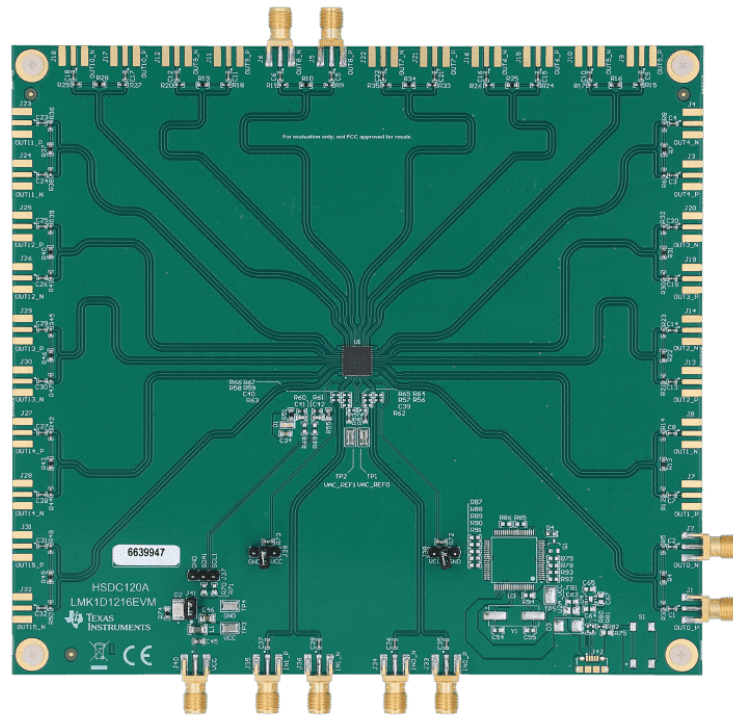


## ABSTRACT

The LMK1D1216 is a high-performance, low-additive jitter LVDS clock buffer with two universal inputs, 16 LVDS outputs, and an input select pin.

This evaluation module (EVM) is designed to demonstrate the electrical performance of the LMK1D1216 or other 48-pin devices in the LMK1Dxxxx family. Throughout this document, the acronym EVM and the phrases evaluation module and evaluation board are synonymous with the LMK1D1216EVM.

The LMK1D1216EVM is equipped with 50-Ω SMA connectors and impedance-controlled 50-Ω microstrip transmission lines for best performance.



**Figure 1-1. LMK1D1216 Evaluation Board**

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## Trademarks

All trademarks are the property of their respective owners.

## 1 Features

- Easy-to-use evaluation board to fan out low-phase noise clocks
- Supports output frequencies of up to 2 GHz
- Simple, fast device configuration and setup
- Control pin(s) configurable through jumpers
- Single supply input powered at either 1.8 V, 2.5 V, or 3.3 V
- Differential or single-ended input clocks accepted
- EVM supports all 16 differential LVDS outputs.

## 2 General Description

The LMK1D1216 is a high-performance, low-additive jitter clock buffer. This has two universal input buffers that support differential clock inputs which can be selected by the control pin. The device also features on-chip bias generators that can provide LVDS common-mode voltage for AC-coupled differential clock inputs.

By default, the evaluation module (EVM) is designed to demonstrate the electrical performance of the LMK1D1216 but can be replaced by the LMK1D2108 and, after populating the missing I2C components, the LMK1D1216I. The I2C-capable LMK1D1216I can be used through Micro-USB and by interfacing with the [TICS Pro software](#).

This fully assembled and factory-tested evaluation board allows complete validation of device functionalities. For optimum performance, the board is equipped with SMA connectors and well-controlled, 50-Ω impedance microstrip transmission lines.

## 3 Signal Path and Control Circuitry

The LMK1D1216 supports single-ended inputs up to 250 MHz and differential inputs up to 2 GHz. Each device provides up to 16 LVDS outputs that operate at the selected input frequency.

For more information, see the [LMK1D1216 Low Additive Jitter LVDS Buffer](#) data sheet (SNAS823) for details.

## 4 Getting Started

The EVM has self-explanatory labeling and offers almost the same naming convention used in the data sheets. The ***bold italic*** text in this document follows the same spelling as the actual labeling on the EVM board. By default, the EVM can be used with differential inputs and, after board modification, with single-ended inputs.

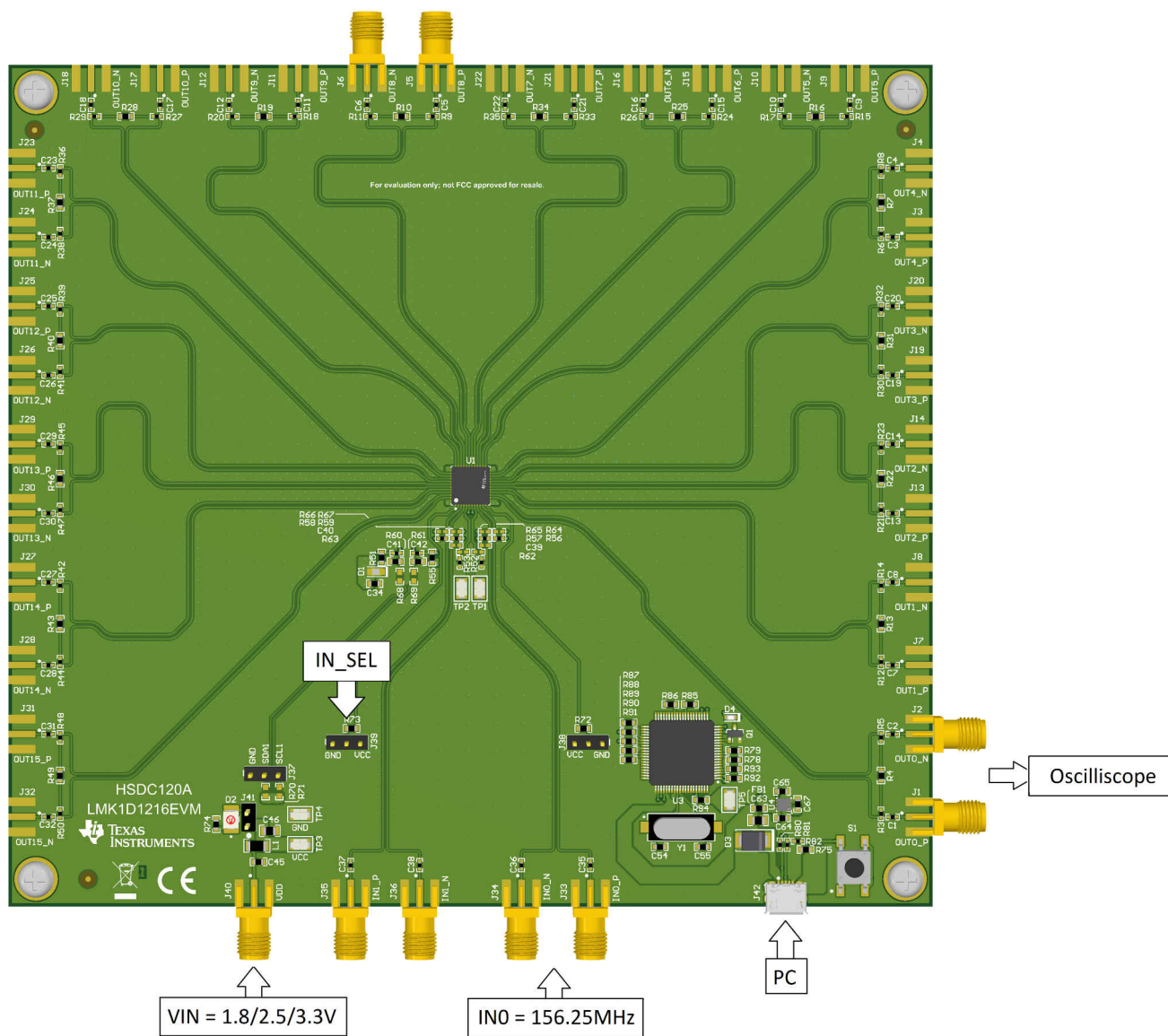


Figure 4-1. LMK1D1216EVM Quick Start Guide

## 5 Power Supply Connection

Connect the power supply source to the SMA connector, **J40** (VDD). Test points, **TP3** (VCC) and **TP4** (GND), can be used as an alternative power supply source. The decoupling capacitors and ferrite bead isolate the EVM power from the power pins of the device.

A supply voltage of 1.71 V to 3.465 V can be used for this EVM.

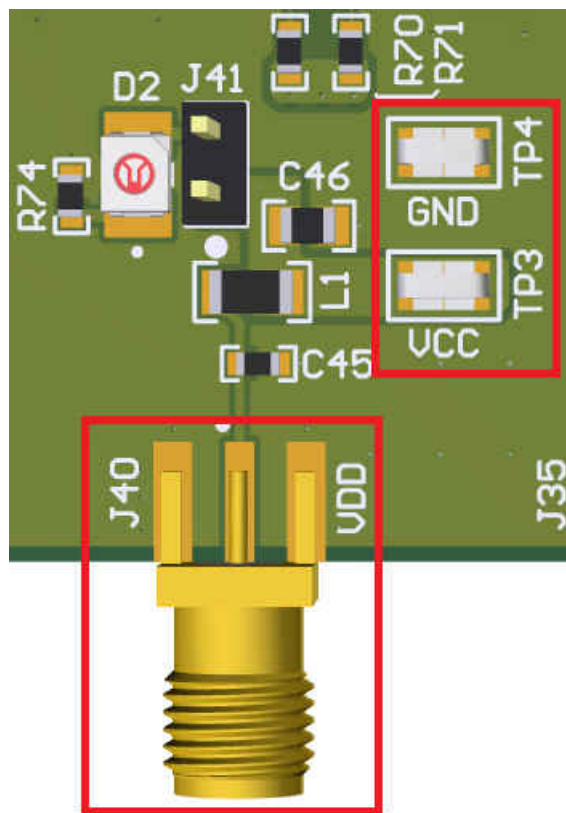


Figure 5-1. Power Supply Connection Layout

## 6 Input Clock Selection

The LMK1D1212 can receive either a differential or single-ended clock as input. The default board configuration is for a differential signal at both device inputs. The inputs can be applied through the SMAs, **J33**, **J34** (IN0\_P, IN0\_N) or **J35**, **J36** (IN1\_P, IN1\_N). These inputs are AC-coupled to the device. The common-mode voltage is provided by the device on-chip bias generator ( $V_{AC\_REF}$ ) pins or **TP2** and **TP1**.

**LMK1D1216:** Jumper, **J39**, can be used to select between the two input clocks. **IN0** is selected when **J39** connects **IN\_SEL** to **GND**. **IN1** is selected when **J39** connects **IN\_SEL** to **VDD**.

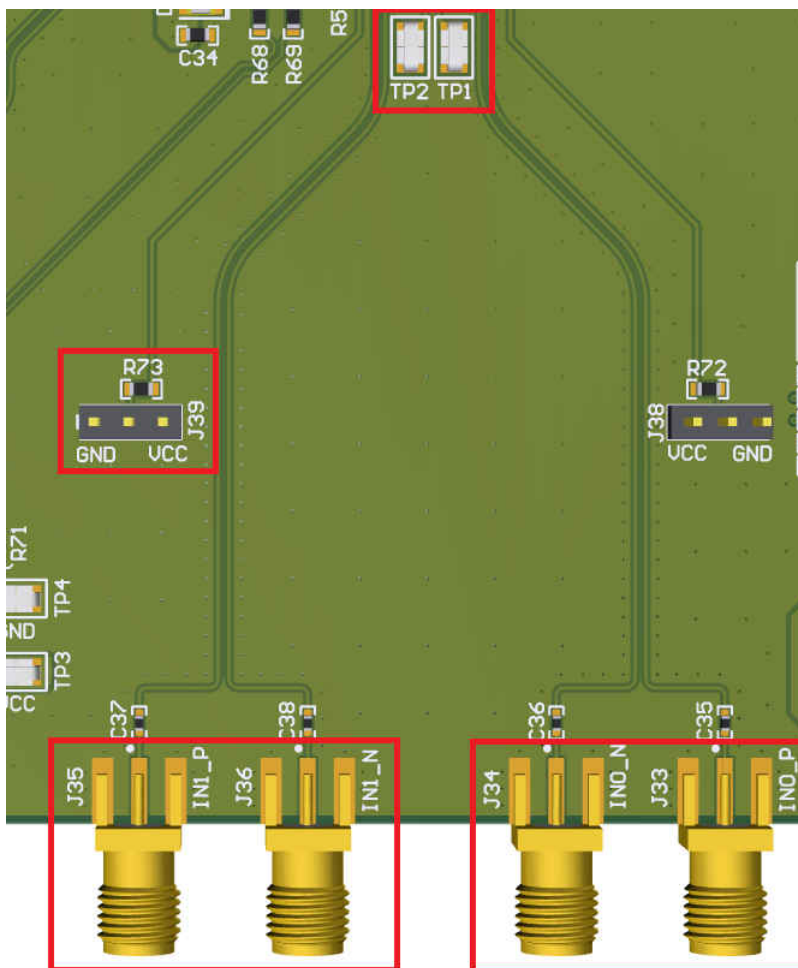


Figure 6-1. Input Clock Selection Layout

### 6.1 Differential Input

Differential input is configured by default.

### 6.2 Single-Ended Input

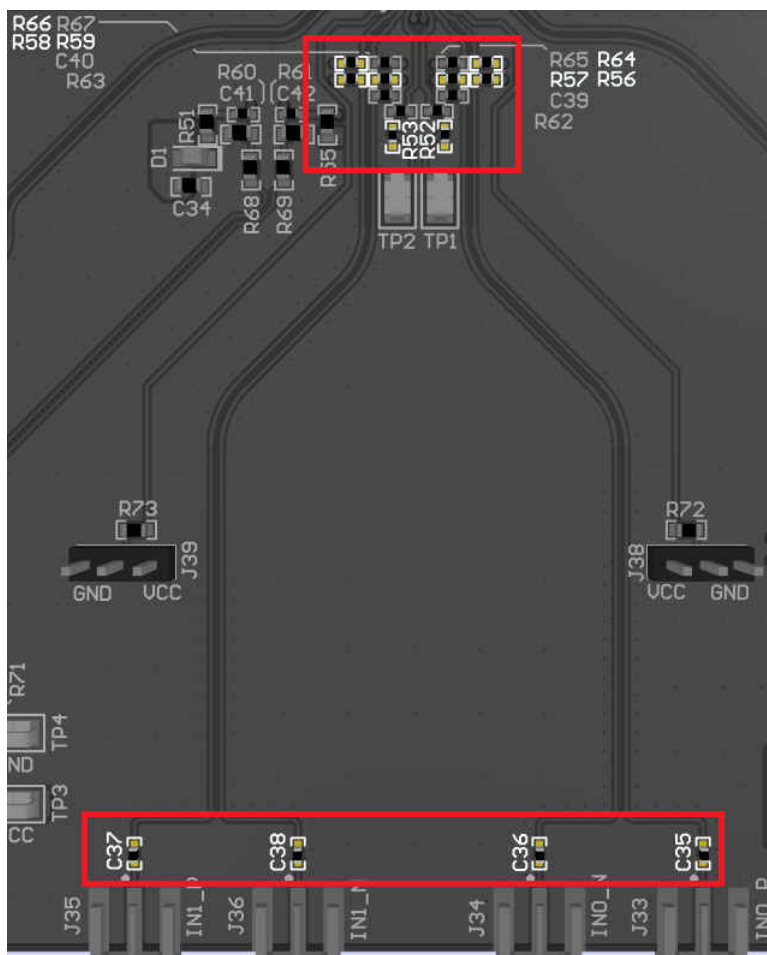
Single-ended input must be configured by replacing or removing passive components on the board. Follow [Table 6-1](#) for proper setup of a single-ended input.

Table 6-1. Single-Ended Configurations by Bias Voltage

| BIAS VOLTAGE TO INx_N (V) | INPUT TO INx_P (V) | INPUT | REMOVE BIASING RESISTOR | REMOVE COMMON-MODE RESISTOR | REPLACE WITH 0-Ω RESISTOR | REPLACE WITH 100-Ω RESISTOR |
|---------------------------|--------------------|-------|-------------------------|-----------------------------|---------------------------|-----------------------------|
| 0.9                       | 1.8 (LVCMOS)       | IN0_N | R56                     | R38                         | C35                       | N/A                         |
|                           |                    | IN0_P | R57                     |                             | C36                       | N/A                         |

**Table 6-1. Single-Ended Configurations by Bias Voltage (continued)**

| BIAS VOLTAGE TO INx_N (V) | INPUT TO INx_P (V) | INPUT | REMOVE BIASING RESISTOR | REMOVE COMMON-MODE RESISTOR | REPLACE WITH 0-Ω RESISTOR | REPLACE WITH 100-Ω RESISTOR |
|---------------------------|--------------------|-------|-------------------------|-----------------------------|---------------------------|-----------------------------|
| 0.9                       | 1.8 (LVCMOS)       | IN1_N | R58                     | R39                         | C37                       | N/A                         |
|                           |                    | IN1_P | R59                     |                             | C38                       | N/A                         |
| 1.25                      | 2.5 (LVCMOS)       | IN0_N | R57                     | R38                         | R52<br>C35, C36           | R64<br>R56                  |
|                           |                    | IN0_P |                         |                             |                           |                             |
| 1.25                      | 2.5 (LVCMOS)       | IN1_N | R59                     | R39                         | R53<br>C37, C38           | R66<br>R58                  |
|                           |                    | IN1_P |                         |                             |                           |                             |
| 1.65                      | 3.3 (LVCMOS)       | IN0_N | R57                     | R38                         | R52<br>C35, C36           | R64<br>R56                  |
|                           |                    | IN0_P |                         |                             |                           |                             |
| 1.65                      | 3.3 (LVCMOS)       | IN1_N | R59                     | R39                         | R53<br>C37, C38           | R66<br>R58                  |
|                           |                    | IN1_P |                         |                             |                           |                             |



## 7 Output Clock

The LMK1D1216 generates up to 16 LVDS outputs. Two outputs (OUT0 and OUT8) are available by default on the EVM through the following SMAs: **J1**, **J2** (OUT0\_P, OUT0\_N) and **J5**, **J6** (OUT8\_P, OUT8\_N). The LVDS outputs are AC-coupled to their respective SMAs. Each output pair has the 100-Ω termination on the board already populated: **R4** (OUT0) and **R10** (OUT8).

The LVDS outputs are AC-coupled to their respective SMAs. Each output pair has the 100-Ω termination on the board already populated: **R4** (OUT0) and **R10** (OUT8).

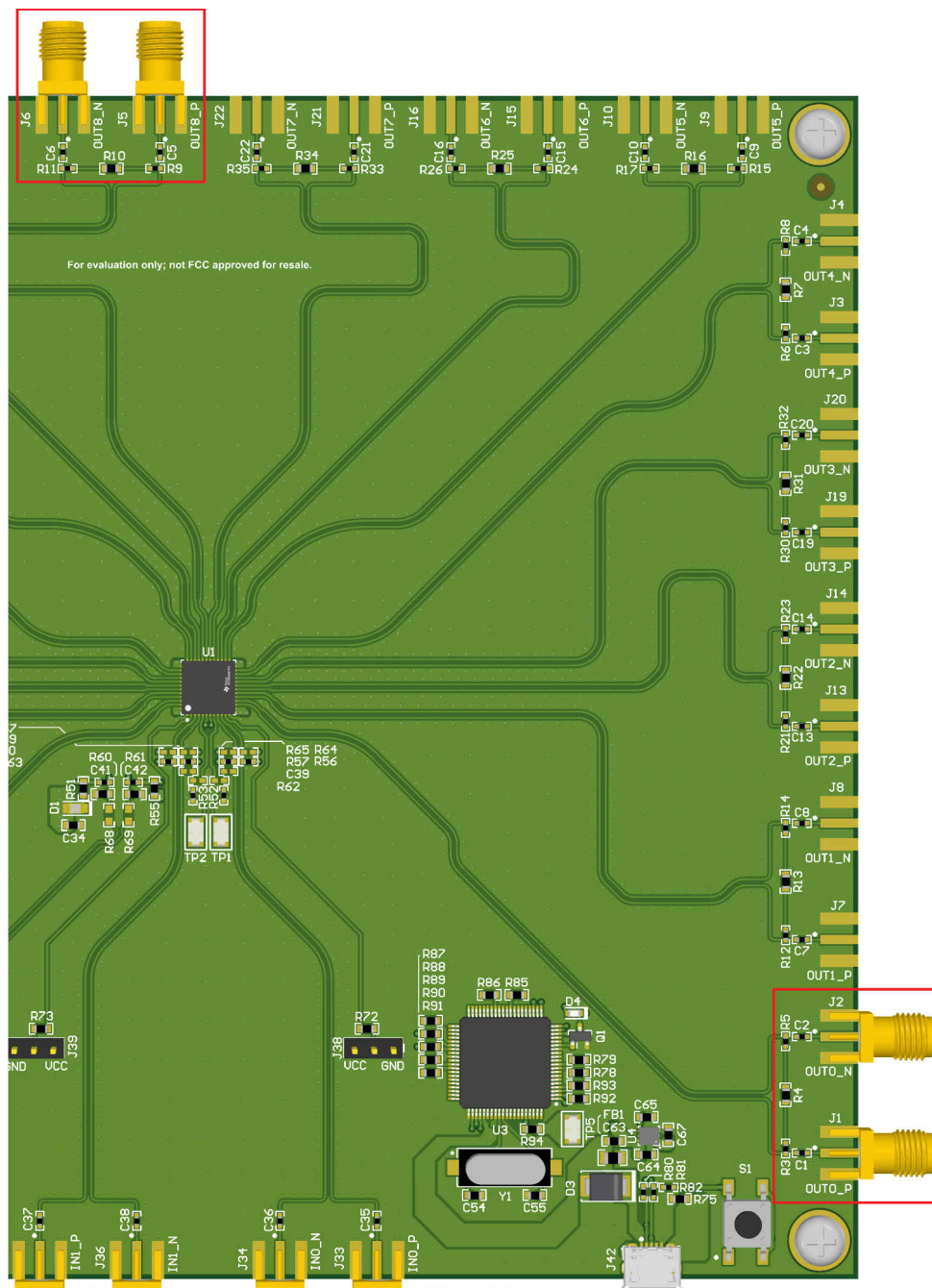


Figure 7-1. Output Clock EVM Layout

## 8 EVM Board Schematic

Figure 8-6 shows the printed circuit board (PCB) schematic.

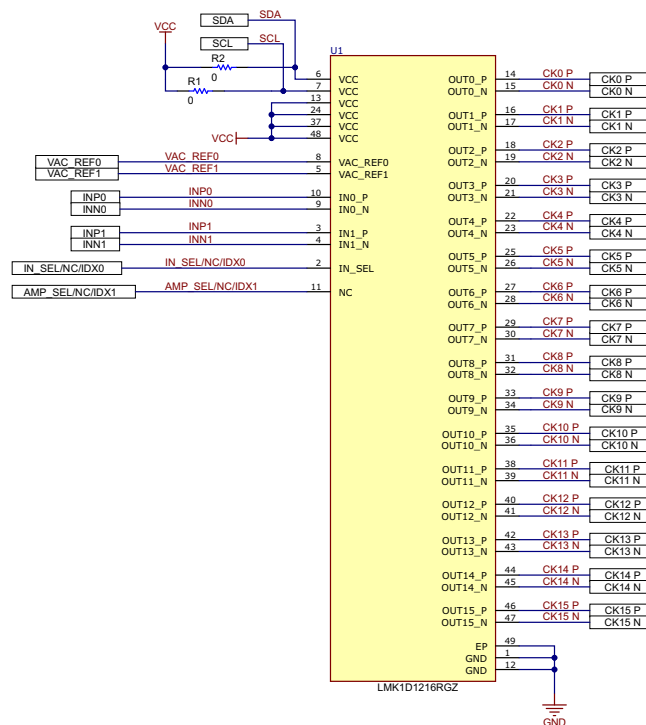
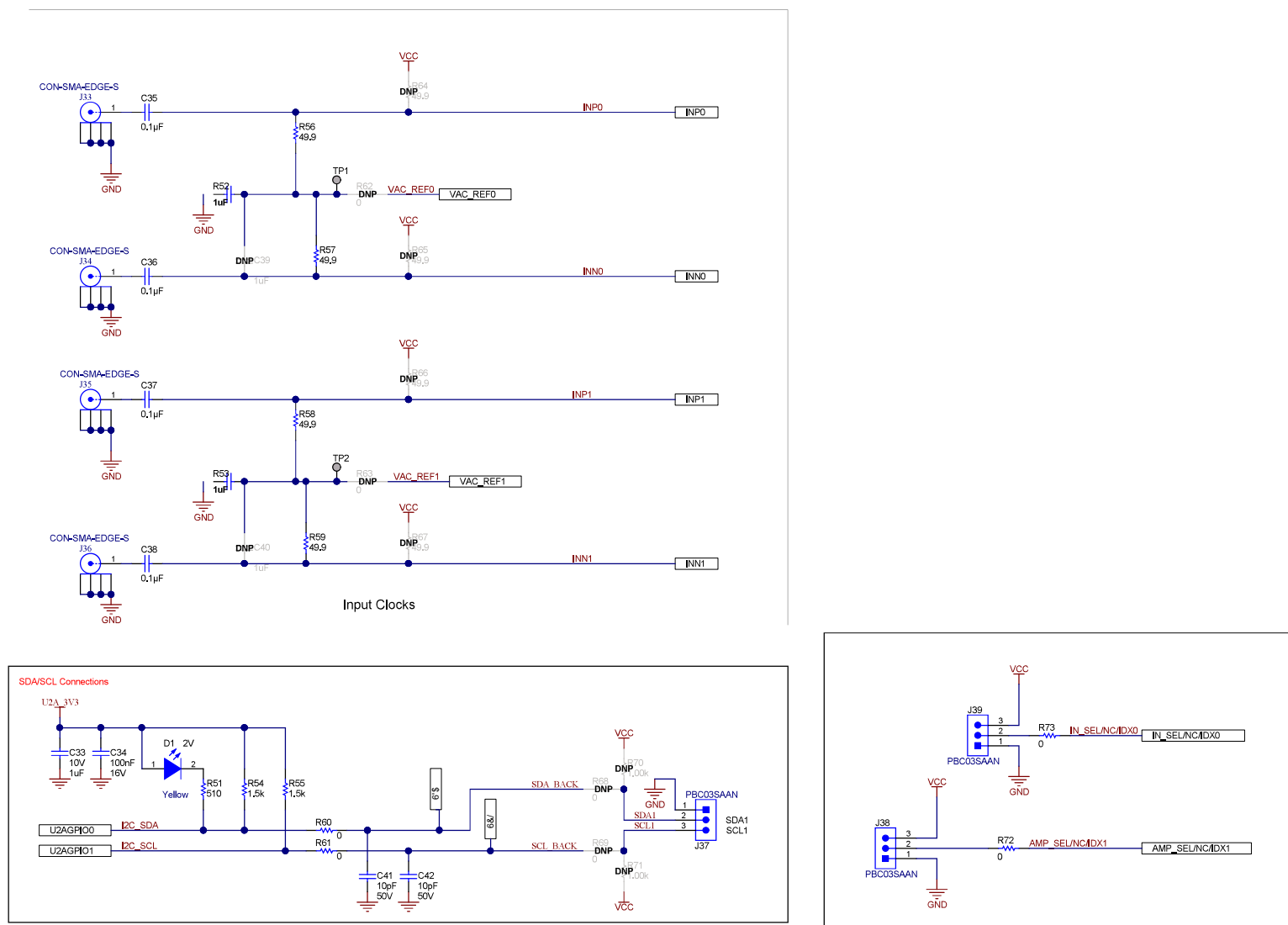
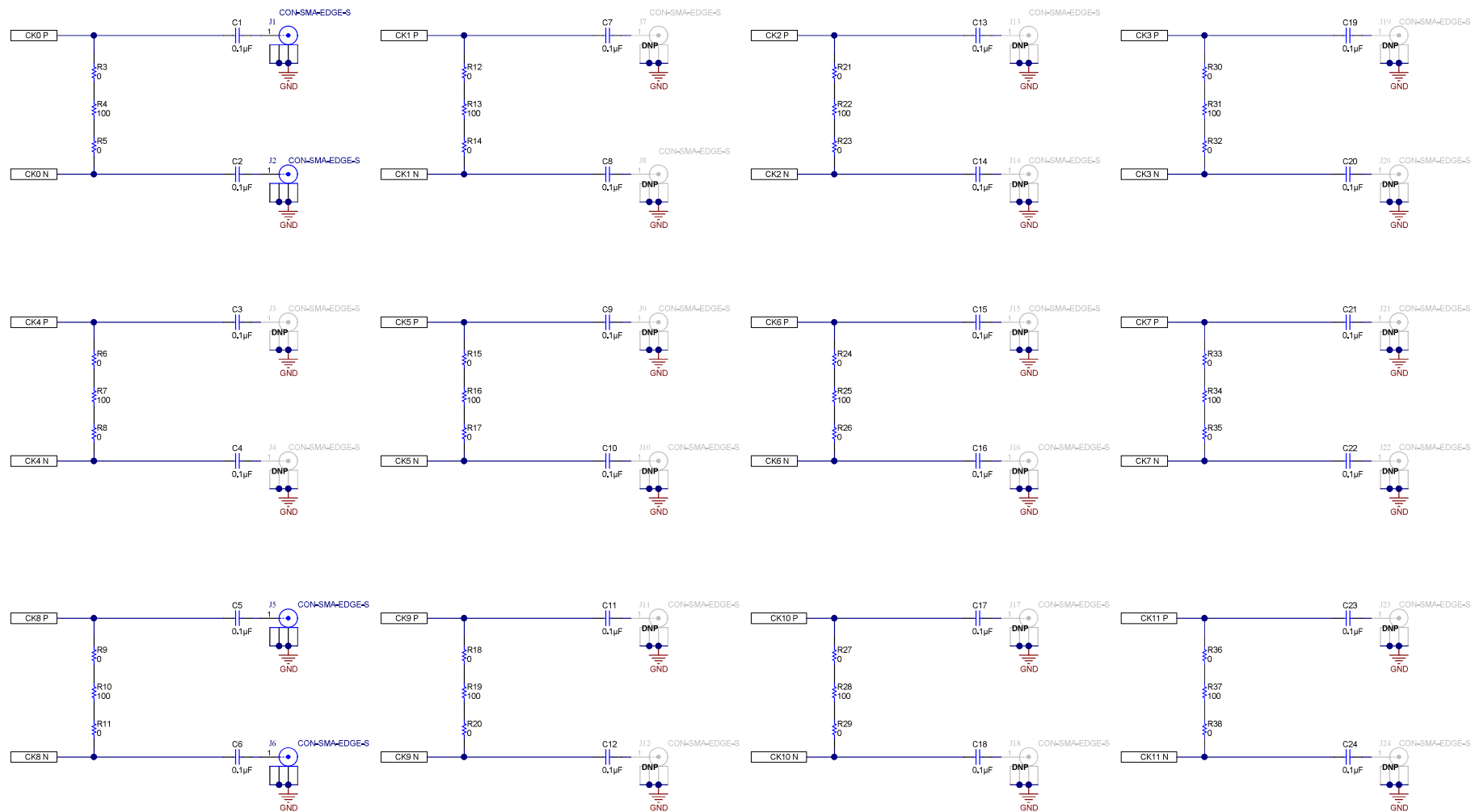


Figure 8-1. LMK1D1216EVM Schematic: Device Sheet



**Figure 8-2. LMK1D1216EVM Schematic: Inputs Sheet**



**Figure 8-3. LMK1D1216EVM Schematic: Outputs 0-11 Sheet**

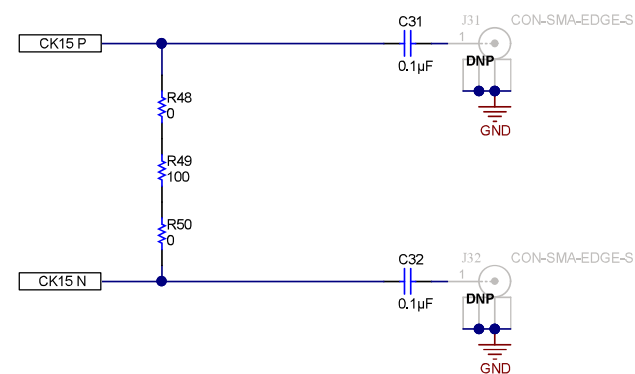
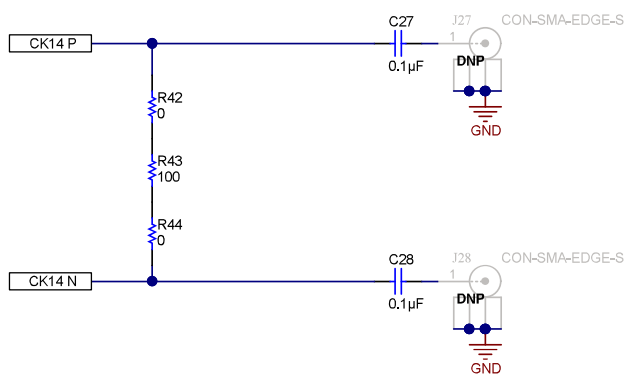
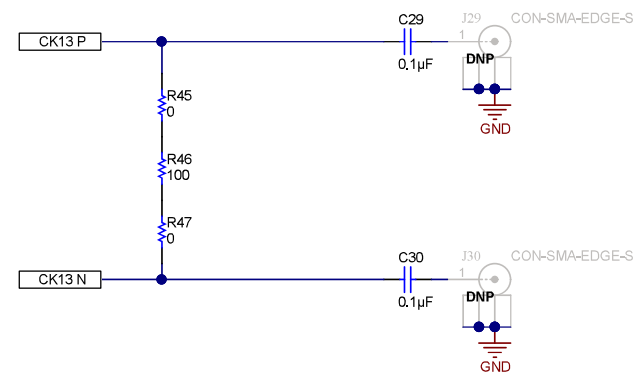
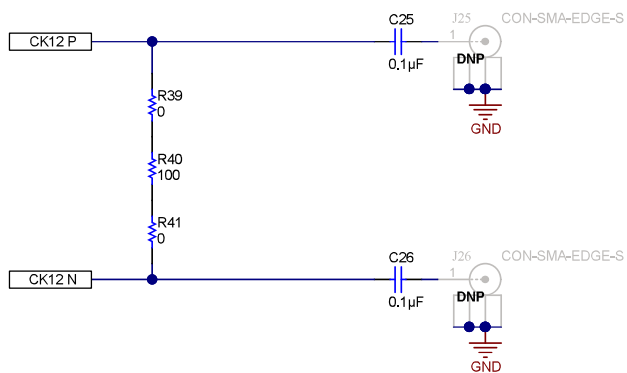


Figure 8-4. LMK1D1216EVM Schematic: Outputs 12-15 Sheet

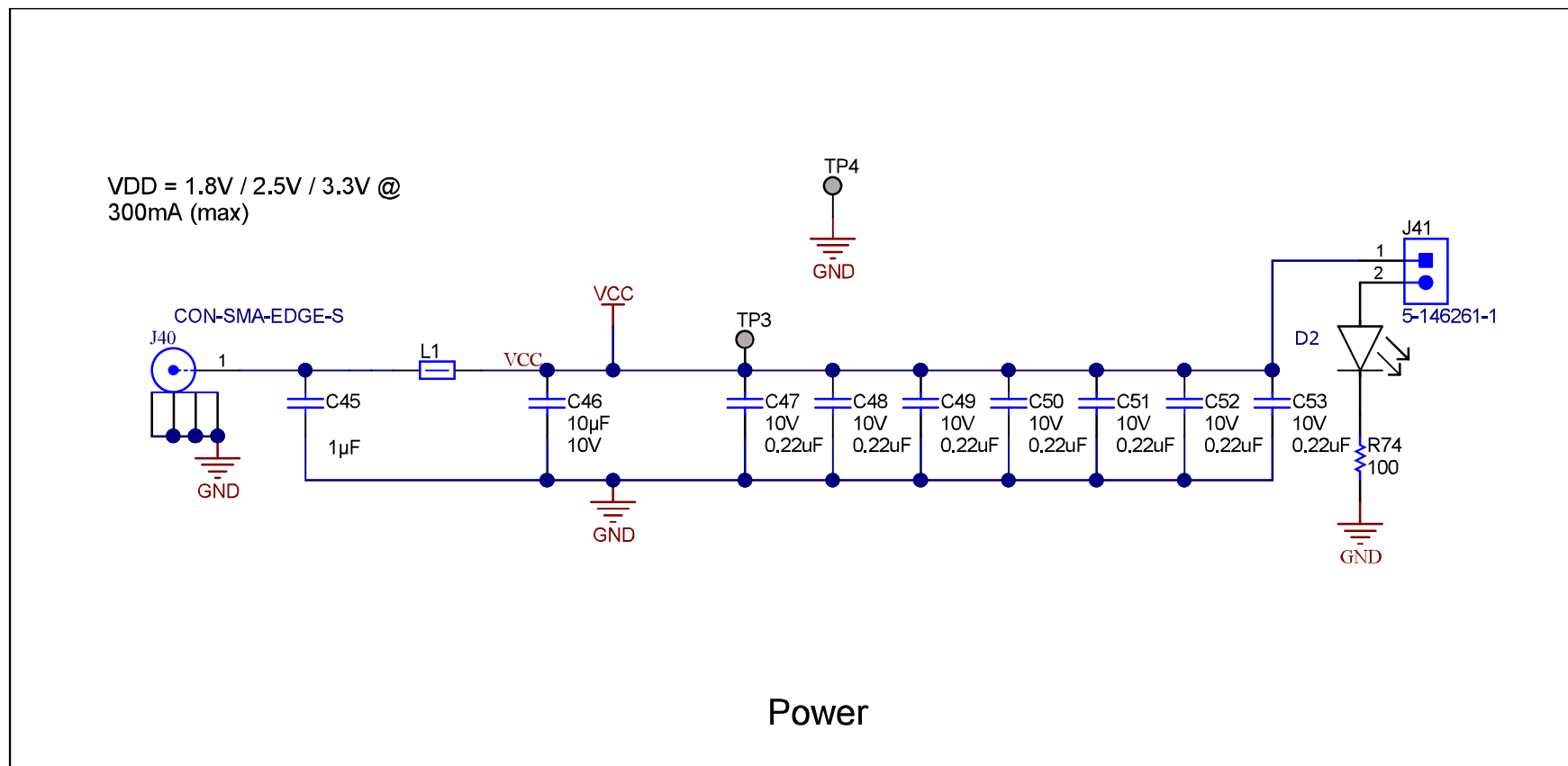
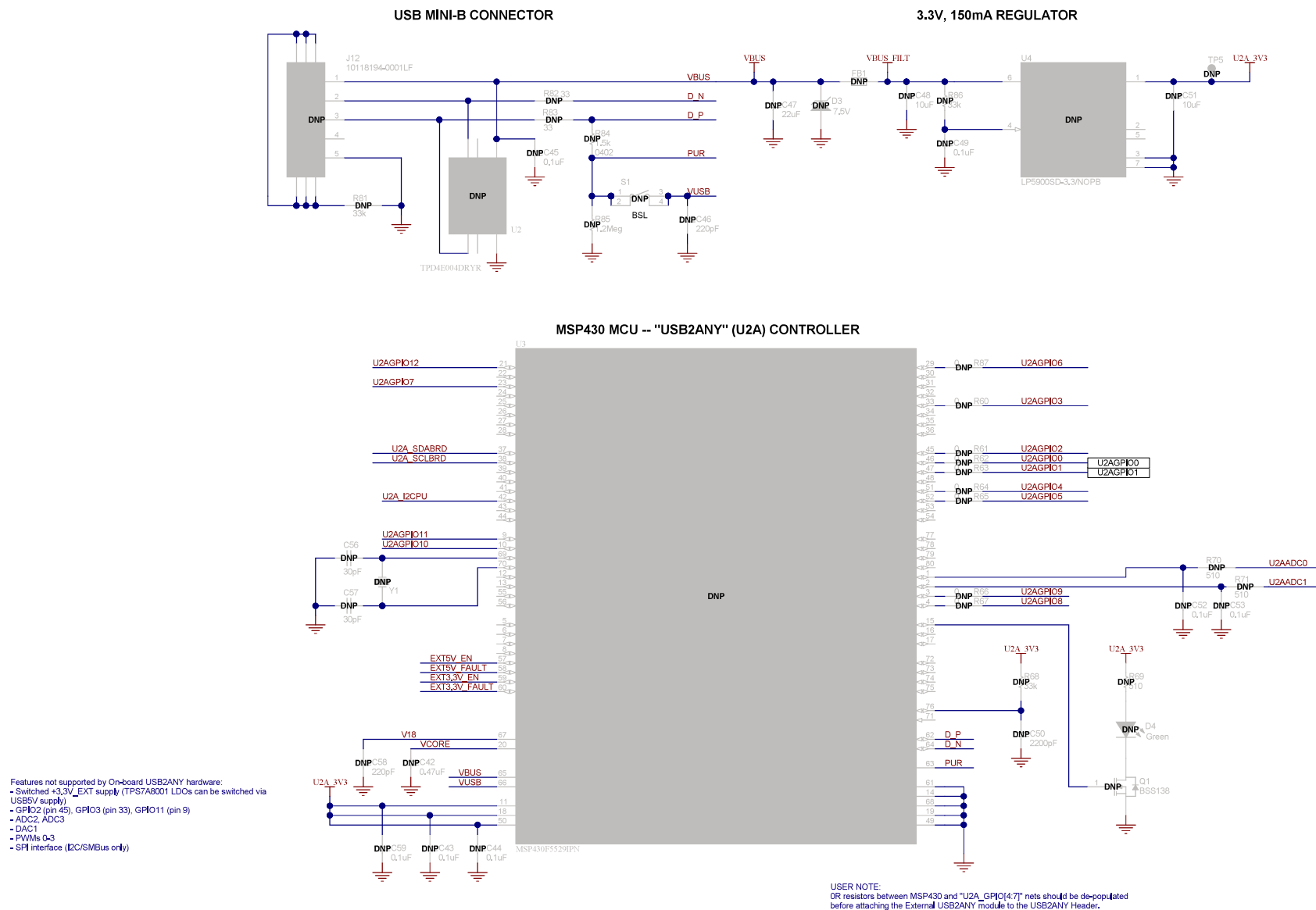


Figure 8-5. LMK1D1216EVM Schematic: Power Supply Sheet



**Figure 8-6. LMK1D1216EVM Schematic: USB Sheet**

## 9 REACH Compliance

### REACH Compliance

*In compliance with the Article 33 provision of the EU REACH regulation we are notifying you that this EVM includes component(s) containing at least one Substance of Very High Concern (SVHC) above 0.1%. These uses from Texas Instruments do not exceed 1 ton per year. The SVHC's are:*

| Component Manufacturer | Component type                                                                 | Component part number | SVHC Substance | SVHC CAS (when available) |
|------------------------|--------------------------------------------------------------------------------|-----------------------|----------------|---------------------------|
| Molex                  | 5.08 Pitch Eurostyle<br>Vertical Fixed Mount PCB<br>Terminal Block, 2 Circuits | 039544-3002           | Lead           | 7439-92-1                 |

## 10 Bill of Materials

**Table 10-1. Bill of Materials**

| DESIGNATOR                                                                                                                                                                | QUANTITY | VALUE  | DESCRIPTION                                                        | PACKAGE REFERENCE | PART NUMBER        | MANUFACTURER                |
|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------|--------|--------------------------------------------------------------------|-------------------|--------------------|-----------------------------|
| C1, C2, C3, C4, C5, C6, C7, C8, C9, C10, C11, C12, C13, C14, C15, C16, C17, C18, C19, C20, C21, C22, C23, C24, C25, C26, C27, C28, C29, C30, C31, C32, C35, C36, C37, C38 | 36       | 0.1uF  | CAP, CERM, 0.1 $\mu$ F, 10 V, +/- 10%, X7R, AEC-Q200 Grade 1, 0402 | 0402              | C0402C104K8RACAUTO | Kemet                       |
| C33                                                                                                                                                                       | 1        | 1uF    | CAP, CERM, 1 uF, 10 V, +/- 10%, X5R, 0603                          | 0603              | C0603C105K8PACTU   | Kemet                       |
| C34                                                                                                                                                                       | 1        | 0.1uF  | CAP, CERM, 0.1 uF, 16 V, +/- 5%, X7R, 0603                         | 0603              | C0603C104J4RACTU   | Kemet                       |
| C41, C42                                                                                                                                                                  | 2        | 10pF   | CAP, CERM, 10 pF, 50 V, +/- 5%, C0G/ NP0, 0603                     | 0603              | C0603C100J5GACTU   | Kemet                       |
| C45                                                                                                                                                                       | 1        | 1uF    | CAP, CERM, 1 $\mu$ F, 10 V, +/- 5%, X7R, AEC-Q200 Grade 1, 0603    | 0603              | C0603X105J8RAC7867 | Kemet                       |
| C46                                                                                                                                                                       | 1        | 10uF   | CAP, CERM, 10 $\mu$ F, 10 V, +/- 5%, X7R, AEC-Q200 Grade 1, 0805   | 0805              | C0805C106J8RACAUTO | Kemet                       |
| C47, C48, C49, C50, C51, C52, C53                                                                                                                                         | 7        | 0.22uF | CAP, CERM, 0.22 uF, 10 V, +/- 10%, X7R, 0402                       | 0402              | GRM155R71A224KE01D | MuRata                      |
| D1                                                                                                                                                                        | 1        | Yellow | LED, Yellow, SMD                                                   | 0805 LED          | LTST-C170KSKT      | Lite-On                     |
| D2                                                                                                                                                                        | 1        |        | SMD RED LED                                                        | SMD_LED           | BOS-3528-2RCQ      | BYD                         |
| H1, H2, H3, H4                                                                                                                                                            | 4        |        | Machine Screw, Round, #4-40 x 1/4, Nylon, Philips panhead          | Screw             | NY PMS 440 0025 PH | B&F Fastener Supply         |
| H5, H6, H7, H8                                                                                                                                                            | 4        |        | Standoff, Hex, 0.5"L #4-40 Nylon                                   | Standoff          | 1902C              | Keystone                    |
| J1, J2, J5, J6, J33, J34, J35, J36, J40                                                                                                                                   | 9        |        | CONN SMA JACK STR EDGE MNT                                         | CONN_JACK         | CON-SMA-EDGE-S     | RF Solutions Ltd.           |
| J37, J38, J39                                                                                                                                                             | 3        |        | Header, 100mil, 3x1, Gold, TH                                      | PBC03SAAN         | PBC03SAAN          | Sullins Connector Solutions |

**Table 10-1. Bill of Materials (continued)**

| DESIGNATOR                                                                                                                                                          | QUANTITY | VALUE  | DESCRIPTION                                  | PACKAGE REFERENCE          | PART NUMBER        | MANUFACTURER      |
|---------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------|--------|----------------------------------------------|----------------------------|--------------------|-------------------|
| J41                                                                                                                                                                 | 1        |        | Header, 100mil, 2x1, Gold, TH                | Header, 2x1, 100mil        | 5-146261-1         | TE Connectivity   |
| L1                                                                                                                                                                  | 1        | 50 ohm | Ferrite Bead, 50 ohm @ 100 MHz, 12 A, 1206   | 1206                       | BLM31SN500SZ1L     | MuRata            |
| R1, R2                                                                                                                                                              | 2        | 0      | RES, 0, 5%, 0.1 W, AEC-Q200 Grade 0, 0402    | 0402                       | ERJ-2GE0R00X       | Panasonic         |
| R3, R5, R6, R8, R9, R11, R12, R14, R15, R17, R18, R20, R21, R23, R24, R26, R27, R29, R30, R32, R33, R35, R36, R38, R39, R41, R42, R44, R45, R47, R48, R50, R60, R61 | 34       | 0      | RES, 0, 5%, 0.063 W, AEC-Q200 Grade 0, 0402  | 0402                       | CRCW04020000Z0ED   | Vishay-Dale       |
| R4, R7, R10, R13, R16, R19, R22, R25, R28, R31, R34, R37, R40, R43, R46, R49, R74                                                                                   | 17       | 100    | RES, 100, 1%, 0.1 W, AEC-Q200 Grade 0, 0603  | 0603                       | CRCW0603100RFKEA   | Vishay-Dale       |
| R51                                                                                                                                                                 | 1        | 510    | RES, 510, 5%, 0.1 W, 0603                    | 0603                       | RC0603JR-07510RL   | Yageo             |
| R52, R53                                                                                                                                                            | 2        | 1uF    | CAP, CERM, 1 uF, 6.3 V, +/- 10%, X7R, 0402   | 0402                       | GRM155R70J105KA12D | MuRata            |
| R54, R55                                                                                                                                                            | 2        | 1.5k   | RES, 1.5 k, 5%, 0.1 W, 0603                  | 0603                       | RC0603JR-071K5L    | Yageo             |
| R56, R57, R58, R59                                                                                                                                                  | 4        | 49.9   | RES, 49.9, 1%, 0.1 W, AEC-Q200 Grade 0, 0402 | 0402                       | ERJ-2RKF49R9X      | Panasonic         |
| R72, R73                                                                                                                                                            | 2        | 0      | RES, 0, 5%, 0.1 W, 0603                      | 0603                       | RC0603JR-070RL     | Yageo             |
| SH1, SH2, SH3                                                                                                                                                       | 3        | 1x2    | Shunt, 100mil, Gold plated, Black            | Shunt                      | SNT-100-BK-G       | Samtec            |
| TP1, TP2, TP3, TP4                                                                                                                                                  | 4        |        | Test Point, Miniature, SMT                   | Test Point, Miniature, SMT | 5019               | Keystone          |
| U1                                                                                                                                                                  | 1        |        | LMK1D1216RGZ                                 | VQFN48                     | LMK1D1216RGZ       | Texas Instruments |
| C39, C40                                                                                                                                                            | 0        | 1uF    | CAP, CERM, 1 uF, 6.3 V, +/- 20%, X7R, 0402   | 0402                       | GRM155R70J105MA12D | MuRata            |

**Table 10-1. Bill of Materials (continued)**

| DESIGNATOR                                                                                                                            | QUANTITY | VALUE  | DESCRIPTION                                      | PACKAGE REFERENCE                            | PART NUMBER         | MANUFACTURER            |
|---------------------------------------------------------------------------------------------------------------------------------------|----------|--------|--------------------------------------------------|----------------------------------------------|---------------------|-------------------------|
| C43, C44, C57, C59, C60, C61, C65                                                                                                     | 0        | 0.1uF  | CAP, CERM, 0.1 uF, 16 V, +/- 5%, X7R, 0603       | 0603                                         | C0603C104J4RACTU    | Kemet                   |
| C54, C55                                                                                                                              | 0        | 30pF   | CAP, CERM, 30 pF, 100 V, +/- 5%, C0G/ NP0, 0603  | 0603                                         | GRM1885C2A300JA01D  | MuRata                  |
| C56, C62                                                                                                                              | 0        | 220pF  | CAP, CERM, 220 pF, 50 V, +/- 1%, C0G/ NP0, 0603  | 0603                                         | 06035A221FAT2A      | AVX                     |
| C58                                                                                                                                   | 0        | 0.47uF | CAP, CERM, 0.47 uF, 10 V, +/- 10%, X7R, 0603     | 0603                                         | GRM188R71A474KA61D  | MuRata                  |
| C63                                                                                                                                   | 0        | 22uF   | CAP, CERM, 22 uF, 10 V, +/- 20%, X5R, 0805       | 0805                                         | LMK212BJ226MG-T     | Taiyo Yuden             |
| C64, C67                                                                                                                              | 0        | 10uF   | CAP, CERM, 10 uF, 10 V, +/- 20%, X5R, 0603       | 0603                                         | C1608X5R1A106M080AC | TDK                     |
| C66                                                                                                                                   | 0        | 2200pF | CAP, CERM, 2200 pF, 50 V, +/- 10%, X7R, 0603     | 0603                                         | C0603C222K5RACTU    | Kemet                   |
| D3                                                                                                                                    | 0        | 7.5V   | Diode, Zener, 7.5 V, 550 mW, SMB                 | SMB                                          | 1SMB5922BT3G        | ON Semiconductor        |
| D4                                                                                                                                    | 0        | Green  | LED, Green, SMD                                  | 1.6x0.8x0.8mm                                | LTST-C190GKT        | Lite-On                 |
| FB1                                                                                                                                   | 0        | 60 ohm | Ferrite Bead, 60 ohm @ 100 MHz, 3.5 A, 0603      | 0603                                         | MPZ1608S600ATAH0    | TDK                     |
| FID1, FID2, FID3, FID4, FID5, FID6                                                                                                    | 0        |        | Fiducial mark. There is nothing to buy or mount. | N/A                                          | N/A                 | N/A                     |
| J3, J4, J7, J8, J9, J10, J11, J12, J13, J14, J15, J16, J17, J18, J19, J20, J21, J22, J23, J24, J25, J26, J27, J28, J29, J30, J31, J32 | 0        |        | CONN SMA JACK STR EDGE MNT                       | CONN_JACK                                    | CON-SMA-EDGE-S      | RF Solutions Ltd.       |
| J42                                                                                                                                   | 0        |        | Receptacle, USB 2.0, Micro-USB Type B, R/A, SMT  | USB-micro B USB 2.0, 0.65mm, 5 Pos, R/A, SMT | 10118194-0001LF     | FCI                     |
| Q1                                                                                                                                    | 0        | 50V    | MOSFET, N-CH, 50 V, 0.22 A, SOT-23               | SOT-23                                       | BSS138              | Fairchild Semiconductor |

**Table 10-1. Bill of Materials (continued)**

| DESIGNATOR                                            | QUANTITY | VALUE  | DESCRIPTION                                                                      | PACKAGE REFERENCE          | PART NUMBER      | MANUFACTURER      |
|-------------------------------------------------------|----------|--------|----------------------------------------------------------------------------------|----------------------------|------------------|-------------------|
| R62, R63                                              | 0        | 0      | RES, 0, 5%, 0.063 W, AEC-Q200 Grade 0, 0402                                      | 0402                       | CRCW04020000Z0ED | Vishay-Dale       |
| R64, R65, R66, R67                                    | 0        | 49.9   | RES, 49.9, 1%, 0.1 W, AEC-Q200 Grade 0, 0402                                     | 0402                       | ERJ-2RKF49R9X    | Panasonic         |
| R68, R69                                              | 0        | 0      | RES, 0, 5%, 0.1 W, 0603                                                          | 0603                       | RC0603JR-070RL   | Yageo             |
| R70, R71                                              | 0        | 1.00k  | RES, 1.00 k, 1%, 0.1 W, 0603                                                     | 0603                       | ERJ-3EKF1001V    | Panasonic         |
| R75, R84, R94                                         | 0        | 33k    | RES, 33 k, 5%, 0.1 W, AEC-Q200 Grade 0, 0603                                     | 0603                       | CRCW060333K0JNEA | Vishay-Dale       |
| R76, R77, R85, R86, R87, R88, R89, R90, R91, R92, R93 | 0        | 0      | RES, 0, 5%, 0.1 W, AEC-Q200 Grade 0, 0603                                        | 0603                       | CRCW06030000Z0EA | Vishay-Dale       |
| R78, R79                                              | 0        | 1.0k   | RES, 1.0 k, 5%, 0.1 W, AEC-Q200 Grade 0, 0603                                    | 0603                       | CRCW06031K00JNEA | Vishay-Dale       |
| R80, R81                                              | 0        | 33     | RES, 33, 5%, 0.063 W, AEC-Q200 Grade 0, 0402                                     | 0402                       | CRCW040233R0JNED | Vishay-Dale       |
| R82                                                   | 0        | 1.5k   | RES, 1.5 k, 5%, 0.063 W, AEC-Q200 Grade 0, 0402                                  | 0402                       | CRCW04021K50JNED | Vishay-Dale       |
| R83                                                   | 0        | 1.2Meg | RES, 1.2 M, 5%, 0.1 W, AEC-Q200 Grade 0, 0603                                    | 0603                       | CRCW06031M20JNEA | Vishay-Dale       |
| R95, R96, R97                                         | 0        | 510    | RES, 510, 5%, 0.1 W, AEC-Q200 Grade 0, 0603                                      | 0603                       | CRCW0603510RJNEA | Vishay-Dale       |
| S1                                                    | 0        |        | Switch, Tactile, SPST-NO, 0.05A, 12V, SMT                                        | SW, SPST 6x6 mm            | FSM4JSMA         | TE Connectivity   |
| TP5                                                   | 0        |        | Test Point, Miniature, SMT                                                       | Test Point, Miniature, SMT | 5019             | Keystone          |
| U2                                                    | 0        |        | 4-Channel ESD Protection Array for High-Speed Data Interfaces, DRY0006A (USON-6) | DRY0006A                   | TPD4E004DRYR     | Texas Instruments |

**Table 10-1. Bill of Materials (continued)**

| DESIGNATOR | QUANTITY | VALUE | DESCRIPTION                                                                                                                               | PACKAGE REFERENCE       | PART NUMBER       | MANUFACTURER      |
|------------|----------|-------|-------------------------------------------------------------------------------------------------------------------------------------------|-------------------------|-------------------|-------------------|
| U3         | 0        |       | 25 MHz Mixed Signal Microcontroller with 128 KB Flash, 8192 B SRAM and 63 GPIOs, -40 to 85 degC, 80-pin QFP (PN), Green (RoHS & no Sb/Br) | PN0080A                 | MSP430F5529IPN    | Texas Instruments |
| U4         | 0        |       | 150-mA Ultra-Low Noise LDO for RF and Analog Circuits Requires No Bypass Capacitor, NGF0006A (WSO-6)                                      | NGF0006A                | LP5900SD-3.3/NOPB | Texas Instruments |
| Y1         | 0        |       | Crystal, 24.000 MHz, 20pF, SMD                                                                                                            | Crystal, 11.4x4.3x3.8mm | ECS-240-20-5PX-TR | ECS Inc.          |

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