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# LB1845

## Monolithic Digital IC PWM Current Controlling Stepping Motor Driver

### Overview

The LB1845 is a PWM current control type stepping motor driver that uses a bipolar drive scheme. It is particularly suitable for driving carriage and paper feed stepping motors in printers and similar products.

### Features

- PWM current control (fixed off time scheme)
- Digital load current selection function
- Sustained output voltage: 45V
- Built-in thermal shutdown circuit

### Specifications

#### Absolute Maximum Ratings at $T_a = 25^\circ\text{C}$

Parameter	Symbol	Conditions	Ratings	Unit
Motor supply voltage	$V_{BB \text{ max}}$		45	V
Peak output current	$I_O \text{ peak}$	$t_W \leq 20\mu\text{s}$	1.75	A
Continuous output current	$I_O \text{ max}$		1.5	A
Logic block supply voltage	$V_{CC}$		7.0	V
Logic input voltage range	$V_{IN}$		-0.3 to $V_{CC}$	V
Emitter output voltage	$V_E$		1.0	V
Allowable power dissipation	$P_d \text{ max1}$	Independent IC	3.0	W
	$P_d \text{ max2}$	With an arbitrarily large heat sink	20.0	W
Operating temperature	$T_{opr}$		-20 to +85	$^\circ\text{C}$
Storage temperature	$T_{stg}$		-55 to +150	$^\circ\text{C}$

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.

# LB1845

## Recommended Operating Ranges at $T_a = 25^\circ\text{C}$

Parameter	Symbol	Conditions	Ratings	Unit
Motor supply voltage	$V_{BB}$		10 to 44.5	V
Logic block supply voltage	$V_{CC}$		4.75 to 5.25	V
Reference voltage	$V_{REF}$		1.5 to 7.5	V

## Electrical Characteristics at $T_a = 25^\circ\text{C}$ , $V_{BB} = 38\text{V}$ , $V_{CC} = 5\text{V}$ , $V_{REF} = 5\text{V}$

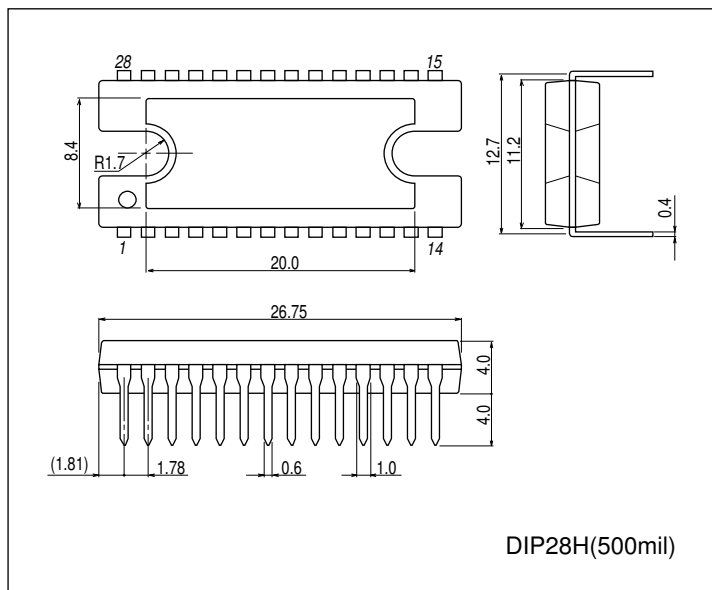
Parameter	Symbol	Conditions	Ratings			unit
			min	typ	max	
[Output Block]						
Output stage supply current	$I_{BB}$ ON			12	16	mA
	$I_{BB}$ OFF			0.7	0.9	
Output saturation voltage 1	$V_O(\text{sat})1$	$I_O = +1.0\text{A}$ Sink		1.2	1.4	V
	$V_O(\text{sat})2$	$I_O = +1.5\text{A}$ Sink		1.4	1.7	
	$V_O(\text{sat})3$	$I_O = -1.0\text{A}$ Source		1.1	1.3	
	$V_O(\text{sat})4$	$I_O = -1.5\text{A}$ Source		1.3	1.6	
Output leakage current	$I_O(\text{leak})1$	$V_O = V_{BB}$ Sink			50	$\mu\text{A}$
	$I_O(\text{leak})2$	$V_O = 0\text{V}$ Source	-50			
Sustained output voltage	$V(\text{sus})$	*	45			V
[Logic Block]						
Logic supply current	$I_{CC}$ ON	$I_O = 0.8\text{V}$ , $I_1 = 0.8\text{V}$		19.5	25.3	mA
	$I_{CC}$ OFF	$I_O = 2.4\text{V}$ , $I_1 = 2.4\text{V}$		15.5	20.1	
Input voltage	$V_{IH}$		2.4			V
	$V_{IL}$				0.8	
Input current	$I_{IH}$	$V_{IH} = 2.4\text{V}$			10	$\mu\text{A}$
	$I_{IL}$	$V_{IL} = 0.8\text{V}$	-10			
Current control threshold voltage	$V_{REF}/V_{SENSE}$	$I_O = 0.8\text{V}$ , $I_1 = 0.8\text{V}$	9.5	10	10.5	
		$I_O = 2.4\text{V}$ , $I_1 = 0.8\text{V}$	13.5	15	16.5	
		$I_O = 0.8\text{V}$ , $I_1 = 2.4\text{V}$	25.5	30	34.5	
Thermal shutdown temperature	$T_S$			170		$^\circ\text{C}$

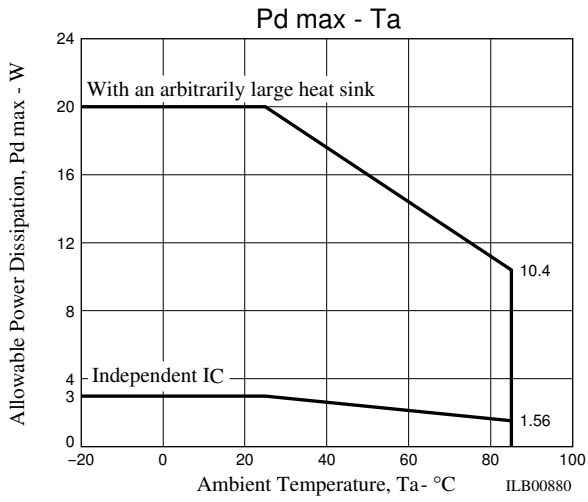
\* Note: Design guaranteed value.

## Package Dimensions

unit: mm (typ)

3147C





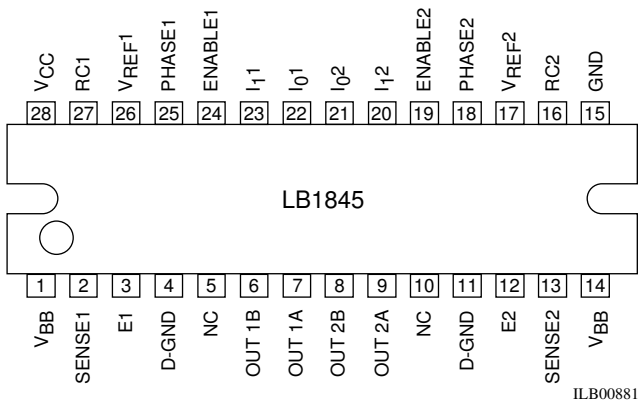
**Truth Table**

ENABLE	PHASE	OUTA	OUTB
L	H	H	L
L	L	L	H
H	-	OFF	OFF

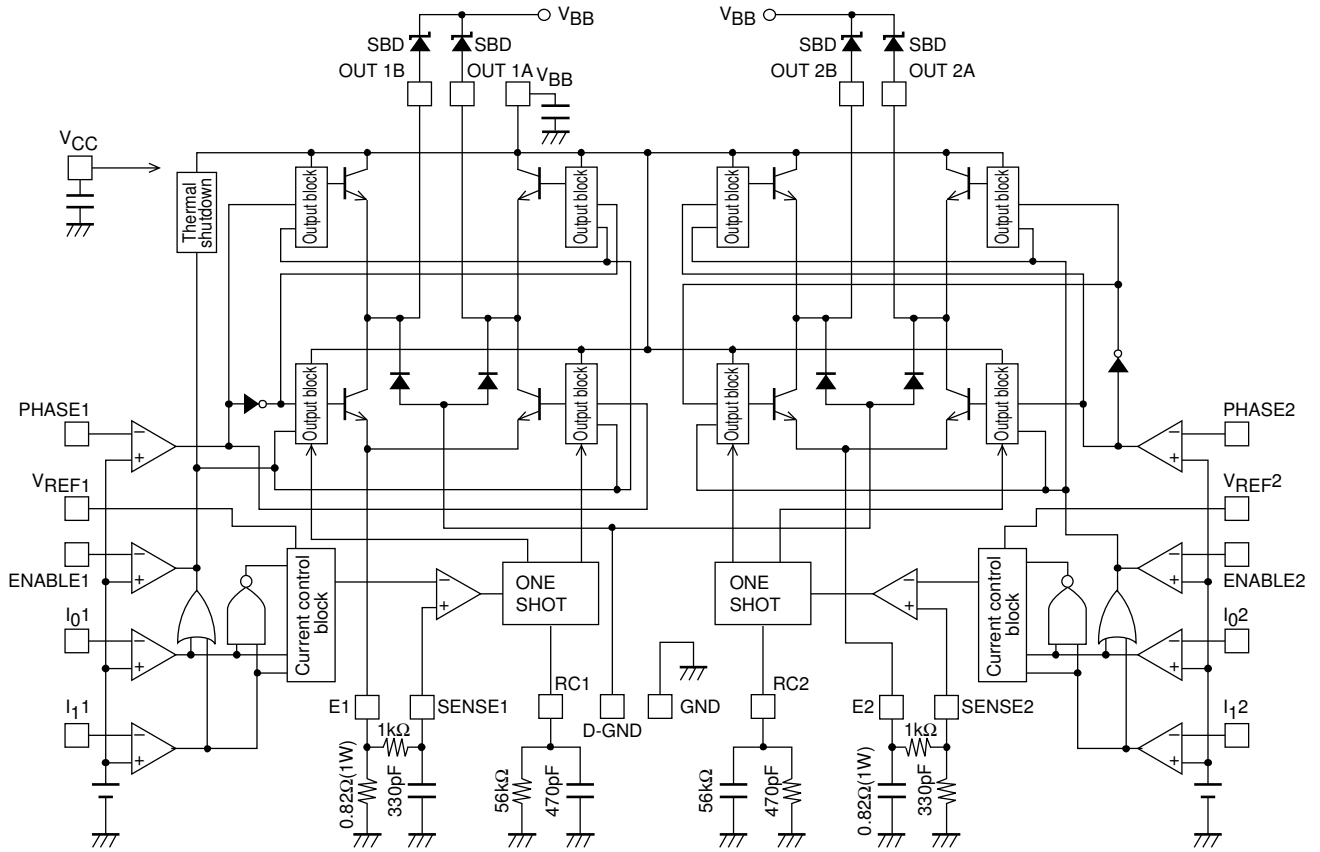
I <sub>0</sub>	I <sub>1</sub>	Output Current
L	L	$V_{REF}/(10 \times R_E) = I_{OUT}$
H	L	$V_{REF}/(15 \times R_E) = I_{OUT} \times 2/3$
L	H	$V_{REF}/(30 \times R_E) = I_{OUT} \times 1/3$
H	H	0

Note: Outputs is OFF when ENABLE is high or in the I<sub>0</sub> = I<sub>1</sub> = high state.

**Pin Assignment**

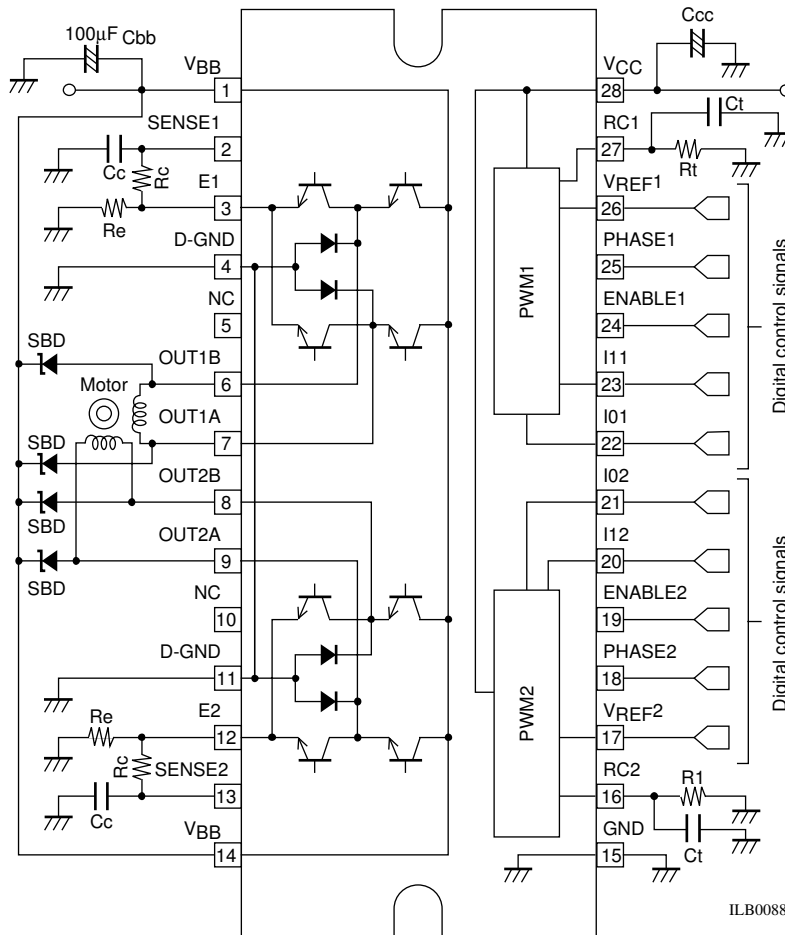


Block Diagram



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Application Circuit Diagram



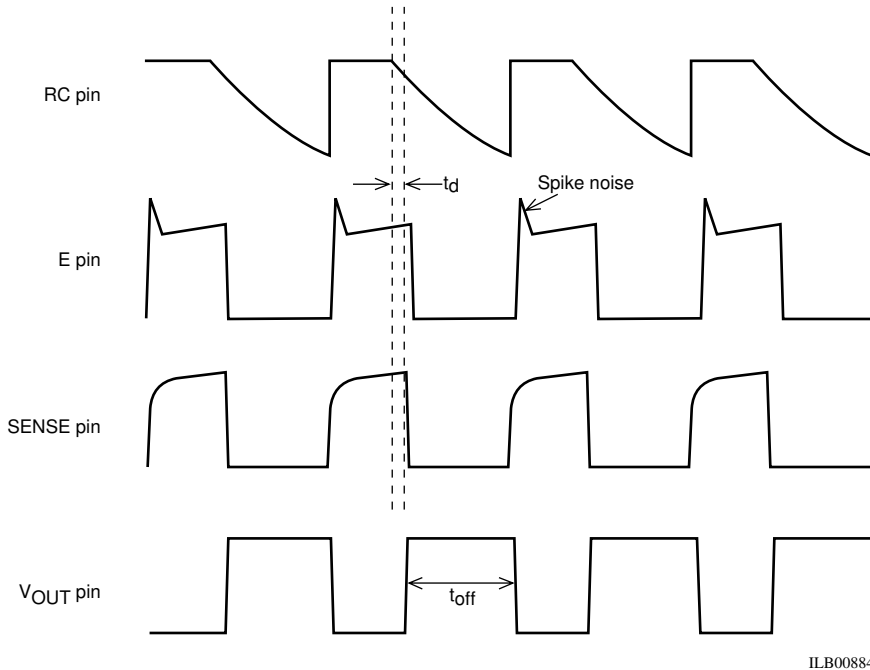
Off time setting values  
 $t_{off} = C_t R_t$   
 $R_e = 0.82\Omega(1W)$   
 $V_{REF} = 5V$   
 $R_t = 56k\Omega$   
 $C_t = 470pF$   
 $R_c = 1k\Omega$   
 $C_c = 330pF$   
 $C_{bb} = 100\mu F$

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**Pin Description**

Pin No	Pin	Function
1, 14	V <sub>BB</sub>	Output stage power-supply voltage
2 13	SENSE1 SENSE2	Set current detection pins. Connect these pins, fed back through noise filters, to E1 and E2.
3 12	E1 E2	The set current is controlled by the resistors R <sub>e</sub> inserted between these pins and ground.
4, 11	D-GND	Internal diode anode connection
6 7 8 9	OUT1B OUT1A OUT2B OUT2A	Outputs
15	GND	Ground
27 16	RC1 RC2	Used to set the output off time for the switched output signal. The fixed off times are set by the capacitors and resistors connected to these pins. $t_{off} = CR$ .
26 17	V <sub>REF1</sub> V <sub>REF2</sub>	Output current settings The output current is determined by the voltage (in the range 1.5 to 7.5V) input to these pins.
25 18	PHASE1 PHASE2	Output phase switching inputs. High-level input: OUTA = high, OUTB = low Low-level input: OUTA = low, OUTB = high
24 19	ENABLE1 ENABLE2	Output on/off settings High-level input: output off Low-level input: output on
22, 23 21, 20	I <sub>01</sub> , I <sub>11</sub> I <sub>02</sub> , I <sub>12</sub>	Digital inputs that set the output current The output currents can be set to 1/3, 2/3, or full by setting these pins to appropriate combinations of high and low levels.
28	V <sub>CC</sub>	Logic block power supply

**Timing chart for pin switching operations during PWM drive**



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Figure 1 Switching Waveforms

$t_{off}$ : Output off time. Determined by external capacitor and resistor C<sub>t</sub> and R<sub>t</sub>. ( $t_{off} \approx C_t \times R_t$ )

$t_d$ : Delay time between the point the set current is sensed at the SENSE pin and the point the output turns off.

## Usage Notes

### 1. External diode

Since this IC adopts a system based on lower side transistor switching drive, an external diode for the regenerative current that occurs during switching is required between  $V_{BB}$  and  $V_{OUT}$ . Use a Schottky barrier diode with a low feedthrough current.

### 2. Noise filters

Since spike noise (see Figure 1) occurs when switching to the on state due to the external diode's feedthrough current, applications must remove noise from the SENSE pin with a noise filter ( $C_c$ ,  $R_c$ ) between the E pin and the SENSE pin.

However, note that if the values of  $C_c$  and  $R_c$  are too large, the SENSE voltage rise will be slowed, and the current setting will be shifted towards a higher current level.

### 3. $V_{REF}$ pin

It is possible to change the output current continuously by continuously changing the  $V_{REF}$  pin voltage. However, this voltage cannot be set to 0V. The  $V_{REF}$  pin input impedance is  $26k\Omega$  ( $\pm 30\%$ ) when  $V_{REF}$  is 5V. Since this pin is used to set the output current, applications must be designed so that noise does not appear on this pin's input.

### 4. GND pin

Since this IC switches large currents, care must be taken to avoid ground loops when the IC is mounted in the application. The section of the PCB that handles large currents should be designed with a low-impedance pattern, and must be separated from the small signal sections of the circuit. In particular, the ground for the sense resistor  $R_e$  must be as close as possible to the IC ground.

### 5. Operation in hold mode

There are cases where a current somewhat larger than the current setting may flow in hold mode (light load mode). Since this IC adopts a lower side switching, lower side sense system, the emitter voltage falls and the sense voltage goes to 0 when the switching state goes to off. The circuit then always turns the output on after the toff period has elapsed. At this time, due to the light load, the existence of the time  $t_d$ , and the fact that the output goes on even if the output current is higher than the set current, the output current will be somewhat higher than the set current.

Applications should set the current setting somewhat lower than required if this occurs.

### 6. Function for preventing the upper and lower outputs being on at the same time

This IC incorporates a built-in circuit that prevents the through currents that occur when the phase is switched. The table lists the output on and off delay times when PHASE and EANBLE are switched.

		Sink side	Source side
When PHASE is switched	On delay time	10 $\mu$ s	9 $\mu$ s
	Off delay time	1.5 $\mu$ s	3 $\mu$ s
When ENABLE is on	On delay time	9 $\mu$ s	9 $\mu$ s
	Off delay time	1.5 $\mu$ s	6.5 $\mu$ s

### 7. 1-2 phase excitation and the double 1-2 phase excitation control sequence

To reduce the vibration that occurs when the motor turns, this IC supports 1-2 phase excitation and double 1-2 phase excitation by using the output current setting digital input pins  $I_0$  and  $I_1$  without changing the  $V_{REF}$  pin voltage.

Tables 1 and 2 list that control sequence, and Figure 2 and Figure 3 present the composite vector diagram for this sequence.

### 2. Noise filters

**Table 1 [1-2 phase excitation] 1/2 Step**

ENABLE1 = ENABLE2 = 0

No	Phase A				Phase B			
	PH1	I <sub>11</sub>	I <sub>01</sub>	Current Value	PH2	I <sub>12</sub>	I <sub>02</sub>	Current Value
0	0	0	0	1	*	1	1	0
1	0	0	1	2/3	0	0	1	2/3
2	*	1	1	0	0	0	0	1
3	1	0	1	2/3	0	0	1	2/3
4	1	0	0	1	*	1	1	0
5	1	0	1	2/3	1	0	1	2/3
6	*	1	1	0	1	0	0	1
7	0	0	1	2/3	1	0	1	2/3

**Table 2 [Double 1-2 phase excitation] about 1/4 Step**

ENABLE1 = ENABLE2 = 0

No	Phase A				Phase B			
	PH1	I <sub>11</sub>	I <sub>01</sub>	Current Value	PH2	I <sub>12</sub>	I <sub>02</sub>	Current Value
0	0	0	0	1	*	1	1	0
1	0	0	0	1	0	1	0	1/3
2	0	0	1	2/3	0	0	1	2/3
3	0	1	0	1/3	0	0	0	1
4	*	1	1	0	0	0	0	1
5	1	1	0	1/3	0	0	0	1
6	1	0	1	2/3	0	0	1	2/3
7	1	0	0	1	0	1	0	1/3
8	1	0	0	1	*	1	1	0
9	1	0	0	1	1	1	0	1/3
10	1	0	1	2/3	1	0	1	2/3
11	1	1	0	1/3	1	0	0	1
12	*	1	1	0	1	0	0	1
13	0	1	0	1/3	1	0	0	1
14	0	0	1	2/3	1	0	1	2/3
15	0	0	0	1	1	1	0	1/3

**Composite Vector Diagram**

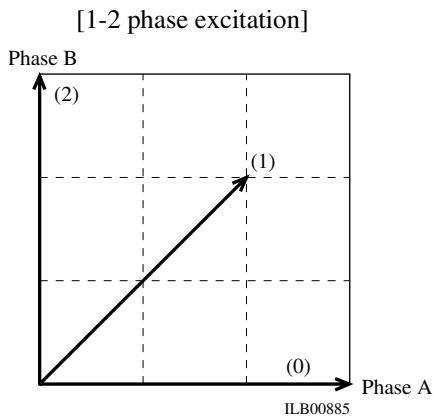


Figure 2 Composite Vector Diagram for the Sequence in Table 1 (1/4 cycle)

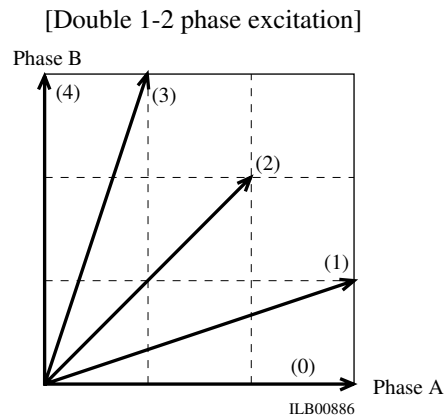
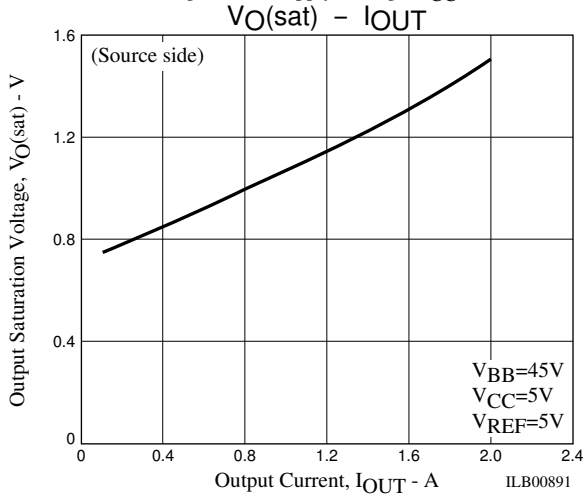
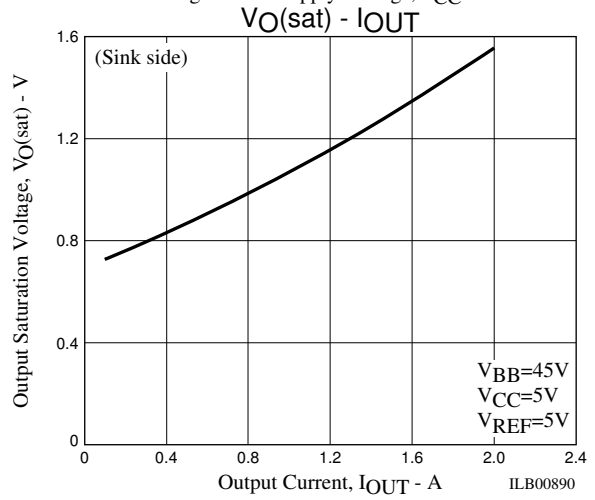
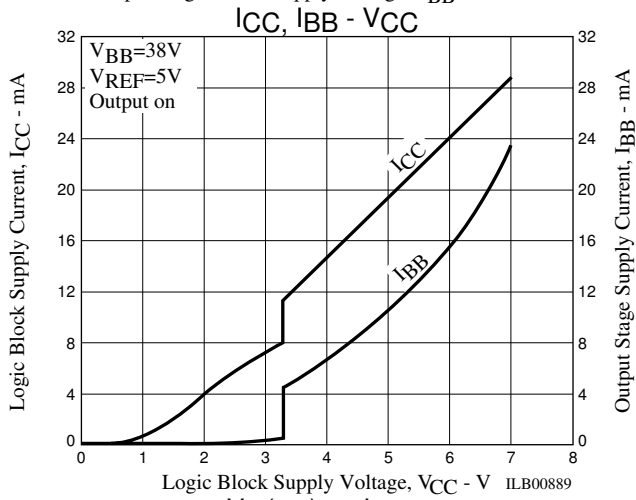
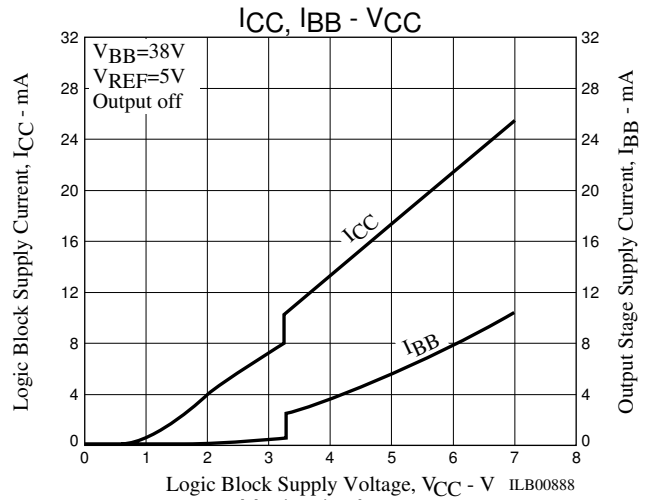
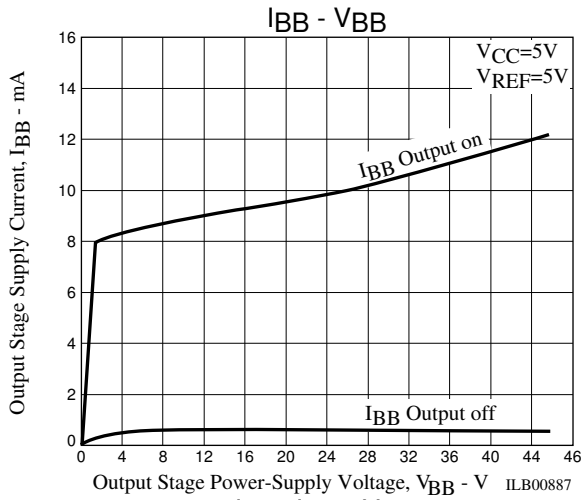


Figure 3 Composite Vector Diagram for the Sequence in Table 2 (1/4 cycle)





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