Quick start guide
KIT_DRIVER_2EDS8265H

PMM Gate Driver AE
Included in this kit

Heatsinks for TO-220 MOSFETs

Evaluation kit
KIT_DRIVER_2EDS8265H
## Components to add – BOM suggestion

<table>
<thead>
<tr>
<th>Component</th>
<th>Quantity</th>
<th>Designator</th>
<th>Comment</th>
<th>Voltage</th>
<th>Footprint</th>
<th>Type</th>
<th>Part number/supplies</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sink diode</td>
<td>2</td>
<td>D11,D12</td>
<td>Schottky diode</td>
<td>30 V</td>
<td>SOD-123</td>
<td>PMEG3020 Schottky diode</td>
<td>816-6858 RS-Components</td>
</tr>
<tr>
<td>Resistors</td>
<td>4</td>
<td>R28,R29,R31,R32</td>
<td></td>
<td></td>
<td>RES805R</td>
<td>SMD ceramic resistor</td>
<td></td>
</tr>
<tr>
<td>TO-220 sockets</td>
<td>2</td>
<td>T11,T12</td>
<td>TO-220 socket</td>
<td></td>
<td>TO-220</td>
<td>Receptacle Connector 0.034” ~ 0.041” (0.86 mm ~ 1.04 mm)</td>
<td>5050865-5 Digi-key</td>
</tr>
</tbody>
</table>
Step 1: Distance bolts mounting
Step 2: Source resistors soldering
Step 3: Sink resistors and sink diodes soldering

Add the sink resistors and the sink diodes only if a differentiation between the turn-on and the turn-off behavior is required.
Step 4: TO-220 sockets soldering
Step 5: MOSFETs placement into the sockets
Step 6: Heatsink mounting (optional)

- Solder the heatsink if the board is used in high voltage scenarios
- In basic measurements it is not necessary
- See next slide for further information on how to properly mount the MOSFETs to the heatsink
TO-220 MOSFET mounting to the heatsink

Recommendations for assembly of Infineon TO packages:
https://www.infineon.com/dgdl/Infineon-Package_recommendations_for_assembly_of_Infineon_TO_packages-AN-v01_00-EN.pdf?fileId=db3a30431936bc4b011938532f885a38
Step 7: Select the SLDO_MODE jumper configuration

- If VCCI=3.3V:
  - connect the SLDO_MODE jumper across VCCI and SLDO (*normal mode operation*)
  - Replace the shunt resistor R30 with 0Ω resistance

- If VCCI ≥3.3V, connect the SLDO_MODE jumper across SLDO and GND (*shunt mode operation*)
  - if VCCI 3.3V ≤ VCCI ≤ 12V, please decrease the shunt resistor R30 according to the table below

<table>
<thead>
<tr>
<th>Available supply</th>
<th>Switching frequency</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>100 KHz</td>
</tr>
<tr>
<td>5 V</td>
<td>&lt; 732 Ω</td>
</tr>
<tr>
<td>8 V</td>
<td>&lt; 2.15 kΩ</td>
</tr>
<tr>
<td>12 V</td>
<td>&lt; 4.02 kΩ</td>
</tr>
<tr>
<td>15 V</td>
<td>&lt; 5.49 kΩ</td>
</tr>
</tbody>
</table>

In this quick start guide the shunt mode is used, as example; the SLDO_MODE jumper is connected across SLDO and GND pins and 12V VCCI is applied.
Step 8: Select the BS_EN jumper configuration

BS_EN jumper:
• Opened, if the MOSFETs are driven independently; in this case, if both channels are used, both VCCA and VCCB must be supplied

• Closed, in half-bridge configurations; in this case the bootstrap circuit is enabled and only VCCB must be supplied

> In this quick start guide only one MOSFET is driven and BS_EN is left opened
Step 8: BNC connectors soldering

- INA to GND
- OUTA to GND
- Vgs_MOSFET
Instrumentation for driver supply generation

- $V_{cc} = 12$ V for CoolMOS™ and 8 V for OptiMOS™
- Set the current limit to 0.3mA
Instrumentation for PWM signals generation

- Use a function generator or a microcontroller
Connections
Instrumentation for signals evaluation
Measurements done on a single MOSFET with $V_{DS} = 0 \, V$ (drain and source shorted)
Equivalent model of the driving circuit
Low-high propagation delay

\[ t_{PDlh} \] defined in the datasheet as time interval \( t(OUTB = 10\% VDD) - t(INB = V_{IH} = 2\ V) \) for a pure capacitive load \( C_{LOAD} = 1.8\ nF \) with \( R_{G,SOURCE} = 0\ \Omega \)

- N.B. In the considered measurements the load is the transistor with \( R_{G,MOSFET} = 0.82\ \Omega \), \( R_{G,SOURCE} = 39\ \Omega \), \( C_{LOAD} \approx 2.8\ nF \) (see slide 24 for \( C_{LOAD} \) calculation)

\( R_{G,SOURCE} = 39\ \Omega \)
\( R_{G,SINK} = 33\ \Omega \)
\( MOSFET = IPA60R099C7 \)
\( R_{G,MOSFET} = 0.82\ \Omega \)
\( C_{LOAD} \approx 2.8\ nF \)
High-Low propagation delay

$t_{PDhl}$ defined in the datasheet as time interval $t(\text{INB} = V_{\text{INL}} = 1.2 \text{ V}) - t(\text{OUTB} = 90\% \text{ VDD})$ for a pure capacitive load $C_{LOAD} = 1.8 \text{ nF}$ with $R_{G,SINK} = 0 \Omega$

N.B. In the considered measurements the load is the transistor with $R_{G,MOSFET} = 0.82 \Omega$, $R_{G,SINK} = 33 \Omega$, $C_{LOAD} \approx 2.8 \text{ nF}$

$R_{G,\text{SOURCE}} = 39 \Omega$

$R_{G,\text{SINK}} = 33 \Omega$

MOSFET = IPA60R099C7

$R_{G,MOSFET} = 0.82 \Omega$

$C_{LOAD} \approx 2.8 \text{ nF}$
$C_{LOAD}$ calculation for IPA60R099C7

\[ Q_{LOAD} = Q_g - Q_{gd} = 28 \text{ nC} \quad \rightarrow \quad C_{LOAD} = \frac{Q_{LOAD}}{V_{GS}} = 2.8 \text{ nF} \quad \text{for} \quad V_{GS} = 10 \text{ V} \rightarrow \]

\[ C_{LOAD} \approx 2.8 \text{ nF} \quad \text{for} \quad V_{GS} = 12 \text{ V} \]
Rise/fall times

\[ R_{G,\text{SOURCE}} = 39 \, \Omega \]
\[ R_{G,\text{SINK}} = 33 \, \Omega \]
\[ \text{MOSFET} = \text{IPA60R099C7} \]
\[ R_{G,\text{MOSFET}} = 0.82 \, \Omega \]
\[ C_{LOAD} \approx 2.8 \, \text{nF} \]
Gate resistors replacement

\[ R_{G,\text{SOURCE}} = 39 \, \Omega \quad \rightarrow \quad 24 \, \Omega \]

\[ R_{G,\text{SINK}} = 33 \, \Omega \quad \rightarrow \quad 20 \, \Omega \]

MOSFET = IPA60R099C7
Rise/fall times: New set of gate resistances

\[ R_{G,\text{SOURCE}} = 24 \, \Omega \]
\[ R_{G,\text{SINK}} = 20 \, \Omega \]
MOSFET = IPA60R099C7
\[ R_{G,\text{MOSFET}} = 0.82 \, \Omega \]
\[ C_{\text{LOAD}} \approx 2.8 \, \text{nF} \]
Gate resistors replacement

\[ R_{G,\text{SOURCE}} = 24 \, \Omega \quad \rightarrow \quad 51 \, \Omega \]

\[ R_{G,\text{SINK}} = 20 \, \Omega \quad \rightarrow \quad 43 \, \Omega \]

\text{MOSFET} = \text{IPA60R099C7}
Rise/fall times: New set of gate resistances

\[ R_{G,\text{SOURCE}} = 51 \ \Omega \]
\[ R_{G,\text{SINK}} = 43 \ \Omega \]
\[ \text{MOSFET} = \text{IPA60R099C7} \]
\[ R_{G,\text{MOSFET}} = 0.82 \ \Omega \]
\[ C_{\text{LOAD}} \approx 2.8 \ \text{nF} \]
MOSFET Replacement

IPA60R099C7 → IPA60R280CFD7

<table>
<thead>
<tr>
<th>Gate to drain charge</th>
<th>$Q_{gd}$</th>
<th>-</th>
<th>5</th>
<th>-</th>
<th>nC</th>
<th>$V_{DD}=400V$, $I_D=5.0A$, $V_{GS}=0$ to $10V$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gate charge total</td>
<td>$Q_g$</td>
<td>-</td>
<td>18</td>
<td>-</td>
<td>nC</td>
<td>$V_{DD}=400V$, $I_D=5.0A$, $V_{GS}=0$ to $10V$</td>
</tr>
</tbody>
</table>

$$C_{LOAD} \approx \frac{13 \text{ nC}}{10 \text{ V}} = 1.3 \text{ nF \ for \ } V_{GS} = 12 \text{ V}$$
Rise/fall times: New MOSFET

\[ R_{G,\text{SOURCE}} = 51 \, \Omega \]
\[ R_{G,\text{SINK}} = 43 \, \Omega \]
\[ \text{MOSFET} = \text{IPA60R280CFD7} \]
\[ R_{G,\text{MOSFET}} = 11 \, \Omega \]
\[ C_{\text{LOAD}} \approx 1.3 \, \text{nF} \]
MOSFET replacement

IPA60R280CFD7 → IPA60R180P7

\[ C_{LOAD} \approx \frac{19 \text{ nC}}{10 \text{ V}} = 1.9 \text{ nF} \quad \text{for } V_{GS} = 12 \text{ V} \]
Rise/fall times: New MOSFET

\[ R_{G,\text{SOURCE}} = 51 \, \Omega \]
\[ R_{G,\text{SINK}} = 43 \, \Omega \]
MOSFET = IPA60R180P7
\[ R_{G,\text{MOSFET}} = 11 \, \Omega \]
\[ C_{\text{LOAD}} \approx 1.9 \, \text{nF} \]
Additional notes

› Note that the MOSFET is not turned-on or -off, you are only charging/discharging the gate-to-source capacitance

› Changing the gate resistors and the MOSFETs, you are changing the load for the driver

› If you want to turn-on or turn-off the MOSFET, you must integrate the board in a proper circuit

› You can not apply directly the voltage (e.g. 400 V) across the MOSFET through the banana connectors on the board

› You must limit the input current from the DC source generator \( \rightarrow \) add an inductance

› You must create a freewheeling path for the current when MOSFET is off

Example: boost converter, simple MOSFET in clamped inductive mode
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