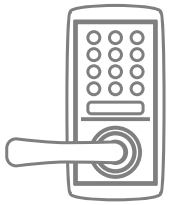
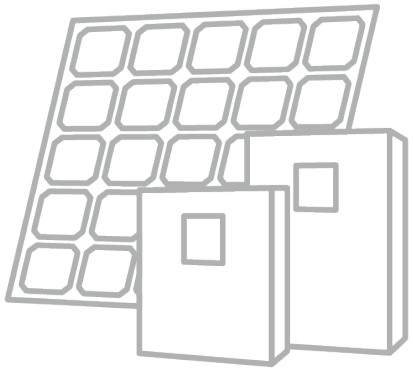
TOSHIBA

R21

PV Inverter for Household Use

Solution Proposal by Toshiba





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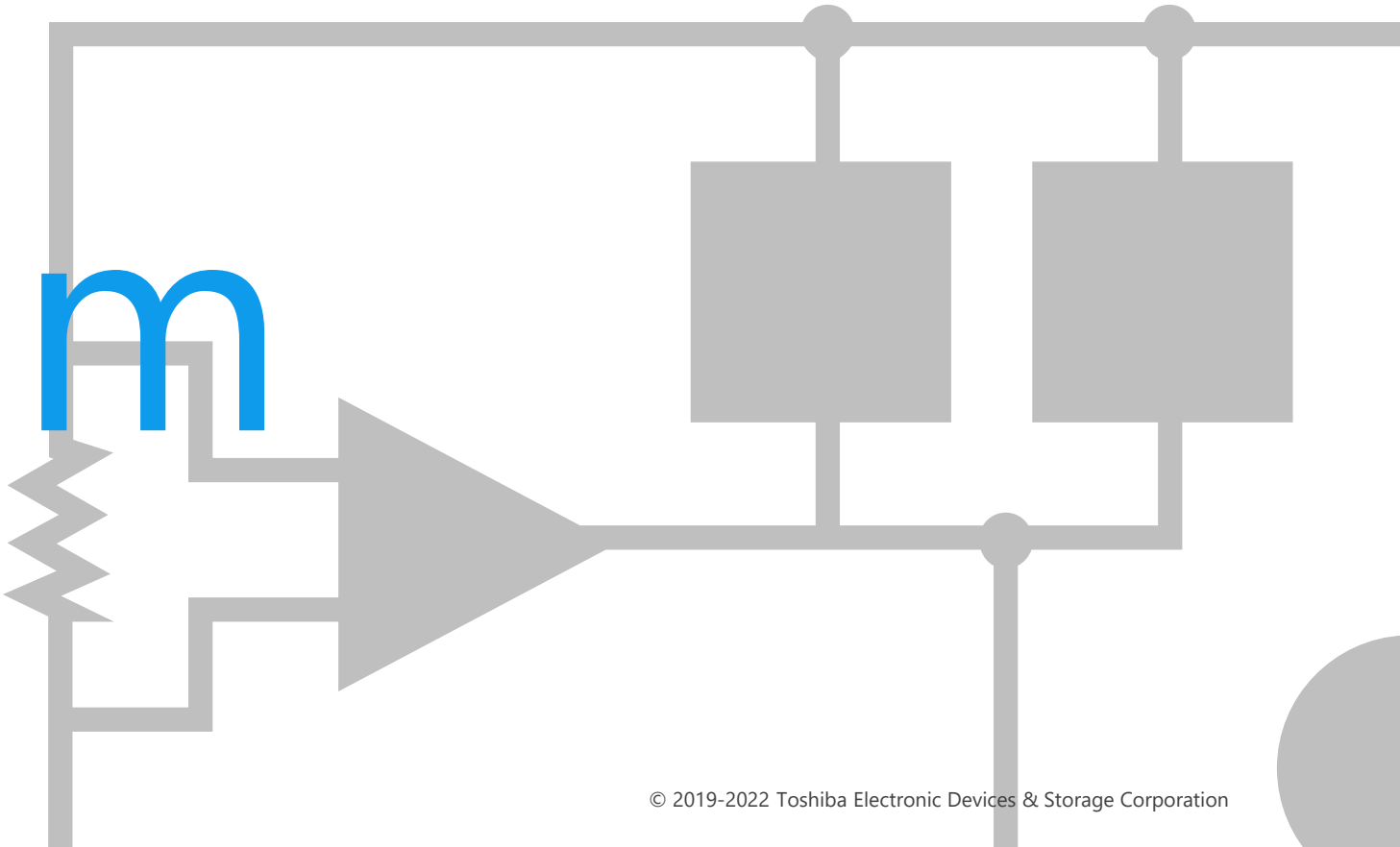
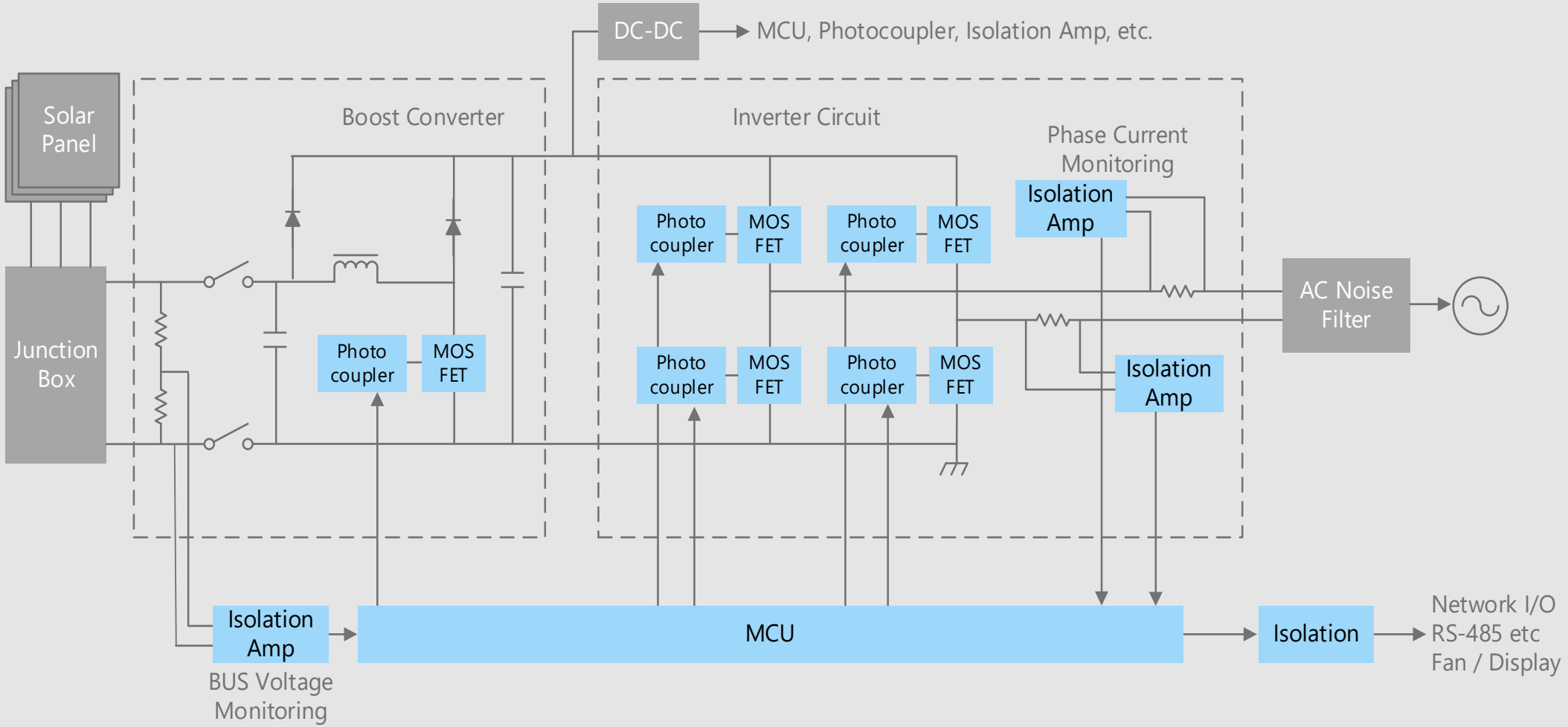
Block Diagram

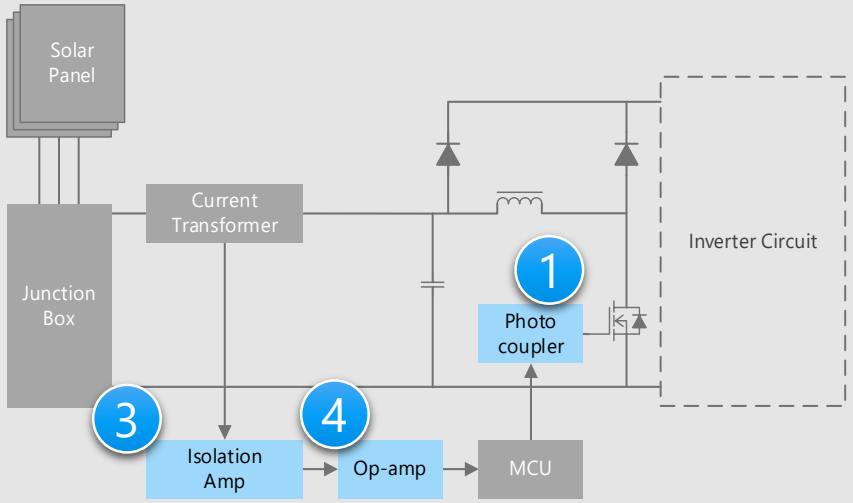


PV Inverter for Household Use　Overall block diagram

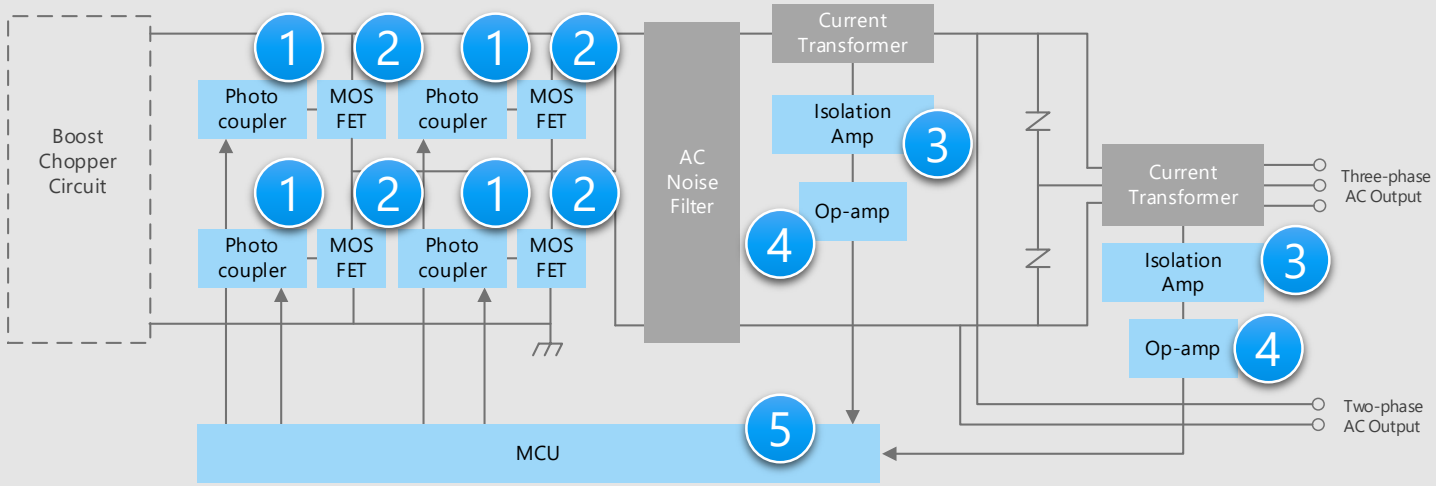


PV Inverter for Household Use　Details of power supply unit

Boost converter circuit



Inverter circuit



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

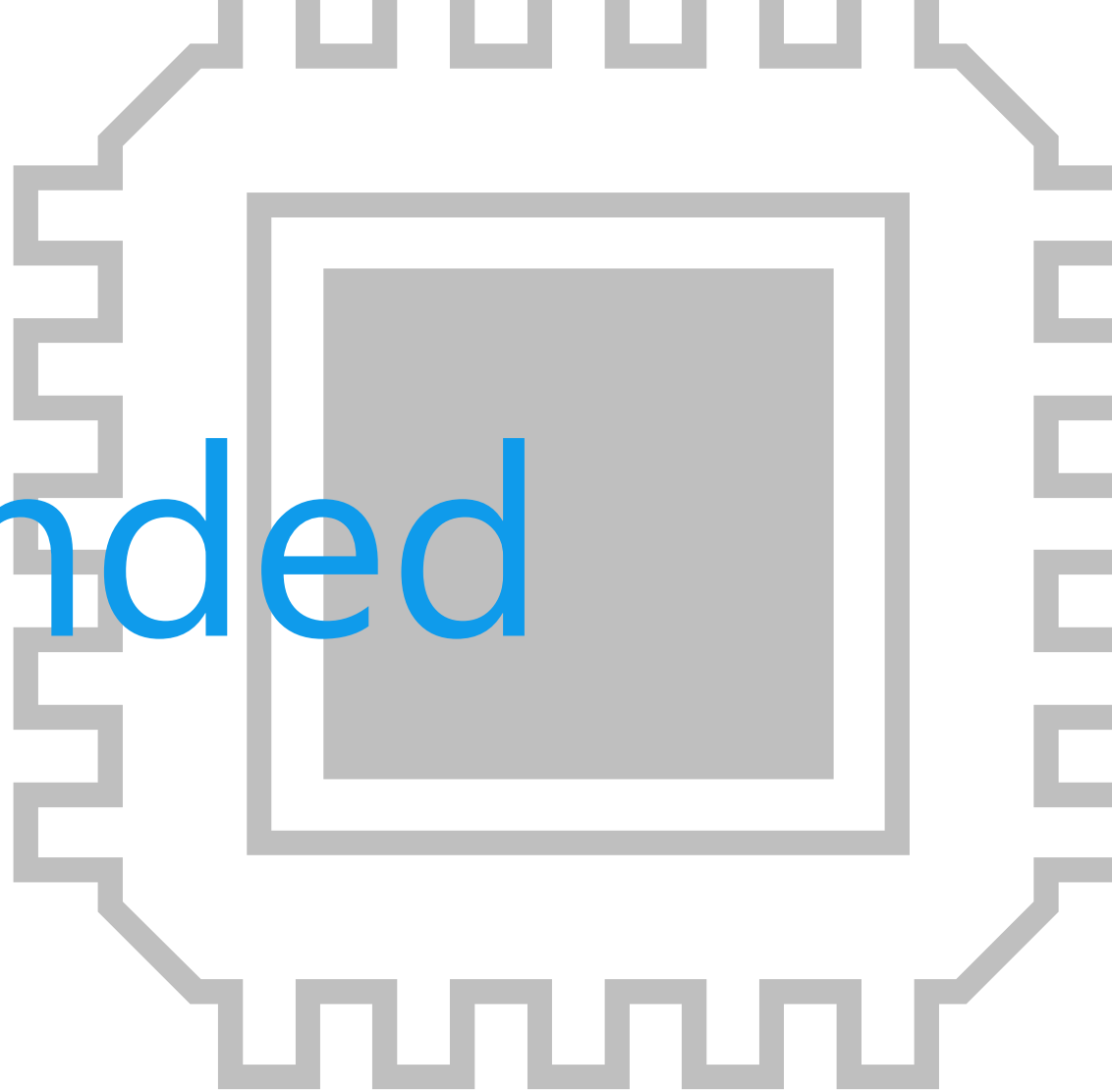
Criteria for device selection

- 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** (1)
  IC output photocoupler
- **Low on-resistance and high speed switching MOSFET** (2)
  DTMOS Series MOSFET
- **Low power consumption and high accuracy in a small package** (3)
  Isolation amplifier
- **Amplify the detected weak signal with low noise** (4)
  Low noise operational amplifier
- **Built-in three-phase PWM is suitable for controlling inverter system** (5)
  MCU M380 Group

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

1a IC output photocoupler

TLP2719(LF4)

Safety | Low loss | Small size packages

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.

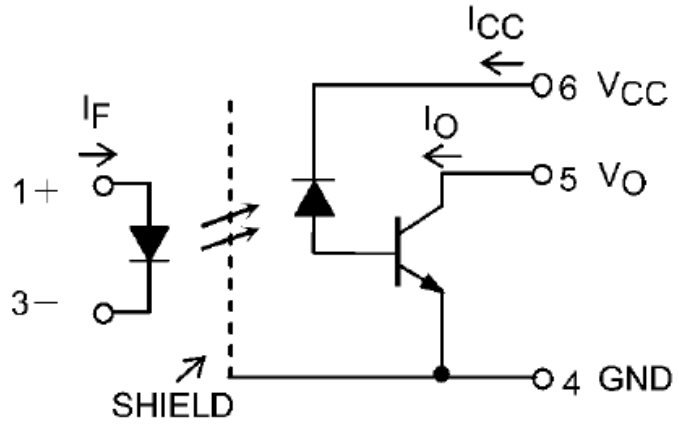
1 Common mode transient immunity (CMTI) of 10 [kV/μs]

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(LF4)
Package	SO6L(LF4) 
BV_S [Vrms]	5000
Data Transfer Rate (Typ.) [Mbps]	1
CM_H, CM_L (Min) [kV/μs]	±10

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1b IC output photocoupler

TLP5231 / TLP5214 / TLP5214A (Smart Gate Driver Coupler)

Safety | Low loss | Small size packages

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

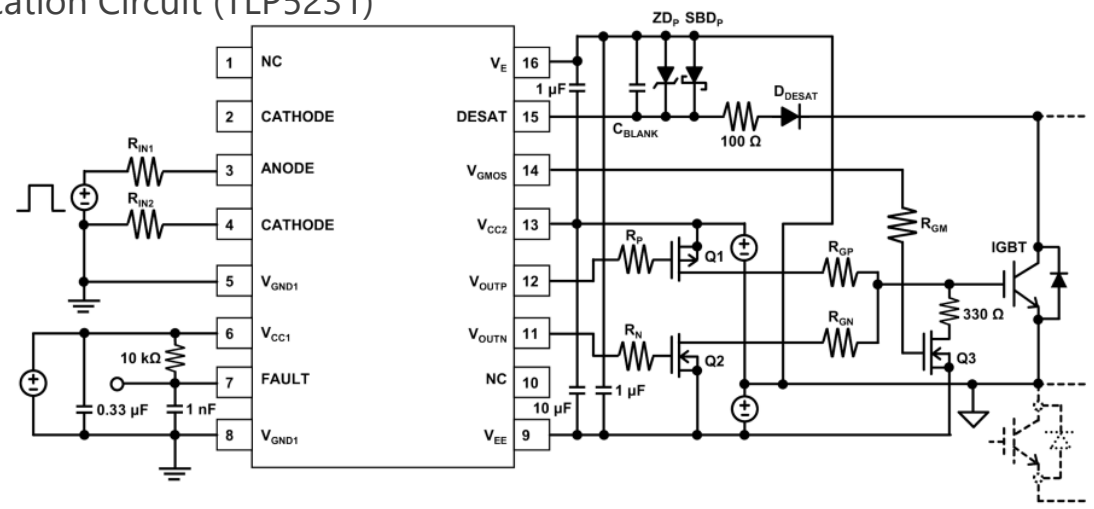
2 Rail-to-rail output

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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2 DTMOS Series MOSFET

TK090E65Z / TK090U65Z / TK090A65Z / TK090N65Z / TK090Z65Z

Safety | Low loss | Small size packages

Value provided

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

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

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

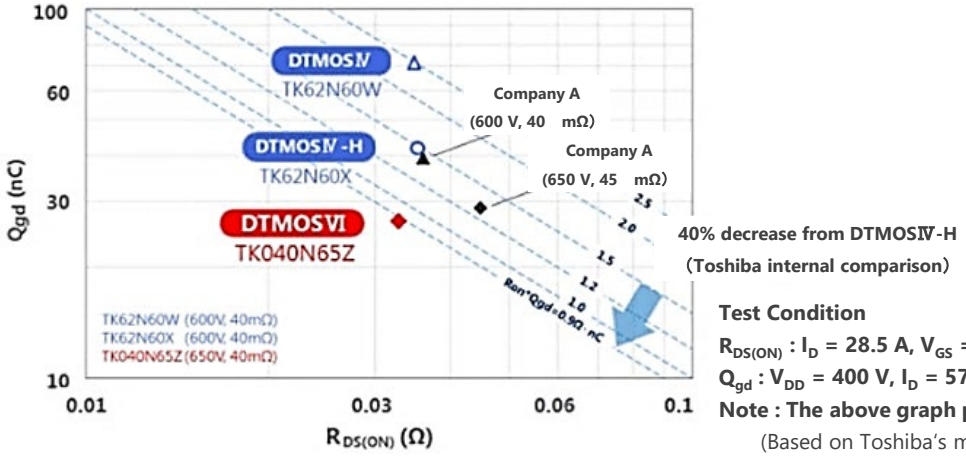
2 Enhancement type

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 dissipation.

Comparisons of figures of merit



40% decrease from DTMOSⅣ-H
(Toshiba internal comparison)

Test Condition
$R_{DS(ON)}$: I_D = 28.5 A, V_{GS} =10 V
Q_{gd} : V_{DD} = 400 V, I_D = 57 A, V_{GS} = 10 V
Note : The above graph plots the mean of the measured values
(Based on Toshiba's measurement data as of March, 2017)

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	0.075
	Max	0.09	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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3 Isolation amplifier
TLP7820

Safety | Low loss | Small size packages

Value provided

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

1 Low current consumption

Introduction of new digital modulation technology has improved current consumption characteristics to input voltage.

2 Low height small package

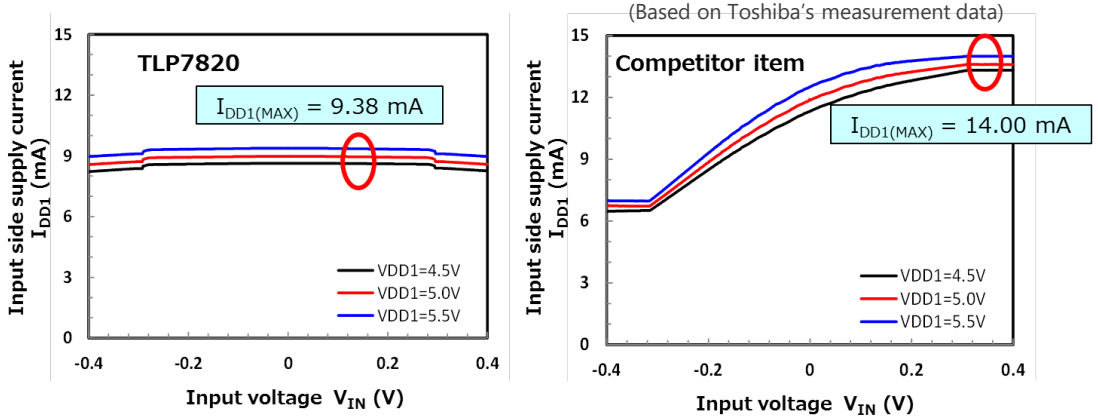
Small and low profile (2.1 [mm] (Max)) SO8L package contributes reducing circuit board area.

3 High accuracy

This optical coupling type isolation amplifier uses an IC chip with a high precision ΔΣ AD convertor circuit on the input side and an IC chip with a high precision DA convertor circuit on the output side.

Current consumption characteristics

(Based on Toshiba's measurement data)



Lineup

Part number	TLP7820
Package	SO8L(LF4)
Gain accuracy [%]	±0.5 / ±1.0 / ±3.0 (rank selectable)
$\|dG/dT_a\|$ (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

Safety | Low loss | Small size packages

Value provided

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

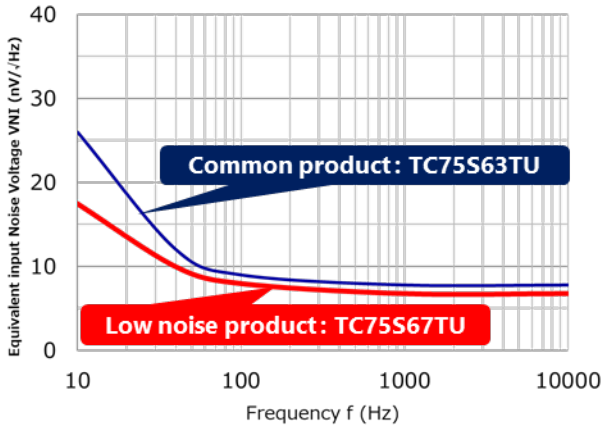
1 Low noise
V_{NI} = 6.0 [nV/√Hz] (Typ.) @f = 1 kHz

Very small signals detected by various sensors [Note] can be amplified with low noise using CMOS operational amplifier. Low input equivalent noise voltage has been realized by optimization of processes.

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

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

Low noise characteristic
(Toshiba internal comparison)



V_{NI} - f

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.) [nV/√Hz] @f = 1 kHz	6

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

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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

TMPM381/383 implements Cortex-M3 core with 40 MHz maximum operation frequency. Various development tool and their partners allow users many options.

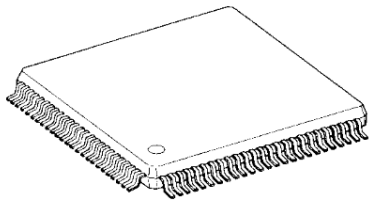
2 System cost down and development efficiency improvement

TMPM381/383 executes system monitoring efficiently by using built-in AD converter. The original NANOFLASH™ is possible to rewrite at high speed. It reduces user software development time period.

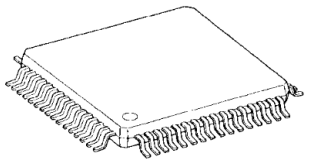
3 Built-in oscillation frequency detector

TMPM381/383 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.

TMPM381FWFG



TMPM383FSUG



Lineup

Part Number	TMPM381FWFG	TMPM383FSUG
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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