Introduction
Automotive, distributed power and battery-powered applications often operate at a voltage that is derived from a widely variable bus voltage. Frequently the operating voltage falls somewhere in the middle of the bus voltage range, such as a 12V automotive operating voltage, from a 4V to 18V bus. These applications require a DC/DC converter that can step up or step down, depending on the voltage present on the bus. Flyback and SEPIC designs are commonly used single-switch solutions for this problem, but both of these solutions typically use a transformer which poses layout and height problems for applications where space is at a premium.

One alternative to a transformer-based topology is to use two low profile inductors and a SEPIC coupling capacitor which transfers the energy between the two inductors much like the core of a transformer. The coupling capacitor provides a low impedance path for the inductor currents to pass either from the input (primary) inductor through the catch diode and to the output, or from the output (secondary) inductor back through the switch to ground. Both inductors act continuously and independently, making their selection easier than selecting the transformer for a flyback or a typical SEPIC circuit. The inductors are not restricted to having the same inductance and can be individually picked for peak currents and allowable ripple.

3V to 20V Input, 5V Output, 3mm Maximum Height SEPIC
Figure 1 shows a 3V to 20V input, 5V output 3mm maximum height SEPIC using the LT\textsuperscript{®}1961, a 1.25MHz, current mode, monolithic, 1.5A peak switch current, boost converter. The output current capability of this circuit varies with input voltage (see Figure 3). At 3V input, the converter can supply up to 410mA of load current and as high as 830mA of load current at 20V input. The tiny coupling capacitor used here is large enough to handle the RMS ripple current transferring between the primary and

![Figure 1. LT1961 in a 3V to 20V Input to 5V Output All Ceramic SEPIC (3mm Maximum Height)](image)

![Figure 2. Efficiency of the Circuit in Figure 1](image)

![Figure 3. The Peak Inductor Currents in L1 and L2 Sum to 1.5A, the Peak Switch Current. Maximum Output Current is the Average Current in L2 at Peak Switch Current](image)
secondary sides of the circuit, and to maintain a voltage
equal to the input voltage in order to provide good
regulation and maximum output power. The current
mode control topology of the LT1961 and the small 10μF
ceramic output capacitor provide excellent transient
response over the wide input voltage range.

4V to 18V Input, 12V Output, 3mm Maximum
Height SEPIC

12V buses are often derived from sources with a wide
input voltage range. For instance, automotive solutions
can have steady-state operating voltages as high as 18V
and as low as 4V for cold-crank conditions. Figure 4
shows a simple, low cost and low profile (<3mm) solution
that avoids the high cost of using both a boost and buck
converter and maintains 12V system power during cold-
crank conditions.

Efficiency, as shown in Figure 5, is typically greater than
75% and as high as 80%. This is better than average for
12V SEPICs and not much less than a similarly priced and
sized 12V buck converter solution which is limited to
greater than 14V input. Maximum load current increases
with input voltage, as shown in Figure 6. 500mA load
current is possible at 12V input and up to 600mA at 18V.
The maximum switch current of the LT1961 is 1.5A and is
the sum of the peak current in L1 and L2. Higher output
voltage raises the current in the input inductor.

The catch diode has a 40V reverse breakdown voltage
rating in order to handle the voltage induced across it
during the switch off-time which is equal to the output
voltage plus the input voltage. The 35V maximum switch
voltage rating of the LT1961 allows the input voltage to go
up as high as 18V. With a DC voltage equal to the input
voltage, the coupling capacitor raises the voltage at the
switch node to a level equal to the input voltage plus the
output voltage. Tiny voltage spiking present on the switch
node of any switching converter requires a few volts of
headroom between the maximum switch voltage rating
and the sum of the input and output voltages. The switching
spikes are reduced to a minimum by keeping the high
\( \Delta V/\Delta t \) discontinuous current path (indicated in bold in
Figures 1 and 4) as short as possible. The placement of the
two power inductors is not crucial which makes it easier
to create a power supply layout that fits confined spaces.

Conclusion
The LT1961 fits into SEPIC solutions for applications with
wide input voltage ranges. The solutions are small, simple
and low profile. All ceramic capacitors and tiny compo-
nents help keep power supply costs to a minimum. The
2-inductor SEPICs shown here eliminate the use of a tall
transformer and offer layout flexibility to fit tight design
constraints.

For applications help,
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