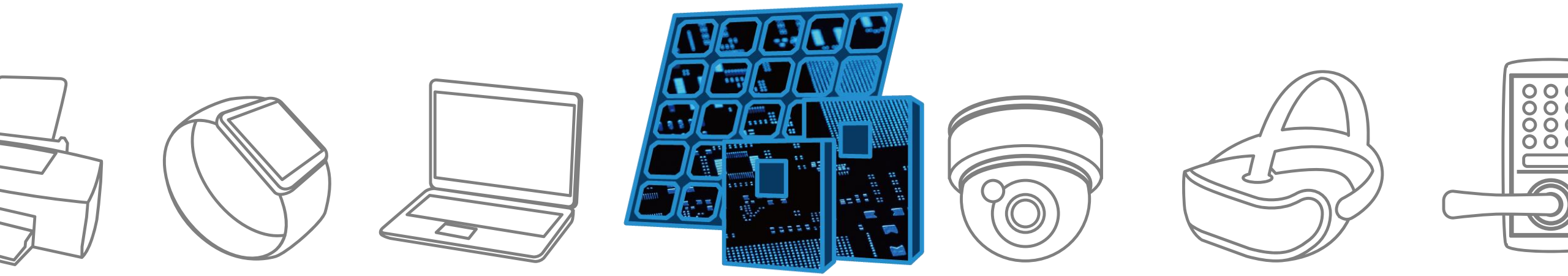
TOSHIBA

R21

Mega-solar Inverters

Solution Proposal by Toshiba



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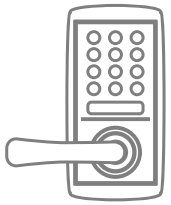

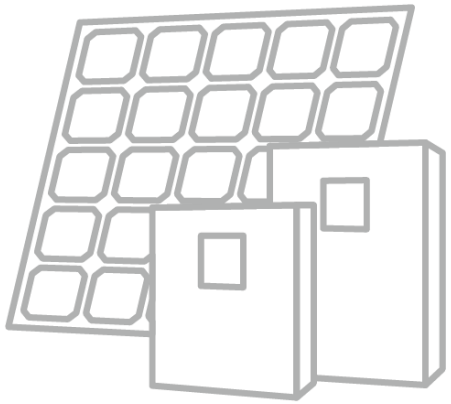

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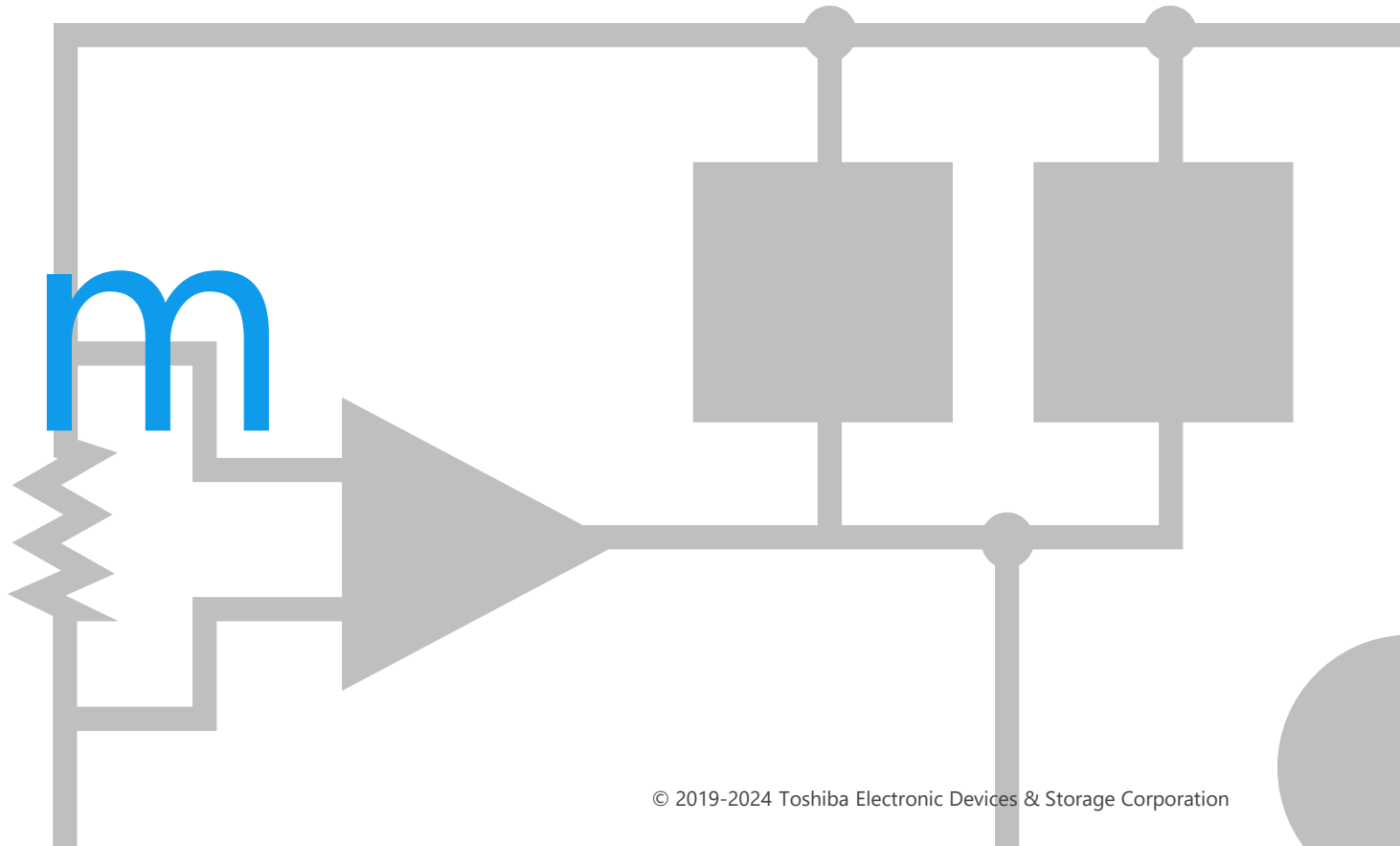
Block Diagram



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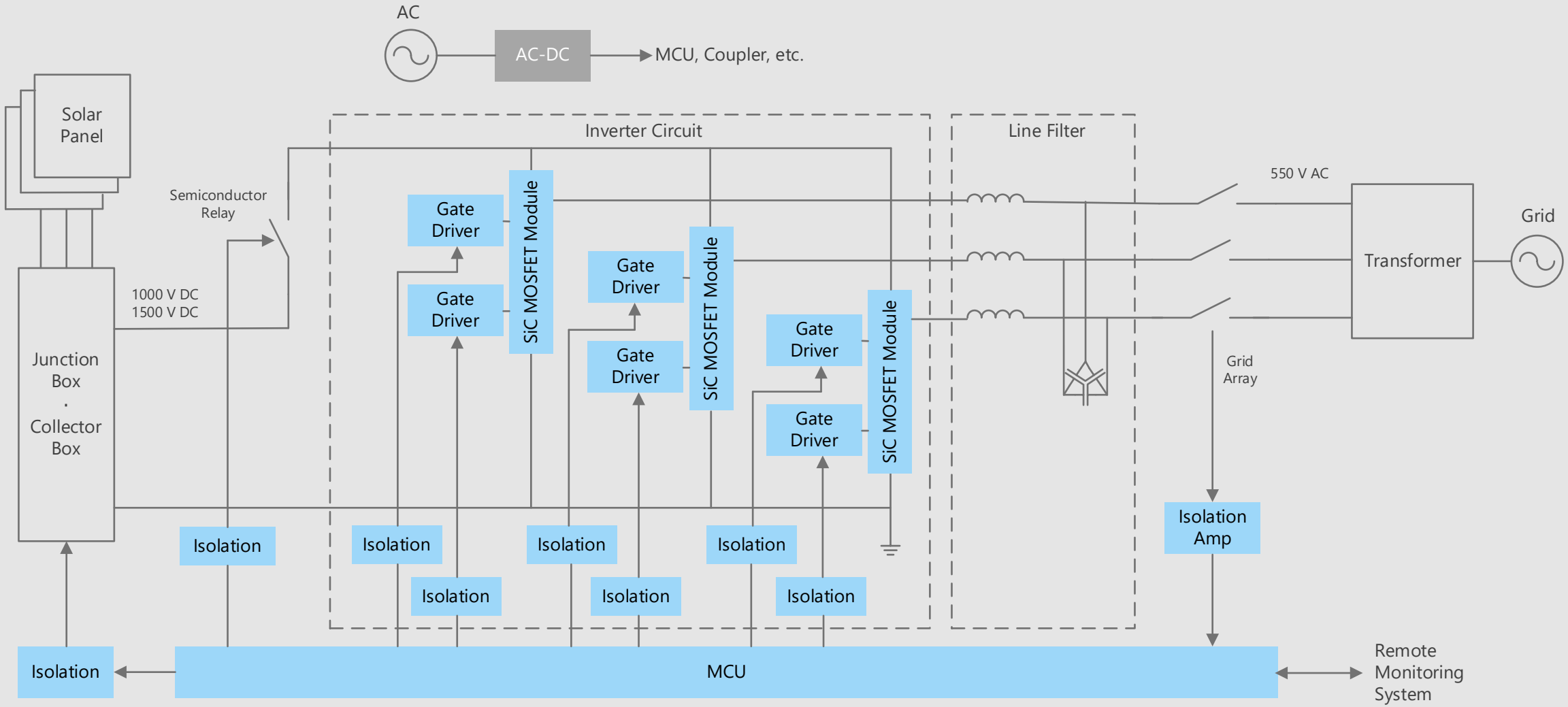
Mega-solar Inverters　Overall block diagram



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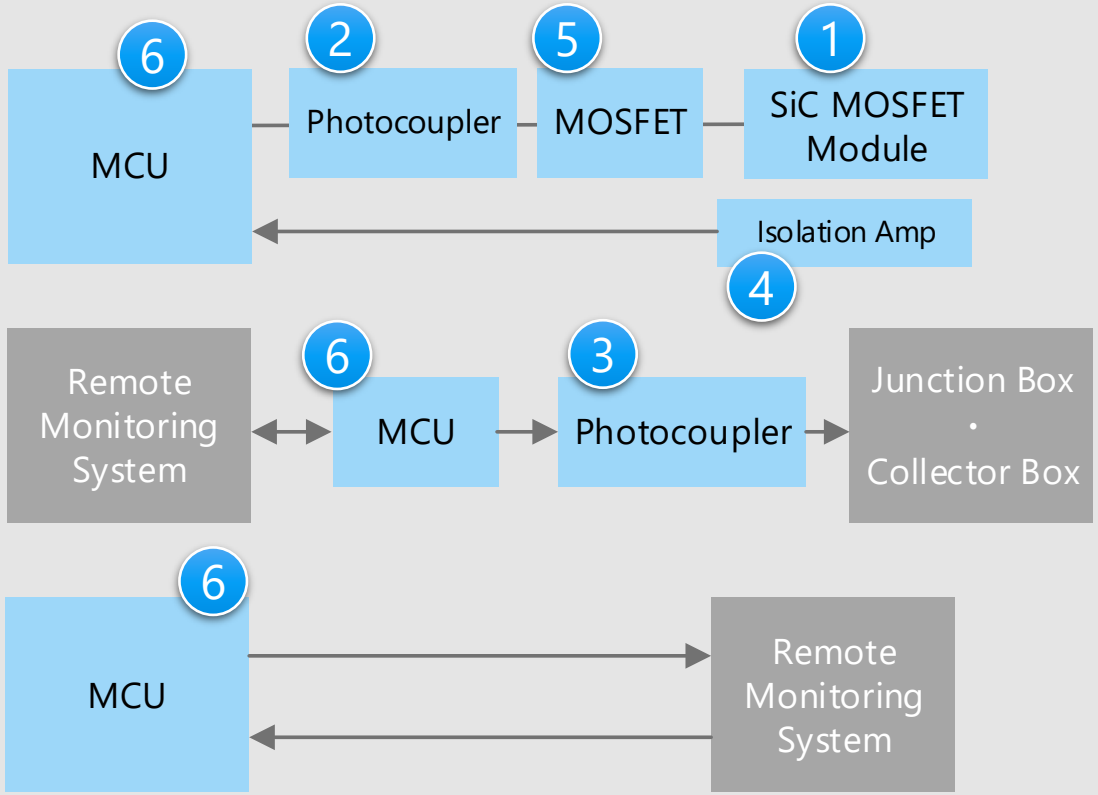
Mega-solar Inverters　Details of Inverter unit (1)

Inverter circuit

Monitor peripheral circuit

Microcontroller peripheral circuit



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

Criteria for device selection

- SiC MOSFET is suitable for high speed switching. For 1000 V or 1500 V DC two-level inverters, SiC MOSFET with V_{DSS}=1700 V or 1900 V are suitable.
- The use of isolating device is effective for the control of high voltage systems.
- Inverter control at each sub system and communication with a cloud are required.

Proposals from Toshiba

- **High speed switching** 1
  SiC MOSFET module
- **Photocoupler having excellent environmental resistance** 2
  IC output photocoupler for IGBT/MOSFET driving
- **Photocoupler having excellent environmental resistance** 3
  IC output photocoupler for high speed transmission
- **Both high precision and high isolation have realized by built-in ΔΣA/D converter** 4
  Isolation amplifier
- **Both P-ch and N-ch MOSFETs are assembled in one package** 5
  Semi-power MOSFET
- **Built-in three-phase complementary PWM and Ethernet controller** 6
  MCU M4N Group

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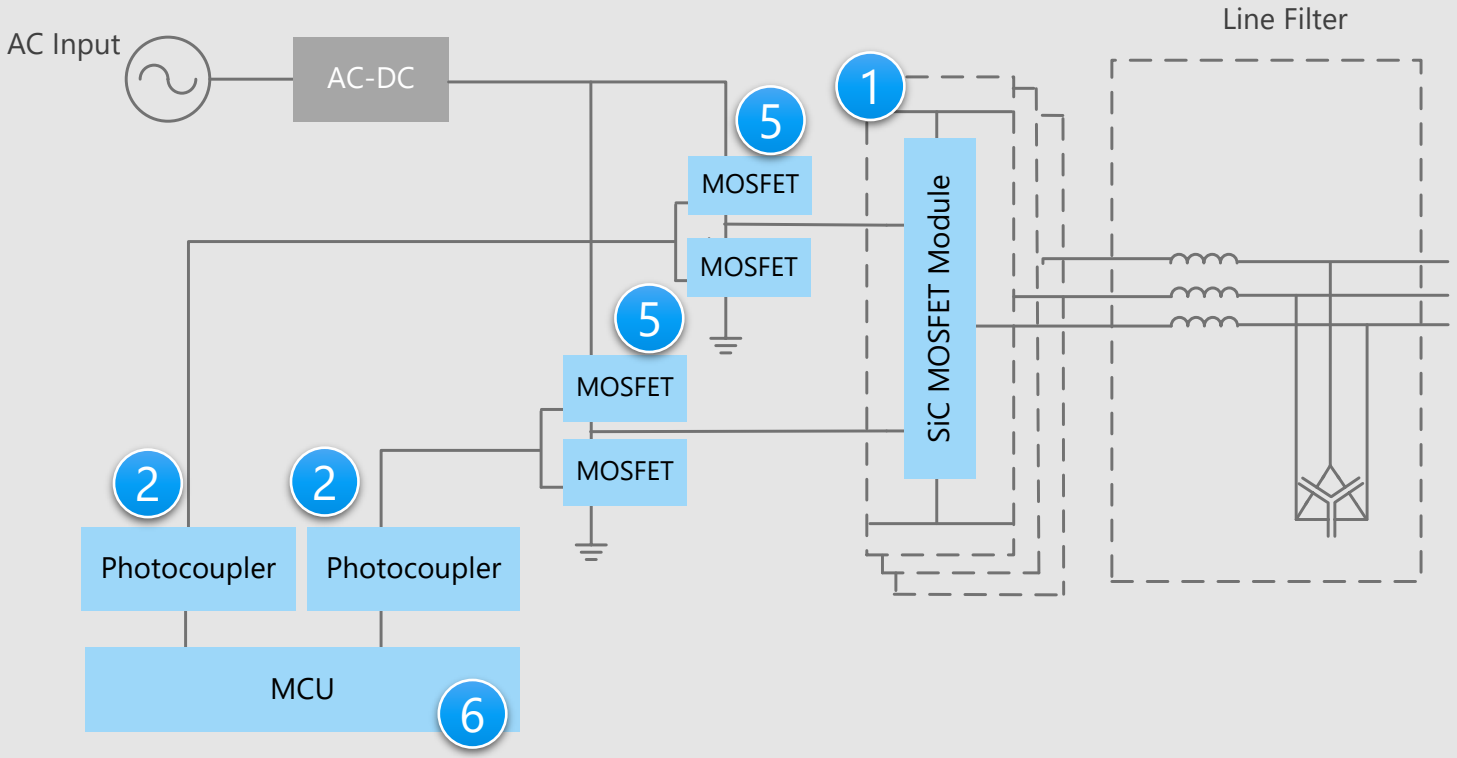
Mega-solar Inverters　Details of Inverter unit (2)

Inverter gate drive circuit



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

Criteria for device selection

- Large current is required to drive the gates of the power MOSFET.
- For high speed switching, MOSFETs with low input capacity are suitable.
- Small package products contribute to the reduction of circuit board area.

Proposals from Toshiba

- **High speed switching** 1
  SiC MOSFET module
- **Photocoupler having excellent environmental resistance** 2
  IC output photocoupler for IGBT/MOSFET driving
- **Both P-ch and N-ch MOSFETs are assembled in one package** 5
  Semi-power MOSFET
- **Built-in three-phase complementary PWM and Ethernet controller** 6
  MCU M4N Group

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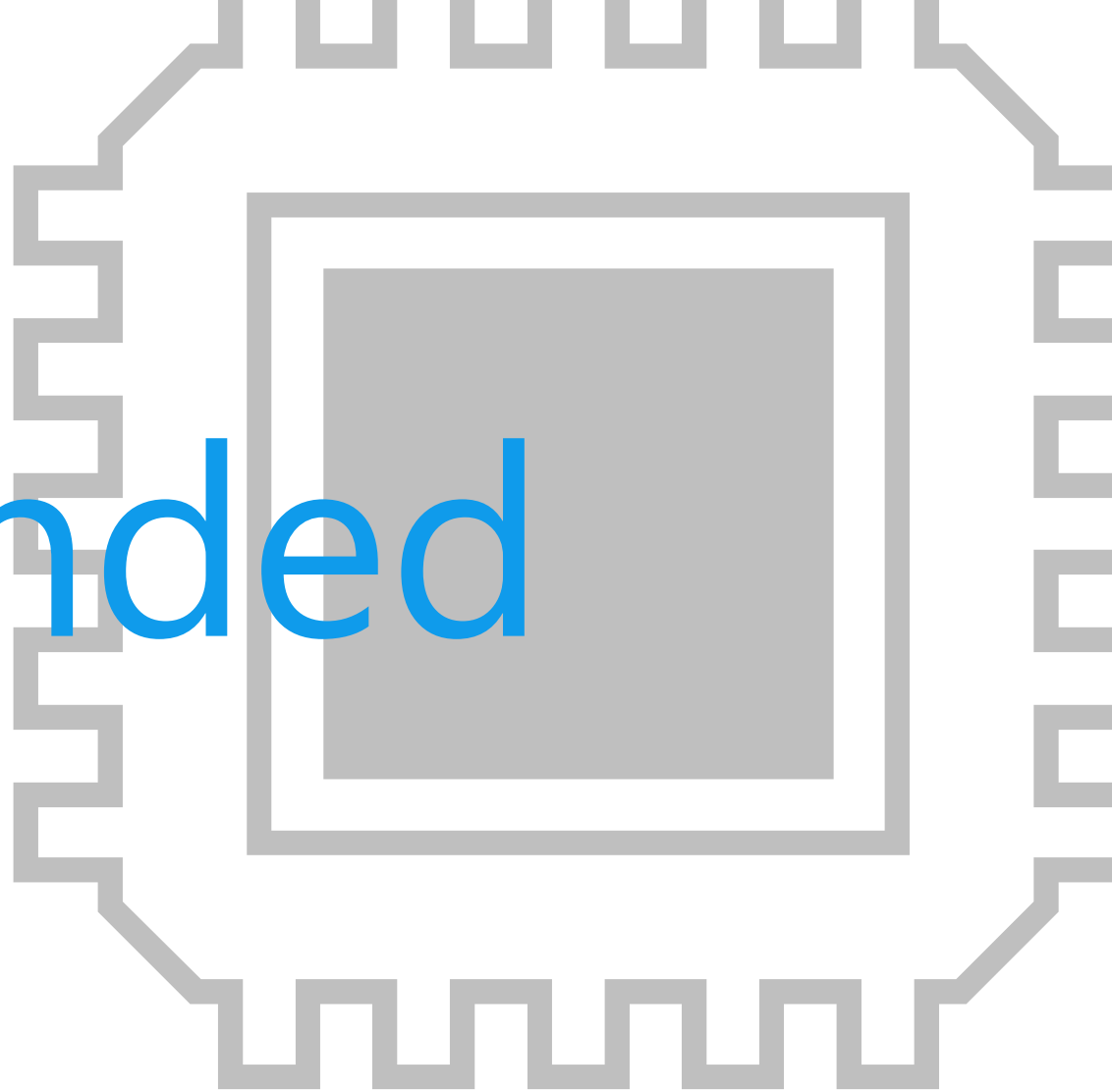
Recommended Devices



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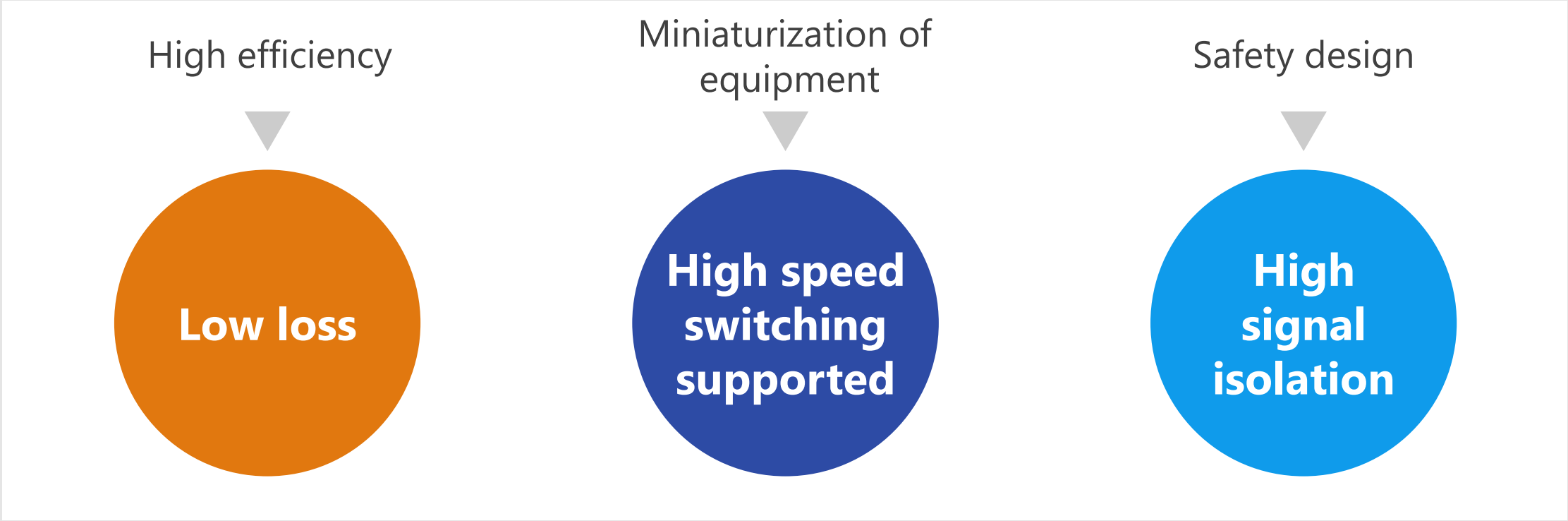
Device solutions to address customer needs

As described above, in the design of mega-solar inverter, **“High efficiency“**, **“Miniaturization of equipment”** and **“Safety design”** are important factors. Toshiba’s proposals are based on these three solution perspectives.



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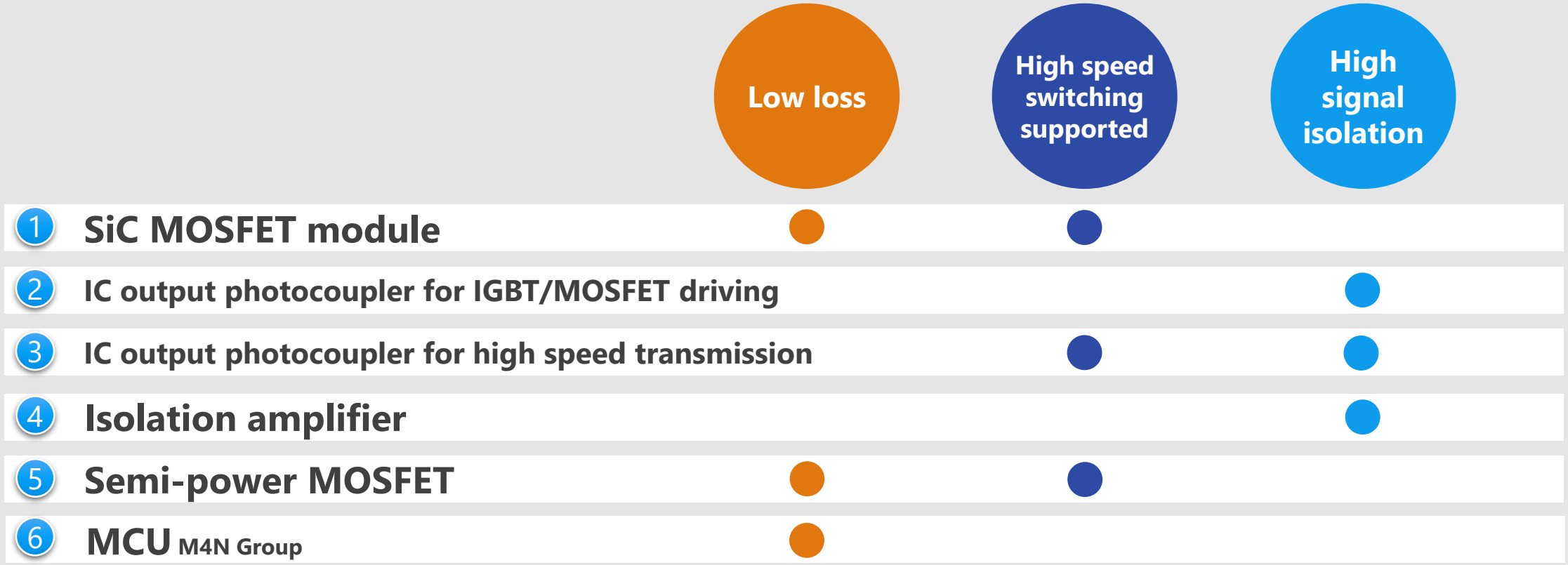
Device solutions to address customer needs



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1 SiC MOSFET module

MG400V2YMS3 / MG250YD2YMS3

Low loss | High speed switching supported | High signal isolation

Value provided

High voltage/low loss SiC MOSFET contributes to more efficient and compact equipment.

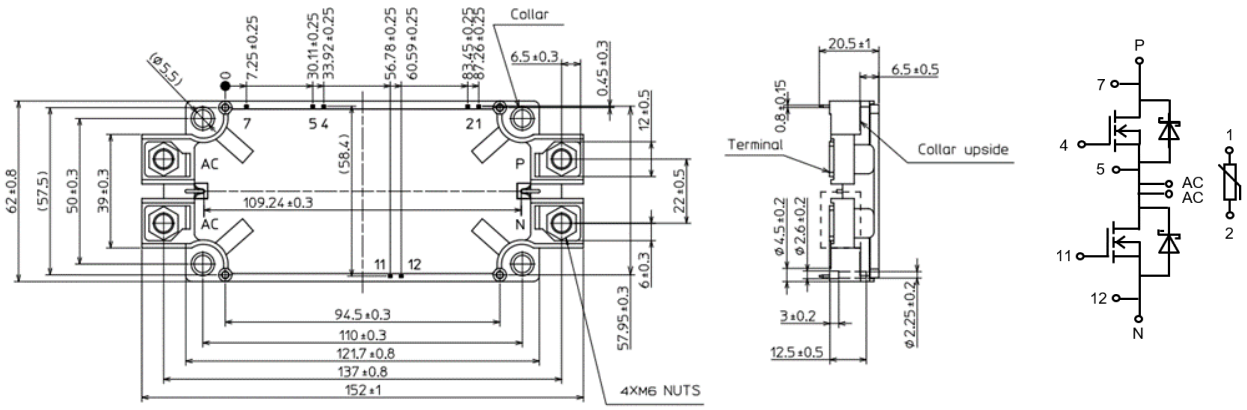
1 High voltage/low loss SiC MOSFET

High voltage SiC MOSFETs with reduced conduction and switching losses are built in.

2 Easy to connect 2-in-1 module

Two MOSFETs in an industry standard package allow easy connection.

Package and equivalent circuit



Line up

Part number	MG400V2YMS3	MG250YD2YMS3
V_{DSS} [V]	1700	2200
I_D [A]	400	250
$V_{DS(on)sense}$ (Typ.) [V] MG400V2YMS3 @I_D=400 A, V_{GS}=20 V, T_{ch}=25 °C MG250YD2YMS3 @I_D=250 A, V_{GS}=20 V, T_{ch}=25 °C	0.8	0.7
Polarity	N-ch	N-ch

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2 IC output photocoupler for IGBT/MOSFET driving

TLP5771H / TLP5772H / TLP5774H

Low loss | High speed switching supported | High signal isolation

Value provided

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

1 Small package

The size of SO6L package is 50 % smaller than Toshiba conventional DIP8 package in terms of mounting area, and it comply with reinforced isolation class of international safety standards.

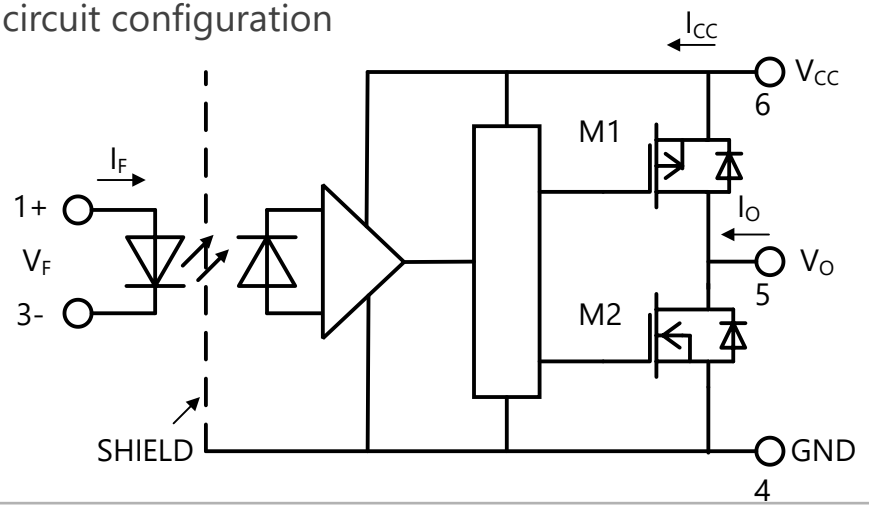
2 Common mode transient immunity (CMTI) of 35 kV/μs

By providing a shield between input and output, high instantaneous common mode rejection of ±35 kV/μs has realized and noise resistance between input and output is excellent.

3 Direct drive by microcontroller

The low input type allows bufferless direct drive by the microcontroller. And a rail-to-rail output allows stable operation of the system and good switching characteristics.

Internal circuit configuration



Line up

Part number	TLP5771H	TLP5772H	TLP5774H
Package	SO6L 		
BV_S [Vrms]	5000	5000	5000
I_{OPH} / I_{OPL} (Max) [A]	-1.0 / +1.0	-2.5 / +2.5	-4.0 / +4.0
I_{FLH} (Max) [mA]	2	2	2
$CM_{H/L}$ (Min) [kV/μs]	±35	±35	±35

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3 IC output photocoupler for high speed transmission

TLP2768B

Low loss | High speed switching supported | High signal isolation

Value provided

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

1 Supports 3.3 V power supply

This photocoupler operates with power supply voltage from 2.7 V to 5.5 V.
Therefore, it can be used in mixed voltage system such as 3.3 V / 5 V.

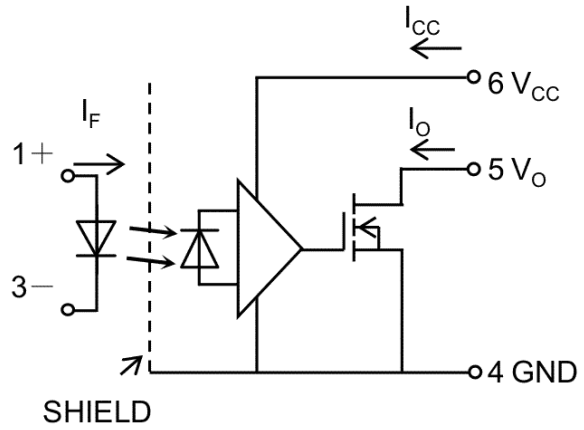
2 Operation at ambient temperature of 125 °C

This photocoupler is designed to operate under severe conditions of ambient temperature environment, such as an inverter, a robot, a machine tool and a high output power supply.

3 No need of external Schmitt trigger

This photocoupler has a built-in Schmitt trigger, which prevents output signal chattering when used with slow input signals and a power supply that causes the waveform to rise and fall gradually. This feature enhances the stability of signal transmission.

Internal circuit configuration



Line up

Part number	TLP2768B
Package	SO6L 
BV_S [Vrms]	5000
I_{FLH} (Max) [mA]	5
tpHL, tpLH (Max) [ns]	60

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4 Isolation amplifier
TLP7820

Low loss | High speed switching supported | High signal isolation

Value provided

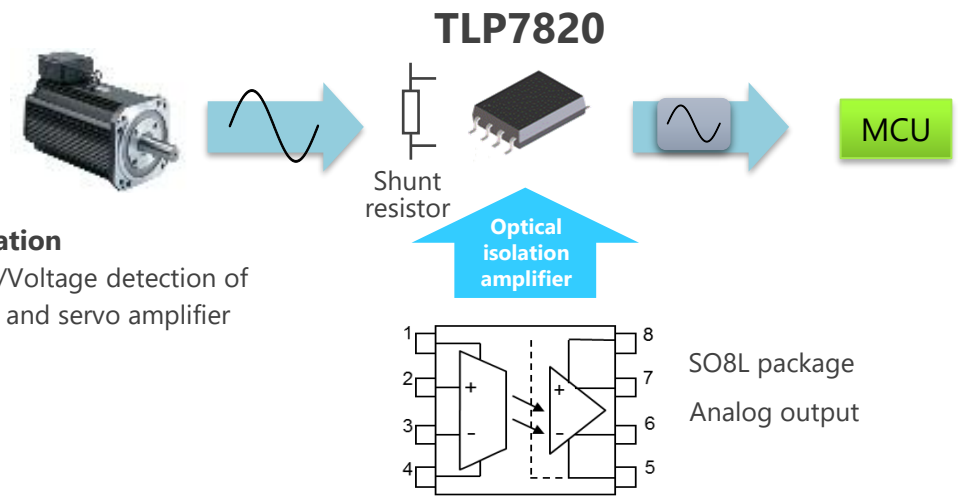
High precision and excellent isolation performance have realized with built-in ΔΣ A/D converter circuit. These enable accurate current/voltage detection.

1 Reduction of input side supply current

By introducing original digital modulation-and-demodulation technology, the input voltage dependency of primary side supply current is improved. The maximum circuit current is reduced by this, and it contributes to primary side power supply designs and the low power consumption design of application.

2 Adoption of SO8L thin package

By adopting thin package SO8L with height of 2.1 mm, TLP7820 contributes to reduction of mounting space in applications.



Application
Current/Voltage detection of inverter and servo amplifier

Line up

Part number	TLP7820
Package height [mm]	2.1
Gain accuracy (Rank B) [%]	±0.5
T_{opr} [°C]	-40 to 105
V_{OS} (Typ.) [mV]	0.9
I_{DD1} (Max) [mA]	12
CMTI (Min) [kV/μs]	15

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5 Semi-power MOSFET

SSM6L820R

Low loss | High speed switching supported | High signal isolation

Value provided

Both P-channel and N-channel MOSFETs with low on-resistance are assembled in one small package (2-in-1 type). It contributes reducing heat generation and mounting area.

1 Low on-resistance

By keeping the on-resistance between the drain and source low, heat generation and power consumption can be kept low.

2 2-in-1 type

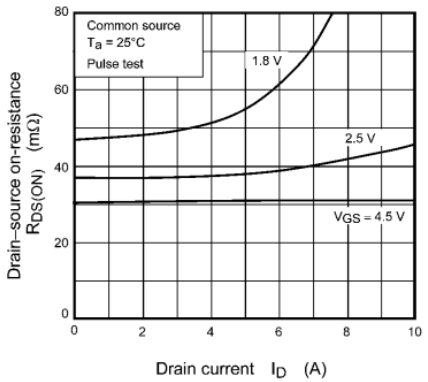
P-channel and N-channel MOSFETs are assembled in one package. Suitable for P-channel and N-channel push-pull circuit.

3 Small package

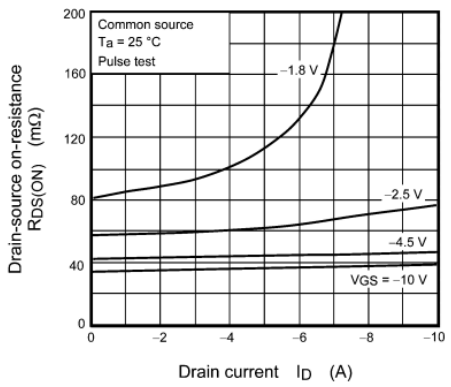
Product lineup includes small and thin packages, contributing to the reduction of mounting area.

Low on-resistance

P-ch



N-ch



Line up

Part number		SSM6L820R	
Package		TSOP6F 	
Polarity		P-ch	N-ch
V_{DSS} [V]		-20	30
I_D [A]		-4	4
$R_{DS(ON)}$ [mΩ] @V_{GS}=+4.5 V (N-ch) @V_{GS}=-10 V (P-ch)	Typ.	30.0	36.0
	Max	39.1	45.0

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Value provided

Built-in an Advanced Programmable Motor Control Circuit (A-PMD) and a variety of communication interfaces. It executes inverter control and cloud communication with low power consumption.

1 Built-in Arm® Cortex®-M4 CPU core

The product lineup is equipped with Arm Cortex-M4 core (maximum operation frequency of 200 MHz). It is suitable for processing sensor data at real time. Various development tool and their partners allow users many options.

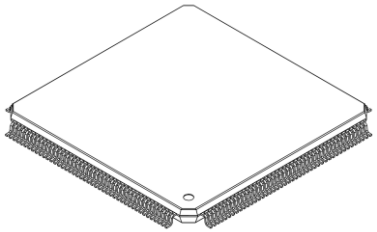
2 Advanced Programmable Motor Control Circuit (A-PMD)

The Advanced Programmable Motor Control Circuit (A-PMD) allows the AD converter to operate synchronously, enabling three-phase complementary PWM output. It also features an emergency stop function triggered by external input.

3 Various communication interfaces

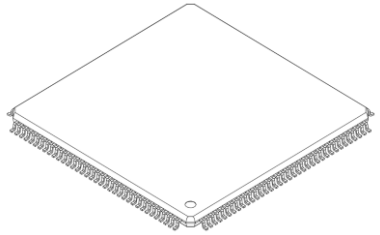
These products support major communication interfaces such as UART, FUART, TSPI, TSSI, I^2C, CAN, USB and ethernet controller (ETHM). User can construct a communication system easily with a cloud.

TMPM4NRF**FG



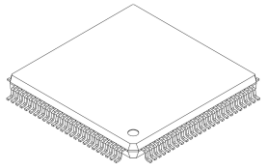
P-LQFP176-2020-0.40-002

TMPM4NQF**FG



P-LQFP144-2020-0.50-002

TMPM4NNF**FG



P-LQFP100-1414-0.50-002

Line up

Part number	TMPM4NRF20/15/10/DFG TMPM4NRF20/15/10/DXBG	TMPM4NQF20/15/10/DFG TMPM4NQF20/15/10/DXBG	TMPM4NNF20/15/10/DFG
Operation frequency	200 MHz (Max)		
Flash ROM	Code: 2048/1536/1024/512 KB + Data: 32 KB		
RAM	256 KB + 2 KB (Backup RAM)		
Timer	32bit x 16ch (16bit x 32ch)		
AD converter	24ch (12bit)		16ch (12bit)
Communication interface	UART: 6ch, FUART: 2ch, I^2C: 5ch, TSPI: 9ch, TSSI: 2ch	UART: 5ch, FUART: 2ch, I^2C: 5ch, TSPI: 8ch, TSSI: 1ch	UART: 3ch, FUART: 1ch, I^2C: 3ch, TSPI: 5ch, TSSI: 1ch
	CAN: 2 units, USB: 2 units, ETHM: 1 unit		CAN: 2 units, USB: 1 unit, ETHM: 1 unit
Package	P-LQFP176-2020-0.40-002 P-VFBGA177-1313-0.80-001	P-LQFP144-2020-0.50-002 P-VFBGA145-1212-0.80-001	P-LQFP100-1414-0.50-002

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