

Product Note

Agilent's TS-5550 Cellular Phone Functional Test Platform

A Flexible System
for Rapid Development
of Cellular Phone
Functional Test



Agilent Technologies
Innovating the HP Way

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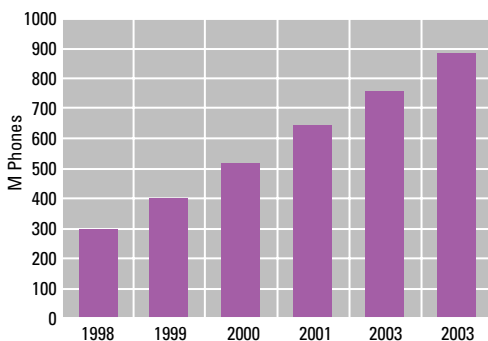
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Introduction

Industry Challenges

Cellular and PCS phone manufacturers work in a dynamic industry. Volumes are increasing at dramatic rates. New phones are being introduced every few months. As a result, the pressure to get products to market can be especially overwhelming. With scarce resources, including people and time, getting a new phone line up and running is a major challenge. With dramatic increases expected in cellular phone demand in the new millennium, cellular phone manufacturers like yourself may need to significantly increase capacity on an existing line. To obtain regional market access, many manufacturers are pursuing significant globalization by deploying production in key countries. Making all this happen so you can get your product to market on time is the key when determining success or failure.

Worldwide Cellular Subscriber Forecast



Manufacturing Goals

Your goal as a cellular phone manufacturer is to produce quality phones better than the competition. Sounds simple. However, in this fast-paced industry, many manufacturers simply can't increase volume or introduce new technologies quick enough. It's critical to get new test systems up and running in virtually no time. This reduces time-to-market and in a competitive, growing market that's your main goal.

Many manufacturers are building more flexible lines to accommodate the rapid introduction of new technologies and respond to increasing market demands. With next generation wireless technologies appearing, it's more important than ever to be flexible and look for ways to reduce risk. While many test engineering departments are struggling to build-in flexibility, their time is valuable and not always available.

Test Engineering Trade-offs

When a new cellular phone is being developed, a test system and production line must be built without delaying introduction. Consequently, test engineering is under tremendous deadline pressure to get the manufacturing test process set up on time. Test systems are a critical element of the process to guarantee production of quality phones. Reducing test development time can significantly impact time-to-market.

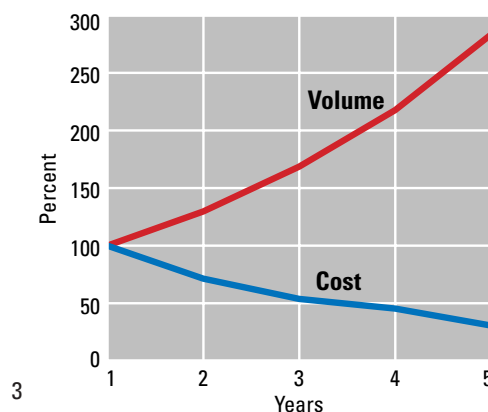
In the past, this was accomplished internally in the cellular phone manufacturing company, simply because the test equipment manufacturer offered little help, with the exception of providing quality measurements. Reducing test times has always been a key parameter in reducing test costs per phone. Once you significantly impact test times, you produce more phones with the same equipment, thereby reducing the test cost per phone. Test engineering departments will optimize tests and instrument I/O, eliminate tests, trade-off test coverage, use faster computers and instruments — even overlap tests in an effort to reduce test times. However, there's a trade-off in this effort. You're not only forced to sacrifice engineering resources to improve test systems, but the schedule on deploying new test systems must remain the same.

Agilent Technologies' Solution

Agilent Technologies' TS-5500 Family of Cellular Phone Functional Test Platforms helps manufacturers get their product to market faster, while lowering test times, decreasing floor space, and lowering total test costs.

The Agilent TS-5550 is the most flexible member of the TS-5500 family with many optional features for mobile phone testing. The TS-5500 family provides a universal test system core of both hardware and software, which can easily be modified to suit your particular test situation. Test system developers can customize the use of instruments and test routines to create a test stand for a specific manufacturing stage.

Cell Phone Manufacturing Pressures



TS-5550 Platform Overview

Measurement-Ready for Cellular Phone Testing

Cellular phone production lines require different types of testing at various stages. Testing cellular phones necessitates certain instruments for the specific tests and integration of this equipment into the manufacturing line. Agilent's TS-5550 features superior measurement equipment integrated with the software to get the job done. Turn-on tests of the cellular phone at board-level include: emulating the battery requirements, verifying the battery charger circuitry, testing the transmitter and receiver circuits and communicating with the mobile to set it up at particular channels or power levels. The TS-5550 features the latest Agilent power supplies, specifically designed for cellular phone battery emulation. Choose the appropriate Agilent modules of RF Test Sets for GSM, CDMA or TDMA radio measurements. The built-in RS-232 capabilities handle communicating with the mobile.

A phone calibration test stage typically involves calibration of the transmitter and receiver, since these are the main components determining the performance of the phone. Calibration can be accomplished with either a call set up or in an asynchronous mode where the mobile is set into a test mode. The TS-5550 not only includes the hardware for phone calibration, but also has software routines to make creating tests faster and easier.

At final test, a call is usually set up between the test set, which is emulating a base station, and the mobile. The tests done at this stage are normally parametric and will be defined by the GSM, CDMA or TDMA standards. To gather these RF measurements, the TS-5550 uses one Agilent RF Test Set for each phone. Today, the RF test set is a crucial part of the system, producing quality phones with the best throughput and lowest cost. Audio tests of the microphone, speaker and hands-free connections are done with the high speed and flexibility of the VXI DSP card. Connections for the audio source and measurement are multiplexed to each phone tested.

With the dramatic increase in high volume cellular phone manufacturing, computer-aided-testing is more valuable than ever. The TS-5550 uses a single PC for

controlling the instruments, running the tests and interfacing to automation equipment. A software test executive, GSM, CDMA or TDMA measurement routines, software utilities and an operator interface panel are also included. The MS Windows NT® operating system enables concurrent testing for the multiple-up systems.

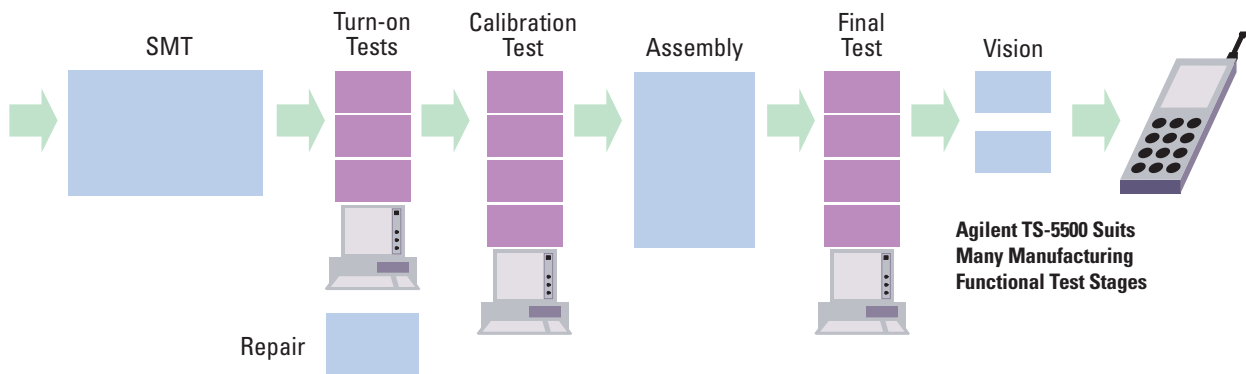
Testing CDMA phones requires the inclusion of signal generators for interference testing, a power meter for low level power measurements and a spectrum analyzer for out-of-band spurious and intermodulation measurements. To save equipment cost, one signal generator is shared between the Agilent 8924C RF test sets in multiple-up configurations.

Faster System Integration

Because Agilent standardizes the racking, cabling and mass interconnect, the functional system is totally integrated for quicker test development. It's a more comprehensive solution that eliminates steps in test development while lowering costs.

Instead of wasting valuable engineering time on one-of-a-kind integration by each project team, use the Agilent platform — an engineered system pre-built for rapid deployment. What's more, one TS-5550 can handle up to four phones with one rack of equipment, reducing integration costs versus building separate racks for each phone.

All of the low frequency resources for testing up to four phones with the TS-5550 are available through a mass interconnect test system interface panel. In addition, the pin configuration is documented allowing you to swap fixtures by changing the interface — all within a matter of minutes. As a result, tests can be designed and debugged using a simple fixturing system, while a more advanced fixture is being developed. Since the system interface is defined and documented, the fixture developer can design and build the fixture concurrent with the test system development, to save valuable development time. The TS-5550 includes interfaces, such as digital I/O and RS-232, for controlling and moni-



toring other devices. Printers and barcode readers are common peripherals at an operator station. And they're ready to be shared in a TS-5550 multiple-up system.

TS-5500 Software Increases Productivity

As a result of its hierarchical software development environment, the TS-5550 delivers maximum re-use. Software is further optimized for fast execution of each routine. This high quality, fully-tested software consists of both developer and test-execution environments. The test system developer uses the hierarchical environment for creating the test program. In addition, Agilent provides a test plan template for typical call processing and parametric tests on a GSM, CDMA or TDMA phone. It's a template that's easily modified to get a phone test up and running quickly.

Alternatively, you can easily build your own test plan from the software building blocks Agilent provides. The Agilent-supplied library of tests, measurements and utilities for GSM, CDMA or TDMA cellular test is fine-tuned for measurement performance.

Test operators view a panel created by the test developer, for conducting tests on specific phones. Agilent provides a sample operator interface that's easy to change or upgrade. Developers can also utilize Visual Basic® to quickly develop a custom operator interface.

Maximize Value with the Complete Product Offering

The TS-5550 is more than just hardware and software tools. It's a whole product including the following system solutions and services:

- System Documentation
- Application Consulting
- Customer Training
- Software Updates
- Cooperative Maintenance
- Extended Warranties
- Repair and Calibration
- Remote Support

This wide range of services lets you take advantage of the full value of the TS-5550.

Documenting a system can be difficult when test engineering's primary job is to keep production up and running. The TS-5550 provides complete documentation of its unique capabilities: cabling, mass interconnect, power distribution and software. You only need to worry about documenting and supporting your customization of the platform.

Agilent also offers system platform training to augment its extensive curriculum of education products. The Agilent team provides worldwide support on the hardware components and the unique platform features. What's more, cooperative support arrangements can be made for optimal uptime of test systems.

The TS-5550 platform needs to be completed to test a phone. For example, test plans, phone communication and fixture interface must be developed. And Agilent can help you get up to speed by providing services and integrated solutions.



Agilent's TS-5550 Platform Meets the Needs of Cellular Phone Manufacturers

Why Buy the TS-5550?

Depending on a manufacturer's production situation, there may be numerous reasons to adopt the platform concept. Take a look at some of the following reasons as they relate one of your upcoming projects.

1. Reduce Test Development Time

Because the TS-5550 is a pre-built system and represents the majority of a test system solution, it's never been easier to keep pace with demand. The software development productivity of the TS-5550 results from a hierarchical approach to test development that maximizes the reusable code in a structured process. The high quality software environment, tests, measurements and utilities are a direct result of intensive design and testing.

The unique platform approach also saves steps in developing the complete system. Because the TS-5550 has a pre-defined architecture, system design and planning steps are reduced. The system interconnections, cabling and racking are specific activities performed by Agilent, while test engineering focuses on interfacing the mass interconnect to the phone and other special requirements. In addition, Agilent provides software documentation, training and support.

2. Save Capital Costs

Sharing equipment and system integration while multiple phones are tested, coupled with standardized cabling and mass interconnect, saves capital costs. Running tests faster translates to less equipment and lower costs. The TS-5550 test platform features a specific instrumentation set that allows Agilent to optimize throughput by tuning the hardware and software for fast execution.

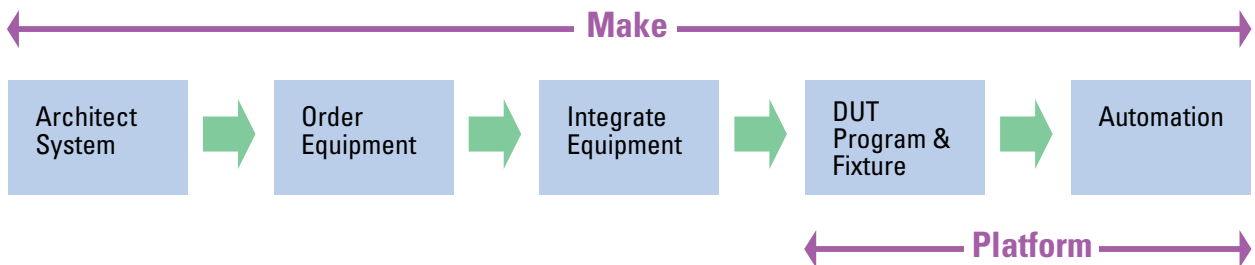
If you're a manufacturer with limited experience in mobile phone testing, you simply don't need to learn the

optimum methods for programming the instrument. With no special effort or time expended, you can use the Agilent software routines for the fastest test times. Since many tests involve communicating with the mobile, specific hardware such as buffered RS-232 has been developed to off-load the computer and speed test execution. This unique combination of multiple-up system architecture and faster test times will reduce your capital costs.

3. Flexibility

Many manufacturing facilities require flexibility to keep up with the dynamics in the cellular phone industry. New production lines are being deployed worldwide. Contract manufacturing is more available for complete phone production. Technologies are constantly changing along with demands for new phone models and features. Building multiple types of phones using diverse technologies with different features is becoming the norm. As manufacturing requirements change in this dynamic market, a flexible testing platform approach is better suited to meet your needs.

The TS-5550 is part of the TS-5500 family of test platforms built with a common architecture and a common core. Software and hardware for GSM, CDMA and TDMA testing is available, providing a common look-and-feel across production lines testing different technologies. The modularity of the system platform lets you add the functionality you need to test many different phones and control fixtures and automation equipment. The TS-5550 can also be configured to combine phone calibration and final test requirements into one multiple-up test stand. Or, tests can be moved easily from a calibration test stand to a final test stand to balance the line capacity. The TS-5500 family of platforms lets you choose either a simple approach to testing with the Agilent TS-5530 or a flexible approach with the TS-5550, depending on your specific test stage needs.



4. Worldwide Deployment

Many companies are operating in a global business environment. For test departments, this sets the stage for many complications, including setting up new production lines in other countries. Typically, production lines are duplicated and local people are trained to run the manufacturing process. However, there's often a heavy burden imposed on the central test engineering department to support the test stands. Any software changes or questions concerning operation eventually make their way back to the already overburdened engineer. Software and test systems may be difficult to troubleshoot and maintain, especially when test engineers have time and resource pressures. With the Agilent test platform approach, stable test results are readily achieved worldwide without logistical nightmares. The TS-5550 has a robust diagnostic fixture and test plan to verify if the system is functioning properly. Because the software, hardware and integration are standardized, Agilent can support the platform worldwide. Support for the integrated solution can be provided locally. A cooperative support arrangement between Agilent and the manufacturing site provides maximum uptime.

5. Built-in Growth Path

More often than not, test stands are created in a schedule-driven environment. It's difficult to take the time to design and create a system that can both be upgraded and leveraged for an extended period of time. Most systems are simply not upgraded. Instead, they're ignored as production matures on a particular model. The goal of Agilent is to upgrade the TS-5500 family annually to keep systems up to date. If the hardware resources are available, test plans written on the TS-5550 platform will run without change on the TS-5530 platform. Using the TS-5530 platform in a simple two-up test stage could save you money because it has limited feature set, measurement capability and automation controls.

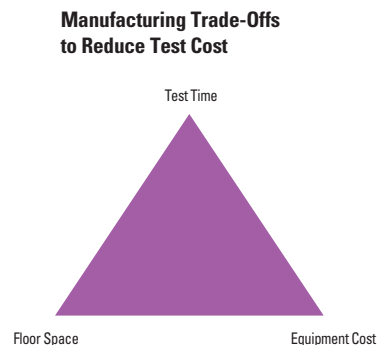
This built-in upgrade path not only preserves your initial investment, it offers the flexibility to grow to a multi-up tester and/or add the latest instruments and computers. In other words, you can get started with the TS-5530 configuration that meets your needs, then upgrade the configuration as production volumes increase. And the results? Longer useful life of test systems as well as a reduction in start-up risks.

6. Reduce Your Total Test Cost

Test cost is only one factor in reducing the total cost of manufacturing a phone; however, it's a tangible cost that can be reduced by test engineering. To reduce test costs, test engineers focus on reducing test times, equipment costs and floor space. The TS-5550 delivers reduced integration costs, floor space, and potentially, test times.

Many cell phone manufacturers are moving towards "multi-up" or multiple phones tested per stand to reduce integration costs and floor space. This is often extremely difficult to create in an asynchronous, simultaneous test environment. Yet, the Agilent platform features this capability, making it easy to configure a multiple-up test stand.

If your factory has limited room for more equipment or new lines, the Agilent platform for testing multiple phones is a real space-saver! Using a four-up system, phones can be tested in one-fourth the floor space. Most electronics manufacturers believe their biggest test costs are tied directly to the instrumentation hardware. However, hidden costs of software engineering time, operating costs and maintenance expenses must also be considered in the cost of test. Operation costs include management, facilities and skilled personnel needed to run the test systems. With a standard platform of hardware and software, support and training costs are lower than that of a one-of-a-kind system.



TS-5550 Platform Capabilities

The TS-5550 provides an integrated platform of hardware and software capabilities so you can implement and maintain your production line. Each feature of the TS-5550 was intended to perform a specific job in the testing process. The following capabilities are covered in more detail:

- Phone Tests and RF Path Support
- Audio Tests
- Battery Emulation and Charging Circuitry
- Low Frequency Measurements
- Communicating to the Phone
- Test Development
- Operator Interface
- Interface to Fixture, Factory and Database
- Maintenance and Support

With standard systems, Agilent optimizes the measurements and tunes the performance to suit the application. For explanation purposes, the following sections review the key capabilities of the TS-5550. However, it's important to recognize that the complete system, rather than individual components, provide the features and benefits mentioned previously.

Phone Tests and RF Path Support

RF Measurements

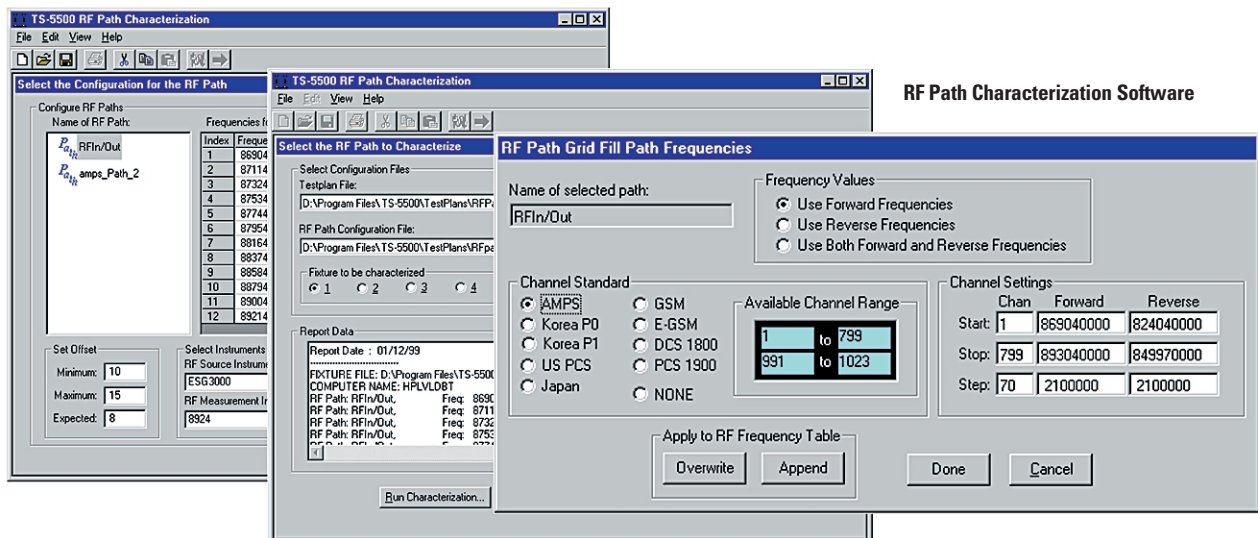
The Agilent RF Test Sets make the crucial measurements. When testing GSM, CDMA and TDMA phones, these instruments provide all of the RF measurement capabilities, phone call initiation and protocol handling. The Agilent 8924C, coupled with its associated options, is used for CDMA and PCS phones. Based on the 8924C,

you can also test the analog cellular mode of CDMA phones, including JTACS/NTACS and AMPS/NAMPS formats. The Agilent 8922M is the GSM test solution and the Agilent 8922P or 8960 is the GSM900, DCS1800 and PCS1900 solution, including dual-band hand-over capability. For the highest throughput in testing GSM phones use the Agilent 8960. The Agilent 8920B or 8960 Test Set is used in TDMA, IS-136 and cellular tests. One test set is dedicated to each phone tested in the system. In addition to making accurate and repeatable measurements for the production of quality phones, the RF instrumentation maximizes production throughput while minimizing the cost per test.

RF Path Characterization

In order to make accurate power measurements with the test sets it's important to understand the RF performance of any cabling and fixturing between the test set and the mobile. Characterization of the RF path runs automatically, using the RF calibration tables in the TS-5550. For measuring RF path loss and loading data into the calibration tables, developers can use the example test plans that support Agilent signal generators and power meters. Documentation describing how to characterize an RF path is included.

Agilent can create a custom RF interface of switches, directional couplers and isolators for routing a high quality RF signal between the instruments and the phone. A custom RF interface combined with the TS-5550 RF Path Characterization software and extra RF instrumentation lets you extend the RF Test Set's measurement capability.



Audio Measurements

Users of cellular phones are becoming more discriminating than ever concerning voice quality. As a result, testing of the speaker, microphone and audio circuits is growing more important.

Today, manufacturers generate single audio tones with the RF test set, audio analyzers and/or other instrumentation. This signal is applied to the microphone, with RMS voltage measured at the speaker or decoded from the phone's transmitted RF signal. This type of testing offers an effective functionality check, but may take considerably longer if a more comprehensive test of the audio circuits is performed, e.g. multiple frequencies and different voltage levels.

In contrast, the TS-5550 employs the Agilent E1432A DSP for comprehensive, efficient audio testing. The E1432A is a 16-channel, 20 kHz bandwidth C-size VXI module that includes transducer signal conditioning and alias protection to perform FFT's and averaging on the input signals. Software is provided to measure frequency response, compressor/expander response, distortion, and other measurements specified in IS-98 for analog phones and GSM11.10 for GSM phones. What's more, it contains a function generator that can be programmed for sine, noise or arbitrary waveforms. Since the E1432A measures all frequencies at once with an FFT, the traditional single tone tests can be replaced with multiple tone within the same time constraints. Plus, distortion measurements can easily be performed if needed. Add to that the fact that this audio measurement capability is a shared system resource, and the benefits continue to grow. Only one E1432A is needed for testing up to four phones!

Multiple channels of audio multiplexing are provided in the Agilent TS-5550 test system interface for both the source and the measurement. This allows switching between acoustic measurements of the microphone, speaker, and ringer, in addition to electrical measurements of the accessory connector.

Battery Emulation

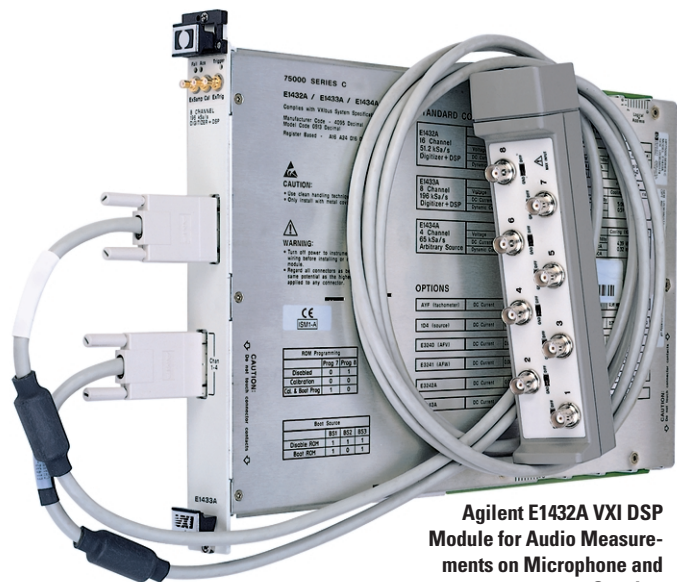
The TS-5550 offers a choice of phone power supplies that emulate a cellular phone battery. The Agilent 66300 Series of power supplies is ideal for testing battery-powered devices such as cellular phones. The power supply not only provides the dc power for testing the device, but also performs the peak current measurements required to characterize the pulsed current

demands of battery powered devices. These power sources not only provide the power for testing the device, but also perform the peak current measurements required to characterize the pulsed current demands of battery powered devices. Since battery life is of utmost importance, the Agilent power supplies offer 0.1% + 2.5 μ A measurement accuracy.

These dynamic dc sources solve three challenges facing digital cellular phone manufacturers. First, many digital wireless telecommunications products transmit in short bursts to conserve power between transmissions, thereby improving battery-operating time. As a result, current is drawn from the battery in pulses causing voltage drop-out on typical supplies. These current pulses are digitized by the Agilent power supply. Utilizing the Agilent power supply, transmit, standby and off-current waveforms can be sampled every 15.6 microseconds.

Second, lower phone operating voltages provide more efficient circuitry and smaller batteries. However, since transmit power remains the same, currents increase with the lower voltage. The Agilent 66311B supplies 5 A peak and 40 watts to each phone. That's another reason why Agilent power supply outputs are optimized for cellular phone requirements.

And finally, high volume manufacturing dictates that the programmable power source is located several meters from the fixture. The path from the source to the phone may have significant resistance and inductance. The 66300 Series tackles each of these challenges with ease, providing the proper voltage/current ratings, local sensing to maintain the proper voltage and transient response — all in one small package at one low cost.



**Agilent E1432A VXI DSP
Module for Audio Measure-
ments on Microphone and
Speaker**

Battery Charging Circuitry

To verify operation of the phone battery charging circuitry, the TS-5550 offers an optional Agilent 6612B/C Power Supply. This 40 watt dc power supply maintains a constant voltage supply that provides programmable current down to the microamp level. That makes it the perfect source for production test application because of its high-speed programming with under 4 millisecond response time.

Low Frequency Measurements

The Digital Multimeter (DMM), frequency counter, audio signal source and audio digital signal processor (DSP) in the TS-5500 provides all dc and low frequency measurements.

The Agilent E1412A is a 6.5 digit VXI DMM for basic measurements made on cellular phones. For instance, at board level tests, it provides probes for basic functionality including continuity and power. The E1412A is a C-size VXI module delivering high accuracy and wide functionality. This DMM can measure AC/DC volts, amps, 2- and 4-wire ohms and frequency/period. A 16-channel multiplexer connects it to the Agilent test system interface.

The Agilent E1420B High Performance Universal Counter is a C-size VXI module providing a full set of traditional universal counter measurements (frequency, period, time interval, totalize and ratio), plus the automatic measurements of rise/fall time, pulse width and phase. It features a 200 MHz frequency range, optional 2.5 GHz channel and 2 nS time interval resolution for accurate measurements of clocks and bus signals. Of course, that makes it ideal for automated applications due to its high speed measurement set-ups, measurements and output of results.

Communicating with the Phone

Built-in Serial Ports

The TS-5550 has RS-232 ports for each phone tested accessible from the test system interface panel. The Agilent TS-5550 Phone Communication Assistant lets you easily create the software needed to communicate with the phone via RS-232.

Developing phone communication software is usually the bulk of the software customization task. Communication over an RS-232 interface can be as simple as Tx/Rx/Ground or it can become complicated with some form of encryption. Phone communications is unique for each manufacturer, and in some cases, even for each phone model. Phone communication is required to command the phone, when it's not on a call. For example, you can change power level, change channel or internally route audio signals. Also, you must communicate with the phone to access registers and perhaps send information to the phone, e.g. calibration of the power levels.

Phone Communications Assistant

TS-5500 family phone communication requires writing actions in Visual C++ and linking them into the test executive. Creating actions requires specific software programming skills, as well as time to code and debug.

The Phone Communication Assistant is a graphical user interface that generates the appropriate test executive and action files normally created by compiling and linking C++ code. The Agilent test executive software and/or the Developer Studio are not required to create this communication software. Because only one environment is needed for development, test development times are lower, with reduced learning and changing between environments.

Once you know the specifications of the serial interface, the Phone Communications Assistant prompts you to describe the type of serial communication. If you're testing a GSM phone, the Communications Assistant will automatically generate some information, but more detailed information still needs to be supplied. This default GSM information, which conforms to the EMMI specification in GSM 11.10 can easily be changed, giving you complete control when desired. The Communications Assistant will generate and compile code that produces a library and necessary support files.

With a self-contained "test harness," the Communications Assistant lets you confirm the functionality of the software without having the entire suite of instruments. You can select the action, specify the parameter values and view what would be produced on the serial interface as a bit stream.

System Software Reduces Development Time

The TS-5550 software provides a complete test development and test execution environment for the entire software development job. Each test stand supports one controller, running software that controls up to four sets of hardware for testing up to four phones simultaneously. The test executive environment is tuned for functional testing of electronic devices in manufacturing. The software runs on a PC with Windows NT 4.0 for optimum performance. Plus, it's all pre-installed and ready to use.

The Agilent TS-5550 Software Development Environment is ideal for test development of cellular phones. It consists of re-useable tests, measurements and utilities for performing specific functions related to GSM and CDMA phone testing. Templates and examples are provided to serve as a starting point for creating tests. The Agilent test executive allows you to organize and order tests, reconfigure the test stand, profile the execution speed and debug tests. The TS-5550 software test execution environment allows an operator to test up to four phones simultaneously and report test information back to the operator. Using the software utilities, the test executive can be easily linked with factory automation, bar code readers and printers.

Agilent TS-5550 Software Development Environment

This hierarchical test development encourages reuse, to decrease development time on upcoming projects. The TS-5550 software provides an efficient and effective structure for developing the test plans and sequencing for functional test of cellular phones. In fact, many measurements, tests and utilities needed are already provided as building blocks. These routines are of the highest Agilent quality and provide maximum performance. A test engineering software team need only create the test plan and sequencing from these integral building blocks of software, add customization for the phone communications and create any custom test and/or measurements. Once a good pass at a test plan and sequence has been accomplished, debug tools and a speed profiler are included to optimize it.

Tests, Measurements and Utilities

Agilent has created tests, measurements and utilities for making measurements and controlling and configuring system components common in cellular phone test systems. The TS-5550 software provides a test plan containing a number of GSM, CDMA and TDMA phone tests. It contains tests, sample limits, looping constructs and variables, providing an excellent point to start building a final test plan for your phone. More than 300 measurements and utilities are provided for use in calibration and final testing of GSM, CDMA or TDMA phones.

Phone Communications Assistant Software

GSM, CDMA and TDMA Phone Test Plan Templates

Name	Value
ZDMA Test Set	RF Test Set
System Type	DCCH System
Protocol Type	Cellular

The C-utilities are used in creating custom phone calibration actions or routines due to the proprietary nature of phone calibration techniques. In addition to the standard action routines Agilent provides more than 1000 reusable C-utilities as dll's for use in building user specifications. In order to characterize the RF path, Agilent provides sample test plans, software routines and utilities. Besides radio test software, Agilent also includes routines for audio and power supplies. All software routines are optimized to work in the multiple-up environment quickly and efficiently. Furthermore, the Agilent software frees developers from the details of I/O languages, instrument languages and driver-level nuances.

Agilent TS-5500 Action Assistant

Even though the TS-5500 software has numerous functions and capabilities, it just isn't possible to create all the actions for each unique mobile phone testing situation. Creating such an action to be used in the test executive is easy when you take advantage of the Agilent TS-5500 Action Assistant.

To create an action, you should be familiar with Microsoft Developer Studio to generate and maintain projects compatible with TS-5500 test executive software. You should also recognize which instruments and hardware require which source files and libraries, in addition to understanding the alliances between actions, topology and test plan files. Debugging a complex action that did not function as expected on its first execution can be a time-consuming task.

The Agilent TS-5500 Action Assistant makes creating and debugging actions easier than writing an action from scratch. And that can save invaluable test development time. It provides a simple, wizard-style interface for generating and maintaining your new action projects. The Action Assistant appears as a toolbar button

in Microsoft Developer Studio, so you can call it up any time during development. Changes will immediately appear in the project.

The Action Assistant takes the drudgery out of creating an action using the following steps:

1. Creating a new project

Stock projects are easily created compliant with Agilent TS-5500 Action standards.

2. Adding an action to a project

You can add and modify actions in projects, while simultaneously updating the action definition and the source code. The Action Assistant features a simple point and click interface for describing the parameters in an action, and editing these parameters as the action is developed.

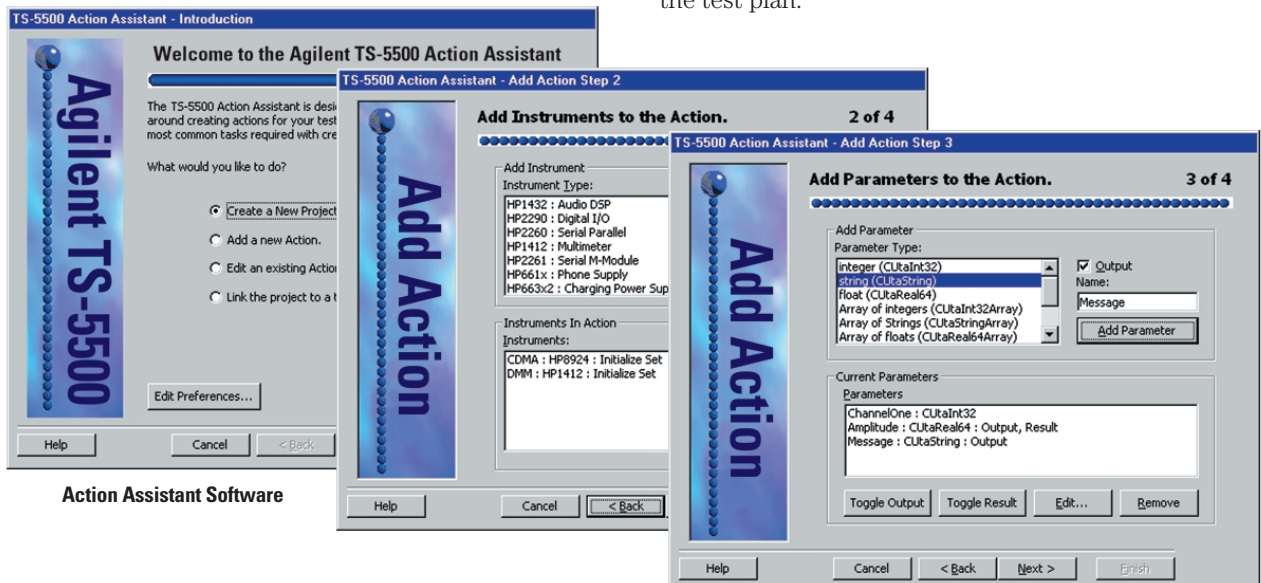
The Action Assistant also recognizes the dependencies of all the instruments in the TS-5500 system, allowing you to specify which instruments the action will utilize. You can describe new instruments, which will be added to the list of available instruments.

3. Editing an existing action

When debugging or enhancing the functionality of an action, you can easily edit the actions you create using the Action Assistant.

4. Linking the project to Agilent TS-5500 test executive software

During this step, Action Assistant compiles the action and creates the appropriate files so the new action can be used in a test plan. Action Assistant helps test plans find the proper files to use these new user-created actions and helps prevent common mistakes when linking these actions to TS-5500 test executive software. New actions will appear as a selection in the action editor for easy point-and-click retrieval by the test plans. Action Assistant also provides an easy way to debug an action while running the test plan.



Action Assistant Software

Agilent TS-5550 Test Execution Environment

The Agilent test execution environment lets an operator test up to four phones simultaneously, then report test information. The heart of the test execution is the TS-5550 operator interface. Designed for cellular phone testing, this template allows the operator to start and stop tests, while monitoring progress as testing occurs. It also handles operator log-in, loading the test plan and simple operator intervention controls. A test report, including parametric data, can be positioned on the screen or sent to a printer. In most production environments, the operator interface should be tailored to individual needs. Factory automation utilities are provided to control equipment such as barcode readers for recording serial numbers and strip printers for printing test results. This custom operator interface, including keypads, touch screen, operator prompts, special screen colors and layout, is developed with Visual Basic methods, properties and events.

Interface to Fixture, Factory and Database

Besides the measurements, battery power, and communication with the phone, the test stand must be interfaced to the fixture and factory environment.

Mass Interconnect

Agilent's TS-5550 Test System Interface is a common, standardized mass interconnection panel for the test fixtures, as well as system resources. While it is designed for up to four UUT's on the multiple-up testers, the test system interface is used on all configurations. A mass interconnection provides lower integration costs and fixturing costs. All the system's non-RF resources come together at the test system interface.

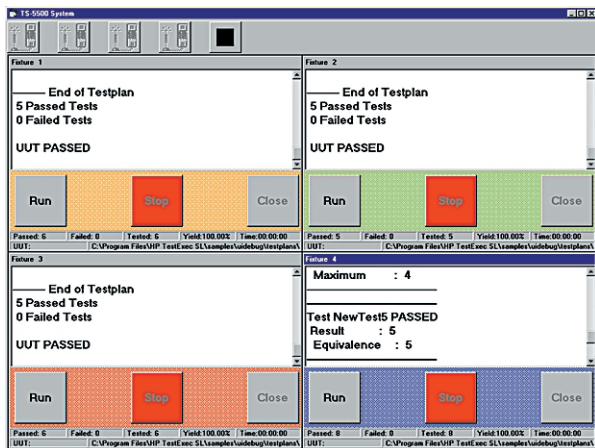
However, you only need to connect the resources/instrumentation required for that particular test or device under test. The TS-5550 Test System Interface includes connectors and cables for the following TS-5550 system resources:

- Audio DSP and Multiplexing
- Digital Multimeter and Multiplexing
- Digital I/O
- General Purpose Switching, Multiplexers, and Matrices
- RS-232 and Parallel Interfaces for Phone Communication and Peripheral Control
- Battery Emulation/Current Measurement
- Charging Power Supply
- Utility Power Supplies
- Monitor, Keyboard and Mouse Connections

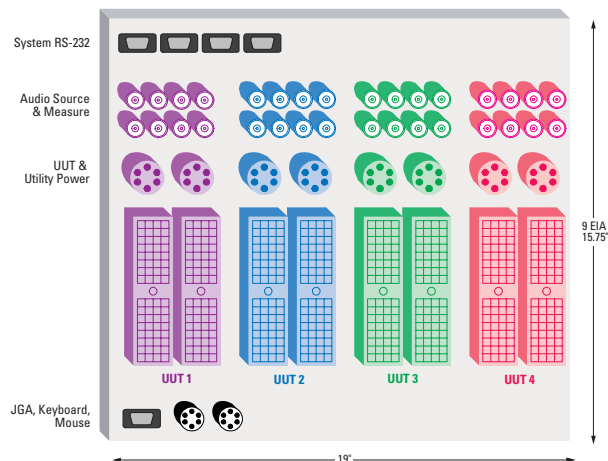
RF connections should be routed directly to the RF equipment or a custom RF interface.

For each UUT, the TS-5550 provides RS-232 channels for phone communication and firmware download. In addition there are four RS-232 channels for system resources that could include strip printers, barcode readers and simple automation control.

Via the TS-5550 Test System Interface, utility power supplies are available for fixture and factory automation power. Utility power is a dc power supply with one to four outputs. Output voltages are user-defined with up to four 60-120 watt modules. Each output can be independently turned on/off, paralleled, remote-sensed and voltage adjusted. These power supplies provide +3.3 Vdc at 25 A, +5 Vdc at 20 A, +12 Vdc at 9 A and +24 Vdc at 5 A.



Four-up Operator Interface Shares Log-in, Barcode Reader and Printer



Agilent TS-5550 Mass Interconnect

Flexible I/O

The I/O Subsystem includes the switching, phone communications and fixture control functions in the VXI M-module format. These M-modules are ideal for the multiple functions needed in testing cellular phones. Because M-modules provide needed user functionality in smaller increments, test costs are reduced. M-modules are an open-industry standard that debuted as computer interface products.

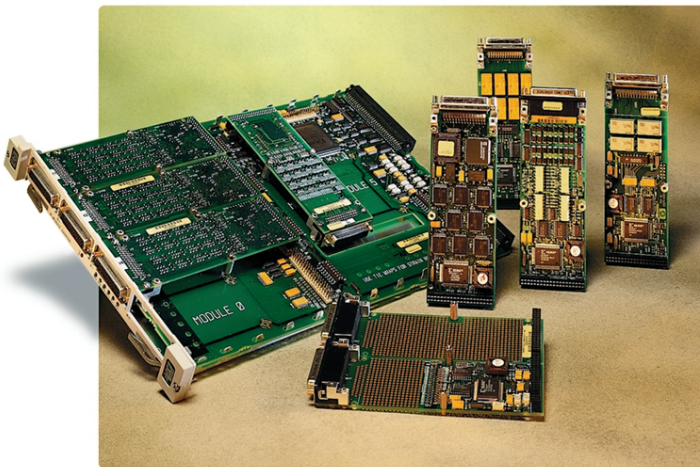
The compact C-size Carrier occupies a single VXI slot and holds up to five M-modules. Each M-module is programmed as a separate device. Any of the following M-modules can be added to the carrier:

- Dual RS-232 and Parallel Interface M-module
- Quad RS-232 M-module
- Digital I/O M-module
- Multiplexer Switching M-module
- Matrix Switching M-module
- General Purpose Switching M-module

Dual RS-232 and Parallel Interface M-module

- Two buffered RS-232 channels for phone communication and automation control
- One buffered bi-directional Centronics parallel port

The Agilent E2260A is used to program individual cellular phones over RS-232 or other phone interface devices with the parallel port. Input and output buffering reduces communication overhead and lowers test time.



VXI M-Module Functionality in Small Increments for Reduced Test Cost

Quad RS-232 M-module

Built-in data handshaking and internal 2 kB data buffers per channel reduce communication overhead for lower test times. These shared-system RS-232 resources are used to drive strip printers, bar code readers and other serial devices.

Digital I/O M-module

- 16 data/actuator lines for independent inputs or outputs
- Open collector outputs: 30 V max

The Digital I/O M-module is used for versatile digital sensing, control of devices and special purpose circuitry within a system. The 16 data lines can be TTL compatible I/O, or TTL compatible inputs and open collector outputs up to 30 V. Each I/O line provides switchable current sinks for actuation of external devices, including high voltage/current relays, switches, high frequency coax relays, microwave and RF switches and programmable attenuators. One bit of the digital I/O in the TS-5500 system drives the relay to control the charger power supply.

Multiplexer Switching M-module

- Dual 8x1 two-wire or single 16x1 two-wire (DPST)

This multiplexer has 16 DPST latching relays organized as two separate 8-to-1 banks. They can also be easily configured as a two-wire 16-to-1 multiplexer. In the standard configuration of the TS-5500, one Agilent E2272A is used to switch the DMM inputs and another is used to multiplex the audio output of the Agilent E1432A DSP.

Matrix Switching M-module

These 16 DPST relays are configured as a 4x4 two-wire signal switching matrix for connecting a group of instruments to several points on a device under test. Flexible switching systems can be developed with multiplexers and general purpose relays connected to matrix switching.

General Purpose Switching M-module

These 16 SPST relays are for general purpose signal switching and control of external devices.

Data Logging and Reporting

The TS-5500 test software logs test results to a file on the PC. For each unit, data such as UUT identity, time, date, test results and test limits are stored in the file. In addition, the operator user has easy access to the data log records. Now, you have flexibility in how you can use the test results.

Typical formats for the TS-5500 data log file are comma-delimited for spreadsheets or Agilent 3070 board test format. The data log output format is specified in the data logging editor. A custom program should be created to move this data to a factory computer or database. Typically this factory-wide database is used for analysis by production or R&D. Factory-wide quality control analysis may also be performed on this data.

The operator user interface can also be programmed to forward the test results file to the factory database. Or, the operator user interface can parse and report the data log records using the XML format and an ActiveX control. Since XML is an extended form of HTML, XML data log records can be read by Internet browsers and other commercial software packages.

Maintenance and Support

System Verification

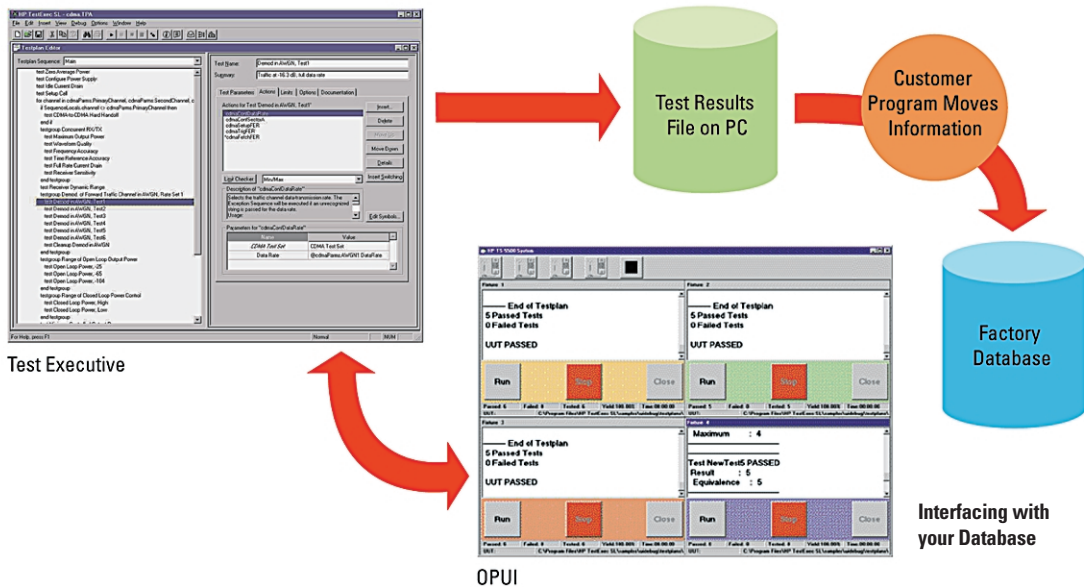
With the addition of special hardware connections to the Agilent Test System Interface and test plan software, operation of the TS-5550 can easily be verified. This verification provides a rough check of the various subsystems at the mass interconnect in the TS-5550. System verification is the starting point of diagnosing potential system failures.

System Engineering

This test stand has been engineered and tested for thermal, RFI/EMI, shake/shock and vibration issues, so you can save time. Safety and grounding considerations are built right into the overall system, cabling and power distribution. The system is CE certified and Year 2000 compliant. System mains power can be configured for worldwide applications.

Support

In a manufacturing environment, maximum system uptime is a key concern. The whole product offering of the TS-5550 insures service and support are part of the product, not an afterthought.



Creating a Complete System

Building test stands from the TS-5550 has never been easier. Simply configure the TS-5500 system from the list of options, then plan the activities to finish the system's deployment.

1. Configure the TS-5550 with a simple menu of choices
2. Plan the Customization

To complete the system, the TS-5550 must be customized to a particular application. Finishing the system can be provided by a manufacturer's test engineering group, Agilent's custom service team or a third party. Customizing the TS-5550 may include some or all of the following activities:

- Project management
- Customer-specific Test Development
- Phone Fixturing and Interface
- Requirements for Special Equipment
- Customizing the Operator Interface
- Database Software Interface

TS-5550 Configuration and Ordering Structure

Configuring and ordering the appropriate models and options for the TS-5550 starts with understanding the test requirements. In addition, you will need to plan the customization of the platform. Since configuring a TS-5500 requires detailed knowledge of both the test system and the mobile phone, you must work closely with Agilent's system engineers to develop a final configuration.

To configure the TS-5550 you should be planning at least these items:

1. Test Plan and Test Stage

You need to plan and identify the tests that need to be performed at the specific test stage and the requirements of the system to make these tests

2. Customization Activities

Since you build a complete system from the TS-5550 platform, customization planning becomes an important step in configuration. For example, you need to consider interfacing to fixtures and automation, completing the test plan, operator interface and serial phone communication software before selecting the appropriate options.

3. Line/System Installation and Support

Any system that is installed into the manufacturing line needs planning for the installation and support. When you configure the TS-5550, you need to consider supplying main ac power, system up-time support, application support and training.

Some key decisions to configure an TS-5550 system are:

- Number of phones tested per system
- Choose Rack Size
- Specify PC Monitor (17-inch monitor included in base system price)
- Specify Radio Format: GSM/Agilent 8922, GSM/Agilent 8960, CDMA/Agilent 8924, or TDMA/Agilent 8920
- Add RF Test Sets: one per phone tested
- Choose type of Utility Power
- Choose system "main" power
- Select phone power supplies
- Select any low frequency VXI instruments and modules
- Specify any other options: Developer Software, Operator Peripherals, Training and Support

Agilent TS-5550 Ordering Structure

The following list of products and options is provided as an introduction to the TS-5550 configuration. This is not a complete list of options available. You should work with Agilent's engineers to configure a system to meet your needs.

Base Systems: Two-up, Three-up, or Four-up

Product #	Option #	Description
E8452A (Two-up)		TS-5550 Base Systems
E8453A (Three-up)		for Multiple-up Mobile
E8454A (Four-up)		Phone Testing, contain:
		<ul style="list-style-type: none"> • HP Vectra PC with hard disk, RAM, CD ROM 3 1/2-inch floppy, Windows NT 4.0, LAN card, Firewire Interface • Agilent C-size VXI Chassis and shared DMM • TS-5550 Test System Interface • Phone Power Supply (two in TS-5552, three in TS-5553, four in TS-5554) • Test Executive Software • Choice of 1.6 m or 2.0 m Rack • 17-inch Monitor (must select E2181A/Option 051) • VXI M-modules per phone: RS-232/Centronics, 16-bit DIO • System Resources: Quad RS-232 • Systems Integration of all options and standard instruments • Power Distribution Unit to power instruments and fans
030		1.6 m Rack (only available for two-up system)
031		2.0 m Rack
210		RS-232/Centronics M-Module
211		Quad RS-232 M-Module
215		16-channel GP Relay M-Module
216		4X4 Matrix M-Module
217		Dual 8-to-1 Multiplexer M-Module
218		16-bit DIO M-Module
410		Audio Test Module
415		Additional DMM
416		16-channel Multiplexer for DMM
420		Counter
480		Charging Power Supply

TS-5500 Family Options

Product #	Option #	Description
E2181A	310	GSM/Agilent 8922 Support
	311	GSM/Agilent 8960 Support
	315	TDMA Support
	320	CDMA/Agilent 8924 Support
	370	Test Developer Software and License
E2181A	041	Utility Power Supply Voltages: 5, 12, 24 V
	042	Utility Power Supply Voltages: 3, 5, 12, 24 V
E2181A	051	17-inch Monitor (not mounted in rack)
	070	Handheld RS-232 Scanner Kit
	071	Fixed Position RS-232 Scanner Kit
	080	RS-232 Strip Printer Kit
E2181A	05B	One Phase Wye with Neutral 4-wire
	05G	230/240V One Phase Wye with Neutral 4-wire
	05K	240/415V One Phase Wye with Neutral 4-wire
	0ED	200V Delta 3-Phase 4-wire
	05C	220V Delta 3-phase 4-wire
	05H	230V Delta 3-phase 4-wire
	0E6	240V Delta 3-phase 4-wire
	0EF	208V Wye 3-phase 4-wire
	05D	240V single-phase earthed 3-wire
	05M	220V single-phase earthed 3-wire
	05F	230V single-phase earthed 3-wire
	05J	240V single-phase earthed 3-wire
	AWX	200V Single Phase 3-wire
	0EB	220V Single Phase 3-wire
	0EJ	230V Single Phase 3-wire
	0EC	240V Single Phase 3-wire
	AWV	120/208V One Phase Wye with Neutral 4-wire
	AWX	127/228V One Phase Wye with Neutral 4-wire
E8709B		GSM/8960 Test Set
E8710A		Agilent 8922M GSM RF Test Set (includes Option 006)
E8711A		Agilent 8922P GSM Multi-band Test Set (includes Option 006)
E8712A		Agilent 8924 CDMA Test Set
E8713B		Agilent E8285A Multi-band CDMA Test Set
E8714A		Agilent 8920B TDMA Test Set
E8715A		Agilent 8920B TDMA/PCS Test Set

TS-5500 Family Support Options

Product #	Option #	Description
E2182A	700	Hard Copy Manual Set for TS-5530
E2182A	710	Test Development Class
E2182A	720	Maintenance Class

Agilent Technologies' Test and Measurement Support, Services, and Assistance

Agilent Technologies aims to maximize the value you receive, while minimizing your risk. We strive to ensure you get the test and measurement capabilities you paid for and obtain the support you need. Our extensive support resources and services can help you choose the right Agilent products for your applications and apply them successfully. Every instrument and system we sell has a global warranty. Support is available for at least five years beyond the production life of the product. Two concepts underlie Agilent's overall support policy: "Our Promise" and "Your Advantage."

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Our Promise means your Agilent test and measurement equipment will meet its advertised performance and functionality. When you are choosing new equipment, we will help you with product information, including realistic performance specifications and practical recommendations from experienced test engineers. When you use Agilent equipment, we can verify it works properly, help with product operation, and provide basic measurement assistance for the use of specified capabilities, at no extra cost, upon request. Many self-help tools are available.

Your Advantage

Your Advantage means Agilent offers a wide range of additional expert test and measurement services, which you can purchase according to your unique technical and business needs. Solve problems efficiently and gain a competitive edge by contracting with us for calibration, extra-cost upgrades, out-of-warranty repairs, and on-site education and training, as well as design, system integration, project management, and other professional engineering services. Experienced Agilent engineers and technicians worldwide can help you maximize your productivity, optimize the return on investment of your Agilent instruments and systems, and obtain dependable measurement accuracy for the life of our products.

For more assistance

with your test & measurement needs go to

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Or contact the test and measurement experts at Agilent Technologies (during normal business hours.)

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Japan:

(tel) (81) 426 56 7832

(fax) (81) 426 56 7840

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(tel) (305) 267 4245

(fax) (305) 267 4286

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(tel) 1 800 629 485

(fax) (61 3) 9272 0749

New Zealand:

(tel) 0 800 738 378

(fax) 64 4 495 8950

Asia Pacific:

(tel) (852) 3197 7777

(fax) (852) 2506 9284

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