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TEST SYSTEMS

The Vector Channel Analyzer

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

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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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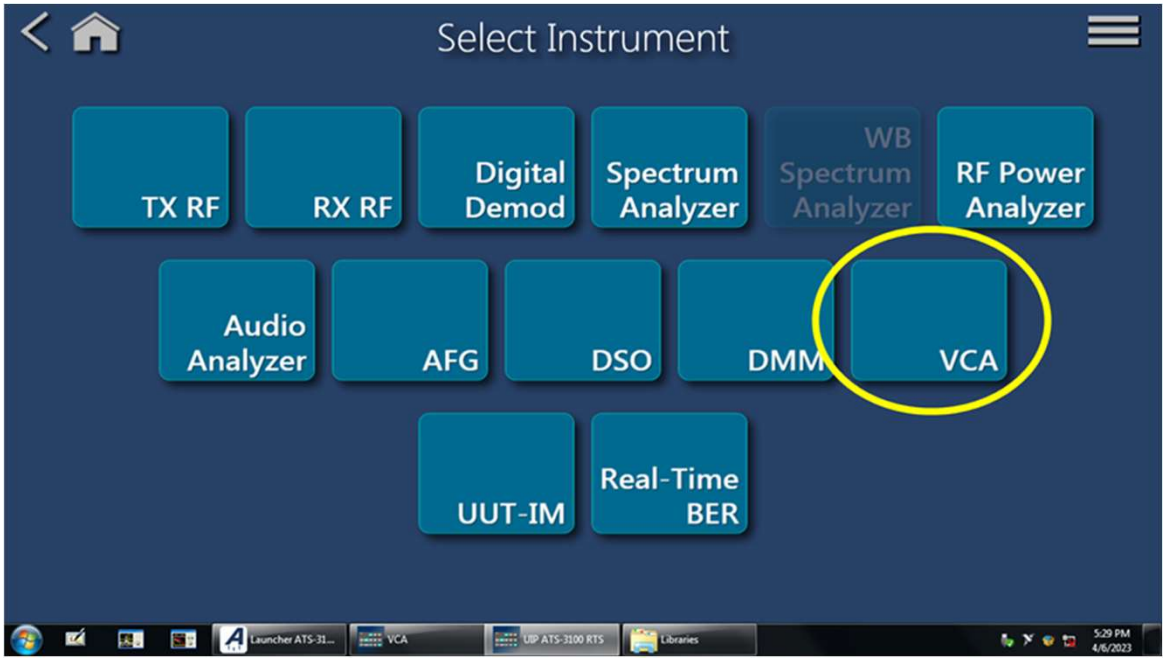
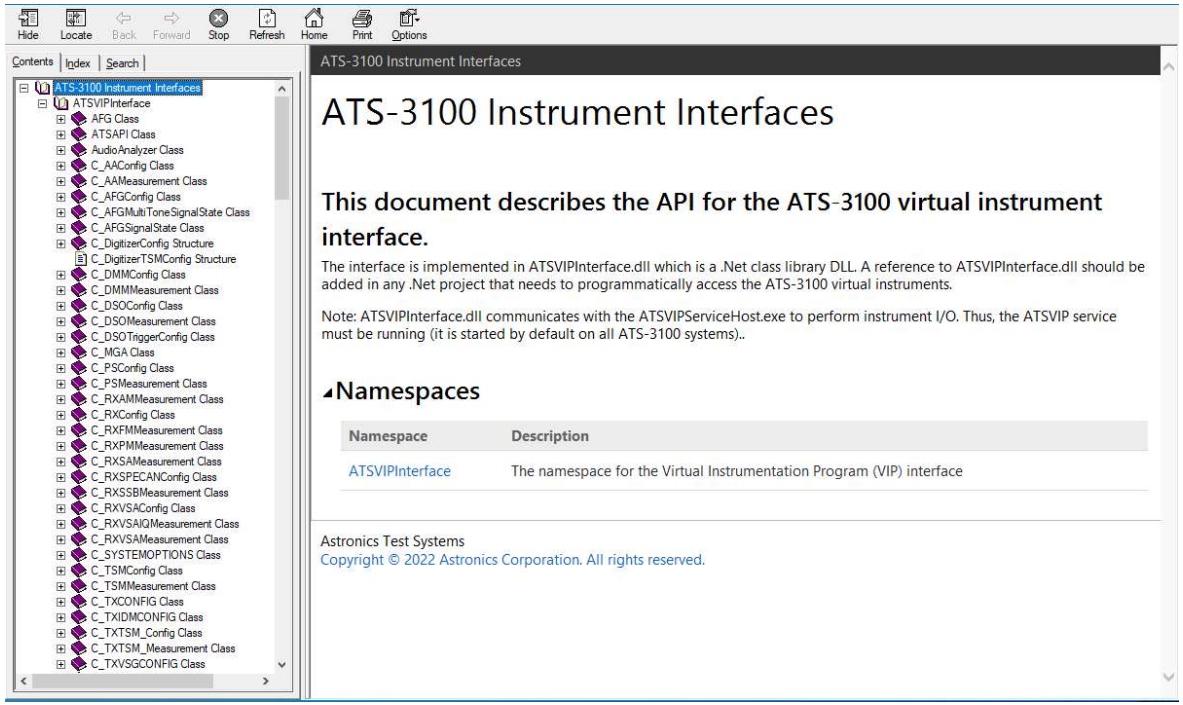
Virtual Instrument Suite

- 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



Virtual Instrument API

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



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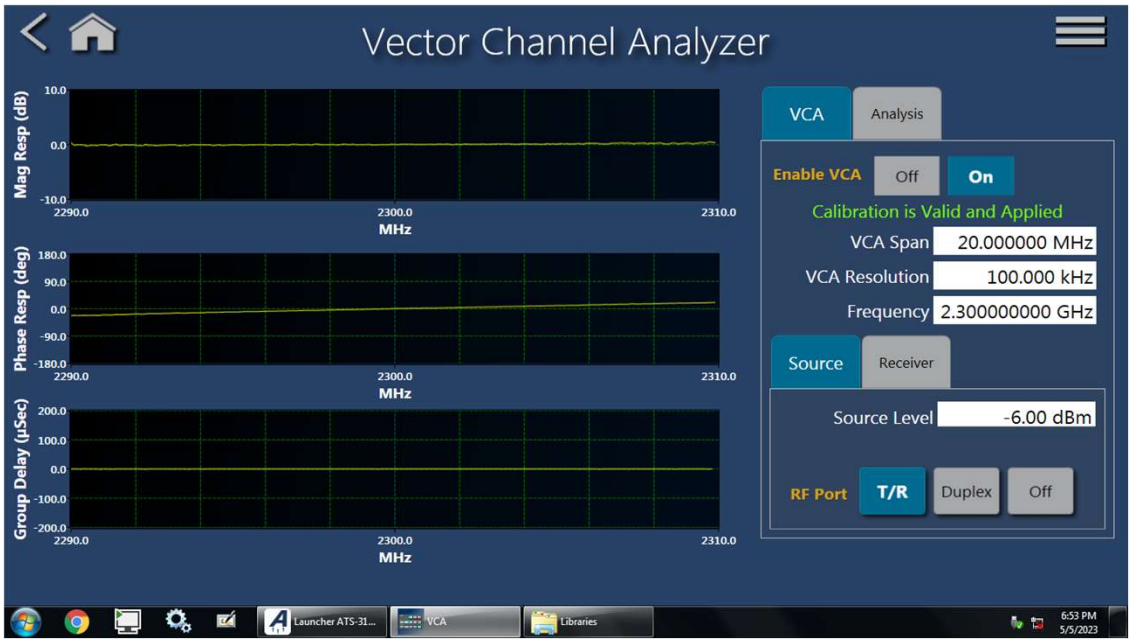
Test Executive and Scripting

- 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 Radio Test Set
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



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

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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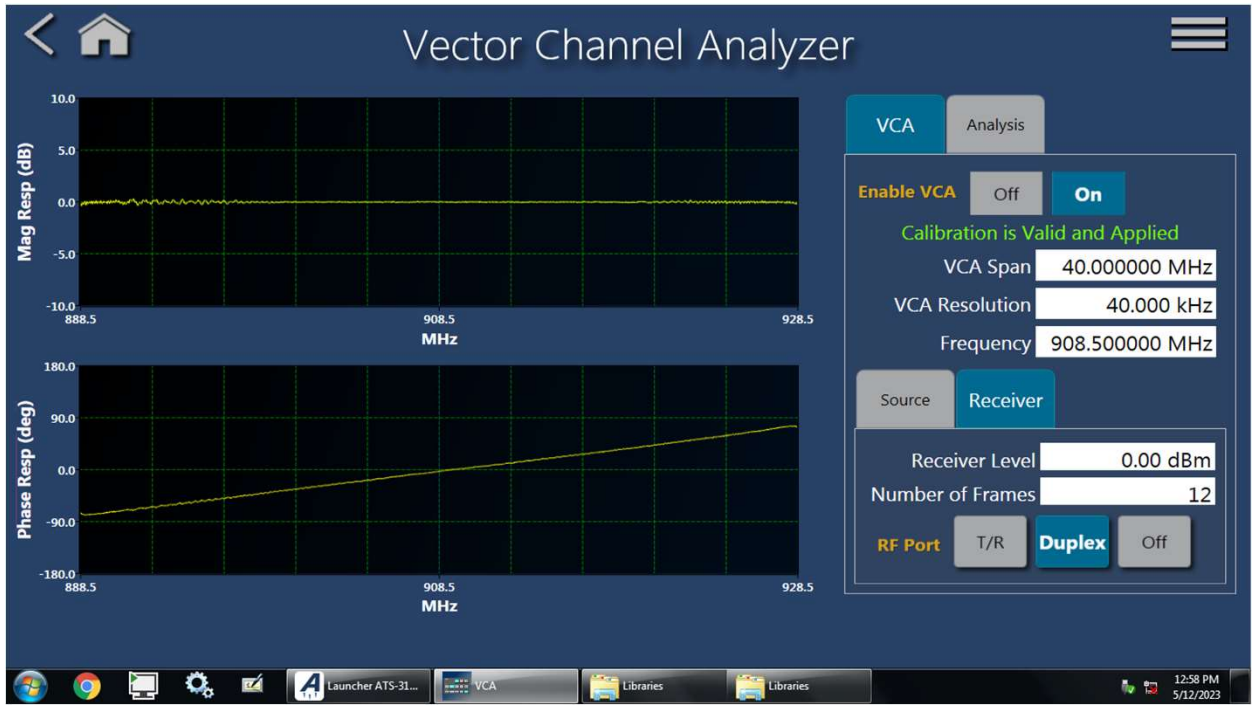
In-Line Measurement Cal

- 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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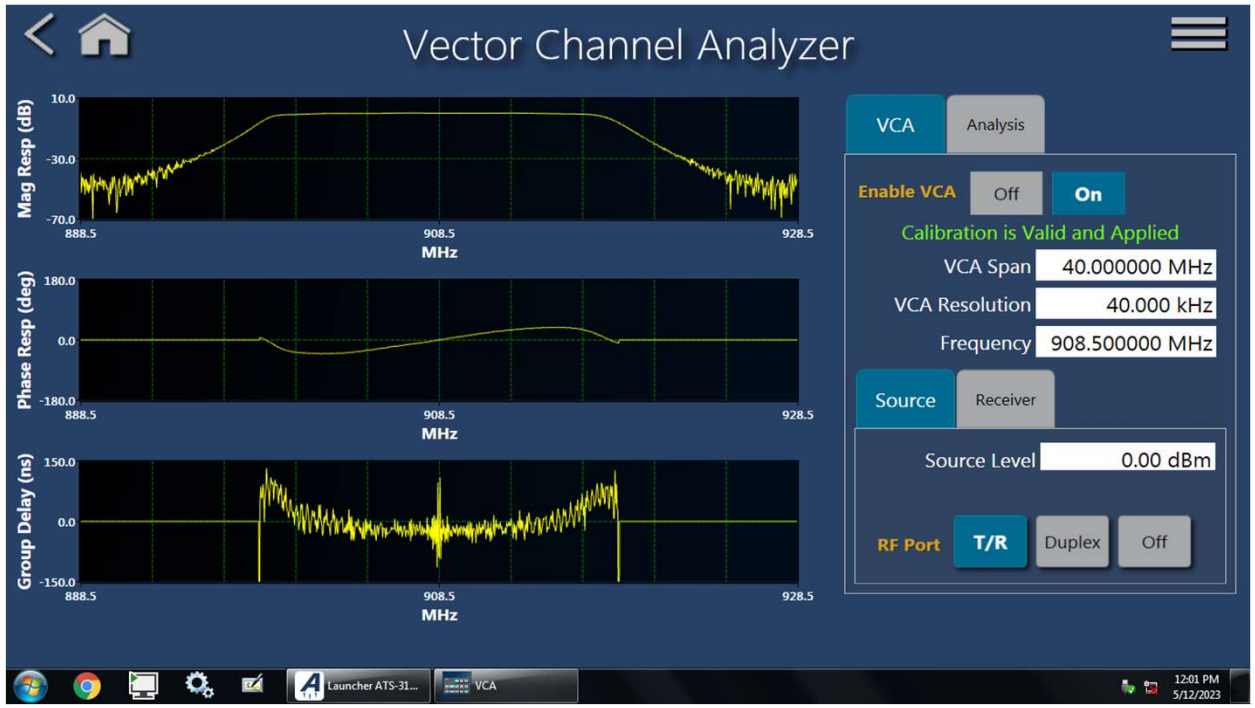
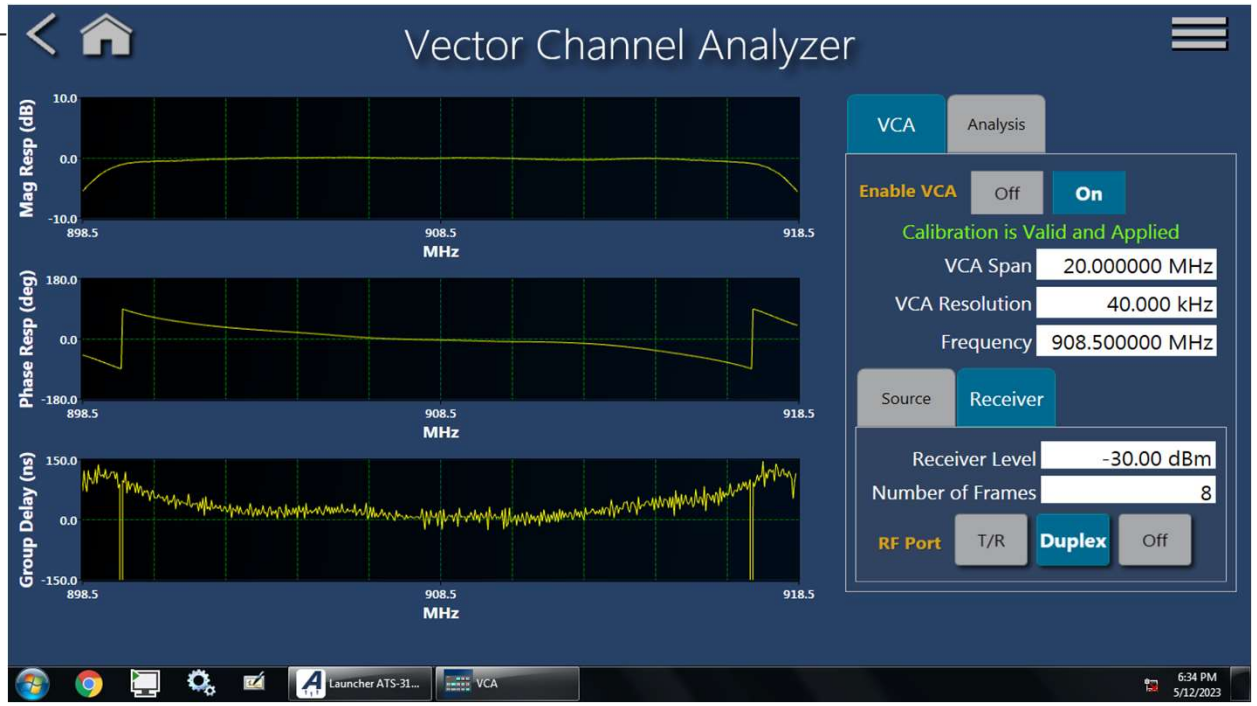
In-Line Measurement Example

- 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



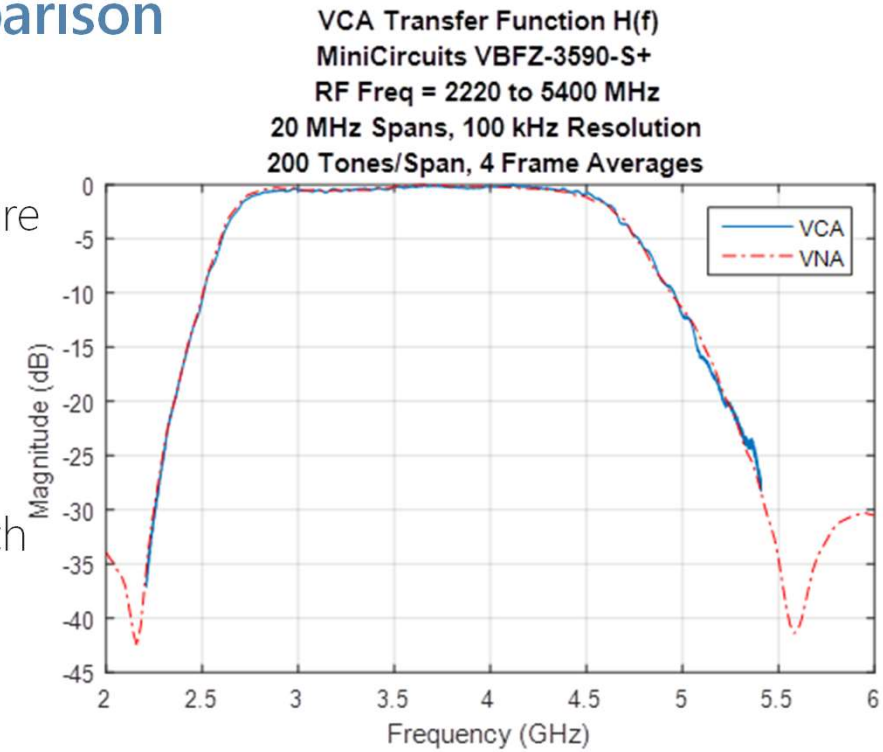
OTA Measurement Example

- 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



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



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.

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