

The Vector Channel Analyzer



A virtual instrument for RF channel measurements on the ATS-3100 Radio Test Set

Tom Costello, PhD
Senior Signal Processing Engineer

astronicstestsystems.com



ATS-3100 Radio Test Set Vector Channel Analyzer

Overview

- Background - Virtual instruments on the ATS-3100 Radio Test Set
 - » Software-Defined Instrument Platform
 - » Suite of Virtual Instruments (VIs)
 - » Test Executive, Test Program Sets and Data Management
- The Vector Channel Analyzer Virtual Instrument
 - » What it measures
 - » Principle of Operation
 - » Use Cases & Example Measurements
 - » Measurement Performance
- Summary

ATS-3100 Radio Test Set

Vector Channel Analyzer



The ATS-3100 RTS Platform

- Software-Defined Instrument Platform
 - » PXIE-based chassis
 - » Windows 10 on-board host PC
 - » 15" Diag Front Panel Touch Screen
- Hardware Spec Highlights
 - » 80 MHz modulation and IF bandwidth
 - » 1 MHz to 6 GHz RF-FE
 - » 100 W continuous RF power input
 - » 0 dBm transmit output with 10 dB headroom
 - » T/R and Duplex RF ports
- User Features
 - » .NET-based API for programmatic control from on-board Test Executive, C#, Matlab.
 - » 32-bit arbitrary sample-rate conversion (10 kS/s to 245.76 MS/s) on Tx and Rx
 - » UUT signal and power interfaces on front panel



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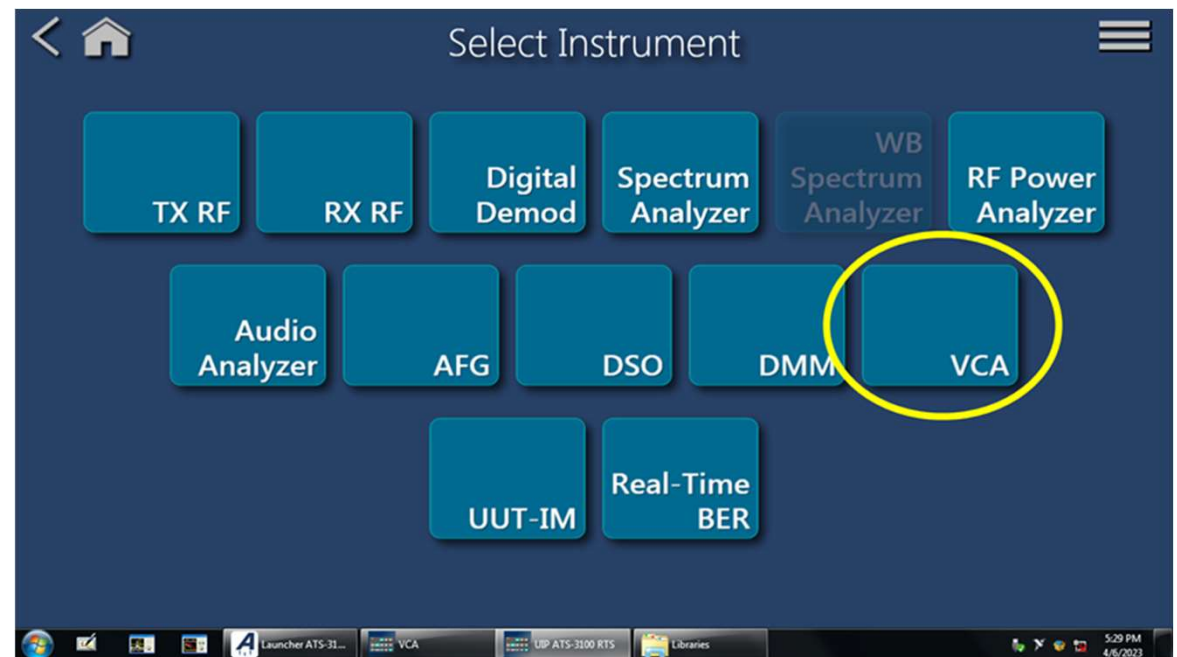
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Virtual Instrument Suite

- RF Performance
 - » Spectrum Analyzer
 - » Analog Generator and Receiver
 - » Digital Generator and Receiver
 - » Power Analyzer (Zero-Span)
 - » **Vector Channel Analyzer (NEW)**
- Audio Performance
 - » Audio Analyzer
 - » Audio Function Generator
- Analog Performance
 - » DSO
 - » DMM



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Virtual Instrument API

- Low-level control for all VIs
 - » .NET-based
 - » Classes for
 - › Hardware configuration
 - › Extensive measurement lib
 - › VI embedding in Test Exec

ATS-3100 Instrument Interfaces

This document describes the API for the ATS-3100 virtual instrument interface.

The interface is implemented in ATSVIPInterface.dll which is a .Net class library DLL. A reference to ATSVIPInterface.dll should be added in any .Net project that needs to programmatically access the ATS-3100 virtual instruments.

Note: ATSVIPInterface.dll communicates with the ATSVIPServiceHost.exe to perform instrument I/O. Thus, the ATSVIP service must be running (it is started by default on all ATS-3100 systems).

Namespaces

Namespace	Description
ATSVIPInterface	The namespace for the Virtual Instrumentation Program (VIP) interface

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Test Executive and Scripting

- Test Executive
 - » Custom test definition
 - » Test Program Set (TPS)
- Graphical User Guidance
 - » Hardware setup
 - » Test execution
 - » Embedded VIs
- Data Management
 - » Logging
 - » Data storage

ATS-3100 RTS

Instrumentation



Script Controls

Select TPS Groups

TrellisWare Family LTI TSM +
99.99.99.214

DEBUG COPY FOR INTERNAL USE
ONLY! TW Family TPS for ATS-3100
(B01X000)

Normal **HANG** Force Go Step Mode Setup Run

Script ended
Incomplete-Passed

Output Detail

Test Group Name: TSM MODULATION ACCURACY
Group Start Time: 2023/02/14 14:32:33

Time	TestID	LL	UL	Value	Units	Dev	Result	Note
14:32:57	5500	-35.0	-29.0	-32.798	dB	26.6%	Pass	TSM MIN MSE TEST 235.000 MHz
14:33:11	5510	-36.0	-30.0	-32.597	dB	13.4%	Pass	TSM MIN MSE TEST 255.000 MHz
14:33:25	5520	-38.0	-32.0	-33.721	dB	42.6%	Pass	TSM MIN MSE TEST 440.000 MHz
14:33:45	5530	-38.0	-32.0	-34.431	dB	19.0%	Pass	TSM MIN MSE TEST 708.000 MHz
14:34:00	5540	-38.0	-32.0	-33.475	dB	50.8%	Pass	TSM MIN MSE TEST 855.000 MHz
14:34:14	5550	-38.0	-32.0	-33.705	dB	43.2%	Pass	TSM MIN MSE TEST 960.000 MHz
14:34:28	5560	-38.0	-32.0	-33.135	dB	62.2%	Pass	TSM MIN MSE TEST 1260.000 MHz
14:34:42	5570	-35.0	-29.0	-31.579	dB	14.0%	Pass	TSM MIN MSE TEST 1805.000 MHz
14:34:59	5580	-32.0	-26.0	-30.229	dB	41.0%	Pass	TSM MIN MSE TEST 2580.000 MHz

Group Stop Time: 2023/02/14 14:35:00
Total Group Test Time: 2 Minutes, 27 Seconds

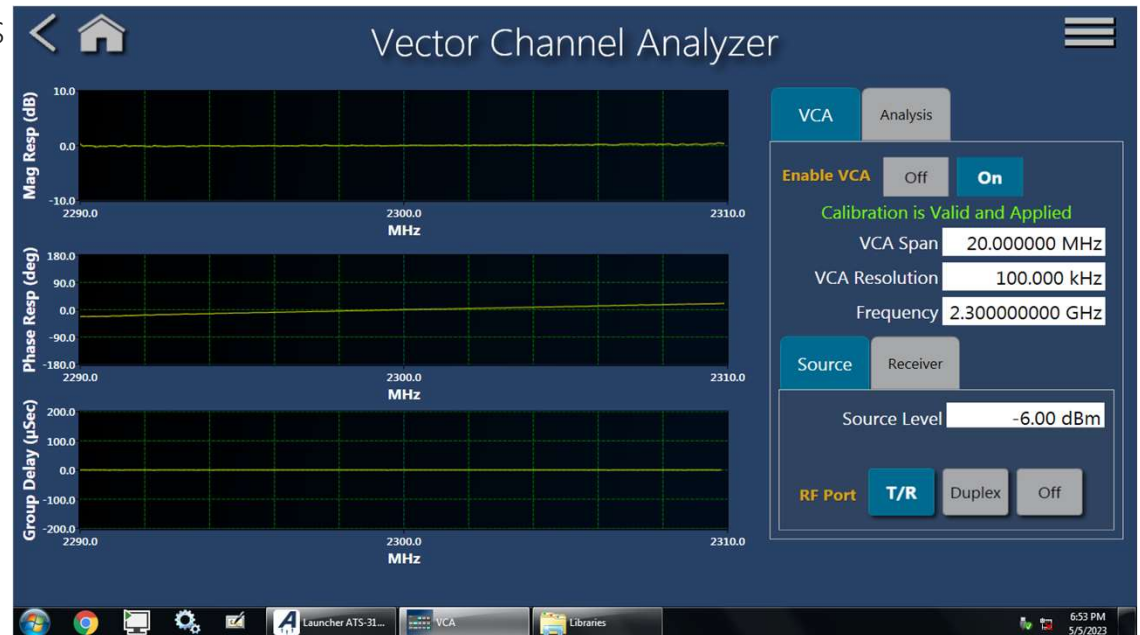
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Vector Channel Analyzer



The Vector Channel Analyzer (VCA) Virtual Instrument

- What it measures
 - » VNA S21 comparable measurements
 - » Complex channel transfer function
 - » Most common formats
 - › Magnitude / Phase
 - › Group delay
- Real-Time Operation
 - » 10 kHz to 40 MHz span
 - » Wide-band stimulus
 - » 64 to 10k points
- Separable Transmit and Receive
- Light-weight tx vector generator
- No receiver phase reference req'd





ATS-3100 Radio Test Set Vector Channel Analyzer

VCA Theory of Operation

- Wide-band stimulus
 - » Discrete multi-tone
 - » Up to 80 MHz span
 - » Resolution to 1 kHz
 - » RTS Tx Power to 0 dBm
- Coherent Rx Synchronization
 - » No local phase reference req'd
 - » Removes Doppler
 - » Removes common phase
 - » Compensates delay-induced phase ramp
- Span calibration supported

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Vector Channel Analyzer



VCA Use Cases

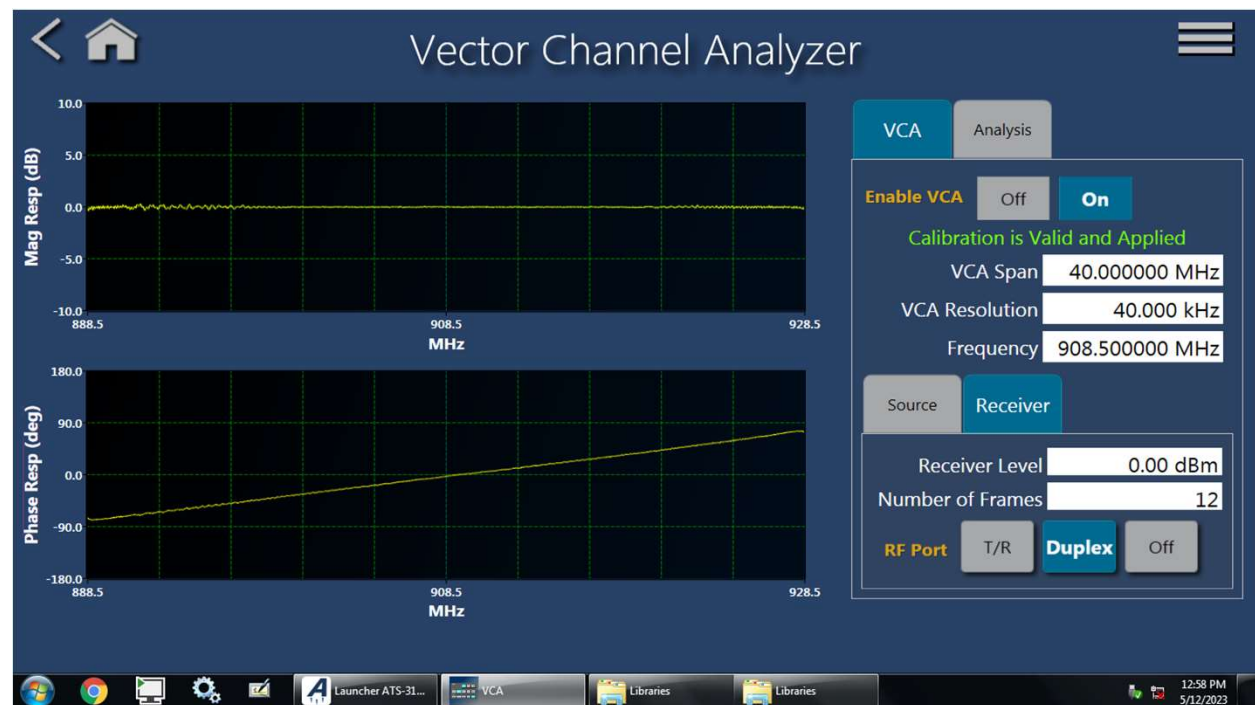
Use Case	Tx/Rx Location	Applications
Lab Bench	Co-located (single RTS unit)	RF Front-Ends In-line RF filters RF Mixers
Over the Air	Separated (embedded tx)	Antennas Remote Site
Moving platform	Separated (embedded tx)	Air-born Vehicular

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Vector Channel Analyzer

In-Line Measurement Cal

- Mag compensation only
 - » With short load at desired reference plane.
 - » Cal is stored and applied to subsequent measurements.
- Phase ramp varies with
 - » Tx/Rx sample-clock phase mismatch
 - » Propagation
- Ramp is removeable with processing, but of limited utility.



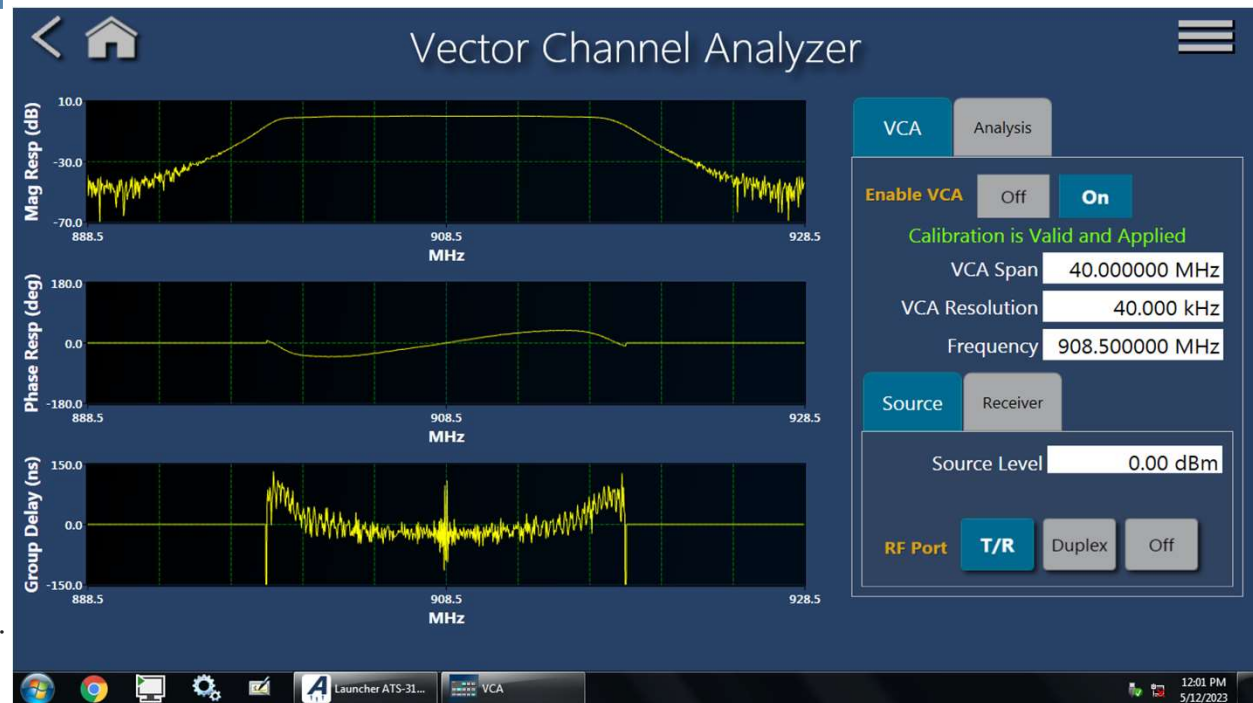
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In-Line Measurement Example

- Mini-Circuits ZVBP909S+
 - » Hi-Q cavity band-pass filter
 - » 900 MHz ISM band
 - » 40 dB out-of-band rejection
 - » ~ 2 dB in-band insertion loss
- VCA Measurements
 - » Magnitude: 30 – 35 dB useful dynamic range
 - » Phase: configurable masking removes low SNR skirts
 - » Group Delay: configurable avg. aperture for smoothing

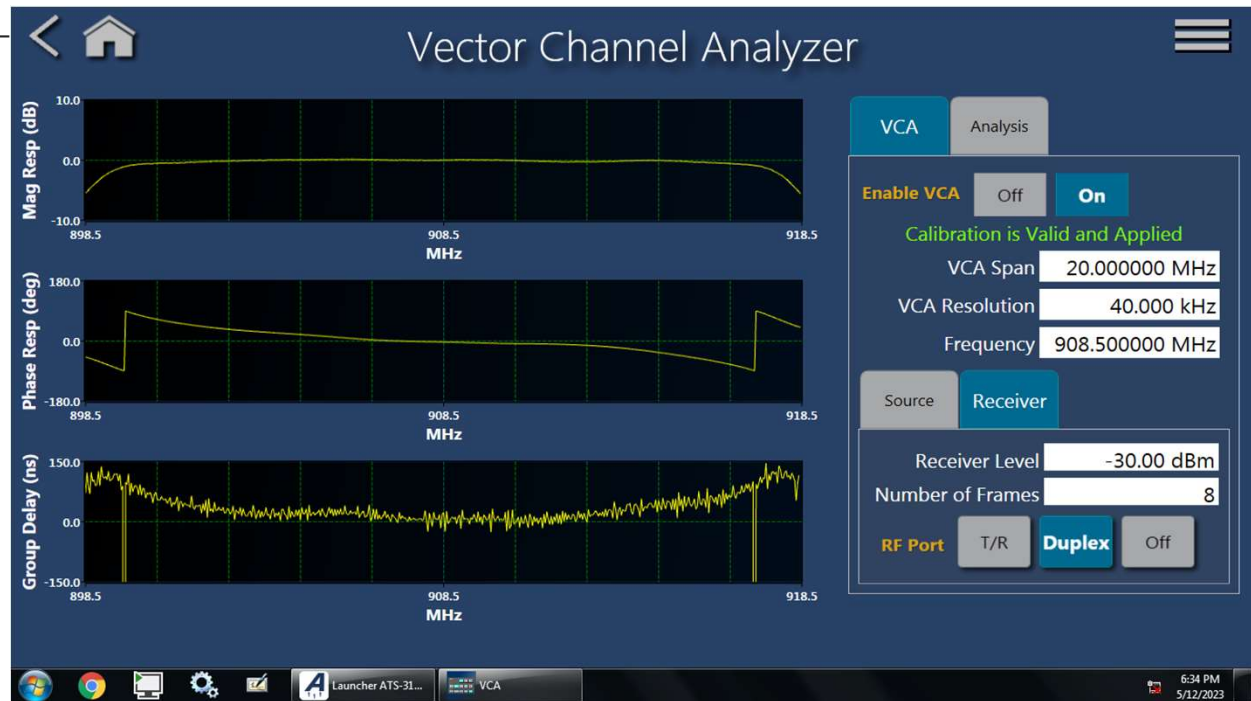


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OTA Measurement Example

- DUT: Mini-Circuits ZVBP909S+
 - » Hi-Q cavity band-pass filter
 - » 900 MHz ISM band
 - » 40 dB out-of-band rejection
 - » ~ 2 dB in-band insertion loss
- VCA Measurements
 - » Separated Tx/Rx
 - » 20 MHz Span (RF SigGen limit)
 - » Indoors LOS 8m path
 - » 12 dBi Yagi antennas at 2m ht.
 - » ~50 dB FSPL
 - » ~26 dB net path loss



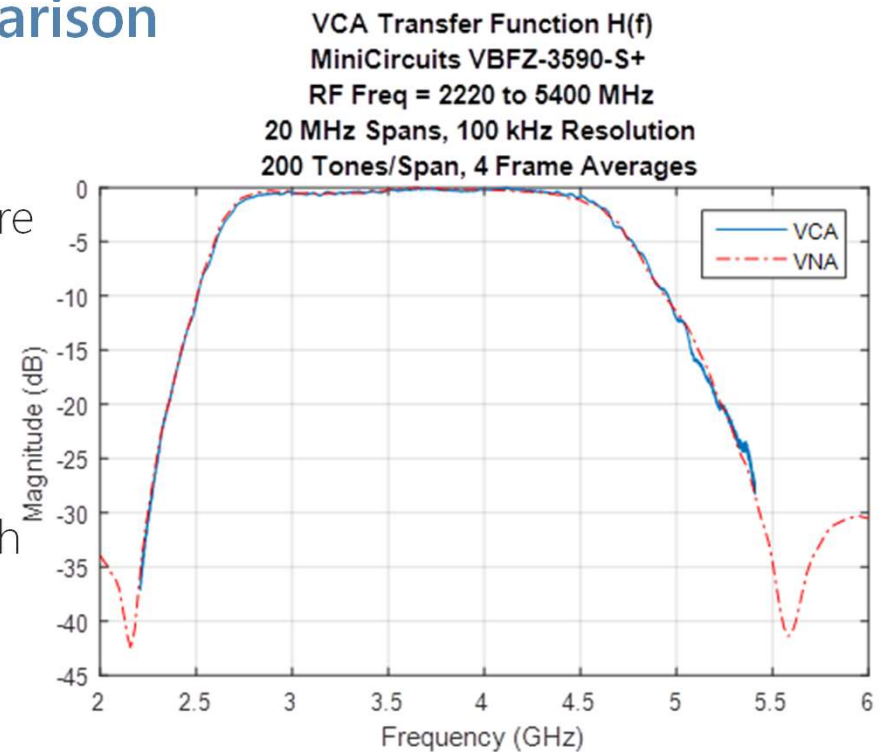
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VCA vs. VNA S21 Performance Comparison

- DUT: Mini-Circuits VBFZ-3590-S+ BPF
 - » 1 GHz wide BPF at 3.5 GHz
 - » Bench instruments for stimulus & i/q capture
 - » 20 MHz VCA spans
 - » ATS-3100 analysis processing
 - » Reference grade VNA
- Results
 - » Simple step & dwell VCA stitching approach
 - » Excellent agreement up to 5 GHz
 - » Better stitching will improve > 5 GHz



A high-angle, front-facing view of an F-35 fighter jet in flight against a blue sky with wispy clouds. The jet is dark grey and has a stealthy, angular design. It is positioned in the upper right portion of the slide, with its wings and canards visible. The background is a gradient of blue and white, suggesting a clear sky.

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Summary

- VCA closely replicates high-end VNA S21 measurements in a virtual instrument
- Separability of Tx and Rx creates new measurement capabilities
- Stimulus vector generator software easily embeddable in virtually any platform.

ATS Irvine
2652 McGaw Ave.
Irvine, CA 92614 USA
+1.949.859.8999

ATS Kilgore
2002 Synergy Blvd. #200
Kilgore, TX 75662 USA
+1.844.903.7333

ATS Westford
5 Lan Dr.
Westford, MA 01886 USA
+1.978.392.0406

ATS Orlando, HQ
12889 Ingenuity Dr.
Orlando, FL 32826 USA
+1.407.381.6062

ATS Ferndown
Peartree Business Centre, Cobham Rd.
Ferndown, Dorset, BH21 7PT, UK
+44 (0) 1202.854.000

ATS Bangalore
No 118 Gayathri Lake Front, 1st Floor
Outer Ring Rd. Near Hebbal Flyover
Bangalore – 560024 INDIA
+91 (080) 4347.5222

ATSales@astronics.com

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