



# SJ-MOS在新型开关电源上的应用

上海长园维安微电子有限公司

- Wayon Profile
- Power MOSFET Product Line
- Super Junction MOSFET Technology
- Super Junction MOSFET Application

## Wayon Company Profile



# Company Introduction

Registered in 1996, **CYG Wayon Circuit Protection Co., Ltd.**, is a global leading provider in manufacturing and supplying circuit protection components and modules. Shenzhen ChangYuan Group Ltd. ("CYG", stock code: 600525 SH), holds controlling shares in Wayon. 2015 turnover: \$53 million



## System Cert. :

ISO9001

ISO14001

TS16949

## Hazardous Substance:

SONY GP Cert.



## LAB Qualification:

UL

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CDTP

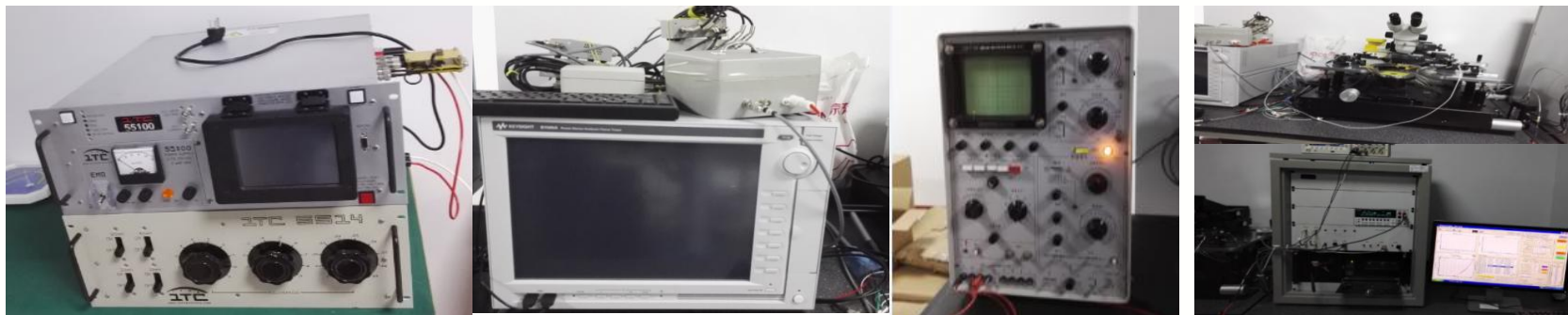
Lab

TUV

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R & D



Reliability/F



Application



**Panasonic**



**SONY**

**ZTE中兴**



**SUNWODA**  
欣旺达

**Letv** 乐视网



**H3C**



**OLYMPUS**



**Coolpad** 酷派

**TCL**

**Honeywell**

**NOKIA**  
CONNECTING PEOPLE

**ERICSSON**

**MEIZU** 魅族

**DESAY** 德赛

**LISHEN**



亚马逊  
**amazon.cn**



**ZDC**

**MOTOROLA**

**Canon**

**htc**  
quietly brilliant



**SUNOa** 顺达

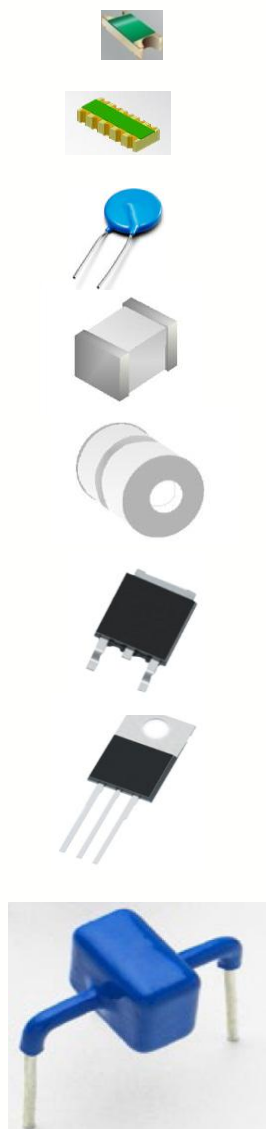
**lenovo** 联想



**BARNES & NOBLE**



## Main Product Lines



**PPTC**

# Power MOSFET

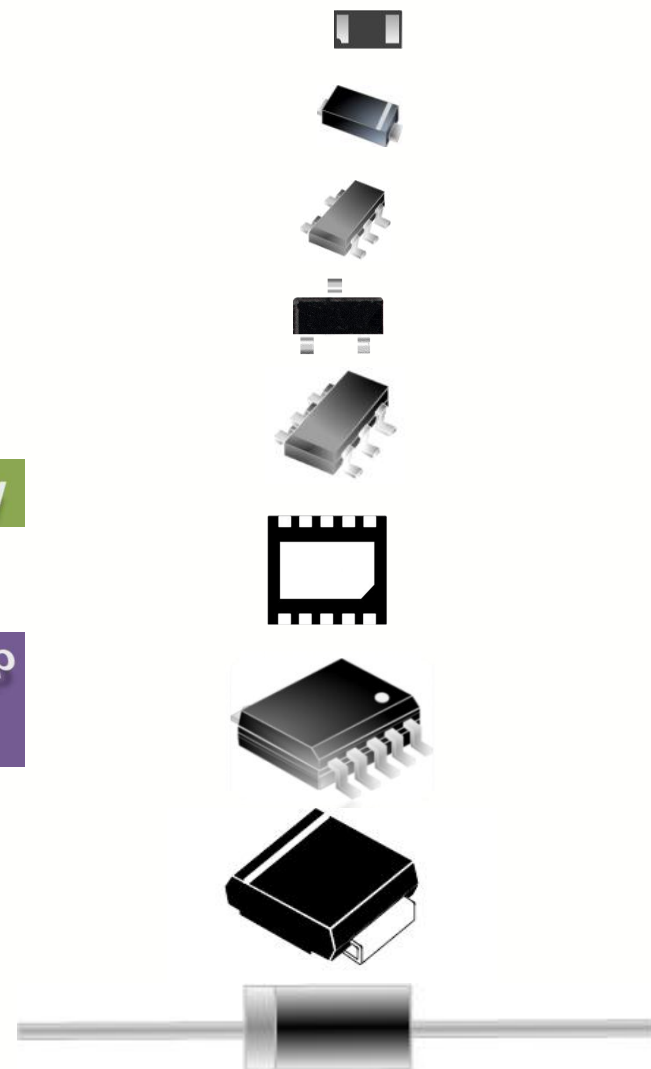
# GDT

MOV

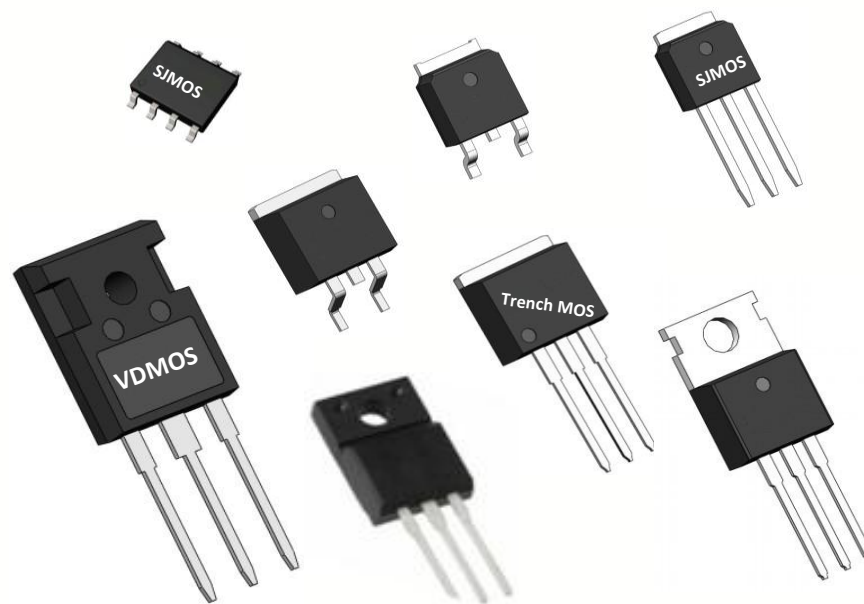
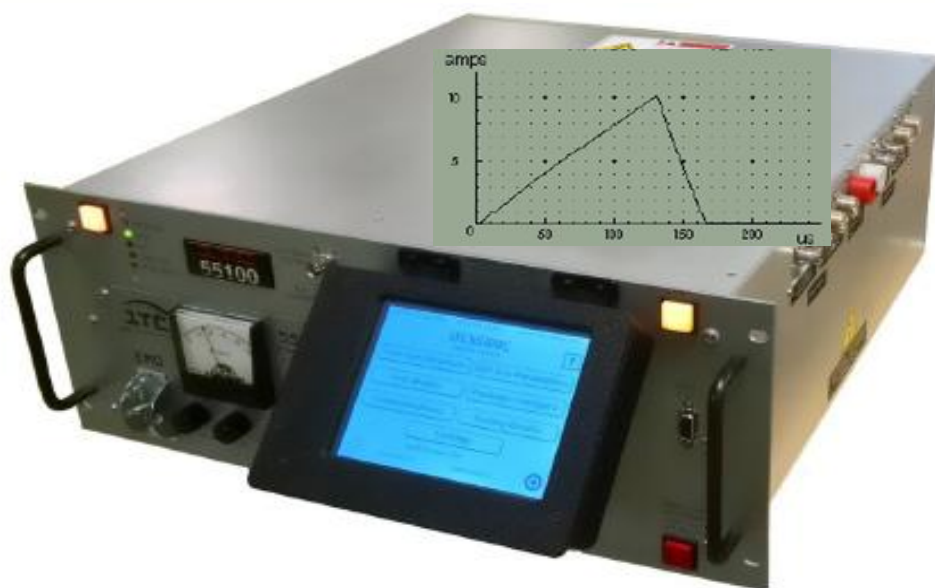
## ESD& EMI Filter

## Low Cap TVS

## Power TVs



# Wayon Power MOSFET Products



## Low Voltage Power MOSFET series

- 60V-100V Trench MOS

## High Voltage Power MOSFET DM series

- 600V/650V/700V 1N-10N VDMOS

## Super Junction Power MOSFET series

- WMOS™ C2 600V/650V 4N-26N
- WMOS™ C2 700V 4N-16N
- WMOS™ FD 600V/650V 14N-26N
- WMOS™ C2 500V/800V/900V

# LV-Trench MOS Product Portfolio

60V

| $R_{DS(on)}$ , max[mΩ] | DPAK       | IPAK       | SOP-8      | TO-220      | TO-263      | TO-262     | TO-247      | TO-3P       |
|------------------------|------------|------------|------------|-------------|-------------|------------|-------------|-------------|
| 4                      |            |            |            | WMK190N06T1 | WMM190N06T1 |            | WMJ190N06T1 | WMI190N06T1 |
| 6.8                    |            |            |            | WMK130N06T1 | WMM130N06T1 |            |             |             |
| 7                      | WMO70N06T1 | WMP70N06T1 |            |             |             |            |             |             |
| 13.5                   | WMO55N06T1 | WMP55N06T1 |            | WMK55N06T1  | WMM55N06T1  | WMN55N06T1 |             |             |
| 15                     |            |            | WMS11N06T1 |             |             |            |             |             |

80V

| $R_{DS(on)}$ , max[mΩ] | DPAK | IPAK | SOP-8 | TO-220      | TO-263      | TO-262 | TO-247 | TO-3P       |
|------------------------|------|------|-------|-------------|-------------|--------|--------|-------------|
| 8.5                    |      |      |       | WMK100N08T1 | WMM100N08T1 |        |        | WMI100N08T1 |
| 11.5                   |      |      |       | WMK75N08T1  | WMM75N08T1  |        |        | WMI75N08T1  |

100V

| $R_{DS(on)}$ , max[mΩ] | DPAK       | IPAK       | SOP-8       | TO-220      | TO-263      | TO-262 | TO-247 | TO-3P       |
|------------------------|------------|------------|-------------|-------------|-------------|--------|--------|-------------|
| 6.5                    |            |            |             | WMK180N10T1 | WMM180N10T1 |        |        | WMI180N10T1 |
| 12                     |            |            |             | WMK100N10T1 | WMM100N10T1 |        |        | WMI100N10T1 |
| 24                     | WMO33N10T1 | WMP33N10T1 |             |             |             |        |        |             |
| 25                     |            |            | WMS008N10T1 |             |             |        |        |             |

## 600V VD-MOSFET DM

| $R_{DS(on)}$ , max[Ω] | DPAK       | IPAK       | TO-220F    | TO-220     | TO-263     | TO-262     | TO-251S3   | TO-251S2   |
|-----------------------|------------|------------|------------|------------|------------|------------|------------|------------|
| 10                    | WMO01N60DM | WMP01N60DM |            |            |            |            |            |            |
| 2.4                   | WMO04N60DM | WMP04N60DM | WML04N60DM |            |            | WMN04N60DM | WMG04N60DM | WMH04N60DM |
| 1.2                   | WMO07N60DM | WMP07N60DM | WML07N60DM |            | WMM07N60DM | WMN07N60DM | WMG07N60DM | WMH07N60DM |
| 0.9                   |            |            | WML10N60DM | WMK10N60DM | WMM10N60DM | WMN10N60DM |            |            |

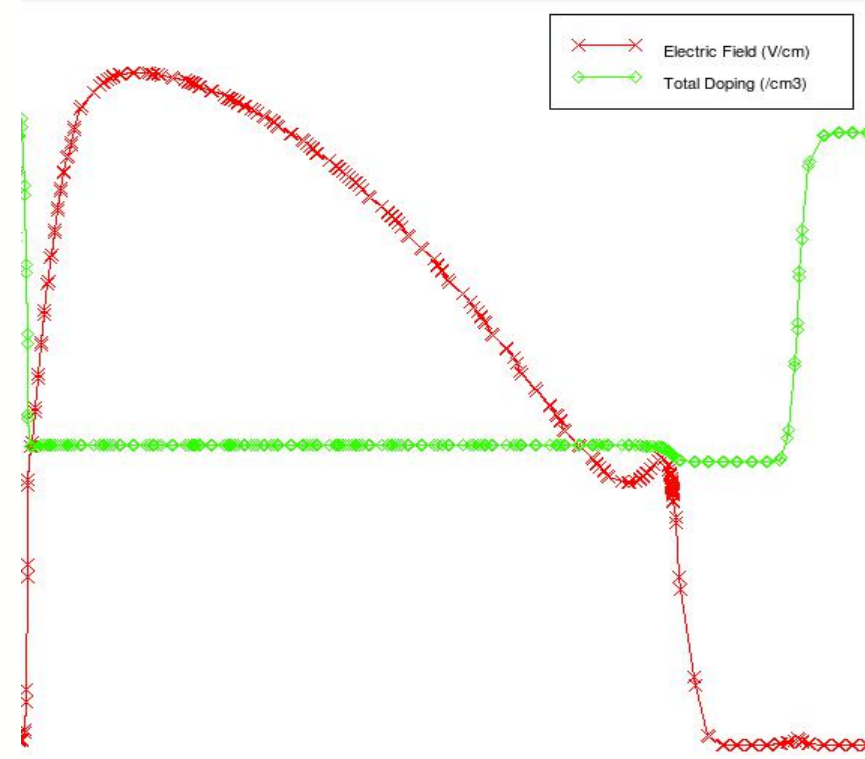
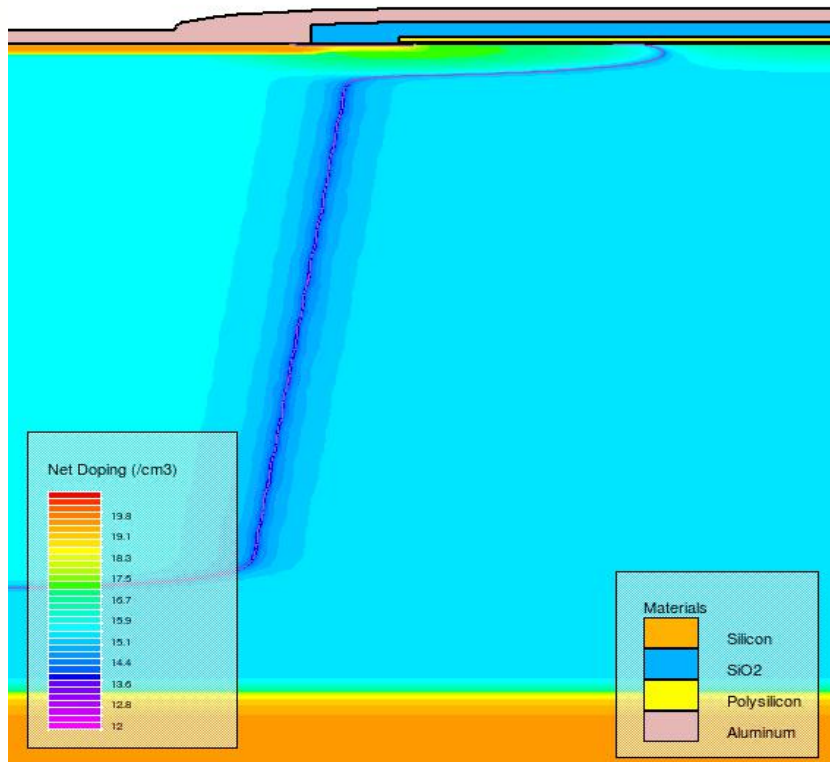
## 650V VD-MOSFET DM

| $R_{DS(on)}$ , max[Ω] | DPAK       | IPAK       | TO-220F    | TO-220     | TO-263     | TO-262     | TO-251S3   | TO-251S2   |
|-----------------------|------------|------------|------------|------------|------------|------------|------------|------------|
| 2.7                   | WMO04N65DM | WMP04N65DM | WML04N65DM |            |            | WMN04N65DM | WMG04N65DM | WMH04N65DM |
| 1.4                   | WMO07N65DM | WMP07N65DM | WML07N65DM |            | WMM07N65DM | WMN07N65DM | WMG07N65DM | WMH07N65DM |
| 1.0                   |            |            | WML10N65DM | WMK10N65DM | WMM10N65DM | WMN10N65DM |            |            |

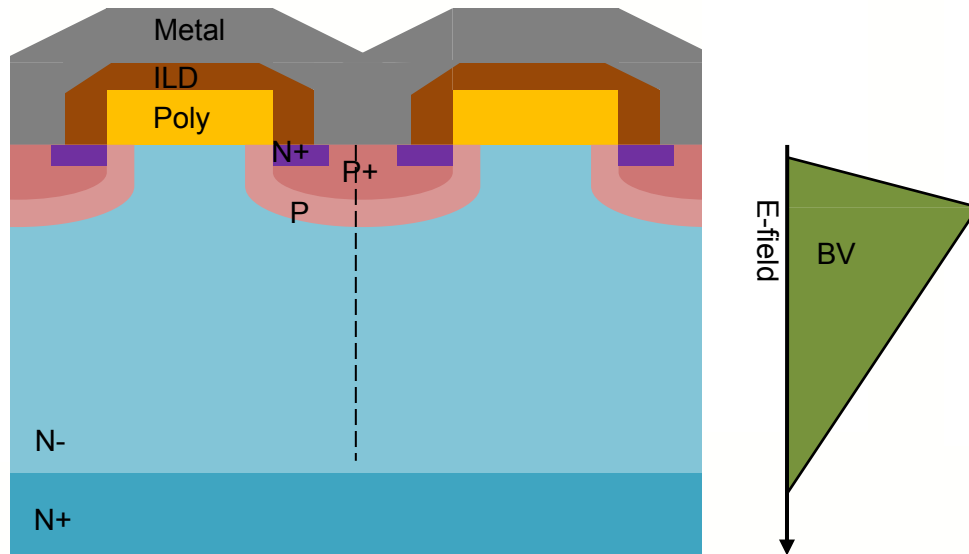
## 700V VD-MOSFET DM

| $R_{DS(on)}$ , max[Ω] | DPAK       | IPAK       | TO-220F    | TO-220     | TO-263     | TO-262     | TO-251S3   | TO-251S2   |
|-----------------------|------------|------------|------------|------------|------------|------------|------------|------------|
| 2.7                   | WMO04N70DM | WMP04N70DM | WML04N70DM |            |            |            | WMG04N70DM | WMH04N70DM |
| 1.7                   | WMO06N70DM | WMP06N70DM | WML06N70DM |            | WMM06N70DM | WMN06N70DM | WMG06N70DM | WMH06N70DM |
| 1.2                   |            |            | WML08N70DM | WMK08N70DM | WMM08N70DM | WMN08N70DM |            |            |

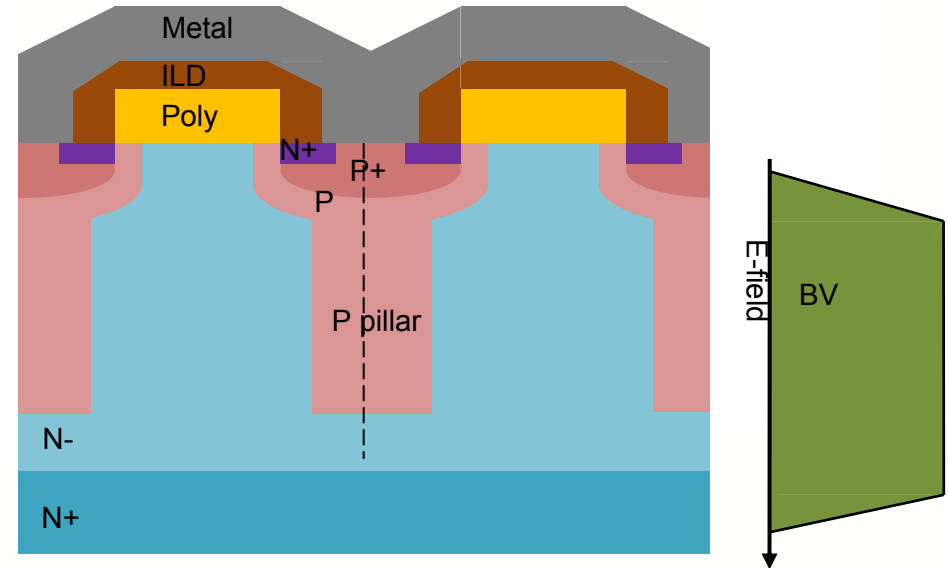
# Super Junction MOSFET Technology



# SJ-MOSFET Structure

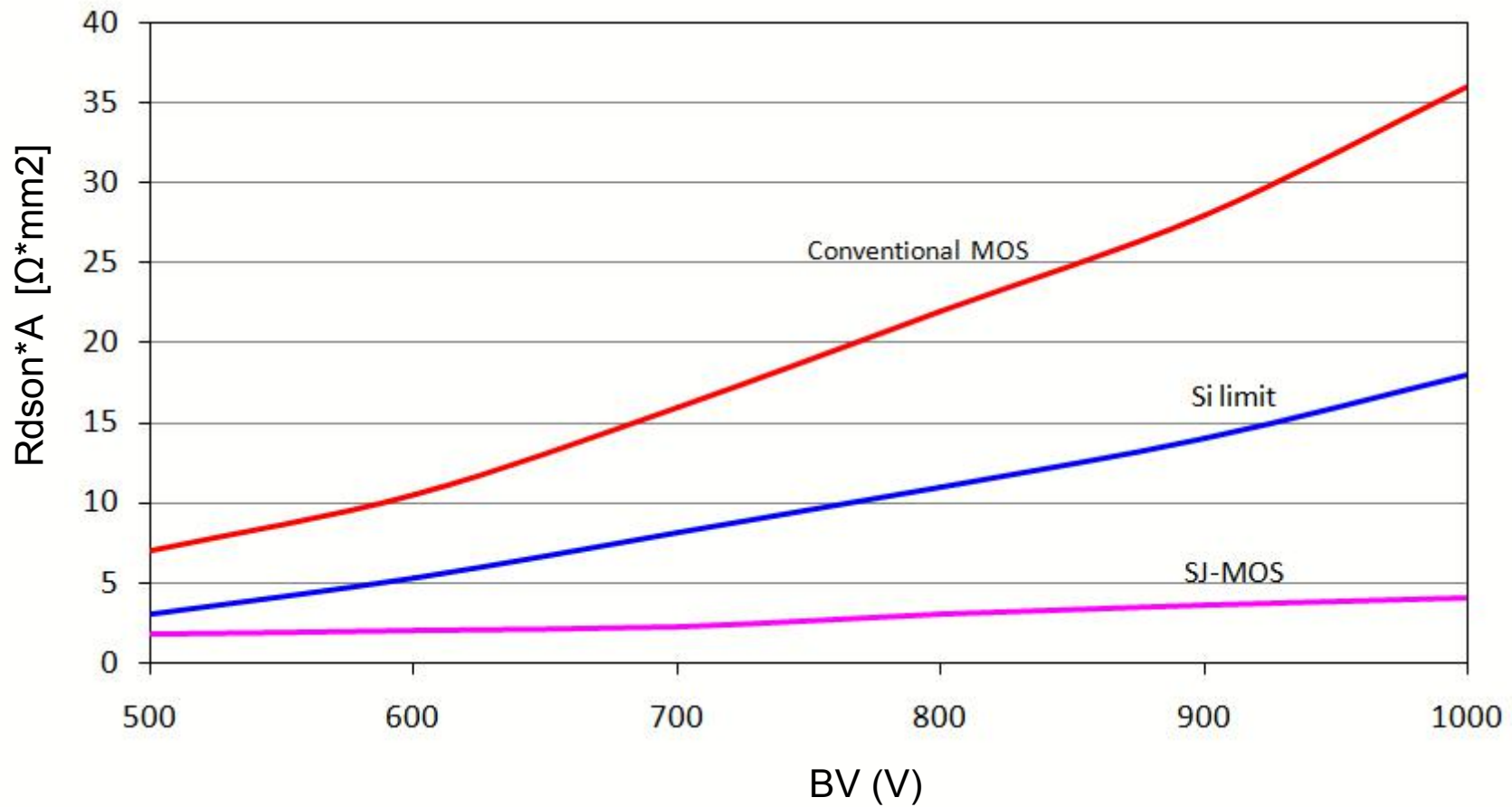


- VDMOS introduced in the 1970s
- Higher BV, larger die size
- $R_{\text{dson}} \cdot A \propto BV^{2.5}$

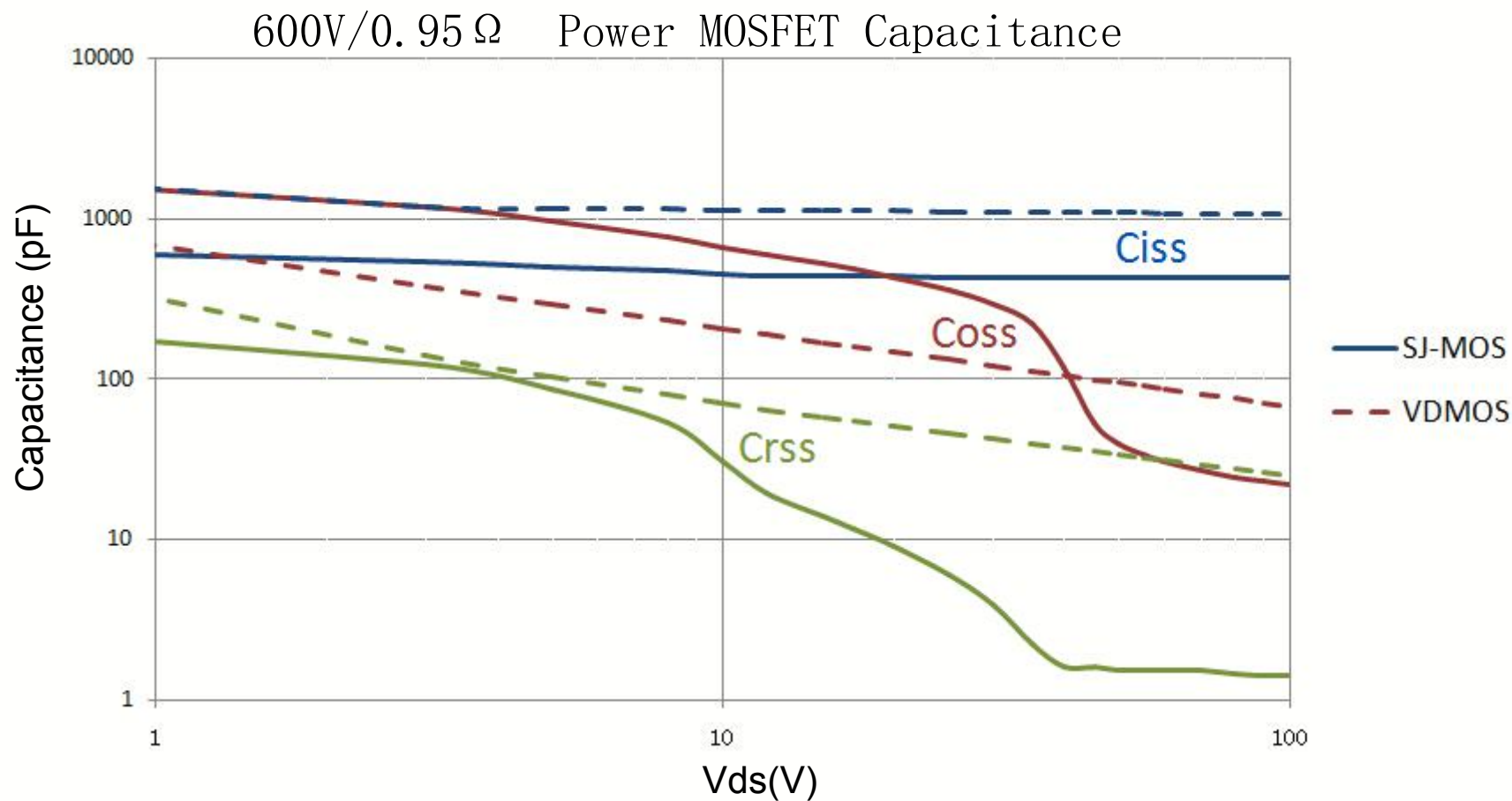


- Charge balance principle
- 1<sup>st</sup> SJ-MOS patent in 1993
- 1<sup>st</sup> commercial SJ-MOSFET in 1998
- Thinner EPI layer
- $R_{\text{dson}} \cdot A \propto BV^{1.32}$

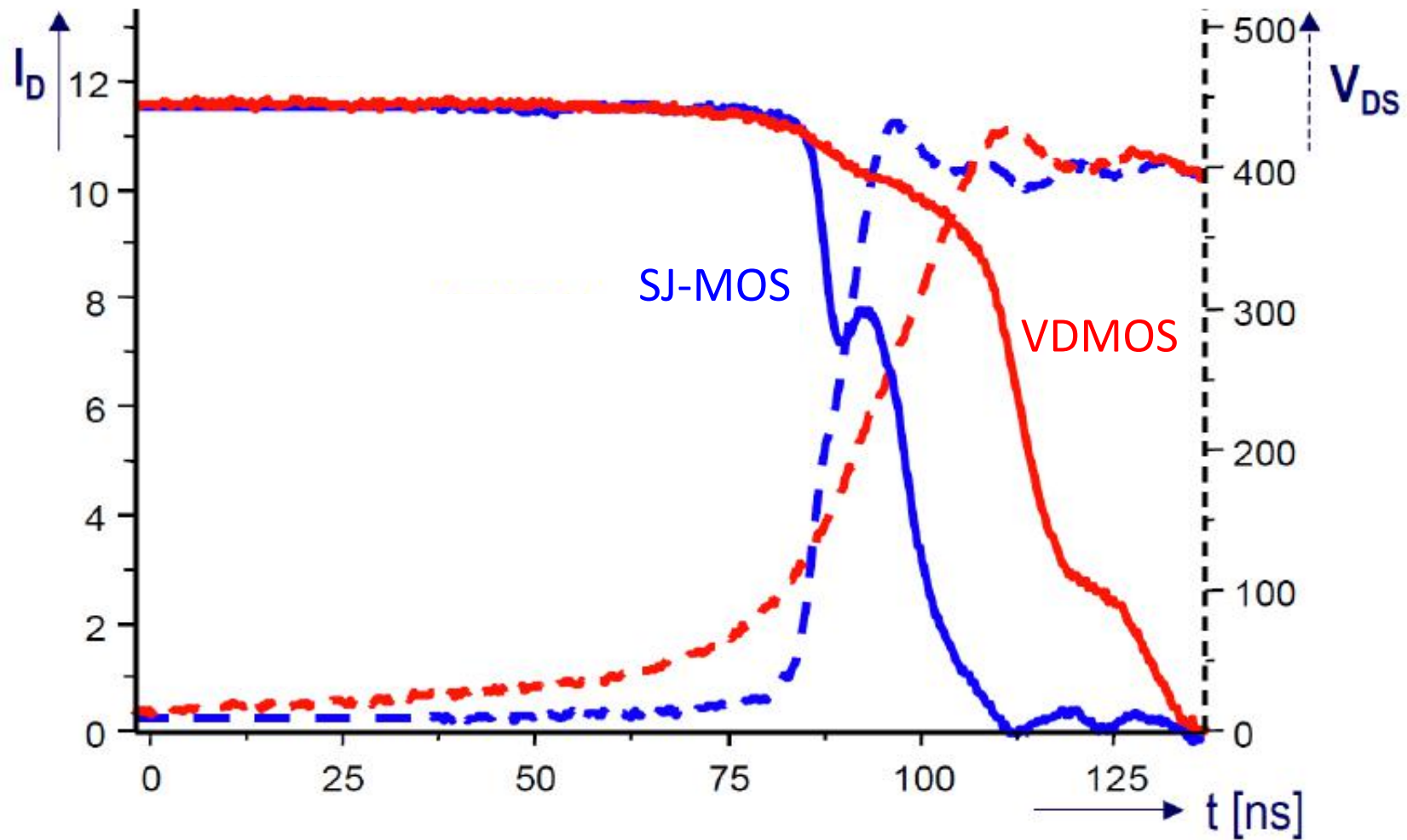
## SJ-MOSFET $R_{\text{dson}}$ vs. BV



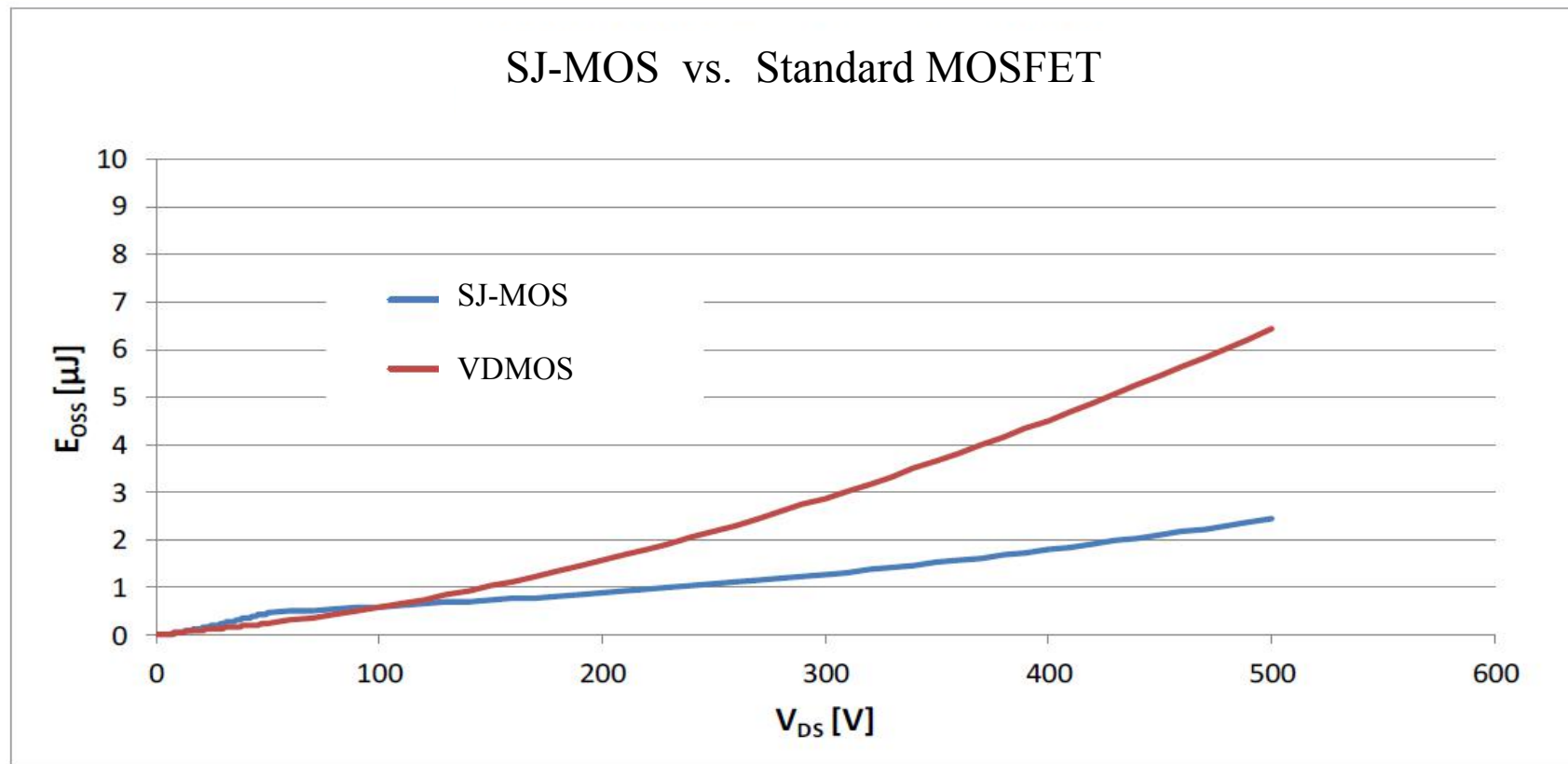
- SJ-MOS can reduce package size, enhance power density



- Smaller capacitance
- Nonlinear



SJ-MOS: higher switching speed, higher frequency



# SJ-MOSFET Advantages

VDMOS



+



Smaller package size



SJ-MOS



SMPS miniature

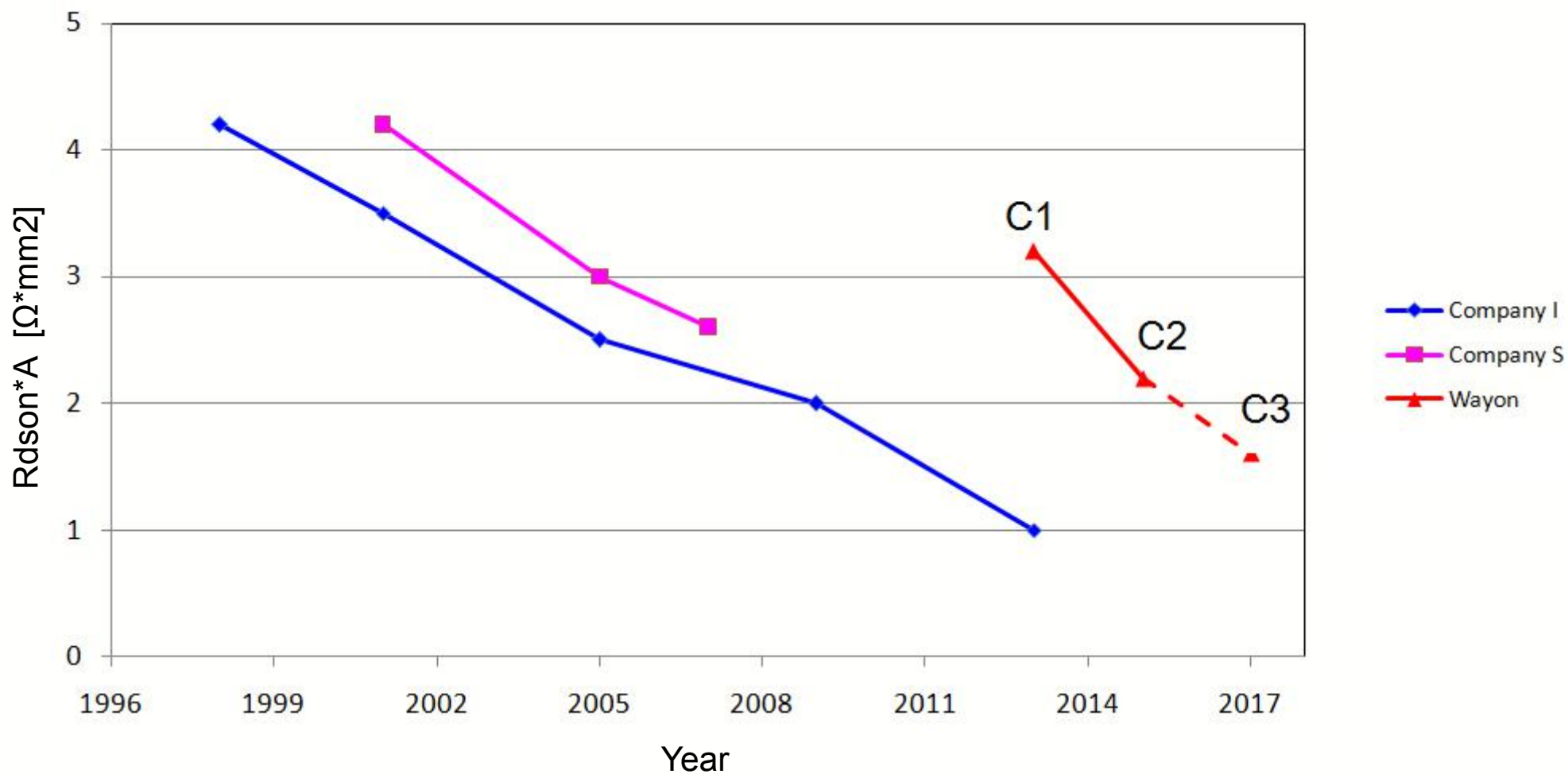


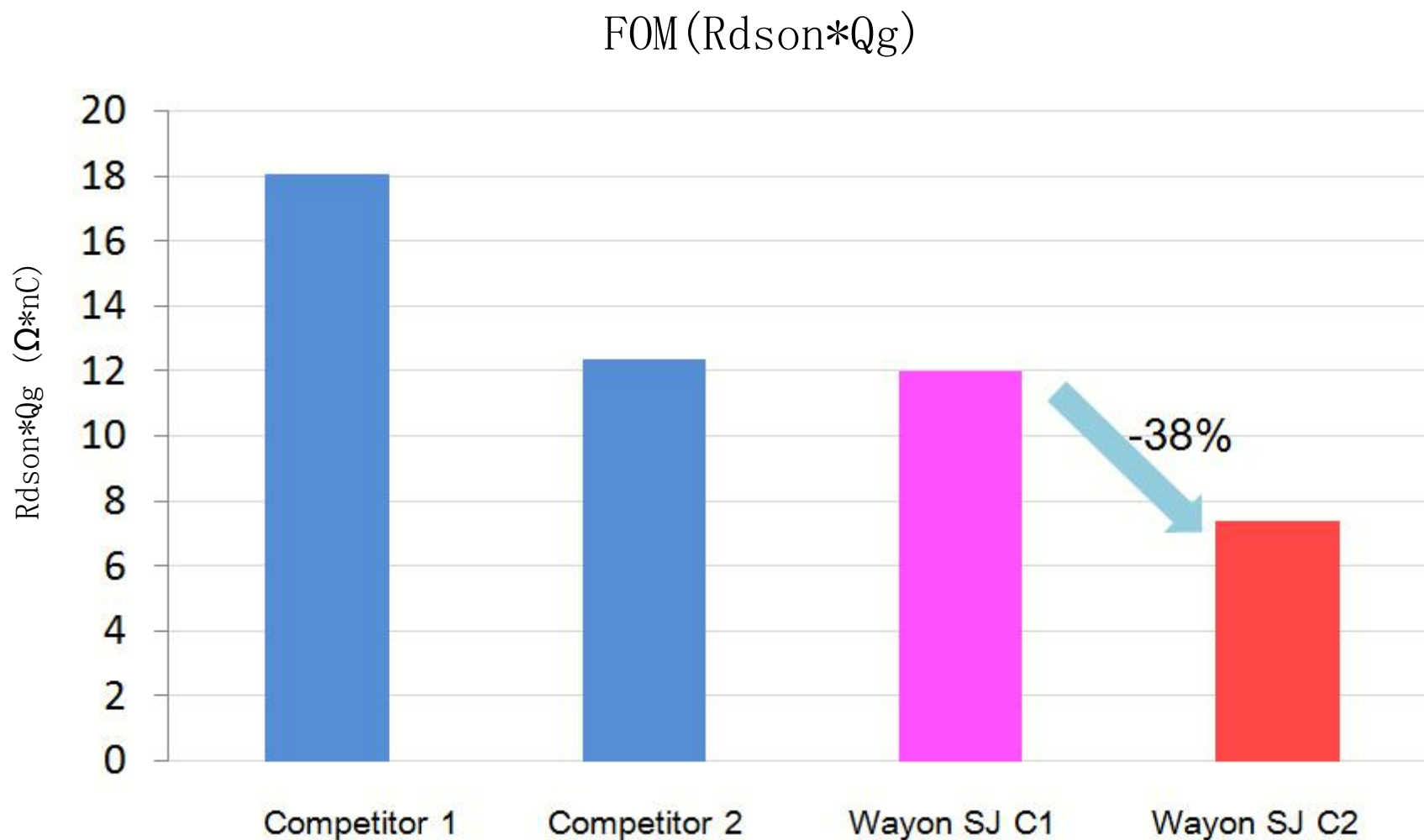
Combo IC



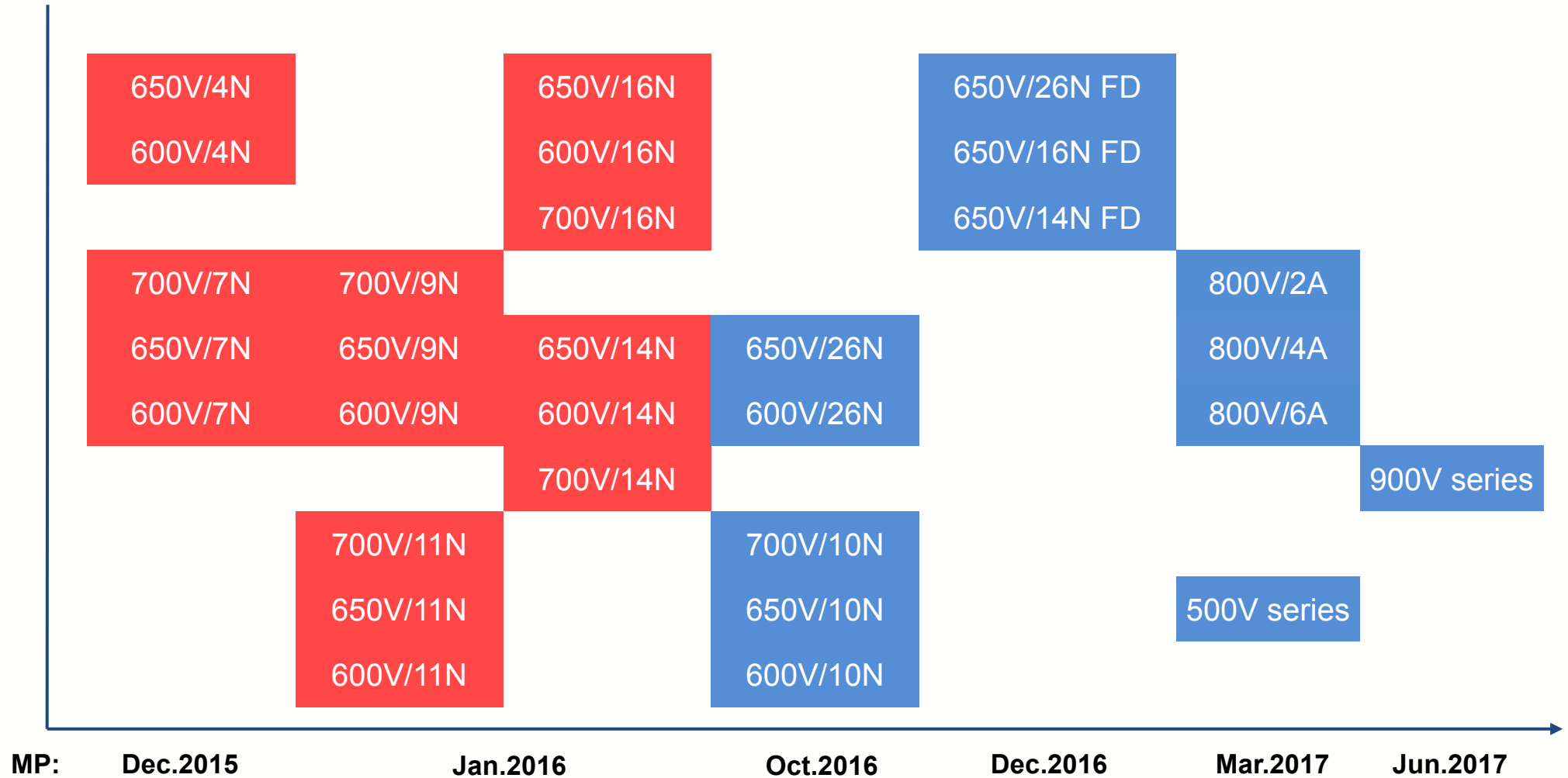
IC+SJ-MOS







# Wayon C2 SJ-MOSFET Road Map



| Test Item | Test Condition                                                      | Duration      | Sample Size | Acc/Reject | Referenced standard |
|-----------|---------------------------------------------------------------------|---------------|-------------|------------|---------------------|
| HTGB      | $T_A = 150^{\circ} \text{ C}$ ,<br>$V_{GS}=30\text{V}$              | 1000 hrs      | 77pcs*3lots | 0/1        | JESD22-A108         |
| HTRB      | $T_A = 150^{\circ} \text{ C}$ ,<br>$V_{DS}=80\%V_{DSmax.}$          | 1000 hrs      | 77pcs*3lots | 0/1        | JESD22-A108         |
| HTSL      | $T_A = 150^{\circ} \text{ C}$                                       | 1000 hrs      | 77pcs*3lots | 0/1        | JESD22-A103         |
| PCT       | $121^{\circ} \text{ C}$ 205KPA<br>100%RH                            | 96 hrs        | 77pcs*3lots | 0/1        | JESD22-A102         |
| TCT       | $-65^{\circ} \text{ C}$ to $150^{\circ} \text{ C}$ ,<br>air to air, | 500<br>cycles | 77pcs*3lots | 0/1        | JESD22-A104         |

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

# SJ-MOSFET C2 Product Portfolio

## 600V SJ-MOSFET C2

| $R_{DS(on),max} [\Omega]$ | TO-252     | TO-251     | TO-251S3   | TO-251S2   | TO-220F    | TO-220     | TO-263     | TO-262     | TO-247     |
|---------------------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|
| 1.9                       | WMO04N60C2 | WMP04N60C2 | WMG04N60C2 | WMH04N60C2 |            |            |            |            |            |
| 1.14                      | WMO07N60C2 | WMP07N60C2 | WMG07N60C2 | WMH07N60C2 | WML07N60C2 | WMK07N60C2 |            |            |            |
| 0.94                      | WMO09N60C2 | WMP09N60C2 | WMG09N60C2 | WMH09N60C2 | WML09N60C2 | WMK09N60C2 |            |            |            |
| 0.73                      | WMO10N60C2 | WMP10N60C2 | WMG10N60C2 | WMH10N60C2 | WML10N60C2 | WMK10N60C2 |            |            |            |
| 0.54                      | WMO11N60C2 | WMP11N60C2 |            |            | WML11N60C2 | WMK11N60C2 | WMM11N60C2 | WMN11N60C2 |            |
| 0.42                      | WMO14N60C2 | WMP14N60C2 |            |            | WML14N60C2 | WMK14N60C2 | WMM14N60C2 | WMN14N60C2 |            |
| 0.32                      | WMO16N60C2 | WMP16N60C2 |            |            | WML16N60C2 | WMK16N60C2 | WMM16N60C2 | WMN16N60C2 |            |
| 0.19                      |            |            |            |            | WML26N60C2 | WMK26N60C2 | WMM26N60C2 | WMN26N60C2 | WMJ26N60C2 |

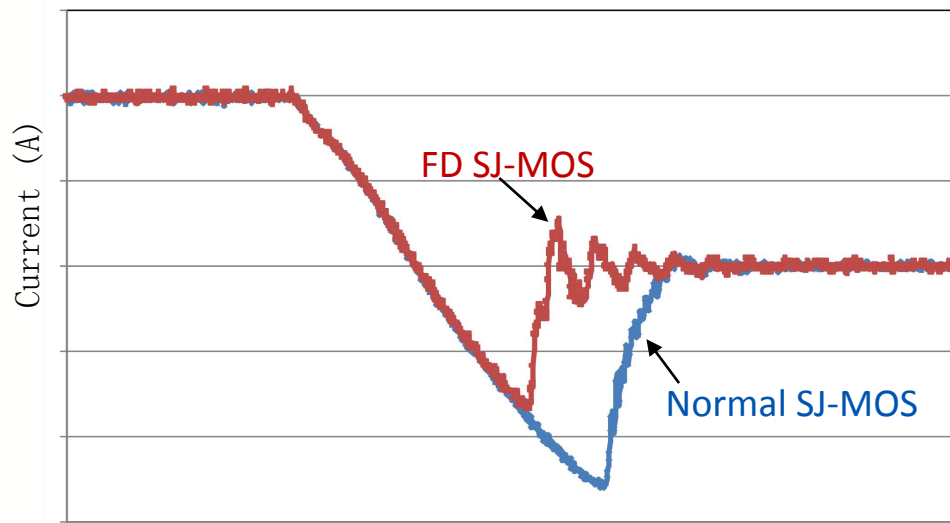
## 650V SJ-MOSFET C2

| $R_{DS(on),max} [\Omega]$ | TO-252     | TO-251     | TO-251S3   | TO-251S2   | TO-220F    | TO-220     | TO-263     | TO-262     | TO-247     |
|---------------------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|
| 1.9                       | WMO04N65C2 | WMP04N65C2 | WMG04N65C2 | WMH04N65C2 |            |            |            |            |            |
| 1.14                      | WMO07N65C2 | WMP07N65C2 | WMG07N65C2 | WMH07N65C2 | WML07N65C2 | WMK07N65C2 |            |            |            |
| 0.94                      | WMO09N65C2 | WMP09N65C2 | WMG09N65C2 | WMH09N65C2 | WML09N65C2 | WMK09N65C2 |            |            |            |
| 0.73                      | WMO10N65C2 | WMP10N65C2 | WMG10N65C2 | WMH10N65C2 | WML10N65C2 | WMK10N65C2 |            |            |            |
| 0.54                      | WMO11N65C2 | WMP11N65C2 |            |            | WML11N65C2 | WMK11N65C2 | WMM11N65C2 | WMN11N65C2 |            |
| 0.42                      | WMO14N65C2 | WMP14N65C2 |            |            | WML14N65C2 | WMK14N65C2 | WMM14N65C2 | WMN14N65C2 |            |
| 0.32                      | WMO16N65C2 | WMP16N65C2 |            |            | WML16N65C2 | WMK16N65C2 | WMM16N65C2 | WMN16N65C2 |            |
| 0.19                      |            |            |            |            | WML26N65C2 | WMK26N65C2 | WMM26N65C2 | WMN26N65C2 | WMJ26N65C2 |

## 700V SJ-MOSFET C2

| $R_{DS(on),max} [\Omega]$ | TO-252     | TO-251     | TO-251S3   | TO-251S2   | TO-220F    | TO-220     | TO-263     | TO-262     |
|---------------------------|------------|------------|------------|------------|------------|------------|------------|------------|
| 2.45                      | WMO04N70C2 | WMP04N70C2 | WMG04N70C2 | WMH04N70C2 |            |            |            |            |
| 1.45                      | WMO07N70C2 | WMP07N70C2 | WMG07N70C2 | WMH07N70C2 | WML07N70C2 | WMK07N70C2 |            |            |
| 1.2                       | WMO09N70C2 | WMP09N70C2 | WMG09N70C2 | WMH09N70C2 | WML09N70C2 | WMK09N70C2 |            |            |
| 0.93                      | WMO10N70C2 | WMP10N70C2 | WMG10N70C2 | WMH10N70C2 | WML10N70C2 | WMK10N70C2 |            |            |
| 0.68                      | WMO11N70C2 | WMP11N70C2 |            |            | WML11N70C2 | WMK11N70C2 | WMM11N70C2 | WMN11N70C2 |
| 0.53                      | WMO14N70C2 | WMP14N70C2 |            |            | WML14N70C2 | WMK14N70C2 | WMM14N70C2 | WMN14N70C2 |
| 0.42                      | WMO16N70C2 | WMP16N70C2 |            |            | WML16N70C2 | WMK16N70C2 | WMM16N70C2 | WMN16N70C2 |

# SJ-MOSFET with Fast Body Diode (FD)



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

| $R_{DS(on),max}[\Omega]$ | 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 |

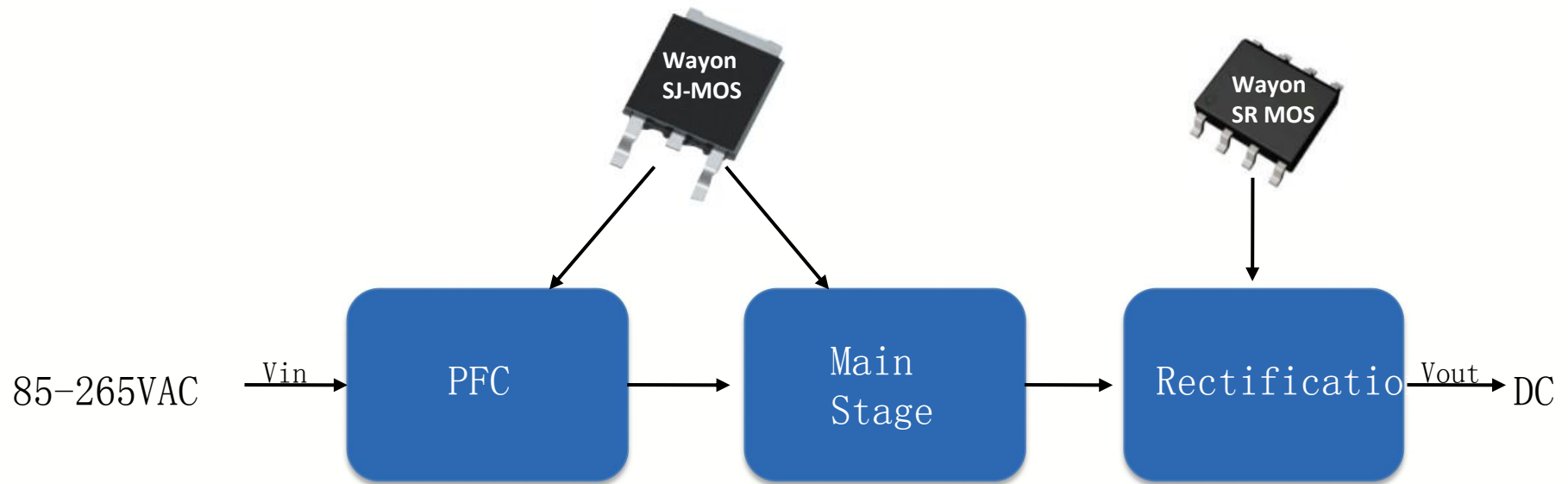
## 650V SJ-MOSFET FD

| $R_{DS(on),max}[\Omega]$ | 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 |

# Super Junction MOSFET Application



# Power Supply Block Diagram



# SJ-MOS Application Fields



Lighting



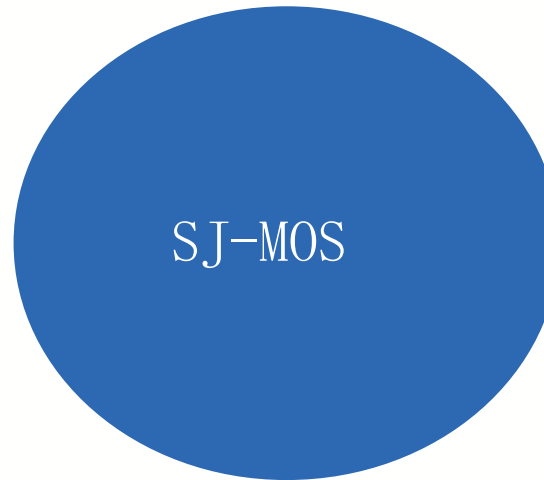
TV



Charger



LED



SJ-MOS



Adapter

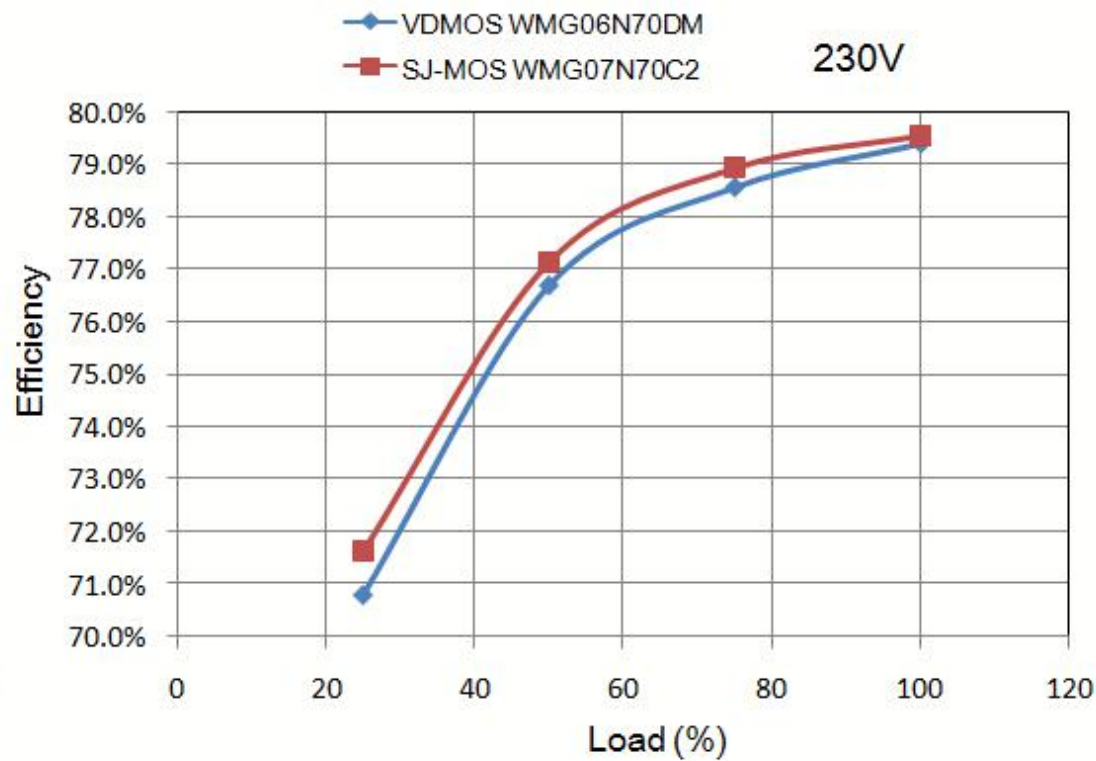
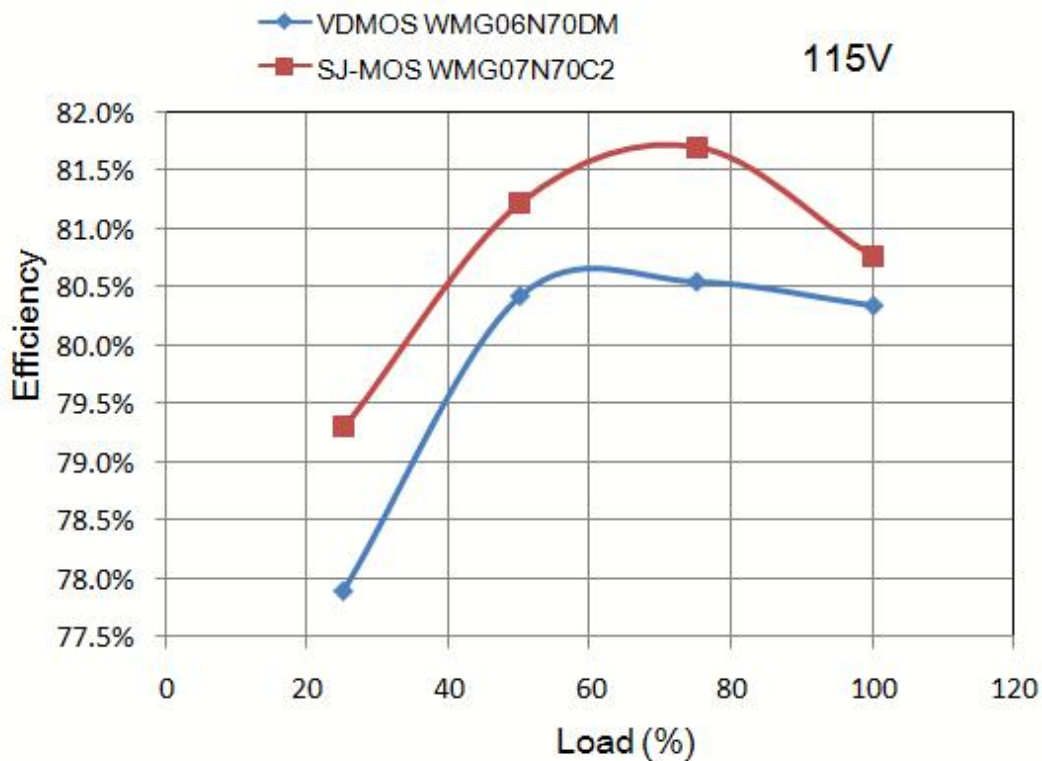


Server/UPS

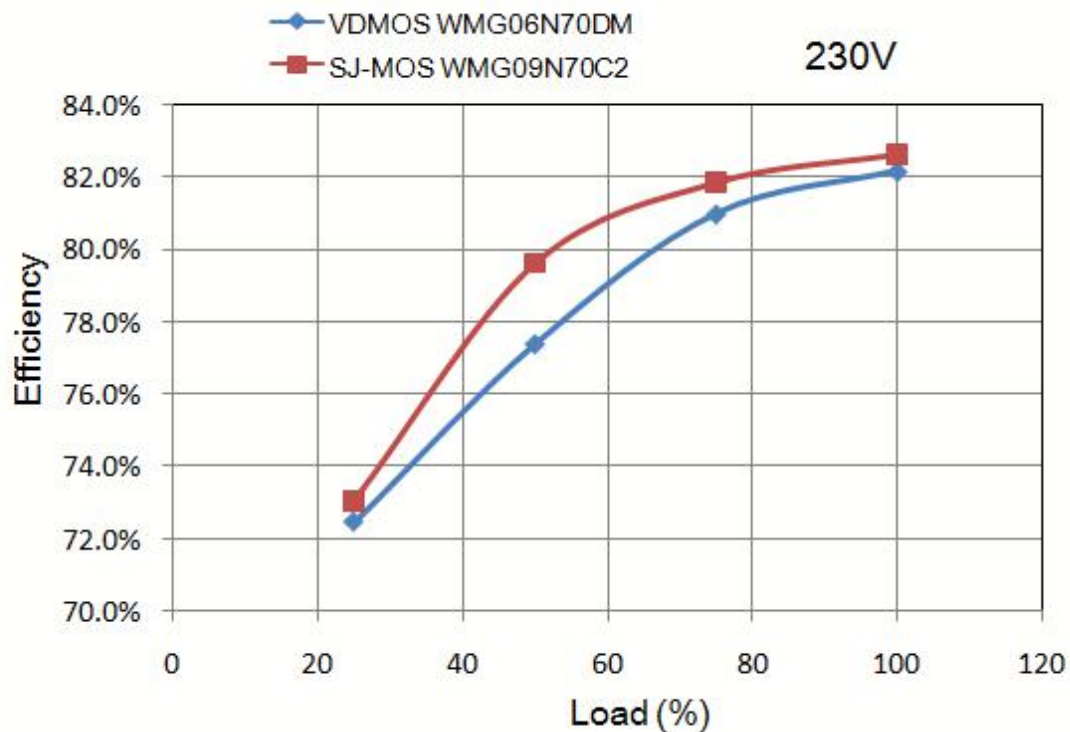
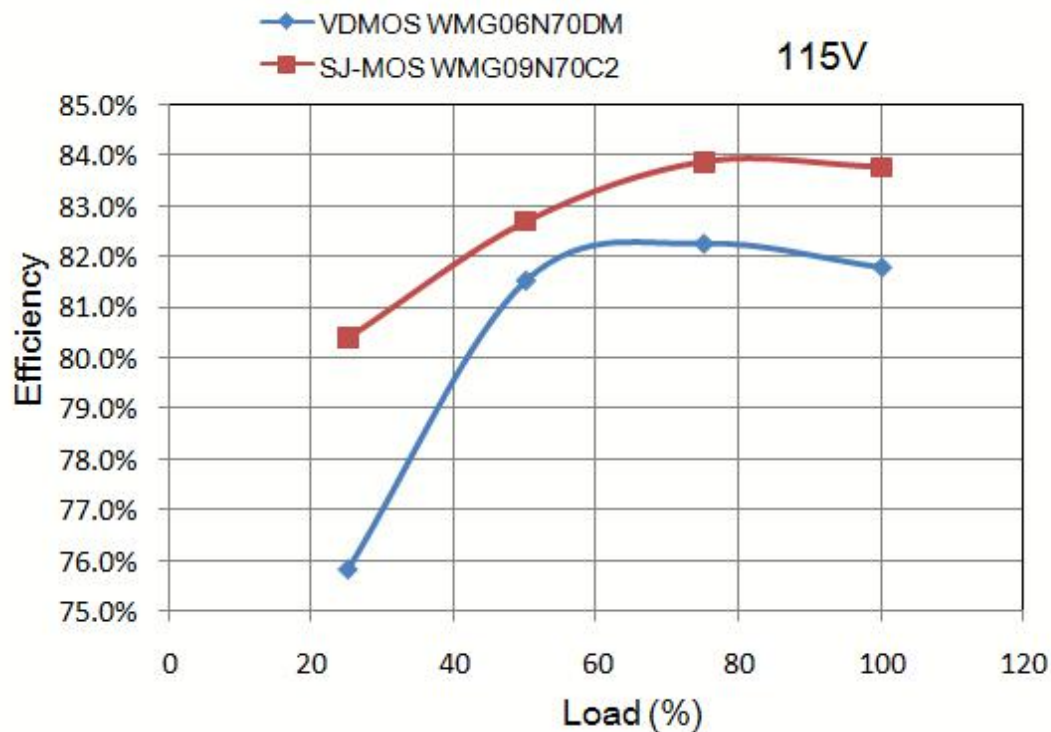


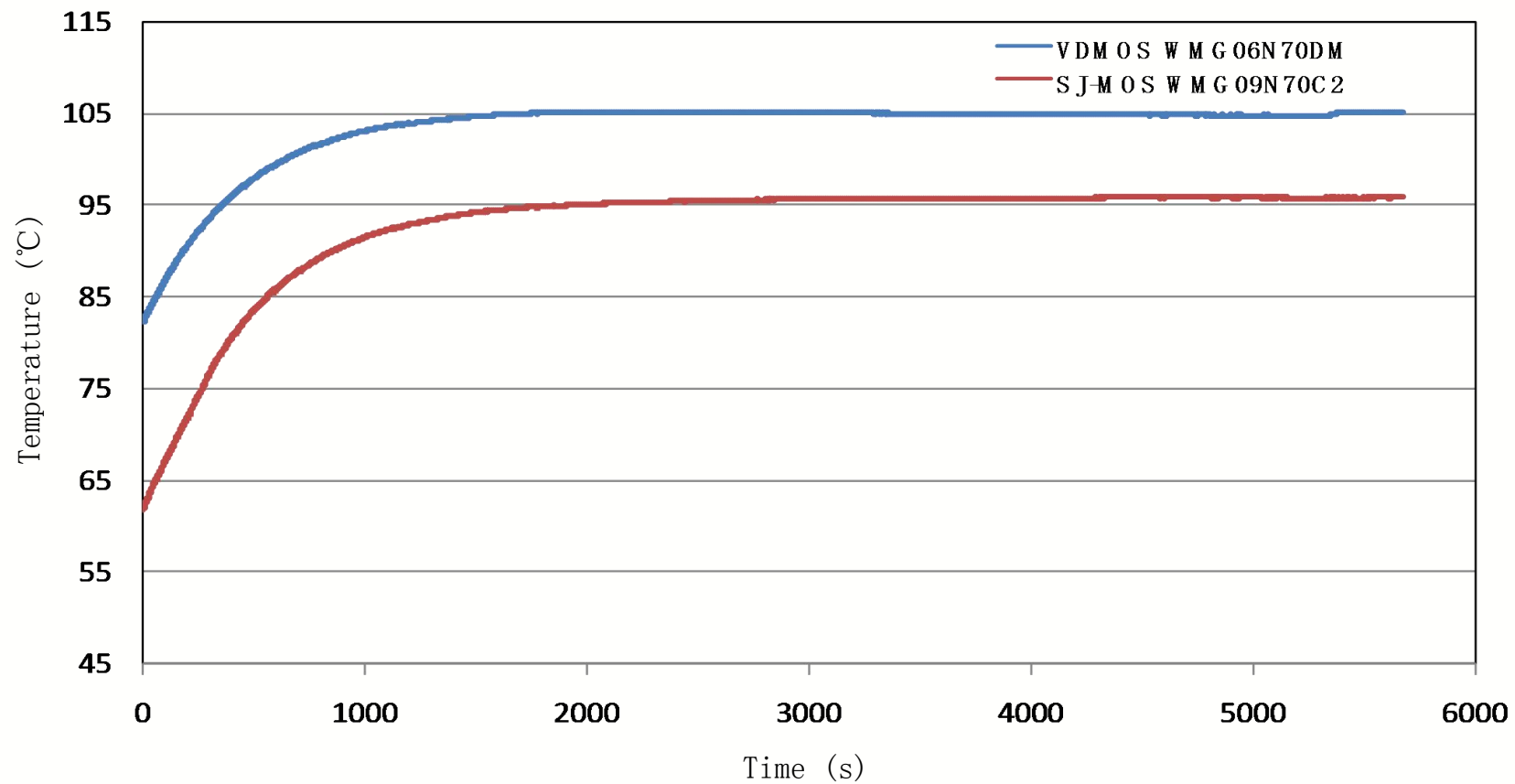
PC

# 10W Charger Application : Efficiency



# 15W Charger Application : Efficiency

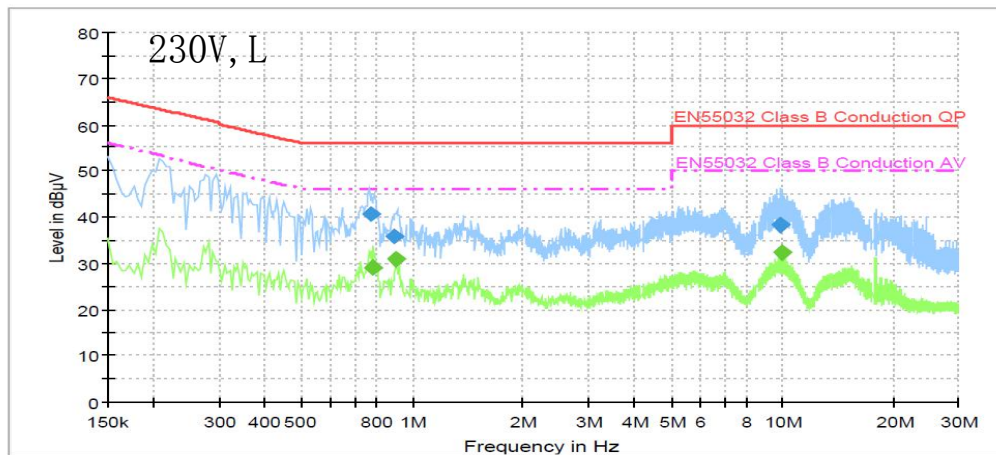




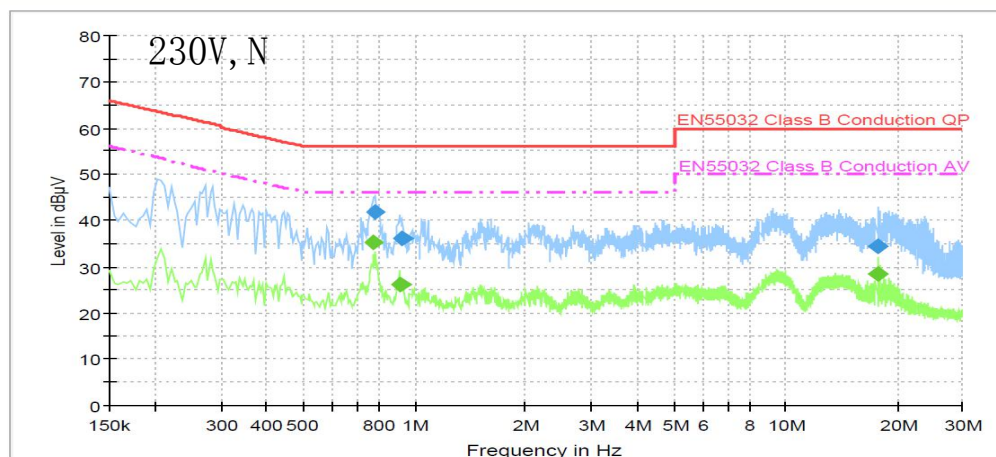
WMG09N70C2 is lower **10°C** than VDMOS WMG06N70DM

# 15W Charger Application : EMI

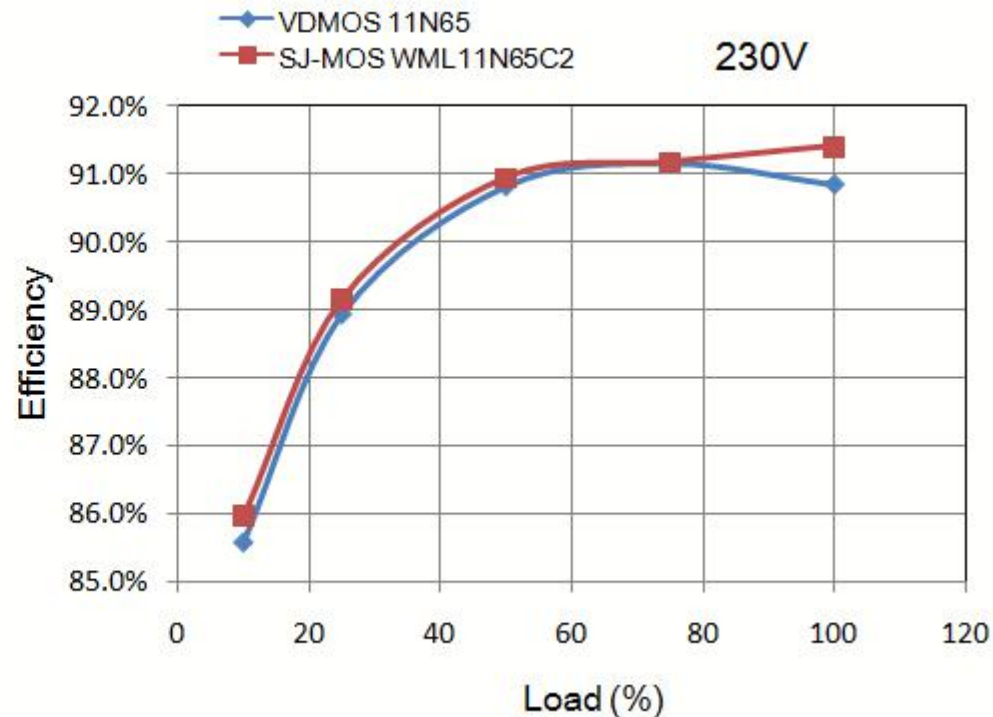
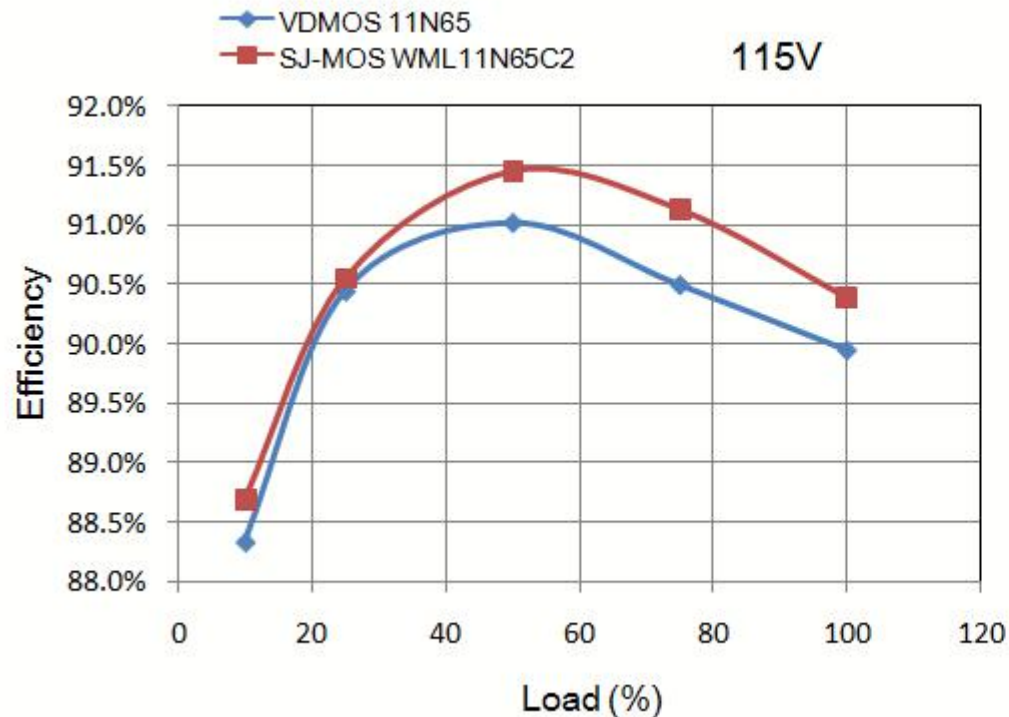
CE



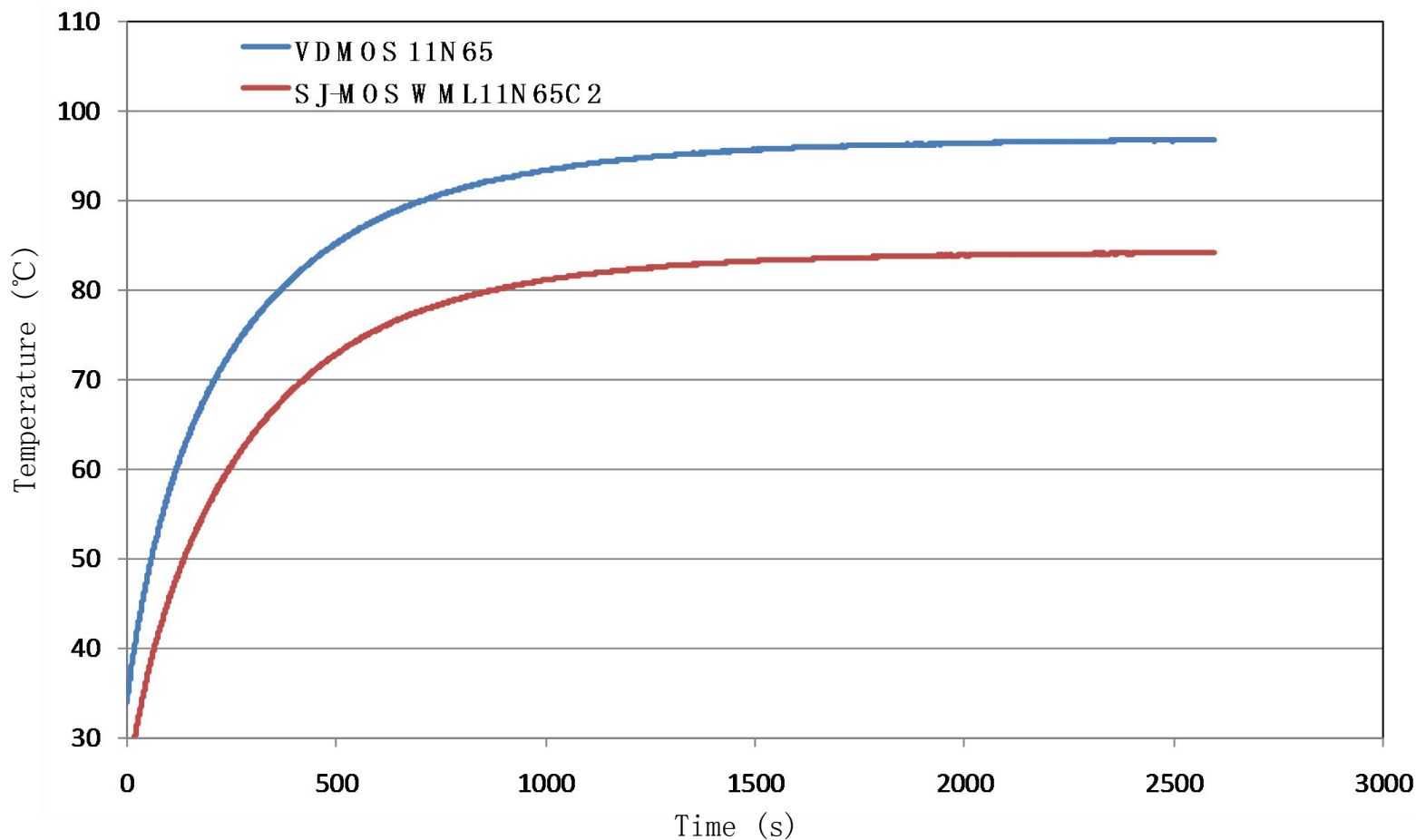
RE



# 65W Adapter Application : Efficiency



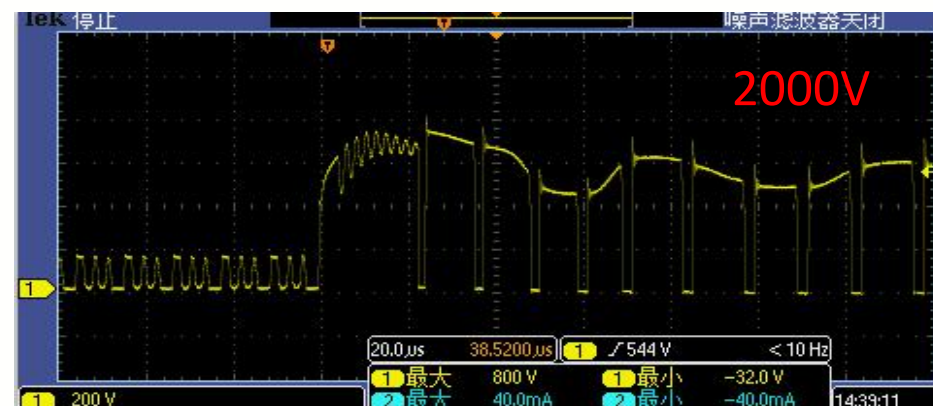
## 65W Adapter Application : Temperature



WML11N65C2 is lower **12.3°C** than VDMOS 11N65

# 33W LED Application : Surge

Single stage PFC, WML11N65C2



# SJ-MOS Selection Guide

## WMOSTM

| SJ-MOS C2 |           |           |            |
|-----------|-----------|-----------|------------|
| 500V      | 600V      | 650V      | 700V       |
| 0.19-2.5Ω | 0.19-1.9Ω | 0.19-1.9Ω | 2.45-0.42Ω |

### Applications & SMPS Topologies

#### Adapter/Charger

PFC/Quasi Resonant Flyback/Flyback /PSR

#### PC

PFC / TTF 80+

#### LCD TV

PFC / Quasi Resonant Flyback/Flyback

#### LED/HID

PFC / Quasi Resonant Flyback/Flyback /PSR

#### Server/UPS

PFC

| SJ-MOS FD |           |
|-----------|-----------|
| 600V      | 650V      |
| 0.2-0.34Ω | 0.2-0.34Ω |

### Applications & SMPS Topologies

#### Adapter/Charger

LLC/Resonant full-bridge

#### PC

Resonant half-bridge (LLC)

#### LCD TV

Resonant half-bridge (LLC)

#### LED/HID

LLC/Resonant full-bridge

#### Server/UPS

LLC/ZVS Full-bridge



# The End