Glossary of Photocoupler and Photorelay Terms

Outline

This document describes the terms used in data sheets of Photocoupler and Photorelay as well as measurement procedures for current transfer ratio, threshold input current, and trigger LED current that are characteristic parameters specific to optical semiconductor devices.

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1. Terms

1.1 General terms

Term	Symbol	Description
Absolute Maximum Rating		Maximum value that must not be exceeded even for an instant during operation
Isolation Voltage	BV_S	Isolating voltage between input and output under the specified conditions
Capacitance (Input to Output), Total Capacitance (Input to Output)	C_S	Electrostatic capacitance between the input and output pins
Capacitance (Input), Input Capacitance	C_T C_t	Electrostatic capacitance between the anode and cathode pins of the LED
Forward Current, Input Forward Current	I_F	Rated current that can flow continuously in the forward direction of the LED
Pulse Forward Current, Input Forward Current (Pulsed)	I_{FP}	Rated current that can flow momentarily in the forward direction of the LED
Peak Transient Forward Current	I_{FPT}	Rated current that can flow momentarily in the forward direction of the LED
Reverse Voltage, Input Reverse Voltage	V_R	Rated reverse voltage that can be applied across the LED's cathode and anode
Reverse Current, Input Reverse Current	I_R	Leakage current flowing in the reverse direction of the LED (from cathode to anode)
Forward Voltage, Input Forward Voltage	V_F	Voltage drop across the anode and cathode pins of the LED under the specified forward-current condition
LED Power Dissipaiton, Input Power Dissipaiton	P_D	Rated power that can be dissipated in the LED
Total Power Dissipaiton	P_T	Total rated power that can be dissipated in both the input and output devices
Isolation Resistance	R_S	Resistance between the input and output pins at the specified voltage
Junction Temperature	T_j	Permissible temperature of the junction of the photodetector or LED
Operating Temperature	T_{opr}	Ambient temperature range in which the device can operate without loss of functionality
Lead Soldering Temperature	T_{sol}	Rated temperature at which the device pins can be soldered without loss of functionality
Storage Temperature	T_{stg}	Ambient temperature range in which the device can be stored without operation
Creepage Distance		Shortest distance along the surface of insulation between the path of two conductive parts (input and output)
Clearance(Clearance Distance)		Shortest distance through air between the path of two conductive parts (input and output)
Internal Isolation Thickness, Insulation Thickness		Distance through insulation. Shortest thickness through internal insulation between the path of two conductive parts (input and output)

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1.2 Transistor output

Term	Symbol	Description
Collector Current	I_C	Rated current allowed to flow to collector
Current Transfer Ratio	I_C/I_F (CTR)	Ratio of output current, I_C, to input current, I_F: $I_C/I_F \times 100$ (unit: %)
Collector Dark Current, Dark Current	I_{CEO} I_{DARK}	Leakage current flowing between collector and emitter
OFF-state Collector Curreent	$I_{C(off)}$	Leakage current flowing between collector and emitter when Low voltage is applied to input
Current Gain Factor	h_{FE}	h_{FE} for phototransistor
Base Photo-Current	I_{PB}	Photo-current generated by the specified input current, I_F, in the phototransistor base block
Collector Power Dissipation	P_C	Rated power that can be dissipated in collector
Turn-On Time	t_{ON} t_{on}	Time required for the output waveform to change from 100% (0%) to 10% (90%) when the input is turned off and back on under the specified conditions
Turn-Off Time	t_{OFF} t_{off}	Time required for the output waveform to change from 0% (100%) to 90% (10%) when the input is turned on and back off under the specified conditions
Storage Time	t_S	Time required for the output waveform to change from 0% (100%) to 10% (90%) when input is turned on and back off under the specified conditions
Fall Time	t_f	Time required for the output waveform to change from 90% to 10%
Rise Time	t_r	Time required for the output waveform to change from 10% to 90%
Collector-Emitter Saturation Voltage	$V_{CE(sat)}$	Voltage between collector and emitter under the specified saturation conditions
Collector-Base Breakdown Voltage	$V_{(BR)CBO}$	Breakdown voltage between collector and base when emitter is open
Collector-Emitter Breakdown Voltage	$V_{(BR)CEO}$	Breakdown voltage between collector and emitter (when base is open)
Emitter-Base Breakdown Voltage	$V_{(BR)EBO}$	Breakdown voltage between emitter and base when collector is open
Emitter-Collector Breakdown Voltage	$V_{(BR)ECO}$	Breakdown voltage between emitter and collector (when base is open)
Collector-Base Voltage	V_{CBO}	Rated voltage that can be applied across collector and base
Collector-Emitter Voltage	V_{CEO}	Rated voltage that can be applied across collector and emitter
Emitter-Base Voltage	V_{EBO}	Rated voltage that can be applied across emitter and base
Emitter-Collector Voltage	V_{ECO}	Rated voltage which can be applied across emitter and collector
Capacitance (Collector to Emitter), Collector-Emitter Capacitance	C_{CE}	Electrostatic capacitance between the collector and emitter pins

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1.3 IC output

Term	Symbol	Description
Common-Mode Transient Immunity at Output High	CM_H	Maximum tolerable rate of rise (fall) of input/output common-mode voltage at which the specified High level can be maintained
Common-Mode Transient Immunity at Output Low	CM_L	Maximum tolerable rate of rise (fall) of input/output common-mode voltage at which the specified Low level can be maintained
High-Level Supply Current	I_{CCH} I_{DDH}	Current supply to the circuit that flows to power supply pins when the output is at the High level
Low-Level Supply Current	I_{CCL} I_{DDL}	Current supply to the circuit that flows to power supply pins when the output is at the Low level
Threshold Input Current	I_{FHL} (I_{FLH})	Minimum input current, I_F, necessary to change the output from High (Low) to Low (High) (*1)
Input Current Hysteresis	I_{HYS}	Difference between I_{FLH} and I_{FHL} for a given device
Threshold Input Voltage	V_{FLH} (V_{FHL})	Maximum input voltage, V_F, necessary to hold the initial output High (Low), or to return the output from Low (High) to High (Low) after the initial output changes from High (Low) to Low (High)
Current Transfer Ratio	I_O/I_F	Ratio of output current, I_O, to input current, I_F: $I_O/I_F \times 100$ (unit: %)
High-Level Output Current	I_{OH}	Output current under the specified High-level output voltage
Peak High-Level Output Current	I_{OPH}	Peak output current under the specified High-level output voltage
Low-Level Output Current	I_{OL}	Output current under the specified Low-level output voltage
Peak Low-Level Output Current	I_{OPL}	Peak output current under the specified Low-level output voltage
High-Level ShortCircuit Output Current	I_{OSH}	Output current under the specified High-level output and short-circuit conditions
Low-Level Short-Circuit Output Current	I_{OSL}	Output current under the specified Low-level output and short-circuit conditions
High-Level Output Voltage	V_{OH}	Output voltage under the specified High-level output current condition
Low-Level Output Voltage	V_{OL}	Output voltage under the specified Low-level output current condition
Output Power Dissipation	P_O	Rated power that can be dissipated in the output stage
Propagation Delay Time (H → L)	t_{PHL}	Time required from when the input changes from the OFF (ON) state to the ON (OFF) state to when the output waveform changes from the High level to specified Low level
Propagation Delay Time (L → H)	t_{PLH}	Time required from when the input changes from the ON (OFF) state to the OFF (ON) state to when the output waveform changes from the Low level to the specified High level
Output Current	I_O	Rated current that can flow to output pins
Peak Output Current	I_{OP}	Rated peak current that can be applied between output pins
Supply Voltage	V_{CC} V_{DD}	Rated voltage that can be applied to power supply pins
Output Voltage	V_O	Rated voltage that can be applied to output pins
UVLO Threshold Voltage	V_{UVLO}	Threshold voltage at which the undervoltage lockout (UVLO) function is tripped
Three-State Enable Voltage	V_E	Rated voltage that can be applied to the enable pin
High-Level Enable Voltage	V_{EH}	Voltage at which the enable pin functions as the High level
Low-Level Enable Voltage	V_{EL}	Voltage at which the enable pin functions as the Low level

(*1) I_F greater than the maximum I_{FHL} (I_{FLH}) is required to ensure that the IC output transitions from High (Low) to Low (High).

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1.4 Photorelay (MOSFET output)

Term	Symbol	Description
Trigger LED Current	(Contact a) I_{FT}	Minimum input current, I_F, necessary to turn on the output MOSFET (*1)
	(Contact b) I_{FC}	Minimum input current, I_F, necessary to turn off the output MOSFET (*1)
Return LED Current	(Contact a) I_{FC}	Maximum input current, I_F, necessary to return the output MOSFET to the OFF state
	(Contact b) I_{FT}	Maximum input current, I_F, necessary to return the output MOSFET to the ON state
OFF-State Output Terminal Voltage	V_{OFF}	Rated voltage that can be applied across the MOSFET's output pins in the OFF state
ON-State Current	I_{ON}	Rated current that can flow between the MOSFET's output pins in the ON state
ON-State Resistance	R_{ON}	Resistance between the MOSFET's output pins under the specified ON-state conditions
OFF-State Current	I_{OFF}	Leakage current flowing between the MOSFET's output pins in the OFF state
Load Current Limiting	I_{LIM}	Output current range in which the current limiting function is tripped
Output Capacitance	C_{OFF}	Capacitance between the MOSFET's output pins (between the two drains)
Turn-ON Time	(Contact a) t_{ON}	Time taken for the output waveform to change from 100% to 10% after the LED current is turned on under the specified conditions
	(Contact b) t_{ON}	Time taken for the output waveform to change from 100% to 10% after the LED current is turned off under the specified conditions
Turn-OFF Time	(Contact a) t_{OFF}	Time taken for the output waveform to change from 0% to 90% after the LED current is turned off under the specified conditions
	(Contact b) t_{OFF}	Time taken for the output waveform to change from 0% to 90% after the LED current is turned on under the specified conditions

(*1) I_F greater than the maximum I_{FT} (I_{FC}) is required to ensure that the photorelay transitions from the OFF (ON) state to the ON (OFF) state.

1.5 Photovoltaic output

Term	Symbol	Description
Forward Current, Output Forward Current	I_{FD}	Rated forward current that can be applied between anode and cathode of the output diode array
Reverse Voltage, Output Reverse Voltage	V_{RD}	Rated reverse voltage that can be applied across anode and cathode of the output diode array
Forward Voltage, Output Forward Voltage	V_{FD}	Forward voltage across the output's anode and cathode
Reverse Current, Output Reverse Current	I_{RD}	Reverse leakage current between the output's anode and cathode
Open Voltage	V_{OC}	Output photovoltaic voltage generated by the specified input current, I_F
Short-Circuit Current	I_{SC}	Output photo-current generated by the specified input current, I_F

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1.6 Triac output

Term	Symbol	Description
Trigger LED Current	I_{FT}	Minimum input current, I_F, necessary to turn on the triac (*1)
OFF-State Output Terminal Voltage	V_{DRM}	Rated voltage that can be applied across T1 and T2 of the triac in the OFF state
R.M.S ON-State Current	$I_{T(RMS)}$	Rated current that can flow between T1 and T2 of the triac in the ON state
Peak ON-State Current, ON-State Current (Pulsed)	I_{TP} I_{ONP}	Rated peak repetitive pulse current that can flow between T1 and T2 of the triac in the ON state
Peak Non-Repetitive Surge Current	I_{TSM}	Rated peak non-repeatitive one-cycle current (commercial frequency, sine half-wave) that can flow between T1 and T2 of the triac in the ON state
Peak OFF-State Current	I_{DRM}	Leakage current that flows between T1 and T2 of the triac in the OFF state
Peak ON-State Voltage	V_{TM}	Voltage across T1 and T2 of the triac in the specified ON state
Holding Current	I_H	Minimum current through T1 and T2 of the triac necessary to maintain the ON state after the triac turns on
Leakage in Inhibited State, Inhibit Current	I_{IH}	Leak current that flows between T1 and T2 of a zero-cross triac in the inhibit state in which a zero-crossing turn-on operation is inhibited
Inhibit Voltage	V_{IH}	Minimum voltage across T1 and T2 of a zero-cross triac at which a zero-crossing turn-on operation is inhibited
Critical Rate of Rise of OFF-State Voltage	dv/dt	Maximum rate of rise of the T1-T2 voltage of the triac at which the triac in the OFF state can maintain the OFF state
Critical Rate of Rise of Commutating Voltage (dV/dt)	dv/dt (C)	Critical rate of rise of the OFF-state voltage during commutation

(*1) I_F greater than the maximum I_{FT} is required to ensure that the triac output transitions from the OFF to the ON state and vice versa.

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1.7 Thyristor output

Term	Symbol	Description
Trigger LED Current	I_{FT}	Minimum input current, I_F, necessary to turn on the thyristor (*1)
Peak Forward Voltage	V_{DRM}	Rated repeative forward voltage that can be applied across the thyristor's anode and cathode in the OFF state
Peak Reverse Voltage	V_{RRM}	Rated repeative reverse voltage that can be applied across the thyristor's anode and cathode
Peak Reverse Gate Voltage	V_{GM}	Rated gate reverse voltage that can be applied across the thyristor's gate and cathode
ON-State Current	$I_{T(RMS)}$	Rated ON-state current that can flow between the thyristor's anode and cathode in the ON state
Peak ON-State Current	I_{TP}	Rated peak repetitive pulse forward current that can flow between the thyristor's anode and cathode in the ON state
Peak One-Cycle Surge Current	I_{TSM}	Rated peak non-repetitive one-cycle current (commercial frequency, sine half-wave) that can flow between the thyrister's anode and cathode in the ON state
OFF-State Current	I_{DRM}	Leakage current that flows in the forward direction between the thyristor's anode and cathode in the OFF state
Reverse Current	I_{RRM}	Leakage current that flows in the reverse direction between the thyristor's anode and cathode
ON-State Voltage	V_{TM}	Forward voltage across the thyristor's anode and cathode in the specified ON-state
Holding Current	I_H	Minimum current through the thyristor's anode and cathode necessary to maintain the ON state after the thyristor turns on
Critical Rate of Rise of OFF-State Voltage	dv/dt	Maximum rate of rise in the voltage across the thyristor's anode and cathode at which the thyristor in the OFF state can maintain the OFF state
Capacitance	C_J	Capacitance on electrodes between anode and gate or between gate and cathode

(*1) I_F greater than the maximum I_{FT} is required to ensure that the thyristor output transitions from the OFF state to the ON state and vice versa.

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2. Measurement procedure for current transfer ratio, I_C/I_F (CTR)
- Transistor output

(1) Circuit diagram

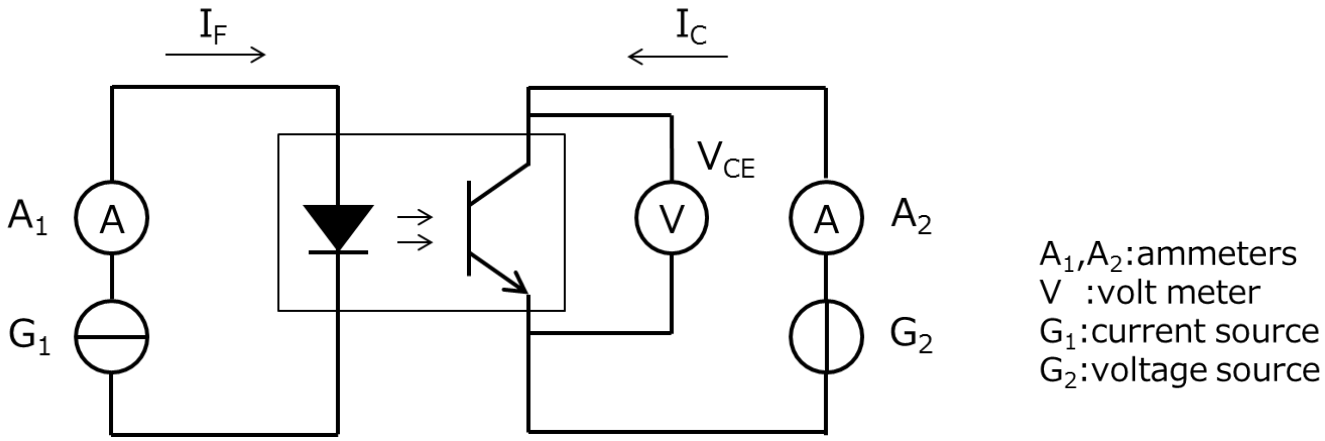

Fig. 2.1 Circuit for the measurement of current transfer ratio, I_C/I_F (CTR) - Transistor output

(2) Measurement procedure

1. The current source, G_1, is regulated to obtain the specified input current, I_F.
2. The voltage source, G_2, is regulated to the specified V_{CE} voltage.
3. The output current, I_C, is measured with the ammeter, A_2.
4. The current transfer ratio is calculated using the equation $I_C / I_F \times 100$ (%), where I_F and I_C are the values obtained at Steps 1 and 3.

3. Measurement procedure for threshold input current, $I_{FHL}(I_{FLH})$
- IC output

(1) Circuit diagram

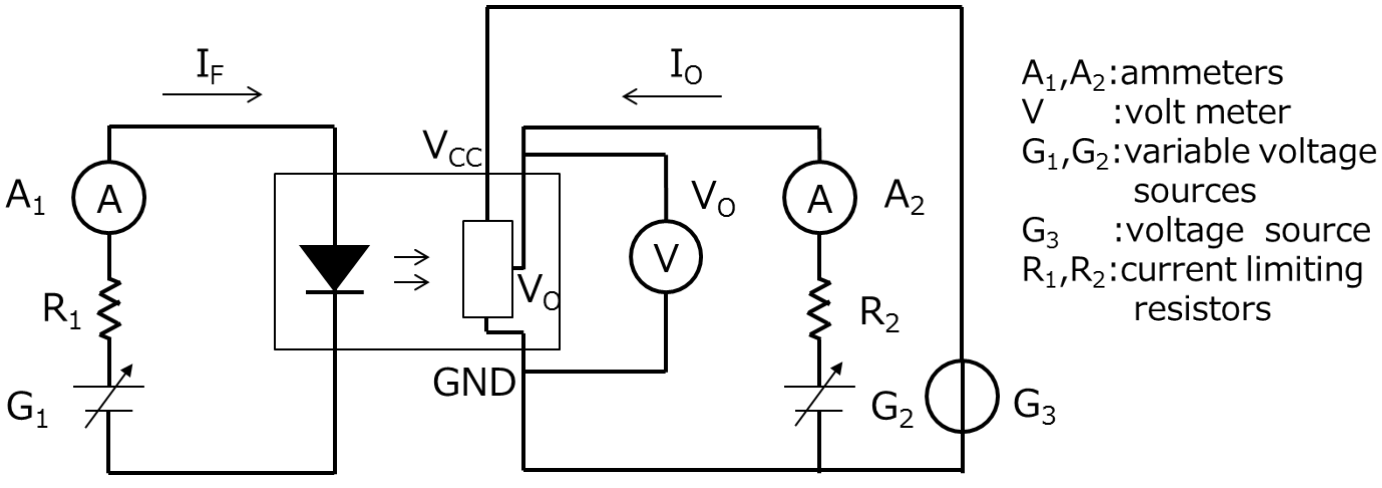

Fig. 2.2 Circuit for the measurement of threshold input current, I_{FHL} (I_{FLH}) - IC output

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(2) Measurement procedure

1. The specified supply voltage is applied to the V_{CC} power supply pin from the voltage source, G_3. The input current, I_F, is held at zero. Voltage is applied to the output pin from the variable voltage source, G_2, through the limiting resistor, R_2.
2. The input current, I_F, is gradually increased from zero with the variable voltage source, G_1, while the output voltage, V_O, is monitored with the voltmeter, V.
3. The input current, I_F, is measured right after the output has switched from the High level (Low level) to the Low level (High level) as prescribed by the specified output voltage (current) condition.
4. The I_F value is defined as the threshold input current, I_{FHL} (I_{FLH}).

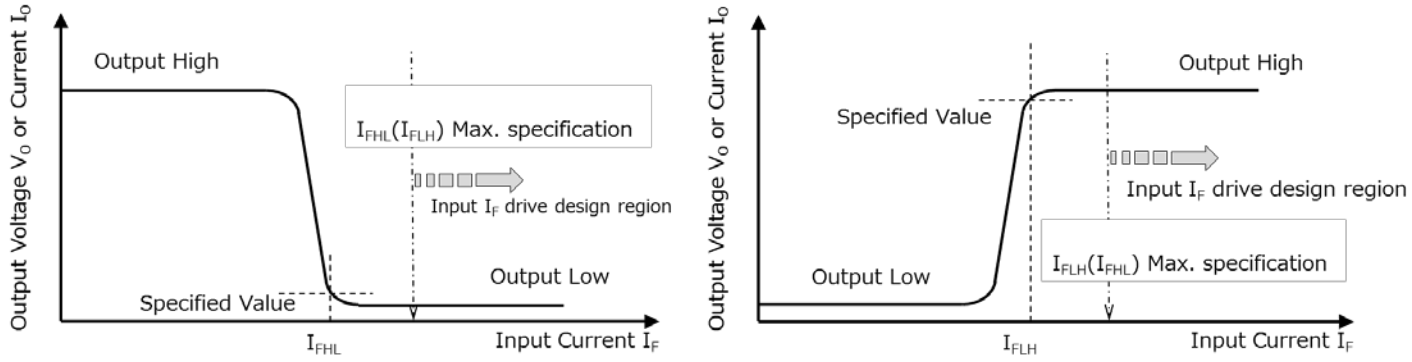

Fig. 2.3 Threshold input current, I_{FHL}(I_{FLH}) - IC output

4. Measurement procedure for trigger LED current, I_{FT}

4.1 Traic output

(1) Circuit diagram

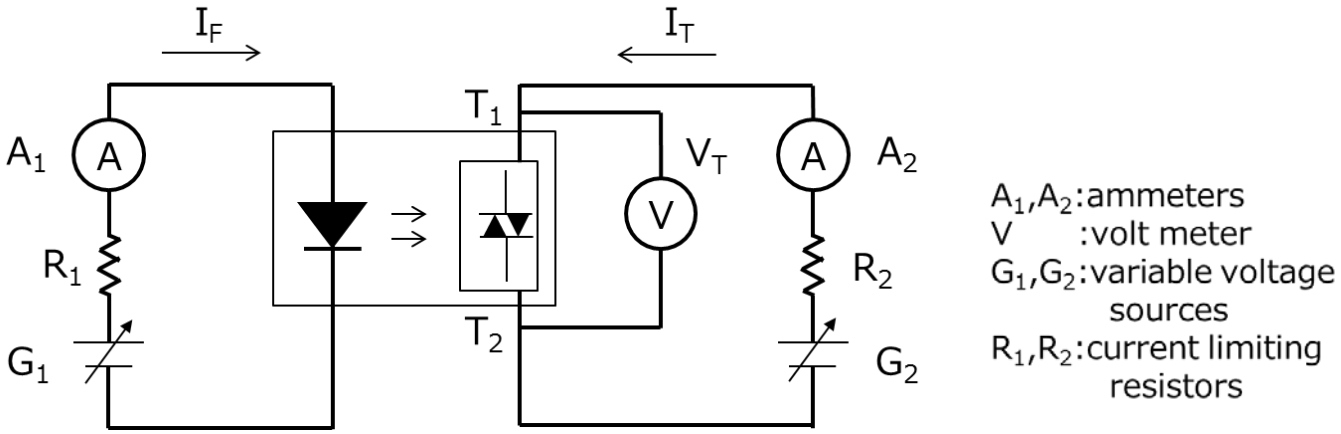

Fig. 2.4 Circuit for the measurement of trigger LED current I_{FT} - Triac output

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(2) Measurement procedure

1. The input current, I_F, is held at zero. Voltage is applied across T_1 and T_2 from the variable voltage source, G_2, through the limiting resistor, R_2.
2. The input current, I_F, is gradually increased from zero with the variable voltage source, G_1, while the output voltage, V_T, is monitored with the voltmeter, V.
3. The input current, I_F, is measured right after the output has switched from the OFF state to the ON state as prescribed by the specified output voltage (current) condition.
4. The I_F value is defined as the trigger LED current, I_{FT}.

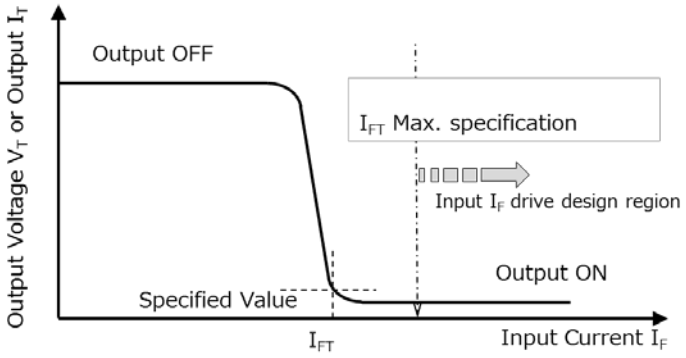

Fig. 2.5 Trigger LED current, I_{FT} - Triac output

4.2 Photorelay (MOSFET output)

(1) Circuit diagram

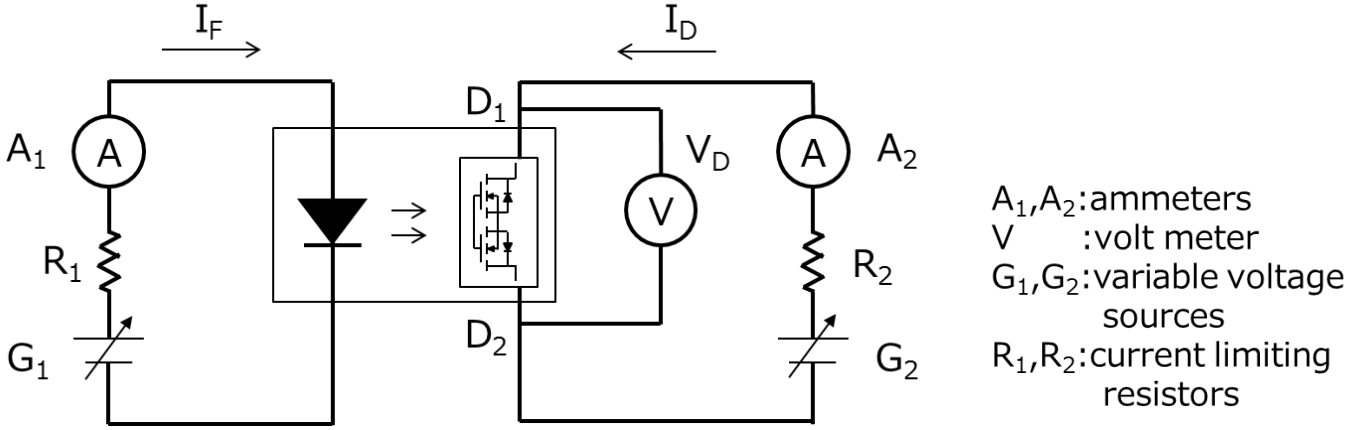

Fig. 2.6 Circuit diagram for Trigger LED current I_{FT}(I_{FC}) - Photorelay(MOSFET output)

(2) Measurement procedure

1. The input current, I_F, is held at zero. Voltage is applied across D_1 to D_2 from the variable voltage source, G_2, through the limiting resistor, R_2
2. The input current, I_F, is gradually increased from zero with the variable voltage source, G_1, while the output voltage, V_D, is monitored with the voltmeter, V.

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3. The input current, I_F, is measured right after the output has switched from the OFF state (ON state) to the ON state (OFF state) as prescribed by the specified output current (I_D) condition.
4. The I_F value is defined as the trigger LED current, I_{FT}(contact a) or (I_{FC}(contact b)).

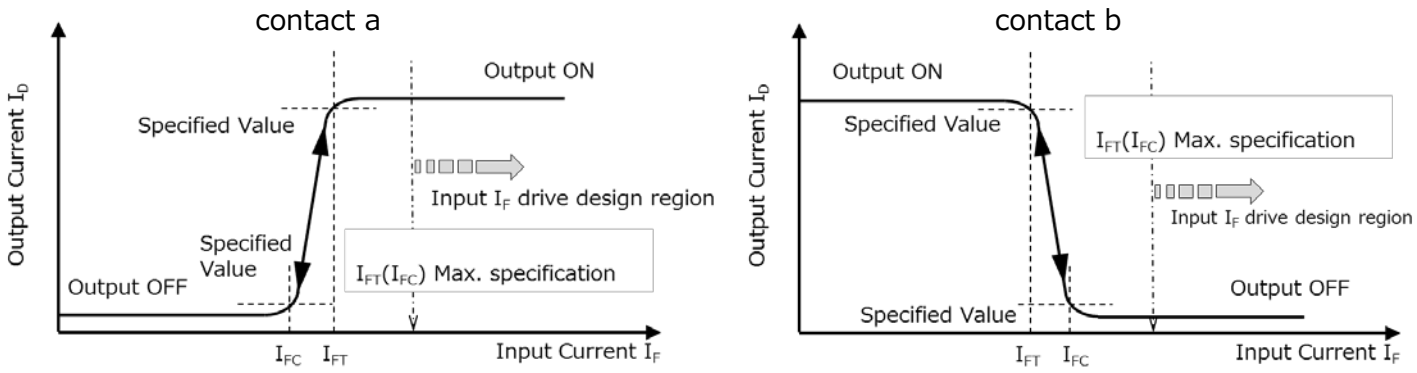

Fig. 2.7 Trigger LED current, I_{FT} (I_{FC}) - Photorelay (MOSFET output)

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