CoolMOS™ CE series within charger applications

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October 2016

Agenda

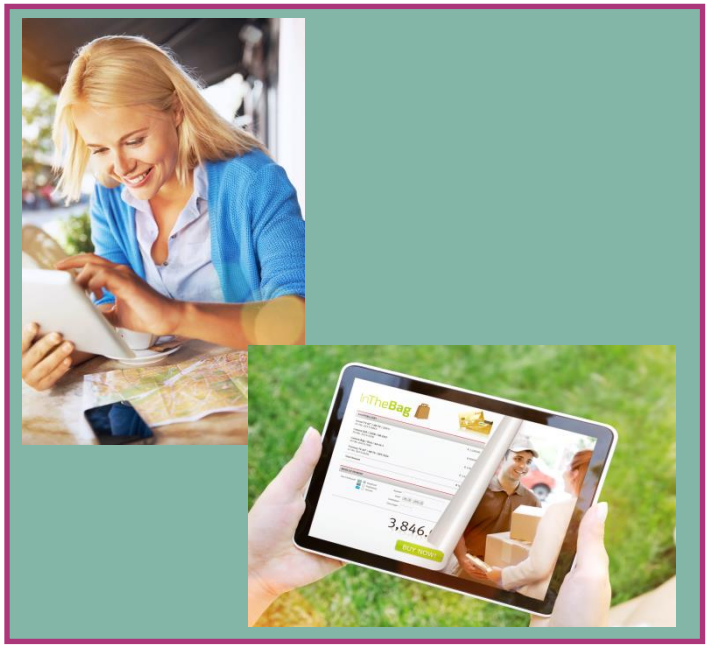
1. CoolMOS™ CE series within charger applications
2. Application tests and benchmarking
3. Success stories

CoolMOS™ CE series for chargers
Introduction

Have you recently used this fancy part?

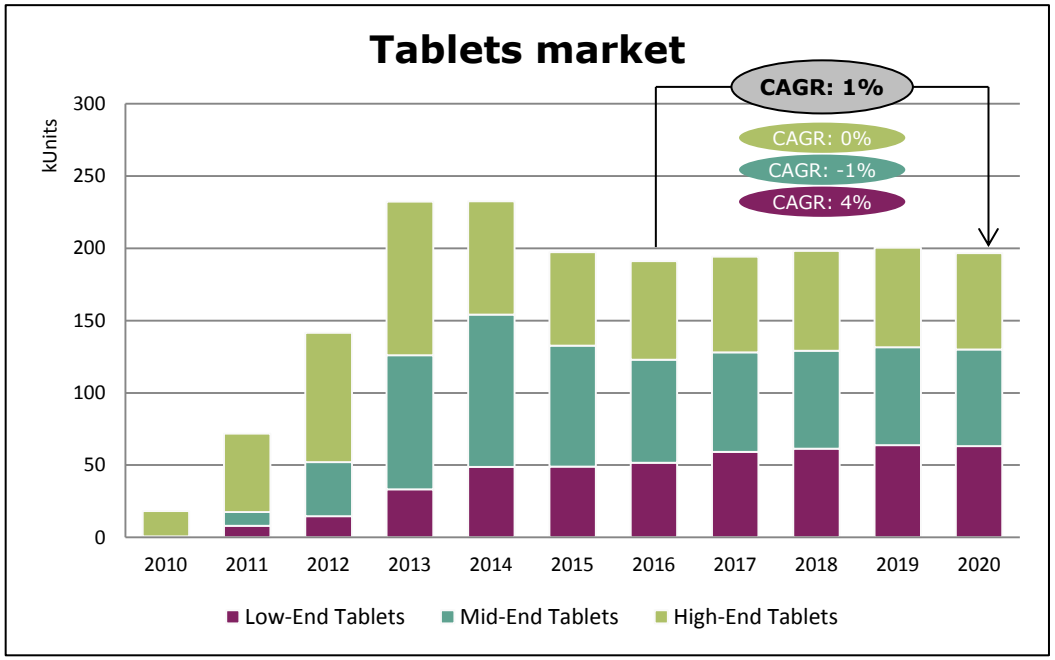
Why not?

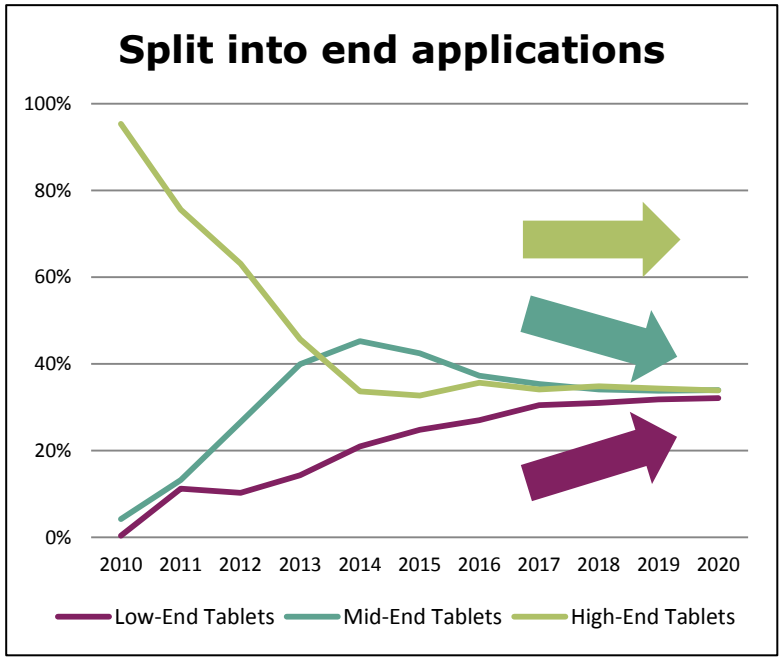
CoolMOS™ CE series for chargers
Introduction



Nowadays everybody is using mobile devices!

CoolMOS™ CE series for chargers
Tablets market ww

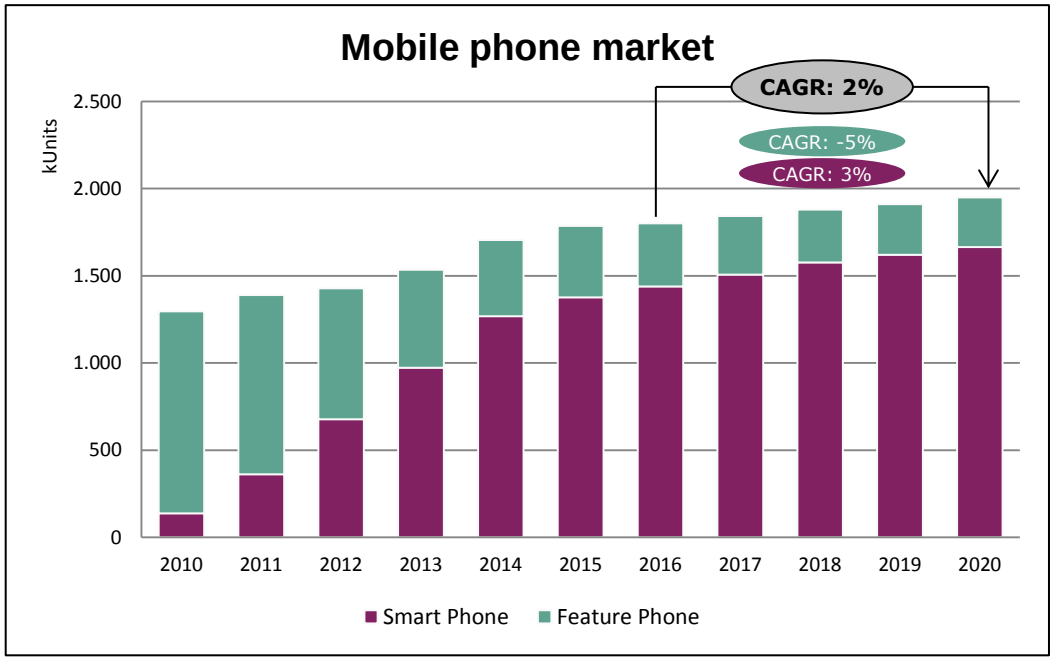


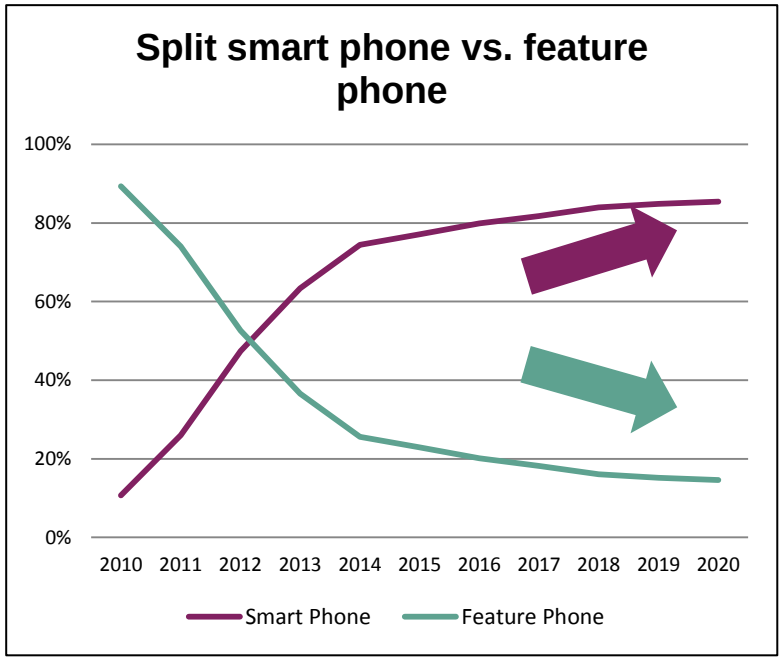


- Overall tablets market growth is **stabilizing at ~200 MUnits p.a.** (smart phones coming closer in terms of screen size)
- **Growth of 4%** (CAGR 16/20) seen at **low-end tablets**. Especially these segment of high interest and gets primarily served via distribution
- Definition
  - Low-end : <150 USD
  - Mid-end : 150 up to 300 USD
  - High-end : >300 USD

Source: IHS Compute Electronics Market Tracker Apr'16

CoolMOS™ CE series for chargers
Mobile phone market ww



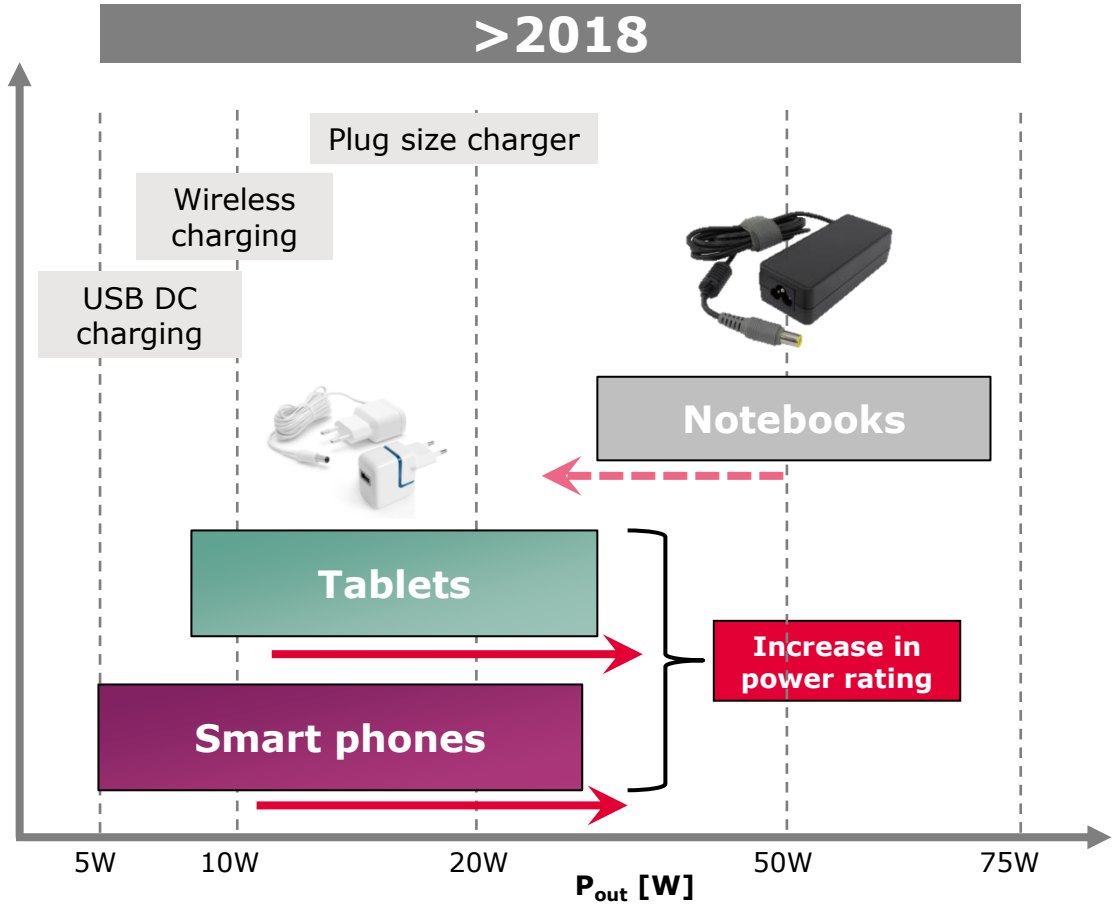


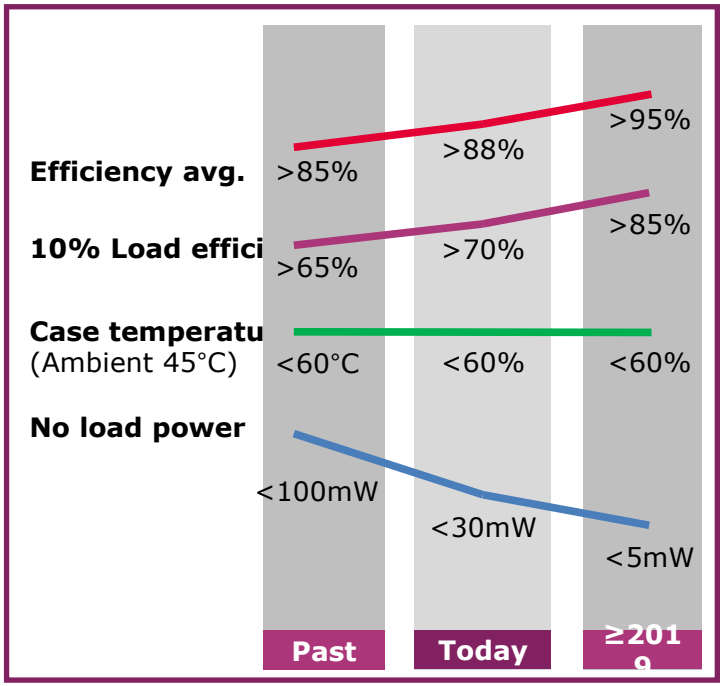
- **Mobile phone** market is a **huge market** and growing with an overall **CAGR of 2%**
- Especially **smart phone** segment becomes **trendy** with a **reasonable growth rate**

- <u>Smart phone segment requires:</u>
  - Small / light-weighted chargers → **high density** and **slim** chargers
  - Fast charging capability → **high power** and **efficient** chargers

Source: IHS Compute Electronics Market Tracker Apr'16

CoolMOS™ CE series for chargers
General performance trends for chargers





Data Source: Infineon's internal assumptions

- Trend towards **increased power rating** → up to 25 W with density target of 15 W/in³
- Trend towards **higher efficiency**

Picture source: Internet, Infineon Media Pool

CoolMOS™ CE series for chargers
Déjà-vu

Tablets
~200 M
Units/yr

Smartphones
~1.8 B
Units/yr

~2.0 B portable devices

that need to get

frequently powered up

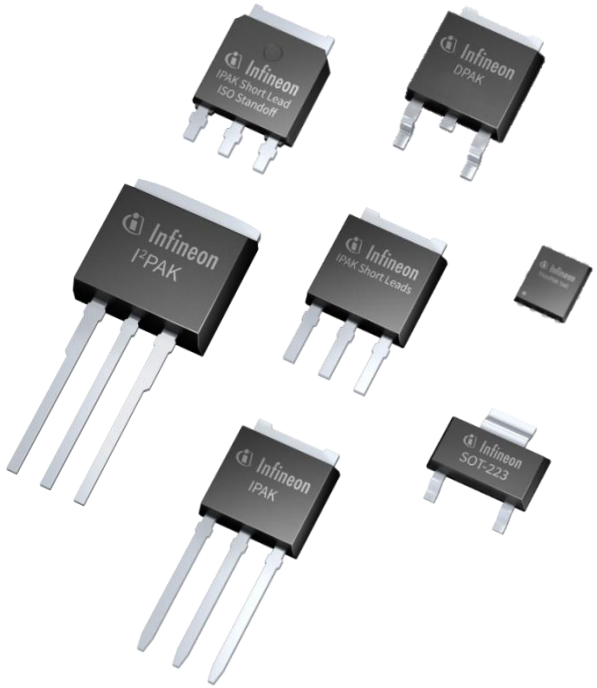
(aftersales market not even included)

CoolMOS™ CE series for chargers
Infineon empowers your charger

With CoolMOS™ CE series Infineon offers the right switch to empower the charger market

Key benefits and features

- High cost competitiveness
- Broad portfolio
- Large variety of packages
- Ease-of-Use technology
- Fast design-in capability (PnP)
- EMI within EN55022B Standard
- Right fit in terms of thermals
- Enabling high power density designs for slim device layout



Don’t forget, all this comes with
the well known **high quality standard** from Infineon

CoolMOS™ CE series for chargers
700 V / 650 V portfolio

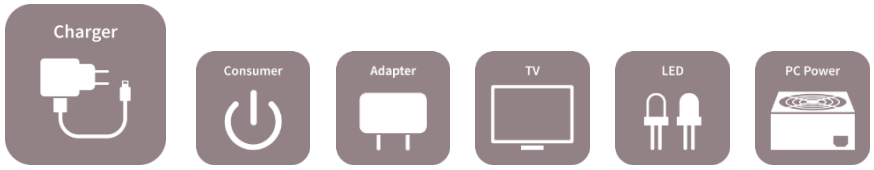
700 V

$R_{DS(ON)}$ [mΩ]	TO-262 I²PAK	TO-252 DPAK	TO-251 IPAK SL	IPAK SL w/ iso lead standoff	SOT-223	ThinPAK 5x6	TO-220FP Wide Creepage
2000/2100		IPD70R2K0CE	IPS70R2K0CE	IPSA70R2K0CE		IPL70R2K1CES	
1400/1500		IPD70R1K4CE	IPS70R1K4CE	IPSA70R1K4CE	IPN70R1K5CE		
950/1000	IPI70R950CE	IPD70R950CE	IPS70R950CE	IPSA70R950CE	IPN70R1K0CE		IPAW70R950CE
600		IPD70R600CE	IPS70R600CE	IPSA70R600CE			IPAW70R600CE

650 V

$R_{DS(ON)}$ [mΩ]	TO-220 FullPAK	TO-252 DPAK	TO-251 IPAK SL	SOT-223
1500	IPA65R1K5CE	IPD65R1K5CE	IPS65R1K5CE	IPN65R1K5CE
1000	IPA65R1K0CE	IPD65R1K0CE	IPS65R1K0CE	
650	IPA65R650CE	IPD65R650CE	IPS65R650CE	
400	IPA65R400CE	IPD65R400CE	IPS65R400CE	

Highly recommended for chargers



- 8 $R_{DS(on)}$ in 8 packages
- New SOT-223 products for charger
- New IPAK SL w/ iso lead stand-off products for charger
- 700 V products for charger / adapter

CoolMOS™ CE series for chargers 600 V portfolio

$R_{DS(ON)}$ [mΩ]	TO-220 FullPAK	TO-252 DPAK	TO-251 IPAK SL	TO-251 IPAK	SOT-223	TO-220FP Wide Creepage
3300		IPD60R3K4CE	IPS60R3K4CE	IPU60R3K4CE	IPN60R3K4CE	
2100		IPD60R2K1CE	IPS60R2K1CE	IPU60R2K1CE	IPN60R2K1CE	
1500	IPA60R1K5CE	IPD60R1K5CE	IPS60R1K5CE	IPU60R1K5CE	IPN60R1K5CE	
1000	IPA60R1K0CE	IPD60R1K0CE	IPS60R1K0CE	IPU60R1K0CE	IPN60R1K0CE	
800	IPA60R800CE	IPD60R800CE	IPS60R800CE			
650/600	IPA60R650CE	IPD60R650CE	IPS60R650CE			IPAW60R600CE
460	IPA60R460CE	IPD60R460CE	IPS60R460CE			
400/380	IPA60R400CE	IPD60R400CE	IPS60R400CE			IPAW60R380CE
280						IPAW60R280CE
190						IPAW60R190CE

- 12 $R_{DS(on)}$ in 6 packages
- New SOT-223 products (mainly for lighting)
- TO-220 FP Wide Creepage (mainly for TV)

Agenda

1 CoolMOS™ CE series within charger applications

2 Application tests and benchmarking

- **10 W travel charger board**
- 18 W quick charger
- 24 W charger

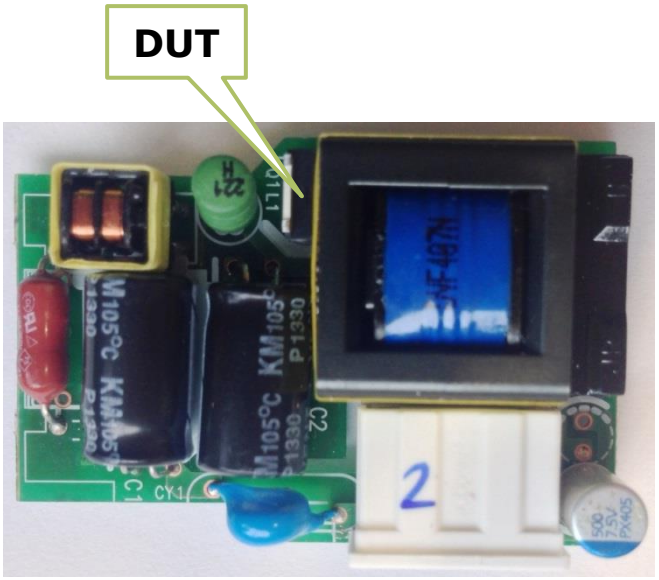
3 Success Stories

Application tests and benchmarking 10 W charger board

Objective : Competitor analysis on 10 W travel charger board (slim type)

Charger specification :

Description	Origin specification
Input	85-264 V_{AC}
Output	5.3 V_{DC} / up to 2 A / up to 10 W
Topology	Peak current controlled flyback (var. frequency)
Switching Frequency	47-50 kHz @FL
Primary MOSFET	**IPS65R1K4C6** (650 V, 1k4 mΩ, IPAK)
Primary Controller	BCD360
PCB Dimension L x W x H [mm]	45 x 31 x 12
Remark	› EMI filter at input › Avg efficiency at end of PCB >80% › No load input power <20 mW @ 230 V_{AC} › Conduction loss dominated design



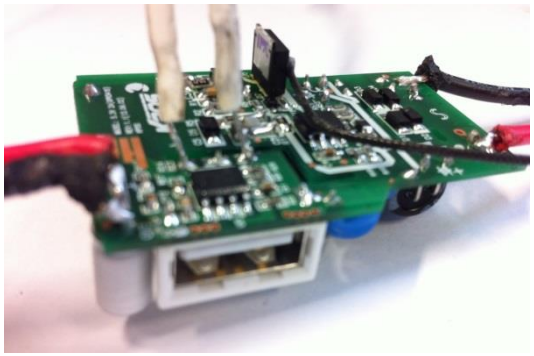
Test applied for benchmarking :

1. **Efficiency measurement**
2. **Thermal measurement**
3. **EMI measurement**

Application tests and benchmarking 10 W charger board

DUT : Common used MOSFET devices, available on the market

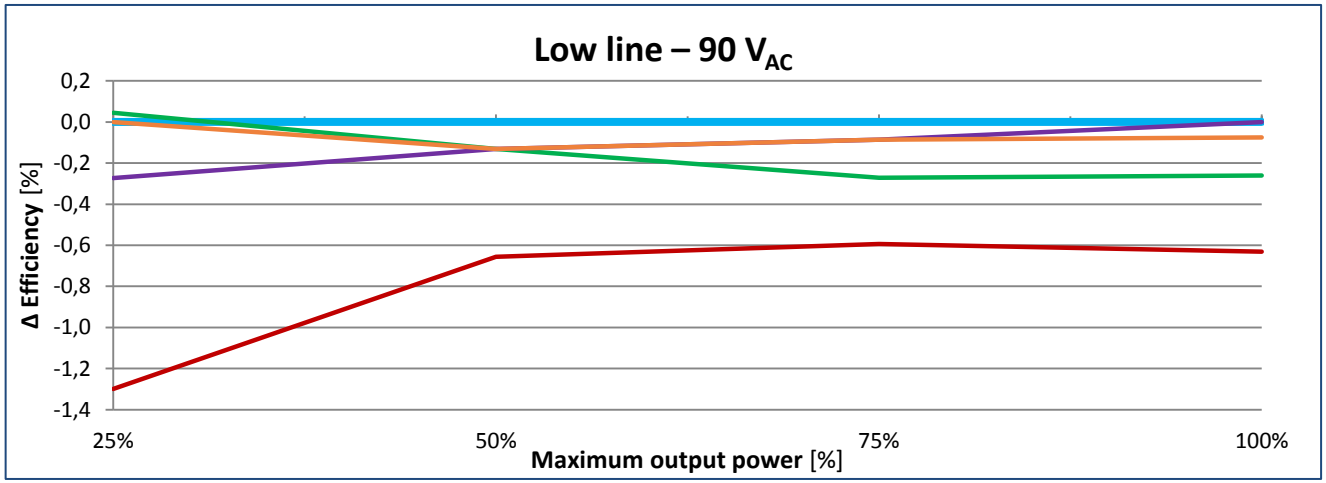
Device	Technology	Package	V_{dss}(br) [V]	$R_{ds(on)}$ max [mΩ] ~2 A, V_{GS}=10 V, T_j=25°C	R_{gate} [Ω]	E_{oss} [uJ] V_{DS}=300 V, V_{GS}=0 V	Q_g [nC] V_{DS}=480 V, I_d=2 A, V_{GS}=10 V	$V_{gs(th)}$ [V] I_d=250 uA
IPS65R1K5CE	**SJ**	**IPAK**	**650**	**1500**	**6.5**	**0.78**	**10.5**	**3.00**
Comp S1	STD	IPAK	650	1300	3.5	1.6	33.0	3.75
Comp S2	STD	IPAK	700	1700	-	-	20.0	3.00
Comp M1	STD	IPAK	650	1450	-	-	15.8	3.00
Comp S3	SJ	IPAK	700	1600	-	-	8.3	3.00

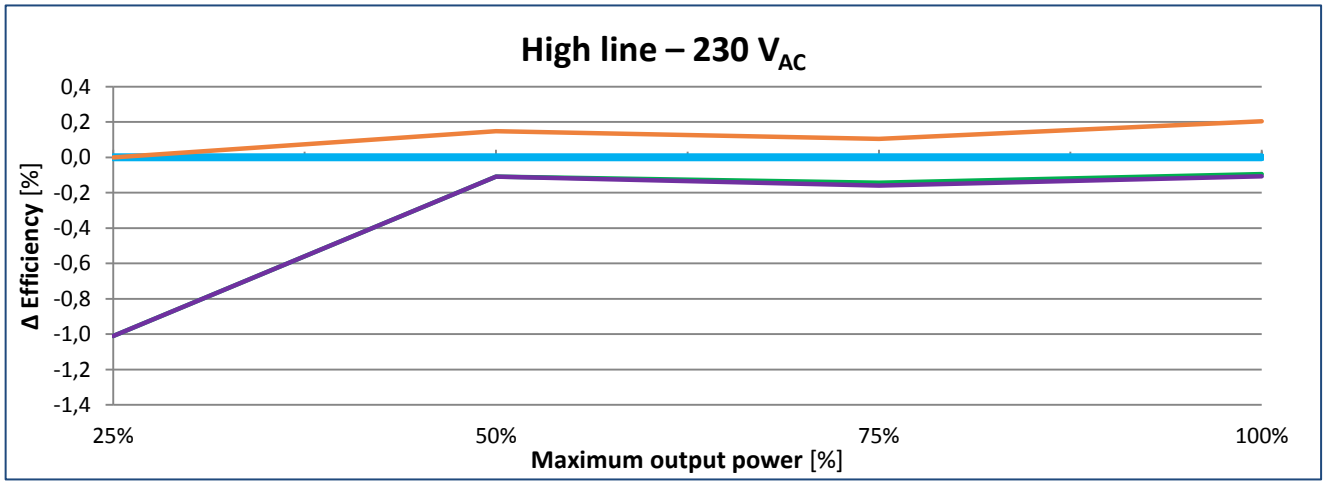


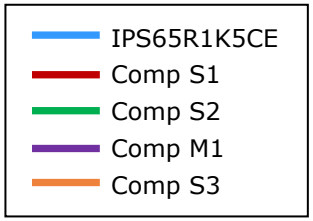
Application tests and benchmarking
10 W charger board

1

Efficiency measurement





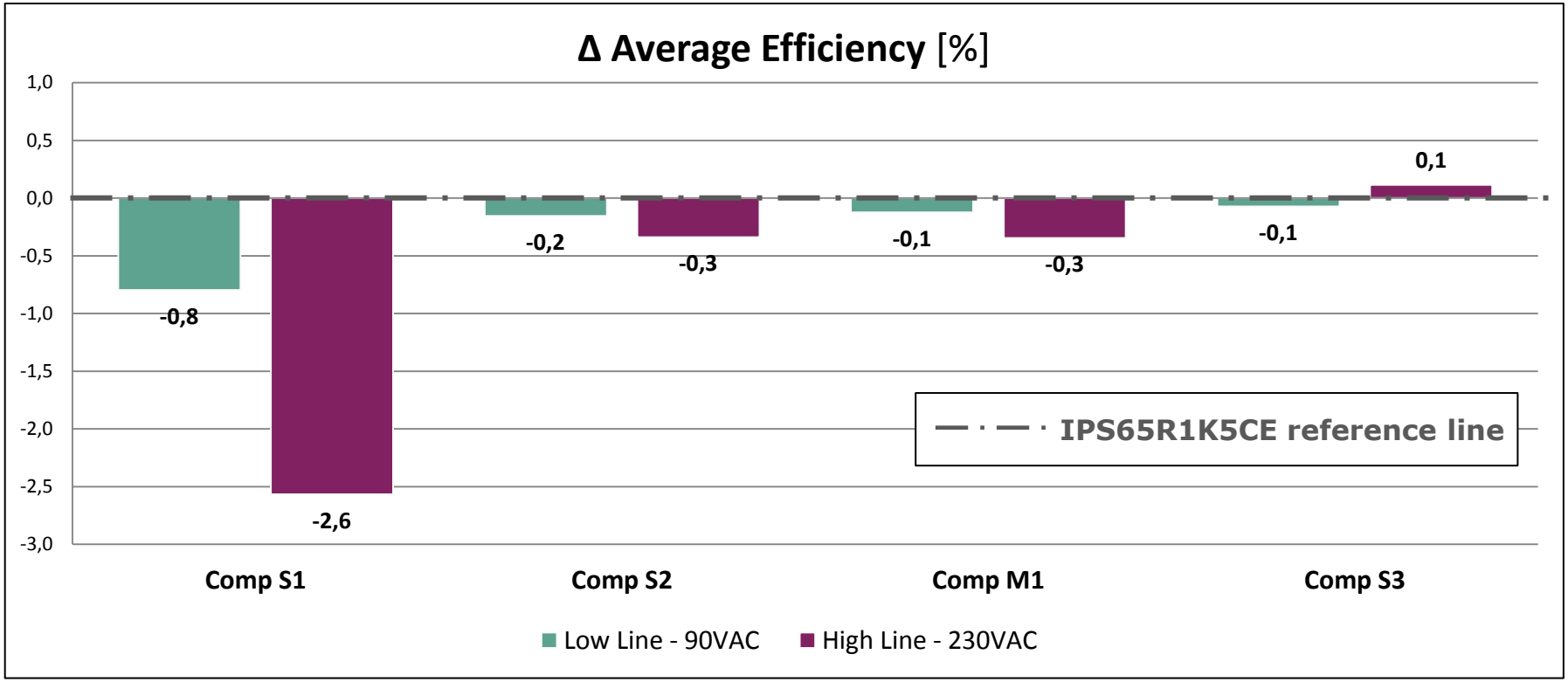


IPS70R1K4CE shows very good performance compared to competitor devices

Application tests and benchmarking
10 W charger board

1

C O N C L U S I O N



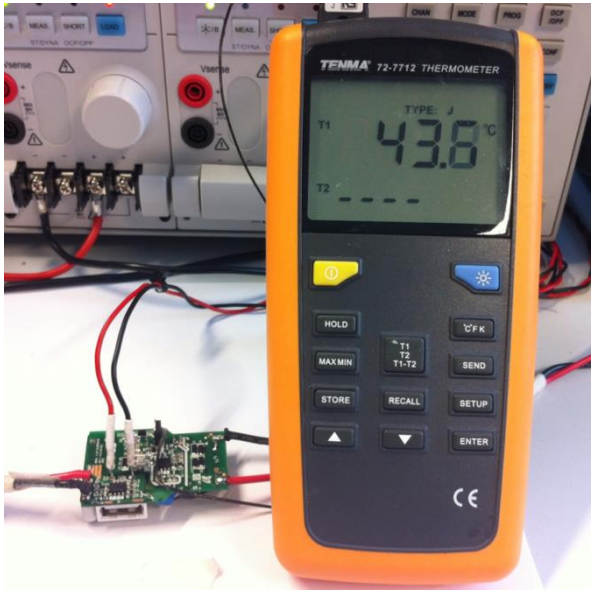
› **CoolMOS™ CE series** shows **better efficiency** compared to competitor MOSFETs

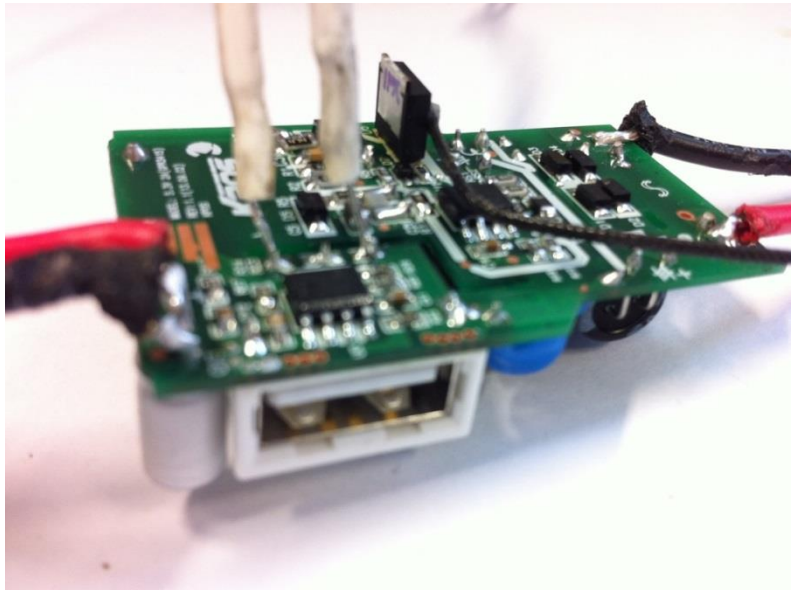
› Exception seen for one competitor at high line (slightly higher efficiency of ~0.1% avg)

Application tests and benchmarking
10 W charger board

2

Thermal measurement



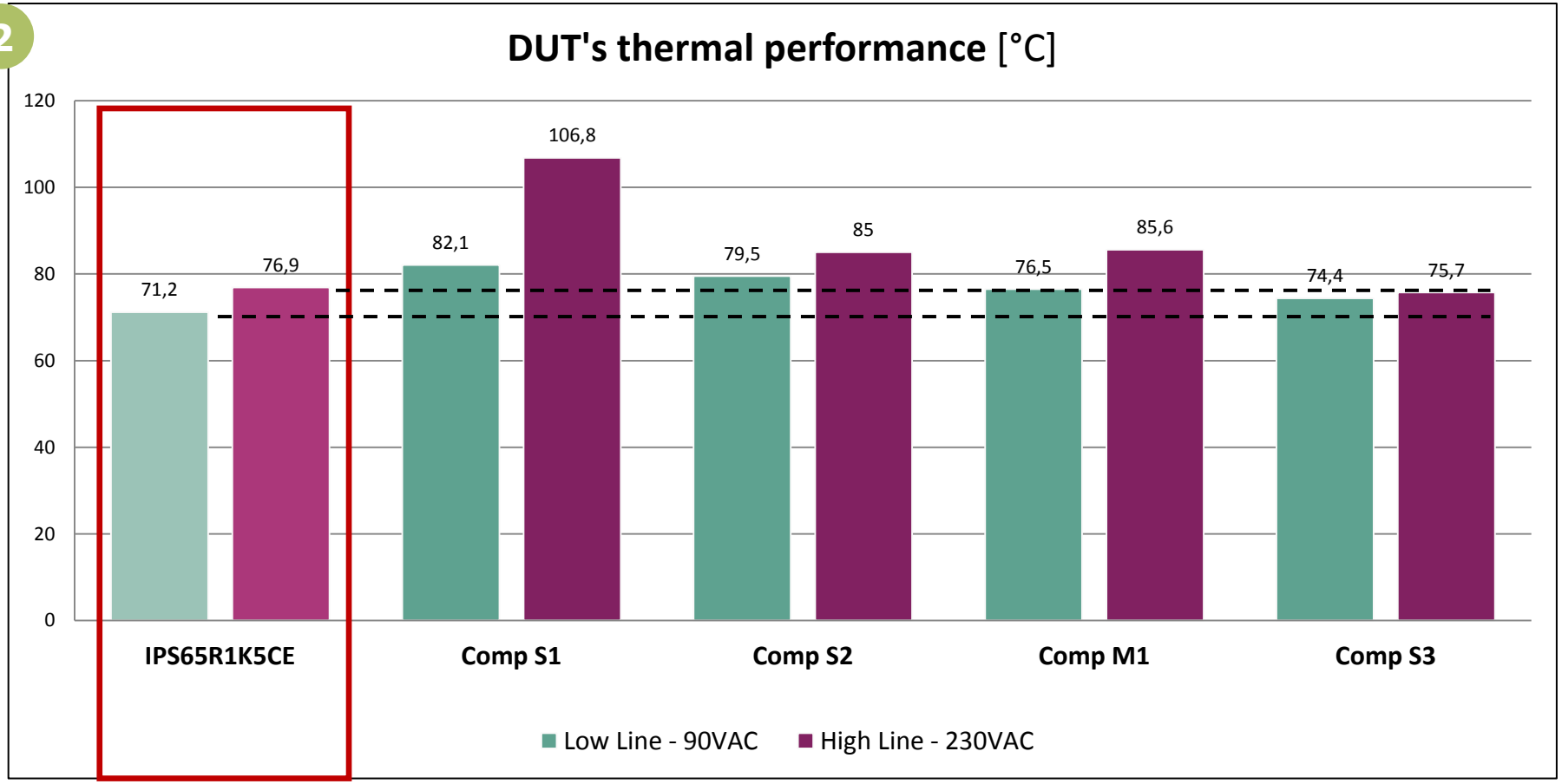


Test Setup:

- Test conditions:
  - V_{in}=90 V_{ac}; V_{out}=5.3 V; I_{out}=2 A; P_{out} = 10.6 W
  - V_{in}=230 V_{ac}; Vout=5.3 V; I_{out}=2 A; P_{out} = 10.6 W
- Unit initially powered up at full load for 2 hrs before recoding temperature measurement
- Thermal measurement applied at high line and low line (full load)

Application tests and benchmarking 10 W charger board

2



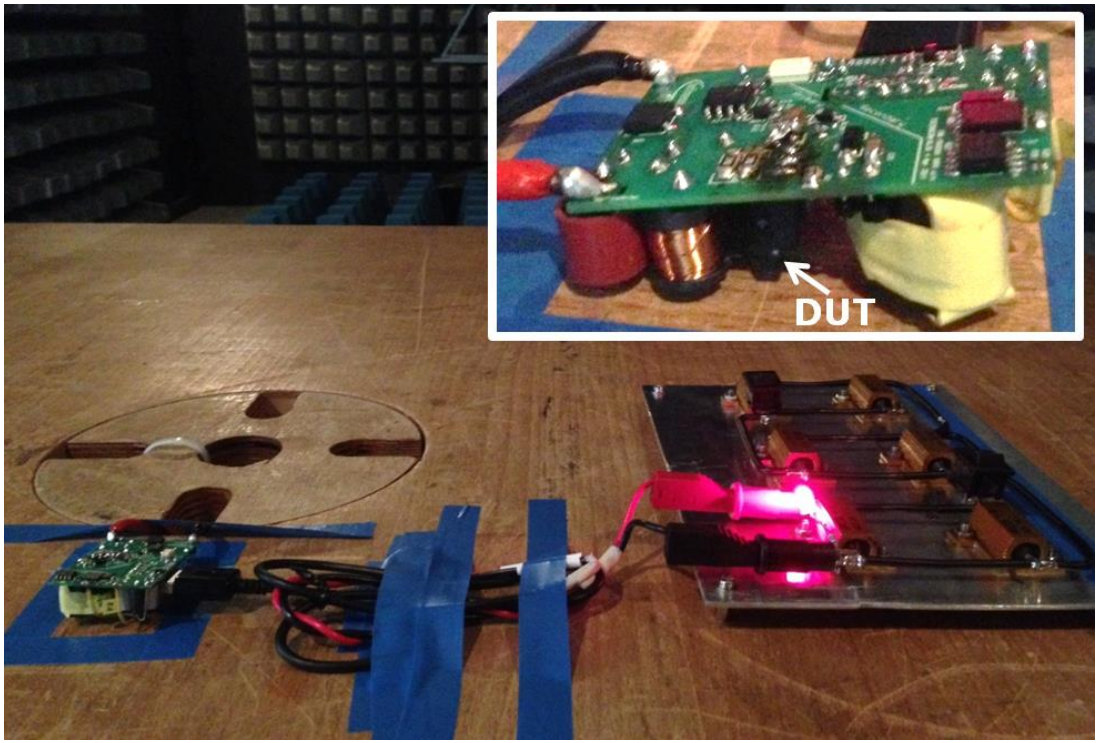
› The lower losses of **CoolMOS™ CE** offers an advantage of **lower temperature** in comparison to competitor MOSFETs

› Only one competitor (SJ device) has reach similar thermal performance

Application tests and benchmarking 10 W charger board

3

EMI measurement (radiated)



HF-Field = 30 MHz to 1 GHz

Orientation = Vertical 0°

EMI measurement applied at high line (230 V_{AC}) + full load

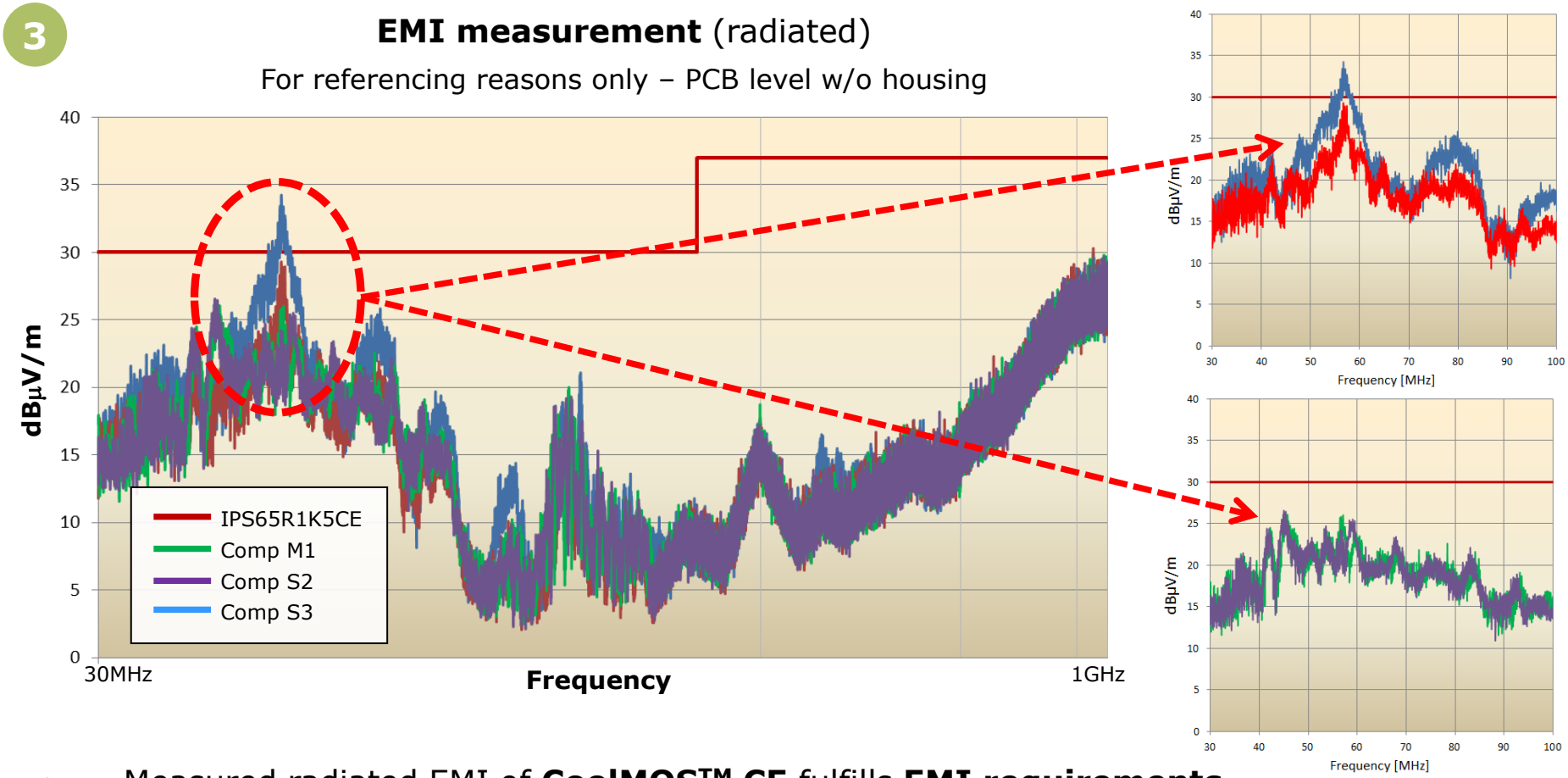
EMI measurement applied on PCB level only (open case). Thus the measurements can only be used as a referencing between the different tested devices

Application tests and benchmarking 10 W charger board

3

EMI measurement (radiated)

For referencing reasons only – PCB level w/o housing



- Measured radiated EMI of **CoolMOS™ CE** fulfills **EMI requirements**
- CoolMOS™ CE due to its fast switching shows slightly higher EMI behavior compared to standard MOS but better behavior as SJ competitor device

Remark acc. to EMI: Pls reference to Infineon's App Note „Optimizing CoolMOS™ CE based power supplies for meeting EMI requirements"

Application tests and benchmarking 10 W charger board

SUMMARY

Priority Ranking (assumed)	Parameter	IPS65R1K5CE (Infineon)	Comp S1	Comp S2	Comp M1	Comp S3
1	EMI [dB] *1)	-2	no data	-3	-4	7
1	Thermals [°C]	77	108	85	85	76
3	Avg efficiency [%] (IFX reference)	0	-1.68	-0.25	-0.23	0.10
4	Ease-of-Use (Best to worst: 1…5)	2	3	1	1	3

Infineon's **CoolMOS™ CE series**

- fulfills the EMI standard (EN55022B)
- shows good thermal behavior
- exceeds the efficiency requirements
- is an „ease-of-use" device – developed to fully meet application requirements

*1) EMI measured on PCB level – useable for referencing between different tested devices only

Agenda

1 CoolMOS™ CE series within charger applications

2 Application tests and benchmarking

- 10 W travel charger board
- **18 W quick charger**
- 24 W charger

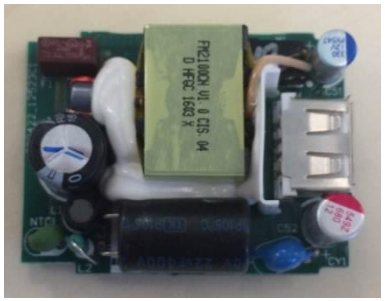
3 Success Stories

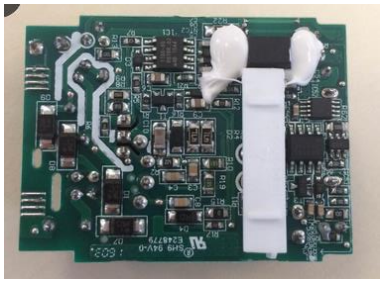
Application tests and benchmarking
18 W quick charger (available on open market)

Objective : Plug&Play replacement with CoolMOS™ CE (IPS70R1K4CE)

Charger specification :

Description	Origin specification
Input Power Specification	100-240 V_{AC}/0.5 A, 50/60 Hz
Communication Protocol	QC2.0
Output Power Specification	5 V/2 A 9 V/2 A
Topology	Flyback
Primary Controller	iW1780-00
Primary MOSFET	**Planar MOS 700 V, 1k4 mΩ, IPAK**
SR Controller	iW671
Case Dimension L x W x H [mm]	53 x 40 x 22
PCB Dimension L x W x H [mm]	46 x 35 x 18



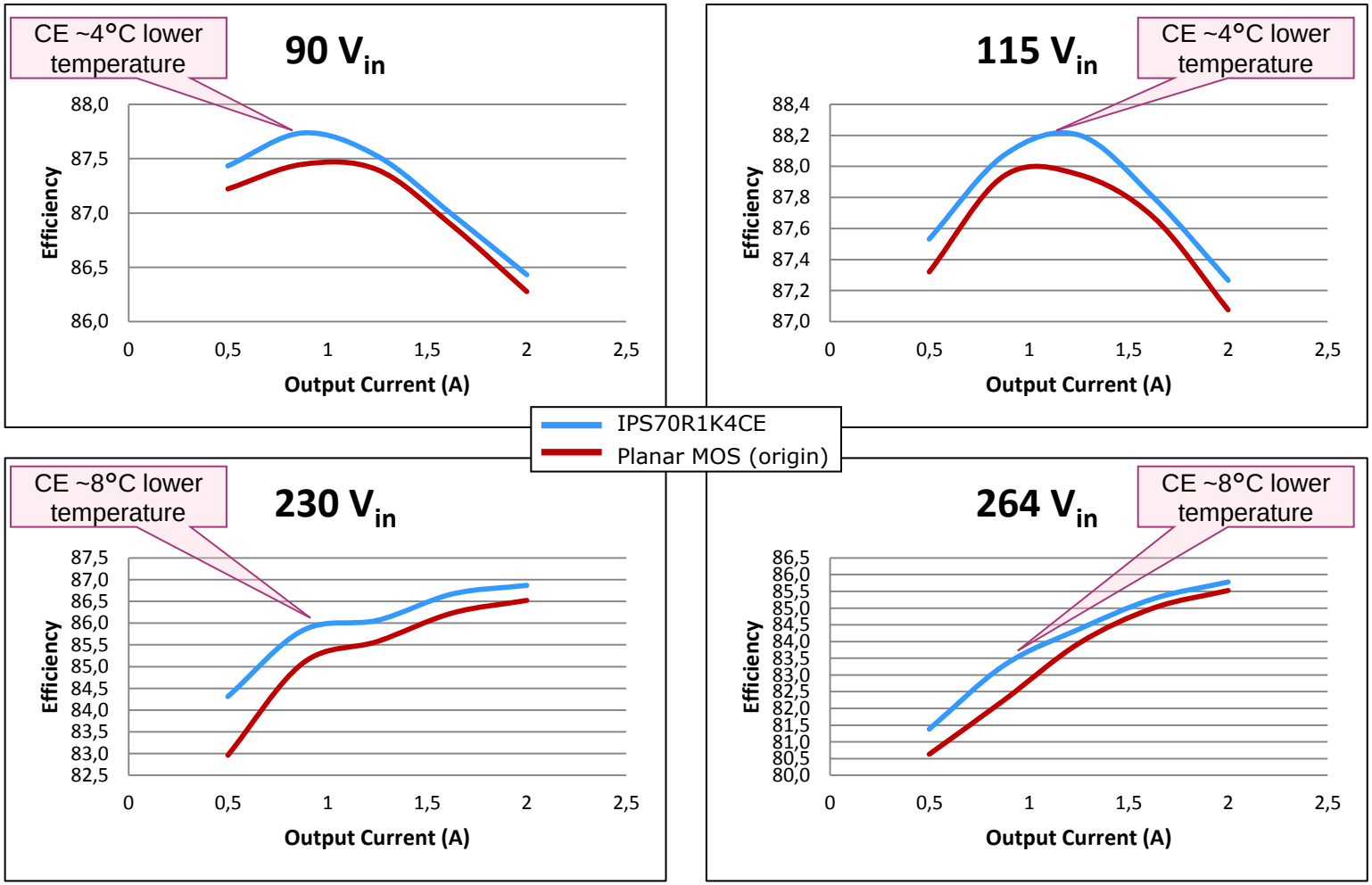


Test methodology : Performing MOSFET related measurements listed as follows

Test	Classification / Initiative
Efficiency measurement	10% load and average load (ref to COC V5 Tier2)
Thermal test for critical components @ 9 V	Temperature measurement of critical components w/o case (FLIR Thermal Camera)
Conducted EMI @ 9 V	Conducted EMI performance according to CISPR 22 / EN5022 Class B (R&S Receiver)
Radiative EMI @ 9 V	Radiative EMI performance according to CISPR 22 / EN5022 Class B (R&S Receiver)

Application tests and benchmarking
18 W quick charger (available on open market)

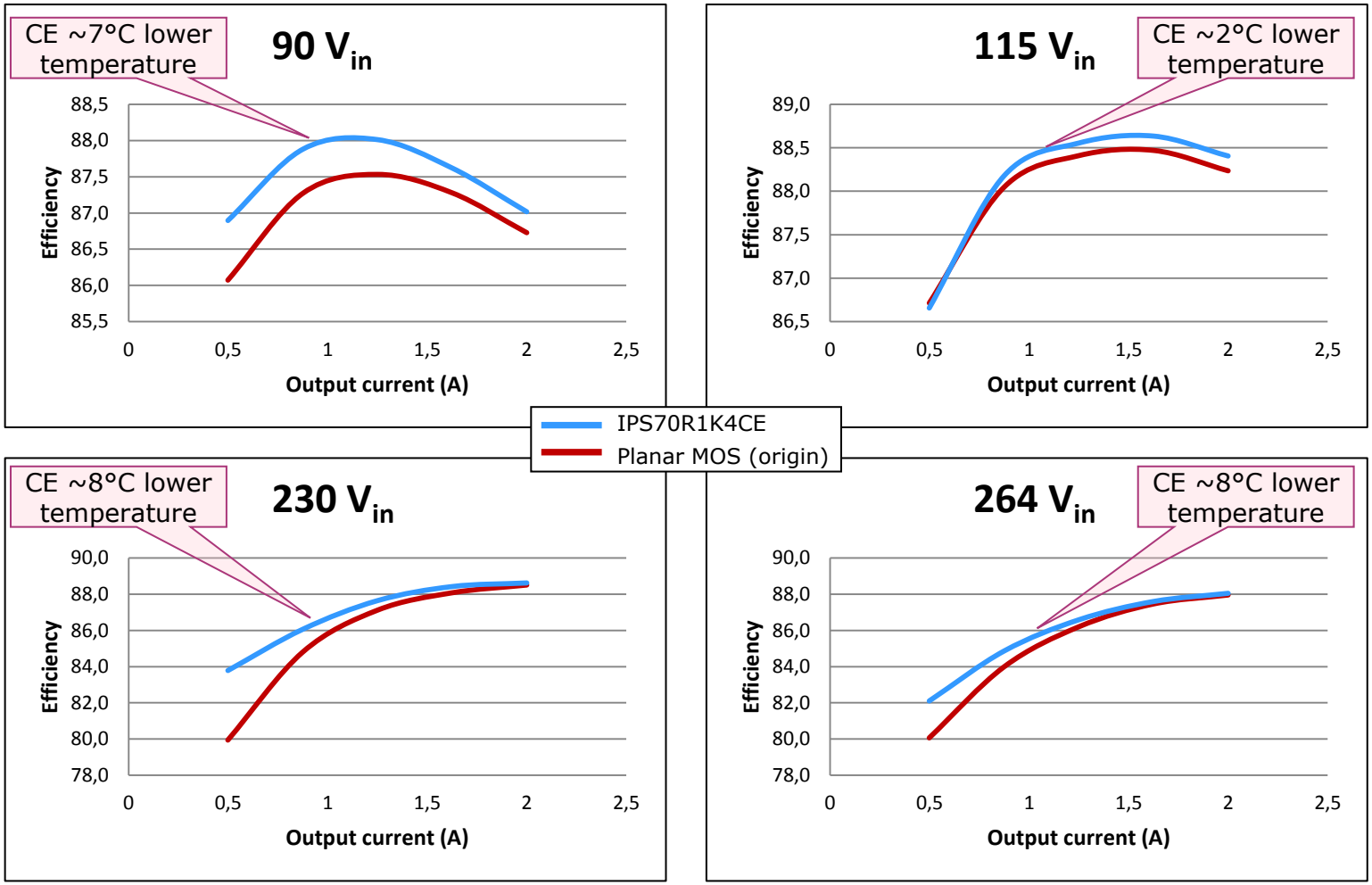
Efficiency measurement @ V_{out} 5 V



IPS70R1K4CE outperforms origin selected planar MOS @ V_{out} 5 V

Application tests and benchmarking
18 W quick charger (available on open market)

Efficiency measurement @ V_{out} 9 V



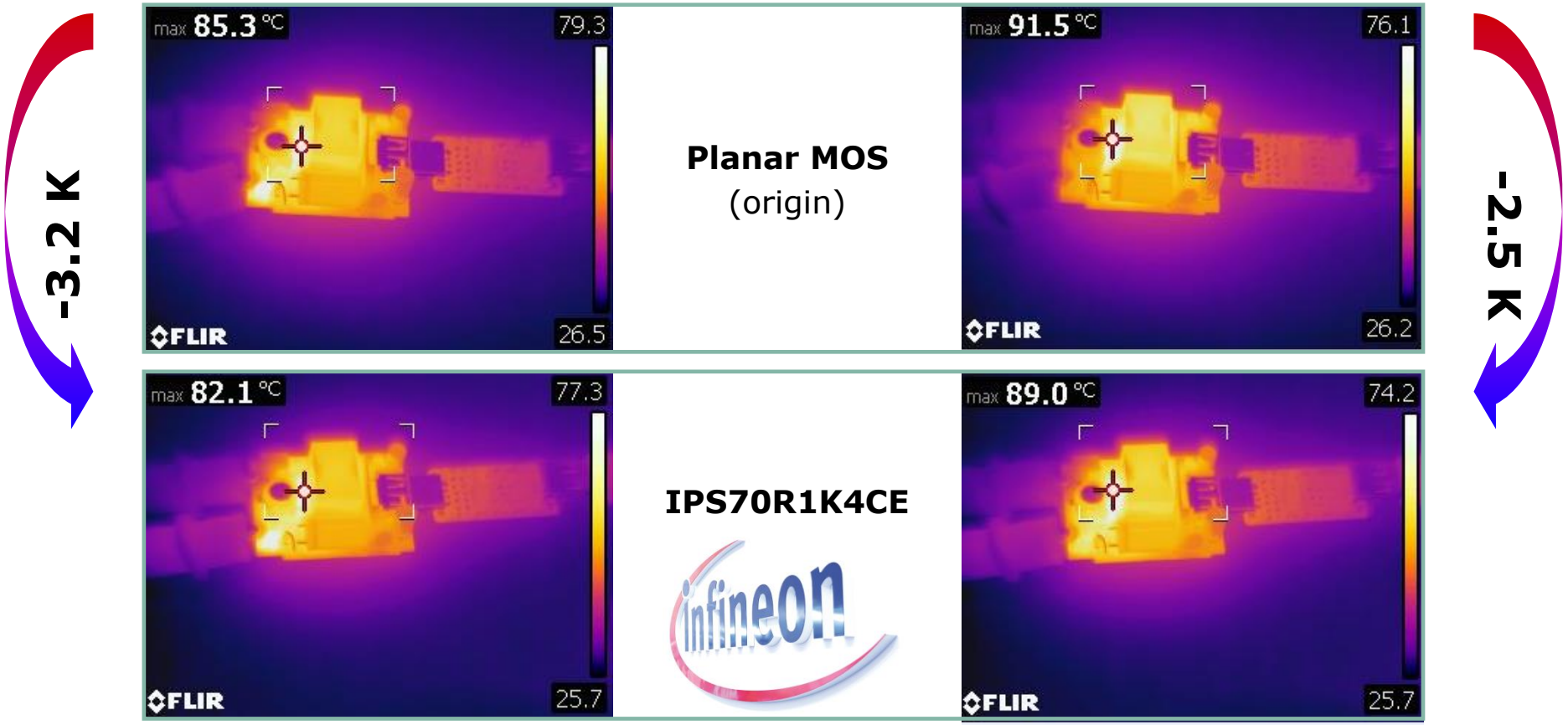
IPS70R1K4CE also outperforms origin selected planar MOS @ V_{out} 9 V

Application tests and benchmarking
18 W quick charger (available on open market)

Thermal Performance

Test condition
V_{in}: 90 V_{AC} / Output: 9 V/2 A

Test condition
V_{in}: 264 V_{AC} / Output: 9 V/2 A

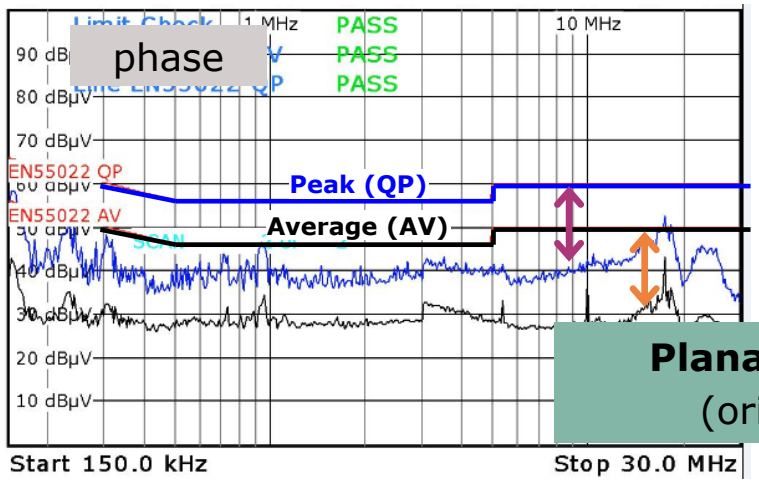


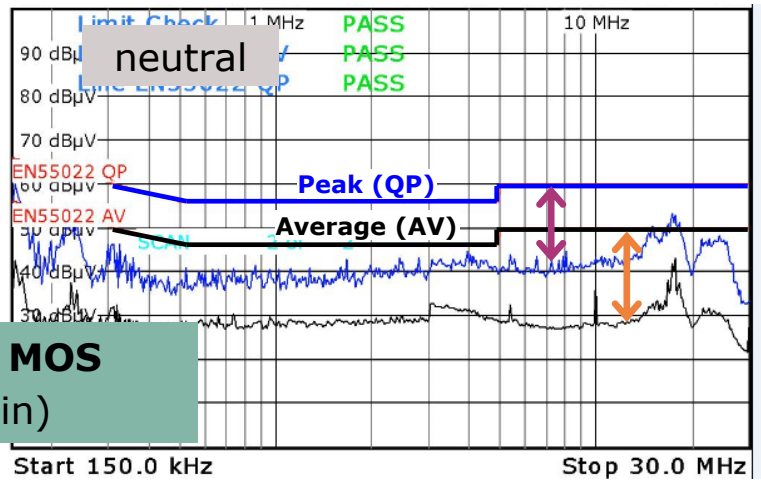
IPS70R1K4CE shows better thermal performance than origin selected planar MOS

Measured after running for 2 hr at full load (room temperature 25°C)

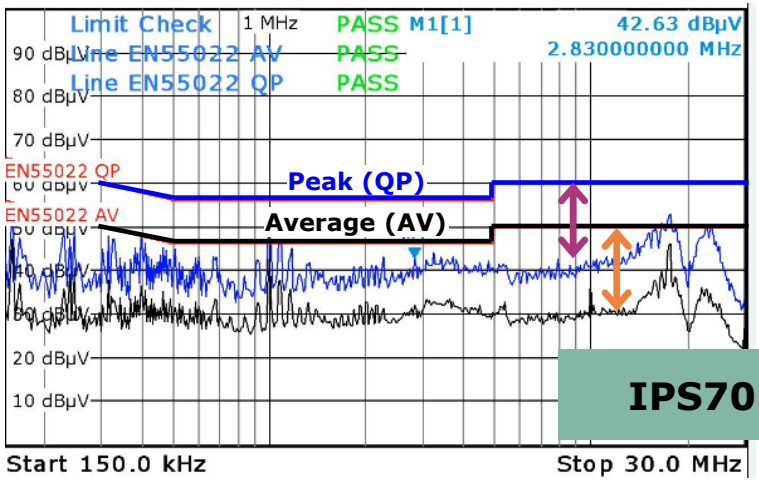
Application tests and benchmarking
18 W quick charger (available on open market)

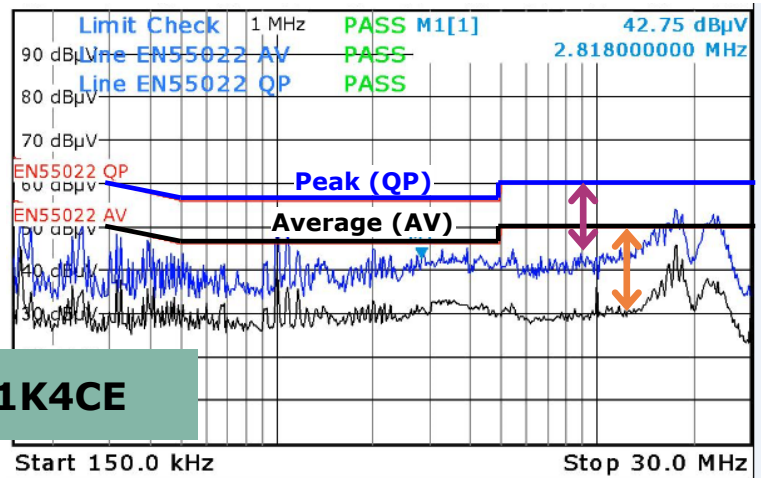
Conductive EMI Performance (230 V_{in})





Planar MOS
(origin)





IPS70R1K4CE

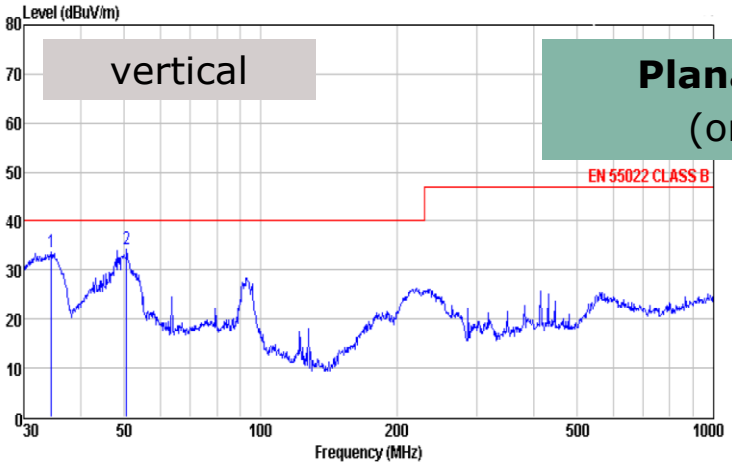
Both tested devices pass the conductive EMI limits according to EN55022

Application tests and benchmarking
18 W quick charger (available on open market)

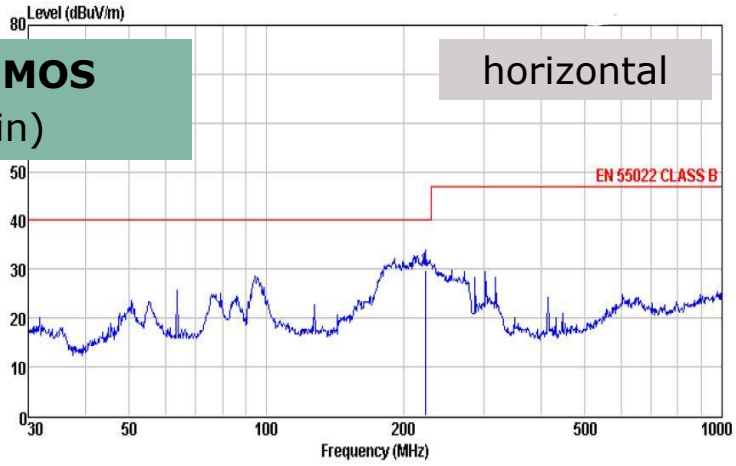
Radiative EMI Performance

Planar MOS
(origin)

vertical

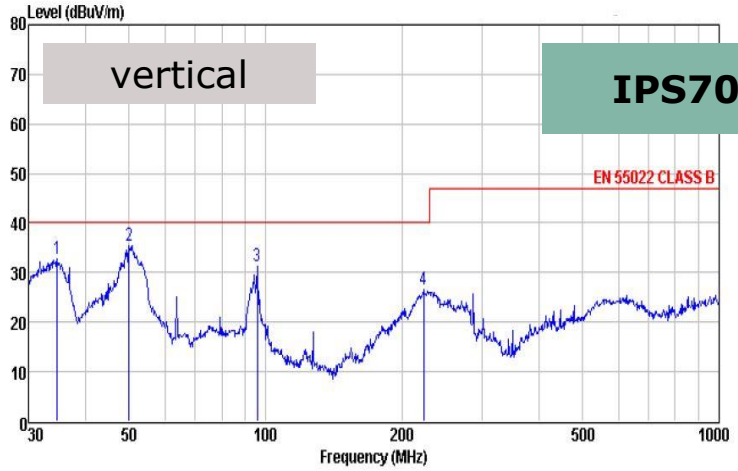


horizontal

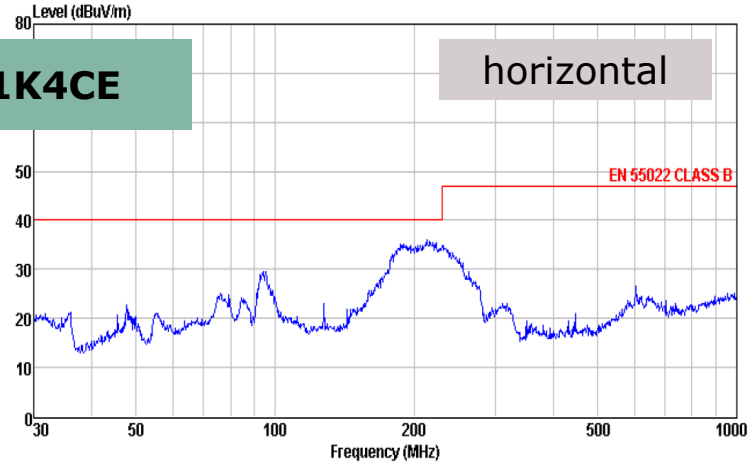


IPS70R1K4CE

vertical



horizontal



Both tested devices pass the radiated EMI limits according to EN55022

Application tests and benchmarking
18 W quick charger (available on open market)

S U M M A R Y

- Overall evaluation result is very promising for Infineon's **CoolMOS™ CE Series**
- **CoolMOS™ CE Series outperforms** the origin used **planar MOS** regarding efficiency and thermal performance over the entire power output range
- **CoolMOS™ CE Series passes EMI criteria** and shows **similar behavior** as **planar MOS** by simply changing the device w/o applying any EMI adjustments
- Conclusion is that **CoolMOS™ CE Series** enables **smaller designs** (form factor) or **higher power density**

Results can be applied across various quick chargers within similar QR flyback topologies

Remark acc. to EMI: Pls reference to Infineon's App Note „Optimizing CoolMOS™ CE based power supplies for meeting EMI requirements"

Agenda

1 CoolMOS™ CE series within charger applications

2 Application tests and benchmarking

- 10 W travel charger board
- 18 W quick charger
- **24 W charger**

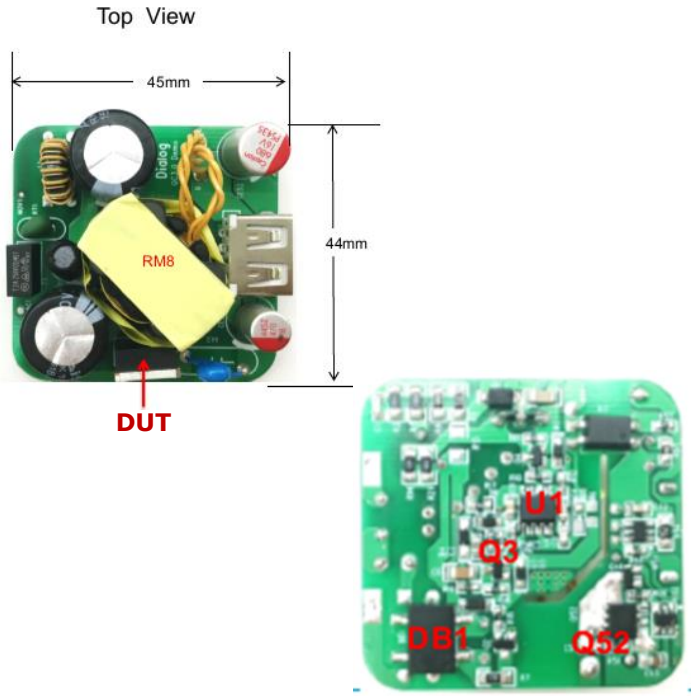
3 Success Stories

Application tests and benchmarking 24 W QC 3.0 (available on open market)

Objective : Plug&Play replacement with CoolMOS™ CE (IPI70R950CE)

Charger Specification :

Description	Origin specification
Charger maker	Not disclosed
Input power specification	100-240 V_{AC}/0.5 A, 50/60 Hz
Communication protocol	QC 3.0
Output power specification	5 V/3 A 9 V/2.7 A 12 V/2 A
Topology	Flyback
Primary MOSFET	**Planar MOS 650 V, 1k1 mΩ, I²PAK**
PCB Dimension L x W x H [mm]	45 x 44 x 18

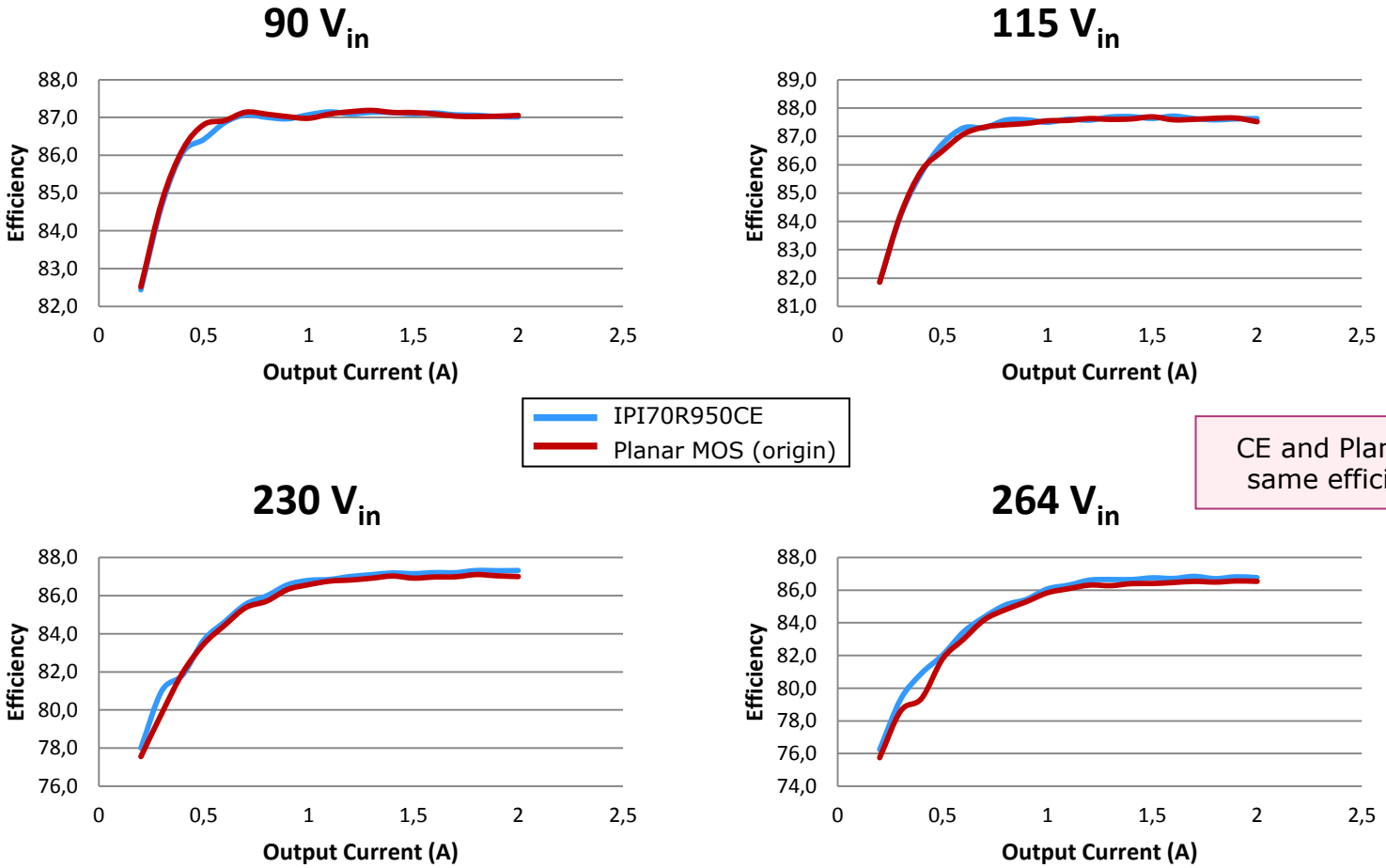


Test methodology : Performing MOSFET related measurements listed as follows

Test	Classification / Initiative
Efficiency measurement	10% load and average load (ref to COC V5 Tier2)
Thermal test for critical components @ 12V	Temperature measurement of critical components w/o case (FLIR Thermal Camera)
Conducted EMI @ 12 V	Conducted EMI performance according to CISPR 22 / EN5022 Class B (R&S Receiver)
Radiative EMI @ 12 V	Radiative EMI performance according to CISPR 22 / EN5022 Class B (R&S Receiver)

Application tests and benchmarking 24 W QC 3.0 (available on open market)

Efficiency Measurement @ V_{out} 5 V

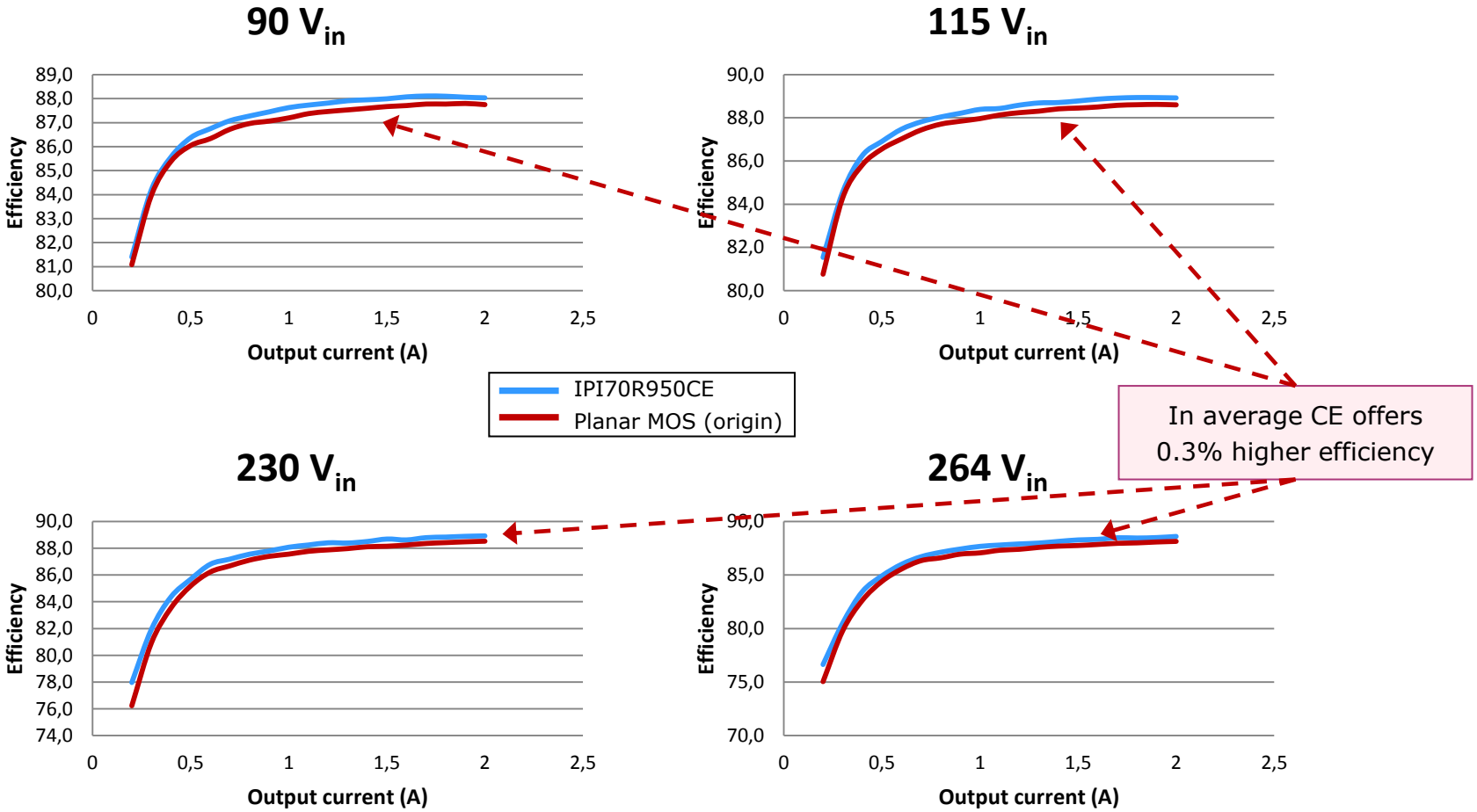


CE and Planar MOS on same efficiency level

CoolMOS™ CE shows similar efficiency compared to origin selected planar MOS @ V_{out} 5 V

Application tests and benchmarking
24 W QC 3.0 (available on open market)

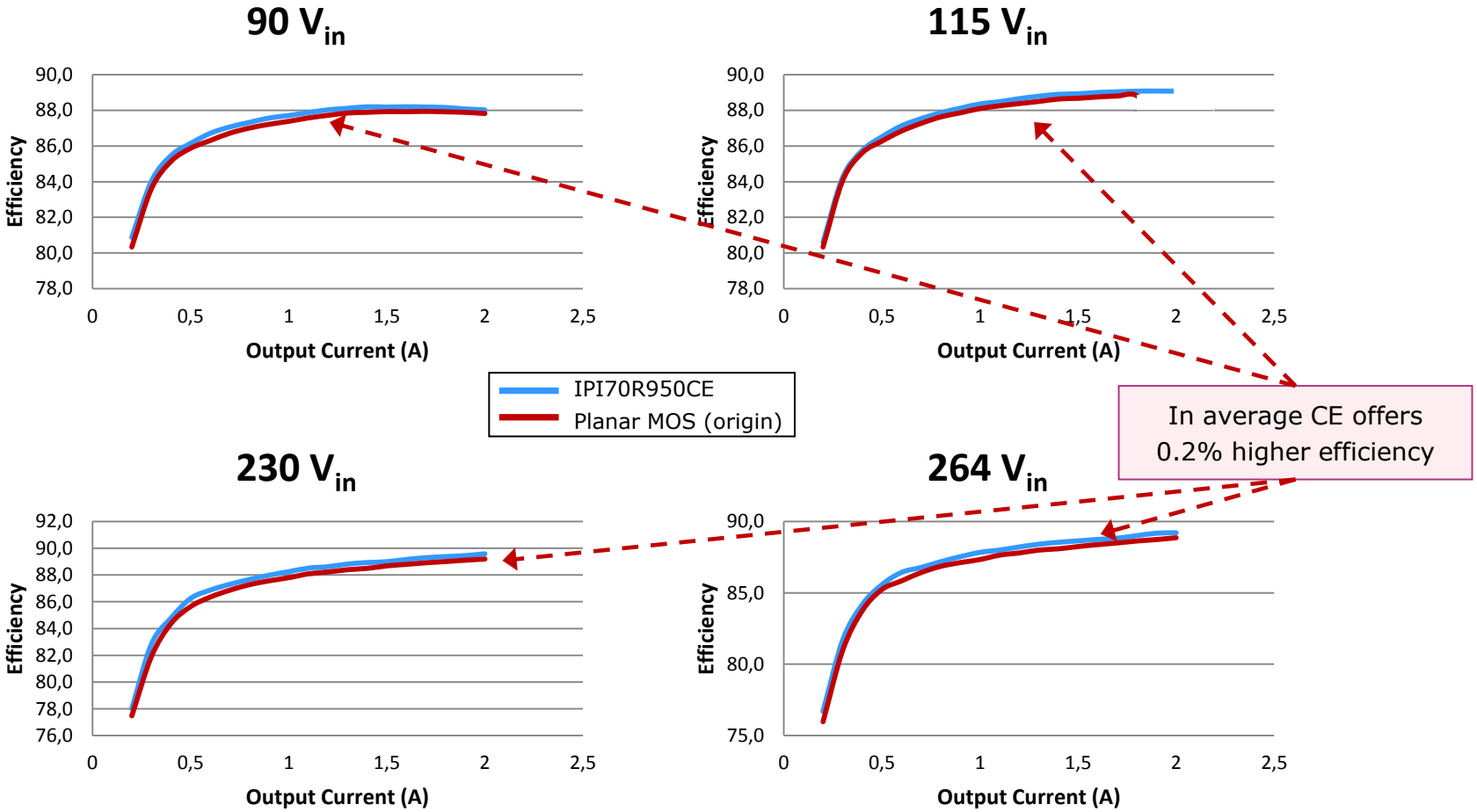
Efficiency measurement @ V_{out} 9 V



CoolMOS™ CE shows improved efficiency compared to origin selected planar MOS @ V_{out} 9 V

Application tests and benchmarking 24 W QC 3.0 (available on open market)

Efficiency measurement @ V_{out} 12 V



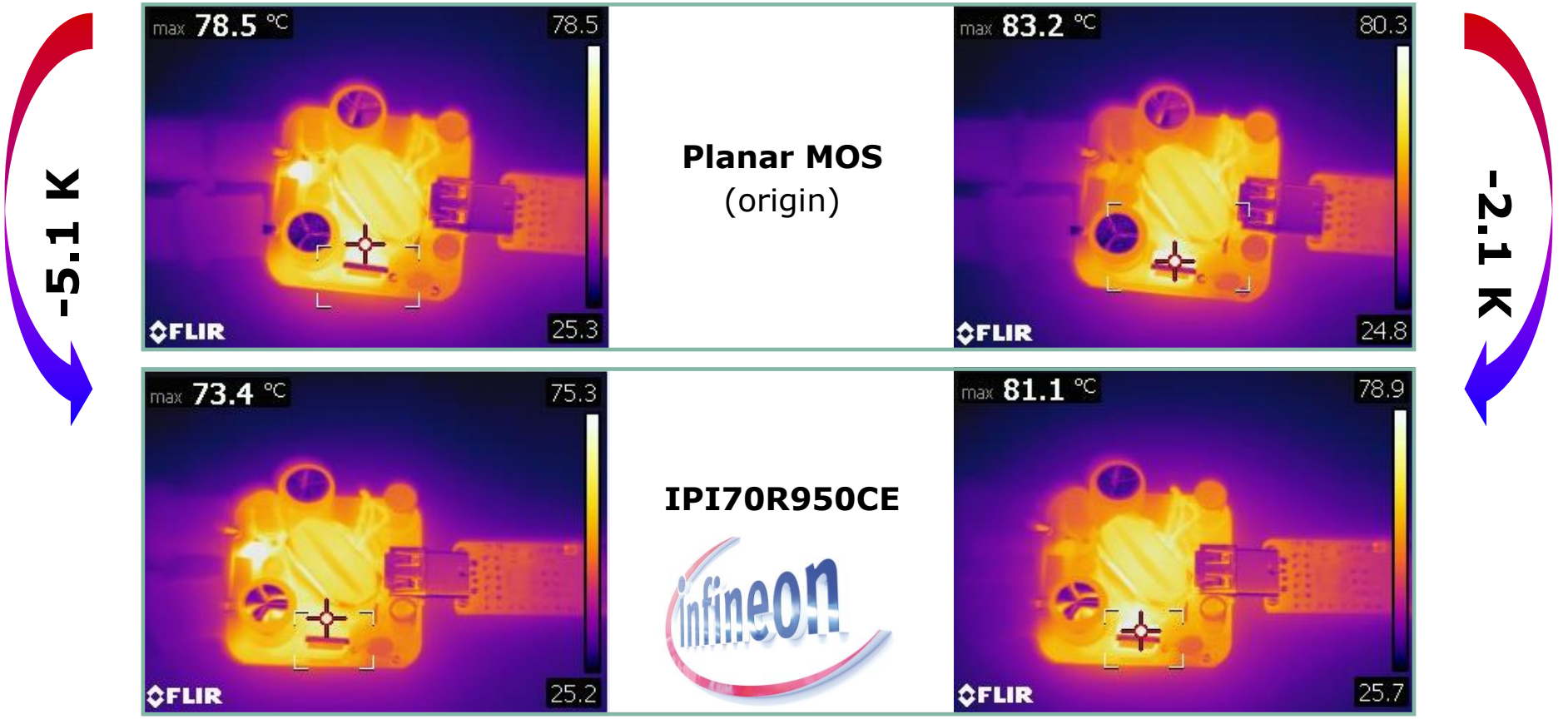
CoolMOS™ CE shows improved efficiency compared to origin selected planar MOS @ V_{out} 12 V

Application tests and benchmarking 24 W QC 3.0 (available on open market)

Thermal performance

Test condition
V_{in}: 90 V_{AC} / Output: 12 V/2 A

Test condition
V_{in}: 264 V_{AC} / Output: 12 V/2 A

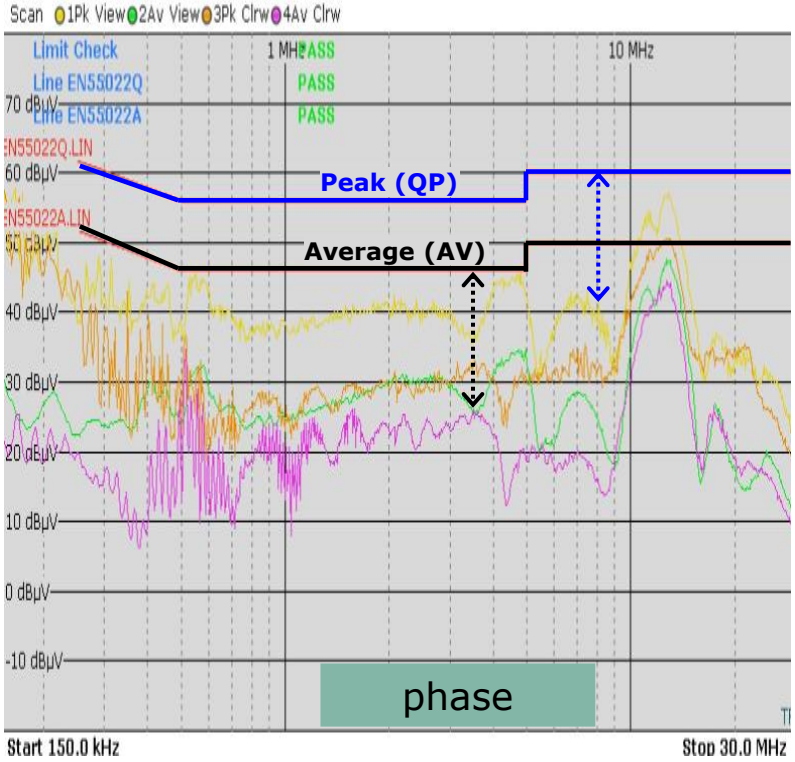


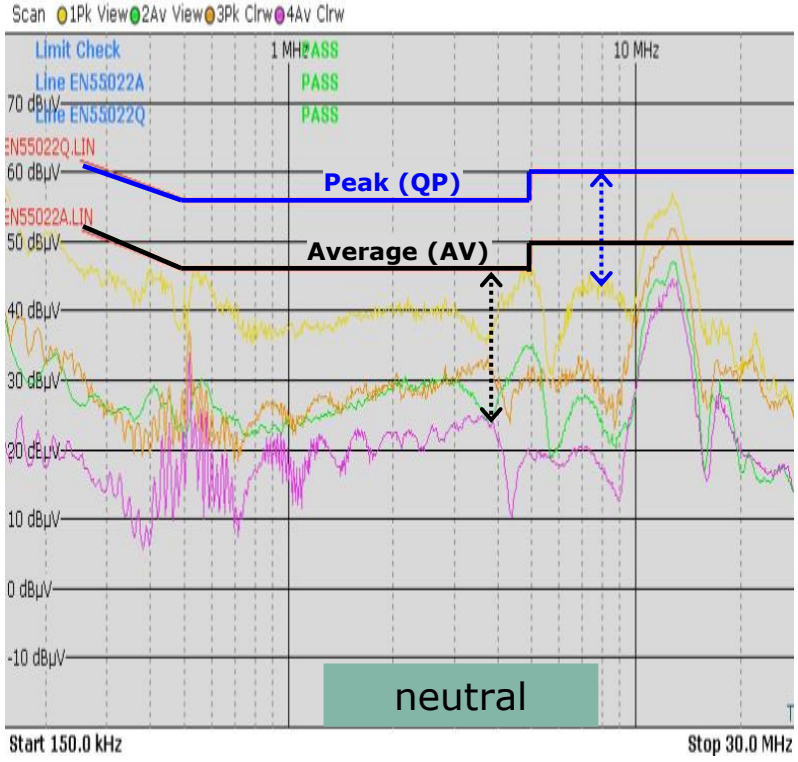
IPI70R950CE shows better thermal performance than origin selected planar MOS

Measured after running for 2 hr at full load (room temperature 25°C)

Application tests and benchmarking 24 W QC 3.0 (available on open market)

Conductive EMI performance (230 V_{in})



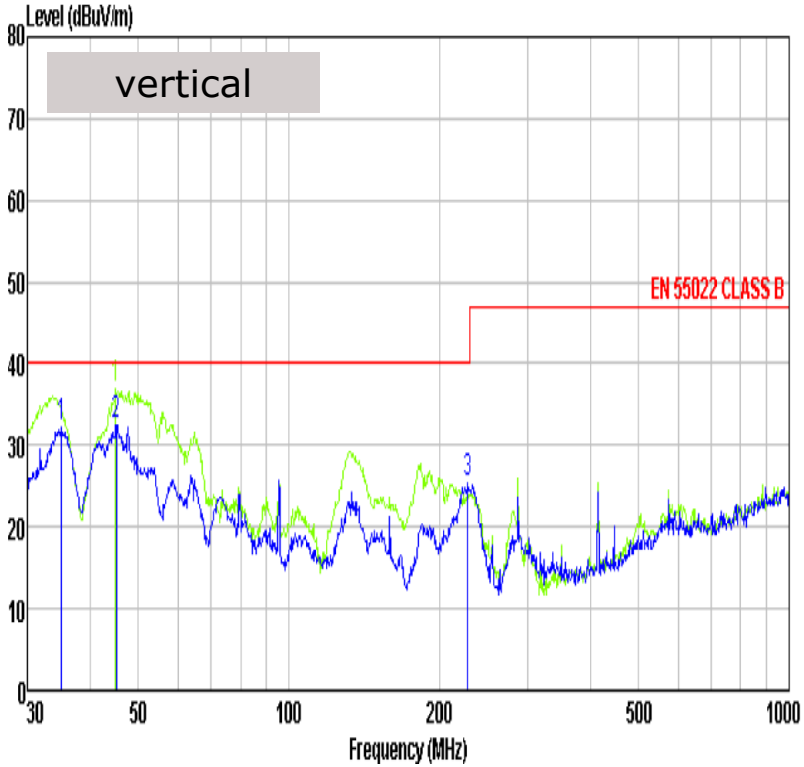


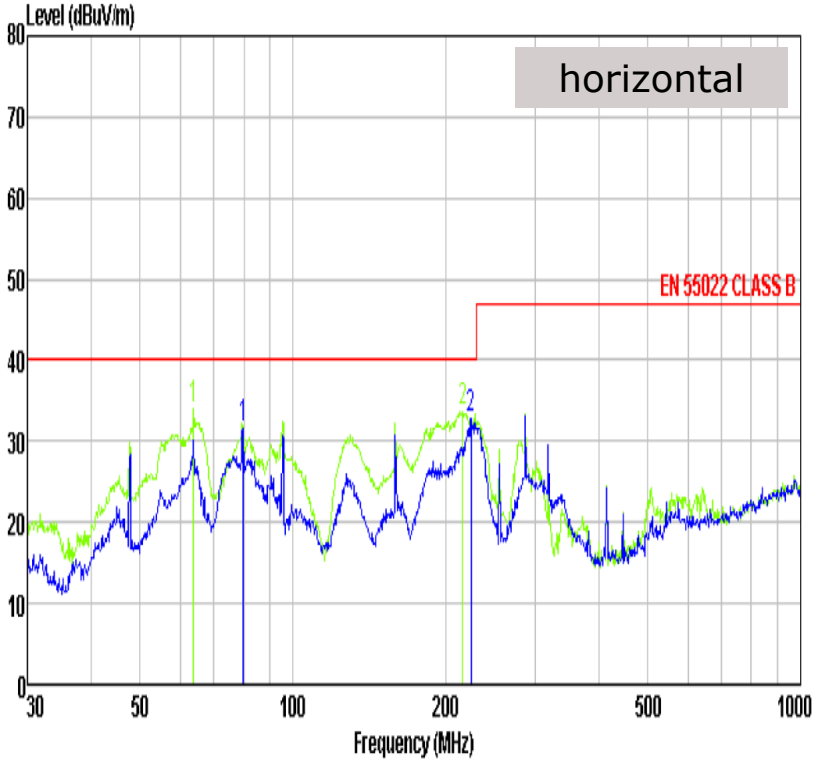
Peak Average	**IPI70R950CE**
Peak Average	**Planar MOS** (origin)

Offset of ~3 dB identified at CoolMOS™ CE by not applying any EMI adjustments (simply PnP!!!)
Both tested devices pass the conductive EMI criteria's

Application tests and benchmarking
24 W QC 3.0 (available on open market)

Radiative EMI Performance (230 V_{in})





IPI70R950CE

Planar MOS (origin)

Slight offset identified at CoolMOS™ CE <u>by not applying any EMI adjustments</u> (simply PnP!!!)
Both tested devices pass the conductive EMI criteria's

Application tests and benchmarking 24 W QC 3.0 (available on open market)

SUMMARY

- Overall evaluation result is very promising for Infineon's **CoolMOS™ CE series**
- **CoolMOS™ CE series performs very well** compared to the origin used **planar MOS** regarding efficiency over the entire power output range
- **CoolMOS™ CE series** shows **improved thermal behavior** compared to the origin used planar MOS
- **CoolMOS™ CE series passes EMI criteria** by simply switching the device w/o applying any EMI adjustments

Results can be applied across various quick chargers within similar QR Flyback topologies

Remark acc. to EMI: Pls reference to Infineon's App Note „Optimizing CoolMOS™ CE based power supplies for meeting EMI requirements"

Agenda

1 CoolMOS™ CE series within charger applications

2 Application tests and benchmarking

3 Success stories

- 15 W Charger using **IPN70R1K5CE** (SOT-223)
- 18 W Charger using **IPSA70R600CE** (IPAK SL with isolated lead stand-off)
- 22.5 W Charger using **IPAN65R650CE** (TO-220 FP Narrow Lead)
- USB-PD Charger using **IPAN65R650CE** (TO-220 FP Narrow Lead)

Success story
Smartphone charger – IPN70R1K5CE

Customer:	Leading Korean charger customer
Application:	15 W mobile charger
IFX Part numbers:	**CoolMOS™ CE Series** – IPN70R1K5CE 700 V, 1.500 mOhms, SOT-223
Competitor:	MagnaChip @ IPAK Diodes @ IPAK
SOP:	Jul 2016
BW value:	2.5 MUSD/YR

What made us win:

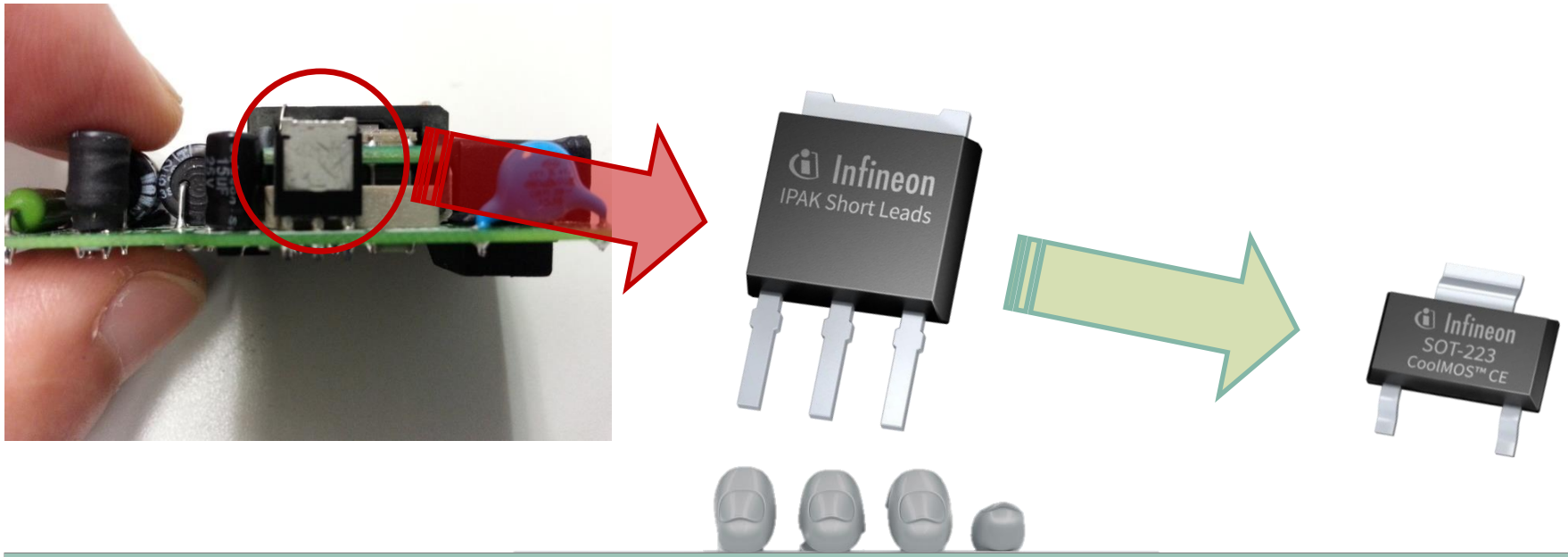
- Huge price pressure in very price sensitive area
- New package offering required cost advantage whilst exactly matching market requirements (standard grade)
- Best fit for target application technology in place (CE)
- Excellent teamwork and alignment btw. Sales – APC – APM – PM

To which type of projects can this success story be replicated?

- Setting a new trend within charger market (package + standard grade)
- Addressing all charger manufacturers
- Extending SOT223 portfolio for upcoming silicon technologies

This case proves that thermal challenges are manageable and small SMD packages fit into adapters

Success story
Smartphone charger – IPN70R1K5CE



Technical benefit

- ~40% space saving
- Capable for reflow soldering

Commercial benefit

- ~15% cost savings on product level

Success story
Mobile charger – IPSA70R600CE

Customer:	Korean Charger Manufacturer
Application:	18 W mobile charger
IFX Part numbers:	**CoolMOS™ CE Series** – IPSA70R600CE 700 V, 600 mOhms, IPAK SL w/ ISO lead stand-off
Competitor:	UTC @ IPAK
SOP:	Oct 2016
BW value:	1.0 MUSD/YR

What made us win:

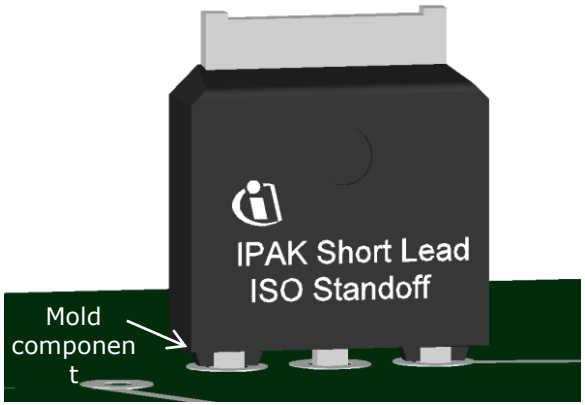
- New package reduces fails at customers production line (improved yield - less efforts - reduced system costs)
- CE series supports to overcome customers EMI weakness
- Highly price competitive device for price sensitive area
- Excellent and fast customer support

To which type of projects can this success story be replicated?

- Where IPAK SL causing issues at customers production line
- Extending IPAK SL w/ ISO lead stand-off for upcoming silicon technologies

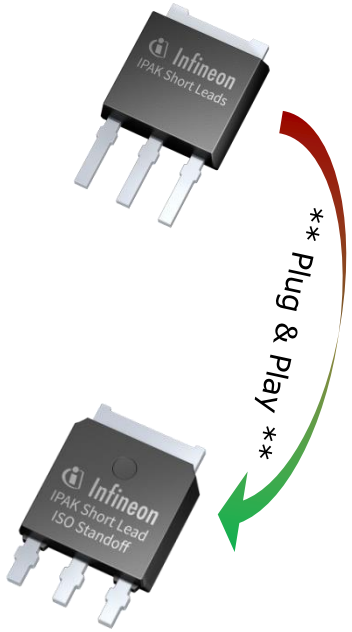
Package innovations improves yield, leads to less efforts and lower system costs on customer side

Success story
Mobile charger – IPSA70R600CE



Key features and benefits of new package

- Mold component defining the distance btw package and PCB
- Efficient cleaning in terms of residual removing
- Less production failures and improved yield
- Full automation capable



Technical benefit

- Improving production yield due to lead stand-off
- CE showing higher performance / efficiency
- CE supports EMI requirements

Commercial benefit

- Cost savings at customers production process

Success story
Mobile charger – IPAN65R650CE

Customer:	Leading Chinese telecommunication customer
Application:	22.5 W mobile charger
IFX Part numbers:	**CoolMOS™ CE series** – IPAN65R650CE 650 V, 650mOhms, TO-220FP Narrow Lead
Competitor:	Vishay @ TO-220FP Toshiba @ TO-220FP
SOP:	Nov 2016
BW value:	1.0 MUSD/YR

What made us win:

- DOE6 standard*1) given as hard requirement for the customer
- IPAN65R650CE passed these criteria's
  (lower switching losses and better EMI behavior than competitor devices)
- Narrow leads reduces the risk of shortages at customers production line

To which type of projects can this success story be replicated?

- Projects where tightened efficiency and EMI requirements are required
- Whenever there is a risk of shortages at customers assembly line

*1) US energy efficiency standard

Superjunction MOSFETs enable customers going for higher efficiency
Package innovations increases production yield on customer side

Success story
USB-PD charger – IPAN65R650CE

Customer:	Leading Finnish power supply manufacturer
Application:	12 V/2 A USB-PD charger 5 V/4.5 A USB-PD charger
IFX Part numbers:	**CoolMOS™ CE Series** – IPAN65R650CE 650 V, 650 mOhms, TO-220 FP Narrow Lead
Competitor:	Toshiba @ TO-220 FP
SOP:	End 2016
BW value:	0.5 MUSD/YR

What made us win:

- DOE6 standard*1) given as hard requirement for the customer
- IPAN65R650CE passed these criteria's
  (lower switching losses and better EMI behavior than competitor device)
- Narrow leads reduces the risk of shortages at customers production line

To which type of projects can this success story be replicated?

- This is already the **proven case** of a **replicated success story**

*1) US energy efficiency standard

Superjunction MOSFETs enable customers going for higher efficiency
Package innovations increases production yield on customer side

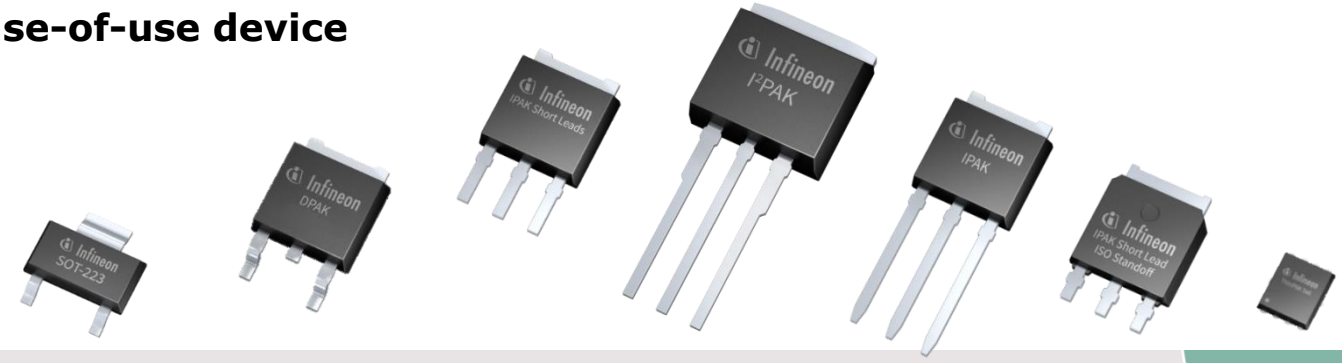
CoolMOS™ CE series for chargers
S U M M A R Y

Commercial aspects:

- CoolMOS™ CE Series is **highly price competitive**
- In line with **Infineon's multi source benefits** (short lead times, stock rotation, etc.)

Technical aspects:

- In comparison to planar and superjunction FET competitors CoolMOS™ CE is:
  - a **high efficient** MOSFET technology, leading to **increase performance**
  - showing **improved thermals**, means **lower device temperature**
  - **fulfilling EMI** standards
    ref to Infineon's App Note „Optimizing CoolMOS™ CE based power supplies for meeting EMI requirements"
  - a proven **ease-of-use device**



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Infineon

CoolMOS™
Nomenclature Power MOSFET „new" (launched after Oct 2015)

Sales Name

I	P	DD	80	R	190	P7	S

Grp 1:
I : Infineon

Grp 2: Device Type
P : Power MOSFET

Grp 3: Package Type
A : TO-220 FullPAK
B : TO-263 (D^2PAK)
C : Bare Die
D : TO-252 (DPAK)
I : TO-262 (I^2PAK)
L : ThinPAK 8x8
N : SOT223
P : TO-220
Q : TO-247PLUS
S : TO-251 (IPAK short lead)
T : TO Lead Less
U : TO-251 (IPAK)
W : TO-247
Z : TO-247 4-pin
DD : TO-252 (Double DPAK)
AW: TO-220 FullPAK wide creepage
AN : TO-220 FullPAK narrow lead
LS : ThinPAK 5x6
DQ : TO-252 Quadruple DPAK
SA : TO-251 (IPAK SL w/ ISO StandOff)

Grp 4: Blocking Voltage
divided by 10 [V]

Grp 5: $R_{DS(on)}$
used as separator

Grp 6: $R_{DS(on)}$
@ mΩ

Grp 7: Series Name
such as C3, C6, …, C, P7, etc.

Grp 8: Reliability Grade
blank: Industrial
A : Automotive
S : Standard

Marking pattern (presented as well on technical datasheet)

80	R	190	P7

Series Name
see Grp 7

Blocking Voltage
see Grp 4

Reliability Grade
R : Industrial
A : Automotive
S : Standard
C : customized

$R_{DS(on)}$ [mΩ]
see Grp 6

Only exception: CoolMOS™ CE is standard grade although not showing „S" at the end.
When CE has been launched new nomenclature was under preparation, thus no changes since P/Ns were already known at customers

CoolMOS™
Traceability and production date code

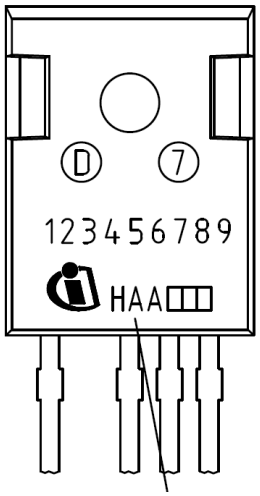
H **AU** **3** **24**

Grp 1: Green product
G: RoHS Compliancy (non HF)
H: RoHS + Halogen Free

Grp 3: Year code
0: 2010
1: 2011
2: 2012
3: 2013
4: 2014
…

Grp 2: Lot identification
AA: Lot #1
AB: Lot #2
AC: Lot #3
…

Grp 4: Calendar week code
01: CW 01
02: CW 02
03: CW 03
…



Code

Based on the above example - HAU324
- Halogen Free Product
- Lot Identification: 21st production lot from CW24/2013
- Date Code: CW 24/2013