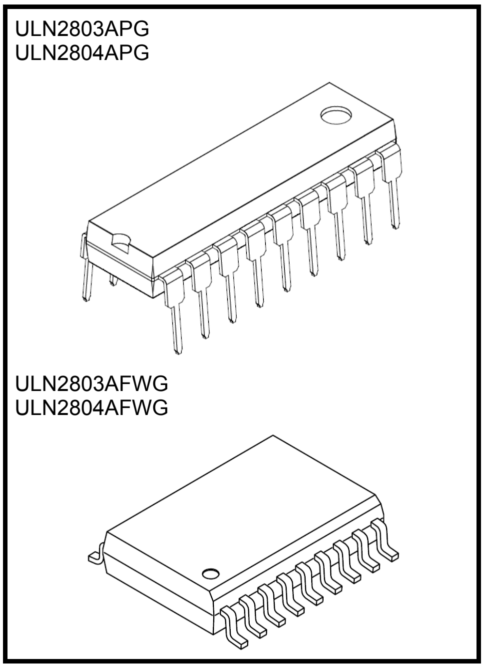
TOSHIBA Bipolar Digital Integrated Circuit Silicon Monolithic

ULN2803APG, ULN2803AFWG, ULN2804APG, ULN2804AFWG

8ch Darlington Sink Driver

The ULN2803APG / AFWG Series are high−voltage, high−current darlington drivers comprised of eight NPN darlington pairs.
All units feature integral clamp diodes for switching inductive loads.
Applications include relay, hammer, lamp and display (LED) drivers.



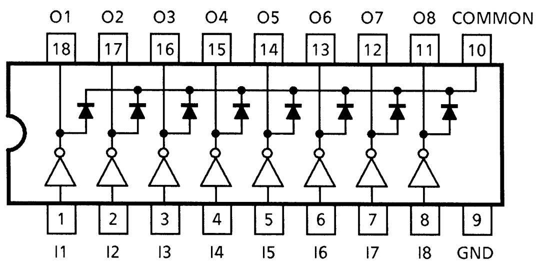
Weight
P-DIP18-300-2.54-001: 1.478 g (Typ.)
P-SOP18-0812-1.27-001: 0.48 g (Typ.)

Features

- Output current (single output)
  500 mA (max)
- High sustaining voltage output
  50 V (min)
- Output clamp diodes
- Inputs compatible with various types of logic.
- Package Type−APG : DIP−18pin
- Package Type−AFWG : SOP−18pin

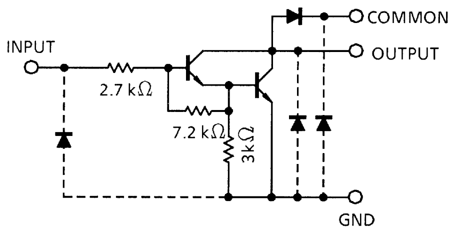
Type	Input Base Resistor	Designation
ULN2803APG / AFWG	2.7 kΩ	TTL, 5 V CMOS
ULN2804APG / AFWG	10.5 kΩ	6~15 V PMOS, CMOS

Pin Connection (top view)

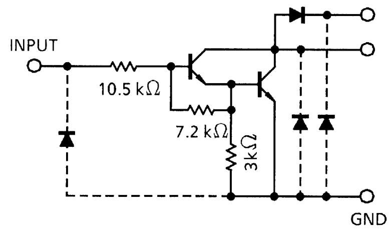


Schematics (each driver)

ULN2803APG / AFWG



ULN2804APG / AFWG



Note: The input and output parasitic diodes cannot be used as clamp diodes.

Absolute Maximum Ratings (Ta = 25°C)

Characteristic		Symbol	Rating	Unit
Output sustaining voltage		$V_{CE\ (SUS)}$	−0.5 to 50	V
Output current		I_{OUT}	500	mA / ch
Input voltage		V_{IN}	−0.5 to 30	V
Clamp diode reverse voltage		V_R	50	V
Clamp diode forward current		I_F	500	mA
Power dissipation	APG	P_D	1.47	W
	AFWG		0.92 / 1.31 (Note)	
Operating temperature		T_{opr}	−40 to 85	°C
Storage temperature		T_{stg}	−55 to 150	°C

Note: On Glass Epoxy PCB (75 × 114 × 1.6 mm Cu 20%)

Recommended Operating Conditions (Ta = −40~85°C)

Characteristic		Symbol	Test Condition	Min	Typ.	Max	Unit
Output sustaining voltage		$V_{CE\ (SUS)}$	—	0	—	50	V
Output current	APG	I_{OUT}	t_{pw} = 25 ms, Duty = 10%, 8 Circuits	0	—	347	mA / ch
			t_{pw} = 25 ms, Duty = 50%, 8 Circuits	0	—	123	
	AFWG		t_{pw} = 25 ms, Duty = 10%, 8 Circuits	0	—	268	
			t_{pw} = 25 ms, Duty = 50%, 8 Circuits	0	—	90	
Input voltage		V_{IN}	—	0	—	30	V
Input voltage (Output on)	ULN2803A	$V_{IN\ (ON)}$	—	2.5	—	30	V
	ULN2804A		—	8	—	30	
Clamp diode reverse voltage		V_R	—	—	—	50	V
Clamp diode forward current		I_F	—	—	—	400	mA
Power dissipation	APG	P_D	Ta = 85°C	—	—	0.76	W
	AFWG		Ta = 85°C (Note)	—	—	0.48	

Note: On Glass Epoxy PCB (75 × 114 × 1.6 mm Cu 20%)

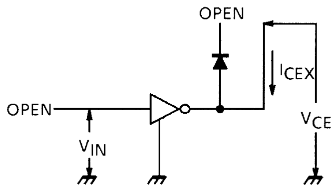
Electrical Characteristics (Ta = 25°C)

Characteristic		Symbol	Test Cir–Cuit	Test Condition		Min	Typ.	Max	Unit
Output leakage current		I_{CEX}	1	V_{CE} = 50 V	Ta = 25°C	—	—	50	μA
				V_{CE} = 50 V	Ta = 85°C	—	—	100	
	ULN2804A			V_{CE} = 50 V	V_{IN} = 1 V	—	—	500	
Collector−emitter saturation voltage		VCE (sat)	2	I_{OUT} = 350 mA, I_{IN} = 500 μA		—	1.3	1.6	V
				I_{OUT} = 200 mA, I_{IN} = 350 μA		—	1.1	1.3	
				I_{OUT} = 100 mA, I_{IN} = 250 μA		—	0.9	1.1	
Input current	ULN2803A	$I_{IN (ON)}$	2	V_{IN} = 3.85 V		—	0.93	1.35	mA
	ULN2804A			V_{IN} = 5 V		—	0.35	0.5	
				V_{IN} = 12 V		—	1.0	1.45	
		$I_{IN (OFF)}$	4	I_{OUT} = 500 μA, Ta = 85°C		50	65	—	μA
Input voltage (Output on)	ULN2803A	$V_{IN (ON)}$	5	V_{CE} = 2 V, I_{OUT} = 200 mA		—	—	2.4	V
				V_{CE} = 2 V, I_{OUT} = 250 mA		—	—	2.7	
				V_{CE} = 2 V, I_{OUT} = 300 mA		—	—	3.0	
	ULN2804A			V_{CE} = 2 V, I_{OUT} = 125 mA		—	—	5.0	
				V_{CE} = 2 V, I_{OUT} = 200 mA		—	—	6.0	
				V_{CE} = 2 V, I_{OUT} = 275 mA		—	—	7.0	
				V_{CE} = 2 V, I_{OUT} = 350 mA		—	—	8.0	
DC current transfer ratio		h_{FE}	2	V_{CE} = 2 V, I_{OUT} = 350 mA		1000	—	—	—
Clamp diode reverse current		I_R	6	Ta = 25°C (Note)		—	—	50	μA
				Ta = 85°C (Note)		—	—	100	
Clamp diode forward voltage		V_F	7	I_F = 350 mA		—	—	2.0	V
Input capacitance		C_{IN}	—	—		—	15	—	pF
Turn−on delay		t_{ON}	8	R_L = 125 Ω, V_{OUT} = 50 V		—	0.1	—	μs
Turn−off delay		t_{OFF}		R_L = 125 Ω, V_{OUT} = 50 V		—	0.2	—	

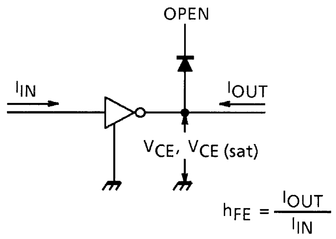
Note: $V_R = V_R$ (max)

Test Circuit

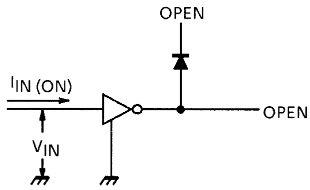
1. I_{CEX}



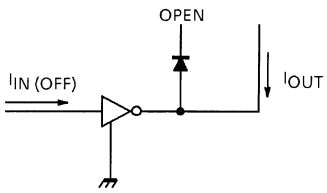
2. $V_{CE\ (sat)}$, h_{FE}



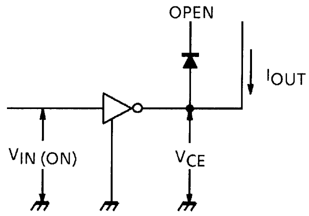
3. $I_{IN\ (ON)}$



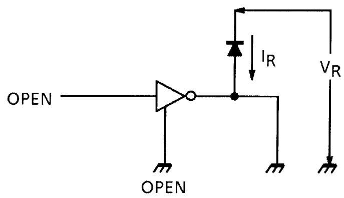
4. $I_{IN\ (OFF)}$



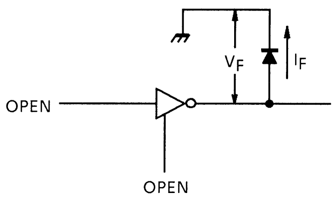
5. $V_{IN\ (ON)}$



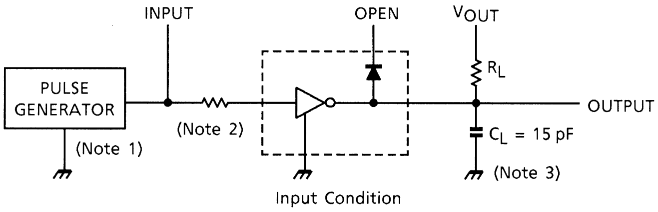
6. I_R

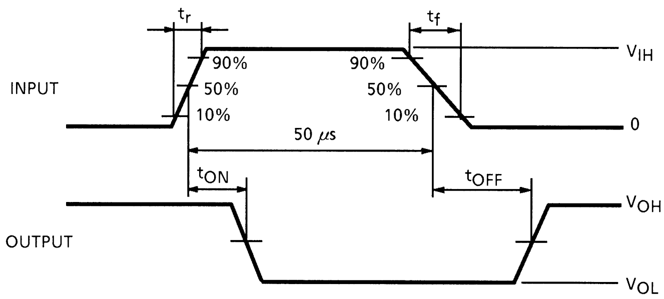


7. V_F



8. t_{ON}, t_{OFF}





Note 1: Pulse Width 50 μs, Duty Cycle 10%
Output Impedance 50 Ω, $t_r \leq 5$ ns, $t_f \leq 10$ ns

Note 2: See below.

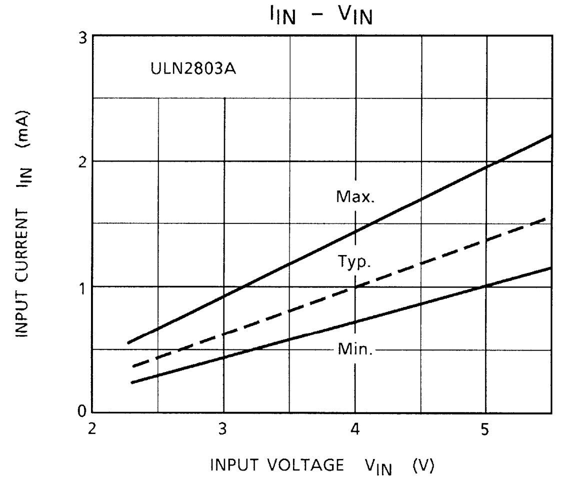
Input Condition

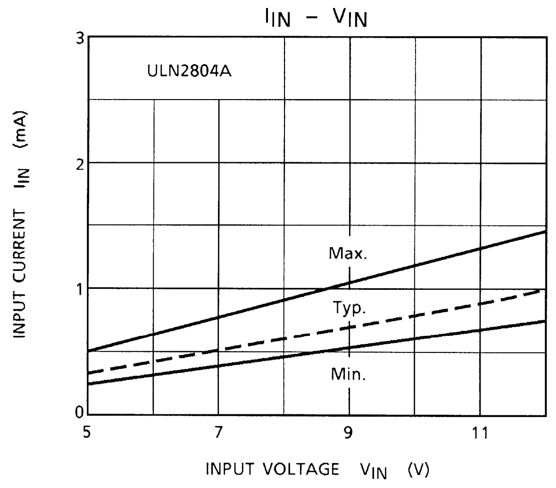
Type Number	R1	V_{IH}
ULN2803A	0Ω	3 V
ULN2804A	0Ω	8 V

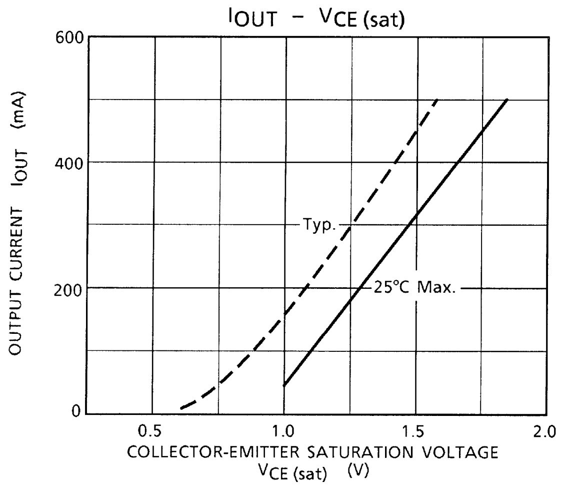
Note 3: C_L includes probe and jig capacitance

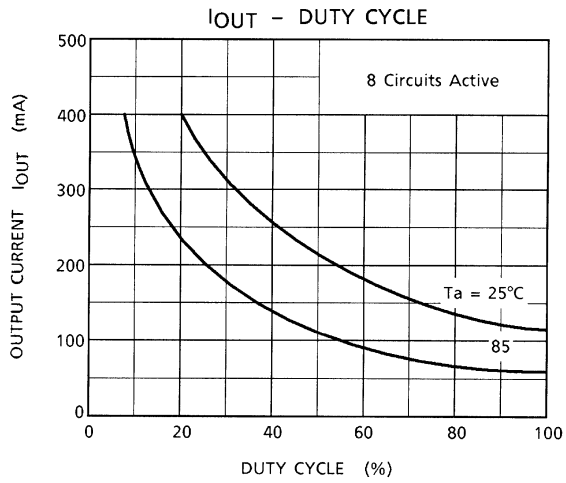
Precautions for Using

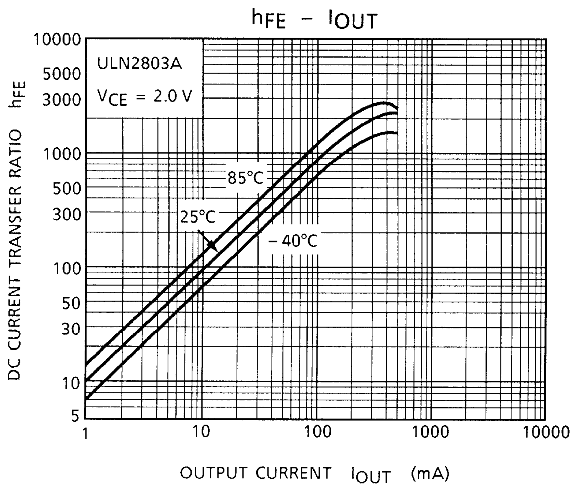
This IC does not integrate protection circuits such as overcurrent and overvoltage protectors.
Thus, if excess current or voltage is applied to the IC, the IC may be damaged. Please design the IC so that excess current or voltage will not be applied to the IC.
Utmost care is necessary in the design of the output line, COMMON and GND line since IC may be destroyed due to short−circuit between outputs, air contamination fault, or fault by improper grounding.

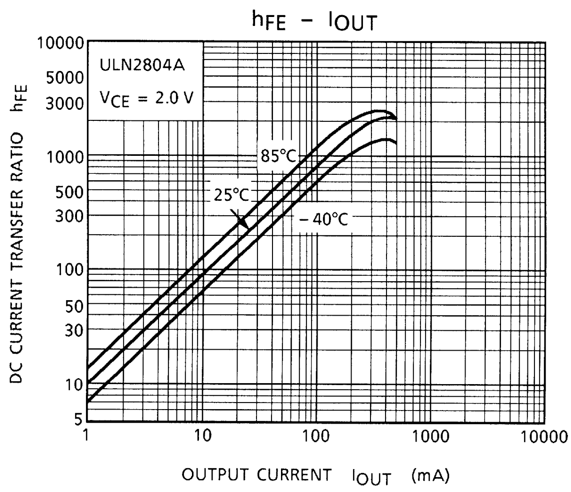

I_{IN} – V_{IN}
ULN2803A
Max.
Typ.
Min.
INPUT CURRENT I_{IN} (mA)
INPUT VOLTAGE V_{IN} (V)
0
1
2
3
2
3
4
5

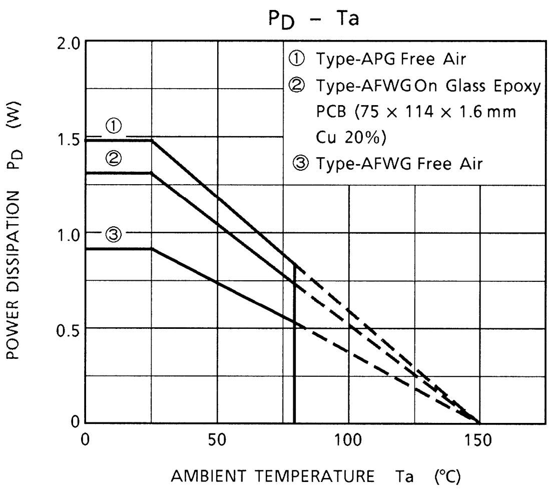

I_{IN} – V_{IN}
ULN2804A
Max.
Typ.
Min.
INPUT CURRENT I_{IN} (mA)
INPUT VOLTAGE V_{IN} (V)
0
1
2
3
5
7
9
11


I_{OUT} – $V_{CE\,(sat)}$
Typ.
25°C Max.
OUTPUT CURRENT I_{OUT} (mA)
COLLECTOR-EMITTER SATURATION VOLTAGE
$V_{CE\,(sat)}$ (V)
0
200
400
600
0.5
1.0
1.5
2.0


I_{OUT} – DUTY CYCLE
8 Circuits Active
Ta = 25°C
85
OUTPUT CURRENT I_{OUT} (mA)
DUTY CYCLE (%)
0
100
200
300
400
500
0
20
40
60
80
100


h_{FE} – I_{OUT}
ULN2803A
V_{CE} = 2.0 V
85°C
25°C
– 40°C
DC CURRENT TRANSFER RATIO h_{FE}
OUTPUT CURRENT I_{OUT} (mA)
5
10
30
50
100
300
500
1000
3000
5000
10000
1
10
100
1000
10000

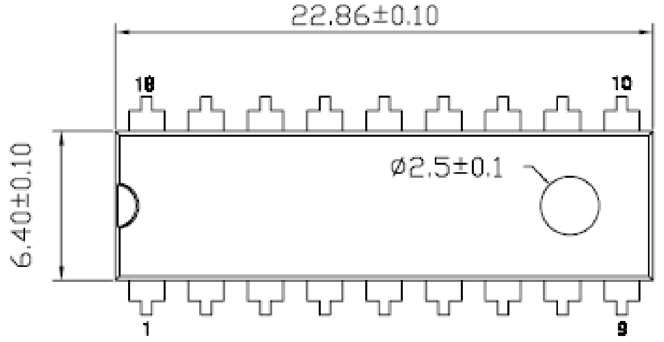

h_{FE} – I_{OUT}
ULN2804A
V_{CE} = 2.0 V
85°C
25°C
– 40°C
DC CURRENT TRANSFER RATIO h_{FE}
OUTPUT CURRENT I_{OUT} (mA)
5
10
30
50
100
300
500
1000
3000
5000
10000
1
10
100
1000
10000

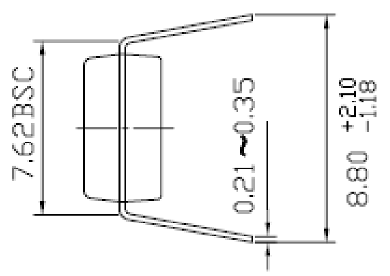


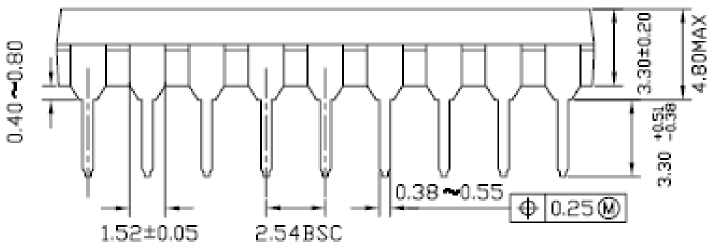
P_D – Ta
① Type-APG Free Air
② Type-AFWG On Glass Epoxy PCB (75 × 114 × 1.6 mm Cu 20%)
③ Type-AFWG Free Air
POWER DISSIPATION P_D (W)
AMBIENT TEMPERATURE Ta (°C)
2.0
1.5
1.0
0.5
0
50
100
150

Package Dimensions

P-DIP18-300-2.54-001 “Unit : mm”





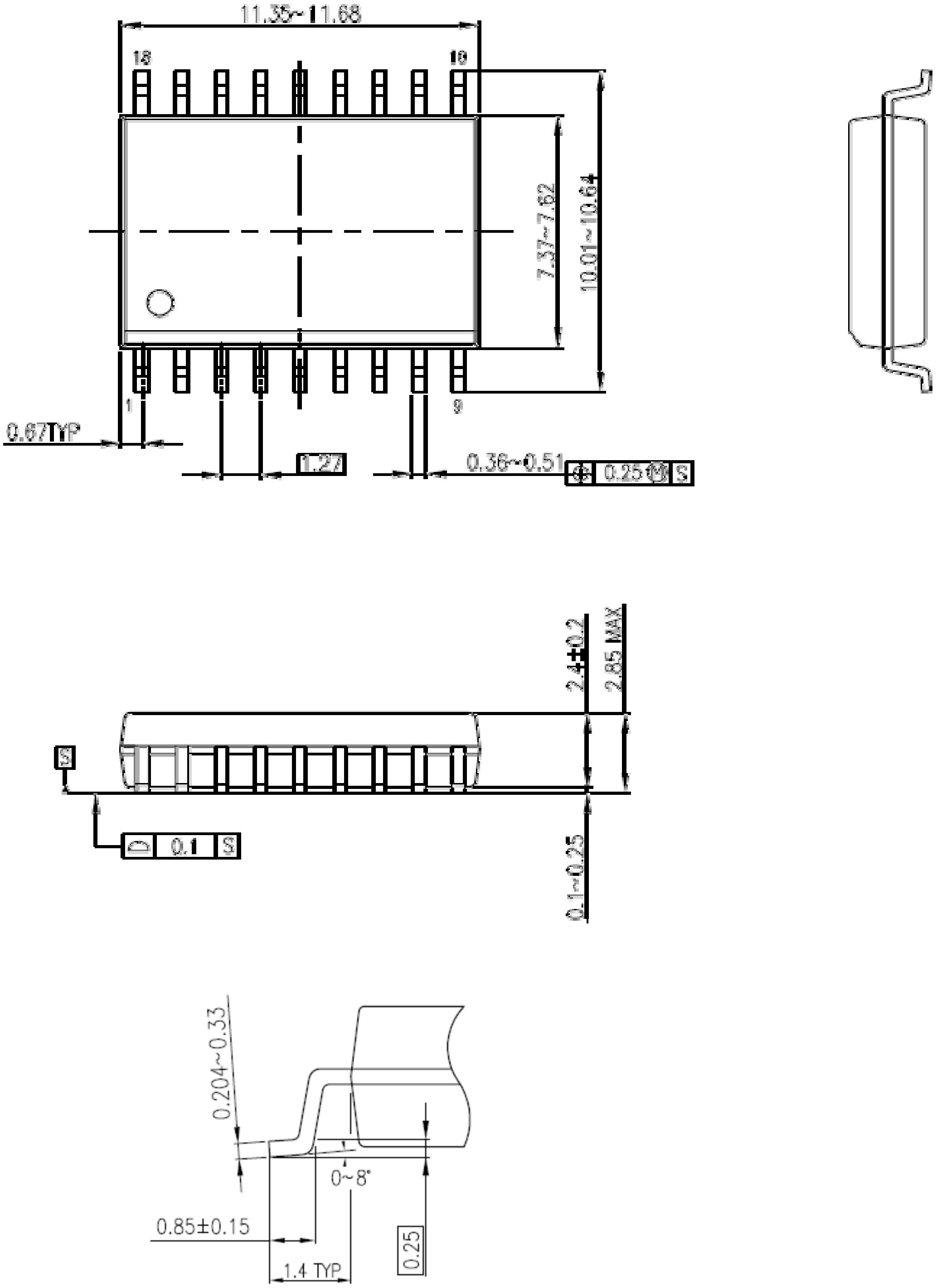


Weight: 1.478 g (typ.)

This drawing is an object for explanation.

Package Dimensions

P-SOP18-0812-1.27-001 "Unit : mm"



Weight: 0.48 g (typ.)

This drawing is an object for explanation.

Notes on Contents

1. Equivalent Circuits

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

2. 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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