Wayon SJ-MOSFET Technology and Application

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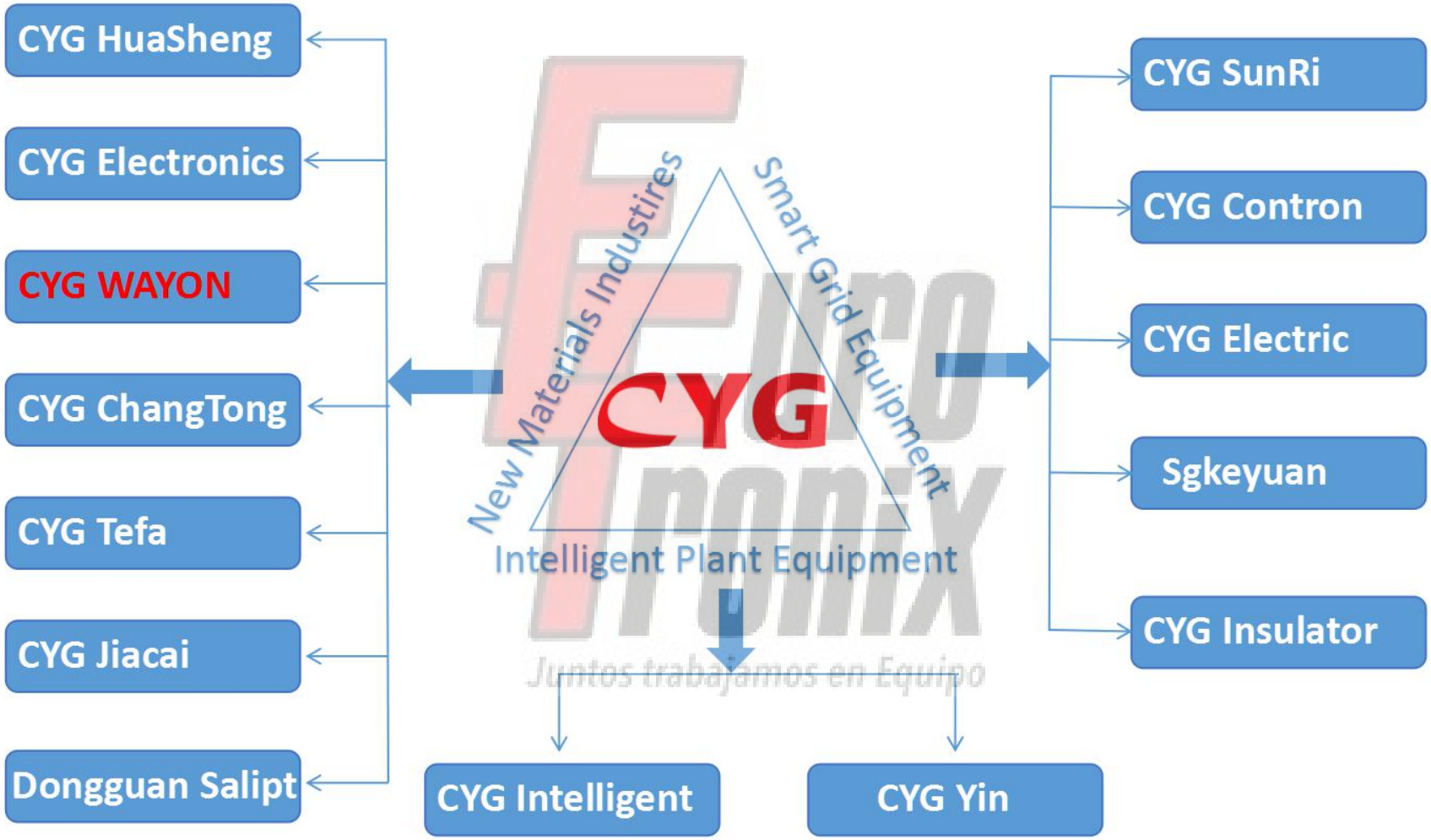
Overview

CYG Established: May, 1986 ; **Stock Code: 600525 SH** **2016 Turnover :** $850Million



- FORBES China Potential Enterprise, 2005/2008/2009
- FORBES China Potential Technology Corporation, 2011
- FORBES Asia's Best Under A Billion Top 200, 2006/2012

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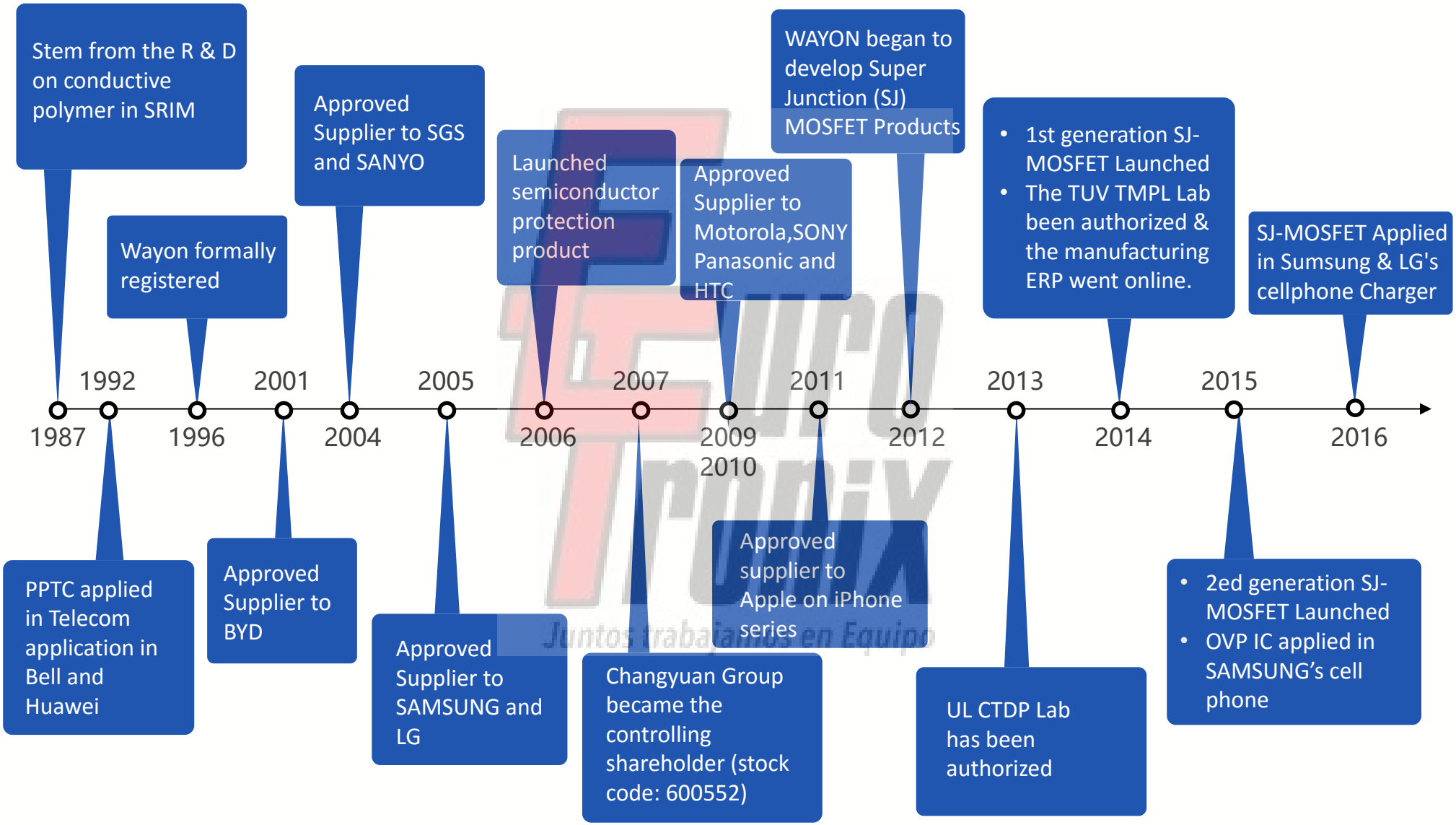
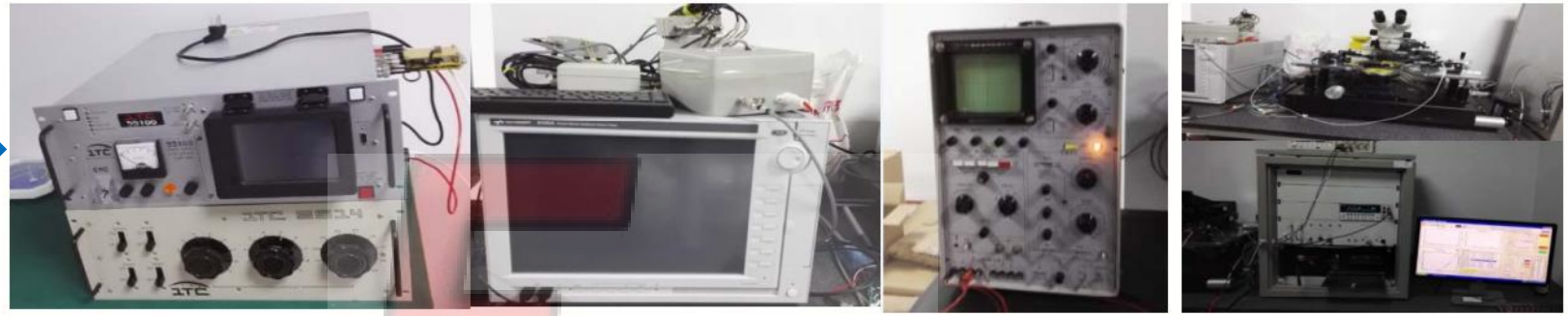
Development History



WAYON Lab

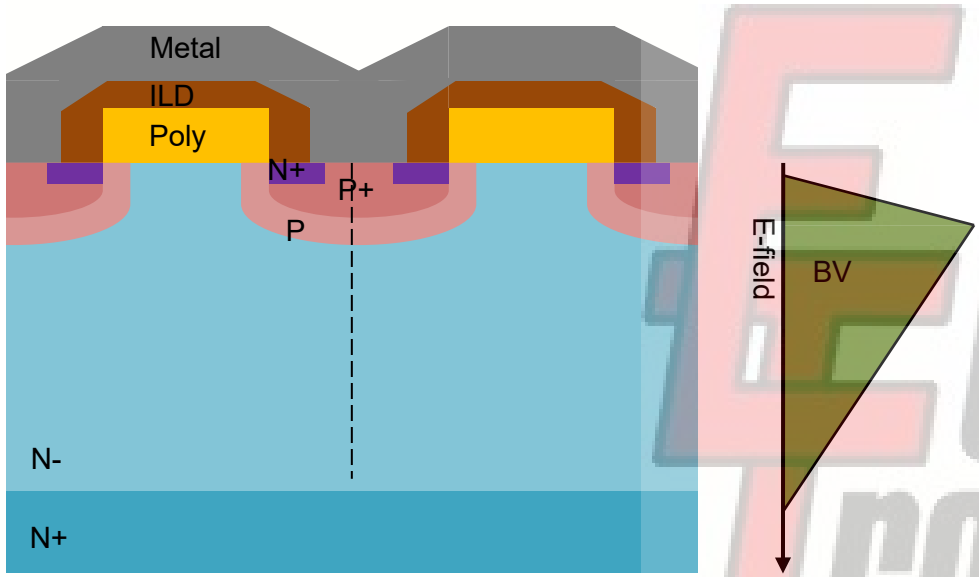
R&D

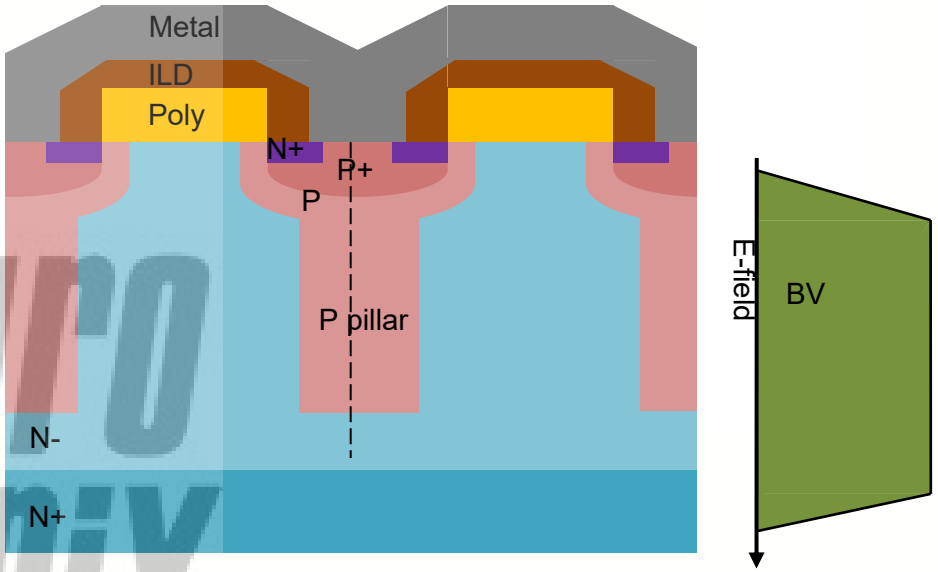


Reliability/FA

Application

SJ-MOSFET Structure

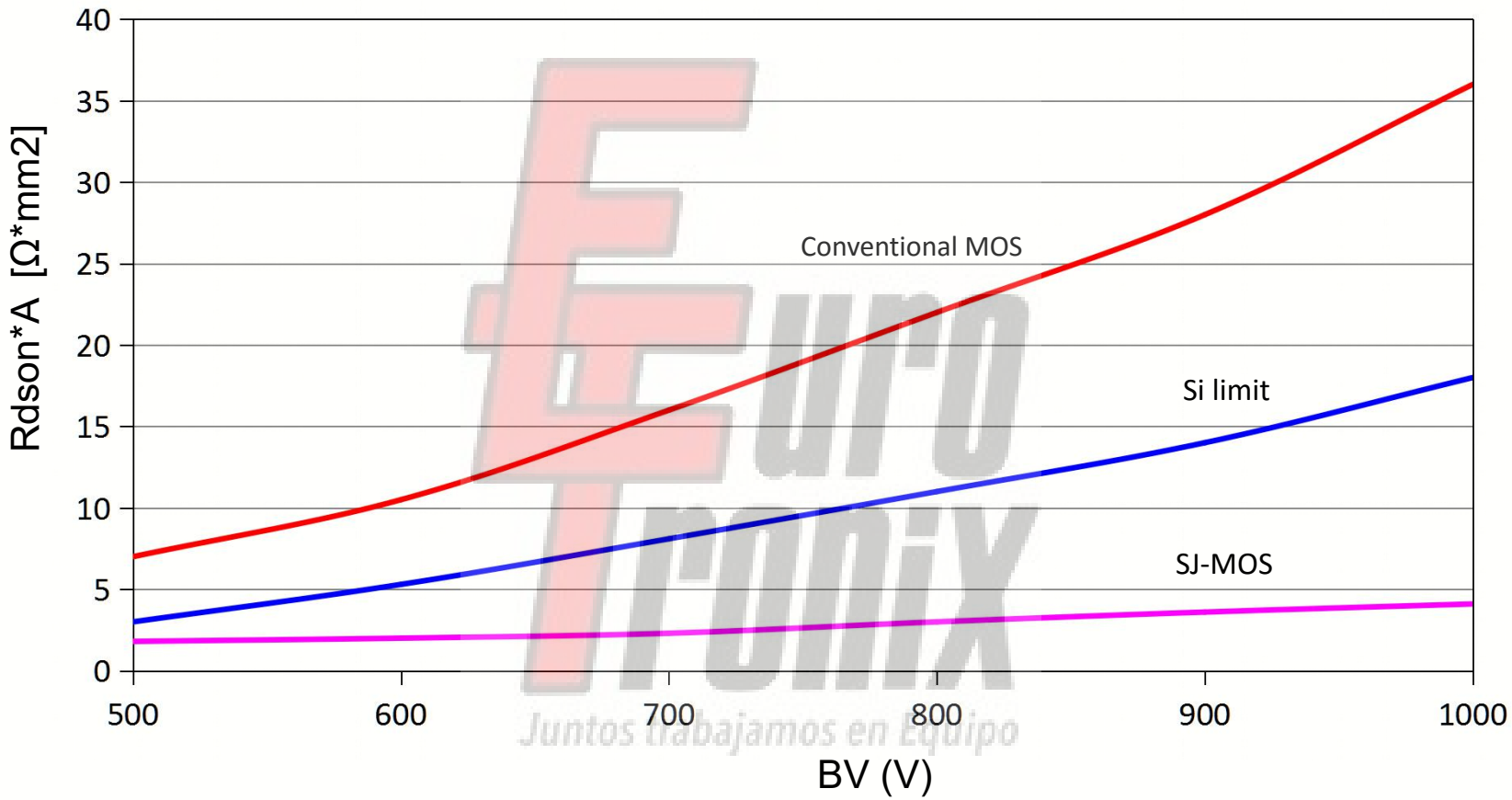




- VDMOS introduced in the 1970s
- Higher BV, larger die size
- Rdson*A $\propto BV^{2.5}$

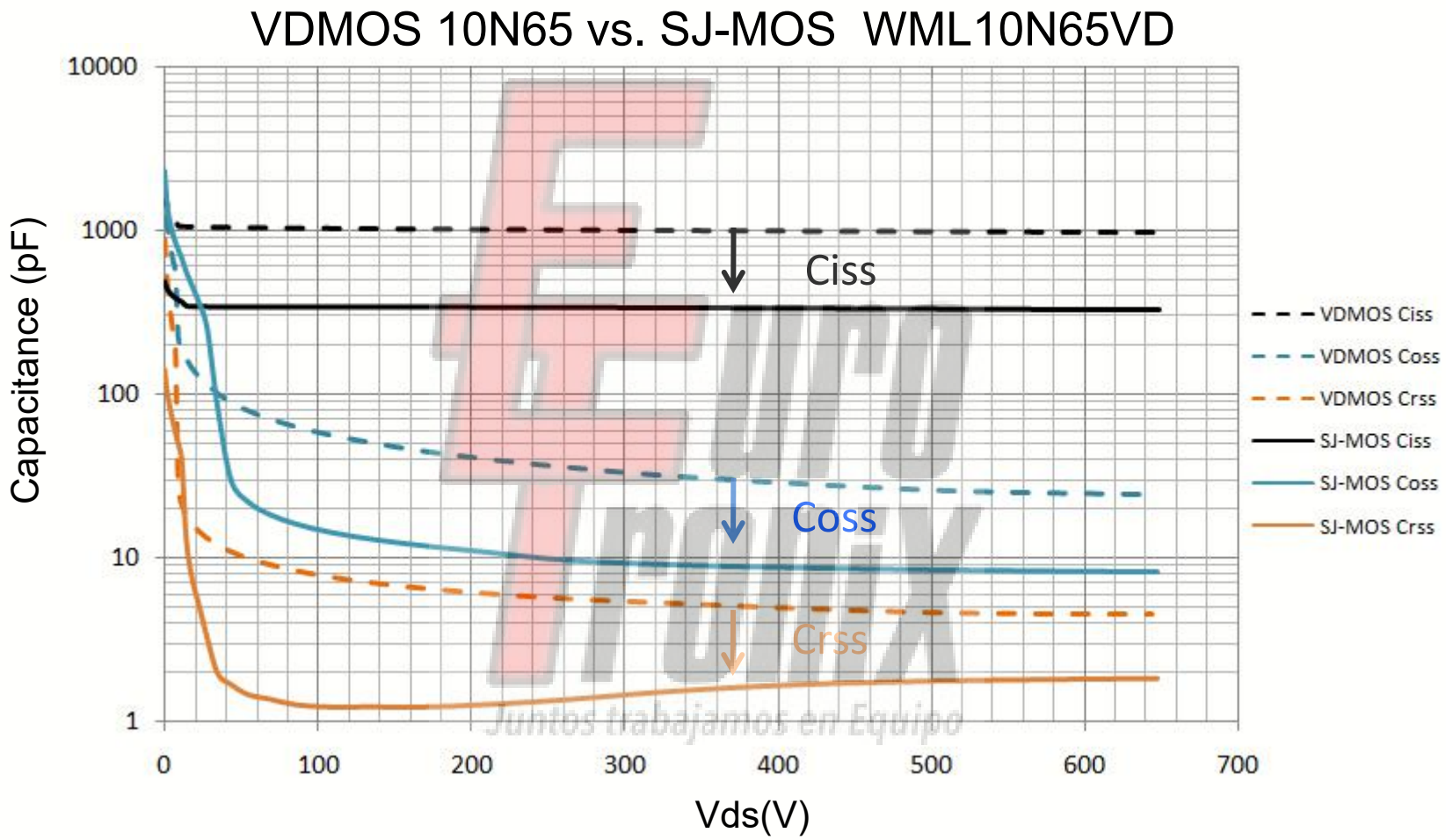
- Charge balance principle
- 1st SJ-MOS patent in 1993
- 1st commercial SJ-MOSFET in 1998
- Thinner EPI layer
- Rdson*A $\propto BV^{1.32}$

SJ-MOSFET Rdson vs. BV



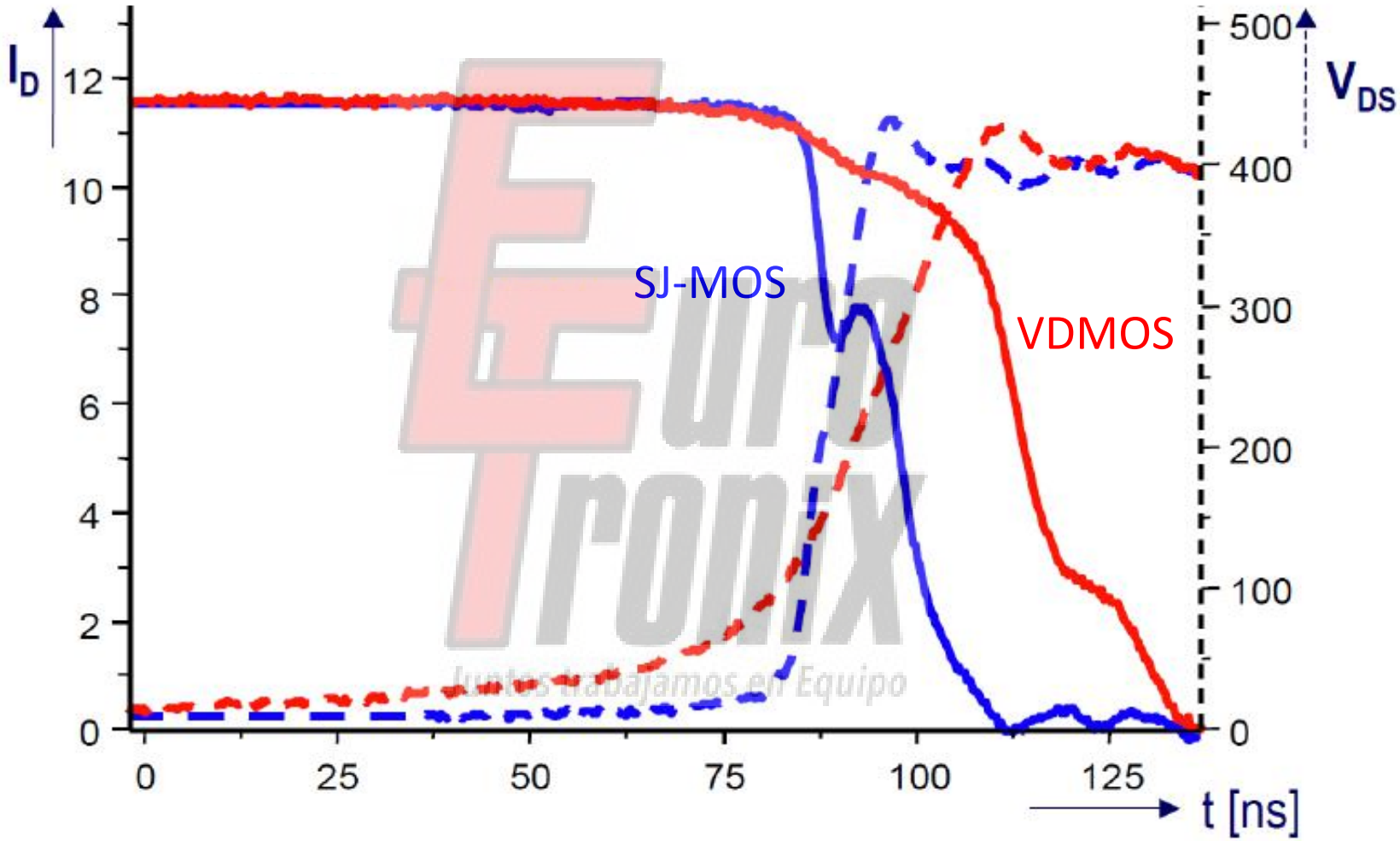
- SJ-MOS can reduce package size, enhance power density

SJ-MOS Characteristics—Capacitance



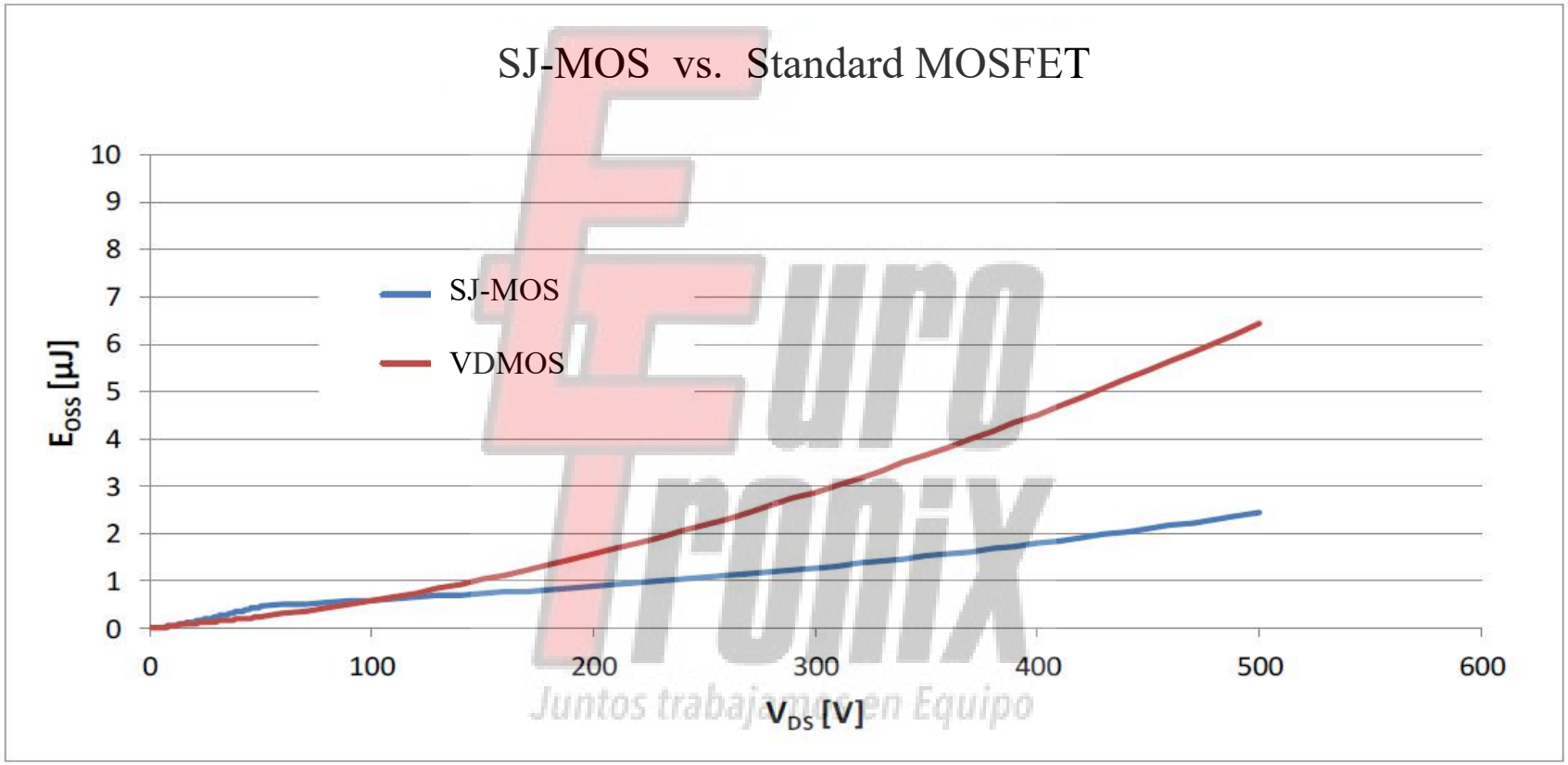
- SJ-MOS capacitance is smaller, less power loss
- Nonlinear

SJ-MOS Characteristics-- Switching



SJ-MOS: higher switching speed, higher frequency

SJ-MOS Characteristics-- Eoss



SJ-MOS: less Coss related power loss

SJ-MOS Advantages

VDMOS | SJ-MOS

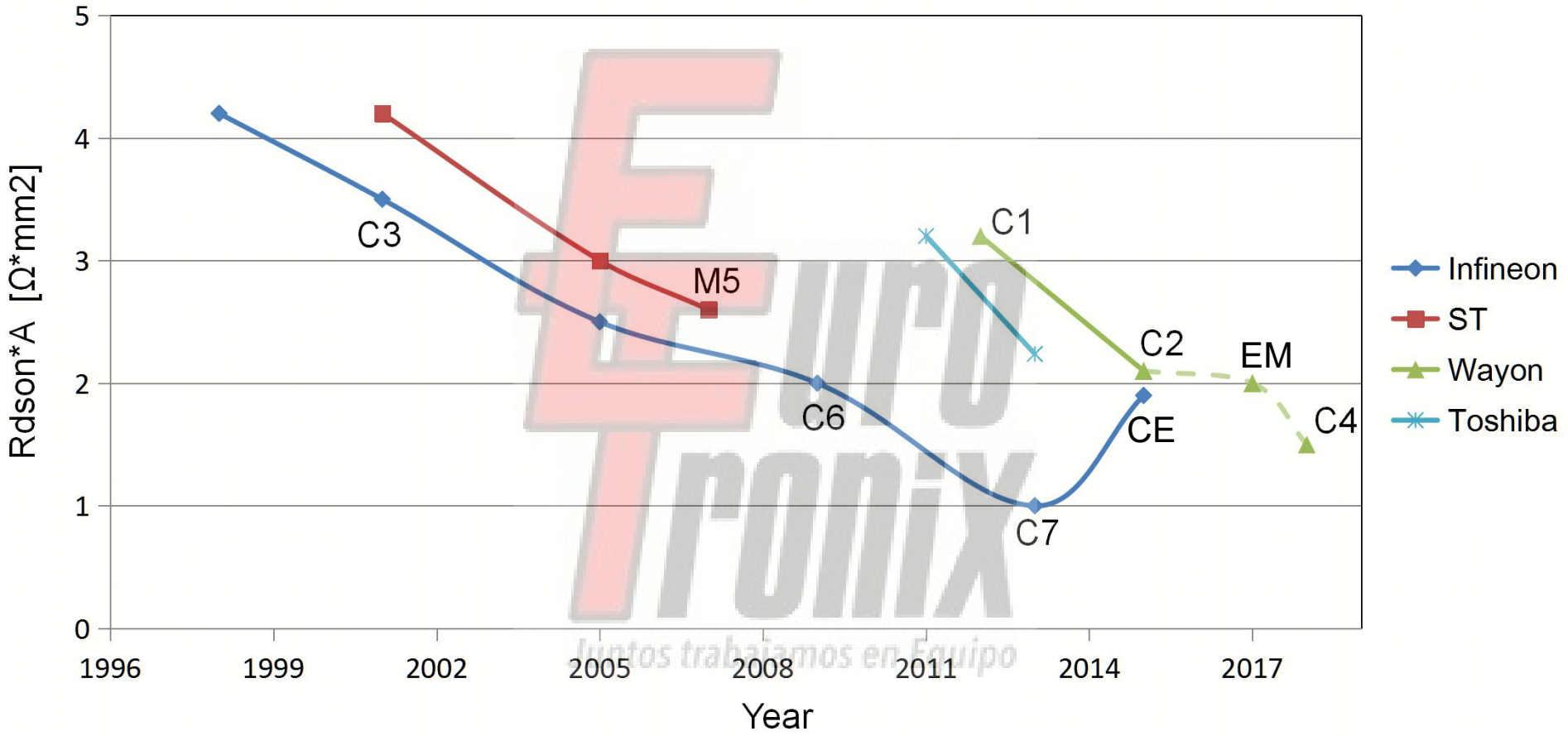
Smaller package size

SMPS miniature

+

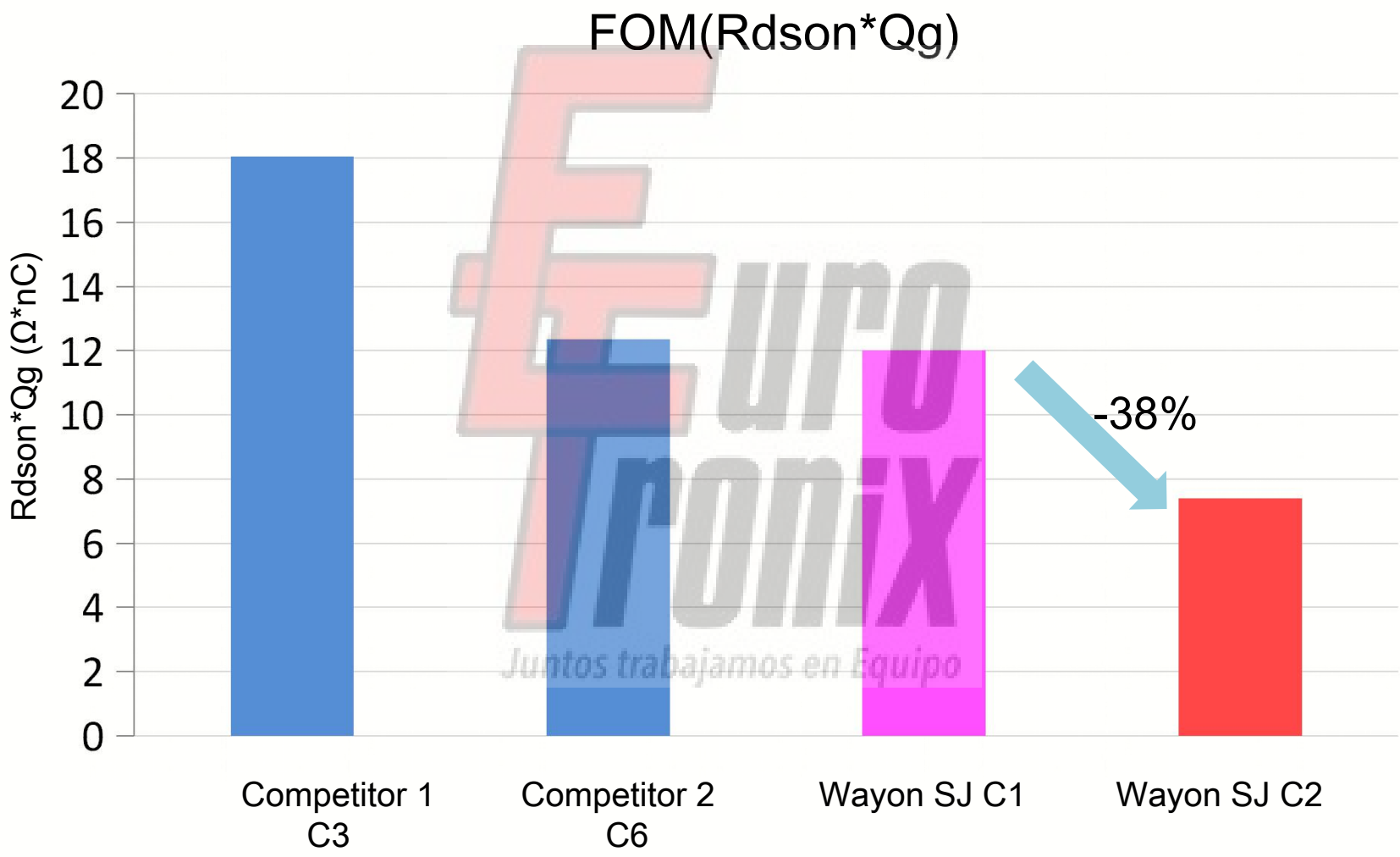
Combo IC

SJ-MOS Technology Development



C2: soft switching SJ-MOS, better efficiency and EMI performance.
EM: further enhance EMI performance.

Wayon SJ-MOS Technology Evolution



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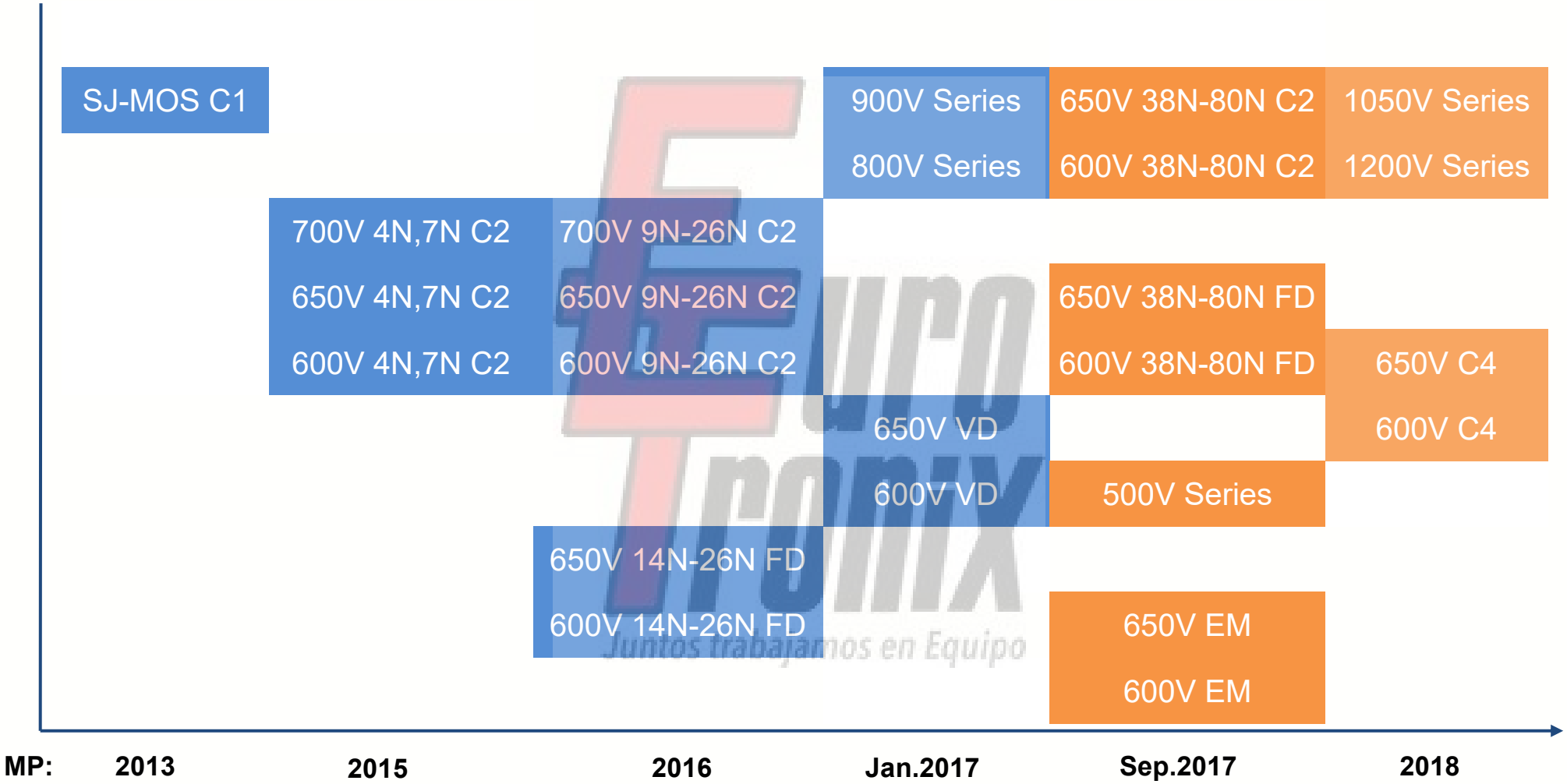
Wayon SJ-MOS Road Map



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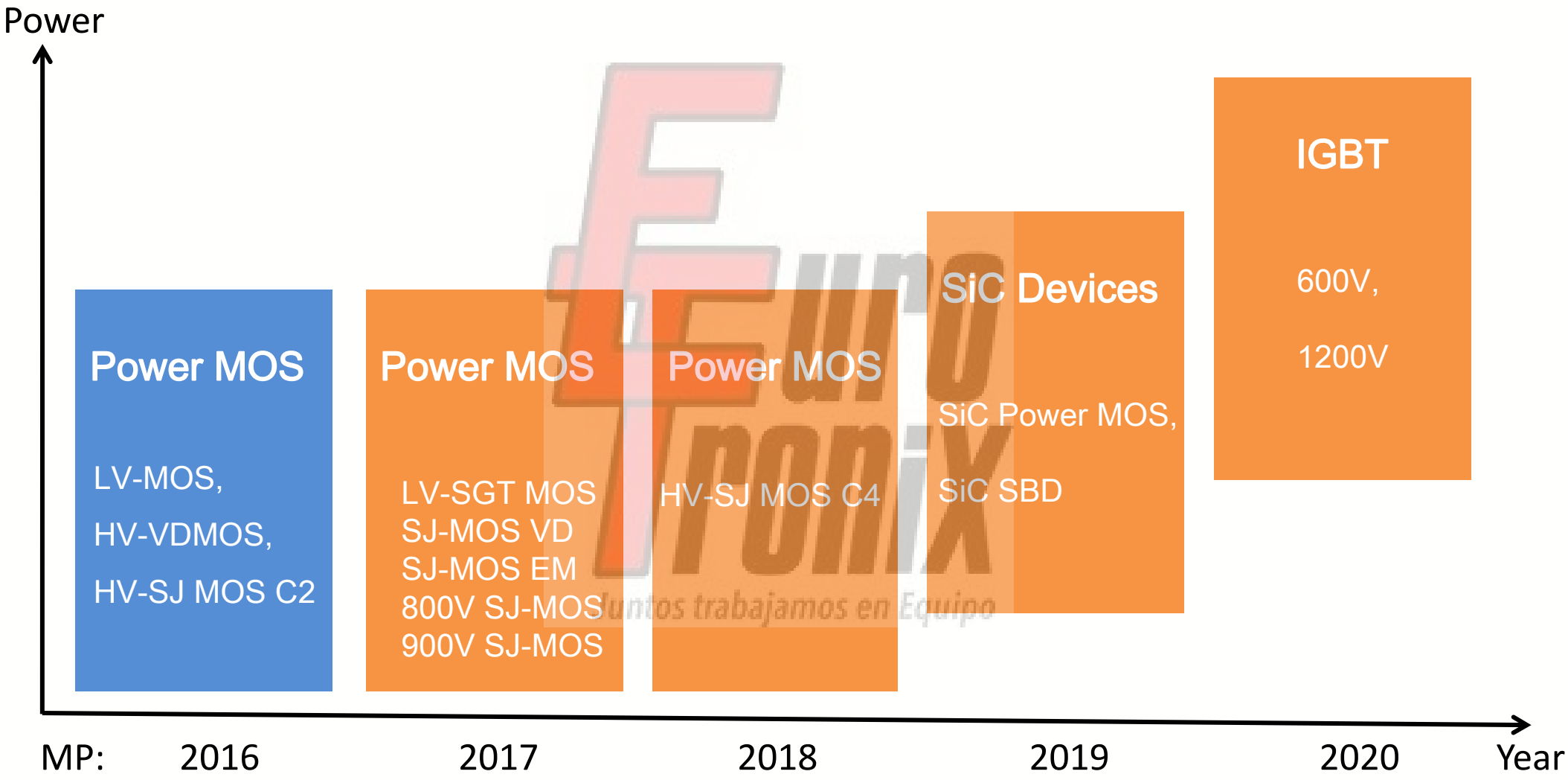
Wayon Power Devices Road Map



SJ-MOS On Board Test Items

- Input and Output Characteristics
  - Efficiency
  - Power saving
- Protections
  - Short circuit
- Environment/Reliability
  - On-Off cycling
  - Voltage stress
  - Burn-in
  - Thermal
  - Temperature& Humidity
  - Cold start
- EMI/EMC
  - Conduction
  - Radiation

Industrial Level Reliability

Test Item	Test Condition	Duration	Sample Size	Acc/Reject	Referenced standard
HTGB	T_A= 150°C , Vgs=30V	1000 hrs	77pcs*3lots	0/1	JESD22-A108
HTRB	T_A = 150°C , Vds=80%Vdsmax.	1000 hrs	77pcs*3lots	0/1	JESD22-A108
HTSL	T_A = 150°C	1000 hrs	77pcs*3lots	0/1	JESD22-A103
PCT	121°C 205KPA 100%RH	96 hrs	77pcs*3lots	0/1	JESD22-A102
TCT	-65°C to 150°C, air to air,	500 cycles	77pcs*3lots	0/1	JESD22-A104

SJ-MOSFET process platform own over 10000hours test life time

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SJ-MOS C2 Product Portfolio

600V SJ-MOSFET C2

$R_{DS(on)}$,max [Ω]	TO-252	TO-251	TO-251S3	TO-251S2	TO-220F	TO-220	TO-263	TO-262	TO-247
1.9	WMO04N60C2	WMP04N60C2	WMG04N60C2	WMH04N60C2	WML04N60C2				
1.14	WMO07N60C2	WMP07N60C2	WMG07N60C2	WMH07N60C2	WML07N60C2	WMK07N60C2			
0.94	WMO09N60C2	WMP09N60C2	WMG09N60C2	WMH09N60C2	WML09N60C2	WMK09N60C2			
0.69	WMO10N60C2	WMP10N60C2	WMG10N60C2	WMH10N60C2	WML10N60C2	WMK10N60C2	WMM10N60C2	WMN10N60C2	
0.54	WMO11N60C2	WMP11N60C2			WML11N60C2	WMK11N60C2	WMM11N60C2	WMN11N60C2	
0.405	WMO14N60C2	WMP14N60C2			WML14N60C2	WMK14N60C2	WMM14N60C2	WMN14N60C2	
0.32	WMO16N60C2	WMP16N60C2			WML16N60C2	WMK16N60C2	WMM16N60C2	WMN16N60C2	
0.3	WMO20N60C2	WMP20N60C2			WML20N60C2	WMK20N60C2	WMM20N60C2	WMN20N60C2	
0.19					WML26N60C2	WMK26N60C2	WMM26N60C2	WMN26N60C2	WMJ26N60C2
0.099					WML38N60C2*	WMK38N60C2*	WMM38N60C2*	WMN38N60C2*	WMJ38N60C2*
0.07					WML53N60C2*				WMJ53N60C2*
0.04									WMJ80N60C2*

650V SJ-MOSFET C2

$R_{DS(on)}$,max[Ω]	TO-252	TO-251	TO-251S3	TO-251S2	TO-220F	TO-220	TO-263	TO-262	TO-247
1.9	WMO04N65C2	WMP04N65C2	WMG04N65C2	WMH04N65C2	WML04N65C2				
1.14	WMO07N65C2	WMP07N65C2	WMG07N65C2	WMH07N65C2	WML07N65C2	WMK07N65C2			
0.94	WMO09N65C2	WMP09N65C2	WMG09N65C2	WMH09N65C2	WML09N65C2	WMK09N65C2			
0.69	WMO10N65C2	WMP10N65C2	WMG10N65C2	WMH10N65C2	WML10N65C2	WMK10N65C2	WMM10N65C2	WMN10N65C2	
0.54	WMO11N65C2	WMP11N65C2			WML11N65C2	WMK11N65C2	WMM11N65C2	WMN11N65C2	
0.405	WMO14N65C2	WMP14N65C2			WML14N65C2	WMK14N65C2	WMM14N65C2	WMN14N65C2	
0.32	WMO16N65C2	WMP16N65C2			WML16N65C2	WMK16N65C2	WMM16N65C2	WMN16N65C2	
0.3	WMO20N65C2	WMP20N65C2			WML20N65C2	WMK20N65C2	WMM20N65C2	WMN20N65C2	
0.19					WML26N65C2	WMK26N65C2	WMM26N65C2	WMN26N65C2	WMJ26N65C2
0.099					WML38N65C2*	WMK38N65C2*	WMM38N65C2*	WMN38N65C2*	WMJ38N65C2*
0.07					WML53N65C2*				WMJ53N65C2*
0.04									WMJ80N65C2*

* Developing

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SJ-MOS C2 Product Portfolio

700V SJ-MOSFET C2

$R_{DS(on)}$,max [Ω]	TO-252	TO-251	TO-251S3	TO-251S2	TO-220F	TO-220	TO-263	TO-262
2.45	WMO04N70C2	WMP04N70C2	WMG04N70C2	WMH04N70C2	WML04N70C2			
1.45	WMO07N70C2	WMP07N70C2	WMG07N70C2	WMH07N70C2	WML07N70C2	WMK07N70C2		
1.2	WMO09N70C2	WMP09N70C2	WMG09N70C2	WMH09N70C2	WML09N70C2	WMK09N70C2		
0.92	WMO10N70C2	WMP10N70C2	WMG10N70C2	WMH10N70C2	WML10N70C2	WMK10N70C2	WMM10N70C2	WMN10N70C2
0.68	WMO11N70C2	WMP11N70C2			WML11N70C2	WMK11N70C2	WMM11N70C2	WMN11N70C2
0.53	WMO14N70C2	WMP14N70C2			WML14N70C2	WMK14N70C2	WMM14N70C2	WMN14N70C2
0.42	WMO16N70C2	WMP16N70C2			WML16N70C2	WMK16N70C2	WMM16N70C2	WMN16N70C2

800V SJ-MOSFET C2

$R_{DS(on)}$,max [Ω]	TO-252	TO-251	TO-220F	TO-220	TO-263	TO-262	TO-247
5.0	WMO03N80C2*	WMP03N80C2*	WML03N80C2*	WMK03N80C2*	WMM03N80C2*	WMN03N80C2*	
2.8	WMO04N80C2	WMP04N80C2	WML04N80C2	WMK04N80C2	WMM04N80C2	WMN04N80C2	
2.45	WMO05N80C2	WMP05N80C2	WML05N80C2	WMK05N80C2	WMM05N80C2	WMN05N80C2	
2.0	WMO07N80C2	WMP07N80C2	WML07N80C2	WMK07N80C2	WMM07N80C2	WMN07N80C2	
1.45	WMO08N80C2*	WMP08N80C2*	WML08N80C2*	WMK08N80C2*	WMM08N80C2*	WMN08N80C2*	
1.05	WMO10N80C2	WMP10N80C2	WML10N80C2	WMK10N80C2	WMM10N80C2	WMN10N80C2	
0.91	WMO11N80C2*	WMP11N80C2*	WML11N80C2*	WMK11N80C2*	WMM11N80C2*	WMN11N80C2*	
0.44			WML13N80C2	WMK13N80C2	WMM13N80C2	WMN13N80C2	WMJ13N80C2
0.29			WML17N80C2*	WMK17N80C2*	WMM17N80C2*	WMN17N80C2*	WMJ17N80C2*
0.19			WML30N80C2*	WMK30N80C2*			WMJ30N80C2*

* Developing

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SJ-MOS C2 Product Portfolio

800V SJ-MOSFET M3 (3rd Generation)

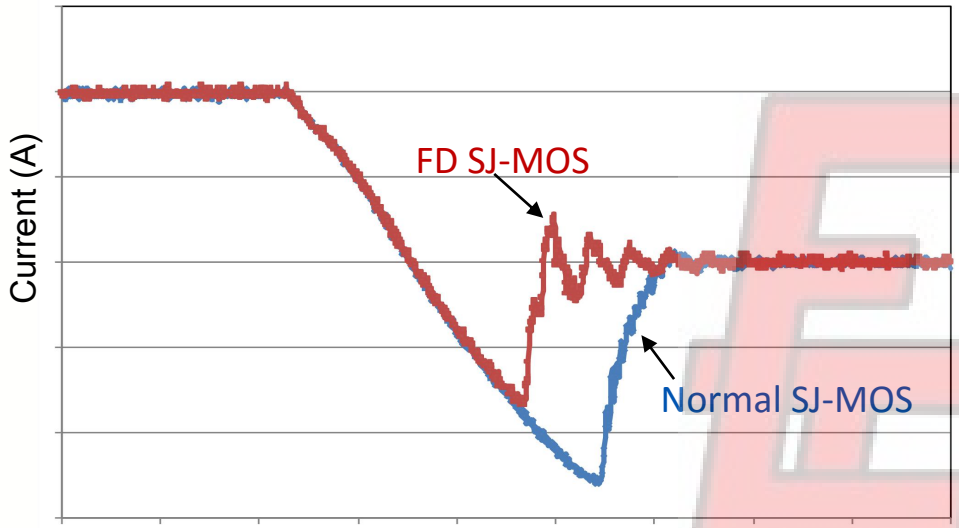
$R_{DS(on)}$,max [Ω]	TO-252	TO-251	TO-220F	TO-220	TO-263	TO-262	TO-247
3.8			WML03N80M3	WMK03N80M3			
2.2			WML05N80M3	WMK05N80M3			
2			WML06N80M3	WMK06N80M3			
1.8			WML07N80M3*	WMK07N80M3*			
1.38			WML08N80M3	WMK08N80M3			
1			WML10N80M3*	WMK10N80M3*			
0.8			WML11N80M3	WMK11N80M3			
0.62			WML12N80M3	WMK12N80M3			
0.48			WML13N80M3*	WMK13N80M3*			
0.36			WML15N80M3*	WMK15N80M3*			
0.26			WML25N80M3*	WMK25N80M3*			
0.195			WML30N80M3*	WMK30N80M3*			

900V SJ-MOSFET C2

$R_{DS(on)}$,max [Ω]	TO-252	TO-251	TO-220F	TO-220	TO-263	TO-262	TO-247
7.0	WMO02N90C2*	WMP02N90C2*					
5.2	WMO03N90C2	WMP03N90C2	WML03N90C2	WMK03N90C2	WMM03N90C2	WMN03N90C2	
3.1	WMO05N90C2	WMP05N90C2	WML05N90C2	WMK05N90C2	WMM05N90C2	WMN05N90C2	
2.5	WMO06N90C2	WMP06N90C2	WML06N90C2	WMK06N90C2	WMM06N90C2	WMN06N90C2	
2.0	WMO07N90C2*	WMP07N90C2*	WML07N90C2*	WMK07N90C2*	WMM07N90C2*	WMN07N90C2*	
1.37	WMO09N90C2	WMP09N90C2	WML09N90C2	WMK09N90C2	WMM09N90C2	WMN09N90C2	
1.2	WMO10N90C2*	WMP10N90C2*	WML10N90C2*	WMK10N90C2*	WMM10N90C2*	WMN10N90C2*	
0.75			WML12N90C2*	WMK12N90C2*	WMM12N90C2*	WMN12N90C2*	WMJ12N90C2*
0.45			WML15N90C2*	WMK15N90C2*	WMM15N90C2*	WMN15N90C2*	WMJ15N90C2*
0.31			WML21N90C2*	WMK21N90C2*			WMJ21N90C2*

* Developing

SJ-MOS with Fast Body Diode(FD Series)



Diode reverse recovery comparison

Benefit:

- Improved diode recovery performances (low trr & Qrr)
- Higher efficiency and robustness in the application
- Targeted for ZVS/LLC topology

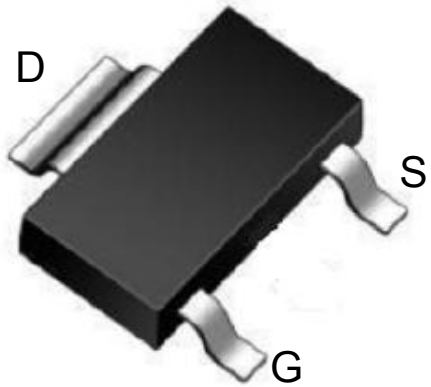
600V SJ-MOSFET FD

$R_{DS(on)}$,max[Ω]	TO-220F	TO-220	TO-263	TO-262	TO-247
0.44	WML14N60FD	WMK14N60FD	WMM14N60FD	WMN14N60FD	
0.34	WML16N60FD	WMK16N60FD	WMM16N60FD	WMN16N60FD	
0.2	WML26N60FD	WMK26N60FD	WMM26N60FD	WMN26N60FD	WMJ26N60FD

650V SJ-MOSFET FD

$R_{DS(on)}$,max[Ω]	TO-220F	TO-220	TO-263	TO-262	TO-247
0.44	WML14N65FD	WMK14N65FD	WMM14N65FD	WMN14N65FD	
0.34	WML16N65FD	WMK16N65FD	WMM16N65FD	WMN16N65FD	
0.2	WML26N65FD	WMK26N65FD	WMM26N65FD	WMN26N65FD	WMJ26N65FD

Advanced SJ-MOS Package: SOT-223-2L



SJ-MOS in SOT-223-2L

Advantage :

- Small package size
- BOM cost reduction

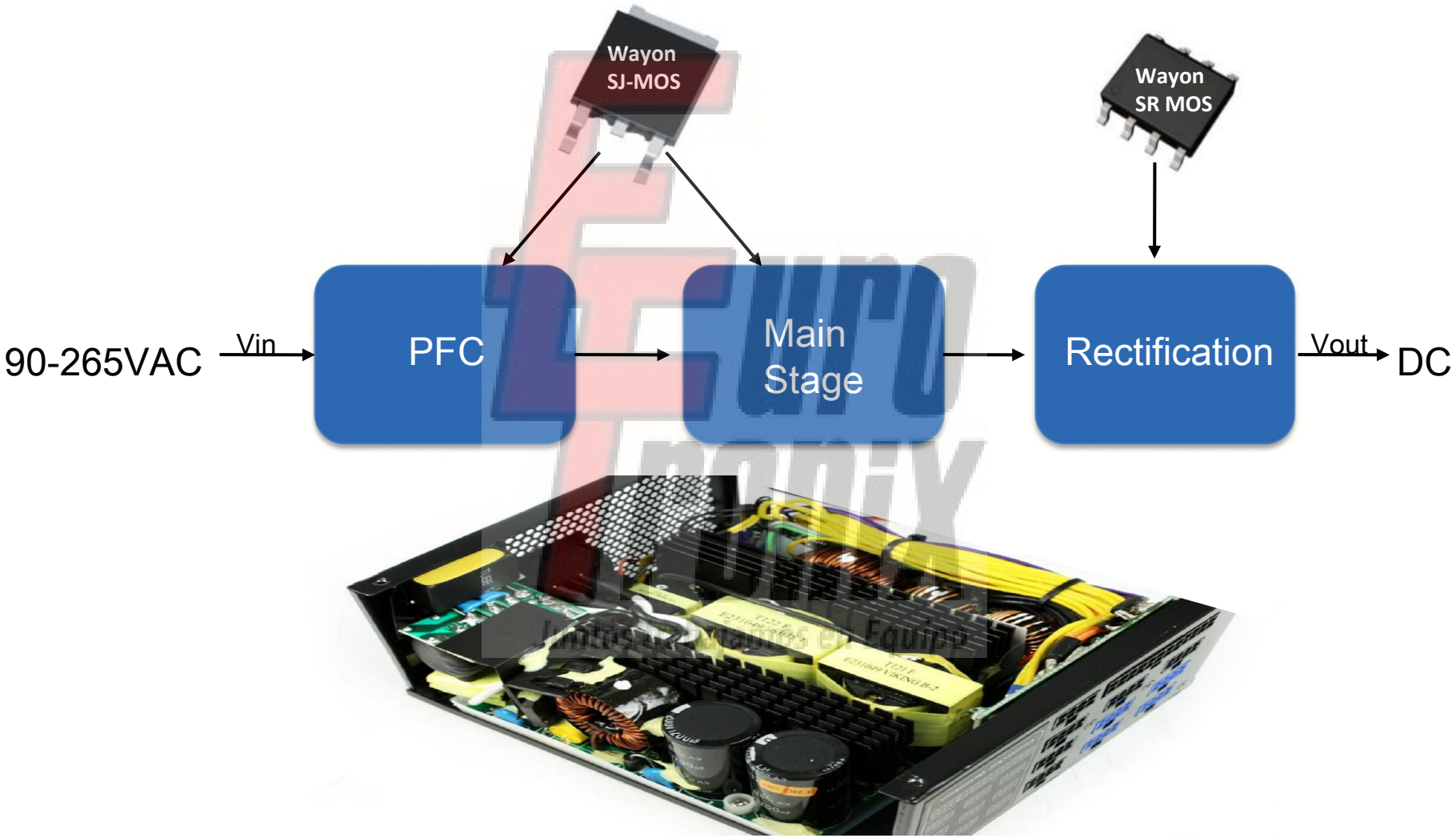
Applications :

- Charger
- Low power LED
- Low power adapter

SJ-MOS C2 SOT-223-2L product portfolio :

$R_{DS(on)}$,max[Ω]	600V	650V	700V
2.45			WMF04N70C2
1.9	WMF04N60C2	WMF04N65C2	
1.45			WMF07N70C2
1.2			WMF09N70C2
1.14	WMF07N60C2	WMF07N65C2	
0.94	WMF09N60C2	WMF09N65C2	

Power Supply Block Diagram



SJ-MOS Application Fields


Lighting


TV


Charger


LED

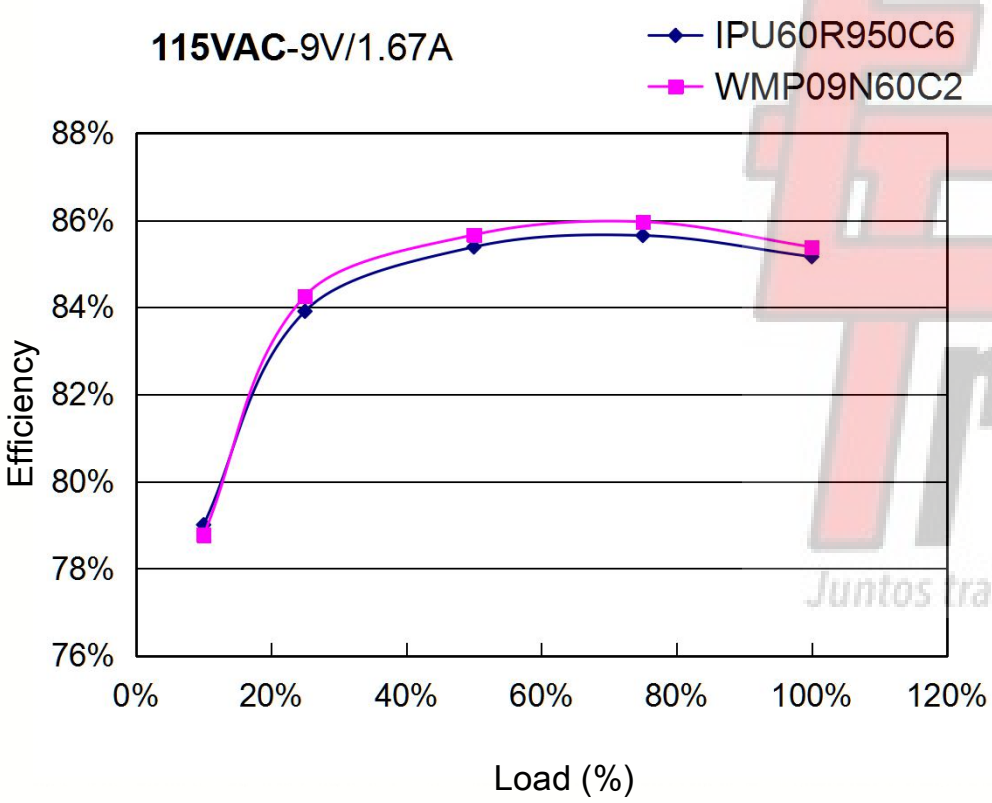
SJ-MOS

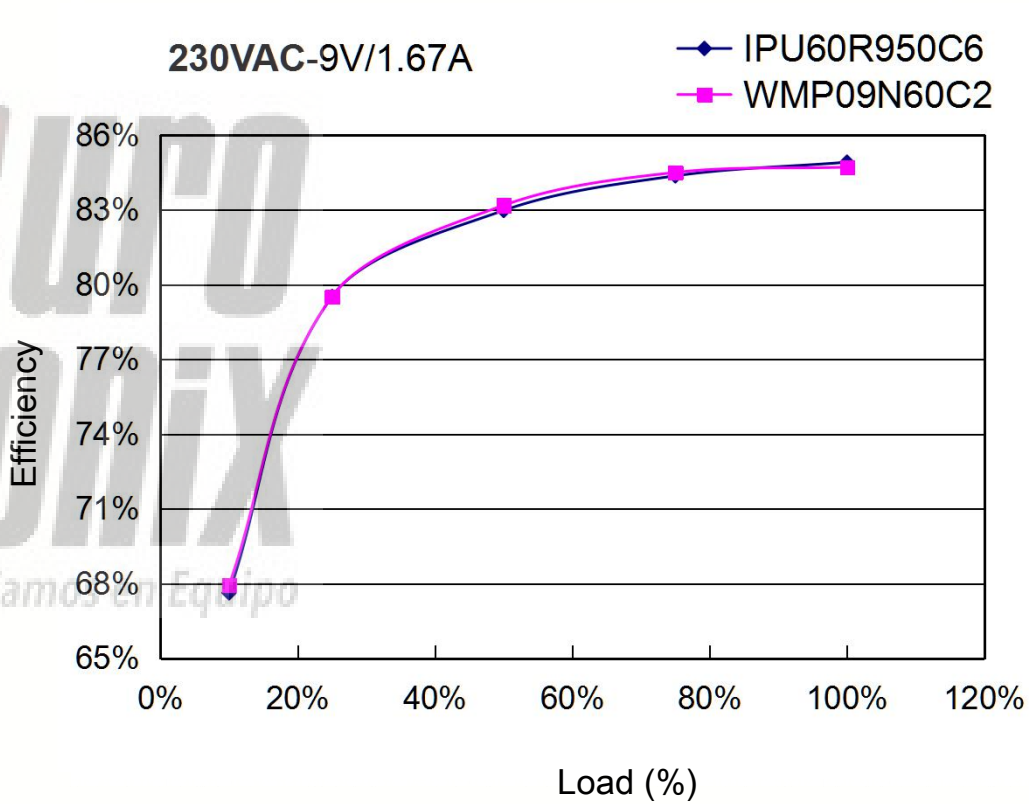

Adapter


Server/UPS

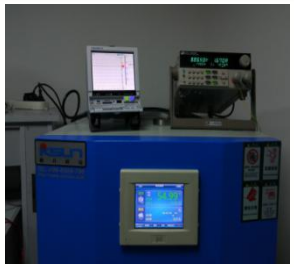

PC

15W Charger Application : Efficiency



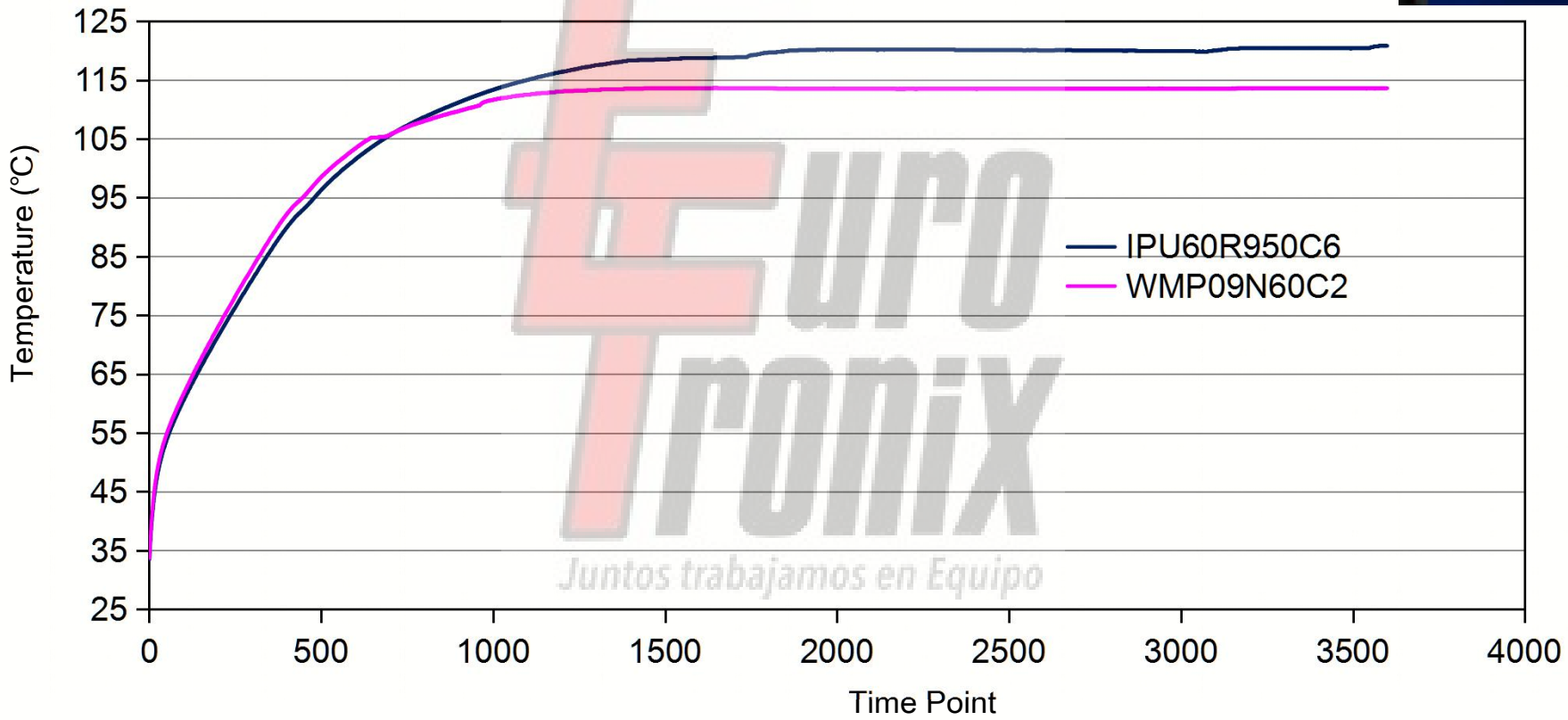


15W Charger Application : Temperature



Ambient temperature：55℃ run time 120min

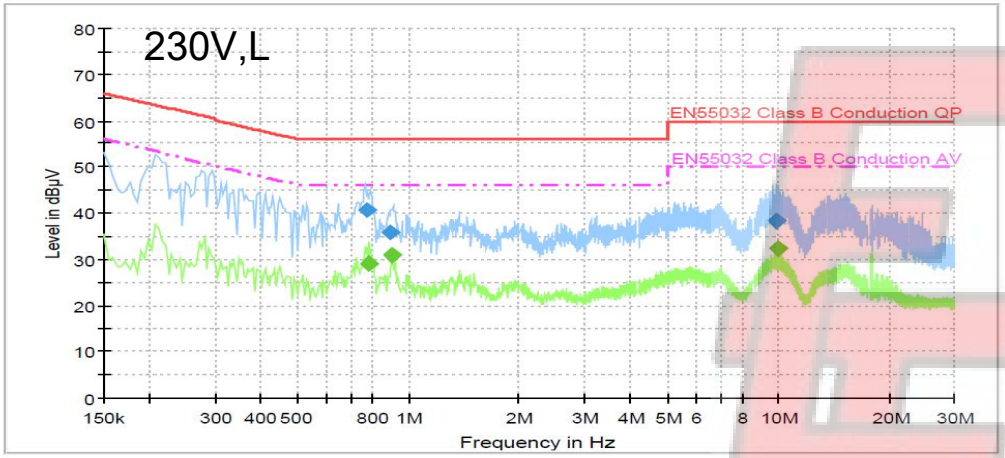
230VAC，9V-1.67A

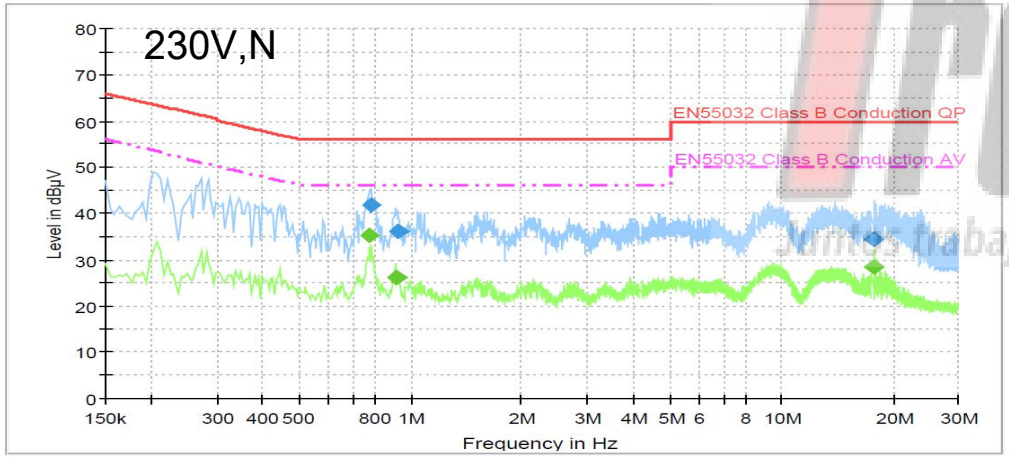


Wayon WMP09N60C2 maximum temperature is 7.2℃ lower than Infineon IPU60R950C6

15W Charger Application : EMI

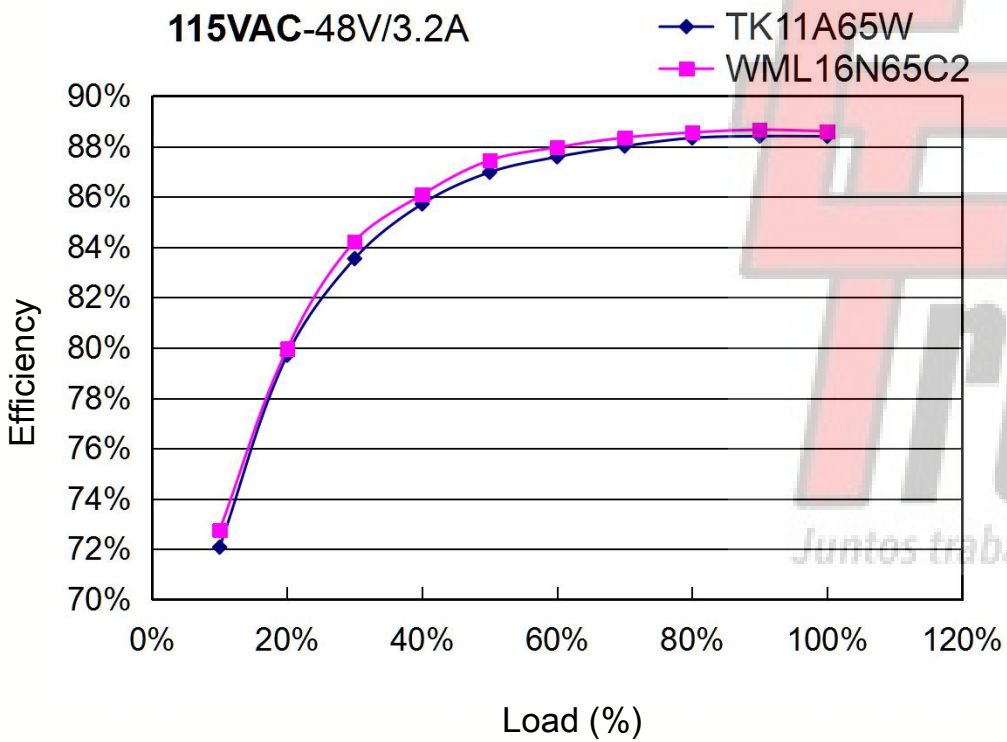
CE

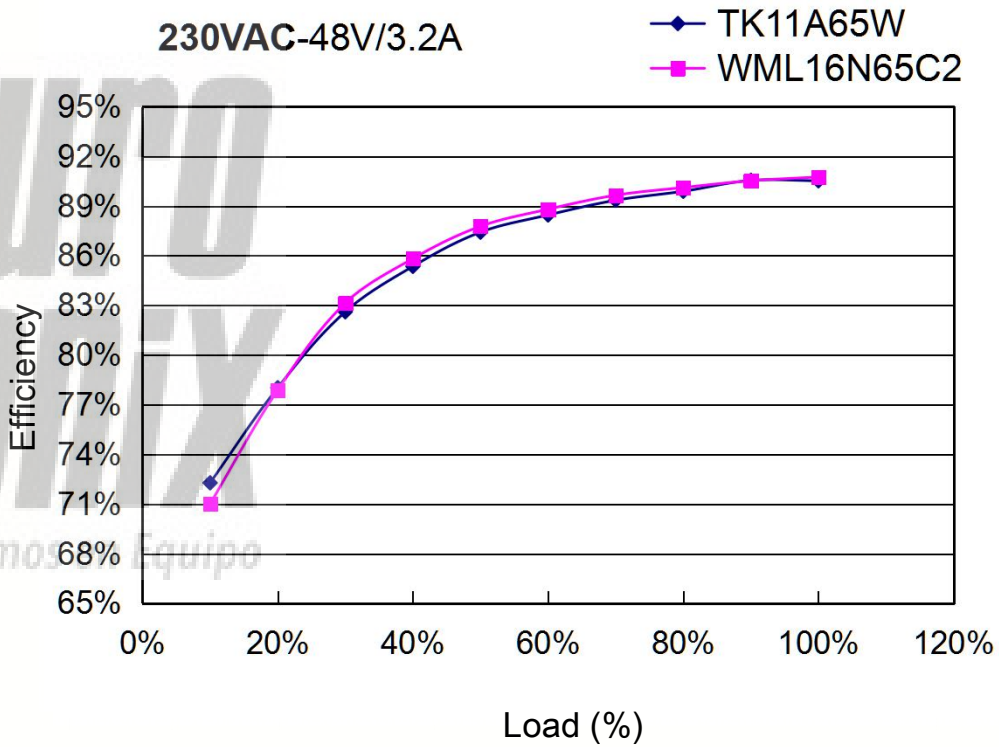




RE

150W LED Application : Efficiency

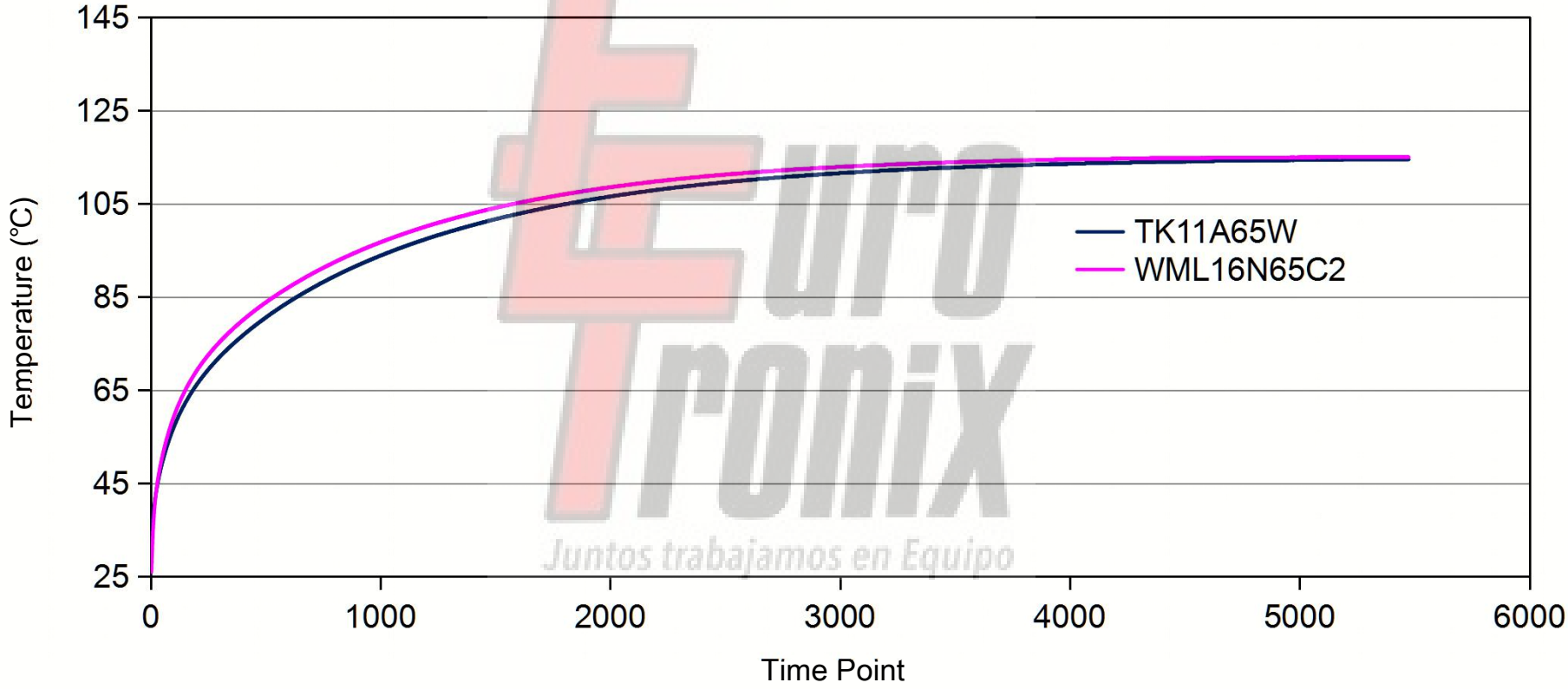




150W LED Application : Temperature

Ambient temperature：25℃ run time 180min

230VAC，48V-3.2A



Wayon WML16N65C2 maximum temperature is 0.4℃ higher than Toshiba TK11A65W

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Wayon SJ-MOS Selection Guide

SoftMOS™

C2						VD		EM		SJ-MOS FD	
500V	600V	650V	700V	800V	900V	600V	650V	600V	650V	600V	650V
0.19-2.5Ω	0.07-1.9Ω	0.07-1.9Ω	0.42-2.45Ω	0.19-4.2Ω	0.4-8.1Ω	0.54-1.4Ω	0.54-1.4Ω	0.19-1.2Ω	0.19-1.2Ω	0.2-0.34Ω	0.2-0.34Ω

Applications & SMPS Topologies

Adapter/Charger
PFC/Quasi Resonant Flyback/Flyback /PSR

Adapter/Charger
Flyback/PFC/PSR

Adapter/Charger
Flyback/PFC/PSR

Adapter/Charger
LLC/Resonant full-bridge

PC
PFC / TTF 80+

PC
PFC / TTF 80+

PC
Resonant half-bridge (LLC)

LCD TV
PFC / Quasi Resonant Flyback/Flyback

TV
Flyback/PFC

TV
Flyback/PFC

LCD TV
LLC

LED/HID
PFC / Quasi Resonant Flyback/Flyback /PSR

LED
Flyback/PFC/PSR

LED
Flyback/PFC/PSR

LED/HID
LLC/Resonant full-bridge

Server/UPS
PFC

Server/UPS
PFC

Server/UPS
LLC/ZVS Full-bridge

The End