LINEAR TECHNOLOGY

DESIGN NOTES

# The LT1776 Provides Power for the IEEE1394 "Fire Wire"

Design Note 191

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Faster microprocessors, more memory and better graphics have fueled the rapid growth of the personal computer industry. However, many of the peripheral connections use older interface technologies that are starting to limit performance and growth for future applications.

The IEEE1394 High Performance Serial Bus ("Fire Wire") addresses these interface issues by providing a flexible and cost-effective way to share real time information among data-intensive applications, such as digital camcorders, digital VCRs and digital video disks (DVDs). This serial bus supports data transfer rates of 100Mbps, 200Mbps and 400Mbps. It also provides unregulated 8VDC to 40VDC at up to 1.5A. As many as sixteen devices can be connected to the IEEE1394 bus, with cable segments between devices of up to 4.5 meters. The junction or node where a device connects to the bus may be a power source, a power sink or neither. Since there may be more than one power source, all power sources are diode connected. The voltage source with the highest potential is allowed to put power on the bus, while the rest are isolated by reverse-biased diodes (see Figure 1).

Figure 2 shows an example of a video camera sending digital video data to a monitor and to a computer, which in turn, is connected to both a digital VCR and a printer, via the IEEE1394 bus.

Figure 3 is a schematic of a circuit that produces a regulated 5V at 500mA from a Fire Wire input (8V to 40V). The LT®1776 is a high voltage, high efficiency buck converter IC. The IC includes an onboard power switch, oscillator, control and protection circuitry. The part can accept an input voltage as high as 40V and the power switch is rated



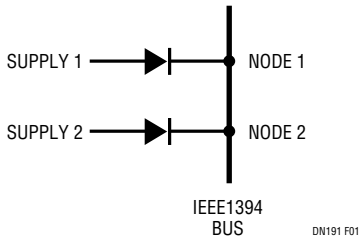


**Figure 1. Two Voltage Sources Diode-Connected to the IEEE1394 Bus; the Source with the Highest Potential Provides Power on the Bus**

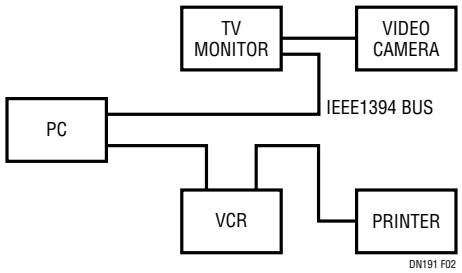


**Figure 2. Typical IEEE1394 Bus System Configuration**

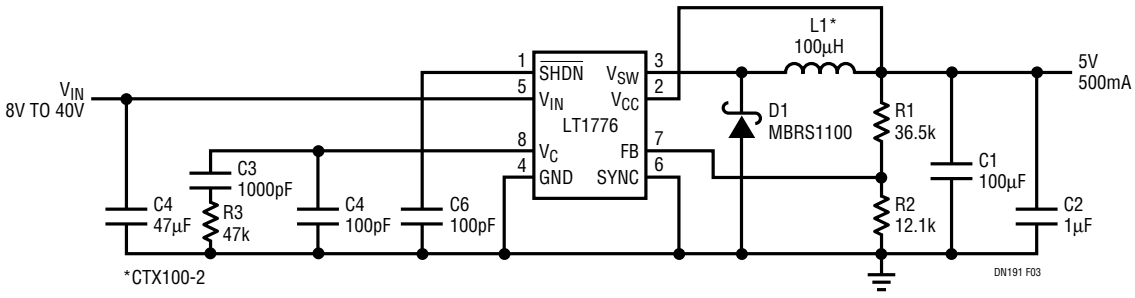


**Figure 3. LT1776 Application Circuit for Generating 5V at 500mA**

at 700mA peak current. Current mode control offers excellent dynamic input supply rejection and overcurrent protection. The SO-8 package and 200kHz switching frequency help minimize PC board area requirements. The part can be disabled by connecting the shutdown ($\overline{SHDN}$) pin to ground, thus reducing input current to a few microamperes. In normal operation, decouple the $\overline{SHDN}$ pin with a 100pF capacitor to ground. The part also has a SYNC pin, used to synchronize the internal oscillator to an external clock, which can be anywhere from 250kHz to 400kHz. To use the part's internal 200kHz oscillator, simply connect the SYNC pin to ground. The circuit uses two techniques to maximize efficiency.

The internal control circuitry draws power from the $V_{CC}$ pin and the LT1776 switch circuitry maintains a rapid rise time (see Figure 4) at high loads. At light loads, it slows down the rise time (see Figure 5) to avoid pulse skipping, thus

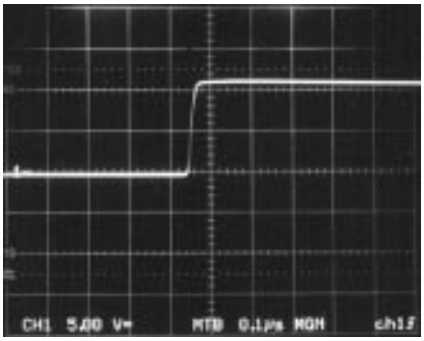

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**Figure 4. Switch Rise Time at Heavy Loads**

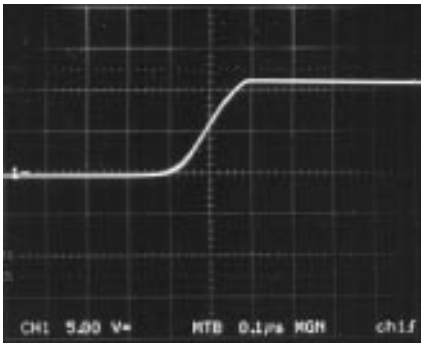

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**Figure 5. Switch Rise Time at Light Loads**

maintaining constant frequency from heavy to light load. This helps significantly in reducing output ripple voltage and switching noise in the audio frequency spectrum. Figure 6 shows typical efficiency curves for various input voltages from 8V to 40V at an output voltage of 5V.

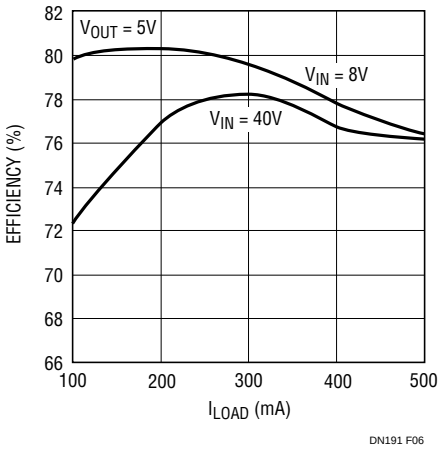

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**Figure 6. Efficiency Curve of Figure 3 Circuit**

Figure 7 presents a scheme that takes the unregulated 8V to 40V supply voltage from the IEEE1394 bus and steps it down to the supply voltage for the physical layer (PHY), using an LT1776 based regulator such as the circuit in Figure 3. The PHY's input voltage can be 1.25V (min), 3.0V, 3.3V, 5V or any other voltage level, provided that LT1776's input voltage is greater than the desired output voltage.

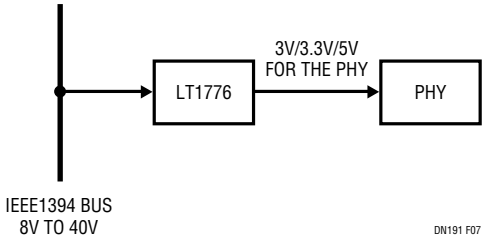

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**Figure 7. LT1776 Provides Power to Physical Layer Electronics (PHY) from IEEE1394 Bus**

Linear Technology also offers the LT1676, which is very similar to the LT1776 except that its maximum input voltage can be as high as 60V. Also, its switching frequency is 100kHz with the option of synchronizing to an external clock in the range of 130kHz to 250kHz. The LT1676's high input voltage range of 7.4V to 60V allows it to be used not only in IEEE1394 "Fire Wire" applications but also in automotive DC/DC and telecom 48V step-down applications.

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