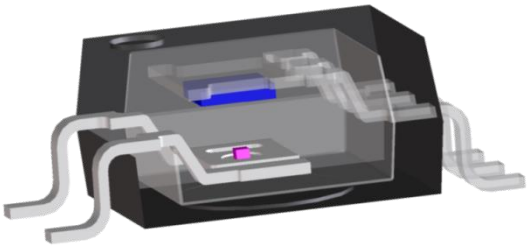
TOSHIBA

Leading Innovation

TOSHIBA Photocouplers

Mouser Chalk Talk: Photorelays replacing Mechanical Relays

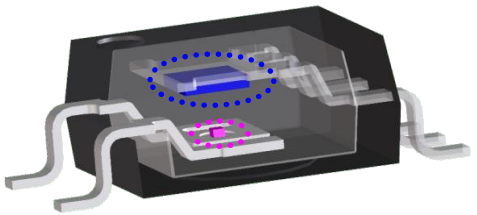


Toshiba America Electronic Components, Inc.
Joseph Tso (Business Development Manager, Optoelectronics)

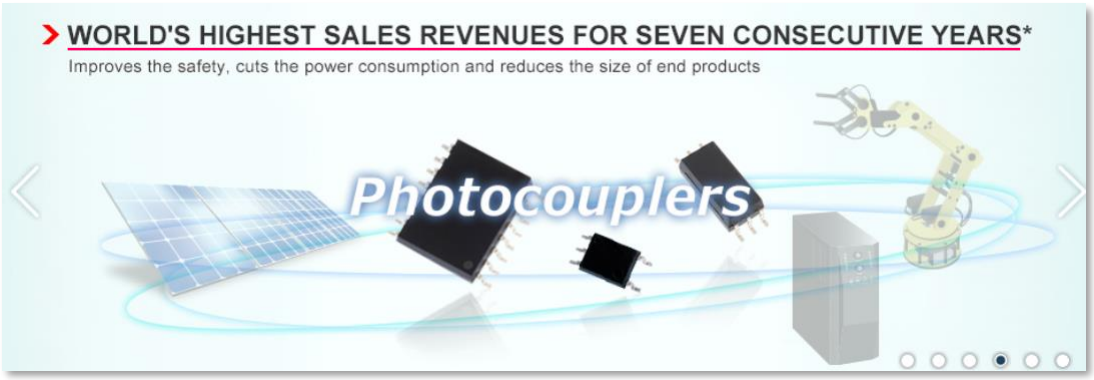
TOSHIBA

Leading Innovation

Overview Of Toshiba Photocouplers



Overview



Over 40 years Photo Coupler Business

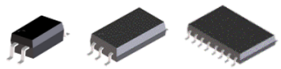
World's No.1 in:

- Photo Couplers sales since 2010 in a row
- Automotive Photo Couplers & Photo Relays
- ATE Photo Relays

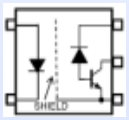
Leading in:

- IC Photo Couplers
- Photo Relays

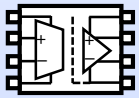
Broad range of Photo couplers



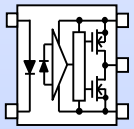
IC output



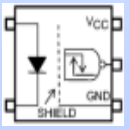
High speed I/O
- ~50Mbps
- Lower consumption



Isolation Amp
- Delta sigma ADC
- Gain error:0.5~3%

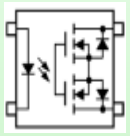


IGBT / MOSFET drive
- ~6.0A output
- Over current protect
- Miller clamp



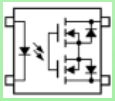
IPM Interface
- ~10Mbps
- VCC ~30V

Photo relays

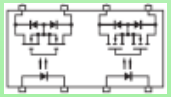


- High current
  5A / 60V
  0.6A / 600V
- Free contact life
- maintenance free
- Smaller than mechanical relay
- Available IC tester prove application
- Various contact form

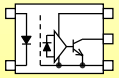
1b



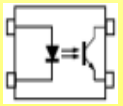
1a1b, 2a, 2b



Automotive



High speed I/O
- TLX9304



Tr output
- TLX9185A

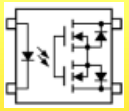
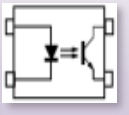
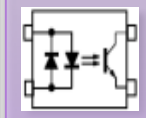


Photo relay
- TLX9175J

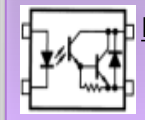
Tr output



DC input
TLP385
TLP383
(Low IF)
TLP291(SE
TLP293
(Low IF)

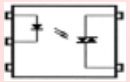


AC input
TLP290(SE
TLP292
(Low IF)

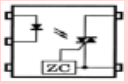


Darlington Tr.
TLP187

Triac output

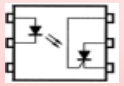


Non ZC
TLP267J



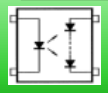
ZC
TLP268J

Thyristor output



TLP748J
TLP548J

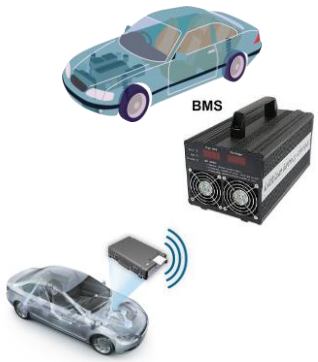
Photo voltaic



- MOS gate voltage regulator
  TLP3906

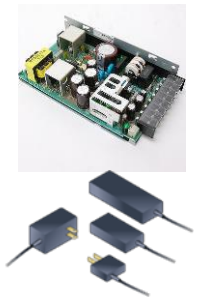
Industrial

Automotive

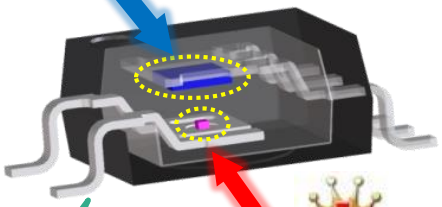


HA

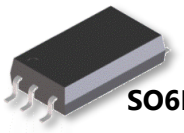
PS

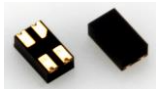


Competitive features of Toshiba

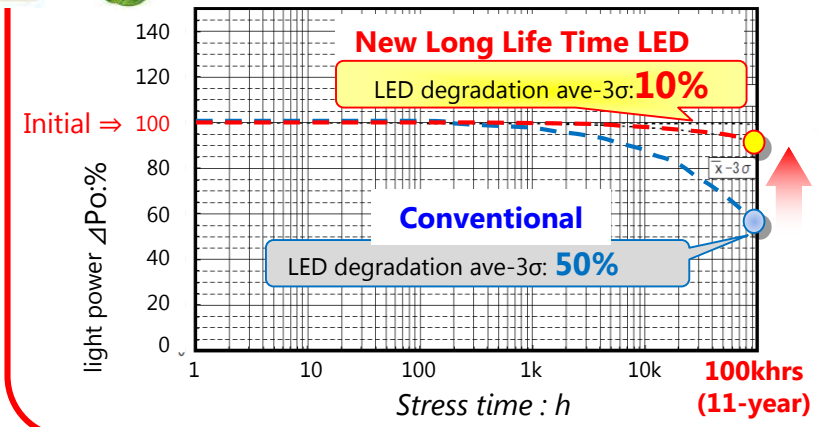


New Package



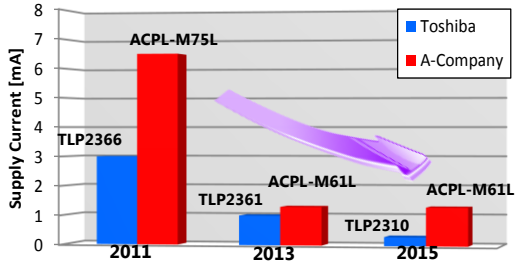


Estimated Light Output degradation (note1)

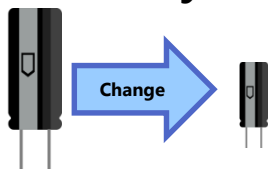


- Long life time
- High Power
- High Temp.
  Up to 125°C

Low Power consumption

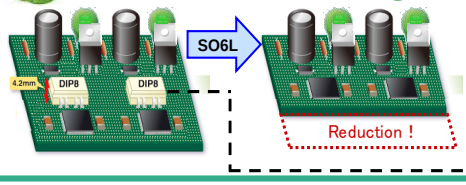


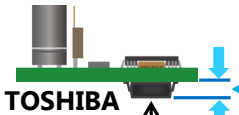
The Lowest current in the industry*



(*) As of July. 2016,
from a survey by Toshiba

Low-profile height < 2.3 mm





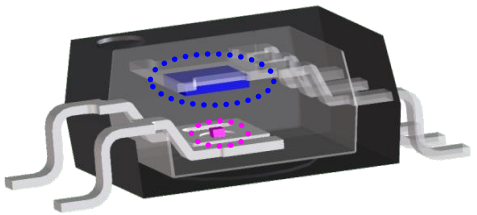
Space Saving

2.3mm max

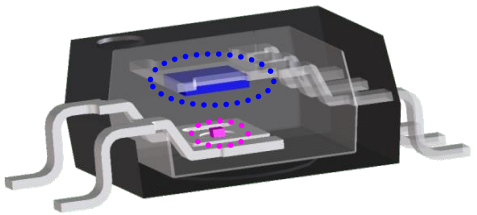
(note1)

"The data is based on evaluation for limited lots. However, we perform the test not taking lot dispersion into account. So please regard the data as a reference. Life time characteristic will be accelerated depending upon using environment (temperature & humidity,conductive current etc.), we would appreciate your understanding.The lifetime prediction of GaAs(MQW) is estimated from deterioration trend and acceleration in GaAs."

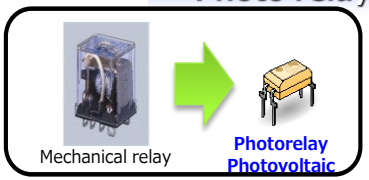
Photorelays



Why Photorelays?



The merit of the Photorelay over Mechanical relays



1. Long Life (Total cost reduction)

Mechanical Relay

Wear & tear!!

Regular maintenance necessary!!

Photorelays

No wear & tear!!

Maintenance free

2. Space saving

Signal relay

125V/1A

Mounting area 94mm²

Photorelay

TLP3109
100V/2A

Mounting area 49m² !

3. Reduction of EMI noise

Mechanical relay

input (Coil)

output (metallic contact)

Bounce

Photorelay

input (LED)

No bounce!

output (MOSFET)

4. Reduction of magnetic field

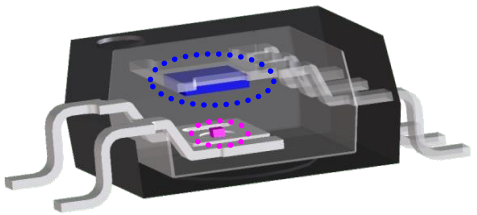
Mechanical relay

Close placements are difficult

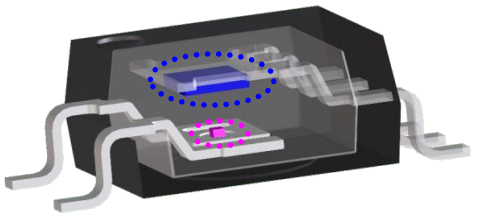
Photorelay

LED light in Photorelay won't be affected one another

Photorelay Application

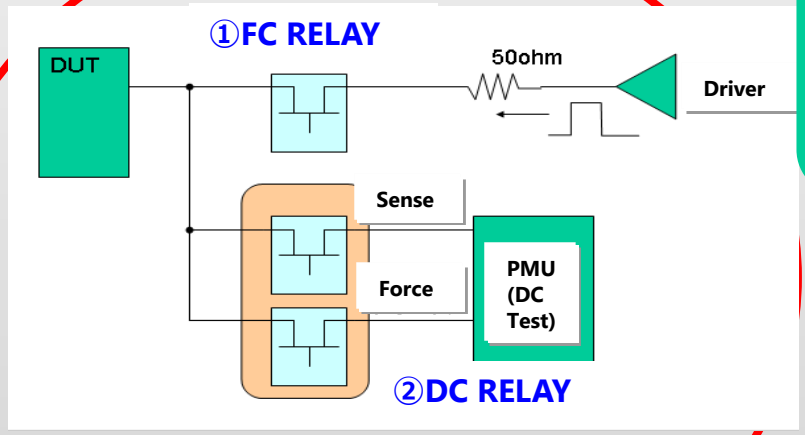


Space-Constraint Applications (E.g. ATE)



Photorelay Application for ATEs (Testers)

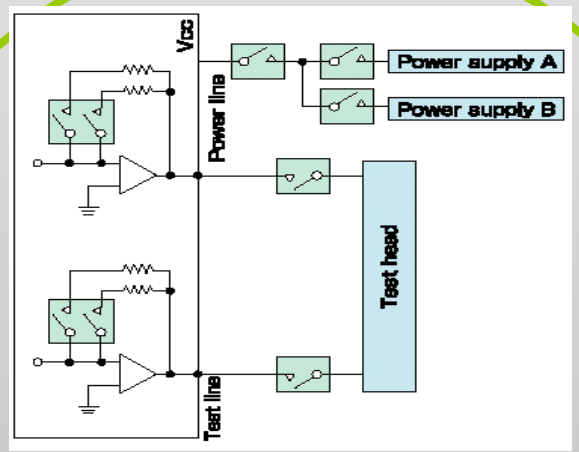
(1)PE : PIN Electronics



Lower C by R、Higher signal transmission、Smaller PKG

Generally, Several thousand and more photorelays are used in a tester including memory/SoC testers. Mainly, there are 2 applications, one is PIN Electronics and the other one is DPS.

(2)DPS: Device Power Supply

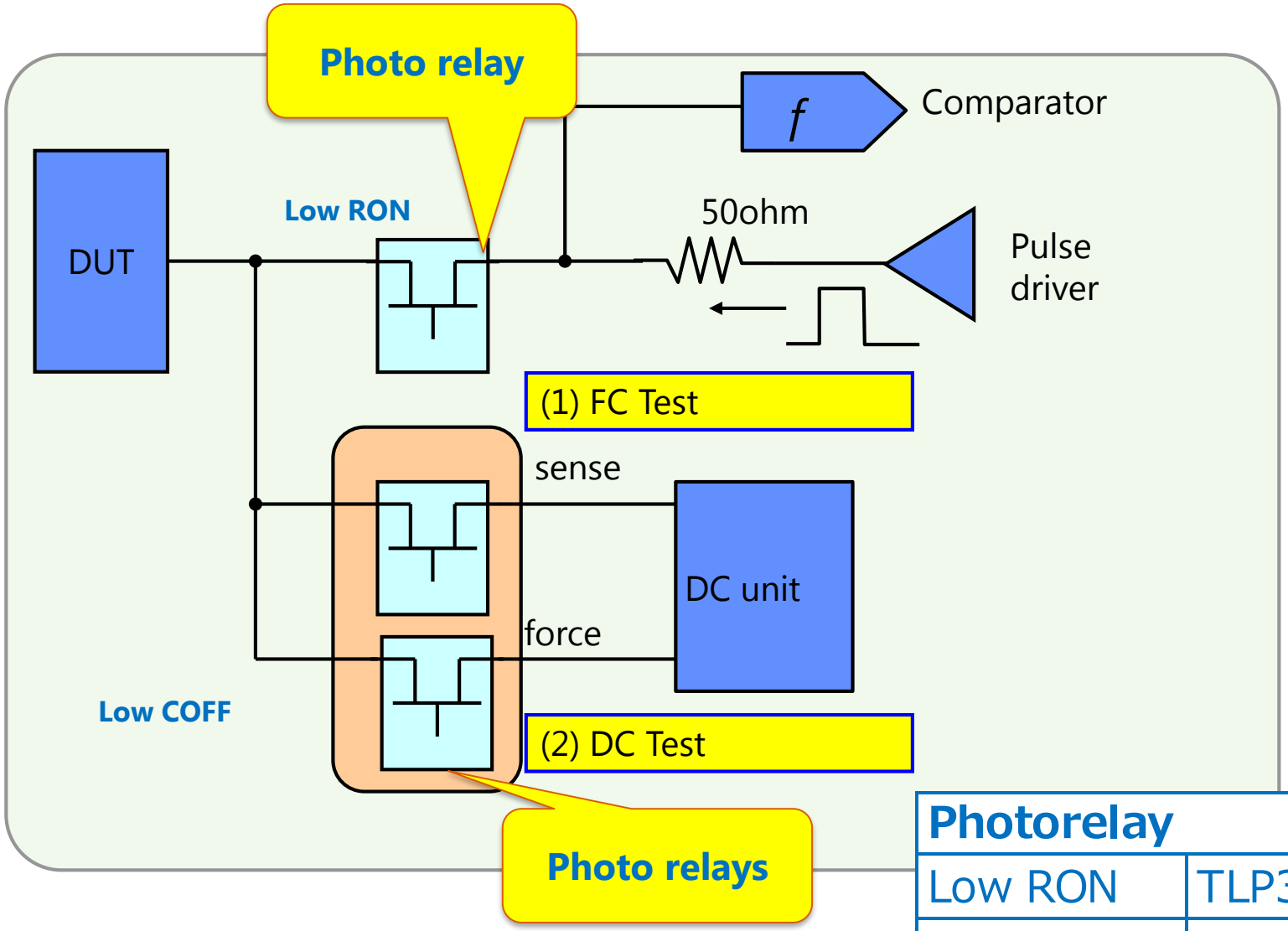


Lower RON/Higher Current

ATE : Automatic test equipment

ATE: Automated *Test* Equipment

Pin Electronics



Photorelay	
Low RON	TLP3475S
Low COFF	TLP3440S

DPS (Devise Power supply)

Photo relays (To change VCC for DUT)

Mechanical relays PDA coupler + MOSFET

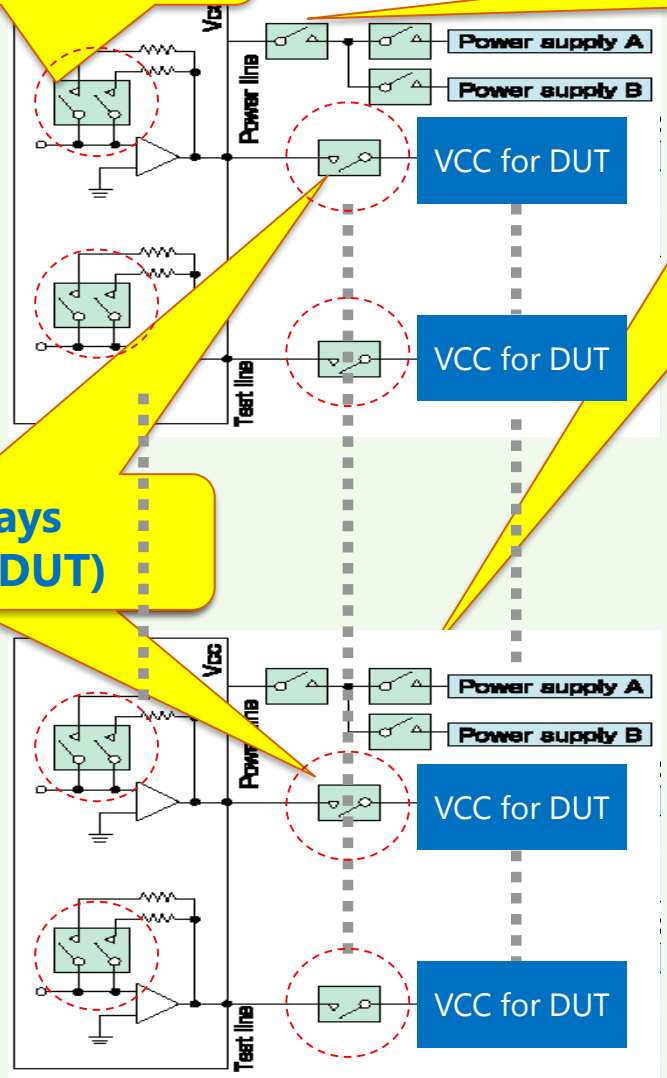


Photo relays (To change DUT)

PDA coupler
TLP3905
TLP3906

Power MOSFET
TK28N65W

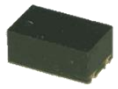
Photorelay	
30V/1.5A	TLP3406S
60V/1A	TLP3407S

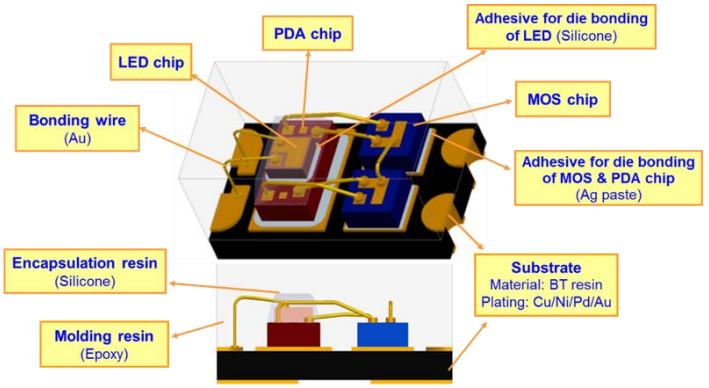
Low RON/High current

VSON4 Lineup

Topr is extended (from 85degC) to 110degC.
Package size: 2.45 mm x 1.45 mm x 1.3 mm (typ)

	Type	VOFF (min.)	ION (max.)	RON (typ.)	RON (max.)	COFF (typ.)	IOFF (max.)	tON (max.)	tOFF (max.)	Bvs (min.)
★	TLP3403	20V	1000mA	0.18Ω	0.22Ω	40pF	1nA	2ms	1ms	500
★	TLP3431	20V	450mA	0.8Ω	1.2Ω	5pF	1nA	0.4ms	0.4ms	500
★	TLP3450	20V	200mA	3Ω	5Ω	0.8pF	1nA	0.2ms	0.2ms	500
★	TLP3440	40V	120mA	12Ω	14Ω	0.45pF	1nA	0.2ms	0.3ms	500
	TLP3441	40V	140mA	5Ω	10Ω	0.7pF	1nA	0.2ms	0.2ms	500
	TLP3442	40V	100mA	15Ω	20Ω	0.3pF	1nA	0.2ms	0.2ms	500
★	TLP3475	50V	300mA	1Ω	1.5Ω	12pF	1nA	0.5ms	0.4ms	500
★	TLP3412	60V	400mA	1Ω	1.5Ω	20pF	1nA	0.5ms	0.5ms	500
★	TLP3451	60V	120mA	10Ω	15Ω	0.7pF	1nA	0.2ms	0.2ms	500
	TLP3417	80V	120mA	7Ω	12Ω	5pF	1nA	0.5ms	0.2ms	500
	TLP3419	80V	200mA	6Ω	8Ω	6.5pF	1nA	0.4ms	0.4ms	500
	TLP3420	100V	100mA	8Ω	14Ω	6pF	0.2nA	0.3ms	0.3ms	500





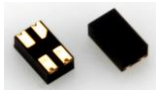
High runner for

- ★ **DPS relay** (For device power source)
- ★ **FC relay** (For high frequency signal) *12GHz(f3dB) insertion loss
- ★ **DC relay** (For DC measurement, Force & Sense)

VSONR4 Lineup (Built-in Resistance)

Package size: 2.75 (L) mm × 1.45 (W) mm × 1.3 (H) mm (typ)

Topr is extended (from 85degC) to 110degC.



Type	VOFF (min.)	ION (max.)	VFON (max.)	RON (typ.)	RON (max.)	COFF (typ.)	CxR (pFΩ) (typ.)	IOFF (max.)	tON (max.)	tOFF (max.)	BVs (min.)	Status
TLP3403R	20V	1000mA	3.0V	0.18Ω	0.22Ω	40pF	7.2	1nA	2ms	1ms	300Vrms	MP
TLP3412R	60V	400mA	3.0V	1Ω	1.5Ω	20pF	20	1nA	0.5ms	0.5ms	300Vrms	MP
TLP3475R	50V	300mA	3.0V	1Ω	1.5Ω	12pF	12	1nA	0.5ms	0.4ms	300Vrms	MP

S-VSON4 Lineup

Industry-smallest mounting area[*1]: 2.00 mm×1.45 mm (typ.)

[*1] As of February 2017, from a survey by Toshiba.

High Operating Temp: 110degC.

2.0×1.45mm

Height=1.75mm

	Type	VOFF(min.)	ION(max.)	RON(typ.)	RON(max.)	COFF(typ.)	C (pF) xR(Ω) (typ.)	IOFF(max.)	tON(max.)	tOFF(max.)	BVs(min.)
★	TLP3406S	30V	1500mA	0.1Ω	0.2Ω	120pF	12	1nA@20V	2ms	1ms	500Vrms
★	TLP3407S	60V	1000mA	0.2Ω	0.3Ω	80pF	16	1nA@50V	2ms	1ms	500Vrms
★	TLP3409S	100V	650mA	0.4Ω	0.6Ω	50pF	20	1nA@80V	2ms	1ms	500Vrms
★	TLP3440S	40V	120mA	12Ω	14Ω	0.45pF	5.4	1nA@40V	0.2ms	0.3ms	500Vrms
★	TLP3475S	60V	400mA	1Ω	1.5Ω	12pF	12	1nA@50V	0.5ms	0.4ms	500Vrms

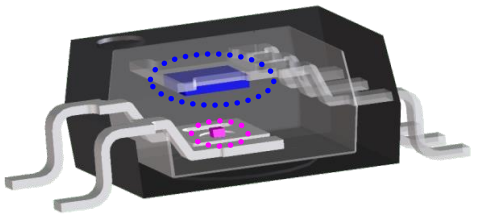
TLP3440S (under development) ES: available CS: B/Sep

★ **DPS relay (For device power source)**

★ **FC relay (For high frequency signal)**

★ **DC relay (For DC measurement, Force&Sence)**

High Current Applications (HVAC, thermostat, etc.)

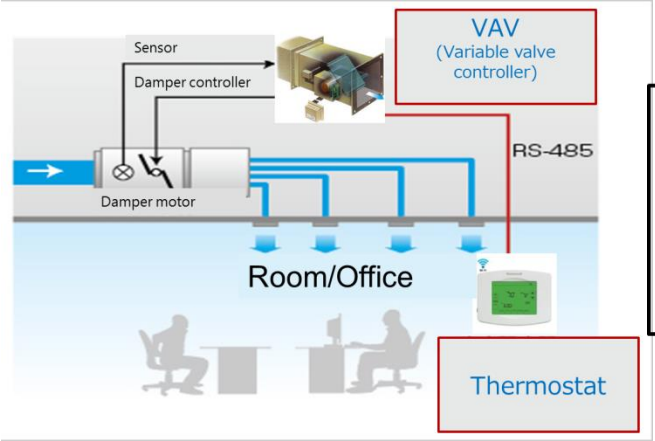


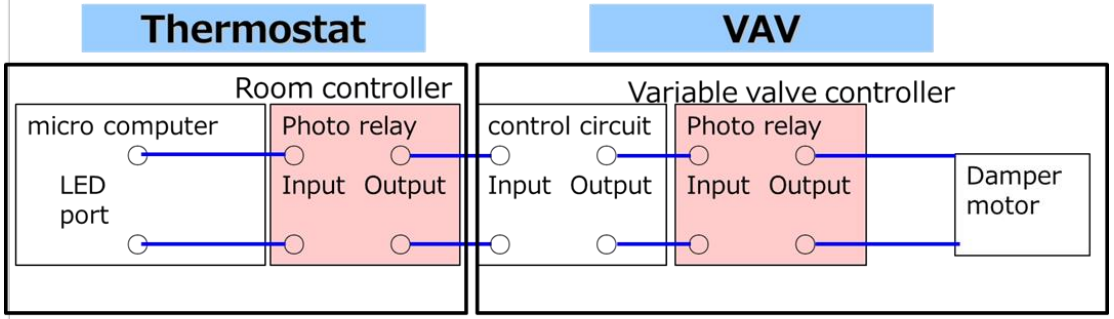
HVAC(Including thermostat)

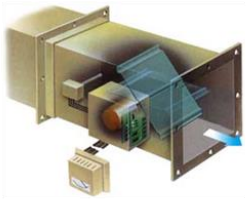
【Function of relay】

HVAC (Heating Ventilation and Air Conditioning)

Photorelays are used for signal transmission from the thermostat to heating, ventilation (damper motor in VAV) and air conditioning control equipment in building automation. Conventionally, mechanical relays are used, but these can be replaced with high capacity photorelays.







【Merits of Photorelays】

- **No noise**
- **Long life**
- **High capacity**

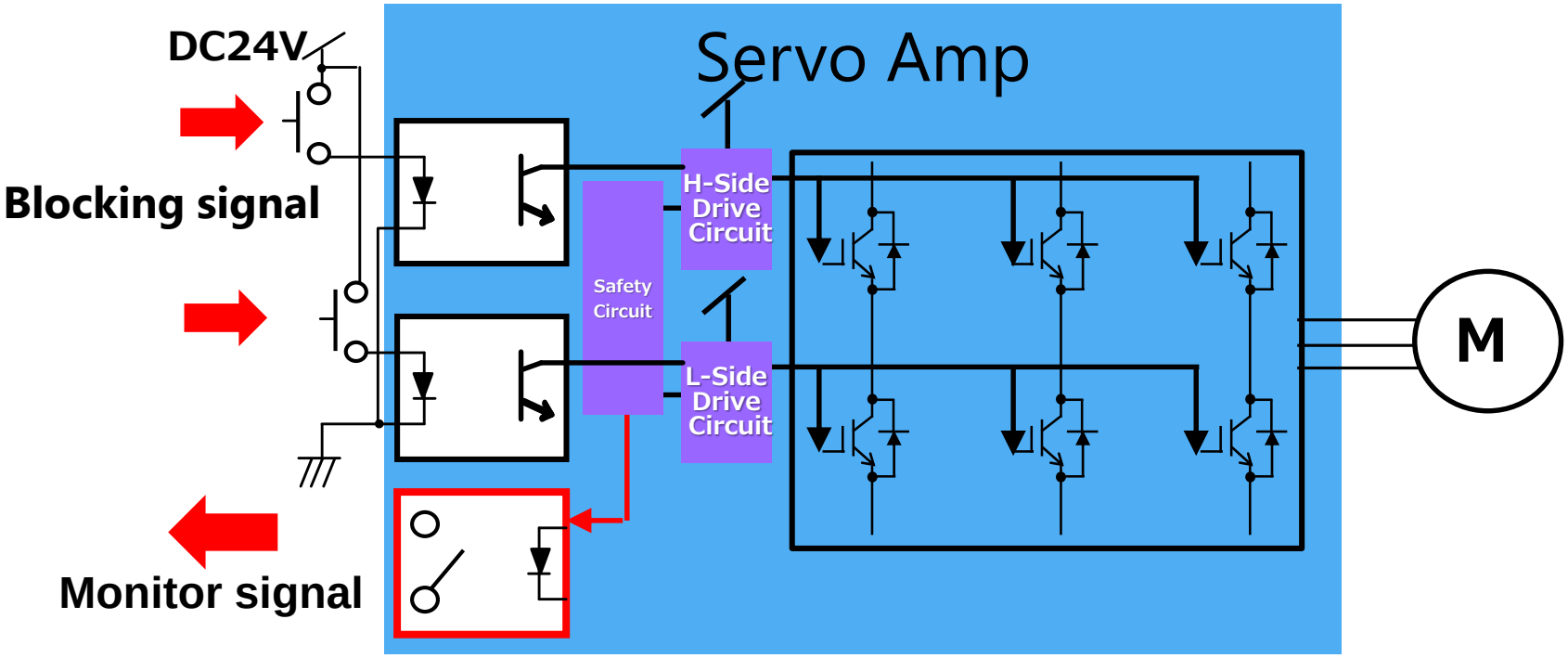
Feature	Contact	Package	Recommended Products
Function Switch	1 Form A	SO6	TLP172AM
		SOP	TLP3109 / TLP3122
		DIP4	TLP241A / TLP3555

FA with STO function

【Function of relay】

The safe torque off function is a safety function. In the event of anomaly (indicated by a safety signal input), drive signal to the servo amplifier shuts down, which in turn stops the motor torque. Photorelays are used to transmit monitor signals to controls, such as PLCs, in the safety circuit of the servo amplifier.

【Use】servo amplifier 、CNC、Robot etc



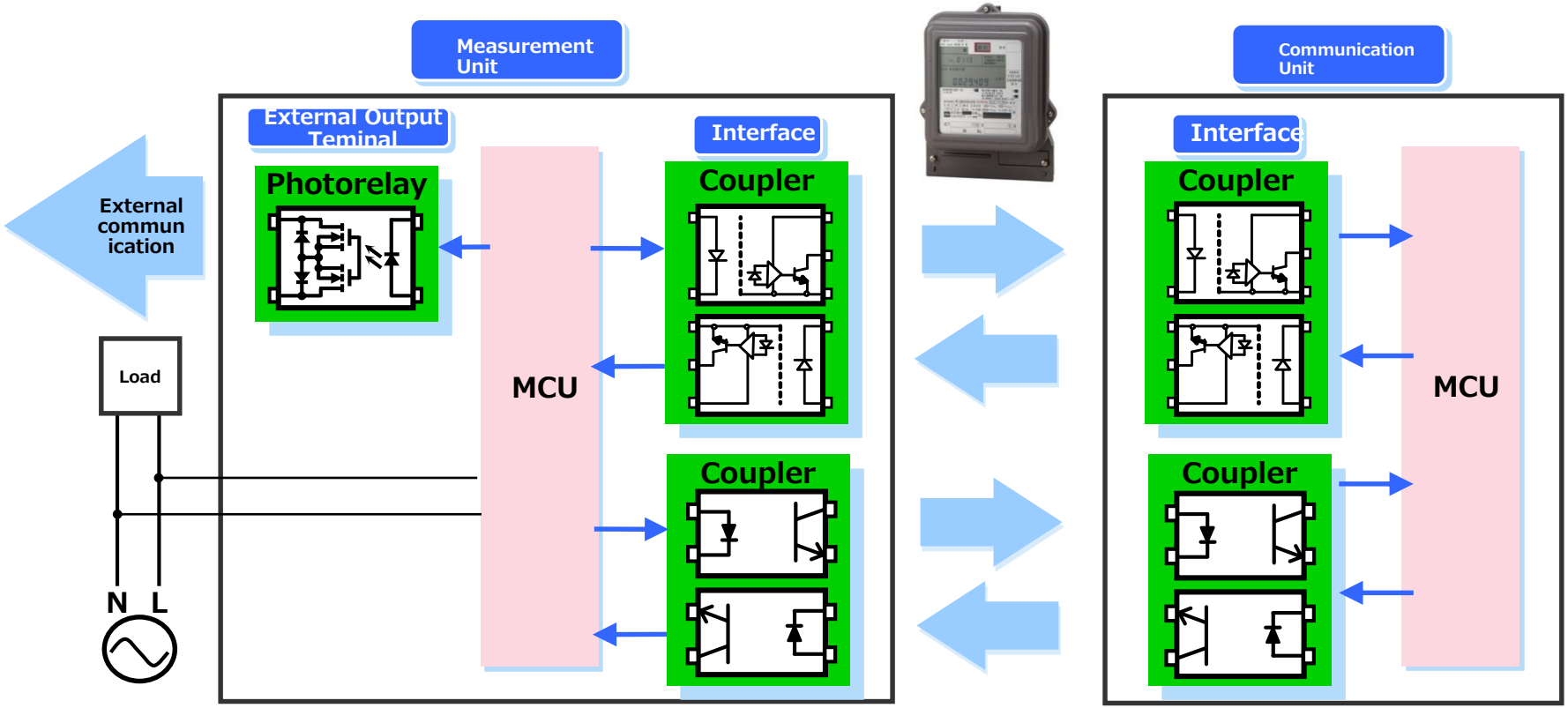
【Merits of Photorelays】

■ Small size　　■ High speed

E-meter・Smart meter

【Function of relay】

Photorelays are used as contact output for external communication.



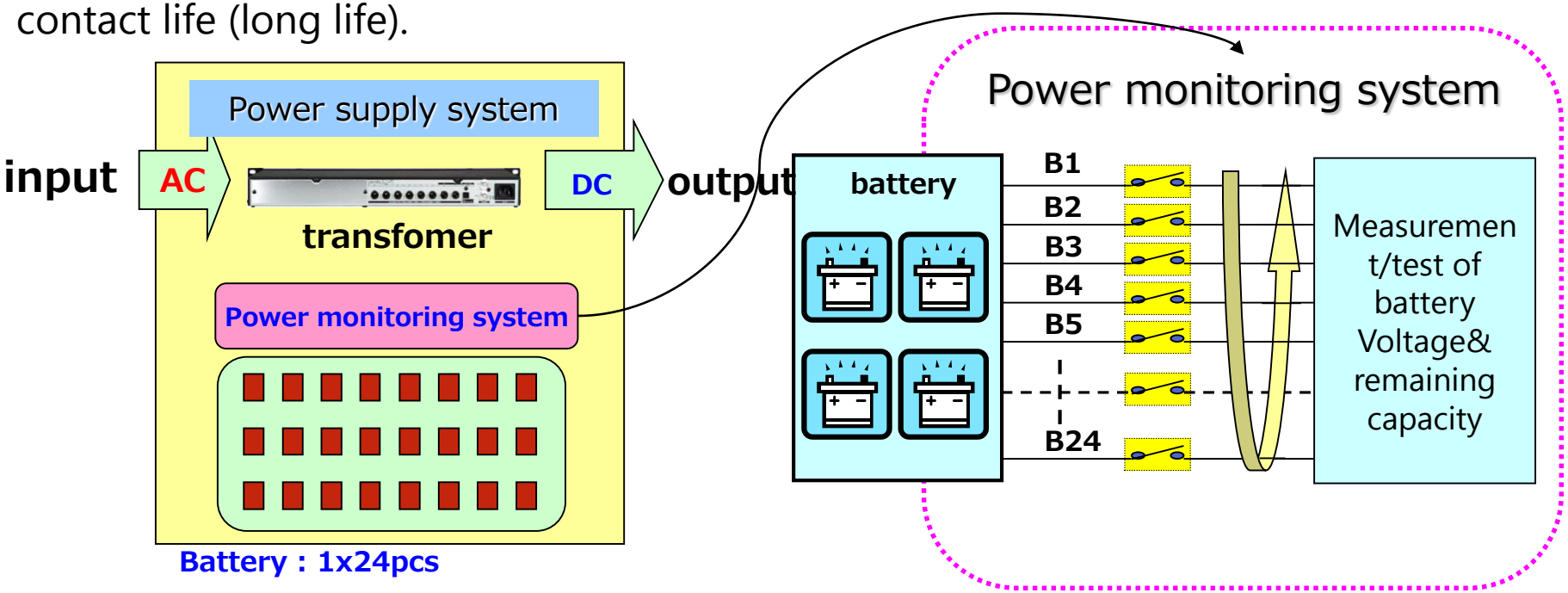
【Merit of Photorelays】

- **High withstand voltage**
- **Reinforced insulation**
- **Long life**

Power monitoring system(BMS etc)

【Function of relay】

Photorelays are in the power monitoring circuit of battery cells. The relay is expected to make many contacts and photorelays are highly recommended as they have no contact life (long life).



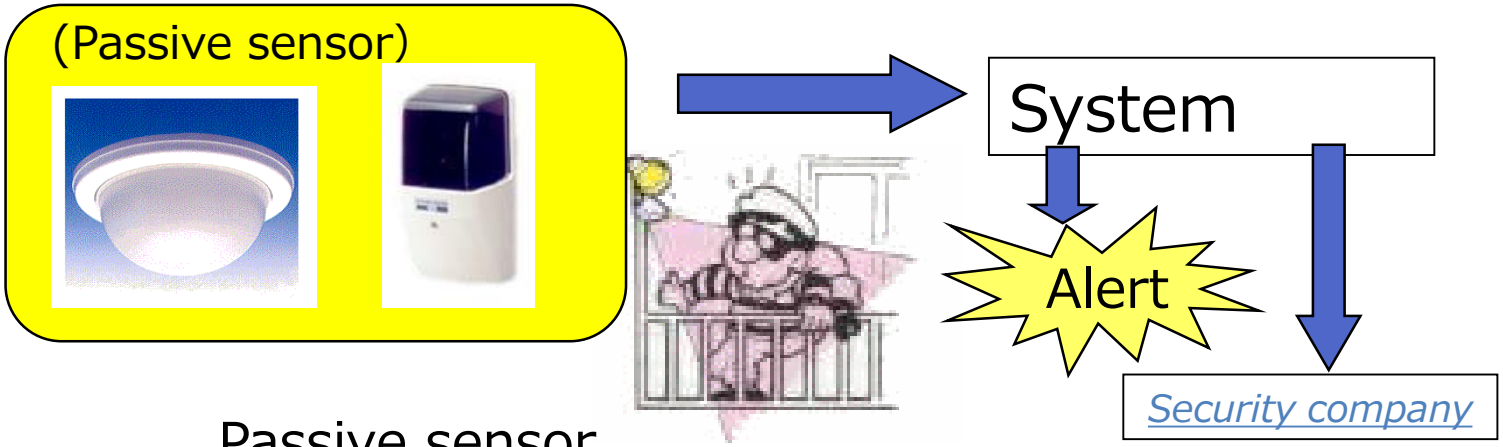
【Benefits of Photorelays】

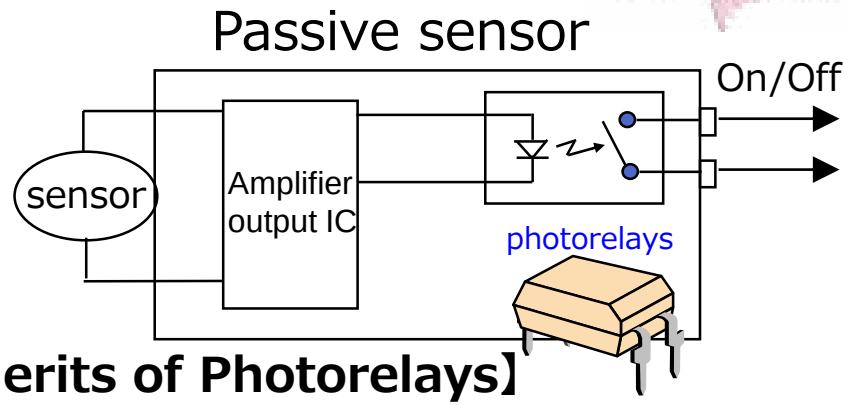
- small size
- long life
- High withstand voltage

Security（ex： Passive sensors）

【Function of relay】

When a suspicious activity is detected by the passive security sensor, the photorelay transmits this information to the reporting terminal.





Block	Types	Package	Recommended Product
Sensor switch	Small size 1 Form A	SO6/2.54SOP4	TLP172AM / TLP170A
	Small size 1 Form B	2.54SOP4	TLP4176G
Output form	High current DIP	DIP	TLP35xx Series
	Small size 1 Form B	2.54SOP4	TLP4176G

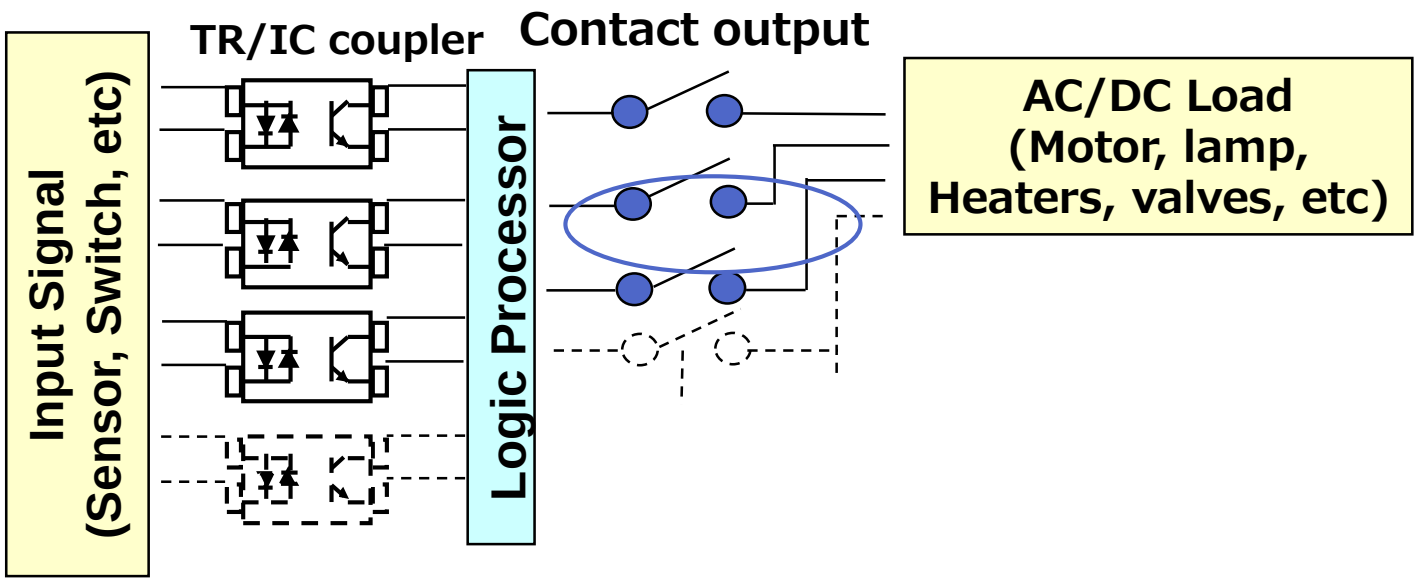
【Merits of Photorelays】

- **Small size**
- **Low power consumption**
- **High capacity**

PLC (Programmable logic controller)

【Function of relay】

A mechanical relay is traditionally used as the contact output of the PLC output stage. However, semiconductor relays (photorelays, PDA couplers + MOSFETs) have become the common choice due to their superior reliability.



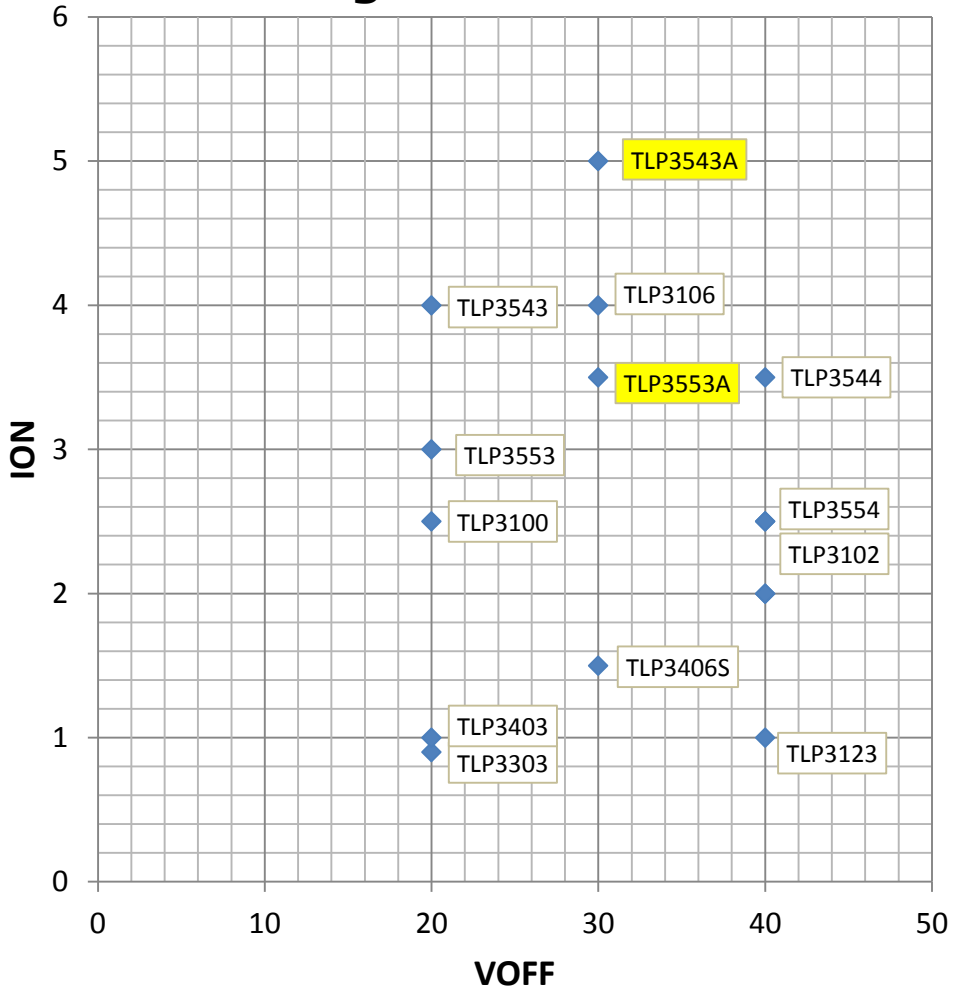
【Merits of Photorelays】

- High reliability
- Small size
- High capacity

List of High current Photorelays

High capacity photorelays (above 1A current) for the replacement of mechanical relays
New product is highly recommended for new design.

Off-state voltage 20 to 40V

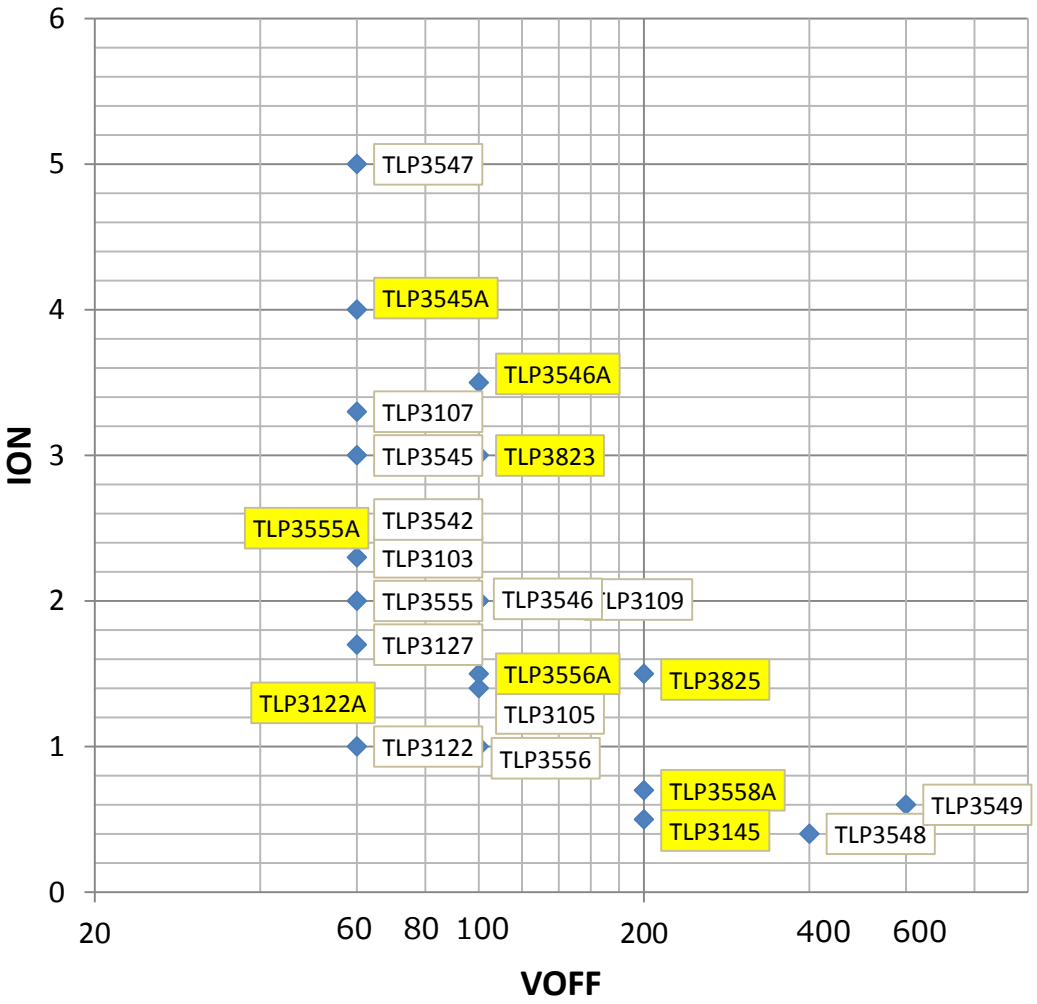


():tentative CY base

Part Number	PKG	VOFF	ION	Current /New	ES	MP
TLP3100	SOP6	20	2.5	Current		
TLP3303	USOP4	20	0.9	Current		
TLP3403	VSON	20	1	Current		
TLP3543	DIP6	20	4	Current		
TLP3553	DIP4	20	3	Current		
TLP3106	SOP6	30	4	Current		
TLP3406S	S-VSON4	30	1.5	Current		
TLP3553A	DIP4	30	(3.5)	New	3Q/17	4Q/17
TLP3543A	DIP6	30	(5)	New	3Q/17	4Q/17
TLP241A	DIP4	40	2	Current		
TLP241AF	DIP4	40	2	Current		
TLP3102	SOP6	40	2.5	Current		
TLP3123	SOP4	40	1	Current		
TLP3544	DIP6	40	3.5	Current		
TLP3554	DIP4	40	2.5	Current		

List of High current Photorelays

Off-state voltage 60 to 600V



():tentative CY base

Part Number	PKG	VOFF	ION	Current /New	ES	MP
TLP3103	SOP6	60	2.3	Current		
TLP3107	SOP6	60	3.3	Current		
TLP3122	SOP4	60	1	Current		
TLP3122A	SO6	60	(1.3)	New	3Q/17	4Q/17
TLP3127	SOP4	60	1.7	Current		
TLP3542	DIP6	60	2.5	Current		
TLP3545A	DIP6	60	(4)	New	3Q/17	4Q/17
TLP3545	DIP6	60	3	Current		
TLP3547	DIP8	60	5	Current		
TLP3555	DIP4	60	2	Current		
TLP3555A	DIP4	60	(2.5)	New	3Q/17	4Q/17
TLP3105	SOP6	100	1.4	Current		
TLP3109	SOP6	100	2	Current		
TLP3546	DIP6	100	2	Current		
TLP3556	DIP4	100	1	Current		
TLP3556A	DIP4	100	(1.5)	New	3Q/17	4Q/17
TLP3546A	DIP6	100	(3.5)	New	3Q/17	4Q/17
TLP3823	DIP8	100	3	New		OK
TLP3558A	DIP4	200	(0.7)	New	3Q/17	4Q/17
TLP3145	SOP4	200	(0.5)	New	2Q/17	3Q/17
TLP3825	DIP8	200	1.5	New		OK
TLP3548	DIP8	400	0.4	Current		
TLP3549	DIP8	600	0.6	Current		

TLP38xx series

New Products

Feature: High ION, Low RON

- TLP3823: 100V / 3A
- TLP3825: 200V / 1.5A
- High Operating Temp: 110degC.
- High BV: 2500 Vrms

Low Input Current

TLP172AM/TLP172GM/TLP175A

TLP172xx Series: 3mA Class
TLP175A: 1mA class
TLP171xx Series: 0.2mA class

– Application –
- FA equipment
- BMS (Battery Management System)
- Security equipment
- Telecom
- replacement from Mechanical relay

Lineup

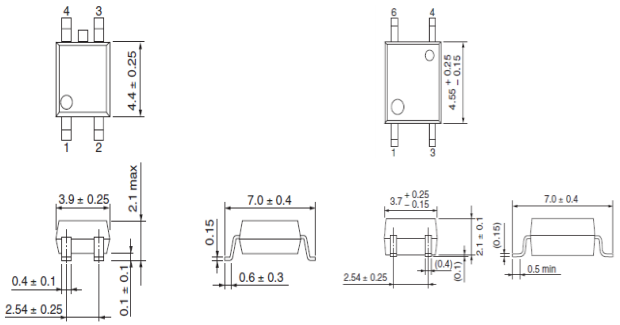
Ta=25℃

NEW

Characteristics	TLP172A	TLP172G	TLP172AM	TLP172GM
Output	1-form-A			
PKG	2.54SOP4		4pin SO6	
IFT (max)	3mA			
VOFF (min)	60 V	350V	60 V	350V
RON (max)	2Ω	50Ω	2Ω	50Ω
ION(max.)	0.4A	0.11A	0.5A	0.11A
BVs(min.)	1.5kVrms		3.75kVrms	
tON(max)	2ms	1ms	2ms	1ms
tOFF(max)	0.5ms	1ms	0.5ms	0.5ms

– PKG exterior–

2.54SOP **4pin SO6**



For load drive with High BVs

TLP240A/240D/240G/240GA/240J/241A

New

①add to new line-up 2A output type, TLP241A

Expanded lineup from **40V** to 600V for V_{OFF}.
I_{ON} are extended to **2.0A** from 0.09A.

②adopted High-intensity LED

Possible to improve initial design margin for I_F.

③SMD and Various lead forms are available

– Application –

- ·FA
- ·BMS
- ·WHM
- ·Security
- ·IoT/ Building Automation
- ·replace Mechanical relay

Line-up

Ta=25℃

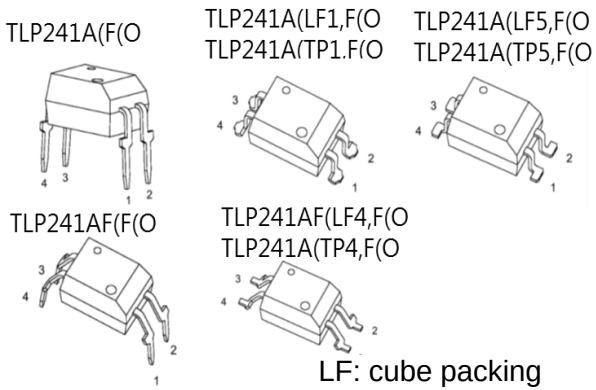
	TLP240A	TLP240D	TLP240G	TLP240GA	TLP240J	TLP241A (New)
Output	1-form-A					
Package	DIP4					
I_{FT} (max)	3mA					
V_{OFF} (min)	60 V	200V	350V	400V	600V	40 V
RON (max)	2Ω	8Ω	50Ω	35Ω	60Ω	0.15Ω
ION(max.)	0.5A	0.25A	0.1A	0.12A	0.09A	2.0A
BVs(min.)	5kVrms					
tON(max)	3ms		2ms			5ms
tOFF(max)	1ms					

Safety standard(Reinforced Insulation)

- UL approved UL1577 file No.E67349
- cUL approved CSA Component Acceptance Service No.5A File No.E67349
- CQC approved GB4943.1, GB8898
- EN60747-5-5 Option (D4) type VDE approved

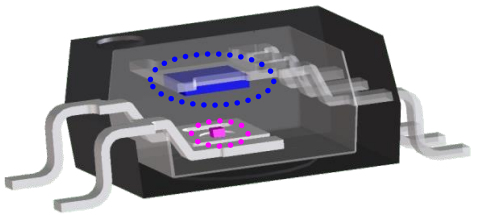
–Order name and Lead forming example –

Ex) : TLP241A



LF: cube packing
TP: tape packing

Photovoltaic



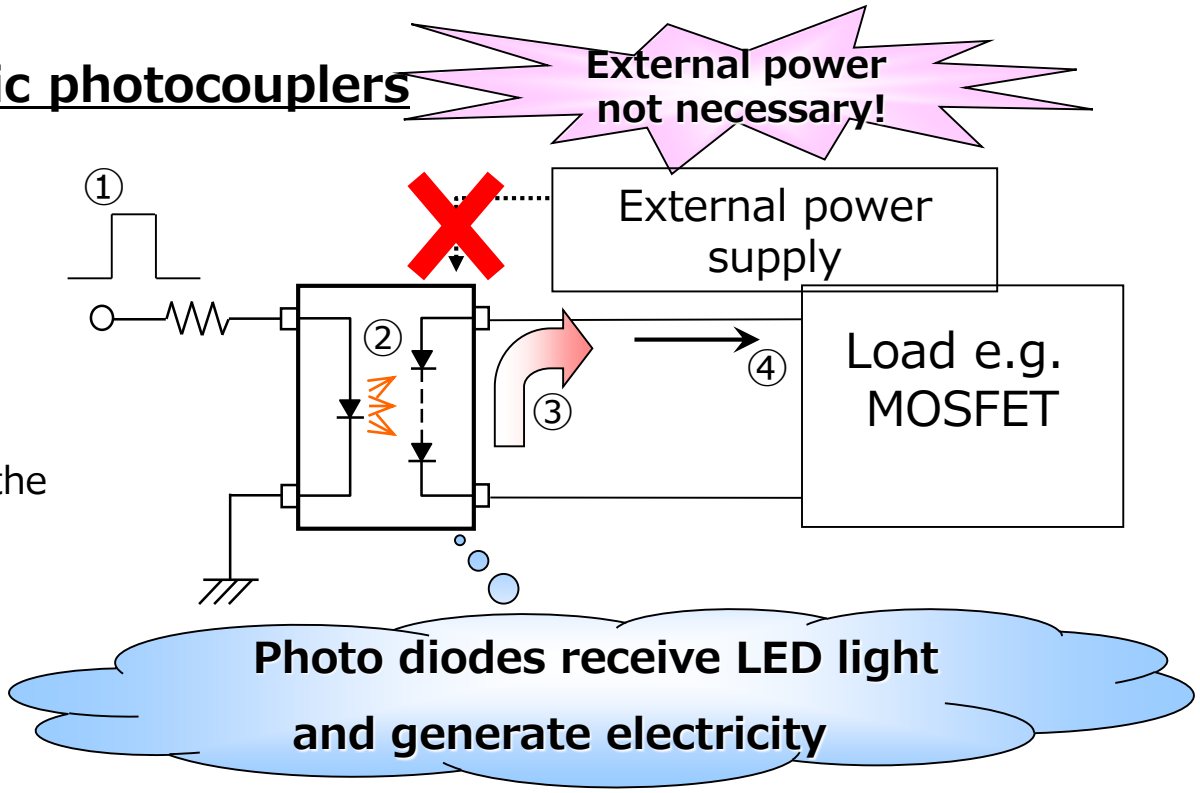
Outline of Photovoltaic coupler

Photovoltaic couplers generate electric voltage by the photo diode arrays that receive the LED light

→ **A gate drive circuit, which does not require an external power supply!**

Operation of photovoltaic photocouplers

1. Apply a voltage on the input
↓
2. LED lights up
↓
3. Light from the LED is received by the photo diodes
↓
4. Electric voltage generated by the photo diodes enters the gate and drives the MOSFET



High Temp. Operation, High BVs, Faster switching Photovol coupler

TLP3905/TLP3906

Compact SO6 Package Photovoltaic coupler!

・125 deg. High temperature operating

Suitable for relay switching under high temperature condition than competitor's equivalents which are guaranteed Topr=85 deg.

・Isolation voltage 3750Vrms

Isolation voltage BVs : up to 3.75kVrms (approved by VDE).

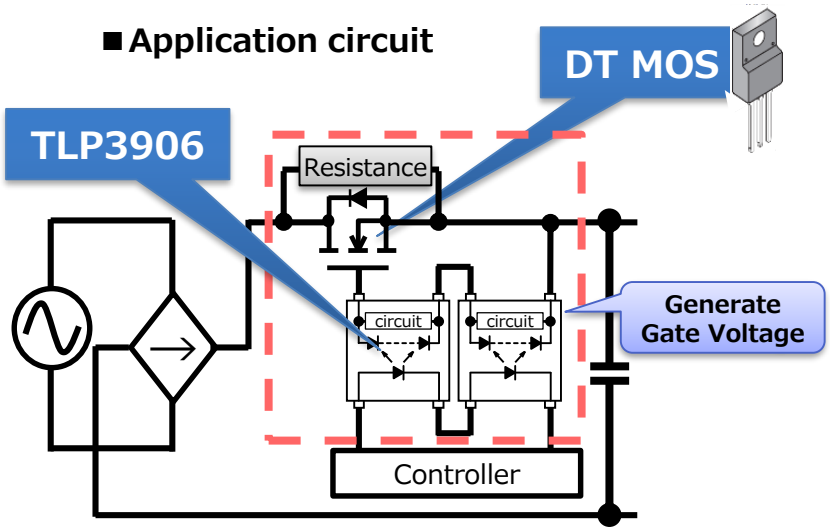
・Faster switching speed

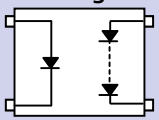
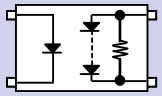
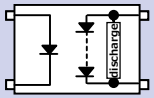
Control circuit is embedded in TLP3906.

→No need to evaluate shunt resistance at output side.

Enables faster switching speed.

■ Application circuit



	Current item	NEW	Current item	NEW
	TLP190B	**TLP3905**	TLP191B	**TLP3906**
Internal circuit	Without discharge resistance 		With discharge resistance 	With discharge circuit 
Package	MFSOP6	**4pin SO6**	MFSOP6	**4pin SO6**
T_{opr}	-40 to 85˚C	**-40 to 125˚C**	-40 to 85˚C	**-40 to 125˚C**
V_{OC}	7V		7V	
I_{SC}	12μA		12μA	
t_{ON} / t_{OFF}	0.2ms / 1ms	0.3ms / 1ms	0.2ms / 3ms	**0.2ms / 0.3ms**
BV_s	2500 V_{rms}	**3750 V_{rms}**	2500 V_{rms}	**3750 V_{rms}**

■ Application

・PLC…Relay contact output module

・SPS…Inrush current prevention circuit

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