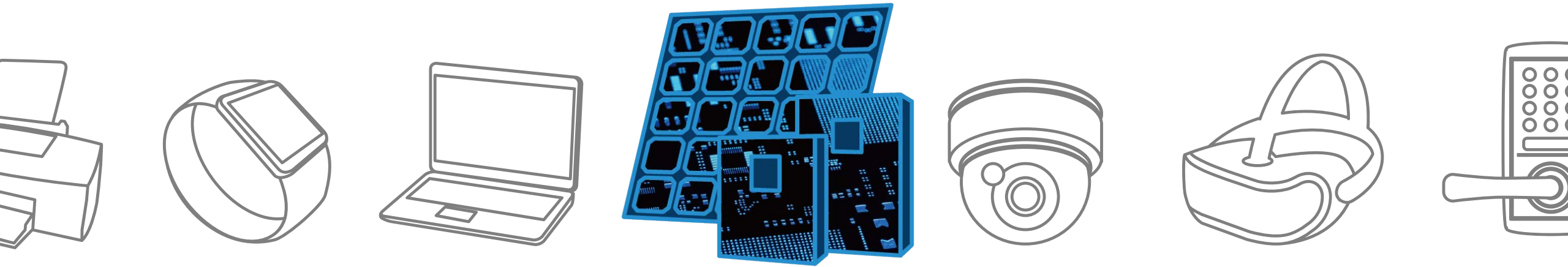


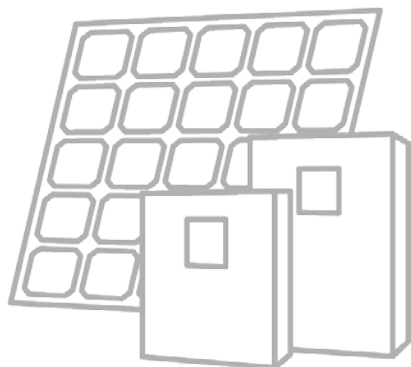
TOSHIBA

PV Inverter for Household Use

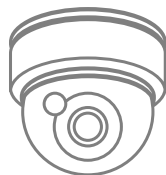
R20

Solution Proposal by Toshiba

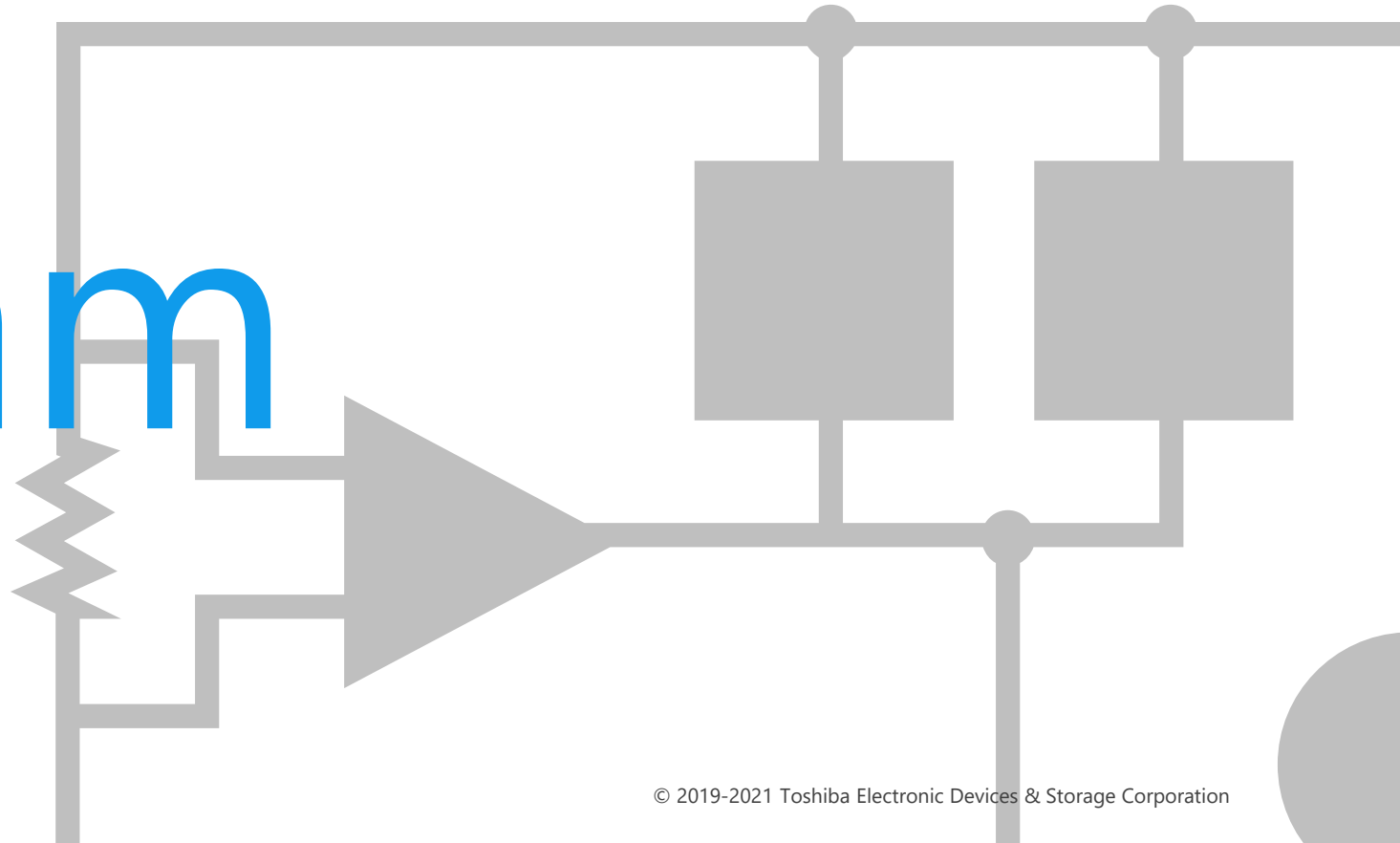




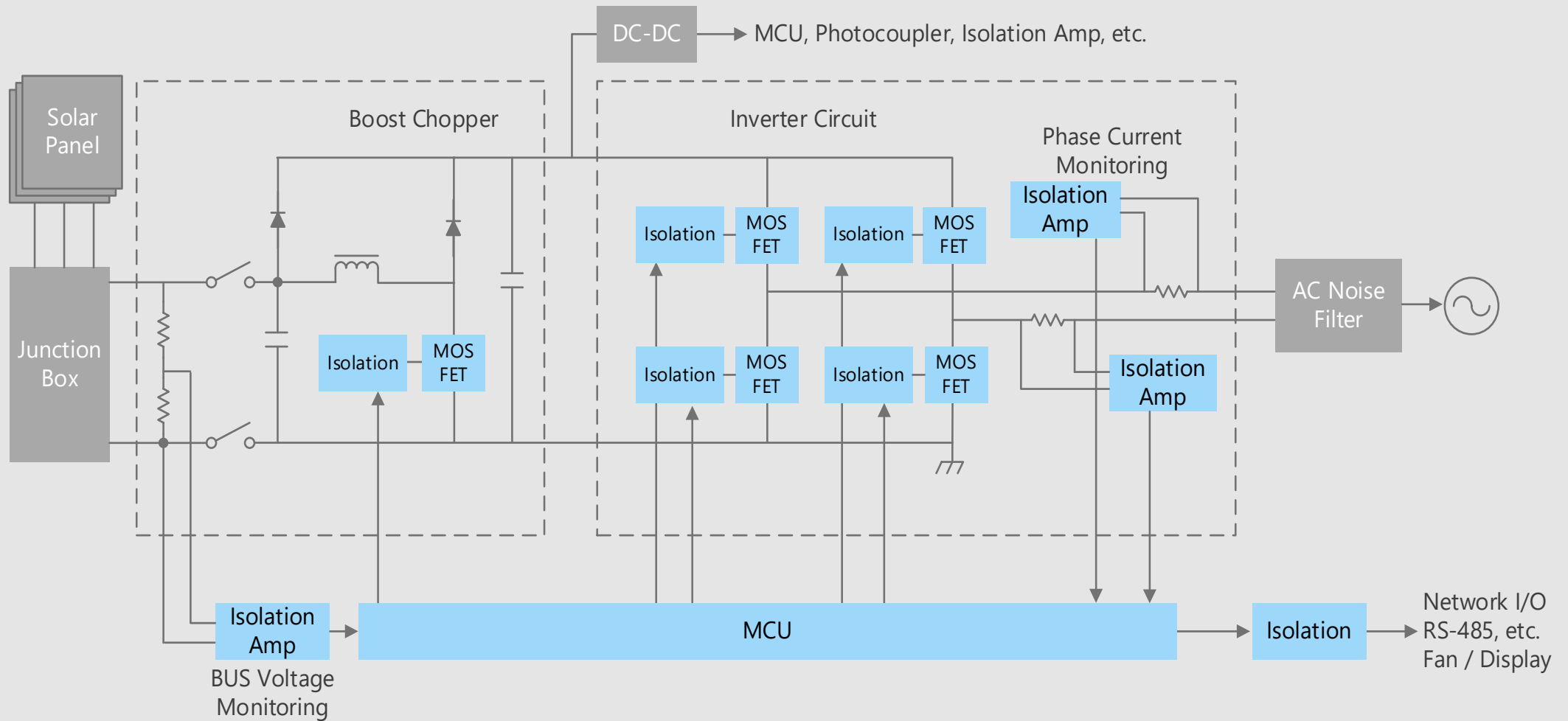
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Block Diagram

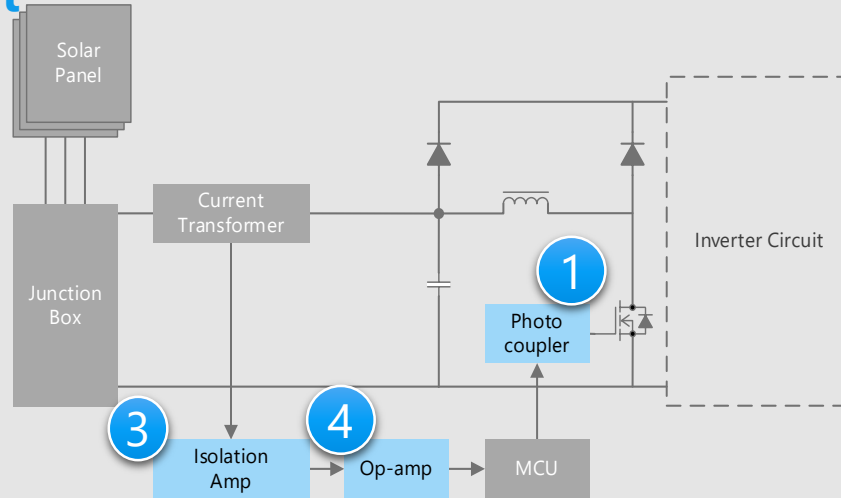


PV Inverter for Household Use Overall block diagram

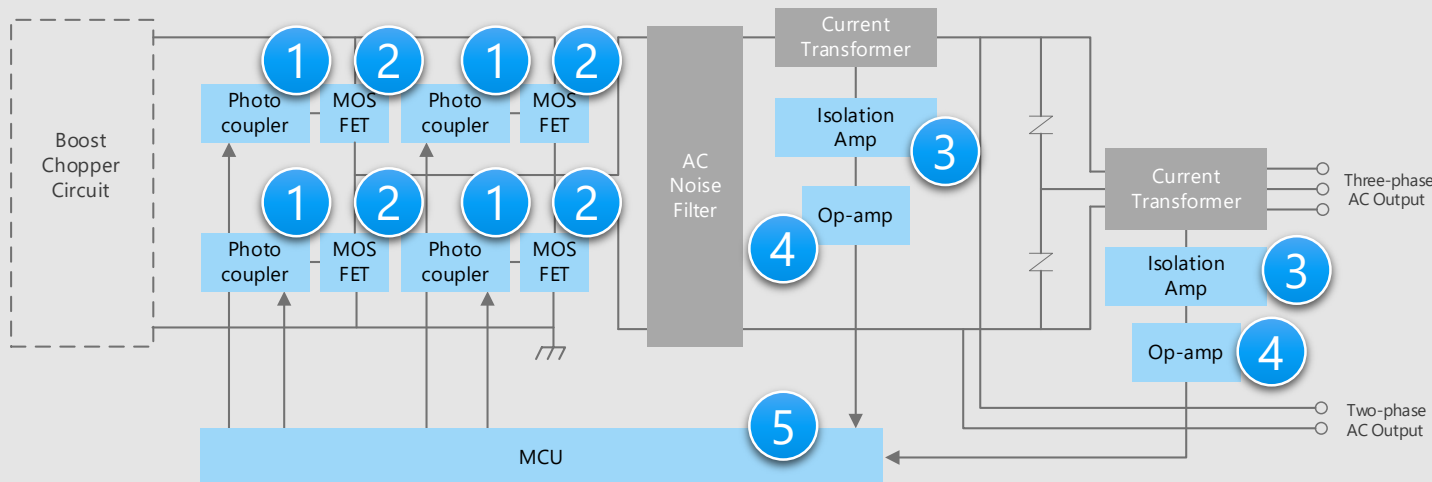


PV Inverter for Household Use Details of power supply unit

Boost converter circuit



Inverter circuit



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

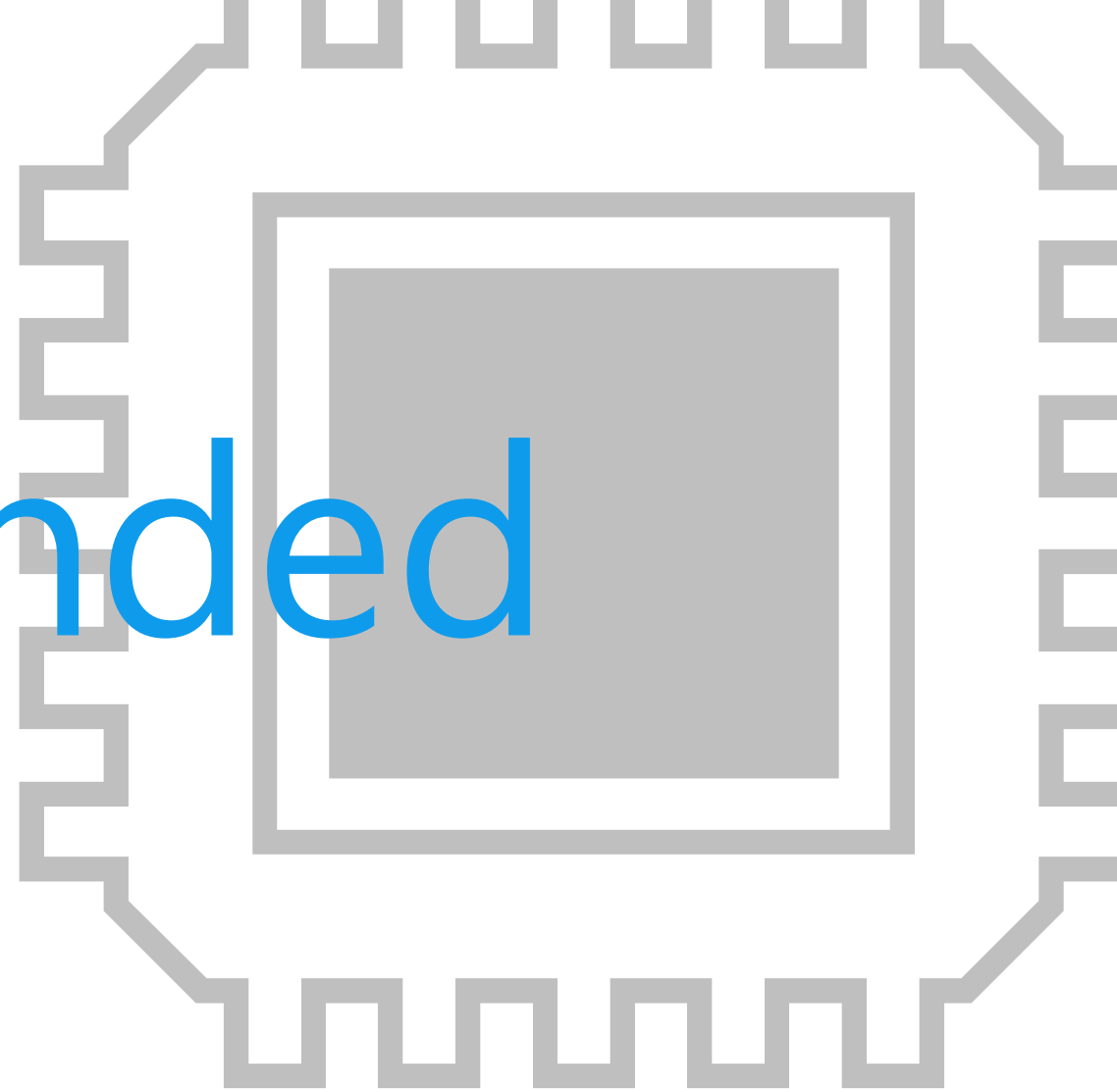
Criteria for device selection

- Inverter output (output Low with LED signal ON) is suitable for low active IPM, and high speed is required for PWM signal transmission.
- To improve the efficiency of the inverter, it is important to select a MOSFET with a balanced on-resistance and switching speed.
- Isolation amplifier is suitable for detecting signals with different reference potentials.
- Signal amplification with high accuracy requires low noise performance.
- Efficient inverter control is required.

Proposals from Toshiba

- **Photocoupler with excellent environmental resistance**
IC output photocoupler 1
- **Low on-resistance and high speed switching MOSFET**
DTMOS Series MOSFET 2
- **Photocoupler with excellent environmental resistance**
Isolation amplifier 3
- **Amplify the detected weak signal with low noise**
Low noise operational amplifier 4
- **Built-in three-phase PWM is suitable for controlling inverter system**
MCU 5

Recommended Devices



Device solutions to address customer needs

As described above, in the design of PV inverter for household use, **“Enhancement of safety of the 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		●	●

Value provided

This photocoupler optically couples an infrared light emitting diode with high optical output power and an integrated circuit light-receiving IC chip with high gain and high speed.

1 For low active IPM

Inverter output (output Low with LED signal ON) is supported for low active IPM driving.

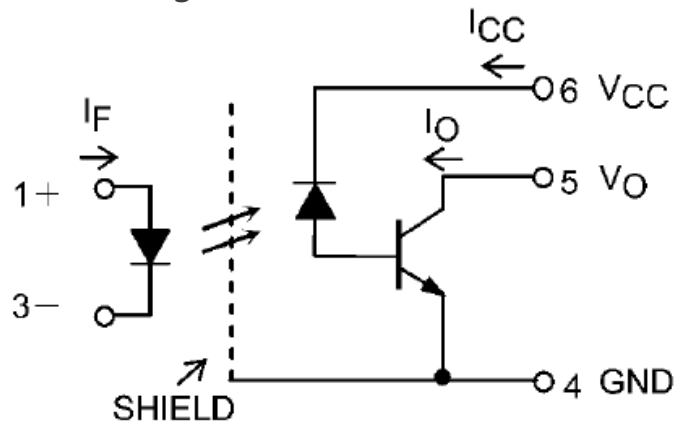
2 Common-mode transient immunity (CMTI) of 10 [kV/μs]

High CMTI is required because a high dV/dt is applied to the control signal terminal of the IPM. This photocoupler has CMTI capability of 10 [kV/μs] or more by providing shield between input and output of the photocoupler.


3 High speed and small delay time variations

IPM drive photocouplers transmit PWM signals, which requires high speed operation.

Internal circuit configuration



Line up

Part number	TLP2719(LF4)
Package	SO6L(LF4) 
BV_S (Min) [Vrms]	5000
NRZ (Typ.) [Mbps]	1
CM_H, CM_L (Min) [kV/μs]	±10

[Return to Block Diagram Top](#)

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

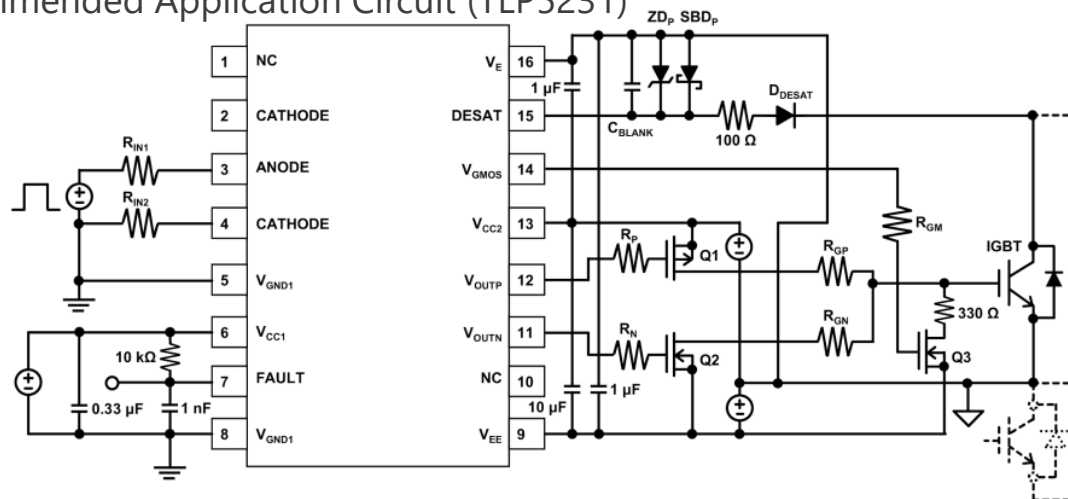
2 Rail-to-rail output

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.

Recommended Application Circuit (TLP5231)



Line up

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.

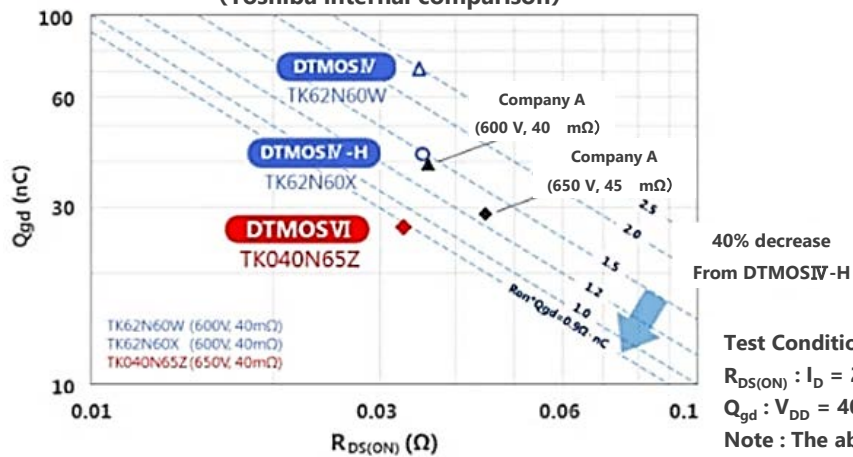
2 Enhancement type

This is an enhancement type that is easy to handle.







3 Various packages

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

Comparisons of figures of merit
(Toshiba internal comparison)



Line up

Part number	TK210V65Z	TK190U65Z	TK110U65Z	TK190A65Z	TK110N65Z	TK110Z65Z
Package	 DFN 8×8	 TOLL	 TOLL	 TO-220SIS	 TO-247	 TO-247-4L
V_{DSS} [V]	650	650	650	650	650	650
I_D [A]	15	15	24	15	24	24
$R_{DS(ON)}$ [Ω] @ $V_{GS} = 10 \text{ V}$	Typ.	0.175	0.149	0.086	0.158	0.092
	Max	0.21	0.19	0.11	0.19	0.11
Polarity	N-ch	N-ch	N-ch	N-ch	N-ch	N-ch
Generation	DTMOSVI	DTMOSVI	DTMOSVI	DTMOSVI	DTMOSVI	DTMOSVI

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Value provided

Isolation amplifier with low current consumption and compact package enables highly accurate current detection.

1 Low current consumption

Introduction of new digital modulation technology has reduced current consumption due to input voltage dependence.

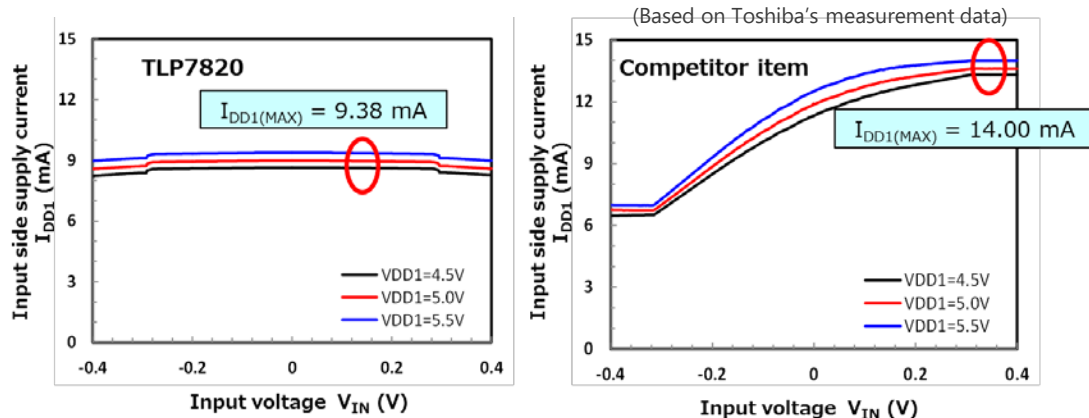
2 Low height compact package

Compact and low profile (2.3 [mm] (Max)) SO8L package contributes reducing mounting area.


3 High accuracy

This optical coupling type isolation amplifier uses an IC with a high precision $\Delta\Sigma$ A/D convertor circuit on the input side and an IC with a high precision D/A convertor circuit on the output side.

Current consumption characteristics



Line up

Part number	TLP7820
Package	SO8L(LF4) 
Gain accuracy [%]	$\pm 0.5 / \pm 1.0 / \pm 3.0$ (rank selection)
$ dG/dT_a $ (Typ.) [V/V/°C]	0.00012
NL ₂₀₀ (Typ.) [%]	0.02
V_{OS} (Typ.) [mV]	0.9
I_{DD1} (Typ.) [mA]	8.6
I_{DD2} (Typ.) [mA]	6.2

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4 Low noise operational amplifier

TC75S67TU



Value provided

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

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

Very small signals detected by various sensors [Note 1] can be amplified with low noise using CMOS operational amplifier by optimizing the processing. We achieved one of the industry's lowest [Note 2] input equivalent noise voltage.

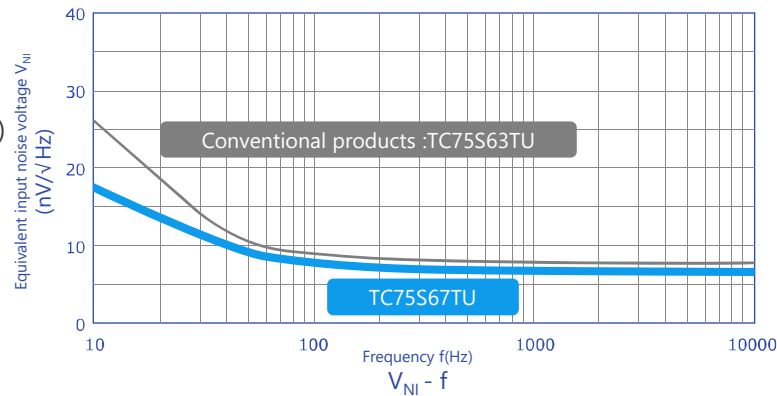
2 Low current consumption
 $I_{DD} = 430$ [μA](Typ.)


The low current consumption characteristics of CMOS processing contributes to the extension of battery life of the compact IoT devices.

3 Low supply voltage operation

$V_{DD} = 2.2$ to 5.5 V

Low noise characteristic
 (Toshiba internal comparison)



Line up	
Part number	TC75S67TU
Package	UFV 
$V_{DD,SS}$ (Max) [V]	± 2.75
$V_{DD,SS}$ (Min) [V]	± 1.1
I_{DD} (Typ. / Max) [μA]	430 / 700 (@ $V_{DD} = 2.5$ V)
V_{NI} (Typ.) [nV/ $\sqrt{\text{Hz}}$] @f=1 kHz	6

[Note 1] Sensor types: vibration detection sensor, shock sensor, accelerometer, pressure sensor, infrared sensor, and temperature sensor, etc.
 [Note 2] Based on Toshiba data (as of May 2017)

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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.

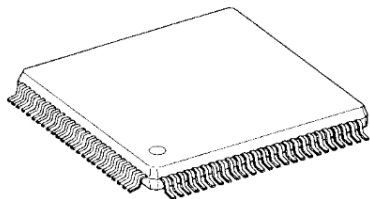
2 System cost down and development efficiency improvement

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

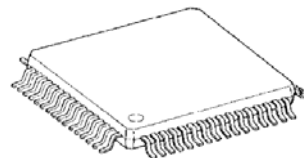
3 Built-in oscillation frequency detector

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



TPM383FSUG



Line up

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 14ch	16bit x 8ch
UART / SIO	3ch	2ch
Full UART	1ch	1ch
ADC	18ch (12bit)	10ch (12bit)
IO Port	83 ports	47 ports

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