

# Keysight Technologies Pre-Configured Functional Test System Platform

Ready-to-go functional test solutions for multiple applications  
in industrial and automotive markets

Technical Overview



## Key Benefits

- Expedites time to production
- Ensures smooth transition from design to production
- Addresses needs of system integrators and channel partners
- Reduces overall system cost
- Minimizes software development time
- Maps resources and interconnects easily
- Provides inclusive self-test on system level
- Low cost of ownership
- CE compliant and EMC qualified

## Features Summary

Complete solution	All typical resources for automotive and industrial applications are available in pre-defined hardware (resource alignment modules and plug-ins)
Ready to go	Solution approach enables focus on the application. Only implementation required for UUT specifics and test plan
Scalable system platform	The resources are distributed on a modular setup, allowing flexible system arrangements inclusive of up/downgrading
User customizable	High degree of user customization possible due to concept with standard components but flexibility through plug-in sub-board concept for custom components and changing/re-routing of resources if required
Time to production	Saves effort in project development process. Based on user's experience with typical development processes, the components of the test platform are designed in such a way that repetitive process steps can be replaced by standardized hardware
Minimized custom cabling	Uses standard cabling for cost effective integration and easy maintenance
From component to turnkey solution	Instrumentation, cross-connect, mass interconnect, fixture, test software, application engineering, and support within streamlined design
Test sequencer software	TestExec SL relieves effort on software development. Hardware setup is directly integrated into the software description of the test system. Software provides multi-up environment. Open interface to databases and device control flow
Supportability	Modular setup, usage of standard cabling, instrument level support, and software debug features enable users to gain low maintenance cost and low MTBF
Self-test on system level	Self-test tools on system level available. Test the systems abilities on the mass interconnect interface (UUT interface) with the help of the integrated self-test software
CE compliant and EMC qualified	EN 55011:1998 + A1:1999 CISPR 11:1997 (mod.) and A1:1999, Group 1, Class A conducting emissions

## Typical Project Development Process

During the typical design phase of a functional test system, many considerations need to be noted. It starts with an analysis of UUT capacities and a review of the test specifications. The result of this phase should be a list with counts of such items as pins, measurement methods, and required instrumentation. Based on this overview, the system's

instrumentation, mass interconnect (design and count of plugs and wires between system and fixture), and the fixture (bed of needles, adapter based, and size and count of connections) can be selected.

Now the major task begins: the definitions of the pin layout of the mass

interconnect (and fixture) and the design of interconnection. Additional features such as standby current consumption (or measurements under load) and additional production requirements, including setup of variants and the preparation of the same system for other projects, may add additional complexity to the design.

## Simplifying the Development Process Using the Keysight Technologies Functional Test Platform

The Keysight Technologies, Inc. pre-configured functional test platform is designed as a generic, ready-to-go test platform to help save effort in every phase of a project. It offers the flexibility to upgrade or downscale

as required. Plus, the pre-configured test platform allows users to focus on the specific requirements of the UUT and project, such as specific instrumentation, the UUT adapter, or the UUT test plan.

Basic components of the test chain

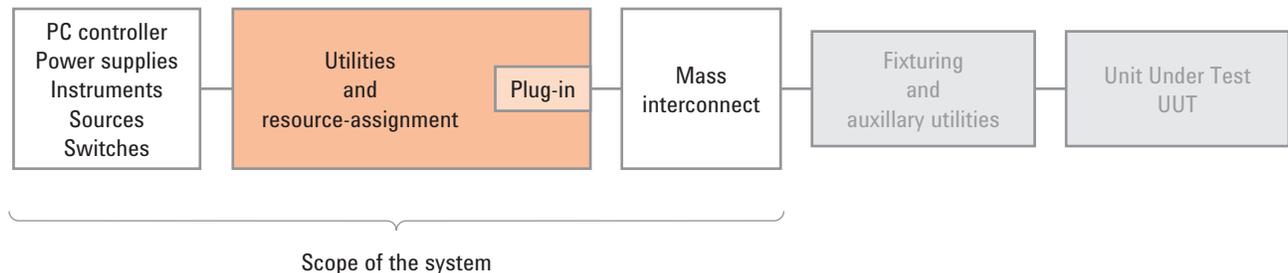


Figure 1. Functional test platform system scope in typical test chain

## Save Effort in the Design, Integration, and Application Process

During each stage of the process, the design of Keysight’s pre-configures functional test system saves you time and effort.

Table 1. Project development process summary



	<b>Review</b>	Study test specifications and UUT capacities. Consider contacting Keysight’s experienced system engineering team for support and suggestions on requirement analysis and system design.
	<b>Instrumentation design</b>	The functional test platform is prepared to contain the set of instrumentation which is matched to the desired application. You can choose from a range of proven and qualified typical system instrumentation or simply adjust the suggested setup.
	<b>System interconnect design</b>	Use the predefined resource assignment modules to obtain a direct, maintainable, and cost effective interconnect in between the instrumentation and the mass interconnect. Use different pre-defined utilities modules that contain selected functionality for recurring applications, and scale them up or down according to requirements.
	<b>Mass interconnect design</b>	Dedicated design of the mass interconnects is no longer necessary. The resource assignment modules define the interface on their own. Almost no custom cable harnesses are needed within the test system, since virtually every cable used in the system is a standard cable.
	<b>Fixture design</b>	Benefit from the design of the Keysight fixture platform for the most effective UUT connect. (Please ask the Keysight Application Engineers for more information.)
	<b>Application setup</b>	Adjust the test system for the application by simply adding custom parts, such as loads to the plug-in sub-modules. Simply adapt the system for other projects by replacing these plug-in boards.
	<b>Software design</b>	Use the test sequencer TestExec SL and its embedded knowledge about the system and resource assignment modules for fast development of switching paths and test sequences. Debug and optimize the test plan using the TestExec development environment. Deploy the test solution and leverage the Keysight device level support.

## Architecture Overview

As shown in Figure 2 and Table 2, the key to Keysight’s pre-configured functional test system is its flexible and modular system design.

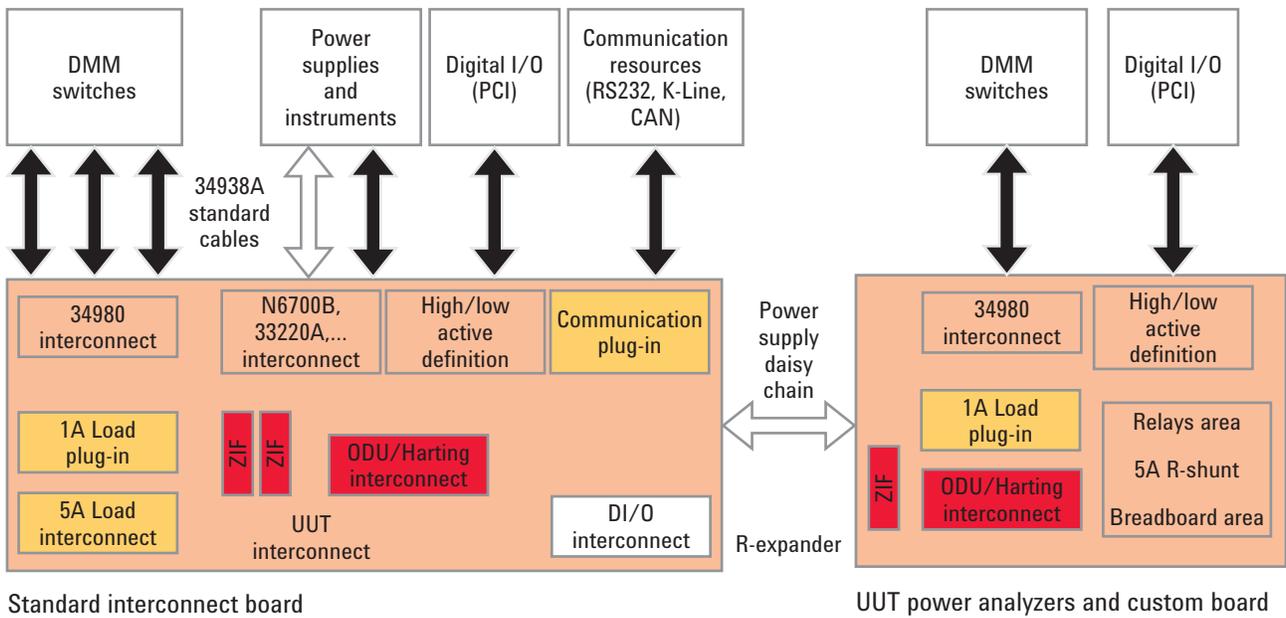
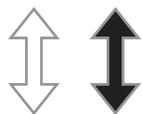


Figure 2. An example of a commonly used Keysight functional test system configuration illustrating the concept of leveraging from resource assignment modules

Table 2. Description of system configuration components shown in Figure 2

<b>Resource alignment module</b>	<p>In this system setup, two different resource alignment modules (shown in orange in Figure 2) are used:</p> <ol style="list-style-type: none"> <li>1. The <b>standard interconnect board</b> represents a generic resource containing application support for UUT digital in/out and UUT analog in/out. It makes the cross-connect between the instrumentation and mass interconnect. It also carries most of the loads in the form of load plug-in sub-boards. Please refer to the “Resource Overview” section for more information.</li> <li>2. The <b>UUT power analyzers and custom board</b> is dedicated to powering up the UUT and measuring standby and full load currents. It contains components to customize an own resources such as custom relays, PCI digital I/O, and the breadboard area.</li> </ol>
<b>Plug-in</b>	Attached to the resource alignment boards are several plug-ins in the form of plug-in sub-boards. (Shown in yellow in Figure 2.) These plug-in sub-boards represent loads or communication lines.
<b>Mass interconnect</b>	It is important to note that the board already contains the representation of the mass interconnect (shown in red in Figure 2,) which makes additional cabling to that interface obsolete. The zero insertion force (ZIF) connectors are used for the low current part (< 1 A) and Molex interconnects, which are usually connected to a Harting connector, and are used for the high current part of the mass interconnect.



Most of the cabling can be covered with standard cables (shown as black arrows in Figure 2) for cost effective integration and to allow easy maintenance.

# Architecture Overview

## Scalability

Figure 3 contains a more detailed view of the pre-configured functional test system's architecture scheme. The orange color code provides an idea of which components may be omitted for downgrade purposes.

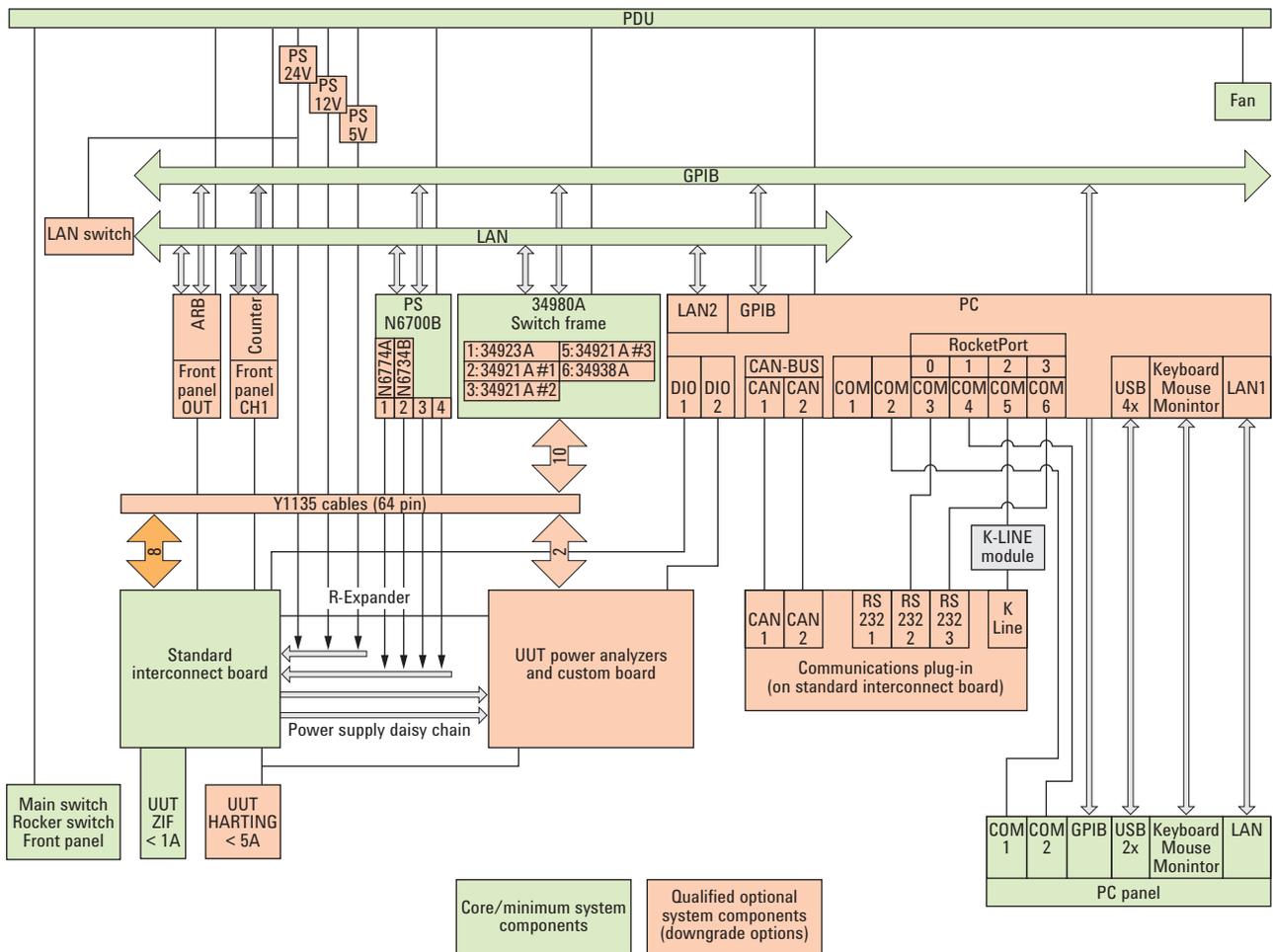


Figure 3. Detailed overview of the scalable system architecture of the pre-configured Keysight functional test platform

## Test System Overview

### Components

Keysight TS-5040 functional test system



- 0.75 m rack
- E3858A power distribution unit
- Rack fan assembly for 220 V system
- TS-5400 family controller, includes 1024 MB RAM, DVD-RW, floppy drive, keyboard, and mouse
- Microsoft Windows XP Professional
- TestExec SL software installed on TS-5400 controller
- N6700B 600 W modular power supply mainframe

Keysight 34980A multifunction switch/measurement unit



- Eight-slot LXI "switch and measurement core"
- Built-in DMM for reduced cost and rack space
- LXI with enhanced Web server for fast development
- GPIB interface
- Five multiplexer modules
- Four versatile matrix modules, including high speed read
- Three general purpose form C switch modules
- Five RF and microwave modules
- Precision, four-channel, isolated DAC for voltage and current
- Instrument-grade DI/DO
- Multifunction card for automation control
- Breadboard module for special applications

Keysight N6700B low profile MPS mainframe



- N6700B 400 W modular power supply mainframe
- Large selection of plug-in modules: 50 to 300 W each
  - Up to four plug-in modules
  - Basic, low cost modules
  - High performance modules for UUT power
  - Precision modules for parametric needs
- N67xx modular power supply mainframe options/modules
- N6700B – 400 W, four slot modular
  - N6701A – 600 W, four slot modular
  - N6702A – 1200 W, four slot modular

Keysight 33220A function generator/arbitrary waveform generator



- Fully-compliant to LXI Class C specification
- 20 MHz sine and square waveforms
- Pulse, ramp, triangle, noise, and DC waveforms
- 14-bit, 50 MSa/s, 64 k-point arbitrary waveforms
- AM, FM, PM, FSK, and PWM modulation types
- Linear and logarithmic sweeps and burst operation
- 10 mVpp to 10 Vpp amplitude range
- Graph mode for visual verification of signal settings
- Connect via USB, GPIB, and LAN

Keysight 53131A universal frequency counter



- 225 MHz bandwidth (optional 1.5, 3, 5, or 12.4 GHz)
- 10- or 12-digit resolution with 1 s gate time
- GPIB interface and IntuiLink connectivity software standard
- Data transfer rate of up to 200 fully-formatted measurements/second

Custom options

- Additional hardware
- Additional PC cards
- Cables and/or PC board for UUT interface/interconnect
- Custom mass interconnect
- Other custom options as defined and agreed

## Key Specifications

Rack size (W x H x D)	0.6 m x 0.75 m x 0.95 m
Power	230 V AC, single-phase, 50/60 Hz, 15 A max
Conformity	Complies with EN 55011:1998, A1:1999 CISPR 11:1997 (mod.), and A1:1999, Group 1, Class A conducting emissions

## Typical Configuration

Resources available on a typical test system:

Resource type	Max current	Wire	Typical	Details and remarks
UUT supply	5 A	4	4	Integrated switching for standby and full current measurement capability
UUT digital input	0.5 A	1	76	Selectable pull-up/pull-down functionality; custom resistors on exchangeable plug-ins
UUT digital output	5 A	1	4	Custom resistors on exchangeable plug-ins between UUT-out and power supply $\pm$ (pull-up/pull-down)
	1 A		12	
UUT analog input	1 A	4	12	
UUT analog output	1 A	2	24	Custom resistors on exchangeable plug-ins between UUT analog out $\pm$
	5 A		4	
Function generator 33220A		2	4	Function generator, counter, or other instruments
Counter 53151		2	4	
Spare instruments		2	3	
Communication lines		3	6	RS232, CAN, LIN, K-Line – 18 lines total
Utility power supplies			5 V	Fixed utility power supplies
			12 V	
			24 V	
Spare resources, custom resources			8	PCI digital I/O
	1 A	2	9	Customer defined in/out
			8	V-measure
	5 A	1	24	Customer defined resources

Total UUT pin-count: 532

## Pre-Configured Functional Test System Tools

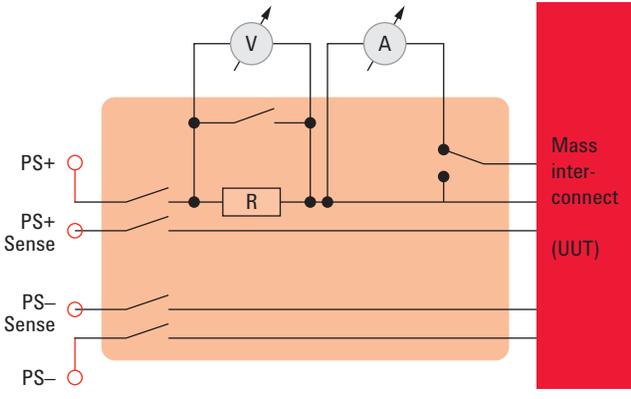
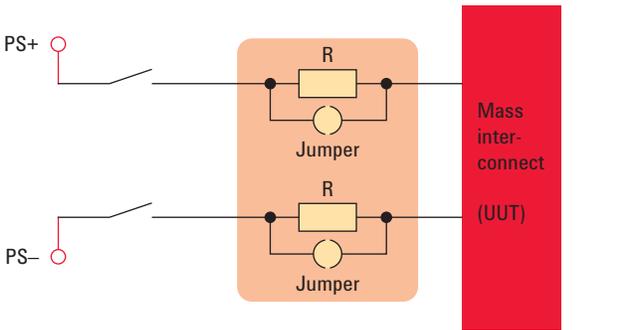
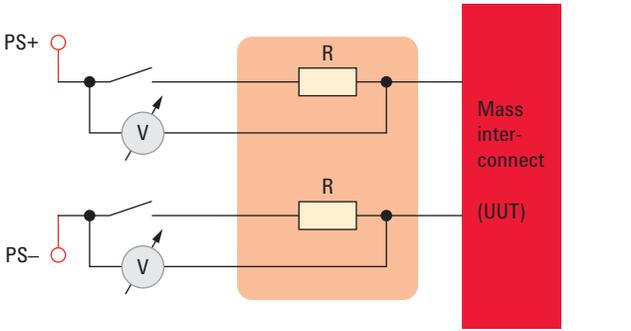
### Resource alignment module

Table 3 gives an overview of the resources which are spread over several alignment modules and plug-

in sub-boards. Please note that the given resource counts are bound to a representative setup. In cases where other resources or resource assignments are needed, please contact

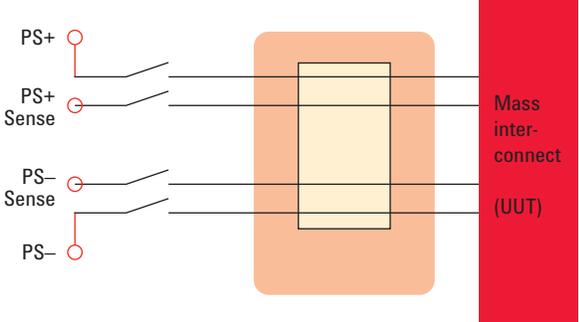
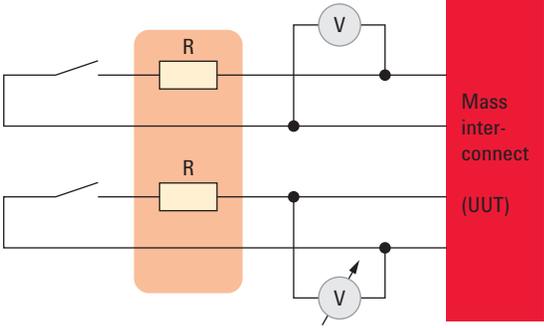
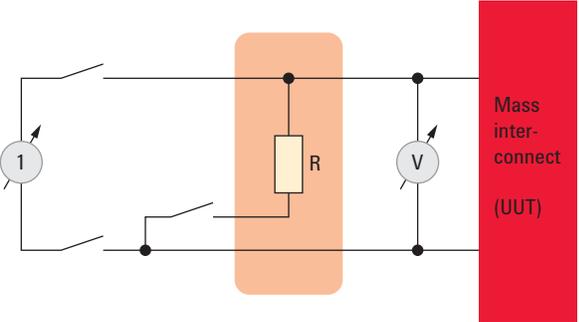
the Keysight application engineering team for assistance with adapting the modulation to the requirements needed by a custom project.

Table 3. Resources spread over several alignment modules and plug-in sub-boards

UUT power supply	4 units < 5 A
	<p>UUT power supply (in four wire): Measures the standby and full load currents of the UUT. Standby current is measured directly with the system's DMM. Full load current is measured via a shunt resistor. A direct connection path can be switched to eliminate the current path from the device. The device can be totally disconnected from the power supply.</p>
UUT digital input	2 x 38 channels (one wire) < 0.5 A
	<p>Stimulus of the UUTs' digital input channels: Jumpers can be used to bridge the resistors on the load plug-in sub-board if none are required. Note that half of the resources can be programmed to work in pull-up or pull-down mode.</p>
UUT digital output	1 x 12 channels (one wire) < 1 A four channels < 5 A
	<p>Measurement of the UUTs' digital output channels in unloaded and loaded state (comparison possible): Loads can be defined in groups and switched to the output. Pull-up or pull-down programmable. Ampere measurement on selected channels available.</p>

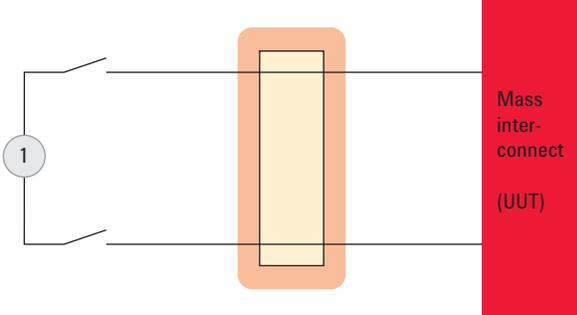
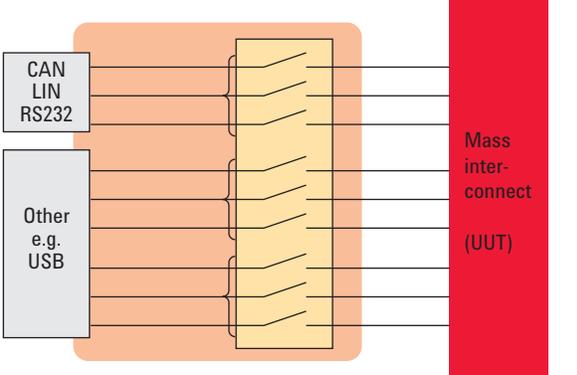
## Pre-Configured Functional Test System Tools

Table 3. Resources spread over several alignment modules and plug-in sub-boards (continued)

<b>UUT analog input</b>	<b>2 x 6 channels (four wire) &lt; 1 A</b>
	<p>Stimulus of the UUTs' analog input channels: Four-wire attachment of the power supply provides precise power at the input for UUT-assisted measurements. These resources also are routed through a load plug-in sub-board that simply propagates the channels without load.</p>
<b>UUT analog output</b>	<b>4 x 6 channels &lt; 1 A 4 + 2 spare channels &lt; 5 A</b>
	<p>Measurement of the UUTs' analog output channels in unloaded and loaded state (comparison possible): Loads can be defined in groups and switched to the output.</p>
<b>Counter (other measurement)</b>	<b>1 x 2 channels (two wire) &lt; 1 A 1 x 5 channels (two wire) 1 x 2 channels spare (two wire)</b>
	<p>Counting of the UUT output channels (attachment of loads possible on plug-in sub-board): Spare instrument paths for additional measurement instruments available.</p>

## Pre-Configured Functional Test System Tools

Table 3. Resources spread over several alignment modules and plug-in sub-boards (continued)

<p><b>Function generator (other stimulus)</b></p>	<p>1 x 4 channels (two wire) &lt; 1 A 1 x 2 channels spare (two wire)</p>
	<p>Frequency stimulus of the UUT input channels: Spare instrument paths for additional stimulus instruments available. These resources are routed through a load plug-in sub-board which simply propagates the channels without load.</p>
<p><b>UUT communication lines</b></p>	<p>5 x triplet = 15 lines 1 triplet spare un-switched</p>
	<p>UUT communication lines are available in triplets for direct usage of CAN, LIN, or RS232. All communication lines are switchable, line-per-line, for error simulation or to gain galvanic isolation between UUT and communication lines for standby current measurements. Other communication protocols are possible by rearrangement and combination of triplets.</p>

## Pre-Configured Functional Test System Tools

### Mass interconnect pin-out

Connector	Resource alignment module	Resource name	Wire count	Count	
ITT ZIF (< 1 A)	Standard interconnect board (ZIF 3+4)	UUT digital input (< 0.5 A)		76	
		UUT digital output		12	
		UUT analog input	4	12	
		UUT analog output	2	24	
		Function generator	2	4	
		Counter	2	7	
		Spare voltage measurement	2	4	
		Spare instrument	2	4	
		Communication lines		18	
		Auxiliary voltage 5 V		2	
		Auxiliary voltage 12 V		2	
		Auxiliary voltage 24 V		2	
		Auxiliary voltage ground (GND)		6	
		System ground		6	
		Safety ground		12	
		Utility digital output (incl. GND)		10	
		Spare	2	16	
		UUT power-analyzers and custom board (ZIF 7)	Custom signal		141
			Auxiliary voltage 5 V		1
			Auxiliary voltage 12 V		1
	Auxiliary voltage 24 V			1	
	Auxiliary voltage GND			3	
	System ground			3	
Harting (< 5 A)	64	UUT digital output		4	
		UUT analog output	2	4	
		Spare	2	2	
	UUT power-analyzers and custom board	UUT battery (BAT)	4	4	
		5 A GP switch	2	2	
	Spare		28		

## Pre-Configured Functional Test System Tools

### Keysight TestExec SL software

The Keysight TestExec SL software reduces development time. The TestExec SL software comes pre-installed on the industrial PC (IPC) and is ready for software development. It provides a complete test development and test execution environment which also allows the user to organize and order tests, reconfigure the tests, profile the execution speed, and debug tests. The software provides an efficient and effective structure for developing the test plans and sequencing for testing tasks.

Several key features in the TestExec SL help the user reduce software development time:

- 1. Accelerated test development:** Action wizard supports multi-language action code writing topology; editor/switch manager with streamlined switching topology configurations
- 2. Streamlined test execution:** Simple hierarchical structure and advanced executive tools, including advanced sequencing and test flow controls, and debugging tools

- 3. Increased productivity:** Throughput multiplier enables parallel multiple-UUT flashing for higher throughput while the test profiler helps to evaluate and analyze post-testing performance
- 4. Integrated test efforts:** Open architecture using Microsoft COM standard for easy sharing; data logging and reporting with customizable format for database systems

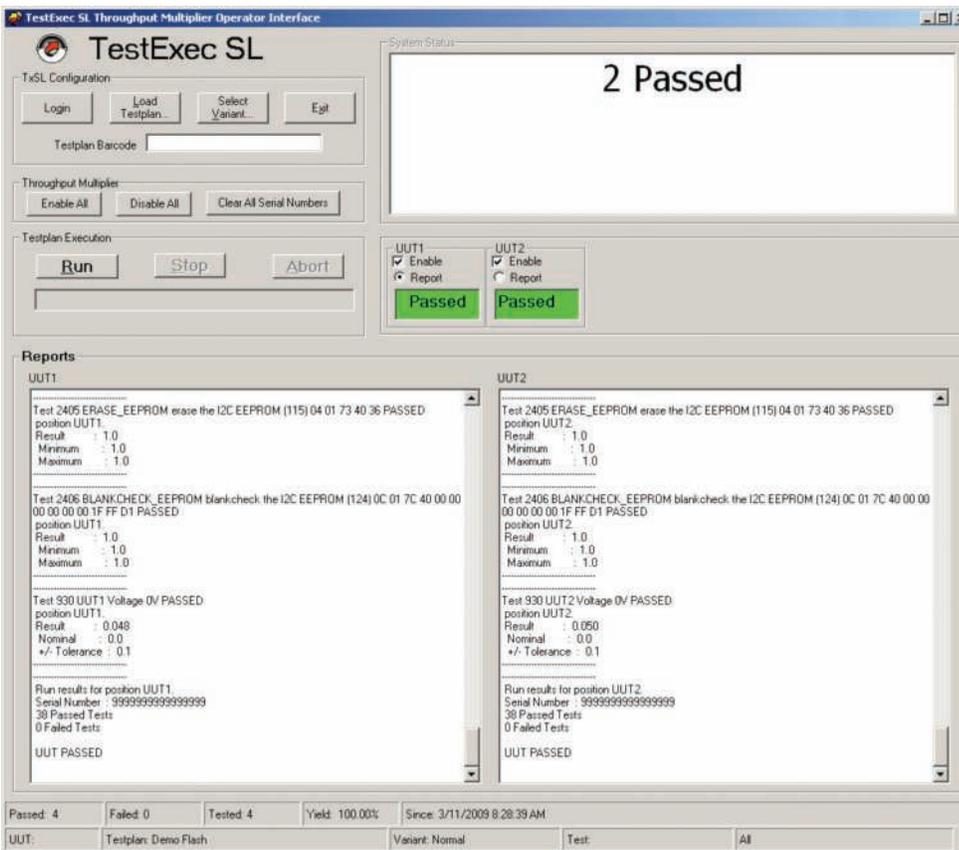


Figure 4. An example of a two-up operator user interface with easy-to-use features

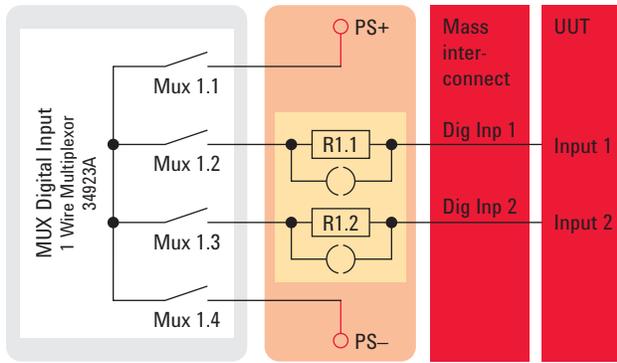
## Pre-Configured Functional Test System Tools

### Embedded switch management

The TestExec Switching Manager simplifies the creation of switch paths in the test plan. The entire

hardware connection information of the test solution is already integrated into the Topology Editor on delivery. This helps the programmer to quickly develop the application and focus on the initial tasks.

#### System concept



#### Topology Editor

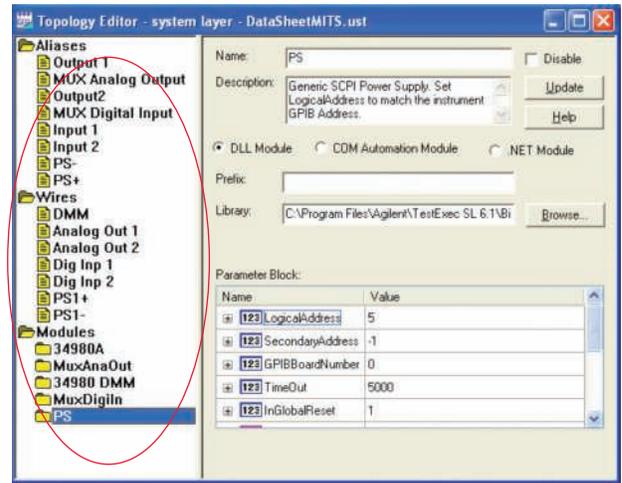


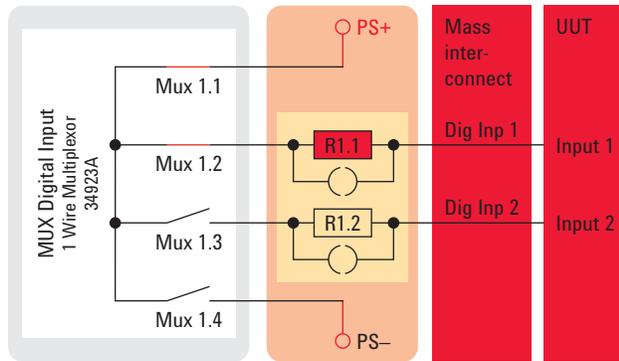
Figure 5. An example of the Topology Editor graphical user interface (GUI)

## Pre-Configured Functional Test System Tools

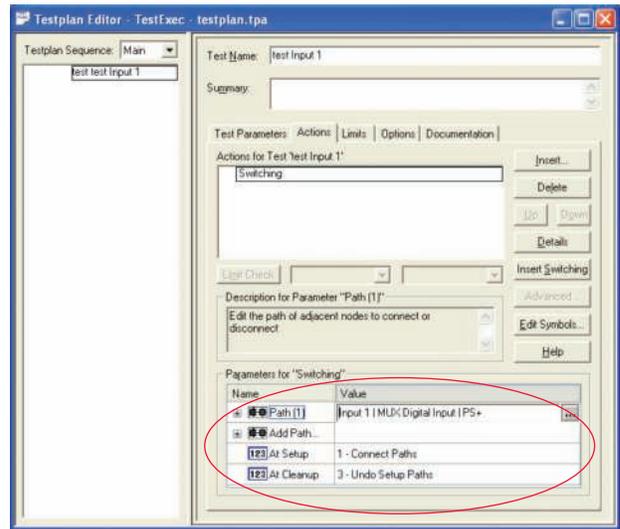
The Switching Manager provides an overview of the entire measurement chain, including available instrumentation, inner system wiring, fixture connection, and wiring and UUT pin-

out. During the setup of switch paths in the Switching Manager, no detailed schematic knowledge is required – the programmer only needs to keep the system concept in mind.

Switch state - Input 1



Switching Manager



Switch path

Input 1 → MUX Digital Input → PS+

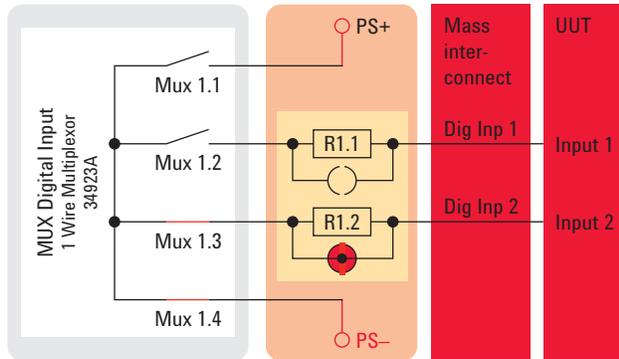
Figure 6. An example of the Switching Manager GUI

## Pre-Configured Functional Test System Tools

In-depth details like instrument addresses, pin/plug numbers, slot numbers, and relay numbers are not needed during test plan creation. The idea is to use easy-to-remember and

descriptive names for all nodes. The Switch Path Editor leads the programmer quickly through the topology by filtering and finding adjacent nodes.

Switch state - Input 2



Switch Path Editor



Switch path

Input 2 → MUX Digital Input → PS-

Figure 7. An example of the Switch Path Editor GUI

## Related Keysight Literature

Publication title	Pub number
<i>Keysight 3498A Multifunction Switch/Measure Unit Data Sheet</i>	5989-1437EN
<i>Keysight N6700B MPS Low-Profile Modular Power System Data Sheet</i>	5989-1411EN
<i>Keysight 33220A 20 MHz Function/Arbitrary Waveform Generator Data Sheet</i>	5988-8544EN
<i>Keysight 53131A/132A/181A Counters Data Sheet</i>	5967-6039EN
<i>Keysight TS-5040 Entry Functional Test Rack for System- and Self-Integrators Data Sheet</i>	5989-7943EN
<i>Keysight TestExec SL 6.1 Data Sheet</i>	5989-8731EN

**myKeysight**

**myKeysight**

[www.keysight.com/find/mykeysight](http://www.keysight.com/find/mykeysight)

A personalized view into the information most relevant to you.



[www.lxistandard.org](http://www.lxistandard.org)

LAN eXtensions for Instruments puts the power of Ethernet and the Web inside your test systems. Keysight is a founding member of the LXI consortium.



**Three-Year Warranty**

[www.keysight.com/find/ThreeYearWarranty](http://www.keysight.com/find/ThreeYearWarranty)

Keysight's commitment to superior product quality and lower total cost of ownership. The only test and measurement company with three-year warranty standard on all instruments, worldwide.



**Keysight Assurance Plans**

[www.keysight.com/find/AssurancePlans](http://www.keysight.com/find/AssurancePlans)

Up to five years of protection and no budgetary surprises to ensure your instruments are operating to specification so you can rely on accurate measurements.

**Keysight Channel Partners**

[www.keysight.com/find/channelpartners](http://www.keysight.com/find/channelpartners)

Get the best of both worlds: Keysight's measurement expertise and product breadth, combined with channel partner convenience.

[www.keysight.com/find/automotive](http://www.keysight.com/find/automotive)

## More information

Please contact Keysight's Systems Solutions to obtain additional details, request pricing information, and discuss customized applications or email our respective regional sales managers directly for more details.

For more information on Keysight Technologies' products, applications or services, please contact your local Keysight office. The complete list is available at: [www.keysight.com/find/contactus](http://www.keysight.com/find/contactus)

### Americas

Canada	(877) 894 4414
Brazil	55 11 3351 7010
Mexico	001 800 254 2440
United States	(800) 829 4444

### Asia Pacific

Australia	1 800 629 485
China	800 810 0189
Hong Kong	800 938 693
India	1 800 112 929
Japan	0120 (421) 345
Korea	080 769 0800
Malaysia	1 800 888 848
Singapore	1 800 375 8100
Taiwan	0800 047 866
Other AP Countries	(65) 6375 8100

### Europe & Middle East

Austria	0800 001122
Belgium	0800 58580
Finland	0800 523252
France	0805 980333
Germany	0800 6270999
Ireland	1800 832700
Israel	1 809 343051
Italy	800 599100
Luxembourg	+32 800 58580
Netherlands	0800 0233200
Russia	8800 5009286
Spain	0800 000154
Sweden	0200 882255
Switzerland	0800 805353
	Opt. 1 (DE)
	Opt. 2 (FR)
	Opt. 3 (IT)
United Kingdom	0800 0260637

For other unlisted countries:  
[www.keysight.com/find/contactus](http://www.keysight.com/find/contactus)  
 (BP-07-10-14)