Data Sheet | October 21, 2004 | FN9025.8

100V/2A Peak, Low Cost, High Frequency Half Bridge Driver

The HIP2101 is a high frequency, 100V Half Bridge N-Channel power MOSFET driver IC. It is equivalent to the HIP2100 with the added advantage of full TTL/CMOS compatible logic input pins. The low-side and high-side gate drivers are independently controlled and matched to 13ns. This gives users total control over dead-time for specific power circuit topologies. Undervoltage protection on both the low-side and high-side supplies force the outputs low. An on-chip diode eliminates the discrete diode required with other driver ICs. A new level-shifter topology yields the low-power benefits of pulsed operation with the safety of DC operation. Unlike some competitors, the high-side output returns to its correct state after a momentary undervoltage of the high-side supply.

Ordering Information

PART NUMBER	TEMP. RANGE (°C)	PACKAGE	PKG. DWG. #
HIP2101IB	-40 to 125	8 Ld SOIC	M8.15
HIP2101IBZ (Note 1)	-40 to 125	8 Ld SOIC (Pb-free)	M8.15
HIP2101EIB	-40 to 125	8 Ld EPSOIC	M8.15C
HIP2101EIBZ (Note 1)	-40 to 125	8 Ld EPSOIC (Pb-free)	M8.15C
HIP2101IR	-40 to 125	16 Ld 5x5 QFN	L16.5x5
HIP2101IRZ (Note 1)	-40 to 125	16 Ld 5x5 QFN (Pb-free)	L16.5x5
HIP2101IR4	-40 to 125	12 Ld 4x4 DFN	L12.4x4A
HIP2101IR4Z (Note 1)	-40 to 125	12 Ld 4x4 DFN (Pb-free)	L12.4x4A

NOTES:

1. Intersil Pb-free products employ special Pb-free material sets; molding compounds/die attach materials and 100% matte tin plate termination finish, which are RoHS compliant and compatible with both SnPb and Pb-free soldering operations. Intersil Pb-free products are MSL classified at Pb-free peak reflow temperatures that meet or exceed the Pb-free requirements of IPC/JEDEC J STD-020C.
2. Add “T” suffix for Tape and Reel packing option.

Features

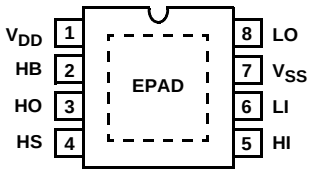
- Drives N-Channel MOSFET Half Bridge
- SOIC, EPSOIC, QFN and DFN Package Options
- SOIC, EPSOIC and DFN Packages Compliant with 100V Conductor Spacing Guidelines of IPC-2221
- Pb-free Product Available (RoHS Compliant)
- Bootstrap Supply Max Voltage to 114VDC
- On-Chip 1Ω Bootstrap Diode
- Fast Propagation Times for Multi-MHz Circuits
- Drives 1000pF Load with Rise and Fall Times Typ. 10ns
- TTL/CMOS Input Thresholds Increase Flexibility
- Independent Inputs for Non-Half Bridge Topologies
- No Start-Up Problems
- Outputs Unaffected by Supply Glitches, HS Ringing Below Ground, or HS Slewing at High dv/dt
- Low Power Consumption
- Wide Supply Range
- Supply Undervoltage Protection
- 3Ω Output Driver Resistance
- QFN/DFN Package:
  - Compliant to JEDEC PUB95 MO-220 QFN - Quad Flat No Leads - Package Outline
  - Near Chip Scale Package footprint, which improves PCB efficiency and has a thinner profile

Applications

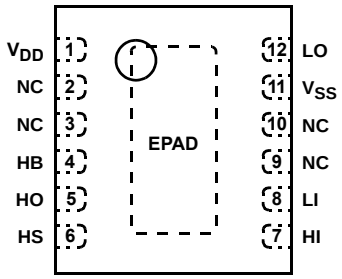
- Telecom Half Bridge Power Supplies
- Avionics DC-DC Converters
- Two-Switch Forward Converters
- Active Clamp Forward Converters

Pinouts

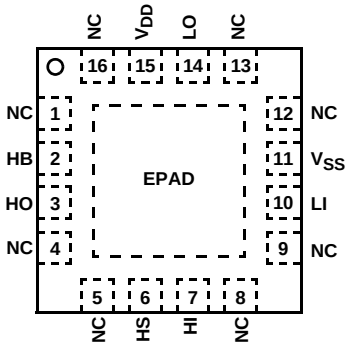
HIP2101 (SOIC, EPSOIC)
TOP VIEW



HIP2101IR4 (DFN)
TOP VIEW

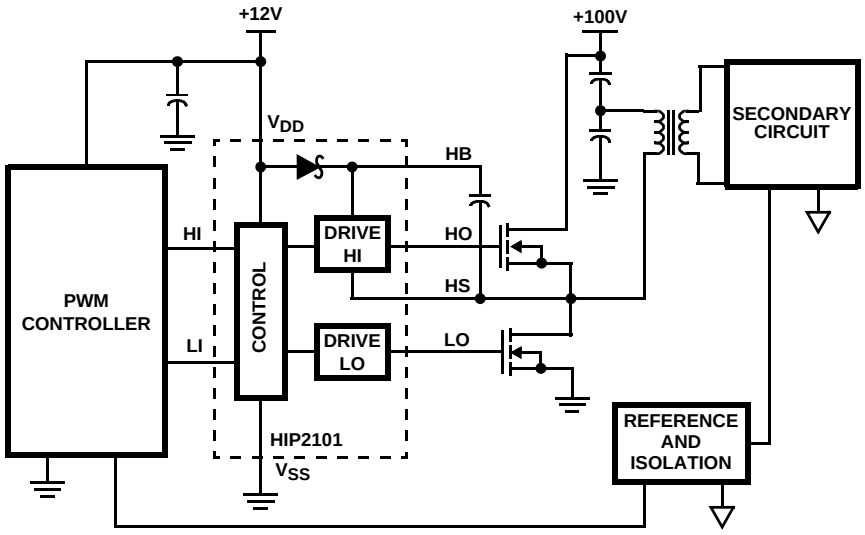


HIP2101 (QFN)
TOP VIEW

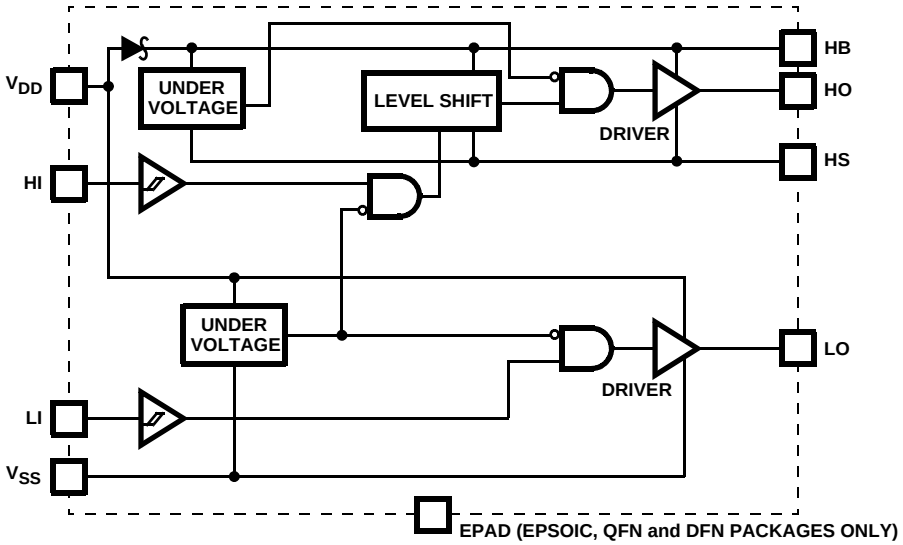


NOTE: EPAD = Exposed PAD.

Application Block Diagram



Functional Block Diagram



*EPAD = Exposed Pad. The EPAD is electrically isolated from all other pins. For best thermal performance connect the EPAD to the PCB power ground plane.

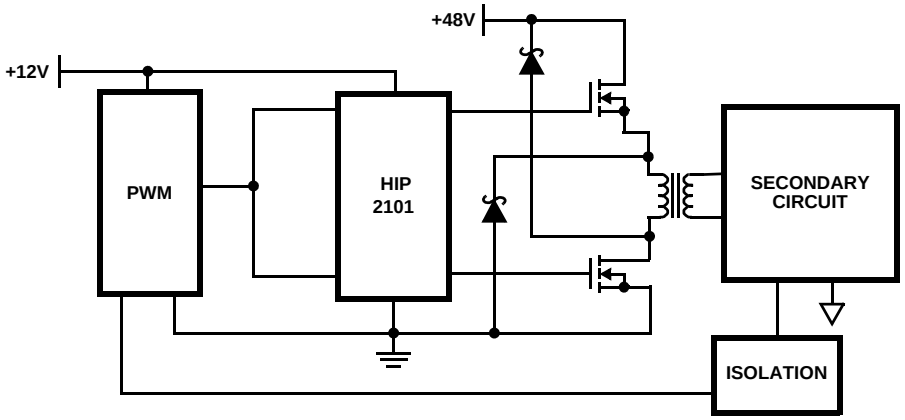


FIGURE 1. TWO-SWITCH FORWARD CONVERTER

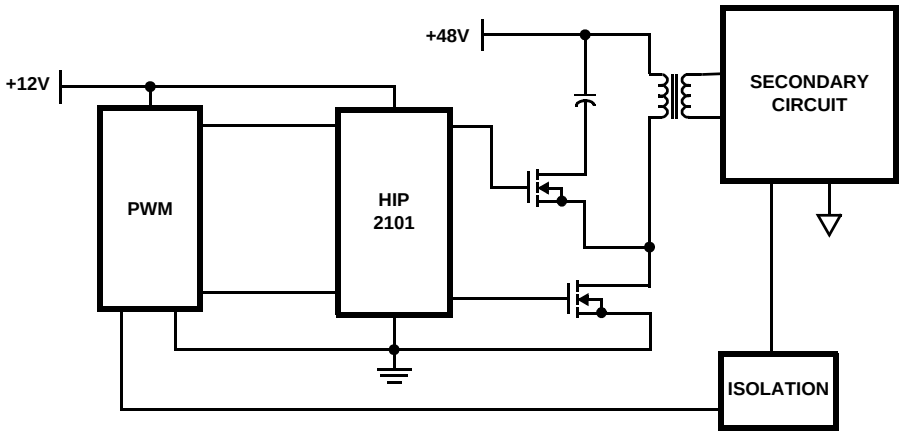


FIGURE 2. FORWARD CONVERTER WITH AN ACTIVE CLAMP

Absolute Maximum Ratings

Supply Voltage, V_{DD}, V_{HB}-V_{HS} (Notes 3, 4) . . . . . -0.3V to 18V
LI and HI Voltages (Note 4) . . . . . -0.3V to 7.0V
Voltage on LO (Note 4) . . . . . -0.3V to V_{DD} +0.3V
Voltage on HO (Note 4) . . . . . V_{HS} -0.3V to V_{HB} +0.3V
Voltage on HS (Continuous) (Note 4) . . . . . -1V to 110V
Voltage on HB (Note 4) . . . . . +118V
Average Current in V_{DD} to HB diode 100mA
ESD Classification . . . . . Class 1 (1kV)

Maximum Recommended Operating Conditions

Supply Voltage, V_{DD} . . . . . +9V to 14.0VDC
Voltage on HS . . . . . -1V to 100V
Voltage on HS . . . . . (Repetitive Transient) -5V to 105V
Voltage on HB . . V_{HS} +8V to V_{HS} +14.0V and V_{DD} -1V to V_{DD} +100V
HS Slew Rate. . . . . <50V/ns

Thermal Information

Thermal Resistance (Typical)	θ_{JA} (°C/W)	θ_{JC} (°C/W)
SOIC (Note 5)	95	N/A
EPSOIC (Note 6)	40	3.0
QFN (Note 6)	37	6.5
DFN (Note 6)	40	3.0

Max Power Dissipation at 25°C in Free Air (SOIC, Note 5) 1.3W
Max Power Dissipation at 25°C in Free Air (EPSOIC, Note 6). . 3.1W
Max Power Dissipation at 25°C in Free Air (QFN, Note 6). 3.3W
Storage Temperature Range . . . . . -65°C to 150°C
Junction Temperature Range . . . . . -55°C to 150°C
Lead Temperature (Soldering 10s - SOIC Lead Tips Only). . 300°C
For Recommended soldering conditions see Tech Brief TB389.

CAUTION: Stresses above those listed in "Absolute Maximum Ratings" may cause permanent damage to the device. This is a stress only rating and operation of the device at these or any other conditions above those indicated in the recommended operating conditions of this specification is not implied.

NOTES:

3. The HIP2101 is capable of derated operation at supply voltages exceeding 14V. Figure 16 shows the high-side voltage derating curve for this mode of operation.
4. All voltages referenced to V_{SS} unless otherwise specified.
5. θ_{JA} is measured with the component mounted on a high effective thermal conductivity test board in free air. See Tech Brief TB379 for details.
6. θ_{JA} is measured in free air with the component mounted on a high effective thermal conductivity test board with "direct attach" features. θ_{JC}, the "case temp" is measured at the center of the exposed metal pad on the package underside. See Tech Brief TB379.

Electrical Specifications

$V_{DD} = V_{HB} = 12V$, $V_{SS} = V_{HS} = 0V$, No Load on LO or HO, Unless Otherwise Specified

PARAMETERS	SYMBOL	TEST CONDITIONS	T_J = 25°C			T_J = -40°C TO 125°C		UNITS
			MIN	TYP	MAX	MIN	MAX	
SUPPLY CURRENTS								
V_{DD} Quiescent Current	I_{DD}	LI = HI = 0V	-	0.3	0.45	-	0.6	mA
V_{DD} Operating Current	I_{DDO}	f = 500kHz	-	1.7	3.0	-	3.4	mA
Total HB Quiescent Current	I_{HB}	LI = HI = 0V	-	0.1	0.15	-	0.2	mA
Total HB Operating Current	I_{HBO}	f = 500kHz	-	1.5	2.5	-	3	mA
HB to V_{SS} Current, Quiescent	I_{HBS}	$V_{HS} = V_{HB}$ = 114V	-	0.05	1.5	-	10	µA
HB to V_{SS} Current, Operating	I_{HBSO}	f = 500kHz	-	0.7	-	-	-	mA
INPUT PINS								
Low Level Input Voltage Threshold	V_{IL}		0.8	1.65	-	0.8	-	V
High Level Input Voltage Threshold	V_{IH}		-	1.65	2.2	-	2.2	V
Input Pulldown Resistance	R_I		-	200	-	100	500	kΩ
UNDER VOLTAGE PROTECTION								
V_{DD} Rising Threshold	V_{DDR}		7	7.3	7.8	6.5	8	V
V_{DD} Threshold Hysteresis	V_{DDH}		-	0.5	-	-	-	V
HB Rising Threshold	V_{HBR}		6.5	6.9	7.5	6	8	V
HB Threshold Hysteresis	V_{HBH}		-	0.4	-	-	-	V

Pin Descriptions

SYMBOL	DESCRIPTION
V_{DD}	Positive Supply to lower gate drivers. De-couple this pin to V_{SS}. Bootstrap diode connected to HB.
HB	High-Side Bootstrap supply. External bootstrap capacitor is required. Connect positive side of bootstrap capacitor to this pin. Bootstrap diode is on-chip.
HO	High-Side Output. Connect to gate of High-Side power MOSFET.
HS	High-Side Source connection. Connect to source of High-Side power MOSFET. Connect negative side of bootstrap capacitor to this pin.
HI	High-Side input.
LI	Low-Side input.
V_{SS}	Chip negative supply, generally will be ground.
LO	Low-Side Output. Connect to gate of Low-Side power MOSFET.
EPAD	Exposed pad. Connect to ground or float. The EPAD is electrically isolated from all other pins.

Timing Diagrams

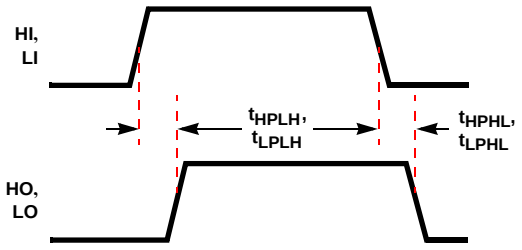


FIGURE 3.

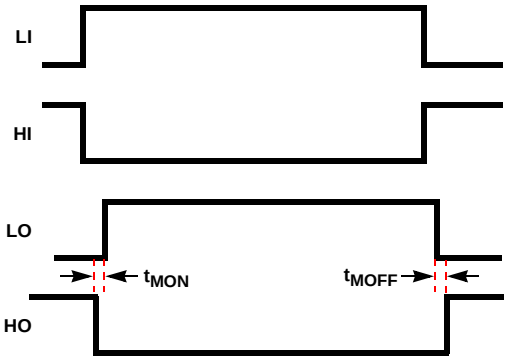


FIGURE 4.

Typical Performance Curves

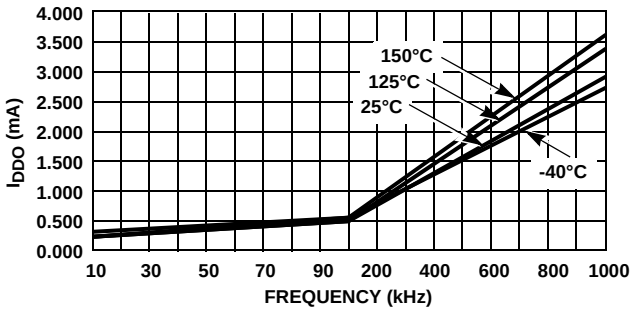


FIGURE 5A.

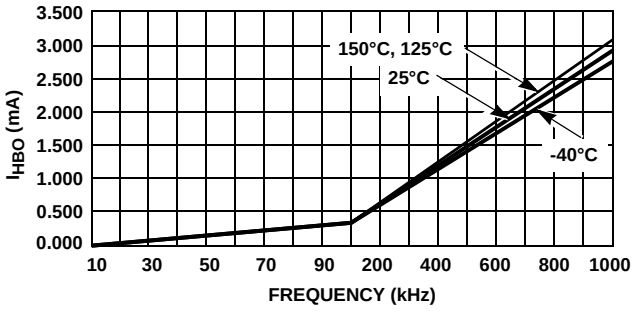


FIGURE 5B.

FIGURE 5. OPERATING CURRENT vs FREQUENCY

Typical Performance Curves (Continued)

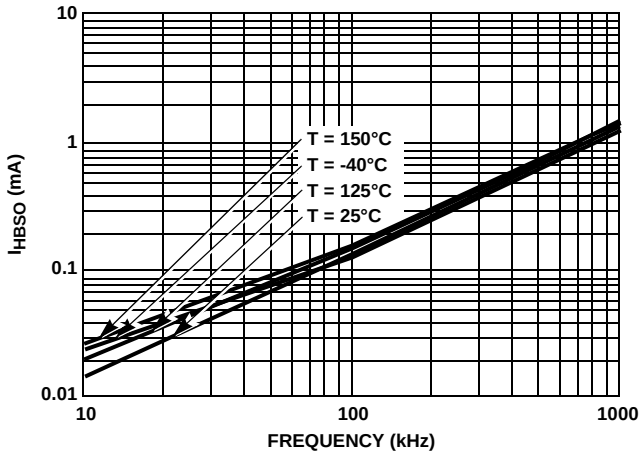


FIGURE 6. HB TO VSS OPERATING CURRENT vs FREQUENCY

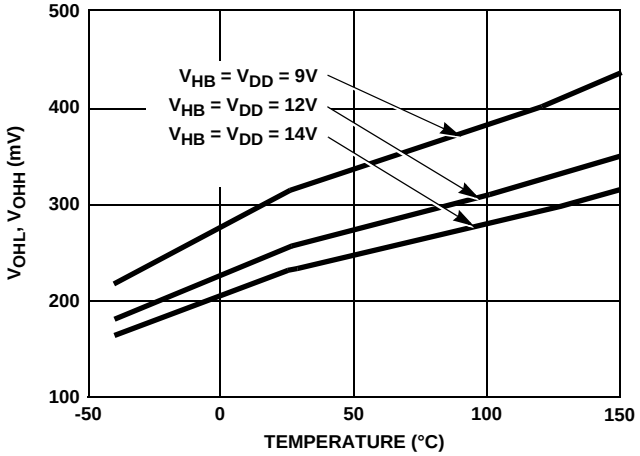


FIGURE 7. HIGH LEVEL OUTPUT VOLTAGE vs TEMPERATURE

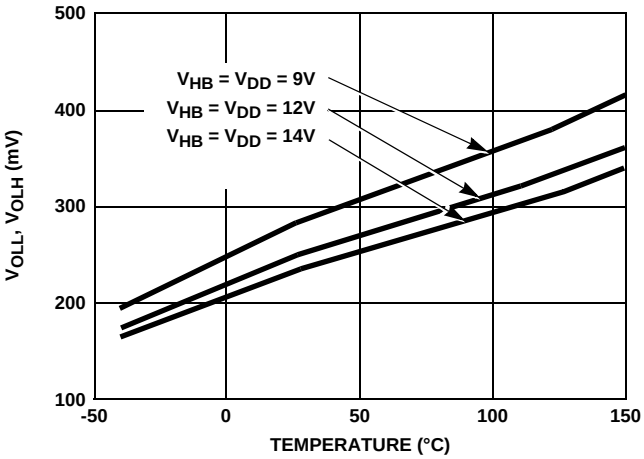


FIGURE 8. LOW LEVEL OUTPUT VOLTAGE vs TEMPERATURE

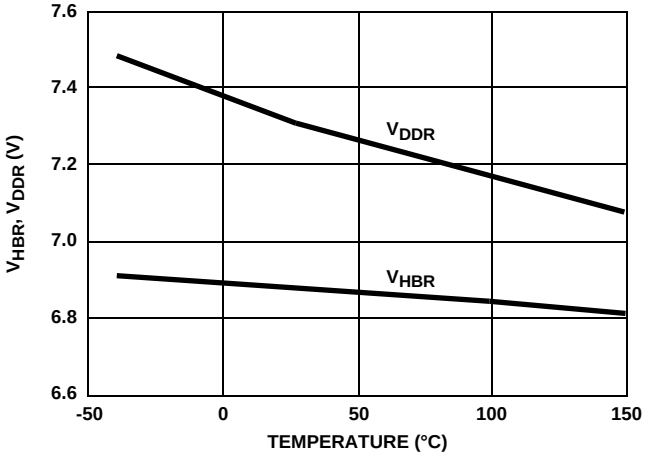


FIGURE 9. UNDERVOLTAGE LOCKOUT THRESHOLD vs TEMPERATURE

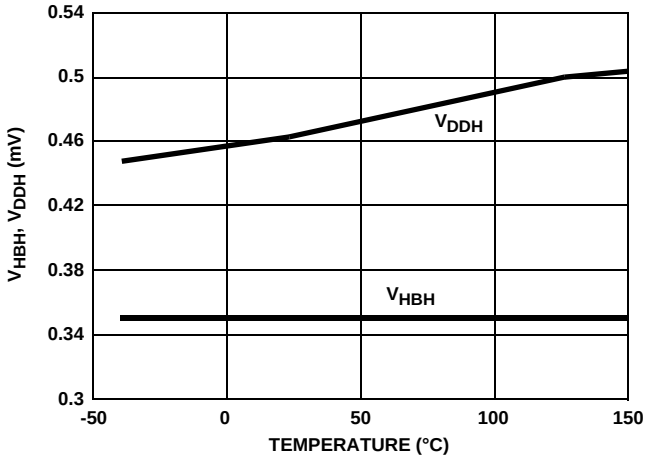


FIGURE 10. UNDERVOLTAGE LOCKOUT HYSTERESIS vs TEMPERATURE

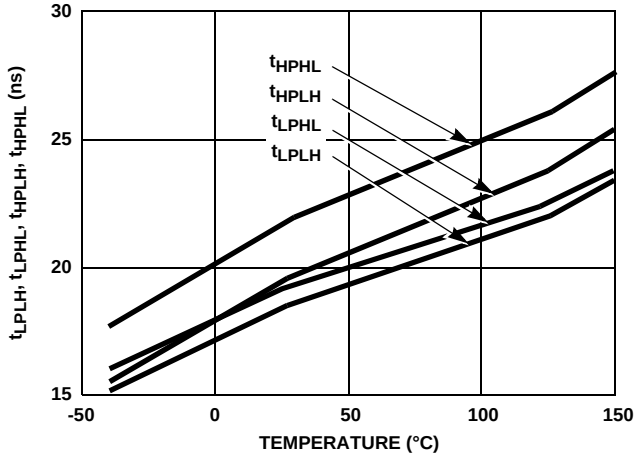


FIGURE 11. PROPAGATION DELAYS vs TEMPERATURE

Typical Performance Curves (Continued)

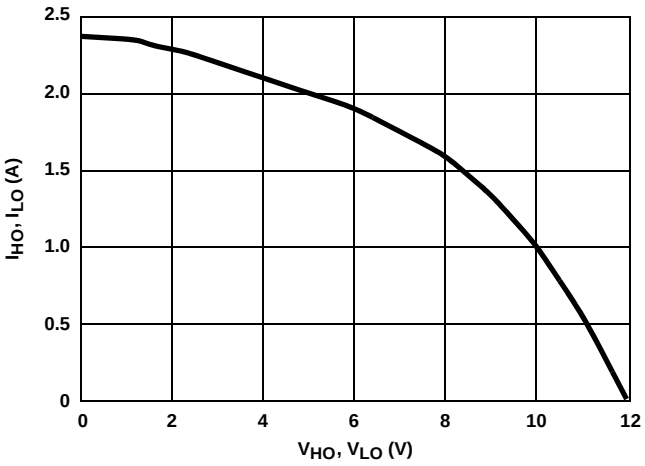


FIGURE 12. PEAK PULLUP CURRENT vs OUTPUT VOLTAGE

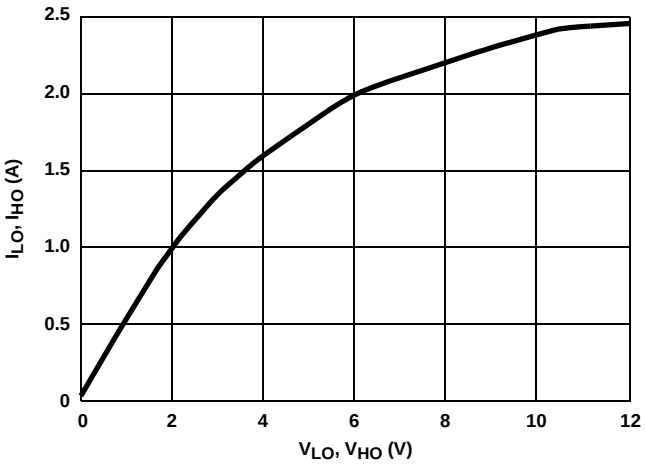


FIGURE 13. PEAK PULLDOWN CURRENT vs OUTPUT VOLTAGE

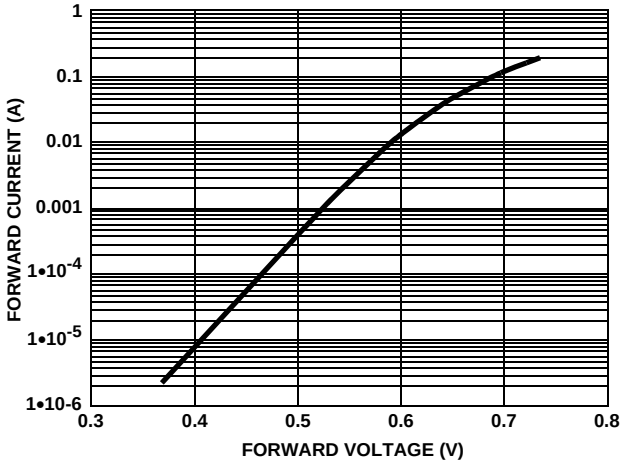


FIGURE 14. BOOTSTRAP DIODE I-V CHARACTERISTICS

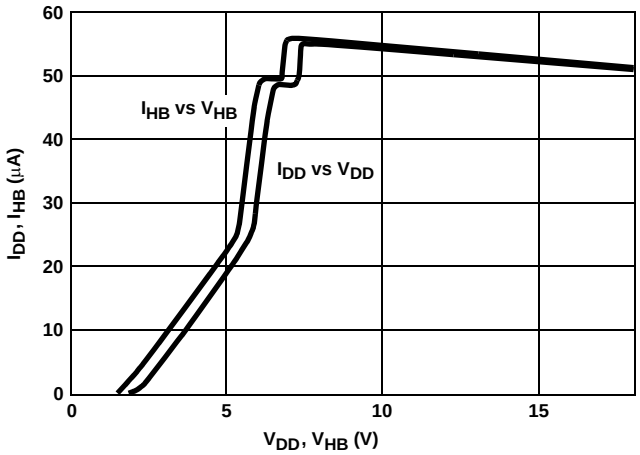


FIGURE 15. QUIESCENT CURRENT vs VOLTAGE

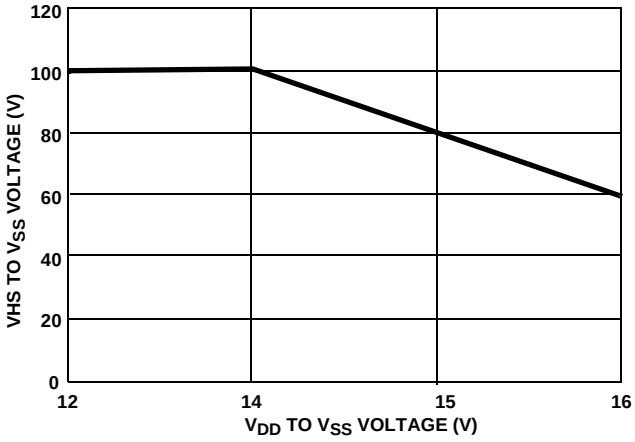
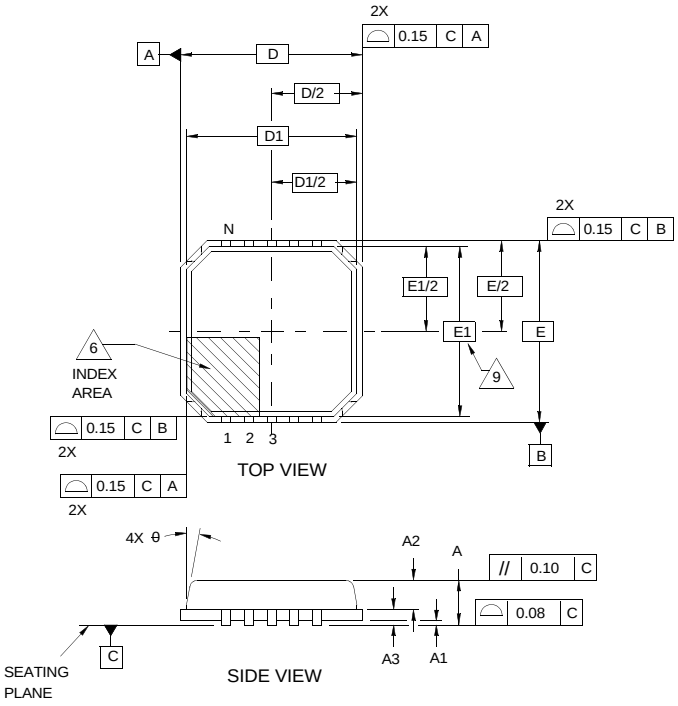
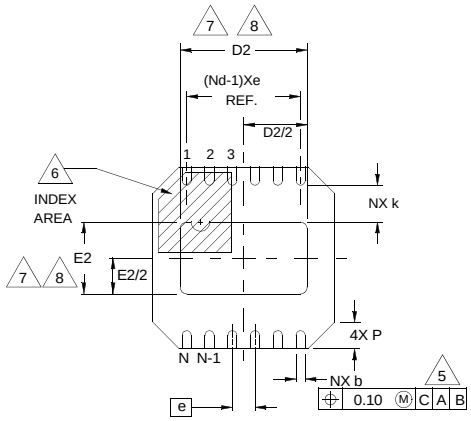
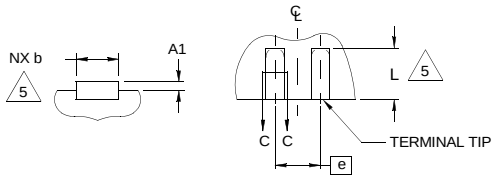


FIGURE 16. VHS VOLTAGE vs V_{DD} VOLTAGE

Dual Flat No-Lead Plastic Package (DFN)
Micro Lead Frame Plastic Package (MLFP)







L12.4x4A

12 LEAD DUAL FLAT NO-LEAD PLASTIC PACKAGE

SYMBOL	MILLIMETERS			NOTES
	MIN	NOMINAL	MAX	
A	-	0.85	0.90	-
A1	0.00	0.01	0.05	-
A2	-	0.65	0.70	-
A3		0.20 REF		-
b	0.18	0.23	0.30	5, 8
D		4.00 BSC		-
D1		3.75 BSC		-
D2	2.65	2.80	2.95	7, 8
E		4.00 BSC		-
E1		3.75 BSC		-
E2	1.43	1.58	1.73	7, 8
e		0.50 BSC		-
k	0.635	-	-	-
L	0.30	0.40	0.50	8
N		12		2
Nd		6		3
P	0.24	0.42	0.60	-
θ	-	-	12	-

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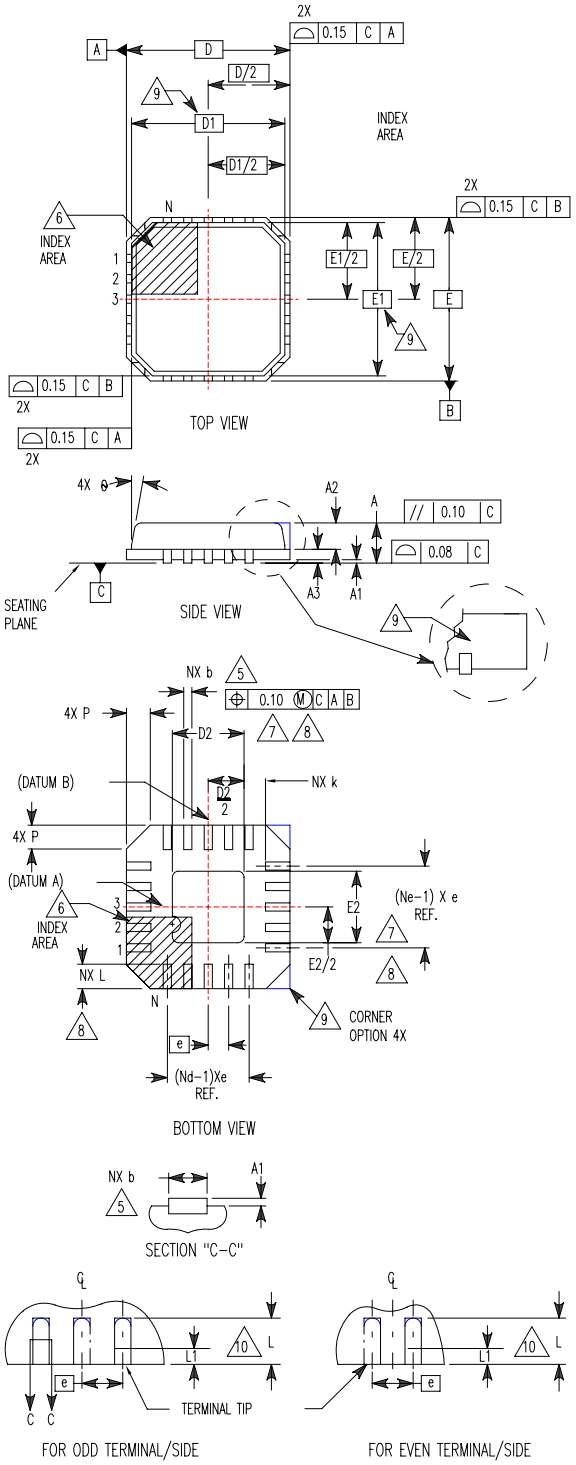
NOTES:

1. Dimensioning and tolerancing conform to ASME Y14.5M-1994.
2. N is the number of terminals.
3. Nd refer to the number of terminals on D.
4. All dimensions are in millimeters. Angles are in degrees.
5. Dimension b applies to the metallized terminal and is measured between 0.15mm and 0.30mm from the terminal tip.
6. The configuration of the pin #1 identifier is optional, but must be located within the zone indicated. The pin #1 identifier may be either a mold or mark feature.
7. Dimensions D2 and E2 are for the exposed pads which provide improved electrical and thermal performance.
8. Nominal dimensions are provided to assist with PCB Land Pattern Design efforts, see Intersil Technical Brief TB389.
9. COMPLIANT TO JEDEC MO-229-VGGD-2 ISSUE C except for the L dimension**.**

Quad Flat No-Lead Plastic Package (QFN)
Micro Lead Frame Plastic Package (MLFP)



L16.5x5

16 LEAD QUAD FLAT NO-LEAD PLASTIC PACKAGE (COMPLIANT TO JEDEC MO-220VHHB ISSUE C)

SYMBOL	MILLIMETERS			NOTES
	MIN	NOMINAL	MAX	
A	0.80	0.90	1.00	-
A1	-	-	0.05	-
A2	-	-	1.00	9
A3		0.20 REF		9
b	0.28	0.33	0.40	5, 8
D		5.00 BSC		-
D1		4.75 BSC		9
D2	2.55	2.70	2.85	7, 8
E		5.00 BSC		-
E1		4.75 BSC		9
E2	2.55	2.70	2.85	7, 8
e		0.80 BSC		-
k	0.25	-	-	-
L	0.35	0.60	0.75	8
L1	-	-	0.15	10
N		16		2
Nd		4		3
Ne	4	4		3
P	-	-	0.60	9
θ	-	-	12	9

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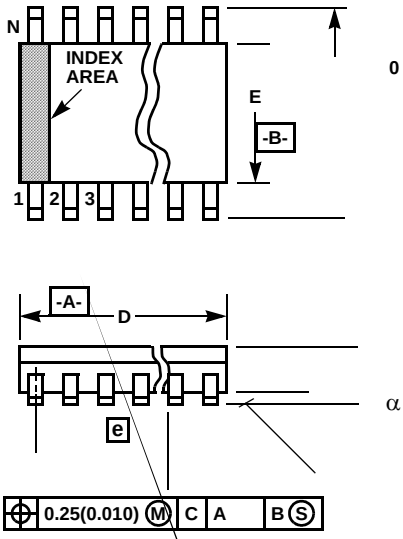
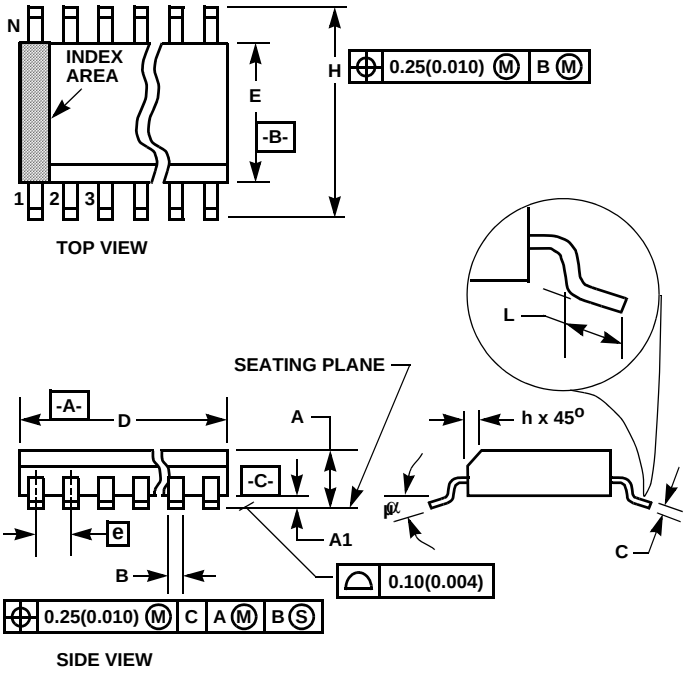
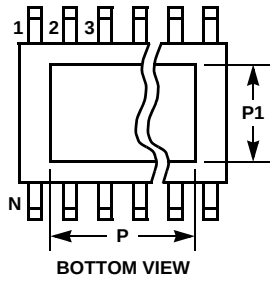
NOTES:

1. Dimensioning and tolerancing conform to ASME Y14.5-1994.
2. N is the number of terminals.
3. Nd and Ne refer to the number of terminals on each D and E.
4. All dimensions are in millimeters. Angles are in degrees.
5. Dimension b applies to the metallized terminal and is measured between 0.15mm and 0.30mm from the terminal tip.
6. The configuration of the pin #1 identifier is optional, but must be located within the zone indicated. The pin #1 identifier may be either a mold or mark feature.
7. Dimensions D2 and E2 are for the exposed pads which provide improved electrical and thermal performance.
8. Nominal dimensions are provided to assist with PCB Land Pattern Design efforts, see Intersil Technical Brief TB389.
9. Features and dimensions A2, A3, D1, E1, P & θ are present when Anvil singulation method is used and not present for saw singulation.
10. Depending on the method of lead termination at the edge of the package, a maximum 0.15mm pull back (L1) maybe present. L minus L1 to be equal to or greater than 0.3mm.


N
INDEX
AREA
E
-B-
1
2
3
0
-A-
D
e
α
0.25(0.010) M C A B S

Small Outline Exposed Pad Plastic Packages (EPSOIC)





M8.15C

8 LEAD NARROW BODY SMALL OUTLINE EXPOSED PAD PLASTIC PACKAGE

SYMBOL	INCHES		MILLIMETERS		NOTES
	MIN	MAX	MIN	MAX	
A	0.056	0.066	1.43	1.68	-
A1	0.001	0.005	0.03	0.13	-
B	0.0138	0.0192	0.35	0.49	9
C	0.0075	0.0098	0.19	0.25	-
D	0.189	0.196	4.80	4.98	3
E	0.150	0.157	3.811	3.99	4
e	0.050 BSC		1.27 BSC		-
H	0.230	0.244	5.84	6.20	-
h	0.010	0.016	0.25	0.41	5
L	0.016	0.035	0.41	0.89	6
N	8		8		7
α	0^o	8^o	0^o	8^o	-
P	-	0.126	-	3.200	11
P1	-	0.099	-	2.514	11

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NOTES:

1. Symbols are defined in the “MO Series Symbol List” in Section 2.2 of Publication Number 95.
2. Dimensioning and tolerancing per ANSI Y14.5M-1982.
3. Dimension “D” does not include mold flash, protrusions or gate burrs. Mold flash, protrusion and gate burrs shall not exceed 0.15mm (0.006 inch) per side.
4. Dimension “E” does not include interlead flash or protrusions. Interlead flash and protrusions shall not exceed 0.25mm (0.010 inch) per side.
5. The chamfer on the body is optional. If it is not present, a visual index feature must be located within the crosshatched area.
6. “L” is the length of terminal for soldering to a substrate.
7. “N” is the number of terminal positions.
8. Terminal numbers are shown for reference only.
9. The lead width “B”, as measured 0.36mm (0.014 inch) or greater above the seating plane, shall not exceed a maximum value of 0.61mm (0.024 inch).
10. Controlling dimension: MILLIMETER. Converted inch dimensions are not necessarily exact.
11. Dimensions “P” and “P1” are thermal and/or electrical enhanced variations. Values shown are maximum size of exposed pad within lead count and body size.