Introduction
Automotive batteries, industrial power supplies, distributed supplies and wall transformers are all sources of wide-ranging, high voltage inputs. The easiest way to step down the voltage from these sources is with a high voltage monolithic step-down switching regulator that can directly accept a wide input range and produce a well-regulated output. The LT3680 and LT3693 are new step-down switching regulators that accept inputs up to 36V and provide excellent line and load regulations and dynamic response. Both regulators offer high efficiency solutions over wide load range. The LT3680 adds low ripple Burst Mode® operation to maximize efficiency at light load currents.

LT3680 and LT3693 Features
Available in either a 10-pin MSOP or a 3mm × 3mm DFN package, the LT3680 and LT3693 offer an integrated 5A power switch and external compensation for design flexibility. Both regulators employ a constant frequency, current mode architecture. The switching frequency can be set between 200kHz and 2.4MHz by using a resistor tied from the RT pin to ground. This allows a trade off between component size and efficiency. The switching frequency can also be synchronized to an external clock for noise sensitive applications. An external resistor divider programs the output voltage to any value above the part’s 0.79V reference.

The easiest way to step down the voltage from a wide ranging, high voltage source is with a monolithic step-down switching regulator that can directly convert the input to a well-regulated output.
the output voltage is above 2.5V, the anode of the boost diode can be connected to output. For output voltages lower than 2.5V, the boost diode can be tied to a separate rail or to the input. For systems that rely on a well-regulated power source, the LT3680 and LT3693 provide a power good flag that signals when \( V_{\text{OUT}} \) reaches 90% of the programmed output voltage.

**Low Ripple Burst Mode Operation of LT3680**

The only difference between LT3680 and LT3693 is that the LT3680 offers low ripple Burst Mode operation, which can be selected by applying a logic low to the SYNC pin. Low ripple Burst Mode operation maintains high efficiency at light load while keeping the output voltage ripple low. During Burst Mode operation, the LT3680 delivers single cycle bursts of current to the output capacitor followed by sleep periods when the output power is delivered to the load only by the output capacitor. Between bursts, all circuitry associated with controlling the output switch is shut down, reducing the input supply current and BD quiescent current to 30µA and 80µA, respectively. As the load current decreases to a no load condition, the percentage of time that LT3680 operates in sleep mode increases and the average input current is greatly reduced, resulting in high efficiency. Both LT3680 and LT3693 have a very low (less than 1µA) shutdown current which significantly extends battery life in applications that spend long periods of shutdown mode. For applications that require constant frequency operation at no load or light load, the LT3693 can be used.

**6.3V–36V to 5V, 3.5A DC/DC Converter with All Ceramic Capacitors**

Figure 1 shows the LT3680 producing 5V at 3.5A from an input of 6.3V to 38V with 65V transient. The circuit is programmed for a 600kHz switching frequency and requires 100mm² of PCB. Figure 2 shows the circuit efficiency at 12V and 24V inputs. At 12V input, the efficiency peaks above 90% and remains high across the entire load range.

The SYNC pin is tied to the ground to enable Burst Mode operation and achieve high efficiency at light load. Figure 3 shows the inductor current and output voltage ripple under single pulse Burst Mode operation at 10mA load. The output voltage ripple \( V_{p-p} \) is less than 20mV as a result of low ripple Burst Mode operation.

An external signal can drive the RUN/SS pin through a resistor and capacitor to program the LT3680’s soft-start, reducing maximum inrush current during start-up.

**3.5V–27V \( V_{\text{IN}} \) to 1.8V \( V_{\text{OUT}} \), 3.5A DC/DC Converter with All Ceramic Capacitors**

For output voltages lower than 2.5V, the integrated boost diode can be tied to the input or a separate rail greater than 2.8V. Figure 4 shows a 1.8V output converter using the LT3680 with the integrated boost diode tie to input. In this application, the maximum input voltage is 27V so that the maximum voltage rating of Boost pin and BD pin are not exceeded.

**Negative Output from Buck Regulators**

Negative output supplies are required for many applications. The circuit in Figure 5 can generate a negative voltage of –5V from buck regulators such as LT3680 or LT3693. The circuit sets the input ground reference and the LT3680 ground reference to –5V to generate negative 5V supply.

**Conclusion**

The wide input range, small size and robustness of the LT3680 and LT3693 make them easy fit in automotive, industrial and distributed power applications. They are highly efficient over the entire load range. The unique low ripple Burst Mode operation of LT3680 helps to save battery power life while maintaining low output ripple.