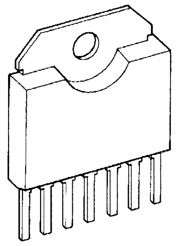
TOSHIBA BIPOLAR LINEAR INTEGRATED CIRCUIT SILICON MONOLITHIC

TA8428K, TA8428FG

DC MOTOR FULL-BRIDGE (H-BRIDGE) DRIVER ICs
(Forward/reverse switching driver ICs)

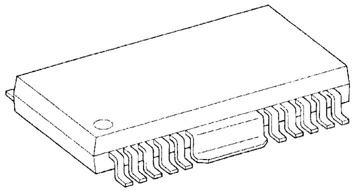
The TA8428K, TA8428FG is Full Bridge Driver IC for Brush Motor Rotation Control.
Forward Rotation, Reverse Rotation, Stop and Braking operations are available.

TA8428K



HSIP7-P-2.54

TA8428FG



HSOP20-P-450-1.00

Weight
HSIP7−P−2.54 : 1.88 g (Typ.)
HSOP20−P−450−1.00 : 0.79 g (Typ.)

FEATURES

- Output Current : TA8428K 1.5 A (AVE.), 3.0 A (PEAK)
  TA8428FG 0.8 A (AVE.), 2.4 A (PEAK)
- 4 modes (forward/reverse/short brake and stop) are available with 2 TTL compatible inputs control. Free-wheeling diodes for back-EMF protection are equipped.
- Thermal shutdown and overcurrent protection circuits
- Operating voltage range: V_{CC} = 7.0 V to 27.0 V

The TA8428FG is RoHS compatible.
The TA8428K is a Sn-plated product. (The Pb-containing materials with a high melting point that are exempted from RoHS directives are used inside the IC.)

About solderability, following conditions were confirmed

- Solderability

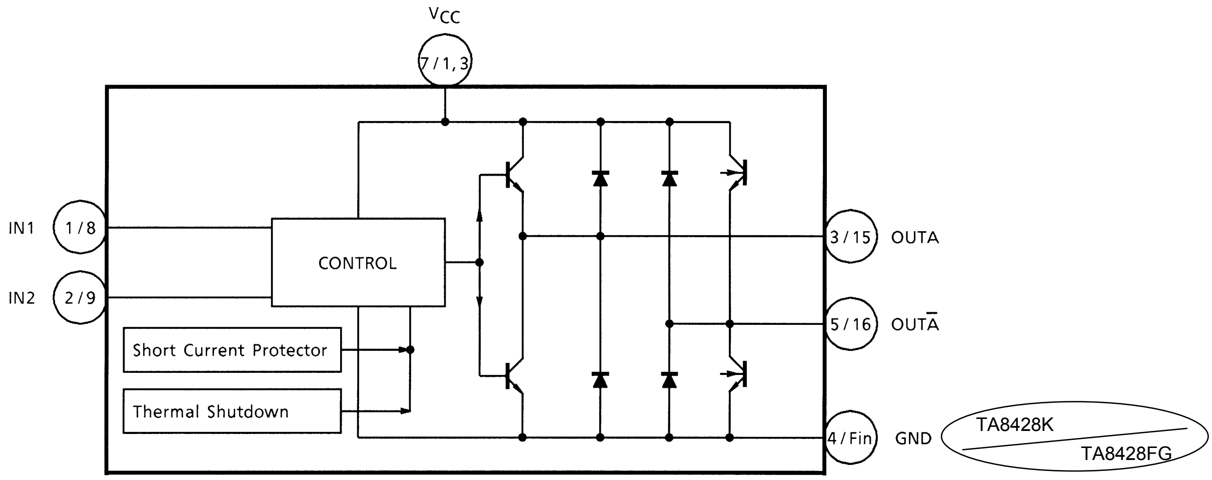
(1) Use of Sn-37Pb solder Bath
· solder bath temperature: 230°C
· dipping time: 5 seconds
· the number of times: once
· use of R-type flux

(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

Terminals of TA8428 written below are sensitive to electrostatic discharge. When handling this product, ensure that the environment is protected against electrostatic discharge by using an earth strap, a conductive mat and an ionizer. Ensure also that the ambient temperature and relative humidity are maintained at reasonable levels.
Terminals which are sensitive to electrostatic discharge: No. 1 and 2 (TA8428K）, No. 8 and 9 (TA8428FG)

The IC should be installed correctly. Otherwise, the IC or peripheral parts and devices may be degraded or permanently damaged.

BLOCK DIAGRAM

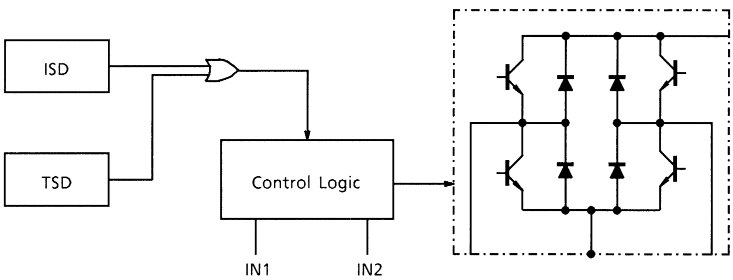


PIN FUNCTION

PIN No.		SYMBOL	FUNCTIONAL DESCRIPTION
K	FG		
1 2	8 9	IN1 IN2	TTL compatible control inputs. (PNP type low active comparator inputs)
3	15	OUTA	Connection pin for a DC motor, which can sink and source currents of up to 1.5 A (TA8428K) or 0.8 A (TA8428FG). Two free-wheeling diodes are internally connected to this pin; one is between this pin and GND and the other is between this pin and V_{CC}.
4	Fin	GND	GND terminal
5	16	OUT $\overline{A}$	Connection pin for a DC motor. This pin has the same function as the OUT A pin.
6	Other pin	N.C	Non connection
7	1, 3	V_{CC}	Supply voltage terminal for control and motor drive.

MULTI-PROTECTION CIRCUITS

TA8428K, TA8428FG has 2 build−in protective functions which work independently.
These circuit operations are as follows.



Note 1: These protection features are provided to temporarily avoid abnormal conditions such as output short circuits and are not guaranteed to prevent the IC from being damaged.

Note 2: These features do not operate outside the guaranteed operating ranges and the IC may be permanently damaged in case of output short circuits.

THERMAL SHUTDOWN (TSD)

- Basic Operation

  When the junction temperature (chip temperature) is equal to or lower than the TSD threshold, output signals are controlled by input signals. However, when the junction temperature exceeds the threshold, output pins are put into a high-impedance state regardless of input signals.
- Functional Description

  Temperature sensing is performed by monitoring the V_F voltage at an on-chip diode. When V_F is low compared to the internal reference voltage, the TSD circuit sends a signal to the control logic to turn off the output transistors. Otherwise, the control logic is controlled by the IN1 and IN2 inputs.

OVERCURRENT PROTECTION (ISD)

- Basic Operation

  When output sink and source currents (TA8428K: at pins 3 and 5; TA8428FG: at pins 15 and 16) are equal to or lower than the overcurrent threshold, output signals are controlled by input signals. However, when any of these currents exceed the threshold, outputs are turned on and off periodically as shown in Figure 1.

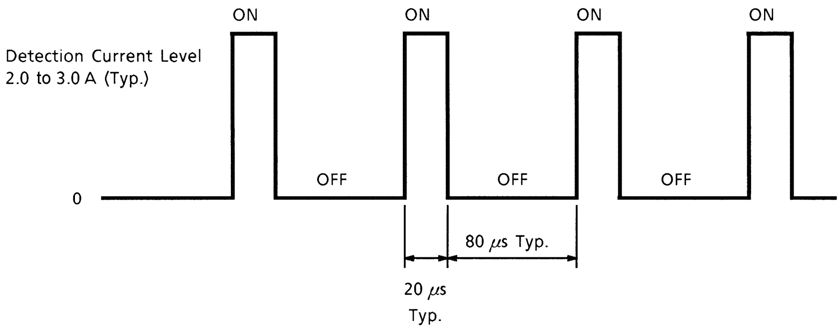


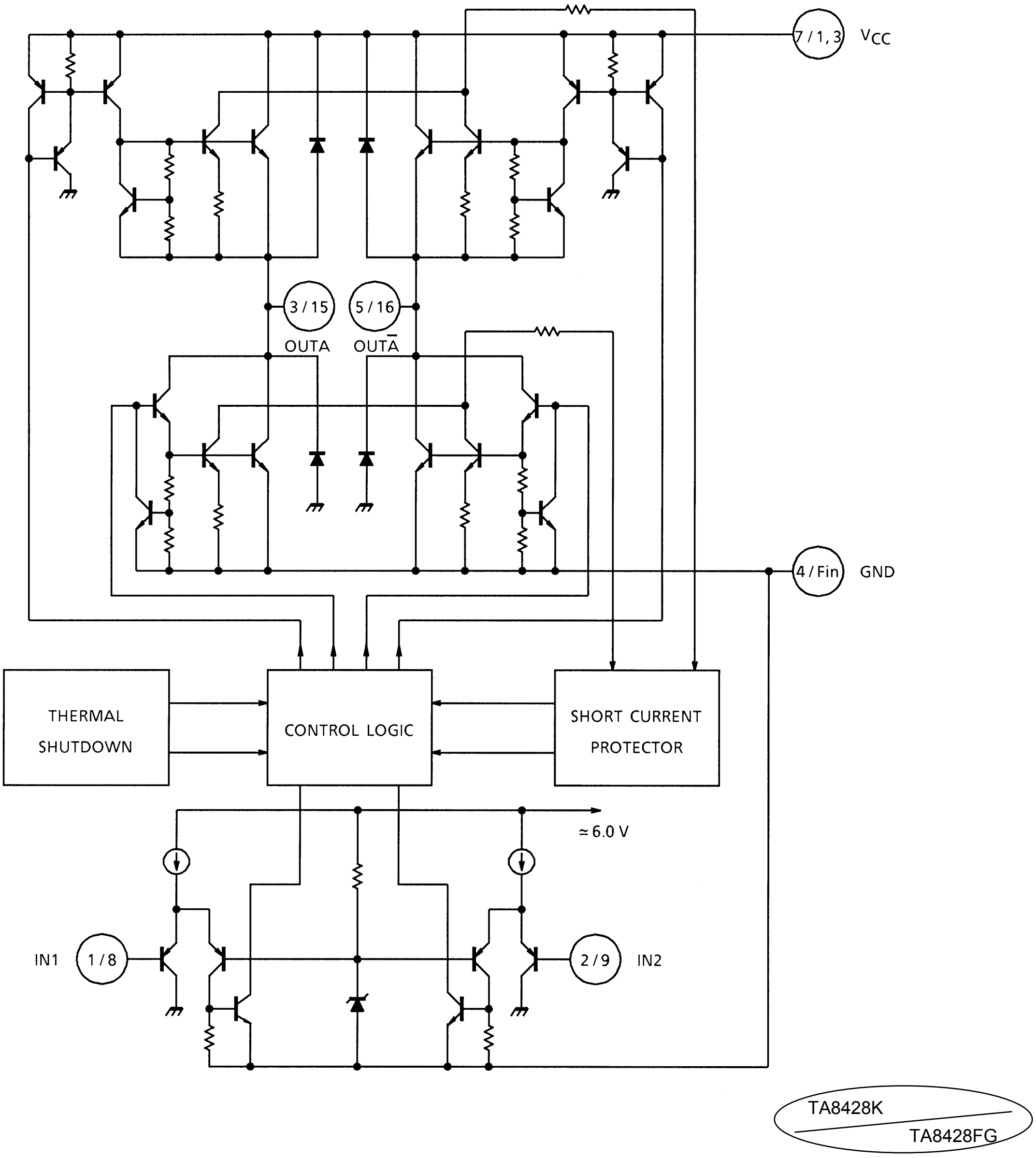
Figure 1 Basic Operation

- Functional Description

  The output current is sensed by monitoring the V_{BE} voltage at each output transistor. The current sensor is connected to each output transistor and to the ISD circuit. If a current higher than the overcurrent threshold flows through any one of the four output transistors, the ISD circuit is activated. This circuit incorporates a timer. If the overcurrent condition persists for 20 μs (typ.), the output is switched to a high-impedance state. Then, it is turned back on after 80 μs (typ.). If the overcurrent condition still persists at this time, the ISD circuit repeats this overcurrent protection sequence until the overcurrent condition is removed.

  This circuit cannot protect the device from all types of over currents. If the outputs are short-circuited to each other or to ground, the IC may be permanently damaged before the protection circuit is activated. Therefore, a resistor or fuse should be connected in the supply voltage line.

INTERNAL CIRCUIT



ABSOLUTE MAXIMUM RATINGS (T_a = 25°C)

CHARACTERISTIC			SYMBOL	RATING	UNIT
Supply Voltage			V_{CC}	30	V
Input Voltage			V_{IN}	−0.3 to V_{CC}	V
Output Current	K type	PEAK	$I_{O (PEAK)}$	3.0 (Note 1)	A
		AVE.	$I_{O (AVE.)}$	1.5	
	FG type	PEAK	$I_{O (PEAK)}$	2.4 (Note 1)	
		AVE.	$I_{O (AVE.)}$	0.8	
Power Dissipation	K type		P_D	1.25 (Note 2)	W
				10.0 (Note 3)	
	FG type		P_D	1.9 (Note 4)	
				2.5 (Note 5)	
Operating Temperature			T_{opr}	−30 to 85	°C
Storage Temperature			T_{stg}	−55 to 150	°C

Note 1: t = 100 ms
Note 2: No heat sink
Note 3: T_C = 85°C
Note 4: This value is obtained by 30 mm × 30 mm × 1.6 mm PCB mounting occupied copper area in excess of 60%
Note 5: This value is obtained by 50 mm × 50 mm × 1.6 mm PCB mounting occupied copper area in excess of 60%

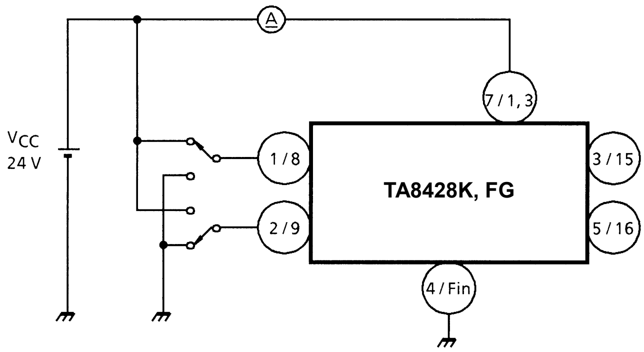
ELECTRICAL CHARACTERISTICS (V_{CC} = 24 V, T_a = 25°C)

CHARACTERISTIC		SYMBOL	TEST CIR-CUIT	Test Condition	MIN	TYP.	MAX	UNIT
Quiescent Current		I_{CC1}	1	Stop mode	—	8	15	mA
		I_{CC2}		Forward/reverse mode	—	35	85	
		I_{CC3}		Brake mode	—	16	30	
Input Voltage		V_{IL}	2	—	—	—	0.8	V
		V_{IH}		—	2.0	—	—	
Input Current		I_{IL}	2	V_{IN} = GND	—	—	50	μA
		I_{IH}		V_{IN} = V_{CC}	—	—	10	
Output Saturation Voltage	K type	V_{sat} (total)	3	I_O = 1.5 A, T_C = 25°C	—	2.2	2.9	V
	FG type			I_O = 0.8 A, T_C = 25°C	—	1.8	2.5	
Output Leakage Current		I_{LU}	4	V_L = 25 V	—	—	50	μA
		I_{LL}			—	—	50	
Diode Forward Voltage	K type	I_{LU}	4	I_F = 1.5 A	—	2.6	—	V
		I_{LL}			—	1.5	—	
	FG type	I_{LU}		I_F = 0.8 A	—	2.2	—	
		I_{LL}			—	1.2	—	
Thermal Shutdown Circuit Operating Temperature		T_{SD}	—	—	—	150	—	°C
Propagation Delay Time		t_{pLH}	2	—	—	1	—	μs
		t_{pHL}	2	—	—	1	—	

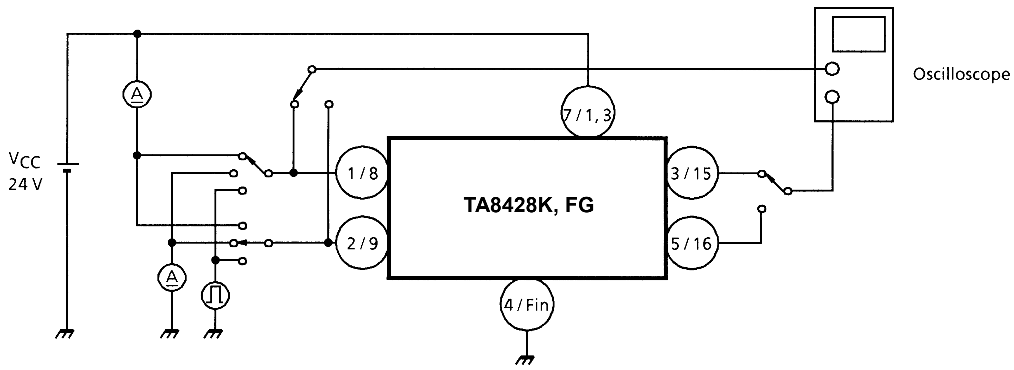
INPUT/OUTPUT FUNCTION

INPUT		OUTPUT		OUTPUT MODE
IN1	IN2	OUTA	OUT $\overline{A}$	
H	H	L	L	Brake
L	H	L	H	CCW (CW)
H	L	H	L	CW (CCW)
L	L	OFF (high impedance)		Stop

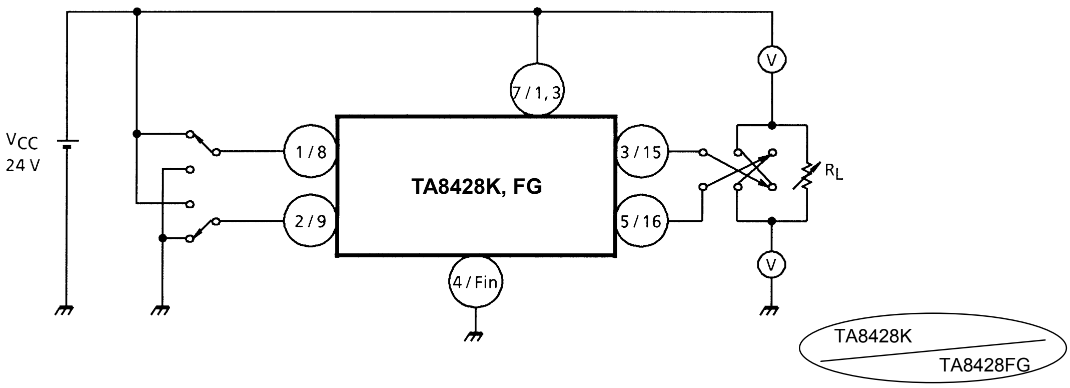
TEST CIRCUIT 1
I_{CC1}, I_{CC2}, I_{CC3}



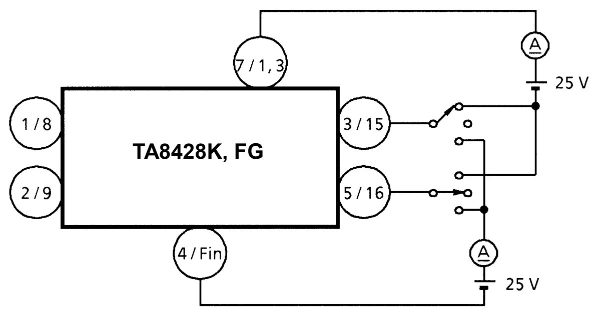
TEST CIRCUIT 2
V_{IL}, V_{IH}, I_{IL}, I_{IH}, t_{pLH}, t_{pHL}



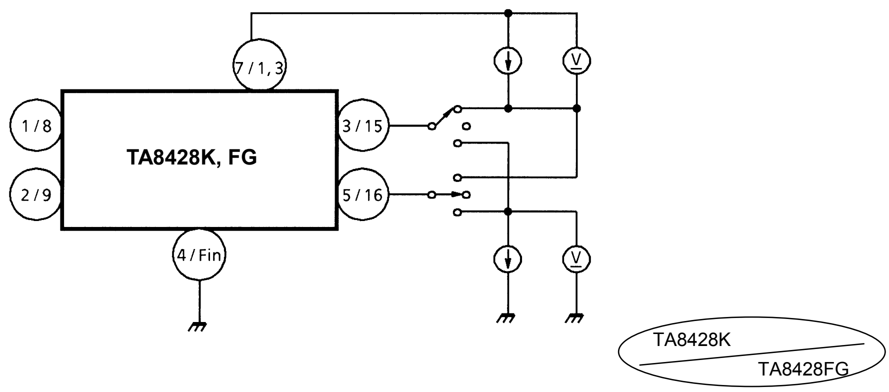
TEST CIRCUIT 3
V_{sat}

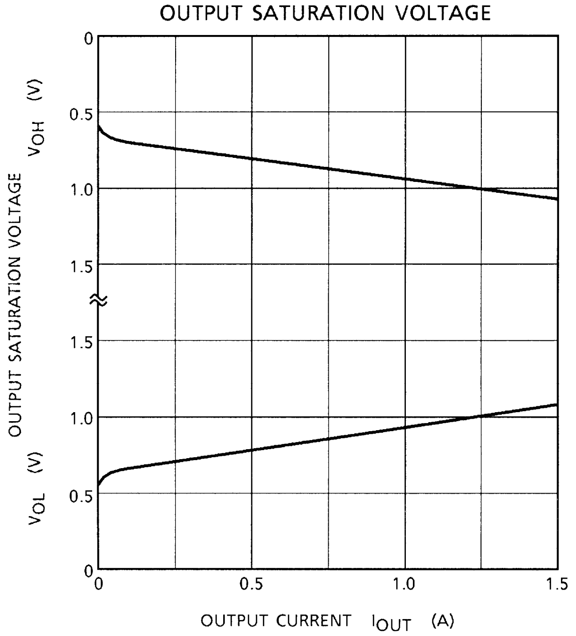


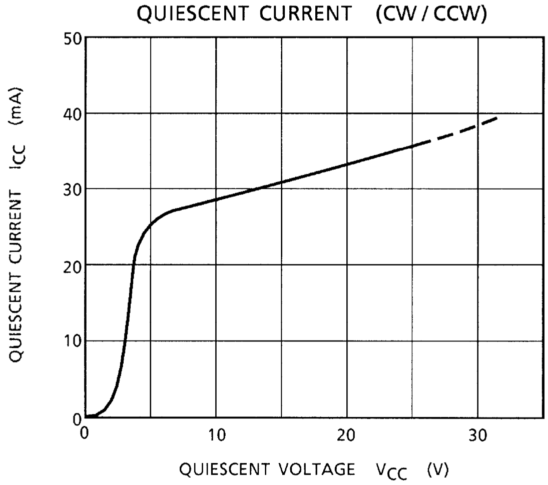
TEST CIRCUIT 4
I_{LU}, I_{LL}

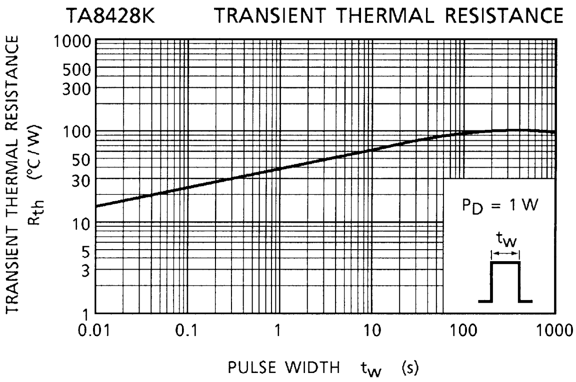


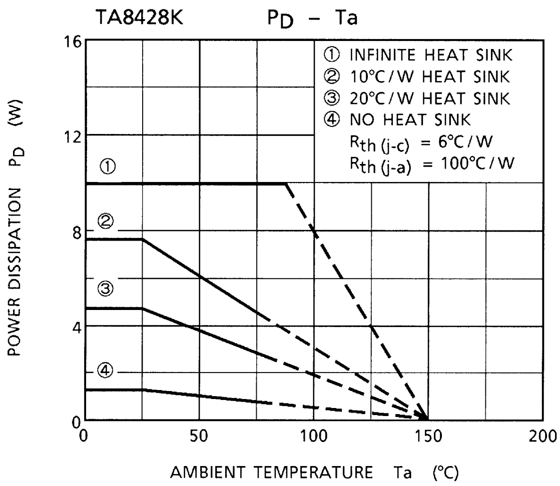
TEST CIRCUIT 5
V_{FU}, V_{FL}

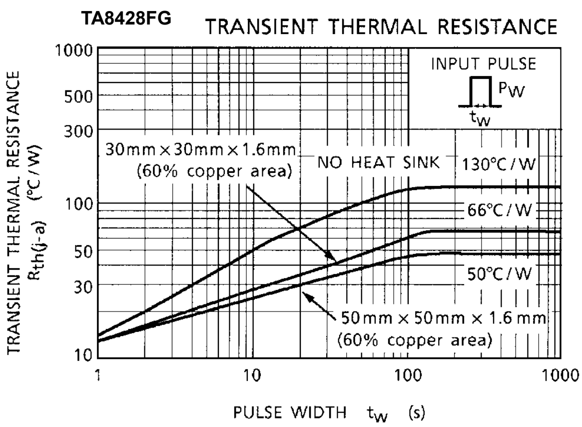


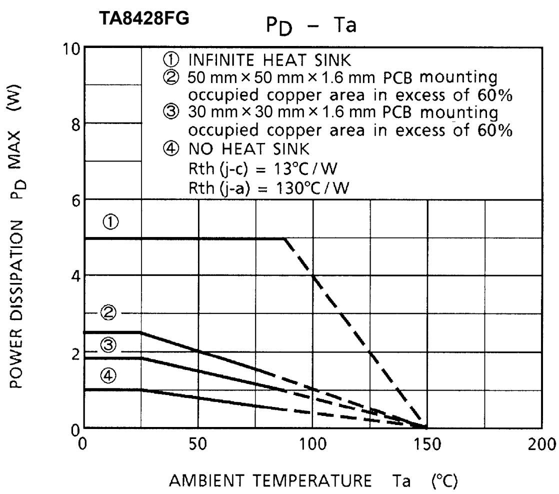

OUTPUT SATURATION VOLTAGE
OUTPUT SATURATION VOLTAGE V_{OH} (V)
V_{OL} (V)
0
0.5
1.0
1.5
1.5
1.0
0.5
0
0
0.5
1.0
1.5
OUTPUT CURRENT I_{OUT} (A)


QUIESCENT CURRENT (CW / CCW)
QUIESCENT CURRENT I_{CC} (mA)
50
40
30
20
10
0
0
10
20
30
QUIESCENT VOLTAGE V_{CC} (V)

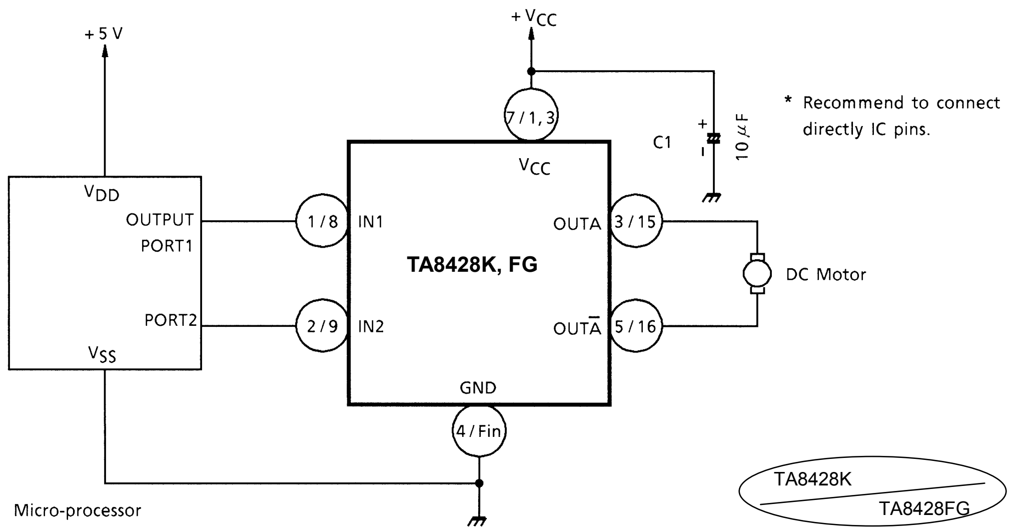

TA8428K TRANSIENT THERMAL RESISTANCE
TRANSIENT THERMAL RESISTANCE R_{th} (°C / W)
1000
500
300
100
50
30
10
5
3
1
0.01
0.1
1
10
100
1000
P_D = 1 W
t_w
PULSE WIDTH t_w (s)

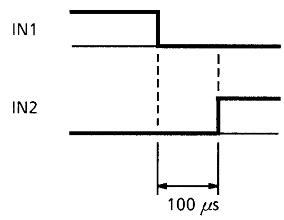

TA8428K P_D – Ta
POWER DISSIPATION P_D (W)
16
12
8
4
0
0
50
100
150
200
① INFINITE HEAT SINK
② 10°C / W HEAT SINK
③ 20°C / W HEAT SINK
④ NO HEAT SINK
$R_{th (j-c)}$ = 6°C / W
$R_{th (j-a)}$ = 100°C / W
①
②
③
④
AMBIENT TEMPERATURE Ta (°C)


TA8428FG TRANSIENT THERMAL RESISTANCE
TRANSIENT THERMAL RESISTANCE $R_{th(j-a)}$ (°C / W)
1000
500
300
100
50
30
10
1
10
100
1000
INPUT PULSE
PW
t_w
30 mm × 30 mm × 1.6 mm (60% copper area)
NO HEAT SINK
130°C / W
66°C / W
50°C / W
50 mm × 50 mm × 1.6 mm (60% copper area)
PULSE WIDTH t_w (s)


TA8428FG P_D – Ta
POWER DISSIPATION P_D MAX (W)
10
8
6
4
2
0
0
50
100
150
200
① INFINITE HEAT SINK
② 50 mm × 50 mm × 1.6 mm PCB mounting occupied copper area in excess of 60%
③ 30 mm × 30 mm × 1.6 mm PCB mounting occupied copper area in excess of 60%
④ NO HEAT SINK
Rth (j-c) = 13°C / W
Rth (j-a) = 130°C / W
①
②
③
④
AMBIENT TEMPERATURE Ta (°C)

APPLICATION CIRCUIT





Note 1: Recommend to take approximately 100 μs of input dead time for reliable operations.

Note 2: In case of mounted on radiators, do not use silicon rubber. (TA8428K)

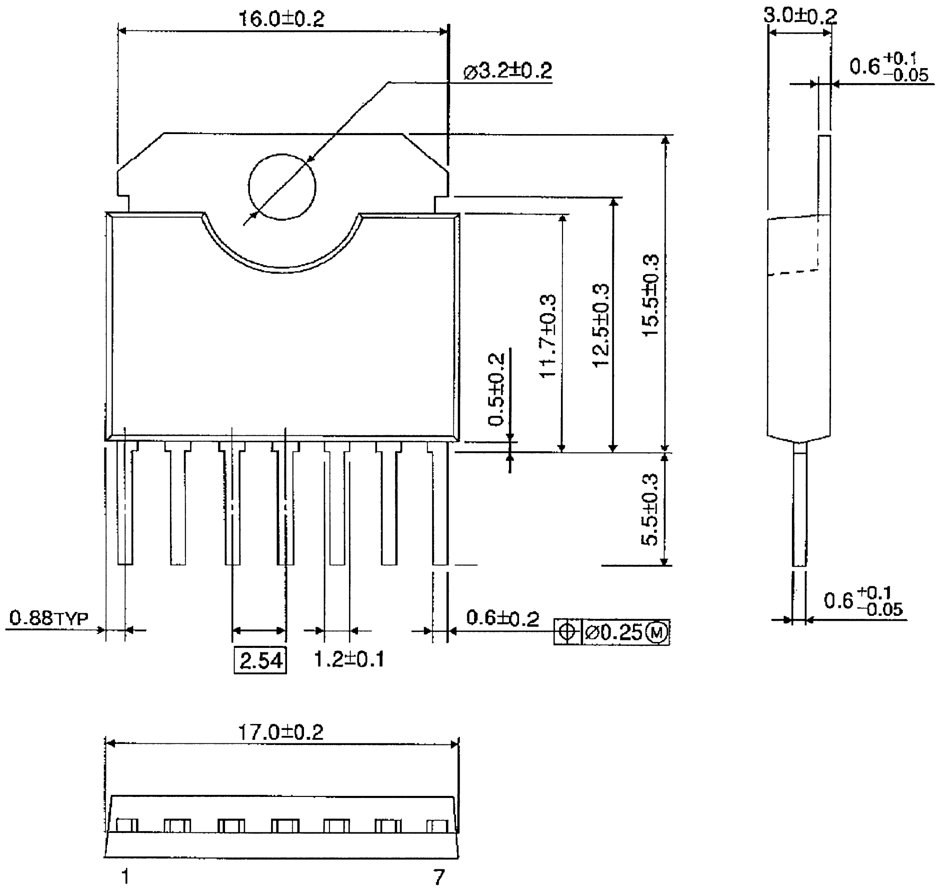
Note 3: Connect and use 1 pin and 3 pin surely. (TA8428FG)

Note 4: When V_{CC} is turned on, the IN1 and IN2 pins must be set low. These pins can be switched only after V_{CC} reaches the specified voltage.

Note 5: Utmost care is necessary in the design of the output, V_{CC}, and GND lines since the IC may be destroyed by short-circuiting between outputs, air contamination faults, or faults due to improper grounding, or by short-circuiting between contiguous pins.

PACKAGE DIMENSIONS

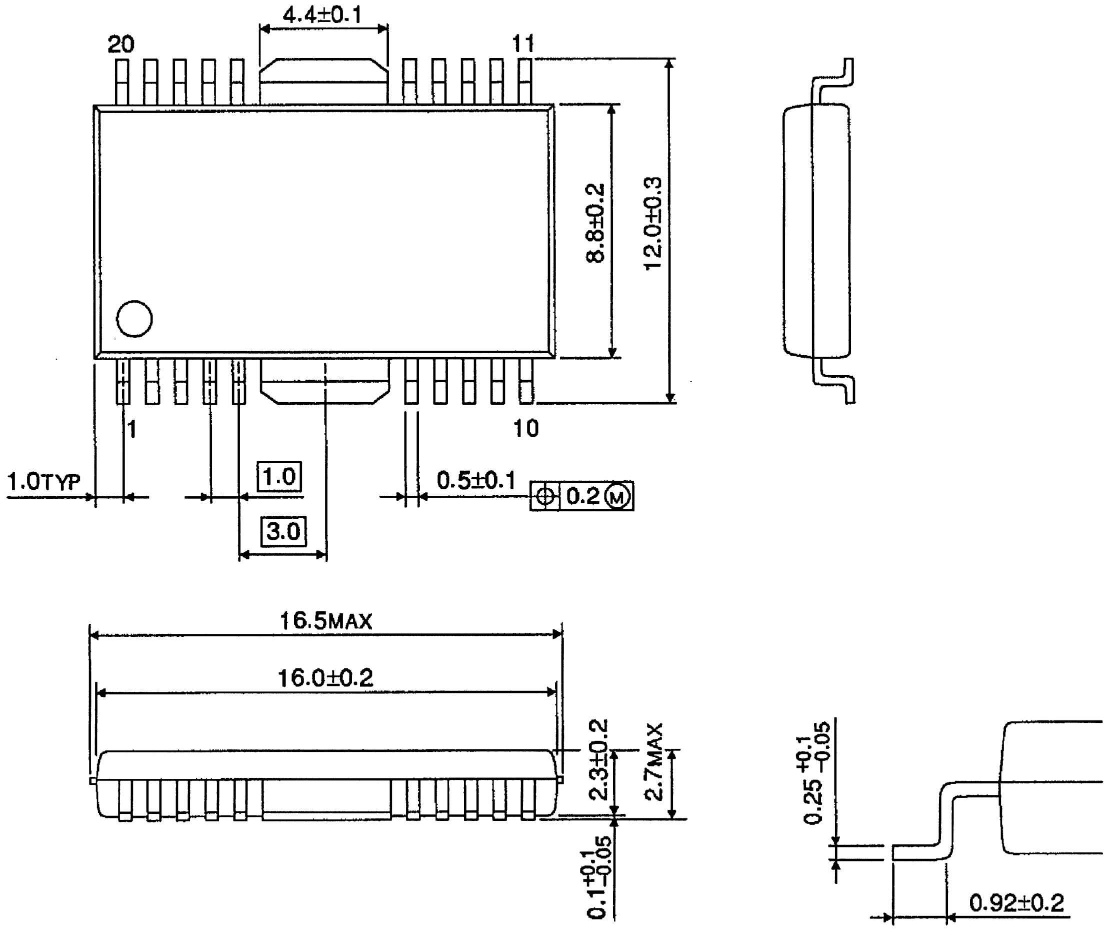
HSIP7−P−2.54 Unit : mm



Weight : 1.88 g (Typ.)

PACKAGE DIMENSIONS

HSOP20−P−450−1.00 Unit : mm



Weight : 0.79 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.

Points to remember on handling of ICs

(1) Over current Protection Circuit

Over current protection circuits (referred to as current limiter circuits) do not necessarily protect ICs under all circumstances. If the Over current protection circuits operate against the over current, clear the over current status immediately.

Depending on the method of use and usage conditions, such as exceeding absolute maximum ratings can cause the over current protection circuit to not operate properly or IC breakdown before operation. In addition, depending on the method of use and usage conditions, if over current continues to flow for a long time after operation, the IC may generate heat resulting in breakdown.

(2) Thermal Shutdown Circuit

Thermal shutdown circuits do not necessarily protect ICs under all circumstances. If the thermal shutdown circuits operate against the over temperature, clear the heat generation status immediately.

Depending on the method of use and usage conditions, such as exceeding absolute maximum ratings can cause the thermal shutdown circuit to not operate properly or IC breakdown before operation.

(3) 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.

(4) 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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