

Generating Fast Transient Voltage Test Profiles

Introduction

The modern car is more electronics intensive than ever. There are microcontrollers and high powered processors involved in everything from the operation of the vehicle's windows, lights, brakes, steering, engine and transmission to all of the high tech infotainment and safety features like adaptive cruise control and lane keeping assist. With the ever increasing electronics content, comes the need to test these systems for proper operation under the environmental extremes the vehicle is subjected to, including the voltage transients induced on the power bus.

During the design phase, expensive bus simulation systems employing sophisticated arbitrary waveform generation and coupling networks for conducted immunity tests are used. But for production test, a simpler and less expensive means for simulating bus voltage variations and transients is often required.

Typically, to simulate a fast transient DC waveform from a DC source requires a supply with a full linear or linear post regulator equipped switch mode power architecture (hybrid). Linears, depending on the power levels required can be large and inefficient. Switch mode power supplies (SMPS), optimized for tightly regulated and low noise outputs offer compact size and efficiency but with the tradeoff of relatively slow transient response. Adding a post linear section does offer a compromise between the two but at the expense of higher cost and complexity and a more limited supply base. In this application note we explore using an economical "off-the-shelf" solution of an electronic load (eLOAD¹) and SMPS DC supply to create a typical bus voltage transient and voltage variation sequence for an automotive ECU test stand.

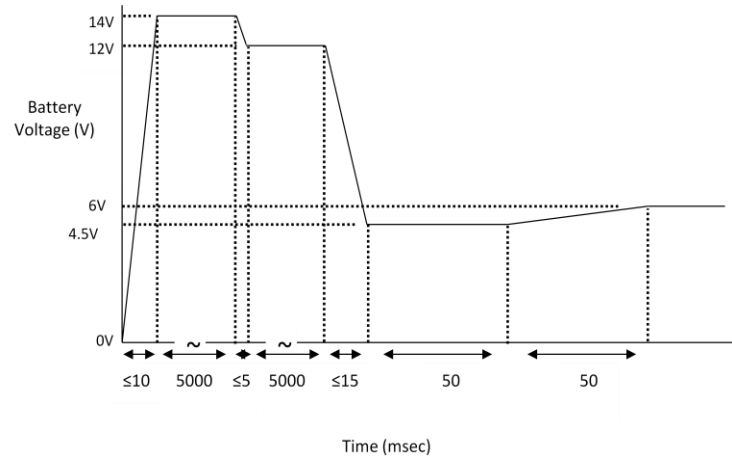
The test setup and results are presented along with a brief discussion of some of the considerations when specifying equipment for conducting similar testing.

Application Requirement

The application statement is to generate a voltage waveform as shown in the following test profile (figure 1). One of the key specifications of concern is generating the 12V to 4.5V transition in less than the 15 msec indicated. Other specs include:

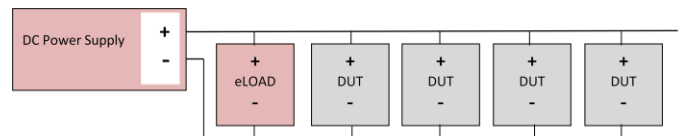
- Support multiple DUTs per test stand
- Each DUT draws up to 60A
- The profile may be supplied to all DUTs simultaneously

- It is not necessary to apply the profile to all DUTs simultaneously if there is a functional limitation, at which point it is acceptable to provide the profile individually to the DUTs
- The goal is to meet the test requirements as cost effectively as possible whether tested as a group or individually



Application Solution

The block diagram for the solution to be tested is straightforward and shown below:



The basic concept uses the eLOAD to pull the bus voltage to the levels required to provide the desired voltage profile. In essence, the combination of power supply and eLOAD provides a flexible and economic hybrid supply. The test setup consists of a programmable supply set at 14Vdc and operating in constant voltage mode with a current limit set to the sum of the max current for the DUTs. The internal sequencing capability of the eLOAD may be used to provide profile timing, if desired to further simplify the test stand by not requiring a sophisticated controller or computer.

To demonstrate the transient feasibility of the concept in this application, a test was run using a DLM40-15 power supply and a SLM 60-60-300 programmable load. The eLOAD is connected in parallel with the DUT load as shown above. The eLOAD is used in a Constant Voltage (CV) mode and is used to pull the supply output to a lower level, which works because the eLOAD will set an impedance low enough to cause the power supply to change modes from constant voltage to constant current (the voltage folds back once the (programmable) current limit is exceeded). It is expected that the method will work with any of the Sorensen DC supply series which feature automatic CV / CC mode crossover control.

In this test, a fixed 1 Ohm power resistor was used to simulate a 14 A load at 14V. The SLM 60-60-300 (60V/60A/300W) eLOAD was connected in parallel across the bus being supplied by the DLM 600W unit. The DLM was set to 14 V and the current limit was set to maximum.

Results

In the scope capture (figure 2) below, at t=0 the SLM (in CV mode) was set at >15V so it is effectively out of the circuit since the set point is above the bus output. At t=1, the eLOAD was switched to V=4.5V. The DLM supply indicated a switch to CC mode and the output dropped to the required level. In this case, as can be seen below, the bus was pulled down to the required level in about 4 msec, well less than the 15msec max. requirement.

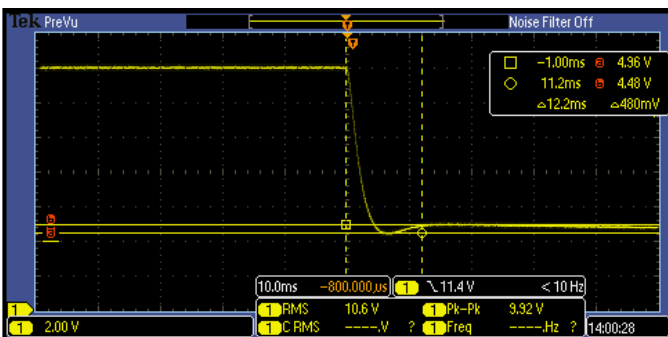


Fig. 2

A complete profile was also simulated to demonstrate that the eLOAD, using internal sequencing could provide a complete test routine. The user has the option of further automating the control of the sequence via remote programming via the GPIB interface. See figure 3 below illustrating the capability.

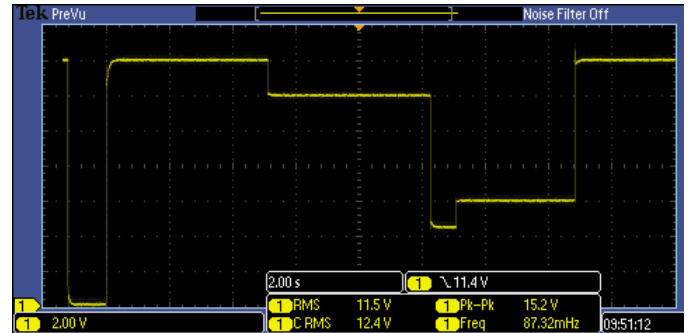


Fig.3

For the actual application we need to scale up the current per DUT and look at sizing the system for simultaneous testing of 4 DUTs.

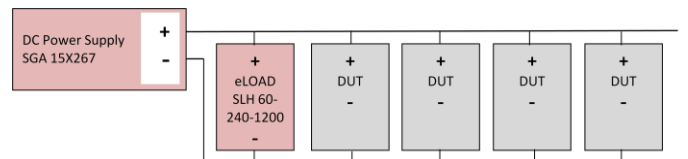
For sizing the eLOAD consider the following: For each DUT

- At 14V max current is 60A; minimum load impedance = $14V/60A = 0.233 \text{ Ohm}$.
- At 4.5V, the 0.233 Ohm load impedance current is $I(\text{load})=19.3 \text{ A}$;
- Current flowing in eLOAD is therefore $I(\text{max}) - I(\text{load})$ where $I(\text{max}) =$ current limit setting of power supply (60A in this case) = $60 - 19.3A = 40.7A$
- eLOAD max dissipation in this case is therefore $I(\text{eLOAD}) \times 4.5V = 183 \text{ W}$ per DUT

Therefore for 4 DUTs we would need an eLOAD with (Pdiss) capacity of $4 \times 183 \text{ watts} = 732W$.

For the power supply we need to be able to supply $4 \times 60A$ of current at 14V. This puts the power supply requirement at about 3400W.

A potential solution therefore would be to use 1 each SGA 15X267 (15V at 267 A max) and 1 each SLH 60-240-1200 (60V, 240A, 1200W) max ratings. For additional current and power margin the SLH 60-360-1800 could be substituted. An alternative solution, depending on needs, would be to use independent power supplies and modular eLOADs.



Conclusions

It has been demonstrated that:

- It is quite feasible to generate power bus transient profiles using economical, off-the-shelf power test equipment. Using separate components provides test stand design flexibility at an economical cost versus dedicated or customized power sources.
- Careful consideration must be given to sizing the equipment appropriately for the DUT and type of test to be conducted.
- A detailed understanding of the DUT electrical characteristics is important in determining the limitations or test envelope that can be achieved.

About AMETEK Programmable Power

Located in San Diego, Ca., AMETEK Programmable Power designs, manufactures and markets precision, programmable AC and DC power supplies, electronic loads, application specific power subsystems, and compliance test solutions for customers requiring & valuing differentiated power products and services.

AMETEK Programmable Power boasts one of the industries' broadest portfolios of programmable power products under the well known and respected Sorensen, Elgar, California Instruments and AMREL brands. AMETEK programmable power supplies and sources serve a wide range of stimulus (T&M) and process power needs in applications including semiconductor fabrication, commercial and defense ATE, oil exploration, solar array and battery string simulation, avionics, general R&D and EMC compliance testing.

With strong brands, a broad product portfolio, exceptional precision power conversion and control expertise, proven power system integration capabilities and deep applications knowledge, AMETEK Programmable Power is your trusted "power partner."

Contact your AMETEK PP sales rep for application assistance to optimize a solution for your test needs.