

Photocouplers Photorelay

TLP223GA, TLP223GAF

1. Applications

- Mechanical relay replacements
- Security Systems
- Measuring Instruments
- Factory Automation (FA)
- Amusement Equipment
- Smart Meters
- Electricity Meters

2. General

The TLP223GA and TLP223GAF photorelay consist of a photo MOSFET optically coupled to an infrared LED. They are housed in a 4-pin DIP package. They provide an isolation voltage of 5000 Vrms, making them suitable for applications that require reinforced insulation.

3. Features

- (1) Normally opened (1-Form-A)
- (2) OFF-state output terminal voltage: 400 V (min)
- (3) Trigger LED current: 2 mA (max)
- (4) ON-state current: 120 mA (max)
- (5) ON-state resistance: 28 Ω (max, $t < 1$ s), 35 Ω (max, Continuous)
- (6) Isolation voltage: 5000 Vrms (min)
- (7) Safety standards

UL-recognized: UL 1577, File No.E67349

cUL-recognized: CSA Component Acceptance Service No.5A File No.E67349

VDE-approved: EN 60747-5-5, EN 62368-1 (**Note 1**)

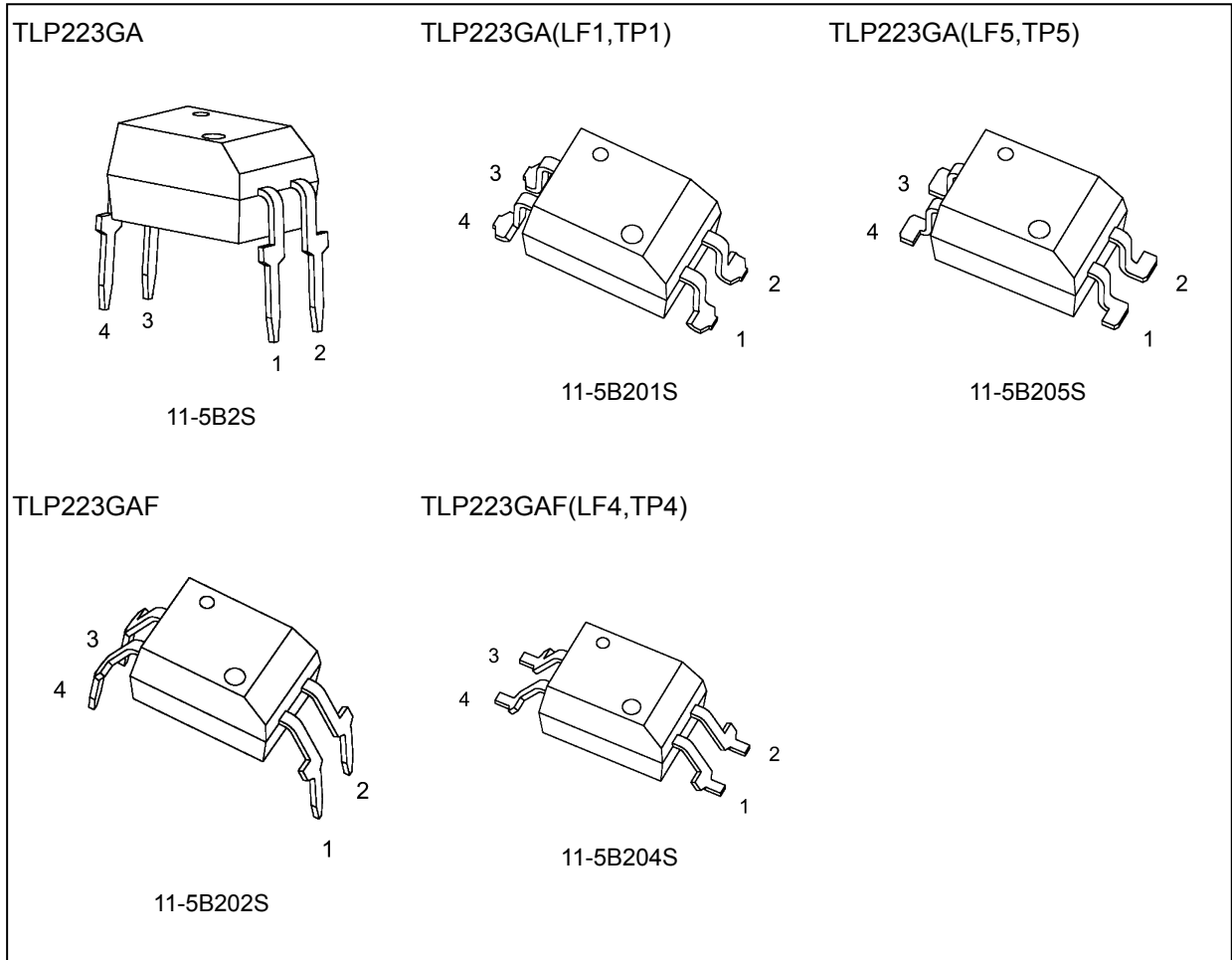
Note 1: When a VDE approved type is needed, please designate the **Option (D4)**.

4. Mechanical Parameters

Characteristics	7.62-mm Pitch TLP223GA	10.16-mm Pitch TLP223GAF	Unit
Creepage distances	7.0 (min)	8.0 (min)	mm
Clearance distances	7.0 (min)	8.0 (min)	
Internal isolation thickness	0.4 (min)	0.4 (min)	

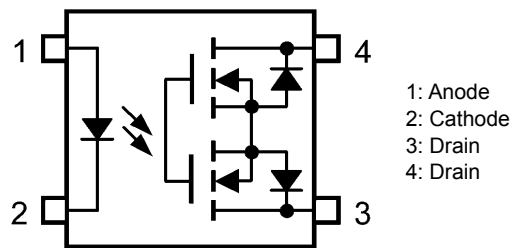
Start of commercial production
2021-10

5. Packaging (Note)

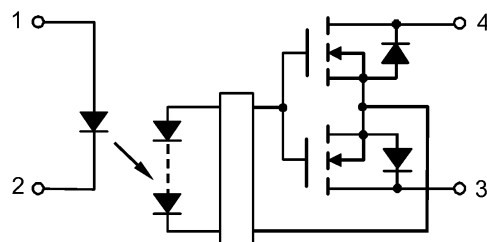


Note: Through-hole type: TLP223GA, TLP223GAF
 Lead forming option: (LF1), (LF4), (LF5)
 Taping option: (TP1), (TP4), (TP5)

6. Pin Assignment



7. Internal Circuit



8. Absolute Maximum Ratings (Note) (Unless otherwise specified, $T_a = 25\text{ °C}$)

	Characteristics	Symbol	Note	Rating	Unit
LED	Input forward current	I_F		30	mA
	Input forward current derating ($T_a \geq 100\text{ °C}$)	$\Delta I_F/\Delta T_a$		-1.2	mA/°C
	Input forward current (pulsed) (100 μ s pulse, 100 pps)	I_{FP}		1	A
	Input reverse voltage	V_R		6	V
	Input power dissipation	P_D		50	mW
	Input power dissipation derating ($T_a \geq 100\text{ °C}$)	$\Delta P_D/\Delta T_a$		-2	mW/°C
	Junction temperature	T_j		125	°C
Detector	OFF-state output terminal voltage	V_{OFF}		400	V
	ON-state current	I_{ON}		120	mA
	ON-state current derating ($T_a \geq 25\text{ °C}$)	$\Delta I_{ON}/\Delta T_a$		-1.2	mA/°C
	ON-state current (pulsed) (t = 100 ms, Duty = 1/10)	I_{ONP}		360	mA
	Output power dissipation	P_O		500	mW
	Output power dissipation derating ($T_a \geq 25\text{ °C}$)	$\Delta P_O/\Delta T_a$		-5.0	mW/°C
	Junction temperature	T_j		125	°C
Common	Storage temperature	T_{stg}		-55 to 125	°C
	Operating temperature	T_{opr}		-40 to 110	
	Lead soldering temperature (10 s)	T_{sol}		260	
	Isolation voltage (AC, 60 s, R.H. \leq 60 %)	BV_S	(Note 1)	5000	

Note: Using continuously under heavy loads (e.g. the application of high temperature/current/voltage and the significant change in temperature, etc.) may cause this product to decrease in the reliability significantly even if the operating conditions (i.e. operating temperature/current/voltage, etc.) are within the absolute maximum ratings.

Please design the appropriate reliability upon reviewing the Toshiba Semiconductor Reliability Handbook ("Handling Precautions"/"Derating Concept and Methods") and individual reliability data (i.e. reliability test report and estimated failure rate, etc).

Note 1: This device is considered as a two-terminal device: Pins 1 and 2 are shorted together, and pins 3 and 4 are shorted together.

9. Recommended Operating Conditions (Note)

Characteristics	Symbol	Note	Min	Typ.	Max	Unit
Supply voltage	V_{DD}		—	—	320	V
Input forward current	I_F		5	7.5	25	mA
ON-state current	I_{ON}		—	—	120	mA

Note: The recommended operating conditions are given as a design guide necessary to obtain the intended performance of the device. Each parameter is an independent value. When creating a system design using this device, the electrical characteristics specified in this data sheet should also be considered.

10. Electrical Characteristics (Unless otherwise specified, $T_a = 25\text{ }^\circ\text{C}$)

	Characteristics	Symbol	Note	Test Condition	Min	Typ.	Max	Unit
LED	Input forward voltage	V_F		$I_F = 10\text{ mA}$	1.1	1.35	1.5	V
	Input reverse current	I_R		$V_R = 6\text{ V}$	—	—	10	μA
	Input capacitance	C_t		$V = 0\text{ V}, f = 1\text{ MHz}$	—	55	—	pF
Detector	OFF-state current	I_{OFF}		$V_{OFF} = 400\text{ V}$	—	—	1	μA
	Output capacitance	C_{OFF}		$V = 0\text{ V}, f = 1\text{ MHz}$	—	53	—	pF

11. Coupled Electrical Characteristics (Unless otherwise specified, $T_a = 25\text{ }^\circ\text{C}$)

	Characteristics	Symbol	Note	Test Condition	Min	Typ.	Max	Unit
Trigger LED current		I_{FT}		$I_{ON} = 120\text{ mA}$	—	0.23	2	mA
	Return LED current	I_{FC}		$I_{OFF} = 10\text{ }\mu\text{A}$	0.1	—	—	
ON-state resistance		R_{ON}		$I_{ON} = 120\text{ mA}, I_F = 5\text{ mA}, t < 1\text{ s}$	—	15	28	Ω
	(Note 1)		$I_{ON} = 120\text{ mA}, I_F = 5\text{ mA}, \text{Continuous}$	—	17	35		

Note 1: Thermally saturated state.

12. Isolation Characteristics (Unless otherwise specified, $T_a = 25\text{ }^\circ\text{C}$)

	Characteristics	Symbol	Note	Test Condition	Min	Typ.	Max	Unit
Total capacitance (input to output)		C_S	(Note 1)	$V_S = 0\text{ V}, f = 1\text{ MHz}$	—	0.8	—	pF
Isolation resistance		R_S	(Note 1)	$V_S = 500\text{ V}, \text{R.H.} \leq 60\%$	10^{12}	10^{14}	—	Ω
Isolation voltage		BV_S	(Note 1)	AC, 60 s	5000	—	—	V _{rms}

Note 1: This device is considered as a two-terminal device: Pins 1 and 2 are shorted together, and pins 3 and 4 are shorted together.

13. Switching Characteristics (Unless otherwise specified, $T_a = 25\text{ }^\circ\text{C}$)

	Characteristics	Symbol	Note	Test Condition	Min	Typ.	Max	Unit
Turn-on time		t_{ON}		See Fig. 13.1.	—	0.3	1.0	ms
Turn-off time		t_{OFF}		$R_L = 200\text{ }\Omega, V_{DD} = 20\text{ V}, I_F = 5\text{ mA}$	—	0.15	0.5	

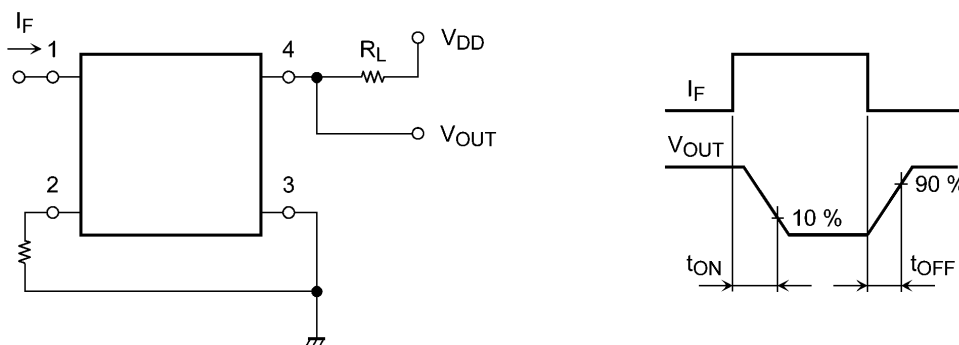


Fig. 13.1 Switching Time Test Circuit and Waveform

14. Characteristics Curves (Note)

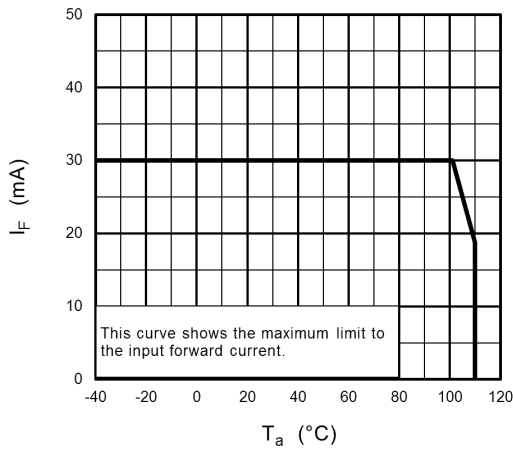


Fig. 14.1 I_F - T_a

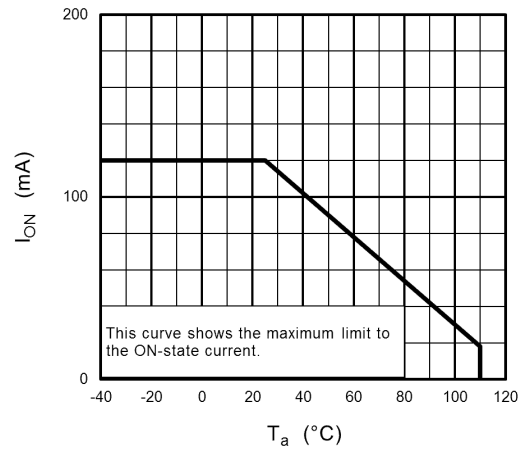


Fig. 14.2 I_{ON} - T_a

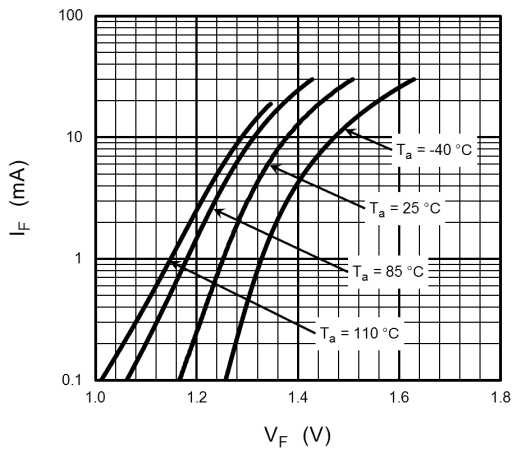


Fig. 14.3 I_F - V_F

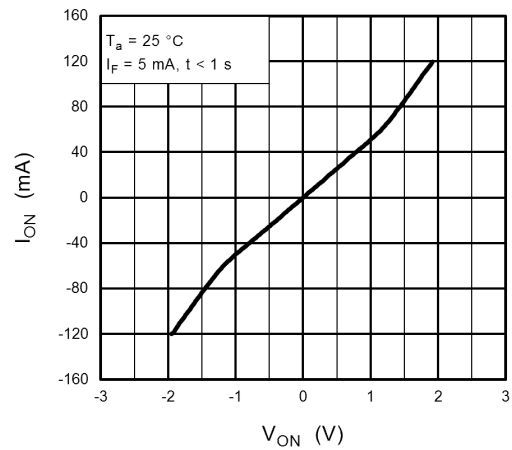


Fig. 14.4 I_{ON} - V_{ON}

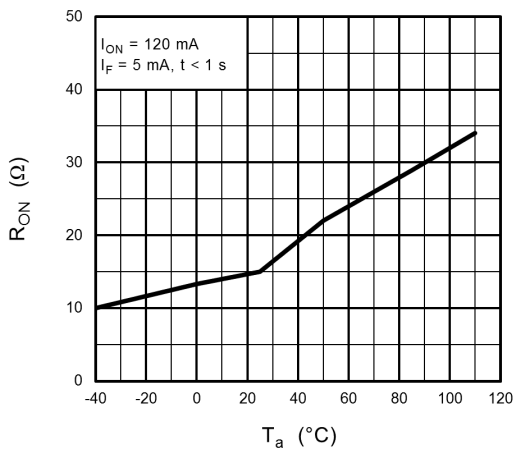


Fig. 14.5 R_{ON} - T_a

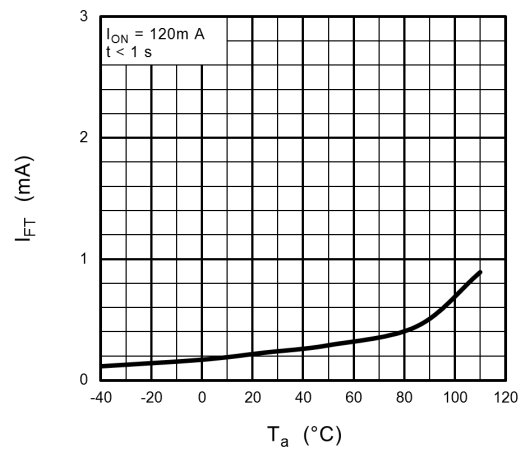


Fig. 14.6 I_{FT} - T_a

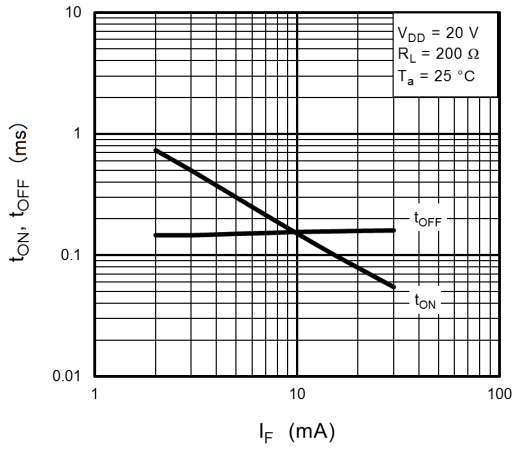


Fig. 14.7 t_{ON} , t_{OFF} - I_F

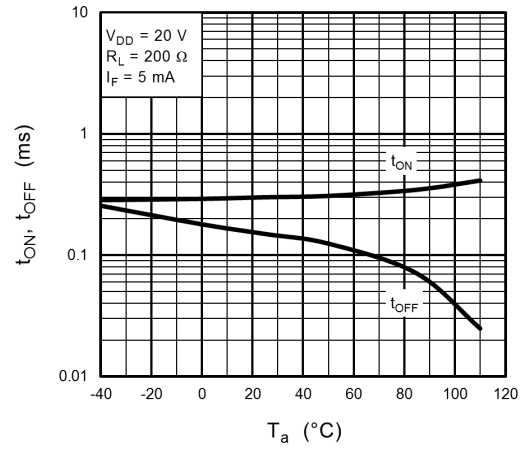


Fig. 14.8 t_{ON} , t_{OFF} - T_a

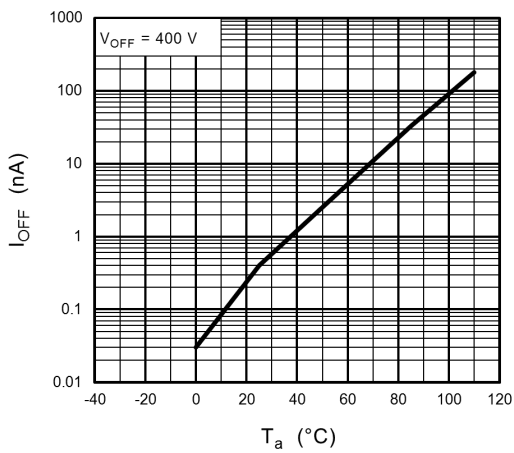


Fig. 14.9 I_{OFF} - T_a

Note: The above characteristics curves are presented for reference only and not guaranteed by production test, unless otherwise noted.

15. Soldering and Storage

15.1. Precautions for Soldering

The soldering temperature should be controlled as closely as possible to the conditions shown below, irrespective of whether a soldering iron or a reflow soldering method is used.

- When using soldering reflow.

The soldering temperature profile is based on the package surface temperature.

(See the figure shown below, which is based on the package surface temperature.)

Reflow soldering must be performed once or twice.

The mounting should be completed with the interval from the first to the last mountings being 2 weeks.

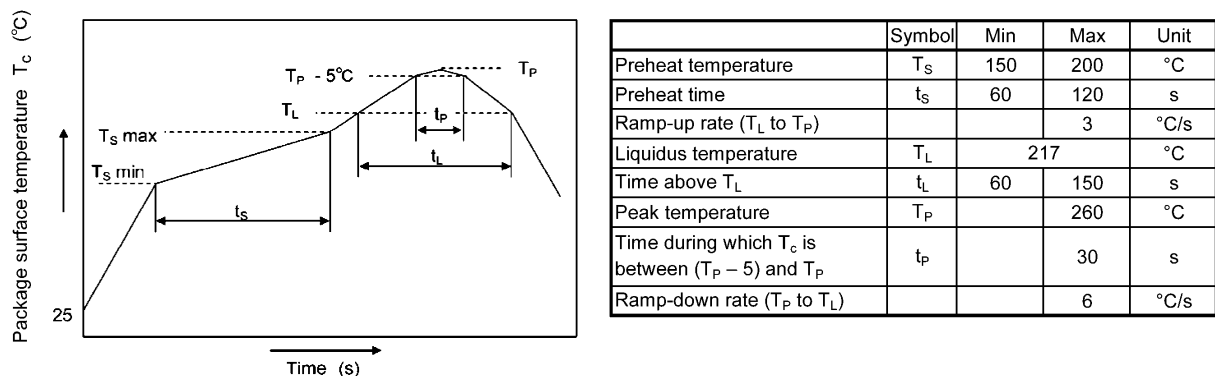


Fig. 15.1.1 An Example of a Temperature Profile When Lead(Pb)-Free Solder Is Used

- When using soldering flow
Preheat the device at a temperature of 150 °C (package surface temperature) for 60 to 120 seconds.
Mounting condition of 260 °C within 10 seconds is recommended.
Flow soldering must be performed once.
- When using soldering Iron
Complete soldering within 10 seconds for lead temperature not exceeding 260 °C or within 3 seconds not exceeding 350 °C
Heating by soldering iron must be done only once per lead.

15.2. Precautions for General Storage

- Avoid storage locations where devices may be exposed to moisture or direct sunlight.
- Follow the precautions printed on the packing label of the device for transportation and storage.
- Keep the storage location temperature and humidity within a range of 5 °C to 35 °C and 45 % to 75 %, respectively.
- Do not store the products in locations with poisonous gases (especially corrosive gases) or in dusty conditions.
- Store the products in locations with minimal temperature fluctuations. Rapid temperature changes during storage can cause condensation, resulting in lead oxidation or corrosion, which will deteriorate the solderability of the leads.
- When restoring devices after removal from their packing, use anti-static containers.
- Do not allow loads to be applied directly to devices while they are in storage.
- If devices have been stored for more than two years under normal storage conditions, it is recommended that you check the leads for ease of soldering prior to use.

16. Land Pattern Dimensions (for reference only)

Unit: mm

TLP223GA

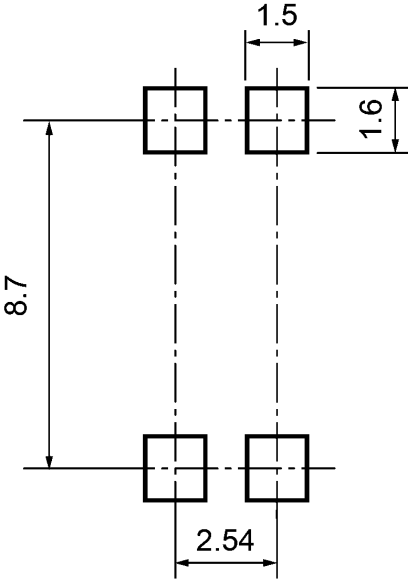


Fig. 16.1 Lead forming and taping option (LF1), (TP1), (LF5), (TP5)

TLP223GAF

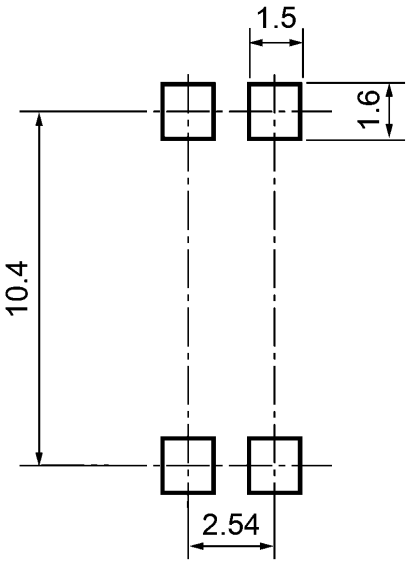


Fig. 16.2 Lead forming and taping option (LF4), (TP4)

17. EN 60747-5-5 Option (D4) Specification

- Part number: TLP223GA (Note 1)
- The following part naming conventions are used for the devices that have been qualified according to option (D4) of EN 60747.

Example: TLP223GA(D4TP1,F)

D4: EN 60747 option

TP1: Tape type

F: [[G]]/RoHS COMPATIBLE (Note 2)

Note 1: Use TOSHIBA standard type number for safety standard application.

e.g., TLP223GA(D4TP1,F → TLP223GA

Note 2: Please contact your Toshiba sales representative for details on environmental information such as the product's RoHS compatibility.

RoHS is the Directive 2011/65/EU of the European Parliament and of the Council of 8 June 2011 on the restriction of the use of certain hazardous substances in electrical and electronic equipment.

Description		Symbol	Rating	Unit
Application classification for rated mains voltage ≤ 300 Vrms for rated mains voltage ≤ 600 Vrms			I-IV I-III	—
Climatic classification			40 / 110 / 21	—
Pollution degree			2	—
Maximum operating insulation voltage	TLPxxxx type	V _{IORM}	890	V _{peak}
	TLPxxxxF type		1130	
Input to output test voltage, Method A V _{pr} = 1.6 × V _{IORM} , type and sample test t _p = 10 s, partial discharge < 5 pC	TLPxxxx type	V _{pr}	1424	V _{peak}
	TLPxxxxF type		1808	
Input to output test voltage, Method B V _{pr} = 1.875 × V _{IORM} , 100% production test t _p = 1 s, partial discharge < 5 pC	TLPxxxx type	V _{pr}	1670	V _{peak}
	TLPxxxxF type		2120	
Highest permissible overvoltage (transient overvoltage, t _{pr} = 60 s)		V _{TR}	8000	V _{peak}
Safety limiting values (max. permissible ratings in case of fault, also refer to thermal derating curve) current (input current I _F , P _{so} = 0) power (output or total power dissipation) temperature		I _{si} P _{so} T _s	400 700 150	mA mW °C
Insulation resistance	V _{IO} = 500 V, T _a = 25 °C V _{IO} = 500 V, T _a = 100 °C V _{IO} = 500 V, T _a = T _s	R _{si}	≥ 10 ¹² ≥ 10 ¹¹ ≥ 10 ⁹	Ω

Fig. 17.1 EN 60747 Insulation Characteristics

Table Insulation Related Specifications (Note)

Insulation Related Parameters	Symbol	TLP223GA	TLP223GAF
Minimum creepage distance	Cr	7.0 mm	8.0 mm
Minimum clearance	Cl	7.0 mm	8.0 mm
Minimum insulation thickness	ti	0.4 mm	0.4 mm
Comparative tracking index	CTI	175	175

Note: If a printed circuit is incorporated, the creepage distance and clearance may be reduced below this value. (e.g., at a standard distance between soldering eye centers of 7.5 mm). If this is not permissible, the user shall take suitable measures.

Note: This photocoupler is suitable for **safe electrical isolation** only within the safety limit data. Maintenance of the safety data shall be ensured by means of protective circuits.



Fig. 17.2 Marking on Packing

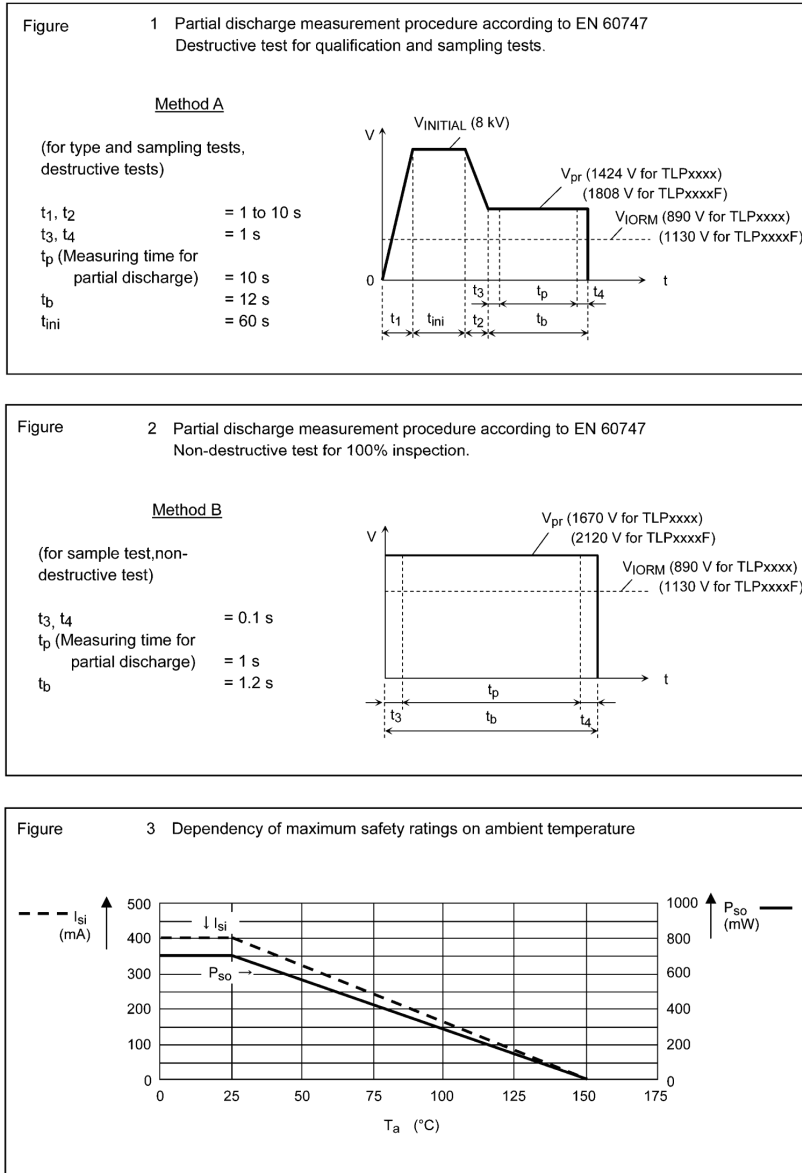


Fig. 17.3 Measurement Procedure

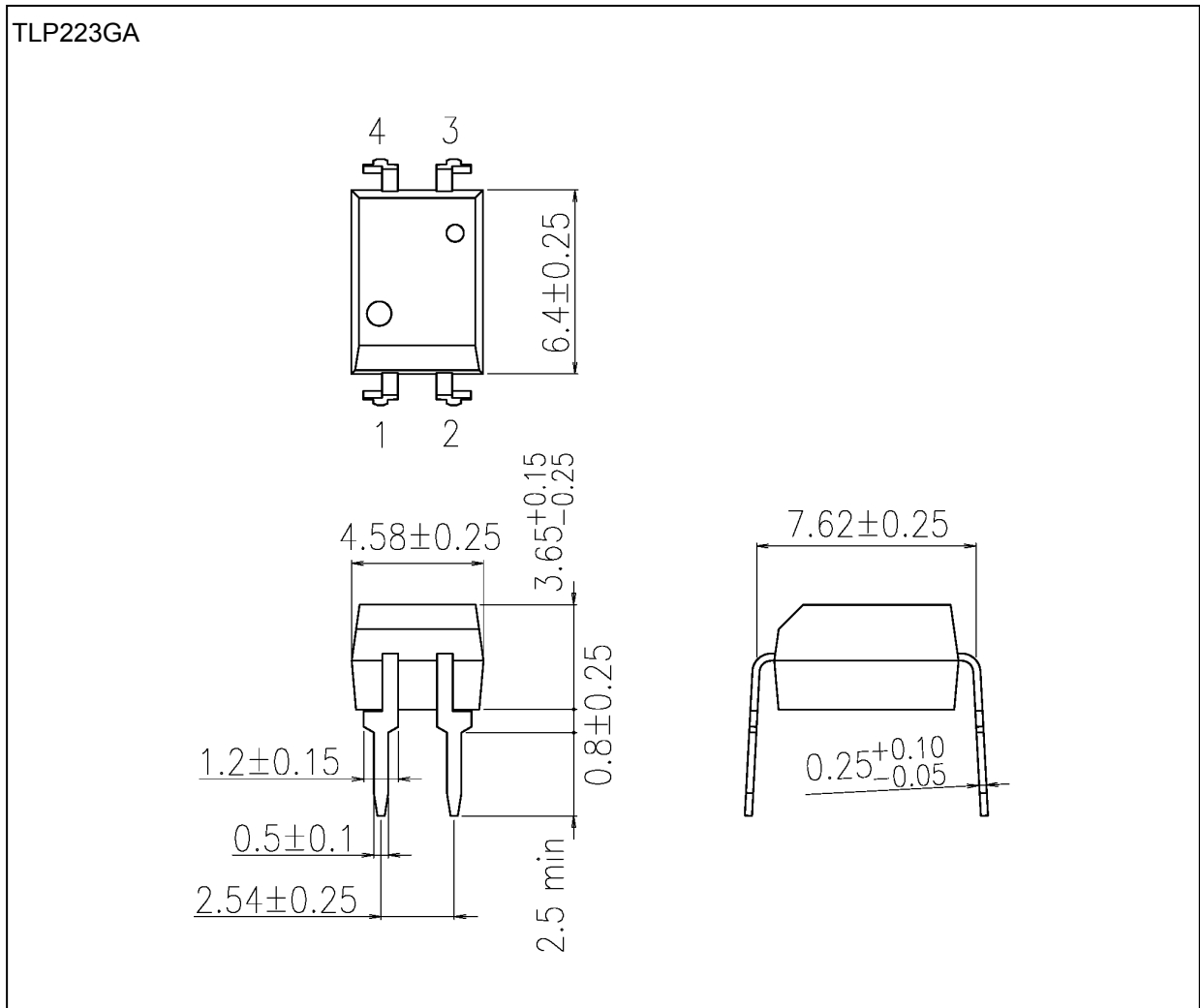
18. Ordering Information (Example of Item Name)

Item Name	Packaging (Note 1)	VDE Option	Packing (MOQ)
TLP223GA(F)	TH		Magazine (100 pcs)
TLP223GA(LF1,F)	LF1		Magazine (100 pcs)
TLP223GA(LF5,F)	LF5		Magazine (100 pcs)
TLP223GA(TP1,F)	LF1		Tape and reel (1500 pcs)
TLP223GA(TP5,F)	LF5		Tape and reel (1500 pcs)
TLP223GA(D4,F)	TH	EN 60747-5-5	Magazine (100 pcs)
TLP223GA(D4LF1,F)	LF1	EN 60747-5-5	Magazine (100 pcs)
TLP223GA(D4LF5,F)	LF5	EN 60747-5-5	Magazine (100 pcs)
TLP223GA(D4TP1,F)	LF1	EN 60747-5-5	Tape and reel (1500 pcs)
TLP223GA(D4TP5,F)	LF5	EN 60747-5-5	Tape and reel (1500 pcs)
TLP223GAF(F)	TH, Wide forming		Magazine (100 pcs)
TLP223GAF(LF4,F)	LF4, Wide forming		Magazine (100 pcs)
TLP223GAF(TP4,F)	LF4, Wide forming		Tape and reel (1000 pcs)
TLP223GAF(D4,F)	TH, Wide forming	EN 60747-5-5	Magazine (100 pcs)
TLP223GAF(D4LF4F)	LF4, Wide forming	EN 60747-5-5	Magazine (100 pcs)
TLP230GAF(D4TP4F)	LF4, Wide forming	EN 60747-5-5	Tape and reel (1000 pcs)

Note 1: TH: Through-hole, LF: Lead forming for surface mount

Package Dimensions

Unit: mm

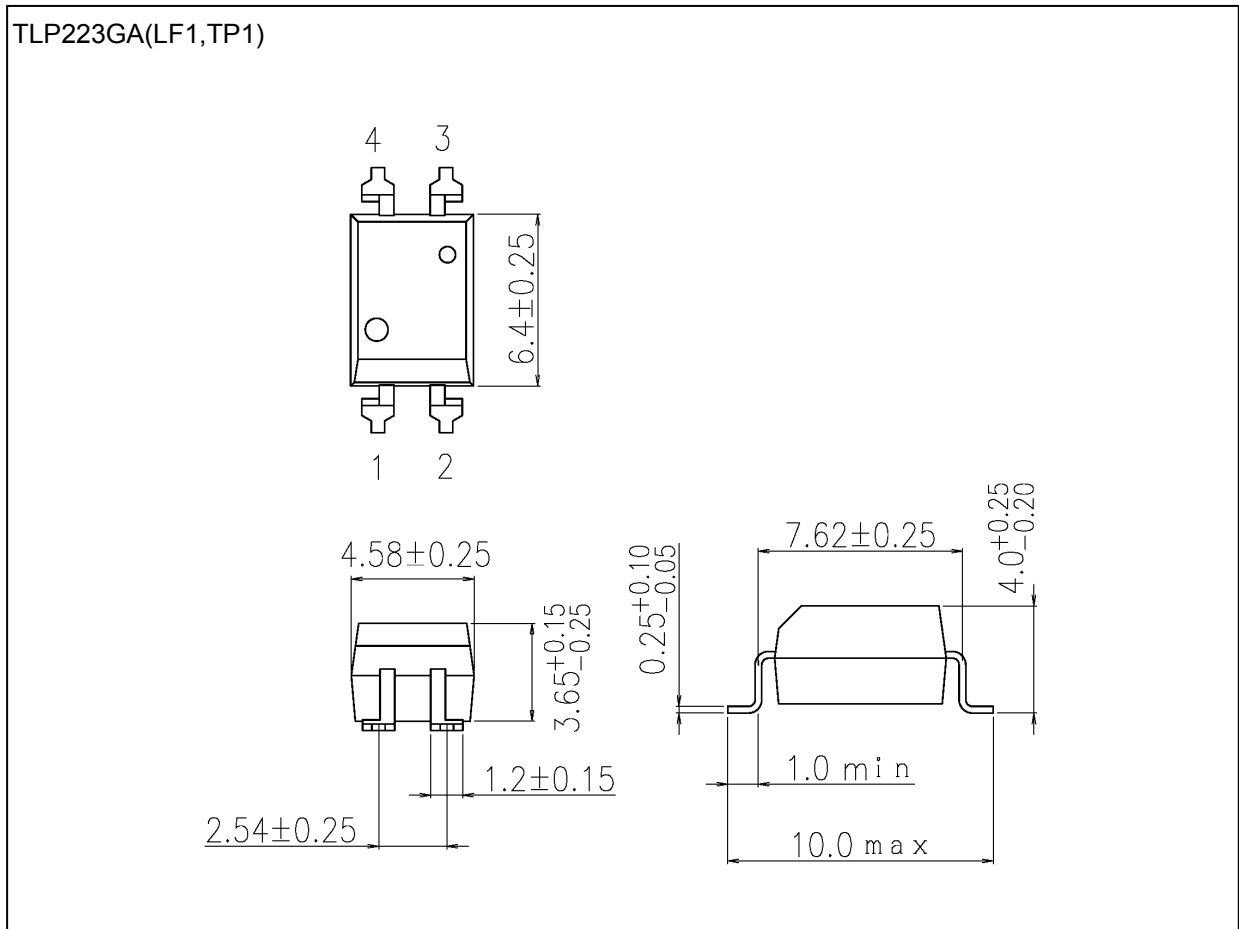


Weight: 0.26 g (typ.)

Package Name(s)
TOSHIBA: 11-5B2S

Package Dimensions

Unit: mm

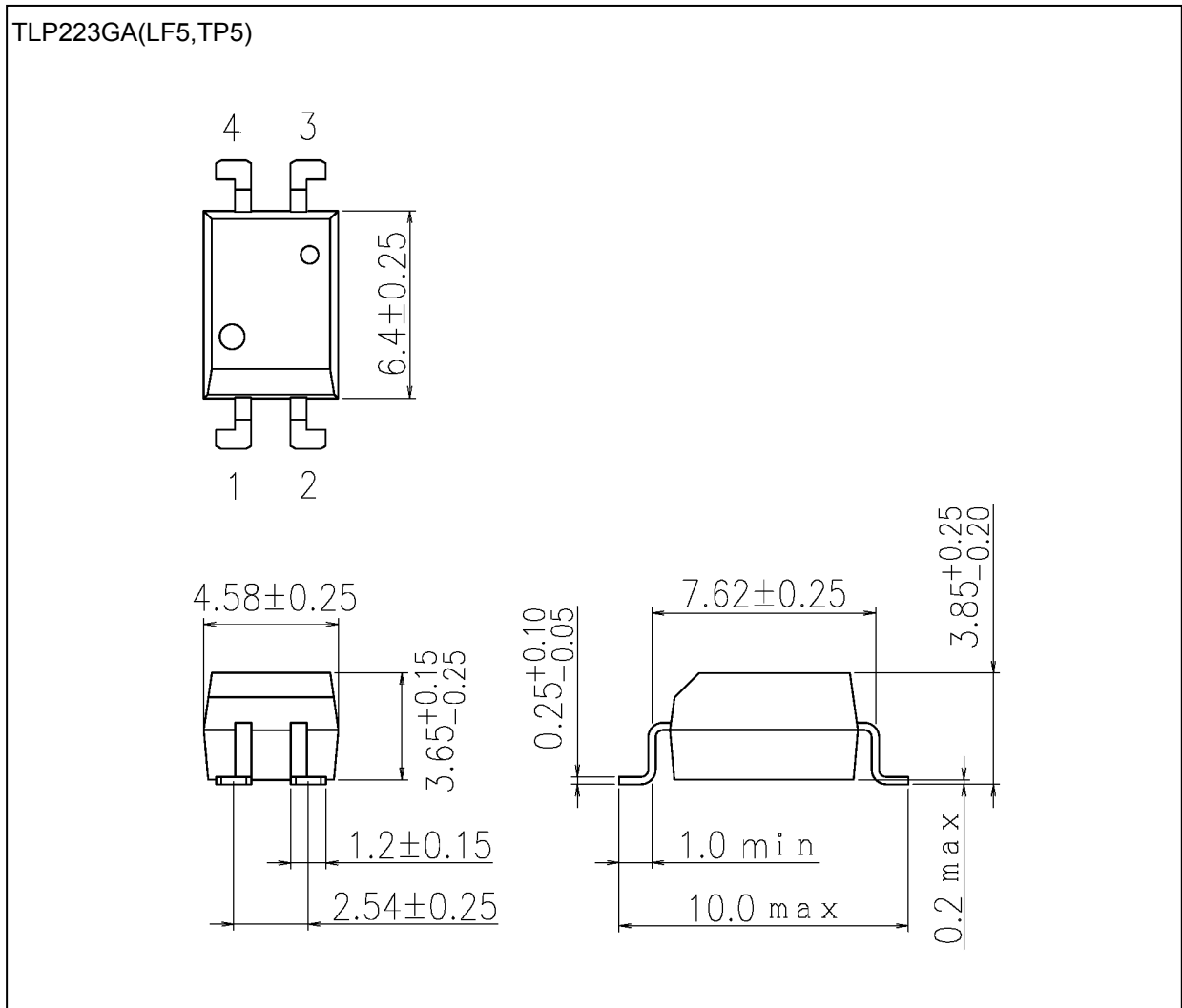


Weight: 0.25 g (typ.)

Package Name(s)
TOSHIBA: 11-5B201S

Package Dimensions

Unit: mm

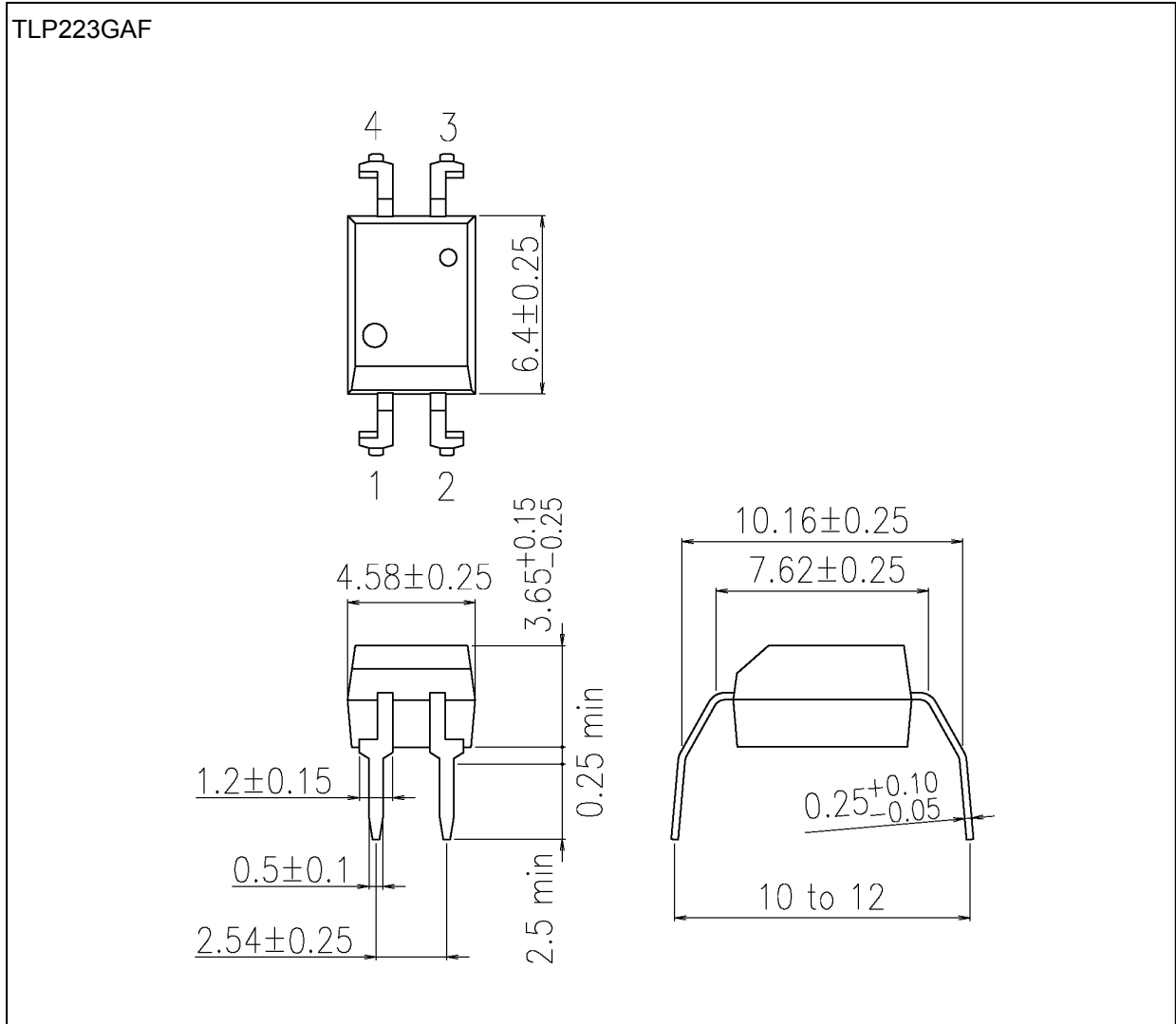


Weight: 0.25 g (typ.)

Package Name(s)
TOSHIBA: 11-5B205S

Package Dimensions

Unit: mm

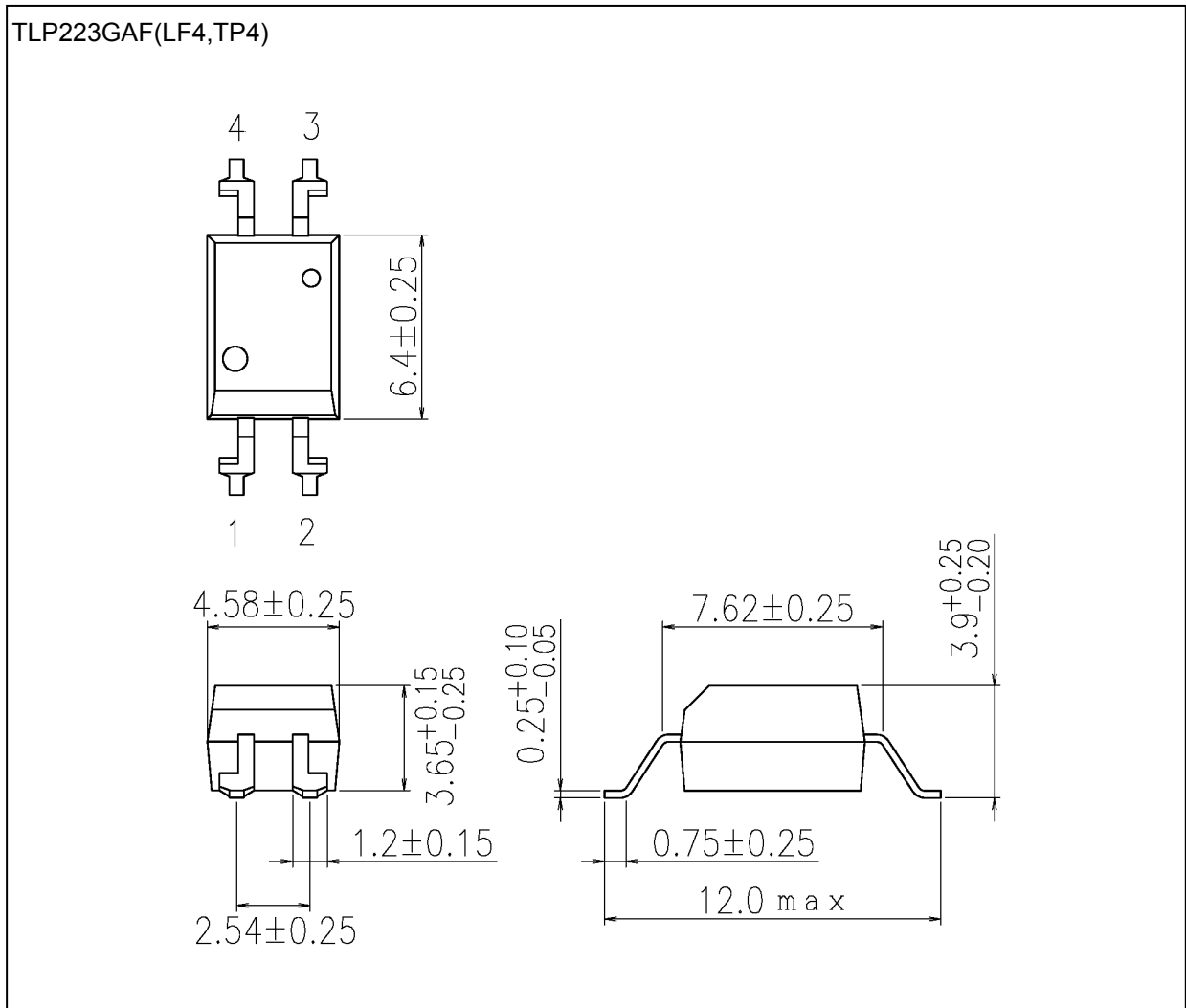


Weight: 0.26 g (typ.)

Package Name(s)
TOSHIBA: 11-5B202S

Package Dimensions

Unit: mm



Weight: 0.25 g (typ.)

Package Name(s)
TOSHIBA: 11-5B204S

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