type	Units	Description
FMModFrequency or ToneFrequency(*)	Real	Hz	Modulation tone frequency for the Frequency-Modulated input signal
FMModIndex or FMDeviation or AMModulationIndex(*)	Real	NA or Hz or Hz	Defines the modulation index (FMModIndex) or frequency deviation (FMDeviation) for the FM modulation tone. “AMModulationIndex" defines the frequency deviation of the FM tone. This parameter is intentionally labeled "AM" to be backwards compatible to the 85121A definition.

5.1.17 AMModFrequency parameter

Name	Type	Units	Description
AMModFrequency or ToneFrequency(*)	Real	Hz	Modulation tone frequency for the Amplitude-Modulated input signal

5.1.18 OutputFrequencyRange Group

Name	Type	Units	Description
{OutputFreqStart} {OutputFreqStop} or StartFrequency(*) StopFrequency(*)	Real or Real array	Hz	Output absolute start/stop frequency range to search for spurs, intermods, phase noise, etc. If *Start* is an array, *Stop* must be an array of the same size.
Or, {OutputOffsetFreqStart} {OutputOffsetFreqStop} or BandLower(*) BandUpper(*)	Real or Real array	Hz	Output relative start/stop frequency range to search for spurs, intermods, phase noise, etc. These frequencies are relative to the OutputCenterFrequency. If *Start* is an array, then *Stop* must be an array of the same size.

5.1.19 OutputFrequency Group

Name	Type	Units	Description
{OutputFreq}	Real or Real array	Hz	Output absolute frequency list for use in a directed spur search
Or, {OutputOffsetFreq}	Real or Real array	Hz	Output relative frequency list for use in a directed spur search These frequencies are relative to the OutputCenterFrequency.

5.1.20 SpurAmpSpec

Name	Type	Units	Description
SpurAmpSpecdBc or, SpurAmpSpecdBm No 85121 equivalent.	Real	dBc or, dBm	Amplitude specification for the spur search Any signal measured at the UUT output that exceeds this amplitude will be recorded as a spur. If specified in “dBc”, it must be in negative dBc relative to the carrier level. If specified in “dBm”, it will be an absolute power level measured at the UUT output.

5.1.21 Beacon Mode

Name	Type	Units	Description
BeaconMode No 85121 equivalent.	Integer	N/A	If BeaconMode is set to 0, the test system will not supply a beacon signal to the UUT. If BeaconMode is set to 1, the test system will supply a beacon signal to the UUT.
BeaconFrequency No 85121A equivalent.	Real	Hz	Input frequency of the beacon signal
BeaconPower	Real	dBm	Signal level used for the beacon signal at the device under test interface

5.1.22 Waveform Model

Name	Type	Units	Description
WaveFileName	String	N/A	Name of the pre-stored waveform file to be used

Name	Type	Units	Description
WaveformType No 85121 equivalent.	String	N/A	Identify the type of waveform such as W-CDMA, GSM, etc.
NumberofChannels No 85121A equivalent	Integer	N/A	Total number of channels within the waveform

5.1.23 Fading

Name	Type	Units	Description
FadingOn No 85121 equivalent.	Integer	N/A	If set to 0, fading is not applied. If set to 1, fading signal is applied.
FrequencyRange No 85121 equivalent.	Real or Real Array	Hz	Rate of the fade change
DynamicRange No 85121 equivalent.	Real	dB	Dynamic range for the fade
FadeTime No 85121 equivalent.	Real	Sec	Length of time to apply the fade
MeasureInterval No 85121 equivalent.	Real	Sec	Length of time between measurements during a fade sequence

5.2 Shared Local Parameter File (LPF) Parameters

5.2.1 Notes

Effort has been made, as far as possible, to reuse 85121A LPF parameter names where it makes sense. There are by necessity differences, though. This is due to standardization and customization efforts, changes due to new measurement hardware and methods, new test requirements, and new test optimizations.

No (+) and (*) nomenclature is used in this section to attempt to display 85121A backwards compatibility where it exists, since it is assumed that most LPF parameters will normally be set once in the LPF file associated with the measurement and not updated each time over the remote interface (although this is possible).

The (opt) tag indicates that a variable is optional. In many cases, a default setting that is adopted in the case of non-definition is described.

5.2.2 SimulateTest

Name	Type	Units	Description
SimulateTest (opt) 1 or 0 Defaults to 0 if not specified	Integer	NA	If set to 1, the test will be run in Simulate mode. This enables the measurement to be run without any equipment connected. Data files will be created and filled with appropriately sized data arrays. The data is, of course, not real measured data, but faked.

5.2.3 InputSignal Group

Name	Type	Units	Description
MaxSafeInputPower (opt) Defaults to -999 dBm if not specified. This forces the user to enter a reasonable value. Used for all measurements that supply signals to the UUT	Real	dBm	Describes the maximum safe input power to the UUT If the test system is asked to supply a power in excess of this amount to the UUT, the software will reset the test system to a safe state (no output RF power) and report an error message to the operator.
InputPowerTolerance (opt) Defaults to 0.1 dB if not specified. Used for all measurements that supply signals to the UUT	Real	dB	Power levels for the signals sent to the UUT will be set within this resolution tolerance. This parameter will be rounded up to the smallest settable resolution of the signal source used in the test system; this is normally 0.01 dB. For Gain Transfer, this parameter also specifies the finest input power step that is used for any search algorithm.

5.2.4 Receiver Group

Name	Type	Units	Description
Averages (opt) Defaults to 1 if not specified. Used for all measurements that make measurements of signals from the UUT	Integer	NA	Number of averages to be used for the measurement receiver, either VSA or Spectrum Analyzer Intermediate measurements that do not form part of the actual measurement output may not use the specified number of averages for speed reasons. Examples of this include quick noise level measurements, auto-range sweeps, path check, and approximate gain measurements.
DoDownconverterCal (opt) Defaults to AUTO if not specified	String “AUTO”, “YES” or “NO”	NA	If left to “AUTO”, the software will perform the Downconverter RF Gain Spot Calibration (see Section 4.6 on page 33) only when triggered by the internal test system timers. For the most accurate amplitude and phase accuracy, set this parameter to “YES” and the software will be forced to calibrate the downconverter at the beginning of the test. Setting this parameter to “NO” will disable any downconverter calibration and is not recommended for achieving specified measurement accuracy.
VSA_DoVSACalibrate (opt) Defaults to AUTO if not specified	String “AUTO”, “YES” or “NO”	NA	If left to “AUTO”, the VSA will perform a self-calibration only when triggered by the internal test system timers. For the most accurate amplitude and phase accuracy, set this parameter to “YES” and the VSA will be forced to self-calibrate at the beginning of the test. Setting this parameter to “NO” will disable any VSA self-calibrating and is not recommended for achieving specified measurement accuracy.

Name	Type	Units	Description
ULPowerMeter_DoSetRefPathAndCalibrate (opt) ULPowerMeter_DoSetRefPathAndZero (opt) DLPowerMeter_DoSetRefPathAndCalibrate (opt) DLPowerMeter_DoSetRefPathAndZero (opt) CalPowerMeter1_DoManualCalibrate CalPowerMeter1_DoManualZero Defaults to AUTO if not specified	String "AUTO", "YES" or "NO"	NA	If left to "AUTO", the power meters will perform a self-calibration or self-zero only when triggered by the internal test system timers. For the most accurate amplitude and phase accuracy, set this parameter to "YES" and the power meters will be forced to self-calibrate or self-zero at the beginning of the test. Setting this parameter to "NO" will disable any calibrating or zeroing and is not recommended for achieving specified measurement accuracy.

5.2.5 UUTDelay Group

Name	Type	Units	Description
FirstPointDelay (opt) Defaults to 0 if not specified	Real	Sec	In a sequence of measurement points, the required settling time of the UUT for the first point in a series. It is the necessary time between when a valid input power or frequency has been applied to the UUT and when the UUT output has settled.
NextPointDelay (opt) Defaults to 0 if not specified	Real	Sec	In a sequence of measurement points, the required settling time of the UUT for an intermediate point in a series. It is the necessary time between when a valid input power or frequency has been applied to the UUT and when the UUT output has settled.
LastPointDelay (opt) Defaults to 0 if not specified	Real	Sec	After a sequence of measurement points has been executed, it is the required measurement delay before another measurement sequence or operation can occur. For example, this parameter can be used to allow for UUT recovery after a power sweep into saturation.

5.2.6 TimeBase Group

Name	Type	Units	Description
TimeBaseSource (opt) Defaults to UUT if not specified	String "UUT", "INT" or "EXT"	NA	Specifies the 10 MHz reference that the test system will lock to For measurements taken with TimeBaseSource set to INT or EXT, the measurement will be required to use a "marker-to-peak" or similar mathematical operation on all received signals from the UUT, as the received signal will in general not be placed exactly at the nominal test system frequency. For measurements taken with TimeBaseSource set to UUT, measurements can run faster since the required frequency spans are less and the markers can be placed on the received signals exactly without a "marker-to-peak" style operation.
UUTTimebaseAccuracy (opt) Only relevant if TimeBaseSource is not UUT Defaults to 1E-8 if not specified	Real	Hz/Hz	Worst-case frequency inaccuracy, in fractional terms, of the UUT timebase At 10 GHz, the default setting of 1E-8 allows the UUT to be up to 100 Hz "off" a perfect 10 GHz. For measurements taken with the TimeBaseSource set to INT or EXT, the measurement will need to ensure a receiver span wide enough to guarantee capturing output signals while the UUT and test system are not locked together. The measurement will add the value of UUTTimebaseAccuracy to the known accuracy of the internal test system 10 MHz reference source (or ExtTimebaseAccuracy if TimeBaseSource is EXT). The resulting worst-case frequency delta between the test system and UUT will

Name	Type	Units	Description
			be used to determine the frequency span required to locate an output signal.
ExtTimebaseAccuracy (opt) Only relevant if TimeBaseSource is EXT Defaults to 1E-9 if not specified	Real	Hz/Hz	Worst-case frequency accuracy, in fractional terms, of the externally-supplied timebase

5.2.7 PathCheck Group

Name	Type	Units	Description
PathCheckSNRThreshold (opt) Defaults to 30 dB if not specified	Real	dB	A signal from the UUT is deemed to have been received correctly if it is within the expected frequency range (defined by the TimeBase parameters in Section 5.2.6) and it appears to have a Signal-To-Noise ratio better than the number defined here. If the measured downlink SNR is less than this value, the test pauses and alerts the operator that the path check has failed. The operator can then elect to retry or abort the test.

5.2.8 StandardTelemetry Group

Note, the PTEConfiguration = YST flag must be set to enable standard telemetry.

For a full description of the path check and standard telemetry flow, see the diagram in Section 2.6.2.

The power levels used for the standard telemetry are controlled by the InputReferencePower and StdTelemetryOffsetPower parameters.

Name	Type	Units	Description
StdTelemetryPowerOffset Defaults to 0 if not specified	Real	dB	Defines the input power offset from the InputReferencePower that will be used in the "Meas" level Path Check and StdTelemetryLevel routines
StdTelemetryLevel Defaults to "Meas" if not specified	String "Ref" or "Meas"	NA	Defines whether the path check and standard telemetry are performed at "Ref" (InputReferencePower) or "Meas" (InputReferencePower+ StdTelemetryPowerOffset). Note: The standard telemetry file contains telemetry mnemonics and limit values for Ref or Meas level telemetry limit checking

5.2.9 SNROrResBW Group

Name	Type	Units	Description
MinSNR (opt) or MaxResBW (opt) If neither are specified, MinSNR defaults to 60 dB, which implies an analyzer tone amplitude measurement repeatability (due to noise effects alone) of approximately 20*log10(1+(10^(-SNR/20))/sqrt(Avgs)) = 0.003 dB repeatability with 10 averages	Real	dB or Hz	MinSNR specifies the minimum desired signal to noise ratio for the measurement. The test will adjust the receiver resolution bandwidth to allow for the specified SNR. If MaxResBW is specified instead, the receiver will not adjust for measured SNR. The receiver will be set to MaxResBW or a bandwidth determined by the required measurement span, whichever is smaller. For CW, two-tone, and multi-tone measurements, the SNR refers to the ratio of the power in a single tone to the noise power in one RBW. In the case of SNR being specified, the UUT output SNR will be measured during the path check. The test will then calculate the required resolution bandwidth necessary to achieve the MinSNR during the measurement. If TIME averaging is being used, the displayed trace of the measurement will display a SNR which is 10*log10(Averages) better than the specified MinSNR. If RMS averaging is used, the displayed SNR is not affected by Averages.
MaxAcquisitionTime Defaults to 999 seconds if not specified	Real	Sec	Maximum allowable time for an analyzer acquisition or sweep time, with the measurement RBW and Averages set If the acquisition time appears to be in excess of this amount, the measurement will raise an error and stop, leaving the test system in a

Name	Type	Units	Description
			safe state.

5.2.10 Spurious Group

Name	Type	Units	Description
MaxResBW (opt)	Real	Hz	If specified, specifies the maximum RBW that the analyzer may use. Note: Normally the measurement is capable of determining an appropriate RBW setting to meet the SpurAmpSpec(PSM) and NoiseGuardBand (see below) parameter settings.
MaxAcquisitionTime Defaults to 999 seconds if not specified	Real	Sec	The maximum allowable time for an analyzer acquisition or sweep time, with the measurement RBW and Averages set. If the acquisition time appears to be in excess of this amount, the measurement will raise an error and stop, leaving the test system in a safe state.
NoiseGuardBand	Real	dB	Guardband in dB that will be subtracted from the spurious specification SpurAmpSpec to allow for noise spikes in the spur search A large guardband increases test time due to smaller than necessary resolution bandwidth. Too small a guardband causes noise spikes to be identified as spurs. Theory indicates that a value of 13 dB prevents identifying noise as spurs.
SpurBWSpec	Real	Hz	If this parameter is greater than zero, a second measurement of any spurs located during the search is made to record the total spur power in this specified bandwidth.

Name	Type	Units	Description
			If this parameter is set to zero, no second measurement is performed.
MaxSpurTableSize	Integer	NA	Sets the maximum number of found spurious signals to be recorded If the number of spurs found exceeds TableSize, the lowest level spur in the table will be replaced by the next found spur that is greater in power level.

5.2.11 FMToneGen Group

Name	Type	Units	Description
InternalTone 1 or 0 Defaults to 1 if not specified.	Integer	NA	If this parameter is 1, the required FM input tone will be generated by the test system signal source. If this parameter is 0, the user must supply an appropriate modulation tone at the specified FMModFrequency. The sensitivity of the external Modulation Input to the PTS is 1 MHz/volt.
FMDevPctTol (required if InternalTone 0)	Real	%	Accuracy with which the externally applied FM tone must create the specified FM deviation using the test system RF source
ToneOff (required if InternalTone 0)	String	NA	ASCII mnemonic command to be sent to the UUT that turns off the ranging signal
ToneOn (required if InternalTone 0)	String	NA	ASCII mnemonic command to be sent to the UUT that turns on the ranging signal
SubCarrierBW (opt.) Defaults to 0 if not	Real	Hz	Modulation bandwidth of the FM subcarrier

Name	Type	Units	Description
specified.			If this parameter is greater than zero, the receiver will measure the subcarrier using band power markers set to this bandwidth. If zero, a normal marker will be used.

5.2.12 AMToneGen Group

Name	Type	Units	Description
AMDepthPctTol(opt) Defaults to 10% if not specified	Real	%dB	Specifies the accuracy with which the internally applied AM tone must be created. For example, a 10% AMModAmpPctRes on a required AMModDepth of 1 dB will be required to hit an AMModDepth of 1 dB+-0.1 dB.

5.2.13 IntTelemetry

Name	Type	Units	Description
{IntTelemetry}	String array	NA	Mnemonics for the intermediate telemetry desired

5.2.14 85121A Compatibility Mode

Name	Type	Units	Description
Compatibility_85121_PSM Defaults to 0 if not specified	Integer	NA	If this parameter is set to 1, Program Schedule Message parameters will be imported in an 85121A backwards-compatible mode, as described in the Measurement Reference document. Note that some required parameters do not have an 85121A equivalent and must be specified as the N1891A type.

5.2.15 Threshold Sequence Group

Name	Type	Units	Description
NumberofSweeps	Integer	NA	Number of times the test will sweep to find the threshold point
ThresholdBackoff	Real	dB	Level in dB which the test will backoff from threshold for the additional sweeps defined by the NumberofSweeps parameter
StepPastThreshold	Real	dB	Level in dB that the test will pass threshold to ensure no verification

5.3 Shared Output Data Parameters

5.3.1 PathCheckResults

These parameters are included in the SecondaryScalarResults datasets. They describe the results of the Path Check routine. (See Section 2.6.4)

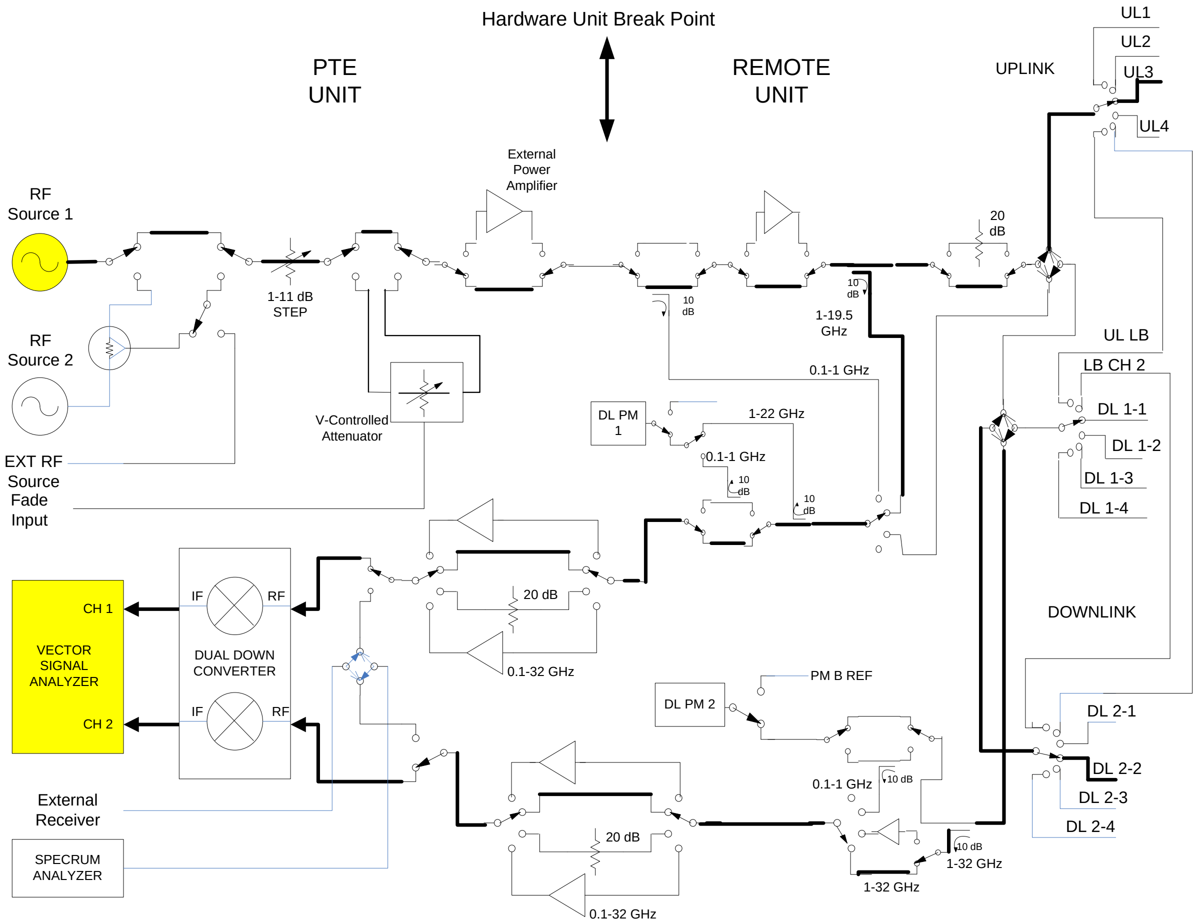
Name	Units	Description
InputSignalPower	dBm	Signal power of the uplink corrected to the UUT input
InputPowerRaw	dBm	Signal power of the uplink measured at VSA CH1
InputPathCal	dB	Uplink path calibration from VSA CH1 to uplink cal reference plane
InputExtHwCal	dB	Uplink external hardware calibration gain from reference plane to UUT input
ActualOutputResBW	Hz	Actual resolution bandwidth of the analyzer that is used to measure the output signal during the Path Check
OutputSNR	dB	Signal to noise ratio (signal power to noise in one RBW) measured on the output signal at the ActualOutputResBW, during the Path Check This result is limit tested by the Path Check routine to determine if a valid output signal has been found.
OutputSNRdBperHz	dB/Hz	Signal to noise density ratio (signal power to noise in one Hz) measured on the output signal at the ActualOutputResBW, during the Path Check
DesiredOutputResBW	Hz	Calculated receiver resolution bandwidth to achieve the MinSNR requirement on the UUT output signal This is used by the measurement to set the receiver RBW if MaxResBW is not specified. Calculated as 10^((OutputSNRdBperHz-MinSNR)/10)
OutputFreqError	Hz	Measured offset in the UUT output frequency, compared to the expected value. This value is used by the measurement to compensate for UUT translation frequency error when the PTS

Name	Units	Description
		frequency reference is not locked to the UUT frequency reference.

6. Test Diagrams

6.1 Measurement Diagrams

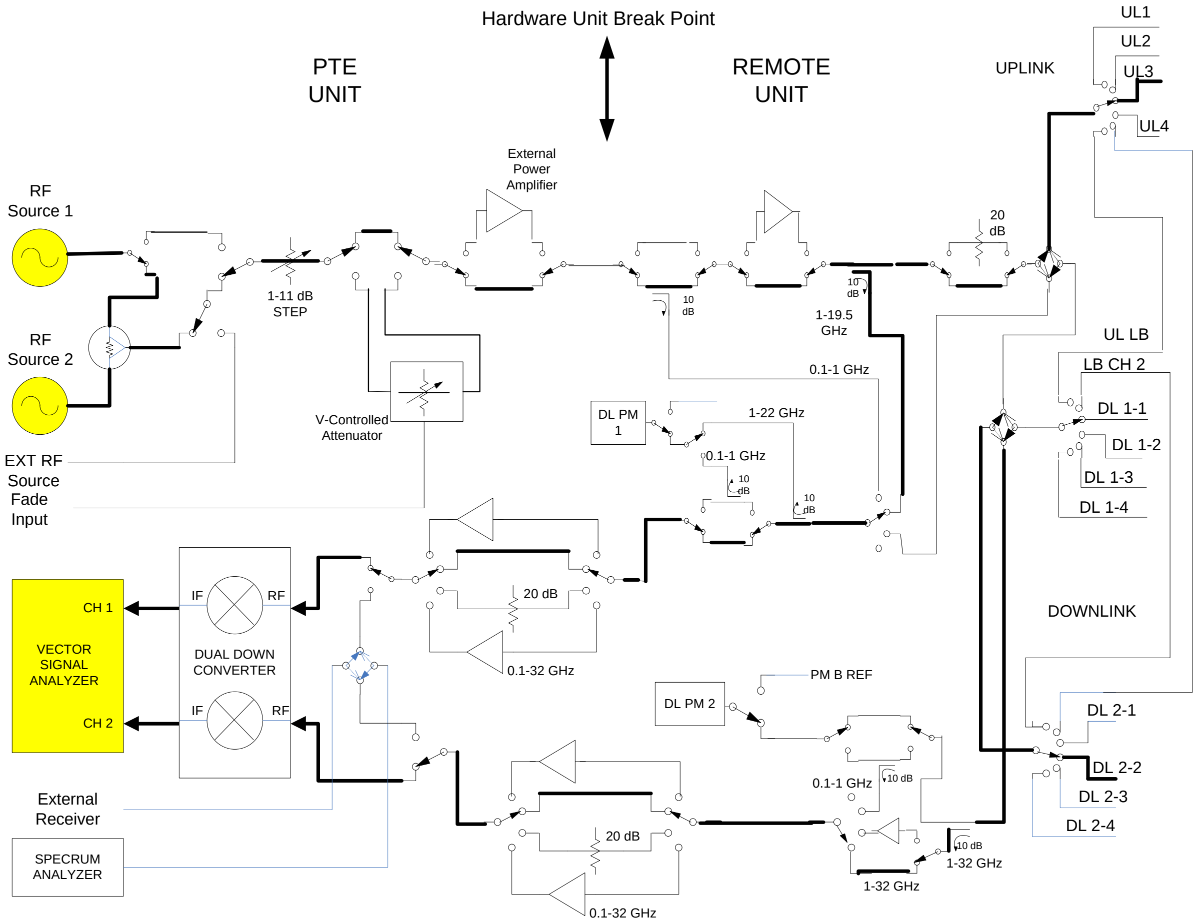
6.1.1 Single Source VSA Measurements



Note: This Diagram is for conceptual use only see the PTE and Remote Unit ICD for actual switching information and routing.

Figure 2 Single Source VSA Measurements

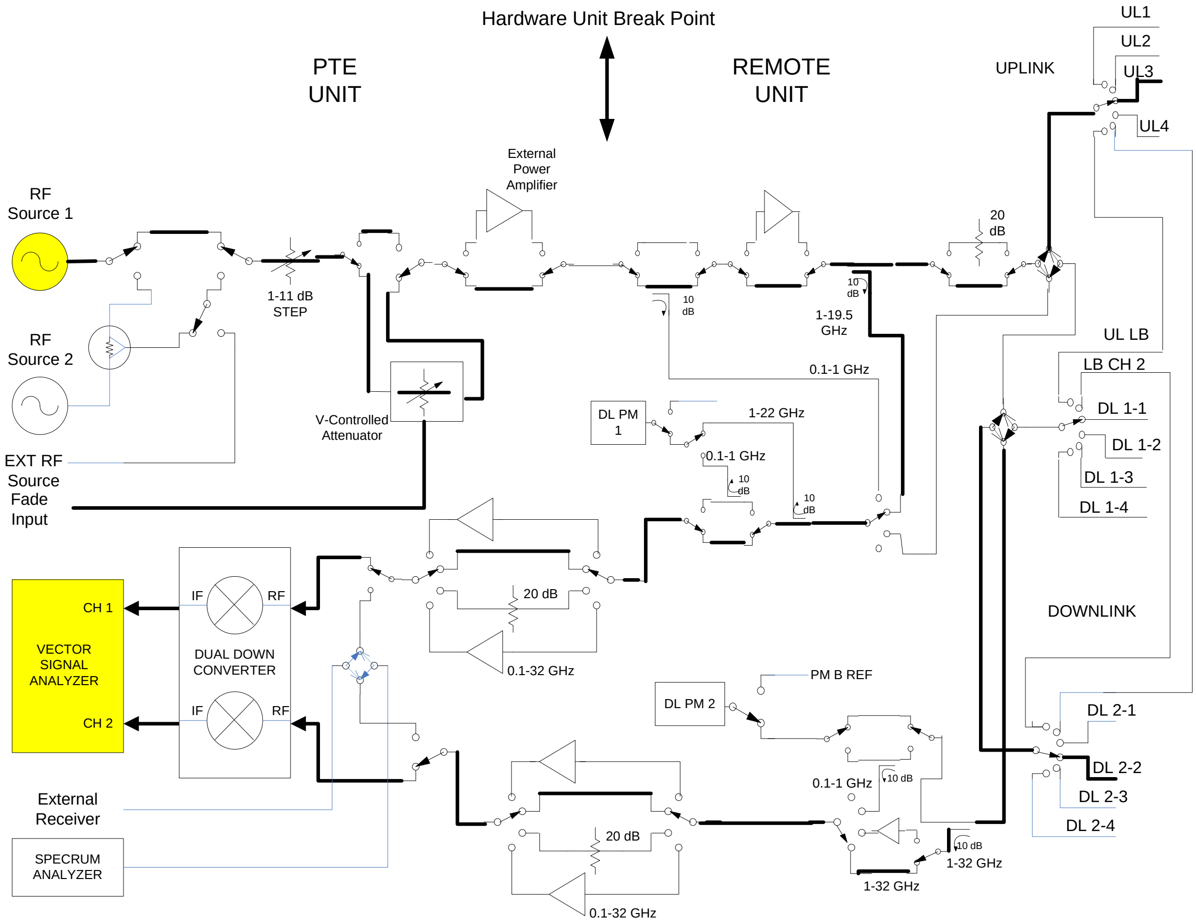
6.1.2 Two Source VSA Measurements



Note: This Diagram is for conceptual use only see the PTE and Remote Unit ICD for actual switching information and routing.

Figure 3 Two Source VSA Measurements

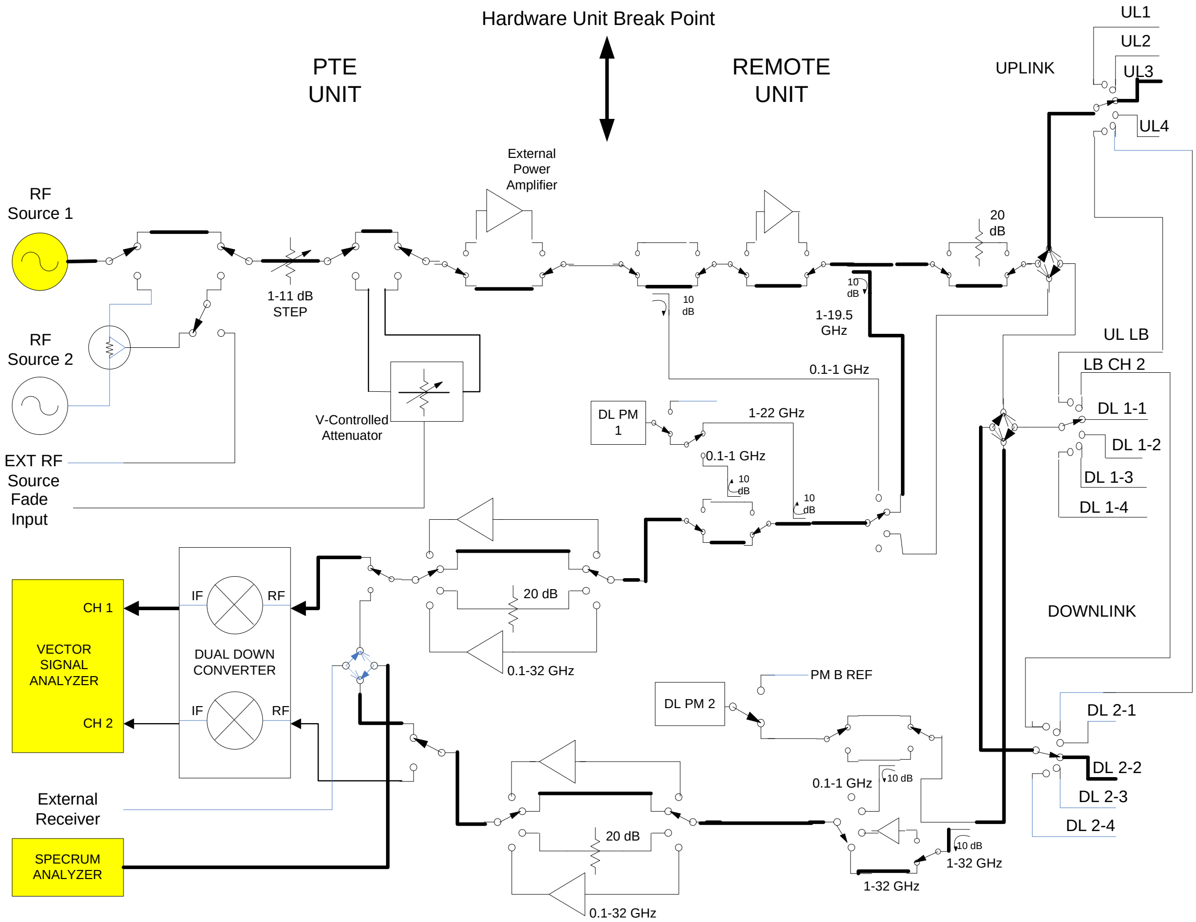
6.1.3 W-CDMA Stimulus VSA Measurements



Note: This Diagram is for conceptual use only see the PTE and Remote Unit ICD for actual switching information and routing.

Figure 4 W-CDMA Stimulus VSA Measurements

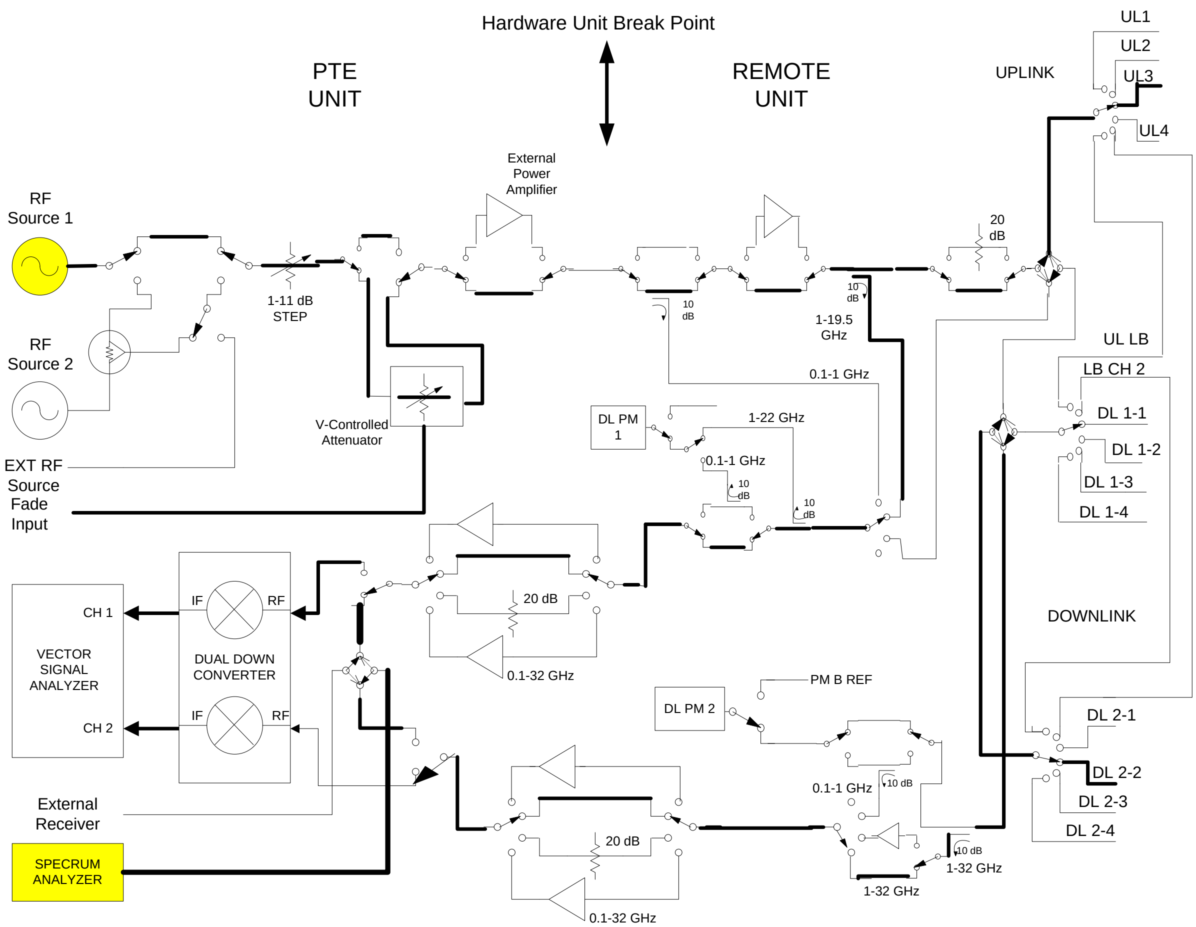
6.1.4 Single Source SA Measurements



Note: This Diagram is for conceptual use only see the PTE and Remote Unit ICD for actual switching information and routing.

Figure 5 Single Source SA Measurements

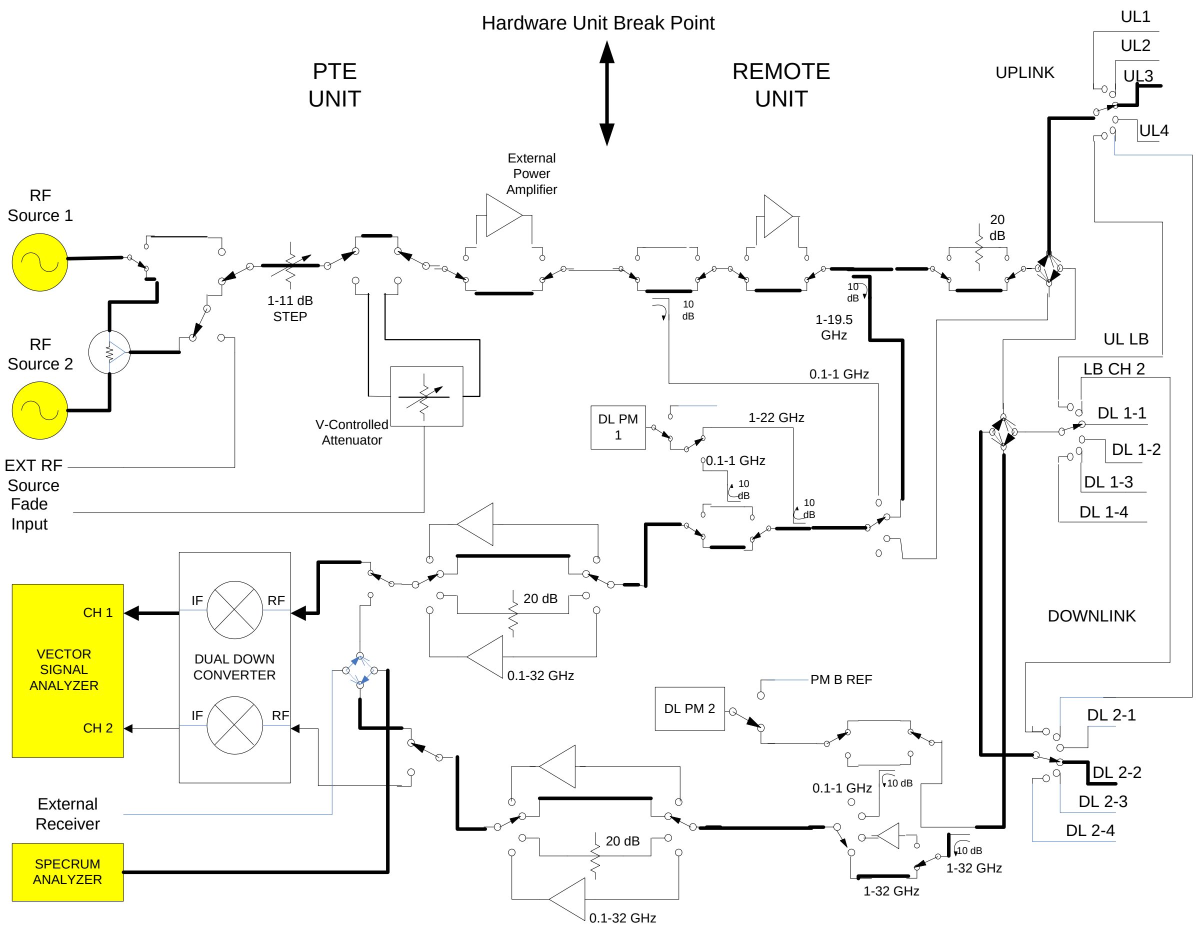
6.1.5 W-CDMA Stimulus SA Measurements



Note: This Diagram is for conceptual use only see the PTE and Remote Unit ICD for actual switching information and routing.

Figure 6 W-CDMA Stimulus SA Measurements

6.1.6 Two Source SA Measurements



Note: This Diagram is for conceptual use only see the PTE and Remote Unit ICD for actual switching information and routing.

Figure 7 Two Source SA Measurements

6.2 Calibration Diagrams

6.2.1 Antenna Port Gain Calibration

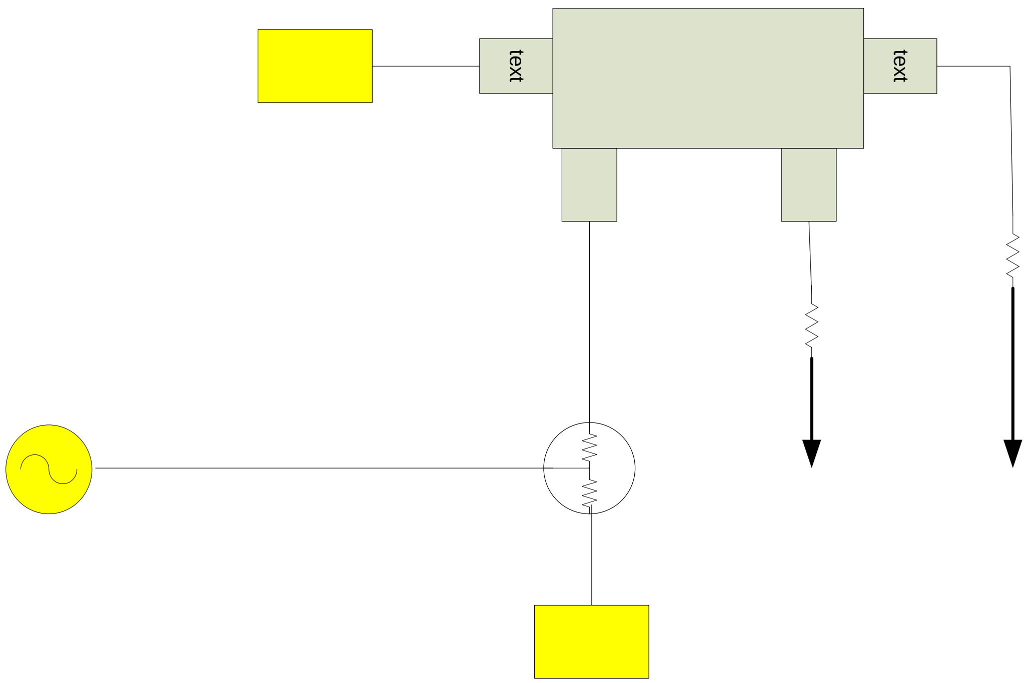


Figure 8 Antenna Port Gain Calibration

CAL PI
CH B

6.2.2 Payload Port Gain Calibration

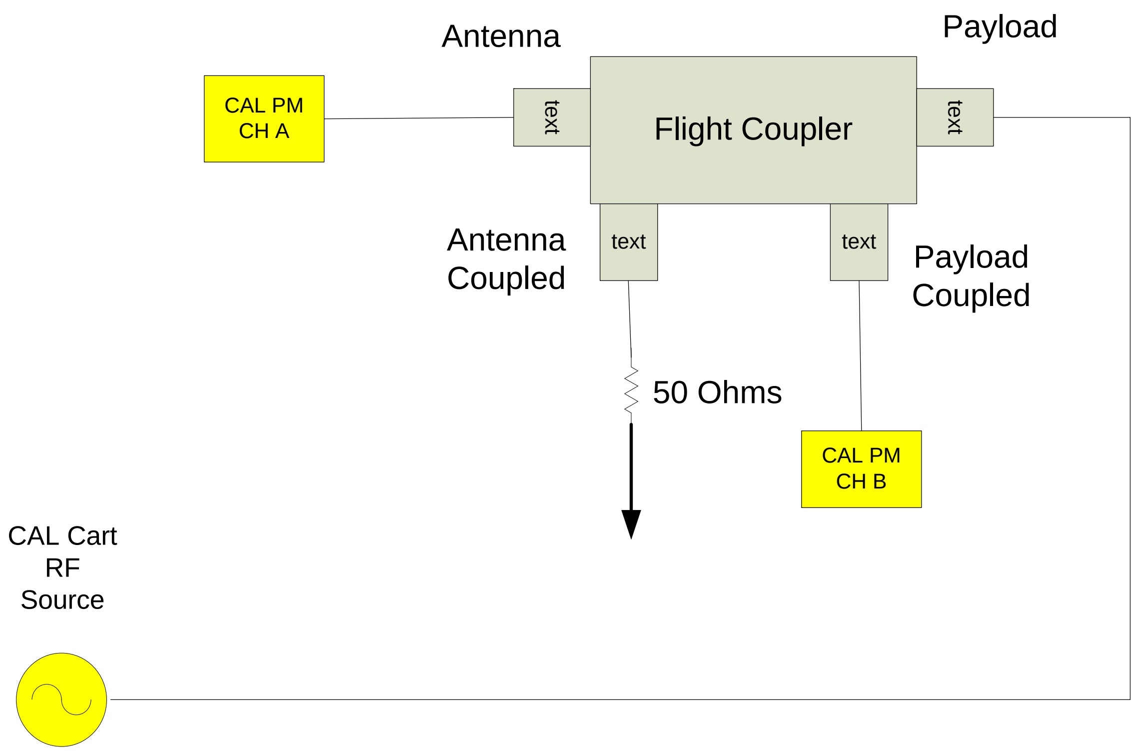


Figure 9 Payload Port Gain Calibration

6.2.3 Uplink Port Gain Calibration

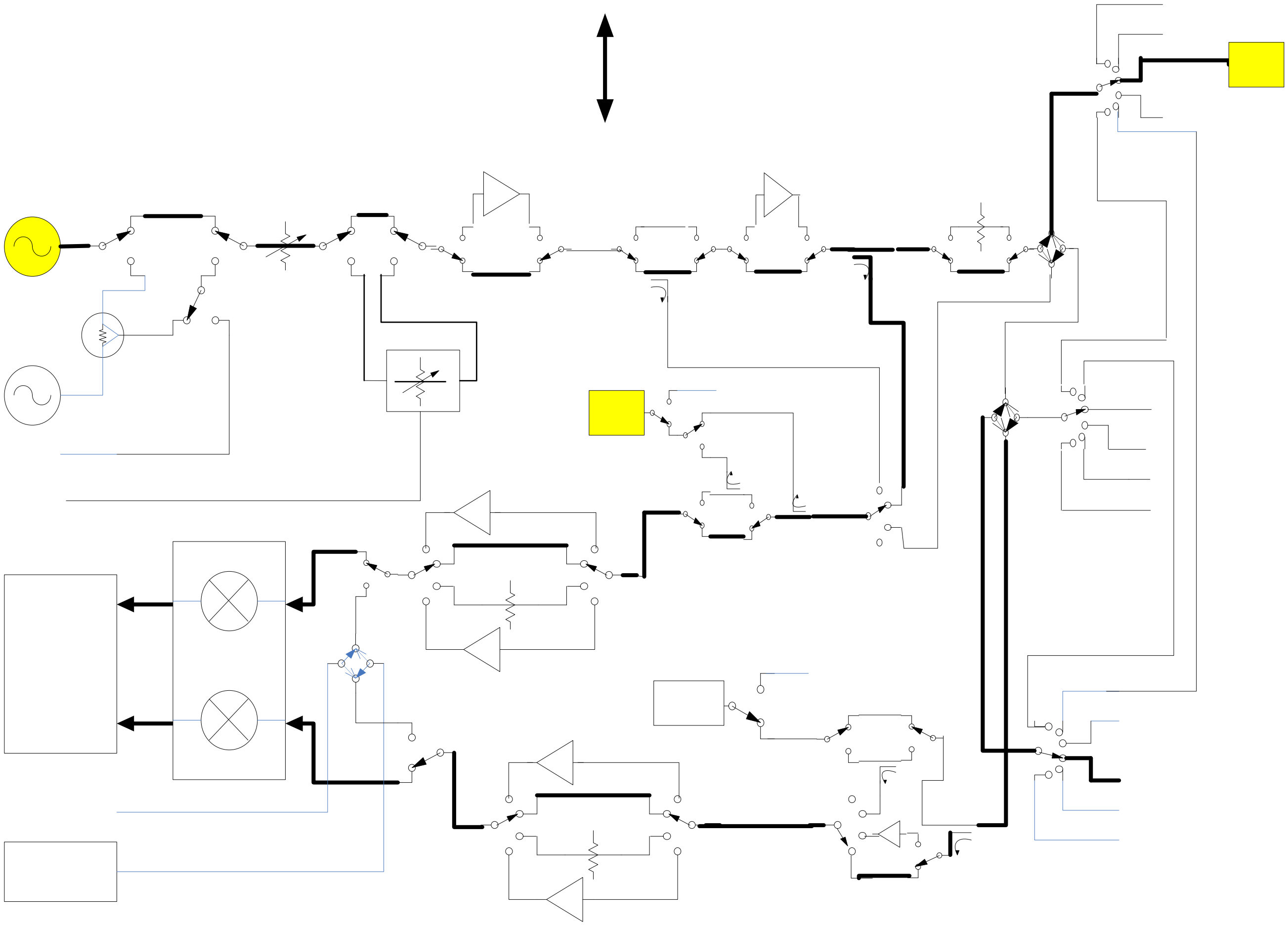


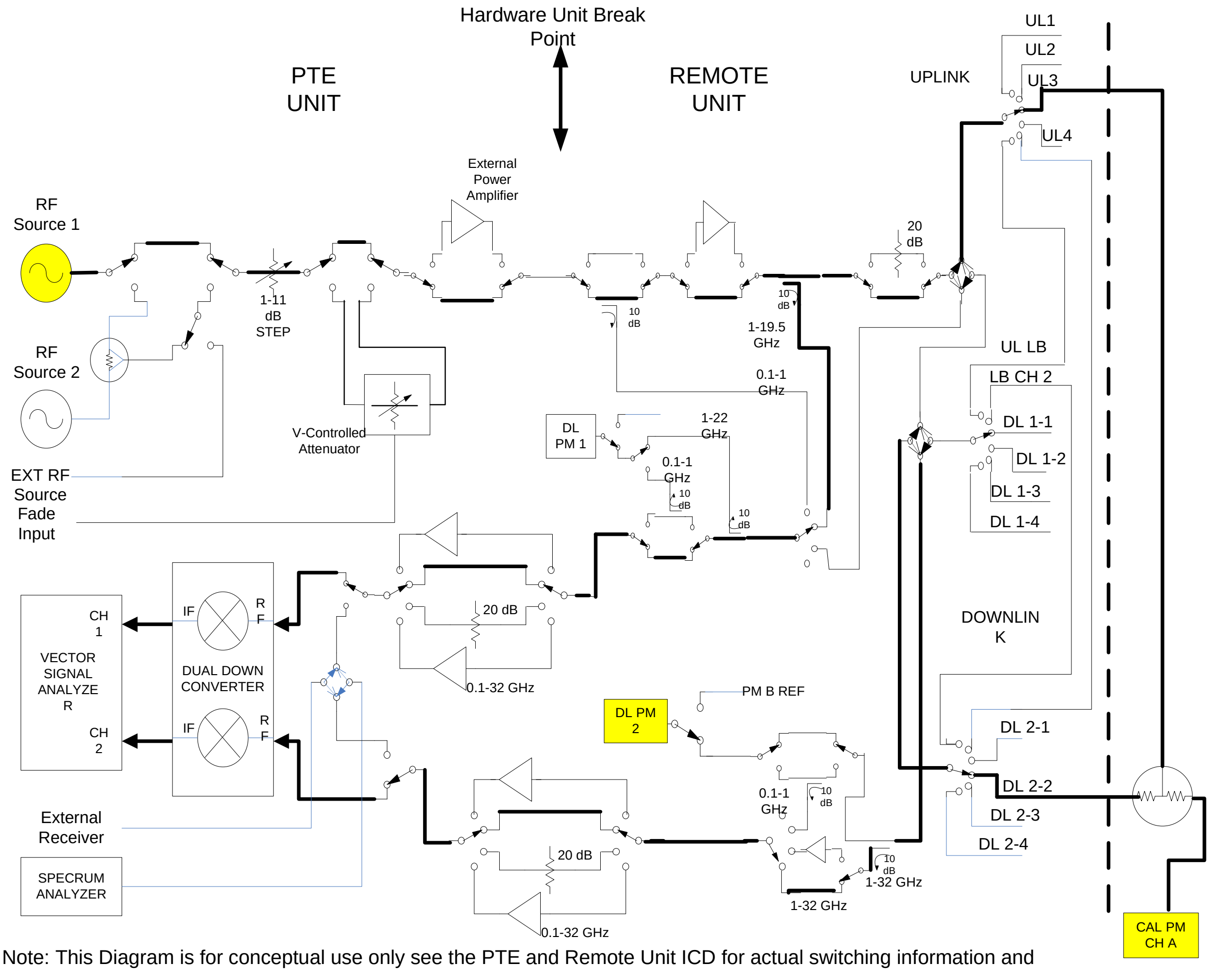
Figure 10 Uplink Port Gain Calibration

RF
Source 1

1-1
dI
STI

RF
Source 2

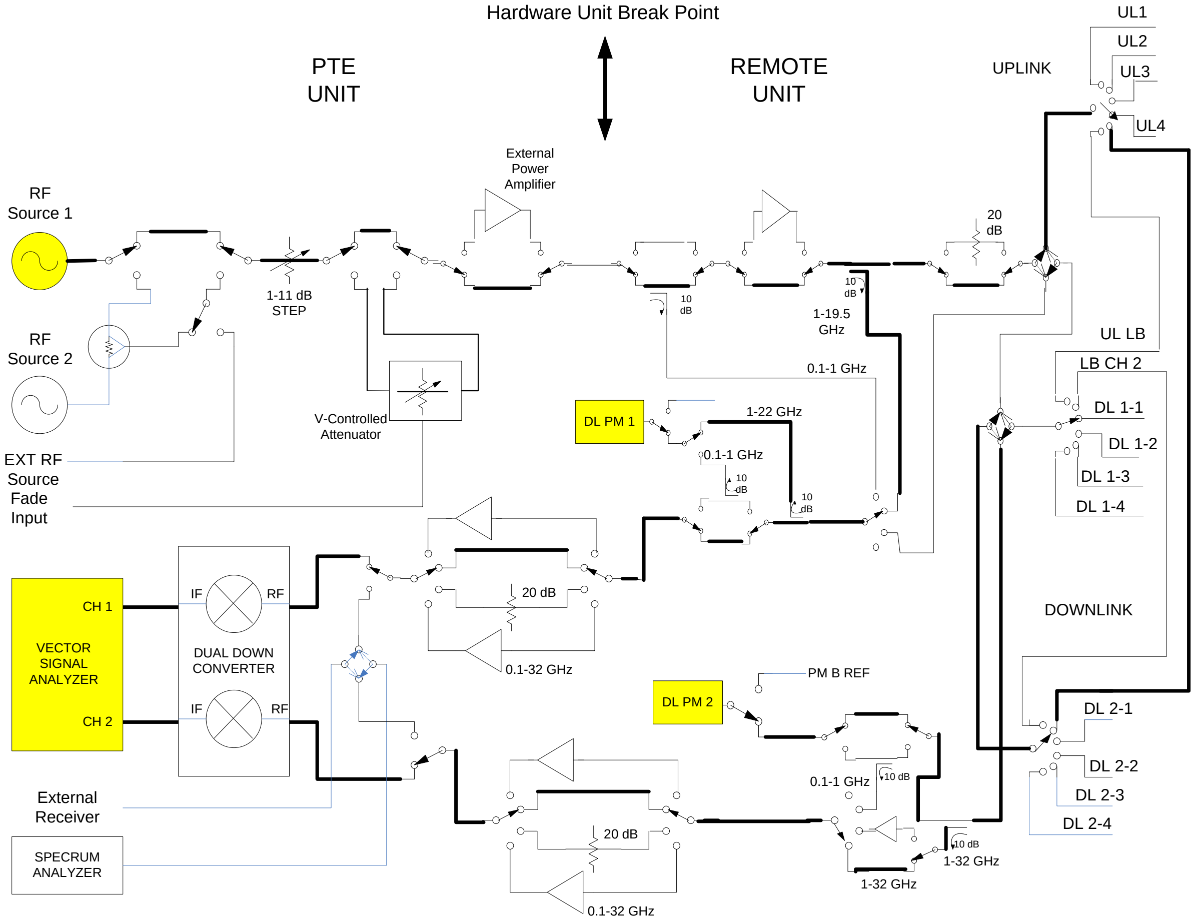
6.2.4 Downlink Port Gain Calibration



Note: This Diagram is for conceptual use only see the PTE and Remote Unit ICD for actual switching information and routing.

Figure 11 Downlink Port Gain Calibration

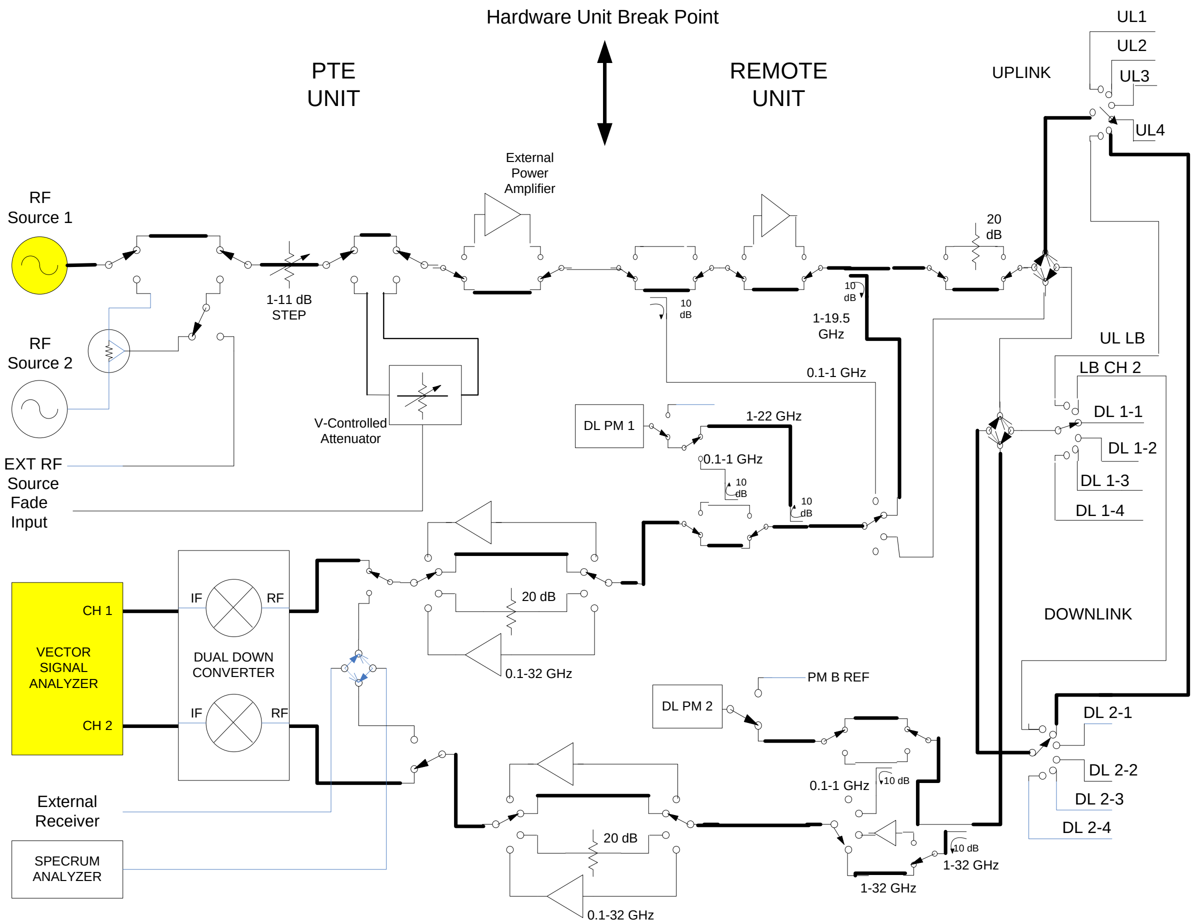
6.2.5 Downconverter RF Gain Calibration



Note: This Diagram is for conceptual use only see the PTE and Remote Unit ICD for actual switching information and routing.

Figure 12 Downconverter RF Gain Calibration

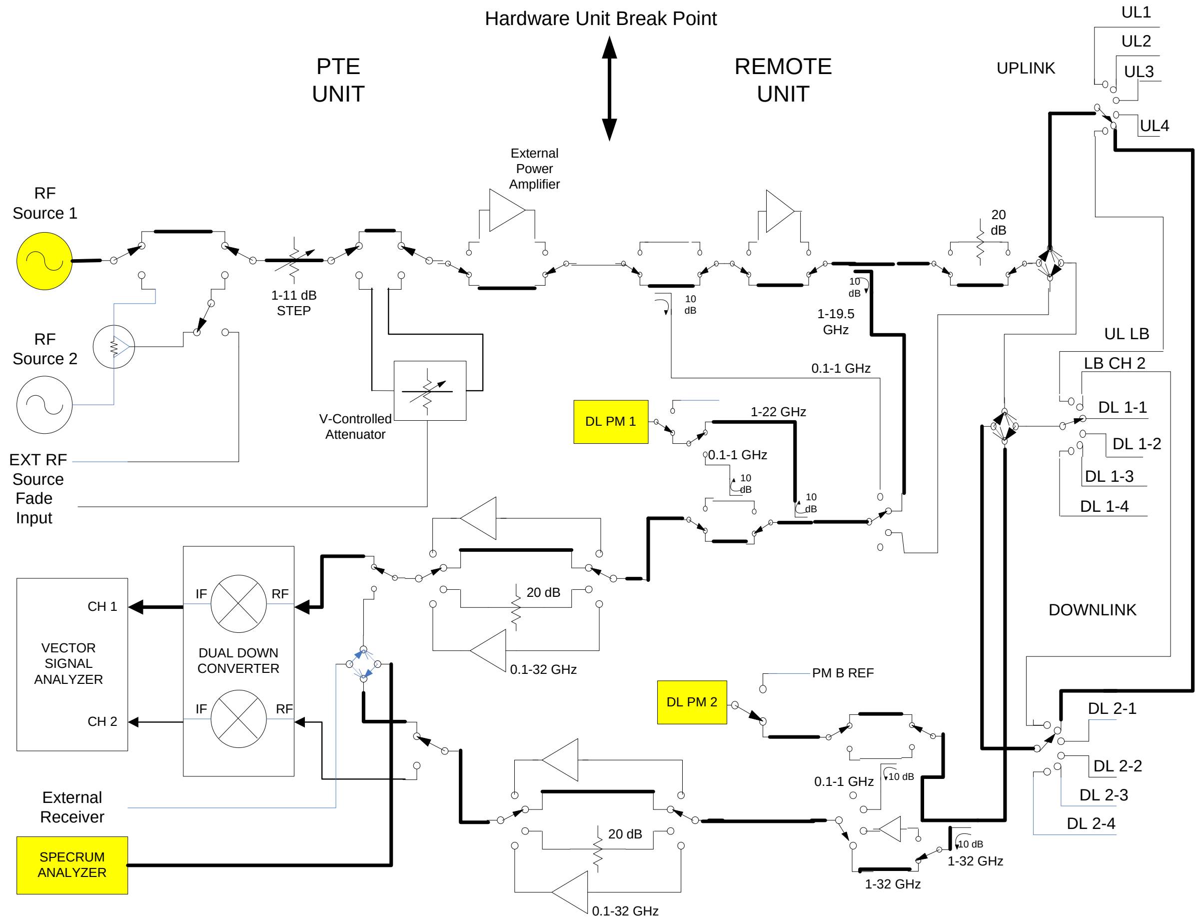
6.2.6 Source or Receiver AMP/PAD Calibration



Note: This Diagram is for conceptual use only see the PTE and Remote Unit ICD for actual switching information and routing.

Figure 13 Source or Receiver AMP/PAD Calibration

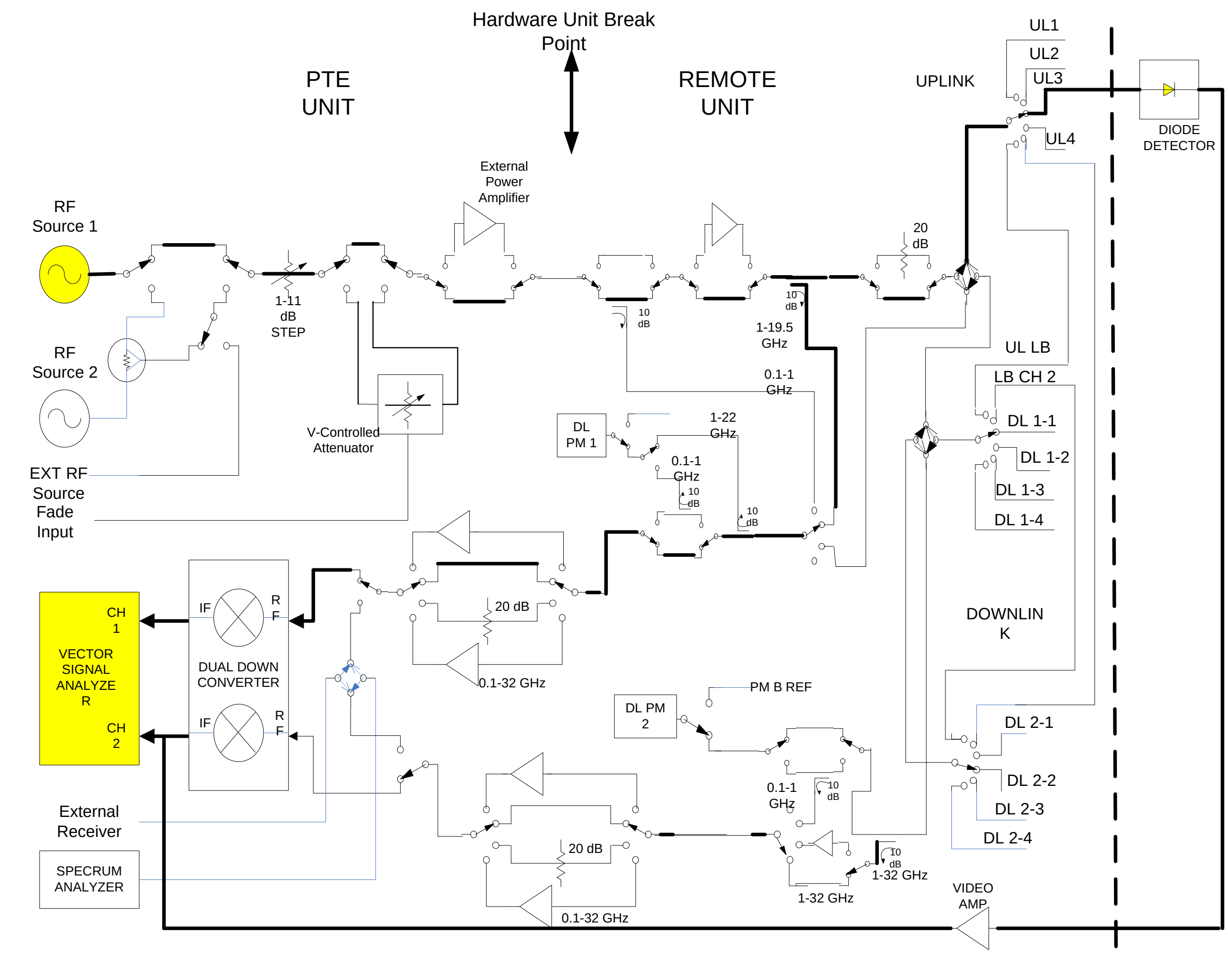
6.2.7 Spectrum Analyzer Gain Calibration



Note: This Diagram is for conceptual use only see the PTE and Remote Unit ICD for actual switching information and routing.

Figure 14 Spectrum Analyzer Gain Calibration

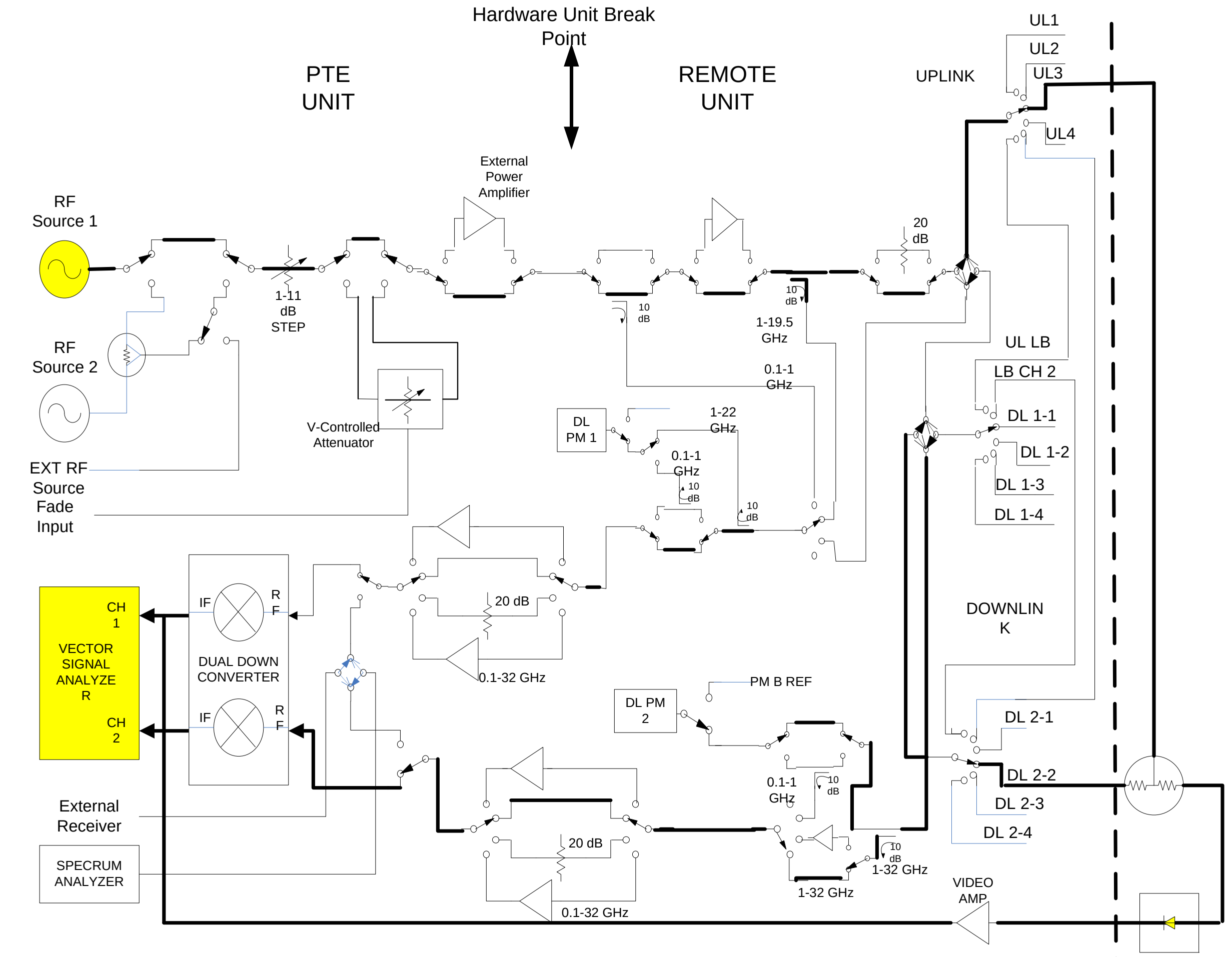
6.2.8 Uplink Port Delay Calibration



Note: This Diagram is for conceptual use only see the PTE and Remote Unit ICD for actual switching information and routing.

Figure 15 Uplink Port Delay Calibration

6.2.9 Downlink Port Delay Calibration

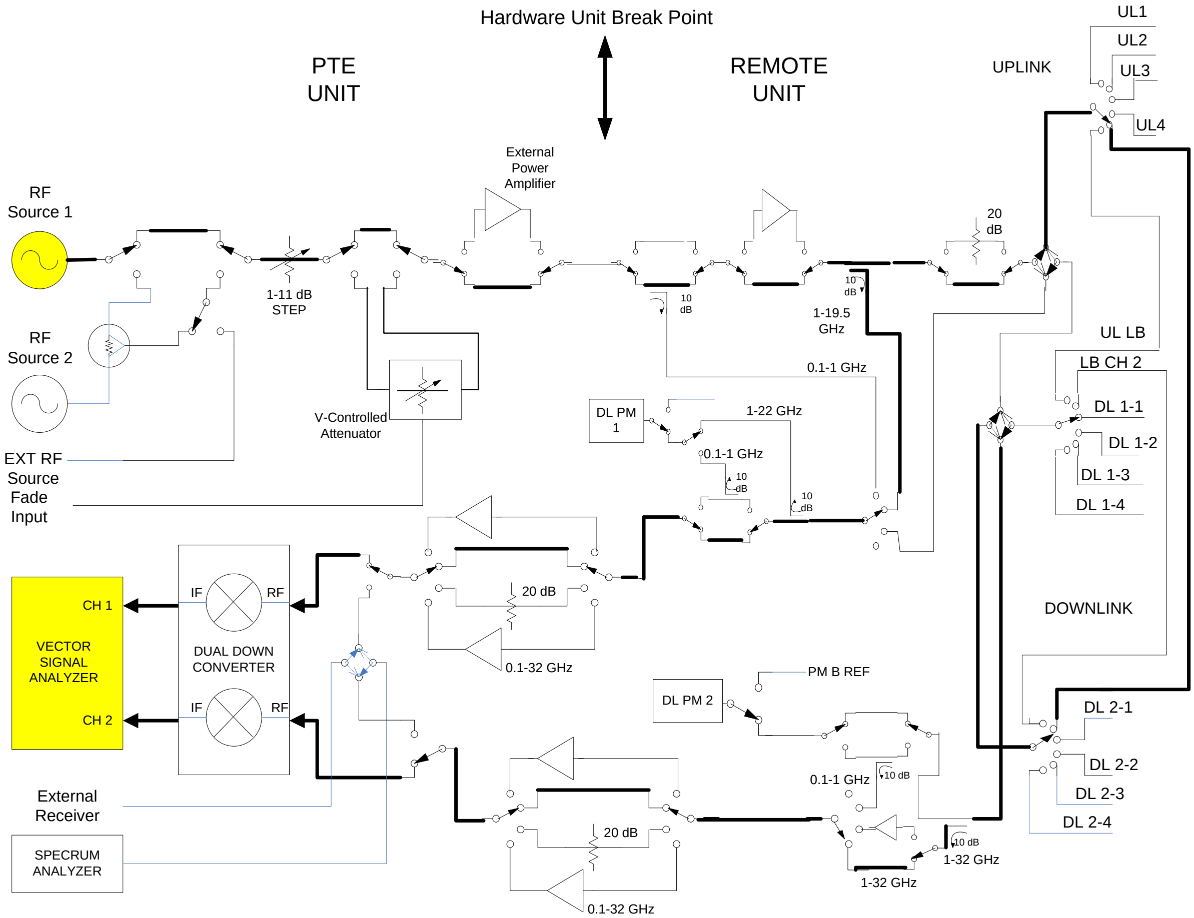


Note: This Diagram is for conceptual use only see the PTE and Remote Unit ICD for actual switching information and routing.

Figure 16 Downlink Port Delay Calibration

6.2.10 Thermal Vacuum Calibration

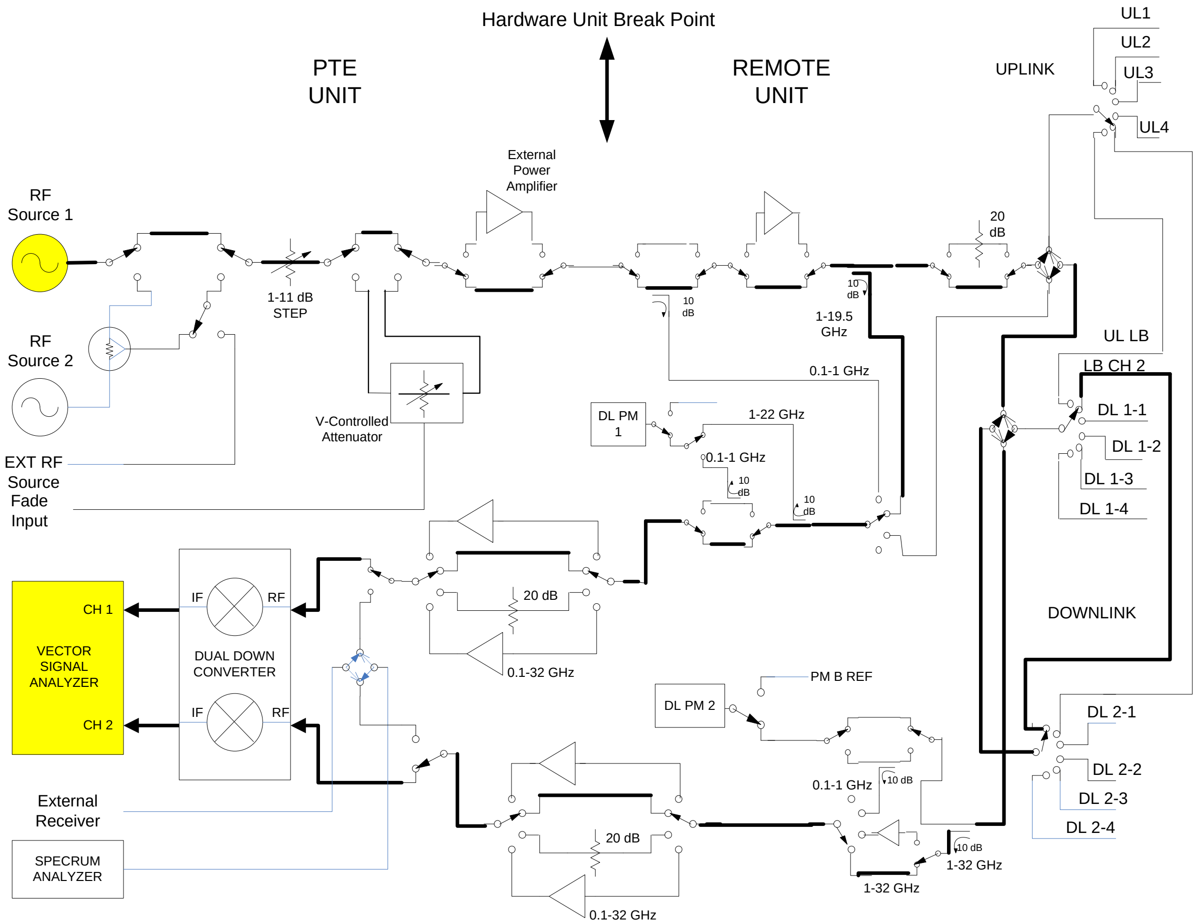
6.2.10.1 Remote Unit AC Measurement



Note: This Diagram is for conceptual use only see the PTE and Remote Unit ICD for actual switching information and routing.

Figure 17 Remote Unit AC Measurement

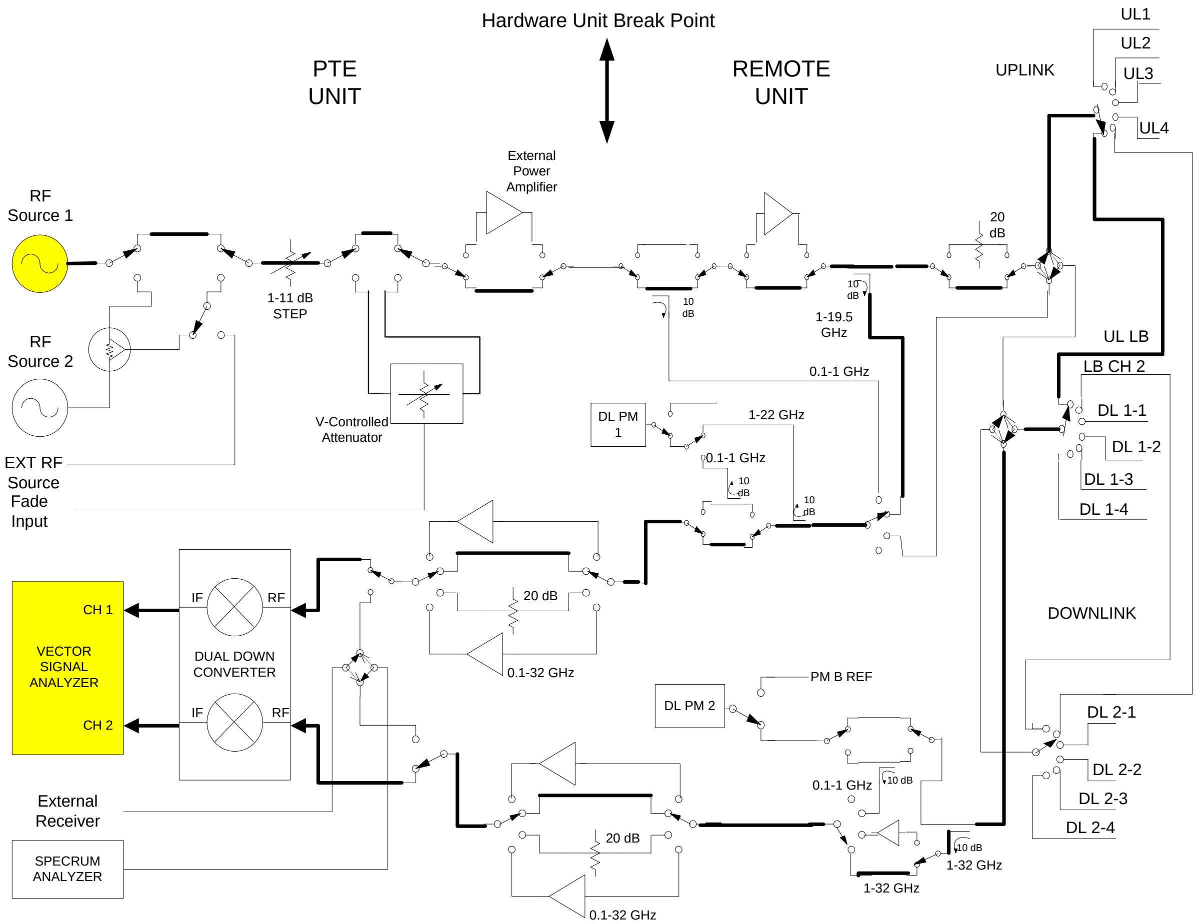
6.2.10.2 Remote Unit BC Measurement



Note: This Diagram is for conceptual use only see the PTE and Remote Unit ICD for actual switching information and routing.

Figure 18 Remote Unit BC Measurement

6.2.10.3 Remote Unit AB Measurement



Note: This Diagram is for conceptual use only see the PTE and Remote Unit ICD for actual switching information and routing.

Figure 19 Remote Unit AB Measurement

6.2.10.4 TV Unit AC Measurement

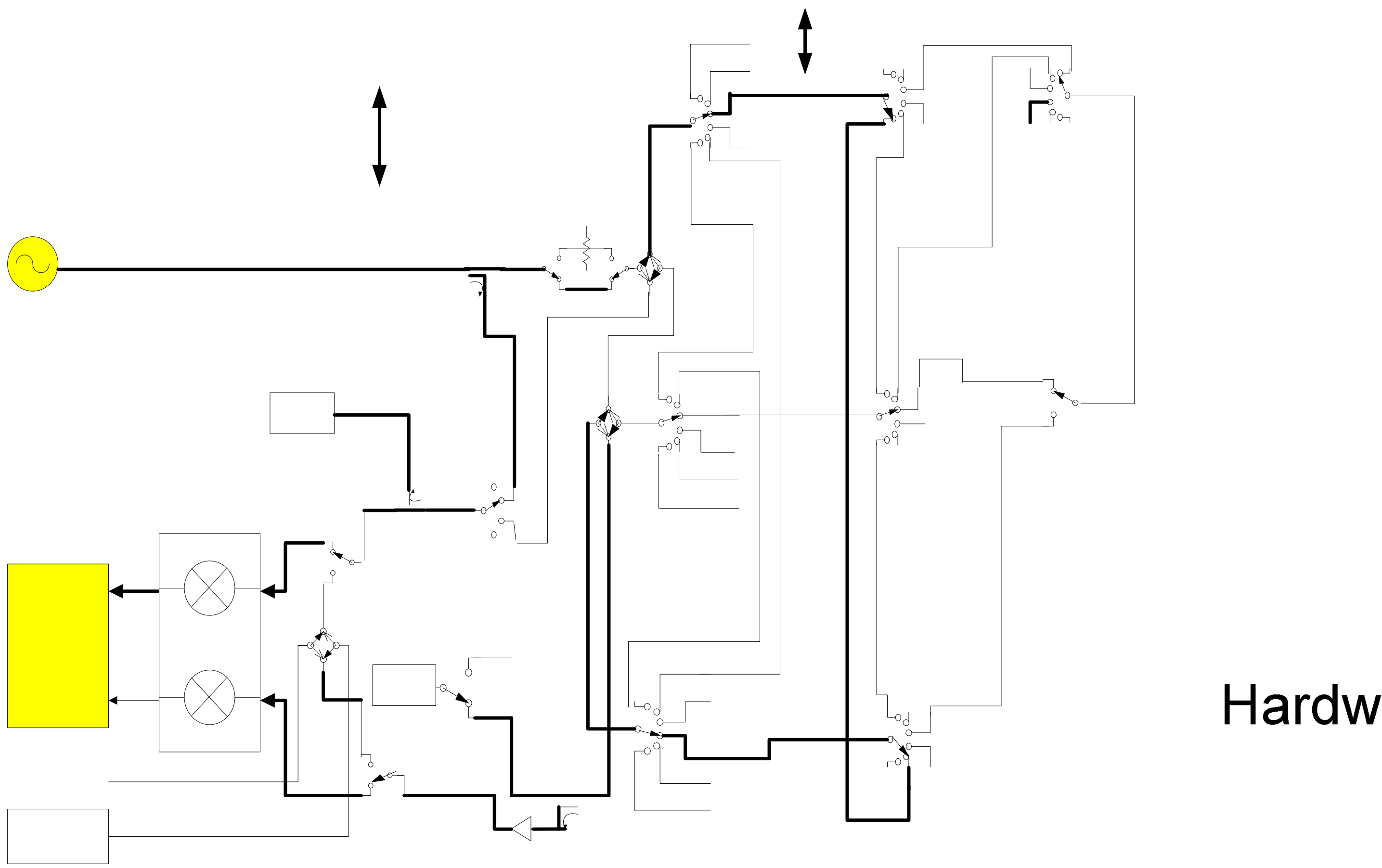


Figure 20 TV Unit AC Measurement

6.2.10.5 TV Unit BC Measurement

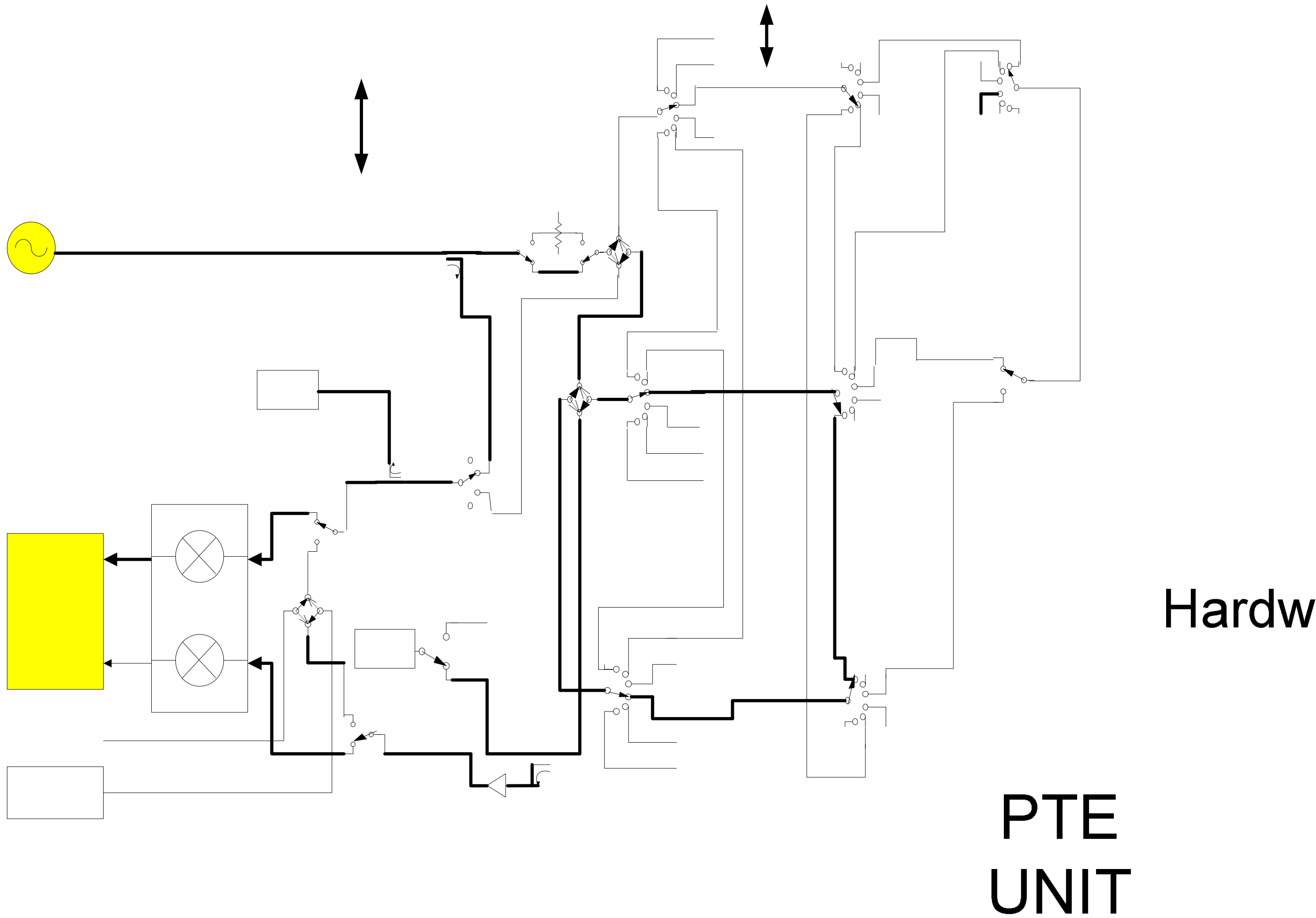


Figure 21 TV Unit BC Measurement

RF
Source 1

6.2.10.6 TV Unit AB Measurement

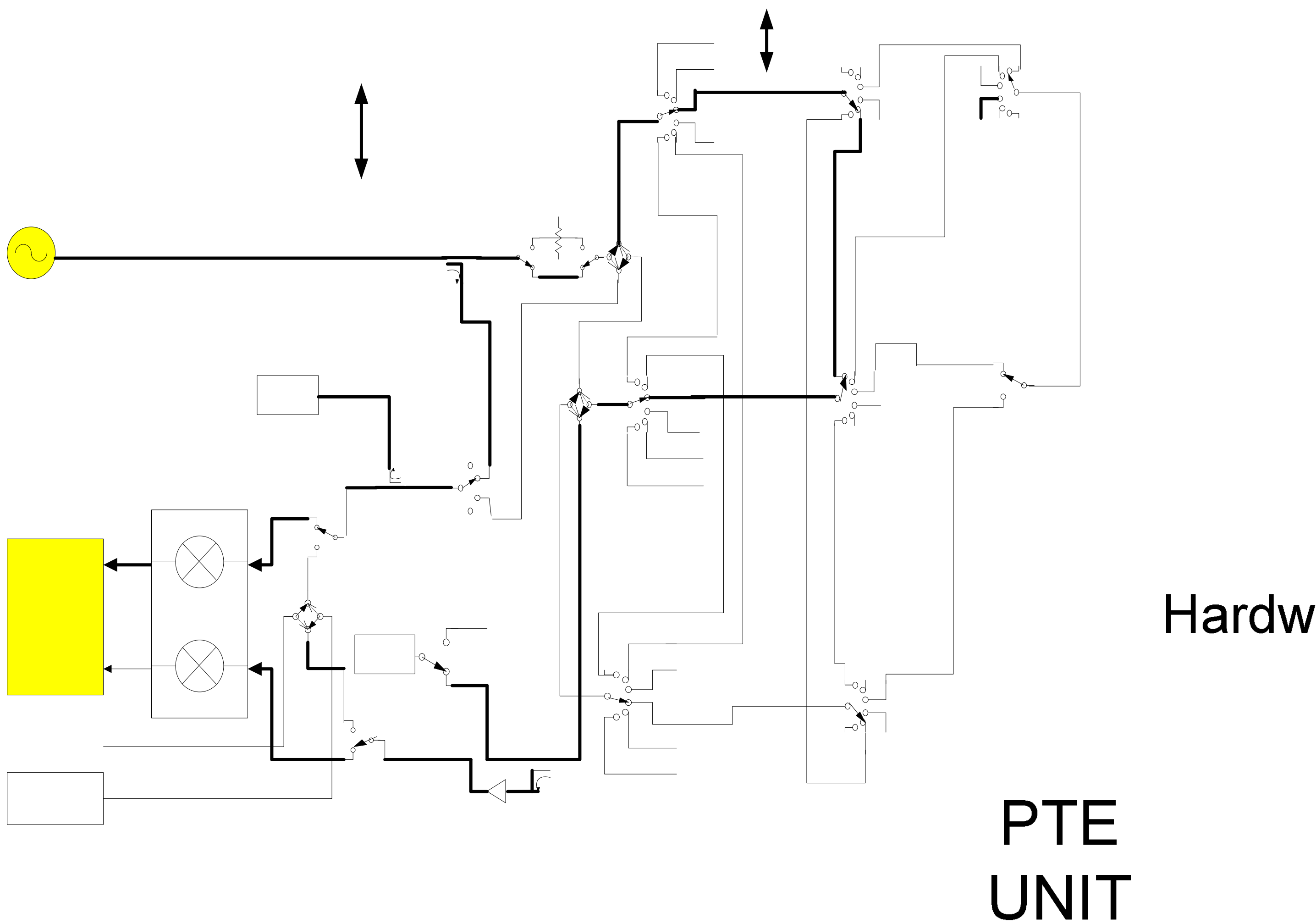


Figure 22 TV Unit AB Measurement

RF
Source 1

6.2.10.7 Wrap Around Cable AC Measurement

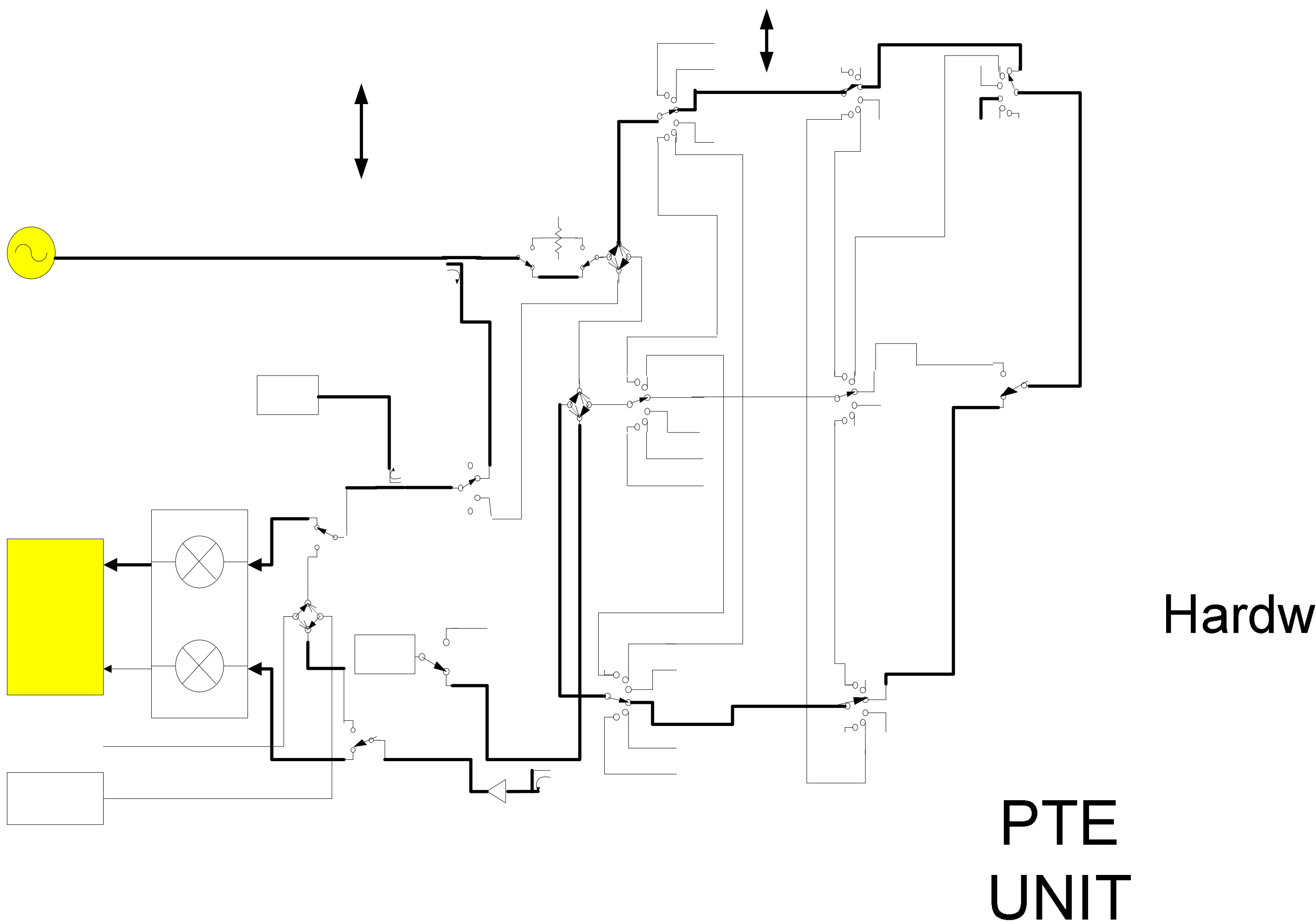


Figure 23 Wrap Around Cable AC Measurement

6.2.10.8 Wrap Around Cable BC Measurement

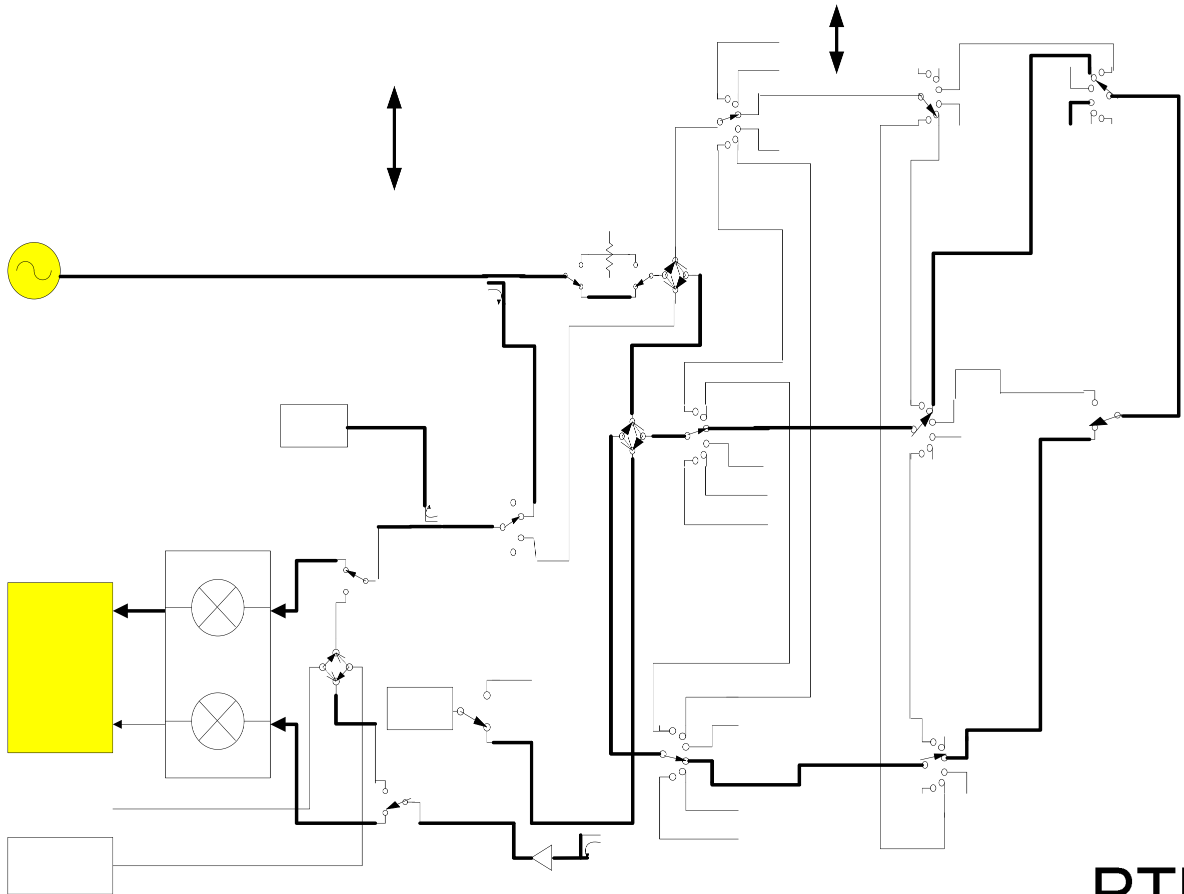


Figure 24 Wrap Around Cable BC Measurement

6.2.10.9 Wrap Around Cable AB Measurement

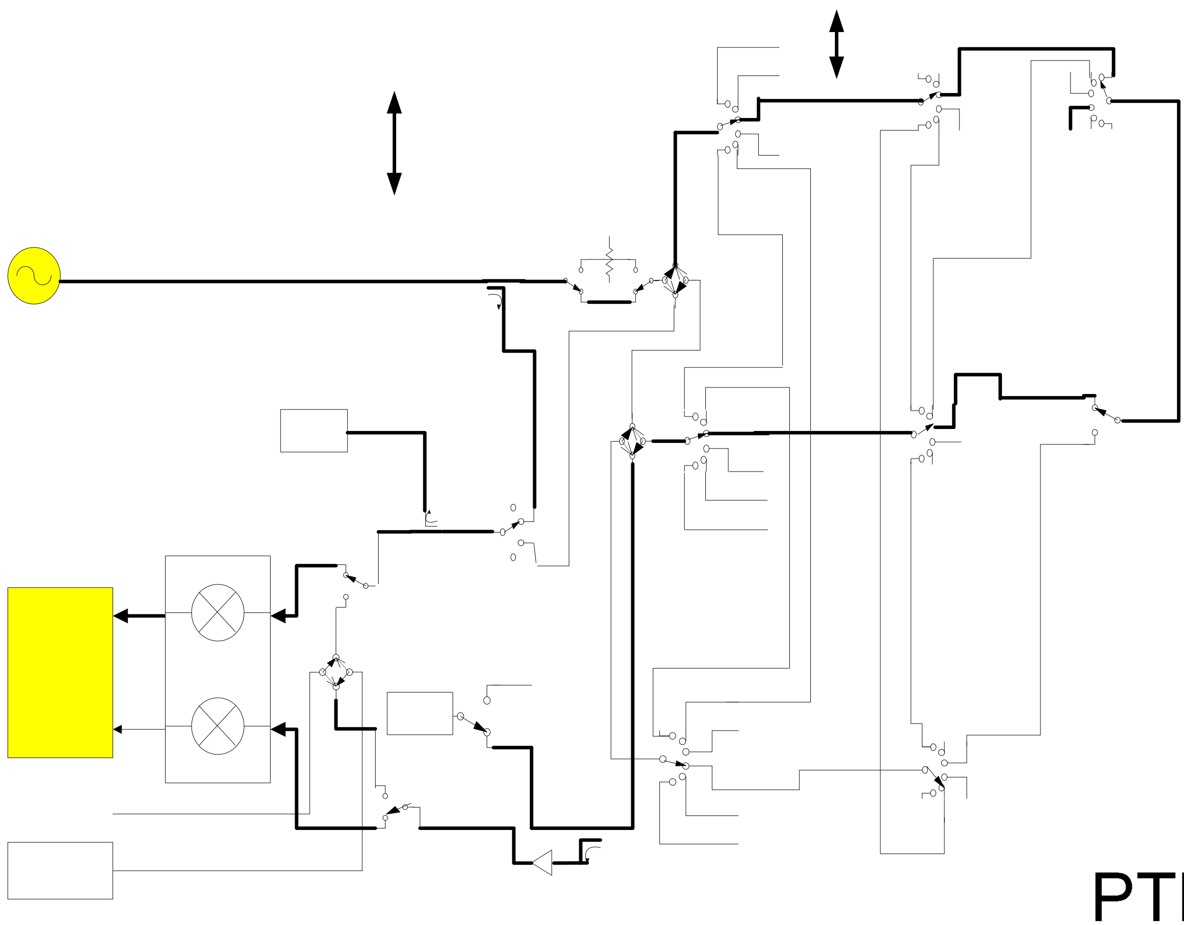


Figure 25 Wrap Around Cable AB Measurement