

Dual Transistor Forward Topology for Small Wattage Power Supply

1-1

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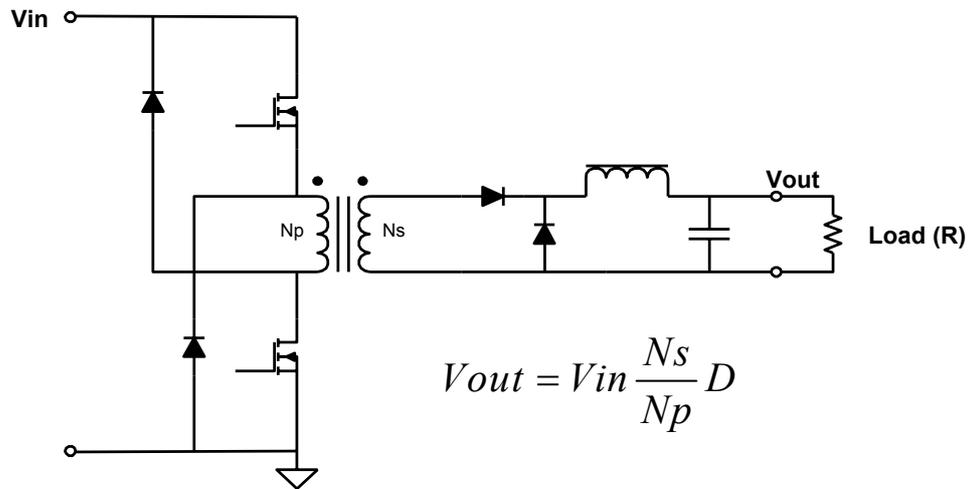
Leon Liang

**Field Application Engineer
South China**

1-2



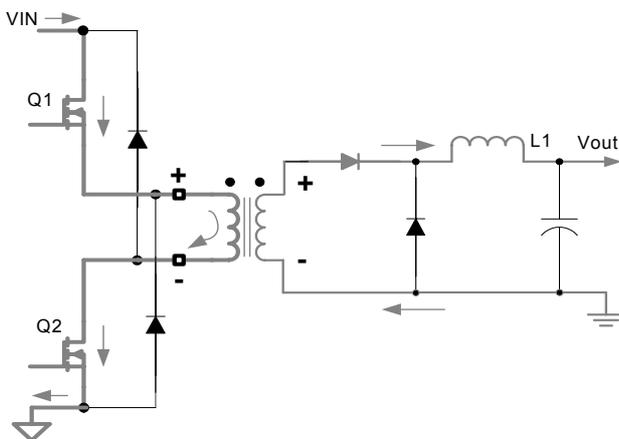
Two Transistor Forward Converter



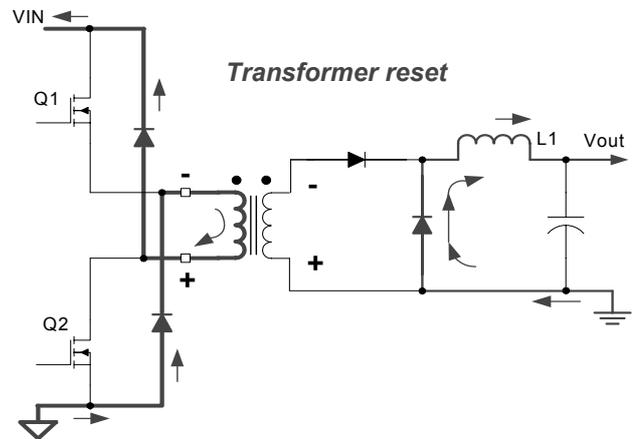
- The two transistors turn on simultaneously.
- Voltage stress on each transistor is the same as V_{in} .
- No reset winding is needed.



Two Transistor Forward Operation



Q1 AND Q2 operate simultaneously, applying V_{in} across the transformer primary and supplying current to the output LC filter.



When **Q1 AND Q2** turn off, the transformer primary inductance current continues to flow through the catch diodes, reversing the primary voltage. The maximum voltage across **Q1** and **Q2** is limited to V_{in} .



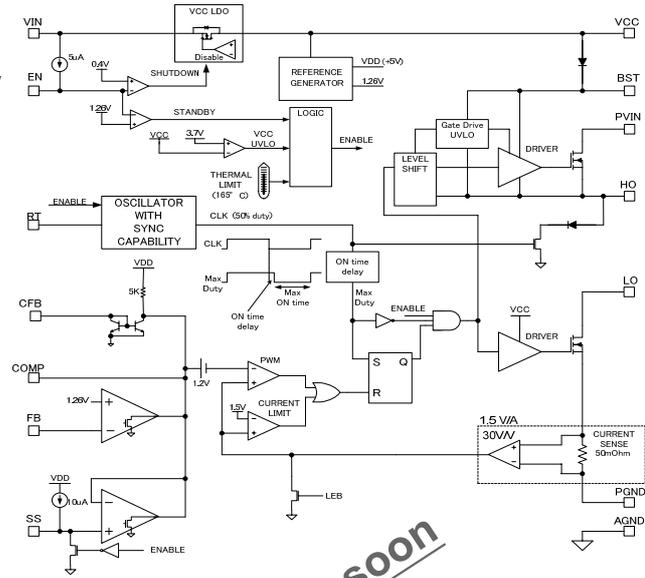
LM5015 High Voltage Two-Switch Forward Regulator

Features

- Dual Integrated 75V N-Channel MOSFETs
- Ultra-wide input voltage range: 4.25V to 75V
- Integrated high voltage bias regulator
- Adjustable output voltage
- 1.5% feedback reference accuracy
- Current mode control with selectable compensation
- Wide bandwidth error amplifier
- Integrated current sensing and limiting
- 50% maximum duty cycle limit
- Single resistor oscillator programming
- Oscillator synchronization capability
- Programmable soft-start
- Enable / Under-voltage Lockout (UVLO) Pin
- Thermal shutdown

Package

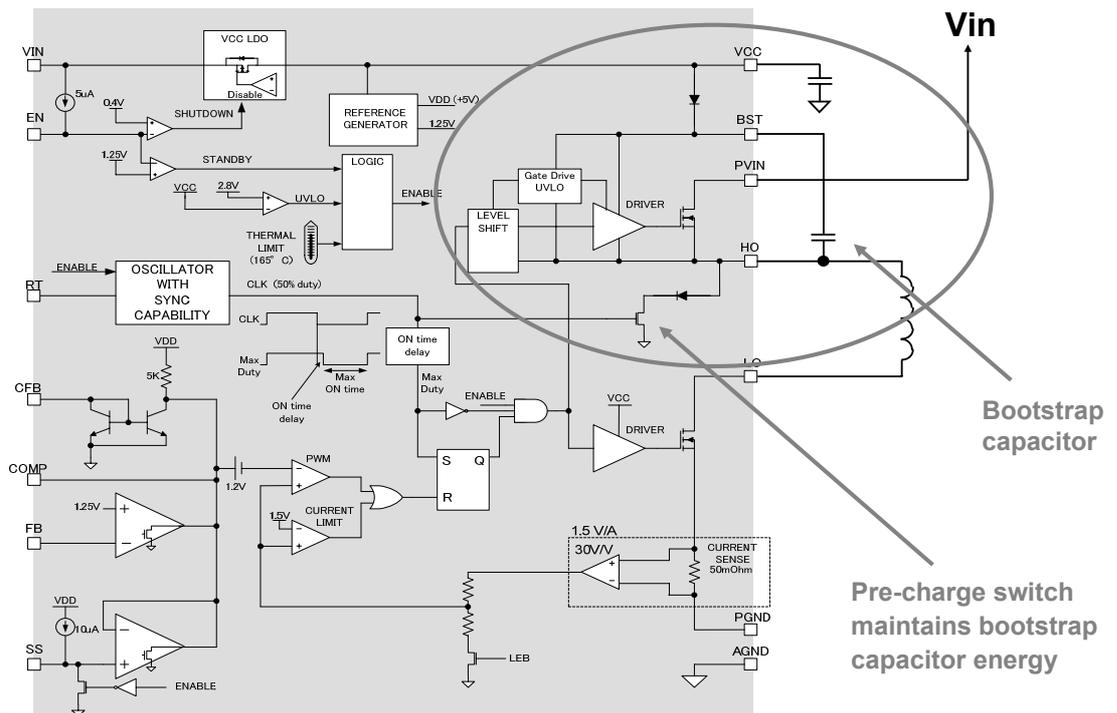
- TSSOP-14EP
- LLP-14 (4 x 3mm)



Coming soon



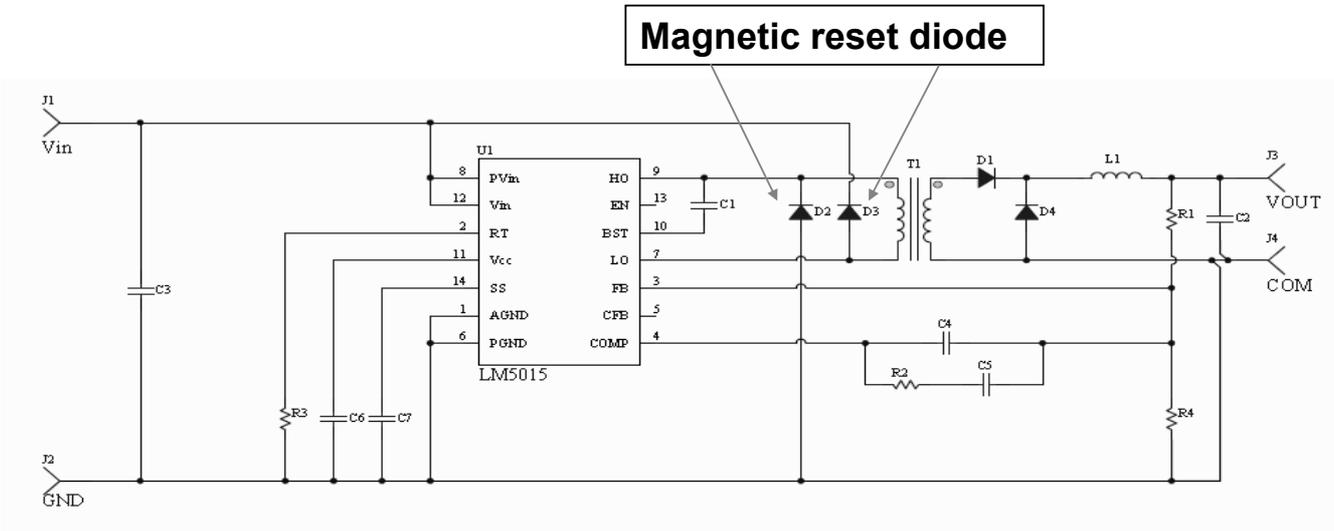
Solving HS Floating Drive Problem





Two Transistor Forward Non-Isolated DC-DC Converter

- $V_{in} = 12V$
- $V_{out} = 3.3V/0.5A$



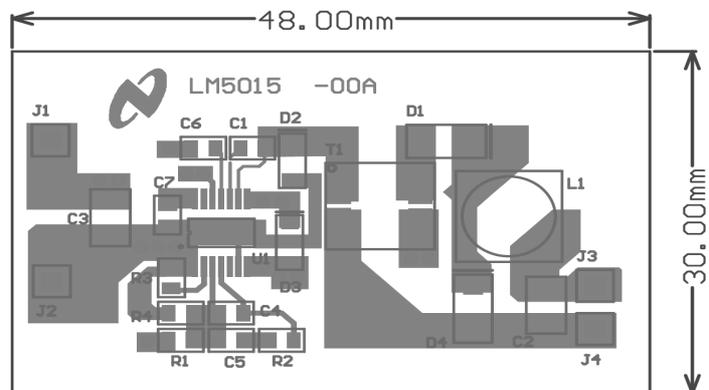
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1-7



Two Transistor Forward Non-Isolated DC-DC Converter - Results

- $V_{in} = 12V$
- $V_{out} = 3.3V/0.5A$
- Switching frequency = 500 KHz
- Efficiency = 72.1%



T1 is a couple choke:

$N_p:N_s = 1:1$, core size is $7 \times 7mm$



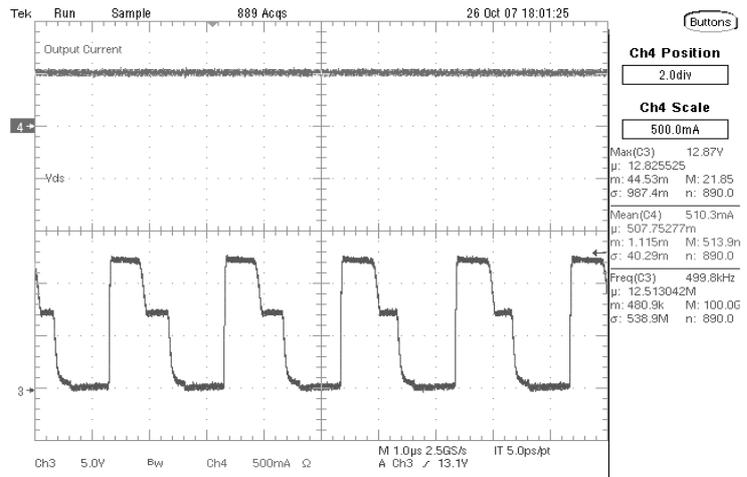
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1-8



Two Transistor Forward, Good EMI Performance

- Output inductor current is continuous.
- No Leakage voltage spike common in flyback converter.

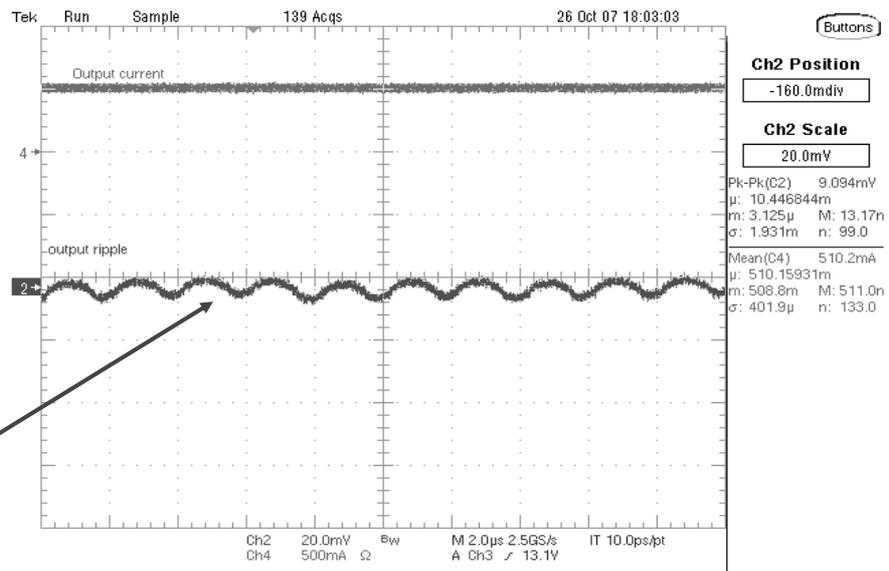


- CH4 : Output Current
- CH3 : Drain Voltage of low side FET

No Snubber Circuit!



Two Transistor Forward, Very Low Output Ripple



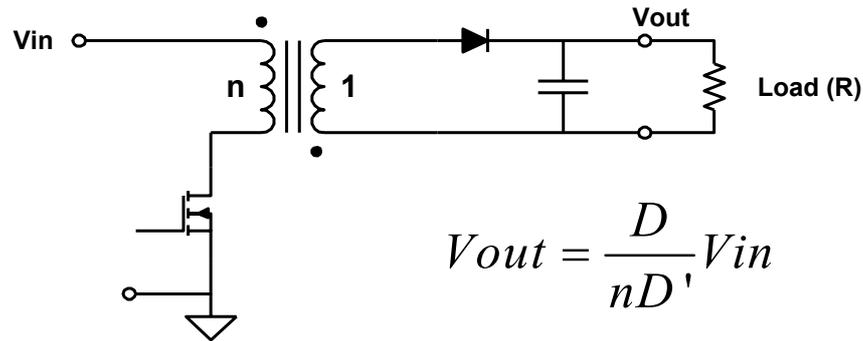
Output ripple is about 9 mV

- CH4 : Output Current
- CH2 : Output ripple voltage





Flyback Converter



- Single magnetic component, it acts as a transformer and inductor.
- Voltage stress on the transistor is V_{in} plus reflected output voltage.
- Transformer need air-gap to present saturation.



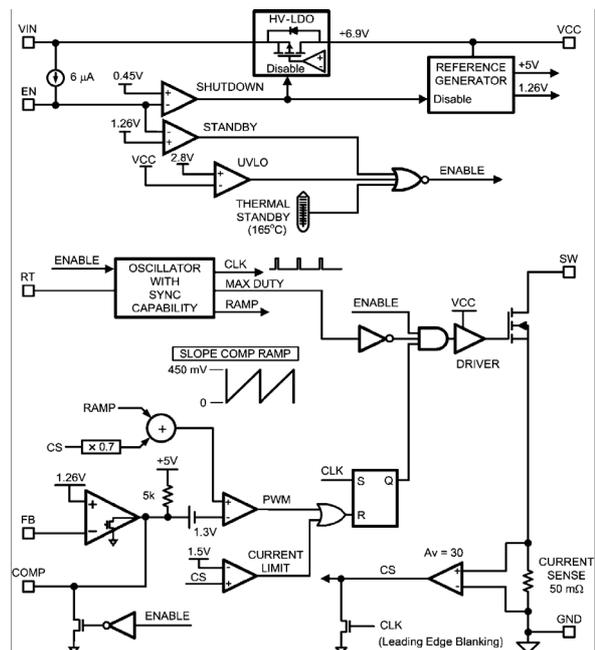
LM5001 Flyback Switch Mode Regulator

Features

- Integrated 75 volt N-Channel MOSFET
- Ultra-wide input voltage range from 3.1V to 75V
- Integrated high voltage bias regulator
- Adjustable output voltage
- 1.5% output voltage accuracy
- Current mode control with selectable compensation
- Wide bandwidth error amplifier
- Integrated current sensing and limiting
- Integrated slope compensation
- 85% maximum duty cycle limit
- Single resistor oscillator programming
- Oscillator synchronization capability
- Enable / Undervoltage Lockout (UVLO) pin
- Thermal shutdown

Packages

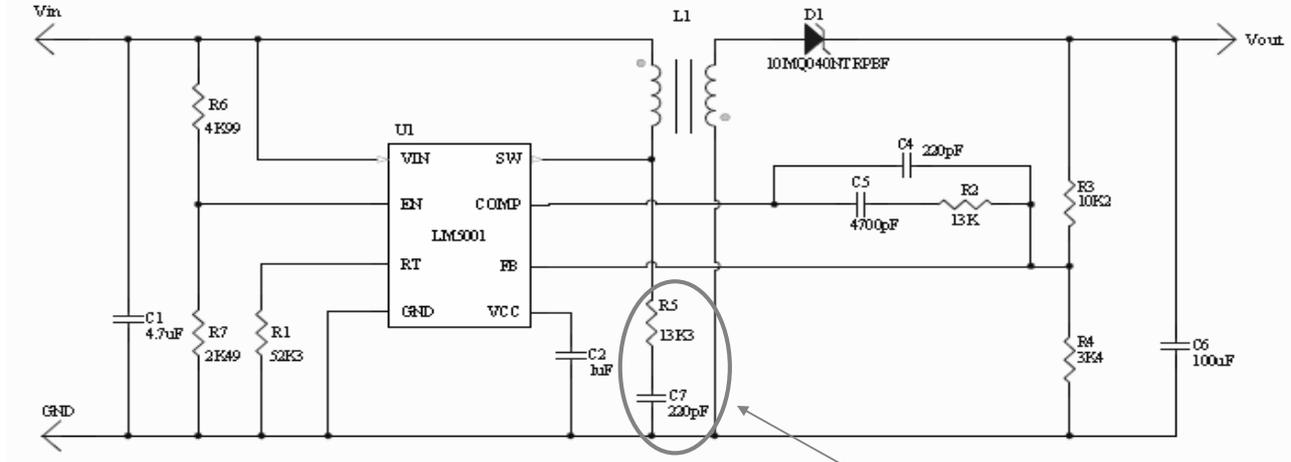
- SO-8
- LLP-8 (4 x 4mm)





Flyback Non-isolated DC-DC Converter

- $V_{in} = 12V$
- $V_{out} = 3.3V/0.5A$

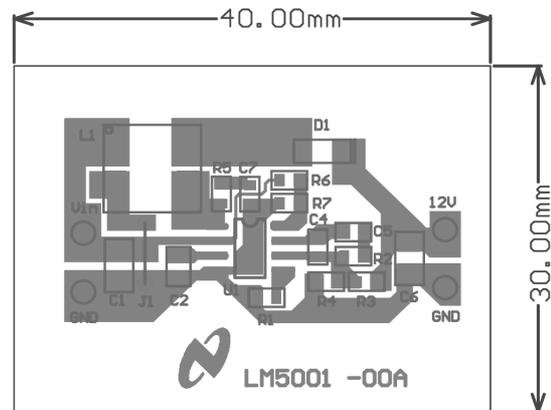


Snubber circuitry



Flyback Non-isolated DC-DC Converter - Results

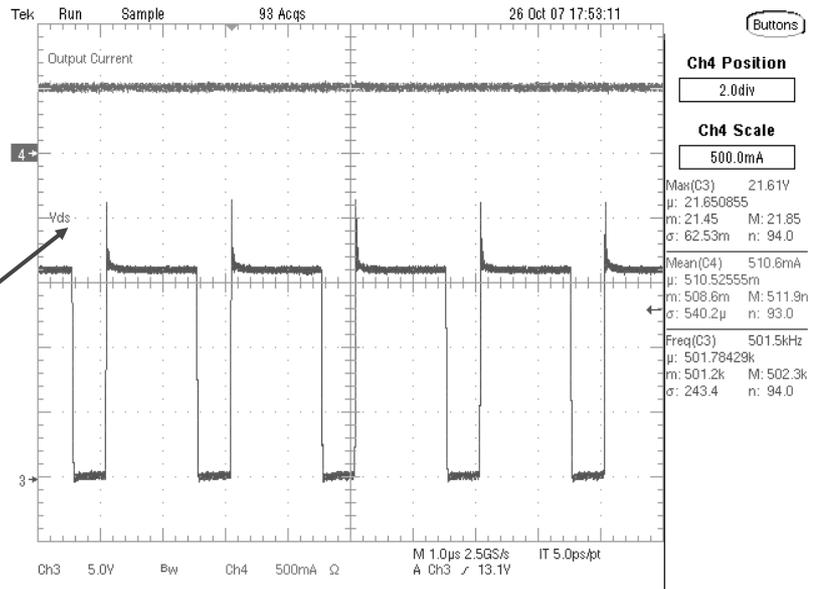
- $V_{in} = 12V$
- $V_{out} = 3.3V/0.5A$
- Switch frequency = 500 KHz
- Efficiency: 68%



T1 is a couple choke:
 $N_p:N_s = 1:1$, core size is 7×7 mm



Flyback Converter, High Leakage Voltage Spike

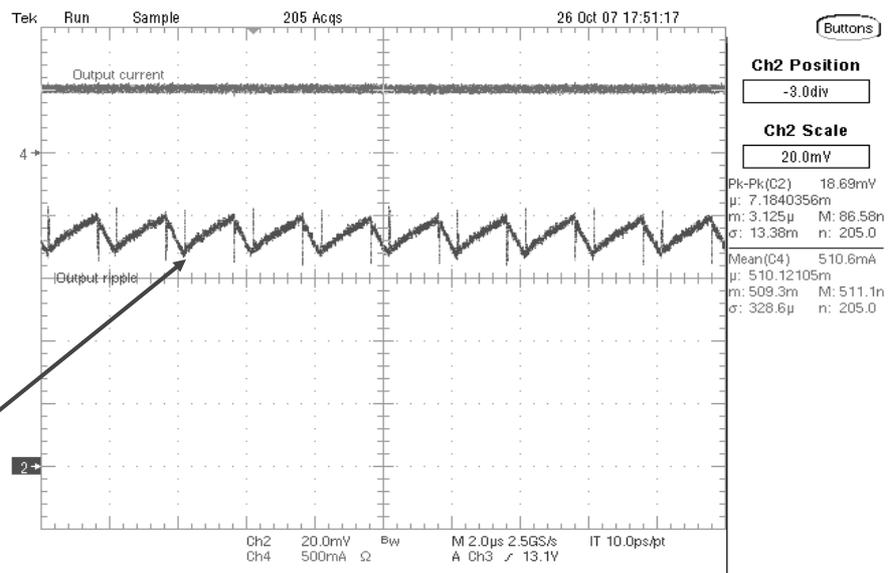


Voltage spike caused by transformer leakage inductance

- CH4 : Output Current
- CH3 : Drain Voltage of FET



Flyback Converter, Output Ripple



Output ripple is about 18 mV

- CH4 : Output Current
- CH2 : Output ripple Voltage





Conclusion

- **Two transistor forward or two transistor flyback reduces voltage stress on the transistors.**
- **No snubber circuit is needed in two transistor forward or two transistor flyback topology.**
- **Monolithic Integrated Circuit (IC) regulators overcome the challenges of the high side MOSFET gate drive through the use of a boot-strap capacitor technique controlled by a high speed level shift circuit.**
- **With integrated regulator approach, two transistor forward/flyback topology can be applicable to small wattage design up to about 15W.**