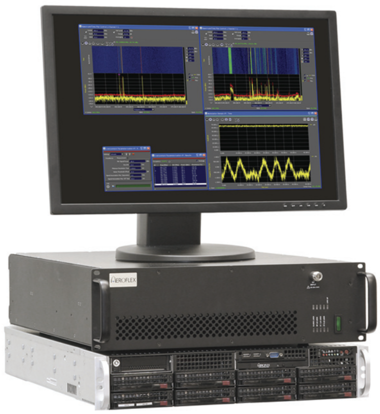
Broadband

Hunter CS1207 Broadband Signal Analyzer



Other analyzers tell you what happened. The BSA shows you why.

The Hunter CS1207 Broadband Signal Analyzer (BSA) instrument is designed to find and to solve the toughest RF issues. It combines live and off-line signal analysis capabilities to address multiple test applications, including:

- Communications
- Radar
- Satellite
- Electronic Warfare (EW)
- Electromagnetic Environment (EME)
- Drive (mobile collections)

The Aeroflex BSA is used to record, process and analyze RF signals.

The system consists of:

Tunable RF downconverter:
Convert RF signals from RF to baseband IF

A/D converter:
Digitize baseband signal

Digital tuner:
Focus on signal of interest and reduce unnecessary data

Processing:
Process raw digitized samples with various algorithms such as advanced triggering, filtering, scaling, statistics

Signal storage:
Store digitized signal for analysis or archiving

Controller:
Computer used to control the system, perform analysis, display results and write data from RAM to archival storage (disk, RAID, USB device)

The CS1207 BSA supports collecting contiguous recordings up to a 70 MHz instantaneous bandwidth (IBW). It also supports scanning across wider bandwidths using sequential recordings. As it is capable of simultaneously processing and coherently displaying time, spectral and modulation domain data, the CS1207 BSA is ideal for R&D, validation and verification and general RF testing. The rich set of analysis tools and features below are included with the CS1207.

- Tunable frequency coverage from 2 MHz to 6 GHz
- Live signal monitoring (display and processing)
- Contiguous signal recording and archiving into 32 GB RAM (80 sec @ 70 MHz BW)
- Scanned sequential mode for monitoring ranges wider than the IBW
- Digital tuners from 70 MHz to 41 kHz bandwidth
- Interactive spectrum/spectrogram/time plots
- Results strip charting
- Signal notepad for recording plots and data
- Channel Power and Adjacent Channel Power Ratio (ACPR) analysis functions
- Modulation domain analysis function with simple modulation classification (AM, FM, CW, pulse, other)

Optional features* available for the CS1207 include:

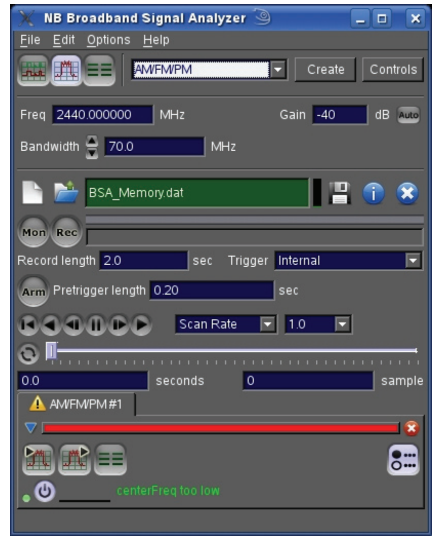
- GPS
- Additional input or output channel
- Scanned sequential mode for recording and archiving
- Spectrum Allocation Table (SAT)
- AM/FM/PM analysis functions
- ASK/FSK/PSK/QAM analysis functions
- ASK Burst/FSK Burst/PSK Burst analysis functions
- Pulse/radar analysis function
- Environmental Signal Parameterization identifies and measures parameters for signals in the environment
- Remote control
- Sequenced recording control (FACS and SW Sequencer)

* All features subject to export restriction

Contact Aeroflex to investigate additional custom capabilities. All Aeroflex products come with the support of highly-experienced and solution-oriented technical staff.

BSA Features and Functions

This section briefly presents some of the BSA features and functions.



Standard BSA software allows the operator to record signals to RAM and then to archive them to internal and external disk drives. These recorded signals can be post-processed by the BSA software suite.

Application Matrix

How BSA features and functions apply to typical BSA applications.

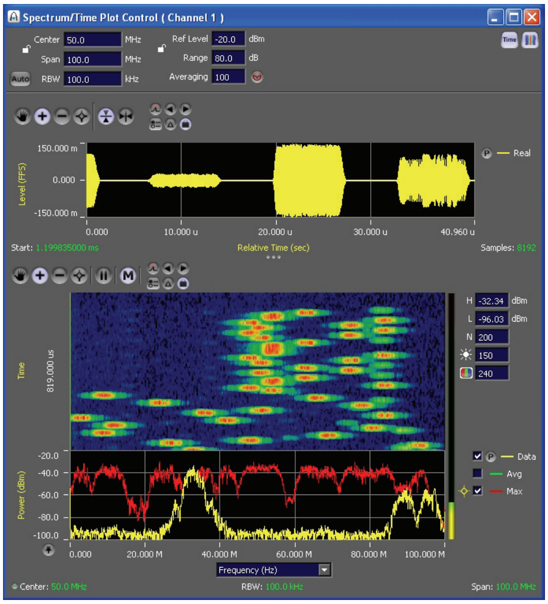
Applications and Descriptions	BSA Functions and Features									
	Spectrum/Spectrogram /Time plot	Strip Chart	Signal Notepad	Channel Power & ACPR	Modulation Domain	Pulse Analysis	Digital Modulations (PSK/QAM/FSK/ASK)	Burst/Agile Signal Analysis (FSK/ASK/PSK/QAM)	Environment Signal Parameterization	Spectrum Allocation Table (SAT)
Communications Test This includes testing radios and radio subsystems. The BSA has had the most impact in engineering design, verification and test (DVT) in the lab and in the field. Both commercial and military radio manufacturers should be targeted along with organizations that specialize in testing radios. The BSA is an excellent fit to emerging standards or proprietary radio waveforms where there is no test equipment yet.	•	•	•	•	•		⊕	⊕		
Radar Test The BSA has been valuable in a number of radar applications, including DVT, field tests,ECM/ECCM tests, stability measurements, and radar cross section measurements. Radar manufacturers, test labs and test ranges have been our best customer for these applications.	•	•	•	•	•	⊕				
Satellite Test The BSA has been used in a variety of satellite payload, ground station and operational monitoring. The system has been used to test communications satellites, XM and Sirius Radio satellites, radar satellites, photo satellites and others.	•	•	•	•	•	⊕	⊕			
Electromagnetic Environment (EME) Test BSAs have been used to characterize the EME in many places around the world for a wide variety of missions. We have additional software aimed at this application, please contact us for details.	•	•	•	•	•	⊕	⊕	⊕	⊕	⊕
EW Test The BSA has been used for a number of EW tests, including radar, ECM/ECCM and CREW.	•	•	•	•	•	⊕		⊕	⊕	⊕
Drive Test BSAs have been used to measure signal characteristics (such as RF power) from a moving vehicle for both civilian and military applications.	•	•	•	•	•	⊕		⊕	⊕	⊕
General test and debug	•	•	•	•	•					

• Useful standard software for applications

⊕ Useful software option for applications

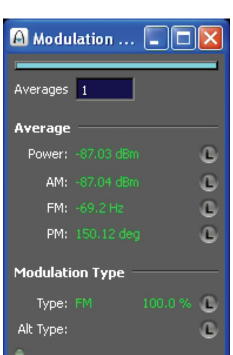
Spectrum/Spectrogram/Time Plot

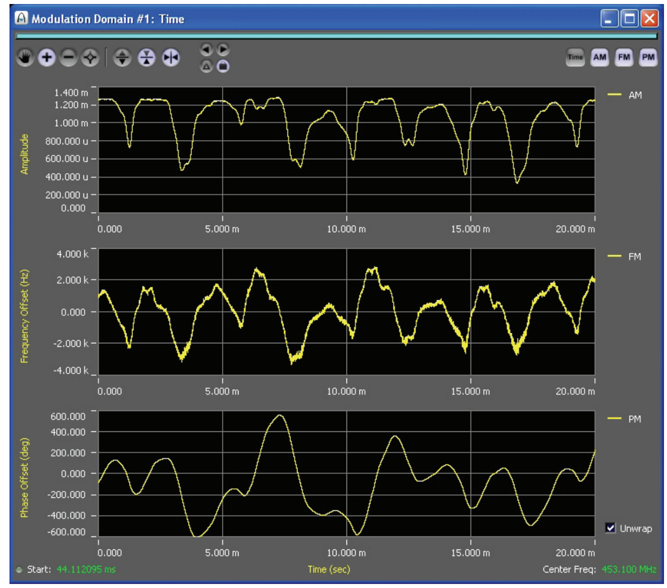
Interactive display of the spectrum, spectrogram (waterfall plot) and the time domain waveform. This analysis tool provides a multi-dimensional tool for viewing data that is valuable for every BSA application.



Modulation Domain

Plots and coherently measures parameters on the AM, FM and PM demodulated waveforms. Estimates the basic modulation type. This is one of the most used functions in BSA and is highly recommended for most applications.



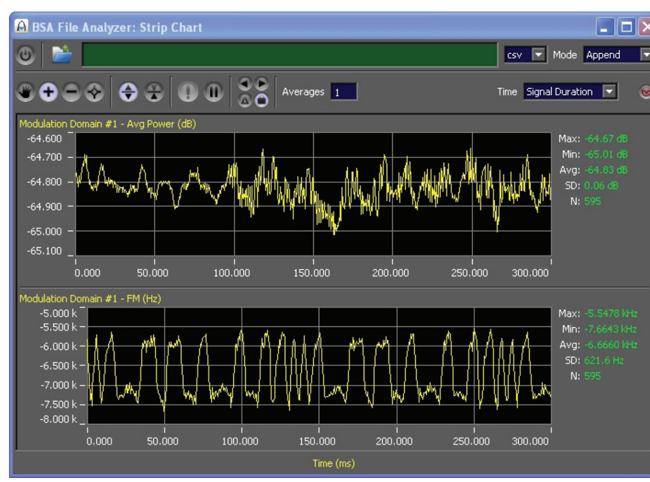


Pulse Analysis

Measures and plots pulse parameters, including carrier frequency, power, pulse width, PRI and modulation (chirp, Barker, etc.) characteristics. This is used for pulse tasks such as radar applications.

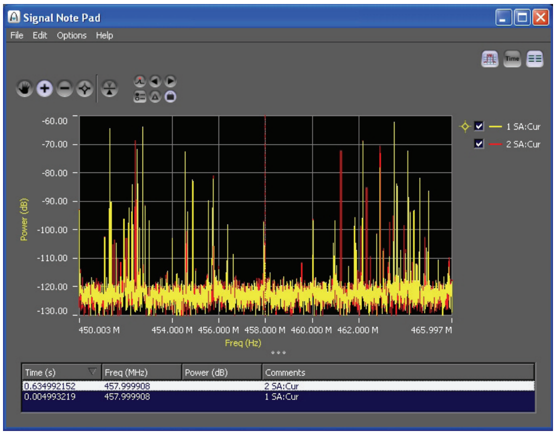
Strip Chart

Various analysis functions calculate numeric values (carrier frequency, power, etc.). Any value from any analysis function can be sent to the strip cart to display the value over time.



Signal Notepad

Any spectrum trace can be stored and viewed with the signal notepad. This allows different traces to be overlaid for easy comparison. The traces can be stored to disk in ASCII format.



Analog and Digital Modulations

AM/FM/PM Perform AM, FM and PM demodulation on a signal. The resultant waveforms can be plotted and analyzed or written to an audio (.wav) or raw binary file. This function is useful in radio test and spectrum monitoring.

ASK Demodulates amplitude shift keyed signals. Plots the demodulated waveforms. Generate, display and write to disk the message symbols. This would be used by communications radio test applications.

FSK Demodulates and plots FSK signals. Generates waveform plots and symbol stream. This function is useful in many digital communications applications.

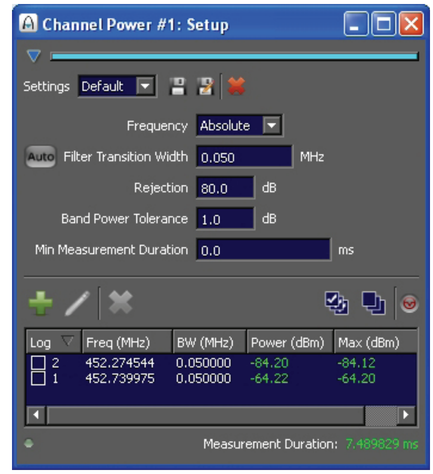
Burst/Agile Signal Analysis

ASK Burst Uses the same core software as the ASK analysis function, except it processes ASK burst signals such as frequency hoppers. The software adds the pulse width, PRI and carrier frequency of every burst. This function is useful in many digital communications applications.

FSK Burst Uses the same core software as the FSK analysis function, except it processes FSK burst signals such as frequency hoppers. The software adds the pulse width, PRI and carrier frequency of every burst. This function is useful in many digital communications applications.

Channel Power

Measures the power in a user defined frequency band. This function is useful in many applications.

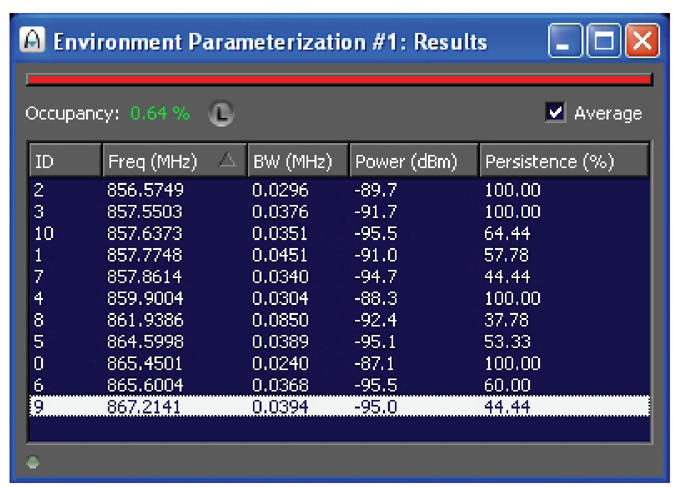


ACPR

The Adjacent Channel Power Ratio (BSA-ACPR) instrument measures the power and ratio of the powers in a main frequency band and bands on either side of this band. This can also be used to estimate the SNR of signals for many applications.

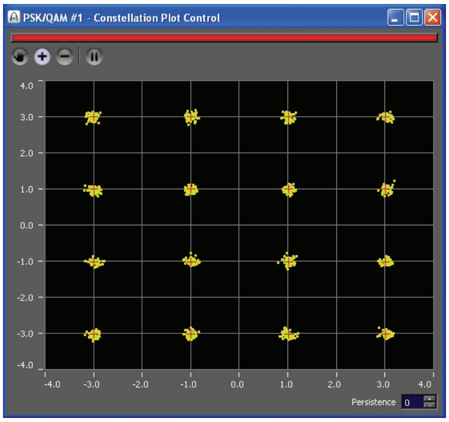
ESP

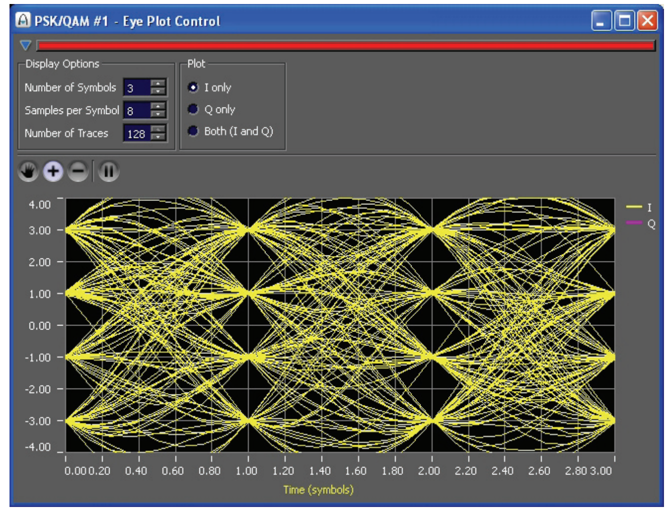
Environment Signal Parameterization detects all signals in a band and measures the signal frequency, power, bandwidth and on-time statistics. This function is used in spectrum monitoring and EME characterization applications.

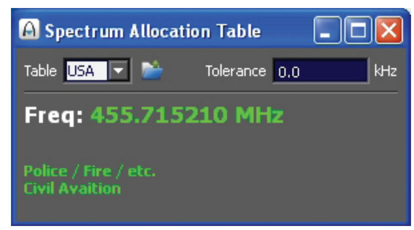


PSK/QAM Suite

The Vector Signal Analyzer demodulates, plots and characterizes PSK and QAM signals. Plots eye diagram, constellation, spectrum and timing offset data. Operates on continuous or burst signals. One function will estimate the PSK/QAM signal type order and its fundamental parameters. This function is useful for digital communications applictions.

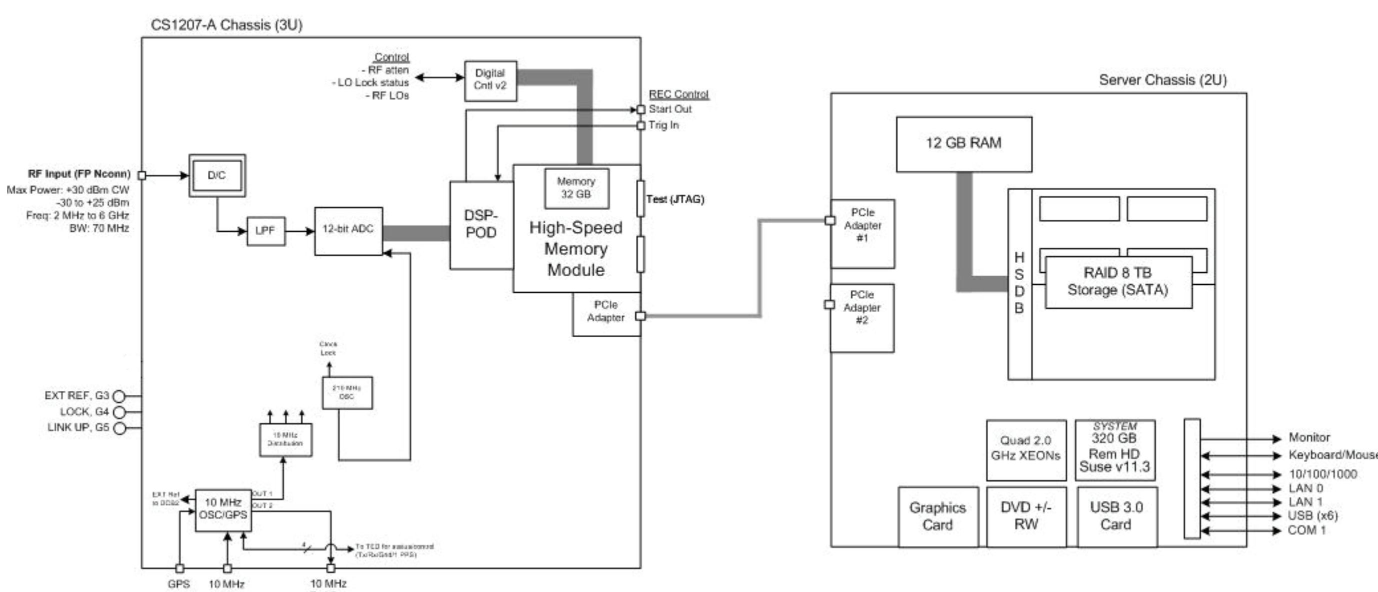






Spectrum Allocation Table (SAT)

The Spectrum Allocation Table (SAT) displays text associated with the spectrum marker frequency. This tool is useful for signal search applications such as spectrum management and EME analysis, but it could be creatively used by all applications.



CS1207 System Block Diagram

SPECIFICATION

FREQUENCY RANGE AND TUNING

FREQUENCY RANGE

2 MHz to 6 GHz

Consists of two signal paths, 'Downconverted' and 'Downconverter Bypass.' The path used is automatically selected based on requested center frequency.

Downconverted (88-6000 MHz)

88 MHz to 6000 MHz (tunable center frequency range)

RF tuning range.

Actual low-end of downconverted range extends to bandwidth/2 below the lowest tuned center frequency.

Digital tuners also usable for narrowing bandwidth (and reducing output sample rate) within this range.

D/C Bypass (2-88 MHz)

2 MHz to 88 MHz (bypasses downconverter)

Tuning within the d/c bypass range is available only using digital tuners.

TUNING RESOLUTION

1 Hz

FREQUENCY ACCURACY

Dependent on 10 MHz reference accuracy

BANDWIDTH

MAXIMUM INSTANTANEOUS BANDWIDTH

When set to center frequency above 88 MHz, max. bandwidth setting is 70 MHz and bandwidth can be set lower if desired using digital tuners.

Downconverted (88-6000 MHz)

70 MHz minimum 3 dB BW

D/C Bypass (2-88 MHz)

84 MHz minimum 3 dB BW at 46 MHz center

For digital tuner decimation factors of 4 and higher, maximum BW in bypass path limited by center frequency and fixed band edge limits of 2 MHz and 88 MHz.

Example: At center frequency = 12.5 MHz, max. BW = 2* (12.5-2) = 21 MHz

PASSBAND AMPLITUDE FLATNESS

Downconverted (88-6000 MHz)

3.0 dB p-p variation, worst-case

1.8 dB p-p variation, typical

Within ±35 MHz of tuned center frequency;

(see Plot 1 for typical passbands 88-6000 MHz)

D/C Bypass (2-88 MHz)

1.5 dB p-p, worst-case 10-88 MHz

3.0 dB p-p, typical 3-88 MHz

(decimation = 2, tuned to 46 MHz)

Maximum rolloff in bypass path is at 2 MHz.

Typically 1.5 dB of rolloff from 10 MHz to 3 MHz, 4 dB of rolloff from 10 MHz to 2 MHz

(see Plots 2, 3 for typical d/c bypass passband 10-88 MHz and 2-10 MHz)

SELECTABLE BANDWIDTHS

Downconverted (88-6000 MHz)

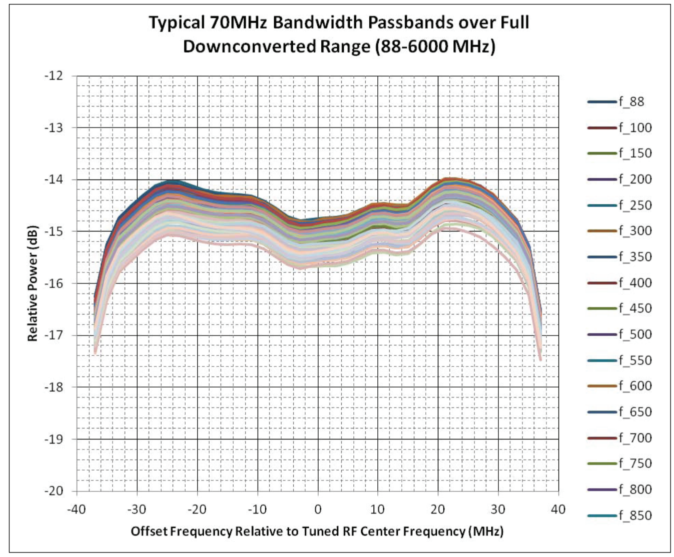
70 MHz, 42 MHz down to 41 kHz

Max. 3 dB bandwidth guaranteed to be at least 70 MHz across full down converted tuning range. Selection range corresponds to digital tuner decimation factors from 2 to 4096 in power-of-two steps.

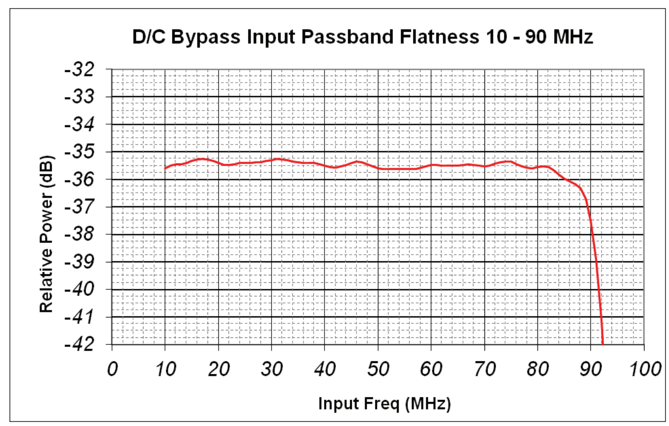
D/C Bypass (2-88 MHz)

84 MHz down to 41 kHz

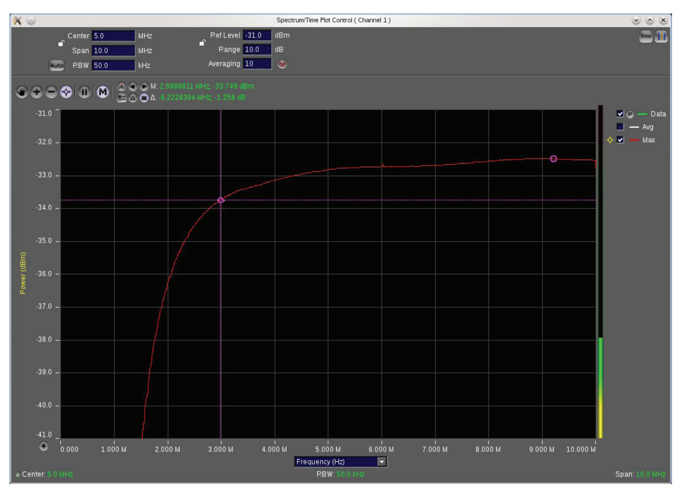
Corresponds to digital tuner decimation factors from 2 to 4096 in power-of-two steps.



Plot 1. Typical 70 MHz bandwidth passbands over full downconverted range (88-6000 MHz)



Plot 2. Typical D/C bypass passband from 10 to 88 MHz



Plot 3. Typical D/C bypass passband rolloff below 10 MHz

INPUT

RF Input

50 ohms, ac coupled

INPUT RETURN LOSS

Downconverted (88-6000 MHz)

13.0 dB (1.58:1) typical worst-case

Anywhere in ±35 MHz passband around tuned RF center frequency.

D/C Bypass (2-88 MHz)

15.0 dB (1.43:1) typical worst-case 10-88 MHz

Max RF Input Power, CW Operational

+25 dBm

Gain set to -25 dB or lower (low enough to avoid full-scale overrange at ADC).

Max RF Input Power, CW Damage Level

+30 dBm

Minimum CW Input Power for Full-Scale at ADC

<=-30 dBm over full frequency range

Maximum gain at all tuned frequencies is at least +30 dB, where (analog-to-digital) gain is measured as:

(Power of signal in dB Full-Scale (dBFS) at ADC) minus (Power of signal at RF Input (dBm)).

GAIN

Max. Gain

>30 dB

At least 30 dB gain in D/C bypass path and at all tuned RF frequencies.

Gain Range, min.

70 dB, min. (>=+30 to <=-40 dB)

Gain controlled via programmable RF Input Attenuator and solid state attenuation at RF

Gain Step

1 dB nominal

Gain Linearity

For 15 dB < Gain <= Max Gain:

±1.0 dB (typical)

For -20 dB < Gain <=15 dB:

±1.5 dB (typical)

All measurements at room temp ±5°C, -50 dBFS < CW Power <0 dBFS

Gain linearity is a function of programmable attenuator linearity, RF path linearity and ADC linearity.

LINEARITY AND DISTORTION

Input IP3

+43 dBm typical (at Gain = -15 dB over full RF range)

Two input tones separated by 1 MHz at +8 dBm (peak power = +14 dBm) and gain = -15 dB, so that combined peak is approx. -1 dBFS. Third order intermods will typically be less than +8 - 2*(43-8) = -62 dBm, or <-70 dBc relative to each tone.

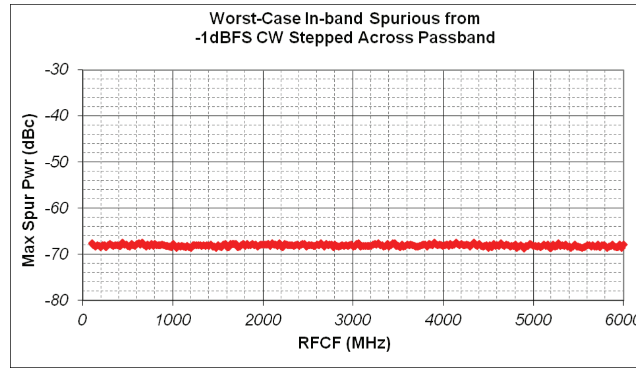
Represents 3rd order intermod levels of -70 dBc or lower for any two tone input with combined peak level of -1 dBFS at ADC, for all input gain settings from +30 to -20 dB.

In-band Spurious Free Dynamic Range

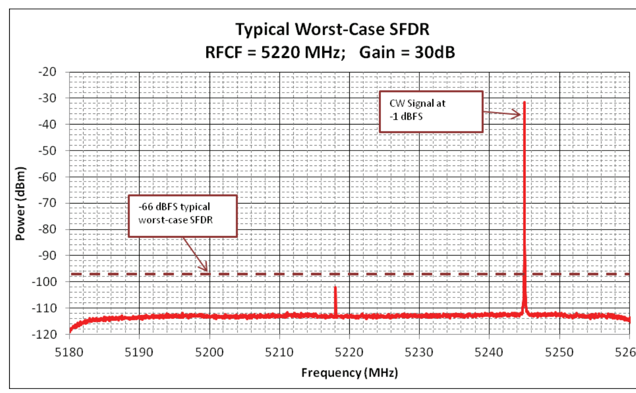
66 dB, typical worst-case in-band spurious

Typical represents a common worst case in-band spurious from any in-band tone at -1 dBFS, when varying the input tone frequency across the full 70 MHz passband (measured with Gain = +30 dB, CW Input power = -31 dBm)

(see Plot 4 for typical worst-case in-band spurious plot over the full RF range; Plot 5 for typical downconverted -1 dBFS single-tone spectrum)



Plot 4. Typical worst-case SFDR across the full RF range



Plot 5. Typical worst-case single-tone spectrum with signal power at -1 dBFS

SPECTRAL PURITY

Phase Noise

Typicals

Offset (Hz)	*Phase Noise (dBc/Hz)*
100	*-63*
1 K	*-77*
10 K	*-88*
100 K	*-111*
1 M	*-124*

Typical worst-case, at RF center frequency of 6 GHz. Limited by thermal noise at 1 MHz offset and higher.

LO Spurious

Typical peak spurious levels

-60 dBc for offset >200 Hz

-70 dBc for offset >25 kHz

-75 dBc for offset >100 kHz

-85 dBc for offset >1 MHz

See Plots 6a-d for typical phase noise and spurious performance

For the very latest specifications visit **www.aeroflex.com**

Frequency Reference

Internal

10 MHz high stability TCXO

5 min. warmup

Stability 1.e-9/day, 1.e-7/year

External 10 MHz Ref. Input

0 to +14 dBm, 50 ohm BNC rear panel input

External GPS Input

Rear panel BNC connector for GPS antenna input, with +5 Vdc bias for active antenna

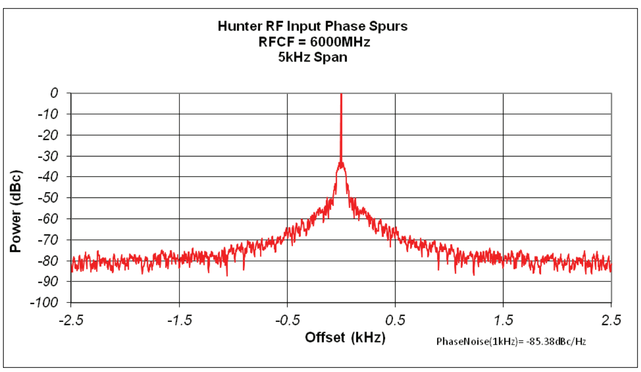
System will automatically lock to either an applied GPS signal via the GPS antenna port, or to an externally applied 10 MHz reference input. If neither are applied, it will run from its internal 10 MHz TCXO.

Ref. Output

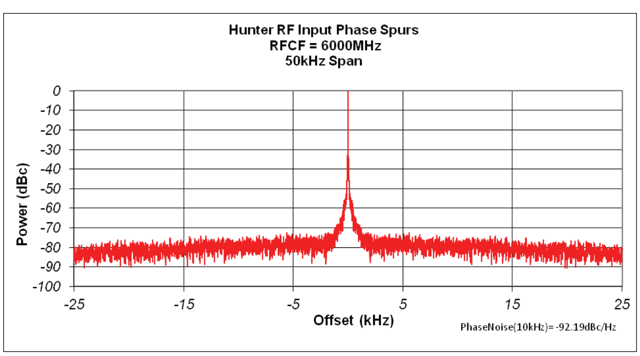
Rear panel BNC output;

+6 dBm sine wave

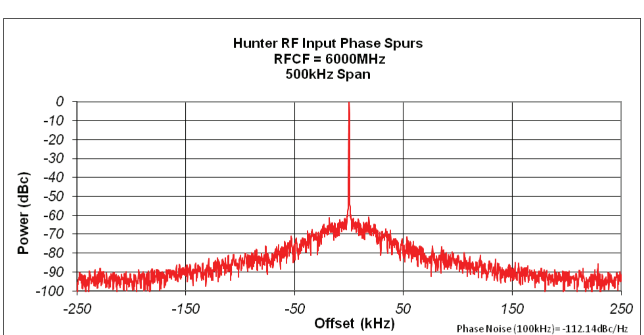
Extra output of 10 MHz; can be used to lock external equipment to the same reference used by the system.



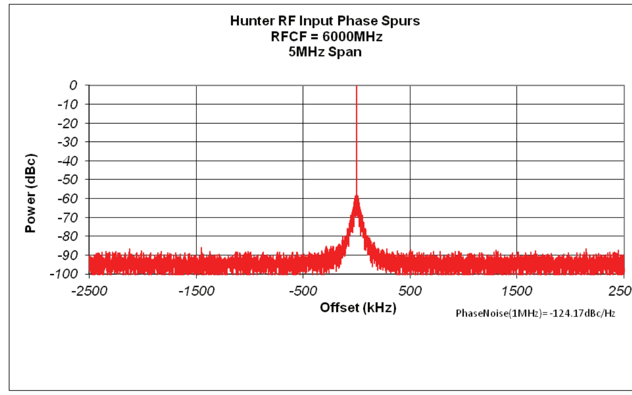
Plot 6a. Typical phase noise and spurs at 5 kHz span



Plot 6b. Typical phase noise and spurs at 50 kHz span



Plot 6c. Typical phase noise and spurs at 500 kHz span



Plot 6d. Typical phase noise and spurs at 5 MHz span

RESIDUAL AND NOISE

RESIDUAL SPURIOUS

Downconverted (88-6000 MHz)

-105 dBm, typical worst-case in passband

D/C Bypass (2-88 MHz)

-113 dBm, typical worst-case 2-10 MHz

-120 dBm, typical worst-case 10-88 MHz

This is the typical maximum level of non signal-related spurious, usually related to leakages and/or mixing products of Los and/or internal spurious products.

Referenced to RF Input, Gain = +30 dB
See Plot 7 for typical downconverted Residual Spurious.
See Plot 8 for typical d/c bypass Residual Spurious.

DISPLAYED AVERAGE NOISE LEVEL

Downconverted (88-6000 MHz)

<-153 dBm/Hz, typical worst-case

Referenced to RF input, at maximum gain setting.

Typical worst-case noise figure = 20 dB at 6 GHz; noise figure improves at lower frequencies, typically 4-6 dB better at 100 MHz than at 6 GHz, at maximum gain setting.

D/C Bypass (2-88 MHz)

<-159 dBm/Hz, typical 10-88 MHz

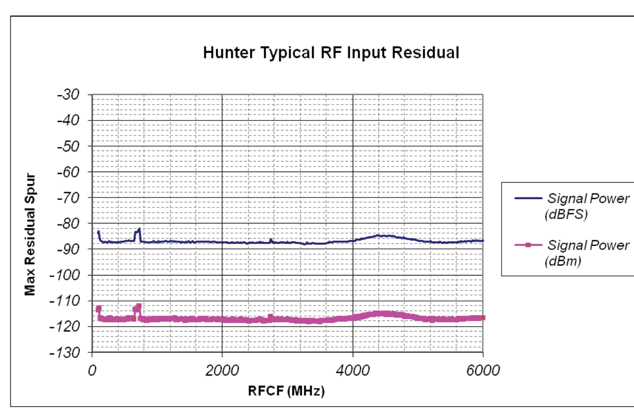
Referenced to RF input, at maximum gain setting.

Noise figure = 14 dB

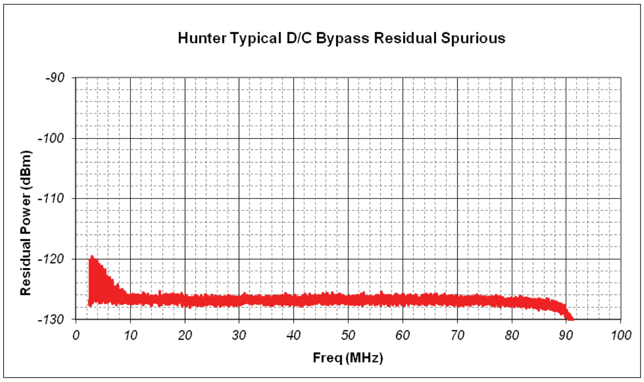
REVERSE LEAKAGE

<-100 dBm, typical, all tuned RF frequencies

This is the typical worst-case leakage out of the RF input, at any gain setting, when tuned anywhere in the RF range, at any frequencies from 2 MHz to 18 GHz.



Plot 7. Typical Hunter residual spurious; worst-case at each RF center frequency



Plot 8. Typical Hunter residual spurious in D/C bypass path

FILTERING

To achieve high levels of near-band and out-of-band rejection, system includes front-end lowpass (6 GHz), two IF bandpass filters and anti-aliasing filtering prior to ADC.

Image Rejection

>80 dB, typical for downconverted path

Image Freq = RFCF + 14300

IF Rejection

>75 dB, typical for downconverted path

Rejection of interfering signal at 7150 ±35 MHz

OOB Rejection

>80 dB, typical for downconverted path

Other non-harmonic related out-of-band signals

Sub-Harmonic Rejection

>52 dB, typical worst-case at 30 dB gain, -30 dBm input power at RFCF/2

CW signal at 1/2 of the tuned RF center frequency, with input power = -30 dBm, will typically create an in-band spur no higher than -82 dBm.

DIGITAL SAMPLING

ADC Resolution

12 bits (ADC)

RF signal is digitized at 12 bits per real sample; then converted through the internal digital downconverter to I/Q samples at 16 bits per sample, with decimation rates from 2 through 4096.

ADC Sample Rate

210 MSamples/sec

Signals are sampled at 210 MSamples/sec. Effective sample rate of 16-bit I/Q samples out is 210.e6/DecimationFactor, where DecimationFactor can be any power-of-2 from 2 through 4096, for an output complex sample rate of 105 MSamples/sec down to 51.3 kSamples/sec, for both I and Q output.

Sample Memory

32 GBytes

8 GSamples of 16-bit Complex samples

Continuous Record Time

>81 seconds at full 70 MHz instantaneous bandwidth;

>46.5 hours of recording at minimum signal bandwidth of 41 kHz

Output complex sample rates from the digital tuner range from 105 MS/sec (at full dec-by-2 bandwidth) to 51.27 kS/sec (at minimum dec-by-4096 bandwidth)

TRIGGERING

Sources

Internal (software or user-generated) and external (trigger input on rear panel)

Type

Rising edge, falling edge

Functions

Pre-trigger, snapshot

Uncertainty

±1 sample from digital tuner (e.g ±9.5 nS at 70 MHz bandwidth)

SPECTRUM ANALYZER FUNCTION

Frequency Span

Defaults to current selected bandwidth (70 MHz to 41 kHz), can be set from 4 Hz to Nyquist (105 MHz)

Resolution Bandwidth

0.4 Hz to 10.0 MHz

Plots

Power vs frequency spectrum, time vs frequency spectrogram, amplitude vs time, interactive signal notepad

Spectral Plot Controls

Center frequency, span, ref level, res BW, gain, power range, # of averages, absolute or relative frequency display

Traces

Live data with selectable persistence, max hold, average N, reference trace

Markers

Current cursor position, delta cursor positions, >20 auxiliary markers, channel markers, event trigger threshold and mask

Marker Functions

Peak search, next peak left/right, cursor readout, nudge left/right, lock

GUI Control

Mouse-enabled multi-level zoom out, pan, markers, custom color controls

SYSTEM COMPONENTS

SERVER CHASSIS

2U chassis containing CPUs, 8 GB RAM standard (OS & application memory), OS+system drive, RAID/data storage, graphics card, optical drive, server I/O, and PCIe interface to Aux/RF chassis

Monitor

24" included

Peripherals

Keyboard, mouse included

System Drives

Removable system/OS drive included

Data Drives

8 TB removable RAID

Optical Drive

DVD ±RW standard

Server Chassis Connectors

USB

USB 2.0 (x4) rear panel standard

Keyboard/Mouse/Monitor

DVI standard, PS2 keyboard, mouse

Ethernet

10/100/1000 x 2

Data Interface to RF

Control and data interface to RF/Aux chasis

RF CHASSIS

3U chassis containing signals I/O, RF downconverter, 32 GB high-speed signal memory module, filtering and reference distribution, A-to-D converter, DSP and control firmware and hardware.

RF Chassis Connectors

RF In

Front panel precision Type-N

Ext Reference In

Rear panel BNC, 50 ohm, -3 to +15 dBm

Locks internal 10 MHz to this external 10 MHz input

External GPS Input

Rear panel BNC connector for GPS antenna input, with +5 Vdc output bias for active antenna

Uses this input if provided, to discipline internal 10 MHz reference to GPS signal (if GPS option enabled)

Additional Reference Out

Rear panel BNC, 50 ohm, +6 ±3 dBm

Can be used to lock additional chassis or external equipment to the same reference used by the system.

Trigger In

Rear panel BNC, LVCMOS, >100 nS pulse width

Start Record Sync Out

Rear panel BNC, 50 ohm, LVCMOS

Data Interface to Server

Control and data interface to server chassis

PHYSICAL

Power Consumption

400 VA @ 110 or 220 VAC

Dimensions

RF: 3U : 19" W x 5.25" H x 27.25" D (483 x 133 x 692 mm)
Server: 2U : 19" W x 3.5" H x 27.5" D (483 x 89 x 699 mm)

Rack-mountable in a 5U combined 19" rack space

Weight

RF: 37 lbs (17 kg)

Server: 46 lbs (21 kg)

ENVIRONMENTAL

Operating Temperature

0 to +35°C

Based on spec'd server temperature range

Operating Humidity

10% to 90%, non-condensing

Storage Temperature

-40 to +75°C

Storage Humidity

5% to 95%, non-condensing

SOFTWARE

Included Functions

Spectrum

Spectrogram

Time waveform plot and analysis

Strip chart plot and analysis

Signal notepad

Channel power

ACPR

Modulation domain plot and analysis

Optional Functions

Spectrum allocation table

Digital modulations (PSK/QAM/ASK/FSK) demodulation and analysis

Environment signal parameters

Burst/agile signal analysis (ASK/FSK/PSK)

High resolution spectrum plot and analysis

Pulse parameterization and analysis

RECOMMENDED CALIBRATION CYCLE

24 months

ORDERING AND CONTACT INFORMATION

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