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.
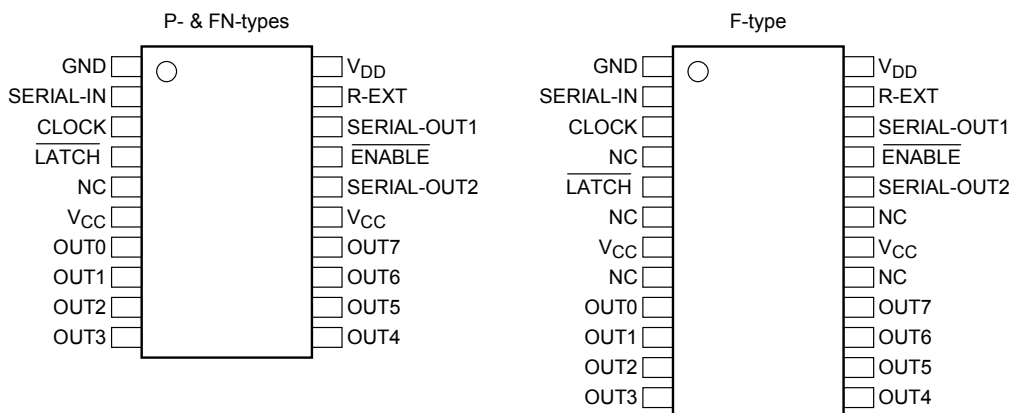
FEATURES

- 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
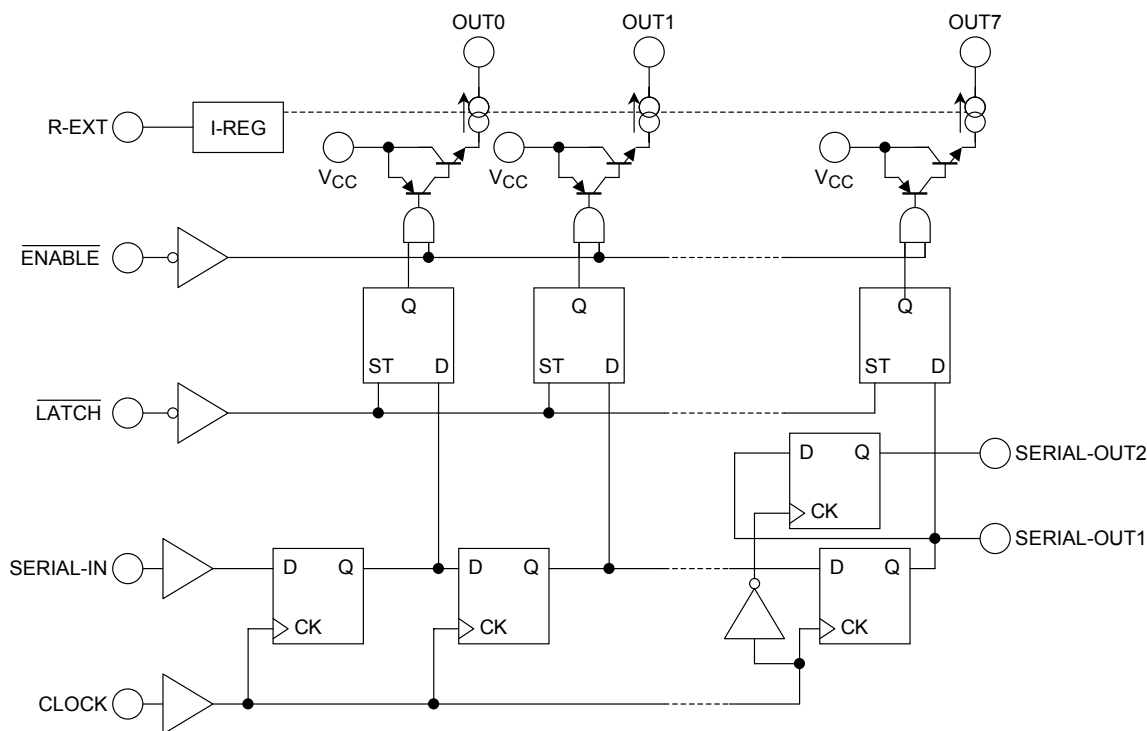
TB62710F

SSOP24-P-300-1.00

TB62710FN
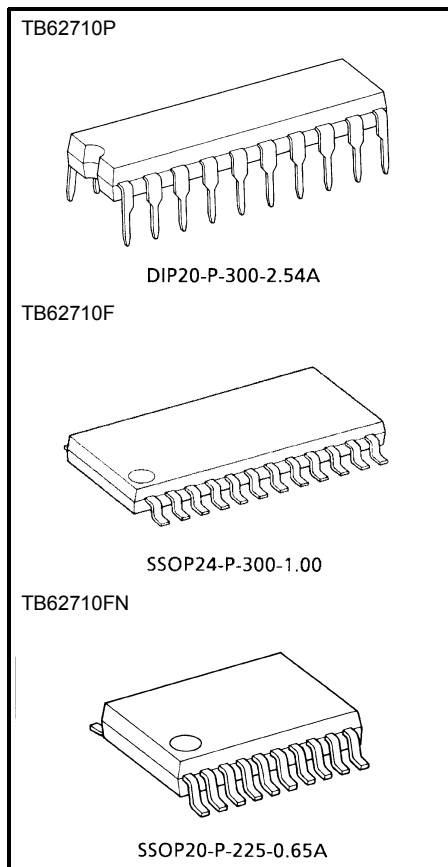
SSOP20-P-225-0.65A

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

GND	V_{DD}
SERIAL-IN	R-EXT
CLOCK	SERIAL-OUT1
$\overline{LATCH}$	$\overline{ENABLE}$
NC	SERIAL-OUT2
V_{CC}	V_{CC}
OUT0	OUT7
OUT1	OUT6
OUT2	OUT5
OUT3	OUT4

F-type

GND	V_{DD}
SERIAL-IN	R-EXT
CLOCK	SERIAL-OUT1
NC	$\overline{ENABLE}$
$\overline{LATCH}$	SERIAL-OUT2
NC	NC
V_{CC}	V_{CC}
NC	NC
OUT0	OUT7
OUT1	OUT6
OUT2	OUT5
OUT3	OUT4

Block Diagram

Truth Table

CLOCK	$\overline{LATCH}$	$\overline{ENABLE}$	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.

2006-06-14

Timing Diagram
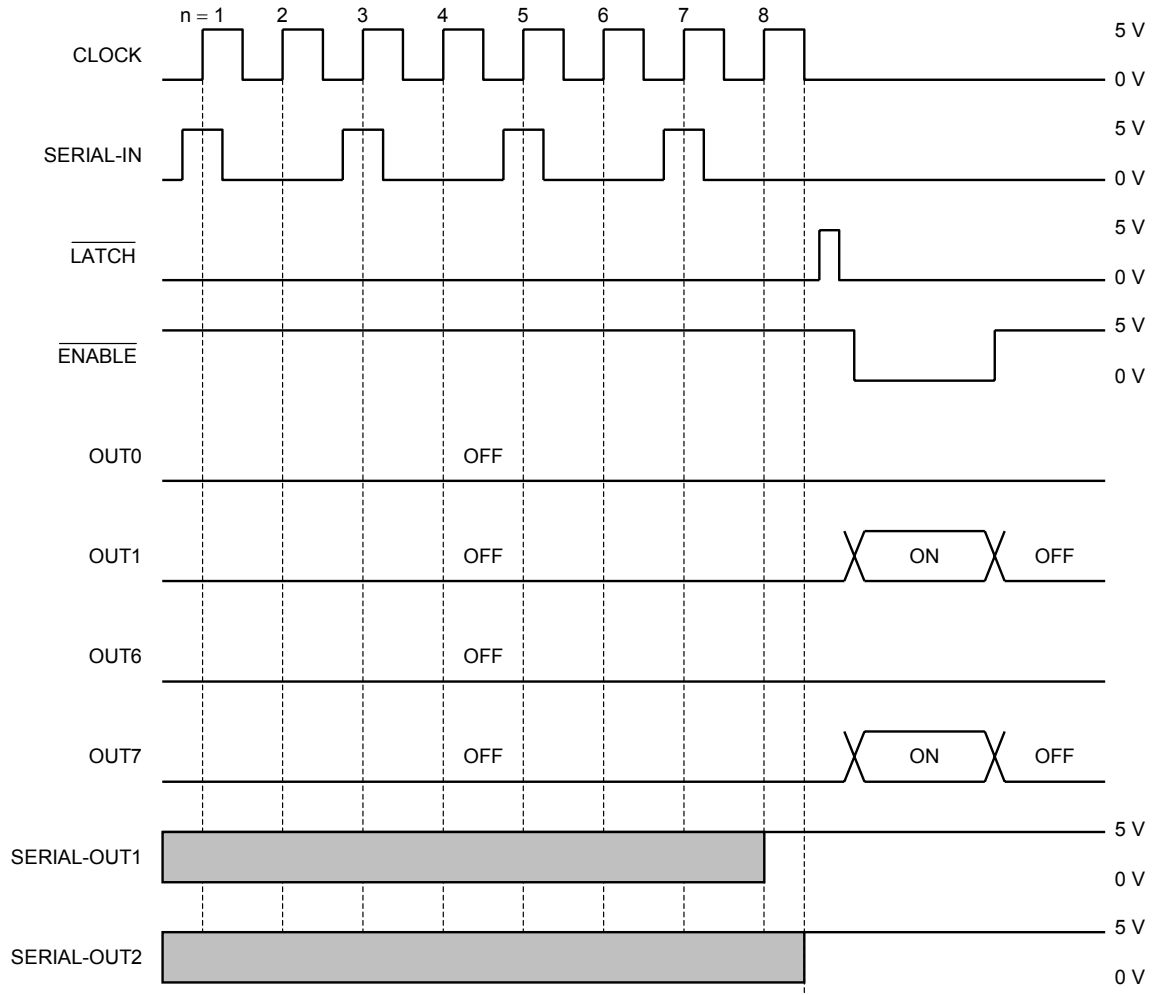
Note 2: The latches circuit holds data by pulling the $\overline{\text{LATCH}}$ terminal Low.
And, when $\overline{\text{LATCH}}$ terminal is a "H" level, latch circuit doesn't hold data, and it passes from the input to the output.
When $\overline{\text{ENABLE}}$ terminal is a "L" level, output terminal 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

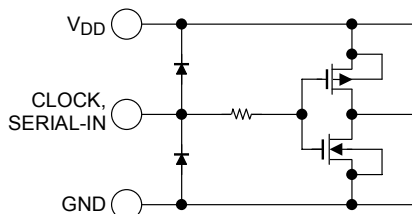## Equivalent Circuits For Inputs and Outputs

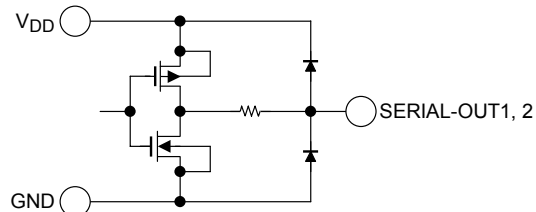### $\overline{\text{ENABLE}}$ terminal
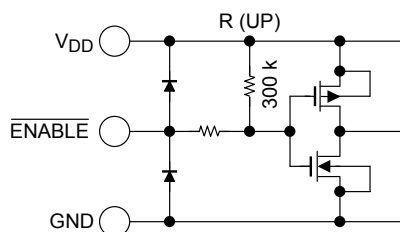
$\overline{\text{LATCH}}$ terminal
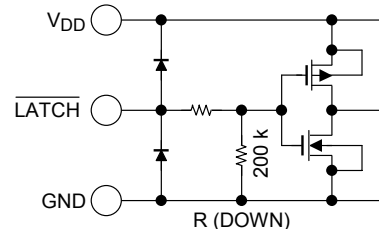
CLOCK, SERIAL-IN terminal

SERIAL-OUT1 and SERIAL-OUT2 terminals

Absolute 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)	$R_{th\,(j\text{-}a)\,1}$	85	°C/W
	F-type (when not mounted)	$R_{th\,(j\text{-}a)\,2}$	210	
	F-type (on PCB)		150	
	FN-type (when not mounted)	$R_{th\,(j\text{-}a)\,3}$	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)

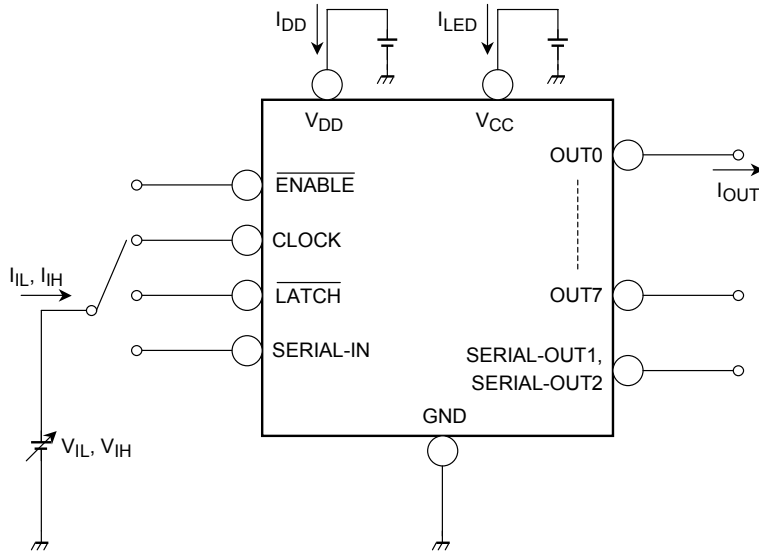| Characteristic		Symbol	Test circuit	Conditions		Min	Typ.	Max	Unit
Output leakage current		I_{LEAK}	—	V_{CC} = 17.0 V		—	—	−10	μA
Output voltage	SERIAL-OUT 1, 2	V_{OH}	—	I_{OH} = −1.0 mA		—	—	0.4	V
		V_{OL}	—	I_{OL} = 1.0 mA		4.6	—	—	
Output current (including current skewing)		I_{OUT1}	—	V_{CC} = 4 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)

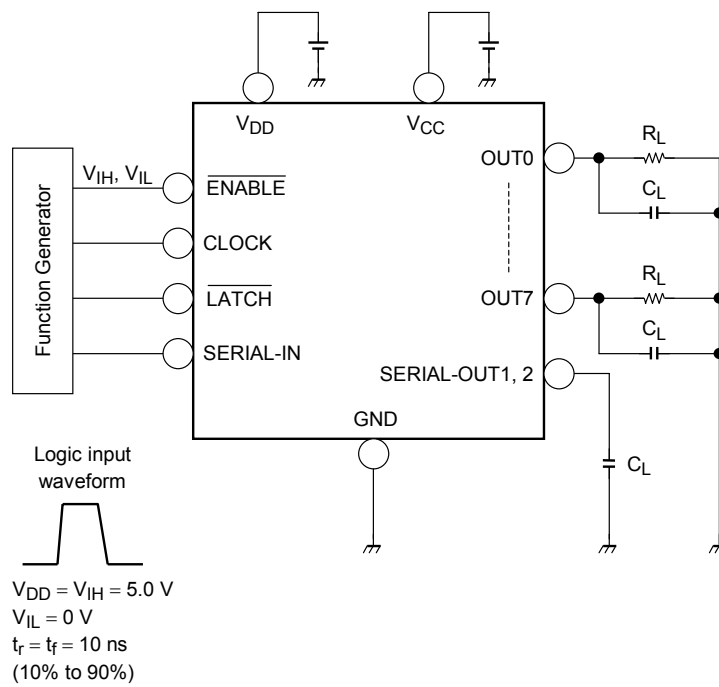| Characteristic		Symbol	Test circuit	Conditions	Min	Typ.	Max	Unit
Propagation delay time ("L" to "H")	CLK-OUTn	t_{pLH}	—		—	200	450	ns
	$\overline{LATCH}$ -OUTn		—					
	$\overline{ENABLE}$ -OUTn		—					
	CLK-SOUTn		—	V_{DD} = 5.0 V, V_{CC} = 17.0 V	—	20	70	
Propagation delay time ("H" to "L")	CLK-OUTn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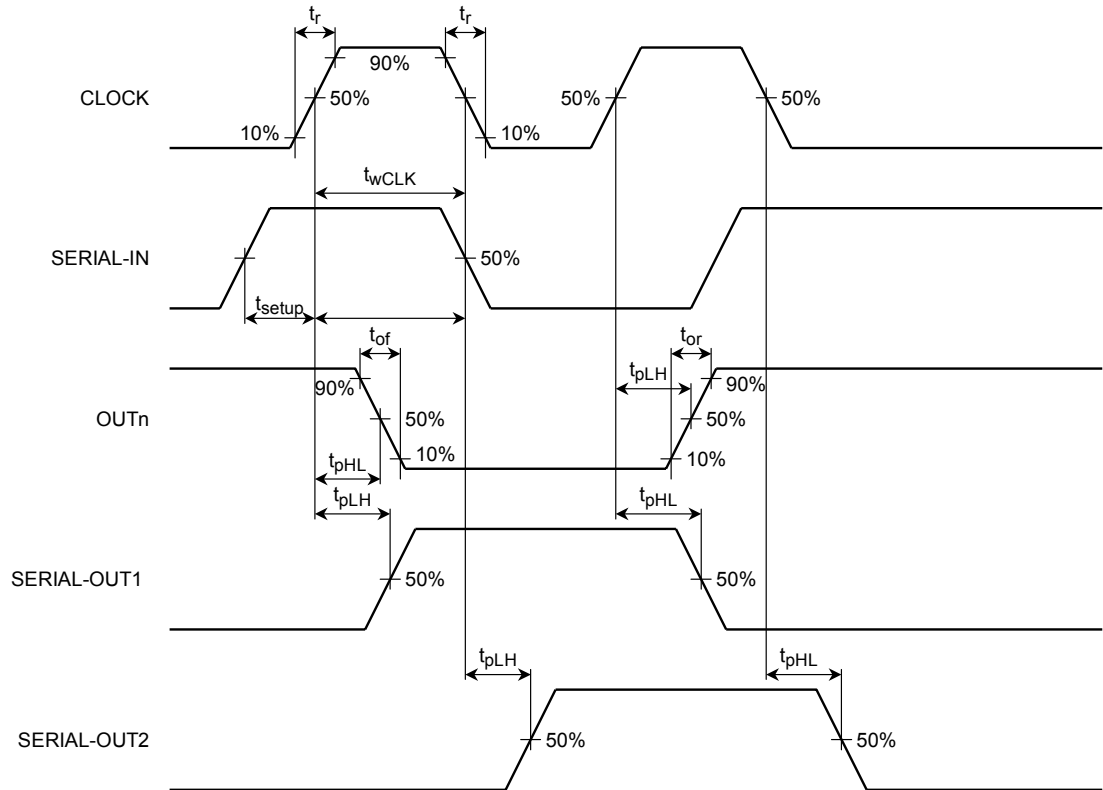
Test Circuit

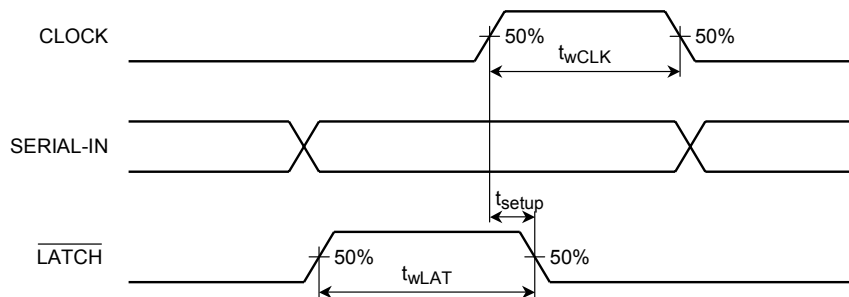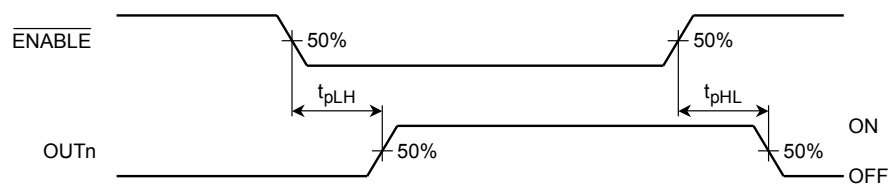### DC Characteristic

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

CLOCK

t_r 90% t_r

50%   50%   50%

10%   10%

t_{wCLK}

SERIAL-IN

50%

t_{setup}

OUTn

t_{of} t_{or}

t_{pLH}

90%   90%

50%   50%

10%   10%

t_{pHL}

t_{pLH}

SERIAL-OUT1

50%   50%

t_{pLH} t_{pHL}

SERIAL-OUT2

50%   50%

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

CLOCK

50%   50%

t_{wCLK}

SERIAL-IN

t_{setup}

$\overline{\text{LATCH}}$

50%   50%

t_{wLAT}

3. $\overline{\text{ENABLE}}$ − OUTn

$\overline{\text{ENABLE}}$

50%   50%

t_{pLH} t_{pHL}

OUTn

50%   50%

ON

OFF

Reference Data (duty curves + package power dissipation)

I_{OUT} – Duty on PCB

TB62710FN
TB62710F
TB62710P

$T_{opr} = 85°C,$
$V_{CC} - V_{OUT} = 2.0\ V$
$T_j = 120°C$

I_{OUT} – Duty on PCB

TB62710FN
TB62710F
TB62710P

$T_{opr} = 60°C,$
$V_{CC} - V_{OUT} = 2.0\ V$
$T_j = 120°C$

I_{OUT} – Duty on PCB

TB62710FN
TB62710F
TB62710P

$T_{opr} = 25°C,$
$V_{CC} - V_{OUT} = 2.0\ V$
$T_j = 120°C$

P_d – T_{opr}

P-type FREE AIR
F-type ON PCB
FN-type ON PCB

I_{OUT} – R_{EXT}

25°C
85°C
$T_{opr} = -40°C$

$I_{OUT}\ (mA) =$
$(1.26 \div R_{EXT}\ (\Omega)) \times 18$

$V_{DD} = 5.0\ V,$
$V_{CE} = 2.0\ V,$
$V_{CC} = 17.0\ V$
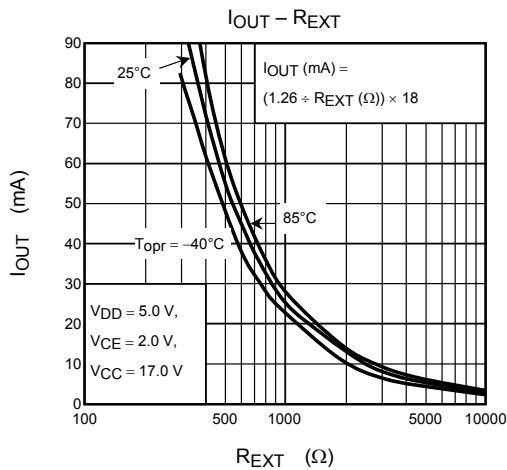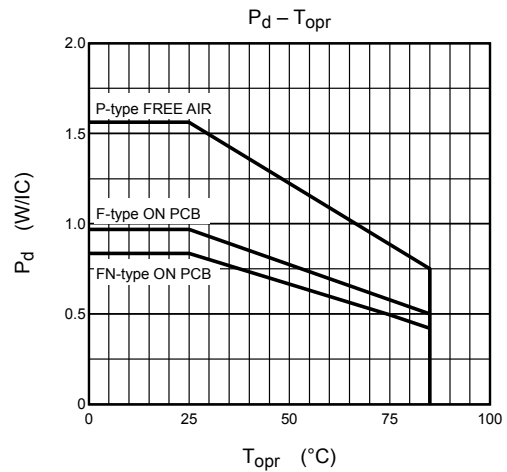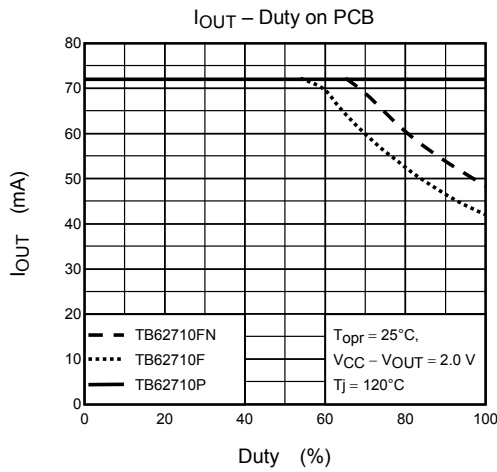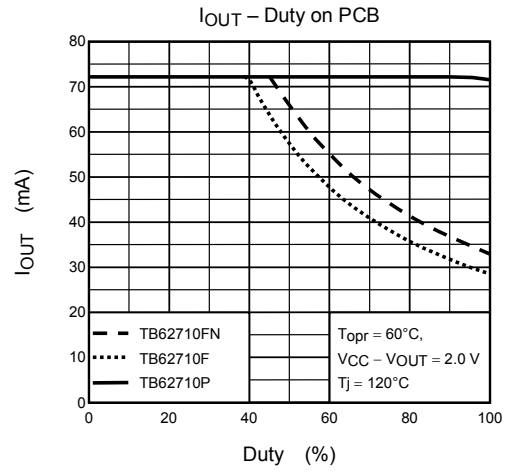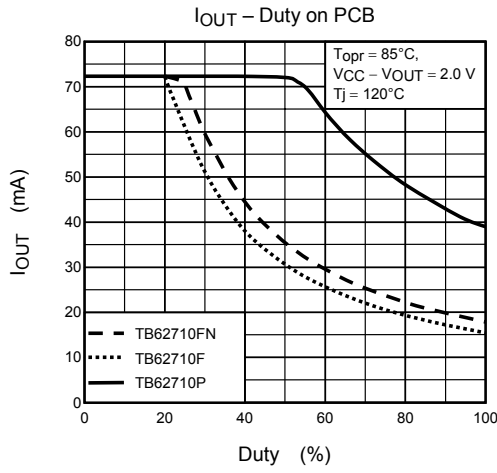
The bottom figure shows an application circuit.
For best results, this IC should be operated with V_O = 2.0 V.

$$V_O \text{ (V)} = V_{CC} - V_{OUT}$$
$$= V_{CC} - V_f \text{ (LED)} - V_{CE1}$$

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.

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

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

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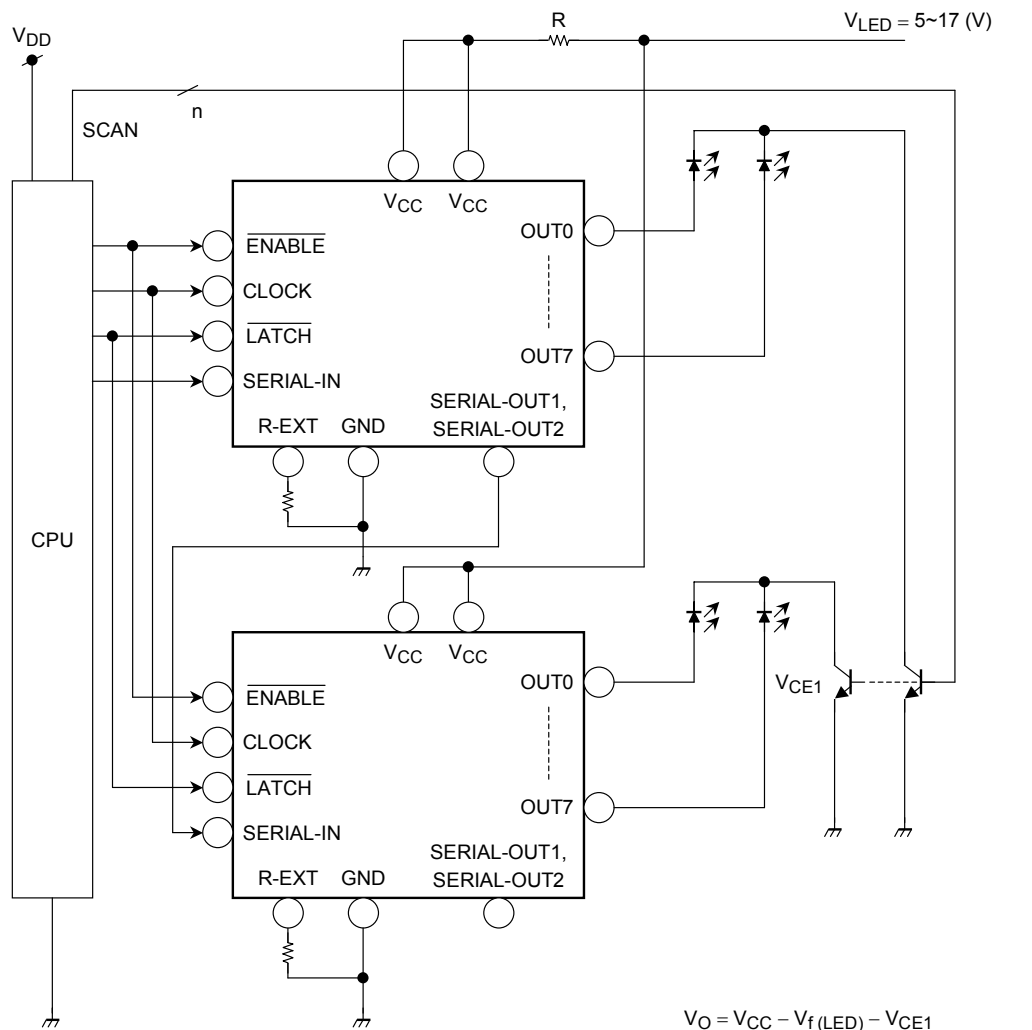
Notes

- 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
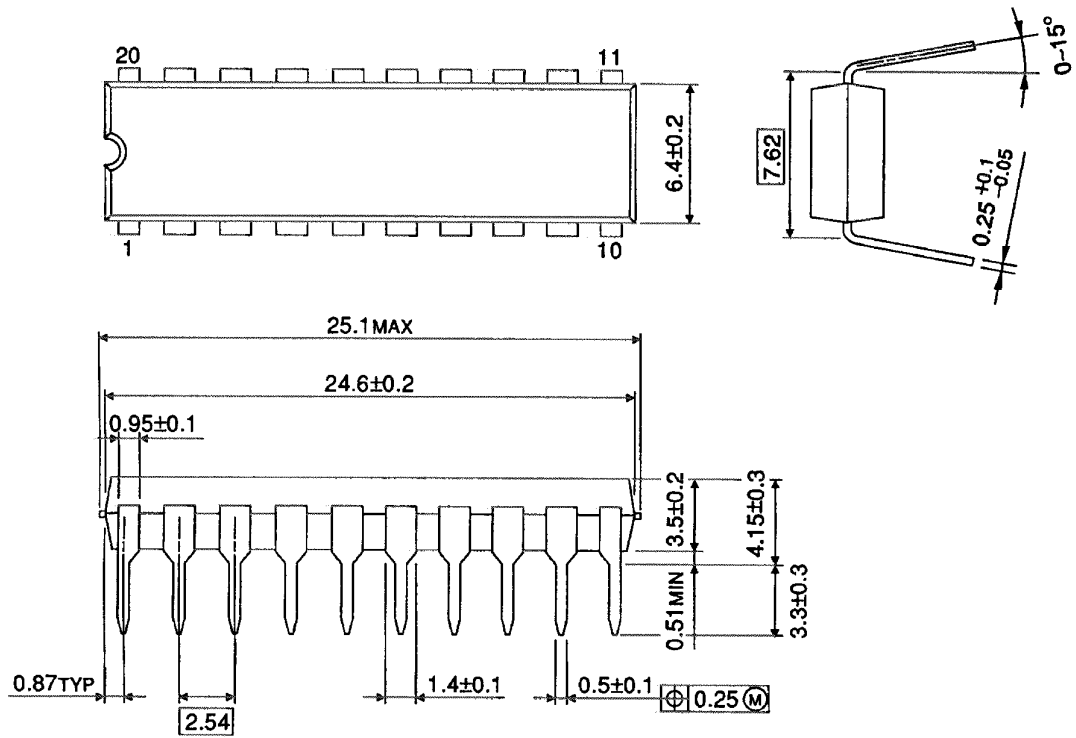
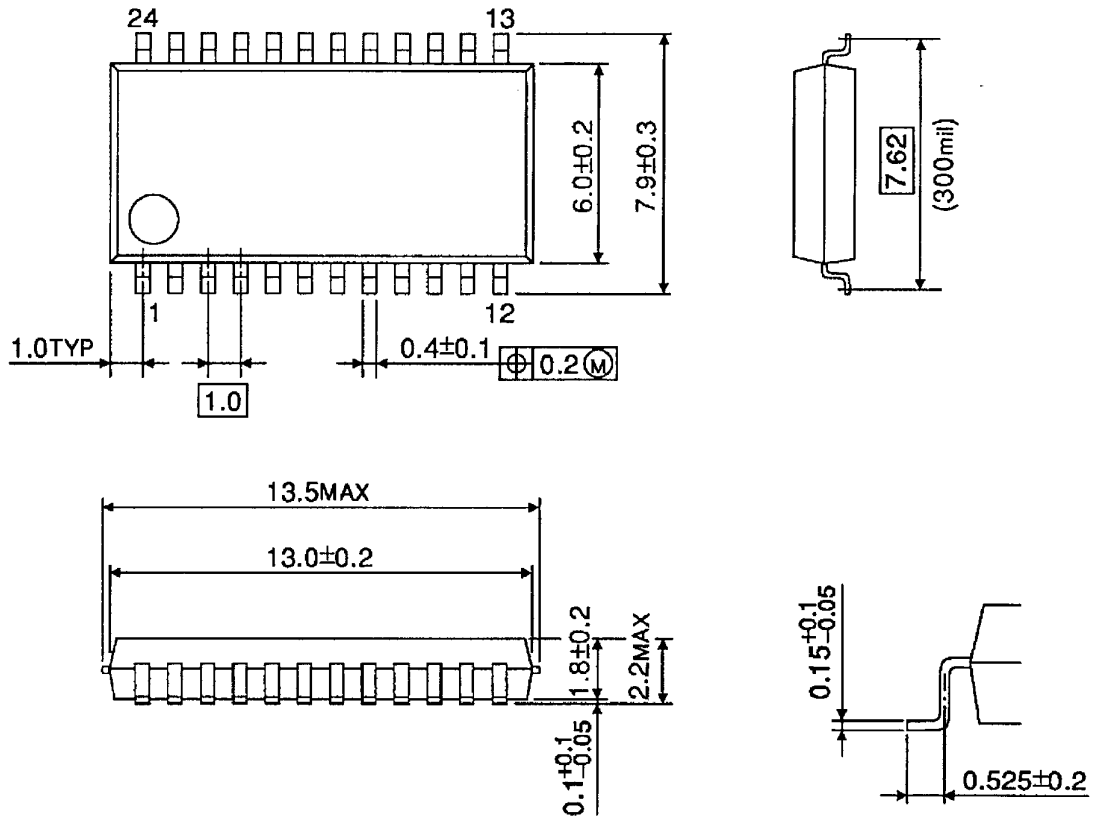Weight: 2.25 g (typ.)

Package Dimensions

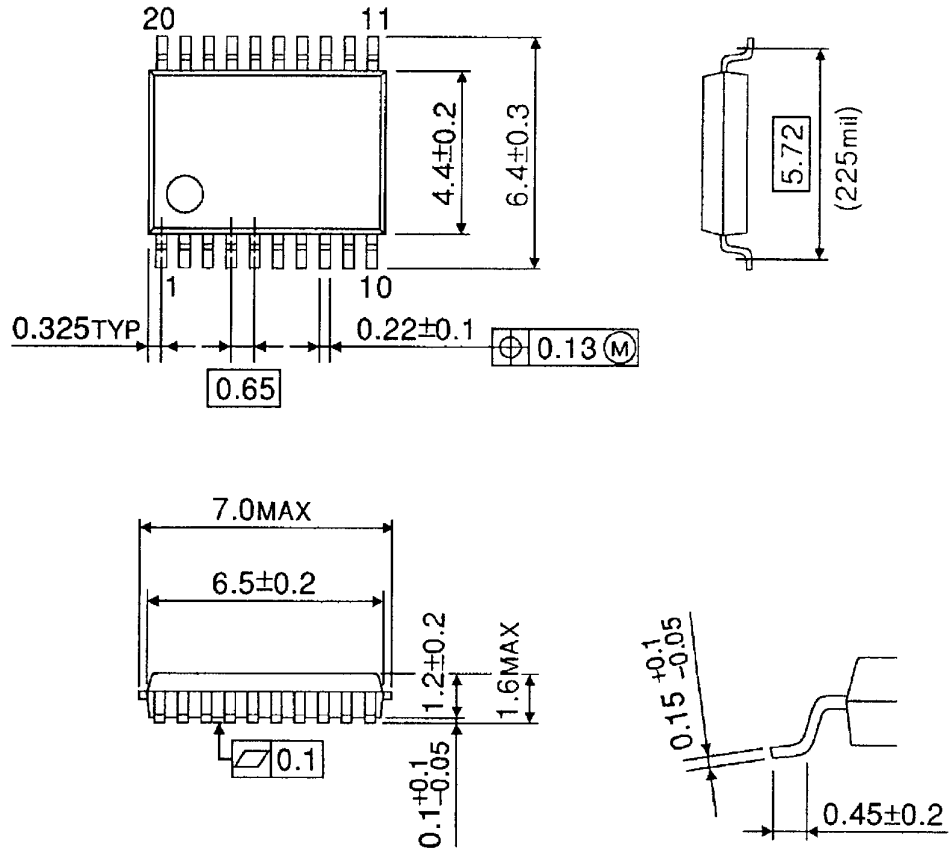SSOP24-P-300-1.00   Unit : mm

Weight: 0.33 g (typ.)

Package Dimensions

SSOP20-P-225-0.65A

Unit : mm

Weight: 0.10 g (typ.)

Notes on Contents

1. Block Diagrams

Some of the functional blocks, circuits, or constants in the block diagram may be omitted or simplified for explanatory purposes.

2. Equivalent Circuits

The equivalent circuit diagrams may be simplified or some parts of them may be omitted for explanatory purposes.

3. Timing Charts

Timing charts may be simplified for explanatory purposes.

4. Application Circuits

The application circuits shown in this document are provided for reference purposes only.
Thorough evaluation is required, especially at the mass production design stage.
Toshiba does not grant any license to any industrial property rights by providing these examples of application circuits.

5. Test Circuits

Components in the test circuits are used only to obtain and confirm the device characteristics. These components and circuits are not guaranteed to prevent malfunction or failure from occurring in the application equipment.

IC Usage Considerations

Notes on Handling of ICs

(1) The absolute maximum ratings of a semiconductor device are a set of ratings that must not be exceeded, even for a moment. Do not exceed any of these ratings.
Exceeding the rating(s) may cause the device breakdown, damage or deterioration, and may result injury by explosion or combustion.

(2) Use an appropriate power supply fuse to ensure that a large current does not continuously flow in case of over current and/or IC failure. The IC will fully break down when used under conditions that exceed its absolute maximum ratings, when the wiring is routed improperly or when an abnormal pulse noise occurs from the wiring or load, causing a large current to continuously flow and the breakdown can lead smoke or ignition. To minimize the effects of the flow of a large current in case of breakdown, appropriate settings, such as fuse capacity, fusing time and insertion circuit location, are required.

(3) If your design includes an inductive load such as a motor coil, incorporate a protection circuit into the design to prevent device malfunction or breakdown caused by the current resulting from the inrush current at power ON or the negative current resulting from the back electromotive force at power OFF. IC breakdown may cause injury, smoke or ignition.
Use a stable power supply with ICs with built-in protection functions. If the power supply is unstable, the protection function may not operate, causing IC breakdown. IC breakdown may cause injury, smoke or ignition.

(4) Do not insert devices in the wrong orientation or incorrectly.
Make sure that the positive and negative terminals of power supplies are connected properly. Otherwise, the current or power consumption may exceed the absolute maximum rating, and exceeding the rating(s) may cause the device breakdown, damage or deterioration, and may result injury by explosion or combustion.
In addition, do not use any device that is applied the current with inserting in the wrong orientation or incorrectly even just one time.

(5) Carefully select external components (such as inputs and negative feedback capacitors) and load components (such as speakers), for example, power amp and regulator.
If there is a large amount of leakage current such as input or negative feedback condenser, the IC output DC voltage will increase. If this output voltage is connected to a speaker with low input withstand voltage, overcurrent or IC failure can cause smoke or ignition. (The over current can cause smoke or ignition from the IC itself.) In particular, please pay attention when using a Bridge Tied Load (BTL) connection type IC that inputs output DC voltage to a speaker directly.

Points to Remember on Handling of ICs

(1) Heat Radiation Design
In using an IC with large current flow such as power amp, regulator or driver, please design the device so that heat is appropriately radiated, not to exceed the specified junction temperature (Tj) at any time and condition. These ICs generate heat even during normal use. An inadequate IC heat radiation design can lead to decrease in IC life, deterioration of IC characteristics or IC breakdown. In addition, please design the device taking into considerate the effect of IC heat radiation with peripheral components.

(2) Back-EMF
When a motor rotates in the reverse direction, stops or slows down abruptly, a current flow back to the motor's power supply due to the effect of back-EMF. If the current sink capability of the power supply is small, the device's motor power supply and output pins might be exposed to conditions beyond maximum ratings. To avoid this problem, take the effect of back-EMF into consideration in system design.

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  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. 021023_A

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