

# Photo IC for optical link

L11354-02

S11355-04



Transmitter  
photo IC  
L11354-02



Receiver  
photo IC  
S11355-04

## For 150 Mbps optical link

These photo ICs are capable of data communication at a transmission speed of 150 Mbps through a plastic optical fiber (POF). The transmitter is composed of a 650 nm RC (resonant cavity) type LED, which is suitable for POF communications, and a driver circuit that supports an LVDS interface. The transmitter has a built-in temperature compensation function that adjusts for the reduction in the light emission power caused by the high temperature of the RC type LED. This function makes light emission with stable power possible over a wide temperature range. The receiver is composed of a PIN photodiode and signal processing circuit. The adoption of a full differential structure using a dummy photodiode eliminates the effects of external noise, achieving high sensitivity. In addition, the photo IC has a sleep function that suppresses power consumption by switching to standby mode when there is no input.

These products feature high quality and high reliability, allowing it to be installed even in automobiles for in-vehicle networking. It is already used as an fiber optical transceiver (FOT) for a MOST network, which is a type of in-vehicle multimedia network.

### Features

- Communication speed up to 150 Mbps
- 3.3 V power supply operation
- Wide operating temperature: -40 to +95 °C
- Suitable for reflow soldering
- Sleep mode function

### Applications

- Data transmission in harsh, noisy environments, such as in FA and OA
- High-speed, short-distance data transmission
- Only for vehicle networks (MOST)

MOST compliant products

Specifications of these products are subject to change without prior notice to keep up with changes in the MOST standard.

### Absolute maximum ratings

| Parameter               | Symbol              | Condition        | Value           | Unit |
|-------------------------|---------------------|------------------|-----------------|------|
| Supply voltage          | L11354-02<br>Vcc_TX | Ta=-40 to +95 °C | -0.5 to +4.5    | V    |
|                         | S11355-04<br>Vcc_RX |                  | -0.5 to +4.6    |      |
| Input voltage           | Vi                  | Ta=-40 to +95 °C | -0.5 to Vcc+0.5 | V    |
| Power dissipation       | L11354-02           | Ta=-40 to +95 °C | 350             | mW   |
|                         | S11355-04           |                  | 320             |      |
| Operating temperature   | Topr                |                  | -40 to +95      | °C   |
| Storage temperature     | Tstg                |                  | -40 to +110     | °C   |
| Soldering temperature*1 | Tsol                |                  | 260 (3 times)   | °C   |

\*1: Reflow soldering, JEDEC J-STD-020 MSL 2a, see P.12

Note: Exceeding the absolute maximum ratings even momentarily may cause a drop in product quality. Always be sure to use the product within the absolute maximum ratings.

### Recommended operating conditions

| Parameter      | Symbol | Condition  | Min.  | Typ. | Max.  | Unit |
|----------------|--------|------------|-------|------|-------|------|
| Supply voltage | Vcc    |            | 3.135 | 3.3  | 3.465 | V    |
| Data rate      | fD     | DCA coding | -     | -    | 150   | Mbps |

L11354-02

**Electrical and optical characteristics\*2 (Ta=-40 to +95 °C, Vcc=3.135 to 3.465, unless otherwise noted\*3)**

| Parameter                      | Symbol                  | Condition         | Min.                    | Typ. | Max.   | Unit |
|--------------------------------|-------------------------|-------------------|-------------------------|------|--------|------|
| Current consumption            | I <sub>cc</sub>         | *4                | -                       | -    | 40     | mA   |
| Peak emission wavelength       | λ <sub>C2</sub>         |                   | 635                     | 650  | 675    | nm   |
| Spectral width (RMS)           | σ <sub>λ2</sub>         |                   | -                       | -    | 17     | nm   |
| Fiber coupled optical output 1 | P <sub>o1</sub>         |                   | -7                      | -    | -1.5   | dBm  |
| Fiber coupled optical output 2 | P <sub>oFF2</sub>       |                   | -                       | -    | -50    | dBm  |
| Extinction ratio               | re                      |                   | 10                      | -    | -      | dB   |
| Rise time                      | t <sub>r</sub>          | 20 to 80%, *4 *5  | -                       | -    | 0.5    | UI   |
| Fall time                      | t <sub>f</sub>          | 80 to 20%, *4 *5  | -                       | -    | 0.5    | UI   |
| Transfer jitter (RMS)          | J <sub>tr2</sub>        | *4 *5             | -                       | -    | 112    | ps   |
| Overshoot                      | r <sub>pos</sub>        | *5                | See "Overshoot" table.  |      |        | -    |
| Undershoot                     | r <sub>nos</sub>        | *5                | See "Undershoot" table. |      |        | -    |
| Input voltage level "/RST"     | V <sub>inRL</sub>       | *6                | -                       | -    | 0.8    | V    |
|                                | V <sub>inRH</sub>       | *6                | 2                       | -    | -      |      |
| Input current "/RST"           | I <sub>inRL</sub>       | /RST=Low          | -                       | -    | -0.1   | μA   |
|                                | I <sub>inRH</sub>       | /RST=High         | -                       | -    | 50     |      |
| Input current "TXN" "TXP"      | I <sub>inTXL</sub>      | TXN, TXP=Low      | -                       | -    | -0.1   | μA   |
|                                | I <sub>inTXH</sub>      | TXN, TXP=High     | -                       | -    | 0.1    |      |
| Frequency range                | During transmission     | F <sub>ON1</sub>  | 12                      | -    | 73.743 | MHz  |
|                                | During non-transmission | F <sub>OFF1</sub> | 0                       | -    | 10     | kHz  |
| Valid MOST data (SP2) time     | t <sub>ON2</sub>        | *7 *8             | -                       | -    | 100    | μs   |
|                                | t <sub>OFF2</sub>       | *7 *9             | -                       | -    | 2      | μs   |
| Eye mask                       | A2 to F2                |                   | See "Eye mask" table.   |      |        | -    |

\*2: Electrical interface conforms to LVDS standards except common mode input voltage.

\*3: Connect a bypass capacitor (0.1 μF) between Vcc and GND at a position within 3 mm from the leads. Also connect a 10 μF capacitor near the photo IC.

The center of the optical fiber is aligned with the center of the package lens. The distance between the fiber end and the lens top is 0.1 mm.

\*4: Input signal rate 150 Mbps (DCA coding)

\*5: Input signal

| Parameter                  | Symbol             | Min. | Typ. | Max.                     | Unit |
|----------------------------|--------------------|------|------|--------------------------|------|
| Differential input voltage | V <sub>id</sub>    | 200  | -    | 1272                     | mV   |
| Common mode input voltage  | V <sub>CM</sub>    | 0.05 | -    | V <sub>cc</sub> tx - 1.2 | V    |
| Total jitter               | t <sub>TJtp1</sub> | -    | -    | 0.15                     | UI   |
| Transfer jitter (RMS)      | J <sub>tr1</sub>   | -    | -    | 50                       | ps   |

\*6: /RST signal

| Parameter                  | Symbol             | Min.            | Max.  | Unit |
|----------------------------|--------------------|-----------------|-------|------|
| Valid supply voltage range | V <sub>VALID</sub> | 1               | 3.465 | V    |
| Logic switching threshold  | V <sub>T</sub>     | 2.97            | -     | V    |
| Logic delay time           | 0→1                | t <sub>D+</sub> | -     | ms   |
|                            | 1→0                | t <sub>D-</sub> | 100   | μs   |

Note: See "Timing chart (P.5)" for the /RST signal timing chart.

\*7: See "Timing chart (P.5)".

\*8: Delay time for light output to turn on

\*9: Delay time for light output to turn off

■ Overshoot

| Parameter | Amplitude*10 | Time (UI) | Overshoot |
|-----------|--------------|-----------|-----------|
| Ao        | -0.200       | -0.630    |           |
| Bo        | -0.200       | 0.100     |           |
| Co        | 0.500        | 0.100     |           |
| Do        | 0.800        | 0.350     |           |
| Eo        | 0.800        | 1.370     |           |
| Fo        | 0.200        | -0.630    |           |
| Go        | 0.200        | -0.350    |           |
| Ho        | 0.500        | -0.100    |           |
| Jo        | 1.400        | -0.100    |           |
| Ko        | 1.400        | 1.370     |           |

\*10: On the basis of  $b_0=0$  and  $b_1=1$

■ Undershoot

| Parameter | Amplitude*11 | Time (UI)*12 | Undershoot |
|-----------|--------------|--------------|------------|
| Au        | 0.800        | -0.630 - x   |            |
| Bu        | 0.800        | -0.530 - x   |            |
| Cu        | 0.850        | -0.530 - x   |            |
| Du        | 0.850        | -0.430       |            |
| Eu        | 0.800        | -0.430       |            |
| Fu        | 0.800        | -0.350       |            |
| Gu        | 0.500        | -0.100       |            |
| Hu        | -0.200       | -0.100       |            |
| Ju        | -0.200       | 1.370        |            |
| Ku        | 1.400        | -0.630 - x   |            |
| Lu        | 1.400        | -0.530 - x   |            |
| Mu        | 1.340        | -0.530 - x   |            |
| Nu        | 1.150        | -0.220 - x   |            |
| Pu        | 1.150        | 0.100        |            |
| Ru        | 0.500        | 0.100        |            |
| Su        | 0.200        | 0.350        |            |
| Tu        | 0.200        | 1.370        |            |

\*11: On the basis of  $b_0=0$  and  $b_1=1$

\*12: The positions of Au, Bu, Cu, Ku, Lu and Mu on the time axis depend on the MOST data pulse width (2 to 6).  
 $x = \text{MOST data pulse width} - 2$   
 For 2UI:  $x=0$ , For 6UI:  $x=4$

■ Eye mask

| Parameter | Amplitude                      | Time (UI) | Eye mask |
|-----------|--------------------------------|-----------|----------|
| A2        | $0.5 \times (b_1 + b_0)$       | 0.150     |          |
| B2        | $0.8 \times (b_1 - b_0) + b_0$ | 0.400     |          |
| C2        | $0.8 \times (b_1 - b_0) + b_0$ | 0.600     |          |
| D2        | $0.5 \times (b_1 + b_0)$       | 0.850     |          |
| E2        | $0.2 \times (b_1 - b_0) + b_0$ | 0.600     |          |
| F2        | $0.2 \times (b_1 - b_0) + b_0$ | 0.400     |          |

## S11355-04

### Electrical and optical characteristics<sup>\*13</sup> (Ta=-40 to +95 °C, Vcc=3.135 to 3.465, unless otherwise noted<sup>\*14</sup>)

| Parameter  | Symbol                    | Condition                      | Min.                                   | Typ. | Max.             | Unit    |
|--|---------------------------|--------------------------------|--|------|------------------|---------|
| Peak sensitivity wavelength                            | $\lambda_p$               |                                | -                                      | 800  | -                | nm      |
| Current consumption (operation mode)                   | Icco                      | <sup>*15</sup>                 | -                                      | -    | 45               | mA      |
| Current consumption (sleeping mode)                    | Iccs                      | Dark state                     | -                                      | -    | 30               | $\mu$ A |
| STATUS   | High level output voltage | Vmh                            | Imh=20 $\mu$ A <sup>*16</sup>          | 2.5  | -                | V       |
|  | Low level output voltage  | Vml                            | Iml=0.88 mA (S11355-04) <sup>*16</sup> | -    | -                | 0.5     |
| Operation to sleeping mode transition receivable level | POFF3                     | <sup>*15 *17 *18</sup>         | -                                      | -    | -35              | dBm     |
| Transfer jitter (RMS)                                  | Jtr4                      |                                | -                                      | -    | 230              | ps      |
| Error rate   | Pe                        | <sup>*15 *18 *19 *20 *21</sup> | -                                      | -    | 10 <sup>-9</sup> | -       |
| Valid MOST data (input signal) frequency               | FON3                      |                                | 12                                     | -    | 73.743           | MHz     |
| Invalid MOST data frequency                            | FOFF3                     |                                | 0                                      | -    | 10               | kHz     |
| Time from input signal start to operation mode         | tON4                      | <sup>*22</sup>                 | -                                      | -    | 10               | ms      |
| Time from input signal start to STATUS ON              | tSTATF                    | <sup>*22</sup>                 | 200                                    | -    | 1000             | $\mu$ s |
| Time from STATUS ON to LVDS output stabilization       | tLVDSV4                   | <sup>*22</sup>                 | -                                      | -    | 100              | $\mu$ s |
| Time from input signal stop to sleeping mode           | tOFF4                     | <sup>*22</sup>                 | -                                      | -    | 1                | ms      |
| LVDS output hold time                                  | tLVDSH4                   | <sup>*22</sup>                 | 1                                      | -    | -                | $\mu$ s |
| Time from input signal stop to STATUS OFF              | tSTATR                    | <sup>*22</sup>                 | -                                      | -    | 2                | $\mu$ s |
| Eye mask   | A4 to F4                  |                                | See "Eye mask" table.                  |      |                  | -       |

<sup>\*13</sup>: Electrical interface conforms to LVDS standards except differential output amplitude level

<sup>\*14</sup>: Connect a bypass capacitor (0.1  $\mu$ F) between Vcc and GND at a position within 3 mm from the leads. Also connect a 10  $\mu$ F capacitor near the photo IC.

<sup>\*15</sup>: Input signal

| Parameter   | Symbol | Min.  | Typ. | Max. | Unit |
|---|--------|-------|------|------|------|
| Optical data that allows Valid MOST data (SP4) to be obtained | Popt3  | -23.5 | -    | -2   | dBm  |
| Rise time   | trtp3  | -     | -    | 2    | ns   |
| Fall time   | tftp3  | -     | -    | 2    | ns   |
| Total jitter  | tTJtp3 | -     | -    | 600  | ps   |
| Extinction ratio  | re     | 10    | -    | -    | dB   |

<sup>\*16</sup>: Changes to operation mode when input light enters the receiver section. When STATUS output is low, the photo IC is in operation mode. When STATUS output is high, the photo IC is in sleeping mode.

<sup>\*17</sup>: Input light is specified as the average power at the fiber end. The optical fiber used is a POF (NA=0.5).

<sup>\*18</sup>: The center of the optical fiber is aligned with the center of the package lens. The distance between the fiber end and the lens top is 0.1 mm.

<sup>\*19</sup>: RL=100 k $\Omega$ , CL=3 pF (including parasitic capacitance such as probe, connector and circuit board)

<sup>\*20</sup>: A standard transmitter specified by HAMAMATSU is used to input light.

<sup>\*21</sup>: Optical input signal rate=150 Mbps (DCA coding)

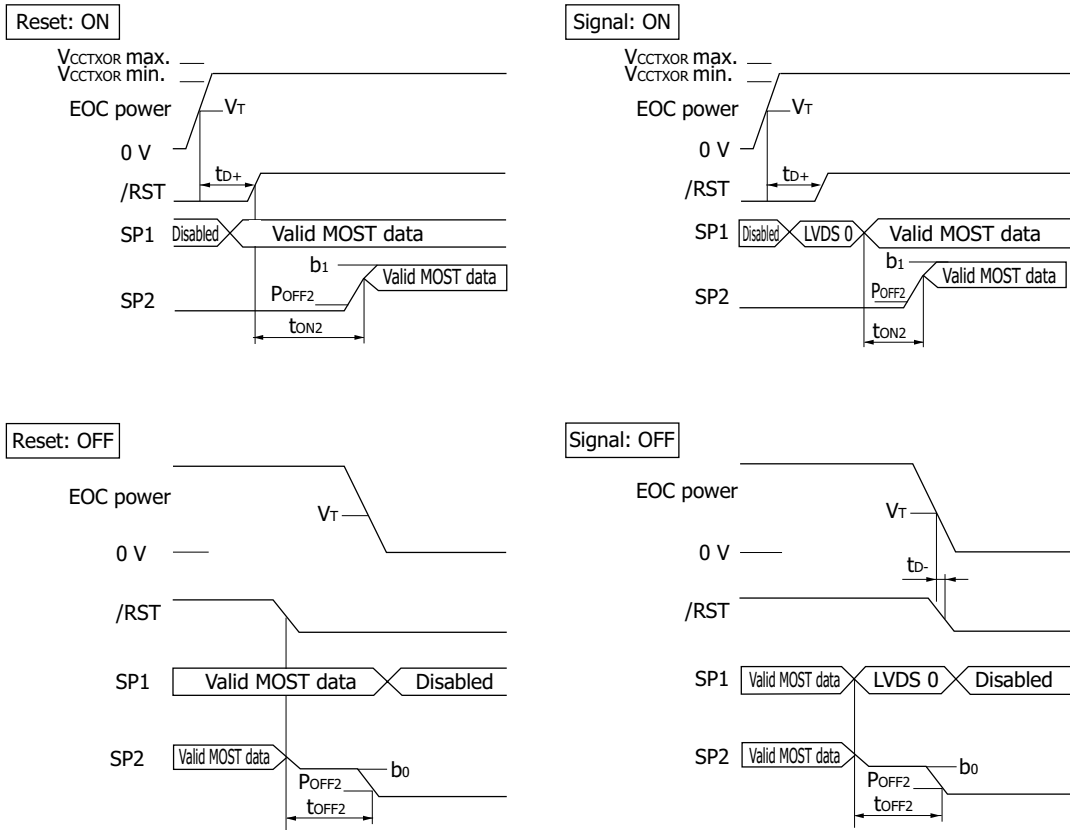
<sup>\*22</sup>: See "Timing chart (P.5)".

#### Eye mask

| Parameter | Amplitude (mV) | Time (UI) | Eye mask |
|-----------|----------------|-----------|----------|
| A4        | 0              | 0.275     |          |
| B4        | 148            | 0.425     |          |
| C4        | 148            | 0.575     |          |
| D4        | 0              | 0.725     |          |
| E4        | -148           | 0.575     |          |
| F4        | -148           | 0.425     |          |
| G4        | 636            | -         |          |
| H4        | -636           | -         |          |

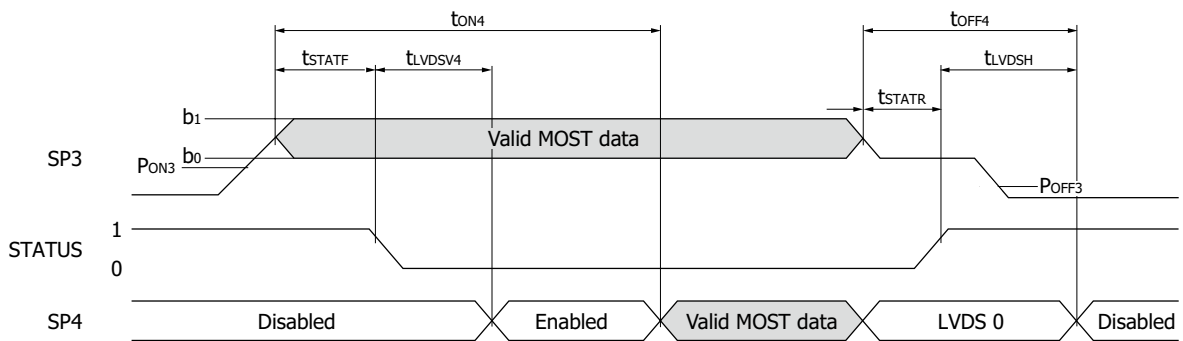
Timing chart

L11354-02



KPIC00176EA

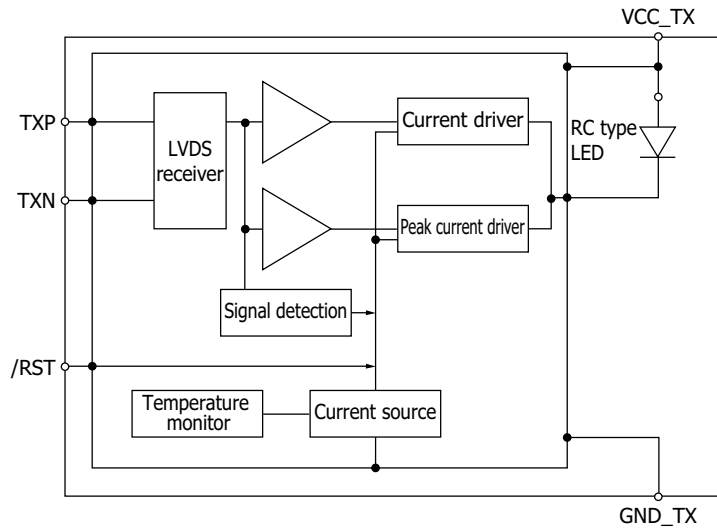
S11355-04



KPIC00181EA

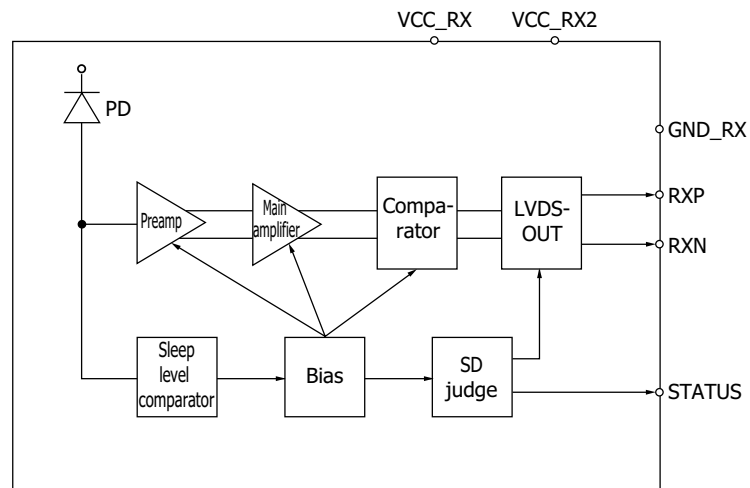
**Block diagram**

L11354-02



KPIC00177EC

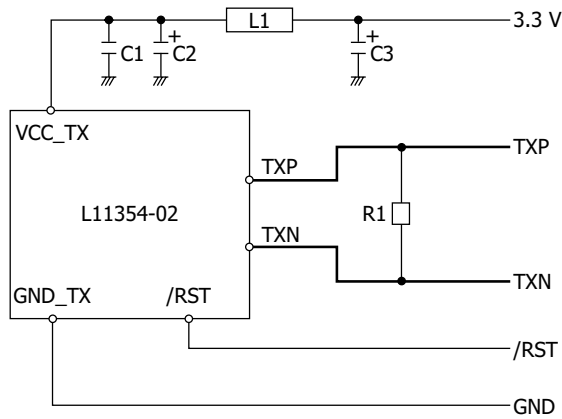
S11355-04



KPIC00178EA

Connection example

L11354-02

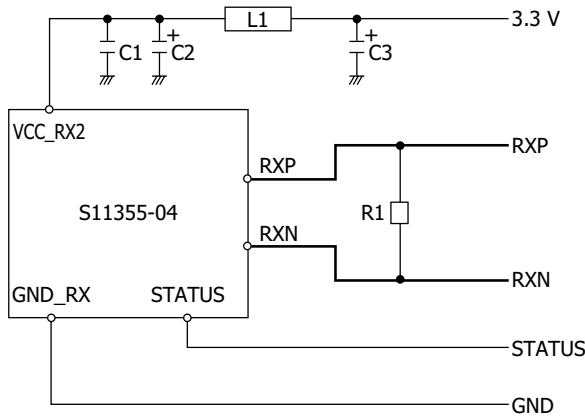


\*Bold line: 50 Ω impedance matching

KPIC0179EB

| Symbol | Part       | Constant |
|--------|------------|----------|
| R1     | Resistor   | 100 Ω    |
| L1     | Inductance | 0.1 μH   |
| C1     | Capacitor  | 0.1 μF   |
| C2     | Capacitor  | 10 μF    |
| C3     | Capacitor  | 10 μF    |

S11355-04



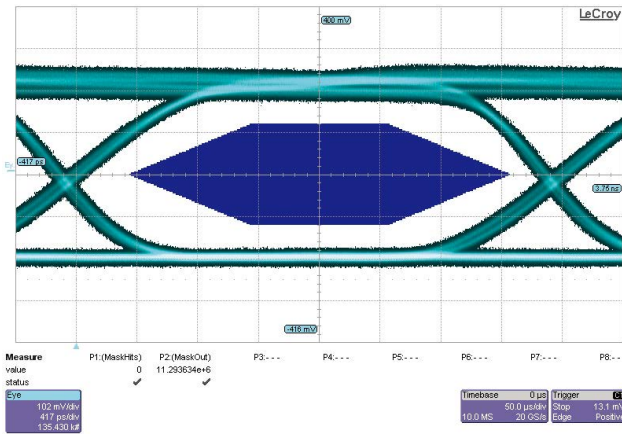
\*Bold line: 50 Ω impedance matching

KPIC0180EE

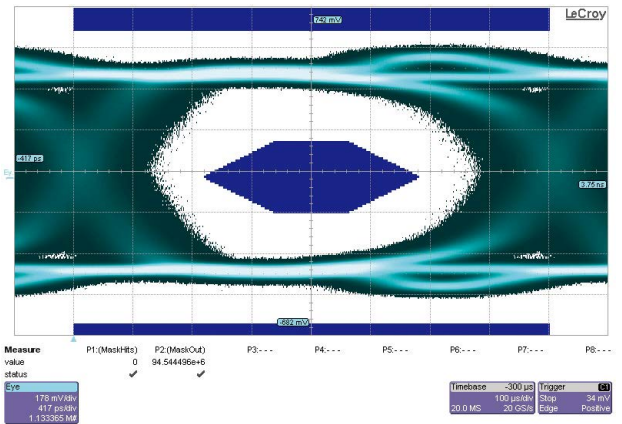
| Symbol | Part       | Constant |
|--------|------------|----------|
| R1     | Resistor   | 100 Ω    |
| L1     | Inductance | 0.1 μH   |
| C1     | Capacitor  | 0.1 μF   |
| C2     | Capacitor  | 10 μF    |
| C3     | Capacitor  | 10 μF    |

**Eye diagram**

Optical output waveform of L11354-02



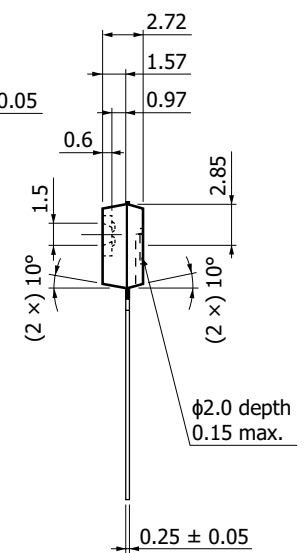
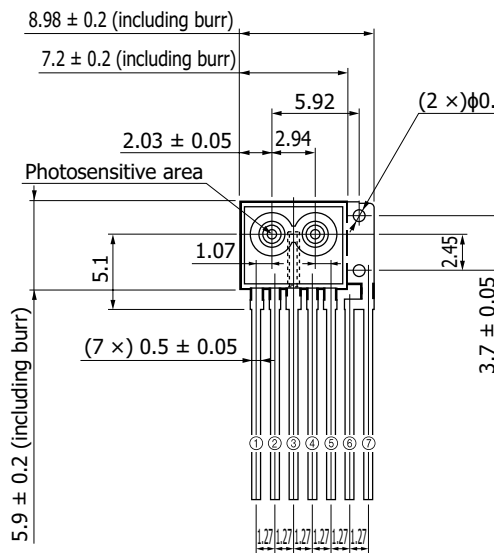
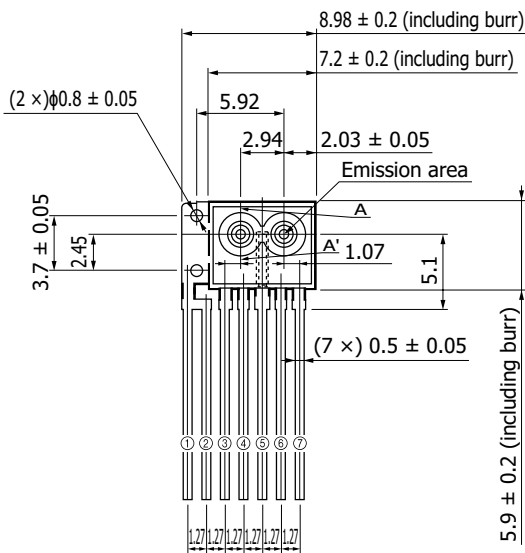
Output waveform of S11355-04



**Dimensional outlines (unit: mm)**

L11354-02

S11355-04



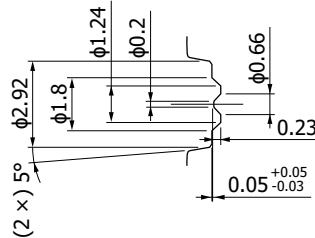
(Specified at lead root)

(Specified at lead root)

- ① /RST
- ② (/RST)
- ③ TXN
- ④ TXP
- ⑤ GND\_TX
- ⑥ Vcc\_TX
- ⑦ NC

- ① STATUS
- ② Vcc\_RX1
- ③ GND\_RX
- ④ RXN
- ⑤ RXP
- ⑥ (Vcc\_RX2)
- ⑦ Vcc\_RX2

Tolerance unless otherwise noted: ±0.1, ±2°  
R0.3 max.  
Lead material: Cu alloy with Ag plating  
Shaded area indicates burr.

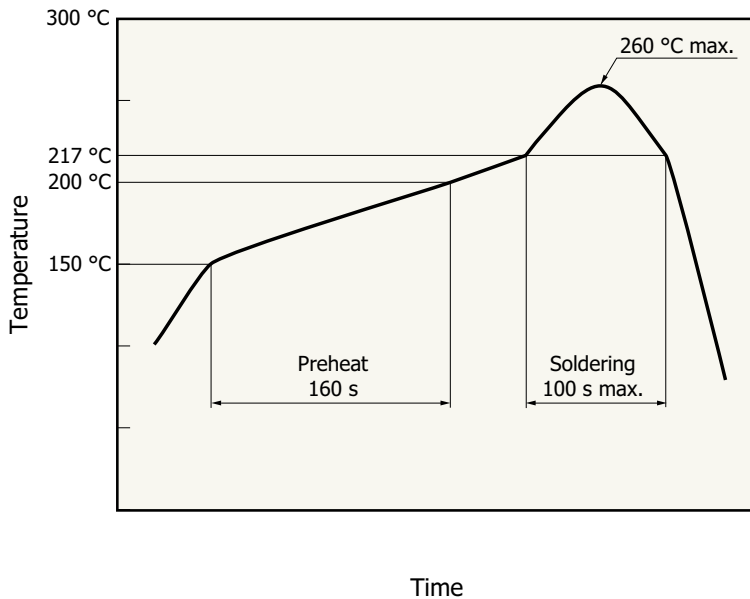


A-A' cross section

KPIC0079ED



### Recommended reflow soldering conditions



KPICB0168EB

- This product supports lead-free soldering. After unpacking, store it in an environment at a temperature of 30 °C or less and a humidity of 60% or less, and perform soldering within 4 weeks.
- The effect that the product receives during reflow soldering varies depending on the circuit board and reflow oven that are used. Before actual reflow soldering, check for any problems by tesitng out the reflow soldering methods in advance.

### Related information

[www.hamamatsu.com/sp/ssd/doc\\_en.html](http://www.hamamatsu.com/sp/ssd/doc_en.html)

#### Precautions

- Disclaimer
- Metal, ceramic, plastic products

Information described in this material is current as of July 2024.

Product specifications are subject to change without prior notice due to improvements or other reasons. This document has been carefully prepared and the information contained is believed to be accurate. In rare cases, however, there may be inaccuracies such as text errors. Before using these products, always contact us for the delivery specification sheet to check the latest specifications.

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