LV8417CS

Bi-CMOS integrated circuit

Forward/Reverse Motor Driver Application Note

ON Semiconductor®

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Overview

The LV8417CS is a 1ch H bridge motor driver IC. The package size is extremely small with wafer level package (WLP). Moreover, the on-resistance is low (upper and lower total 0.27Ω typ.).
The H bridge of this IC is P-N composition and thereby reduces the external parts without need of charge pump. Therefore, LV8417CS realizes reduction of mounting area which enables lower cost and smaller application size.

Function

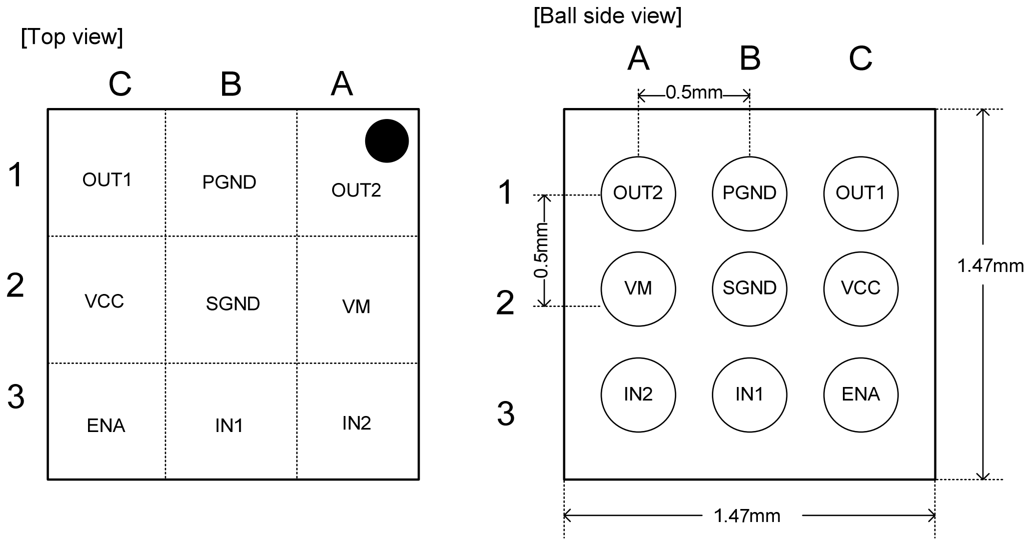
- DMOS output transistor adoption
  (Upper and lower total RON = 0.27Ωtyp)
- The application voltage range is wide (2.0V to 10.5V).
- Iomax=1.0A (t≦100ms 2.0A, t≦10ms 3.8A)
- The compact package is adopted.
- Current consumption 0 when standing by
- Built-in brake function

Typical Applications

- Camera
- Portable device
- TOY

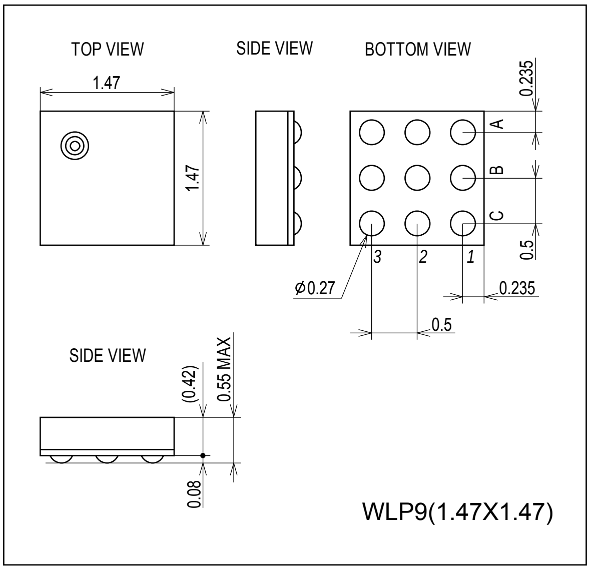
Pin Assignment

WLP9 (1.47×1.47)



Package Dimensions

unit: mm (typ)



Caution: The package dimension is a reference value, which is not a guaranteed value.

Block Diagram

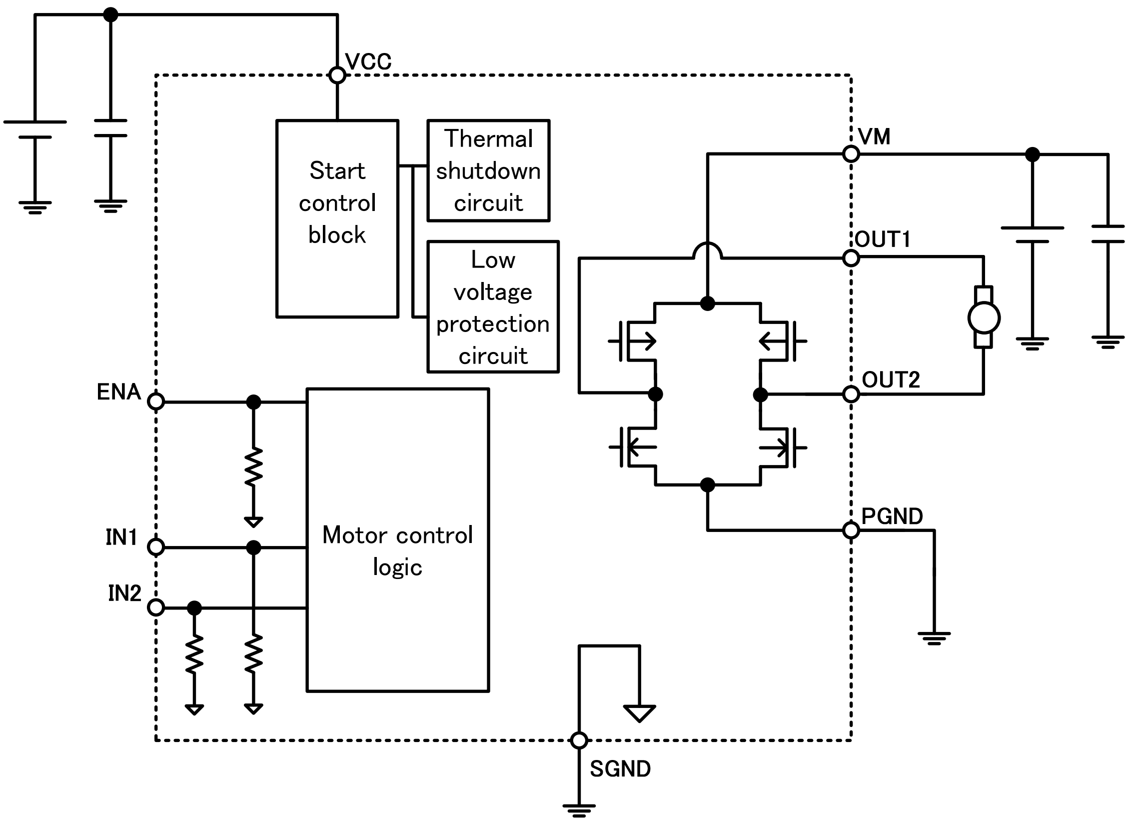


Figure1 DC motor drive

Specifications

Maximum Ratings at Ta = 25°C, SGND = PGND = 0V

Parameter	Symbol	Conditions	Ratings	Unit
Supply voltage (for load)	Vmmax		-0.5 to 12.6	V
Supply voltage (for control)	Vccmax		-0.5 to 6.0	V
Output current	Iomax		1.0	A
Output peak current1	Iopeak1	t≤100mS	2.0	A
Output peak current2	Iopeak2	t≤10mS	3.8	A
Input voltage	VINmax		-0.5 to VCC+0.5	V
Operating temperature	Topr		-20 to +85	°C
Storage temperature	Tstg		-55 to 150	°C
Allowable power dissipation	Pd	*	0.85	W

* Mounted on a specified circuit board: 57.0mm×57.0mm×1.6mm glass epoxy both sides

Caution 1) Absolute maximum ratings represent the value which cannot be exceeded for any length of time.
Caution 2) Even when the device is used within the range of absolute maximum ratings, as a result of continuous usage under high temperature, high current, high voltage, or drastic temperature change, the reliability of the IC may be degraded. Please contact us for the further details.

Stresses exceeding Maximum Ratings may damage the device. Maximum Ratings are stress ratings only. Functional operation above the Recommended Operating Conditions is not implied. Extended exposure to stresses above the Recommended Operating Conditions may affect device reliability.

Recommended Operating Conditions at Ta = 25°C

Parameter	Symbol	Conditions	Ratings			Unit
			min	typ	max	
Supply voltage (VM pin)	VM		2.0		10.5	V
Supply voltage (VCC pin)	VCC		2.7		5.5	V
Input signal voltage	VIN		0		VCC	V
Input signal frequency	fmax			200		kHz

Electrical Characteristics at Ta=25°C and VCC=3.0V, VM=6.0V, SGND=PGND=0V (unless otherwise noted)

Parameter		Symbol	Conditions	Min	Typ.	Max	Unit	Note
Standby load power supply current		IMO	EN=0V			1	μA	(1)
Operating consumption current		IM1	EN=3V No loading		80	120	μA	(3)
Standby control power supply current		ICO	EN=IN1=IN2=0V			1	μA	(2)
Operating consumption current		IC1	EN=3V No loading		0.5	0.8	mA	(3)
High-level input voltage		VIH	2.7V≤VCC≤5.5V	0.6 x VCC		VCC	V	
Low-level input voltage		VIL	2.7V≤VCC≤5.5V	0		0.2 x VCC	V	
High-level input current 1 (ENA, IN1, IN2)		IIH1	VIN=3V		20	30	μA	(4)
Low-level input current 1 (ENA, IN1, IN2)		IIL1	VIN=0V	-1			μA	(4)
Pull down resistance		RDN	EN,IN1,IN2	100	200	400	kΩ	(4)
Output block on- resistance		RON	Sum of top and bottom on-resistance		0.27	0.4	Ω	(5)
Low voltage detection operation voltage		VCS1	Watching VCC pin voltage	2.1	2.3	2.5	V	(6)
Low voltage detection unlock voltage		VCS2	Watching VCC pin voltage	2.3	2.5	2.7	V	(6)
Thermal shutdown operating temperature		Tth	*Design-guaranteed	150	180	210	°C	(7)
Output block	Turn on time	TPLH	No loading		0.1	0.15	μS	(8)
Output block	Output response time H	TIOH	No loading *Design-guaranteed		0.23	0.35	μS	(9)
Output block	Turn off time	TPHL	No loading		0.1	0.15	μS	(8)
Output block	Output response time L	TIOL	No loading *Design-guaranteed		0.25	0.38	μS	(9)

*Notes

(1) Current consumption when output at VM pin is OFF.
(2) Current consumption when output at VCC pin is OFF.
(3) Current consumption of VCC pin when ENA = 3V (at IC start-up).
(4) Pin ENA and IN1 are pulled down by resistor.
(5) This value represents the sum of upper and lower saturation voltage of OUT pin divided by current.
(6) All the power transistors are turned off if a low VCC condition is detected.
(7) All the power transistors are turned off if the thermal protection circuit is activated.
They are turned on again as the temperature decreases.
(8) Turn off time represents rise time from 10 to 90% and fall time from 90 to 10%. (Figure2)
(9) Output response time represents the time between the change of input pin voltage by 50% and the change of OUT pin voltage by 10%. (Figure2)

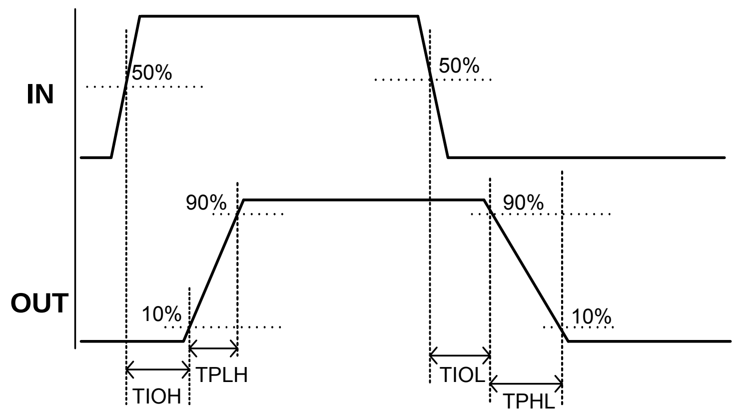


Figure2 Output block time chart

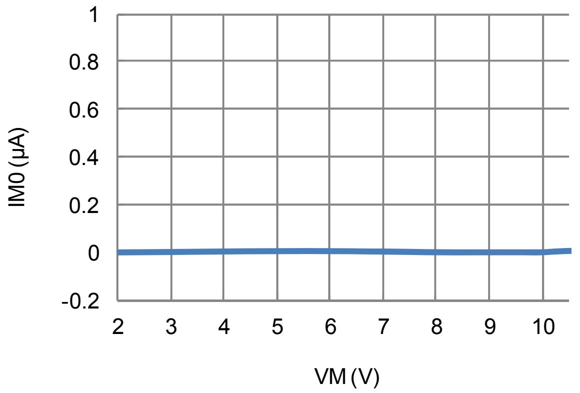


Figure 3 Standby Load Power Supply Current vs VM Voltage

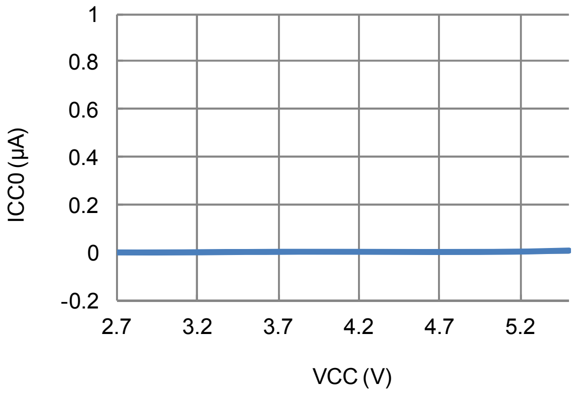


Figure 4 Standby Control Power Supply Current vs VCC Voltage

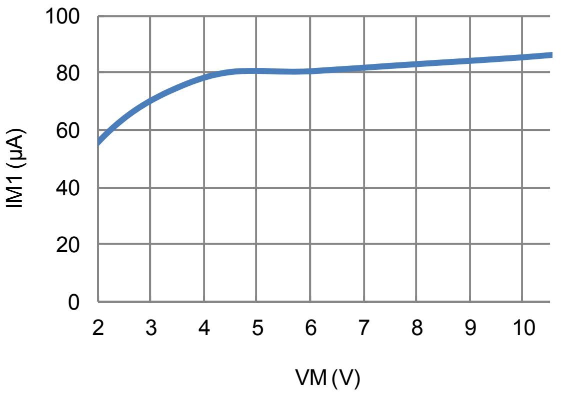


Figure 5 VM Operating Consumption Current vs VM Voltage

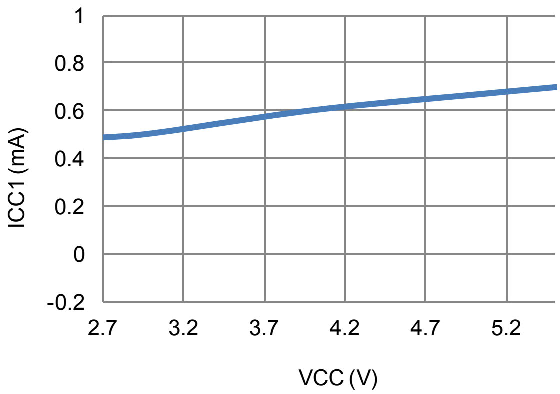


Figure 6 VCC Operating Consumption Current vs VCC Voltage

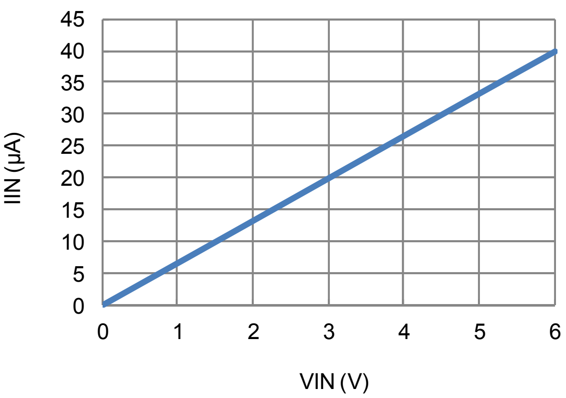


Figure 7 Input Supply current vs Vin Voltage

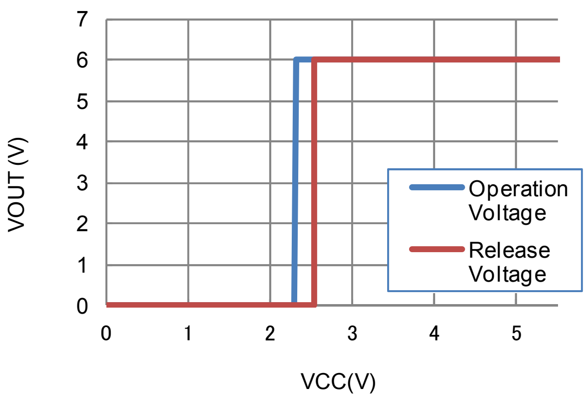


Figure 8 Low Voltage Protection Function Voltaage vs VCC Voltage

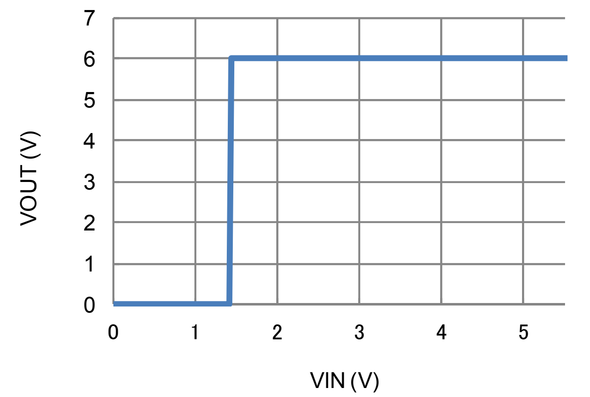


Figure 9 Input "H" Level Voltage vs VIN Voltage

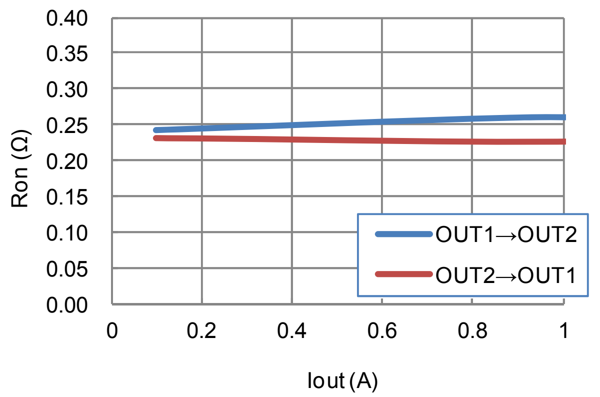


Figure 10 Output on Resistance vs Output Current (VM=6V, VCC=3V)

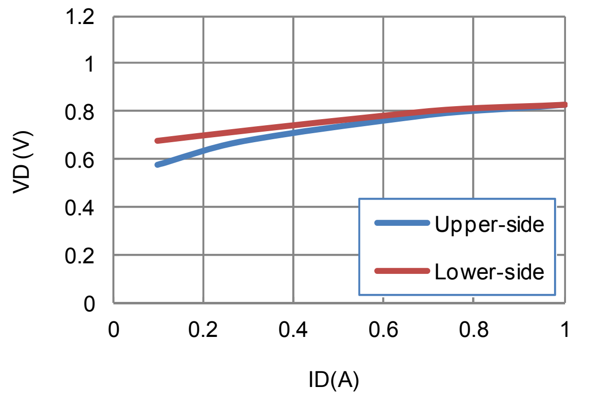


Figure 11 Diode Forward Voltage vs ID Current

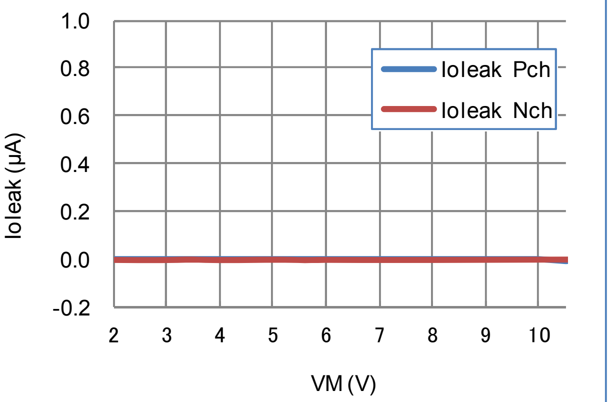


Figure 12 Output Leak Current vs VM Voltage

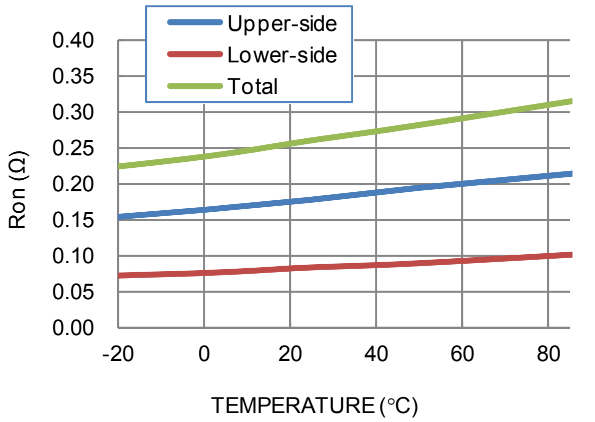
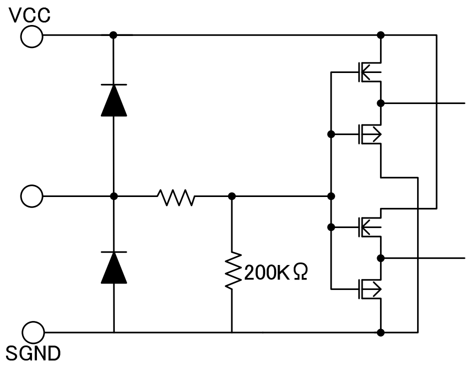
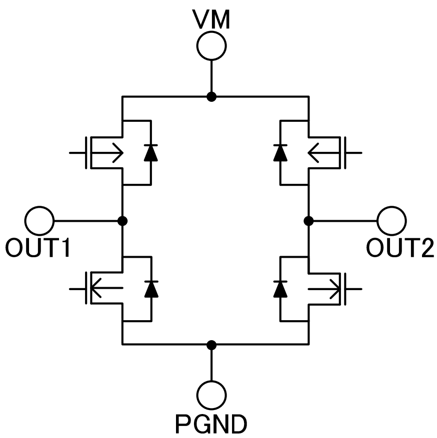


Figure 13 Output on Resistance vs Junction Temperature (VM=6V, VCC=3V)

Pin function

No.	Name	Description	Equivalent circuit diagram
C-3	ENA	Logic enable pin (built-in pull down resistor)	
B-3	IN1	Driver output switching pin	
A-3	IN2	Driver output switching pin	
C-2	VCC	Supply pin for control	
B-2	SGND	GND pin for control	
A-2	VM	Supply pin for load	
C-1	OUT1	Driver output pin	
A-1	OUT2	Driver output pin	
B-1	PGND	GND pin for load	

Operation explanation

1. Truth value table

ENA	IN1	IN2	OUT1	OUT2	MODE
H	H	H	L	L	Brake
	H	L	H	L	Forward
	L	H	L	H	Reverse
	L	L	Z	Z	Standby
L	-	-	Z	Z	Standby

-: Ignore Z: High-Impedance

* Current consumption is zero during standby mode.
* At low voltage and thermal shutdown, all the power transistors are OFF and the motor rotation is stopped.

2. Thermal shutdown function

The thermal shutdown circuit is incorporated and the output is turned off when junction temperature Tj exceeds 180°C. As the temperature falls by hysteresis, the output turned on again (automatic restoration). The thermal shutdown circuit does not guarantee the protection of the final product because it operates when the temperature exceed the junction temperature of Tjmax=150°C.

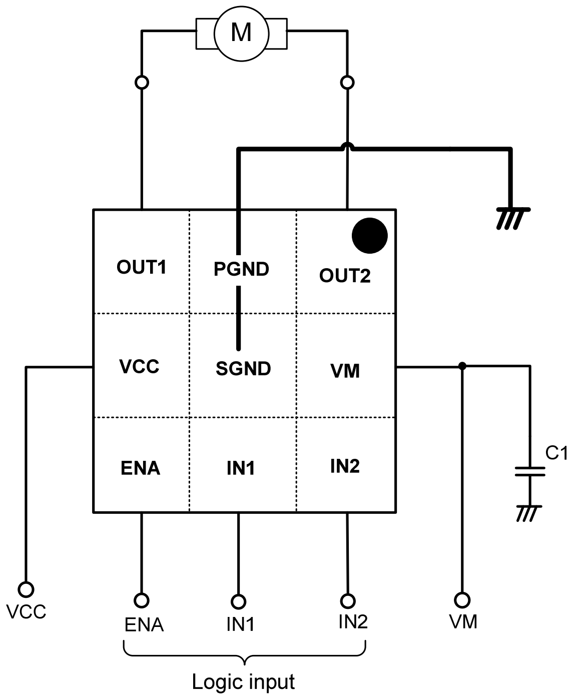
TSD = 180°C (typ)
ΔTSD = 30°C (typ)

3. Low voltage protection function

When the VCC power supply voltage is as follows typical 2.3V, the output does OFF.
When the VCC power supply voltage is as above typical 2.5V, the IC outputs a set state.

Application Circuit Example

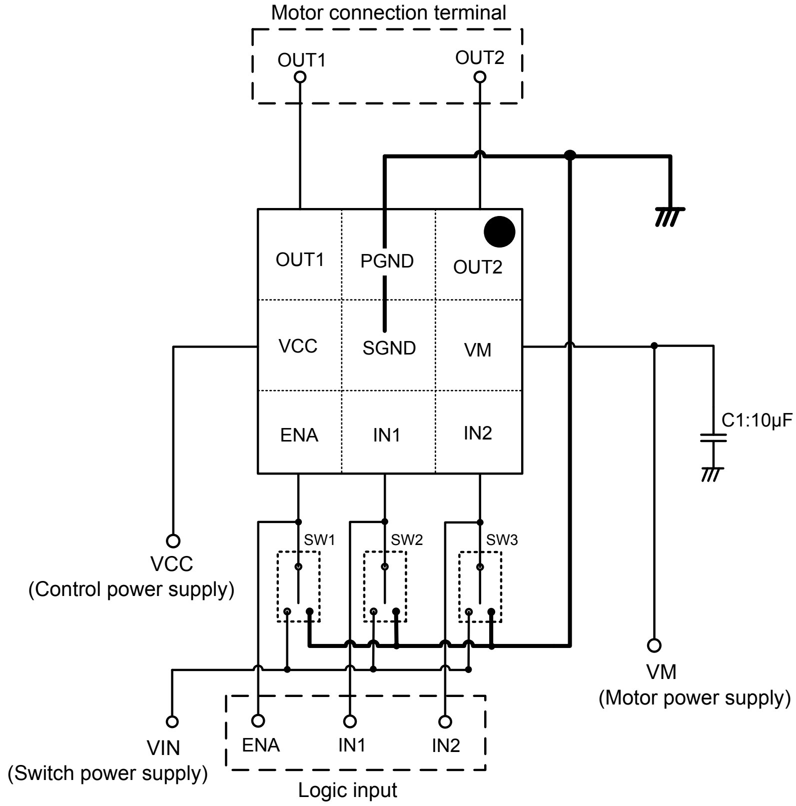
1. Example of applied circuit when DC motor driving



* Bypass capacitor (C1) connected between V_{CC}-GND of all examples of applied circuit recommends the electric field capacitor of 0.1μA to 10μA.
Confirm there is no problem in operation in the state of the motor load including the temperature property about the value of the capacitor.
Mount the position where the capacitor is mounted on nearest IC.

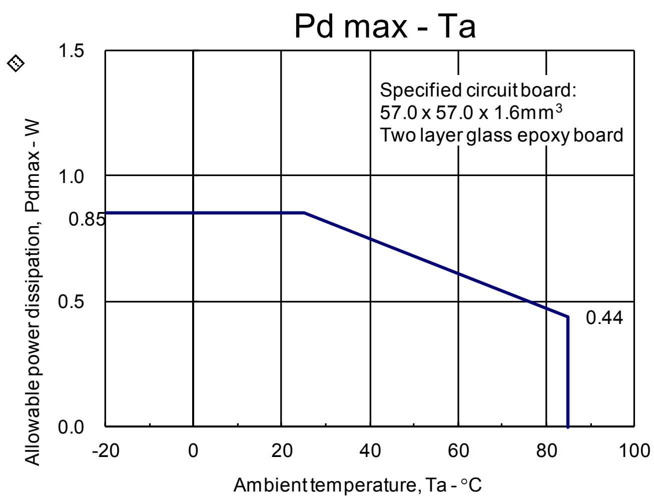
Evaluation Board Manual

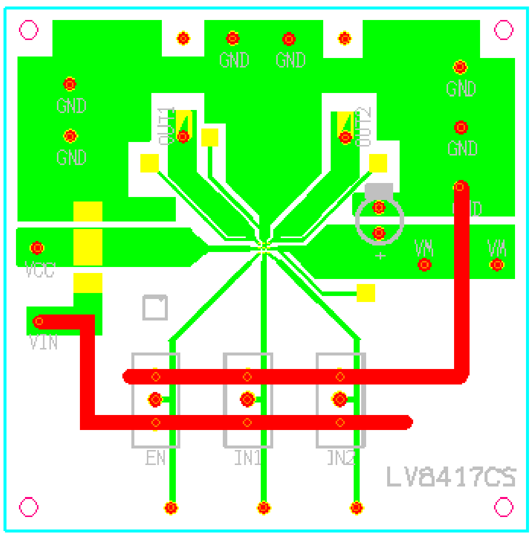
1. Evaluation Board circuit diagram



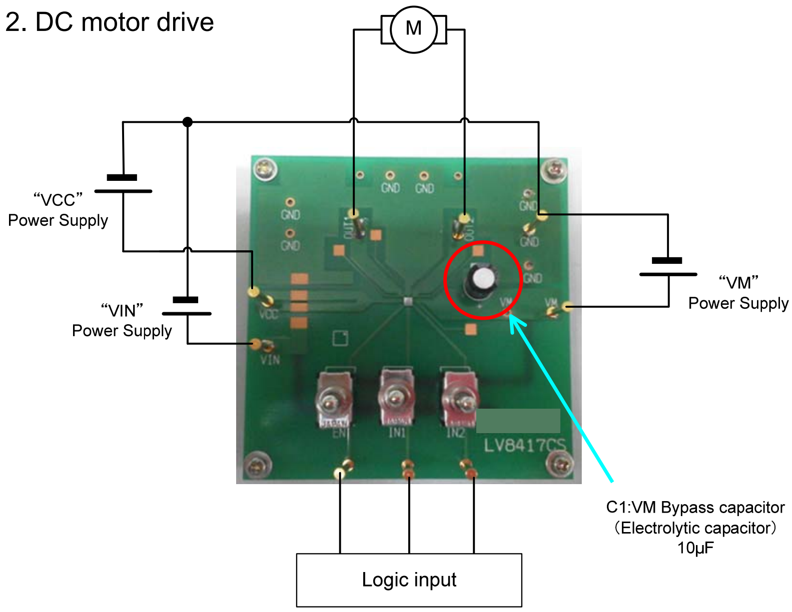
Bill of Materials for LV8417CS Evaluation Board

Designator	Qty	Description	Value	Tol	Footprint	Manufacturer	Manufacturer Part Number	Substitution Allowed	Lead Free
IC1	1	Motor Driver			WLP (1.47x1.47)	ON Semiconductor	LV8417CS	No	Yes
C1	1	VCC Bypass capacitor	10μF 50V	±20%		SUN Electronic Industries	50ME10HC	Yes	Yes
SW1-SW3	3	Switch				MIYAMA	MS-621-A01	Yes	Yes
TP1-TP9	9	Test points				MAC8	ST-1-3	Yes	Yes





2. DC motor drive



- Connect OUT1 and OUT2, to a DC motor each.
- Connect the motor power supply with the terminal VM, the control power supply with the terminal VCC, the switch power supply with the terminal VIN. Connect the GND line with the terminal GND.
- DC motor becomes the predetermined output state corresponding to the input state by inputting a signal such as the following truth value table into IN1/IN2.
- See the table in p.7 for further information on input logic.

When you drive DC motor with LV8417CS, caution is required to switch motor rotation from forward to reverse because when doing so, electromotive force (EMF) is generated and in some cases, current can exceed the ratings which may lead to the destruction and malfunction of the IC .
Coil current (Iout) for each operation is obtained as follows when switching motor rotation from forward to reverse.

- Starting up motor operation
  Coil current Iout = (VM – EMF) / coil resistance
  At startup, Iout is high because EMF is 0. As the motor starts to rotate, EMF becomes higher and Iout becomes lower.
- When switching motor rotation from forward to reverse:
  Coil current Iout = (VM + EMF) / coil resistance
  When EMF is nearly equal to VM at a max, make sure that the current does not exceed Iomax since a current which is about double the startup current may flow at reverse brake.
- Short brake:
  Coil current: Iout = EMF / coil resistance
  Since EMF is 0 when the rotation of motor stops, Iout is 0 as well.

When you switch motor rotation form forward to reverse, if Iout is higher than Iomax, you can operate short brake mode between forward and reverse either to slow down or stop the motor.

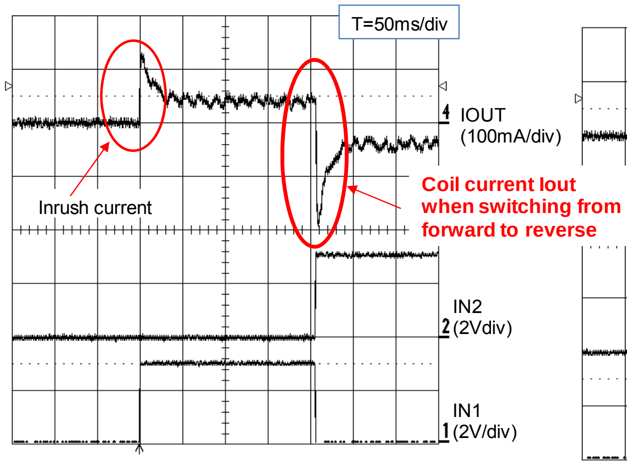


Figure14 Without Break MODE

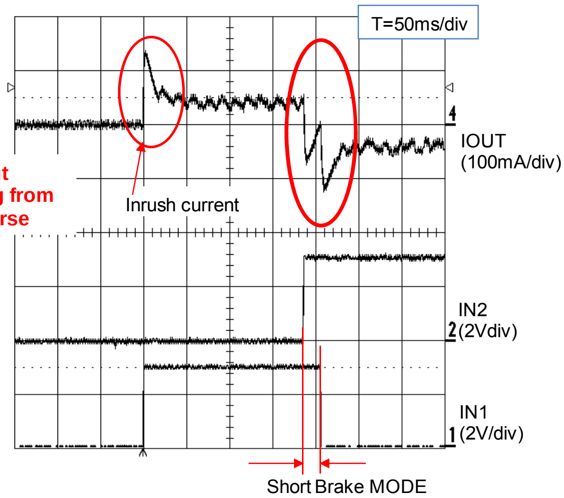
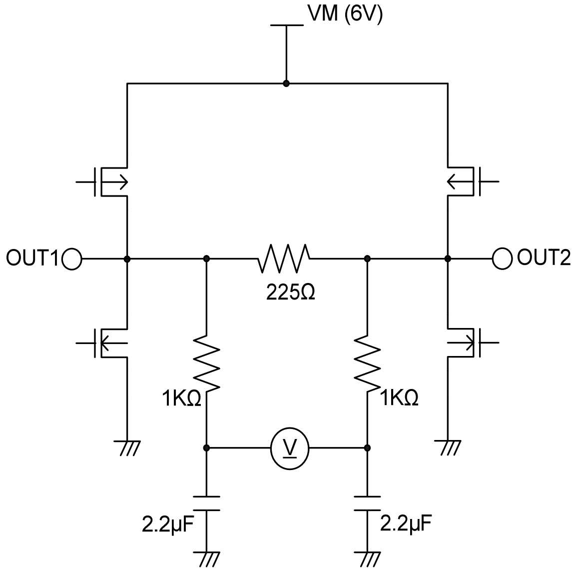


Figure15 With Break MODE

Input and output characteristics of H-Bridge

LV8417CS can be driven by direct PWM control of H-Bridge by inputting PWM signal to IN.
However output response of H-Bridge worsens around On-duty 0%, which generates dead zone. As a result, IC control loses lineality.
If you intend to drive motor in such control range, make sure to check the operation of your motor.

Input-Output Characteristics of H-Bridge (reference data)
Forward/Reverse⇔Brake
VM=6.0V, VCC=3.0V



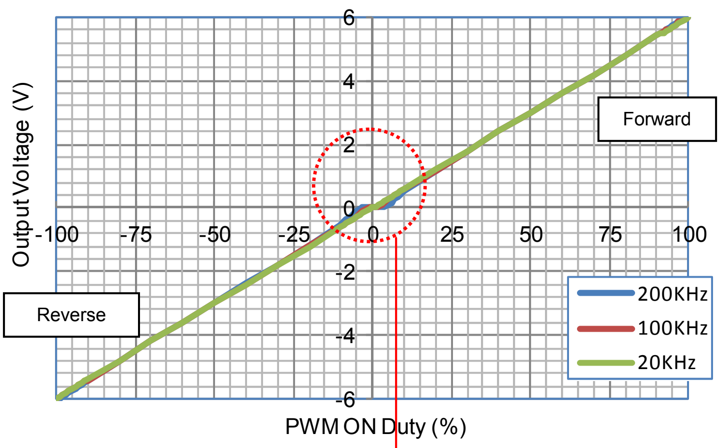


Figure 16 Input and Output Characteristics of H-Bridge

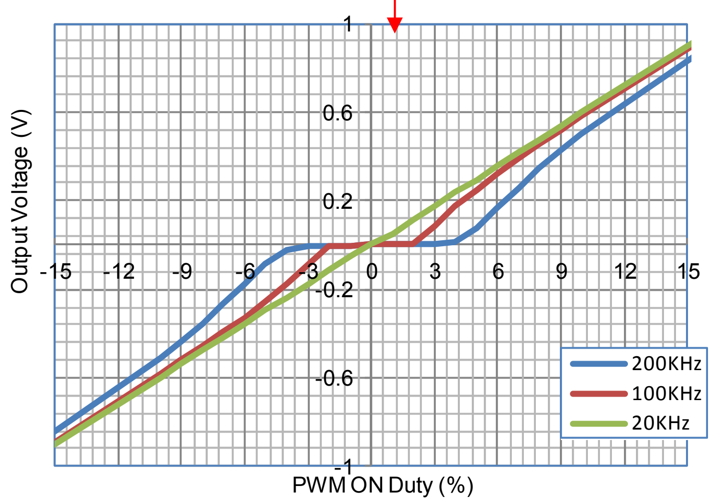


Figure 17 Input and Output Characteristics of H-Bridge (At the time of microinput)