Quick Reference Guide for Isolated and Off-Line PWM Controllers and Other Useful Helper ICs

This document lists data sheets and applications information for isolated power supply designs. Links, shown in blue, take you to the full documentation on the Maxim website.

19-2066; Rev 1; 9/01

EVALUATION KIT AVAILABLE

Current-Mode PWM Controllers for Isolated Power Supplies

General Description

The MAX5021/MAX5022 current-mode PWM controllers contain all the control circuitry required for the design of wide input voltage range isolated power supplies. These devices are well suited for use in universal input (85VAC to 265VAC) off-line or telecom (-36VDC to -72VDC) power supplies.

An undervoltage lockout (UVLO) circuit with large hysteresis coupled with low startup and operating current reduce power dissipation in the startup resistor and allow use of ceramic bypass capacitors. The 262kHz switching frequency is internally trimmed to ±12% accuracy; this allows the optimization of the magnetic and filter components resulting in compact, cost-effective power supplies. The MAX5021 with 50% maximum duty cycle and MAX5022 with 75% maximum duty cycle are recommended for forward converters and flyback converters, respectively. The MAX5021/MAX5022 are available in 6-pin SOT23, 8-pin µMAX, and 8-pin DIP packages and are rated for operation over the -40°C to +85°C temperature range.

Applications

Universal Off-Line Power Supplies

Standby Power Supplies

Isolated Power Supplies

Isolated Telecom Power Supplies

Mobile Phone Chargers

Features

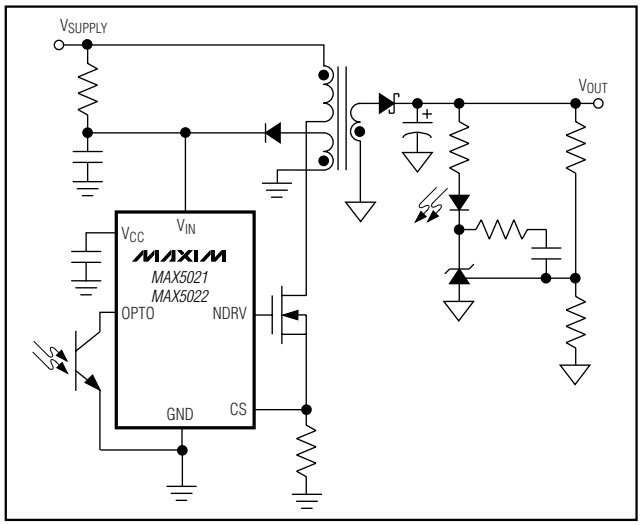
- **Available in a Tiny 6-Pin SOT23 Package**
- **50µA Typical Startup Current**
- **1.2mA Typical Operating Current**
- **Large UVLO Hysteresis of 14V**
- **Fixed Switching Frequency of 262kHz ±12%**
- **50% Maximum Duty Cycle Limit (MAX5021)**
- **75% Maximum Duty Cycle Limit (MAX5022)**
- **60ns Cycle-by-Cycle Current-Limit Response Time**

Ordering Information

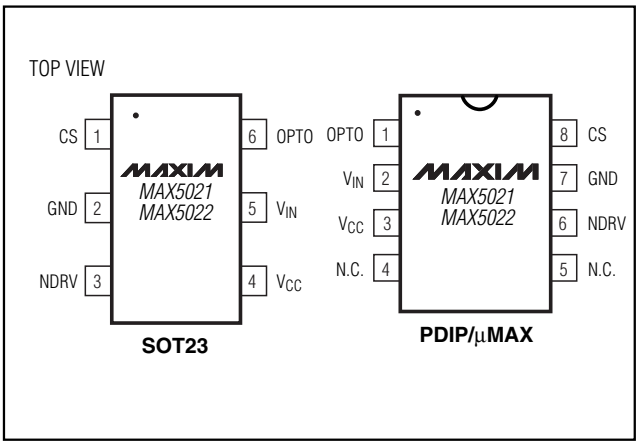
PART	MAX DUTY CYCLE	TEMP. RANGE	PIN-PACKAGE	TOP MARK
MAX5021EUT	50%	-40°C to +85°C	6 SOT23-6	AASQ
MAX5021EUA	50%	-40°C to +85°C	8 µMAX	—
MAX5021EPA	50%	-40°C to +85°C	8 PDIP	—
MAX5022EUT	75%	-40°C to +85°C	6 SOT23-6	AASR
MAX5022EUA	75%	-40°C to +85°C	8 µMAX	—
MAX5022EPA	75%	-40°C to +85°C	8 PDIP	—

WARNING: The MAX5021/MAX5022 are designed to work with high voltages. Exercise caution!

Typical Operating Circuit



Pin Configuration



For pricing, delivery, and ordering information, please contact Maxim/Dallas Direct! at 1-888-629-4642, or visit Maxim's website at www.maxim-ic.com.

MAX5022 Evaluation Kit

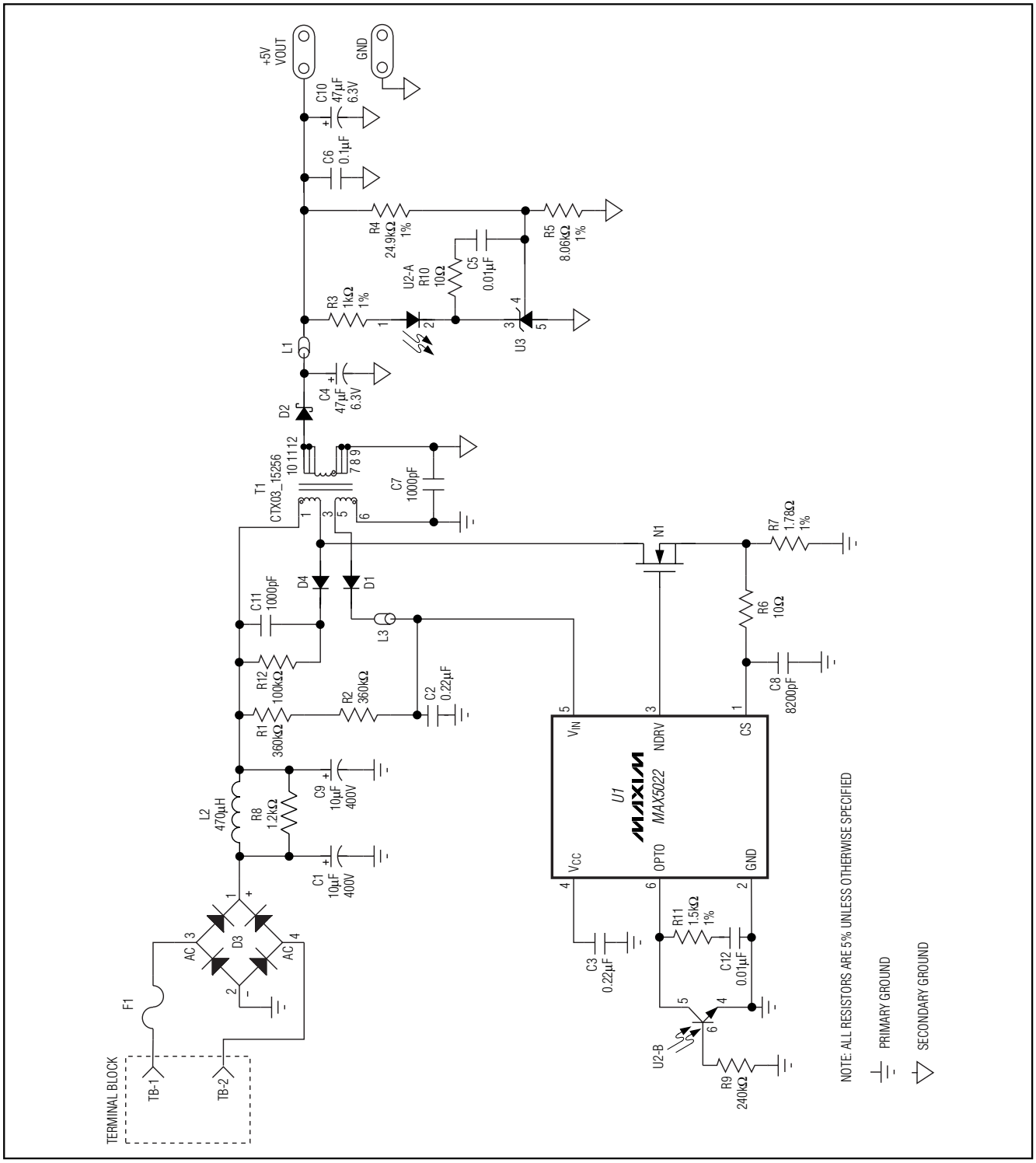


Figure 2. MAX5022 EV Kit Schematic

19-2590; Rev 0; 10/02

EVALUATION KIT AVAILABLE

MAXIM

Current-Mode PWM Controllers with an Error Amplifier for Isolated/Nonisolated Power Supplies

General Description

The MAX5052/MAX5053 current-mode PWM controllers contain all the control circuitry required for the design of wide-input-voltage isolated and nonisolated power supplies. The MAX5052 is well suited for universal input (rectified 85VAC to 265VAC) or telecom (-36VDC to -72VDC) power supplies. The MAX5053 is well suited for low-input-voltage (10.8VDC to 24VDC) power supplies.

The MAX5052/MAX5053 contain an internal error amplifier that regulates the tertiary winding output voltage. This implements a primary-side regulated, isolated power supply, eliminating the need for an optocoupler. An input undervoltage lockout (UVLO) is provided for programming the input-supply start voltage and to ensure proper operation during brownout conditions. The input-supply start voltage is externally programmable with a voltage-divider. To shutdown the device, the UVLO pin is pulled low. Internal digital soft-start reduces output voltage overshoot. The internal thermal shutdown circuit protects the device in the event the junction temperature exceeds +130°C.

The MAX5052 has an internal bootstrap UVLO with large hysteresis that requires a minimum voltage of 23.6V for startup. The MAX5053 does not have the internal bootstrap UVLO and can be biased directly from a minimum voltage of 10.8V.

The 262kHz switching frequency is internally trimmed to ±12% accuracy; this allows the optimization of the magnetic and filter components resulting in compact, cost-effective power supplies. The MAX5052A/MAX5053A are offered with a 50% maximum duty-cycle limit. The MAX5052B/MAX5053B are offered with a 75% maximum duty-cycle limit. These devices are available in 8-pin µMAX packages and operate over the -40°C to +85°C temperature range.

Applications

- Universal Input AC Power Supplies
- Industrial Power Conversion
- Isolated Telecom Power Supplies
- Isolated Keep-Alive Circuits
- Networking Systems
- 12V Boost Regulators
- Computer Systems/ Servers
- 12V SEPIC Regulators

Functional Diagram/Typical Operating Circuit/Selector Guide appear at end of data sheet.

Features

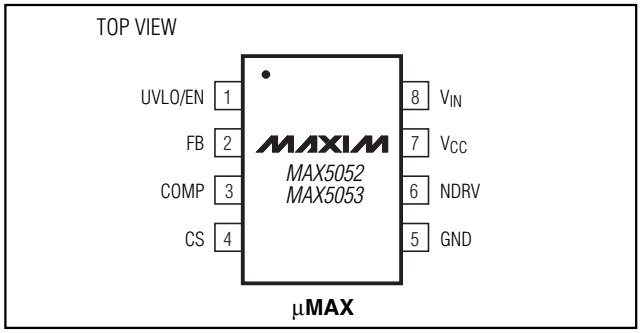
- **Available in a Tiny 8-Pin µMAX Package**
- **Current-Mode Control**
- **50W Output Power**
- **Universal Offline Input Voltage Range Rectified 85VAC to 265VAC (MAX5052)**
- **V_{IN} Directly Driven from 10.8V to 24V Input (MAX5053)**
- **Digital Soft-Start**
- **Programmable Input Startup Voltage**
- **Internal Bootstrap UVLO with Large Hysteresis (MAX5052)**
- **Internal Error Amplifier with 1% Accurate Reference**
- **Thermal Shutdown**
- **45µA (typ) Startup Supply Current**
- **1.4mA (typ) Operating Supply Current**
- **Fixed Switching Frequency of 262kHz ±12%**
- **50% Maximum Duty-Cycle Limit (MAX5052A/MAX5053A)**
- **75% Maximum Duty-Cycle Limit (MAX5052B/MAX5053B)**
- **60ns Cycle-by-Cycle Current-Limit Response Time**

Ordering Information

PART	TEMP RANGE	PIN-PACKAGE
MAX5052AEUA	-40°C to +85°C	8 µMAX
MAX5052BEUA	-40°C to +85°C	8 µMAX
MAX5053AEUA	-40°C to +85°C	8 µMAX
MAX5053BEUA	-40°C to +85°C	8 µMAX

Warning: *The MAX5052/MAX5053 are designed to work with high voltages. Exercise caution.*

Pin Configuration



For pricing, delivery, and ordering information, please contact Maxim/Dallas Direct! at 1-888-629-4642, or visit Maxim's website at www.maxim-ic.com.

MAX5052A Evaluation Kit

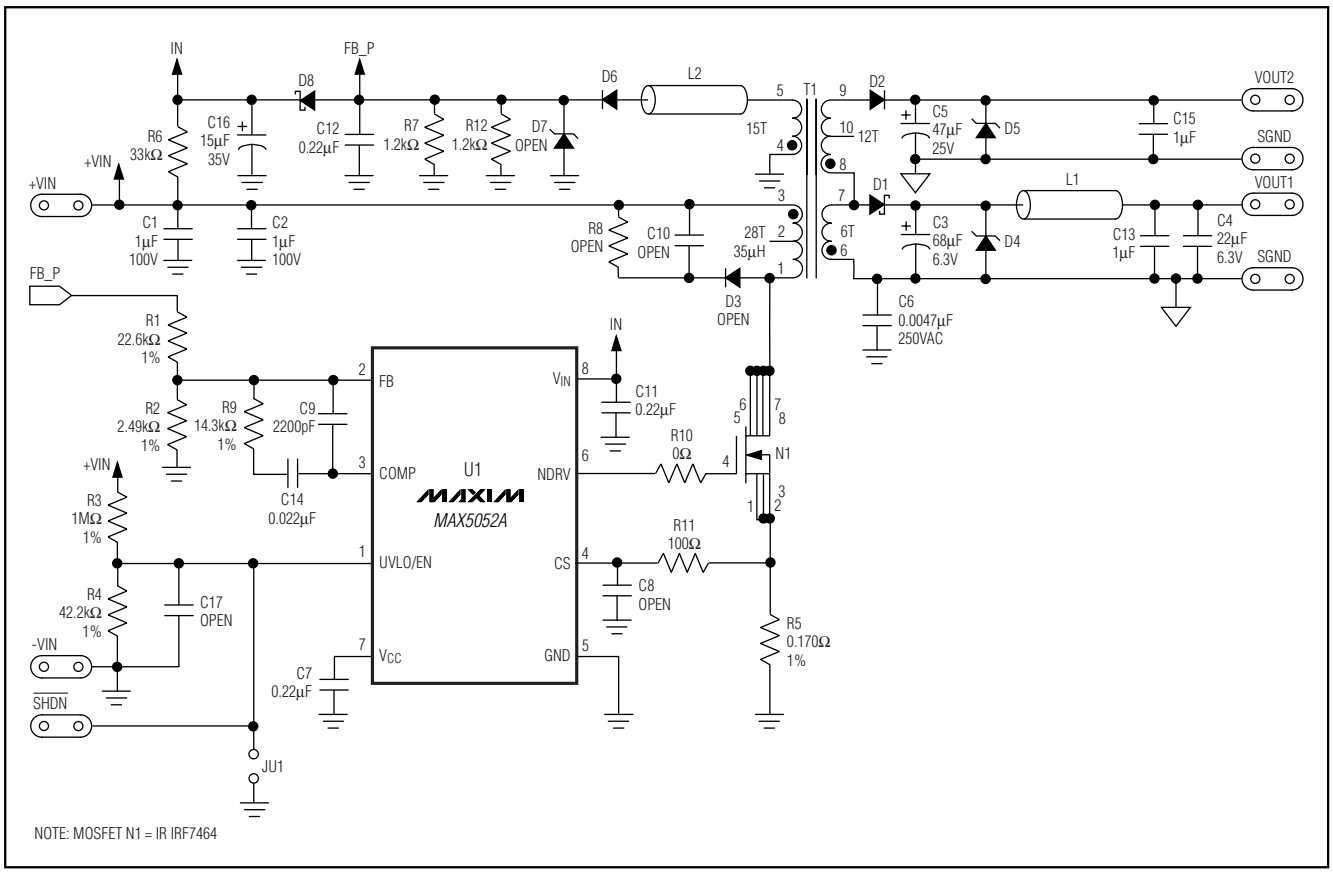


Figure 5. MAX5052A EV Kit Schematic

19-2082; Rev 0; 7/01

EVALUATION KIT AVAILABLE

Current-Mode PWM Controllers with Integrated Startup Circuit for Isolated Power Supplies

General Description

The MAX5014/MAX5015 integrate all the building blocks necessary for implementing DC-DC fixed-frequency isolated power supplies. These devices are current-mode controllers with an integrated high-voltage startup circuit suitable for isolated telecom/industrial voltage range power supplies. Current-mode control with leading-edge blanking simplifies control-loop design and internal ramp compensation circuitry stabilizes the current loop when operating at duty cycles above 50% (MAX5014). The MAX5014 allows 85% operating duty cycle and could be used to implement flyback converters, whereas the MAX5015 limits the operating duty cycle to less than 50% and can be used in single-ended forward converters. A high-voltage startup circuit allows these devices to draw power directly from the 18V to 110V input supply during startup. The switching frequency is internally trimmed to 275kHz ±10%, thus reducing magnetics and filter component costs.

The MAX5014/MAX5015 are available in 8-pin SO packages. An evaluation kit (MAX5015EVKIT) is also available.

Warning: *The MAX5014/MAX5015 are designed to operate with high voltages. Exercise caution.*

Applications

Telecom Power Supplies

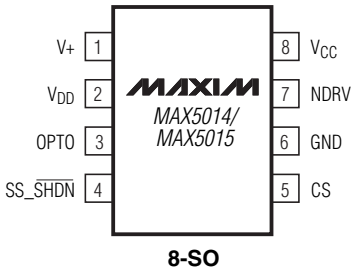
Industrial Power Supplies

Networking Power Supplies

Isolated Power Supplies

Pin Configuration

TOP VIEW



8-SO

Features

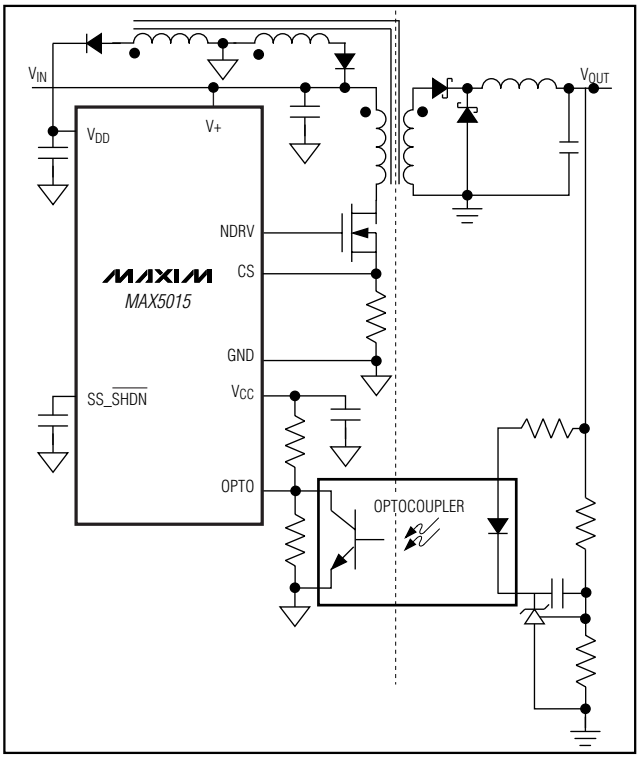
- ♦ Wide Input Range: (18V to 110V) or (13V to 36V)
- ♦ Current-Mode Control
- ♦ Leading-Edge Blanking
- ♦ Internally Trimmed 275kHz ±10% Oscillator
- ♦ Low External Component Count
- ♦ Soft-Start
- ♦ High-Voltage Startup Circuit
- ♦ Pulse-by-Pulse Current Limiting
- ♦ Thermal Shutdown
- ♦ SO-8 Package

Ordering Information

PART	TEMP. RANGE	PIN-PACKAGE
MAX5014CSA*	0°C to +70°C	8-SO
MAX5014ESA*	-40°C to +85°C	8-SO
MAX5015CSA*	0°C to +70°C	8-SO
MAX5015ESA*	-40°C to +85°C	8-SO

**See Selector Guide at end of data sheet.*

Typical Operating Circuit



For pricing, delivery, and ordering information, please contact Maxim/Dallas Direct! at 1-888-629-4642, or visit Maxim's website at www.maxim-ic.com.

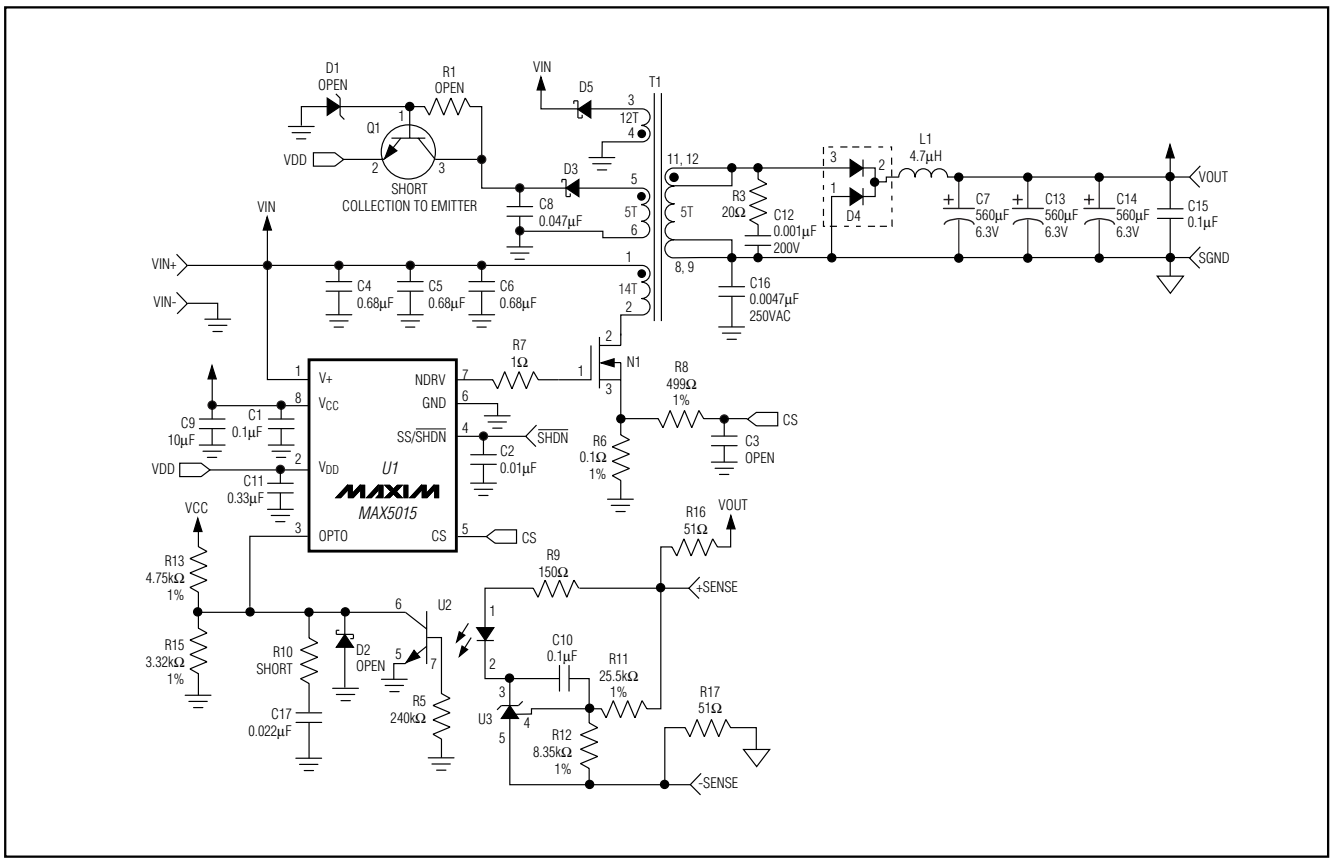


Figure 4. MAX5015 EV Kit Schematic

19-1555; Rev 2; 4/02

EVALUATION KIT AVAILABLE

High-Voltage PWM Power-Supply Controller

General Description

The MAX5003 high-voltage switching power-supply controller has all the features and building blocks needed for a cost-effective flyback and forward voltage-mode control converter. This device can be used to design both isolated and nonisolated power supplies with multiple output voltages that operate from a wide range of voltage sources. It includes a high-voltage internal start-up circuit that operates from a wide 11V to 110V input range. The MAX5003 drives an external N-channel power MOSFET and has a current-sense pin that detects overcurrent conditions and turns off the power switch when the current-limit threshold is exceeded. The choice of external power MOSFET and other external components determines output voltage and power.

The MAX5003 offers some distinctive advantages: soft-start, undervoltage lockout, external frequency synchronization, and fast input voltage feed-forward. The device is designed to operate at up to 300kHz switching frequency. This allows use of miniature magnetic components and low-profile capacitors. Undervoltage lockout, soft-start, switching frequency, maximum duty cycle, and overcurrent protection limit are all adjustable using a minimum number of external components. In systems with multiple controllers, the MAX5003 can be externally synchronized to operate from a common system clock.

Warning: *The MAX5003 is designed to operate with high voltages. Exercise caution.*

The MAX5003 is available in 16-pin SO and QSOP packages. An evaluation kit (MAX5003EVKIT) is also available.

Applications

Telecommunication Power Supplies

ISDN Power Supplies

+42V Automobile Systems

High-Voltage Power-Supply Modules

Industrial Power Supplies

Features

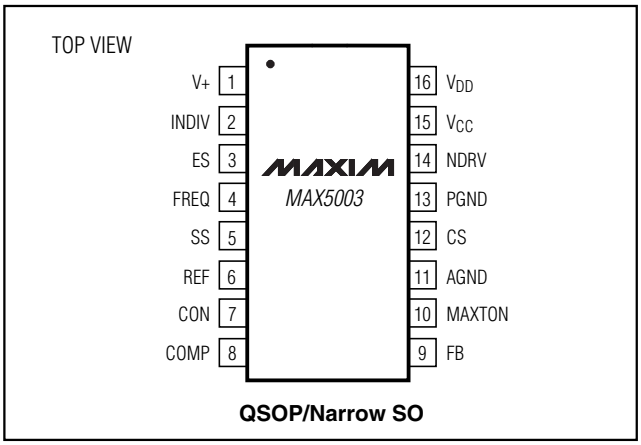
- **Wide Input Range: 11V to 110V**
- **Internal High-Voltage Startup Circuit**
- **Externally Adjustable Settings**
  - **Output Switch Current Limit**
  - **Oscillator Frequency**
  - **Soft-Start**
  - **Undervoltage Lockout**
  - **Maximum Duty Cycle**
- **Low External Component Count**
- **External Frequency Synchronization**
- **Primary or Secondary Regulation**
- **Input Feed-Forward for Fast Line-Transient Response**
- **Precision ±2.5% Reference over Rated Temperature Range**
- **Thermal Shutdown**

Ordering Information

PART	TEMP. RANGE	PIN-PACKAGE
MAX5003CEE	0°C to +70°C	16 QSOP
MAX5003CSE	0°C to +70°C	16 Narrow SO
MAX5003C/D	(Note A)	Dice
MAX5003EEE	-40°C to +85°C	16 QSOP
MAX5003ESE	-40°C to +85°C	16 Narrow SO

Note: *Dice are designed to operate over a -40°C to +140°C junction temperature (T_J) range, but are tested and guaranteed at T_A = +25°C.*

Pin Configuration



QSOP/Narrow SO

For pricing, delivery, and ordering information, please contact Maxim/Dallas Direct! at 1-888-629-4642, or visit Maxim's website at www.maxim-ic.com.

MAX5003 Evaluation Kit

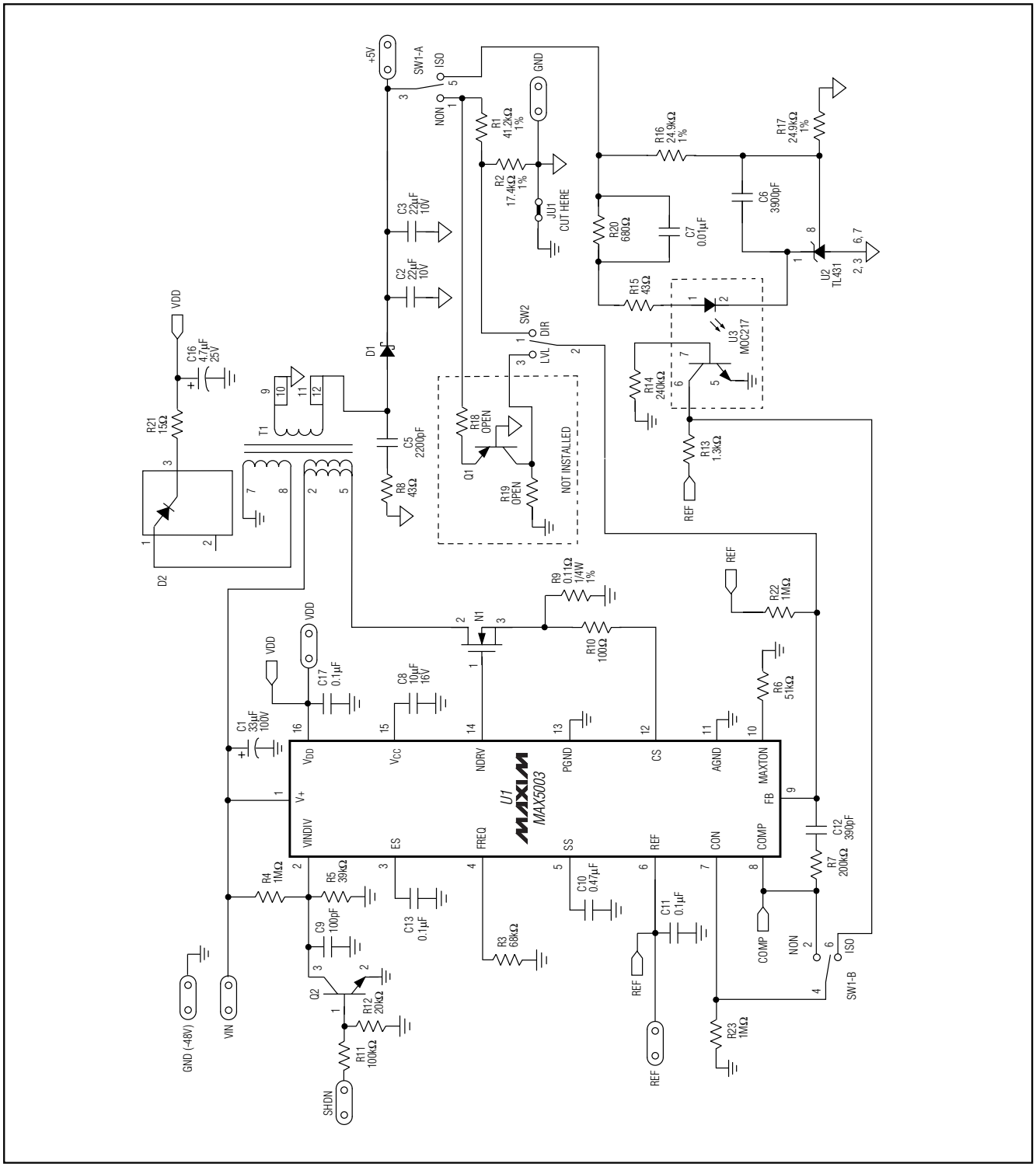


Figure 1. MAX5003 EV Kit Schematic

XX-XXXX; Rev 0; 4/03

PR .2 Tboblet
04/15/03

MAXIM

Parallelable, Clamped Two-Switch Power-Supply Controller IC

General Description

The MAX5051 is a clamped, two-switch power-supply controller IC. This device can be used both in forward or flyback configurations with input voltage ranges from 11V to 76V. It provides comprehensive protection mechanisms against possible faults, resulting in very high reliability power supplies. When used in conjunction with secondary-side synchronous rectification, power-supply efficiencies can easily reach 92% for a +3.3V output power supply operated from a 48V bus. The integrated high- and low-side gate drivers provide more than 2A of peak gate drive current to two external N-channel MOSFETs. Low startup current reduces the power loss across the bootstrap resistor. A feedforward voltage-mode topology provides excellent line rejection while avoiding the pitfalls of traditional current-mode control.

The MAX5051 power-supply controller is primary as well as secondary-side parallelable, allowing the design of scaleableable power systems when necessary. When paralleling the primary side, dedicated pins allow for simultaneous wake-up or shutdown of all paralleled units, thus avoiding any one unit current-hogging during startup or fault conditions.

The MAX5051 generates a lookahead signal for driving secondary-side synchronous MOSFETs. Special primary-side synchronization inputs/outputs allow two primaries to be operated 180° out of phase for increased output power and lower input ripple currents.

The MAX5051 is available in a 28-pin TSSOP-EP package and operates over a wide temperature range of -40°C to +125°C.

Applications

High-Efficiency Isolated Telecom/Datacom Power Supplies

48V and 12V Server Power Supplies

48V Power-Supply Modules

42V Automotive Power Systems

Industrial Power Supplies

Features

- ♦ **Wide Input Voltage Range, 11V to 76V**
- ♦ **Voltage Mode With Input Voltage Feed-Forward**
- ♦ **Ripple-Phased Parallel Topology Compatible For High Current/Power Output**
- ♦ **2A Integrated High- and Low-Side MOSFET Drivers**
- ♦ **SYNCIN And SYNCOUT Pins Enable 180° Out Of Phase Operation**
- ♦ **Programmable Brownout and Bootstrap UVLOs**
- ♦ **High-Side Driver Bootstrap Capacitor Pre-Charge Driver**
- ♦ **Low Current-Limit Threshold For High Efficiency**
- ♦ **Programmable Switching Frequency**
- ♦ **Reference Voltage Soft-Start For Startup Without Overshoots**
- ♦ **Startup Synchronization With Multiple Paralleled Primaries**
- ♦ **Programmable Integrating Current-Limit Fault Protection**
- ♦ **Look-Ahead PWM Signal For Secondary-side Synchronous Rectifier Drivers**
- ♦ **Look-Ahead Drivers For Either High-Speed Optocouplers or Pulse Transformer**
- ♦ **Wide -40°C to +125°C Operating Range**
- ♦ **Thermally Enhanced 28-Pin TSSOP Package**

Ordering Information

PART	TEMP RANGE	PIN-PACKAGE
MAX5051AUI	-40°C to +125°C	28-TSSOP-EP*

**EP = Exposed pad.*

Pin Configuration appears at end of data sheet.

For pricing, delivery, and ordering information, please contact Maxim/Dallas Direct! at 1-888-629-4642, or visit Maxim's website at www.maxim-ic.com.

Parallelable, Clamped Two-Switch Power-Supply Controller IC

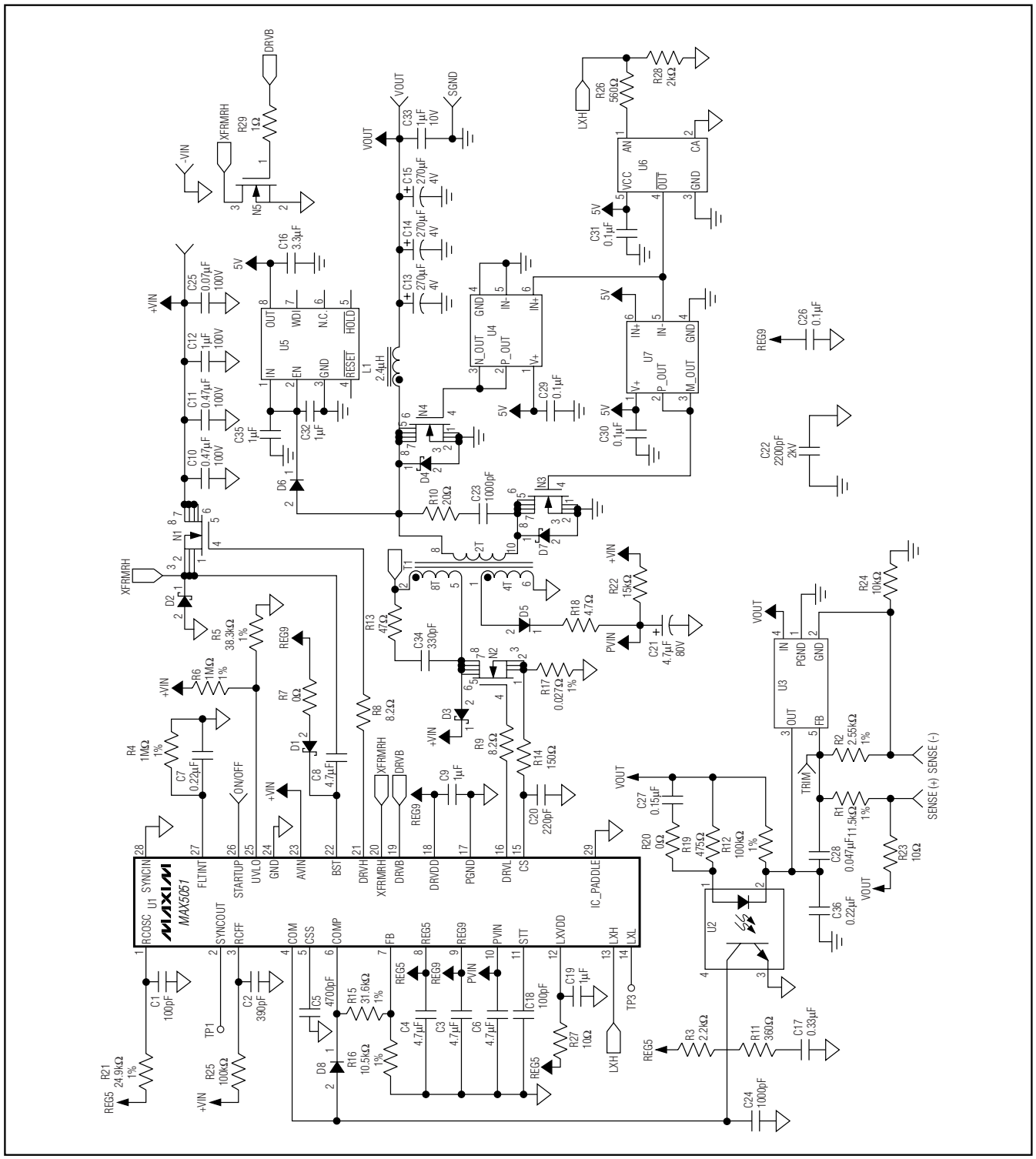


Figure 8. Schematic Of A 48V Input 3.3V at 15A Output Synchronously Rectified, Isolated Power Supply

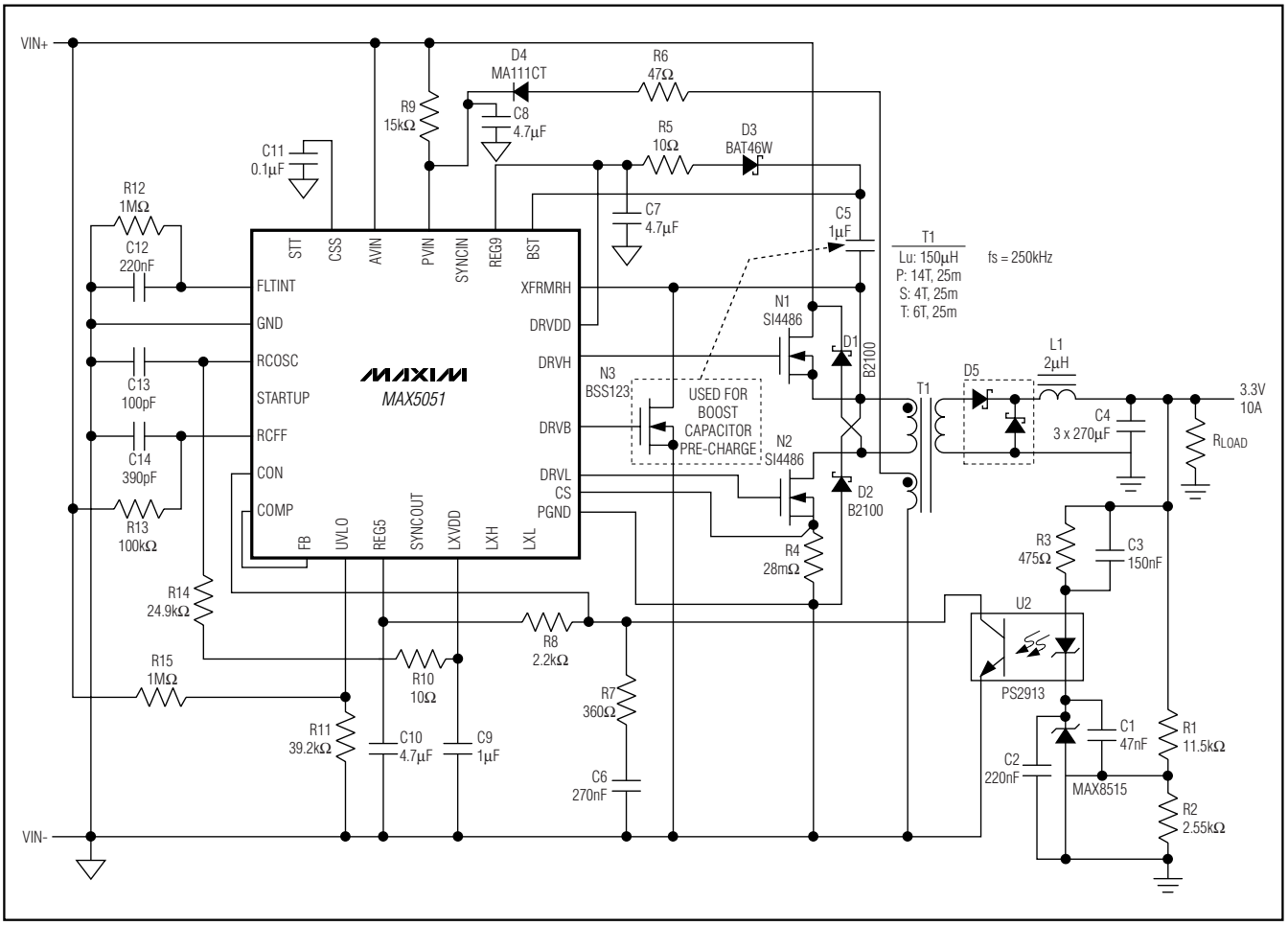


Figure 2. Typical Application Circuit

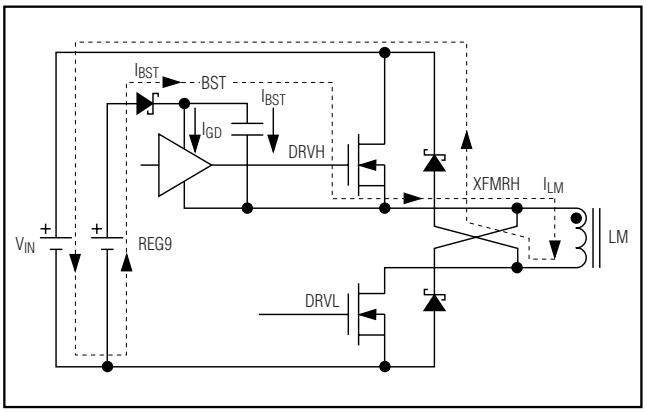


Figure 3. Boost Capacitor Charging Path During Transformer Reset

19-2419; Rev 2; 5/03

7.6A, 12ns, SOT23 MOSFET Driver

General Description

The MAX5048A/MAX5048B are high-speed MOSFET drivers capable of sinking/sourcing 7.6A/1.3A peak currents. These devices take logic input signals and drive a large external MOSFET. The MAX5048A/MAX5048B have inverting and noninverting inputs that give the user greater flexibility in controlling the MOSFET. They feature two separate outputs working in complementary mode, offering flexibility in controlling both turn-on and turn-off switching speeds.

The MAX5048A/MAX5048B have internal logic circuitry, which prevents shoot-through during output state changes. The logic inputs are protected against voltage spikes up to +14V, regardless of V+ voltage. Propagation delay time is minimized and matched between the inverting and noninverting inputs. The MAX5048A/MAX5048B have very fast switching times combined with very short propagation delays (12ns typ), making them ideal for high-frequency circuits.

The MAX5048A/MAX5048B operate from a +4V to +12.6V single power supply and typically consume 0.95mA of supply current. The MAX5048A has CMOS input logic levels, while the MAX5048B has standard TTL input logic levels. These devices are available in a space-saving 6-pin SOT23 package.

Applications

Power MOSFET Switching

Switch-Mode Power Supplies

DC-DC Converters

Motor Control

Power-Supply Modules

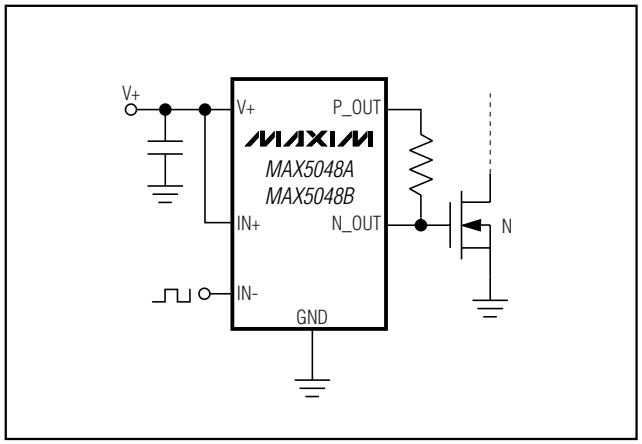
Features

- **Independent Source-and-Sink Outputs for Controllable Rise and Fall Times**
- **+4V to +12.6V Single Power Supply**
- **7.6A/1.3A Peak Sink/Source Drive Current**
- **0.23Ω Open-Drain N-Channel Sink Output**
- **2Ω Open-Drain P-Channel Source Output**
- **12ns (typ) Propagation Delay**
- **Matching Delay Time Between Inverting and Noninverting Inputs**
- **V_{CC}/2 CMOS (MAX5048A)/TTL (MAX5048B) Logic Inputs**
- **1.6V Input Hysteresis**
- **Up to +14V Logic Inputs (Regardless of V+ Voltage)**
- **Low Input Capacitance: 2.5pF (typ)**
- **-40°C to +125°C Operating Temperature Range**
- **6-Pin SOT23 Package**

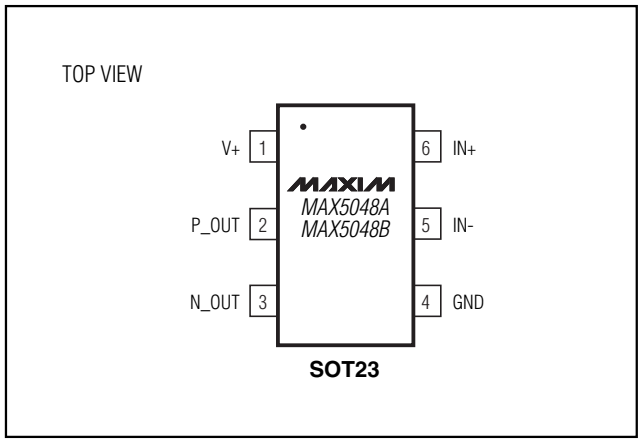
Ordering Information

PART	TEMP RANGE	PIN-PACKAGE	LOGIC INPUT	TOP MARK
MAX5048AAUT-T	-40°C to +125°C	6 SOT23-6	V_{CC}/2 CMOS	ABEC
MAX5048BAUT-T	-40°C to +125°C	6 SOT23-6	TTL	ABED

Typical Operating Circuit



Pin Configuration



For pricing, delivery, and ordering information, please contact Maxim/Dallas Direct! at 1-888-629-4642, or visit Maxim's website at www.maxim-ic.com.

7.6A, 12ns, SOT23 MOSFET Driver

- In a multilayer PC board, the component surface layer surrounding the MAX5048A/MAX5048B should consist of a GND plane containing the discharging and charging current loops.

Chip Information

TRANSISTOR COUNT: 676

PROCESS: BiCMOS

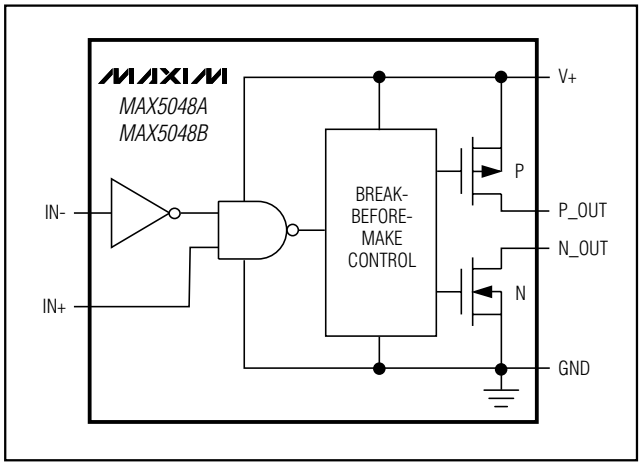


Figure 2. MAX5048A/MAX5048B Functional Diagram

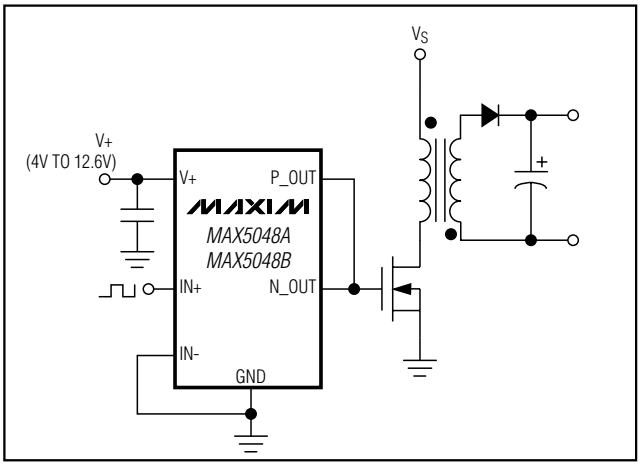


Figure 3. Noninverting Application

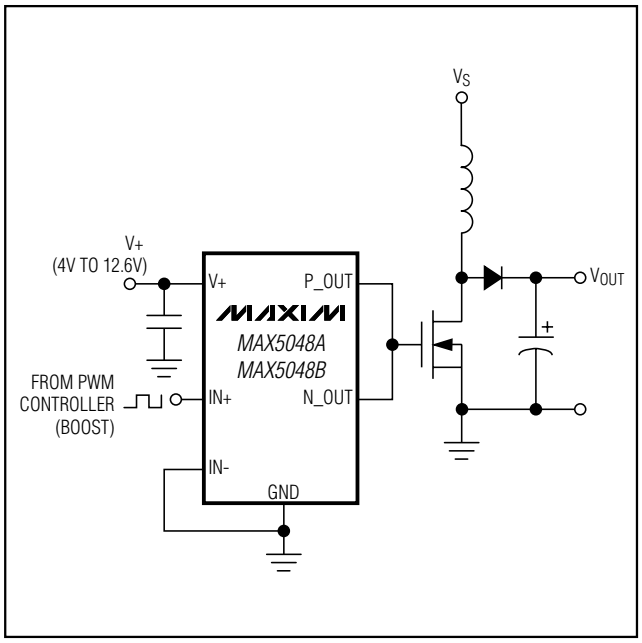


Figure 4. Boost Converter

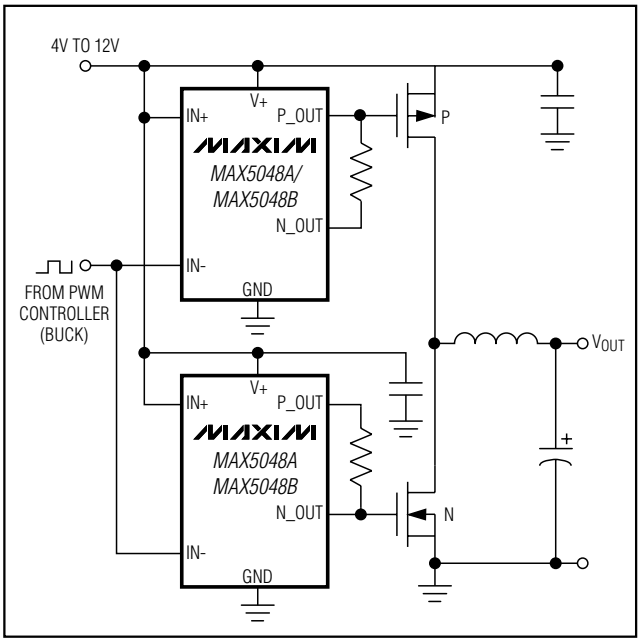


Figure 5. MAX5048A/MAX5048B in High-Power Synchronous Buck Converter

19-2619; Rev 0; 10/02

MAXIM

65V, Low-Quiescent-Current, High-Voltage Linear Regulators with µP Reset and Watchdog Timer

General Description

The MAX5023/MAX5024 high-voltage linear regulators operate from a +6.5V to +65V input voltage and deliver up to 150mA of output current. These devices consume only 60µA of quiescent current with no load and withstand a -60V reverse-battery voltage at the input. The MAX5023/MAX5024 include an active-low internal microprocessor (µP) reset circuit that asserts when the regulator output drops below the preset output voltage threshold by 7.5% or 12.5%, depending on the device selected. Both devices are available with a fixed +3.3V or +5V output. These devices are short-circuit protected and include thermal shutdown.

In addition to an enable input to turn on or off the regulator, the MAX5023/MAX5024 include a $\overline{HOLD}$ input that allows for the implementation of a self-holding circuit without requiring external components. Setting $\overline{HOLD}$ low after enabling the regulator, forces the regulator to remain on even if EN is subsequently set low. Releasing $\overline{HOLD}$ shuts down the regulator.

The MAX5023 includes a watchdog input that monitors a pulse train from the µP and generates reset pulses if the watchdog input remains high or low for a duration longer than the 1.6s watchdog timeout period. The MAX5024 includes a SET input which, when connected to ground, selects a preset output voltage of +3.3V (MAX5024S/MAX5024T) or +5V (MAX5024L/MAX5024M). Set the adjustable output voltage by connecting SET to the regulator's output through a resistive-divider network.

The MAX5023/MAX5024 operate over the automotive temperature range (-40°C to +125°C) and are available in a thermally enhanced, surface-mount 8-pin SO package.

Applications

Automotive
Industrial
Home Security
Fire/Smoke Alarms
Telecom/Networking

Features

- **Wide Operating Input Voltage Range +6.5V to +65V**
- **Thermally Enhanced 8-Pin SO Package Dissipates 1.5W**
- **Guaranteed 150mA Output Current**
- **60µA No-Load Supply Current**
- **-60V Reverse-Battery Protection**
- **Preset +3.3V or +5.0V Output Voltage**
- **Thermal and Short-Circuit Protection**
- **Operate Over -40°C to +125°C Temperature Range**
- **Integrated µP Reset Circuit**
- **Watchdog Timer with 1.6s Timeout Period (MAX5023)**
- **Regulator Enable and Hold Inputs Implement Self-Holding Circuit**
- **SET Input for Adjustable Output Voltage (MAX5024)**

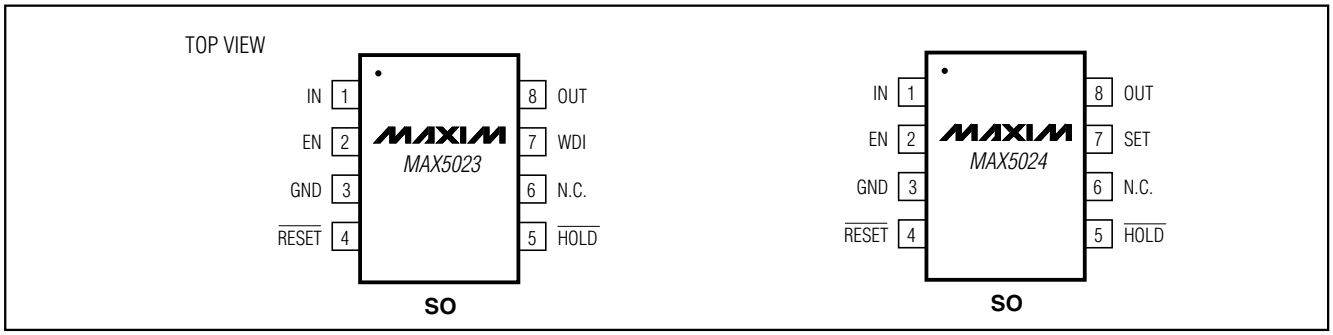
Ordering Information

PART	TEMP RANGE	PIN-PACKAGE
MAX5023 _ ASA	-40°C to +125°C	8 SO
MAX5024 _ ASA	-40°C to +125°C	8 SO

Note: *These parts offer a choice of reset thresholds, reset threshold tolerances, and regulator output voltages. From the Selector Guide, insert the desired suffix letter into the blank to complete the part number.*

Selector Guide and Typical Operating Circuit appear at end of data sheet.

Pin Configurations



For pricing, delivery, and ordering information, please contact Maxim/Dallas Direct! at 1-888-629-4642, or visit Maxim's website at www.maxim-ic.com.

Example 1:

T_A = +95°C

V_{IN} = +14V

V_{OUT} = +5V

Find the maximum allowable output current. First calculate package dissipation at the given temperature as follows:

$$P_D = 1.538W - (0.01923W/°C)(95°C - 70°C) = 1.057W$$

Then determine the maximum output current:

$$I_{OUT(MAX)} = \frac{(1.057W)}{(14V)-(5V)} = 117.4mA$$

Example 2:

T_A = +125°C

V_{IN} = +14V

V_{OUT} = +3.3V

Calculate package dissipation at the given temperature as follows:

$$P_D = 1.538W - (0.01923W/°C)(125°C - 70°C) = 480.4mW$$

And establish the maximum current:

$$I_{OUT(MAX)} = \frac{(480.4mW)}{(14V)-(3.3V)} = 44.89mA$$

Example 3:

T_A = +50°C

V_{IN} = +14V

V_{OUT} = +5V

Calculate package dissipation at the given temperature as follows:

$$P_D = 1.538W$$

And find the maximum output current:

$$I_{OUT(MAX)} = \frac{(1.538W)}{(14V)-(5V)} = 170.9mA \Rightarrow I_{OUT(MAX)} = 150mA$$

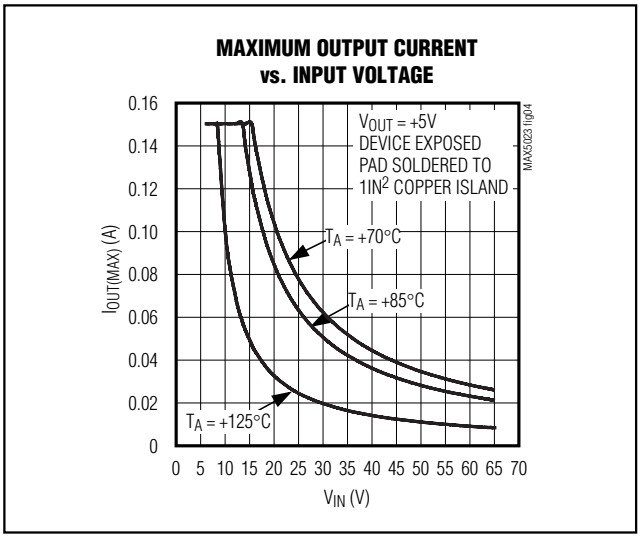


Figure 6. Maximum Output Current vs. Input Voltage

In Example 3, the maximum output current is calculated as 170.9mA, however, the maximum output current cannot exceed 150mA. Use Figure 6 to quickly determine allowable maximum output current for selected ambient temperatures.

Capacitor Selection and Regulator Stability

For stable operation over the full temperature range and with load currents up to 150mA, use a 15µF (min) output capacitor with an ESR < 0.5Ω. To reduce noise and improve load-transient response, stability, and power-supply rejection, use larger output capacitor values such as 22µF.

Some ceramic dielectrics exhibit large capacitance and ESR variation with temperature. For dielectric capacitors such as Z5U and Y5V, use 22µF or more to ensure stability at temperatures below -10°C. With X7R or X5R dielectrics, 15µF should be sufficient at all operating temperatures. For high-ESR tantalum capacitors use 22µF or more to maintain stability. To improve power-supply rejection and transient response use a minimum 10µF capacitor between IN and GND.