



SANYO Semiconductors

DATA SHEET

An ON Semiconductor Company

LB1945D — Monolithic Digital IC PWM Current Control Stepping Motor Driver

Overview

The LB1945D is a PWM current control stepping motor driver that uses a bipolar drive technique. It is optimal for use with the carriage and paper feed stepping motors used in printers.

Functions and Features

- PWM current control (external clock)
- Digital load current selection function (supports 1-2, W1-2, and 2-phase excitation)
- Built-in high and low side diodes
- Simultaneous on state prevention function (through-current prevention)
- Built-in thermal shutdown circuit
- Noise canceling function

Specifications

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

| Parameter | Symbol | Conditions | Ratings | Unit |
|------------------------------|--------------|-------------------------|------------------|------------------|
| Motor supply voltage | V_{BB} max | | 30 | V |
| Output peak current | I_O peak | $tW \leq 20\mu\text{s}$ | 1.0 | A |
| Output continuous current | I_O max | | 0.8 | A |
| Logic system supply voltage | V_{CC} max | | 6.0 | V |
| Logic input voltage range | V_{IN} | | -0.3 to V_{CC} | V |
| Emitter output voltage range | V_E | | 1.0 | V |
| Allowable power dissipation | P_d max | Independent IC | 2.8 | W |
| Operating temperature | T_{opr} | | -20 to +90 | $^\circ\text{C}$ |
| Storage temperature | T_{stg} | | -55 to +150 | $^\circ\text{C}$ |

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LB1945D

Recommended Operating Range at Ta = 25°C

| Parameter | Symbol | Conditions | Ratings | Unit |
|-----------------------------|------------------|------------|--------------|------|
| Motor supply voltage | V _{BB} | | 10 to 28 | V |
| Logic system supply voltage | V _{CC} | | 4.75 to 5.25 | V |
| Reference voltage | V _{REF} | | 1.5 to 5.0 | V |

Electrical Characteristics at Ta = 25°C, V_{BB} = 24V, V_{CC} = 5V, V_{REF} = 5V

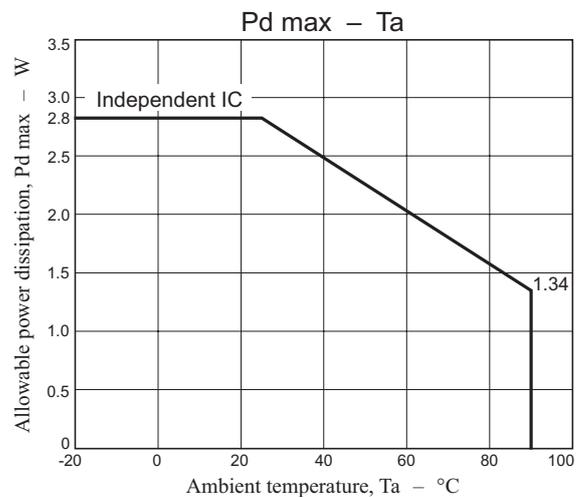
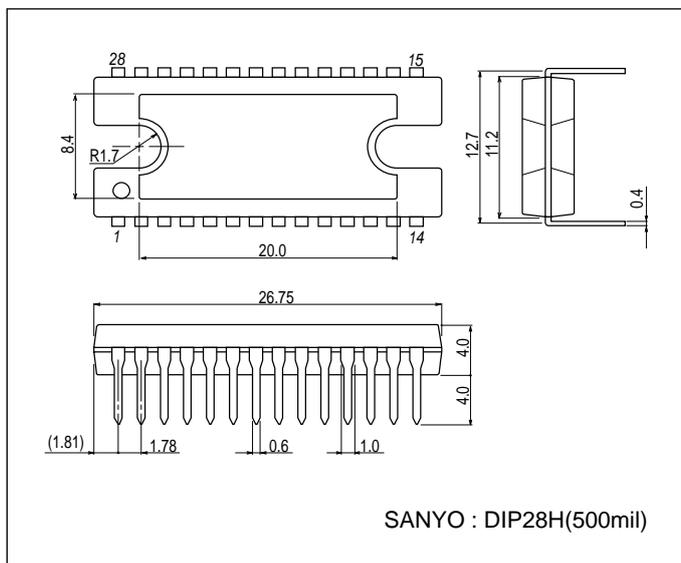
| Parameter | Symbol | Conditions | Ratings | | | Unit |
|-------------------------------------|--|--|---------------------|----------------|----------------------|------|
| | | | min | typ | max | |
| Output block | | | | | | |
| Output stage supply current | I _{BB ON} I _{BB OFF} | I ₁ = 0.8V, I ₂ = 0.8V, ENABLE = 0.8V ENABLE = 3.2V | 0.5 | 1.0 | 2.0 0.2 | mA |
| Output saturation voltage 1 | V _{O sat1} | I _O = +0.5A, sink side | | 0.3 | 0.5 | V |
| Output saturation voltage 2 | V _{O sat2} | I _O = +0.8A, sink side | | 0.5 | 0.7 | V |
| Output saturation voltage 3 | V _{O sat3} | I _O = -0.5A, source side | | 1.6 | 1.8 | V |
| Output saturation voltage 4 | V _{O sat4} | I _O = -0.8A, source side | | 1.8 | 2.0 | V |
| Output leakage current | V _{O1(leak)} V _{O2(leak)} | V _O = V _{BB} , sink side V _O = 0V, source side | -50 | | 50 | μA |
| Output sustain voltage | VSUS | L = 3.9mH, I _O = 1.0A* | 30 | | | V |
| Logic block | | | | | | |
| Logic supply current | I _{CC ON} I _{CC OFF} | I ₁ = 0.8V, I ₂ = 0.8V, ENABLE = 0.8V ENABLE = 3.2V | 50 7 | 70.0 10.0 | 92 13 | mA |
| Input voltage | V _{IH} V _{IL} | | 3.2 | | 1.8 | V |
| Input current | I _{IH} I _{IL} | V _{IH} = 3.2V V _{IL} = 0.8V | 35 7 | 50 10 | 65 13 | μA |
| Set current control threshold value | V _{REF} / V _{SEN} | I ₁ = 0.8V, I ₂ = 0.8V I ₁ = 3.2V, I ₂ = 0.8V I ₁ = 0.8V, I ₂ = 3.2V | 9.5 13.5 25.5 | 10 15 30 | 10.5 16.5 34.5 | |
| Reference current | I _{REF} | V _{REF} = 5.0V, I ₁ = 0.8V, I ₂ = 0.8V | 17.5 | 25 | 32.5 | μA |
| CR pin current | I _{CR} | CR = 1.0V | -1.0 | | | μA |
| Thermal shutdown temperature | TS | | | 170 | | °C |
| Thermal shutdown hysteresis | TSHY | | | 40 | | °C |

*: The design specification items are design guarantees and are not measured.

Package Dimensions

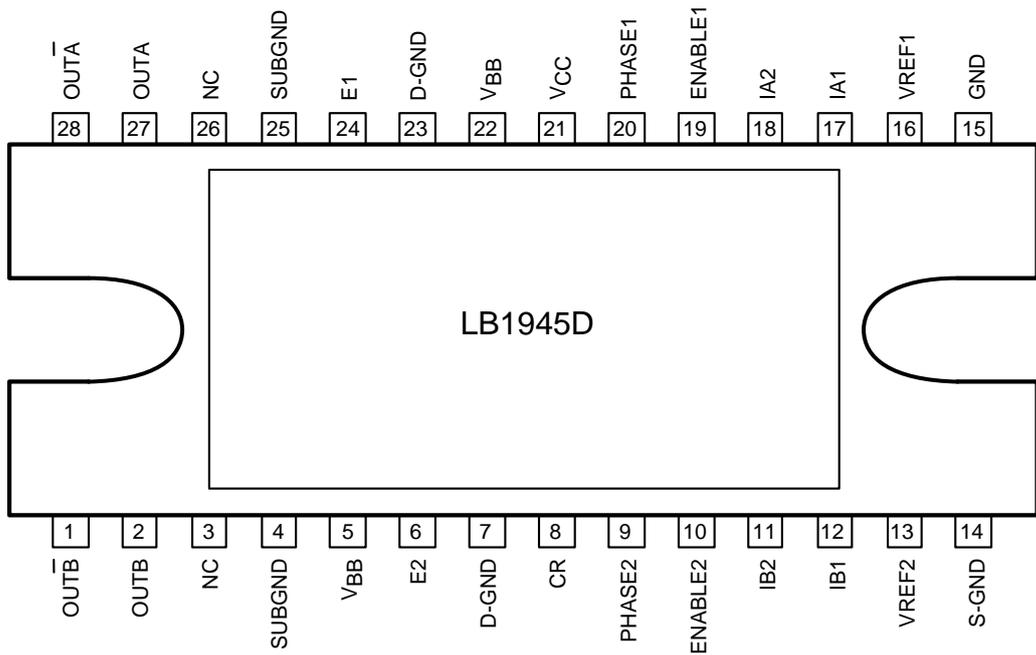
unit:mm (typ)

3147C



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Pin Assignment

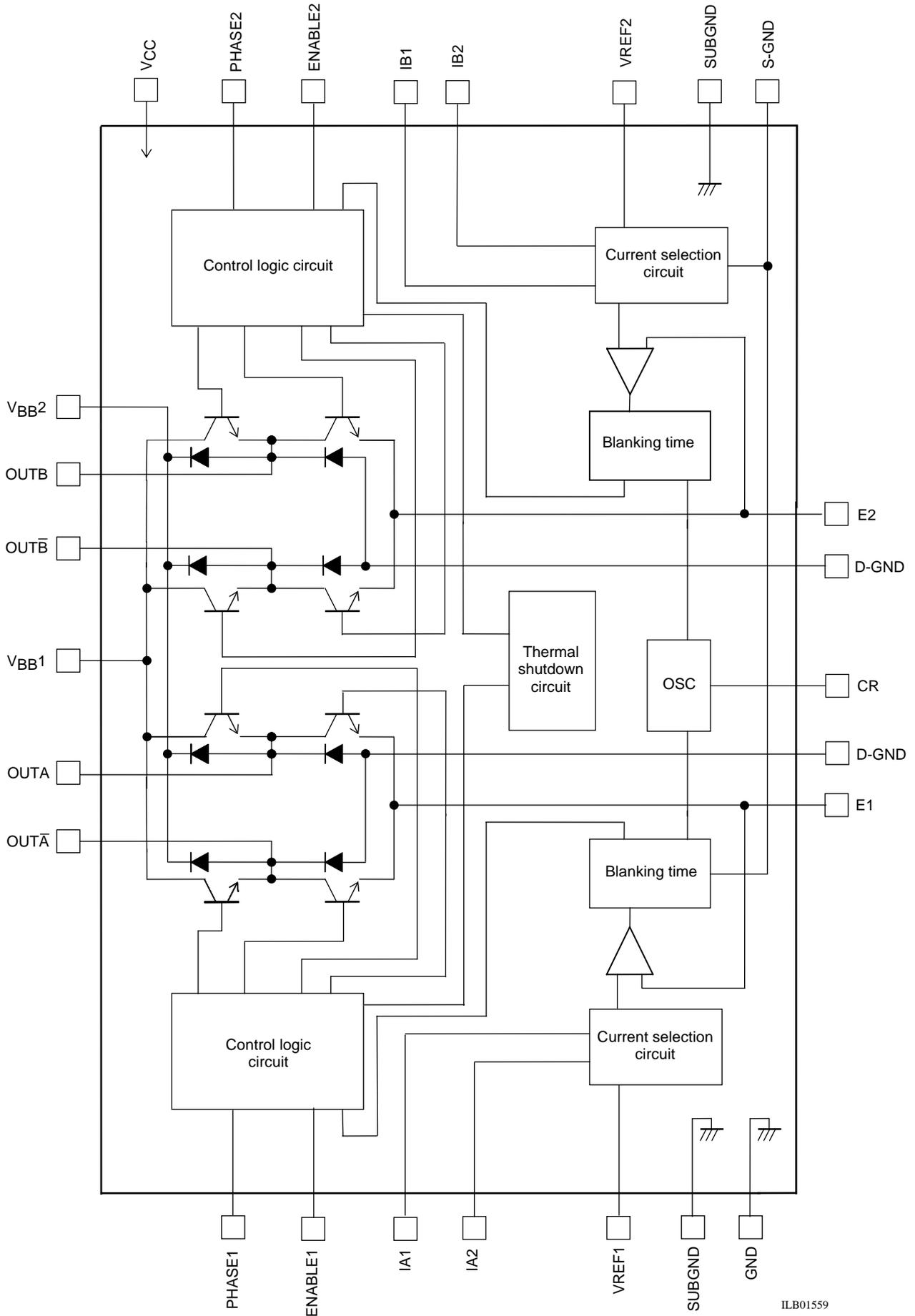


Pin Functions

| Pin No. | Pin | Description |
|---------|------------------|---|
| 22 | V _{BB1} | Output stage power supply voltage |
| 5 | V _{BB2} | High side diode cathode connection |
| 24 | E1 | The set current is controlled by inserting resistors R _E between these pins and ground. |
| 6 | E2 | |
| 27 | OUTA | Output pins |
| 28 | OUT \bar{A} | |
| 2 | OUTB | |
| 1 | OUT \bar{B} | |
| 15 | GND | Ground |
| 14 | S-GND | Sense ground |
| 4, 25 | SUBGND | IC sub-ground |
| 23 | D-GND | Low side built-in diode ground (anode side) |
| 7 | | |
| 8 | CR | Chopping is performed at the period of a triangle wave set by the RC circuit connected to this pin. The triangle wave off time is the noise cancellation time. |
| 16 | VREF1 | Output current settings. (The output current is determined by providing an input in the range 1.5V to 5V.) |
| 13 | VREF2 | |
| 20 | PHASE1 | Output phase switching inputs High-level input: OUTA = high, OUT \bar{A} = low Low-level input: OUTA = low, OUT \bar{A} = high |
| 9 | PHASE2 | |
| 19 | ENABLE1 | Output on/off control inputs High-level input: Output off Low-level input: Output on |
| 10 | ENABLE2 | |
| 17, 18 | IA1, IA2 | Output current setting digital inputs. The output current is set to 1/3, 2/3 or 1 by input high/low levels to these pins. |
| 12, 11 | IB1, IB2 | |
| 21 | V _{CC} | Logic block power supply voltage |

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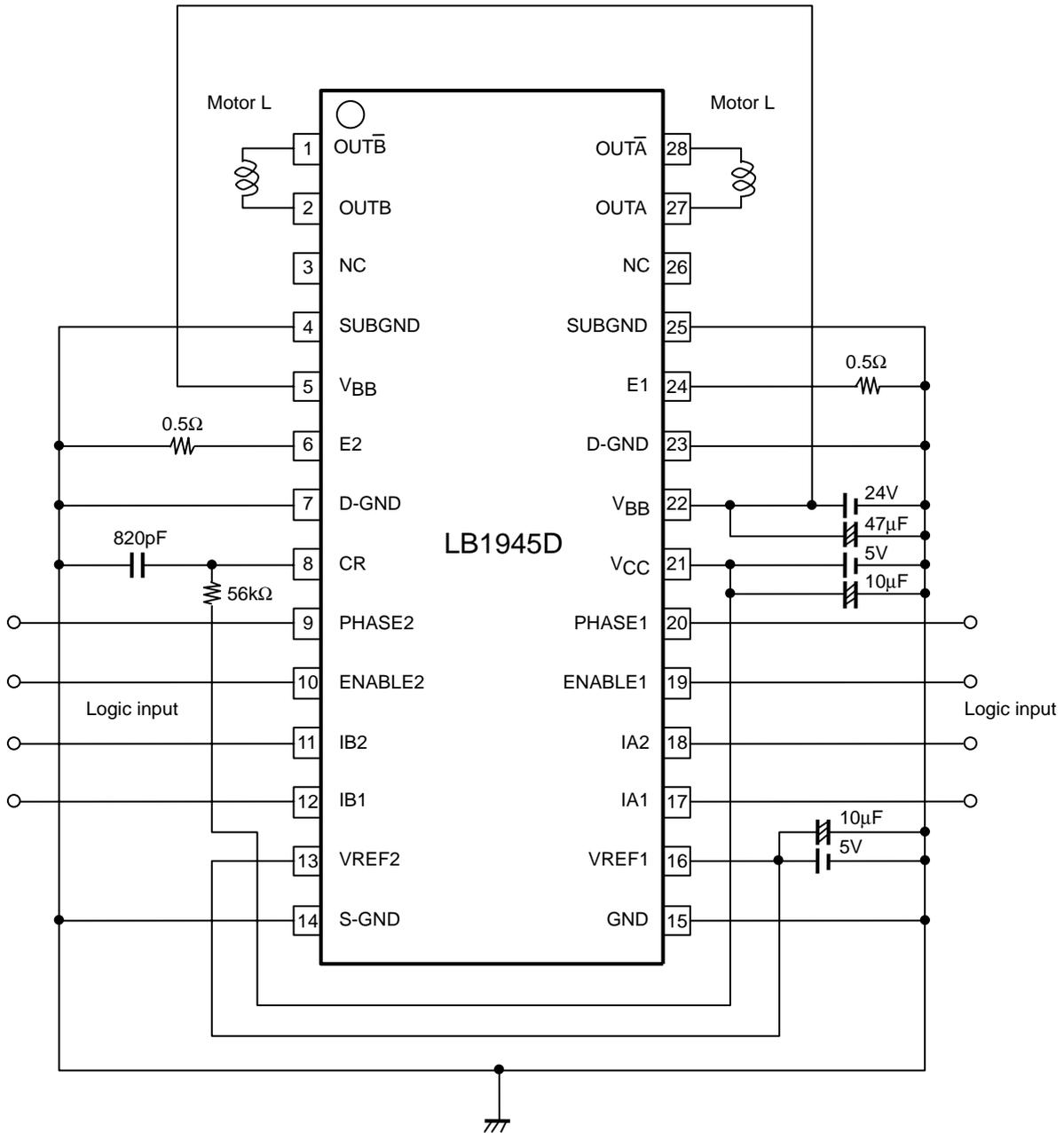
Block Diagram



ILB01559

LB1945D

Application circuit



ILB01556

Truth Table

| ENABLE | PHASE | OUTA | OUT \bar{A} |
|--------|-------|------|---------------|
| Low | High | High | Low |
| Low | Low | Low | High |
| High | - | OFF | OFF |

| I ₁ | I ₂ | Output current |
|----------------|----------------|--|
| Low | Low | $V_{ref}/(10 \times R_E) = I_{OUT}$ |
| High | Low | $V_{ref}/(15 \times R_E) = I_{OUT} \times 2/3$ |
| Low | High | $V_{ref}/(30 \times R_E) = I_{OUT} \times 1/3$ |
| High | High | 0 |

Note: The output is turned off when ENABLE is high or in the I₁ = I₂ = high state.

Clockwise/counterclockwise Operating Sequence
2-phase excitation drive

Clockwise rotation

IA1 = IA2 = IB1 = IB2 = 0

| No. | PHASE1 | OUTA | OUT \bar{A} | PHASE2 | OUTB | OUT \bar{B} |
|-----|--------|------|---------------|--------|------|---------------|
| 0 | 0 | 0 | 1 | 0 | 0 | 1 |
| 1 | 1 | 1 | 0 | 0 | 0 | 1 |
| 2 | 1 | 1 | 0 | 1 | 1 | 0 |
| 3 | 0 | 0 | 1 | 1 | 1 | 0 |

Counterclockwise rotation

IA1 = IA2 = IB1 = IB2 = 0

| No. | PHASE1 | OUTA | OUT \bar{A} | PHASE2 | OUTB | OUT \bar{B} |
|-----|--------|------|---------------|--------|------|---------------|
| 0 | 0 | 0 | 1 | 1 | 1 | 0 |
| 1 | 1 | 1 | 0 | 1 | 1 | 0 |
| 2 | 1 | 1 | 0 | 0 | 0 | 1 |
| 3 | 0 | 0 | 1 | 0 | 0 | 1 |

Control Sequence
2-phase excitation

Table 1

ENABLE1 = ENABLE2 = 0

| NO | Phase A | | | | Phase B | | | |
|----|---------|-----|-----|---------------|---------|-----|-----|---------------|
| | PH1 | IA2 | IA1 | Current value | PH2 | IB2 | IB1 | Current value |
| 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 1 |
| 1 | 1 | 0 | 0 | 1 | 0 | 0 | 0 | 1 |
| 2 | 1 | 0 | 0 | 1 | 1 | 0 | 0 | 1 |
| 3 | 0 | 0 | 0 | 1 | 1 | 0 | 0 | 1 |

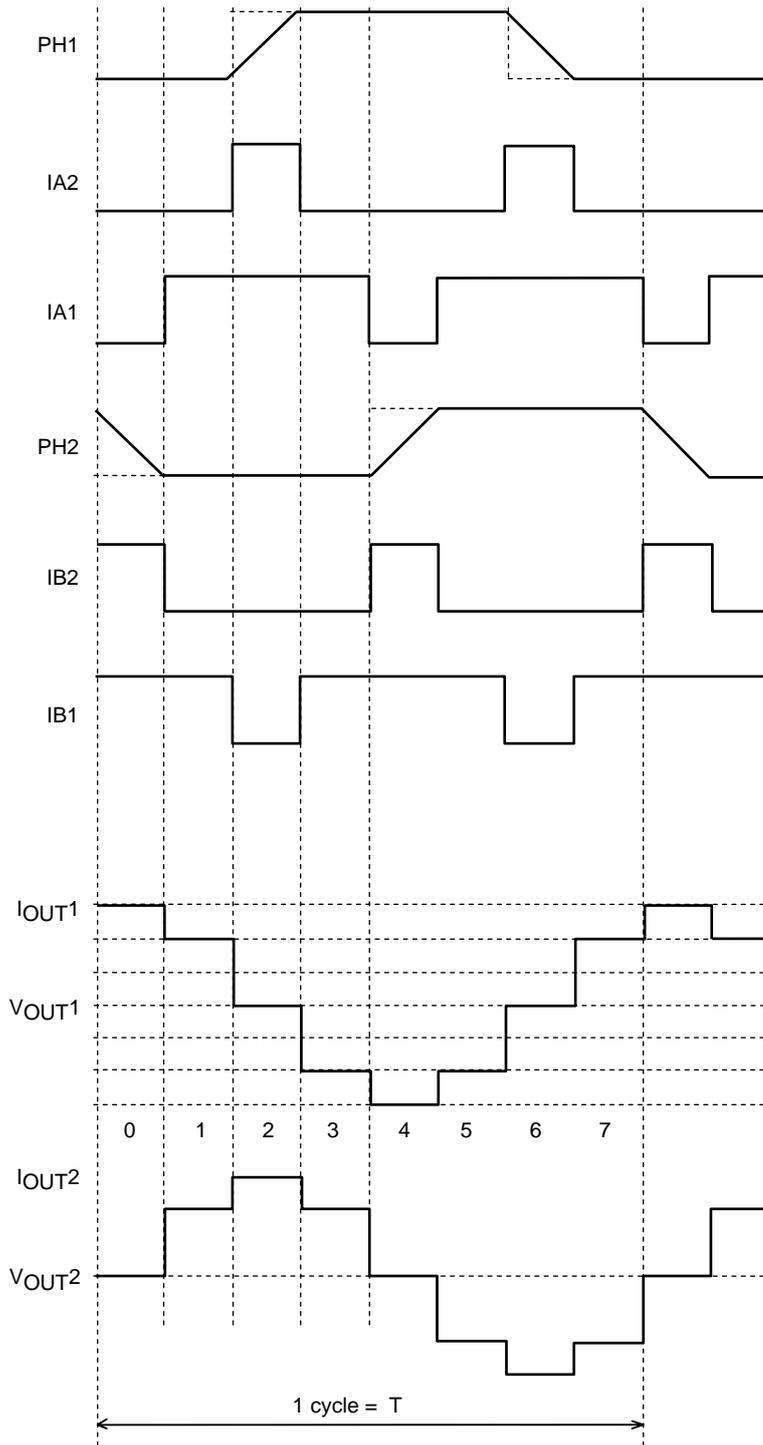
1-2 phase excitation - 1/2 step

Table 2

ENABLE1 = ENABLE2 = 0

| No. | Phase A | | | | Phase B | | | |
|-----|---------|-----|-----|---------------|---------|-----|-----|---------------|
| | PH1 | IA2 | IA1 | Current value | PH2 | IB2 | IB1 | 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 |

1-2 phase Excitation Timing Chart



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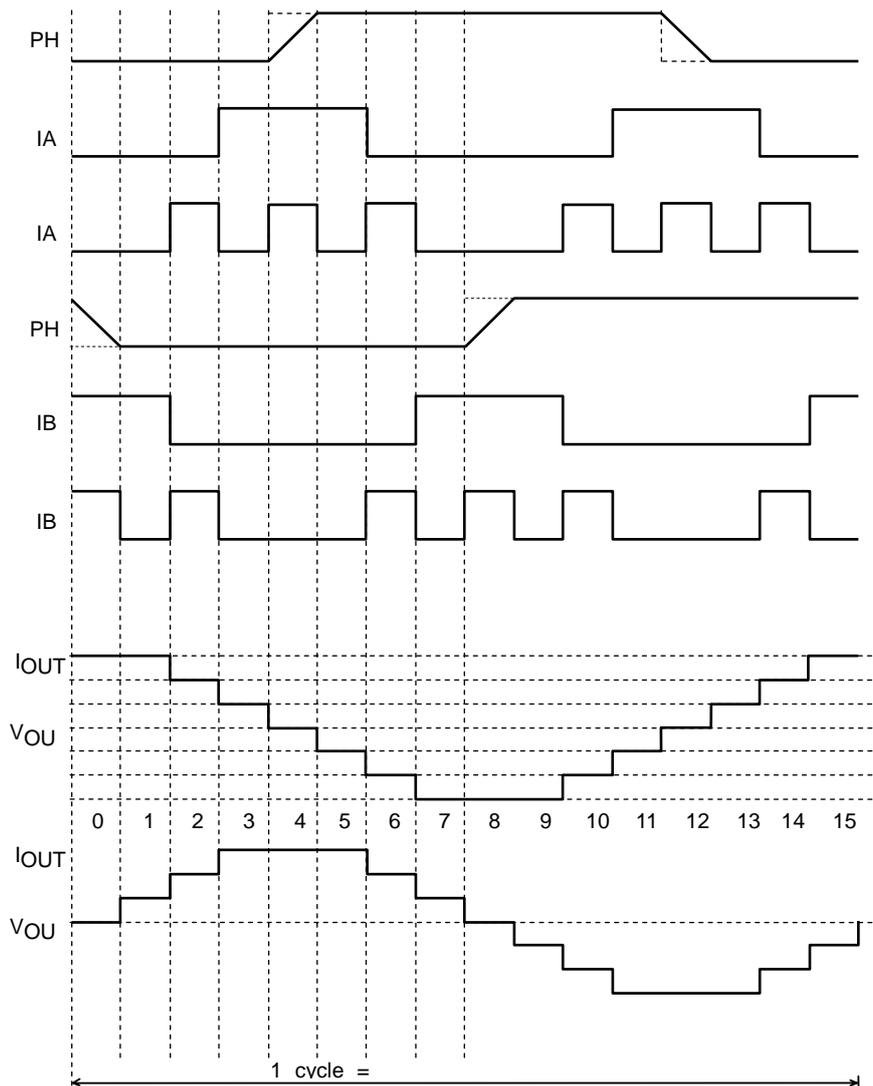
W1-2 phase excitation - about 1/4 step

Table 3

ENABLE1 = ENABLE2 = 0

| NO | Phase A | | | | Phase B | | | |
|----|---------|-----|-----|---------------|---------|-----|-----|---------------|
| | PH1 | IA2 | IA1 | Current value | PH2 | IB2 | IB1 | 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 |

W1-2 phase Excitation Timing Chart



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Simplified Equations for Determining RC Component Values

The equations for setting the RC oscillator circuit rise time (T1) and fall time (T2) are shown below.

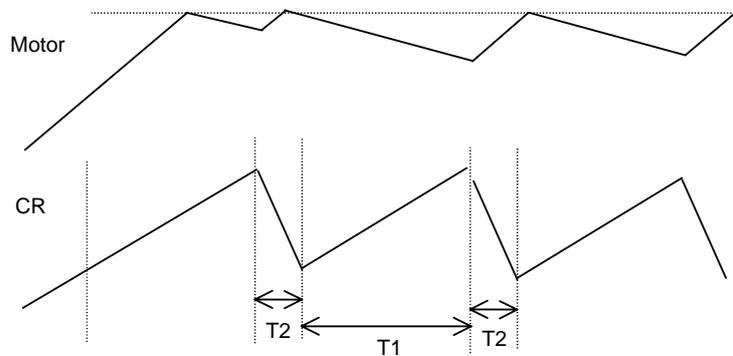
$$T1 \approx 0.44C \times R \text{ (s)}$$

$$T2 \approx 0.72 \times (C \times R \times 1000) / (R + 1000) \text{ (s)}$$

(C:220 to 4700pF, R = 10 to 150kΩ)

The oscillator frequency must be set using the simplified equations shown above.

Note that the triangle wave fall time (T2) is also used as the noise canceller time.



Usage Notes

1. VREF

Since the VREF pin is the input pin for the reference voltage that sets the current, applications must be designed so that noise does not appear on this pin.

2. Ground pins

Since this IC switches high currents, the following points concerning grounding must be observed.

- The fins on the package rear surface, pins 7 and 8, and pins 21 and 22 must all be grounded.
- Sections of the circuit that carry large currents must be implemented with wide lines in the printed circuit pattern, and must be physically separated from the small signal system.
- The E pin sense resistor (RE) must be position as close as possible to the IC ground (pin 14).
- The capacitors between VCC and ground and between VBB and ground must be positioned as close as possible to the VCC and VBB pins on the printed circuit pattern.

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