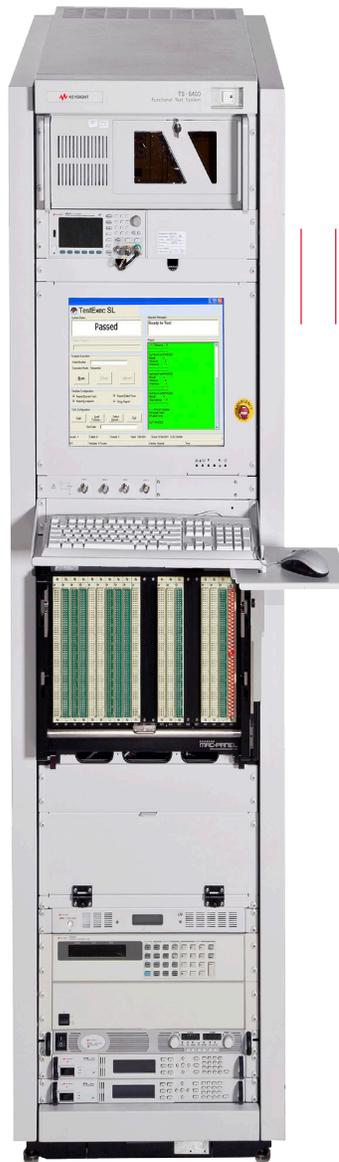


# Keysight Technologies

## Increasing Manufacturing Throughput of Automotive Controllers

### Application Note



Using the Keysight TS-5400 high performance PXI functional test system for multiple DUTs



## Introduction

Marketplace competition has made reducing costs a paramount goal for today's automotive manufacturers. One place they look for savings is from their component suppliers. Under pressure to provide lower cost products, manufacturers of automotive controllers must find a solution to increase production throughput, without compromising product quality.

This application note describes how automotive manufacturers can boost throughput using the Keysight TS-5400 Series 3 high performance PXI function test system for multiple devices under test (DUTs). This system provides thorough test coverage, high accuracy, and repeatability for optimum assurance of product quality.

## System Description

### Hardware

TS-5400 Series 3 is a PXI-based high performance automotive functional test system with LXI instrumentation designed to lower the cost of testing with higher data transmission rates. The system interface uses only one type of high density interconnect cable assemblies (ICA) to support testing of up to 464 measurement pins.

### Software

The system comes with the Windows 7 64-bit operating system and Keysight TestExec SL 7.1.2. Keysight TestExec SL 7.1.2 is a proven functional test solution for electronics manufacturing and includes the TS-5000 library of over 400 pre-built automotive tests. Since the TS-5400 is compatible with most test executive software, customers also maintain the option of selecting their preferred type of test sequencer.

### Application

Robust interconnect design, scalability, and enhanced software capability render the system suitable for high pin count DUT test applications (> 200 pins) and for simultaneous testing of multiple DUTs. Manufacturers of automotive controllers have a choice of instrumentation types, options, and configurations to suit their test needs. Figure 1 provides a high-level description of the system interconnections of TS-5400 Series 3.

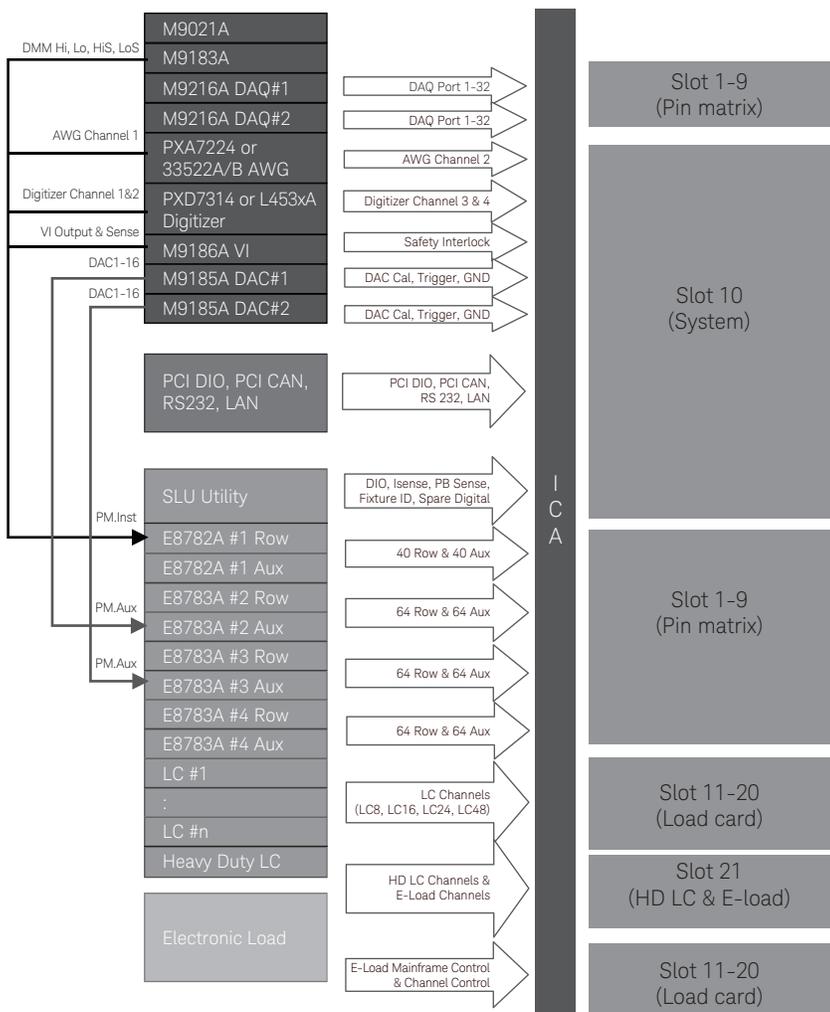


Figure 1. High-level block diagram and system interconnections of the TS-5400 Series 3

## Implementation

To test multiple DUTs and achieve higher throughput, a test system needs to provide high pin density. This allows the test solution to support average automotive devices as well as high pin count devices such as engine control units (ECUs) for powertrains.

To highlight the performance benefits of the TS-5400 Series 3 this section illustrates the differences between this parallel processing unit and using a traditional sequential test solution. The comparisons are based on testing two homogenous ECUs in production. Figure 2 shows a simplified block diagram of TS-5400 Series 3 test setup for two ECUs.

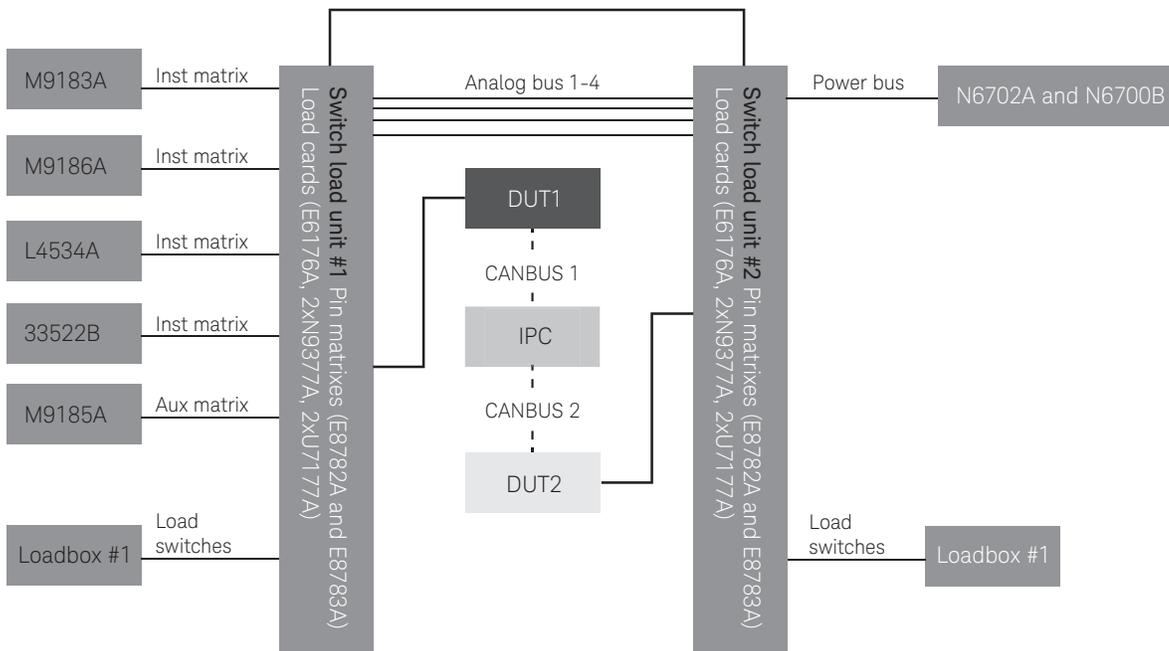


Figure 2. Simplified block diagram of the TS-5400 Series 3 test setup for two DUTs

In the past, the common practice for increasing production throughput has been to increase the number of test systems. Since test instrumentation is shared for the DUTs, the TS-5400 system minimizes asset investments, and provides greater throughput per foot of manufacturing floor. Additional savings stem from the TS-5400's architecture, which is able to simultaneously test multiple DUTs on a single system by re-using instrument resources. This capability allows test throughput to be improved via three methods.

## Implementation

### Throughput multiplier

The throughput multiplier is a TestExec SL feature that enables batch testing of multiple, identical DUTs. The throughput multiplier consolidates common tasks such as load/unload, instrument setup, and load routing, and is an effective tool for overlapping inherent latency in DUTs and instrumentations. For example, test and setup can often be executed at the same time or only once for both DUTs (refer to Figure 3). This is particularly beneficial when the instruments, such as power supplies and digitizers, require longer setup time.

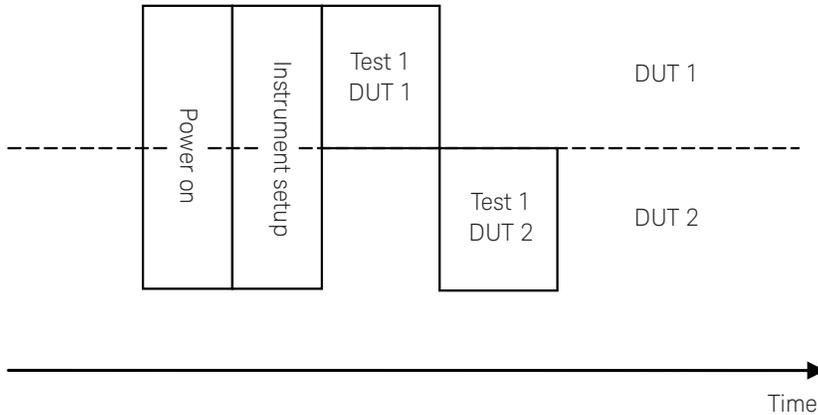


Figure 3. Setup typically needs to be executed once for multiple modules

More commonly, there is a need to put a delay between setup and measurement since modules take time to settle from a sent command. For example, the setup and latency of two DUTs can be overlapped provided both DUTs have their own individual serial port. Therefore, the delay for the two DUTs is shared, rather than sequential (refer to Figure 4).

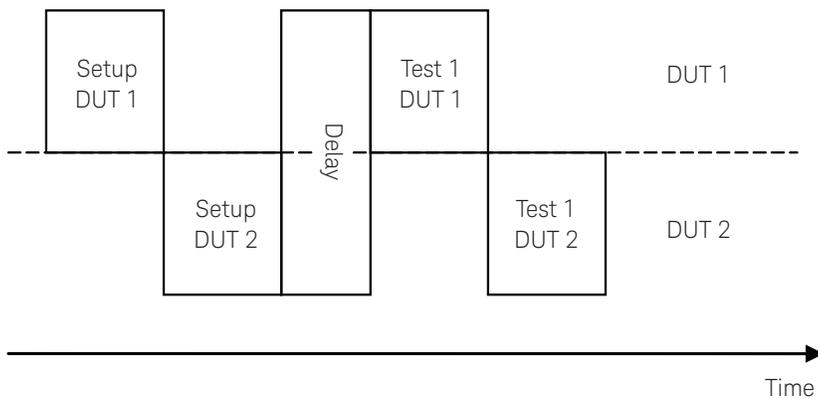


Figure 4. Multiple modules setup and measurement sharing a single delay

## Implementation

### EEPROM background test

EEPROM testing needs to be done for most automotive controllers. A good way to shorten the total test time is to run the EEPROM test in the background while performing DUT functional test.

The multiple DUTs test capability of the TS-5400 allows the EEPROM testing for both DUTs to be done almost in parallel, as shown in Figure 5. The key criterion here is that each DUT must have a dedicated serial port to facilitate this parallel approach. EEPROM test for most automotive controllers can constitute as much as 40 percent of the total test time. By running EEPROM tests in the background, production throughput can be improved significantly.

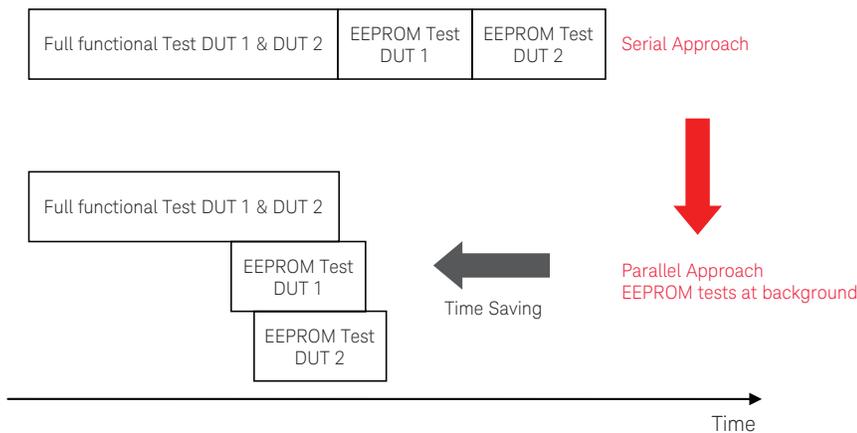


Figure 5. EEPROM tests running in the background during functional testing, significantly reduces the total test time

### Optimization with high-performance power supply

Test time improvement is also achieved by using an Keysight LXI-compliant N6700B/ N6702A modular power supply on the TS-5400 Series 3. The power supply works with high-performance, auto-ranging DC power modules to provide high accuracy, fast programming speeds, and quick output response time (five to ten times faster than other programmable power supplies). This approach shaves off approximately 200 ms per signal output. Testing automotive controllers frequently requires different power levels to simulate the controller's in-use monitoring of the vehicle's environment. A typical ECU could require more than 10 various signal conditions. By trimming 200 ms per output, more than two seconds of test time is eliminated, total test time is reduced by roughly three seconds after optimization, providing approximately a 5 percent of throughput improvement per DUT.

## Implementation

### Performance comparison

Table 1 shows actual results of testing two DUTs at a controller product facility using both a traditional method of testing the DUTs in series, and using the parallel testing capabilities provided by the TS-5400 Series 3. Testing using a serial approach required 59 seconds to produce one unit, while the TS-5400 Series 3 produced two units within 78 seconds, averaging 39 seconds per unit. Multiple DUTs benchmark testing performed on a TS-5400 Series 3 shows approximately a 34 percent test time reduction, which translates to about a 51 percent throughput improvement.

Production	Test time (seconds)	Annual output (unit)
One DUT on customer's site	59 sec/1 DUT	285k
Two DUTs with TS-5400	78 sec/2 DUTs	431k
Difference	-34% per DUT	51%

Table 1: Throughput comparison, assuming operation runs 80 percent of the year with two production shifts (eight hours per shift)

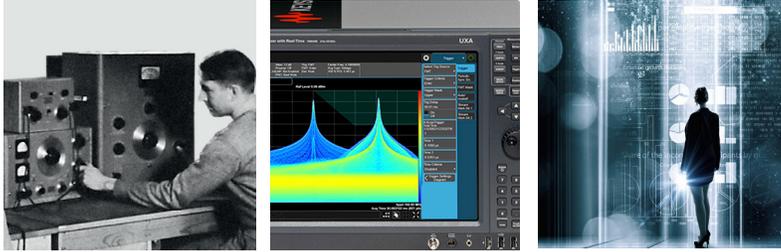
## Results and Conclusions

With escalating industry pressure to lower costs by increasing throughput, the TS-5400 Series 3 with multiple DUTs test capability offers ways to increase throughput and help automotive controller manufacturers significantly reduce their cost of test. Based on actual manufacturing testing, the TS-5400 Series 3 was demonstrated its ability to reduce test times by 34 percent per DUT and increase throughput by 51 percent annually. Since the TS-5400 Series 3 reduces the equipment necessary to realize these meaningful achievements, additional savings are realized by frugal use of production floor space.

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