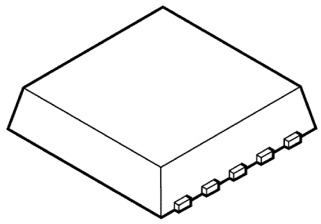
TOSHIBA CMOS Integrated Circuits Silicon Monolithic

TCA62724FMG(O,S,EL

3-Channel Constant-Current LED Driver

The TCA62724FMG is an optimal constant-current LED driver for RGB pixel LEDs.
The device supports 16 dimming states for each color in the RGB pixel LED setup, resulting in 4096 colors for carrying out illumination by internal PWM.
The Max forward current of the LED is set up using the external resistor.
This IC is especially for driving back light white LEDs in LCD of PDA, Cellular Phone, or Handy Terminal Equipment.



SON10-P-0303-0.50

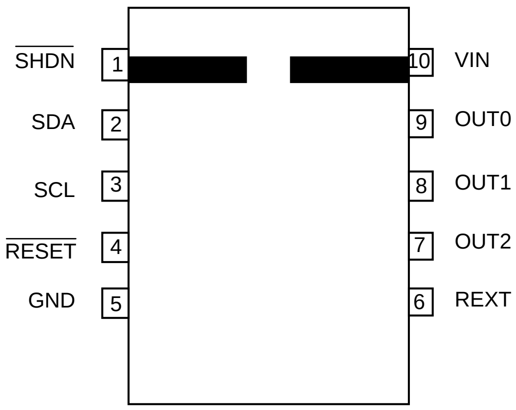
Weight: 0.018 g (typ.)

Features

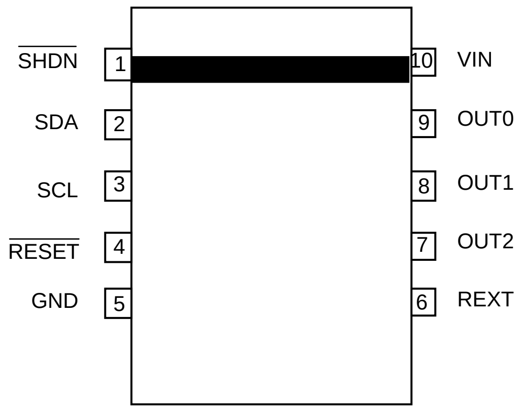
- Power supply voltage range : 2.8 to 5.5 V
- Constant current range : 5 to 150 mA
- Low consumption current
  - Supply current at operation (Iout = 20 mA / DC) : 700 μA (Max)
  - Supply current at standby : 10 μA (Max)
- For anode common LED
- I^2C interface
- Package : SON10-P-0303-0.50

Pin Assignment (top view)

Ass'ly in first half of year
(The 26th week from the first week)



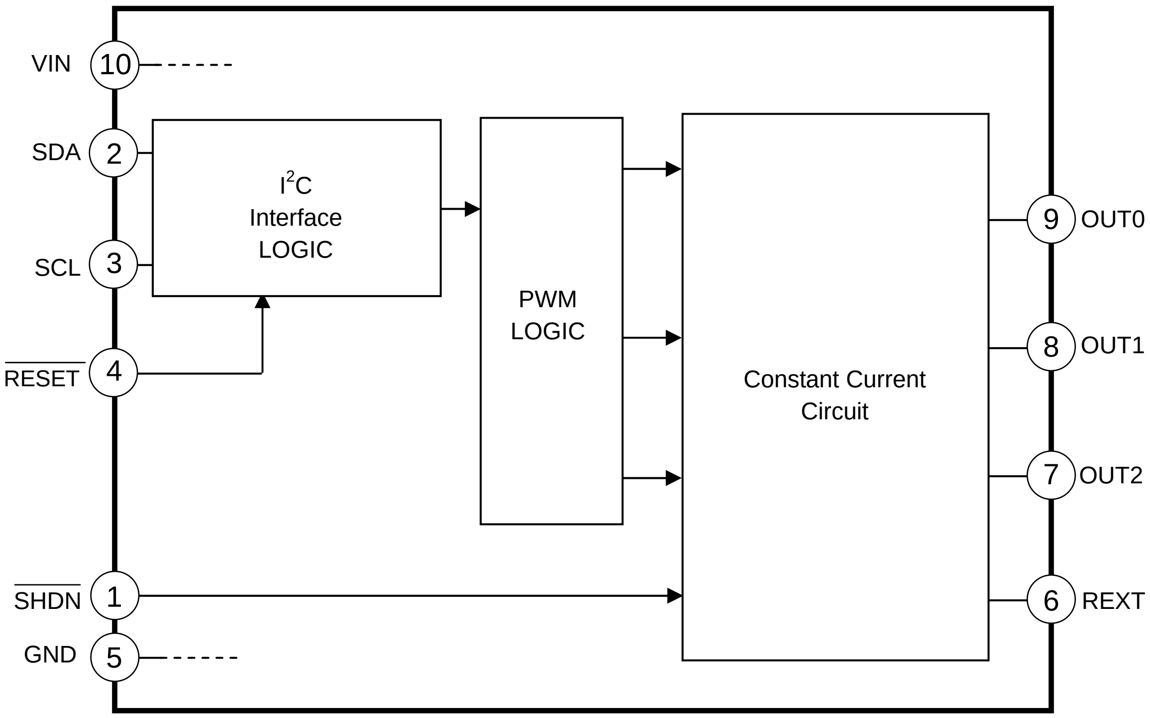
Ass'ly in latter half of year
(The 53rd week from the 27th week)



Terminal Description

Pin No.	Pin Name	Function
1	$\overline{\text{SHDN}}$	The shutdown signal input terminal. In the case of "L" level input, the IC becomes the power-saving mode. In the case of "H" level input, the IC becomes the operation mode.
2	SDA	Serial data input / output terminal.
3	SCL	Serial clock input terminal.
4	$\overline{\text{RESET}}$	The data reset signal input terminal. In the case of "L" level input, data is reset. In the case of "H" level input, the IC becomes the operation mode.
5	GND	Grand terminal.
6	REXT	The output current setting resistor connection terminal. Resistance is connected with this terminal between GND. The output current does not flow when this terminal is opened. Excessive output current will destroy the IC if this terminal is connected to GND.
7	OUT2	Constant current output terminal.
8	OUT1	
9	OUT0	
10	VIN	Supply voltage input terminal.

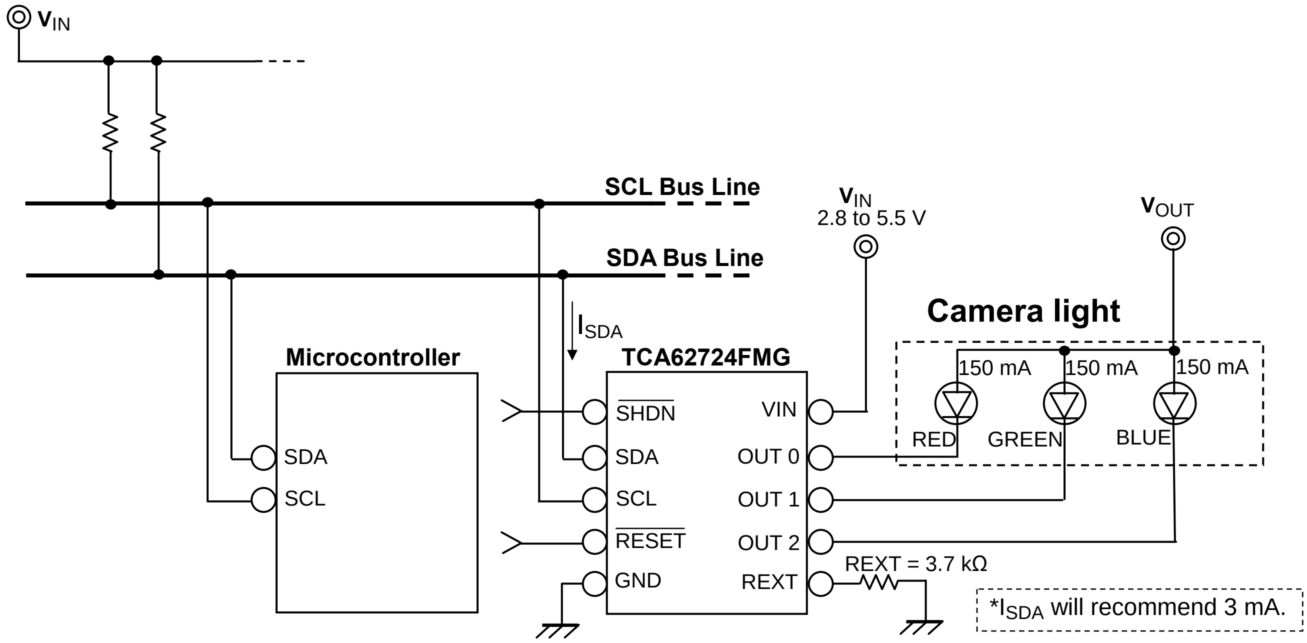
Block Diagram



Example Applications : Cellular Phone

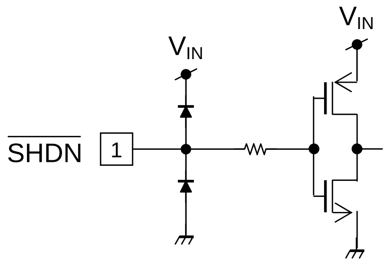
Application as Camera Light

(Primary-color red, green and blue LEDs combine to emit good-quality white light for color reproducibility.)

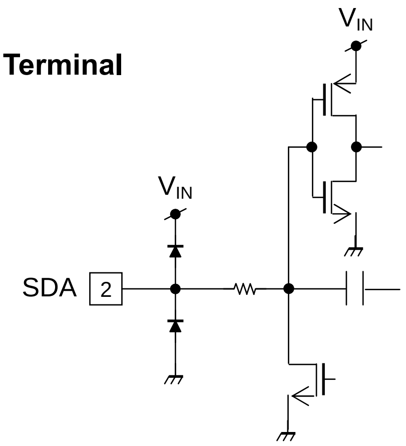


I/O Equivalent Pin Circuits

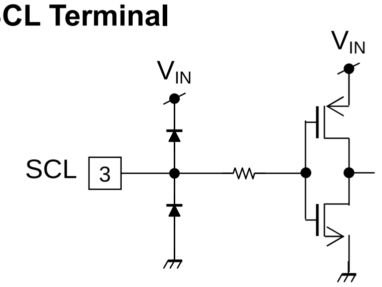
1. $\overline{\text{SHDN}}$ Terminal



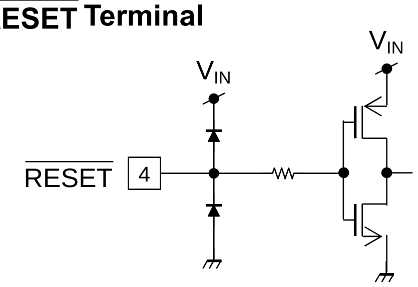
2. SDA Terminal



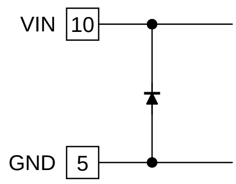
3. SCL Terminal



4. $\overline{\text{RESET}}$ Terminal



5. VIN,GND Terminal



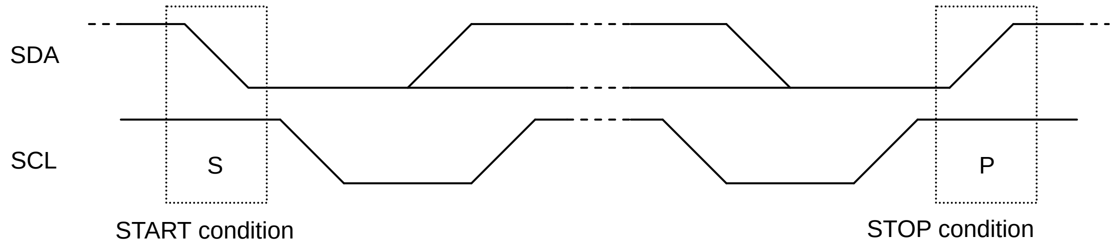
I²C Interface

*DATA transfer format

S	Slave address 7 bits	R/W	A	Sub-address 8 bits	A	DATA byte 8 bits	A	P

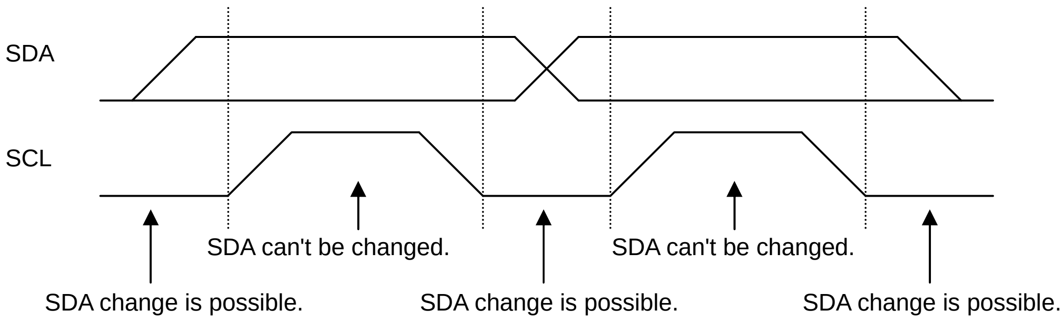
*START condition (S), STOP condition (P)

START condition : A HIGH to LOW transition on the SDA line while SCL is HIGH.
STOP condition : A LOW to HIGH transition on the SDA line while SCL is HIGH.



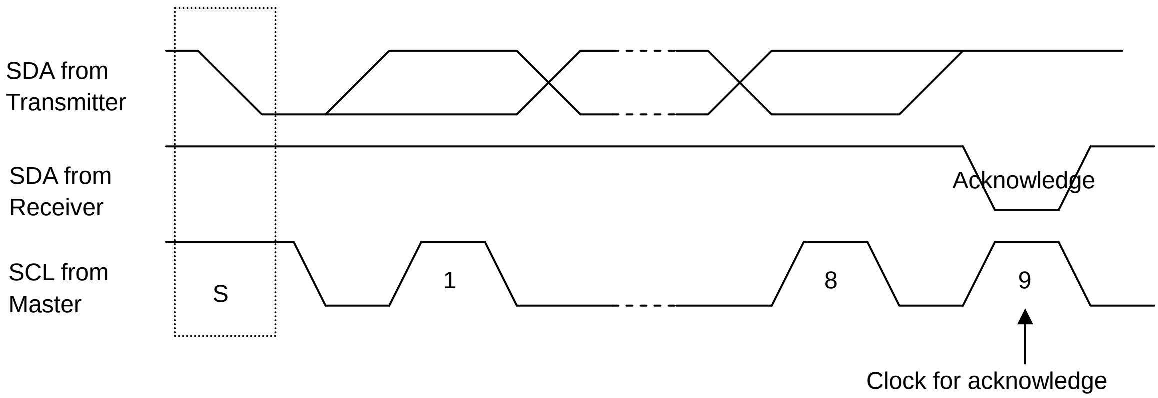
*DATA validity

Please do not change SDA, when SCL is "H".
SDA can be changed, when SCL is "L".



*Acknowledge (A)

Whenever it receives the 1-byte data from a transmitter, a receiver has to generate acknowledge .The receiver is obliged to generate an Acknowledge after each byte has been received.



*Slave address

TCA62724FMG

Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
1	0	1	0	1	0	1	R/W

R/W: When this bit is set to “H”, READ mode applies; when it is set to “L”, WRITE mode applies.

*Sub-address

PWM0 (PWM Duty Data Setup of OUT0)

Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
AI	0	0	0	0	0	0	1

PWM1 (PWM Duty Data Setup of OUT1)

Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
AI	0	0	0	0	0	1	0

PWM2 (PWM Duty Data Setup of OUT2)

Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
AI	0	0	0	0	0	1	1

ENABLE / SHDN (Data Setup of ENABLE / SHDN)

Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
AI	0	0	0	0	1	0	0

AI: When this bit is set to “H”, auto-increment is OFF; when it is set to “L”, auto-increment is ON.

*DATA byte

PWM0, PWM1, and PWM2 DATA

PWM ON Duty DATA (0/15 to 15/15)

Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
Don’t use				PWM ON Duty DATA			

(default =”0000”)

Bit 3	Bit 2	Bit 1	Bit 0	PWM ON Duty
DATA				
1	1	1	1	15/15
1	1	1	0	14/15
1	1	0	1	13/15
1	1	0	0	12/15
1	0	1	1	11/15
1	0	1	0	10/15
1	0	0	1	9/15
1	0	0	0	8/15
0	1	1	1	7/15
0	1	1	0	6/15
0	1	0	1	5/15
0	1	0	0	4/15
0	0	1	1	3/15
0	0	1	0	2/15
0	0	0	1	1/15
0	0	0	0	0/15

ENABLE / $\overline{\text{SHDN}}$ DATA

Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
Don’t use				X	X	ENABLE	$\overline{\text{SHDN}}$

(default = ”00000000”)

ENABLE DATA

- H : Output blinks at PWM0, PWM1, and PWM2 rate
- L : Output is OFF

$\overline{\text{SHDN}}$ data

- H : Output blinks at PWM0, PWM1, and PWM2 rate
- L : Power-saving mode

*WRITE mode

Auto-increment OFF

S	Slave Address	R/W (0)	A	Sub-address	A	DATA	A	Sub-address	A	DATA	- - -	P

Auto-increment ON

S	Slave Address	R/W (0)	A	Sub-address	A	DATA	A	DATA	A	- - -	P

The data of the immediately following Sub-address can be written in.

*READ mode

S	Slave Address	R/W (1)	A	First Byte	A	Second Byte	P

First byte (ENABLE / $\overline{\text{SHDN}}$ DATA and PWM2 DATA)

Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
x	x	ENABLE	$\overline{\text{SHDN}}$	PWM2 DATA			

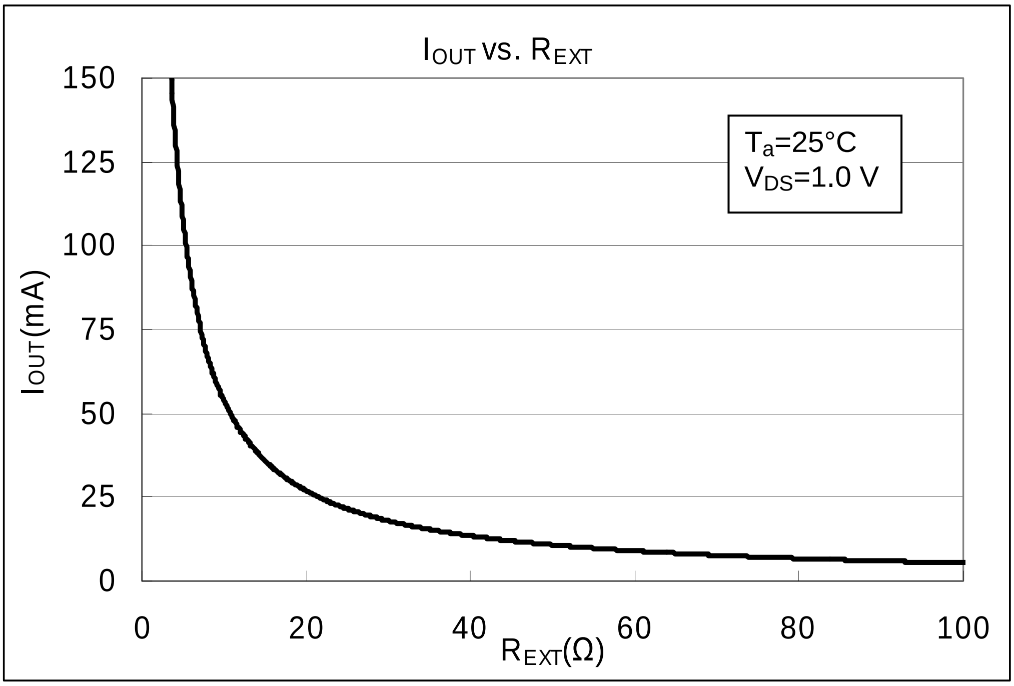
Second byte (PWM1 DATA and PWM0 DATA)

Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
PWM1 DATA				PWM0 DATA			

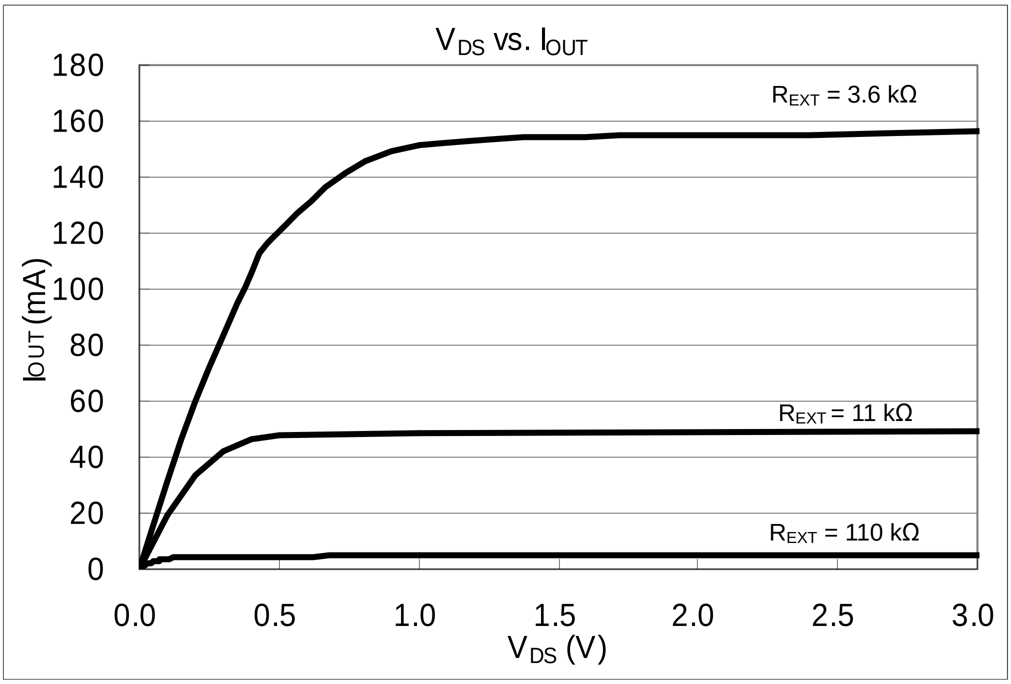
Setting of Output Current (Reference Data)

The output current is set by the resistance connected between terminal R_{EXT} and GND.
The output current can be set according to the following expression.

$$I_{OUT}\ (mA) = \frac{1.17\ (V)}{R_{EXT}\ (k\Omega)} \times 460$$



Output Voltage – Output Current (Reference Data)



Note1: These application examples are provided for reference only. Thorough evaluation and testing should be implemented when designing your application's mass production design.

Absolute Maximum Ratings (T_a = 25°C)

Characteristic	Symbol	Ratings *1	Unit
Supply voltage	V_{IN}	−0.3 ~ +6.0	V
Output voltage	V_{OUT}	−0.3 ~ +6.0	V
Input voltage (SDA/SCL/ $\overline{SHDN}$ / $\overline{RESET}$ Terminal)	V_{in}	−0.3 ~ V_{IN}+0.3 *2	V
Power dissipation	P_D	0.36 (free air)	W
		0.79(on PCB) *3,4	
Thermal resistance	$R_{th\ (j\text{-}a)}$	340 (free air)	°C/W
		158 (on PCB) *3	
Operating temperature	T_{opr}	−40 ~ +85	°C
Storage temperature	T_{stg}	−55 ~ +150	°C
Maximum junction temperature	T_j	150	°C

Note1: Voltage is ground referenced.
Note2: Do not exceed 6.0V.
Note3: PCB condition 40 mm x 40 mm x 1.6 mm, Cu = 10 %
Note4: The power dissipation decreases the reciprocal of the saturated thermal resistance (1/ Rth(j-a)) for each degree (1°C) that the ambient temperature is exceeded (Ta = 25°C).

Recommended Operating Condition

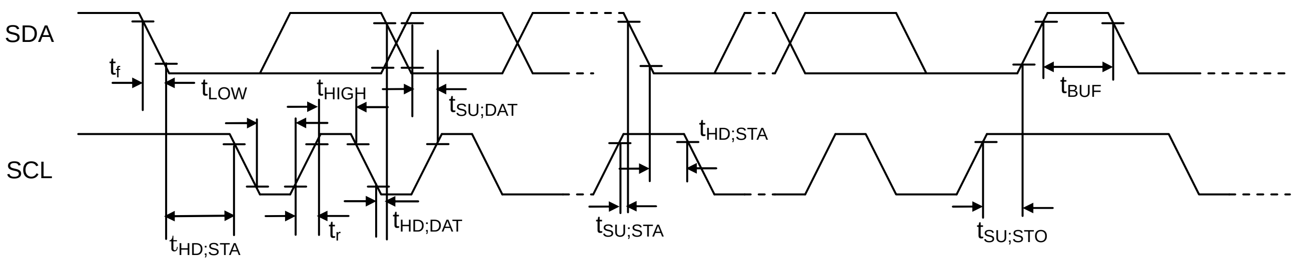
Characteristic	Symbol	Condition	Min	Typ.	Max	Unit
Supply voltage	V_{IN}	-	2.8	3.6	5.5	V
Constant current output	I_{OUT}	OUT0 to OUT2	5	-	150	mA/ch
REXT resistance	R_{EXT}	-	3.7	-	109	kΩ

Electrical Characteristics (unless otherwise specified, T_a = 25°C, V_{IN} = 3.6V)

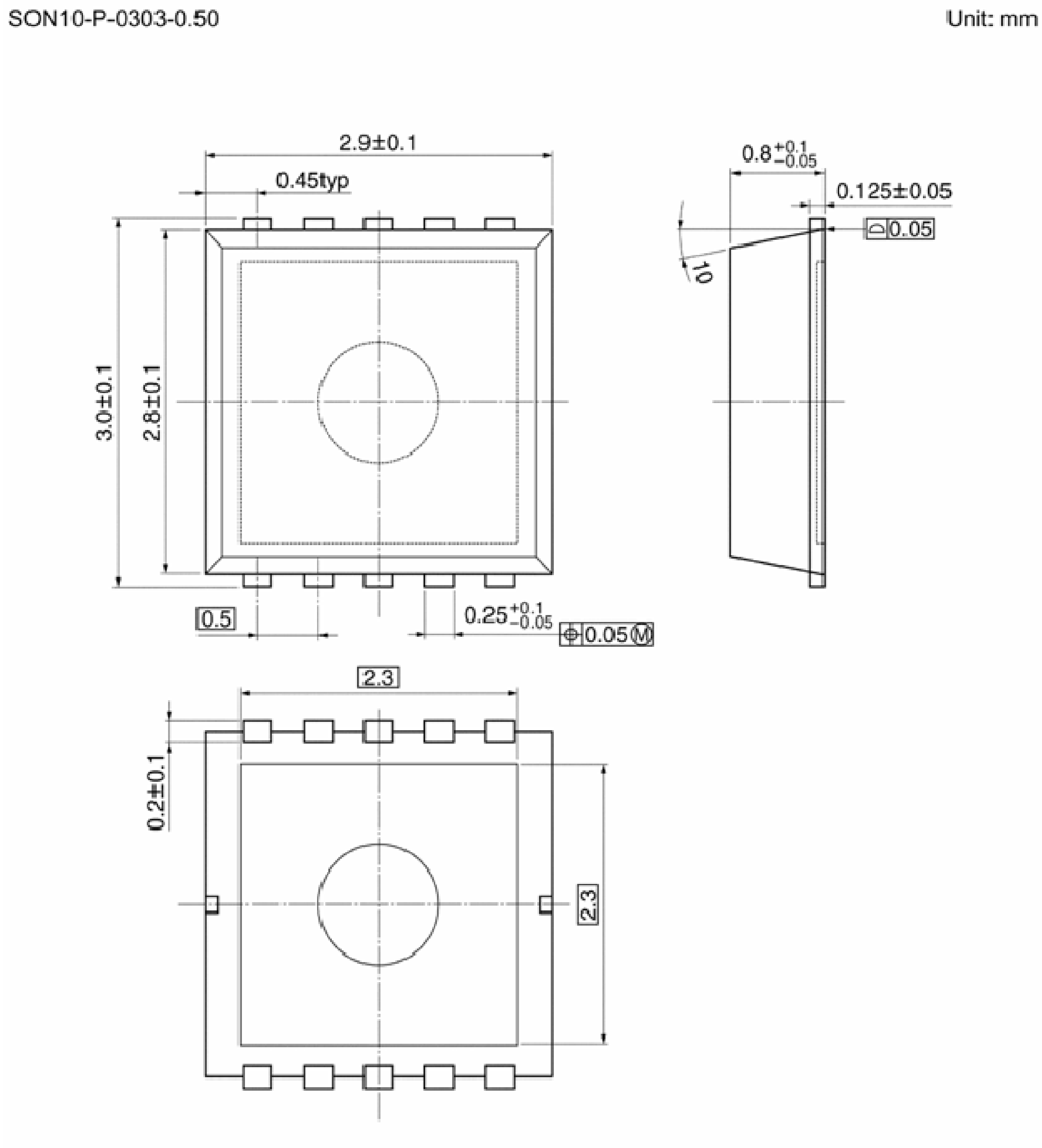
Characteristic		Symbol	Condition	Min	Typ	Max	Unit
Supply voltage		V_{IN}	-	2.8	3.6	5.5	V
Supply current (IC operation)		I_{IN} (On)	R_{EXT} = 27.6 kΩ, V_{IN} = 3.6 V	-	-	700	μA
Supply current (IC standby)		I_{IN} (Off)	$\overline{SHDN}$ = L	-	-	10	μA
Input voltage	High level	V_{IH}	Measuring terminal is SDA, SCL, $\overline{SHDN}$, $\overline{RESET}$	0.7V_{IN}	-	V_{IN}+0.15V	V
	Low level	V_{IL}		−0.15	-	0.3V_{IN}	
Input current	High level	I_{IH}	Measuring terminal is SCL, $\overline{SHDN}$, $\overline{RESET}$	−1.0	-	1.0	μA
	Low level	I_{IL}		−1.0	-	1.0	
Gain (I_{OUT} / I_{REXT})		GAIN	R_{EXT}=11kΩ	359	460	560	A/A
REXT terminal voltage		V_{REXT}	V_{IN}=3.6V, R_{EXT}=11kΩ	1.09	1.17	1.25	V
Output leakage current		I_{OZ}	$\overline{SHDN}$ ="L", V_{OUT}=5.5V	-	-	0.1	μA
Constant current accuracy between bits		dI_{OUT}	V_{IN} = 3.6 V, R_{EXT} = 11 kΩ	-	±1	±7.5	%
PWM frequency		f_{PWM}	-	-	3.0	-	kHz
Time from $\overline{SHDN}$ release to start of operation		t_{RE}	-	-	-	5	ms

Characteristics of the SDA and SCL Bus Lines for I^2C-bus Devices

Characteristic	Symbol	Standard Mode		Unit
		Min	Max	
SCL clock frequency	f_{SCL}	0	100	kHz
Bus free time between STOP and START condition	t_{BUF}	4.7	-	μs
Hold time (repeated) START condition	$t_{HD;STA}$	4.0	-	μs
Setup time for repeated START condition	$t_{SU;STA}$	4.7	-	μs
Setup time for STOP condition	$t_{SU;STO}$	4.0	-	μs
Data hold time	$t_{HD;DAT}$	0	-	ns
Data setup time	$t_{SU;DAT}$	250	-	ns
LOW period of the SCL clock	t_{LOW}	4.7	-	μs
HIGH period of the SCL clock	t_{HIGH}	4.0	-	μs
Rise time of both SDA and SCL signals	t_f	-	1000	ns
Fall time of both SDA and SCL signals	t_r	-	300	ns



Package Dimensions



Weight: 0.018 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 (T_J) 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.

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

RESTRICTIONS ON PRODUCT USE