Cranking Simulator for Automotive Applications

- **Input** 24V DC
- **Output** Adjustable by Microcontroller between 2..15V @ 50W
  
  3 Cranking Pulses programmed:
  - DaimlerChrysler Engine Cranking Test Pulse DC-10615
  - Volkswagen Cold Start Test Pulse VW80000
  - Volkswagen Warm Start Test Pulse VW80000

- **Switching Frequency** 250 kHz nominal
1 Startup

The startup waveform with an output voltage of 12.6V and no load attached is shown in Figure 1. The converter is started by the enable input.

Channel C2: Output voltage
2V/div, 2ms/div

Figure 1
2 Switching Node

The switching node with an output voltage of 12.6V and a load of 4.0A is shown in Figure 2.

Channel C2: **Switching node**, -1.2V min. voltage / 28.3V max. voltage

5V/div, 2us/div

![Figure 2](image-url)
3 Output Ripple

The output ripple voltage at an output voltage of 12.6V and a load of 4.0A is shown in Figure 3.

Channel C2: \textbf{Output voltage}, 40mV peak-peak
20mV/div, 2us/div, AC coupled

![Figure 3](image-url)
4 Load Step Response

The response to a load step and a load dump at an output voltage of 12.6V is shown in Figure 4.

Channel C2: **Output voltage**, -117mV undershoot / 92mV overshoot
50mV/div, 2ms/div, AC coupled

Channel C1: **Load current**, load step 2.0A to 4.0A and vice versa
2A/div, 2ms/div

![Load Step Response Graph](image-url)
5 Input ripple voltage

The input ripple voltage at an output voltage of 12.6V and a load of 4.0A is shown in Figure 5 and Figure 6. Figure 5 shows the ripple on the input capacitors of the buck converter; Figure 6 shows the ripple as seen on the plugs in front of the input filter.

**Figure 5**
Channel C2: **Input voltage**, 120mV peak-peak
50mV/div, 2us/div, AC coupled

**Figure 6**
Channel C2: **Input voltage**, 4mV peak-peak
20mV/div, 2us/div, AC coupled

![Figure 5](image1)

![Figure 6](image2)
6 Frequency Response

Figure 7 shows the closed loop response at an output voltage of 12.6V and a load of 4.0A.

- 55 deg phase margin @ crossover frequency 22.6 kHz
- -25 dB gain margin
7 Cranking Test Pulses

Figure 8 shows the “Daimler-Chrysler Engine Cranking Test Pulse DC-10615” with a constant load of 50W on the output.

Channel C2: **Output voltage**
- 2V/div, 2s/div

Channel C1: **Load current**
- 5A/div, 2s/div

![Figure 8](image-url)
Figure 9 shows the “Volkswagen Cold Start Test Pulse VW80000” with a constant load of 50W on the output.

Channel C2: **Output voltage**
- 2V/div, 200ms/div

Channel C1: **Load current**
- 5A/div, 200ms/div

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**Figure 9**
Figure 10 shows the “Volkswagen Warm Start Test Pulse VW80000” with a constant load of 50W on the output.

Channel C2:  **Output voltage**  
2V/div, 2s/div

Channel C1:  **Load current**  
5A/div, 2s/div
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