1. Photo of the prototype (71.12mm x 62.23mm).
2. **Startup**

The input and output voltage behavior at full and no-load conditions is shown in the images below.

**Ch.1: Input voltage (10V/div, 20ms/div, 20MHz BWL)**  
**Ch.3: Output voltage (10V/div, 20MHz BWL)**  
**Load = 11A (full load), Vin = 29V**

---

Same condition as above but with zero load:
3. Shut down

The input and output voltage behavior during shut-down at full is shown below.

Ch.1: Input voltage (10V/div, 20ms/div, 20MHz BWL)
Ch.3: Output voltage (10V/div, 20MHz BWL)

Load = 11A, Vin = 29V

4. Output voltage regulation
5. Efficiency
The efficiency data, versus input and output voltage are shown in the tables and graphs below. The load (constant-current electronic load) has been varied from 0 to 11A. The input voltage has been set to 27V and 29V. Switching frequency setup:
   a) 100KHz: pin 1-2 of J5 left open
   b) 250KHz pin 1-2 of J5 shorted

```
Vin (V) | In(mA) | Pin (W) | Vout (V) | Iout(A) | Pout (W) | Efficiency (%)
-------|--------|--------|----------|---------|---------|----------------
29.01  | 32.1   | 0.9312 | 23.77    | 0       | 0       | 0%
29.02  | 76.0   | 2.206  | 23.77    | 0.0531  | 1.262   | 57.2%
29.01  | 117.0  | 3.394  | 23.77    | 0.1025  | 2.436   | 71.8%
29.00  | 198.9  | 5.77   | 23.77    | 0.2020  | 4.80    | 83.2%
29.00  | 450.5  | 13.06  | 23.77    | 0.5035  | 11.97   | 91.6%
29.02  | 871.6  | 25.29  | 23.77    | 1.0062  | 23.92   | 94.6%
29.01  | 1704   | 49.43  | 23.76    | 2.0098  | 47.75   | 96.6%
29.00  | 4192   | 121.57 | 23.76    | 5.0190  | 119.25  | 98.1%
29.00  | 9206   | 266.97 | 23.75    | 11.021  | 261.75  | 98.0%
```

```
27Vin, Fsw = 250 KHz
Vin (V) | In(mA) | Pin (W) | Vout (V) | Iout(A) | Pout (W) | Efficiency (%)
-------|--------|--------|----------|---------|---------|----------------
27.04  | 32.1   | 0.8680 | 23.76    | 0       | 0       | 0%
27.04  | 78.9   | 2.133  | 23.76    | 0.0532  | 1.264   | 59.2%
27.03  | 122.9  | 3.322  | 23.76    | 0.1027  | 2.440   | 73.5%
27.02  | 210.6  | 5.69   | 23.76    | 0.2021  | 4.80    | 84.4%
27.01  | 481.3  | 13.00  | 23.76    | 0.5035  | 11.96   | 92.0%
27.04  | 931.8  | 25.20  | 23.76    | 1.0060  | 23.90   | 94.9%
27.04  | 1820   | 49.21  | 23.76    | 2.0115  | 47.79   | 97.1%
27.02  | 4490   | 121.32 | 23.76    | 5.0200  | 119.28  | 98.3%
27.03  | 9861   | 266.54 | 23.76    | 11.034  | 262.17  | 98.4%
```
### 27Vin, Fsw = 100 KHz

<table>
<thead>
<tr>
<th>Vin (V)</th>
<th>Iin(mA)</th>
<th>Pin (W)</th>
<th>Vout (V)</th>
<th>Iout(A)</th>
<th>Pout (W)</th>
<th>Efficiency (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>27.01</td>
<td>18.3</td>
<td>0.4943</td>
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<td>0%</td>
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<tr>
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<tr>
<td>27.00</td>
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<tr>
<td>27.00</td>
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<td>5.34</td>
<td>23.76</td>
<td>0.2024</td>
<td>4.81</td>
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<tr>
<td>27.02</td>
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<td>12.61</td>
<td>23.76</td>
<td>0.5038</td>
<td>11.97</td>
<td>94.9%</td>
</tr>
<tr>
<td>27.01</td>
<td>914.6</td>
<td>24.70</td>
<td>23.76</td>
<td>1.0065</td>
<td>23.91</td>
<td>96.8%</td>
</tr>
</tbody>
</table>

More details about efficiency:

![Efficiency Graph](#)

Light load details:

![Light Load Efficiency Graph](#)
6. **Output Ripple Voltage**

The output ripple voltage has been measured by supplying the converter at 29V while running at full load.

**Ch.3: Output ripple voltage** (20mV/div, AC coupling, 2usec/div, 20MHz BWL)

---

The following shows the measurement taken at the same conditions but without any bandwidth limit.

**Ch.3: Output ripple voltage** (20mV/div, AC coupling, 2usec/div, no BWL)
7. **Switch Node**

The images below show the drain of Q3 taken at Vin = 29V and full load.

Ch.3: Q3 Drain-Source voltage (10V/div, 1us/div, no BWL)

![Waveform 1](image1)

Same waveform but at smaller time base.

Ch.3: Q3 Drain-Source voltage (10V/div, 10ns/div, no BWL)

![Waveform 2](image2)
8. Behavior in short circuit

The images below show the behavior of inductor current during short circuit condition at Vin = 29V.

**Ch.4: L1 inductor current (10A/div, 20ms/div, 20MHz BWL)**

Same measurement but with smaller time base:
**Ch.4: L1 inductor current (10A/div, 200us/div, 20MHz BWL)**
9. **Current limit protection**

The images below show the behavior of the converter during current limit protection (without latch). Vin has been set to 29V and the current increased until switch-off.

**Ch.4: L1 inductor current (5A/div, 20ms/div, 20MHz BWL)**

Load = 14.1A

Same measurement as above, but with smaller time base:

**Ch.4: L1 inductor current (5A/div, 1ms/div, 20MHz BWL)**

Load = 14.1A
10. Behavior during over voltage protection

The images below show the behavior of the converter during over-voltage protection (with latch), performed by decreasing R9 to a value equivalent to \( V_{out} = 30 \text{V} \). \( V_{in} \) has been set to 29V and the load set to 1A for the first screenshot and to 10A for the second one.

Ch.1: Output voltage (10V/div, 10ms/div, 20MHz BWL)
Ch.4: L1 inductor current (5A/div, 20MHz BWL)
Load = 1A

Ch.1: Output voltage (10V/div, 10ms/div, 20MHz BWL)
Ch.4: L1 inductor current (5A/div, 20MHz BWL)
Load = 10A
11. Load transient response

The converter has been loaded by switching the output current between 2A and 10A while supplied at 29V. The image below shows the output voltage deviation from nominal value.

Ch.3: Output voltage (100mV/div, 500us/div, AC coupling, 20MHz BWL)
Ch.4: Output current (5A/div, 20MHz BWL)

12. Feedback Loop Analysis

The image below shows the open loop gain and phase bode plot of the converter. The board has been supplied at Vin = 29V and the load was a constant-current electronic load, set to 11A.
Crossover frequency: 12.49 KHz
Phase margin: 63.16 deg.
Gain margin: 16.44 dB
13. Thermal Analysis

During the thermal analysis, the converter has been placed vertical on the bench in still air conditions, while supplied at 29V and fully loaded.
The thermal image has been taken after 30 minutes @ Ta = 25°C.

![Thermal Image](IR20170623_1067.is2)

<table>
<thead>
<tr>
<th>Name</th>
<th>Temperature</th>
<th>Emissivity</th>
<th>Background</th>
</tr>
</thead>
<tbody>
<tr>
<td>Q1</td>
<td>68.1°C</td>
<td>0.95</td>
<td>25.0°C</td>
</tr>
<tr>
<td>Q2</td>
<td>68.1°C</td>
<td>0.95</td>
<td>25.0°C</td>
</tr>
<tr>
<td>Q3</td>
<td>66.3°C</td>
<td>0.95</td>
<td>25.0°C</td>
</tr>
<tr>
<td>R7</td>
<td>63.8°C</td>
<td>0.95</td>
<td>25.0°C</td>
</tr>
<tr>
<td>L1</td>
<td>62.9°C</td>
<td>0.95</td>
<td>25.0°C</td>
</tr>
<tr>
<td>U1</td>
<td>64.8°C</td>
<td>0.95</td>
<td>25.0°C</td>
</tr>
</tbody>
</table>
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