



MPQ18024

100V, 4A, High-Frequency,
Half-Bridge Gate Driver
AEC-Q100 Qualified

DESCRIPTION

The MPQ18024 is a high-frequency, 100V, half-bridge, N-channel power MOSFET driver. Its low-side and high-side driver channels are controlled independently and matched with less than 5ns of time delay. Under-voltage lockout (UVLO) on the high-side and low-side supplies force their outputs low in the case of an insufficient supply. The integrated bootstrap diode reduces the external component count.

FEATURES

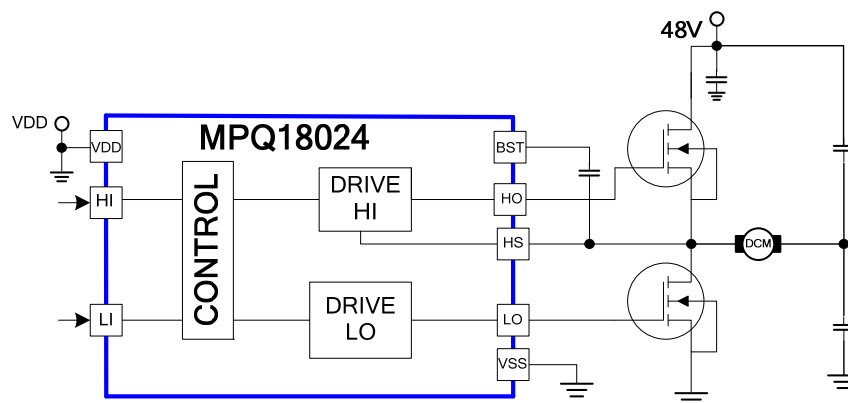
- Guaranteed Industrial / Automotive Temperature Range Limits
- Drives an N-Channel MOSFET Half-Bridge
- 100V V_{BST} Voltage Range
- On-Chip Bootstrap Diode
- Typical Propagation Delay of 20ns
- Gate Drive Matching of Less than 5ns
- Drives a 2.2nF Load with 15ns of Rise Time and 12ns of Fall Time at 12V VDD
- TTL-Compatible Input
- Quiescent Current of Less than 160 μ A
- UVLO for both High-Side and Low-Side
- Available in a SOIC-8E Package
- Available in AEC-Q100 Qualified Grade 1

APPLICATIONS

- Car DC/DC Power Systems
- Half-Bridge Motor Drivers

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TYPICAL APPLICATION



ORDERING INFORMATION

Part Number*	Package	Top Marking
MPQ18024HN-AEC1	SOIC-8 EP	See Below

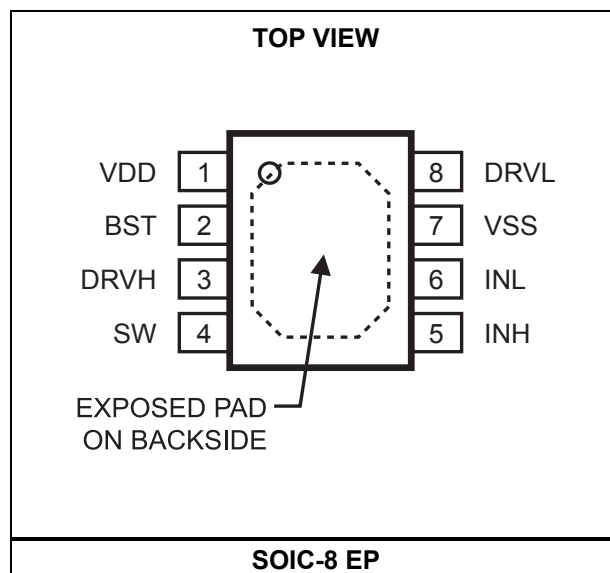
* For Tape & Reel, add suffix –Z (e.g. MPQ18024HN-AEC1–Z).

TOP MARKING

MP18024
LLLLLLLL
MPSYWW

MP18024: Part number
 LLLLLLLL: Lot number
 MPS: MPS prefix
 Y: Year code
 WW: Week code

PACKAGE REFERENCE



PIN FUNCTIONS

Pin #	Name	Description
1	VDD	Supply input. VDD supplies power to all of the internal circuitries. Place a decoupling capacitor to ground close to VDD to ensure a stable and clean supply.
2	BST	Bootstrap. BST is the positive power supply for the internal floating high-side MOSFET driver. Connect a bypass capacitor between BST and SW.
3	DRVH	Floating driver output.
4	SW	Switching node.
5	INH	Control signal input for the floating driver.
6	INL	Control signal input for the low side driver.
7	VSS	Chip ground. Connect the exposed pad to VSS for proper thermal operation.
Exposed Pad		
8	DRVL	Low-side driver output.

ABSOLUTE MAXIMUM RATINGS ⁽¹⁾

Supply voltage (V_{DD}) -0.3V to 18V
SW voltage (V_{SW}) -5.0V to 110V
BST voltage (V_{BST}) -0.3V to 110V
BST to SW -0.3V to 18V
DRVH to SW -0.3V to (BST - SW) + 0.3V
DRVL to VSS -0.3V to (V_{DD} + 0.3V)
All other pins -0.3V to (V_{DD} + 0.3V)
CDM rating (AEC-Q100-011C1)
All pins Class C6
HBM rating (AEC-Q100-002)
BST, DRVH Class H1C
Other pins Class H2
Continuous power dissipation ($T_A = 25^\circ\text{C}$) ⁽²⁾
..... 2.5W
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 16.0V
SW voltage (V_{SW})
..... (-10V / <100ns) to 100V - VDD
SW slew rate <50V/ns
Operating junction temp. (T_J) -40°C to 125°C

Thermal Resistance ⁽⁴⁾ θ_{JA} θ_{JC}
SOIC-8 EP 50 12 ... $^\circ\text{C/W}$

NOTES:

- 1) Exceeding these ratings may damage the device.
- 2) The maximum allowable power dissipation is a function of the maximum junction temperature $T_J(\text{MAX})$, 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 $P_D(\text{MAX}) = (T_J(\text{MAX}) - T_A) / \theta_{JA}$. Exceeding the maximum allowable power dissipation produces an excessive die temperature, causing the regulator to 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, $T_J = -40^{\circ}C$ to $+125^{\circ}C$, typical values tested at $T_J = +25^{\circ}C$, unless otherwise noted.

Parameter	Symbol	Condition	Min	Typ	Max	Units
Supply Currents						
VDD quiescent current	I _{DDQ}	INL = INH = 0		120	160	μA
VDD operating current	I _{DDO}	fsw = 500kHz		9		mA
Floating driver quiescent current	I _{BSTQ}	INL = INH = 0		70	100	μA
Floating driver operating current	I _{BSTO}	fsw = 500kHz		8.5		mA
Leakage current	I _{LK}	BST = SW = 100V		0.05	2.5	μA
Inputs						
INL/INH high				2.2	2.6	V
INL/INH low			1	1.5		V
INL/INH internal pull-down resistance	R _{IN}			185		kΩ
Under-Voltage Protection (UVP)						
VDD rising threshold	V _{DDR}		8.1	8.5	8.9	V
VDD hysteresis	V _{DDH}			0.5		V
(BST - SW) rising threshold	V _{BSTR}		6.8	7.4	8	V
(BST - SW) hysteresis	V _{BSTH}			0.55		V
Bootstrap Diode						
Bootstrap diode VF @ 100μA	V _{F1}			0.5		V
Bootstrap diode VF @ 100mA	V _{F2}			0.95		V
Bootstrap diode dynamic R	R _D	@ 100mA		2.3		Ω
Low-Side Gate Driver						
Low-level output voltage	V _{OLL}	I _O = 100mA		0.08		V
High-level output voltage to rail	V _{OHL}	I _O = -100mA		0.23		V
Peak pull-up current ⁽⁵⁾	I _{OHL}	V _{DRVL} = 0V, V _{DD} = 12V		3		A
		V _{DRVL} = 0V, V _{DD} = 16V		4.7		A
Peak pull-down current ⁽⁵⁾	I _{OLL}	V _{DRVL} = V _{DD} = 12V		4.5		A
		V _{DRVL} = V _{DD} = 16V		6		A
Floating Gate Driver						
Low-level output voltage	V _{OLH}	I _O = 100mA		0.08		V
High-level output voltage to rail	V _{OHH}	I _O = -100mA		0.23		V
Peak pull-up current ⁽⁵⁾	I _{OHH}	V _{DRVH} = 0V, V _{DD} = 12V		2.6		A
		V _{DRVH} = 0V, V _{DD} = 16V		4		A
Peak pull-down current ⁽⁵⁾	I _{OLH}	V _{DRVH} = V _{DD} = 12V		4.5		A
		V _{DRVH} = V _{DD} = 16V		5.9		A
Switching spec – low-side gate driver						
Turn-off propagation delay INL falling to DRVL falling	T _{DLFF}			20		ns
Turn-on propagation delay INL rising to DRVL rising	T _{DLRR}			20		
DRVL rise time		C _L = 2.2nF		15		ns
DRVL fall time		C _L = 2.2nF		9		ns

ELECTRICAL CHARACTERISTICS (continued)

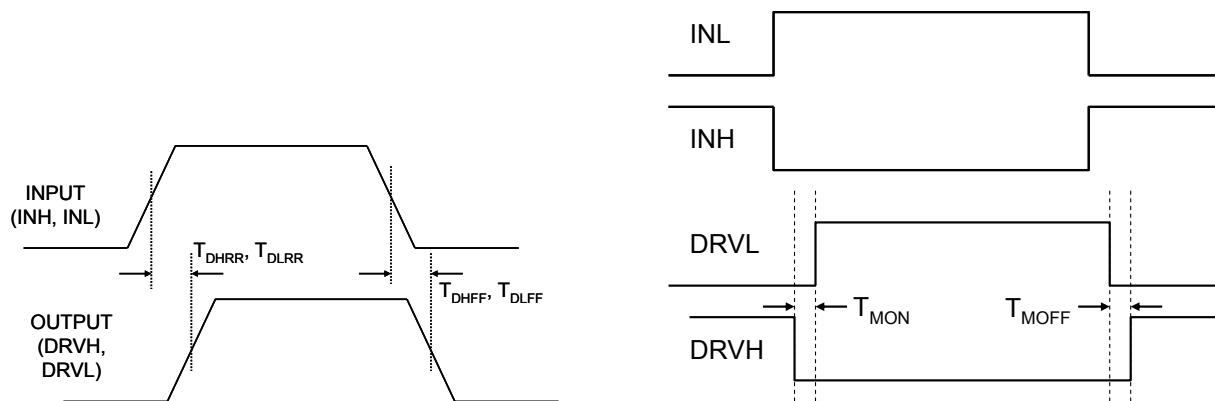
$V_{DD} = V_{BST} - V_{SW} = 12V$, $V_{SS} = V_{SW} = 0V$, no load at DRVH and DRVL, $T_J = -40^{\circ}C$ to $+125^{\circ}C$, typical values tested at $T_J = +25^{\circ}C$, unless otherwise noted.

Parameter	Symbol	Condition	Min	Typ	Max	Units
Switching Spec – Floating Gate Driver						
Turn-off propagation delay INL falling to DRVH falling	T_{DHFF}			20		ns
Turn-on propagation delay INL rising to DRVH rising	T_{DHRR}			20		ns
DRVH rise time		$C_L = 2.2nF$		15		ns
DRVH fall time		$C_L = 2.2nF$		12		ns
Switching Spec – Matching						
Floating driver turn-off to low-side driver turn-on ⁽⁵⁾	T_{MON}			1	5	ns
Low-side driver turn-off to floating driver turn-on ⁽⁵⁾	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
Thermal shutdown ⁽⁵⁾				170		$^{\circ}C$
Thermal shutdown hysteresis ⁽⁵⁾				25		$^{\circ}C$

NOTE:

5) Guaranteed by design.

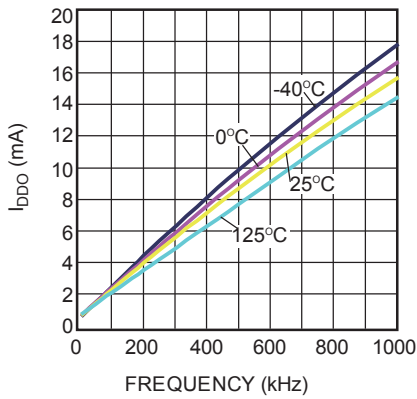
TIMING DIAGRAM



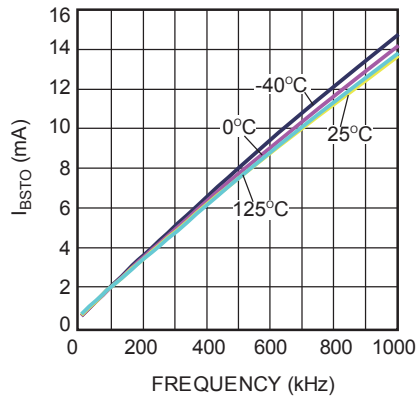
TYPICAL PERFORMANCE CHARACTERISTICS

$V_{DD} = 12V$, $V_{SS} = V_{SW} = 0V$, $T_A = +25^\circ C$, unless otherwise noted.

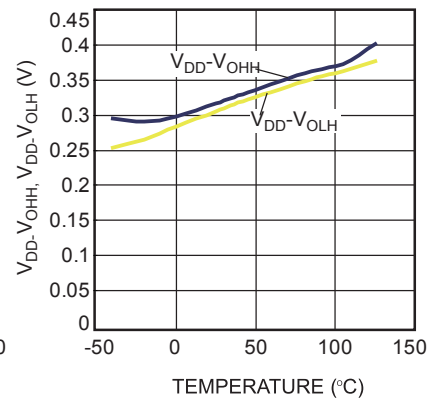
I_{DDO} Operation Current vs. Frequency



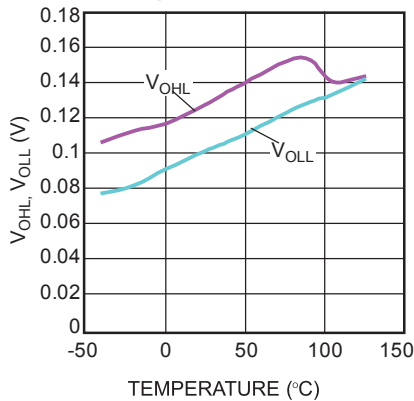
I_{BSTO} Operation Current vs. Frequency



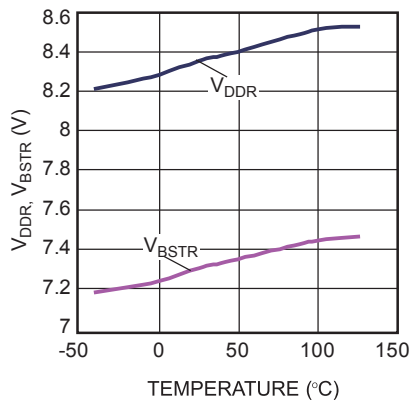
High-Level Output Voltage vs. Temperature



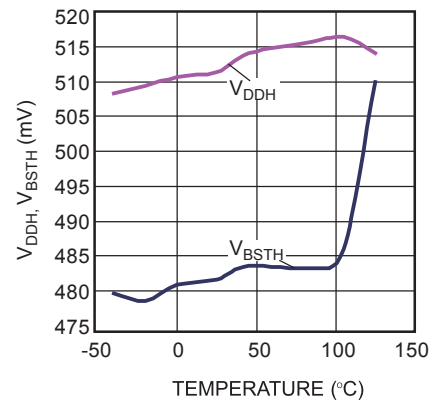
Low-Level Output Voltage vs. Temperature



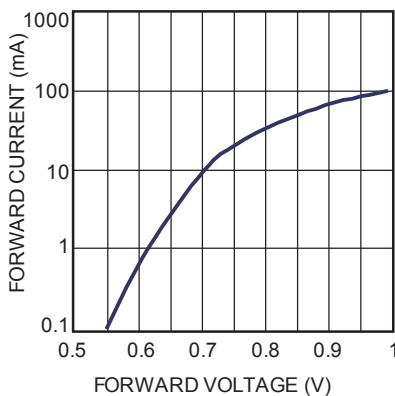
Under-Voltage Lockout Threshold vs. Temperature



Under-Voltage Lockout Hysteresis vs. Temperature

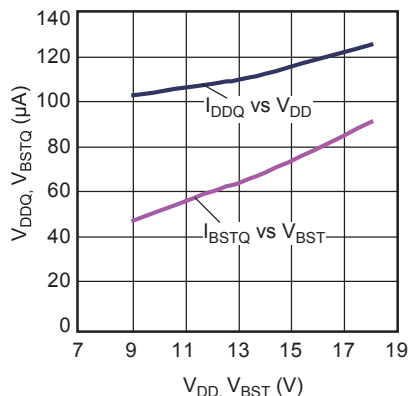


Bootstrap Diode I-V Characteristic

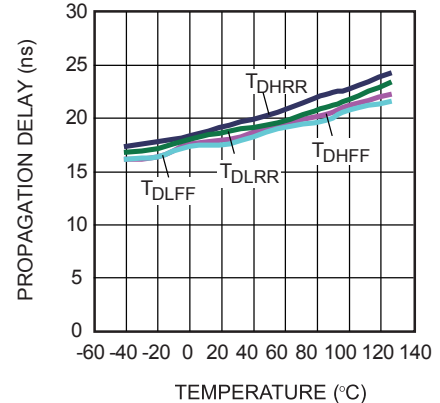


Quiescent Current vs. Voltage

$I_{NH}=I_{NL}=0V$



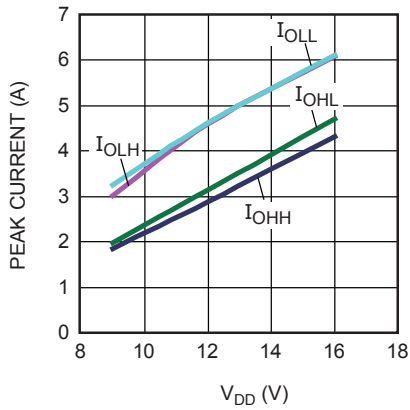
Propagation Delay vs. Temperature



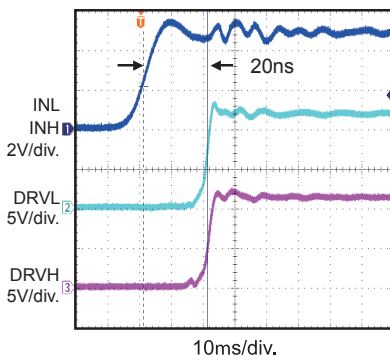
TYPICAL PERFORMANCE CHARACTERISTICS (continued)

$V_{DD} = 12V$, $V_{SS} = V_{SW} = 0V$, $T_A = +25^\circ C$, unless otherwise noted.

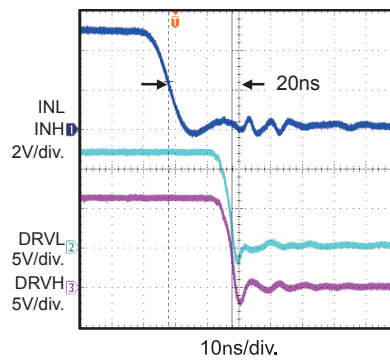
Peak Current vs.
 V_{DD} Voltage



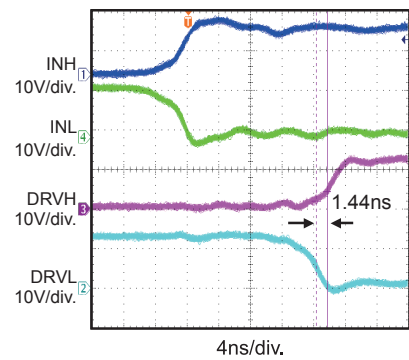
Turn-On Propagation Delay



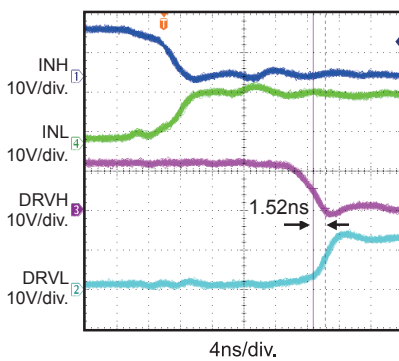
Turn-Off Propagation Delay



Gate Drive Matching T_{MOFF}

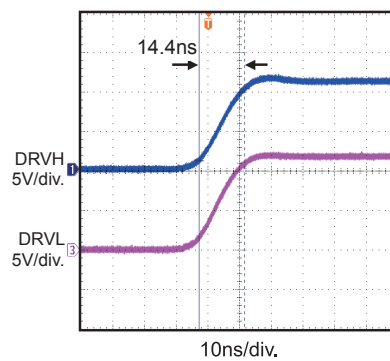


Gate Drive Matching T_{MON}



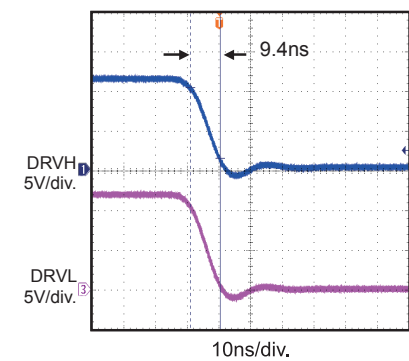
Drive Rise Time

2.2nF Load



Drive Fall Time

2.2nF Load



BLOCK DIAGRAM

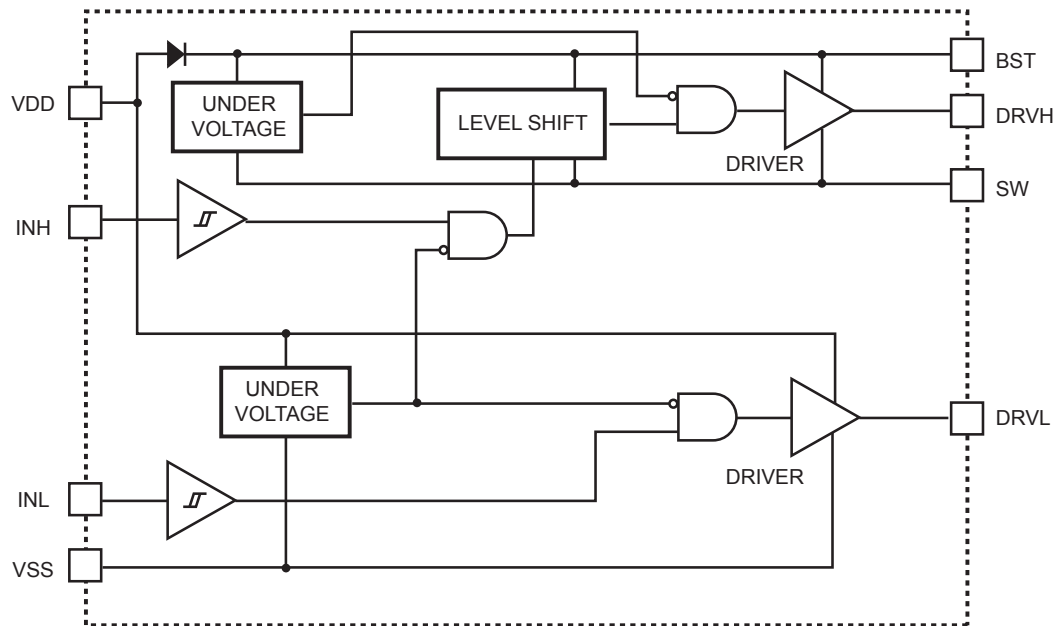


Figure 1: Functional Block Diagram

APPLICATION

The input signals of INH and INL can be controlled independently. If both INH and INL control the high-side MOSFET (HS-FET) and low-side MOSFET (LS-FET) of the same bridge, shoot through can be prevented by setting a sufficient dead time between INH and INL low, and vice versa (see Figure 2). Dead time is defined as the time interval between INH low and INL low.

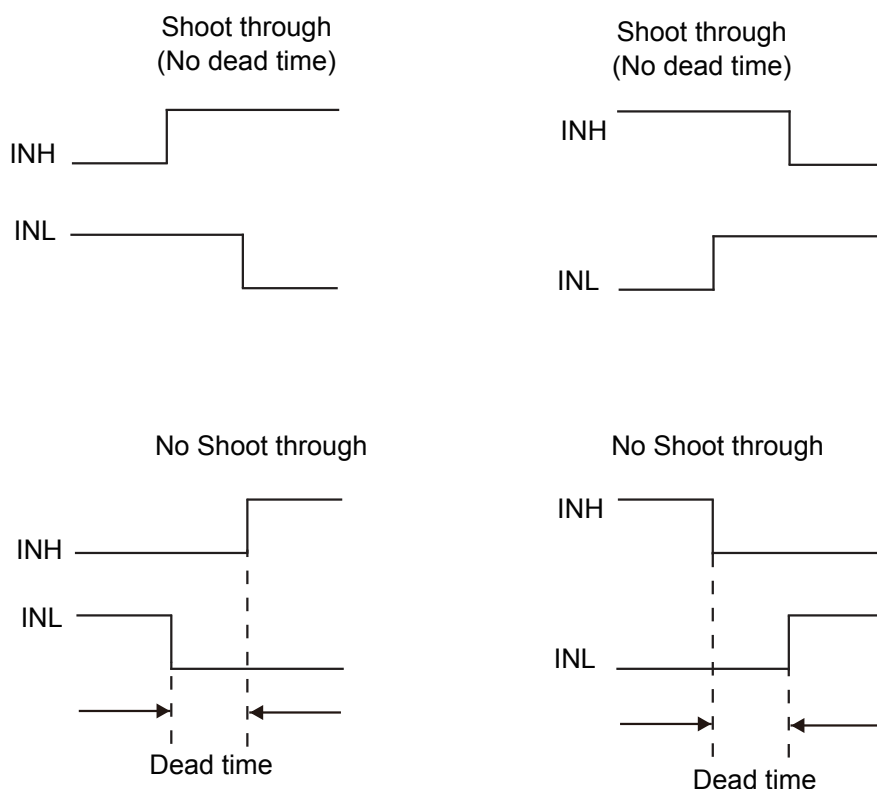


Figure 2: Shoot-Through Timing Diagram

REFERENCE DESIGN CIRCUITS

Half-Bridge Converter

The MPQ18024 drives the MOSFETs with alternating signals (with dead time) in a half-bridge converter topology. Because the pulse-

width modulation (PWM) controller drives INH and INL with alternating signals, the input voltage can rise as high as 100V (see Figure 3 through Figure 5).

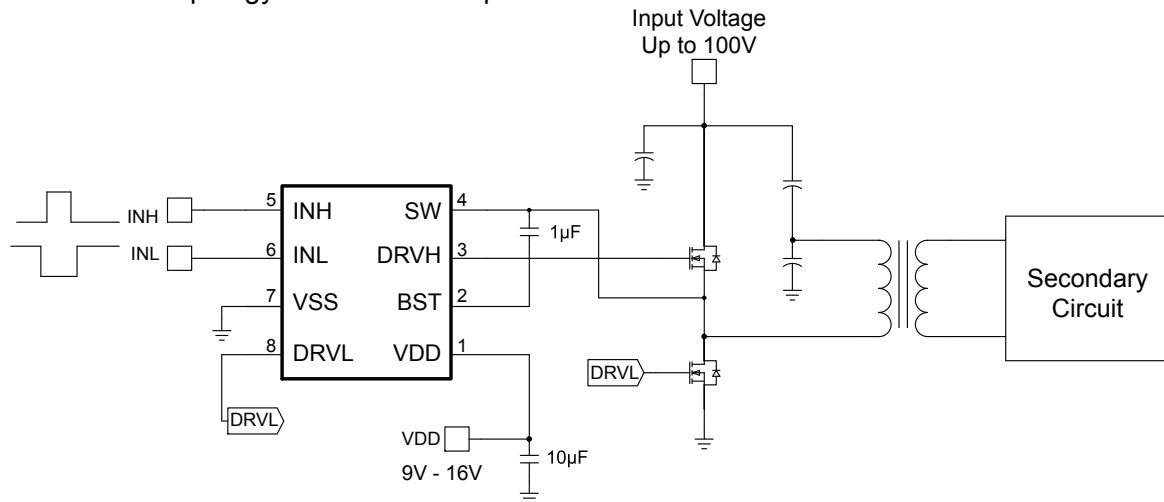


Figure 3: Half-Bridge Converter

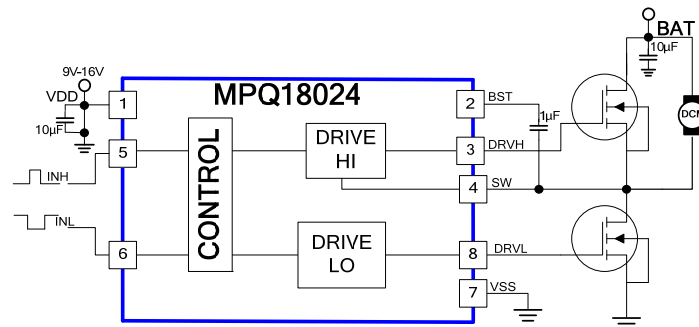


Figure 4: Half-Bridge for Unidirectional Motor

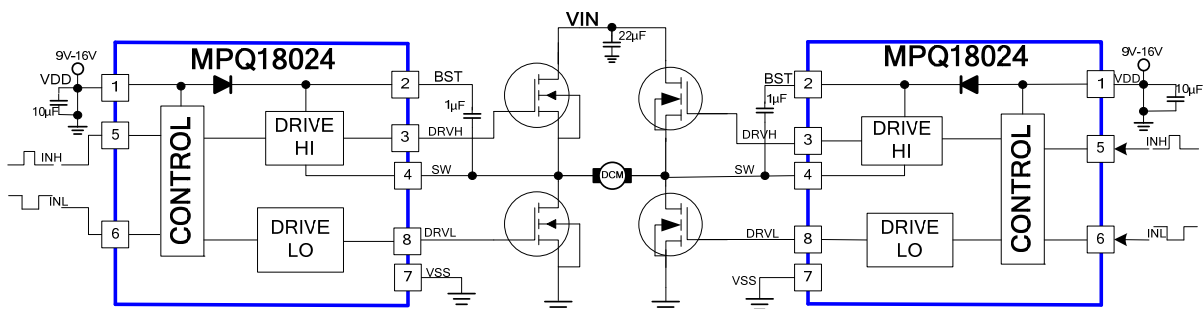
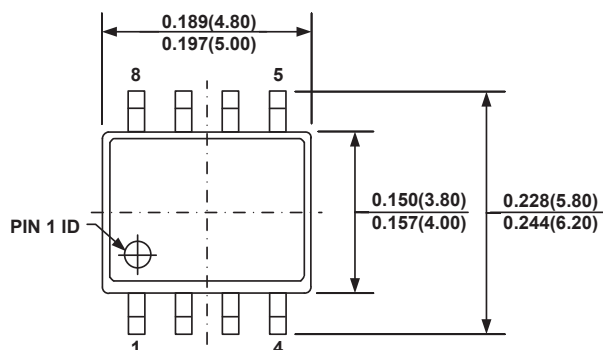


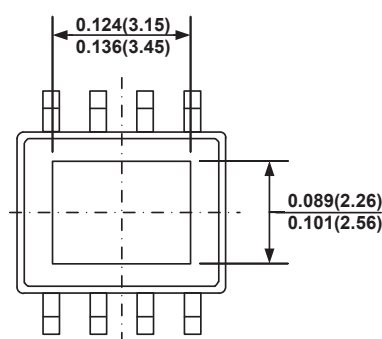
Figure 5: 2x MPQ18024 for One Bidirectional DC Motor

PACKAGE INFORMATION

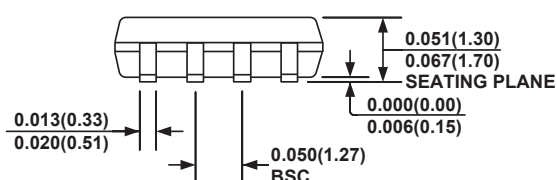
SOIC-8E



TOP VIEW

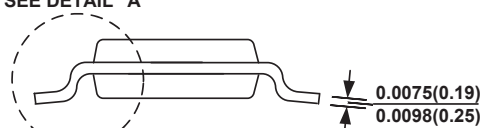


BOTTOM VIEW

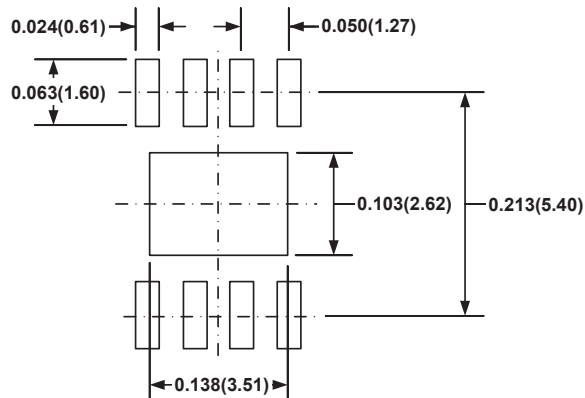


FRONT VIEW

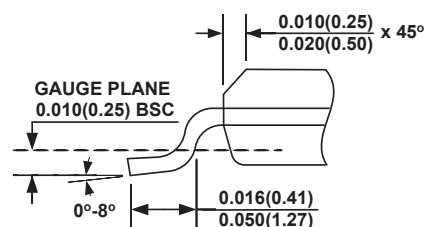
SEE DETAIL "A"



SIDE VIEW



RECOMMENDED LAND PATTERN



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 BA.
- 6) DRAWING IS NOT TO SCALE.

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