

M66311P/FP

16-Bit LED Driver with Shift Register and Latch

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Description

M66311P/FP is a LED array driver having a 16 bit serial-input and parallel output shiftregister function with direct coupled reset input and output latch function.

This product guarantees the output electric current of 24 mA which is sufficient for anode common LED drive, capable of flowing 16 bits continuously at the same time.

Parallel output is open drain output.

In addition, as this product has been designed in complete CMOS, power consumption can be greatly reduced when compared with conventional BIPOLAR or Bi-CMOS products.

Furthermore, pin lay-out ensures the realization of an easy printed circuit.

Features

- Anode common LED drive
- High output current all parallel output $I_{OL} = 24$ mA simultaneous lighting available
- Low power dissipation: 100 μ W/package (max)
($V_{CC} = 5$ V, $T_a = 25^\circ\text{C}$, quiescent state)
- High noise margin
schmitt input circuit provides responsiveness to a long line length.
- Equipped with direct-coupled reset
- Open drain output
(except serial data output)
- Wide operating temperature range: $T_a = -40$ to $+85^\circ\text{C}$
- Pin lay-out facilitates printed circuit wiring. (This lay-out facilitates cascade connection and LED connection.)

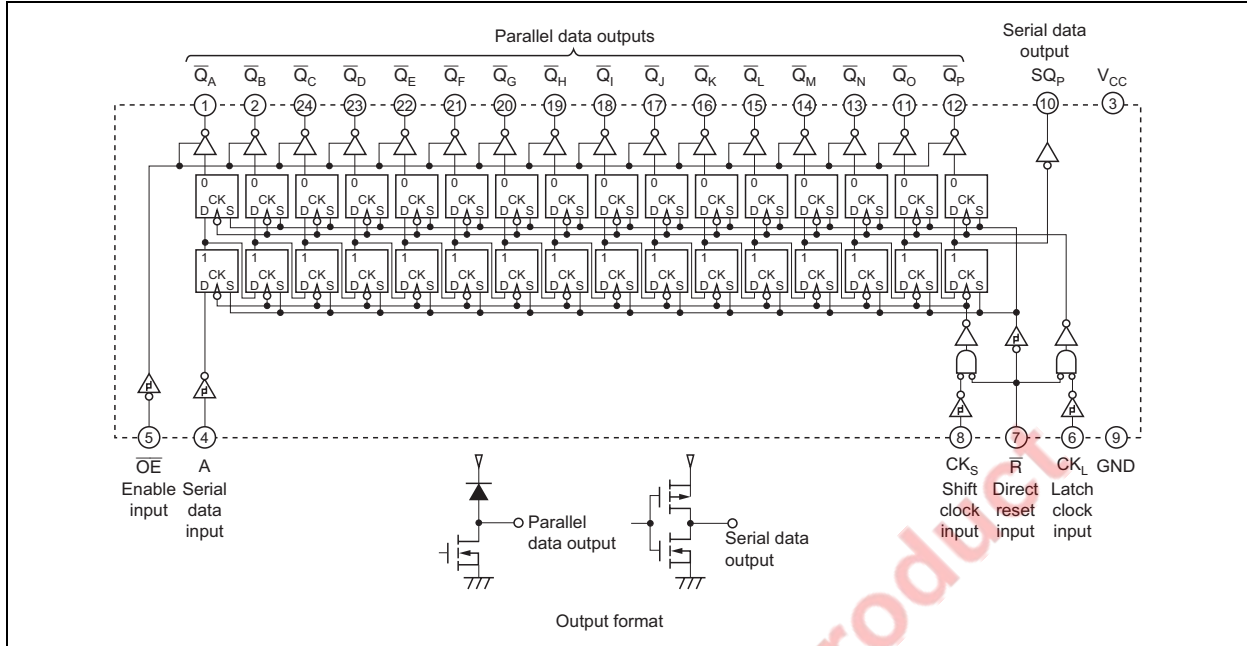
Application

LED array drive of BUTTON TELEPHONE

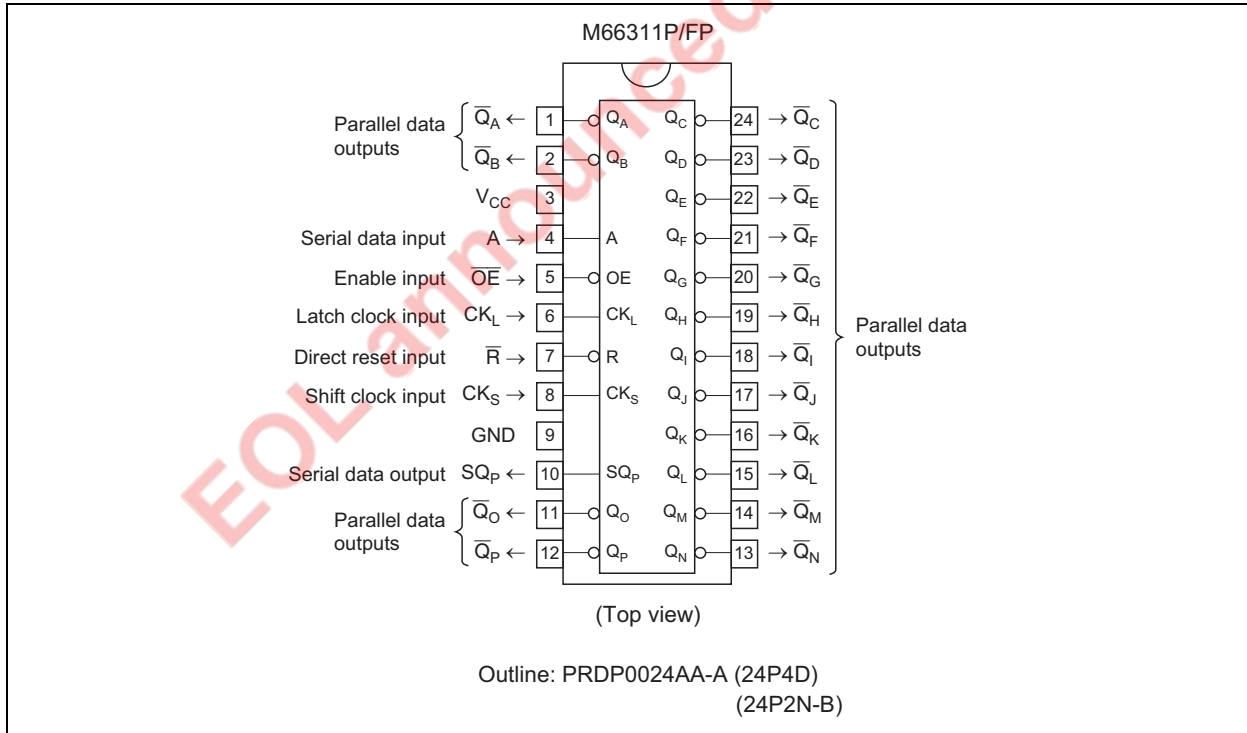
LED array drive of ERASER of a PPC copier

Other various LED modules

Logic Diagram



Pin Arrangement



Functional Description

As M66311P/FP uses silicon gate CMOS process, it realizes high-speed and high-output currents sufficient for LED drive while maintaining low power consumption and allowance for high noises.

Each bit of a shiftregister consists of two flip-flops having independent clocks for shifting and latching.

As for clock input, shift clock input CK_S and latch clock input CK_L are independent from each other, shift and latch operations being made when “L” changes to “H”.

Serial data input A is the data input of the first-step shiftregister and the signal of A shifts shifting registers one by one when a pulse is impressed to CK_S . When A is “H”, the signal of “L” shifts.

When the pulse is impressed to CK_L , the contents of the shifting register at that time are stored in a latching register, and they appear in the outputs from Q_A to Q_P .

Outputs from \bar{Q}_A to \bar{Q}_P are open drain outputs.

To extend the number of bits, use the serial data output SQ_P which shows the output of the shifting register of the 16th bit.

If CK_S and CK_L are connected, the state of the shifting register with one clock delay is outputted to \bar{Q}_A to \bar{Q}_P .

When reset input \bar{R} is changed to “L”, \bar{Q}_A to \bar{Q}_P and SQ_P are reset. In this case, shifting and latching registers are set.

If “H” is impressed to output enable input OE, \bar{Q}_A to \bar{Q}_P reaches the high impedance state, but SQ_P does not reach the high impedance state. Furthermore, change in OE does not affect shift operation.

Function Table ^(Note)

| Operation Mode | Input | | | | | Parallel Data Output | | | | | | | | | | | | | | | | Serial Data Output SQ_P | Remarks | | |
|-----------------------------|-----------|--------|--------|---|------------|----------------------|---------------|---------------|---------------|---------------|---------------|---------------|---------------|---------------|---------------|---------------|---------------|---------------|---------------|---------------|---------------|---------------------------|---------|-----------------------|-----------------------|
| | \bar{R} | CK_S | CK_L | A | \bar{OE} | \bar{Q}_A | \bar{Q}_B | \bar{Q}_C | \bar{Q}_D | \bar{Q}_E | \bar{Q}_F | \bar{Q}_G | \bar{Q}_H | \bar{Q}_I | \bar{Q}_J | \bar{Q}_K | \bar{Q}_L | \bar{Q}_M | \bar{Q}_N | \bar{Q}_O | \bar{Q}_P | | | | |
| Reset | L | X | X | X | X | Z | Z | Z | Z | Z | Z | Z | Z | Z | Z | Z | Z | Z | Z | Z | Z | Z | Z | L | — |
| Shift latch operation | Shift t1 | H | ↑ | X | H | L | \bar{Q}_A^0 | \bar{Q}_B^0 | \bar{Q}_C^0 | \bar{Q}_D^0 | \bar{Q}_E^0 | \bar{Q}_F^0 | \bar{Q}_G^0 | \bar{Q}_H^0 | \bar{Q}_I^0 | \bar{Q}_J^0 | \bar{Q}_K^0 | \bar{Q}_L^0 | \bar{Q}_M^0 | \bar{Q}_N^0 | \bar{Q}_O^0 | \bar{Q}_P^0 | q_O^0 | Output lighting "H" | |
| | Latch t2 | H | X | ↑ | X | L | L | q_A^0 | q_B^0 | q_C^0 | q_D^0 | q_E^0 | q_F^0 | q_G^0 | q_H^0 | q_I^0 | q_J^0 | q_K^0 | q_L^0 | q_M^0 | q_N^0 | q_O^0 | q_P^0 | q_O^0 | Output lights-out "L" |
| | Shift t1 | H | ↑ | X | L | L | \bar{Q}_A^0 | \bar{Q}_B^0 | \bar{Q}_C^0 | \bar{Q}_D^0 | \bar{Q}_E^0 | \bar{Q}_F^0 | \bar{Q}_G^0 | \bar{Q}_H^0 | \bar{Q}_I^0 | \bar{Q}_J^0 | \bar{Q}_K^0 | \bar{Q}_L^0 | \bar{Q}_M^0 | \bar{Q}_N^0 | \bar{Q}_O^0 | \bar{Q}_P^0 | q_O^0 | Output lights-out "L" | |
| | Latch t2 | H | X | ↑ | X | L | Z | q_A^0 | q_B^0 | q_C^0 | q_D^0 | q_E^0 | q_F^0 | q_G^0 | q_H^0 | q_I^0 | q_J^0 | q_K^0 | q_L^0 | q_M^0 | q_N^0 | q_O^0 | q_O^0 | q_P^0 | — |
| Output disable | X | X | X | X | H | Z | Z | Z | Z | Z | Z | Z | Z | Z | Z | Z | Z | Z | Z | Z | Z | Z | Z | q_P | — |

Note

- ↑: Change from low-level to high-level
- \bar{Q}^0 : Output state \bar{Q} before CK_L changed
- X: Irrelevant
- q^0 : Contents of shift register before CK_S changed
- q: Contents of shift register
- t_1, t_2 : t_2 is set after t_1 is set
- Z: High impedance

Absolute Maximum Ratings

(Ta = -40 to +85°C, unless otherwise noted)

| Item | Symbol | Ratings | Unit | Conditions |
|--------------------------------|----------------------------------|-------------------------------|------|----------------------------------|
| Supply voltage | V _{CC} | -0.5 to +7.0 | V | |
| Input voltage | V _I | -0.5 to V _{CC} + 0.5 | V | |
| Output voltage | V _O | -0.5 to V _{CC} + 0.5 | V | |
| Input protection diode current | I _{IK} | -20 | mA | V _I < 0 V |
| | | 20 | | V _I > V _{CC} |
| Output parasitic diode current | I _{OK} | -20 | mA | V _O < 0 V |
| | | 20 | | V _O > V _{CC} |
| Output current per output pin | Q _A to Q _P | I _O | mA | |
| | SQ _P | | | ±25 |
| Supply/GND current | I _{CC} | -20, +410 | mA | V _{CC} , GND |
| Power dissipation | P _d | 500 | mW | (Note) |
| Storage temperature range | T _{stg} | -65 to +150 | °C | |

Note: M66311FP; Ta = -40 to +70°C, Ta = 70 to 85°C are derated at -6 mW/°C.

Recommended Operating Conditions

(Ta = -40 to +85°C, unless otherwise noted)

| Item | Symbol | Limits | | | Unit |
|-----------------------------|------------------|--------|-----|-----------------|------|
| | | Min | Typ | Max | |
| Supply voltage | V _{CC} | 4.5 | 5 | 5.5 | V |
| Input voltage | V _I | 0 | — | V _{CC} | V |
| Output voltage | V _O | 0 | — | V _{CC} | V |
| Operating temperature range | T _{opr} | -40 | — | +85 | °C |

Electrical Characteristics

(V_{CC} = 4.5 to 5.5V, unless otherwise noted)

| Item | Symbol | Limits | | | | | Unit | Conditions | |
|--|-----------------|-----------------------|-----|----------------------|-----------------------|----------------------|------|---|-----------------------------------|
| | | Ta = 25°C | | | Ta = -40 to +85°C | | | | |
| | | Min | Typ | Max | Min | Max | | | |
| Positive-going threshold voltage | V _{T+} | 0.35×V _{CC} | — | 0.7×V _{CC} | 0.35×V _{CC} | 0.7×V _{CC} | V | V _O = 0.1 V, V _{CC} = 0.1 V I _O = 20 μA | |
| Negative-going threshold voltage | V _{T-} | 0.2×V _{CC} | — | 0.55×V _{CC} | 0.2×V _{CC} | 0.55×V _{CC} | V | V _O = 0.1 V, V _{CC} = 0.1 V I _O = 20 μA | |
| Low-level output voltage Q _A to Q _P | V _{OL} | — | — | 0.1 | — | 0.1 | V | V _I = V _{T+} , V _{T-} V _{CC} = 4.5 V | I _{OL} = 20 μA |
| | | — | — | 0.44 | — | 0.53 | | | I _{OL} = 24 mA |
| | | — | — | 0.73 | — | 0.94 | | | I _{OL} = 40 mA (Note) |
| High-level output voltage SQ _P | V _{OH} | V _{CC} - 0.1 | — | — | V _{CC} - 0.1 | — | V | V _I = V _{T+} , V _{T-} V _{CC} = 4.5 V | I _{OH} = -20 μA |
| | | 3.83 | — | — | 3.66 | — | | | I _{OH} = -4 mA |
| Low-level output voltage SQ _P | V _{OL} | — | — | 0.1 | — | 0.1 | V | V _I = V _{T+} , V _{T-} V _{CC} = 4.5 V | I _{OL} = 20 μA |
| | | — | — | 0.44 | — | 0.53 | | | I _{OL} = 4 mA |
| High-level input current | I _{IH} | — | — | 0.5 | — | 5.0 | μA | V _I = V _{CC} , V _{CC} = 5.5 V | |
| Low-level input current | I _{IL} | — | — | -0.5 | — | -5.0 | μA | V _I = GND, V _{CC} = 5.5 V | |
| Maximum output leakage current Q _A to Q _P | I _O | — | — | 1.0 | — | 10.0 | μA | V _I = V _{T+} , V _{T-} V _{CC} = 5.5 V | V _O = V _{CC} |
| | | — | — | -1.0 | — | -10.0 | | | V _O = GND |
| Quiescent supply current | I _{CC} | — | — | 20.0 | — | 200.0 | μA | V _I = V _{CC} , GND, V _{CC} = 5.5 V | |

Note: M66311 is used under the condition of an output current I_{OL} = 40 mA, the number of simultaneous drive outputs is restricted as shown in the Duty Cycle-I_{OL} of Standard characteristics.

Switching Characteristics

(V_{CC} = 5 V)

| Item | Symbol | Limits | | | | | Unit | Conditions |
|---|------------------|-----------|-----|-----|-------------------|-----|------|---|
| | | Ta = 25°C | | | Ta = -40 to +85°C | | | |
| | | Min | Typ | Max | Min | Max | | |
| Maximum clock frequency | f _{max} | 5 | — | — | 4 | — | MHz | C _L = 50 pF R _L = 1 kΩ (Note 2) |
| Low-level to high-level and high-level to low-level output propagation time (CK _S -SQ _P) | t _{PLH} | — | — | 100 | — | 130 | ns | |
| | t _{PHL} | — | — | 100 | — | 130 | ns | |
| High-level to low-level output propagation time (\bar{R} -SQ _P) | t _{PHL} | — | — | 100 | — | 130 | ns | |
| Low-level to high-level output propagation time (\bar{R} - \bar{Q}_A to \bar{Q}_P) | t _{PLZ} | — | — | 150 | — | 200 | ns | |
| Low-level to high-level and high-level to low-level output propagation time (CK _L - \bar{Q}_A to \bar{Q}_P) | t _{PZL} | — | — | 100 | — | 130 | ns | |
| | t _{PLZ} | — | — | 150 | — | 200 | ns | |
| Output enable time to low-level and high-level (\bar{OE} - \bar{Q}_A to \bar{Q}_P) | t _{PZL} | — | — | 100 | — | 130 | ns | |
| | t _{PLZ} | — | — | 150 | — | 200 | ns | |
| Input Capacitance | C _I | — | — | 10 | — | 10 | pF | |
| Output Capacitance | C _O | — | — | 15 | — | 15 | pF | $\bar{OE} = V_{CC}$ |
| Power dissipation Capacitance (Note 1) | C _{PD} | — | 5 | — | — | — | pF | |

Note: 1. C_{PD} is the internal capacitance of the IC calculated from operation supply current under no-load conditions. (per latch)

The power dissipated during operation under no-load conditions is calculated using the following formula:

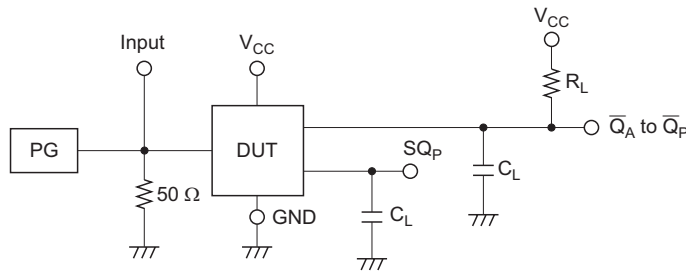
$$P_D = C_{PD} \cdot V_{CC}^2 \cdot f_l + I_{CC} \cdot V_{CC}$$

Timing Requirements

(V_{CC} = 5 V)

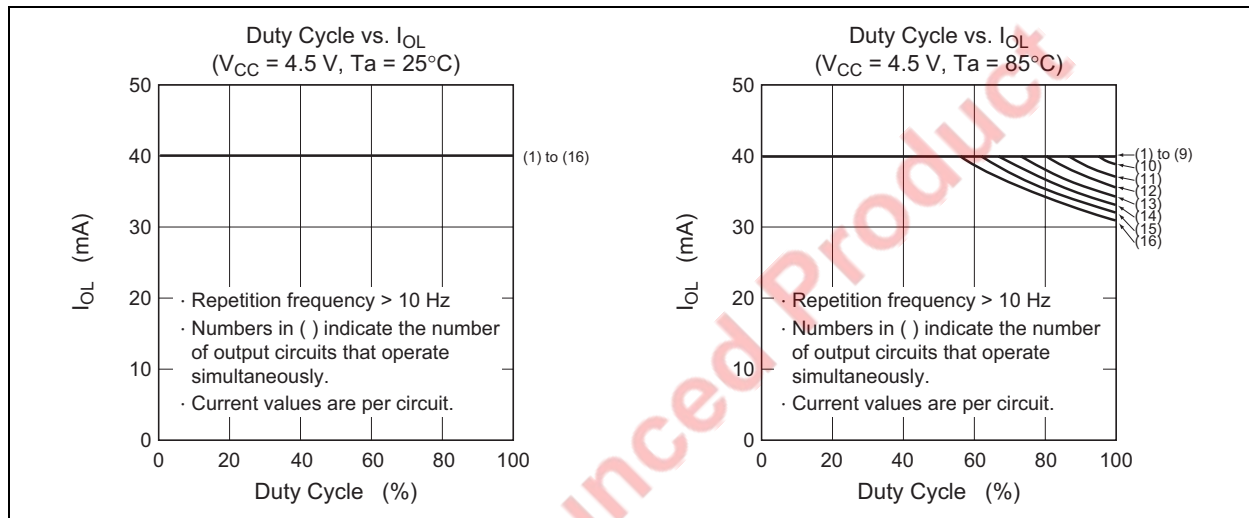
| Item | Symbol | Limits | | | | | Unit | Conditions |
|---|------------------|-----------|-----|-----|-------------------|-----|------|------------|
| | | Ta = 25°C | | | Ta = -40 to +85°C | | | |
| | | Min | Typ | Max | Min | Max | | |
| CK _S , CK _L , \bar{R} pulse width | t _w | 100 | — | — | 130 | — | ns | (Note 2) |
| A setup time with respect to CK _S | t _{SU} | 100 | — | — | 130 | — | ns | |
| CK _S setup time with respect to CK _L | t _{SU} | 100 | — | — | 130 | — | ns | |
| A hold time with respect to CK _S | t _H | 10 | — | — | 15 | — | ns | |
| \bar{R} , recovery time with respect to CK _S , CK _L | t _{REC} | 50 | — | — | 70 | — | ns | |

Note: 2. Test Circuit

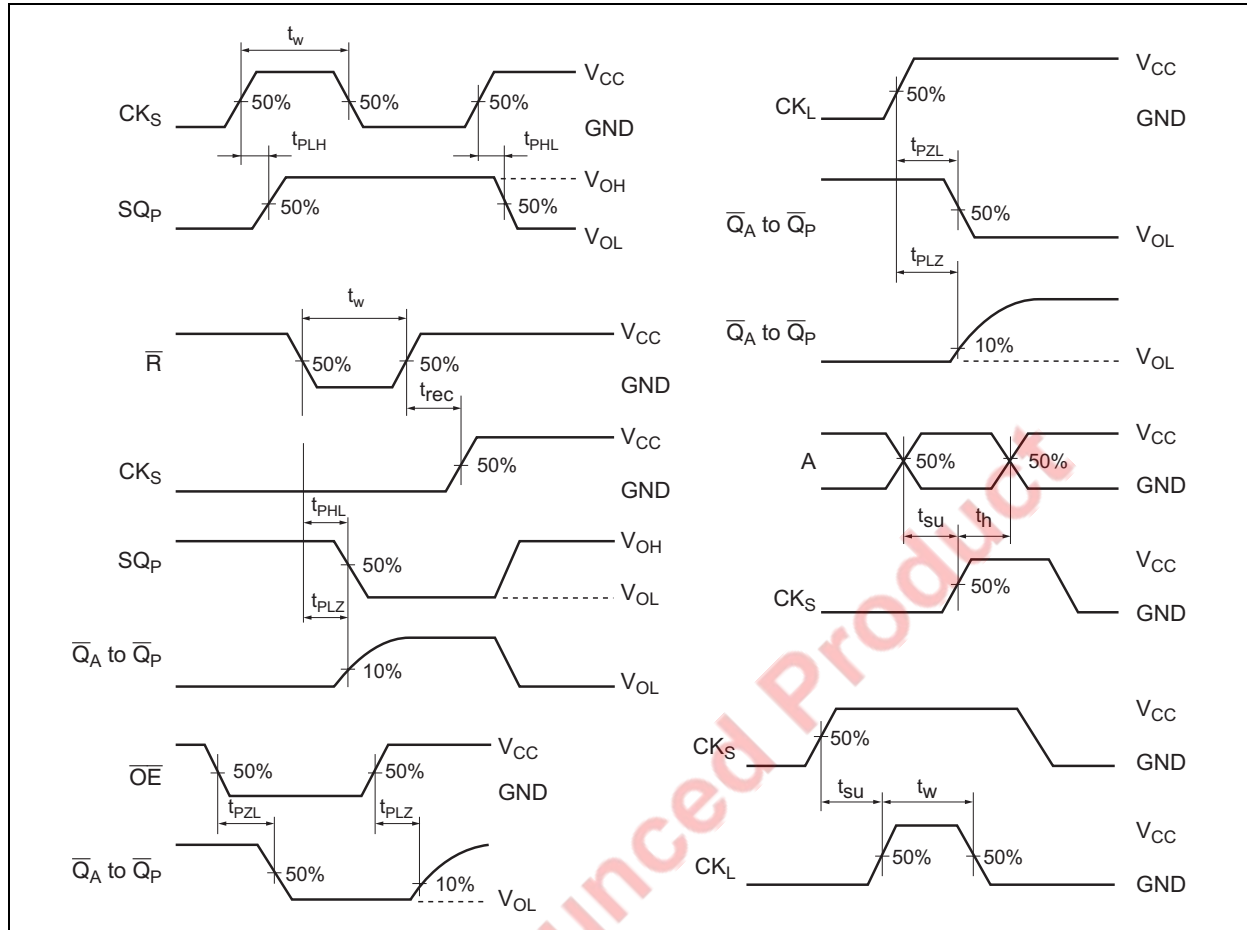


- (1) The pulse generator (PG) has the following characteristics (10% to 90%): $t_r = 6 \text{ ns}$, $t_f = 6 \text{ ns}$
- (2) The capacitance C_L includes stray wiring capacitance and the probe input capacitance.

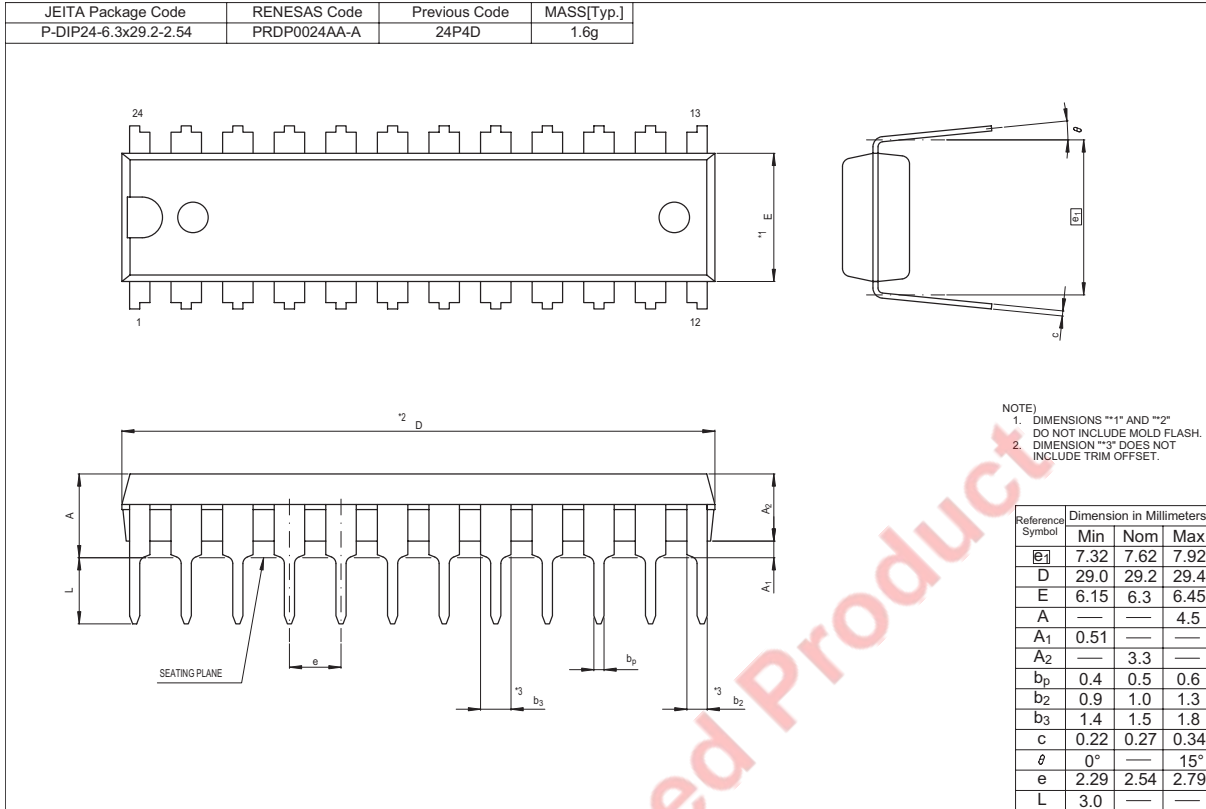
Typical Characteristics



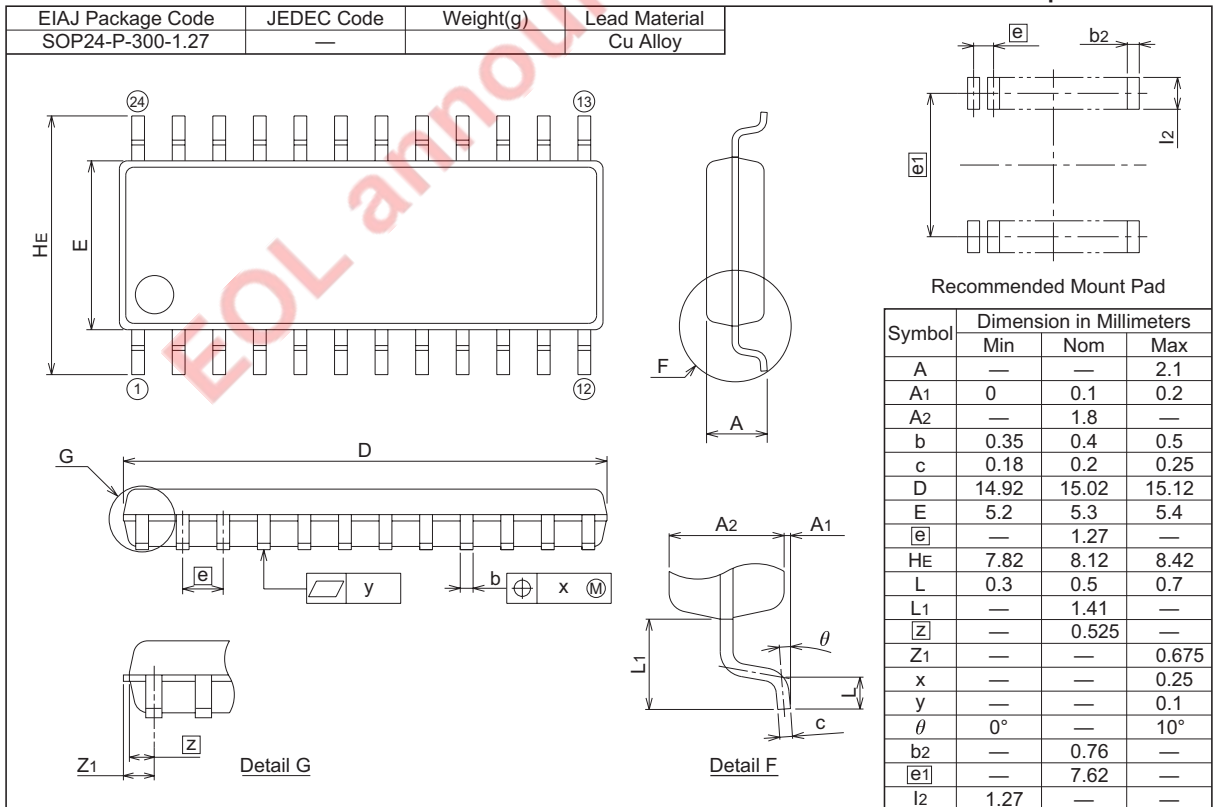
Timing Chart



Package Dimensions



24P2N-B



Notes:

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