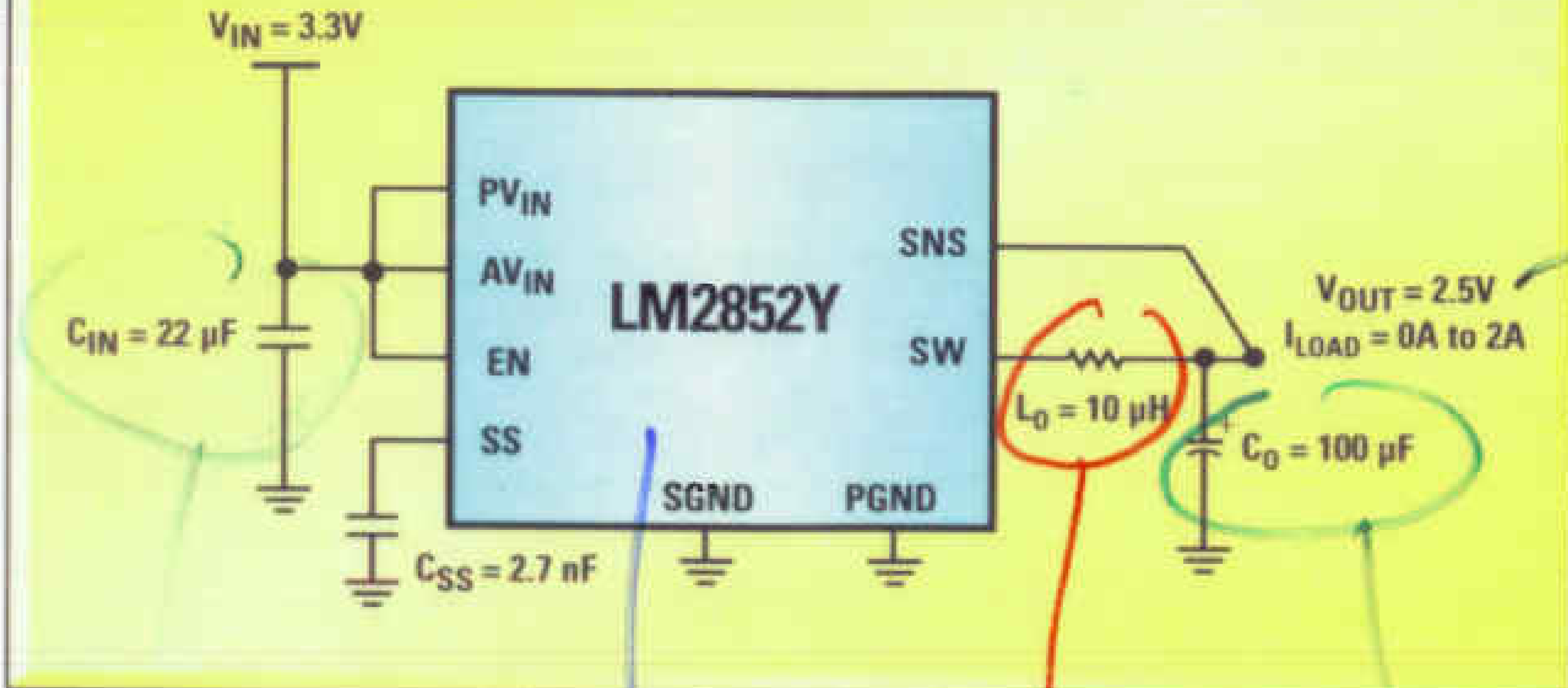
LM2852 Typical application circuit



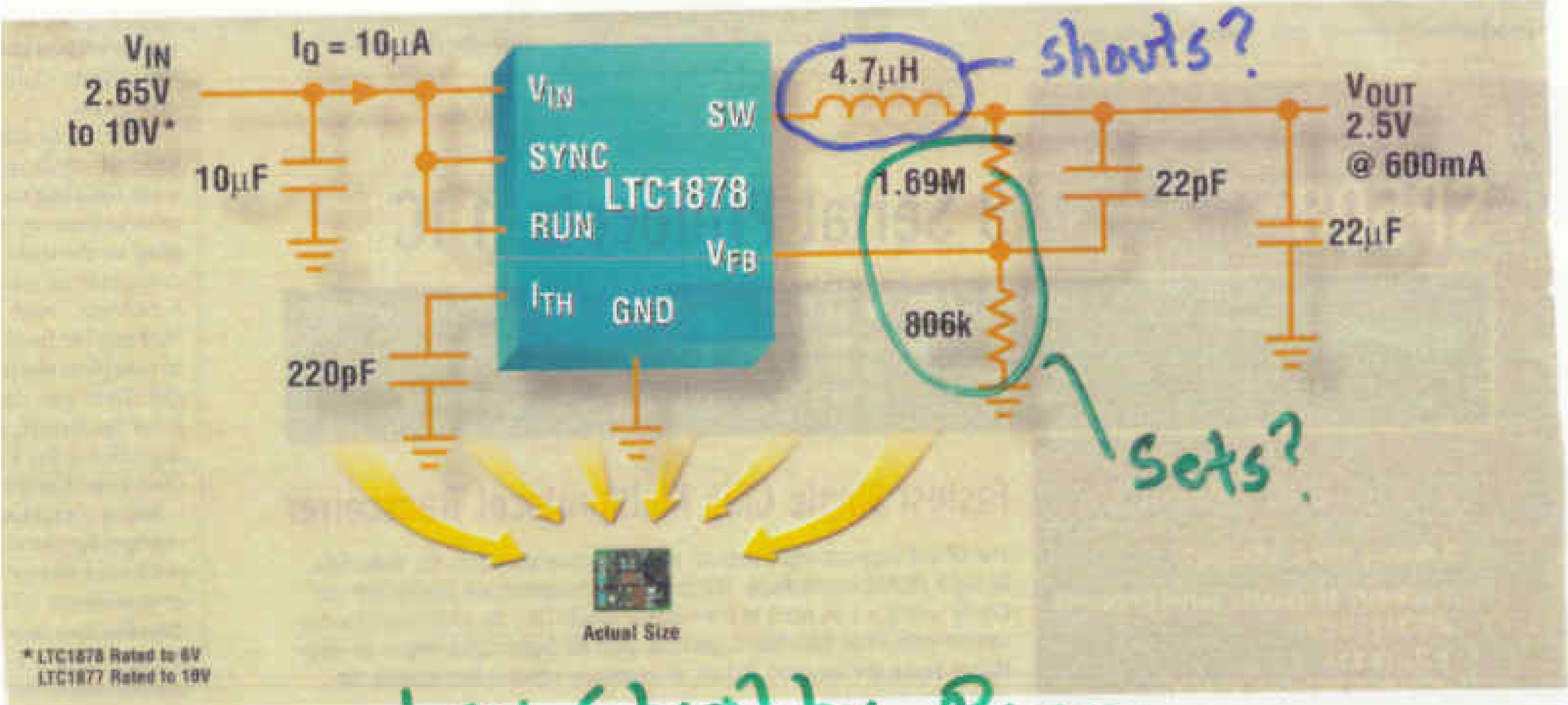
$V_o(\text{min}) = .8$

$C_{IN}(ex)$

$f_{sw} \sim \frac{1}{2}$ MHz
Internal
... switches

L_{EX}

C_{EX} low f
Ta caps



Low Standby Powa

95% Efficient Synchronous Step-Down Regulators Draw Only 10µA

Linear Technology

meaning

Need external L C's R

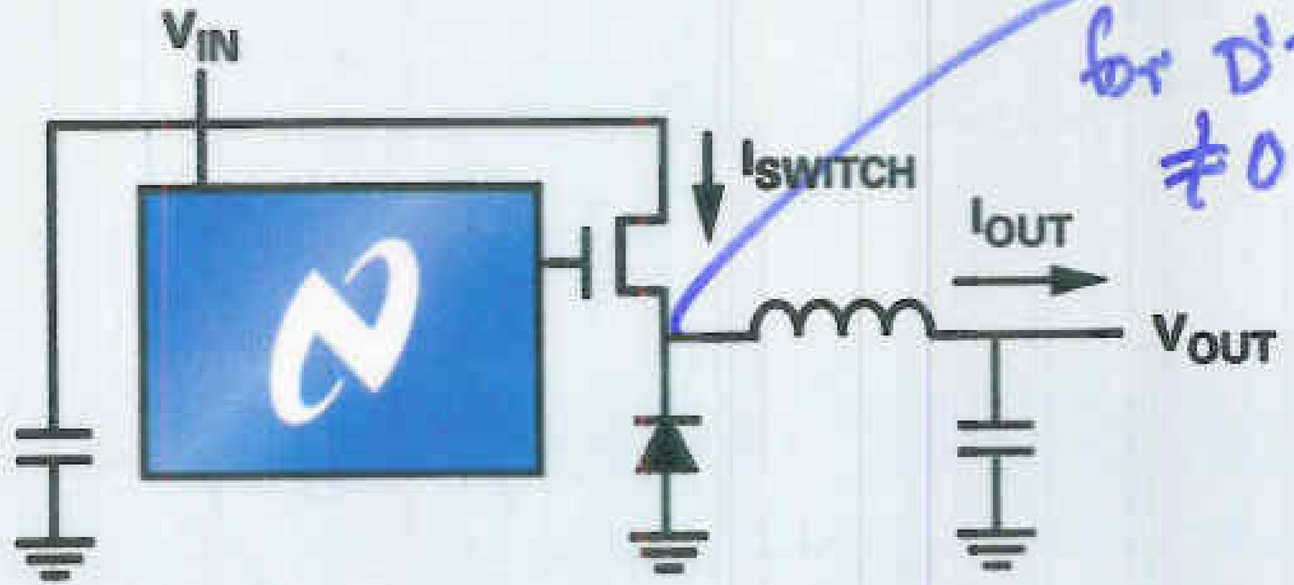
Features

- No External FETs or Schottky Diode Required

on board chip switches drives

- 10µA Quiescent Current
- Up To 95% Efficiency
- 2.65V to 10V Input Voltage (LTC1877)
- 600mA Output Current
- <1µA Shutdown Current
- Selectable Burst Mode™ Operation
- 550kHz Constant Frequency Operation Synchronizable from 400kHz to 700kHz
- Uses Ceramic or Tantalum Capacitors
- Small, Thin 8-Pin MSOP Package

Non-synchronous buck



V_D ? for $D'T_{SW} \neq 0$

Function: Step-down ($V_{OUT} < V_{IN}$)

When to use: Typically when V_{IN} is 3x to 5x V_{OUT} and I_{OUT} is > 0.5A and < 5A

Characteristics: Easy to design and good efficiency for the above-mentioned typical $V_{IN}/V_{OUT}/I_{OUT}$ conditions

Devices to use: All buck integrated regulators and controllers

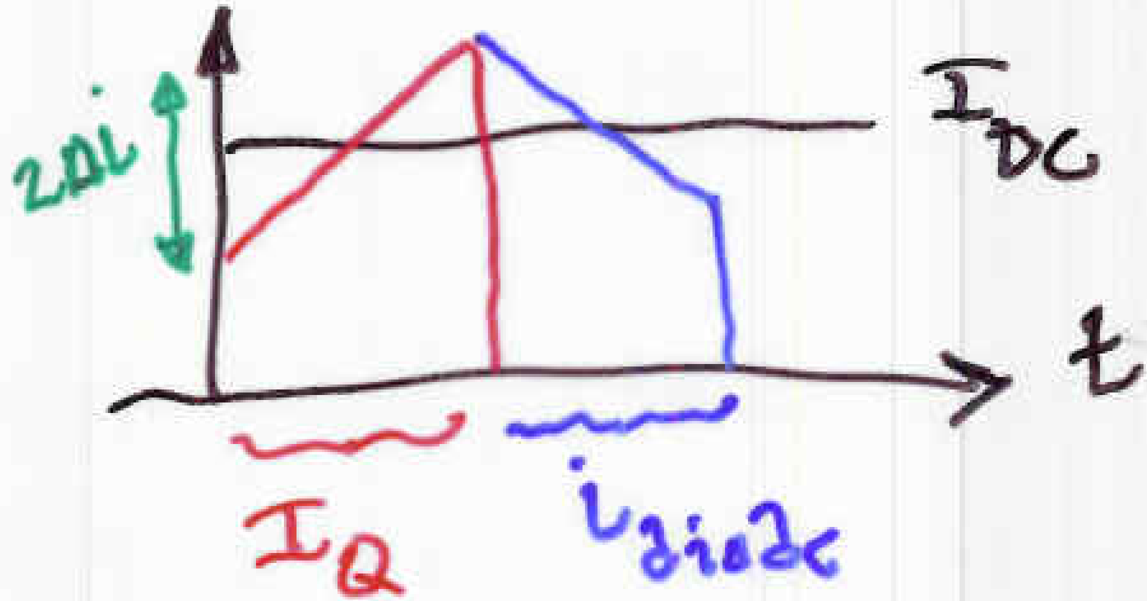
Cost of diode

smart diode?

Why are diode losses high?

Which transition of diode has most loss

$i_L(t)$



L acts as a "flywheel"

$$2\Delta i = \frac{V_{IN} - V_{out}}{L} \frac{D}{f_{SW}}$$

Choose desired Δi

Pick L f_{w}

Pick $D \equiv \frac{V_o}{V_{IN}}$

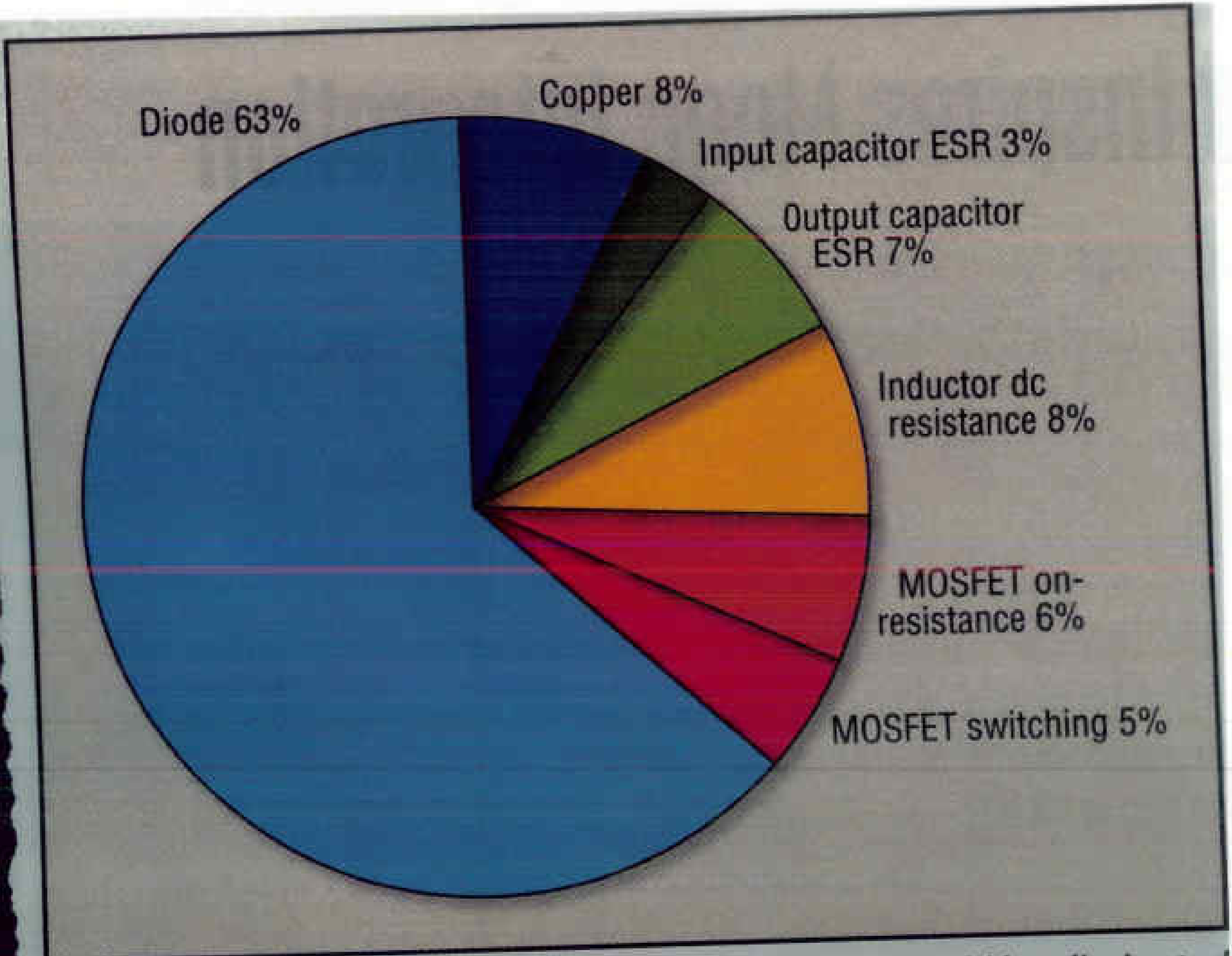


Fig. 6. *Power loss caused by the freewheeling diode should be eliminated to increase the converter's efficiency.*

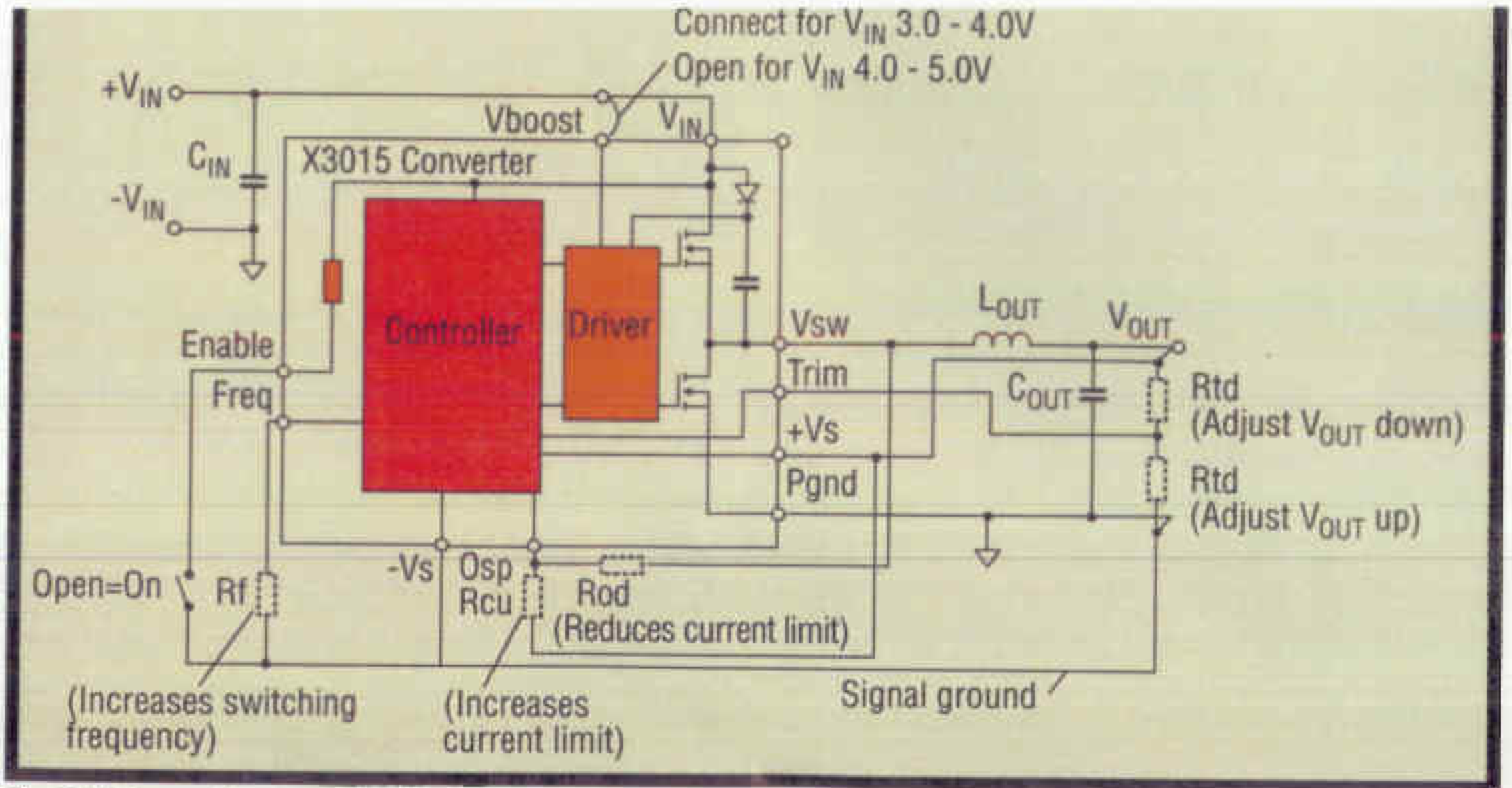


Fig. 1. *This synchronous buck converter is optimized for minimum switching and conduction losses.*

Synchronous Rectification in High–Performance Power Converter Design

— *By Robert Selders, Jr., Applications Engineer*

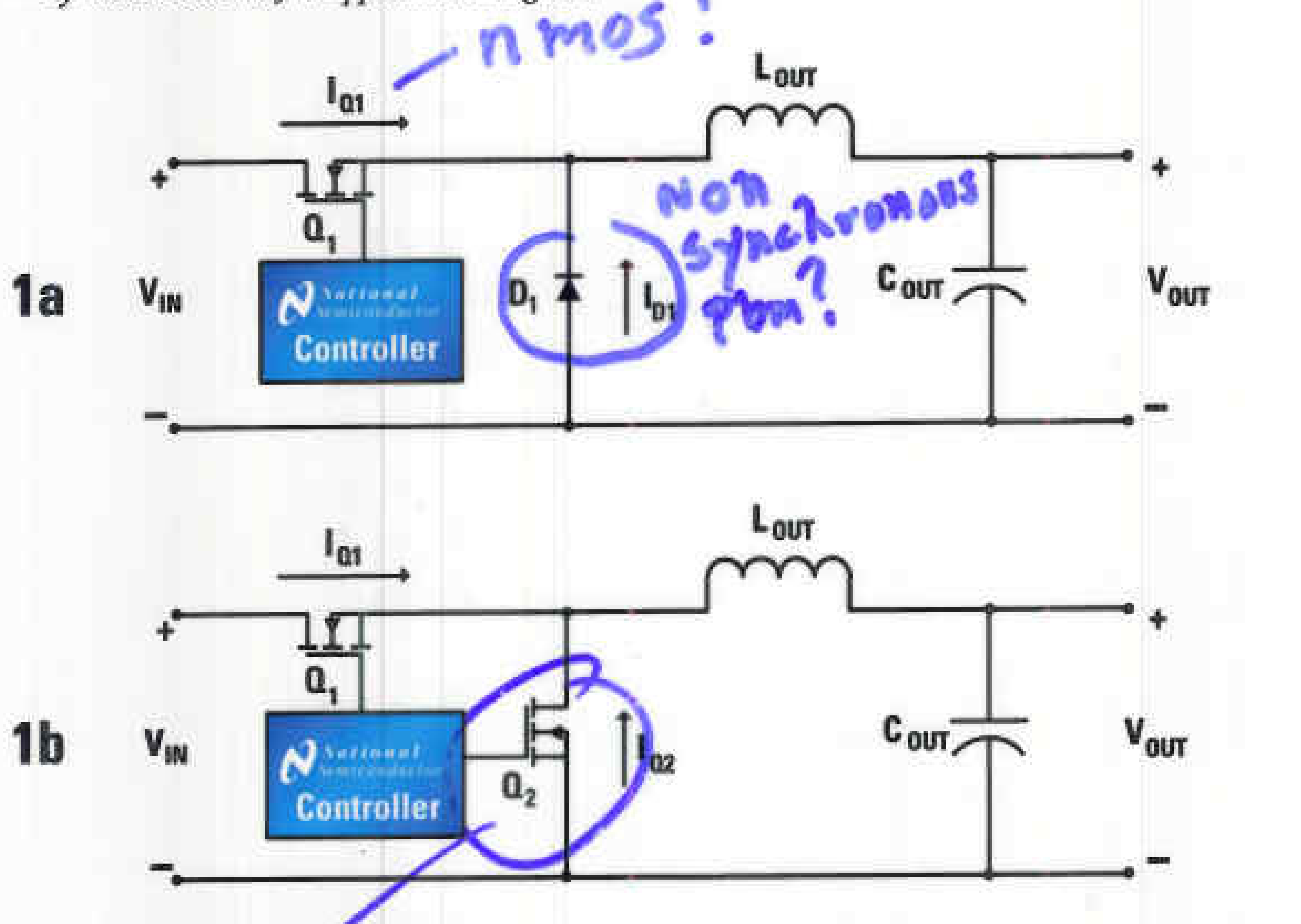
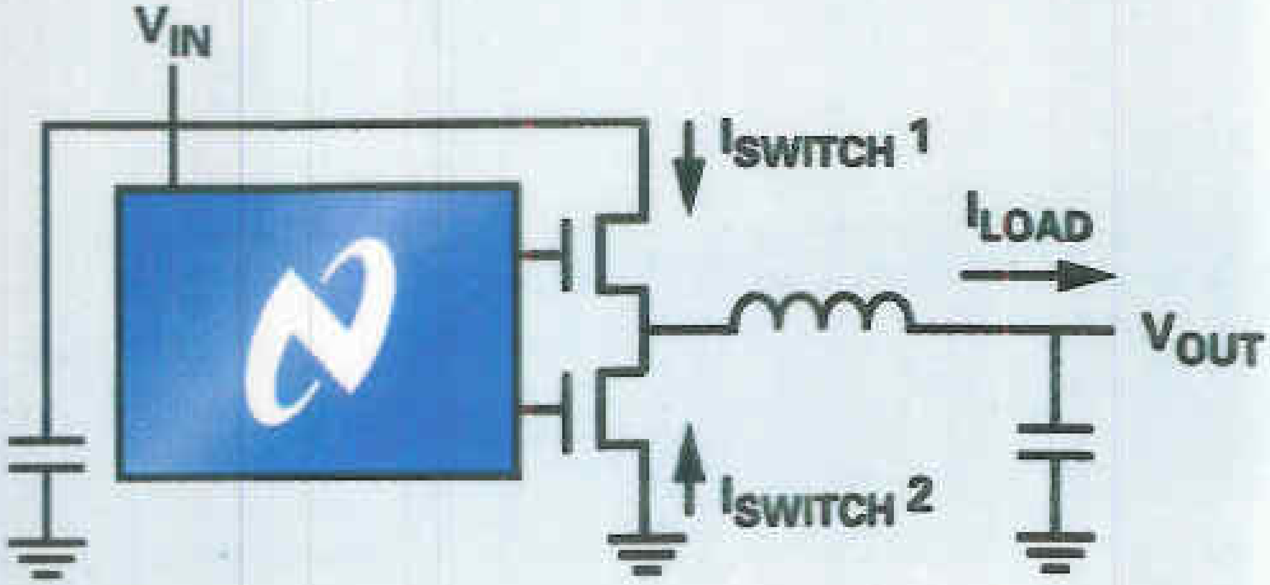


Figure 1. (a) Non-synchronous and (b) Synchronous Buck Converters

replace 1V power diode

1. avoid shootthrough
2. Always CCM (no need ch5)
3. $V_{ON} = I * R_{ON}$ (parallel) FETS
4. Need 100A 1mΩ

Synchronous buck



Function: Step-down ($V_{OUT} < V_{IN}$)

When to use: When high efficiency is required with high-output current (> 5A) or low duty cycles ($V_{IN} > 5 \times V_{OUT}$ and/or $I_{OUT} < 0.5A$)

Characteristics: A second switch replaces the diode in the basic buck topology, reducing losses in the conditions mentioned above

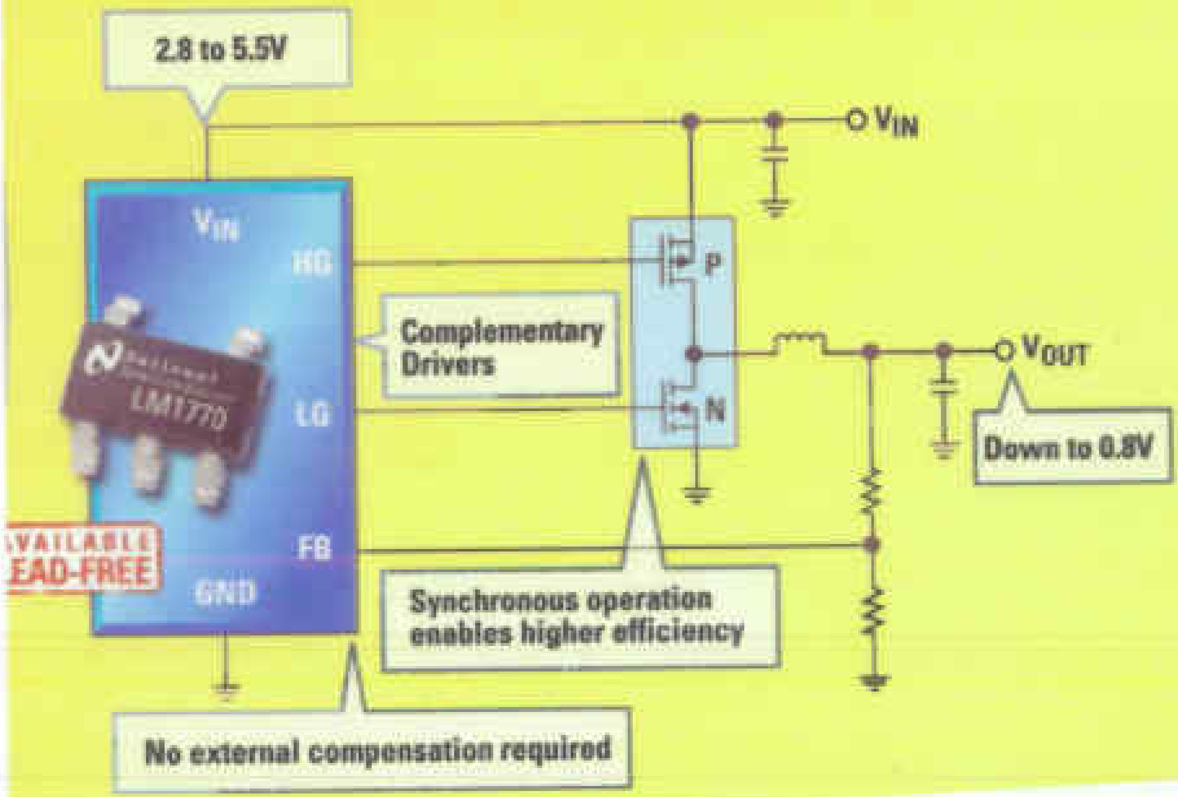
Devices to use: Any "synchronous rectification" buck integrated regulator or controller

Figure 2: Step-down configurations

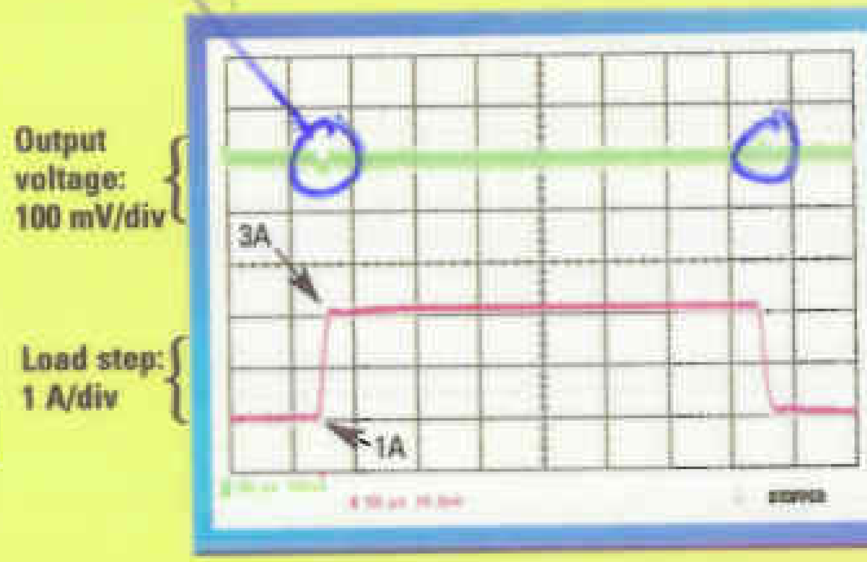
Cost of FET Drives ?

High-Efficiency LM1770 Synchronous Controller for Low-Voltage DC-DC Conversion

Application Circuit



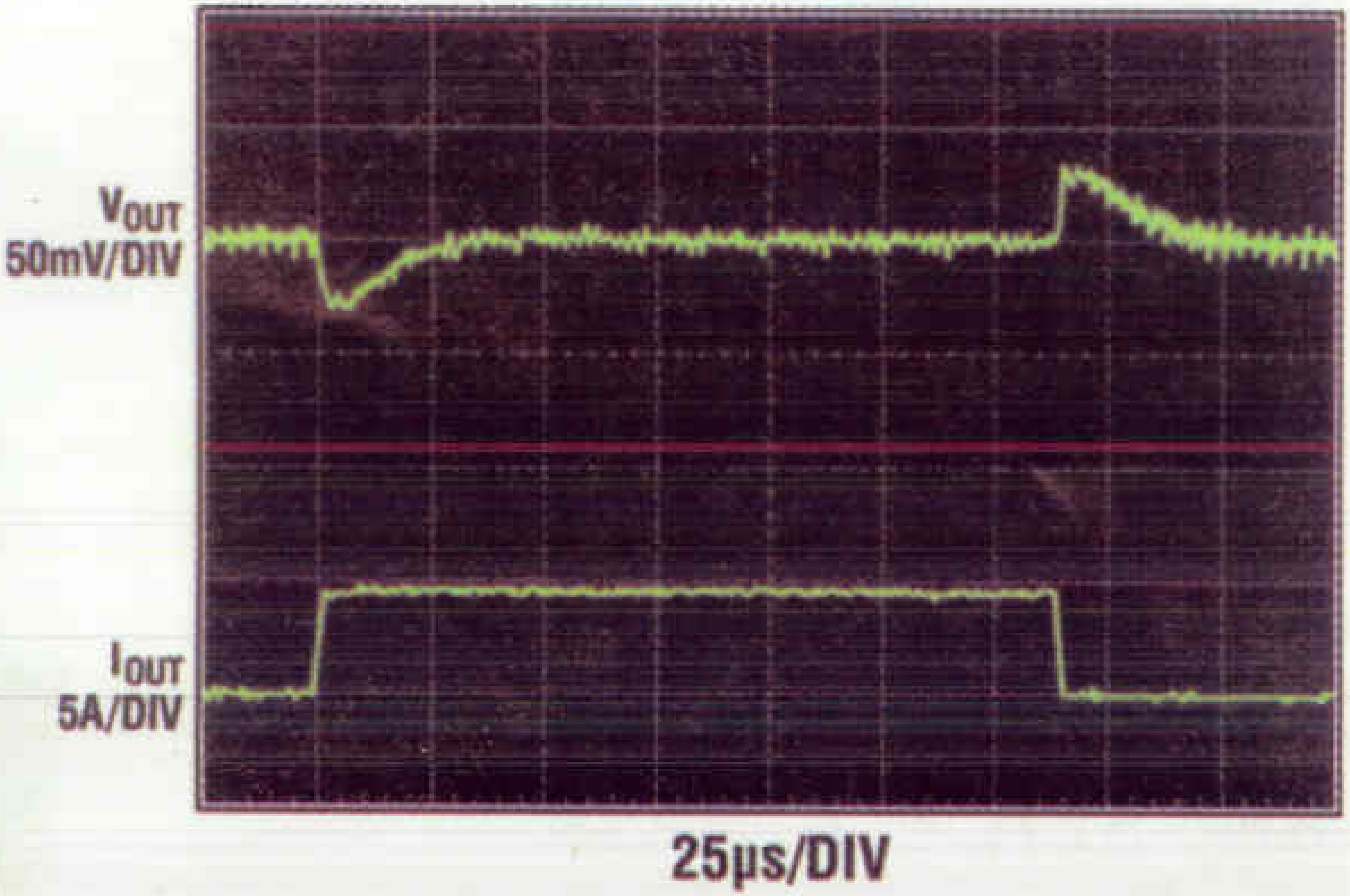
Transient Response



V_{IN}= 5V, V_{OUT}= 3.3V

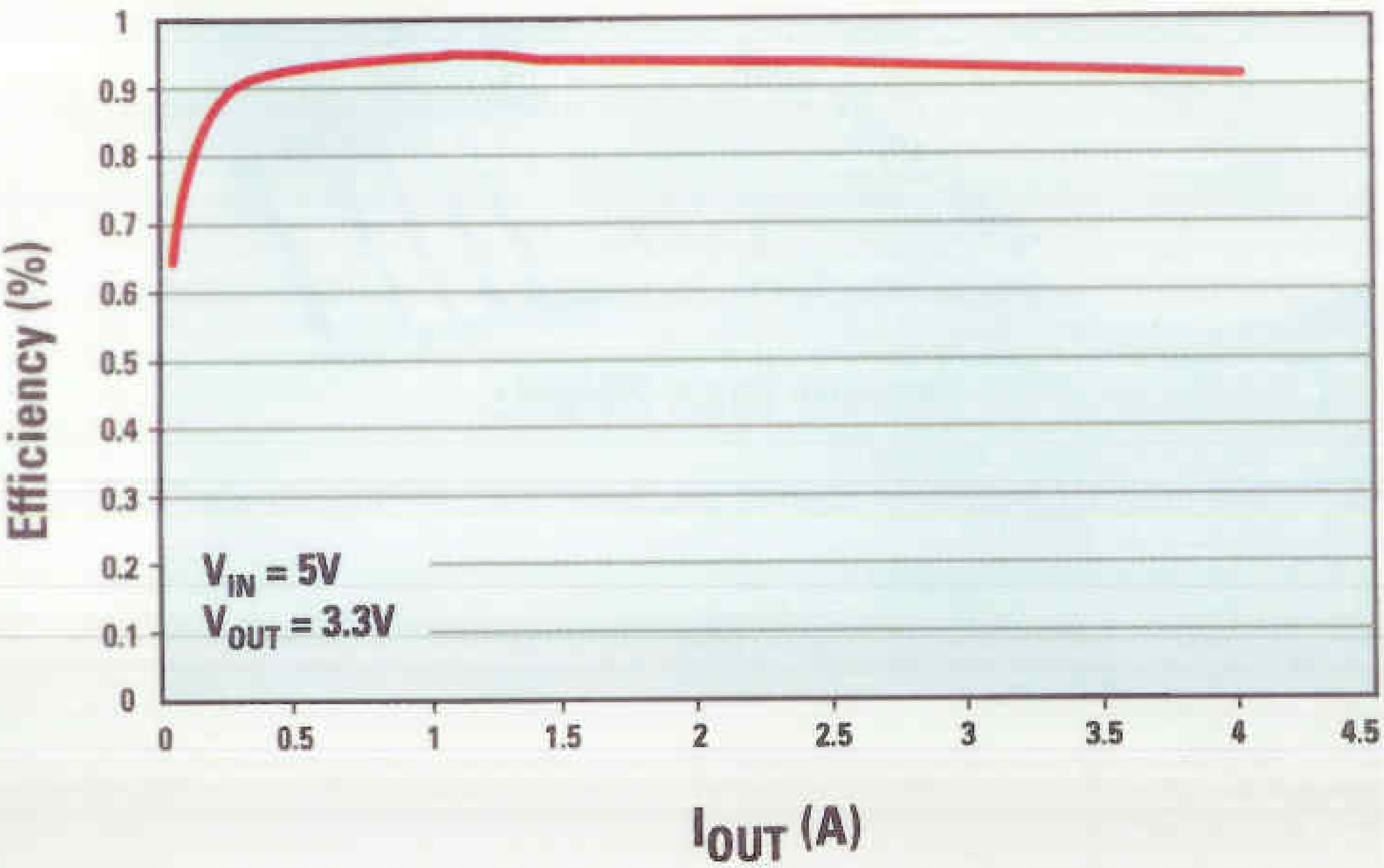
Ultrafast Transient Response

2% ΔV_{OUT} with a 5A Step

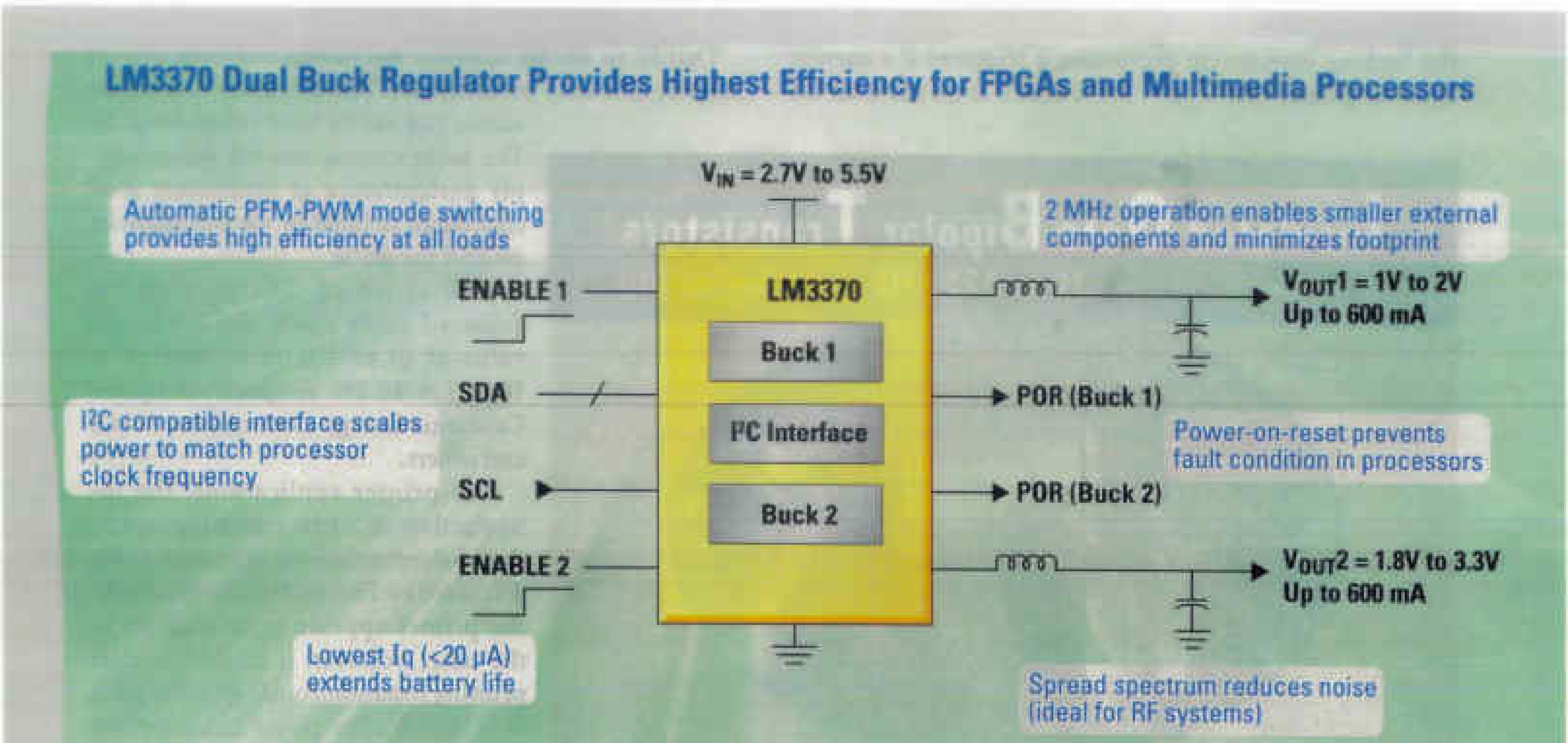


V_{IN} = 12V, V_{OUT} = 1.5V, 0A to 5A Load Step
(C_{OUT} = 3 x 22µF CERAMICS, 470µF POS CAP)

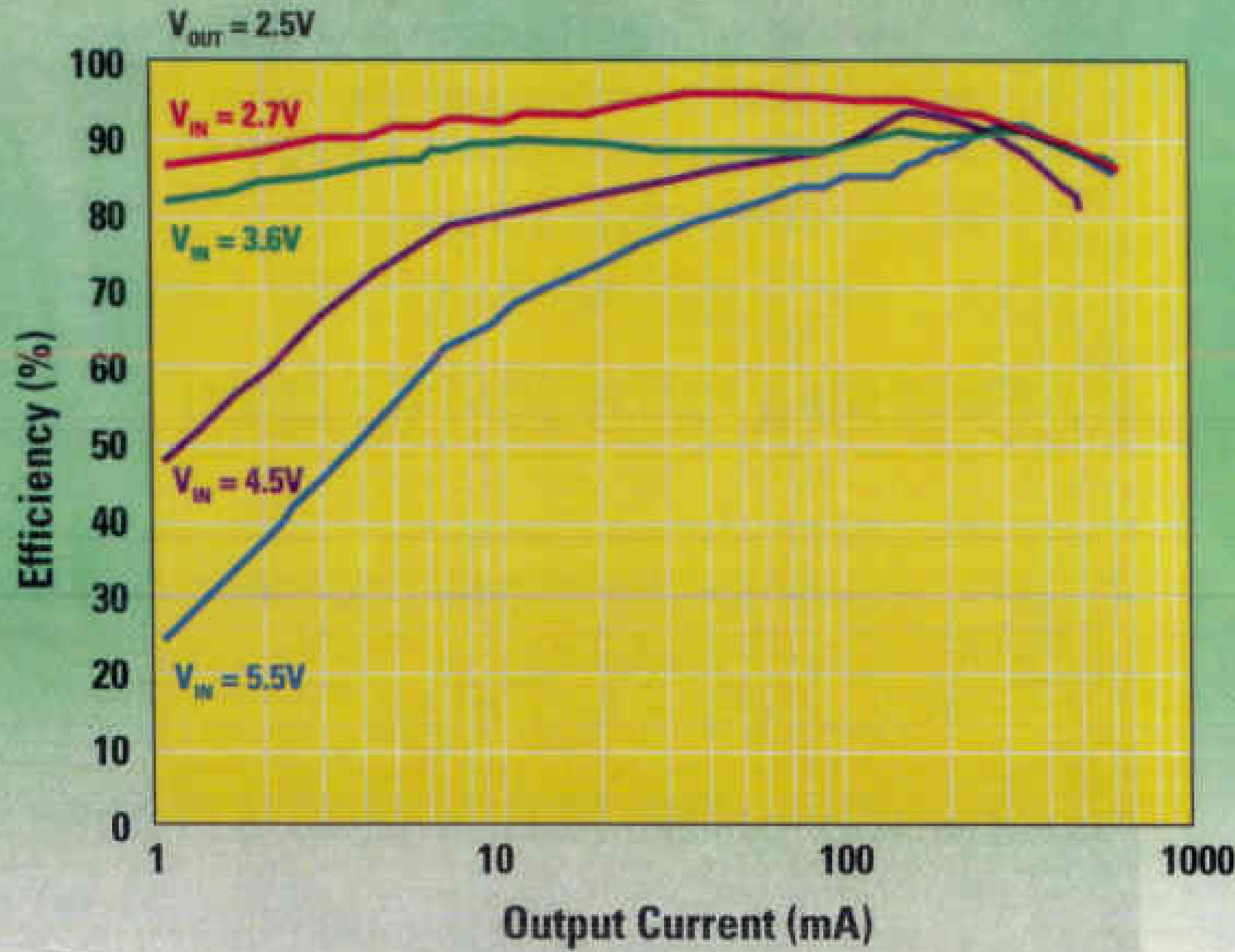
>90% Efficiency Over Load Current

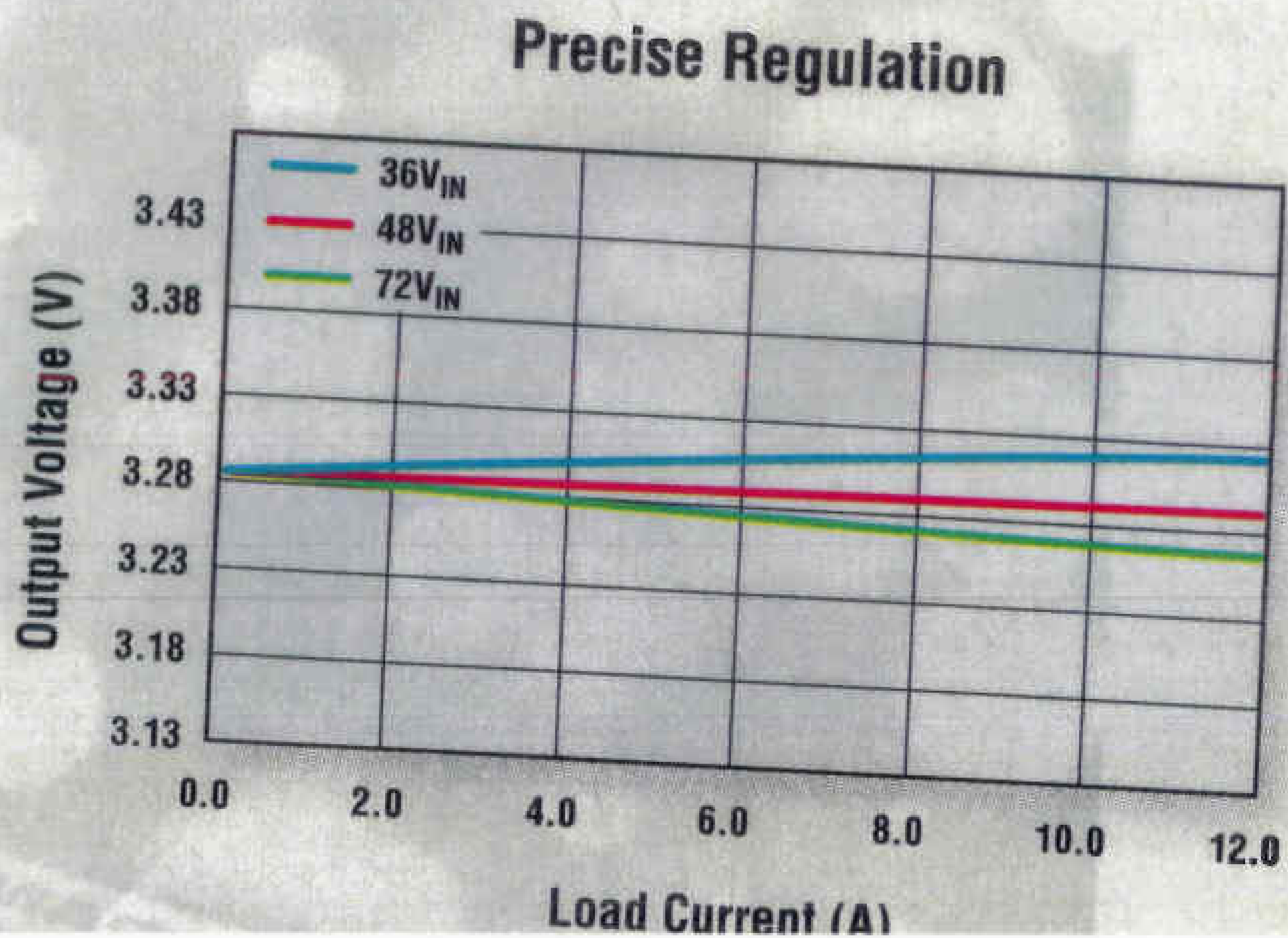


BOGO
for low i applications



High Efficiency Across All Loads





Precise Regulation
36V_IN
48V_IN
72V_IN
Output Voltage (V)
3.43
3.38
3.33
3.28
3.23
3.18
3.13
0.0
2.0
4.0
6.0
8.0
10.0
12.0
Load Current (A)

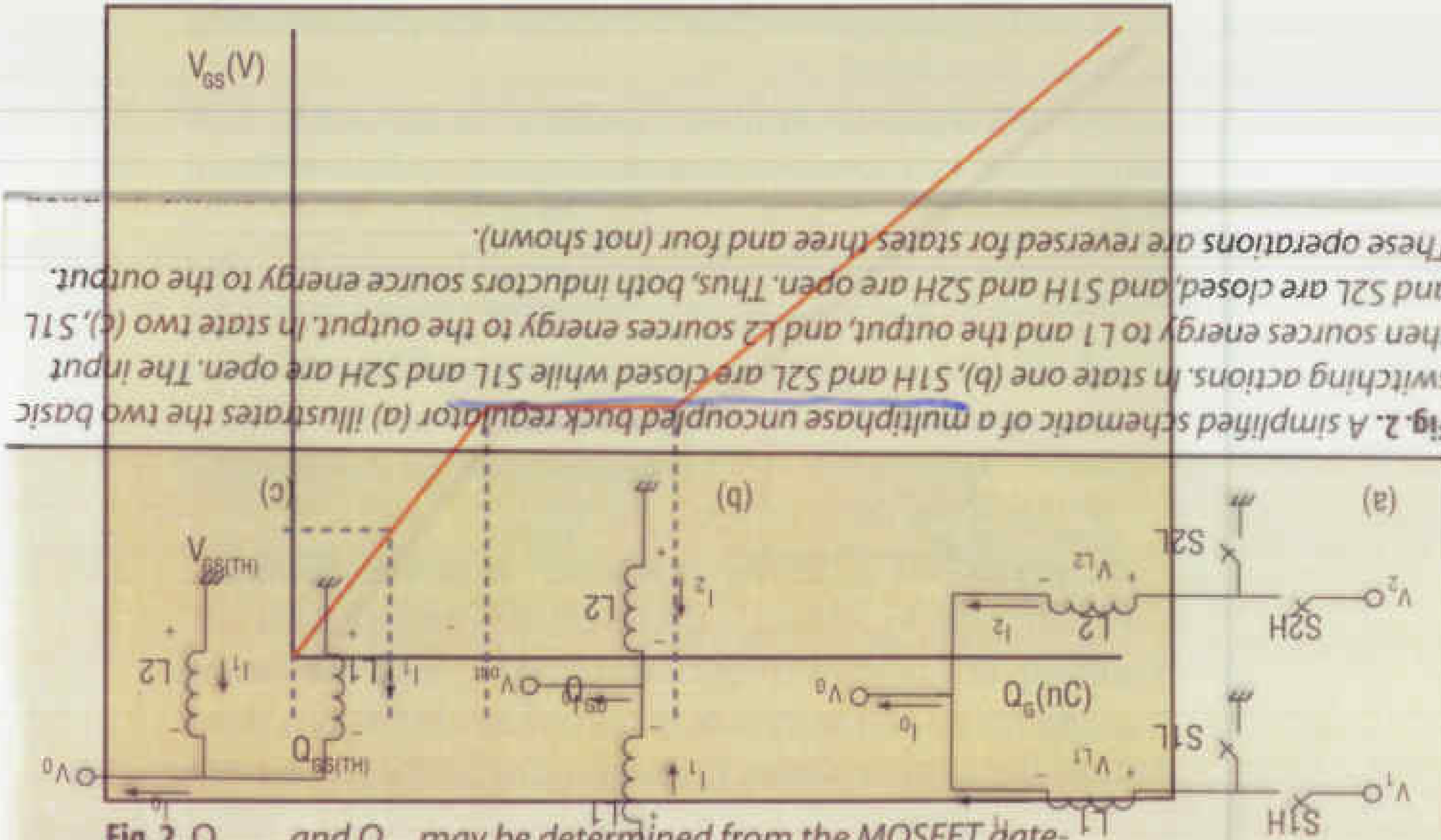


Fig. 2. A simplified schematic of a multiphase uncoupled buck regulator (a) illustrates the two basic switching actions. In state one (b), S1H and S2L are closed while S1L and S2H are open. The input then sources energy to L1 and the output, and L2 sources energy to the output. In state two (c), S1L and S2L are closed, and S1H and S2H are open. Thus, both inductors source energy to the output. These operations are reversed for states three and four (not shown).

Fig. 2. $Q_{GS(TH)}$ and Q_{GD} may be determined from the MOSFET gate-charge curve.

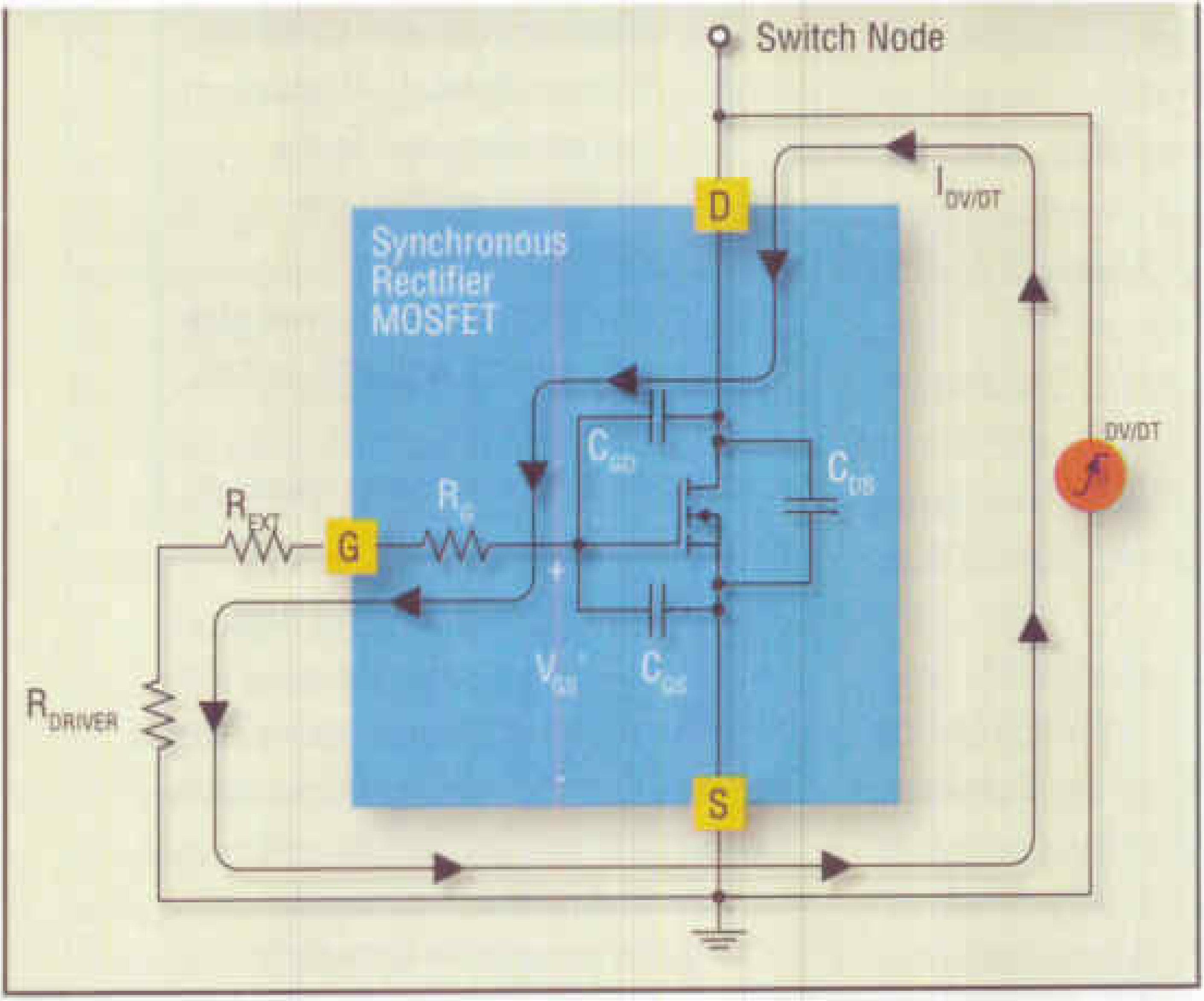


Fig. 1. *Turn-on of the high-side MOSFET (not shown) produces a voltage transient dv/dt across the low-side (synchronous) MOSFET, which leads to the off-state current conduction shown here.*

(1) +V rail connected to D
Δ dv/dt

(2) Via C_{gd} lower FET ON
Short

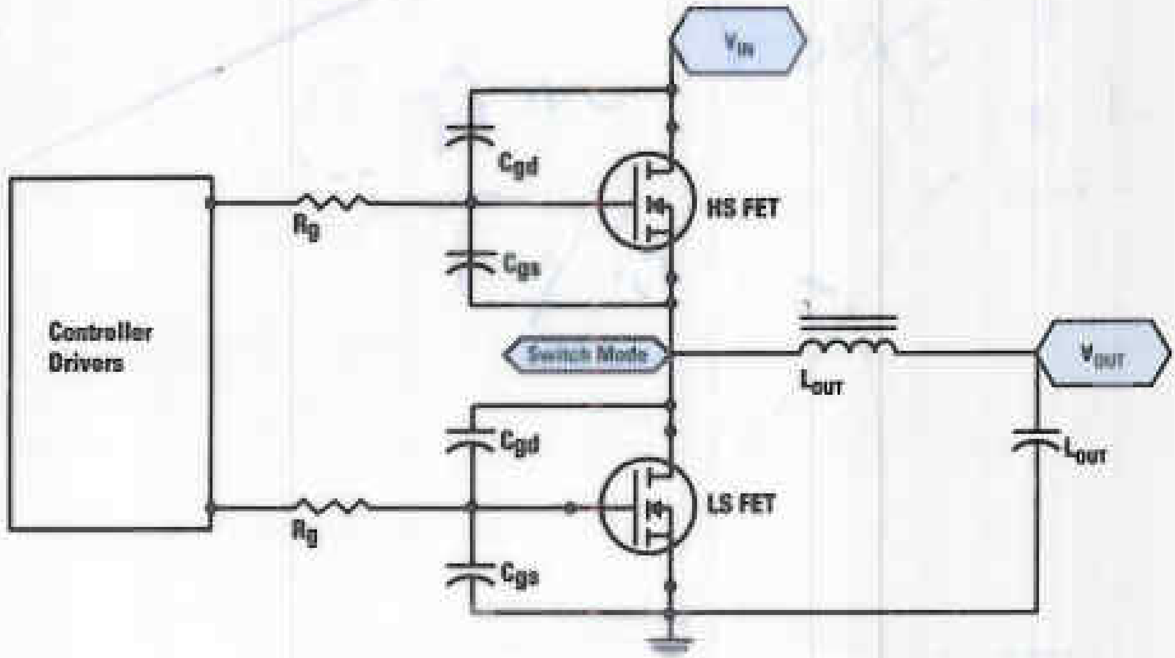


Figure 3. Synchronous Buck Converter

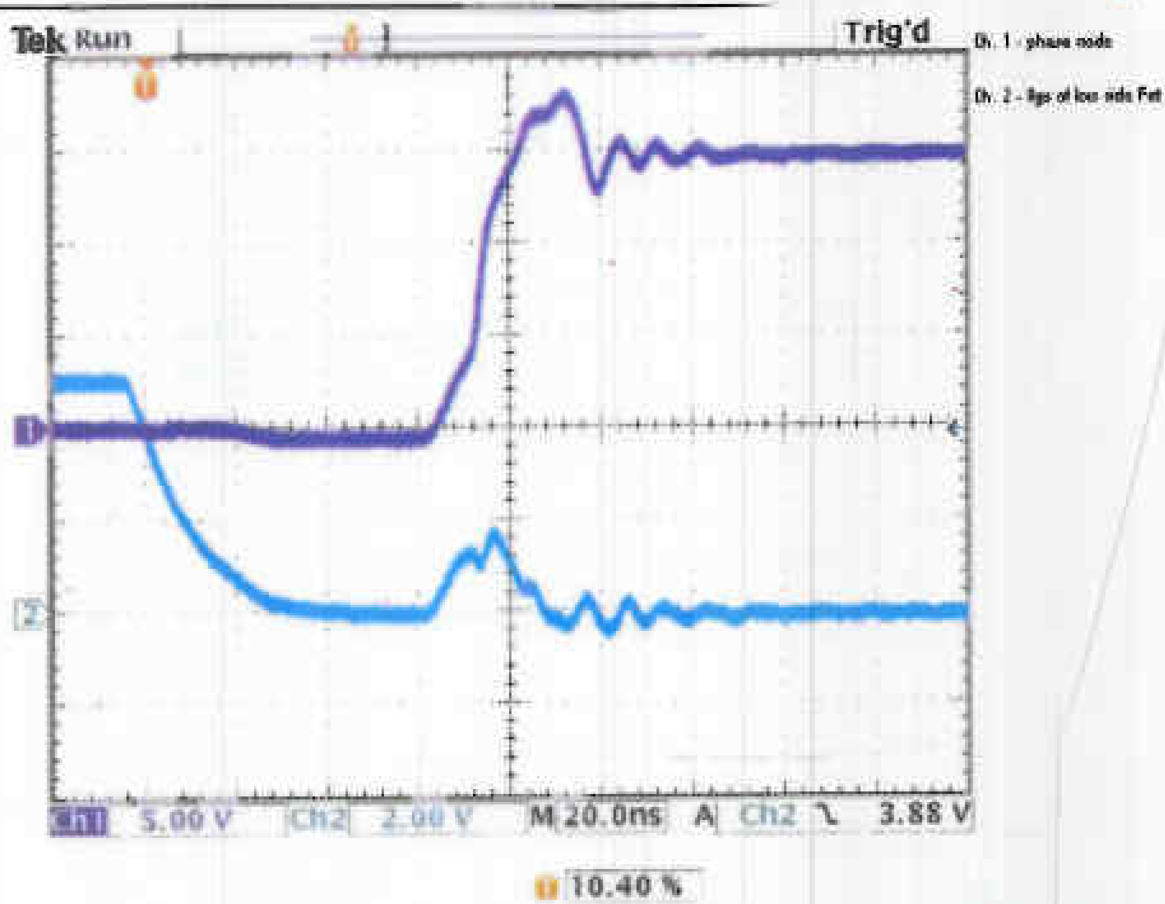


Figure 4. dv/dt induced step on the low-side MOSFET
Ch 1 Switch node
Ch 2 Vgs _ low-side MOSFET