MP1921A

100V, 2.5A, High Frequency Half-Bridge Gate Driver

The Future of Analog IC Technology

DESCRIPTION

The MP1921A is a high-frequency, 100V, half bridge, N-channel power MOSFET driver. Its low side and high side driver channels are independently controlled and matched with a time delay of less than 5ns. Under-voltage lockout on both high side and low side supplies force their outputs low in case of insufficient supply. The integrated bootstrap diode reduces external component count.

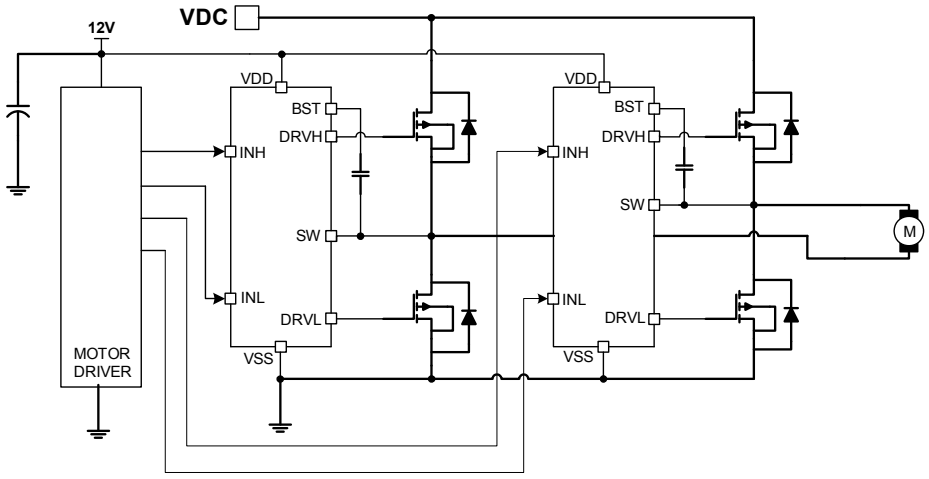
FEATURES

- Drives N-Channel MOSFET Half Bridge
- 120V V_{BST} Voltage Range
- On-Chip Bootstrap Diode
- Typical 16ns Propagation Delay Time
- Less Than 5ns Gate Drive Matching
- Drives 1nf Load with 12ns/9ns Rise/Fall Times with 12V VDD
- TTL Compatible Input
- Less Than 150μA Quiescent Current
- UVLO for Both High Side and Low Side
- In SOIC8E, SOIC-8, 3×3mm QFN8, 3×3mm QFN9 and 4x4mm QFN10 Packages

APPLICATIONS

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

TYPICAL APPLICATION



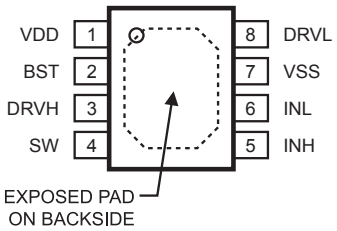
ORDERING INFORMATION

Part Number	Package	Top Marking
MP1921HN-A*	SOIC8E	MP1921-A
MP1921HQ-A	QFN8 (3x3mm)	AHA
MP1921HQE-A	QFN9 (3x3mm)	AHL
MP1921HR-A	QFN10 (4x4mm)	MP1921 A
MP1921HS-A	SOIC-8	MP1921-A

* For Tape & Reel, add suffix –Z (e.g. MP1921HN–A–Z);
For RoHS compliant packaging, add suffix –LF (e.g. MP1921HN–A–LF–Z)

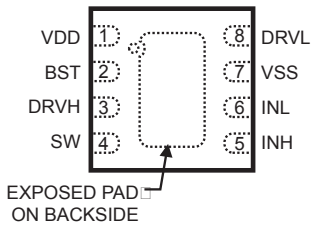
PACKAGE REFERENCE

TOP VIEW



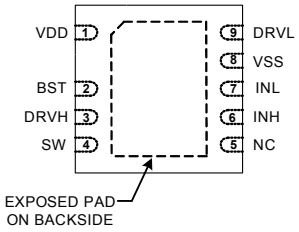
SOIC8EP

TOP VIEW



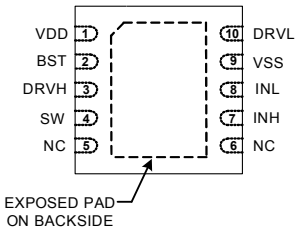
QFN8

TOP VIEW



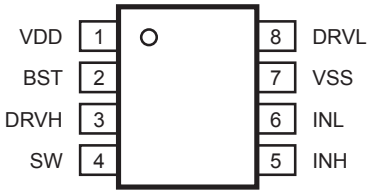
QFN9

TOP VIEW



QFN10

TOP VIEW



SOIC-8

ABSOLUTE MAXIMUM RATINGS (1)

Supply Voltage (V_{DD})..... -0.3V to +20V
SW Voltage (V_{SW}) .....
..... -5.0V (-15V for <100ns) to +105V
BST Voltage (V_{BST}) ..... -0.3V to +120V
BST to SW ..... -0.3V to +18V
DRVH to SW..... -0.3V (-5V for <100ns) to (BST-SW) + 0.3V
DRVL to VSS ..... -0.3V to (VDD + 0.3V)
All Other Pins ..... -0.3V to (V_{DD} + 0.3V)
Continuous Power Dissipation (T_A =25°C) (2)
SOIC8E 2.6W
QFN8 (3x3mm) 2.5W
QFN9 (3x3mm) 2.5W
QFN10 (4x4mm) 2.66W
SOIC-8 ..... 1.3W
Junction Temperature..... 150°C
Lead Temperature ..... 260°C
Storage Temperature.....-65°C to +150°C

Recommended Operating Conditions (3)

Supply Voltage (V_{DD})..... 9.0V to 18V
SW Voltage (V_{SW}) .....
.....-1.0V to +100V
SW slew rate..... <50V/nsec
Operating Junction Temp. (T_J). -40°C to +125°C

Thermal Resistance (4)	θ_{JA}	θ_{JC}	
SOIC8E	48	10	°C/W
QFN8 (3x3mm)	50	12	°C/W
QFN9 (3x3mm)	50	12	°C/W
QFN10 (4x4mm)	47	7	°C/W
SOIC-8	96	45	°C/W

Notes:

1) Exceeding these ratings may damage the device.
2) The maximum allowable power dissipation is a function of the maximum junction temperature T_J(MAX), the junction-to-ambient thermal resistance θ_{JA}, and the ambient temperature T_A. The maximum allowable continuous power dissipation at any ambient temperature is calculated by P_D(MAX)=(T_J(MAX)-T_A)/ θ_{JA}. Exceeding the maximum allowable power dissipation will cause excessive die temperature, and the regulator will go into thermal shutdown. Internal thermal shutdown circuitry protects the device from permanent damage.
3) The device is not guaranteed to function outside of its operating conditions.
4) Measured on JESD51-7, 4-layer PCB.

ELECTRICAL CHARACTERISTICS

V_{DD} = V_{BST}-V_{SW}=12V, V_{SS}=V_{SW} = 0V, No load at DRVH and DRVL, T_A= 25°C, unless otherwise noted.

Parameter	Symbol	Condition	Min	Typ	Max	Units
Supply Currents						
VDD quiescent current	I_{DDQ}	INL=INH=0		100	150	μA
VDD operating current	I_{DDO}	f_{sw}=500kHz		2.8	3.5	mA
Floating driver quiescent current	I_{BSTQ}	INL=INH=0		60	90	μA
Floating driver operating current	I_{BSTO}	f_{sw}=500kHz		2.1	3	mA
Leakage Current	I_{LK}	BST=SW=100V		0.05	1	μA
Inputs						
INL/INH High				2	2.4	V
INL/INH Low			1	1.4		V
INL/INH internal pull-down resistance	R_{IN}			185		kΩ
Under Voltage Protection						
VDD rising threshold	V_{DDR}		7.7	8.1	8.5	V
VDD hysteresis	V_{DDH}			0.5		V
(BST-SW) rising threshold	V_{BSTR}		6.7	7.1	7.5	V
(BST-SW) hysteresis	V_{BSTH}			0.55		V
Bootstrap Diode						
Bootstrap diode VF @ 100uA	V_{F1}			0.5		V
Bootstrap diode VF @ 100mA	V_{F2}			0.9		V
Bootstrap diode dynamic R	R_D	@ 100mA		2.5		Ω
Low Side Gate Driver						
Low level output voltage	V_{OLL}	I_O=100mA		0.15	0.22	V
High level output voltage to rail	V_{OHL}	I_O=-100mA		0.45	0.6	V
Peak pull-up current	I_{OHL}	V_{DRVL}=0V, V_{DD}=12V		1.5		A
		V_{DRVL}=0V, V_{DD}=16V		2.5		A
Peak pull-down current	I_{OLL}	V_{DRVL}=V_{DD}=12V		2.5		A
		V_{DRVL}=V_{DD}=16V		3.5		A
Floating Gate Driver						
Low level output voltage	V_{OLH}	I_O=100mA		0.15	0.22	V
High level output voltage to rail	V_{OHH}	I_O=-100mA		0.45	0.6	V
Peak pull-up current	I_{OHH}	V_{DRVH}=0V, V_{DD}=12V		1.5		A
		V_{DRVH}=0V, V_{DD}=16V		2.5		A
Peak pull-down current	I_{OLH}	V_{DRVH}=V_{DD}=12V		2.5		A
		V_{DRVH}=V_{DD}=16V		3.5		A

ELECTRICAL CHARACTERISTICS *(continued)*

V_{DD} = V_{BST}-V_{SW}=12V, V_{SS}=V_{SW} = 0V, No load at DRVH and DRVL, T_A= 25°C, unless otherwise noted.

Parameter	Symbol	Condition	Min	Typ	Max	Units
Switching Spec. --- Low Side Gate Driver						
Turn-off propagation delay INL falling to DRVL falling	T_{DLFF}			16		ns
Turn-on propagation delay INL rising to DRVL rising	T_{DLRR}			16		
DRVL rise time		C_L=1nF		12		ns
DRVL fall time		C_L=1nF		9		ns
Switching Spec. --- Floating Gate Driver						
Turn-off propagation delay INL falling to DRVH falling	T_{DHFF}			16		ns
Turn-on propagation delay INL rising to DRVH rising	T_{DHRR}			16		ns
DRVH rise time		C_L=1nF		12		ns
DRVH fall time		C_L=1nF		9		ns
Switching Spec. --- Matching						
Floating driver turn-off to low side drive turn-on	T_{MON}			1	5	ns
Low side driver turn-off to floating driver turn-on	T_{MOFF}			1	5	ns
Minimum input pulse width that changes the output	T_{PW}				50(5)	ns
Bootstrap diode turn-on or turn-off time	T_{BS}			10(5)		ns

Note:
5) Guaranteed by design.

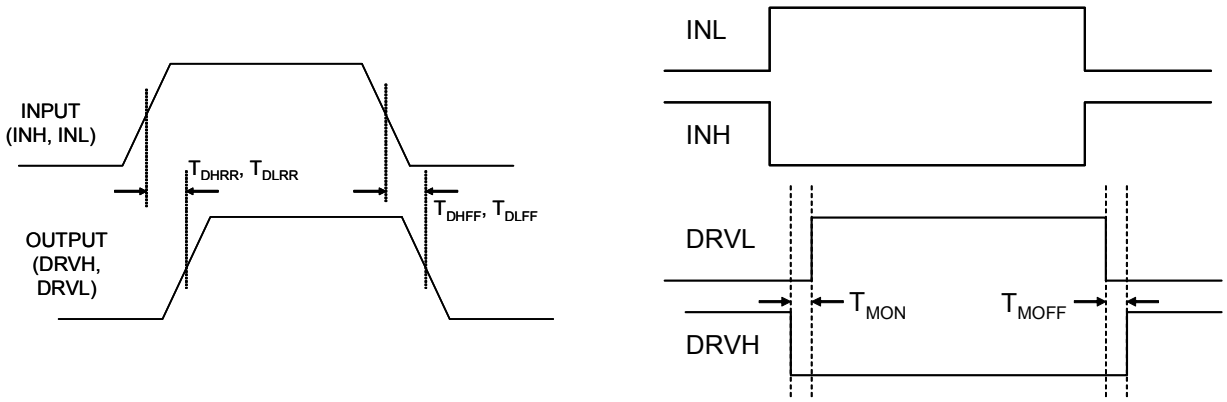
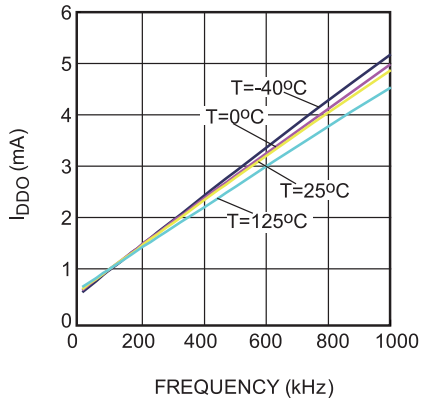


Figure 1—Timing Diagram

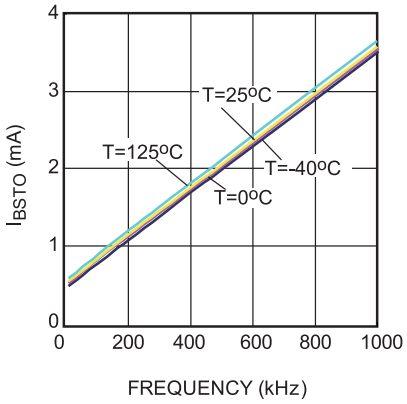
TYPICAL PERFORMANCE CHARACTERISTICS

V_{DD} =12V, V_{SS}=V_{SW} = 0V, T_A= 25°C, unless otherwise noted.

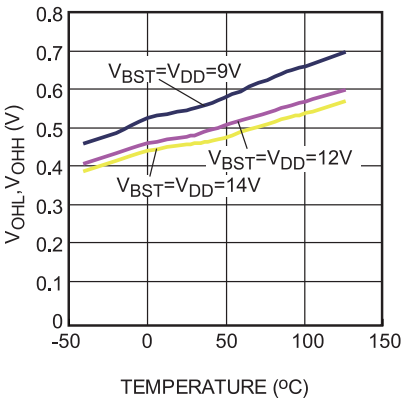
I_{DDO} Operation Current vs. Frequency



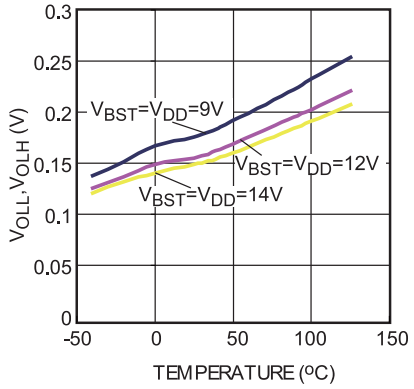
I_{BSTO} Operation Current vs. Frequency



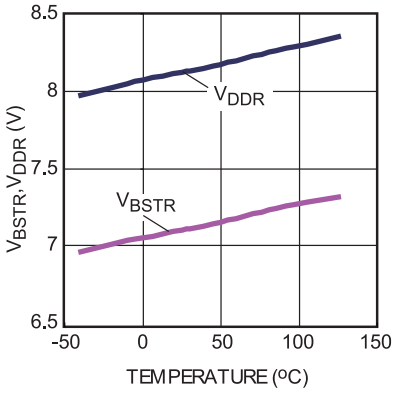
High Level Output Voltage vs.Temperature



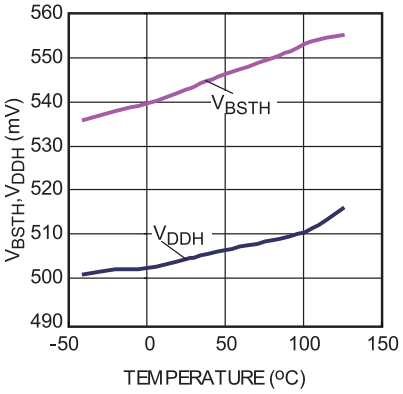
Low Level Output Voltage vs. Temperature



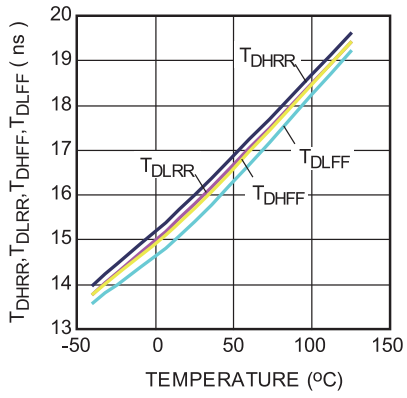
Undervoltage Lockout Threshold vs.Temperature



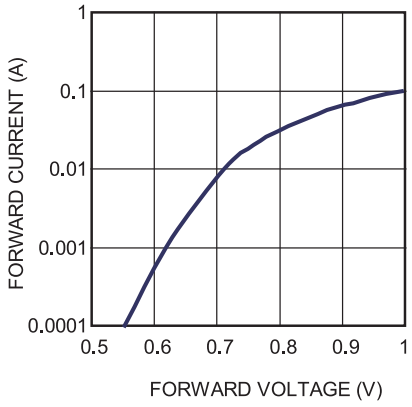
Undervoltage Lockout Hysteresis vs.Temperature



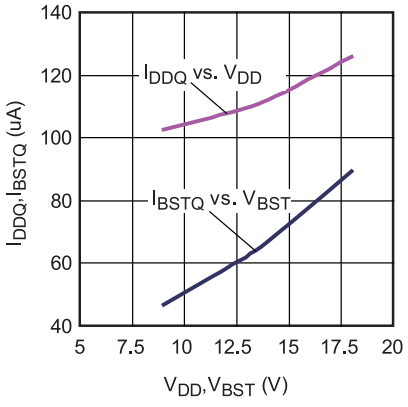
Propagation Delay vs. Temperature



Bootstrap Diode I-V Characteristics



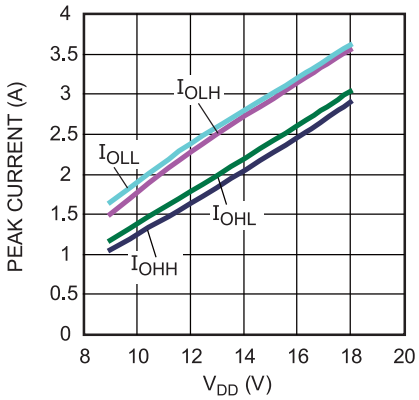
Quiescent Current vs. Voltage



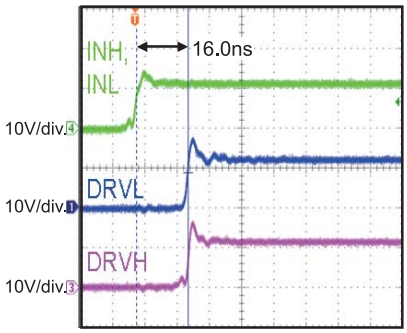
TYPICAL PERFORMANCE CHARACTERISTICS *(continued)*

V_{DD} =12V, V_{SS}=V_{SW} = 0V, T_A= 25°C, unless otherwise noted.

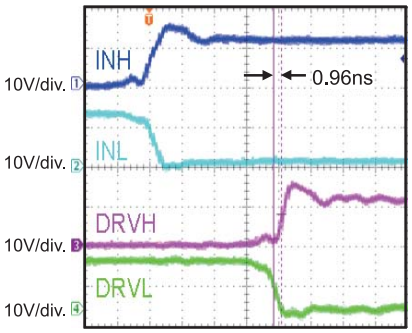
Peak Current vs. V_{DD} Voltage



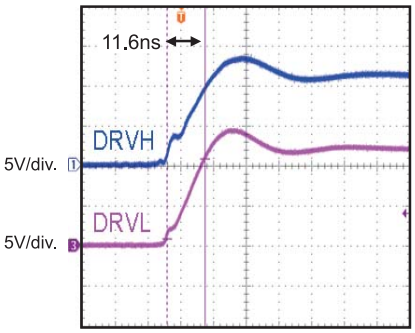
Turn-on Propagation Delay



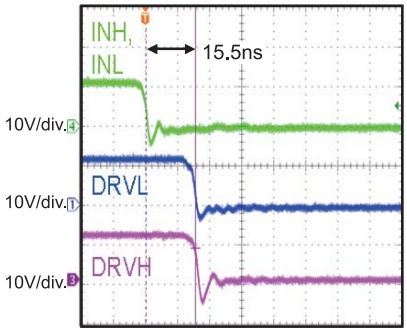
Gate Drive Matching T_{MOFF}



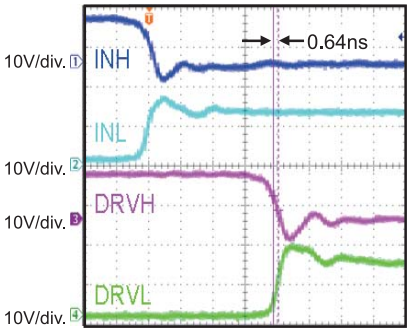
Drive Rise Time (1nF Load)



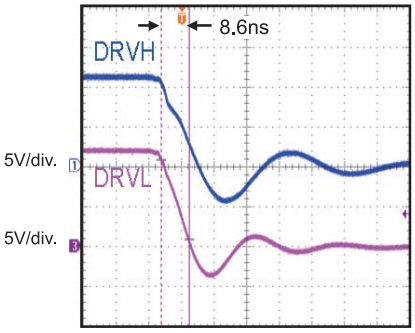
Turn-off Propagation Delay



Gate Drive Matching T_{MON}



Drive Fall Time (1nF Load)



PIN FUNCTIONS

SOIC8EP, SOIC-8, QFN8(3x3mm)	QFN9 (3x3mm)	QFN10 (4x4mm)	Name	Description
1	1	1	VDD	Supply input. This pin supplies power to all the internal circuitry. A decoupling capacitor to ground must be placed close to this pin to ensure stable and clean supply.
2	2	2	BST	Bootstrap. This is the positive power supply for the internal floating high-side MOSFET driver. Connect a bypass capacitor between this pin and SW pin.
3	3	3	DRVH	Floating driver output.
4	4	4	SW	Switching node.
	5	5,6	NC	No connection.
5	6	7	INH	Control signal input for the floating driver.
6	7	8	INL	Control signal input for the low side driver.
7	8	9	VSS, Exposed Pad	Chip ground. Connect exposed pad to VSS for proper thermal operation.
8	9	10	DRVL	Low side driver output.

BLOCK DIAGRAM

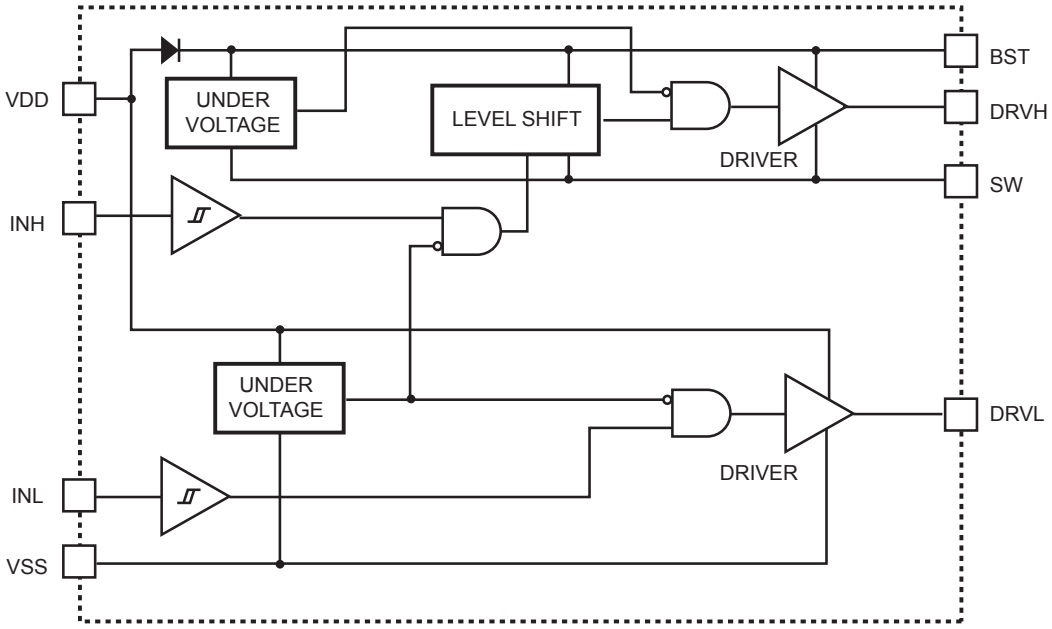
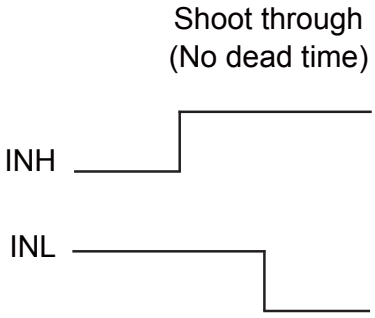
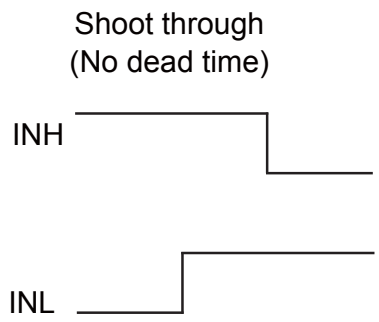


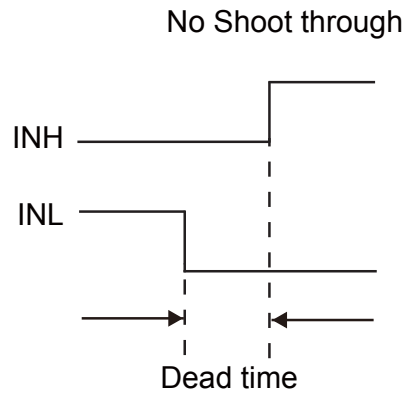
Figure 2—Function Block Diagram

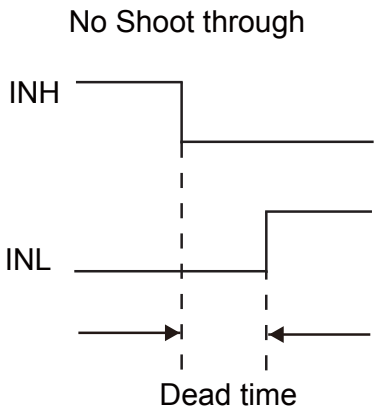
APPLICATION

The input signals of INH and INL can be controlled independently. If both INH and INL are controlling HSFET and LSFET of the same bridge, then users must avoid shoot through by setting sufficient dead time between INH and INL low, and vice versa. See below figure. Dead time is defined as the time internal between INH low and INL low.









REFERENCE DESIGN CIRCUITS

Half Bridge Converter

In half-bridge converter topology, the MOSFETs are driven alternately with some dead time. Therefore, INH and INL are driven with alternating signals from the PWM controller. The input voltage can be up to 100V in this application.

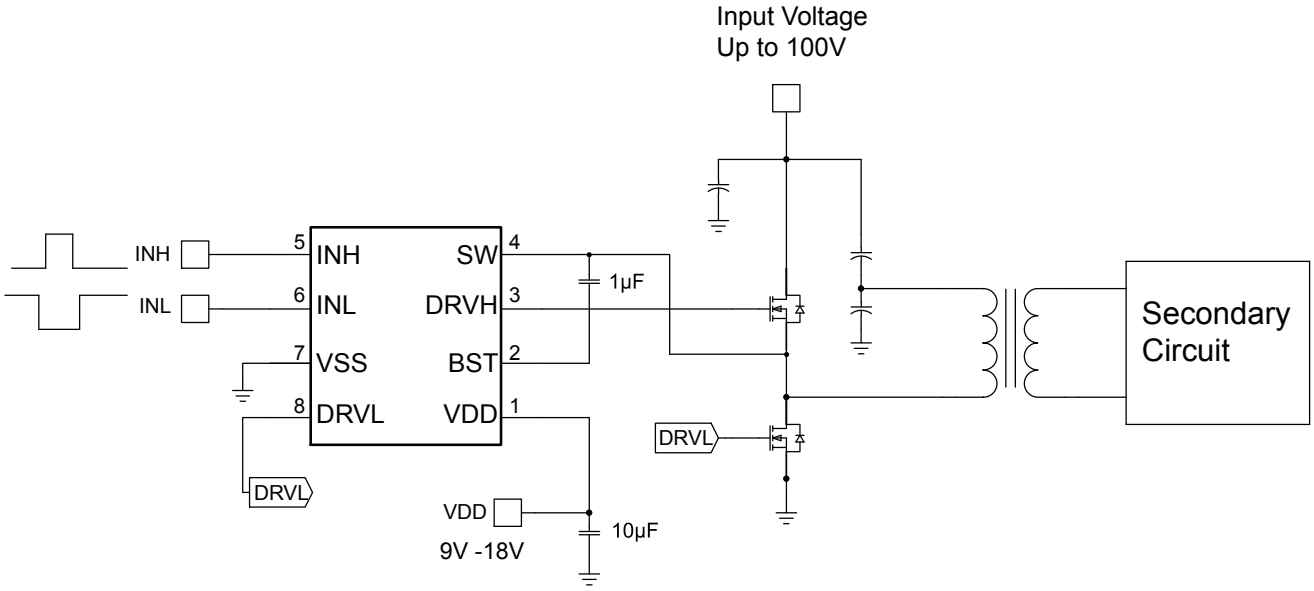


Figure 3 – Half Bridge Converter

Two-Switch Forward Converter

In two-switch forward converter topology, both MOSFETs are turned on and off together. The input signal (INH and INL) comes from the PWM controller, which senses the output voltage (and output current if current-mode control is used). The Schottky diodes clamp the reverse swing of the power transformer and must be rated at the input voltage. The input voltage can be up to 100V in this circuit.

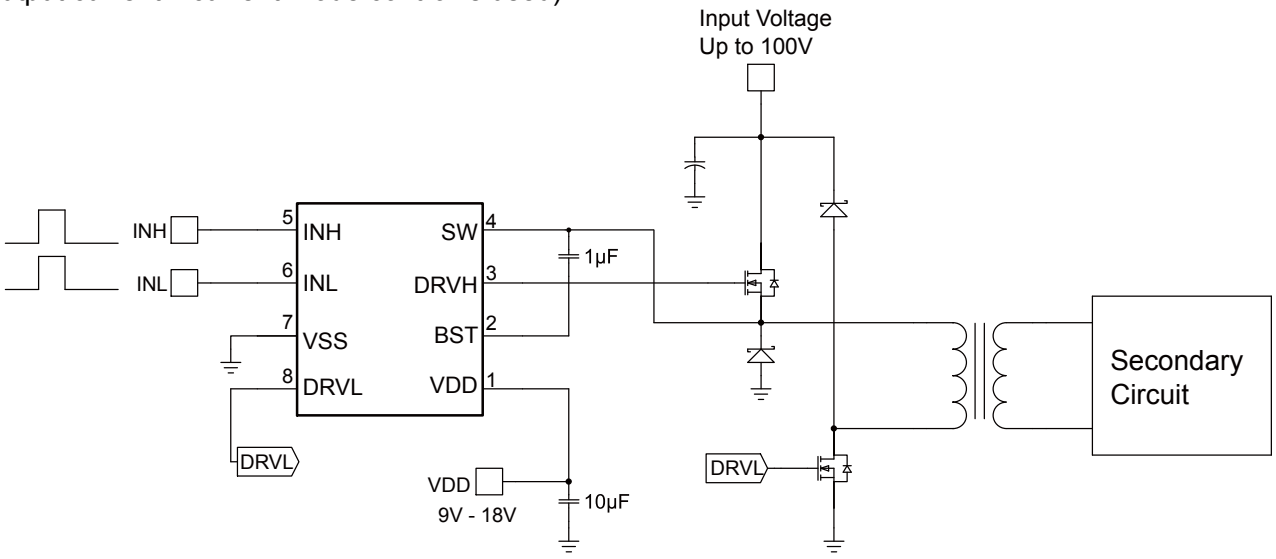


Figure 4 – Two-Switch Forward Converter

Active-Clamp Forward Converter

In active-clamp forward converter topology, the MOSFETs are driven alternately. The high-side MOSFET, along with capacitor C_{reset}, is used to reset the power transformer in a lossless manner. This topology lends itself well to run at duty cycles exceeding 50%. For these reasons, the input voltage may not be able to run at 100V for this application.

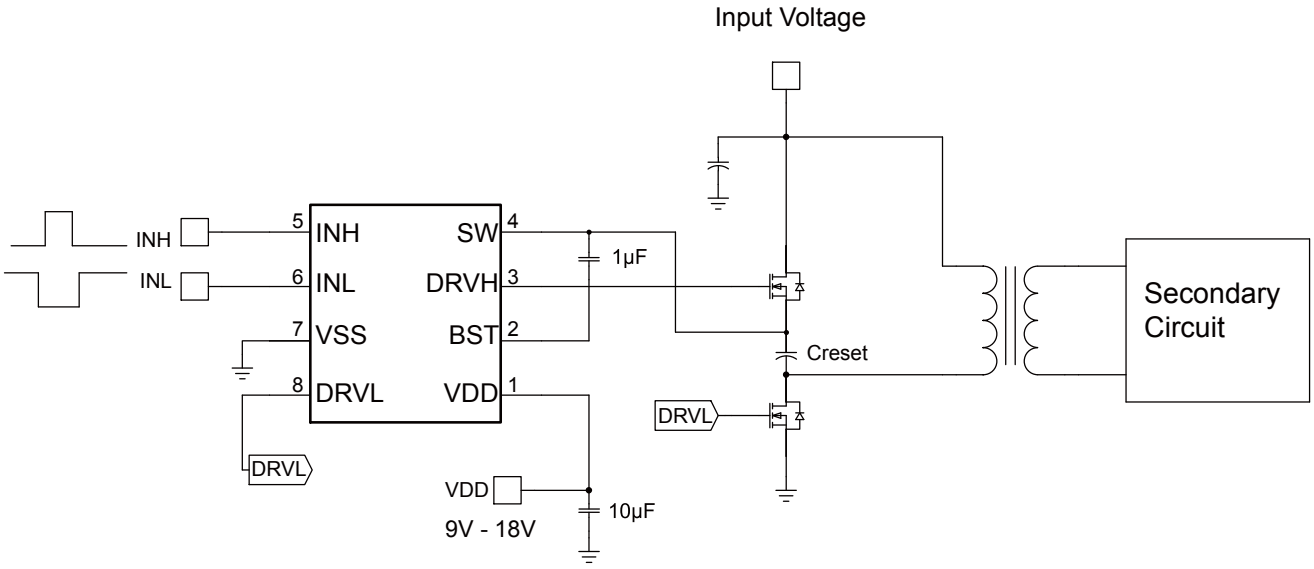
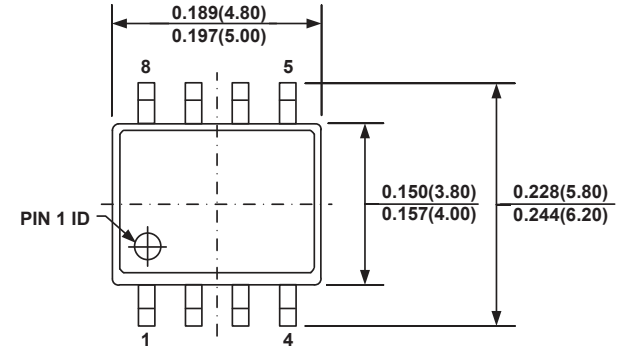


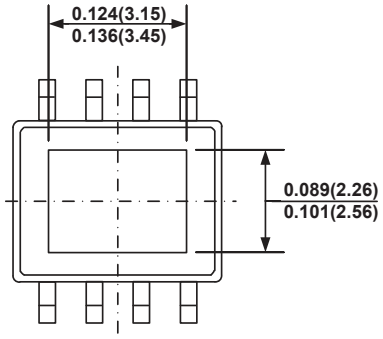
Figure 5 – Active-Clamp Forward Converter

PACKAGE INFORMATION

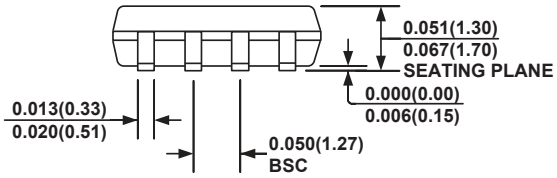
SOIC8E



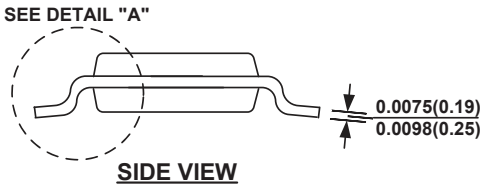
TOP VIEW



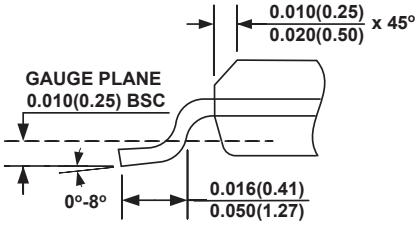
BOTTOM VIEW



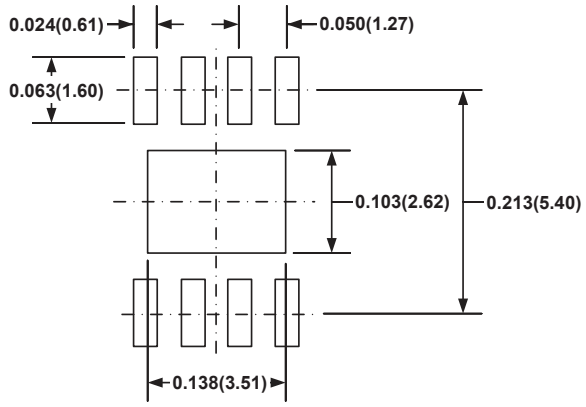
FRONT VIEW



SIDE VIEW



DETAIL "A"

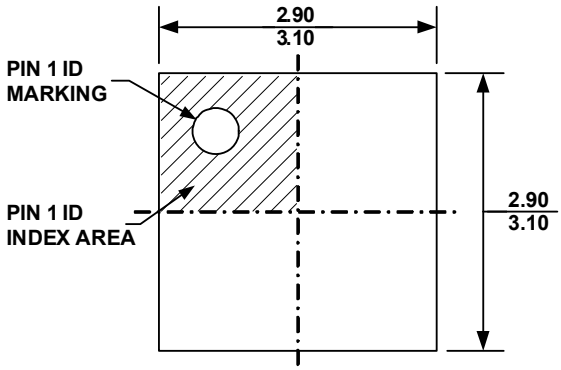


RECOMMENDED LAND PATTERN

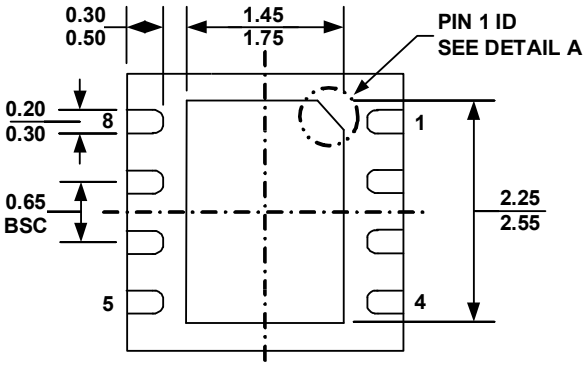
NOTE:

1) CONTROL DIMENSION IS IN INCHES. DIMENSION IN BRACKET IS IN MILLIMETERS.
2) PACKAGE LENGTH DOES NOT INCLUDE MOLD FLASH, PROTRUSIONS OR GATE BURRS.
3) PACKAGE WIDTH DOES NOT INCLUDE INTERLEAD FLASH OR PROTRUSIONS.
4) LEAD COPLANARITY (BOTTOM OF LEADS AFTER FORMING) SHALL BE 0.004" INCHES MAX.
5) DRAWING CONFORMS TO JEDEC MS-012, VARIATION BA.
6) DRAWING IS NOT TO SCALE.

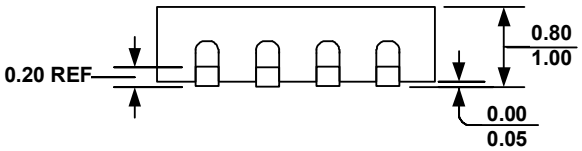
QFN8 (3×3mm)



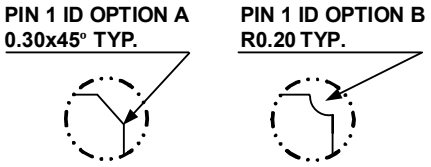
TOP VIEW



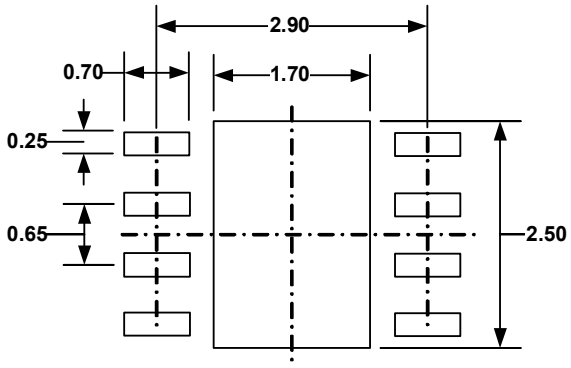
BOTTOM VIEW



SIDE VIEW



DETAIL A

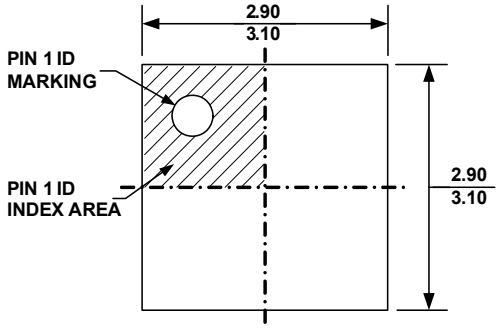


RECOMMENDED LAND PATTERN

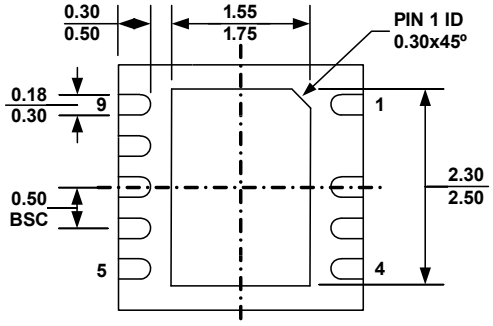
NOTE:

1) ALL DIMENSIONS ARE IN MILLIMETERS
2) EXPOSED PADDLE SIZE DOES NOT INCLUDE MOLD FLASH
3) LEAD COPLANARITY SHALL BE 0.10 MILLIMETER MAX
4) DRAWING CONFORMS TO JEDEC MO-229, VARIATION VEEC-2.
5) DRAWING IS NOT TO SCALE

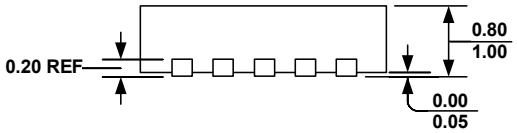
QFN9 (3×3mm)



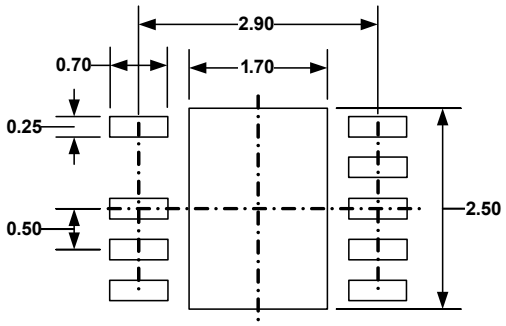
TOP VIEW



BOTTOM VIEW



SIDE VIEW

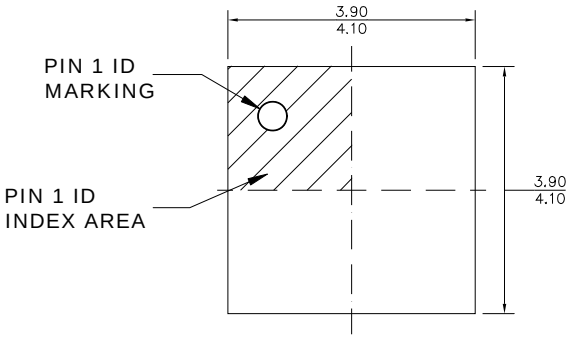


RECOMMENDED LAND PATTERN

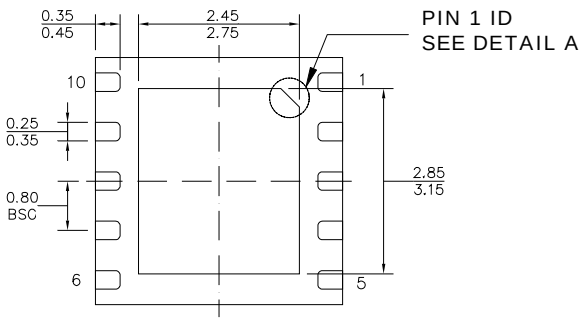
NOTE:

1) ALL DIMENSIONS ARE IN MILLIMETERS
2) EXPOSED PADDLE SIZE DOES NOT INCLUDE MOLD FLASH
3) LEAD COPLANARITY SHALL BE0.10 MILLIMETER MAX
4) DRAWING CONFORMS TO JEDEC MO-229, VARIATION VEED-5.
5) DRAWING IS NOT TO SCALE

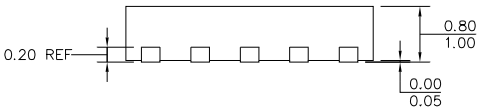
QFN10 (4×4mm)



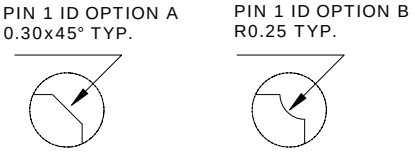
TOP VIEW



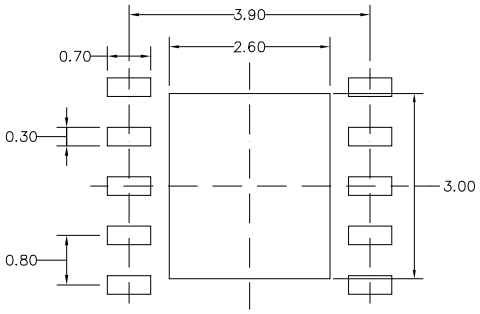
BOTTOM VIEW



SIDE VIEW



DETAIL A

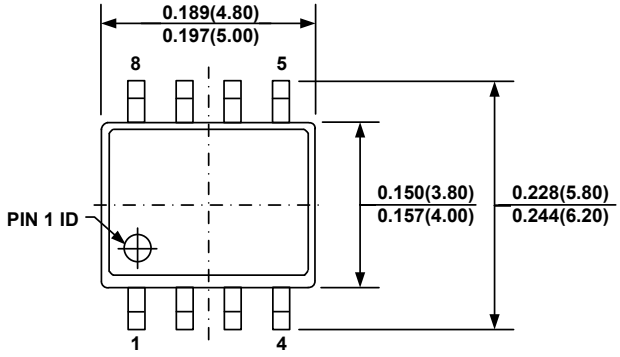


RECOMMENDED LAND PATTERN

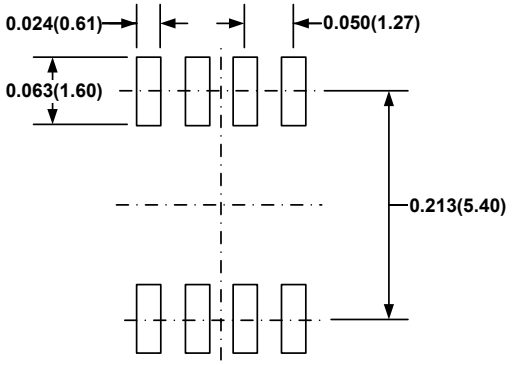
NOTE:

1) ALL DIMENSIONS ARE IN MILLIMETERS.
2) EXPOSED PADDLE SIZE DOES NOT INCLUDE MOLD FLASH.
3) LEAD COPLANARITY SHALL BE 0.10 MILLIMETERS MAX.
4) JEDEC REFERENCE IS MO-220.
5) DRAWING IS NOT TO SCALE.

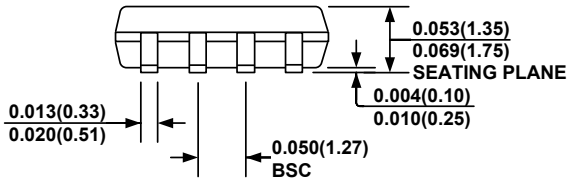
SOIC-8



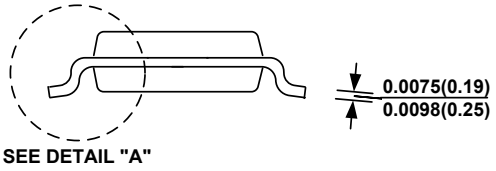
TOP VIEW



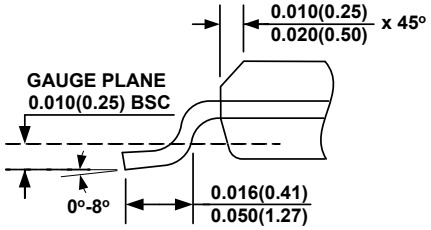
RECOMMENDED LAND PATTERN



FRONT VIEW



SIDE VIEW



DETAIL "A"

NOTE:

1) CONTROL DIMENSION IS IN INCHES. DIMENSION IN BRACKET IS IN MILLIMETERS.
2) PACKAGE LENGTH DOES NOT INCLUDE MOLD FLASH, PROTRUSIONS OR GATE BURRS.
3) PACKAGE WIDTH DOES NOT INCLUDE INTERLEAD FLASH OR PROTRUSIONS.
4) LEAD COPLANARITY (BOTTOM OF LEADS AFTER FORMING) SHALL BE 0.004" INCHES MAX.
5) DRAWING CONFORMS TO JEDEC MS-012, VARIATION AA.
6) DRAWING IS NOT TO SCALE.

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