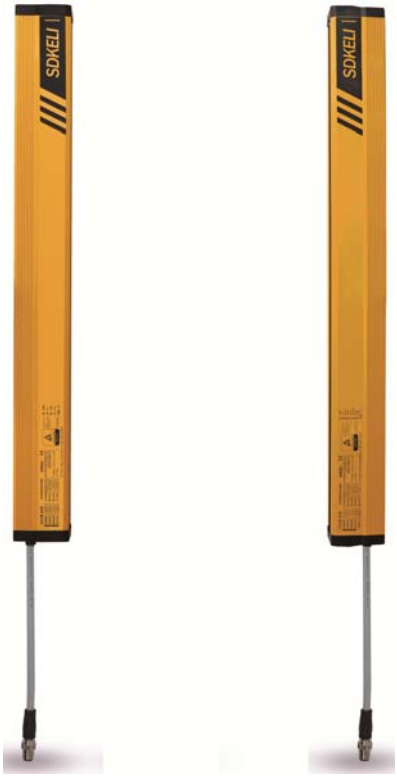
SDKELI®

CT4 Safety Light Curtain

（Type 4）

Operation Manual



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Jining KeLi Photoelectronic Industrial Co., Ltd.

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Ⅰ · Legislation and standards

(1) CT4 series light curtain complies with the following legislations and standards:

- EU legislations
  Machinery Directive 2006/42/EC
  EMC Directive 2014/30/EU
- European Standards
  EN 61496-1:2013 (Type 4 ESPE)
  EN 61496-2:2013 (Type 4 AOPD)
  EN ISO 13849-1:2015 (Category 4、PL e)
  EN 61326-1:2013
- International Standards
  IEC 61496-1:2012 (Type 4 ESPE),
  IEC 61496-2:2013 (Type 4 AOPD)
  IEC 61326-1
  ISO 13855

(2) CT4 light curtain received the following approvals from TÜV SÜD:

- EC Type-Examination in accordance with the EU Machinery Directive
  Type 4 ESPE (IEC 61496-1)
  Type 4 AOPD (IEC 61496-2)
- EMC Competent Body Certificate(Test using MW power supply: RS-35-24)
- TÜV type approval
  Type 4 ESPE (IEC 61496-1)
  Type 4 AOPD (IEC 61496-2)
  Category 4（EN ISO 13849-1/-2）
  PL e（EN ISO 13849-1/-2）

(3) CT4 light curtain is designed according to the standards listed below :

- EN/IEC 61508
- EN/IEC 61010-1
- EN 60204-1
- EN 60529
- 2014/35/EU (Low voltage directive)

Ⅱ · User instructions

Read this manual thoroughly and confirm the product from the appearance before installing, operating and maintaining CT4 light curtain. Please contact us if you have any questions or comments.

(1) Quality Assurance

The quality guarantee period of CT4 light curtain is 12 months.

KELI makes no warranty or representation, express or implied, regarding non-infringement, merchantability, or fitness for particular purpose of the products. Any buyer or user acknowledges that the buyer or user alone has determined that the products will suitably meet the requirements of their intended use. KELI disclaims all other

warranty, express or implied.

(2) Limitations of Liability

KELI shall not be responsible for special, indirect, or consequential damages, loss of profits or commercial loss in any way connected with the products, whether such claim is based on contract, warranty, negligence, or strict liability.

In no event shall responsibility of KELI for any act exceed the individual price of the product on which liability is asserted.

In no event shall KELI be responsible for warranty, repair, or other claims regarding the products unless KELI's analysis confirms that the products were properly handled, stored, installed, and maintained and not subject to contamination, abuse, misuse, or inappropriate modification or repair.

(3) Precautions for Use

If you do not use the product specifications as specified in this manual, or modify the product without authorization, the company will not guarantee the function and performance of the product.

At the customer's request, KELI will provide applicable third party certification documents. But the third party certification documents are not sufficient to fully explain the applicability of CT4 grating to the product, machine or system.

The following are some examples of applications for which particular attention must be given.

Outdoor use, uses involving potential chemical contamination or electrical interference, or conditions or uses not described in this document.

Nuclear energy control systems, combustion systems, railroad systems, aviation systems, medical equipments, amusement machines, vehicles, and installations subject to separate industry or government regulations.

Systems, machines, and equipments that could present a risk to life or property.

Please learn about all application restrictions for CT4 light curtain.

Never use CT4 light curtain in applications that may pose a serious risk to life or property and can not guarantee the security of the entire system.

After the product is scrapped, it should be disposed of as industrial waste. When disposing of it, be sure to follow the requirements and rules, regulations, and laws of industrial wastes in the country or region where the product is located.

(4) Performance

Performance data given in this document is provided as a guide for the user in determining suitability and does not constitute a warranty. It may represent the result of KELI's test conditions, and the users must correlate it to actual application requirements.

(5) Change in Specifications

Product specifications and accessories may be changed at any time based on improvements and other reasons.

When the product's rating, performance, or structure changes, the product's specifications will change accordingly. For the change of product specifications, our company will not notify, if in doubt, please contact us.

(6) Errors and Omissions

The contents of the manual have been made as accurate and complete as possible, but there is no guarantee that there are no errors or omissions in this manual.The Company shall not be responsible for any errors or omissions that may have occurred in this

specification.

(7) Copyright and Copy Permission

This document shall not be copied for sales or promotions without permission.

This document is protected by copyright and is intended solely for use in conjunction with CT4 light curtain. Please notify us before copying or reproducing this document in any manner, for any other purpose. If copying or transmitting this document to another, please copy or transmit it in its entirety.

Ⅲ. Precautions on safety

The following special information may appear at any place in the manual or on CT4 light curtain, as a warning of potential risk or promotion of special attention to information about clarifying or simplifying certain procedures.

This is the safety alert symbol. It is used to alert you to potential personal injury hazards. Obey all safety messages that follow this symbol to avoid possible injury or death.

! WARNING

WARNNING indicates an actual or potential risk or health hazard. They are designed to help you to prevent accidents. Read carefully and follow the warnings!

! CAUTION

CAUTION indicates the key information which, if not avoided, can result in expected legal dispute, or equipment damage.
Read carefully and follow the cautions!

Ⅳ. Precautions for safe use

Make sure to observe the following precautions that are necessary for ensuring safe use of the product.

(1) Thoroughly read this manual and understand the installation procedures, operation check procedures, and maintenance procedures before using the product.

(2) CT4 light curtain should only be installed, checked, and maintained by a qualified person.

(3) A qualified person is defined as “a person or persons who, by possession of a recognized degree or certificate of professional training, or who, by extensive knowledge, training and experience, has successfully demonstrated the ability to solve problems relating to the subject matter and work” .

(4) OSSDs must satisfy the following conditions:

Not short-circuited with 24V.

Not short-circuited with active signal.

OSSDs output should not exceed the rating.

(5) Do not drop the product.

(6) Dispose of the product in accordance with the relevant rules and regulations of the country or area where the product is used.

Ⅴ. Meaning of symbols

 Symbol of emitter in this operation manual

 Symbol of receiver in this operation manual

Section1 Product description

1.1. System components

CT4 safety light curtain is composed of an emitter, a receiver and two transmission cables, as shown in Figure 1.1. The system works with 24V DC power supply, and supplies two channels of PNP output, EDM function, one channel of auxiliary output (unsafe), and state indicating function. The detection range is 8m and 15m. The detection capability is 14mm, 30mm and 46mm. The detection height is 232mm to 1672mm with the extension accuracy of 120mm, refer to 1.7.

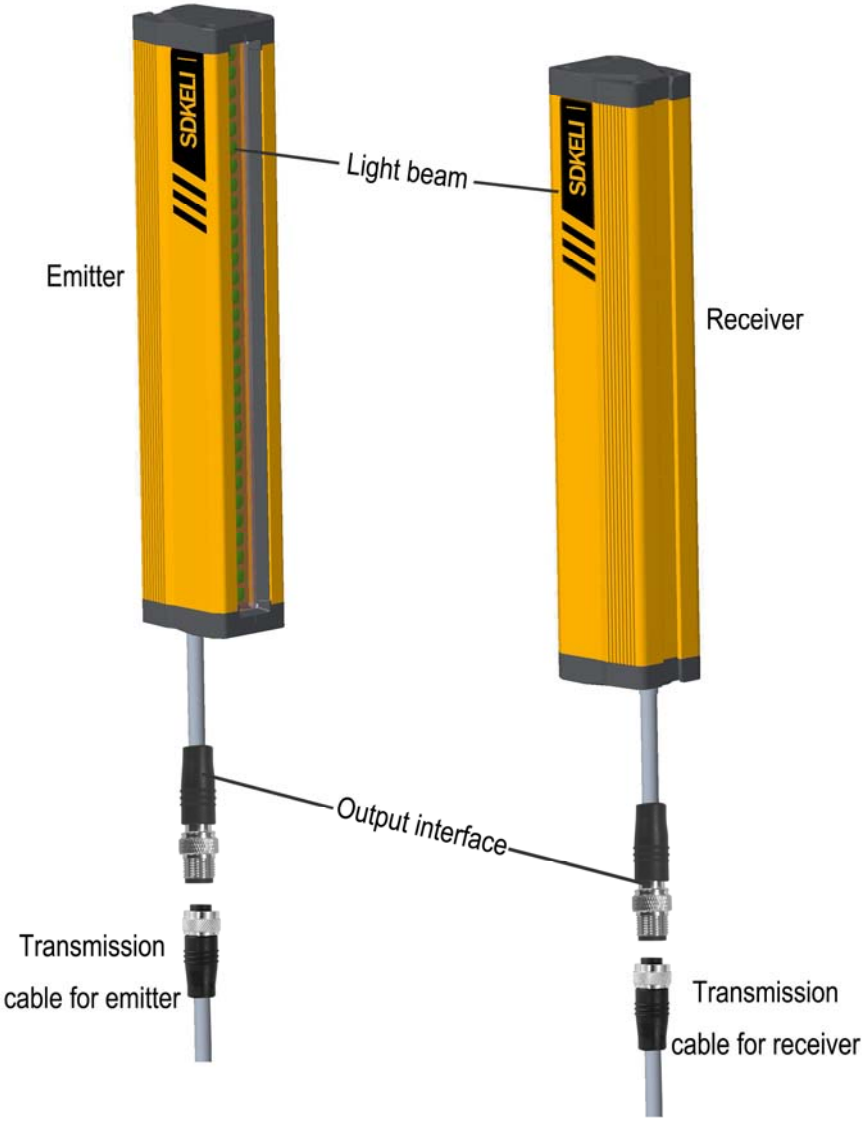
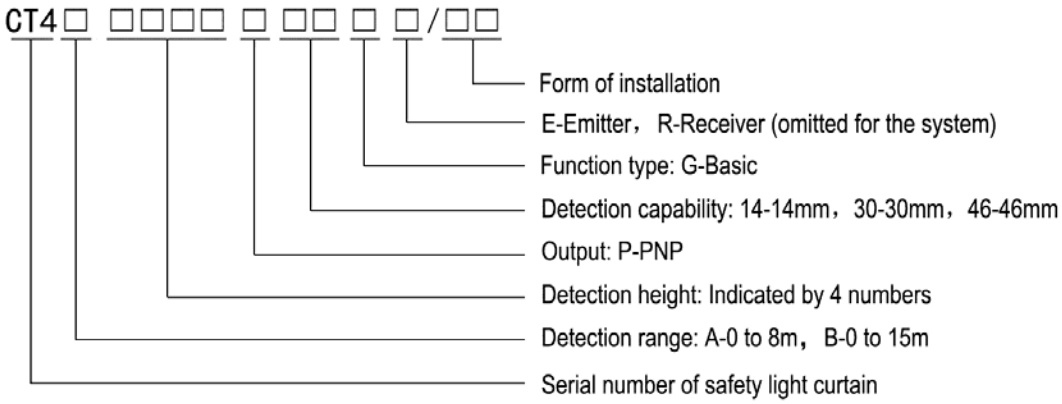


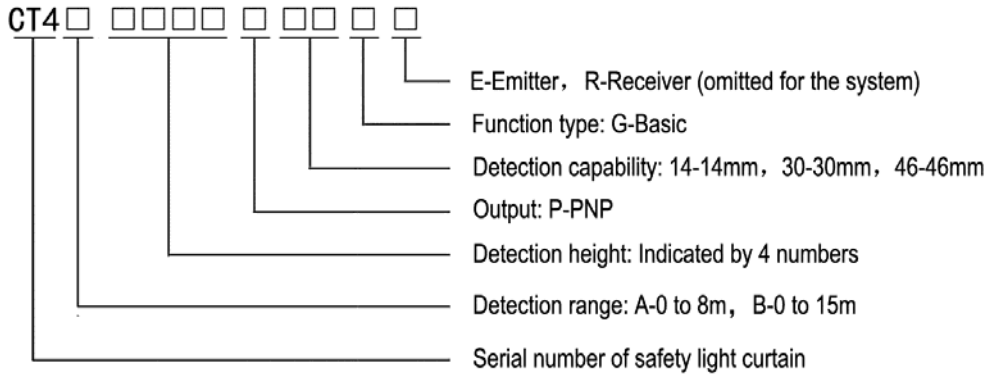
Fig 1.1 Composition of CT4 System

1.2. Specifications

1.2.1 System specification



1.2.2 Emitter / receiver specification



1.2.3 Transmission cable specification

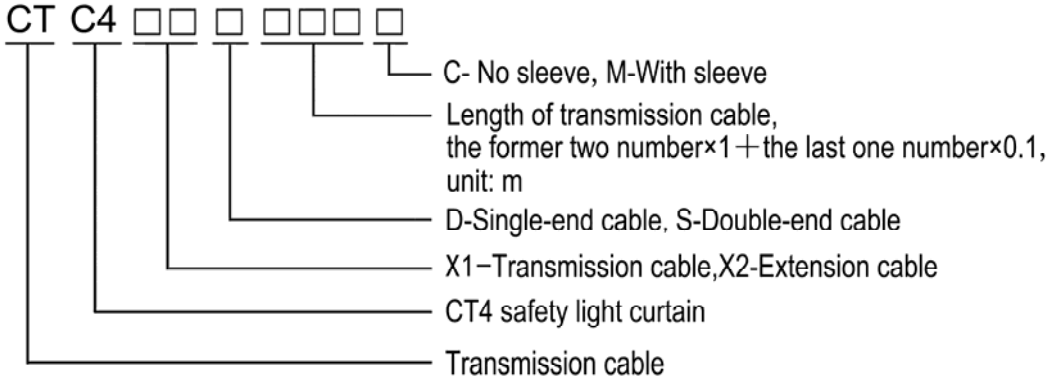


Table 1.2 Code of bracket installation

NO.	Form	Code
1	ZC mounting	ZC
2	Pipe mounting	GC
3	Double-arm side mounting- T-groove	SCT
4	T-groove mounting	TC
5	Scatter shield ZC mounting	FZC
6	Scatter shield pipe mounting	GF
7	Scatter shield double-arm mounting	SF
8	Magnatic attachment mounting	CX
9	Scatter shield column mounting	FL
10	Scatter shield magnet mounting	CF
11	Double-bracket arm mounting	G1
12	Plate support with magnet mounting	ZBC
13	Plate support with bolt mounting	ZBL

1.3. Transmission cables

The transmission cable is made of oil-resistant PVC sheathed 8-core shielded cable. One end is an 8-core M12-hole type plug-in connected to the sensor. The other end of each core is stripped from the wire and then connected to the device.

The standard length: series A is 3m or 10m and series B is 5m or 20m.

Connections of transmission cables are shown in Fig 1.3.

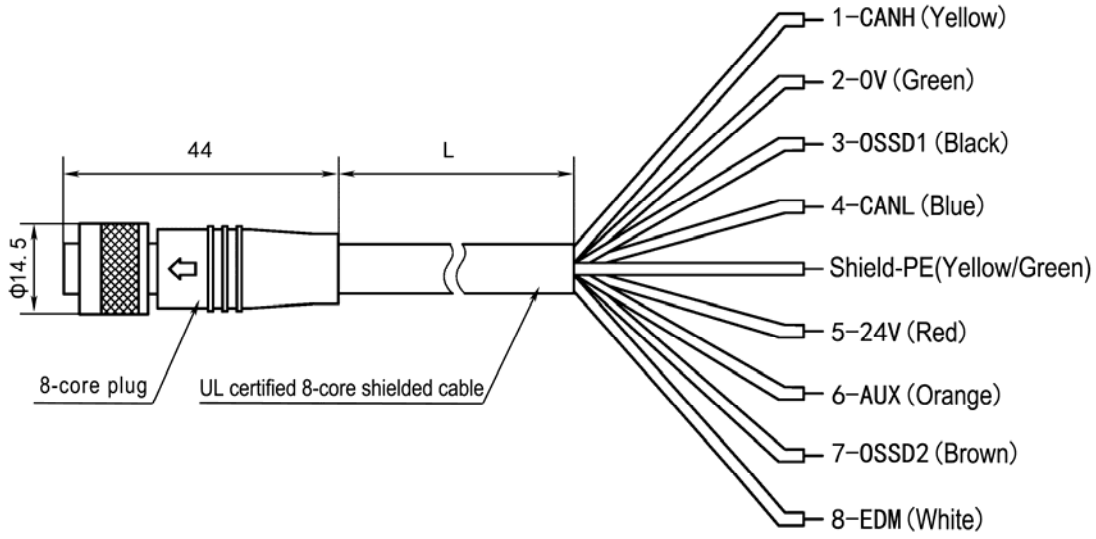


Fig 1.3 Schematic Diagram of Connection Points of CT4 Secure Grating Transmission Cable

If the standard transmission cable can not meet the requirements of the use, the extension cable can be used to increase the length of transmission cable. Extension cable is the 8-core shield cable, with the hole seat at one end and the pin seat at the other end. The standard length of extension cable is 5m, 10m and 20m. Cable specifications are shown in Table 1.3:

Table 1.3 List of Specifications for CT4 Safety Grating Cables

Name	Specifications	Unit	Single/double terminal	Cable specifications	length
CT4 transmission cable – single terminal 3 m	CTC4X1D030C	Pcs	single	UL2464(8×22AWG)	3m
CT4 transmission cable - single terminal 5 m	CTC4X1D050C	Pcs	single	UL2464(8×22AWG)	5m
CT4 transmission cable - single terminal 10 m	CTC4X1D100C	Pcs	single	UL2464(8×22AWG)	10m
CT4 transmission cable - single terminal 20 m	CTC4X1D200C	Pcs	single	UL2464(8×22AWG)	20m
CT4 Transmission Cable Extension Line - Dual Terminal 5 m	CTC4X2S050C	Pcs	double	UL2464(8×22AWG)	5m
CT4 Transmission Cable Extension Line - Dual Terminal 10 m	CTC4X2S100C	Pcs	double	UL2464(8×22AWG)	10m
CT4 Transmission Cable Extension Line - Dual Terminal 20 m	CTC4X2S200C	Pcs	double	UL2464(8×22AWG)	20m

1.4. Applications

To be protected by CT4 safety light curtain, the detected object must meet the following conditions:

(1) CT4 light curtain can only detect objects which intrude into the detection zone. Detection zone is the rectangular area between the emitter and the receiver, formed by protective height and operating range.

(2) CT4 light curtain cannot detect transparent and/or translucent objects.

(3) The size of the guarded object must not be less than the detection capability. Detection capability is the sensing function parameter limit specified by the supplier that will cause actuation of the system. The detection capability of CT4 light curtain is 14mm, 30mm and 46mm. The users must verify the detection capability through the test rod before using the light curtain.

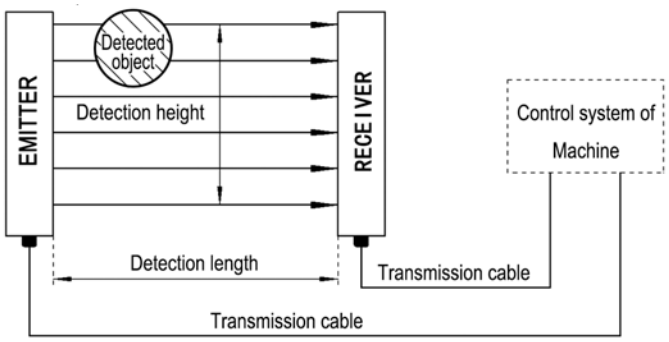


Fig 1.4 Operation schematic diagram

- The guarded machine must be able to stop any where in its cycle, and can only achieve the upper dead point protection for rigid equipment.
- The guarded machine must not present a hazard from flying parts.
- The guarded machine must have a consistent stopping time and adequate control mechanisms.
- All applicable governmental and local rules, codes, and regulations must be satisfied. This is the user's and employer's responsibility.
- All safety-related machine control elements must be designed so that an alarm in the control logic or failure of the control circuit does not lead to failure to danger.
- Do not use radio equipment such as cellular phones, walkie-talkies, or transceivers near CT4 light curtain.
- Do not use CT4 light curtain in the following types of environments:
  Areas with heavy smoke, particulate matter, and corrosives;
  Areas exposed to intense interference light, such as direct sunlight;
  Areas with high humidity where condensation is likely to occur;
  Areas exposed to vibration or shock levels higher than in the specification provisions;
  Areas where the product may come into contact with water;
  Areas where the product may get wet with oil that can solve adhesive;
  Environments where flammable or explosive gases are present.

! WARNING

Install a protective structure so that the hazardous part of a machine can only be reached by passing through the sensor's detection zone.

1.5. Appearance

CT4 safety light curtain is composed of emitter and receiver, as shown in Fig 1.5.

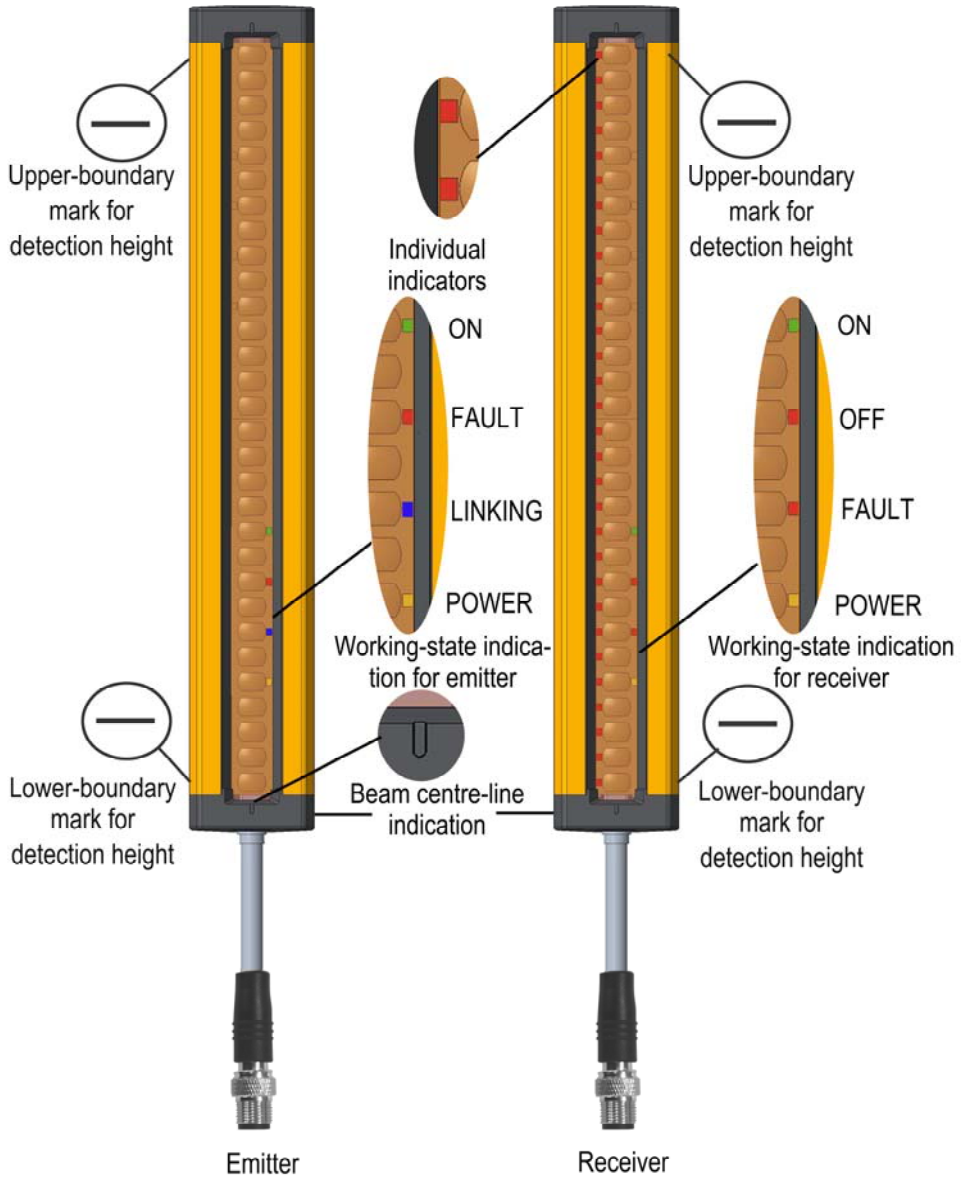


Fig 1.5 Appearance Information of CT4 Safety Grating

Table 1.5 List of indicator light information description

Light curtain	LED indicator	Color	Description
Emitter	POWER	Yellow	Power light, turns on while the power of emitter is on.
	LINK	Blue	Link light, turns on while there is communication between emitter and receiver.
	FAULT	Red	Fault light, turns on when the system self-test and the emitter is in fault state or the communication is wrong.
	ON	Green	On light, turns on when the OSSDs output ON-state, and the guarded machine works.
Receiver	POWER	Yellow	Power light, turns on while the power is on.
	ON	Green	On light, turns on when the OSSDs output ON-state. The guarded machine works.
	OFF	Red	Off light, turns on when the OSSDs output OFF-state and the guarded machine can't work.
	FAULT	Red	Fault light, turns on when the system is in fault state. The OSSDs output OFF-state and the guarded machine can't work, When the EDM fault, communication fault, OSSD output fault and external light interference. Wiring errors include EDM, link and OSSD wiring errors.
	Diversion instructions	Red	Diversion instructions light, turns on when the detection beam is in a shading state.

1.6. Technical parameters

Pursuant standard			
Executed standards	EN 61496-1:2013 (Type 4 ESPE) EN 61496-2:2013 (Type 4 AOPD) EN ISO 13849-1:2015 (Category 4、PL e) EN 61326-1:2013 IEC 61496-1:2012 (Type 4 ESPE), IEC 61496-2:2013 (Type 4 AOPD) IEC 61326-1 ISO 13855		
Related standards	2014/35/EU (Low Voltage Directive) EN/IEC 61508 EN/IEC 61010-1 EN 60204-1 EN/IEC 62061		
Safety class			
Safety level	Type 4 Category 4 PL e		
DCavg	99%		
CCF	100		
$MTTF_D$ /PFH_D	See 1.7 Parameter table		
Optical characteristics			
Detection capability (Opaque objects)	14mm	30mm	46mm
Operating range	Type A: 0 to 8m; Type B: 0 to 15m		
Protection height	232 to 1672mm (Refer to 1.7)		
Effective aperture angle (EAA)	Within ±2.5° for the emitter and receiver at a detection distance of at least 3m according to IEC61496-2		
Light source	Infrared LED (850nm wavelength)		
Environment			
Ambient temperature	Operation	-10℃ to 55℃ (non-condensing)	
	Storage	-30 ℃to 70℃	
Ambient humidity	Operation	35% RH to 85%RH	
	Storage	35% RH to 95%RH	
Resistance to light interference	Incandescent lamp	3000 Lux	
	Fluorescent lamp	3000 Lux	
	Sunlight	10000 Lux	

Homologous optical interference	There shall be no failure to danger of CT4 by light interference from the emitting elements of an AOPD of identical design.	
Enclosure rating		IP65/IP67
Vibration resistance		IEC 61496-1: 10 to 55Hz frequency range, 1 octave/min. sweep rate, 0.35mm + 0.05 amplitude, 20 sweeps per axis
Shock resistance		IEC61496-1: 10g, 16 ms duration, 1000 bumps for each axis (applies to all 3 axes)
Materials	Enclosure	Extruded aluminum
	End caps	Black nylon, glass reinforced
	Optical window	Poly methyl meth acrylic (PMMA)
	Transmission cable	RVVP
Electrical characteristics		
Supply voltage		24V DC±20% (ripple p-p5% max.)
Current consumption (no load)	Emitter	＜200 mA
	Receiver	＜200 mA
Response time		6 ms to 79 ms (Refer to 1.7)
Safety outputs (OSSD)		PNP transistor outputs×2, In ON-state, the load current ≤ 300mA, the output voltage ≥ Vcc-2V In OFF-state, the leakage current≤1mA, the residual voltage ≤ 1V(excluding the effect of wire extension) Capacitive load: 0.9 uF Inductive load: 2H at 4Hz, increase when frequency decreases
Max. length of transmission cable	Emitter	50m
	Receiver	50m
Startup waiting time		＜1s
Test function		Self-test (After power ON, and during operation)
Protection circuit		Overvoltage and overcurrent protection Output short-circuit protection
Mutual interference prevention function		Interference light avoidance algorithm
Auxiliary function		
Auxiliary output (AUX)		Unsafe output, one channel of PNP output, opposites to the OSSDs Shading state: output current≤300mA, output voltage≥Vcc-2V Light passing state: output current＜2mA , output voltage＜2V
External device monitoring (EDM)		EDM is used to monitor the NC contact of the external relay or contactor Input voltage of ON state: 0V to 7V or open circuit

	Input voltage of OFF state: 9V to 24V
Accessories	
Accessories	Test piece, operation manual, installation accessories, manufacturer certificate, packing list

1.7. Parameter table

Detection capability 14mm

Specification	Protective height H(mm)	No. of beams	Response time (ms)	$MTTF_D$(Year)	PFH_D (1/h)	MTTF (Year)	Dimensions (mm) 52×40×L
CT4□0232P14G	232	30	＜14	282	8.67E-09	45	52×40×264
CT4□0352P14G	352	45	＜19	231	1.08E-08	36	52×40×384
CT4□0472P14G	472	60	＜24	195	1.19E-08	32	52×40×504
CT4□0592P14G	592	75	＜30	169	1.50E-08	29	52×40×624
CT4□0712P14G	712	90	＜35	149	1.61E-08	26	52×40×744
CT4□0832P14G	832	105	＜41	133	1.87E-08	24	52×40×864
CT4□0952P14G	952	120	＜46	120	2.03E-08	22	52×40×984
CT4□1072P14G	1072	135	＜52	110	2.23E-08	21	52×40×1104
CT4□1192P14G	1192	150	＜57	101	2.47E-08	19	52×40×1224
CT4□1312P14G	1312	165	＜62	94	2.74E-08	18	52×40×1344
CT4□1432P14G	1432	180	＜68	87	3.08E-08	17	52×40×1464
CT4□1552P14G	1552	195	＜73	81	3.08E-08	16	52×40×1584
CT4□1672P14G	1672	210	＜79	76	3.41E-08	15	52×40×1704

Note: “□” stands for “A” or “B” (Refer to 1.2).

Detection capability 30mm

Specification	Protective height H(mm)	No. of beams	Response time (ms)	$MTTF_D$(Year)	PFH_D (1/h)	MTTF (Year)	Dimensions (mm) 52×40×L
CT4□0232P30G	232	11	＜7	394	5.94E-09	41	52×40×264
CT4□0352P30G	352	16	＜9	357	6.44E-09	39	52×40×384
CT4□0472P30G	472	21	＜11	326	7.04E-09	37	52×40×504
CT4□0592P30G	592	26	＜12	300	7.76E-09	36	52×40×624
CT4□0712P30G	712	31	＜14	278	8.67E-09	34	52×40×744
CT4□0832P30G	832	36	＜16	259	9.81E-09	33	52×40×864
CT4□0952P30G	952	41	＜18	243	9.81E-09	31	52×40×984
CT4□1072P30G	1072	46	＜20	228	1.08E-08	30	52×40×1104
CT4□1192P30G	1192	51	＜21	215	1.08E-08	29	52×40×1224
CT4□1312P30G	1312	56	＜23	203	1.19E-08	28	52×40×1344
CT4□1432P30G	1432	61	＜25	193	1.19E-08	27	52×40×1464
CT4□1552P30G	1552	66	＜27	184	1.33E-08	26	52×40×1584
CT4□1672P30G	1672	71	＜29	175	1.50E-08	25	52×40×1704

Note: “□” stands for “A” or “B” (Refer to 1.2).

Detection capability 46mm

Specification	Protective height H(mm)	No. of beams	Response time (ms)	$MTTF_D$(Year)	PFH_D (1/h)	MTTF (Year)	Dimensions (mm) 52×40×L
CT4□0232P46G	232	7	＜6	429	5.38E-09	43	52×40×264
CT4□0352P46G	352	10	＜7	402	5.94E-09	41	52×40×384
CT4□0472P46G	472	13	＜8	378	6.44E-09	40	52×40×504
CT4□0592P46G	592	16	＜9	357	6.44E-09	38	52×40×624
CT4□0712P46G	712	19	＜10	338	7.04E-09	37	52×40×744
CT4□0832P46G	832	22	＜11	321	7.04E-09	36	52×40×864
CT4□0952P46G	952	25	＜12	305	7.76E-09	35	52×40×984
CT4□1072P46G	1072	28	＜13	291	7.76E-09	34	52×40×1104
CT4□1192P46G	1192	31	＜14	278	8.67E-09	33	52×40×1224
CT4□1312P46G	1312	34	＜15	266	8.67E-09	32	52×40×1344
CT4□1432P46G	1432	37	＜16	256	9.81E-09	31	52×40×1464
CT4□1552P46G	1552	40	＜17	246	9.81E-09	30	52×40×1584
CT4□1672P46G	1672	43	＜19	237	1.08E-08	29	52×40×1704

Note: "□" stands for "A" or "B" (Refer to 1.2).

1.8. Dimensions of major parts

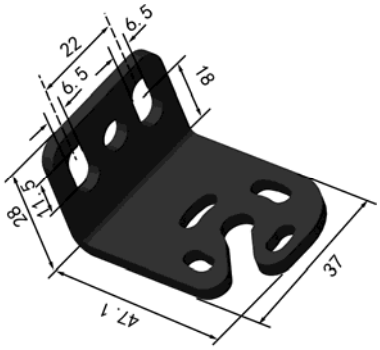


Fig 1.8.1 Mounting Bracket

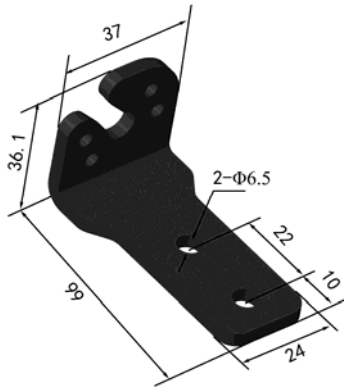


Fig 1.8.2 Rotating Bracket

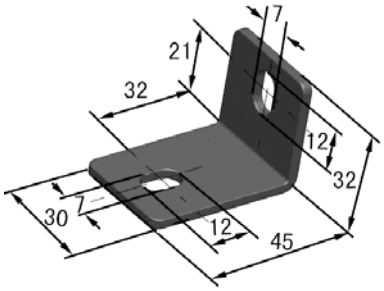


Fig 1.8.3 L-shaped Bent Plate Bracket

1.9. Test pieces

According to the different detection precision of the light curtain, different test pieces are

respectively corresponding.

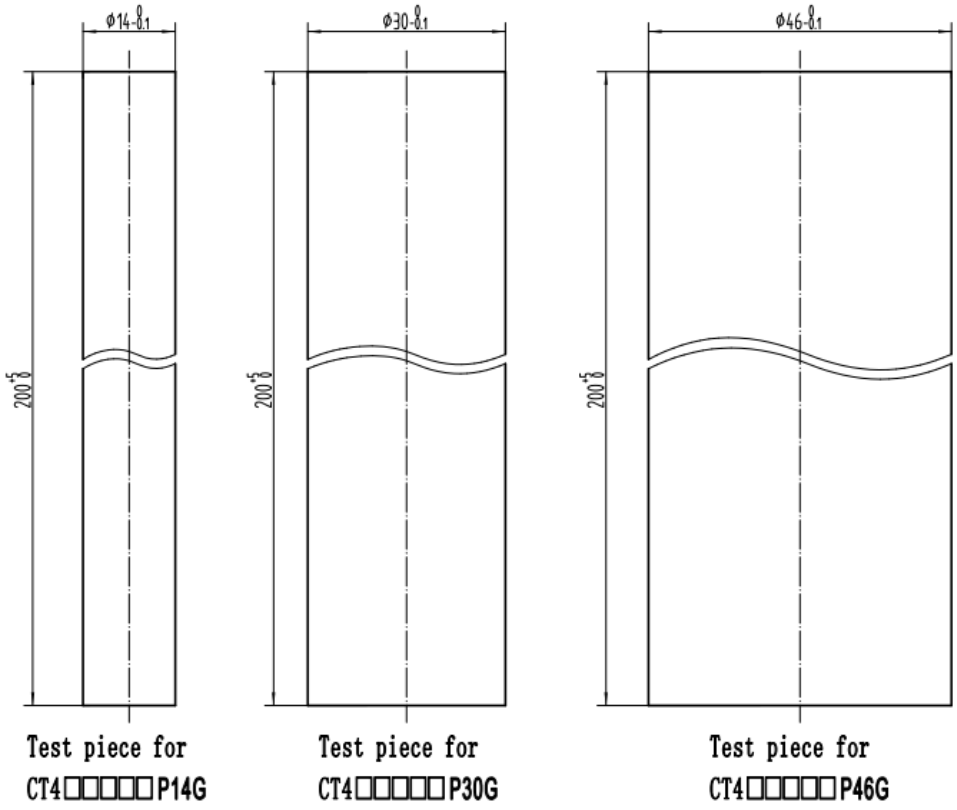


Fig. 1.9.1 Specimen Specification Diagram (Unit: mm)

Test method of the test piece: The axis of the test piece is perpendicular to the center line of the beam, and when the test piece is placed at any position within the protection area of the light curtain, the light curtain is in OFF state; when the test piece is placed outside the protection area of the light curtain, the curtain is in ON state.

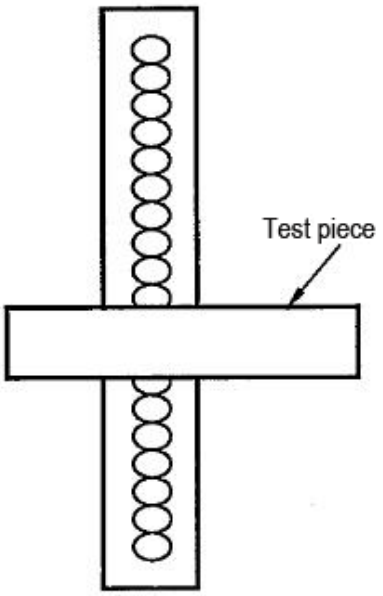


Fig. 1.9.2 Test Method

Section2 Function introduction

2.1. Input / Output interface circuit

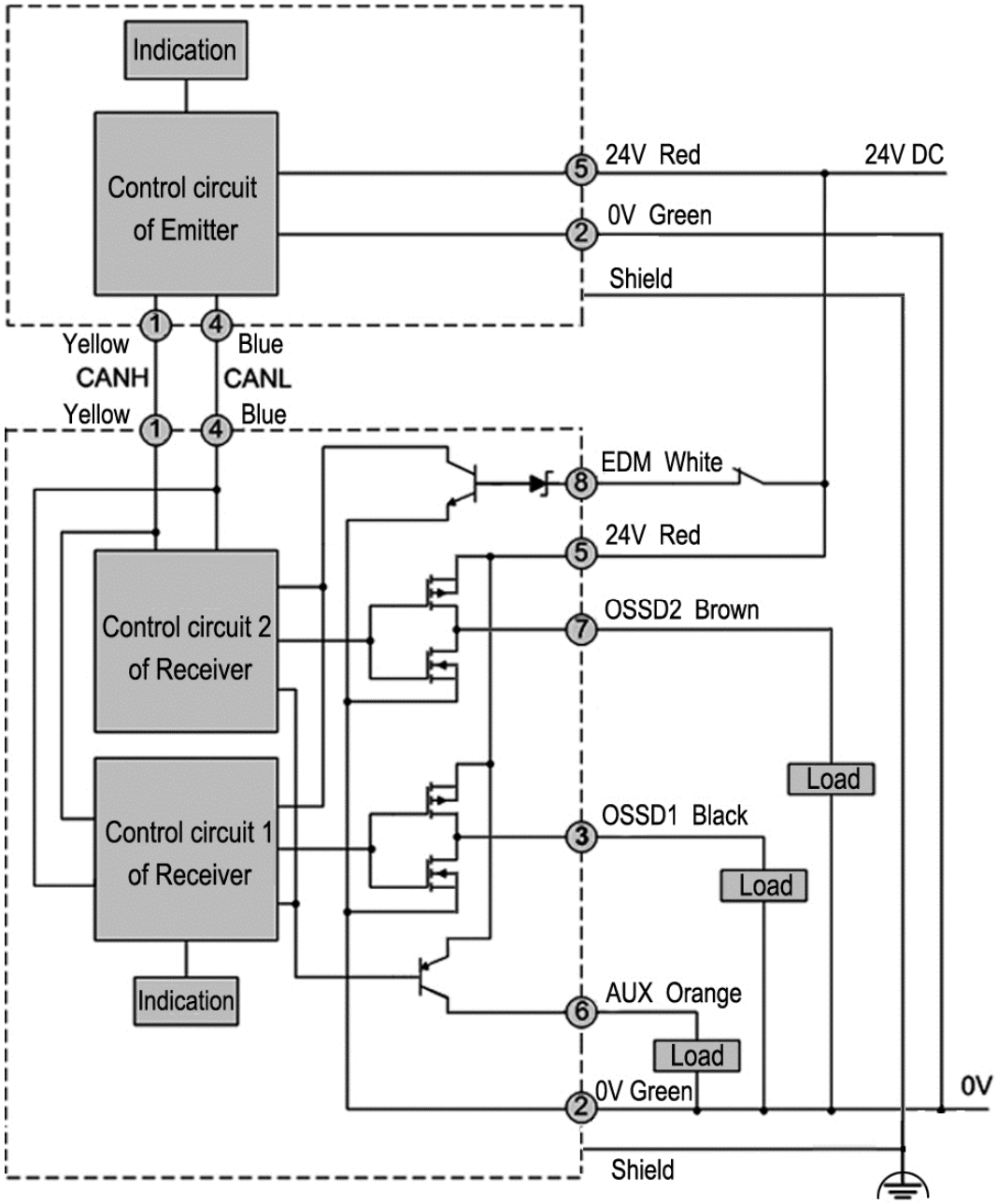


Fig 2.1 Input and Output Interface Circuit Diagram

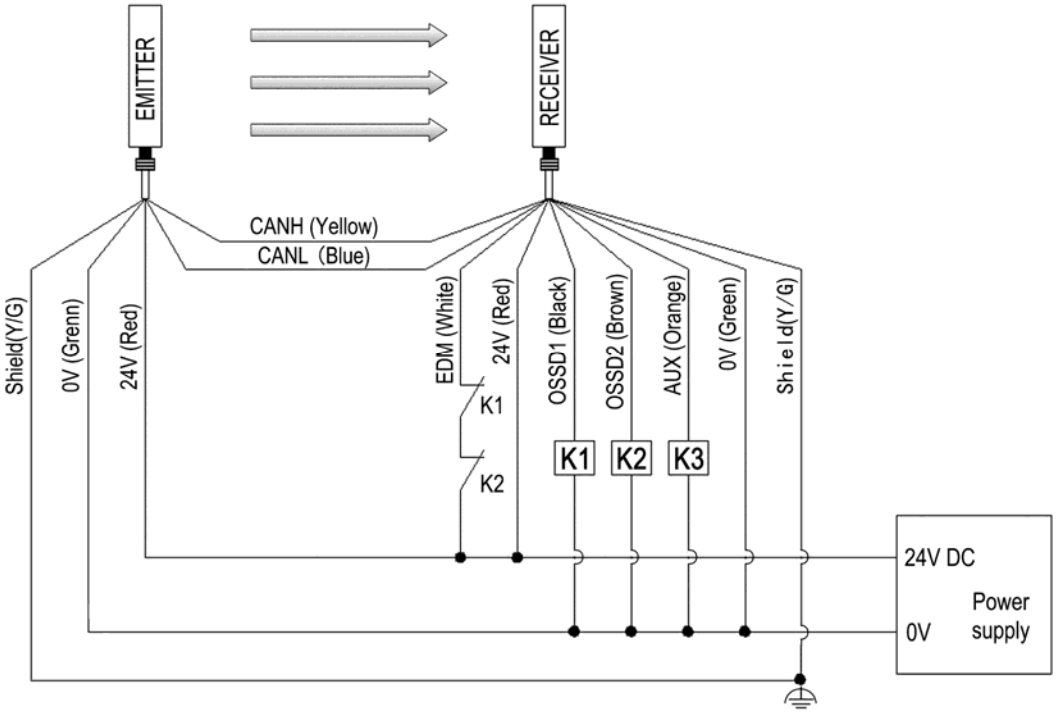
Table 2.1 Signal and wiring introduction:

Signal label	Meaning of signal	Wiring
Red	Anode of input 24V DC	Connect with anode of input 24V DC
Green	Cathode of input 24V DC	Connect with cathode of input 24V DC
Yellow	The CAN communication interface between emitter and receiver	Link CANH respectively between emitter and receiver.
Blue	The CAN communication interface between emitter and receiver	Link CANH respectively between emitter and receiver.
White	Input interface of monitoring of external device	Connect with the NC contact of the external relay and then connect the relay with anode of 24V.
Orange	Auxiliary output interface	Unsafe output, not allowed to be used as safety function.
Black	Controlling output interface	Safe output interface, supplies one channels of safety output
Brown	Controlling output interface	Safe output interface, supplies one channels of safety output

Note 1: The digits in the circle are the core-numbers of the connector.

2.2. Wiring

2.2.1 Wiring when using EDM function

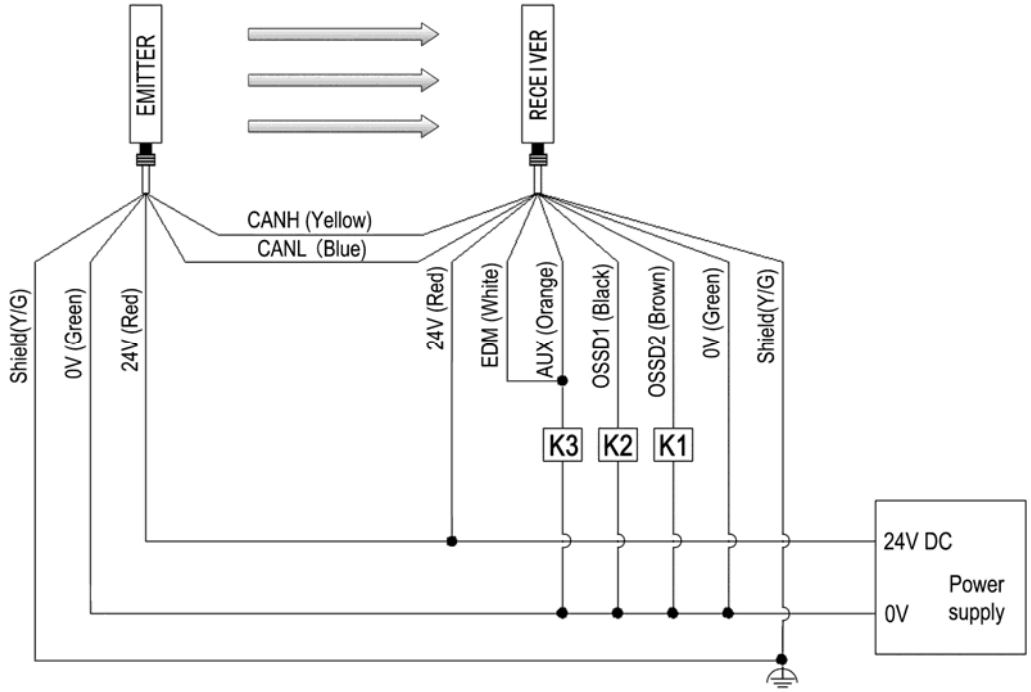


K1、K2：Relay or other device that controls hazardous parts of the machine

K3：Load or PLC, etc. (for monitoring). CT4 can operate even if K3 is not connected.

2.2.2 Wiring when EDM function is not required

The external device monitoring function is disabled by connecting AUX and EDM as shown below:



K1、K2：Relay or other device that controls hazardous parts of the machine

K3：Load or PLC, etc. (for monitoring). CT4 can operate even if K3 is not connected.

For mode setting of auxiliary output, please refer to 2.3.3.

2.3. Function declaration

2.3.1 Self-test function

The CT4 performs the self-test when power is turned ON (within 1 second) to check the function and wiring. Also, it regularly performs the self-test (within the response time) while operating, to avoid to output failure to danger signal.

If an error is found in the self-test, the CT4 enters lockout state, keeps the OSSDs in OFF-state, and indicates the error at the same time. After the error is removed, only though re-power can release the lockout state .

1) Self-Test Details

   The self-test detects the types of errors described below.

   Emitter

   - Broken or short-circuited cable
   - Communication failure
   - Internal circuit failure

   Receiver

   - Abnormal external power supply voltage
   - OSSDs wiring failure
   - EDM wiring failure
   - Communication failure
   - External light influence
   - Internal circuit failure

2) Safety output detect

   - While CT4 light curtain is in light-passing state, OSSDs outputs ON-state signal with periodical OFF-state signal, as shown in Fig 2.3.1. When OSSDs output circuit failure or be shorted with other interface signals, the detect signal varies, and feedback wrong state, the system turns into lockout state, the fault indicator flicker output, after the fault resolved, the system automatically steps out of the fault state.

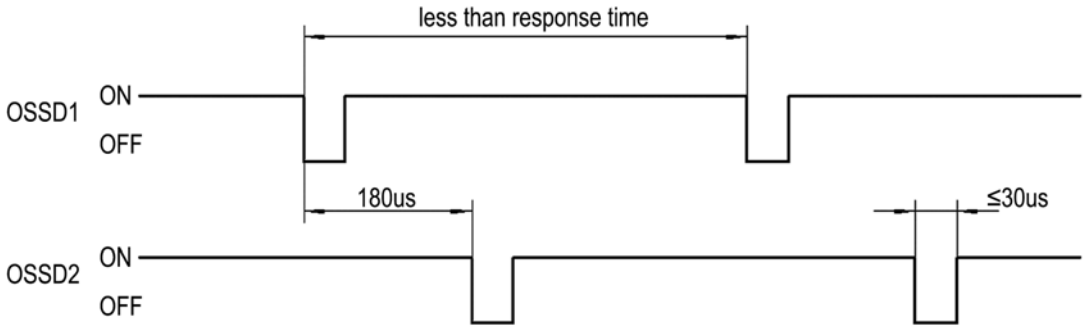


Fig 2.3.1 Security Output Detection Diagram

3) Light influence detect

- While external influence light is detected, the system turns into light-shaded state and the fault indicator flicker output, after the fault resolved, the system automatically steps out of the fault state.

4) Communication Detection

- When the communication wiring between the transmitter and the receiver is wrong or the signal transmission is wrong, the system enters into shading-state, the fault indicator flicker output, after the fault resolved, the system automatically steps out of the fault state.

5) Internal circuit detection

- When the internal signal of the system is incorrect, it enters the lockout-state.

2.3.2 External device monitoring（EDM）

WARNING

Prohibit short circuit between EDM and AUX, while using EDM function. Otherwise, the EDM function can't work.

The EDM function is used to monitor the faulty state of the relay(or contactor) that controls the dangerous parts of the machine, such as adhesion.

The receiver judges the operating state of the external device by monitoring the voltage of the EDM signal interface. When the EDM signal fails, the CT4 enters into lockout-state, after the fault resolved, the fault indicator flicker output, and the system automatically steps out of the fault state.

For example, after OSSD enters the OFF state of 500ms from ON, the normally closed contacts of external devices are not closed, the specified voltage is not input into the EDM signal interface, and the receiver is judged as external equipment failure and steps into lockout-state.

To ensure the safety of EDM functions, you need to use a safety relay with mandatory guidance or a contactor .

1) Function realization

When using the EDM function, the external voltage signal(9V to 24V) is input to the EDM signal interface through the normally closed contacts of the monitored device, refer to 2.2.1 about the wiring.

If the EDM function is not needed, short circuit EDM and AUX, refer to 2.2.2 about the wiring.

2) Timing Chart

After the power is on, the CT4 reads the EDM interface signal. When the state of the safe output signal changes, the state of the EDM input signal does not change within 500 ms, and CT4 enters into lockout-state, as shown in Fig 2.3.2

Fig 2.3.2 Timing Chart

2.3.3 Auxiliary output (unsafe)

WARNING

- AUX can't be used for safety-control circuit. Failure to do so may result in serious injury.
- The load capacity of AUX is not larger than 300mA; failure to do so may result in fault of CT4.

When EDM is not used, AUX provide the input signal of EDM for CT4. It can also be used as a state monitoring signal for CT4, which can drive relays, indicator PLCs, etc..

The timing chart is shown in Fig 2.3.3.

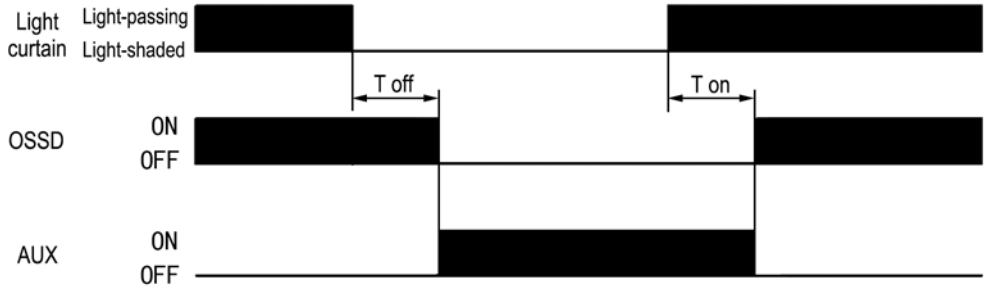


Fig 2.3.3 Timing Chart

T off：Response time for OSSD from ON to OFF, refer to 1.6 about the details.

T on：Response time for OSSD from OFF to ON, ≥80ms.

2.3.4 Auto-reset function

When the interrupting object is removed from the detection zone, the OSSDs automatically turn into ON-state.

Section3 Installation and wiring

Please read the warnings carefully before installing, to avoid faulty installation which may cause personal injury.

3.1. Installation requirements

WARNING

- Make sure that the machine is OFF while installing, failure to do so may resulting in serious injury.
- Do not use this sensor for machines that cannot be stopped by electrical control. For example, do not use it for a pressing machine that uses a full-rotation clutch. Otherwise, the machine may not stop before a person reaches the hazardous part, resulting in serious injury.
- Install the sensor system so that it is not affected by the reflective surface, otherwise, may affect the normal detecting function, resulting in serious injury.
- Do not use CT4 in flammable and explosive environment, otherwise, it may cause explosion.
- Make sure that foreign material such as water, oil, or dust does not enter the CT4 or the connector while the cap is removed.
- When using a wireless device such as a mobile phone or a radio transceiver near the product, make sure to check that the product is not affected by electromagnetic waves generated by the wireless device and that it can work normally.
- If this product is used in an air medium with heavy smoke or fine particles or a corrosive chemical, it may result in a decline in product quality.
- The CT4 cannot protect a person from an object flying from a hazardous zone. Install protective cover(s) or fence(s).

3.1.1 Detection zone and installation method

WARNING

- Install a protective structure so that the hazardous part of a machine can only be reached by passing through the sensor's detection zone. Install the sensors so that part of the person is always present in the detection zone when working in a machine's hazardous zones.
- If a person is able to step into the hazardous zone of a machine and remain behind the CT4's detection zone, take some other measures to prevent the machine from being restarted. Failure to do so may result in serious injury.

Do not use the sensor system with mirrors in a retro-reflective configuration as shown in Fig3.1.1.1. Doing so may hinder the normal detection.

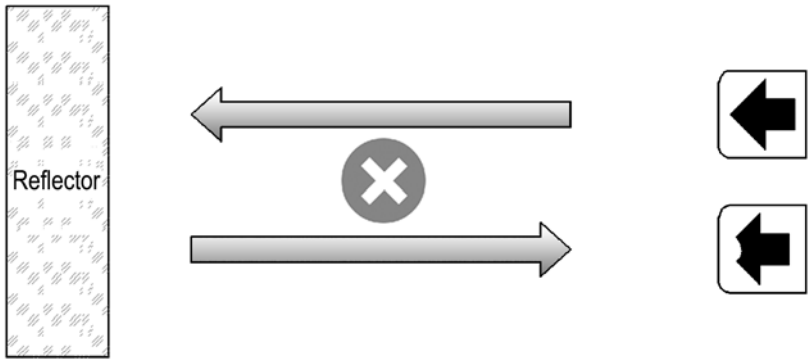


Fig 3.1.1.1 Reflector Constitutes a Schematic Diagram of the Transmitting System.

Correct installation

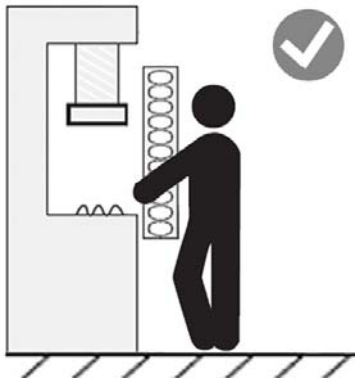


Fig 3.1.1.2 The hazardous zone of a machine can be reached only by passing through the sensor's detection zone.

Incorrect installation

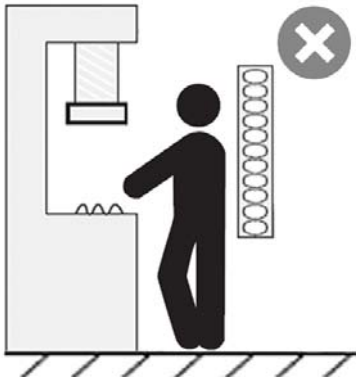


Fig 3.1.1.3 The operator is between the sensor's detection zone and the hazardous zone of a machine.

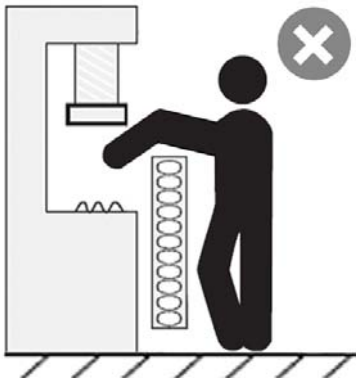


Fig 3.1.1.4 The operator can reach the hazardous zone of a machine through the upper zone to the sensor's detection zone(the ESPE is two low).

Fig 3.1.1.5 The operator can reach the hazardous zone of a machine through the lower zone to the sensor's detection zone(the ESPE is two high).

3.1.2 Safety distance

WARNING

Make sure to secure the safety distance (S) between the CT4 and the hazardous part. Otherwise, the machine may not stop before a person reaches the hazardous part, resulting in serious injury.

CAUTION

The response time of a machine is the time period from when the machine receives a stop signal to when the machine's hazardous part stops. Measure the response time on the actual system. Also, periodically check that the response time of the machine has not changed.

The safety distance is the distance that must be set between the CT4 and a machine's hazardous part to stop the hazardous part before a person or object reaches it (as shown in Fig 3.1.2). The safety distance varies according to the standards of each country and the individual specifications of each machine. Always refer to the relevant standards.

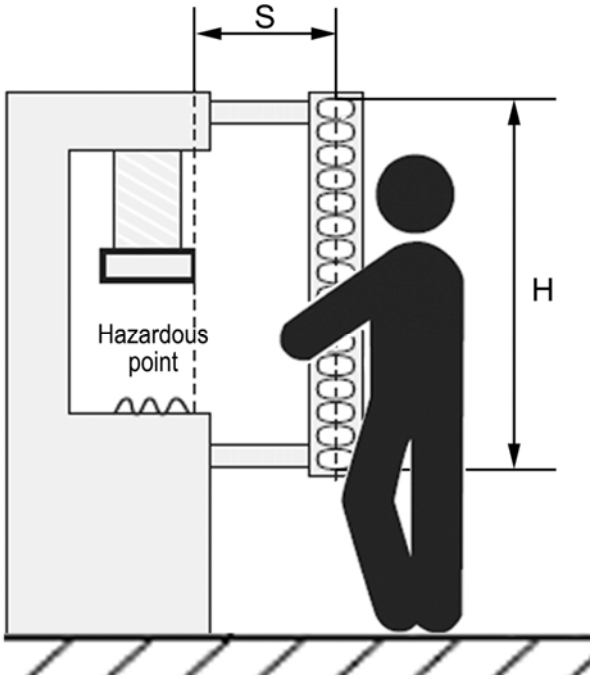


Fig 3.1.2 Safety Distance Diagram

Calculate the safety distance according to International Standard ISO 13855-2002 (European standard EN 999) (Reference)

If a person approaches the detection zone of the CT4 perpendicularly

$S = K \times T + C$ . . . Formula (1)

•S: Safety distance

•K: Approach speed to the detection zone

•T: Total response time of the machine and CT4

•C: Additional distance calculated by the detection capability of CT4

(1) System that has detection capability of 40mm or less

Use K = 2,000mm/s and C = 8 x (d - 14mm) in formula (1)

for the calculation.

$S = 2{,}000\text{mm/s} \times (Tm + Ts) + 8 \times (d - 14\text{mm})$

• S = Safety distance (mm)

• Tm = Machine's response time (s)

• Ts = Response time of CT4 from ON to OFF (s)

• d = Detection capability of CT4(mm)

[Calculation example]

Tm = 0.29s, Ts = 0.02s, d= 14mm:

$S = 2{,}000\text{mm/s} \times (0.29\text{s} + 0.02\text{s}) + 8 \times (14\text{mm} - 14\text{mm})$

= 620mm . . . Formula (2)

If the result < 100mm, use S = 100mm.

If the result exceeds 500mm, use the following expression where K = 1,600mm/s.

$S = 1{,}600\text{mm/s} \times (Tm + Ts) + 8 \times (d - 14\text{mm})$ . . . Formula (3)

So S= 496mm

If the result of this formula (3) < 500mm, use S = 500mm.

(2) A system with larger detection capability than 40mm

Calculate by using Equation (1) with K = 1,600mm/s and C = 850mm:

S = 1,600mm/s × (Tm ＋ Ts) ＋ 850 . . . Formula (4)

• S = Safety distance(mm)

• Tm = Response time of the machine(s)

• Ts = CT4's response time from ON to OFF (s)

[Example]

Tm = 0.29s，Ts = 0.02s:

S = 1,600mm/s × (0.29s ＋ 0.02s) ＋ 850mm

= 1346mm

Calculate the safety distance according to American standard ANSI B11.19 (reference)

If a person approaches the detection zone of the F3SJ perpendicularly, calculate the safety distance as

shown below.

S = K × (Ts ＋ Tc ＋ Tr ＋ Tbm) ＋ Dpf

•S: Safety distance

•K: Approach speed to the detection zone(the value recommended by OSHA standard is 1,600mm/s)

Approach speed K is not specified in the ANSI B.11.19 standard. To determine the value of K to apply,

consider all factors, including the operator's physical ability.

•Ts = Machine's stopping time (s)

•Tr = Response time of CT4 from ON to OFF (s)

•Tc =Machine control circuit's maximum response time required to activate its brake (s)

•Tbm = Additional time (s)

If a machine has a brake monitor, "Tbm= Brake monitor setting time - (Ts + Tc)". If it has no brake

monitor, we recommend using 20% or more of (Ts + Tc) as additional time.

•Dpf = Additional distance

According to ANSI's formula, Dpf is calculated as shown below:

Dpf = 3.4 × (d － 7.0): Where d is the detection capability of CT4（unit: mm）

[Calculation example]]

K = 1,600mm/s, Ts + Tc = 0.07s, brake monitor setting time = 0.1s,

Tr = 0.02s, d = 14mm:

Tbm = 0.1 － 0.07 = 0.03s

Dpf = 3.4 × (14 － 7.0) = 23.8mm

S = 1,600 × (0.07 ＋ 0.02 ＋ 0.03) ＋ 23.8 = 215.8mm

3.1.3 Distance from reflective surfaces

WARNING

Install the sensor system so that it is not affected by reflective surfaces. Failure to do so may hinder the normal detection, resulting in serious injury.

Install the sensor system at distance D or further from highly reflective surfaces such as metallic walls, floors, ceilings, or workpieces, as shown in Fig 3.1.3.

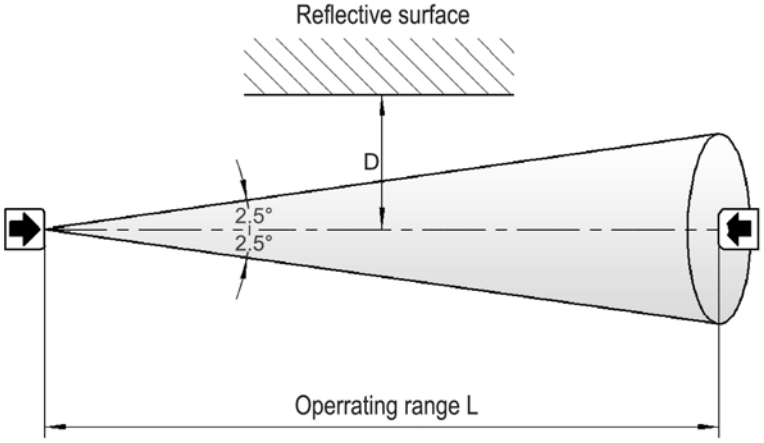


Fig 3.1.3 Reflector Distance Diagram

Distance between an emitter and a receiver (operating range L)	Allowable installation distance D
0 to 3m	0.13m
＞3m	L×tan2.5 ° = L×0.044 (m)

3.1.4 Mutual interference prevention

If several safety light curtains operate in close proximity to each other, the sender beams of one system may interfere with the receiver of another system, as shown in figure A.1. This can disrupt the protective function of the system. This would mean that the operator is at risk. You must avoid such mounting scenarios or take appropriate measures, e.g. by reversing the transmission direction of a system (figure A.2) or by mounting non reflective sight protection walls (figure A.3).

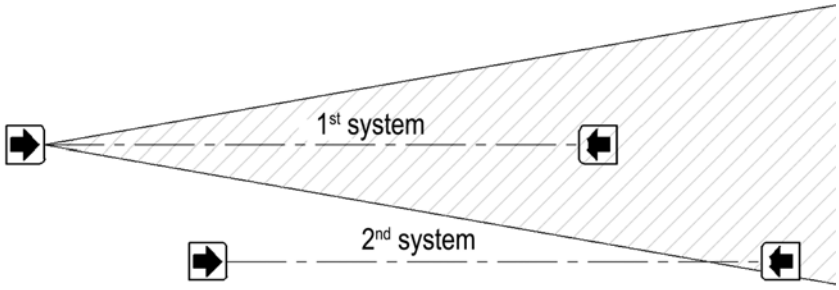


Figure A.1 Unwanted influencing of a 2nd system.
The receiver of the 2nd system is affected by the beams of the 1st

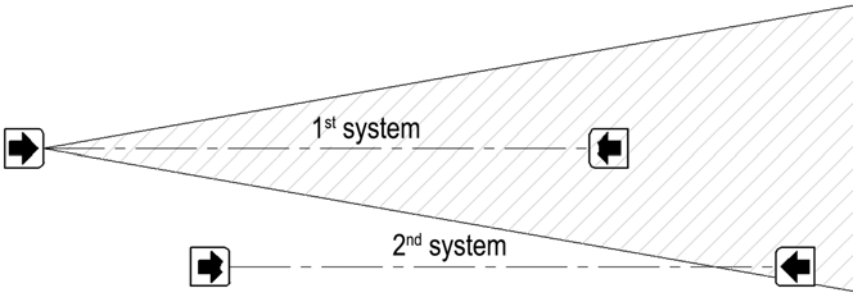


Figure A.2 Reversing the transmission direction of systems in close proximity.
The emitter of the 2nd system is not affected by the beams of the 1st system.

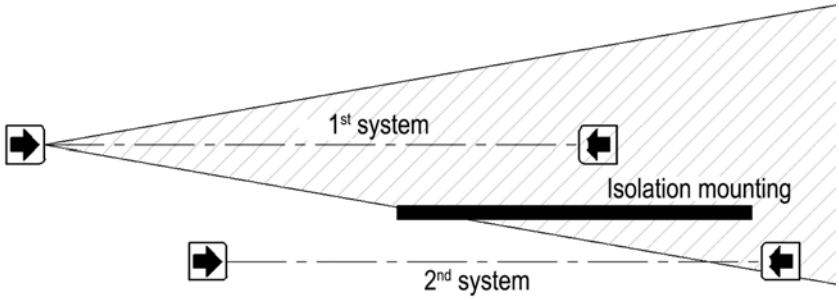


Figure A.3 Mounting non reflective sight protection wall
The emitter of the 2nd system is not affected by the beams of the 1st system.

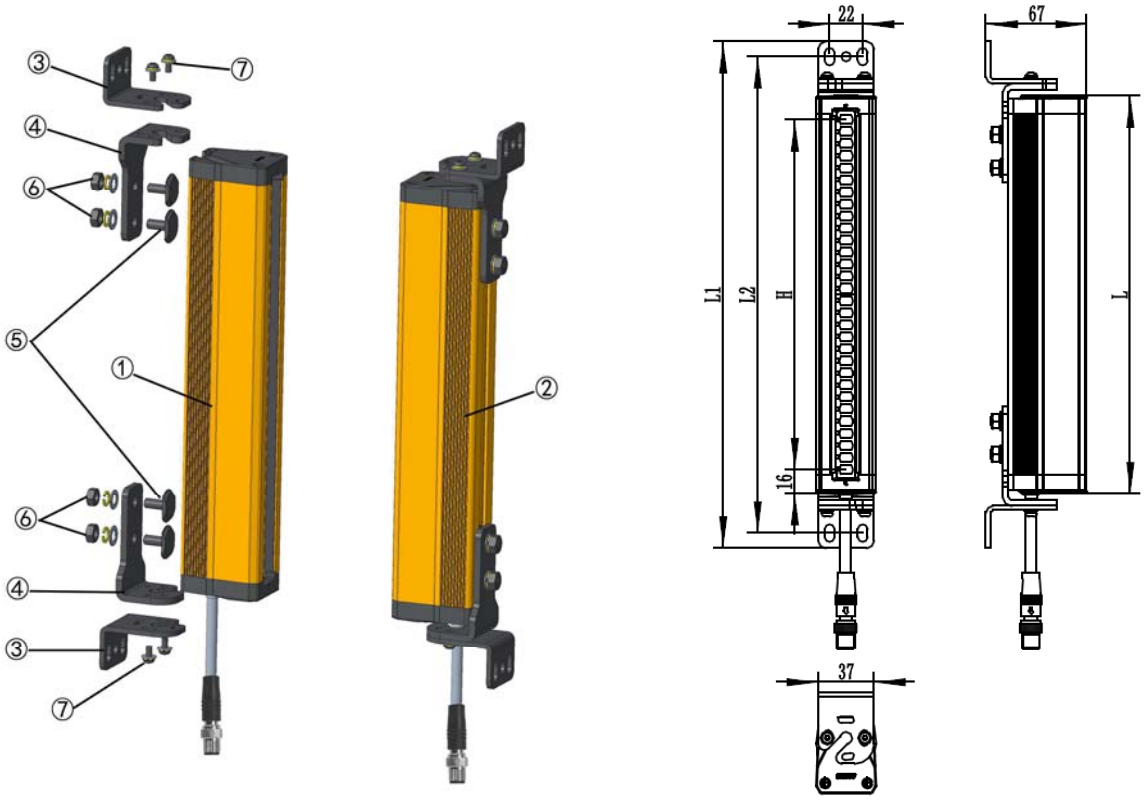
3.2. Installation

! WARNING

- Install the emitter and receiver in parallel.
- Install the emitter and receiver so that their vertical direction should match.
- If the vibration of the work environment exceeds the specified value, other measures should be taken to reduce the vibration.
- Installation should strictly abide by the provisions of the safe distance. Refer to 3.1.2 about calculation of actual safety distance.
- The installation of CT4 should make sure that the hazardous part of a machine can not be reached by passing through the upper, lower and back side of the detection zone. And the installation position can not be changed after installed.
- Install a protective structure so that the hazardous part of a machine can only be reached by passing through the sensor's detection zone. Install the sensors so that part of the person is always present in the detection zone when working in a machine's hazardous zones. Failure to do so may result in serious injury.
- Make sure that the CT4 is securely mounted and its cables and connectors are properly connected.

3.2.1 Installation method

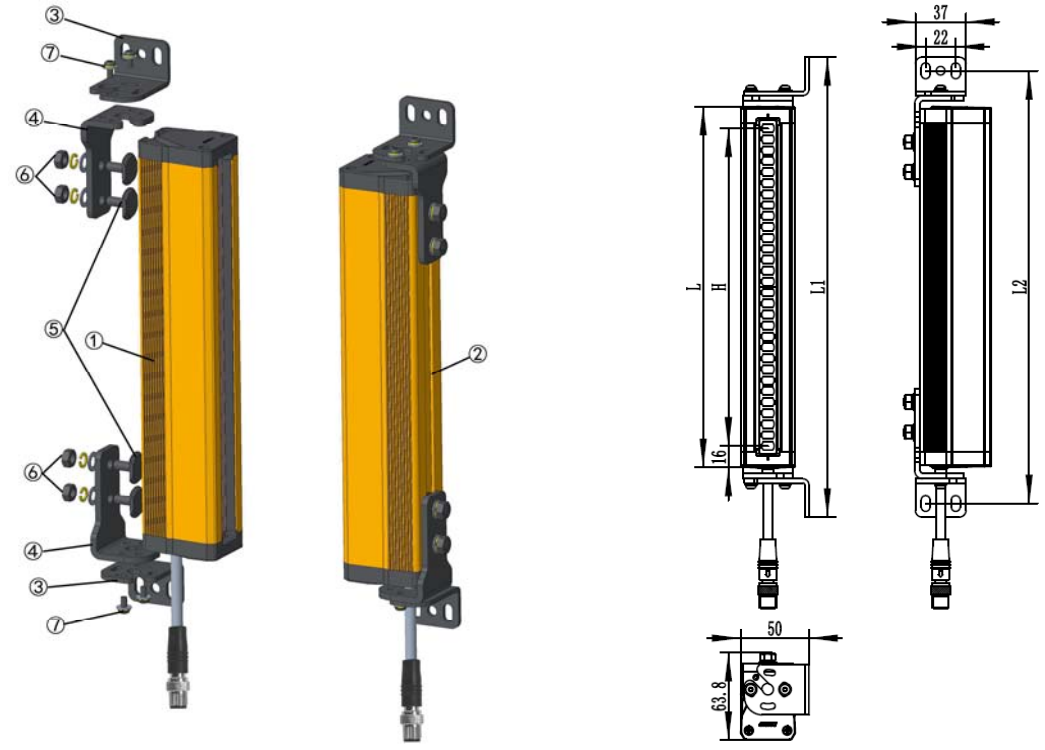
Common front mounting



Common front mounting Dimensions

Fig 3.2.1.1 Common Front Mounting Diagram

Common side mounting



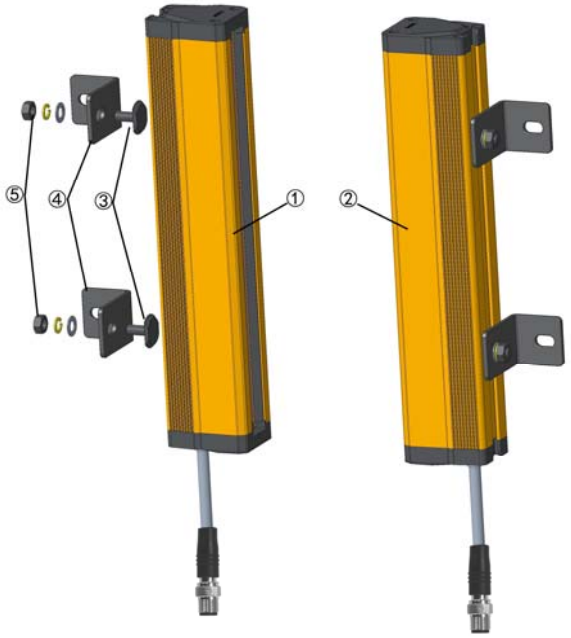
Common side mounting Dimensions

Fig 3.2.1.2 Common Side Mounting Diagram

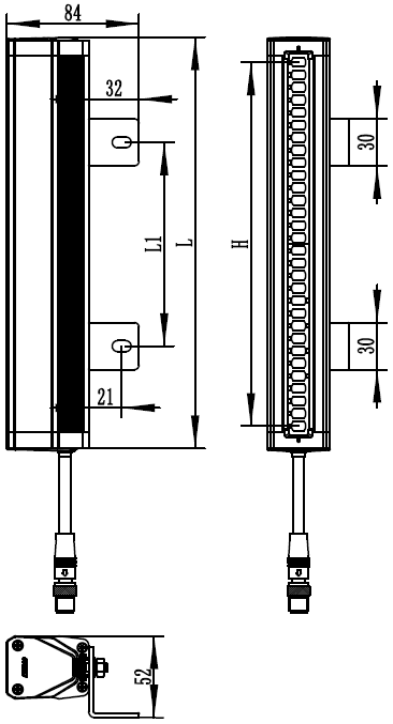
①Emitter ②Receiver ③Mounting brackets ④Rotating bracket ⑤T-bolt
⑥M6×16 inner hexagon screws ⑦M4×8 socket head cap screws

H	Protective height (Refer to 1.7 Parameter table)
L	H＋32mm
L1	H＋102mm(min)
L2	H＋82mm(min)

T-groove mounting



T-groove side mounting method



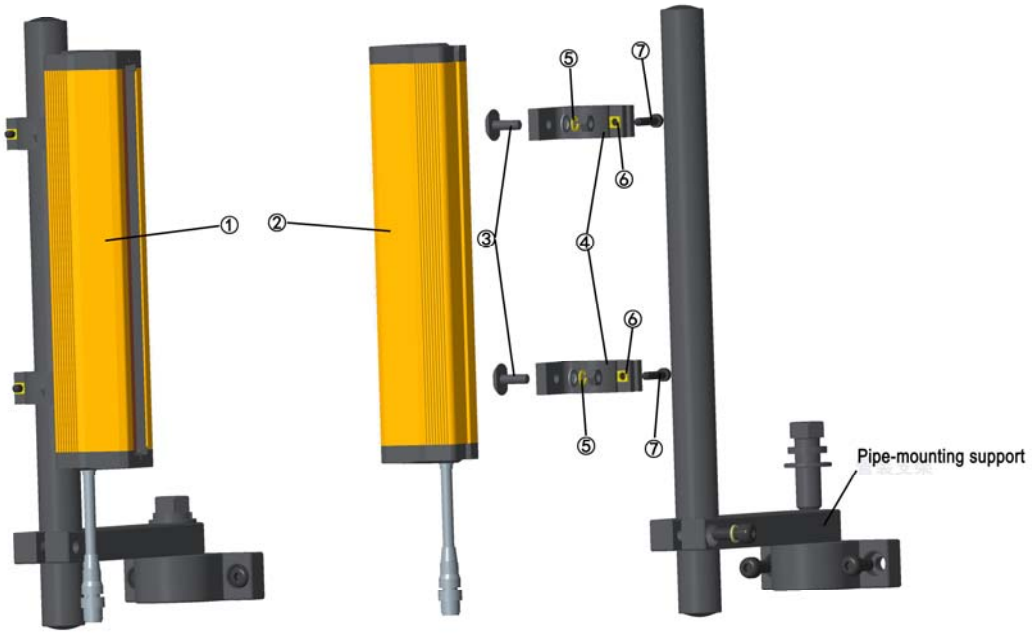
Dimensions

Fig 3.2.1.3 T-groove side mounting diagram

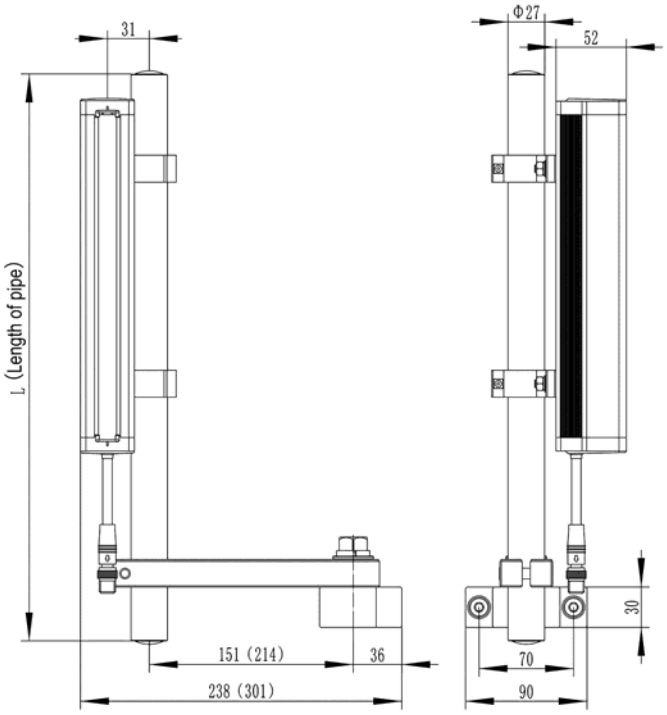
①Emitter ②Receiver ③T-bolt ④L-bend bracket ⑤M6×16 inner hexagon screws

H	Protective height (Refer to 1.7 Parameter table)
L	H＋32mm
L1	L/2＜L1＜L

Pipe mounting



Pipe mounting method



Dimensions

Fig3.2.1.4 Pipe mounting and Installation Diagram

①Emitter ②Receiver ③T-bolt ④Q-Pipe clamp ⑤M6×16 inner hexagon screws ⑥M5 square nut ⑦M5×25 hexagon socket head cap screw with spring washer

Scatter shield mounting

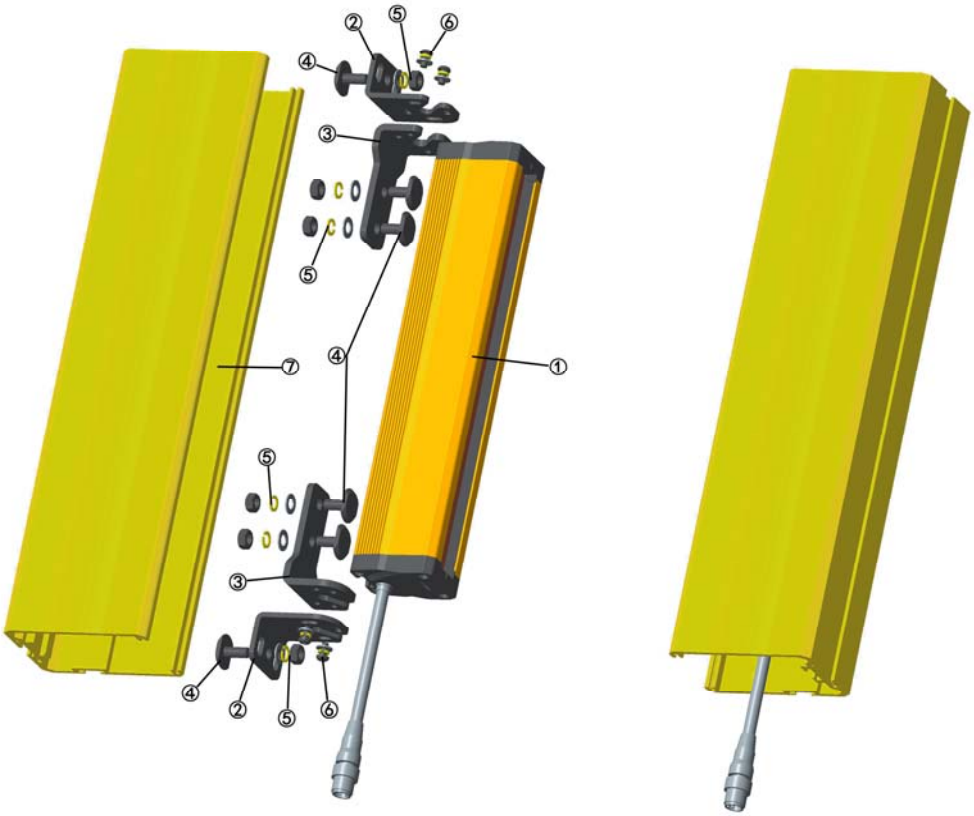


Fig 3.2.1.5 Scatter shield mounting diagram

①Emitter/Receiver ②Mounting brackets ③Rotating bracket ④T-bolt ⑤M6×16 inner hexagon screws ⑥M4×8 socket head cap screws ⑦Protection cover

※Warm prompt:

All of the above mounting methods need M6×16 inner hexagon screws (with Φ6 elastic/plain washers) to fix the brackets to the guarded machine.

3.3. Wiring

3.3.1 Precautions

WARNING

- Wiring when the power of CT4 is turned OFF
- Double or reinforced insulation must be applied between the input/output interface and dangerous voltage, otherwise may lead to electric shock.
- Connect the load between OSSDs and 0V line. Connecting between OSSDs and 24V DC line is dangerous because the operation mode is reversed to "ON when blocked".
- Do not short-circuit OSSDs to the 24V DC line. Otherwise, the OSSDs is always ON.
- The two OSSDs must be used together; otherwise it may reduce the safety of the system.
- Do not connect each line of CT4 to a DC power supply higher than 24V+20%. Also, do not connect to an AC power supply. Failure to do so may result in electric shock.
- The power supply of CT4 should not be higher than 24V±20%, otherwise it may affect the stability of the light curtain.
- While uses EDM function, short circuit between EDM and AUX is forbidden, otherwise, the EDM function is invalid.
- When replacing cable connectors with other types of connectors, connectors with IP67 or higher protection level should be used.
- Properly perform the wiring after confirming the signal names of all the terminals.
- Be sure to route the CT4 cable separate from high-potential power lines or through an exclusive conduit.
- Be sure to follow the relevant electrical codes, regulations, rules, and laws of the country or region where the product is used when wiring electrical wiring.

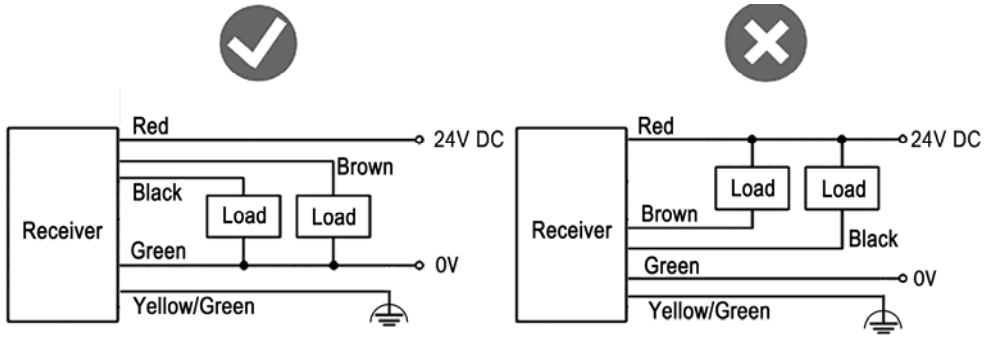


Fig 3.3.1 Schematic Diagram of Correct and Error Load Wiring

CAUTION

Hot plugging for the connectors of CT4 is forbidden!
The emitter and the receiver should be powered on at the same time!

3.3.2 Power supply

WARNING

For CT4 light curtain, the DC power supply unit must satisfy all of the following conditions.

In order to ensure that the CT4 fulfills requirements of IEC 61496-1, the DC power supply must fulfill all of the following requirements:

- Must be within the rated power voltage (24V DC ± 20%)
- Fulfill requirements of load current
- Must comply with EMC directives (industrial environment)
- Double or reinforced insulation must be applied between the primary and secondary circuits
- Output holding time must be 20ms or longer when the supply voltage fluctuates or drops
- The output current is bigger than 1A, with automatic recovery of overcurrent protection characteristics
- The power supply must have output overvoltage and overcurrent protection function
- Overcurrent protection is realized by the resettable fuse (PPTC) inside of the CT4 light curtain, external power supply must have overcurrent protection function to prevent input current to be greater than 1.5A
- Must comply with laws and regulations, regarding EMC and electrical equipment safety, of the country or region where the CT4 is used (Ex: In EU, the power supply must comply with the EMC Directive and the Low Voltage Directive.)

3.3.3 Wiring steps

WARNING

When extending the communication line with a cable other than the dedicated cable, use a cable with the same or superior specifications, and don't make it exceed the specified maximum length, failure to do so may affect the stability of CT4.

Wiring steps：

1) Connect the emitter's cable to the emitter (8 core)
2) Connect the receiver's cable to the receiver (8 core)
3) Connect the power's 0V and the shielding layer to the ground
4) Wiring according to 2.2 on the basis of the functional requirements.

3.3.4 Wiring of the emitter's cable and the emitter

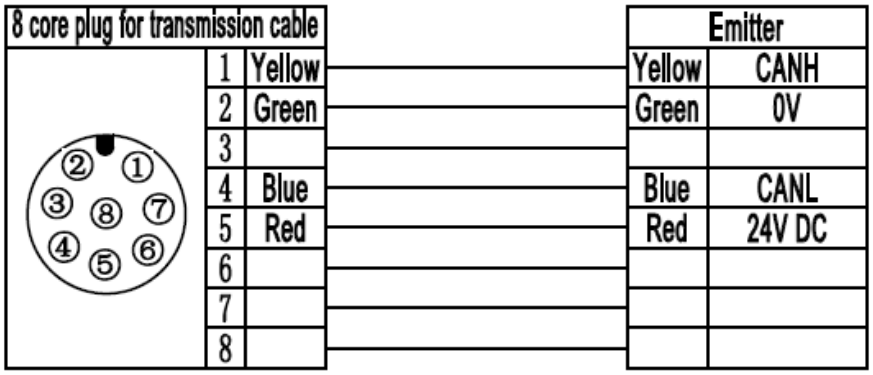


Fig 3.3.4 Wiring Diagram of the Emitter's Cable and the Emitter

3.3.5 Wiring of the receiver's cable and the receiver

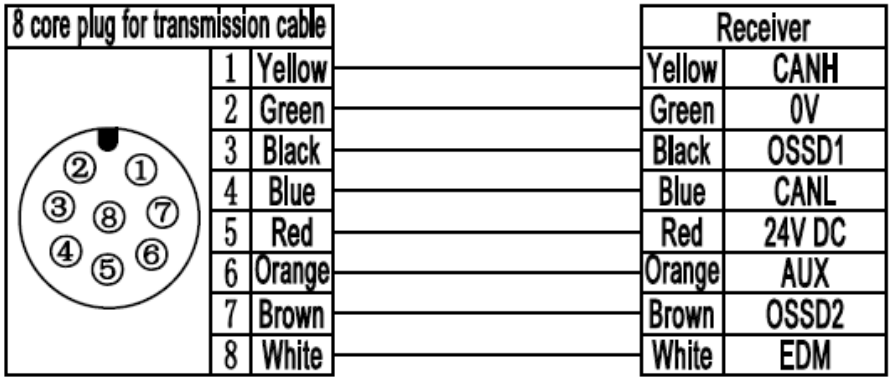


Fig 3.3.5 Wiring Diagram of the Receiver's Cable and the Receiver

Section4 Check and debugging

WARNING

Make sure to test the operation of CT4 after installation to verify that CT4 operates as intended. Make sure to stop the machine until the test is complete. Unintended function settings may cause a person to go undetected, resulting in serious injury.

After installation, the highest level administrator must use the following checklist to verify the operation, placing a check mark in each of the boxes.

4.1. Installation condition check

☐ The machine itself does not prevent the operation of safety functions such as stopping.

☐ The hazardous part of a machine cannot be reached without passing through the detection zone of CT4.

☐ CT4 can always detect a worker who is working in the hazardous zone.

☐ Safety distance has been calculated. Calculated distance: S =____mm.

☐ The actual distance is equal to or greater than the calculated distance. Actual distance =__ mm.

☐ Reflective objects are not installed in prohibited zones.

☐ It can't be used in flammable or explosive atmosphere.

4.2. Wiring check before power is turned on

☐ Power supply unit must be dedicated to CT4. It must have tolerance against total rated current of devices if it is connected to multiple devices.

☐ The power supply unit is a 24V DC unit that conforms to the EMC Directive, Low-voltage Directive, and output holding specifications.

☐ The power supply polarity is not connected in reverse.

☐ Emitter/receiver cables are properly connected to the respective emitters/receivers, and the signal cables are connected correctly.

☐ Double insulation or reinforced insulation is used between I/O lines and the hazard potential (dangerous power supplies, etc.).

☐ Loads are not connected to the 24V DC line.

☐ OSSDs are not short-circuited to 24V DC line.

☐ All lines are not connected to dangerous power source.

☐ Specification of emitter and receiver must be the same.

☐ When 2 or more sets of CT4 are used, mutual interference prevention measures are taken.

☐ AUX can not be used as safety output.

☐ Power supply's 0V and the shielding layer must be grounded.

☐ Use transmission cables prepared by KELI, and the length of the cables can't exceed the specified value.

☐ Neither connectors nor terminals can be loose.

☐ Cables must not be bent, cracked, or damaged. The cables in the connector end should be relaxed to avoid damaging the connectors.

4.3. Operation check while the machine is stopped

☐ The diameter is consistent with the detection capability of CT4.

When the test rod enters into the detection zone, CT4 light curtain retains light-shaded state; after the test rode leaves the detection zone, the light curtain turns into light-passing state.

Move the test rod slowly through the protective field to be tested, as shown in figure ①, the red OFF-state indicator on the receiver is on.

Then move the test piece along the edges of the protective field, as shown in figure ②, the red OFF-state indicator on the receiver is on. Remove the test piece, the green ON-state indicator on the receiver is on.

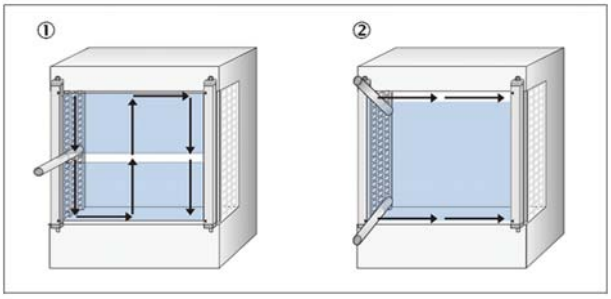


Fig 4.3 Schematic Diagram of the Test Method of the Test Piece in the Detection Area

☐ When use EDM function, if CT4 light curtain is in light-shaded state and the input of the external device is OFF, the system turns into lockout state.

4.4. Checking that hazardous parts stop while the machine operates

☐ The hazardous parts stop immediately when a test piece is inserted into the detection zone at 3 positions: "directly in front of the emitter", "directly in front of the receiver", and "between the emitter and receiver". (Use the appropriate test piece.)

☐ The hazardous parts remain stopped as long as the test piece is in the detection zone.

☐ The hazardous parts stop when the power of CT4 is turned OFF.

☐ The actual response time of the whole machine is equal to or less than the calculated value.

! WARNING

- For presses on which the slide can stop at any point in one stroke, the braking must not have any failure!
- For presses which can only realize upper dead point protection, the machine tool can not have the clutch failure!
- If the braking is at fault, the guarded machine must be repaired!
- If the braking of guarded machine is at fault, the CT4 can not protect the operator.

Section5 Maintenance

WARNING

- Perform daily and 6-month inspection for CT4. Otherwise, the system may fail to work properly, resulting in serious injury.
- Do not try to disassemble, repair, or modify this product. Doing so may cause the safety functions to stop working properly.

CAUTION

Hot plugging for the connectors of CT4 is forbidden!

To ensure safety, keep a record of the inspection results. When the user is a different person from those who installed or designed the system, he/she must be properly trained for maintenance.

5.1. Inspection at startup and when changing operators

☐ There is no approach route other than through the detection zone of CT4.

☐ Part of the operator's body always remains in the detection zone of CT4 when working around the machine's hazardous part.

☐ The actual safety distance is equal to or greater than the calculated value.

☐ Reflective objects are not installed in prohibited zones.

☐ There must be no dirt on nor damage to the optical surface.

☐ The test piece is not deformed, fulfills requirements of the detection capability.

☐ When the power of CT4 is turned ON while nothing is in the detection zone, it must output light-passing state in 1s.

☐ The light curtain retains light-shaded state while the test piece is moved around in the detection zone according to 4.3.

☐ When use EDM function, if CT4 light curtain is in light-shaded state and the input of the external device is OFF, the system turns into lockout state.

5.2. Inspection for the guarded machine

☐ The hazardous parts are movable when nothing is in the detection zone.

☐ The hazardous parts stop immediately when a test piece is inserted into the detection zone.

☐ The hazardous parts remain stopped as long as the test piece is in the detection zone.

☐ The hazardous parts stop when the power of the CT4 is turned OFF while nothing is in the detection zone.

☐ The machine itself does not prevent the operation of safety functions such as stopping.

5.3. Items to inspect every 6 months or when machine settings are changed

In addition to inspection items in 4.1 and 4.2, following items must also be verified.

☐ The outputs of CT4 and the machine are properly wired.

☐ The total number of times that the control relays/contactors have switched is significantly lower than their design lives.

☐ There is no interference light.

☐ Power supply's 0V must be grounded.

☐ The cables must not be bent, cracked, nor damaged.

☐ CT4 is fixed fasten, no loose.

☐ The changing of machine setting affects the safety of the control system.

Section6 **Troubleshooting**

WARNING

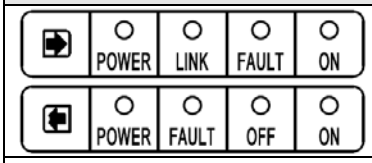
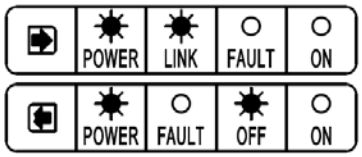
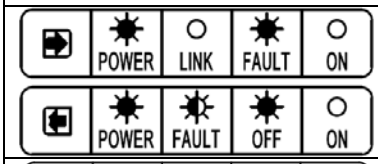
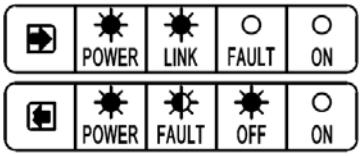
Do not try to disassemble, repair, or modify this product. Otherwise may cause the safety functions to stop working properly.

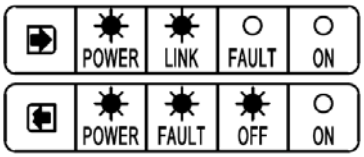
CAUTION

While in operation, the power supply's 0V and the shielding layer must be grounded!

6.1. Fault state

If an error is detected, the CT4 enters lockout state, keeps the OSSDs in OFF-state. When the OSSDs, EDM, and CAN signal lines are wired incorrectly or the receiver detects optical interference, the receiver's fault indicator flashes. When other faults are detected, the red fault indicator is always on. After the OSSDs are connected incorrectly, the fault needs to be re-powered to release the fault status. The other faults caused by wiring errors, the system automatically cancels the fault status, after the fault is recovered.

Phenomenon	Cause	Solution
	No working power	Check and repair the electric circuit or replace the power supply
	Bad for light	Restart the machine
	Dirty surface	Clean the surface
	Emitter or Receiver fault	Replace the emitter or Receiver with a same specification one
	Communication fault	Check and repair the electric circuit
	Emitter fault	Replace the emitter with a same specification one
	Emitter fault	Replace the emitter with a same specification one
	Check that there is interference light in the detection zone	Eliminate interference source
	Short circuit between OSSD and other signals	Check and repair the electric circuit
	When use EDM function, the response time of the external device delay or failure.	Replace the external device
	Fault of the receiver	Replace the receiver with a same specification one

	Supply voltage drops below the specified value or lack of supply current	Replace the power supply
	Fault of the receiver	Replace the receiver with a same specification one

☀ : ON ○ : OFF ☀ FLASH

6.2. Fault of brake system of the machine

Phenomenon	Cause	Solution
The CT4 type safety light bar indicator is normal and the device does not work.	The electric circuit of guarded machine connected with OSSD short circuit or wrong connected	Check and repair the electric circuit of guarded machine connected with OSSD
	Electric failure of guarded machine	Check and repair electric circuit of guarded machine
The CT4 type safety light indicator is converted to normal, the safety grating is blocked, and the equipment cannot be stopped.	Electric failure of guarded machine	Check and repair electric circuit of guarded machine
	The braking of guarded machine is at fault.	Check the guarded machine
The CT4 safety light barrier indicator is switched to normal, the safety grating is blocked, and the device cannot stop immediately.	The clutch of guarded machine is at fault	Check the guarded machine

Section7 Version

Version	Date	Modification
V1.0	2019-03	

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