DESCRIPTION

The MP1924 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 less than 5ns in time delay. 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 an N-Channel MOSFET Half Bridge
- 118V $V_{BST}$ 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 Rise Time and 12ns Fall Time at 12V VDD
- TTL-Compatible Input
- Quiescent Current of Less than 150μA
- UVLO for Both High Side and Low Side
- QFN-10 (4mmx4mm) and SOIC-8 Packages

APPLICATIONS

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

All MPS parts are lead-free, halogen free, and adhere to the RoHS directive. For MPS green status, please visit MPS website under Quality Assurance.

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ORDERING INFORMATION

<table>
<thead>
<tr>
<th>Part Number</th>
<th>Package</th>
<th>Top Marking</th>
</tr>
</thead>
<tbody>
<tr>
<td>MP1924HR*</td>
<td>QFN-10 (4x4mm)</td>
<td>See Below</td>
</tr>
<tr>
<td>MP1924HS**</td>
<td>SOIC-8</td>
<td>See Below</td>
</tr>
</tbody>
</table>

* For Tape & Reel, add suffix –Z (e.g. MP1924HR–Z)
For RoHS compliant packaging, add suffix –LF (e.g. MP1924HR–LF–Z)

** For Tape & Reel, add suffix –Z (e.g. MP1924HS–Z)
For RoHS compliant packaging, add suffix –LF (e.g. MP1924HS–LF–Z)

TOP MARKING (MP1924HR)

MPSYWW  
MP1924  
LLLLLL

MPS: MPS prefix;  
Y: year code;  
WW: week code;  
MP1924: product code of MP1924HR;  
LLLLLLL: lot number;

TOP MARKING (MP1924HS)

MP1924  
LLLLLLL 
MPSYWW

MP1924: product code of MP1924HS;  
LLLLLLL: lot number;  
MPS: MPS prefix;  
Y: year code;  
WW: week code;
**PACKAGE REFERENCE**

**ABSOLUTE MAXIMUM RATINGS**

Supply Voltage ($V_{DD}$) .............. -0.3V to 18V  
SW Voltage ($V_{SW}$) .................. -5.0V to 105V  
BST Voltage ($V_{BST}$) ............... -0.3V to 118V  
BST to SW .................................. -0.3V to (BST-SW) + 0.3V  
DRVH to SW ............................. -0.3V to (VDD + 0.3V)  
DRVL to VSS ............................. -0.3V to (VDD + 0.3V)  
All Other Pins .......................... -0.3V to (VDD + 0.3V)  

Continuous Power Dissipation  
(QFN-10 (4mmx4mm)) .................. 2.66W  
(SOIC-8) .................................. 1.3W  

 Junction Temperature .................... 150°C  
Lead Temperature ...................... 260°C  
Storage Temperature ................... -65°C to 150°C  

**Recommended Operating Conditions**

Supply Voltage $V_{DD}$ .................. 9.0V to 16.0V  
SW Voltage ($V_{SW}$) .................. -1.0V to 100V  
SW Slew Rate ........................... <50V/μs  
Operating Junction Temp. ($T_J$) .... -40°C to 125°C  

**Thermal Resistance**

(QFN-10 (4mmx4mm)) .................. 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 $T_J(\text{MAX})$, the junction-to-ambient thermal resistance $\theta_{JA}$, 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 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, $T_A = +25^\circ C$, unless otherwise noted.

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Symbol</th>
<th>Condition</th>
<th>Min</th>
<th>Typ</th>
<th>Max</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>Supply Currents</td>
<td>$I_{DDQ}$</td>
<td>$INL = INH = 0$</td>
<td>100</td>
<td>150</td>
<td>µA</td>
<td></td>
</tr>
<tr>
<td></td>
<td>$I_{DDO}$</td>
<td>$f_{sw} = 500kHz$</td>
<td>9</td>
<td>mA</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Floating driver quiescent current</td>
<td>$I_{BSTQ}$</td>
<td>$INL = INH = 0$</td>
<td>60</td>
<td>90</td>
<td>µA</td>
<td></td>
</tr>
<tr>
<td></td>
<td>$I_{BSTO}$</td>
<td>$f_{sw} = 500kHz$</td>
<td>7.5</td>
<td>mA</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Leakage current</td>
<td>$I_{LK}$</td>
<td>$BST = SW = 100V$</td>
<td>0.05</td>
<td>1</td>
<td>µA</td>
<td></td>
</tr>
<tr>
<td>Inputs</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>$INL/INH High$</td>
<td></td>
<td>2</td>
<td>2.4</td>
<td>V</td>
<td></td>
</tr>
<tr>
<td></td>
<td>$INL/INH Low$</td>
<td></td>
<td>1</td>
<td>1.4</td>
<td>V</td>
<td></td>
</tr>
<tr>
<td></td>
<td>$INL/INH internal pull-down resistance$</td>
<td></td>
<td>185</td>
<td>kΩ</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Under Voltage Protection</td>
<td>$V_{DDR}$</td>
<td></td>
<td>8.1</td>
<td>8.4</td>
<td>8.8</td>
<td>V</td>
</tr>
<tr>
<td></td>
<td>$V_{DDH}$</td>
<td></td>
<td>0.5</td>
<td></td>
<td>V</td>
<td></td>
</tr>
<tr>
<td></td>
<td>$V_{BSTR}$</td>
<td></td>
<td>6.9</td>
<td>7.3</td>
<td>7.7</td>
<td>V</td>
</tr>
<tr>
<td></td>
<td>$V_{BSTH}$</td>
<td></td>
<td>0.55</td>
<td></td>
<td>V</td>
<td></td>
</tr>
<tr>
<td>Bootstrap Diode</td>
<td>$V_{F1}$</td>
<td></td>
<td>0.5</td>
<td></td>
<td>V</td>
<td></td>
</tr>
<tr>
<td></td>
<td>$V_{F2}$</td>
<td></td>
<td>0.95</td>
<td></td>
<td>V</td>
<td></td>
</tr>
<tr>
<td></td>
<td>$R_{D}$</td>
<td></td>
<td>2</td>
<td></td>
<td>Ω</td>
<td></td>
</tr>
<tr>
<td>Low Side Gate Driver</td>
<td>$V_{OLL}$</td>
<td>$IO = 100mA$</td>
<td>0.08</td>
<td></td>
<td>V</td>
<td></td>
</tr>
<tr>
<td></td>
<td>$V_{OHL}$</td>
<td>$IO = -100mA$</td>
<td>0.23</td>
<td></td>
<td>V</td>
<td></td>
</tr>
<tr>
<td>Source Current$^{(5)}$</td>
<td>$I_{OHL}$</td>
<td>$V_{DRVL} = 0V$, $V_{DD} = 12V$</td>
<td>3</td>
<td></td>
<td>A</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>$V_{DRVL} = 0V$, $V_{DD} = 16V$</td>
<td>4.7</td>
<td></td>
<td>A</td>
<td></td>
</tr>
<tr>
<td>Sink Current$^{(5)}$</td>
<td>$I_{OLL}$</td>
<td>$V_{DRVL} = V_{DD} = 12V$</td>
<td>4.5</td>
<td></td>
<td>A</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>$V_{DRVL} = V_{DD} = 16V$</td>
<td>6</td>
<td></td>
<td>A</td>
<td></td>
</tr>
<tr>
<td>Floating Gate Driver</td>
<td>$V_{OLH}$</td>
<td>$IO = 100mA$</td>
<td>0.08</td>
<td></td>
<td>V</td>
<td></td>
</tr>
<tr>
<td></td>
<td>$V_{OHH}$</td>
<td>$IO = -100mA$</td>
<td>0.23</td>
<td></td>
<td>V</td>
<td></td>
</tr>
<tr>
<td>Source Current$^{(5)}$</td>
<td>$I_{OHH}$</td>
<td>$V_{DRVH} = 0V$, $V_{DD} = 12V$</td>
<td>2.6</td>
<td></td>
<td>A</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>$V_{DRVH} = 0V$, $V_{DD} = 16V$</td>
<td>4</td>
<td></td>
<td>A</td>
<td></td>
</tr>
<tr>
<td>Sink Current$^{(5)}$</td>
<td>$I_{OLH}$</td>
<td>$V_{DRVH} = V_{DD} = 12V$</td>
<td>4.5</td>
<td></td>
<td>A</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>$V_{DRVH} = V_{DD} = 16V$</td>
<td>5.9</td>
<td></td>
<td>A</td>
<td></td>
</tr>
</tbody>
</table>
ELECTRICAL CHARACTERISTICS (continued)

\[ V_{DD} = V_{BST} - V_{SW} = 12V, \ V_{SS} = V_{SW} = 0V, \] No load at DRVH and DRVL, \( T_A = +25^\circ C \), unless otherwise noted.

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Symbol</th>
<th>Condition</th>
<th>Min</th>
<th>Typ</th>
<th>Max</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Switching Spec. --- Low Side Gate Driver</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Turn-off propagation delay INL falling to DRVL falling</td>
<td>( T_{DLFF} )</td>
<td></td>
<td>20</td>
<td>ns</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Turn-on propagation delay INL rising to DRVL rising</td>
<td>( T_{DLRR} )</td>
<td></td>
<td>20</td>
<td>ns</td>
<td></td>
<td></td>
</tr>
<tr>
<td>DRVL rise time</td>
<td>( C_L = 2.2nF )</td>
<td></td>
<td>15</td>
<td>ns</td>
<td></td>
<td></td>
</tr>
<tr>
<td>DRVL fall time</td>
<td>( C_L = 2.2nF )</td>
<td></td>
<td>9</td>
<td>ns</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Switching Spec. --- Floating Gate Driver</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Turn-off propagation delay INH falling to DRVH falling</td>
<td>( T_{DHFF} )</td>
<td></td>
<td>20</td>
<td>ns</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Turn-on propagation delay INH rising to DRVH rising</td>
<td>( T_{DHRR} )</td>
<td></td>
<td>20</td>
<td>ns</td>
<td></td>
<td></td>
</tr>
<tr>
<td>DRVH rise time</td>
<td>( C_L = 2.2nF )</td>
<td></td>
<td>15</td>
<td>ns</td>
<td></td>
<td></td>
</tr>
<tr>
<td>DRVH fall time</td>
<td>( C_L = 2.2nF )</td>
<td></td>
<td>12</td>
<td>ns</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Switching Spec. --- Matching</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Floating driver turn-off to low side drive turn-on</td>
<td>( T_{MON} )</td>
<td></td>
<td>1</td>
<td>5</td>
<td>ns</td>
<td></td>
</tr>
<tr>
<td>Low side driver turn-off to floating driver turn-on</td>
<td>( T_{MOFF} )</td>
<td></td>
<td>1</td>
<td>5</td>
<td>ns</td>
<td></td>
</tr>
<tr>
<td>Minimum input pulse width that changes the output</td>
<td>( T_{PW} )</td>
<td></td>
<td></td>
<td></td>
<td>50</td>
<td>ns</td>
</tr>
<tr>
<td>Bootstrap diode turn-on or turn-off time</td>
<td>( T_{BS} )</td>
<td></td>
<td></td>
<td></td>
<td>10</td>
<td>ns</td>
</tr>
<tr>
<td>Thermal shutdown</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>150</td>
</tr>
<tr>
<td>Thermal shutdown hysteresis</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>25</td>
</tr>
</tbody>
</table>

**Note:**

5) Guaranteed by design.

---

**Figure 1: Timing Diagram**
### PIN FUNCTIONS

<table>
<thead>
<tr>
<th>QFN4x4-10 Pin #</th>
<th>SOIC-8 Pin #</th>
<th>Name</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>1</td>
<td>VDD</td>
<td>Supply input. This pin supplies power to all the internal circuitry. Place a decoupling capacitor to ground close to this pin to ensure stable and clean supply.</td>
</tr>
<tr>
<td>2</td>
<td>2</td>
<td>BST</td>
<td>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.</td>
</tr>
<tr>
<td>3</td>
<td>3</td>
<td>DRVH</td>
<td>Floating driver output.</td>
</tr>
<tr>
<td>4</td>
<td>4</td>
<td>SW</td>
<td>Switching node.</td>
</tr>
<tr>
<td>5, 6</td>
<td></td>
<td>NC</td>
<td>No connection.</td>
</tr>
<tr>
<td>7</td>
<td>5</td>
<td>INH</td>
<td>Control signal input for the floating driver.</td>
</tr>
<tr>
<td>8</td>
<td>6</td>
<td>INL</td>
<td>Control signal input for the low side driver.</td>
</tr>
<tr>
<td>9</td>
<td>7</td>
<td>VSS, exposed pad</td>
<td>Chip ground. Connect exposed pad to VSS for proper thermal operation.</td>
</tr>
<tr>
<td>10</td>
<td>8</td>
<td>DRVL</td>
<td>Low side driver output.</td>
</tr>
</tbody>
</table>


TYPICAL PERFORMANCE CHARACTERISTICS

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

- **IDDQ Operation Current vs. Frequency**
- **IBSTO 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**
- **Bootstrap Diode I-V Characteristic**
- **Quiescent Current vs. Voltage**
- **Propagation Delay vs. Temperature**
TYPICAL PERFORMANCE CHARACTERISTICS (continued)

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

- **Sink Current vs. $V_{DD}$ Voltage**
- **Source Current vs. $V_{DD}$ Voltage**
- **Source Current vs. Output Voltage $V_{DD}=12V$**

- **Sink Current vs. Output Voltage $V_{DD}=12V$**
TYPICAL PERFORMANCE CHARACTERISTICS (continued)
$V_{DD} = 12V$, $V_{SS} = V_{SW} = 0V$, $T_A = +25^\circ C$, unless otherwise noted.

**Turn-on Propagation Delay**
- INL, INH: 2V/div.
- DRVH, DRVL: 5V/div.
- 10ns/div.

**Turn-off Propagation Delay**
- INL, INH: 2V/div.
- DRVH, DRVL: 5V/div.
- 10ns/div.

**Gate Drive Matching $T_{MOFF}$**
- INL, INH: 10V/div.
- DRVH, DRVL: 10V/div.
- DRVL: 5V/div.
- 4ns/div.

**Gate Drive Matching $T_{MON}$**
- INH: 10V/div.
- INL: 10V/div.
- DRVH, DRVL: 10V/div.
- DRVL: 5V/div.
- 4ns/div.

**Drive Rise Time**
- 2.2nF Load
- DRVH, DRVL: 5V/div.
- 10ns/div.

**Drive Fall Time**
- 2.2nF Load
- DRVL: 5V/div.
- 10ns/div.
Figure 2: Function Block Diagram
APPLICATION

The input signals of INH and INL can be controlled independently. If both INH and INL control the high-side MOSFET and low-side MOSFET of the same bridge, then users must avoid shoot through by setting sufficient dead time between INH and INL low, and vice versa. See Figure 3 below. Dead time is defined as the time interval between INH low and INL low.

Shoot through (No dead time)

INH

INL

No Shoot through

INH

INL

Dead time

INH

INL

Dead time

INH

INL

No Shoot through

INH

INL

Dead time

INH

INL

Dead time

INH

INL

No Shoot through

INH

INL

Dead time

INH

INL

Figure 3: Shoot-Through Timing Diagram
REFERENCE DESIGN CIRCUITS

Half Bridge Converter
The MP1924 drives the MOSFETs with alternating signals (with dead time) in half-bridge converter topology. Therefore, from the PWM controller drives INH and INL with alternating signals the input voltage can go up to 100V.

![Figure 4: Half Bridge Converter](image)

Two-Switch Forward Converter
In two-switch forward converter topology, both MOSFETs are turned on and off simultaneously. The input signal (INH and INL) comes from a PWM controller that senses the output voltage (and output current during current-mode control).

The Schottky diodes clamp the reverse swing of the power transformer and must be rated for the input voltage. The input voltage can go up to 100V.

![Figure 5: Two-Switch Forward Converter](image)
Active-Clamp Forward Converter

In active-clamp forward converter topology, the MP1924 drives the MOSFETs with alternating signals. The high-side MOSFET, in conjunction with $C_{\text{reset}}$, is used to reset the power transformer in a lossless manner. This topology lends itself well to run at duty cycles exceeding 50%. The device may not be able to run at 100V under this topology.

![Fig 6 Active-Clamp Forward Converter](image-url)
PACKAGE INFORMATION

QFN-10 (4mm×4mm)

PIN 1 ID MARKING

PIN 1 ID INDEX AREA

TOP VIEW

BOTTOM VIEW

SIDE VIEW

DETAIL A

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.

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 AA.
6) DRAWING IS NOT TO SCALE.