

## DESCRIPTION

The MPQ18021A 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

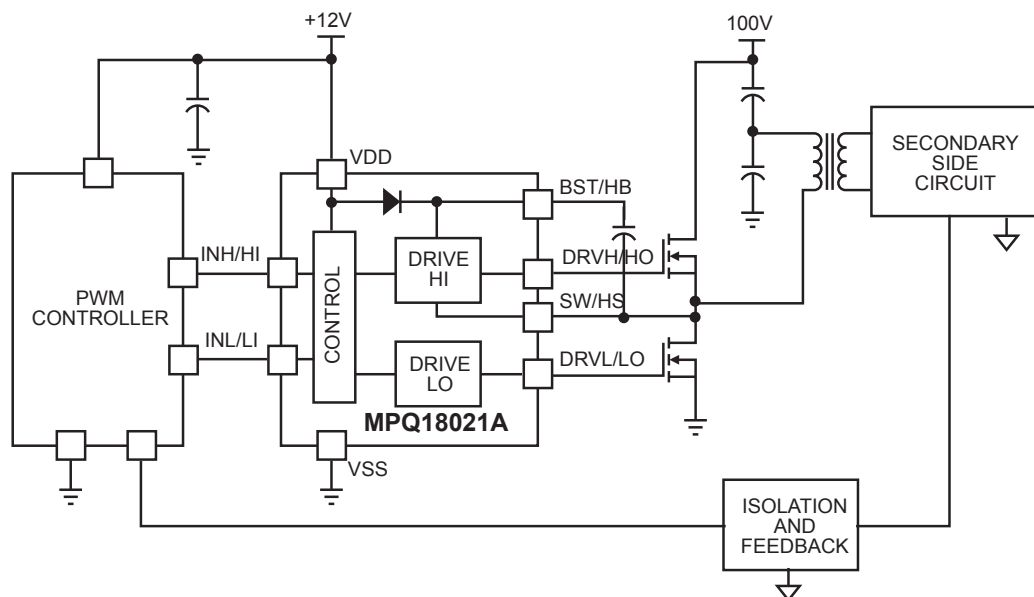
- Drives N-Channel MOSFET Half Bridge
- 115V  $V_{BST}$  Voltage Range
- On-Chip Bootstrap Diode
- Typical 16ns Propagation Delay Time
- Less Than 5ns Gate Drive Matching
- Drives 1nF Load with 12ns/9ns Rise/Fall Times with 12V VDD
- TTL Compatible Input
- Less Than 150 $\mu$ A Quiescent Current
- UVLO for Both High-Side and Low-Side
- In SOIC8 Package

## APPLICATIONS

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

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## TYPICAL APPLICATION

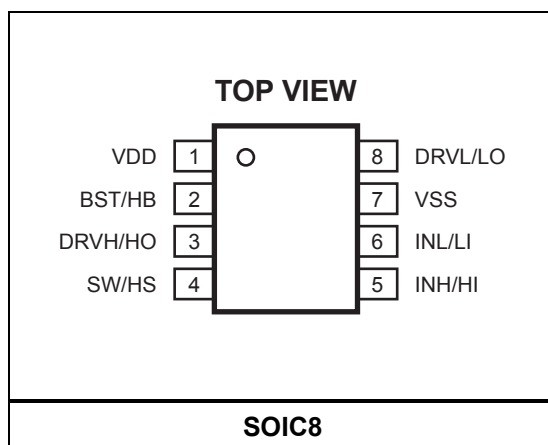


## ORDERING INFORMATION

| Part Number   | Package | Top Marking |
|---------------|---------|-------------|
| MPQ18021HS-A* | SOIC8   | MP18021A    |

\* For Tape & Reel, add suffix -Z (e.g. MPQ18021HS-A-Z);  
For RoHS compliant packaging, add suffix -LF (e.g. MPQ18021HS-A-LF-Z)

## PACKAGE REFERENCE



### ABSOLUTE MAXIMUM RATINGS <sup>(1)</sup>

|                                                                    |                          |
|--------------------------------------------------------------------|--------------------------|
| Supply Voltage (VDD).....                                          | -0.3V to +20V            |
| SW Voltage (V <sub>SW</sub> ) .....                                | -5.0V to +105V           |
| BST Voltage (V <sub>BST</sub> ) .....                              | -0.3V to +120V           |
| BST to SW .....                                                    | -0.3V to +18V            |
| DRVH to SW .....                                                   | -0.3V to (BST-SW) + 0.3V |
| DRVL to VSS .....                                                  | -0.3V to (VDD + 0.3V)    |
| All Other Pins.....                                                | -0.3V to (VDD + 0.3V)    |
| Continuous Power Dissipation (T <sub>A</sub> =25°C) <sup>(2)</sup> |                          |
| SOIC8.....                                                         | 1.4W                     |
| Junction Temperature .....                                         | 150°C                    |
| Lead Temperature .....                                             | 260°C                    |
| Storage Temperature.....                                           | -65°C to +150°C          |

### Recommended Operating Conditions <sup>(3)</sup>

|                                                  |                 |
|--------------------------------------------------|-----------------|
| Supply Voltage (V <sub>DD</sub> ).....           | 9.0V to 18V     |
| SW Voltage (V <sub>SW</sub> ) .....              | -1.0V to +100V  |
| SW slew rate .....                               | <50V/ns         |
| Operating Junction Temp. (T <sub>J</sub> ) ..... | -40°C to +125°C |

|                                          |                       |                       |
|------------------------------------------|-----------------------|-----------------------|
| <b>Thermal Resistance <sup>(4)</sup></b> | <b>θ<sub>JA</sub></b> | <b>θ<sub>JC</sub></b> |
| SOIC8 .....                              | 90 .....              | 45... °C/W            |

#### Notes:

- Exceeding these ratings may damage the device.
- The maximum allowable power dissipation is a function of the maximum junction temperature T<sub>J</sub>(MAX), the junction-to-ambient thermal resistance θ<sub>JA</sub>, and the ambient temperature T<sub>A</sub>. The maximum allowable continuous power dissipation at any ambient temperature is calculated by P<sub>D</sub>(MAX)=(T<sub>J</sub>(MAX)-T<sub>A</sub>)/ θ<sub>JA</sub>. 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.
- The device is not guaranteed to function outside of its operating conditions.
- Measured on JESD51-7, 4-layer PCB.

## ELECTRICAL CHARACTERISTICS

VDD = V<sub>BST</sub>-V<sub>SW</sub>=12V, VSS=V<sub>SW</sub> = 0V, No load at DRVH and DRVL, T<sub>J</sub>= -40°C to +125°C, Typical Value are T<sub>J</sub>=25°C, unless otherwise noted.

| Parameter                             | Symbol            | Condition                                              | Min | Typ  | Max  | Units |
|---------------------------------------|-------------------|--------------------------------------------------------|-----|------|------|-------|
| Supply Currents                       |                   |                                                        |     |      |      |       |
| VDD quiescent current                 | I <sub>DDQ</sub>  | INL=INH=0                                              |     | 100  | 150  | μA    |
| VDD operating current                 | I <sub>DDO</sub>  | f <sub>sw</sub> =500kHz                                |     | 2.8  | 3.5  | mA    |
| Floating driver quiescent current     | I <sub>BSTQ</sub> | INL=INH=0                                              |     | 60   | 90   | μA    |
| Floating driver operating current     | I <sub>BSTO</sub> | f <sub>sw</sub> =500kHz                                |     | 2.1  | 3    | mA    |
| Leakage Current                       | I <sub>LK</sub>   | 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 <sub>IN</sub>   |                                                        |     | 185  |      | kΩ    |
| Under Voltage Protection              |                   |                                                        |     |      |      |       |
| VDD rising threshold                  | V <sub>DDR</sub>  |                                                        | 7.4 | 8.1  | 8.9  | V     |
| VDD hysteresis                        | V <sub>DDH</sub>  |                                                        |     | 0.5  |      | V     |
| (BST-SW) rising threshold             | V <sub>BSTR</sub> |                                                        | 6.5 | 7.1  | 7.7  | V     |
| (BST-SW) hysteresis                   | V <sub>BSTH</sub> |                                                        |     | 0.55 |      | V     |
| Bootstrap Diode                       |                   |                                                        |     |      |      |       |
| Bootstrap diode VF @ 100uA            | V <sub>F1</sub>   |                                                        |     | 0.5  |      | V     |
| Bootstrap diode VF @ 100mA            | V <sub>F2</sub>   |                                                        |     | 0.9  |      | V     |
| Bootstrap diode dynamic R             | R <sub>D</sub>    | @ 100mA                                                |     | 2.5  |      | Ω     |
| Low Side Gate Driver                  |                   |                                                        |     |      |      |       |
| Low level output voltage              | V <sub>OLL</sub>  | I <sub>O</sub> =100mA                                  |     | 0.15 | 0.32 | V     |
| High level output voltage to rail     | V <sub>OHL</sub>  | I <sub>O</sub> =-100mA                                 |     | 0.45 | 1    | V     |
| Peak pull-up current                  | I <sub>OHL</sub>  | V <sub>DRV<sub>L</sub></sub> =0V, V <sub>DD</sub> =12V |     | 1.5  |      | A     |
|                                       |                   | V <sub>DRV<sub>L</sub></sub> =0V, V <sub>DD</sub> =16V |     | 2.5  |      | A     |
| Peak pull-down current                | I <sub>OLL</sub>  | V <sub>DRV<sub>L</sub></sub> =V <sub>DD</sub> =12V     |     | 2.5  |      | A     |
|                                       |                   | V <sub>DRV<sub>L</sub></sub> =V <sub>DD</sub> =16V     |     | 3.5  |      | A     |
| Floating Gate Driver                  |                   |                                                        |     |      |      |       |
| Low level output voltage              | V <sub>OLH</sub>  | I <sub>O</sub> =100mA                                  |     | 0.15 | 0.32 | V     |
| High level output voltage to rail     | V <sub>OHH</sub>  | I <sub>O</sub> =-100mA                                 |     | 0.45 | 1    | V     |
| Peak pull-up current                  | I <sub>OHH</sub>  | V <sub>DRV<sub>H</sub></sub> =0V, V <sub>DD</sub> =12V |     | 1.5  |      | A     |
|                                       |                   | V <sub>DRV<sub>H</sub></sub> =0V, V <sub>DD</sub> =16V |     | 2.5  |      | A     |
| Peak pull-down current                | I <sub>OLH</sub>  | V <sub>DRV<sub>H</sub></sub> =V <sub>DD</sub> =12V     |     | 2.5  |      | A     |
|                                       |                   | V <sub>DRV<sub>H</sub></sub> =V <sub>DD</sub> =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,  $T_J = -40^{\circ}C$  to  $+125^{\circ}C$ , Typical Value are  $T_J = 25^{\circ}C$ , unless otherwise noted.

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

## Note:

5) Guaranteed by design.

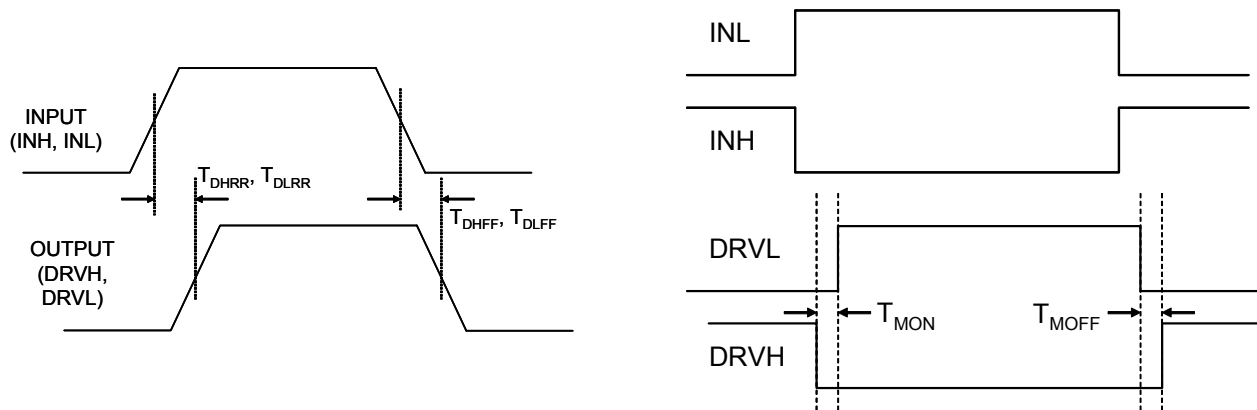


Figure 1: Timing Diagram

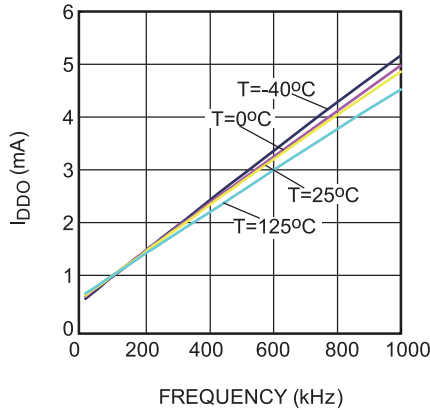
## PIN FUNCTIONS

| Pin # | Name    | Description                                                                                                                                                       |
|-------|---------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 1     | VDD     | Supply input. Supplies power to all the internal circuitry. Requires a decoupling capacitor to ground placed close to this pin to ensure stable and clean supply. |
| 2     | BST/HB  | Bootstrap. Positive power supply for the internal floating high-side MOSFET driver. Connect a bypass capacitor between this pin and SW pin.                       |
| 3     | DRVH/HO | Floating driver output.                                                                                                                                           |
| 4     | SW/HS   | Switching node.                                                                                                                                                   |
| 5     | INH/HI  | Control signal input for the floating driver.                                                                                                                     |
| 6     | INL/LI  | Control signal input for the low side driver.                                                                                                                     |
| 7     | VSS     | Chip ground.                                                                                                                                                      |
| 8     | DRVL/LO | Low side driver output.                                                                                                                                           |

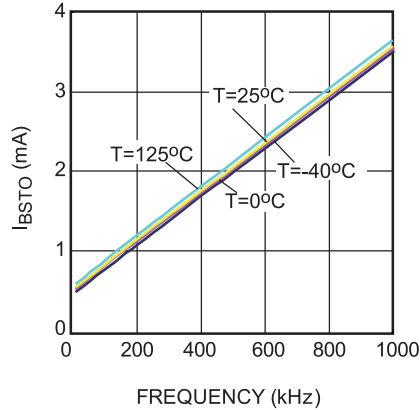
# TYPICAL PERFORMANCE CHARACTERISTICS

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

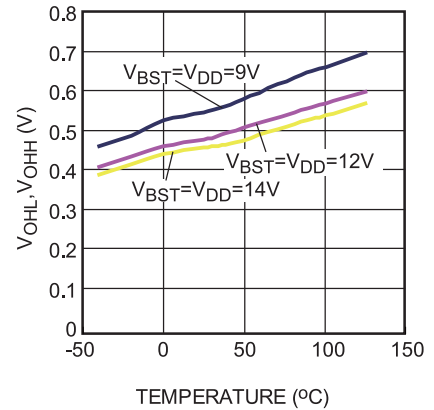
**$I_{DDO}$  Operation Current vs. Frequency**



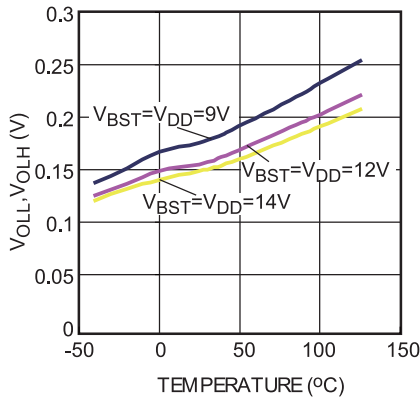
**$I_{BSTO}$  Operation Current vs. Frequency**



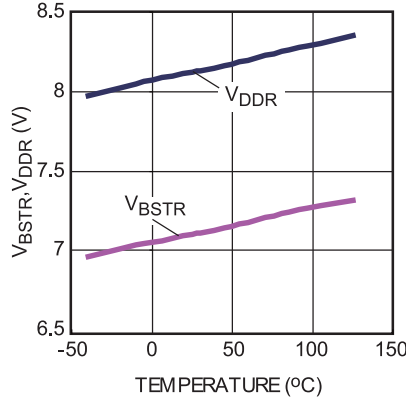
**High Level Output Voltage vs. Temperature**



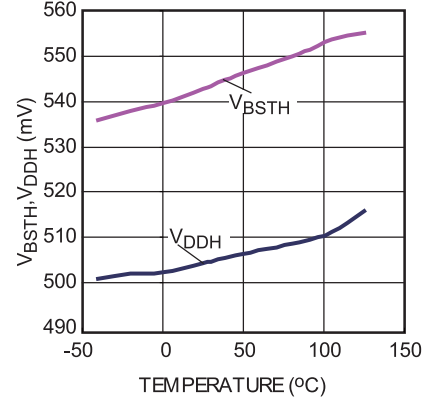
**Low Level Output Voltage vs. Temperature**



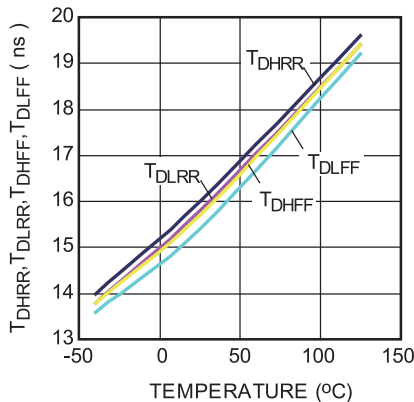
**Undervoltage Lockout Threshold vs. Temperature**



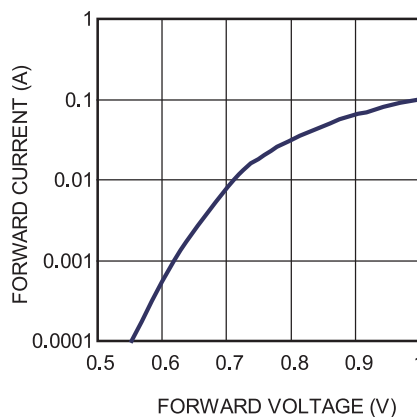
**Undervoltage Lockout Hysteresis vs. Temperature**



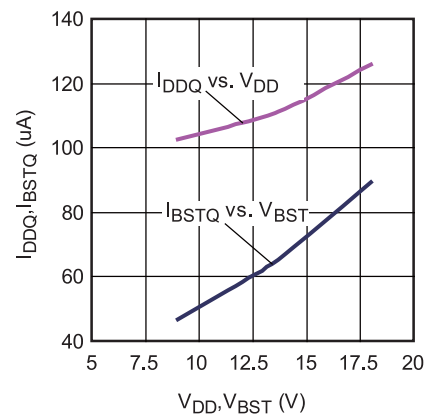
**Propagation Delay vs. Temperature**



**Bootstrap Diode I-V Characteristics**



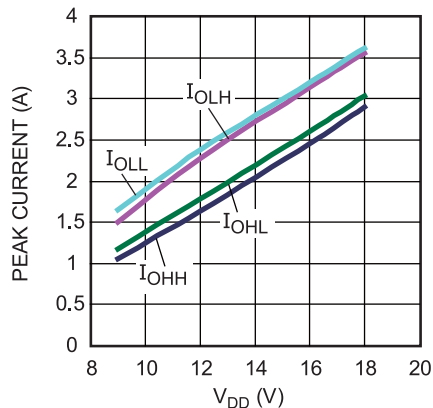
**Quiescent Current vs. Voltage**



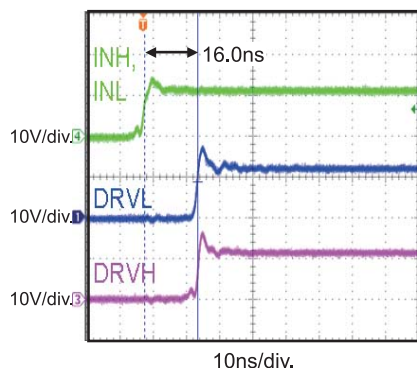
# **TYPICAL PERFORMANCE CHARACTERISTICS (continued)**

**VDD = 12V, VSS = V<sub>SW</sub> = 0V, T<sub>A</sub> = 25°C, unless otherwise noted.**

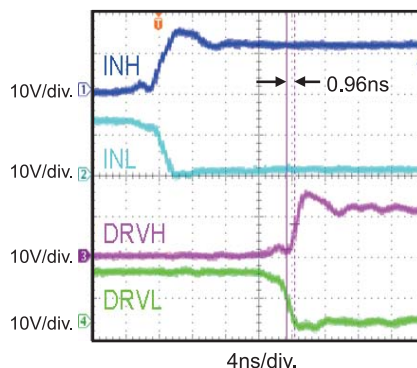
**Peak Current vs.  
V<sub>DD</sub> Voltage**



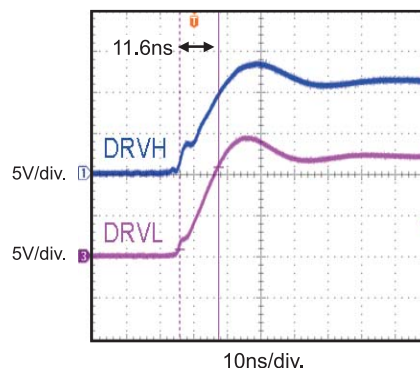
**Turn-on Propagation Delay**



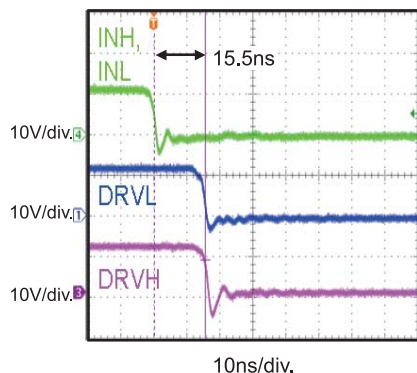
**Gate Drive Matching T<sub>MOFF</sub>**



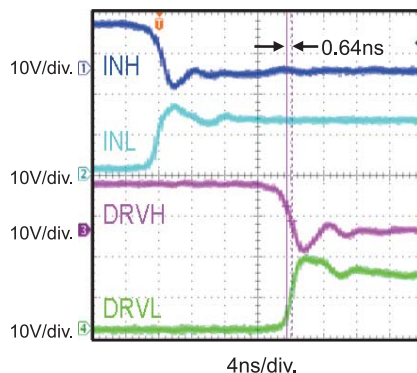
**Drive Rise Time (1nF Load)**



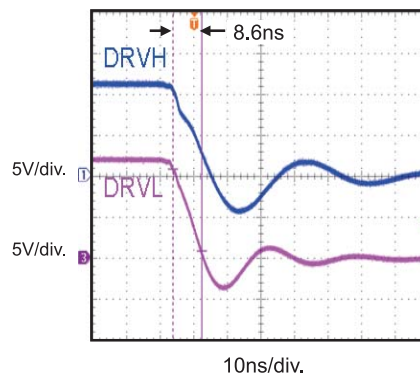
**Turn-off Propagation Delay**



**Gate Drive Matching T<sub>MON</sub>**



**Drive Fall Time (1nF Load)**



## BLOCK DIAGRAM

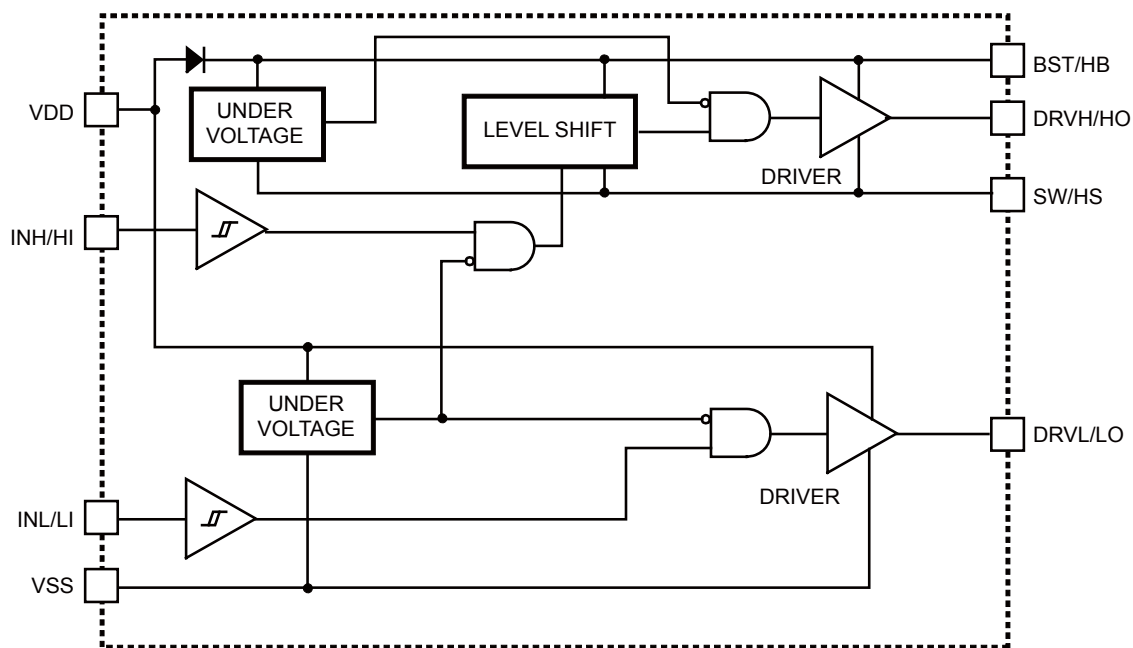


Figure 2: Functional Block Diagram



## APPLICATION

The INH and INL input signals can be controlled independently. If both INH and INL control the HSFET and LSFET of the same bridge, then users must avoid shoot through by a setting

sufficient dead time between INH low and INL high, and vice versa, as per **Figure 3** below. Dead time is defined as the time interval when both INH and INL are low.

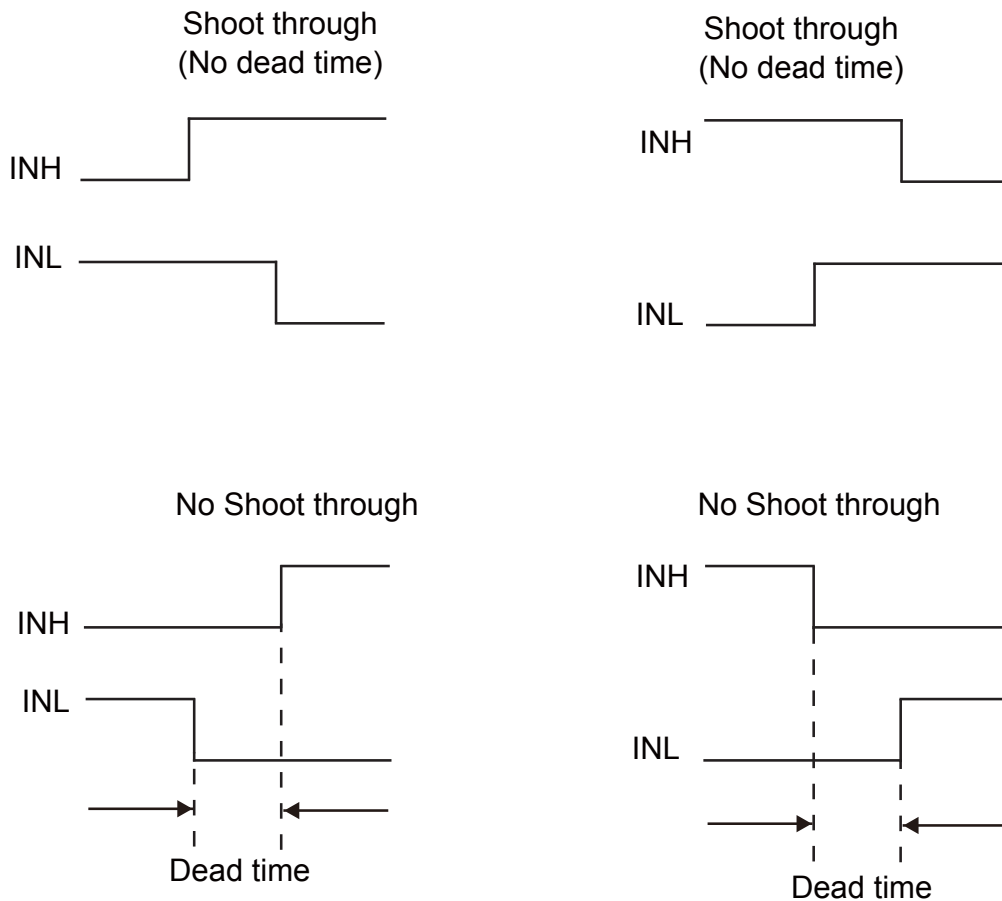


Figure 3: INH and INL Dead Time

## REFERENCE DESIGN CIRCUITS

### Half-Bridge Converter

In half-bridge converter topology, the MOSFETs are alternately driven with some dead time between signals. Therefore, INH and INL are

driven with alternating signals from the PWM controller. The input voltage can go up to 100V in this application.

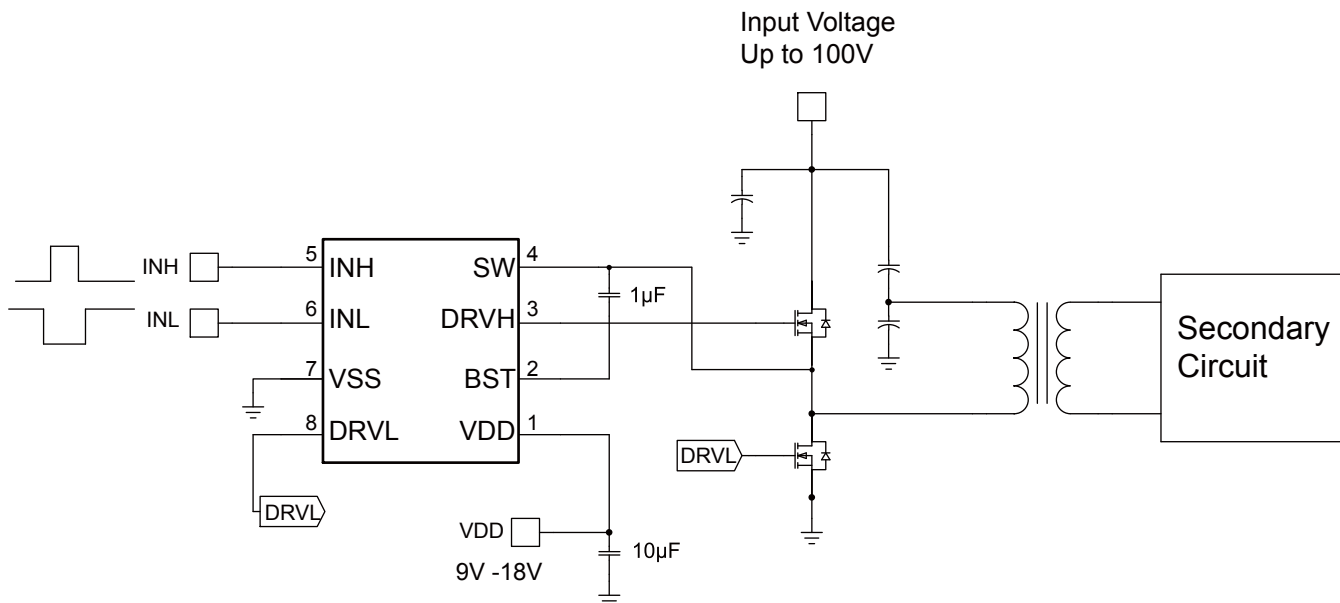


Figure 4: Half-Bridge Converter

### Two-Switch Forward Converter

In two-switch forward converter topology, both MOSFETs turn on and off together. The input signals (INH and INL) come 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 go up to 100V in this circuit.

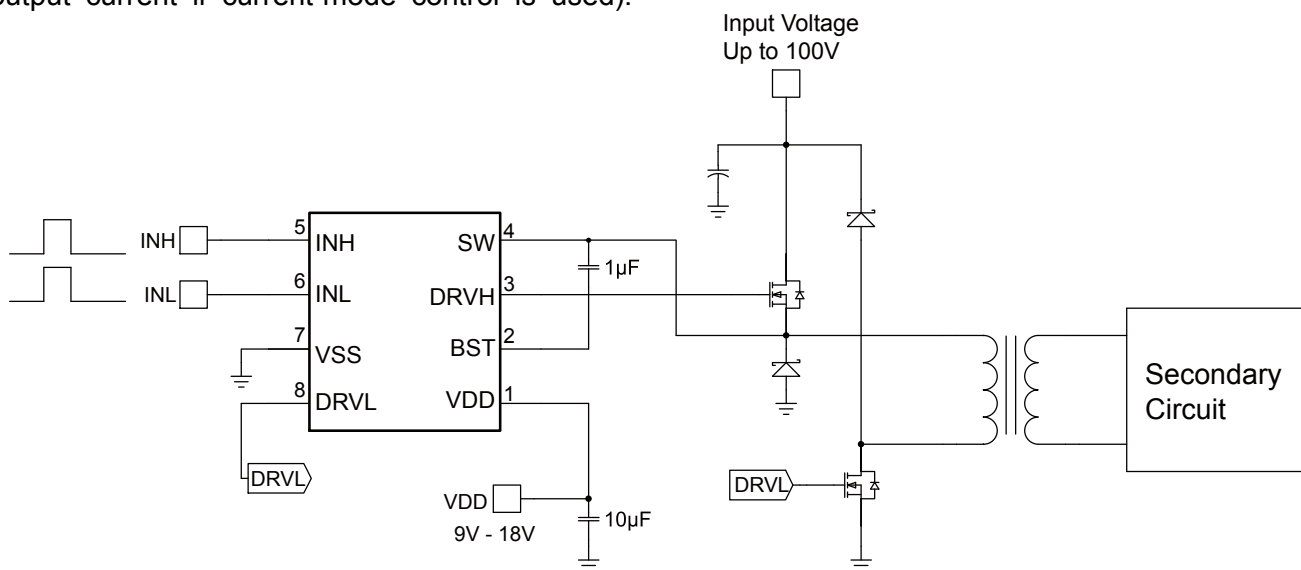


Figure 5: Two-Switch Forward Converter

### Active-Clamp Forward Converter

In active-clamp forward converter topology, the MOSFETs are driven alternately. The high-side MOSFET and the capacitor  $C_{reset}$  losslessly reset the power transformer.

This topology lends itself well to run at duty cycles exceeding 50%. Therefore, the input voltage for this application may not be able to go to 100V.

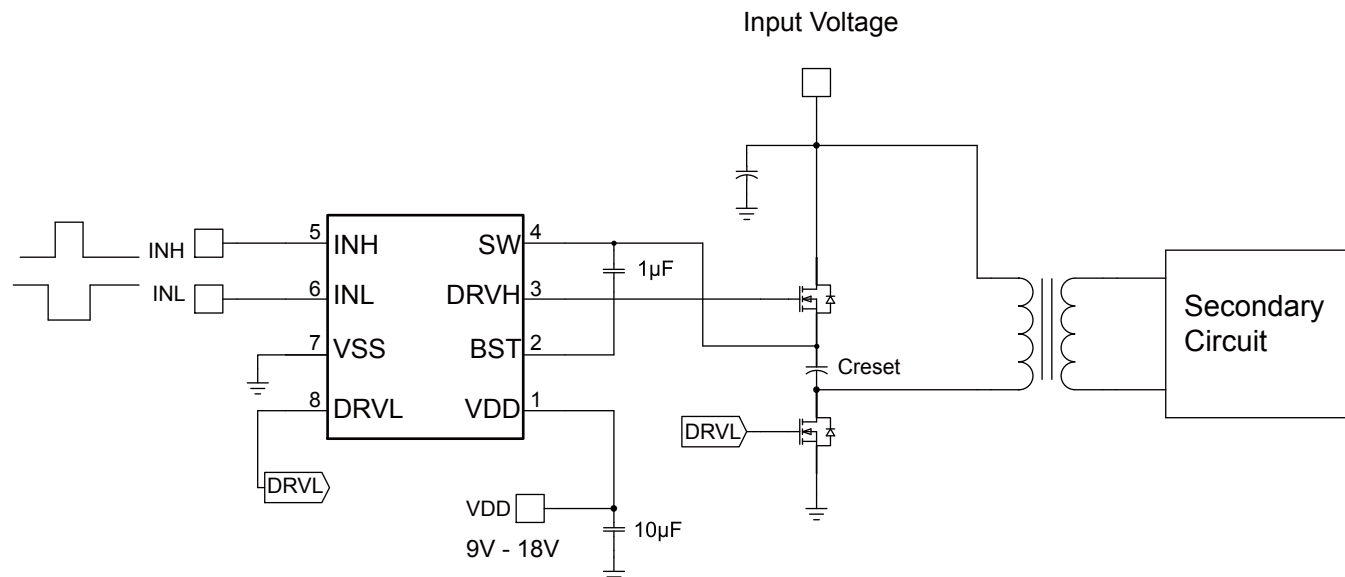
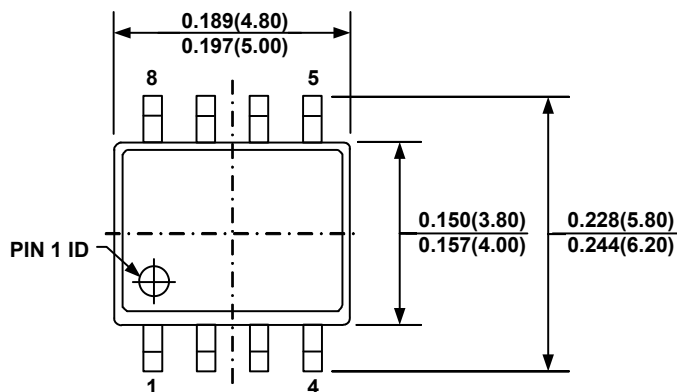


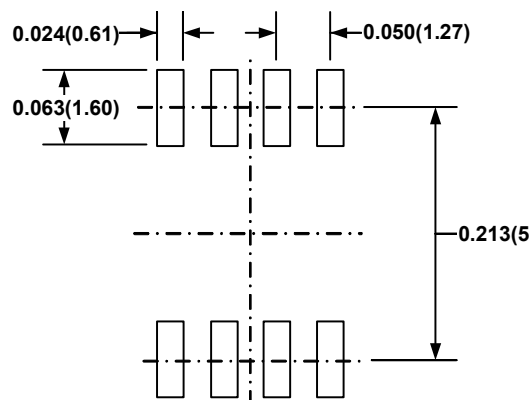
Figure 6: Active-Clamp Forward Converter

# PACKAGE INFORMATION

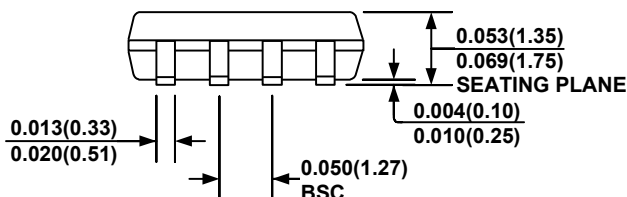
## SOIC8



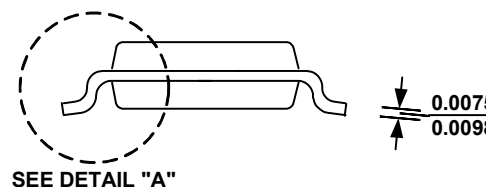
**TOP VIEW**



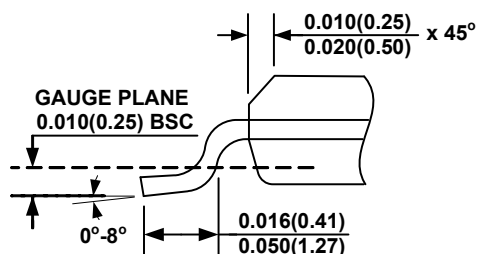
**RECOMMENDED LAND PATTERN**



**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 A.
- 6) DRAWING IS NOT TO SCALE.

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**Наши контакты:**

**Телефон:** +7 812 627 14 35

**Электронная почта:** [sales@st-electron.ru](mailto:sales@st-electron.ru)

**Адрес:** 198099, Санкт-Петербург,  
Промышленная ул, дом № 19, литера Н,  
помещение 100-Н Офис 331