FAIRCHILD SEMICONDUCTOR®

April 2008

FAN3100
Single 2A High-Speed, Low-Side Gate Driver

Features

- 3A Peak Sink/Source at V_{DD} = 12V
- 4.5 to 18V Operating Range
- 2.5A Sink / 1.8A Source at V_{DD} = 6V
- Dual-Logic Inputs Allow Configuration as Non-Inverting or Inverting with Enable Function
- Internal Resistors Turn Driver Off If No Inputs
- 13ns Typical Rise Time and 9ns Typical Fall-Time with 1nF Load
- Choice of TTL or CMOS Input Thresholds
- MillerDrive™ Technology
- Typical Propagation Delay Time Under 20ns with Input Falling or Rising
- 6-Lead 2x2mm MLP or 5-Pin SOT23 Packages
- Rated from –40°C to 125°C Ambient

Applications

- Switch-Mode Power Supplies
- High-Efficiency MOSFET Switching
- Synchronous Rectifier Circuits
- DC-to-DC Converters
- Motor Control

Description

The FAN3100 2A gate driver is designed to drive an N-channel enhancement-mode MOSFET in low-side switching applications by providing high peak current pulses during the short switching intervals. The driver is available with either TTL (FAN3100T) or CMOS (FAN3100C) input thresholds. Internal circuitry provides an under-voltage lockout function by holding the output low until the supply voltage is within the operating range. The FAN3100 delivers fast MOSFET switching performance, which helps maximize efficiency in high-frequency power converter designs.

FAN3100 drivers incorporate MillerDrive™ architecture for the final output stage. This bipolar-MOSFET combination provides high peak current during the Miller plateau stage of the MOSFET turn-on / turn-off process to minimize switching loss, while providing rail-to-rail voltage swing and reverse current capability.

The FAN3100 also offers dual inputs that can be configured to operate in non-inverting or inverting mode and allow implementation of an enable function. If one or both inputs are left unconnected, internal resistors bias the inputs such that the output is pulled low to hold the power MOSFET off.

The FAN3100 is available in a lead-free finish 2x2mm 6-lead Molded Leadless Package (MLP), for smallest size with excellent thermal performance, or industry-standard 5-pin SOT23.

Functional Pin Configurations

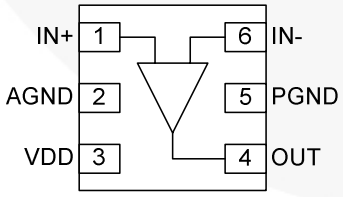


Figure 1. 2x2mm 6-Lead MLP (Top View)

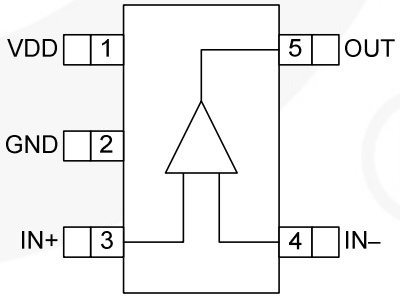


Figure 2. SOT23-5 (Top View)

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Ordering Information

Part Number	Input Threshold	Package	Packing Method	Quantity / Reel
FAN3100CMPX	CMOS	6-Lead 2x2mm MLP	Tape & Reel	3000
FAN3100CSX	CMOS	5-Pin SOT23	Tape & Reel	3000
FAN3100TMPX	TTL	6-Lead 2x2mm MLP	Tape & Reel	3000
FAN3100TSX	TTL	5-Pin SOT23	Tape & Reel	3000

All packages are lead free per JEDEC: J-STD-020B standard.

Package Outlines

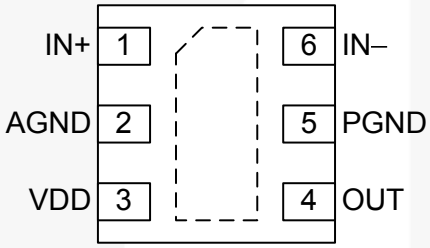


Figure 3. 2x2mm 6-Lead MLP (Top View)

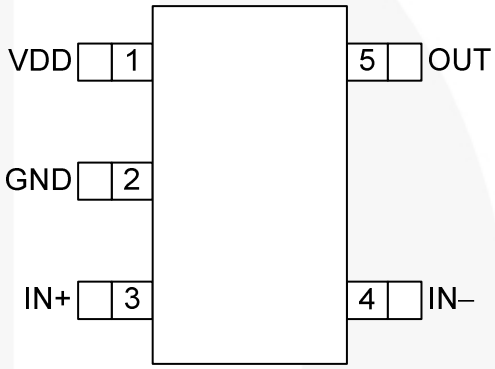


Figure 4. SOT23-5 (Top View)

Thermal Characteristics[1]

Package	Θ_{JL}[2]	Θ_{JT}[3]	Θ_{JA}[4]	Ψ_{JB}[5]	Ψ_{JT}[6]	Units
6-Lead 2x2mm Molded Leadless Package (MLP)	2.7	133	58	2.8	42	°C/W
SOT23-5	56	99	157	51	5	°C/W

Notes:

1. Estimates derived from thermal simulation; actual values depend on the application.
2. Theta_JL (Θ_{JL}): Thermal resistance between the semiconductor junction and the bottom surface of all the leads (including any thermal pad) that are typically soldered to a PCB.
3. Theta_JT (Θ_{JT}): Thermal resistance between the semiconductor junction and the top surface of the package, assuming it is held at a uniform temperature by a top-side heatsink.
4. Theta_JA (Θ_{JA}): Thermal resistance between junction and ambient, dependent on the PCB design, heat sinking, and airflow. The value given is for natural convection with no heatsink, as specified in JEDEC standards JESD51-2, JESD51-5, and JESD51-7, as appropriate.
5. Psi_JB (Ψ_{JB}): Thermal characterization parameter providing correlation between semiconductor junction temperature and an application circuit board reference point for the thermal environment defined in Note 4. For the MLP-6 package, the board reference is defined as the PCB copper connected to the thermal pad and protruding from either end of the package. For the SOT23-5 package, the board reference is defined as the PCB copper adjacent to pin 2.
6. Psi_JT (Ψ_{JT}): Thermal characterization parameter providing correlation between the semiconductor junction temperature and the center of the top of the package for the thermal environment defined in Note 4.

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Pin Definitions

SOT23 Pin #	MLP Pin #	Name	Pin Description
1	3	VDD	**Supply Voltage**. Provides power to the IC.
	2	AGND	**Analog ground** for input signals (MLP only). Connect to PGND underneath the IC.
2		GND	**Ground** (SOT-23 only). Common ground reference for input and output circuits.
3	1	IN+	**Non-Inverting Input**. Connect to VDD to enable output.
4	6	IN-	**Inverting Input**. Connect to AGND or PGND to enable output.
5	4	OUT	**Gate Drive Output**: Held low unless required inputs are present and V_{DD} is above UVLO threshold.
	Pad	P1	**Thermal Pad** (MLP only). Exposed metal on the bottom of the package which is electrically connected to pin 5.
	5	PGND	**Power Ground** (MLP only). For output drive circuit; separates switching noise from inputs.

Output Logic

IN+	IN−	OUT
0[7]	0	0
0[7]	1[7]	0
1	0	1
1	1[7]	0

Note:

7. Default input signal if no external connection is made.

Block Diagrams

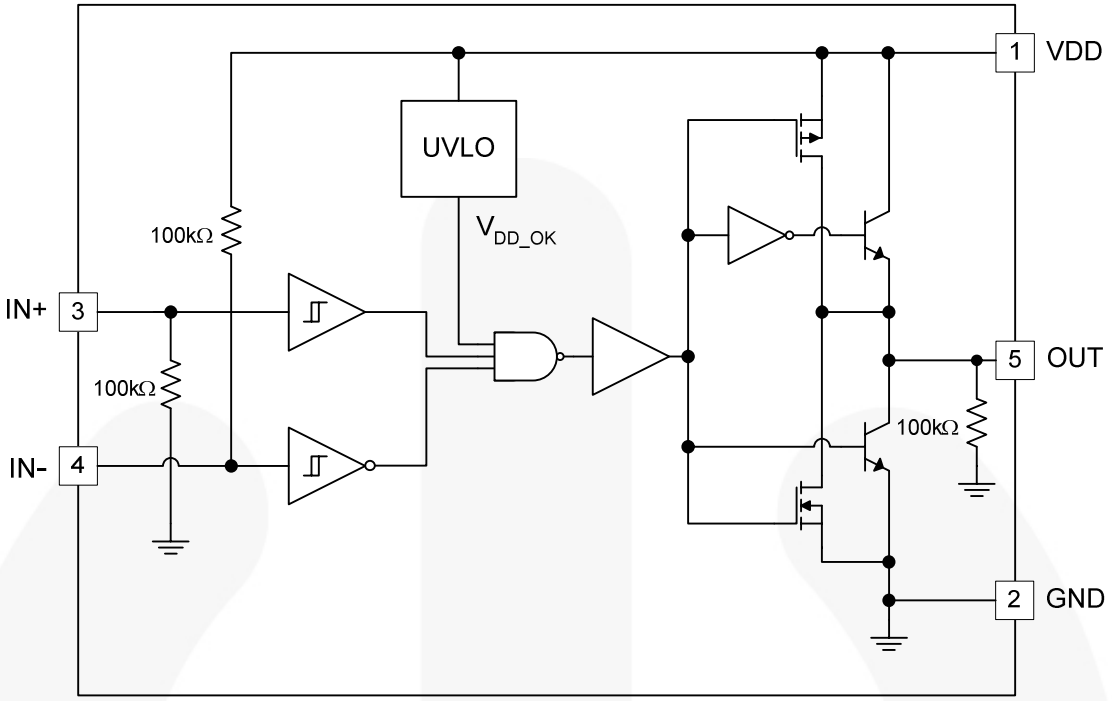


Figure 5. Simplified Block Diagram (SOT23 Pin-out)

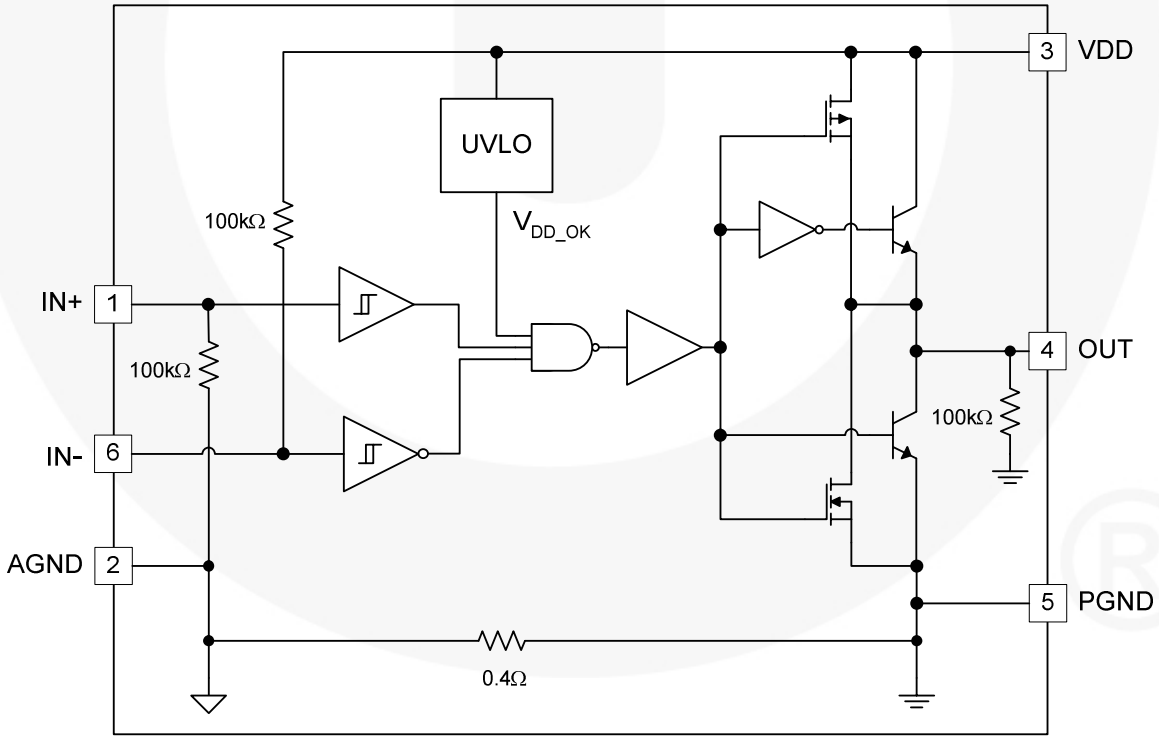


Figure 6. Simplified Block Diagram (MLP Pin-out)

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Absolute Maximum Ratings

Stresses exceeding the absolute maximum ratings may damage the device. The device may not function or be operable above the recommended operating conditions and stressing the parts to these levels is not recommended. In addition, extended exposure to stresses above the recommended operating conditions may affect device reliability. The absolute maximum ratings are stress ratings only.

Symbol	Parameter		Min.	Max.	Unit
V_{DD}	VDD to PGND		-0.3	20.0	V
V_{IN}	Voltage on IN+ and IN- to GND, AGND, or PGND		GND - 0.3	V_{DD} + 0.3	V
V_{OUT}	Voltage on OUT to GND, AGND, or PGND		GND - 0.3	V_{DD} + 0.3	V
T_L	Lead Soldering Temperature (10 seconds)			+260	ºC
T_J	Junction Temperature			+150	ºC
T_{STG}	Storage Temperature		-65	+150	ºC
ESD	Electrostatic Discharge Protection Level	Human Body Model, JEDEC JESD22-A114	4		kV
		Charged Device Model, JEDEC JESD22-C101	750		V

Recommended Operating Conditions

The Recommended Operating Conditions table defines the conditions for actual device operation. Recommended operating conditions are specified to ensure optimal performance to the datasheet specifications. Fairchild does not recommend exceeding them or designing to Absolute Maximum Ratings.

Symbol	Parameter	Min.	Max.	Unit
V_{DD}	Supply Voltage Range	4.5	18.0	V
V_{IN}	Input Voltage IN+, IN-	0	V_{DD}	V
T_A	Operating Ambient Temperature	-40	+125	ºC

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Electrical Characteristics

Unless otherwise noted, V_{DD} = 12V, T_J = -40°C to +125°C. Currents are defined as positive into the device and negative out of the device.

Symbol	Parameter	Conditions	Min.	Typ.	Max.	Unit
Supply						
V_{DD}	Operating Range		4.5		18.0	V
I_{DD}	Supply Current Inputs/EN Not Connected	FAN3100C[8]		0.20	0.35	mA
		FAN3100T		0.5	0.8	mA
V_{ON}	Turn-On Voltage		3.5	3.9	4.3	V
V_{OFF}	Turn-Off Voltage		3.3	3.7	4.1	V
Inputs (FAN3100T)						
V_{INL_T}	IN+, IN- Logic Low Voltage, Maximum		0.8			V
V_{INH_T}	IN+, IN- Logic High Voltage, Minimum				2.0	V
I_{IN+}	Non-inverting Input	IN from 0 to V_{DD}	-1		175	µA
I_{IN-}	Inverting Input	IN from 0 to V_{DD}	-175		1	µA
V_{HYS}	IN+, IN- Logic Hysteresis Voltage		0.2	0.4	0.8	V
Inputs (FAN3100C)						
V_{INL_C}	IN+, IN- Logic Low Voltage		30			$\%V_{DD}$
V_{INH_C}	IN+, IN- Logic High Voltage				70	$\%V_{DD}$
I_{INL}	IN Current, Low	IN from 0 to V_{DD}	-1		175	µA
I_{INH}	IN Current, High	IN from 0 to V_{DD}	-175		1	µA
V_{HYS_C}	IN+, IN- Logic Hysteresis Voltage			17		$\%V_{DD}$
Output						
I_{SINK}	OUT Current, Mid-Voltage, Sinking[9]	OUT at $V_{DD}/2$, C_{LOAD} = 0.1µF, f = 1kHz		2.5		A
I_{SOURCE}	OUT Current, Mid-Voltage, Sourcing[9]	OUT at $V_{DD}/2$, C_{LOAD} = 0.1µF, f = 1kHz		-1.8		A
I_{PK_SINK}	OUT Current, Peak, Sinking[9]	C_{LOAD} = 0.1µF, f = 1kHz		3		A
I_{PK_SOURCE}	OUT Current, Peak, Sourcing[9]	C_{LOAD} = 0.1µF, f = 1kHz		-3		A
t_{RISE}	Output Rise Time[10]	C_{LOAD} = 1000pF		13	20	ns
t_{FALL}	Output Fall Time[10]	C_{LOAD} = 1000pF		9	14	ns
t_{D1}, t_{D2}	Output Prop. Delay, CMOS Inputs[10]	0 - 12V_{IN}; 1V/ns Slew Rate	7	15	28	ns
t_{D1}, t_{D2}	Output Prop. Delay, TTL Inputs[10]	0 - 5V_{IN}; 1V/ns Slew Rate	9	16	30	ns
I_{RVS}	Output Reverse Current Withstand[9]			500		mA

Note:

8. Lower supply current due to inactive TTL circuitry.
9. Not tested in production.
10. See Timing Diagrams of Figure 7 and Figure 8.

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Timing Diagrams

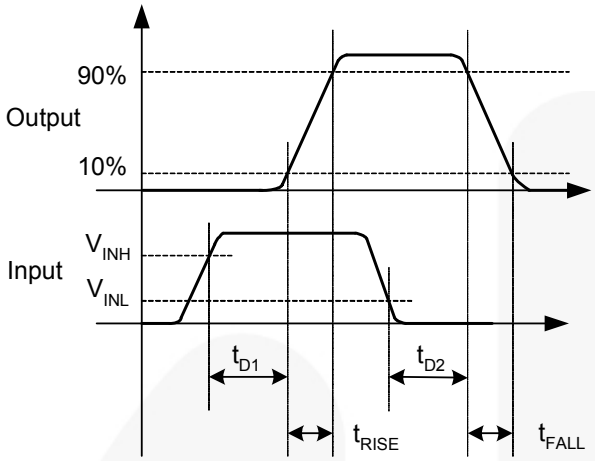


Figure 7. Non-Inverting

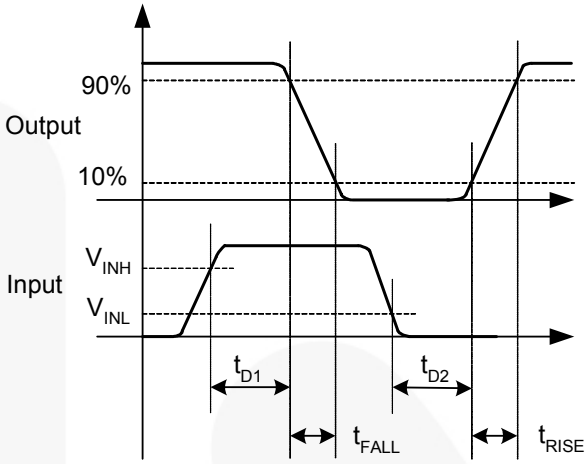


Figure 8. Inverting

Typical Performance Characteristics

Typical characteristics are provided at 25°C and V_{DD}=12V unless otherwise noted.

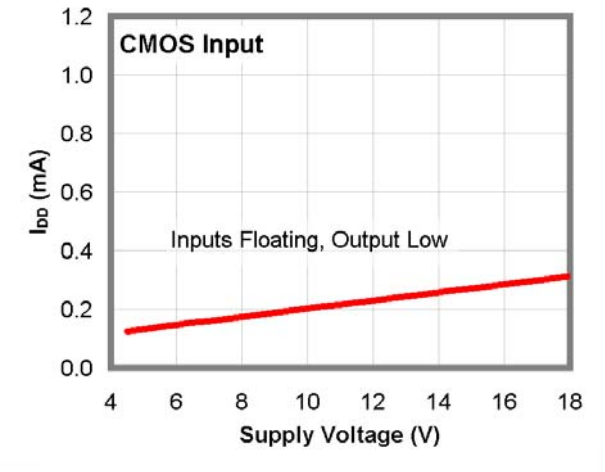


Figure 9. I_{DD} (Static) vs. Supply Voltage

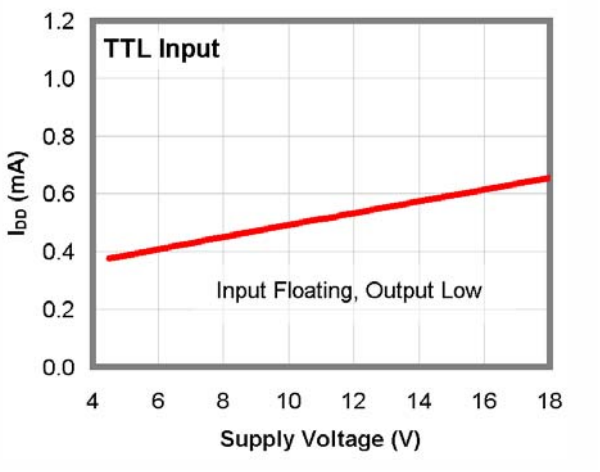


Figure 10. I_{DD} (Static) vs. Supply Voltage

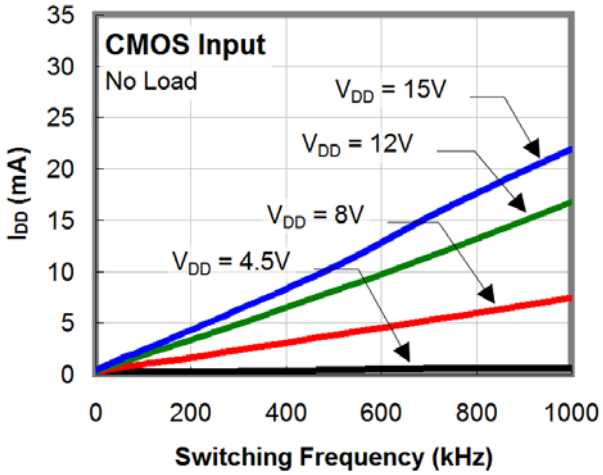


Figure 11. I_{DD} (No-Load) vs. Frequency

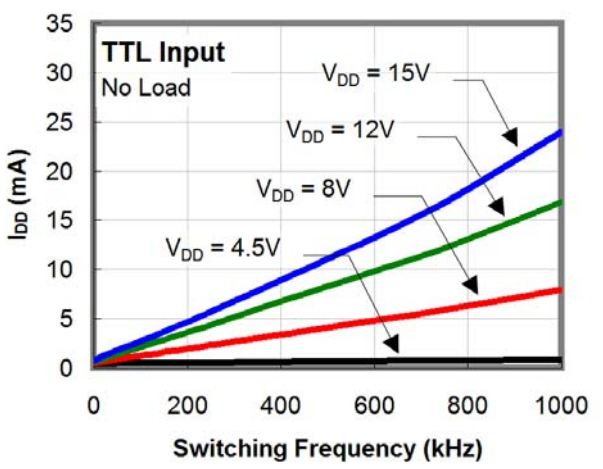


Figure 12. I_{DD} (No-Load) vs. Frequency

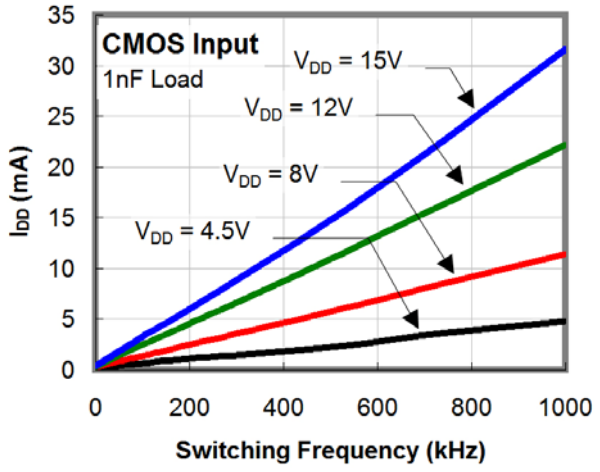


Figure 13. I_{DD} (1nF Load) vs. Frequency

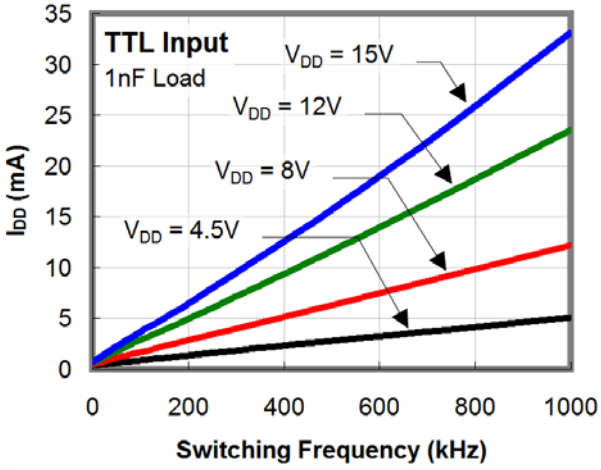


Figure 14. I_{DD} (1nF Load) vs. Frequency

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Typical Performance Characteristics

Typical characteristics are provided at 25°C and V_{DD}=12V unless otherwise noted.

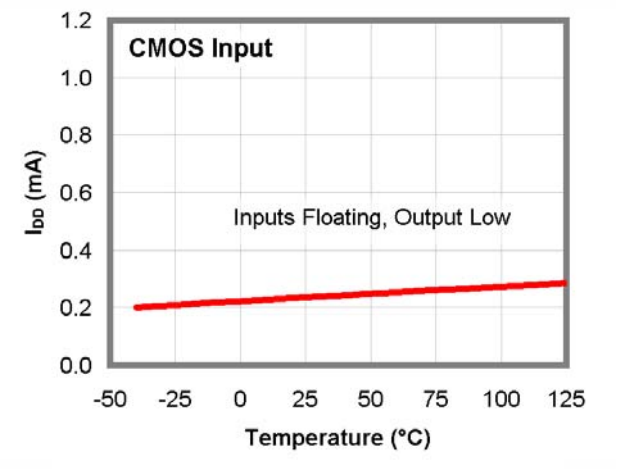


Figure 15. I_{DD} (Static) vs. Temperature

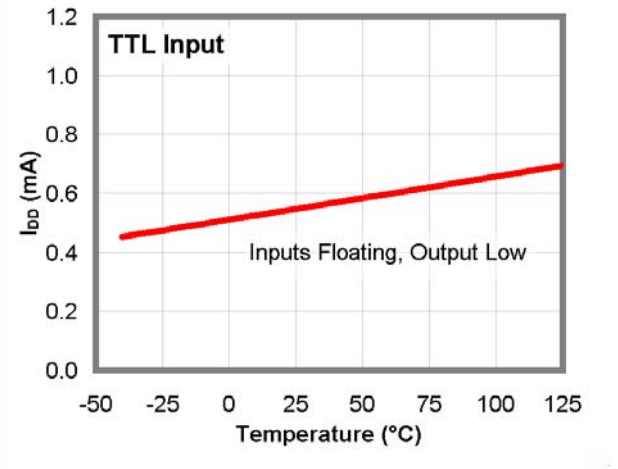


Figure 16. I_{DD} (Static) vs. Temperature

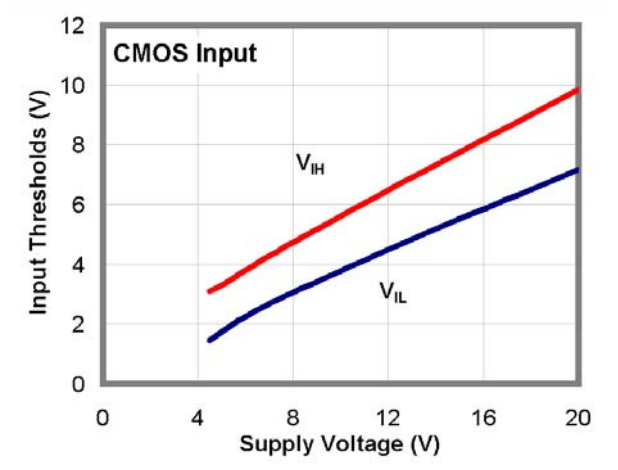


Figure 17. Input Thresholds vs. Supply Voltage

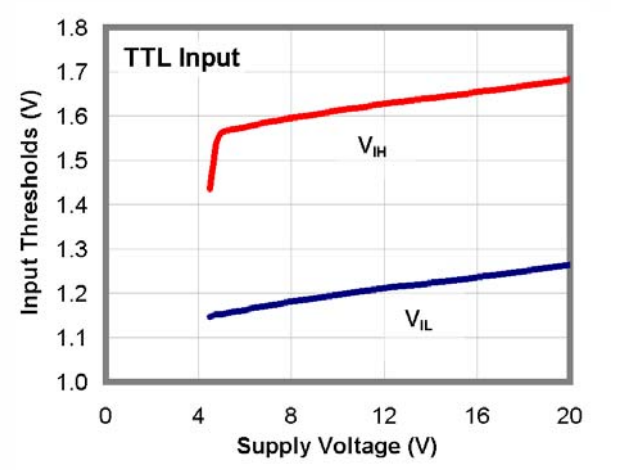


Figure 18. Input Thresholds vs. Supply Voltage

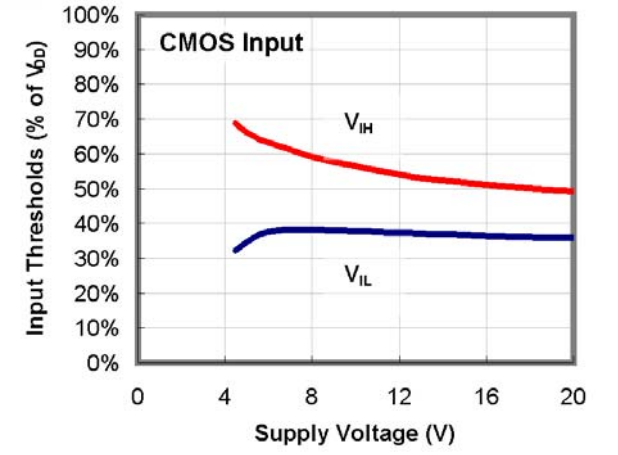


Figure 19. Input Thresholds % vs. Supply Voltage

Typical Performance Characteristics

Typical characteristics are provided at 25°C and V_{DD}=12V unless otherwise noted.

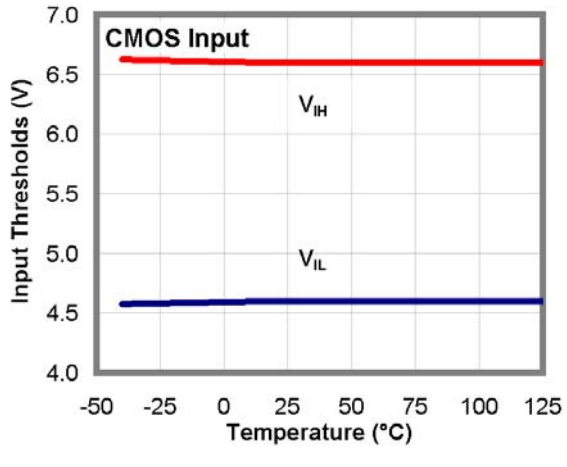


Figure 20. CMOS Input Thresholds vs. Temperature

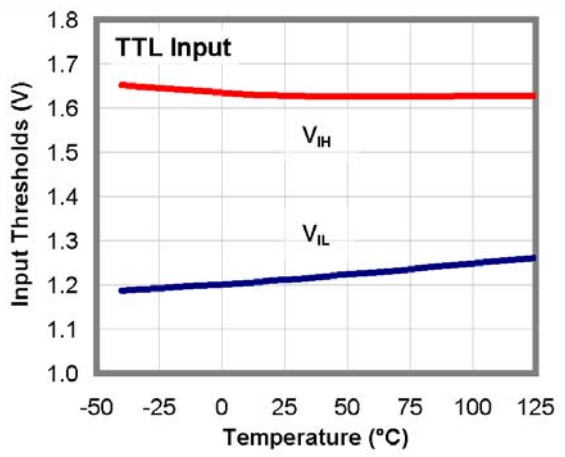


Figure 21. TTL Input Thresholds vs. Temperature

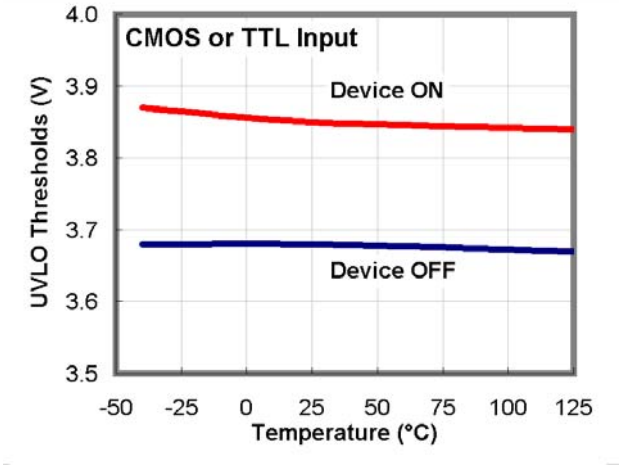


Figure 22. UVLO Thresholds vs. Temperature

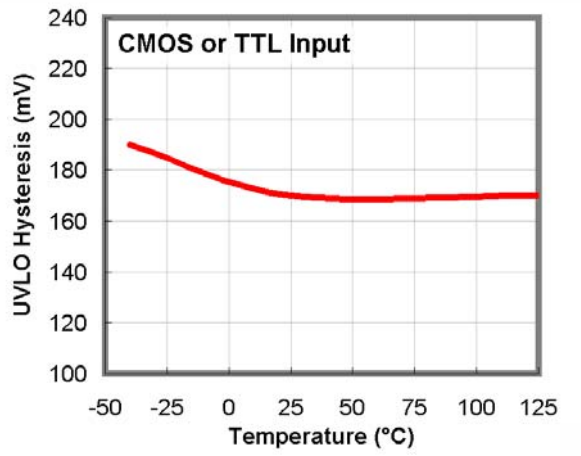


Figure 23. UVLO Hysteresis vs. Temperature

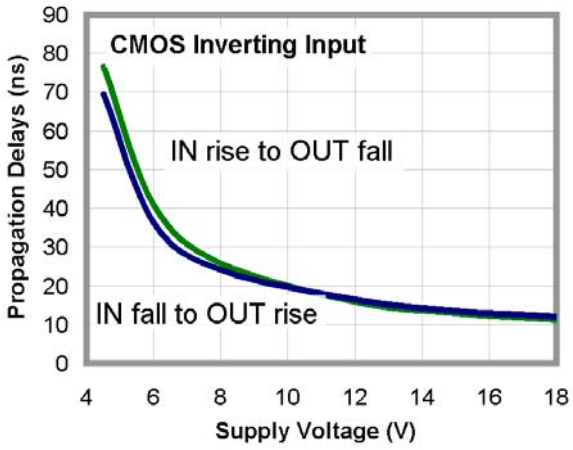


Figure 24. Propagation Delay vs. Supply Voltage

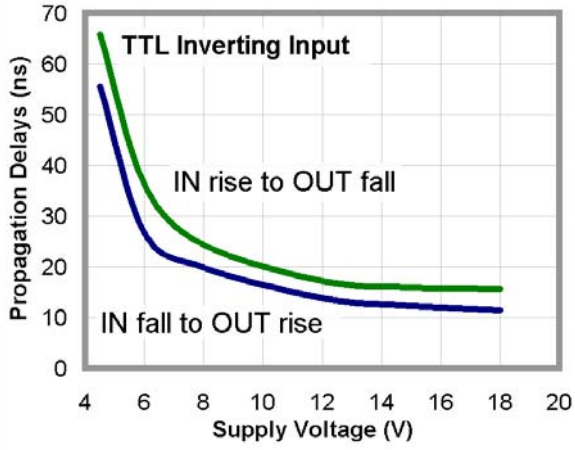


Figure 25. Propagation Delay vs. Supply Voltage

Typical Performance Characteristics

Typical characteristics are provided at 25°C and V_{DD}=12V unless otherwise noted.

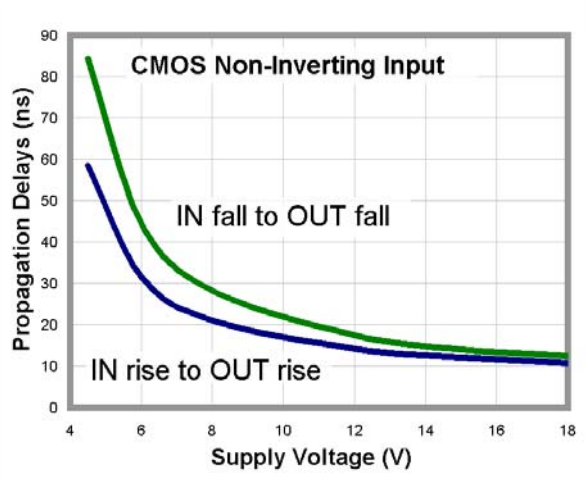


Figure 26. Propagation Delay vs. Supply Voltage

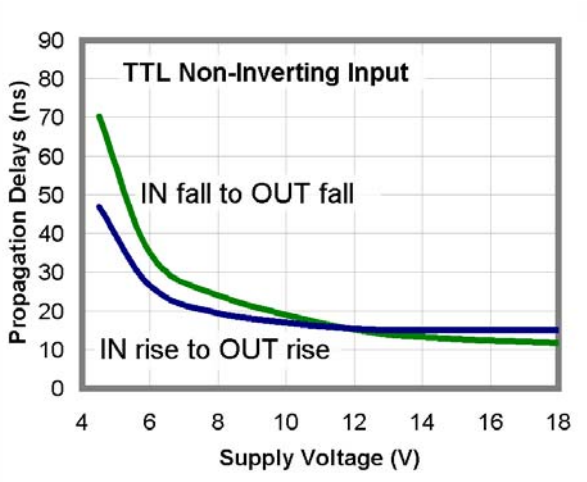


Figure 27. Propagation Delay vs. Supply Voltage

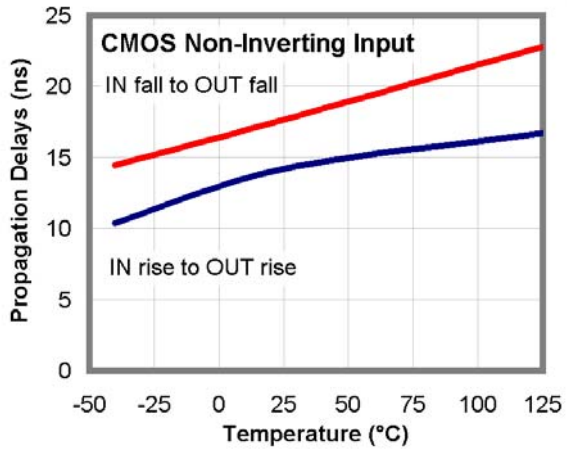


Figure 28. Propagation Delay vs. Temperature

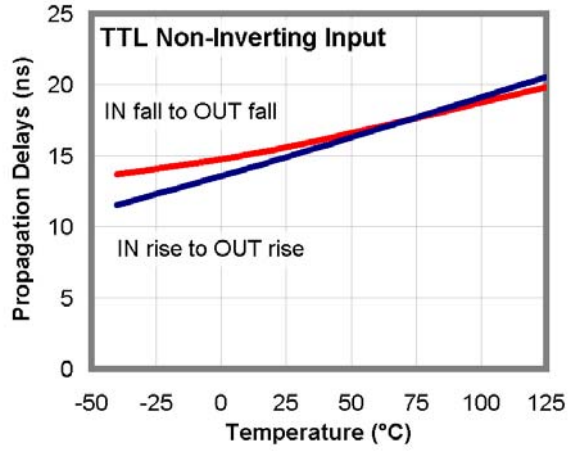


Figure 29. Propagation Delay vs. Temperature

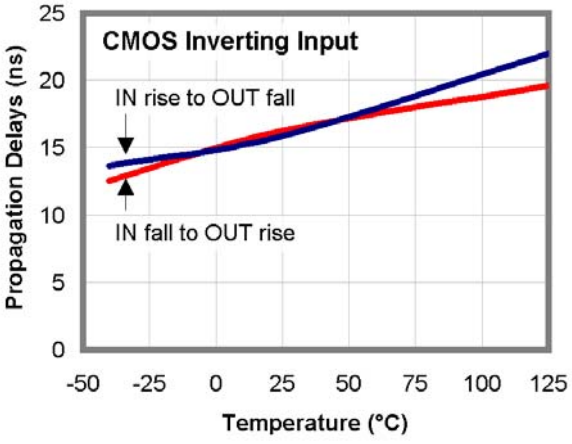


Figure 30. Propagation Delay vs. Temperature

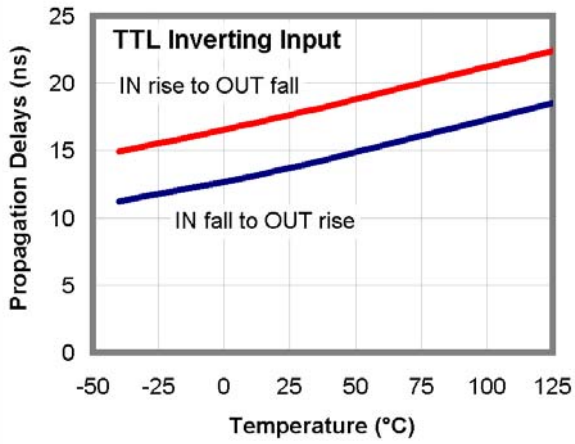


Figure 31. Propagation Delay vs. Temperature

Typical Performance Characteristics

Typical characteristics are provided at 25°C and V_{DD}=12V unless otherwise noted.

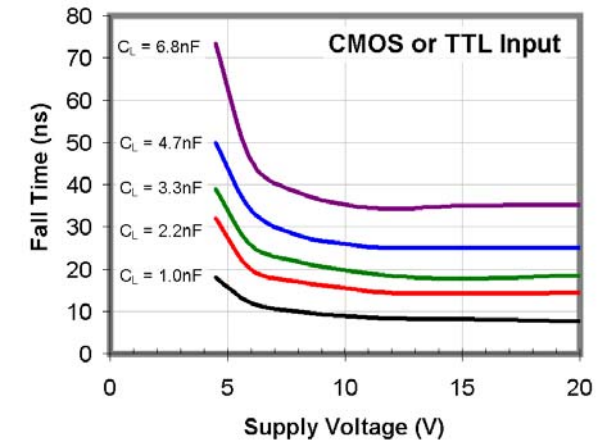


Figure 32. Fall Time vs. Supply Voltage

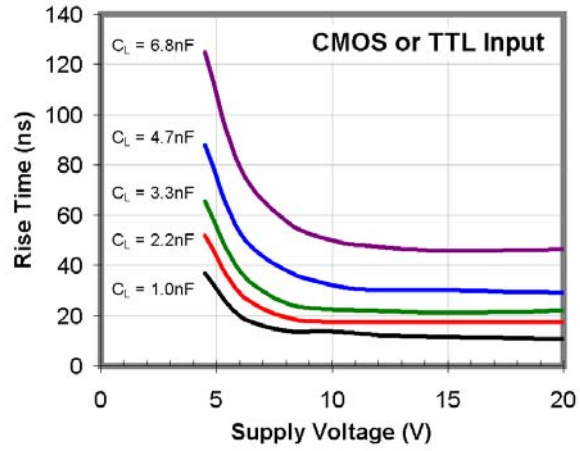


Figure 33. Rise Time vs. Supply Voltage

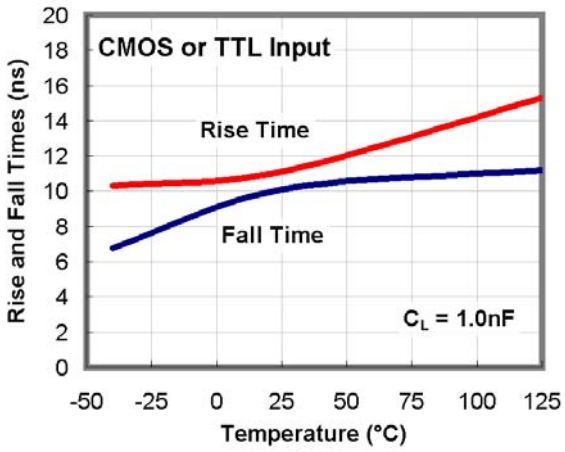


Figure 34. Rise and Fall Time vs. Temperature

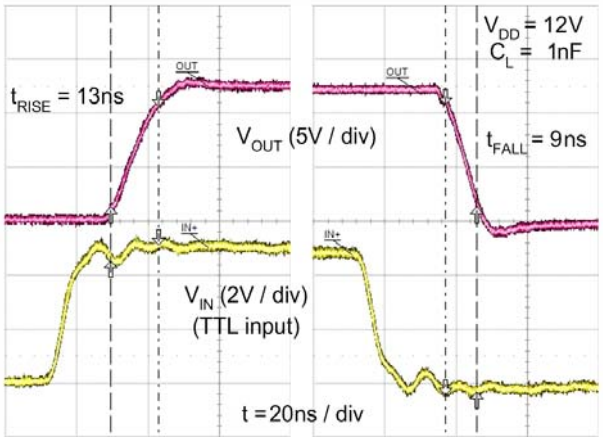


Figure 35. Rise / Fall Waveforms with 1nF Load

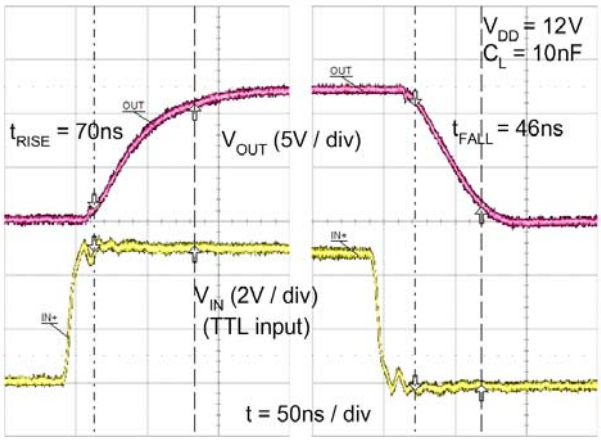


Figure 36. Rise / Fall Waveforms with 10nF Load

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Typical Performance Characteristics

Typical characteristics are provided at 25°C and V_{DD}=12V unless otherwise noted.

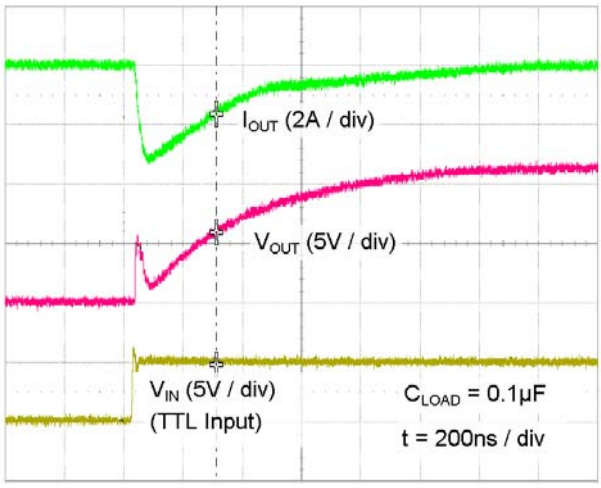


Figure 37. Quasi-Static Source Current with V_{DD}=12V

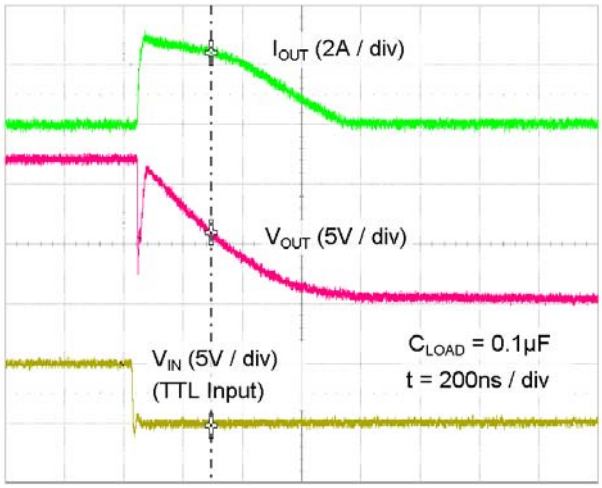


Figure 38. Quasi-Static Sink Current with V_{DD}=12V

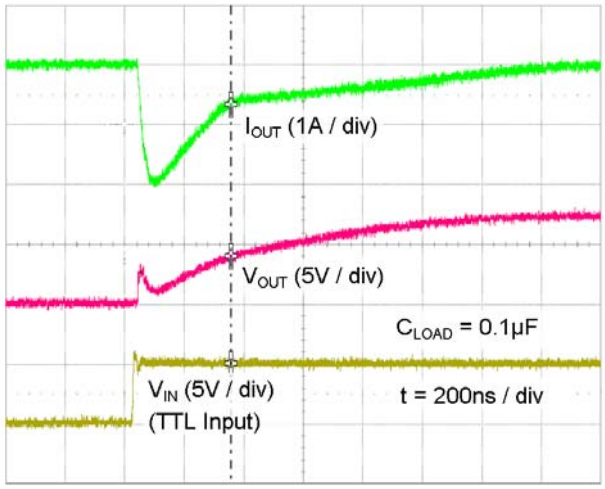


Figure 39. Quasi-Static Source Current with V_{DD}=8V

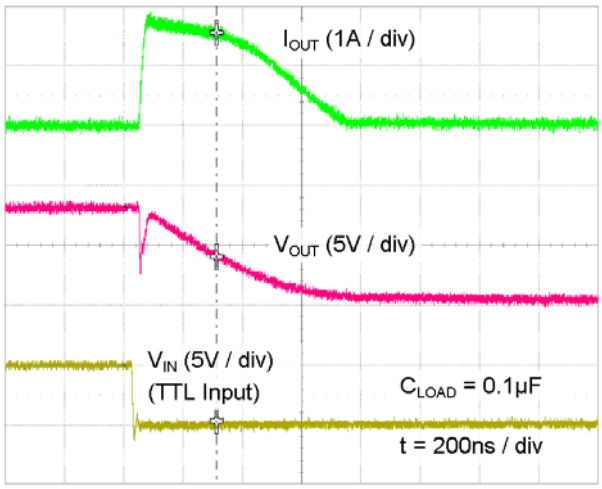


Figure 40. Quasi-Static Sink Current with V_{DD}=8V

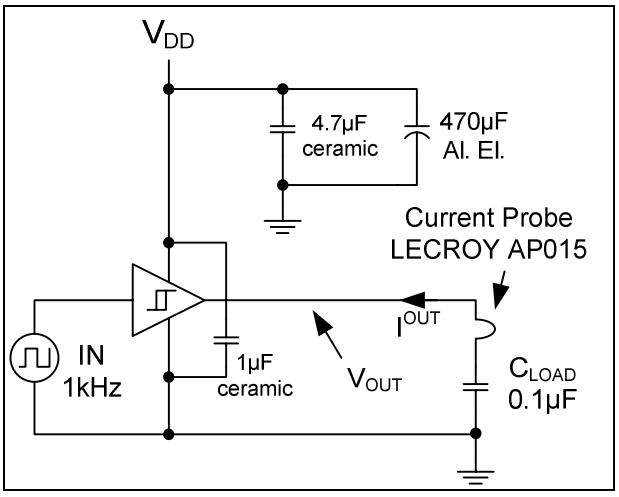


Figure 41. Quasi-Static I_{OUT} / V_{OUT} Test Circuit

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Applications Information

Input Thresholds

The FAN3100 offers TTL or CMOS input thresholds. In the FAN3100T, the input thresholds meet industry-standard TTL logic thresholds, independent of the V_{DD} voltage, and there is a hysteresis voltage of approximately 0.4V. These levels permit the inputs to be driven from a range of input logic signal levels for which a voltage over 2V is considered logic high. The driving signal for the TTL inputs should have fast rising and falling edges with a slew rate of 6V/µs or faster, so the rise time from 0 to 3.3V should be 550ns or less. With reduced slew rate, circuit noise could cause the driver input voltage to exceed the hysteresis voltage and retrigger the driver input, causing erratic operation.

In the FAN3100C, the logic input thresholds are dependent on the V_{DD} level and, with V_{DD} of 12V, the logic rising edge threshold is approximately 55% of V_{DD} and the input falling edge threshold is approximately 38% of V_{DD}. The CMOS input configuration offers a hysteresis voltage of approximately 17% of V_{DD}. The CMOS inputs can be used with relatively slow edges (approaching DC) if good decoupling and bypass techniques are incorporated in the system design to prevent noise from violating the input voltage hysteresis window. This allows setting precise timing intervals by fitting an R-C circuit between the controlling signal and the IN pin of the driver. The slow rising edge at the IN pin of the driver introduces a delay between the controlling signal and the OUT pin of the driver.

Static Supply Current

In the I_{DD} (static) typical performance graphs (Figure 9 - Figure 10 and Figure 15 - Figure 16), the curve is produced with all inputs floating (OUT is low) and indicates the lowest static I_{DD} current for the tested configuration. For other states, additional current flows through the 100kΩ resistors on the inputs and outputs shown in the block diagrams *(see Figure 5 - Figure 6).* In these cases, the actual static I_{DD} current is the value obtained from the curves plus this additional current.

MillerDrive™ Gate Drive Technology

FAN3100 drivers incorporate the MillerDrive™ architecture shown in Figure 42 for the output stage, a combination of bipolar and MOS devices capable of providing large currents over a wide range of supply voltage and temperature variations. The bipolar devices carry the bulk of the current as OUT swings between 1/3 to 2/3 V_{DD} and the MOS devices pull the output to the high or low rail.

The purpose of the MillerDrive™ architecture is to speed up switching by providing the highest current during the Miller plateau region when the gate-drain capacitance of the MOSFET is being charged or discharged as part of the turn-on / turn-off process. For applications that have zero voltage switching during the MOSFET turn-on or turn-off interval, the driver supplies high peak current for fast switching even though the Miller plateau is not present. This situation often occurs in synchronous rectifier applications because the body diode is generally conducting before the MOSFET is switched on.

The output pin slew rate is determined by V_{DD} voltage and the load on the output. It is not user adjustable, but if a slower rise or fall time at the MOSFET gate is needed, a series resistor can be added.

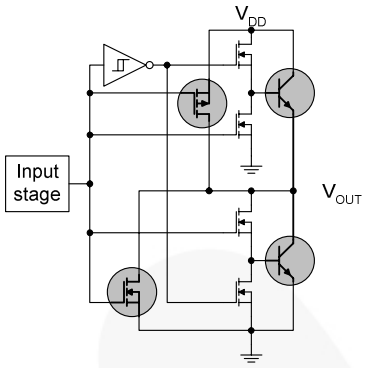


Figure 42. MillerDrive™ Output Architecture

Under-Voltage Lockout

The FAN3100 start-up logic is optimized to drive ground referenced N-channel MOSFETs with a under-voltage lockout (UVLO) function to ensure that the IC starts up in an orderly fashion. When V_{DD} is rising, yet below the 3.9V operational level, this circuit holds the output low, regardless of the status of the input pins. After the part is active, the supply voltage must drop 0.2V before the part shuts down. This hysteresis helps prevent chatter when low V_{DD} supply voltages have noise from the power switching. This configuration is not suitable for driving high-side P-channel MOSFETs because the low output voltage of the driver would turn the P-channel MOSFET on with V_{DD} below 3.9V.

VDD Bypass Capacitor Guidelines

To enable this IC to turn a power device on quickly, a local, high-frequency, bypass capacitor C_{BYP} with low ESR and ESL should be connected between the VDD and GND pins with minimal trace length. This capacitor is in addition to bulk electrolytic capacitance of 10µF to 47µF often found on driver and controller bias circuits.

A typical criterion for choosing the value of C_{BYP} is to keep the ripple voltage on the V_{DD} supply ≤5%. Often this is achieved with a value ≥ 20 times the equivalent load capacitance C_{EQV}, defined here as Q_{gate}/V_{DD}. Ceramic capacitors of 0.1µF to 1µF or larger are common choices, as are dielectrics, such as X5R and X7R, which have good temperature characteristics and high pulse current capability.

If circuit noise affects normal operation, the value of C_{BYP} may be increased to 50-100 times the C_{EQV}, or C_{BYP} may be split into two capacitors. One should be a larger value, based on equivalent load capacitance, and the other a smaller value, such as 1-10nF, mounted closest to the VDD and GND pins to carry the higher-frequency components of the current pulses.

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Layout and Connection Guidelines

The FAN3100 incorporates fast reacting input circuits, short propagation delays, and powerful output stages capable of delivering current peaks over 2A to facilitate voltage transition times from under 10ns to over 100ns. The following layout and connection guidelines are strongly recommended:

- Keep high-current output and power ground paths separate from logic input signals and signal ground paths. This is especially critical when dealing with TTL-level logic thresholds.
- Keep the driver as close to the load as possible to minimize the length of high-current traces. This reduces the series inductance to improve high-speed switching, while reducing the loop area that can radiate EMI to the driver inputs and other surrounding circuitry.
- The FAN3100 is available in two packages with slightly different pinouts, offering similar performance. In the 6-pin MLP package, Pin 2 is internally connected to the input analog ground and should be connected to power ground, Pin 5, through a short direct path underneath the IC. In the 5-pin SOT23, the internal analog and power ground connections are made through separate, individual bond wires to Pin 2, which should be used as the common ground point for power and control signals.
- Many high-speed power circuits can be susceptible to noise injected from their own output or other external sources, possibly causing output re-triggering. These effects can be especially obvious if the circuit is tested in breadboard or non-optimal circuit layouts with long input, enable, or output leads. For best results, make connections to all pins as short and direct as possible.
- The turn-on and turn-off current paths should be minimized as discussed in the following sections.

Figure 43 shows the pulsed gate drive current path when the gate driver is supplying gate charge to turn the MOSFET on. The current is supplied from the local bypass capacitor, C_{BYP}, and flows through the driver to the MOSFET gate and to ground. To reach the high peak currents possible, the resistance and inductance in the path should be minimized. The localized C_{BYP} acts to contain the high peak current pulses within this driver-MOSFET circuit, preventing them from disturbing the sensitive analog circuitry in the PWM controller.

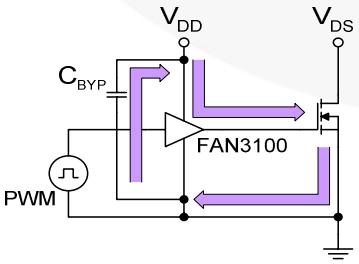


Figure 43. Current Path for MOSFET Turn-On

Figure 44 shows the current path when the gate driver turns the MOSFET off. Ideally, the driver shunts the current directly to the source of the MOSFET in a small circuit loop. For fast turn-off times, the resistance and inductance in this path should be minimized.

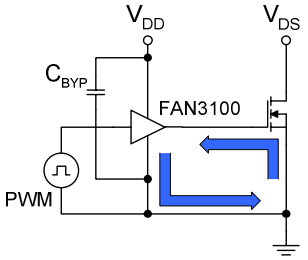


Figure 44. Current Path for MOSFET Turn-Off

Truth Table of Logic Operation

The FAN3100 truth table indicates the operational states using the dual-input configuration. In a non-inverting driver configuration, the IN- pin should be a logic low signal. If the IN- pin is connected to logic high, a disable function is realized, and the driver output remains low regardless of the state of the IN+ pin.

IN+	IN-	OUT
0	0	0
0	1	0
1	0	1
1	1	0

In the non-inverting driver configuration in Figure 45, the IN- pin is tied to ground and the input signal (PWM) is applied to IN+ pin. The IN- pin can be connected to logic high to disable the driver and the output remains low, regardless of the state of the IN+ pin.

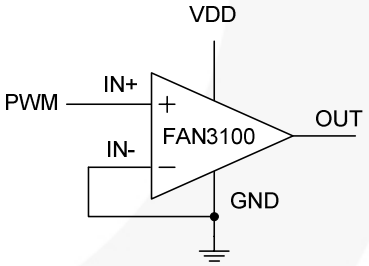


Figure 45. Dual-Input Driver Enabled, Non-Inverting Configuration

In the inverting driver application shown in Figure 46, the IN+ pin is tied high. Pulling the IN+ pin to GND forces the output low, regardless of the state of the IN- pin.

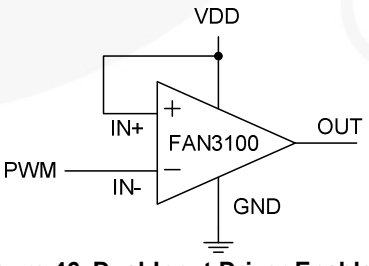


Figure 46. Dual-Input Driver Enabled, Inverting Configuration

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Operational Waveforms

At power up, the driver output remains low until the V_{DD} voltage reaches the turn-on threshold. The magnitude of the OUT pulses rises with V_{DD} until steady-state V_{DD} is reached. The non-inverting operation illustrated in Figure 47 shows that the output remains low until the UVLO threshold is reached, then the output is in-phase with the input.

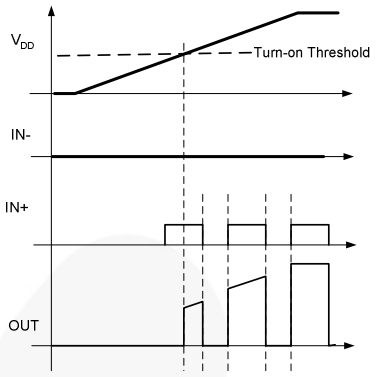


Figure 47. Non-Inverting Start-Up Waveforms

For the inverting configuration of Figure 46, start-up waveforms are shown in Figure 48. With IN+ tied to VDD and the input signal applied to IN–, the OUT pulses are inverted with respect to the input. At power up, the inverted output remains low until the V_{DD} voltage reaches the turn-on threshold, then it follows the input with inverted phase.

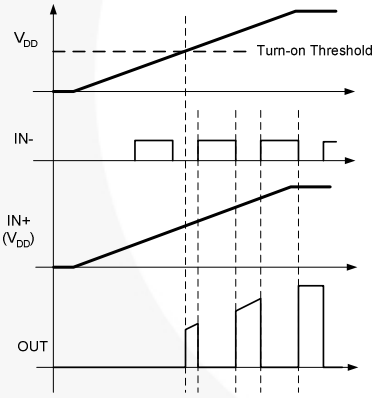


Figure 48. Inverting Start-Up Waveforms

Thermal Guidelines

Gate drivers used to switch MOSFETs and IGBTs at high frequencies can dissipate significant amounts of power. It is important to determine the driver power dissipation and the resulting junction temperature in the application to ensure that the part is operating within acceptable temperature limits.

The total power dissipation in a gate driver is the sum of two components; P_{GATE} and $P_{DYNAMIC}$:

$$P_{TOTAL} = P_{GATE} + P_{DYNAMIC} \quad (1)$$

Gate Driving Loss: The most significant power loss results from supplying gate current (charge per unit time) to switch the load MOSFET on and off at the switching frequency. The power dissipation that results from driving a MOSFET at a specified gate-source voltage, V_{GS}, with gate charge, Q_G, at switching frequency, f_{SW}, is determined by:

$$P_{GATE} = Q_G \bullet V_{GS} \bullet F_{SW} \quad (2)$$

Dynamic Pre-drive / Shoot-through Current: A power loss resulting from internal current consumption under dynamic operating conditions, including pin pull-up / pull-down resistors, can be obtained using the *I_{DD} (no-Load) vs. Frequency* graphs in Typical Performance Characteristics to determine the current $I_{DYNAMIC}$ drawn from V_{DD} under actual operating conditions:

$$P_{DYNAMIC} = I_{DYNAMIC} \bullet V_{DD} \quad (3)$$

Once the power dissipated in the driver is determined, the driver junction rise with respect to circuit board can be evaluated using the following thermal equation, assuming ψ_{JB} was determined for a similar thermal design (heat sinking and air flow):

$$T_J = P_{TOTAL} \bullet \psi_{JB} + T_B \quad (4)$$

where:

T_J = driver junction temperature

ψ_{JB} = (psi) thermal characterization parameter relating temperature rise to total power dissipation

T_B = board temperature in location defined in the Thermal Characteristics table.

In a typical forward converter application with 48V input, as shown in Figure 49, the FDS2672 would be a potential MOSFET selection. The typical gate charge would be 32nC with V_{GS} = V_{DD} = 10V. Using a TTL input driver at a switching frequency of 500kHz, the total power dissipation can be calculated as:

$$P_{GATE} = 32nC \bullet 10V \bullet 500kHz = 0.160W \quad (5)$$

$$P_{DYNAMIC} = 8mA \bullet 10V = 0.080W \quad (6)$$

$$P_{TOTAL} = 0.24W \quad (7)$$

The 5-pin SOT23 has a junction-to-lead thermal characterization parameter ψ_{JB} = 51°C/W.

In a system application, the localized temperature around the device is a function of the layout and construction of the PCB along with airflow across the surfaces. To ensure reliable operation, the maximum junction temperature of the device must be prevented from exceeding the maximum rating of 150°C; with 80% derating, T_J would be limited to 120°C. Rearranging Equation 4 determines the board temperature required to maintain the junction temperature below 120°C:

$$T_{B,MAX} = T_J - P_{TOTAL} \bullet \psi_{JB} \quad (8)$$

$$T_{B,MAX} = 120°C – 0.24W \bullet 51°C/W = 108°C \quad (9)$$

For comparison purposes, replace the 5-pin SOT23 used in the previous example with the 6-pin MLP package with ψ_{JB} = 2.8°C/W. The 6-pin MLP package can operate at a PCB temperature of 119°C, while maintaining the junction temperature below 120°C. This illustrates that the physically smaller MLP package with thermal pad offers a more conductive path to remove the heat from the driver. Consider the tradeoffs between reducing overall circuit size with junction temperature reduction for increased reliability.

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Typical Application Diagrams

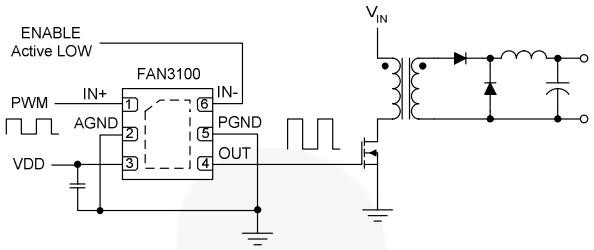


Figure 49. Forward Converter, Primary-Side Gate Drive (MLP Package Shown)

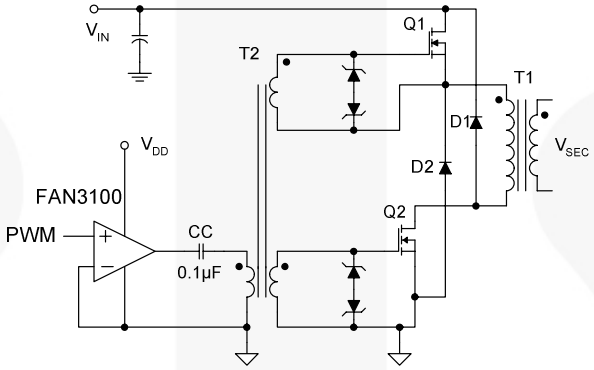


Figure 50. Driver for Two-Transistor Forward Converter Gate Transformer

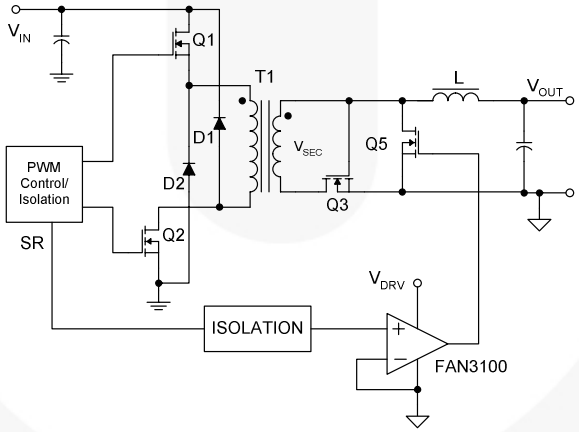


Figure 51. Secondary Synchronous Rectifier Driver

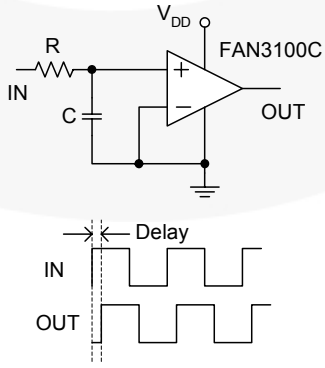


Figure 52. Programmable Time Delay Using CMOS Input

Table 1. Related Products

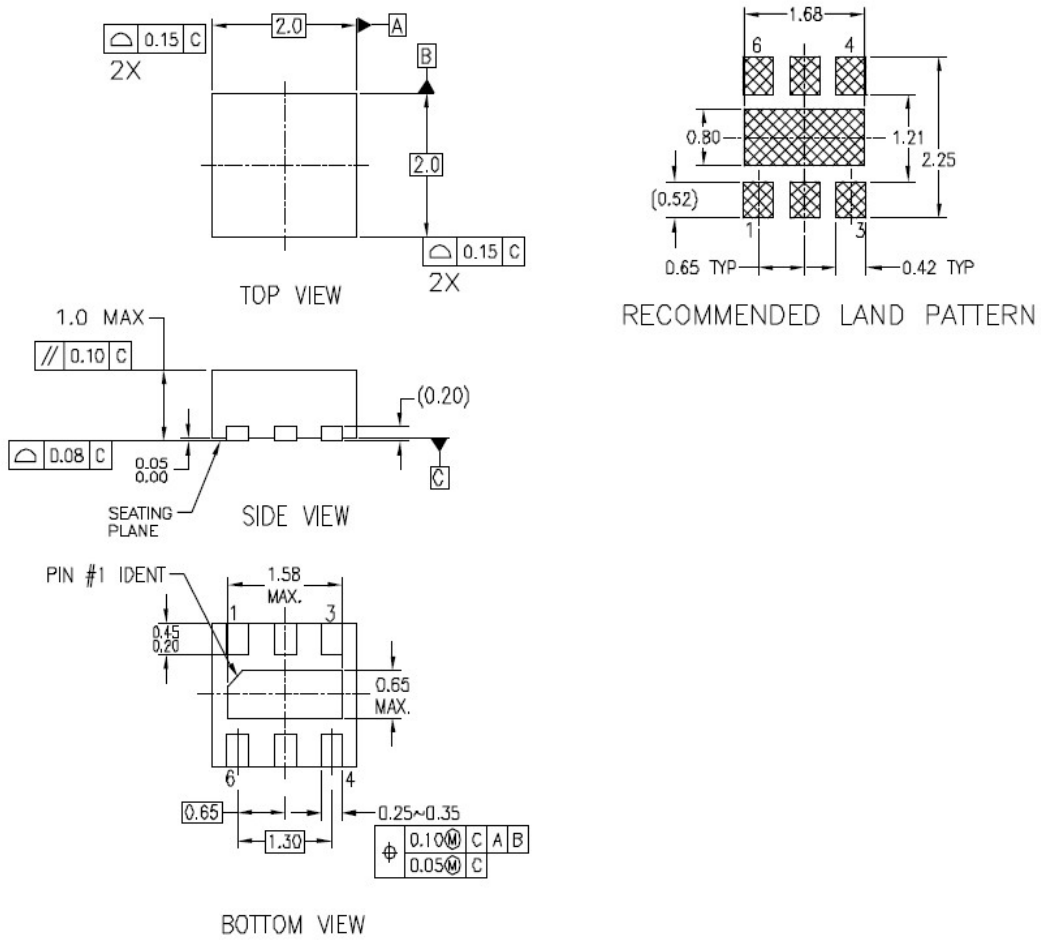
Part Number	Type	Gate Drive[11] (Sink/Src)	Input Threshold	Logic	Package
FAN3100C	**Single 2A**	**+2.5A / -1.8A**	**CMOS**	**Single Channel of Two-Input/One-Output**	**SOT23-5, MLP6**
FAN3100T	**Single 2A**	**+2.5A / -1.8A**	**TTL**	**Single Channel of Two-Input/One-Output**	**SOT23-5, MLP6**
FAN3226C	Dual 2A	+2.4A / -1.6A	CMOS	Dual Inverting Channels + Dual Enable	SOIC8, MLP8
FAN3226T	Dual 2A	+2.4A / -1.6A	TTL	Dual Inverting Channels + Dual Enable	SOIC8, MLP8
FAN3227C	Dual 2A	+2.4A / -1.6A	CMOS	Dual Non-Inverting Channels + Dual Enable	SOIC8, MLP8
FAN3227T	Dual 2A	+2.4A / -1.6A	TTL	Dual Non-Inverting Channels + Dual Enable	SOIC8, MLP8
FAN3228C	Dual 2A	+2.4A / -1.6A	CMOS	Dual Channels of Two-Input/One-Output, Pin Config.1	SOIC8, MLP8
FAN3228T	Dual 2A	+2.4A / -1.6A	TTL	Dual Channels of Two-Input/One-Output, Pin Config.1	SOIC8, MLP8
FAN3229C	Dual 2A	+2.4A / -1.6A	CMOS	Dual Channels of Two-Input/One-Output, Pin Config.2	SOIC8, MLP8
FAN3229T	Dual 2A	+2.4A / -1.6A	TTL	Dual Channels of Two-Input/One-Output, Pin Config.2	SOIC8, MLP8
FAN3223C	Dual 4A	+4.3A / -2.8A	CMOS	Dual Inverting Channels + Dual Enable	SOIC8, MLP8
FAN3223T	Dual 4A	+4.3A / -2.8A	TTL	Dual Inverting Channels + Dual Enable	SOIC8, MLP8
FAN3224C	Dual 4A	+4.3A / -2.8A	CMOS	Dual Non-Inverting Channels + Dual Enable	SOIC8, MLP8
FAN3224T	Dual 4A	+4.3A / -2.8A	TTL	Dual Non-Inverting Channels + Dual Enable	SOIC8, MLP8
FAN3225C	Dual 4A	+4.3A / -2.8A	CMOS	Dual Channels of Two-Input/One-Output	SOIC8, MLP8
FAN3225T	Dual 4A	+4.3A / -2.8A	TTL	Dual Channels of Two-Input/One-Output	SOIC8, MLP8

Note:

11. Typical currents with OUT at 6V and V_{DD} = 12V.

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Physical Dimensions



NOTES:

A. CONFORMS TO JEDEC REGISTRATION MO-229, VARIATION VCCC, DATED 11/2001
B. DIMENSIONS ARE IN MILLIMETERS.
C. DIMENSIONS AND TOLERANCES PER ASME Y14.5M, 1994

MLP06BrevA

Figure 53. 2x2mm, 6-Lead Molded Leadless Package (MLP)

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Physical Dimensions (Continued)

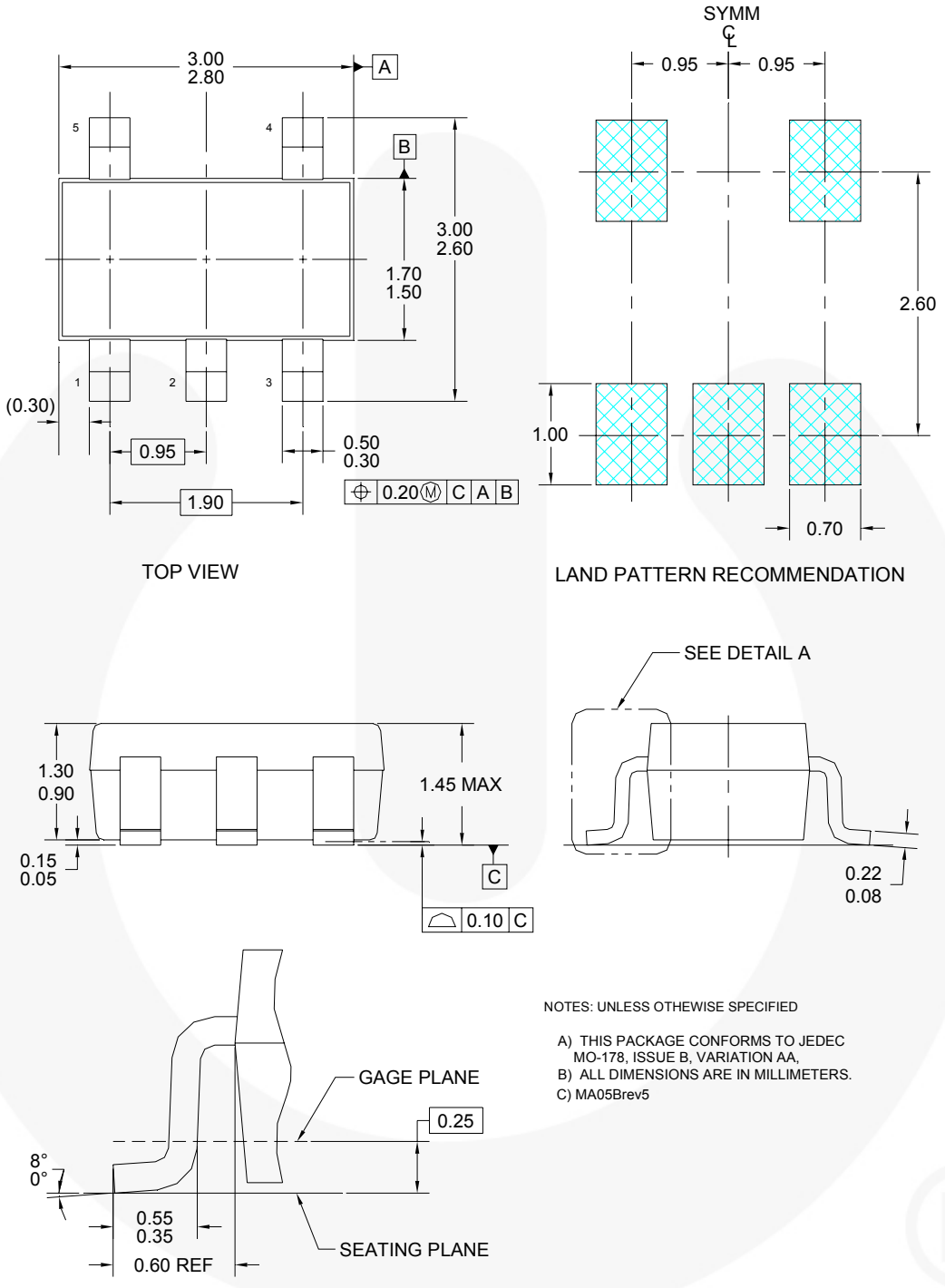


Figure 54. 5-Lead SOT-23

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FPS™
F-PFS™
FRFET®
Global Power Resource℠
Green FPS™
Green FPS™ e-Series™
GTO™
IntelliMAX™
ISOPLANAR™
MegaBuck™
MICROCOUPLER™
MicroFET™
MicroPak™
MillerDrive™
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Power-SPM™
PowerTrench®
Programmable Active Droop™
QFET®
QS™
Quiet Series™
RapidConfigure™
Saving our world, 1mW at a time™
SmartMax™
SMART START™
SPM®
STEALTH™
SuperFET™
SuperSOT™-3
SuperSOT™-6
SuperSOT™-8
SupreMOS™
SyncFET™
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the power franchise
TinyBoost™
TinyBuck™
TinyLogic®
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TinyPower™
TinyPWM™
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Datasheet Identification	Product Status	Definition
Advance Information	Formative / In Design	This datasheet contains the design specifications for product development. Specifications may change in any manner without notice.
Preliminary	First Production	This datasheet contains preliminary data; supplementary data will be published at a later date. Fairchild Semiconductor reserves the right to make changes at any time without notice to improve design.
No Identification Needed	Full Production	This datasheet contains final specifications. Fairchild Semiconductor reserves the right to make changes at any time without notice to improve the design.
Obsolete	Not In Production	This datasheet contains specifications on a product that is discontinued by Fairchild Semiconductor. The datasheet is for reference information only.

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