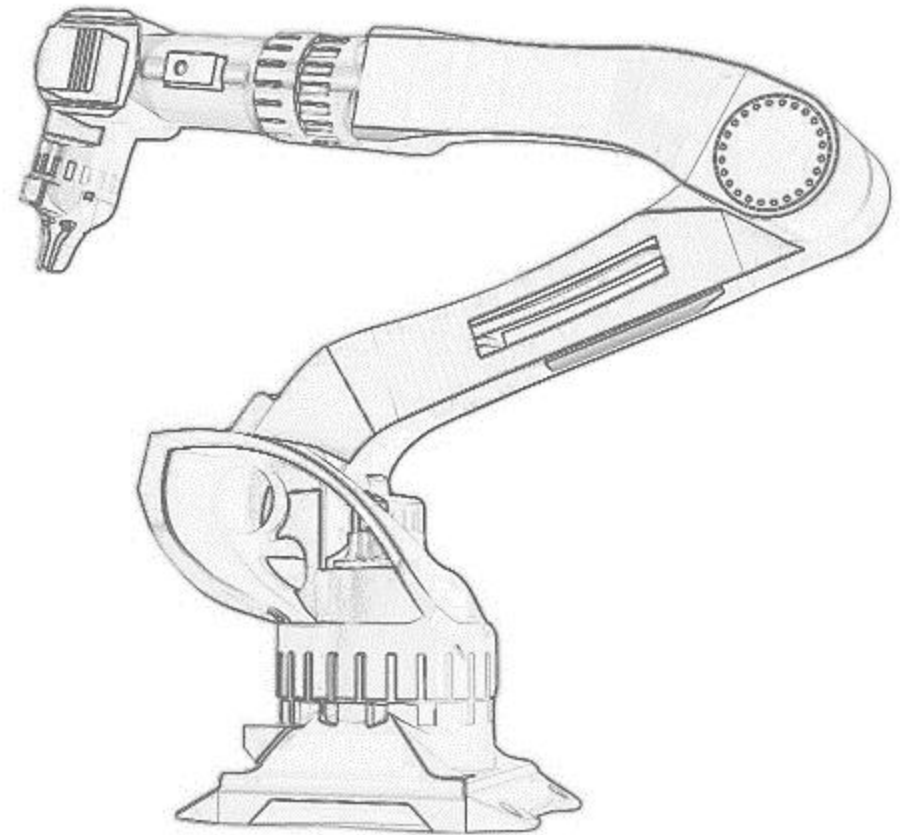


TOSHIBA

Industrial Power Solutions



CONTENT



01 Coverage & Focus Overview



02 PLC / Motion / IO Control Solutions



03 Motor Drives / Robot Solutions



04 Products Highlights



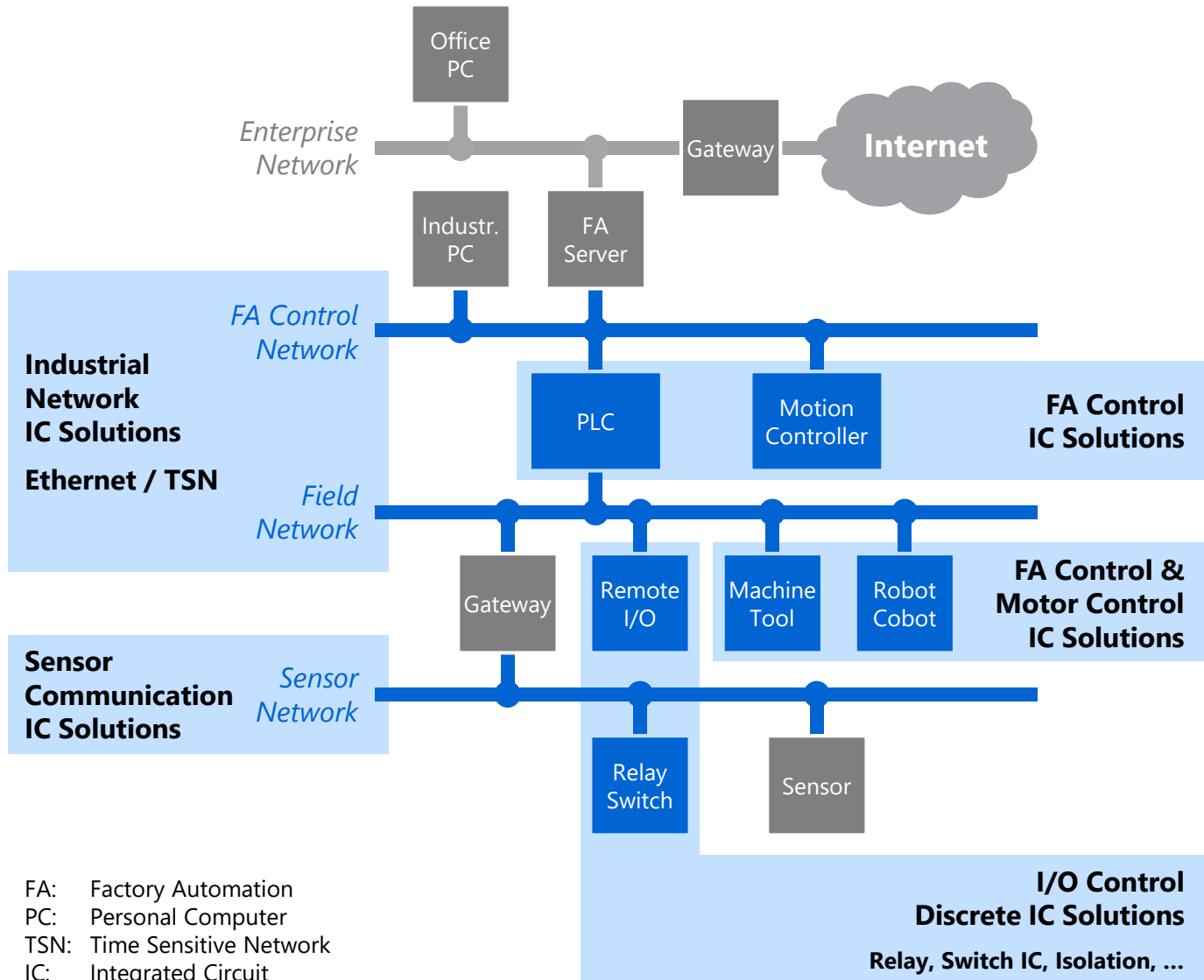
01

Coverage and Focus Overview





FACTORY AUTOMATION COVERAGE



Toshiba IC Solutions

1 Enhanced Functionality

2 Digital Real-Time Connection


3 Energy Efficiency




FACTORY AUTOMATION SOLUTIONS & PRODUCTS



PLC, Motion,
IO Control



Drives
Robots



Sensors,
Actuators

Control & Communication

Neutrino
Ethernet TSN
Bridge

Small
Signal

Motor
MCU

MCD

Neutrino
TSN
Stand-alone
Endpoint

Power

MOSFET

Power
Supply

E-Fuse IC

Power
MOSFET

LV/HV IPD

Gate Driver

SiC Diode

LDO

I/O Signal

Photo
Coupler

Photo
Relay

Digital
Isolator

Diodes

Photo
Coupler

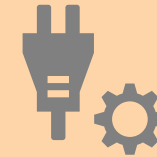
Small
Signal

LDO

Photo
Relay

System Solutions

Reference Design Center



Power
Management



Motor
Control

AGV / Robot Reference Model



Single MCU
Multi-Axis Control



REFERENCE DESIGN CENTER



Reference Solutions

Exemplary Design Solutions for Various Industrial Applications



Design Sources

Direct Access to Circuit Diagrams, BOM, Design Manual and PCB Files



Contact Window

Access to Toshiba's Technical Experts and Sales Team



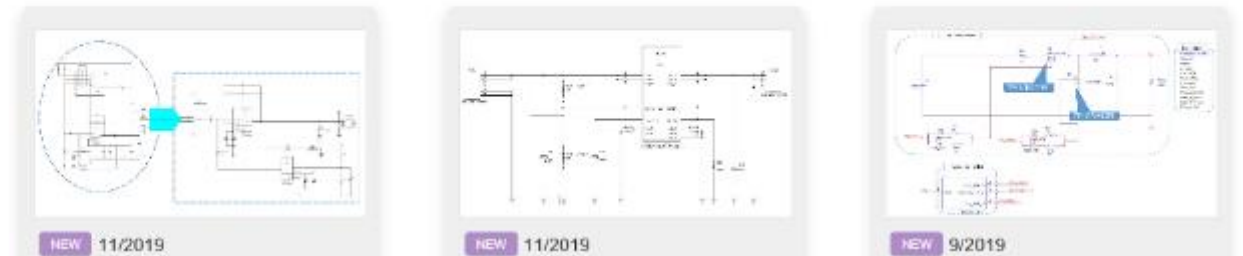
<https://toshiba.semicon-storage.com/eu/design-support/referencedesign.html>

Reference Design Center



All Designs (48 designs)

Sort: Title | Design Files | Date





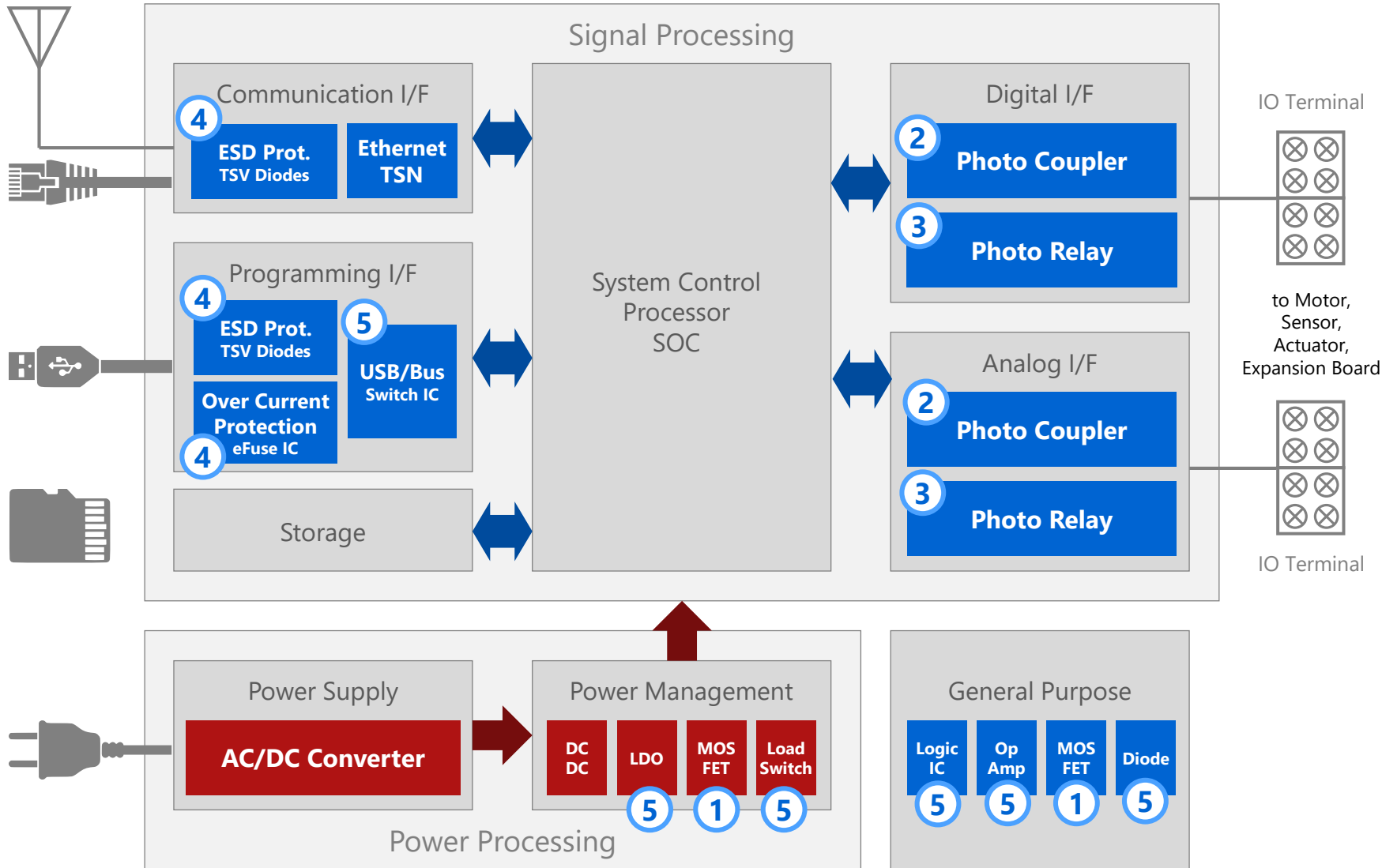
02

PLC / Motion / IO Control Solutions





PLC / MOTION CONTROLLER / REMOTE IO



Key Products

① LV MOSFET

High Efficiency for High Power Density

② Photocouplers

Long LED life time, lowest supply current, large line-up

③ Photorelays

Replacement of mechanical relays

④ Protection Devices

TVS diode for ESD protection of data line and antenna.
eFuse IC against over-current

⑤ Others

For LDOs, Load Switches, Logic, BUS switches, Diodes or Op.-Amps please check toshiba.semicon-storage.com



MOSFET FOR POWER SUPPLY & DC/DC conversion

Extensive Portfolio

1 Main Switches

DTMOS IV with integrated **High-Speed Diode**, 600/650V

2 PFC

DTMOS VI / DTMOS IV-H for **High-Speed Switching**, 600/650V And **SiC Diodes**

3 Rectification

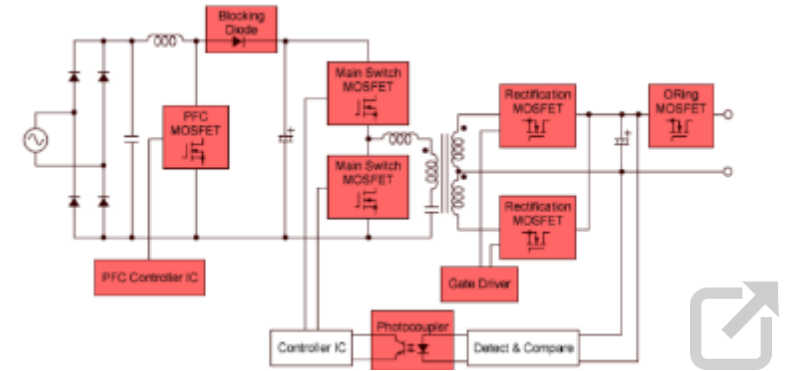
UMOS VIII/IX/X, 40V ~ 120V

4 O-Ring

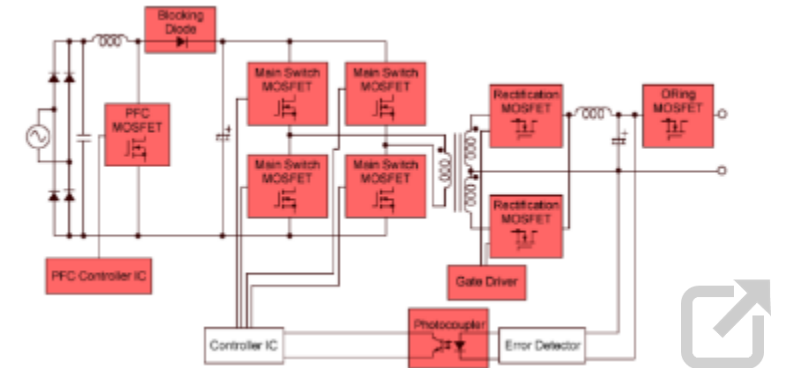
UMOS VIII/IX/X

Application Examples

AC/DC Resonant **Half-Bridge** Power Supply
150W – 1.6kW

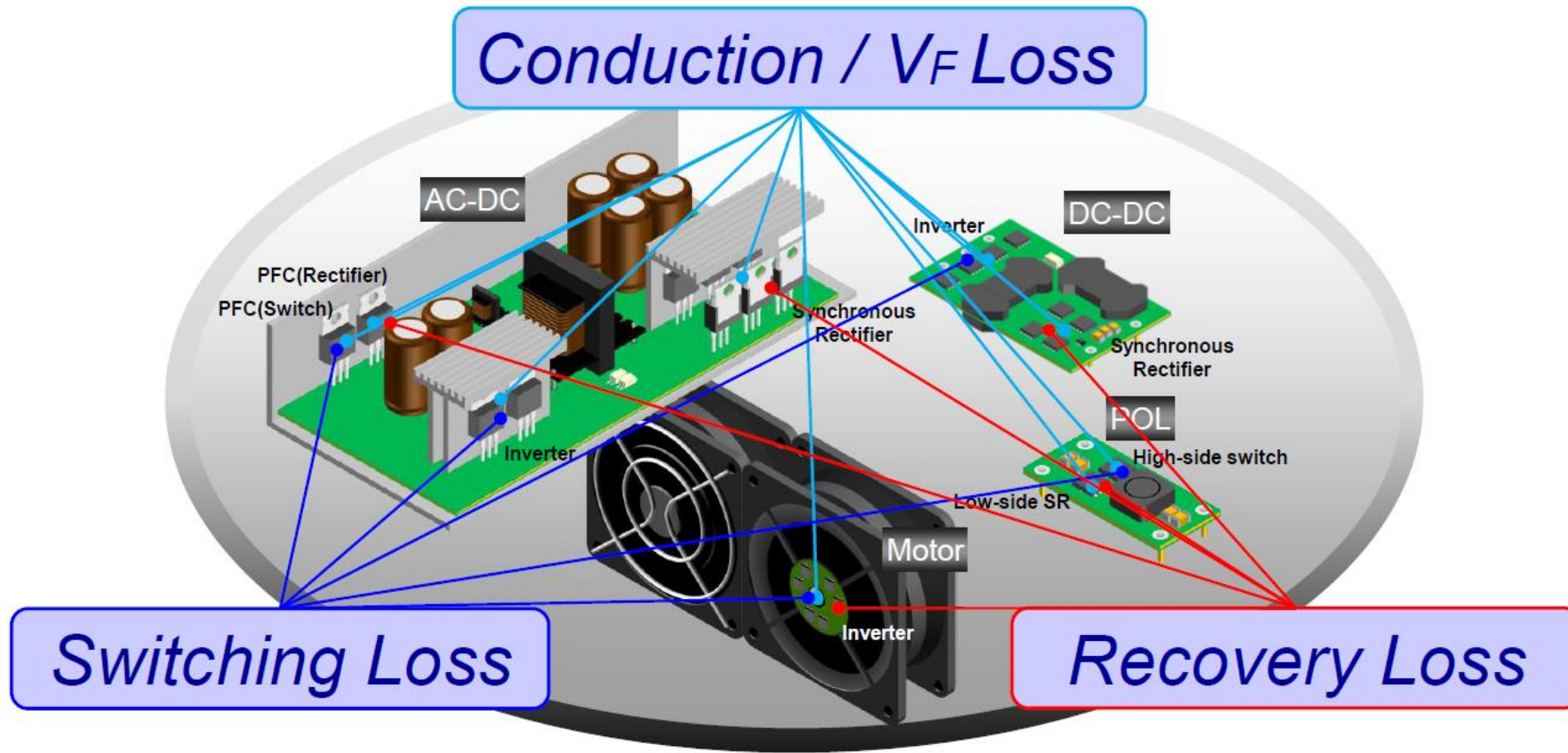


AC/DC Resonant **Full-Bridge** Power Supply
> 1kW



High Efficiency with High-Speed Switching Performance

TOSHIBA HV & LV Power MOSFET - with best-in-class technologies





PHOTOCOUPLER

Product Highlights

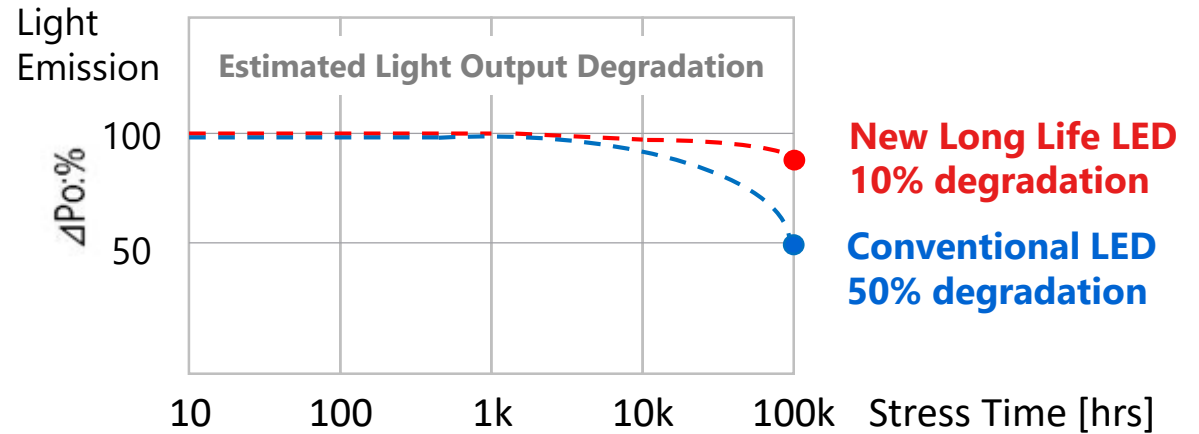
1 Long Lifetime, high performance LED

High Reliability
High operation temperature
up to +125°C!

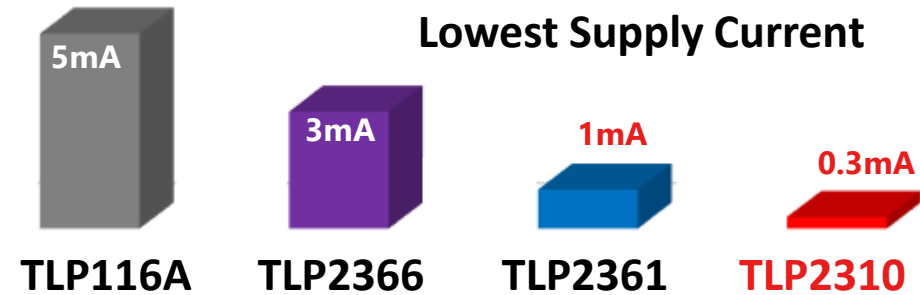
2 High performance detector chip for lowest power consumption

3 New low height packages
save space & cost

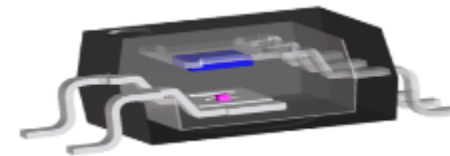
4 Large Product Portfolio



SO6 
2.3mm height



IC Output up to 50Mbps
Transistor Output
Photorelays
Isolation Amplifier





PHOTORELAYS

Product Highlights

1

Excellent switching characteristics
(high speed, low noise)

2

Low input current / low voltage drive

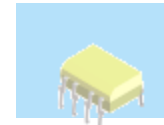
3

Miniaturization of mounting area

4

High reliability (long life)
No wear and tear induced degradation

Replacement for Mechanical relay



DIP4/DIP6/DIP8



VSON4
2.45mm
× 1.45mm
× 1.4mm(t)

NEW



SVSON4
2.0mm
× 1.45mm
× 1.75mm(t)

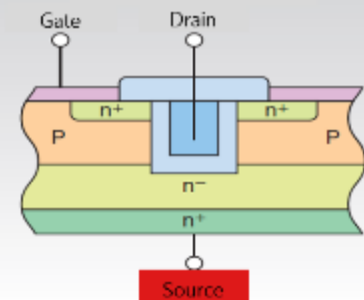


SO6(ZEUS)

Latest UMOS Technology

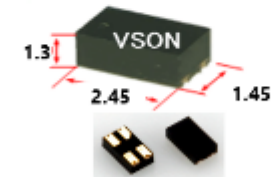
- U-MOS^{III} deployment
- DTMOS for next item

Trench construction



Smallest VSON Package

- Small Package Size:
• 2.45mm × 1.45mm × 1.3mm





03

Motor Drives & Robot Solutions



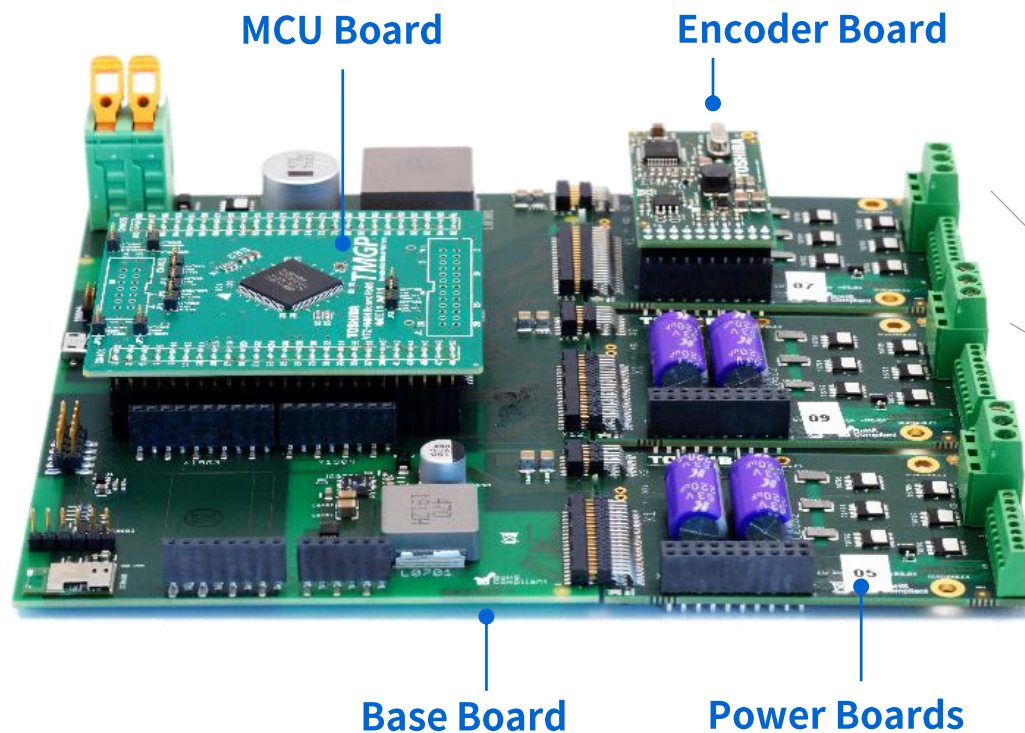
SERVO DRIVE REFERENCE MODEL

3 BLDC servo motors control by a single MCU

- M4KN MCU, 160MHz, 512kB Flash, 100-pin

200W Power stage, 3-phase inverter

- 6x TPW3R70APL, 100V/150A, LV MOSFET, class leading low on resistance: 3.7mΩ



Demo Model
3 BLDC Servo
Motor Control



<http://toshiba.semicon-storage.com/eu/semiconductor/design-development/reference-model/servodrive.html>

Modular and Versatile Platform – Supporting Various Use Cases



AGV Reference Model

3 BLDC servo motors control by a single MCU

- M4KQ MCU, 160MHz, 512kB, Flash, 144-pin

Power stage, 3-phase inverter

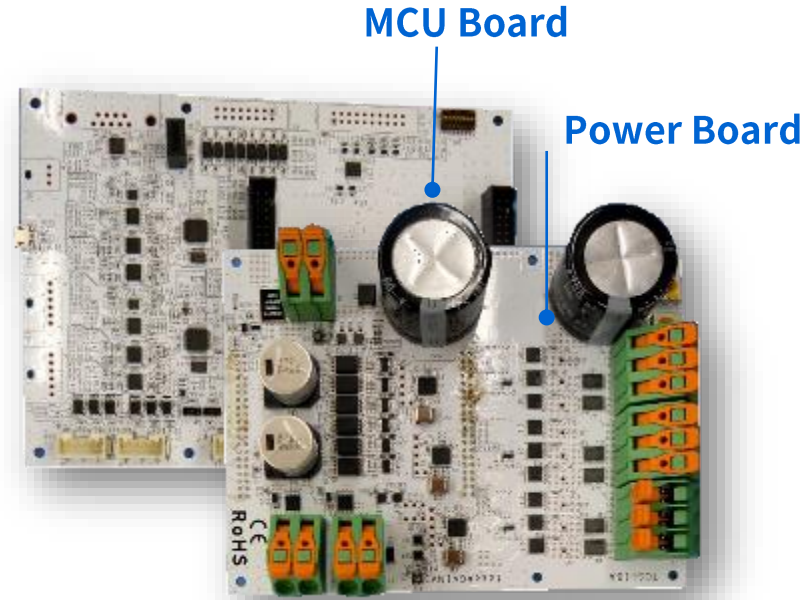
- TPH2R408QM low-voltage MOSFET, class leading low on resistance: 3.5mΩ

Toshiba SCiB™ SIP series as replacement for lead-acid batteries

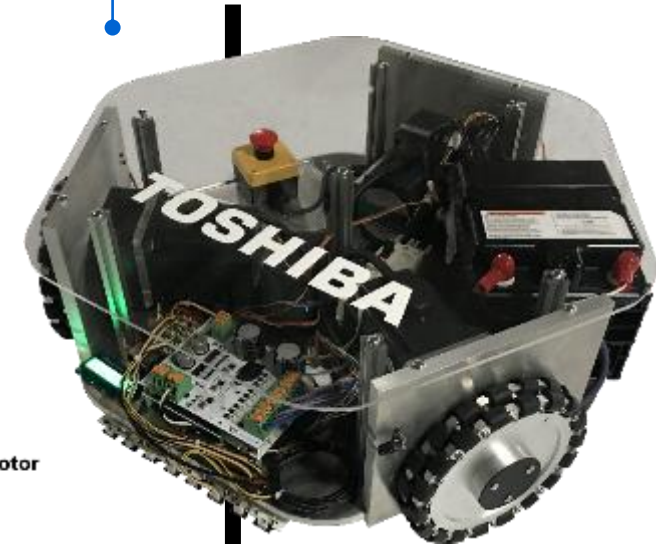
- SIP24 (24V)



<https://www.scib.jp/en/product/sip/index.htm>

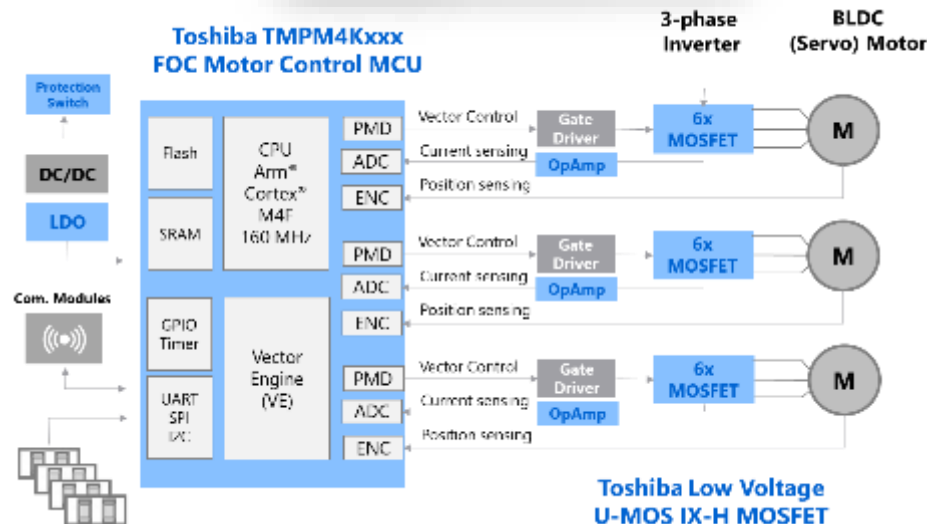


3-OmniWheel AGV



CCD Sensor

Track





SOLUTIONS FOR MOTOR CONTROL AND DRIVE CIRCUITS

1 Inverter

Leading edge MOSFET reduces energy losses

2 Power Devices

Improved power density and efficiency by SiC MOSFET & Diode

3 Motor Control MCU

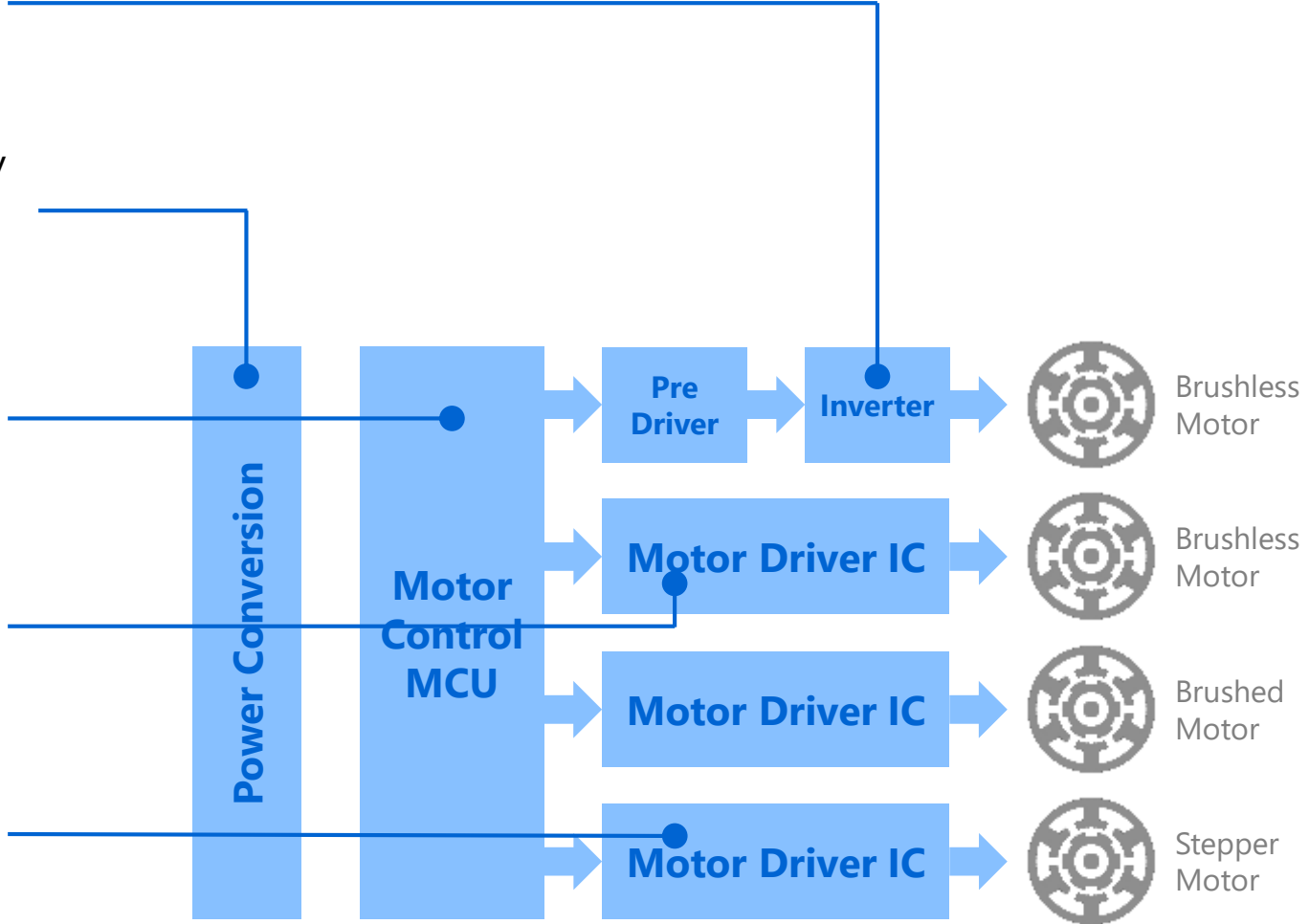
Precise motor control provides improved energy efficiency

4 Driver IC for Brushless DC

Toshiba phase control technology improves energy efficiency

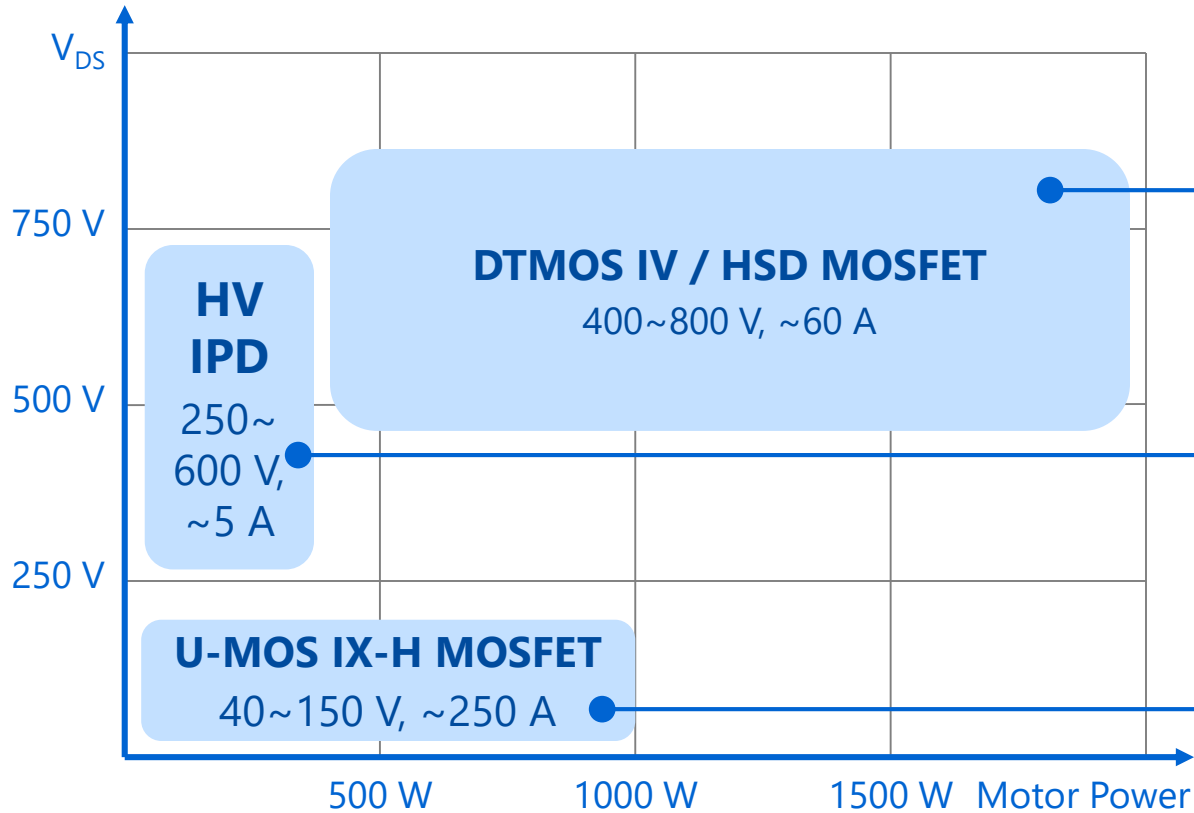
5 Driver IC for Stepping Motor

Toshiba original **AGC** technology reduces motor energy losses





LV/HV MOSFET FOR INVERTER



High Voltage MOSFET

Fast switching reduces losses, High Speed Diode optimizing efficiency

Intelligent Power Devices – IPD

Integrated solution based on MOSFET / IGBT compact, protected, high efficiency

Low Voltage MOSFET

Low R_{ON} , $T_{CH} = 175^{\circ}\text{C}$
40V/60V options for low V_{DS} spike

Low $R_{DS(ON)}$, Fast Switching, Wide Voltage Range

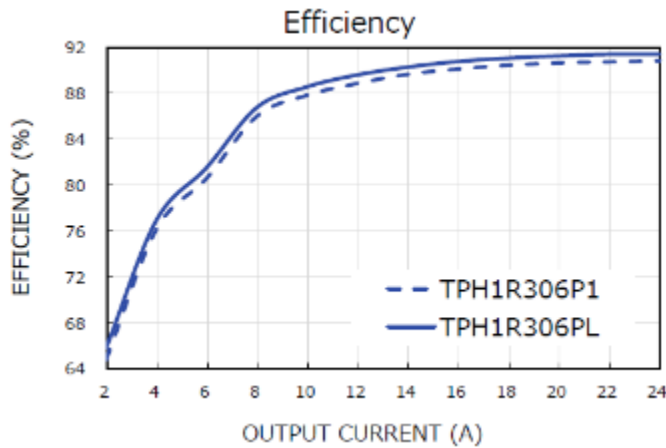


LOW VOLTAGE MOSFET FOR INVERTER



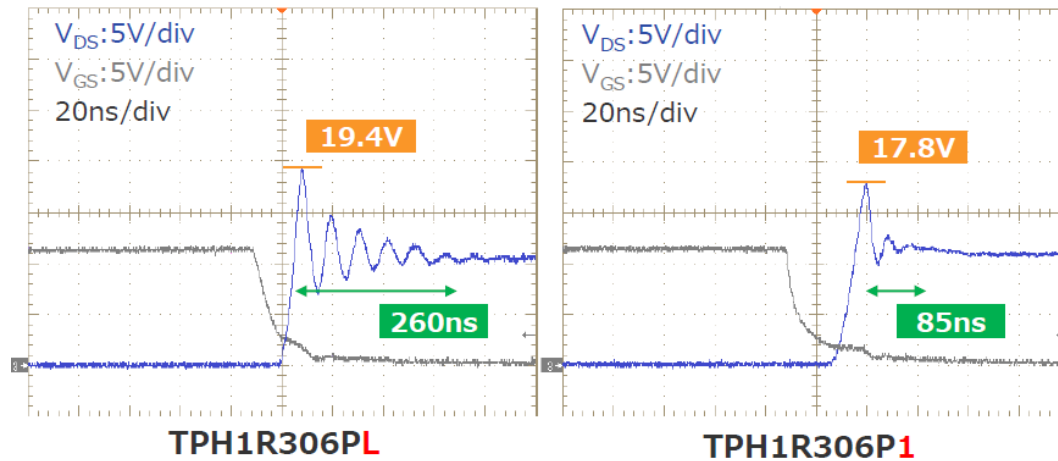
High Efficiency

- Industry leading process enables **low On Resistance $R_{DS(ON)}$**
- improved trade off between $R_{DS(ON)}$ and Q_{gr} , Q_{SW} , Q_{OSS}



Easy Design In

- $T_{CH} = 175^{\circ}C$ (U-MOS IX-H)
- high avalanche energy
- 40V/60V options for **low V_{DS} spike** and **shorter ringing**



Test Condition:
 $V_{DD} = 30 V$, $I_{DSF} = -25 A$, $di/dt = 100 A/\mu s$, $T_a = 25^{\circ}C$



Wide Line-Up

- supports voltages from 20V to 250V
- huge variety of packages (SMD and THD)
- Top-side cooling (DSOP package)



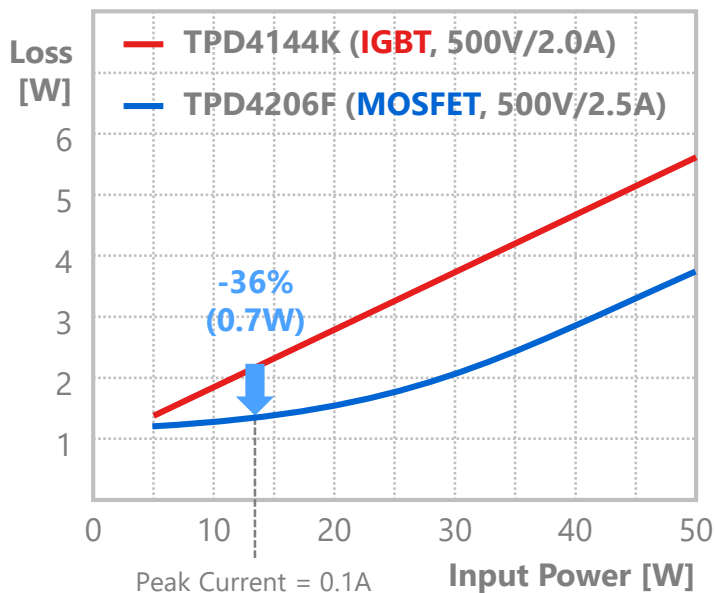


INTELLIGENT POWER DEVICES - IPD



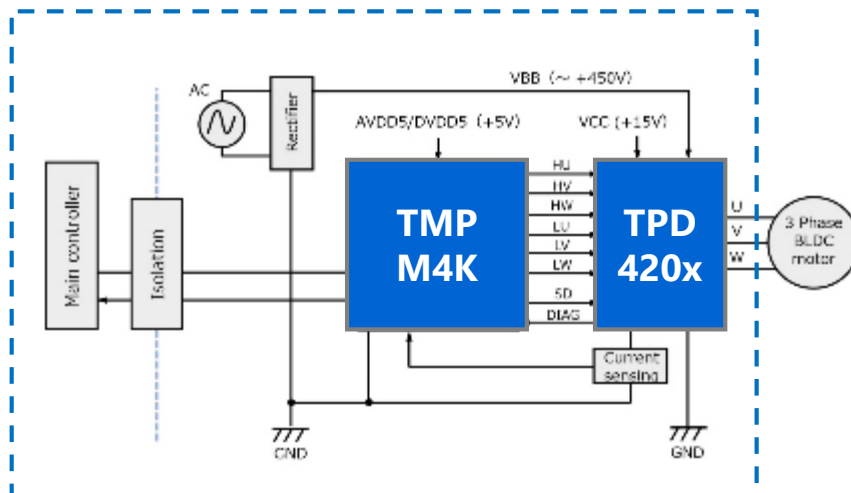
High Efficiency

- include driver and output stage
- multichip MOSFET-output modules reduce losses by 36% compared to monolithic IGBT modules



System Reliability

- monitoring load conditions and providing feedback to MCU
- includes protection and diagnostic circuits



Motor Reference Design with IPD



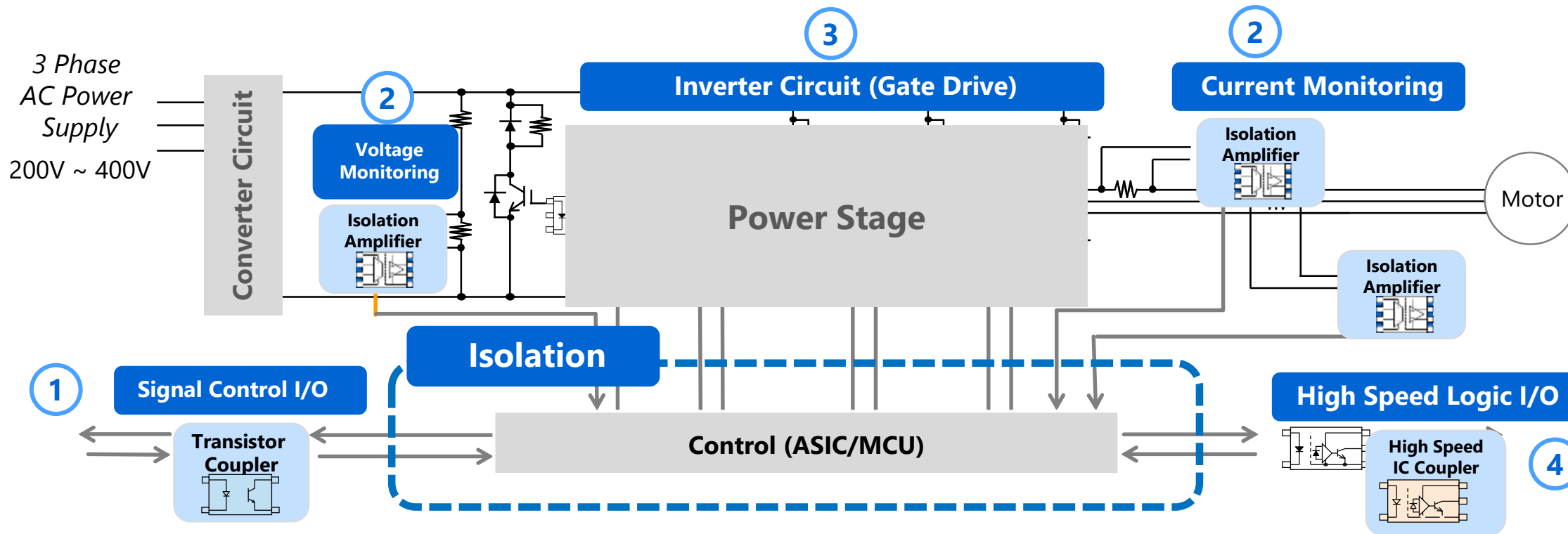
Wide Line-Up

- supports voltages from 60V to 600V
- MOSFET or IGBT output transistor
- sine wave or square wave drive type
- surface mount (SMD) and through-hole device (THD) and dual-in-line (DIL) packages





OPTICAL ISOLATION IN INVERTER SYSTEMS



1 Signal Control I/O

- P/Ns: **TLP383 / TLP293**
- Low If Transistor Couplers
- Extended Top Range + 125 °C

3 Gate Driver

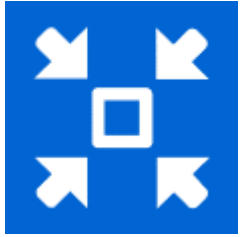
- Smart Gate Driver: **TLP5231**
- Rail to Rail Gate Driver: **TLP5754**
- Peak Output Current: **4A**

2 Voltage/Current Monitoring

- Isolation Amplifier
- Analogue Output Type **TLP7820**
- Digital Output Type **TLP7830**

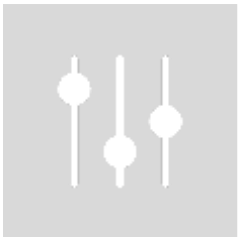
4 High Speed I/O

- 50 Mbps to 20 kbps data rates
- Ultra Low Power Consumption
- Extended Top Range + 125°C



04

Discretes Product Highlights



- 01 U-MOS Low voltage MOSFETs
- 02 DTMOS Superjunction MOSFETs
- 03 SiC Diodes & MOSFETs
- 04 Photocouplers
- 05 Photorelays
- 06 eFuse IC
- 07 LDO
- 08 SMOS MOSFET

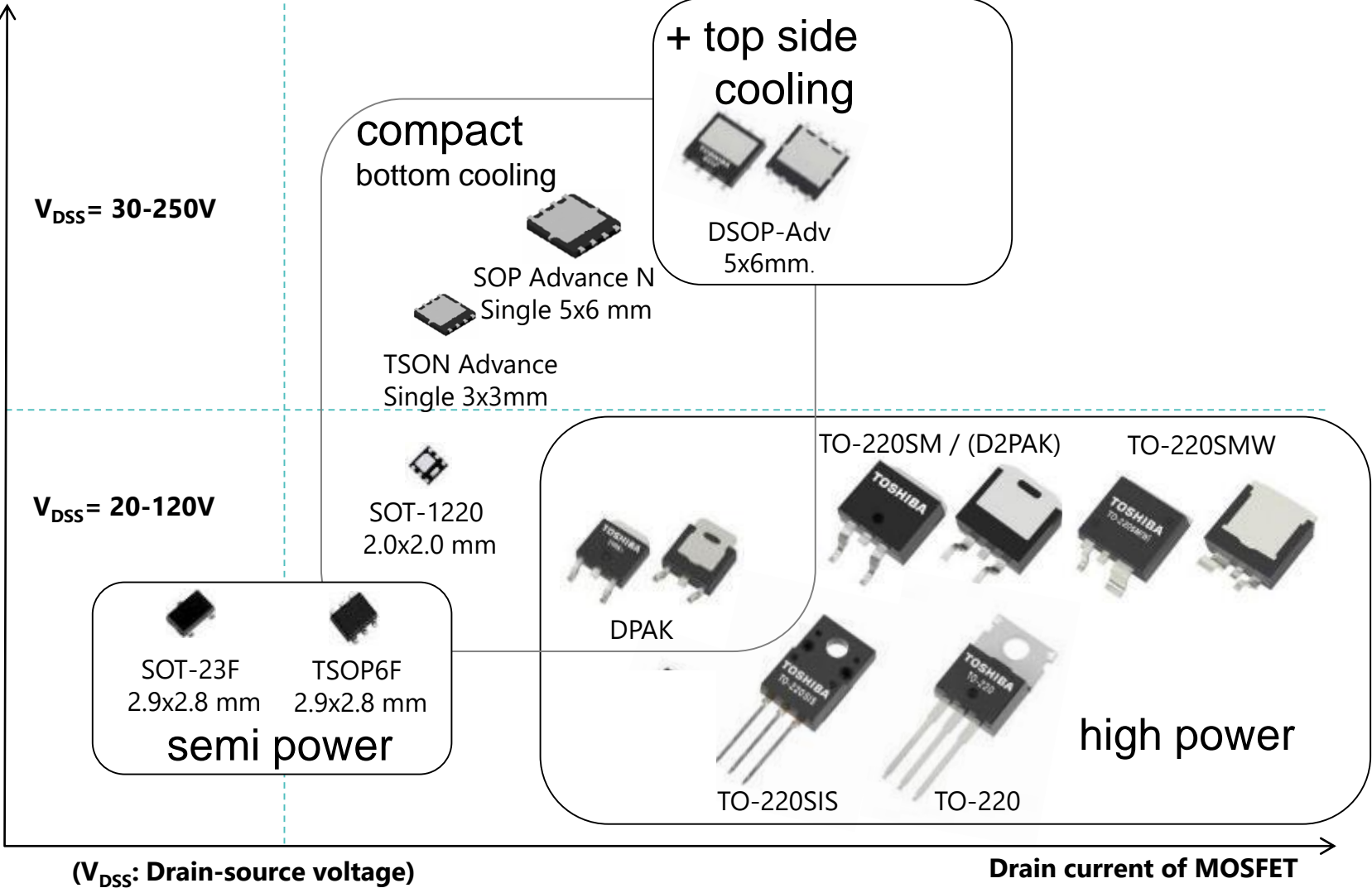
01

U-MOS Low voltage Power MOSFET's

20~250V

For DC/DC conversion, Battery and Sync. Rectifier

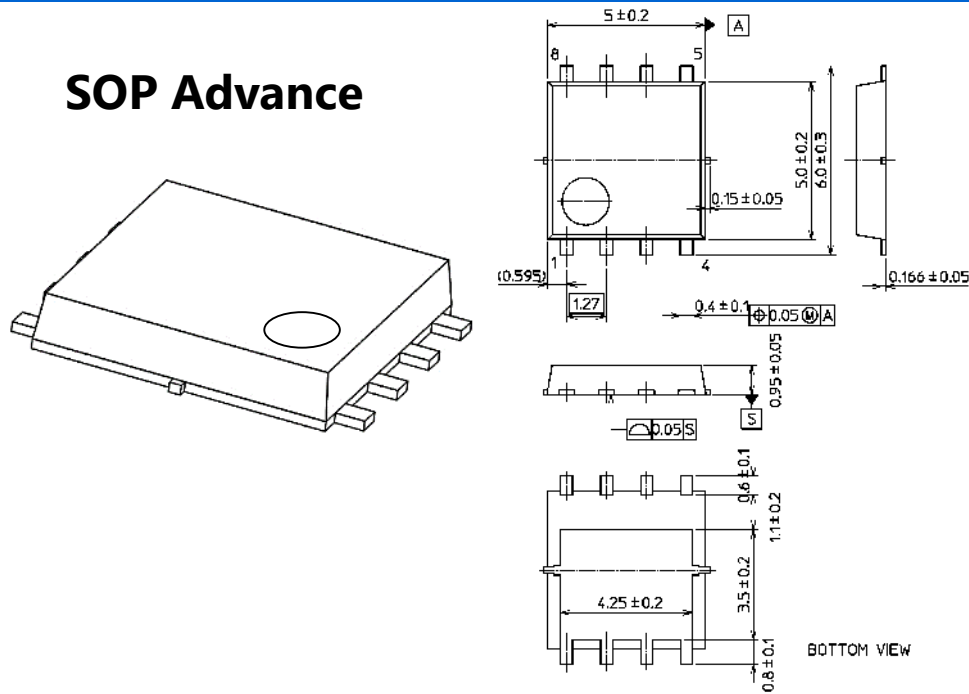
Low Voltage MOSFET: Wide Package Lineup



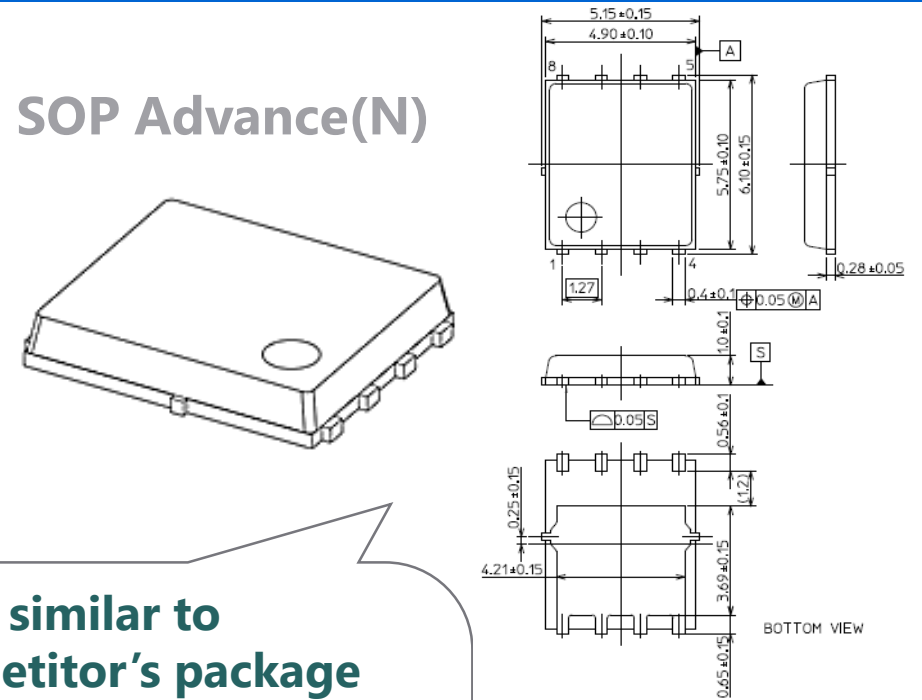
New 5x6 package, "SOP Advance(N)"

Introduction of new 5x6 package, "SOP Advance(N)" in addition to conventional "SOP Advance" as parallel production for further assembly capacity increase.

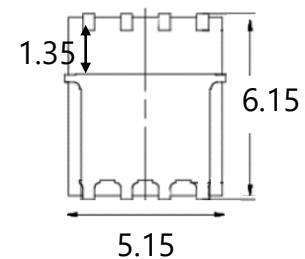
SOP Advance



SOP Advance(N)



More similar to competitor's package



Example of a popular competitor package

U-MOS IX & X to boost efficiency of switching application

1 U-MOS IX

30V : TPHP6503PL 0,65m Ω (max)
40V : TPHP8504PL 0,85m Ω (max)
60V : TPH1R306PL 1,34m Ω (max)
100V: TPH3R70APL 3,70m Ω (max)


**SOP-Adv.
5x6mm**

- Excellent trade off: $R_{ds(on)} * Q_{oss}$
- For highest efficiency in sync. rectifier & DC/DC
- **low spike performance** at selected 40V and 60V item
- Packages: 3x3mm, 5x6mm, DSOP, DPAK, TO-220FL /AB

2 U-MOS X

Initial Item :

80V: TPH2R408QM 2,43m Ω (max) (5x6mm)

80V: TPN8R408QM 8,4m Ω (max) (3x3mm)

- All U-MOS X show **low spike performance and high dv/dt capability**
- Further improved FOM: $R_{DS(ON)}$ & Q_g , Q_{sw} , Q_{oss}
- Better V_{th} distribution for simple paralleling



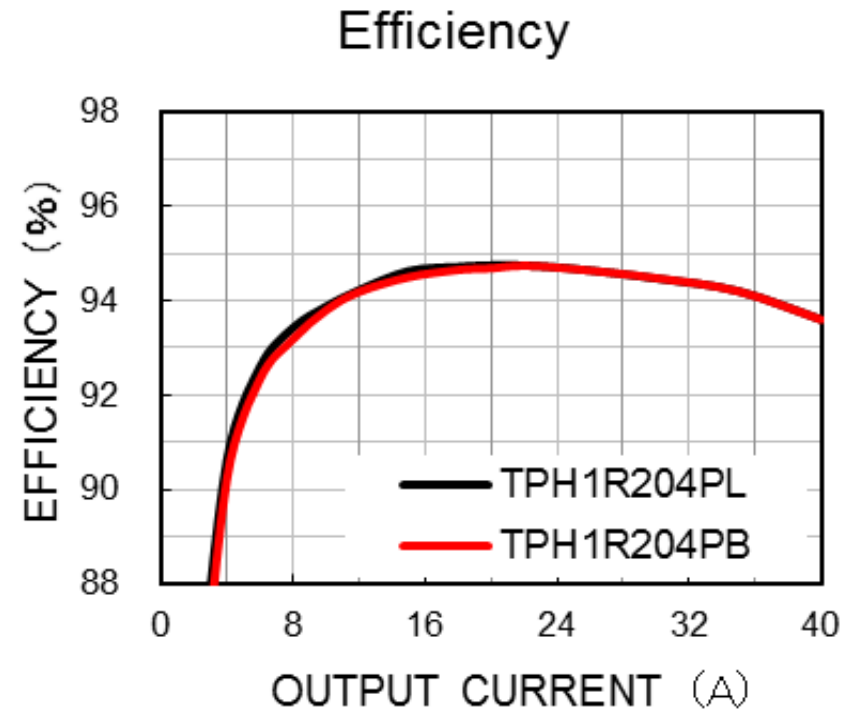
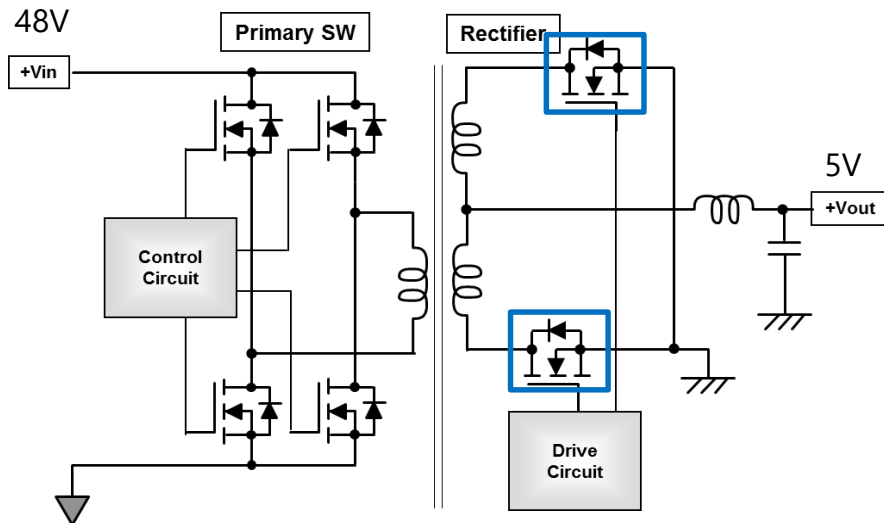
$t_{ch} = 175^{\circ}\text{C}$ supported by both series

U-MOSIX-H low spike MOSFET's

Low V_{ds} spike type is designed to keep efficiency !!

Efficiency comparison between
Low V_{ds} spike type and high speed type

TPH1R204PL : High speed type
TPH1R204PB : Low V_{ds} spike type



New U-MOS X-H 80V Series

TPH2R408QM & TPN19008QM N-channel power MOSFETs

New devices can significantly enhance power supply efficiency



Part number	Rds(on)max	Package	
TPH4R008QM	4 mΩ	5x6 mm	SOP Adv (N)
TPH2R408QM	2,43 mΩ	5x6 mm	SOP Adv (N)
TPN190008QM	19 mΩ	3x3 mm	TSON Adv
TPN12008QM	12 mΩ	3x3 mm	TSON Adv
TPN8R408QM	8,4 mΩ	3x3 mm	TSON Adv

Application

- Telecom Power supply
- Industrial Power supply synchronous rectification at 24~28V output Voltage
- Motor drive Power stage at 36V power Tool

Features

- Lowest Rds(on) in Form factor available
- Excellent low FOM Rds(on) x Q(oss) and Rds(on) x Q(sw)
- 5x6 Package SOP Adv "N" style for improved compatibility
- tj: 175°C
-

Advantages

- Low conduction loss
- High efficiency switching
- More thermal head room

Benefits

- Lower heat generation
- Smaller space consumption, helping to reduce costs

02

DTMOS High voltage MOSFETs

600~800V Superjunction MOSFETs

For Power supply

Toshiba DTMOS Superjunction MOSFET's Overview

Toshiba's MOSFET solution for significantly reduced $R_{ds(on)}$ vs chip area DTMOS with deep trench filling process

DTMOS IV : 600~650V various Chip options:

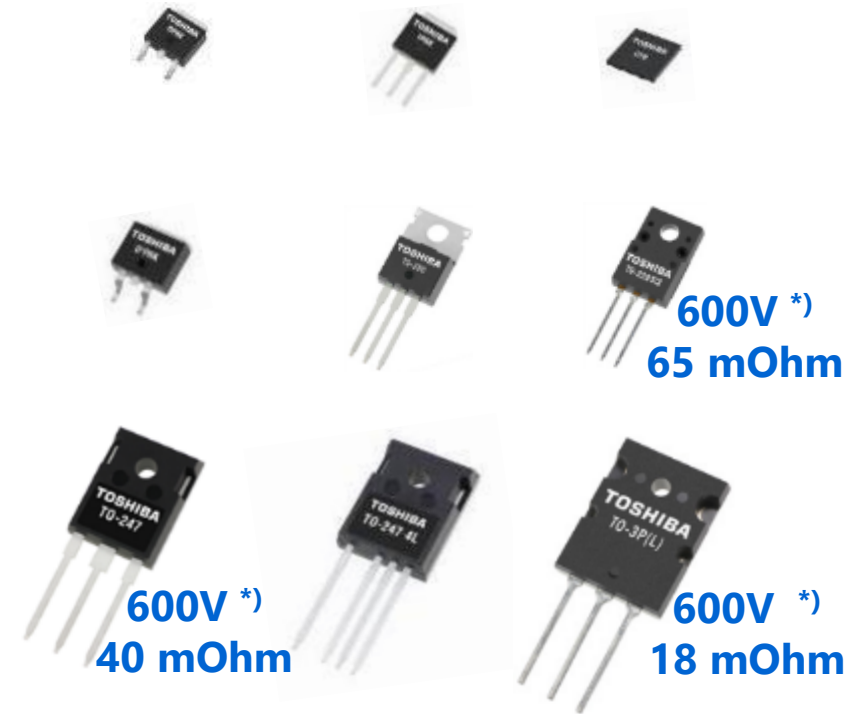
- W - suffix: Standard type
- X - suffix: High speed switching type
- W5-suffix: High speed body diode included

500 & 800V standard type

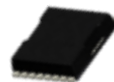
DTMOS V : 600~650V low EMI noise type

DTMOS VI: 650V for fastest switching

- Lowest $Q_{dg} \times R_{on}$ figure of merit
- Highest efficiency switching
- Introducing new power package: TOLL



new

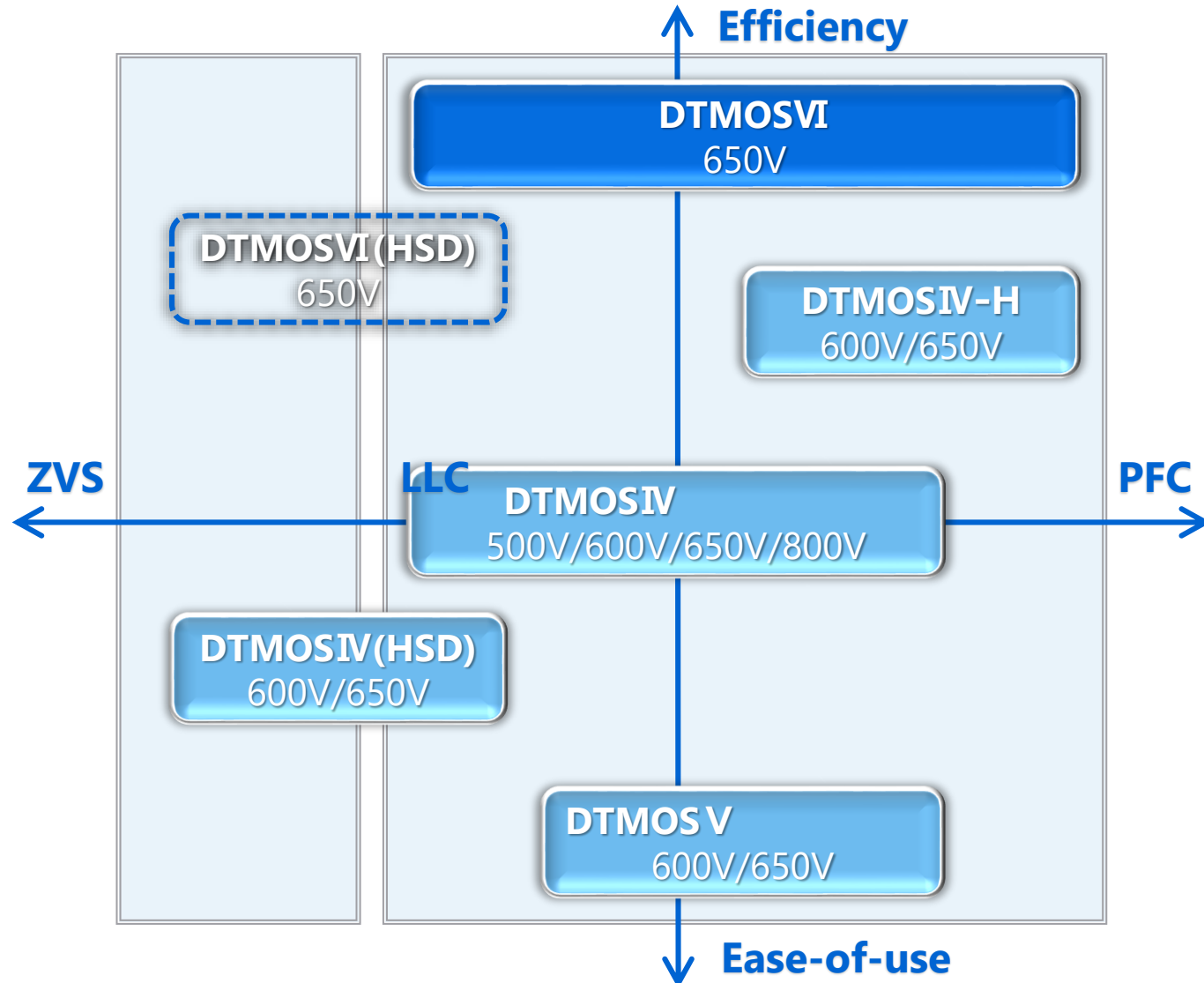


new

*) max $R_{ds(on)}$ values
of DTMOS IV item

DTMOS series in Selection Guide

Solutions for each part of your application



New series: DTMOSVI

High speed switching concept
High voltage series ($V_{DSS}=650V$)

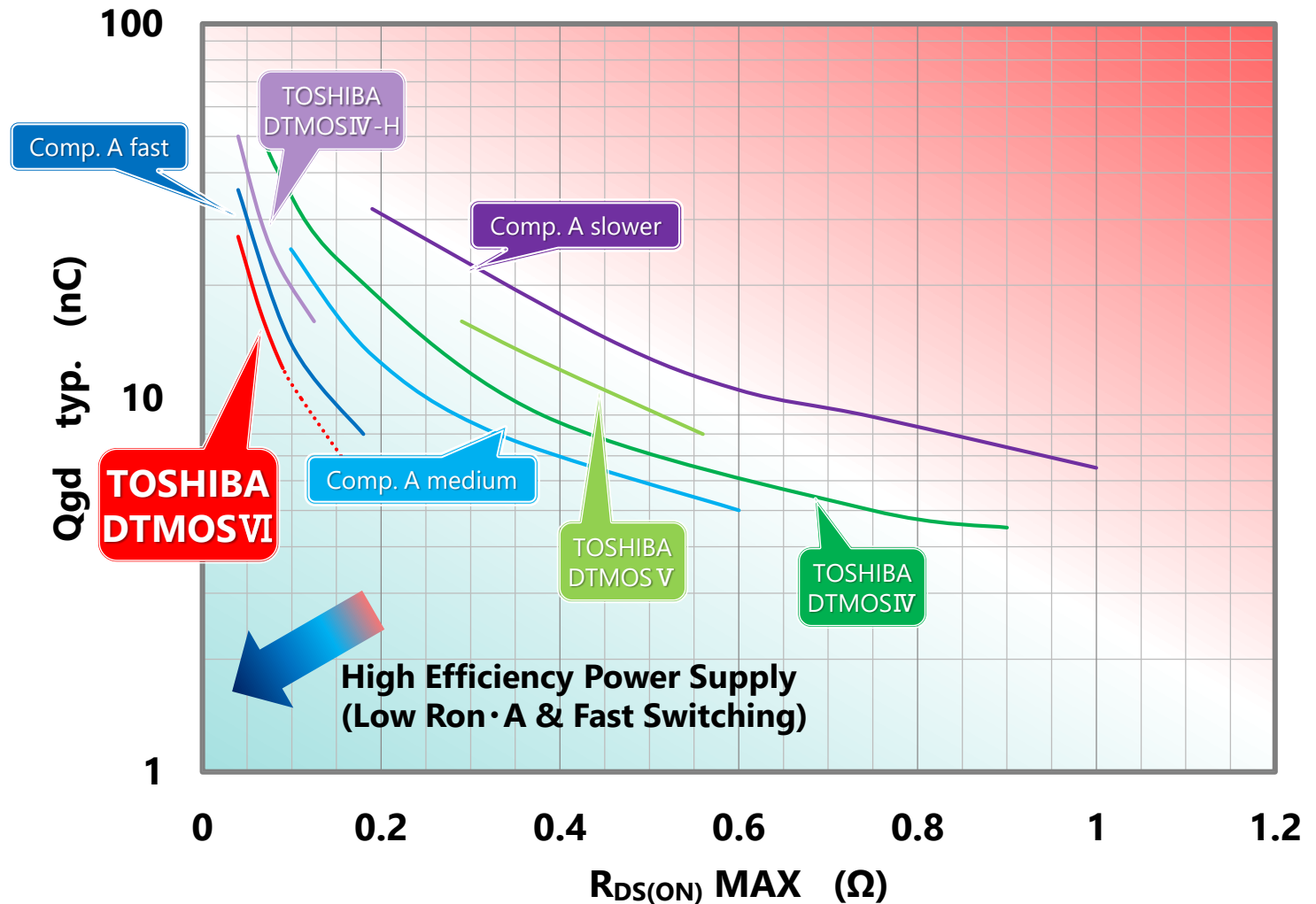
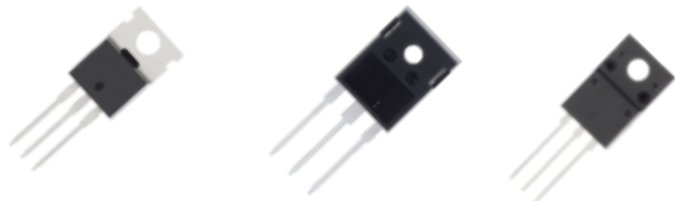
DTMOS VI Development Concept

DTMOSVI 650V is targeting strong reduction of $R_{on} \times Q_{gd}$

- For highest efficiency switching
- New SMD Package: TOLL
- 3 Packages with Kelvin source



- Standard 3Pin Packages:



DTMOS VI



DTMOSVI 650V Series Superjunction MOSFETs

Line up is expanding

New devices can significantly enhance power supply efficiency

$R_{DS(ON)}$ max (Ω)	DFN8x8	TO-220SIS	TO-247	TO-247-4L	Q_g (nC) Typ.	C_{iss} ($V_{DS}=300$ V) (pF) Typ.
0.19 / 0.21					25	1370
0.155 / 0.17					29	1635
0.11 / 0.125					40	2250
0.090 / 0.099					47	2780
0.065					62	3650
0.040					105	6250

Application

- Switching power supplies of industrial equipment, data centers and power conditioners of photovoltaic generators

Features

- Best in class FOM: $R_{(on)} \cdot Q_{gd}$ product (-40% vs previous generation DTMOS IV-H)
- Packages with Kelvin source pin : DFN8x8 and TO247-4

Advantages & Benefits

- Combination of lower conduction + switching losses
- Higher efficiency switching allows lower heat generation and smaller form factor
- Smaller form factor can, help to reduce costs

- All item at Mass Production level
- Further Package to come: TOLL with Kelvin source



03




SiC Diodes & MOSFETs

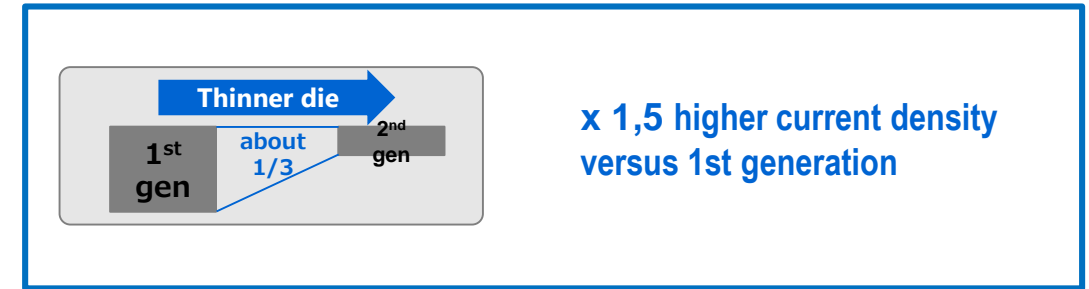
650~1200V

SiC Diodes



SiC Diodes: 2nd generation of 650V SiC SBD

V_{RRM} (V)	$I_{F(DC)}$ (A)	TO-220F-2L	TO-220-2L	TO-247 (Center tap)
				
650	2		TRS2E65F	
	3		TRS3E65F	
	4	TRS4A65F	TRS4E65F	
	6	TRS6A65F	TRS6E65F	
	8	TRS8A65F	TRS8E65F	
	10	TRS10A65F	TRS10E65F	
	12	TRS12A65F	TRS12E65F	TRS12N65FB
	16			TRS16N65FB
	20			TRS20N65FB
24			TRS24N65FB	
Production level		Mass production		



Application

- PFC at Power supply,
- PV-Inverter and UPS

Features

- Low leakage current and low V_f
- Low thermal runaway of I_r
- x1,5 higher surge current I_{fsm}
- Lower switching loss due to thinner wafer

Advantages

- Higher efficiency PFC operation
- Increased thermal margin
- High operation frequency allow small filter

Benefits

- Improved system performance & lower system costs
- Reduced form factor & cooling requirements



SiC MOSFET (1200V) 2nd generation



1200V SiC
MOSFET

TO-3PN package

V_{DSS} (V)	$R_{DS(ON)}$ (m Ω)		Part number
	(Typ.)	(Max)	
1200	70	90	TW070J120B

Application

- 400V AC input AC-DC power supplies,
- Photovoltaic (PV) inverters
- Bi-directional DC-DC converters for UPS
- Off-board charging of EV
- Inverter for battery storage system (BESS)

Features

- Low $R_{ds(on)}$:70m Ω (typ)
- High V_{th} & wide V_{GSS}
- Low Q_g 67nC (typ), Low C_{iss} : 1680pF (typ)
- Built in Schottky Diode

Advantages

- High efficiency switching
- High operation frequency allows smaller filter
- Simplified handling
- High V_{th} helping to prevent malfunction
- High robustness

Benefits

- Improved system performance
- Reduced form factor
- Reduced cooling requirements

SiC MOSFET: TW070J120B - enabling simplified application design

Wide V_{GSS} rating

- The wider V_{GSS} ratings compared with the others' SiC MOSFET.
- SiC MOSFET's V_{GSS} : -10V ~ 25V

High V_{th}

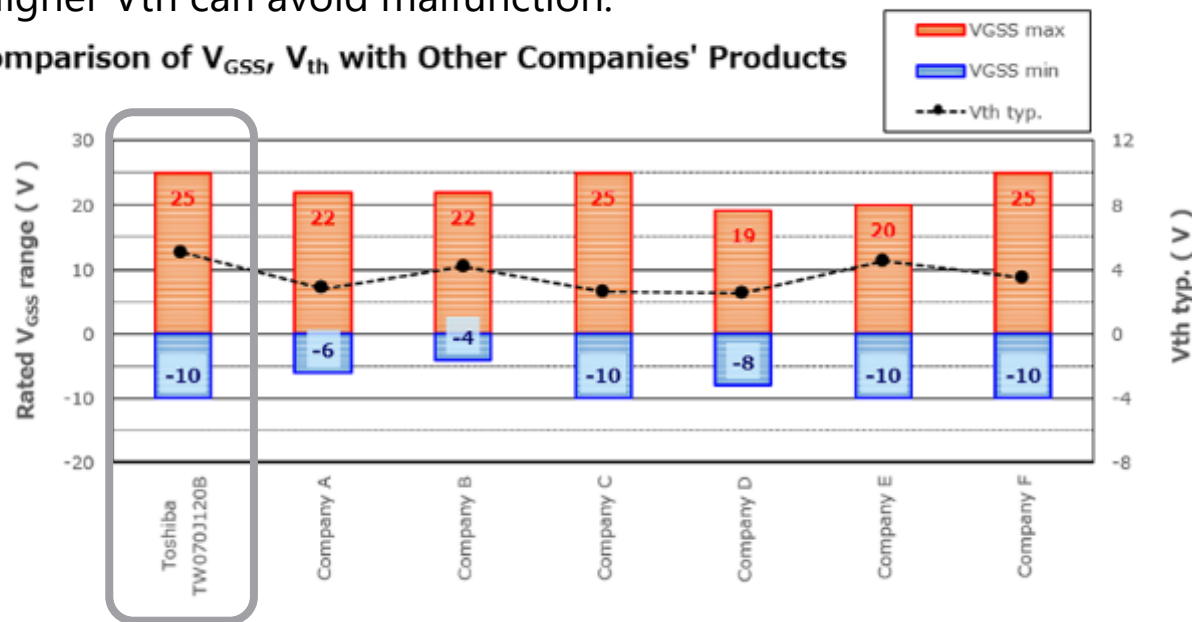
- The higher V_{th} compared with the others' SiC MOSFET.
- SiC MOSFET's V_{th} : 5.0V (typ.)
- spec: 4.2V ~ 5.8V

Built-in Schottky diode

- Lower Diode forward voltage (Absolute value)
- SiC MOSFET's V_F : -1.35V typ.

Wider V_{GSS} rating can make application design easy.
Higher V_{th} can avoid malfunction.

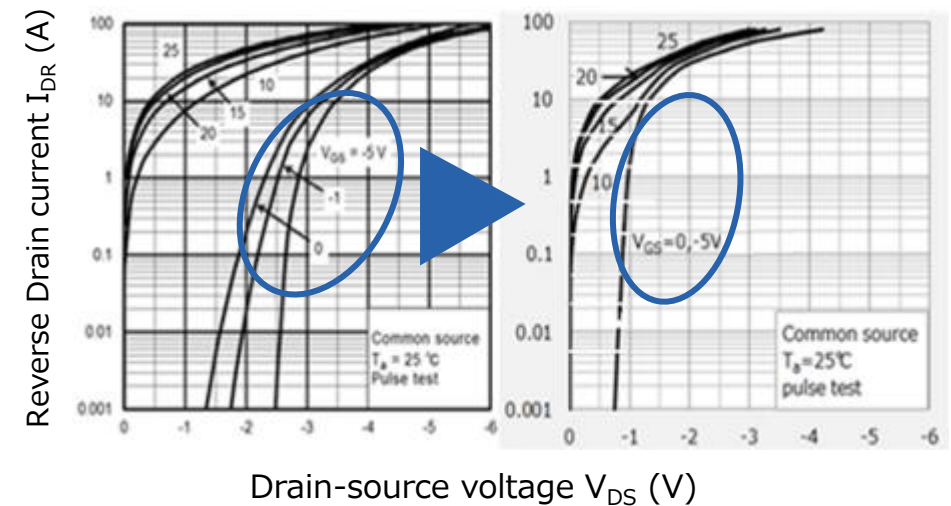
Comparison of V_{GSS} , V_{th} with Other Companies' Products



Lower V_{DSF} Absolute value due to built-in SBD

1st Gen.

2nd Gen. Built-in SBD

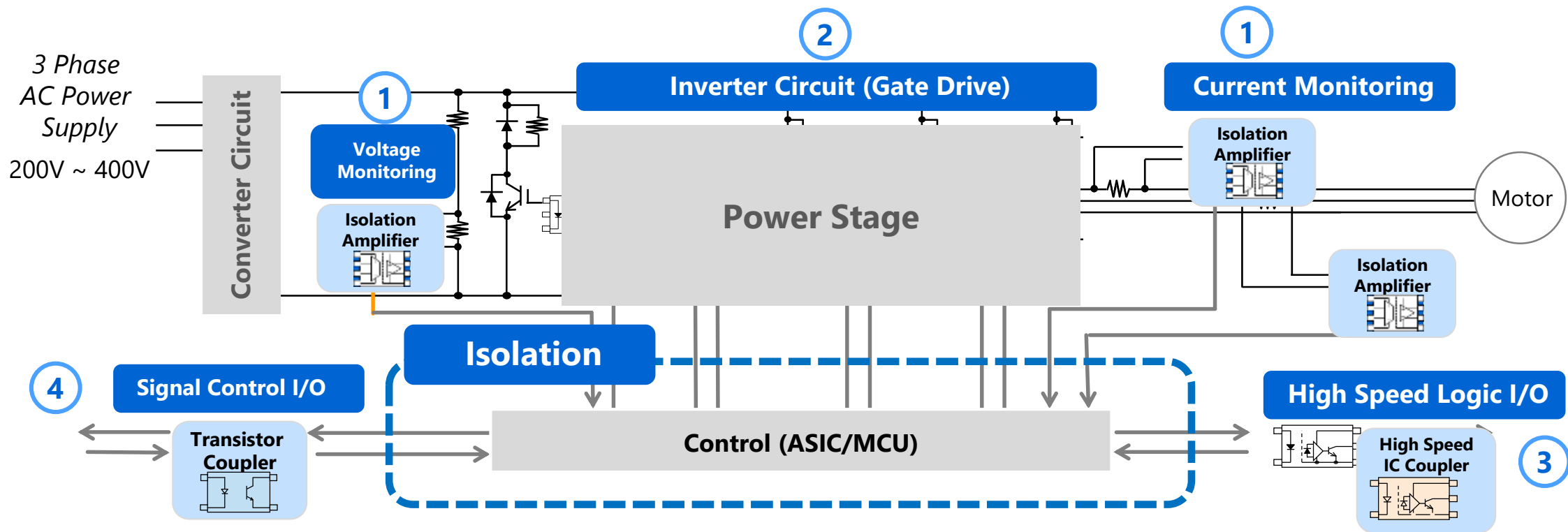


04

Photocouplers



OPTICAL ISOLATION IN INVERTER SYSTEMS



1	Voltage/Current Monitoring	<ul style="list-style-type: none"> • Isolation Amplifier • Analogue Output Type TLP7820 • Digital Output Type TLP7830
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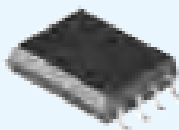

2	Gate Driver	<ul style="list-style-type: none"> • Smart Gate Driver: TLP5231 • Rail to Rail Gate Driver: TLP5754 • Peak Output Current: 4A
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3	High Speed I/O	<ul style="list-style-type: none"> • 50 Mbps to 20 kbps data rates • Ultra Low Power Consumption • Extended Top Range + 125°C
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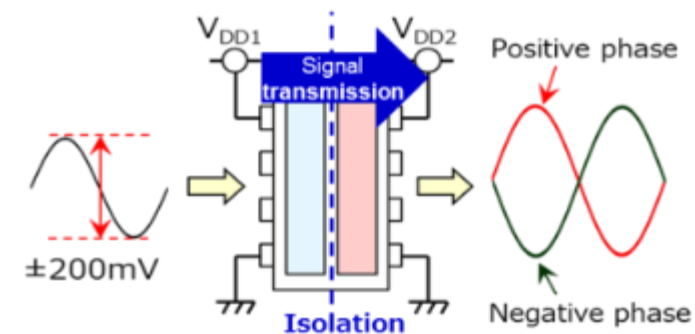
4	Signal Control I/O	<ul style="list-style-type: none"> • P/Ns: TLP383 / TLP293 • Low If Transistor Couplers • Extended Top Range + 125 °C
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1 - Isolation Amplifier

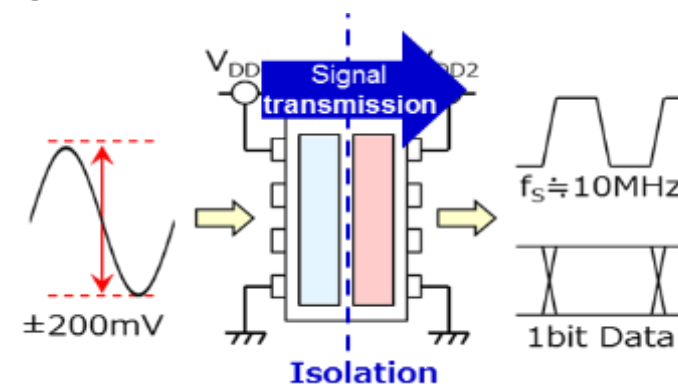
Line-up

Creepage / Clearance (mm)	8.0	7.0	8.0
Isolation Voltage (V_{rms})	5000	5000	5000
Package	S08L(LF4)	DIP8	
			
Output Configuration			(Type F)
Analog Output	TLP7820	TLP7920	TLP7920F
Digital Output	TLP7830	TLP7930	TLP7930F





































Analog Output:



Digital Output:




2 - IGBT / MosFET Gate Driver Coupler Line-up

Peak Output Current	Propagation Delay Time (max.)	Supply Voltage V _{CC}	Threshold Input Current I _{FLH} (max.)	Output	Package						
					SO6	SO6L* ¹	SO6L* ¹ LF4	SO8L* ¹	SO16L* ¹	DIP8	DIP8 F type* ¹
Package											
± 6 A	500 ns	15 V ~ 30 V	5 mA							TLP358H 	TLP358HF 
± 4 A	150 ns	15 V ~ 30 V	4 mA 6 mA	Rail to Rail		TLP5754 	TLP5754(LF4)  TLP5754H(LF4) 		TLP5214A 		
		10 V ~ 30 V	2 mA	Rail to Rail		TLP5774 	TLP5774(LF4)* 				
± 2.5 A	150 ns	15 V ~ 30 V	4 mA	Rail to Rail		TLP5752 	TLP5752(LF4)  TLP5752H(LF4) 				
		10 V ~ 30 V	2 mA	Rail to Rail		TLP5772 	TLP5772(LF4)* 				
	200 ns	15 V ~ 30 V	5 mA			TLP5702 	TLP5702(LF4) 	TLP5832 		TLP352 	TLP352F 
		10 V ~ 30 V	7,5 mA		TLP152						
± 1 A	150 ns	15 V ~ 30 V	4 mA	Rail to Rail		TLP5751 	TLP5751(LF4)  TLP5751H(LF4) 		TLP5231*  dual output		
		10 V ~ 30 V	2 mA	Rail to Rail		TLP5771 	TLP5771(LF4)* 				
± 0.6 A	200 ns		7,5 mA		TLP155E						
	500 ns	10 V ~ 30 V	5 mA		TLP151A 	TLP5701 	TLP5701(LF4) 				
	700 ns		5 mA						TLP351H 	TLP351HF 	

*1 SO6L, SO8L, SO16L and F type of DIP Photocouplers have 8mm clearance / creepage distances

* new product

 Photocouplers with a maximum operating temperature of 110°C

 Photocouplers with a maximum operating temperature of 125°C

High operation temp. (+125°C) Gate Drivers in SO6L(LF4) Pkg.

Features:

- **High operation temperature: $T_a \text{ max.} = 125^\circ\text{C}$**
- Peak Output Current: 4A, 2.5A and 1A
- High Speed Switching: 150 ns (min.)
- Low Propagation Skew: 80 ns (max.)
- Low Supply Current: 3mA (max.)

Characteristics	TLP5754H	TLP5752H	TLP5751H
Peak current (max)	$\pm 4 \text{ A}$	$\pm 2.5 \text{ A}$	$\pm 1 \text{ A}$
Operation temperature range	-40 ~ 125°C		
Supply current (max)	3,0 mA		
Threshold input current (max)	4,0 mA		
tpHL / tpLH (max)	150 ns		
Tpsk (max)	80 ns		
Supply Voltage	15V to 30V		
Common Mode Transient Immunity	+/- 35kV/ μs		

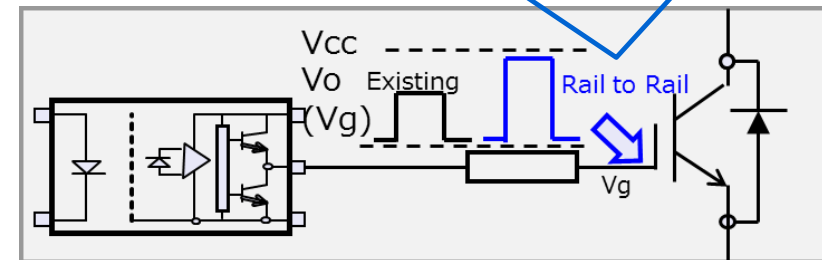
Applications:

- MosFET and IGBT Gate Drivers
- Inverters for PV and FA
- Air Conditioners
- Induction Cooktops (IH)
- Home Appliances



Rail to Rail:

- Generates full swing voltage output signal
- Contributes to low power consumption
- **Reduces conduction losses by ~10%**



2,5A Pre-Driver with dual output and integrated protection circuit

Features:

- Dual Output with integrated active timing control for driving complementary external n-/p-channel MosFET buffers
- Overcurrent detection by monitoring collector voltage
- Power Device Protection by soft turn-off function
- Fault Feedback function to controllers
- Under Voltage Lockout function applied to both positive and negative power supply of gate circuit
- Direct Replacement of ACPL-339J

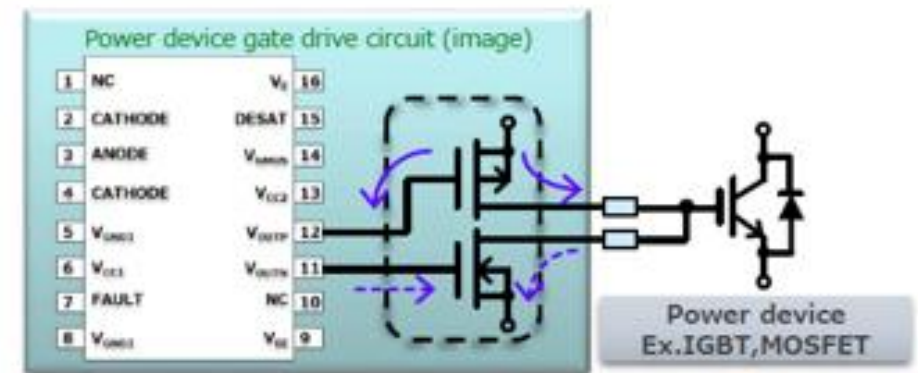
Characteristics	TLP5231
Package height (max.)	2.3 mm
Peak output current	±2.5 A (max)
Operating temp. range	-40 to 110°C
Threshold Input Current	3.5 mA (max)
Propagation Delay time t_{pHL} / t_{pLH}	300 ns (Max)
Common mode transient immunity	±25 kV/μs (min.)

Applications:

- AC Servo / Robots / Power Conditioners
- Industrial Inverters and Uninterruptible Power Supply (UPS)



Flexible Design:



**Smart Gate Driver
TLP5231**

No need to change

+



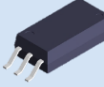
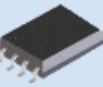




























































**p-ch / n-ch
MosFET
buffer**

Changeable according to required gate current


**Changeable
according to
required power
ratings**


3 - High-Speed IC Coupler Line-up


Recommended
for new designs!

Data Rate (typ.)	Output Form		Supply Voltage Vcc	Package			
				SO6	SO6L*1	SO6L*1 LF4	SO8L*1 2-ch
Package							
~ 50 Mbps	Totem Pole	Inverter Logic	2.7 V - 5.5 V	TLP2367 	TLP2767 		
~ 20 Mbps	Open Collector	Inverter Logic	2.7 V - 5.5 V	TLP2368 	TLP2768A 	TLP2768A(LF4) 	
	Totem Pole	Inverter Logic	2.7 V - 5.5 V	TLP2366 	TLP2766A* 	TLP2766A(LF4)* 	
		Buffer Logic	2.7 V - 5.5 V	TLP2370  	TLP2770  	□	TLP2270  
~ 15 Mbps	Totem Pole	Buffer Logic	2.2 V - 5.5 V	TLP2372*  			
		Inverter Logic	2.7 V - 5.5 V	TLP2361  	TLP2761  	TLP2761(LF4)  	TLP2261  
~ 10 Mbps	Open Collector	Inverter Logic	2.7 V - 5.5 V	TLP2362 			
		Inverter Logic	2.7 V - 5.5 V	TLP2363* (for PLC)			
	Totem Pole	Inverter Logic	2.7 V - 5.5 V AC input	TLP2391 			
		Buffer Logic	9V - 15 V		TLP2735 		
		Buffer Logic	4.5 V - 30 V	TLP2345  	TLP2745  	TLP2745(LF4)  	
~ 5 Mbps	Totem Pole	Inverter Logic	IPM Drive	TLP2348  	TLP2748  	TLP2748(LF4)  	
		Buffer Logic	2.2 V - 5.5 V	TLP2312*  			
		Buffer Logic	2.7 V - 5.5 V	TLP2310  	TLP2710  	TLP2710(LF4)  	TLP2210  
		Buffer Logic	3.0 V - 20 V	TLP2395 			
		Inverter Logic	AC input	TLP2398 			
~ 1-2 Mbps	Open Collector	Buffer Logic	3.0 V - 20 V	TLP2355  			
		Inverter Logic	IPM Drive	TLP2358  			
~ 100 Kbps	Open Collector	Inverter Logic	4.5 V - 30 V IPM Drive	TLP2304 	TLP2704 	TLP2704(LF4) 	
		Inverter Logic	~4.0 V - 30 V	TLP109  TLP2309 	TLP2719*	TLP2719(LF4)*	

*1 SO6L, SO8L have 8mm clearance / creepage distances

 Photocouplers with a maximum operating temperature of 110°C

 Photocouplers with a maximum operating temperature of 125°C

 Low power - maximum input threshold current (IFLH/IFHL) of 1,6mA or less

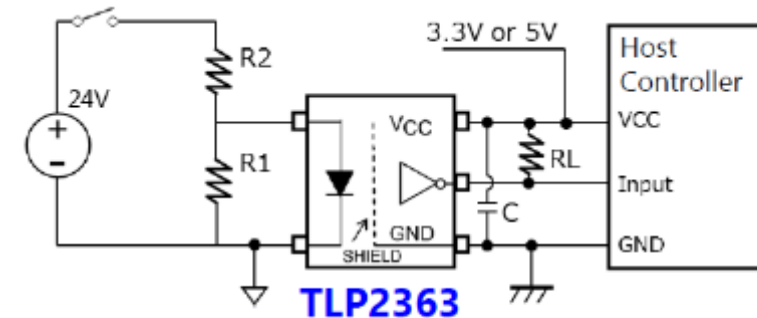
* new product

10 Mbps Photo-IC for PLCs (IEC61131-2)

Features:

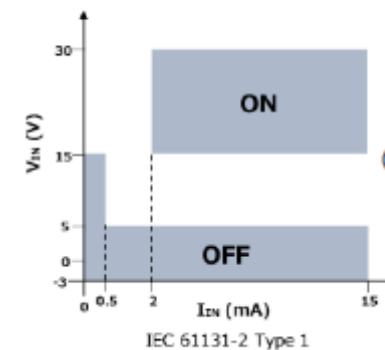
- Compliance with IEC61131-2 standard for PLC digital input modules (type 1) by combination with 2 resistors
- Guaranteed minimum and maximum threshold input current at whole range of operating temperature
- High immunity to slow input for both LED side and detector side to contribute to the gradual shut-down/start up test for PLC

Characteristics comparison	TLP2362*	TLP2363
Package	SO6 5pin	SO6 5pin
Supply Voltage VCC	15V to 30V	15V to 30V
Supply Current ICCH / ICCL (max.)	4.0 mA	4.0 mA
Threshold input current IFHL min.	-	0.3 mA
Threshold input current IFHL max.	5.0 mA	2.4 mA
Propagation Delay time t_{pHL} / t_{pLH} (max.)	100 ns	80 ns
Operating temp. range	-40 to 125°C	-40 to 110°C
Isolation Voltage BVs (min.)	3750 Vrms	3750 Vrms



A system can follow IEC 61131-2 type 1 when TLP2363 is used under below conditions. (Note)

R1	R2	RL	VCC
1.1 kΩ	2.7 kΩ	1 kΩ	3.3 V



(Note) It is not guarantee of compliance with the standard.

Please utilize this material as a reference only.

*PLC : Programmable Logic Controller

3 - New: TLP2312 / TLP2372

Recommended
for new designs!

2,2V operation 5Mbps and 20Mbps Photo-ICs in 5pin SO6 package

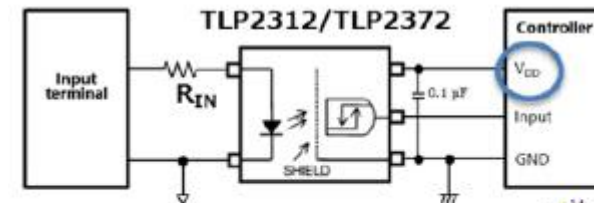
Features:

- Can be operated by low supply voltage of 2.2V
- Operable for 2.5V / 3.3V / 5V supply voltage (VDD) systems
- Totem Pole Output with buffer logic
- High immunity to slow input (60s) for LED and Photodetector sides

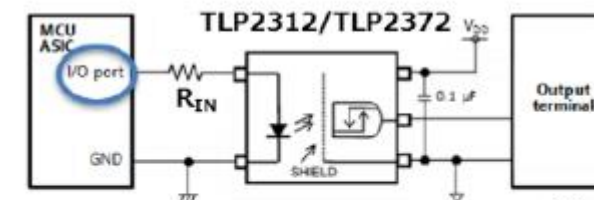
Characteristics	TLP2312	TLP2372
Package	SO6 5pin	SO6 5pin
Datarate	5 Mbps	20 Mbps
Supply Voltage VDD	2.2V to 5.5V	2.2V to 5.5V
Supply Current IDD (max.)	0.5 mA	0.5 mA
Threshold input current IFHL max.	1.6 mA	1.6 mA
Propagation Delay time t_{pHL} / t_{pLH} (max.)	250 ns	60 ns
Pulse width distortion $ t_{pHL}-t_{pLH} $	20 ns	20 ns
Operating temp. range	-40 to 125°C	-40 to 110°C
Isolation Voltage BVs (min.)	3750 Vrms	3750 Vrms

Applications:

- Programmable Logic Controllers (PLCs)
- High-Speed Digital Interfacing
- Industrial Inverters



Unnecessary to build another power supply circuit to operate these photocouplers due to the low operatable supply voltage.


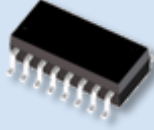



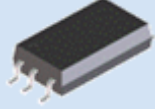












These photocouplers can be driven from a microcontroller or ASIC directly due to the low threshold input current characteristic.



4 - Transistor Coupler Line-up

Recommended
for new designs!

		Package					
		SO4 1-channel	SO16 4-channel	SO16 4-channel	4pin SO6 1-channel	DIP4 1-channel	SO6L 1-channel
							
Isolation Voltage		3750 Vrms	2500 Vrms	3750 Vrms	3750 Vrms	5000 Vrms	5000 Vrms
DC Input	Standard	TLP291(SE	TLP291-4		TLP185(SE	TLP785	TLP385
DC Input	Low If	TLP293 		TLP293-4 	TLP183 		TLP383 
DC Input	High V _{CEO}				TLP188		TLP388 
AC Input	Standard	TLP290(SE	TLP290-4		TLP184(SE		
AC Input	Low If	TLP292 		TLP292-4 	TLP182 		
Darlington	High V _{CEO}				TLP187		TLP387
On-Chip RBE	Low If / High Speed				TLP2301 		TLP2701 

 Photocouplers with a maximum operating temperature of 125°C

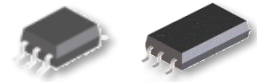
Low input current Transistor Couplers with linear CTR

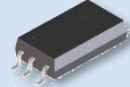



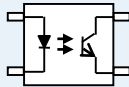
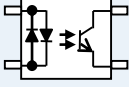
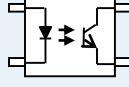
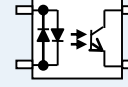
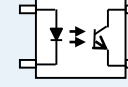
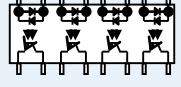
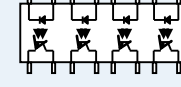
Features:

- Stable and linear CTR over wide I_f range
- Stable and linear CTR over wide T_a range
- CTR specified at I_f of 0.5mA
- Wide temp. Range to +125 ° C
- Low profile packages SO6L, SO6, SO4 and SO16

Applications:

- Lighting / DALI
- Switching Power Supplies
- PLC
- I/O Interface Boards
- FA (Inverter, AC Servo)



Specification	TLP383 (DC input)	TLP182 (AC input)	TLP183 (DC input)	TLP292 (AC input)	TLP293 (DC input)	TLP292-4 (AC input)	TLP293-4 (DC input)
Package	SO6L 4pin 	SO6 4pin 		SO4 		SO16 	
Schematic							
CTR [IC/IF]	50 to 600% @ $I_f = 0.5 \text{ mA}$ and 5 mA					50 to 600% @ $I_f = 16 \text{ mA}$ LA & LGB Ranks @ $I_f = 0,5\text{mA}$	
Delay time [tOFF]	35 μ s (typ) @ $I_f = 1.6\text{mA}$	35 μ s (typ.) @ $I_f = 1.6 \text{ mA}$				35 μ s (typ.) @ $I_f = 16 \text{ mA}$	
Topr	-55 to 125 °C						
BVs	5000 Vrms	3750 Vrms					

05

Photorelays

Photorelays for Industrial Control Equipment

UL 508 certified Photorelays - Definition

- UL 508 is a safety standard for industrial control equipment such as programmable logic controllers (PLC), power units and uninterruptable power supplies (UPS).
- Devices used in such equipment are also defined by UL 508. Specifically, switching devices including Mechanical relays and Solid State Relays are requested to comply with the UL 508 standard. Photorelays belong to the “solid state relay” product group and are within the scope of UL 508.
- Other, general purpose Photocouplers such as transistor couplers or logic output IC Couplers are not in this scope.
- Criteria to meet UL 508 certification is to guarantee a case temperature T_c of 105°C.
- Customers can “easily” replace mechanical relays by Toshiba Photorelays in these applications!

Photorelays for Industrial Control Equipment

UL 508 certified Photorelays – Line-up

(@Ta=25°C)

Part number	Absolute Maximum Rating					I _{FT} max (mA)	R _{ON} typ. (Ω)	R _{ON} max (Ω)	C _{OFF} typ. (pF)	I _{OFF} max		t _{ON} max (ms)	t _{OFF} max (ms)
	V _{OFF} (V)	I _{ON} (A)	I _{ONP} (A)	T _c (°C)	T _{opr} (°C)					(μA)	@V _{OFF} (V)		
TLP172GM	350	0.11	0.33	105	-40~85	3.0	22	35	30	1	350	1	0.5
TLP176AM	60	0.7	2.1	105	-40~85	3.0	0.15	2	100	1	60	3	0.5
TLP3122A	60	1.4	4.2	105	-40~85	3.0	0.13	0.25	100	1	60	3	1
TLP240A	60	0.5	1.5	105	-40~85	3.0	0.6	2	130	1	60	3	1
TLP240D	200	0.25	0.75	105	-40~85	3.0	5	8	80	1	200	3	1
TLP240G	350	0.1	0.3	105	-40~85	3.0	25	35	30	1	350	2	1
TLP240GA	400	0.12	0.36	105	-40~85	3.0	17	28	80	1	400	2	1
TLP240J	600	0.09	0.27	105	-40~85	3.0	30	40	75	1	600	2	1
TLP241A	40	2.0	6.0	105	-40~85	3.0	0.06	0.1	300	1	40	5	1
TLP3556A	100	2.0	6.0	105	-40~85	3.0	0.11	0.2	110	1	100	2	0.5
TLP3558A	200	0.7	2.1	105	-40~85	3.0	0.9	2	110	1	200	1	0.5
TLP3543A	30	5.0	15.0	105	-40~85	3	0.02	0.04	1100	1	30	5	0.5
TLP3545A	60	4.0	12.0	105	-40~85	3	0.035	0.06	640	1	60	5	0.5
TLP3546A	100	3.5	10.5	105	-40~85	3	0.05	0.08	450	1	100	5	0.5
TLP3547	60	5.0	15.0	105	-40~85	5	0.022	0.05	850	1	60	5	1
TLP3548	400	0.4	1.2	105	-40~85	1	3.0	5.0	410	1	400	1	1
TLP3549	600	0.6	1.8	105	-40~85	5	1.35	2.0	4300	10	600	3	1



Features:

- UL 508 certified
- UL Product Category NRNT – industrial control switch and solid state control device for non-motor rated loads
 - Operation Temperature Range Top: -40 to +85°C
 - Case Temperature T_c (max.): +105°C

Applications:

- Industrial Control Equipment
- Programmable logic controller (PLC)
- I / O interface
- Building Automation Systems (HVAC, Thermostat)
- Replacement of various mechanical relays in AC Systems (24V to 400V) or DC Systems (24V to 125 V)

High Current Photorelays with Top = -40 to + 110 °C

Features:

- High Current Relays in DIP6, DIP4, 2.54SOP4 and 2.54SOP6 packages
- Extended Operating Temperature Range: **-40 to +110°C**

Applications:

- Thermostat / HVAC
- Factory Automation
- PLC - Programmable Logic Controller

Partnumber	Package	V _{OFF} (min.)	I _{ON} (max.)	I _{ONP} (max.)	I _{FT} (max.)	R _{ON} (typ.)	R _{ON} (max.)	C _{OFF} (typ.)	I _{OFF} (max.)	t _{ON} (max.)	t _{OFF} (max.)	BVs (min.)
TLP3543A	DIP6	30 V	5 A	15 A	3 mA	20 mΩ	40 mΩ	1100 pF	1 μA	5 ms	0,5 ms	2500 V
TLP3545A	DIP6	60 V	4 A	12 A	3 mA	35 mΩ	60 mΩ	640 pF	1 μA	5 ms	1 ms	2500 V
TLP3546A	DIP6	100 V	3,5 A	10,5 A	3 mA	50 mΩ	80 mΩ	450 pF	1 μA	5 ms	0,5 ms	2500 V
TLP3553A	DIP4	30 V	4 A	9 A	3 mA	25 mΩ	50 mΩ	450 pF	1 μA	3 ms	1 ms	2500 V
TLP3555A	DIP4	60 V	3 A	9 A	3 mA	45 mΩ	100 mΩ	250 pF	1 μA	2 ms	1 ms	2500 V
TLP3556A	DIP4	100 V	2 A	6 A	3 mA	110 mΩ	200 mΩ	110 pF	1 μA	2 ms	0,5 ms	2500 V
TLP3558A	DIP4	200 V	0,7 A	2,1 A	3 mA	900 mΩ	2000 mΩ	110 pF	1 μA	1 ms	0,5 ms	2500 V
TLP3106A	2.54SOP6	30 V	4,5 A	13,5 A	3 mA	22 mΩ	30 mΩ	1200 pF	1 μA	2 ms	0,5 ms	1500 V
TLP3107A	2.54SOP6	60 V	4 A	12 A	3 mA	28 mΩ	40 mΩ	750 pF	1 μA	2 ms	0,5 ms	1500 V
TLP3109A	2.54SOP6	100 V	3 A	9 A	3 mA	50 mΩ	65 mΩ	460 pF	1 μA	2 ms	0,5 ms	1500 V
TLP3146	2.54SOP4	30 V	3,3 A	9 A	3 mA	30 mΩ	50 mΩ	450 pF	1 μA	2 ms	1 ms	1500 V
TLP3147	2.54SOP4	60 V	2,5 A	7,5 A	3 mA	50 mΩ	100 mΩ	240 pF	1 μA	2 ms	0,5 ms	1500 V
TLP3149	2.54SOP4	100 V	1,5 A	4,5 A	3 mA	120 mΩ	200 mΩ	160 pF	1 μA	2 ms	0,5 ms	1500 V
TLP3145	2.54SOP4	200 V	0,4 A	1,2 A	3 mA	1000 mΩ	2000 mΩ	160 pF	1 μA	0,5 ms	0,5 ms	1500 V

VSON4 package is one of smallest packages for Photorelays

Features:

- Ultra Small Package Dimension: 2.54 (W) x 1.54 (L) x 1.3 mm (H)
- Industrial Operating Temperature Range: -40 to +110°C

Applications:

- Semiconductor Test Equipment
- FA
- PLC







Partnumber	V _{OFF} (min.)	I _{ON} (max.)	R _{ON} (typ.)	R _{ON} (max.)	C _{OFF} (typ.)	C(pF) x R (Ω) (typ.)	I _{OFF} (max.)	t _{ON} (max.)	t _{OFF} (max.)	BVs (min.)
TLP3403	20 V	1000 mA	0.18 Ω	0.22 Ω	40 pF	7.2	1 nA	2 ms	1 ms	500 V
TLP3431	20 V	450 mA	0.8 Ω	1.20 Ω	5 pF	4	1 nA	0.5 ms	0.5 ms	500 V
TLP3450	20 V	200 mA	3 Ω	5 Ω	0.8 pF	2.4	1 nA	0.2 ms	0.2 ms	500 V
TLP3440	40 V	120 mA	12 Ω	14 Ω	0.45 pF	5.4	1 nA	0.2 ms	0.3 ms	500 V
TLP3441	40 V	140 mA	5 Ω	10 Ω	0.7 pF	3.5	1 nA	0.2 ms	0.2 ms	500 V
TLP3442	40 V	100 mA	15 Ω	20 Ω	0.3 pF	4.5	1 nA	0.2 ms	0.2 ms	500 V
TLP3475	50 V	300 mA	1 Ω	1.5 Ω	12 pF	12	1 nA	0.5 ms	0.4 ms	500 V
TLP3412	60 V	400 mA	1 Ω	1.5 Ω	20 pF	20	1 nA	0.5 ms	0.5 ms	500 V
TLP3451	60 V	120 mA	10 Ω	15 Ω	0.7 pF	7	1 nA	0.2 ms	0.2 ms	500 V
TLP3417	80 V	120 mA	7 Ω	12 Ω	5 pF	35	1 nA	0.5 ms	0.2 ms	500 V
TLP3419	80 V	200 mA	6 Ω	8 Ω	6.5 pF	39	1 nA	0.4 ms	0.4 ms	500 V
TLP3420	100 V	100 mA	8 Ω	14 Ω	6 pF	48	1 nA	0.3 ms	0.3 ms	500 V

06

eFuse IC

What is eFuse?

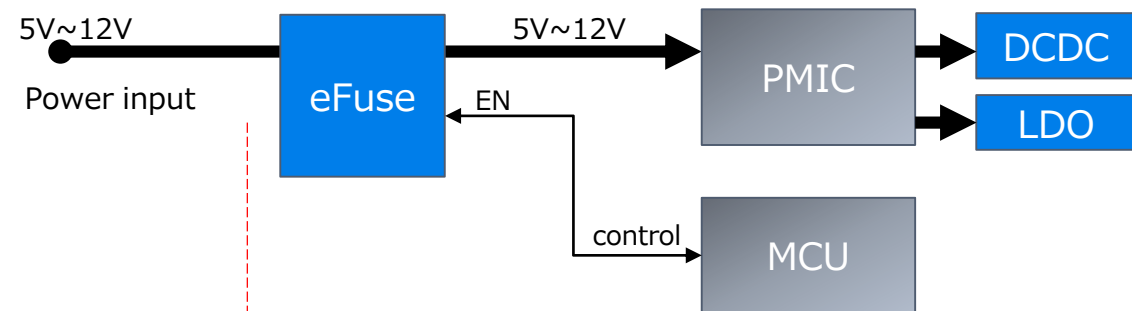
■ Different from eFuse IC and conventional Fuse

	Toshiba eFuse IC	Conventional Fuse	Chip Fuse	Poly Fuse
Package size	~ 3x3mm 	3x10mm~ 	1mmx0.5mm~ 	1mmx0.5mm~ 
Repeatability	OK	One time	One time	OK
Clamp current/accuracy	11%	None	None	None
Clamp voltage accuracy	7%	None	None	None
Short circuit response	150ns	1s ~	5s ~	0.1s ~
Thermal shut down	160°C	None	None	None

■ Application Example

Suitable for Hot Swapping application

- USB connector for NBPC, Tablet
- SSD/HDD for Datacenter
- etc.



If eFuse IC got certification of IEC62368, no need to evaluate after circuit by customer.

■ Benefit to use Toshiba eFuse IC

- ✓ It can protect internal IC from unexpected overcurrent and overvoltage.
- ✓ Because eFuse itself has IEC62368 Certification, it can reduce the evaluation of final set to certify IEC62368.

eFuse IC Road Map

~2018

2019

2020

2021

2022

40V FET driver IC

TCK40xG Common source Small Nch FET Driver IC

2.3 to 28V (40V abs max)
Auto Discharge
Over voltage protection



MP: OK

TCK42xG Common drain Small Nch FET Driver IC

2.7 to 28V (40V abs max)
Over voltage protection
Stable VGS control



MP: Mar. '21

18V~36V Load SW-IC

TCK32xG Dual OVP IC

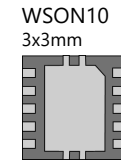
2.9 ~ 36V, 2A
Dual Input
Uni-Direction
Auto selection



MP: OK

eFuse IC 15V, 2A 3x3mm TCKE7xxNL FLAG output

Over voltage clamping : Adjustable
Slew rate : Adjustable
Current limit : 0.5A~2A
Reverse current block Latch (NL)



MP: Nov. '20

eFuse IC 30V, 4A 2x2mm TCKE9xxNx FLAG output

Over voltage clamping : 3V/ 5V/ 12V/None
Slew rate: Adjustable
Current limit : 0.5A~4A
Auto retry(NA)/Latch(NL)



Under Development

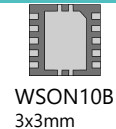
~6V Load SW-IC

TCK2292xG/2297xG 2A, SRC

1.1 ~ 5.5V, 2A
Low RON 25mΩ
Low IQ 0.1μA~
Selectable SRC



Low Ron: 28mΩ
Over voltage clamping
Over current clamping : 0.5A~5A, Adjustable
Slew rate control : Adjustable
Reverse current protection (Option)
Auto retry(NA)/Latch type (NL)



MP: OK

TCK2291xG 2A, RCB, TSD

1.1 ~ 5.5V, 2A
Low RON 31mΩ
Low IQ 11μA
True RCB, TSD



TCK207AN 2A Low Vin

0.75 ~ 3.6V, 2A
Low RON 20mΩ
RCB
Mold package



MP: Mar.'21

TCK22xxx/1024G 2A OCP

1.1 ~ 5.5V,
Low RON 31mΩ
Low IQ 25μA~
Selectable OCP



TCK12xBG 1A Ultra-low Iq

1.0 ~ 5.5V, 1A
Ultra-low Iq(ON) 0.22nA
Small package WCSP4F



eFuse IC 5V/12V 3x2mm TCKE10512xx Dual type

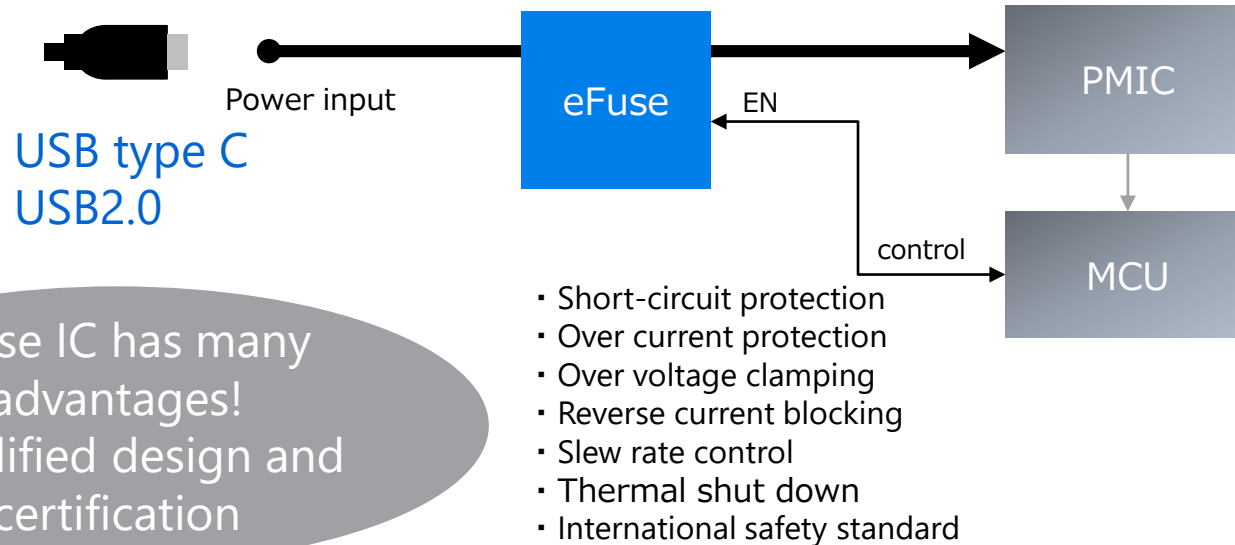
5V/12V Dual eFuse IC
Over voltage clamping: Adjustable
Slew rate : Adjustable
Current limit : 0.5A~4.5A
Latch(NL)



Under Development

Advantages of Toshiba eFuse IC (Electronic fuse)

Toshiba eFuse IC incorporates various high-performance and high-precision protection functions that cannot be realized with conventional fuses in one package. Compared to the realization of functions by combining discrete passive components and multiple ICs, it contributes to higher safety, lower cost by reducing the number of components, and size reduction by reducing the mounting area. In addition, since it can be used repeatedly, it is an effective product for reducing maintenance costs for repairs and recovery time.



eFuse IC has many advantages!
Simplified design and certification



IEC62368-1 certification (TUV)



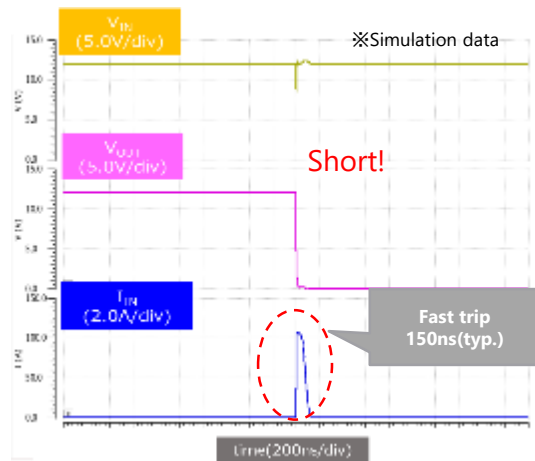
IEC62368-1 CB certification

Toshiba efuse IC TCKE8 series also has high-speed short-circuit protection function, high-precision overcurrent protection function, high-precision overvoltage clamp function, backflow prevention function, slew rate adjustment function, overheat protection function, etc. that could not be realized with conventional fuses. Furthermore, it has acquired the certification of international safety standard (IEC62368-1) and contributes to robust protection, safety and simplification of design, and cost reduction including repair and maintenance

Toshiba eFuse IC Technology

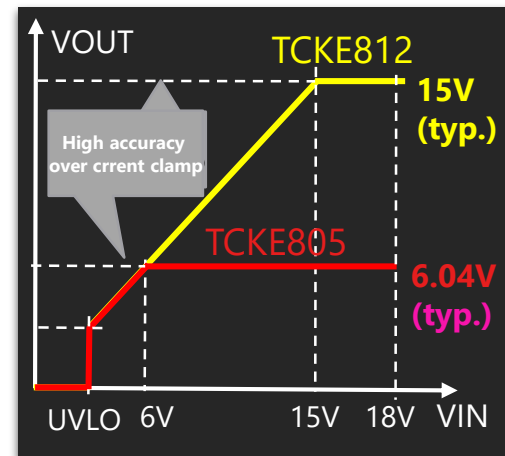
Toshiba eFuse IC built-in various protection functions.
High protection performance can be achieved
by replacing conventional fuses and protection circuits.

Ultra Fast 150ns (typ.) Short circuit Protection



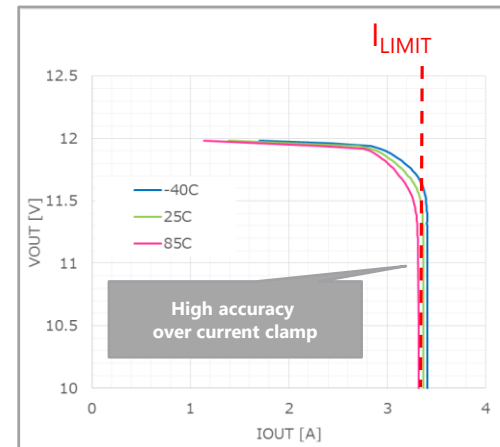
Instantly shut off IOUT
by Fast Trip function

High Accuracy Over Voltage Protection



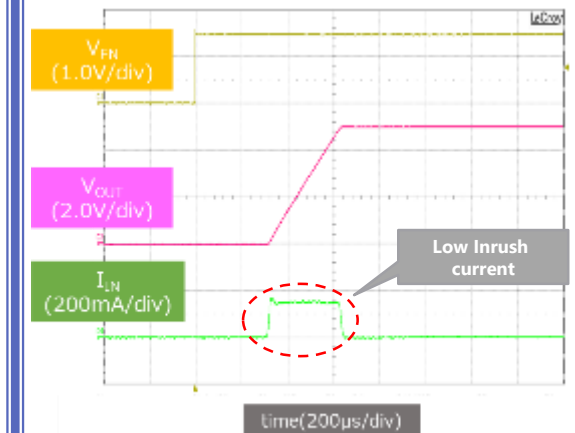
Keeping Vout Stable when Over
voltage input happen.

High Accuracy Over Current Protection



Keeping Iout under Limit current

Very low & Adjustable Inrush current



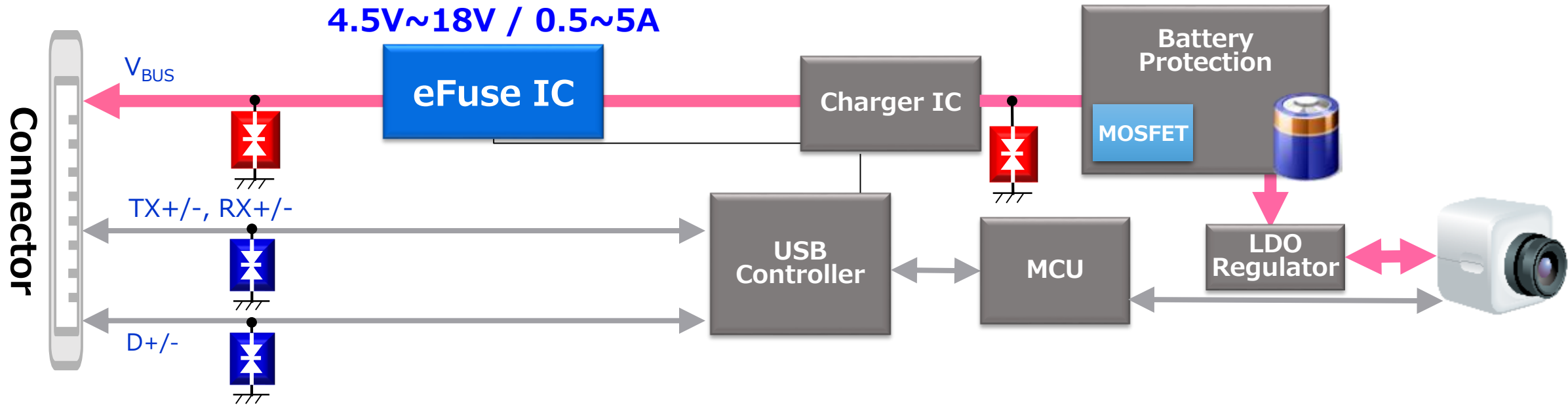
The slew rate variable function
keeps the inrush current low

IEC62368-1 Qualified

Toshiba eFuse IC for short-circuit protection of USB VBUS and IEC62368 certification

Toshiba eFuse IC has obtained IEC62368-1 certification. This product is suitable for short-circuit protection of USB terminal Vbus and power supply terminal

Toshiba eFuse IC is IEC62368-1 certified



Regarding the short-circuit protection function, it detects the short-circuit condition at high speed and controls the internal MOSFET to quickly limit the output. It is suitable for short-circuit protection of VBUS terminal. Toshiba eFuse IC also has overvoltage protection and slew rate adjustment functions. Since it is built-in, it is possible to integrate the functions of other power supply ICs into the Toshiba eFuse IC. The specific usage is as follows. In the TCKE8 series, the operating voltage can be set from 4.5V to 18V, and the overcurrent limit can be set from 0.5A to 5A with an external resistor. For details, please refer to our application note and data sheet.

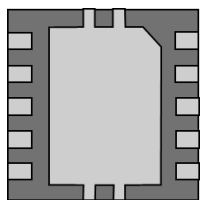
18V, 5A eFuse IC with Adjustable OCP

TCKE800/805/812 series 18V, 5A eFuse IC with Small package

Main features

- Input Voltage : 4.4V ~ 18V
- Low RON : WSON10B 28mΩ (typ) @Io=5A
- Adjustable Over current Protection by External Resistance : 0.5A to 5.0A
- High Accuracy Over current Protection: ±11%
- High Accuracy Over voltage Clamp: ±7%
 - TCKE805 : 6.04V (typ)
 - TCKE812 : 15.1V (typ)
 - TCKE800 : No OVC
- Adjustable Slew rate control by External Capacitance
- Thermal shutdown : 160°C (typ.)
- Auto-retry /Latched type

IEC62368-1 certified



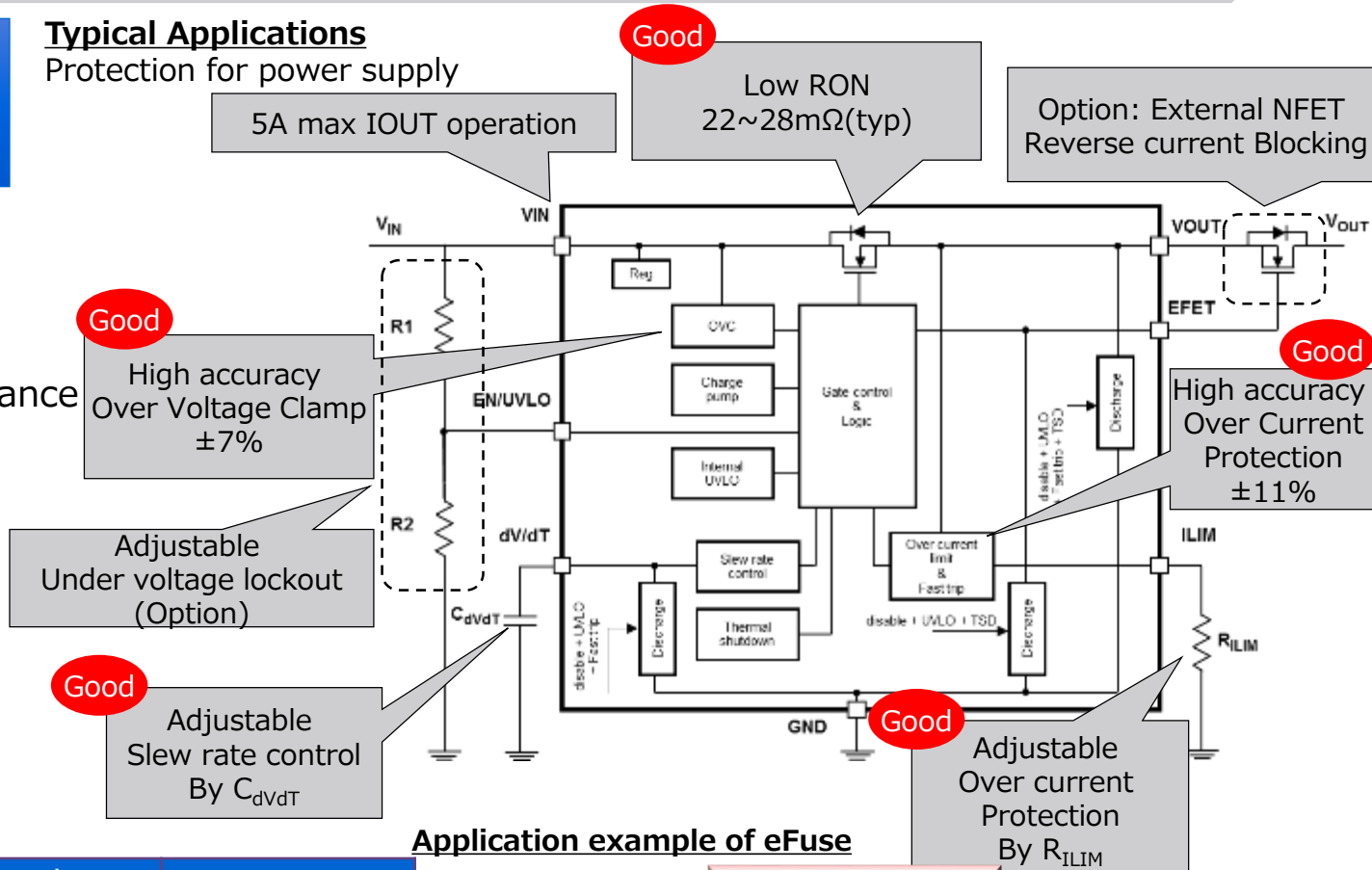
WSON10B
3.0x3.0mm

TOSHIBA

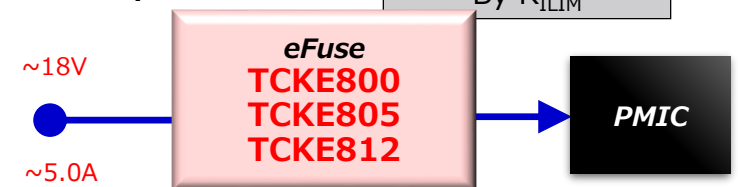
Product	Over voltage clamp	Recovery
TCKE805NA	6.04V	Auto-retry
TCKE805NL	6.04V	Latched
TCKE812NA	15.1V	Auto-retry
TCKE812NL	15.1V	Latched
TCKE800NA	なし	Auto-retry
TCKE800NL	なし	Latched

Typical Applications

Protection for power supply



Application example of eFuse



5V power rail : TCKE805 OVC = 6 V (typ.)
12V power rail : TCKE812 OVC = 15 V (typ.)

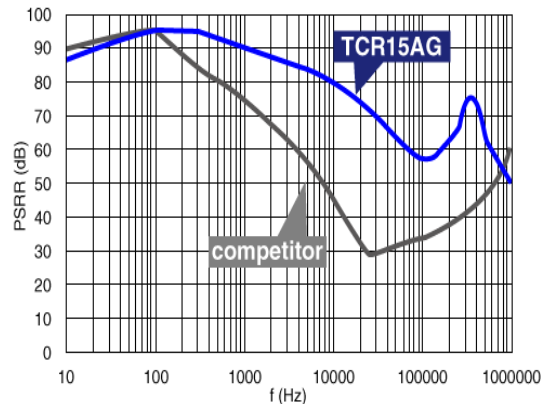
07

LDO

Features of LDO from Toshiba

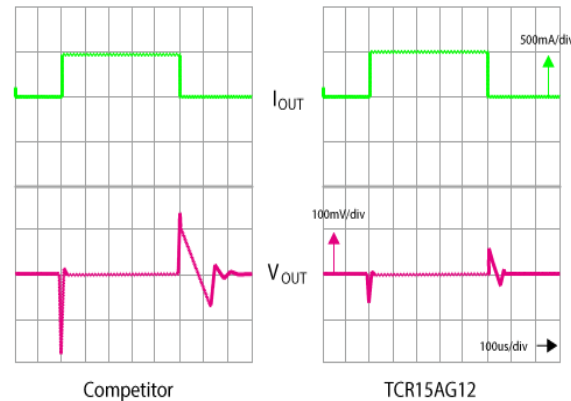
LDOs offer stable and long operation

Remove Noise from Power line



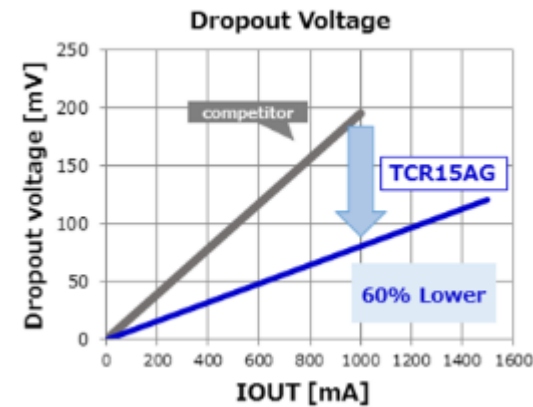
Remove Input noise by High PSRR advanced technology.

Keep Stable Output When Load changes



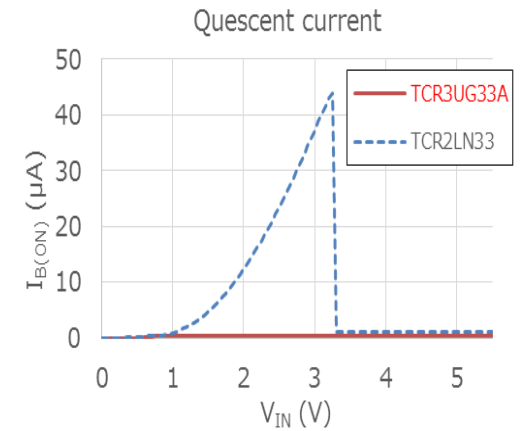
Keep V_{OUT} Stable when load current suddenly changes.

Low power Loss by Low Dropout



Low input voltage is acceptable by low dropout

Long life operation By Low Quiescent



Keep Low IQ with Bypass mode when V_{IN} is lower than V_{OUT} .

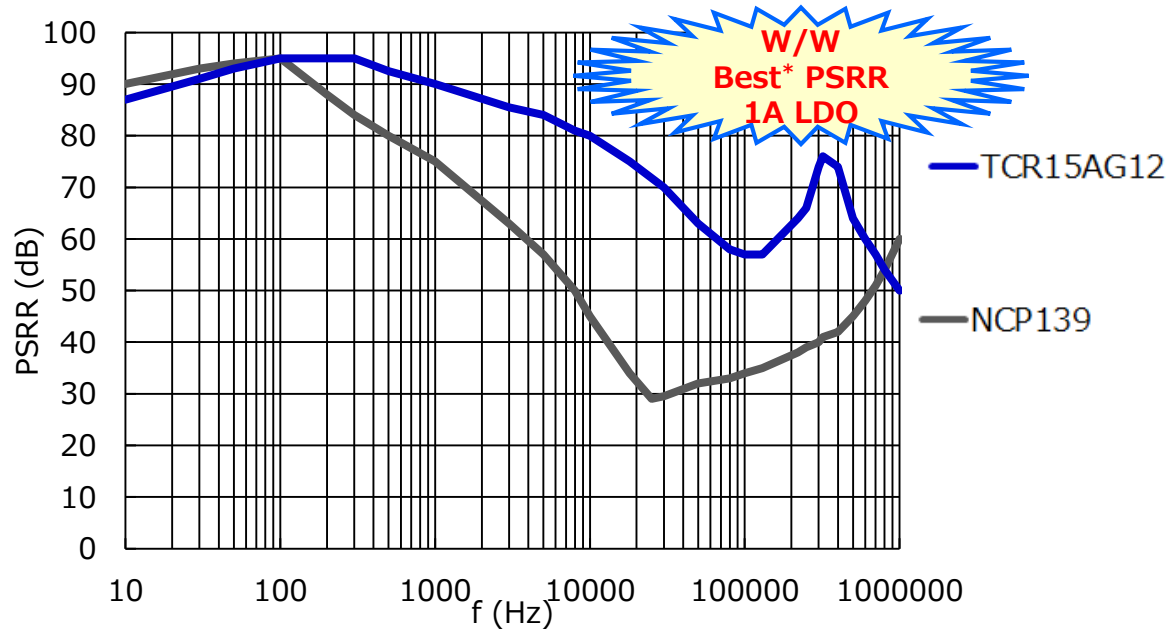
<https://toshiba.semicon-storage.com/ap-en/product/linear/lDO-regulator.html>

1.5A Ultra Low Dropout LDO

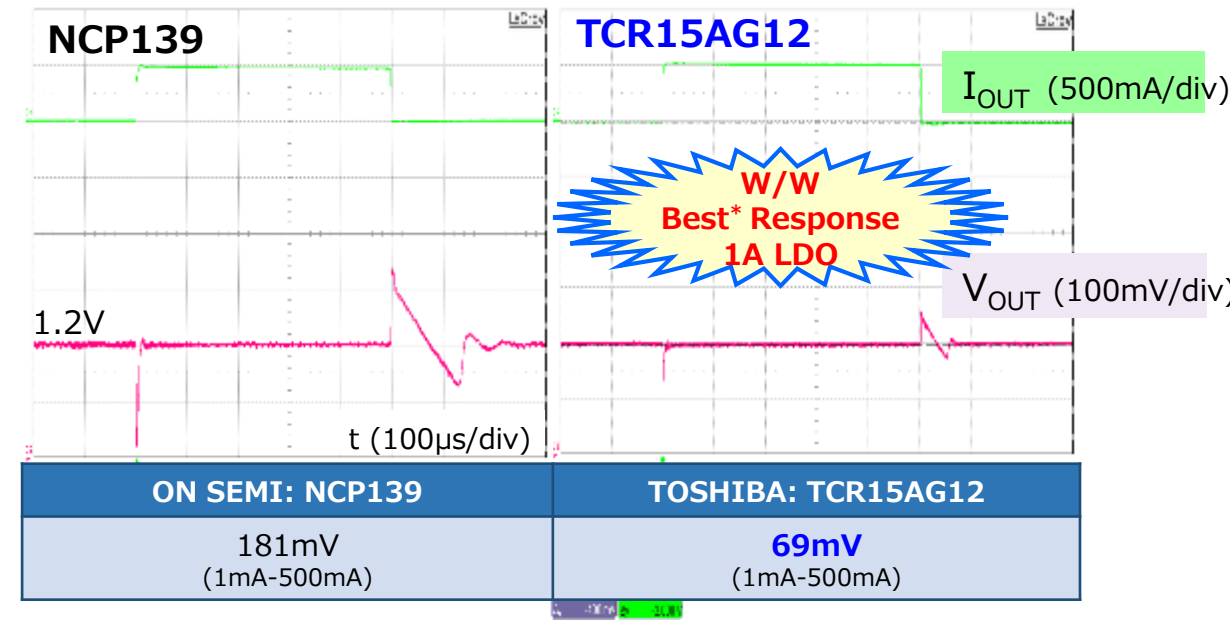
High Ripple Rejection and Fast Load transient

Sensors need high PSRR requirement from 1kHz to several 100 kHz.
Toshiba LDO use breakthrough IP to achieve best PSRR.

PSRR comparison



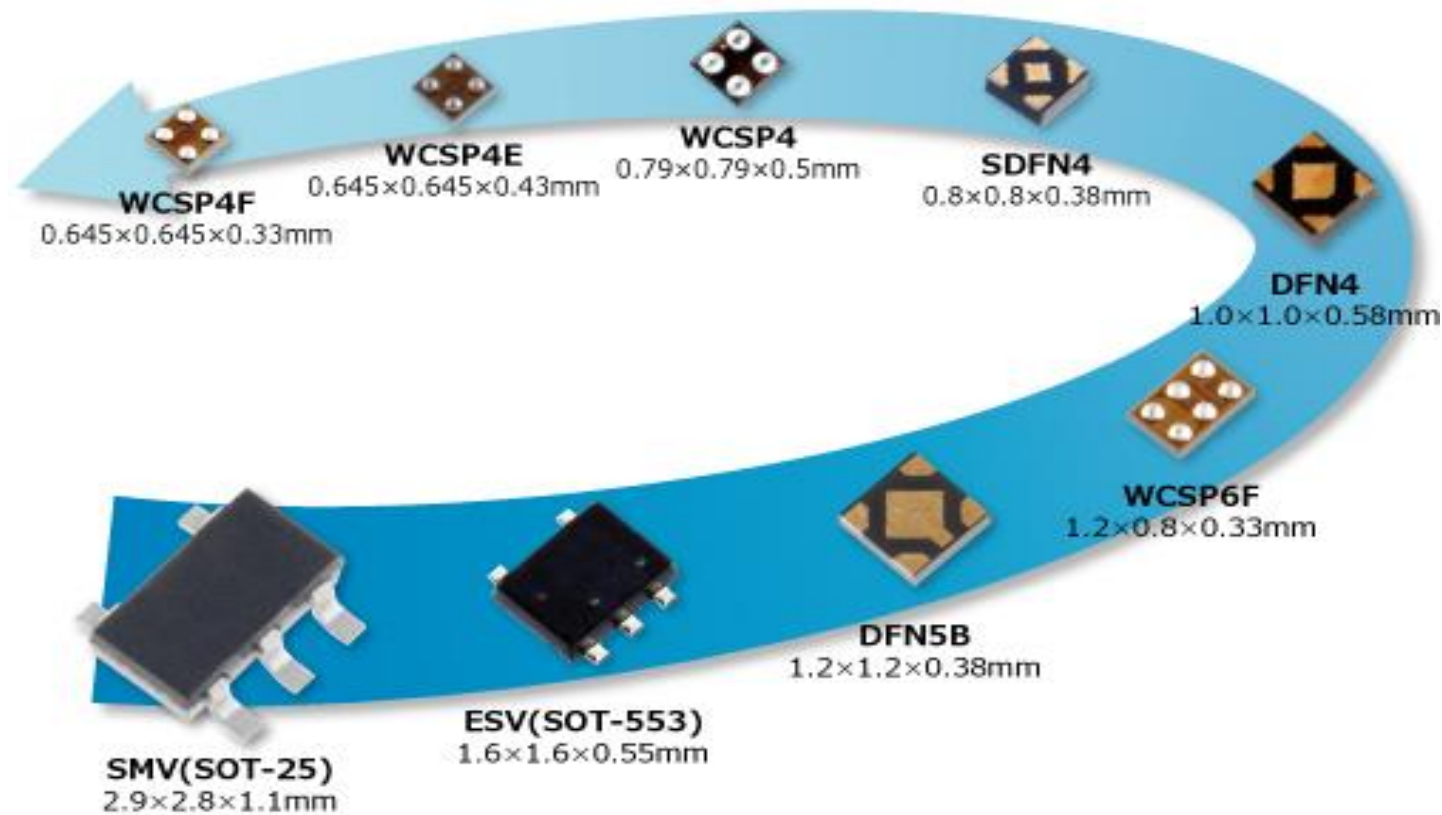
Load transient comparison



LDO Package Variety

Wide packaging options

Toshiba's LDO regulators are available in a wide range of packages from general-purpose packages to ultra-small WCSP and SDFN4 packages.



LDO Line-up

Unit: mm

New!

New!

New!

New!

New!

New!

New!

TOSHIBA

	I _{OUT} (A)	Part Number	package	Feature	V _{IN} max. (V)	V _{IN} -V _{OUT} (mV)		I _B (μA)	PSRR (dB)	Replacement for		
						V _{OUT} = 1.2V	V _{OUT} = 3.0V			Company T	Company Ri	Company On
	1.5	TCR15AG	WCSP6F	Low Dropout	5.5	77 @V _{OUT} =0.9V I _{OUT} =1.0A	-	25	95 @0.9V	-	-	-
	1.3	TCR13AG	WCSP6F	Low Dropout	5.5	92 @V _{OUT} =0.9V I _{OUT} =1.0A	-	52	90 @0.9V	-	RP115	NCP706
	0.8	TCR8BMxx	DFN5B	Low dropout	5.5	180 @800mA	195 @800mA	20	98 @0.8V	-	-	-
	0.5	TCR5BMxx	DFN5B	Low dropout	5.5	105 @500mA	130 @500mA	19	98 @0.8V	-	RP105L	NCP134AMX
		TCR5AMxx	DFN5B	Low dropout	5.5	150 @500mA	330 @500mA	38	86 @1.2V	-	RP105L	NCP134AMX
	0.42	TCR4DGxx	WCSP4E	Small package	5.5	627 @420mA	221 @420mA	65	70 @2.5V	-	-	NCP161AFC
	0.3	TCR3UGxx	WCSP4F	Super low I _B	5.5	660 @300mA	140 @300mA	0.34	70 @0.8V	-	-	NCP170
		TCR3UMxx	DFN4			667 @300mA	196 @300mA					
		TCR3UFxx	SOT-25			667 @300mA	206 @300mA					
		TCR3DGxx	WCSP4E	Small pkg.	5.5	470 @300mA	180 @300mA	65	70 @2.5V	LP5907UVE	-	NCP160AFC
		TCR3DMxx	DFN4	Standard 300mA		490 @300mA	200 @300mA			LP5907SNX	RP114Kxx1D	NCP114xMX
		TCR3DFxx	SOT-25			510 @300mA	220 @300mA			LP5907MFX	RP114Nxx1D	NCP114xSN
	0.2	TCR2LNxx	SDFN4	Low I _B	5.5	680 @150mA	200 @150mA	1	-	TPS706xxDBV	RP110Kxx1D	NCP4685DMU
		TCR2LExx	SOT-553			-	-			-		
		TCR2LFxx	SOT-25			-	RP110Nxx1D			NCP4682DSN		
		TCR2ENxx	SDFN4	Standard 200mA	5.5	360 @150mA	130 @150mA	35	73 @2.5V	TPS730xxDBV	RP109Kxx1D	NCP4586DMU
		TCR2EExx	SOT-553			-	-			-		
		TCR2EFxx	SOT-25			-	RP109Nxx1D			NCP4586DSN		
	TCR2DGxx	WCSP4	High R.R	5.5	193 @100mA	64 @100mA	45	85 @1.2V	TLV705xxYFM	-	NCP729FC	

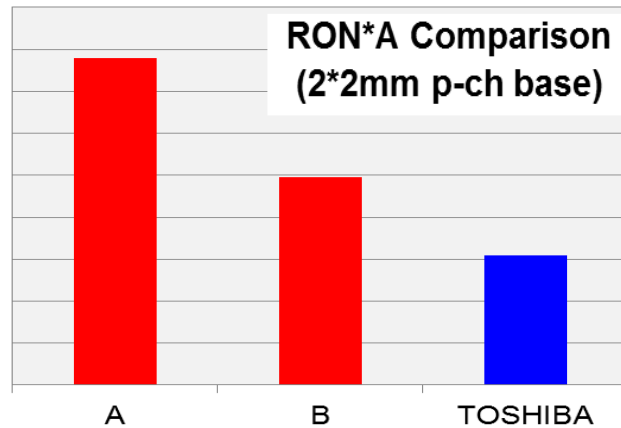
08

Small Signal MOSET

Features of MOSFET from Toshiba

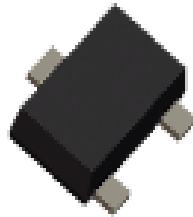
Toshiba MOSFETs can support various switching applications

Low Power consumption



Keeping top class RON by
Advanced trench process.

Wide variety of Package



SOT-23F
2.9*2.4mm
PD:1.0W



UDFN6B
2.0*2.0mm
PD:1.25W



WCSP6C
1.0*1.5mm
PD:1.2W

It can be used anywhere.
Load SW/Switching/Signal control.

Wide variety of Products

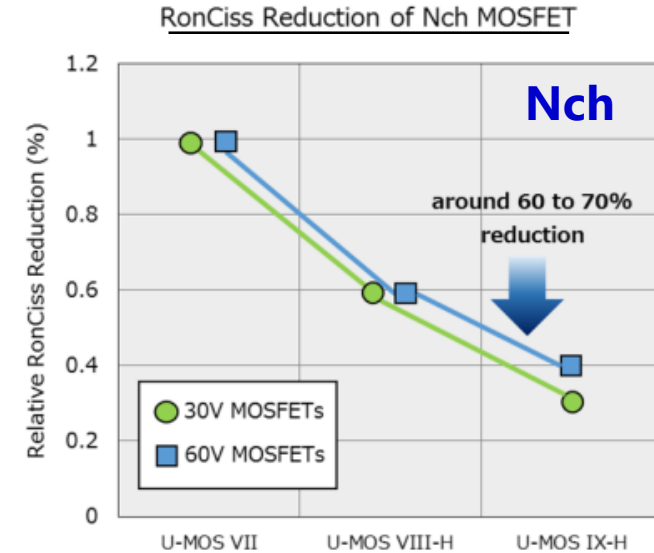
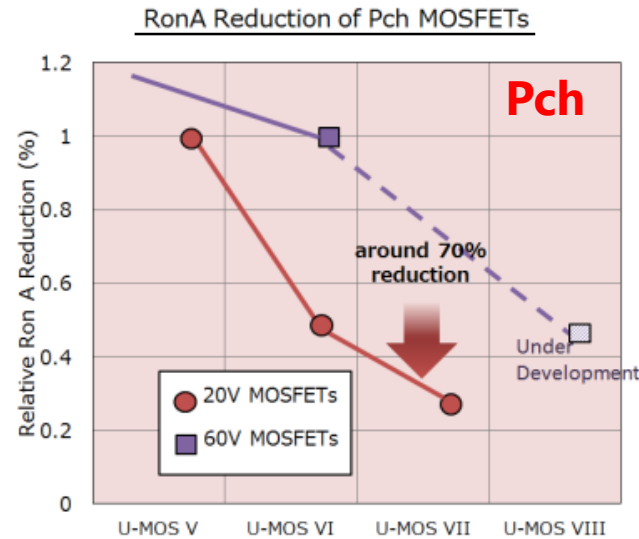
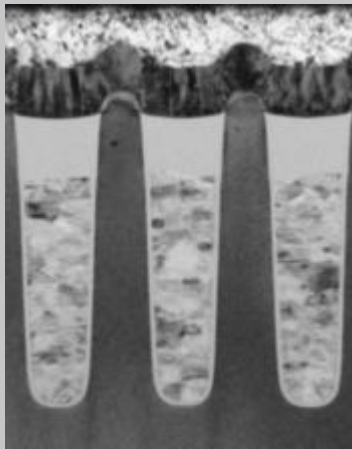
V _{DSS}
12-30V
30-60V
80-120V
150-250V
12-30V
40-100V
200-900V

Wide lineup of MOSFET

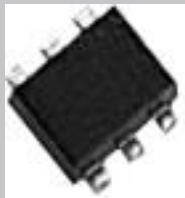
Base Technologies of MOSFET

Base technologies: Keeping top class trench process*

Process view of SSM6J511NU



Highly Focused Package



TSOP6F
2.9*2.8mm
PD:1.5W



SOT-23F
2.9*2.4mm
PD:1.0W



UDFN6B
2.0*2.0mm
PD:1.25W

The following are Toshiba focus characteristics with the latest trench process.

- **Low $R_{DS(ON)}$** Reduce insertion loss
- **Low Ciss** Reduce switching loss
- **High V_{DSS}** Expand applicable applications

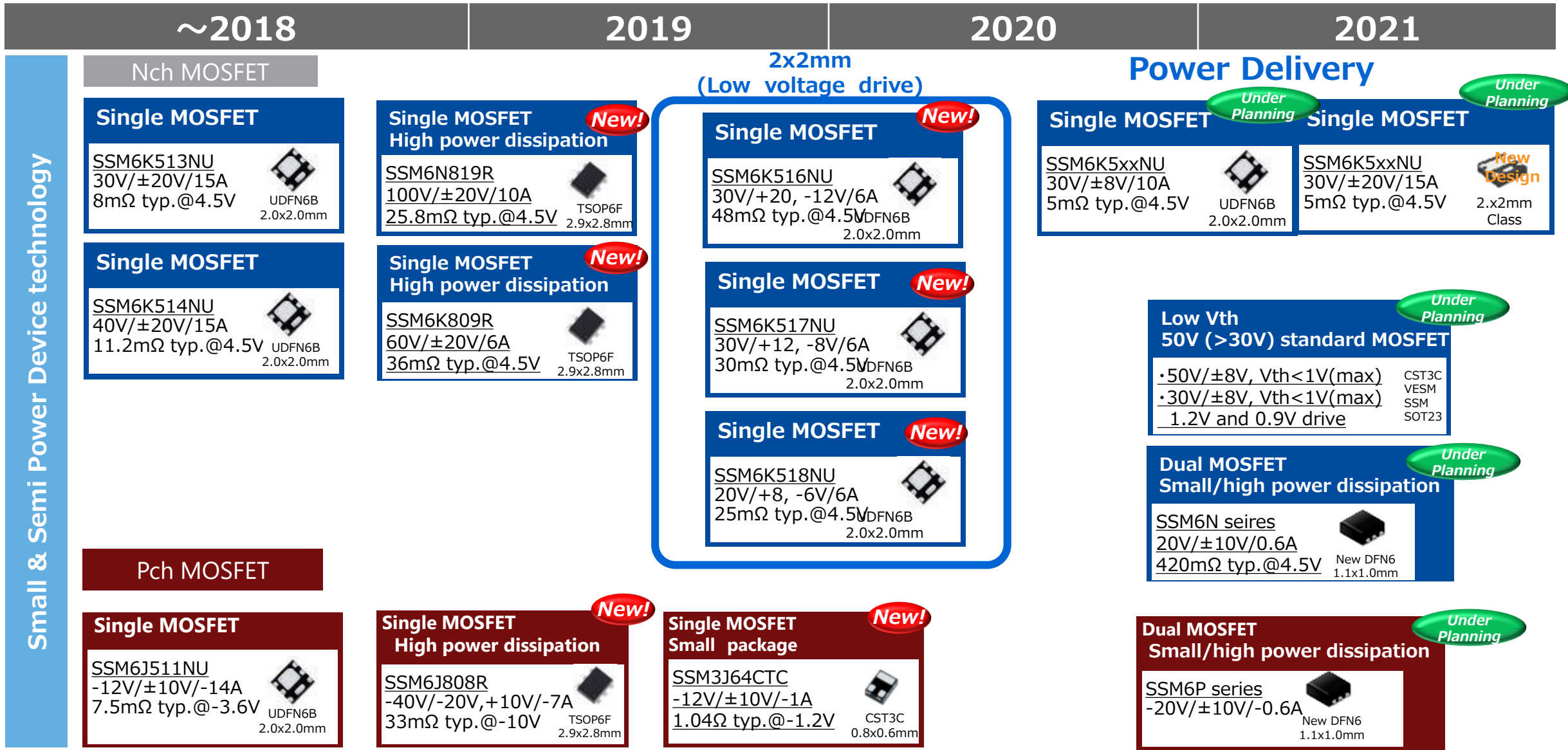
Toshiba line-up these products in small packages.

*Semi-power semiconductor devices under 2×2 mm as of Jun. 2015. Toshiba survey.











Small and High Power Dissipation(PD) Package Line-up

Package	Size	2.9x2.8mm	2.0x2.1mm	1.6x1.6mm	1.2x1.2mm	1.0x0.6mm	0.8x0.6mm
3pin	Standard	S-Mini/SOT23 2.5x2.9 / 2.4x2.9 	SOT-323 (USM) 	SOT-416 (SSM) 	SOT-723 (VESM) 	SOT-883 (CST3) 	CST3C  New!
	High PD	SOT-23F 2.4x2.9mm 	SOT-323F(UFM) 		CST3B *1.2x0.8mm 		
6pin	Standard	SOT-26 	SOT-363(US6) 	SOT-356 (ES6) 			
	High PD	TSOP6F  New!	SOT-363F (UF6) SOT-1220 (UDFN6B) 		WCSP6C *1.0x1.5mm 		
Over 8pin	High PD	PS-8 	VS-8 *2.9x1.5mm 			Toshiba focuses on small and high-PD packages.	

MOSFETs Roadmap (Single, Dual)

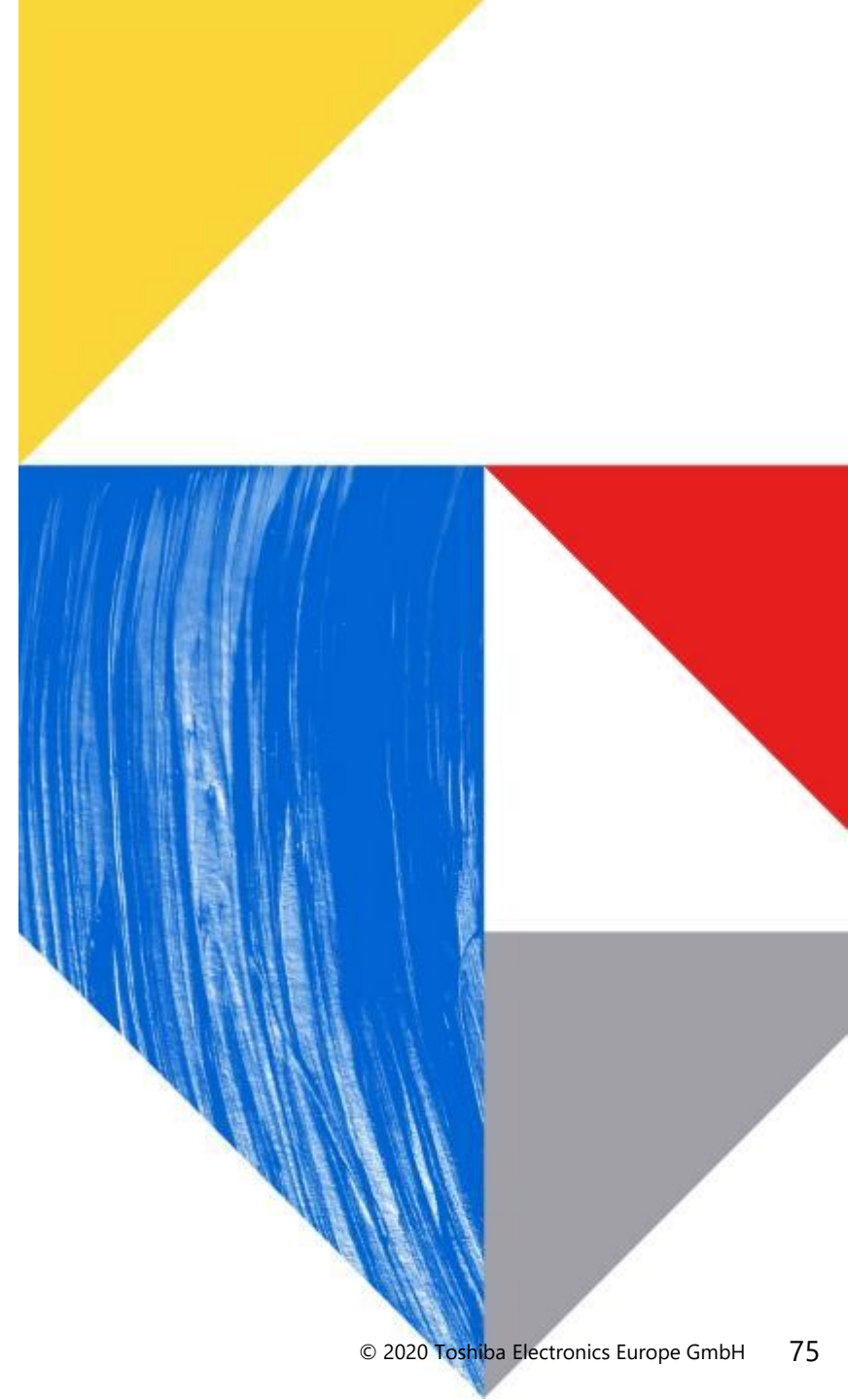


Small Package MOSFET line up

Channel polarity	V _{DSS} (V)	I _D (A)	R _{DS(ON)} typ. (Ω) @ V _{GS} = (V)				Single						Dual		
			1.2	1.5	2.5	4.0 or 4.5	CST3C  0.8x0.6mm	SOT-883 (CST3)  1.0x0.6mm	SOT-723 (VESM)  1.2x1.2mm	SOT-416 (SSM)  1.6x1.6mm	SOT-323/ SOT-323F   2.0x2.1mm	SOT23/S-Mini   2.5x2.9mm	SOT-563 (ES6)  1.6x1.6mm	SOT-363/ SOT-363F  2.0x2.1mm	
Nch	20	0.1	-	5.2	2.2	1.5	-	-	-	-	SSM3K16FU	-	SSM6N16FE	-	
		0.18	5	3	2	1.5	-	SSM3K35CT	SSM3K35MFV	SSM3K35FS	-	-	SSM6N35FE	SSM6N35FU	
		0.2	-	3	2.1	1.6	SSM3K16CTC	-	-	-	-	-	-	-	
		0.25	2.4	1.7	1.1	0.75	SSM3K35CTC	-	SSM3K35AMFV	SSM3K35AFS	-	-	SSM6N35AFE	SSM6N35AFU	
		0.5	-	0.95	0.66	0.51	-	-	-	-	SSM3K36TU	-	-	SSM6N36TU	
		0.8	-	0.36	0.23	0.19	-	-	SSM3K56MFV	SSM3K56FS	-	-	SSM6N56FE	-	
	1.4	-	-	-	-	-	SSM3K56ACT	-	-	-	-	-	-		
	30	0.1	-	-	~4.0	~2.3	SSM3K15ACTC	SSM3K15ACT	SSM3K15AMFV SSM3K44MFV*	SSM3K15AFS SSM3K44FS*	SSM3K15AFU	SSM3K15F	SSM6N15AFE SSM6N44FE*	SSM6N15AFU SSM6N44FU*	
	60	~0.2	High speed	-	5.7 *CST3C	3.2	SSM3K72CTC	-	-	SSM3K72CFS	SSM3K7002CFU	T2N7002AK	-	-	SSM6N7002CFU
~0.4		High ESD	-	-	1.2	-	New! SSM3K72KCT*	-	SSM3K72KFS*	SSM3K7002KFU*	T2N7002BK* SSM3K7002KF*	SSM6N7002BFE*	SSM6N7002KFU*		
Pch	-12	-1.0	1.0	0.68	0.4	0.29	New! SSM3J64CTC*	-	-	-	-	-	-	-	
		-0.1	-	18	8	6	-	-	-	-	SSM3J16FU	-	-	-	
		-0.1	11	8.2	5.6	4.3	-	SSM3J35CT	-	SSM3J35FS	-	-	SSM6P35FE	SSM6P35FU	
		-0.25	3.2	2.3	1.5	1.1	SSM3J35CTC*	-	SSM3J35AMFV*	SSM3J35AFS*	-	-	New! SSM6P35AFE*	New! SSM6P35AFU*	
		-0.33	-	2.2	1.2	0.95	New! SSM3J65CTC*	-	-	SSM3J36FS	SSM3J36TU	-	-	SSM6P36FE	SSM6P36TU
		-0.7	1.1	0.78	0.51	0.4	-	-	-	-	-	-	-	-	-
		-0.8	-	-	-	-	-	-	SSM3J56MFV	-	-	-	-	-	-
		-1.4	0.77	0.56	0.38	0.31	-	SSM3J56ACT	-	-	-	-	-	-	-
		-30	-0.1	-	-	14	8	-	SSM3J15CT	SSM3J15FV	SSM3J15FS	SSM3J15FU	SSM3J15F	SSM6P15FE	SSM6P15FU
-0.2	-		-	2.4	-	-	-	-	-	-	-	-	-		
-0.4	-		-	-	1.4	-	-	-	-	-	2SJ305	-	-		
Complementally	20	0.18	5	3	2	1.5	-	-	-	-	-	SSM6L35FE	SSM6L35FU		
		-0.1	11	8.2	5.6	4.3	-	-	-	-	-	-	-		
		0.5	-	0.95	0.66	0.51	-	-	-	-	-	-	-		
		-0.33	-	2.2	1.2	0.95	-	-	-	-	-	-	SSM6L36FE	SSM6L36TU	

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Thank you.



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