TMI8263 Dual H-Bridge Motor Driver

FEATURES

- 8-V to 45-V Operating Supply Voltage Range
- 2.5-A Maximum Drive Current at 24 V and T_A = 25℃
- Dual H-Bridge Motor Driver
  - – Single and Dual Brushed DC
  - – Stepper
- Multiple Decay Modes
  - – Mixed Decay
  - – Slow Decay
  - – Fast Decay
- Low Current Sleep Mode
  Built-In 3.3-V Reference Output
- Protection Features
  - – Overcurrent Protection (OCP)
  - – Thermal Shutdown (TSD)
  - – VM Undervoltage Lockout (UVLO)
  - – Fault Condition Indication Pin (nFAULT)
- Small Packages
  - HTSSOP28

GENERAL DESCRIPTION

The TMI8263 provides an integrated motor driver solution for printers, scanners, and other automated equipment applications. The device has two H-bridge drivers, and can drive a bipolar stepper motor or two brushed DC motors. The output driver block consists of N-channel power MOSFETs configured as H-bridges .

A simple PWM interface allows easy interfacing to controller circuits. The TMI8263 is capable of driving up to 2.5-A peak output current per H-bridge.

A low-power sleep mode is provided to achieve ultra- low quiescent current draw by shutting down most of the internal circuitry.

Internal protection features are provided for over current, undervoltage and over temperature. Fault conditions are indicated on nFAULT.

The TMI8263 which comply with ROHS specifications, and the lead frame is 100% lead-free.

APPLICATIONS

- Office Automatic Machines
- Printers and Scanners
- Robotics
- Gaming Machines
- Factory Automation

TYPICAL APPILCATION

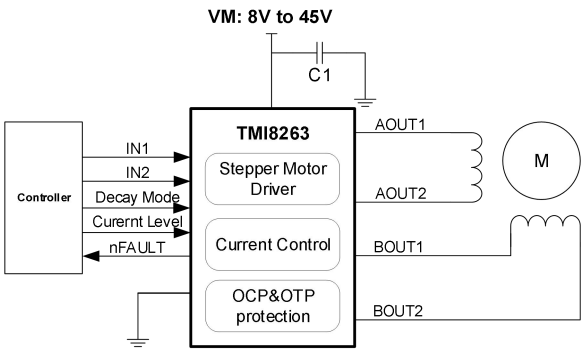


Figure 1. Basic Application Circuit

ABSOLUTE MAXIMUM RATINGS (Note 1)

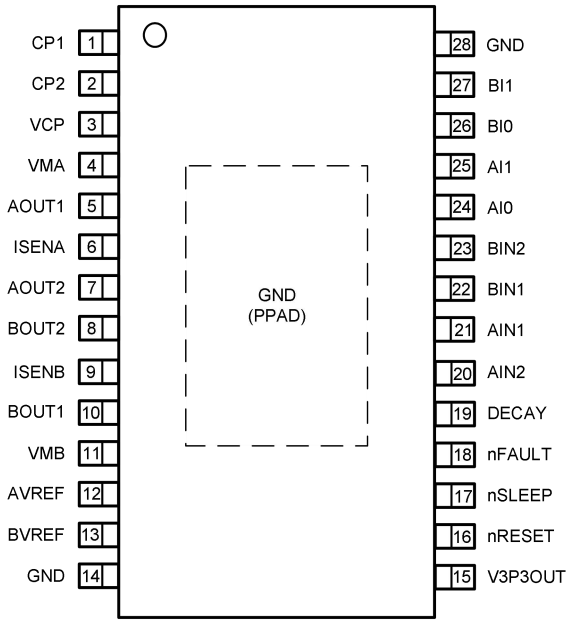
Parameter	Min	Max	Unit
Power supply voltage (VM)	-0.3	48	V
Power supply ramp rate (VMx)		1	V/μs
Digital pin voltage	-0.3	7	V
Reference input pin voltage (VREF)	-0.3	4	V
Continuous motor drive output current	0	2.5	A
Operating ambient temperature, T_A	-40	85	°C
Operating virtual junction temperature, T_J (Note 2)	-40	150	°C
Storage temperature T_{stg}	-60	150	°C

ESD RATING

Items	Description	Value	Unit
V_{ESD}	Human body model	±2000	V
	Charged device model (CDM)	±750	V

JEDEC specification JS-001

PACKAGE/ORDER INFORMATION



HTSSOP28(Top view)

TMI8263/XXXXX (TMI8263: Device Code, XXXXX: Inside Code) for TMI8263

Part Number	Package	Top mark	Quantity/ Reel
TMI8263	HTSSOP28	TMI8263 XXXXX	4500

The TMI8263 device is Pb-free and RoHS compliant.

PIN FUNCTIONS

PIN			Function
Number	Name	I/O(1)	
14、28	GND	-	Device ground.
4	VMA	-	Bridge A power supply. Connect a 0.1μF bypass capacitor to ground, as well as a sufficient bulk capacitance rated for VM.
11	VMB	-	Bridge B power supply. Connect a 0.1μF bypass capacitor to ground, as well as a sufficient bulk capacitance rated for VM.
15	V3P3OUT	O	3.3V regulator output. Bypass to GND with a 0.47-μF 6.3-V ceramic capacitor.
1	CP1	IO	Charge pump flying capacitor. Connect a 0.01-μF 50-V capacitor between CP2 2 CP1 and CP2.
2	CP2	IO	
3	VCP	IO	High-side gate drive voltage. Connect a 0.1μF ceramic capacitor and 1-MΩ resistor to VM.
21	AIN1	I	Bridge A input 1. Logic input controls state of AOUT1. Internal pulldown.
20	AIN2	I	Bridge A input 2. Logic input controls state of AOUT2. Internal pulldown.
24	AI0	I	Bridge A current set. Sets bridge A current: 00 = 100%, 01 = 71%, 10 = 38%, 11 = 0. Internal pulldown.
25	AI1	I	
22	BIN1	I	Bridge B input 1. Logic input controls state of BOUT1. Internal pulldown.
23	BIN2	I	Bridge B input 2. Logic input controls state of BOUT2. Internal pulldown.
26	BI0	I	Bridge B current set. Sets bridge B current: 00 = 100%, 01 = 71%, 10 = 38%, 11 = 0. Internal pulldown.
27	BI1	I	
19	DECAY	I	Decay mode. Low = slow decay, open = mixed decay, high = fast decay. Internal pulldown and pullup.
16	nRESET	I	Reset input. Active-low reset input initializes internal logic and disables the H-bridge outputs. Internal pulldown.
17	nSLEEP	I	Sleep mode input. Logic high to enable device, logic low to enter low-power sleep mode. Internal pulldown.
12	AVREF	I	Bridge A current set reference input.
13	BVREF	I	Bridge B current set reference input.
18	nFAULT	OD	Fault. Logic low when in fault condition (overtemperature, overcurrent).
5	AOUT1	O	Bridge A output 1.
7	AOUT2	O	Bridge A output 2.
10	BOUT1	O	Bridge B output 1.

PIN FUNCTIONS(Continued)

PIN			Function
Number	Name	I/O(1)	
8	BOUT2	O	Bridge B output 2.
6	ISENA	IO	Bridge A ground / Isense. Connect to current sense resistor for bridge A.
9	ISENB	IO	Bridge B ground / Isense. Connect to current sense resistor for bridge B.

(1) Directions: I = input, O = output, OZ = tri-state output, OD = open-drain output, IO = input/output

RECOMMENDED OPERATING CONDITIONS

Items	Description	Min	Max	Unit
VM	Power supply voltage range	8.0	45	V
VREF	VREF input voltage	1	3.5	V
IV3P3	V3P3OUT load current		10	mA
f_{PWM}	Externally applied PWM frequency	0	100	kHz

(1) All VM pins must be connected to the same supply voltage.

(2) Operational at VREF between 0V and 1V, but accuracy is degraded.

ELECTRICAL CHARACTERISTICS

T_A = 25°C, over recommended operating conditions (unless otherwise noted)

PARAMETER	SYMBOL	TEST CONDITIONS	MIN	TYP	MAX	UNIT
POWER SUPPLY						
VM operating supply current	I_{VM}	VM = 24 V, f_{PWM} < 50 kHz		3	5	mA
VM sleep mode supply current	I_{VMQ}	VM = 24V		1	10	µA
VM undervoltage lockout voltage	V_{UVLO}	VM rising		6	8	V
V3P3OUT voltage	V_{3P3}	IOUT = 0 to 1 mA, VM = 24 V, T_J = 25°C	3.18	3.30	3.40	V
		IOUT = 0 to 1 mA	3.10	3.30	3.50	V
	$V_{3P3UVLO}$			2		V
LOGIC-LEVEL INPUTS						
Input low voltage	V_{IL}			0.7	0.8	V
Input high voltage	V_{IH}		1.8		5.25	V
Input hysteresis	V_{HYS}			0.45		V
Input low current	I_{IL}	VIN = 0V	–20		20	µA
Input high current	I_{IH}	VIN = 3.3V		35	50	µA
Pulldown resistance	R_{PD}			100		kΩ
nFAULT OUTPUT (OPEN-DRAIN OUTPUT)						
output low voltage	V_{OL}	I_O = 5 mA			0.5	V
output high leakage current	I_{OH}	V_O = 3.3 V			1	µA
DECAY INPUT						
Input low threshold voltage	V_{IL}	For slow decay mode	0		1.0	V
Input high threshold voltage	V_{IH}	For fast decay mode	2.0			V
Input current		Decay = 5V			±45	µA
Pullup resistance	R_{PU}			130		kΩ
Pulldown resistance	R_{PD}			80		kΩ
H-BRIDGE FETS						
HS FET on resistance	$R_{DS(ON)}$	VM = 24 V, I_O = 1 A		0.2		Ω
LS FET on resistance	$R_{DS(ON)}$	VM = 24 V, I_O = 1 A		0.2		Ω
Off-state leakage current	I_{OFF}		-5		5	µA
MOTOR DRIVER						
Internal PWM frequency	f_{PWM}			40		kHz
Current sense blanking time	t_{BLANK}			3.75		µs
Rise time	t_R	VM = 24 V	30		200	ns
Fall time	t_F	VM = 24 V	30		200	ns
Dead time	t_{DEAD}			20		ns
Input deglitch time	t_{DEG}		1.7		2.5	µs

ELECTRICAL CHARACTERISTICS (Continued)

T_A = 25°C, over recommended operating conditions (unless otherwise noted)

PARAMETER	SYMBOL	TEST CONDITIONS	MIN	TYP	MAX	UNIT
CURRENT CONTROL						
xVREF input current	I_{REF}	xVREF = 3.3 V	-3		3	μA
xISENSE trip voltage	V_{TRIP}	xVREF = 3.3 V, I_{SENSE}=0.5Ω, 100% current setting	630	660	680	mV
		xVREF = 3.3 V, I_{SENSE}=0.5Ω, 71% current setting	445	468	480	mV
		xVREF = 3.3 V, I_{SENSE}=0.5Ω, 38% current setting	230	251	265	mV
Current sense amplifier gain	A_{ISENSE}	Reference only		5		V/V
PROTECTION CIRCUITS						
Overcurrent protection trip level	I_{OCP}			4.5		A
Thermal shutdown temperature	$T_{SD\ (Note3)}$		150	170	180	°C

Note 1: Absolute Maximum Ratings are those values beyond which the life of a device may be impaired.

Note 2: T_J is calculated from the ambient temperature T_A and power dissipation P_D according to the following formula: $T_J = T_A + P_D \times \theta_{JA}$. The maximum allowable continuous power dissipation at any ambient temperature is calculated by $P_{D\ (MAX)} = (T_{J(MAX)}-T_A)/\theta_{JA}$.

Note 3: Thermal shutdown threshold and hysteresis are guaranteed by design.

OPERATION

Overview

The TMI8263 is an integrated motor driver solution for a bipolar stepper motor or two brushed DC motors. The device integrates two NMOS H-bridges, current sense, regulation circuitry, and detailed fault detection. The TMI8263 can be powered with a supply voltage between 8 V and 45 V and is capable of providing an output current up to 2.5A full-scale.

A PWM interface allows for easy interfacing to the controller circuit. The winding current control allows the external controller to adjust the regulated current that is provided to the motor. The current regulation is highly configurable, with three decay modes of operation. Fast, slow, and mixed decay can be selected depending on the application requirements. A low-power sleep mode is included which allows the system to save power when not driving the motor.

A variety of integrated protection features protect the device in the case of a system fault. These include undervoltage lockout (UVLO), charge pump undervoltage (CPUV), overcurrent protection (OCP), and overtemperature shutdown (TSD). Fault conditions are indicated on the nFAULT pin.

Control Modes

The AIN1 and AIN2 input pins directly control the state of the AOUT1 and AOUT2 outputs; similarly, the BIN1 and BIN2 input pins directly control the state of the BOUT1 and BOUT2 outputs. The logic is shown in Table 1.

Table 1. H-Bridge Control Logic

xIN1	xIN2	xOUT1	xOUT2
0	0	L	L
0	1	L	H
1	0	H	L
1	1	H	H

The control inputs have internal pulldown resistors of approximately 100 kΩ.

Current Regulation

In TMI8263, motor peak current can be limited by the analog reference input VREF and the resistance of external sense resistor on the SENSEx pin approximately according to the below equation:

$$I_{CHOP}\ (A)=\frac{V_{REF}\ (V)}{A_V \times R_{ISEN}(\Omega)}=\frac{V_{REF}\ (V)}{5 \times R_{ISEN}(\Omega)}$$

For example:

If VREF = 3.3 V and a R_{ISEN} = 0.5 Ω, the TMI8263 full-scale (100%) chopping current will be 1.32A; The two input pins (xI1 and xI0) of each H-bridge are set high and low signals; the current in each bridge is scaled to the corresponding percentage of the full-scale current set by the VREF input pin and the sense resistor. The function of the pin is shown in Table 2.

Table 2. H-Bridge xI0,xI1 Pin Functions

xI1	xI0	RELATIVE CURRENT (% FULL-SCALE CHOPPING CURRENT)
1	1	0%
1	0	38%
0	1	71%
0	0	100%

For example:

If VREF = 3.3 V and a R_{ISEN} = 0.5 Ω, When the current is set to 100% (xI1, xI0 = 00), the chopping current will be 1.32 A; When the current is set to 71% (xI1, xI0 = 01), the chopping current will be1.32 A x 71% =0.937A; andWhen the current is set to 38% (xI1, xI0 = 10), the chopping current will be1.32 A x 38% =0.502A; If (xI1, xI0 = 11) the bridge will be disabled and no current will flow.

Decay Mode

During PWM current chopping, the H-bridge is enabled to drive current through the motor winding until the PWM current chopping threshold is reached. This is shown in Figure 2 as case 1. The current flow direction shown indicates the state when the xENBL pin is high.

Once the chopping current threshold is reached, the H-bridge can operate in two different states, fast decay or slow decay.

In fast decay mode, once the PWM chopping current level has been reached, the H-bridge reverses state to allow winding current to flow in a reverse direction. As the winding current approaches zero, the bridge isdisabled to prevent any reverse current flow. Fast decay mode is shown in Figure 2 as case 2.

In slow decay mode, winding current is re-circulated by enabling both of the low-side FETs in the bridge. This is shown in Figure 2 as case 3.

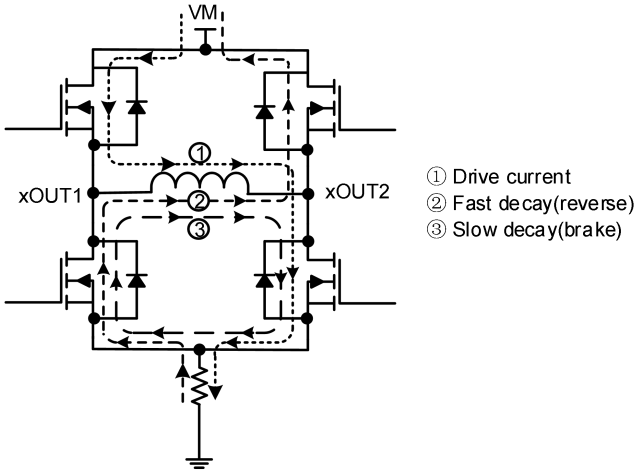


Figure 2. Decay Mode

The TMI8263 supports fast decay, slow decay and a mixed decay mode. Slow, fast, or mixed decay mode is selected by the state of the DECAY pin - logic low selects slow decay, open selects mixed decay operation, and logic high sets fast decay mode. Note that the DECAY pin sets the decay mode for both H-bridges.

Mixed decay mode begins as fast decay, but at a fixed period of time (75% of the PWM cycle) switches to slow decay mode for the remainder of the fixed PWM period.

VM Undervoltage Lockout (UVLO)

If at any time the voltage on the VM pin falls below the undervoltage-lockout threshold voltage, all FETs in the H-bridge will be disabled. Operation resumes when VM rises above the UVLO threshold.

Overcurrent Protection (OCP)

An analog current limit circuit on each FET limits the current through the FET by removing the gate drive. If this analog current limit persists for longer than the OCP time, all FETs in the H-bridge will be disabled and the nFAULT pin will be driven low. The device will remain disabled until either nRESET pin is applied, or VM is removed and reapplied.

Overcurrent conditions on both high and low side devices; that is, a short to ground, supply, or across the motor winding will all result in an overcurrent shutdown. Note that overcurrent protection does not use the current sense circuitry used for PWM current control, and is independent of the I_{SENSE} resistor value or VREF voltage.

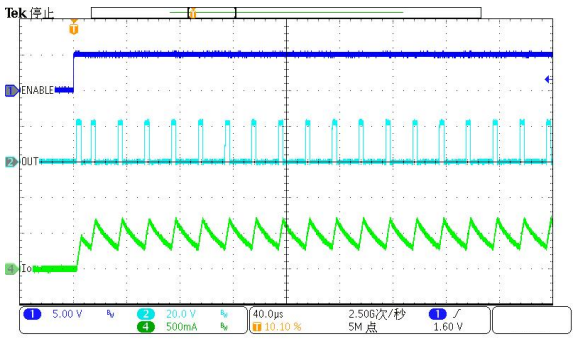
Thermal Shutdown (TSD)

If the die temperature exceeds safe limits, all FETs in the H-bridge are disabled. After the die temperature has fallen to a safe level, operation automatically resumes.

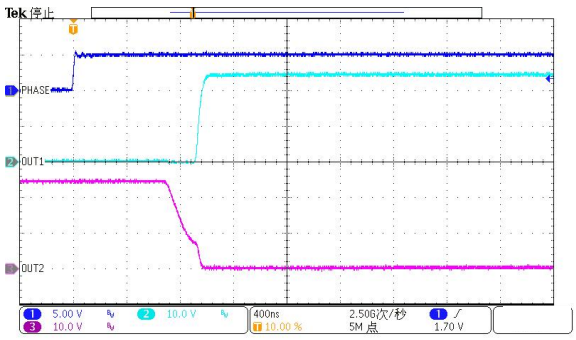
VM Control

In some systems, varying VM as a means of changing motor speed is desirable.

Application Curves

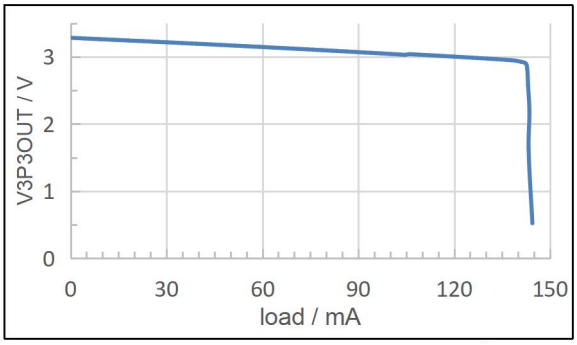


TMI8263 Current Limiting



TMI8263 Direction Change

TMI8263 Drive Stepper Motor



TMI8263 V3P3OUT Load Capacity

APPLICATION INFORMATION

Application information

The TMI8263 can be used to control a bipolar stepper motor. The PWM interface controls the outputs and current control can be implemented with the internal current regulation circuitry. Detailed fault reporting is provided with the internal protection circuits and nFAULT pin.

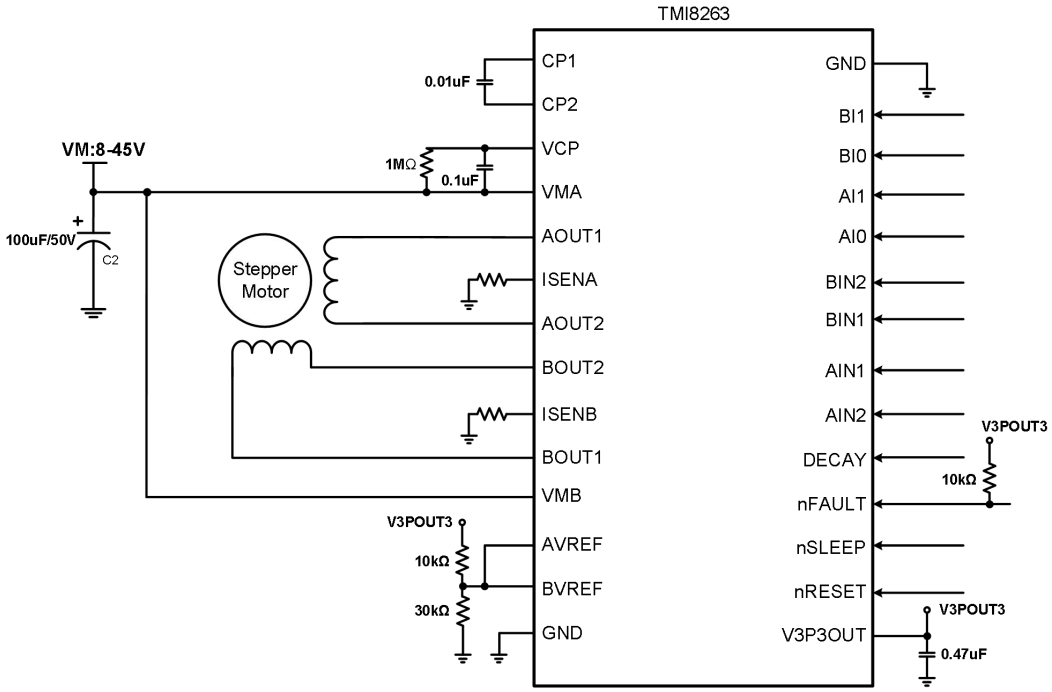


Figure 3. TMI8263 Typical Application

Block Diagram

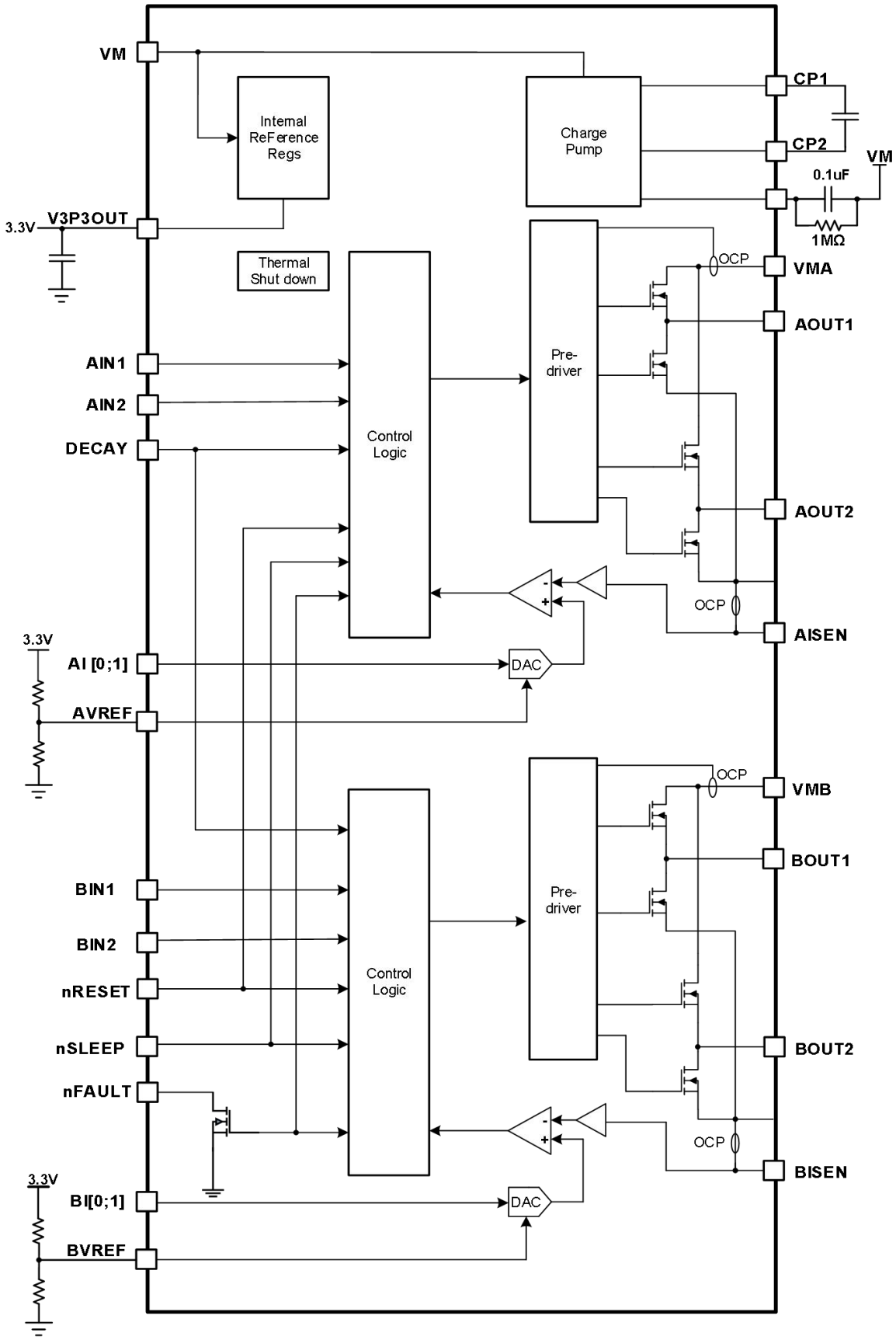
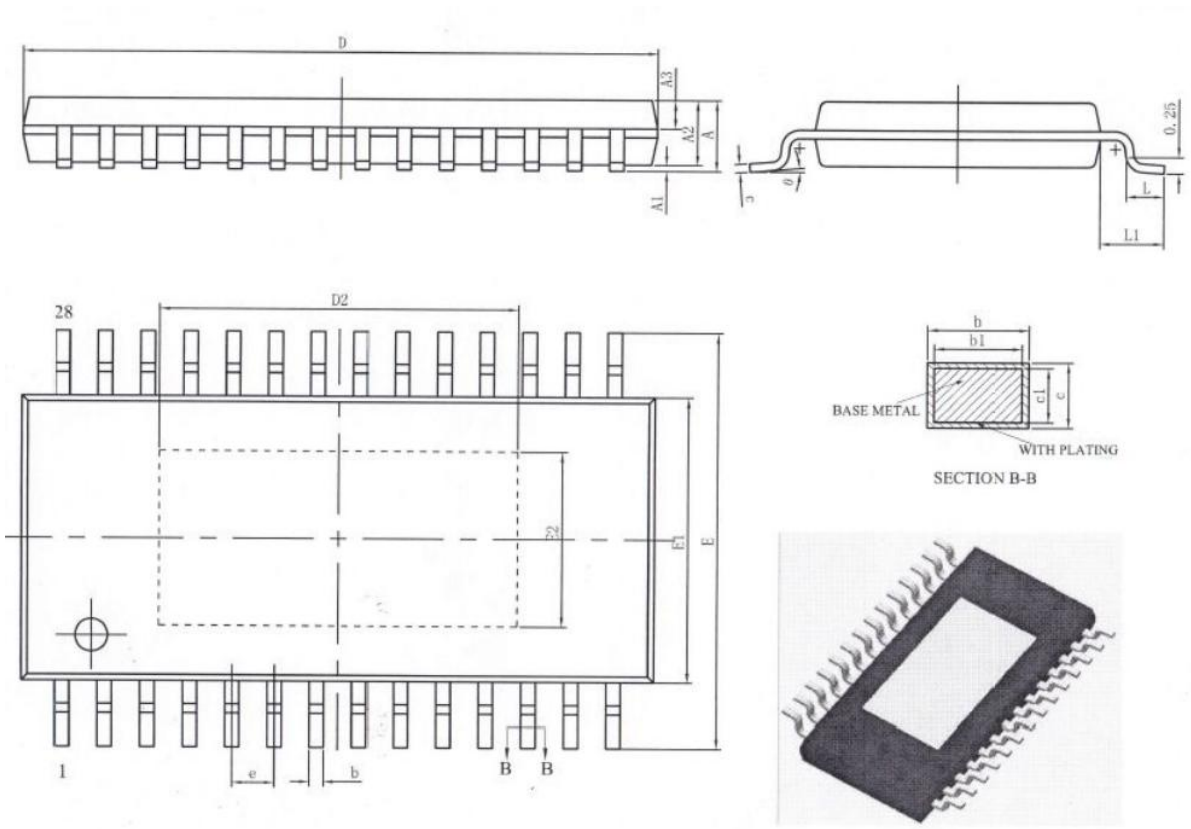


Figure 4. TMI8263 Block Diagram

PACKAGE INFORMATION

HTSSOP28



Unit: mm

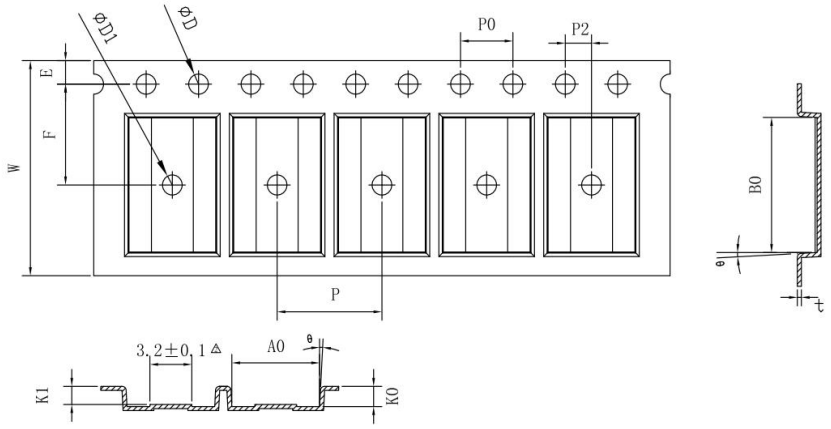
Symbol	Dimensions In Millimeters			Symbol	Dimensions In Millimeters		
	Min	NOM	Max		Min	NOM	Max
A	-	-	1.20	D2	3.95	4.05	4.15
A1	0.05	-	0.15	E	6.20	6.40	6.60
A2	0.80	-	1.00	E1	4.30	4.40	4.50
A2	0.39	0.44	0.49	E2	2.75	2.85	2.95
b	0.20	-	0.29	e	0.65BSC		
b1	0.19	0.22	0.25	L	0.45	0.60	0.75
c	0.13	-	0.18	L1	1.00BSC		
c1	0.12	0.13	0.15	θ	0°	-	8°
D	9.60	9.70	9.80				

Note:

1) All dimensions are in millimeters.
2) Package length does not include mold flash, protrusion or gate burr.
3) Package width does not include inter lead flash or protrusion.
4) Lead popularity (bottom of leads after forming) shall be 0.10 millimeters max.
5) Pin 1 is lower left pin when reading top mark from left to right.

TAPE AND REEL INFORMATION

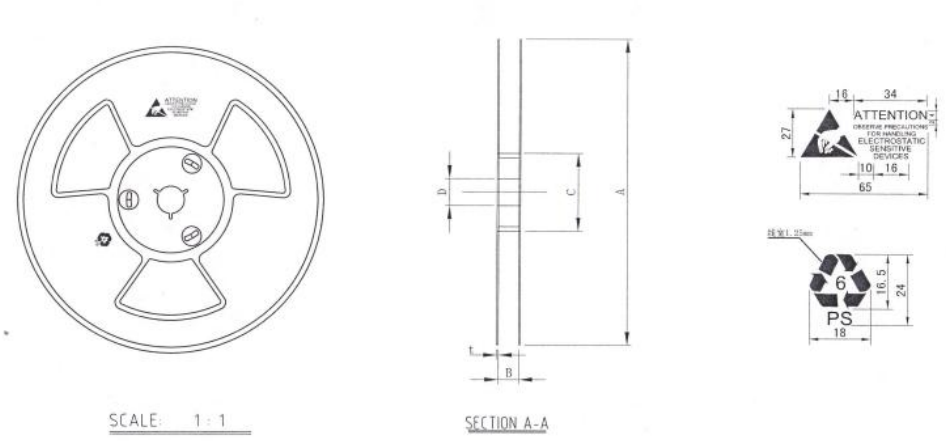
TAPE DIMENSIONS: HTSSOP28



Unit: mm

Symbol	Dimensions	Symbol	Dimensions	Symbol	Dimensions	Symbol	Dimensions
A0	6.70±0.10	θ	5° TYP	E	1.75±0.10	D1	1.55MIN
B0	10.05±0.10	t	0.30±0.05	F	7.50±0.10	P0	0.30±0.10
K0	1.50±0.10	W	16.00±0.30	P2	2.00±0.10	10P0	40.00±0.20
K1	1.35±0.10	P	8.00±0.10	D	1.50±0.10		

REEL DIMENSIONS: HTSSOP28



Unit: mm

Ø A	B	Ø C	Ø D	t
329±1.0	16.8±1.0	100±0.5	13.3±0.3	2.0±0.3

Note:

1) All Dimensions are in Millimeter
2) Quantity of Units per Reel is 4500
3) MSL level is level 3.

Important Notification

This document only provides product information. Xi'an TOLL Microelectronic Inc. (TMI) reserves the right to make corrections, modifications, enhancements, improvements, and other changes to its products and to discontinue any product without notice at any time.

Xi'an TOLL Microelectronic Inc. (TMI) cannot assume responsibility for use of any circuitry other than circuitry entirely embodied in a TMI product. No circuit patent licenses are implied.

http:// www.toll-semi.com