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SUPPLY VOLTAGE TRANSIENT TEST INPUT VOLTAGE DROPOUTS, DIPS AND SWITCHED LOGIC

1. SCOPE

1.1. This test procedure describes a method for exposing electronic modules to momentary dips, dropouts and switching transients (input and output lines) of input voltage to the module.

1.2. **Dip** is a momentary reduction of supply voltage.
Drop Out is a momentary loss of supply voltage at the inputs of an electronic module. Dropouts may occur repetitively or singly. They may occur for duration of 10 microsecond up to 1.5 seconds, as defined in the test plan.
Mechanical Switching Transient (Logic Inputs) is a transient produced by the non ideal opening or closure of a mechanical switch (switch bounce) producing a noisy level transition. These switching transients are simulated by a pulse source and may consist of one or a series of pulses following the nominal switching event.
Switched Logic Input is an input to the DUT which responds to a digital signal source from either a regulated voltage or from system ground.

2. VOLTAGE DROPOUTS TEST

2.1. Voltage Dropouts can occur in the vehicle during the operation of switches and electrical loads or it can be caused by loose connections. The test is designed to exceed realistic vehicle conditions in order to trigger potential susceptibilities in analog and digital circuits, which may not be apparent under normal operating conditions, particularly digital logic reset and memory functions. All electronic devices designed for the vehicle environment should be exposed to this procedure to test their performance when subjected to momentary fluctuations of voltage at their inputs.

3. VOLTAGE DIPS TEST

3.1. This test simulates the voltage dip that can occur when a heavy load such as the A/C compressor or radiator fan switches on.

4. SWITCHED LOGIC TRANSIENTS TEST

4.1. This test is designed to simulate mechanical s itch bounce.

5. TEST EQUIPMENT

5.1. **Drop out test equipment**: >1 A, 1 +/- 0.5 µs rise time, EM TEST / AMETEK VDS 200 or equivalent.
Oscilloscope: BW >10 MHz, Tektronix or equivalent.
Power Supply: 13.5 Volts +/- 0.2 Volts, SAE J1113/1, paragraph 6.6 HP 6033 or 6038 or equivalent.
Pulse Generator: Pulse width > 1 µs, HP 8112A or equivalent
Switched Logic test equipment: >1 A, 1 +/- 0.5 µs rise time, EM TEST / AMETEK VDS 200 or equivalent.
Voltage Probe: BW >10 MHz, Tektronix probe or equivalent.
Programmable Controller GPIB/USB: for control of instruments in automated tests.
Data Acquisition Equipment GPIB/USB: for measurement and control.

6. TEST METHOD

6.1. A Voltage Drop Generator is placed in series with individual input leads of the DUT to cause a momentary dropout of voltage at supply and switched logic inputs.
DUT inputs, which receive an unregulated voltage from the vehicle electrical system, are exposed to voltage dips ranging from 13.5 to 0 V dc.
Switched logic inputs are exposed to momentary closures to either system ground or to regulated voltage.

6.2. **Functional Performance Status Classification**
Use categories per SAE J1113-1. or as defined by automotive OEM EMC spec.
The test plan includes:

- classification of DUT functions
- performance region requirements
- inputs and outputs to be tested
- system voltage levels to be applied
- functions to be monitored
- the number of samples required
- DUT identifier and development level (ED/DV/PV)
- PCB(s) identifier

6.3. **DUT Configuration**
The DUT is set up to perform the functions specified in the test plan. All inputs to be tested may be connected to a number of switches at once. However, the dropouts are normally done one input at a time. In some cases, combinations of inputs are exposed to various dip levels to simulate known vehicle conditions.

6.4. **Equipment Configuration**
A Voltage Drop Generator is placed in series with each DUT input designated in the test plan to allow momentary dropouts, dips of voltage, and switched logic.

Set up the test equipment to produce the desired pulse at the minimum pulse duration (normally 10 µs). The pulse shape will normally become distorted by loading of the DUT when applied to the terminal under test. Therefore, measurements of pulse duration and level are made by temporarily substituting a 1 kilohm resistive load in place of the DUT. (See FIG 6.1 - A)

6.5. **Voltage Dropout Test**

- The DUT can be installed either on an insulating table or on a ground plane. Using a ground plane is necessary only if the component or the sensors or actuators are directly connected to the vehicle chassis. In this case, the component is connected to the ground plane according to its real vehicle installation and no other ground connection is authorized.
- The component 12 V power (and its associated ground) lines submitted to the test must have a maximum length of 500 mm.
- The cross-section of the wiring must be representative.
- For other lines, a wiring harness of a maximum length of 2000 mm should be preferably used (using the real wiring harness is allowed).
- In the case of sensor outputs connected to the 12 V through a pull up resistor, the concerned outputs must be connected to the generator through the equivalent resistance. Its value has to be provided in the technical specification and is specified in the test plan.
- Operate the DUT to perform the functions required by the test plan.
- Apply 5 repetitive dropouts to the line(s) under test with 3 seconds minimum between dropouts while monitoring DUT performance.
- Increment the pulse duration and again apply 5 repetitive dropouts. Increment sizes are indicated in TBL 6.1 - A.
- Note that the tolerances for the pulses must be ±5%.
- When an effect on required performance is observed, record the effect threshold of the dropout duration and a description of the effect. Determine the threshold between pulses if an effect occurs. (Example, if an effect occurs at 10 ms, find the threshold between 1 ms and 10 ms).
- Apply 5 repetitive dropouts at each incremental duration until the maximum duration is reached.
- Record all effects.
- Complete the above steps for each terminal of the DUT to be tested.
- At this point, connect all of the battery lines tested in the above paragraphs together and repeat the same procedure as outlined above for this configuration.

Note that the Test Parameters may differ based on EM specification that outlines what dropout voltage and intervals to use.

- *The supply voltage must drop out from 11 V to 0 V and return to 11 V.*
- *The duration of the drop out increases from 100 µs to 2 s in increments as shown in TBL 6.1 - A.*
- *Drop outs are set by open circuit (≥1 kΩ load) with fall time and rise time less than 10 µs each.*
- *The component operation must be monitored during the test and the interval time between dropouts is sufficient to verify normal component operation.*
- *Minimum number of drop outs for each duration is10.*
- *Time between drop outs is minimum 5 s or response time of the component, whichever is greater.*

6.6. **Voltage Dip Test**

- The DUT can be installed either on an insulating table or on a ground plane. Using a ground plane is necessary only if the component or the sensors or actuators are directly connected to the vehicle chassis. In this case, the component is connected to the ground plane according to its real vehicle installation and no other ground connection is authorized.
- The component 12 V power (and its associated ground) lines submitted to the test must have a maximum length of 500 mm.
- The cross-section of the wiring must be representative.
- For other lines, a wiring harness of a maximum length of 2000 mm should be preferably used (using the real wiring harness is allowed).
- In the case of sensor outputs connected to the 12 V through a pull up resistor, the concerned outputs must be connected to the generator through the equivalent resistance. Its value has to be provided in the technical specification and is specified in the test plan.
- Set up the test equipment and Voltage Dip Generator to achieve a voltage dip from 13.5 V to V (minimum) where V (minimum) is equal to 5.5 V decreasing to 1.5 V in steps of 0.5 V.
- The pulse is applied for a minimum duration of 100 µs.
- Apply 5 dips to the terminal(s) under test with 3 seconds minimum between dips, while monitoring DUT performance.
- Increase the voltage dip amount by increments of 0.5 V ±5% applying 5 repetitive dips for each incremental dip level.
- Record all effects with DUT performance.
- Repeat the above steps at dip duration of 0.1, 10, and 500 milliseconds ±5%.
- Monitor the performance of DUT functions during exposure to the changing dip levels, especially functions related to memory storage, digital logic and reset circuits.
- At this point, connect all of the battery lines tested in the above paragraphs together and repeat the same procedure as outlined above for this configuration.

Note that the Test Parameters may differ based on EM specification that outlines what dips voltage and intervals to use.

- *A dip is from 11 V to the dip voltage for the specified duration and then back to 11 V.*
- *The dip voltages are: 5.5 V, 5.0 V, 4.5 V, 4.0 V and 3.5 V.*
- *Dips to each voltage level are for 0.1 ms, 0.25 ms, 1 ms, 10 ms and 500 ms durations, with fall time and rise time less than 50 µs each (during the test).*
- *Voltage shall be applied to the supply voltage lines*
- *The component operation shall be monitored during the dip test and the interval time between dips shall be sufficient to verify normal component operation.*
- *At each dip voltage, run through the range of dip durations at least 5 times - Each supply voltage line shall be dipped individually.*

6.7. **Switched Logic Inputs Test**

- Low frequency (<10 Hz) logic inputs, which respond to a switched closure to system ground, are to be tested using a Voltage Drop Generator (see FIG 6.1 - B for example configuration).
  - Apply single switch closures to ground of 0.01, 0.1, 1, 10 and 100 milliseconds duration.
  - Multiple ground outs (pulse trains) of 10 percent duty cycle or less may also be used at each increment.
  - Monitor the performance of the DUT function associated with the logic input being tested.
  - Record effective "switch bounce" performance or any other effect to functional performance.
- Low frequency switched logic inputs which respond to a switched closure to a regulated voltage source are to be tested using a drop out type Voltage Drop Generator.
  - Insert the switch in series with the terminal to be tested.
  - Pulse the switch circuit to achieve momentary digital high signals at the duration of 0.01, 0.1, 1, 10 and 100 milliseconds.
  - Monitor for effects.
  - For this test, lines must be tested individually.

Figure (6.1)

FIG 6.1 - A

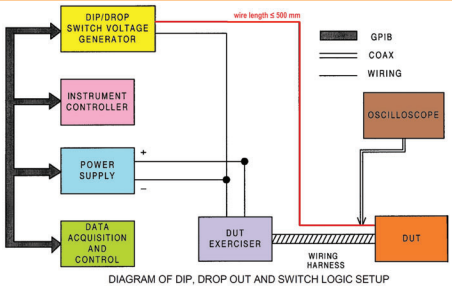
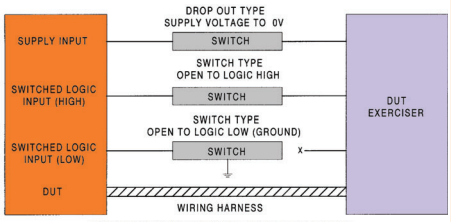


DIAGRAM OF DIP, DROP OUT AND SWITCH LOGIC SETUP

FIG 6.1 - B



EXAMPLE CONFIGURATION OF DUT AND EQUIPMENT

TBL 6.1 -A

INCREMENT SIZES TABLE		
START	STOP	INCREMENT
10 µs	100 µs	10 µs
100 µs	1 ms	100 µs
1 ms	10 ms	1 ms
10 ms	100 ms	10 ms
100ms	1.5 sec	100 ms

7. TEST AUTOMATION

7.1. Data acquisition equipment may be used to monitor the DUT. This is especially useful for functions, which are not easily observed, such as data bus operation, memory storage and diagnostic functions. The data acquisition equipment may be interfaced to a computer to allow automatic report generation.

REVISION CHANGES

Jan 12, 2024	Rev-A	Release		C.R.

END OF DOCUMENT