TOAHIBA Bi-CMOS Integrated Circuit Silicon Monolithic

TB62710P, TB62710F, TB62710FN

8-Bit Constant-Current LED Driver for Cathode Common LED

The TB62710P, TB62710F and TB62710FN are specifically designed for use as LED and LED display (cathode-common) Constant-current drivers.
The constant-current output circuits can be set up using an external resistor (IOUT = −90 mA max).

These ICs are monolithic integrated circuits have been designed using the Bi-CMOS process.

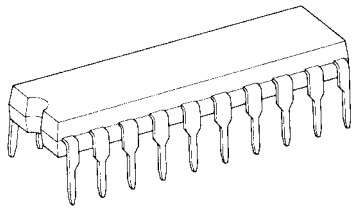
The devices consist of an 8-bit shift register, a latch, an ANDgate and constant-current drivers.

FEATURES

- Constant-current output:
  A single resistor can be used to set any output current in the range −5~−90 mA.
- Maximum clock frequency: f_{CLK} = 15 MHz
  (operating while connected in cascade, T_{opr} = 25°C)
- 5-V CMOS compatible input
- Packages:
  P-type: DIP20-P-300-2.54A
  F-type: SSOP24-P-300-1.00
  FN-type: SSOP20-P-225-0.65A
- Constant-output-current accuracy:

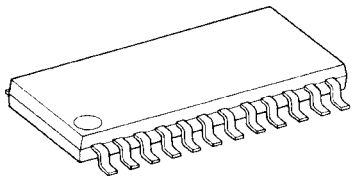
Output − GND Voltage	Current accuracy		Output Current (max)
	between bits	between ICs	
≥ 2.0 V (min)	±6%	±15%	−5~−90 mA
≥ 1.5 V (min)			−5~−40 mA

TB62710P



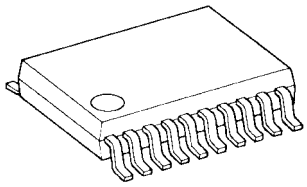
DIP20-P-300-2.54A

TB62710F



SSOP24-P-300-1.00

TB62710FN

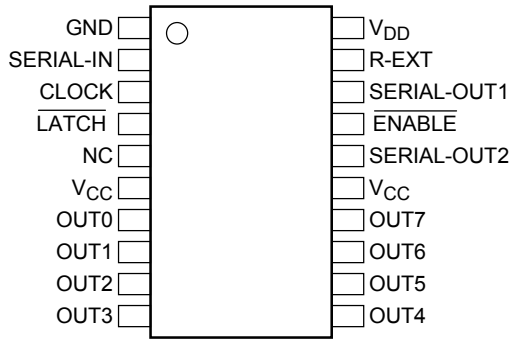


SSOP20-P-225-0.65A

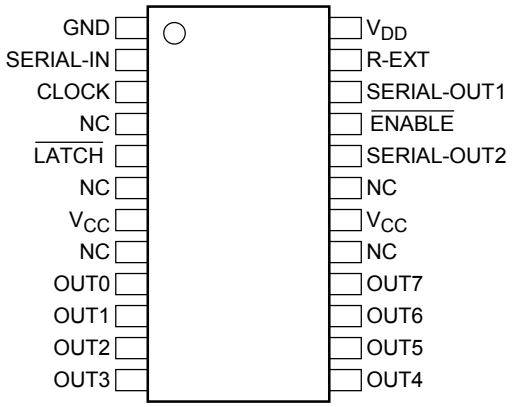
Weight
DIP20-P-300-2.54A: 2.25 g (Typ.)
SSOP24-P-300-1.00: 0.33 g (Typ.)
SSOP20-P-225-0.65A: 0.10 g (Typ.)

Pin Assignment (top view)

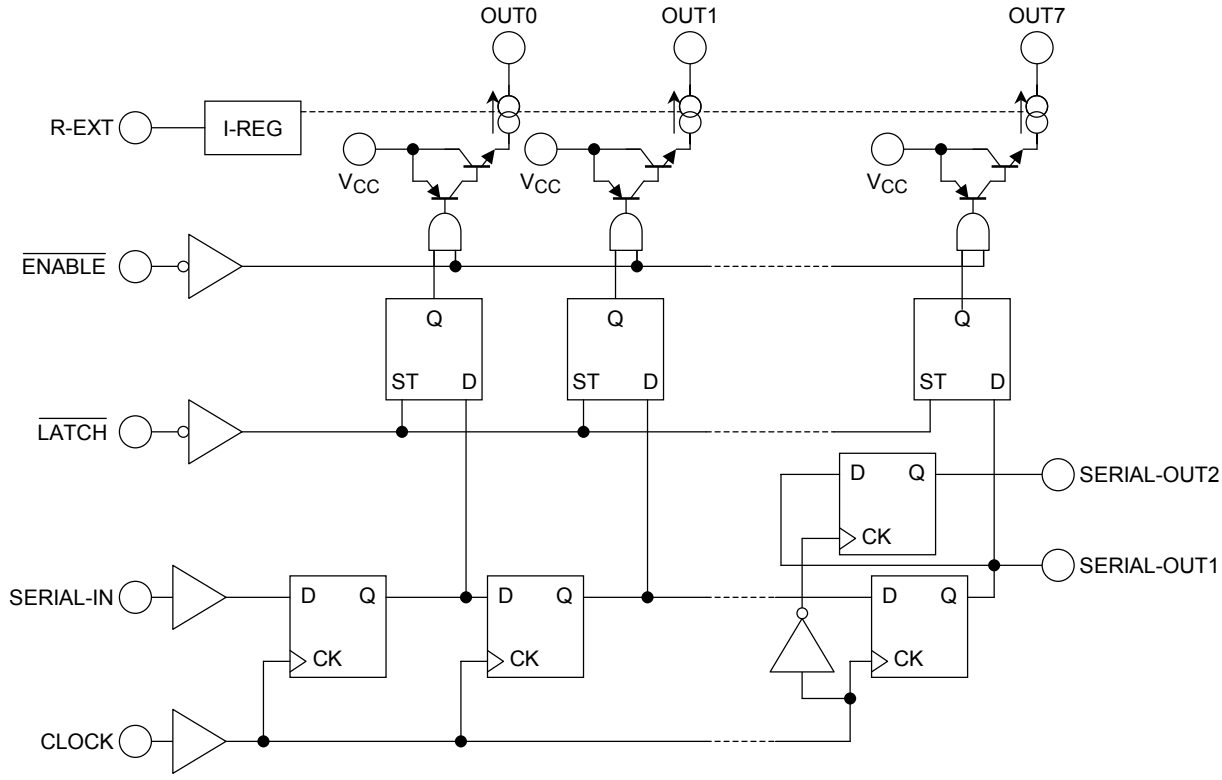
P- & FN-types



F-type



Block Diagram

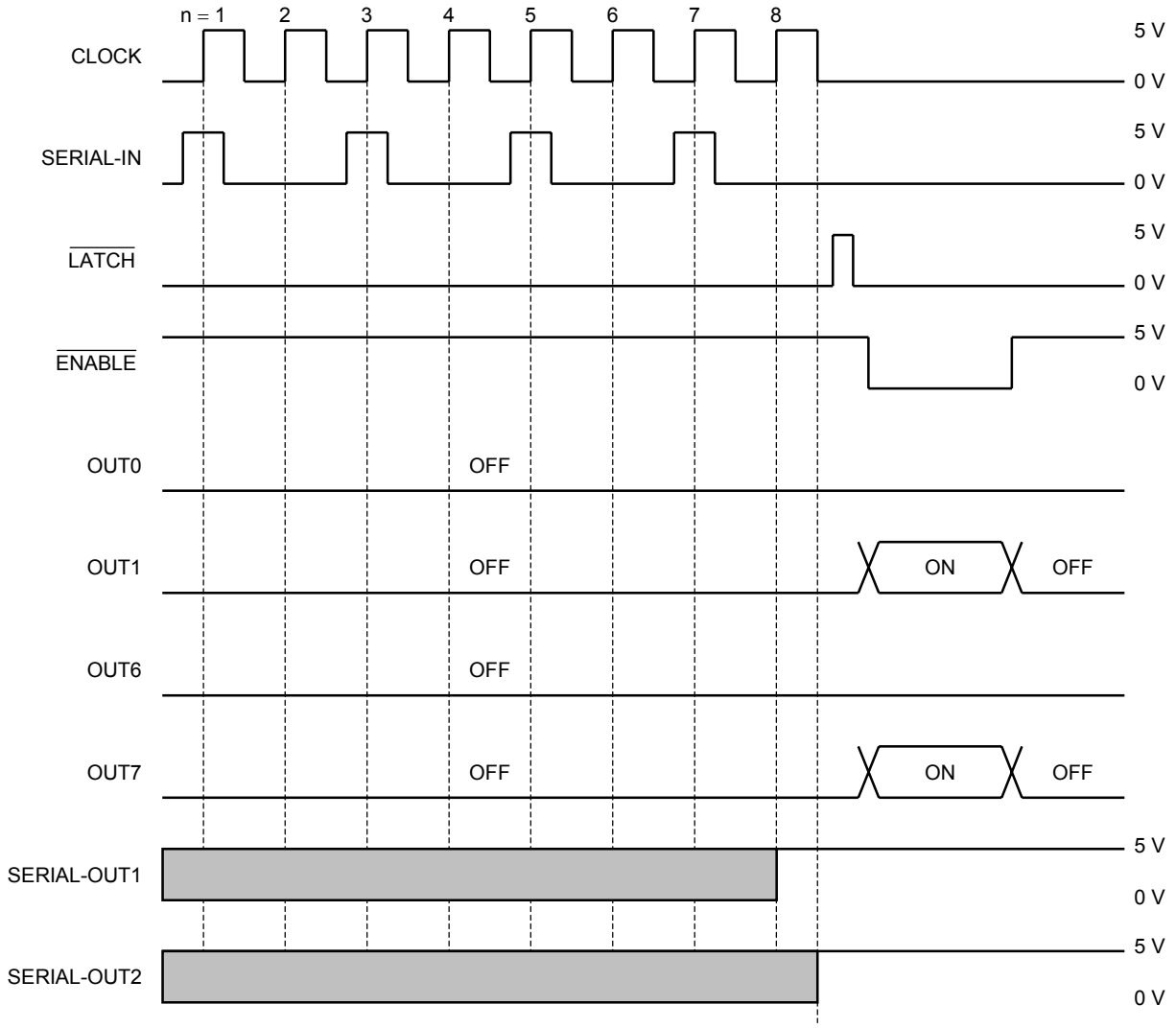


Truth Table

CLOCK	$\overline{\text{LATCH}}$	$\overline{\text{ENABLE}}$	SERIAL-IN	OUT0⋯ OUT5 ⋯ OUT7	SERIAL-OUT
↑	H	L	Dn	Dn ⋯ Dn – 5 ⋯ Dn – 7	Dn – 7
↑	L	L	Dn + 1	No Change	Dn – 6
↑	H	L	Dn + 2	Dn + 2 ⋯ Dn – 3 ⋯ Dn – 5	Dn – 5
↓	X	L	Dn + 3	Dn + 2 ⋯ Dn – 3 ⋯ Dn – 5	Dn – 5
↓	X	H	Dn + 3	OFF	Dn – 5

Note 1: OUT0~OUT7 = ON when Dn = “H”; OUT0~OUT7 = OFF when Dn = “L”.
In order to ensure that the level of the power supply voltate is correct, an external resistor must be connected between R-EXT and GND.

Timing Diagram



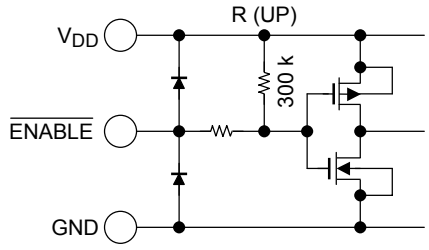
Note 2: The latches circuit holds data by pulling the $\overline{\text{LATCH}}$ terminal Low.
And, when $\overline{\text{LATCH}}$ terminal is a “H” level, latch circuit doesn’t hold data, and it passes from the input to the output.
When $\overline{\text{ENABLE}}$ terminal is a “L” level, output terminal OUT0~ OUT7 respond to the data, and on & off does.
And, when $\overline{\text{ENABLE}}$ terminal is a “H” level, it offs with the output terminal regardless of the data.

Terminal Description

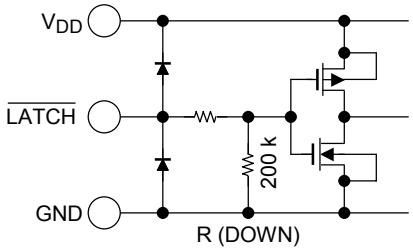
Pin No.		Pin Name	Function
P/FN-Type	F-Type		
1	1	GND	GND terminal for control logic
2	2	SERIAL-IN	Input terminal for serial data for data shift register
3	3	CLOCK	Input terminal for clock for data shift on rising edge
4	5	$\overline{\text{LATCH}}$	Input terminal for data strobe When the $\overline{\text{LATCH}}$ input is driven High, data is latched. When it is pulled Low, data is hold.
6, 15	7, 18	V_{CC}	0 V~17 V supply voltage terminal for LED
7~14	9~16	OUT0~OUT7	Output terminals
17	21	$\overline{\text{ENABLE}}$	Input terminal for output enable. All outputs (OUT0~OUT7) are turned off, when the $\overline{\text{ENABLE}}$ terminal is driven High. And are turned on, when the terminal is driven Low.
16	20	SERIAL-OUT2	Output terminal for serial data input on SERIAL-IN terminal
18	22	SERIAL-OUT1	Output terminal for serial data input on SERIAL-IN terminal
19	23	R-EXT	Input terminal used to connect an external resistor. This regulated the output current.
20	24	V_{DD}	5-V supply voltage terminal
5	4, 6, 8, 17, 19	NC	Not connected

Equivalent Circuits For Inputs and Outputs

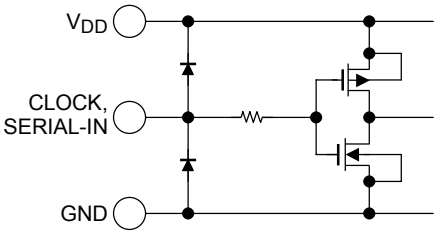
$\overline{\text{ENABLE}}$ terminal



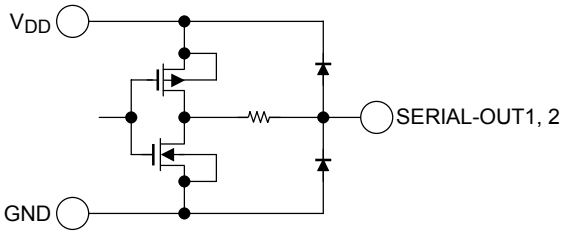
$\overline{\text{LATCH}}$ terminal



CLOCK, SERIAL-IN terminal



SERIAL-OUT1 and SERIAL-OUT2 terminals



Maximum Ratings (T_{opr} = 25°C)

Characteristic		Symbol	Rating	Unit
Supply voltage		V_{DD}	0~7.0	V
Supply voltage for LED		V_{LED}	0~17.0	V
Input voltage		V_{IN}	−0.4~V_{DD} + 0.4	V
Output current		I_{OUT}	−90	mA
Output voltage		V_{OUT}	−0.4~17	V
Clock frequency		f_{CLK}	15	MHz
V_{CC} terminal current		IV_{CC}	1440	mA
Power Dissipation (Note 3)	P-type (when not mounted)	P_{d1}	1.47	W
	F-type (when not mounted)	P_{d2}	0.59	
	F-type (on PCB)		0.83	
	FN-type (when not mounted)	P_{d3}	0.71	
	FN-type (on PCB)		0.96	
Thermal Resistance (Note 3)	P-type (when not mounted)	$R_{th\ (j-a)\ 1}$	85	°C/W
	F-type (when not mounted)	$R_{th\ (j-a)\ 2}$	210	
	F-type (on PCB)		150	
	FN-type (when not mounted)	$R_{th\ (j-a)\ 3}$	175	
	FN-type (on PCB)		130	
Operating Temperature		T_{opr}	−40~85	°C
Storage Temperature		T_{stg}	−55~150	°C

Note 3: P-Type: Powes dissipation is derated by 12.5 mW/°C if device is mounted on PCB and ambient temperature is above 25°C.

F-Type: Powes dissipation is derated by 6.7 mW/°C if device is mounted on PCB and ambient temperature is above 25°C.
With device mounted on PCB of 60% Cu and of dimensions 50 mm × 50 mm × 1.6 mm

FN-Type: Powes dissipation is derated by 7.7 mW/°C if device is mounted on PCB and ambient temperature is above 25°C.
With device mounted on PCB of 40% Cu and of dimensions 50 mm × 50 mm × 1.6 mm

Recommended Operating Conditions (T_{opr} = –40°C ~85°C unless otherwise specified)

Characteristic		Symbol	Conditions		Min	Typ.	Max	Unit
Supply voltage		V_{DD}	—		4.5	5.0	5.5	V
Supply voltage for LED		V_{CC1}	$V_{CC} - V_{OUT} \geqq 2.0$ V, $I_{OUT} \leqq -90$ mA		4	—	17	V
		V_{CC2}	$V_{CC} - V_{OUT} \geqq 1.5$ V, $I_{OUT} \leqq -40$ mA		3.5	—	17	
Output voltage		V_{OUT}	V_{CC} common		0	—	−17	V
Output current		I_{OUT}	DC1 circuit		−5	—	−78	mA
		I_{OH}	SERIAL-OUT1, 2		—	—	−1.0	
		I_{OL}	SERIAL-OUT1, 2		—	—	1.0	
Input voltage		V_{IH}	V_{DD} = 4.5~5.5 V		0.7 V_{DD}	—	V_{DD} + 0.3	V
		V_{IL}			−0.3	—	0.3 V_{DD}	
$\overline{\text{LATCH}}$ pulse width		t_{wLAT}	V_{DD} = 4.5~5.5 V		100	—	—	ns
CLOCK pulse width		t_{wCLK}	V_{DD} = 4.5~5.5 V		50	—	—	ns
$\overline{\text{ENABLE}}$ pulse width		t_{wENA}	V_{DD} = 4.5~5.5 V		1000	—	—	ns
Set-up time for DATA		t_{setup}	V_{DD} = 4.5~5.5 V		100	—	—	ns
Hold time for DATA		t_{hold}	V_{DD} = 4.5~5.5 V		100	—	—	ns
Clock frequency		t_{CLK}	V_{DD} = 4.5~5.5 V, Cascade operation		—	—	10.0	ns
Power Dissipation	P-type	P_{d1}	T_{opr} = 85°C	When not mounted	—	—	0.76	W
	F-type	P_{d2}		On PCB	—	—	0.43	
	FN-type	P_{d3}			—	—	0.50	

Electrical Characteristics (T_{opr} = 25°C, V_{DD} = 5 V, V_{CC} = 17 V unless otherwise specified)

Characteristic		Symbol	Test circuit	Conditions		Min	Typ.	Max	Unit
Output leakage current		I_{LEAK}	—	V_{CC} = 17.0 V		—	—	−10	μA
Output voltage	SERIAL-OUT 1, 2	V_{OH}	—	I_{OH} = −1.0 mA		—	—	0.4	V
		V_{OL}	—	I_{OL} = 1.0 mA		4.6	—	—	
Output current (including current skewing)		I_{OUT1}	—	V_{CC} = 4 V, V_{OUT} = V_{CC} − 2.0 V	R_{EXT} = 360 Ω	−62.1	−73.0	−83.9	mA
		I_{OUT2}	—	V_{CC} = 4 V, V_{OUT} = V_{CC} − 2.0 V	R_{EXT} = 620 Ω	−34.0	−40.0	−46.0	
		I_{OUT3}	—	V_{CC} = 3.5 V, V_{OUT} = V_{CC} − 1.5 V	R_{EXT} = 620 Ω	−32.3	−38.0	−43.7	
	Current skew	ΔI_{OUT}	—	Same as I_{OUT1}, I_{OUT2} and I_{OUT3}		—	±1.5	±6.0	%
Supply voltage regulation		$\%/V_{DD}$	—	Ta = −40~85°C	R_{EXT} = 360 Ω	—	1.5	5.0	%/V
Pull-up resistor		$R_{in\ (Up)}$	—	—		150	300	600	kΩ
Pull-down resistor		$R_{in\ (Down)}$	—	—		100	200	400	kΩ
Supply current	V_{DD}	$I_{DD\ (OFF)}$	—	All outputs = OFF	R_{EXT} = OPEN	—	0.6	1.2	mA
		$I_{DD\ (ON)\ 1}$	—	DATA = ALL “H”, All outputs = ON (no load)	R_{EXT} = 360 Ω	—	7.5	10.0	
		$I_{DD\ (ON)\ 2}$	—	DATA = ALL “H”, All outputs = ON (no load)	R_{EXT} = 620 Ω	—	4.0	7.0	
	V_{CC}	$I_{CC\ (OFF)}$	—	DATA = ALL “L”, All outputs = OFF (no load)	R_{EXT} = 620 Ω	—	0.5	1.0	
		$I_{CC\ (ON)}$	—	DATA = ALL “H”, All outputs = ON (no load)	R_{EXT} = 360 Ω	—	42.0	52.0	

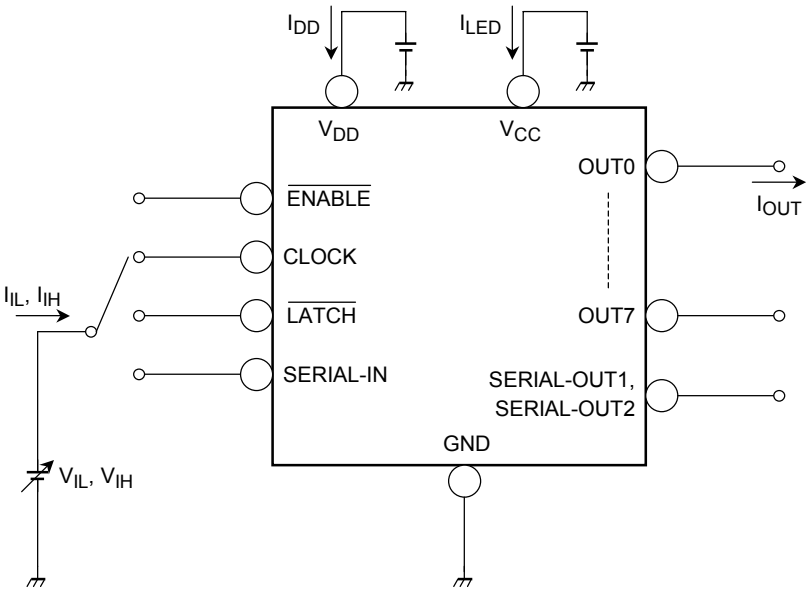
Switching Characteristics (T_{opr} = 25°C unless otherwise specifed)

Characteristic		Symbol	Test circuit	Conditions	Min	Typ.	Max	Unit
Propagation delay time (“L” to “H”)	CLK-OUTn	t_{pLH}	—	V_{DD} = 5.0 V, V_{CC} = 17.0 V V_{OUT} = V_{CC} − 2.0 V V_{IH} = V_{DD}, V_{IL} = GND R_{EXT} = 620 Ω C_L = 10.5 pF t_{or}: 10~90% t_{of}: 90~10% t_{pLH}: 50~10% t_{pHL}: 50~90% Set the switching characteristics according to the result of measuring the voltage waveform.	—	200	450	ns
	$\overline{\text{LATCH}}$ -OUTn		—					
	$\overline{\text{ENABLE}}$ -OUTn		—					
	CLK-SOUTn		—		—	20	70	
Propagation delay time (“H” to “L”)	CLK-OUTn	t_{pHL}	—		—	60	180	ns
	$\overline{\text{LATCH}}$ -OUTn		—					
	$\overline{\text{ENABLE}}$ -OUTn		—					
	CLK-SOUTn		—		—	20	70	
Pulse width	CLK	t_{wCLK}	—		—	20	30	ns
	$\overline{\text{LATCH}}$	t_{wLAT}	—		—	10	25	
Set-up time $\overline{\text{LATCH}}$ /SIN/ CLOCK	DATA = “L” → “H”	t_{setup}	—		—	25	50	ns
			—					
Hold time $\overline{\text{LATCH}}$ /SIN/ CLOCK	DATA = “H” → “L”	t_{hold}	—		—	0	30	ns
			—					
Slow clock	Rise time (Note 4)	t_r	—		—	—	10	μs
	Fall time (Note 4)	t_f	—		—	—	10	μs
Output rise time		t_{or}	—		25	55	110	ns
Output fall time		t_{of}	—		250	450	600	ns

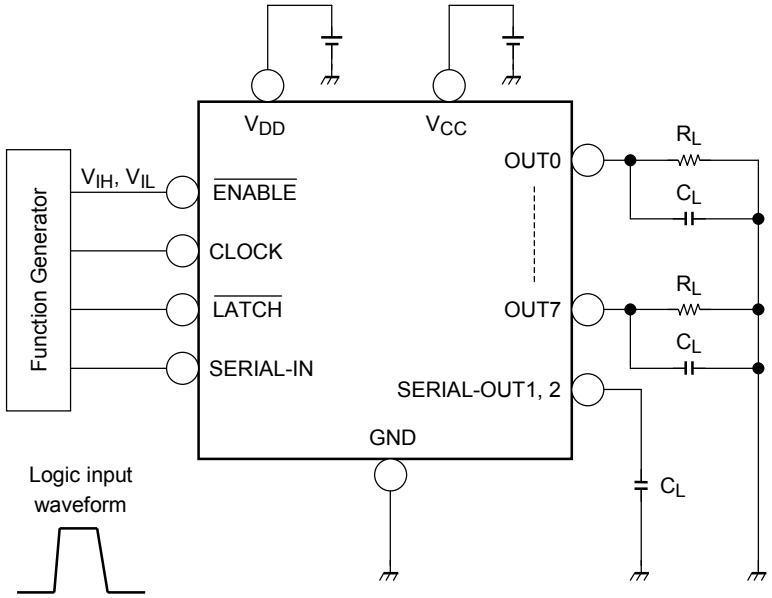
Note 4: If the device is connected in a cascade and t_r/t_f for the waveform is large, it may not be possible to achieve the timing required for data transfer. Please consider the timings carefully.

Test Circuit

DC Characteristic



AC Characteristic

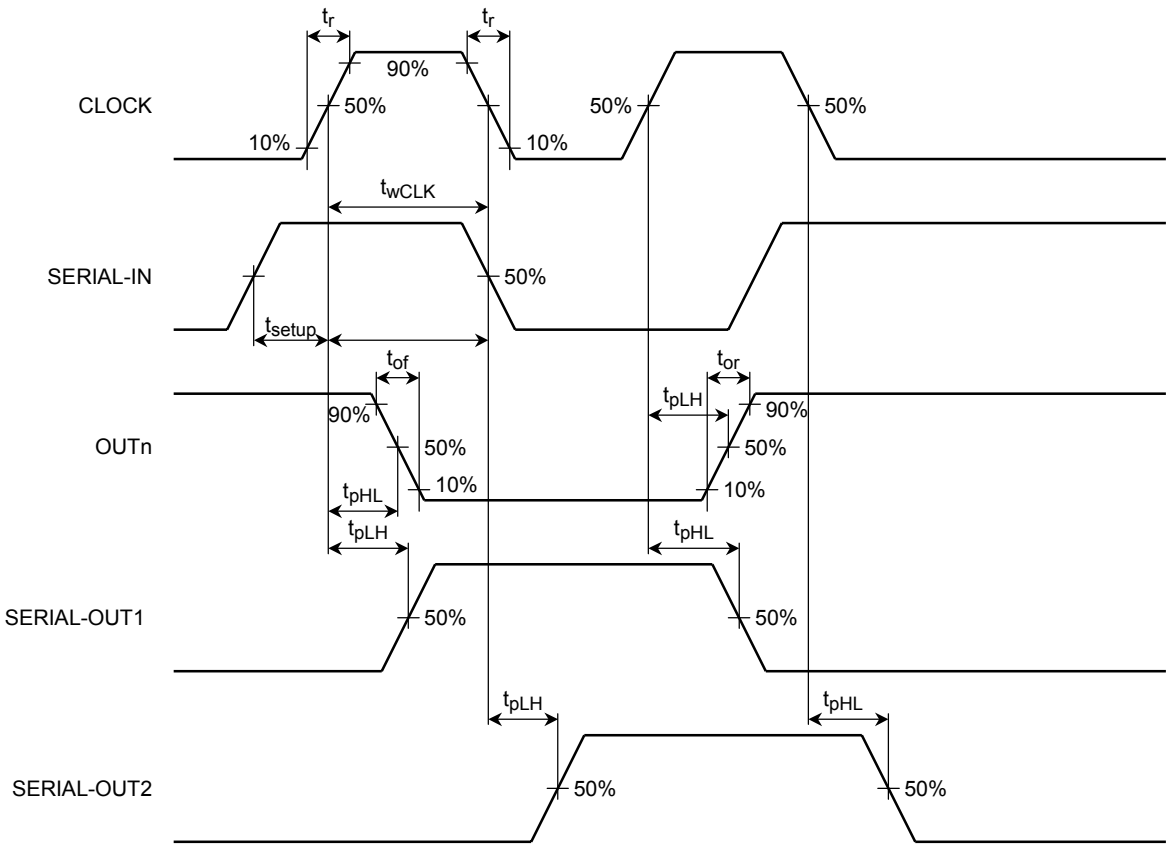


Logic input waveform

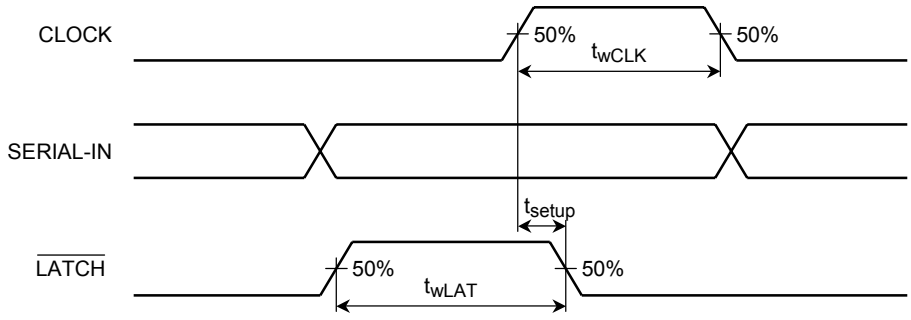
$V_{DD} = V_{IH} = 5.0$ V
$V_{IL} = 0$ V
$t_r = t_f = 10$ ns
(10% to 90%)

Timing Waveforms

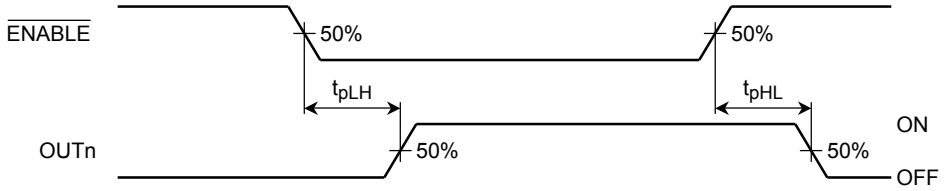
1. CLOCK, SERIAL OUTn



2. CLOCK, $\overline{\text{LATCH}}$

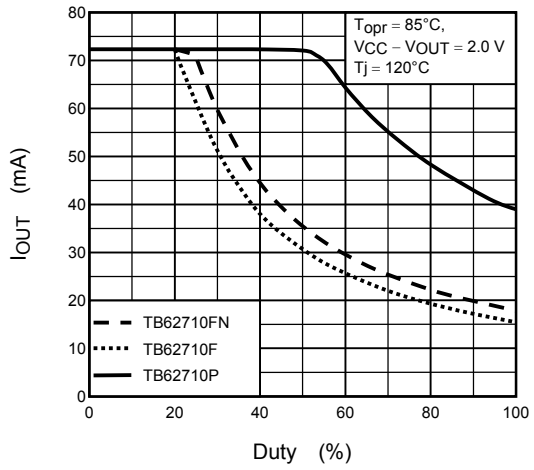


3. $\overline{\text{ENABLE}}$ – OUTn

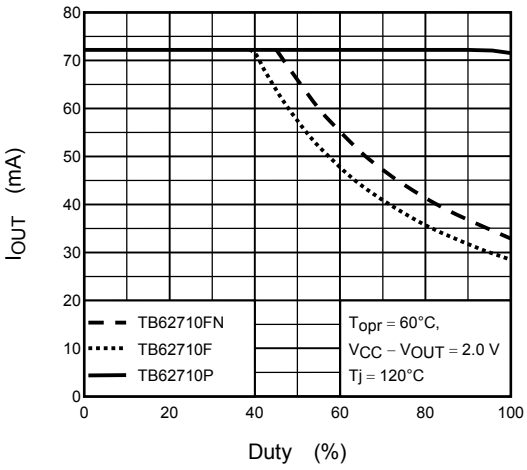


Reference Data (duty curves + package power dissipation)

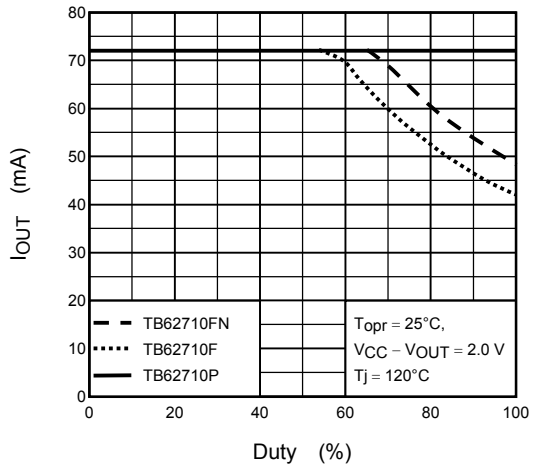
I_{OUT} – Duty on PCB



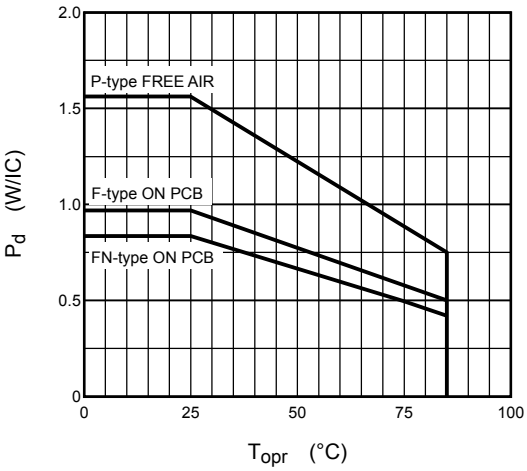
I_{OUT} – Duty on PCB



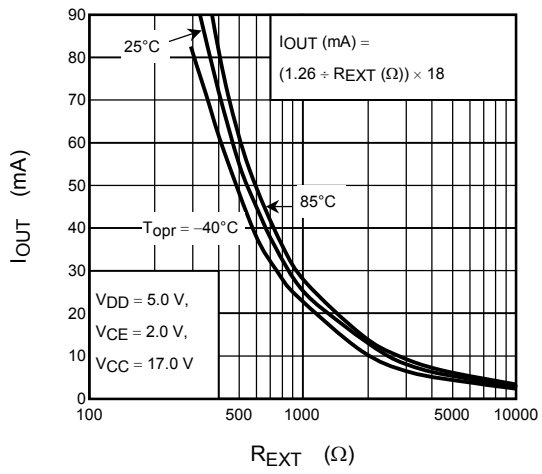
I_{OUT} – Duty on PCB



P_d – T_{opr}



I_{OUT} – R_{EXT}



The bottom figure shows an application circuit.
For best results, this IC should be operated with V_O = 2.0 V.

V_O (V) = V_{CC} – V_{OUT}
= V_{CC} – V_f (LED) – V_{CE1}

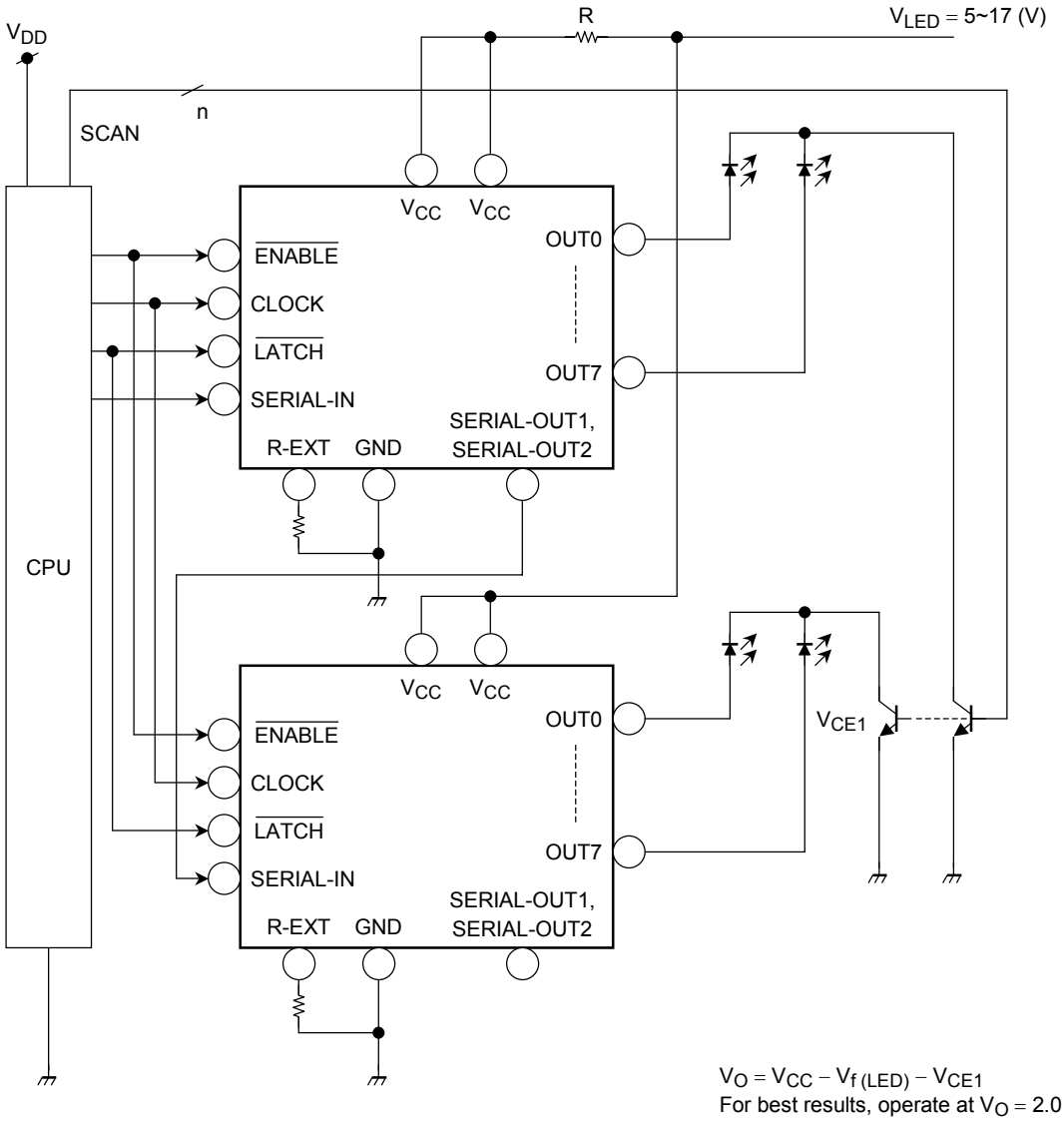
When V_{CC} is high and the V_f of the LED is low.
V_O is also high , the increase in power dissipation may in turn adversely affect the IC's output current.
In this case, reduce the voltage by connecting an external resistor.
In this way the IC's output current can be stabilized.

$$R = \frac{V_{CC} - V_f - V_O\,(\min)}{I_{OUT}\,(\max) \times \text{BIT number}\,(\max)}$$

It is looked for.

it is also possible that the IC will operate in an unstable manner due to the inductance of the wiring.
To counter this, it is recommended that the IC be situated as close as possible on the PCB to the LED module, and as far as possible from other ICs. Otherwise, there is the risk that the IC will malfunction.

Application



$V_O = V_{CC} - V_{f\,(LED)} - V_{CE1}$
For best results, operate at V_O = 2.0 V

Notes

- Operation may become unstable due to the electromagnetic interference caused by the wiring and other phenomena.
  To counter this, it is recommended that the IC be situated as close as possible to the LED module.
  If overvoltage is caused by inductance between the LED and the output terminals, both the LED and the terminals may suffer damage as a result.

- There is only one GND terminal on this device when the inductance in the GND line and the resistor are large, the device may malfunction due to the GND noise when output switchings by the circuit board pattern and wiring.
  To achieve stable operation, it is necessary to connect a resistor between the REXT terminal and the GND line.
  Fluctuation in the output waveform is likely to occur when the GND line is unstable or when a capacitor (of more than 50 pF) is used.
  Therefore, take care when designing the circuit board pattern layout and the wiring from the controller.

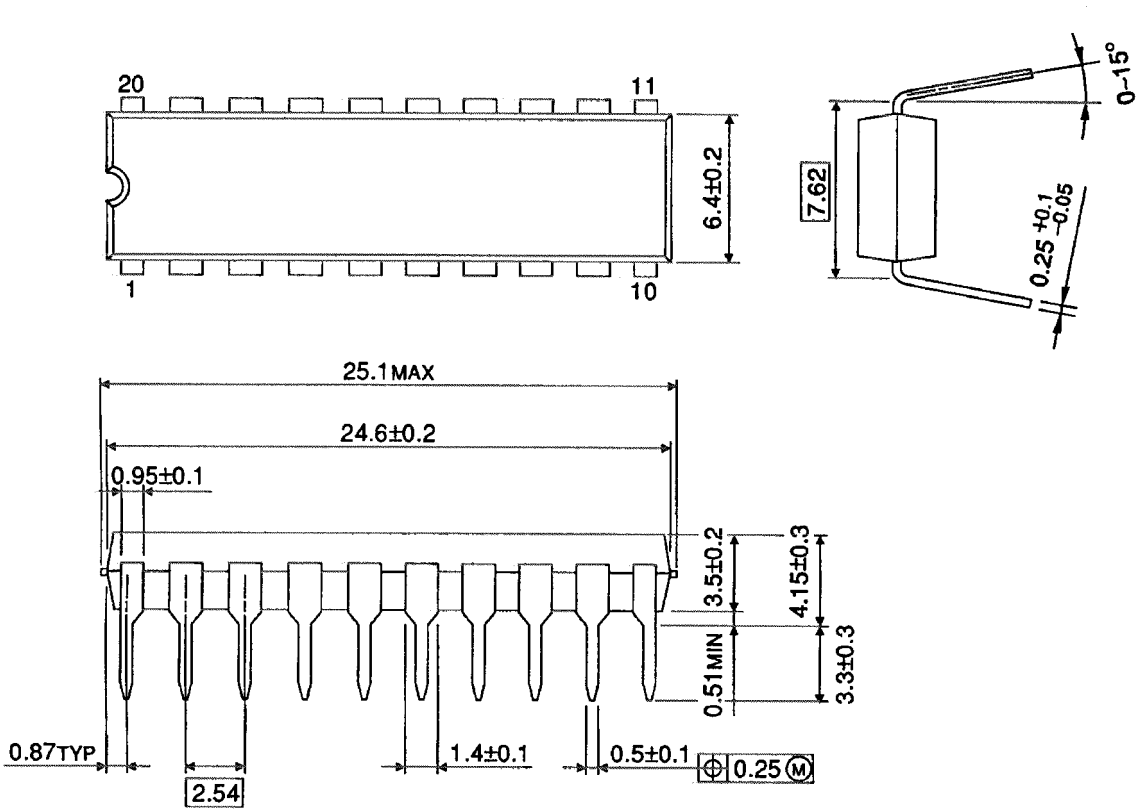
- This application circuit is a reference example and is not guaranteed to work in all conditions.
  Be sure to check the operation of your circuits.

- This device does not include protection circuits for overvoltage, overcurrent or overtemperature.
  If protection is necessary, it must be incorporated into the control circuitry.

- The device is likely to be destroyed if a short-circuit occurs between either of the power supply pins and any of the output terminals when designing circuits, pay special attention to the positions of the output terminals and the power supply terminals (V_{DD} and V_{LED}), and to the design of the GND line.

Package Dimensions

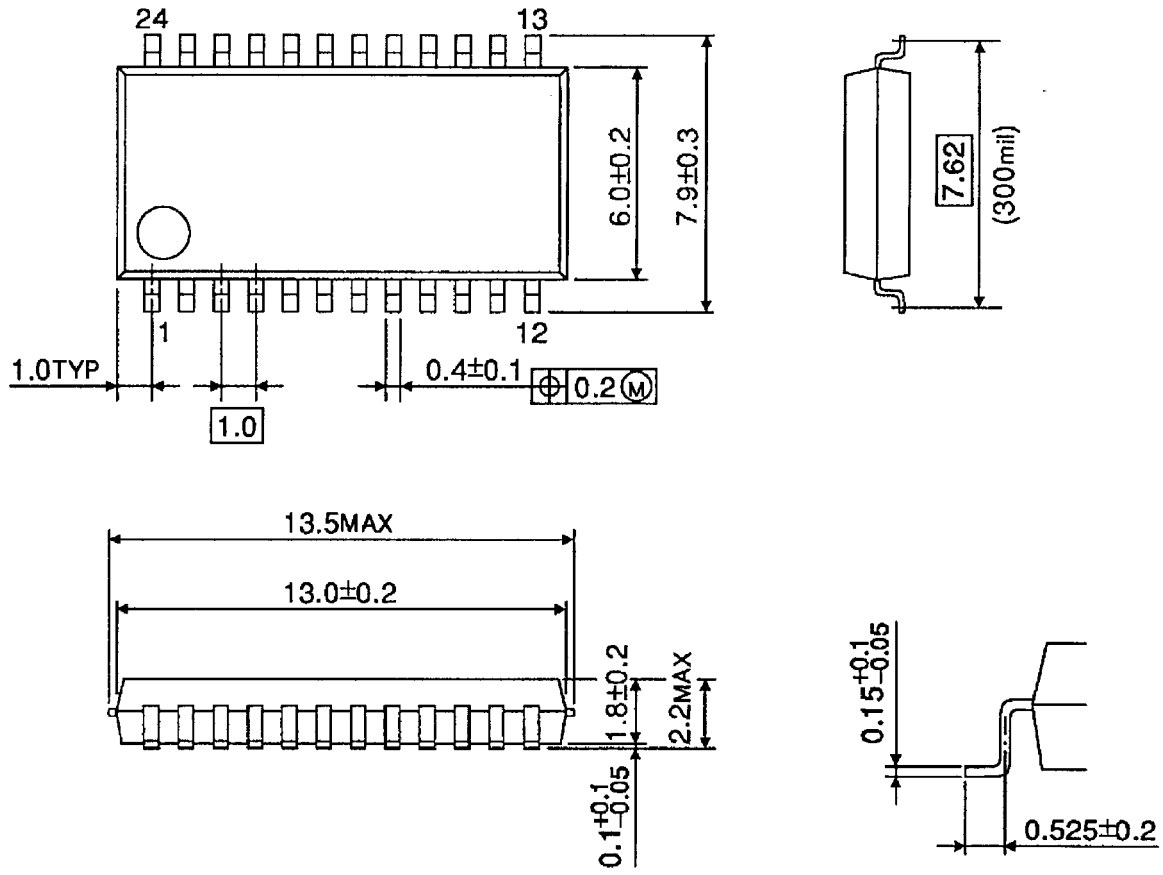
DIP20-P-300-2.54A Unit : mm



Weight: 2.25 g (typ.)

Package Dimensions

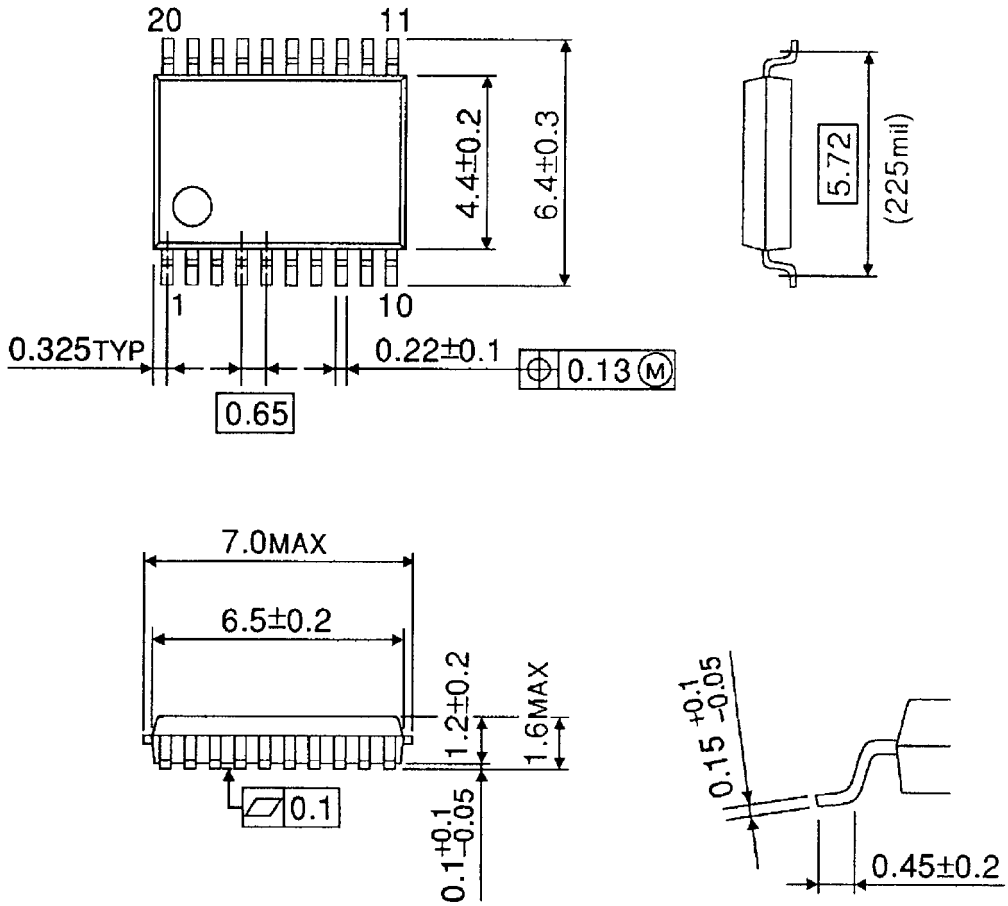
SSOP24-P-300-1.00 Unit : mm



Weight: 0.33 g (typ.)

Package Dimensions

SSOP20-P-225-0.65A Unit : mm



Weight: 0.10 g (typ.)

RESTRICTIONS ON PRODUCT USE

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- TOSHIBA is continually working to improve the quality and reliability of its products. Nevertheless, semiconductor devices in general can malfunction or fail due to their inherent electrical sensitivity and vulnerability to physical stress. It is the responsibility of the buyer, when utilizing TOSHIBA products, to comply with the standards of safety in making a safe design for the entire system, and to avoid situations in which a malfunction or failure of such TOSHIBA products could cause loss of human life, bodily injury or damage to property.
  In developing your designs, please ensure that TOSHIBA products are used within specified operating ranges as set forth in the most recent TOSHIBA products specifications. Also, please keep in mind the precautions and conditions set forth in the “Handling Guide for Semiconductor Devices,” or “TOSHIBA Semiconductor Reliability Handbook” etc..
- The TOSHIBA products listed in this document are intended for usage in general electronics applications (computer, personal equipment, office equipment, measuring equipment, industrial robotics, domestic appliances, etc.). These TOSHIBA products are neither intended nor warranted for usage in equipment that requires extraordinarily high quality and/or reliability or a malfunction or failure of which may cause loss of human life or bodily injury (“Unintended Usage”). Unintended Usage include atomic energy control instruments, airplane or spaceship instruments, transportation instruments, traffic signal instruments, combustion control instruments, medical instruments, all types of safety devices, etc.. Unintended Usage of TOSHIBA products listed in this document shall be made at the customer’s own risk.
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