LV8075LP

Bi-CMOS LSI

Constant-voltage Control 1-channel Forward/Reverse DC Motor Driver Application Note

ON Semiconductor®

http://onsemi.com

Overview

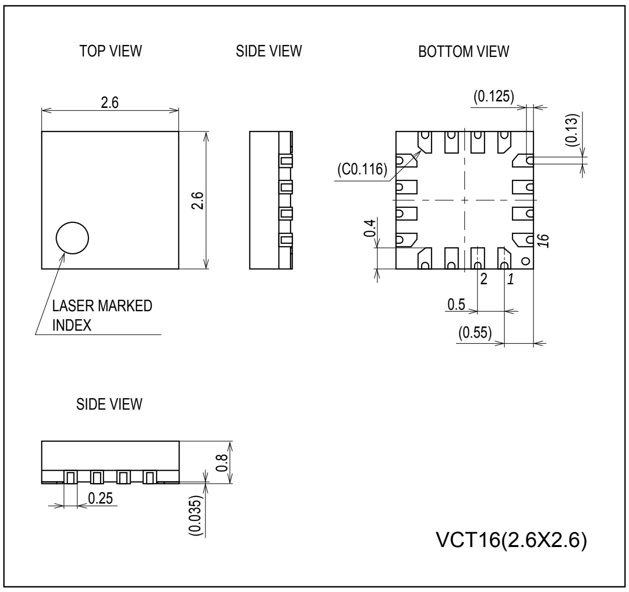
The LV8075LP is a low voltage bidirectional DC motor driver with a typical input voltage of 2.5 to 5.5 V and output currents up to 500mA. The unique output full-bridge incorporates source-side linear operation to allow a constant voltage across the motor coil. This regulated output minimizes motor voltage change due to I ×$R_{DS\,(ON)}$ variation and battery voltage tolerance.
Internal protection circuitry includes thermal shutdown, under voltage lockout.

Function

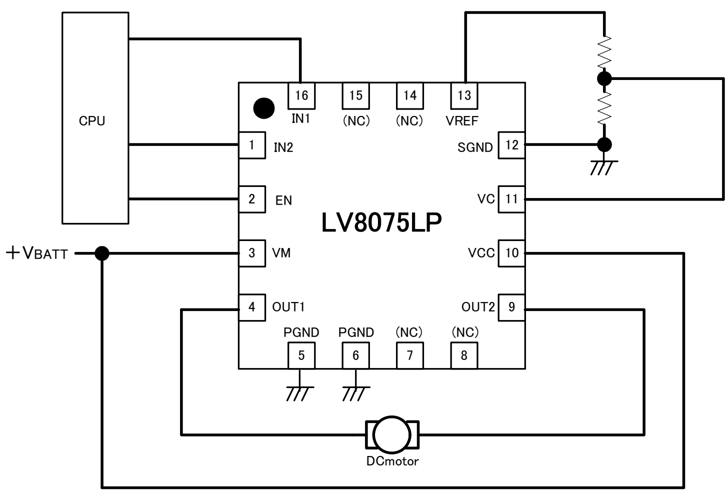
- Constant voltage control forward/reverse H-bridge
  Parallel input-Analog value must be entered for constant voltage reference input
  V (OUT) = V (VC) × 2.0
- 500mA output peak rating
- Low power standby mode
- Small 2.6mm×2.6mm, 0.80mm nominal height VCT16 package
- Control voltage and motor voltage separable
- Built-in thermal protection circuit and under-voltage detection protection circuit
- -30 to 85 operating temperature range

Typical Applications

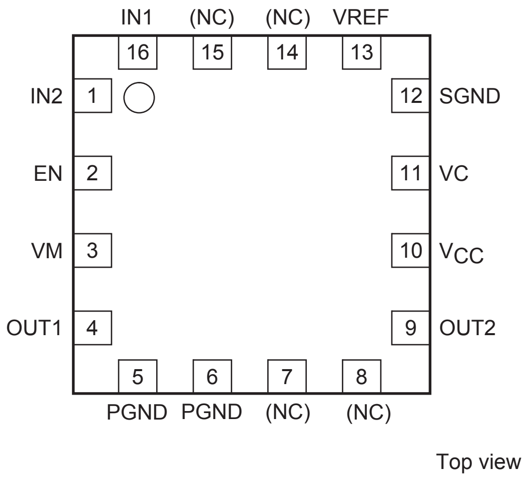
- Camera lens/shutters/lens barrier control
- Battery powered toys and games
- Portable printers/scanners
- Robotics actuators and pumps
- Low noise test instrumentation systems

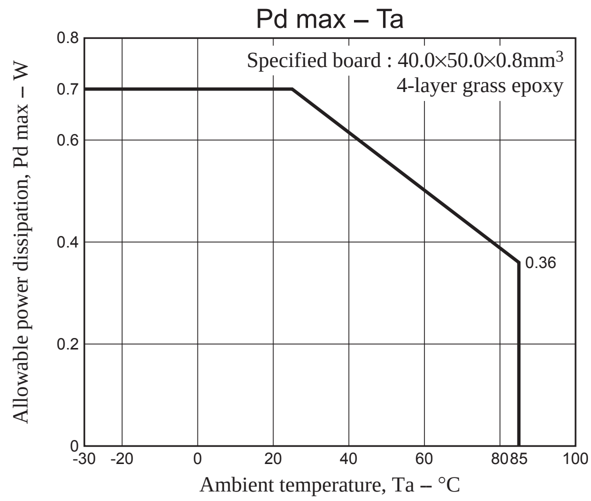


Typical Application

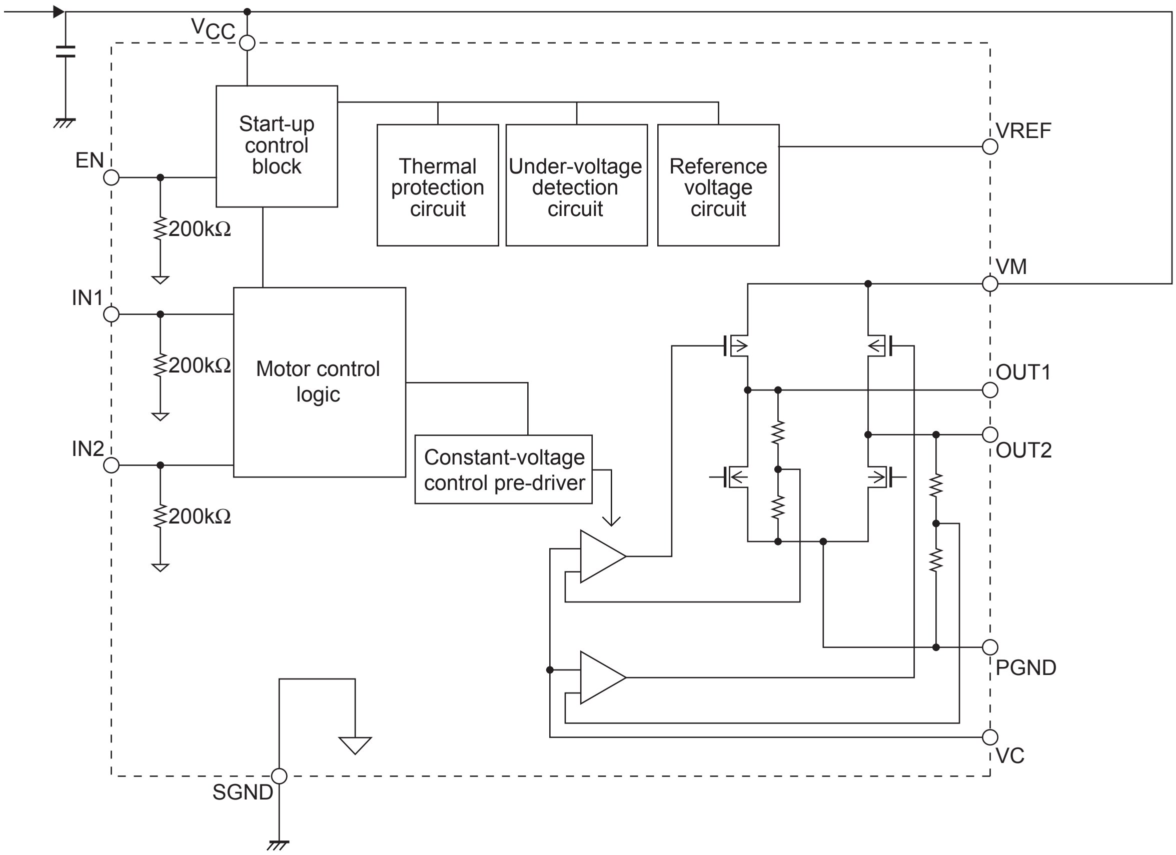


Pin Assignment





Block Diagram



Specifications

Absolute Maximum Ratings at Ta = 25°C

Parameter	Symbol	Conditions	Ratings	Unit
Maximum control power supply	V_{CC} max		6	V
Maximum load power supply	VM max		6	V
Maximum control pin voltage	V_C max		6	V
Maximum output current	I_O max	OUT1, 2	0.5	A
VREF maximum current	IREF max	VREF	1	mA
Allowable power dissipation	Pd max	Mounted on a circuit board*	700	mW
Operating temperature	Topr		-30 to +85	°C
Storage temperature	Tstg		-40 to +150	°C

* Specified circuit board : 40.0×50.0×0.8mm^3 : glass epoxy four-layer board

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

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	
Control power-supply voltage	V_{CC}		2.5		5.5	V
Load power-supply voltage	VM		2.5		5.5	V
Output control input voltage	Vcont	VC pin	0		V_{CC}-1	V
Input pin “H” voltage	V_{IN}H	IN1, 2,EN pin	V_{CC} × 0.6		V_{CC}+0.3	V
Input pin “L” voltage	V_{IN}L	IN1, 2,EN pin	-0.1		V_{CC} × 0.2	V

Electrical Characteristics at Ta = 25°C, V_{CC} = VM = 3.0V, PGND = SGND = 0V, unless otherwise specified.

Parameter	Symbol	Conditions	Ratings			Unit
			min	typ	max	
Standby current consumption 1	I_{CCO}	EN, IN1, 2 = H/L/L or EN = L			1	μA
Standby current consumption 1	I_{MO}	EN, IN1, 2 = H/L/L or EN = L			1	μA
Operating current consumption	$V_{CC}1$	EN = H, IN1 or IN2 = H		0.5	1.0	mA
H-level input current	I_{IN}H	200kΩ pull-down, V_{IN} = 3V	10	15	20	μA
L-level input current	I_{IN}L	V_{IN} = 0V		0	1	μA
Reference voltage output	VREF	IREF = 500μF	1.4	1.5	1.6	V
Output on-resistance	Ron1	Total of top and bottom		1.75	2.5	Ω
Constant-voltage control output voltage	V_{OUT}	VC = 1.0V	1.94	2.0	2.06	V
Under-voltage detection operating voltage	V_{CS}	V_{CC} Voltage	2.1	2.2	2.35	V
Thermal protection temperature	TSD	Design guarantee value*	150	180	210	°C
Output rise time	Tr	(Note)		1.6	3.0	μs
Output fall time	Tf	(Note)		0.2	1.0	μs

* Design guarantee value and no measurement is made.

Note : Specify rising control start time → 90% of OUT output voltage, and falling control start time → 10% of OUT output voltage.

Truth Table

Constant voltage output H-bridge

EN	IN1	IN2	OUT1	OUT2	Mode
H	H	H	L	L	Brake
	H	L	H	L	Forward evolution
	L	H	L	H	Reverse rotation
	L	L	off	off	Stand by
L	-	-	off	off	Stand by

"-" entries indicate don't care state, "off" indicates output off state, insert 20kΩ impedance across PGND.

Constant voltage output value : V (OUT) = V (VC) ×2.0

Pin Functions

Pin No.	Pin name	Description
10	V_{CC}	Power supply pin for control
5, 6	PGND	Power ground pins for IC
12	SGND	IC system ground
3	VM	Power supply pin for constant voltage output H-bridge
2	EN	IC enable pin. Power-saving mode is established when L-level is applied. Pulled-down with 200kΩ
16, 1	IN1, 2	Input pins for manipulating constant-current output H-bridge (OUT1, 2) . Pulled-down with 200kΩ
4, 9	OUT1, 2	Constant voltage H-bridge output pins
13	VREF	Reference voltage output, outputs 1.5V
11	VC	Analog voltage input pin for constant voltage setting. Must be short-circuited to V_{CC} pin when using saturation control.

Reference data

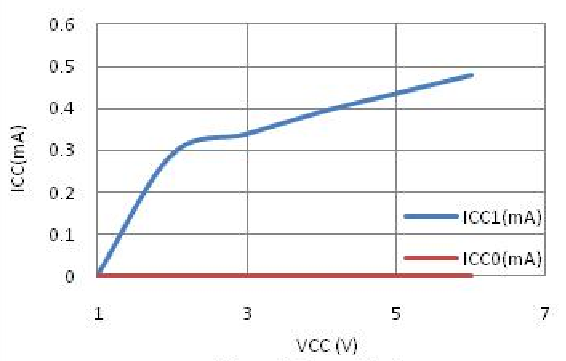


Figure 1 Current Drain vs VCC Voltage

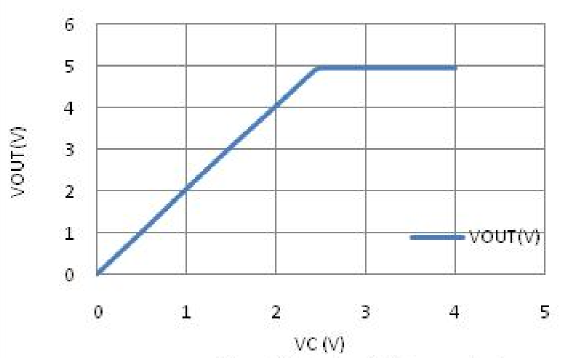


Figure 2 ConstantVoltage output vs VC Voltage at VCC=5V

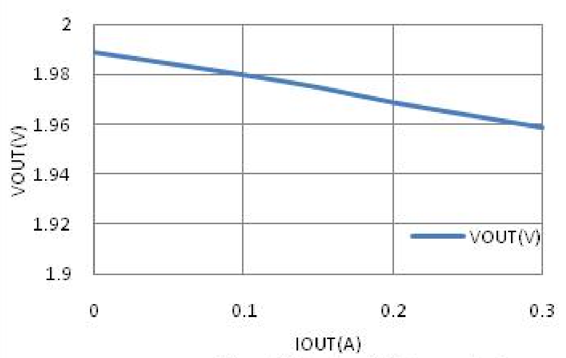


Figure 3 ConstantVoltage output vs IOUT at VCC=3V/VC=1.0V

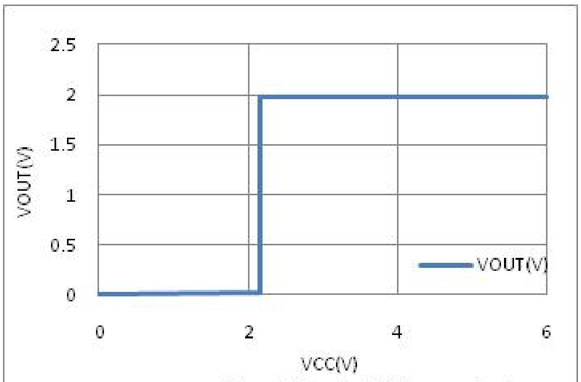


Figure 4 ConstantVoltage output vs VCC at VC=1.0V

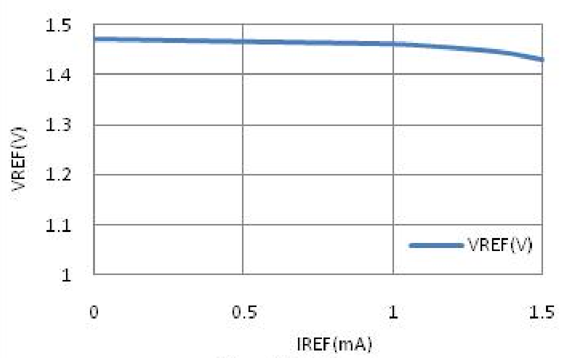


Figure 5 VREF voltage vs IREF at VCC=3V

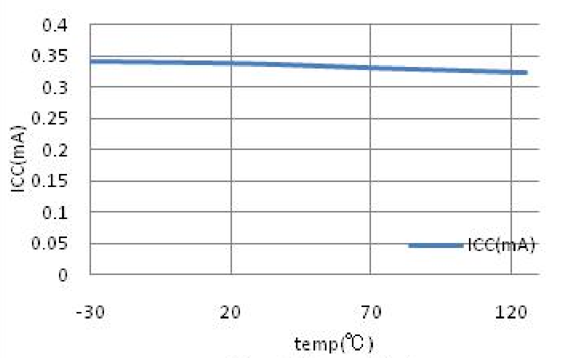


Figure 6 Current drain vs temperture at VCC=3V

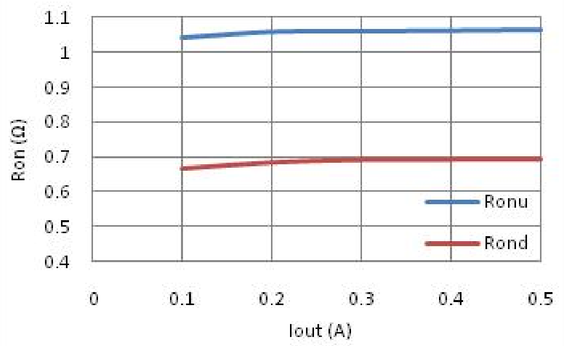


Figure 7 Output on Resistance
vs Output Current at VM=3V

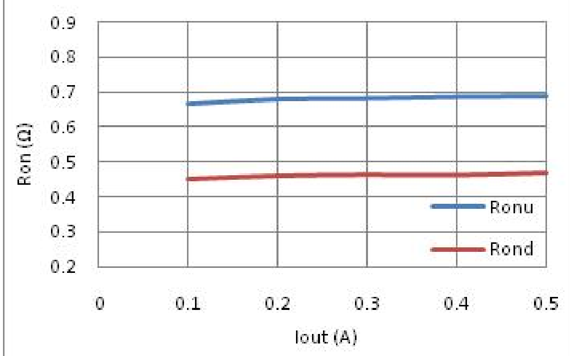


Figure 8 Output on Resistance
vs Output Current at VM=5V

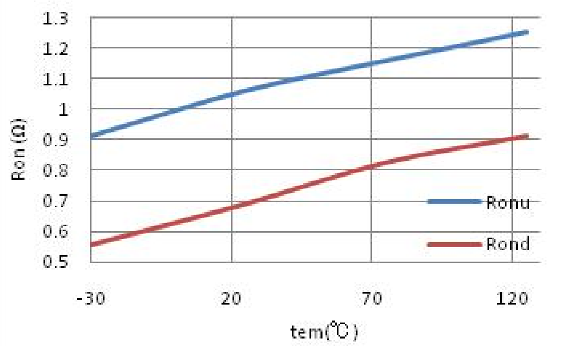


Figure 9 Output on Resistance
vs temperture at VM=3V/Io=0.3A

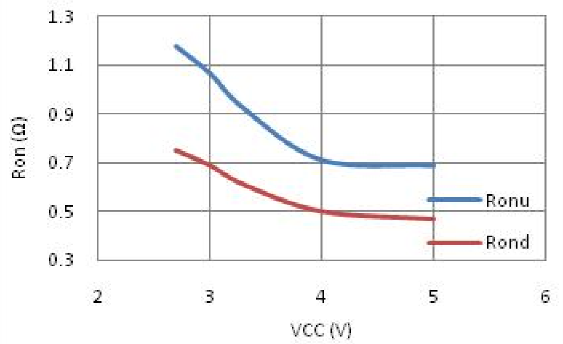
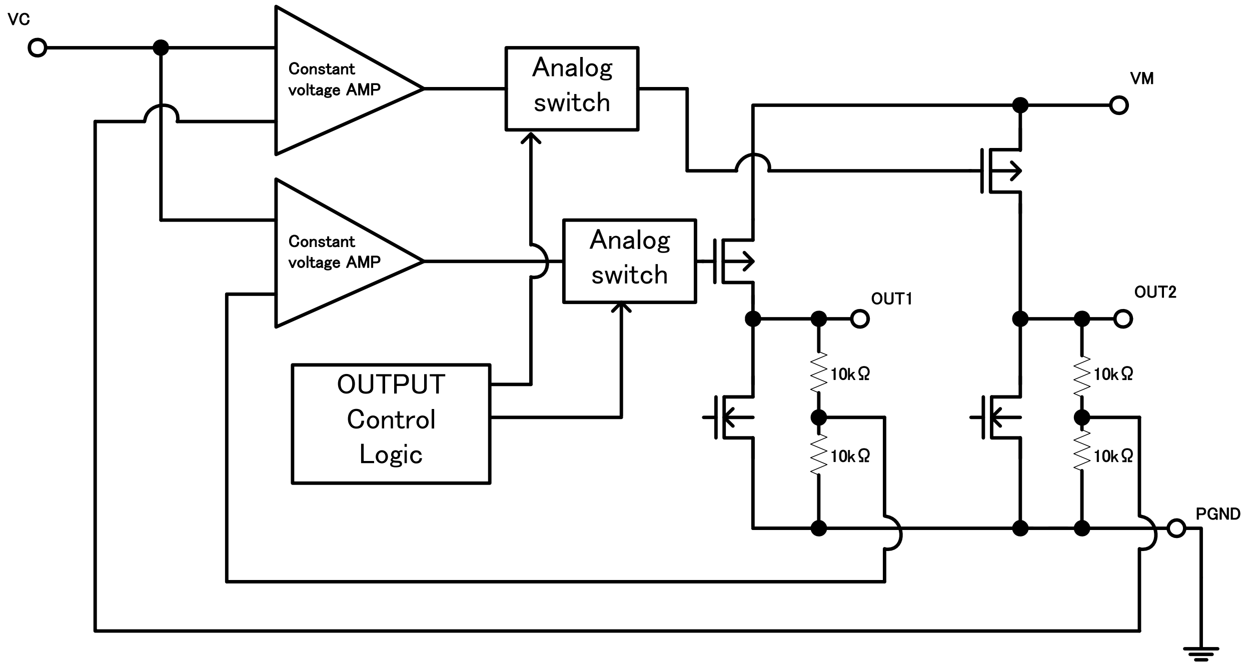


Figure 10 Output on Resistance
vs VM at Io=0.3A

APPLICATION INFORMATION

1. Constant voltage output



LV8075LP controls output voltage by controlling Pch power transistor to detect the voltage of OUT in order to obtain VOUT voltage of VC×2.0.
However, make sure that the voltage of VOUT does not exceed VM.

Constant-voltage control is unnecessary. When you use this IC for Full-drive, make sure to short VC and VCC.

OUT has impedance of 20kΩ to PGND.

2. Thermal Shutdown

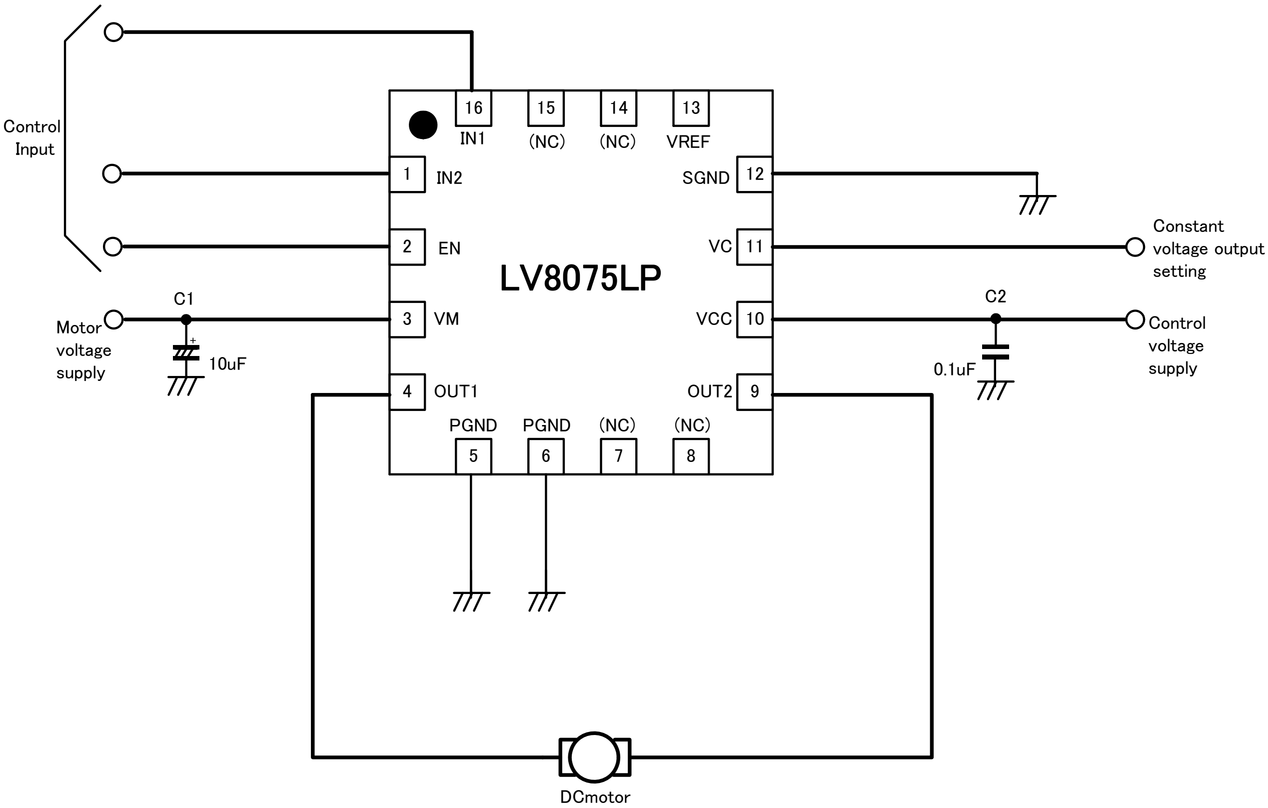
The LV8075LP will disable the outputs if the junction temperature reaches 180°C.

When temperature falls 30 °C, the IC outputs a set output mode.

3. Low voltage protection function

When the power supply voltage is as follows 2.2V in LV8075LP, OFF does the output.

Motor connecting figure



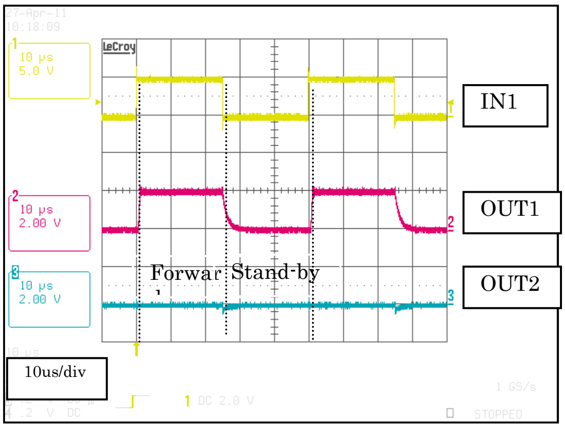
VCC and VM can be used as common pins.
Even when you apply different voltage to VCC and VM, you can supply higher voltage to either one of the two pins. Also either one of the two can be powered first.

The output voltage of VREF is 1.5V.
When VC and VREF are connected, you can set 3.0V of output voltage for OUT.

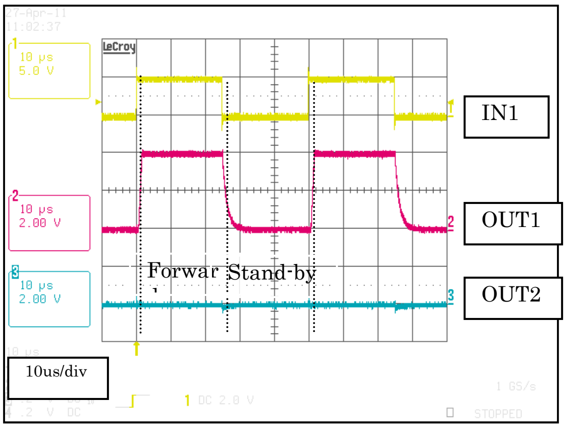
The capacitor C1 and C2 are used to stabilize the power supply. A requirement for capacitance may vary depends on a layout of board, capability of motor or power supply.
Recommendation range for C1: approx. 0.1μF to 10μF
Recommendation range for C2: approx. 0.01μF to 1μF
In order to set an optimum capacitance for stable power supply, make sure to confirm the waveform of the supply voltage of a motor under operation

Waveform example

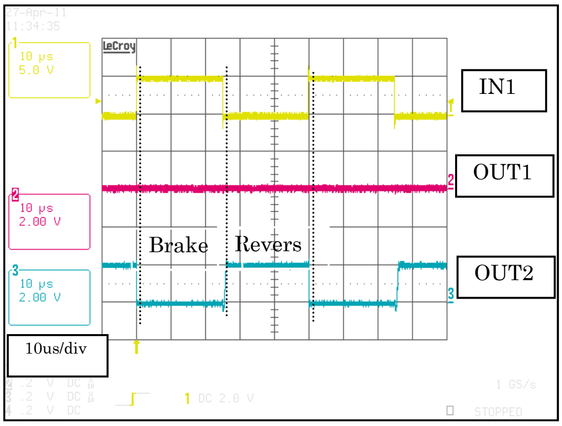
No load VCC=VM=5V VC=1.0V IN2="L"



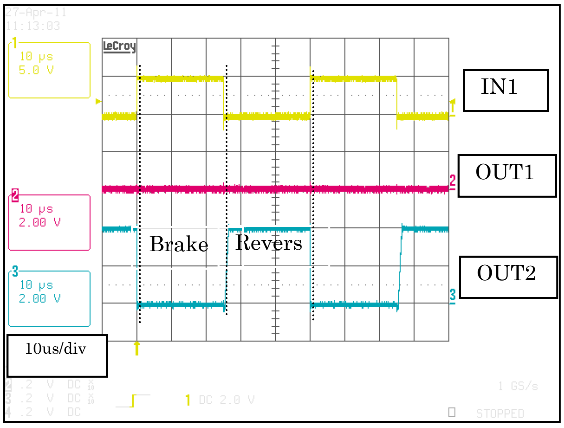
No load VCC=VM=5V VC=2.0V IN2="L"



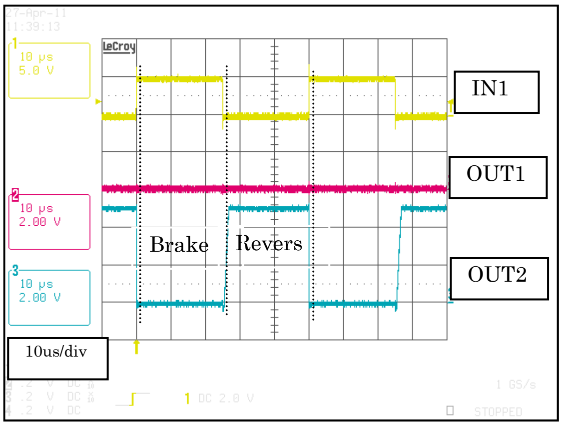
No load VCC=VM=5V VC=1.0V IN2="H"



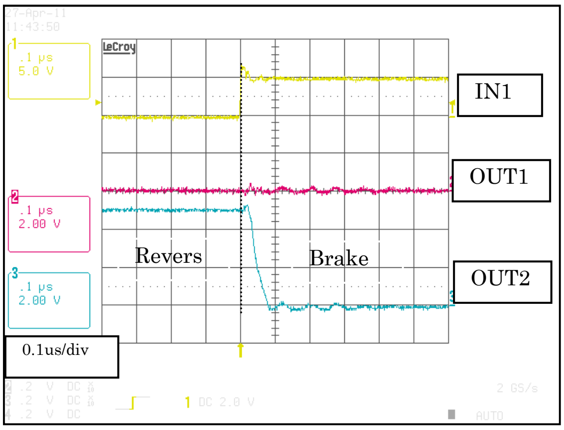
No load VCC=VM=5V VC=2.0V IN2="H"



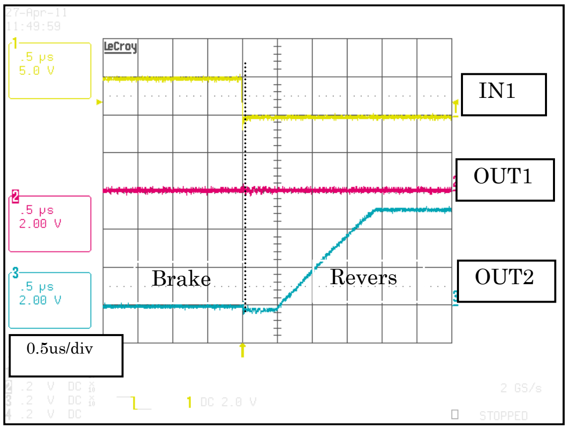
No load VCC=VM=5V VC=3.0V IN2="H"



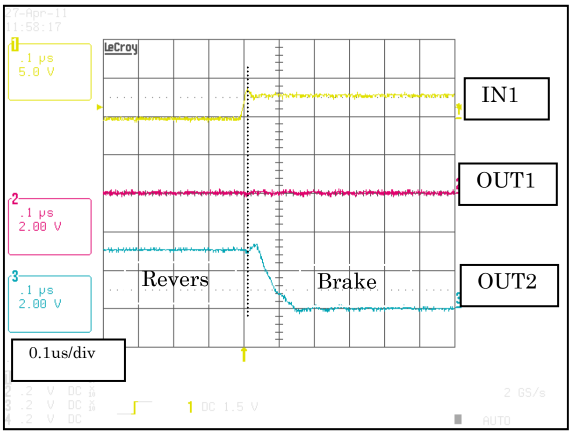
No load VCC=VM=5V VC=3.0V IN2="H"
Time scale expansion "fall time"



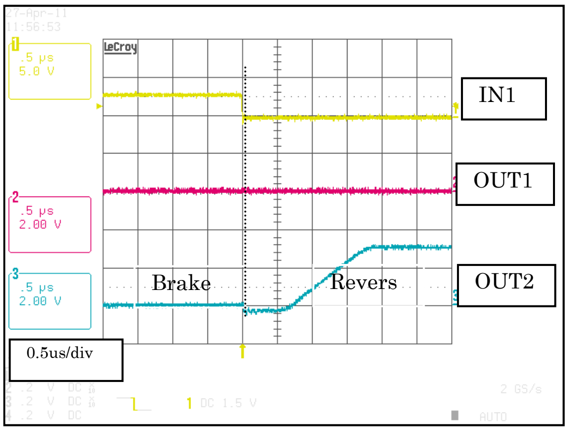
No load VCC=VM=5V VC=3.0V IN2="H"
Time scale expansion "rise time"



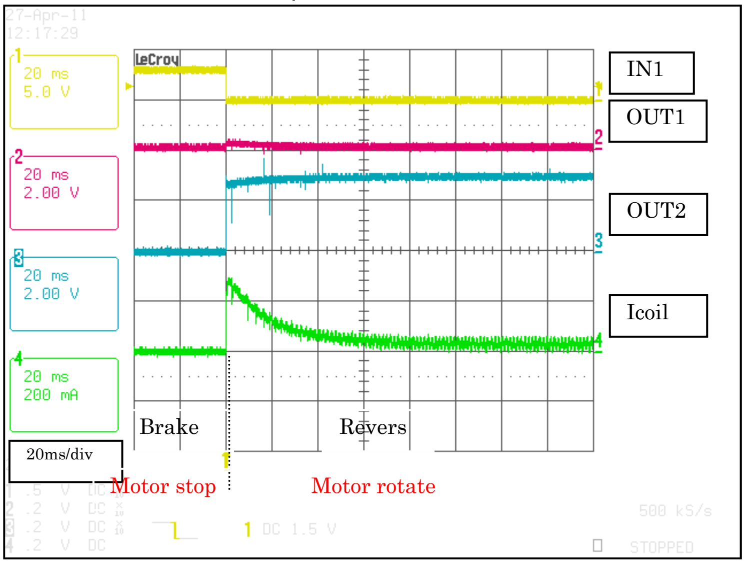
No load VCC=VM=3V VC=3.0V IN2="H"
Time scale expansion "fall time"



No load VCC=VM=3V VC=3.0V IN2="H"
Time scale expansion "rise time"

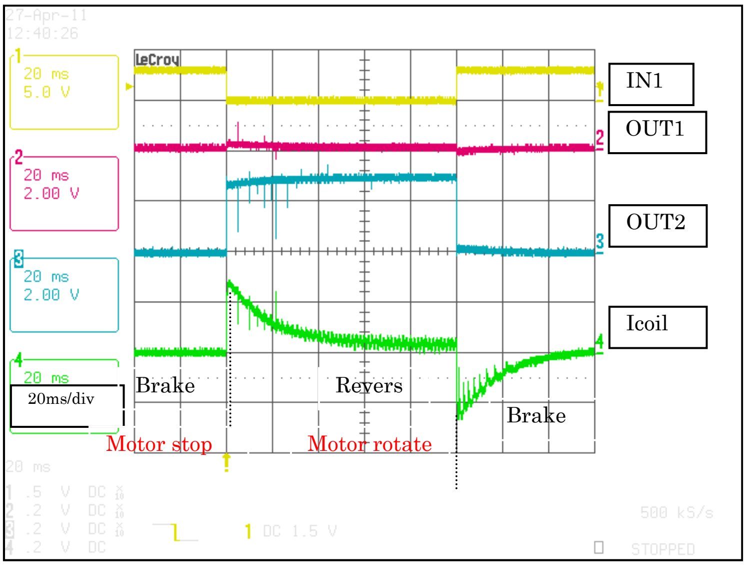


DC motor load VCC=VM=3V VC=3.0V IN2="H"
Current waveform example "motor start"



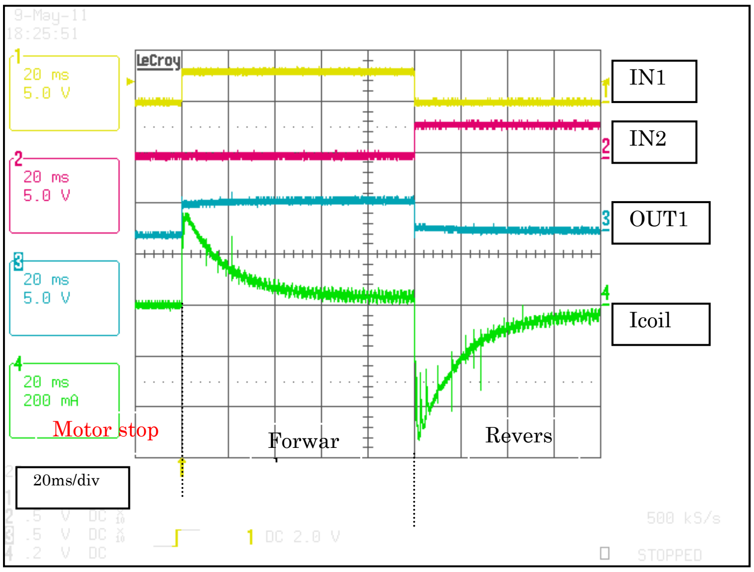
High current flows when the DC motor starts to rotate. After a while, induced voltage "Ea" is generated from motor and current value gradually decreases in the course of motor rotation.
Given that the coil resistor is Rcoil, motor supply voltage is Vm, the motor current Im is obtained as follows: Im= (Vm-Ea) /Rcoil

DC motor load VCC=VM=3V VC=3.0V IN2="H"
Current waveform example "brake current"



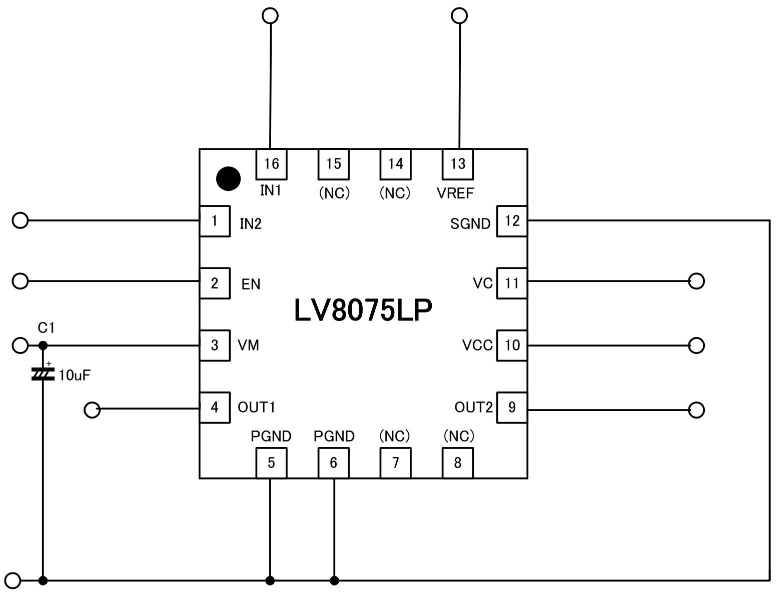
By setting brake mode while the DC motor is under rotation, DC motor becomes short-brake state and thereby decreases rotation count rapidly.
In this case, the current of Im=Ea/Rcoil flows reversely due to the induced voltage Ea generated while the motor was under rotation. And by stopping the rotation of DC motor, Ea becomes 0. Therefore, the current also becomes 0.

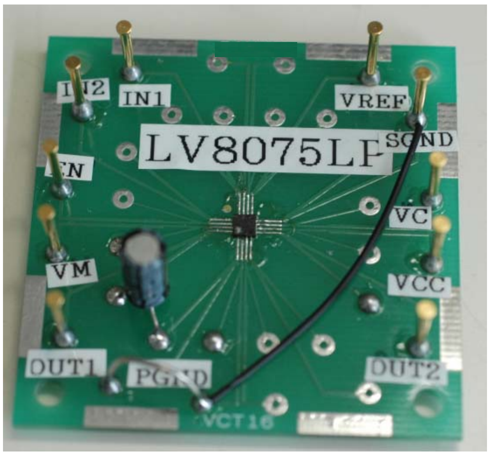
DC motor load VCC=VM=3V VC=3.0V
Current waveform example "active reverse brake current"

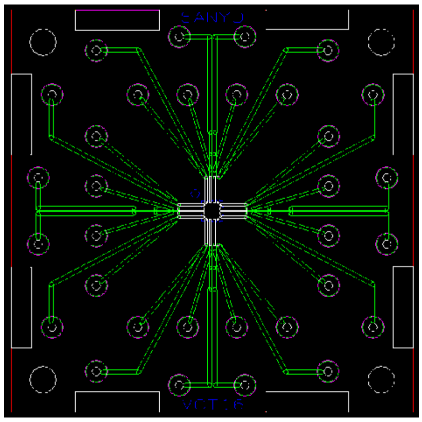


If a direction of rotation is switched while the DC motor is under rotation, torque for reverse rotation is generated. Therefore, the change of rotation takes place more abruptly.
In this case, since the voltage of VM is added as well as the induced voltage Ea that occurred during the motor rotation, the following current flows: Im= (VM+Ea) /Rcoil
Since this driving method generates the highest current at the startup of DC motor, if the current value exceeds the Iomax, it is recommended to set brake mode between forward and reverse to reduce induced voltage.

Evaluation board description



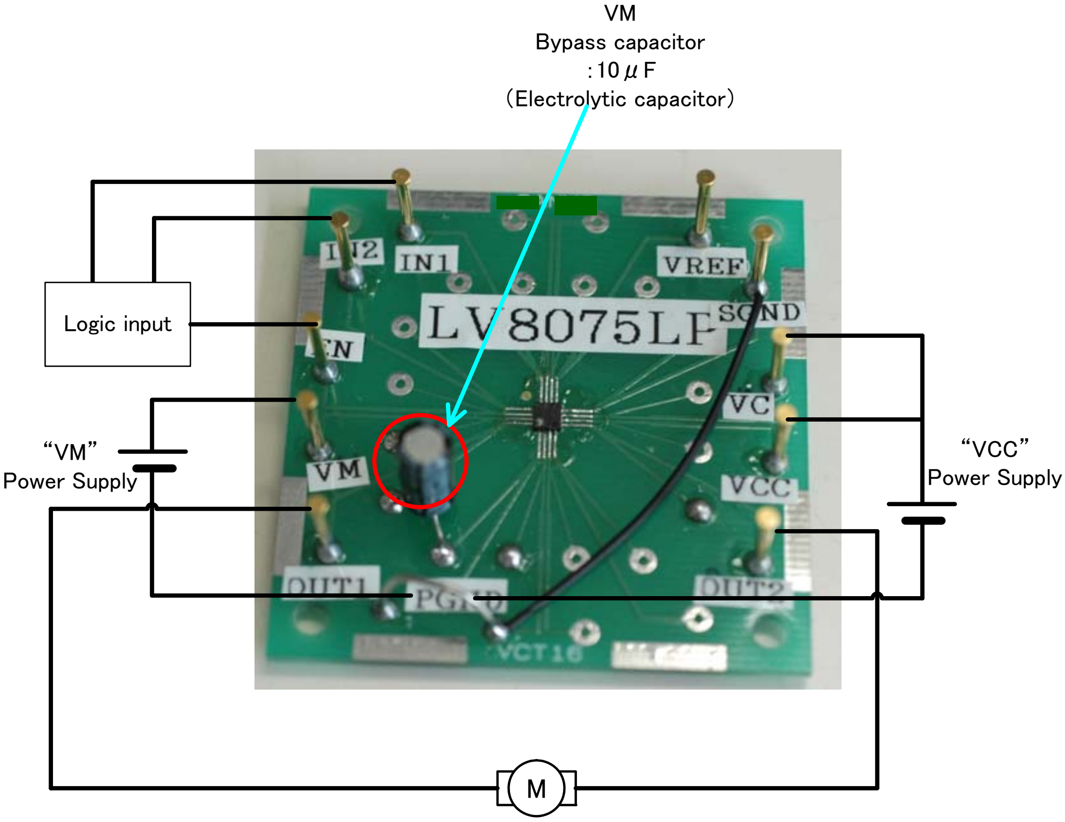




Bill of Materials for LV8075LP Evaluation Board

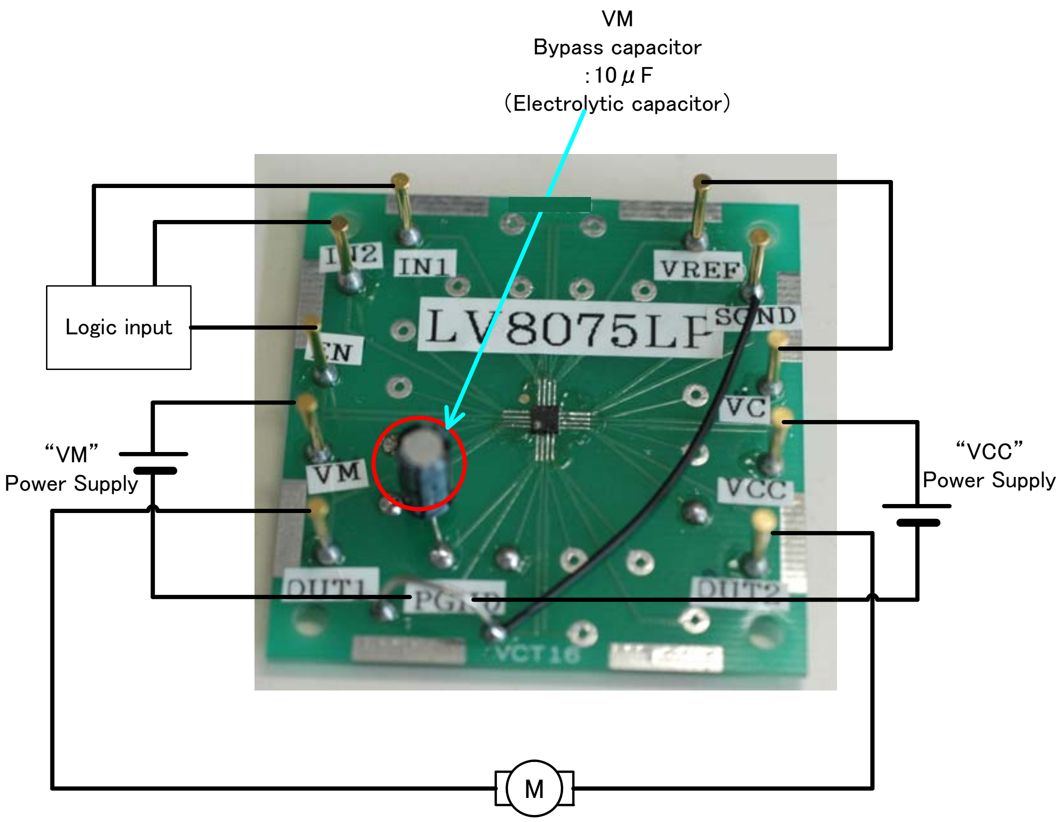
Designator	Qty	Description	Value	Tol	Footprint	Manufacturer	Manufacturer Part Number	Substitution Allowed	Lead Free
IC1	1	Motor Driver			VCT16	ON Semiconductor	LV8075LP	No	Yes
C1	1	VCC Bypass capacitor	10μF 50V			SUN Electronic Industries	50ME10HC	Yes	Yes
TP1-TP11	11	Test points				MAC8	ST-1-3	Yes	Yes

OUTPUT Full-Drive (VCC-VC short)

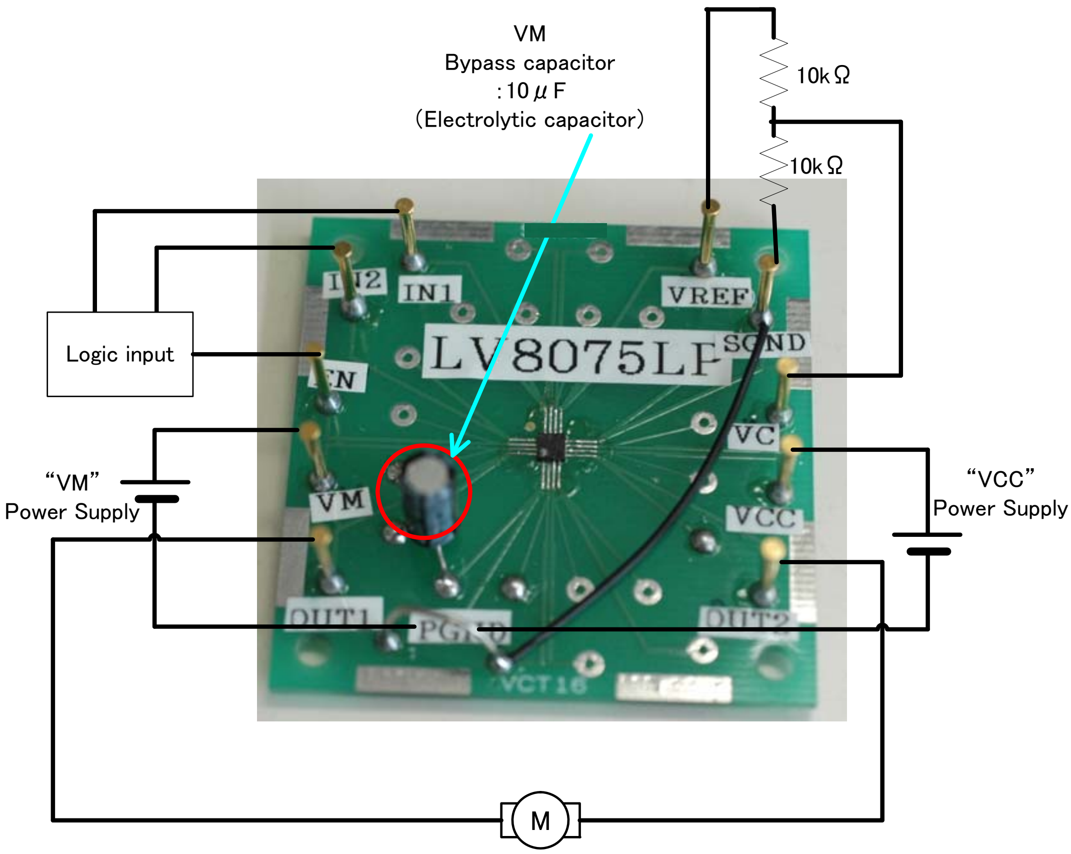


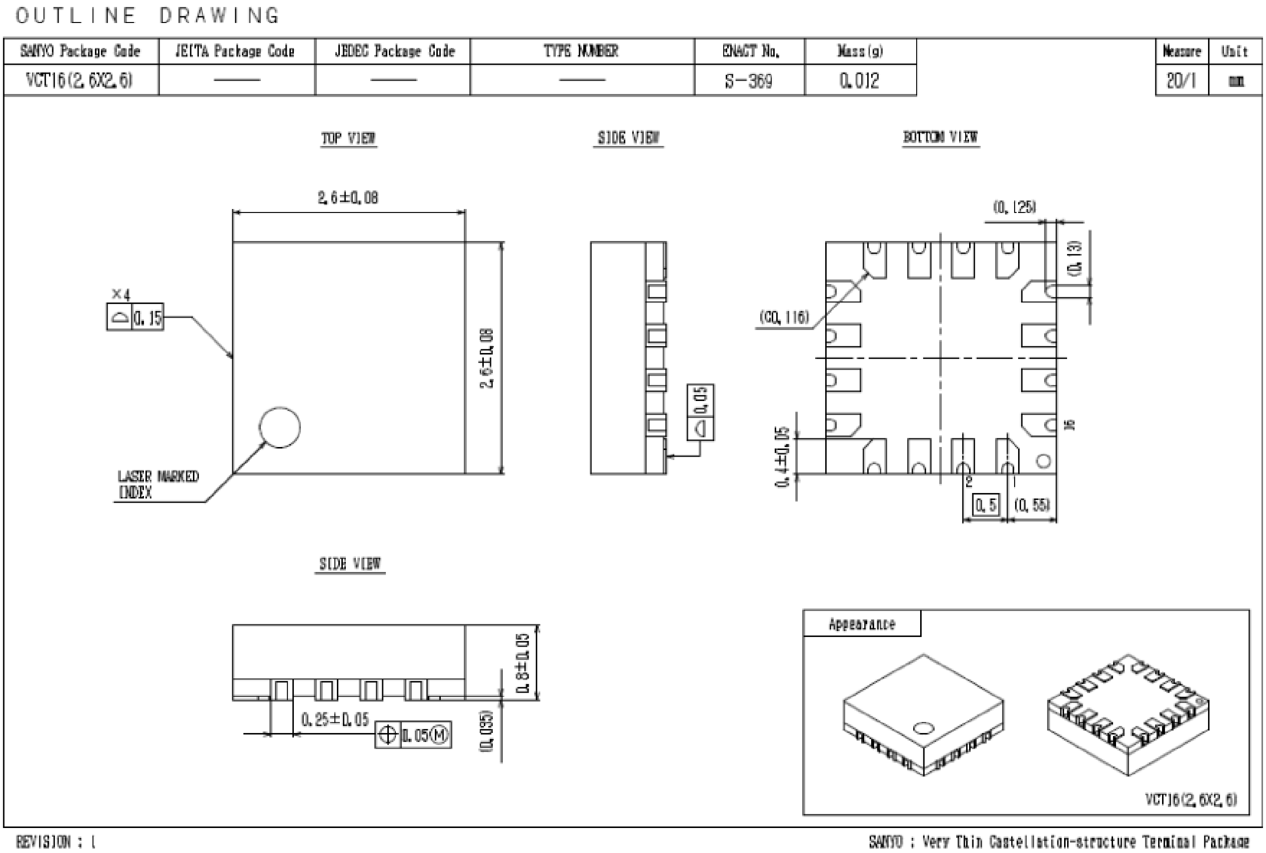
- Connect OUT1 and OUT2 to a DC motor each.
- Connect the motor power supply with the terminal VM, the control power supply with the terminal VCC. Connect the GND line with the terminal GND.
- DC motor becomes the predetermined output state corresponding to the input state by inputting a signal such as the following truth value table into EN, IN1, IN2.
- See the table in p.4 for further information on input logic.

OUTPUT constant voltage 3.0V drive (VREF-VC short)

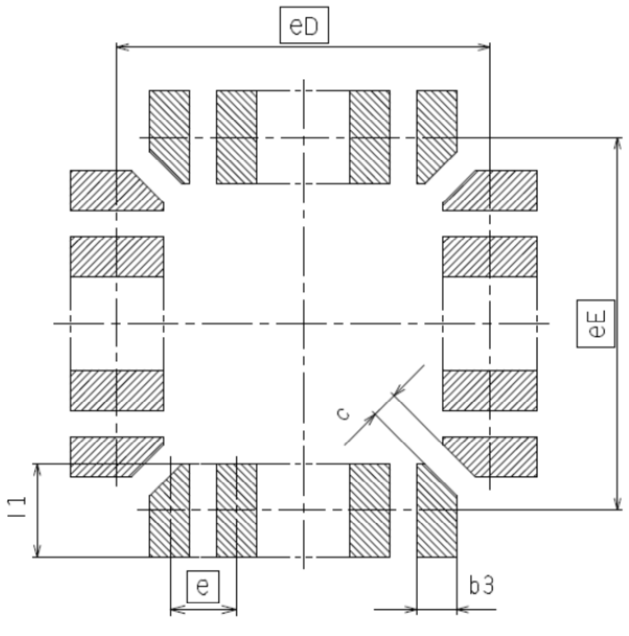


OUTPUT constant voltage 1.5V drive (VC voltage setting)





Recommended Soldering Footprint



(Unit:mm)

Reference symbol	Packages name				
	VCT/UCT16(2.6X2.6)	VCT/UCT20(2.6X2.6)	VCT/UCT20(3.0X3.0)	VCT/UCT24(3.0X3.0)	VCT/UCT24(3.5X3.5)
eD	2.30	2.30	2.70	2.70	3.20
eE	2.30	2.30	2.70	2.70	3.20
e	0.50	0.40	0.50	0.40	0.50
b_3	0.30	0.19	0.30	0.19	0.30
l_1	0.70	0.70	0.70	0.70	0.70
c	0.20	0.20	0.20	0.20	0.20