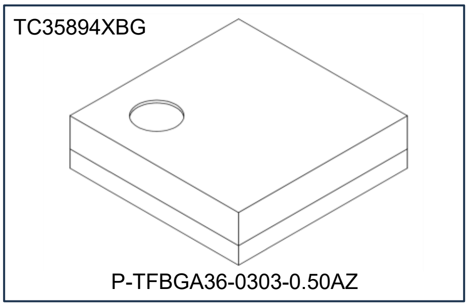
CMOS Digital Integrated Circuit Silicon Monolithic

TC35894XBG/TC35894FG

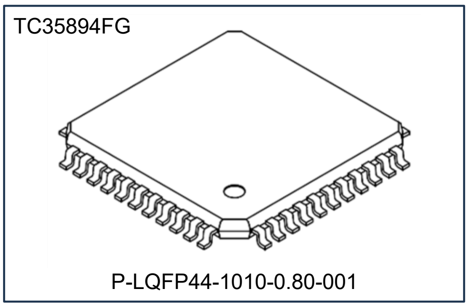
Mobile Peripheral Devices

Overview

The TC35894XBG/TC35894FG is IO Expander LSI which has I²C bus target for host interface, PWM/Timer control, GPIO control, and key matrix control. Those features are set and selected at the TC35894XBG/TC35894FG registers by software.



Weight: 0.025 g (typ.)



Weight: 0.35 g (typ.)

Features

- I²C Target for host interface
- GPIO Functions
  - Maximum 24 general purpose input/output ports
  - Selectable input or output port
  - Selectable pull-up or pull-down/connecting or non-connecting resistor
  - Selectable drive current (3 types)
  - Supporting pseudo open drain output buffer
  - Selectable interrupt detecting by level/edge/both edges and active low/high
  - Automatic escape from sleep mode by signal input
- Key Board
  - Key Matrix (Max 8 × 12 = 96 keys)
  - Support special function keys and dedicated keys
  - Key de-bouncing function
- PWM/Timer
  - 3 timer module for LED back light control
  - LED switching control by PWM sequencer
- Internal oscillator for system clock
- Sleep mode for reducing of power consumption
- Operating voltage 1.62 V to 3.60 V

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References

[1] I^{2}C Bus Specification

"The I^{2}C -Bus Specification" Version 2.1 January 2000, Philips Semiconductor

1. Overview

TC35894XBG/TC35894FG is LSI for IO expansion. The functional block is constituted by PWM/Timer control part, GPIO control part, Key control part, and the I^{2}C target interface. Assignment on the pin of each function can be changed by software.

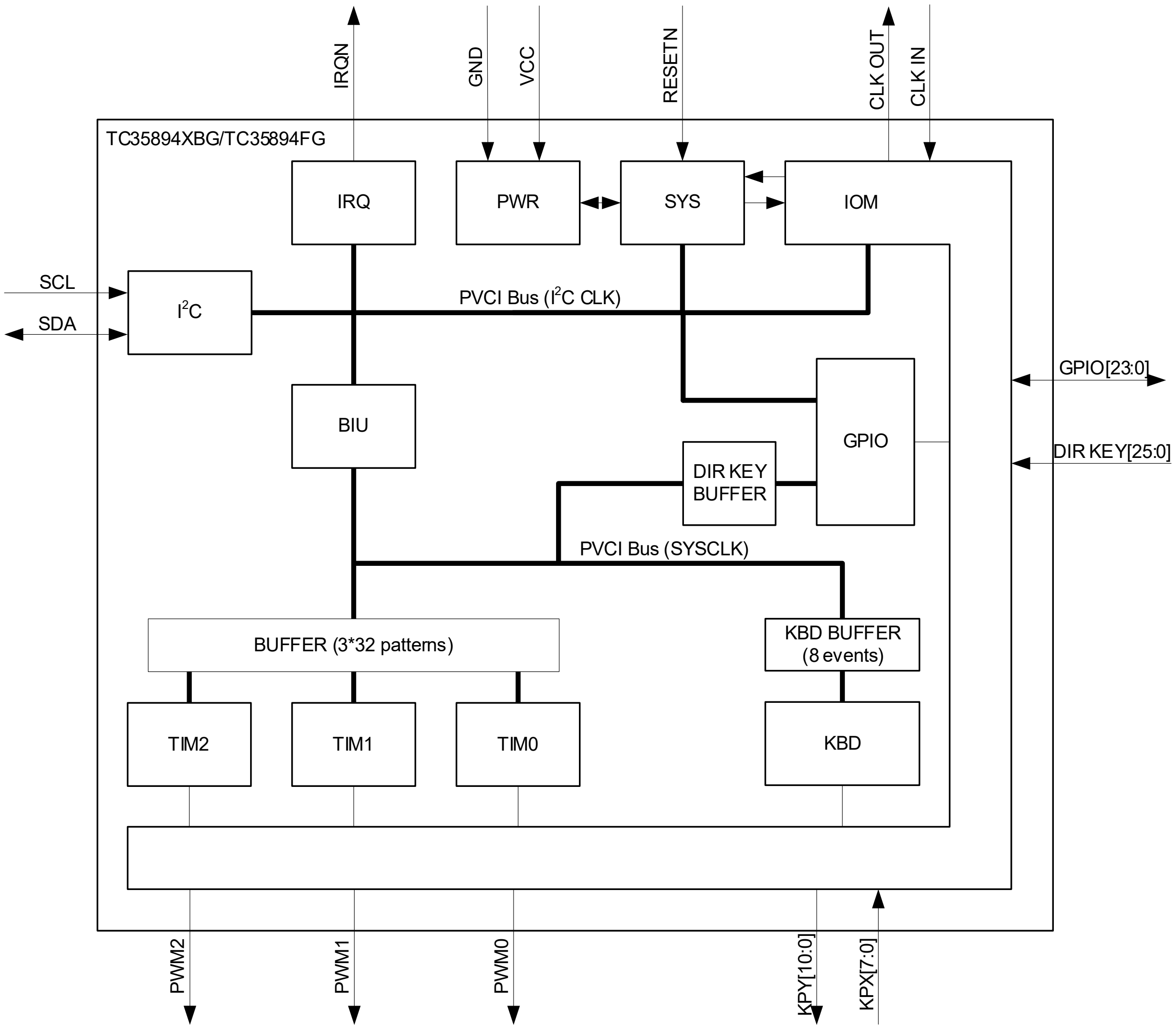


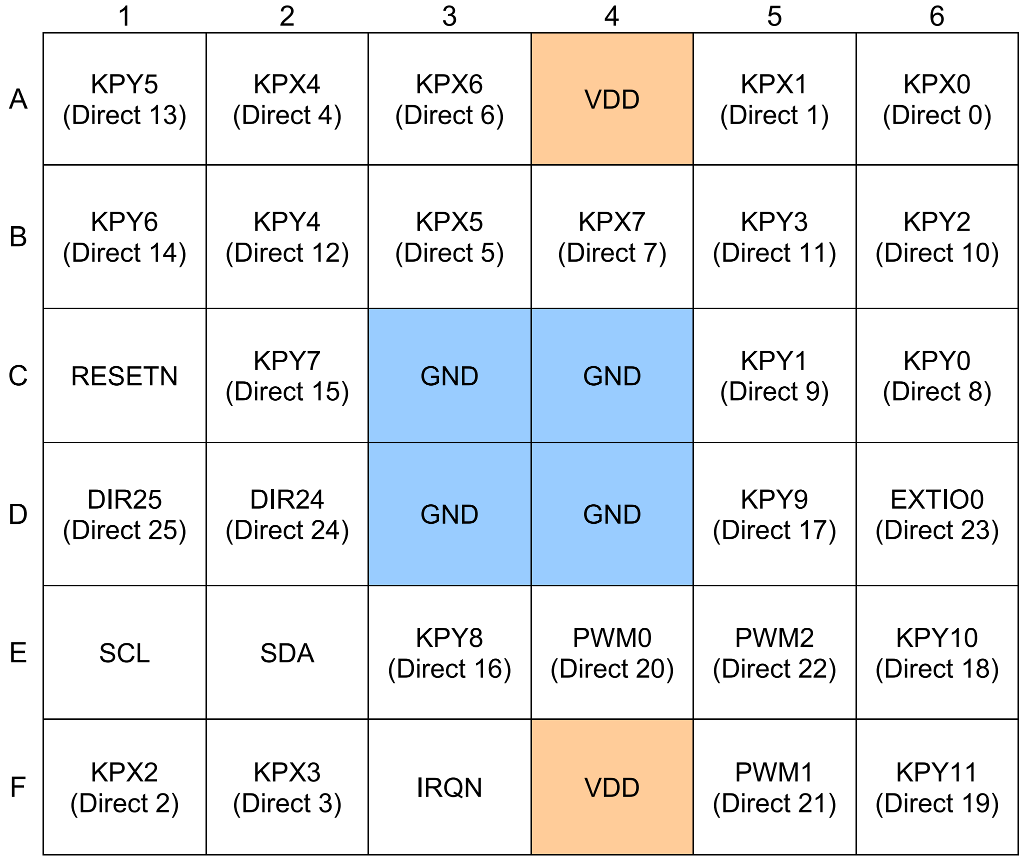
Figure 1.1 TC35894XBG/TC35894FG Block diagram

2. Features

- I^{2}C target for host interface
- GPIO functions
  - Maximal 24 general purpose input/output ports
  - Selected pull-up/pull-down resistor connection or release by register setting
  - Selected three output drive modes by register setting
  - Support pseudo open drain output buffers
  - Selected interrupt sensitivity (positive/negative edge, both edges, high/low level)
  - Escape from sleep mode by input signal
  - Direct keyboard function
- Keyboard functions
  - Key matrix: maximal 8 × 12 = 96 keys
  - Support special function keys and dedicated keys
  - Key de-bouncing
- PWM/Timer functions
  - Three channel timer modules for LED/back light control
  - LED switching control by PWM sequencer
- Internal oscillator circuit for system clock
- Two operating modes (Sleep & Operation) for low power consumption
- Operating voltage area: 1.62 V to 3.60 V

3. Pin LAYOUT

3.1. TC35894XBG Pin Layout



	1	2	3	4	5	6
A	KPY5 (Direct 13)	KPX4 (Direct 4)	KPX6 (Direct 6)	VDD	KPX1 (Direct 1)	KPX0 (Direct 0)
B	KPY6 (Direct 14)	KPY4 (Direct 12)	KPX5 (Direct 5)	KPX7 (Direct 7)	KPY3 (Direct 11)	KPY2 (Direct 10)
C	RESETN	KPY7 (Direct 15)	GND	GND	KPY1 (Direct 9)	KPY0 (Direct 8)
D	DIR25 (Direct 25)	DIR24 (Direct 24)	GND	GND	KPY9 (Direct 17)	EXTIO0 (Direct 23)
E	SCL	SDA	KPY8 (Direct 16)	PWM0 (Direct 20)	PWM2 (Direct 22)	KPY10 (Direct 18)
F	KPX2 (Direct 2)	KPX3 (Direct 3)	IRQN	VDD	PWM1 (Direct 21)	KPY11 (Direct 19)

Figure 3.1 TC35894XBG Pin Layout (Top view)

3.2. TC35894FG Pin Layout

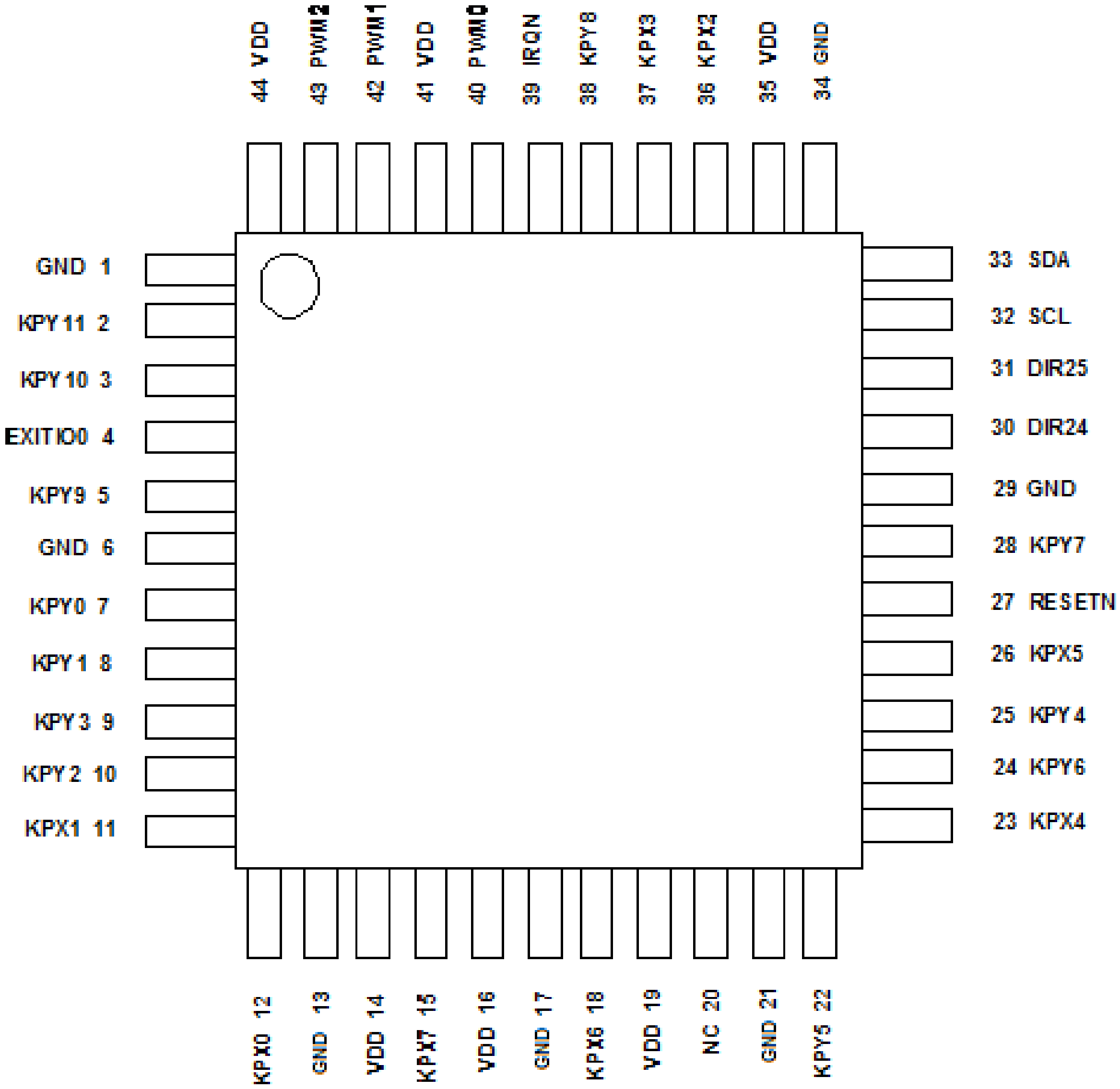


Figure 3.2 TC35894FG Pin Layout (Top view)

3.3. Pin Table

The following table explains the top level pin functionality. All inputs have CMOS Schmitt characteristics. Pins configured as inputs shall never be left floating. They are either driven by an external source or the input is internally terminated by a software configurable pull up/down resistor. The symbol in the table shows "I" for input, "I/O" multiple direction, "OD" for open drain, "P" for selectable setting of pull-up or pull-down, "PU" for pull-up, and "Hi-Z" for high impedance

Table 3.1 Functional Description of the Pins

Name	I/O (Note 1)	Default (Note 1)	Description
VDD	VDD	-	LSI supply voltage
GND	GND	-	Common ground
SCL	I	I	I^2C clock, up to 400 kHz (fail-safe (Note 2))
SDA	I/OD	Hi-Z	I^2C data (fail-safe (Note 2))
IRQN	OD	Hi-Z	Interrupt to host processor Low active. (fail-safe (Note 2))
RESETN	I	I	reset line, low active (fail-safe (Note 2))
KPX0 KPX1 KPX2 KPX3 KPX4 KPX5 KPX6 KPX7	I/O, P	I, PU	General purpose I/O, keyboard or direct key
KPY0 KPY1 KPY2 KPY3 KPY4 KPY5 KPY6 KPY7 KPY8 KPY9 KPY10	I/O, P	I, PU	General purpose I/O, keyboard or direct Key
KPY11	I/O, P	I, PU	General purpose I/O, direct key, keyboard or clock output
PWM0 PWM1 PWM2	I/O, P	I, PU	General purpose I/O, direct key or PWM0 General purpose I/O, direct key or PWM1 General purpose I/O, direct key or PWM2
EXTIO0	I/O, P	I, PU	General purpose I/O or direct key
DIR24	I, P	I, PU	Clock input, direct key or I^2C address control DIR24 can be used as clock input when the internal RC-oscillator is not used. The re-programming of I^2C target address is also controlled by DIR24: ● Pull-down: I^2C target address is fixed ● Pull-up or external clock connected: Re-programming of I^2C address is enabled
DIR25	I, P	I, PU	Direct key

Note 1: I/O can be one of: "I" for Input, "I/O" for bidirectional, "OD" for open drain output, "P" for configurable pull-up/pull down, "PU" for pull up, "Hi-Z" for high impedance.

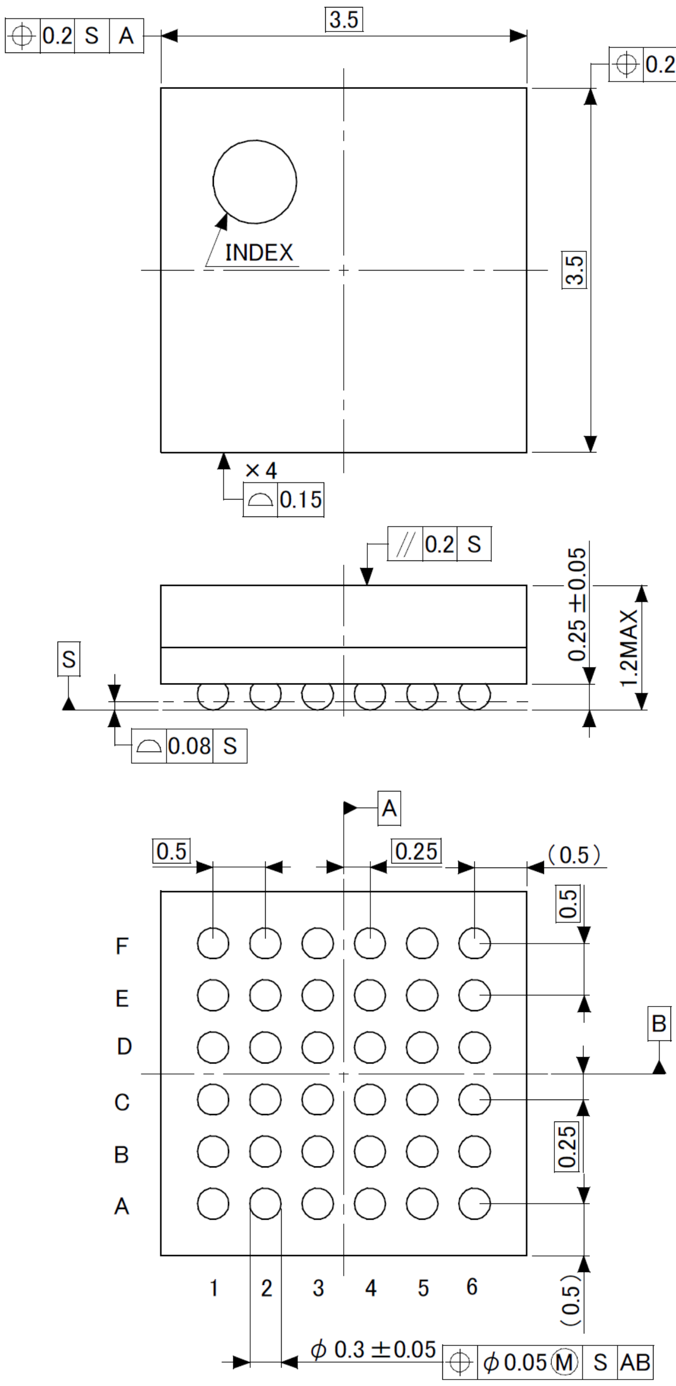
Note 2: The term "fail-safe" means that the TC35894XBG/TC35894FG can be powered down without harming the functionality of a wire attached to this pin or without causing current flow through the pin.

4. Package Mechanical Dimensions

4.1. TC35894XBG Package Mechanical Dimensions

The following drawing shows the dimensions of TC35894XBG (P-TFBGA36-0303-0.50AZ, 0.50 mm pitch) ackage.

Unit: mm



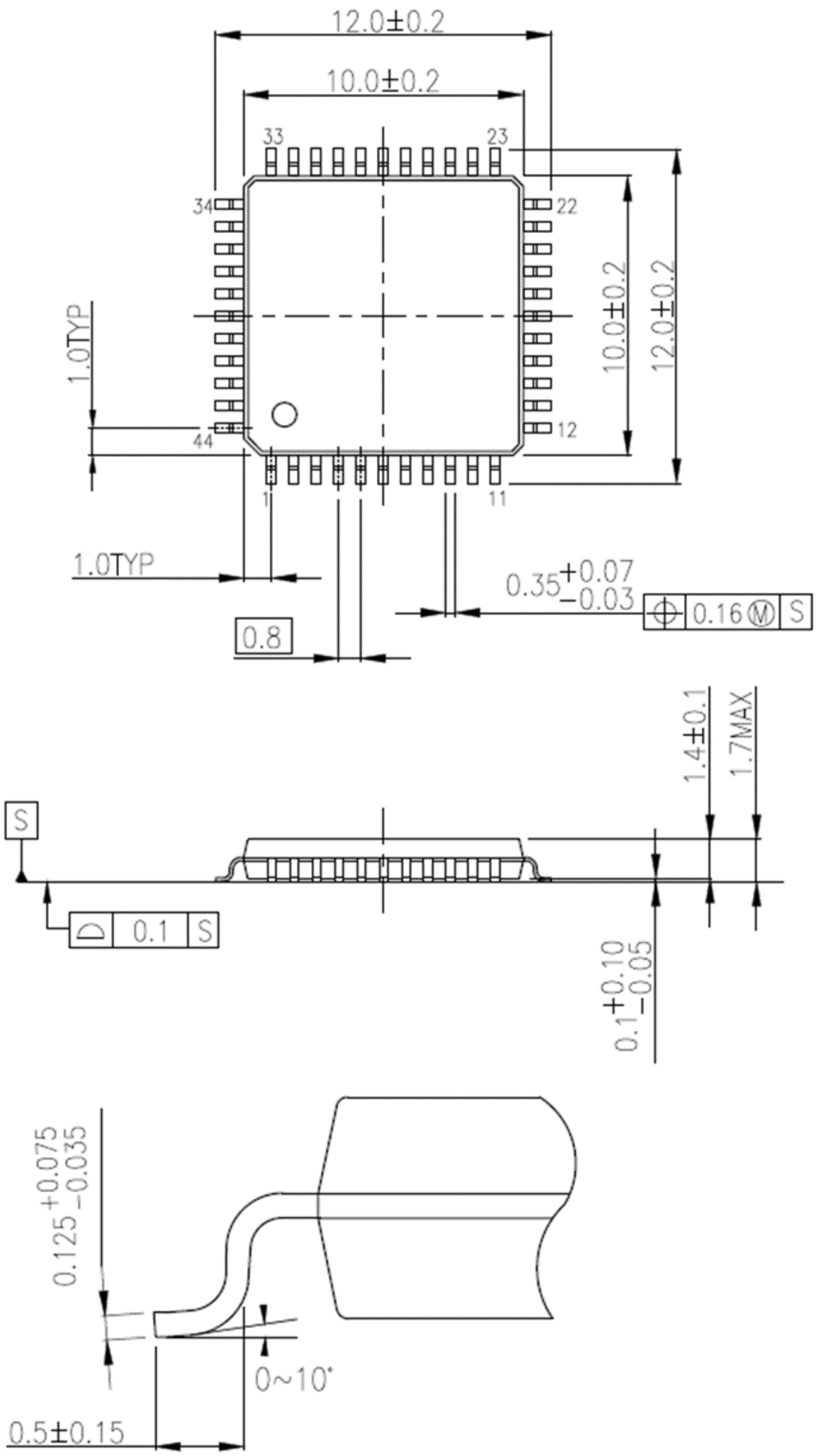
Weight: 0.025 g (typ.)

Figure 4.1 TC35894XBG Package (P-TFBGA36-0303-0.50AZ)

4.2. TC35894FG Package Mechanical Dimensions

The following drawing shows the dimensions of TC35894FG (P-LQFP44-1010-0.80-001, 0.80mm pitch) package.

Unit: mm



Weight: 0.35 g (typ.)

Figure 4.2 TC35894FG Package (P-LQFP44-1010-0.80-001)

5. Electrical Characteristics

5.1. Absolute Maximum Ratings

GND = 0 V reference

Symbol	Description	Min	Typ.	Max	Unit
VDD	Supply Voltage	-0.3	-	3.9	V
V_{IN}	CMOS input voltage	-0.3	-	VDD + 0.3	V
V_{OUT}	DC output voltage	-0.3	-	VDD + 0.3	
I_{in}	Maximum input current	-10	-	10	mA
T_{stg}	Storage Temperature	-40	-	125	°C

5.2. Operating Conditions

GND = 0 V reference

Symbol	Description	Min	Typ.	Max	Unit
VDD	Power supply	1.62	1.8	3.6	V
T_a	Ambient temperature range	-40	25	85	°C

5.3. DC Electrical Specification

Symbol	Description	Min	Typ.	Max	Unit
V_{NOISE}	Input stability of the supply voltage (Peak to Peak)	-	-	0.05	%/V
		-	-	100	mV
V_{OH}	High level output voltage of IOs				V
	V_{OUT} @ 1 mA I_{OUT} and DRV = 00, T_a = 25 °C	0.75 * VDD	-	VDD	
	V_{OUT} @ 2 mA I_{OUT} and DRV = 01, T_a = 25 °C	0.75 * VDD	-	VDD	
	V_{OUT} @ 4 mA I_{OUT} and DRV = 11, T_a = 25 °C	0.75 * VDD	-	VDD	
V_{OL}	Low level output voltage of IOs				
	V_{OUT} @ -1 mA I_{OUT} and DRV = 00, T_a = 25 °C	0	-	0.25 * VDD	
	V_{OUT} @ -2 mA I_{OUT} and DRV = 01, T_a = 25 °C	0	-	0.25 * VDD	
	V_{OUT} @ -4 mA I_{OUT} and DRV = 11, T_a = 25 °C	0	-	0.25 * VDD	
V_{IH}	High level input voltage	0.65 * VDD	-	-	V
V_{IL}	Low level input voltage	-	-	0.35 * VDD	V
VHYS	Hysteresis width	50	-	-	mV
I_{IL}	Low level input current	-	-	-10	µA
	Low level input current with pull-up (VDD = 1.8 V)	-25	-	-110	
I_{IH}	High level input current	-	-	10	
	High level input current with pull-down (VDD = 1.8 V)	25	-	110	
Iquies	Consumption current in SLEEP mode (VDD = 1.8 V, T_a = 25 °C)	-	15	-	µA
Iop (Note 1), (Note 2)	Consumption current in OPERATION mode (VDD = 1.8 V, T_a = 25 °C)	-	122	-	

Note 1: Measured using typical applications on PWM and Keyboard. Measured values are indications, only. Values cannot be guaranteed, because they depend on external circuitry and on use case.

Note 2: When using AUTOSLEEP function and no PWM in use, the average current figures for operation mode get close to the ones specified in Iquies.

6. Revision History

Table 6.1 Revision History

Revision	Date	Description
1.1	2015-12-11	Newly released
1.2	2016-09-07	Modified DRIVE3 register in section 6.3.
1.3	2017-11-15	Corrected typos. Added Revision History. Changed header, footer and the last page. Changed corporate name.
1.4	2018-03-12	Added Supply Voltage in Table 14.2.
1.41	2018-10-23	Added description of trademark. Corrected typos. Modified descriptions in section 2. Modified Table 13.1 and Table 13.2. Revised the last page “RESTRICTIONS ON PRODUCT USE”, and added URL.
1.42	2019-05-14	Modified CLKEN register in section 5.5. Modified DBOUNCE register in section 9.2.14.
2.00	2026-04-24	Marged with TC35894FG Updated the terms “Master/Slave” to “Controller/Target”. Revised the structure for the web-posted datasheet. Removed section 4 to section 11. Removed section 16 to section 17. Corrected typos. Revised the last page “RESTRICTIONS ON PRODUCT USE”.

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