Synthetic

5000 Series Synthetic Multi-function

Adaptable Reconfigurable Test Environment

AEROFLEX
A passion for performance.

SMART^E™ 5000
SMART ENVIRONMENT 5000 SERIES

The SMART^E 5000™ test environment provides a modular approach for implementing multi-function configurable (and reconfigurable) test systems. A SMART^E™ RF/microwave sub-system, at about the size of a microwave synthesizer, can perform measurements that tradionally would require five or more separate RF/microwave instruments. SMART^E™ is a complete integrated environment with all the hardware and software needed for calibration, test execution, test reporting and test analysis.

- Complete synthetic test environment
  - Hardware, software, processes, support
- Configurable to the application
  - Optimize via multi-vendor COTS modules
- Proven systems deployment
  - Satellite payload, T/R modules, ATE
- Mixed signal capabilities
  - DC, digital, analog, RF/microwave
- System level architecture
  - Calibration, verification, alignment
- Open system architecture
  - System hardware & software, TPS

The SMART^E™ 5000 is a complete test solutions environment from Aeroflex. It encompasses hardware, software, processes and support which provide significant competitive advantage for our customers.

The Aeroflex SMART^E™ 5000 Test Environment is based upon the 5th generation evolution of Aeroflex synthetic test technology. Aeroflex synthetic test systems are successfully deployed in a variety of high performance test applications which Aeroflex began shipping for radar applications more than 12 years ago. Today these synthetic test systems are employed for challenging test problems in conjunction with satellite payload test, advanced T/R module test and military ATE.

A Synthetic Test System utilizes multi-functional stimulus and response measurement hardware channels tightly coupled with Digital Signal Processing software (rather than a collection of dedicated function instruments) to generate signals and perform measurements.

Synthetic test environments offer the lowest total cost of test, as much as 10 times the throughput and typically take less than half the rack space and weight of conventional discrete-instrument based systems.

This leading edge environment is provided using COTS system components, from Aeroflex as well as other OEMs, to ensure the customer of having the test solution best matched to the requirements in question at the most favorable price. Furthermore, the extensive application of industry standards in the composition of the environment ensures that SMART^E™ test solutions fit well into the customer operating environment and that customer personnel are familiar with its implementation approach.

System hardware components are provided in LXI, PXI, cPCI or discrete instrument form factors. SMART^E™ Software encompasses Microsoft Windows™, Microsoft Visual Studio™, National Instruments TestStand™ National Instruments Measurement Automation Studio™ and Java™ for test scripts - all of which are broadbased industry standard system software components.

SMART^E 5000™ test environments are scaleable in performance and function, ideal for implementing configurable and reconfigurable systems that provide flexibility and resistance to obsolescence and are vastly superior to historical rack-and-stack test solutions.

A single synthetic stimulus and measurement channel pair can perform the tests that traditionally require multiple standalone instruments. Thus, there is also a remarkable savings in size and weight requirements for a complete microwave test solution.

The Aeroflex SMART^E™ 5000 is a multi-purpose test environment, capable of being configured for a variety of combinations of digital, analog and RF/microwave stimulus and measurement capabilities matched to specific customer requirements.

Aeroflex can provide systems configured to unique customer requirements, including customized hardware and software for new technologies or unique methodologies. Standard, turn-key system configurations are also offered to address specific common applications. Available turn-key application system products offered by Aeroflex include:

- SMART^E™ 5100 TRM - Transmit/Receive module test environment
- SMART^E™ 5200 PTS - Satellite payload test environment
- SMART^E™ 5300 Military ATE environment

The information in this data sheet is generally applicable to a SMART^E™ 5000 as a general-purpose test system platform as well as the above turn-key application system products. For additional information regarding turn-key systems, please consult the specific data sheets provided for each.

From a key subsystem perspective, SMART^E™ 5000 systems are constructed of the following available building blocks (Figure 1):

- Stimulus subsystem
- Response measurement subsystem
- System calibration, signal routing & signal conditioning subsystem
- System controller & software
- System infrastructure subsystem

Configuring SMART^E™ 5000 Synthetic Test Hardware

Test requirements come in a seemingly endless variety. The one constant is that the test environment should be applications-driven, able to deliver the specific levels of performance required at a competitive price.

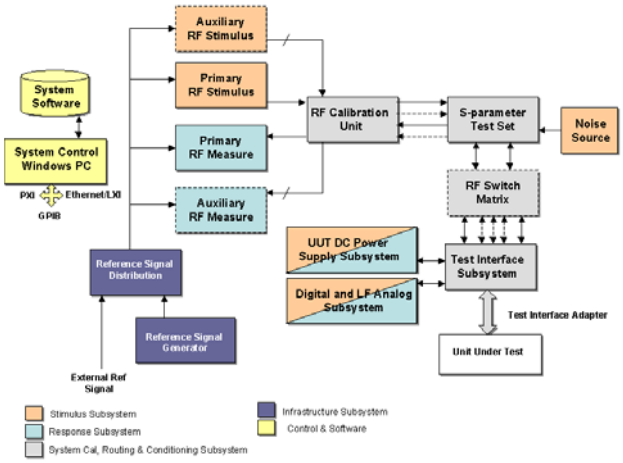

Figure 1. Generic Block Diagram of a SMART^E™ 5000 Environment Test Solution

The devices to be tested dictate the number of simultaneous stimulus signals and the range of frequency, power and modulation of the stimulus signals required. The specifications and test strategy of the devices to be tested dictate the measurements and, therefore, the measurement instruments required in terms of both function and performance. The combination of the DUT test signal requirements and the characteristics of the measurement instruments dictate the calibration and signal routing and conditioning components of the system.

With the SMART^E™ 5000, customers can configure test capability that matches the test problem to be solved. A SMART^E™ 5000 environment also enables expansion or reconfiguration of a system to meet new requirements, thereby providing test resource investment longevity and significantly greater immunity from the obsolescence issues that plague the rack-and-stack genre.

Stimulus Subsystem

A stimulus subsystem can encompass a wide variety of combinations of digital, analog and RF/microwave "channels". In SMART^E™ 5000 Series, digital and analog capability is typically provided in PXI/cPCI form factor, RF and microwave functionality in PXI or LXI form factor. However, conventional rack mounted instruments may also be utilized in cases whereby they provide the best match to the measurement problem, though usually not the "best modularity" of implementation.

PXI/cPCI can well supply, in particular, DC, digital stimulus, arbitrary waveforms, digital to analog signal generation and even RF and microwave signal generation up to about 6 GHz. Aeroflex offers unique PXI COTS instruments for digital signal stimulus up to 100 MHz with extremely low programming time overhead in a test sequence. Aeroflex provides fast, low phase noise micro-synthesizers in PXI to drive very wideband Local Oscillators used for its RF and

microwave signal channels, which are otherwise implemented in LXI form factor.

Aeroflex systems offer integration of either modular or bench DC power supplies from the best of the industry's DC power supply vendors.

Need a high performance TACAN signal generation capability in a test system?

Figure 2. IFF-45TS Transponder /Interrogator/TACAN Test Subsystem

The Aeroflex IFF-45TS (Figure 2) is an RF signal simulator that provides support for AIMS Mark XIIA transponders and interrogators and can be integrated into a SMART^E™ test solution. It operates under control of the SMART^E™ computer and provides versatile signal generation and measurement capability of Mark XIIA system signals in bench and over-the-air applications.

Need a dedicated analog synthesizer in the system? Configure an Agilent™ 8257D or N8211A (LXI version of the 8257D) (Figure 3) into the system. SMART^E™ systems are designed to accommodate system components from multiple vendors and in multiple form factors or interface implementations.

Figure 3. Agilent™ 8257 and N8211 Synthesizers supported as auxiliary RF signal sources in the SMART^E™ environment.

SMART^E™ RF/microwave Stimulus Subsystem

For the primary (and possibly auxiliary) RF/microwave stimulus elements of the system, Aeroflex offers state of the art synthetic stimulus capability. An Aeroflex synthetic stimulus channel is composed of individual modular building blocks for the baseband, IF upconversion, RF upconversion and the LO to drive the upconverter.

Figure 4 shows an all-LXI version (the modules are all half-19 inch rack width, 1U or 2U height) of a SMART^E™ synthetic RF/microwave stimulus channel which can be configured in bands to operate to 26.5 GHz in the configuration shown.

An additional 1U module may be added to extend the range of the upconverter to 40 GHz.

The RF upconverter may be configured in bands to cover the specific range of frequencies required. The baseband (shown as a baseband waveform generator BWG in Figure 4) for a given RF/microwave stimulus channel configuration may be provided by one or more multiplexed analog or digitally generated signals and Aeroflex offers either or both narrow band and wideband options. For digitally based AWG signaling, the SMART^E™ 5000 also offers optional baseband processors with deep, high speed sample memory streaming.

Any RF/microwave stimulus channel may be configured with an optional power amp unit to generate higher power levels over the entire range of the upconverter output or on a unique band selection basis. Aeroflex offers both standard and custom configurations in broadband or band specific requirements context to match to the specific test requirements of the customer and the device under test.

For stimulus subsystem components other than RF/microwave necessary for implementing a complete system solution, Aeroflex offers a number of both standard and customizable building blocks as well as support for COTS components from other vendors.

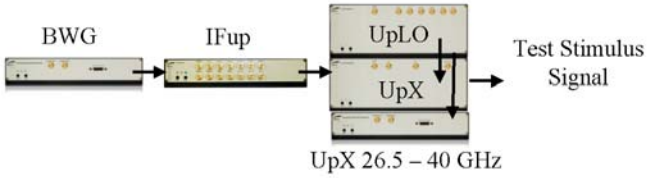

Figure 4. Components of an LXI version of a SMART^E™ RF/microwave Stimulus Channel

Response Measurement Subsystem

Like the stimulus subsystem the response measurement subsystem of a SMART^E™ can encompass a wide variety of mixed signal capability from DC through microwave. As for the stimulus subsystem, system module components in PXI/cPCI, LXI or discrete instrument form factor may all be utilized in concert.

Common modular instrumentation capability is available off the shelf for digital multimeters, digital sampling oscilloscopes, arbitrary waveform generators, digital IO and a variety of other measurement functions in PXI/cPCI and LXI and response measurement subsystems may each consist of one or more channels, which may be optionally configured for tuning speed, power level and frequency range.

These include:

- UUT Interface Subsystems
- UUT Power Supplies
- System Infrastructure - racks, cooling, AC distribution, etc.
- Digital IO Subsystems
- Industry Standard PXI Synthetic Instrumentation Modules

SMART^E™ 5000 RF/microwave Response System

A SMART^E™ 5000 RF/microwave Synthetic Response Subsystem consists of one or more channels, each made up of four to six LXI module components depending upon the operating frequency range required and the methods chosen for system calibration, signal routing, signal conditioning and UUT interface. In addition, other modules may be required for reference signal generation interconnection and LO distribution depending upon how the overall system is implemented. The half-19 inch rack width, 1U or 2U modules required for 26.5 GHz test frequency range is shown in Figure 5.

Specifically, a SMART^E™ 5000 Synthetic RF/microwave Response Subsystem channel consists of two major subsystems, Response Baseband and Response RF/microwave Subsystems.

The Response Baseband may be configured either from standard SMART^E™ 5000 baseband components or from Aeroflex or other vendor COTS components.

These may include:

- Aeroflex ASL 40151 NB+WB waveform digitizer (BDig)
- Aeroflex ASL baseband data processor
- Aeroflex broadband BSA signal recorder/analyzers
- COTS digitizers

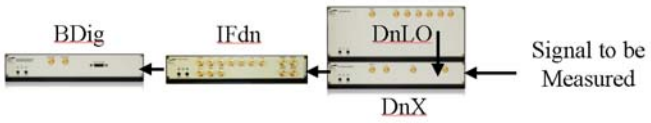

Figure 5. SMART^E™ 5000 RF/Microwave Response Subsystem

The Response RF Subsystem channel consists of the following:

- Baseband digitizer/processor (BDig)
- IF downconverter (IFdn)
- RF downconverter (DnX)
- 26.5 to 40 GHz downconverter (optional)
- RF downconverter LO (DnLO)
- Response calibration and signal conditioning module(s)

Two LO options are offered, the standard LO is a YIG model which requires only 1U in LXI module height. The second is micro-synthesizer based and requires a 2U LXI module as shown in Figure 5.

The LO may be the same LO as utilized in stimulus channels in the RF Stimulus subsystem. In Figure 4, the fast tuning LO option is shown. The standard YIG LO is 1U in height.

The test response signal at microwave frequencies is delivered to a Local Calibration Unit (LCU) which provides amplitude adjustment capability and routes reference and UUT test stimulus signals for making a measurement. The LCU provides a multi-decade dB step attenuator and also provides Standards Lab (NIST) traceable power level measurement sensors and meters for performing calibration.

The signal to be measured is routed from the response input of the LCU to the RF Downconverter. The tunable LO is set to frequency translate the signal frequency to be measured to an IF at 4.5 GHz which is then provided as an input to the IF downconverter. The IF downconverter translates the 4.5 GHz input to either a 50 MHz narrowband or 400 MHz wideband output. The standard SMART^E™ 5000 baseband digitizer provides both narrow and broadband baseband signal capture capabilities.

Calibration, Signal Routing and Signal Conditioning Subsystem

In over 10 years of deploying synthetic microwave test systems Aeroflex has engineered a calibration strategy and architecture that is fundamental to the acceptance and success of its high performance systems. The strategy is based upon a very specific hierarchical calibration strategy involving three distinct levels of calibration as follows:

- Primary calibration
- Operational reference plane origin calibration
- Extended reference plane calibration

This hierarchy is specifically designed to minimize the overhead and maximize the convenience of calibration and verification as well as to establish the highest level of measurement quality of Aeroflex Synthetic Test Systems on a system-level basis.

Primary calibration is related to the components of the system responsible for establishing the most fundamental stimulus and measurement parametric behavior of the system. For the RF/microwave elements of the system these include the reference frequency generator, noise source, power meter and power sensors, s-parameter calibration kits, along with a core calibration resource, known as the Local Calibration Unit (or LCU). For low frequency stimulus, a high performance PXI DMM, for example, may be the primary reference standard, easily removed for calibration periodically.

The Local Calibration Unit facilitates the second level in the calibration hierarchy for RF/microwave signaling. It is the point at which all system resources are integrated to provide a fundamental reference plane origin for both RF/microwave stimulus and response signaling. The Local Calibration Unit provides signal multiplexing to DUT test ports and to industry standard NIST traceable power calibration instruments.

Signal Routing

Any test system comes with its own unique set of signal routing requirements. SMART^E™ solves this problem by offering "Standard Customizable" Signal Routing Components and Subsystems. For example, for the RF/microwave signal routing components, SMART^E™ offers a combination of the LCU switching, a variety of RF switch tree/multiplexer configurations in LXI, PXI switch and multiplexer selections, an LXI s-parameter test set option and fully custom multiple or single "switch solution" module configuration. LCUs are available as standard components, in standard optional configurations and as customized units built to accommodate a specific application requirement.

Inevitably, complex signal routing translates to complexity in programming for the customer application engineer. SMART^E™ software eliminates this problem using a system configuration file in which all possible switch paths are defined by name and a simple "path set" function is provided to set up any signal path desired without concern for driving certain control bits or registers. SMART^E™ system software handles all such bit and register mapping automatically from the high level information in the system configuration file.

Signal Conditioning

Signal conditioning capabilities are vitally important, particularly for the RF/microwave elements of the system. Power levels as a function of signal source and frequency may have to be customized to the application. An LCU may include internal power amp, LNA and Noise source to provide a broad range of both stimulus and measurement signal conditioning. A separate customized power amp assembly may be added to the system to accommodate multi-band implementations as required. Industry standard step attenuators are provided centrally in the LCU to adjust either input or output signal levels. Fine attenuation is provided over a high resolution continuous 30 dB range as well to provide stimulus steps to 0.1 dB or even less.

System Controller and Software

Aeroflex SMART^E™ 5000 systems feature the utilization of a Windows™ based dual Intel processor computer as the primary controller/processor in the system.

Beyond Windows, a number of commercial off-the-shelf software components are integrated into the system. The most significant of these include Microsoft Office Professional and the National Instruments Professional Test Suite™.

SMART^E™ test solutions are shipped with a comprehensive software suite, which supports both interactive and automated sequence modes of operation of the system. Developed over a decade's experience in synthetic test, the system software is modular and is based upon object-oriented technology and the Microsoft Windows™ platform.

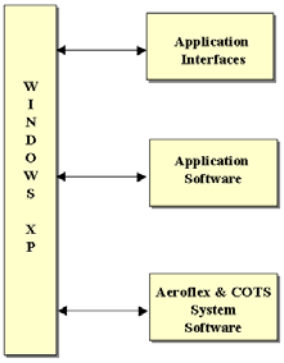

Figure 6. SMART^E™ 5000 System Software Model.

There are three primary tiers of software in the layered model which is shown in Figure 6. A more detailed view of the elements of each of the three layers is provided in Figure 7.

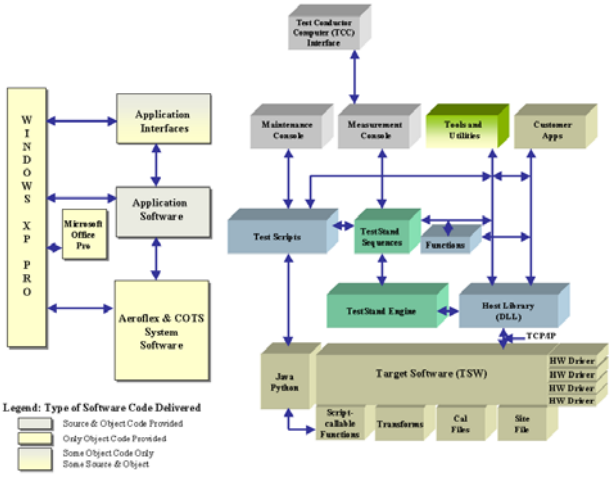

Figure 7. Software Layer Components

The lower tier of Figure 6, identified as the "Aeroflex & COTS System Software" shows the SMART^E™ system foundation software, the primary component of which is referred to as the Target Software (TSW). This includes hardware drivers, interpreters for test script execution, test script callable functions, system infrastructure software and all the elements of the software which make up the core functionality of the system. This software is very closely associated with system hardware and fundamental stimulus and measurement methodologies.

The upper portion of the model illustrates a number of different methods by which a user or user application interfaces with the system to execute applications. All such methods interface to the TSW via a Dynamic Link Library based Application Programming Layer which is called the Microwave Virtual Instrument Host Library. Three of the system execution interface methods are provided as standard elements for the system by Aeroflex. The fourth method ("customer applications" in this figure), represents the ability of the customer to apply any chosen method which can directly utilize the DLL library. This could be C, C++ or other programming environments.

There are two standard user interfaces supplied with SMART^E™ software. These are shown in the software model as the Maintenance Console and the Aeroflex Measurement Console (AMC).

The maintenance console provides considerable functionality beyond "maintenance". It is a Graphical Operator Interface with user selectable functions for:

- Calibration
- User interactive system setup
- Source control
- Measurement control
- New test development
- Diagnostics
- Test script loading and execution

Low level control of hardware is accessible from the Maintenance Console and multiple setups can be saved in Configuration Files (.ini). This is a Microsoft C++ application provided as a standard feature on all SMART^E™ 5000 Test Systems. Figure 8 shows the "main menu" of the Maintenance Console illustrating the specific functionality which is available via this software.

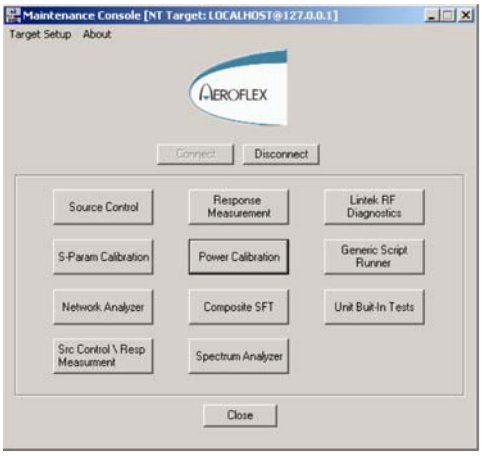

Figure 8. SMART^E™ 5000 System Maintenance Console Interface

The second standard SMART^E™ 5000 system operation and execution interface, the Aeroflex Measurement Console, is a graphical interface for executing measurement sequences. Measurement sequences may be standard tests available from an Aeroflex standard test library or customized or unique tests written by the customer, Aeroflex application engineers or a system integrator. Using AMC, tests may be executed on a standalone basis or as a batched sequence of tests. New sequences are easily formed from existing test files.

Standard tests provided by Aeroflex follow a structure which includes parameter entry, measurement control sequence stepping, and results display in a consistent and systematic manner.

The key features of AMC include:

- User management (permissions)
- Graphical interface for entering parameters, executing tests, and viewing results in local mode
- Error and debug logs
- Local display and control for continuous tests
- Generates reports
- Test data returned to AMC following sequence execution
- AMC displays plots, tables, and scalar data in tabbed format
- AMC saves results to file for archiving and/or printing

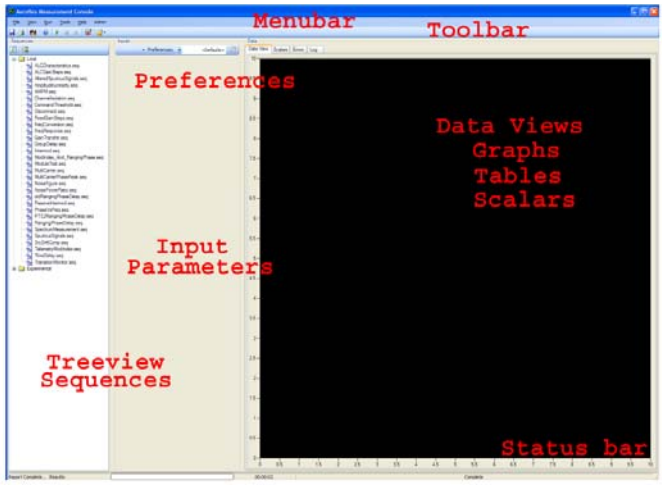

Figure 9. Topological View of the SMART^E™ Measurement Console

Figure 9 shows the "topology" of the AMC. A selected file of tests is presented in a tree structure at the left of this display. When a test is selected the parameters which have been pre-programmed as variables and set at run time are presented just to the right of the tests tree. The test might have had very specific default values which are loaded automatically ahead of this instance of the test loading process by a test engineer who utilized the set preferences feature. Each sequence contains custom preferences. These preferences are located above the parameters groupbox.

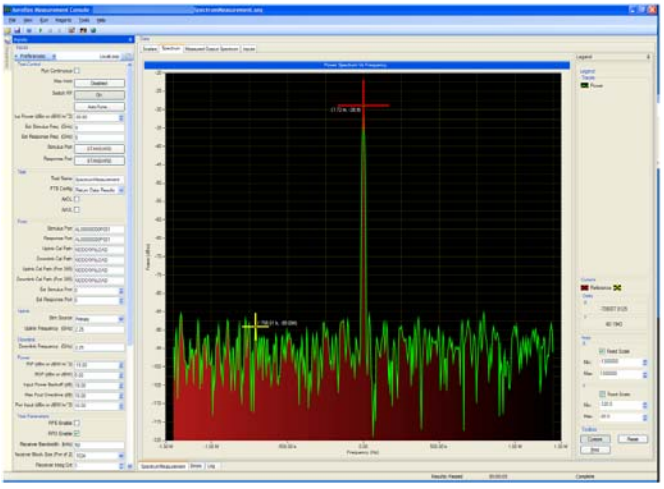

Figure 10. AMC Spectral Measurement Example

Figure 10 illustrates the AMC interface to a spectral test which has been executed according to the parameters at left. Active display tools such as cursor control and color aids have been activated from the controls on the right. This is a test for which it is quite useful to run continuously while in an interactive mode, updating as a spectrum analyzer would while, perhaps, some adjustment is made to the unit under test. This is an option built into the test sequence and AMC tools.

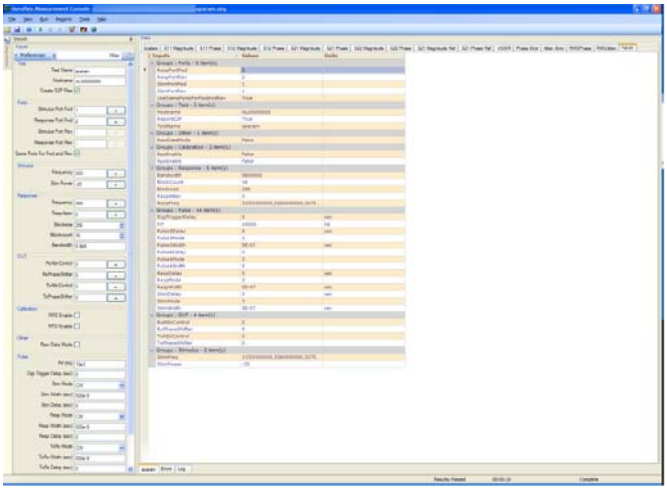

Figure 11. AMC Test Input Parameter Value Table

Figure 11 illustrates another element of an AMC based test. The Data Views, Graphs, Tables and Scalars area shown in this figure, is structured as a programmable tab set in the structure of the test sequence. Tabs may be dedicated to tables, graphs, and execution log results - virtually any type of data or representations of data. Figure 11 illustrates one of the standard tabs named inputs, which is a tabulation of all of the input parameters utilized in executing the test sequence.

Figure 12 shows the results for a tab under which a plot of S21 for a specific UUT was created. Cursor and point plotting tools were activated for this screen presentation.

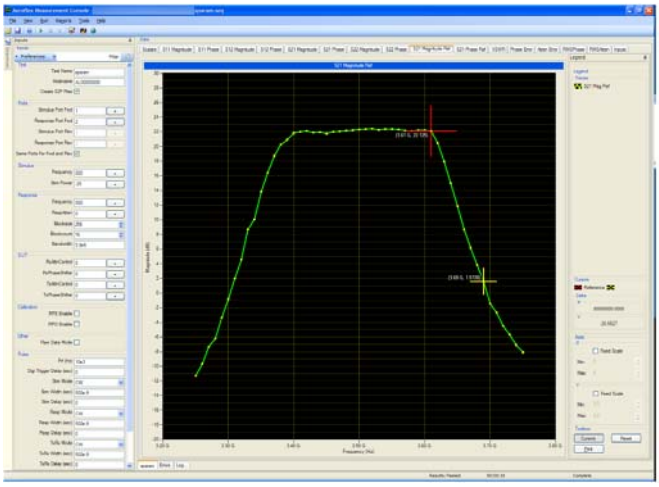

Figure 12. Sample s-parameter Test Results

The Measurement Console interface also provides an effective means by which a SMART^E™ 5000 system may be controlled from an external computer. For example, a Payload Control Computer, which is responsible for safely controlling the various functions of a satellite payload, can also control SMART^E™ 5000 Test Resources for making the various required measurements . This control functionality is generally undertaken across a LAN interface between the computer which controls the payload and the computer which controls SMART^E™.

The Measurement Console provides effective access from the SMART^E™ 5000 User Interface to the numerous and robust capabilities of National Instrument's TestStand™ which is the de facto industry standard test management software application environment and a key COTS of SMART^E™ software. Figure 13 is a simplified model of the TestStand™ software.

Figure 13. TestStand™ Software Components Model

TestStand™ embodies a vast collection of DLL based functionalities. This software exports an ActiveX Automation API giving it the capability to service calls from any programming environment that supports ActiveX automation servers. Test programmers may create, edit, execute, and debug sequences. Both a sequence editor and operator interface are provided to access TestStand™ functionality.

TestStand™ provides SMART^E™ with flexibility in test sequence or sub-sequence programming and execution and makes it straightforward to sequence entire scripts, script callable functions or individual API calls, enabling hierarchical customization of tests.

Measurement console standard analysis and results publishing software includes a powerful plotting package, which enables virtually any results to be plotted, as well as a library of common standard analytical tools. Results may be stored into spreadsheets then taken off line for post processing analysis as well.

Tests Libraries

Aeroflex has developed for its Synthetic Test Systems customers numerous test scripts, DLL's and interactive menu driven measurement and analysis software. Customers have also generated test scripts. This repertoire provides the Synthetic Test customer with major advantages.

First, since the software has been instantiated and utilized in multiple customer environments for multiple applications, customers have a high degree of confidence that the algorithms supporting these scripts are proven, robust and reliable.

Second, Aeroflex ships its Synthetic Test Systems with a number of example test scripts and procedures representative of the specific applications required by the customer. This means that test bring-up and debug time are greatly reduced from those required when application software must be developed from a cold start.

The advantages of Synthetic Testers can be measured in saved project dollars and reduced time to test bring-up. Table 1 lists representative tests supplied with a SMART^E™ 5000 Synthetic Test Environment.

General Microwave Measurement	
Error-corrected s-parameters – Pulsed & CW	Noise Figure and Noise Power
Signal Power, Adjacent Channel Power, Peak Power, Average Power, Envelope Power	Bit Error Rate (BER), Modulation Error Rate (MER)
Modulation and Demodulation	Group Delay
Pulsed Signal Timing	Phase
Signal Spectral Characteristics	Phase Noise
TR Module Tests	
s Parameters	Noise Figure
DC Control	Pout vs Pin
Harmonics	Pulse Measurements
Spurs	Third Order Intercept
Total Absorbed Power	
Satellite Payload Tests	
Gain Transfer/ALC Characteristics	Frequency Response
Spectrum, Spurs	Frequency Conversion
AM to PM	Amplitude Linearity
Noise Figure	Channel Isolation
Group Delay	Modulation Index
Fixed Gain Steps	ALC Gain Steps
Command Threshold	Multicarrier Test
ATE Tests – Contact Aeroflex for Additional Information	
Radar Test Suite	CNI Test Suite
End-to-End Flight Line Tests	Phase Noise
Customized Tests	

Table 1. SMART^E™ Standard Test Library Offerings

System Infrastructure Components

System infrastructure components refer to components generally required to make the various SMART^E™ 5000 individual subsystems operate as an integrated environment. In some instances, these may be provided by the customer application environment. The SMART^E™ 5000 family provides for the following required or optional infrastructure components:

- LXI module sub-rack
- System racks with AC power infrastructure including uninterruptible power supply, cooling, EMI shielding
- System reference signal generation and distribution modules
- LO distribution modules (optional - depends upon application requirements)
- System interconnect cable assemblies
- LAN interface router
- UUT interfaces

System Options

Aeroflex offers both standard and custom options to help customers maximize the value delivered by an Aeroflex Synthetic Test Environment. For a complete list and detailed information on Aeroflex Synthetic Test Solutions Options, please see the Aeroflex web site or the Synthetic Tester Options Configuration guide.

Available Synthetic Tester Options include:

System infrastructure options

- Customized system racks
- Low phase noise rubidium system reference oscillator

Calibration Options

- System signal sources
- Local calibration units
- Remote calibration units
- Power level transfer standard instruments

DUT Interface Options

- High frequency
- Digital IO
- DC power
- Application specific interface adapter panels
- Virginia panel universal interfaces

Stimulus and Measurement

- COTS auxiliary signal sources
- Ultra fast-tuning signal sources
- L-Series AWG and digitizer modules
- Noise source options
- Phase noise measurement sub-system
- COTS voltmeters, digital IO, ADC, DAC & other Instrument modules
- Aeroflex deep memory broadband waveform generators
- Aeroflex deep memory broadband recorder/analyzers

SMART^E™ Processes

We refer to Processes as one of the four elements of the SMART^E™ environment. A number of key processes or practices are embodied in the design, calibration methods, test methods and verification methods which are ultimately manifest in the hardware and software implementation. Some of these processes and practices are well known and accepted as standard in the industry and have been implemented in a practical and at hand way in SMART^E™. For example, the capability of setting an original calibration reference plane and then extending it through methods such as s-parameter embedding or incremental s-parameter calibration steps which do not require a complete calibration are common. SMART^E™ provides a complete spectrum of these processes for selection, according to the requirements and complexities of a customer's particular application.

As another "process example" consider the problem of calibrating and measuring microwave levels for a product under test in a TVAC chamber located tens of meters away from the test system. Aeroflex processes for handling this problem encompass unique remote calibration units with embedded, TVAC ready sensors and signal paths to ensure calibration at the remote port thus enabling measurement repeatability to the tenth of a dB at very high frequencies.

SMART^E™ processes provide the ability of the system hardware and software components to make system confirmation and correlation measurements, even with the UUT connected, at any point in a test program. This is an incredibly useful and powerful capability for applications where it is important to confirm that testing is stable, to provide a strong basis of correlation or even a simple confidence check before embarking upon a given test cycle.

Processes which verify calibration readiness or isolate a failed subsystem or module cannot be valued enough when critical throughput applications are involved. These processes have evolved over a decade of Aeroflex experience in implementing true synthetic test systems.

There are several additional examples of process and practices which are embodied in SMART^E™ to provide a complete test solution. Another capability that should be mentioned in this context is the process of logging without impact to throughput. If desired, a log of every test step executed by a SMART^E™ system may be acquired during test and saved. Logs of the steps followed when a system is turned-on are maintained. Finally, logs of errors which occur in a test sequence are also acquired and saved.

When the inevitable questions about whether it is the tester or the product exhibiting a problem, whether a recurring problem is at hand or what test steps led to a given fatal or non-fatal error, the process of logging adds a powerful knowledge capability to the SMART^E™ environment.

SMART^E™ Support

The objective to offer a complete test solution environment cannot be realized without offering exceptional support programs which meet the needs of the applications markets associated with product offering.

Phased Array Radar T/R Module test customers' main requirements are about meeting high volume production goals to make sure that a full complement of modules which meet or exceed their specifications is ready when the radar mainframe is ready. These customers are also engineering new product evolutions even as the current product manufacturing is in full swing. Support requirements: rapid access to FRU replacement modules and direct access to technical expertise for new test requirements.

If one thinks that T/R module test customers are sensitive to down time or unexpected technical issues, just talk with a test engineer who is involved with TVAC test with a satellite payload. The combination of the direct costs of the TVAC chamber, the expert human resources deployed and on-call, and the potential for business penalties if critical deadlines are missed add up to a support challenge that can cost a customer literally multiple tens of thousands or even hundreds of thousands of dollars for each day of delay. This application environment requires a support strategy which starts with high system reliability and can then readily bring factory expertise to bear on a test system problem within an hour of problem reporting, and can have a flagged system back in operation, re-calibrated and excecuting tests in less than a working shift. Downtime outside of TVAC test periods is, on the other hand, more of an annoyance than a critical occurrence and a week or more of downtime can be tolerated, particularly by those customers that are operating with multiple systems.

How do you characterize the support requirements of a ATE customer? First of all, there are multiple customers - from the prime equipment engineering and manufacturing test teams who have requirements similar to the T/R Module test customer, to the repair and maintenance depot that wants minimum inventory FRU support and access to expertise to minimize no-problem-found returns while maximizing repair efficiency and return time, to the flight line or in-theatre support front line that want the simplest and fastest go/no-go operational test possible with maximum reliability of the test solution since the best tester repair strategy in this case, with the exception of truly trivial repairs, is to send the tester out and bring the good one in as fast as possible.

Meeting some of these support requirements is more of a product design challenge than a post sales support challenge. Synthetic test equipment addresses some of these product design challenges very nicely and efficiently. For example, synthetic test solutions are scaleable, providing a common core capability which can be configured for engineering, manufacturing, depot and even front-line test requirements - from most to least complex in the tester configuration hierarchy.

Ultimately in the actual realm of post-installation support, there are five key components in the SMART^E™ support provided by Aeroflex:

1. Hierarchical failure data driven, owned spare module programs

2. Hot back-up system and component leasing

3. Spare modules pools

4. Instant access to factory expertise

5. Flexible support programs

In the synthetic tester business one quickly learns that it is absolutely necessary to be forthright in talking about reliability and times to repair. Data are accumulated continuously on failure events, with the intent to improve weak subsystems, while at the same time being willing to discuss the relatively more-likely-to-fail components and the realities of diagnosing and repair. This enables the presentation of realistic probabilities, costs and mean time to repair so that customers may decide systematically how to implement a support strategy.

The first decision point is whether or not to purchase owned spares or even a complete back-up system to ensure minimum possible turnaround time when making an FRU or system change in the event of a failure. This decision can only be made when a cost-based understanding of downtime is developed and fundamental questions as to how much downtime can be expected/tolerated are fully answered. Inevitably, the tendency by all customers will be to avoid purchasing owned-spares unless there is large cost leverage provided by any given spare assembly. This conclusion leads very naturally into the second component.

How can one get spares support without having to buy it?

One way to get the kind of support afforded by customer-owned spares for critical test periods is to lease either a complete system or critical FRU assemblies and hold them on-site at the test location during the critical period. SMART^E™ can provide this support service - certainly on the basis of critical module level and, usually, even at the complete back-up system level, given adequate notice. Aeroflex offers this service in a two-tier rate structure with a reduced charge for placing resources at the site but not using them as compared to the resources being placed into back-up service.

Customer owned spares and at-site back-up spares are oriented to customers who require repair in less than a work shift. For customers who can tolerate a spare delivery time of 24 to 48 hours, Aeroflex provides regional shared spares pools for synthetic test system equipment. This means that in the EU or North America, fast transportation and no import/export restrictions enable a shared spare component to be shipped from a pool location to a customer site overnight. Both in-warranty and post warranty support options are available to provide guaranteed turnaround on supply of spare FRU modules from shared spares pools at very favorable rates as compared to purchase or at site lease rates.

Modular, synthetic test systems lend themselves very well to automated verification and diagnosis to the FRU module level. Customers are offered variations in the depth of training to develop as much in-house expertise as desired. However in certain circumstances, customers could require access to a higher level of expertise than is available from in-house experts. SMART^E™ addresses this problem.

Firstly if a system application permits it (from security and infrastructure perspectives), any SMART^E™ installation can be connected to the factory for access by local factory experts - from highly trained customer support technicians, to product line engineers, to design engineers and ultimately to system engineers, as needed. These experts can also be accessed via phone, by calling the SMART^E™ Support Hotline (+1 614 540 8306). Support programs with guaranteed response times are available on a 365/24 basis if needed, for maintenance and repair, and for applications assistance requirements.

Ultimately, the defining element for SMART^E™ support is that Aeroflex understands that each customer has its own unique profile which drives and determines the required and optimal support strategy, and support program implementation. As for system hardware and software elements, the SMART^E™ environment is configurable as to the type of support needed, whether constant or variable, to ensure that customers meet their critical business goals - with a single point of support responsibility/contact for the entire system.

SMART^E™ - in Summary

Hardware - Software - Processes - Support

Hardware

- State of the art synthetic test environment
- Industry standards platforms supported
- Multi-vendor modular implementation supported

Software

- Modern object oriented layered software implementation
- Industry standards components
- Extensive proven test management and test libraries support
- Legacy TPS support

Processes

- System level, not collection of instruments level orientation
- Over a decade base of experience in synthetic calibration, verification, diagnosis
- Fast start-up for new applications

Support

- Single point of contact for support of any system
- Configurable support programs
- Provides fast-response to downtime-sensitive installations worldwide

SMART^E™ 5000 SPECIFICATIONS

As a highly configurable, modular solutions test environment, SMART^E™ system specifications can be tailored to best match the requirements of the targeted test application. The following data are provided to characterize the range of specifications available via components which have been qualified for SMART^E™ test solutions. Additional components continue to be qualified or developed. Please refer to the Aeroflex web site, specific system data sheets or contact your sales representative for the latest offerings and associated specifications or to investigate the possibility for development of customized SMART^E™ components.

KEY RF/MICROWAVE SPECIFICATIONS

SYNTHETIC STIMULUS FUNCTIONALITY

Parameter	Specification	Comments
Frequency range	50 MHz to 26.5 GHz	Options to 40 GHz
Frequency settability	4 Hz	Primary RF Stimulus Channel
Maximum Output Power - Standard	≥ + 10 dBm	Referenced to LCU output ports
Maximum Output Power With Amp Bank Switched In	≥ +33 dBm	Referenced to LCU output ports. Higher power options available
Output power range Primary Stimulus Channel	125 dB (+33 dBm peak to -95 dBm)	90 dB limit on amplitude stepping within a single test
Output power resolution	0.01 dB	
Instantaneous bandwidth Narrowband Wideband	 20 MHz 400 MHz	
Spectral purity - harmonics <3 GHz >3 GHz	-40 dBc -60 dBc	Pertains to un-amplified or amplified (via power amplifier subsystem) stimulus signals at the LCU output.
Spectral purity General spurious Power line related	Spec: -60 dBc -50 dBc	
Modulation capability Primary Stimulus Channel	AM, FM, PM, Pulse, Arbitrary	Hardware capability provides broadband baseband for more advanced chirp modulation, for example.
Pulse Width	0.1 μs to 50 ms	
Pulse Duty Cycle	Off (0%), CW (100%) or Pulsed (1 to 99 %)	
Power Settability Uncertainty (CW) Band 1: 2 MHz to 70 MHz Band 2: 50 MHz to 8 GHz Band 3: 8 to 12 GHz Band 4: 12 to 20 GHz Band 5: 20 to 26.5 GHz Band 6: 26.5 GHz to 40 GHz	 ± 0.15 dB ± 0.15 dB ± 0.15 dB ± 0.22 dB ± 0.3 dB ± 0.3 dB	Defined as 2 sigma uncertainty, into 50 ohms at the plane of the LCU, for signal levels of 10 to -40 dBm. For a <+/- 2 °C change in ambient temperature

SYNTHETIC MEASUREMENT FUNCTIONALITY

Parameter	Specification	Comments
Frequency range	50 MHz to 40 GHz	Including PXI baseband digitizer
Instantaneous bandwidth		
Narrowband	20 MHz	
Wideband	400 MHz	
Maximum Input Power (CW)	1 W	Input Attenuator >0
Maximum Input Power (Pulsed)	5 W	1 μs, 10%
Input RF attenuator	0 to 90 dB, step 10 dB	
Spectral Purity - residual spurious	-107 dBm	Residual Spurious Input Terminated no LNA
0.05 to 40 GHz		
Spectral Purity - input related		For full scale input
Input related spurious	-60 dBc	
Input related harmonic	-50 dBc	
Repeatability short term	0.0707 dB	Assume that ambient temperature does not change
Gain Stability	0.1 dB/°C Nominal	
Input VSWR		At the MUX Interface
1 MHz to 8 GHz	1.5:1	
8 GHz to 20 GHz	1.9:1	
20 GHz to 40 GHz	3.0:1	

Since SMART^E™ is a highly configurable environment, specifications ultimately depend upon the modules selected to populate a given subsystem. Following are selected examples.

DC Power	Configurable modular or bench COTS supplies
	Switching and linear, single and multiple output supplies
Digital IO	Up to 400 MHz (DDR and LVDS)
	Programmable -2.2 to +3.3 V at up to 100 MHz
Digitizers	Up to 16 bits resolution at 200 MS/s (24 bits at audio rates)
	Up to 10 bits resolutions at 1.2 GS/s
	Up to 5 GS/s at 8 bits
AWG	Up to 16 bits at up to 200 MS/s
	Up to 1.2 GHz at 14 bits
	Up to 2 GS/s at 8 bits
	Sample Memory Depths up to 16 GS
DMM	Full function voltage, current and optional LC
	Programmable sample rates and resolutions, up to 1.8 GS/s

Aeroflex SMART^E™ Synthetic Test Solutions Products

With more than a decade's experience in fielding synthetic test systems, Aeroflex offers complete synthetic technology solutions for:

- Satellite Payload testing
- T/R module testing
- General-purpose microwave testing
- ATE including CNI, Radar and EW

Aeroflex Systems Products now offer modularity, scalability and flexibility in a SMART^E™ Synthetic Test Environment and enable test resources to be configured for meeting specific test requirements, minimizing initial capital expenditures and maximizing test environments lifecycles. These systems offer cost-effective combinations of high precision with high throughput at frequencies up to 40 GHz. Following is a short description of a few of the industry-leading offerings by Aeroflex which can be utilized either as stand-alone systems or integrated as elements of the Aeroflex Synthetic Multifunction Adaptable Reconfigurable Test Environment SMART^E™.

The Aeroflex STI 1000C and STI 1000C+ are synthetic test systems used for making the large volume of highly demanding tests for satellite payloads.

Aeroflex STI 1000C

Aeroflex T/R Module Test Systems including the TRM 1000C and the SMART^E™ 5140 are utilized by the top phased array radar OEM's in the US and Europe.

TRM 1000C and the SMART^E™ 5140

Aeroflex PXI modules provide modular RF/microwave, digital IO, pulse generation and control in SMART^E™ test solutions.

Aeroflex PXI modules

The Aeroflex IFF-45TS is an RF signal simulator that provides ATE system support for TACAN/IFF applications.

Aeroflex IFF-45TS

Aeroflex PN9xxx Series Phase Noise Analyzers provide modular integrated or standalone measurements which are critical to modern communications and radar systems.

Aeroflex PN9xxx Series

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AEROFLEX
A passion for performance.

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Our passion for performance is defined by three attributes represented by these three icons: solution-minded, performance-driven and customer-focused.

Part No. 46891/295, Issue 2, 11/07