



## EMC TEST EXERCISER FOR AUTOMOTIVE ELECTRONICS EMC COMPONENT LEVEL VALIDATION

Quality EMC testing involves not only having the RF test equipment setup properly and calibrated, but to also have the Device Under Test (DUT) support equipment designed well enough so that it does not interfere with the test results.

Product's EMC test plan must specify whether the tester should be located outside of the chamber, or inside, along with the method(s) that will be used to carry signals and power through the chamber wall. Fiber-optics is a preferred choice, but a filtered bulkhead may be permissible. It is preferred not to use a filtered bulkhead as it introduces inductive and capacitive loading that would otherwise not be found in the product's final application.

To adequately test the DUT and appropriately simulate real world automotive conditions, more than bus communication is required. The DUTs normally contain multiple input and output lines that need to be either controlled for functionality or properly loaded.

A test box can be as simple as resistive terminations or as complex as high-speed data converters and radio frequency communications. A simple solution where the test box is composed of mostly passive devices is always preferable.

In most cases, fiber-optic converters will be used to communicate data from the support equipment to and from the controller located outside the chamber. The fiber-optic systems do not directly address the potential for the support equipment to either generate noise, or be susceptible during immunity testing. They do, however, maintain the shielding effectiveness of the chamber or other type of enclosure.

The test box can be separated into two sections:

1. the filter/passive section (interface from the harness connector, inputs from the fiber-optic lines, and ports for powering/grounding)
2. The active section (contains the active electronics used to simulate communications and loading conditions).

By separating the two, filtering of the signal and power lines can be achieved while maintaining the metallic enclosure's shielding effectiveness.

Radiated emissions on complex test boxes is caused by common mode currents on the power and signal lines causing the harness to become a radiating antenna. EMC compliance testing on test boxes containing active components is mandatory prior to be used in the actual DUT validation.

There is a risk in using test boxes with active electronics for DUT EMC validations. Unexpected interruptions in functionality of the system might be avoided by the use of a ferrite clamp placed directly on the wiring of the test box to prevent RF energy from coupling into the metal enclosure through the cabling. Conducted and



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Radiated RF energy may be coupled into the test box through the impedance of the active electronic devices inside. This type of event makes it difficult to properly assess the immunity performance of the DUT.

Always use common mode chokes on power and ground lines, special filters for CAN bus, feed through PI filters on all discrete signal lines, and multiple ferrite clamps on other signal lines.

The exerciser must meet specific EMC requirements. See electromagnetic compatibility measurement procedures and limits for vehicle components SAE J1113/1 Jul. 95, sections 6.4 Artificial Loads, 6.5 Grounding and Shielding and 6.6 Power Supply.

### DUT Exerciser Structure

1. Shielded enclosure that contains
  - Connectors for the main 1.7 meter harness to DUT
  - Test points for I/O lines (e.g. banana jacks)
  - Tri-state switches for I/O lines measurements in open, short to ground, and short to VBATT state.
  - Active electronics to simulate input signals (not recommended)
  - Small size devices for outputs loading simulation (not recommended)
  - Passive electronics to ensure proper I/O loading in each DUT operating mode
  - Fiber-optic support for parametric measurements
  - Fiber-optic CAN bus support
2. Test frame fixture for motion simulation (e.g. power lift-gate controller as DUT, lift-gate drive motor and latch motor as loads). This requires the actual motors, hall effect sensors, cables, and grounding connections used in vehicle.
3. Data Acquisition System, Laptops, CAN bus HW/SW

### Guideline

- Build two sets of DUT exercisers and fixtures to make possible parallel testing. The DUT exerciser should be dedicated for EMC testing, have inventory number, and revision changes logbook. The exerciser, loads fixture, auxiliary equipment, and test setup configuration should be kept in a safe storage area for the life time of product plus warranty. Avoid irreversible changes to an exerciser used in previous validations.
- Provide exerciser's operating instructions and block diagram. If the exerciser includes a fixture for "in vehicle simulation loads support" provide system's description. It is preferable to hook the DUT to "in vehicle" intent subassemblies to ensure proper I/O loading, connectors, and cables.
- Place all support equipment in a shielded enclosure. Use fiber-optic or in-line filters, shielded box, and shielded cable for remote equipment placed outside the EMC chamber. Using fiber-optic DMM probes or communication bus diagnostic control messages to monitor the I/O pins for electrical parameters is



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important but not enough to ensure that no DUT production software adjustments are necessary for a full EMC compliance to OEM and international standards.

- DUT's diagnostic services are acceptable as long as the operator is aware about the differences and limitations from production software. The I/O status data logged over communication bus might need some translation before being correlated with electrical parameters listed in product's manual.
- Ensures the exerciser's simulation software (example LabView application) is synchronized with the DUT's software revision level to avoid logging false deviations and stored DTCs in response to incorrect counters and bad timing. The same for communication bus scheduler data acquisition and control scripts.
- Avoid using not EMC certified third party subassemblies (motors, sensors) for DUT's critical outputs. Ensure all interdependent parts meet OEM specifications before using them as reference in DUT's evaluation.
- The intent of the EMC validation is to find bugs occurring under RF stress conditions in DUT's production SW/HW. Smart controllers performing sequential tasks based on multiple interdependent input/output conditions should be evaluated for performance in conjunction with all elements comprising a default system configuration.
- Terminate I/O loads cables toward exerciser with banana plugs and mount banana jacks on the exerciser panel as test points. This allows fast replacement and easy electrical parameter measurements. The exerciser's I/O test points should be listed in the OEM approved EMC test plan.
- A plain pass-through type of exerciser with test points is recommended. No external resistors, LEDs, or any other electronic component that can compromise the DUT's I/O expected parameters (V, I, Z, L, frequency, duty cycle) shall be used. Monitoring equipment shall use high impedance connections to exerciser's test points.
- Input signals from buttons or toggle switches located in another module are activated in EMC chambers using software controlled relay-boxes capable to transfer the proper level of voltage or current required to activate the monitored functions. Such simulation method should be approved by OEM and called in the test plan.
- Electronic switch panels using low current rocker or push-pull buttons accessible to occupants in vehicle are activated in EMC chambers using pneumatic. The air compressed system is software controlled and ensures the proper sequence and timing for pressing the buttons asynchronously from DUT's or exerciser's software.



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- The communication bus scheduler should be developed using popular HW/SW (for example: Dearborn Group, Vector, or Netway). This way the scheduler script used to activate and monitor the DUT can be easily used in EMC laboratories. DUT's events and I/O status readings are stored in log files and saved for further processing as part of the final EMC report. Readings from oscilloscope probes are mixed with screens from EMC equipment control software and recorded straight on DVD media as video file. Verify EMC lab's capability to provide a wide range of DUT's functional performance data besides the EMC test method mandatory information.
- The communication bus hardware should have fiber-optic support. Important is to use RF bullet proof fiber-optic satellite for both emissions and immunity sourced from a separate battery. The bus loading per test method should follow OEM recommendations.
- Optimize the DUT cycling time if possible to save EMC testing time. In some instances the minimum dwell time of 2 seconds might not be sufficient to evaluate all DUT's functions for RF immunity. A dwell time above 10 seconds will increase the test cost for RI ALSE, TEM Cell, and BCI test methods.
- Minimize the DUT cycling time if possible to save EMC testing time. For complex controllers most likely the minimum dwell time of 2 seconds is not enough to run immunity for all functions. Above 10 seconds dwell time the EMC test cost will increase for RI ALSE and BCI test methods.
- Production harness shall be used whenever is possible. If not available, select the production intent wire gauge to avoid voltage drops for high current outputs.
- The length of the DUT harness for RE must be as specified in the OEM EMC technical specifications (1700 mm + 300mm). Provide the EMC lab with at least three sets of matting connectors interfacing the DUT. The test technician will have to build special harnesses for RI ALSE, TEM CELL, and ESD handling.
- Provide the EMC lab the production intent of automotive fuse type and size. The test plan should list also the wire gauge for all I/O and the length of cables on both sides of RF boundary.
- The recommended wire color scheme is:

**BLACK = POWER GROUND, RED = BATTERY+, ORANGE = IGNITION(S), GREEN = DATA BUS-, BLUE = DATA BUS+**