User's Guide
LEDMCUEVM-132 MSP432™ LED Controller Evaluation Module

ABSTRACT
This user's guide describes the specifications, board connection description, characteristics, operation, and use of the LEDMCUEVM-132 that uses the MSP432™ to control specific LED evaluation modules (EVMs). A complete schematic diagram, printed circuit board layouts, and bill of materials are included in this document.

Table of Contents
1 Description............................................................................................................................................................3
  1.1 Typical Applications...........................................................................................................................................3
  1.2 Connector Description .......................................................................................................................................4
2 Features and Specifications......................................................................................................................................6
3 Schematic, PCB Layout, and Bill of Materials.........................................................................................................6
  3.1 Schematic..........................................................................................................................................................7
  3.2 Layout..............................................................................................................................................................8
  3.3 Bill of Materials................................................................................................................................................11
4 Software..............................................................................................................................................................14
  4.1 Demonstration Kit Software Installation for LEDMCUEVM-132 Board.........................................................14
  4.2 Step-by-Step Installation Instructions................................................................................................................14
  4.3 Installation Error Recovery................................................................................................................................24
  4.4 Checking for Updates........................................................................................................................................25
5 LEDMCUEVM-132 Power UP and Operation......................................................................................................29
  5.1 GUI Start-up....................................................................................................................................................29
  5.2 MCU Control Window......................................................................................................................................32
  5.3 SPI Command Window...................................................................................................................................34
  5.4 GUI Devices Window and Example Connections and Power Up...............................................................37

List of Figures
Figure 1-1. Connection Diagram of Computer, USB Cable, and LEDMCUEVM-132.................................................4
Figure 2-1. High-Level Diagram of the LEDMCUEVM-132.....................................................................................6
Figure 3-1. LEDMCUEVM-132 Schematic............................................................................................................7
Figure 3-2. TPS92520EVM-133 Assembly Drawing...............................................................................................8
Figure 3-3. TPS92520EVM-133 Top Layer and Top Overlay (Top View)...............................................................8
Figure 3-4. TPS92520EVM-133 Inner-Layer 1.........................................................................................................9
Figure 3-5. TPS92520EVM-133 Inner-Layer 2.........................................................................................................9
Figure 3-6. TPS92520EVM-133 Bottom Layer and Bottom Overlay (Bottom View).............................................10
Figure 4-1. Setup Screen 1....................................................................................................................................14
Figure 4-2. Setup Screen 2....................................................................................................................................15
Figure 4-3. Setup Screen 3....................................................................................................................................15
Figure 4-4. Setup Screen 4....................................................................................................................................16
Figure 4-5. Setup Screen 5....................................................................................................................................16
Figure 4-6. Setup Screen 6....................................................................................................................................17
Figure 4-7. Setup Screen 7....................................................................................................................................17
Figure 4-8. Setup Screen 8....................................................................................................................................18
Figure 4-9. Setup Screen 9....................................................................................................................................18
Figure 4-10. Setup Screen 10 ...............................................................................................................................19
Figure 4-11. Setup Screen 11 ...............................................................................................................................19
Figure 4-12. Setup Screen 12 ...............................................................................................................................20
List of Figures

Figure 4-20. Help Menu and Checking for Updates.................................................................................................................. 25
Figure 4-21. Update Screen 1................................................................................................................................................ 25
Figure 4-22. Update Screen 2................................................................................................................................................ 25
Figure 4-23. J15 Jumper and RESET_SW1 Switch for Bootloader Mode................................................................................. 26
Figure 4-24. Setup Screen 5.................................................................................................................................................... 27
Figure 4-25. Setup Screen 6.................................................................................................................................................... 27
Figure 4-26. J15 Jumper and RESET_SW1 Switch for Normal Mode........................................................................................... 28
Figure 5-1. LEDMCUEVM-132 Connection to PC Using USB Cable.......................................................................................... 29
Figure 5-2. GUI Setup Screen 1................................................................................................................................................ 30
Figure 5-3. GUI EVM Selection and Setup Screen ................................................................................................................... 30
Figure 5-4. TPS92520 - EVM133 GUI Start-up Screen Showing Different Windows................................................................. 31
Figure 5-5. MCU Control (External PWM) Window.................................................................................................................. 32
Figure 5-6. MCU External PWM for PWM_1 and PWM_2.......................................................................................................... 32
Figure 5-7. MCU External PWM for PWM_3 and PWM_4.......................................................................................................... 33
Figure 5-8. SPI Command Window........................................................................................................................................... 34
Figure 5-9. SPI Read Example................................................................................................................................................... 35
Figure 5-10. SPI Write Example................................................................................................................................................ 36
Figure 5-11. LEDMCUEVM-133 + TPS92520EVM-133 Connections and Setup............................................................... 37
Figure 5-12. TPS92520EVM-133 Menu From EVM Selection and Setup Window................................................................. 38
Figure 5-13. TPS92520EVM-133 Device Command Window.................................................................................................... 38
Figure 5-14. LEDMCUEVM-133 + TPS92518EVM-878 Connections and Setup............................................................... 39
Figure 5-15. TPS92518EVM-878 Menu From EVM Selection and Setup Window................................................................. 40
Figure 5-16. TPS92518EVM-878 Device Command Window.................................................................................................... 40
Figure 5-17. LEDMCUEVM-132 + TPS92682EVM-069 + TPS92520EVM-133 Connections and Setup.......................... 41
Figure 5-18. TPS92520, TPS92682 - LPP074 - E1 Menu From EVM Selection and Setup Window.............................................. 41
Figure 5-19. Devices Window for the "TPS92520, TPS92682 - LPP074 - E1" Selection From "EVM Selection and Setup" Screen........................................................................................................................................... 42
Figure 5-20. LEDMCUEVM-132 + TPS92682EVM-069 + TPS92520EVM-133 + TPS92662EVM6-901 Connections and Setup............................................................... 43
Figure 5-21. "TPS92520, TPS92682, TPS92662 - LPP074 - E2 Menu From EVM Selection and Setup Window........... 44
Figure 5-22. Devices Window for the TPS92520, TPS92682, TPS92662 - LPP074 - E2 Selection From EVM Selection and Setup Screen........................................................................................................................................... 44

List of Tables

Table 1-1. Connector Descriptions........................................................................................................................................ 5
Table 1-2. Test Points............................................................................................................................................................. 5
Table 3-1. LEDMCUEVM-132 Bill of Materials................................................................................................................... 11

Trademarks

MSP432™, LauchPad™, and LaunchPad™ are trademarks of Texas Instruments. Microsoft®, .NET Framework®, Windows®, and are registered trademarks of Microsoft Corporation. All other trademarks are the property of their respective owners.
1 Description

This user's guide describes the specifications, board connection description, characteristics, operation, and use of the LEDMCUEVM-132 MCU LED controller evaluation module (EVM). The LEDMCUEVM-132 implements SPI communications that support multiple devices on the bus, UART communications for the LMMs family of devices, CAN transceiver for UART to control LMM family of devices, 4 PWM signals for dimming, multiple IOs, isolated 5-V supply, digital isolators, and a standard CAN bus with a transceiver. A complete schematic diagram, printed-circuit board layouts, and bill of materials are included in this document.

1.1 Typical Applications

This document outlines the operation and implementation of the LEDMCUEVM-132 as LED MCU controller board that communicates and controls other EVMs in the automotive LED driver and matrix managers.
1.2 Connector Description

Table 1-1 describes the connectors and Table 1-2 lists the test points on the EVM and how to properly connect, set up, and use the LEDMCUEVM-132.

Figure 1-1 shows the connection diagram and the default jumper locations of the LEDMCUEVM-132.
### Table 1-1. Connector Descriptions

<table>
<thead>
<tr>
<th>Connector</th>
<th>Function</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>J6</td>
<td>Provide primary SPI, SSN, and PWM signals to compatible EVMs</td>
<td>J6 includes the MISO, MOSI, SCK, SSN0-3, PWM1, PWM2, GPIO-0, and ground pins.</td>
</tr>
<tr>
<td>J9</td>
<td>Provide additional control signals to EVMs</td>
<td>J9 includes SNN4-5, PWM3-4, CANH-L, UART_RX-TX, GPIO1-4, PWM3-4, and GND-ISO, which is the ground of the EVM attached.</td>
</tr>
<tr>
<td>J1</td>
<td>Micro-USB connector to PC</td>
<td>Connector that uses Micro-USB cable to connect to the PC for GUI control.</td>
</tr>
<tr>
<td>J3</td>
<td>CAN0 bus signals that are generated from UART signals</td>
<td>J3 has CAN0_H, CAN0_L, V-ISO (5V), and GND-ISO, which is the ground of the attached EVM. The UART RXD and TXD signals are sent to an CAN-Transceiver to generate the differential signals for CAN0 bus. J3 is a standard 100 mil header that can be used as test points or can be used to connect to an EVM by a cable harness.</td>
</tr>
<tr>
<td>J4</td>
<td>UART signals</td>
<td>J4 are the single ended UART TXD and RXD signals that are from the MCU. J4 is a standard 100 mil header that can either be used as test points or can be used to connect to an EVM by a cable harness.</td>
</tr>
<tr>
<td>J8</td>
<td>All SPI signals</td>
<td>J8 has all the SPI signals put together in one location for probing signals. It includes MISO, MOSI, SCK, SSN0-5, and GND-ISO. J8 is a standard 100 mil header that can either be used as test points or can be used to connect to an EVM by a cable harness.</td>
</tr>
<tr>
<td>J12</td>
<td>All PWM signals</td>
<td>J12 has all four PWM signals (PWM1, PWM2, PWM3, and PWM4) created by the MCU and GND-ISO. J12 is a standard 100 mil header that can either be used as test points or can be used to connect to an EVM by a cable harness.</td>
</tr>
<tr>
<td>J2</td>
<td>All GPIO signals</td>
<td>J2 has all five GPIO signals (GPIO_0, GPIO_1, GPIO_2, GPIO_3, and GPIO_4) on the header. J2 is a standard 100 mil header that can either be used as test points or can be used to connect to an EVM by a cable harness.</td>
</tr>
<tr>
<td>J10</td>
<td>CAN1 differential bus signals</td>
<td>J10 connects to the differential CAN1 bus which was generated from CAN1 port of MCU that is connected to the CAN transceiver. J10 is a standard 100 mil header that can either be used as test points or can be used to connect to an EVM by a cable harness.</td>
</tr>
<tr>
<td>J11</td>
<td>CAN1 single ended bus signals</td>
<td>J11 connects directly to the CAN1 signal ended signals that come from the MCU and go to the CAN transceiver. J11 is a standard 100 mil header that can either be used as test points or can be used to connect to an EVM by a cable harness.</td>
</tr>
<tr>
<td>J5</td>
<td>Launch Pad emulator connector</td>
<td>This is allows for the use of the LaunchPad™ emulator connections from other LaunchPads.</td>
</tr>
<tr>
<td>J7</td>
<td>XDIS110 programming connector</td>
<td>This connector allows for the debugging or programming of the MSP432 device.</td>
</tr>
<tr>
<td>J13</td>
<td>3V3 external supply connection</td>
<td>This allows for the connection of an external 3V3 supply that is not generated from the USB 5-V connection.</td>
</tr>
<tr>
<td>J15</td>
<td>BOOT-LOADER mode jumper</td>
<td>This jumper is used to place the MSP432 in boot-loader mode when an update to the firmware is needed.</td>
</tr>
</tbody>
</table>

### Table 1-2. Test Points

<table>
<thead>
<tr>
<th>Test Point</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>GND (TP9, TP10, TP12)</td>
<td>These test points are connected to the GND connection from the PC through the USB cable.</td>
</tr>
<tr>
<td>GND-ISO (TP20, TP21, TP22, and TP25)</td>
<td>The test points are connected to the isolated grounds that connect to the secondary side of the digital isolators the isolate 5-V supply. GND-ISO connects to the GND connections of the EVMs.</td>
</tr>
<tr>
<td>V-ISO (TP24)</td>
<td>This test point connects to V-ISO, which is an isolated 5 V that power the digital isolators and can be used by EVMs as an external 5-V supply.</td>
</tr>
<tr>
<td>VREF+ (TP11)</td>
<td>This test point connects to reference voltage of the MSP432.</td>
</tr>
<tr>
<td>nHIG (TP6)</td>
<td>This test point connects to the inhibit pin of the MSP432.</td>
</tr>
<tr>
<td>VDDC (TP7)</td>
<td>This test point connects to the VDDC pin of the MSP432.</td>
</tr>
</tbody>
</table>
2 Features and Specifications

The LEDMCUEVM-132 provides a host of features that allow it to be used with a variety of EVMs and for the easy evaluation and debug of devices and systems.

- A SPI bus that supports up to six devices is provided and is accessed via J6, J9, and J12 connectors. It comes from the MCU (MSP432E401Y) through a digital isolator to the connectors. J12 can be used with debug probes or can be mated to a connector that uses a standard 100-mil header.
- There are two pairs of PWM signals (PWM1 + PWM2 and PWM3 + PWM4) that can be used for PWM dimming of supported devices. These signals support up to 4 kHz operation and have the ability to be phase shifted by 180 degrees. J12 is a standard 100-mil head that can either be used for probing or to mate with a standard 100-mil connector.
- Five GPIOs are provided and depending on the EVM selection the GPIOs are either enabled or disabled. See the user's guide of the EVM for more details.
- The MCU generates UART commands that are used by the TPS92662 lighting matrix manager device. The single-ended communication is passed through a digital isolator and into a CAN transceiver to generate a differential signal that is commonly used in noisy environments. Either the single-ended UART signals are available via J4 header or the differential CAN signals are available by header J3.
- There is an isolated 5-V supply that is created from the USB bus (5 V) and is supplied to the secondary side to power the digital isolators, CAN transceivers, and is passed on to other EVMs as V-ISO. Not all EVMs use this supply. Some have their own supplies separated from the LEDMCUEVM-133.
- The LEDMCUEVM-133 supports firmware updates by the USB connection to the PC.
- If the customer wants to develop their own firmware for the MSP432E401Y, then they have that ability to do that by using J7 and the XDIS110 JTAG Debug Probe.
- The MSP432E401Y can also be connected to the Emulator connections of an external MSP-EXP432E401Y LaunchPad using J5.
- The LEDMCUEVM-132 has a connection to the CAN bus of the MSP432 and it is also attached to a CAN transceiver to generate a CAN signal. This hardware is not yet supported by the GUI.

3 Schematic, PCB Layout, and Bill of Materials

This section contains the LEDMCUEVM-132 schematics, PCB layouts, and bill of materials (BOM).
3.1 Schematic

Figure 3-1 illustrates the LEDMCUEVM-132 schematic.

Figure 3-1. LEDMCUEVM-132 Schematic
3.2 Layout

The LEDCUEVM-132 is a 4-layer board. Figure 3-2, Figure 3-3, Figure 3-4, Figure 3-5, and Figure 3-6 illustrate the assembly, top, inner-layer1, inner-layer2, and the bottom side of the LEDCUEVM-132 PCB layout. The Inner-layer 1 is a ground plane and there is no routing on this layer.

![Figure 3-2. TPS92520EVM-133 Assembly Drawing](image1)

![Figure 3-3. TPS92520EVM-133 Top Layer and Top Overlay (Top View)](image2)
Figure 3-4. TPS92520EVM-133 Inner-Layer 1

Figure 3-5. TPS92520EVM-133 Inner-Layer 2
Figure 3-6. TPS92520EVM-133 Bottom Layer and Bottom Overlay (Bottom View)
### 3.3 Bill of Materials

Table 3-1 lists the LEDMCUEVM-132 bill of materials.

<table>
<thead>
<tr>
<th>Designator</th>
<th>Qty</th>
<th>Value</th>
<th>Description</th>
<th>Package</th>
<th>Part Number</th>
<th>Manufacturer</th>
</tr>
</thead>
<tbody>
<tr>
<td>C1</td>
<td>1</td>
<td>3,300 pF</td>
<td>CAP, CERM, 3300 pF, 50 V, +/- 10%, X7R</td>
<td>0603</td>
<td>885012206086</td>
<td>Wurth Elektronik</td>
</tr>
<tr>
<td>C2</td>
<td>1</td>
<td>15 pF</td>
<td>CAP, CERM, 15 pF, 50 V, +/- 5%, C0G/NP0</td>
<td>0402</td>
<td>GRM1555C1H150JA01D</td>
<td>MuRata</td>
</tr>
<tr>
<td>C3</td>
<td>1</td>
<td>2.2 µF</td>
<td>CAP, CERM, 2.2 µF, 6.3 V, +/- 10%, X5R</td>
<td>0402</td>
<td>GRM155R60J225KE95D</td>
<td>MuRata</td>
</tr>
<tr>
<td>C4, C5, C20, C21</td>
<td>4</td>
<td>0.1 µF</td>
<td>CAP, CERM, 0.1 µF, 50 V, +/- 20%, X7R, AEC-Q200 Grade 1</td>
<td>0402</td>
<td>CGA2B3X7R1H104M050BB</td>
<td>TDK</td>
</tr>
<tr>
<td>C6, C22</td>
<td>2</td>
<td>4.700 pF</td>
<td>CAP, CERM, 4700 pF, 50 V, +/- 10%, X7R</td>
<td>0805</td>
<td>C0805C472K5RACTU</td>
<td>Kemet</td>
</tr>
<tr>
<td>C7, C8, C9, C10, C14, C16, C17</td>
<td>7</td>
<td>0.1 µF</td>
<td>CAP, CERM, 0.1 µF, 16 V, +/- 10%, X7R</td>
<td>0402</td>
<td>GRM155R71C104KA88D</td>
<td>MuRata</td>
</tr>
<tr>
<td>C11, C15, C18, C19</td>
<td>4</td>
<td>12 pF</td>
<td>CAP, CERM, 12 pF, 50 V, +/- 5%, C0G/NP0</td>
<td>0402</td>
<td>GRM1555C1H120JA01D</td>
<td>MuRata</td>
</tr>
<tr>
<td>C12</td>
<td>1</td>
<td>2.2 µF</td>
<td>CAP, CERM, 2.2 µF, 16 V, +/- 20%, X5R</td>
<td>0603</td>
<td>885012106018</td>
<td>Wurth Elektronik</td>
</tr>
<tr>
<td>C13</td>
<td>1</td>
<td>1 µF</td>
<td>CAP, CERM, 1 µF, 16 V, +/- 10%, X5R</td>
<td>0402</td>
<td>EMK105BJ105KVHF</td>
<td>Taiyo Yuden</td>
</tr>
<tr>
<td>C23, C24, C25, C26, C27, C28, C29, C30</td>
<td>8</td>
<td>0.1 µF</td>
<td>AP, CERM, 0.1 µF, 25 V, +/- 10%, X7R, AEC-Q200 Grade 1</td>
<td>0603</td>
<td>CGA3E2X7R1E104K080AA</td>
<td>TDK</td>
</tr>
<tr>
<td>C31</td>
<td>1</td>
<td>2.2 µF</td>
<td>CAP, CERM, 2.2 µF, 10 V, +/- 10%, X7R, AEC-Q200 Grade 1</td>
<td>0603</td>
<td>GRM188R71A225KE15J</td>
<td>MuRata</td>
</tr>
<tr>
<td>C32, C36</td>
<td>2</td>
<td>0.1 µF</td>
<td>CAP, CERM, 0.1 µF, 50 V, +/- 10%, X7R</td>
<td>0603</td>
<td>06035C104KAT2A</td>
<td>AVX</td>
</tr>
<tr>
<td>C33</td>
<td>1</td>
<td>2.2 µF</td>
<td>CAP, CERM, 2.2 µF, 25 V, +/- 10%, X7R</td>
<td>0805</td>
<td>08053C225KAT2A</td>
<td>AVX</td>
</tr>
<tr>
<td>C34, C35</td>
<td>2</td>
<td>10 pF</td>
<td>CAP, CERM, 10 pF, 50 V, +/- 5%, C0G/NP0, AEC-Q200 Grade 1</td>
<td>0603</td>
<td>CGA3E2C0G1H100D080AA</td>
<td>TDK</td>
</tr>
<tr>
<td>C37, C38</td>
<td>2</td>
<td>1 µF</td>
<td>CAP, CERM, 1 µF, 25 V, +/- 10%, X7R, AEC-Q200 Grade 1</td>
<td>0603</td>
<td>GCM188R71E105KA64D</td>
<td>MuRata</td>
</tr>
<tr>
<td>C39</td>
<td>1</td>
<td>0.01 µF</td>
<td>CAP, CERM, 0.01 µF, 1500 V, +/- 10%, X7R</td>
<td>1812</td>
<td>1812SC103KAT1A</td>
<td>AVX</td>
</tr>
<tr>
<td>D1, D2</td>
<td>2</td>
<td>LED, Green</td>
<td></td>
<td>1.6x0.8x0.8mm</td>
<td>LTST-C190GKT</td>
<td>Lite-On</td>
</tr>
<tr>
<td>H1</td>
<td>1</td>
<td>HEAT SINK FOR TI MOD, 50x13.9mm</td>
<td></td>
<td></td>
<td>ATS-T110P-521-C1-R1</td>
<td>Advanced Thermal Solutions</td>
</tr>
<tr>
<td>H1, H2, H3, H4</td>
<td>4</td>
<td>Machine Screw, Round, #4-40 x 1/4, Nylon, Philips panhead</td>
<td>NY PMS 440 0025 PH</td>
<td>B&amp;F Fastener Supply</td>
<td></td>
<td></td>
</tr>
<tr>
<td>H5, H6, H7, H8</td>
<td>4</td>
<td>Standoff, Hex, 0.5&quot;L #4-40 Nylon</td>
<td></td>
<td>1902C</td>
<td>Keystone</td>
<td></td>
</tr>
<tr>
<td>J1</td>
<td>1</td>
<td>Connector, Receptacle, Micro-USB Type AB, R/A, Bottom Mount SMT</td>
<td>5.6x2.5x8.2mm</td>
<td>475890001</td>
<td>Molex</td>
<td></td>
</tr>
</tbody>
</table>
### Table 3-1. LEDMCUEVM-132 Bill of Materials (continued)

<table>
<thead>
<tr>
<th>Designator</th>
<th>Qty</th>
<th>Value</th>
<th>Description</th>
<th>Package</th>
<th>Part Number</th>
<th>Manufacturer</th>
</tr>
</thead>
<tbody>
<tr>
<td>J2</td>
<td>1</td>
<td></td>
<td>Header, 100mil, 6x1, Gold, TH</td>
<td>6x1 Header</td>
<td>TSW-106-07-G-S</td>
<td>Semtec</td>
</tr>
<tr>
<td>J3, J10, J12</td>
<td>3</td>
<td></td>
<td>Header, 100mil, 5x1, Gold, TH</td>
<td>5x1 Header</td>
<td>HSTW-105-07-G-S</td>
<td>Semtec</td>
</tr>
<tr>
<td>J4, J11</td>
<td>2</td>
<td></td>
<td>Header, 100mil, 4x1, Gold, TH</td>
<td>Header, 100mil, 4x1, TH</td>
<td>TSW-104-07-G-S</td>
<td>Semtec</td>
</tr>
<tr>
<td>J5</td>
<td>1</td>
<td></td>
<td>Header, 2.54mm, 10x1, Gold, TH</td>
<td>Header, 2.54mm, 10x1, TH</td>
<td>TSW-110-08-G-S</td>
<td>Semtec</td>
</tr>
<tr>
<td>J6</td>
<td>1</td>
<td></td>
<td>Receptacle, 2.54mm, 10x2, Gold, R/A, TH</td>
<td>Receptacle, 2.54mm, 10x2, R/A, TH</td>
<td>SSW-110-02-G-D-RA</td>
<td>Semtec</td>
</tr>
<tr>
<td>J7</td>
<td>1</td>
<td></td>
<td>Header (Shrouded), 1.27mm, 5x2, Gold, SMT</td>
<td>Header(Shrouded), 1.27mm, 5x2, SMT</td>
<td>FTSH-105-01-F-DV-K</td>
<td>Semtec</td>
</tr>
<tr>
<td>J8</td>
<td>1</td>
<td></td>
<td>Header, 100mil, 10x1, Gold, TH</td>
<td>10x1 Header</td>
<td>TSW-110-07-G-S</td>
<td>Semtec</td>
</tr>
<tr>
<td>J9</td>
<td>1</td>
<td></td>
<td>Receptacle, 100mil, 7x2, Gold, R/A, TH</td>
<td>Receptacle, 7x2, 2.54mm, R/A, TH</td>
<td>SSW-107-02-G-D-RA</td>
<td>Semtec</td>
</tr>
<tr>
<td>J13, J14, J15</td>
<td>3</td>
<td></td>
<td>Header, 100mil, 2x1, Tin, TH</td>
<td>Header, 2 PIN, 100mil, Tin</td>
<td>PEC02SAAN</td>
<td>Sullins Connector Solutions</td>
</tr>
<tr>
<td>L1, L2</td>
<td>2</td>
<td>51 µH</td>
<td>Coupled inductor, 51 µH, A, 0.14 ohm, SMD</td>
<td>7.1x6mm</td>
<td>B82793S513N201</td>
<td>TDK</td>
</tr>
<tr>
<td>R1</td>
<td>1</td>
<td>1.0Meg</td>
<td>RES, 1.0 M, 5%, 0.1 W, AEC-Q200 Grade 0</td>
<td>0603</td>
<td>CRCW06031M00JNEA</td>
<td>Vishay-Dale</td>
</tr>
<tr>
<td>R2</td>
<td>1</td>
<td>51 k</td>
<td>RES, 51 k, 5%, 0.063 W, AEC-Q200 Grade 0</td>
<td>0402</td>
<td>CRCW040251K0JNED</td>
<td>Vishay-Dale</td>
</tr>
<tr>
<td>R3</td>
<td>1</td>
<td>30 K</td>
<td>RES, 30 k, 5%, 0.063 W, AEC-Q200 Grade 0</td>
<td>0402</td>
<td>CRCW040230K0JNED</td>
<td>Vishay-Dale</td>
</tr>
<tr>
<td>R4, R32</td>
<td>2</td>
<td>4.75 K</td>
<td>RES, 4.75 k, 1%, 0.1 W, AEC-Q200 Grade 0</td>
<td>0603</td>
<td>CRCW06034K75FKEA</td>
<td>Vishay-Dale</td>
</tr>
<tr>
<td>R5, R6, R18, R19, R20, R21, R28, R29</td>
<td>8</td>
<td>0</td>
<td>RES, 0, 5%, 0.1 W, AEC-Q200 Grade 0</td>
<td>0402</td>
<td>ERJ-2GE0R00X</td>
<td>Panasonic</td>
</tr>
<tr>
<td>R7, R9, R38, R39</td>
<td>4</td>
<td>61.9</td>
<td>RES, 61.9, 1%, 0.1 W, AEC-Q200 Grade 0</td>
<td>0603</td>
<td>CRCW060361R9FKEA</td>
<td>Vishay-Dale</td>
</tr>
<tr>
<td>R8, R14, R15, R16, R17, R23, R33, R34</td>
<td>8</td>
<td>10 k</td>
<td>RES, 10 k, 5%, 0.063 W, AEC-Q200 Grade 0</td>
<td>0402</td>
<td>CRCW040210K0JNED</td>
<td>Vishay-Dale</td>
</tr>
<tr>
<td>R10, R40</td>
<td>2</td>
<td>0</td>
<td>RES, 0, 5%, 0.063 W</td>
<td>0402</td>
<td>MCR01MZPJ000</td>
<td>Rohm</td>
</tr>
<tr>
<td>R11</td>
<td>1</td>
<td>5.60 k</td>
<td>RES, 5.60 k, 1%, 0.1 W, AEC-Q200 Grade 0</td>
<td>0603</td>
<td>ERJ3JEKF5601V</td>
<td>Panasonic</td>
</tr>
<tr>
<td>R12</td>
<td>1</td>
<td>10 k</td>
<td>RES, 10.0 k, 1%, 0.1 W, AEC-Q200 Grade 0</td>
<td>0603</td>
<td>CRCW060310K0FKEA</td>
<td>Vishay-Dale</td>
</tr>
<tr>
<td>R13, R41</td>
<td>2</td>
<td>100</td>
<td>100 Ohms ±1% 0.125W, 1/8W Chip Resistor 0603 (1608 Metric) Automotive AEC-Q200, Moisture Resistant Thick Film</td>
<td>0603</td>
<td>RK73H1JTTD1000F</td>
<td>KOA Speer</td>
</tr>
<tr>
<td>R22</td>
<td>1</td>
<td>1 M</td>
<td>RES, 1.0 M, 5%, 0.063 W, AEC-Q200 Grade 0</td>
<td>0402</td>
<td>CRCW04021M00JNED</td>
<td>Vishay-Dale</td>
</tr>
<tr>
<td>Designator</td>
<td>Qty</td>
<td>Value</td>
<td>Description</td>
<td>Package</td>
<td>Part Number</td>
<td>Manufacturer</td>
</tr>
<tr>
<td>------------</td>
<td>-----</td>
<td>-------</td>
<td>-------------</td>
<td>---------</td>
<td>-------------</td>
<td>--------------</td>
</tr>
<tr>
<td>R24</td>
<td>1</td>
<td>4.87 k</td>
<td>RES, 4.87 k, 1%, 0.063 W, AEC-Q200 Grade 0</td>
<td>0402</td>
<td>CRCW0402K87FKED</td>
<td>Vishay-Dale</td>
</tr>
<tr>
<td>R25</td>
<td>1</td>
<td>100</td>
<td>RES, 100, 5%, 0.063 W, AEC-Q200 Grade 0</td>
<td>0402</td>
<td>CRCW0402100RJNED</td>
<td>Vishay-Dale</td>
</tr>
<tr>
<td>R26, R27</td>
<td>2</td>
<td>390</td>
<td>RES, 390, 5%, 0.063 W, AEC-Q200 Grade 0</td>
<td>0402</td>
<td>CRCW0402390RJNED</td>
<td>Vishay-Dale</td>
</tr>
<tr>
<td>R30</td>
<td>1</td>
<td>51</td>
<td>RES, 51, 5%, 0.063 W, AEC-Q200 Grade 0</td>
<td>0402</td>
<td>CRCW040251R0JNED</td>
<td>Vishay-Dale</td>
</tr>
<tr>
<td>R31</td>
<td>1</td>
<td>2.0 k</td>
<td>RES, 2.0 k, 5%, 0.063 W, AEC-Q200 Grade 0</td>
<td>0402</td>
<td>CRCW04022K0JNED</td>
<td>Vishay-Dale</td>
</tr>
<tr>
<td>RESET_SW1, Wake_SW1</td>
<td>2</td>
<td></td>
<td>SWITCH TACTILE SPST-NO 0.05A 12V, SMT</td>
<td>3.5x1.35x3.55mm</td>
<td>PTS840 PM SMTR LFS</td>
<td>C&amp;K Components</td>
</tr>
<tr>
<td>TP6, TP7, TP9, TP10, TP11, TP12</td>
<td>6</td>
<td></td>
<td>Test Point, Miniature, Black, TH</td>
<td>TH</td>
<td>5001</td>
<td>Keystone</td>
</tr>
<tr>
<td>TP20, TP21, TP22, TP24, TP25</td>
<td>5</td>
<td></td>
<td>Terminal, Turret, TH, Double</td>
<td>TH</td>
<td>1502-2</td>
<td>Keystone</td>
</tr>
<tr>
<td>U1</td>
<td>1</td>
<td></td>
<td>Single Output High PSRR LDO, 1 A, Adjustable 1.2 to 5.5 V Output, 2.7 to 5.5 V Input, 8-pin SON (DRB), -40 to 125 degC, Green (RoHS &amp; no Sn/Br)</td>
<td>DBR0008B</td>
<td>TPS79601DRBR</td>
<td>Texas Instruments</td>
</tr>
<tr>
<td>U2</td>
<td>1</td>
<td></td>
<td>4-Channel USB ESD Solution with Power Clamp</td>
<td>DRY0006A</td>
<td>TPD4S012DRYR</td>
<td>Texas Instruments</td>
</tr>
<tr>
<td>U3</td>
<td>1</td>
<td></td>
<td>MSP432E401YTPDT, (TQFP-128)</td>
<td>PDT0128A</td>
<td>MSP432E401YTPDT</td>
<td>Texas Instruments</td>
</tr>
<tr>
<td>U4</td>
<td>1</td>
<td></td>
<td>High Speed, Robust EMC, Reinforced Six-Channel Digital Isolator</td>
<td>DBQ0016A</td>
<td>ISO7762DBQR</td>
<td>Texas Instruments</td>
</tr>
<tr>
<td>U5, U7</td>
<td>2</td>
<td></td>
<td>Automotive Fault Protected CAN Transceiver With Flexible Data-Rate</td>
<td>D0008A</td>
<td>TCAN1042VDRQ1</td>
<td>Texas Instruments</td>
</tr>
<tr>
<td>U6</td>
<td>1</td>
<td></td>
<td>Miniature, 1 W Isolated Regulated DC-DC Converter, -40 to 85 degC, 12-pin SOP</td>
<td>DVB0012A</td>
<td>DCR010505U</td>
<td>Texas Instruments</td>
</tr>
<tr>
<td>U8, U10</td>
<td>2</td>
<td></td>
<td>High-speed, robust EMC six-channel digital isolator</td>
<td>DBQ0016A</td>
<td>ISO7762FDBQR</td>
<td>Texas Instruments</td>
</tr>
<tr>
<td>U9</td>
<td>1</td>
<td></td>
<td>High Speed, Robust EMC, Reinforced Six-Channel Digital Isolator</td>
<td>DBQ0016A</td>
<td>ISO7761DBQR</td>
<td>Texas Instruments</td>
</tr>
<tr>
<td>U11</td>
<td>1</td>
<td></td>
<td>Low-Capacitance 6-Channel +/-15 kV ESD Protection Array for High-Speed Data Interfaces</td>
<td>RSE0008A</td>
<td>TPD6E004RSER</td>
<td>Texas Instruments</td>
</tr>
<tr>
<td>Y1</td>
<td>1</td>
<td></td>
<td>Crystal, 32.768 kHz, SMD</td>
<td>D1.9xL6mm</td>
<td>CMR200T-32.768KDZY-UT</td>
<td>Citizen FineDevice</td>
</tr>
<tr>
<td>Y2</td>
<td>1</td>
<td></td>
<td>Crystal, 25 MHz, 8pF, SMD</td>
<td>3.2x0.75x2.5mm</td>
<td>NX3225GA-25.000M-STD-CRG-2</td>
<td>NDK</td>
</tr>
</tbody>
</table>
4 Software
This section describes the installation of the GUI software, the necessary drivers to operate the LEDMCUEVM-132.

4.1 Demonstration Kit Software Installation for LEDMCUEVM-132 Board
4.1.1 Installation Overview
This is a summary of the installation steps. To see step-by-step instructions with screen shots, see Section 4.2.

1. Click on TPS92518, 520, 682 LaunchPad™ Evaluation Software Installer.exe
2. Right click, and choose Run As Administrator
3. Click yes when Windows Account Control asks to allow the program to make changes to the computer
4. Click I Agree to the installation license terms and install in the recommended location

Installation will take a few minutes, as it may need to install Microsoft®.NET Framework®. If the installer asks if you wish to reboot after installing Microsoft .NET, you must click Restart Later and allow the driver installation to complete.

After running the TPS92518, 520, 682 LaunchPad Evaluation Software Installer.exe, the evaluation software window appears as shown in Figure 4-1.

4.2 Step-by-Step Installation Instructions
This section shows the detailed installation instructions with screen shots.

![Figure 4-1. Setup Screen 1](image)

Click Next > to install.
Click **Next >** to accept the License Agreement.

Select **Full Install** and click **Next >** to install the evaluation software, the UniFlash, and the required XDS drivers. Full installation for both Microsoft® Windows® 10 and Microsoft® Windows® 7 are provided.
If Microsoft® .NET Framework 4.5 or higher does not exist on the computer, the .NET Framework installation begins. Installation of .NET Framework will take several minutes. If the .NET Framework 4.5 or higher exists on the computer, the installation jumps to the XDS driver installation.

A window appears indicating the completion of the .NET Framework installation.
Click the Next > to proceed.

Click the Next > button to install the XDS driver.
Figure 4-8. Setup Screen 8

Figure 4-8 shows the completion of the XDS driver installation.

The TI-Emulators installation starts at this point. This will install the necessary drivers for running the application. In the next few steps (as shown in Figure 4-9, Figure 4-10, and Figure 4-11) click Next > to perform the installation.

Figure 4-9. Setup Screen 9
Accept the license agreement in Figure 4-10.

Figure 4-11. Setup Screen 11
In the next few windows click **Next >**, and if prompted by Windows Security about software installation as shown in **Figure 4-12**, select **Install**.

![Figure 4-12. Setup Screen 12](image)

The screen showing the completion of the TI Emulators installation is shown in **Figure 4-13**. Click on **Finish** to move to the next step.

![Figure 4-13. Setup Screen 13](image)
The UniFlash installation starts at this point. UniFlash is required to program the LaunchPad. In the next few steps as shown in Figure 4-14, Figure 4-15, and Figure 4-16 click Next > to proceed and start the installation.

![Setup Screen 14](image1)

**Figure 4-14. Setup Screen 14**

![Setup Screen 15](image2)

**Figure 4-15. Setup Screen 15**
When UniFlash installation is complete, click the **Finish** button to launch the UniFlash and program the LaunchPad.
Figure 4-18. Setup Screen 18

Figure 4-18 shows the completion of the TPS92520-Q1 Evaluation Software. Un-check Launch Application and click the Finish button.
4.3 Installation Error Recovery

If the screen shown in Figure 4-19 appears, use the following steps (one time) to install an unsigned driver.

1. Click **Start** and select **Settings**
2. Click **Update and Security**
3. Click **Recovery**
4. Click **Restart Now** under **Advanced Start-up**
5. Click **Troubleshoot**
6. Select **Advanced Options**
7. Select **Start-up Settings**
8. Click **Restart**
9. On the **Start-up Settings** screen, press F7 during reboot to disable driver signature enforcement. The host computer restarts.
10. Repeat the entire re-installation process
11. A message appears informing that installing the .NET Framework failed. Close that window and continue.
12. Double-click **Install unsigned drivers**

After restarting a second time, the host computer resets. The reset requires all drivers to be digitally signed the next time a default installation executes, unless these steps are repeated.
4.4 Checking for Updates

This section shows the detailed instructions for checking if there is an update and how to install it. Run the TPS92518, 520, 682 LaunchPad Evaluation Software and go to the **Help** menu, see Figure 4-20.

Click **Check for Updates** > to run updater.

![Figure 4-20. Help Menu and Checking for Updates](image)

**Figure 4-20. Help Menu and Checking for Updates**

Click the **Yes** button to accept risks for accessing the Internet.

![Figure 4-21. Update Screen 1](image)

**Figure 4-21. Update Screen 1**
Go to the LEDMCUEVM-132 (PSIL-132) and locate J15 and RESET_SW1. Install shorting jumper at J15 locations as illustrated and then press the RESET_SW1 as Figure 4-23 shows. This places the MCU in Bootloader mode.

Figure 4-22. Update Screen 2

Figure 4-23. J15 Jumper and RESET_SW1 Switch for Bootloader Mode
Click the **Yes** button to run the updater. The **LPP Updater** will run and once finished will ask if you would like to re-launch the GUI applications.

![LPP Updater](image)

**Figure 4-24. Setup Screen 5**

Click the **Yes** button to re-launch the GUI.

A window appears indicating the the **LEDMCUEVM-132** must be changed from bootloader mode to normal mode. This is accomplished by removing the shorting jumper from J15 then pressing the **RESET_SW1** switch and wait 3 seconds to ensure device drivers reload, see **Figure 4-26**.

![LEDController_GUI-LP Restart](image)

**Figure 4-25. Setup Screen 6**
Figure 4-26. J15 Jumper and RESET_SW1 Switch for Normal Mode

Click the **OK** button to restart the GUI.
5 LEDMCUEVM-132 Power UP and Operation

To start the EVM operation, connect the USB cable to the computer and the LEDMCUEVM-132.

![Micro USB Cable to PC](image)

**Figure 5-1. LEDMCUEVM-132 Connection to PC Using USB Cable**

Connect the appropriate mating EVM to header J9 for TPS92518HVEVM-878 and TPS92682EVM-069/70 or J9 + J6 for the TPS92520EVM-133. Connect J3 to TPS92662EVM6-901 to communicate using UART using CAN transceiver. Additional connections and jumper settings may need to be used for the system to work properly. Reference the appropriate EVM user's guide and schematics for detailed information.

5.1 GUI Start-up

Run the program **LED_Controller_GUI_LP.exe**, located at the “\Texas Instruments\TPS92518, 520, 682 LaunchPad Evaluation Software”, to start the GUI. The window shown in **Figure 5-2** opens. If the **TPS92518, 520, 682 Launchpad Evaluation Software** shortcut was installed on the desktop then that can also be used to run the application.
Click the **Please select an EVM** drop-down menu to see the available EVMs that are supported by the LEDMCUEVM-132 and the GUI.

Depending on the selection, either select the number of devices or select the desired device address then click **Add Device**.
The GUI will start up and show 4 separate windows (1-MCU Control, 2-SPI Command, 3-Watchdog (NOTE: not all EVM selections use this feature), and 4-Devices), see Figure 5-4.

Figure 5-4. TPS92520 - EVM133 GUI Start-up Screen Showing Different Windows
5.2 MCU Control Window

The MCU Control window allows external control of the PWM dimming using the LEDMCUEVM-132 connections to the attached EVM. PWM control is available for each channel with frequency and duty cycle control for frequencies and duty cycles that are not covered by the register settings. It also allows for 180 degree phase shift in between channels if desired. For example, if a PWM signal of 3 kHz was desired, they could use this feature.

![Figure 5-5. MCU Control (External PWM) Window](image)

PWM 1 is the first PWM generator from the MCU and controls Duty Cycle 1 at PF2 pin of MCU and Duty Cycle 2 at PF3 pin of the MCU. PMW1-DutyCycle 1 coincides with PWM_1 on the EVM and PMW1-DutyCycle 2 coincides with PWM_2 of the EVM, see Figure 5-6. Furthermore, The PWM frequency of PMW 1 generator is the same for both PWM_1 and PWM_2 and is separate from PWM 2 generator, which controls PWM_3 and PWM_4 on the EVM.

![Figure 5-6. MCU External PWM for PWM_1 and PWM_2](image)
PWM 2 is the second PWM generator from the MCU and controls Duty Cycle 1 at PG0 pin of the MCU and Duty Cycle 2 at GP1 pin of the MCU. PWM 2 generator signals connects to PWM_3 (PG0) and PWM_4 (PG1) on the attached EVM, see Figure 5-7.

![Figure 5-7. MCU External PWM for PWM_3 and PWM_4](image)

Depending on the EVM, the PWM signals will be mapped to PWM_1, 2, 3, 4, or some combination of the four. For example, TPS92520EVM-133 uses PWM_1 and PWM_2 from the PWM 1 generator of the MCU.
5.3 SPI Command Window

The SPI command box allows register read and write actions and it also records the SPI status sequentially. There are times when specific register settings may want to be controlled directly instead of through the simplified interface of the GUI. The following section is an example of doing reads and writes for when the LEDMCUEVM-132 is connected to the TPS92520EVM-133 to ensure proper communications.

Figure 5-8. SPI Command Window
To ensure a connection from the board to the TPS92520-Q1 exists, perform the following steps as shown in Figure 5-9.

1. Write the register address eleven (0x11h), which is the CH1TON register, in the Register Address box: 0x11.
2. Double-click the Send button.

The default value of 0x07 for the register 11 will be shown in the SPI Status window, see Figure 5-9.

![Figure 5-9. SPI Read Example](image-url)
To write data to the associated register address here is an example where channel 1 of the TPS92520EVM-133 is enabled using the write command:

- Click the check box next to **Write**
- Write the desired data in the box next to **Write Data**: as shown in [Figure 5-10](#).
- Click **Send**.

![Figure 5-10. SPI Write Example](image-url)
5.4 GUI Devices Window and Example Connections and Power Up

The device command window is the primary window that is different depending on which EVM is selected from the drop-down menu from the EVM Selection and Setup window. Some selections allow you to choose more than one device and a tab is created for each of the devices. The tab also shows the address number of the device as "Addr x". The user's guide for each EVM should be referenced for specific descriptions of the features or the devices and how it is implemented into the GUI.

The LEDMCUEVM-132 can be connected to several LED related EVMs to create your own system within the confines of what the GUI supports for EVMs and devices. Here are a few example Device windows, connections, and setups for using the LEDMCUEVM-132 with supported EVMs.

5.4.1 TPS92520EVM-133 Connections and Power UP

The TPS92520EVM-133 can be connected to the LEDMCUEVM-132 and use the associated GUI to monitor and control the TPS92520-Q1 device using the SPI bus to read and write commands. Here is a typical setup for controlling and testing the TPS92520EVM-133, note jumper locations are in red, see Figure 5-11.

![Figure 5-11. LEDMCUEVM-133 + TPS92520EVM-133 Connections and Setup](image-url)
5.4.2 TPS92520EVM-133 Devices Window

When selecting the TPS92520EVM-133 from the EVM Selection and Setup window, simply select the Add Device button to start the GUI, see Figure 5-12.

![Figure 5-12. TPS92520EVM-133 Menu From EVM Selection and Setup Window](image)

The Devices window of the TPS92520EVM-133 shows separate sub-windows that control each channel with features such as Analog Current control, On Time control, ADC measurements, and PWM duty cycle control along with many other selection boxes, and fault indication boxes, see Figure 5-13. See the TPS92520EVM-133 Users Guide for specifics on the operation of the GUI and how it controls the TPS92520-Q1 device.

![Figure 5-13. TPS92520EVM-133 Device Command Window](image)
5.4.3 TPS92518EVM-878 Connections and Power Up

The TPS92518EVM-878 can be connected to the LEDMCUEVM-132 and use the associated GUI to monitor and control the TPS92518HV-Q1 device using the SPI bus to read and write commands. Here is a typical setup for controlling and testing the TPS92518EVM-878, see Figure 5-14. Note jumper locations are in red.

Figure 5-14. LEDMCUEVM-133 + TPS92518EVM-878 Connections and Setup
5.4.4 TPS92518EVM-878 Devices Window

When selecting the TPS92518EVM-878 from the EVM Selection and Setup window, simply select the Add Device button to start the GUI, see Figure 5-15.

![Image of EVM Selection and Setup window]

Figure 5-15. TPS92518EVM-878 Menu From EVM Selection and Setup Window

The Devices window of the TPS92518EVM-878 shows separate sub-windows that control each channel with features such as **Peak Threshold** control, **Off Time** control, ADC measurements, and many other selection boxes, and fault indication boxes. See the TPS92518EVM-878 user’s guide for specifics on the operation of the GUI and how it controls the TPS92518HV-Q1 device.

![Image of Device Command Window]

Figure 5-16. TPS92518EVM-878 Device Command Window
5.4.5 TPS92682EVM-069 + TPS92520EVM-133 Connection and Power UP

The LEDMCUEVM-132 can be connected to the multiple EVMs to create more complicated LED systems. The TPS92682EVM-069 and the TPS92520EVM-133 can be connect together such that the TPS92682EVM-069 boost a lower input voltage, such a battery, and boost it to a higher voltage for use by the buck LED driver (TPS92520EVM-133). The LEDMCUEVM-132 and the GUI support these features by using the SPI bus. Here is a typical setup for controlling and testing the TPS92682EVM-069 with the TPS92520EVM-133. The loads are generally LEDs but can be a stacked diodes or power resistors depending on what testing is required. Use the "TPS92520, TPS92682 - LPP074 - E1" selection from EVM Selection and Setup screen to control this setup.

![Figure 5-17. LEDMCUEVM-132 + TPS92682EVM-069 + TPS92520EVM-133 Connections and Setup](image)

5.4.6 TPS92520, TPS92682 - LPP074 - E1 Devices Window

When selecting the "TPS92520, TPS92682 - LPP074 - E1" from the EVM Selection and Setup window, simply select the Add Device button to add the "682" at address 0 and change the selections to have the "520" at address 1 then select Add Device to add the second device, see FIG. This will start up after it has reached the number of devices you selected previously in the GUI, see Figure 5-18.

![Figure 5-18. TPS92520, TPS92682 - LPP074 - E1 Menu From EVM Selection and Setup Window](image)

The Devices window of the TPS92662EVM6-901 shows separate sub-windows that control each channel with features sure as V/I Adjust control, Slope control, PWM duty cycle control, selection boxes for "Constant
Voltage" and "Dual Phase", and fault indication boxes. See the TPS92682EVM-069 Users Guide for specifics on the operation of the GUI and how it controls the TPS92682-Q1 device.

Figure 5-19. Devices Window for the "TPS92520, TPS92682 - LPP074 - E1" Selection From "EVM Selection and Setup" Screen
5.4.7 TPS92682EVM-069 + TPS92520EVM-133 + TPS92662EVM6-901 Connection and Power UP

Another example is using TPS92682EVM-069, TPS92520EVM-133, and the TPS92662EVM6-901. The TPS92682EVM-069 and the TPS92520EVM-133 can be connected together such that the TPS92682EVM-069 boost a lower input voltage, such a battery, and boost it to a higher voltage for use by the buck LED driver (TPS02520EVM-133). The TPS92662EVM6-901 is a lighting matrix manager that has the ability to individually perform shunt FET dimming of the LEDs in the string. The LEDMCUEVM-132 and the GUI support these features by using the SPI bus and the UART over CAN hardware of the LEDMCUEVM-132. Here is a typical setup for controlling and testing the "TPS92520, TPS92682, TPS92662 - LPP074 - E2" selection from EVM Selection and Setup screen.

![Diagram of LEDMCUEVM-132 + TPS92682EVM-069 + TPS92520EVM-133 + TPS92662EVM6-901 Connections and Setup](image-url)
5.4.8 TPS92662EVM6-901 Devices Window

When selecting the "TPS92520, TPS92682, TPS92662 - LPP074 - E2" from the EVM Selection and Setup window, simply select two devices then select the Add Device button for both the 682 and 520 to start the GUI, see Figure 5-21.

The Devices window of the TPS92662EVM6-901 shows separate sub-windows that control each channel with features such as Phase Shift control, Width/DC control, selection boxes for "ALL" channels and "85" phase shift. See the TPS92520EVM-074 Users Guide for specifics on the operation of the GUI and how it controls the TPS92662-Q1 device.

Figure 5-21. "TPS92520, TPS92682, TPS92662 - LPP074 - E2" Menu From EVM Selection and Setup Window

Figure 5-22. Devices Window for the TPS92520, TPS92682, TPS92662 - LPP074 - E2 Selection From EVM Selection and Setup Screen
STANDARD TERMS FOR EVALUATION MODULES

1. Delivery: TI delivers TI evaluation boards, kits, or modules, including any accompanying demonstration software, components, and/or documentation which may be provided together or separately (collectively, an “EVM” or “EVMs”) to the User (“User”) in accordance with the terms set forth herein. User's acceptance of the EVM is expressly subject to the following terms.

1.1 EVMs are intended solely for product or software developers for use in a research and development setting to facilitate feasibility evaluation, experimentation, or scientific analysis of TI semiconductors products. EVMs have no direct function and are not finished products. EVMs shall not be directly or indirectly assembled as a part or subassembly in any finished product. For clarification, any software or software tools provided with the EVM (“Software”) shall not be subject to the terms and conditions set forth herein but rather shall be subject to the applicable terms that accompany such Software.

1.2 EVMs are not intended for consumer or household use. EVMs may not be sold, sublicensed, leased, rented, loaned, assigned, or otherwise distributed for commercial purposes by Users, in whole or in part, or used in any finished product or production system.

2 Limited Warranty and Related Remedies/Disclaimers:

2.1 These terms do not apply to Software. The warranty, if any, for Software is covered in the applicable Software License Agreement.

2.2 TI warrants that the TI EVM will conform to TI's published specifications for ninety (90) days after the date TI delivers such EVM to User. Notwithstanding the foregoing, TI shall not be liable for a nonconforming EVM if (a) the nonconformity was caused by neglect, misuse or mistreatment by an entity other than TI, including improper installation or testing, or for any EVMs that have been altered or modified in any way by an entity other than TI, (b) the nonconformity resulted from User's design, specifications or instructions for such EVMs or improper system design, or (c) User has not paid on time. Testing and other quality control techniques are used to the extent TI deems necessary. TI does not test all parameters of each EVM. User's claims against TI under this Section 2 are void if User fails to notify TI of any apparent defects in the EVMs within ten (10) business days after delivery, or of any hidden defects within ten (10) business days after the defect has been detected.

2.3 TI's sole liability shall be at its option to repair or replace EVMs that fail to conform to the warranty set forth above, or credit User's account for such EVM. TI's liability under this warranty shall be limited to EVMs that are returned during the warranty period to the address designated by TI and that are determined by TI not to conform to such warranty. If TI elects to repair or replace such EVM, TI shall have a reasonable time to repair such EVM or provide replacements. Repaired EVMs shall be warranted for the remainder of the original warranty period. Replaced EVMs shall be warranted for a new full ninety (90) day warranty period.

WARNING

Evaluation Kits are intended solely for use by technically qualified, professional electronics experts who are familiar with the dangers and application risks associated with handling electrical mechanical components, systems, and subsystems.

User shall operate the Evaluation Kit within TI’s recommended guidelines and any applicable legal or environmental requirements as well as reasonable and customary safeguards. Failure to set up and/or operate the Evaluation Kit within TI’s recommended guidelines may result in personal injury or death or property damage. Proper set up entails following TI’s instructions for electrical ratings of interface circuits such as input, output and electrical loads.

NOTE:
EXPOSURE TO ELECTROSTATIC DISCHARGE (ESD) MAY CAUSE DEGREDATION OR FAILURE OF THE EVALUATION KIT; TI RECOMMENDS STORAGE OF THE EVALUATION KIT IN A PROTECTIVE ESD BAG.
3 Regulatory Notices:

3.1 United States

3.1.1 Notice applicable to EVMs not FCC-Approved:

**FCC NOTICE:** This kit is designed to allow product developers to evaluate electronic components, circuitry, or software associated with the kit to determine whether to incorporate such items in a finished product and software developers to write software applications for use with the end product. This kit is not a finished product and when assembled may not be resold or otherwise marketed unless all required FCC equipment authorizations are first obtained. Operation is subject to the condition that this product not cause harmful interference to licensed radio stations and that this product accept harmful interference. Unless the assembled kit is designed to operate under part 15, part 18 or part 95 of this chapter, the operator of the kit must operate under the authority of an FCC license holder or must secure an experimental authorization under part 5 of this chapter.

3.1.2 For EVMs annotated as FCC – FEDERAL COMMUNICATIONS COMMISSION Part 15 Compliant:

**CAUTION**

This device complies with part 15 of the FCC Rules. Operation is subject to the following two conditions: (1) This device may not cause harmful interference, and (2) this device must accept any interference received, including interference that may cause undesired operation.

Changes or modifications not expressly approved by the party responsible for compliance could void the user's authority to operate the equipment.

**FCC Interference Statement for Class A EVM devices**

*NOTE:* This equipment has been tested and found to comply with the limits for a Class A digital device, pursuant to part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference when the equipment is operated in a commercial environment. This equipment generates, uses, and can radiate radio frequency energy and, if not installed and used in accordance with the instruction manual, may cause harmful interference to radio communications. Operation of this equipment in a residential area is likely to cause harmful interference in which case the user will be required to correct the interference at his own expense.

**FCC Interference Statement for Class B EVM devices**

*NOTE:* This equipment has been tested and found to comply with the limits for a Class B digital device, pursuant to part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference in a residential installation. This equipment generates, uses and can radiate radio frequency energy and, if not installed and used in accordance with the instructions, may cause harmful interference to radio communications. However, there is no guarantee that interference will not occur in a particular installation. If this equipment does cause harmful interference to radio or television reception, which can be determined by turning the equipment off and on, the user is encouraged to try to correct the interference by one or more of the following measures:

- Reorient or relocate the receiving antenna.
- Increase the separation between the equipment and receiver.
- Connect the equipment into an outlet on a circuit different from that to which the receiver is connected.
- Consult the dealer or an experienced radio/TV technician for help.

3.2 Canada

3.2.1 For EVMs issued with an Industry Canada Certificate of Conformance to RSS-210 or RSS-247

**Concerning EVMs Including Radio Transmitters:**

This device complies with Industry Canada license-exempt RSSs. Operation is subject to the following two conditions:

(1) this device may not cause interference, and (2) this device must accept any interference, including interference that may cause undesired operation of the device.

**Concernant les EVMs avec appareils radio:**

Le présent appareil est conforme aux CNR d'Industrie Canada applicables aux appareils radio exempts de licence. L’exploitation est autorisée aux deux conditions suivantes: (1) l’appareil ne doit pas produire de brouillage, et (2) l’utilisateur de l’appareil doit accepter tout brouillage radioélectrique subi, même si le brouillage est susceptible d’en compromettre le fonctionnement.

**Concerning EVMs Including Detachable Antennas:**

Under Industry Canada regulations, this radio transmitter may only operate using an antenna of a type and maximum (or lesser) gain approved for the transmitter by Industry Canada. To reduce potential radio interference to other users, the antenna type and its gain should be so chosen that the equivalent isotropically radiated power (e.i.r.p.) is not more than that necessary for successful communication. This radio transmitter has been approved by Industry Canada to operate with the antenna types listed in the user guide with the maximum permissible gain and required antenna impedance for each antenna type indicated. Antenna types not included in this list, having a gain greater than the maximum gain indicated for that type, are strictly prohibited for use with this device.
Concernant les EVMs avec antennes détachables
Conformément à la réglementation d'Industrie Canada, le présent émetteur radio peut fonctionner avec une antenne d'un type et d'un gain maximal (ou inférieur) approuvé par l'émetteur par Industrie Canada. Dans le but de réduire les risques de brouillage radioélectrique à l'intention des autres utilisateurs, il faut choisir le type d'antenne et son gain de sorte que la puissance isotrope rayonnée équivalente (p.i.r.e.) ne dépasse pas l'intensité nécessaire à l'établissement d'une communication satisfaisante. Le présent émetteur radio a été approuvé par Industrie Canada pour fonctionner avec les types d'antenne énumérés dans le manuel d'usage et ayant un gain admissible maximal et l'impédance requise pour chaque type d'antenne. Les types d'antenne non inclus dans cette liste, ou dont le gain est supérieur au gain maximal indiqué, sont strictement interdits pour l'exploitation de l'émetteur.

3.3 Japan

3.3.1 Notice for EVMs delivered in Japan: Please see http://www.tij.co.jp/lsds/ti_ja/general/eStore/notice_01.page

3.3.2 Notice for Users of EVMs Considered “Radio Frequency Products” in Japan: EVMs entering Japan may not be certified by TI as conforming to Technical Regulations of Radio Law of Japan.

If User uses EVMs in Japan, not certified to Technical Regulations of Radio Law of Japan, User is required to follow the instructions set forth by Radio Law of Japan, which includes, but is not limited to, the instructions below with respect to EVMs (which for the avoidance of doubt are stated strictly for convenience and should be verified by User):

1. Use EVMs in a shielded room or any other test facility as defined in the notification #173 issued by Ministry of Internal Affairs and Communications on March 28, 2006, based on Sub-section 1.1 of Article 6 of the Ministry’s Rule for Enforcement of Radio Law of Japan,
2. Use EVMs only after User obtains the license of Test Radio Station as provided in Radio Law of Japan with respect to EVMs, or
3. Use of EVMs only after User obtains the Technical Regulations Conformity Certification as provided in Radio Law of Japan with respect to EVMs. Also, do not transfer EVMs, unless User gives the same notice above to the transferee. Please note that if User does not follow the instructions above, User will be subject to penalties of Radio Law of Japan.

日本国内に輸入される評価用キット、ボードについては、次のところをご覧ください。
http://www.tij.co.jp/lsds/ti_ja/general/eStore/notice_01.page

3.3.3 Notice for EVMs for Power Line Communication: Please see http://www.tij.co.jp/lsds/ti_ja/general/eStore/notice_02.page

電力線搬送波通信についての開発キットをお使いになる際の注意事項については、次のところをご覧ください。http://www.tij.co.jp/lsds/ti_ja/general/eStore/notice_02.page

3.4 European Union

3.4.1 For EVMs subject to EU Directive 2014/30/EU (Electromagnetic Compatibility Directive):
This is a class A product intended for use in environments other than domestic environments that are connected to a low-voltage power-supply network that supplies buildings used for domestic purposes. In a domestic environment this product may cause radio interference in which case the user may be required to take adequate measures.
4 **EVM Use Restrictions and Warnings:**

4.1 **EVMS ARE NOT FOR USE IN FUNCTIONAL SAFETY AND/OR SAFETY CRITICAL EVALUATIONS, INCLUDING BUT NOT LIMITED TO EVALUATIONS OF LIFE SUPPORT APPLICATIONS.**

4.2 **User must read and apply the user guide and other available documentation provided by TI regarding the EVM prior to handling or using the EVM, including without limitation any warning or restriction notices. The notices contain important safety information related to, for example, temperatures and voltages.**

4.3 **Safety-Related Warnings and Restrictions:**

4.3.1 **User shall operate the EVM within TI’s recommended specifications and environmental considerations stated in the user guide, other available documentation provided by TI, and any other applicable requirements and employ reasonable and customary safeguards. Exceeding the specified performance ratings and specifications (including but not limited to input and output voltage, current, power, and environmental ranges) for the EVM may cause personal injury or death, or property damage. If there are questions concerning performance ratings and specifications, User should contact a TI field representative prior to connecting interface electronics including input power and intended loads. Any loads applied outside of the specified output range may also result in unintended and/or inaccurate operation and/or possible permanent damage to the EVM and/or interface electronics. Please consult the EVM user guide prior to connecting any load to the EVM output. If there is uncertainty as to the load specification, please contact a TI field representative. During normal operation, even with the inputs and outputs kept within the specified allowable ranges, some circuit components may have elevated case temperatures. These components include but are not limited to linear regulators, switching transistors, pass transistors, current sense resistors, and heat sinks, which can be identified using the information in the associated documentation. When working with the EVM, please be aware that the EVM may become very warm.**

4.3.2 **EVMs are intended solely for use by technically qualified, professional electronics experts who are familiar with the dangers and application risks associated with handling electrical mechanical components, systems, and subsystems. User assumes all responsibility and liability for proper and safe handling and use of the EVM by User or its employees, affiliates, contractors or designees. User assumes all responsibility and liability to ensure that any interfaces (electronic and/or mechanical) between the EVM and any human body are designed with suitable isolation and means to safely limit accessible leakage currents to minimize the risk of electrical shock hazard. User assumes all responsibility and liability for any improper or unsafe handling or use of the EVM by User or its employees, affiliates, contractors or designees.**

4.4 **User assumes all responsibility and liability to determine whether the EVM is subject to any applicable international, federal, state, or local laws and regulations related to User’s handling and use of the EVM and, if applicable, User assumes all responsibility and liability for proper disposal and recycling of the EVM consistent with all applicable international, federal, state, and local requirements.**

5. **Accuracy of Information:** To the extent TI provides information on the availability and function of EVMs, TI attempts to be as accurate as possible. However, TI does not warrant the accuracy of EVM descriptions, EVM availability or other information on its websites as accurate, complete, reliable, current, or error-free.

6. **Disclaimers:**

6.1 **EXCEPT AS SET FORTH ABOVE, EVMS AND ANY MATERIALS PROVIDED WITH THE EVM (INCLUDING, BUT NOT LIMITED TO, REFERENCE DESIGNS AND THE DESIGN OF THE EVM ITSELF) ARE PROVIDED “AS IS” AND “WITH ALL FAULTS.” TI DISCLAIMS ALL OTHER WARRANTIES, EXPRESS OR IMPLIED, REGARDING SUCH ITEMS, INCLUDING BUT NOT LIMITED TO ANY EPIDEMIC FAILURE WARRANTY OR IMPLIED WARRANTIES OF MERCHANTABILITY OR FITNESS FOR A PARTICULAR PURPOSE OR NON-INFRINGEMENT OF ANY THIRD PARTY PATENTS, COPYRIGHTS, TRADE SECRETS OR OTHER INTELLECTUAL PROPERTY RIGHTS.**

6.2 **EXCEPT FOR THE LIMITED RIGHT TO USE THE EVM SET FORTH HEREIN, NOTHING IN THESE TERMS SHALL BE CONSTRUED AS GRANTING OR CONFESSION ANY RIGHTS BY LICENSE, PATENT, OR ANY OTHER INDUSTRIAL OR INTELLECTUAL PROPERTY RIGHT OF TI, ITS SUPPLIERS/LICENSED OR ANY OTHER THIRD PARTY, TO USE THE EVM IN ANY FINISHED END-USER OR READY-TO-USE FINAL PRODUCT, OR FOR ANY INVENTION, DISCOVERY OR IMPROVEMENT, REGARDLESS OF WHEN MADE, CONCEIVED OR ACQUIRED.**

7. **USER’S INDEMNITY OBLIGATIONS AND REPRESENTATIONS. USER WILL DEFEND, INDEMNIFY AND HOLD TI, ITS LICENSEES AND THEIR REPRESENTATIVES HARMLESS FROM AND AGAINST ANY AND ALL CLAIMS, DAMAGES, LOSSES, EXPENSES, COSTS AND LIABILITIES (COLLECTIVELY, "CLAIMS") ARISING OUT OF OR IN CONNECTION WITH ANY HANDLING OR USE OF THE EVM THAT IS NOT IN ACCORDANCE WITH THESE TERMS. THIS OBLIGATION SHALL APPLY WHETHER CLAIMS ARISE UNDER STATUTE, REGULATION, OR THE LAW OF TORT, CONTRACT OR ANY OTHER LEGAL THEORY, AND EVEN IF THE EVM FAILS TO PERFORM AS DESCRIBED OR EXPECTED.**
Limitations on Damages and Liability:

8.1 General Limitations. IN NO EVENT SHALL TI BE LIABLE FOR ANY SPECIAL, COLLATERAL, INDIRECT, PUNITIVE, INCIDENTAL, CONSEQUENTIAL, OR EXEMPLARY DAMAGES IN CONNECTION WITH OR ARISING OUT OF THESE TERMS OR THE USE OF THE EVMS, REGARDLESS OF WHETHER TI HAS BEEN ADVISED OF THE POSSIBILITY OF SUCH DAMAGES. EXCLUDED DAMAGES INCLUDE, BUT ARE NOT LIMITED TO, COST OF REMOVAL OR REINSTALLATION, ANCILLARY COSTS TO THE PROCUREMENT OF SUBSTITUTE GOODS OR SERVICES, RETESTING, OUTSIDE COMPUTER TIME, LABOR COSTS, LOSS OF GOODWILL, LOSS OF PROFITS, LOSS OF SAVINGS, LOSS OF USE, LOSS OF DATA, OR BUSINESS INTERRUPTION. NO CLAIM, SUIT OR ACTION SHALL BE BROUGHT AGAINST TI MORE THAN TWELVE (12) MONTHS AFTER THE EVENT THAT GAVE RISE TO THE CAUSE OF ACTION HAS OCCURRED.

8.2 Specific Limitations. IN NO EVENT SHALL TI'S AGGREGATE LIABILITY FROM ANY USE OF AN EVM PROVIDED HEREUNDER, INCLUDING FROM ANY WARRANTY, INDEMNITY OR OTHER OBLIGATION ARISING OUT OF OR IN CONNECTION WITH THESE TERMS, EXCEED THE TOTAL AMOUNT PAID TO TI BY User FOR THE PARTICULAR EVM(S) AT ISSUE DURING THE PRIOR TWELVE (12) MONTHS WITH RESPECT TO WHICH LOSSES OR DAMAGES ARE CLAIMED. THE EXISTENCE OF MORE THAN ONE CLAIM SHALL NOT ENLARGE OR EXTEND THIS LIMIT.

9. Return Policy. Except as otherwise provided, TI does not offer any refunds, returns, or exchanges. Furthermore, no return of EVM(s) will be accepted if the package has been opened and no return of the EVM(s) will be accepted if they are damaged or otherwise not in a resalable condition. If User feels it has been incorrectly charged for the EVM(s) it ordered or that delivery violates the applicable order, User should contact TI. All refunds will be made in full within thirty (30) working days from the return of the components(s), excluding any postage or packaging costs.

10. Governing Law: These terms and conditions shall be governed by and interpreted in accordance with the laws of the State of Texas, without reference to conflict-of-laws principles. User agrees that non-exclusive jurisdiction for any dispute arising out of or relating to these terms and conditions lies within courts located in the State of Texas and consents to venue in Dallas County, Texas. Notwithstanding the foregoing, any judgment may be enforced in any United States or foreign court, and TI may seek injunctive relief in any United States or foreign court.

Mailing Address: Texas Instruments, Post Office Box 655303, Dallas, Texas 75265
Copyright © 2019, Texas Instruments Incorporated
IMPORTANT NOTICE AND DISCLAIMER

TI PROVIDES TECHNICAL AND RELIABILITY DATA (INCLUDING DATASHEETS), DESIGN RESOURCES (INCLUDING REFERENCE DESIGNS), APPLICATION OR OTHER DESIGN ADVICE, WEB TOOLS, SAFETY INFORMATION, AND OTHER RESOURCES “AS IS” AND WITH ALL FAULTS, AND DISCLAIMS ALL WARRANTIES, EXPRESS AND IMPLIED, INCLUDING WITHOUT LIMITATION ANY IMPLIED WARRANTIES OF MERCHANTABILITY, FITNESS FOR A PARTICULAR PURPOSE OR NON-INFRINGEMENT OF THIRD PARTY INTELLECTUAL PROPERTY RIGHTS.

These resources are intended for skilled developers designing with TI products. You are solely responsible for (1) selecting the appropriate TI products for your application, (2) designing, validating and testing your application, and (3) ensuring your application meets applicable standards, and any other safety, security, or other requirements. These resources are subject to change without notice. TI grants you permission to use these resources only for development of an application that uses the TI products described in the resource. Other reproduction and display of these resources is prohibited. No license is granted to any other TI intellectual property right or to any third party intellectual property right. TI disclaims responsibility for, and you will fully indemnify TI and its representatives against, any claims, damages, costs, losses, and liabilities arising out of your use of these resources.

TI's products are provided subject to TI’s Terms of Sale (www.ti.com/legal/termsofsale.html) or other applicable terms available either on ti.com or provided in conjunction with such TI products. TI’s provision of these resources does not expand or otherwise alter TI’s applicable warranties or warranty disclaimers for TI products.

Mailing Address: Texas Instruments, Post Office Box 655303, Dallas, Texas 75265
Copyright © 2020, Texas Instruments Incorporated