

## SOLUTION FLYER

# RF Front End and Transceiver Manufacturing Test Solution

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# Solution Overview

## Integrated Solution for RF Front End and Transceiver Manufacturing Test

As development schedules constrict under market window pressures and product complexity increases with every iteration of cellular and connectivity wireless communication standards, semiconductor test engineers need a production test solution that can help accelerate time to market and reduce the cost of test. For RF transceivers and RF front ends, including power amplifiers (PAs), low-noise amplifiers (LNAs), RF switches, RF filters, and integrated RF front end modules (FEMs), the NI Semiconductor Test System provides significant test time and throughput advantages over alternative ATE solutions.



Figure 1. NI Semiconductor Test System

NI's heavy involvement in standards bodies and lab applications translates to strong experience and compelling solutions for the latest wireless standards, such as 5G NR and Wi-Fi 6. NI offers significant IP and cutting-edge instrumentation ranging from femtoampere-class DC instrumentation for sensitive I-V measurements to mmWave instrumentation with industry-leading bandwidth to tackle the newest wireless chipset. This document provides an overview of NI's integrated, multi-site production test ATE solution for RF transceivers and front ends for both handset/user equipment (UE) and base station/small-cell devices.

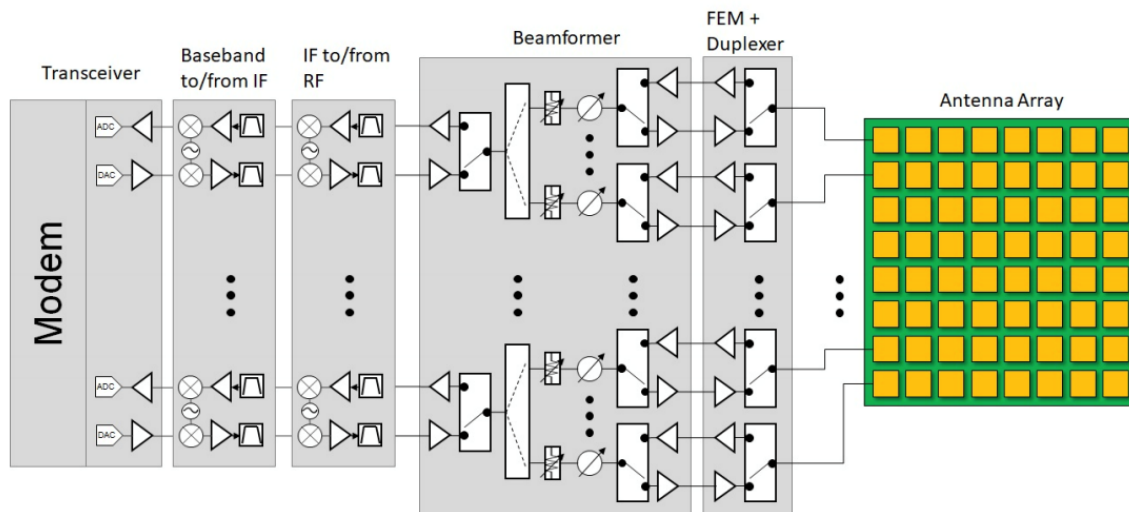


Figure 2. Example 5G RFIC Architecture with Multi-user MIMO and Beamforming Capabilities

As with traditional semiconductor ATE solutions, STS has modular instrumentation resources that can be configured with the ideal mix of DC, digital, and RF instrumentation resources to perform multi-site test of RF front-end ICs or modules. STS is ready for the production test cell, with support for manipulators,

handlers, and wafer probers (with traditional tower probe and direct dock probe options), and a standard spring pin layout facilitates highly transferable test programs and load boards. STS also features a comprehensive set of software tools for quickly and efficiently developing, debugging, and deploying test programs, including a measurement library for RF measurements such as transmit power, adjacent channel power (ACP), error vector magnitude (EVM), output power servoing, S-parameter measurements, noise floor, noise figure, harmonics, third-order intercept (IP3), and more. For applications that require extended capabilities, NI offers standard add-ons for high-power RF (+40 dBm at the RF blind-mates for transmit and receive), noise figure measurements with Y-factor support, and high frequency harmonics measurements (up to 18 GHz). To complete the solution, NI offers comprehensive engineering services, bring-up services, training, and support.

## Key Benefits

- Integrated production test solution for RF and mmWave cellular and connectivity devices
- Industry-leading 1 GHz bandwidth (without stitching) for complex RF measurements
- Support for wireless standards, including GSM, TD SCDMA, WCDMA, LTE, LTE-A, 5G NR, and 802.11a/b/g/n/ac/ax
- Latest technology emerging from the design lab, including digital predistortion (DPD), envelope tracking, FPGA-based power servoing, support for new RF frequencies, and higher RF, IF, and mmWave port count
- Up to 48 bidirectional Sub-6 GHz RF ports or 72 bidirectional mmWave ports (with eight integrated 5-21 GHz IF ports)
- Support for SerDes (up to 12.5 or 28.2 Gbps), JESD204B, MIPI RFFE, SPI, and custom digital protocols
- Optional high-power RF up to +40 dBm
- Optional harmonics measurements - up to 18 GHz
- Optional noise figure measurements - with Y-factor and cold source support

## Standard Features

- Drag-and-drop test step templates for common semiconductor test operations
- Interactive software for performing manual tests and debugging automated tests
- Calibration for RF instrumentation up to the blind-mates, and DC/Digital instrumentation up to the spring probe interface
- Test Sequencer: NI TestStand with TestStand Semiconductor Module
- Code Development: LabVIEW or C# .NET
- STS Maintenance Software

## Optional Features

- High-power RF (+40 dBm transmit and receive)
- Harmonics measurement (up to 18 GHz)
- Noise figure measurement (with Y-factor and cold source support)

## Test Head Features

- Zero footprint test head
- Manipulator interface kits for Reid Ashman, InTest, Esmo, Arktek, Asia Microhandling, and others
- Support for packaged device handlers and wafer probers (traditional tower probe and direct dock probe)
- 220 V power
- Fan cooled
- Standard spring pin layout

# About the NI Semiconductor Test System

The NI Semiconductor Test System (STS) brings the long history and value of the industry-standard PXI platform to a production-ready ATE offering that can scale up to meet evolving test requirements or scale down to meet constricting budgets. Leverage the latest high-performance PXI instruments, such as the 1 GHz bandwidth mmWave Vector Signal Transceiver (VST), for performing demanding measurements on RF and mixed-signal ICs, while meeting all the operational needs of the semiconductor production environment.

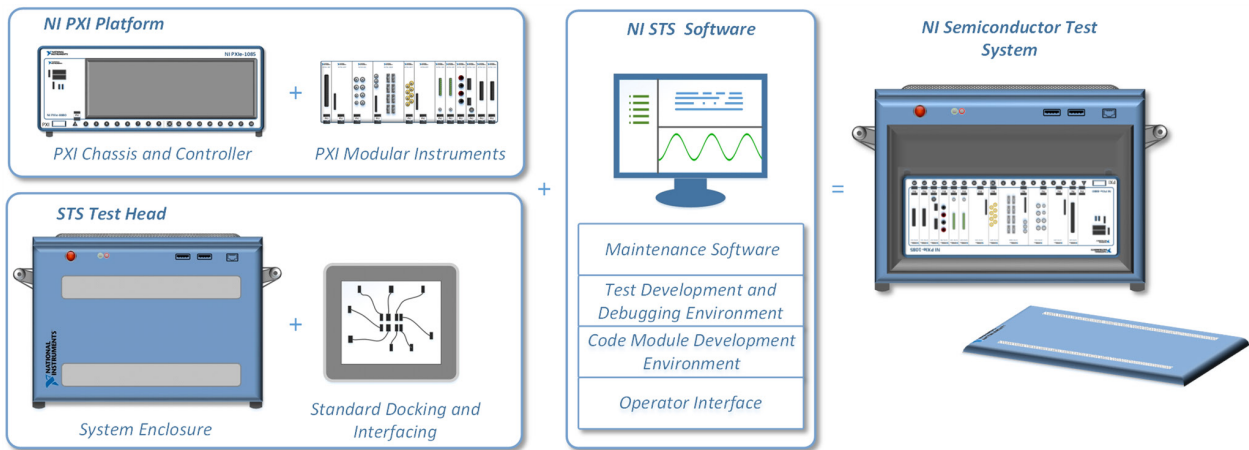


Figure 3. STS provides the excellent measurement coverage and quality expected from lab-grade PXI instruments in a production-ready form factor.

STS comes in three sizes—T1, T2, and T4—that accommodate one, two, and four instrumentation chassis, which equates to 14, 30, or 64 instrumentation slots, respectively. All test systems share a common interfacing infrastructure and interchangeable device interface boards, so you can scale up to meet exact pin-count and site-count requirements in production, as well as scale down for characterization. This ability to scale with common hardware and software infrastructure helps you not only optimize system costs, but also simplify data correlation from production to characterization, which helps accelerate your time to market.

STS offers you a framework to meet today's production test requirements, but also the flexibility to evolve test capabilities and meet next-generation test requirements. This means you can upgrade or augment key components with the latest PXI instrumentation, the newest PXI controllers featuring the best COTS computing technology and the latest advances in RF, digital, and DC instrumentation. This protects your investment in the test system over multiple technology generations and gives you the ability to cost-effectively adapt to changing requirements.

# STS Software

NI offers a single, version-controlled STS Software Bundle, which provides all of the necessary pieces to efficiently develop, debug, and deploy test programs, including interactive software and prebuilt test code for common semiconductor test actions. Additionally, customers can customize the STS Software Bundles to include custom operator interfaces, custom report processing tools, third-party software tools, and other factory integration tools.

To learn more about STS software, read the [STS Software Bundle white paper](#).

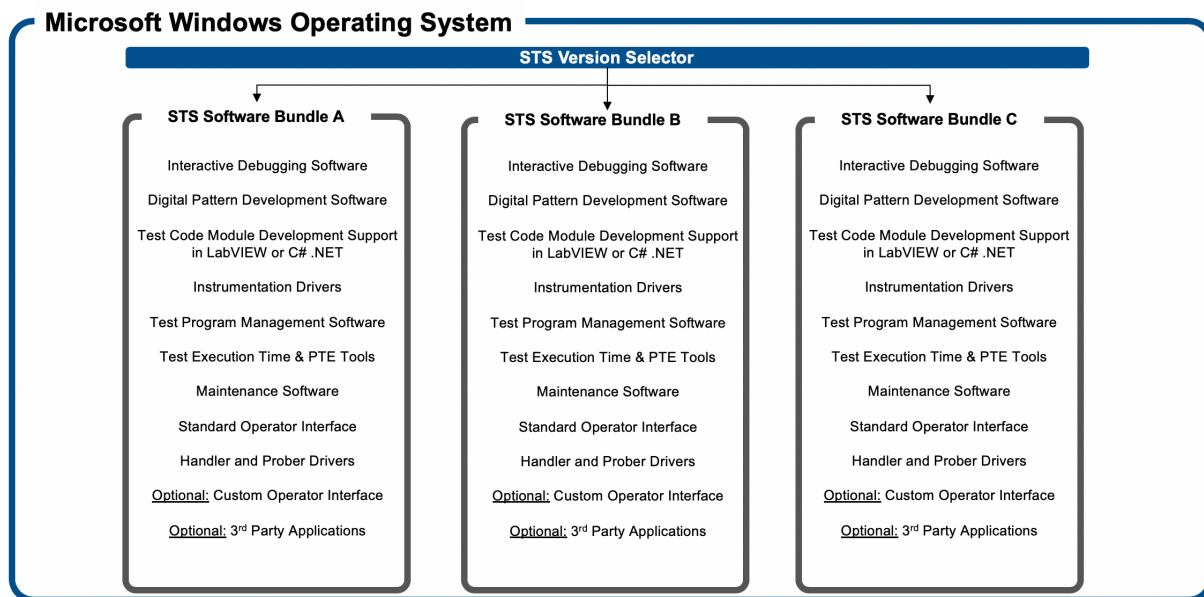


Figure 4. STS Software is a comprehensive set of software tools for developing, deploying, and debugging test programs, and for calibrating the tester.

## Managing STS Software Bundle Versions

The STS Version Selector tool simplifies the management of installed bundles and ensures that the test is executed on the same underlying software as it was developed on, which eliminates the need for re-qualification and streamlines future deployment of replicate testers.

## Interactive Software

Included in the NI STS Software Bundle are tools to help interactively develop pin maps and digital patterns, perform interactive measurements, view measurements results, and debug paused test sequences to rapidly iterate on test parameters and check key device performance indicators. For RF power amplifiers and front-end modules, the NI-RFmx Soft Front Panel includes both spectral analysis and cellular personalities, which you can use to take interactive composite and overlapped measurements, share saved settings and recall them from other testers to guarantee results correlation, and debug automated test programs.

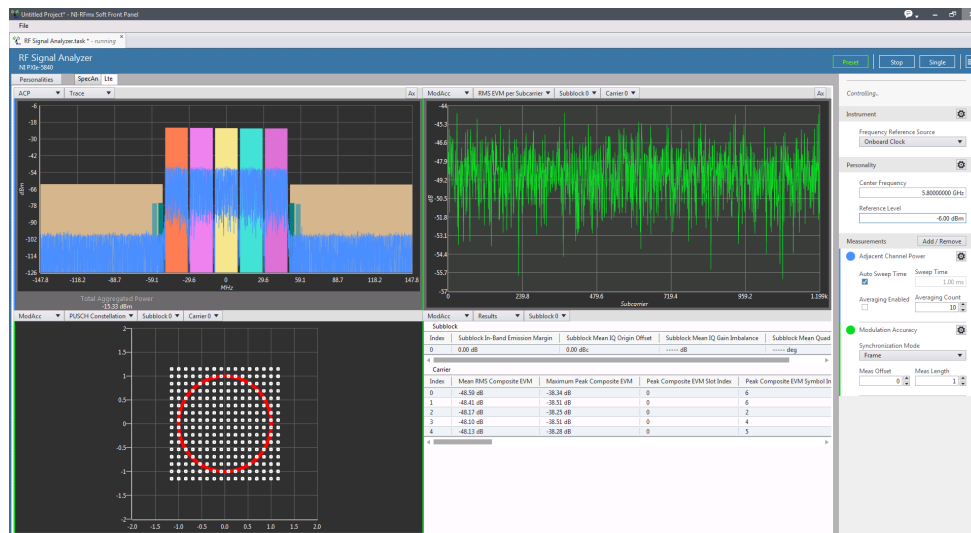


Figure 5. RFmx Soft Front Panel

## Test Program Management

STS uses TestStand, the industry-standard test management software, and the TestStand Semiconductor Module to manage test programs and sequence individual test code modules. TestStand includes functionality and tools to reduce test execution time and improve parallel test efficiency (PTE). You can view step time analysis, filter your data by site or batch, for example, and compare results after modifying the test program. The built-in Execution Profiler provides performance statistics and immediate visualization of current executions, threads, and resources.

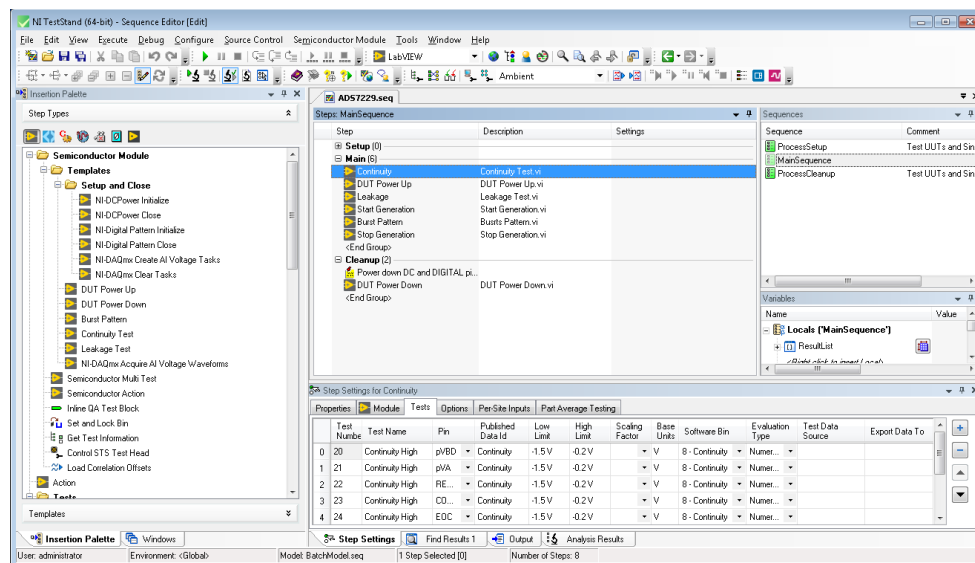


Figure 6. TestStand Industry-Standard Test Management Software

## TestStand Semiconductor Module Step Templates

Use prebuilt and ready-to-configure example test step templates to perform common operations, such as continuity test, leakage test, burst digital pattern, and various RF tests, such as generate or measure LTE signal.

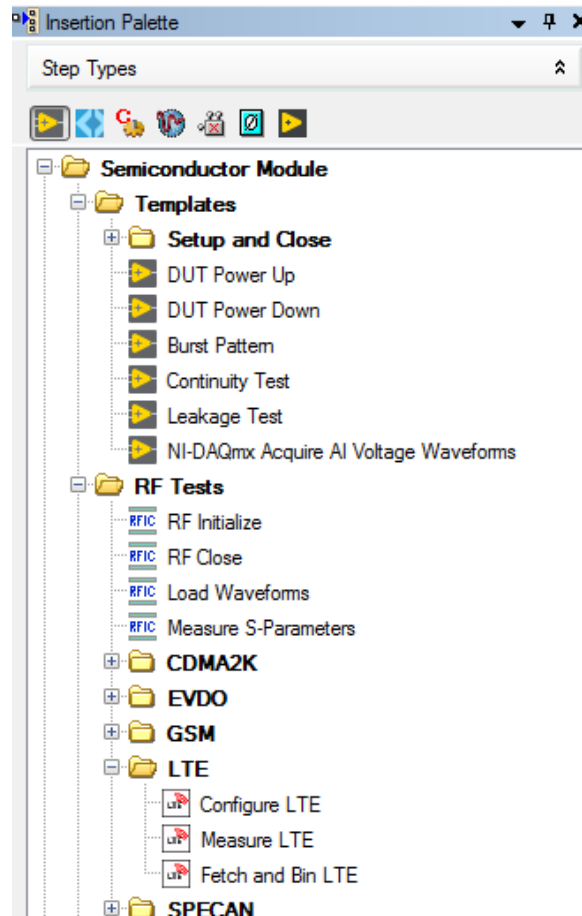


Figure 7. RFmx Step Templates for Common Wireless Operations

## Test Code Module Programming Languages

For writing new test code modules, or customizing existing ones, STS supports both LabVIEW and C#.NET. Quickly and directly control specific instrument resources to customize test parameters with resource-specific drivers and APIs or use high-level NI-RFmx software to quickly obtain the high-performance measurements you need with the extensive, user-friendly NI-RFmx library of measurement IP—like EVM and adjacent channel power (ACP)—for wireless technologies ranging from 2G through 5G NR, Wi-Fi, Bluetooth, and IoT.

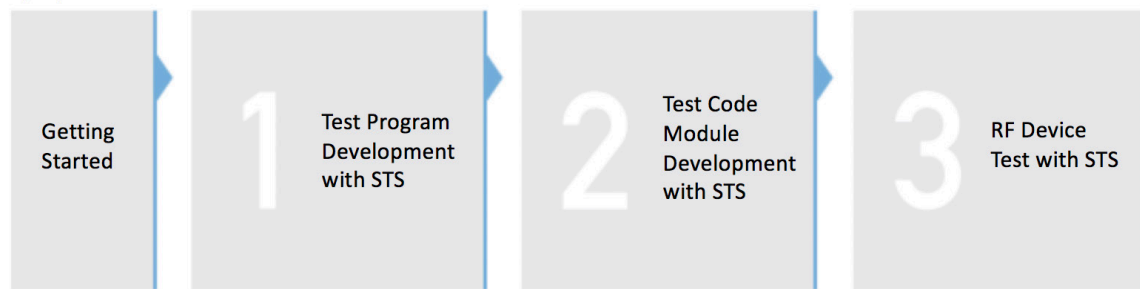


# STS Engineering Services

Interested in a turnkey solution? Contact your NI sales manager to learn about the various options for engineering services, such as test program development, custom operator interface (OI) development, load board development, test cell integration, tester migration, and more.

## STS Training Options

Semiconductor production test engineers are often challenged to test more complex parts in a fraction of the time and budget. The [STS Test Engineer Curriculum](#) is a series of three courses designed to quickly teach semiconductor production test engineers how to develop and debug configuration-based test programs, create custom measurements, and optimize advanced test programs for mixed-signal and RF devices using the NI Semiconductor Test System (STS). Learn more at [ni.com/training](https://ni.com/training).



*Figure 8. Reduce development time and costs through faster learning and increased productivity with NI customer education, a training and certification program designed to help you successfully develop applications.*

### Test Program Development with STS

In this course, you will follow a typical workflow to develop test programs for a new semiconductor device using the NI Semiconductor Test System (STS). Upon completion of the course, you will be able to use STS tester resources interactively to create, modify, execute, and debug test programs with pre-existing code modules to collect test data and generate test time reports.

### Test Code Module Development with STS

In this course, you will learn to use LabVIEW and TestStand to create custom test steps and optimize test program execution. This course can be taken directly after Test Program Development with STS.

### RF Device Test with STS

In this course, you will learn to develop and debug test programs for RF parts using the NI Semiconductor Test System (STS). Upon completion of the course, you will be able to use STS tester resources interactively to create, modify, execute, and debug RF test programs with pre-existing code modules to collect test data and generate test time reports. This course should be taken by test engineers that are responsible for testing RF parts and should be taken after Test Program Development with STS and Test Code Module Customization with STS.



# STS Services and Support

You expect NI systems to help you solve some of the most challenging engineering problems; expect the same level of capability in our services. With every STS deployment, NI partners with you to determine the level of service that best meets your application needs and ensures long term success. Learn more at [ni.com/sts/services](https://ni.com/sts/services).



## Obtain Basic Support

Obtain peace of mind through support from STS experts to accompany your in-house maintenance operations. One year of our Basic Service Program is included with every STS.



## Maximize Production Uptime

Maximize uptime of your STS with faster turnaround times from NI when hardware fails, or expert support is needed. NI has the global infrastructure and resources to help you manage a tiered sparing model across your STS installed base. NI provides flexible service options from a regional inventory of spares that can be shipped the same day to an on-site spares inventory that you can access in minutes.



## Optimize Tester Performance

In addition to system calibration features of STS, NI provides on-site and laboratory calibration options to meet a wide range of needs. NI is a proven veteran with unrivaled experience calibrating precision instrumentation—over 10 years calibrating PXI instruments and more than 20 years working with calibrating precision instrumentation.



## Maximize Efficiency

To help you quickly develop and deploy testers, NI offers a variety of options for engineering services, such as test program development, custom operator interface (OI) development, load board development, test cell integration, tester migration, and more. NI also delivers a spectrum of services to help integrate STS into your factory and train your engineers, technicians and operators.



## Achieve Longevity

NI knows every application has different requirements for support and longevity and is committed to providing the life cycle support you need for your application. NI provides a consultative engagement on the life cycle status of products, recommended updates, and planning related to sustaining engineering.

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