TOSHIBA
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System Catalog Sep. 2015

High-Power Electric Solutions

SEMICONDUCTOR & STORAGE PRODUCTS
http://toshiba.semicon-storage.com/

High-Power Semiconductor Devices

Perfect Recipes for Solution Evolution

What is required for high-power devices for industrial applications? Efficiency is obviously important-but not only that. Now, customers are looking for premium solutions that allow them to realize electrical equipment with a high level of safety and superb energy-saving performance. Toshiba boasts decades of experience in semiconductor chip fabrication and packaging technologies, contributing to efficiency improvement in the field of power electronics.
Its unequalled and innovative technologies will open up new paths for the future. Renewable energy generation is just one example of the applications that have benefited and will benefit from our leading-edge technologies.
Toshiba's high-power semiconductor devices help fulfill all the major requirements for power electronics-safety, energy saving, high reliability and high efficiency.

Injection Enhanced Gate Transistors (IEGTs)

An injection-enhanced gate transistor (IEGT) is a voltage-driven device for switching large current. Fabricating insulated-gate bipolar transistors (IGBTs) with high collector-emitter voltage (V_{CES}) is difficult because of a sharp increase in on-state voltage in the high current region. To overcome this limitation, IEGTs are fabricated using a unique emitter structure. Additionally, the outstanding turn-off performance and the wide safe operating area of IEGTs make it possible to reduce the power consumption, shrink the size and improve the efficiency of equipment. IEGTs are ideal for industrial motor control applications that support today's social infrastructure, including industrial drive systems and power converters. Toshiba's IEGTs are available in press-pack type and module type packages. You can select IEGTs that best suit the power capacity and load characteristics requirements for your applications.

Features of IEGTs

- High collector-emitter voltage and low saturation voltage
- Wide safe operating area (SOA) equivalent to that of IGBTs (high di/dt and dv/dt)
- Simplified and small gate drive circuitry due to voltage drive
- High switching speed

Principle of Operation

Cross-sectional structure of an IGBT and the factors that limit its collector-emitter voltage

Figure A shows the cross-sectional structure of a conventional IGBT and the carrier distribution in the N-base region. The carrier concentration decreases monotonically across the N-base region from the collector electrode to the emitter electrode. In order to increase the collector-emitter voltage of an IGBT, a deep N-base region is necessary between the collector and emitter electrodes. However, a deep N-base region leads to an area with lower carrier concentration. The consequent increase in electrical resistance results in an increase in voltage drop and thus an increase in on-state voltage.

Characteristics of the IEGT gate structure and the injection enhancement (IE) effect

Figure B shows the cross-sectional structure of and the carrier distribution in an IEGT. The IEGT has an IGBT-like structure with deeper and wider trench gates than the IGBT. This structure increases the gate-to-emitter resistance, preventing carriers from passing through the emitter side. Consequently, carrier concentration is enhanced near the emitter electrode in the N-base region. As this phenomenon has the same effect as carrier injection and accumulation, it is called the injection enhancement (IE) effect. This trench-gate structure helps reduce an increase in voltage drop even at high collector-emitter voltage rating.

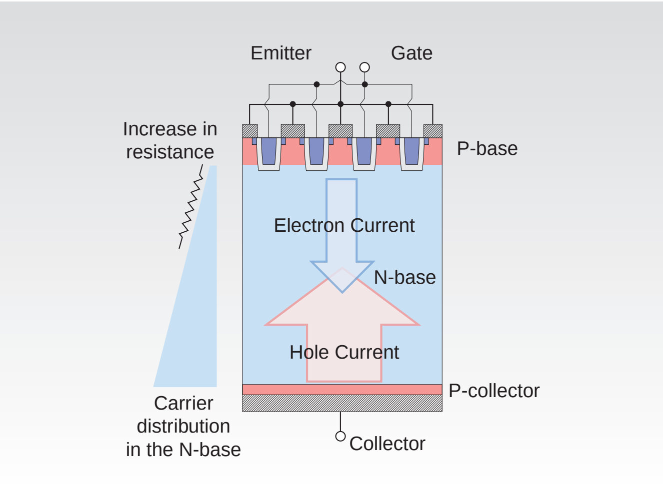


Figure A Cross-Sectional View of and Carrier Distribution in an IGBT
Because carrier concentration near the emitter is low, an increase in the collector-emitter voltage rating leads to an increase in on-state voltage.

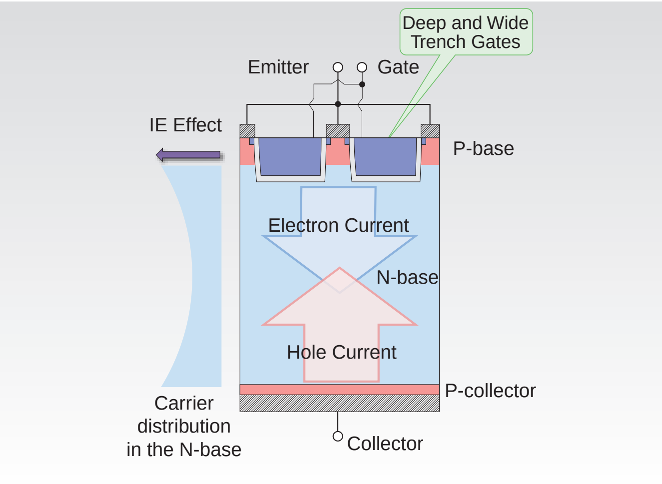
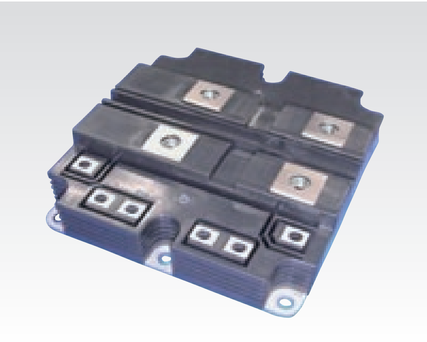


Figure B Cross-Sectional View of and Carrier Distribution in an IEGT
Carrier concentration near the emitter is enhanced near the emitter. Consequently, electron injection increases, reducing on-state voltage.

Hybrid IEGT / SiC-SBD Modules

The requirements for rail traction motor control systems include not only low noise and comfortable ride but also compact size, light weight and energy efficiency. To meet these requirements, Toshiba has developed a Plastic Case Module IEGT (PMI) that incorporates silicon carbide Schottky barrier diodes (SiC-SBDs).



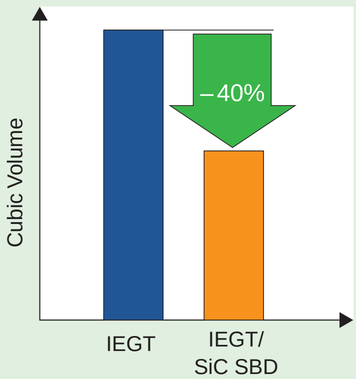
1.7-kV/1200-A Hybrid IEGT/SiC-SBD Module

Helps reduce equipment size

Power Inverter with Hybrid IEGT/ SiC-SBDs for Rail Traction
(NEDO Demonstration Project in 2009 to 2011)

NEDO: New Energy and Industrial Technology Development Organization

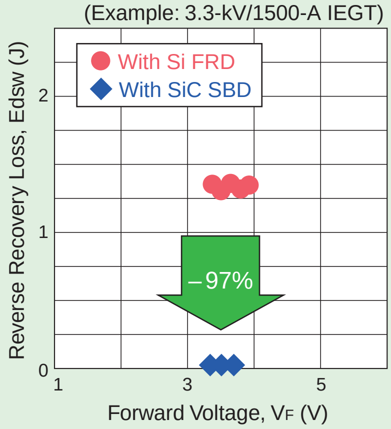
Approx. 40% reduction in equipment cubic volume



Volume Comparison
(Including Cooling and Motor Control Unit)

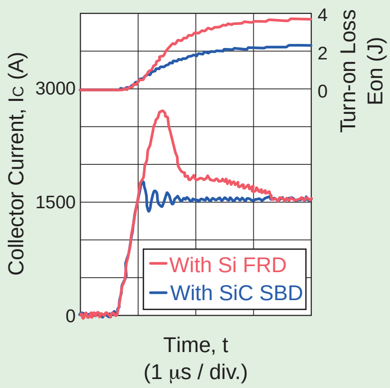
97% reduction in diode reverse recovery loss

(Example: 3.3-kV/1500-A IEGT)



Comparison of Reverse Recovery Loss

Significant reduction in reverse recovery current Reduction in turn-on loss

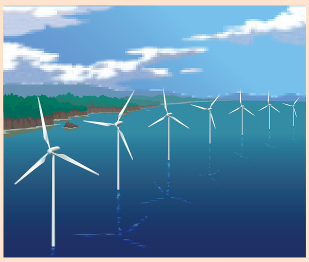


Comparisons of Reverse Recovery Current and Turn-on Loss

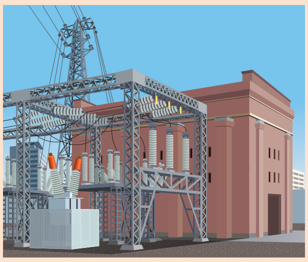
FRD: Fast Recovery Diode

Intended Applications of IEGTs

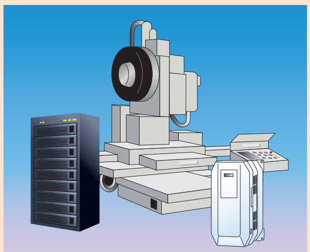
Rail traction



Green energy generation



Power transmission & distribution (T&D)



Industrial motor control and inverters

Injection Enhanced Gate Transistors (IEGTs)

Press-Pack IEGTs (PPIs)

All electrical connections in a PPI are made using pressure. Without wire bonding, the PPI is less vulnerable to thermal fatigue. Using many PPIs in series makes it possible for a system to keep running uninterrupted even if a few PPIs fail due to an electrical fault or damage. This is because the collector and emitter electrodes of the failed PPIs are short-circuited. PPIs can be cooled from both the collector and emitter sides. Hermetically sealed in a ceramic and metal enclosure, the press pack is highly moisture-resistant and can be immersed in cooling liquid for efficient cooling.

Characteristics of PPIs

▶ Electrical connections using pressure

Multiple IEGT chips are placed in an array on the same plane, and individual IEGT chips are uniformly pressed from both sides using a molybdenum plate. The collector and emitter electrodes of each IEGT chip are brought into contact with the corresponding copper electrodes of the press pack enclosure via the molybdenum plate by applying mechanical pressure. This not only makes electrical connections and but also allows heat dissipation.

▶ High reliability due to hermetic sealing

Inert gas is hermetically sealed inside the press pack in order to prevent electrodes from being degraded due to oxidation. Thus, PPIs provide high thermal reliability.

▶ Outstanding parallel operation technology

The wiring inside the gate terminal plate is designed to switch all the parallel IEGT chips simultaneously so that they will not interfere with each other and oscillate when switching.

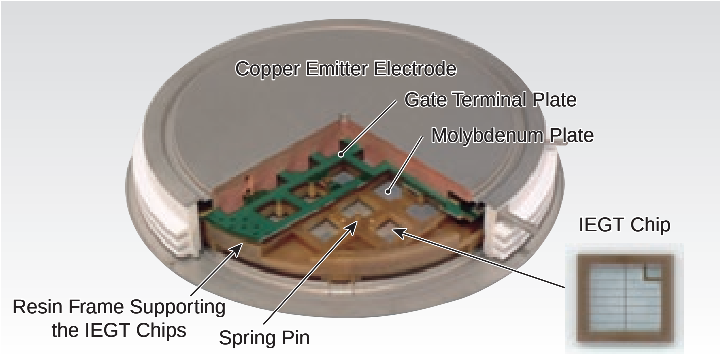
▶ Rupture-resistant package structure

IEGT chips are positioned on a resin frame to make them less prone to rupture even if a chip is melt and destroyed during switching.

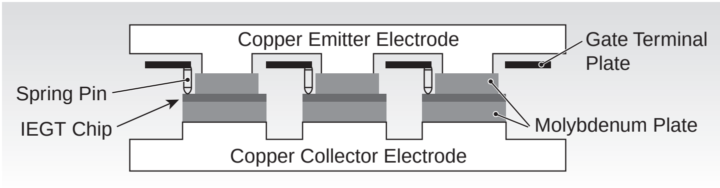
PPI Installation Example

In the example shown at right, three series-connected PPIs are vertically stacked.
The PPI are placed between cooling fins, and pressure is applied from above and below to hold them firmly. An elaborate setup is necessary to ensure that pressure is uniformly applied across the PPIs. The spring helps reduce thermal contraction to keep a constant pressure.

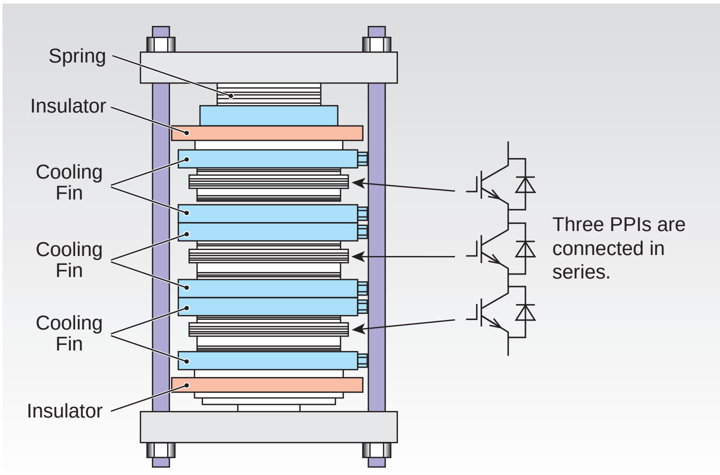
■PPI Structure



■Cross-Sectional View of a PPI



■PPI Installation Example



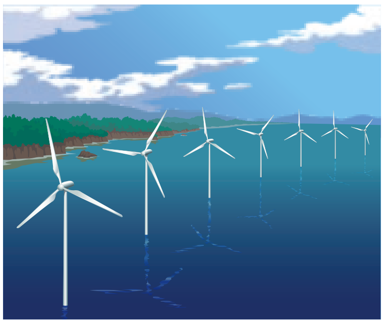
PPI Product Lineup

Part Number	Package	Absolute Maximum Ratings				$V_{CE(sat)}$ (V)		V_F (V)	
		V_{CES} (V)	I_C (A)	P_C (W)	T_j (˚C)	Max	Test Condition @I_C (A) / V_{GE} (V)	Max	Test Condition @I_C (A) / V_{GE} (V)
ST1200FXF24	PPI85B	3300	1200	2000	125	4.2	1200 / 15	3.8	1200 / 0
ST750GXH24	PPI85B	4500	750	2000	125	4	750 / 15	4.2	750 / 0
ST1200GXH24A	PPI85B	4500	1200	5000	125	3.8	1200 / 15	–	–
ST1500GXH24	PPI125A2	4500	1500	5000	125	4	1500 / 15	4.2	1500 / 0
ST2100GXH24A	PPI125A2	4500	2100	7000	125	4	2100 / 15	–	–

Application Examples

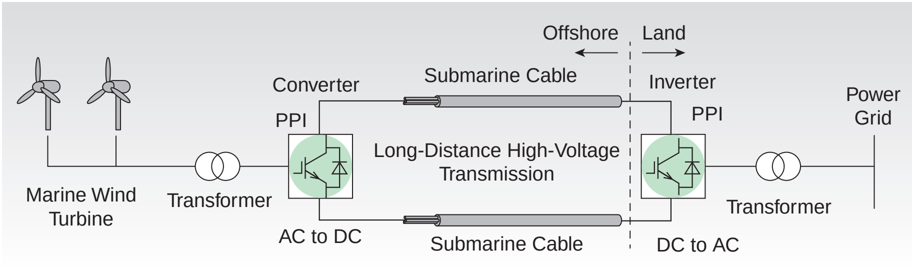
Converters for High-Voltage Direct-Current (HVDC) Transmission

HVDC transmission is utilized to efficiently transmit renewable energy captured in remote places, for example, windmills on the sea, to the sites where energy is used. The generated AC voltage is converted to DC voltage and transmitted ashore over long distances or via submarine power cables. At the receiving end, the DC voltage is converted back into AC voltage to feed electricity consumers. PPIs are used for high-voltage converters.



Marine Wind Turbine

Submarine Power Transmission System

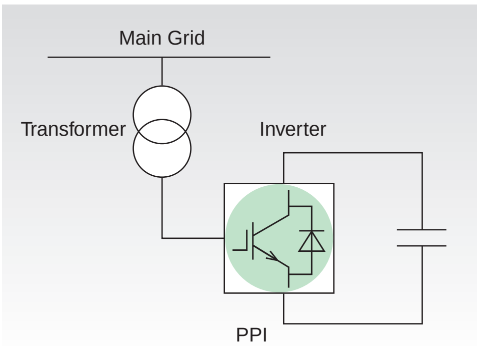


Static VAR Compensators (SVCs)

SVCs are electrical equipments for improving electricity quality (e.g., power factor correction) on transmission networks. PPIs are utilized as high-voltage, high-current power devices for active SVC applications such as static VAR generators (SVGs) and static synchronous compensators (STATCOMs).

SVG Inverter Circuit

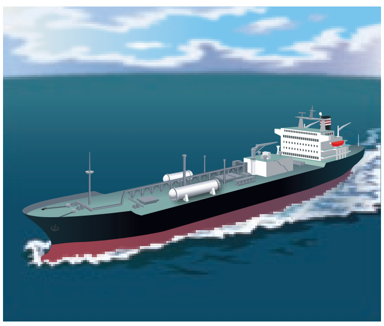
Substation



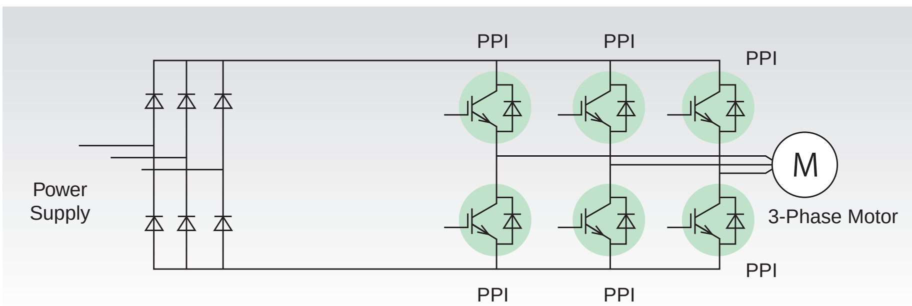
Middle-Voltage Inverters

PPIs, which allow series connection and double-sided cooling, are ideal for high-capacity inverter applications.

Inverter Circuit



Electric Propulsion Ship



Injection Enhanced Gate Transistors (IEGTs)

Plastic Case Module IEGTs (PMIs)

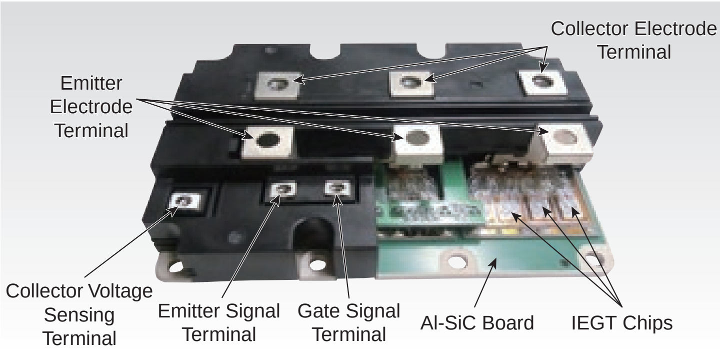
PMIs can be screwed onto a cooling fin, simplifying equipment assembly. PMIs incorporate an Al-SiC base plate with a low thermal expansion coefficient and have an optimal internal structure and parts. Consequently, they are less susceptible to thermal fatigue and provide an improved power cycling capability for prolonged service life. The PMI package uses a high-CTI* material that is less sensitive to tracking destruction in order to improve isolation voltage on the package surface.

*CTI (Comparative Tracking Index)

Characteristics of PMIs

- **Easy-to-assemble plastic module casing**
  Many IEGT chips are soldered on a ceramic insulating board and wire-bonded to the module terminals. The plastic module is easy to use because it dissipates heat from one side and is internally insulated.
- **Base plate made from a composite Al-SiC material**
  To ensure thermal reliability, the package has a composite aluminum silicon-carbide (Al-SiC) plate with a low thermal expansion coefficient on its underside.

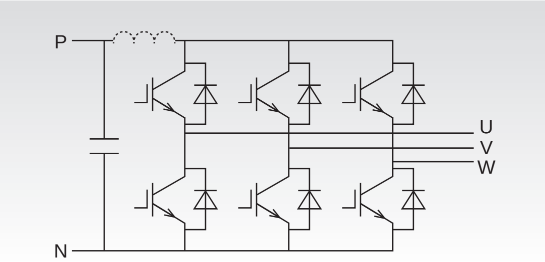
PMI Structure



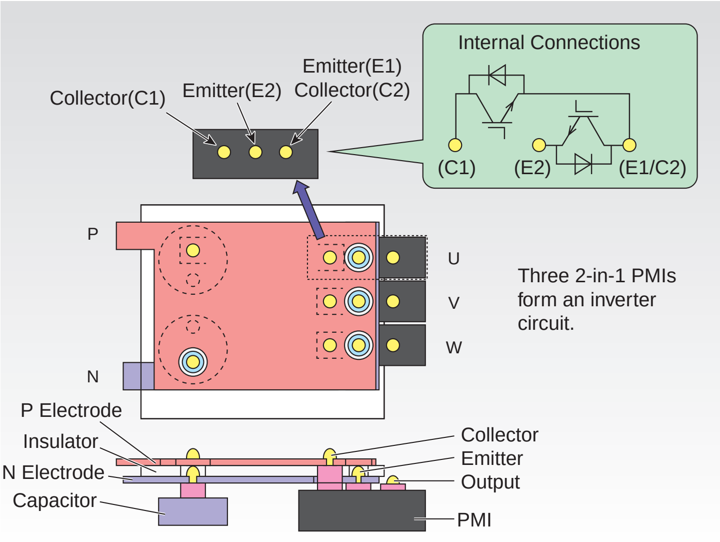
PMI Installation Example

A compact inverter circuit can be created by using 2-in-1 PMIs that contain two IEGTs. The example shown at right uses three 2-in-1 PMIs. The stray inductance can be reduced by using a laminated electrode plate.

Inverter Circuit



PMI Installation Example



PMI Product Lineup

Part Number	Package	Absolute Maximum Ratings				$V_{CE(sat)}$ (V)		V_F (V)		Circuit Configuration
		V_{CES} (V)	I_C (A)	P_C (W)	T_j (˚C)	Max	Test Condition @I_C (A) / V_{GE} (V)	Max	Test Condition @I_C (A) / V_{GE} (V)	
MG1200V2YS61**	PMI142C	1700	1200	2600	150	TBD	1200 / 15	TBD	1200 / 0	2 in 1
MG400FXF2YS53	PMI143C	3300	400	1350	125	4.5	400 / 15	3.5	400 / 0	2 in 1
MG500FXF2YS61	PMI142C	3300	500	1700	150	4.6	500 / 15	4.1	500 / 0	2 in 1
MG800FXF1US53	PMI143B	3300	800	2600	125	4.5	800 / 15	3.5	800 / 0	1 in 1
MG1200FXF1US53	PMI193	3300	1200	4000	125	4.5	1200 / 15	3.5	1200 / 0	1 in 1
MG1500FXF1US62	PMI193D	3300	1500	4000	150	4.4	1500 / 15	3.8	1500 / 0	1 in 1
MG900GXH1US53	PMI193	4500	900	4000	125	4.7	900 / 15	3.8	900 / 0	1 in 1

TBD: To Be Determined

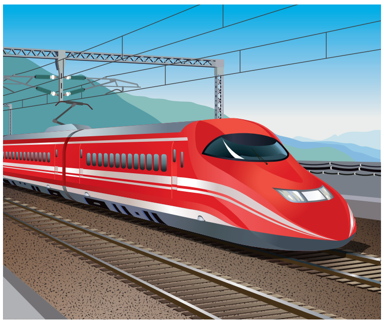
**: Under development

Application Examples

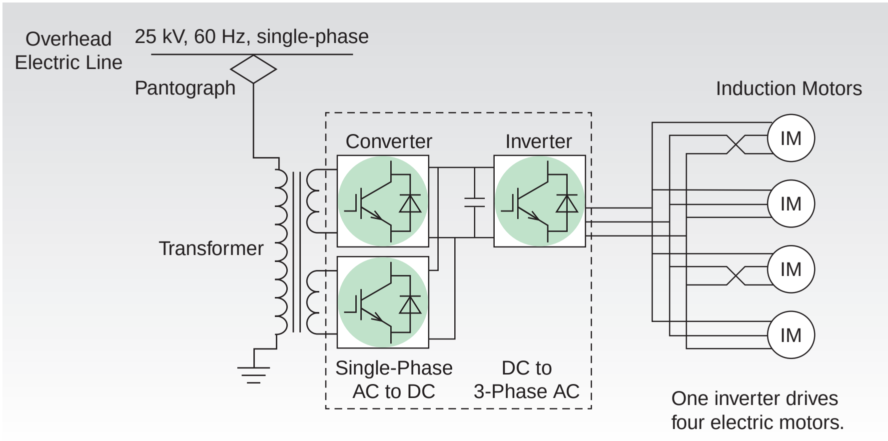
Rail traction

PMIs are suitable for inverter and converter applications that drive traction motors for rail transport systems, including the Shinkansen, rapid transits and urban rail transits. PMIs help improve efficiency and save energy.

Main Circuit System for Rail Traction



Rail Traction

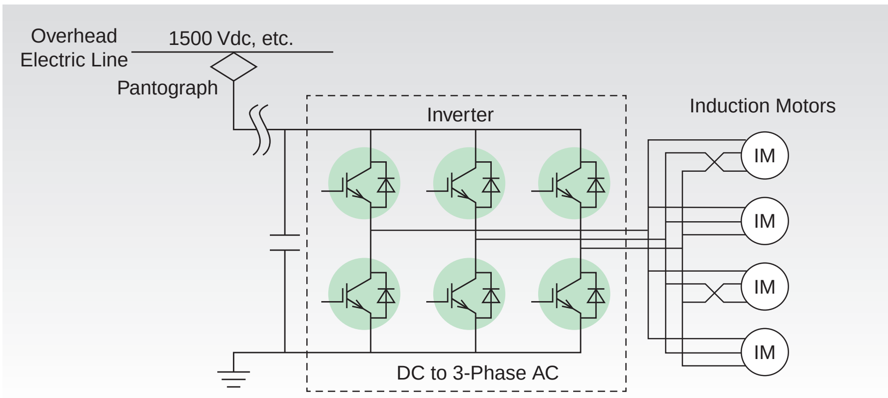


Subways and Light-Rail Systems

PMIs are also used for inverter applications that drive rail traction powered by DC overhead lines.

Main Circuit System for Light-Rail

Light-Rail

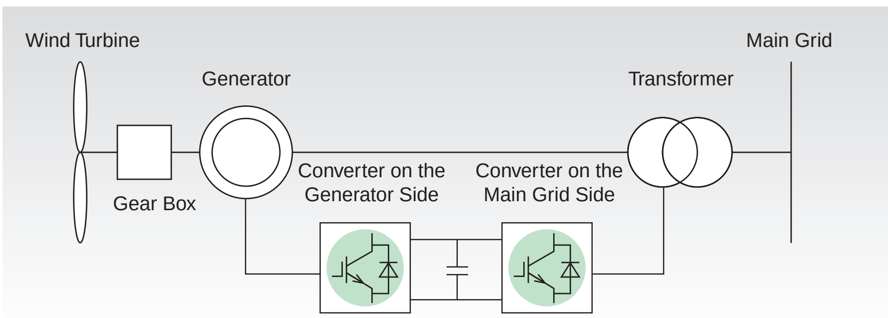


Windmill

IEGTs are commonly used in the power converter for windmill that convert the power of wind into electricity.

Windmill System

Wind Turbine



DTMOS

Power MOSFETs are indispensable for converters, inverters and other switching power supplies. DTMOS is a power MOSFET series with a superjunction structure that feature high current-switching capability. With a V_{DSS} of 600 V or so, DTMOS is suitable for mid- to high-voltage applications.

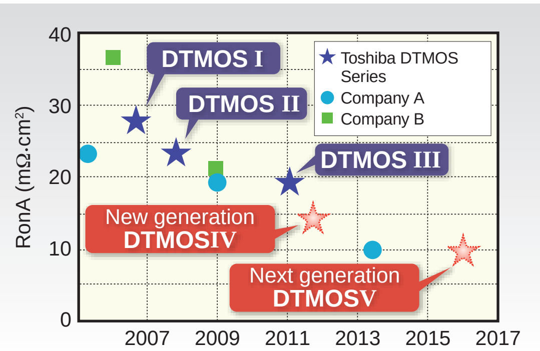
Gen-4 Super-Junction MOSFET Series (DTMOSIV)

Fabricated using a state-of-the-art single-epitaxial process, the DTMOSIV series exhibits an RonA lower than 15 mΩ.cm^2. The reduction in RonA, a performance index for MOSFETs, directly translates to a reduction in conduction loss, which helps improve the efficiency and reduce the size of industrial equipment.

Product features

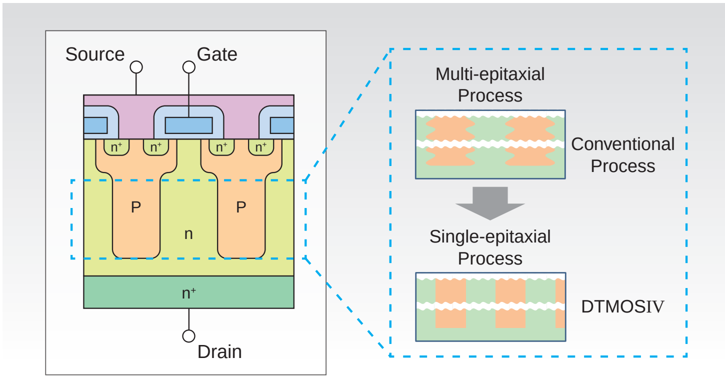
- Exhibits 30% lower RonA and significantly higher performance than the previous DTMOSIII series
- Reduces an increase in RonA in the high-temperature region
- Simplified manufacturing processes

Reduction in RonA



Super-Junction Structure

Because of the vertically formed P layer, the DTMOSIV series combines high V_{DSS} and low $R_{DS(ON)}$.
Fabricated using the state-of-the-art single epitaxial process, DTMOSIV provides high performance and high-effectiveness because of a small geometry and simplified manufacturing process.



Major Product Lineup

Ta = 25˚C

Part Number	Series	Absolute Maximum Ratings			$R_{DS(ON)}$ (Ω) Max	C_{iss} (pF) Typ.	Q_g (nC) Typ.	Package
		V_{DSS} (V)	V_{GSS} (V)	I_D (A)	$\|V_{GS}\|$ = 10 V			
TK31A60W	Standard DTMOSIV Series	600	±30	30.8	0.088	3000	86	TO-220SIS
TK31E60W			±30	30.8	0.088	3000	86	TO-220
TK31J60W			±30	30.8	0.088	3000	86	TO-3P(N)
TK31N60W			±30	30.8	0.088	3000	86	TO-247
TK31V60W			±30	30.8	0.098	3000	86	DFN8x8
TK39A60W			±30	38.8	0.065	4100	110	TO-220SIS
TK39J60W			±30	38.8	0.065	4100	110	TO-3P(N)
TK39N60W			±30	38.8	0.065	4100	110	TO-247
TK62J60W			±30	61.8	0.04	6500	180	TO-3P(N)
TK62N60W			±30	61.8	0.04	6500	180	TO-247
TK100L60W			±30	100	0.018	15000	360	TO-3P(L)
TK35A65W		650	±30	35	0.08	4100	100	TO-220SIS
TK35N65W			±30	35	0.08	4100	100	TO-247
TK49N65W			±30	49.2	0.055	6500	160	TO-247
TK31E60X	High-Speed Switching DTMOSIV-H Series	600	±30	30.8	0.088	3000	65	TO-220
TK31N60X			±30	30.8	0.088	3000	65	TO-247
TK31V60X			±30	30.8	0.098	3000	65	DFN8x8
TK31Z60X**			±30	30.8	0.088	3000	65	TO-247-4L
TK39N60X			±30	38.8	0.065	4100	85	TO-247
TK39Z60X**			±30	38.8	0.065	4100	85	TO-247-4L
TK62N60X			±30	61.8	0.04	6500	135	TO-247
TK62Z60X**			±30	61.8	0.04	6500	135	TO-247-4L
TK31J60W5	DTMOSIV (HSD) Series with a High-Speed Diode	600	±30	30.8	0.099	3000	105	TO-3P(N)
TK31N60W5			±30	30.8	0.099	3000	105	TO-247
TK31V60W5			±30	30.8	0.109	3000	105	DFN8x8
TK39J60W5			±30	38.8	0.074	4100	135	TO-3P(N)
TK39N60W5			±30	38.8	0.074	4100	135	TO-247
TK62J60W5			±30	61.8	0.045	6500	205	TO-3P(N)
TK62N60W5			±30	61.8	0.045	6500	205	TO-247
TK35A65W5		650	±30	35	0.095	4100	115	TO-220SIS
TK35N65W5			±30	35	0.095	4100	115	TO-247
TK49N65W5			±30	49.2	0.057	6500	185	TO-247

**: Under development

Note: The specifications and release schedules for the products under development are subject to change without notice.

U-MOS

U-MOS is a low-V_{DSS} MOSFET series suitable for AC-DC and DC-DC converter applications in a wide range of electronic equipment such as small industrial equipment, communication systems and IT equipment. U-MOS is available with a V_{DSS} ranging from 30 V to 250 V necessary for industrial applications.

Gen-8/9 Low-V_{DSS} Trench MOSFET Series (U-MOSVIII-H/U-MOSIX-H)

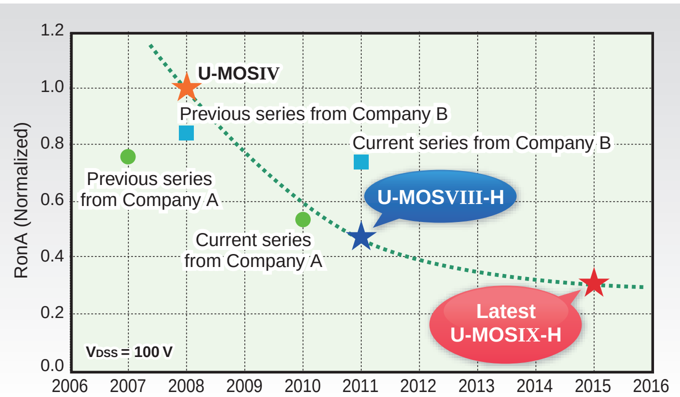
Fabricated using a state-of-the-art trench process, the Gen-8 low-V_{DSS} trench MOSFET series, U-MOSVIII-H, provides significantly lower RonA*1 than its predecessor.
By using a latest trench structure and a high-speed process, the Gen-9 low-V_{DSS} trench MOSFET, U-MOSIX-H, offers industry-leading performance. Furthermore, improvements in switching properties makes it possible to reduce Qoss*2. Both U-MOSVIII-H and U-MOSIX-H contribute to improving the efficiencies of charging/discharging circuits and boost/buck converters for industrial power supply and storage battery applications.

Features of U-MOSIX-H

U-MOSIX provides a 46% reduction in RonA*1 over U-MOSVIII-H.

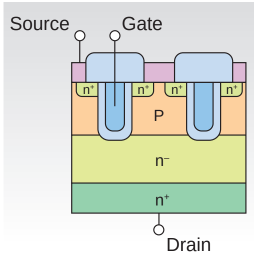
- Top-class low $R_{DS(ON)}$
- Low Qoss design *2
- Tch = 175 ˚C
- Package
  SOP Advance/TSON Advance/ DSOP Advance

Reduction in RonA



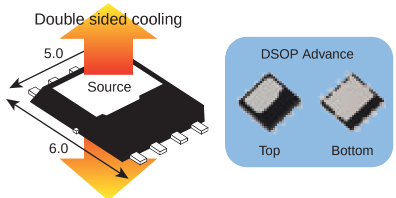
Trench Structure

The vertical gate channel formed in the shape of a U groove makes it possible to increase the cell density and reduce on-resistance.



DSOP Advance Package
(Double sided cooling) 5.0 × 6.0 × 0.95 mm

The DSOP Advance series combines trench chip and packaging technologies to reduce on-resistance, thereby help improving efficiencies of AC-DC and DC-DC power supply.



*1: RonA: Performance indicators that is the product of Ron (on-resistance) and A (effective area of current conduction)
*2: Qoss: Output charge (drain-source charge)

Major Product Lineup

Ta = 25˚C

Part Number	Absolute Maximum Ratings		$R_{DS(ON)}$ (mΩ) Max			Ciss (pF) Typ.	Qg (nC) Typ.	Package	Series
	V_{DSS} (V)	V_{GSS} (V)	|VGS| = 10 V	|VGS| = 6.5 V	|VGS| = 4.5 V				
TPH4R003NL	30	±20	4	–	6.2	1110	6.8	SOP Advance	U-MOSVIII-H
TPH3R203NL		±20	3.2	–	4.7	1600	9.5	SOP Advance	U-MOSVIII-H
TPH1R403NL		±20	1.4	–	2.1	3400	20	SOP Advance	U-MOSVIII-H
TPHR9003NL		±20	0.9	–	1.4	5300	32	SOP Advance	U-MOSVIII-H
TPWR8503NL		±20	0.85	–	1.3	5300	32	DSOP Advance	U-MOSVIII-H
TPHR8504PL	40	±20	0.85	–	1.4	7370	103	SOP Advance	U-MOSIX-H
TPWR8004PL		±20	0.8	–	1.35	7370	103	DSOP Advance	U-MOSIX-H
TPH1R005PL**	45	±20	1.04	–	1.7	7350	99	SOP Advance	U-MOSIX-H
TPH5R906NH	60	±20	5.9	14	–	2340	38	SOP Advance	U-MOSVIII-H
TPH4R606NH		±20	4.6	11	–	3050	49	SOP Advance	U-MOSVIII-H
TK100A06N1		±20	2.7	–	–	10500	140	TO-220SIS	U-MOSVIII-H
TK100E06N1		±20	2.3	–	–	10500	140	TO-220	U-MOSVIII-H
TPH2R306NH		±20	2.3	4.7	–	4700	72	SOP Advance	U-MOSVIII-H
TPH2R608NH	75	±20	2.6	–	–	4600	72	SOP Advance	U-MOSVIII-H
TPH8R008NH	80	±20	8	–	–	2300	35	SOP Advance	U-MOSVIII-H
TPH4R008NH		±20	4	–	–	4100	59	SOP Advance	U-MOSVIII-H
TPW4R008NH		±20	4	–	–	4100	59	DSOP Advance	U-MOSVIII-H
TK100A08N1		±20	3.2	–	–	9000	130	TO-220SIS	U-MOSVIII-H
TK100E08N1		±20	3.2	–	–	9000	130	TO-220	U-MOSVIII-H
TPH4R50ANH	100	±20	4.5	–	–	4000	58	SOP Advance	U-MOSVIII-H
TPW4R50ANH		±20	4.5	–	–	4000	58	DSOP Advance	U-MOSVIII-H
TK100A10N1		±20	3.8	–	–	8800	140	TO-220SIS	U-MOSVIII-H
TK100E10N1		±20	3.4	–	–	8800	140	TO-220	U-MOSVIII-H
TK56A12N1	120	±20	7.5	–	–	4200	69	TO-220SIS	U-MOSVIII-H
TK56E12N1		±20	7	–	–	4200	69	TO-220	U-MOSVIII-H
TK72A12N1		±20	4.5	–	–	8100	130	TO-220SIS	U-MOSVIII-H
TK72E12N1		±20	4.4	–	–	8100	130	TO-220	U-MOSVIII-H

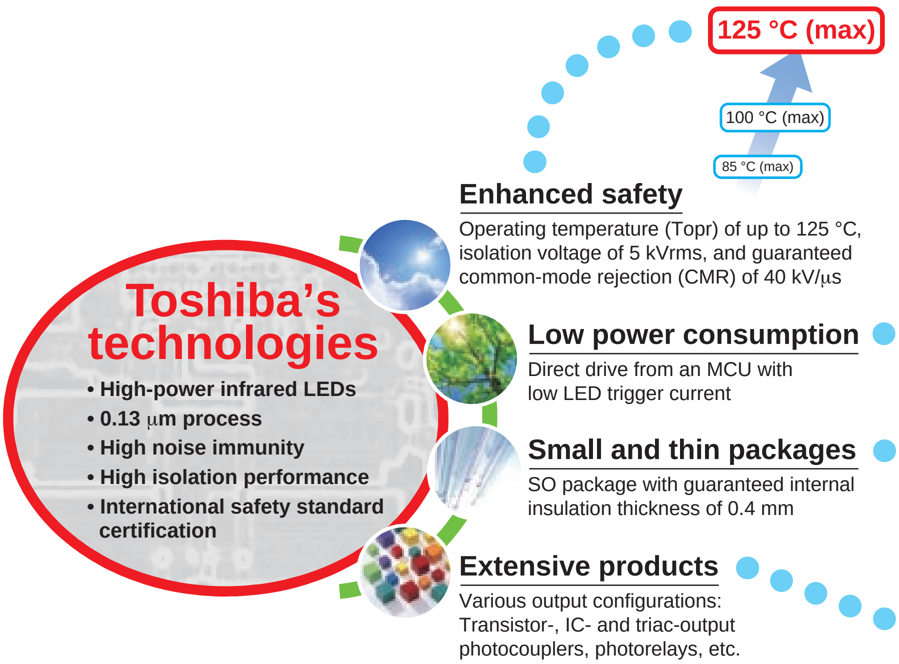
**: Under development

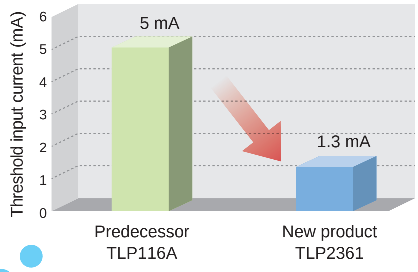
Note: The specifications and release schedules for the products under development are subject to change without notice.

Photocouplers

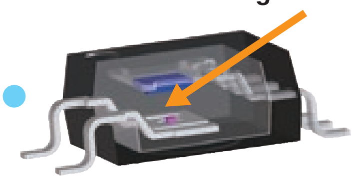
Toshiba has over 40 years of experience in photocouplers, which have been used for a variety of applications, ranging from industrial equipment such as inverters and semiconductor test systems to home appliances and housing equipment such as air conditioners and photovoltaic power generation systems. Toshiba offers photocouplers in insulated resin packages that consist of a high-power infrared LED coupled with a photo detector fabricated using the latest process. Certified to major international safety standards, these photocouplers provide high isolation voltage and low power consumption, making them ideal for applications that require enhanced safety and environmental friendliness.

Feature





Insulation thickness of 0.4 mm or greater



Driver photocoupler with overcurrent protection **TLP5214**

Product Lineup

▶IGBT / MOSFET Gate Drivers

Part Number	Output Peak Current I_{OP} (A) Max	Function*1	Supply Voltage Operating Range V_{CC} (V)	Operating temperature T_{opr} (°C)	Propagation Delay Time t_{pHL} / t_{pLH} (µs) Max	Threshold LED Input Current I_{FLH} (mA) Max	Isolation Voltage BV_S (Vrms)	Package
TLP358H	±6.0	UVLO	15 to 30	–40 to 125	0.5	5	3750	DIP8
TLP5754	±4.0	R to R, UVLO	15 to 30	–40 to 110	0.15	4	5000	SO6L
TLP5214	±4.0	OCP, AMC, R to R, UVLO	15 to 30	–40 to 110	0.15	6	5000	SO16L
TLP250H	±2.5	UVLO	10 to 30	–40 to 125	0.5	5	3750	DIP8
TLP350H		UVLO	15 to 30	–40 to 125	0.5	5	3750	DIP8
TLP700H		UVLO	15 to 30	–40 to 125	0.5	5	5000	SDIP6
TLP5702		UVLO	15 to 30	–40 to 110	0.2	5	5000	SO6L
TLP152		UVLO	10 to 30	–40 to 100	0.19/0.17	7.5	3750	5pin SO6
TLP5752		R to R, UVLO	15 to 30	–40 to 110	0.15	4	5000	SO6L
TLP5751	±1.0	R to R, UVLO	15 to 30	–40 to 110	0.15	4	5000	SO6L
TLP351H	±0.6		10 to 30	–40 to 125	0.7	5	3750	DIP8
TLP701H			10 to 30	–40 to 125	0.7	5	5000	SDIP6
TLP5701		UVLO	10 to 30	–40 to 110	0.5	5	5000	SO6L
TLP2451A			10 to 30	–40 to 125	0.5	5	3750	SO8
TLP151A			10 to 30	–40 to 110	0.5	5	3750	5pin SO6
TLP705A			10 to 30	–40 to 100	0.2	7.5	5000	SDIP6
TLP155E			10 to 30	–40 to 100	0.2	7.5	3750	5pin SO6

*1: OCP: over current protection, AMC: active miller clamp, R to R: rail to rail output, UVLO: under voltage lock out
*2: Operating range, not recommended operating conditions

Isolation Amplifier (Analog Output Type)

Part Number	Gain G (V/V) Typ.	V_{OUT} Non-linearity NL_{200} (%) Typ.	Common-mode Transient Immunity CMTI (kV/μs) Typ.	Input Offset Voltage Vos (mV) Typ.	Supply Current		Isolation Voltage BV_S (Vrms)	Package
					Input I_{DD1} (mA) Max	Output I_{DD2} (mA) Max		
TLP7820	8.2 ±0.5% ±1.0% ±3.0%	0.02	20	0.9	12	10	5000	SO8L
TLP7920**								DIP8

**: Under development

Isolation Amplifier (Digital Output Type)

Part Number	Gain Error G_E (%) Typ.	Signal-to-(noise + distortion) Ratio SNDR (dB) Typ.	Signal-to-Noise Ratio SNR (dB) Typ.	Output Clock Frequency f_{CLK} (MHz) Typ.	Input Offset Voltage Vos (mV) Typ.	Supply Current		Isolation Voltage BV_S (Vrms)	Package
						Input I_{DD1} (mA) Max	Output I_{DD2} (mA) Max		
TLP7830**	0.1	75	80	10	0.6	12	8	5000	SO8L
TLP7930**									DIP8

**: Under development

IPM Driver Couplers

Part Number	Data Rate and Output Type	Supply Voltage*1 V_{CC} (V)	High/Low-level Supply Current I_{CC} (mA) Max	Operating temperature T_{opr} (°C)	Propagation Delay Time t_{pHL} / t_{pLH} (μs) Max	Threshold LED Input Current I_{FHL} / I_{FLH} (mA) Max	Isolation Voltage BV_S (Vrms)	Package
TLP759 (IGM)	1 Mbps Open-collector	to 30	1.0 (μA) (I_{CCH})	–55 to 100	1.0	CTR: 25% Min @IF = 10 mA, Vcc = 4.5 V, Vo = 0.4V	5000	DIP8
TLP109 (IGM)		to 30	1.0 (μA) (I_{CCH})	–55 to 125	1.0		3750	5pin SO6
TLP754	1 Mbps Open-collector	4.5 to 30	1.3	–40 to 125	0.55/0.4	5.0 (Inverter logic)	5000	DIP8
TLP714		4.5 to 30	1.3	–40 to 125	0.55/0.4	5.0 (Inverter logic)	5000	SDIP6
TLP2704		4.5 to 30	1.3	–40 to 125	0.55/0.5	5.0 (Inverter logic)	5000	SO6L
TLP104		4.5 to 30	1.3	–40 to 125	0.55/0.4	5.0 (Inverter logic)	3750	5pin SO6
TLP2955	5 Mbps Totem-pole	3 to 20	3	–40 to 125	0.25	1.6 (Buffer logic)	5000	DIP8
TLP715		4.5 to 20	3	–40 to 100	0.25	3.0 (Buffer logic)	5000	SDIP6
TLP2355		3 to 20	3	–40 to 125	0.25	1.6 (Buffer logic)	3750	5pin SO6
TLP2958	5 Mbps Totem-pole	3 to 20	3	–40 to 125	0.25	1.6 (Inverter logic)	5000	DIP8
TLP718		4.5 to 20	3	–40 to 100	0.25	3.0 (Inverter logic)	5000	SDIP6
TLP2358		3 to 20	3	–40 to 125	0.25	1.6 (Inverter logic)	3750	5pin SO6
TLP2345	10 Mbps Totem-pole	4.5 to 30	3	–40 to 110	0.12	1.6 (Buffer logic)	3750	5pin SO6
TLP2745		4.5 to 30	3	–40 to 110	0.12	1.6 (Buffer logic)	5000	SO6L
TLP2348		4.5 to 30	3	–40 to 110	0.12	1.6 (Inverter logic)	3750	5pin SO6
TLP2748		4.5 to 30	3	–40 to 110	0.12	1.6 (Inverter logic)	5000	SO6L

*1: Operating range, not recommended operating conditions CTR:Current Transfer Ratio

High speed Logic Couplers

Part Number	Data Rate and Output Type	Supply Voltage*1 V_{CC} (V)	High/Low-level Supply Current I_{CC} (mA) Max	Operating temperature T_{opr} (°C)	Propagation Delay Time t_{pHL} / t_{pLH} (μs) Max	Threshold LED Input Current I_{FHL} / I_{FLH} (mA) Max	Isolation Voltage BV_S (Vrms)	Package
TLP2301	20 kbps Open-collector	V_{CEO} = 40V	–	–55 to 125	30	GB Rank CTR: 100% Min @IF = 1 mA, VCE = 5 V	3750	4pin SO6
TLP2701**							5000	SO6L
TLP2303	100 kbps Open-collector	4.5 to 18	0.01/1.5	–40 to 125	15/50	CTR: 900% Min @IF = 0.5 mA, Vcc = 4.5 V, Vo = 0.4 V	3750	5pin SO6
TLP2703							5000	SO6L
TLP109	1 Mbps Open-collector	to 30	1.0 (μA) (I_{CCH})	–55 to 125	0.8	CTR: 25% Min @IF = 10 mA, Vcc = 4.5 V, Vo = 0.4 V	3750	5pin SO6
TLP2309		2.7 to 20	1.0 (μA) (I_{CCH})	–40 to 110	1.0	CTR: 15% Min @IF = 10 mA, Vcc = 3.3 V, Vo = 0.4 V	3750	5pin SO6
TLP2395	5 Mbps Totem-pole	3.0 to 20	3	–40 to 125	0.25	2.3 (Buffer logic)	3750	5pin SO6
TLP2361	15 Mbps Totem-pole	2.7 to 5.5	1	–40 to 125	0.08	1.6 (Inverter logic)	3750	5pin SO6
TLP2761		2.7 to 5.5	1	–40 to 125	0.08	1.6 (Inverter logic)	5000	SO6L
TLP2366	20 Mbps Totem-pole	2.7 to 5.5	3	–40 to 125	0.04	3.5 (Inverter logic)	3750	5pin SO6
TLP2766		2.7 to 5.5	3	–40 to 125	0.04	3.5 (Inverter logic)	5000	SO6L
TLP2362	10 Mbps Open-collector	2.7 to 5.5	4	–40 to 125	0.10	5.0 (Inverter logic)	3750	5pin SO6
TLP2768	20 Mbps Open-collector	2.7 to 5.5	4	–40 to 125	0.06	5.0 (Inverter logic)	5000	SDIP6
TLP2768A		2.7 to 5.5	4	–40 to 125	0.06	5.0 (Inverter logic)	5000	SO6L
TLP2368		2.7 to 5.5	4	–40 to 125	0.06	5.0 (Inverter logic)	3750	5pin SO6

*1: Operating range, not recommended operating conditions CTR: Current Transfer Ratio **: Under development

SiC Schottky Barrier Diodes (SiC SBDs)

Ta = 25˚C

Part Number	Absolute Maximum Ratings				Electrical Characteristics				Circuit Configuration	Package
	Repetitive Peak Revers Voltage V_{RRM} (V)	Forward DC Current $I_{F(DC)}$ (A)	Junction Temperature T_j (˚C)	Storage Temperature T_{stg} (˚C)	Peak Forward Voltage V_{FM} (V)		Repetitive Peak Revers Current I_{RRM} (μA)			
					Max	@I_F (A)	Max	@V_{RRM} (V)		
TRS6E65C	650	6	175	–55 to 175	1.7	6	90	650	Single	TO-220-2L
TRS6A65C					1.7	6	90	650	Single	TO-220F-2L
TRS8E65C		8			1.7	8	90	650	Single	TO-220-2L
TRS8A65C					1.7	8	90	650	Single	TO-220F-2L
TRS10E65C		10			1.7	10	90	650	Single	TO-220-2L
TRS10A65C					1.7	10	90	650	Single	TO-220F-2L
TRS12E65C		12			1.7	12	90	650	Single	TO-220-2L
TRS12A65C					1.7	12	90	650	Single	TO-220F-2L
TRS12N65D					1.7	12	90	650	Center-tapped	TO-247
TRS16A65C		16			1.7	16	90	650	Single	TO-220F-2L
TRS16N65D					1.7	16	90	650	Center-tapped	TO-247
TRS20N65D		20			1.7	20	90	650	Center-tapped	TO-247
TRS24N65D		24			1.7	24	90	650	Center-tapped	TO-247
TRS20J120C	1200	20			1.7	20	90	1200	Single	TO-3P(N)

Motor Driver (Intelligent Power Devices: IPDs)

Part Number	Absolute Maximum Ratings		Feature				Protection			Package
	V_{BB} (V)	I_{OUT} (A)	Hall Sensors/ Hall IC Inputs	6 Terminals	3-Phase Distribution Circuit PWM Logic	FGC Rotation Pulse Selection	Over-current	Over-temperature	Under-voltage	
TPD4151K	250	1	✓	–	✓	–	✓	✓	✓	DIP26
TPD4142K	500	1	✓	–	✓	–	✓	✓	✓	
TPD4146K			✓	–	✓	✓	✓	✓	✓	
TPD4123K			–	✓	–	–	✓	✓	✓	
TPD4123AK			–	✓	–	–	–	✓	✓	
TPD4144K		2	–	✓	–	–	✓	✓	✓	
TPD4144AK			–	✓	–	–	–	✓	✓	
TPD4135K		3	–	✓	–	–	✓	✓	✓	
TPD4135AK			–	✓	–	–	–	✓	✓	

High-Voltage Power MOSFETs (N-ch)

Part Number	Absolute Maximum Ratings			$R_{DS(ON)}$ (Ω) Max	Q_g (nC) Typ.	C_{iss} (pF) Typ.	Series	Package
	V_{DSS} (V)	V_{GSS} (V)	I_D (A)	$\|V_{GS}\|$ = 10 V				
TK10J80E	800	±30	10	1	46	2000	π-MOSVIII	TO-3P(N)
TK9J90E	900	±30	9	1.3	46	2000	π-MOSVIII	TO-3P(N)
2SK4207		±30	13	0.95	45	2790	π-MOSIV	TO-3P(N)

Discrete IGBTs (for Hard-Switching Applications)

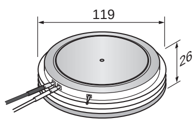
Ta = 25˚C

Part Number	Absolute Maximum Ratings					$V_{CE(sat)}$ (V) Max	t_f (μs) (Inductive Load) Typ.	Integrated Diode	Package
	V_{CES} (V)	I_C (A)	I_{CP} (A)	P_C (W)	T_j (˚C)	V_{GE} = 15 V			
GT15J341	600	15	60	30	150	2.0	0.08	✓	TO-220SIS
GT20J341		20	80	45	150	2.0	0.05	✓	TO-220SIS
GT30J121		30	60	170	150	2.45	0.05	–	TO-3P(N)
GT30J341		59	120	230	175	2.0	0.04	✓	TO-3P(N)

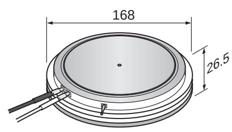
List of Packages

IEGTs (PPI / PPM)

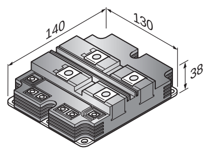
PPI85B



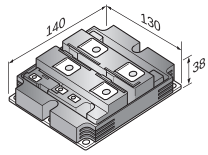
PPI125A2



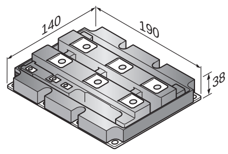
PMI142C / PMI143C



PMI143B

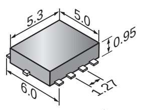


PMI193 / PMI193D

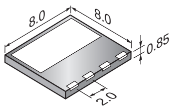


SiC SBDs / IPDs / MOSFETs / IGBTs

SOP Advance

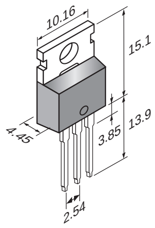


DFN8x8

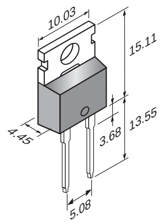


Bottom view

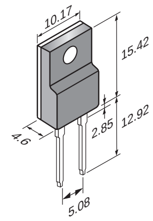
TO-220



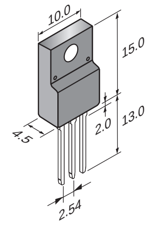
TO-220-2L



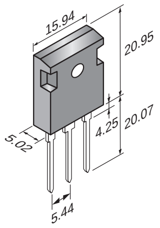
TO-220F-2L



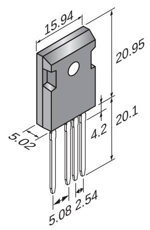
TO-220SIS (SC-67)



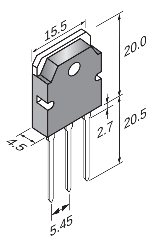
TO-247



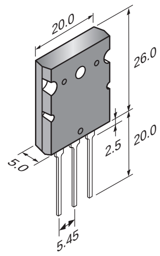
TO-247-4L



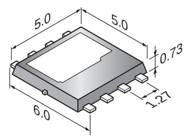
TO-3P(N) (SC-65)



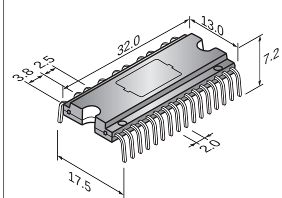
TO-3P(L)



DSOP Advance

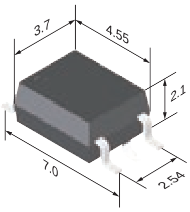


DIP26

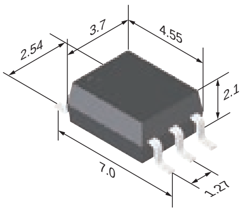


Photocouplers

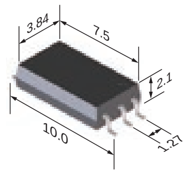
4pin SO6



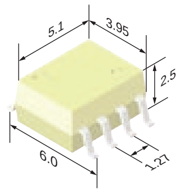
5pin SO6



SO6L



SO8



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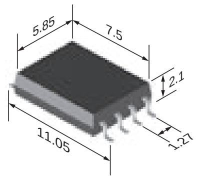

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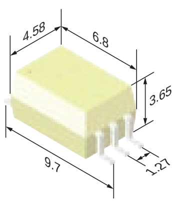

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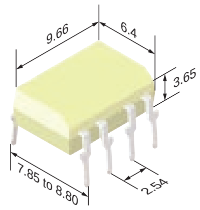

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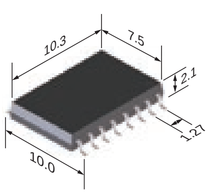

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