

PoE PSE Controller

Introduction

The Microchip family of PSE controllers include the PD69200, PD69210, and PD69220 devices. The PD69200 controller is based on the NXP Kinetis® L family, MKL15Z128VFM4. The PD69210 and PD69220 are based on the Microchip SAM D21 family. The PD69200 and PD69220 are pin compatible with an identical feature set. The PD69200 is available for existing designs. The PD69210 and PS69220 are recommended for all new designs.

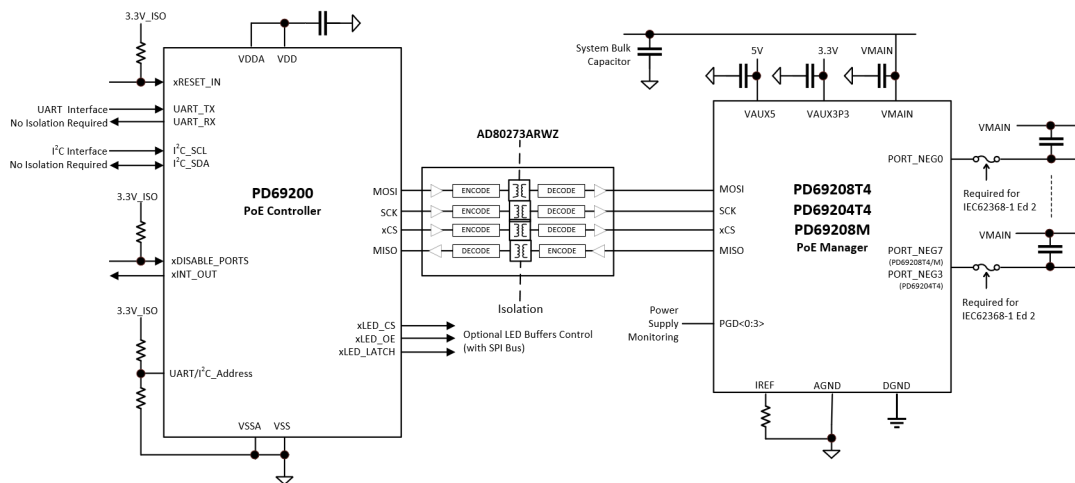
When paired with the Microchip PD69208T4, PD69204T4, or PD69208M Managers, the PD69200 controller is part of a Power over Ethernet Power Source Equipment (PSE) system. This system enables designers to integrate enhanced mode PoE capabilities, as specified in IEEE® 802.3af, IEEE 802.3at, IEEE 802.3bt, and PoH standards.

The PD69200 is available in a 32-pin, 5 mm x 5 mm QFN package.

Typical PoE Application

The following figure shows the typical PoE application of PD69208T4 and PD69200 devices.

Figure 1. Typical PoE Application



Consult Microchip AN3361 *Designing an IEEE 802.3af/802.3at/802.3bt-Compliant PD69208 48-Port PoE System* for complete reference design.

Features

The following is the list of feature details of PSE Controller devices.

- Complies with IEEE 802.3 af/at, IEEE 802.3 bt, and HDBaseT (POH) standards
- Port matrix and priority
- Cascade up to 12 PoE devices for 48 logical ports
- 45 W maximum two pair power and capable of 90 W per four pair port (.bt)
- Supports three power management modes: Class (LLDP), Dynamic, and Static
- Supports 16 power banks based on four power supplies
- Port power limit setting
- Interrupt from power supply to PoE drivers
- Interrupt out pin for system and port events
- System OK indication
- Disable ports input pin
- System and port status and port measurements
- Legacy detection support
- LED stream support
- Fast and perpetual PoE support
- Software download through I²C or UART communication interface
- 32-pin, 5 mm x 5 mm QFN package
- Pin compatible with PD69220
- MSL3 and RoHS compliant

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1. Architecture

The following figures show the simplified hardware and the firmware architecture of the PoE system based on the PD69200 controller and the PD69208T4, PD69204T4, and PD69208M managers.

Figure 1-1. Simplified Hardware Architecture

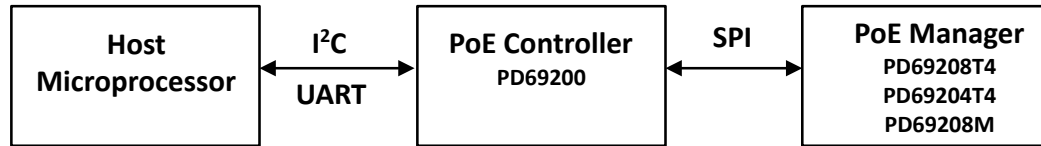
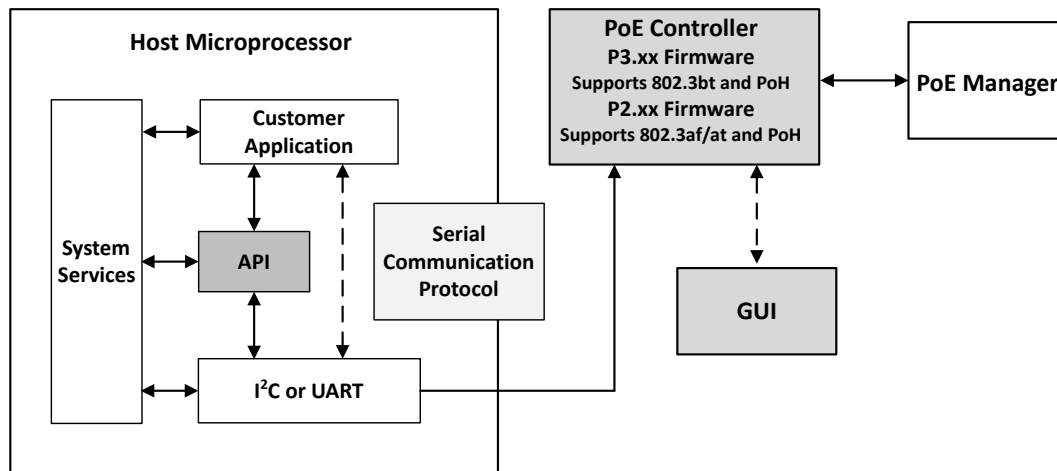


Figure 1-2. Simplified Firmware Architecture



- Dark grey boxes indicate Microchip supplied firmware
- Light grey boxes indicate Microchip provided documentation
- White boxes are user supplied

1.1 Firmware

- Firmware is pre-programmed in PD69200 controller. The firmware version is identifiable via the IC ordering part number.
- Firmware is vendor agnostic with regards to the choice of the host controller.
- May operated “stand alone” or with I²C or UART communication to host.
- The default profiles are coded into the firmware. Microchip offers a configuration tool for profile modification.
- Firmware is field-upgradeable via the I²C or UART link.

1.2 Communication

Communication between the host application and the controller’s firmware may be done via a 15 byte protocol. Customers may use a Microchip provided API. Microchip provides a Serial Communication Protocol guide.

1.3 GUI

This is a diagnostic tool to control the Microchip PSE emulating or bypassing the host processor.

1.4 Software Library

The firmware (without the boot section), GUI, and API is available on Microchip's software library <https://www.microchip.com/doclisting/SoftwareLib.aspx>.

1.5 SPI Communication

The PD69208T4, PD69204T4, and PD69208M managers use SPI communication in SPI slave mode to communicate with the various controllers. Each manager has an address determined by ADDR0-ADDR3 pins. Each controller can support up to 12 ICs at addresses 0–11. The actual frequency between PD69200 and PD6920x ICs is 1 MHz.

The following table lists the SPI communication packet structure.

Table 1-1. SPI Communication – Packet Structure

| Control Byte Selects PD69208T4 According to Address | R/W Bit | Internal Register Address | Number of Words (Read Access Only) | Data Written to IC (Write Access Only) Read from IC (Read Access Only) |
|--|-----------|------------------------------|---------------------------------------|---|
| 8 bits | R(0)/W(1) | 8 bits | 8 bits | 16 bits |

See the PD69208T4, PD69204T4, and PD69208M Manager datasheet for additional details on the SPI interface.

1.6 UART

A pull-up resistor is required on the UART communication line. For more information, see *AN3361 Designing an IEEE802.3af/at/bt PoE System Based on PD692x0/PD69208*.

Following is the UART communications configuration setting details:

- Bits per second: 19,200 bps
- Data bits: 8
- Parity: None
- Stop bits: 1
- Flow control: None

1.7 I²C

The PD69200 requires the host to support I²C clock stretch.

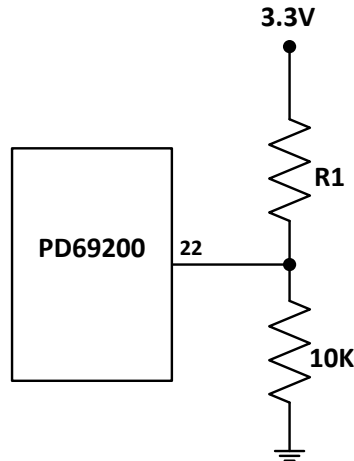
Following is the I²C communication configuration setting details:

- Address: 7 bits
- Clockstretch: host should support
- Transaction: 15 bytes or 1 byte

1.8 UART - I²C Address Selection

The choice of UART or I²C interface between the host CPU is made by applying a specific voltage level to pin #22 (I2C_ADDR_MEAS) on the PD69200. Additionally, the specific I²C address is also set by this voltage level. The voltage is set via an external resistor as shown in the following figure.

Figure 1-3. I²C Address Selection



The following table shows the specific values of R to choose UART or I²C and to set the address.

Table 1-2. I²C Address Selection for PD69200

| I2C_ADDR Voltage Low Level (V) | I2C_ADDR Voltage High Level (V) | I ² C Address (Hexadecimal) | R1- K Ω (1%) |
|--------------------------------|---------------------------------|--|---------------------|
| 0 | 0.21 | UART | N.C. |
| 0.21 | 0.41 | 0x4 | 97.6 |
| 0.41 | 0.62 | 0x8 | 53.6 |
| 0.62 | 0.83 | 0xC | 35.7 |
| 0.83 | 1.03 | 0x10 | 25.5 |
| 1.03 | 1.24 | 0x14 | 19.1 |
| 1.24 | 1.44 | 0x18 | 14.7 |
| 1.44 | 1.65 | 0x1C | 11.3 |
| 1.65 | 1.86 | 0x20 | 8.87 |
| 1.86 | 2.06 | 0x24 | 6.81 |
| 2.06 | 2.27 | 0x28 | 5.23 |
| 2.27 | 2.48 | 0x2C | 3.92 |
| 2.48 | 2.68 | 0x30 | 2.80 |
| 2.68 | 2.89 | 0x34 | 1.87 |
| 2.89 | 3.09 | 0x38 | 1.02 |
| 3.09 | 3.30 | 0x3C | 0.324 |

2. Electrical Specifications

For a complete list of electrical ratings and characteristics, see *NXP MKL15Z128VFM4 Data Sheet*.

2.1 Electrical Characteristics

The following table list typical value conditions of PD69200.

Table 2-1. Typical Value Conditions

| Symbol | Parameter | Min Typ | Value | Max | Units |
|-----------------|----------------------|---------|-------|------|-------|
| T _A | Ambient temperature | -40 | 25 | 85 | °C |
| V _{DD} | 3.3 V supply voltage | 3.0 | 3.3 | 3.63 | V |

2.2 Immunity

The following table lists the immunity conditions of PD69200.

Table 2-2. PD69200 Immunity

| Symbol | Parameter | Conditions | Min | Max | Units |
|--------|------------|------------------|-------|------|-------|
| ESD | ESD rating | HBM ¹ | -2000 | 2000 | V |
| | ESD rating | CDM ² | -500 | 500 | V |

Notes:

1. Determined according to JEDEC Standard JESD22-A114, *Electrostatic Discharge (ESD) Sensitivity Testing Human Body Model (HBM)*.
2. Determined according to JEDEC Standard JESD22-C101, *Field-Induced Charged-Device Model Test Method for Electrostatic-Discharge-Withstand Thresholds of Microelectronic Components*.

2.3 Absolute Maximum Ratings

Stresses beyond those listed in this section may cause permanent damage to the device. This is a stress rating only and functional operation of the device at these or other conditions beyond those indicated in the operational sections of this specification is not implied. Exposure to absolute maximum rating conditions for extended periods may affect the device reliability.

Table 2-3. Absolute Maximum Ratings

| Symbol | Parameter | Minimum | Maximum | Units |
|---|--|---------|---------|-------|
| V _{DD} | Digital supply voltage | -0.3 | 3.8 | V |
| V _{DDA} | Analog supply voltage | VDD-0.3 | VDD+0.3 | V |
| V _{DIO} | Digital pin input voltage (Except RESET) | -0.3 | 3.6 | V |
| V _{AIO} | Analog pins ¹ and RESET pin input voltage | -0.3 | VDD+0.3 | V |
| Lead Soldering Temperature (40 s, reflow) | — | — | 260 | °C |
| Storage Temperature | — | -55 | 150 | °C |

Note:

1. Analog pins are defined as pins that do not have an associated general purpose I/O port function.

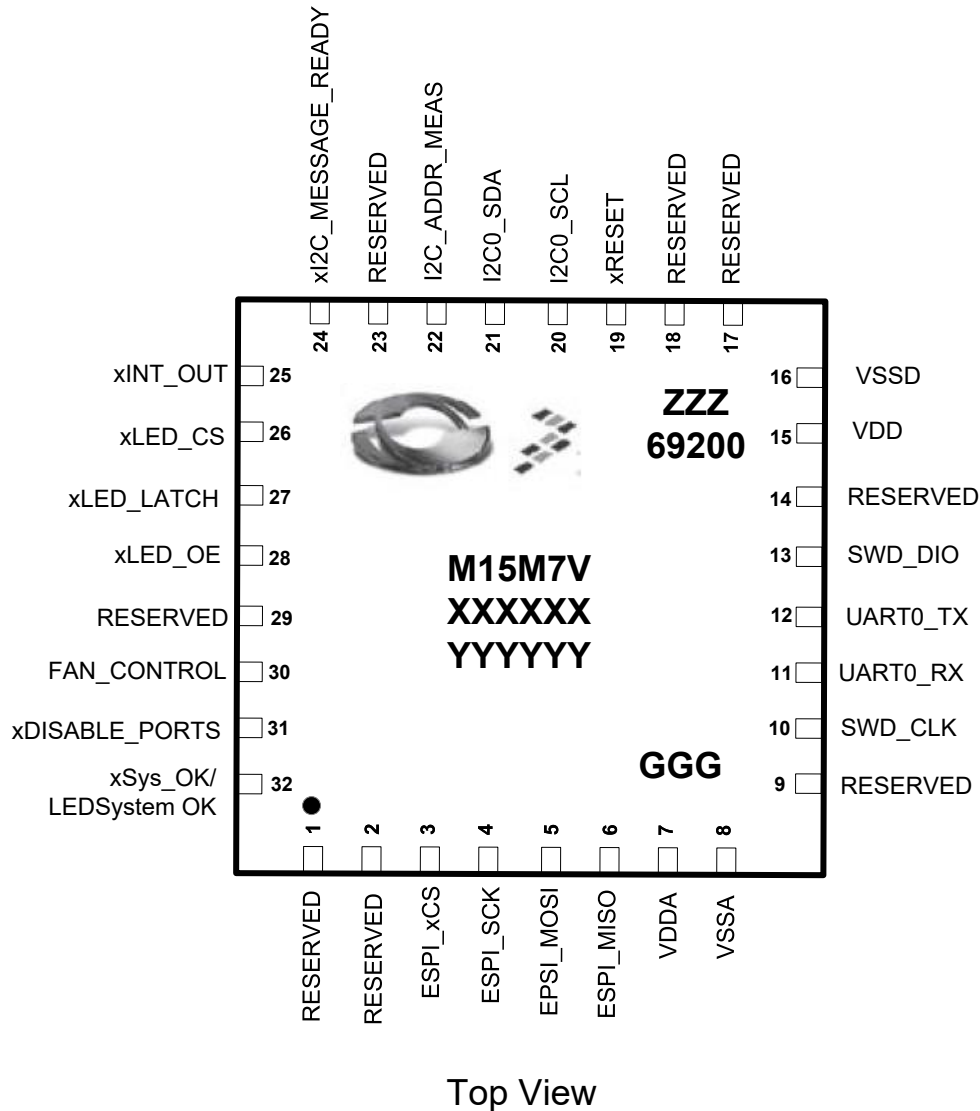
3. Pin Descriptions

The following section describes the 32 pins of PD69200.

3.1 Pin Configuration and Pinout

The following figure shows the top view of PD69200.

Figure 3-1. PD69200 Pin Diagram



Note: For definitions about markings in the pinout diagram, see [Ordering Information](#).

3.2 Pin Details

The following tables describe the functional pin descriptions of the PD69200 device.

Table 3-1. PD69200 Pin Description

| Number | Designation | Type | Description |
|--------|-------------|------------|--|
| 1 | Reserved | OUT | Reserved UART - Leave Open |
| 2 | Reserved | IN | Reserved UART - Pull up to 3.3 V via 10K |
| 3 | ESPI_xCS | OUT | ESPI Bus to PoE Manager. SPI chip select. Pull-up required. See AN3361 for pin connection requirements. (Active Low) |
| 4 | ESPI_SCK | OUT | ESPI Bus to PoE Manager. SPI clock output to PD6920x, and LED stream clock output, set to 1 MHz. |
| 5 | ESPI_MOSI | OUT | ESPI Bus to PoE Manager. SPI Master Out Slave In. SPI packets are transmitted on this line. |
| 6 | ESPI_MISO | IN | ESPI Bus to PoE Manager. SPI Master In Slave Out. SPI packets are received on this line. |
| 7 | VDDA | Supply | Main Supply 3.3 V |
| 8 | VSSA | GND | Ground |
| 9 | Reserved | Analog_IN | Reserved Analog_IN. Connect to 3.3 V. |
| 10 | SWD_CLK | | Leave Open |
| 11 | UART0_RXx | IN | UART receive from host. 15-byte protocol commands are received on this line. The baud rate is set to 19,200 bps. A pull up is required. See AN3361 for details. |
| 12 | UART0_TX | OUT | UART transmit to host. 15-byte protocol reply/telemetry is transmitted on this line. The baud rate is set to 19,200 bps. |
| 13 | SWD_DIO | | Leave Open |
| 14 | Reserved | Analog_IN | Reserved Analog_IN. Connect to 3.3 V or GND through 10 kΩ. |
| 15 | VDD | Supply | Main Supply 3.3 V |
| 16 | VSSD | GND | Ground |
| 17 | Reserved | Oscillator | Reserved – Oscillator input – Leave open |
| 18 | Reserved | Oscillator | Reserved – Oscillator output – Leave open |
| 19 | xRESET | IN/OUT | Host Reset input. This pin is active low. The controller can generate self-reset. In this case, the xRESET pin is driven low by the controller for about 100 μs. See AN3361 for pin connection requirements. |

.....continued

| Number | Designation | Type | Description |
|--------|-----------------------|-----------|--|
| 20 | I2C0_SCL | IN/OUT | I ² C clock from the host master. Speed is limited to 400 KHz. Clock stretch required. Pull-up required, see AN3361 for details. |
| 21 | I2C0_SDA | IN/OUT | I ² C bidirectional data. 15-byte protocol messages are transmitted on this line. A pull up is required. See AN3361 for more details. |
| 22 | I2C_ADDR_MEAS | Analog_IN | Analog input to determine I ² C address or UART operation. |
| 23 | Reserved | | Connect to GND |
| 24 | xI2C_MESSAGE_READY | OUT | I ² C message ready for reading by the host. The controller asserts this line low when it has an answer to the host. Therefore, the host can poll this line and initiate an I ² C read cycle only when the message is ready. This pin is active low. After the host reads the data from the controller, this pin is asserted to high. |
| 25 | xINT_OUT | OUT | Interrupt output indication. This line is asserted low when a pre-configured event is in progress. This pin is active low. |
| 26 | xLED_CS | OUT | Chip select signal for LED stream. This pin is active low. |
| 27 | xLED_LATCH | OUT | Latch signal for LED stream. This pin is active low. |
| 28 | xLED_OE | OUT | Output enable signal for LED stream. This pin is active low. |
| 29 | Reserved | Analog_IN | Reserved Analog_IN. Connect to 3.3 V. |
| 30 | FAN_CONTROL | OUT | Logic out that may be used to control a fan driver. This pin is active high. |
| 31 | xDISABLE_PORTS | IN | Disable all PoE ports. When this input is asserted low, the controller shuts down all of the PoE ports in the system. See AN3361 for pin connection requirements. (Active Low) |
| 32 | xSys_OK/LED System OK | OUT | System validity indication. The behavior of this output is controlled by individual software mask. (Active Low) |
| ePAD | ePAD | — | Connect to VSSA. Sufficient copper mass is needed to ensure adequate thermal performance. |

3.3 Recommended PCB Layouts

3.3.1 Recommended PCB Layout for 32-Pin QFN 5 mm x 5 mm

The following figures show the PCB layout pattern for PD69200. The units are in mm.

Figure 3-2. Top Layer Copper PCB Layout

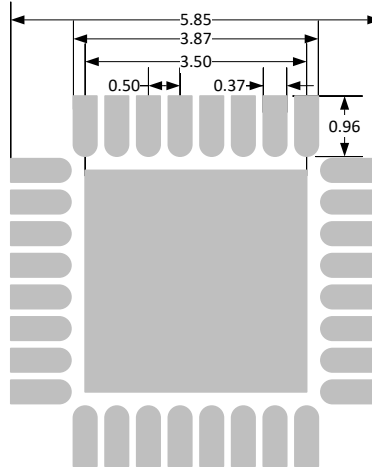
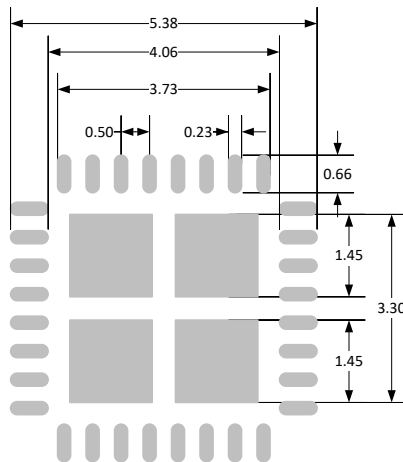


Figure 3-3. PD69200 Top-Layer Solder Paste and Vias PCB Layout for Thermal Pad Array



The contract manufacturer has latitude to modify the solder paste stencil for manufacturability reasons. The solder paste stencil covers 65% to 80% of the thermal pad and must not allow solder to be applied to the thermal vias under the QFN package using any method they deem appropriate. Any design should be subject to system validation and qualification prior to commitment to mass production of field deployment. Use a 5 mil stencil.

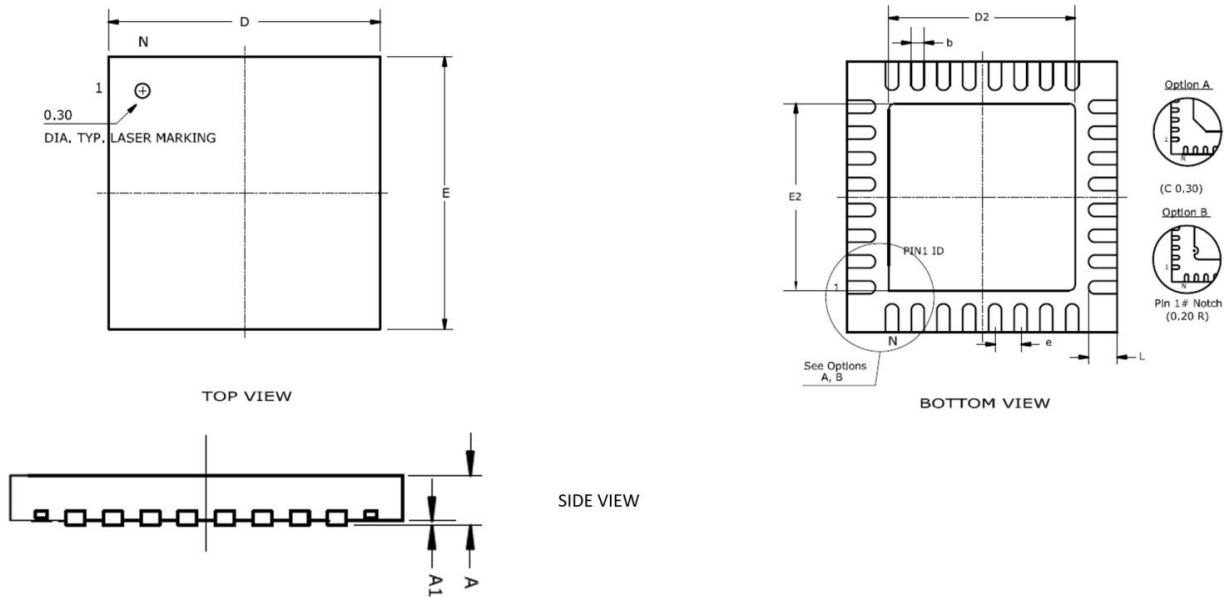
4. Package Information

This section describes the package drawings of PD69200 device.

4.1 PD69200 Package Outline Drawing

The following figure shows the package drawing (32 Pin QFN 5 mm x 5 mm) of the PD69200 device.

Figure 4-1. PD69200 Package Outline Drawing



The following table lists the dimensions and measurements of the PD69200 package.

Table 4-1. PD69200 Package Outline Dimensions and Measurements

| Dimension | Millimeters | | Inches | |
|-----------|-------------|------|-----------|-------|
| | Min | Max | Min | Max |
| A | 0.80 | 1.00 | 0.031 | 0.039 |
| A1 | 0.00 | 0.05 | 0 | 0.002 |
| e | 0.50 BSC | — | 0.02 BSC | — |
| L | 0.30 | 0.50 | 0.012 | 0.02 |
| b | 0.18 | 0.30 | 0.007 | 0.012 |
| D2 | 3.50 | 3.70 | 0.138 | 0.147 |
| E2 | 3.50 | 3.70 | 0.138 | 0.147 |
| D | 5.00 BSC | — | 0.197 BSC | — |
| E | 5.00 BSC | — | 0.197 BSC | — |

Note: Dimensions do not include protrusions. They should not exceed 0.155 mm (.006 in) on any side. Lead dimension should not include solder coverage. The dimensions are in millimeters and inches for reference.

4.2 Thermal Specifications

The following table list the thermal specifications of the PD69200.

Table 4-2. Thermal Specifications

| Thermal Resistance | Typ | Units | Notes |
|--------------------|-----|-------|--|
| θ_{JA} | 33 | °C/W | Junction-to-ambient thermal resistance |
| θ_{JC} | 1.8 | °C/W | Junction-to-case thermal resistance |

4.3 Recommended Solder Reflow Information

Following list shows the recommended solder reflow information details.

- RoHS 6/6
- Pb-free 100%
- Matte Tin Finish
- Package Peak Temperature for Solder Reflow (40 s maximum exposure)—260 °C (0 °C, -5 °C)

Table 4-3. Classification Reflow Profiles

| Profile Feature | Sn-PbEutectic Assembly | Pb-Free Assembly |
|---|------------------------|------------------|
| Average Ramp-up Rate (TS_{max} to T_p) | 3 °C/second max | 3 °C/second max |
| Preheat | | |
| Temperature Min (TS_{min}) | 100 °C | 150 °C |
| Temperature Max (TS_{max}) | 150 °C | 200 °C |
| Time (ts_{min} to ts_{max}) | 60 s to 120 s | 60 s to 180 s |
| Time Maintained | | |
| Time Maintained Temperature (T_L) | 183 °C | 217 °C |
| Time (t_L) | 60 s to 150 s | 60 s to 150 s |
| Peak Classification Temperature (TP) | 210 °C to 235 °C | 240 °C to 255 °C |
| Time within 5 °C of Actual Peak Temperature (t_p) | 10 s to 30 s | 20 s to 40 s |
| Ramp-down Rate | 6 °C/second max | 6 °C/second max |
| Time 25 °C to Peak Temperature | 6 minutes max | 8 minutes max |

Figure 4-2. Classification Reflow Profiles

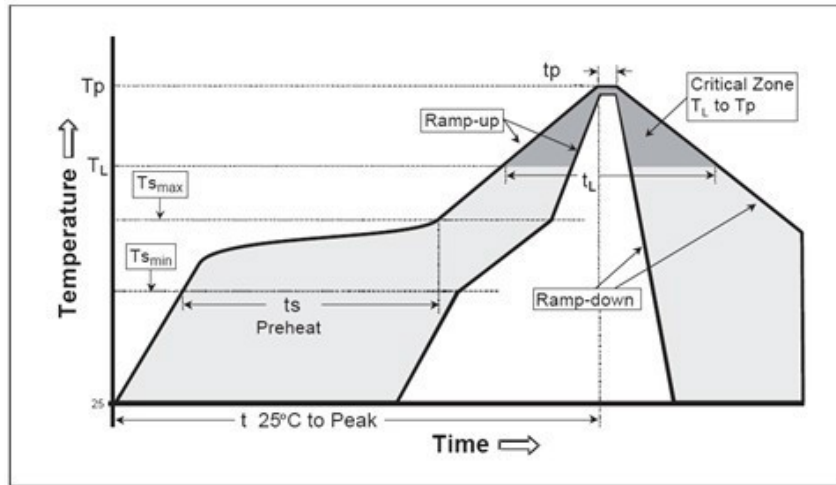


Table 4-4. Pb-Free Process—Package Classification Reflow Temperatures

| Package Thickness | Volume mm ³ < 350 | Volume mm ³ 350– 2000 | Volume mm ³ > 2000 |
|--|------------------------------|----------------------------------|-------------------------------|
| Less than 1.6 mm ¹ | 260 + 0 °C | 260 + 0 °C | 260 + 0 °C |
| 1.6 mm to 2.5 mm ¹ | 260 + 0 °C | 250 + 0 °C | 245 + 0 °C |
| Greater than or equal to 2.5 mm ¹ | 250 + 0 °C | 245 + 0 °C | 245 + 0 °C |

Note:

1. Tolerance: The device manufacturer or supplier should assure process compatibility up to and including the stated classification temperature, meaning that the peak reflow temperature is 0 °C. For example, 260 °C to 0 °C, at the rated MSL value.

Note: Exceeding the ratings that are mentioned in the preceding table might cause damage to the device.

4.4 Reference Documents

- IEEE Std 802.3-2018 Clause 33 Power over Ethernet over 2-Pair and Clause 145 Power over Ethernet
- PD692x0 Communication Protocol User Guide
- AN3361 Designing an IEEE802.3af/at/bt PoE System Based on PD692x0/PD69208
- PD69208T4, PD69204T4, and PD69208M PoE PSE Manager Data Sheet
- PD69210 and PD69220 PoE PSE Controller Data Sheet

5. Ordering Information

The following table lists the part ordering information for PD69200 devices.

Table 5-1. Ordering Information

| Part Number | Package | Packaging Type | Temperature | Part Marking | Tray Marking |
|--|---|----------------|-----------------|--|---|
| PD69200D ¹ - VVVV ² SS ³ | Plastic QFN 5 mm × 5 mm (32 lead) | Tray | −40 °C to 85 °C | Microsemi Logo NXP Logo 69200 ZZZ ⁴ M15M7V ⁵ XXXXXX ⁶ YYYYYY ⁷ GGG ⁴ | PD69200- VVVSS PD-OOOOGabb ⁸ YYWW |
| PD69200D ¹ - VVVV ² SS ³ -TR | Plastic QFN 5 mm × 5 mm (32 lead) | Tape and Reel | −40 °C to 85 °C | Microsemi Logo NXP Logo 69200 ZZZ ⁴ M15M7V ⁵ XXXXXX ⁶ YYYYYY ⁷ GGG ⁴ | — |

Notes:

1. D stands for the detection method set as:
 - C = IEEE802.3 and pre-standard
 - R = IEEE802.3 only
2. VVVV is firmware revision.
3. SS stands for firmware parameters options.
4. Internal Microchip use only
5. NXP short part number
6. NXP mask set, may be 5 or 6 characters (consult NXP for details)
7. NXP manufacture date code, may be 5 or 6 characters (consult NXP for details)
8. Operational part number

The firmware release note has all required information about how to specify the choice of VVVV and SS. Find the Firmware Release Notes in the [Microchip Software Libraries](#), and register to My Microchip account to access the release notes.

Note: The package meets RoHS, Pb-free of the European Council to minimize the environmental impact of electrical equipment.

Note: Initial burning of controller's firmware is performed in the factory. Firmware upgrades can be performed by users using the communication interface. For more information, see TN-140 (Catalog Number: 06-0024-081).

6. Revision History

| Revision | Date | Description |
|----------|---------|---|
| B | 02/2022 | <ul style="list-style-type: none">• Updated Figure 1. Typical PoE Application and Figure 3-1. PD69200 Pin Diagram.• Updated Ordering Information. |
| A | 03/2020 | <p>This is the initial issue of this document.</p> <p>The PD69200 PoE PSE Controller was previously described in the following documents:</p> <ul style="list-style-type: none">• PD69208T4 and PD69200 Datasheet - Revision 6, September 2019, Document Number PD-000303603• PD69204T4 and PD69200 Datasheet - Revision 6, September 2019, Document Number PD-000303601• PD69208M and PD69200 Datasheet - Revision 6, September 2019, Document Number PD-000303451 |

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