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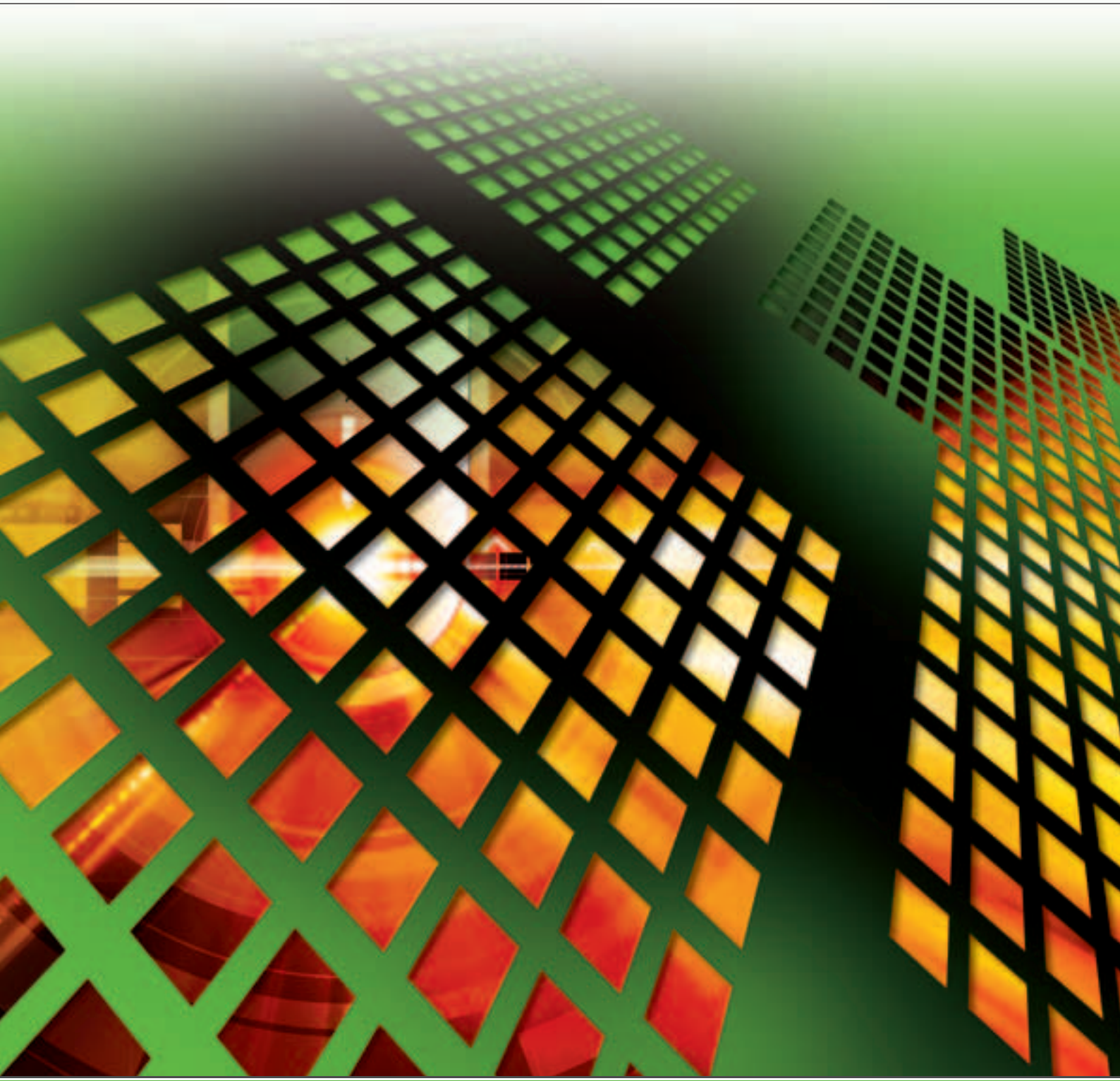
2010-5

SYSTEM CATALOG

Semiconductors for Power Supplies

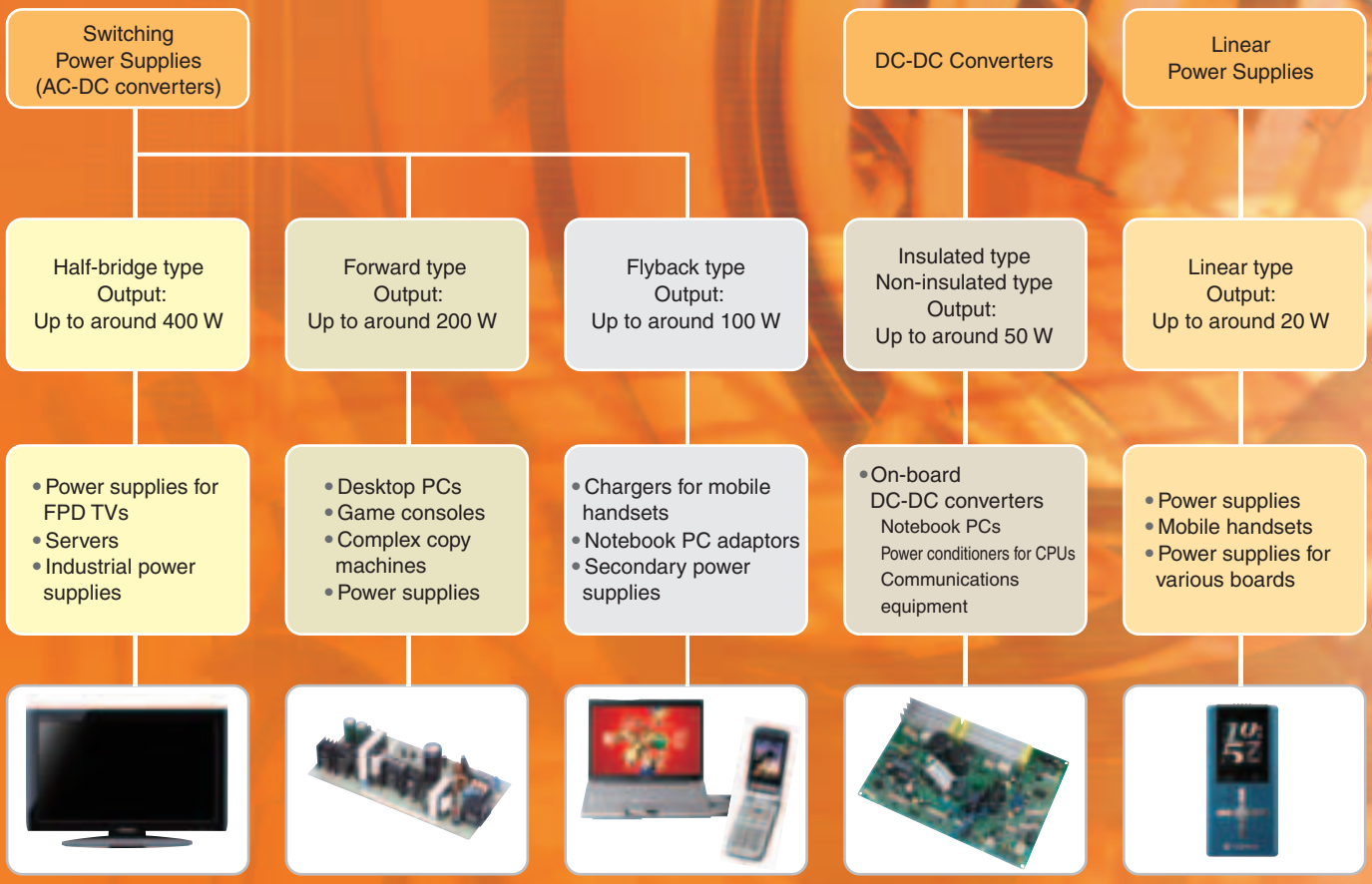


SEMICONDUCTOR

http://www.semicon.toshiba.co.jp/eng

Power Supply Circuit Types and Their Applications

Power supply circuitry includes two blocks: an AC-DC block that converts an alternating current to a direct current, and a DC-DC block that converts an input DC voltage into several working voltages appropriate for operating the electronic circuitry.
To meet customer demands, Toshiba supports low- to high-power applications and helps improve energy-saving performance and power efficiency.



Power Supply Schemes and Recommended Semiconductor Components Linear Power Supplies

	Switching Power Supplies (AC-DC converters)	DC-DC Converters	Linear Power Supplies
Regulator ICs		P.10 to P.19	P.10 to P.19
PFC controller ICs	P.20		
Specialized ICs		P.6 to P.9, P.21	
Power MOSFETs	P.22, P.26	P.24	
Power transistors	P.28	P.28	
Inverter control ICs	P.28		
Photocouplers	P.29	P.29	
Diodes	P.30	P.30	

Features of Toshiba's Semiconductor Components for Power Supply Applications

Power MOSFETs

- **Primary-Side MOSFETs** P.22, P26
  - Low ON-resistance and low gate capacitance
  - Maintains the high avalanche capability of proven conventional products
- **Secondary-Side MOSFETs for Synchronous Rectification** P.24
  - Ultra-high speed and low ON-resistance
  - New additions to the ultra-high-speed trench series with a V_{DSS} of 60 V to 100 V

Diodes P.30

- Schottky barrier diodes with low leakage current and low forward voltage
- Trench structure with high breakdown voltage
- The leakage current at high temperature is reduced by 90% compared to conventional products.

Power Transistors

- **Power transistors for switching applications** P.28
  - Fast-switching and high-h_{FE} transistors are offered in a variety of packages.
- **Power transistors for MOS gate driving** P.28
  - An NPN transistor and a PNP transistor are housed in a small surface-mount package to provide a fast gate driving capability for devices like power MOSFETs.

DC-DC Converter ICs P.6

- Small, thin package and high efficiency
- PS-8 or SOP Advance with low thermal resistance
- Multiple outputs P.8
- Digital control P.9

Regulator ICs

- **Series Regulators** P.10
  - Low dropout, low V_{OUT} and on/off switch
- **Point Regulator ICs** P.14
  - CMOS and bipolar regulators
  - Single- and dual-output regulators
- **Shunt Regulator ICs** P.19
  - High precision of ±1% and thin package

Photocouplers P.29

TLP181/TLP285/TLP781
To meet customer needs, Toshiba offers photocouplers in a variety of packages that are certified by international safety standards.

- DIP4: TLP781
- SOP4: TLP285
- MFSOP: TLP181

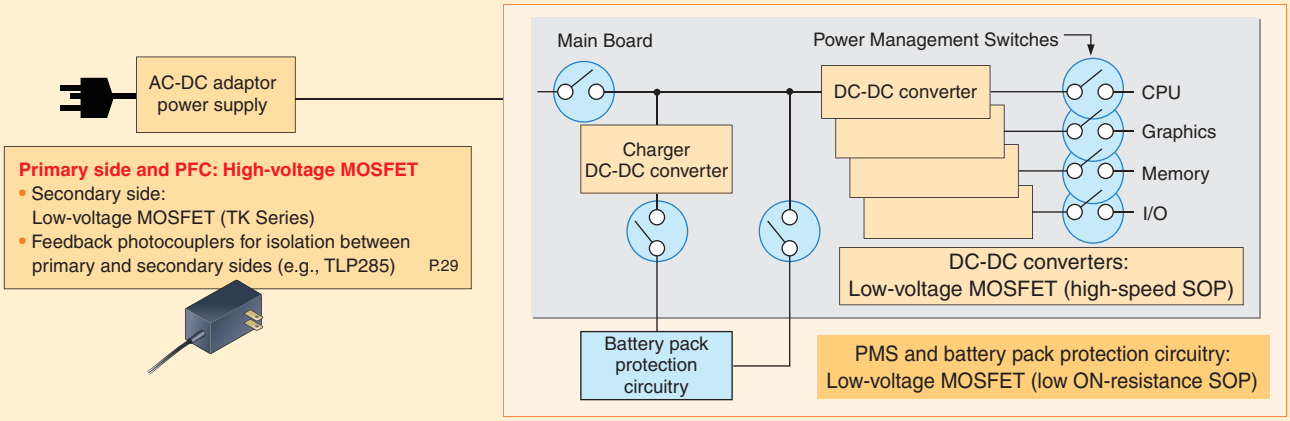
Contents

Configuration Examples of Power Supply Circuitry

Mobile Equipment

Block Diagram

For mobile equipment, such as notebook PCs, DC-DC converters are necessary to support not only inputs from external power supplies, but also those from internal power supplies including batteries. Toshiba also offers low ON-resistance power MOSFETs and multiple-output power supply ICs to improve energy efficiency.



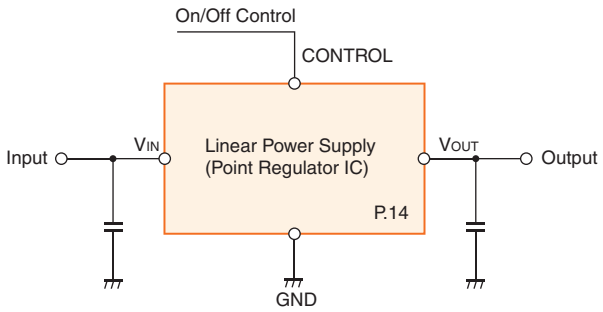
● Linear Power Supplies (Point Regulator ICs)

Since point regulator ICs are physically small, a constant-voltage source can be easily embedded in space-limited applications.

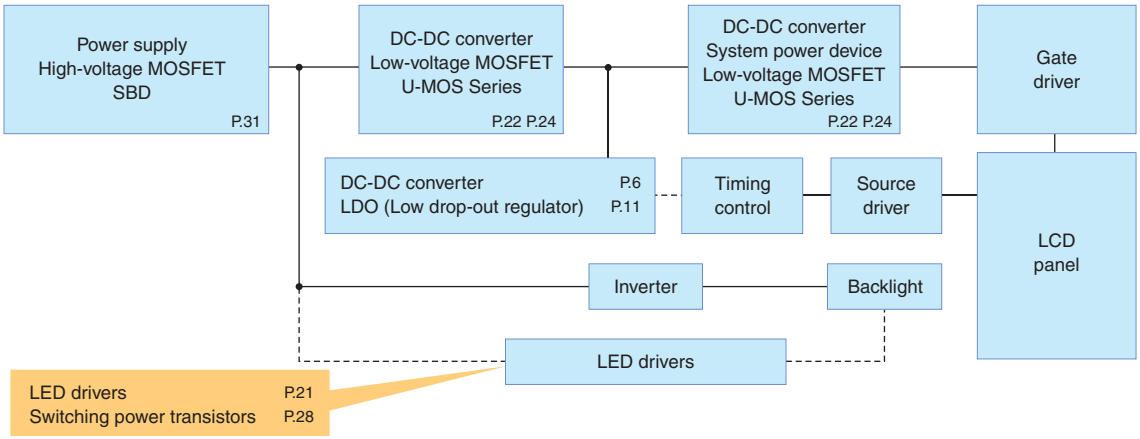
Point regulator ICs are available in fixed and adjustable voltage versions. Compared to switching power supplies, linear power supplies generate less noise and require fewer external components.

Application Examples

- General-purpose applications



LCD Displays

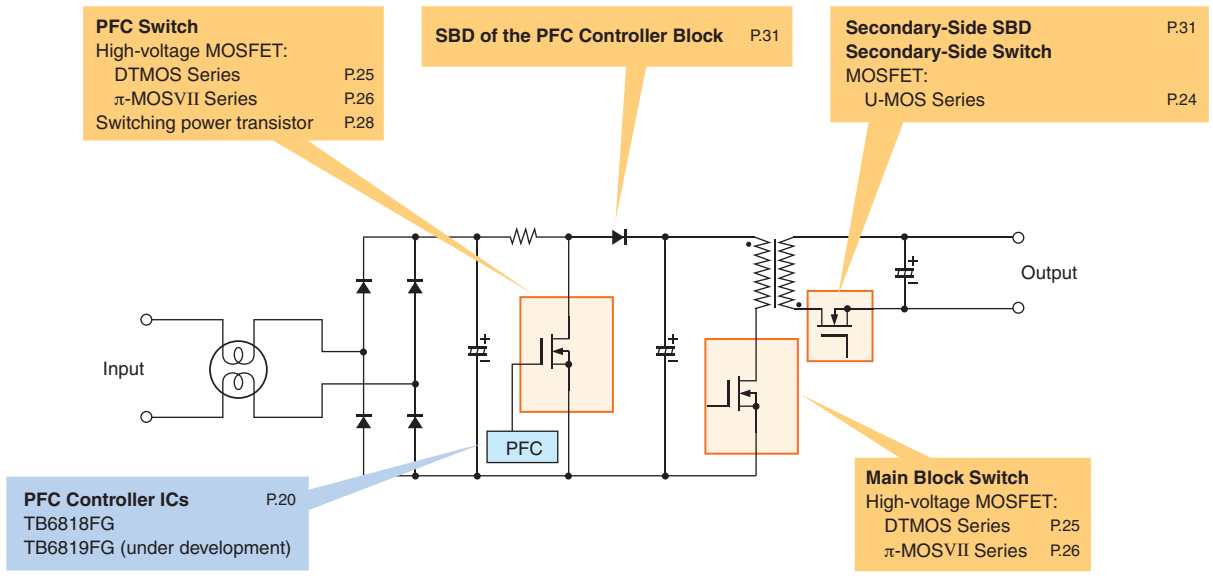


● Switching Power Supplies (AC-DC Power Supplies)

Switching power supplies are used at a frequency above 100 kHz. Toshiba offers MOSFETs ideal for fast switching.

Application Examples

- Notebook PC adaptors

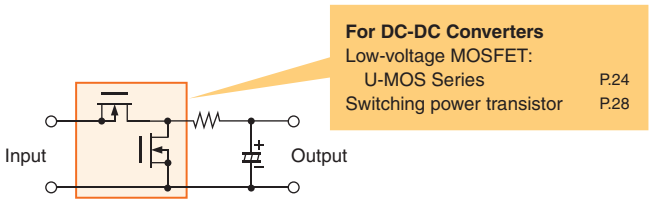


● DC-DC Converters (Isolated)

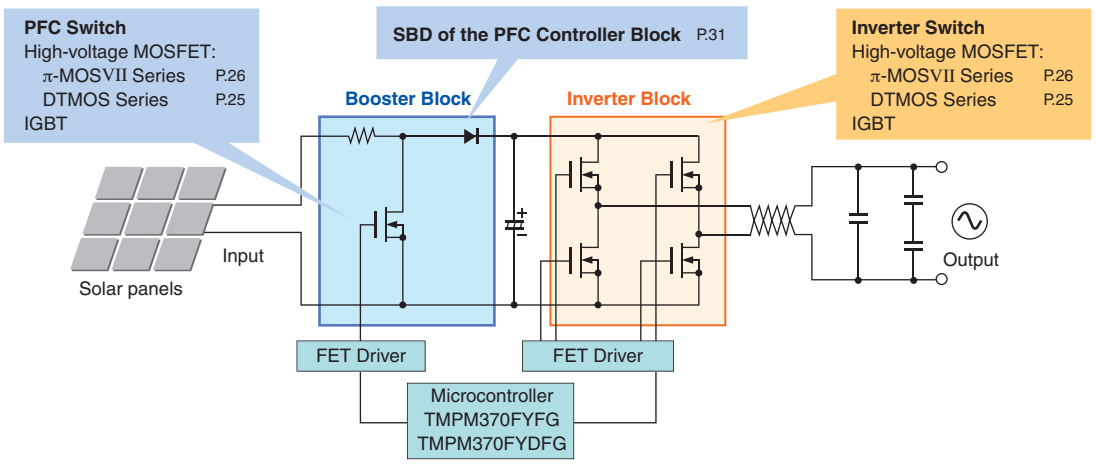
A DC-DC converter can be used in energy-saving mode or for generating a DC supply voltage for internal circuitry separately from that of the main DC power source, such as a battery.

Application Examples

- General-purpose applications



Solar Power Inverters (Power Conditioner Systems (PCS))



DC-DC Converter ICs

These DC-DC converter ICs are best suited to low-voltage, high-current drive of ICs implemented in various equipment, such as SoCs and ASICs.
Small and efficient DC-DC converters can be built by adding only a few external parts.

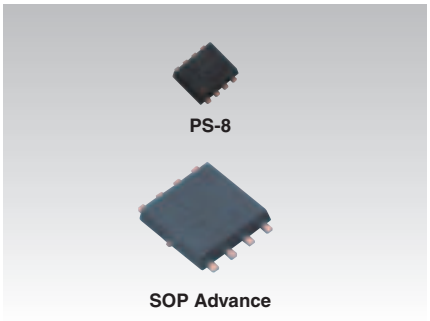
Single-Output DC-DC Converter ICs

Features

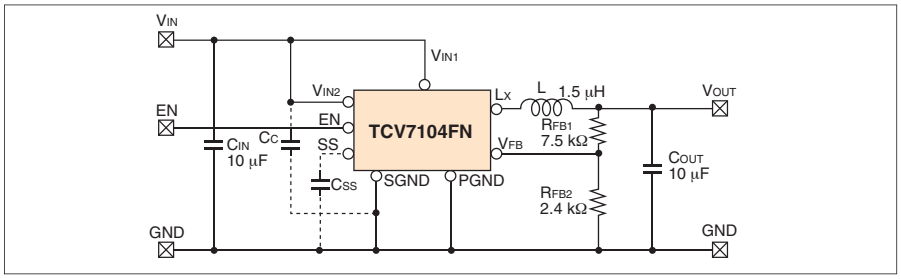
- Available with output current capabilities ranging from 0.7 A to 5.0 A.
- High efficiency: 95% typical when the TCV7104FN is used @ V_{IN} = 5 V, V_{OUT} = 3.3 V, I_{OUT} = 0.7 A, Tj = 25°C
- Reduces the size of external parts by offering the high-frequency switching ability and offers fast transient response using current-mode control.
- High accuracy reference voltage (V_{FB}): 0.8 V ± 1% (with the TCV7100/01/02/03F, TCV7104/06FN @ Tj = 25°C)
- A ceramic capacitor can be used as an output filter capacitor.
- Various features: Thermal shutdown, overcurrent protection, undervoltage lockout (UVLO), soft-start (with programmable soft-start time)

Application Examples

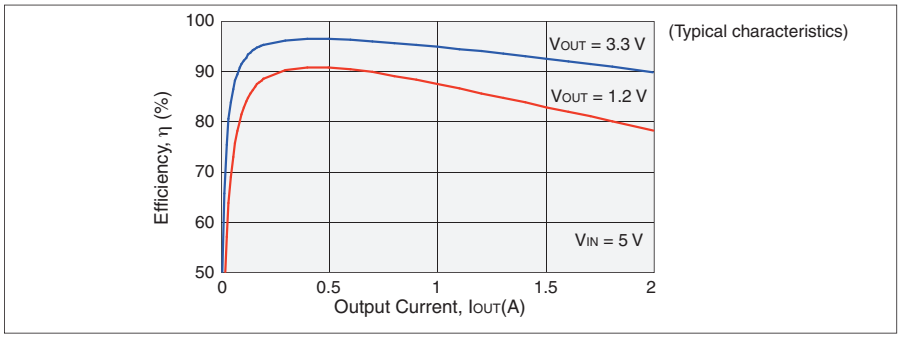
- LCD TVs
- Copies
- Plasma TVs
- Amusement equipment
- Digital home appliances



Application Circuit Example (V_{OUT} = 3.3V)



Efficiency Curves



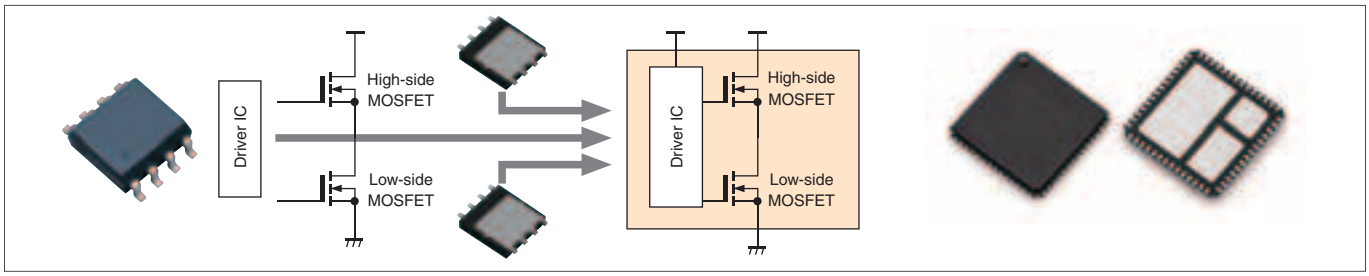
Multi-Chip Module (MCM)

Features

- Designed as low-voltage, high-current buck DC-DC converters for CPUs, etc.
- Efficient heat radiation from the package bottom to the PCB
- Wire impedance reduction with internal wire optimization
- The dedicated driver IC provides high-efficiency operation with optimal dead time control.

Application Examples

- Servers
- Game consoles
- PCs



Product Lineup: Single-Output DC-DC Converter ICs

Part Number	Type	Absolute Maximum Ratings		Input Voltage Range (V)	Output Voltage Typ. (V)	Switching Frequency Typ. (kHz)	Packaging	Remarks
		Output Current (mA)	Input Voltage (V)					
TB7100F	Buck	700	6	3 to 5.5	Variable	550	PS-8	Integrates a switching element on-chip. External rectification Schottky barrier diode
TB7101F(T5L1.2,F)	Buck	1000	6	2.7 to 5.5	1.2	1000	PS-8	Integrates a switching element on-chip. Soft-start EN threshold: CMOS level
TB7101F(T5L1.5,F)	Buck	1000	6	2.7 to 5.5	1.5	1000	PS-8	Integrates a switching element on-chip. Soft-start EN threshold: CMOS level
TB7101F(T5L1.8,F)	Buck	1000	6	2.8 to 5.5	1.8	1000	PS-8	Integrates a switching element on-chip. Soft-start EN threshold: CMOS level
TB7101F(T5L2.5,F)	Buck	1000	6	3.5 to 5.5	2.5	1000	PS-8	Integrates a switching element on-chip. Soft-start EN threshold: CMOS level
TB7101F(T5L3.3,F)	Buck	1000	6	4.3 to 5.5	3.3	1000	PS-8	Integrates a switching element on-chip. Soft-start EN threshold: CMOS level
TB7102F	Buck	1000	6	2.7 to 5.5	Variable	1000	PS-8	Integrates a switching element on-chip. Soft-start EN threshold: CMOS level
TB7101AF(T5L1.2,F)	Buck	1000	6	2.7 to 5.5	1.2	1000	PS-8	Integrates a switching element on-chip. Soft-start EN threshold: TTL level
TB7101AF(T5L1.5,F)	Buck	1000	6	2.7 to 5.5	1.5	1000	PS-8	Integrates a switching element on-chip. Soft-start EN threshold: TTL level
TB7101AF(T5L1.8,F)	Buck	1000	6	2.8 to 5.5	1.8	1000	PS-8	Integrates a switching element on-chip. Soft-start EN threshold: TTL level
TB7101AF(T5L2.5,F)	Buck	1000	6	3.5 to 5.5	2.5	1000	PS-8	Integrates a switching element on-chip. Soft-start EN threshold: TTL level
TB7101AF(T5L3.3,F)	Buck	1000	6	4.3 to 5.5	3.3	1000	PS-8	Integrates a switching element on-chip. Soft-start EN threshold: TTL level
TB7102AF	Buck	1000	6	2.7 to 5.5	Variable	1000	PS-8	Integrates a switching element on-chip. Soft-start EN threshold: TTL level
TC7704FNG	Buck	1000	5.5	2.7 to 5.5	Variable	3000	SSOP16	Integrates a switching element on-chip. LDO mode Soft-start
TCV7100F	Buck	2500	6	2.7 to 5.5	Variable	800	SOP Advance	Integrates a switching element on-chip. Soft-start Time adjustable
TCV7101F	Buck	3800	6	2.7 to 5.5	Variable	600	SOP Advance	External rectification MOSFET Soft-start Time adjustable
TCV7102F	Buck	3000	6	2.7 to 5.5	Variable	1400	SOP Advance	Integrates a switching element on-chip. Soft-start Time adjustable
TCV7103F	Buck	5000	6	2.7 to 5.5	Variable	1000	SOP Advance	External rectification MOSFET Soft-start Time adjustable
TB7107FN	Buck	2000	25	4.5 to 20	Variable	380	PS-8	Integrates a switching element on-chip. External rectification Schottky barrier diode Soft-start, Time adjustable
TCV7104FN	Buck	2000	6	2.7 to 5.5	Variable	1500	PS-8	Integrates a switching element on-chip. Soft-start Time adjustable
TCV7106FN	Buck	2000	6	2.7 to 5.5	Variable	550	PS-8	Integrates a switching element on-chip. Soft-start Synchronous rectification←→Chopper
TB7106F*	Buck	3000	25	4.5 to 20	Variable	500	SOP Advance	Integrates a switching element on-chip. External rectification Schottky barrier diode Soft-start, Time adjustable

* : Under development

Product Lineup: Multi-Chip Module (MCM)

Part Number	Packaging	Absolute Maximum Ratings		Description	Typical Control Input Voltage (V)	Remarks
		V_{IN}-PGND Voltage (V)	I_{OUT} (A)			
TB7007FL ☆	QFN56	30	35	Operating frequency: 1 MHz Undervoltage lockout, standby function, boot switch	5	3.3-V PWM input

☆: Dry-packed

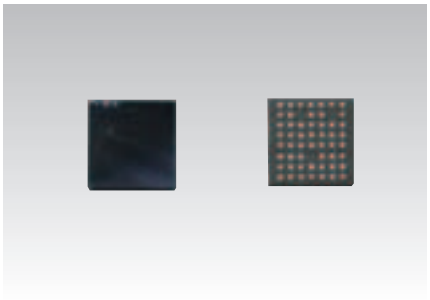
Multiple-Output DC-DC Converter IC for Mobile Handsets, TB6830WBG (Under Development)

Overview

The TB6830WBG is a multiple-output DC-DC converter IC that consists of a 2-channel boost DC-DC converter, a single-channel buck/boost DC-DC converter and a 5-channel low-dropout (LDO) regulator. Since the TB6830WBG incorporates LDOs, operating modes can be selected between LDO and buck/boost modes under light-load conditions. The TB6830WBG is housed in a WCSP package measuring 4.3 mm x 4.3 mm.

Application Examples

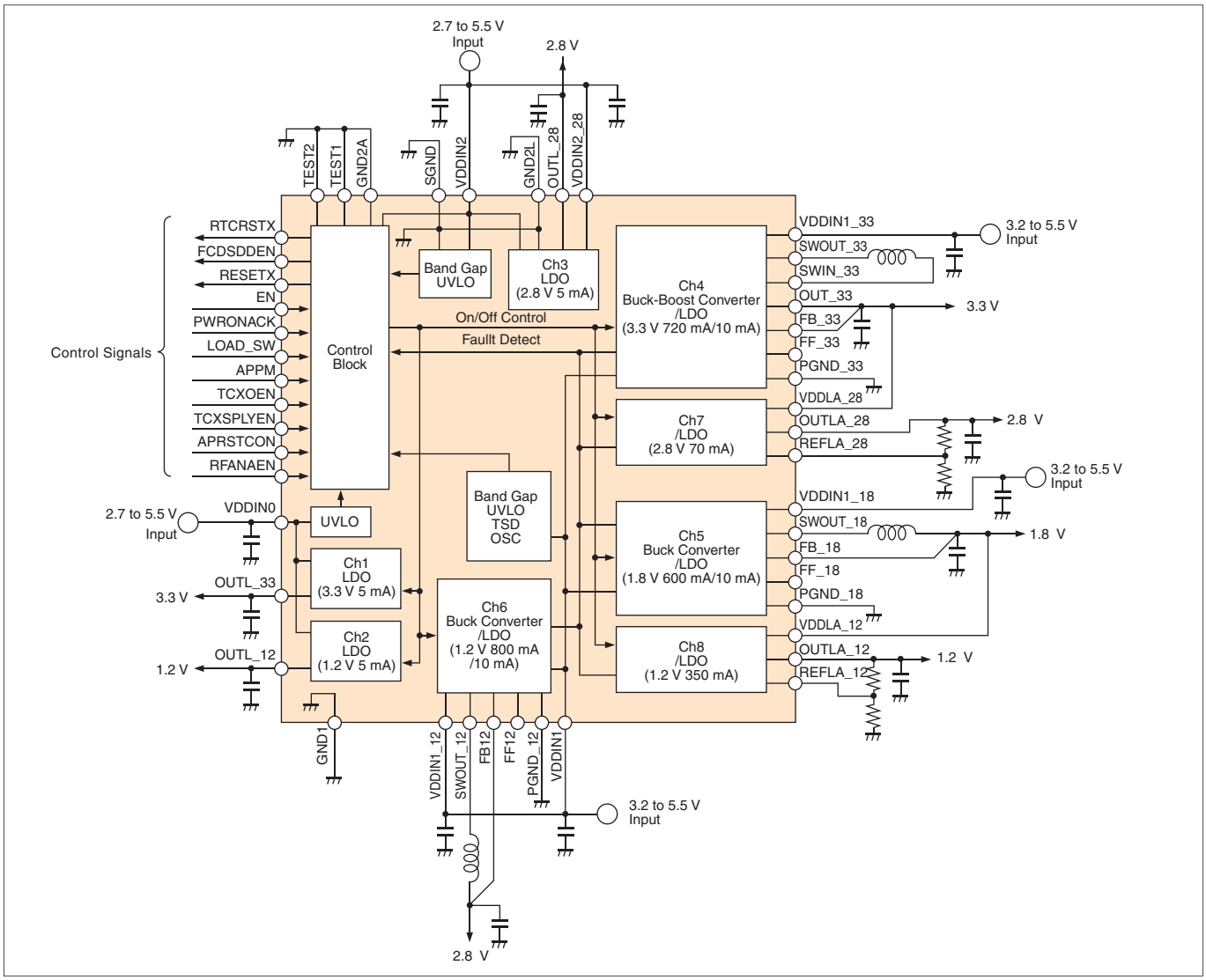
- Cell Phones



Features

- Monolithic BiCD IC
- Input voltage range: 2.7 V to 5.5 V
- Three-channel DC-DC converters
  - Current-controlled PWM regulation
  - Two-channel buck converters and one-channel buck-boost converter
  - Selectable between LDO and buck/boost modes.
  - Oscillation frequency: 1.5 MHz (typ.)
  - Output currents: 720 mA/3.3 V, 600 mA/1.8 V, 800 mA/1.2 V
- Five-channel LDO regulators
- Undervoltage lockout (UVLO)
- Overcurrent protection (OCP)
- Short-circuit protection (SCP)
- Thermal shutdown (TSD)

Block Diagram



Digitally-Controlled Buck DC-DC Converter IC, TC7750FTG (Under Development)

Overview

The TC7750FTG is a buck DC-DC converter IC that can be controlled digitally.

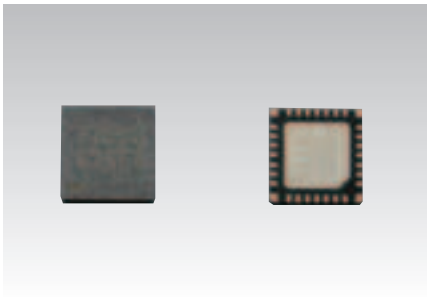
The TC7750FTG offers a PMBus communication feature that conforms to the POLA standard.

Features

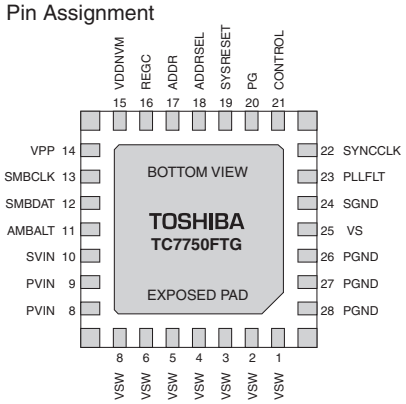
- Input voltage range: 2.7 V to 5.5 V
- Output voltage of a wide programmable range: 0.6 V to (VIN - 0.3) V @ 0.75 MHz
- Output current: 3.0 A (max)
- PMBus communication feature: Conforms to the POLA standard.
- Monitoring functions with programmable detection thresholds
  - Programmable output undervoltage detection (POUVD)
  - Programmable output overvoltage detection (POOVD)
  - Programmable output overcurrent detection (POOCD)
  - Overtemperature detection with programmable threshold (POTD)
  - Input undervoltage detection with programmable threshold (PIUVD)
- Power supply protection features with programmable protection sequences
  - Overtemperature protection (OTP)
  - Input undervoltage protection (IUVP)
  - Peak output overcurrent protection (POOCP)
- Snap-acting secondary protection
  - Thermal shutdown (TSD)
  - Overcurrent shutdown (PISD)
- Synchronous rectification drive
- One-shot boost control circuitry to suppress output voltage drop due to a sudden load change
- Small and flat QFN28 package

Application Examples

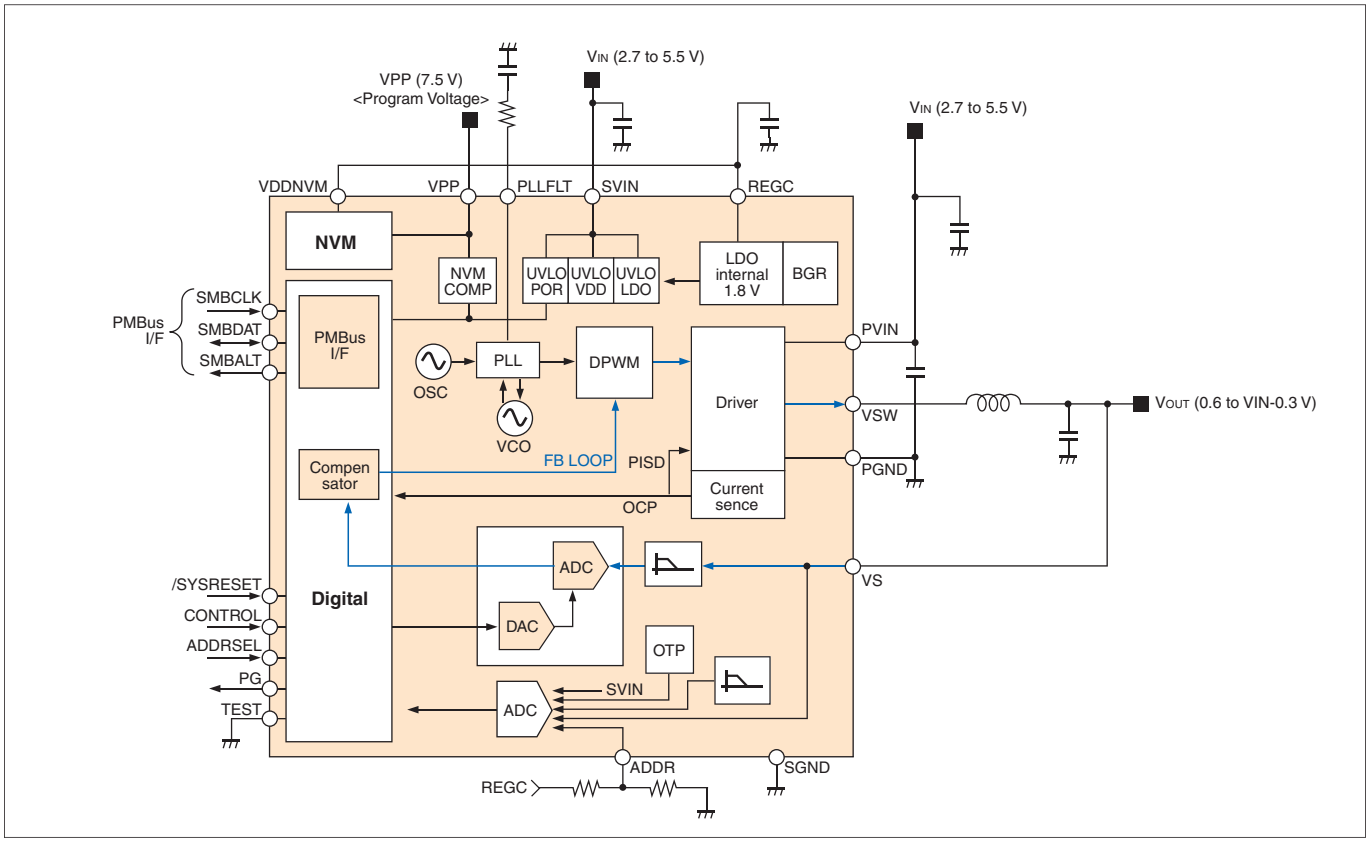
- POL power supplies (servers, printers, etc.)



Pin Assignment



Block Diagram



Series Regulators

TA78/79 Series (General-Purpose Regulators)

Features

- Available with output voltages from 3.3 V to 24 V
- Surface-mount and leaded packages
- Available with output currents from 100 mA to 1 A
- Protection features: Overcurrent and thermal shutdown

Application Examples

- PC peripherals
- Office equipment
- Digital home appliances
- Audio equipment

Product Lineup

Part Number	Output Voltage (V)																Output Current (mA)	Input Voltage (V)	Power Dissipation (W)	Output Accuracy (%)	Bias Current (max)(mA)	Dropout Voltage (typ.)(V)	Protection		Packaging
	3.3	4	5	5.7	6	7	7.5	8	9	10	12	13.2	15	18	20	24							Overcurrent (Drooping)	Thermal Shutdown	
Device id: xx	033	04	05	057	06	07	75	08	09	10	12	132	15	18	20	24									
TA78xxAF	○	○	○	–	–	○	–	○	○	–	–	–	–	–	–	–	1000	20	1.0@Ta = 25°C		8	2.0@IOUT = 1 A	○	○	New PW-Mold
TA78xxF	–	–	○	○	○	○	–	○	○	○	○	–	○	○	○	○	1000		1.0@Ta = 25°C	±4@Tj = 25°C	8	2.0@IOUT = 1 A	○	○	New PW-Mold
TA78MxxF	–	–	○	–	○	–	–	○	○	○	○	–	○	○	○	○	500		1.0@Ta = 25°C		8	1.7@IOUT = 350 mA	○	○	New PW-Mold
TA78LxxF	–	–	○	–	○	○	–	○	○	○	○	–	○	○	○	○	150	35(@VOUT = Up to 15 V) /40(@VOUT = from 18 V)	0.5@Ta = 25°C	±5@Tj = 25°C		1.7@IOUT = 150 mA	○	○	PW-Mini
TA78LxxPF	–	–	○	–	○	○	–	○	○	○	○	–	○	–	–	–	150		0.62@Ta = 25°C		6(@VOUT = Up to 6 V)/ 6.5(@VOUT = from 7 V)	2.0@IOUT = 150 mA	○	○	PS-8
TA78LxxxAP (Note)	–	–	○ 005	–	○ 006	○ 007	○ 075	○ 008	○ 009	○ 010	○ 012	○ 132	○ 015	○ 018	○ 020	○ 024	150		0.8@Ta = 25°C	±4@Tj = 25°C		1.7@IOUT = 150 mA	○	○	LSTM
TA78LxxS	–	–	○	–	–	○	–	○	○	○	○	–	○	–	–	–	100		0.6@Ta = 25°C			1.7@IOUT = 100 mA	○	○	TO-92

Note: Device ids are shown on the lower row.

Part Number	Output Voltage (V)										Output Current (mA)	Input Voltage (V)	Power Dissipation (W)	Output Accuracy (%)	Bias Current (max)(mA)	Dropout Voltage (typ.)(V)	Protection		Packaging
	–5	–6	–8	–9	–10	–12	–15	–18	–20	–24							Overcurrent (Drooping)	Thermal Shutdown	
Device id: xx	05	06	08	09	10	12	15	18	20	24									
TA79LxxF	○	○	○	○	○	○	○	○	○	○	150	-35(@VOUT = Up to -15 V) /-40(@VOUT = from -18 V)	0.5@Ta = 25°C	±4@Tj = 25°C	6(@VOUT = Up to -6 V)/ 6.5(@VOUT = from -7 V)	1.7@IOUT = 40 mA	○	○	PW-Mini
TA79L0xxP	○	○	○	○	○	○	○	○	○	○	150		0.8@Ta = 25°C			1.7@IOUT = 40 mA	○	○	LSTM

Low-Drop-Out Regulators (LDO)

TA48 Series (LDO Regulators)

Features

- The TA48xxBF Series allows use of a 2.2-µF ceramic capacitor as an output capacitor.*Note 1
- Wide range of output voltages available: 1.5 V to 9 V
- The TA4800AF allows the output voltage to be adjusted with external resistors.
- Protection features: Overcurrent, thermal shutdown, overvoltage*Note 2 and reverse voltage*Note 2

*Note 1: The capacitance of an output capacitor needs to be optimized for each system.
*Note 2: Available only with the TA48MxxF Series

Application Examples

- PC peripherals
- Office equipment
- Digital home appliances
- Audio equipment

Product Lineup

Part Number	Output Voltage (V)												Output Current (mA)	Input Voltage (V)	Power Dissipation (W)	Output Accuracy (%) @Tj = 25°C	Bias Current (mA) @IOUT = 0 A	Dropout Voltage (V)	Protection				Packaging
	1.5	1.8	2	2.5	3	3.3	3.45	4	5	8	9	Variable							Overcurrent (Drooping)	Thermal Shutdown	Over-voltage	Reverse Voltage	
Device id: xx	015	018	02	025	03	033	0345	04	05	08	09	–											
TA48xxBF	○	○	–	○	–	○	–	–	○	○	○	–	1000	16	1 @ Ta = 25°C	±3	0.85(typ.)	1.1(max) @ IOUT = 500 mA VOUT = 1.5 V/ 0.5(max) @ IOUT = 500 mA VOUT = from 1.8 V	○	○			New PW-Mold
TA4800AF	–	–	–	–	–	–	–	–	–	–	–	○	1000	16	1 @ Ta = 25°C	±2.5(VREF)	0.85(typ.)	0.5(max) @ IOUT = 500 mA	○	○			New PW-Mold, 5-pin
TA48MxxF	–	–	–	○	○	○	○	○	○	–	–	–	500	29	1 @ Ta = 25°C	±4	0.85(typ.) @ VOUT = Up to 3.45 V/ 0.9(typ.) @ VOUT = 4 V/ 1.0(typ.) @ VOUT = 5 V	0.35(max) @ IOUT = 250 mA	○	○	○	○	New PW-Mold
TA48LxxF	–	○	○	○	○	○	–	–	○	–	–	–	150	16	0.5 @ Ta = 25°C	±3	0.8(max)	0.4(max) @ IOUT = 40 mA VOUT = 1.8 V/ 0.35(max) @ IOUT = 40 mA VOUT = from 2 V	○	○			PW-Mini

TA48S Series (LDO Regulators with On/Off Control)

Features

- The on/off control switch helps to save a system's power dissipation.
- The TA48SxxAF Series allows use of a 3.3-µF ceramic capacitor as an output capacitor.*Note 3
- Available with output voltages from 1.5 V to 9 V
- The TA48S00AF and TA48LS00F allow the output voltage to be adjusted with external resistors.
- Protection features: Overcurrent and thermal shutdown

*Note 3: The capacitance of an output capacitor needs to be optimized for each system.

Application Examples

- PC peripherals
- Office equipment
- Digital home appliances
- Audio equipment

Product Lineup

Part Number	Output Voltage (V)							Output Current (mA)	Input Voltage (V)	Power Dissipation (W)	Output Accuracy (%) @Tj = 25°C	Bias Current (mA) @IOUT = 0 A	Dropout Voltage (V)	Protection		Packaging
	1.5	1.8	2.5	3.3	5	9	Variable							Overcurrent (Drooping)	Thermal Shutdown	
Device id: xx	015	018	025	033	05	09	–									
TA48SxxAF	○	○	○	○	○	○	–	1000	16	1 @ Ta = 25°C	±3	0.85(typ.) @ VOUT = Up to 5 V/ 0.9(typ.) @ VOUT = 9 V	1.1(max) @ IOUT = 500 mA VOUT = 1.5 V/ 0.5(max) @ IOUT = 500 mA VOUT = from 1.8 V	○	○	New PW-Mold, 5-pin
TA48S00AF	–	–	–	–	–	–	○	1000	16	1 @ Ta = 25°C	±2.5(VREF)	0.85(typ.)	0.5(max) @ IOUT = 500 mA	○	○	New PW-Mold, 5-pin
TA48LSxxF	○	○	○	○	○	–	–	300	14	*1.2 @ Ta = 25°C	±2.5	1.0(typ.)	0.7(max) @ IOUT = 150 mA VOUT = 1.5 V/ 0.5(max) @ IOUT = 150 mA VOUT = from 1.8 V	○	○	PS-8
TA48LS00F	–	–	–	–	–	–	○	300	14	*1.2 @ Ta = 25°C	±2.3(VREF)	1.0(typ.)	0.5(max) @ IOUT = 150 mA	○	○	PS-8

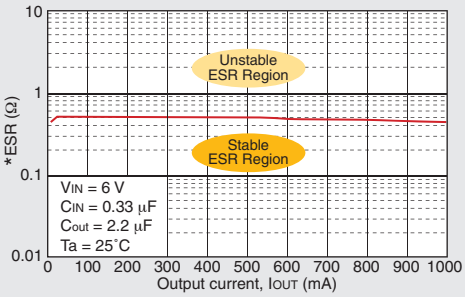
*: When mounted on an FR-4 glass-epoxy board

3 Regulator ICs

Increased stable ESR region (Prevents LDO from oscillation)

Intended only as a guide

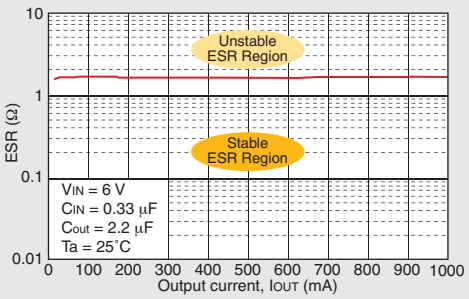
TA4805F (Predecessor)



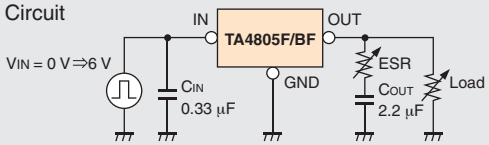
A wider stable range of ESR provides greater LDO stability.

Significant increase in the stable ESR region, three times larger than the TA4805F

TA4805BF (New Product)



Test Circuit

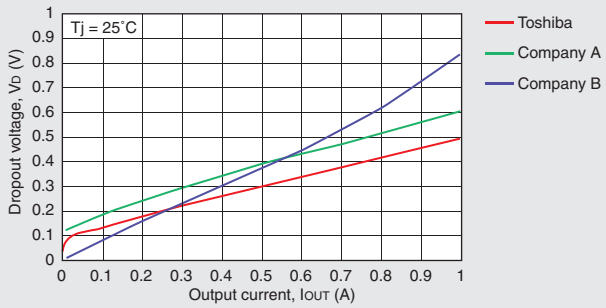


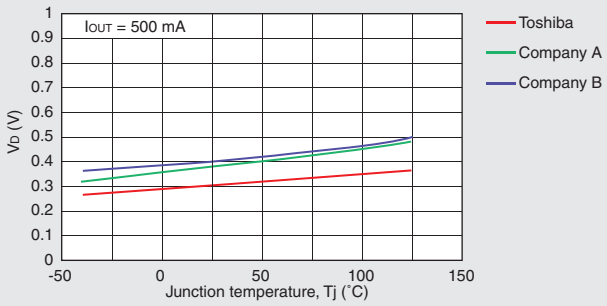
*ESR: equivalent series resistance for a capacitor

The stable ESR region is greatly affected by the voltage, current, temperature and capacitor type. Perform experiments to assure stability.

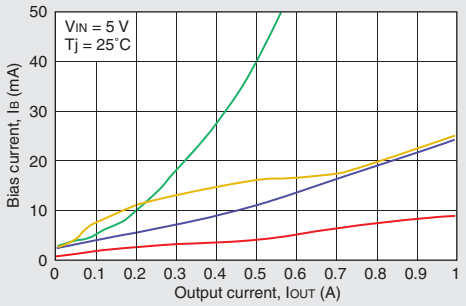
Lower dropout voltage (Reduced system power consumption)

The low input-to-output differential can lead to a reduction in system power consumption.





Reduced bias current (Reduced system power consumption)

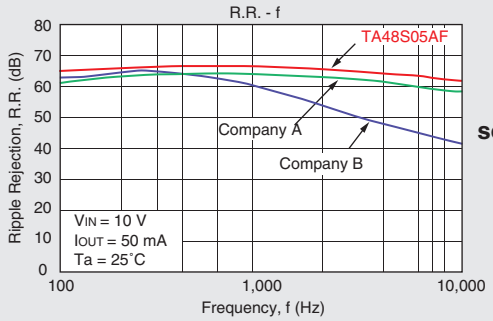


A device's power dissipation can be reduced due to lower bias current (I_B).
When I_{OUT} = 500 mA, there will be a difference of approx. 23°C in junction temperature (Tj) between Toshiba's and Company A's devices.

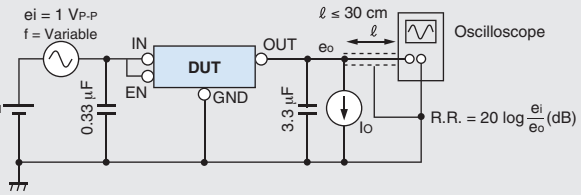
Note: Based on Toshiba's own standards

Power dissipation (P_D) of a regulators IC: $P_D = V_{IN} \times I_B + (V_{IN} - V_{OUT}) \times I_{OUT}$
V_{IN}: Input voltage (V) V_{OUT}: Output voltage (V)
I_B: Bias current (A) I_{OUT}: Output current (A)

Higher ripple rejection (Lower noise)



Ideal for video, audio and sound equipment.



The TA48S05AF exhibits high ripple rejection even at high frequencies.
Toshiba: 63 dB (@f = 10 kHz)
Company A: 59 dB (@f = 10 kHz) Company B: 42 dB (@f = 10 kHz)

TA58L/M and TA78DS Series (LDO Regulators)

Features

- Available with output voltages from 5 V to 15 V
- Surface-mount and leaded packages
- 60-V load dump protection
- High-accuracy output voltage: ± 3% (@Tj = 25°C), ± 4% (@Tj = -40 to 105°C) (TA58L/M Series)

Application Examples

- PC peripherals
- Office equipment
- Digital home appliances
- Audio equipment
- Automotive equipment

Product Lineup

Part Number	Output Voltage (V)							Output Current (mA)	Input Voltage (V)	Power Dissipation (W)	Output Accuracy (%) @Tj = 25˚C	Bias Current (mA) @IOUT = 0 A	Dropout Voltage (V)	Protection				Packaging
	5	6	8	9	10	12	15							Overcurrent (Drooping)	Thermal Shutdown	Over-voltage	Reverse Voltage	
Device id: xx	05	06	08	09	10	12	15											
TA58MxxF	○	○	○	○	○	○	○	500	29(DC)/ 60(pulse)	1@Ta = 25˚C	±3	0.5 to 0.7	0.35(max)@IOUT = 250 mA	○	○	○	○	New PW-Mold
TA58MxxS	○	○	○	○	○	○	○	500	29(DC)/ 60(pulse)	2@Ta = 25˚C	±3	0.5 to 0.7	0.35(max)@IOUT = 250 mA	○	○	○	○	TO-220NIS
TA58LxxF	○	○	○	○	○	○	○	250	29(DC)/ 60(pulse)	1@Ta = 25˚C	±3	0.45 to 0.75	0.4(max)@IOUT = 200 mA	○	○	○	○	New PW-Mold
TA58LxxS	○	○	○	○	○	○	○	250	29(DC)/ 60(pulse)	2@Ta = 25˚C	±3	0.45 to 0.75	0.4(max)@IOUT = 200 mA	○	○	○	○	TO-220NIS
TA78DSxxF	○	○	○	○	○	○	○	30	29(DC)/ 60(pulse)	0.5@Ta = 25˚C	±5	0.6 to 1.0	0.3(max)@IOUT = 10 mA	○	○	○	○	PW-Mini
TA78DS05AF	○	–	–	–	–	–	–	30	29(DC)/ 60(pulse)	0.5@Ta = 25˚C	±4	0.6 to 1.0	0.3(max)@IOUT = 10 mA	○	○	○	○	PW-Mini
TA78DSxxBP	○	○	○	○	○	○	○	30	29(DC)/ 60(pulse)	0.8@Ta = 25˚C	±5	0.6 to 1.0	0.3(max)@IOUT = 10 mA	○	○	○	○	LSTM
TA78DS05CP	○	–	–	–	–	–	–	30	29(DC)/ 60(pulse)	0.8@Ta = 25˚C	±4	0.6 to 1.0	0.3(max)@IOUT = 10 mA	○	○	○	○	LSTM

*: The input bias current differs from device to device. See the technical datasheet for each device.

TA58MS Series (LDOs with On/Off Control)

Features

- The on/off control switch helps to save a system's power dissipation.
- Available with output voltages from 3.3 V to 12 V
- The TA58MS00F allows the output voltage to be adjusted with external resistors
- 60-V load dump protection

Application Examples

- PC peripherals
- Office equipment
- Digital home appliances
- Audio equipment
- Automotive equipment

Product Lineup

Part Number	Output Voltage (V)							Output Current (mA)	Input Voltage (V)	Power Dissipation (W)	Output Accuracy (%) @Tj = 25˚C	Bias Current (mA) @IOUT = 0 A	Dropout Voltage (V)	Protection				Packaging
	3.3	5	6	8	9	12	Variable							Overcurrent (Foldback)	Thermal Shutdown	Over-voltage	Reverse Voltage	
Device id: xx	033	05	06	08	09	12	–											
TA58MSxxF	○	○	○	○	○	○	–	500	29(DC)/ 60(pulse)	1@Ta = 25˚C	±3	2.5 (typ.)	0.4(max) @IOUT = 250 mA	○	○	○	○	New PW-Mold, 5-pin
TA58MS00F	–	–	–	–	–	–	○	500		10@Tc = 25˚C	±2.5(VREF)		2(max) @IOUT = 250 mA	○	○	○	○	New PW-Mold, 5-pin

TA58ST/LT Series (LDOs with Voltage Tracking)

Features

- The voltage tracking function provides high-accuracy output voltages between 2.5 V and 13.4 V.
- Tracking accuracy: ±10 mV @ VIN = 14 V and Tj = 25°C
- The on/off control switch helps to save a system's power dissipation.
- 60-V load dump protection

Application Examples

- PC peripherals
- Office equipment
- Digital home appliances
- Audio equipment
- Automotive equipment

Product Lineup

Part Number	Output Voltage (V)	Output Current (mA)	Input Voltage (V)	Power Dissipation (W)	Tracking Accuracy (mV) @Tj = 25˚C	Bias Current (mA) @IOUT = 0 A	Dropout Voltage (V)	Protection				Packaging
	2.5 to 13.4(Variable)							Overcurrent (Drooping)	Thermal Shutdown	Over-voltage	Reverse Voltage	
TA58ST00F	○	50	38(DC)/ 60(pulse)	0.425 @Ta = 25˚C	±10	0.6 (max)	0.3(max) @IOUT = 10 mA	○	○	○	○	SOP-8
TA58LT00F	○	150		1@Ta = 25˚C 10@Tc = 25˚C		0.8 (max)	0.3(max) @IOUT = 50 mA	○	○	○	○	New PW-Mold, 5-pin

*: When mounted on an FR-4 glass-epoxy board

CMOS Point Regulator ICs

Single-Output CMOS Low-Dropout Regulators

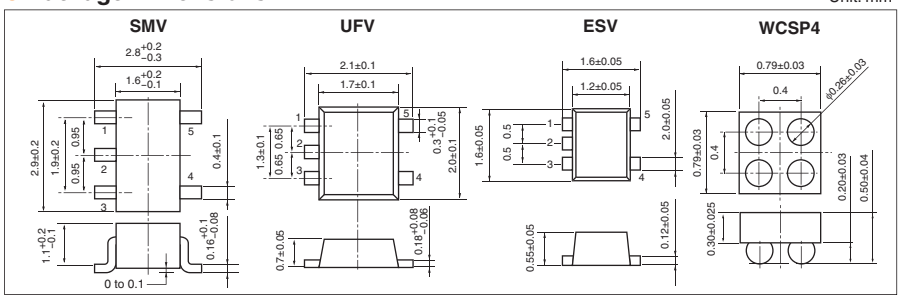
The CMOS point regulators are available in ultra-small WCSP4 package (0.79 x 0.79 x 0.5 mm), SMV packages (SOT23-5 or SC-74A), UFV and ESV packages. Since small ceramic capacitors can be used on the input and output lines, these regulators are ideal for applications that require high-density board assembly such as mobile handsets.

Application Examples

- Mobile handsets

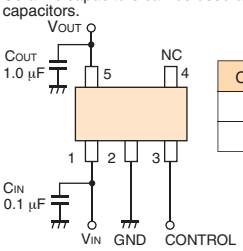
Package Dimensions

Unit: mm



Application Circuit Example (SMV/UFV)

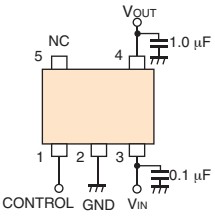
Ceramic capacitors can be used as input and output capacitors.



CONTROL	VOUT
High	ON
Low	OFF

Application Circuit Example (ESV)

Ceramic capacitors can be used as input and output capacitors.



CONTROL	VOUT
High	ON
Low	OFF

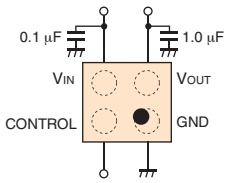
Standard Series

Features

- Low bias current
- Low-output voltage devices are available.
- Overcurrent protection
- Allows use of ceramic capacitors on the input and output lines.
- Small packages: Available in SMV and ESV packages.

Application Circuit Example (WCSP4)

Ceramic capacitors can be used as input and output capacitors.



CONTROL	VOUT
High	ON
Low	OFF

Part Number SMV(SOT23-5)(SC-74A)	Output Current (mA)	Output Voltage (V)	Maximum Input Voltage (V)	Dropout Voltage (mV)	Bias Current (µA)	Ripple Rejection (dB)
TCR5SB10A*	200	1.0	5.5	350 (typ.)@IOUT = 50 mA	35 (typ.)	70 (typ.) @1 kHz
TCR5SB105A*		1.05		310 (typ.)@IOUT = 50 mA		
TCR5SB11A*		1.1		310 (typ.)@IOUT = 50 mA		
TCR5SB115A*		1.15		270 (typ.)@IOUT = 50 mA		
TCR5SB12A		1.2		260 (typ.)@IOUT = 50 mA		
TCR5SB125A*		1.25		230 (typ.)@IOUT = 50 mA		
TCR5SB13A*		1.3		230 (typ.)@IOUT = 50 mA		
TCR5SB14A*		1.4		190 (typ.)@IOUT = 50 mA		

Part Number SMV(SOT23-5)(SC-74A)	Part Number ESV(SOT353)	Output Current (mA)	Output Voltage (V)	Maximum Input Voltage (V)	Dropout Voltage (mV)	Bias Current (µA)	Ripple Rejection (dB)
TCR5SB15A	TCR5SC15FE	150	1.5	6	300 (typ.)@IOUT = 50 mA	32 (typ.)	70 (typ.) @1 kHz
TCR5SB16A	TCR5SC16FE		1.6				
TCR5SB17A	TCR5SC17FE		1.7		250 (typ.)@IOUT = 50 mA		
TCR5SB18A	TCR5SC18FE		1.8		200 (typ.)@IOUT = 50 mA		
TCR5SB19A	TCR5SC19FE		1.9				
TCR5SB20A	TCR5SC20FE		2.0		150 (typ.)@IOUT = 50 mA		
TCR5SB21A	TCR5SC21FE		2.1				
TCR5SB22A	TCR5SC22FE		2.2		130 (typ.)@IOUT = 50 mA		
TCR5SB23A	TCR5SC23FE		2.3				
TCR5SB24A	TCR5SC24FE		2.4		90 (typ.)@IOUT = 50 mA		
TCR5SB25A	TCR5SC25FE		2.5				
TCR5SB26A	TCR5SC26FE		2.6				
TCR5SB27A	TCR5SC27FE		2.7				
TCR5SB28A	TCR5SC28FE		2.8				
TCR5SB29A	TCR5SC29FE		2.9				
TCR5SB30A	TCR5SC30FE		3.0				
TCR5SB31A	TCR5SC31FE		3.1				
TCR5SB32A	TCR5SC32FE		3.2				
TCR5SB33A	TCR5SC33FE		3.3				
TCR5SB34A	TCR5SC34FE		3.4				
TCR5SB35A	TCR5SC35FE		3.5				
TCR5SB36A	TCR5SC36FE		3.6				
TCR5SB37A			3.7				
TCR5SB38A			3.8				
TCR5SB39A			3.9				
TCR5SB40A			4.0				
TCR5SB41A			4.1				
TCR5SB42A			4.2				
TCR5SB43A			4.3				
TCR5SB44A			4.4				
TCR5SB45A			4.5				
TCR5SB46A			4.6				
TCR5SB47A			4.7				
TCR5SB48A			4.8				
TCR5SB49A			4.9				
TCR5SB50A			5.0				

*: Under development

High-Ripple-Rejection ratio, Low-Noise, 200-mA Series

Features

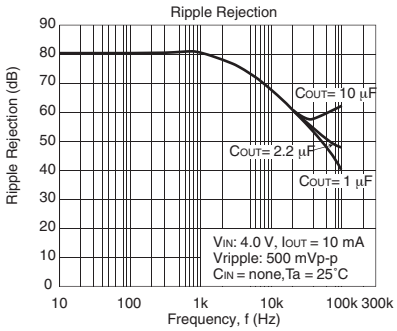
- High maximum output current: I_{OUT} = 200 mA (max)
- High ripple rejection ratio: R.R = 80 dB (typ.)@f = 1 kHz
- Low output noise voltage: V_{NO} = 30 μVrms (typ.) for 3.0-V-output devices
- Overcurrent protection
- Allows use of ceramic capacitors on the input and output lines.: C_{IN} = 0.1 μF, C_{OUT} = 1.0 μF
- Small packages:
  Available in WCSP4, SMV (SOT23-5, SC74A) and UFV packages.

Part Number			Output Current (mA)	Output Voltage (V)	Maximum Input Voltage (V)	Dropout Voltage (mV)	Bias Current (μA)	Ripple Rejection Ratio (dB)	Output Noise Voltage (μVrms)
SMV(SOT23-5)(SC-74A)	UFV	WCSP4							
TCR5SB12		**TCR4S12WBG***	200	1.2	6.0	500 (typ.)@I_{OUT} = 50 mA	40 (typ.)	80 (typ.) @1 kHz	25 (typ.)
TCR5SB15	**TCR5SB15U**	**TCR4S15WBG**		1.5		150 (typ.)@I_{OUT} = 50 mA			
TCR5SB16	**TCR5SB16U**	**TCR4S16WBG***		1.6					
TCR5SB17	**TCR5SB17U**	**TCR4S17WBG***		1.7		130 (typ.)@I_{OUT} = 50 mA			
TCR5SB18	**TCR5SB18U**	**TCR4S18WBG**		1.8					
TCR5SB19	**TCR5SB19U**	**TCR4S19WBG***		1.9		110 (typ.)@I_{OUT} = 50 mA			
TCR5SB20	**TCR5SB20U**	**TCR4S20WBG***		2.0					
TCR5SB21	**TCR5SB21U**	**TCR4S21WBG***		2.1					30 (typ.)
TCR5SB22	**TCR5SB22U**	**TCR4S22WBG***		2.2					
TCR5SB23	**TCR5SB23U**	**TCR4S23WBG***		2.3					
TCR5SB24	**TCR5SB24U**	**TCR4S24WBG***		2.4		90 (typ.)@I_{OUT} = 50 mA			
TCR5SB25	**TCR5SB25U**	**TCR4S25WBG***		2.5					
TCR5SB26	**TCR5SB26U**	**TCR4S26WBG***		2.6					
TCR5SB27	**TCR5SB27U**	**TCR4S27WBG***		2.7					
TCR5SB28	**TCR5SB28U**	**TCR4S28WBG**		2.8					
TCR5SB29	**TCR5SB29U**	**TCR4S29WBG***		2.9					
TCR5SB30	**TCR5SB30U**	**TCR4S30WBG**		3.0					
TCR5SB31	**TCR5SB31U**	**TCR4S31WBG***		3.1					35 (typ.)
TCR5SB32	**TCR5SB32U**	**TCR4S32WBG***		3.2					
TCR5SB33	**TCR5SB33U**	**TCR4S33WBG***		3.3					
TCR5SB34	**TCR5SB34U**	**TCR4S34WBG***		3.4					
TCR5SB35	**TCR5SB35U**	**TCR4S35WBG***		3.5					
TCR5SB36	**TCR5SB36U**	**TCR4S36WBG***		3.6					
TCR5SB37	**TCR5SB37U**			3.7		85 (typ.)@I_{OUT} = 50 mA			40 (typ.)
TCR5SB38	**TCR5SB38U**			3.8					
TCR5SB39	**TCR5SB39U**			3.9					
TCR5SB40	**TCR5SB40U**			4.0					
TCR5SB41	**TCR5SB41U**			4.1					
TCR5SB42	**TCR5SB42U**			4.2					
TCR5SB43	**TCR5SB43U**			4.3					
TCR5SB44	**TCR5SB44U**			4.4					
TCR5SB45	**TCR5SB45U**			4.5					
TCR5SB46	**TCR5SB46U**			4.6					
TCR5SB47	**TCR5SB47U**			4.7					
TCR5SB48	**TCR5SB48U**			4.8					
TCR5SB49	**TCR5SB49U**			4.9					
TCR5SB50	**TCR5SB50U**			5.0					

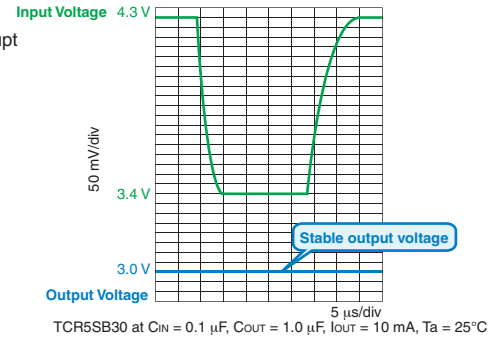
*: Under development

Typical Performance Characteristics (TCR5SB30)

High ripple rejection ratio of 80 dB, typical

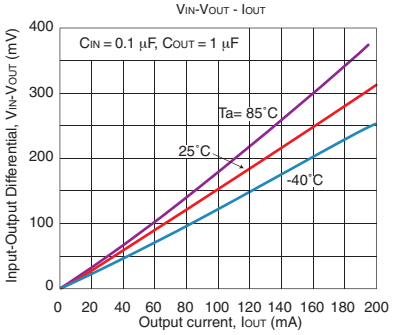


Fast output response to abrupt changes in the input power line

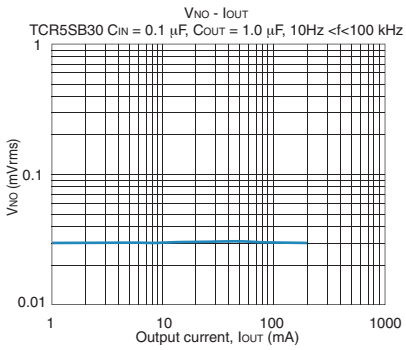


TCR5SB30 at C_{IN} = 0.1 μF, C_{OUT} = 1.0 μF, I_{OUT} = 10 mA, Ta = 25°C

Supplies output currents up to 200 mA, typical.



Very low output noise voltage (V_{NO}) of 30 μVrms, typical



Dual-Output CMOS Low-Dropout Regulators

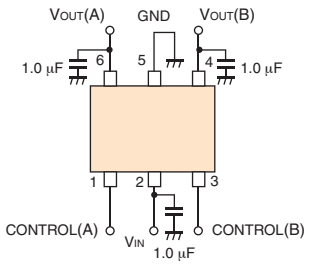
Fabricated using the CMOS process, these low-dropout regulators provide dual outputs that can deliver 200-mA output current. These regulators incorporate overcurrent protection circuitry. Each output voltage can be independently turned on/off via the control pins.

They are available in SM6 (SOT-26, SC-74) and UF6 packages. Small ceramic capacitors can be used as input and output capacitors.

Features

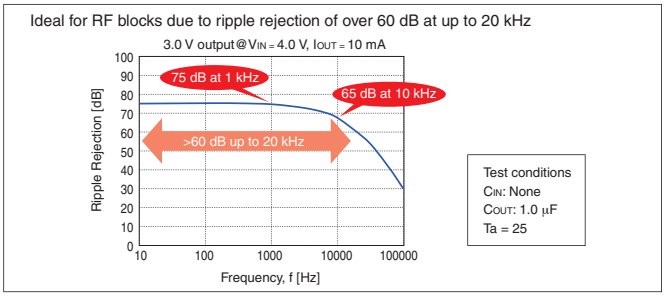
- High maximum output current: I_{OUT} = 200 mA (max)
- Low dropout voltage: V_{IN}-V_{OUT} = 200 mV (max)@I_{OUT} = 50 mA, 3.3-V output
- Low bias current: I_B = 60 μA (typ.) @I_{OUT}(A) = 0 mA, I_{OUT}(B) = 0 mA
- High ripple rejection ratio: R.R = 75 dB(typ.)@f = 1 kHz
- Overcurrent protection

Application Circuit Example (SM6/UF6)



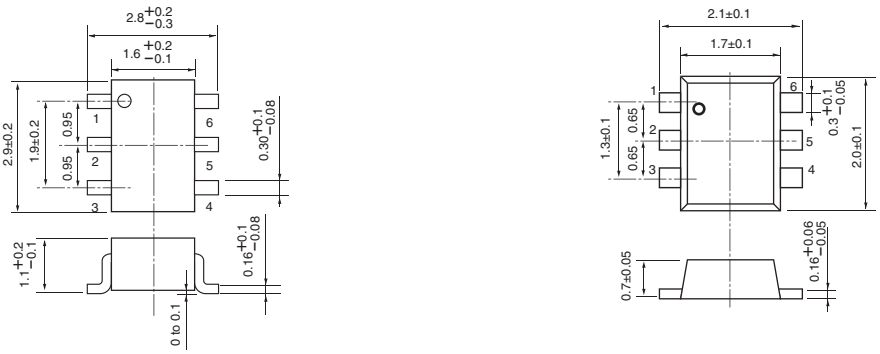
CONTROL	VOUT
High	ON
Low	OFF

Ripple Rejection Ratio



Package Dimensions

Unit: mm



Product Lineup

Part Number		Output Current (mA)	Output Voltage (V)		Maximum Input Voltage (V)	Bias Current (μA)	Ripple Rejection Ratio (dB)
SM6(SOT-26)(SC-74)	UF6		VOUT(A)	VOUT(B)			
TCR6DA1528	**TCR6DA1528U***	200	1.5 V	2.8 V	6	60 (typ.)	75
TCR6DA1828	**TCR6DA1828U***		1.8 V	2.8 V			
	TCR6DA2530U*		2.5 V	3.0 V			

*: Under development

Bipolar Point Regulator ICs

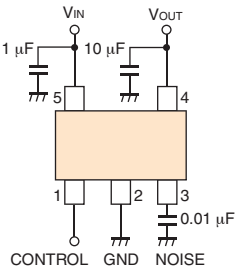
The TAR5S series are low dropout regulators with an integrated control switch and available in single and dual configurations in ultra-small packages. The TAR5S series are ideal for battery-operated applications such as cellular phones, portable audio players and personal digital assistants (PDAs).

Singlel-Output Bipolar Low-Dropout Regulators

Features

- Dropout voltage 130 mV (typ.), 200 mV (max)@50 mA
- Low noise: 30 μVrms (typ.), with a noise bypass capacitor
- High ripple rejection: R.R. = 70 dB (typ. @f = 1 kHz)
- On/off control (On at 1.5 V or higher; off at 0.4 V or lower)
- Standby current of 0.1 μA or less (when off)
- Thermal shutdown and overcurrent protection
- Ceramic capacitors can be used

Application Circuit Example

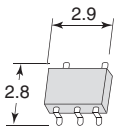


Product Lineup

TAR5SxxU, TAR5SBxx and TAR5Sxx Series

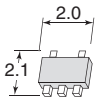
TAR5Sxx TAR5SBxx TAR5SxxU	Output Current (mA)	Output Voltage (V)	Maximum Input Voltage (V)	Ripple Rejection (dB)
15	200	1.5	15	70 (typ.) @1 kHz
16		1.6		
17		1.7		
18		1.8		
19		1.9		
20		2.0		
21		2.1		
22		2.2		
23		2.3		
24		2.4		
25		2.5		
26		2.6		
27		2.7		
28		2.8		
29		2.9		
30		3.0		
31		3.1		
32		3.2		
33		3.3		
34		3.4		
35		3.5		
36		3.6		
37		3.7		
38		3.8		
39		3.9		
40		4.0		
41		4.1		
42		4.2		
43		4.3		
44		4.4		
45		4.5		
46		4.6		
47		4.7		
48		4.8		
49		4.9		
50		5.0		

TAR5Sxx Series, TAR5SBxx Series

Packaging	Absolute Maximum Ratings	
	Output Current (mA)	Power Dissipation (mW)*
SMV (SC-74A) (SOT-23-5) 	200	380

*: When mounted on a glass epoxy circuit board of 30 mm x 30 mm. Pad dimension of 50 mm²

TAR5SxxU Series

Packaging	Absolute Maximum Ratings	
	Output Current (mA)	Power Dissipation (mW)*
UFV 	200	450

*: When mounted on a glass epoxy circuit board of 30 mm x 30 mm. Pad dimension of 35 mm²

Dual-Output Bipolar Low-Dropout Regulators

TAR8DxxK Series (Dual-Output Regulators with Independent On/Off Control)

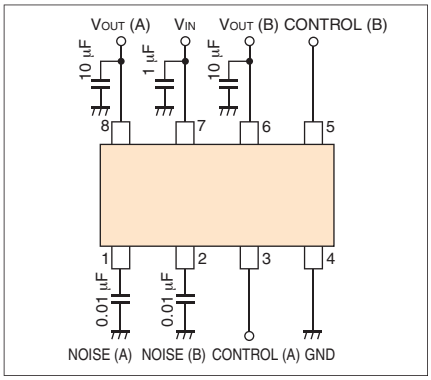
Features

- Incorporates a two-output regulator in an ultra-small 8-pin package (US8), one of the world's smallest packages of this type.
- Output voltage can be set in 0.1-V steps, between 1.5 V and 5.0 V. (Semi-custom products)

Typical Characteristics

- Dropout voltage: 120 mV (typ.), 180 mV (max) @30 mA
- Low noise: 30 μVrms (typ.), with a noise bypass capacitor
- High ripple rejection: 70 dB (typ. @f = 1 kHz)
- Each channel can be controlled individually.
- Standby current of 1 μA or less (when off)
- Thermal shutdown and overcurrent protection

Application Circuit Example



TAR8HxxK Series (Dual-Output Regulators)

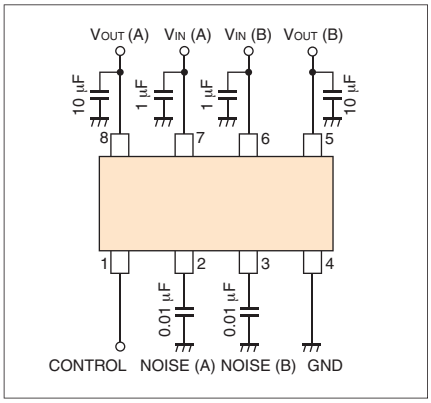
Features

- Incorporates a two-output regulator in an ultra-small 8-pin package (US8), one of the world's smallest packages of this type.
- Output voltage can be set in 0.1-V steps, between 1.5 V and 5.0 V. (Semi-custom products)

Typical Characteristics

- Dropout voltages
  Channel A: 130 mV (typ.), 200 mV (max) @30 mA
  Channel B: 150 mV (typ.), 300 mV (max) @60 mA
- Low noise: 30 μVrms (typ.), with a noise bypass capacitor
- High ripple rejection: 65 dB (typ. @f = 200 Hz)
- On/off control (On at 2.2 V or higher, off at 0.4 V or lower)
- Standby current of 10 μA or less (when off)
- Thermal shutdown and overcurrent protection

Application Circuit Example

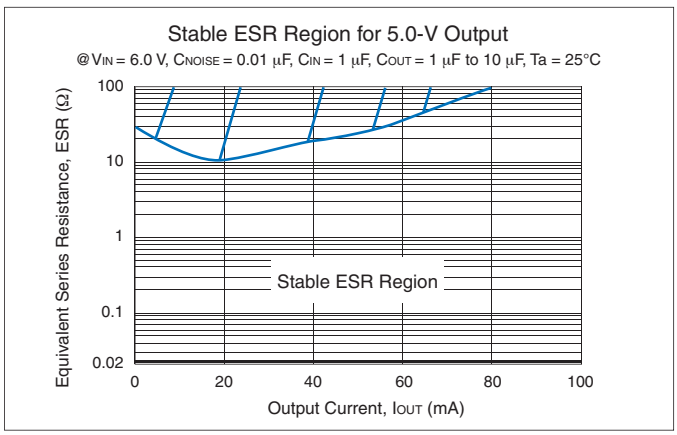


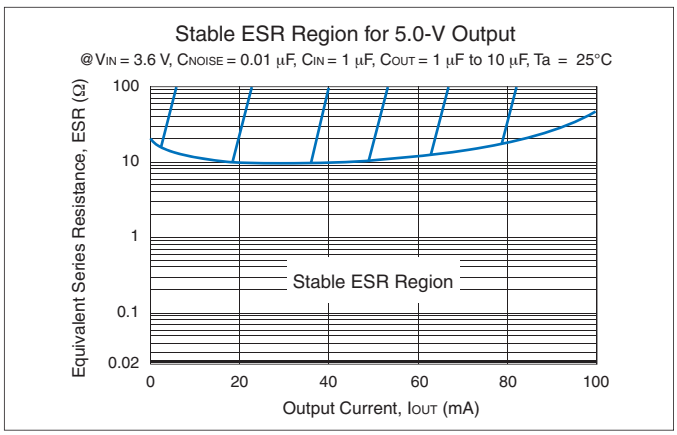
Application Notes

Stable ESR Regions

The graphs below show the stable ESR ranges as a function of load current, where the output voltage does not oscillate, evaluated using Toshiba's evaluation circuit. The Dual-output regulators are designed to work with ceramic output capacitors.

Stable ESR Regions





TAR8Dxx Series (Dual-Output Regulators with Independent On/Off Control)

Output voltage can be set in 0.1-V steps between 1.5 V and 5.0 V. (Semi-custom products)

● Product Lineup

Part Number	Ch	Output Voltage (V)	Measurement Current (mA)	Maximum Input Voltage (V)	Ripple Rejection (dB)	Absolute Maximum Ratings: Output Current (mA)	Absolute Maximum Ratings: Power Dissipation (mW)	Packaging
TAR8D01K	A	2.5	30	15	70 (typ.) @1 kHz	100	400	US8
	B	2.8						
TAR8D02K	A	2.0						
	B	2.8						
TAR8D03K	A	2.8						
	B	3.0						
TAR8D04K	A	1.5						
	B	1.5						
TAR8D05K	A	2.8						
	B	2.8						
TAR8D06K	A	2.9						
	B	2.9						
TAR8D07K	A	3.0						
	B	3.0						
TAR8D08K	A	2.8						
	B	2.85						

Dual-Output Regulators: TAR8Hxx Series (Dual-Circuit)

Output voltage can be set in 0.1-V steps between 1.5 V and 5.0 V. (Semi-custom products)

● Product Lineup

Part Number	Ch	Output Voltage (V)	Measurement Current (mA)	Maximum Input Voltage (V)	Ripple Rejection (dB)	Absolute Maximum Ratings: Output Current (mA)	Absolute Maximum Ratings: Power Dissipation (mW)	Packaging
TAR8H01K	A	2.8	30	12	65 (typ.) @200 Hz	100	400	US8
	B	3.0	60			150		
TAR8H02K	A	2.8	30			100		
	B	2.8	60			150		
TAR8H03K	A	2.5	30			100		
	B	2.8	60			150		
TAR8H04K	A	2.5	30			100		
	B	3.0	60			150		
TAR8H05K	A	1.8	30			100		
	B	2.8	60			150		
TAR8H06K	A	1.5	30			100		
	B	2.5	60			150		

Usage Precautions

A bypass capacitor should be connected to the NOISE pin for stable operation; the recommended value is 0.0047 μF or higher.
Although all devices in this catalog incorporate thermal shutdown and overcurrent protection circuits, these features are not intended to keep the devices within their absolute maximum ratings.
Toshiba recommends that the specific datasheets be checked and that devices always be used within their absolute maximum ratings.

Shunt Regulators

Toshiba's shunt regulators provide a high-accuracy reference voltage and are available in small and thin packages.

TA76 Series (High-Accuracy Shunt Regulators)

● Features

- High-accuracy reference voltage: ±1% (TA76L431 and TA76432Ax Series)
- Available in small, thin packages

Application Examples

- AC-DC converters
- DC-DC converters
- Reference voltage sources

● Product Lineup

Part Number	Reference Voltage @Tj = 25°C: Typical Value (V)	Reference Voltage @Tj = 25°C: Accuracy (%)	Absolute Maximum Ratings: V_{KA}(V)	Absolute Maximum Ratings: I_K(mA)	Packaging	Comments
TA76431S	2.495	±2.2	37	150	LSTM	
TA76431F/FR					PW-Mini	The F and FR versions have reverse pin ordering.
TA76L431FB	2.495	±1	20	50	S-Mini	
TA76L431S	2.49	±1			LSTM	
TA76L431FT					UFV	
TA76432S	1.26	±1.4	20	20	LSTM	
TA76432F/FR					PW-Mini	The F and FR versions have reverse pin ordering.
TA76432FC					SMV	
TA76432FT					UFV	
TA76432AS		±1			LSTM	
TA76432AF/AFR					PW-Mini	The F and FR versions have reverse pin ordering.
TA76432AFT					UFV	
TA76433FC	1.26	±1.4	15	20	SMV	Cathode and input pins are isolated.

4 PFC Controller ICs

PFC Control

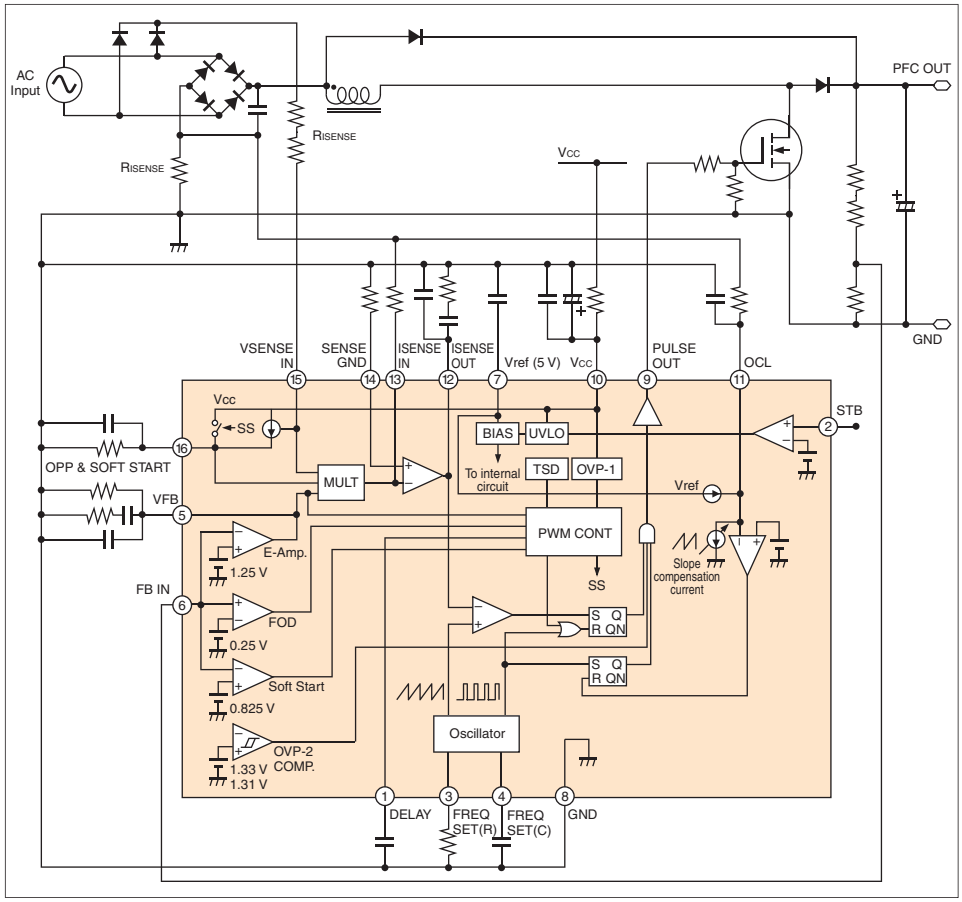
Toshiba has been developing power factor correction (PFC) controllers for reducing power factor degradation (or an increase in reactive power) and noise on AC mains due to harmonics current.

PFC Controller IC TB6818FG

Features

- Operating voltage range: 8.4 V (typ.) to 26 V (max)
- Startup voltage: 10.0 V (typ.)
- Pulse output mute on startup
- Noise reduction for PFC transformer
- Maximum drive current: 1.0 A (typ.)
- Consumption current in Standby mode: 250 μA (typ.)
- AC instantaneously-stop detection
- Variety of protection circuits
  - DC input overvoltage protection (OVP 1)
  - PFC output overvoltage protection (OVP 2)
  - Undervoltage lockout (UVLO)
  - Open feedback-loop detector
  - Thermal shutdown (TSD)

Block Diagram



Products Under Development or Planning

Part Number	Conduction	Supply Voltage (V)	Packaging	Status
TB6818FG	CCM	8 to 26	SSOP16	Available
TB6819FG	CRM	10 to 25	SOP8	Under development

MOSFETs for PFC

Product Lineup

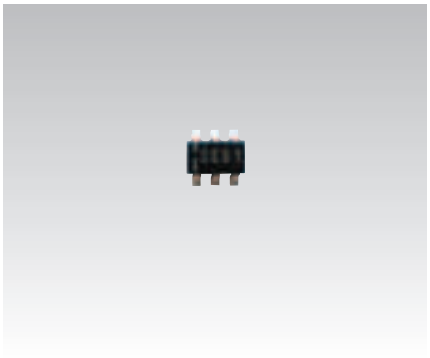
Part Number	Absolute Maximum Ratings		$R_{DS(ON)}$ Max (Ω)	Qg typ. (nC)	Ciss typ. (pF)	Packaging	Series
	V_{DSS}(V)	I_D (A)	V_{GS} = 10 V				
TK12A60D	600	12	0.55	38	1800	TO-220SIS	π-MOSVII
TK13A60D		13	0.43	40	2300	TO-220SIS	
TK12A60U						TO-220SIS	
TK12E60U*		12	0.4	14	720	TO-220	
TK12J60U						TO-3P(N)	
TK15A60U						TO-220SIS	
TK15E60U*		15	0.3	17	950	TO-220	DTMOSII
TK15J60U						TO-3P(N)	
TK20A60U						TO-220SIS	
TK20E60U*		20	0.19	27	1470	TO-220	
TK20J60U						TO-3P(N)	

* Under development

5 Specialized ICs

White LED Drivers (Drives White LEDs for LCD Backlight at High Efficiency)

The family of white LED drivers features high brightness with low power consumption, helping to reduce product size. It is ideal for LCD backlight and secondary camera flash applications. Both switching and charge-pump DC-DC converters are available.



Features

- Small packaging: SOT23-6, VQON24, PLP
- High efficiency: >85% (switching-regulated type)
- Low noise: No inductors required (charge-pumped type)
- Analog dimming control
- High quality: Protection circuitry (OVD)
- High accuracy: ±5% output current

Product Lineup

Switching-Regulated Drivers

Part Number	Features	Status
TB62734FUG	Analog dimming; OVD	Available
TB62736FUG	High efficiency; analog dimming	Available
TB62737FUG/FPG	OVD; high efficiency	Available
TB62756FUG	PWM dimming; high efficiency	Available
TB62757FUG/FPG	PWM dimming; OVD; high efficiency	Available
TB62750FTG	High current (up to 800 mA)	Under development
TB62752AFUG/TB62755FPG	Multiple output lines (up to 8 LEDs)	Available
TB62752BFUG	OVD threshold = 31.5 V (typ.)	Available
TB62754AFNG	Medium-sized LCD backlighting	Available
TB62758FTG	Medium-sized LCD backlighting	Available

Non-step-up constant-current drivers are also available.

Charge-Pumped Drivers

Part Number	Features	Status
TCA62753FUG	5-V constant-voltage output	Available

Automotive System Power Supply ICs

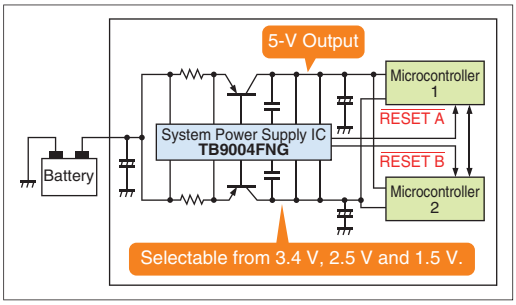
TB9004FNG System Power Supply IC with Low Standby Current

Ideal for engine, brake control and electric power steering (EPS) control systems

Features

- Two output voltages for high-end, high-performance microcontrollers
  - Output 1: Selectable from 3.4 V, 2.5 V and 1.5 V
  - Output 2: 5 V
- Two reset outputs for two microcontrollers
- Zero standby current for battery-saving
- Designed for automotive applications
- Operating temperature range: -40°C to 125°C
- Separate current limiters for each power supply

System Organization Example



Product Lineup

Part Number	Packaging	Functions	Characteristics				Remarks	Supply Voltage (V)
			Output Voltage Typ. (V)	Output Current (mA)	Input Voltage Max (V)	Power Dissipation Max (W)		
TB9000FG	SSOP16	CPU voltage regulator, watchdog timer	5	10 (Max) Note	45 (1 s)	0.6	Low current consumption: 120 μA (typ.) Reset on watchdog timeout Reset detection: 4.7 V External transistor required	6 to 16
TB9000AFG	SSOP16	CPU voltage regulator, watchdog timer	5	10 (Max) Note	45 (1 s)	0.6	Low current consumption: 120 μA (typ.) Reset on watchdog timeout Reset detection: 4.2 V External transistor required	6 to 16
TB9000CFNG	SSOP20 (0.65)	CPU voltage regulator, watchdog timer	5	10 (Max) Note	45 (1 s)	0.68	Low current consumption: 120 μA (typ.) Reset on watchdog timeout Reset detection: 4.2 V External transistor required	6 to 16
TB9001FNG	SSOP20 (0.65)	CPU voltage regulator, watchdog timer	5	5 (Max) Note	45 (1 s)	0.68	Low current consumption: 95 μA (typ.) Internal 32-kHz clock External transistor required	6 to 16
TB9004FNG	SSOP24 (0.65)	CPU dual voltage regulator, watchdog timer	3.4/2.5/1.5 5.0	10 (Min) Note	45 (1 s)	0.85	3.4/2.5/1.5 V selectable 2 reset pins Low current consumption: 0 μA (V_{CC}1/2: off) (typ.) External transistor required	6 to 16
TB9005FG *	SSOP20 (0.65)	CPU voltage regulator, watchdog timer	5	10 (Max) Note	45 (1 s)	0.68	Low current consumption: 90 μA (typ.) Reset on watchdog timeout Reset detection: 4.7 V or 4.2 V (selectable) External transistor required	6 to 18

Note: An external transistor is required. The gain varies with the transistor.

*: Under development

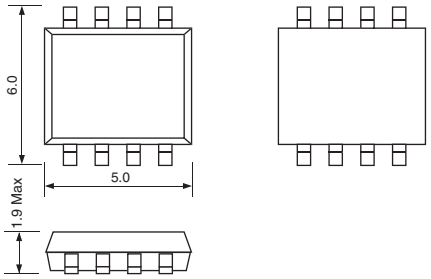
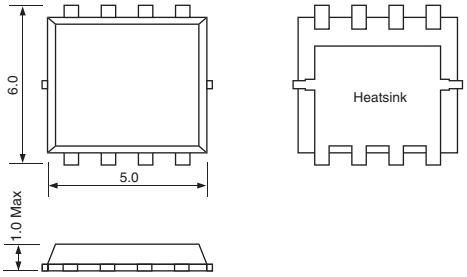
Power MOSFETs

Synchronous Rectification DC-DC Converters Enhanced Efficiency by Thermally Enhanced Package and New Process Technology

● Thermally Enhanced Packages

Toshiba has developed the SOP Advance package with the same footprint as the standard SOP-8 package. With an external heatsink on the bottom, the SOP Advance package offers enhanced thermal characteristics, realizing a high power dissipation and thus high-current capability.

Unit: mm

SOP-8	SOP Advance
	

		SOP-8	SOP Advance	Features of the SOP Advance
Footprint Area	(mm^2)	30	30	Same footprint as the SOP-8
Total height (max)	(mm)	1.9	1.0	Low profile, t = 0.9 mm
Rth(ch-a) (t = 10 s) (Note 1)	(˚C / W)	65.8	44.6	High power dissipation
Current rating	(A)	18	40	High current guarantee
Package resistance (Note 2)	(mΩ)	1.6	0.5	Low package resistance

Note 1: When mounted on a glass-epoxy board (25.4 mm x 25.4 mm x 0.8 mm) Note 2: Without chip resistance

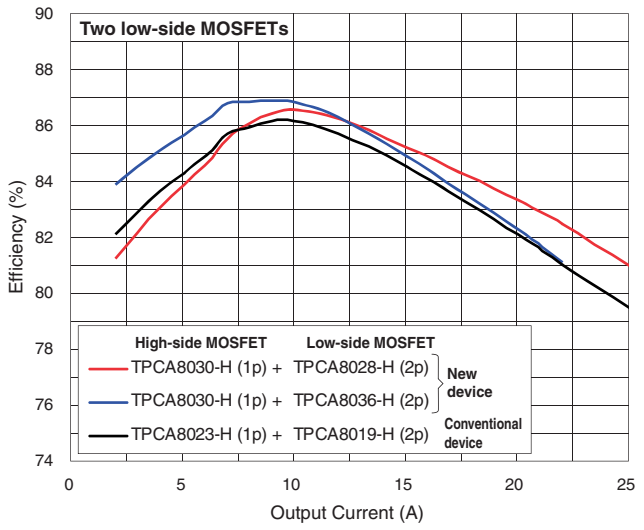
● New Process Technology

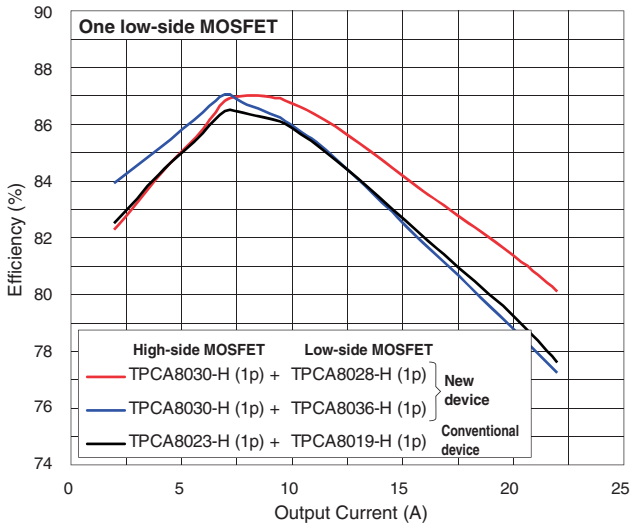
Toshiba has developed a new process technology to further reduce an internal gate-resistance/gate-capacitance ratio (Cgd/Cgs) for minimizing the self-turn-on loss while maintaining both the low ON-resistance and low gate charge characteristics.

	$R_{DS(ON)}$ Typ. @ 4.5 V(mΩ)	rg Typ.(Ω)	Cgd/Cgs Typ.(%)
TPCA8028-H (New generation)	2.3	1.0	6.8
TPCA8019-H (One gen. ago)	3.1	1.0	6.6
TPCA8004-H (Two gen. ago)	4.8	2.4	12.7

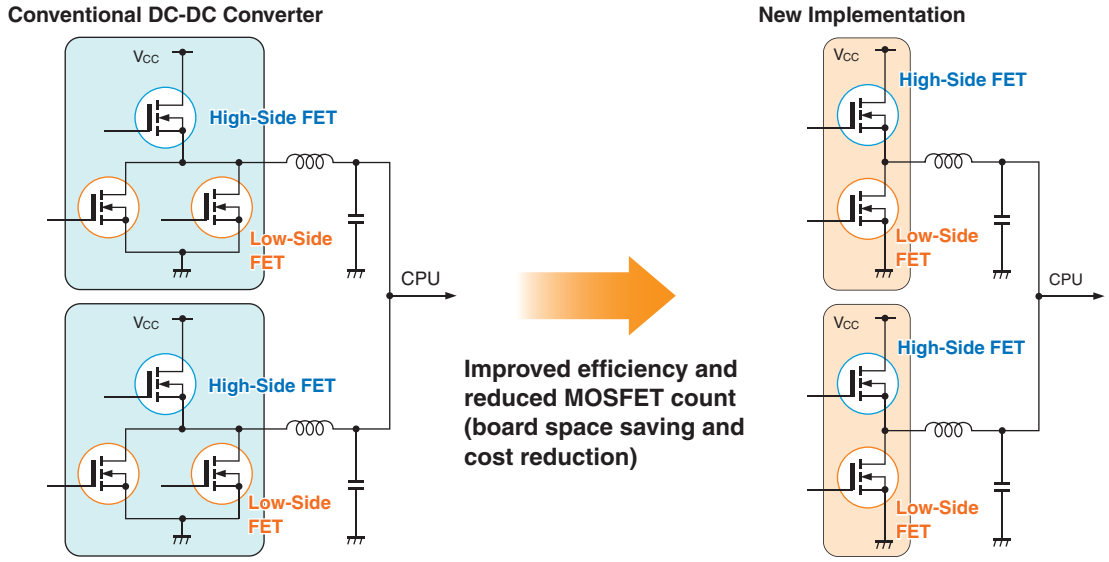
Efficiency Characteristics

f = 300 kHz, V_{IN} = 19.5 V, V_{OUT} = 1.1 V





Recommended Implementation to Reduce the MOSFET Count and Board Area Required



High-Side FET: TPCA8005-H x 2
Low-Side FET: TPCA8004-H x 4

High-Side FET: TPCA8030-H x 2
Low-Side FET: TPCA8028-H x 2

Product Lineup

Part Number	Absolute Maximum Ratings		Packaging	Configuration	$R_{DS(ON)}$ Max (mΩ)		Crss (pF)	Ciss (pF)	Series
	V_{DSS} (V)	I_D (A)			4.5 V	10 V	V_{DS} = 10 V, V_{GS} = 0 V, f = 1 MHz		
TPCP8001-H	30	7.2	PS-8		25	16	75	640	U-MOSIII-H
TPCP8005-H	30	11			15.7	12.9	83	1433	U-MOSV-H
TPCM8001-H	30	20	TSSOP Advance	N-ch Single	14	9.5	120	1130	U-MOSIII-H
TPCM8003-H	30	21			15.7	12.9	83	1433	U-MOSV-H
TPCM8002-H	30	30			8.2	6.2	135	2270	U-MOSV-H
TPCM8004-H	30	24			13.4	11	83	1433	U-MOSV-H
TPCM8A05-H	30	20		MOSBD	17.2	12.9	55	1300	U-MOSV-H
TPC8021-H	30	11	SOP-8	N-ch Single	25	17	75	640	U-MOSIII-H
TPC8031-H	30	11			16.1	13.3	83	1433	U-MOSV-H
TPC8037-H	30	12			13.9	11.4	83	1433	U-MOSV-H
TPC8038-H	30	12			13.9	11.4	83	1433	U-MOSV-H
TPC8032-H	30	15			8.6	6.5	135	2270	U-MOSV-H
TPC8033-H	30	17			7.2	5.3	170	2900	U-MOSV-H
TPC8034-H	30	18			4.5	3.5	284	4614	U-MOSV-H
TPC8040-H	30	13			11.1	9.7	110	1700	U-MOSVI-H
TPC8039-H	30	17			6.9	6	170	2600	U-MOSVI-H
TPC8036-H	30	18			5.1	4.5	230	3500	U-MOSVI-H
TPC8035-H	30	18			3.6	3.2	380	6000	U-MOSVI-H
TPC8216-H	30	6.4		N-ch Dual	23	20	65	900	U-MOSVI-H
TPC8A05-H	30	10		MOSBD	17.6	13.3	55	1300	U-MOSV-H
TPC8A03-H	30	15			7.0	5.6	100	2640	U-MOSV-H
TPC8A04-H	30	18			4.5	3.6	180	4400	U-MOSV-H
TPCA8023-H	30	21	SOP Advance	N-ch Single	15.7	12.9	83	1433	U-MOSV-H
TPCA8030-H	30	24			13.4	11	83	1433	U-MOSV-H
TPCA8031-H	30	24			13.4	11	83	1433	U-MOSV-H
TPCA8018-H	30	30			8.2	6.2	135	2270	U-MOSV-H
TPCA8012-H	30	40			6.8	4.9	170	2900	U-MOSV-H
TPCA8019-H	30	45			4.1	3.1	284	4614	U-MOSV-H
TPCA8040-H	30	23			10.8	9.4	110	1700	U-MOSVI-H
TPCA8039-H	30	34			6.6	5.7	170	2600	U-MOSVI-H
TPCA8036-H	30	38			4.8	4.2	230	3500	U-MOSVI-H
TPCA8028-H	30	50			3.2	2.8	380	6000	U-MOSVI-H
TPCA8A05-H	30	20		MOSBD	17.2	12.9	55	1300	V-MOSBD
TPCA8A02-H	30	34			6.7	5.3	100	2640	V-MOSBD
TPCA8A04-H	30	42			4.1	3.2	180	4400	V-MOSBD

6 Power MOSFETs

High-Speed Power MOSFETs for DC-DC Converters (V_{DSS} = 40 V to 250 V)

By employing microfabrication technology and reducing the gate charge, the power MOSFET series achieves extremely high speed and low $R_{DS(ON)}$.

Application Examples

- DC-DC converters
- Motor drives

Features

- Low $R_{DS(ON)}$
- Total gate charge (Qg) reduction
- High-speed switching
- High avalanche capability

Product Lineup

Part Number	Absolute Maximum Ratings		Packaging	Configuration	R_{ON} Max @V_{GS} = 10 V (mΩ)	Crss Typ. @V_{DS} = 10V, f = 1MHz (pF)	Ciss Typ. @V_{DS} = 10V, f = 1MHz (pF)	Series
	V_{DSS} (V)	I_D (A)						
TPC8022-H		7.5	SOP-8	N-ch Single	27	55	650	U-MOSIII-H
TPC8047-H*		(16)			(7.6)	(135)	(2590)	U-MOSVI-H
TPC8046-H*		(18)			(5.7)	(185)	(3545)	U-MOSVI-H
TPC8045-H*		(18)			(3.9)	(305)	(5800)	U-MOSVI-H
TPCA8020-H	40	7.5	SOP Advance		27	55	650	U-MOSIII-H
TPCA8014-H		30			9	110	1365	U-MOSIII-H
TPCA8047-H*		(32)			(7.3)	(135)	(2590)	U-MOSVI-H
TPCA8046-H*		(38)			(5.4)	(185)	(3545)	U-MOSVI-H
TPCA8045-H*		(46)			(3.6)	(305)	(5800)	U-MOSVI-H
TPC8213-H		5	SOP-8 Dual		50	35	625	U-MOSIII-H
TPC8050-H*		(11)	SOP-8		(14.5)	(95)	(2590)	U-MOSVI-H
TPC8049-H*		(13)			(10.7)	(130)	(3545)	U-MOSVI-H
TPC8048-H*	60	(16)			(6.9)	(210)	(5800)	U-MOSVI-H
TPCA8016-H		25	SOP Advance		21	70	1375	U-MOSIII-H
TPCA8050-H*		(24)			(14.2)	(95)	(2590)	U-MOSVI-H
TPCA8049-H*		(28)			(10.4)	(130)	(3545)	U-MOSVI-H
TPCA8048-H*		(35)			(6.6)	(210)	(5800)	U-MOSVI-H
TPC8051-H*	80	(13)	SOP-8		(9.7)	(150)	(5800)	U-MOSVI-H
TPCA8051-H*		(28)	SOP Advance		(9.4)	(150)	(5800)	U-MOSVI-H
TPCP8003-H		2.2	SOP-8		180	22	360	U-MOSIII-H
TPC8214-H	100	2.2	SOP-8 Dual		180	22	360	U-MOSIII-H
TPCA8006-H		18	SOP Advance		67	17	780	π-MOSVII
TPCA8022-H		22			26	110	2330	U-MOSIII-H
TPCA8009-H	150	7			350	20	600	π-MOSV "MACHII"
TPCA8010-H	200	5.5			450	20	600	π-MOSV "MACHII"
TPCA8008-H	250	4			580	20	600	π-MOSV "MACHII"
TPCP8103-H		-4.8	PS-8	P-ch Single	40	115	800	U-MOSIII-H
TPC8116-H	-40	-7.5	SOP-8		30	170	1190	U-MOSIII-H
TPCA8107-H		-7.5	SOP Advance		30	170	1190	U-MOSIII-H
TPC8406-H	-40	-6.5	SOP-8 Dual	P-ch+N-ch	30	170	1190	U-MOSIII-H
	40	6.5			27	55	650	U-MOSIII-H

*: Under development

Synchronous Rectification U-MOS Series (V_{DSS} = 60 V to 100 V)

The ultra-high-speed trench MOSFET series realizes high speed and low ON-resistance and offers a V_{DSS} of 60 V to 100 V and a 50% reduction in Qg-$R_{DS(ON)}$ trade-off. This series of MOSFETs is housed in TO-220 packages, allowing them to be used for secondary-side synchronous rectification of switching power supplies.

Features

- Low ON-resistance achieved by submicron technology
- Approximately 50% reduction in Qg-$R_{DS(ON)}$ trade-off (compared with conventional products) through an optimized trench structure
- Guaranteed avalanche capability
- Protection Zener diode between gate and source
- High power dissipation due to the TO-220(W) package with an exposed heatsink on the backside of the package

Product Lineup

Part Number	Absolute Maximum Ratings			$R_{DS(ON)}$ (mΩ) @V_{GS} = 10 V		Q_gTyp. (nC)	Q_{sw}Typ. (nC)	Packaging
	V_{DSS} (V)	I_D (A)	P_D (W)	Typ.	Max	V_{DS} = V_{DSS} x 0.8, I_D = $I_{D\ (DC)}$		
TK70D06J1	60	70	140	5.1	6.4	87	30	TO-220(W)
TK70A06J1	60	70	45	5.1	6.4	87	30	TO-220SIS
TK60D08J1	75	60	140	6.2	7.8	86	27	TO-220(W)
TK60A08J1	75	60	45	6.2	7.8	86	27	TO-220SIS
TK80D08K3	75	80	100	3.6	4.5	175	80	TO-220(W)
TK80A08K3	75	80	40	3.6	4.5	175	80	TO-220SIS
TK40D10J1	100	40	100	11.5	15	76	25	TO-220(W)
TK40A10J1	100	40	40	11.5	15	76	25	TO-220SIS
TK55D10J1	100	55	140	8.4	10.5	110	33	TO-220(W)
TK55A10J1	100	55	45	8.4	10.5	110	33	TO-220SIS
TK50X15J1	150	50	125	22	30	75	33	TFP

Super-Junction DTMOS Series (V_{DSS} = 600, 650 V)

The DTMOS devices employ a new super-junction structure that enables an ultra-low-ON resistance with the maximum V_{DSS} rating of 600 V. The DTMOS Series aids in reduction of power consumption and miniaturization of electronic equipment.

Features

- Low ON-resistance TK50J60T: 65 mΩ (max) @V_{GS} = 10 V, I_D = 25 A
- Low gate charge TK20A60U: Qg = 27 nC typ., 600 V / 20 A

Performance Comparisons Between the DTMOS and Conventional MOSFET (π-MOSVI) Devices (600 V/20 A)

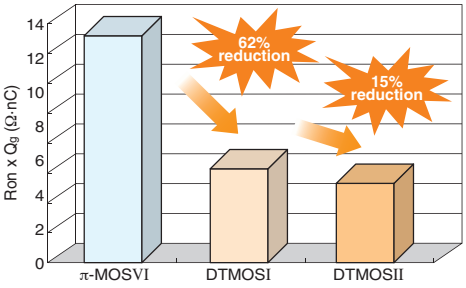
		Series	DTMOSII			π-MOSVI			
		Part Number	TK20J60U			2SK3911			
		Ratings	600 V/20 A			600 V/20 A			
Characteristic	Symbol	Test Conditions	Min	Typ.	Max	Min	Typ.	Max	Unit
Gate leakage current	± I_{GSS}	V_{GS} condition*, V_{DS} = 0 V	—	—	± 1	—	—	± 10	μA
Drain cut-off current	I_{DSS}	V_{DS} = 600 V, V_{GS} = 0 V	—	—	100	—	—	100	μA
Drain-source breakdown voltage	$V_{(BR)DSS}$	I_D = 10 mA, V_{GS} = 0 V	600	—	—	600	—	—	V
Gate threshold voltage	V_{th}	V_{DS} = 10 V, I_D = 1 mA	3.0	—	5.0	2.0	—	4.0	V
Drain-source ON-resistance	$R_{DS(ON)}$	V_{GS} = 10 V, I_D = 10 A	—	0.165	0.19	—	0.22	0.32	Ω
Total gate charge	Q_g	V_{DD} = 400 V, V_{GS} = 10 V, I_D = 20 A	—	27	—	—	60	—	nC
Diode forward voltage	V_{DSF}	I_{DR} = 20 A, V_{GS} = 0 V	—	—	–1.7	—	—	–1.7	V

*: Test conditions: TK20J60U: V_{GS} = ± 30 V, 2SK3911: V_{GS} = ± 25 V

Figure-of-Merit (FOM) Comparison

Ron x Qg, the product of ON-resistance and total gate charge, is reduced by 62%, compared with the conventional MOSFETs with the same chip size.

*Ron x Qg is a figure-of-merit index for the switching speed of MOSFETs.



Product Lineup

Part Number	Absolute Maximum Ratings		$R_{DS(ON)}$ Max (Ω)	Q_g Typ. (nC)	C_{iss} Typ. (pF)	Package	Series
	V_{DSS} (V)	I_D (A)	V_{GS} = 10 V				
TK12A60U	600	12	0.4	14	720	TO-220SIS	DTMOSII
TK12D60U		12	0.4	14	720	TO-220(W)	
TK12J60U		12	0.4	14	720	TO-3P(N)	
TK12X60U		12	0.42	14	720	TFP	
TK15A60U		15	0.3	17	950	TO-220SIS	
TK15D60U		15	0.3	17	950	TO-220(W)	
TK15J60U		15	0.3	17	950	TO-3P(N)	
TK15X60U		15	0.3	17	950	TFP	
TK20A60U		20	0.19	27	1470	TO-220SIS	
TK20D60U		20	0.19	27	1470	TO-220(W)	
TK20J60U		20	0.19	27	1470	TO-3P(N)	
TK20X60U		20	0.20	27	1470	TFP	
TK40J60T		40	0.08	67	3900	TO-3P(N)	DTMOSI
TK40J60U		40	0.08	(57)	(3600)	TO-3P(N)	
TK40M60U		40	0.08	(57)	(3600)	TO-3P(N)	
TK50J60U *		50	0.065	67	4050	TO-3P(N)	
TK13A65U	650	13	0.38	17	950	TO-220SIS	DTMOSII
TK13J65U *		13	0.38	17	950	TO-3P(N)	
TK17A65U *		17	0.26	27	1470	TO-220SIS	
TK17J65U *		17	0.26	27	1470	TO-3P(N)	

*: Under development

Next-Generation π-MOSVII Series (V_{DSS} = 400 V to 650 V)

The latest addition to the π-MOS portfolio, the π-MOSVII Series offers reduced capacitances due to optimized chip design and is available with a greatly wider range of electrical characteristics.

Features

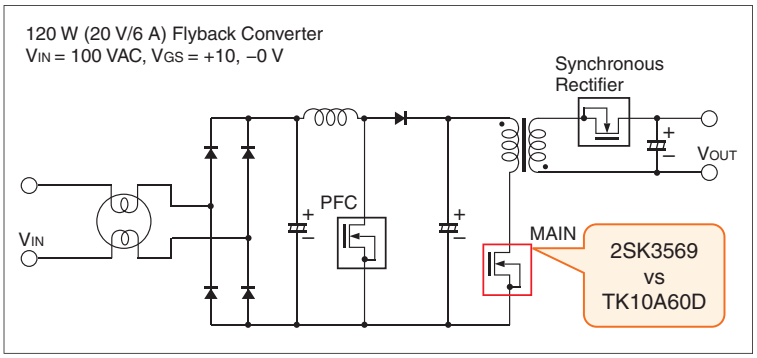
- 15% reduction in Qg from π-MOSVI due to optimized chip design
- Available in 50-V steps of V_{DSS} and in finer steps of RDS(ON).
- Rated avalanche and reverse recovery current capabilities

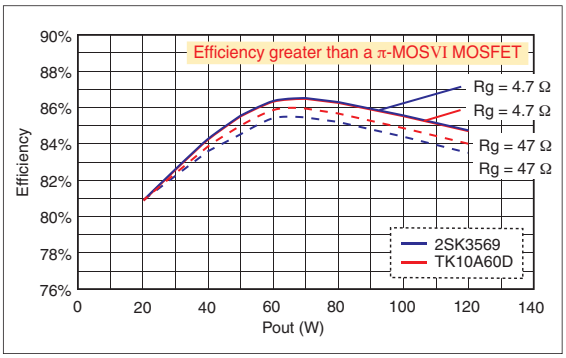
Performance Comparisons Between π-MOSVII and π-MOSVI Devices (600 V/10 A)

		Series	π-MOSVII			π-MOSVI			
		Part Number	TK10A60D			2SK3569			
		Ratings	600 V/10 A			600 V/10 A			
		Package	TO-220SIS			TO-220SIS			
Characteristic	Symbol	Test Conditions	Min	Typ.	Max	Min	Typ.	Max	Unit
Gate leakage current	± I_{GSS}	V_{GS} condition*, V_{DS} = 0 V	—	—	± 1	—	—	± 10	μA
Drain cut-off current	I_{DSS}	V_{DS} = 600 V, V_{GS} = 0 V	—	—	10	—	—	100	μA
Drain-source breakdown voltage	$V_{(BR)DSS}$	I_D = +10 mA, V_{GS} = 0 V	600	—	—	600	—	—	V
Gate threshold voltage	V_{th}	V_{DS} = 10 V, I_D = 1 mA	2.0	—	4.0	2.0		4.0	V
Drain-source ON-resistance	$R_{DS(ON)}$	V_{GS} = 10 V, I_D = 5 A	—	—	0.75	—	—	0.75	Ω
Total gate charge	Q_g	V_{DD} = 400 V, V_{GS} = 10 V, I_D = 10 A	—	25	—	—	42	—	nC
Diode forward voltage	V_{DSF}	I_{DR} =10 A, V_{GS} = 0 V	—	—	–1.7	—	—	–1.7	V

*: Test conditions: TK10A60D : V_{GS} = ± 30 V, 2SK3569 : V_{GS} = ± 25 V

Efficiency Test Circuit





Product Lineup

Part Number	Absolute Maximum Ratings		$R_{DS(ON)}$ (Ω)	Existing Equivalent Part Number	Package
	V_{DSS} (V)	I_D (A)	V_{GS} = 10 V		
TK10X40D	400	10	0.55	2SK3499	TFP
TK11A45D	450	11	0.62	2SK3869	TO-220SIS
TK13A45D		13	0.46	2SK3743	TO-220SIS
TK16A45D		16	0.27	2SK3935	TO-220SIS
TK4A50D	500	4	2	—	TO-220SIS
TK5A50D		5	1.5	2SK3563	TO-220SIS
TK5P50D		5	1.5	2SK3863/2SK4103	DPAK
TK6A50D		6	1.4	—	TO-220SIS
TK7A50D		7	1.2	—	TO-220SIS
TK7P50D		7	1.22	—	DPAK
TK8A50D		8	0.85	2SK3561	TO-220SIS
TK10A50D		10	0.72	—	TO-220SIS
TK12A50D		12	0.52	2SK3568	TO-220SIS
TK13A50D		13	0.4	2SK4012	TO-220SIS
TK15J50D		15	0.4	2SK4107	TO-3P(N)
TK15A50D		15	0.3	2SK3934	TO-220SIS
TK18A50D		18	0.27	—	TO-220SIS
TK20J50D		20	0.27	2SK4108	TO-3P(N)
TK4A53D	525	4	1.7	—	TO-220SIS
TK5A53D		5	1.5	2SK3563	TO-220SIS
TK5P53D		5	1.5	—	DPAK
TK6A53D		6	1.3	—	TO-220SIS
TK6P53D		6	1.3	—	DPAK
TK12A53D		12	0.58	—	TO-220SIS
TK12X53D		12	0.58	2SK3398	TFP
TK4A55DA	550	3.5	2.45	—	TO-220SIS
TK4A55D		4	1.9	—	TO-220SIS
TK4P55D		4	1.88	—	DPAK

Part Number	Absolute Maximum Ratings		$R_{DS(ON)}$ (Ω)	Existing Equivalent Part Number	Package
	V_{DSS} (V)	I_D (A)	V_{GS} = 10 V		
TK5A55D	550	5	1.7	—	TO-220SIS
TK8A55DA		7.5	1.07	—	TO-220SIS
TK9A55DA		8.5	0.86	—	TO-220SIS
TK11A55D		11	0.63	—	TO-220SIS
TK12A55D		12	0.57	—	TO-220SIS
TK12J55D		12	0.57	—	TO-3P(N)
TK14A55D		14	0.37	—	TO-220SIS
TK16A55D		16	0.33	—	TO-220SIS
TK16J55D		16	0.37	—	TO-3P(N)
TK2P60D	600	2	4.3	2SK2865	New PW-Mold
TK2Q60D		2	5	2SK4002	New PW-Mold 2
TK3A60DA		2.5	2.8	—	TO-220SIS
TK4A60DA		3.5	2.2	2SK3567	TO-220SIS
TK4P60DA		3.5	2.2	2SK3975	DPAK
TK4A60D		4	1.7	—	TO-220SIS
TK6A60D		6	1.25	2SK3562	TO-220SIS
TK8A60DA		7.5	1	2SK3667	TO-220SIS
TK10A60D		10	0.75	2SK3569	TO-220SIS
TK12A60D		12	0.55	—	TO-220SIS
TK13A60D		13	0.43	2SK3797	TO-220SIS
TK15A60D		15	0.37	—	TO-220SIS
TK2A65D	650	2	3.26	—	TO-220SIS
TK3A65DA		2.5	2.51	—	TO-220SIS
TK5A65D		5	1.43	—	TO-220SIS
TK8A65D		8	0.84	—	TO-220SIS
TK12A65D *		12	0.54	—	TO-220SIS
TK13A65D *		13	0.47	—	TO-220SIS

*: Under development

High-Speed π-MOS Diode(HSD) Series (V_{DSS} = 450 V to 600 V)

The HSD Series integrates a high-speed diode, which provides an efficiency improvement for a variety of equipment. The integrated diode reduces the reverse recovery time (trr) through minority carrier lifetime control. The HSD Series suitable for motor and inverter applications.

● Product Lineup

High-Speed Diode Series (HSD Series)

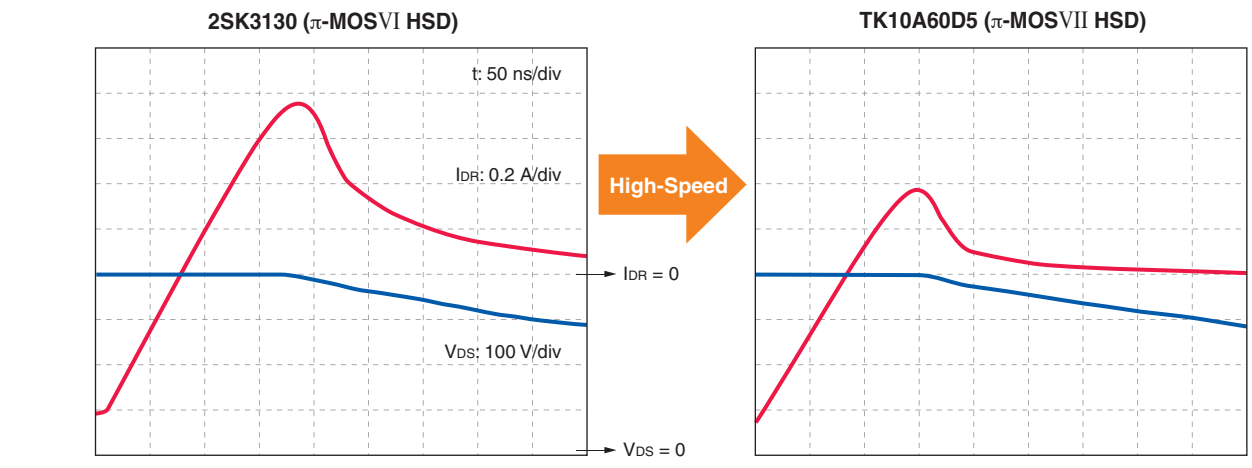
Applications	Part Number	Absolute Maximum Ratings			Package	$R_{DS(ON)}$ Max (Ω) VGS = 10 V	Trr Typ. (ns)	Series
		V_{DSS} (V)	I_D (A)	P_D (W)				
Motor control Inverters Switching power supplies	**2SK3868**	500	5	35	TO-220SIS	1.7	150	π-MOSV
	TK5A50D5 ✻			35	TO-220SIS	2.1	130	π-MOSVII
	2SK3417			50	TO-220FL/SM	1.8	60	π-MOSV
	TK7A50D5 ✻		7	35	TO-220SIS	1.68	130	π-MOSVII
	2SK4042		8	40	TO-220SIS	0.97	185	π-MOSVI
	TK12A50D5		12	45	TO-220SIS	0.73	120	π-MOSVII
	2SK3314	600	15	1850	TO-3P(N)	0.49	105	π-MOSV
	2SK3131		50	250	TO-3P(L)	0.11	105	π-MOSVI
	2SK3936		23	150	TO-3P(N)	0.25	380	π-MOSVI
	TK4A60DA5 ✻		3.5	35	TO-220SIS	3.08	130	π-MOSVII
	TK4A60D5 ✻		4	35	TO-220SIS	2.38	130	π-MOSVII
	2SK3947		6	40	TO-220SIS	1.4	150	π-MOSVI
	2SK4015		10	45	TO-220SIS	0.86	170	π-MOSVI
	TK10A60D5 ✻			45	TO-220SIS	1.05	90	π-MOSVII
	2SK4016		13	50	TO-220SIS	0.5	160	π-MOSVI
	2SK3906		20	150	TO-3P(N)	0.33	400	π-MOSVI

✻: Under development

● Characteristics of the High-Speed Diode Series

Faster internal diode

V_{DD} = 400 V, di/dt = 10 A/μs, I_{DR} = 3 A, 25˚C



7 Power Transistors

Switching Power Transistors (for Self-Excited DC-DC Converters)

AC 100 V Series

Packaging	Part Number	Absolute Maximum Ratings			DC Characteristics						Switching Characteristics		
		V_{CBO} (V)	V_{CEO} (V)	I_C (A)	h_{FE} (2) Min			V_{CE}(sat) Max			t_r Max	t_{stg} Max	t_f Max
						V_{CE} (V)	I_C (A)	(V)	I_C (A)	I_B (A)	(μs)		
MSTM	**2SC6010**	600	285	1	100	5	0.1	1.0	0.6	0.075	0.4	3.0	0.24
	2SC6034	600	285	1	125	5	0.1	1.0	0.6	0.075	0.4	3.5	0.24
LSTM	**2SC5549**	400	400	1	20	5	0.04	1.0	0.2	0.025	0.5	5.0	0.3
TPS	**2SC5351**	650	450	2	20	5	0.2	1.0	0.8	0.1	0.5	2.0	0.3
TPL	**2SC5266A**	600	400	5	20	5	0.5	1.0	2.0	0.25	0.5	2.0	0.3
PW-Mold	New **TTC003**	600	400	1.5	20	5	0.3	1.0	1.2	0.15	0.12(typ.)	1.5(typ.)	0.1(typ.)
	2SA2034	–400	–400	–2	80	–5	–0.1	–1.0	–0.5	–0.1	0.3	2.5	0.3
	2SC5548	600	370	2	60	5	0.2	1.0	0.8	0.1	0.5	3.0	0.3
	2SC5548A	600	400	2	40	5	0.2	1.0	0.8	0.1	0.5	2.0	0.3
TO-220NIS	**2SC5459**	600	400	3	20	5	0.3	1.0	1.2	0.15	0.5	2.0	0.3
	2SC5172	600	400	5	20	5	0.5	1.0	2.0	0.25	0.5	2.0	0.3

AC 200 V Series

Packaging	Part Number	Absolute Maximum Ratings			DC Characteristics						Switching Characteristics		
		V_{CBO} (V)	V_{CEO} (V)	I_C (A)	h_{FE} (2) Min			(V)	V_{CE}(sat) Max		t_r Max	t_{stg} Max	t_f Max
						V_{CE} (V)	I_C (A)		I_C (A)	I_B (A)	(μs)		
MSTM	**2SC6040**	800	410	1	60	5	0.1	1.0	0.8	0.1	0.5	4.0	0.2
	2SC6042	800	375	1	100	5	0.1	1.0	0.8	0.1	0.5	4.5	0.2
TPS	**2SC5562**	900	800	0.8	15	5	0.08	1.0	0.3	0.06	0.7	4.5	0.5
PW-Mold	New **2SC6142**	800	375	1.5	100	5	0.1	0.9	0.8	0.1	0.2(typ.)	3.5(typ.)	0.15(typ.)
TO-220NIS	**2SC5353**	900	800	3	15	5	0.15	1.0	1.2	0.24	0.7	4.0	0.5
	2SC5439	1000	450	8	14	5	1.0	1.0	3.2	0.64	0.2(typ.)	3.5	0.15(typ.)

Power Transistors for MOS Gate Drivers (for High-Speed Gate Drive of MOS Devices)

2 in 1 Multi-chip Device (PNP Tr + NPN Tr)

Packaging	Part Number	Polarity	Absolute Maximum Ratings				h_{FE}		V_{CE} (V)	I_C (A)	V_{CE}(sat) (V)	I_C (A)	I_B (mA)
			V_{CEO} (V)	I_C (A)	I_{CP} (A)	P_C (mW)	Min	Max			Max		
SMV	**HN4B101J**	PNP	–30	–1.0	–5	550	200	500	–2	–0.12	–0.2	–0.4	–13
		NPN	30	1.2	5	550	200	500	2	0.12	0.17	0.4	13
	HN4B102J	PNP	–30	–1.8	–8	750	200	500	–2	–0.2	–0.2	–0.6	–20
		NPN	30	2	8	750	200	500	2	0.2	0.14	0.6	20
VS-6	**TPC6901A**	PNP	–50	–0.7	–5	400	200	500	–2	–0.1	–0.23	–0.3	–10
		NPN	50	1	5	400	400	1000	2	0.1	0.17	0.3	6
	TPC6902	PNP	–30	–1.7	–8	700	200	500	–2	–0.2	–0.2	–0.6	–20
		NPN	30	2	8	700	200	500	2	0.2	0.14	0.6	20
PS-8	**TPCP8901**	PNP	–50	–0.8	–5	830	200	500	–2	–0.1	–0.2	–0.3	–10
		NPN	50	1	5	830	400	1000	2	0.1	0.17	0.3	6
	TPCP8902	PNP	–30	–2	–8	890	200	500	–2	–0.2	–0.2	–0.6	–20
		NPN	30	2	8	890	200	500	2	0.2	0.14	0.6	20

8 Inverter Control ICs

Cortex™-M3 Core and Vector Motor Control Engine

TMPM370FYFG <Under development>/TMPM370FYDFG <Under development>

- ARM Cortex™-M3 CPU core
  - Operating voltage: I/O = 4.5 to 5.5 V
  - Maximum operating frequency: 80 MHz (derived by multiplying a 10-MHz clock by a factor of 8 with on-chip PLL)
  - On-chip memory: 256-KB flash ROM, 10-KB RAM
  - High-speed computation: Multiplier (1-7 cycles), divider (2-12 cycles)
  - On-chip debug logic: JTAG or 2-wire SWD (Serial Wire Debug) interface
  - Low-power: Clock gearing (f/1, f/2, f/4, f/8 or f/16), operation mode (NORMAL/STOP)
- On-chip peripherals
  - Next-generation PMDs (motor control timers): 2 channels
    - Vector Engine: 1 channel
    - Encoder inputs: 2 channels
    - Comparator for emergency stop
  - 12-bit AD converter: 2-μs conversion time, 2 unit, 22-channel ADCs (with three channels sharing the same pins)
  - 16-bit timer/counter: 8 channels (free-run, compare output, PPG, input capture)
  - Serial interface: 4 UART/SIO channels
  - Watchdog timer (WDT)
  - Power-on reset (POR)
  - Low voltage detection (LVD)
  - Oscillation frequency detection (OFD)

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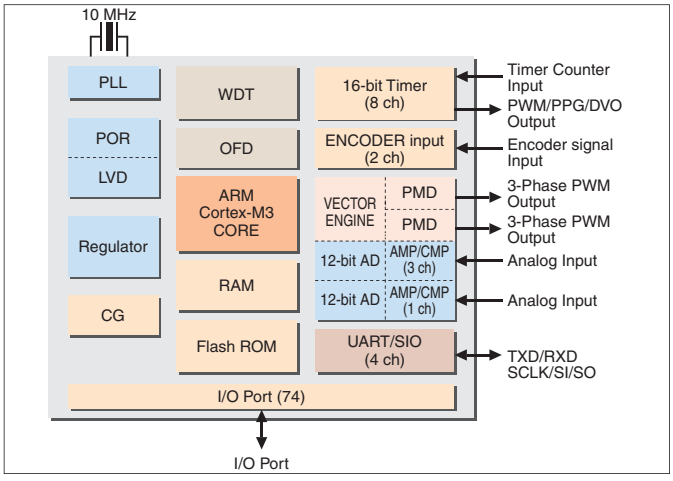
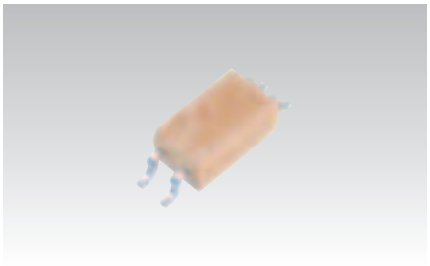
- Packages
  - 100-pin LQFP (14 x 14 mm, 0.5-mm lead pitch)
  - 100-pin QFP (14 x 20 mm, 0.65-mm lead pitch)



Transistor-Output Photocouplers

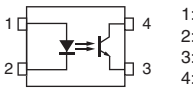
New Transistor-Output Photocoupler Certified for Reinforced Insulation in a Mini-Flat Package: TLP285

The TLP285 is a new addition to Toshiba's transistor-output photocoupler offerings in a small, thin (SOP4 mini-flat) package that is compliant with the reinforced insulation class of international safety standards.
The TLP285 has achieved certification for a safety level higher than the previous devices by providing a creepage/clearance distance of more than 5 mm; insulation thickness of more than 0.4 mm; and thus the isolation voltage of more than 3750 Vrms.



- VDE-approved: EN60747-5-2-approved with option V4
  Maximum working insulation voltage: 707 Vpk
  Maximum transient overvoltage: 6000 Vpk
- UL-recognized: UL1577 (File No. E67349)
- BSI and SEMKO-approved: BS EN60065: 2002, BS EN60950-1: 2006
  Reinforced insulation class: Maximum working voltage = 250 Vrms
- Creepage/clearance: 5.0 mm (min)
- Insulation thickness: 0.4 mm (min)
- Operating temperature: Ta = –55˚C to 110˚C

Pin Configuration



1: Anode
2: Cathode
3: Emitter
4: Corrector

Product Lineup
(Photocouplers with transistor output providing isolated feedback from the secondary side to the primary side)

Part Number	Package	Feature	CTR (@IF, VCE) (%)	Absolute Maximum Ratings(Ta=25˚C)				Safety Standards			
				IF (mA)	VCEO (V)	IC (mA)	Isolation voltage (Vrms)	UL cUL	VDE** EN60747-5-2	BSI EN60065 EN60950	SEMKO EN60065 EN60950
TLP181(,T)*	MFSOP6	General purpose	See table below.	50	80	50	3750	○	○	○	○
TLP285(,T)*	SOP4	1.27 mm lead pitch		50	80	50	3750	○	○	○	○
TLP781	DIP4	UL-approved (double protection)		60	80	50	5000	○	○	○	○

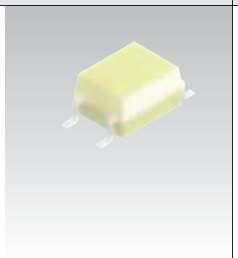
*Products whose part numbers are appended with the letter T are manufactured by Toshiba Semiconductor Thailand.
**The EN60747-5-2 approvals vary with packages. For details, please contact our sales representative.

CTR (IC/IF) Rank Table @IF = 5 mA, VCE = 5 V Unit: %

Rank	None	Y	YH	GB	GR	GRL	GRH	BL	BLL
Min	50	50	75	100	100	100	150	200	200
Max	600	150	150	600	300	200	300	600	400

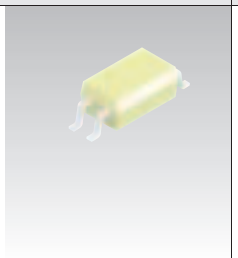
Package Dimensions

MFSOP6



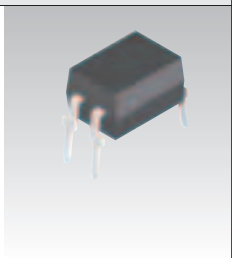
Unit: mm

SOP4



Unit: mm

DIP4(TLP781)



Unit: mm

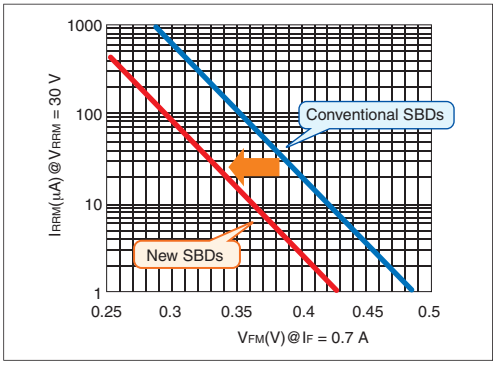
Schottky Barrier Diodes (SBDs) and High-Efficiency Diodes (HEDs)

New Series of Schottky Barrier Diodes

As the second-generation series of Schottky barrier diodes, Toshiba has developed new devices with a reverse breakdown voltage of 30 V. Owing to low peak forward voltage (VFM) and low peak repetitive reverse current (IRRM) characteristics, these SBDs provide low power loss, help reduce the size and improve the power efficiency of mobile handsets, switching power supplies, etc., thereby improving their overall performance.

- Voltage rating V_{RRM} = 30 V
  (Devices with V_{RRM} of 40 V to 60 V will be added to the conventional series.)
- Current rating $I_{F(AV)}$ = 1 A to 2 A
  More devices will be added to provide wider current rating options.
- Peak forward voltage (Typical characteristics: CRS10I30A)
  V_{FM} = 0.35 Vtyp. (0.39 V Max(@I_{FM} = 0.7 A))
- Package Small surface-mount packages (US-FLAT/S-FLAT)
  Devices will be available in M-FLAT and TO-220 packages.

Tradeoff Relationship between the Forward Voltage and Reverse Leakage Current (Example)



Part Number	Packaging	Absolute Maximum Ratings					Electrical Characteristics (Max)		
		V_{RRM}(V)	$V_{F(AV)}$(A)	I_{FSM}(A)	T_j(°C)	T_{stg}(°C)	I_{RRM}(mA)	V_{FM}(V)	@I_{FM}(A)
CRS10I30A	S-FLAT	30	1.0	20	150	−55 to 150	0.06	0.39	0.7
CRS10I30B	S-FLAT	30	1.0	20	150	−55 to 150	0.06	0.42	1.0
CRS15I30A	S-FLAT	30	1.5	20	150	−55 to 150	0.06	0.46	1.5
CRS20I30A	S-FLAT	30	2.0	20	150	−55 to 150	0.06	0.49	2.0
CUS10I30A	US-FLAT	30	1.0	20	150	−55 to 150	0.06	0.39	0.7
CUS15I30A	US-FLAT	30	1.5	20	150	−55 to 150	0.06	0.46	1.5

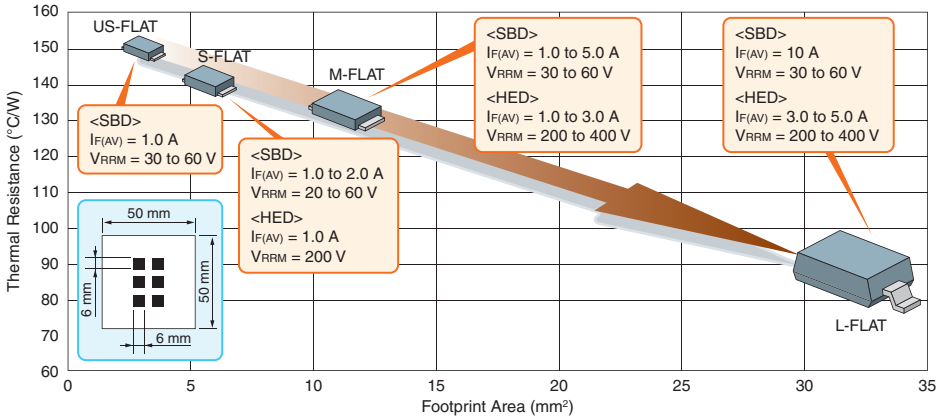
Surface-Mount Package Trend for Diodes

Toshiba has been working to develop the most compact surface-mount packages which allow communication equipment to be miniaturized.

Footprint and Thermal Resistance

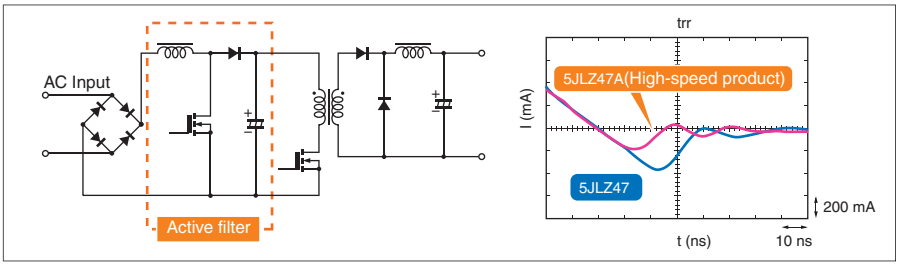
(Ta = 25°C)

Glass-epoxy board (Board size: 50 mm□, Solder land: 6 mm□)



HED Reverse Recovery Characteristics

Toshiba provides high-efficiency diodes (HEDs) with fast reverse recovery to meet high-efficiency, high-frequency and low-noise requirements of electronic equipment. In addition to general HEDs with the maximum reverse recovery time of 50 ns, Toshiba has been working to offer the rank "A" HEDs with the maximum recovery time of 35 ns.



Product Lineup

Schottky Barrier Diodes (SBDs)

Packaging	Part Number	Absolute Maximum Ratings					Electrical Characteristics (Max)				
		V_{RRM} (V)	$I_{F(AV)}$ (A)	I_{FSM} (A)	T_j (°C)	T_{stg} (°C)	I_{RRM} (mA)	V_{FM} (V)	@I_{FM} (A)	C_j (pF)(Typ.)	Conditions
US-FLAT™	CUS05	20	1.0	20	125	–40 to 150	1.0	0.37	0.7	40	V_R = 10 V, f = 1 MHz
	CUS06	20	1.0	20	150	–40 to 150	0.03	0.45	0.7	40	
	CUS01	30	1.0	20	125	–40 to 150	1.5	0.37	0.7	40	
	CUS02	30	1.0	20	150	–40 to 150	0.1	0.45	0.7	40	
	New CUS10I30A	30	1.0	20	150	–55 to 150	0.06	0.39	0.7	50	
	New CUS15I30A	30	1.5	20	150	–55 to 150	0.06	0.46	1.5	50	
	CUS03	40	0.7	20	150	–40 to 150	0.1	0.52	0.7	45	
	CUS04	60	0.7	20	150	–40 to 150	0.1	0.58	0.7	38	
S-FLAT™	CRS06	20	1.0	20	125	–40 to 150	1	0.36	1.0	60	V_R = 10 V, f = 1 MHz
	CRS01	30	1.0	20	125	–40 to 150	1.5	0.37	0.7	40	
	CRS02	30	1.0	20	125	–40 to 150	0.05	0.4	0.7	40	
	CRS03	30	1.0	20	150	–40 to 150	0.1	0.45	0.7	40	
	CRS05	30	1.0	20	150	–40 to 150	▽	0.45	1.0	60	
	CRS11	30	1.0	20	125	–40 to 150	1.5	0.36	1.0	60	
	New CRS10I30A	30	1.0	20	150	–55 to 150	0.06	0.39	0.7	50	
	New CRS10I30B	30	1.0	20	150	–55 to 150	0.06	0.42	1.0	50	
	CRS08	30	1.5	30	125	–40 to 150	1	0.36	1.5	90	
	CRS09	30	1.5	30	150	–40 to 150	0.05	0.46	1.5	90	
	New CRS15I30A	30	1.5	20	150	–55 to 150	0.06	0.46	1.5	50	
	CRS14	30	2.0	30	150	–40 to 150	0.05	0.49	2.0	90	
	New CRS20I30A	30	2.0	20	150	–55 to 150	0.06	0.49	2.0	50	
	CRS15◇	30	3.0	30	150	–40 to 150	0.05	0.52	3.0	90	
	CRS04	40	1.0	20	150	–40 to 150	0.1	0.49	0.7	47	
	CRS12	60	1.0	20	150	–40 to 150	0.1	0.58	1.0	40	
	CRS13	60	1.0	20	150	–40 to 150	0.05	0.55	1.0	40	
M-FLAT™	CMS08	30	1.0	25	125	–40 to 150	1.5	0.37	1.0	70	V_R = 10 V, f = 1 MHz
	CMS09	30	1.0	25	150	–40 to 150	0.5	0.45	1.0	70	
	CMS06	30	2.0	40	125	–40 to 150	3.0	0.37	2.0	130	
	CMS07	30	2.0	40	150	–40 to 150	0.5	0.45	2.0	130	
	CMS17	30	2.0	30	150	–40 to 150	0.1	0.48	2.0	90	
	CMS01	30	3.0	40	125	–40 to 150	5.0	0.37	3.0	190	
	CMS02	30	3.0	40	125	–40 to 150	0.5	0.4	3.0	170	
	CMS03	30	3.0	40	150	–40 to 150	0.5	0.45	3.0	190	
	CMS18	30	3.0	40	150	–40 to 150	0.01	0.66	3.0	–	
	CMS04	30	5.0	70	125	–40 to 150	8.0	0.37	5.0	330	
	CMS05	30	5.0	70	150	–40 to 150	0.8	0.45	5.0	330	
	CMS10	40	1.0	25	150	–40 to 150	0.5	0.55	1.0	50	
	CMS11	40	2.0	30	150	–40 to 150	0.5	0.55	2.0	95	
	CMS16	40	3.0	30	150	–40 to 150	0.2	0.55	3.0	95	
	CMS19	40	3.0	40	150	–40 to 150	0.01	0.68	3.0	–	
	CMS14	60	2.0	40	150	–40 to 150	0.2	0.58	2.0	77	
	CMS15	60	3.0	60	150	–40 to 150	0.3	0.58	3.0	102	
	CMS20	60	3.0	40	150	–40 to 150	0.01	0.72	3.0	–	
L-FLAT™	CLS01	30	10	100	125	–40 to 150	1.0	0.47	10	530	V_R = 10 V, f = 1 MHz
	CLS02	40	10	100	125	–40 to 150	1.0	0.55	10	420	
	CLS03	60	10	100	125	–40 to 150	1.0	0.58	10	345	
TO-220NIS	5FWJ2CZ47M	30	5.0	50	125	–40 to 150	3.5	0.47	2.5	138	V_R = 10 V, f = 1 MHz
	5GWJ2CZ47C	40	5.0	50	125	–40 to 150	3.5	0.55	2.5	100	
	10FWJ2CZ47M	30	10	100	125	–40 to 150	3.5	0.47	5.0	290	
	10GWJ2CZ47C	40	10	100	125	–40 to 150	3.5	0.55	5.0	195	
	20FWJ2CZ47M	30	20	200	125	–40 to 150	10	0.47	10	680	
	30FWJ2CZ47M	30	30	300	125	–40 to 150	15	0.47	15	820	
	30GWJ2CZ47C	40	30	300	125	–40 to 150	15	0.55	15	600	
	30QWK2CZ47	120	30	250	150	–40 to 150	0.05	0.85	15	227	

Note: I_{FSM}, I_{RRM} and V_{FM} are specified per diode. ▽: I_{RRM} = 5 μA Max (V_R = 5 V) ◇: $I_{F(DC)}$ = 3 A

High-Efficiency Diodes (HEDs)

Packaging	Part Number	Absolute Maximum Ratings					Electrical Characteristics (Max)				
		V_{RRM} (V)	$I_{F(AV)}$ (A)	I_{FSM} (A)	T_j (°C)	T_{stg} (°C)	I_{RRM} (mA)	V_{FM} (V)	@I_{FM} (A)	C_j (pF)(Typ.)	Conditions
S-FLAT™	New CRH02	200	0.5	10	150	–40 to 150	10	0.95	0.5	35	I_F = 1 A, di/dt = –30 A/μs
	CRH01	200	1.0	15	150	–40 to 150	10	0.98	1.0	35	
M-FLAT™	CMH04	200	1.0	20	150	–40 to 150	10	0.98	1.0	35	I_F = 1 A, di/dt = –30 A/μs
	CMH07	200	2.0	40	150	–40 to 150	10	0.98	2.0	35	
	CMH01	200	3.0	40	150	–40 to 150	10	0.98	3.0	35	
	CMH05	400	1.0	20	150	–40 to 150	10	1.3	1.0	50	
	CMH05A	400	1.0	10	150	–40 to 150	10	1.8	1.0	35	
	CMH08	400	2.0	30	150	–40 to 150	10	1.3	2.0	50	
	CMH08A	400	2.0	20	150	–40 to 150	10	1.8	2.0	35	
	CMH02	400	3.0	40	150	–40 to 150	10	1.3	3.0	50	
	CMH02A	400	3.0	30	150	–40 to 150	10	1.8	3.0	35	
L-FLAT™	CLH01	200	3.0	60	150	–40 to 150	10	0.98	3.0	35	I_F = 2 A, di/dt = –50 A/μs
	CLH05	200	5.0	100	150	–40 to 150	10	0.98	5.0	35	
	CLH02	300	3.0	50	150	–40 to 150	10	1.3	3.0	35	
	CLH06	300	5.0	60	150	–40 to 150	10	1.3	5.0	35	
	CLH03	400	3.0	30	150	–40 to 150	10	1.8	3.0	35	
	CLH07	400	5.0	50	150	–40 to 150	10	1.8	5.0	35	
TO-220NIS (Center Leadless)	5DLZ47A	200	5.0	50	150	–40 to 150	10	0.98	5.0	35	I_F = 2 A, di/dt = –20 A/μs
	5GLZ47A	400	5.0	50	150	–40 to 150	50	1.8	5.0	35	
	5JLZ47	600	5.0	50	150	–40 to 150	50	2.0	5.0	50	
	5JLZ47A	600	5.0	40	150	–40 to 150	50	4.0	5.0	35	
TO-220NIS	5DL2CZ47A	200	5.0	25	150	–40 to 150	10	0.98	2.5	35	I_F = 2 A, di/dt = –20 A/μs
	5FL2CZ47A	300	5.0	25	150	–40 to 150	10	1.3	2.5	35	
	5GL2CZ47A	400	5.0	25	150	–40 to 150	50	1.8	2.5	35	
	5JL2CZ47	600	5.0	25	150	–40 to 150	50	2.0	2.5	50	
	10DL2CZ47A	200	10	50	150	–40 to 150	10	0.98	5.0	35	
	10FL2CZ47A	300	10	50	150	–40 to 150	10	1.3	5.0	35	
	10GL2CZ47A	400	10	50	150	–40 to 150	50	1.8	5.0	35	
	10JL2CZ47	600	10	50	150	–40 to 150	50	2.0	5.0	50	
	10JL2CZ47A	600	10	40	150	–40 to 150	50	4.0	5.0	35	
	16DL2CZ47A	200	16	80	150	–40 to 150	50	0.98	8.0	35	I_F = 2 A, di/dt = –50 A/μs
	16FL2CZ47A	300	16	80	150	–40 to 150	50	1.3	8.0	35	
	20DL2CZ47A	200	20	100	150	–40 to 150	50	0.98	10	35	
	20FL2CZ47A	300	20	100	150	–40 to 150	50	1.3	10	35	

OVERSEAS SUBSIDIARIES AND AFFILIATES

(As of October 01, 2009)

2010-5

SCE0024D

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