LM5041, LM5100

LM5041 Application: DC - DC Converter Featuring the Cascaded Power Converter Topology

Literature Number: SNVA560
LM5041 Application DC – DC Converter
Featuring the Cascaded Power Converter Topology
Current Fed Push-Pull Concept

- Push and Pull outputs operate continuously, alternating with a slight overlap.
- Output voltage is controlled by the Buck stage which operates at 2X the Push-Pull frequency.
- Continuous output current from the Push-Pull stage requires minimal filtering.
- High Efficiency achieved with low Push-Pull switching losses and matched Sync rectifier loading.
- Favorable topology for multi-output converters.
CASCaded CURRENT FED BENEFITS

• A Current-Fed Push-Pull Converter is a Buck type converter consisting of a Buck Regulation stage followed by (cascaded by) a Push-Pull Isolation Stage
• The Buck Stage Capacitor and the Output Stage Inductor have been eliminated from the Voltage-Fed
• Reduced switching loss in PP stage
• The Push-Pull Stage voltage stresses are reduced to Vout * N * 2 over all line conditions, similar to Voltage-Fed
• The output rectification can be easily optimized, similar to Cascaded Voltage-Fed
Current-Fed Waveforms

Trace 1: Push_Pull XFR Side A
Trace 2: Push_Pull XFR Side B
Trace 3: Buck Stage Switching Node

Note: There is an overlap time where both the Push and the Pull switches are ON. This is required to maintain the inductor current path.

Vin = 60V
Vout = 2.5V
Iout = 20A
Current-Fed Waveforms

Vin = 48V
Vout = 2.5V
Iout = 20A

Ch 1,2  Push-Pull  Vds
Ch 3,4  Push-Pull  Ids
Current-Fed Waveforms
Expanded Scale

Note, Switches only switch ½ current

Ch 1,2  Push-Pull  $V_{\text{ds}}$
Ch 3,4  Push-Pull  $I_{\text{ds}}$

Vin = 48V
Vout = 2.5V
Iout = 20A
Why is Reducing Secondary Rectification Losses Important?

- Secondary Rectifiers: 40%
- Primary Switching: 15%
- Filter Inductor: 15%
- Transformer: 20%
- Control: 10%

Estimate for typical 3.3V Output, 35 – 80V Input
## Comparison of Rectifier Stresses

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<th>Rectifier Voltage Stresses</th>
<th>Example: 3.3V Out, 35 - 80V Input</th>
<th>Example: Assumptions</th>
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<td>Forward</td>
<td>Vin * (Ns/Np)</td>
<td>20V</td>
<td>High Line with XFR Ratio 4:1</td>
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<tr>
<td>Push-Pull</td>
<td>Vin * (Ns/Np) * 2</td>
<td>26.7V</td>
<td>High Line with XFR Ratio 6:1</td>
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<tr>
<td>Cascaded PP</td>
<td>Vout * 2</td>
<td>6.6V</td>
<td>All Line conditions XFR Ratio 6:1</td>
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<th>Topology</th>
<th>Rectifier Current Ratios</th>
<th>Example: 3.3V Out, 35 - 80V Input</th>
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<tr>
<td>Forward</td>
<td>Iout * D and Iout * (1-D)</td>
<td>16 / 84%</td>
<td>Ratio at High Line</td>
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<tr>
<td>Push-Pull</td>
<td>50% * Iout</td>
<td>50%</td>
<td>All line conditions</td>
</tr>
<tr>
<td>Cascaded PP</td>
<td>50% * Iout</td>
<td>50%</td>
<td>All line conditions</td>
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LM5041 Cascaded PWM Controller

Features
- Internal Start-up Bias Regulator
- Programmable Line Under Voltage Lockout with Adjustable Hysteresis
- Current Mode Control
- Internal Error Amplifier with Reference
- Dual Mode Over-Current Protection
- Programmable Push-Pull Overlap or Deadtime
- Internal Push-Pull Gate Drivers
- Programmable Soft-Start
- Programmable Oscillator with Sync Capability
- Precision Reference
- Thermal Shutdown (165°C)

Packages: TSSOP16 and LLP16 (5 x 5 mm)
LM5100 / 1 High Voltage Buck Stage Gate Driver

Features
- Drives both a High Side and Low Side N-Channel MOSFET
- Independent Inputs (TTL for LM5101 or CMOS for LM5100)
- Bootstrap Supply Voltage to 116VDC
- Fast Propagation Times
- Drives 1000pF Loads with 10nS Rise and Fall Times
- Outputs Unaffected by Supply Glitching, HS Ringing Below Ground or HS High Slew Rates
- Supply Rail Under-voltage Lockout
- Low Power Consumption
- Pin for pin compatible with HIP2100/2101

Typical Applications
- Current Fed Push-Pull Power Converters
- Half Bridge Power Converters
- Full Bridge Power Converters
- Two Switch Forward Power Converters
- Active Clamp Forward Power Converters

Package
- SOIC – 8
- LLP - 10
Application Converter
Performance

Input Range: 35 to 80V
Output Voltage: 2.5V
Output Current: 0 to 50A
Measured Efficiency:
  89% @ 50A and 91% @20A
Board Size: 2.3 x 3.0 x 0.5
Load Regulation: 1%
Line Regulation: 0.1%
Line UVLO, Current Limit
LM5041 / LM5100 Demo Board
2.5V @ 50A Cascaded DC-DC Converter
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