SOLUTION FLYER

IoT Device Manufacturing Test Solution

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Solution Overview

Integrated Solution for IoT Semiconductor Device Manufacturing Test

As development schedules shrink under time-to-market pressures and product complexity increases with every iteration, semiconductor test engineers need a production test solution that can scale up to meet evolving test requirements or scale down to meet constricting budgets. The NI Semiconductor Test System (STS) is built on the PXI platform, which provides the excellent measurement coverage and quality expected from lab-grade PXI instruments in a production-ready form factor.

Figure 1. NI Semiconductor Test System

Semiconductor chipmakers know that the emergence of the Internet of Things (IoT) has led to an increase in diversity and volume of IoT semiconductor devices with an ultra-cost-optimized price point that can be difficult to address with traditional ATE solutions. For microcontroller-based IoT devices with communication standards such as Bluetooth LE, NB-IoT, WiFi, or ZigBee, STS provides a flexible production test platform that can scale up to meet expanding production volumes or scale down to meet constricting budgets. The following sections provide an overview of NI's integrated, multi-site production test solution for IoT semiconductor devices.

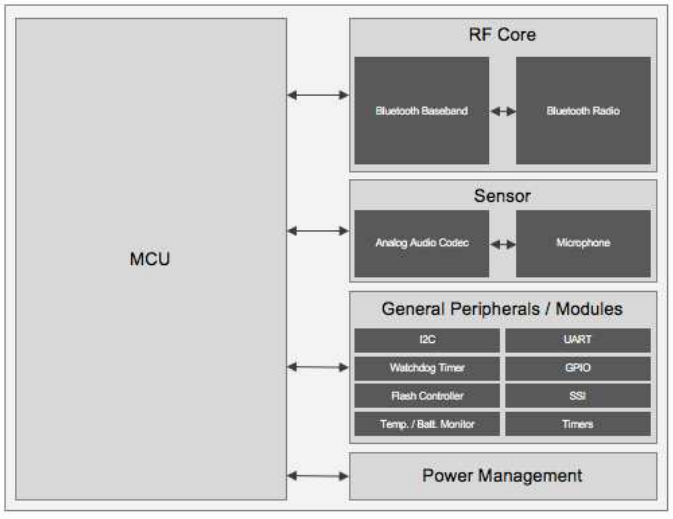


Figure 2. Typical Microcontroller-based IoT Device

The system comes with the necessary resources to perform multi-site test of various microcontroller-based IoT semiconductor devices. Common instrumentation resources include RF, digital, VI (DC Source Measure Units), switches, and more. Interactive software helps to ease test program development, accelerate tester bring up, and simplify the debugging process. Comprehensive measurement library provides a higher-level starting point for test program development with drag-and-drop options for common semiconductor actions, such as continuity tests, leakage tests, bursting a digital pattern, or testing RF capabilities for WiFi, Bluetooth LE, NB-IoT, and ZigBee.

For applications that require additional measurement capabilities, NI offers optional oscilloscope or arbitrary waveform generator resources, as well as dynamic signal acquisition resources to accurately measure the frequency content of signals with a very high dynamic range, such as sound and vibration measurements.

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 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.

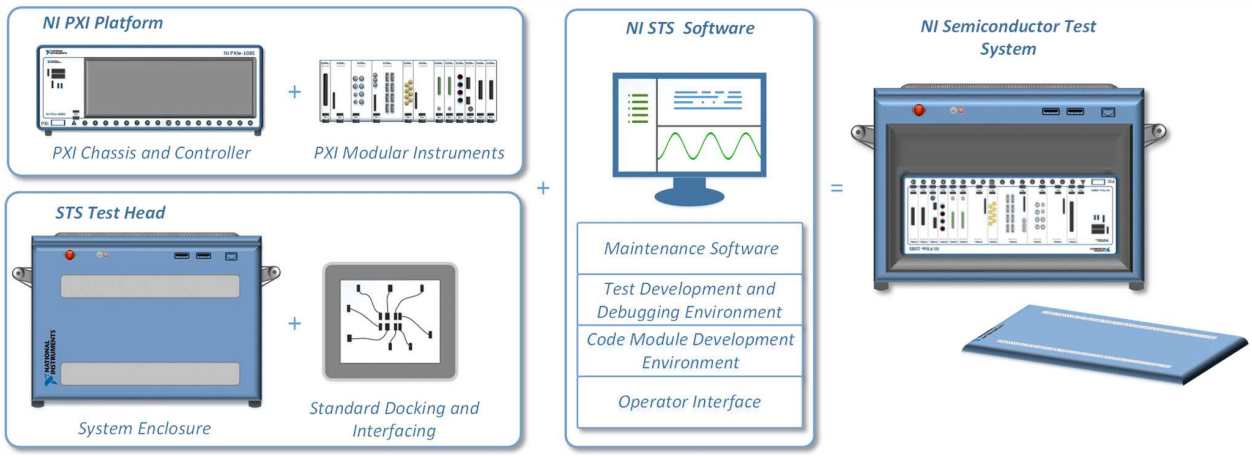


Figure 3. STS provides the excellent measurement coverage and quality expected from lab-grade PXI instruments in a production-ready form factor.

STS comes in three sizes—T1, T2, and T4—that accommodate one, two, and four 18-slot PXI chassis (4U, 19 in. rack space), respectively. All test systems support 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 has the potential to 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.

Typical STS Configurations

STS resources can be scaled up or down to meet application requirements, but here are three example STS configurations that can serve as a starting point for microcontroller-based IoT semiconductor devices with with communication standards such as Bluetooth LE, NB-IoT, WiFi, or ZigBee.

STS Size	Bidirectional RF Ports	Digital Channels	General VI Channels	High-Power VI Channels
T2	8	160	8	1
T4	16	320	16	1

Table 2. Example STS Reference Configuration Resources for IoT Devices

Standard Features

- Support for wireless connectivity standards such as Bluetooth LE, NB-IoT, WiFi, and ZigBee
- Drag-and-drop RF, DC, and digital semiconductor test measurement steps
- Calibration: RF to blind-mates, DC and Digital to spring probe interface
- Test Sequencer: NI TestStand with TestStand Semiconductor Module
- Code Development: LabVIEW 2018 and C#
- STS Debug and Maintenance Software
- Tester Software Version: 18.0
- PC Operating System: Windows 10, 64-bit

Optional Features

- Audio input and output channels
- High-frequency signal generation and capture channels

Test Head Features

- Zero footprint test head
- Manipulator interface kits for Reid Ashman, InTest, Esmo, Arktek, Asia Microhandling, and others
- 220 V power
- Fan cooled
- Standard spring pin layout

Typical STS configurations for production test of microcontroller-based IoT semiconductor devices include a mix of the following instrumentation resources:

Vector Signal Transceiver

The PXI Vector Signal Transceiver (VST) combines an RF and baseband vector signal analyzer and generator with a user-programmable FPGA and high-speed serial and parallel digital interfaces for real-time signal processing and control.

Figure 4. PXIe-5840 RF VST

Frequency Range	*375 MHz* to 6 GHz*
Maximum Bandwidth	*1 GHz*
Nominal Output Power	*+15 dBm**
5G NR System EVM	*0.32%*
802.11ax System EVM	*-50 dB*
Input/output Noise Density	*< -160 dBm/Hz*

**Specifications shown are STS system-level specifications, even though the PXI VST might have different specifications when used outside of STS*

Digital Pattern Instrument

The PXI Digital Pattern Instrument delivers ATE-class digital to the industry-standard PXI platform, combining the functionality of pin electronics hardware for digital interfacing and DC parametric measurements with digital timing flexibility by bursting digital patterns based on vectors with defined time sets and levels. PXI Digital Pattern Instruments include many more features that make it ideal for testing a broad range of RF and mixed-signal ICs, including RF power amplifiers and front-end modules.

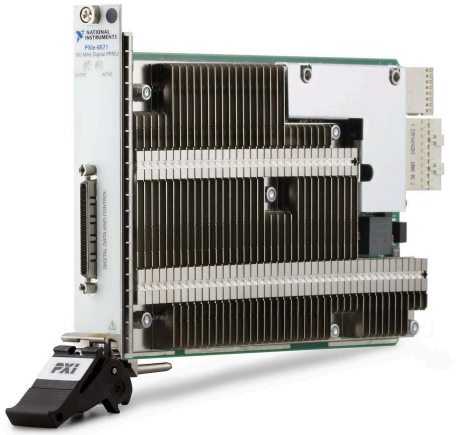


Figure 5. PXIe-6571 Digital Pattern Instrument

Number of Channels	*32**
Max Data Rate	*200 Mbps*
Max Clock Rate	*160 MHz***
Edge Placement Accuracy	*39.0625 ps*
Digital Voltage Range	*-2 to 6 V*
PPMU Measure Voltage Range	*-2 to 6 V*
PPMU Force Voltage Range	*-2 to 7 V*
PPMU Active Load	*16 mA*

**32 channels per module, up to 512 in a synchronized subsystem.*

***Clock rates above 133 MHz will have a non-50% duty cycle.*

Source Measure Unit (SMU)

NI SMUs combine high-precision source and measure capability with features designed to reduce test time and increase flexibility. These features include high channel density for building parallel SMU test

systems, deterministic hardware sequencing for minimizing software overhead, and high-speed update and sample rates for quickly changing setpoints and acquiring data.

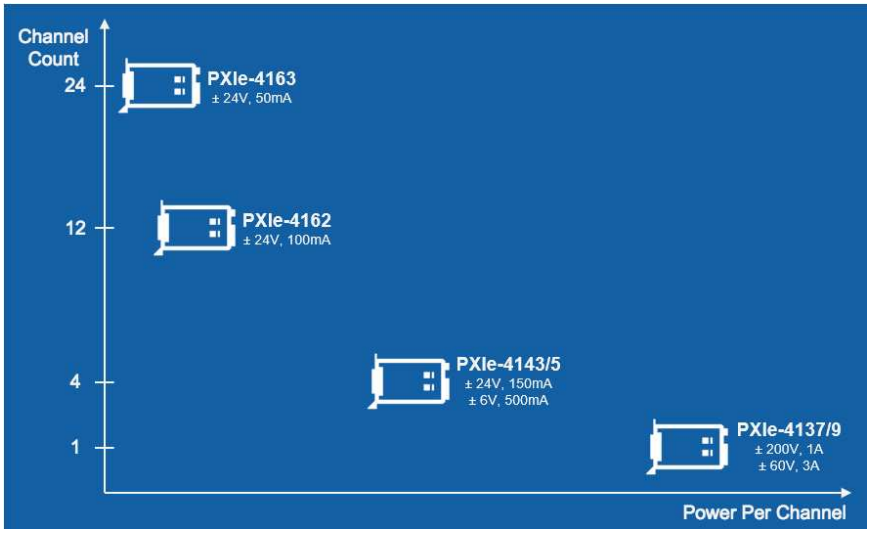
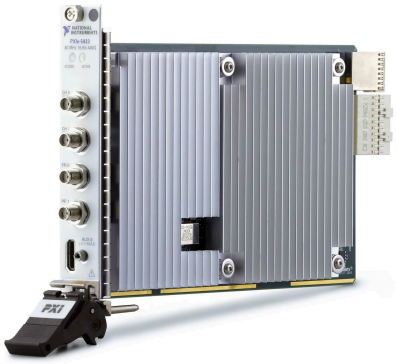


Figure 6. Channel Density Comparison of 1-slot SMU Resource Options

Waveform Generator

NI waveform generators produce precise waveforms, including sine, square, triangle, and ramp, as well as arbitrary, user-defined waveforms using sequences of data or streaming continuously from a host or peer-to-peer instrument within mixed-signal test systems. Synchronize waveform generator channels with other instruments at picosecond-level accuracy for high-channel-count and mixed-signal applications.

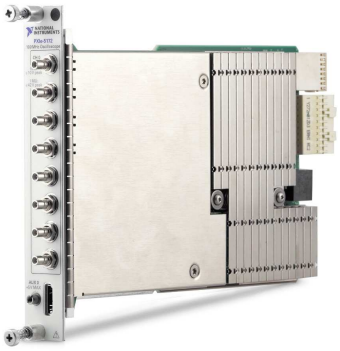


Number of Channels	*2*
Maximum Bandwidth	*80 MHz*
Maximum Update Rate	*800 MS/s*
Onboard Memory	*1 GB*
Resolution	*16-bit*
Voltage Range	*±6 V (50 Ω)* *±12 V (High-Z)*

Figure 6. PXIe-5433 Waveform Generator

Oscilloscope

NI oscilloscopes are flexible, software-defined instruments that are versatile enough for both time- and frequency-domain measurements, with numerous triggering modes and deep onboard memory. Additionally, you can synchronize oscilloscope channels with other instruments at picosecond-level accuracy for high-channel-count and mixed-signal applications.



Number of Channels	*8*
Maximum Bandwidth	*100 MHz*
Maximum Sample Rate	*250 MS/s*
Resolution	*14-bit*
Voltage Range	*±40 V*
Analog Input Impedance	*50 Ω, 1 MΩ*

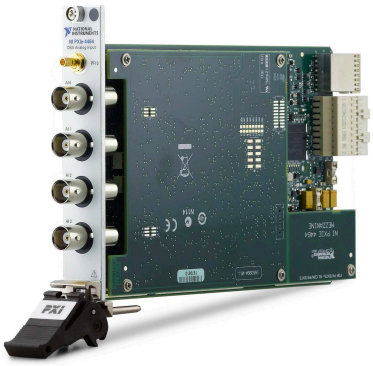
Figure 7. PXIe-5172 Oscilloscope

Sound and Vibration Instrumentation

NI Sound and Vibration instruments are designed specifically to accurately measure the frequency content of signals with a very high dynamic range, such as sound and vibration measurements. They provide software-configurable AC/DC coupling, antialiasing filters, and IEPE conditioning to ensure precision measurements with microphones, accelerometers, and other transducers with large dynamic ranges.

Number of Channels	*2*
Output Coupling	*DC*
Maximum Update Rate	*51.2 kS/s*
Resolution	*24-bit*
Voltage Range	*±10 V*

Figure 8. PXIe-4463 Sound and Vibration Output Module



Number of Channels	*4*
Input Coupling	*AC/DC*
Maximum Sample Rate	*204.8 kS/s*
Resolution	*24-bit*
Dynamic Range	*119 dB*
Voltage Range	*±42.4 V*

Figure 9. PXIe-4464 Sound and Vibration Acquisition Module

STS Software

NI offers a single, version-controlled STS Software Bundle, which provides all of the necessary pieces to efficiently develop, debug, deploy, and replicate testers. 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.

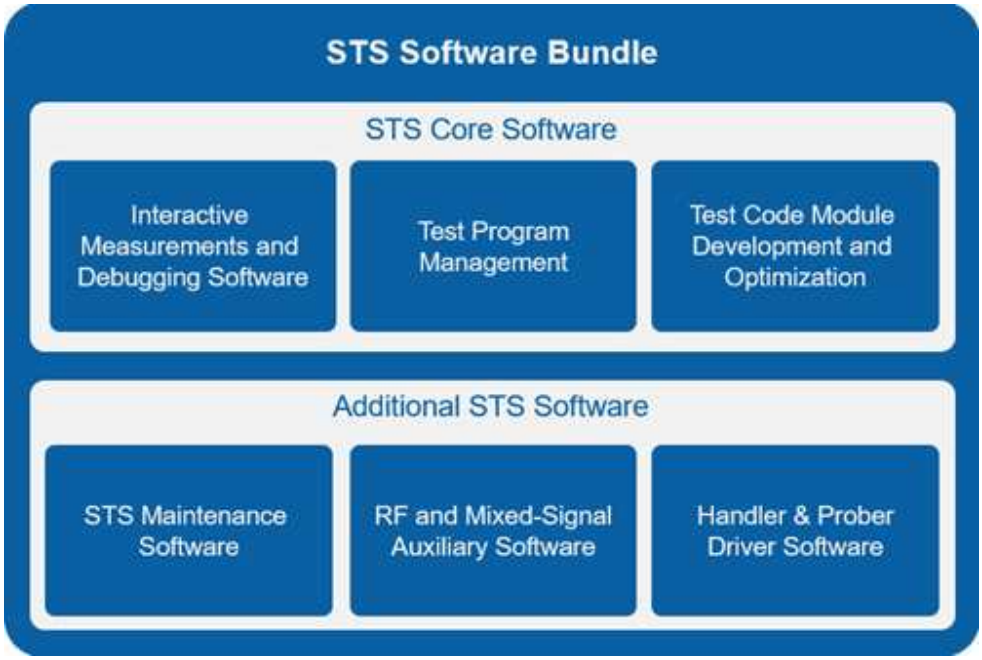


Figure 7. STS Software Bundle

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. InstrumentStudio allows you to take interactive measurements, export configurations to code, and monitor and debug automated test programs. Save project-level configurations for easier test repeatability with specific devices under test, or export instrument configurations to programming environments to simplify your test code modules and guarantee measurement correlation. You can also use InstrumentStudio in parallel to monitor and debug running test programs.

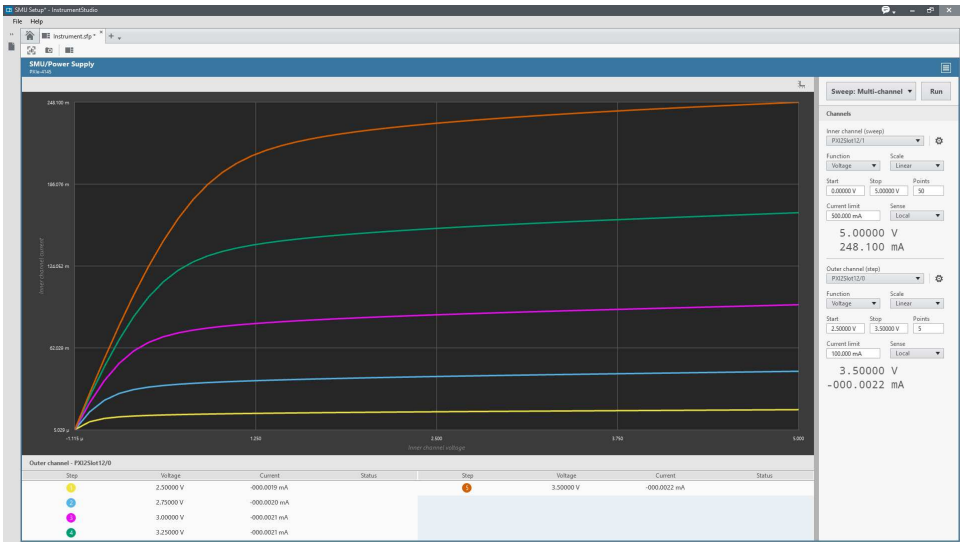


Figure 11. InstrumentStudio Interactive Software for STS Instrumentation Resources

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 time and increase 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.

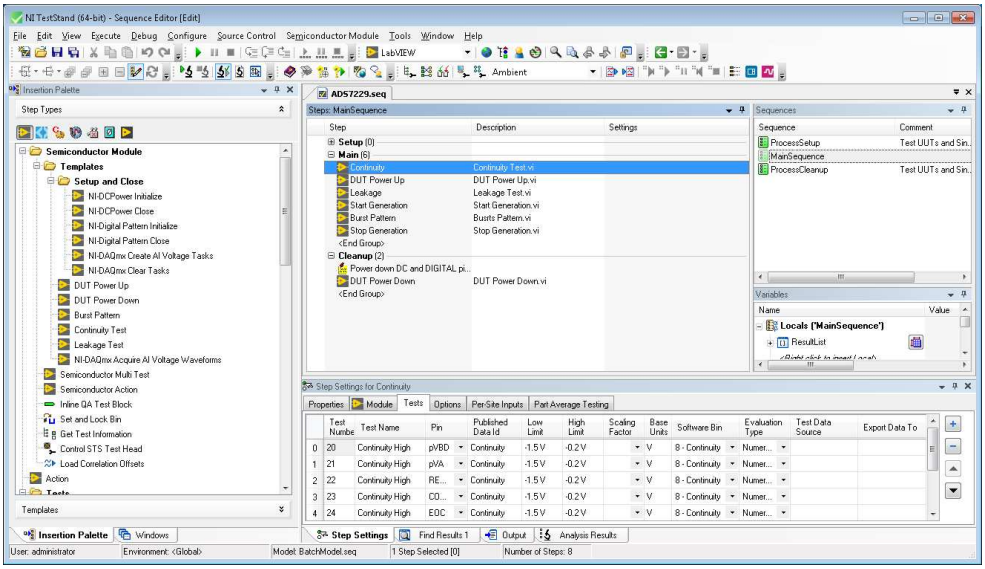


Figure 9. TestStand Industry-Standard Test Management Software

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.

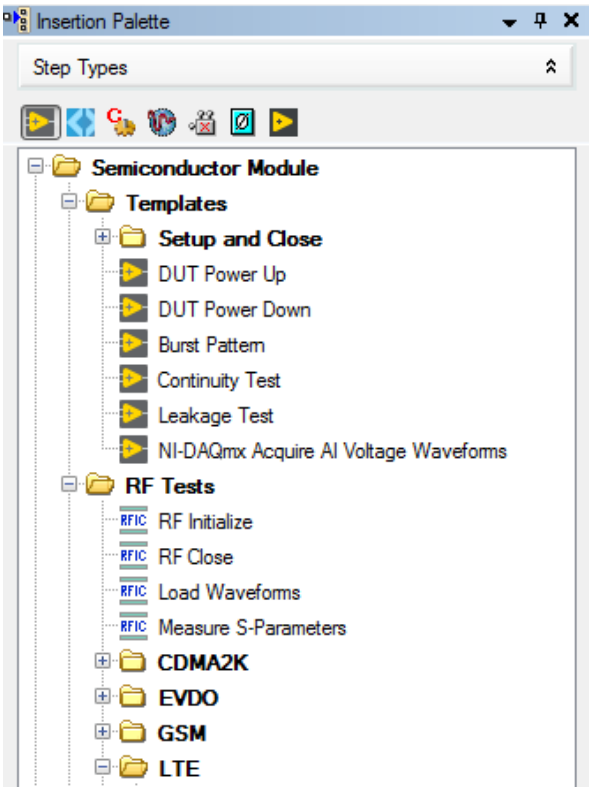


Figure 10. RFmx Step Templates for Common DC, Digital and Wireless Operations

Test Code Module Programming Languages

For writing new test code modules, or customizing existing ones, STS supports both LabVIEW and C#. 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 perform the high-performance RF generations and measurements you need with the extensive, user-friendly NI-RFmx library of RF measurement IP for wireless technologies ranging from Wi-Fi, Bluetooth LE, and NB-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.

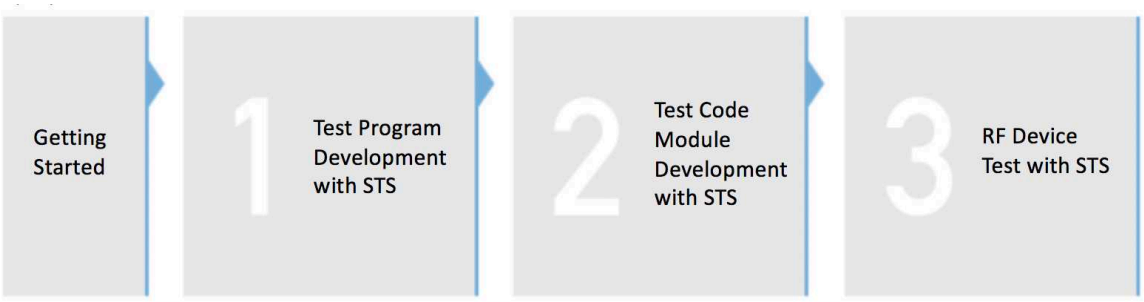


Figure 11. Reduce development time and costs through faster learning and increased productivity with NI customer education, a training and certification program designed to help you successfully develop applications.

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.

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.

3 January 2019