DI-139 Design Idea
LinkSwitch®-TN

High Efficiency, Dual Output Buck Converter

Application	Device	Power Output	Input Voltage	Output Voltage	Topology
Metering	LNK304DN	1.25 W	85 – 265 VAC	12 V, 3.3 V	Buck

Design Highlights
- Low cost dual output design
- Universal input voltage range operation allows a single design to be sold worldwide
- Feedback derived from simple and inexpensive voltage divider
- Excellent regulation on 3.3 V output (±5%)
- Excellent Energy Efficiency
  - Low stand-by input power consumption: <300 mW at 230 VAC with 50 mW output load.
  - Much higher efficiency compared to typical Zener/linear regulated solutions
- Meets CISPR-22/EN55022B limits for conducted EMI

Operation
The power supply shown in Figure 1 is implemented using a simple buck topology that allows for two output voltages without the need for a transformer. Typical applications include metering power supplies, where a 3.3 V supply is required for metrology and a 12 V supply is required to switch on and off relays or power a radio for remote meter reading.

Resistor RF1 is a fusible flame proof type, which acts as a fuse in the event of a catastrophic failure and provides differential surge filtering. Diode D1 provides AC input rectification while C1 and C2 provide smoothing and, together with L1, act as a π-filter. EMI is further reduced by the integrated frequency jitter feature of the LinkSwitch family of devices (see Figure 3).

During the MOSFET off-time, capacitor C4 is charged to the output voltage via D3 (the voltage drops of D2 and D3 cancel). This voltage is used to provide feedback to U1 via the resistor divider formed by R1 and R2. The FB pin is sampled during each switching cycle. If the current that flows into the feedback pin of U1 is less than 49 µA, the subsequent cycle is enabled. During each enabled switching cycle, U1's internal MOSFET is enabled, causing a linear ramp in current through L2 and C5. Once the internal current limit is reached, the MOSFET turns off, and the inductor current can freewheel via diode D2. Regulation is maintained by adjusting the ratio of enabled to disabled cycles.

Regulation on the 3.3 V output is maintained by a very simple, low-cost discrete linear regulator formed by Q1, R4, R5, R7, R8 and VR1. Reference Zener VR1 is biased with a 10 mA current set by R7 and R8. The value of VR1 is chosen to be a V_{BE} drop above the desired output so that with Q1 connected in an emitter follower configuration, a 3.3 V output is obtained. Resistor R8 provides for finer control of the output voltage set-point. Resistor R4 protects Q1 against over-current conditions. Transistor Q1 is a small signal

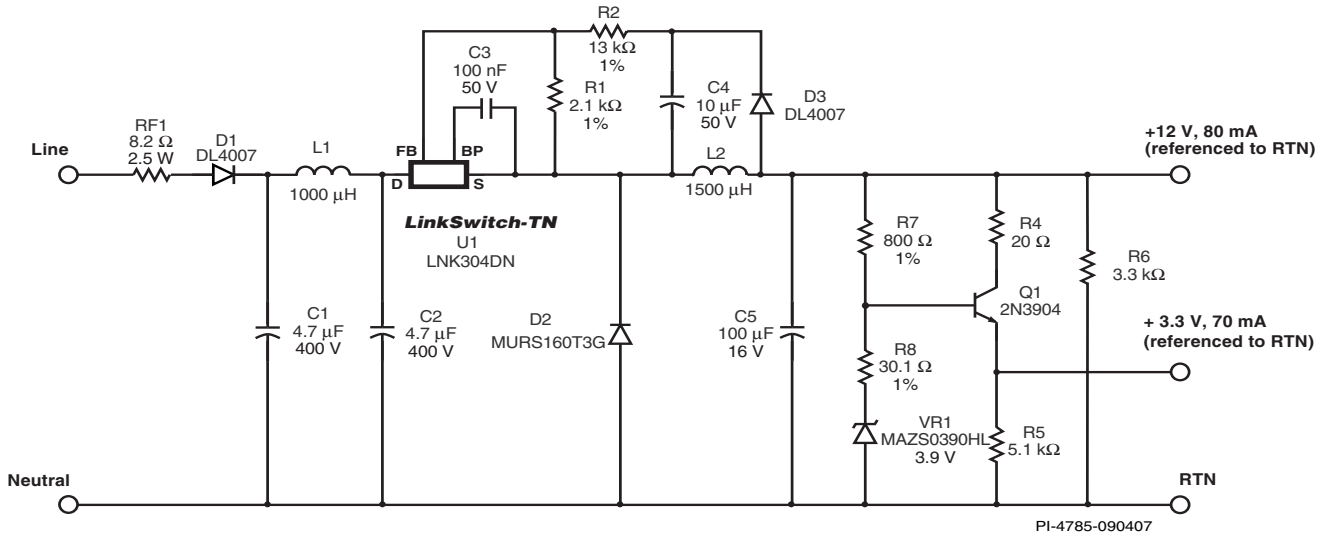

Figure 1. 1.25 W Dual Output Supply Using LinkSwitch-TN.

transistor.

Key Design Points

- A Zener with a low test current (5 mA) should be selected for VR1. The initial tolerance directly affects the output tolerance; a 2% part gives an overall variation including line and load regulation of ±5%.
- Resistors R5 and R6 are optional and provide a small pre-load on each of the two outputs to help maintain voltage regulation down to no load. These can be omitted if no-load regulation is not needed.
- R8 provides a small additional voltage drop to provide better accuracy on the 3.3 V output using a standard 3.9 V Zener.
- For best accuracy, choose R1 and R2 to be 1% tolerance metal film resistors.
- Resistor R7 should be chosen such that a Zener test current of approximately 5 mA - 10 mA flows through VR1.
- D2 is an ultra-fast type diode with t_{RR} = 25 ns. Although a slower diode (such as the UF4005) may be used, this might cause higher reverse recovery current spikes and reduce efficiency.

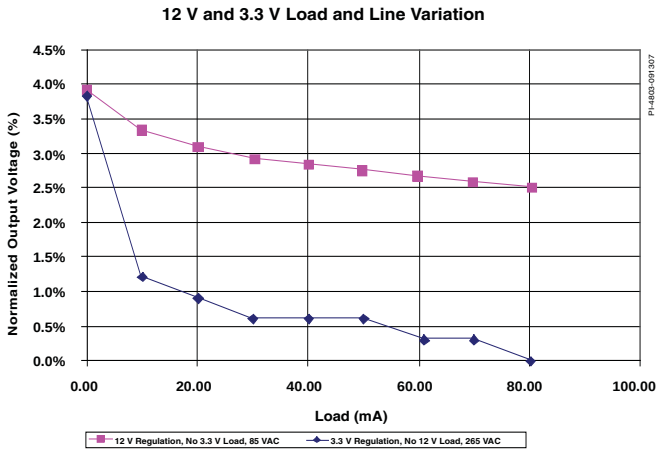

Figure 2. Worst Case Load and Line Regulation Results.

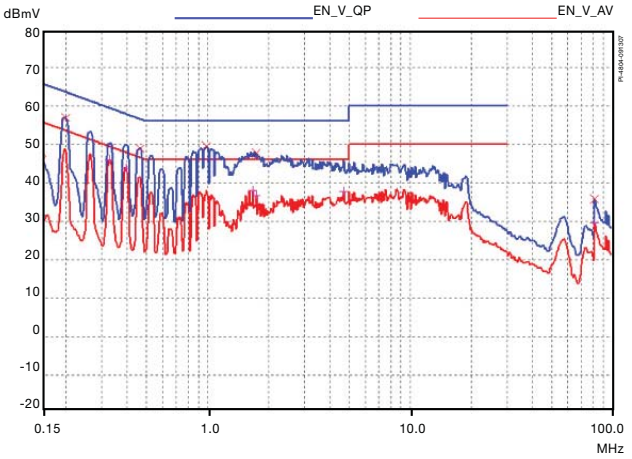

Figure 3. Conducted EMI Scan to EN55022B Limits Measured at 230 VAC Input (Worst Case).

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