

## Photocouplers LTV-3120 series

### 1. DESCRIPTION

The LTV-3120 optocoupler is ideally suited for driving power IGBTs and MOSFETs used in motor control inverter applications and inverters in power supply system. It contains an AlGaAs LED optically coupled to an integrated circuit with a power output stage. The 2.5A peak output current is capable of directly driving most IGBTs with ratings up to 1200 V/100 A. For IGBTs with higher ratings, the LTV-3120 series can be used to drive a discrete power stage which drives the IGBT gate.

The Optocoupler operational parameters are guaranteed over the temperature range from  $-40^{\circ}\text{C} \sim +105^{\circ}\text{C}$ .

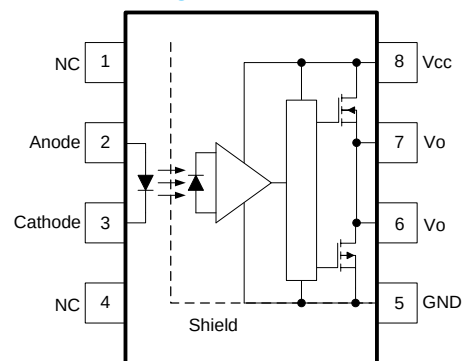
#### 1.1 Features

- 2.5 A maximum peak output current
- 2.0 A minimum peak output current
- Rail-to-rail output voltage
- 400 ns maximum propagation delay
- 150 ns maximum propagation delay difference
- Under Voltage Lock-Out protection (UVLO) with hysteresis
- 15 kV/us minimum Common Mode Rejection (CMR) at  $V_{\text{CM}} = 1500 \text{ V}$
- $I_{\text{CC}} = 3.0 \text{ mA}$  maximum supply current
- Wide operating range: 15 to 30 Volts ( $V_{\text{CC}}$ )
- Guaranteed performance over temperature  $-40^{\circ}\text{C} \sim +105^{\circ}\text{C}$ .
- Offer low power dissipation with  $R_{\text{ON}} \leq 1\Omega$
- MSL Level 1
- Safety approval:
  - UL/ cUL Recognized 5000  $V_{\text{RMS}}/1 \text{ min}$
  - IEC/EN/DIN EN 60747-5-5  $V_{\text{IORM}} = 630 \text{ Vpeak}$

#### 1.2 Applications

- IGBT/MOSFET gate drive
- Uninterruptible power supply (UPS)
- Industrial Inverter
- AC/Brushless DC motor drives

#### Functional Diagram



A 0.1µF bypass Capacitor must be connected between Pin 5 and 8. See note 11.

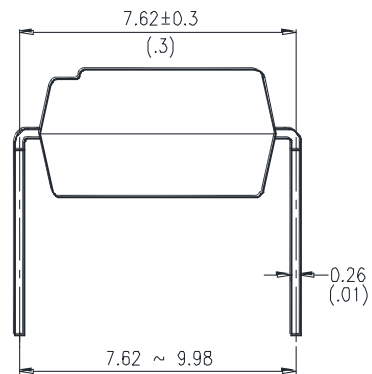
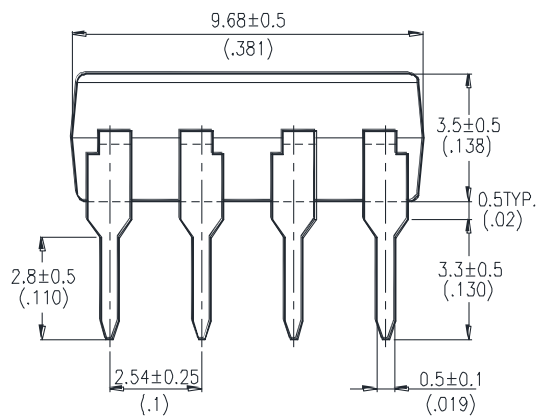
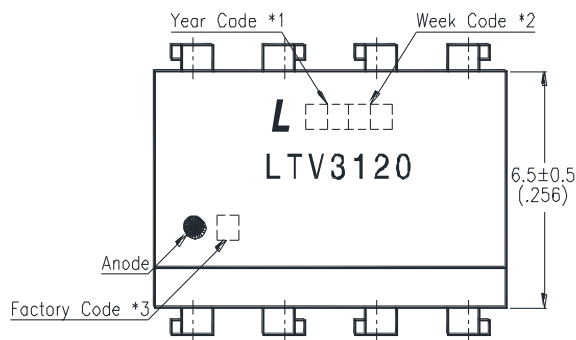
#### Truth Table

| LED | $V_{\text{CC}}-\text{GND}$<br>(Turn-ON,<br>+ve going) | $V_{\text{CC}}-\text{GND}$<br>(Turn-OFF,<br>-ve going) | $V_{\text{O}}$ |
|-----|-------------------------------------------------------|--------------------------------------------------------|----------------|
| OFF | 0 - 30 V                                              | 0 - 30 V                                               | Low            |
| ON  | 0 - 11.0 V                                            | 0 - 9.5 V                                              | Low            |
| ON  | 11.0 - 13.5 V                                         | 9.5 - 12 V                                             | Transition     |
| ON  | 13.5 - 30 V                                           | 12 - 30 V                                              | High           |

## Photocouplers LTV-3120 series

### 2. PACKAGE DIMENSIONS

#### 2.1 LTV-3120



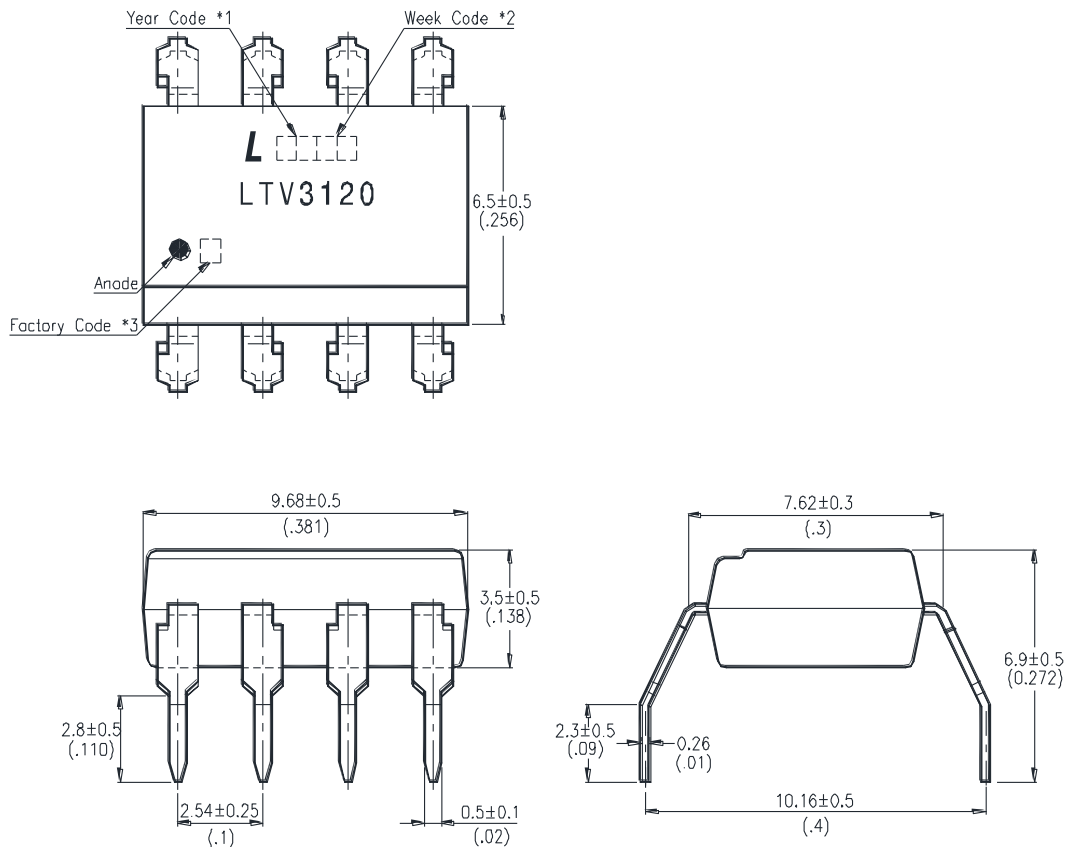
#### Notes :

- \*1. Year date code.
- \*2. 2-digit work week.
- \*3. Factory identification mark  
(Y : Thailand).

Dimensions are in Millimeters and (Inches).

## Photocouplers LTV-3120 series

### 2.2 LTV-3120M



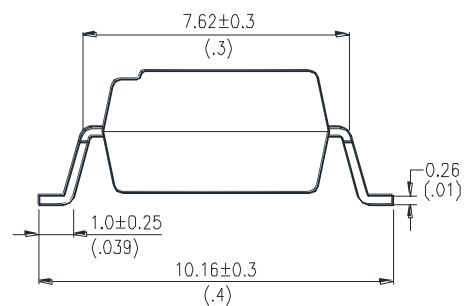
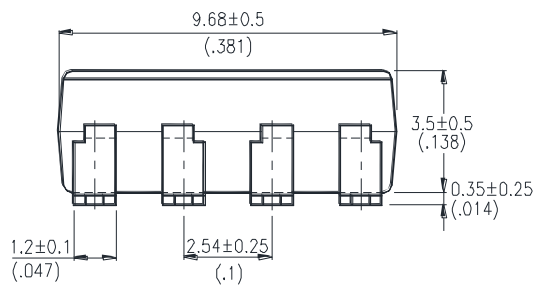
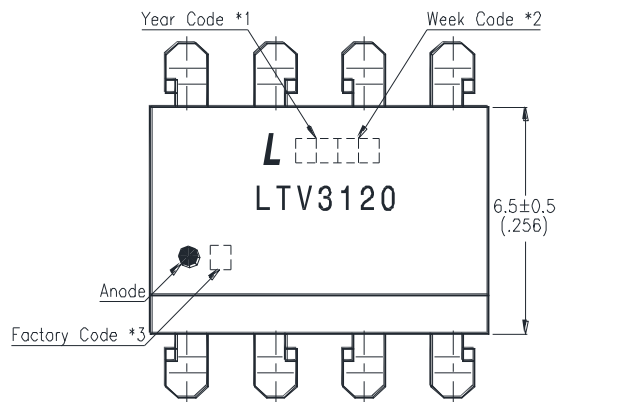
#### Notes

- \*1. Year date code.
- \*2. 2-digit work week.
- \*3. Factory identification mark  
(Y : Thailand).

Dimensions are in Millimeters and (Inches).

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### 2.3 LTV-3120S



#### Notes :

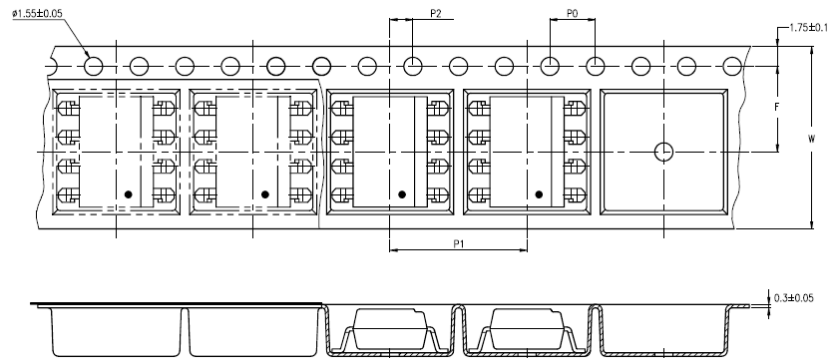
- \*1. Year date code.
- \*2. 2-digit work week.
- \*3. Factory identification mark  
(Y : Thailand).

Dimensions are in Millimeters and (Inches).

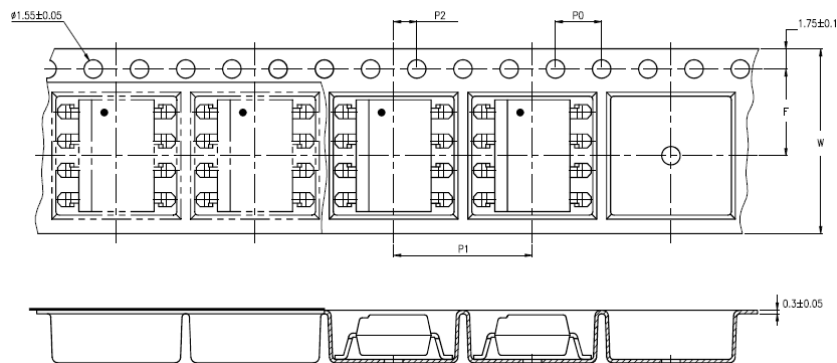
## Photocouplers LTV-3120 series

### 3. TAPING DIMENSIONS

#### 3.1 LTV-3120S-TA



#### 3.2 LTV-3120S-TA1



| Description                            | Symbol         | Dimension in mm (inch) |
|----------------------------------------|----------------|------------------------|
| Tape wide                              | W              | 16 $\pm$ 0.3 (0.63)    |
| Pitch of sprocket holes                | P <sub>0</sub> | 4 $\pm$ 0.1 (0.15)     |
| Distance of compartment                | F              | 7.5 $\pm$ 0.1 (0.295)  |
|                                        | P <sub>2</sub> | 2 $\pm$ 0.1 (0.079)    |
| Distance of compartment to compartment | P <sub>1</sub> | 12 $\pm$ 0.1 (0.47)    |

#### 3.3 Quantities Per Reel

| Package Type     | LTV-3120 |
|------------------|----------|
| Quantities (pcs) | 1000     |

## Photocouplers LTV-3120 series

### 4. RATING AND CHARACTERISTICS

#### 4.1 Absolute Maximum Ratings

| Parameter                                                          | Symbol                  | Min  | Max      | Unit      | Note |
|--------------------------------------------------------------------|-------------------------|------|----------|-----------|------|
| Storage Temperature                                                | $T_{stg}$               | -55  | +125     | °C        |      |
| Operating Temperature                                              | $T_{opr}$               | -40  | +105     | °C        |      |
| Output IC Junction Temperature                                     | $T_J$                   |      | 125      | °C        |      |
| Isolation Voltage                                                  | $V_{iso}$               | 5000 |          | $V_{RMS}$ |      |
| Total Output Supply Voltage                                        | $(V_{CC} - V_{EE})$     | 0    | 35       | V         |      |
| Average Forward Input Current                                      | $I_F$                   |      | 25       | mA        |      |
| Reverse Input Voltage                                              | $V_R$                   |      | 5        | V         |      |
| Peak Transient Input Current<br>( $<1 \mu s$ pulse width, 300 pps) | $I_{F(TRAN)}$           |      | 1        | A         |      |
| “High” Peak Output Current                                         | $I_{OH(PEAK)}$          |      | 2.5      | A         | 1    |
| “Low” Peak Output Current                                          | $I_{OL(PEAK)}$          |      | 2.5      | A         | 1    |
| Input Current (Rise/Fall Time)                                     | $t_{r(IN)} / t_{f(IN)}$ |      | 500      | ns        |      |
| Output Voltage                                                     | $V_{O(PEAK)}$           | -0.5 | $V_{CC}$ | V         |      |
| Power Dissipation                                                  | $P_I$                   |      | 40       | mW        |      |
| Output Power Dissipation                                           | $P_O$                   |      | 250      | mW        |      |
| Total Power Dissipation                                            | $P_T$                   |      | 295      | mW        |      |
| Lead Solder Temperature                                            | $T_{sol}$               |      | 260      | °C        |      |

Ambient temperature = 25°C, unless otherwise specified. Stresses exceeding the absolute maximum ratings can cause permanent damage to the device. Exposure to absolute maximum ratings for long periods of time can adversely affect reliability.

#### 4.2 Recommended Operating Conditions

| Parameter             | Symbol       | Min  | Max | Unit |
|-----------------------|--------------|------|-----|------|
| Operating Temperature | $T_A$        | -40  | 105 | °C   |
| Supply Voltage        | $V_{CC}$     | 15   | 30  | V    |
| Input Current (ON)    | $I_{FL(ON)}$ | 7    | 16  | mA   |
| Input Voltage (OFF)   | $V_{F(OFF)}$ | -3.0 | 0.8 | V    |

## Photocouplers LTV-3120 series

### 4.3 ELECTRICAL OPTICAL CHARACTERISTICS

|        | Parameter                                     | Symbol                  | Min.            | Typ.           | Max.            | Unit  | Test Condition                                                  | Figure      | Note |
|--------|-----------------------------------------------|-------------------------|-----------------|----------------|-----------------|-------|-----------------------------------------------------------------|-------------|------|
| Input  | Input Forward Voltage                         | $V_F$                   | 1.2             | 1.37           | 1.8             | V     | $I_F = 10\text{mA}$                                             | 13          |      |
|        | Input Forward Voltage Temperature Coefficient | $\Delta V_F / \Delta T$ |                 | -1.237         |                 | mV/°C | $I_F = 10\text{mA}$                                             |             |      |
|        | Input Reverse Voltage                         | $BV_R$                  | 5               |                |                 | V     | $I_R = 10\mu\text{A}$                                           |             |      |
|        | Input Threshold Current (Low to High)         | $I_{FLH}$               |                 | 1.4            | 5               | mA    | $R_g = 10\Omega$ ,<br>$C_g = 25\text{nF}$ , $V_O > 5\text{V}$   | 6,<br>7, 18 |      |
|        | Input Threshold Voltage (High to Low)         | $V_{FHL}$               | 0.8             |                |                 | V     |                                                                 |             |      |
|        | Input Capacitance                             | $C_{IN}$                |                 | 33             |                 | pF    | $f = 1\text{MHz}$ , $V_F = 0\text{V}$                           |             |      |
| Output | High Level Supply Current                     | $I_{CCH}$               |                 | 1.9            | 3.0             | mA    | $R_g = 10\Omega$ ,<br>$C_g = 25\text{nF}$ , $I_F = 10\text{mA}$ | 4, 5        |      |
|        | Low Level Supply Current                      | $I_{CCL}$               |                 | 2.1            | 3.0             | mA    | $R_g = 10\Omega$ ,<br>$C_g = 25\text{nF}$ , $V_F = 0\text{V}$   |             |      |
|        | High level output current                     | $I_{OH}$                |                 | -2.0           | -1.0            | A     | $V_O = (V_{CC} - 2.5\text{V})$                                  | 16          | 1    |
|        |                                               |                         |                 | -              | -2.5            |       | $V_{CC} - V_O \leq 15\text{V}$                                  |             | 2    |
|        | Low level output current                      | $I_{OL}$                | 1.0             | 2.0            |                 | A     | $V_O = (V_{CC} + 2.0\text{V})$                                  | 17          | 1    |
|        |                                               |                         | 2.5             |                |                 |       | $V_{CC} - V_{EE} \leq 15\text{V}$                               |             | 3    |
|        | High level output voltage                     | $V_{OH}$                | $V_{CC} - 0.25$ | $V_{CC} - 0.1$ |                 | V     | $I_F = 10\text{mA}$ ,<br>$I_O = -100\text{mA}$                  | 1, 2,<br>14 | 4    |
|        | Low level output voltage                      | $V_{OL}$                |                 | $V_{EE} + 0.1$ | $V_{EE} + 0.25$ | V     | $I_F = 0\text{mA}$ , $I_O = 100\text{mA}$                       | 3, 15       |      |
|        | UVLO Threshold                                | $V_{UVLO+}$             | 11.0            | 12.7           | 13.5            | V     | $V_O > 5\text{V}$ , $I_F = 10\text{mA}$                         | 19          |      |
|        |                                               | $V_{UVLO-}$             | 9.5             | 11.2           | 12.0            | V     | $V_O < 5\text{V}$ , $I_F = 10\text{mA}$                         |             |      |
|        | UVLO Hysteresis                               | $UVLO_{HYS}$            |                 | 1.5            |                 | V     |                                                                 |             |      |

All Typical values at  $T_A = 25^\circ\text{C}$  and  $V_{CC} - V_{EE} = 30\text{V}$ , unless otherwise specified; all minimum and maximum specifications are at recommended operating condition. (As page 6)

## Photocouplers LTV-3120 series

### 5. SWITCHING SPECIFICATION

| Parameter                                                      | Symbol    | Min. | Typ. | Max. | Unit        | Test Condition                                                                                                                                                                     | Figure                     | Note |
|----------------------------------------------------------------|-----------|------|------|------|-------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------|------|
| Propagation Delay Time to High Output Level                    | $t_{PHL}$ | 100  | 242  | 400  | ns          | $R_g = 10\Omega$ ,<br>$C_g = 25nF$ ,<br>$f = 20\text{ kHz}$ ,<br>Duty Cycle = 50%<br>$I_F = 7\text{ to }16\text{ mA}$ ,<br>$V_{CC} = 15\text{ to }30V$<br>$V_{EE} = \text{ground}$ | 8, 9, 10,<br>11, 12,<br>20 |      |
| Propagation Delay Time to Low Output Level                     | $t_{PLH}$ | 100  | 183  | 400  |             |                                                                                                                                                                                    |                            |      |
| Pulse Width Distortion                                         | PWD       |      | -60  | -120 |             |                                                                                                                                                                                    |                            | 10   |
| Propagation delay difference between any two parts or channels | PDD       | -150 |      | 150  |             |                                                                                                                                                                                    |                            | 7    |
| Output Rise Time (20 to 80%)                                   | $T_r$     |      | 42   |      |             |                                                                                                                                                                                    | 20                         |      |
| Output Fall Time (80 to 20%)                                   | $T_f$     |      | 50   |      |             |                                                                                                                                                                                    |                            |      |
| Common mode transient immunity at high level output            | CMH       | 15   |      |      | kV/ $\mu s$ | $T_A = 25^\circ C$ ,<br>$I_F = 10\text{ to }16\text{ mA}$ ,<br>$V_{CM} = 1500\text{ V}$ ,<br>$V_{CC} = 30\text{ V}$                                                                | 21                         | 8    |
| Common mode transient immunity at low level output             | CML       | 15   |      |      | kV/ $\mu s$ | $T_A = 25^\circ C$ ,<br>$V_F = 0\text{ V}$ ,<br>$V_{CM} = 1500\text{ V}$ ,<br>$V_{CC} = 30\text{ V}$                                                                               |                            | 9    |

All Typical values at  $T_A = 25^\circ C$  and  $V_{CC} - V_{EE} = 30\text{ V}$ , unless otherwise specified; all minimum and maximum specifications are at recommended operating condition. (As page 6)



## Photocouplers LTV-3120 series

### 6. ISOLATION CHARACTERISTIC

| Parameter                         | Symbol    | Min. | Typ.                 | Max. | Unit     | Test Condition                                                   | Note |
|-----------------------------------|-----------|------|----------------------|------|----------|------------------------------------------------------------------|------|
| Withstand Insulation Test Voltage | $V_{ISO}$ | 5000 | —                    | —    | V        | $RH \leq 50\%$ , $t = 1\text{min}$ ,<br>$T_A = 25^\circ\text{C}$ | 5, 6 |
| Input-Output Resistance           | $R_{I-O}$ | —    | $6.5 \times 10^{11}$ | —    | $\Omega$ | $V_{I-O} = 500\text{V DC}$                                       | 5    |
| Input-Output Capacitance          | $C_{I-O}$ | —    | 1.0                  | —    | pF       | $f = 1\text{MHz}$                                                |      |

All Typical values at  $T_A = 25^\circ\text{C}$  unless otherwise specified. All minimum and maximum specifications are at recommended operating condition. (As page 6)

#### Notes:

- Maximum pulse width =  $10\mu\text{s}$ , maximum duty cycle = 0.2%.
- Output is sourced at -2.5 A with a maximum pulse width =  $10\mu\text{s}$ .  $V_{CC}-V_O$  is measured to ensure 15 V or below.
- Output is sourced at 2.5 A with a maximum pulse width =  $10\mu\text{s}$ .  $V_O-V_{EE}$  is measured to ensure 15 V or below.
- In this test  $V_{OH}$  is measured with a DC load current. When driving capacitive loads,  $V_{OH}$  will approach  $V_{CC}$  as  $I_{OH}$  approaches zero amps.
- Device is considered a two terminal device: pins 1, 2, 3 and 4 are shorted together and pins 5, 6, 7 and 8 are shorted together.
- According to UL1577, each photocoupler is tested by applying an insulation test voltage  $5250 V_{RMS}$  for one second (leakage current less than  $10\mu\text{A}$ ). This test is performed before the 100% production test for partial discharge
- The difference between  $T_{PHL}$  and  $T_{PLH}$  between any two LTV-3120 parts under same test conditions.
- Common mode transient immunity in high stage is the maximum tolerable negative  $dV_{CM}/dt$  on the trailing edge of the common mode impulse signal,  $V_{CM}$ , to assure that the output will remain high.
- Common mode transient immunity in low stage is the maximum tolerable positive  $dV_{CM}/dt$  on the leading edge of the common mode impulse signal,  $V_{CM}$ , to assure that the output will remain low.
- Pulse Width Distortion is defined as  $T_{PHL} - T_{PLH}$  for any given device.
- At least a  $0.1\mu\text{F}$  or bigger bypass capacitor must be connected/ closed across pin 8 and pin 5. Failure to provide the bypass may impair the switching property. Normally, it is recommended to place a  $1\mu\text{F}$  multi-layer ceramic capacitor. To parallel one larger capacitor ( $>1\mu\text{F}$ ) to optimize performance is better.

## Photocouplers LTV-3120 series

### 7. TYPICAL PERFORMANCE CURVES & TEST CIRCUITS

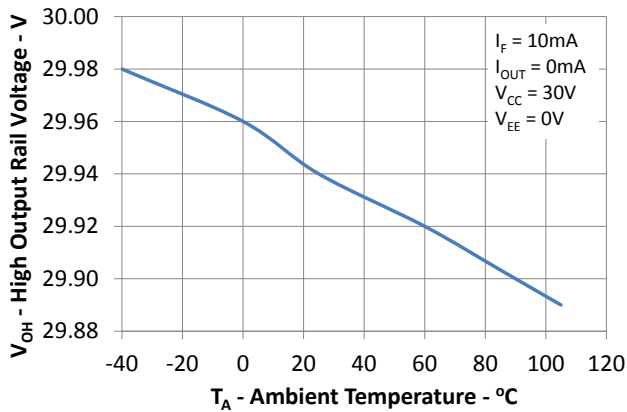


Figure 1: High output rail voltage vs. Temperature

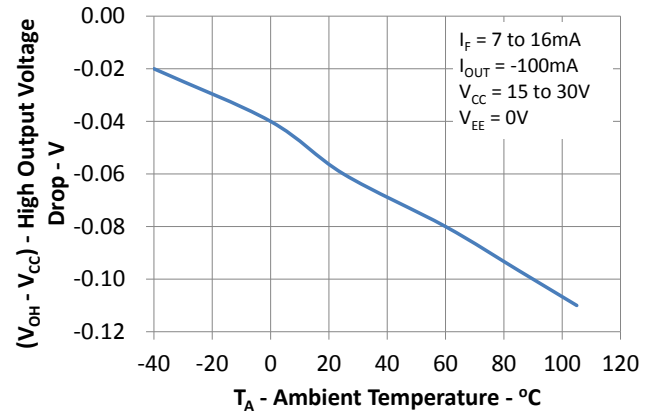


Figure 2:  $V_{OH}$  vs. Temperature

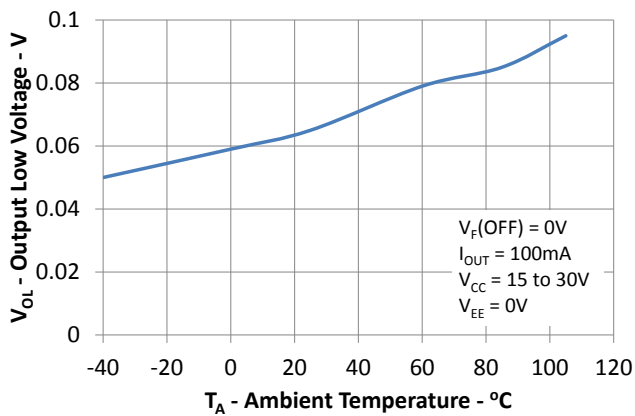


Figure 3:  $V_{OL}$  vs. Temperature

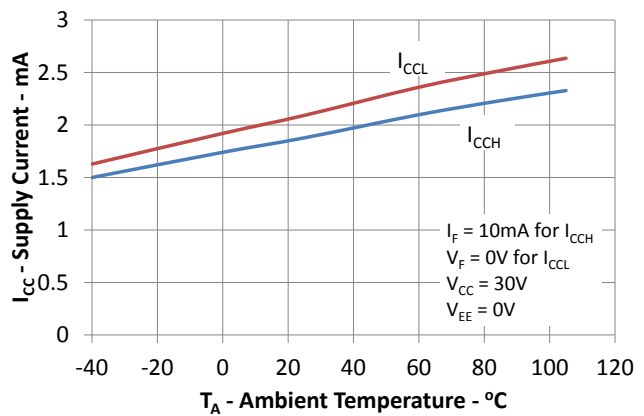


Figure 4:  $I_{CC}$  vs. Temperature

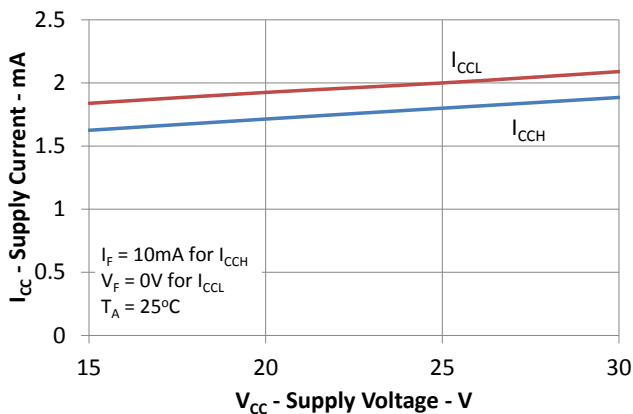


Figure 5:  $I_{CC}$  vs.  $V_{CC}$

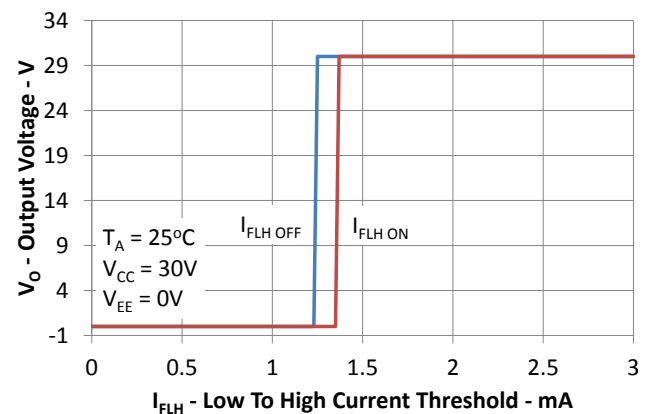


Figure 6: IFLH Hysteresis

## Photocouplers LTV-3120 series

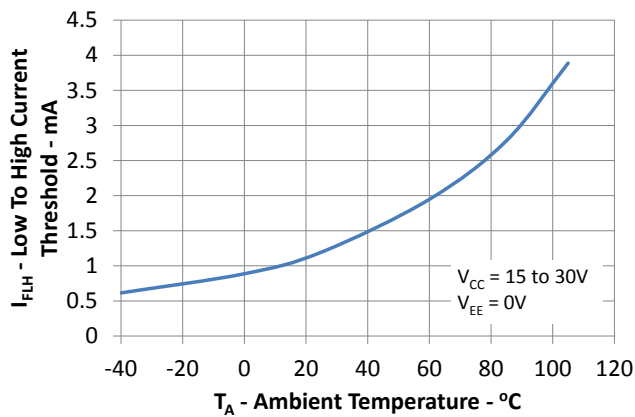


Figure 7:  $I_{FLH}$  vs. Temperature

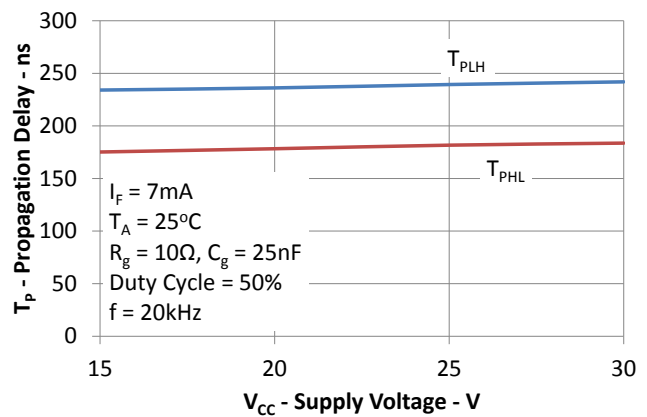


Figure 8: Propagation Delays vs.  $V_{CC}$

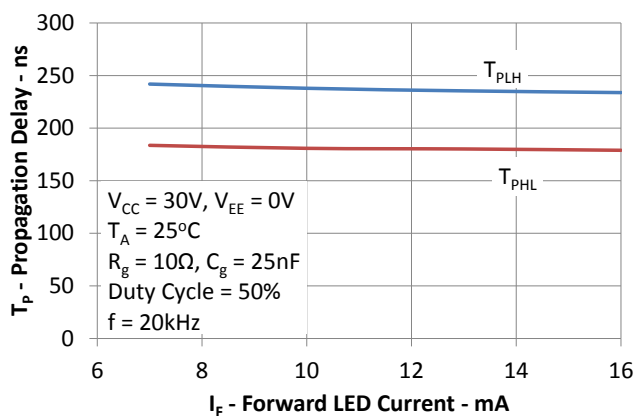


Figure 9: Propagation Delays vs.  $I_F$

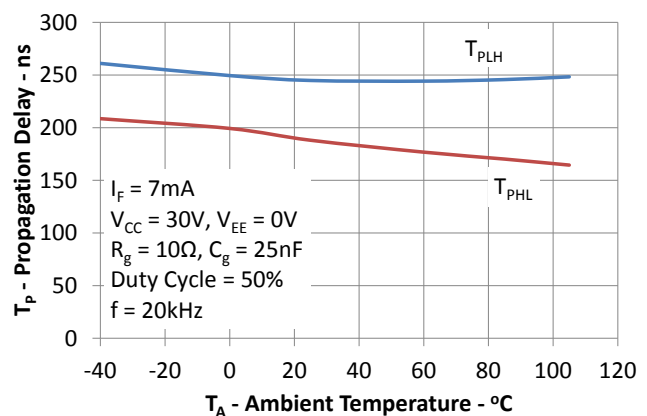


Figure 10: Propagation Delays vs. Temperature

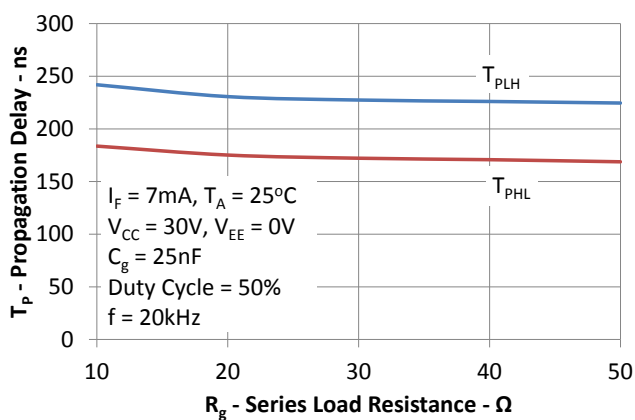


Figure 11: Propagation Delays vs.  $R_g$

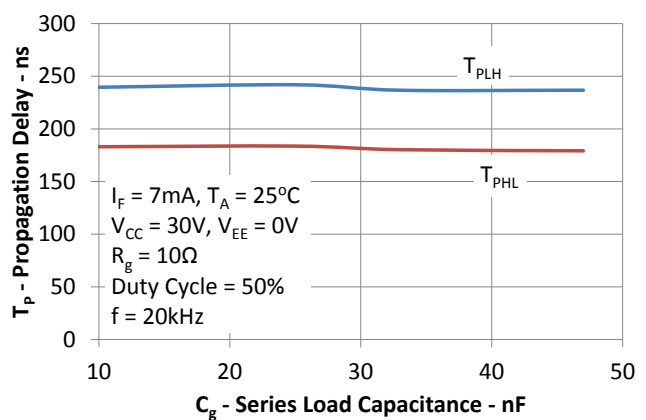


Figure 12: Propagation Delays vs.  $C_g$

# Photocouplers LTV-3120 series

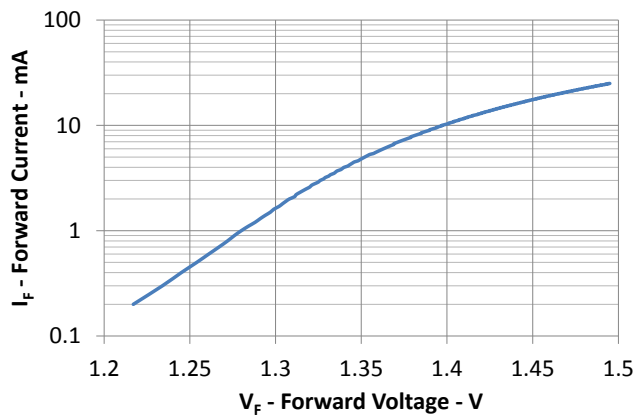


Figure 13: Input Current vs. Forward Voltage

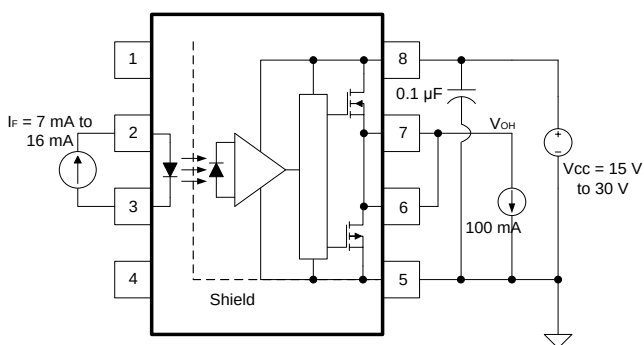


Figure 14 : V<sub>OH</sub> Test Circuit

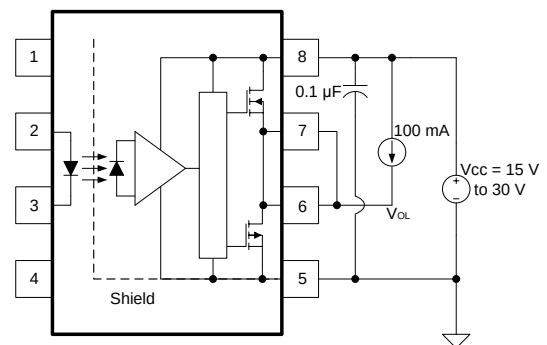


Figure 15 : V<sub>OL</sub> Test Circuit

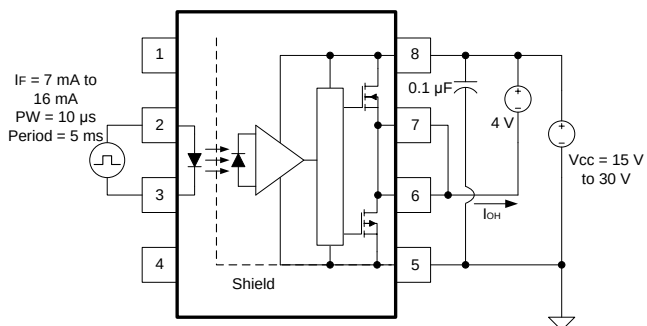


Figure 16 : I<sub>OH</sub> Test Circuit

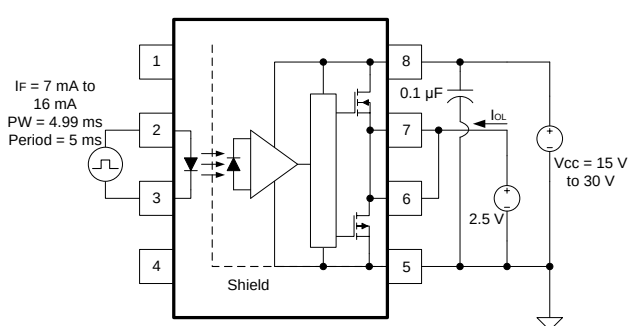


Figure 17 : I<sub>OL</sub> Test Circuit

## Photocouplers LTV-3120 series

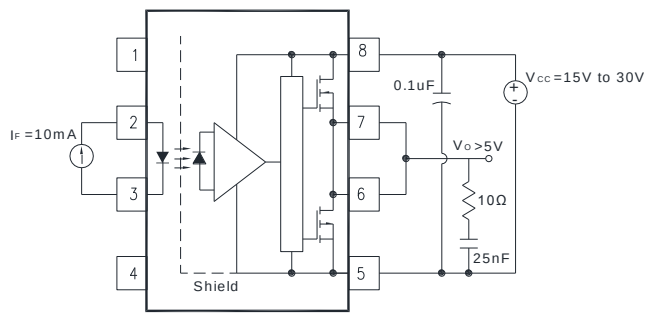


Figure 18 :  $I_{FLH}$  Test Circuit

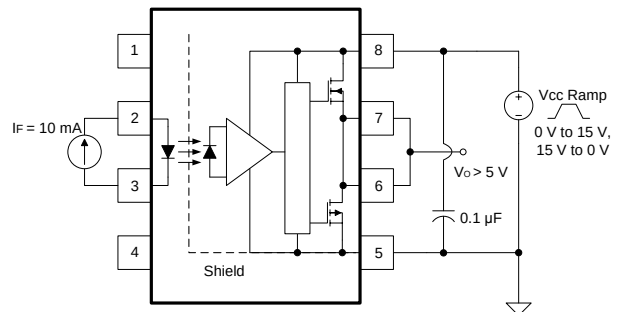


Figure 19 : UVLO Test Circuit

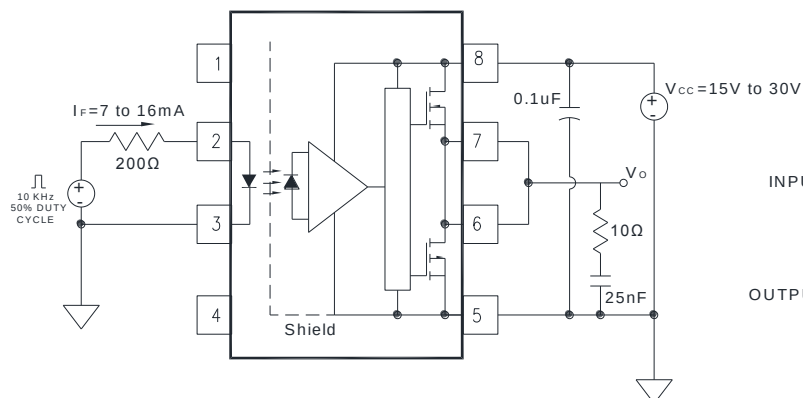


Figure 20 :  $t_r$ ,  $t_f$ ,  $t_{PLH}$  and  $t_{PHL}$  Test Circuit and Waveforms

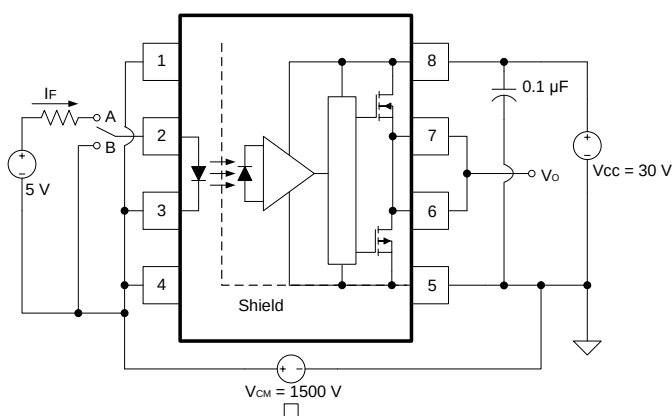
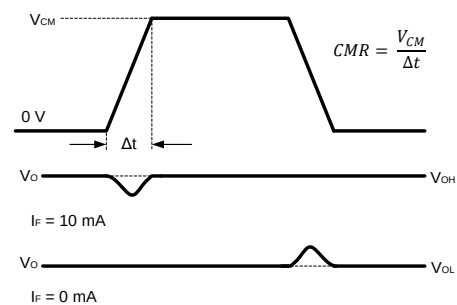


Figure 21 : CMR Test Circuit and Waveforms



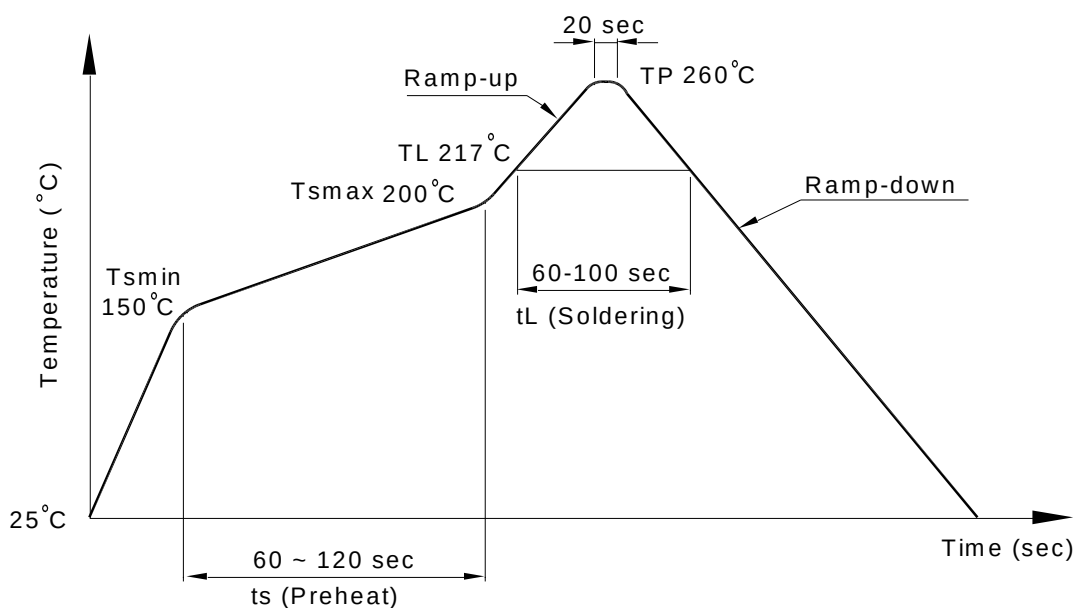
## Photocouplers LTV-3120 series

### 8. TEMPERATURE PROFILE OF SOLDERING

#### 8.1 IR Reflow soldering (JEDEC-STD-020C compliant)

One time soldering reflow is recommended within the condition of temperature and time profile shown below. Do not solder more than three times.

| Profile item                     | Conditions     |
|----------------------------------|----------------|
| Preheat                          |                |
| - Temperature Min ( $T_{Smin}$ ) | 150°C          |
| - Temperature Max ( $T_{Smax}$ ) | 200°C          |
| - Time (min to max) ( $t_s$ )    | 90±30 sec      |
| Soldering zone                   |                |
| - Temperature ( $T_L$ )          | 217°C          |
| - Time ( $t_L$ )                 | 60 ~ 100 sec   |
| Peak Temperature ( $T_P$ )       | 260°C          |
| Ramp-up rate                     | 3°C / sec max. |
| Ramp-down rate                   | 3~6°C / sec    |



## Photocouplers LTV-3120 series

### 8.2 Wave soldering (JEDEC22A111 compliant)

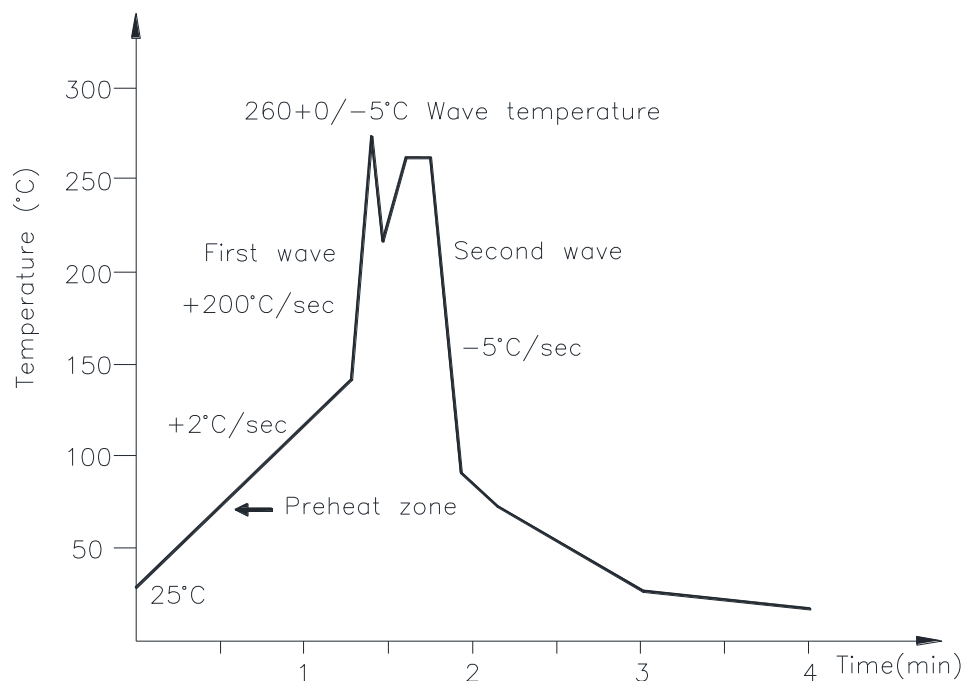
One time soldering is recommended within the condition of temperature.

Temperature:  $260 \pm 0/-5^{\circ}\text{C}$

Time: 10 sec.

Preheat temperature: 25 to  $140^{\circ}\text{C}$

Preheat time: 30 to 80 sec.



### 8.3 Hand soldering by soldering iron

Allow single lead soldering in every single process. One time soldering is recommended.

Temperature:  $380 \pm 0/-5^{\circ}\text{C}$

Time: 3 sec max.

## Photocouplers LTV-3120 series

### 9. ORDERING INFORMATION

| Parameter | Option | Minimum CMR  |                     | Input-On<br>Current<br>(mA) | Remark                            |
|-----------|--------|--------------|---------------------|-----------------------------|-----------------------------------|
|           |        | dV/dt (V/μs) | V <sub>CM</sub> (V) |                             |                                   |
| LTV-3120  |        | 15,000       | 1500                | 10                          | Single Channel, DIP-8             |
|           | M      |              |                     |                             | Single Channel, Wide Lead Spacing |
|           | S      |              |                     |                             | Single Channel, SMD-8             |