



# Single/Dual, 16ns, High Sink/Source Current Gate Drivers

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## General Description

The MAX15024/MAX15025 single/dual, high-speed MOSFET gate drivers are capable of operating at frequencies up to 1MHz with large capacitive loads. The MAX15024 includes internal source-and-sink output transistors with independent outputs allowing for control of the external MOSFET's rise and fall time. The MAX15024 is a single gate driver capable of sinking an 8A peak current and sourcing a 4A peak current. The MAX15025 is a dual gate driver capable of sinking a 4A peak current and sourcing a 2A peak current. An integrated adjustable LDO voltage regulator provides gate-drive amplitude control and optimization.

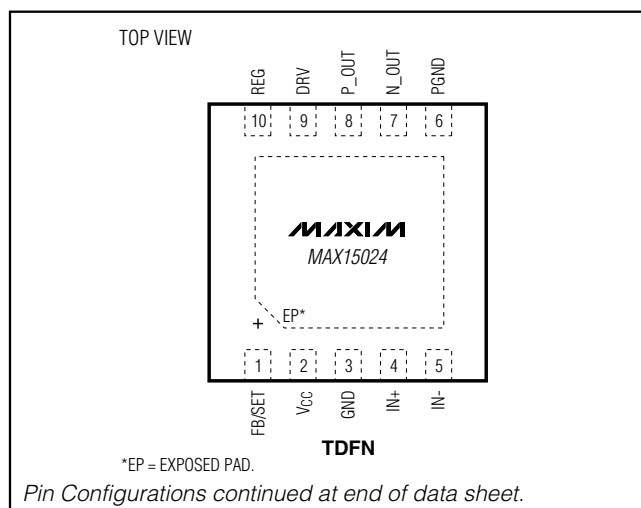
The MAX15024A/C and MAX15025A/C/E/G accept transistor-to-transistor (TTL) input logic levels while the MAX15024B/D and MAX15025B/D/F/H accept CMOS-input logic levels. High sourcing/sinking peak currents, a low propagation delay, and thermally enhanced packages make the MAX15024/MAX15025 ideal for high-frequency and high-power circuits. The MAX15024/MAX15025 operate from a 4.5V to 28V supply. A separate output driver supply input enhances flexibility and permits a soft-start of the power MOSFETs used in synchronous rectifiers.

The MAX15024/MAX15025 are available in 10-pin TDFN packages and are specified over the -40°C to +125°C automotive temperature range.

## Applications

Synchronous Rectifier Drivers  
Power-Supply Modules  
Switching Power Supply

## Pin Configurations



## Features

- ◆ 8A Peak Sink Current/4A Peak Source Current (MAX15024)
- ◆ 4A Peak Sink Current/2A Peak Source Current (MAX15025)
- ◆ Low 16ns Propagation Delay
- ◆ 4.5V to 28V Supply Voltage Range
- ◆ On-Board Adjustable LDO for Gate-Drive Amplitude Control and Optimization
- ◆ Separate Output Driver Supply
- ◆ Independent Source and Sink Outputs (MAX15024)
- ◆ Matched Delays Between Inverting and Noninverting Inputs (MAX15024)
- ◆ Matched Delays Between Channels (MAX15025)
- ◆ CMOS or TTL Logic-Level Inputs with Hysteresis for Noise Immunity
- ◆ -40°C to +125°C Operating Temperature Range
- ◆ Thermal-Shutdown Protection
- ◆ 1.95W Thermally Enhanced TDFN Power Packages

## Ordering Information

PART	PIN-PACKAGE	PKG CODE	TOP MARK
MAX15024AATB+T*	10 TDFN-EP**	T1033-1	ATX
MAX15024BATB+T	10 TDFN-EP**	T1033-1	ATY
MAX15024CATB+T*	10 TDFN-EP**	T1033-1	—
MAX15024DATB+T*	10 TDFN-EP**	T1033-1	—
MAX15025AATB+T	10 TDFN-EP**	T1033-1	ATZ
MAX15025BATB+T*	10 TDFN-EP**	T1033-1	AUA
MAX15025CATB+T*	10 TDFN-EP**	T1033-1	AUB
MAX15025DATB+T*	10 TDFN-EP**	T1033-1	AUC
MAX15025EATB+T*	10 TDFN-EP**	T1033-1	—
MAX15025FATB+T*	10 TDFN-EP**	T1033-1	—
MAX15025GATB+T*	10 TDFN-EP**	T1033-1	—
MAX15025HATB+T*	10 TDFN-EP**	T1033-1	—

**Note:** All devices are specified over the -40°C to +125°C operating temperature range.

+Denotes a lead-free package.

\*Future product—contact factory for availability.

\*\*EP = Exposed pad. T = Tape and reel.

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

**Block Diagrams appear at end of data sheet.**



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For pricing, delivery, and ordering information, please contact Maxim Direct at 1-888-629-4642, or visit Maxim's website at [www.maxim-ic.com](http://www.maxim-ic.com).

MAX15024/MAX15025

# Single/Dual, 16ns, High Sink/Source Current Gate Drivers

## ABSOLUTE MAXIMUM RATINGS

V <sub>CC</sub> to GND	-0.3V to +30V
REG to GND	-0.3V to the lower of +22V or (V <sub>CC</sub> + 0.3V)
DRV to PGND	-0.3V to +22V
IN <sub>-</sub>	-0.3V to +22V
FB/SET to GND	-0.3V to +6V
P_OUT to DRV	-22V to +0.3V
N_OUT to PGND	-0.3V to +22V
OUT1, OUT2 to PGND	-0.3V to (V <sub>DRV</sub> + 0.3V)
PGND to GND	-0.3V to +0.3V
P_OUT, N_OUT Continuous Source/Sink Current*	200mA
OUT1, OUT2 Continuous Source/Sink Current*	200mA

Continuous Power Dissipation (T <sub>A</sub> = +70°C)	
10-Pin TDFN, Single-Layer Board (derate 18.5mW/°C above +70°C)	1481.5mW
Junction-to-Case Thermal Resistance	8.5°C/W
10-Pin TDFN, Multilayer Board (derate 24.4mW/°C above +70°C)	1951.2mW
Junction-to-Case Thermal Resistance	8.5°C/W
Operating Temperature Range	-40°C to +125°C
Junction Temperature	+150°C
Storage Temperature Range	-65°C to +150°C
Lead Temperature (soldering, 10s)	+300°C

\*Continuous output current is limited by the power dissipation of the package.

Stresses beyond those listed under "Absolute Maximum Ratings" may cause permanent damage to the device. These are stress ratings only, and functional operation of the device at these or any other conditions beyond those indicated in the operational sections of the specifications is not implied. Exposure to absolute maximum rating conditions for extended periods may affect device reliability.

## MAX15024 ELECTRICAL CHARACTERISTICS

(V<sub>CC</sub> = V<sub>DRV</sub> = V<sub>REG</sub> = 10V, FB/SET = GND, T<sub>A</sub> = T<sub>J</sub> = -40°C to +125°C, unless otherwise noted. Typical values are at T<sub>A</sub> = T<sub>J</sub> = +25°C). (Note 1)

PARAMETER	SYMBOL	CONDITIONS	MIN	TYP	MAX	UNITS
<b>SYSTEM SPECIFICATIONS</b>						
Input Voltage Range	V <sub>CC</sub>	V <sub>CC</sub> powered only, V <sub>REG</sub> = V <sub>DRV</sub> decoupled with minimum 1μF to GND	MAX15024B/D	6.5	28.0	V
			MAX15024A/C	4.5	28.0	
		V <sub>CC</sub> = V <sub>REG</sub> = V <sub>DRV</sub> (MAX15024D)		6.5	18.0	
		V <sub>CC</sub> = V <sub>REG</sub> = V <sub>DRV</sub> (MAX15024C)		4.5	18.0	
V <sub>DRV</sub> Turn-On Voltage	V <sub>DRV_ON</sub>	V <sub>CC</sub> = V <sub>REG</sub> = 10V, IN+ = V <sub>CC</sub> , IN- = GND		1.7	2.3	V
Quiescent Supply Current		IN <sub>-</sub> = V <sub>CC</sub> or GND		700	1350	μA
Quiescent Supply Current Under UVLO Condition		IN <sub>-</sub> = V <sub>CC</sub> or GND		250		μA
Switching Supply Current		Switching at 250kHz, C <sub>L</sub> = 0		1.5	3.0	mA
V <sub>CC</sub> Undervoltage Lockout	UVLO_ V <sub>CC</sub>	V <sub>CC</sub> rising	3.0	3.4	3.8	V
V <sub>CC</sub> Undervoltage-Lockout Hysteresis				300		mV
V <sub>CC</sub> Undervoltage Lockout to Output Delay		V <sub>CC</sub> rising		100		μs
		V <sub>CC</sub> falling		2		
<b>REG REGULATOR (V<sub>CC</sub> = 12V, REG = V<sub>DRV</sub>, C<sub>L</sub> = 1μF, FB/SET = GND)</b>						
Output Voltage	V <sub>REG</sub>	12V < V <sub>CC</sub> < 28V, 0 < I <sub>LOAD</sub> < 10mA	9	10	11	V
Dropout Voltage	V <sub>R-DO</sub>	V <sub>CC</sub> = 6.5V, I <sub>LOAD</sub> = 100mA		0.4	0.9	V
		V <sub>CC</sub> = 4.5V, I <sub>LOAD</sub> = 50mA		0.2	0.5	
Load Regulation		V <sub>CC</sub> = 12V, I <sub>LOAD</sub> = 0 to 100mA		1		%
Line Regulation		12V < V <sub>CC</sub> < 28V		10		mV
FB/SET Reference Voltage		External resistive divider connected at FB/SET	1.10	1.23	1.35	V
FB/SET Threshold		V <sub>FB</sub> falling		220		mV
FB/SET Input Leakage Current		V <sub>FB</sub> = 5.5V (Note 2)	-125		+125	nA

# Single/Dual, 16ns, High Sink/Source Current Gate Drivers

MAX15024/MAX15025

## MAX15024 ELECTRICAL CHARACTERISTICS (continued)

( $V_{CC} = V_{DRV} = V_{REG} = 10V$ ,  $FB/SET = GND$ ,  $T_A = T_J = -40^{\circ}C$  to  $+125^{\circ}C$ , unless otherwise noted. Typical values are at  $T_A = T_J = +25^{\circ}C$ ). (Note 1)

PARAMETER	SYMBOL	CONDITIONS	MIN	TYP	MAX	UNITS
<b>DRIVER OUTPUT (SINK)</b>						
Driver Output Resistance	R <sub>ON-N</sub>	V <sub>CC</sub> = V <sub>REG</sub> = V <sub>DRV</sub> = 10V, sinking 100mA	T <sub>A</sub> = +25°C	0.45	0.60	Ω
			T <sub>A</sub> = +125°C	0.625	0.850	
		V <sub>CC</sub> = V <sub>REG</sub> = V <sub>DRV</sub> = 4.5V, sinking 100mA (MAX15024C/D)	T <sub>A</sub> = +25°C	0.50	0.65	
			T <sub>A</sub> = +125°C	0.7	0.9	
Peak Output Current	I <sub>PK-N</sub>	N <sub>OUT</sub> = 10V		8		A
Maximum Load Capacitance		SOA condition: C <sub>L</sub> × V <sub>DRV</sub> <sup>2</sup> ≤ 20μJ, for V <sub>DRV</sub> = 10V		200		nF
Latchup Robustness				500		mA
<b>DRIVER OUTPUT (SOURCE)</b>						
Driver Output Resistance	R <sub>ON-P</sub>	V <sub>CC</sub> = V <sub>REG</sub> = V <sub>DRV</sub> = 10V, sourcing 100mA	T <sub>A</sub> = +25°C	0.875	1.500	Ω
			T <sub>A</sub> = +125°C	1.2	2.0	
		V <sub>CC</sub> = V <sub>REG</sub> = V <sub>DRV</sub> = 4.5V, sourcing 100mA (MAX15024C/D)	T <sub>A</sub> = +25°C	0.95	1.65	
			T <sub>A</sub> = +125°C	1.25	2.20	
Peak Output Current	I <sub>PK-P</sub>	P <sub>OUT</sub> = 0V		4		A
Latchup Robustness				500		mA
<b>LOGIC INPUTS</b>						
Logic 1 Input Voltage	V <sub>IH</sub>	MAX15024A/C	2.0			V
		MAX15024B/D	4.25			
Logic 0 Input Voltage	V <sub>IL</sub>	MAX15024A/C			0.8	V
		MAX15024B/D			2	
Logic Input Hysteresis		MAX15024A/C		0.4		V
		MAX15024B/D		1		
Logic Input Current Leakage		V <sub>IN</sub> = 18V or GND	-75	0.01	+75	μA
Input Capacitance				10		pF
<b>SWITCHING CHARACTERISTICS FOR V<sub>CC</sub> = V<sub>DRV</sub> = V<sub>REG</sub> = 10V, P<sub>OUT</sub> AND N<sub>OUT</sub> ARE CONNECTED TOGETHER (see Figure 1)</b>						
Rise Time	t <sub>R</sub>	C <sub>LOAD</sub> = 1nF		3		ns
		C <sub>LOAD</sub> = 5nF		12		
		C <sub>LOAD</sub> = 10nF		24		
Fall Time	t <sub>F</sub>	C <sub>LOAD</sub> = 1nF		3		ns
		C <sub>LOAD</sub> = 5nF		8		
		C <sub>LOAD</sub> = 10nF		16		
Turn-On Delay Time	t <sub>D-ON</sub>	C <sub>LOAD</sub> = 1nF (Note 2)	8	16	32	ns
Turn-Off Delay Time	t <sub>D-OFF</sub>	C <sub>LOAD</sub> = 1nF (Note 2)	8	16	32	ns
Mismatch Propagation Delays from Inverting and Noninverting Inputs to Output		C <sub>LOAD</sub> = 1nF		1		ns

# Single/Dual, 16ns, High Sink/Source Current Gate Drivers

## MAX15024 ELECTRICAL CHARACTERISTICS (continued)

( $V_{CC} = V_{DRV} = V_{REG} = 10V$ ,  $FB/SET = GND$ ,  $T_A = T_J = -40^{\circ}C$  to  $+125^{\circ}C$ , unless otherwise noted. Typical values are at  $T_A = T_J = +25^{\circ}C$ ). (Note 1)

PARAMETER	SYMBOL	CONDITIONS	MIN	TYP	MAX	UNITS
<b>SWITCHING CHARACTERISTICS FOR <math>V_{CC} = V_{DRV} = V_{REG} = 4.5V</math> (see Figure 1) (MAX15024C/D)</b>						
Rise Time	$t_R$	$C_{LOAD} = 1nF$		3		ns
		$C_{LOAD} = 5nF$		11		
		$C_{LOAD} = 10nF$		22		
Fall Time	$t_F$	$C_{LOAD} = 1nF$		2.5		ns
		$C_{LOAD} = 5nF$		8		
		$C_{LOAD} = 10nF$		16		
Turn-On Delay Time	$t_{D-ON}$	$C_{LOAD} = 1nF$		18		ns
Turn-Off Delay Time	$t_{D-OFF}$	$C_{LOAD} = 1nF$		18		ns
Mismatch Propagation Delays from Inverting and Noninverting Inputs to Output		$C_{LOAD} = 1nF$		2		ns
Minimum Input Pulse Width that Changes the Output	$t_{PW}$			15		ns
<b>THERMAL CHARACTERISTICS</b>						
Thermal-Shutdown Temperature		Temperature rising		+160		$^{\circ}C$
Thermal-Shutdown Temperature Hysteresis				15		$^{\circ}C$

## MAX15025 ELECTRICAL CHARACTERISTICS

( $V_{CC} = V_{DRV} = V_{REG} = 10V$ ,  $FB/SET = GND$ ,  $T_A = T_J = -40^{\circ}C$  to  $+125^{\circ}C$ , unless otherwise noted. Typical values are at  $T_A = T_J = +25^{\circ}C$ ). (Note 1)

PARAMETER	SYMBOL	CONDITIONS	MIN	TYP	MAX	UNITS
<b>SYSTEM SPECIFICATIONS</b>						
Input Voltage Range	$V_{CC}$	$V_{CC}$ powered only, $V_R = V_{DRV}$ decoupled with minimum $1\mu F$ to GND	MAX15025B/D/F/H	6.5	28	V
			MAX15025A/C/E/G	4.5	28	
		$V_{CC} = V_{REG} = V_{DRV}$ (MAX15025F/H)	6.5	18.0		
		$V_{CC} = V_{REG} = V_{DRV}$ (MAX15025E/G)	4.5	18.0		
$V_{DRV}$ Turn-On Voltage	$V_{DRV\_ON}$	$V_{CC} = V_{REG} = 10V$ , $IN1 = V_{CC}$ , $IN2 = V_{CC}$ (MAX15025A/B/E/F) or GND for (MAX15025C/D/G/H)		1.7	2.3	V
Quiescent Supply Current		$IN_- = V_{CC}$ or GND		700	1350	$\mu A$
Quiescent Supply Current Under UVLO Condition		$IN_- = V_{CC}$ or GND		250		$\mu A$
Switching Supply Current		Switching at 250kHz, $C_L = 0$		1.5	3.0	mA
$V_{CC}$ Undervoltage Lockout	UVLO_ $V_{CC}$	$V_{CC}$ rising	3.0	3.4	3.8	V

# Single/Dual, 16ns, High Sink/Source Current Gate Drivers

**MAX15024/MAX15025**

## MAX15025 ELECTRICAL CHARACTERISTICS (continued)

( $V_{CC} = V_{DRV} = V_{REG} = 10V$ ,  $FB/SET = GND$ ,  $T_A = T_J = -40^{\circ}C$  to  $+125^{\circ}C$ , unless otherwise noted. Typical values are at  $T_A = T_J = +25^{\circ}C$ ). (Note 1)

PARAMETER	SYMBOL	CONDITIONS	MIN	TYP	MAX	UNITS
V <sub>CC</sub> Undervoltage-Lockout Hysteresis				300		mV
V <sub>CC</sub> Undervoltage Lockout to Output Delay		V <sub>CC</sub> rising		100		μs
		V <sub>CC</sub> falling		2		
<b>REG REGULATOR (V<sub>CC</sub> = 12V, V<sub>REG</sub> = V<sub>DRV</sub>, C<sub>L</sub> = 1μF, FB/SET = GND)</b>						
Output Voltage	V <sub>REG</sub>	12V < V <sub>CC</sub> < 28V, 0 < I <sub>LOAD</sub> < 10mA	9	10	11	V
Dropout Voltage	V <sub>R-DO</sub>	V <sub>CC</sub> = 6.5V, I <sub>LOAD</sub> = 100mA		0.4	0.9	V
		V <sub>CC</sub> = 4.5V, I <sub>LOAD</sub> = 50mA		0.2	0.5	
Load Regulation		V <sub>CC</sub> = 12V, I <sub>LOAD</sub> = 0 to 100mA		1		%
Line Regulation		12V < V <sub>CC</sub> < 28V		10		mV
FB/SET Reference Voltage		External resistive divider connected at FB/SET	1.10	1.23	1.35	V
FB/SET Threshold		V <sub>FB</sub> rising		220		mV
FB/SET Input Leakage Current		V <sub>FB</sub> = 5.5V	-125		+125	nA
<b>DRIVER OUTPUT SINK</b>						
Driver Output Resistance	R <sub>ON-N</sub>	V <sub>CC</sub> = V <sub>REG</sub> = V <sub>DRV</sub> = 10V, sinking 100mA	T <sub>A</sub> = +25°C	1.0	1.6	Ω
			T <sub>A</sub> = +125°C	1.25	2.10	
		V <sub>CC</sub> = V <sub>REG</sub> = V <sub>DRV</sub> = 4.5V, sinking 100mA (MAX15025E/F/G/H)	T <sub>A</sub> = +25°C	1.10	1.65	
			T <sub>A</sub> = +125°C	1.5	2.2	
Peak Output Current	I <sub>PK-N</sub>	OUT <sub>-</sub> = 10V		4		A
Maximum Load Capacitance		SOA condition: C <sub>L</sub> × V <sub>DRV</sub> <sup>2</sup> ≤ 20μJ, for V <sub>DRV</sub> = 10V		100		nF
Latchup Robustness				500		mA
<b>DRIVER OUTPUT SOURCE</b>						
Driver Output Resistance	R <sub>ON-P</sub>	V <sub>CC</sub> = V <sub>REG</sub> = V <sub>DRV</sub> = 10V, sourcing 100mA	T <sub>A</sub> = +25°C	1.75	2.50	Ω
			T <sub>A</sub> = +125°C	2.25	3.50	
		V <sub>CC</sub> = V <sub>REG</sub> = V <sub>DRV</sub> = 4.5V, sourcing 100mA (MAX15025E/F/G/H)	T <sub>A</sub> = +25°C	1.85	2.60	
			T <sub>A</sub> = +125°C	2.50	3.75	
Peak Output Current	I <sub>PK-P</sub>	OUT <sub>-</sub> = 0V		2		A
Latchup Robustness				500		mA
<b>LOGIC INPUTS</b>						
Logic 1 Input Voltage	V <sub>IH</sub>	MAX15025A/C/E/G	2.0			V
		MAX15025B/D/F/H	4.25			
Logic 0 Input Voltage	V <sub>IL</sub>	MAX15025A/C/E/G			0.8	V
		MAX15025B/D/F/H			2	
Logic Input Hysteresis		MAX15025A/C/E/G		0.4		V
		MAX15025B/D/F/H		1		
Logic Input Current Leakage		V <sub>IN</sub> = 18V or GND	-75	+0.01	+75	μA
Input Capacitance				10		pF

# Single/Dual, 16ns, High Sink/Source Current Gate Drivers

## MAX15025 ELECTRICAL CHARACTERISTICS (continued)

( $V_{CC} = V_{DRV} = V_{REG} = 10V$ ,  $FB/SET = GND$ ,  $T_A = T_J = -40^{\circ}C$  to  $+125^{\circ}C$ , unless otherwise noted. Typical values are at  $T_A = T_J = +25^{\circ}C$ ). (Note 1)

PARAMETER	SYMBOL	CONDITIONS	MIN	TYP	MAX	UNITS
<b>SWITCHING CHARACTERISTICS FOR <math>V_{CC} = V_{DRV} = V_{REG} = 10V</math> (see Figure 1)</b>						
Rise Time	$t_R$	$C_{LOAD} = 1nF$		6		ns
		$C_{LOAD} = 5nF$		24		
		$C_{LOAD} = 10nF$		48		
Fall Time	$t_F$	$C_{LOAD} = 1nF$		5		ns
		$C_{LOAD} = 5nF$		16		
		$C_{LOAD} = 10nF$		32		
Turn-On Delay Time	$t_{D-ON}$	$C_{LOAD} = 1nF$ (Note 2)	8	16	32	ns
Turn-Off Delay Time	$t_{D-OFF}$	$C_{LOAD} = 1nF$ (Note 2)	8	16	32	ns
Mismatch Propagation Delays Between 2 Channels		$C_{LOAD} = 1nF$		1		ns
<b>SWITCHING CHARACTERISTICS FOR <math>V_{CC} = V_{DRV} = V_{REG} = 4.5V</math> (see Figure 1) (MAX15025E/F/G/H)</b>						
Rise Time	$t_R$	$C_{LOAD} = 1nF$		5		ns
		$C_{LOAD} = 5nF$		20		
		$C_{LOAD} = 10nF$		42		
Fall Time	$t_F$	$C_{LOAD} = 1nF$		4		ns
		$C_{LOAD} = 5nF$		15		
		$C_{LOAD} = 10nF$		30		
Turn-On Delay Time	$t_{D-ON}$	$C_{LOAD} = 1nF$		18		ns
Turn-Off Delay Time	$t_{D-OFF}$	$C_{LOAD} = 1nF$		18		ns
Mismatch Propagation Delays Between 2 Channels		$C_{LOAD} = 1nF$		2		ns
Minimum Input Pulse Width that Changes the Output	$t_{PW}$			15		ns
<b>THERMAL CHARACTERISTICS</b>						
Thermal-Shutdown Temperature		Temperature rising		+160		$^{\circ}C$
Thermal-Shutdown Temperature Hysteresis				15		$^{\circ}C$

**Note 1:** All devices are 100% production tested at  $T_A = +25^{\circ}C$ . Limits over temperature are guaranteed by design.

**Note 2:** Design guaranteed by bench characterization. Limits are not production tested.

# Single/Dual, 16ns, High Sink/Source Current Gate Drivers

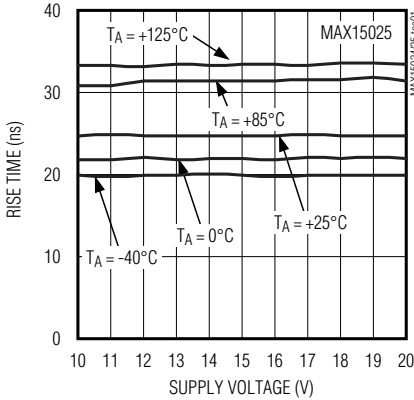
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## Typical Operating Characteristics

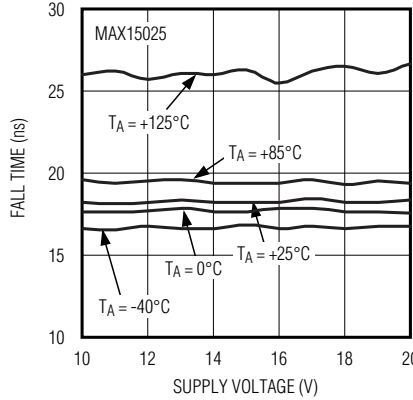
( $T_A = +25^\circ\text{C}$ , unless otherwise noted.)

MAX15024/MAX15025

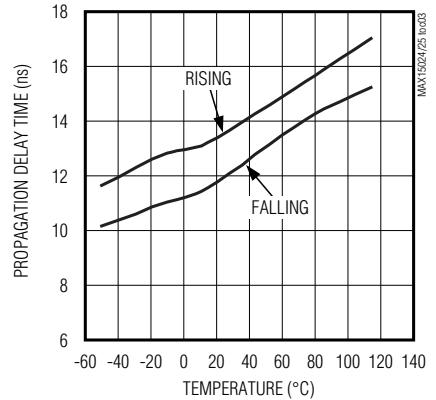
**RISE TIME vs. SUPPLY VOLTAGE  
(DUAL DRIVER WITH 5nF LOAD)**



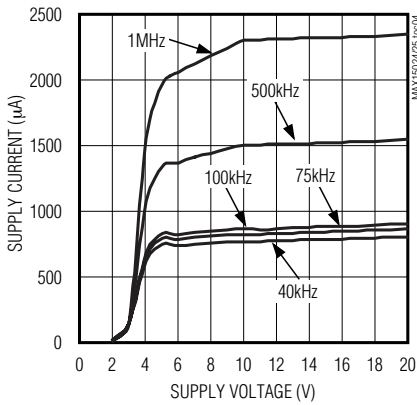
**FALL TIME vs. SUPPLY VOLTAGE  
(WITH 5nF LOAD)**



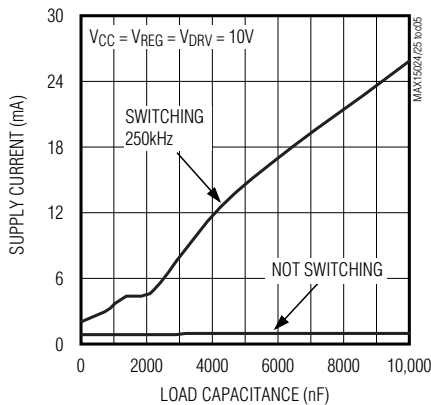
**PROPAGATION DELAY TIME vs. TEMPERATURE (1nF LOAD)**



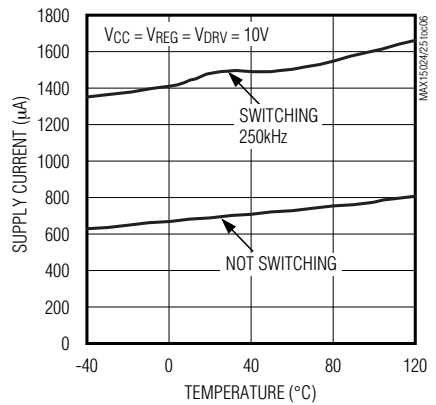
**SUPPLY CURRENT vs. SUPPLY VOLTAGE  
(PROGRAMMED EXTERNALLY TO 5V)**



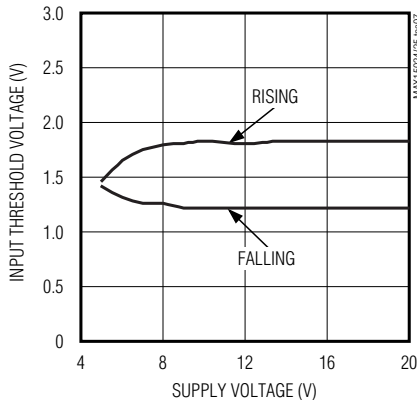
**SUPPLY CURRENT vs. LOAD CAPACITANCE**



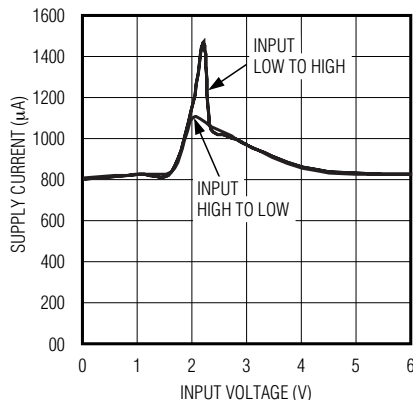
**SUPPLY CURRENT vs. TEMPERATURE**



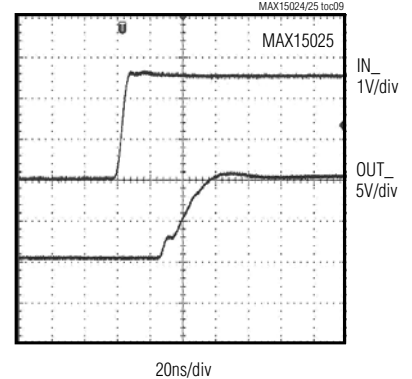
**INPUT THRESHOLD VOLTAGE vs. SUPPLY VOLTAGE (TTL)**



**SUPPLY CURRENT vs. LOGIC IN**



**LOGIC INPUT VOLTAGE vs. OUTPUT VOLTAGE (5nF RISING)**

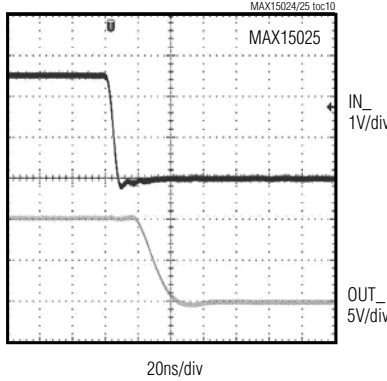


# Single/Dual, 16ns, High Sink/Source Current Gate Drivers

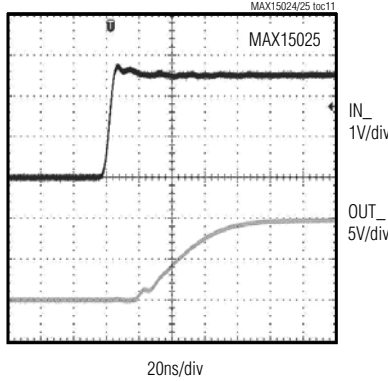
## Typical Operating Characteristics (continued)

(T<sub>A</sub> = +25°C, unless otherwise noted.)

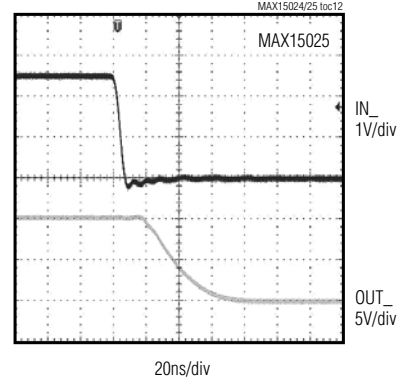
**LOGIC INPUT VOLTAGE vs. OUTPUT VOLTAGE  
(5nF FALLING)**



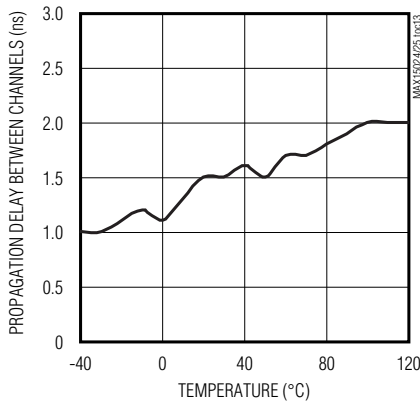
**LOGIC INPUT VOLTAGE vs. OUTPUT VOLTAGE  
(10nF RISING)**



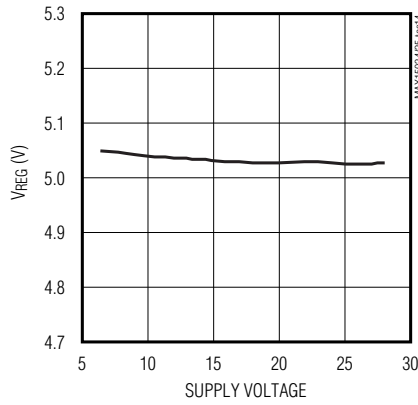
**LOGIC INPUT VOLTAGE vs. OUTPUT VOLTAGE  
(10nF FALLING)**



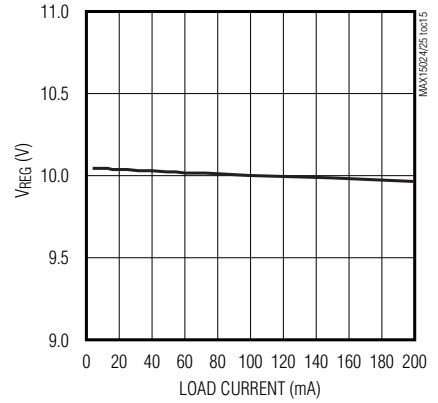
**PROPAGATION DELAY MISMATCH  
vs. TEMPERATURE**



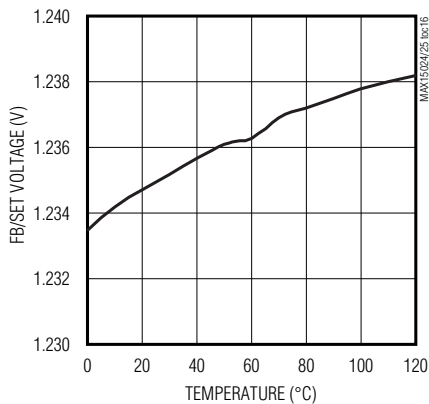
**LINE REGULATION OF V<sub>REG</sub>  
(PROGRAMMED EXTERNALLY TO 5.04V)**



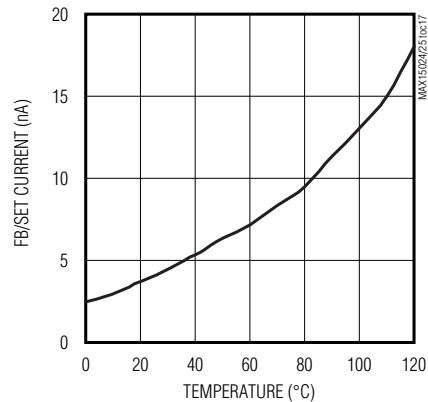
**LOAD REGULATION OF V<sub>REG</sub>**



**FB/SET VOLTAGE  
vs. TEMPERATURE**



**FB/SET CURRENT  
vs. TEMPERATURE**





# Single/Dual, 16ns, High Sink/Source Current Gate Drivers

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## Pin Description

**MAX15024/MAX15025**

MAX15024	PIN		NAME	FUNCTION
	MAX15025A MAX15025B MAX15025E MAX15025F	MAX15025C MAX15025D MAX15025G MAX15025H		
1	1	1	FB/SET	LDO Regulator Output Set. Feedback for V <sub>REG</sub> adjustment (V <sub>FB</sub> > 200mV). Connect FB/SET to GND for a fixed 10V output REG. Connect FB/SET to a resistor ladder to set V <sub>REG</sub> .
2	2	2	V <sub>CC</sub>	Power-Supply Input. Bypass to GND with a low-ESR ceramic capacitor of 1μF. Input of the internal housekeeping regulator and of the main REG regulator.
3	3	3	GND	Signal Ground
4	—	—	IN+	Driver Noninverting Logic Input. Connect to V <sub>CC</sub> when not used.
—	4	4	IN1	Driver 1 Noninverting Logic Input
5	—	—	IN-	Driver Inverting Logic Input. Connect to GND when not used.
—	5	—	IN2	Driver 2 Noninverting Logic Input
—	—	5	IN2	Driver 2 Inverting Logic Input
6	6	6	PGND	Power Ground. Sink current return. Source of the internal pulldown n-channel transistor.
7	—	—	N_OUT	Sink Output. Open-drain n-channel output. N_OUT sinks current for power MOSFET turn-off.
—	7	7	OUT2	Driver 2 Output
8	—	—	P_OUT	Source Output. Pullup p-channel output (open drain). Sources current for power MOSFET turn-on.
—	8	8	OUT1	Driver 1 Output
9	9	9	DRV	Output Driver Supply Voltage. Decouple DRV with a low ESR > 0.1μF ceramic capacitor to PGND placed in close proximity to the device. DRV can be powered independently from REG. Connect DRV, REG, and V <sub>CC</sub> together when there is no need for special DRV supply sequencing and the power-MOSFET gate voltage does not need to be regulated or limited.
10	10	10	REG	Voltage Regulator Output. Connect to DRV for driving the power MOSFET with regulated V <sub>GS</sub> amplitude. Bypass with a low-ESR 1μF (minimum) ceramic capacitor to GND placed in close proximity to the device to ensure regulator stability.
EP	EP	EP	EP	Exposed Pad. Internally connected to GND. Connect to GND plane or thermal pad and use multiple vias to a solid copper area on the bottom of the PCB.

# Single/Dual, 16ns, High Sink/Source Current Gate Drivers

## Detailed Description

The MAX15024 single gate driver's internal source and sink transistor outputs are brought out of the IC to independent outputs allowing control of the external MOSFET's rise and fall time. The MAX15024 single gate driver is capable of sinking an 8A peak current and sourcing a 4A peak current. The MAX15025 dual gate drivers are capable of sinking a 4A peak current and sourcing a 2A peak current.

An integrated adjustable low-dropout linear voltage regulator (LDO) provides gate drive amplitude control and optimization. The single gate-driver propagation delay time is minimized and matched between the inverting and noninverting inputs. The dual gate-driver propagation delay is matched between channels.

The MAX15024 has a dual input (IN+ and IN-), allows the use of an inverting or noninverting input, and is offered in TTL or CMOS-logic standards. The MAX15025 is offered with configurations of inverting and noninverting inputs with TTL or CMOS standards (see the *Selector Guide*).

The MAX15024A/B and MAX15025A/B/C/D can be powered using V<sub>CC</sub> only, whereas the MAX15024C/D and MAX15025E/F/G/H can be used in two configurations:

- V<sub>CC</sub> powered only
- V<sub>CC</sub>, REG, and DRV are connected together

### LDO Voltage Regulator Feedback Control

The MAX15024/MAX15025 include an internal LDO designed to deliver a stable reference voltage for use as a supply voltage for the internal MOSFET gate drivers. Connect the LDO feedback FB/SET to GND to set V<sub>REG</sub> to a stable 10V. Connect FB/SET to a resistor-divider between V<sub>REG</sub> and GND to set V<sub>REG</sub>:

$$V_{REG} = V_{FB/SET} \times (1 + R_2 / R_1) \text{ (see Figure 2)}$$

### V<sub>CC</sub> Undervoltage Lockout

When V<sub>CC</sub> is below the UVLO threshold, the internal n-channel transistor is ON and the internal p-channel transistor is OFF, holding the output at GND independent of the state of the inputs so that the external MOSFETs remain OFF in the UVLO condition. The UVLO threshold is 3.5V (typ) with 200mV (typ) hysteresis to avoid chattering.

When the device is operated at very low temperatures and below the UVLO threshold, the driver output could go high impedance. In this case, it is recommended adding a 10k $\Omega$  resistor to PGND to discharge the gate of the external MOSFET (see Figures 4 and 5).

## Input Control

The MAX15024 features inverting and noninverting input terminals. These inputs provide for flexibility of design and use. Connect IN+ to V<sub>CC</sub> when using IN- as an inverting input. Connect IN- to GND when using IN+ as a noninverting input.

## Shoot-Through Protection

The MAX15024/MAX15025 provide protection that avoids any cross-conduction between the internal p-channel and n-channel devices. It also eliminates shoot-through, thus reducing the quiescent supply current.

## Exposed Pad (EP)

The MAX15024/MAX15025 include an exposed pad allowing greater heat dissipation from the internal die to the outside environment. Solder the exposed pad carefully to GND or thermal pad to enhance the thermal performance.

## Applications Information

### Supply Bypassing, Device Grounding, and Placement

Ample supply bypassing and device grounding are extremely important because when large external capacitive loads are driven, the peak current at the V<sub>DRV</sub> pin can approach 4A, while at the PGND pin, the peak current can approach 8A. V<sub>DRV</sub> drops and ground shifts are forms of negative feedback for inverters and, if excessive, can cause multiple switching when the inverting input is used and the input slew rate is low. The device driving the input should be referenced to the MAX15024/MAX15025 GND. Ground shifts due to insufficient device grounding can disturb other circuits sharing the same AC ground return path. Any series inductance in the V<sub>DRV</sub>, OUT\_, and/or PGND paths can cause oscillations due to the very high di/dt that results when the MAX15024/MAX15025 are switched with any capacitive load. A 0.1 $\mu$ F or larger value ceramic capacitor is recommended for bypassing V<sub>DRV</sub> to GND and should be placed as close to the pins as possible. When driving very large loads (> 10nF) at minimum rise time, 10 $\mu$ F or more of parallel storage capacitance is recommended. A ground plane is highly recommended to minimize ground return resistance and series inductance. Care should be taken to place the MAX15024/MAX15025 as close as possible to the external MOSFET being driven to further minimize board inductance and AC path resistance.

# Single/Dual, 16ns, High Sink/Source Current Gate Drivers

MAX15024/MAX15025

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## Power Dissipation

Power dissipation of the MAX15024/MAX15025 consists of three components: the quiescent current, capacitive charge and discharge of internal nodes, and the output current (either capacitive or resistive load). The sum of these components must be kept below the maximum power-dissipation limit. The quiescent current is 700µA typ. The current required to charge and discharge the internal nodes is frequency dependent (see the *Typical Operating Characteristics*). The MAX15024/MAX15025 power dissipation when driving a ground-referenced resistive load is:

$$P = D \times R_{ON(MAX)} \times I_{LOAD}^2$$

where D is the fraction of the period the MAX15024/MAX15025s' output pulls high,  $R_{ON(MAX)}$  is the maximum on-resistance of the device with the output high (p-channel), and  $I_{LOAD}$  is the output load current of the MAX15024/MAX15025. For capacitive loads, the power dissipation for each driver is:

$$P = C_{LOAD} \times V_{DRV}^2 \times FREQ$$

where  $C_{LOAD}$  is the capacitive load,  $V_{DRV}$  is the driver supply voltage, and FREQ is the switching frequency.

## Layout Information

The MAX15024/MAX15025 MOSFET drivers source and sink large currents to create very fast rise and fall edges at the gate of the switching MOSFET. The high di/dt can cause unacceptable ringing if the trace lengths and impedances are not well controlled. The following

printed-circuit board (PCB) layout guidelines are recommended when designing with the MAX15024/MAX15025:

- Place one or more 1µF decoupling ceramic capacitor(s) from  $V_{DRV}$  to PGND as close to the device as possible. At least one storage capacitor of 10µF (min) should be located on the PCB with a low resistance path to the VCC pin of the MAX15024/MAX15025.
- There are two AC current loops formed between the device and the gate of the MOSFET being driven. The MOSFET looks like a large capacitance from gate to source when the gate is being pulled low. The active current loop is from MOSFET gate to OUT\_ of the MAX15024/MAX15025 to PGND of the MAX15024/MAX15025, and to the source of the MOSFET. When the gate of the MOSFET is being pulled high, the active current loop is from the  $V_{DD}$  terminal of the  $V_{DRV}$  terminal of decoupling capacitor, to the  $V_{DRV}$  of the MAX15024/MAX15025, to the OUT\_ of the MAX15024/MAX15025, to the MOSFET gate, to the MOSFET source, and to the negative terminal of the decoupling capacitor. Both charging current loop and discharging current loop are important. It is important to minimize the physical distance and the impedance in these AC current paths.
- Keep the device as close as possible to the MOSFET.
- In the multilayer PCB, the inner layers should consist of a GND plane containing the discharging and charging current loops.

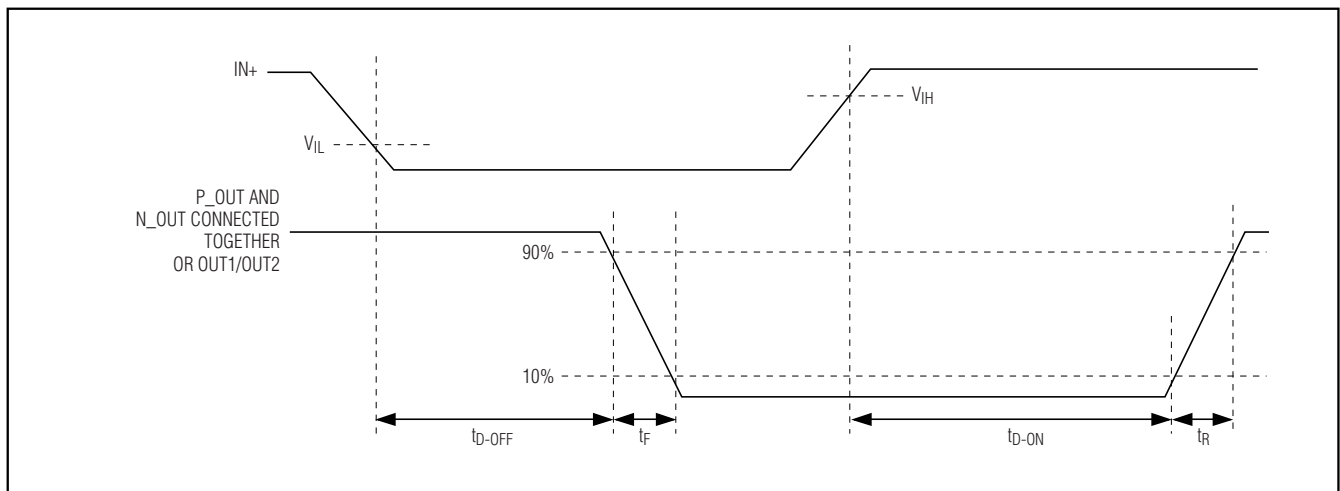


Figure 1. Timing Diagram

# Single/Dual, 16ns, High Sink/Source Current Gate Drivers

## Typical Operating Circuits

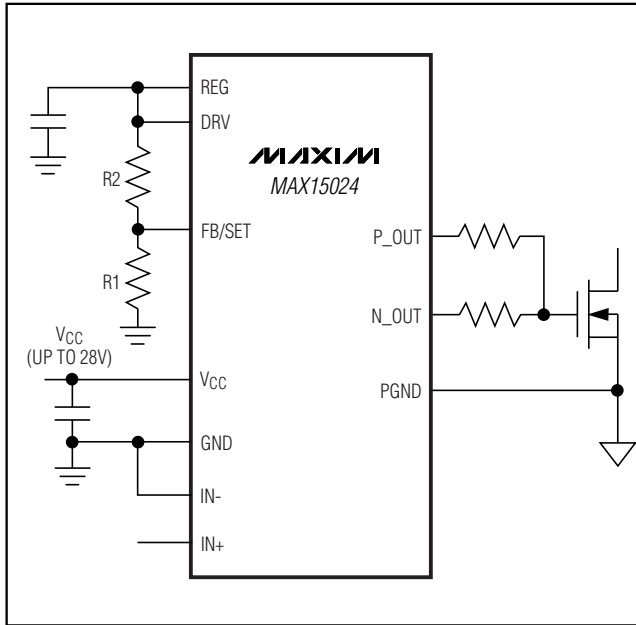


Figure 2. Connect FB/SET to GND for  $V_{REG} = 10V$  (Connect EP to GND)

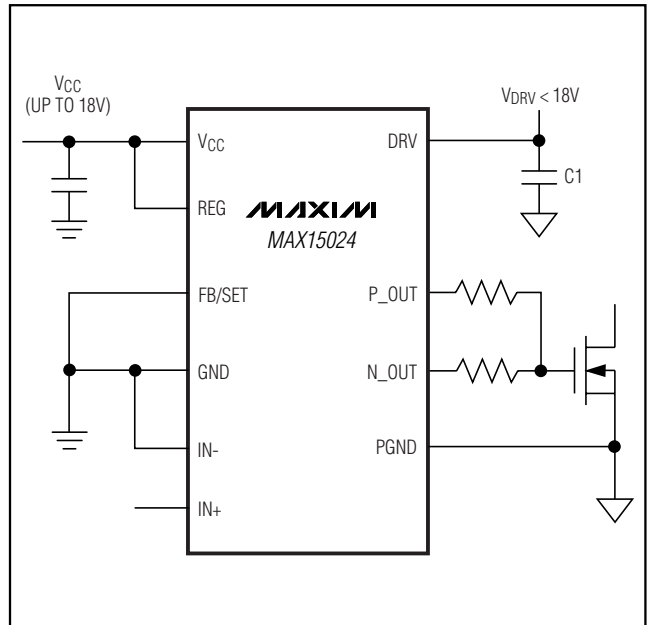


Figure 3. Operation Using a Different Supply Rail for DRV (Connect EP to GND)

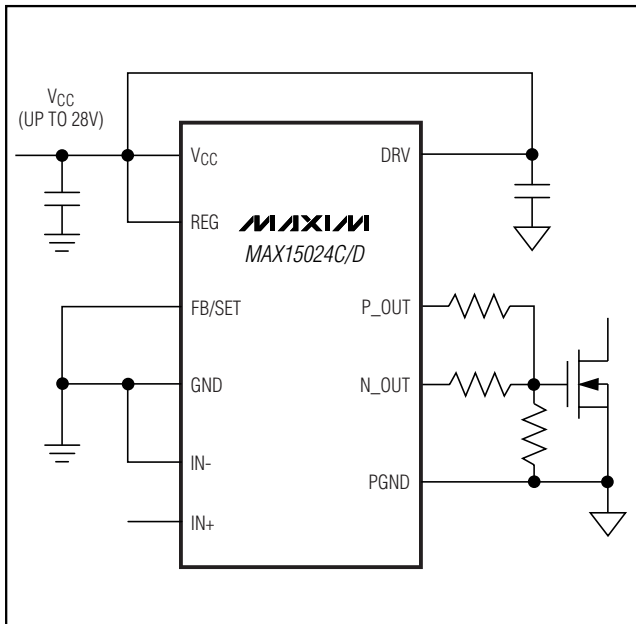


Figure 4. Operation Using a  $V_{CC} = DRV = REG$  (Connect EP to GND)

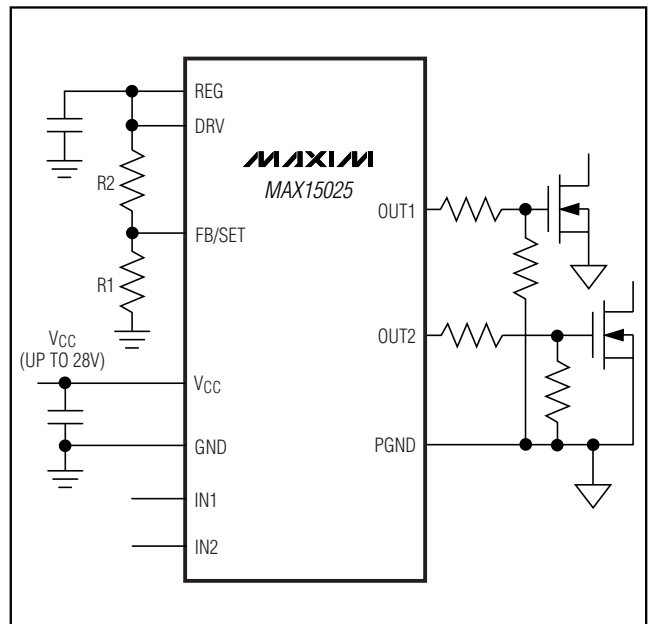
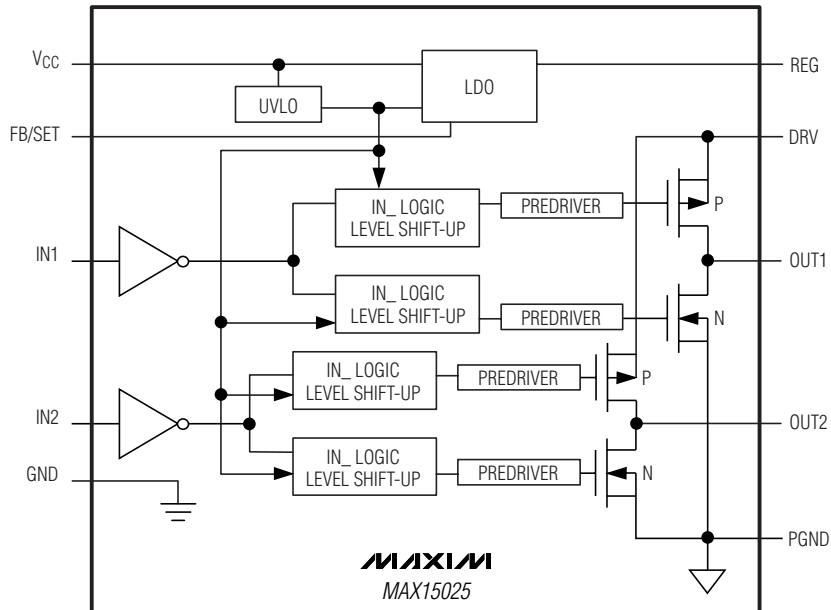
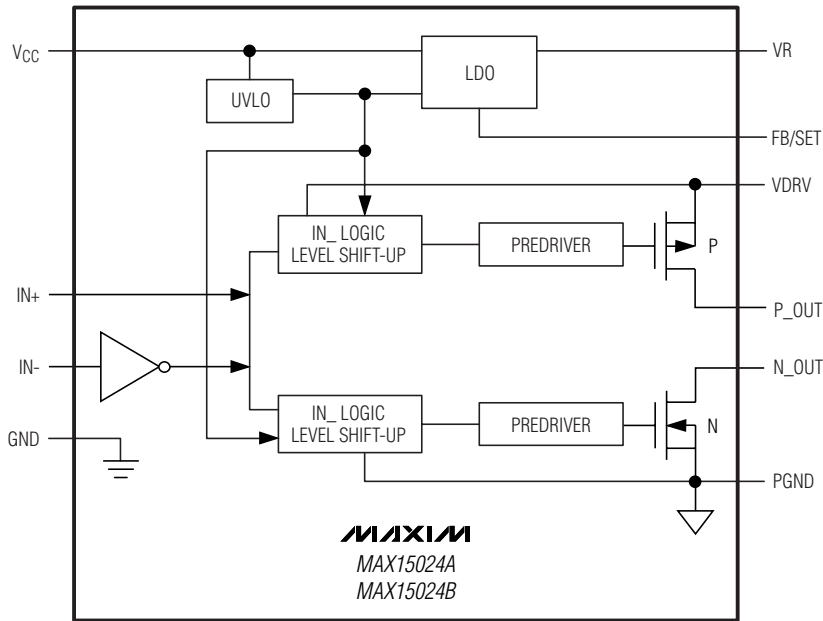


Figure 5. Connect FB/SET to GND for  $V_{REG} = 10V$  (Connect EP to GND)

# Single/Dual, 16ns, High Sink/Source Current Gate Drivers



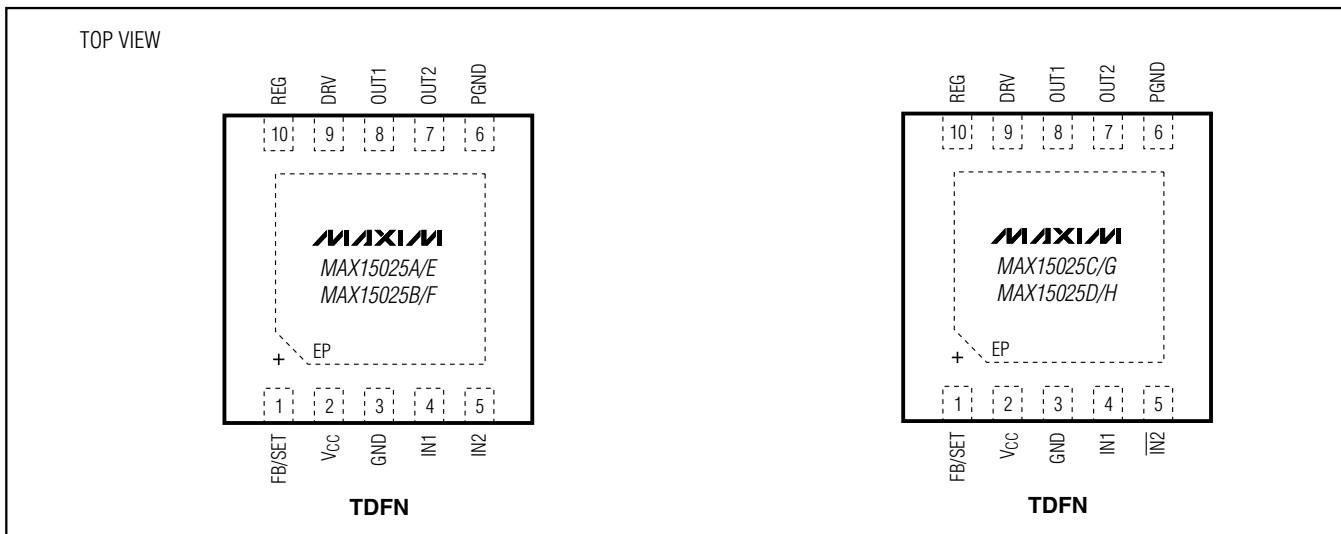
# Single/Dual, 16ns, High Sink/Source Current Gate Drivers

## Selector Guide

PART	NO. OF CHANNELS	PEAK CURRENTS (SINK/SOURCE)	INPUTS	LOGIC LEVELS	TOP MARK	V <sub>CC</sub> -POWERED ONLY	V <sub>CC</sub> = V <sub>REG</sub> = V <sub>DRV</sub>
MAX15024AATB+	1	8A/4A	Complementary	TTL	ATX	✓	—
MAX15024BATB+	1	8A/4A	Complementary	CMOS	ATY	✓	—
MAX15024CATB+	1	8A/4A	Complementary	TTL	—	✓	✓
MAX15024DATB+	1	8A/4A	Complementary	CMOS	—	✓	✓
MAX15025AATB+	2	4A/2A	Noninverting	TTL	ATZ	✓	—
MAX15025BATB+	2	4A/2A	Noninverting	CMOS	AUA	✓	—
MAX15025CATB+	2	4A/2A	Noninverting (1)/ Inverting (2)	TTL	AUB	✓	—
MAX15025DATB+	2	4A/2A	Noninverting (1)/ Inverting (2)	CMOS	AUC	✓	—
MAX15025EATB+	2	4A/2A	Noninverting	TTL	—	✓	✓
MAX15025FATB+	2	4A/2A	Noninverting	CMOS	—	✓	✓
MAX15025GATB+	2	4A/2A	Noninverting (1)/ Inverting (2)	TTL	—	✓	✓
MAX15025HATB+	2	4A/2A	Noninverting (1)/ Inverting (2)	CMOS	—	✓	✓

**Note:** All devices operate in a -40°C to +125°C temperature range and come in a 10-pin TDFN package.

## Pin Configurations (continued)



## Chip Information

PROCESS: BiCMOS

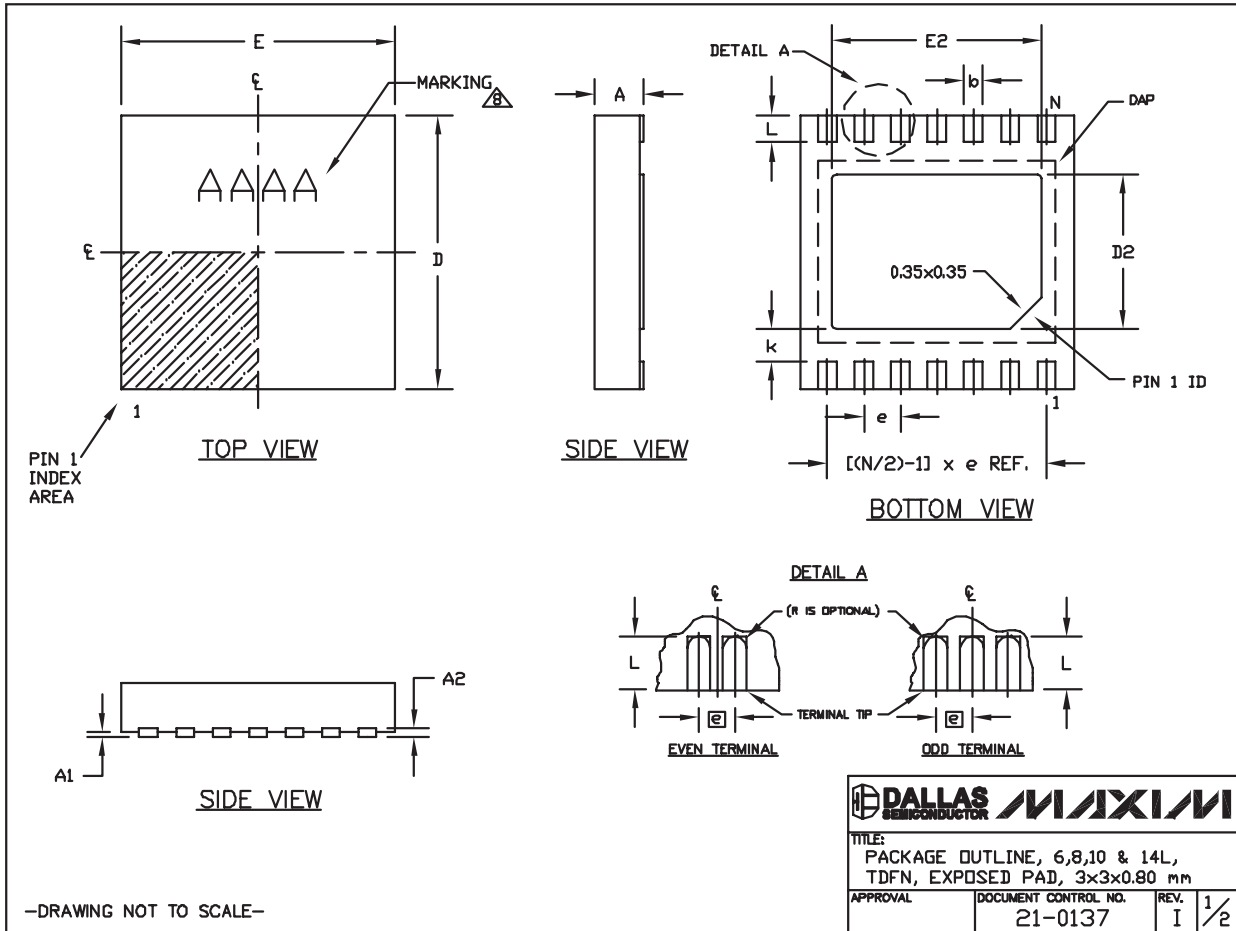
# Single/Dual, 16ns, High Sink/Source Current Gate Drivers

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## Package Information

(The package drawing(s) in this data sheet may not reflect the most current specifications. For the latest package outline information go to [www.maxim-ic.com/packages](http://www.maxim-ic.com/packages).)

MAX15024/MAX15025



6, 8, & 10L, DFN THIN.EPS

# Single/Dual, 16ns, High Sink/Source Current Gate Drivers

## Package Information (continued)

(The package drawing(s) in this data sheet may not reflect the most current specifications. For the latest package outline information go to [www.maxim-ic.com/packages](http://www.maxim-ic.com/packages).)


COMMON DIMENSIONS		
SYMBOL	MIN.	MAX.
A	0.70	0.80
D	2.90	3.10
E	2.90	3.10
A1	0.00	0.05
L	0.20	0.40
k	0.25 MIN.	
A2	0.20 REF.	

PACKAGE VARIATIONS							
PKG. CODE	N	D2	E2	e	JEDEC SPEC	b	[(N/2)-1] x e
T633-2	6	1.50±0.10	2.30±0.10	0.95 BSC	MO229 / WEEA	0.40±0.05	1.90 REF
T833-2	8	1.50±0.10	2.30±0.10	0.65 BSC	MO229 / WEEC	0.30±0.05	1.95 REF
T833-3	8	1.50±0.10	2.30±0.10	0.65 BSC	MO229 / WEEC	0.30±0.05	1.95 REF
T1033-1	10	1.50±0.10	2.30±0.10	0.50 BSC	MO229 / WEED-3	0.25±0.05	2.00 REF
T1033-2	10	1.50±0.10	2.30±0.10	0.50 BSC	MO229 / WEED-3	0.25±0.05	2.00 REF
T1433-1	14	1.70±0.10	2.30±0.10	0.40 BSC	----	0.20±0.05	2.40 REF
T1433-2	14	1.70±0.10	2.30±0.10	0.40 BSC	----	0.20±0.05	2.40 REF

**NOTES:**

1. ALL DIMENSIONS ARE IN mm. ANGLES IN DEGREES.
2. COPLANARITY SHALL NOT EXCEED 0.08 mm.
3. WARPAGE SHALL NOT EXCEED 0.10 mm.
4. PACKAGE LENGTH/PACKAGE WIDTH ARE CONSIDERED AS SPECIAL CHARACTERISTIC(S).
5. DRAWING CONFORMS TO JEDEC MO229, EXCEPT DIMENSIONS "D2" AND "E2", AND T1433-1 & T1433-2.
6. "N" IS THE TOTAL NUMBER OF LEADS.
7. NUMBER OF LEADS SHOWN ARE FOR REFERENCE ONLY.
8. MARKING IS FOR PACKAGE ORIENTATION REFERENCE ONLY.

—DRAWING NOT TO SCALE—

		
TITLE: PACKAGE OUTLINE, 6,8,10 & 14L, TDFN, EXPOSED PAD, 3x3x0.80 mm		
APPROVAL	DOCUMENT CONTROL NO.	REV.
	21-0137	I 2/2

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