



Agilent TS-5020 Automotive Electronics Functional Test System

Product Note

Test Engineering Challenges

On time test deployment within budget requires a test system providing adequate test coverage and test times while ensuring the manufacture of quality products. In developing a test platform, you must balance three competing goals: **time** (test development, execution and system deployment); **cost** (capital and integration); and **scope** (throughput, accuracy and flexibility) [see Figure 1]. In today's automotive electronics manufacturing environment, a reusable, scalable test platform meets evolving test requirements and lets you stay competitive.

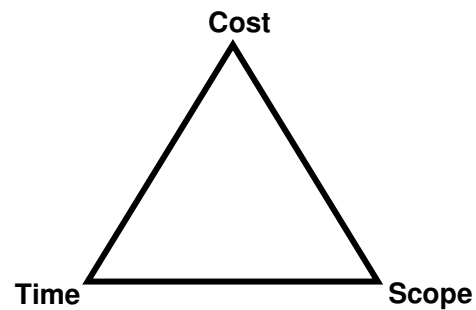
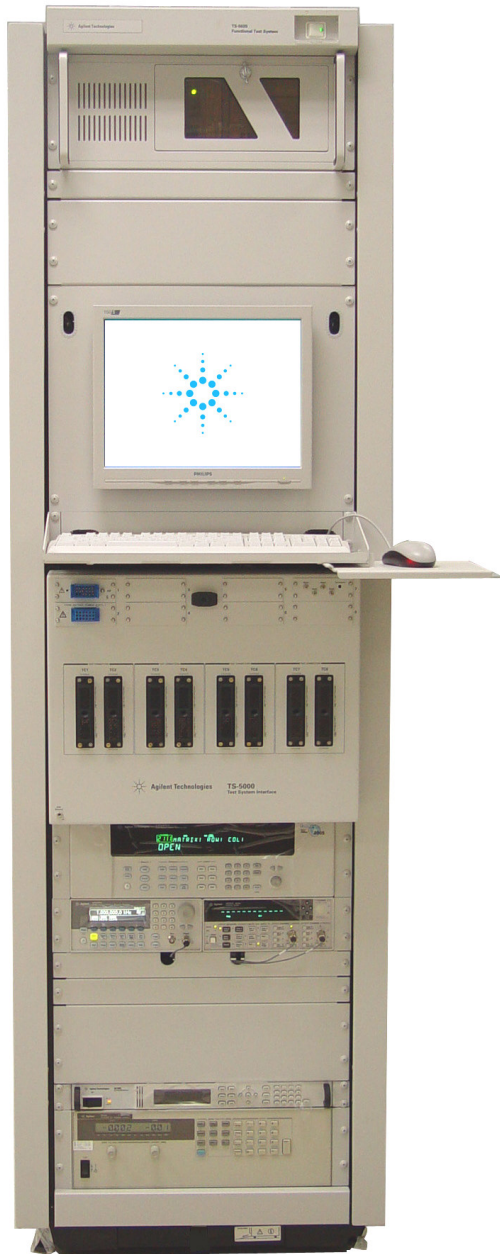


Figure 1: The Balancing Challenge

There are three approaches to choose from when creating a test system: use your in-house test department to develop and build your own, outsource the development of an entire system, or use a commercial off-the-shelf platform as the basis for the test system to be deployed.

The Agilent Technologies TS-5020 is another addition to our commercial, off-the-shelf platform tuned specifically for Automotive Electronics Functional Test. With the look and feel of the higher-end TS-5400 Series II, the TS-5020 attempts to address the requirement for a lower cost measurement system, catering to a medium pin count range with light duty switching.

Manufacturing Goals

Producing quality ECMs faster and at a lower cost than the competition, without compromising test coverage, can be an overwhelming challenge in the fast-paced automotive electronics industry. In exploring the three competing goals [see Figure 1], the need to focus on each individually, while simultaneously studying how they relate to one another, becomes increasingly clear. Meeting the tremendous deadline pressure to get manufacturing test lines set up on time requires test engineering to perform faster test development, execution and line integration. In turn, increasing throughput to decrease the test cost per ECM requires faster test system to accommodate the rapid introduction of new convenience, security, safety and body electronic modules.

Achieving the proper balance among all the three goals is difficult yet necessary for manufacturers to better meet OEM timelines. In an effort to find this balance, where time is the ultimate constraint, manufacturers are forced to make decisions on trading test coverage, for maintaining a lean time-to-market. Or, manufacturers are forced to make decisions on trading wide ranging, flexible ECM test capability for module-dedicated test systems – a poor use of assets in the long term. Making a decision between issues of quality and test system capabilities is a choice no manufacturer should have to face. That's why Agilent is pleased to introduce another competitive test system that allows for flexibility in **scope**, and yet maintains a low **cost** providing you a faster **time** to market.

The Agilent Solution

The TS-5020 Automotive Electronics Functional Test System helps manufacturers get their products to market faster by accelerating test system deployment. Engineered with the three critical manufacturing goals in mind, this system caters for flexibility, speed and quality to automotive electronics production. When it comes to flexibility, a universal test system core of both hardware and software can easily be modified to suit your particular test strategy and range of ECMs. As for speed and quality, the test executive accelerates both the development and execution of tests with over 400 test routines tuned towards automotive applications.

From simple ECMs, like climate control, immobilizers and RKE (remote-keyless entry), to safety ECMs such as airbag and ABS/TC, the TS-5020 aims to meet the price for performance value. The system comes equipped with measurement resources, switching, a test executive and automotive tuned library routines. Racking, cabling and optional fixturing are included, as well as standard software development tools that enable test engineers to deploy test systems at a much faster rate than building test systems from individual components.

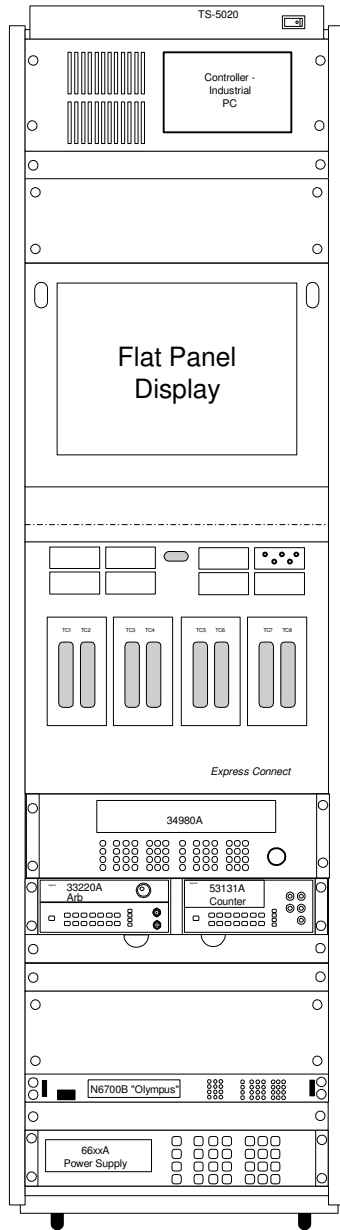


Figure 2: E2240A

AGILENT E2240A – TS-5020 Automotive Electronics Functional Test System

At the heart of the E2240A [see Figure 2] is the award winning Agilent 34980A Switch/ Measurement Unit with a built in 6.5 digit multimeter. The system interface uses the Express Connect method. GPIB instruments are optional to enhance the measurement capabilities of the system together with a range of power supplies.

Key Features

Measurement Switching

The 34980A provides the switching platform for the TS-5020. To achieve a low cost low pin count switching, the module supplied with the 34980A is configured as a 16x4x16 (16 instrument x 4 bus x 16 pin) switch matrix. Additional modules can be added and configured as 4x32 to increase the pin channel support up to 112 pins total.

Measurement

Keeping the TS-5020 a low cost system, the 34980A also offers a built-in Digital Multi Meter (DMM) complete with independently configurable channels for the measurements you choose. This is a 6½ digits DMM with a .004% of accuracy with DC voltage measurements. Complete with channel alarms and math-functions.

Load Switching

With its eight-slot mainframe, the 34980A can be added with a 20 channel “form A” switch to provide light duty load switching enabling it to support 3A continuous current with a 5A peak.

Mass Interconnect

The switching interconnects to the unit under test (UUT) via the Express Connect interface. This interconnect consist of an interface connect assembly (ICA) and an interface test adapter (ITA), each having its own connector blocks and matching pins. The ICA is mounted to the system rack and feature a hinged insert that, when released, allows the panel to fold down 90° away from the system. This design allows convenient access to the wiring. The ITA inserts into the ICA and locks in place.

Additional Module Options for 34980A

34933A Dual / Quad 4x8 Reed Matrix Module

Increments the pin count when required

34938A 20 Channel 5A Form A Switch Module

A 20 Channel switch, allows for simple light duty load switching, supporting a 3A continuous current with a 5A peak.

3494xA Quad 1 x 4 RF Multiplexer Module

An RF multiplexer offering bi-directional switching for test signals with high channel isolation. Available in 50 or 75 ohm supporting 3Ghz and 1.5Ghz respectively.

34945A RF Switch/Attenuator Driver Module for 34980A

A switch/attenuator driver allowing control of switches and attenuators external to the system. The module provides power and control signals for many of the popular microwave switches and attenuators.

Additional Instrument Options

33220A Function / Arbitrary Waveform Generator

The 33220A uses direct digital synthesis techniques to create stable, low-distortion output signals that ensure accurate results. It offers 11 standard waveforms plus pulse and arbitrary waveforms. You could also create custom waveforms using the 14-bit, 50MSa/s, 64K-point arbitrary waveform function. The variable-edge pulse function, along with the PWM, provides excellent flexibility for automotive test applications.

53131A Universal Frequency Counter

The two-channel 53131A offers 10 digits per second of frequency or period resolution and bandwidth of 225 MHz. Time interval resolution is specified at 500ps. An optional third channel provides frequency measurements up to 3 GHz, 5 GHz, or 12.4 GHz. With fast signal processing and automated limit tests, the 53131A can make measurements such as frequency, rise/fall time, phase and more quickly and correctly.

66xxA DC Power Supply

This series of 200W linear-regulated dc power supplies is fully programmable via GPIB designed to maximize the throughput

of UUTs through the manufacturing test process with fast up and down programming time.

N67xxA Low-Profile Modular Power Supply System

A family of small and flexible modular power supply made of a 4-slot mainframe that accepts 1 to 4 modules allowing it to provide up to 400W of power. Additional options exist to expand this to a maximum output power of 1200W. Fast command processing makes it ideal for product test environments.

System Configurations

Key Components of the E2240A

34980A Multifunction Switch / Measure Mainframe with built-in DMM

34933A Dual / Quad 4x8 Reed Matrix Module for 34980A

E2235A Industrial PC

Optional Instruments

34933A Dual / Quad 4x8 Reed Matrix Module for 34980A

34938A 20 Channel 5A Form A Switch Module for 34980A

34941A Quad 1 x 4 50 ohm 3 GHz RF Multiplexer Module for 34980A

34942A Quad 1 x 4 75 ohm 1.5 GHz RF Multiplexer Module for 34980A

34945A RF Switch/Attenuator Driver Module for 34980A

66xxA DC System Power Supply, 200W

N67xxA Low-Profile Modular Power Supply System, 50W-300W

33220A Function / Arbitrary Waveform Generator

53131A Universal Frequency Counter

Block Diagrams and Hardware Overview

The architecture of the TS-5020 utilizes a Windows XP Pro-based controller connected to the Agilent 34980A Multifunction Switch/Measure Mainframe with a choice of plug-in modules which includes switching, D/A converters and a light load module.

The controller runs Agilent TestExec SL software, a mature test executive with hundreds of pre-tested automotive-tuned library routines.

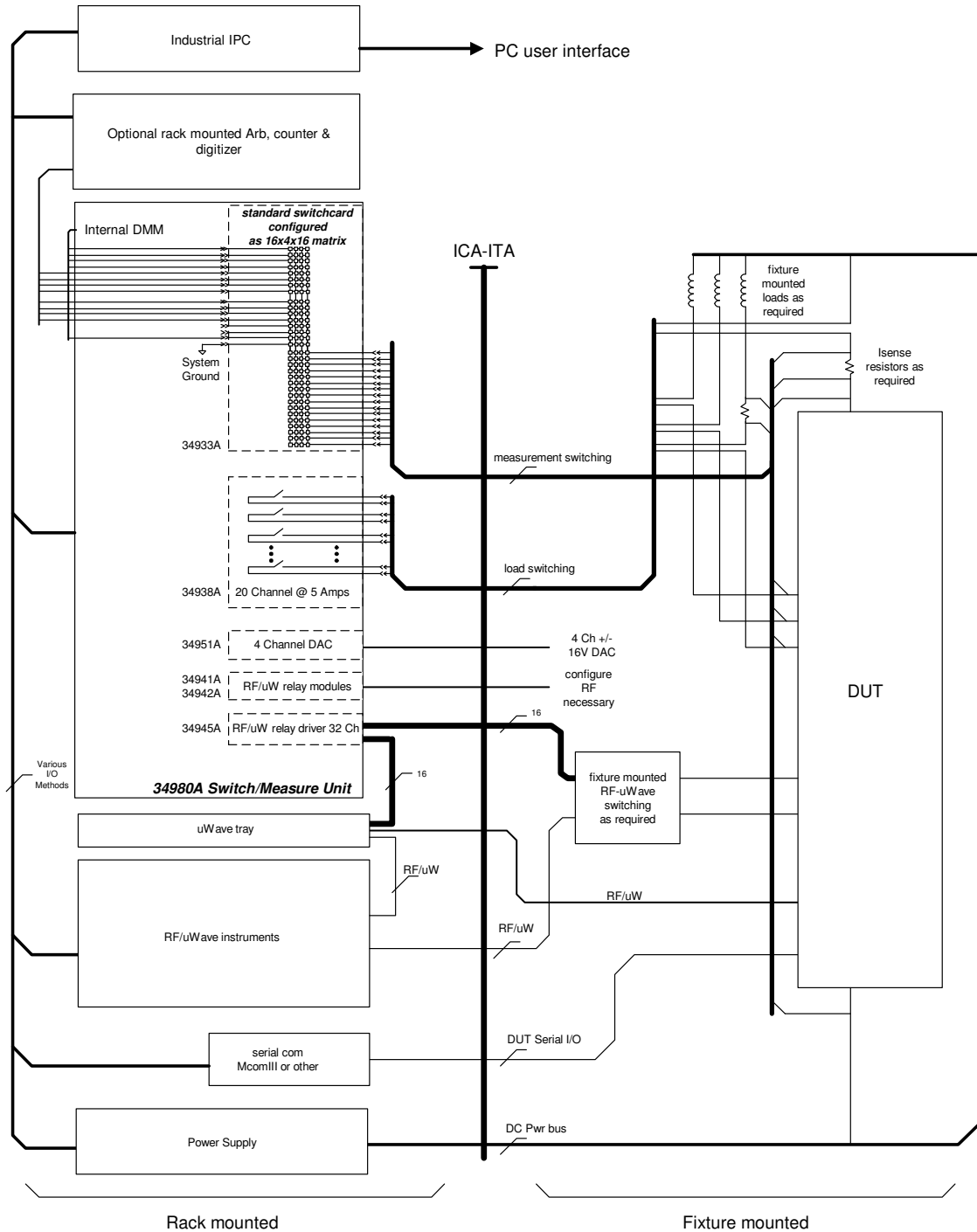


Figure 3: System Block Diagram

Unique attributes of automotive functional testing

Functional testing of automotive Electronic Control Modules (ECM) can strain the capabilities of a typical test system. The TS-5020 can address a wide range of ECMs, from climate control to ABS to air bag control. In the table below [see Table 1], we'll take a closer look at the test requirements for some of these ECMs and the solution which the TS-5020 can provide.

Test requirements

The advancement of electronically controlled functions of today's cars requires a wide range of capabilities: fast switching; versatile signal generation; and serial communications to name a few. The TS-5020 is designed to meet these challenges by increasing production volume with higher throughput while reducing the cost of test. As summarized in the table below, the TS-5020 offers a variety of solutions for each of the critical test requirements.

Table 1: TS-5020 solutions for automotive Electronic Control Module testing

Test Requirements for ECM	The Agilent TS-5020 Solution
Fast switching for routing of multiple signals and loads	<ul style="list-style-type: none">• Programmable, easy to use switch path editor• Scalable switching solution to cater up to 112 pins• Load switching support up to 5A• Maximum of 80 load channels• 42V-ready solution
Real-world waveform and signal generation	<ul style="list-style-type: none">• Variable reluctance and Hall-effect sensor simulation
High-current and high-voltage response handling	<ul style="list-style-type: none">• Flyback voltage and current handling• Voltages up to 150V, currents up to 5A• Period, frequency, timing and duration measurement capabilities
Serial communication	<ul style="list-style-type: none">• ISO-9141 capability• J1850 capability• J1939 / CAN capability / fault-tolerant CAN / single-wire CAN

Test Methodologies

The ability to test many types of modules with one system improves development leverage. Adding test methodologies that accelerate the measurement of each module, regardless of type, is the next step toward lower-cost test.

The Agilent TS-5020 offers two approaches that improve the flexibility and speed of the testing process. One is UUT-assisted testing, in which the ECM becomes an active participant in the testing process. The other is the throughput-multiplier strategy, which enables batch testing of multiple identical ECMs.

UUT-Assisted Test

As shown in Figure 4 below, most ECM designs include a serial interface. Communication protocols vary by manufacturer, but most comply with OBD2 standards. Variations include ISO-9141, J1939/CAN and J1850. The serial link is used in the automobile itself and can also assist in the testing of the module.

As a programmable device, the ECM can be loaded with either operational code or test code. Operational code is either present in ROM during test or is downloaded when the unit is shipped. Test code is either included in ROM or downloaded through the serial link into the module. By using test code as part of the test program, the TS-5020 establishes a set of condition to which the ECM responds. This test approach is called UUT-assisted test.

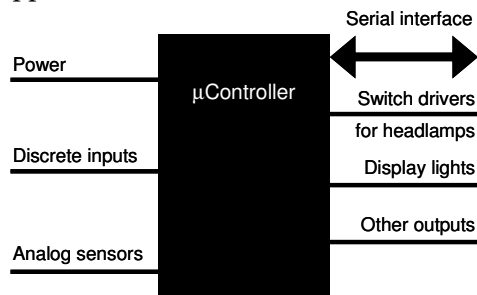


Figure 4: Example of Serial Interface for an Electronic Control Module (ECM)

Three mode

The TS-5020 enables three different modes for performing UUT-assisted test. The best choice of mode depends on the test stimulus source and response destination.

- **Serial Link Evaluation:** This mode simply evaluates the serial link and microcontroller. Commands sent to the microcontroller over the serial link prompt a response that is sent back to the test system. The system then verifies the response and may perform a full CRC memory check. Parametric tests may also be run to test serial link characteristics such as delay, rise or fall time, and input impedance.
- **I/O Status Evaluation:** This mode uses the test system I/O to determine ECM input states. It does this by sending a message over the serial link to the ECM prompting it to run a test routine. For example, this mode may be used to apply an analog input to the ECM to verify A/D conversion and the module's handling and communication of data over the serial link. (For example, the analog input may be a simulation of a sensor's output for air temperature.) In this mode, the test system can use UUT-assisted testing to assess proper functioning of several functions at once, including the controller, serial link, A/D and waveform processing circuitry.
- **Input Evaluation:** In this mode, the test system supplies an input then reads the value at either the input or output of the module. The evaluation can verify proper receipt of the signal at the module input or if the input caused the appropriate output.

Throughput Multiplier

The throughput multiplier test strategy (multiple-up UUT testing) is one way to increase throughput for a manufacturing environment. Multiple UUT testing not only consolidates tasks common to multiple

modules, such as load/unload, instrument setup of signal and load routing, it's also an effective strategy for overlapping inherent latencies in the UUT or test system [shown in Figure 5 and 6].

Testing

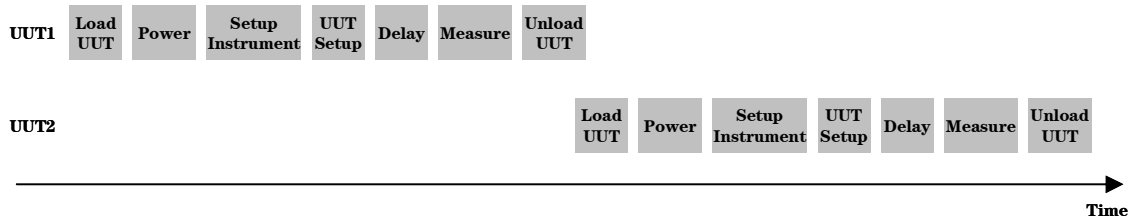


Figure 5: Single-up testing of use UUT at a time

Testing

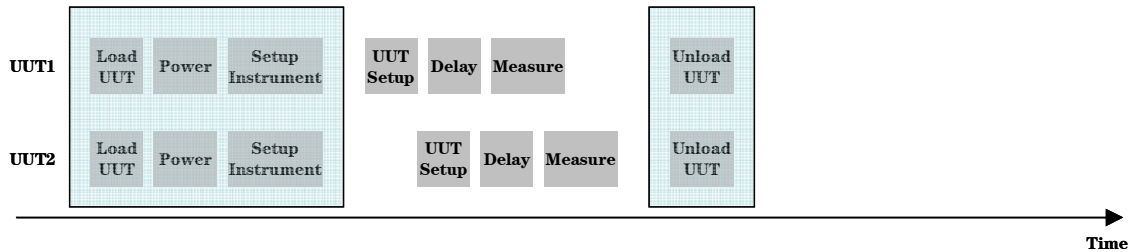


Figure 6: Multiple-up testing of two or more UUTs

Reduce Total Test Cost

Test cost is only one factor in reducing the total cost of manufacturing an ECM; however, it's the tangible cost that can be reduced by test engineering to reduce cost times, equipment costs and floor space. The TS-5020 answers the call by delivering reduced integration costs, floor space and test times.

With the volume increase in safety, security and convenience modules, manufacturers are looking for ways to meet their line-production rate without building up inventory on the production line. Using the *throughput multiplier* for parallel multiple-up testing of ECMs not only reduces floor space and increases asset utilization, it decreases test times per ECM.

Most electronics manufacturers insist that their biggest test costs are tied directly to the instrumentation hardware. But that may not be the case. Hidden costs of software engineering time, operating costs and maintenance expenses must also be considered in the cost equation. Operation costs include management, facilities, and the 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

System Software Reduces Development Time

The TestExec SL software which comes with the TS-5020 provides a complete test development and test execution environment for the entire software development job. The test executive environment is tuned for functional testing of electronic devices in manufacturing. The software runs on a PC with Windows XP Pro for optimum performance. Plus, it's all pre-installed and ready to use. The TestExec SL development environment is ideal for creating ECM functional test plans. It consists of re-usable tests, measurements and utilities for performing specific functions related to automotive

electronics functional test. 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. What's more, the software test execution environment allows an operator to test up to N modules simultaneously (where $N > 1$) 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.

The Agilent TestExec SL Software Development Environment

The hierarchical test development architecture encourages reuse to decrease development time on upcoming projects. The software provides an efficient and effective structure for developing the test plans and sequencing for functional test of automotive ECMs. In fact, many measurements, tests and utilities are already provided as building blocks. Over 400 routines tuned towards automotive test provide maximum quality. A test engineering software team needs only create the test plan and sequencing from the integral building blocks of software, add customization for the manufacturer's specific ECM serial commands and create any customer test and/or measurements.

Find the right solution for your needs

To discuss your requirement in detail, please call your local Agilent office to arrange a consultation. To learn more about the TS-5000 family, visit us on the web at www.agilent.com/find/TS-5020. The web site also contains information about the full range of Agilent products and services that can help your engineering teams simulate and diagnose system performance in the design stage.

Agilent Technologies' Test and Measurement Support, Services and Assistance

Agilent Technologies aims to maximize the value you receive, while minimizing your risk and problems. We strive to ensure that you get the test and measurement capabilities you pay 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 underline Agilent's overall support policy: "Our Promise" and "Your Advantage"

Our Promise

"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 that it works properly, helps with product operation, and provides basic measurement assistance for use of specified capabilities, at no extra cost upon request. Many self-help tools are available.

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Online Assistance

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