# LTC4440A-5

## High Speed, High Voltage, High Side Gate Driver

## 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

## 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**
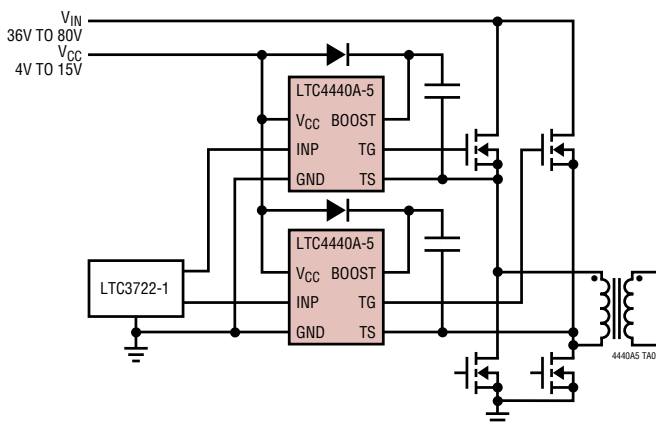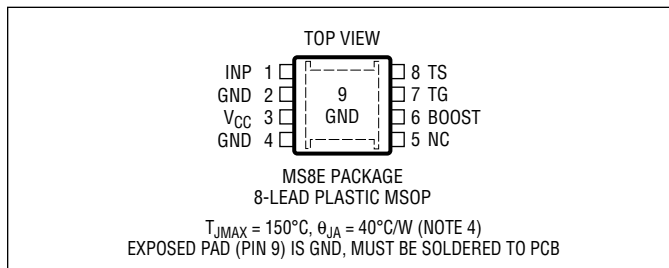


**LTC4440A-5 Driving a 1000pF Capacitive Load**



$V_{CC}$ = BOOST-TS = 5V
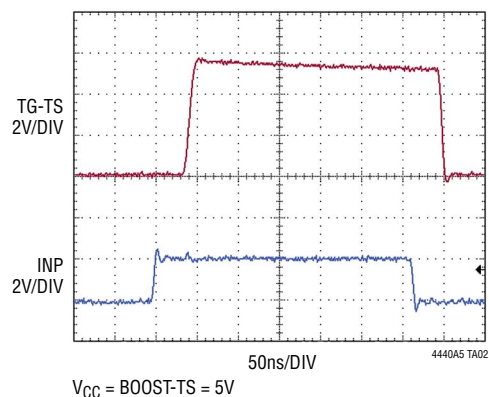
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# LTC4440A-5

# 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

TOP VIEW

```
        INP  1        8  TS
        GND  2    9   7  TG
        VCC  3   GND  6  BOOST
        GND  4        5  NC
```

MS8E PACKAGE
8-LEAD PLASTIC MSOP

$T_{JMAX} = 150°C$, $\theta_{JA} = 40°C/W$ (NOTE 4)
EXPOSED PAD (PIN 9) IS GND, MUST BE SOLDERED TO PCB

# 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 $T_A = 25°C$. $V_{CC} = V_{BOOST} = 6V$, $V_{TS} = GND = 0V$, unless otherwise noted. **(Note 2)**

| SYMBOL | PARAMETER | CONDITIONS | | MIN | TYP | MAX | UNITS |
|---|---|---|---|---|---|---|---|
| **Main Supply ($V_{CC}$)** | | | | | | | |
| $I_{VCC}$ | DC Supply Current<br>Normal Operation<br>UVLO | INP = 0V<br>$V_{CC}$ < UVLO Threshold (Falling) – 0.1V | | | 200<br>18 | 325<br>40 | μA<br>μA |
| UVLO | Undervoltage Lockout Threshold | $V_{CC}$ Rising<br>$V_{CC}$ Falling<br>Hysteresis | ●<br>● | 2.75<br>2.60 | 3.20<br>3.04<br>160 | 3.65<br>3.50 | V<br>V<br>mV |
| **Bootstrapped Supply (BOOST – TS)** | | | | | | | |
| $I_{BOOST}$ | DC Supply Current<br>Normal Operation | INP = 0V<br>INP = 6V | | | 0<br>310 | 450 | μA<br>μA |

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LINEAR
TECHNOLOGY

# ELECTRICAL CHARACTERISTICS

The ● denotes specifications which apply over the specified operating junction temperature range, otherwise specifications are at $T_A$ = 25°C. $V_{CC}$ = $V_{BOOST}$ = 6V, $V_{TS}$ = GND = 0V, 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 | $I_{TG}$ = –10mA, $V_{OH}$ = $V_{BOOST}$ – $V_{TG}$ | | | 0.7 | | V |
| $V_{OL}$ | Low Output Voltage | $I_{TG}$ = 100mA | ● | | 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%, $C_L$ = 1nF<br>10% – 90%, $C_L$ = 10nF | | | 10<br>100 | | ns<br>ns |
| $t_f$ | Output Fall Time | 10% – 90%, $C_L$ = 1nF<br>10% – 90%, $C_L$ = 10nF | | | 7<br>70 | | ns<br>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:

$$T_J = T_A + (PD \bullet \theta_{JA}°C/W)$$

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.
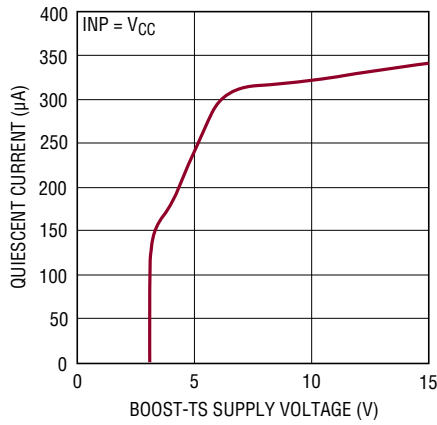
# TYPICAL PERFORMANCE CHARACTERISTICS

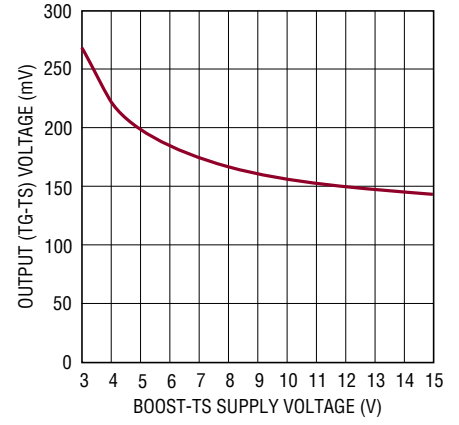### $V_{CC}$ Supply Quiescent Current vs Voltage



INP = GND

INP = $V_{CC}$
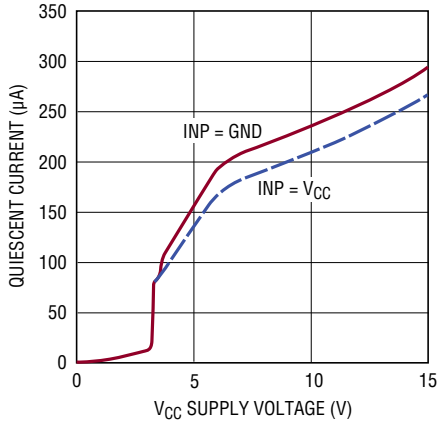
4440A5 G01

### BOOST-TS Supply Quiescent Current vs Voltage



INP = $V_{CC}$

4440A5 G02

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



4440A5 G03

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



$I_{TG}$ = 1mA

$I_{TG}$ = 10mA

$I_{TG}$ = 100mA
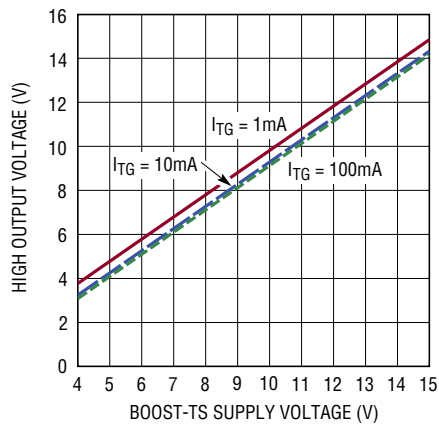
4440A5 G04

### Input (INP) Thresholds vs Supply Voltage



$V_{IH}$

$V_{IL}$
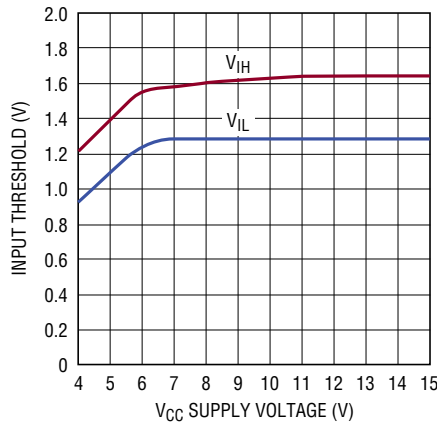
4440A5 G05

### 2MHz Operation



INPUT (INP) 5V/DIV

OUTPUT (TG) 5V/DIV

250ns/DIV
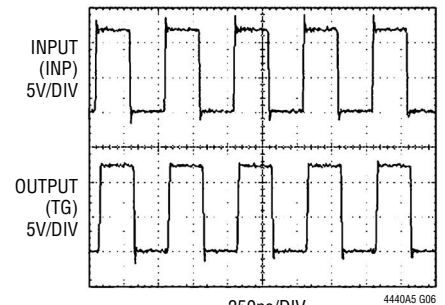
4440A5 G06

$V_{CC}$ = BOOST-TS = 12V

### $V_{CC}$ Supply Current vs Temperature



INP = GND

INP = $V_{CC}$
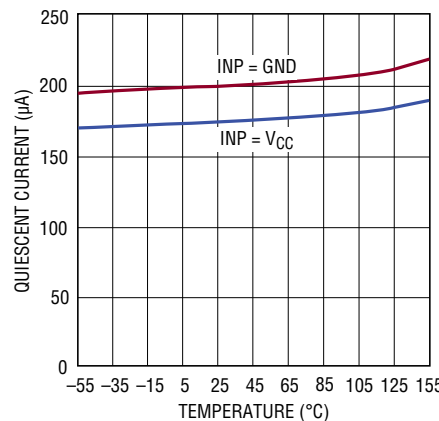
4440A5 G07

### $V_{CC}$ Undervoltage Lockout Thresholds vs Temperature



RISING
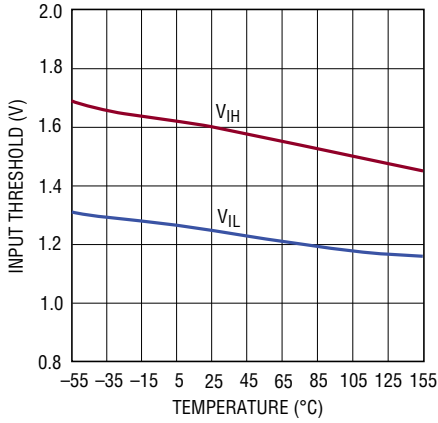
FALLING
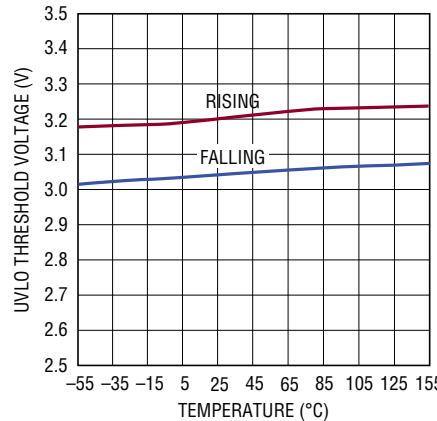
4440A5 G08

### BOOST-TS Quiescent Current vs Temperature
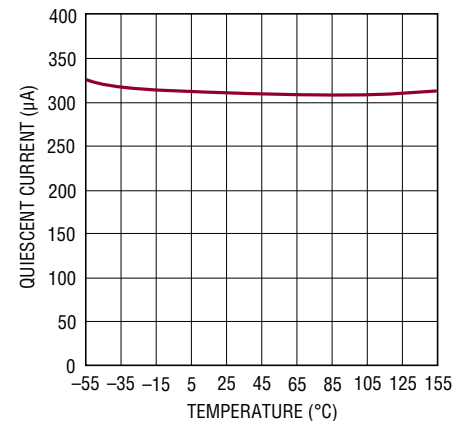


4440A5 G09

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# TYPICAL PERFORMANCE CHARACTERISTICS
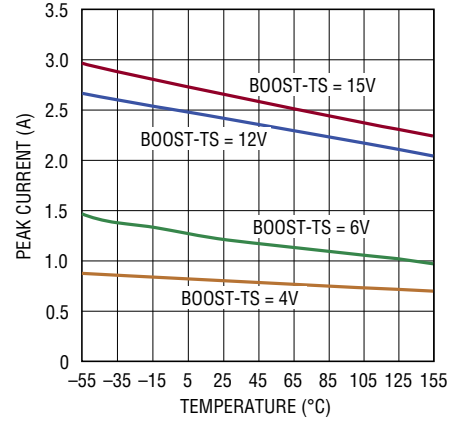
**Input (INP) Threshold vs Temperature**

INPUT THRESHOLD (V) vs TEMPERATURE (°C)
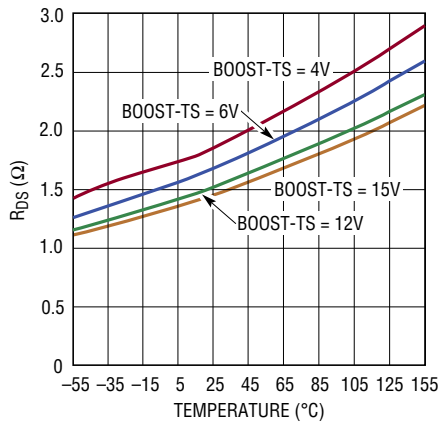
$V_{IH}$

$V_{IL}$

4440A5 G10

**Input Threshold Hysteresis vs Temperature**

HYSTERESIS ($V_{IH}$-$V_{IL}$) (mV) vs TEMPERATURE (°C)
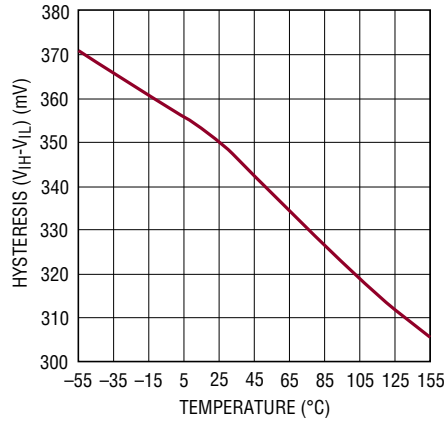
4440A5 G11

**Peak Driver (TG) Pull-Up Current vs Temperature**

PEAK CURRENT (A) vs TEMPERATURE (°C)

BOOST-TS = 15V
BOOST-TS = 12V
BOOST-TS = 6V
BOOST-TS = 4V

4440A5 G12

**Output Driver Pull-Down Resistance vs Temperature**

$R_{DS}$ (Ω) vs TEMPERATURE (°C)

BOOST-TS = 4V
BOOST-TS = 6V
BOOST-TS = 15V
BOOST-TS = 12V

4440A5 G13

**Propagation Delay vs Temperature**

PROPAGATION DELAY (ns) vs TEMPERATURE (°C)

$V_{CC}$ = BOOST = 6V

$t_{PLH}$
$t_{PHL}$
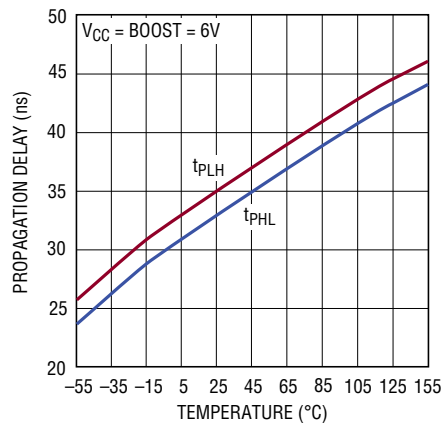
4440A5 G14

**Driving a 3300pF Capacitive Load**

TG-TS
2V/DIV

INP
2V/DIV

50ns/DIV

$V_{CC}$ = BOOST-TS = 5V

4440A5 G15

**Driving a 3300pF Capacitive Load**

TG-TS
5V/DIV

INP
2V/DIV

50ns/DIV

$V_{CC}$ = BOOST-TS = 12V

4440A5 G16
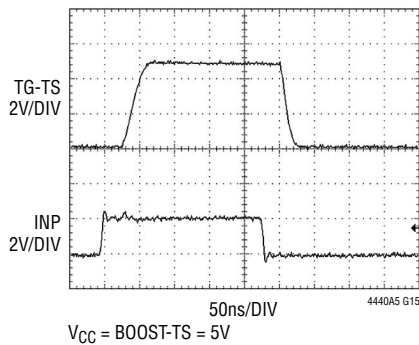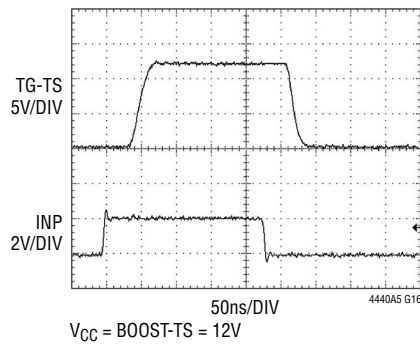
# PIN FUNCTIONS

**INP (Pin 1):** Input Signal. TTL/CMOS compatible input referenced to GND (Pin 2).

**GND (Pins 2, 4, Exposed Pad Pin 9):** Ground. The exposed pad must be electrically connected to Pins 2 and 4 and soldered to PCB ground for rated thermal performance.

**$V_{CC}$ (Pin 3):** Chip Supply. This pin powers the internal low side circuitry. A low ESR ceramic bypass capacitor should be tied between this pin and the GND pin (Pin 2).

**NC (Pin 5):** No Connect. No connection required. For convenience, this pin may be tied to Pin 6 (BOOST) on the application board.

**BOOST (Pin 6):** High Side Bootstrapped Supply. An external capacitor should be tied between this pin and TS (Pin 8). Normally, a bootstrap diode is connected between $V_{CC}$ (Pin 3) and this pin. Voltage swing at this pin is from $V_{CC}$ – $V_D$ to $V_{IN}$ + $V_{CC}$ – $V_D$, where $V_D$ is the forward voltage drop of the bootstrap diode.
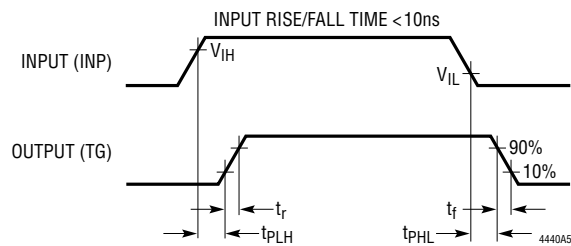
**TG (Pin 7):** High Current Gate Driver Output (Top Gate). This pin swings between TS and BOOST.

**TS (Pin 8):** Top (High Side) source connection or GND if used in ground referenced applications.

# BLOCK DIAGRAM
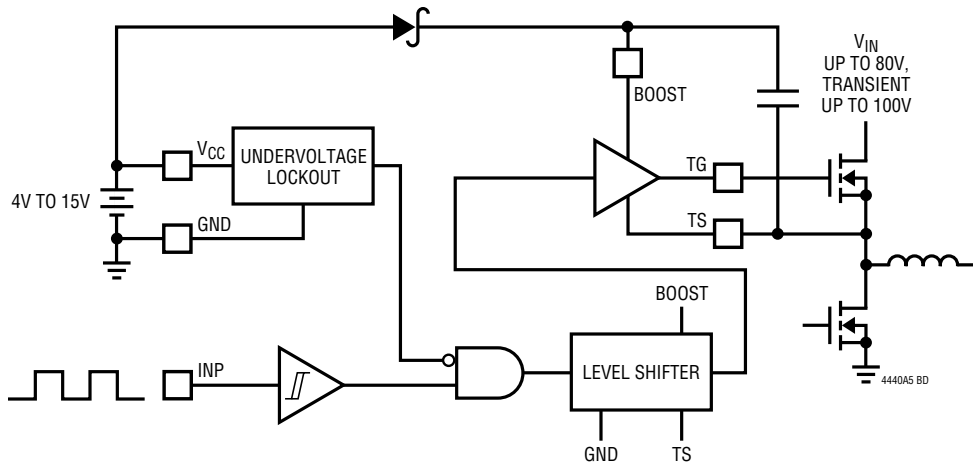


# TIMING DIAGRAM

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# APPLICATIONS INFORMATION

## Overview

The LTC4440A-5 receives a ground-referenced, low voltage digital input signal to drive a high side N-channel power MOSFET whose drain can float up to 80V above ground, eliminating the need for a transformer between the low voltage control signal and the high side gate driver. The LTC4440A-5 normally operates in applications with input supply voltages ($V_{IN}$) up to 80V, but is able to withstand and continue to function during 100V, 100ms transients on the input supply.

The powerful output driver of the LTC4440A-5 reduces the switching losses of the power MOSFET, which increase with transition time. The LTC4440A-5 is capable of driving a 1nF load with 10ns rise and 7ns fall times using a bootstrapped supply voltage $V_{BOOST-TS}$ of 6V.

## Input Stage

The LTC4440A-5 employs TTL/CMOS compatible input logic level or thresholds that allow a low voltage digital signal to drive standard threshold power MOSFETs. The LTC4440A-5 contains an internal voltage regulator that biases the input buffer, allowing the input thresholds ($V_{IH}$ = 1.6V, $V_{IL}$ = 1.25V) to be relatively independent of variations in $V_{CC}$. The 350mV hysteresis between $V_{IH}$ and $V_{IL}$ eliminates false triggering due to noise during switching transitions. However, care should be taken to keep this pin from any noise pickup, especially in high frequency, high voltage applications. The LTC4440A-5 input buffer has a high input impedance and draws negligible input current, simplifying the drive circuitry required for the input.

## Output Stage

A simplified version of the LTC4440A-5's output stage is shown in Figure 1. The pull-down device is an N-channel MOSFET (N1) and the pull-up device is an NPN bipolar junction transistor (Q1). The output swings from the lower rail (TS) to within an NPN $V_{BE}$ (~0.7V) of the positive rail (BOOST). This large voltage swing is important in driving external power MOSFETs, whose $R_{DS(ON)}$ is inversely proportional to its gate overdrive voltage ($V_{GS} - V_{TH}$).

The LTC4440A-5's peak pull-up (Q1) current is 1.1A while the pull-down (N1) resistance is 1.85Ω, with a BOOST-TS supply of 6V. The low impedance of N1 is required to
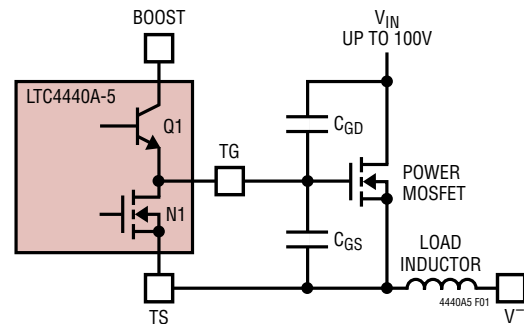


Figure 1. Capacitance Seen by TG During Switching

discharge the power MOSFET's gate capacitance during high-to-low signal transitions. When the power MOSFET's gate is pulled low (gate shorted to source through N1) by the LTC4440A-5, its source (TS) is pulled low by its load (e.g., an inductor or resistor). The slew rate of the source/gate voltage causes current to flow back to the MOSFET's gate through the gate-to-drain capacitance ($C_{GD}$). If the MOSFET driver does not have sufficient sink current capability (low output impedance), the current through the power MOSFET's $C_{GD}$ can momentarily pull the gate high, turning the MOSFET back on.

A similar scenario exists when the LTC4440A-5 is used to drive a low side MOSFET. When the low side power MOSFET's gate is pulled low by the LTC4440A-5, its drain voltage is pulled high by its load (e.g., inductor or resistor). The slew rate of the drain voltage causes current to flow back to the MOSFET's gate through its gate-to-drain capacitance. If the MOSFET driver does not have sufficient sink current capability (low output impedance), the current through the power MOSFET's $C_{GD}$ can momentarily pull the gate high, turning the MOSFET back on.

## Rise/Fall Time

Since the power MOSFET generally accounts for the majority of the power loss in a converter, it is important to quickly turn it on or off, thereby minimizing the transition time in its linear region. The LTC4440A-5 can drive a 1nF load with a 10ns rise time and 7ns fall time.

The LTC4440A-5's rise and fall times are determined by the peak current capabilities of Q1 and N1. The predriver that drives Q1 and N1 uses a nonoverlapping transition scheme to minimize cross-conduction currents. N1 is fully turned off before Q1 is turned on and vice versa.

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# 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

$\theta_{JA}$ = 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 (200µA)(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:

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:

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:

A. 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.

B. 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.

C. 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.

D. Keep the copper trace between the driver output pin and the load short and wide.

E. 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 2500mm$^2$ 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.
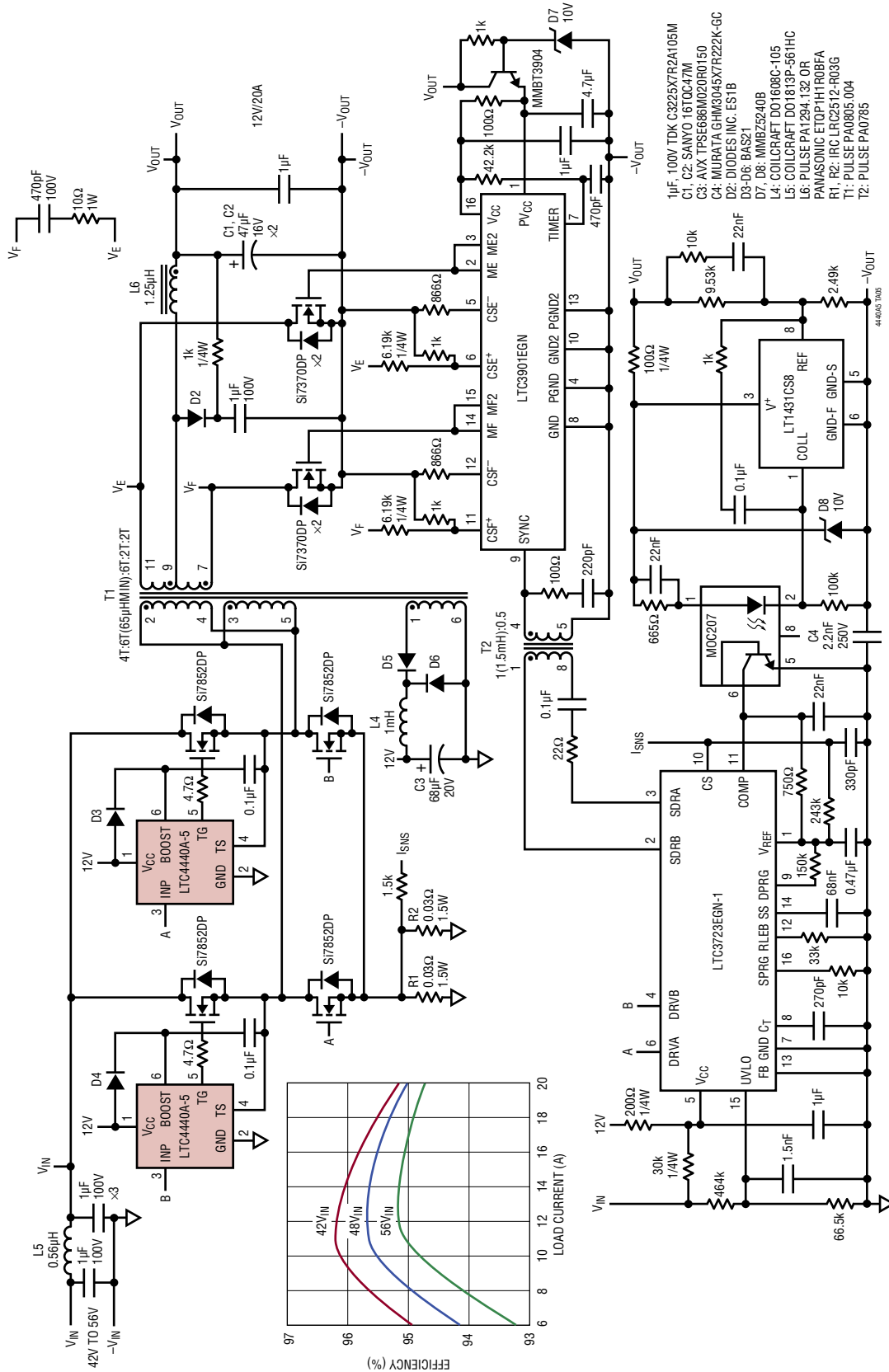
# TYPICAL APPLICATIONS

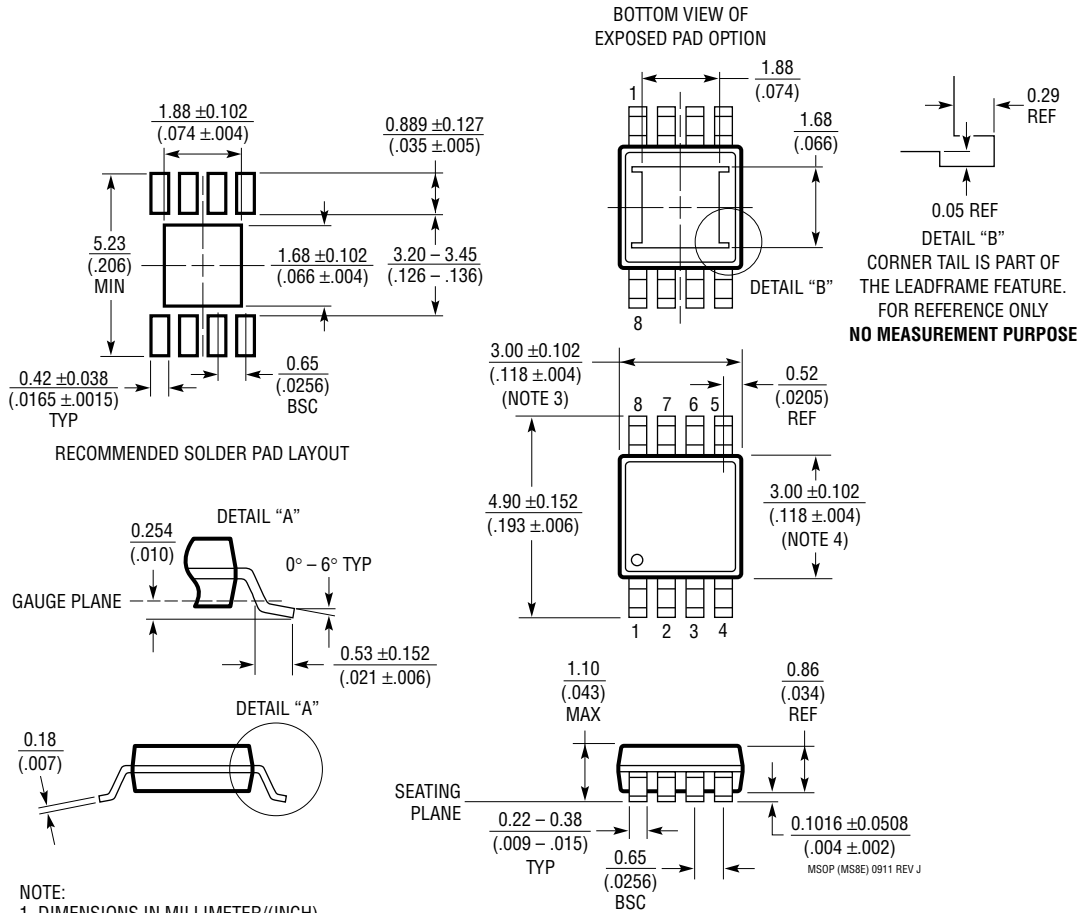**LTC3722/LTC4440A-5 420W 36V-60V$_{IN}$ to 12V/35A Isolated Full-Bridge Supply**
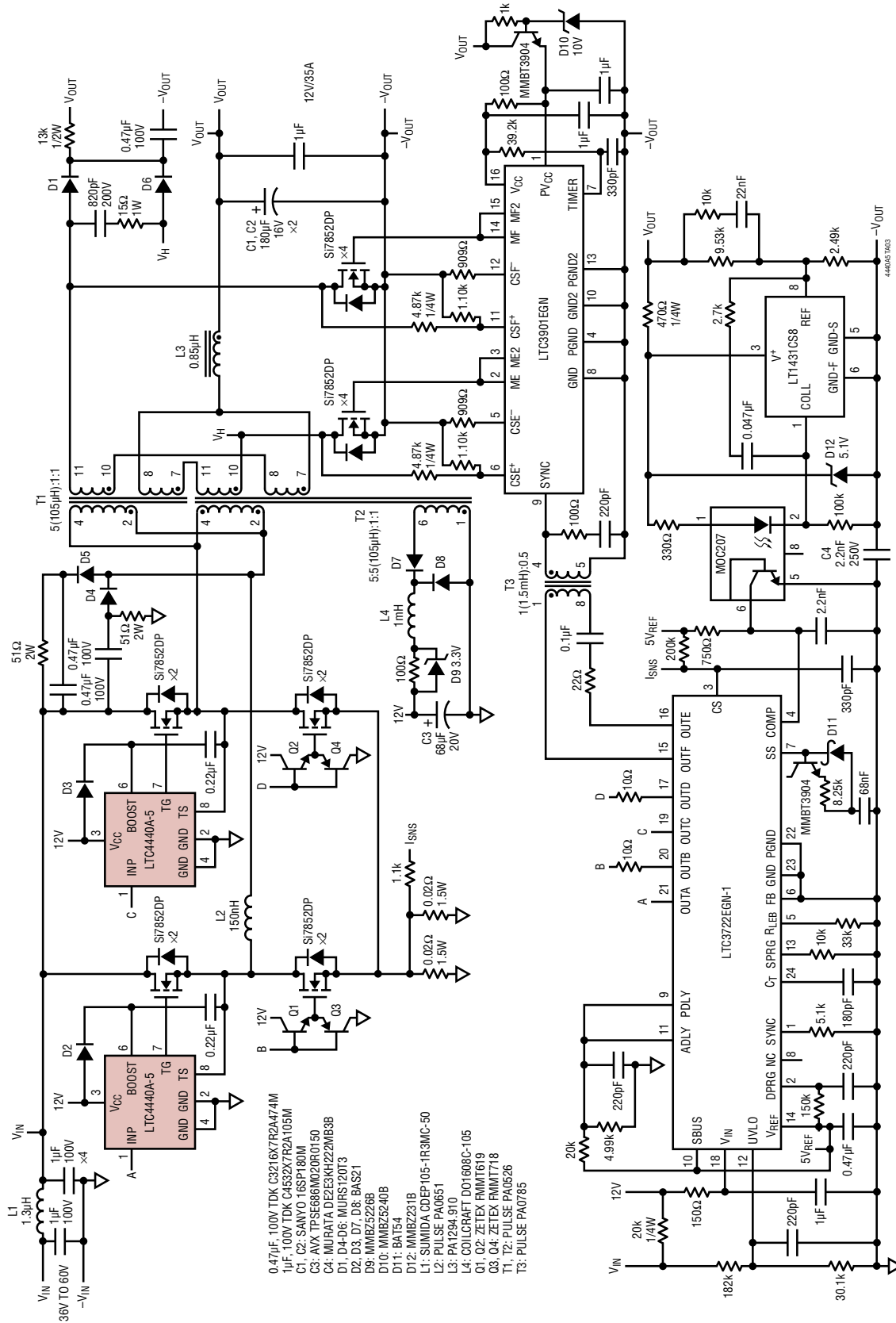
# TYPICAL APPLICATIONS



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

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# PACKAGE DESCRIPTION

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

BOTTOM VIEW OF
EXPOSED PAD OPTION

1.88 ±0.102
(.074 ±.004)

0.889 ±0.127
(.035 ±.005)

5.23
(.206)
MIN

1.68 ±0.102
(.066 ±.004)

3.20 – 3.45
(.126 – .136)

0.42 ±0.038
(.0165 ±.0015)
TYP

0.65
(.0256)
BSC

RECOMMENDED SOLDER PAD LAYOUT

1.88
(.074)

1.68
(.066)

1

8

DETAIL "B"

0.29
REF

0.05 REF
DETAIL "B"
CORNER TAIL IS PART OF
THE LEADFRAME FEATURE.
FOR REFERENCE ONLY
**NO MEASUREMENT PURPOSE**

DETAIL "A"

0.254
(.010)

GAUGE PLANE

0° – 6° TYP

0.53 ±0.152
(.021 ±.006)

DETAIL "A"

0.18
(.007)

3.00 ±0.102
(.118 ±.004)
(NOTE 3)

0.52
(.0205)
REF

8  7  6  5

4.90 ±0.152
(.193 ±.006)

3.00 ±0.102
(.118 ±.004)
(NOTE 4)

1  2  3  4

1.10
(.043)
MAX

0.86
(.034)
REF

SEATING
PLANE

0.22 – 0.38
(.009 – .015)
TYP

0.65
(.0256)
BSC

0.1016 ±0.0508
(.004 ±.002)
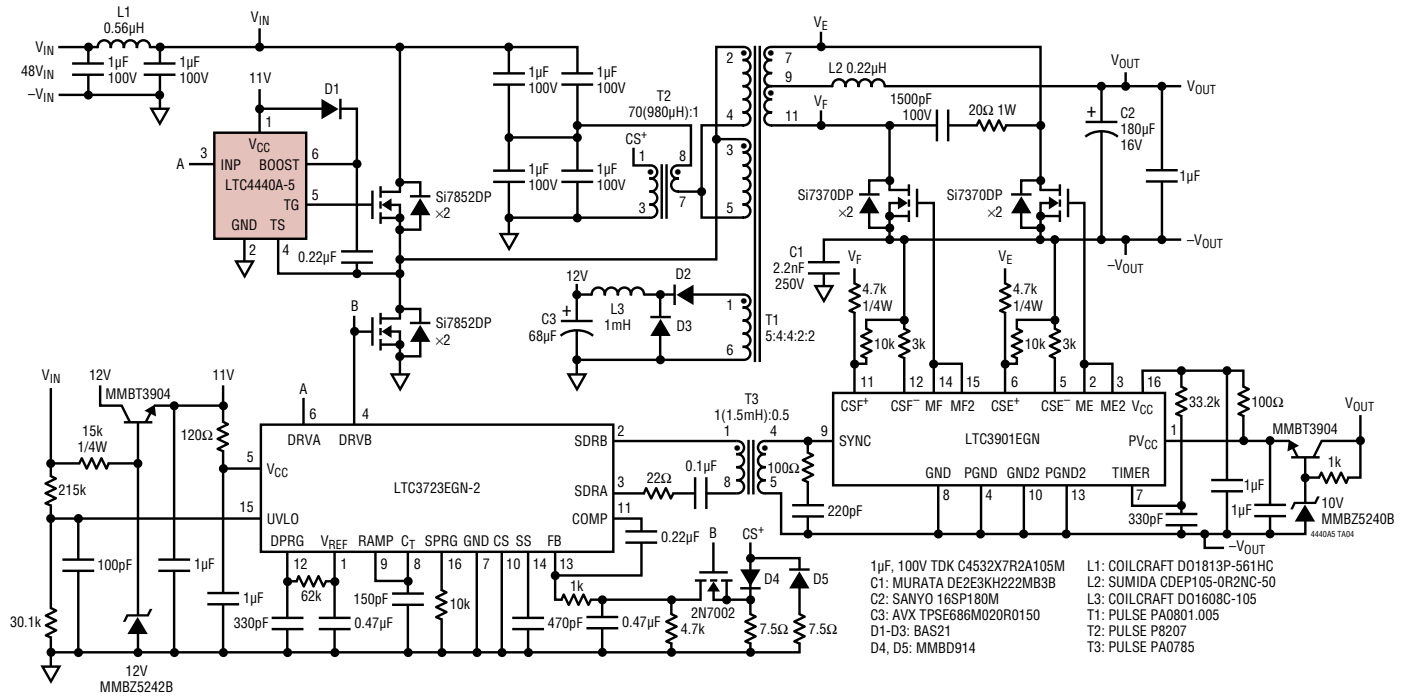
MSOP (MS8E) 0911 REV J

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**

1µF, 100V TDK C4532X7R2A105M
C1: MURATA DE2E3KH222MB3B
C2: SANYO 16SP180M
C3: AVX TPSE686M020R0150
D1-D3: BAS21
D4, D5: MMBD914

L1: COILCRAFT DO1813P-561HC
L2: SUMIDA CDEP105-0R2NC-50
L3: COILCRAFT DO1608C-105
T1: PULSE PA0801.005
T2: PULSE P8207
T3: PULSE PA0785

# 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 ≤ V$_{CC}$ ≤ 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 ≤ V$_{CC}$ ≤ 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 ≤ V$_{CC}$ ≤ 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 |

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