

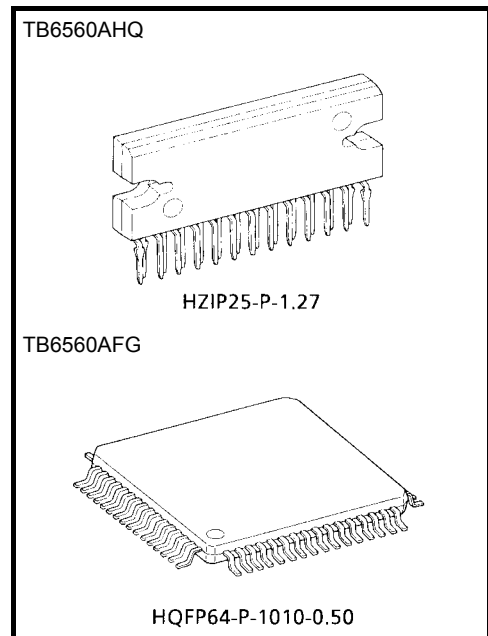
TB6560AHQ, TB6560AFG

PWM Chopper-Type Bipolar Driver IC for Stepping Motor Control

The TB6560AHQ/AFG is a PWM chopper-type stepping motor driver IC designed for sinusoidal-input microstep control of bipolar stepping motors. The TB6560AHQ/AFG can be used in applications that require 2-phase, 1-2-phase, 2W1-2-phase and 4W1-2-phase excitation modes. The TB6560AHQ/AFG is capable of low-vibration, high-performance forward and reverse driving of a two-phase bipolar stepping motor using only a clock signal.

Features

- Single-chip motor driver for sinusoidal microstep control of stepping motors
- High output withstand voltage due to the use of BiCD process:
Ron (upper and lower sum) =
TB6560AHQ: 0.6 Ω (typ.)
TB6560AFG: 0.7 Ω (typ.)
- Forward and reverse rotation
- Selectable phase excitation modes (2, 1-2, 2W1-2 and 4W1-2)
- High output withstand voltage: $V_{DSS} = 40$ V
- High output current: $I_{OUT} =$ TB6560AHQ: 3.5 A (peak)
TB6560AFG: 2.5 A (peak)
- Packages: HZIP25-P-1.27
HQFP64-P-1010-0.50
- Internal pull-down resistors on inputs: 100 k Ω (typ.)
- Output monitor pin: I_{MO} current (I_{MO} (max)) = 1 mA
- Reset and enable pins
- Thermal shutdown (TSD)



Weight

HZIP25-P-1.27: 9.86 g (typ.)

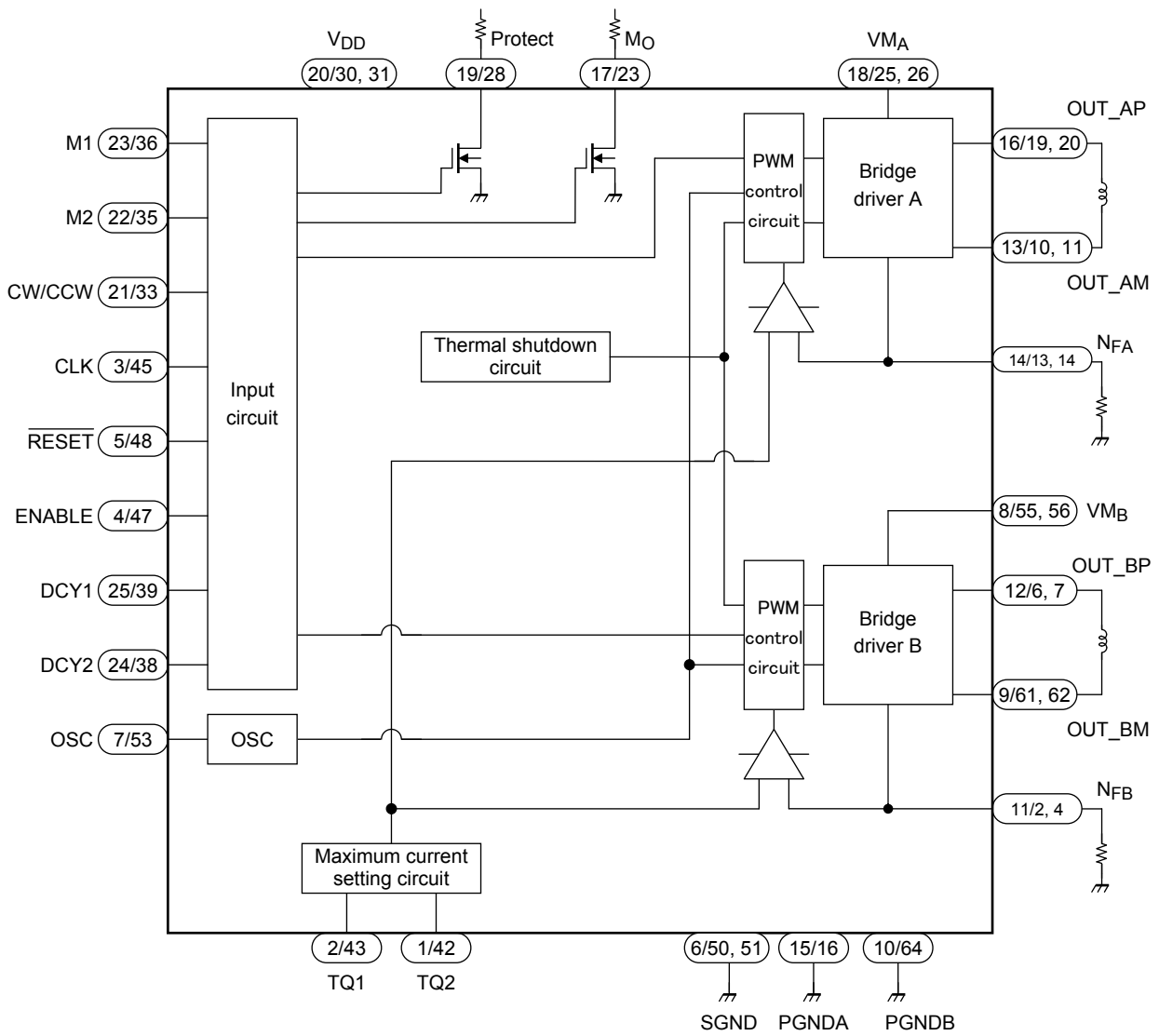
HQFP64-P-1010-0.50: 0.26 g (typ.)

*Solderability

1. Use of Sn-37Pb solder bath
*solder bath temperature = 230°C
*dipping time = 5 seconds
*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

*: These ICs are highly sensitive to electrostatic discharge. When handling them, ensure that the environment is protected against electrostatic discharge. Ensure also that the ambient temperature and relative humidity are maintained at reasonable level.

Block Diagram



TB6560AHQ/TB6560AFG

Pin Functions

Pin No.		I/O	Symbol	Functional Description	Remarks
TB6560 AHQ	TB6560 AFG				
1	42	Input	TQ2	Torque setting input (current setting)	Internal pull-down resistor
2	43	Input	TQ1	Torque setting input (current setting)	Internal pull-down resistor
3	45	Input	CLK	Clock input for microstepping	Internal pull-down resistor
4	47	Input	ENABLE	H: Enable; L: All outputs OFF	Internal pull-down resistor
5	48	Input	$\overline{\text{RESET}}$	L: Reset (The outputs are reset to their initial states.)	Internal pull-down resistor
6	50/51	—	SGND	Signal ground (for control block)	(Note 1)
7	53	—	OSC	A CR oscillation circuit is connected to this pin. Performs output chopping.	
8	55/56	Input	VM _B	Motor power supply pin (for phase-B driver)	(Note 1)
9	61/62	Output	OUT _{BM}	OUT _B output	(Note 1)
10	64 (*)	—	PGNDB	Power ground	
11	2/4 (*)	—	N _{FB}	Connection pin for a B-channel current sensing resistor Two pins of the TB6560AFG should be short-circuited.	(Note 1)
12	6/7	Output	OUT _{BP}	OUT _B output	(Note 1)
13	10/11	Output	OUT _{AM}	OUT _A output	(Note 1)
14	13/14 (*)	—	N _{FA}	Connection pin for an A-channel current sensing resistor Two pins of the TB6560AFG should be short-circuited.	(Note 1)
15	16	—	PGNDA	Power ground	
16	19/20	Output	OUT _{AP}	OUT _A output	(Note 1)
17	23	Output	M _O	Initial state sensing output. This pin is enabled in the initial state.	Open drain
18	25/26	Input	VM _A	Motor power supply pin (for phase-A driver)	(Note 1)
19	28	Output	Protect	When TSD is activated: High; when in normal state: High-Z.	Open drain
20	30/31	Input	V _{DD}	Power supply pin for control block	(Note 1)
21	33	Input	CW/CCW	Rotation direction select input. L: Clockwise; H: Counterclockwise	Internal pull-down resistor
22	35	Input	M2	Excitation mode setting input	Internal pull-down resistor
23	36	Input	M1	Excitation mode setting input	Internal pull-down resistor
24	38	Input	DCY2	Current decay mode setting input	Internal pull-down resistor
25	39	Input	DCY1	Current decay mode setting input	Internal pull-down resistor

(*): The pin assignment of the TB6560AFG is different from that of the TB6560FG.

TB6560AHQ: There is no no-connect (NC) pin.

TB6560AFG: Except the above pins, all pins are NC. The pin numbers of NC pins are: 1, 3, 5, 8, 9, 12, 15, 17, 18, 21, 22, 24, 27, 29, 32, 34, 37, 40, 41, 44, 46, 49, 52, 54, 57, 58, 59, 60, and 63.

Applying a voltage to NC pins does not cause any problem since they are not connected inside the IC.

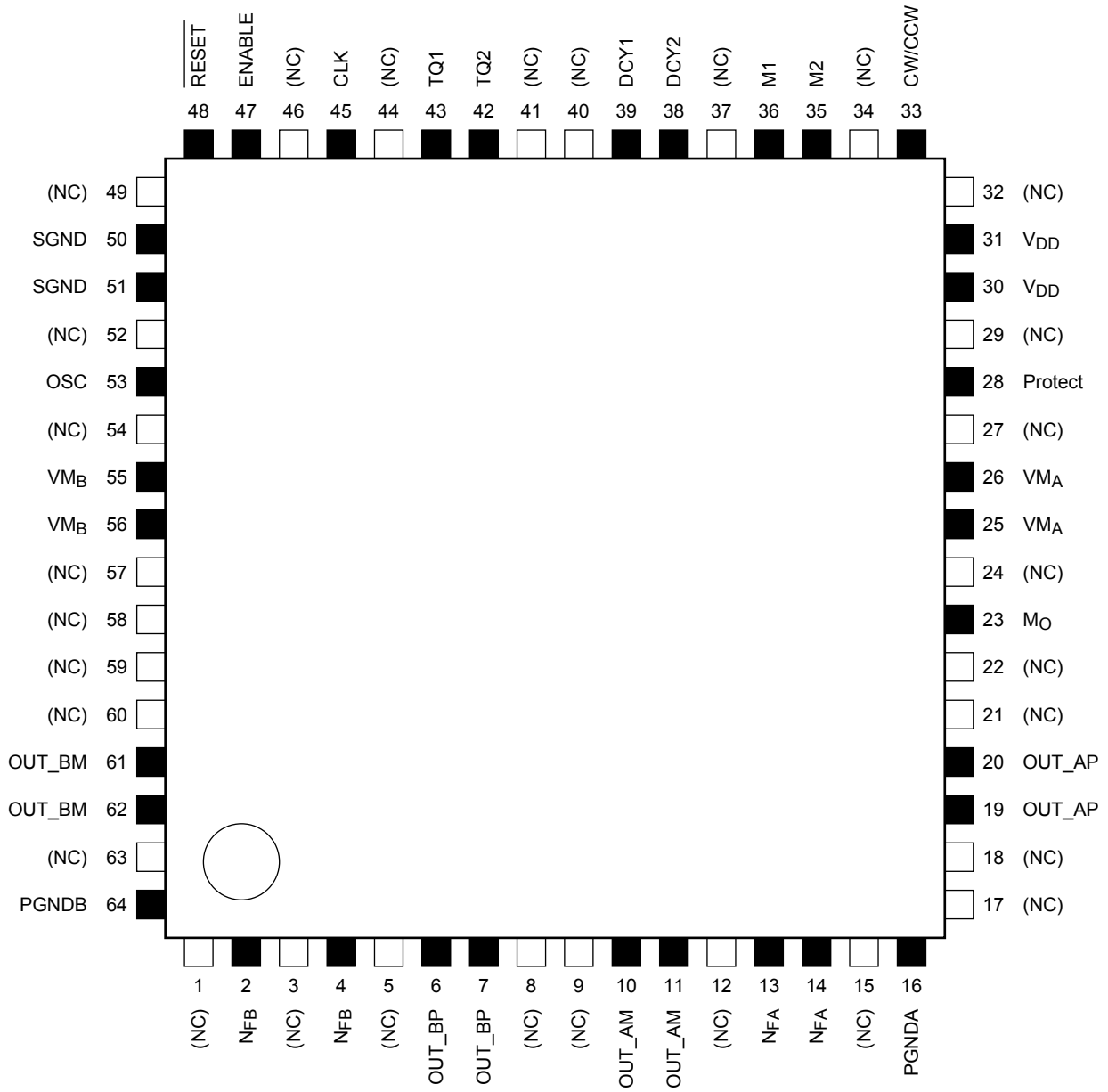
All control input pins have an internal pull-down resistor of 100 k Ω (typ.)

Note 1: As for the TB6560AFG, two pins that have the same functionality should be short-circuited at a location as close to the TB6560AFG as possible.

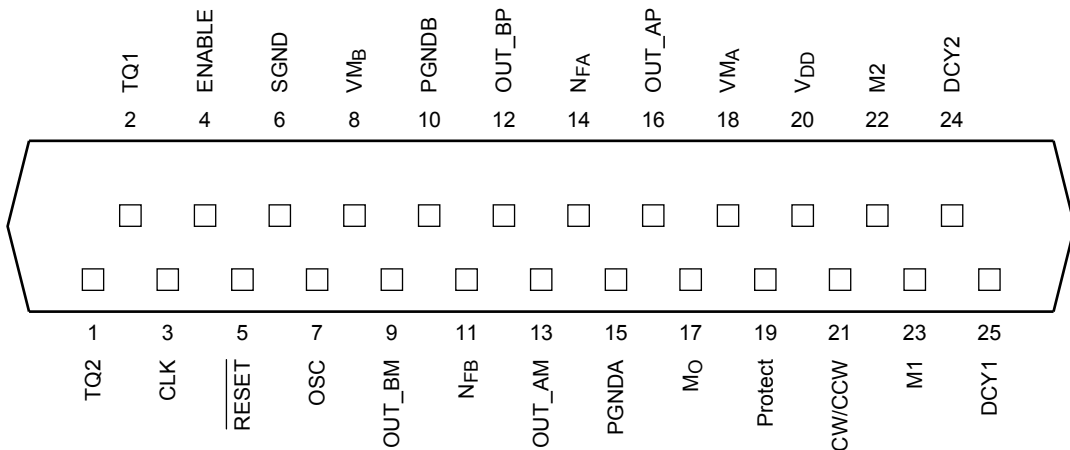
(The electrical characteristics provided in this document are measured when those pins are handled in this manner.)

Pin Assignment (top view)

TB6560AFG



TB6560AHQ



Absolute Maximum Ratings ($T_a = 25^\circ\text{C}$)

Characteristics		Symbol	Rating	Unit	
Power supply voltage		V_{DD}	6	V	
		$V_{M(A/B)}$	40		
Output current (per phase)	Peak	I_O (PEAK)	TB6560AHQ	3.5	A
			TB6560AFG	2.5	
M _O drain current		$I_{(M_O)}$	1	mA	
Protect drain current		$I_{(Protect)}$	1	mA	
Input voltage		V_{IN}	V_{DD}	V	
Power dissipation	TB6560AHQ	P_D	5 (Note 1)	W	
			43 (Note 2)		
	TB6560AFG		1.7 (Note 3)		
	4.2 (Note 4)				
Operating temperature		T_{opr}	-30 to 85	$^\circ\text{C}$	
Storage temperature		T_{stg}	-55 to 150	$^\circ\text{C}$	

Note 1: $T_a = 25^\circ\text{C}$, without heatsink.

Note 2: $T_a = 25^\circ\text{C}$, with infinite heatsink (HZIP25).

Note 3: $T_a = 25^\circ\text{C}$, with soldered leads.

Note 4: $T_a = 25^\circ\text{C}$, when mounted on a board (4-layer board).

Operating Range ($T_a = -30$ to 85°C)

Characteristics		Symbol	Test Condition	Min	Typ.	Max	Unit
Power supply voltage		V_{DD}	—	4.5	5.0	5.5	V
		$V_{M(A/B)}$	$V_{M(A/B)} \geq V_{DD}$	4.5	—	34	V
Output current	TB6560AHQ	I_{OUT}	—	—	—	3	A
	TB6560AFG		—	—	—	1.5	
Input voltage		V_{IN}	—	0	—	5.5	V
Clock frequency		f_{CLK}	—	—	—	15	kHz
OSC frequency		f_{OSC}	—	—	—	600	kHz

Electrical Characteristics (T_a = 25°C, V_{DD} = 5 V, V_M = 24 V)

Characteristics		Symbol	Test Condition	Min	Typ.	Max	Unit
Input voltage	High	V _{IN (H)}	M1, M2, CW/CCW, CLK, RESET, ENABLE, DCY1, DCY2, TQ1, TQ2	2.0	—	V _{DD}	V
	Low	V _{IN (L)}		-0.2	—	0.8	
Input hysteresis voltage	(Note)	V _{INhys}		—	400	—	mV
Input current		I _{IN (H)}	M1, M2, CW/CCW, CLK, RESET, ENABLE, DCY1, DCY2, TQ1, TQ2 V _{IN} = 5.0 V Internal pull-down resistor	30	55	80	μA
		I _{IN (L)}	V _{IN} = 0 V	—	—	1	
V _{DD} supply current		I _{DD1}	Outputs: Open, RESET : H, ENABLE: H (2, 1-2 phase excitation)	—	3	5	mA
		I _{DD2}	Outputs: Open, RESET : H, ENABLE: H (4W1-2, 2W1-2 phase excitation)	—	3	5	
		I _{DD3}	RESET : L, ENABLE: L	—	2	5	
		I _{DD4}	RESET : H, ENABLE: L	—	2	5	
V _M supply current		I _{M1}	RESET : H/L, ENABLE: L	—	0.5	1	mA
		I _{M2}	RESET : H/L, ENABLE: H	—	0.7	2	
Channel-to-channel voltage differential		ΔV _O	B/A, C _{OSC} = 330 μF	-5	—	5	%
V _{NF} voltage change according to the torque settings		V _{NFHH}	TQ1 = H, TQ2 = H	10	20	30	%
		V _{NFHL}	TQ1 = L, TQ2 = H	45	50	55	
		V _{NFLH}	TQ1 = H, TQ2 = L	70	75	80	
		V _{NFLL}	TQ1 = L, TQ2 = L	—	—	100	
Minimum clock pulse width		t _{W (CLK)}	C _{OSC} = 330 pF	30	—	—	μs
M _O output residual voltage		V _{OL M_O}	I _{OL} = 1 mA	—	—	0.5	V
Protect output rest voltage (Note)		V _{OL Protect}	I _{OL} = 1 mA	—	—	0.5	V
TSD threshold	(Note)	TSD	—	—	170	—	°C
TSD hysteresis	(Note)	TSDhys	—	—	20	—	°C
Oscillating frequency		f _{OSC}	C _{OSC} = 330 pF	60	130	200	kHz

Note: Not tested in production

Electrical Characteristics (T_a = 25°C, V_{DD} = 5 V, V_M = 24 V)

Characteristics			Symbol	Test Condition	Min	Typ.	Max	Unit		
Output ON-resistance		TB6560AHQ	R _{on U1H}	I _{OUT} = 1.5 A	—	0.3	0.4	Ω		
			R _{on L1H}		—	0.3	0.4			
		TB6560AFG	R _{on U1F}	I _{OUT} = 1.5 A	—	0.35	0.5			
			R _{on L1F}		—	0.35	0.5			
A-/B-phase chopping current (Note 1)	4W1-2-phase excitation	2W1-2-phase excitation	1-2-phase excitation	Vector	TQ1 = L, TQ2 = L	θ = 0	—	100	—	%
		—	—			θ = 1/16	—	100	—	
		2W1-2-phase excitation	—			θ = 2/16	93	98	100	
		—	—			θ = 3/16	91	96	100	
		2W1-2-phase excitation	—			θ = 4/16	87	92	97	
		—	—			θ = 5/16	83	88	93	
		2W1-2-phase excitation	—			θ = 6/16	78	83	88	
		—	—			θ = 7/16	72	77	82	
		2W1-2-phase excitation	1-2-phase excitation			θ = 8/16	66	71	76	
		—	—			θ = 9/16	58	63	68	
		2W1-2-phase excitation	—			θ = 10/16	51	56	61	
		—	—			θ = 11/16	42	47	52	
		2W1-2-phase excitation	—			θ = 12/16	33	38	43	
		—	—			θ = 13/16	24	29	34	
		2W1-2-phase excitation	—			θ = 14/16	15	20	25	
		—	—			θ = 15/16	5	10	15	
	2-phase excitation		—	—	—	100	—			
Reference voltage			V _{NF}	TQ1, TQ2 = L (100 %) OSC = 100 kHz	450	500	550	mV		
Output transistor switching characteristics (Note 2)			t _r	R _L = 10 Ω, V _{NF} = 0.5 V	—	1	—	μs		
			t _f		—	1	—			
Delay time (Note 2)			t _{pLH}	RESET _̄ to output	—	1	—	μs		
			t _{pLH}	ENABLE to output	—	3	—			
			t _{pHL}	—	—	2	—			
Output leakage current		Upper side	I _{LH}	V _M = 40 V	—	—	1	μA		
		Lower side	I _{LL}		—	—	1			

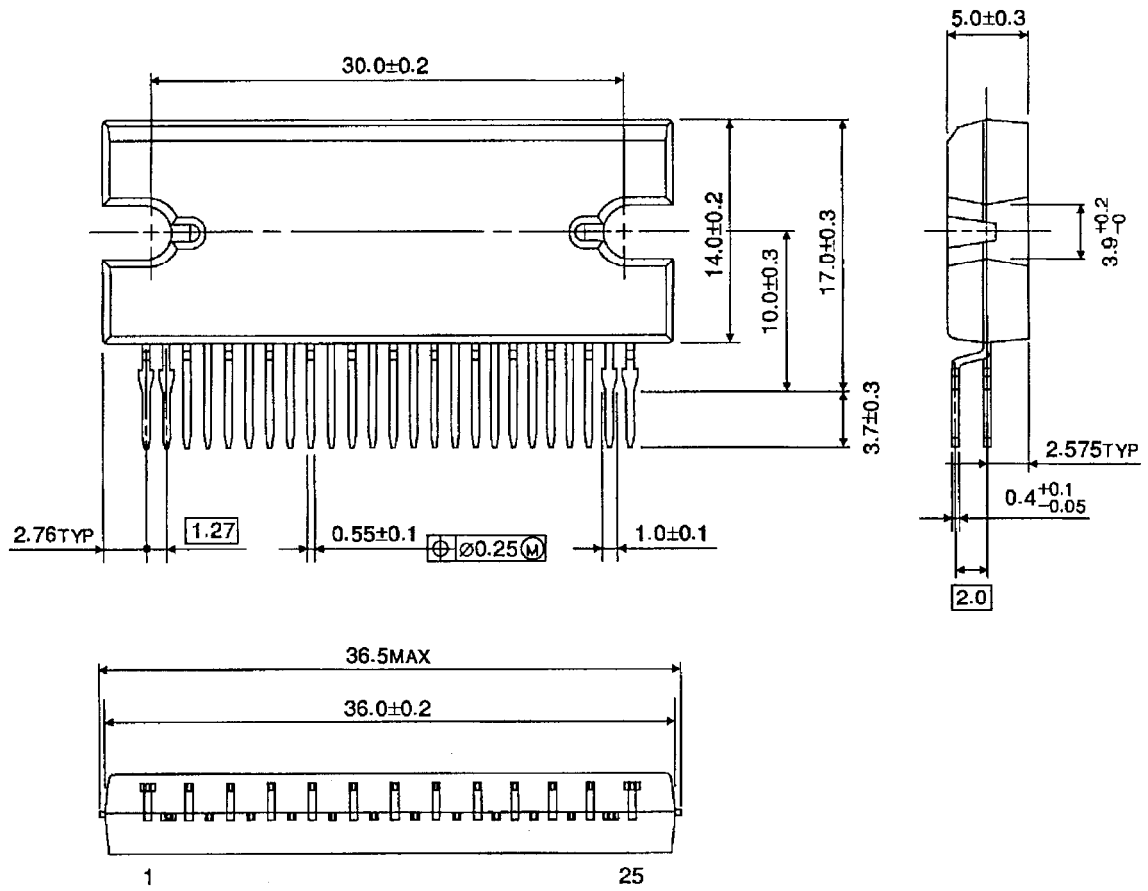
Note 1: Relative to the peak current at θ = 0.

Note 2: Not tested in production.

Package Dimensions

HZIP25-P-1.27

Unit : mm



Weight: 9.86 g (typ.)