

The one-stop-shop for USB power delivery solutions



인피니언 전력반도체 솔루션
가상부스에 오신 걸 환영합니다!



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

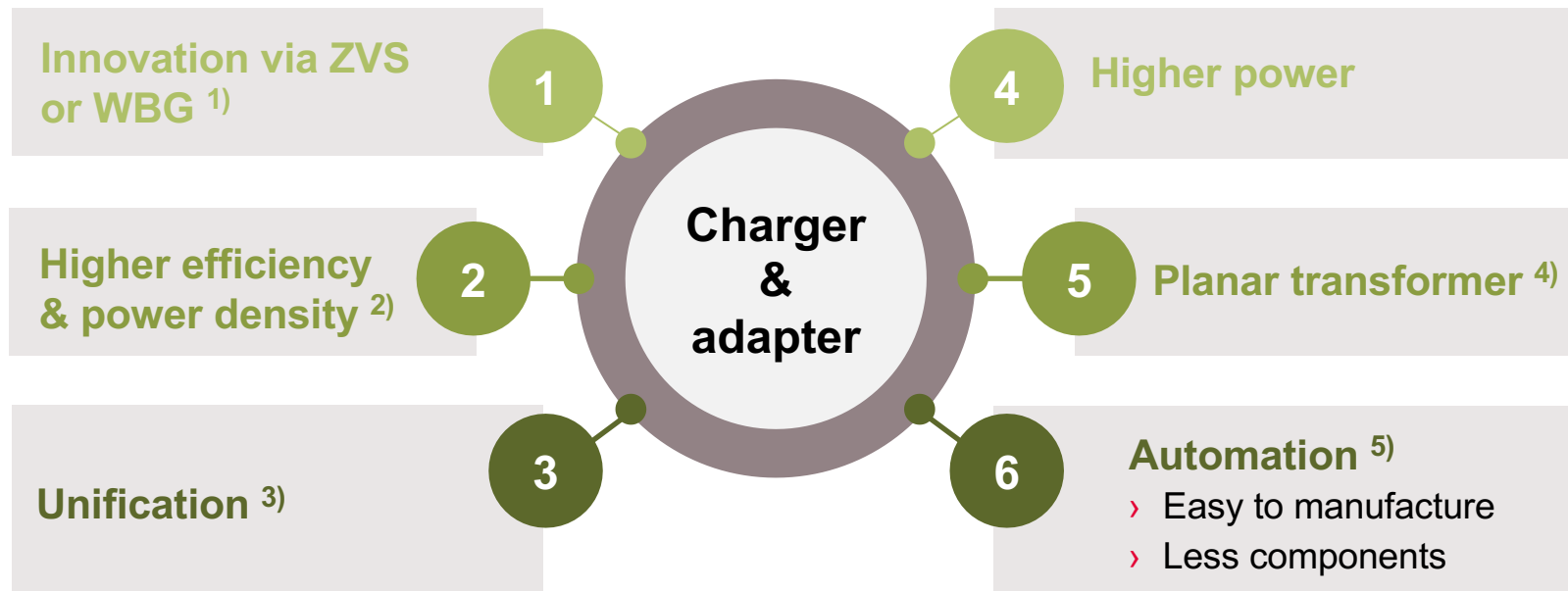
Light weight

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

Low cost

Overall BOM cost is sensitive in consumer orientated applications

Technical trends in chargers & adapters



1) ZVS or WBG (wide bandgap) can help to reduce power losses

2) Higher efficiency enabling smaller form factor, hence increasing power density

Selected topology and discretes in combination with optimized transformer design play a major role

3) Govern policy will require unification to save the e-waste, the USB-PD protocol will be supposed to unify the chargers

4) Form factor, cost, consistent performance, high volume production, etc.

5) Automated assembly of boards & magnetics. Less external components, SMD package, planar transformers, etc.

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



Customers' benefits

1 Price competitiveness

2 Lead time and supply flexibility

3 High power/density enablement

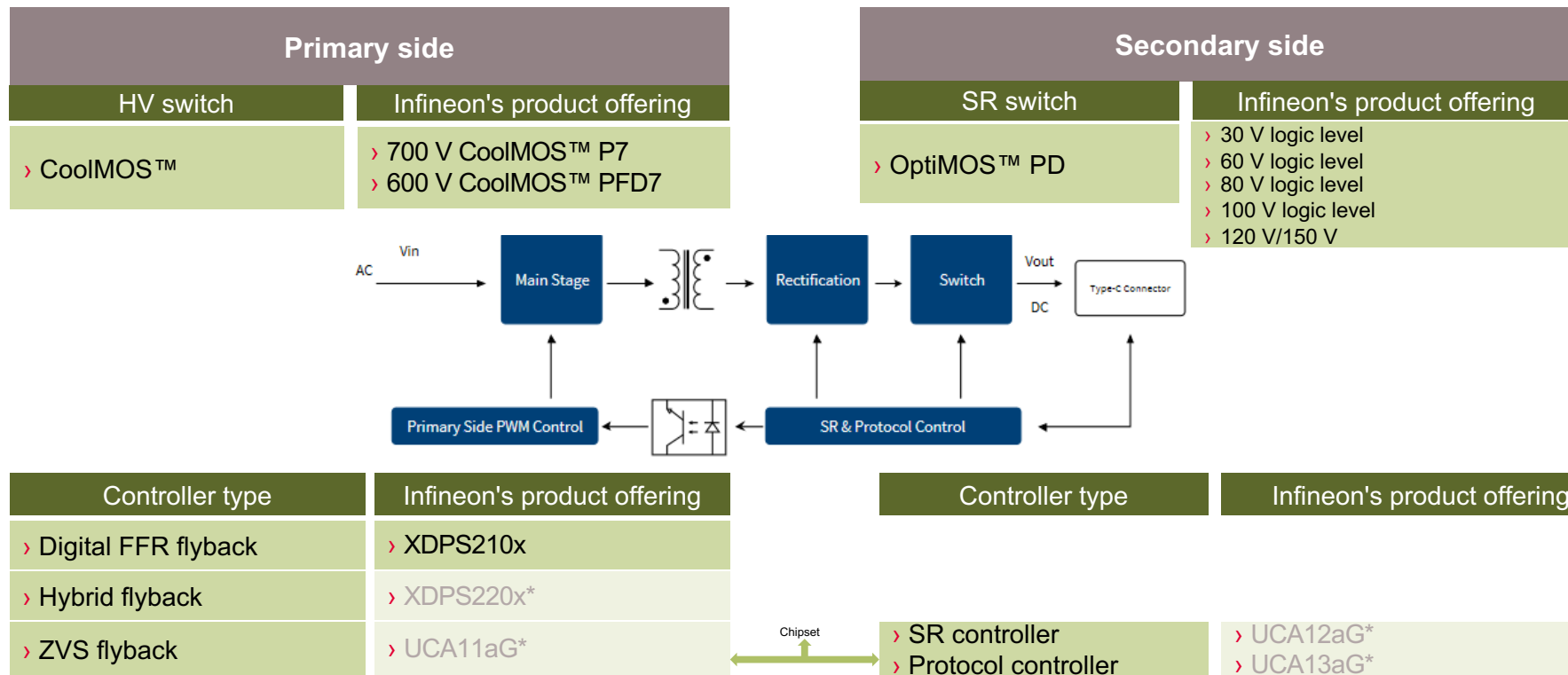
4 One-stop-shop

5 Flexible support

Infineon's offers

- › The economic system saves scale of wide considerations, e.g., reference designs to save design cost and time to market, granular portfolios to save purchasing efforts and supply management cost, high efficiency to save thermal management cost, etc.
- › Charger application-oriented portfolios with improved cost structure from 300 mm production, smaller package, and right-fit qualification
- › Three dedicated frontend and five backend facilities (incl. subcons) secure supply
- › Preparations to shorten L/T, e.g. stocks in Die Bank and warehouse, distribution inventory, etc.
- › Digital ZVS controller with high-performance power MOSFET enables high-efficiency designs
- › SMD packages (DPAK, ThinPAK, PQFN, etc.) can further shrink PCB sizes
- › Granular portfolio of high- and low-voltage MOSFETs as well as controllers allows for variable charger designs
- › Long term roadmap supports customer market continuous positioning
- › Plenty of ready-to-use reference designs to save design efforts
- › Large field application engineering team and partners dedicated to provide professional and flexible support for your design

Proven one-stop-shop solution for USB PD chargers



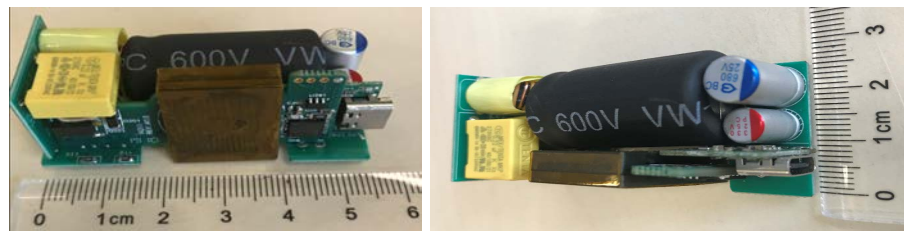
*coming soon

Ready-to-use 45 W USB PD reference design



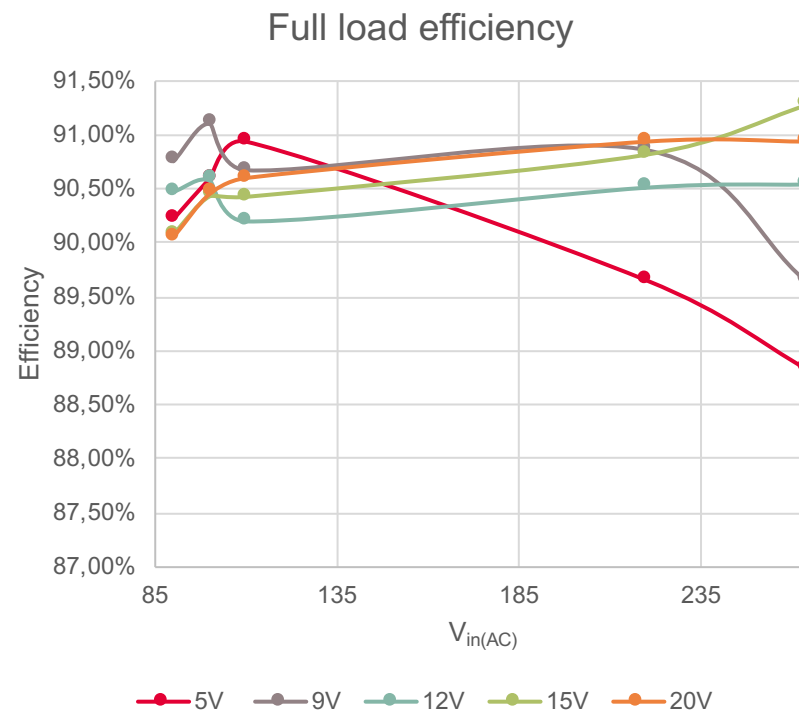
- › Reference design which meets standard regulations
- › Full USB PD capability
- › 21 W/inch³ uncased power density, enabled by XDPS21071 zero-voltage-switching, 140 kHz operation and planar transformer design
- › High volume shipment already
- › Digital platform can extend design with minimum efforts

REF_XDPS21071_45W1

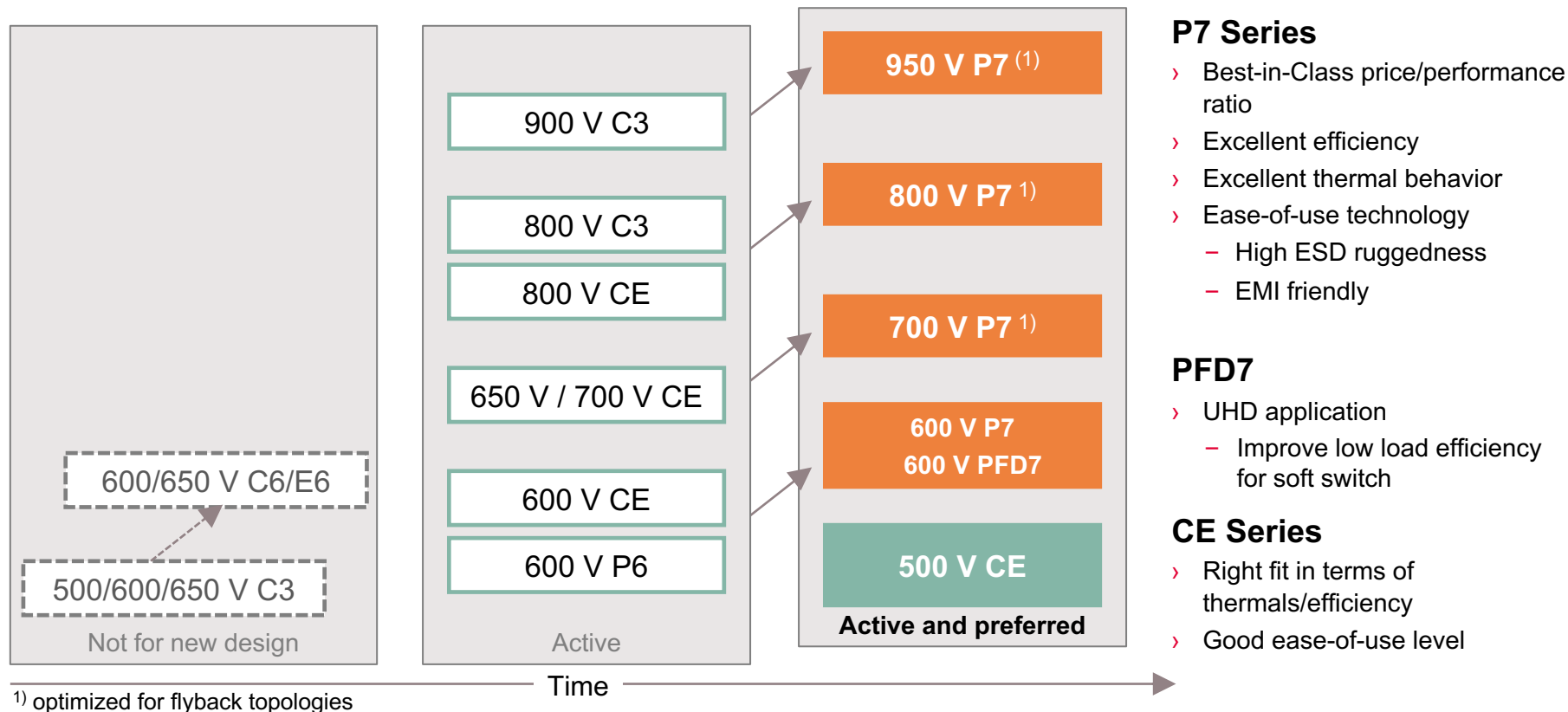


PCB size L55 mm * W25 mm*H25 mm (21.5 W/inch³ PCBA)

Functionality	Part name	# of pcs
Primary PWM controller	XDPS21071	1
Primary HV MOSFET	IPD70S360P7	1
Secondary synchronous rectifier MOSFET	BSC0805LS	1
Load switch	ISZ0901NLS	1
ZVS MOSFET	BSL606SN	1



CoolMOS™ positioning for Low Power SMPS market



P7 Series

- › Best-in-Class price/performance ratio
- › Excellent efficiency
- › Excellent thermal behavior
- › Ease-of-use technology
 - High ESD ruggedness
 - EMI friendly

PFD7



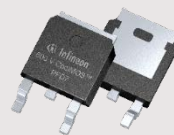


- › UHD application
 - Improve low load efficiency for soft switch

CE Series

- › Right fit in terms of thermals/efficiency
- › Good ease-of-use level

600 V CoolMOS™ PFD7

600 V CoolMOS™ PFD7 – portfolio overview

R_{DS(on)} [mΩ]	 TO-220FP_NL	 IPAK SL	 DPAK	 SOT-223	 ThinPAK 5x6
2000			IPD60R2K0PFD7S	IPN60R2K0PFD7S	
1500			IPD60R1K5PFD7S	IPN60R1K5PFD7S	IPLK60R1K5PFD7
1000		IPS60R1K0PFD7S	IPD60R1K0PFD7S	IPN60R1K0PFD7S	IPLK60R1K0PFD7
600		IPS60R600PFD7S	IPD60R600PFD7S	IPN60R600PFD7S	IPLK60R600PFD7
360	IPAN60R360PFD7S	IPS60R360PFD7S	IPD60R360PFD7S	IPN60R360PFD7S	IPLK60R360PFD7
280	IPAN60R280PFD7S	IPS60R280PFD7S	IPD60R280PFD7S		
210	IPAN60R210PFD7S	IPS60R210PFD7S	IPD60R210PFD7S		
125	IPAN60R125PFD7S				











CoolMOS™ PFD7 Portfolio

600 V

 Available

 Coming soon

600 V CoolMOS™ P7 portfolio

	$R_{DS(on)}$ [mΩ] Max.	 DPAK	 D²PAK	 ThinPAK 8x8	 TO220 FullPAK	 TO220	 TO220 FP NL	 TO220 FP WC	 TO247	 TO247-4	 SOT223
Industrial grade	600	IPD60R600P7			IPA60R600P7	IPP60R600P7					
	360/365	IPD60R360P7	IPB60R360P7	IPL60R365P7	IPA60R360P7	IPP60R360P7					
	280/285	IPD60R280P7	IPB60R280P7	IPL60R285P7	IPA60R280P7	IPP60R280P7					
	180/185	IPD60R180P7	IPB60R180P7	IPL60R185P7	IPA60R180P7	IPP60R180P7			IPW60R180P7	IPZA60R180P7	
	160				IPA60R160P7	IPP60R160P7					
	120/125		IPB60R120P7	IPL60R125P7	IPA60R120P7	IPP60R120P7			IPW60R120P7	IPZA60R120P7	
	99/105		IPB60R099P7	IPL60R105P7	IPA60R099P7	IPP60R099P7			IPW60R099P7	IPZA60R099P7	
	80		IPB60R080P7	IPL60R085P7	IPA60R080P7	IPP60R080P7			IPW60R080P7	IPZA60R080P7	
	60/65		IPB60R060P7	IPL60R065P7	IPA60R060P7	IPP60R060P7			IPW60R060P7	IPZA60R060P7	
	45		IPB60R045P7						IPW60R045P7	IPZA60R045P7	
	37								IPW60R037P7	IPZA60R037P7	
	24								IPW60R024P7	IPZA60R024P7	
Standard grade	600	IPD60R600P7S			IPA60R600P7S		IPAN60R600P7S	IPAW60R600P7S			IPN60R600P7S
	360	IPD60R360P7S			IPA60R360P7S		IPAN60R360P7S	IPAW60R360P7S			IPN60R360P7S
	280	IPD60R280P7S			IPA60R280P7S		IPAN60R280P7S	IPAW60R280P7S			
	180	IPD60R180P7S			IPA60R180P7S		IPAN60R180P7S	IPAW60R180P7S			

CoolMOS™ P7 Portfolio

600 V 700 V 800 V 950 V










- > Large $R_{DS(on)}$ and package variety
- > Offering through hole and SMD packages
- > Suitable for a wide variety of applications and power ranges

700 V CoolMOS™ P7

Product portfolio



700 V CoolMOS™ P7 SJ MOSFETs

HBM class	R _{DS(ON)} [mΩ]	Standard Grade						Industrial Grade
		 TO-220 FullPAK	 TO-220 FP Narrow lead	 TO-251 IPAK SL	 TO-251 IPAK SL w/ ISO lead standoff	 TO-252 DPAK	 SOT-223	 ThinPAK 5x6
1C (>1kV)	2000				IPSA70R2K0P7S		IPN70R2K0P7S	IPLK70R2K0P7*
	1400			IPS70R1K4P7S	IPSA70R1K4P7S	IPD70R1K4P7S	IPN70R1K4P7S	IPLK70R1K4P7*
	1200				IPSA70R1K2P7S		IPN70R1K2P7S	IPLK70R1K2P7*
	900	IPA70R900P7S	IPAN70R900P7S	IPS70R900P7S	IPSA70R900P7S	IPD70R900P7S	IPN70R900P7S	IPLK70R900P7*
	750	IPA70R750P7S	IPAN70R750P7S		IPSA70R750P7S		IPN70R750P7S	IPLK70R750P7*
2 (>2kV)	600	IPA70R600P7S	IPAN70R600P7S	IPS70R600P7S	IPSA70R600P7S	IPD70R600P7S	IPN70R600P7S	IPLK70R600P7*
	450	IPA70R450P7S	IPAN70R450P7S		IPSA70R450P7S		IPN70R450P7S	
	360	IPA70R360P7S	IPAN70R360P7S	IPS70R360P7S	IPSA70R360P7S	IPD70R360P7S	IPN70R360P7S	

Recommended for cost-effective designs

*coming soon

CoolMOS™ P7 Portfolio










600 V **700 V** 800 V 950 V

800 V CoolMOS™ P7

Recommended for PFC/flyback topologies**



800 V CoolMOS™ P7 SJ MOSFETs

HBM class	$R_{DS(on)}$ [mΩ]	Industrial grade								
										
1C (>1kV)	4500					IPU80R4K5P7		IPD80R4K5P7	IPN80R4K5P7	
	3300					IPU80R3K3P7		IPD80R3K3P7	IPN80R3K3P7	
	2400					IPU80R2K4P7	IPS80R2K4P7	IPD80R2K4P7	IPN80R2K4P7	
	2000					IPU80R2K0P7	IPS80R2K0P7	IPD80R2K0P7	IPN80R2K0P7	IPLK80R2K0P7*
2 (>2kV)	1400		IPP80R1K4P7	IPA80R1K4P7		IPU80R1K4P7	IPS80R1K4P7	IPD80R1K4P7	IPN80R1K4P7	IPLK80R1K4P7*
	1200		IPP80R1K2P7	IPA80R1K2P7		IPU80R1K2P7	IPS80R1K2P7	IPD80R1K2P7	IPN80R1K2P7	IPLK80R1K2P7*
	900		IPP80R900P7	IPA80R900P7		IPU80R900P7	IPS80R900P7	IPD80R900P7	IPN80R900P7	IPLK80R900P7*
	750		IPP80R750P7	IPA80R750P7		IPU80R750P7	IPS80R750P7	IPD80R750P7	IPN80R750P7	IPLK80R750P7*
	600		IPP80R600P7	IPA80R600P7		IPU80R600P7	IPS80R600P7	IPD80R600P7	IPN80R600P7	IPLK80R600P7*
	450		IPP80R450P7	IPA80R450P7	IPAN80R450P7			IPD80R450P7		
	360	IPW80R360P7	IPP80R360P7	IPA80R360P7	IPAN80R360P7			IPD80R360P7		
	280	IPW80R280P7	IPP80R280P7	IPA80R280P7	IPAN80R280P7			IPD80R280P7		

CoolMOS™ P7 Portfolio





600 V 700 V **800 V** 950 V

The perfect fit for flyback based power lighting designs

** Excluding half- and full-bridge configurations

*coming soon

950 V CoolMOS™ P7 product portfolio

950 V CoolMOS™ P7 SJ MOSFETs					
		Industrial grade			
HBM Class	R _{DS(on)} [mΩ]	 TO-220 FullPAK	 TO-251 IPAK LL	 TO-252 DPAK	 SOT-223
1C (>1kV)	3700		IPU95R3K7P7		IPN95R3K7P7
	2000		IPU95R2K0P7	IPD95R2K0P7	IPN95R2K0P7
2 (>2kV)	1200	IPA95R1K2P7	IPU95R1K2P7	IPD95R1K2P7	IPN95R1K2P7
	750	IPA95R750P7	IPU95R750P7	IPD95R750P7	
	450	IPA95R450P7	IPU95R450P7	IPD95R450P7	

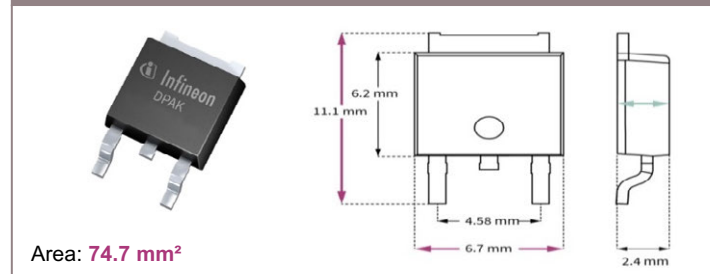
CoolMOS™ P7 Portfolio

600 V 700 V 800 V **950 V**

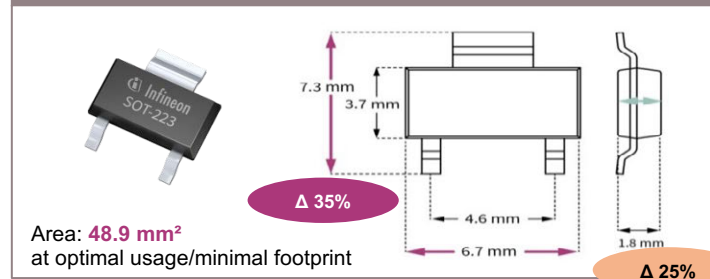


Cost-effective drop-in replacement for DPAK

TO-252 DPAK

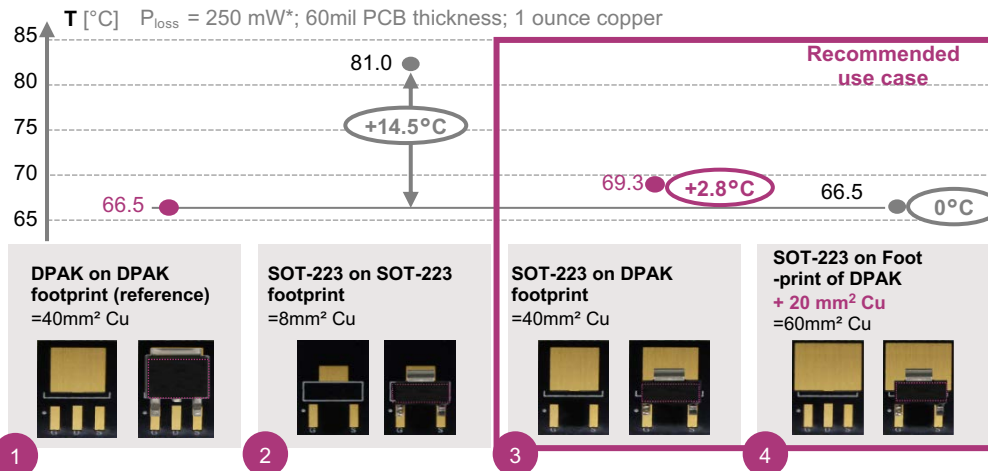


SOT-223



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.

Package innovations

SOT-223

IPAK SL w/ ISO
standoffTO-220 FP w/
Narrow Lead

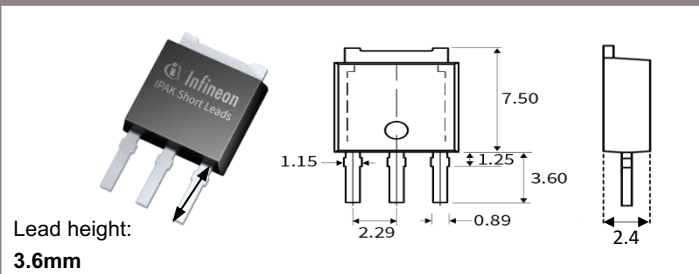
ThinPAK 8x8

Learn more: www.infineon.com/sot-223

IPAK Short Lead with ISO Standoff

For higher assembly yields in charger applications

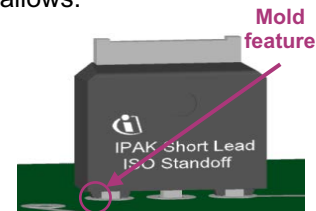
IPAK Short Lead



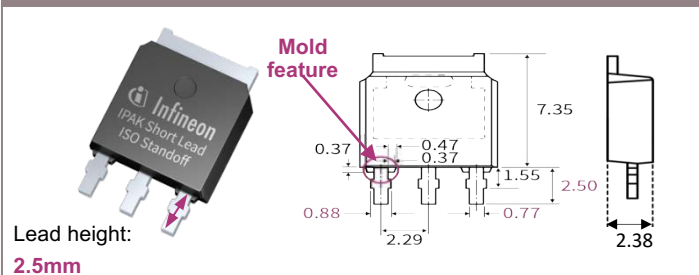
Key features

Well-defined mold feature at bottom of package body allows:

- › the package to be fully inserted into PCB
- › to keep well defined isolation distance between PCB and package body
- › to avoid residues after soldering and cleaning process



IPAK Short Lead w/ ISO Standoff



RDS(on) [mΩ]	CoolMOS™ CE	CoolMOS™ P7
	700 V	700 V
2000	IPSA70R2K0CE	IPSA70R2K0P7S
1400	IPSA70R1K4CE	IPSA70R1K4P7S
1200		IPSA70R1K2P7S
900/950	IPSA70R950CE	IPSA70R900P7S
750		IPSA70R750P7S
600	IPSA70R600CE	IPSA70R600P7S
450		IPSA70R450P7S
360		IPSA70R360P7S

This package solution offers **larger effective creepage distance** between the legs, and **more effective cleaning** in terms of reducing residue, resulting in **better assembly yield**.

Package innovations

SOT-223

IPAK SL w/ ISO
standoff

TO-220 FP w/
Narrow Lead

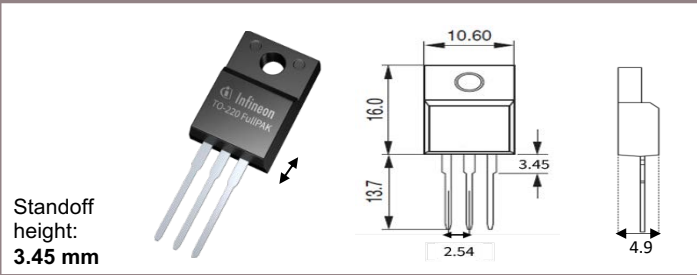
ThinPAK 8x8

Learn more: www.infineon.com/ipak-sl-isostandoff

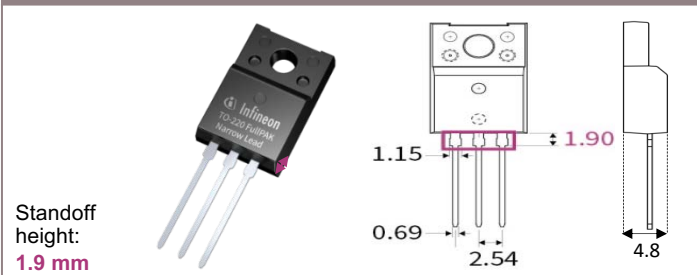
TO-220 FullPAK Narrow Lead

Solution for size reduction of adapters and chargers

Standard TO-220 FullPAK



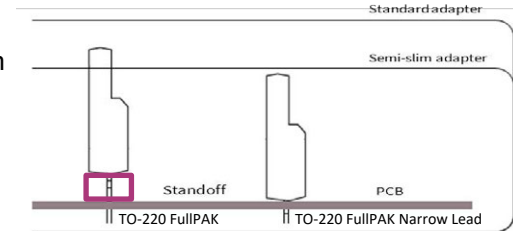
TO-220 FullPAK Narrow Lead



Key features

The optimized standoff makes the package highly attractive for slim and semi-slim adapters, by offering:

- 24% reduced width
- 44% reduced height
- 23% reduced leg width



RDS(on) [mΩ]	CoolMOS™ CE			CoolMOS™ P7	
	500 V	600 V	650 V	700 V	800 V
900				IPAN70R900P7S	
750/800		IPAN60R800CE		IPAN70R750P7S	
600/650		IPAN60R650CE	IPAN60R650CE	IPAN70R600P7S	
450/500	IPAN50R500CE			IPAN70R450P7S	IPAN80R450P7
360				IPAN70R360P7S	IPAN80R360P7
280					IPAN80R280P7

This package solution can be **fully inserted into PCB** and therefore, perfectly matches **height requirements** in **semi-slim adapter** and charger applications.

Package innovations

SOT-223 IPAK SL w/ ISO standoff TO-220 FP w/ Narrow Lead ThinPAK 8x8

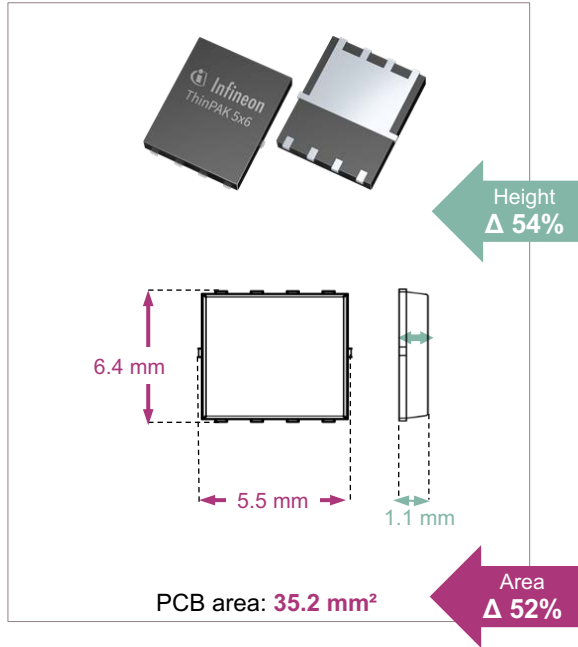
Learn more: www.infineon.com/TO220-FP_narrowlead

ThinPAK 8x8

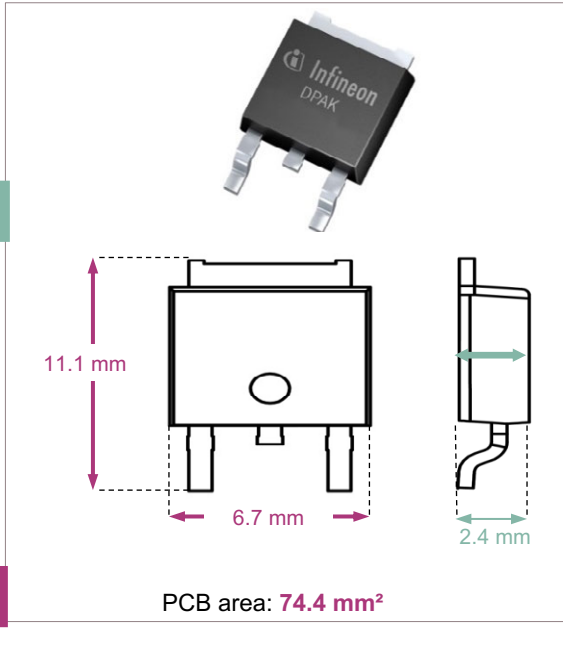
smaller footprint & slim design with better performance



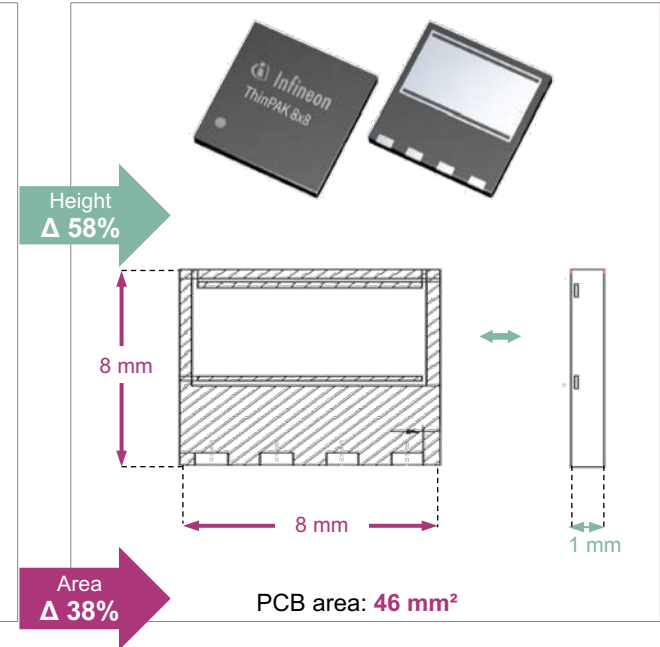
ThinPAK 5x6



DPAK



ThinPAK 8x8



Package innovations

SOT-223

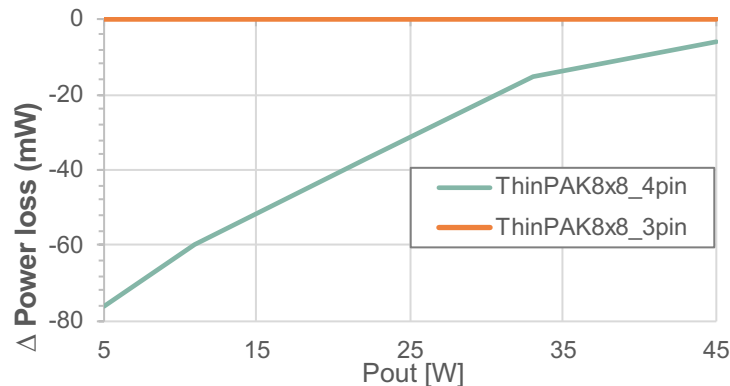
IPAK SL w/ ISO
standoff

TO-220 FP w/
Narrow Lead

ThinPAK 8x8

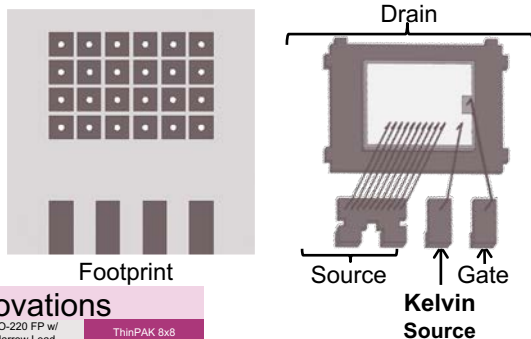
Smaller foot print • Enables slim design
Better hot spot • Better performance with Kelvin source

CoolMOS™ in ThinPAK 8x8 features 4pin kelvin source capability



** Measurements done on 45 W charger

ThinPAK 8x8



Package innovations

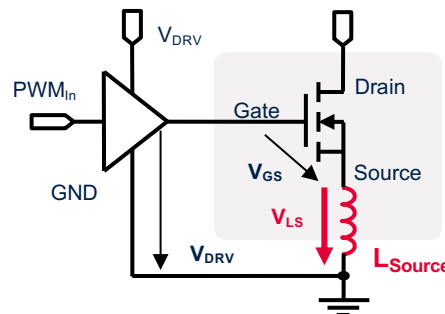
SOT-223

I-PAK SL w/ ISO
standoff

TO-220 FP w/
Narrow Lead

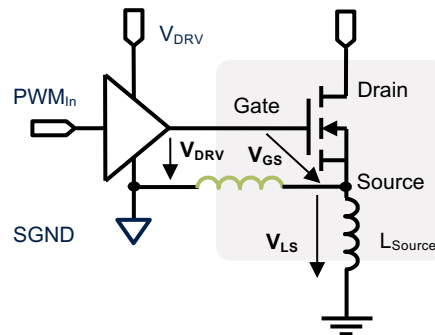
ThinPAK 8x8

Other MOSFET 3pin configuration



- > Parasitic source inductance causes higher V_{GS} ringing
- > Parasitic source inductance counter-acts drive voltage

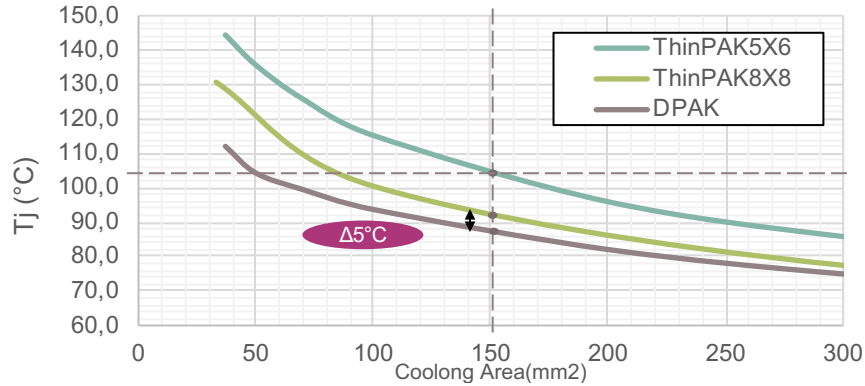
ThinPAK 8x8 4pin configuration



- > Kelvin source delivers improved **signal integrity** & **faster switching** by removing effect of source inductance

ThinPAK 8x8 contributes to fulfill end-users requirement for case hot spot

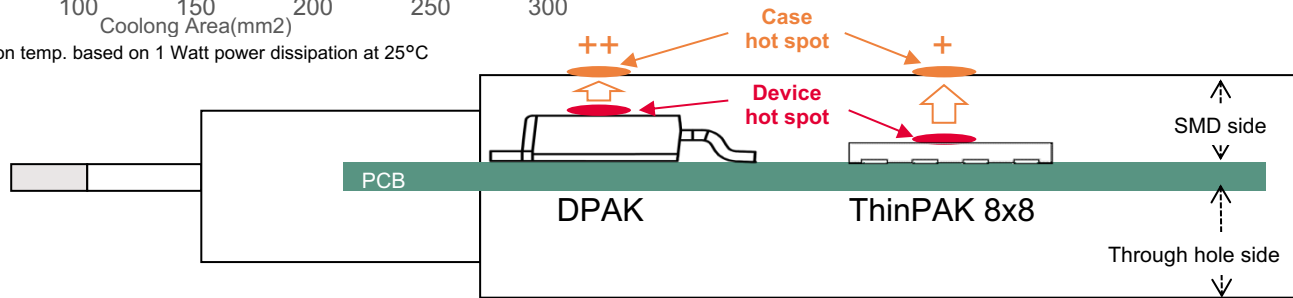
Thermal behavior



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

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



Package innovations

SOT-223

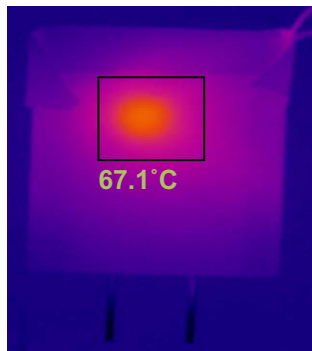
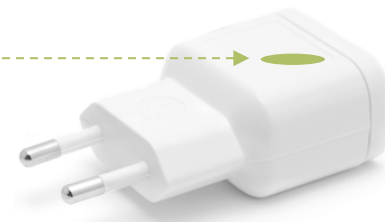
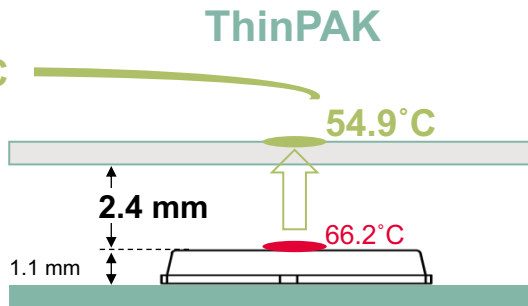
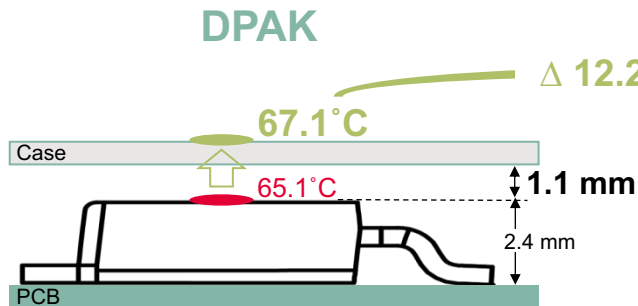
IPAK SL w/ ISO
standoff

TO-220 FP w/
Narrow Lead

ThinPAK 8x8

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

ThinPAK reduces hot spot temp due to more space between case & device



Value proposition

- › Much **lower case hot spot temperature** than DPAK
- › Supports **slimmer design** with better case hot spot behavior

Package innovations

SOT-223

IPAK SL w/ ISO
standoff


TO-220 FP w/
Narrow Lead

ThinPAK 8x8

- › Tested in 18 W customer mobile charger with same drain copper area on PCB
- › Power dissipated through MOSFET body diode 770 mW at 25°C ambient

CoolMOS™ in ThinPAK 8x8

the best solution for high density

ThinPAK 8x8 			
$R_{DS(on)}$	C7 600 V	P7 600 V	C7 650 V
[mΩ]			
365		IPL60R365P7	
285		IPL60R285P7	
230			IPL65R230C7
195			IPL65R195C7
185	IPL60R185C7	IPL60R185P7	
130			IPL65R130C7
125	IPL60R125C7	IPL60R125P7	
105		IPL60R105P7	
104	IPL60R104C7		
99			IPL65R099C7
85		IPL60R085P7	
70			IPL65R070C7
65	IPL60R065C7	IPL60R065P7	

Features

- › Small footprint (8x8mm²)
- › Low profile (1mm)
- › Low parasitic inductance
- › Separate driver source pin
- › RoHS compliant
- › Halogen free mold compound

Benefits

- › Reduced board space consumption
- › Increased power density
- › Short commutation loop
- › Smooth switching waveform
- › Easy to use products
- › Environment friendly

Package innovations

SOT-223

IPAK SL w/ ISO
standoff

TO-220 FP w/
Narrow Lead

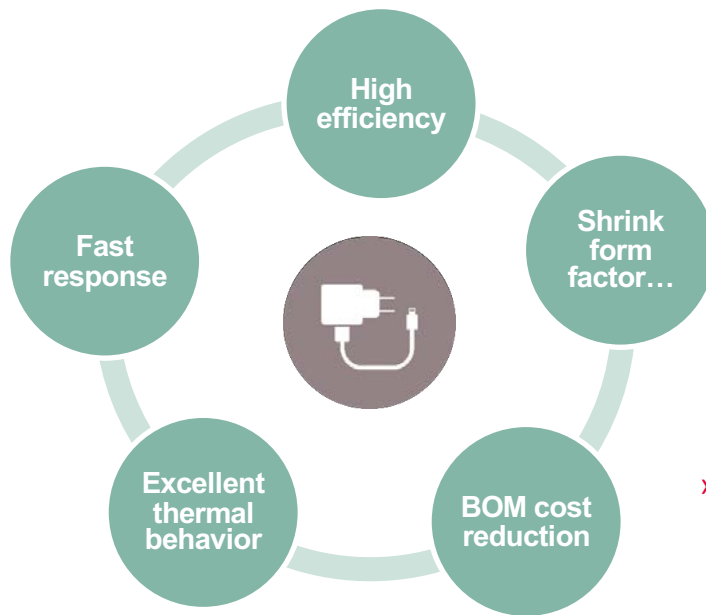
ThinPAK 8x8

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

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

- › Quick quote response
- › Short lead times

- › OptiMOS™ PD achieves **lower temperature** in a 3x3 package compared to the next best alternative in 5x6

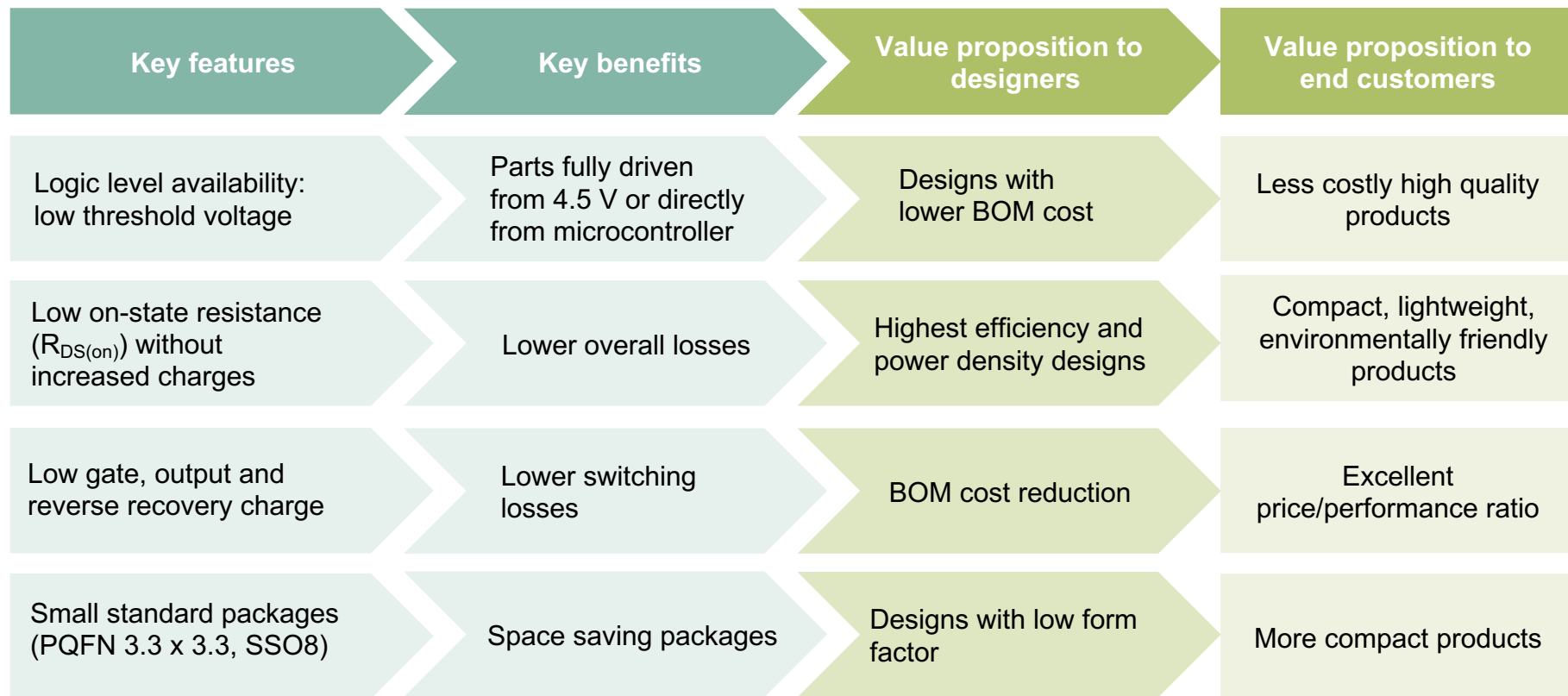


- › ...with OptiMOS™ PD in **5x6 and 3x3 packages**

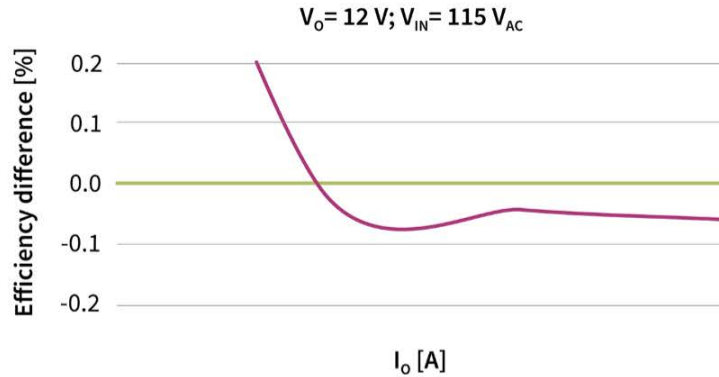


- › OptiMOS™ provides **lower charges** for:
 - less switching losses
 - excellent price/performance ratio

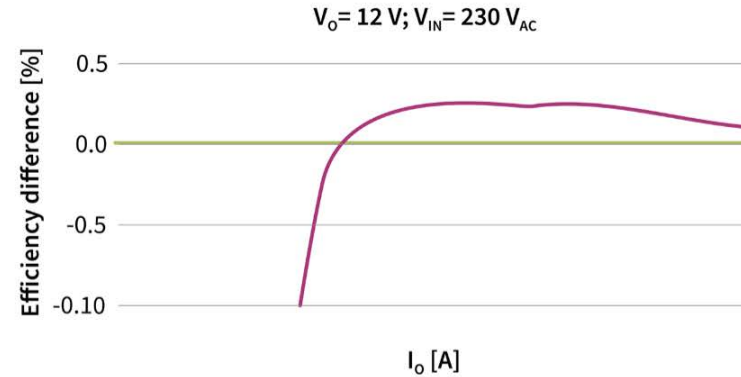
OptiMOS™ PD – value proposition



OptiMOS™ PD 100 V logic level SR efficiency comparison



- BSZ0804LS, 100 V, 9.6 m Ω , PQFN 3.3 x 3.3 package
- Next best alternative, 100 V, 9.5 m Ω , 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.

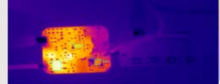
SR temp. rise: 30.7°C



BSZ0804LS

$V_{in} = 90\text{ V}_{AC}$ 60 Hz

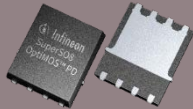

SR temp. rise: 34.6°C



Next best alternative 100 V, 9.5 m Ω in 5x6 package

$V_{in} = 90\text{ V}_{AC}$ 60 Hz

OptiMOS™ PD – optimized for synchronous rectification in charger and adapter designs

Package	Voltage Class [V]	$R_{DS(on)}$ max. @ $V_{GS} = 10V$ [mΩ]	$R_{DS(on)}$ max. @ $V_{GS} = 4.5V$ [mΩ]	Part number	Application
SuperSO8 	60	2.7	3.9	BSC0702LS	5V/5A 5V/6A
		6.5	9.4	BSC0703LS	5V/5A 18W QC3.0
		9.4	13.5	BSC0704LS	18W QC2.0 18W QC3.0
	100	3.4	4.8	BSC0802LS	USB PD 3.0
		7.0	10.2	BSC0805LS	>35W PD< 65W PD
		9.8	14.0*	BSC0804LS	>35W PD< 65W PD
	120	14.6	20.8	BSC0803LS	24W QC2.0
		8.2	11.0	BSC0302LS	>35W PD< 65W PD
	150	9.3	10.5**	BSC0402NS	>35W PD< 65W PD
		11.0	11.5**	BSC0403NS	>35W PD< 65W PD
PQFN 3.3x3.3 	25	3.1	3.9	ISZ0501NLS	Load switch
		6.0	8.1	ISZ0901NLS	Load switch
	-30	8.6	13.4*	BSZ0905PNS	Load switch
		3.0	3.5	BSZ0909LS	>= 4A
	30	4.5	5.7	BSZ0910LS	3-5A
		7.0	9.0	BSZ0911LS	<= 3A
	60	4.0	5.6	BSZ0702LS	5V/4~5A 18W QC3.0
		6.5	9.4	BSZ0703LS	18W QC3.0
		9.9	14	BSZ0704LS	18W QC2.0
	80	7.0	9.4	BSZ0602LS	18W QC3.0
		9.6	13.5	BSZ0804LS	>35W PD< 65W PD
	100	14.6	20.8	BSZ0803LS	24W QC2.0




Legend:

*@ $V_{GS} = 6V$

**@ $V_{GS} = 8V$

- BiC performance for differentiated designs
- Best choice for a wide range of designs lead time optimized (<10 weeks LT)

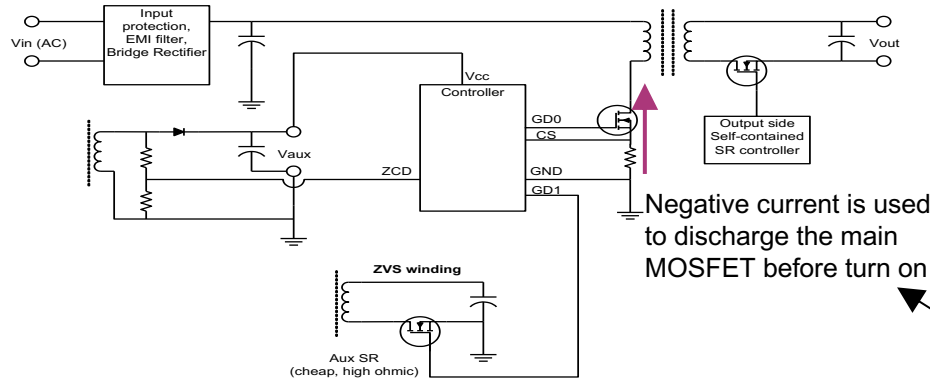
XDPS21071 digital FFR flyback controller value proposition

Customers' driver		Infineon offers	Customers' benefits
Performance		Zero voltage switching (ZVS)	<ul style="list-style-type: none"> › Reduced switching losses › High efficiency of >90%
		Frequency law optimization	<ul style="list-style-type: none"> › Optimized efficiency across various line/load conditions › High 4-point average efficiency of >90% surpassing regulatory standard
		Active bust-mode operation with multiple entry/exit threshold	<ul style="list-style-type: none"> › Surpassed regulatory efficiency of @ 10% load with 4% margin › Surpassed no-load input power regulatory standard with <25 mW › Free of acoustic noise and light load control scheme
Ease of design		Integrated dual MOSFET gate driver	<ul style="list-style-type: none"> › No external MOSFET gate driver needed › Save BOM cost and count
		Easy ZVS implementation with an external 60 V n-channel MOSFET	<ul style="list-style-type: none"> › ZVS MOSFET shares common ground with the controller › Easy to drive and no expensive high-side driver needed › Low cost and widely available off the shelf 60 V MOSFET
Robustness		VCS offset	<ul style="list-style-type: none"> › Different overload threshold for different output › A fail-safe mechanism to limit output power in the event of a failure with PD controller
		CrCM operation with valley detection	<ul style="list-style-type: none"> › Avoid CCM operation › No potential of shoot-through with SR MOSFET

XDP™ digital FFR flyback controller

ZVS operating principle

Application block diagram

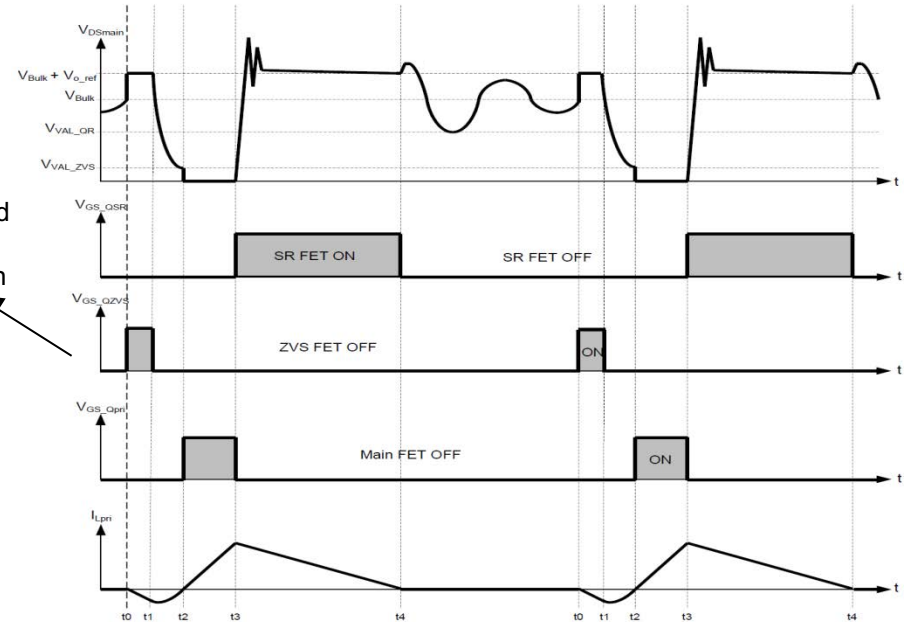


$$ZVS_{ton} \sim \sqrt{L_p * C_{eqv}} * \frac{V_{bulk} + N_{pa} * V_{zvs}}{N_{pa} * V_{zvs}}$$

$$T_{delay} = \frac{\pi}{2} * \sqrt{L_p * C_{eqv}}$$



Operation waveform



Patent: [US9673718B2](https://patents.google.com/patent/US9673718B2)

Support material

Collaterals and brochures



- › Product briefs
- › Selection guides
- › Application brochures
- › Presentations
- › Press releases, Ads

Technical Material



- › Application notes
- › Technical articles
- › Simulation models
- › Datasheets, MCDS files
- › PCB design data

Videos and online courses



- › Technical videos
- › Online courses
- › Product information

- › www.infineon.com/charger
- › www.infineon.com/adapter
- › www.infineon.com/USB-PD
- › www.infineon.com/xdps21071
- › www.infineon.com/p7
- › www.infineon.com/OptiMOS



Part of your life. Part of tomorrow.