

FEATURES

- Wide Operating V_{IN} Range: Up to 80V
- Rugged Architecture Tolerant of 100V V_{IN} Transients
- Powerful 1.85Ω Driver Pull-Down (with 6V Supply)
- Powerful 1.1A Peak Current Driver Pull-Up (with 6V Supply)
- 7ns Fall Time Driving 1000pF Load
- 10ns Rise Time Driving 1000pF Load
- Drives Standard Threshold MOSFETs
- TTL/CMOS Compatible Inputs with Hysteresis
- Input Thresholds are Independent of Supply
- Undervoltage Lockout
- Thermally Enhanced 8-Lead MSOP Package

APPLICATIONS

- Automotive Power Systems
- Telecommunications Power Systems
- Distributed Power Architectures
- Server Power Supplies
- High Density Power Modules
- General Purpose Low or High Side Driver

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DESCRIPTION

The **LTC®4440A-5** is a high frequency high side N-channel MOSFET gate driver that is designed to operate in applications with V_{IN} voltages up to 80V. The LTC4440A-5 can also withstand and continue to function during 100V V_{IN} transients. The powerful driver capability reduces switching losses in MOSFETs with high gate capacitances. The LTC4440A-5's pull-up has a peak output current of 1.1A and its pull-down has an output impedance of 1.85Ω .

The LTC4440A-5 features supply independent TTL/CMOS compatible input thresholds with 350mV of hysteresis. The input logic signal is internally level-shifted to the bootstrapped supply, which may function at up to 95V above ground.

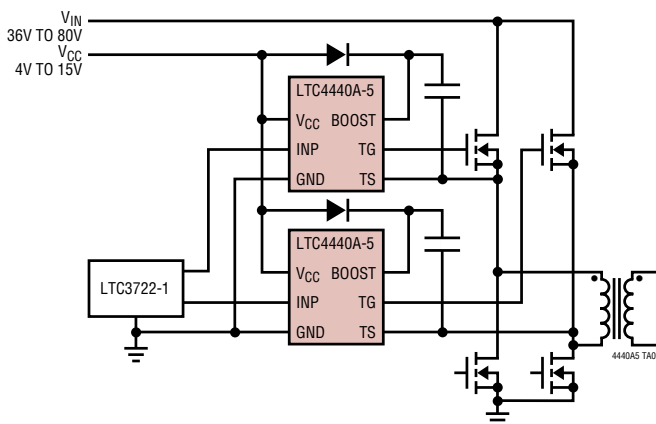
The LTC4440A-5 is optimized for driving (5V) logic level FETs and contains an undervoltage lockout circuit that disables the external MOSFET when activated.

The LTC4440A-5 is available in the thermally enhanced 8-lead MSOP package.

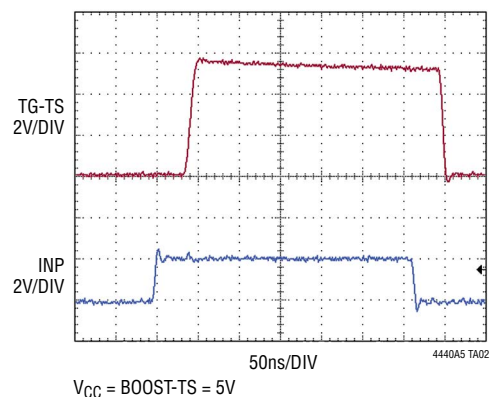
PARAMETER	LTC4440A-5	LTC4440-5	LTC4440
Max Operating TS	80V	60V	80V
Absolute Max TS	100V	80V	100V
MOSFET Gate Drive	4V to 15V	4V to 15V	8V to 15V
V_{CC} UV ⁺	3.2V	3.2V	6.3V
V_{CC} UV ⁻	3.04V	3.04V	6.0V

TYPICAL APPLICATION

Synchronous Phase-Modulated Full-Bridge Converter



LTC4440A-5 Driving a 1000pF Capacitive Load



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LTC4440A-5

ABSOLUTE MAXIMUM RATINGS

(Note 1)

Supply Voltage

V_{CC} -0.3V to 15V

BOOST – TS -0.3V to 15V

INP Voltage -0.3V to 15V

BOOST Voltage (Continuous) -0.3V to 95V

BOOST Voltage (100ms) -0.3V to 115V

TS Voltage (Continuous) -5V to 80V

TS Voltage (100ms) -5V to 100V

Operating Junction Temperature Range (Notes 2, 3)

LTC4440AI-5 -40°C to 125°C

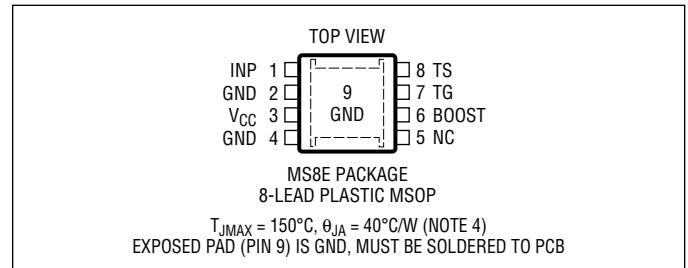
LTC4440AH-5 -40°C to 150°C

LTC4440AMP-5 -55°C to 150°C

Storage Temperature Range -65°C to 150°C

Lead Temperature (Soldering, 10 sec) 300°C

PIN CONFIGURATION



ORDER INFORMATION

LEAD FREE FINISH	TAPE AND REEL	PART MARKING*	PACKAGE DESCRIPTION	TEMPERATURE RANGE
LTC4440AIMS8E-5#PBF	LTC4440AIMS8E-5#TRPBF	LTGKP	8-Lead Plastic MSOP	-40°C to 125°C
LTC4440AHMS8E-5#PBF	LTC4440AHMS8E-5#TRPBF	LTGKP	8-Lead Plastic MSOP	-40°C to 150°C
LTC4440AMPMS8E-5#PBF	LTC4440AMPMS8E-5#TRPBF	LTGKP	8-Lead Plastic MSOP	-55°C to 150°C

Consult LTC Marketing for parts specified with wider operating temperature ranges. *The temperature grade is identified by a label on the shipping container. Consult LTC Marketing for information on nonstandard lead based finish parts.

For more information on lead free part marking, go to: <http://www.linear.com/leadfree/>

For more information on tape and reel specifications, go to: <http://www.linear.com/tapeandreel/>

ELECTRICAL CHARACTERISTICS

The ● denotes specifications which apply over the specified operating junction temperature range, otherwise specifications are at $T_A = 25^\circ\text{C}$. $V_{CC} = V_{BOOST} = 6\text{V}$, $V_{TS} = \text{GND} = 0\text{V}$, unless otherwise noted. (Note 2)

SYMBOL	PARAMETER	CONDITIONS	MIN	TYP	MAX	UNITS
Main Supply (V_{CC})						
I_{VCC}	DC Supply Current Normal Operation UVLO	INP = 0V $V_{CC} < \text{UVLO Threshold (Falling)} - 0.1\text{V}$		200 18	325 40	μA μA
UVLO	Undervoltage Lockout Threshold	V_{CC} Rising V_{CC} Falling Hysteresis	● 2.75 ● 2.60	3.20 3.04	3.65 3.50	V V mV
Bootstrapped Supply (BOOST – TS)						
I_{BOOST}	DC Supply Current Normal Operation	INP = 0V INP = 6V		0 310	450	μA μA

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ELECTRICAL CHARACTERISTICS

The ● denotes specifications which apply over the specified operating junction temperature range, otherwise specifications are at $T_A = 25^\circ\text{C}$. $V_{CC} = V_{BOOST} = 6\text{V}$, $V_{TS} = \text{GND} = 0\text{V}$, unless otherwise noted. (Note 2)

SYMBOL	PARAMETER	CONDITIONS		MIN	TYP	MAX	UNITS
Input Signal (INP)							
V_{IH}	High Input Threshold	INP Ramping High	●	1.2	1.55	2	V
V_{IL}	Low Input Threshold	INP Ramping Low	●	0.8	1.25	1.6	V
$V_{IH} - V_{IL}$	Input Voltage Hysteresis				0.350		V
I_{INP}	Input Pin Bias Current				± 0.01	± 2	μA
Output Gate Driver (TG)							
V_{OH}	High Output Voltage	$I_{TG} = -10\text{mA}$, $V_{OH} = V_{BOOST} - V_{TG}$			0.7		V
V_{OL}	Low Output Voltage	$I_{TG} = 100\text{mA}$	●		185	400	mV
I_{PU}	Peak Pull-Up Current		●	0.7	1.1		A
R_{DS}	Output Pull-Down Resistance		●		1.85	4	Ω
Switching Timing							
t_r	Output Rise Time	10% – 90%, $C_L = 1\text{nF}$			10		ns
		10% – 90%, $C_L = 10\text{nF}$			100		ns
t_f	Output Fall Time	10% – 90%, $C_L = 1\text{nF}$			7		ns
		10% – 90%, $C_L = 10\text{nF}$			70		ns
t_{PLH}	Output Low-High Propagation Delay		●		35	80	ns
t_{PHL}	Output High-Low Propagation Delay		●		33	80	ns

Note 1: Stresses beyond those listed under Absolute Maximum Ratings may cause permanent damage to the device. Exposure to any Absolute Maximum Rating condition for extended periods may affect device reliability and lifetime.

Note 2: The LTC4440A-5 is tested under pulsed load conditions such that $T_J \approx T_A$. The LTC4440AI-5 is guaranteed over the -40°C to 125°C operating junction temperature range, The LTC4440AH-5 is guaranteed over the -40°C to 150°C operating junction temperature range and the LTC4440AMP-5 is tested and guaranteed over the -55°C to 150°C operating junction temperature range.

High junction temperatures degrade operating lifetimes; operating lifetime is derated to junction temperatures greater than 125°C . Note that the maximum ambient temperature consistent with these specifications is determined by specific operating conditions in conjunction with board layout, the rated package thermal impedance and other environment factors.

Note 3: T_J is calculated from the ambient temperature T_A and power dissipation PD according to the following formula:

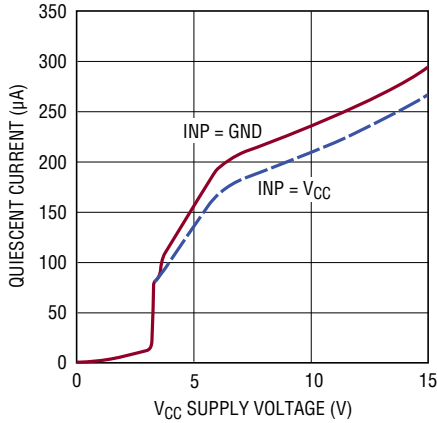
$$T_J = T_A + (PD \cdot \theta_{JA}^\circ\text{C/W})$$

Continuous operation above the specified absolute operating junction temperature may impair device reliability or permanently damage the device.

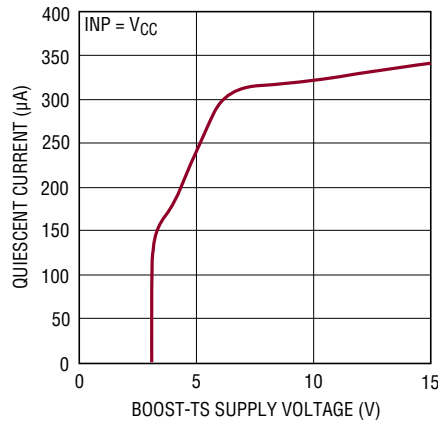
Note 4: Failure to solder the exposed pad of the MS8E package to the PC board will result in a thermal resistance much higher than 40°C/W .

TYPICAL PERFORMANCE CHARACTERISTICS

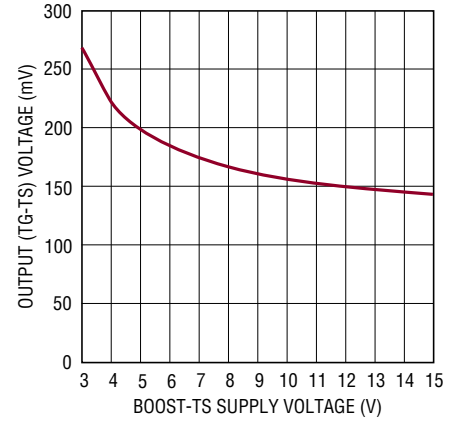
V_{CC} Supply Quiescent Current vs Voltage



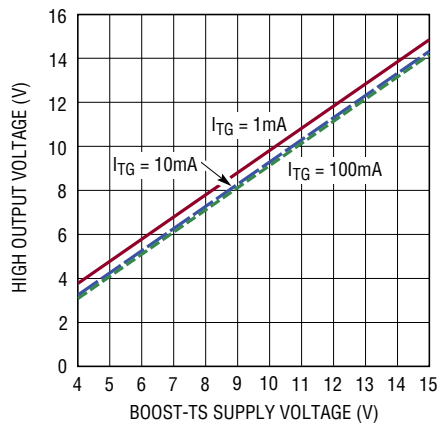
BOOST-TS Supply Quiescent Current vs Voltage



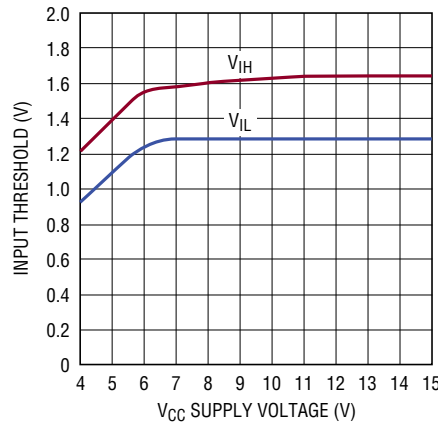
Output Low Voltage (V_{OL}) vs Supply Voltage



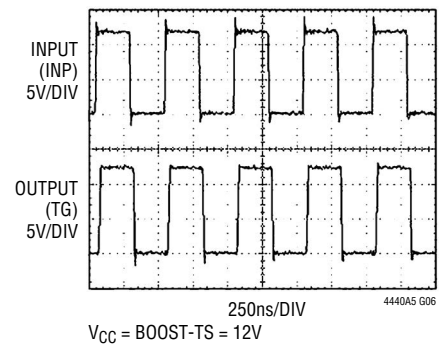
Output High Voltage (V_{OH}) vs Supply Voltage



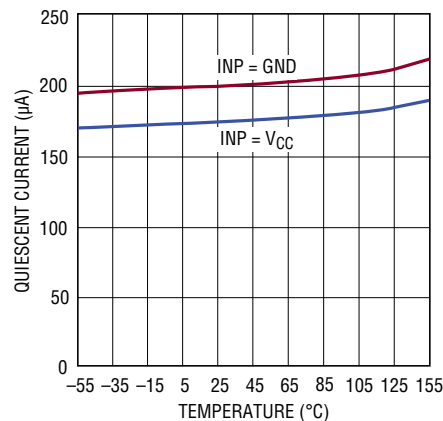
Input (INP) Thresholds vs Supply Voltage



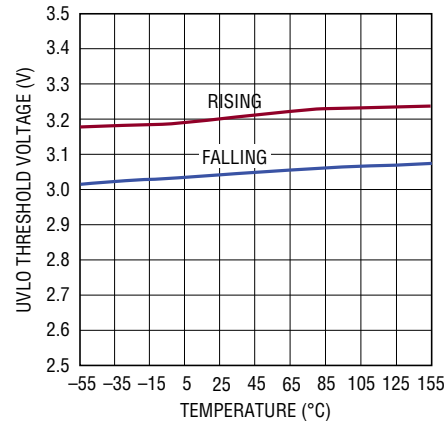
2MHz Operation



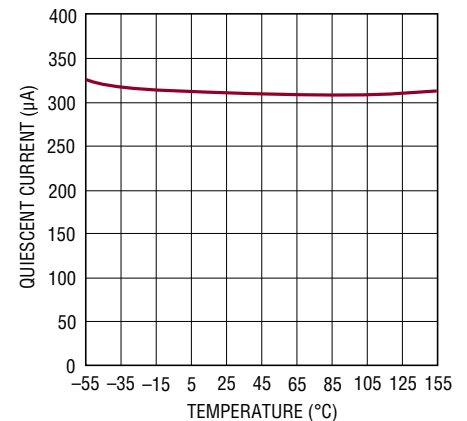
V_{CC} Supply Current vs Temperature



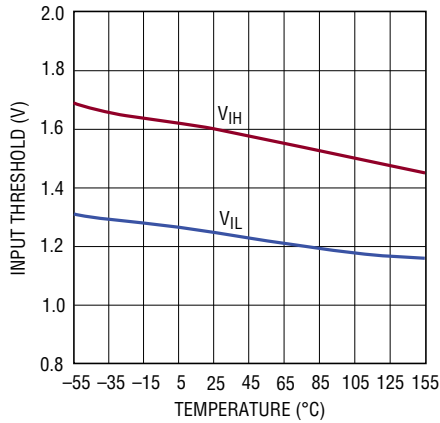
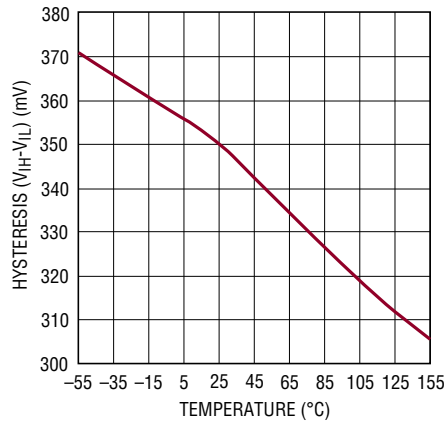
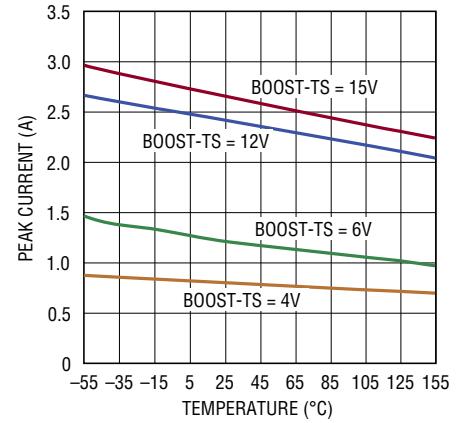
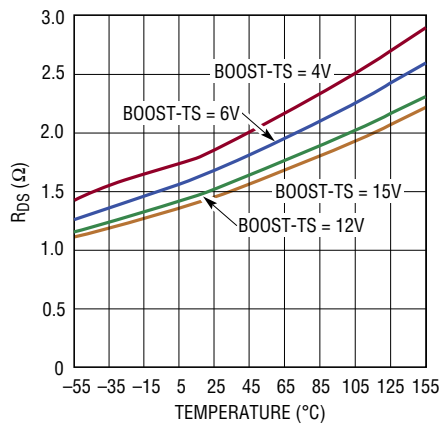
V_{CC} Undervoltage Lockout Thresholds vs Temperature



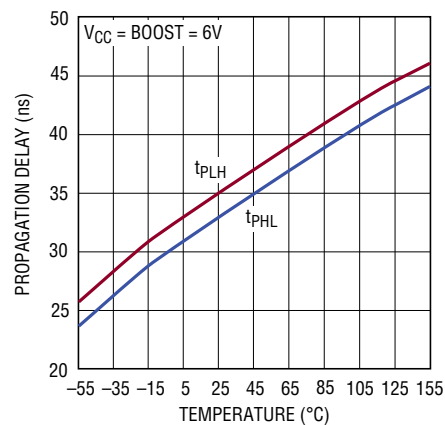
BOOST-TS Quiescent Current vs Temperature



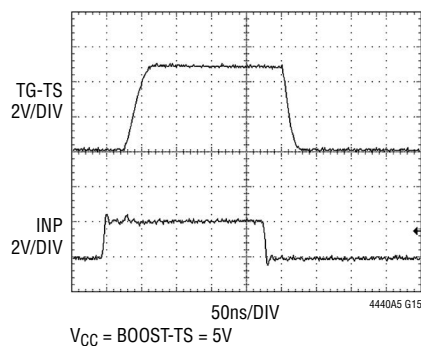
TYPICAL PERFORMANCE CHARACTERISTICS

Input (INP) Threshold
vs TemperatureInput Threshold Hysteresis
vs TemperaturePeak Driver (TG) Pull-Up Current
vs TemperatureOutput Driver Pull-Down
Resistance vs Temperature

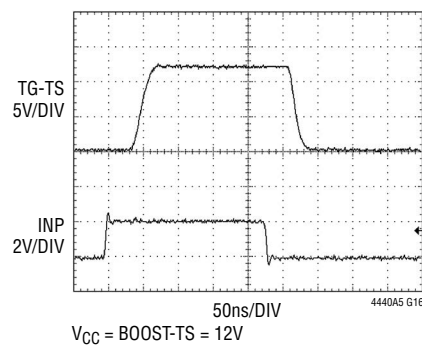
Propagation Delay vs Temperature



Driving a 3300pF Capacitive Load



Driving a 3300pF Capacitive Load



APPLICATIONS INFORMATION

Power Dissipation

To ensure proper operation and long-term reliability, the LTC4440A-5 must not operate beyond its maximum temperature rating. Package junction temperature can be calculated by:

$$T_J = T_A + PD (\theta_{JA})$$

where:

T_J = Junction Temperature

T_A = Ambient Temperature

PD = Power Dissipation

θ_{JA} = Junction-to-Ambient Thermal Resistance

Power dissipation consists of standby and switching power losses:

$$PD = P_{STDBY} + P_{AC}$$

where:

P_{STDBY} = Standby Power Losses

P_{AC} = AC Switching Losses

The LTC4440A-5 consumes very little current during standby. The DC power loss at $V_{CC} = 6V$ and $V_{BOOST-TS} = 6V$ is only $(200\mu A)(6V) = 1.2mW$ with $INP = 0V$.

AC switching losses are made up of the output capacitive load losses and the transition state losses. The capacitive load losses are primarily due to the large AC currents needed to charge and discharge the load capacitance during switching. Load losses for the output driver driving a pure capacitive load C_{OUT} would be:

$$\text{Load Capacitive Power} = (C_{OUT})(f)(V_{BOOST-TS})^2$$

The power MOSFET's gate capacitance seen by the driver output varies with its V_{GS} voltage level during switching. A power MOSFET's capacitive load power dissipation can be calculated using its gate charge, Q_G . The Q_G value corresponding to the MOSFET's V_{GS} value (V_{CC} in this case) can be readily obtained from the manufacturer's Q_G vs V_{GS} curves:

$$\text{Load Capacitive Power (MOS)} = (V_{BOOST-TS})(Q_G)(f)$$

Transition state power losses are due to both AC currents required to charge and discharge the driver's internal

nodal capacitances and cross-conduction currents in the internal gates.

Undervoltage Lockout (UVLO)

The LTC4440A-5 contains an undervoltage lockout detector that monitors V_{CC} . When V_{CC} falls below 3.04V, the internal buffer is disabled and the output pin TG is pulled down to TS.

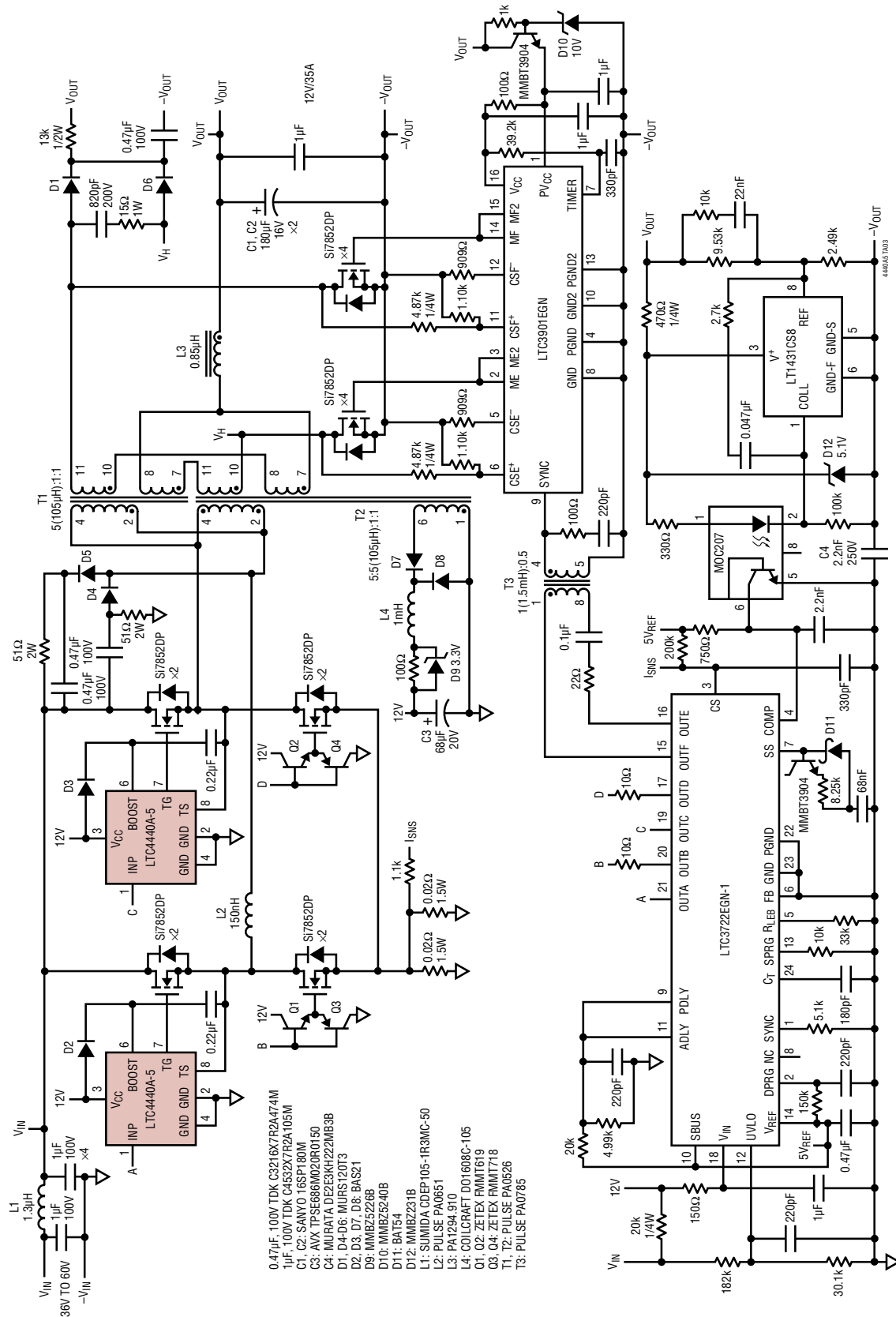
Bypassing and Grounding

The LTC4440A-5 requires proper bypassing on the V_{CC} and $V_{BOOST-TS}$ supplies due to its high speed switching (nanoseconds) and large AC currents (Amperes). Careless component placement and PCB trace routing may cause excessive ringing and under/overshoot.

To obtain the optimum performance from the LTC4440A-5:

- Mount the bypass capacitors as close as possible between the V_{CC} and GND pins and the BOOST and TS pins. The leads should be shortened as much as possible to reduce lead inductance.
- Use a low inductance, low impedance ground plane to reduce any ground drop and stray capacitance. Remember that the LTC4440A-5 switches >2A peak currents and any significant ground drop will degrade signal integrity.
- Plan the power/ground routing carefully. Know where the large load switching current is coming from and going to. Maintain separate ground return paths for the input pin and the output power stage.
- Keep the copper trace between the driver output pin and the load short and wide.
- When using the MS8E package, be sure to solder the exposed pad on the back side of the LTC4440A-5 package to the board. Correctly soldered to a 2500mm² double-sided 1oz copper board, the LTC4440A-5 has a thermal resistance of approximately 40°C/W. Failure to make good thermal contact between the exposed back side and the copper board will result in thermal resistances far greater than 40°C/W.

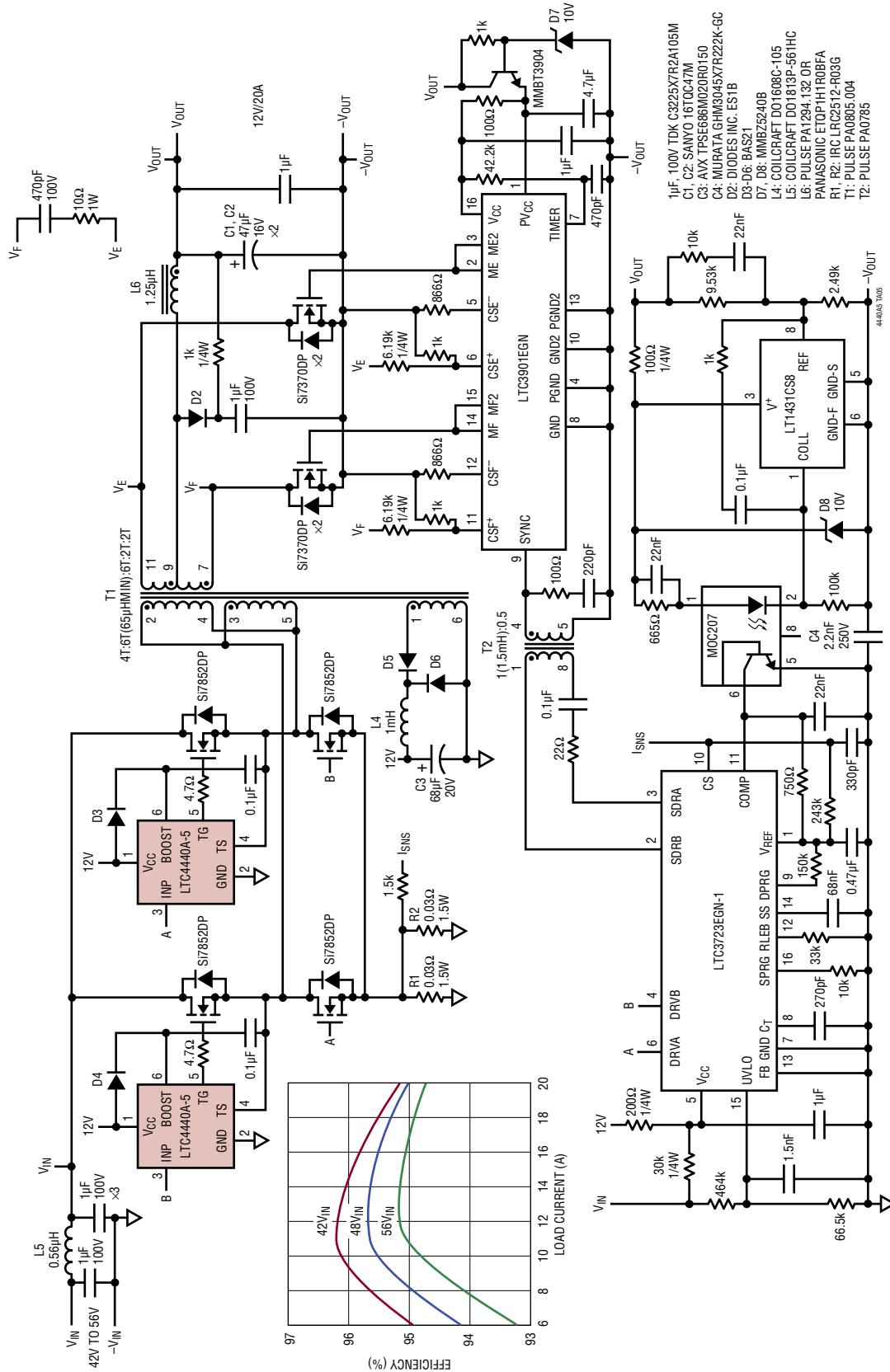
TYPICAL APPLICATIONS

LTC3722/LTC4440A-5 420W 36V-60V_{IN} to 12V/35A Isolated Full-Bridge Supply

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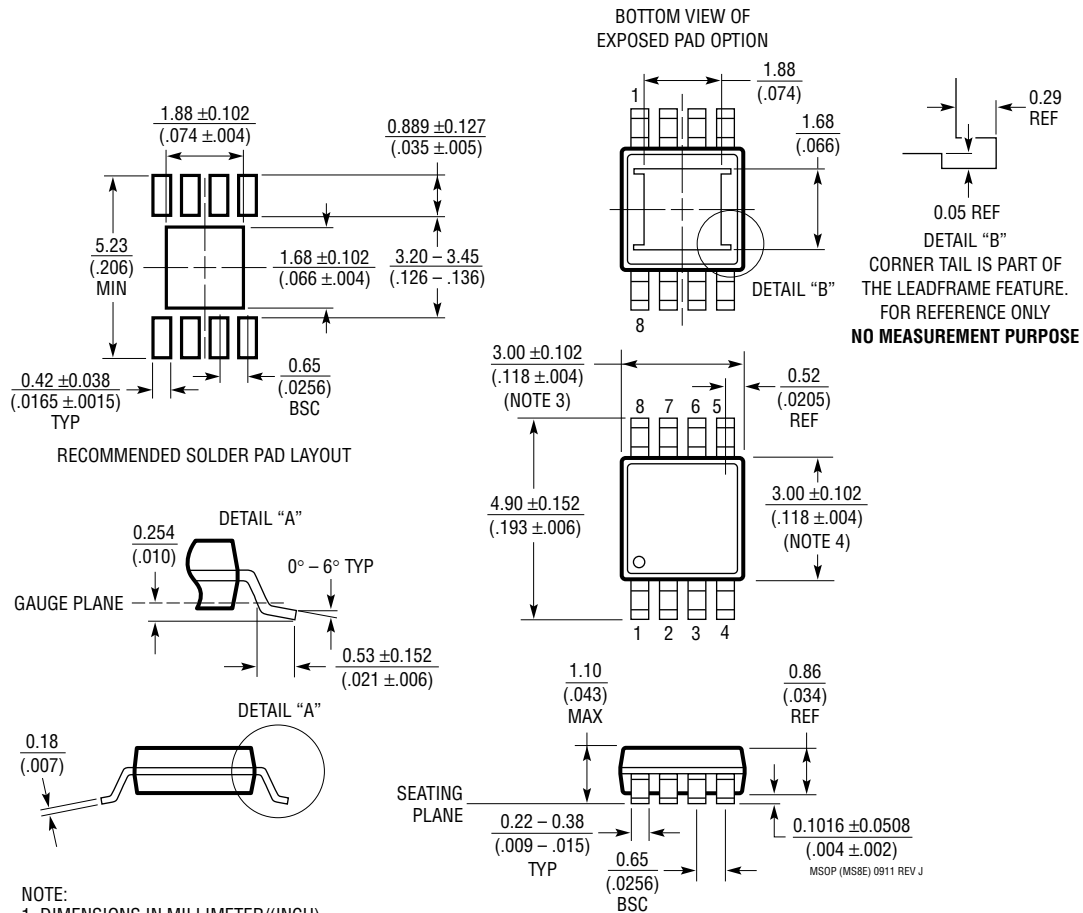
TYPICAL APPLICATIONS

LTC3723-1 240W 42-56V_{IN} to 12V/20A Isolated 1/4Brick (2.3" × 1.45")



PACKAGE DESCRIPTION

MS8E Package
8-Lead Plastic MSOP, Exposed Die Pad
 (Reference LTC DWG # 05-08-1662 Rev J)

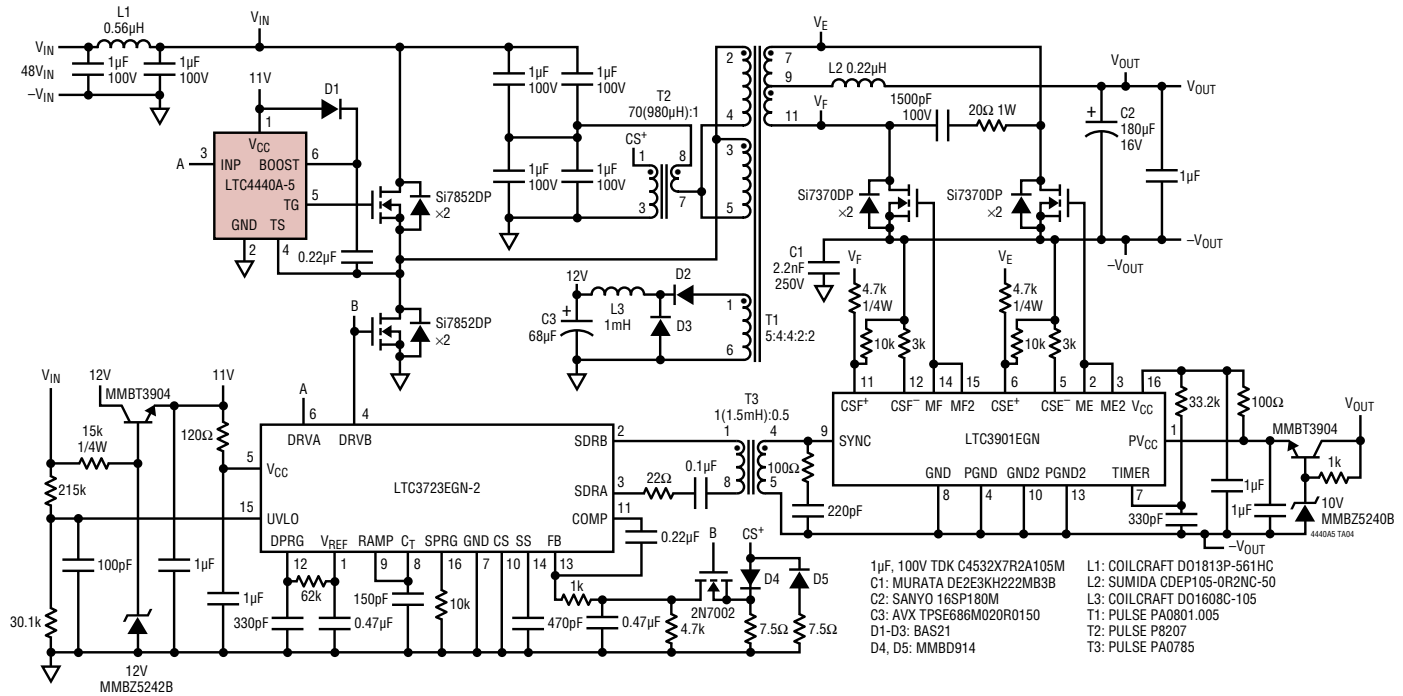


NOTE:

1. DIMENSIONS IN MILLIMETER/(INCH)
2. DRAWING NOT TO SCALE
3. DIMENSION DOES NOT INCLUDE MOLD FLASH, PROTRUSIONS OR GATE BURRS. MOLD FLASH, PROTRUSIONS OR GATE BURRS SHALL NOT EXCEED 0.152mm (.006") PER SIDE
4. DIMENSION DOES NOT INCLUDE INTERLEAD FLASH OR PROTRUSIONS. INTERLEAD FLASH OR PROTRUSIONS SHALL NOT EXCEED 0.152mm (.006") PER SIDE
5. LEAD COPLANARITY (BOTTOM OF LEADS AFTER FORMING) SHALL BE 0.102mm (.004") MAX
6. EXPOSED PAD DIMENSION DOES INCLUDE MOLD FLASH. MOLD FLASH ON E-PAD SHALL NOT EXCEED 0.254mm (.010") PER SIDE.

TYPICAL APPLICATION

240W 42V-56V_{IN} to Unregulated 12V Half-Bridge Converter



RELATED PARTS

PART NUMBER	DESCRIPTION	COMMENTS
LTC4444/LTC4444-5	High Voltage Synchronous N-Channel MOSFET Driver with Shoot-Through Protection	Up to 100V Supply Voltage, $7.2V \leq V_{CC} \leq 13.5V$, 3A Peak Pull-Up/0.55Ω Peak Pull-Down
LTC4446	High Voltage Synchronous N-Channel MOSFET Driver without Shoot-Through Protection	Up to 100V Supply Voltage, $7.2V \leq V_{CC} \leq 13.5V$, 3A Peak Pull-Up/0.55Ω Peak Pull-Down
LTC4441/LTC4441-1	N-Channel MOSFET Gate Driver	Up to 25V Supply Voltage, $5V \leq V_{CC} \leq 25V$, 6A Peak Output Current
LTC3900	Synchronous Rectifier Driver for Forward Converters	Programmable Time Out, Reverse Inductor Current Sense
LTC3901	Synchronous Rectifier Driver for Push-Pull and Full-Bridge Converters	Programmable Time Out, Reverse Inductor Current Sense
LTC3722-1/LTC3722-2	Synchronous Dual Mode Phase Modulated Full-Bridge Controllers	Adaptive Zero Voltage Switching, High Output Power Levels (Up to Kilowatts)
LTC3723-1/LTC3723-2	Synchronous Push-Pull PWM Controllers	Current Mode or Voltage Mode Controllers
LTC3765/LTC3766	Isolated Synchronous Forward Controller Chip Set	Active Clamp Reset, Direct Flux Limit™ with Onboard Gate Drivers Ideal for Medium Power 24V and 48V Input Applications
LT1952/LT1952-1	Synchronous Forward Active Clamp Controllers	Ideal for Medium Power 24V and 48V Input Applications