Signal Hound®

PCR4200

Phase Coherent Receiver

Product Manual

Signal Hound PCR4200 Product Manual

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Contents

1 Overview

This document outlines the operation and functionality of the PCR4200 Phase Coherent Receiver. This document will help you understand the capabilities, performance specifications, and features of your PCR4200.

The PCR4200 is a high dynamic range, 100 kHz to 20 GHz, 4-channel receiver, where each channel can stream time stamped I/Q data to a PC over a 10 GbE SFP+ link using VITA 49 format at up to 50 MSPS (40 MHz BW).

The channels may be independently tuned using the independent local oscillators (LO), or tuned together using the shared LO. A single channel can be used as a sweeping channel, covering 100 kHz to 20 GHz about 10 times per second at 100 kHz RBW.

Additionally, a vector signal generator is available to facilitate tighter phase alignment between channels when integrating into a system.

Two units can be connected together to form an 8-channel array of phase coherent receive channels.

2 Preparation

2.1 Initial Inspection

Check your package for shipping damage before opening. Your box should contain a SFP+ module and 3 meter fiber optic cable, a GPS antenna, a 12V power supply, and a Signal Hound PCR4200.

2.2 Software Installation

See the Spike Software manual for installation instructions. You must have administrator privileges to install the software. During the installation of the Spike software, the USB device drivers will also be installed.

2.3 Software Requirements

Supported Operating Systems

- Windows 11/10*

- Ubuntu Linux 22.04/20.04/18.04, 64-bit
- RHEL 8 (API only)

System Requirements

- Processor – 4th generation or newer Intel dual/quad core i-series processors***
  - Quad core 8th generation or newer i7 / i9 recommended
- 8 GB RAM - 1 GB for the Spike software
- 10 GbE SFP+ network interface adapter (SM200C and SM435C)
- OpenGL 3.0 capable graphics processor** (When using the Spike software application)

(* We do not recommend running in a virtual machine (i.e. Parallels/VMWare/etc.))

(** Certain display features are accelerated with this functionality.)

(***Our software is optimized for Intel CPUs. We recommend them exclusively.)

2.4 Connecting Your PCR4200

For full setup instructions and network troubleshooting for the PCR4200, see the network configuration manual.

2.4.1 ⚠Caution – PCR4200 Surfaces May Be Hot

Depending on operating conditions, ambient temperature, and air flow around the unit, the PCR4200 may be hot to the touch after prolonged use. Use caution when touching the unit.

2.5 Front and Back Panels

2.5.1 The PCR4200 Front Panel

The **front panel** has 8 connectors:

1. Channel 1 RF Input. Type N connector. Do not exceed +20 dBm or damage may occur.
2. Channel 2 RF Input. Type N connector. Do not exceed +20 dBm or damage may occur.
3. USB 2.0 micro-B connector. Used for network configuration and firmware updates.
4. Status LED: Alternates red/green as commands are processed and sweeps are generated.

5. SFP+ connector: 10 GbE bi-directional data connection to the PC, using an optical SFP+ module and fiber optic cable.

6. Channel 3 RF Input. Type N connector. Do not exceed +20 dBm or damage may occur.

7. Channel 4 RF Input. Type N connector. Do not exceed +20 dBm or damage may occur.

8. 9-16V DC power input: Use the included 12V supply, or a battery that can source 60 watts.

9. RF Output from the internal vector signal generator (VSG).

2.5.1.1 LED States

The possible PCR4200 LED states are OFF, RED, GREEN, and ALTERNATING. All combinations of device and LED state are described below.

Initialization States:

OFF – until the power cable and USB cable are both connected.

ORANGE/RED – during device initialization once the power and USB cables are connected.

GREEN – once the device is initialized, the GREEN LED state represents the IDLE state.

Operational States:

ALTERNATING RED/GREEN – when the device is actively processing and executing commands.

GREEN – Device is idle or only streaming VITA 49 data

RED – Indicates a failure. Usually indicates no 10 GbE connection to PC.

OFF – Device has lost power

2.5.2 The PCR4200 Back Panel

The back panel has 9 SMA connectors

1. 10 MHz In. Used to discipline the 125 MHz OCXO to an external time base

2. 125 MHz In. Used on secondary PCR4200s in a PCR8200 array

3. 125 MHz Out. Used on primary PCR4200s in a PCR8200 array
4. Local Oscillator In. Used on secondary PCR4200s in a PCR8200 array
5. Local Oscillator Out. Used on primary PCR4200s in a PCR8200 array
6. SYNC In. Used on secondary PCR4200s in a PCR8200 array
7. SYNC Out. Used on primary PCR4200s in a PCR8200 array
8. TRIG In. 3.3V logic, 5V tolerant trigger input / external PPS input
9. GPS Antenna. Connect an active GPS antenna here when using the internal GPS. Output is about 3.3 volts DC.

3 Measurement and Acquisition Modes of Operation

This section details the core measurement and acquisition modes for the PCR4200. Channels may be configured as phase coherent I/Q Streaming channels or Independently Tuned I/Q Streaming channels. Additionally, any single channel may be used for swept spectrum analysis instead of streaming.

3.1.1 Phase Coherent I/Q Streaming

Channels configured for phase coherent streaming use the shared LO, combined with factory and user phase offsets for tightly matched channel phases. Decimation may be 1, 2, or 4, resulting in bandwidths of 50, 25, or 12.5 MSPS.

For best phase stability, a 30 minute warmup, followed by 15 minutes continuous streaming, is recommended before calibrating phase offsets. See Appendix for typical performance.

3.1.2 Independently Tuned I/Q Streaming

Channels configured for independently tuned streaming use the channel's independent LO. Decimation may be 1, 2, or 4, resulting in bandwidths of 50, 25, or 12.5 MSPS. All streaming channels (phase coherent and independently tuned) share a common decimation rate.

3.1.3 Swept Spectrum Analysis

In the Spike software or using the API, any single channel may optionally be configured as the sweep channel. This channel's mode of operation is the mode which is commonly associated with spectrum analyzers. Through the software you will configure the device and request the device perform a sweep across your desired span, up to the full 100 kHz – 20 GHz. The PCR4200 uses fixed local oscillator (LO) frequencies to acquire each 40 MHz patch of spectrum. If the start and stop frequency do not map to the same LO step, multiple 40MHz patches are acquired and concatenated to form the sweep. Sweep rates above 200 GHz/s are possible with RBWs of 30 kHz or higher.

The processing performed on each 40MHz patch is determined by the settings provided. A maximum RBW of 3 MHz and a minimum RBW of 1 kHz is available in this mode, but low RBWs may be further limited by span.

3.1.4 Triggering

When streaming I/Q or VITA49 data, a high rate trigger may be optionally enabled, indicating the logic level of the TRIGGER input for each sample. This is typically used in larger systems, where the state of another piece of equipment (e.g. a transmitter) is required for analyzing the data. A 3.3V CMOS trigger with 50 ohm output impedance is ideal, but 5V logic with 50 ohm output impedance is acceptable. Higher or lower output impedance may work with a short BNC cable, but longer cables may cause issues with reflection.

Triggering can be used in Spike's Zero Span mode. You can specify an immediate, video, external, or frequency mask trigger (FMT). Immediate triggering causes the measurement to occur immediately and can be thought of a 'no-trigger'. Video triggering allow you to begin the measurement only after a signal exceeds a specific amplitude on the RF input. This is useful when you need to analyze a periodic transmission. External triggering triggers a measurement after a hardware trigger occurs on the trigger SMA port. If your transmitter has a trigger output, you can route this to the trigger in SMA. You can trigger on the rising edge or falling edge of a signal.

3.1.5 Internal GPS and Time Stamping

The internal GPS, when the antenna is connected and GPS signal is present, synchronizes the OCXO to typically within a part per billion after about 10 minutes. The pulse-per-second (PPS) signal also generates an automatic internal trigger that is used to time stamp I/Q data in all I/Q streaming modes.

3.1.5.1 Internal GPS adjustments

The internal GPS is highly configurable. The main adjustments the user should be aware of are the Dynamic Platform Model (e.g. stationary, driving, in an aircraft), and antenna cable delay. For more information, see the u-blox-F9-TIM-2.25 Interface Description. Please note that the PCR4200 uses UBX-formatted data and the timepulse features. Care should be taken not to override these. See API manual for more information.

3.1.5.2 External GPS Time Stamping

The trigger input can be configured as a pulse-per-second (PPS) input. When using this feature, the user must set the PCR's clock to the UTC time at the next PPS, in between two PPS events.

It is recommended that the user also connect an external 10 MHz time base from the external GPS to discipline the PCR4200's frequency. This will provide the best frequency accuracy and time stamping in the absence of the internal GPS.

3.1.6 I/Q Streaming Options

Streaming channels may be configured as "local" or VITA 49.

When streaming channels are configured as VITA 49, data is streamed directly to a specified IP address, port, and MAC address using only simple xon/xoff flow control from the NIC card, bypassing the API entirely. In this mode, the user is responsible for ensuring that the network configuration can provide gap-free reception of data.

3.2 VITA49

Each channel on the PCR4200 is assigned a unique stream identifier, and are treated as independent, time aligned, VITA 49 streams. The PCR4200 uses Signal Data packets and Context packets. Both types contain headers with metadata which includes a Stream Identifier and timestamp.

3.2.1 VITA 49 Data Format

The PCR VITA49 data format is documented here,

https://signalhound.com/sigdownloads/SDK/online_docs/pcr_api/iq_v_r_t.html

3.2.2 Configuring VITA 49 Streams

Each VITA 49 streaming channel must be configured with a destination IP address, UDP port, and MAC address, and they may be identical or unique. This enables various configurations, anywhere from a single PC doing everything, to a system with 5 separate PCs, one for command/control and one for each stream, through a smart switch.

Streaming channels can be set up to include periodic context packets (1 context packet followed by N data packets, where N is selectable). Context packets will cycle through valid streams, providing center frequency, reference level, and other context for that particular stream. See the PCR4200 API documentation for additional information.

When streaming channels are configured as local, they are streamed through the API. The advantage of using the API is an additional layer of flow control taking advantage of the 2 GB

DDR memory buffer is used, ensuring gap-free data for a much wider range of PC, OS, and NIC card combinations. Additionally, local streaming byte swaps for direct storage as short ints.

3.3 Vector Signal Generator

A built-in vector signal generator, roughly -20 to +10 dBm, 30 MHz to 20 GHz, is provided for system calibration and alignment. Generally, alignment at the system's antenna connectors is sufficient. When transmitting over the air it is the user's responsibility to follow local and federal regulations. No harmonic filtering is included, so over-the-air applications may require external filters or attenuation to meet federal requirements.

A buffer of 4096 samples can be used to generate chirps, multi-tone signals, or pseudo-Gaussian noise, to assist in system alignment. It uses the same shared LO as the receive channels, but some bands require a frequency divider, meaning the output phase should not be treated as deterministic. Samples are clocked out at 125 MSPS.

4 Understanding the PCR4200 Hardware

4.1 Highlights

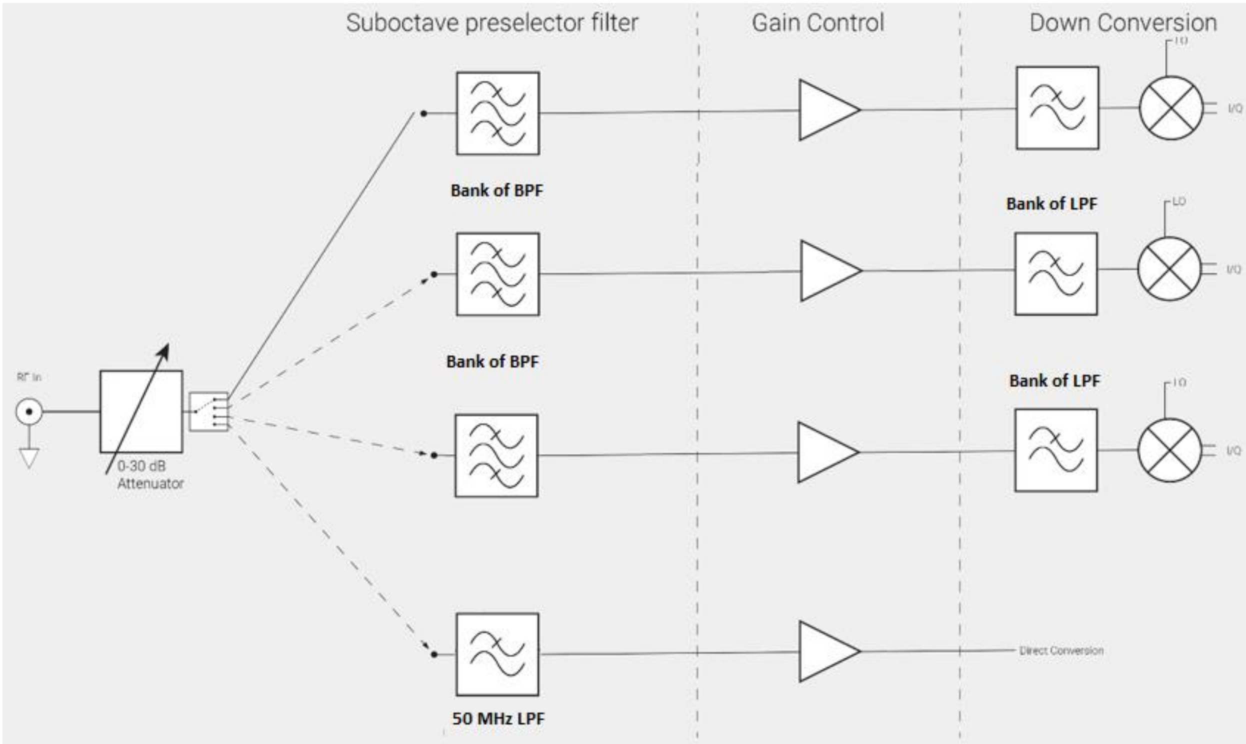
The PCR4200 uses an ultra-low phase noise 125 MHz OCXO, which is multiplied and filtered to generate a clean 1 GHz reference. The shared Local oscillator (LO) uses this 1 GHz reference in a translation loop architecture, providing very low close-in phase noise with considerably lower spurious than a DDS. The independent local oscillators and ADCs use the buffered 125 MHz output directly as their reference. This 125 MHz reference is also available as an output, typically used to daisy-chain PCR4200s together.

The PCR4200 has been designed to have high IP3 and low DANL at all input levels, giving users the ability to monitor the spectrum at full sensitivity without worrying about overdriving the front end or generating excessive intermodulation products. Care was taken to isolate the channels to minimize crosstalk effects.

A single channel vector signal generator with a 4096 sample I/Q buffer, operating off of the 125 MHz clock, is included for system phase alignment. Please note that harmonics and spurious are higher than a typical dedicated signal generator. External filtering may be needed for some applications. The output power is adjustable over a range of about 30 dB. See appendix for typical maximum output power.

4.2 Front End Architecture

One of four channels shown:



Each PCR4200 channel is a low IF receiver. We chose this architecture to complement our low phase noise local oscillator (LO), while avoiding the shortfalls of zero IF (direct) conversion, and because of the availability of high linearity direct conversion demodulators and I/Q mixers.

The PCR4200 contains 3 mixer bands covering 40 MHz to 20 GHz, and one direct conversion band covering 100 kHz to 50 MHz. A preselector, consisting of 16 sub-octave band pass filters, covers 45 MHz to 20 GHz. At frequencies below 200 MHz, the bandwidth may be less than 40 MHz at some frequencies due to preselector band edges.

Three separate mixers, optimized for IP3 and image rejection within their operating range, convert the incoming RF signal into baseband I/Q signals. In the PCR4200, the LO is typically injected above the RF by 4-44 MHz. This generates a baseband I/Q signal, which is filtered and then digitized at 125 MSPS, and streamed to Intel's Arria 10 FPGA.

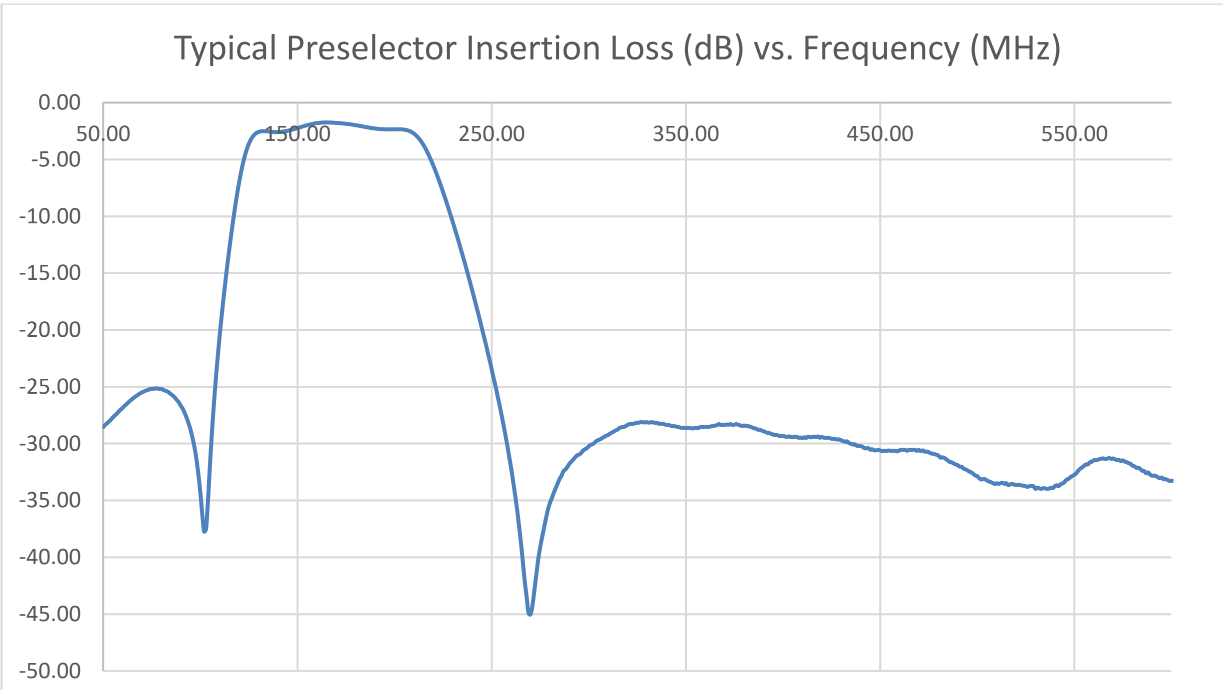
When a PCR4200 channel is using the shared LO (i.e. phase coherent streaming) it benefits from a low phase noise, low spurious translation loop circuit. Independent LOs use a fractional-N PLL, with frequencies selected to reduce, but not eliminate, fractional-N spurs.

An LO feedthrough cancellation circuit helps reduce the LO feedthrough above 5.6 GHz for most frequencies, but some LO frequencies exceed its tuning range (see Appendix for typical plot).

4.2.1 Preselector

The preselector is a collection of sub-octave filters spanning 45 MHz to 20 GHz. It removes out-of-band energy from the RF input before any amplification or mixing occurs.

The preselectors have a shape similar to the one shown (filter 7):

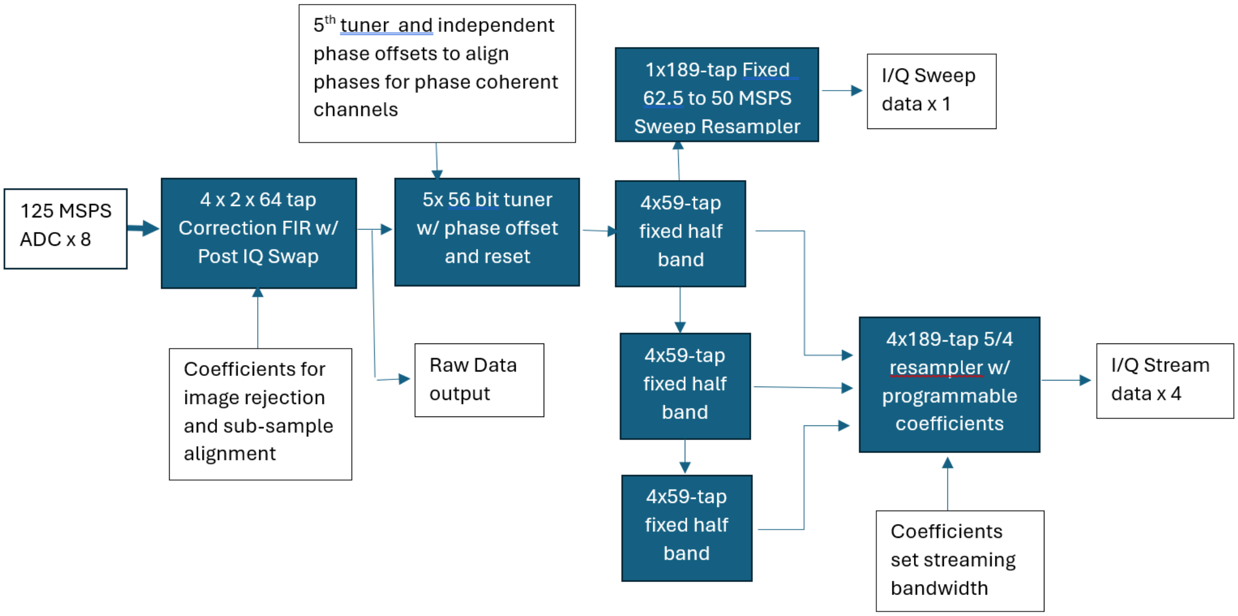


When using preselector filters with I/Q streaming, or when predicting if a preselector will help block an interfering signal, use the following tables.

Preselector Filters

Filter	Range used for Sweeps (MHz)	Useable Range for I/Q streaming (MHz)
0 (LPF)	0-47	0-50
1	47-63	42-68
2	63-92	59-100
3	92 - 136.7	86-146
4	136.7 - 198	130-210
5	198 - 293	190-303
6	293 - 410	280-440
7	410 - 644.5	400-645
8	644.5 - 957	Full 40 MHz span
9	957 - 1560	Full 40 MHz span
10	1560 - 2200	Full 40 MHz span
11	2200 - 3000	Full 40 MHz span
12	3000 - 4500	Full 40 MHz span
13	4500 - 5600	Full 40 MHz span
14	5600 - 8500	Full 40 MHz span
15	8500 - 13250	Full 40 MHz span
16	13250 - 20000	Full 40 MHz span

4.3 Signal Processing in the FPGA



The digitized data is processed with a special FIR filter to reject the image response and flatten the frequency response, and optionally time-align the channels. This data is then phase corrected, digitally tuned to select the lower sideband, decimated down to 50 MSPS I/Q, and optionally decimated to 25 MSPS or 12.5 MSPS.

The PCR4200 includes a 2 GB DDR capture buffer. This is used primarily for “local” streaming to the API.

4.4 Residual and Spurious Signals

4.4.1 Residual Signals

A residual signal appears even when there is no signal input. The PCR4200 has some low level residual signals, typically found above 5 GHz and below -112 dBm.

4.4.2 Spurious Signals

Typically, the spur with the highest amplitude will be the image response, located 10-90 MHz below the actual RF signal. This will typically be around -60 dBc below 5 GHz, -53 dBc above 5 GHz.

Spurious signals also arise from spectral impurities in the LO, as well as undesired mixing products. The translation loop architecture used by the shared LO tends to have very few spurs, but the independent LO will have some fractional-N spurs, depending on frequency selected.

These are typically less than 1 MHz from the carrier, typically less than -50 dBc, and will mix with the RF input signals.

The architecture of the PCR4200 does not have any subharmonic LO spurs, and uses a preselector and low pass filter combination to remove most RF harmonic energy, but a low level of harmonic mixing may occur, typically below -60 dBc. For most frequencies, these will be too low to interfere with typical measurements.

An additional class of spur can appear when the shared LO is tuned to a strong RF signal between 40 MHz and 5.6 GHz, but the channel is using the independent LO. A small amount of the shared LO can leak onto the independent LO, resulting in spurs, typically below -50 dBc. This spur is not observed above 5.6 GHz, and is most visible on the swept channel as it can create a spur at each 40 MHz step within the preselector pass band.

4.5 Scalloping Loss

An FFT-based spectrum analyzer uses digital resolution bandwidths rather than discrete analog filters. Moving from analog to digital introduces some new terms important to measurement accuracy, like FFT bins, window functions, spectral leakage and scalloping loss. To sum up, an FFT produces an array of discrete frequency bins and their associated amplitude. Real-world signals rarely line up exactly with a single frequency bin, which can result in some ugly behavior unless a window function is used. Many different window functions are available, with various strengths and weaknesses.

For the PCR4200, swept modes default to a flat top window, which offers excellent amplitude flatness and therefore very little scalloping loss, in exchange for a wider resolution bandwidth and longer processing time. Most RBWs used by the PCR4200 are from flat top windows, so scalloping loss is negligible.

4.6 Dynamic Range

Dynamic range has many definitions, but one common definition in spectrum analysis is 2/3(TOI – DANL). A typical number for 1 GHz, -10 dBm reference level (10 dB attenuator), would be: TOI= +21 dBm, DANL = -150 dBm (1 Hz RBW). Dynamic range, 2/3 (TOI – DANL) = 114 dB, and would be mostly a function of RBW and frequency.

4.7 Protecting the RF Input

The PCR4200 channels each have a DC block rated to 16 VDC and some ESD protection, but ESD damage is still possible. Signals above +20 dBm peak (not RMS) can also cause damage. Some common events which may lead to front end damage include:

1) Applying more than +20 dBm peak power, such as an antenna exposed to a radar pulse, or even the pulse from suddenly connecting a large DC voltage.
2) ESD from a passive antenna, either from discharge to an antenna element, or from connecting a large antenna or cable which has built up a static charge.

For any application which may expose the PCR4200 to front end damage, including connecting to active or passive antennas, a coaxial limiter is recommended to protect the input.

A limiter will protect against overpowering the input, typically raising the damage level above 2 watts, as well as offering additional protection against ESD. It will also offer some protection against the energy spike you get when connecting to equipment with a DC or static voltage present when used with an additional DC block. The energy may significantly exceed +20 dBm for several microseconds.

Generally, the performance at low input signal levels is just the insertion loss of the limiter, but at high signal levels there will be some nonlinearity and the resulting intermodulation products. A typical limiter will have an IP3 around +30 dBm, so for input signals below -20 dBm there should be little to no effect on PCR4200 linearity.

If it is a passive antenna mounted using a long coaxial cable, it may be building up a significant static charge until it is connected. For this reason, it might make the most sense to keep the limiter connected to the far end of the antenna cable rather than the PCR4200. A DC block is probably not necessary for passive antennas in most cases.

4.8 Power Management

⚠ **Caution:** *After the* PCR4200 *has been running for a while, it may be hot!*

The PCR4200, when running, typically consumes 45 watts of power, and can be a bit higher or lower depending on channel configuration and frequency.

The FPGA in the PCR4200 has a maximum operating core temperature of 100 °C. Exceeding this will cause the PCR4200 to automatically power down as much as possible. The user must remove power until it has sufficiently cooled before resuming operations.

When using the 110/220V wall adapter, power interruptions and large surges may cause the device to lose connection to the PC. Operation can be restored by reconnecting manually or automatically, but several seconds of data acquisition may be lost. Depending on application and location, consider using battery power or a surge-protected uninterruptible power supply (UPS).

4.8.1 Active Cooling

An active cooling module removes most of the heat generated in the PCR4200. The fan will be turned on when the device is warm, off when the device is cool, and has variable speed control. Vibration from the fans may affect phase noise, so the fan may be turned off during critical measurements, but must be turned back on before the device overheats.

5 Troubleshooting

Troubleshooting information can be found in the Spike user manual and the network configuration manual for troubleshooting 10GbE networking issues.

6 Calibration and Adjustment

Calibration and adjustment of the PCR4200 can be performed by Signal Hound. Additionally, calibration software is freely available for customer on-site calibration, but requires specialized equipment typically found only in calibration labs. The calibration software provided can perform timebase adjustments only. If other adjustments are required, the analyzer must be returned to Signal Hound.

Contact Signal Hound for more information regarding calibration software and required equipment, or to schedule a calibration.

7 Functional Specifications

7.1 Sweep

IBW	40 MHz
Frequency range	100 kHz to 20 GHz
RBW range	1 kHz to 3 MHz
RBW / VBW ratio	1 to 1000, selectable/arbitrary
Sweep speed	160 GHz/sec @ 10 kHz RBW
	18 GHz/sec @ 1 kHz RBW

7.2 IQ Streaming (Zero Span)

IBW	40MHz (all models, all frequencies)
Frequency Range	100kHz to 20GHz
Sample Rate	12.5MS/s to 50MS/s
	(Additional software decimation for local streaming)
BW	Selectable, arbitrary.
	(Sample rate * 0.8) maximum 1 dB bandwidth.
	BW may be limited by preselector filter at low frequencies

8 PCR4200 Specifications

The following specifications are based on a set of operating conditions, which are the power-up default settings, unless otherwise stated: 1) Operating in the Preset condition, 2) Using internal timebase, 3) Video processing set for average and power, 4) VBW, sweep, gain, and attenuation in the default auto mode, 4) Ambient room temperature (18 - 28C)

IP2 and IP3 testing is performed at a -10 dBm reference level with preselector on, and normalized to a 0 dBm reference level, which is the functional equivalent of 0 dB RF gain, or the “preamplifier off” setting of a typical receiver. At maximum sensitivity (-20 dBm reference level), IP2 and IP3 will typically be 20 dB lower. DANL is tested at maximum sensitivity (-20 dBm reference level)

Frequency Range	100kHz to 20GHz
RF Input Impedance (type-N connector)	50Ω Nominal
Calibrated Streaming I/Q	5MHz to 40MHz of selectable I/Q bandwidth.
Resolution Bandwidths (RBW)	1kHz to 3MHz for swept spectrum
Timebase Accuracy	GPS disciplined OCXO remains within ±5 x 10-10 when locked to GPS;
	Holdover of ±5 x 10-9 per day for aging
	(±2 x 10-8 first day typical)
	Holdover of ±1 x 10-8 for temperature over -40°C to 65°C typical
System Noise Figure (typical)	7-9 dB from 50 MHz to 2.7 GHz
	9-11 dB from 2.7 GHz to 5.6 GHz
	7-9 dB from 5.6GHz to 12GHz
	9-13 dB from 12GHz to 20GHz
IP_2	+75dBm from 50MHz to 7GHz
	+65dBm from 7GHz to 9GHz
	+70dbm from 9GHz to 20GHz
IP_3	+28dBm 100kHz to 3GHz (+35 typical)
	+18dBm 3GHz to 9GHz (+28 typical)
	+23dBm 9GHz to 20GHz (+30 typical)

Amplitude Accuracy (+10dBm to Displayed Average Noise Level (DANL))

100kHz to 6GHz	>6GHz to 20GHz	RBW filter shape
±2.0dB	±3.0dB	Flat-Top windowing
+2.0dB/-2.6dB	+3.0/-3.6dB	Nuttall windowing

[5]**Displayed Average Noise Level (DANL)**

Input Frequency Range	dBm/Hz
1 MHz to 50 MHz	–160 dBm (-165 typical)
50 MHz to 2.7 GHz	–161 dBm (-165 typical)
2.7 GHz to 12 GHz	–160 dBm (-164 typical)
12 GHz to 18 GHz	–159 dBm (-163 typical)
18 GHz to 20 GHz	-157 dBm (-162 typical)

LO Leakage at RF Input -82dBm from 100kHz to 5GHz
-56dBm from 5GHz to 12GHz (-70 typical)
-47dBm from 12GHz to 20GHz (-60 typical)

[5]**Residual Responses** < -108 dBm (0dB attenuation, 50-ohm load on RF input)
Typical: 3-4 spurs between -120 and -114 dBm

[5]**Spurious Responses** (any ref level (RL) from +10dBm to -20dBm, in 5dB increments, input 10dB below RL, RBW ≤ 30kHz)

Input Freq. Range	Worst spur (dBc)	Typical (dBc)
100 kHz to 2.5 GHz	-47	-57
2.5 GHz to 5.5 GHz	-44	-60
5.5 GHz to 8.2 GHz	-37	-50
8.2 GHz to 20 GHz	-44	-60

Sub-Octave Preselector 45MHz to 20GHz

8 Channel Sample Delay (6” cable) 0.7 ns uncorrected delay typical on channels 5-8

[5]SSB Phase Noise at 1 GHz Center Frequency, Shared LO

Offset Frequency	dBc/Hz
10Hz	-75
100 Hz	-105
1 kHz	-128 (-133 typical)
10 kHz	-136 (-140 typical)
100 kHz	-138 (-141 typical)
1 MHz	-138 (-140 typical)

[5]SSB Phase Noise at 1 GHz Center Frequency, Independent LO, Typical

Offset Frequency	dBc/Hz, Typical
10Hz	-70
100 Hz	-95
1 kHz	-110
10 kHz	-125
100 kHz	-130
1 MHz	-135

Vector Signal Generator	
Amplitude Accuracy	±3 dB
Image Rejection	500 MHz-20 GHz: -35 dBc, below 500 MHz -23 dBc (-50 dBc typical)
Carrier Feedthrough	(-45 dBc typical)
Harmonics	-15 dBc typical
Output Power	-20 to +3 dBm typical
I/Q Buffer Size	4096 I/Q samples maximum at 125 MSPS
Synchronization	GPS data in each packet with ± 40ns time-stamping
Connectivity	PC / laptop with a 10 GbE SFP+ interface is required, and a minimum of a quad core 6th Gen i7 is recommended.

RF Input Protection	±16 VDC, +20 dBm peak RF input power
	ESD: 1.5 kV HBM, 1250 V CDM (typical)
[8]**Operating Temperature**	Standard: 32°F to 122°F (0°C to +50°C)
	Option 1: -40°F to 140°F (-40°C to +60°C)
[6]**Size**	12" x 11.5" x 3" active cooling
Weight	16.2 lbs.
Power Consumption	45-50 watts typical sourced from the 12V AC wall adapter or from an external 9V to 16V supply when using the Option-12 LEMO Pigtail.

[1]*Dynamic Range is defined here as ⅔ of the difference between IP_3 and DANL as measured in ITU-R SM.1837, normalized to dB/Hz*

[2]*For EVM measurements of signals having symbol rates between 100 kHz and 1MHz. The SM200A/B will contribute a somewhat higher EVM error for symbol rates outside of this range.*

[4]*Streaming I/Q and burst I/Q are bandwidth limited to the speed of the available Ethernet connection.*

[5]*DANL, Residual Responses, Spurious Mixer Responses, and Phase Noise specifications are production tested and guaranteed only at 23°C (±5°C). Typical performance of these characteristics, over the instrument's operating temperature range, will be published as graphs in the User's Manual.*

[6]*The SM200 length is 10.97" (0.77" longer) when counting the front panel type-N RF input connector and 0.375" higher when counting feet.*

9 Warranty and Disclaimer

9.1 Warranty

The information contained in this manual is subject to change without notice. Signal Hound makes no warranty of any kind with regard to this material, including, but not limited to, the implied warranties or merchantability and fitness for a particular purpose. Signal Hound shall not be liable for errors contained herein or for incidental or consequential damages in connection with the furnishing, performance, or use of this material. This Signal Hound product has a warranty against defects in material and workmanship for a period of two years from date of shipment. During the warranty period, Signal Hound will, at its option, either repair or replace products that prove to be defective.

9.2 Warranty Service

For warranty service or repair, this product must be returned to Signal Hound. The Buyer shall pay shipping charges to Signal Hound and Signal Hound shall pay UPS Ground, or equivalent, shipping charges to return the product to the Buyer. However, the Buyer shall pay all shipping charges, duties, and taxes, to and from Signal Hound, for products returned from another country.

9.3 Limitation of Warranty

The foregoing warranty shall not apply to defects resulting from improper use by the Buyer, Buyer-supplied software or interfacing, unauthorized modification or misuse, operation outside of the environmental specifications for the product. No other warranty is expressed or implied. Signal Hound specifically disclaims the implied warranties or merchantability and fitness for a particular purpose.

9.4 Exclusive Remedies

The remedies provided herein are the Buyer's sole and exclusive remedies. Signal Hound shall not be liable for any direct, indirect, special, incidental, or consequential damages, whether based on contract, tort, or any other legal theory.

9.5 Certification

Signal Hound certifies that, at the time of shipment, this product conformed to its published specifications.

9.6 Credit Notice

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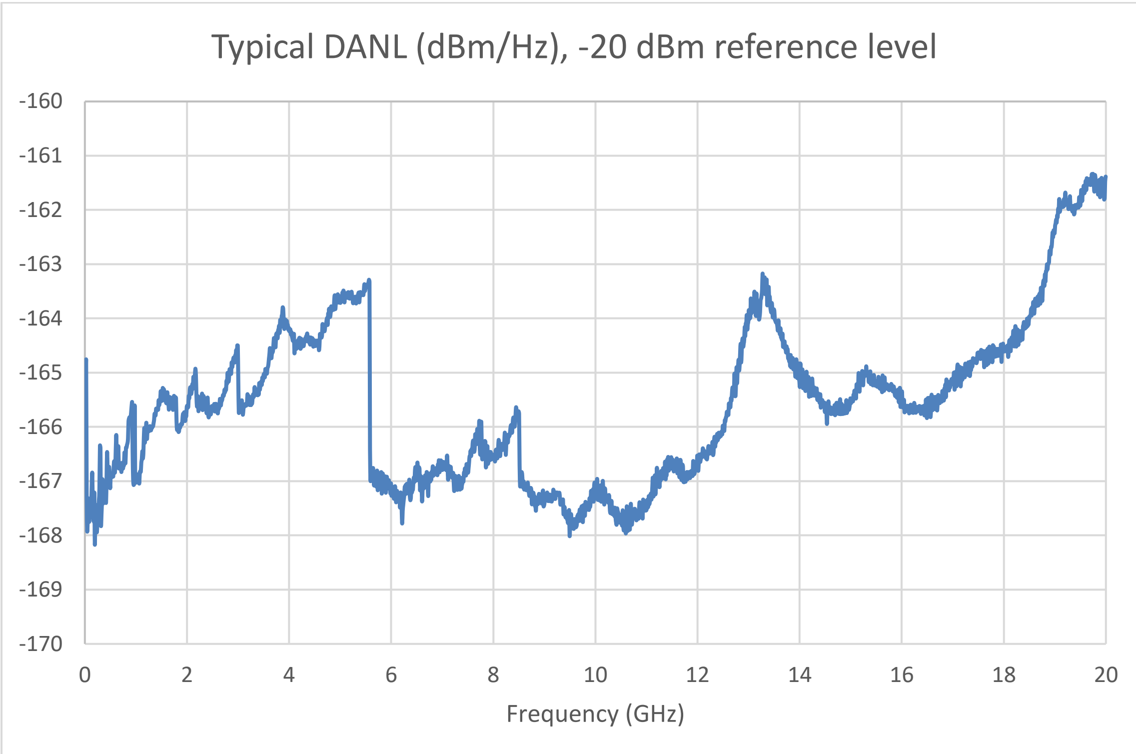
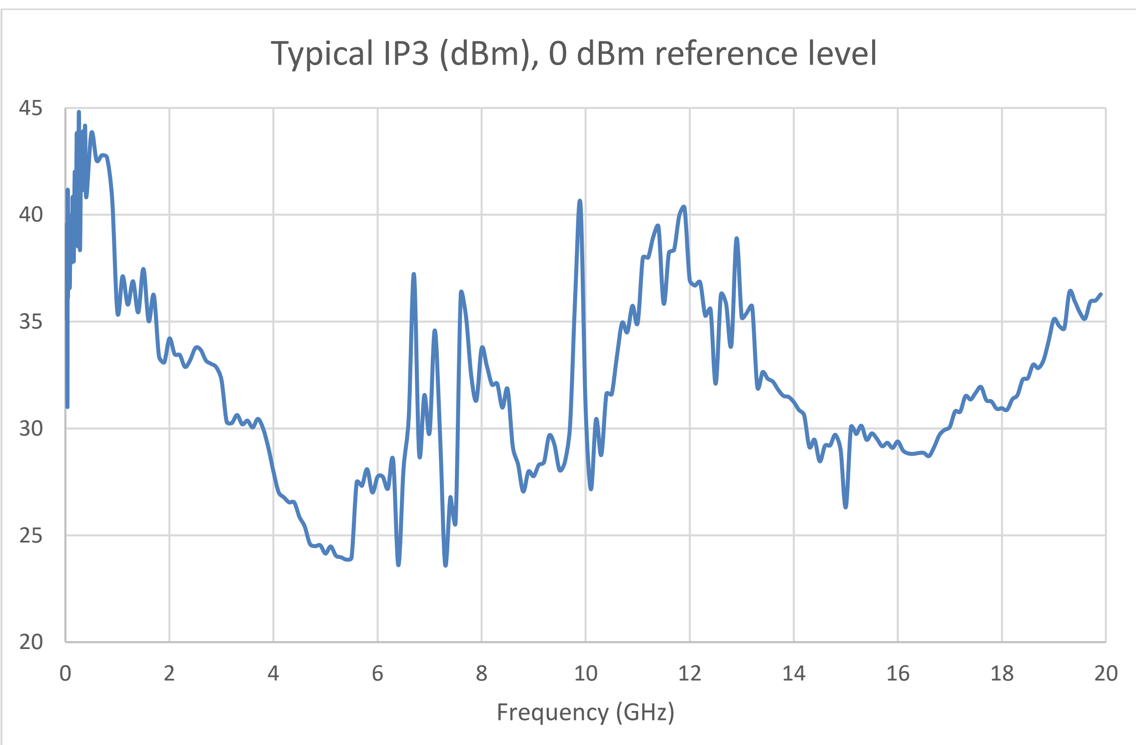
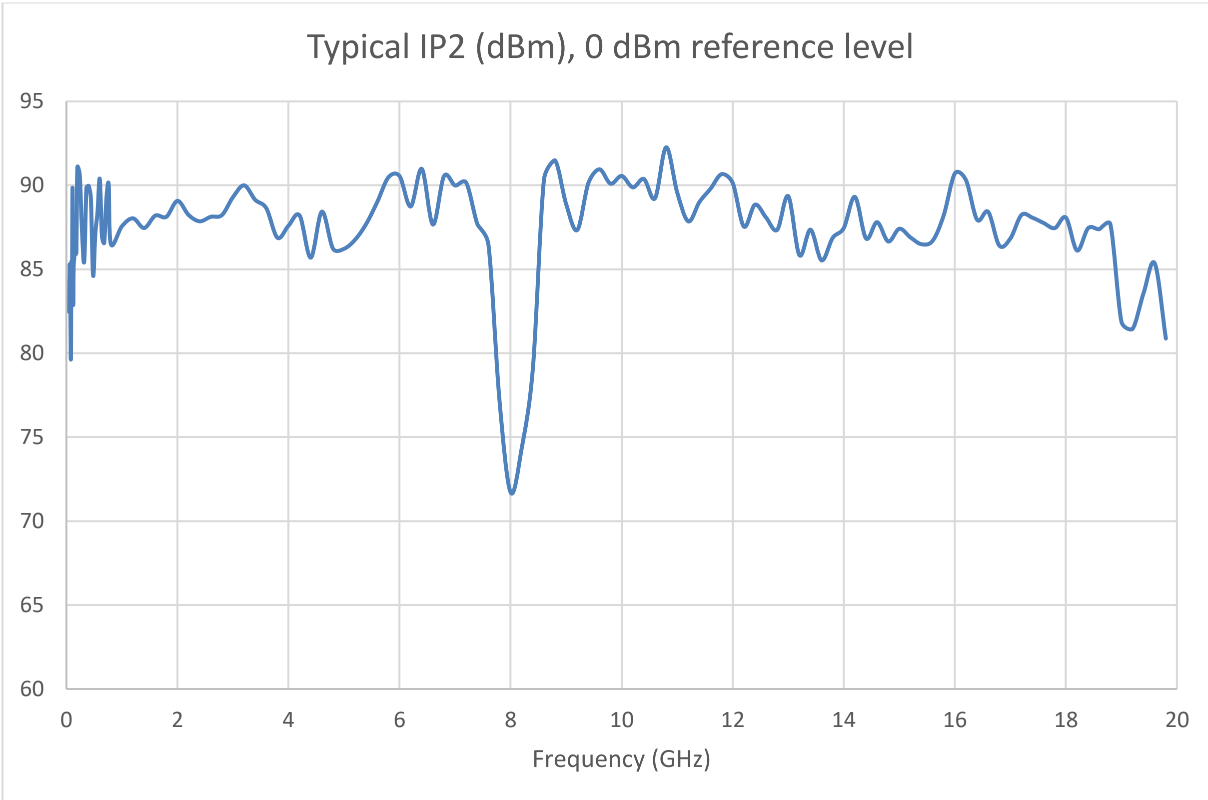
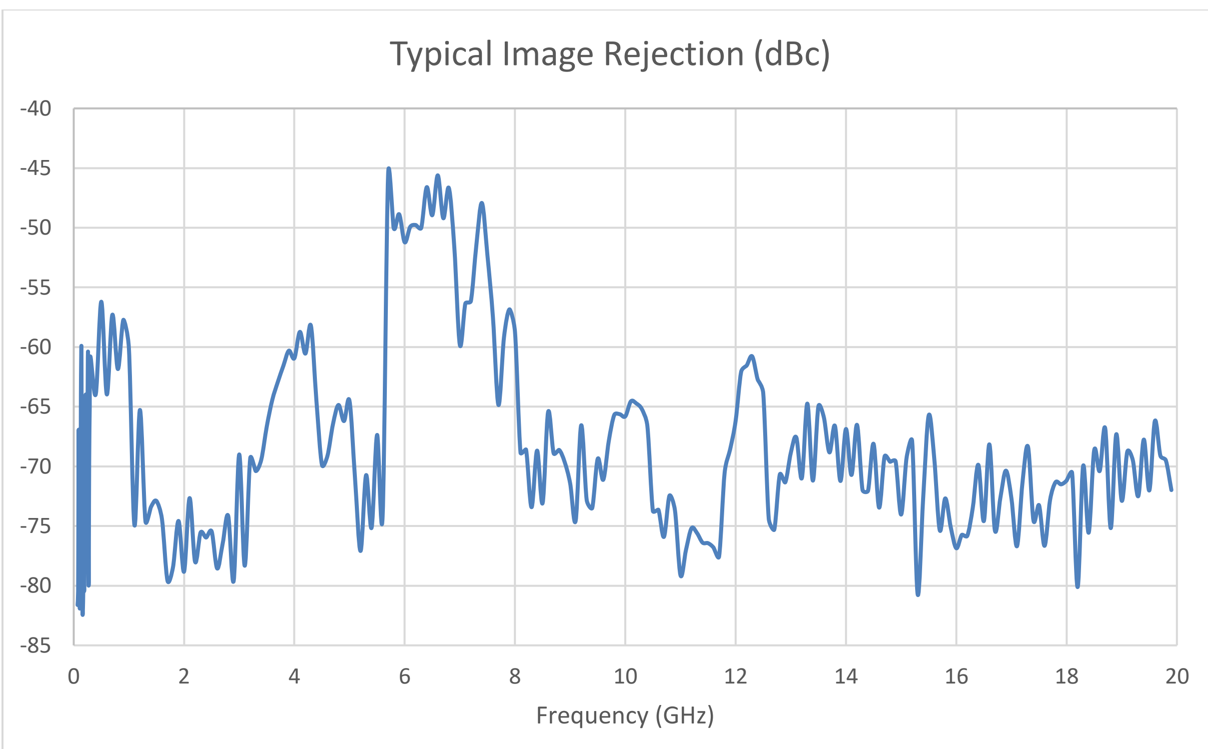
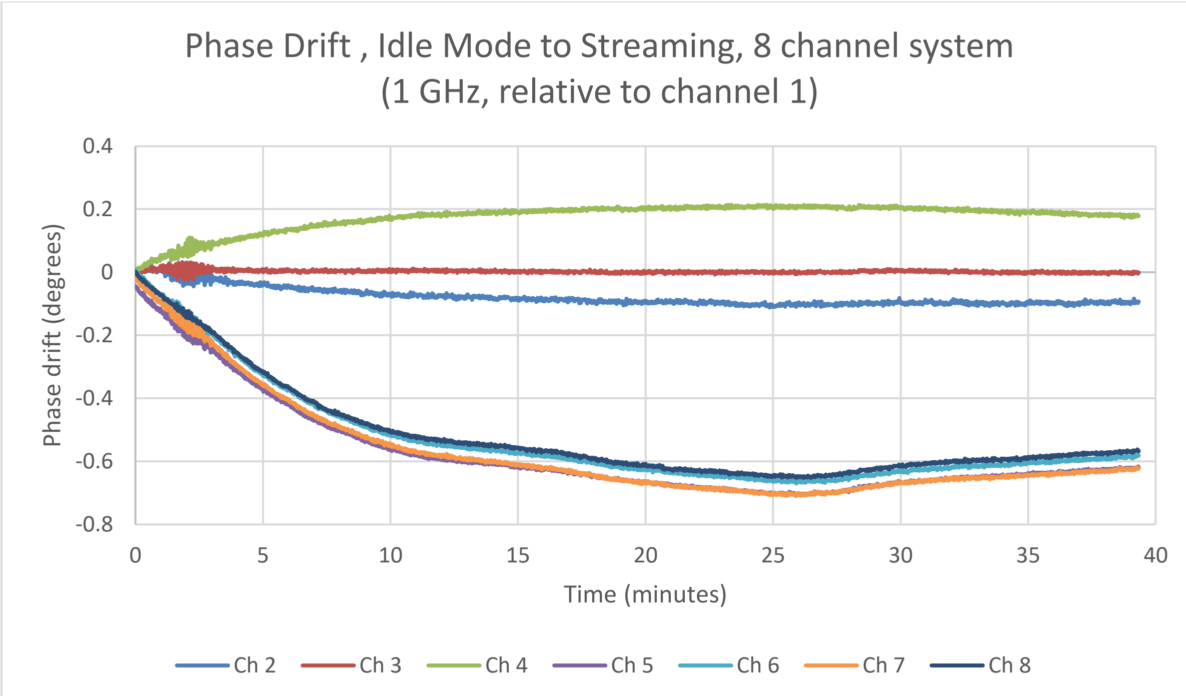
10 Appendix A: Typical Performance



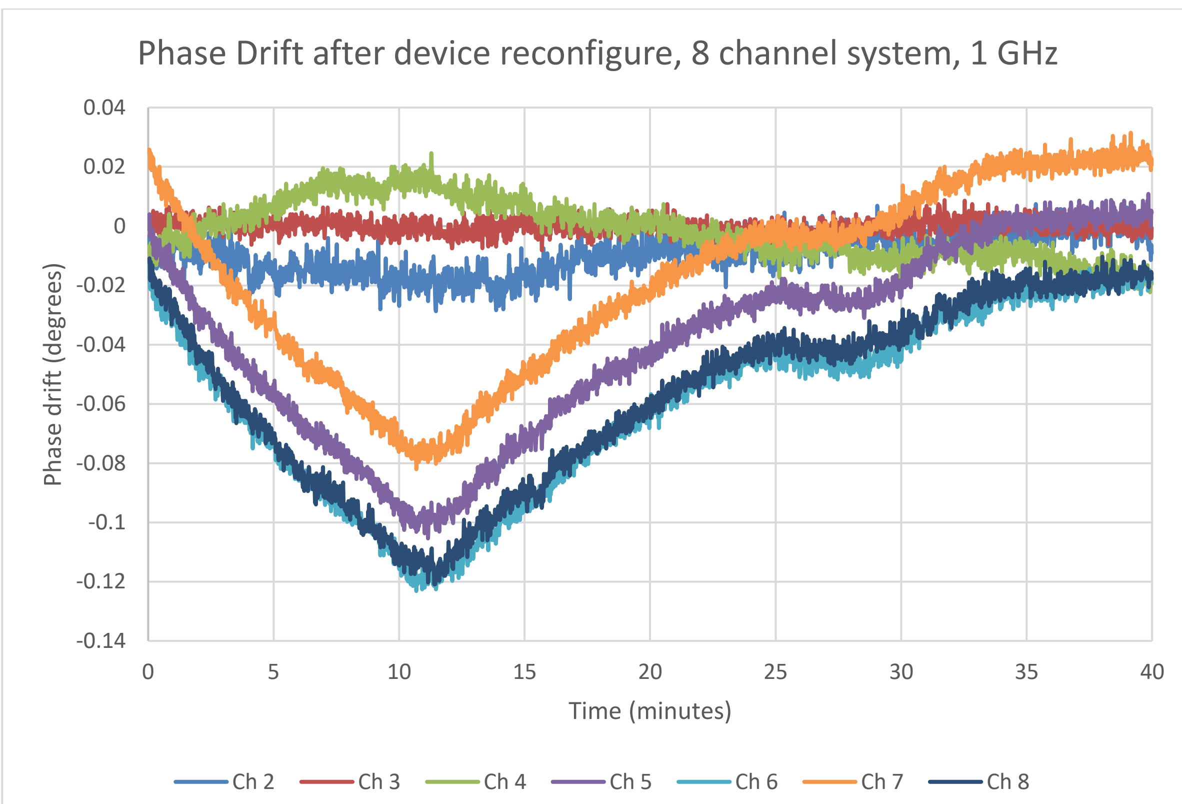


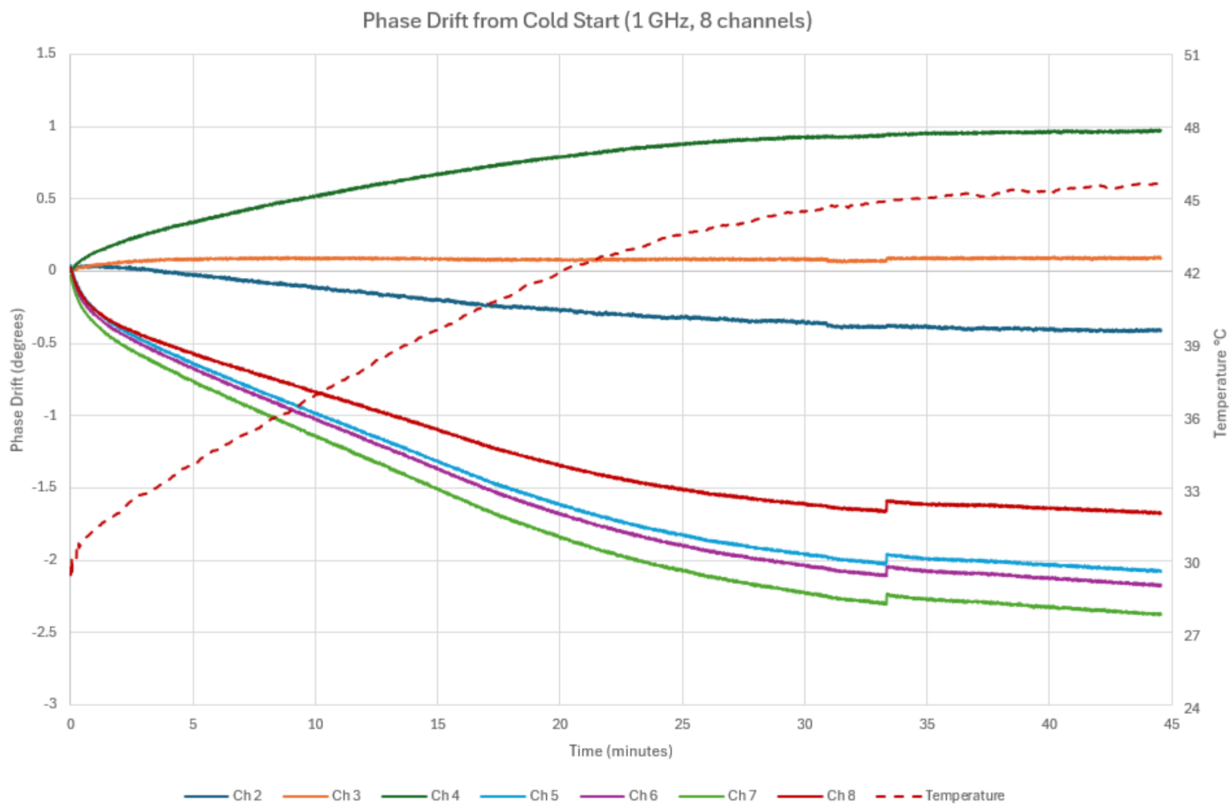

Typical IP2 (dBm), 0 dBm reference level
95
90
85
80
75
70
65
60
0
2
4
6
8
10
12
14
16
18
20
Frequency (GHz)

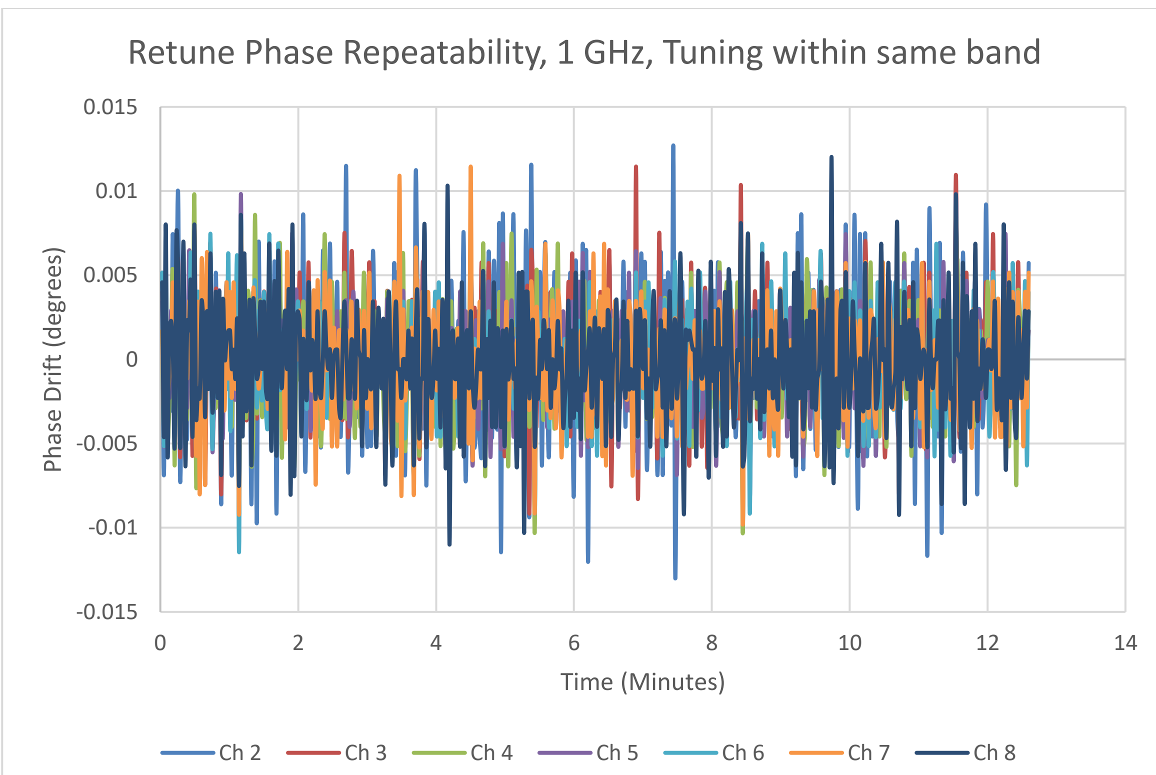

Typical Image Rejection (dBc)
-40
-45
-50
-55
-60
-65
-70
-75
-80
-85
0
2
4
6
8
10
12
14
16
18
20
Frequency (GHz)

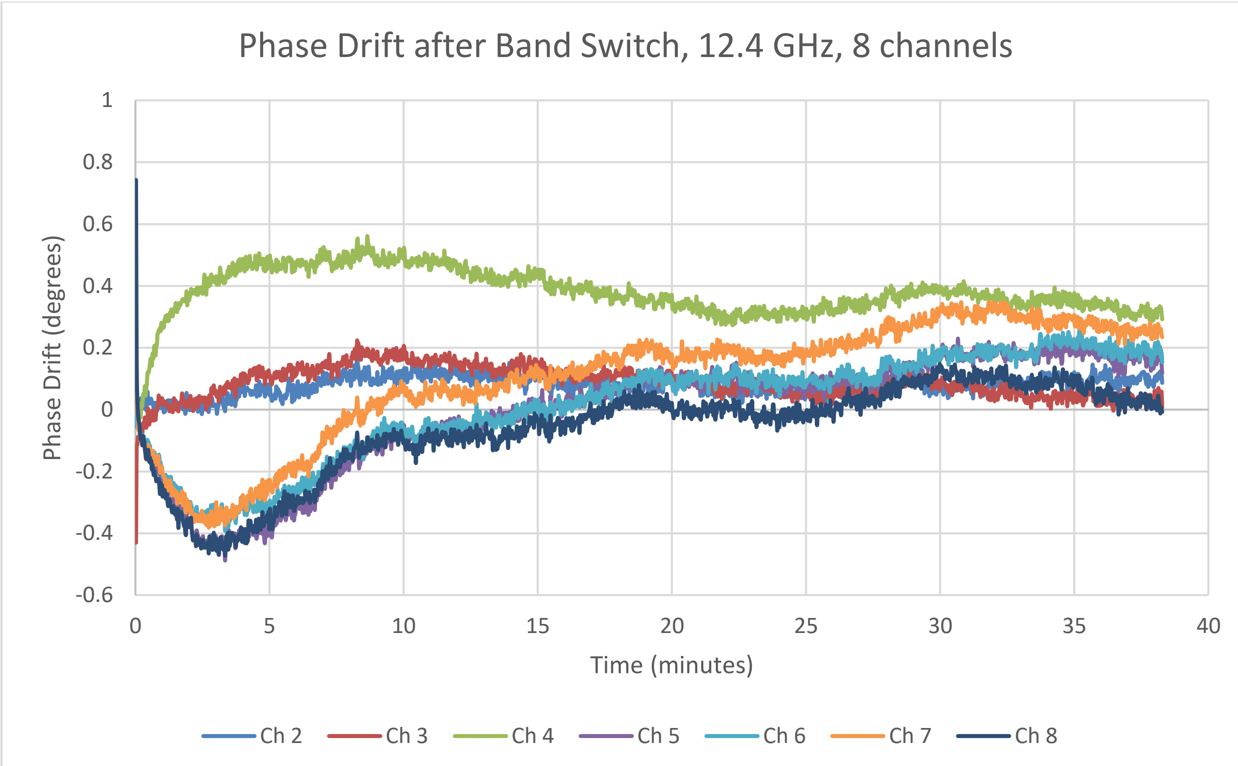


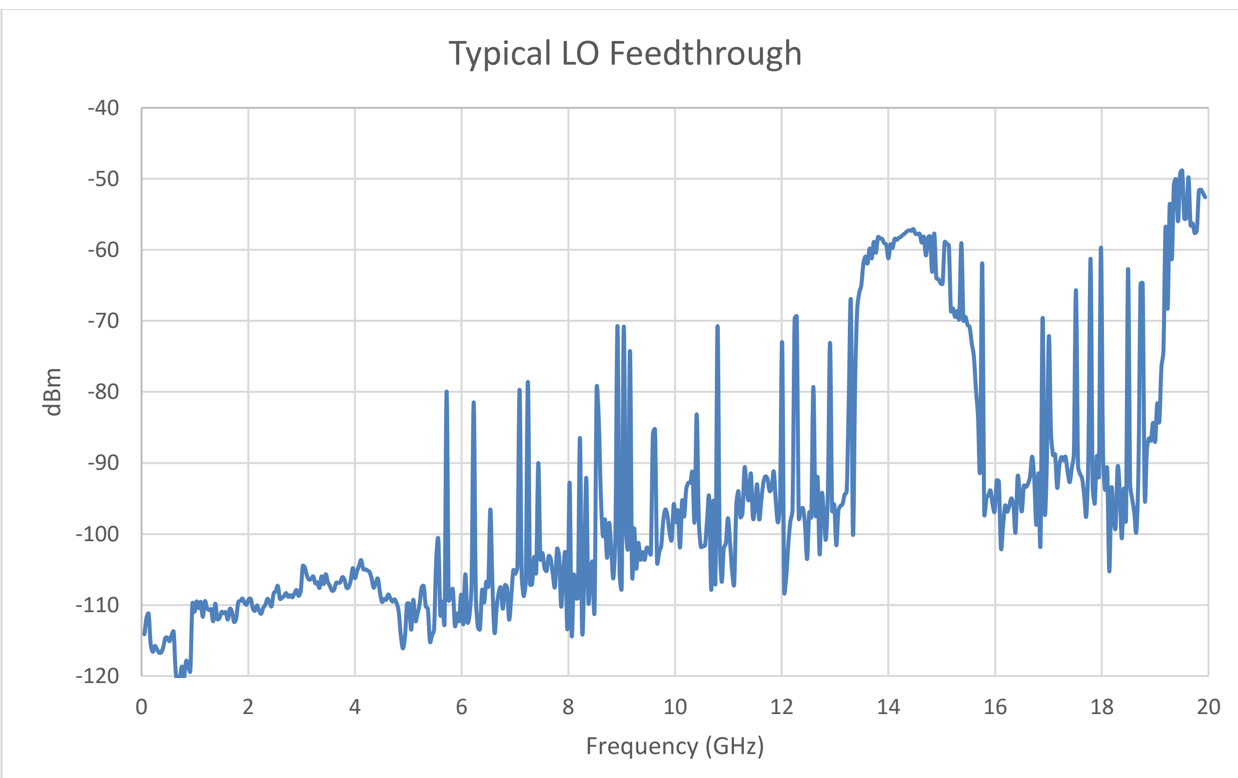
(recommend 30 minutes warmup + 15 minutes streaming before phase calibration)

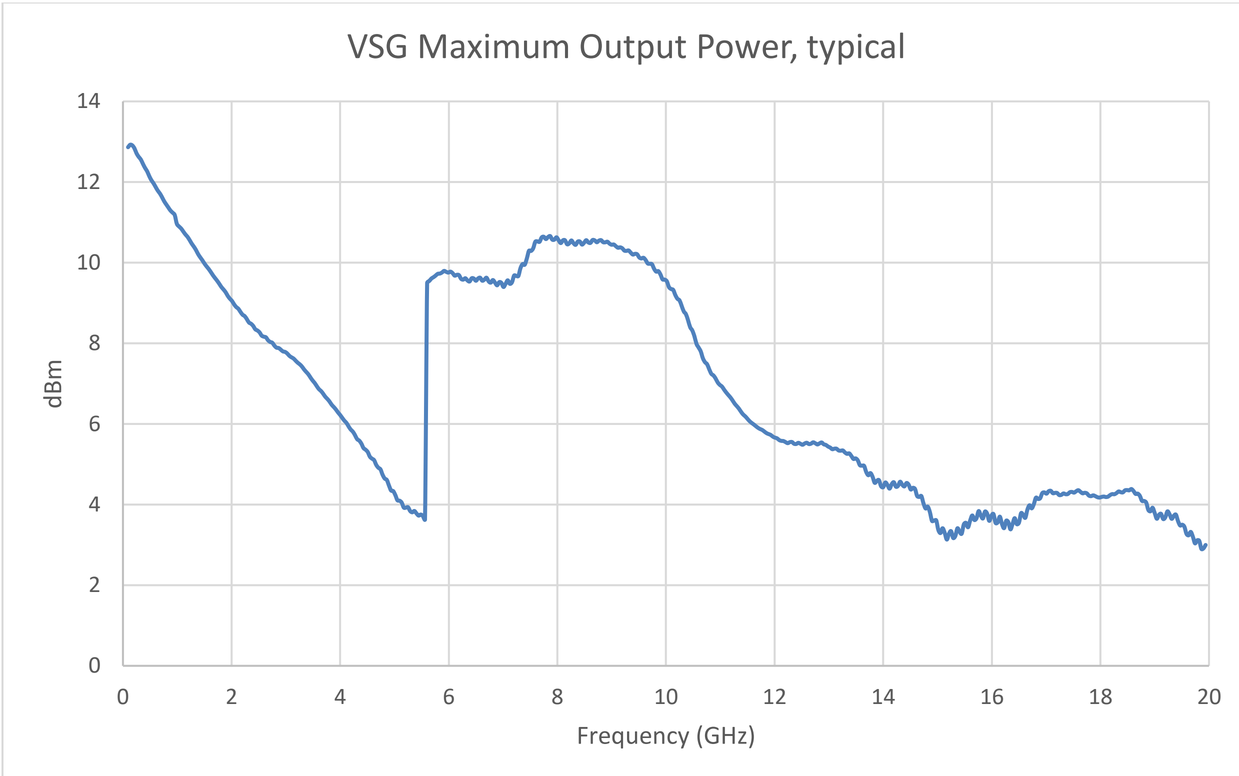


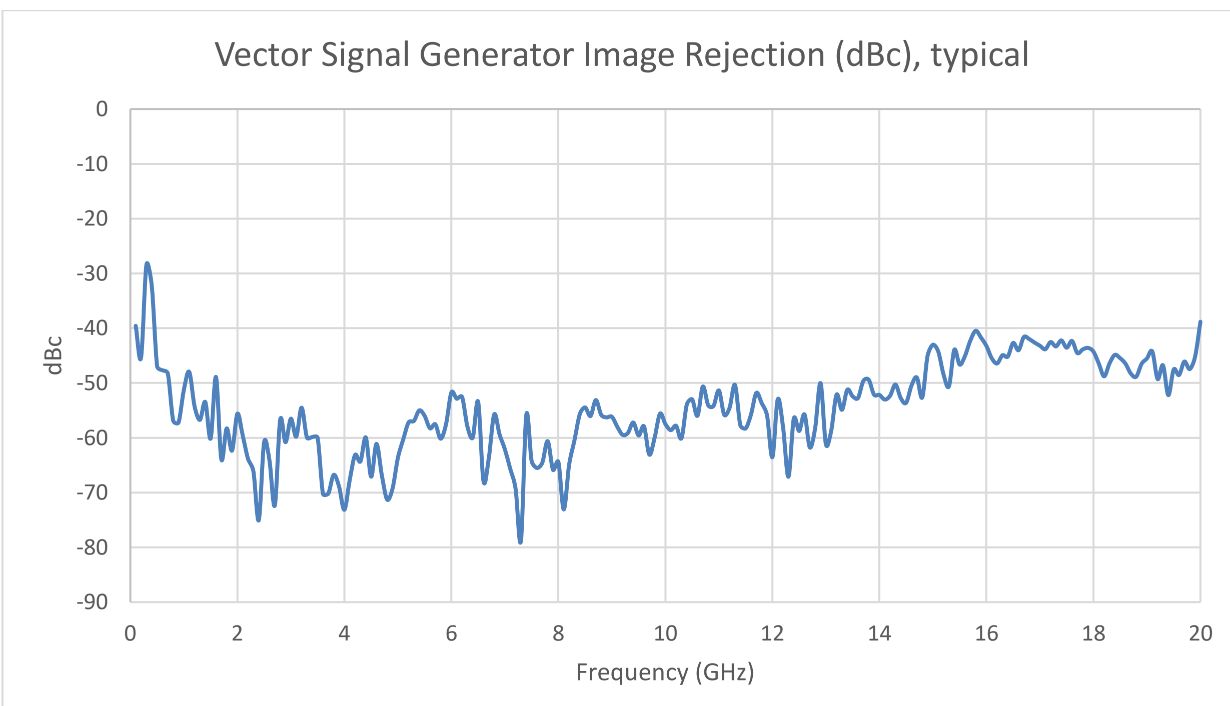

Phase Drift from Cold Start (1 GHz, 8 channels)
Phase Drift (degrees)
Temperature °C
Time (minutes)
1.5
1
0.5
0
-0.5
-1
-1.5
-2
-2.5
-3
51
48
45
42
39
36
33
30
27
24
0
5
10
15
20
25
30
35
40
45
Ch 2
Ch 3
Ch 4
Ch 5
Ch 6
Ch 7
Ch 8
Temperature


Retune Phase Repeatability, 1 GHz, Tuning within same band
Phase Drift (degrees)
Time (Minutes)
0.015
0.01
0.005
0
-0.005
-0.01
-0.015
0
2
4
6
8
10
12
14
Ch 2
Ch 3
Ch 4
Ch 5
Ch 6
Ch 7
Ch 8


Phase Drift after Band Switch, 12.4 GHz, 8 channels
Phase Drift (degrees)
1
0.8
0.6
0.4
0.2
0
-0.2
-0.4
-0.6
0
5
10
15
20
25
30
35
40
Time (minutes)
Ch 2
Ch 3
Ch 4
Ch 5
Ch 6
Ch 7
Ch 8


Typical LO Feedthrough
dBm
-40
-50
-60
-70
-80
-90
-100
-110
-120
0
2
4
6
8
10
12
14
16
18
20
Frequency (GHz)


VSG Maximum Output Power, typical
dBm
14
12
10
8
6
4
2
0
0
2
4
6
8
10
12
14
16
18
20
Frequency (GHz)


Vector Signal Generator Image Rejection (dBc), typical
dBc
0
-10
-20
-30
-40
-50
-60
-70
-80
-90
0
2
4
6
8
10
12
14
16
18
20
Frequency (GHz)