

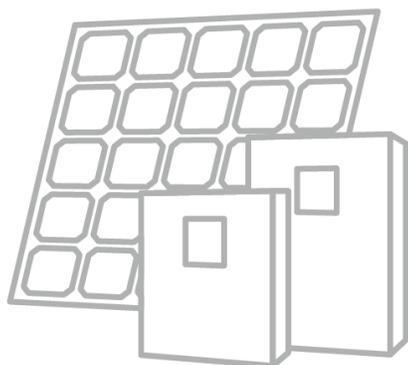
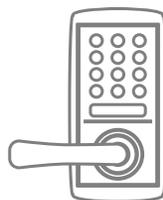
TOSHIBA

PV Inverter for Household Use

Solution Proposal by Toshiba

R22

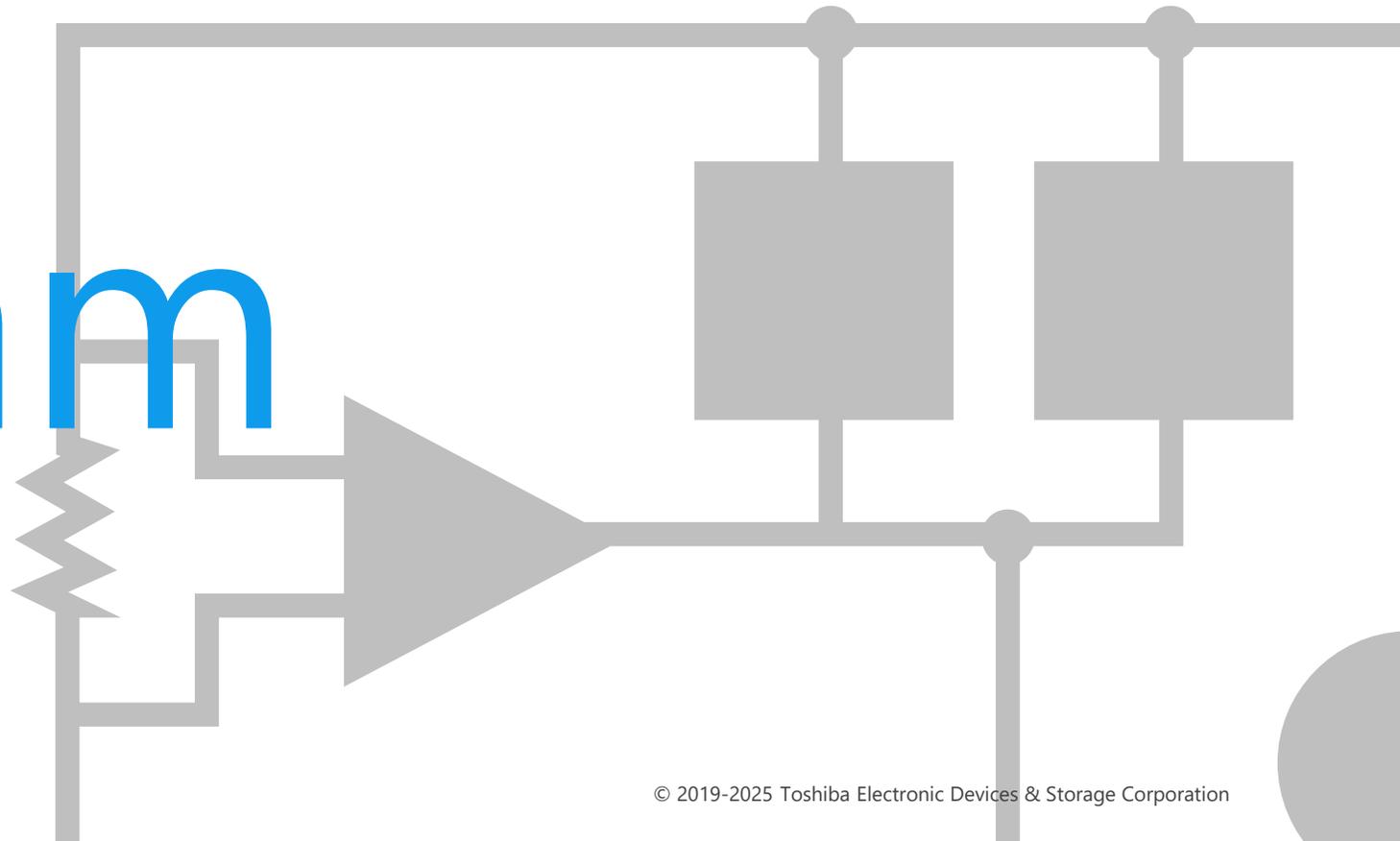




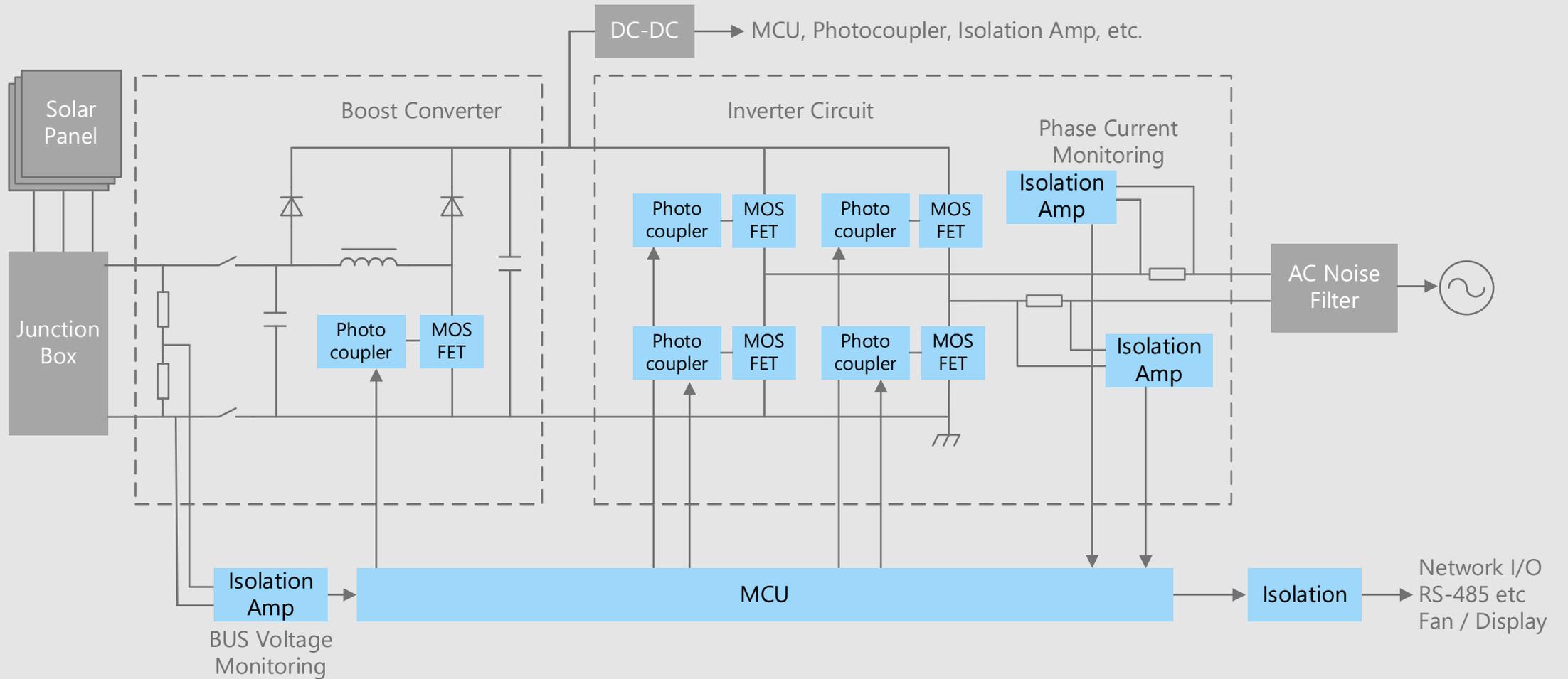
Toshiba Electronic Devices & Storage Corporation provides comprehensive device solutions to customers developing new products by applying its thorough understanding of the systems acquired through the analysis of basic product designs.



Block Diagram

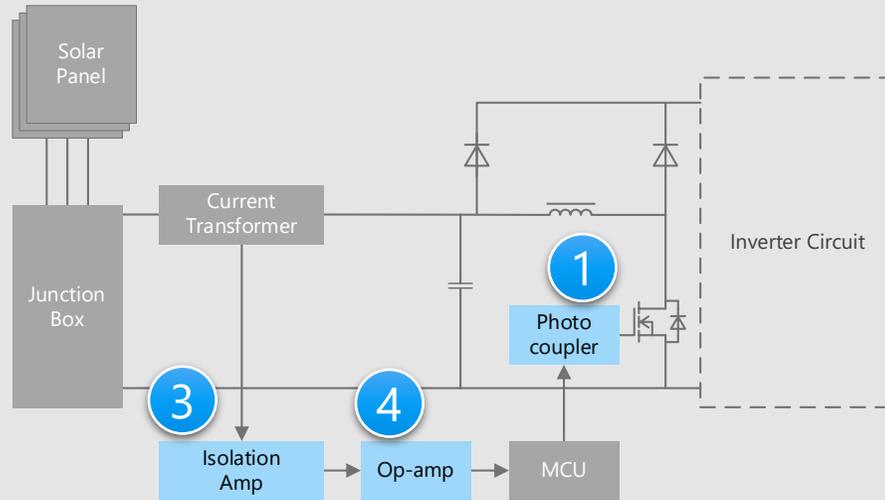


PV Inverter for Household Use Overall block diagram

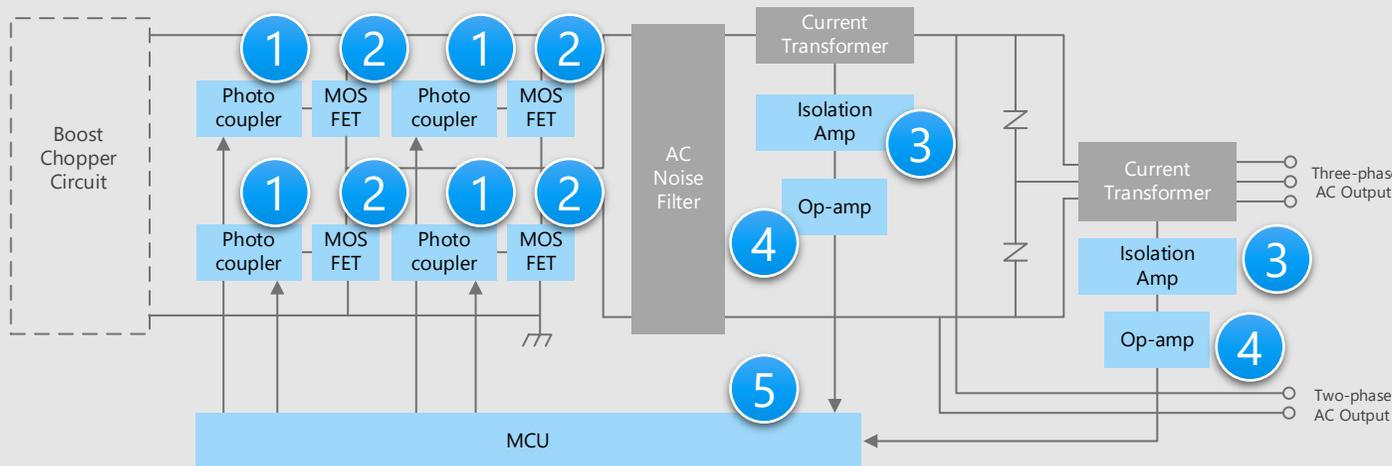


PV Inverter for Household Use Details of power supply unit

Boost converter circuit



Inverter circuit



Criteria for device selection

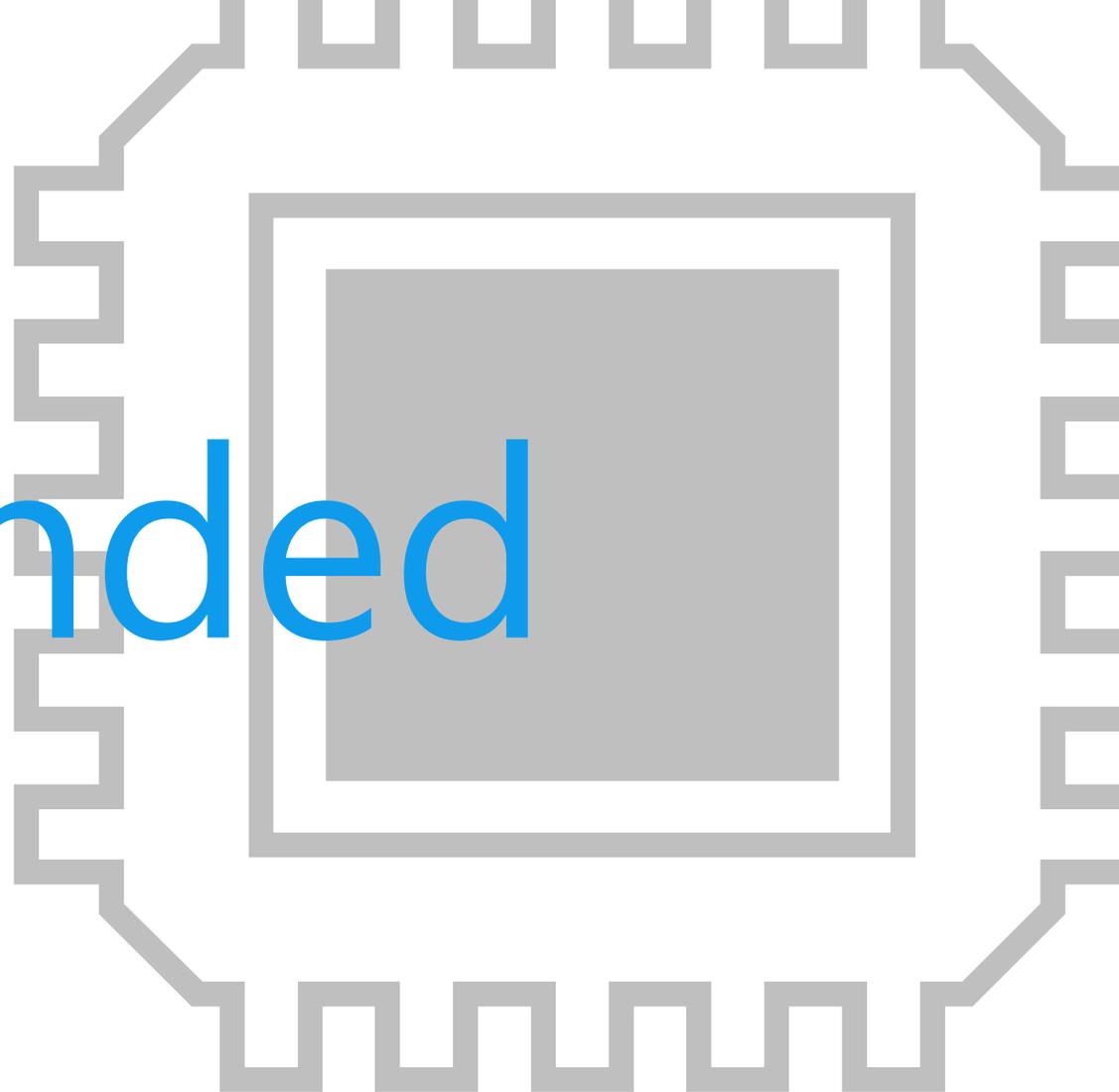
- IC output photocoupler capable of high speed PWM signal transmission is suitable for controlling converters and inverters.
- MOSFET with a good balance between on-resistance and switching speed is suitable for increasing the efficiency of the inverter.
- Isolation amplifier is suitable for detecting signals with different reference potentials.
- Low noise operational amplifier is suitable for high accuracy signal amplification.

Proposals from Toshiba

- **Photocoupler that is resistant to noise and can operate at high temperature**
IC output photocoupler
- **Low on-resistance and high speed switching MOSFET**
DTMOS Series MOSFET
- **Low power consumption and high accuracy control in a small package**
Isolation amplifier
- **Amplify the detected weak signal with low noise**
Low noise operational amplifier
- **Built-in three-phase PWM is suitable for controlling inverter system**
MCU M380 Group

* Click on the number in the circuit diagram to jump to the detailed description page

Recommended Devices



Device solutions to address customer needs

As described above, in the design of PV inverter for household use, **“Enhancement of safety of set”**, **“High efficiency”** and **“Miniaturization of circuit boards”** are important factors. Toshiba’s proposals are based on these three solution perspectives.



Device solutions to address customer needs



	Safety	Low loss	Small size packages
① IC output photocoupler	●		●
② DTMOS Series MOSFET		●	●
③ Isolation amplifier	●	●	●
④ Low noise operational amplifier		●	●
⑤ MCU M380 Group		●	●

Value provided

This is the photocoupler that coupled an infrared light emitting diode with high output power and a light receiving IC chip with high gain and high speed.

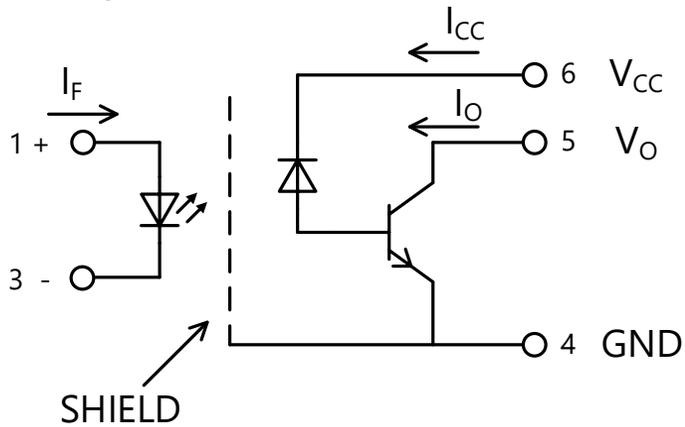
1 Common mode transient immunity (CMTI) of 10 [kV/μs]

This photocoupler has CMTI capability of 10 kV/μs or more by providing shield between input and output of the photocoupler.

2 High speed

IC output photocouplers transmit PWM signals, which requires high speed operation.

Internal circuit configuration



Lineup

Part number	TLP2719
Package	SO6L 
BV _S [Vrms]	5000
Data transfer rate (Typ.) [Mbps]	1
CM _H , CM _L (Min) [kV/μs]	±10

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IC output photocoupler

TLP5231 / TLP5214 / TLP5214A (Smart Gate Driver Coupler)



Value provided

The built-in various protective functions make it easy to design the gate drive circuit.

1 Protective functions

Various protective functions [Note] including an overcurrent detection by monitoring collector voltage are built in.

[Note] Gate signal soft turn off, fault feedback function

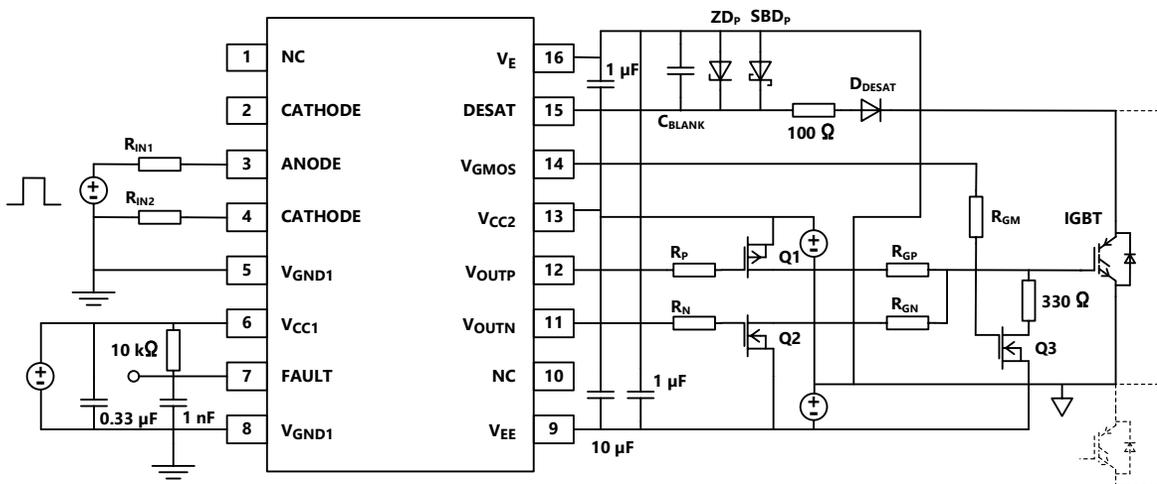
2 Rail-to-rail output

TLP5231, TLP5214 and TLP5214A generate a full-swing voltage output signal and contribute to low power consumption.

3 High temperature of 110 °C (ambient) operation

These photocouplers are designed to operate under severe ambient temperature conditions.

Application Circuit (TLP5231)



Lineup

Part number	TLP5231	TLP5214	TLP5214A
Package	SO16L	SO16L	SO16L
I_{OP} (Max) [A]	±2.5	±4.0	±4.0
t_{pHL}/t_{pLH} (Max) [ns]	300	150	150
BV_S [Vrms]	5000	5000	5000
T_{opr} [°C]	-40 to 110	-40 to 110	-40 to 110
$V_{CC2} - V_{EE}$ [V]	21.5 to 30	15 to 30	15 to 30
$I_{FHL}(I_{FLH})$ (Max) [mA]	3.5	6	6
DESAT Filter	✓	-	✓

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Value provided

DTMOS series contribute to achieve higher efficiency by $R_{DS(ON)} \times Q_{gd}$ improvement.

1 $R_{DS(ON)} \times Q_{gd}$ improvement

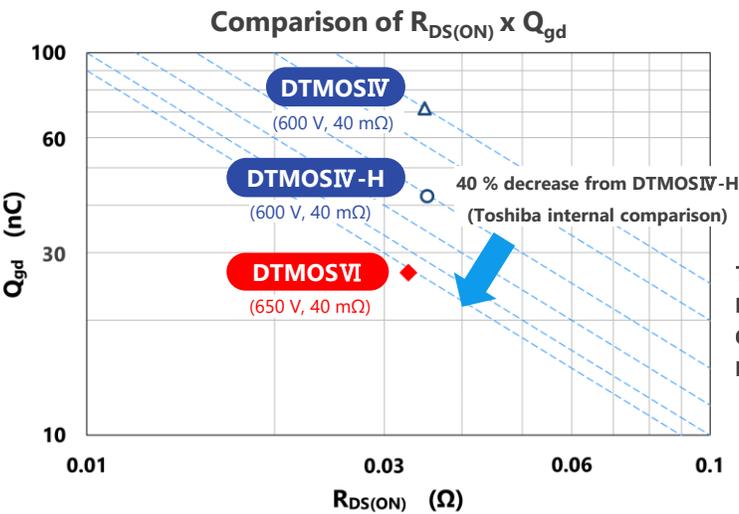
In the DTMOSVI series, the $R_{DS(ON)} \times Q_{gd}$ is reduced by approximately 40 % compared with our conventional DTMOSIV-H series product by optimizing the gate design and processes.

2 Enhancement type

This is an enhancement type that is easy to handle.

3 Various packages

Wide package lineup: from through hole type to small surface mount type with high heat dissipating.



Test Condition
 $R_{DS(ON)}$: $I_D = 28.5 \text{ A}$, $V_{GS} = 10 \text{ V}$
 Q_{gd} : $V_{DD} = 400 \text{ V}$, $I_D = 57 \text{ A}$, $V_{GS} = 10 \text{ V}$
 Plots the mean of the measured values.
 (Based on Toshiba's measurement data as of March, 2023)

Lineup

Part number	TK090E65Z	TK090U65Z	TK090A65Z	TK090N65Z	TK090Z65Z
Package	TO-220	TOLL	TO-220SIS	TO-247	TO-247-4L
V _{DSS} [V]	650	650	650	650	650
I _D [A]	30	30	30	30	30
R _{DS(ON)} [Ω] @V _{GS} = 10 V	Typ.	0.075	0.07	0.075	0.075
	Max	0.09	0.09	0.09	0.09
Polarity	N-ch	N-ch	N-ch	N-ch	N-ch
Generation	DTMOSVI	DTMOSVI	DTMOSVI	DTMOSVI	DTMOSVI

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Value provided

This is an isolation amplifier suitable for current and voltage detection of motors and inverters.

1 High isolation performance

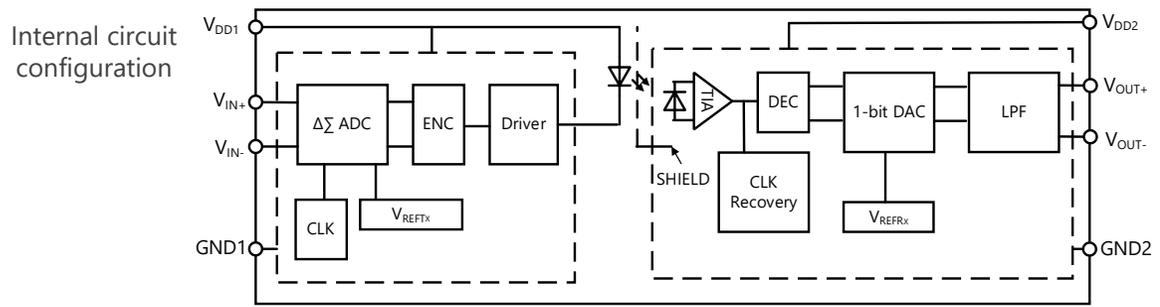
This optical coupling type isolation amplifier has a high-precision $\Delta\Sigma$ AD conversion circuit on the input side and a high precision DA conversion circuit on the output side.

2 Support for common mode

Common-mode transient immunity is provided with CMTI [Note 1] = 15 kV/ μ s (Min).
[Note 1] CMTI: Common Mode Transient Immunity

3 5 V system power supply voltages

Input power supply voltage
 V_{DD1} = 4.5 to 5.5 V
Output power supply voltage
 V_{DD2} = 3.0 to 5.5 V



[Note 1] Bypass capacitor of 0.1 μ F must be connected between 1 and 4 pins and between 5 and 8 pins.

UL-approved: UL1577, File No.E67349
cUL-approved: CSA Component Acceptance Service No.5A File No.E67349
VDE-approved: EN 60747-5-5, EN 62368-1 [Note 2]

[Note 2] When a VDE approved type is needed, please designate the Option (D4).

Lineup	
Part number	TLP7820
Package	SO8L(LF4) 
BV_S [Vrms]	5000
T_{opr} [°C]	-40 to 105
CMTI (Min) [kV/ μ s]	15

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Value provided

Very small signals detected by various sensors can be amplified with very low noise.

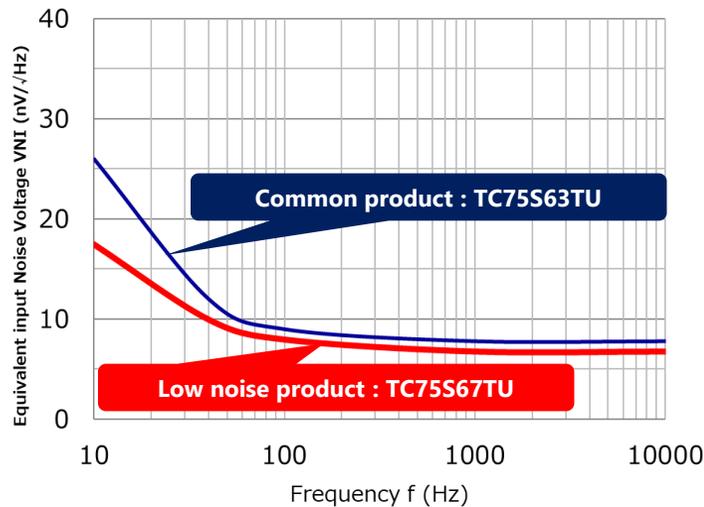
1 Low noise

$V_{NI} = 6.0 \text{ [nV}/\sqrt{\text{Hz}}] \text{ (Typ.) @} f = 1 \text{ kHz}$

Small signals detected by various sensors [Note] can be amplified with low noise using CMOS operational amplifier. Low input equivalent noise voltage has been achieved by optimizing the processing.

[Note] Sensor types: vibration detection sensor, shock sensor, accelerometer, pressure sensor, infrared sensor, temperature sensor, etc.

Noise characteristics
(Toshiba internal comparison)



2 Low current consumption

$I_{DD} = 430 \text{ [}\mu\text{A]} \text{ (Typ.)}$

Low current consumption characteristics are realized by using the CMOS process.

Lineup	
Part number	TC75S67TU
Package	UFV 
$V_{DD,SS}$ (Max) [V]	± 2.75
$V_{DD,SS}$ (Min) [V]	± 1.1
I_{DD} (Typ.) [μA]	430
V_{NI} (Typ.) [$\text{nV}/\sqrt{\text{Hz}}$] @ $f = 1 \text{ kHz}$	6

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Value provided

Toshiba original oscillation frequency detector (OFD) can be utilized for abnormal operation detection of system.

1 Built-in Arm® Cortex®-M3 CPU core

TPM381/383 implements Cortex-M3 core with 40 MHz maximum operation frequency. Various development tool and their partners allow users many options.

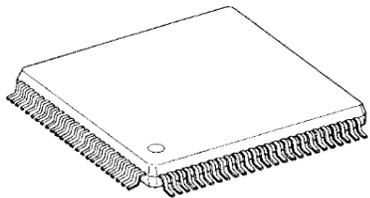
2 System cost down and development efficiency improvement

TPM381/383 executes system monitoring efficiently by using built-in AD converter. The original NANO FLASH™ is possible to rewrite at high speed. It reduces user software development time period.

3 Built-in oscillation frequency detector

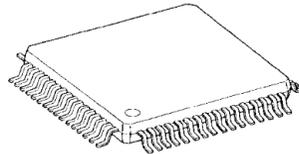
TPM381/383 implements Toshiba original oscillation frequency detector (OFD) which detects abnormal oscillation at the hardware level. This function can be utilized for abnormal operation detection of system.

TPM381FWFG



LQFP100-P-1414-0.50H

TPM383FSUG



LQFP64-P-1010-0.50E

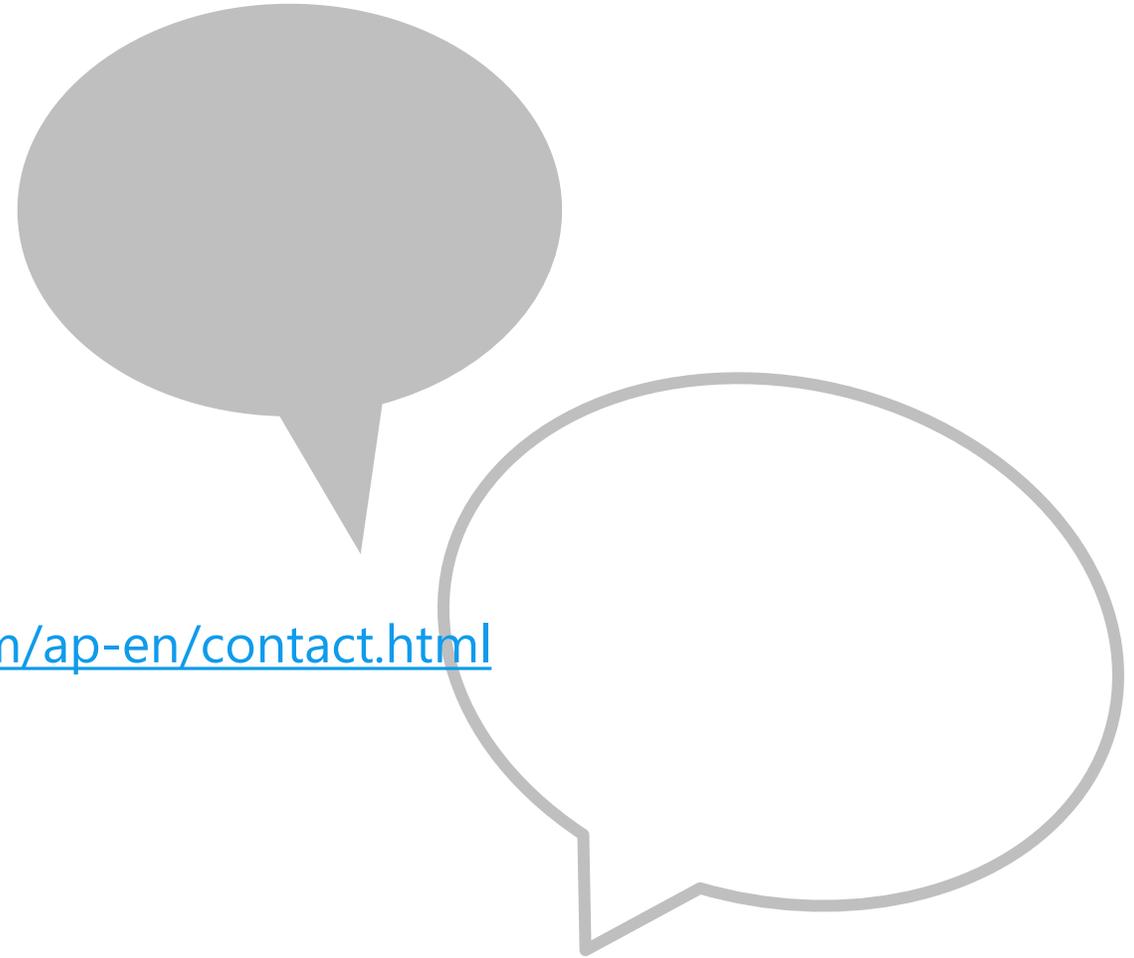
Lineup

Part number	TPM381FWFG	TPM383FSUG
Maximum operation frequency	40 MHz	40 MHz
Instruction ROM	128 KB	64 KB
RAM	10 KB	8 KB
Timer	16bit x 8ch	16bit x 8ch
UART / SIO	3ch	2ch
Full UART	1ch	1ch
AD converter	18ch (12bit)	10ch (12bit)
IO Port	83 ports	47 ports

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