

Infiniteon solutions for USB Type-C chargers

Sep 2021



Agenda

- 1 Charger market typical environment
- 2 Infineon offerings and value proposition
- 3 Product highlights
- 4 MOSFET recommendation for chargers

Agenda

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Charger market typical environment

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Infineon offerings and value proposition

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Product highlights

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MOSFET recommendation for chargers

Key drivers behind the charger market evolution

High power

- › Peak power capability needed to charge bigger and bigger batteries faster

Small form factor

- › Makes it easier to carry from A to B
→ improved end-user experience

Unification

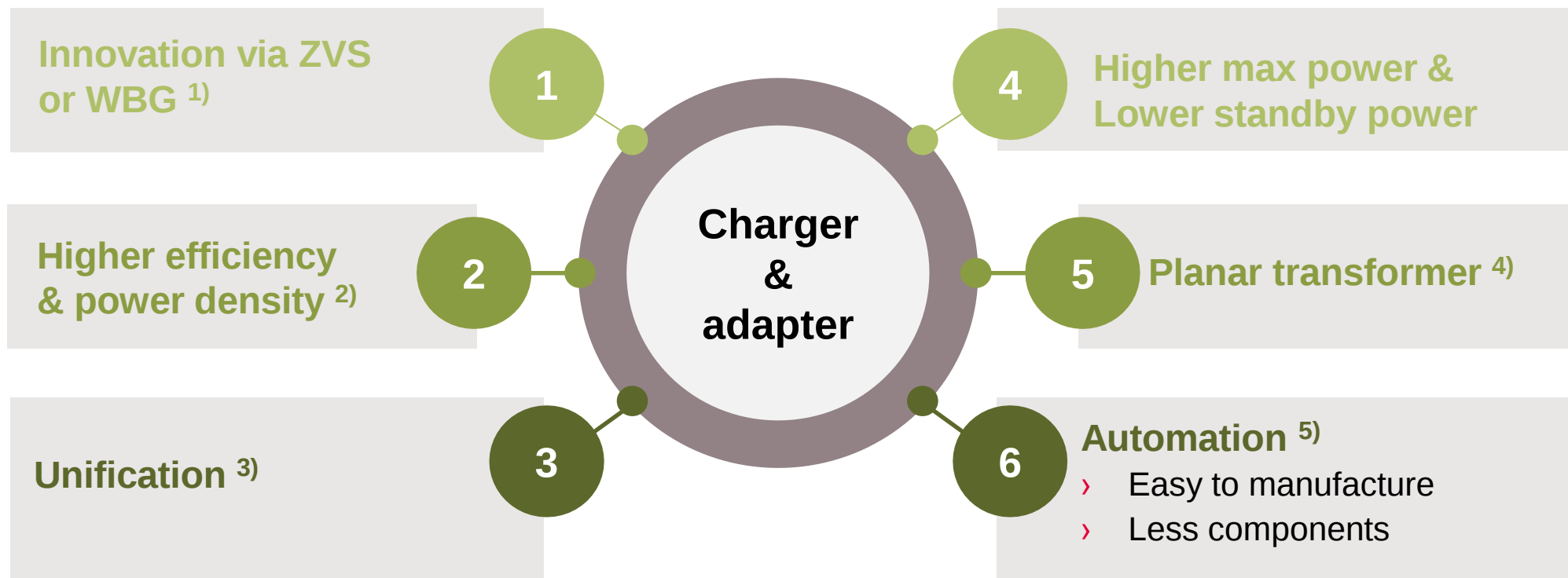
- › One charger for all mobile devices
→ improved end-user experience

Low cost

- › Overall BOM cost is sensitive in consumer oriented applications



Technical trends in chargers & adapters



Remarks:

- 1) ZVS (Zero Voltage Switching) or WBG (wide bandgap) can help to reduce power losses
- 2) Higher efficiency enabling smaller form factor and high power density design play a major role
- 3) Governing policy will require unification of charging standards to save the e-waste and USB-C PD protocol is projected to unify the chargers
- 4) Planar transformer can further shrink form factor, besides, it provides the benefit of consistent performance and high volume production
- 5) Automated assembly can save the production cost and improve the production efficiency leading to the needs of less external components, SMD package, planar transformers, etc.

USB-C: Past, present, and future

2015 onward



Data, video, power over USB-C

USB-C enabled one-cable docking for ultra-sleek, ultra-mobile notebooks, and smart phones

Now



USB-C in every car

Abundance of USB-C ports in every car to fast-charge every passenger's smart phone, tablet, and notebook PC

Next 5 years



USB-C powers everything

USB-C becomes a common DC power source and replaces most conventional power adapters up to 240 W

Moving to a USB-C powered world



Mobile PCs and tablets



Smartphones



USB-C chargers & power adapters



Next: Consumer products

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MOSFET recommendation for chargers

Top 5 reasons to select Infineon as core partner for USB-C PD charger

Customers' benefits

1 High power/density enablement

- › Digital ZVS controller with high-performance MOSFET and CoolGAN™ enables high-efficiency designs
- › High integration(e.g. SR/protocol integration enabled by PAG1S) saves the component counts
- › SMD packages (DPAK, ThinPAK, PQFN, etc.) further shrink PCB sizes

2 Price competitiveness

- › Charger application-oriented portfolios improves cost structure with 12-inch wafer production, smaller package, and right-fit qualification
- › Wide considerations to reduce overall cost
 - Reference designs save design cost and time to market
 - Granular portfolios save value chain management cost
 - High efficiency save thermal management cost

3 Lead time and supply flexibility

- › Dedicated frontend and backend facilities as well as subcons to secure supply
- › Preparations to shorten L/T, e.g. stocks in die bank and warehouse, distribution inventory, etc.

4 Broad range of customer solutions

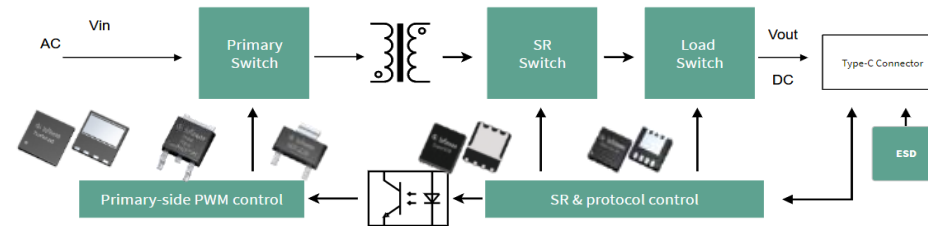
- › Broad coverage from cost-performance oriented solutions to (ultra-)high efficiency topologies
- › Output power from 18 W to ~100 W, multi-port applications
- › Long term roadmap supports continuous customer market positioning

5 Timely support

- › Plenty of ready-to-use reference designs to save design efforts
- › Large field application engineering team and partners across the globe dedicated to provide professional and flexible support for your design

The complete product portfolio for USB-PD chargers & adapters from the one-stop-shop

Primary side		Secondary side	
HV switch	Portfolio	LV/MV switch	Portfolio
> Primary Switch	> 600 V/700 V/800 V CoolMOS™ P7 > 600 V CoolMOS™ PFD7 > 600 V/650 V CoolMOS™ C7	> SR FET	> OptiMOS™ PD 60 V, 80 V, 100 V, 120 V, 150 V > CoolGaN™ 100 V e-mode HEMT*
	> CoolGaN™ 600 V e-mode HEMT > CoolGaN™ IPS 600 V* (single HEMT + driver) > CoolGaN™ IPS 600 V (half-bridge + driver)	> Load Switch	> OptiMOS™ PD 25 V, 30 V
		> ESD	> V _{BUS} 3.3 V, 5 V, 15 V, 20 V

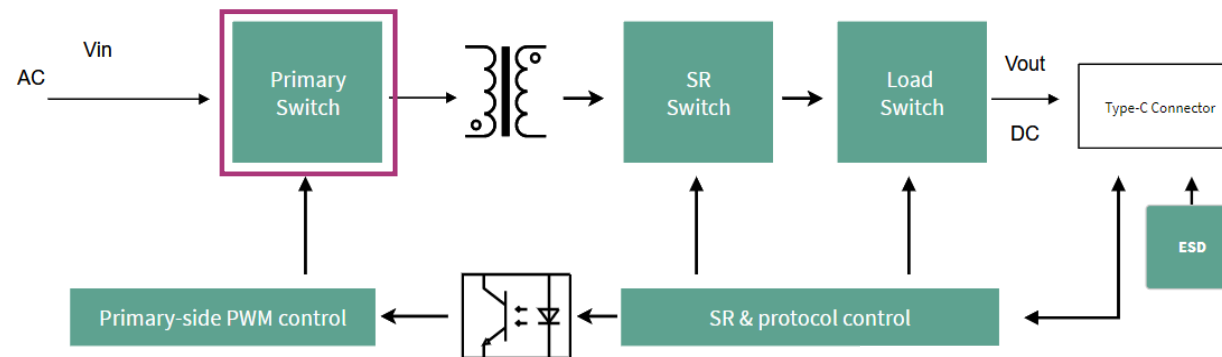


Solution offering	PWM controller	SR controller	PD controller
> 20 W – 65 W QR flyback topology	> EZ-PD™ PAG1P		> EZ-PD™ PAG1S (programmable)
> High Density 45 W – 65 W ZVS flyback topology	> XDP™ digital power XDPS21081	> 3rd party	> EZ-PD™ CCG3PA (programmable)
> Ultrahigh density 65 W Hybrid flyback topology	> XDP™ digital power XDPS2201	> 3rd party	> EZ-PD™ CCG3PA (programmable)
> 45 W/65 W GaN QR flyback topology	> EZ-PD™ PAG1P		> EZ-PD™ PAG1S (programmable)
> Ultra high density > 65 W * Hybrid flyback topology	> 3 rd party PFC + XDP™ digital power XDPS2210 *	> 3rd party	> EZ-PD™ CCG3PA (programmable)
> 65 W Dual Type-C port *	> EZ-PD™ PAG1P		> EZ-PD™ PAG1S + CCG7D (programmable)

* coming soon

The complete product portfolio for USB-PD chargers & adapters from the one-stop-shop - Primary switch

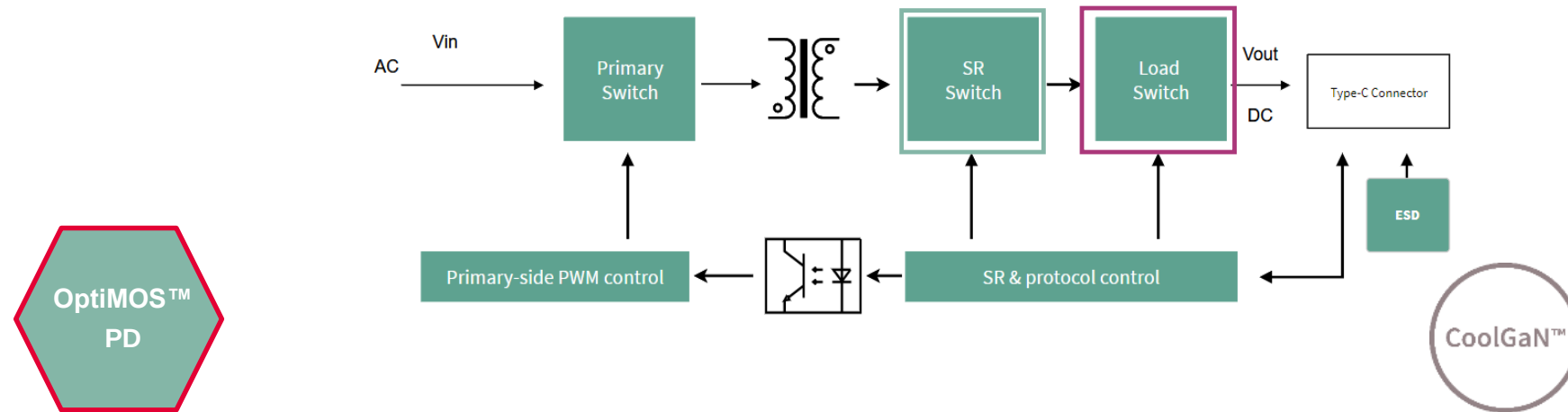
Primary side	
HV switch	Portfolio
> Primary Switch	> 600 V/700 V/800 V CoolMOS™ P7 > 600 V CoolMOS™ PFD7 > 600 V/650 V CoolMOS™ C7
	> CoolGaN™ 600 V e-mode HEMT > CoolGaN™ IPS 600 V* (single HEMT + driver) > CoolGaN™ IPS 600 V (half-bridge + driver)



- > Low power orientated features with balanced pricing performance
- > Close competitor to GaN with low E-passive CoolMOS™ in ThinPAK
- > Broad package portfolio supports different design targets
- > Boosting the efficiency to next level
- > Ease-of-use with integrated function isolated gate drivers
- > Customer configurability

The complete product portfolio for USB-PD chargers & adapters from the one-stop-shop – SR and Load switch

Secondary side	
LV/MV switch	Portfolio
> SR FET	> OptiMOS™ PD 60 V, 80 V, 100 V, 120 V, 150 V > CoolGaN™ 100 V e-mode HEMT*
> Load Switch	> OptiMOS™ PD 25 V, 30 V

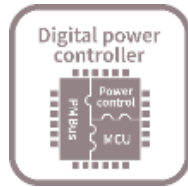


- > Tailored portfolio for USB-PD with balancing cost and performance
- > PQFN 5x6 and 3x3 available to shrink PCB size
- > Outstand high switching performance to boost system efficiency
- > Logic level devices enable low voltage Gate drive performance
- > Improved leadtime and cost saving

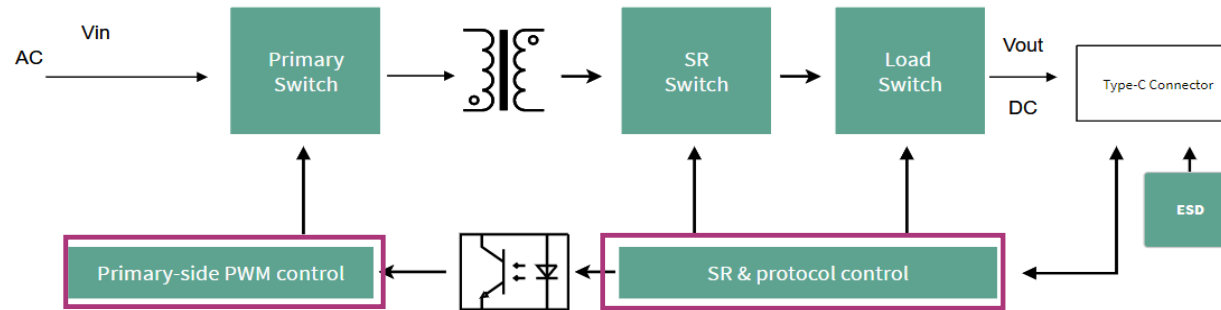
- > Boosting the efficiency to next level
- > High frequency operation without sacrificing efficiency
- > Smaller package

* coming soon

The complete product portfolio for USB-PD chargers & adapters from the one-stop-shop – PWM, SR and Protocol Controllers



- › **Full IC chipset solutions** for PWM, Sync. Rectification and USB-PD
- › Broad coverage from cost-performance oriented solutions to (ultra-)high efficiency topologies; output power up to ~100W
- › Optimized chipset for multi-port applications (coming soon)
- › ZVS control enable the high efficiency designs

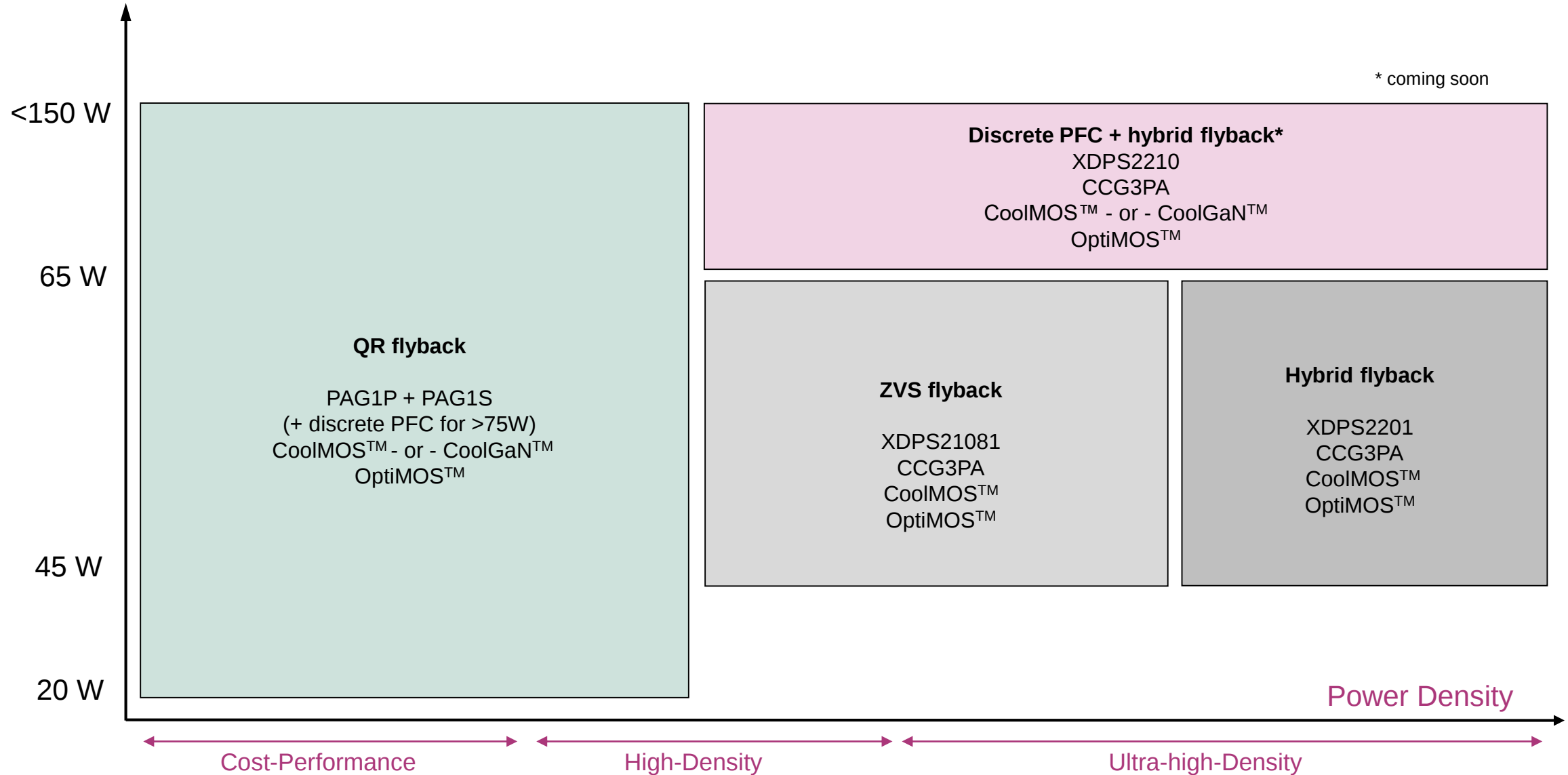


Solution offering	PWM controller	SR controller	PD controller
› 20 W – 65 W QR flyback topology	› EZ-PD™ PAG1P	↔	› EZ-PD™ PAG1S (programmable)
› High Density 45 W – 65 W ZVS flyback topology	› XDP™ digital power XDPS21081	› 3rd party	› EZ-PD™ CCG3PA (programmable)
› Ultrahigh density 65 W Hybrid flyback topology	› XDP™ digital power XDPS2201	› 3rd party	› EZ-PD™ CCG3PA (programmable)
› 45 W/65 W GaN QR flyback topology	› EZ-PD™ PAG1P	↔	› EZ-PD™ PAG1S (programmable)
› Ultrahigh density > 65 W * Hybrid flyback topology	› 3 rd party PFC + XDP™ digital power XDPS2210 *	› 3rd party	› EZ-PD™ series CCG3PA (programmable)
› 65 W Dual Type-C port *	› EZ-PD™ PAG1P		› EZ-PD™ PAG1S + CCG7D (programmable)

* coming soon

High-density chargers & adapters

Product positioning



USB-C charger & adapter - Reference design overview

Power rating (W)	20	33	65	45	65	65	65
Topology	QR Flyback	QR Flyback	QR Flyback	QR Flyback	QR Flyback	ZVS Flyback	Hybrid Flyback
Primary/secondary control	secondary	secondary	secondary	secondary	secondary	primary	primary
PWM IC	PAG1P	PAG1P	PAG1P	PAG1P	PAG1P	XDPS21081	XDPS2201
SR IC	PAG1S	PAG1S	PAG1S	PAG1S	PAG1S	3rd party	3rd party
USB-PD IC						CCG3PA	CCG3PA
High-voltage PWM switch	CoolMOS™	CoolMOS™	CoolMOS™	CoolGaN™	CoolGaN™	CoolMOS™	CoolMOS™
Medium-voltage SR switch	OptiMOS™	OptiMOS™	OptiMOS™	OptiMOS™	OptiMOS™	OptiMOS™	OptiMOS™
V _{BUS} Switch (Load switch)	OptiMOS™	OptiMOS™	OptiMOS™	OptiMOS™	OptiMOS™	OptiMOS™	OptiMOS™
No of output Ports (C=type C)	1C	1C	1C	1C	1C	1C	1C
Uncased size in mm x mm x mm	55 x 36 x 21	60 x 35 x 20	52 x 42 x 22	39 x 35.4 x 30.2	52 x 42 x 22	60 x 28 x 25	37 x 43 x 19
Uncased power density (W/in³)	7.8	12.9	22.16	17.71	22.16	25.4	31
full load efficiency @ 264 V V _{in} (in %)	87.35%	89.86%	90.78%	90.51%	91.82%	92.51%	93.7%
Full load efficiency @ 100 V V _{in} (in%)	88.32%	89.28%	88.62%	91.25%	90.40%	90.74%	91.9%
CoC Tier 2 & DoE Level VI compliance	✓	✓	✓	✓	✓	✓	✓
Standby Power (mW) – 230 V _{AC}	<25	<25	<50	<30	<50	<65	<60
feedback loop	Pulse trf	Pulse trf	Pulse trf	Pulse trf	Pulse trf	Opto cplr	Opto cplr
Programmable USB-PD protocol functionality	✓	✓	✓	✓	✓	✓	✓
USB-PD PPS feature	✓	✓	✓	✓	✓	–	✓

20 W USB-PD/PPS reference design using EZ-PD™ PAG1S+P

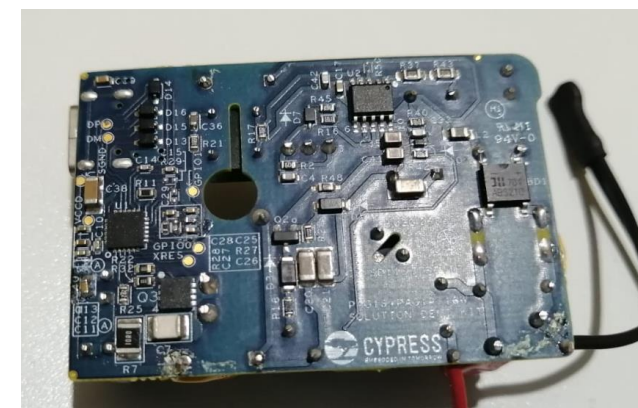
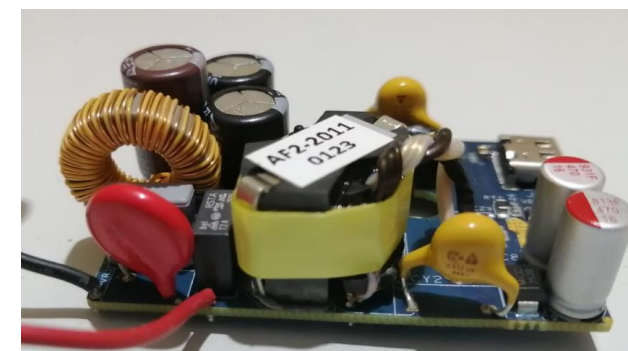
- › The 20 W USB-C PD type C PPS charger demo board uses Infineon's PAG1S and PAG1P controllers along with Infineon MOSFETs. The solution meets the global efficiency standards including DoE Level VI/ CoC Tier 2 and offers a low standby power of <30 mW. Together, PAG1S and PAG1P offer a low BOM cost and allow for high performance PD/ PPS/QC compliant solutions.

Featured Products

Primary PWM controller	CYPAP111A3-10SXQ
Primary MOSFETs	IPS70R900P7SAKMA1
Secondary SR MOSFET	BSZ097N10NS5ATMA1
Load switch	BSZ0902NSATMA1
USB-PD IC	CYPAS111A1-24LQXQ
Transformer	RM7
Bulk capacitor	42 µF

Technical specification

Input voltage	90 V _{AC} ~ 265 V _{AC}
Input frequency	47-63 Hz
Output voltage	Variable V _{OUT} by PD protocol: Fixed PDOS 5 V/3 A, 9 V/2 A, 9 V/2.22 A PPS: 3.3–5.9 V/3 A, 3.3 – 11 V/1.81 A
Output power	20 W
Efficiency	EC COCV5 Tier2 and DOELV6 (Peak efficiency of 89.31%)
Standby power (no load) @230 Vac	<30 mW
Board dimensions	55 x 36 x 21 mm ³ (L x W x H)



Order code: CY-SD1125

33 W USB-PD/PPS reference design using EZ-PD™ PAG1S+P

- › The 33 W USB-PD type C PPS charger demo board comes along with the PAG1S and PAG1P controllers combined with Infineon 's high- and low-voltage MOSFETs. The solution meets the global efficiency standards including DoE Level VI/ CoC Tier 2 and is targeted for USB PD (including PPS), QC power adapters.

Featured products

Primary PWM controller	CYPAP111A3-10SXQ
Primary MOSFETs	IPA70R600P7SXXSA1
Secondary SR MOSFET	BSZ097N10NS5ATMA1
Load switch	BSZ0902NSATMA1
USB-PD+SR IC	CYPAS111A1-24LQXQ
Transformer	RM8
Bulk capacitor	59 uF

Technical specification

Input voltage	90 V _{AC} ~ 265 V _{AC}
Input frequency	47-63 Hz
Output voltage	Variable V _{OUT} by PD protocol: Fixed: 5 V/3 A, 9 V/3 A PPS: 3.3 – 11 V/3 A
Output power	33 W
Efficiency	EC COCV5 Tier2 and DOELV6 (Peak efficiency of 91.22 %)
Standby power (no load) @230 V _{AC}	<30 mW
Board dimensions	60 x 35 x 20 mm ³ (L x W x H)



Order code: CY-SD1121A

65 W USB-PD/PPS reference design using EZ-PD™ PAG1S+P

- › The 65 W USB-PD type C PPS charger reference design features Infineon's PAG1S and PAG1P controllers along with Infineon's high-voltage CoolMOS™ superjunction MOSFET. The solution meets the global efficiency standards including DoE Level VI/ CoC Tier 2 and passes the conducted emission as per EN 55032 B standard.

Featured Products

Primary PWM controller	CYPAP111A3-10SXQ
Primary MOSFET	IPL60R185C7
Secondary SR MOSFET	BSC098N10NS5
VBUS MOSFET	BSZ0902NS
PD+SR IC	CYPAS111A1-24LQXQ
Transformer	RM10
Bulk capacitor	103 uF

Technical specification

Input voltage	90 V _{AC} ~ 265 V _{AC}
Input frequency	47-63 Hz
Output voltage/current	Variable V _{OUT} by PD protocol as: Fixed PDOs: 20 V/3.25 A, 15 V/3 A, 12 V/3 A, 9 V/3 A, 5 V/3 A PPS PDOs : 3.3 – 21 V / 3 A
Output power	65 W
Efficiency	EC COCV5 Tier2 and DOELV6 (peak efficiency of 91.77%)
Input standby power	<50 mW @ no load 230 V _{AC}
Power density (uncased)	22.16 W/in ³
Board dimensions	52 x 42 x 22 mm ³ (L x W x H)



Order code: CY-SD1126

45 W USB-PD/PPS reference design using EZ-PD™ PAG1S+P and CoolGaN™

- › The 45 W USB-PD type C PPS charger reference design features Infineon's PAG1S and PAG1P controllers along with Infineon's high voltage CoolGaN™ 600 V e-mode HEMT. The solution meets the global efficiency standards including DoE Level VI/ CoC Tier 2 and passes the conducted emission as per EN 55032 B standard

Featured products

Primary PWM controller	CYPAP111A3-10SXQ
Primary MOSFET	IGLD60R190D1S 190 mΩ 8X8
Secondary SR MOSFET	BSC160N15NS5ATMA1
VBUS MOSFET	BSZ0902NSATMA1
PD+SR IC	CYPAS111A1-24LQXQ
Transformer	RM8
Bulk capacitor	94 µF

Technical specification

Input voltage	90 V _{AC} ~ 265 V _{AC}
Input frequency	47-63 Hz
Output voltage/current	Variable V _{OUT} by PD protocol as: Fixed PDOs: 20 V/3.25 A, 15 V/3 A, 12 V/3 A, 9 V/3 A, 5 V/3 A PPS PDOs : 3.3 – 21 V / 3 A
Output power	45 W
Efficiency	EC COCV5 Tier2 and DOELV6 (peak efficiency of 91.85%)
Input standby power	<30 mW @ no load 230 V _{AC}
Power density (uncased)	17.71 W/in ³
Board dimensions	39 x 35.4 x 30.2 mm ³ (L x W x H)



Order code: CY-SD1124A

65 W USB-PD/PPS reference design using EZ-PD™ PAG1S+P and CoolGaN™



- › The 65 W USB-PD type-C PPS charger reference design features Infineon's PAG1S and PAG1P controllers along with Infineon's high voltage CoolGaN™ 600 V e-mode HEMT. The solution meets the global efficiency standards including DoE Level VI/ CoC Tier 2 and passes the conducted emission as per EN 55032 B standard

Featured products

Primary PWM controller	CYPAP111A3-10SXQ
Primary MOSFET	IGLD60R190D1S 190 mΩ 8X8
Secondary SR MOSFET	BSC0805LS 100 V 7 mΩ
V _{BUS} MOSFET	BSZ0909LS 30 V 3 mΩ
PD+SR IC	CYPAS111A1-24LQXQ
Transformer	RM10
Bulk capacitor	121 uF

Technical specification

Input voltage	90 V _{AC} ~ 265 V _{AC}
Input frequency	47-63 Hz
Output voltage/current	Variable V _{OUT} by PD protocol as: Fixed PDOs: 20 V/3.25 A, 15 V/3 A, 12 V/3 A, 9 V/3 A, 5 V/3 A PPS PDOs : 3.3 – 21 V / 3 A
Output power	65 W
Efficiency	EC COCV5 Tier2 and DOELV6 (peak efficiency of 92.25%)
Input standby power	<50 mW @ no load 230 V _{AC}
Power density (uncased)	22.16 W/in ³
Board dimensions	52 x 42 x 22 mm ³ (L x W x H)



Order code: CY-SD1126A

65 W USB-PD/PPS reference design using XDPS21081 + CCG3PA

- › This is a 65 W USB-PD type-C charger reference design in a small form factor. The reference design has been developed to demonstrate the performance by meeting various regulatory limits as well as allowing for small form factor designs. It features Infineon's digital ZVS Flyback controller XDPS21081, 600 V CoolMOS™ C7 Super junction MOSFET, OptiMOS™ PD synchronous rectification MOSFET, CCG3PA USB-C Power Delivery port controller, 30 V OptiMOS™ MOSFET which serves as a safety switch and small-signal MOSFET.

Featured products	
Primary PWM controller	XDPS21081
Primary MOSFET	IPL60R185C7
Secondary SR MOSFET	BSC0802LS
ZVS MOSFET	BSL606SN
PD IC	CYPD3174
Output switch	BSZ0910LS
S/R IC	3 rd party
Bulk capacitor	100 μ F

Technical specification	
Input voltage	90 V _{AC} ~ 265 V _{AC}
Input frequency	47~64 Hz
Output voltage/current	Variable V _{out} by PD protocol as: 20 V/3.25 A, 5 V/3 A, 9 V/3 A, 12 V/3 A, 15 V/3 A
Output power	65 W
Efficiency	EC COCV5 Tier2 and DOELV6 (peak efficiency of 93.49%)
Input standby power	<65 mW @ no load
Board dimensions (uncased)	60 x 28 x 25 mm ³ (L x W x H)
Power density (uncased)	25.4 W/in ³



Order code: REF XDPS2108165W1TOBO1

65 W USB-PD/PPS demo design with XDPS2201 + CCG3PA

- › This is a 65 W USB-PD type C PPS charger demo board that uses Infineon XDPS2201 together with two CoolMOS™ superjunction MOSFETs in a half-bridge configuration. It demonstrates high power density and high efficiency with both fixed and PPS output in an ultra-compact form factor supporting up to 65W.
- › It features Infineon's digital hybrid Flyback controller XDPS2201, dual 600 V CoolMOS™ C7 Superjunction MOSFET, OptiMOS™ PD synchronous-rectification MOSFET, EZ-PD™ CCG3PA USB-C power delivery port controller and OptiMOS™ MOSFET which serves as a safety switch.

Featured products	
Primary PWM controller	XDPS2201
Primary MOSFETs	IPD60R180C7, IPP60R180C7
Secondary SR MOSFET	BSC093N15NS5
Load switch	BSZ086P03NS3
USB-PD IC	CYPD3174-24
Transformer	RM8
Bulk capacitor	100 uF

Technical specification	
Input voltage	90 V _{AC} ~ 265 V _{AC}
Input frequency	50/64 Hz
Output voltage/current	Variable V _{out} by PD protocol: 5 V, 9 V, 12 V, 15 V, 20 V & PPS: 5-20 V
Output power	65 W
Efficiency	@230 V _{AC} full power: 93.8%
Input standby power	<0.1 W
Board dimensions (uncased)	37 x 43 x 19 mm ³ (L x W x H)
Power density (uncased)	31 W/in ³



Order code: DEMOXDPS220165W1TOBO1

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Infineon offerings and value proposition

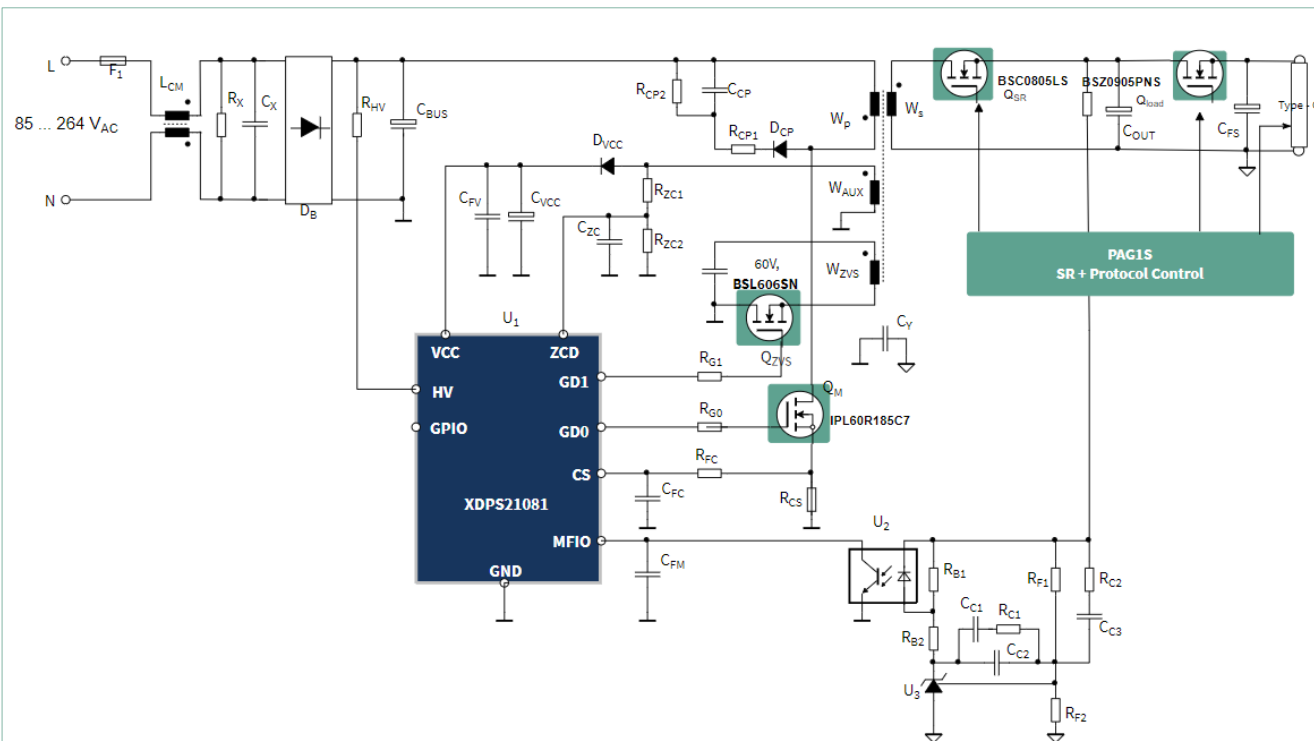
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Product highlights

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MOSFET recommendation for chargers

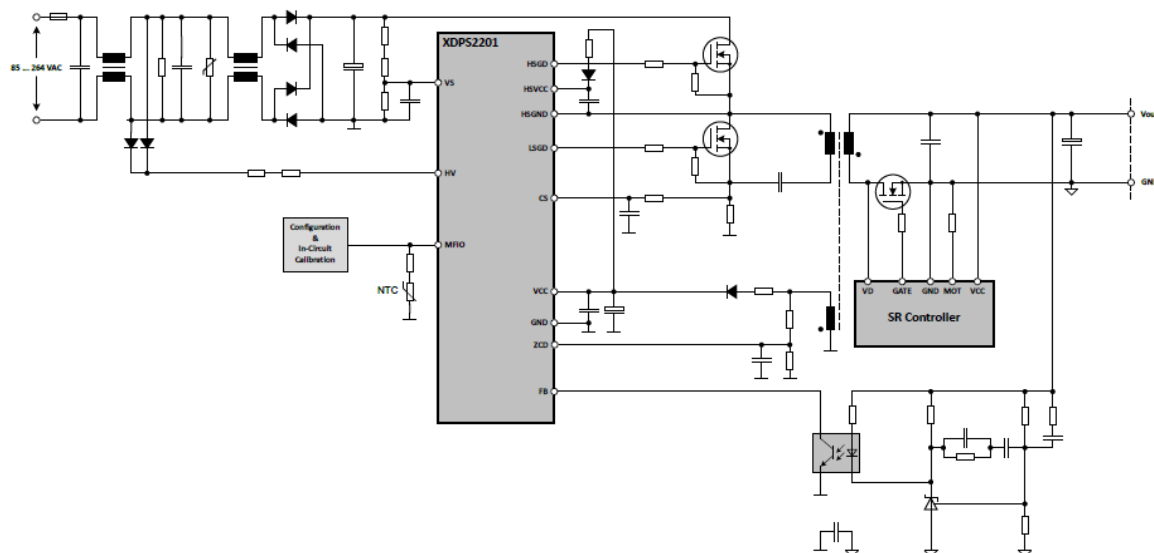
Highlights



- › High switching frequency up to 140 kHz
- › High efficiency with QR mode zero voltage switching and frequency reduction
- › Adaptive ZVS pulse control
- › Optimized frequency law to support higher efficiency at variable V_{out} 5~20 V as well as light-medium load
- › Fast dynamic response with skip cycle burst mode
- › CCM avoidance to ease of SR design
- › Package
 - 12 SOIC (16 SOIC body)

XDP™ digital power XDPS2201 - Digital multi-mode hybrid flyback IC

System / application overview



Highlights

- › Integrated 600 V startup cell and high-/low-side MOSFET driver
- › Multi-mode operation for optimized efficiency over line/load/Vout conditions
 - ZVS in all conditions
 - CRM* for best maximum efficiency
 - ZV-RVS** for light-load operation
 - Active burst mode for very light-load and standby
- › Support of USB-PD variable Vout applications
- › Frequency Jitter for improved EMI
- › Highly flexible IC parameters to meet specific system requirement – configurable via UART interface
- › High system robustness through comprehensive set of IC protections
 - Reported by pin-toggling
- › Package
 - 14 SOIC (16 SOIC body)

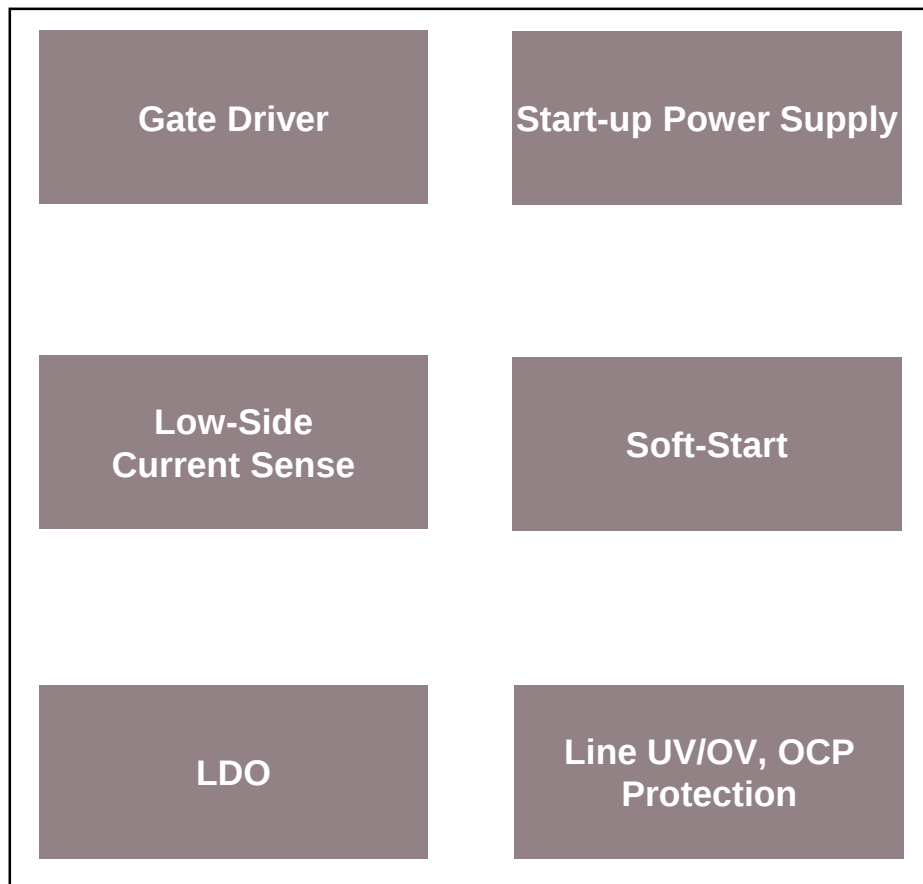
* CRM: Continuous Resonant Mode

** ZV-RVS: Zero Voltage Resonant Valley Switching

EZ-PD™ PAG1P - USB-C power delivery primary start-up controller

System / application overview

PAG1P: USB-C Power Delivery Primary Gate Driver



Highlights

- › Works across universal AC mains input 90 V_{AC} to 265 V_{AC}
- › Operates with PWM inputs from a secondary-side controller
- › Low-side gate driver to drive primary FET (1-A source)
- › Soft-start with duty-cycle clamping
- › Integrates high-voltage start-up and shunt regulator
- › Line undervoltage and overvoltage protection
- › Overcurrent protection against load short-circuit
- › Operates over a temperature range of -40 °C to 105 °C
- › Package
 - 10 SOIC (4.9 x 3.9 mm²)

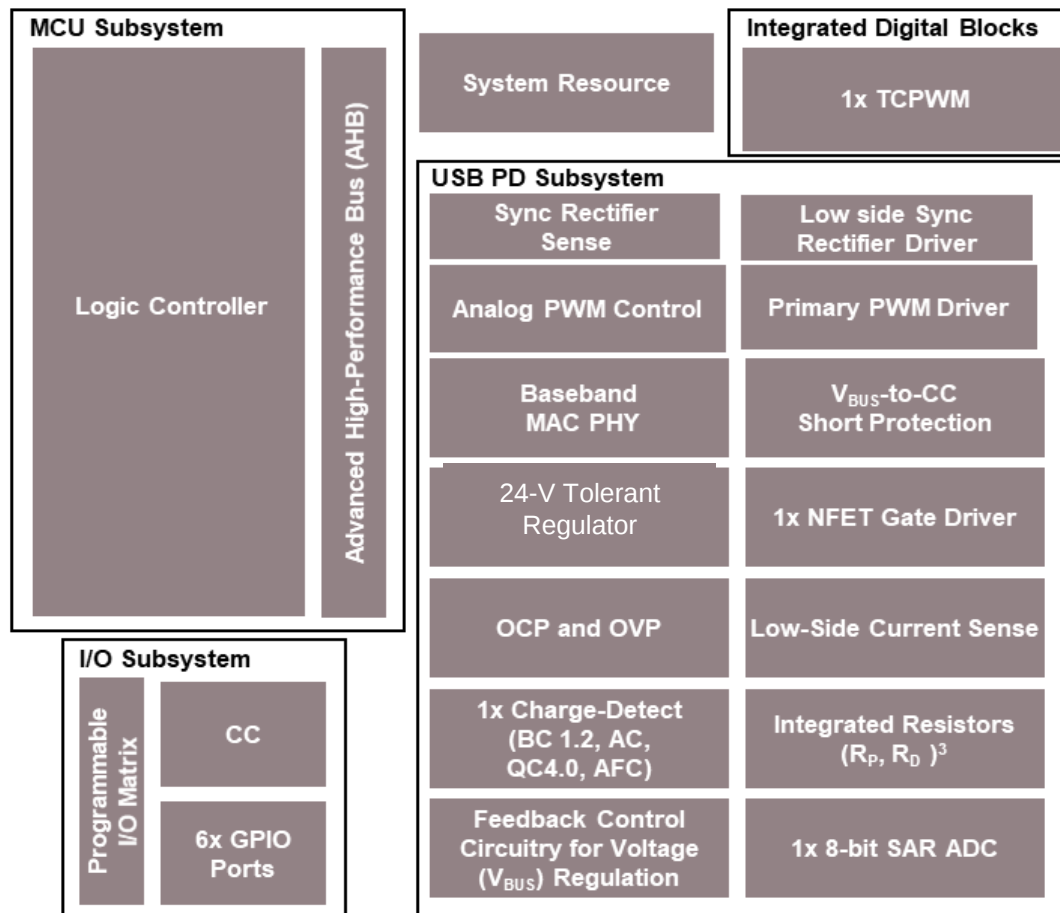
* CRM: Continuous Resonant Mode

** ZV-RVS: Zero Voltage Resonant Valley Switching

EZ-PD™ PAG1S - USB-C power delivery secondary-side controller

System / application overview

PAG1S: USB-C Power Delivery Secondary Controller

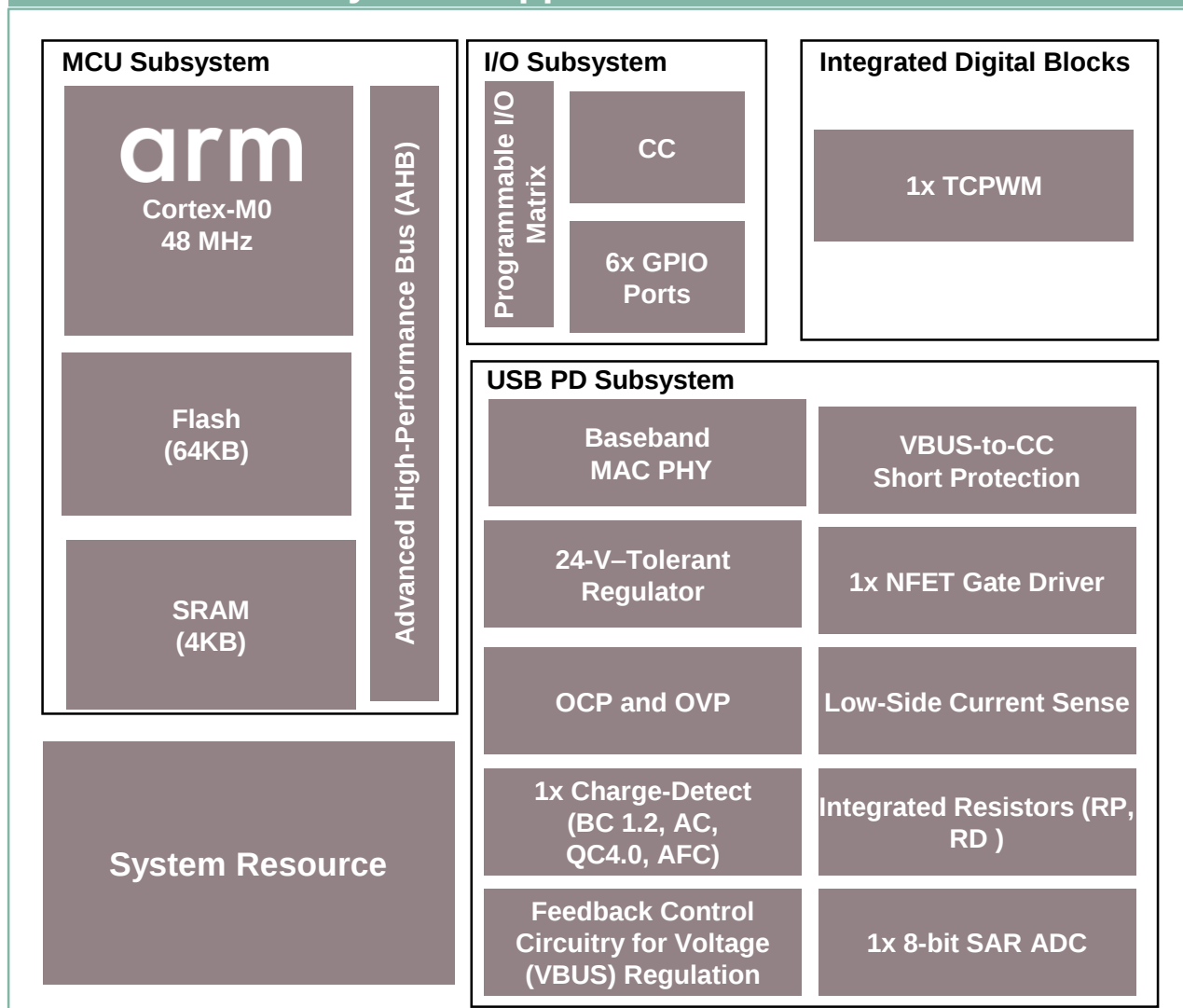


Highlights

- › PPS/PD3.0/QC4.0 integrated flyback controller for chargers/adapters
- › Works with both primary side-controlled and secondary-side-controlled flyback designs
- › Integrated secondary-side regulation, synchronous rectifier, and charging port controller offering a single-chip secondary-side controller
- › Supports Quasi-Resonant (QR)/Critical Conduction (CrCM), valley switching, discontinuous conduction (DCM), and Burst Modes
- › Integrated digital blocks
 - One timer/counter/pulse-width modulator (TCPWM) block, 6x GPIOs
- › Integrated analog blocks
 - Integrated 2xVBUS discharge FETs and a NFET gate driver to drive the load switch
 - Low-side current sense¹ capable of detecting 100-mA change
- › Package
 - 24 QFN (16 mm²)

EZ-PD™ CCG3PA-NFET - Plug and play USB-C PD controller

System / application overview

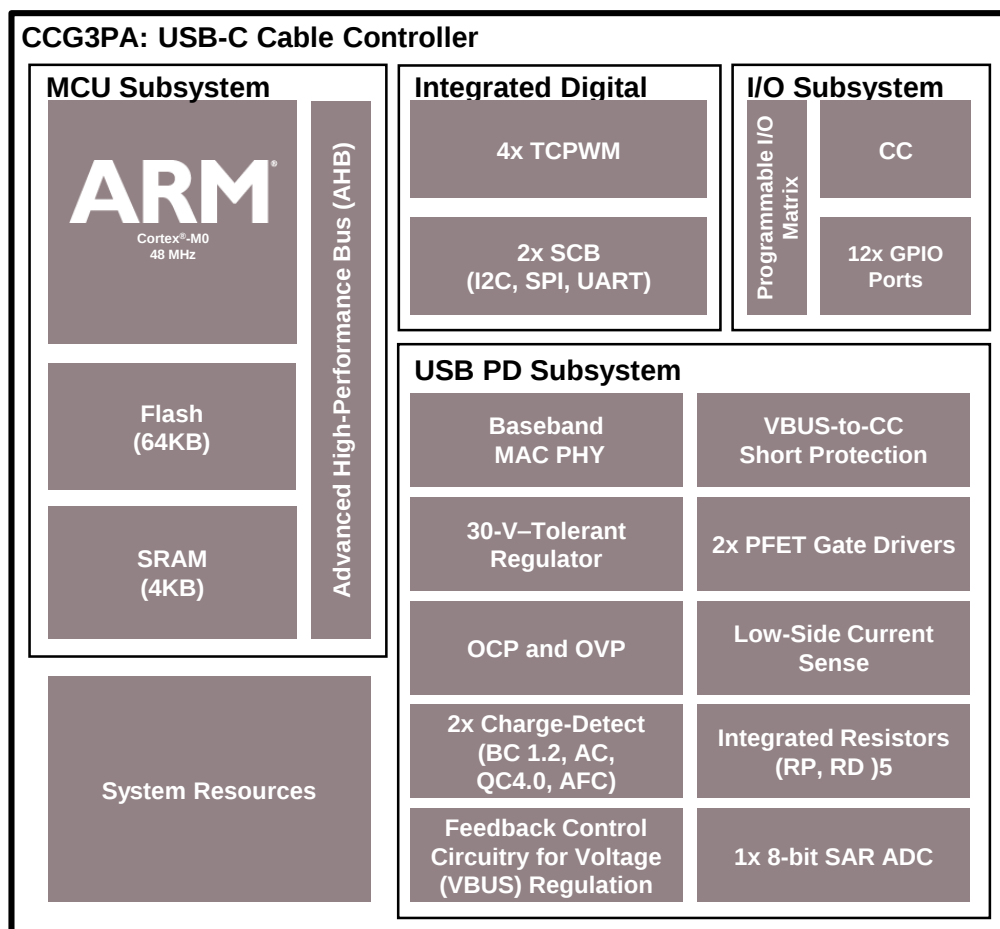


Highlights

- › USB-C PD Controller, PD 3.0 Transceiver, and Qualcomm QC 4.0
 - VBUS-to-CC Short Protection
 - EZ-PD Config Utility to configure customer-specific parameters
 - Integrated high-voltage 24-V-tolerant LDO to power CCG3PA-NFET
- › Integrated Digital Blocks
 - One timer/counter/pulse-width modulator (TCPWM) block, 6x GPIOs
- › Integrated Analog Blocks
 - Configurable V_{BUS} overvoltage protection (OVP), overcurrent (OCP) protection, undervoltage protection (UVP), and short-circuit protection (SCP)
 - Integrated 2x V_{BUS} discharge FETs and a NFET gate driver to drive the load switch
 - Low-side current sense¹ capable of detecting 100-mA change
 - One legacy charge-detect block (BC 1.2, Apple Charging 2.4A, QC 4.0, and Samsung AFC²)
- › Arm® Cortex®-M0 with MCU Subsystem and 64KB Flash
- › High-Voltage Operation
 - High-voltage (3–24 V, 24-V maximum) V_{BUS} voltage inputs
- › Package
 - 24 QFN (16 mm²)

EZ-PD™ CCG3PA - USB-C and power delivery port controller

System / application overview

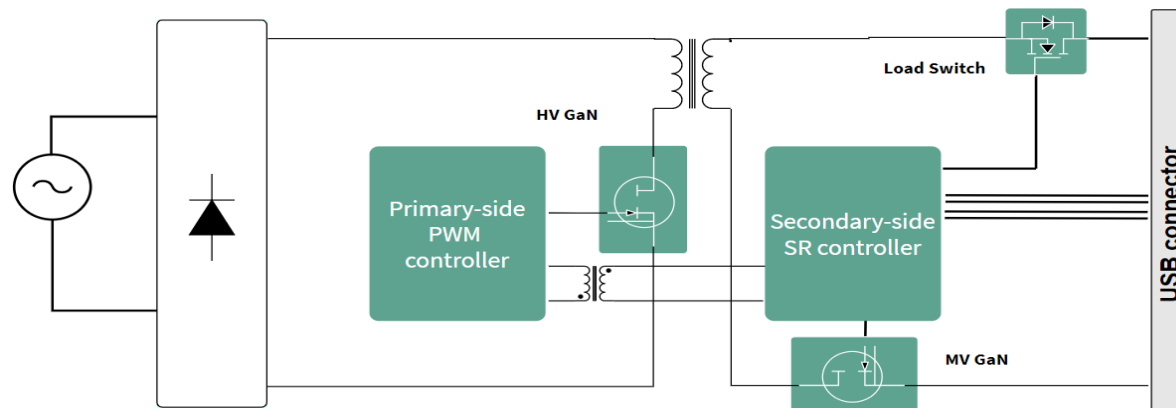


Highlights

- › USB-C PD Controller, PD 3.0 Transceiver, and Qualcomm QC 4.0
 - VBUS-to-CC Short Protection
 - EZ-PD Config Utility to configure customer-specific parameters
 - Integrated high-voltage 30-V-tolerant LDO to power CCG3PA
- › Integrated Digital Blocks
 - Four timer/counter/pulse-width modulator (TCPWM) blocks, 12x GPIOs
 - Two serial communication blocks (SCBs) for configurable master/slave I²C, SPI or UART
- › Integrated Analog Blocks
 - Configurable V_{BUS} overvoltage protection (OVP), overcurrent (OCP) protection, undervoltage protection (UVP), and short-circuit protection (SCP)
 - Integrated 2x V_{BUS} discharge FETs and a PFET gate driver to drive the load switch
 - Low-side current sense capable of detecting 100-mA change
 - Two legacy charge-detect block (BC 1.2, Apple Charging 2.4A, QC 4.0, and Samsung AFC²)
- › Arm® Cortex®-M0 with MCU Subsystem and 64KB Flash
- › High-Voltage Operation
 - High-voltage (3–30 V, 30-V maximum) V_{BUS} voltage inputs
- › Package
 - 24 QFN (16 mm²), 16 SOIC

GaN offerings for USB-C chargers & adapters

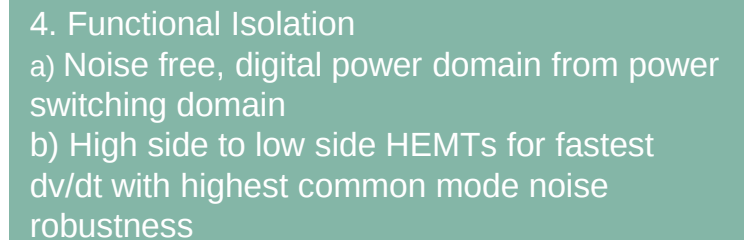
- › Gallium nitride (GaN) offers fundamental advantages over silicon. In particular, the higher critical electrical field makes it very attractive for power semiconductor devices with outstanding specific dynamic on-state resistance and smaller capacitances compared to silicon MOSFETs, which makes GaN HEMTs great for high speed switching. Not only because of the resulting power savings and total system cost reduction, it also allows a higher operating frequency, improves the power density as well as the overall system efficiency.



Product	Part number	Package
CoolGaN™ 600 V e-mode HEMT	IGLD60R190D1S	PG-LSON-8-1 (DFN 8x8)
CoolGaN™ 600 V Integrated Power Stage (driver + single HEMT*)	IGI60F0014A1L	PG-LIQFN-21-1 (QFN 8x8)
CoolGaN™ 600 V Integrated Power Stage (driver + half-bridge HEMT)	IGI60F1414A1L	PG-TIQFN-28-1 (QFN 8x8)
CoolGaN™ 100V e-mode HEMT *	IQC0800NLS	PG-VSON-6-3 (PQFN 3x5)

* coming soon

3. Gate Drive configurability of dv/dt of HEMT



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CoolMOS™ 7 tailored for Chargers & Adapters

Smartphone charger

Tablet charger

CoolMOS™ SJ MOSFET technology

- › Suitable for flyback topologies and DCM PFC*
- › Target application: low power SMPS

*excluding half- or full-bridge configurations

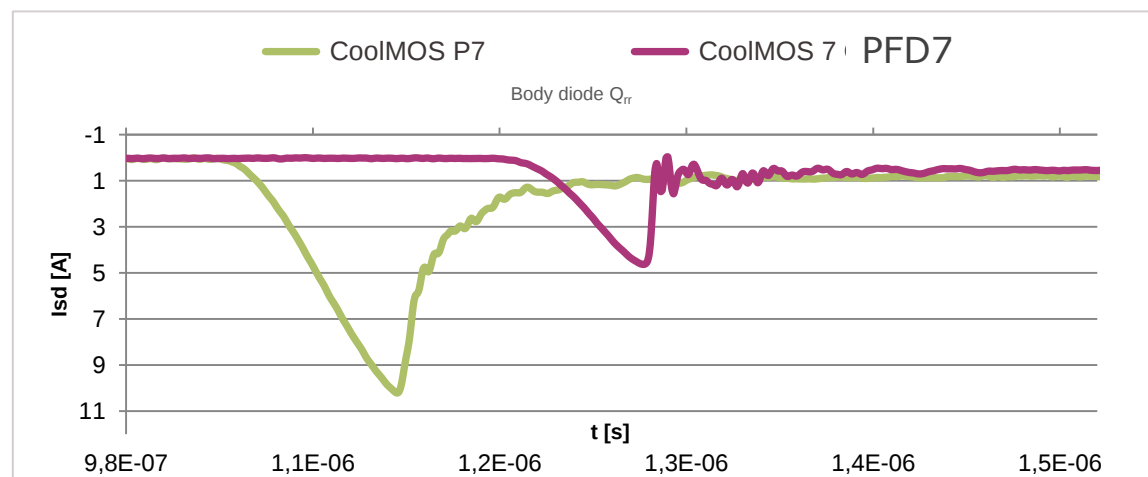
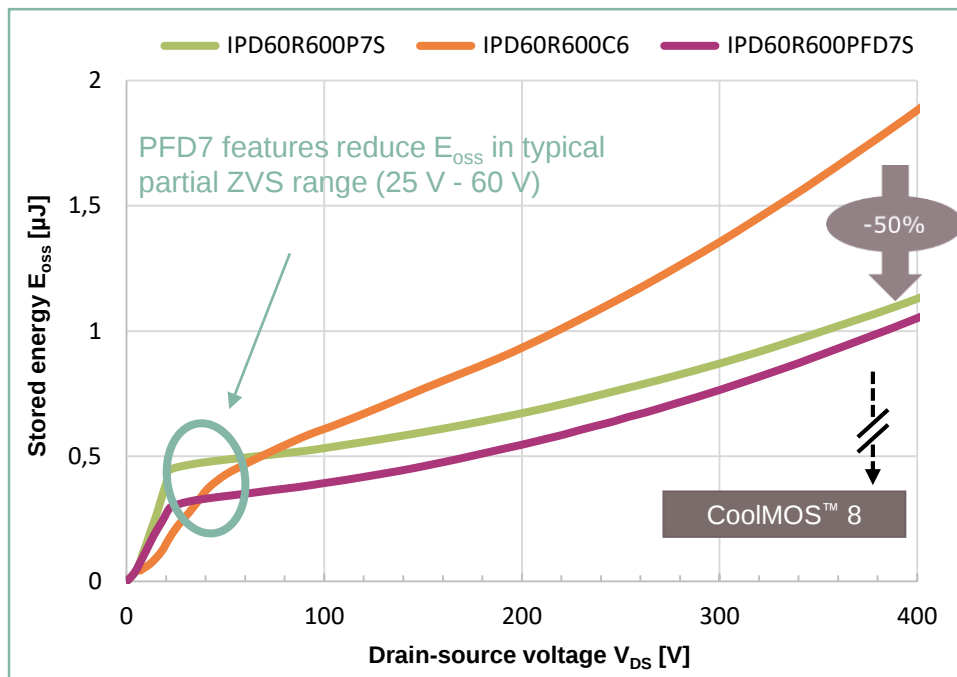
Notebook adapter

TV adapter

Corner stones of CoolMOS™ 7 Superjunction MOSFET technology:

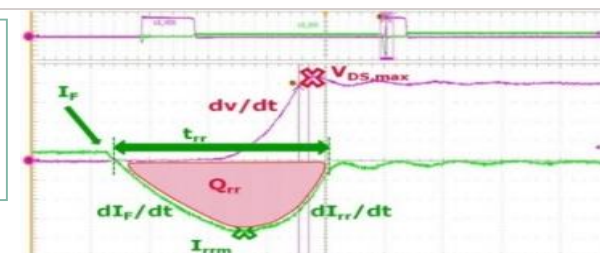
- › **Cost competitiveness** compared to similar competitor technologies
- › Supporting **increased switching frequency** in order to reduce magnetics
- › **Best fit for target applications:**
 - Standard grade to optimize the cost
 - Proven CoolMOS™ performance (like high efficiency, high reliability, etc.) to save thermal management cost
 - 300mm wafer diameter production allows for high volume

600 V CoolMOS™ PFD7 with optimized switching technology parameters



CoolMOS™ PFD7:

Further >20% E_{oss} reduction compared to CoolMOS™ P7 at partial ZVS turn-on voltages

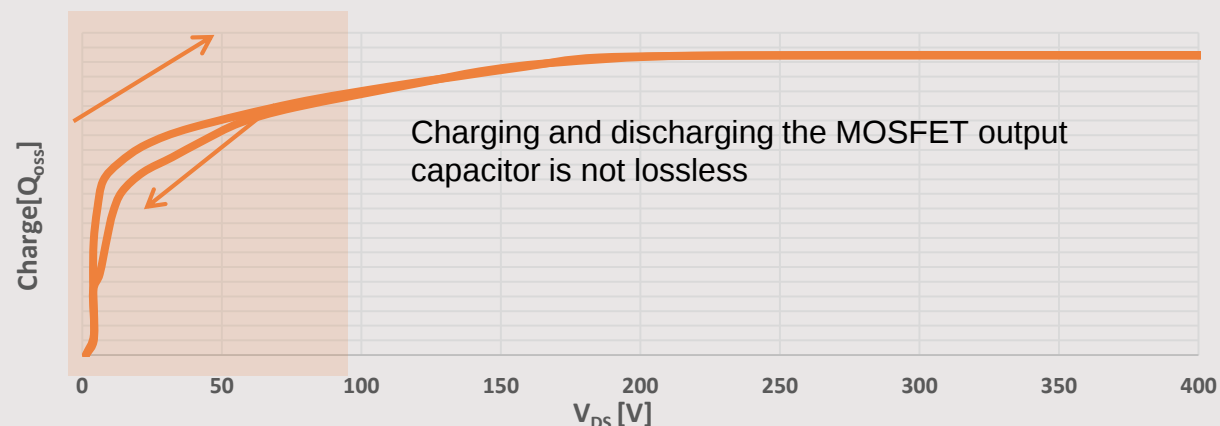


600 V CoolMOS™ PFD7 with optimized switching - technology corner stones:

- > Similar thermal performance to P7
- > Integrated Zener diode for ESD protection
- > Better efficiency in hard & soft-switching applications (reduced E_{oss} & Q_{oss})
- > Lower gate driving losses (Q_g , Q_{gd})
- > JEDEC compliance
- > Fast body diode with ultralow Q_{rr}
- > Reduces stress on device while the body diode is not fully recovered
- > Provides an extra safety margin for repetitive hard commutation and reduces design-in effort

600 V CoolMOS™ PFD7 with optimized switching technology parameters

Q_{oss} charge/discharge



C_{oss} hysteresis loss mathematical description

$$E_{dissipated} = \int_0^{V_{DS}} C_{oss(V_{DS})} \cdot V_{DS} \cdot dV_{DS} - \int_{V_{DS}}^0 C_{oss(V_{DS})} \cdot V_{DS} \cdot dV_{DS}$$

C_{oss} hysteresis loss mechanism

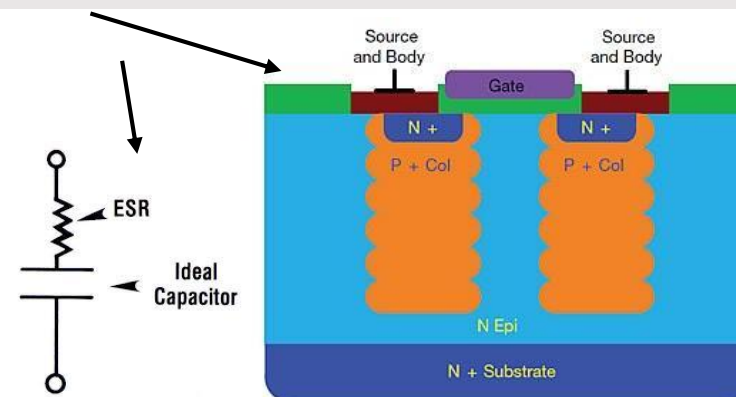
- › Superjunction construction consists of pillars of alternating P and N types, this makes the electric field distribution uniform, which allows for a high level of doping at the N drift regions insuring lower $R_{DS(on)}$, while maintaining high-voltage break down capability
- › Depending on the technology used and manufacturing methods, the shape of the edge of those pillars can exhibit a left over charges as the device turns off and the pillars deplete, which is dissipated into the columns

Hysteresis losses

- › ZVS topologies recycle the energy that is stored in the MOSFET output capacitance.
- › Charging and discharging the MOSFET output capacitor is not lossless
- › Switching frequency dependent
- › Occurs in the 0 -100 V V_{DS} range

Dependencies

- › **Base technology:** technology and manufacturing process
- › **Voltage class:** C_{oss} hysteresis loss gets worse with higher voltage technologies.
- › **$R_{DS(on)}$:** $e_{Passive}$ scales with $R_{DS(on)}$



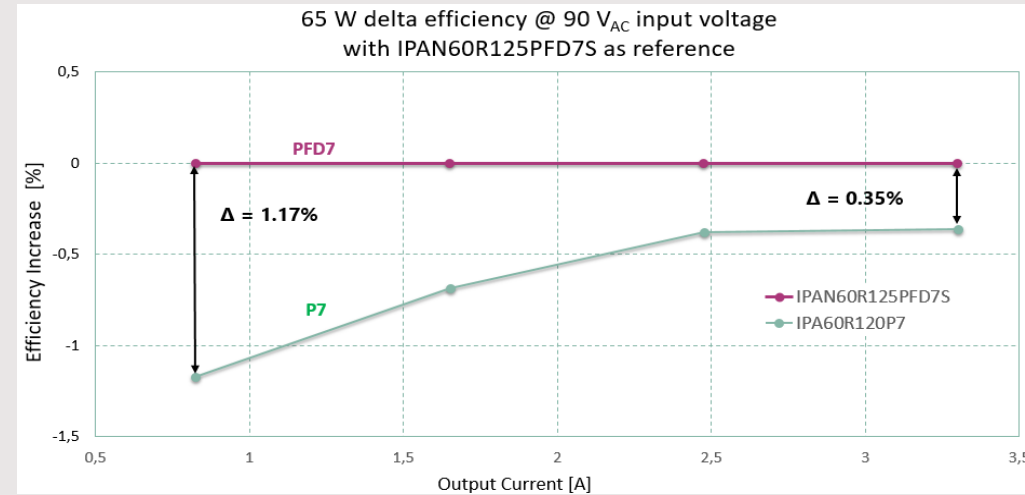
600 V CoolMOS™ PFD7 pushes efficiency and density towards a new state-of-the-art

Up to 1.17 % efficiency increase (compared to CoolMOS™ P7 technology)

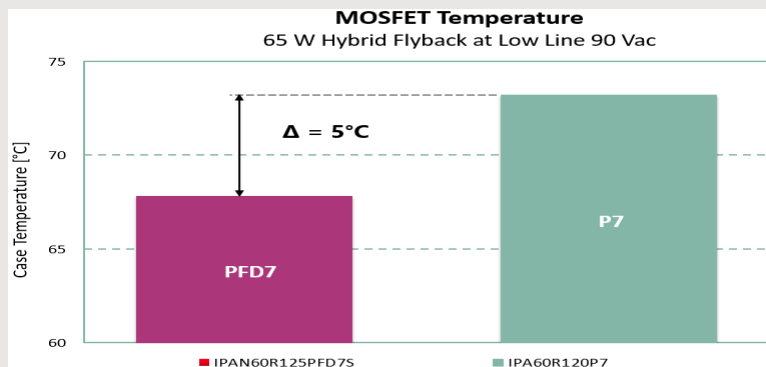


65 W Infineon internal test-board

- Input voltage: 90 V_{AC} – 265 V_{AC}
- Output voltage: 5 - 20 V
- Nominal power: 65 W
- Operation frequency: 100 - 220 kHz
- Transformer: RM10LP

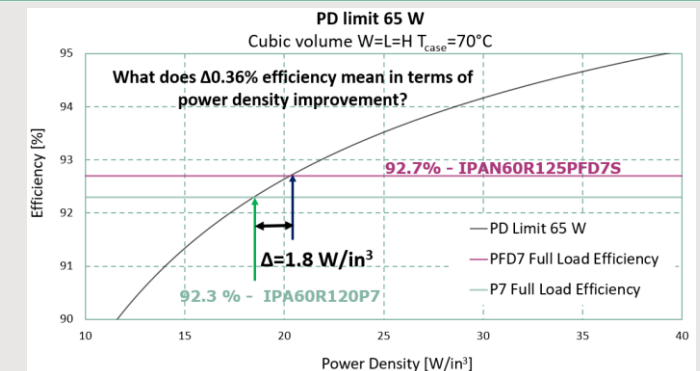


Up to 1.8 W/in³ power density increase (compared to CoolMOS™ P7)

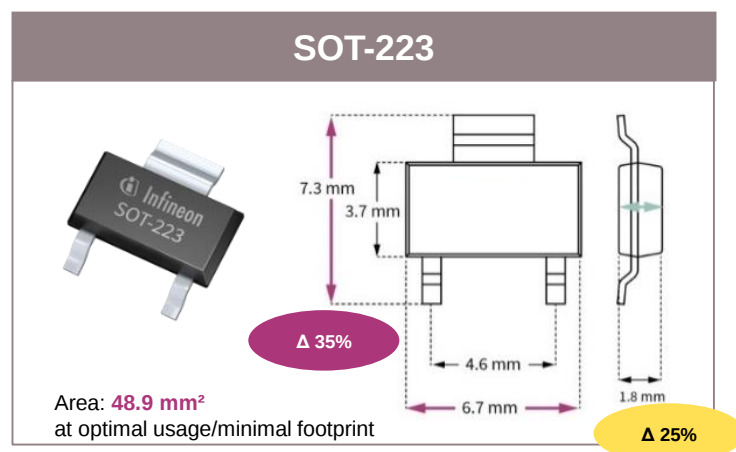


Left: At the same power, PFD7 enables a 5°C lower case temperature.

Right: The efficiency increase at peak-power results in a significant power density increase.

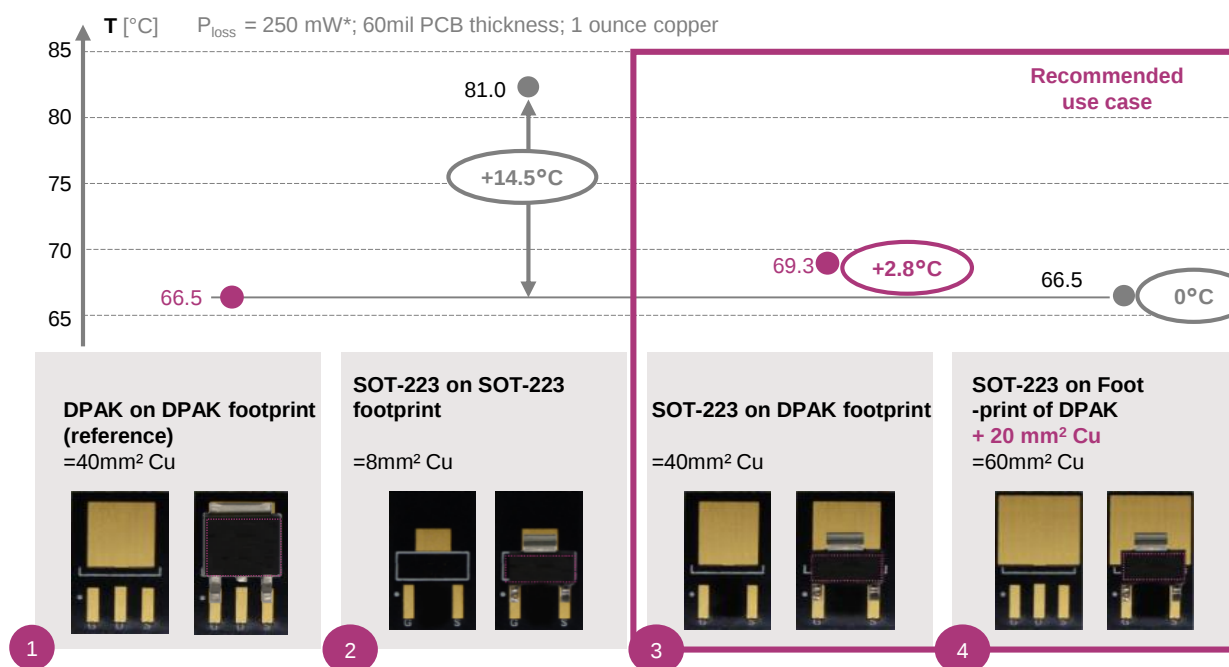


SOT-223 - cost-effective drop-in replacement for DPAK



Thermal behavior similar to DPAK

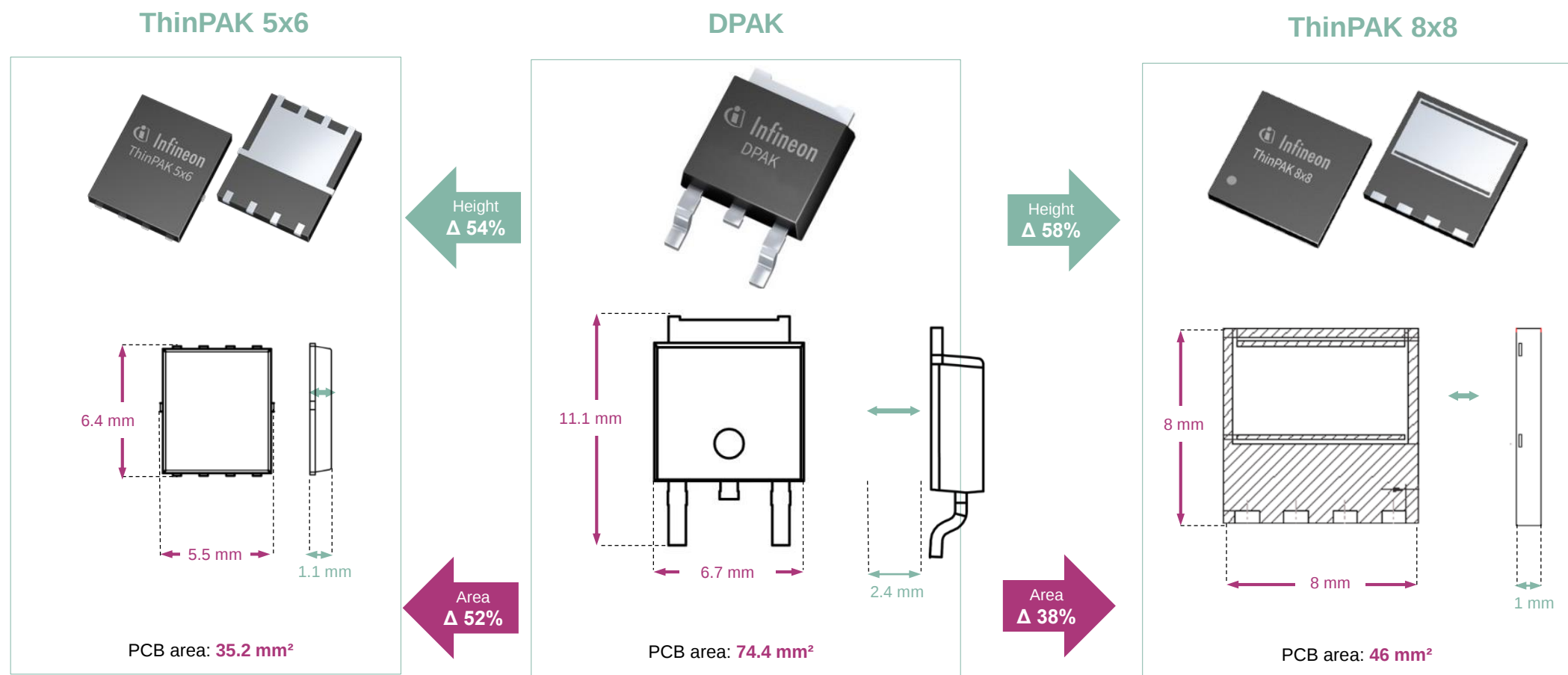
- › The thermal behavior of the SOT-223 depends on layout of the board and on the power dissipated:



* Evaluated on internal IFX test PCBs; results independent of technology

This package solution is a suitable **drop-in replacement for DPAK** at **lower cost**, enabling **space savings** in designs with low power dissipation.

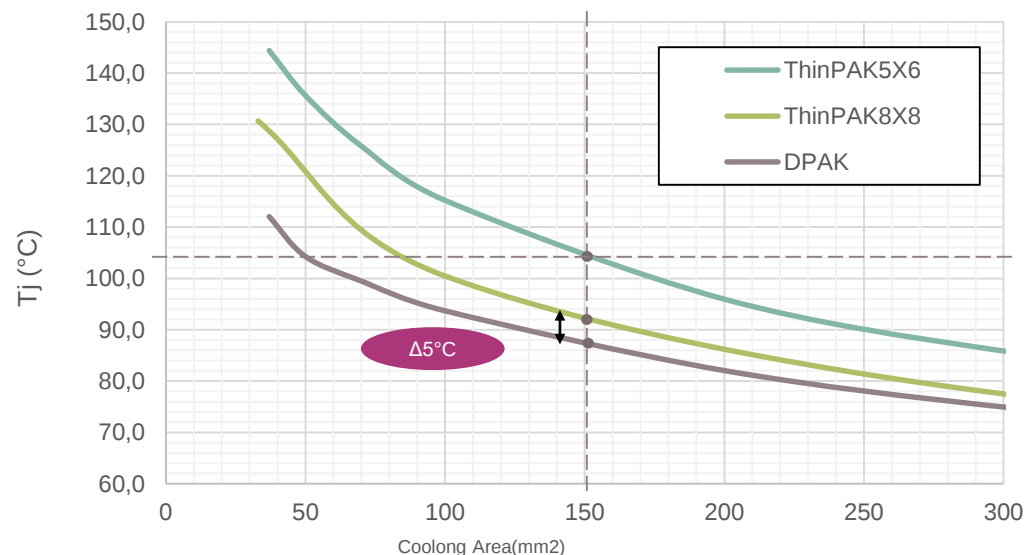
ThinPAK 8x8 offers smaller footprint & slim design with better performance



Smaller foot print • Enables slim design
Better hot spot • Better performance with Kelvin source

ThinPAK 8x8 contributes to fulfill end-user requirements for case hot spot

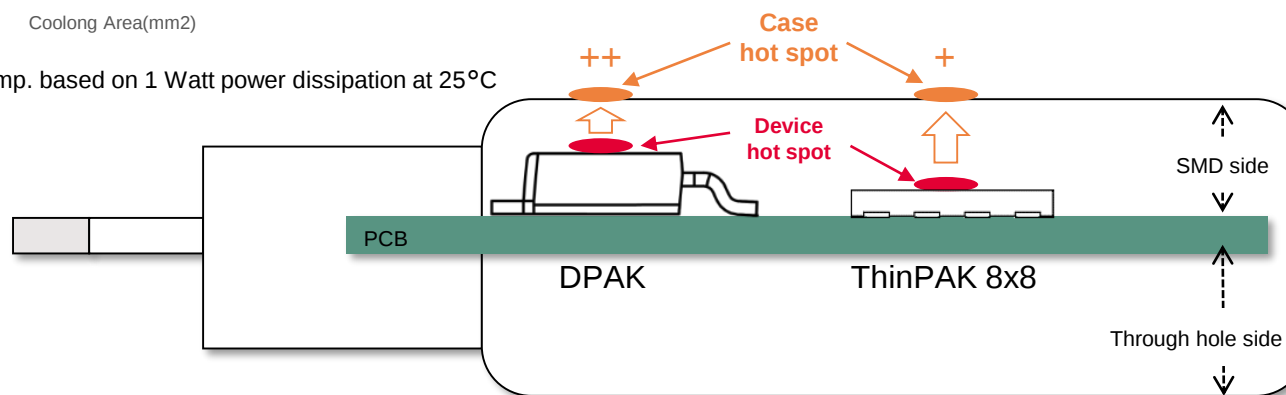
Thermal behavior



Remarks

- › MOSFET surface temperature is tested for the device hot spot temperature on the PCB for design reliability
- › End-users' requirement is to lower the case hot spot temperature for the sense of touch not to feel hot

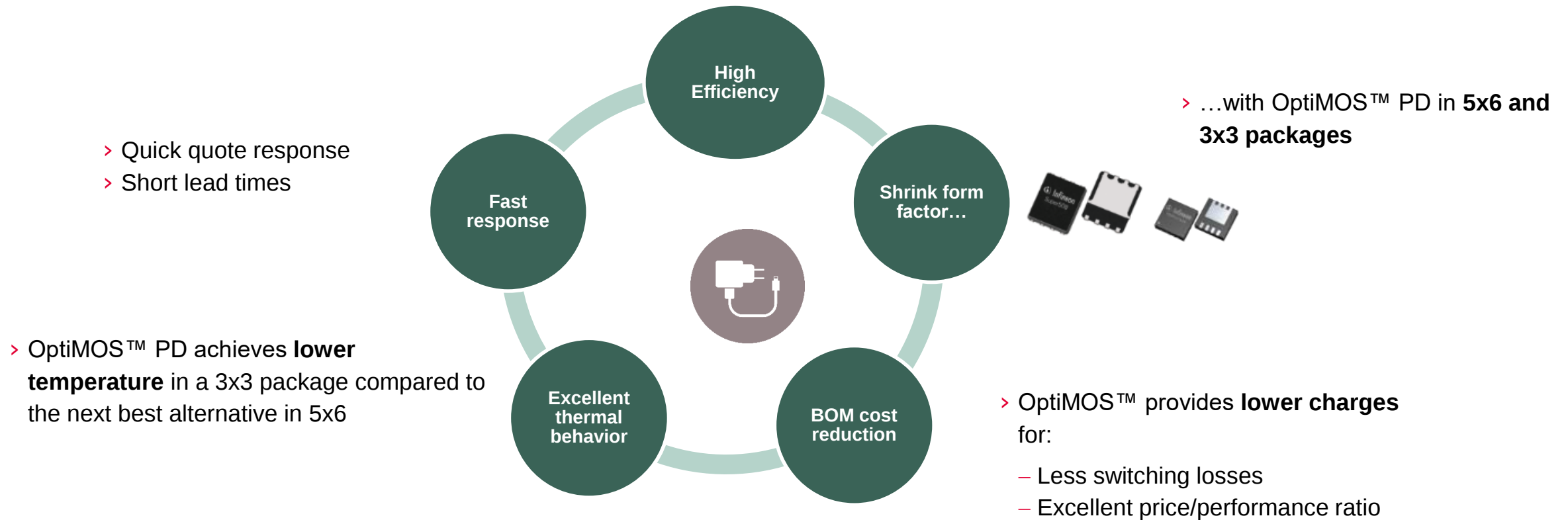
** Simulated junction temp. based on 1 Watt power dissipation at 25°C



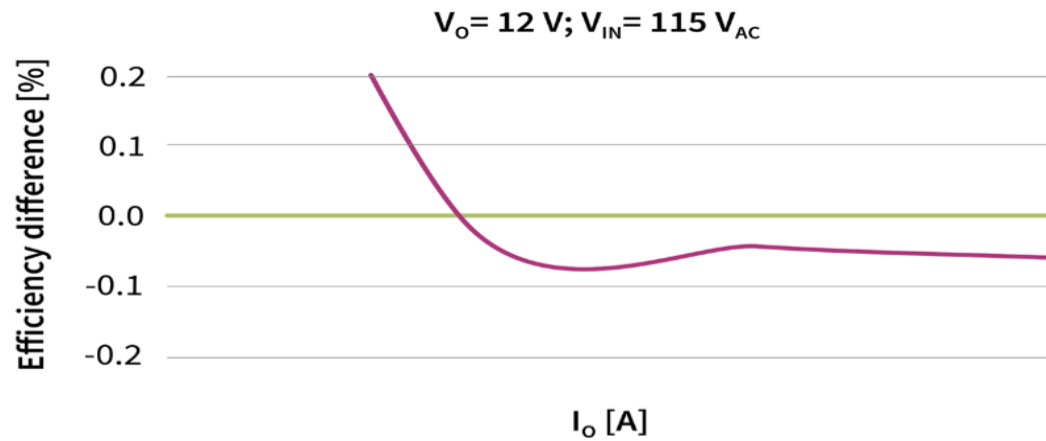
ThinPAK 8x8 lowers case hot spot temperature with more space between device and case than DPAK

OptiMOS™ PD perfectly addresses the needs of charger & adapter designs

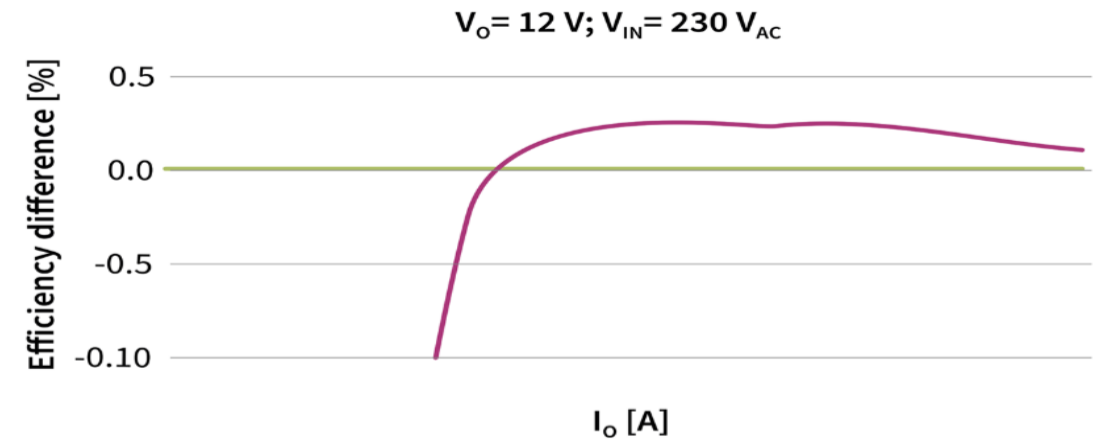
- > OptiMOS™ PD **meets efficiency standards** even in a 3x3 package
- > OptiMOS™ PD enables **high power density designs**



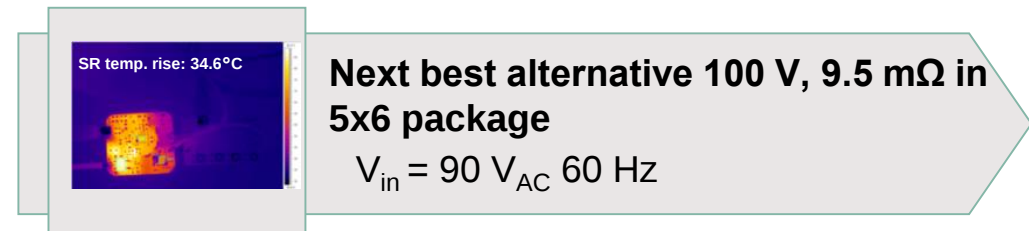
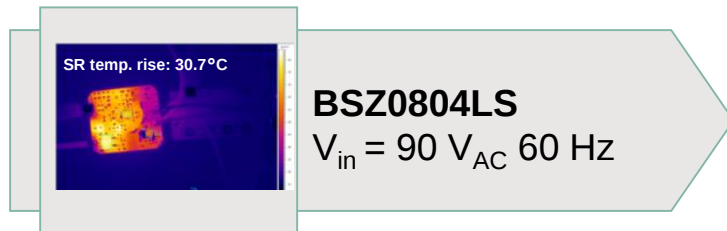
OptiMOS™ PD 100 V logic level SR efficiency comparison



- BSZ0804LS, 100 V, 9.6 mΩ, PQFN 3.3 x 3.3 package
- Next best alternative, 100 V, 9.5 mΩ, 5x6 package



OptiMOS™ PD 100 V offers similar overshoot at a 3x smaller footprint than the next best 100 V alternative resulting in higher power density.



Agenda

1

Charger market typical environment

2

Infineon offerings and value proposition

3

Product highlights

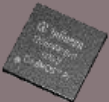
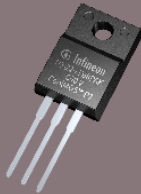
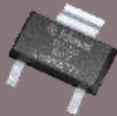
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MOSFET recommendation for chargers

600 V CoolMOS™ P7 SJ MOSFETs

- > The 600 V CoolMOS™ P7 SJ MOSFET family is a general purpose series, targeting a broad variety of applications, amongst them chargers & adapters.
- > It is Infineon's most well-balanced CoolMOS™ technology in terms of combining ease of use and excellent efficiency performance. Compared to its predecessors, it offers higher efficiency and improved power density due to the significantly reduced gate charge (Q_G) and switching losses (E_{OSS}) levels, as well as optimized on-state resistance ($R_{DS(on)}$).

600 V CoolMOS™ P7: recommended products for chargers & adapters

$R_{DS(on)}$ [mΩ]	DPAK 	ThinPAK 8x8 	TO-220 FullPAK 	TO-220 FP Narrow Lead 	SOT-223 
600	IPD60R600P7S		IPA60R600P7S	IPAN60R600P7S	IPN60R600P7S
360/365	IPD60R360P7S	IPL60R365P7	IPA60R360P7S	IPAN60R360P7S	IPN60R360P7S
280/285	IPD60R280P7S	IPL60R285P7	IPA60R280P7S	IPAN60R280P7S	
180/185	IPD60R180P7S	IPL60R185P7	IPA60R180P7S	IPAN60R180P7S	
120/125		IPL60R125P7			
105		IPL60R105P7			

700 V CoolMOS™ P7 SJ MOSFETs

- › The 700 V CoolMOS™ P7 family has been developed to serve today's and, especially, tomorrow's trends in Flyback topologies. The family products address the low power SMPS market, mainly focusing on mobile phone chargers and notebook adapters. 700 V CoolMOS™ P7 achieves outstanding efficiency gains of up to 4 percent and a decrease in device temperature of up to 16 K compared to the competition. In contrast with the previous 650 V CoolMOS™ C6 technology, 700 V CoolMOS™ P7 offers 2.4 percent gain in efficiency and 12 K lower device temperature, measured at a flyback-based charger application, operated at 140 kHz switching speed.

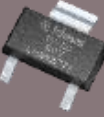
700 V CoolMOS™ P7: recommended products for chargers & adapters

$R_{DS(on)}$ [mΩ]	TO-220 FP Narrow lead 	TO-252 DPAK 	SOT-223 
2000			IPN70R2K0P7S
1400		IPD70R1K4P7S	IPN70R1K4P7S
1200			IPN70R1K2P7S
900	IPAN70R900P7S	IPD70R900P7S	IPN70R900P7S
750	IPAN70R750P7S		IPN70R750P7S
600	IPAN70R600P7S	IPD70R600P7S	IPN70R600P7S
450	IPAN70R450P7S		IPN70R450P7S
360	IPAN70R360P7S	IPD70R360P7S	IPN70R360P7S

800 V CoolMOS™ P7 SJ MOSFETs

- › With the 800 V CoolMOS™ P7 series, Infineon sets a benchmark in 800 V superjunction technologies and combines best-in-class performance with the remarkable ease of use. This product family is a perfect fit for Flyback-based consumer and industrial SMPS applications. In addition, it is also suitable for PFC stages within consumer, as well as solar applications, fully covering the market needs in terms of its price/performance ratio.
- › Compared to competition, the 800 V CoolMOS™ P7 technology allows to integrate much lower $R_{DS(on)}$ values into small packages, such as a DPAK. This finally enables high power density designs at highly competitive price levels.

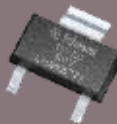
800 V CoolMOS™ P7: recommended products for chargers & adapters

$R_{DS(on)}$ [mΩ]	TO-220 FullPAK 	TO-220 FullPAK Narrow lead 	TO-252 DPAK 	SOT-223 
1400	IPA80R1K4P7		IPD80R1K4P7	IPN80R1K4P7
1200	IPA80R1K2P7		IPD80R1K2P7	IPN80R1K2P7
900	IPA80R900P7		IPD80R900P7	IPN80R900P7
750	IPA80R750P7		IPD80R750P7	IPN80R750P7
600	IPA80R600P7		IPD80R600P7	IPN80R600P7
450	IPA80R450P7	IPAN80R450P7	IPD80R450P7	
360	IPA80R360P7	IPAN80R360P7	IPD80R360P7	
280	IPA80R280P7	IPAN80R280P7	IPD80R280P7	

600 V CoolMOS™ PFD7 SJ MOSFETs

- › The 600 V CoolMOS™ PFD7 MOSFET series sets a new benchmark in 600 V superjunction (SJ) technologies, shaped by Infineon's experience of more than 20 years in pioneering in superjunction technology innovation. The series combines best-in-class performance with state-of-the-art ease of use and features an integrated fast body diode ensuring a robust device and in turn reduced BOM for the customer. This product family offers up to 1.17 percent efficiency increase compared to the CoolMOS™ P7 technologies, which leads to a power density increase of 1.8 W/in³.
- › CoolMOS™ PFD7 pushes the SJ MOSFET technology to new limits leading to outstanding improvement of lower conduction and charge/discharge losses as well as a reduced turn-off and gate-driving losses.

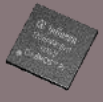
600 V CoolMOS™ PFD7: recommended products for chargers & adapters

$R_{DS(on)}$ [mΩ]	TO-220 FP Narrow lead 	TO-252 DPAK 	SOT-223 	ThinPAK 5x6 
2000		IPD60R2K0PFD7S	IPN60R2K0PFD7S	
1500		IPD60R1K5PFD7S	IPN60R1K5PFD7S	IPLK60R1K5PFD7
1000		IPD60R1K0PFD7S	IPN60R1K0PFD7S	IPLK60R1K0PFD7
600		IPD60R600PFD7S	IPN60R600PFD7S	IPLK60R600PFD7
360	IPAN60R360PFD7S	IPD60R360PFD7S	IPN60R360PFD7S	IPLK60R360PFD7
280	IPAN60R280PFD7S	IPD60R280PFD7S		
210	IPAN60R210PFD7S	IPD60R210PFD7S		
125	IPAN60R125PFD7S			

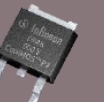
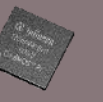
600 V / 650 V CoolMOS™ C7 SJ MOSFETs

- › The 600 V and 650 V CoolMOS™ C7 Superjunction MOSFET series are designed to achieve record level efficiency performance – they offer substantial efficiency benefits over the whole load range in hard switching applications compared to previous series and competition. This is achieved by minimizing switching losses via ultralow levels of switching losses (E_{OSS}) (approximately 50 percent reduction compared to the CoolMOS™ CP), reduced gate charge (Q_G) and a careful balance of other relevant product key parameters. The low E_{OSS} and Q_G also enable operation at higher switching frequency and related size reduction of the circuit magnetics.

600 V CoolMOS™ C7: recommended products for chargers & adapters

$R_{DS(on)}$ [Ω]	TO-262 DPAK 	ThinPAK 8x8 	TO-220 FullPAK 
180/185	IPD60R180C7	IPL60R185C7	IPA60R180C7
120/125		IPL60R125C7	IPA60R120C7
99/104		IPL60R104C7	IPA60R099C7

650 V CoolMOS™ C7: recommended products for chargers & adapters

$R_{DS(on)}$ [Ω]	TO-262 DPAK 	ThinPAK 8x8 	TO-220 FullPAK 
225/230	IPD65R225C7	IPL65R230C7	IPA65R225C7
190/195	IPD65R190C7	IPL65R195C7	IPA65R190C7
125/130		IPL65R130C7	IPA65R125C7
95/99		IPL65R099C7	IPA65R095C7

CoolMOS™ SJ MOSFET packages for charger & adapter applications



- › **SOT-223** : The SOT-223 package without a middle pin is a cost-effective alternative to DPAK, addressing the need for cost reductions in price- sensitive applications. It offers a smaller footprint, while still being pin-to-pin compatible with DPAK, thus, allowing a drop-in replacement for DPAK and second sourcing. Moreover, SOT-223 achieves comparable thermal performance to DPAK and enables customers to achieve improved form factors or space savings in designs with low power dissipation.

Voltage [V]	Series	R _{DS(on)} [mΩ]									
		0-59	60-89	90-149	150-199	200-299	300-400	401-600	601-899	900-1500	>1500
600	P7						360	600			
700	P7						360	450/600	700	900/1200/ 1400	2000
800	P7								650/750	900/1200/ 1400	2000/2400/ 3300/4500



- › **ThinPAK 5x6**: ThinPAK 5x6 reduces the PCB area by 52 percent and height by 54 percent when compared to the DPAK package which is widely used in chargers and adapters. Also, ThinPAK 5x6 enables a reduced charger and adapter case hot spot temperature by increasing the space between the MOSFET and the charger and adapter case.

Voltage [V]	Series	R _{DS(on)} [mΩ]									
		0-59	60-89	90-149	150-199	200-299	300-400	401-600	601-899	900-1500	>1500
600	PFD7						360	600		1000/1500	



- › **ThinPAK 8x8**: With a very small footprint of only 64 mm² (vs. 150 mm² for the D²PAK) and a very low profile with only 1 mm height (vs. 4.4 mm for the D²PAK) the ThinPAK 8x8 leadless SMD package for high voltage MOSFETs is a first choice to decrease system size in power-density driven designs. Low parasitic inductance and a separate 4-pin Kelvin source connection offer the best efficiency and ease of use. The package is RoHS compliant with halogen-free mold compound.

Voltage [V]	Series	R _{DS(on)} [mΩ]									
		0-59	60-89	90-149	150-199	200-299	300-400	401-600	601-899	900-1500	>1500
600	P7		65/85	105/125	185	285	365				
	C7		65	104/125	185						
	C7		70	99/130	195	230					

OptiMOS™ PD – The tailor made portfolio for USB-C PD synchronous rectification



- › Infineon's OptiMOS™ PD low-voltage MOSFET portfolio represents the best fit for USB power delivery and fast charger designs.
- › **OptiMOS™ PD power MOSFETs in PQFN 3.3x3.3 mm x mm and SuperSO8** packages are optimized for synchronous rectification in charger and adapter SMPS applications. The small package sizes translates into shrinking form factors.

OptiMOS™ PD: selected highlight products for synchronous rectification in chargers & adapters

PN	VDS	$R_{DS(on)} \max. @ V_{GS} = 10V$ [mΩ]	Package	Power
ISC0702NLS	60	2.8mΩ	PQFN 5x6	27 W/33W
ISC0703NLS	60	6.9mΩ	PQFN 5x6	27 W
ISZ0702NLS	60	4.5mΩ	PQFN 3.3x3.3	27 W
ISZ0703NLS	60	7.3mΩ	PQFN 3.3x3.3	27 W
BSZ0704LS	60	9.9mΩ	PQFN 3.3x3.3	27 W
ISC0602NLS	80	7.3mΩ	PQFN 5x6	45 W/65 W
ISC0603NLS	80	8.9mΩ	PQFN 5x6	45 W/65 W
ISZ0602NLS	80	7.8mΩ	PQFN 3.3x3.3	27 W
ISC0802NLS	100	3.6mΩ	PQFN 5x6	65 W/100 W
ISC0806NLS	100	5.4mΩ	PQFN 5x6	45 W/65 W/100W
ISC0805NLS	100	7.8mΩ	PQFN 5x6	45 W/65 W
ISC0804NLS	100	10.9mΩ	PQFN 5x6	45 W/65 W
ISC0803NLS	100	16.9mΩ	PQFN 5x6	27 W
ISZ0804NLS	100	11.5mΩ	PQFN 3.3x3.3	45 W/65 W
ISZ0803NLS	100	16.9mΩ	PQFN 3.3x3.3	27 W
BSC0302LS	120	8mΩ	PQFN 5x6	45 W/65 W
BSC0303LS	120	12mΩ	PQFN 5x6	45 W/65 W
BSC0402NS	150	9.3mΩ	PQFN 5x6	45 W/65 W
BSC0403NS	150	11mΩ	PQFN 5x6	45 W/65 W

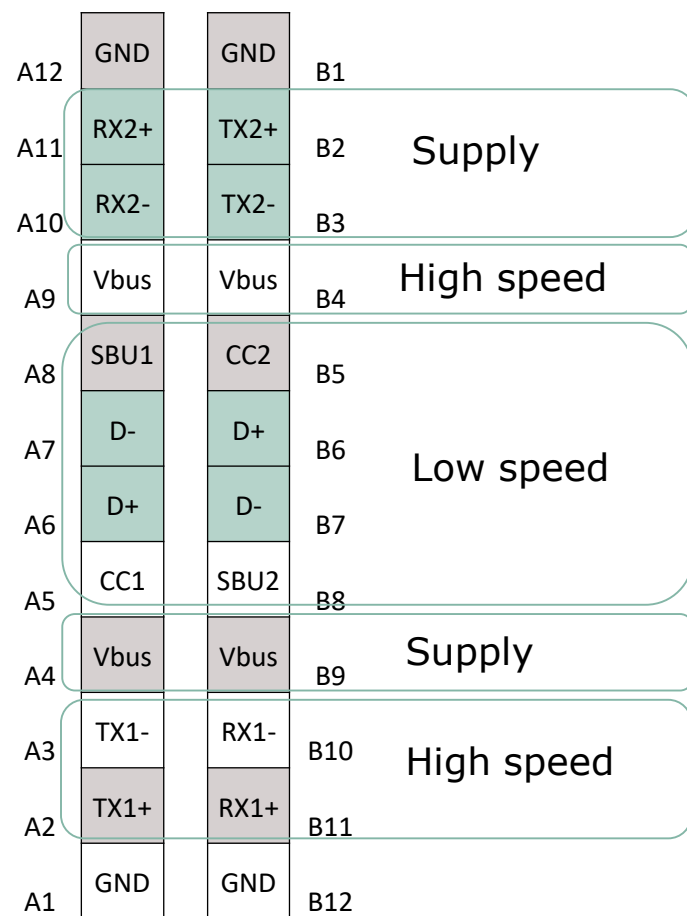
OptiMOS™ PD: selected highlight products serving as load switch in chargers & adapters

PN	VDS	$R_{DS(on)} \max. @ V_{GS} = 10V$ [mΩ]	Package	Power
BSZ0905PNS	-30	8.6mΩ	PQFN 3.3x3.3	27W
ISZ0501NLS	25	3.1mΩ	PQFN 3.3x3.3	65W/100W
ISZ0901NLS	25	6mΩ	PQFN 3.3x3.3	27W/45W/65W
BSZ0909LS	30	3mΩ	PQFN 3.3x3.3	65W/100W
BSZ0910LS	30	4.5mΩ	PQFN 3.3x3.3	45W/65W
BSZ0911LS	30	7mΩ	PQFN 3.3x3.3	27W/45W

TVS for USB type-C ESD protection (PD, USB 3/4, Thunderbolt 3)



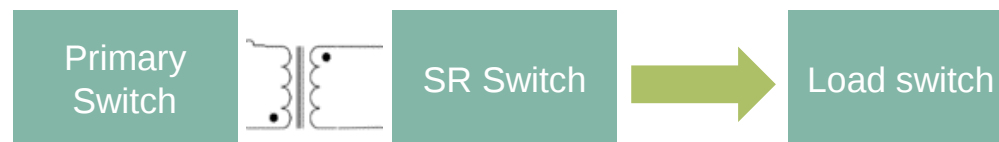
ESD Solution



TVS: selected highlight products serving as ESD Protection Solution in chargers & adapters

USB type C Line	Type	VRWM (V)	Cap (pF)	VESD (kV)	R _{dyn} (Ohm)	V _{cl} @16A (V)	I _{R,max} (nA)	Package
Rx/Tx/ USB3.2	ESD134	±2.1V	0.25pF	±20kV	0.28Ω	7.7V	20nA	0201
Rx/Tx USB3.2/USB4	ESD150	±3.3V	0.15pF	±12kV	0.15Ω	5.3V	10nA	0201
D+ / D-	ESD131 / ESD133	±5.5V	0.23pF	±20kV	0.66/0.56Ω	13V	100nA	0201 / 01005
D+ / D-	ESD108	±5.5V	0.28pF	±12kV	0.78Ω	20V	20nA	0201
SBU/CC, D+/D-, VBUS 5V	ESD245 / ESD246	±5.5V	5.8/5.5pF	±15kV	0.1Ω	7.5V	30nA	0201 / 01005
VBUS 9-15V	ESD249 / ESD259	±18V	4.2pF	±16kV	0.27Ω	23.5V	100nA	0201
VBUS 20V	ESD239 / ESD240	±22V	3.2/3.0pF	±16kV	0.27/0.3Ω	27V	100nA	0201 / 01005
VBUS 20V	ESD253	±24V	2.8pF	±15kV	0.3Ω	31V	100nA	0201

Power MOSFET recommendation for $\leq 65\text{ W}$

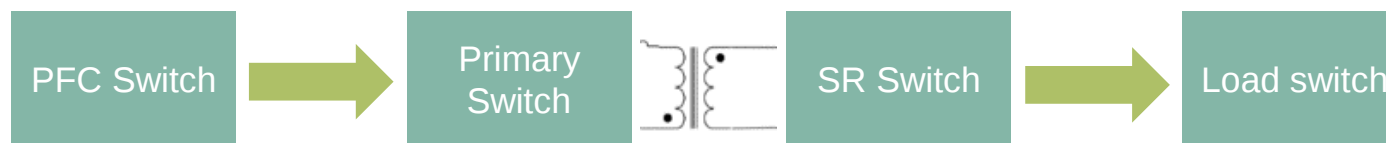


Primary Switch	VDS	$R_{DS(on)}$	Package	Power
IPN70R1K4P7S	700 V	1.4 Ω	SOT-223	18 W
IPN70R900P7S	700 V	0.9 Ω	SOT-223	33 W
IPN70R600P7S	700 V	0.6 Ω	SOT-223	45 W
IPAN70R600P7S	700 V	0.6 Ω	TO-220F	45 W
IPL60R365P7	600 V	0.365 Ω	ThinPAK 8x8	45/65 W
IPN70R360P7S	700 V	0.36 Ω	SOT-223	65 W
IPD70R600P7S	700 V	0.6 Ω	TO-252	65 W
IPAN70R360P7S	700 V	0.36 Ω	TO-220F narrow lead	65 W
IPL60R185C7	600 V	0.185 Ω	ThinPAK 8x8	65 W
IPL60R185P7	600 V	0.185 Ω	ThinPAK 8x8	65 W

PN	VDS	$R_{DS(on)}$	Package	Power
ISC0702NLS	60	2.8m Ω	PQFN 5x6	27 W/33W
ISC0703NLS	60	6.9m Ω	PQFN 5x6	27 W
ISZ0702NLS	60	4.5m Ω	PQFN 3.3x3.3	27 W
ISZ0703NLS	60	7.3m Ω	PQFN 3.3x3.3	27 W
BSZ0704LS	60	9.9m Ω	PQFN 3.3x3.3	27 W
ISC0602NLS	80	7.3m Ω	PQFN 5x6	45 W/65 W
ISC0603NLS	80	8.9m Ω	PQFN 5x6	45 W/65 W
ISZ0602NLS	80	7.8m Ω	PQFN 3.3x3.3	27 W
ISC0805NLS	100	7.8m Ω	PQFN 5x6	45 W/65 W
ISC0804NLS	100	10.9m Ω	PQFN 5x6	45 W/65 W
ISC0803NLS	100	16.9m Ω	PQFN 5x6	27 W
ISZ0804NLS	100	11.5m Ω	PQFN 3.3x3.3	45 W/65 W
ISZ0803NLS	100	16.9m Ω	PQFN 3.3x3.3	27 W
BSC0302LS	120	8m Ω	PQFN 5x6	45 W/65 W
BSC0303LS	120	12m Ω	PQFN 5x6	45 W/65 W
BSC0402NS	150	9.3m Ω	PQFN 5x6	45 W/65 W
BSC0403NS	150	11m Ω	PQFN 5x6	45 W/65 W

PN	VDS	$R_{DS(on)}$ max.	Package	Power
BSZ0905PNS	-30	8.6m Ω	PQFN 3.3x3.3	27W
ISZ0901NLS	25	6m Ω	PQFN 3.3x3.3	27W/45W/65W
BSZ0910LS	30	4.5m Ω	PQFN 3.3x3.3	45W/65W
BSZ0911LS	30	7m Ω	PQFN 3.3x3.3	27W/45W

Power MOSFET recommendation for > 75 W



PFC Switch	VDS	R _{DS(on)}	Package	Topology
IPD60R180P7S	600 V	0.18 Ω	TO-252	PFC
IPAN60R280P7S	600 V	0.28 Ω	TO-220F	PFC
IPAN60R180P7S	600 V	0.18 Ω	TO-220F	PFC
IPL60R185C7	600 V	0.185 Ω	ThinPAK 8x8	PFC
IPL60R125C7	600 V	0.125 Ω	ThinPAK 8x8	PFC

Primary Switch	VDS	R _{DS(on)}	Package	Topology
IPD60R360P7S	600 V	0.36 Ω	TO-252	ACF, LLC, ZVS & Hybrid mode Flyback
IPAN60R600P7S	600 V	0.60 Ω	TO-220F	ACF, LLC, ZVS & Hybrid mode Flyback
IPAN60R360P7S	600 V	0.36 Ω	TO-220F	ACF, LLC, ZVS & Hybrid mode Flyback
IPL60R365P7	600 V	0.365 Ω	ThinPAK 8x8	ACF, LLC, ZVS & Hybrid mode Flyback
IPLK60R360PFD7	600 V	0.36 Ω	ThinPAK 5x6	ACF, LLC, ZVS & Hybrid mode Flyback
IPAN70R360P7S	700 V	0.36 Ω	TO-220F	Flyback
IPA65R225C7	650 V	0.225 Ω	TO-220F	Flyback
IPL65R230C7	650 V	0.23 Ω	ThinPAK 8x8	Flyback
IPL65R195C7	650 V	0.195 Ω	ThinPAK 8x8	Flyback
IPD65R190C7	650 V	0.19 Ω	TO-252	Flyback

SR Switch	VDS	R _{DS(on)}	Package
ISC0702NLS	60 V	2.8 mΩ	PQFN 5x6
ISC0703NLS	60 V	6.9 mΩ	PQFN 5x6
ISC0802NLS	100	3.6mΩ	PQFN 5x6
ISC0806NLS	100	5.4mΩ	PQFN 5x6

Load Switch	VDS	R _{DS(on)}	Package
ISZ0501NLS	25	3.1mΩ	PQFN 3.3x3.3
BSZ0909LS	30 V	3.0 mΩ	PQFN 3x3
BSZ0910LS	30 V	5.7 mΩ	PQFN 3x3



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Revision history

Major changes since the last revision

Document version	Date of release	Description of changes
V1.0	July xx, 2021	First release
V2.0	Sep. xx, 2021	1) Page5: Added low standby power in the fourth bubble 2) Page7: Added a picture of power tools 3) Page9: Change into“ CoolMOS™ and CoolGAN™” from ”Mosfets” in the first sentence 4) Page10: Add ESD block information, correct the opto-coupler symbol 5) Page14: Corrected the “discrete PFC for >65W” into “discrete PFC for >75W“ 6) Page16: Corrected the Peak efficiency of into 89.31% from 89.27% 7) Page21: Added the bulk cap value in the first table; Add the peak efficiency in the second table. Corrected the standby power into 65mW from 70mW 8) Page22: Corrected the AC input into 230V from 100V in Efficiency value. 9) Page32: Removed 700V indication for not limiting 700V P7. 10) Page49: Add the ZVS recommendation 11) Page50-51: Correct the R_{don} into Ω from mΩ 12) Page50-51: Update the OptiMOS™ recommendation