Features
- 20 V to 50 V Back Bias
- 200 mA Sinking Current
- 100 mA Sourcing Current
- Propagation Delay <200 ns Driving 100 pF Capacitive Load
- Low Quiescent Current
- 3.3 V TTL Logic Control
- 3 mm 16-Lead PQFN Package
- Halogen-Free “Green” Mold Compound
- RoHS* Compliant

Description
The MADR-009150 switch driver is designed to work with MACOM’s high power and high voltage PIN diode switches. This driver has complementary outputs which can provide up to 200 mA bias current to a SPDT PIN diode switch. The back bias voltage can be selected to be any voltage between 20 V to 50 V. This switch driver can be easily controlled by standard 3.3 V TTL logic. With low quiescent current, this driver has a typical delay of <200 ns when driving 100 pF capacitive load.

This driver is packaged in a lead free 3 mm 16-lead PQFN package and is available in tape and reel packaging for high volume applications.

Ordering Information

<table>
<thead>
<tr>
<th>Part Number</th>
<th>Package</th>
</tr>
</thead>
<tbody>
<tr>
<td>MADR-009150</td>
<td>bulk</td>
</tr>
<tr>
<td>MADR-009150-TR1000</td>
<td>1000 Piece Reel</td>
</tr>
</tbody>
</table>

1. Reference Application Note M513 for reel size information.

* Restrictions on Hazardous Substances, European Union Directive 2011/65/EU
Electrical Specifications:  \( T_A = 25^\circ C, \ V_{CC} = 3.3 \ V, \ V_{DD} = 50 \ V \)

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Test Conditions</th>
<th>Units</th>
<th>Min.</th>
<th>Typ.</th>
<th>Max.</th>
</tr>
</thead>
<tbody>
<tr>
<td>( V_{CC} ) Quiescent Current</td>
<td>( C = 3.3 \ V )</td>
<td>( \mu A )</td>
<td>—</td>
<td>50</td>
<td>—</td>
</tr>
<tr>
<td>( V_{DD} ) Quiescent Current</td>
<td>( C = 0 \ V ) or ( 3.3 \ V )</td>
<td>( mA )</td>
<td>—</td>
<td>0.5</td>
<td>—</td>
</tr>
<tr>
<td>Control Input Leakage Current(^6)</td>
<td>( C = 3.3 \ V )</td>
<td>( \mu A )</td>
<td>—</td>
<td>25</td>
<td>—</td>
</tr>
<tr>
<td>( R_{PULL-UP}, ) Output Pull-up On Resistance</td>
<td>( 100 \ mA ) Load</td>
<td>( \Omega )</td>
<td>—</td>
<td>19</td>
<td>—</td>
</tr>
<tr>
<td>( R_{PULL-DOWN}, ) Output Pull-down On Resistance</td>
<td>( 200 \ mA ) Load</td>
<td>( \Omega )</td>
<td>—</td>
<td>6</td>
<td>—</td>
</tr>
<tr>
<td>Switching Speed Driving 100 pF Capacitors(^6)</td>
<td>( 50% ) control to 90% Voltage ( 50% ) control to 10% Voltage ( 10% ) to 90% Voltage ( 90% ) to 10% Voltage</td>
<td>ns</td>
<td>—</td>
<td>120</td>
<td>—</td>
</tr>
<tr>
<td>( T_{ON} )</td>
<td></td>
<td></td>
<td>140</td>
<td>—</td>
<td>—</td>
</tr>
<tr>
<td>( T_{OFF} )</td>
<td></td>
<td></td>
<td>30</td>
<td>—</td>
<td>—</td>
</tr>
<tr>
<td>( T_{RISE} )</td>
<td></td>
<td></td>
<td>30</td>
<td>—</td>
<td>—</td>
</tr>
<tr>
<td>( T_{FALL} )</td>
<td></td>
<td></td>
<td>30</td>
<td>—</td>
<td>—</td>
</tr>
<tr>
<td>Switching Speed Driving the MASW-000936 Switch(^7)</td>
<td>( 50% ) control to 90% RF ( 50% ) control to 10% RF ( 50% ) control to 90% RF ( 50% ) control to 10% RF</td>
<td>ns</td>
<td>—</td>
<td>320</td>
<td>—</td>
</tr>
<tr>
<td>( T_{ON} )</td>
<td></td>
<td></td>
<td>300</td>
<td>—</td>
<td>—</td>
</tr>
<tr>
<td>( T_{OFF} )</td>
<td></td>
<td></td>
<td>420</td>
<td>—</td>
<td>—</td>
</tr>
<tr>
<td>( T_{RISE} )</td>
<td></td>
<td></td>
<td>160</td>
<td>—</td>
<td>—</td>
</tr>
<tr>
<td>( T_{FALL} )</td>
<td></td>
<td></td>
<td>—</td>
<td>—</td>
<td>—</td>
</tr>
<tr>
<td>Driver Power Up Time</td>
<td>Note 8</td>
<td>( \mu s )</td>
<td>—</td>
<td>30</td>
<td>—</td>
</tr>
<tr>
<td>Driver Power Down Time</td>
<td>Note 9</td>
<td>( \mu s )</td>
<td>—</td>
<td>500</td>
<td>—</td>
</tr>
</tbody>
</table>

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5. This leakage current is due to an active pull-down NMOS FET at the control input.
6. During this test, there was 100 pF capacitive load at each output (no current load).
7. MACOM MASW-000936 is a 120 W SPDT PIN diode switch requiring 100 mA current to bias series and shunt diodes. These results were measured with a 2.7 GHz, 9.5 dBm sine wave signal.
8. The driver power up time is the time needed for the internal bias voltages to reach 90% of their steady state value during power up.
9. The driver power down time is the time needed for the internal voltages to discharge to 10% of their steady state value during power down.
Recommended Operating Conditions

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Test Conditions</th>
<th>Units</th>
<th>Min.</th>
<th>Typ.</th>
<th>Max.</th>
</tr>
</thead>
<tbody>
<tr>
<td>$V_{CC}$</td>
<td></td>
<td>V</td>
<td>3.0</td>
<td>3.3</td>
<td>3.6</td>
</tr>
<tr>
<td>$V_{DD}$</td>
<td></td>
<td>V</td>
<td>20</td>
<td></td>
<td>50</td>
</tr>
<tr>
<td>$C$</td>
<td>Logic &quot;0&quot;</td>
<td>V</td>
<td>0.0</td>
<td>0.0</td>
<td>0.8</td>
</tr>
<tr>
<td></td>
<td>Logic &quot;1&quot;</td>
<td></td>
<td>2.0</td>
<td>$V_{CC}$</td>
<td>$V_{CC}$</td>
</tr>
<tr>
<td>$I_{SINK}$, Sinking Current per Output</td>
<td></td>
<td>mA</td>
<td></td>
<td></td>
<td>200</td>
</tr>
<tr>
<td>$I_{SOURCE}$, Sourcing Current per Output</td>
<td></td>
<td>mA</td>
<td></td>
<td></td>
<td>100</td>
</tr>
<tr>
<td>Total Capacitive load per Output (Operating)</td>
<td></td>
<td>pF</td>
<td></td>
<td></td>
<td>100</td>
</tr>
<tr>
<td>Operating Temperature</td>
<td></td>
<td>°C</td>
<td>-40</td>
<td>+25</td>
<td>+85</td>
</tr>
</tbody>
</table>

Absolute Maximum Ratings

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Absolute Maximum</th>
</tr>
</thead>
<tbody>
<tr>
<td>$V_{CC}$</td>
<td>$-0.5 \leq V_{CC} \leq +5.5$ V</td>
</tr>
<tr>
<td>$V_{DD}$</td>
<td>$-0.5 \leq V_{DD} \leq +55$ V</td>
</tr>
<tr>
<td>$C$</td>
<td>$-0.5 \leq V_{CC} \leq +5.5$ V</td>
</tr>
<tr>
<td>Sinking Current per Output</td>
<td>250 mA</td>
</tr>
<tr>
<td>Sourcing Current per Output</td>
<td>125 mA</td>
</tr>
<tr>
<td>Capacitive Load per Output</td>
<td>125 pF</td>
</tr>
<tr>
<td>Operating Temperature</td>
<td>-40°C to +110°C</td>
</tr>
<tr>
<td>Storage Temperature</td>
<td>-55°C to +150°C</td>
</tr>
</tbody>
</table>

Logic Truth Table

<table>
<thead>
<tr>
<th>Input C</th>
<th>Output A</th>
<th>Output B</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>$\approx GND^{13}$</td>
<td>$\approx V_{DD}^{14}$</td>
</tr>
<tr>
<td>1</td>
<td>$\approx V_{DD}^{14}$</td>
<td>$\approx GND^{13}$</td>
</tr>
</tbody>
</table>

13. The actual output low voltage can be calculated by: $V_{OL} = I_{SINK} \times R_{Pull-Down}$.
14. The actual output low voltage can be calculated by: $V_{OH} = V_{DD} - I_{SOURCE} \times R_{Pull-Up}$.

Handling Procedures

Please observe the following precautions to avoid damage:

Static Sensitivity

These electronic devices are sensitive to electrostatic discharge (ESD) and can be damaged by static electricity. Proper ESD control techniques should be used when handling these HBM classification 1C devices.
Typical Performance Curves

**Quiescent $I_{CC}$**: $V_{CC} = 3.3$ V, $V_{DD} = 50$ V

**Output Pull-up On Resistance**: $V_{CC} = 3.3$ V

**Quiescent $I_{DD}$**: $V_{CC} = 3.3$ V, $V_{DD} = 50$ V

**Output Pull-down On Resistance**: $V_{CC} = 3.3$ V

**Control Leakage Current**: $V_{CC} = C = 3.3$ V, $V_{DD} = 50$ V
Typical Performance Curves\textsuperscript{15}

Switching Speed Driving 100 pF Capacitors: $T_{\text{ON}}$

Switching Speed Driving 100 pF Capacitors: $T_{\text{OFF}}$

Switching Speed Driving 100 pF Capacitors: $T_{\text{RISE}}$

Switching Speed Driving 100 pF Capacitors: $T_{\text{FALL}}$

15. During this test, there was 100 pF capacitive load at each output (no current load). $V_{\text{CC}} = 3.3$ V. Control input was a 0 V to 3.3 V pulse with rise and fall time of 6 ns.
Typical Performance Curves\textsuperscript{16}

Switching Speed Driving MASW-000936: $T_x$ ON

\begin{center}
\begin{tikzpicture}
\begin{axis}[
width=\textwidth,
height=0.5\textwidth,
title style={yshift=-5pt},
title={$T_{ON}$ (ns)},
xtick={-40,-20,0,20,40,60,80,100},
xticklabels={-40,-20,0,20,40,60,80,100},
xticklabel style={yshift=-5pt},
ytick={0,200,400,600,800},
yticklabels={0,200,400,600,800},
axis lines=left,
mark options={solid},
]
\addplot[color=blue,domain=-40:100,samples=100] {20 + 0.02*x};
\addplot[color=orange,domain=-40:100,samples=100] {40 + 0.02*x};
\addplot[color=black,domain=-40:100,samples=100] {60 + 0.02*x};
\end{axis}
\end{tikzpicture}
\end{center}

\begin{center}
\begin{tikzpicture}
\begin{axis}[
width=\textwidth,
height=0.5\textwidth,
xtick={-40,-20,0,20,40,60,80,100},
xticklabels={-40,-20,0,20,40,60,80,100},
xticklabel style={yshift=-5pt},
xtick={-40,-20,0,20,40,60,80,100},
xticklabels={-40,-20,0,20,40,60,80,100},
xis lines=left,
mark options={solid},
]
\addplot[draw=none] table [x=Temperature, y=Vdd=20 V] {data.txt};
\addplot[draw=none] table [x=Temperature, y=Vdd=40 V] {data.txt};
\addplot[draw=none] table [x=Temperature, y=Vdd=50 V] {data.txt};
\end{axis}
\end{tikzpicture}
\end{center}

Switching Speed Driving MASW-000936: $T_x$ OFF

\begin{center}
\begin{tikzpicture}
\begin{axis}[
width=\textwidth,
height=0.5\textwidth,
xtick={-40,-20,0,20,40,60,80,100},
xticklabels={-40,-20,0,20,40,60,80,100},
xticklabel style={yshift=-5pt},
xtick={-40,-20,0,20,40,60,80,100},
xticklabels={-40,-20,0,20,40,60,80,100},
xis lines=left,
mark options={solid},
]
\addplot[draw=none] table [x=Temperature, y=Vdd=20 V] {data.txt};
\addplot[draw=none] table [x=Temperature, y=Vdd=40 V] {data.txt};
\addplot[draw=none] table [x=Temperature, y=Vdd=50 V] {data.txt};
\end{axis}
\end{tikzpicture}
\end{center}

Switching Speed Driving MASW-000936: $R_x$ ON

\begin{center}
\begin{tikzpicture}
\begin{axis}[
width=\textwidth,
height=0.5\textwidth,
axis lines=left,
mark options={solid},
]
\addplot[draw=none] table [x=Temperature, y=Vdd=20 V] {data.txt};
\addplot[draw=none] table [x=Temperature, y=Vdd=40 V] {data.txt};
\addplot[draw=none] table [x=Temperature, y=Vdd=50 V] {data.txt};
\end{axis}
\end{tikzpicture}
\end{center}

Switching Speed Driving MASW-000936: $R_x$ OFF

\begin{center}
\begin{tikzpicture}
\begin{axis}[
width=\textwidth,
height=0.5\textwidth,
axis lines=left,
mark options={solid},
]
\addplot[draw=none] table [x=Temperature, y=Vdd=20 V] {data.txt};
\addplot[draw=none] table [x=Temperature, y=Vdd=40 V] {data.txt};
\addplot[draw=none] table [x=Temperature, y=Vdd=50 V] {data.txt};
\end{axis}
\end{tikzpicture}
\end{center}

16. MACOM’s MASW-000936 is a 120 W SPDT PIN diode switch requiring 100 mA current to bias series and shunt diodes. These results were measured with a 2.7 GHz, 9.5 dBm sine wave signal. Control input was a 0 V to 3.3 V pulse with rise and fall time of 6 ns.
17. This application circuit is configured to bias the series diodes of the MASW-000936 switch with 100 mA current. Shunt diode bias current is depending on the value of V_DD. With V_DD of 40 V, the shunt diode current is around 38 mA.

18. This driver can also be used to drive a series/shunt, series/shunt, SP2T switch. RX shunt diode bias should be connected to the TX series diode bias as shown in the schematic above. TX shunt diode bias should be connected to the RX series diode bias. To the driver, the sourcing current is the shunt diode forward bias current. The sinking current is the sum of the shunt diode bias current and the series diode bias current.
Lead-Free 3 mm 16-Lead PQFN†

† This is not a JEDEC standard package.
Meets JEDEC moisture sensitivity level 1 requirements.
Plating is NiPdAu.
20 - 50 V Driver for High Power PIN Diode Switches

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