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# LB1940T

# LB1940U

## Monolithic Digital IC

## 2-ch H-Bridge Constant Current Driver

### Overview

The LB1940T and LB1940U are 2-phase exciter type bipolar stepper motor driver ICs that feature low-voltage, (supporting 3V battery) and low current operation with low saturation voltage. These ICs enable constant-current control of actuators, and are optimal for driving the actuators of PC peripherals such as USB compatible scanners, FDDs, and printers, as well as for controlling the shutter, iris, and AF of a digital still camera.

### Features

- Low-voltage driving  
2-power source type:  $V_S = 1.6$  to  $7.5V$ ,  $V_{DD} = 1.9$  to  $6.5V$   
Single power source type:  $V_S = V_{DD} = 1.9$  to  $7.5V$
- Low saturation output:  $V_{O(sat)} = 0.3V$  at  $I_O$  of  $200mA$
- Constant-current control
- Built-in reference voltage ( $V_{ref} = 0.9V$ )
- Small-sized, low-profile package (LB1940T: TSSOP20; 225mil; thickness (t) = 1.2mm max.)  
(LB1940U: MSOP20; thickness (t) = 0.85mm max.)

### Specifications

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

| Parameter                   | Symbol        | Conditions                     | Ratings       | Unit       |
|-----------------------------|---------------|--------------------------------|---------------|------------|
| Maximum supply voltage      | $V_B$ max     | $V_{S1}, V_{S2}, V_{DD}$       | -0.3 to +10.5 | V          |
| Output applied voltage      | $V_{OUT}$ max | OUT1, OUT2, OUT3, OUT4         | -0.3 to +10.5 | V          |
| Output Current              | $I_O$ max     |                                | 400           | mA         |
| Input applied voltage       | $V_{IN}$ max  | ENA1, ENA2, IN1, IN2, VC       | -0.3 to +10.5 | V          |
| Allowable power dissipation | $P_d$ max     | Mounted on a specified board * | 800           | mW         |
| Operating temperature       | $T_{opr}$     |                                | -20 to +85    | $^\circ C$ |
| Storage temperature         | $T_{stg}$     |                                | -55 to +150   | $^\circ C$ |

\* Mounted on a Specified board: 114.3mm×76.1mm×1.6mm, glass epoxy

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.

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## Allowable Operating Range at $T_a = 25^\circ\text{C}$

| Parameter                          | Symbol   | Conditions                           | Ratings |     |     | unit |
|------------------------------------|----------|--------------------------------------|---------|-----|-----|------|
|                                    |          |                                      | min     | typ | max |      |
| Function-guaranteed voltage range  | VOPR1    | $V_{DD}$ system, $V_S = 2.0\text{V}$ | 1.9     |     | 6.5 | V    |
|                                    | VOPR2    | $V_S$ system, $V_{DD} = 5.0\text{V}$ | 1.6     |     | 7.5 |      |
| Low level input threshold voltage  | $V_{IL}$ | ENA1, ENA2, IN1, IN2                 | -0.3    |     | 1.0 | V    |
| High level input threshold voltage | $V_{IH}$ | ENA1, ENA2, IN1, IN2                 | 2.0     |     | 6.0 | V    |
| VC input voltage                   | VC       |                                      | 0.19    |     | 1.0 | V    |

## Electrical Characteristics at $T_a = 25^\circ\text{C}$ , $V_S = 3\text{V}$ , $V_{DD} = 5\text{V}$

| Parameter  | Symbol               | Conditions   | Ratings |      |      | unit          |
|--|----------------------|--|---------|------|------|---------------|
|  |                      |  | min     | typ  | max  |               |
| Standby current dissipation                              | ISTB                 | $V_S = V_{DD} = 6.5\text{V}$   |         | 0.1  | 1.0  | $\mu\text{A}$ |
| <b>Regulator output circuit</b>                          |                      |  |         |      |      |               |
| VREF output voltage                                      | VREF                 | $I_{OL} = 0$ to $1\text{mA}$   | 0.85    | 0.9  | 0.95 | V             |
| SVDD output voltage                                      | SVDD                 | $I_{OL} = 10\text{mA}$   | 4.70    | 4.85 |      | V             |
| <b>H bridge output circuit</b>                           |                      |  |         |      |      |               |
| OUT output saturation voltage<br>(at saturation control) | $V_{O(\text{sat})1}$ | $V_{DD} = 5.0\text{V}$ , $V_S = 2.0\text{V}$<br>$I_O = 200\text{mA}$ (PNP side)  |         | 0.20 | 0.30 | V             |
|  | $V_{O(\text{sat})2}$ | $V_{DD} = 5.0\text{V}$ , $V_S = 2.0\text{V}$<br>$I_O = 200\text{mA}$ (NPN side)  |         | 0.10 | 0.15 | V             |
| OUT output current<br>(at constant current control)      | $I_{OUT1}$           | $V_{DD} = 6.0\text{V}$ , $V_C = 0.2\text{V}$ , $V_S = 3.5\text{V}$<br>$R_L = 5\Omega$ (between OUT-OUT), $R_{FB} = 2\Omega$  | 94      | 100  | 106  | $\text{mA}$   |
|  | $I_{OUT2}$           | $V_C = \frac{R_b}{R_a + R_b} V_{REF}$ ( $R_a = 70\text{k}\Omega$ , $R_b = 20\text{k}\Omega$ ) *<br>$V_{DD} = 6.0\text{V}$ , $V_S = 2.0\text{V}$<br>$R_L = 5\Omega$ (between OUT-OUT), $R_{FB} = 1\Omega$ | 180     | 200  | 220  | $\text{mA}$   |
| VS system operating current consumption                  | IS1                  | $V_C = \frac{R_b}{R_a + R_b} V_{REF}$ ( $R_a = 70\text{k}\Omega$ , $R_b = 20\text{k}\Omega$ ) *  |         | 1.5  | 3    | $\text{mA}$   |
| $V_{DD}$ system operating current dissipation            | $I_{DD1}$            | $V_C = \frac{R_b}{R_a + R_b} V_{REF}$ ( $R_a = 70\text{k}\Omega$ , $R_b = 20\text{k}\Omega$ ) *<br>ENA1 = 2V   |         | 4    | 7    | $\text{mA}$   |
| VC input current   | IVC                  | $V_{DD} = 6.0\text{V}$ , $V_S = 2.0\text{V}$ , $V_C = 1.9\text{V}$   | 0       |      | -1   | $\mu\text{A}$ |
| <b>Control input circuit</b>                             |                      |  |         |      |      |               |
| Control pin maximum input current                        | $I_{IH}$             | $V_{IH} = 5.5\text{V}$   |         | 80   | 100  | $\mu\text{A}$ |
|  | $I_{IL}$             | $V_{IL} = \text{GND}$  | -1      |      | 0    |               |

\* For  $R_a$  and  $R_b$ , refer to Application Circuit Diagram.

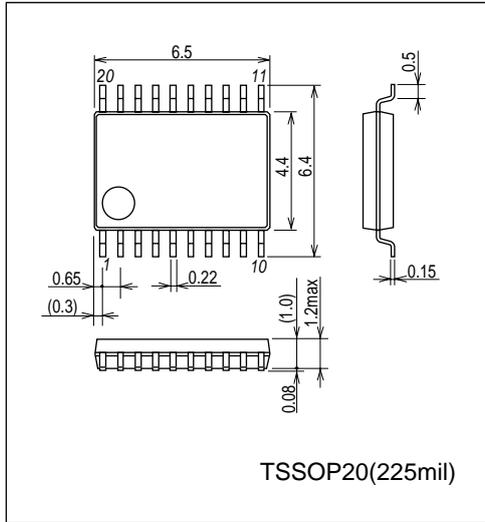
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## Package Dimensions

unit : mm (typ)

3246

[LB1940T]

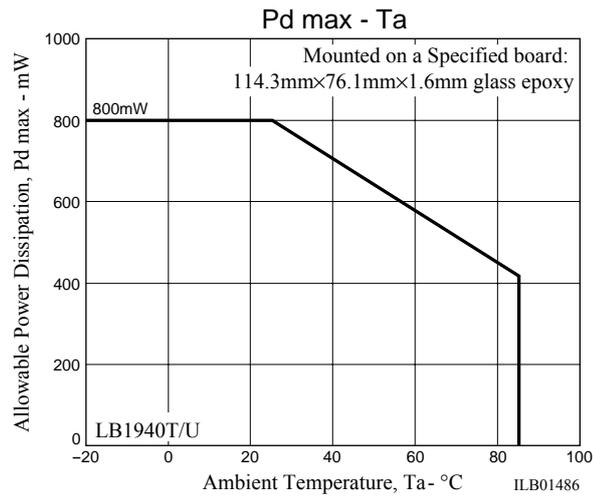
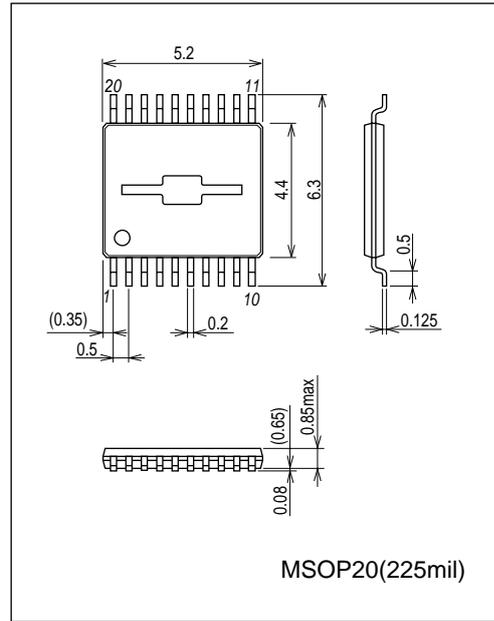


## Package Dimensions

unit : mm (typ)

3262

[LB1940U]

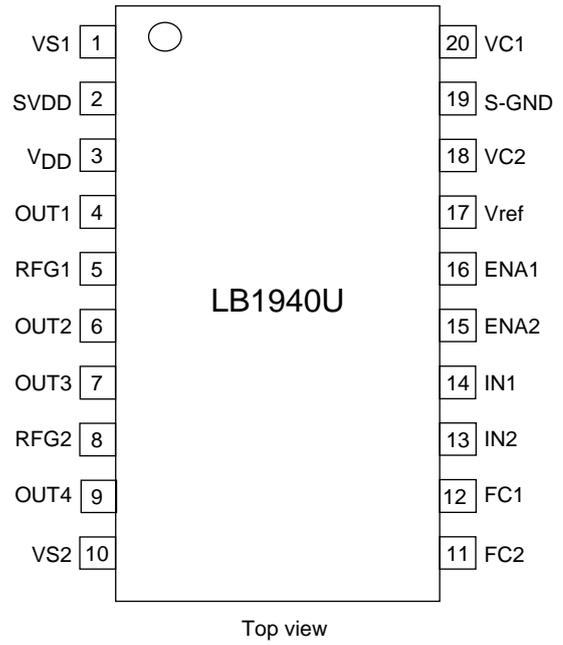
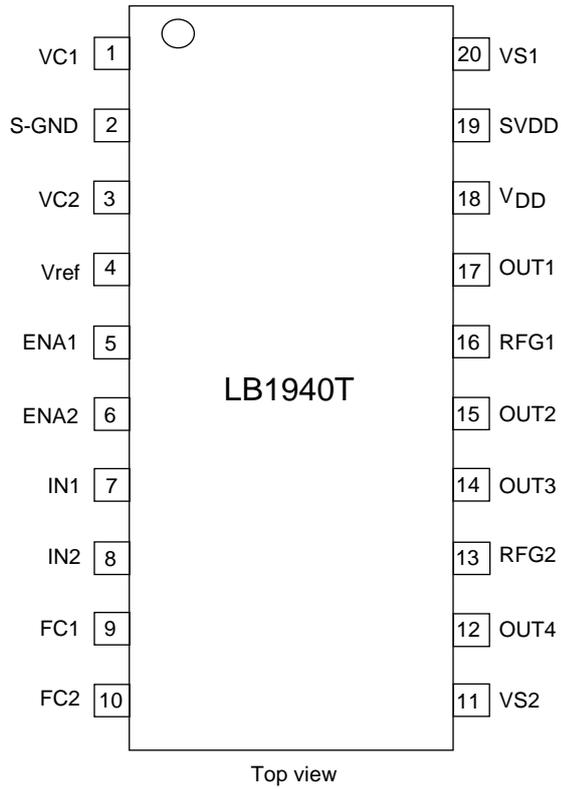


## True Table

| Input                       |   |    |   | Output               |   |   |   | SVDD | Mode                               |
|-----------------------------|---|----|---|----------------------|---|---|---|------|------------------------------------|
| ENA                         |   | IN |   | OUT                  |   |   |   |      |                                    |
| 1                           | 2 | 1  | 2 | 1                    | 2 | 3 | 4 |      |                                    |
| L                           | L |    |   |                      |   |   |   |      | Standby (current dissipation zero) |
| H                           |   | H  |   | L                    | H |   |   | on   | Reverse rotation                   |
|                             |   | L  |   | H                    | L |   |   | on   | Forward rotation                   |
|                             | H |    | H |                      |   | L | H | on   | Reverse rotation                   |
|                             |   |    | L |                      |   | H | L | on   | Forward rotation                   |
| A blank means "don't care". |   |    |   | A blank means "off". |   |   |   |      |                                    |

# LB1940T, LB1940U

## Pin Assignment

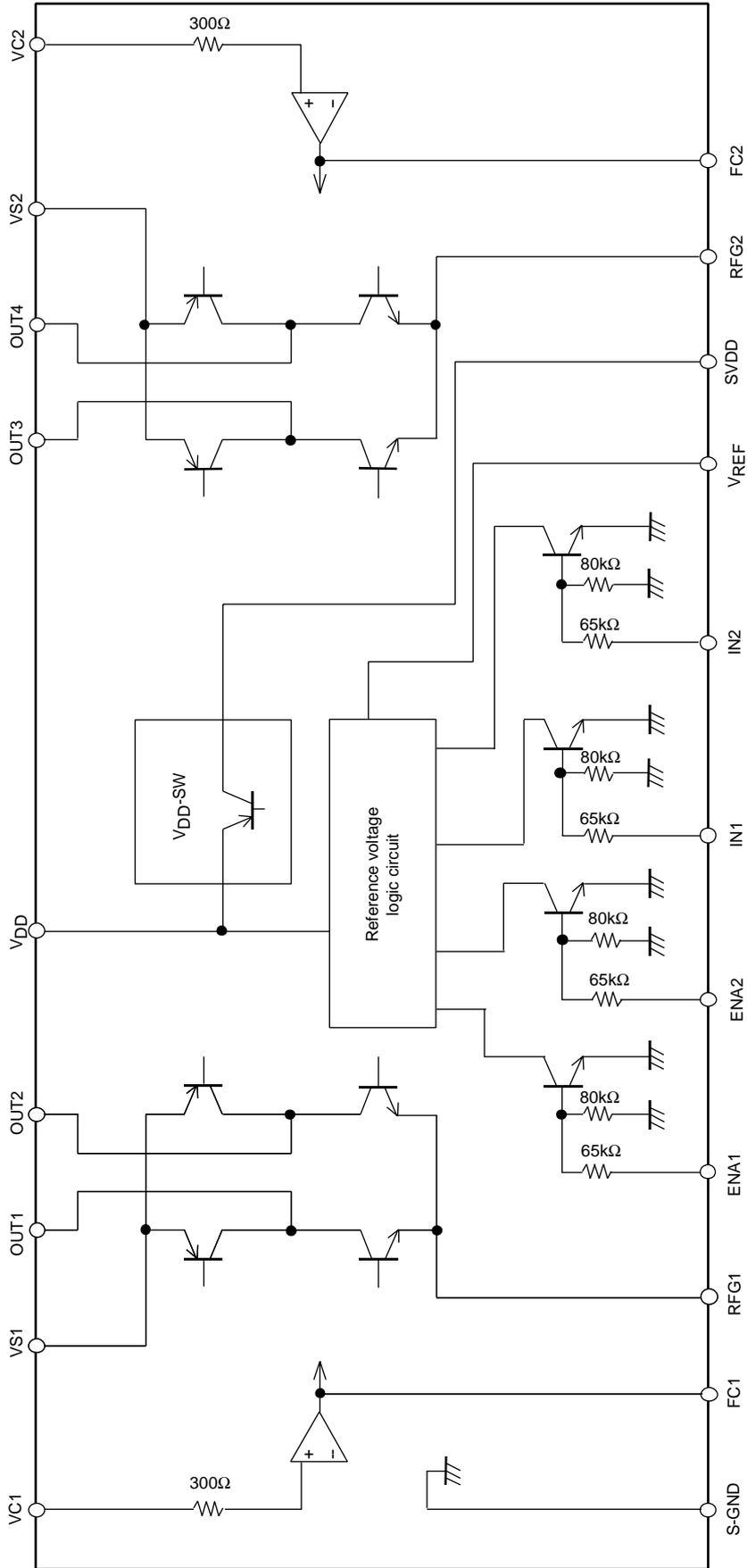


## Pin Description

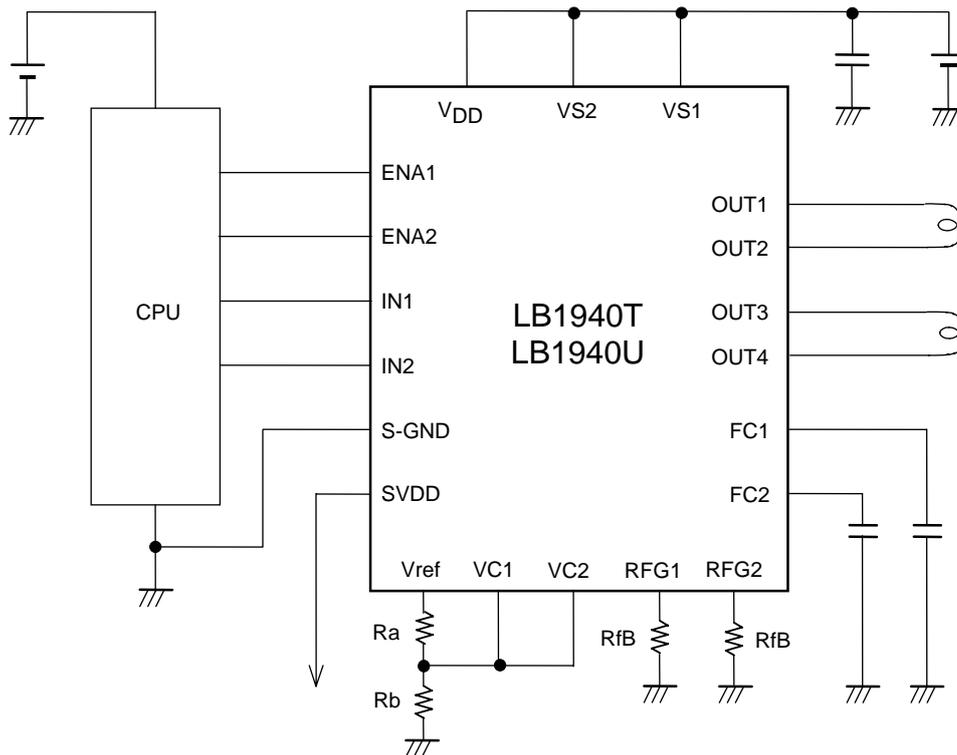
| Pin No. |         | Pin Name | Description                                 | Pin No. |         | Pin Name        | Description                      |
|---------|---------|----------|---|---------|---------|-----------------|----------------------------------|
| LB1940T | LB1940U |          |   | LB1940T | LB1940U |                 |                                  |
| 1       | 20      | VC1      | Reference voltage input for 1ch control     | 11      | 10      | VS2             | Motor power supply (+)           |
| 2       | 19      | S-GND    | GND for control system                      | 12      | 9       | OUT4            | Motor drive output 4             |
| 3       | 18      | VC2      | Reference voltage input for 2ch control     | 13      | 8       | RFG2            | Constant-current detection pin   |
| 4       | 17      | Vref     | Reference voltage output                    | 14      | 7       | OUT3            | Motor drive output 3             |
| 5       | 16      | ENA1     | Signal input for 1ch control                | 15      | 6       | OUT2            | Motor drive output 2             |
| 6       | 15      | ENA2     | Signal input for 2ch control                | 16      | 5       | RFG1            | Constant-current detection pin 1 |
| 7       | 14      | IN1      | Signal input for 1ch control                | 17      | 4       | OUT1            | Motor drive output 1             |
| 8       | 13      | IN2      | Signal input for 2ch control                | 18      | 3       | V <sub>DD</sub> | Control system power supply (+)  |
| 9       | 12      | FC1      | C connection pin for 1ch phase compensation | 19      | 2       | SVDD            | Control system power output      |
| 10      | 11      | FC2      | C connection pin for 2ch phase compensation | 20      | 1       | VS1             | Motor power supply (+)           |

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## Block Diagram



Application Circuit Diagram



At constant-current control: The OUT current is controlled so that the RFG pin voltage is equal to the VC input pin voltage.

For example,  $I_{OUT} = 200\text{mA}$  ( $= 0.2\text{V}/1\Omega$ ) when  $VC = 0.2\text{V}$  and  $R_{FB} = 1\Omega$ .

\*: There is no priority relationship between respective input voltages (ENA, IN) and respective supply voltages ( $V_{DD}$ , VS). For example, operation with  $V_{IN} = 5\text{V}$ ,  $V_{DD} = 3\text{V}$ ,  $VS = 2\text{V}$  is possible.

Note: The input voltage range to the reference voltage input pin VC for constant-current setting is from 0.19V to 1.0V.

Constant current setting

The composition of the constant-control circuit of this IC is as shown in the figure below.

The voltage entered in the VC pin is entered as a reference to the “+” side input of the constant-current control amplifier.

The “-” side of this constant-current control amplifier is connected to the RFG pin via the wire bonded resistor  $R_b$  ( $= 0.1\Omega$ ).

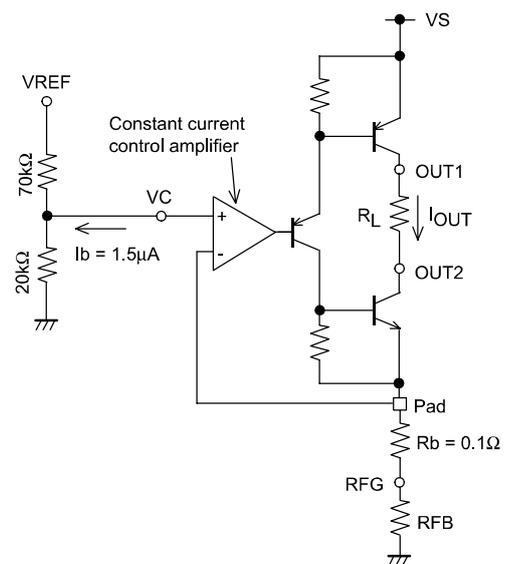
The constant-current control circuit consists of comparison of the voltage generated at the external current detection resistor with the above reference voltage.

In addition, since the bias current  $I_b$  ( $= 1.5\mu\text{A}$ ) flows out of the positive (+) input of the constant current control amplifier during the constant current control, if the voltage is input to the VC pin by dividing the VREF voltage by 4.5 according to the dividing resistance ( $70\text{k}\Omega$  and  $20\text{k}\Omega$ ) as shown in the figure, the formula for calculating the VC voltage is as follows :

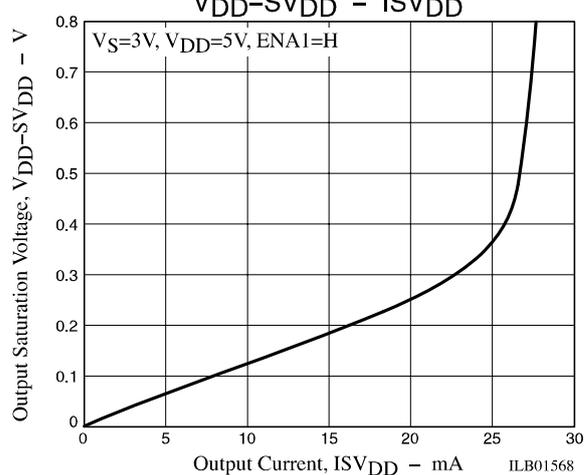
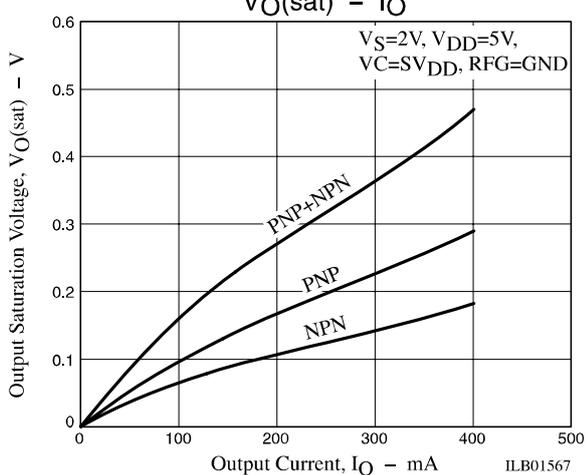
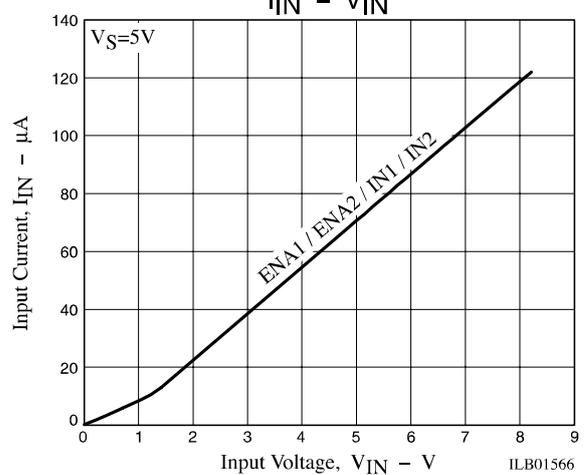
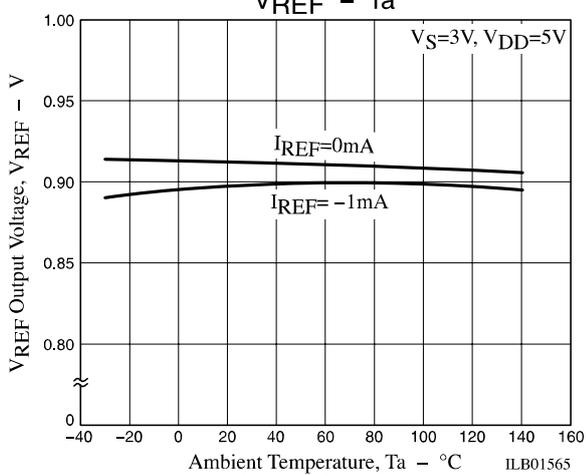
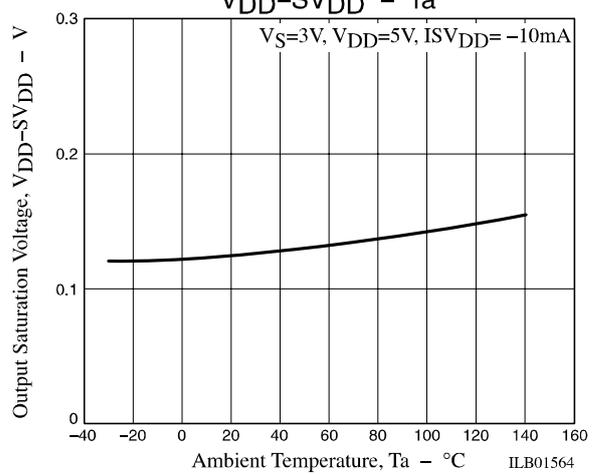
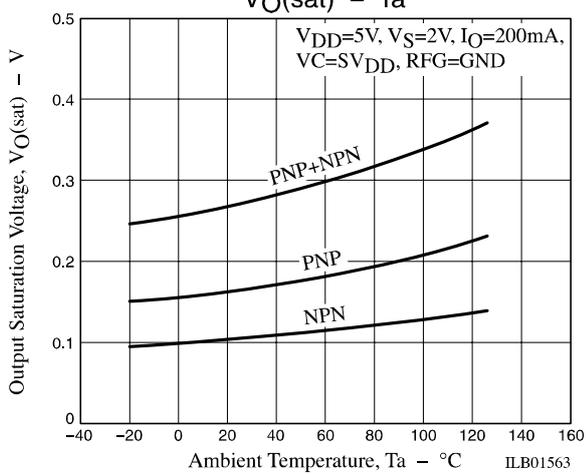
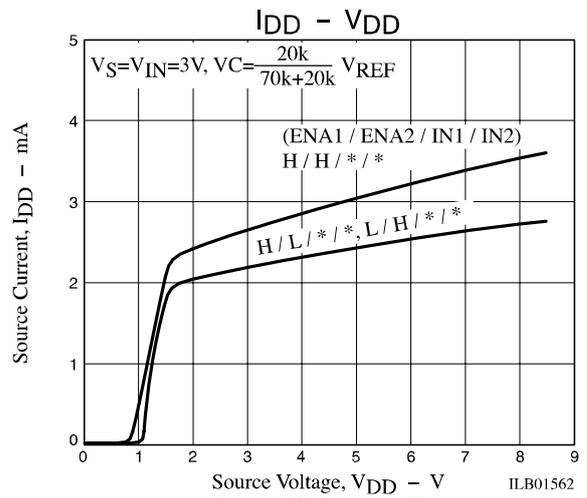
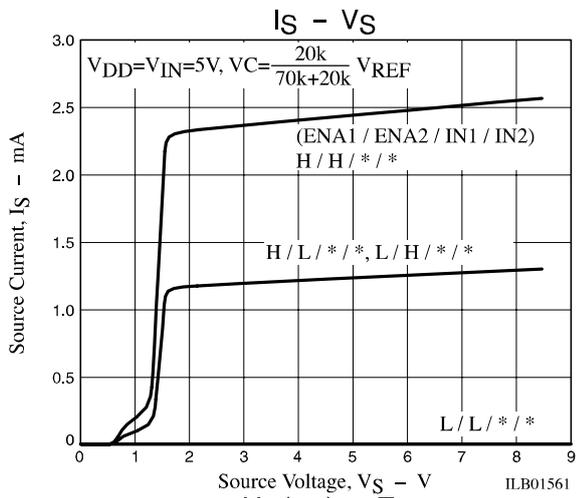
$$VC = V_{REF}/4.5 + I_b \times 20\text{k}\Omega = V_{REF}/4.5 + 0.03$$

Therefore, the theoretical equation to set the constant current  $I_{OUT}$  is as follows:

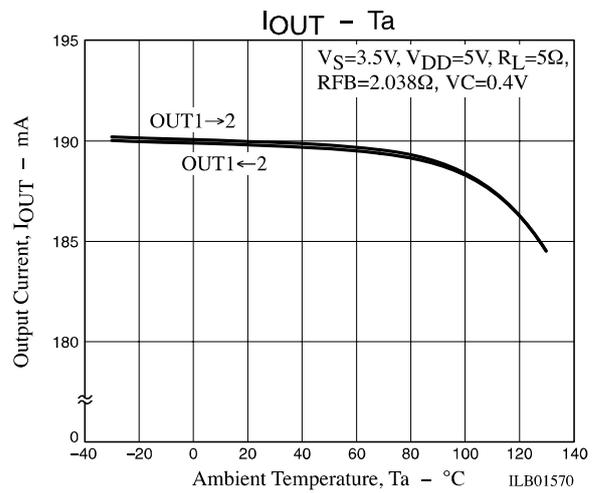
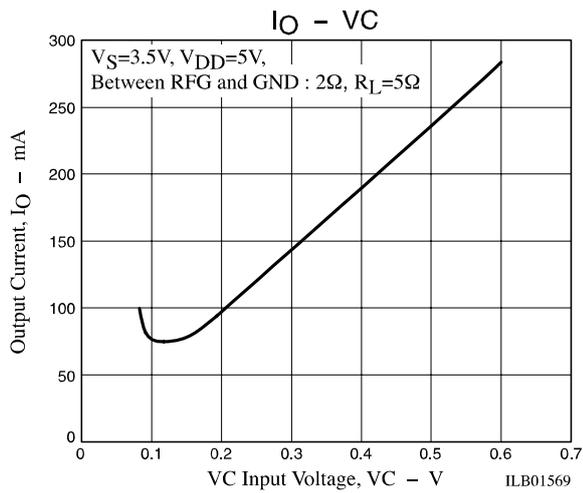
$$I_{OUT} = VC / (R_{FB} + R_b) = (V_{REF}/4.5 + 0.03) / (R_{FB} + R_b)$$



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