



A Bird Technologies Group Company

4CH-VSG2000

Four Channel (50 MHz - 2 GHz, 110 MHz BW), Phase Coherent Vector Signal Generator

The X-COM 4CH-VSG2000 provides RF and microwave engineers four, phase coherent, arbitrary waveform, vector signal generators in a single 2U high enclosure. The system is well suited for projects that:

- Simulate complex communications environments
- Test MIMO systems
- Develop and test Multi-receiver devices
- Inject controlled interference to devices under test

Each RF channel is easily programmed through the X-COM MCVSG Control software graphical user interface to single play or loop waveform sequences. Waveform sequences are made up of waveform segments that are linked. Link parameters specify how many times a segment is looped and the delay between loops. Separate controls provide the flexibility of setting the center frequency and amplitude of each channel's RF carrier that is modulated by the waveform segments contained in the sequences. All, or a subset of the channels can be set to the same center frequency and the user has the option of phase locking them or varying the phase of each relative to the other carriers. Alternatively, the four channels can be programmed to operate completely independently in phase and frequency.



The operator is free to utilize waveform segments that are recorded spectrum which were saved as digital I & Q files, waveforms created using MATLAB® or other tools. Using the X-COM program RF Editor, users can edit all or portions of recorded spectrum and add them to waveforms in the user's RF Editor library. The segments are then available to the MCVSG control software in order to be compiled in to sequence tables.

Each RF channel has a dedicated 1 TByte SSD drive to store on-board waveform segments. An individual waveform segment or sequence table is selected for playback through the MCVSG GUI for each channel. The operator then sets each channel's RF center frequency and power level and arms channels to start playback based upon an external trigger or through the GUI. When the start command is received, the armed channels' RF is turned on and modulated by the segment or sequence.

FEATURES

Four independent, phase coherent vector signal generators in a single 2U enclosure saves rack space and weight. Perfect for mobile operating environments and high density automated test applications

Each signal generator can be independently programmed to play any waveform within an RF span of up to 110 MHz at carrier frequencies ranging from 50 MHz to 2 GHz

Baseband I & Q outputs also available from each channel for maximum flexibility

1 TB of waveform storage available per channel provides up to 20 minutes of waveform storage at a span of 110 MHz and longer durations at lower bandwidths

Direct transfer recorded spectrum segments edited in RF Editor, or the inclusion of user-generated waveform segments, maximizes the available sources of spectrum for playback

External triggers, or those generated by the MC-VSG Control software, can be used to switch between different waveform segments on all or a subset of the four signal generators

APPLICATIONS

Electronic Warfare

Efficiently and quickly test designs of MIMO and other multi-channel electronic support, attack and countermeasure systems. Simultaneously transmit different waveforms or time/phase shifted versions of the same waveform to stress test receivers. Long duration spectral captures from battlefield conditions by the IQC-2110 provide an exact replica of wideband RF spectrum scenarios.

Satellite Communications

Transmit across nearly an entire transponder utilizing the four signal generators, each operating at 110 MHz bandwidth and tuned to adjacent sub-bands. Easily test the compatibility of direct sequence or frequency hopped CDMA systems with other wideband access schemes using waveforms grouped in RF Editor and up-converted to IF by the 4CH-VSG2000.

Terrestrial Wireless

Shorten the time to design RF and IF circuits for multi-waveform devices and speed production testing through the use of concurrent waveform injection. Verify the performance of a single waveform device in the presence of multiple interfering signal types.

Radar

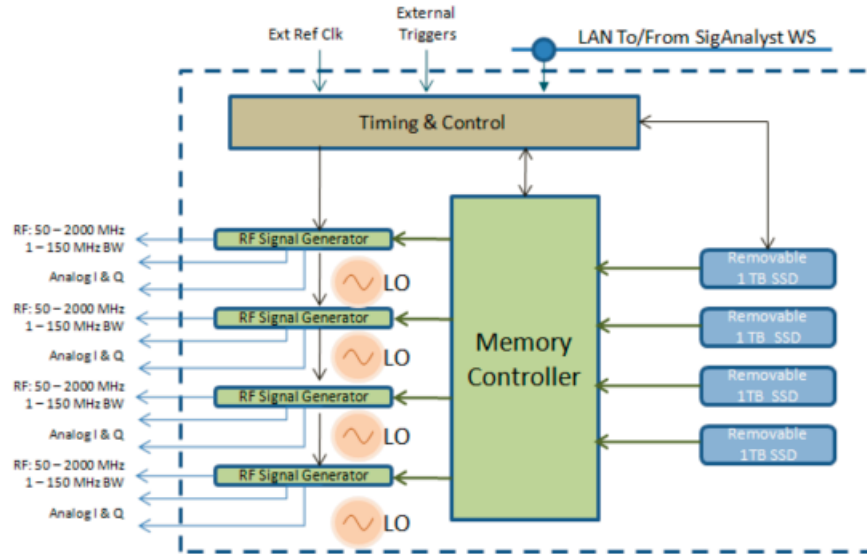
Improve and test the effectiveness of active phased array antennas and associated waveforms.



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FUNCTIONAL DESCRIPTION AND BLOCK DIAGRAM:



A simplified block diagram of the X-COM 4CH-VSG2000 is shown above. It consists of four major functional sub-systems; waveform memory modules, the Memory Controller, Timing and Control Subsystem and the RF Signal Generators. Taken as a whole, the 4CH-VSG2000 provides four independent, arbitrary waveform, vector signal generators. The RF signal generators can act independently or be configured so that their outputs are time and phase synchronized.

Waveform Memory Modules (WMM)

Each RF channel is supplied with 1TB of removable, solid state disk drive capacity. If, for example a channel is utilizing its full 110 MHz channel bandwidth, playing back a spectrum record from the digital I & Q outputs of a high sample rate spectrum analyzer, the 1TB memory will provide 22 minutes of capacity. Lower signal bandwidths will require lower data rates with a commensurate increase in signal capacity from the SSD. Waveform segments for the 4CH-VSG2000 are stored in high dynamic range, interleaved 16 bit I and Q format.

Four SSD WMMs are housed in the 4CH-VSG2000 enclosure. They slide in from the front of the unit. To load waveform segments or sequences, they are removed from the 4CH-VSG2000 enclosure and inserted in the X-COM Datapack programmer which is attached to the X-COM SigAnalyst work station. Waveform segments can be any time length and of any span from 10 KHz to 110 MHz in occupied bandwidth but must be padded to a file size which is an integer multiple of 256KBytes. Segments can be:

- Entire files, or time slices of recorded RF spectrum and stored in the .XIQ, .TIQ, .bin, .txt or .mat format
- Files created in digital signal processing software such as MATLAB® or RF Express®
- A combination of recorded and created waveforms that have been edited, concatenated and combined in RF Editor



X-COM Datapack Programmer



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Memory Controller Module (MCM)

The MCM consists of; the 16 bit Digital to Analog converters (DAC) used to convert stored waveform files to analog I & Q waveforms prior to up-conversion, the single shared DAC timing source, and the time source divider circuits necessary to allow each channel to work under a different sample rate (span BW). The output of each DAC is low pass filtered for proper spectral reconstruction.

Waveform segments are stored on the WMM of each RF channel. Waveform sequencing tables are loaded in to the MCM which then controls the execution of the waveform playback sequence for each channel. Any combination of the four channels can be simultaneously playing a waveform segment or sequence, all under control of the MCM. A sequence consists of a series of waveform segments that can be played once or looped with specified time delays between loops prior to the playback of the next segment in the sequence. Once waveform segments have been stored in the WMM and a sequencing table stored in the MCM, the Memory Control Module works with the Timing and Control Subsystem to manage all the system disk resources to ensure seamless, zero delay waveform segment to segment transitions.

Timing and Control Subsystem (TCS)

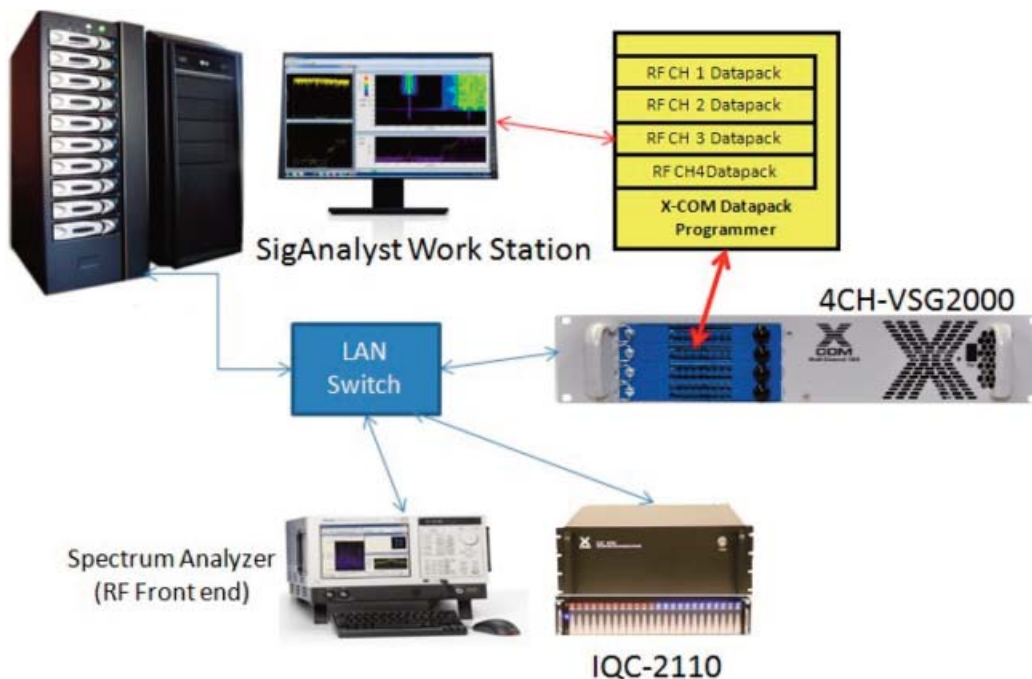
The 4CH-VSG2000 can accept a high precision 10 MHz external time source to ensure precise synchronization between it and the other equipment in a typical development or automated test environment. The TCS also manages the external trigger input that can be used to initiate the starting or stopping of waveform playback across one or more of the four channels. I&Q channel slew settings/calibration and LO tuning for each channel are also controlled by the TCS.

RF Signal Generators (RSG)

Four independent RSGs use a single frequency reference source to ensure the phase coherency of their output so critical in MIMO test and development environments. Each can also be rapidly tuned to a different center frequency with excellent frequency settling times and amplitude flatness. RF amplitude levels can be set for each channel independently, along with center frequency for each RSG.

The maximum RF bandwidth of any RSG is 110 MHz and the RF center frequencies are independently tunable over the frequency range of 50 MHz to 2 GHz.

TYPICAL SYSTEM CONFIGURATION





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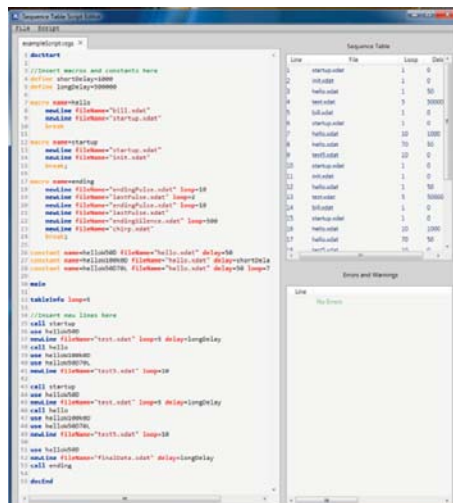
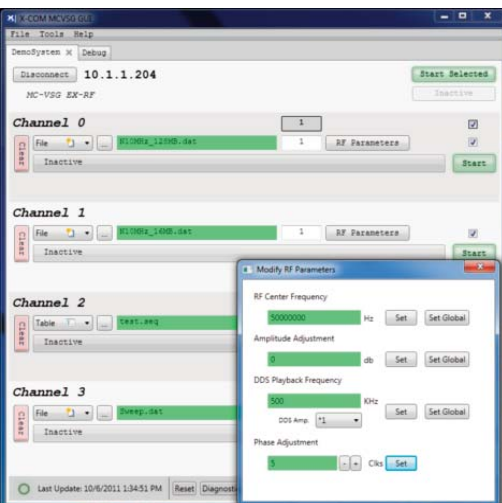
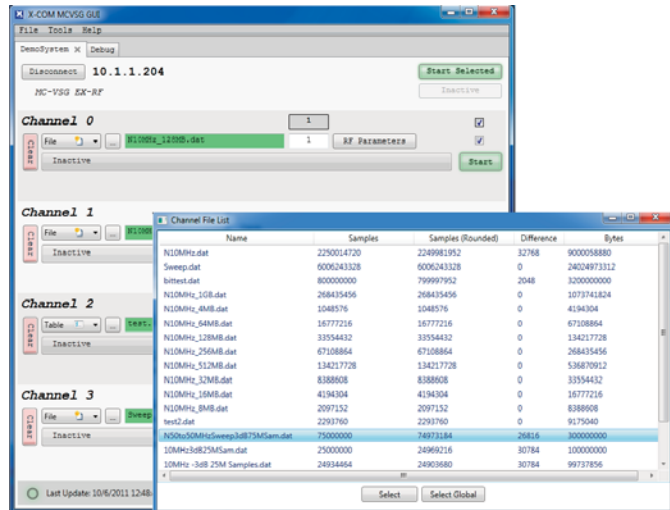
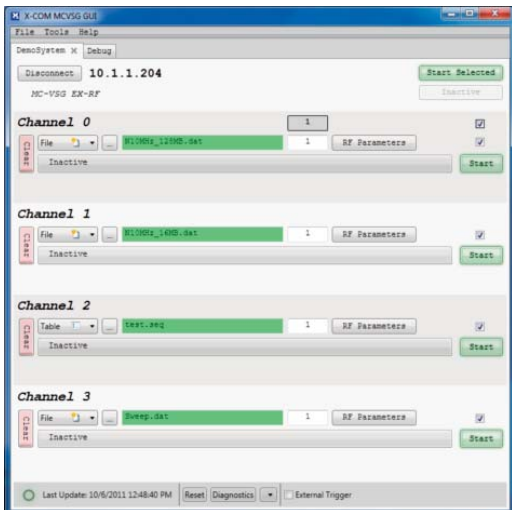
As shown in the figure on the previous page, the 4CH-VSG2000 is connected through a LAN switch to either a Windows 7 PC running the X-COM MC-VSG Control application or a SigAnalyst workstation. The advantage of using an X-COM SigAnalyst WS is its hardware configuration, specifically designed to accommodate multiple MiniSAS interfaces to X-COM IQC2110 Datapacks and up to 16TB of RAID5 waveform archive storage. The SigAnalyst WS also is equipped with an LSI Host Bus Adapter allowing direct MiniSAS connection to the X-COM Datapack Programmer. This is the device used for waveform segment programming of the four, removable 4CH-VSG2000 1TB Waveform Memory Modules (WMM).

A quad core processor and 24GB of RAM support the high speed execution of X-COM's Spectro-X and Spectro PDW analysis, search and waveform identification programs, and RF Editor for editing and customizing waveform segments. Other waveform development tools such as MATLAB®, Agilent's SignalStudio or RF Express from Tektronix can also reside and run on the SigAnalyst. In the case of RF Express, files can be exported in TIQ formats which are compatible with the X-COM software suite.

MCVSG CONTROL SOFTWARE

Full control of the 4CH-VSG2000 as well as the creation and editing of waveform sequence tables is provided through the graphical user interface of the MCVSG Control Software. The application is designed to run in a Windows 7 environment. The PC running the MCVSG program requires a LAN connection and can then work with any number of 4CH-VSG2000 as long as they each are assigned a unique IP address on the network. Each 4CH-VSG2000 is accessible through its own tab in the main GUI window as shown above.

The user has the option of setting up each channel to either use a waveform segment or waveform sequence as the I & Q modulation source. Then each of the WMMs is viewed and a segment or sequence is selected. Through the use of the Select Global option, the same waveform segment or sequence can be assigned to all four of the channels.





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Next, the user sets the RF Parameters of the channel through the RF Parameter Modify window. Here, the user has control of each carrier's center frequency, amplitude and phase. In particular, the phase of any carrier can be adjusted relative to any other carrier in 3ps increments.

Each channel that has been assigned either a waveform segment or waveform sequence and had its RF Parameters set is now armed. Modulation of its RF carrier by the selected file is initiated either through the GUI or via receipt of an external, TTL leading edge trigger. The user has the option of selecting how each channel playback is begun.

From the Tools menu in the MCVSG GUI, the operator can open multiple copies of the Waveform Sequence Editor window. Similar in appearance, keywords and syntax to C or XML, the MCVSG scripting language enables the 4CH-VSG2000 operator to build, compile, save and load waveform sequences. A separate program called the X-COM JBOD loader is used to load the sequences, or individual waveform segments, on to the 4CH-VSG2000 WMMs.

SPECIFICATIONS

This section provides the specifications of the 4CH-VSG2000, multi-channel vector signal generator. Minimum or maximum specifications are warranted under the following conditions

30 minute warm-up time at ambient temperature

Calibration cycles have been maintained

Operating temperature of 10° C to 35° C

Specifications are subject to change without notice. The most recent specifications for the X-COM 4CH-VSG2000 may be found at www.xcomsystems.com/manuals

1. RF PERFORMANCE, SINGLE OUTPUT CHANNEL*

1.1 RF Output Frequency (RF Out)

Range	50-2000 MHz
Resolution (Step Size)	1 Hz
Stability, inclusive of temperature and aging ¹	±2 ppm
RF Bandwidth (3dB) max.	110 MHz
Spectral purity ¹	
10 Hz	-38 dBc / Hz ^{1/2}
100 Hz	-43 dBc / Hz ^{1/2}
1 kHz	-48 dBc / Hz ^{1/2}
10 kHz	-78 dBc / Hz ^{1/2}
100 kHz	-103 dBc / Hz ^{1/2}
1 MHz	-123 dBc / Hz ^{1/2}

¹Using internal 10 MHz reference clock

1.2 RF Output Amplitude (RF Out)

Output power, minimum, single-tone CW output, digital input signal = -3dB full scale	0 dBm
Output power attenuation	0 to 25 dB
Output power resolution (step size)	0.1 dB
Uncertainty ²	±1 dB
Repeatability	< 0.1 dBm
Spurious Free Dynamic Range	
<10 kHz offset	-50 dBc
>10 kHz offset	-60 dBc
Harmonic suppression	< -30 dBc
Signal-to-noise ratio, single tone	> 85 dB
Image rejection, single tone	< -50 dBc
LO leakage, single tone	< -60 dBm
In-band ripple, measured from carrier	
< 100 MHz BW	±2 dB
Connector	SMA
Impedance, Nominal	50 ohms
VSWR (max.)	<1.8:1
Output ports	1 Per channel

²At carrier frequency & into load VSWR of <1.1:1



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1.3 Baseband I/Q Output (I/Q Out)

Connectors	SMA
Impedance, Nominal	50 ohms
VSWR (max.)	<1.8:1
Output bandwidth (3dB) max.	110 MHz
Output power, typical, single-tone CW output, digital input signal = -3dBc full scale	5 dBm
Output power attenuation range	fixed
Output ports	2 Per channel

1.4 Phase Coherency

Channel to channel phase tracking (RF output < 1GHz)	< 1 deg
Phase offset range	300 psec
Phase offset resolution	3 psec

1.5 Modulation Signal

Format	I & Q baseband
Resolution	16 bits
Supported Sample Rates	150, 75, 50, 25, 12.5 MS/sec
Source	Solid-State Drive Arrays

1.6 External Trigger

Modes	single, loop
Source	external
Type	Rising edge
Level	5 V
Connector	BNC(F)

*Unless stated otherwise, RF performance specifications apply to all 4 channels independent of the number of active channels.

2. REFERENCE, STORAGE AND COMMUNICATION

2.1 Internal Reference Oscillator (REF Out)

Frequency	10 MHz
Stability, temperature and aging inclusive	±2 ppm
Output Level (nominal)	3.3 Vp-p
Output Waveform	Square wave (LVCMOS)
Load	> 1000 ohms , < 15 pF
Connector	BNC (F)

2.2 Reference Oscillator Input Requirements (REF In)

Frequency	10 MHz
Uncertainty, max.	±10 ppm
Input Level (nominal)	0 to +13 dBm
Input Impedance	50 Ohms
Connector	BNC (F)

2.3 Communication Interface

Interface	Ethernet 10BASE-T or 100BASE-TX(auto-sensing) Ethernet Version 2.0/IEEE 802.3
Protocols	TCP/IP
Connector	RJ-45



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2.4 Internal Waveform Storage

Capacity (per channel)	1024 Gb
Playback time, max. ³	
150 MS/Sec (110 MHz BW)	22 Min.
75 MS/Sec (60 MHz BW)	44 Min.
50 MS/Sec (40 MHz BW)	66 Min.
Data Rate (max.)	600 MB/sec
Format	Linux software RAID level 0, ext2 file system

³Overprovisioning and wear-leveling will reduce total capacity.

2.5 PC Software

Hardware Requirements	Windows 7 256 MB RAM & Pentium III or equivalent processor (512 MB RAM & Pentium 4/M or higher recommended) 800 x 600, 256 color display (1280 x 720, 16 bit or higher resolution recommended) 100 MB free disk space. Mouse or pointing device CD-ROM Drive (for installation) Adobe Acrobat Reader (for Quick Start manual) Ethernet connection
Operating Systems	Windows 7
Communication Method	Ethernet

3. Mechanical

Housing	Aluminum
Buttons	Power On/Off – front panel
Power Indicator	Green LED labeled “Power” – front panel
Connectors – rear panel	SMA RF & base-band output (12) BNC(F) external trigger in BNC(F) reference clock in BNC(F) reference clock out RJ-45 LAN DB9 IEC Power jack
Power Input	120/240 VAC, IEC inlet
Voltage Range and Power Requirements	84-264 VAC, 375 W peak
Chassis grounding terminal	#10-32 x 3/4” UNC
Cooling method	Forced air, front panel intake
Warm-Up	Specifications apply after a 30 minute warm-up period at ambient temperature.
Operating Temperature	10 to 35 °C
Storage Temperature	-20 to +80 °C
Humidity, Max	80% non-condensing
Altitude, Max	4600m above sea level
Weight, Max	10 lbs
Dimensions, Max	19” x 30” x 3.5” (2 RU)



WAVEFORM MEMORY MODULE FILE FORMAT DEFINITION

The 4CH-VSG2000 system has 4 Datapacks, 1 per channel. Each Datapack provides 1,024 GB of storage capacity. These Datapacks are built using four 1.8" 256 GB solid state hard drives configured as a Linux software RAID Level 0 array. The file system on the Datapacks is EXT2.

Waveform files can be loaded onto the Datapack using an MC-VSG Datapack Programmer. This programmer offers four External MiniSAS ports, 1 for each Datapack. These ports can be accessed using an LSI Logic Fusion MPT2-compatible Host Bus Adapter. All necessary hardware and software to perform this loading is part of the standard equipment list delivered with a 4CH-VSG2000.

The file extension for Waveforms is .DAT. The file format of the .DAT file is interleaved I/Q, whereby the first 16-bit I sample in time is followed by its corresponding 16-bit Q sample with subsequent I/Q samples following till the end of the file. An interleaver program is part of the 4CH-VSG2000 software suite. It can accept non-interleaved I & Q files in .XIQ format, interleave them and output the file as a .DAT format. Other non-interleaved file formats such as .TIQ or .bin can be converted to .XIQ using the X-COM Spectro-X software program.

In a .DAT file, the Least Significant Byte is stored first, followed by the Most Significant Byte within the file: Io[7:0]Io[15:8] Qo[7:0]Qo[15:8] I1[7:0]I1[15:8] Q1[7:0]Q1[15:8] ... In[7:0]In[15:8] Qn[7:0]Qn[15:8]
The I/Q samples are stored as binary, signed (ones complement) samples.

The following minimum file size limitations currently exist with the system:

WAVEFORM FILE SIZE LIMITATIONS

Minimum Unrepeated (single time playback) File Size	256 KB
Minimum Repeated (looped playback) File Size	128 MB
File Size Multiple ⁵	256 KB

⁵Every file to be played back must be a multiple of 256 KB (262,144 bytes)

ORDERING INFORMATION

4CH-VSG2000	4 Channel Vector Signal Generator with four 1TB Datapacks (WMM)
WMM-PGR-4SL	Datapack Programmer, accommodates up to 4 each WMM Datapacks

ACCESSORIES

WMM-SDD-1TB	Waveform Memory Module for X-COM VSG's, 1 TB SSD sample memory
SA-DAT-AN	SignAnalyst(tm) Spectrum Analysis System

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30303 Aurora Rd. :: Solon, OH 44139 :: 866.695.4569 :: www.bird-technologies.com

12345-B Sunrise Valley Drive :: Reston, VA 20191 :: 703.390.1087 :: www.xcomsystems.com