HUBERT
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Whitepaper No. 12

HUBERT Power Amplifiers and the Load Dump

MADE IN GERMANY

Revision 1.0

1 Introduction

During the testing of electrical and electronic high-voltage components in motor vehicles, the robustness to the dynamics of the vehicle electrical system during a **load dump** is tested. Changes to the test voltage of up to 3000 V/ms are required. Due to their rather slow signal processing, classic DC power supplies are generally unable to achieve these slew rates.

The perfect task for the fast HUBERT 4-quadrant power amplifiers.

In the following sections, examples of test setups and tests from the **VW80300** automotive factory standard are presented. The focus is on the presentation of the transient characteristics of the HUBERT 4-quadrant power amplifier. The required number and definition of the test cycles as well as the evaluation of the DUT are not part of the considerations.

Two 1 kW 4-quadrant amplifiers **HUBERT A1110-40-QE** provide the necessary AC voltage source. The test signals are generated by a standard arbitrary generator.

2 Test Setup

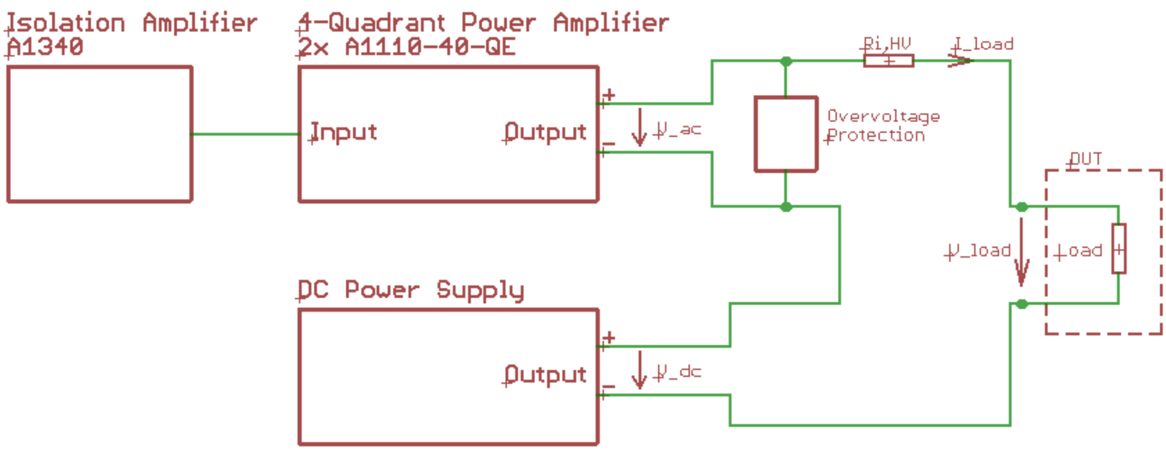

Figure 1: DC-Source + AC-Source

Figure 1 shows the test setup: The DC source supplies a test object with the necessary DC voltage and the HUBERT power amplifier connected in series supplies the required AC voltage (AC source). For simplicity's sake, further networks in the supply lines, which are listed according to the standard, have been omitted. However, the galvanic isolation of the sources and protection against a possible overvoltage at the output of the power amplifier are important here.

2.1 VW80300 EHV-10, Load Dump up to the Limit Voltage

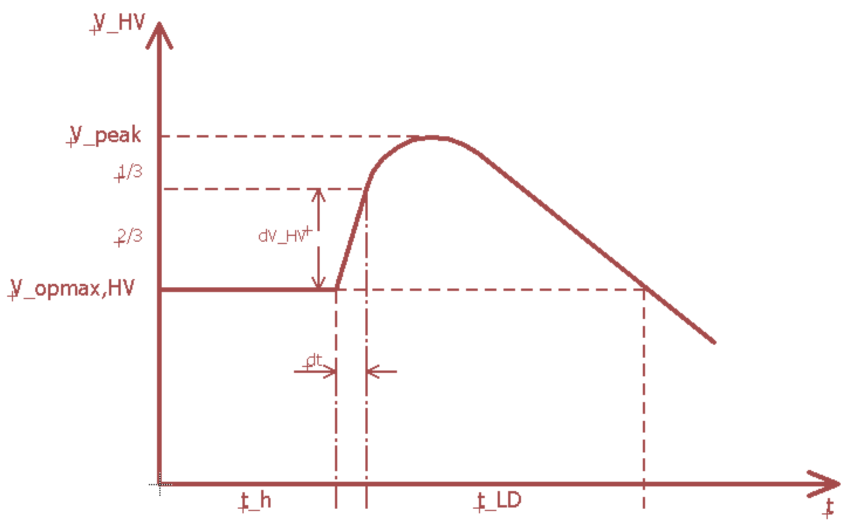

Figure 2: Voltage Curve to HV voltage limit

Figure 2 shows the temporal course of the test voltage. A challenge is the standard-compliant voltage rise dV_HV/dt = 250 V/ms (= 0,25 V/µs).

The following operating parameters were selected for the test:

$V_{\_opmax,HV} = 400$ V ; $V_{\_peak} = 550$ V ; $t_{\_LD} = 10$ ms ; $t_{\_h} > 10$ s,
$R_{i\_HV} = 100$ mOhm, R = 100 Ohm

The difference V_d is calculated as follows:
$V_d = V_{\_peak} - V_{\_opmax,HV} = 150$ V.

This results in a rise time for the ‚2/3' voltage swing: $dV_{\_HV/dt} = 100$ V/400 µs.

No rise time is defined for the last third of the voltage swing. The two 4-quadrant amplifiers were operated in bridge mode for the test. This provides a maximum output voltage of +/-150 V_p and the complete voltage swing (3/3) can be generated by the AC amplifier in this case. If V_d is greater than 150 V, the DC power supply takes over 1/3 and the AC amplifier takes over 2/3.

For the qualitative evaluation of the transient response, the rounded signal shape was not used for the control signal. A pulse signal with a rise time and fall time of 10 µs was used to control the 4-quadrant power amplifier.

Figure 3: C3:V_load; C4:I_load

Figure 3 shows the result or the temporal voltage curve at the load (blue curve). The rise time is 10 µs and thus the required rise time is achieved over the entire voltage range with sufficient reserve.

2.2 VW80300 EHV-10, the Fast Load Dump

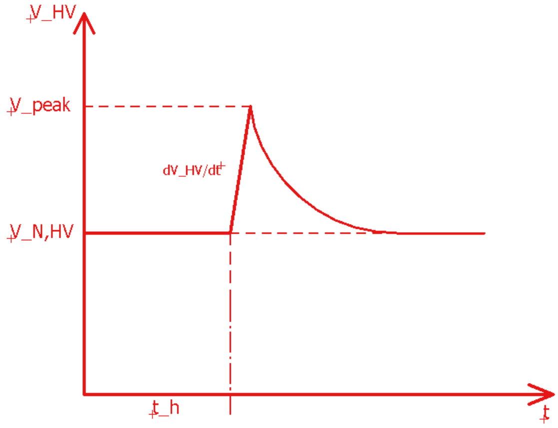

Figure 4: Fast Load Dump

Figure 4 shows the time course of the standard-compliant test voltage with a required maximum rise time of 3000 V/ms (3 V/µs).

The definition of V_peak is: V_peak = V_N,HV + 20 V

Also for this test the operating parameters as in section 2.1 were selected. However, the rise and fall time of the control signal was reduced to 5 µs.

$V_{\_opmax,HV}$ = 400 V ; $t_{\_h}$ > 10 s,
R_{i_HV} = 100 mOhm, R = 100 Ohm

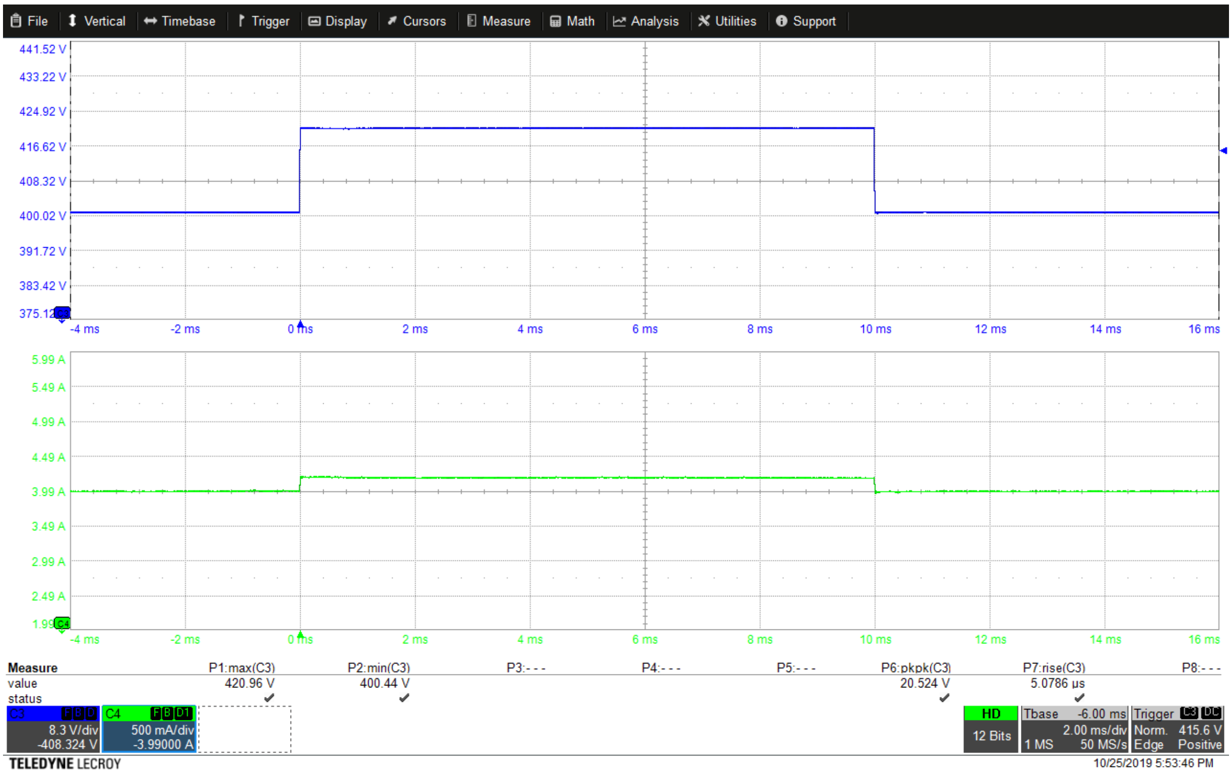

Figure 5 C3:V_load; C4:I_load, fast load dump

The result in section 2.1 already suggested it: The required faster increase of the test voltage is achieved effortlessly in 5 µs with a lower voltage swing (blue curve), as shown in Figure 5.

3 Conclusion

For testing electrical and electronic components in motor vehicles, fast, bipolar power sources are required to simulate the vehicle electrical system.

The examples above show: The broadband HUBERT 4-quadrant line amplifiers are a suitable choice. They reliably deliver the required test voltages at the required speed.

Which amplifier model or amplifier system should be used (see also White Paper No. 6: More Voltage and Current) depends primarily on the required power, especially in the fourth quadrant, and on the required load current or ripple current.

It would be a pleasure for us to assist you with the design of your test station.

Do you have any questions about this or other applications?
We are happy to support you by telephone or e-mail.

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5 Document History

Revision	Date	Changelog
1.0	November 2019	Initial publication