

# Welcome!

# Texas Instruments New Product Update

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# **AUTOMOTIVE USB PD CHARGING: SOLVING CHALLENGES WITH THE NEW, FULLY-INTEGRATED TPS25772/762-Q1 USB TYPE-C<sup>®</sup> & POWER DELIVERY SOLUTION**

New product  
update

Zack Albus  
- Applications manager

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# Agenda

- USB PD charging in automotive
- Product overview
- Designing automotive charging solutions
- Available resources and getting started

# USB Type-C<sup>®</sup> PD technology overview



## What is USB Type-C<sup>®</sup>/PD?

USB Type-C<sup>®</sup>/PD (Power Delivery) is an expanding interface providing scalability for power and signaling, enabling a reversible-plug connector and is specification-driven by the [USB-IF](#)

## Where is USB Type-C<sup>®</sup>/PD?



## Why now?

- A single USB Type-C<sup>®</sup> connector can deliver functions that several connectors provide today in everyday electronic products
- USB PD can support up to 240 W across a wide  $V_{BUS}$  range versus standard USB Type-C<sup>®</sup> at 15 W
- USB PD enables increasing demand of video and high data rates through alternate modes

# USB PD charging in automotive

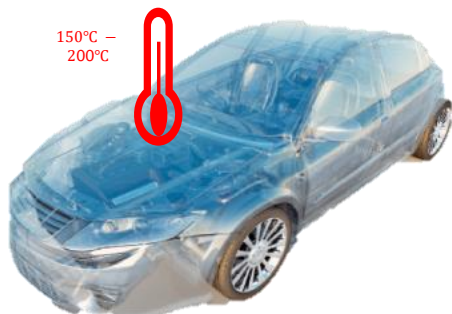
## Common design considerations

- Number of ports, location
- Charging performance, data support
- Solution footprint and cost
- System compliance
- Use-case flexibility

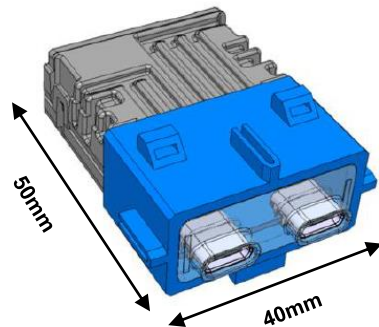


# Automotive USB charging design challenges

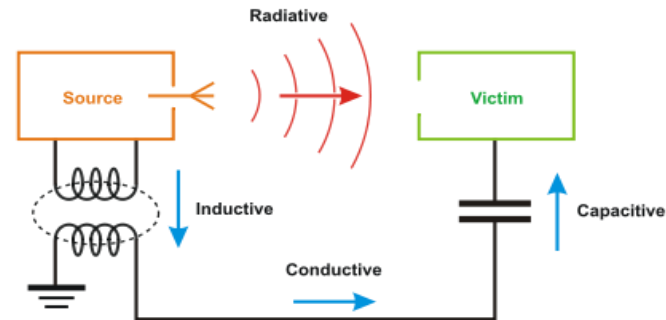
## Thermal management



## Form-factor, air flow



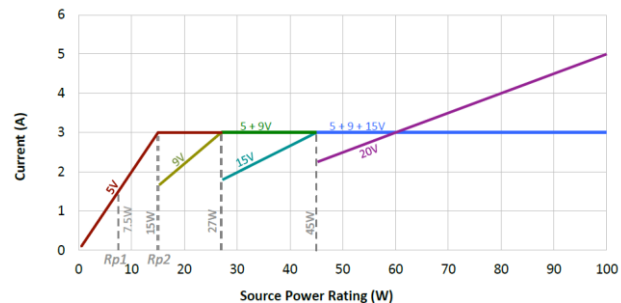
## Electromagnetic compatibility - EMC



## Power charging compatibility



## Increasing power density

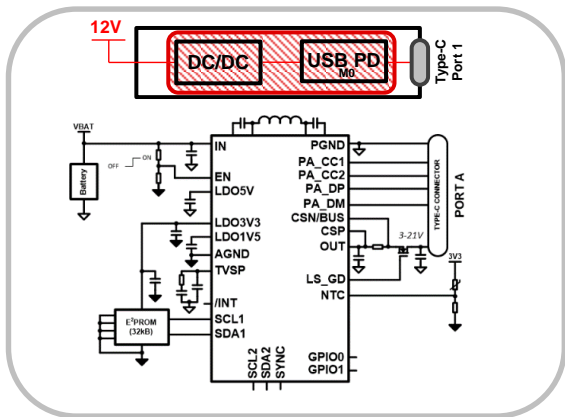


# TPS25762/772-Q1 65-W buck-boost converter with single, dual-port USB Power Delivery and legacy BC1.2 support

## Features

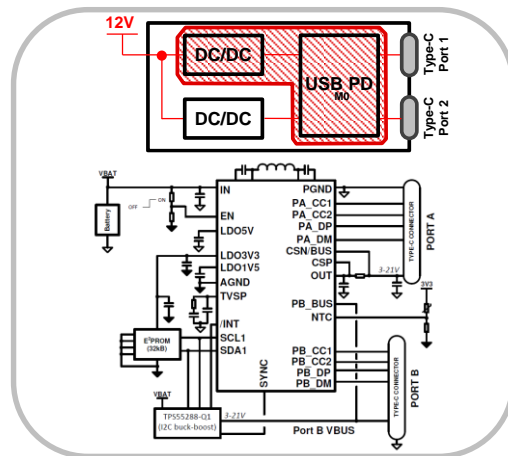
- Input voltage: **5.5-V to 18-V operating** (5.5-V to 40-V tolerance)
- **USB PD** controller with **PPS**
  - $V_{BUS}$  output: 3 V to 21 V with  $\pm 20$ -mV step size
  - $I_{BUS}$  output:  $\pm 50$ -mA current limit step size
- Integrated buck-boost converter supporting up to **65 W**
- FPWM and spread spectrum (300/400/450 kHz)
- Configurable  $V_{BUS}$  cable droop compensation (internal)
- Integrated  $V_{CONN}$  support
- **High efficiency:**  $T_A = 25\text{ }^\circ\text{C}$ ,  $V_{IN} = 12\text{ V}$ , Load = 20V/3A, Effic. = 95%.
- Fast charge: USB PD(PPS), BC1.2, Divider-3, HVDCP(9V/2A)
- Protection: **OVP, OTSD, CC/DP/DM short to  $V_{BAT}/V_{BUS}$**

Single port  
TPS25762



6-mm x 5-mm QFN  
(29 pin)

Dual port  
TPS25772

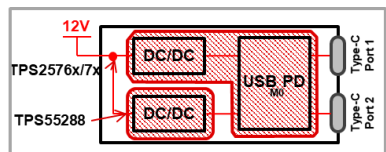


## Benefits

- **Fully integrated USB Type-C® PD & buck-boost converter** solution
- **Smart power management** of dual-charge ports supported with second I<sup>2</sup>C buck-boost converter
- **Smart thermal** management and **engine on/off** management
- **FW upgrade** capability for flexibility, product longevity
- Fast charge support for new PD and legacy devices
- Design robustness with up to 30V **short** protection and cable droop compensation
- Butterfly pin-out design for low EMI

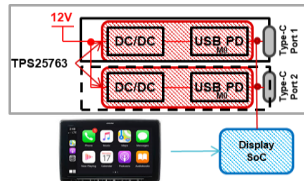
# Cabin USB Power Delivery options

## Rear seat chargers



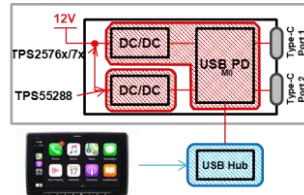
TPS25772-Q1 + TPS55288-Q1

## Rear seat entertainment



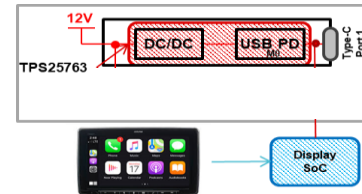
TPS25772-Q1 + TPS55288-Q1  
2 x TPS25763-Q1 (DP alt mode)

## Charge, media or connectivity hub



TPS25772-Q1 + TPS55288-Q1

## Head unit



1 x TPS25762-Q1  
1 x TPS25763-Q1 (DP alt mode)

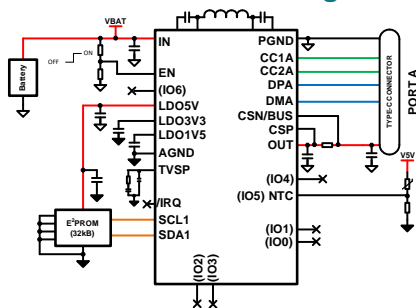




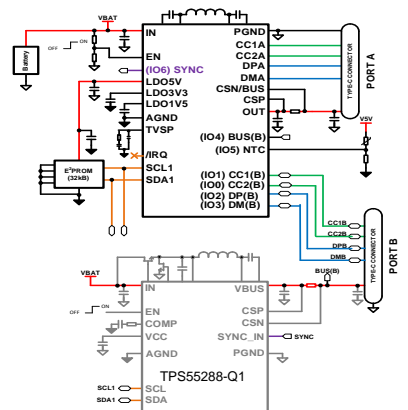
# Designing for automotive

TPS25762-Q1  
single port

USB-C PD charge



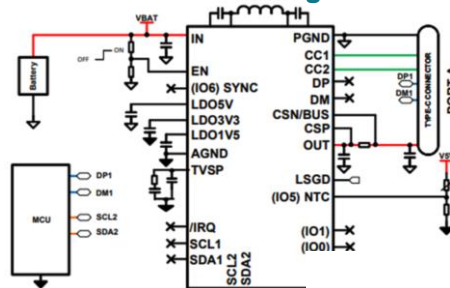
One-port charge



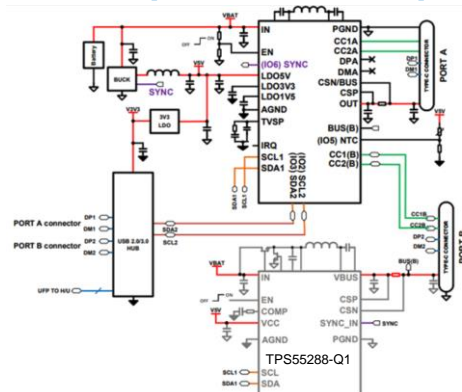
Two-port charge

TPS25772-Q1  
dual port

USB-C PD charge + data



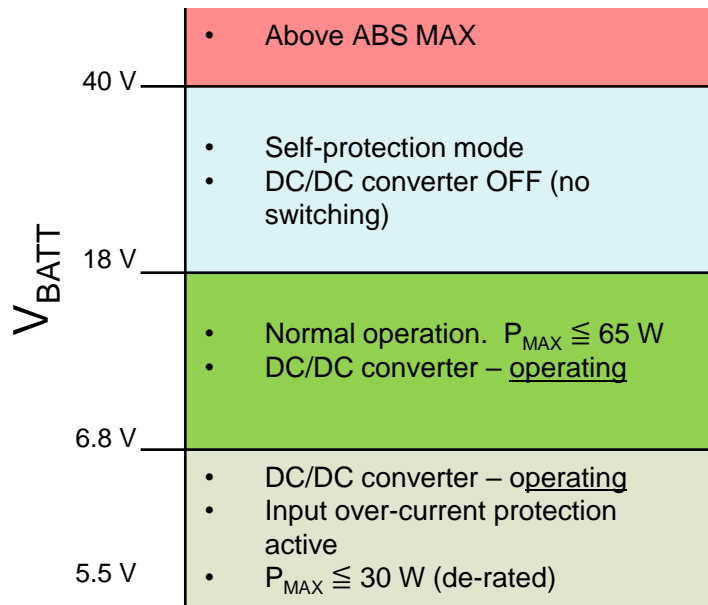
One-port charge + USB2.0 data  
[FW load over I<sup>2</sup>C via MCU]



Two-port charge + USB2.0 data  
[FW load over I<sup>2</sup>C via HUB]

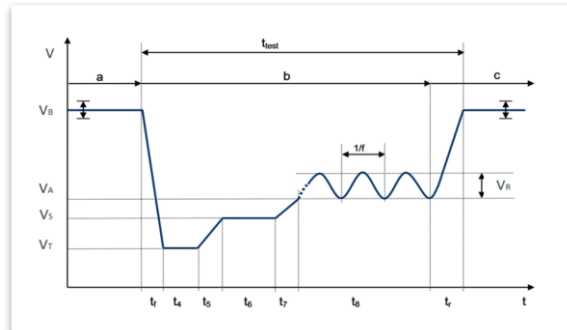
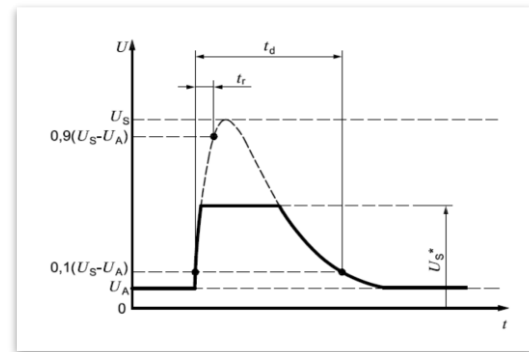
# Automotive battery scenarios

## Operating condition



Safely support load dump

Functionally support warm crank



# Low battery protection scenario

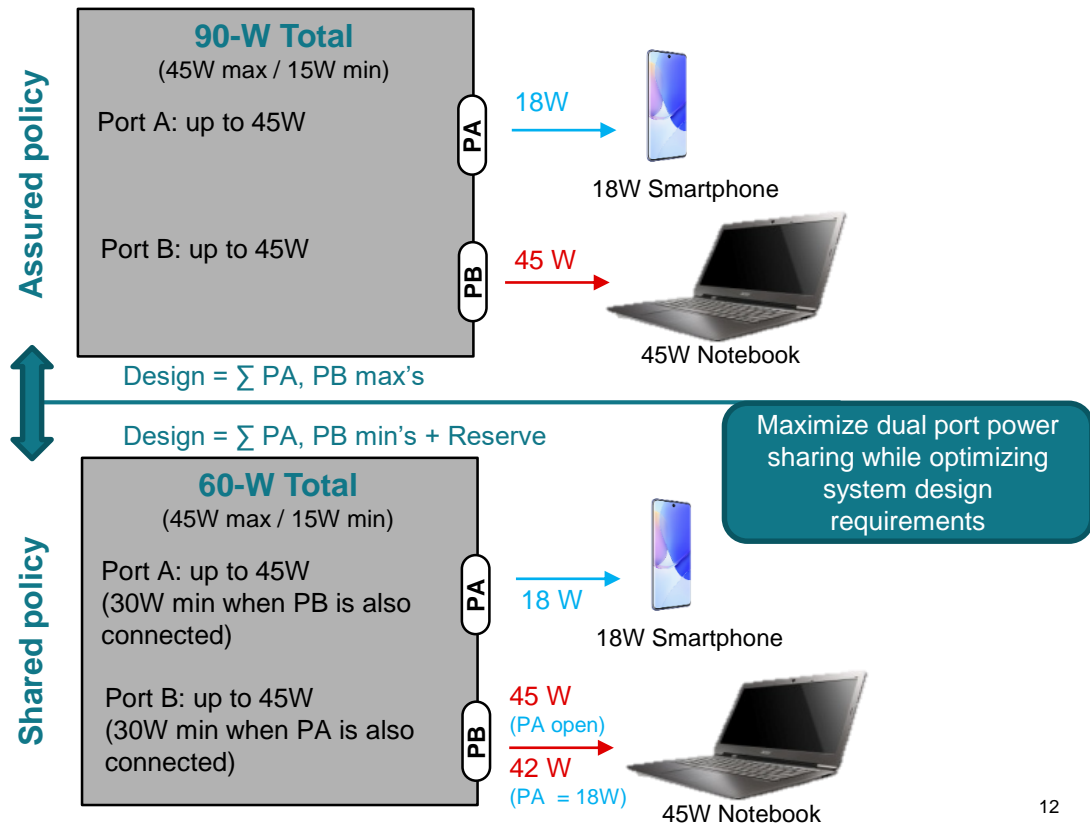


## Example configuration

- Rising / falling supply voltage monitoring
- Programmable  $V_{BATT}(V_{IN})$  power foldback
- Total power foldback to setpoint as defined
- Configurable timeout for engine off, port shutdown

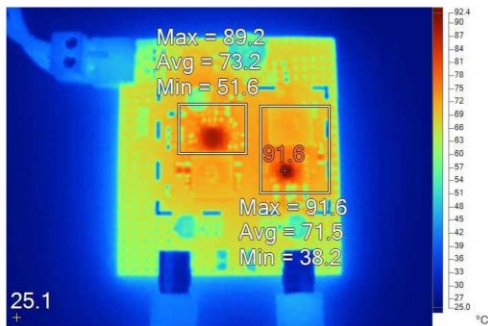
# Source power policy management (SPM)

- Integrated SPM manages multiple ports
- Provides power sharing control across ports based on application requirements
- Configurable parameters:
  - # of ports
  - Total system power
  - Min / Max port power
  - Policy and mode control
  - Power foldback via voltage/temperature

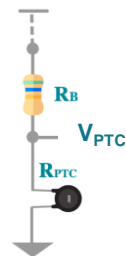
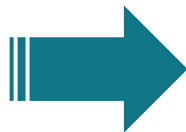


# Flexible thermal management

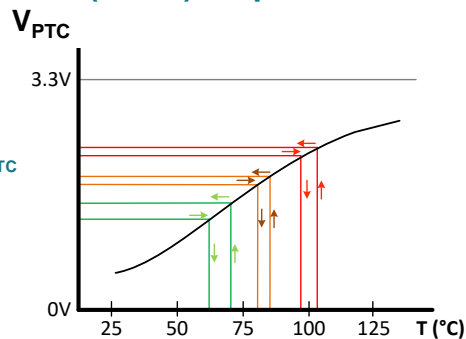
Example: 60-W dual port



60 mm x 65 mm, 4 layer (2 oz: 1,4 / 1 oz: 2,3)



PTC (linear) output characteristic



GUI configurable setpoints and power limits

GUI screenshot showing configurable setpoints and power limits for thermal management. The interface includes a "Thermal Foldback" toggle set to "Enabled" and three tabs: "PRESET1", "PRESET2", and "CUSTOM".

Phase	RISING $V_{TH}$	FALLING $V_{TH}$	TOTAL MAX W
PHASE 1	1.82 V	1.75 V	45.00 W
PHASE 2	1.87 V	1.84 V	30.00 W
PHASE 3	1.92 V	1.88 V	7.50 W

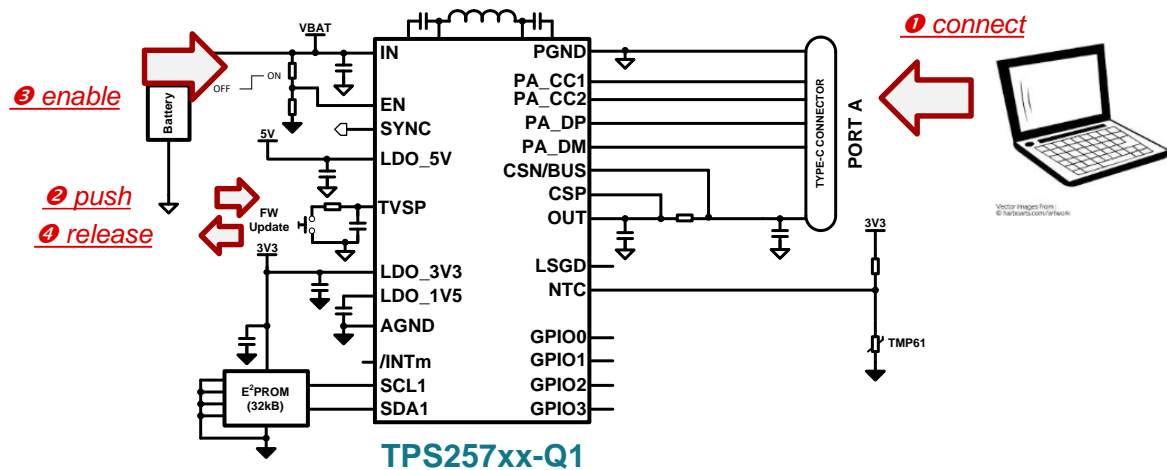
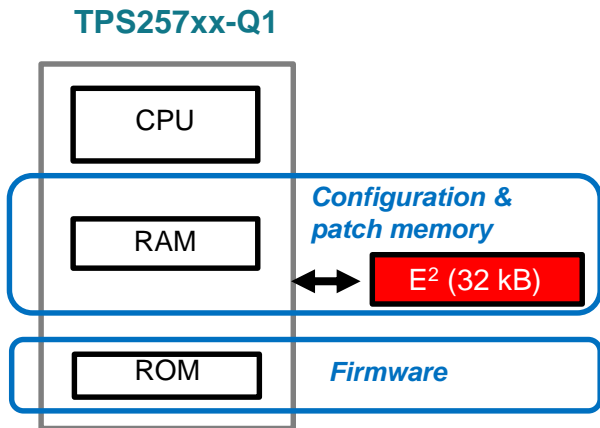
PD Controller Action: Total VBUS Power = 60W

New Source Capabilities lower than normal operation PDO or APDO

Ports Disabled

Max W Phase 1 >= Max W Phase 2 >= Max W Phase 3

# FW update via USB



## FW update flow:

- Connect PC to Port A
- Open GUI SW, modify and update configuration
- TPS257xx-Q1 authenticates FW update
- TPS257xx-Q1 updates EEPROM via I<sup>2</sup>C
- TPS257xx-Q1 error checks FW download
- TPS257xx-Q1 reboots from updated EEPROM

## Benefits:

- Simplified programming in-field (USB port)
- Future interop compatibility
- Evolving USB PD spec compliance
- System configuration changes via FW vs HW

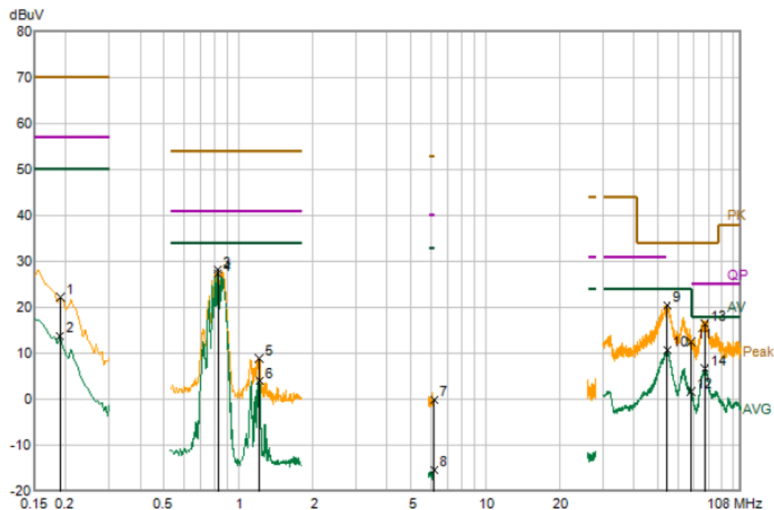
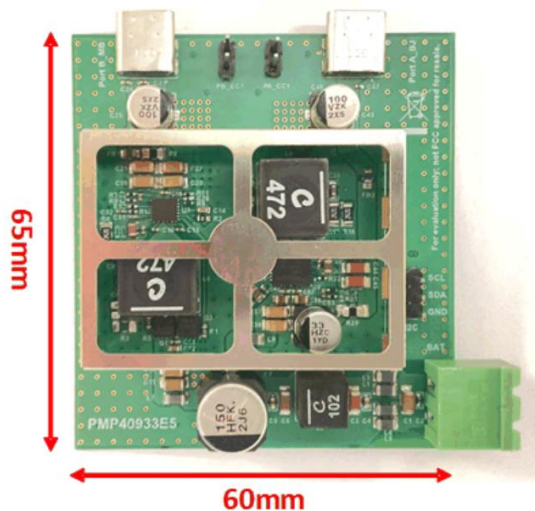
# Application configuration GUI

The image displays a central workflow diagram consisting of four red gears connected by arrows, labeled "Setup", "Config", "Load", and "Monitor". This workflow is overlaid on a collage of screenshots from the application configuration GUI:

- Setup:** A screenshot showing a "Device Connected" status for a "USB Device" with options for "Quick Start" and "Hardware Setup".
- Config:** A screenshot titled "HOW WOULD YOU LIKE TO continue?" with options for "Start Configuration" and "Update Firmware".
- Load:** A screenshot titled "SB PORT A" showing power settings for "Part Power" (MAX POWER: 60.00 W, MIN POWER: 15.00 W) and "VCONN Max Current" (45mA).
- Monitor:** A screenshot titled "BUILD GUI FLASH IMAGE" showing "BASE FIRMWARE IMAGE SELECTION" and "USB ENDPOINT FLASH" options.

# Proven EMI performance: PMP40933

CISPR 25 Class 5, 400-kHz rated 120-W automotive dual USB Type-C<sup>®</sup> Power Delivery charger reference design





# Getting started

Content type	Content title	Link to content
Product folder(s)	TPS25772-Q1 and TPS25762-Q1	<a href="#">Dual port</a> and <a href="#">Single port</a>
Evaluation module(s)	Evaluation module for dual-port USB Type-C® Power Delivery charger	<a href="#">TPS25772Q1EVM-CO-149</a>
	Single port USB Type-C® Power Delivery charger evaluation module	<a href="#">TPS25762Q1EVM</a>
	Evaluation module for dual-port USB Type-C® Power Delivery Media Hub	TPS25772Q1EVM-150
Configuration GUI	Graphical user interface for the TPS257xx-Q1 device family and EVMs	<a href="#">TPS257XX-Q1-GUI</a>
Reference design(s)	CISPR 25 Class 5 400-kHz-rated 120-W Automotive Dual USB Type-C® Power Delivery charger reference design	<a href="#">PMP40933</a>
	CISPR 25 Class 5 400-kHz-rated 60-W automotive Single USB Type-C® Power Delivery charger reference design	Contact TI
Documentation	TPS2576x/TPS2577x Source Power Management	<a href="#">Application note</a>
	TPS2576x-Q1/77x-Q1 Firmware Update	<a href="#">Application note</a>
	TPS257XX-Q1-GUI Configuration Guide	<a href="#">User guide</a>
Test report(s)	TPS25772-Q1 and TPS25762-Q1 charging test report	Contact TI
	TPS25772-Q1 Dual-port USB PD charging power sharing test report	Contact TI

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