LINEAR TECHNOLOGY

DESIGN NOTES

Versatile Industrial Power Supply Takes High Voltage Input and Yields from Eight 1A to Two 4A Outputs – Design Note 520

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Introduction

Today's industrial electronic systems contain many of the same components as consumer electronics—microcontrollers, FPGAs, system-on-chip ASICs and other electronics—requiring multiple low voltage rails at widely varied load currents. Industrial applications can also demand a pushbutton interface, an always-on supply for a real-time clock (RTC) or memory and the ability to take input power from a high voltage supply. Other required features may be a watchdog timer (WDT), a kill or reset button, software adjustable voltage levels and error reporting of low input/output voltages and high die temperature.

The LTC®3375 is a highly configurable multioutput step-down power converter that offers the features often required by industrial electronics while providing the flexibility to configure various outputs with maximum currents ranging from 1A to 4A.

Configurable Maximum Output Current

The LTC3375's eight 1A channels can be combined to produce various combinations of 1A, 2A, 3A and 4A buck regulators, as shown by the 15 different output current configurations in Table 1.

Connecting the feedback pin of a given channel to its V_{IN} pin configures that channel as a slave to the adjacent channel. The switch pins of the two channels are connected together to share a single inductor and output capacitor. Master/slave channels are enabled via the master's enable pin and regulate to the master's feedback network.

Output current can be increased to 3A or 4A by connecting additional adjacent channels. The circuit in Figure 1 shows the LTC3375 configured with a 3A output, a 1A output, two 2A outputs and an always-on LDO. It also illustrates how the LTC3375 can be connected to control the start-up of an upstream external buck controller via the on-chip pushbutton interface to supply input power to the LTC3375 buck regulators.

Table 1. LTC3375 Maximum Current Configurations

NUMBER OF BUCKS	OUTPUT CONFIGURATION
8	1A, 1A, 1A, 1A, 1A, 1A, 1A, 1A
7	1A, 1A, 1A, 1A, 1A, 1A, 2A
6	1A, 1A, 1A, 1A, 1A, 3A
6	1A, 1A, 1A, 1A, 2A, 2A
5	1A, 1A, 1A, 1A, 4A
5	1A, 1A, 1A, 2A, 3A
5	1A, 1A, 2A, 2A, 2A
4	1A, 1A, 2A, 4A
4	1A, 1A, 3A, 3A
4	1A, 2A, 2A, 3A
4	2A, 2A, 2A, 2A
3	1A, 3A, 4A
3	2A, 2A, 4A
3	2A, 3A, 3A
2	4A, 4A

External V_{CC} LDO and External Input Power Supply Start-Up Control

The LTC3375 can control an external LDO pass device to supply its V_{CC} power and any other low current electronics such as an RTC. The V_{CC} powers the internal pushbutton circuitry, WDT, internal registers and open-drain pull-ups. The external LDO in Figure 1 creates a 3.3V supply from the 24V rail.

When the pushbutton is pressed, the ON pin is released and the RUN pin is pulled high on the LTC3891, supplying input power to the buck regulators of the LTC3375. When the LTC3891 achieves regulation, the PGOOD pin is released, enabling EN1 of the LTC3375 and turning on the 2A regulator. The remaining regulators can be enabled with the precision threshold enable pins or via software-controlled I^2C commands. Pressing the pushbutton again for 10 seconds or more, or pulling $\overline{KILL}$ low for 50ms or more, causes the ON pin to be pulled low, disabling all of the buck regulators.

Unique Power Control and Features

The I²C interface allows extensive control of regulator operation. Each regulator may be set to a high efficiency Burst Mode® operation to save power at light loads or set to forced continuous mode for lower output ripple voltage. Each regulator can also have the switching cycle phase shifted by 0°, 90°, 180°, or 270° with respect to the reference clock to allow a lower input ripple current when multiple outputs are supplying large loads. Another feature is the ability to manipulate each output voltage up or down by adjusting the feedback reference voltage from the default 725mV setting in 25mV steps (ranging from 425mV to 800mV). The I²C interface is also used for reporting error conditions for each regulator.

The LTC3375 has a reset ($\overline{RST}$) pin and an interrupt request ($\overline{IRQ}$) pin, which can be programmed to report when any regulator's output voltage has dropped below 92.5% of the regulation point. The $\overline{IRQ}$ pin can also be programmed to report when the input voltage drops below the undervoltage lockout (UVLO) threshold or when the die temperature has reached a set temperature threshold. The regulator's PGOOD and UVLO status, the die temperature warning and the measured die temperature can be monitored by the microprocessor via the I²C interface.

One problem with microprocessors is that a software bug can cause the program to hang. The LTC3375 includes a watchdog timer input (WDI) pin to monitor the SCL pin or some other pin to determine if the software is still running. If the software has stopped running, the watchdog timer output (WDO) pin can be used to reset the microprocessor or power down the HV buck and the LTC3375 buck regulators. Connecting the WDO pin to the $\overline{RST}$ pin of a microprocessor causes the microprocessor to reset when the WDT is not satisfied. Connecting the WDO pin to the $\overline{KILL}$ pin causes the ON pin to go low, disabling the HV buck and all LTC3375 regulators. The $\overline{KILL}$ pin can be pulled low by a pushbutton "paper clip" switch to power down all the regulators as a last resort.

Conclusion

The LTC3375 can be configured with multiple regulated 1A to 4A outputs totaling up to 8A, and includes many features required by today's industrial electronics.

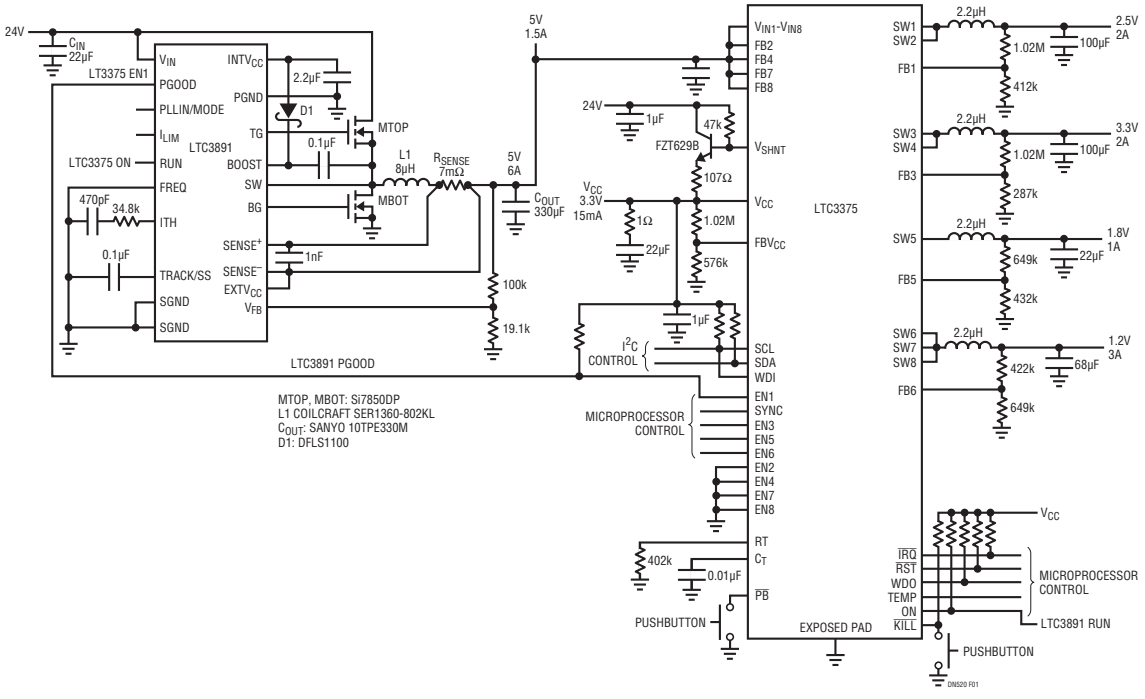

Figure 1. Low Voltage Power Supply with Pushbutton Control of Upstream HV Buck and Always-On LDO

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