3.6A Brushed DC Motor Driver with Internal Current Sense(PWM Control)

Features

- H-Bridge Motor Driver
  -Drives One DC Motor, One Winding of
  -a Stepper Motor, or Other Loads
- Wide 6.8V to 45V Operating Voltage
- 3.6A Peak Current Drive
- PWM Control Interface
- Integrated Current Regulation
- Low-Power Sleep Mode
- VM Undervoltage Lockout (UVLO)
- Overcurrent Protection (OCP)
- Thermal Shutdown (TSD)
- Automatic Fault Recovery
- SOP-8(EP)Small Package and Footprint

Applications

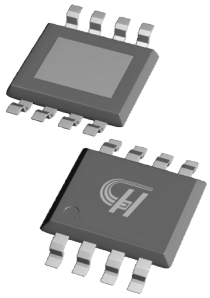
- Printers
- Appliances
- Industrial Equipment
- Other Mechatronics Applications

General Description

The HCR8871 device is the brushed-DC motor drivers for printers, appliances, industrial equipment, and other small machines. Two logic inputs control the H-bridge driver, which consists of four N-channel MOSFETs that can control motors bidirectionally with up to 3.6A peak current. The inputs can be pulse width modulated (PWM)to control motor speed, using a choice of current -decay modes. Setting both inputs slow enter a low -power sleep mode.

The HCR8871 device does not use analog input reference voltage and current sensing resistor to regulate current limitation. TMI8871 use low power RILIM resistor to set current limit. The ability to limit current to a known level can significantly reduce the system power requirements and bulk capacitance needed to maintain stable voltage, especially for motor startup and stall conditions.

The device is fully protected from faults and short circuits, including UVLO, OCP, and TSD.



SOP-8(EP)

Figure 1. Package Type of HCR8871

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Pin Configuration

SOP-8(EP) (Top View)

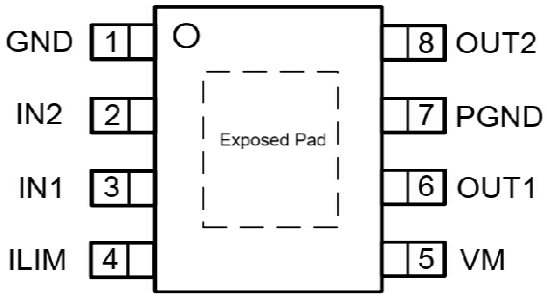
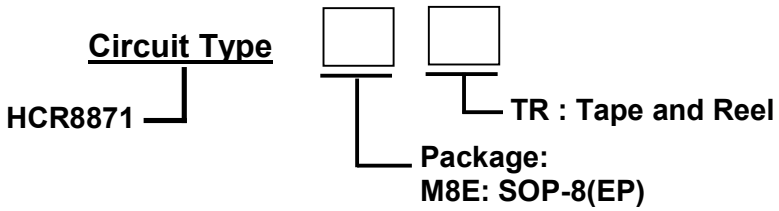


Figure 2. Pin Configuration of HCR8871 (Top View)

Pin Function Table

Name	Pin	Function Description
	SOP-8(EP)	
GND	1	Logic ground. Connect to board ground
IN2	2	Logic inputs. Controls the H-bridge output. Has internal pulldowns.
IN1	3	Logic inputs. Controls the H-bridge output. Has internal pulldowns.
ILIM	4	Current limit setting. Connect a resistor to GND to set the current chopping threshold
VM	5	6.8V to 45V power supply. Connect a 0.1μF bypass capacitor to ground, as well as sufficient bulk capacitance, rated for the VM voltage.
OUT1	6	H-bridge output. Connect directly to the motor or other inductive load.
PGND	7	Connect to PCB Ground.
OUT2	8	H-bridge output. Connect directly to the motor or other inductive load.
	EP	Exposed Pad, Connect to board ground.

Ordering Information



Ordering Code

Part Number	Marking ID note2	Operating Junction Temperature Range	Package	Quantity per Reel
HCR8871M8ETR	HCR8871XX	-40'C to +125'C	SOP-8(EP)	2500pcs/TR

Note 2: the "XX" is lot number code.

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Functional Block Diagram

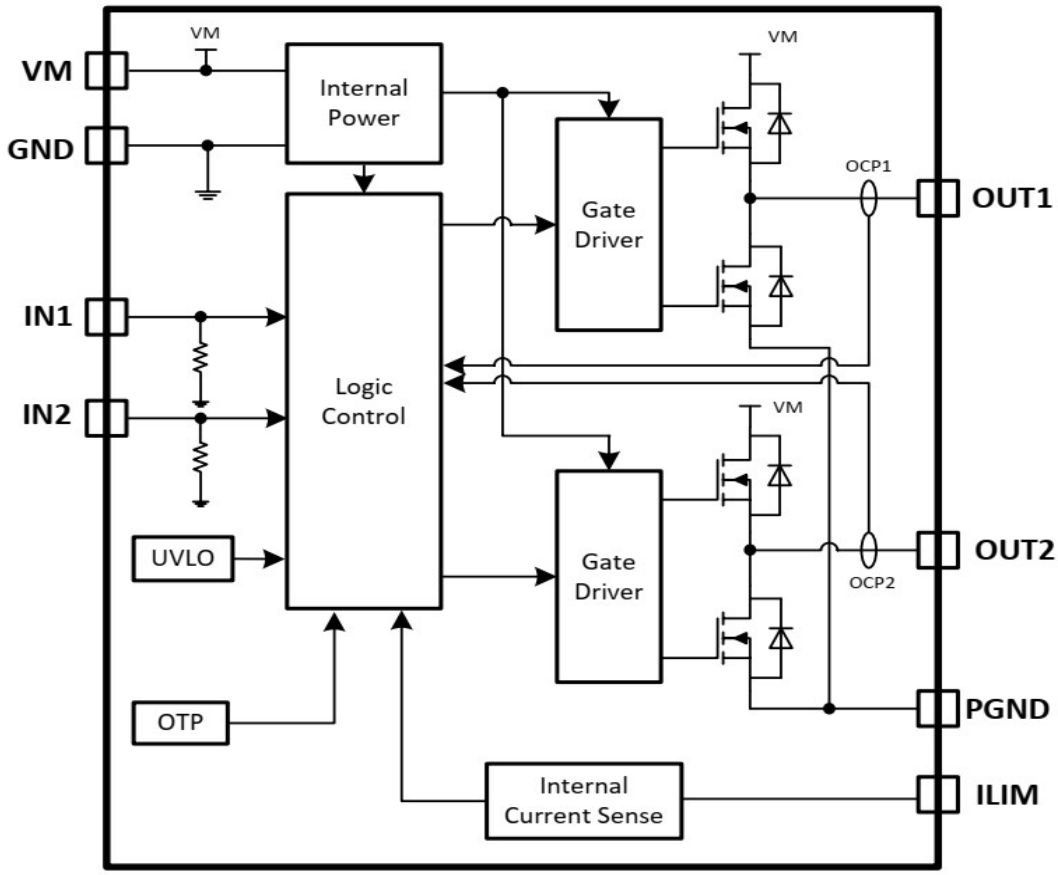


Figure 3. Functional Block Diagram

Typical Application Circuit

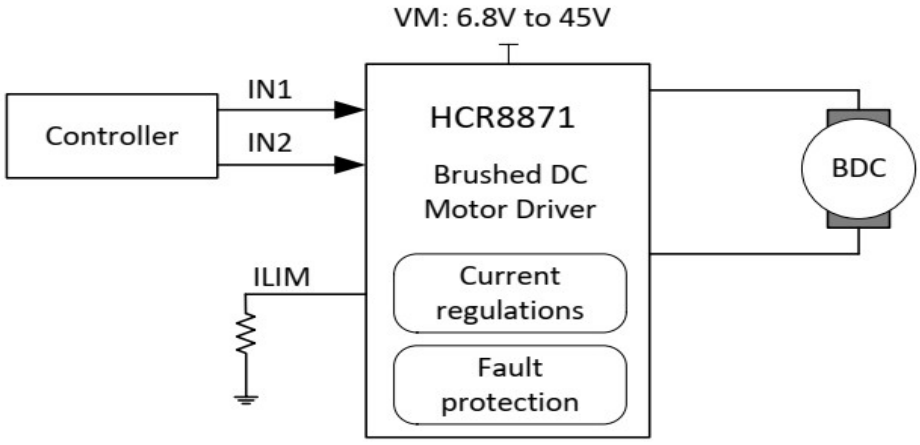


Figure 4. Basic Application Circuit

Absolute Maximum Ratings

Over Operating free-air temperature range (unless otherwise [1/2]

Parameter	Symbol	Value	Unit
Input Supply Voltage Range [3]	VM	-0.3 to +48	V
Logic Input Voltage	IN1, IN2	-0.3 to +6	V
Current Limit set Pin Voltage	ILIM	-0.3 to +6	V
Continuous Phase node Pin Voltage	OUT1, OUT2	-0.7 to (VM+0.7)	V
Output Current (100% duty cycle)	Iout	0 to 3.5	A
Junction-to-ambient thermal resistance [4]	RθJA	41.1	'C/W
Junction-to-case thermal resistance [4]	RθJC	23.1	'C/W
Storage Temperature Range	TSTG	-65 to +150	'C
Operating Junction Temperature [5]	TJ	-40 to +150	'C
Lead Temperature (Soldering, 10s)	TLEAD	260	'C
Human Body Model for all pins	VESD_HBM	±2000	V
Charge Device Model for all pins	VESD_CDM	200	V

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

2: All voltages are with respect to the GND pin.

3: To protect the chip, the VM voltage should not exceed 16V under any operating conditions and the VM VM capacitance should be increased to suppress spikes when using inductive loads.

4: The package thermal impedance is calculated in accordance with JESD-51.

5: TJ is calculated from the ambient temperature TA and power dissipation PD according to the following formula: TJ = TA + PD x θJA. The maximum allowable continuous power dissipation at any ambient temperature is calculated by PD (MAX) = (TJ(MAX)-TA)/θJA.

Recommended Operating Conditions

over operating free-air temperature range (unless otherwise noted) (6).

Parameter	Symbol	Test Condition	Min	Type	Max	Unit
Power supply voltage Range	VM		6.8	-	45	V
Logic Input Voltage(IN1,IN2)	VI		0	-	5.5	V
Logic Input PWM frequency(IN1,IN2)	fPWM		0	-	200	KHz
Peak output current	Ipeak		0	-	3.6	A
Operating Junction Temperature Range	TJ		-40	-	+125	'C

Note 6: Power dissipation and thermal limits must be observed.

Electrical Characteristics

(TA = +25°C, over recommended operating condition unless otherwise noted)

Parameter	Symbol	Test Condition	Min.	Typ.	Max.	Unit
Power Supply (VM)						
VM Operating Voltage	VM		6.8	-	45	V
VM Operating Supply Current	IVM	VM=12V	-	3	10	mA
VM Sleep Mode Supply Current	IVMSLEEP	VM=12V	-	-	10	uA
Turn-on time[note6]	tON	VM>VUVLO with IN1 or IN2 high	-	30	50	us
logic-Level Inputs (IN1, IN2)						
Input Logic-Low Voltage	VIL	-	-	-	0.5	V
Input Logic-High Voltage	VIH	-	1.6	-	-	V
Input Logic hysteresis	VHYS	-	-	0.5	-	V
Input Logic Low Current	IIL	VIN=0V	-1.0	-	1.0	uA
Input Logic High Current	IIH	VIN=3.3V	-	62	-	uA
Pulldown Resistance	RPD	to GND	-	53	-	KΩ
Propagation delay	tPD	Inx to OUTx change	-	0.7	-	us
Time to sleep	tsleep	Inputs low to sleep	-	1	1.5	ms
MOTOR Driver Outputs (OUT1, OUT2)						
High-side FET ON-Resistance	RDS(ON)_High	VM=24V, IOUT=1A	-	430	-	mΩ
Low-side FET ON-Resistance	RDS(ON)_Low	VM=24V, IOUT=1A	-	480	-	mΩ
Output dead time	tDEAD	-	-	220	-	ns
Body diode forward voltage	Vd	IOUT=1A	-	0.9	-	V
Current Regulation						
Constant for Calculating Current regulation	VILIM	IOUT=1A	-	64	-	KV
PWM off-time	tOFF	-	-	25	-	us
PWM blanking time	tBLANK	-	-	2	-	us
Protection Circuits						
VM undervoltage Lockout	VUVLO_fall	WM falls until UVLO triggers	-	6.2	-	V
	VUVLO_rise	WM rises until operation recovers	-	6.5	-	V
VM undervoltage hysteresis	VUV_HYS	Rising to falling threshold	-	240	-	mV
Overcurrent Protection Trip level	IOCP	-	-	4.5	-	A
Overcurrent Deglitch Time	tOCP	-	-	1.8	-	us
Overcurrent Retry Time	tRETRY	-	-	3	-	ms

Electrical Characteristics(con.)

(TA = +25°C, over recommended operating condition unless otherwise noted)

Parameter	Symbol	Test Condition	Min.	Typ.	Max.	Unit
Protection Circuits						
Thermal Shutdown threshold[note7]	TSD		-	150	-	'C
Thermal Shutdown hysteresis[note7]	THYS		-	30	-	'C

Note 6. tON applies when the device initially powers up, and when it exits sleep mode.

7. Thermal shutdown threshold and hysteresis are guaranteed by design.

Typical Characteristics

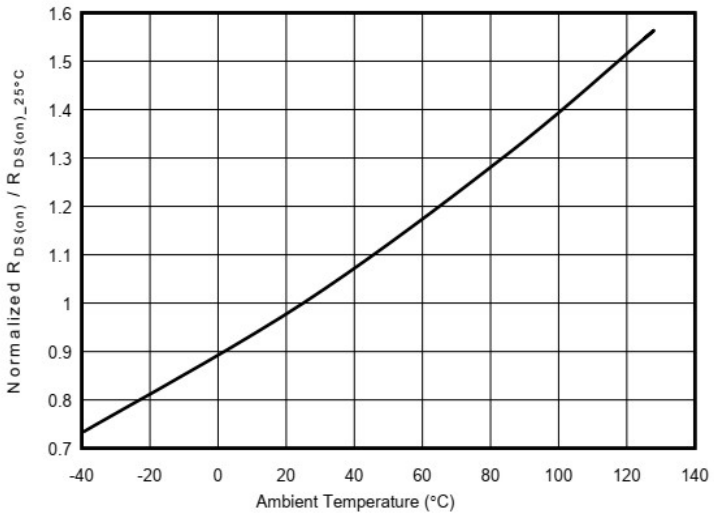


Figure 5. RDS(on) vs temperature

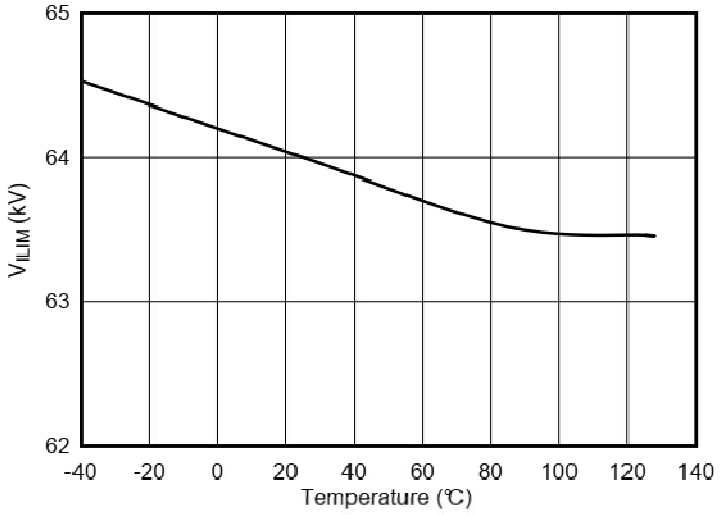


Figure 6. VILIM vs Temperature

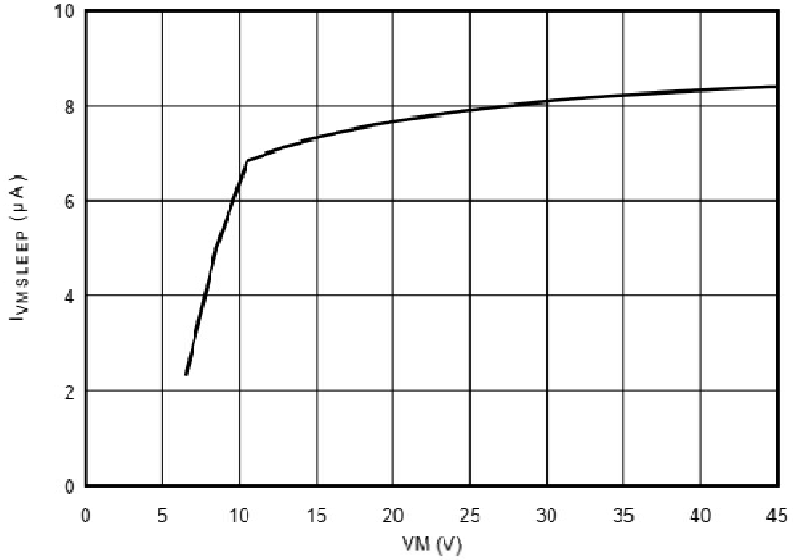


Figure 7. IVMSLEEP vs VM at 25'C

3.6A Brushed DC Motor Driver with Internal Current Sense(PWM Control)

Detailed Deacription

Overview

The HCR8871 devices are optimized 8-pin devices for driving brushed DC motors with 6.8V to 45V and up to 3.6A peak current. The integrated current regulation restricts motor current to a predefined maximum. Two logic inputs control the H-bridge driver, which consists of four N-channel MOSFETs that have a typical $R_{DS(ON)}$ of 0.9Ω (including one high-side and one low-side FET). A single-power input, VM, serves as both device power and the motor winding bias voltage. The integrated charge pump of the device boosts VM internally and fully enhances the high-side FETs. Motor speed can be controlled with pulse-width modulation, at frequencies between 0 to 100kHz. The devices have an integrated sleep mode that is entered by bringing both inputs low. An assortment of protection features prevents the device from being damaged if a system fault occurs.

Feature Description

Bridge Control

The HCR8871 output consists of four N-channel MOSFETs that are designed to drive high current. These outputs are controlled by the two logic inputs IN1 and IN2 as listed in Table 1.

The inputs can be set to static voltages for 100% duty cycle drive, or they can be pulse-width modulated (PWM) for variable motor speed. When using PWM, switching between driving and braking

Bridge Control(con.)

typically works best. For example, to drive a motor forward with 50% of the maximum RPM, IN1 = 1 and IN2 = 0 during the

driving period, and IN1 = 1 and IN2 = 1 during the other period. Alternatively, the coast mode (IN1 = 0, IN2 = 0) for fast current decay is also available. The input pins can be powered before VM is applied.

Table 1. H-Brifge Control

IN1	IN2	OUT1	OUT2	Description
0	0	High-Z	High-Z	Coast; H-bridge disabled to High-Z(sleep entered after 1 ms)
0	1	L	H	Reverse (Current OUT2 -> OUT1)
1	0	H	L	Forward (Current OUT1 -> OUT2)
1	1	L	L	Brake; low-side slow decay

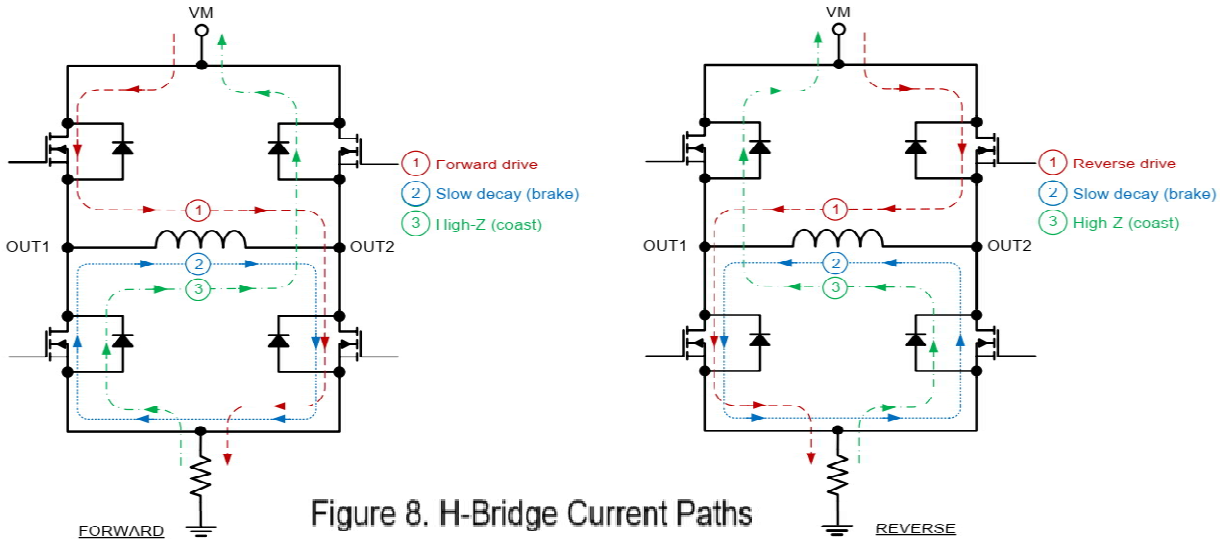


Figure 8. H-Bridge Current Paths

Feature Description(con.)

Sleep Mode

When the IN1 and IN2 pins are both low for time t_{SLEEP} (typically 1 ms), the HCR8871 device enters a low power sleep mode, where the outputs remain High-Z and the device uses IVMSLEEP (μA) of current. If the device is powered up while both inputs are low, it immediately enters sleep mode. After the IN1 or IN2 pins are high for at least 5 μs, the device is operational 50 μs (tON) later.

Current Regulation

In HCR8871, motor peak current can be limited by the resistor attached on the ILIM pin and GND according to the below equation:

$$I_{TRIP}\ (A) = \frac{V_{ILIM}\ (kV)}{R_{ILIM}(k\Omega)} = \frac{64(kV)}{R_{ISEN}(k\Omega)}$$

For example, if RILIM = 32 kΩ, the HCR8871 device limits motor current to 2 A no matter how much load torque is applied. The minimum allowed R_{ILIM} is 15 kΩ. System designers should always under -stand the min and max I_{TRIP}, based on the R_{ILIM} resistor component tolerance and the HCR8871 specified VILIM range.

When I_{TRIP} has been reached, the device enforces slow current decay by enabling both low-side FETs, and it does this for time t_{OFF} (typically 25 μs).

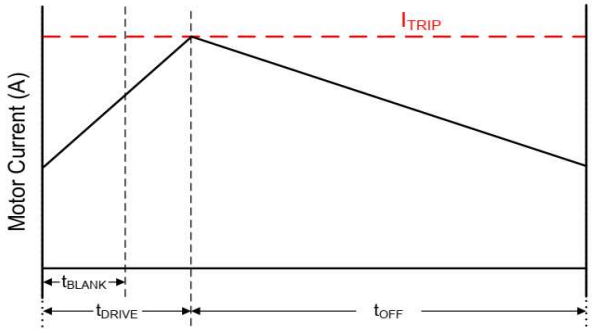


Figure 9. Current Regulation Time Periods

After t_{OFF} has elapsed, the output is re-enabled according to the two inputs INx. The drive time (t_{DRIVE}) until reaching another I_{TRIP} event heavily depends on the VM voltage, the motor's back-EMF, and the motor's inductance.

Dead Time

When an output changes from driving high to driving low, or driving low to driving high, dead time is automatically inserted to prevent shoot--through. t_{DEAD} is the time in the middle when the output is High-Z. If the output pin is measured during t_{DEAD}, the voltage will depend on the direction of current. If current is leaving the pin, the voltage will be a diode drop below ground. If current is entering the pin, the voltage will be a diode drop above VM. This diode is the body diode of the high-side or low-side FET.

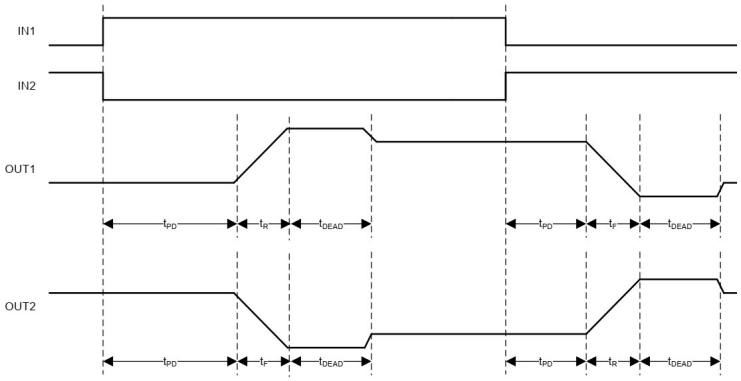


Figure 10. Propagation Delay Time

Protection Circuits

The HCR8871 device is fully protected against VM undervoltage, overcurrent, and overtemperature events.

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)

If the output current exceeds the OCP threshold, I_{OCP}, for longer than t_{OCP}, all FETs in the H-bridge are disabled. After a duration of tRETRY, the H-bridge is re-enabled according to the state of the INx pins. If the overcurrent fault is still present, the cycle repeats; otherwise normal device operation resumes.

Feature Description(con.)

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.

Device Functional Modes

The HCR8871 devices can be used in multiple ways to drive a brushed DC motor.

PWM With Current Regulation

This scheme uses all of the capabilities of the device. The ITRIP current is set above the normal operating current, and high enough to achieve an adequate spin-up time, but low enough to constrain current to a desired level. Motor speed is controlled by the duty cycle of one of the inputs, while the other input is static. Brake or slow decay is typically used during the off-time.

PWM Without Current Regulation

If current regulation is not required, a 15kΩ to 18kΩ resistor should be used on ILIM pin. This mode provides the highest-possible peak current which is up to 3.6 A for a few hundred milliseconds

PWM Without Current Regulation(con.)

(depending on PCB characteristics and the ambient temperature). If current exceeds 3.6 A, the device might reach overcurrent protection (OCP) or overtemperature shutdown (TSD). If that happens, the device disables and protects itself for about 3ms (t_{RETRY}) and then resumes normal operation.

Static Inputs with Current Regulation

The IN1 and IN2 pins can be set high and low for 100% duty cycle drive, and ITRIP can be used to control the current of the motor, speed, and torque capability.

VM Control

In some systems, varying VM as a means of changing motor speed is desirable. In application, local bulk capacitance is needed on VM to GND to stable VM voltage during the operation with motor starts up or stops. At least a 47μF bulk capacitor with voltage rating of operation voltage is recommended. However, the system-level testing is required to determine the appropriate size bulk capacitors.

APPLICATION INFORMATION

Application information

The HCR8871 devices are typically used to drive one brushed DC motor as below:

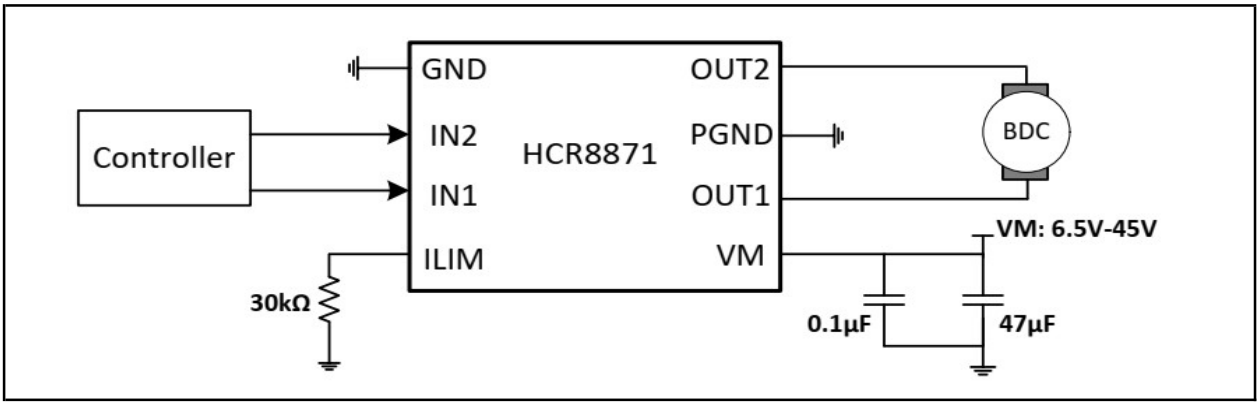
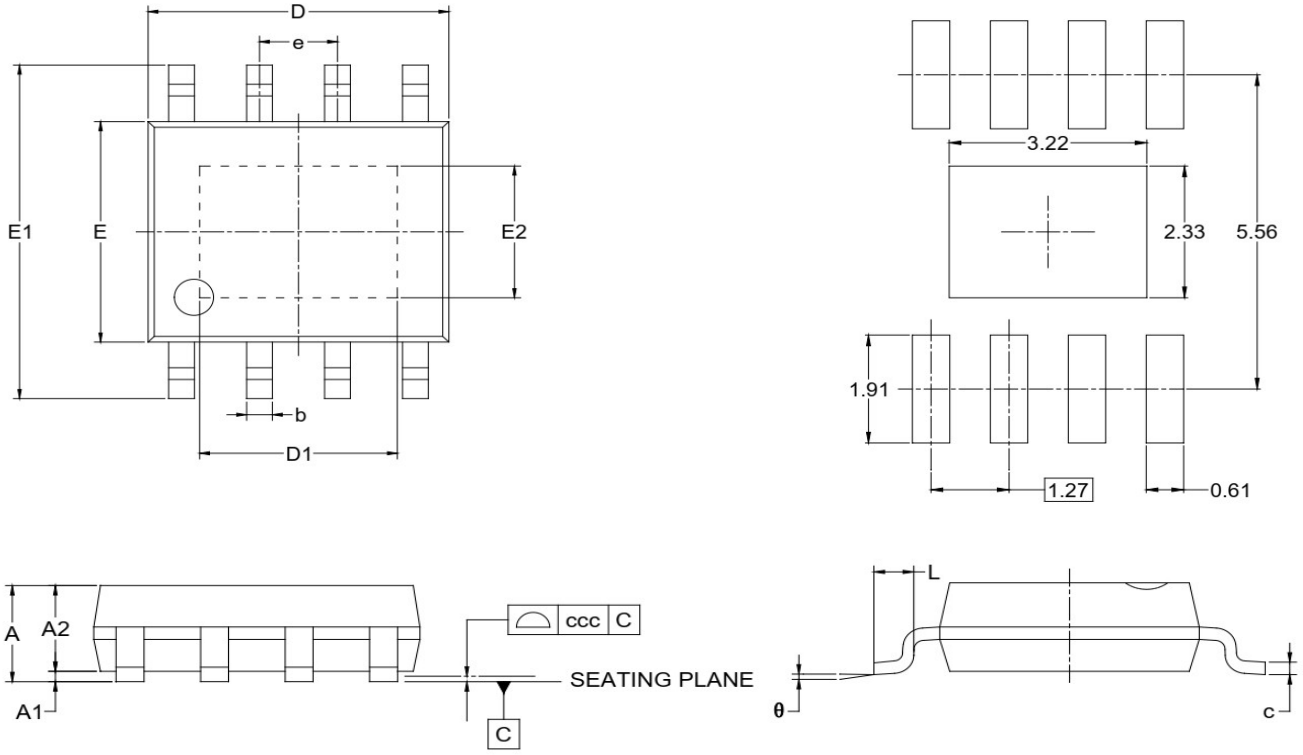


Figure 11. Type Application Circuit

3.6A Brushed DC Motor Driver with Internal Current Sense(PWM Control)

Mechanical Dimensions

M8E PKG: SOP-8(EP) **unit:mm**



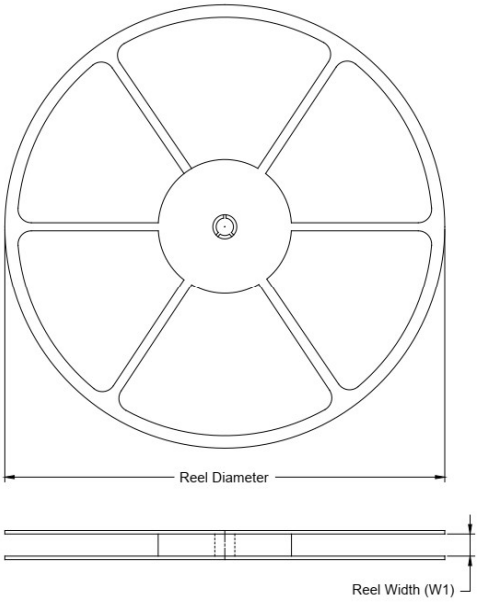
Symbol	Dimensions In Millimeters		
	MIN	MOD	MAX
A			1.700
A1	0.000	-	0.150
A2	1.250	-	1.650
b	0.330	-	0.510
c	0.170	-	0.250
D	4.700	-	5.100
D1	3.020	-	3.420
E	3.800	-	4.000
E1	5.800	-	6.200
E2	2.130	-	2.530
e	1.27 BSC		
L	0.400	-	1.270
θ	0°	-	8°
ccc	0.100		

NOTE:

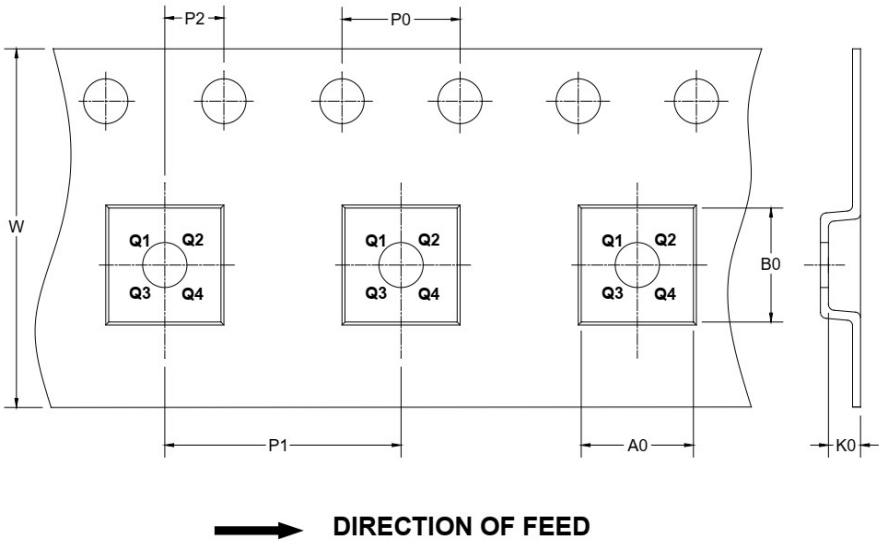
1. Plastic or metal protrusions of 0.15mm maximum per side are not included.
2. BSC (Basic Spacing between Centers), "Basic" spacing is nominal.
3. This drawing is subject to change without notice.

TAPE AND REEL INFORMATION

REEL DIMENSIONS



TAPE DIMENSIONS

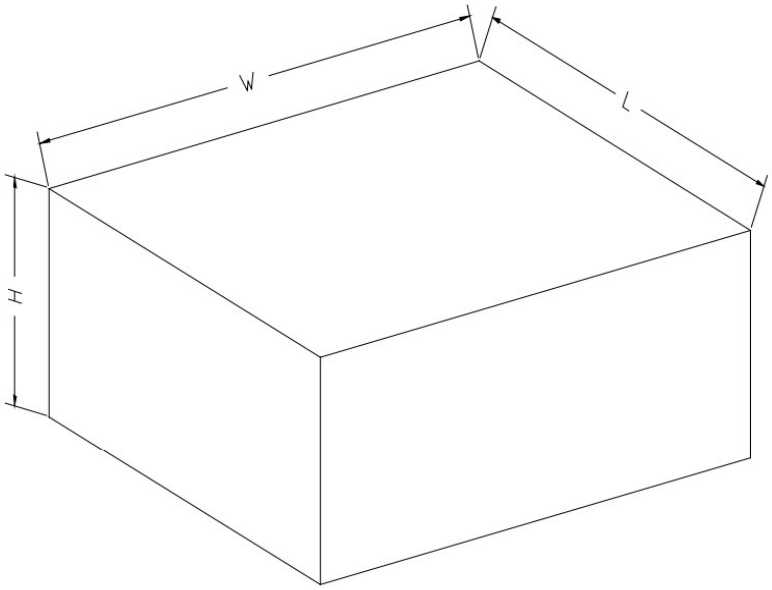


NOTE: The picture is only for reference. Please make the object as the standard.

KEY PARAMETER LIST OF TAPE AND REEL

Package Type	Reel Diameter	Reel Width W1 (mm)	A0 (mm)	B0 (mm)	K0 (mm)	P0 (mm)	P1 (mm)	P2 (mm)	W (mm)	Pin1 Quadrant
SOP-8(EP)	13″	12.4	6.4	5.4	2.1	4.0	8.0	2.0	12.0	Q1

CARTON BOX DIMENSIONS



NOTE: The picture is only for reference. Please make the object as the standard.

KEY PARAMETER LIST OF CARTON BOX

Reel Type	Length (mm)	Width (mm)	Height (mm)	Pizza/Carton
13″	386	280	370	5