Methods for Testing Automobile Lighting, Safety, and Infotainment Systems
Introduction

Today’s automobiles increasingly feature sophisticated and complex lighting, radar, safety, information, and entertainment systems. And, while these technological advances contribute immensely to overall vehicle safety and intelligence, they introduce new testing challenges that may not previously have been a factor. This applications kit addresses test issues and suggests instrumentation that helps solve automotive test measurement challenges for automobile lighting, safety, and infotainment systems so you can learn how to resolve the challenges that are driving you.

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Get advice for your application.
Send us your question or join the discussion in our application forum.
Automotive LEDs (light emitting diodes) are becoming more and more popular as automotive manufacturers use an increasing number of LEDs in interior lighting such as overhead lighting, truck lighting, mood lighting, and dashboard lighting. In addition, LEDs are being used more for automobile flood lighting, headlights, taillights, indicator lights, and other exterior lighting.

LEDs need to be verified through the following tests:
- Forward voltage
- Reverse leakage current
- Reverse breakdown
- Light output

Featuring bipolar sourcing and wide current measurement range, Keithley SourceMeter® Source Measure Unit (SMU) Instruments enable complete and comprehensive LED testing with a single instrument.

Keithley SourceMeter SMU instruments offer:
- Four-quadrant operation with smooth transitions through 0V
- High current sensitivity with 0.1fA sensitivity for measuring leakage currents
- Voltage measurement with 1µV resolution and voltage sourcing with 5µV resolution
- Internal scripting language for fast automated testing
- Precision timing and channel synchronization of multiple SMU instruments with less than 500ns latency

Learn how to overcome the Electrical Measurement Challenges of High Brightness LEDs. Download the e-guide.
Safety Systems

Airbag Inflators and Seatbelt Pre-tensioner Actuators

Two key challenges for testing sensitive components such as airbag inflators is to do so without stressing or damaging the devices. The pyrotechnic device that actually triggers the gas discharge that inflates the airbag is called an initiator. The resistance of the initiator is a valid indication of a good device. To safely test the initiator, the test current must be kept below some specified level to prevent activating the initiator prematurely, which would not only destroy the device under test (DUT) but also presents a potential hazard. An initiator must be electrically isolated from the inflator housing because excessive leakage current between the housing and the initiator can prevent proper operation of the device. Consequently, an airbag module requires two resistance measurements. One test (for the initiator) measures a relatively low resistance using a limited test current; the other test (for isolation) measures a relatively high resistance using a moderately high voltage. In addition to the challenge of testing sensitive components such as airbag inflators without stressing or damaging the devices, it’s also challenging to find all of the testing performance required to do so in just one instrument.

Keithley’s Series 2790 SourceMeter® Airbag Test System tests single-stage or dual-stage inflators in a complete, one-instrument solution for automated testing of individual or multiple airbag inflators:

- Test inflators with source current as low as 1mA
- Test up to four devices in one setup
- Test both low resistance for continuity and high resistance for leakage resistance measurements
- Choose from five different configurations to cover a wide range of test applications
- Perform a complete test in under two seconds

Learn more about testing airbag inflators. Download the application note Testing Dual Airbag Inflators and Modules with the Model 2790 SourceMeter® Switch System.
Safety Systems

Single-instrument Solution for Simplified Airbag Assembly Electrical Characterization

The Model 2790 SourceMeter® Switch System is a high voltage, multi-channel resistance measurement solution that speeds and simplifies electrical checks of airbag inflators and many other automotive electrical test applications. It's the only commercial instrument that combines all the sourcing, measurement, and signal routing capabilities required to measure insulation resistance and conductor continuity in one compact, affordable instrument. Through the use of plug-in source/switch modules, the Model 2790 provides programmable high voltage and low current sourcing, 6½-digit DMM measurements, plus multi-channel switching support. This unique combination of capabilities establishes a new standard for price and performance in airbag inflator and other test applications.

Other Applications

The Model 2790 is the ideal solution for a variety of automotive electrical test applications, including:

- Pinched wire, high voltage, insulation resistance testing in automotive seats, avionics, etc.
- Multipin connector/harness continuity and leakage resistance measurements
- Multicontact/switch dry circuit continuity and leakage tests
- Automotive power/fuse center continuity and leakage resistance characterization
- PCB/PWB and general purpose short/open circuits testing

Download the Model 2790 data sheet to learn more.

Get advice for your application. Send us your question or join the discussion in our application forum.
Safety Systems

Radar for Passenger Safety

Radar technology is being incorporated into automobiles to address the ultimate goal of enhanced safety. Radar technology will take RF in automotive applications out to 79GHz and incorporate ultra-wideband (UWB) short range systems. Radar will be used for front/rear park assist, forward collision warning, lane change assist, blind spot detection, collision mitigation braking systems, and full speed range adaptive cruise control. These radar systems must have the flexibility and adaptability required for total awareness around the vehicle for complete collision detection and avoidance.

Designers of these systems need tools that can both generate and analyze extremely complex pulse patterns and can offer advanced scanning methodologies to validate the designs. These tools must be able to handle complex radar baseband, IF, and RF signals, as well as identify multi-system interference.

Tektronix offers oscilloscopes and real-time spectrum analyzers that can capture wide bandwidth data at high speed with long record lengths. With the most advanced triggering available on any measurement instrumentation, Tektronix oscilloscopes and analyzers can capture very short transients and extract small signals in the presence of large signals to help you efficiently design robust, reliable, and life-saving automotive radar systems.

Learn more about the fundamentals of the MDO4000B Series Mixed Domain Oscilloscopes.

Learn more about the Fundamentals of Real-Time Spectrum Analyzers.

Get advice for your application. Send us your question or join the discussion in our application forum.
Collision avoidance and adaptive cruise control systems have the ability to quickly and automatically stop a car to prevent it from accidentally running into the car in front of it. But for drivers to trust and completely rely on this capability, the safety system must be inherently safe and robust and must operate properly 100% of the time. It cannot be susceptible to external interference nor can it generate signals with incorrect data that may cause the system to perform improperly.

Adaptive cruise control and collision avoidance systems operate with radar transmitters and receivers in the 24GHz band and in the 77GHz band. Analyzing transient events and baseband signals at these frequencies requires fast signal acquisition, instruments with wide bandwidth capture, and vector signal analysis.
Safety Systems

Designing and Debugging Reliable Systems for Collision Avoidance – DPO7000C Digital Phosphor Oscilloscope and Vector Signal Analysis Software

Combined with a high frequency down converter, the Tektronix DPO7000C Series Oscilloscopes and SignalVu™ Analysis Software provide the signal acquisition necessary for detecting anomalies in RF systems and can:

- Capture signals with bandwidths up to 3.5GHz
- Sample waveforms at rates up to 40GSamples/second
- Detect random events by using one of the 1400 sophisticated triggering options
- Store up to 500 million samples
- Obtain time resolution as narrow as 250 femtoseconds

Learn more about the DPO7000. Read the data sheet.

SignalVu-PC analysis software enables detailed analysis in multiple domains.

Learn more about SignalVu-PC. Read the data sheet.

Characterize pulse trains, including anomalies, with data acquired from the DPO7000C-series oscilloscopes and study pulse shapes, frequency deviation, and phase trajectory with SignalVu analysis software.

Get advice for your application. Send us your question or join the discussion in our application forum.
Proper pressure in the tire is critical to automobile safety and efficiency. Under-inflated tires are more susceptible to ply separation and sidewall casing breakdown and cause thousands of accidents and injuries each year. In addition, it's estimated that just a 10% under inflation of a tire will reduce fuel economy by 1%. It’s no wonder that a majority of the countries where vehicles are manufactured are requiring tire pressure monitoring systems. So, a reliable tire pressure monitoring system is now an essential component of a new automobile.

Extensive verification and testing of a tire monitoring system is a critical necessity for every manufacturer of these systems. Since the sensors monitor a rotating tire, these systems must be wireless and typically operate in the range of 300MHz to 500MHz.

Robust operation with minimal susceptibility to interference of any kind is of prime concern for safety systems. Design and test engineers must ensure that their designs do not transmit incorrect information due to external interference and must also ensure that their transmission circuitry does not inject random signals that could also create incorrect tire measurements. Instrumentation is needed to evaluate the RF transmission in both the time domain and the frequency domain.

Tektronix MDO4000 Mixed Domain Oscilloscopes provide a one-instrument solution for analyzing and testing RF designs with time-correlated acquisition of time domain, frequency domain data, and digital data. The MDO4000B has these outstanding features:

- Mixed signal oscilloscope with integrated spectrum analyzer
- Four analog channels with bandwidths up to 1GHz
- 16 digital channels with 60.6ps fine timing resolution
- 1 spectrum analyzer channel
  - Frequency range 9Hz to 6GHz
  - Ultra-wide capture bandwidth >1GHz
  - Spurious-free dynamic range 65dBc (typical)

Download the data sheet to learn more.
Meeting EMC standards and eliminating EMI in automotive systems requires designs that both minimize emissions and can shield circuits from the increasing sources of noise in the automotive environment. The increase in noise sources is resulting from both integrated electronics and electronics devices brought into the automobile. Internal sources of interfering noise can originate from navigation systems, engine control systems, and wireless communication systems. External sources of noise brought into the automobile can include mobile phones, tablet computers, electronic gaming devices, and radar detection devices.

EMI/EMC test challenges include:
- Testing designs to ensure that emission levels will comply with national and international EMC standards
- Identifying the sources of noise that are interfering with system performance
  - RF interference
  - Power transients
  - Electrostatic discharge
  - Changing electric and magnetic fields from drivetrain power electronics and motors
- Capturing random events

An infrequent transient is captured on a Tektronix RSA series real time spectrum analyzer using patented DPX™ spectrum display technology. The red areas are frequently-occurring signals, and the blue and green portions are transients.

View the webinar: Practical Approach to EMI Diagnostics.

Get advice for your application. Send us your question or join the discussion in our application forum.
Safety Systems

Perform Comprehensive EMI/EMC Pre-Compliance and Diagnostics with High-Confidence Results

Tektronix real time spectrum analyzers, mixed domain oscilloscopes, along with SignalVu-PC are unprecedented in their ability to identify the source of EMI/EMC interference and to perform pre-compliance and compliance measurements.

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<td>- Low feed thru</td>
<td>- Discover elusive transient, impulse, and signal-within-signal events with 100% probability with over 292,000/s spectrum updates and swept DPX</td>
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<td>- Detecting low-level signals in broad sweeps with narrow resolution bandwidths</td>
<td>- Trigger and isolate spectrum events with 100% probability using patented DPX Density™, Frequency Mask, and Time-qualified Triggering, Frequency Edge, and cross-trigger oscilloscopes or logic analyzers within the event record</td>
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<td>- Detecting and characterizing impulse noise</td>
<td>- Analyze signals with MIL-STD and CISPR compliant filters and detectors</td>
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<td>- Finding signals-within-signals</td>
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<td>- Determining clock stability and settling to tuning, microphonics, and phase-hits</td>
<td>- Speed spur testing with the fastest scanning technology for wide spans and narrow resolution bandwidths</td>
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<td>- Correlating transient emissions to hardware and software states</td>
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| Pre-Compliance and Compliance                                                         | |
|--------------------------------------------------------------------------------------| |
| - Testing to standards and compliance levels with required filters and detectors     | |
| - Applying corrected measurements and limit lines                                    | |

Learn more about the Tektronix family of spectrum analyzers including real-time spectrum analyzers, mixed domain oscilloscopes, and analysis software.

RSA5000/6000 Series Real-Time Spectrum Analyzers

Get advice for your application.

Send us your question or join the discussion in our application forum.
The world’s highways will soon support intelligent transportation systems that will permit communication between vehicles, as well as between vehicles and roadside infrastructure. The technology is a dedicated short-range communication link based on the 802.11p WiFi standard. This communication link will enhance safety and improve flow on major highways.

Other 802.11 communication protocols will be utilized in vehicles so passengers can use their WiFi-enabled devices to make their travel more enjoyable.

Design and performance verification of 802.11-based communication systems built into the automobile involves a wide range of RF measurements such as:

- Carrier frequency error
- Symbol timing error
- Average and peak burst power
- I-Q origin offset
- Error vector magnitude
- Constellation analysis
- Symbol extraction

The problem is determining the root cause of a problem when an RF parameter is not within the required specification. View the 802.11 RF transmission simultaneously with both a time-correlated view of the time domain and the control signals using an MDO4000B-series Mixed Domain Oscilloscope. See what is happening in the time domain at the exact time an anomaly occurs in the frequency domain of the RF signal. With the MDO4000B series oscilloscopes, problems in the RF transmitter/receiver chain can be quickly and efficiently identified.

Analyze 802.11 signals in both the frequency domain and the time domain with the MD04000B Mixed Domain Oscilloscope and SignalVu-PC Vector Analysis Software.

Safety and Infotainment
Incorporating Wireless Access in Vehicular Environments

Learn more about 802.11 testing with the primer:
WiFi: Overview of the 802.11 Physical Layer and Transmission Measurements

Get advice for your application.
Send us your question or join the discussion in our application forum.
Drivers expect excellent audio quality from their in-vehicle audio system. Designs need to incorporate high
resolution, high speed components to reproduce high fidelity music. In addition, good reception of transmitted
music requires circuitry that is stable and injects low noise into the receiver chain. Finally, the system must have
low distortion speakers so the quality designed into the circuitry is not compromised by poor-performing speakers.
The challenge is in designing good, low-distortion, low-noise systems with a flat frequency response over the
20Hz – 20kHz audio spectrum. Test tools are needed to:

- Generate a wide range of signals
  - AM, FM
  - Sine wave and noise signals
- Capture DUT signals
  - Acquiring the full characteristics of the signal with high speed sampling and wide analog bandwidths
  - Identifying anomalies that need to be eliminated
- Analyze signal quality with FFT-based analysis tools
Infotainment

Efficient, Easy-to-Use, and Cost-effective Tools to Ensure Audio Quality

Tektronix offers a variety of cost-effective general purpose test instrumentation to make audio system testing and debugging both efficient and easy.

**AFG3000C Series Arbitrary Function Generators - Create Any Type of Stimulus Signal**
- Two channel versions for stereo system test
- AM, FM, sine wave, and noise signals for audio testing
- Models with bandwidths from 10MHz to 240MHz
- Arbitrary waveforms up to 128ksamples long with sample rates up to 2Gsample/s

**MDO3000 Series Oscilloscopes - Capture Any Audio Signal and Detect Spurious Signals or Unstable/Oscillating Waveforms**
- Two or four analog channels for stereo signal acquisitions and for determining channel timing relationships
- Spectrum analyzer with up to 1GHz bandwidth
- Optional arbitrary function generator for audio signal generation
- Optional logic analyzer, protocol analyzer, and DMM
- 125 trigger combinations

See the AFG3000C Data Sheet to learn more.

Learn more about the MDO3000 Series. Read the data sheet.
Before speakers are installed in the automobile’s interior, these verification tests must be performed:

- Distortion
- Frequency response
- Power output
- Rub and buzz analysis

During production, test speed is critical to minimize test costs. For cost-effective and fast production testing of audio speakers, Keithley’s Model 2015 and Model 2015-P Audio Analyzing Multimeters combine a digital multimeter (DMM) and an audio analyzer into one compact, half-rack measurement instrument solution. Well-equipped for testing automobile audio speakers, these instruments feature:

- THD, THD+noise, SINAD measurements
- 20Hz – 20kHz sine wave generator
- Fast frequency sweeps for fast production testing
- Identification of peak spectral components (Model 2015-P)
- A comprehensive set of 13 DMM functions
  - DCV, ACV, DCl, ACI, 2ΩΩ, 4ΩΩ, temperature, frequency, period, dB, dBm, and continuity measurements, and diode testing
  - Multi-functional design minimizes added equipment costs when configuring test setups

Download the data sheet to learn more about the Model 2015 and Model 2015-P.
Tektronix and Keithley maintain a comprehensive, constantly-expanding collection of application notes, technical briefs, and other resources to help engineers stay on the cutting edge of technology. For further information, please visit www.tektronix.com or www.keithley.com.

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