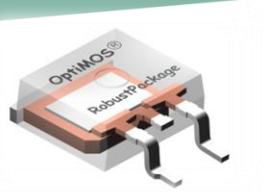
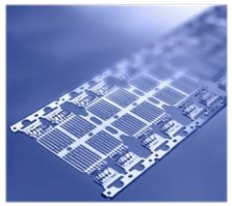
Automotive Power MOSFET

Customer Presentation

January 2017

www.infineon.com/automotivemosfet





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Infineon and International Rectifier: A Powerful Combination

Automotive MOSFETs (Combined IR + IFX) Selection Guide

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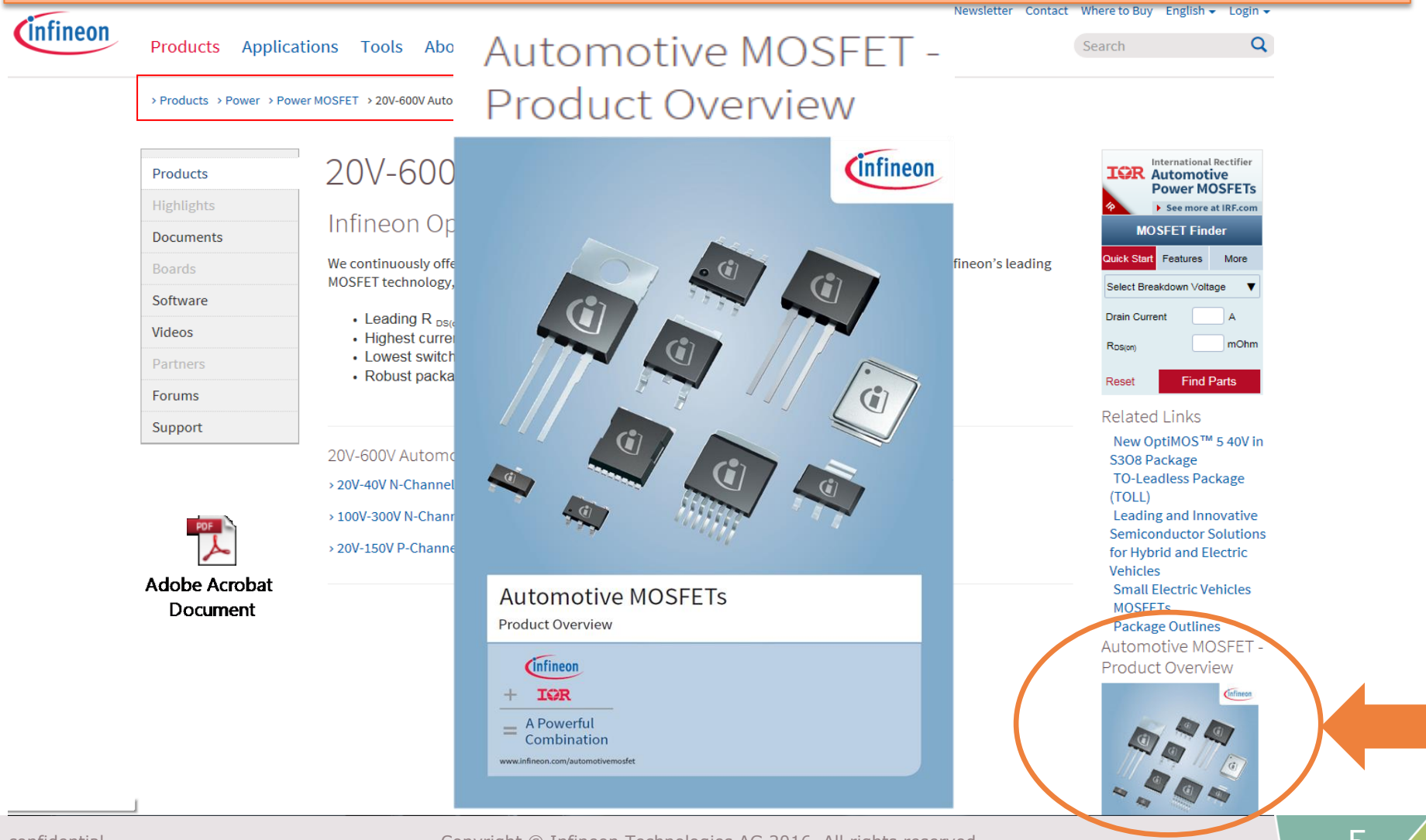

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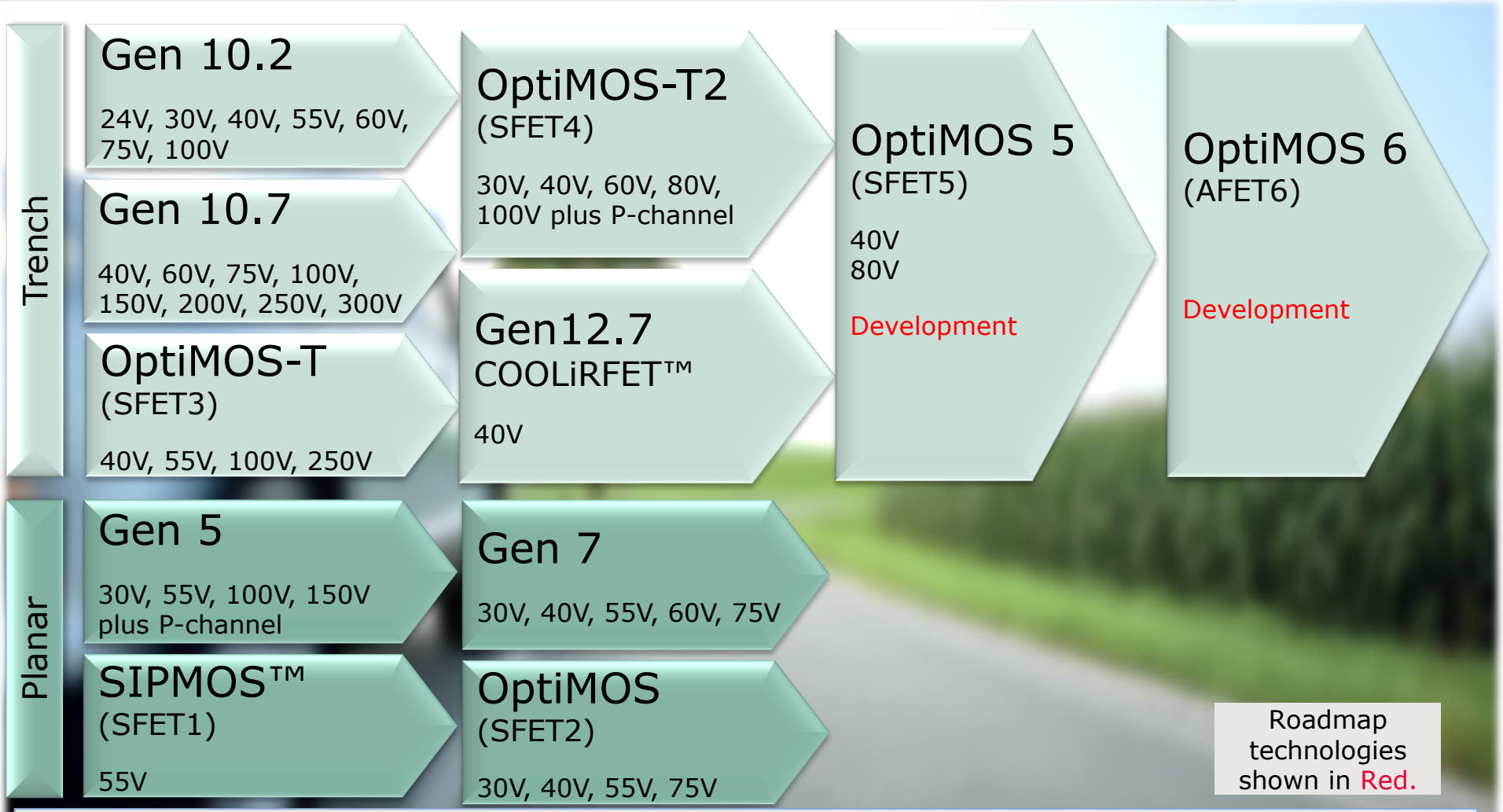
Process Technology Portfolio and Roadmap

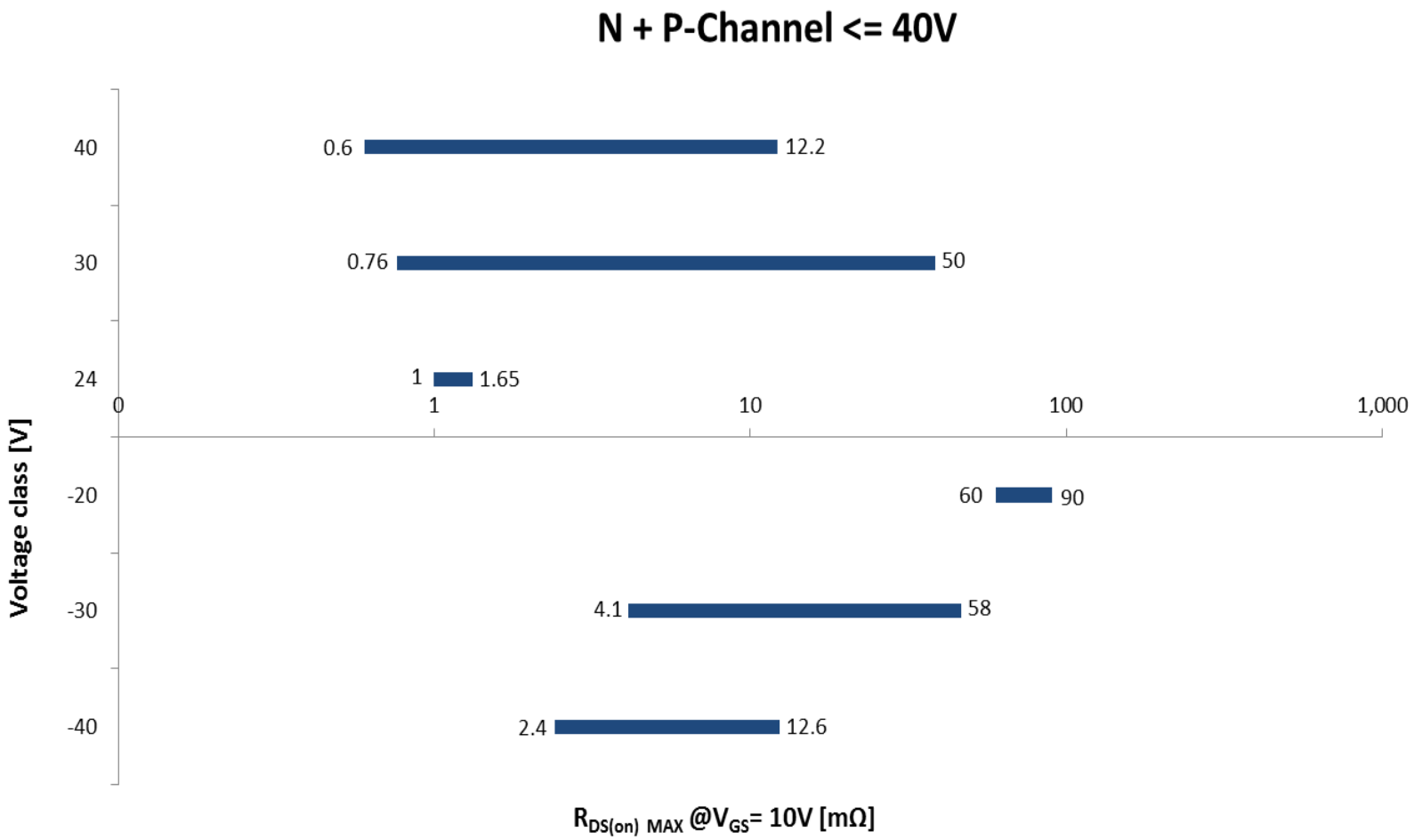
Infineon Technology Leadership in Trench Power MOSFETs



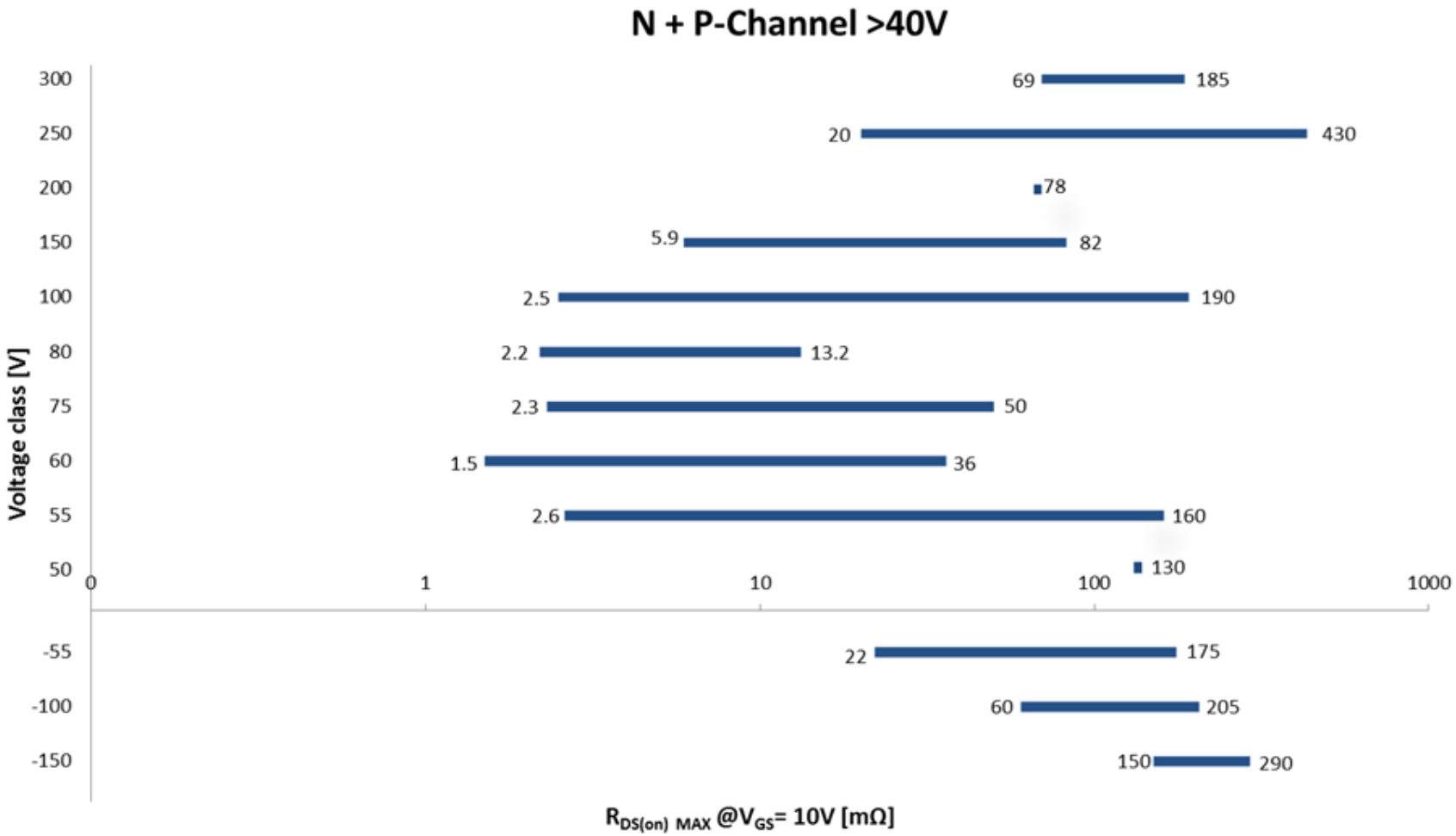
IFX offers planar and trench technologies to address the needs of the entire Automotive MOSFET Market:

- SFET2, Gen7, Gen5 ➔ Planar ➔ Thermal/Rth driven applications
- SFET5, SFET4, Gen12.7, SFET3, Gen10.7, Gen10.2 ➔ Trench ➔ Rds_{on} driven applications

Packages available by voltage class vs. RDS(on) N and P-Channel 20V to 40V



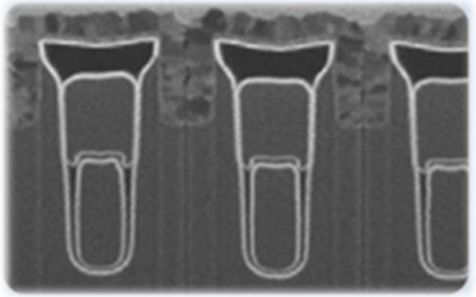
Packages available by voltage class vs. RDS(on) N and P-Channel 50V to 300V



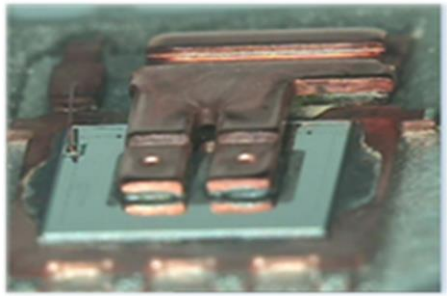
Infineon Automotive MOSFET Process Technology Roadmap

OptiMOS-5 (SFET5)
Infineon's next-generation leading Trench Technology

Leading OptiMOS-5 MOSFET Trench Technology Features and Customer Benefits

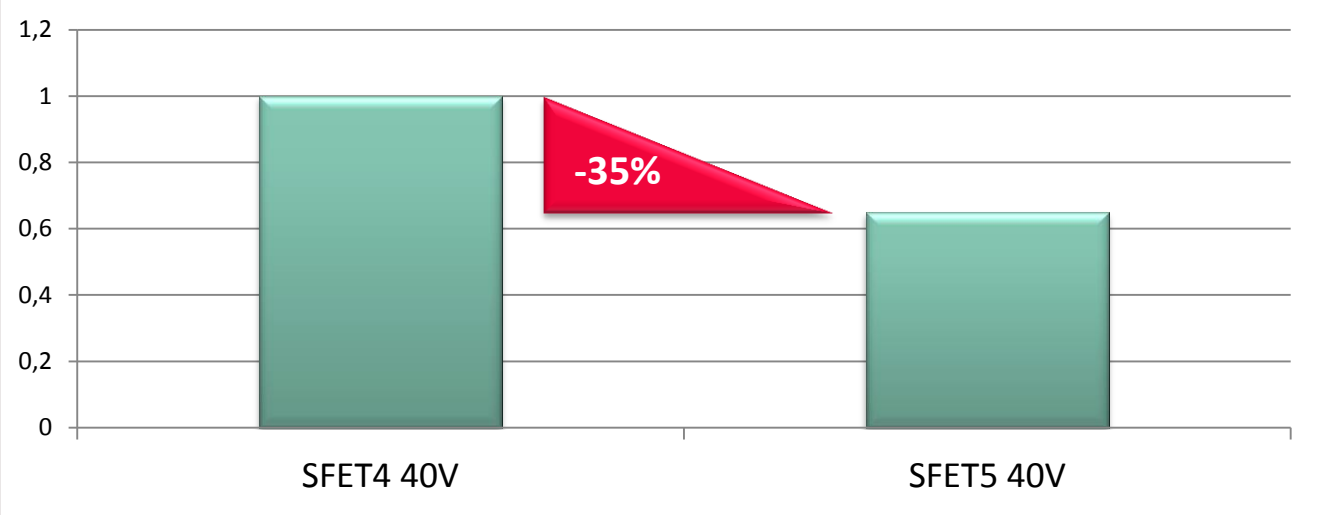


- **Improved R_{DSon} * Area**
  - *Leading R_{DSon} and Low conduction losses*
  - *Smaller packages*
- **Improved Switching Parameters**
  - *Reduced Ciss & Coss*
  - *Improved switching behavior and EMC*
- **New Top-side Copper-Clip Contact Technology**
  - *Smaller packages for same power*
  - *Lower thermal resistance*
  - *Leading current capability*



An Advantage of OptiMOS™5
Major Improvement in Rds(on) Resistance.

Technology Comparison — R_{DSon}·A



Product Comparison – BIC 40V in SSO8 (5x6)

Parameter	IPC100N04S4-02	IPC100N04S5-1R2	SSO8 S5 40V vs S4 40V
R_{DSon} [mΩ]	2.4	1.2	**50% Reduction in Conduction Losses**
Q_G [nC]	79	73	**Constant Qg at 50% Rdson Reduction**
FOM [nC*mΩ]	190	88	**50% Better FOM**

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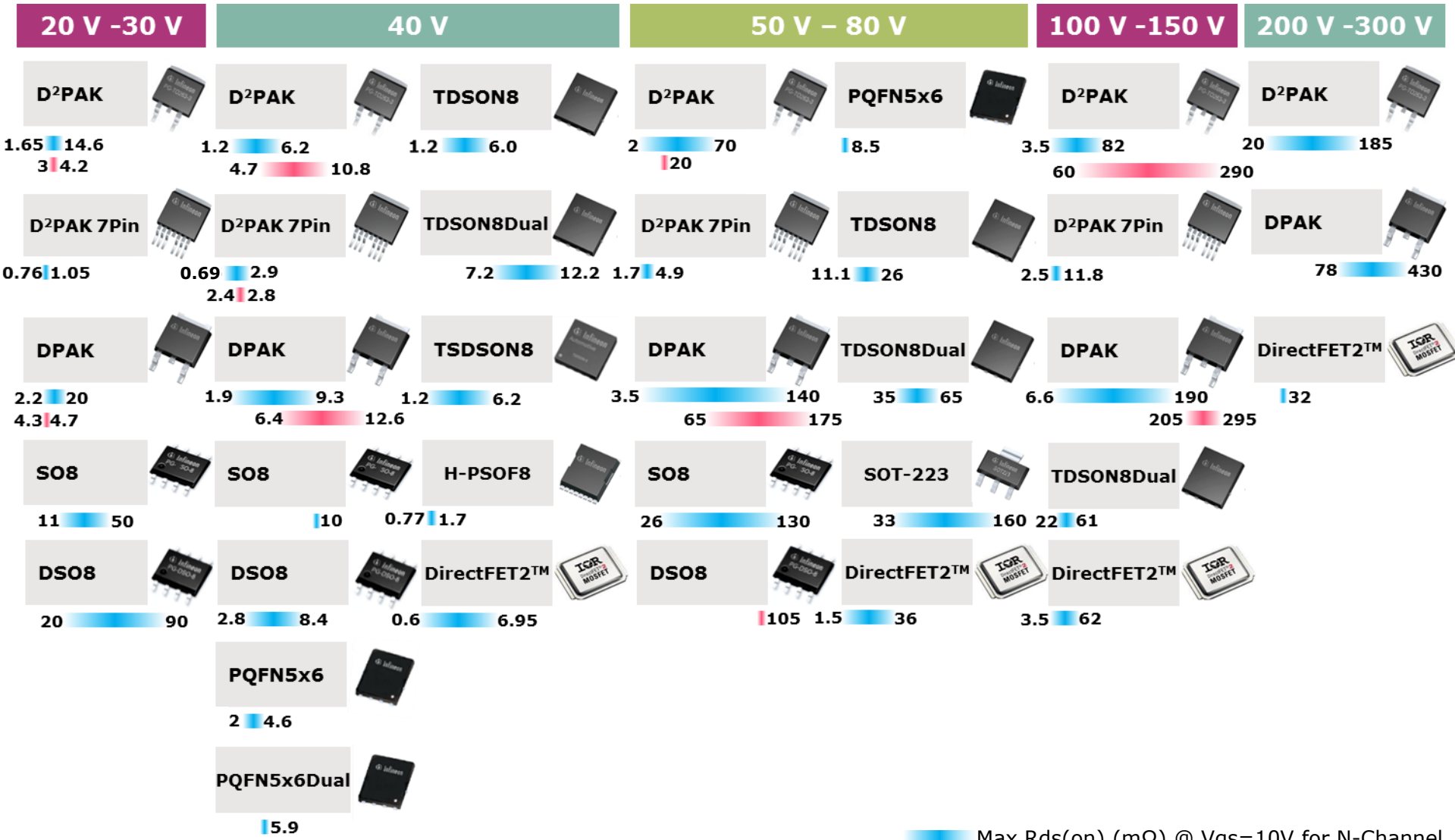
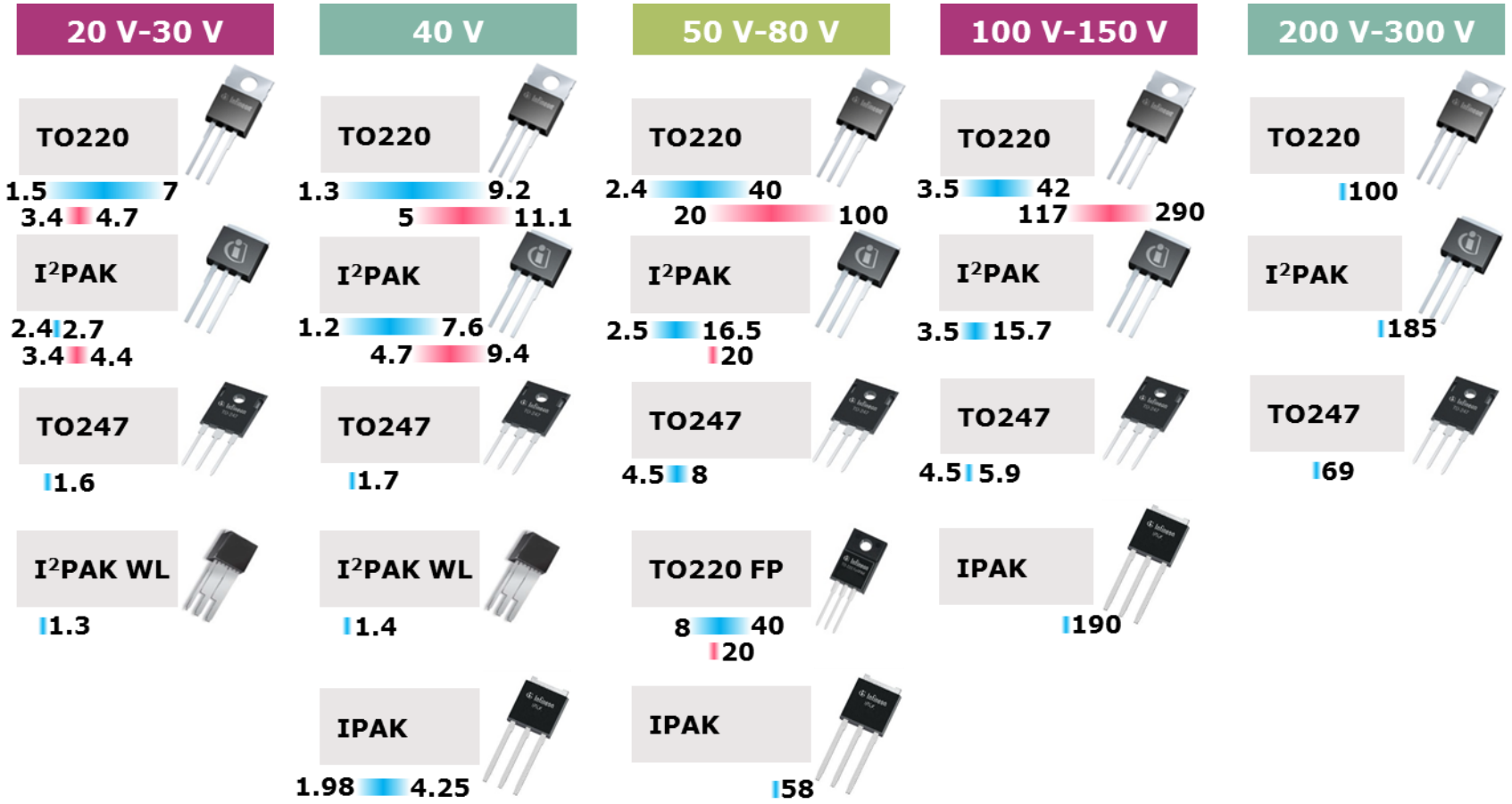
Surface Mount Packages
Rds(on) Range by Voltage Class



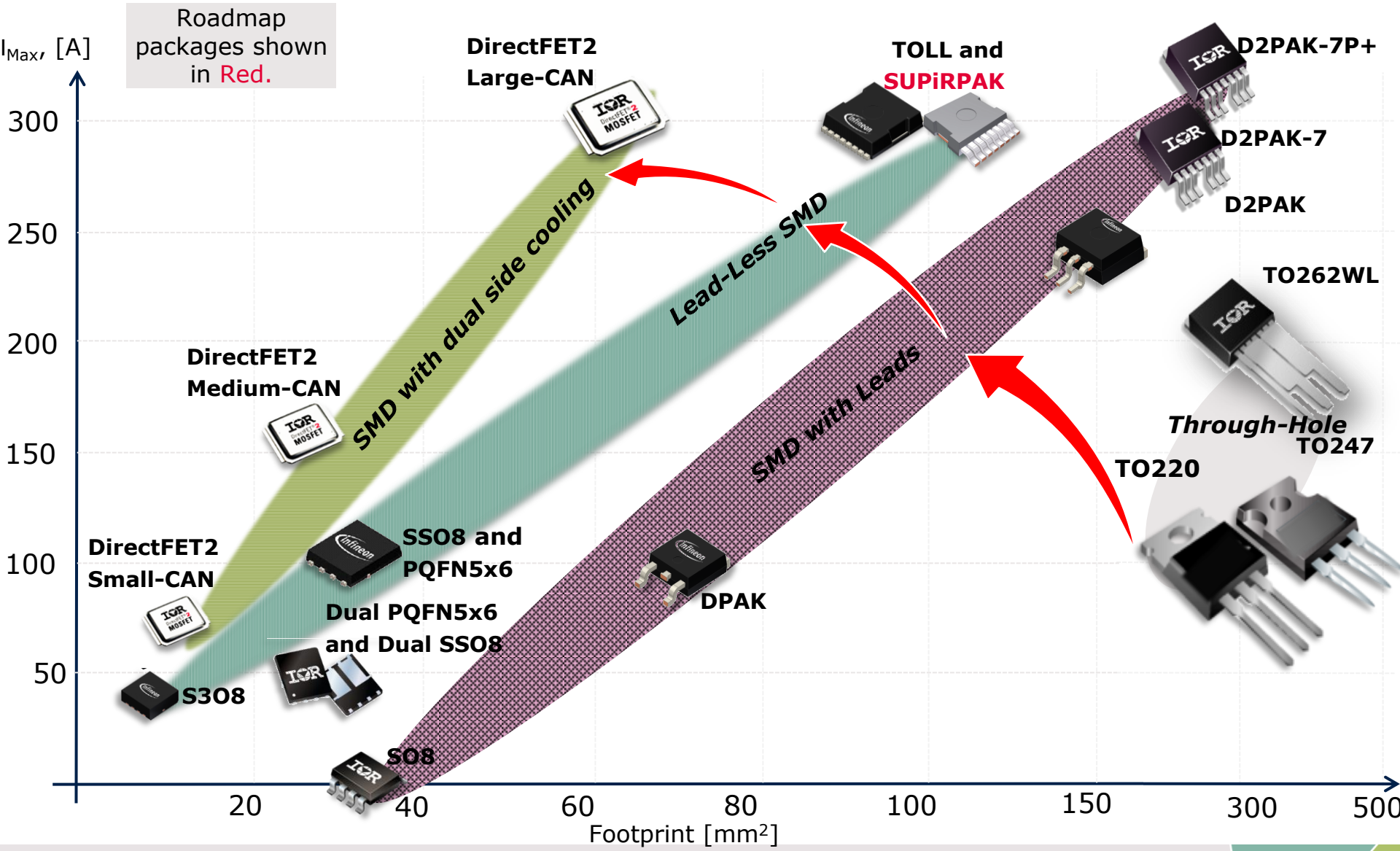
Through Hole Packages
Rds(on) Range by Voltage Class



Max Rds(on) (mΩ) @ Vgs=10V for N-Channel

Max Rds(on) (mΩ) @ Vgs=10V for P-Channel

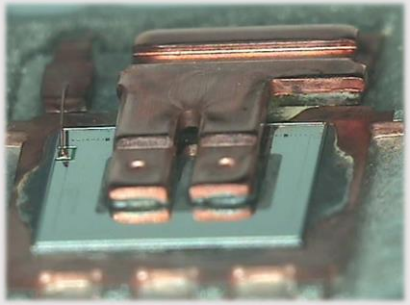
Package Portfolio and Roadmap
Advancing cooling and miniaturization

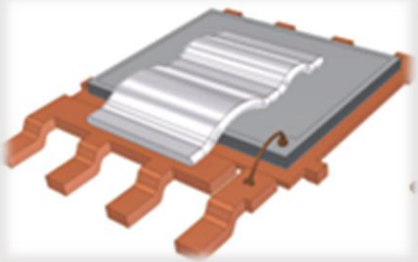


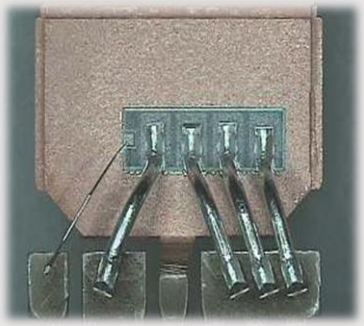
Automotive MOSFET Package Development

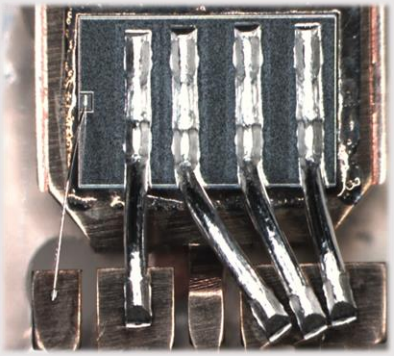
- **Connecting Technologies Improvements**
  - *Copper clips, ribbon bond, thicker bond wires, diffusion soldering, etc.*
  - *DirectFET2®, TO-262 WideLead, D2PAK-7P+*

- **Benefits:**
  - *Higher current capabilities*
  - *Better thermal performance*
  - *100% Pb free products*



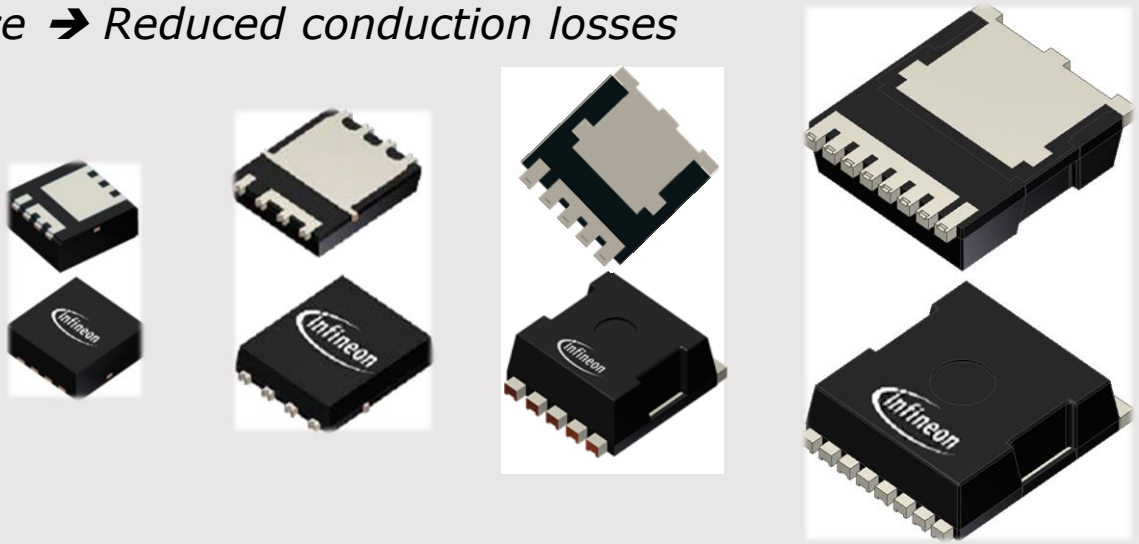






Automotive MOSFET Package Development

- **Development of new Leadless Packages**
  - Shrink Super SO8 (S308)
  - Dual & Single Super SO8 (SS08)/PQFN5x6
  - TOLL (TO-Leadless)
  - SUPiRPAK
- **Features and Benefits:**
  - *Smaller ➔ Less PC Board space required. Possible cost savings.*
  - *Lower Resistance ➔ Reduced conduction losses*



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Infineon Automotive MOSFET Products

3x3mm Packages
Shrink Super SO8 (S3O8)

Shrink Super SO8 (S3O8) Automotive Package 40V Product Portfolio

Sales Name	Technology	max Ron 10V (mΩ)	ID (A)	LL/NL
IPZ40N04S5L-2R8	OptiMOS-5 40V	2.8	40	LL
IPZ40N04S5-3R1	OptiMOS-5 40V	3.1	40	NL
IPZ40N04S5L-4R8	OptiMOS-5 40V	4.8	40	LL
IPZ40N04S5-5R4	OptiMOS-5 40V	5.4	40	NL
IPZ40N04S5L-7R4	OptiMOS-5 40V	7.4	40	LL
IPZ40N04S5-8R4	OptiMOS-5 40V	8.4	40	NL

S3O8

L x W x H
3.3x3.3x1.0mm³

BiC 40V
2.8mΩ

I_{DC} = **40A**

Cu-Clip soldered

- *Only requires one-sixth the PCB area of a DPAK*
- *Two devices take less PCB area than one Dual SSO8*
- *Uses benchmark OptiMOS-5 technology → Very low R_{DSon}*
- *40A current rating in a very small package*

- ***In production now!***

Infineon Automotive MOSFET Products

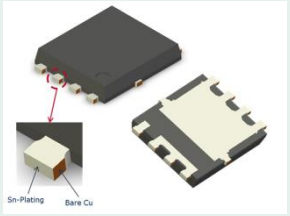
5x6mm Packages

- Single Super SO8 (single SS08)
- PQFN5x6

Single Super SO8 Automotive-Qualified Package
40V Next Generation Product Portfolio in OptiMOS-5

Sales Name	max Ron 10V (mOhm)	ID (A)	LL/NL
IPC100N04S5-1R2	1.2	100	NL
IPC100N04S5L-1R1	1.1	100	LL
IPC100N04S5-1R7	1.7	100	NL
IPC100N04S5L-1R5	1.5	100	LL
IPC100N04S5-1R9	1.9	100	NL
IPC100N04S5L-1R9	1.9	100	LL
IPC100N04S5-2R8	2.8	100	NL
IPC100N04S5L-2R6	2.6	100	LL
IPC90N04S5-3R6	3.6	90	NL
IPC90N04S5L-3R3	3.3	90	LL
IPC70N04S5-4R6	4.6	70	NL
IPC70N04S5L-4R2	4.2	70	LL
IPC50N04S5-5R8	5.8	50	NL
IPC50N04S5L-5R5	5.5	50	LL

Single SSO8



L x W x H

6.5x5.1x1.0mm³

BiC 40V

1.2mΩ

50% Rds(on) Reduction compared to SFET4 BiC !

I_{DC} = **100A**

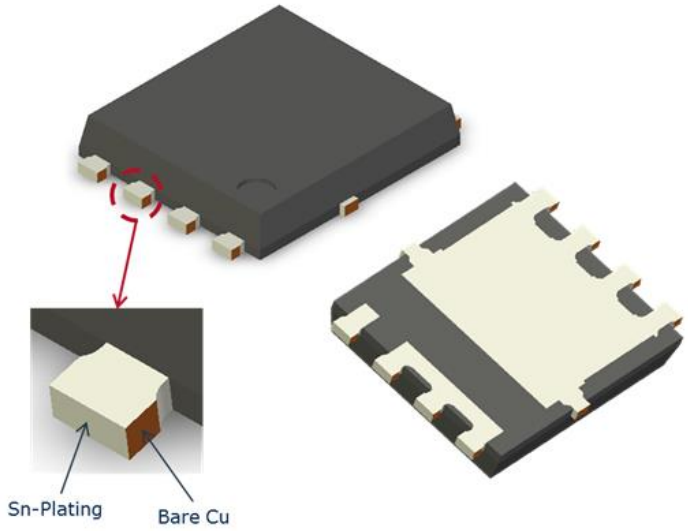
Cu-Clip soldered

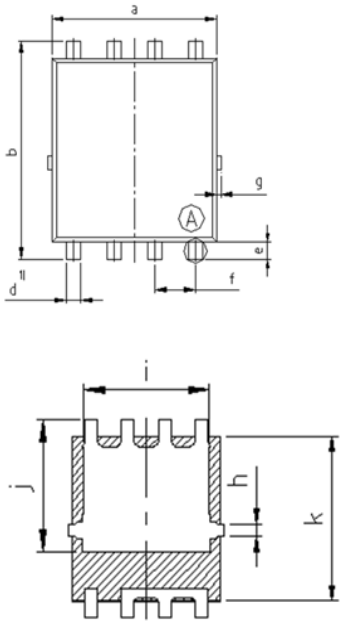
› ***Available now!***

OptiMOS-5 SSO8 Package
Features and Benefits

- Full 1000 hour life at the max Tj of 175C.
- New lead-frame for better AOI feature. Complete front surface of the lead has tin plating.
- No Source bond wires, but Cu clip connection for better resistance and thermal performance
- Fused Source connection for better current density than competitors with only three isolated Source pins
- Can replace a DPAK and Save half of the PCB area

OptiMOS-5 SSO8 Package Detail





Characteristic		Target nominal dimension (mm)
Package X	a	5.15
Package Y	b	6.44
Package thickness	c	1.00
Lead width	d	0.44
Lead length	e	0.48
Lead pitch	f	1.27
Fish tail length	g	0.13
Fish tail width	h	0.40
Heat sink X	i	4.30
Heat sink Y	j	4.30
Molded Body	k	5.48

PQFN56 Automotive-Qualified High Voltage MOSFET Portfolio

Device	Vds (V)	Technology	max Ron (mΩ)	ID (A)	Package	LL/NL
AUIRFN7107TR	75	Gen10.7	8.5	76	PQFN56	NL
AUIRFN7110TR	100	Gen10.7	14.5	58	PQFN56	NL

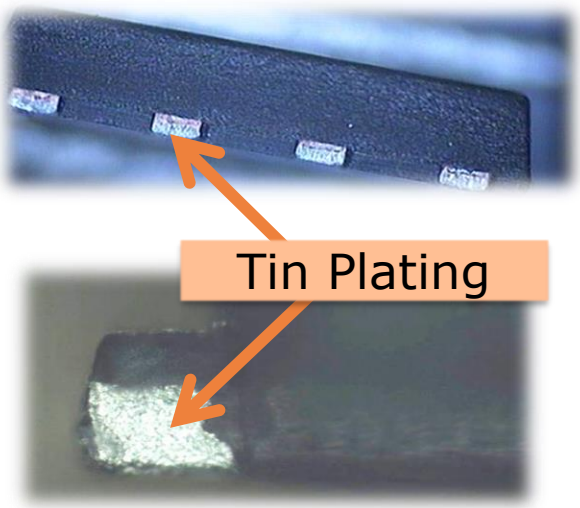
- *Can replace a DPAK in only half the PCB area*
- *Low R_{DSon} → low conduction losses*
- ***In production now!***

PQFN56

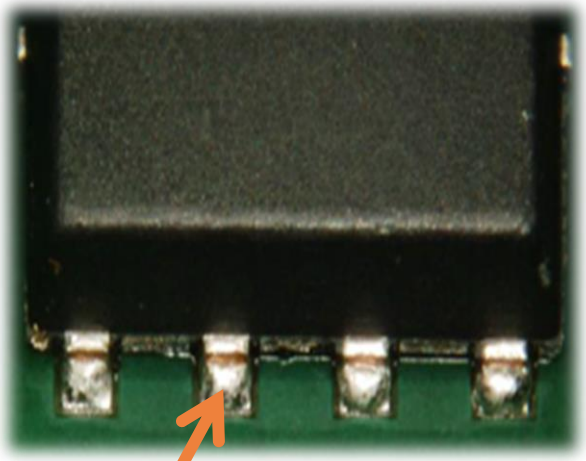
Al ribbon wire

PQFN56 Leadless Package
Extended Lead with End Lead Plating

Side View



Solderability Testing Results



End Lead Plating Ensures Good Solderability

AOI - Inspectable Solder Joint

Good Solder Cover Range at End Lead

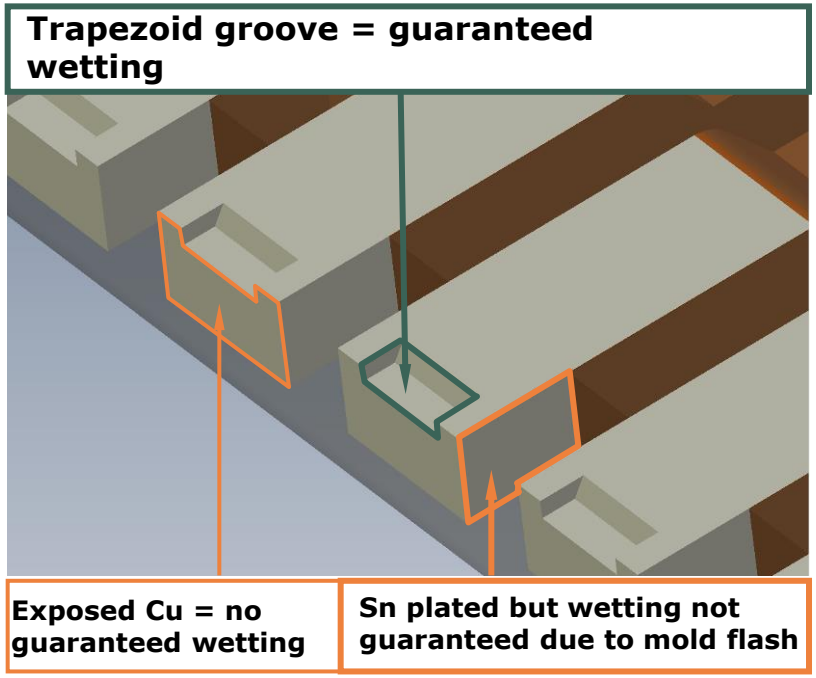
Solder Across the Lead from Side to Side

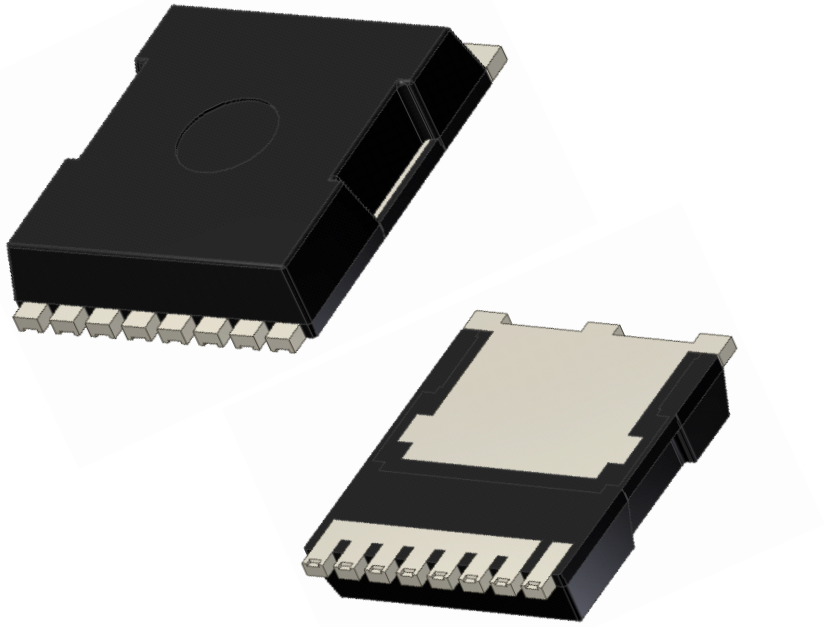
Infineon Automotive MOSFET Products

TOLL (TO Lead-Less) package products

TO-Leadless Package Features

- *30% less board space compared with D²PAK*
- Reduced package electrical and thermal resistance
- Lower lead inductances for optimized switching performance
- *Compatible with AOI at your manufacturing site*





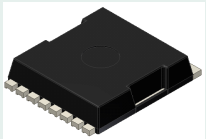
OPTIMOS-T2 40V TOLL
Automotive Product Portfolio

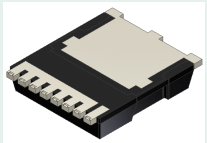
› 40V Product Family

Product Name	Technology	max Ron 10V (mΩ)	ID (A)	LL/NL	SOP
IPLU300N04S4-R8	OptiMOS-T2 40V	0.77	300	NL	released
IPLU300N04S4-1R1	OptiMOS-T2 40V	1.1	300	NL	released
IPLU250N04S4-1R7	OptiMOS-T2 40V	1.7	250	NL	released

› ***In production now!***

TOLL





L x W x H
11.7x9.9x2.3mm

BiC 40V
0.77mΩ

I_{DC} = **300A**

Al-bond wire

NEW OPTIMOS-5 80V TOLL Automotive Product Portfolio

Device	Technology	max Ron (mOhm)	ID (A)	Package	LL/NL
IAUT300N08S5N012	OptiMOS 5 80V	1.2mOhm	300	TOLL	NL
IAUT165N08S5N029	OptiMOS 5 80V	2.9mOhm	165	TOLL	NL

› ***Available now!***

TOLL

L x W x H
11.7x9.9x2.3mm

BIC 80V
1.2mΩ

I_{DC} = **300A**

Al bond wire

NEW OPTIMOS-5 100V TOLL Automotive Product Portfolio

Device	Technology	max Ron (mOhm)	ID (A)	Package	LL/NL
IAUT300N10S5N015	OptiMOS 5 100V	1.50	300	TOLL	NL
IAUT150N10S5N035	OptiMOS 5 100V	3.50	150	TOLL	NL

SFET5 100V TOLL	Project schedule
Deliverable	
ES	Available
QS	Q3 2017
SOP	Q1 2018

TOLL

L x W x H
11.7x9.9x2.3mm

BIC 100V
1.5mΩ

I_{DC} = **300A**

Al bond wire

Preliminary Information. Subject to change.

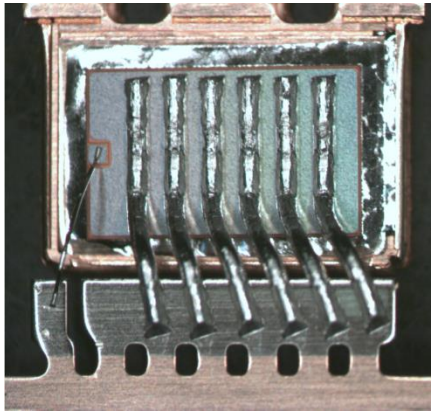
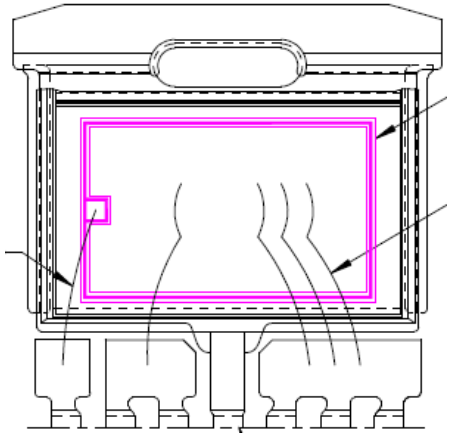
* Please contact Product Marketing if you require urgent sampling support

Infineon Automotive MOSFET Products

D2PAK-7P+ package products

NEW! D2PAK-7P+ Package Feature

Same Footprint, 50% More Current!

D2PAK-7P+	D2PAK-7P
	
Maximum 6 x 500µm Wire	**Maximum 4 x 500µm Wire**
360A	**240A**

Footprint 100% Compatible

D2PAK-7P+ 40V Product Portfolio

Device	Technology	max Ron (mΩ)	ID (A)	Package	LL/NL
AUIRFSA8409-7P **In Production Now!**	Gen12.7 40V	0.69	360	D2PAK-7P+	NL

Same D2PAK-7P footprint → **Drop in replacement**

Up to 360A current →

Benchmark Rds(on) →

Improved power density

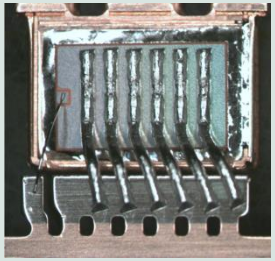
Product Datasheet available online:

http://www.irf.com/product-info/datasheets/data/auirfsa8409-7p.pdf

Targeted Applications

- **Battery Switch**
- **Reverse Battery Protection**
- **EPS Phase Switch**

D2PAK-7P+



L x W x H
15.2.7x10.2x4.4mm
(Same as D2PAk-7P)

BIC 40V
0.69mΩ

I_{DC} = **360A**

Al bond wire

Infineon Automotive MOSFET Products

Dual Super SO8 (Dual SS08)

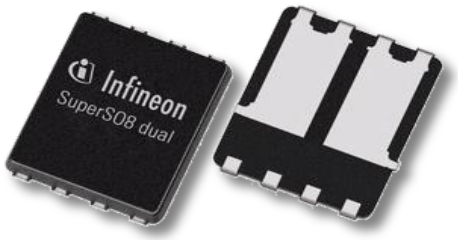
Dual Super-SO8/PQFN56 Product Family Planar & Trench, 40V/60V/100V Products

› *Can replace two DPAKs while taking 75% less PCB area*

OptiMOS Dual SSO8	Technology	max Ron 10V (mOhm) / channel	ID (A) / channel	max RthJC [K/W]	LL/NL	Package
AUIRFN8459	Gen12.7 40V	5.9	50	3.0	NL	PQFN56 Dual
IPG20N04S4L-07A	OptiMOS-T2 40V	7.2	20	2.3	LL	PG-TDSON-8-10
IPG20N04S4-08A	OptiMOS-T2 40V	7.6	20	2.3	NL	PG-TDSON-8-10
IPG20N04S4L-08A	OptiMOS-T2 40V	8.2	20	2.8	LL	PG-TDSON-8-10
IPG20N04S4L-11A	OptiMOS-T2 40V	11.6	20	3.7	LL	PG-TDSON-8-10
IPG20N04S4-12A	OptiMOS-T2 40V	12.2	20	3.7	NL	PG-TDSON-8-10
IPG20N06S4L-11A	OptiMOS-T2 60V	11.2	20	2.3	LL	PG-TDSON-8-10
IPG20N06S4L-14A	OptiMOS-T2 60V	13.7	20	3.0	LL	PG-TDSON-8-10
IPG20N06S4-15A	OptiMOS-T2 60V	15.5	20	3.0	NL	PG-TDSON-8-10
IPG20N06S4L-26A	OptiMOS-T2 60V	26.0	20	4.5	LL	PG-TDSON-8-10
IPG20N06S2L-35A	OptiMOS 55V	35.0	20	2.3	LL	PG-TDSON-8-10
IPG20N06S2L-50A	OptiMOS 55V	50.0	20	2.9	LL	PG-TDSON-8-10
IPG20N06S2L-65A	OptiMOS 55V	65.0	20	3.5	LL	PG-TDSON-8-10
IPG20N10S4L-22A	OptiMOS-T2 100V	22.0	20	2.2	LL	PG-TDSON-8-10
IPG20N10S4L-35A	OptiMOS-T2 100V	35.0	20	3.2	LL	PG-TDSON-8-10
IPG20N10S4-36A	OptiMOS-T2 100V	35.0	20	3.2	NL	PG-TDSON-8-10
IPG16N10S4-61A	OptiMOS-T2 100V	61.0	16	4.8	NL	PG-TDSON-8-10
IPG16N10S4L-61A	OptiMOS-T2 100V	61.0	16	5.2	LL	PG-TDSON-8-10

› **Front-end technology options:**

- *OptiMOS™ 55V: Thermal driven applications*
- *OptiMOS™-T2 40V: R_{DSon} driven applications*
- *Gen12.7 40V: R_{DSon} driven applications*
- *OptiMOS™-T2 60V: R_{DSon} driven applications*
- *OptiMOS™-T2 100V: R_{DSon} driven applications*
- *AOI-compatible leads (a.k.a. wettable flanks)*
- *Standard leads w/o AOI at lower price*



Infineon Automotive MOSFET Products

DirectFET2® -
Increase System Efficiency and Power Density

DirectFET2® - Improve System Efficiency, Reliability and Power Density

- Very Small Package Size and Height
- Lowest Package Resistance and Inductance
- Lowest Top-Side Thermal Impedance
- No Lead Frame, Wire Bond, or Molding
- 100% Pb lead-free, Solution to Address RoHS

- Increased System Efficiency
- Increased power Density
- Reduced Parasitic Ringing

DirectFET2® Success Story

End Car Manufacturer:
Major OEM

Application:
Adaptive Steering System

Production Date:

2015

More System Information:

Link

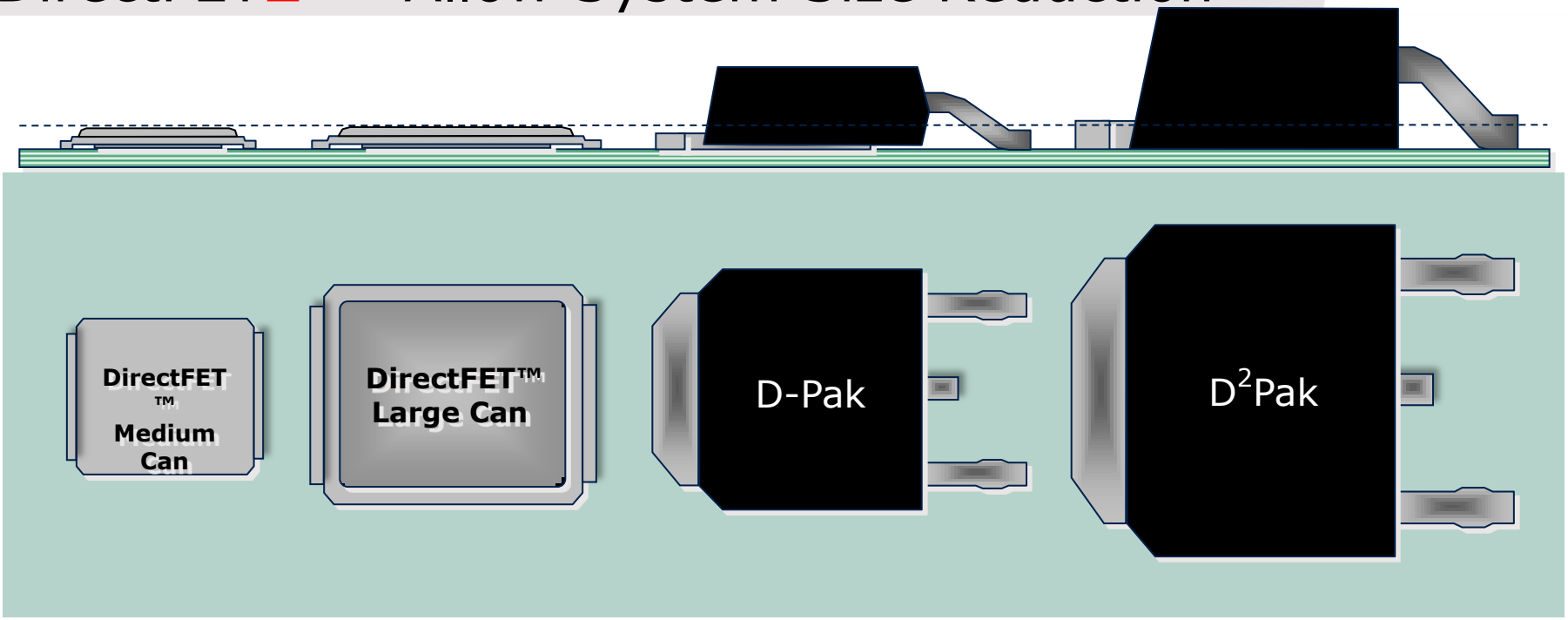
Part Numbers:

40V 3mOhm Medium-Can AUIRF7736M2
(6 per board)

Key Factors for Design Win:

- ✓ Good reliability, ideal for automotive applications
- ✓ Small footprint - **DirectFET®2** Medium Can is 54% smaller than DPAK
- ✓ Better thermal performance vs. conventional packages

DirectFET2® - Allow System Size Reduction



5.05 x 6.35 x 0.70	7.00 x 9.10 x 0.70	6.73 x 10.4 x 2.38	10.7 x 15.9 x 4.83
(0.085 grams)	(0.178 Grams)	(0.325 grams)	(1.26 grams)
32.1mm²	**63.7mm²**	70.1mm²	170mm²
22.4mm³	**44.6mm³**	166mm³	822mm³

9% Area Reduction
73% Volume Reduction

63% Area Reduction
95% Volume Reduction

54% Area Reduction
87% Volume Reduction

81% Area Reduction
97% Volume Reduction

DirectFET2® Released Portfolios

Part numbers	Voltage (V)	max Ron 10V (mOhm)	QG typ (nC)	ID (A)	Package	NL/LL	Optimized Feature
AUIRF8739L2	40	0.6	362	309	Large Can - L8	NL	Low Rds(on)
AUIRF7739L2	40	1.0	220	270	Large Can - L8	NL	Low Rds(on)
AUIRF7738L2	40	1.6	147	210	Large Can - L6	NL	Low Rds(on)
AUIRF8736M2	40	1.9	136	137	Medium Can - M4	NL	Low Rds(on)
AUIRF7737L2	40	1.9	89	156	Large Can - L6	NL	Low Rds(on)
AUIRF7736M2	40	3.0	72	108	Medium Can - M4	NL	Low Rds(on)
AUIRL7736M2	40	3.0	59	143	Medium Can - M4	LL	Low Rds(on)
AUIRF7734M2	40	4.9	48	72	Medium Can - M2	NL	Low Rds(on)
AUIRL7732S2	40	6.6	24	65	Small Can - SC	LL	Low Rds(on)
AUIRF7732S2	40	7.0	30	55	Small Can - SC	NL	Low Rds(on)
AUIRF7749L2	60	1.6	200	200	Large Can - L8	NL	Low Rds(on)
AUIRF7648M2	60	7.0	35	68	Medium Can - M4	NL	Low Qg
AUIRF7640S2	60	36.0	7	21	Small Can - SB	NL	Low Qg
AUIRF7759L2	75	2.3	200	160	Large Can - L8	NL	Low Rds(on)
AUIRF7769L2	100	3.5	200	124	Large Can - L8	NL	Low Rds(on)
AUIRF7669L2	100	4.4	81	114	Large Can - L8	NL	Low Qg
AUIRL7766M2	100	10.0	44	51	Medium Can - M4	LL	Low Rds(on)
AUIRF7647S2	100	31.0	14	24	Small Can - SC	NL	Low Qg
AUIRF7665S2	100	62.0	8	14	Small Can - SB	NL	Low Qg
AUIRF7675M2	150	56.0	21	18	Medium Can - M2	NL	Low Qg
AUIRF7799L2	250	32.0	110	35	Large Can - L8	NL	Low Rds(on)

Automotive MOSFET
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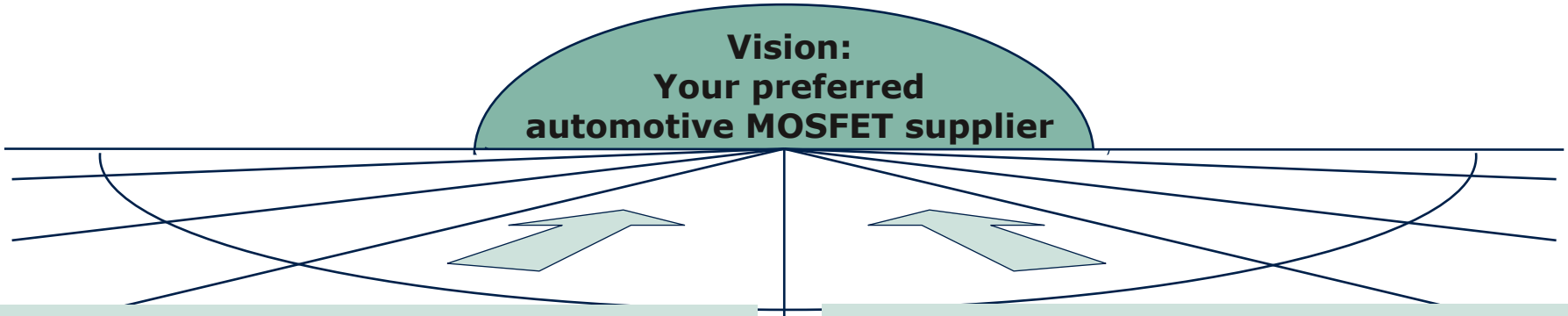


Our leading market position today

› Benchmark OptiMOS™-5 trench technology: Rds_{on} < 1mΩ. *Better energy efficiency & potential space savings*

› Excellent *Application Engineering support for your R&D*

› Zero Defect program: *Quality focus. Lower total costs.*

› Broad portfolio of automotive qualified devices
- Planar and trench technology devices
- N- and P-channel MOSFET devices
- Standard and new innovative packages
- Products available from 24V to 300V
- The best from IR and Infineon brought together
- *Hundreds of part numbers to choose for your design*

› Leadership on legal/green requirements: offering the first 100% Pb-free devices. *Supporting your future needs.*

Our plans to support you in the future

› Focus on new packages
- Integration – *Space savings (PCB area/cost)*
- Smaller packages – *Space savings*
- High current devices – *Capability to drive larger loads. Savings potential by eliminating parallel devices*.

› Next OptiMOS™-5 trench technology
- *even better performance for conduction energy efficiency & improved EMC switching behavior*
- *enables innovative packages*

› Latest product information & support on our homepage:
www.infineon.com/automotivemosfet

Automotive MOSFET Naming System

I → Infineon

Device:

P for Power-MOSFET
T for Twin Power-MOSFET (Common Drain)

Package Type:

B for TO263/D²PAK
C for SuperSO8 (TDSON-08)
D for TO252/DPAK
I for TO262/I²PAK
LU for TO-Leadless (H-PSOF)
P for TO220
G for Dual SuperSO8 (TDSON-08)
Z for Shrink SuperSO8 (TSDSON-08)

Continuous drain current I_{Dmax}

P for p-channel
N for n-channel

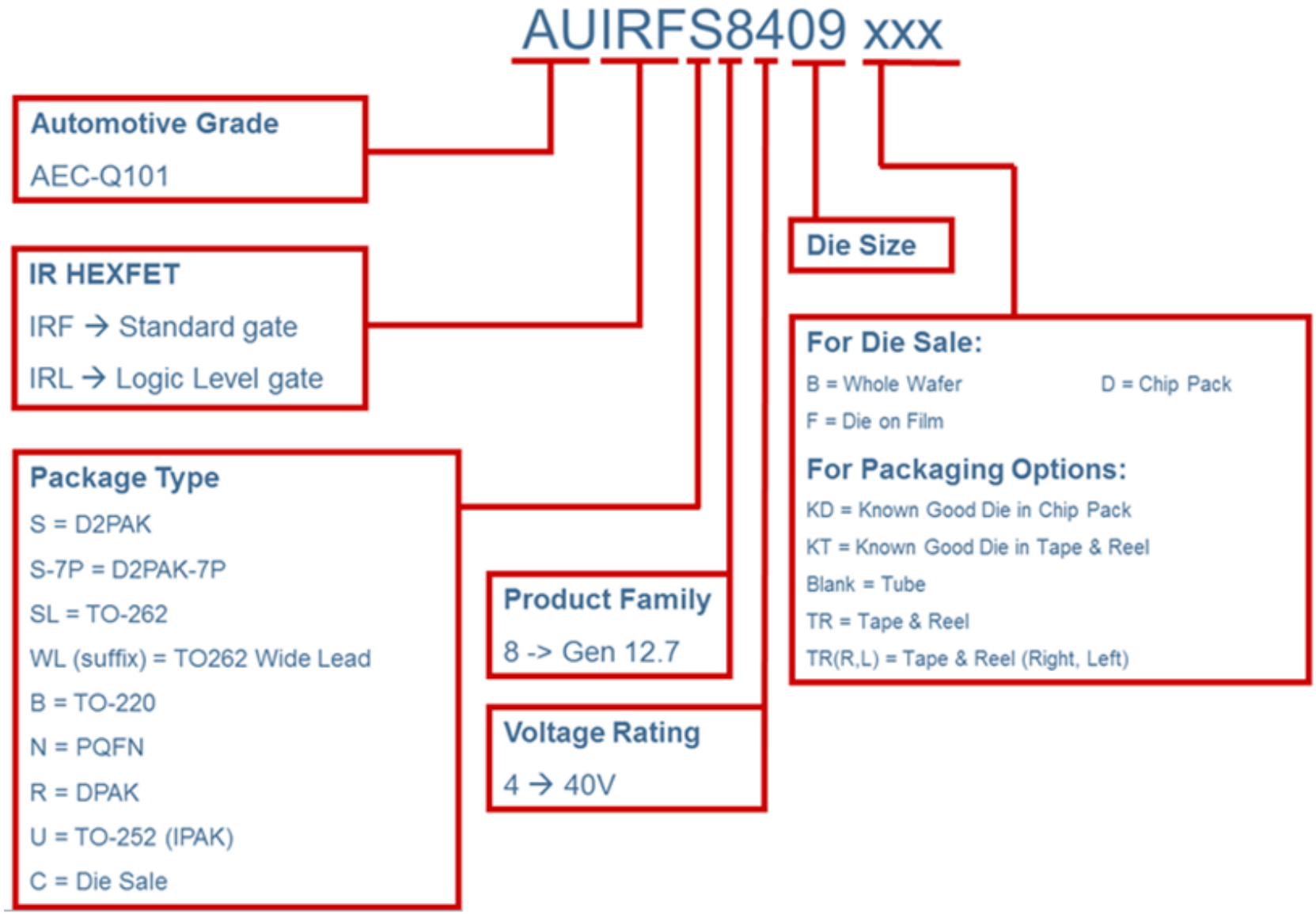
Breakdown voltage V_{BrDSS} ÷10

S for SFET1
S2 for OptiMOS™
S3 for OptiMOS™-T
S4 for OptiMOS™-T2
S5 for OptiMOS™-5
P3 for PFET3 Trench
P4 for PFET4 Trench

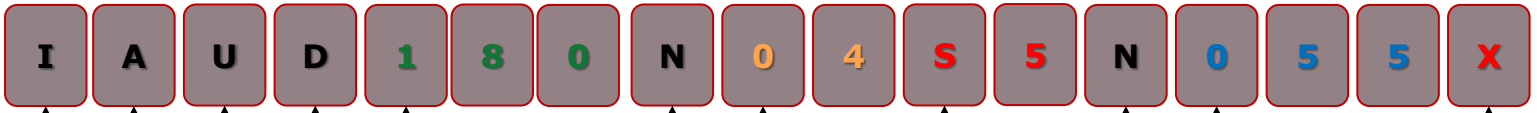
L for Logic Level
(no L is Normal Level)

$R_{DSon,max}$ in mΩ
"H" in front
for higher ohmic version
i.e. H5=5.5mΩ
"R" as decimal separator
i.e. 1R3=1.3mΩ

Former IRF Gen12.7 COOLiRFET™ Naming System



Future Automotive MOSFET Naming System



Optional
(i.e. customized)

$R_{DSon,max}$ xx.x mΩ

L logic level
N normal level

S5 OptiMOS™-5

Breakdown voltage
V_{BrDSS} ÷10

P p-channel
N n-channel

Continuous drain current I_{Dmax}

Package Type:

A sTOLL
B TO263/D²PAK
C Single SSO8 (TDSON-08)
D TO252/DPAK
G Dual SSO8 (TDSON-08)
I TO262/I²PAK
P TO220
T TOLL (H-PSOF, MO-299)
S SUPiRPAK
Z S3O8 (TSDSON-08)

U/X → Standard
/ Extended
(i.e.qualification)

A → Automotive

I → Infineon

Part of your life. Part of tomorrow.

Infineon