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.

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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 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.

![Figure 2-1. High-Level Diagram of the LEDMCUEVM-132](image-url)

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.
3.2 Layout

The LEDMCUEVM-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 LEDMCUEVM-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>GRM155SC1H150JA01D</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>CO805C472K5RACTU</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>GRM155SC1H120JA01D</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>0603SC104KAT2A</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>GMC1R88R71E010KA64D</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>ATS-TI10P-521-C1-R1</td>
<td>Advanced Thermal Solutions</td>
<td></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></td>
<td>NY PMS 440 0025 PH</td>
<td>B&amp;F Fastener Supply</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></td>
<td>5.6x2.5x8.2mm</td>
<td>475890001</td>
<td>Molex</td>
</tr>
<tr>
<td>J2</td>
<td>1</td>
<td>Header, 100mil, 6x1, Gold, TH</td>
<td></td>
<td>6x1 Header TSW-106-07-G-S</td>
<td>Semtec</td>
<td></td>
</tr>
<tr>
<td>J3, J10, J12</td>
<td>3</td>
<td>Header, 100mil, 5x1, Gold, TH</td>
<td></td>
<td>5x1 Header HTSW-105-07-G-S</td>
<td>Semtec</td>
<td></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>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>B82793SS13N201</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>MCR01MZP000</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>ERJ3JEK5601V</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>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>CRCW04024K87FKED</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>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>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>CRCW04022K00JNED</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><strong>U1</strong></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 Pb/Sb)</td>
<td>DRB0008B</td>
<td>TPS79601DRBR</td>
<td>Texas Instruments</td>
</tr>
<tr>
<td><strong>U2</strong></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><strong>U3</strong></td>
<td>1</td>
<td></td>
<td>MSP432E401YTPDT, (TQFP-128)</td>
<td>PDT0126A</td>
<td>MSP432E401YTPDT</td>
<td>Texas Instruments</td>
</tr>
<tr>
<td><strong>U4</strong></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><strong>U5, U7</strong></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><strong>U6</strong></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><strong>U8, U10</strong></td>
<td>2</td>
<td></td>
<td>High-speed, robust EMC six-channel digital isolator</td>
<td>DBQ0016A</td>
<td>ISO7760FDBQR</td>
<td>Texas Instruments</td>
</tr>
<tr>
<td><strong>U9</strong></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><strong>U11</strong></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><strong>Y1</strong></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><strong>Y2</strong></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 4-10. Setup Screen 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.

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

**Figure 4-15. Setup Screen 15**

**Figure 4-16. Setup Screen 16**
When UniFlash installation is complete, click the **Finish** button to launch the UniFlash and program the LaunchPad.

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
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.

Figure 4-19. Setup Screen 19
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.

Figure 4-20. Help Menu and Checking for Updates

Click Check for Updates > to run updater.

Figure 4-21. Update Screen 1

Click the Yes button to accept risks for accessing the Internet.
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](image1)

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

Click the Yes button to re-launch the GUI.

A window appears indicating 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](image2)

**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.

![Figure 5-1. LEDMCUEVM-132 Connection to PC Using USB Cable](image)

Connect the appropriate mating EVM to header J9 for TPS92518EVM-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.

![EVM Selection and Setup](image)

**Figure 5-2. GUI Setup Screen 1**

Depending on the selection, either select the number of devices or select the desired device address then click **Add Device**.

![EVM Selection and Setup](image)

**Figure 5-3. GUI EVM Selection and Setup Screen**
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.
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

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 PWM1-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 seperate from PWM 2 generator, which controls PWM_3 and PWM_4 on the EVM.

Figure 5-6. MCU Exnternal PWM for PWM_1 and PWM_2

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.
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.

Figure 5-7. MCU External PWM for PWM_3 and PWM_4

DutyCycle 1 (PG1): 45
DutyCycle 2 (PG1): 85
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](image-url)
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)
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.

![TPS92518EVM-878 Menu From EVM Selection and Setup Window](image1)

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.

![TPS92518EVM-878 Device Command Window](image2)

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 (TPS02520EVM-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.

![Diagram showing LEDMCUEVM-132 + TPS92682EVM-069 + TPS92520EVM-133 Connections and Setup](image)

Figure 5-17. LEDMCUEVM-132 + TPS92682EVM-069 + TPS92520EVM-133 Connections and Setup

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.

![Image of EVM Selection and Setup Window](image)

Figure 5-18. TPS92520, TPS92682 - LPP074 - E1 Menu From EVM Selection and Setup Window

The Devices window of the TPS92662EVM6-901 shows separate sub-windows that control each channel with features sure as VI Adjus 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.

Figure 5-20. LEDMCUEVM-132 + TPS92682EVM-069 + TPS92520EVM-133 + TPS92662EVM6-901 Connections and Setup
5.4.8 TPS92662EVM-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.

![Figure 5-21. "TPS92520, TPS92682, TPS92662 - LPP074 - E2" Menu From EVM Selection and Setup Window](image)

The **Devices** window of the TPS92662EVM-901 shows separate sub-windows that control each channel with features sure 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 5-22. Devices Window for the TPS92520, TPS92682, TPS92662 - LPP074 - E2 Selection From EVM Selection and Setup Screen](image)