TOSHIBA Bi-CMOS Integrated Circuit Silicon Monolithic

TB62725BPG, TB62725BFG, TB62725BFNG

8-bit Constant-Current LED Driver of the 3.3-V and 5-V Power Supply Voltage Operation

The TB62725BPG/BFG/BFNG are comprised of constant-current drivers designed for LEDs and LED displays. The output current value can be set using an external resistor.

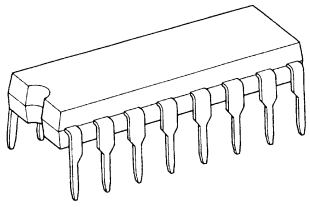
As a result, all outputs will have virtually the same current levels.

This driver incorporates an 8-bit constant-current output, an 8-bit shift register, an 8-bit latch circuit and an 8-bit AND-gate circuit.

These drivers have been designed using the Bi-CMOS process. This devices are a product for the Pb free.

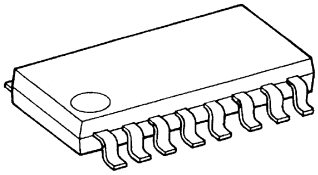
The suffix (G) appended to the part number represents a Lead (Pb) -Free product.

TB62725BPG



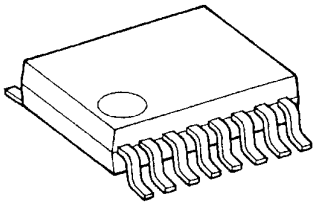
DIP16-P-300-2.54A

TB62725BFG



SSOP16-P-225-1.00A

TB62725BFNG



SSOP16-P-225-0.65B

Weight

DIP16-P-300-2.54A: 1.11 g (typ.)

SSOP16-P-225-1.00A: 0.14 g (typ.)

SSOP16-P-225-0.65B: 0.07 g (typ.)

Features

Output current capability and number of outputs:
90 mA × 8 outputs

Constant current range: 5 to 80 mA

Application output voltage:

0.7 V (output current 5 to 80 mA)

0.4 V (output current 5 to 40 mA)

For anode-common LEDs

Input signal voltage level: 3.3-V and 5-V CMOS level (Schmitt trigger input)

Maximum output terminal voltage: 17 V

Serial data transfer rate: 20 MHz (max, cascade connection)

Operating temperature range: T_{opr} = −40 to 85°C

Package:

Type BPG:	DIP16-P-300-2.54A
Type BFG:	SSOP16-P-225-1.00A
Type BFNG:	SSOP16-P-225-0.65B

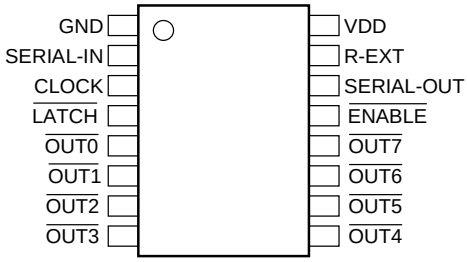
Package and pin layout: Pin layout and functionality are similar to those of the TB62705C series and TB62725A series.
(Each characteristic value is different.)

Constant-current accuracy (all outputs on)

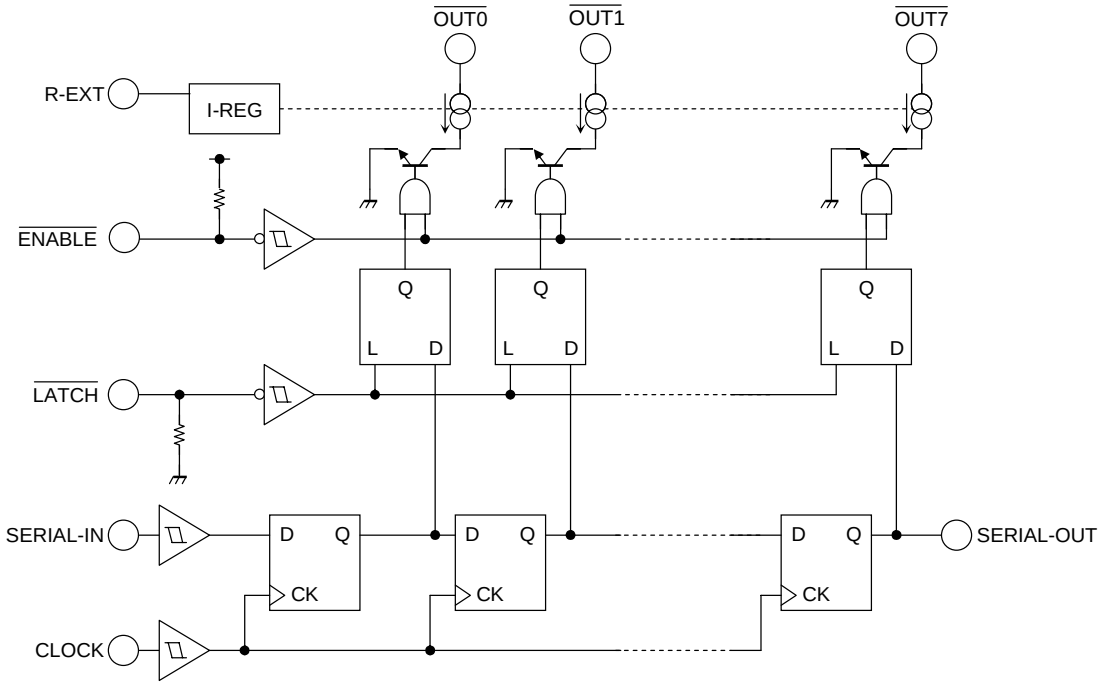
Output Voltage	Current Error between Bits	Current Error between ICs	Output Current
≧ 0.4 V	±6%	±15%	5 to 40 mA
≧ 0.7 V			5 to 90 mA

Pin Assignment (top view)

Pin layout and functionality are similar to those of the TB62705C. (each characteristic value is different.)



Block Diagram

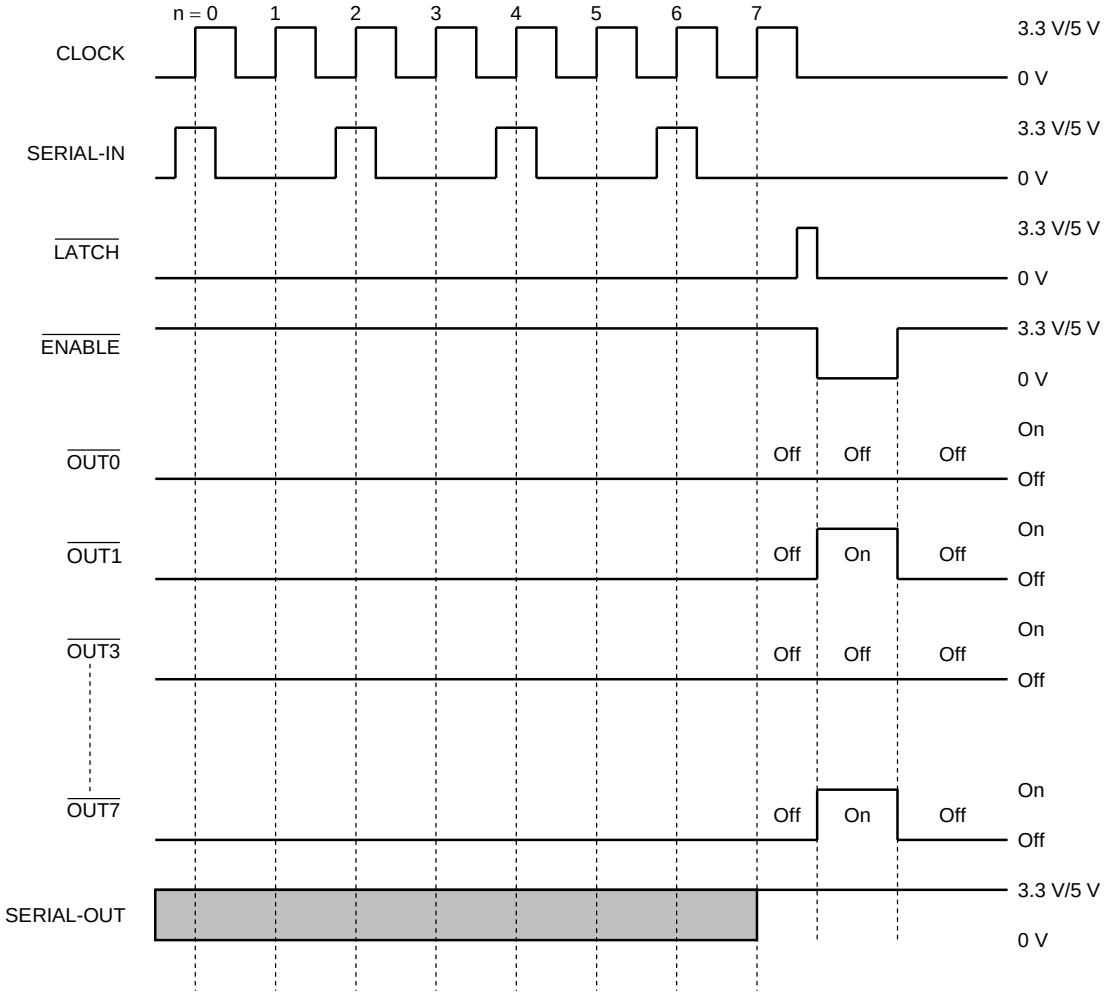


Truth Table

CLOCK	LATCH	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 to OUT7 = On when Dn = H; to OUT0 to OUT7 = Off when Dn = L.
In order to ensure that the level of the power supply voltage is correct, an external resistor must be connected between R-EXT and GND.

Timing Diagram



Warning: Latch circuit is leveled-latch circuit. Be careful because it is not triggered-latch circuit.

Note 2: The latches circuit holds data by pulling the $\overline{\text{LATCH}}$ terminal Low.
And, when $\overline{\text{LATCH}}$ terminal is a high-level, latch circuit doesn't hold data, and it passes from the input to the output.
When $\overline{\text{ENABLE}}$ terminal is a low-level, output terminal $\overline{\text{OUT0}}$ to $\overline{\text{OUT7}}$ respond to the data, and on and off does.

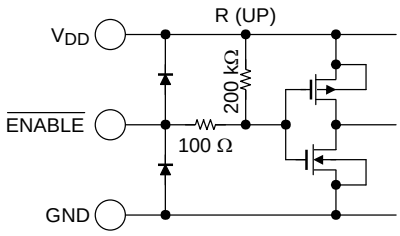
Attention: This IC can be used in 3.3 V or 5.0 V. However, use the V_{DD} power supply and the input level in the same voltage system.

Terminal Description

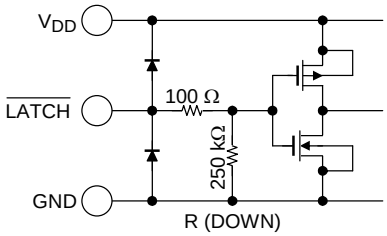
Pin No.	Pin Name	Function
1	GND	GND terminal for control logic.
2	SERIAL-IN	Input terminal for serial data for data shift register.
3	CLOCK	Input terminal for clock for data shift on rising edge.
4	$\overline{\text{LATCH}}$	Input terminal for data strobe. When the $\overline{\text{LATCH}}$ input is driven High, data is latched. When it is pulled Low, data is hold.
5 to 12	$\overline{\text{OUT0}}$ to $\overline{\text{OUT7}}$	Constant-current output terminals.
13	$\overline{\text{ENABLE}}$	Input terminal for output enable. All outputs ($\overline{\text{OUT0}}$ to $\overline{\text{OUT7}}$) be turned off, when the $\overline{\text{ENABLE}}$ terminal is driven High. And are turned on, when the terminal is driven Low.
14	SERIAL-OUT	Output terminal for serial data input on SERIAL-IN terminal.
15	R-EXT	Input terminal used to connect an external resistor. This regulated the output current.
16	V_{DD}	3.3-V and 5-V supply voltage terminal.

Equivalent Circuits for Inputs and Outputs

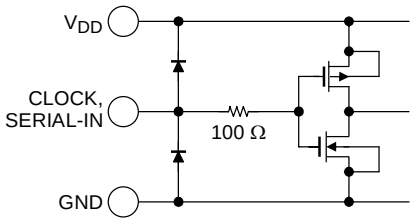
$\overline{\text{ENABLE}}$ Terminal



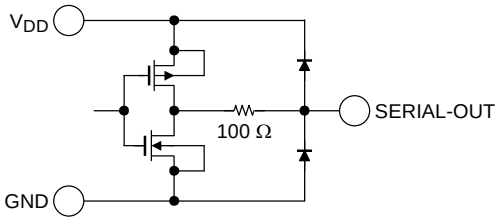
$\overline{\text{LATCH}}$ Terminal



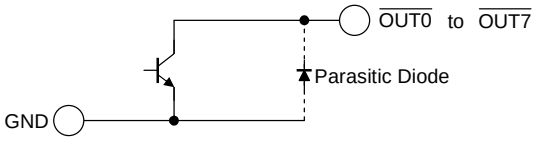
CLOCK, SERIAL-IN Terminal



SERIAL-OUT Terminal



$\overline{\text{OUT0}}$ to $\overline{\text{OUT7}}$ Terminals



Absolute Maximum Ratings (T_{opr} = 25°C)

Characteristics		Symbol	Rating	Unit
Supply voltage		V_{DD}	6	V
Input voltage		V_{IN}	−0.2 to V_{DD} + 0.2	V
Output current		I_{OUT}	90	mA/ch
Output voltage		V_{OUT}	−0.2 to 17	V
Power dissipation (Note 3)	BPG-type (when not mounted)	P_{d1}	1.47	W
	BFG/BFNG-type (when not mounted)	P_{d2}	0.37	
	BFG/BFNG-type (on PCB)		0.78	
Thermal resistance (Note 3)	BPG-type (when not mounted)	$R_{th\ (j\text{-}a)\ 1}$	85	°C/W
	BFG/BFNG-type (when not mounted)	$R_{th\ (j\text{-}a)\ 2}$	330	
	BFG/BFNG-type (on PCB)	$R_{th\ (j\text{-}a)\ 3}$	160	
Operating temperature		T_{opr}	−40 to 85	°C
Storage temperature		T_{stg}	−55 to 150	°C

Note 3: BPG-type: Power dissipation is delated by 11.76 mW/°C if device is mounted on PCB and ambient temperature is above 25°C.
BFG and BFNG-type: Power dissipation is delated by 7.69 mW/°C if device is mounted on PCB and ambient temperature is above 25°C. With device mounted on glass-epoxy PCB of less than 40% Cu and of dimensions 50 mm × 50 mm × 1.6 mm

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

Characteristics	Symbol	Test Condition	Min	Typ.	Max	Unit
Supply voltage	V_{DD}	—	3		5.5	V
Output voltage	V_{OUT}	—	—	0.7	4	V
Output current	I_{OUT}	Each DC 1 circuit	5	—	80	mA/ch
	I_{OH}	SERIAL-OUT	—	—	−1	mA
	I_{OL}	SERIAL-OUT	—	—	1	
Input voltage	V_{IH}	—	0.7 × V_{DD}	—	V_{DD} + 0.15	mA
	V_{IL}		−0.15	—	0.3 × V_{DD}	
Clock frequency	f_{CLK}	Cascade Connected	—	—	20	MHz
$\overline{\text{LATCH}}$ pulse width	$t_{w\overline{LATCH}}$	—	50	—	—	ns
$\overline{\text{ENABLE}}$ pulse width (Note 4)	$t_{w\overline{ENABLE}}$	$I_{OUT} \geqq 20$ mA	2000	—	—	ns
		$I_{OUT} < 20$ mA	3000	—	—	
CLOCK pulse width	t_{wCLOCK}	—	25	—	—	ns
Set-up time for CLOCK terminal	t_{SETUP1}		10	—	—	
Hold time for CLOCK terminal	t_{HOLD}		10	—	—	
Set-up time for $\overline{\text{LATCH}}$ terminal	t_{SETUP2}		50	—	—	

Note 4: When the pulse of the low level is inputted to the $\overline{\text{ENABLE}}$ terminal held in the high level.

Electrical Characteristics (V_{DD} = 5 V, Ta = 25°C unless otherwise specified)

Characteristics	Symbol	Test Condition		Min	Typ.	Max	Unit
Supply voltage	V_{DD}	Normal operation		4.5	5	5.5	V
Output current	I_{OUT1}	V_{OUT} = 0.4 V, V_{DD} = 3.3 V	R_{EXT} = 490 Ω	29.84	35.10	40.36	mA
	I_{OUT2}	V_{OUT} = 0.4 V, V_{DD} = 5 V	R_{EXT} = 250 Ω	29.58	34.80	40.02	
	I_{OUT3}	V_{OUT} = 0.7 V, V_{DD} = 3.3 V	R_{EXT} = 490 Ω	58.40	68.70	79.00	
	I_{OUT4}	V_{OUT} = 0.7 V, V_{DD} = 5 V	R_{EXT} = 250 Ω	57.55	67.70	77.85	
Output current Error between bits	ΔI_{OUT1}	V_{OUT} = 0.4 V, All outputs ON	R_{EXT} = 490 Ω	—	±1.5	±6	%
	ΔI_{OUT2}	V_{OUT} = 0.7 V, All outputs ON	R_{EXT} = 250 Ω	—	±1.5	±6	
Output leakage current	I_{OZ}	V_{OUT} = 15 V		—	1	5	μA
Input voltage	V_{IH}	—		0.7 V_{DD}	—	V_{DD}	V
	V_{IL}	—		GND	—	0.3 V_{DD}	
SOUT terminal	V_{OL}	I_{OH} = 1.0 mA, V_{DD} = 3.3 V		—	—	0.3	V
		I_{OH} = 1.0 mA, V_{DD} = 5 V		—	—	0.3	
Output voltage	V_{OH}	I_{OL} = −1.0 mA, V_{DD} = 3.3 V		3	—	—	V
		I_{OH} = 1.0 mA, V_{DD} = 5 V		4.7	—	—	
Output current Supply voltage Regulation	%/V_{DD}	V_{DD} = 3 V → 5.5 V		—	±1.5	±5.0	%
Pull-up resistor	$R_{(Up)}$	$\overline{\text{ENABLE}}$ terminal		100	200	400	kΩ
Pull-down resistor	$R_{(Down)}$	$\overline{\text{LATCH}}$ terminal		125	250	500	kΩ
Supply current	$I_{DD\ (OFF)\ 1}$	V_{OUT} = 15.0 V	R_{EXT} = OPEN	—	0.1	0.5	mA
	$I_{DD\ (OFF)\ 2}$	V_{OUT} = 15.0 V, All outputs OFF	R_{EXT} = 490 Ω	1	3	5	
	$I_{DD\ (OFF)\ 3}$	V_{OUT} = 15.0 V, All outputs OFF	R_{EXT} = 250 Ω	3	6	8	
	$I_{DD\ (ON)\ 1}$	V_{OUT} = 0.7 V, All outputs ON	R_{EXT} = 490 Ω	—	6	9	
		Same as the above, T_{opr} = −40°C		—	—	15	
	$I_{DD\ (ON)\ 2}$	V_{OUT} = 0.7 V, All outputs ON	R_{EXT} = 250 Ω	—	12	17	
		Same as the above, T_{opr} = −40°C		—	—	29	

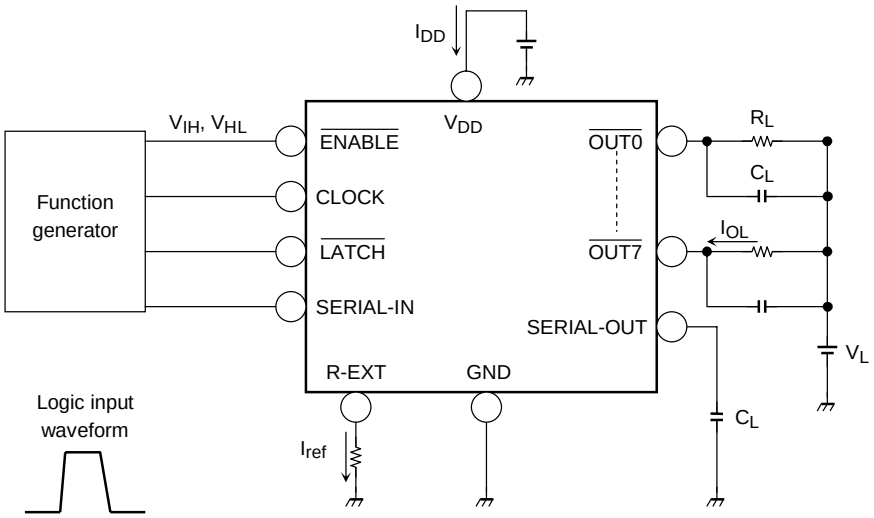
Switching Characteristics (T_{opr} = 25°C unless otherwise specified)

Characteristics	Symbol	Test Condition	Min	Typ.	Max	Unit
Propagation delay time	t_{pLH1}	CLK to $\overline{OUTn}$, $\overline{LATCH}$ = "H", $\overline{ENABLE}$ = "L"	—	150	300	ns
	t_{pLH2}	$\overline{LATCH}$ to $\overline{OUTn}$, $\overline{ENABLE}$ = "L"	—	140	300	
	t_{pLH3}	$\overline{ENABLE}$ to $\overline{OUTn}$, $\overline{LATCH}$ = "H"	—	140	300	
	t_{pLH}	CLK to SERIAL OUT	2	5	—	
	t_{pHL1}	CLK to $\overline{OUTn}$, $\overline{LATCH}$ = "H", $\overline{ENABLE}$ = "L"	—	170	340	
	t_{pHL2}	$\overline{LATCH}$ to $\overline{OUTn}$, $\overline{ENABLE}$ = "L"	—	170	340	
	t_{pHL3}	$\overline{ENABLE}$ to $\overline{OUTn}$, $\overline{LATCH}$ = "H"	—	170	340	
	t_{pHL}	CLK to SERIAL OUT	2	5	—	
Output rise time	t_{or}	10 to 90% of voltage waveform	40	85	150	ns
Output fall time	t_{of}	90 to 10% of voltage waveform	40	70	150	ns
Maximum clock rise time	t_r	Cascade connection isn't guarantee. (Note 5)	—	—	5	us
Maximum clock fall time	t_f		—	—	5	us

Conditions: (refer to test circuit.)
T_{opr} = 25°C, $V_{DD} = V_{IH}$ = 5 V, V_{OUT} = 0.7 V, V_{IL} = 0 V, R_{EXT} = 490 Ω, V_L = 5.0 V, R_L = 100 Ω, C_L = 10.5 pF

Note 5: 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.

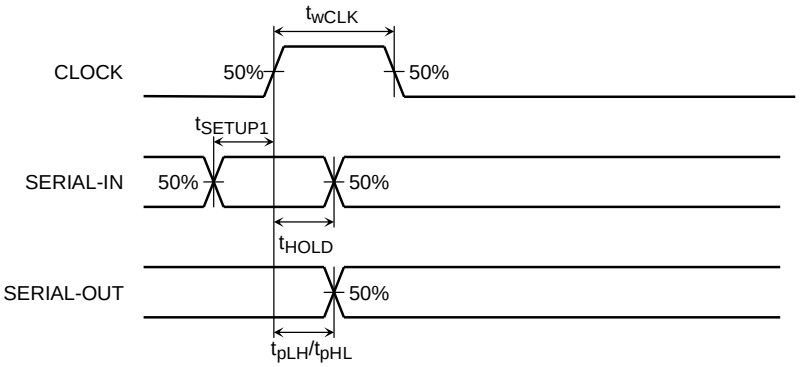
Test Circuit



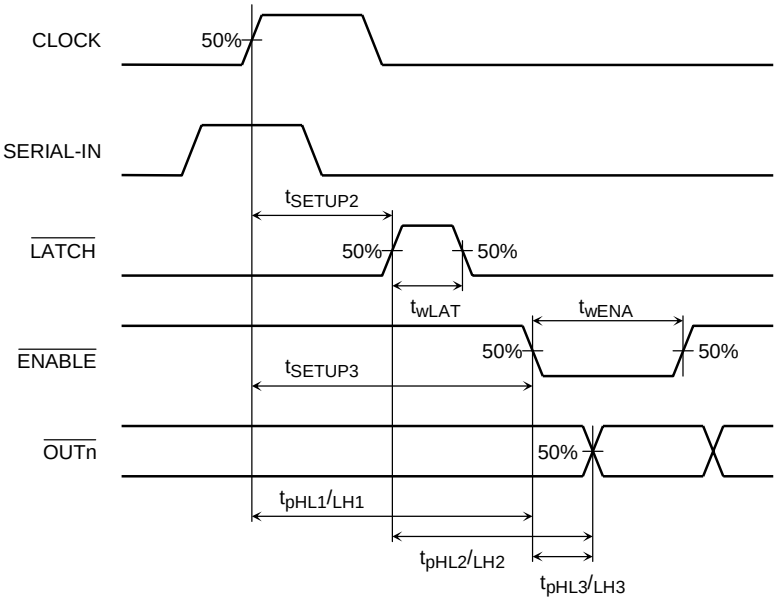
$V_{DD} = V_{IH}$ = 5 V
V_{IL} = 0 V
$t_r = t_f$ = 10 ns
(10% to 90%)

Timing Waveforms

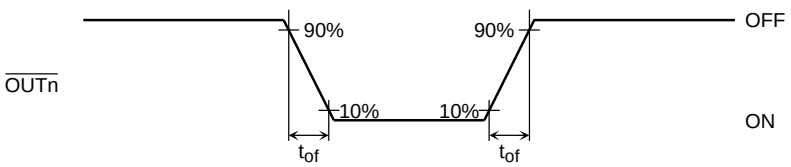
1. CLOCK, SERIAL-IN, SERIAL-OUT



2. CLOCK, SERIAL-IN, $\overline{\text{LATCH}}$, $\overline{\text{ENABLE}}$, $\overline{\text{OUTn}}$

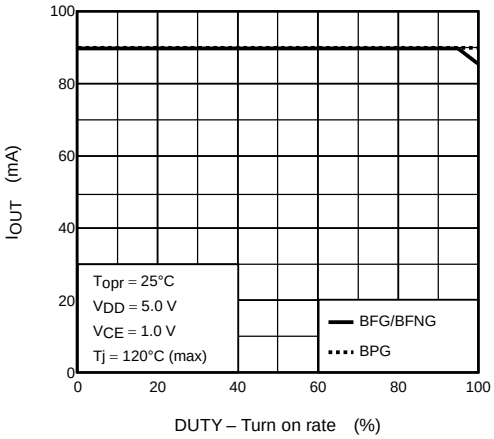


3. $\overline{\text{OUTn}}$

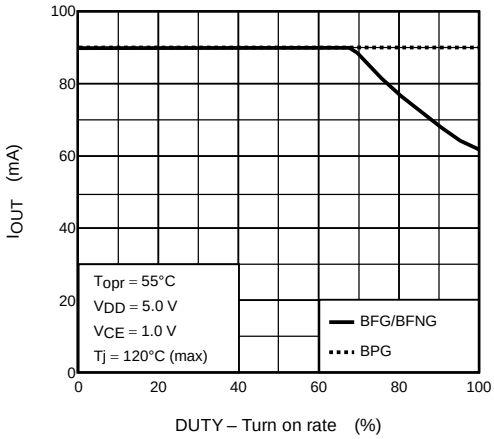


Output Current – Duty (LED turn-on rate)

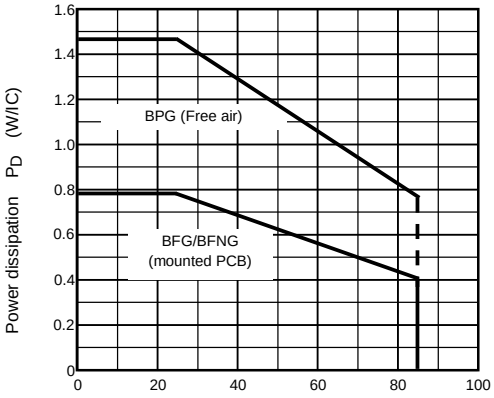
I_{OUT} – DUTY On PCB
(recommended)



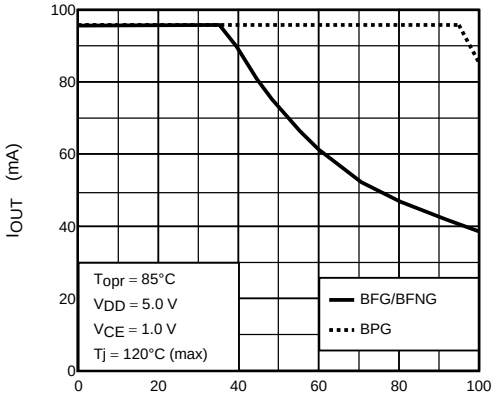
I_{OUT} – DUTY On PCB
(recommended)



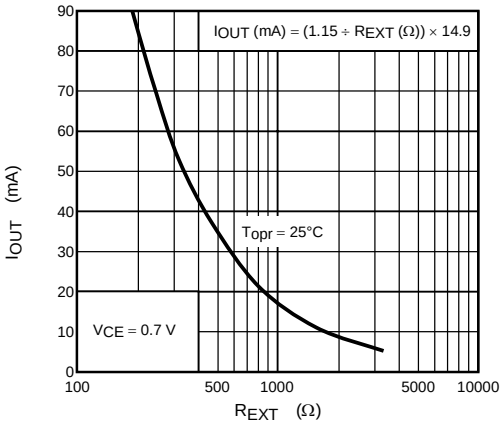
P_d –T_{opr}



I_{OUT} – DUTY On PCB
(recommended)

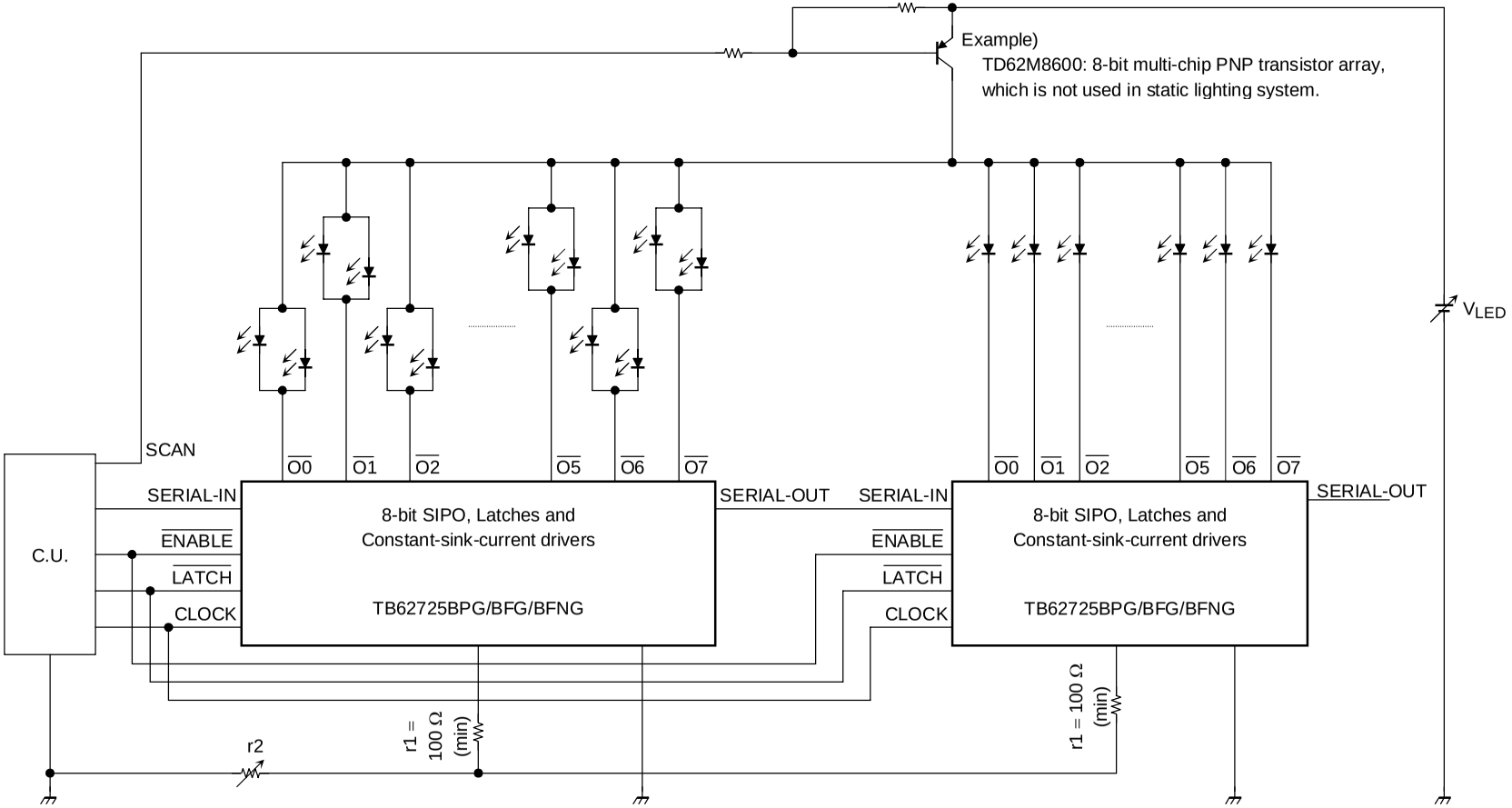


I_{OUT} – R_{EXT}



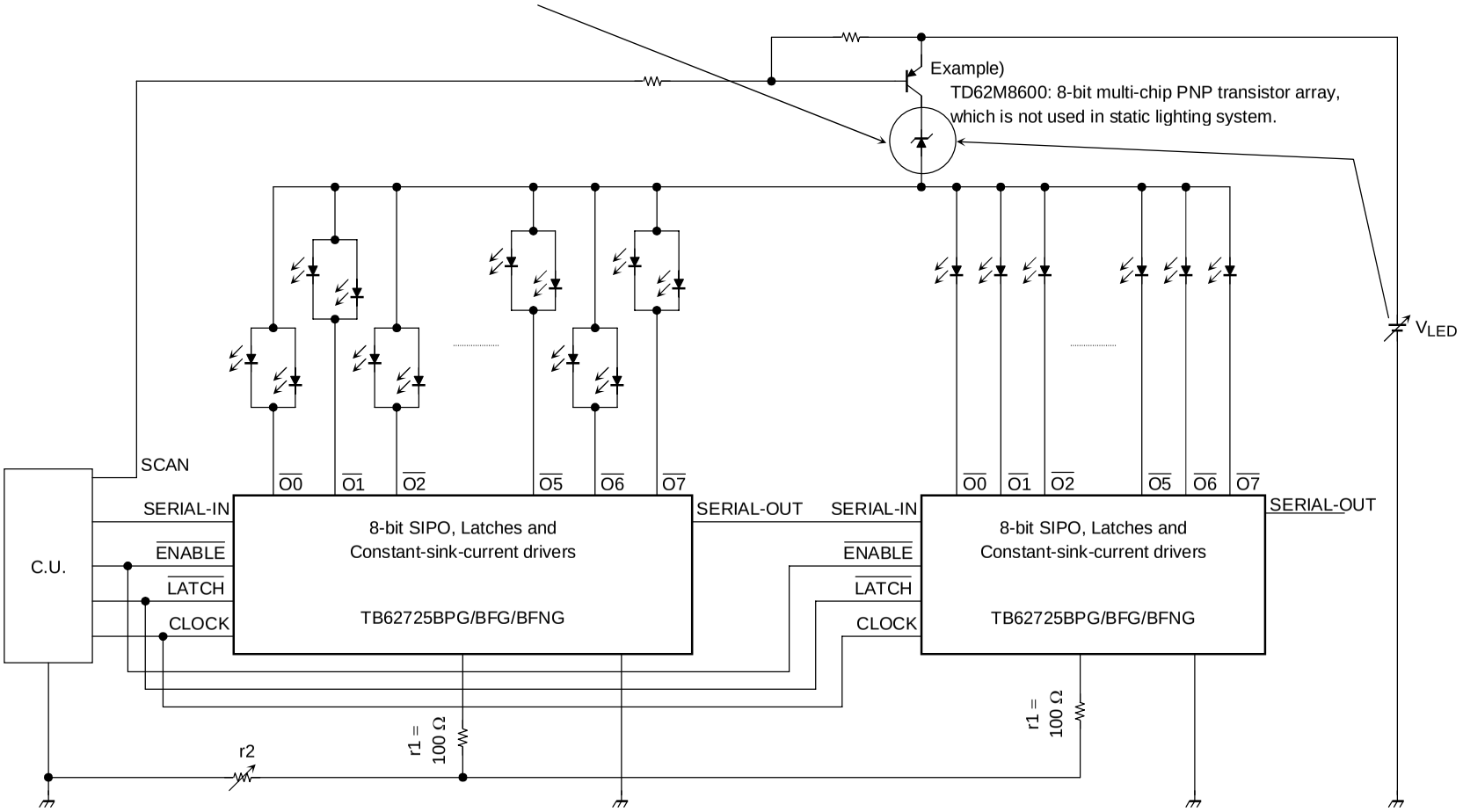
Application Circuit (example 1): The general composition in static lighting of LED.

More than V_{LED} (V) $\geqq V_f$ (total max) +0.7 is recommended with the following application circuit with the LED power supply V_{LED}.
r1: The setup resistance for the setup of output current of every IC.
r2: The variable resistance for the brightness control of every LED module.



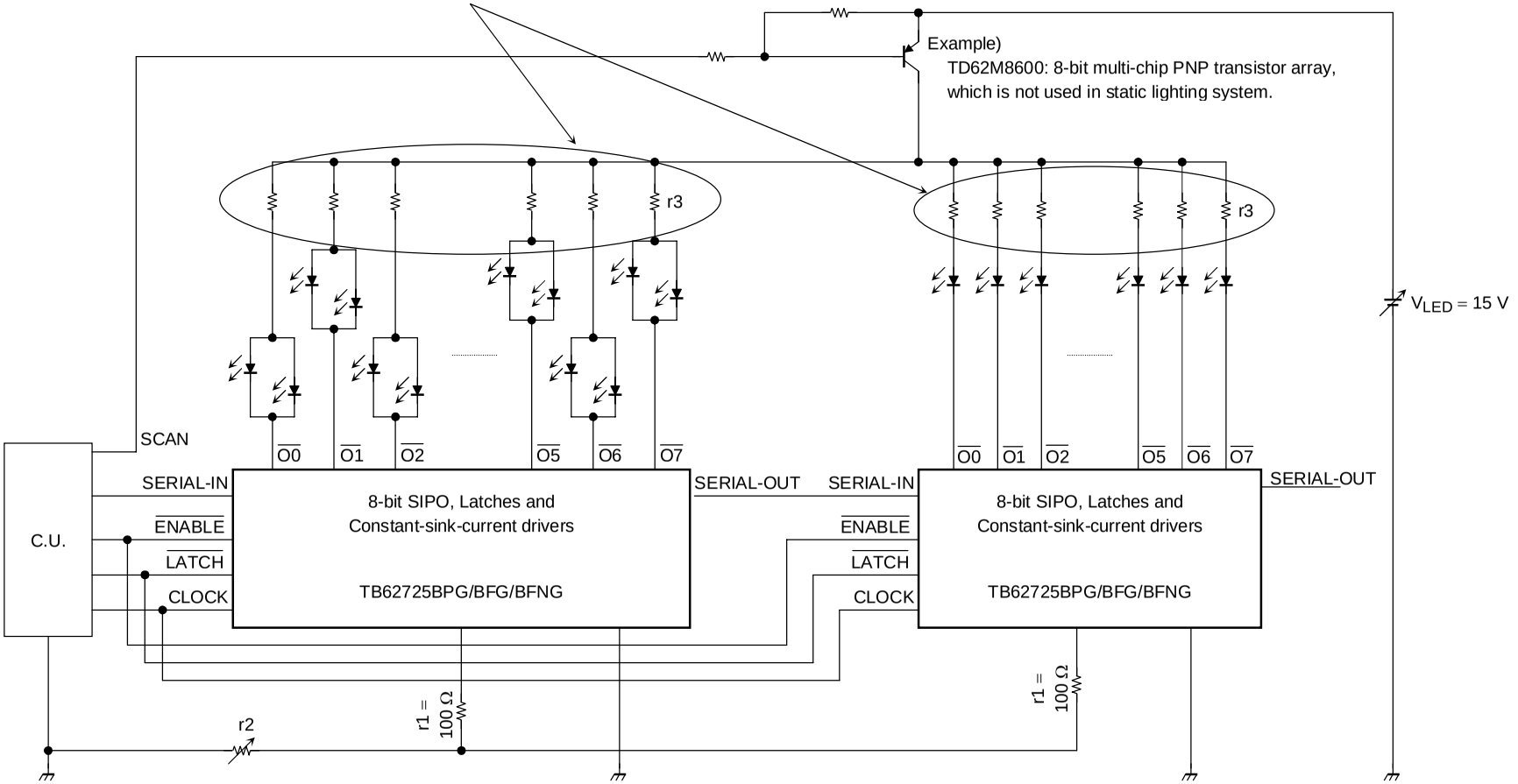
Application Circuit (example 2): When the condition of V_{LED} is V_{LED} > 17 V.

The unnecessary voltage is one effective technique as to making the voltage descend with the zennor diode.



Application Circuit (example 3): When the condition of V_{LED} is $V_f + 0.7 < V_{LED} < 17$ V.

$V_{OUT} = V_{LED} - V_f = 0.7$ to 1.0 V is the most suitable for V_{OUT}.
Surplus V_{OUT} causes an IC fever and the useless consumption electric power.
It is the one way of being effective to build in the r3 in this problem.
r3 can make a calculation to the formula r3 (ohms) = surplus V_{OUT}/I_{OUT}.
Though the resistance parts increase, the fixed constant current performance is kept.



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 switching 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.

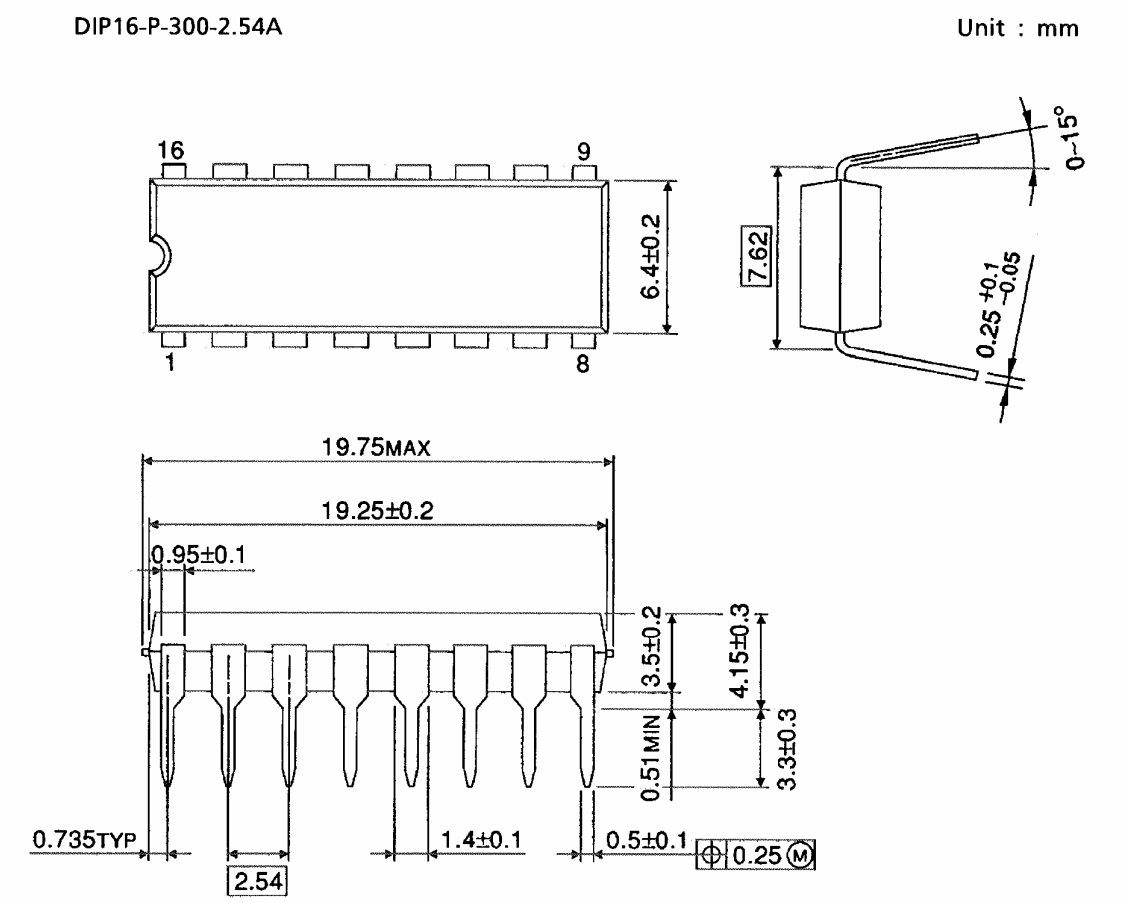
This application circuit is a reference example and is not guaranteed to work in all conditions.
Be sure to check the operation of your circuits.

This device does not include protection circuits for over voltage, over current or over temperature.
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.

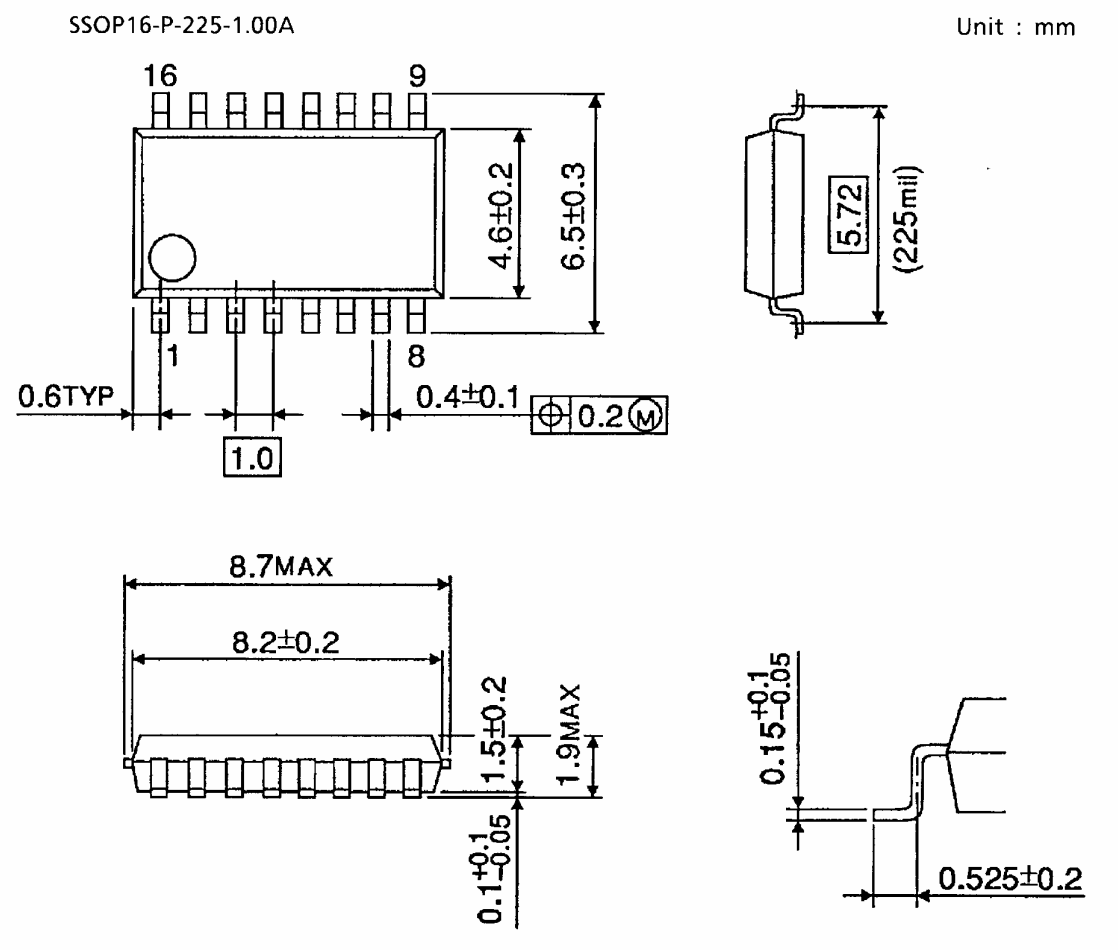
Package Dimensions

DIP16-P-300-2.54A Unit : mm



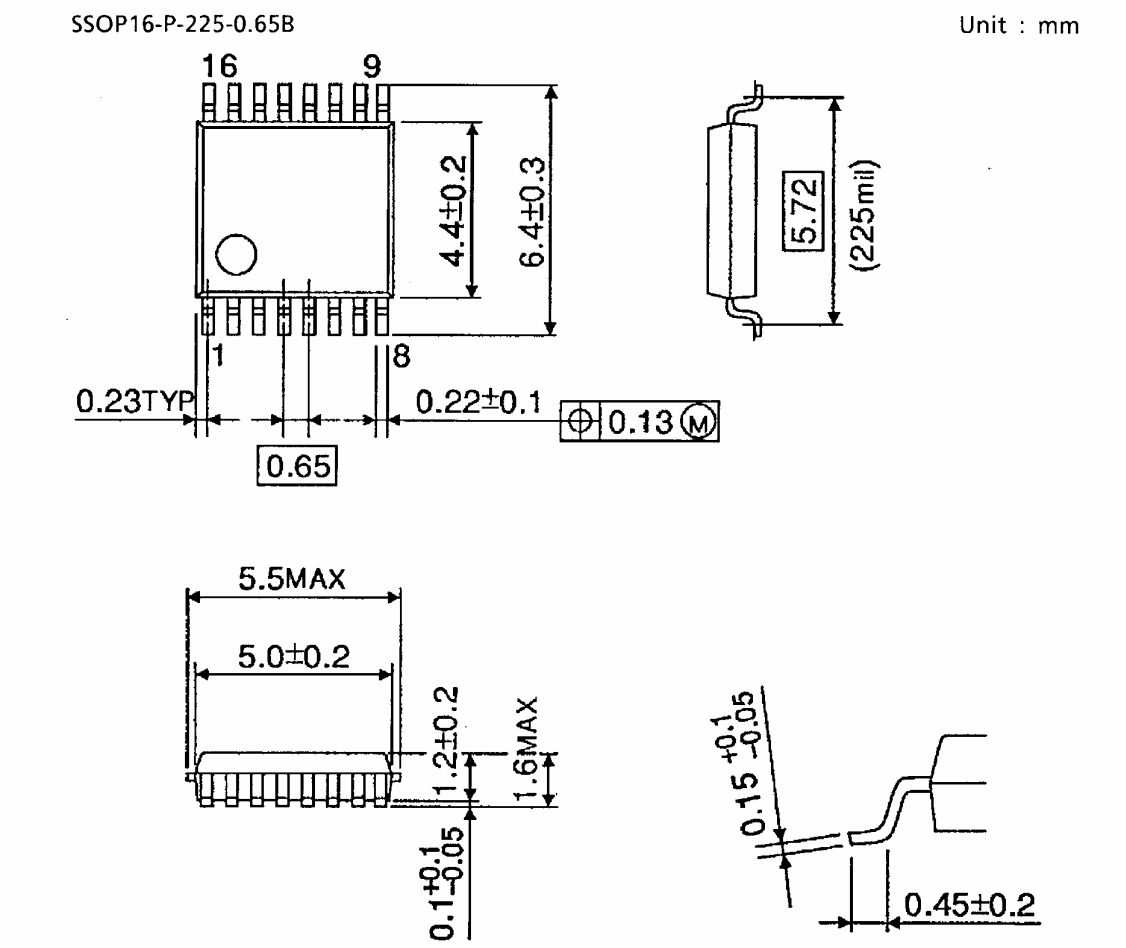
Weight: 1.11 g (typ.)

Package Dimensions



Weight: 0.14 g (typ.)

Package Dimensions



Weight: 0.07 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 absolute maximum ratings. To avoid this problem, take the effect of back-EMF into consideration in system design.

About solderability, following conditions were confirmed

- Solderability

  (1) Use of Sn-37Pb solder Bath
  - solder bath temperature = 230°C
  - dipping time = 5 seconds
  - the number of times = once
  - use of R-type flux

  (2) Use of Sn-3.0Ag-0.5Cu solder Bath
  - solder bath temperature = 245°C
  - dipping time = 5 seconds
  - the number of times = once
  - use of R-type flux

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