# HA13480S

**Three-Phase Motor Driver with Speed Discriminator**

## Description

HA13480S is three phase brushless DC motor driver for scanner of 24V LBP (Laser Beam Printer) application. Features and functions are as follows.

## Functions

- 1A three phase output circuit (Current drive type)
- Forward/reverse circuit
- Start/stop circuit
- Digital speed control circuit
- Current limiter circuit
- Ready circuit
- OTSD (Over Temperature Shut Down) Circuit

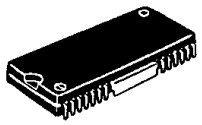
## Features

- Soft switching
- Low acoustic noise
- 2kHz FG frequency acceptable
- No chemical capacitor
- No snubber component

## Ordering Information

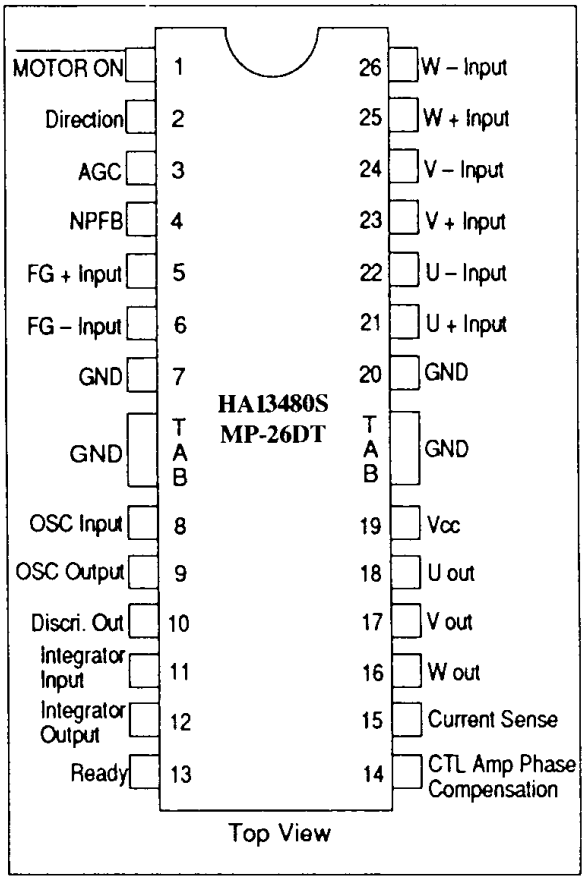
| Type No. | Package |
|---|---|
| HA13480S | MP-26DT |

**HA13480S**

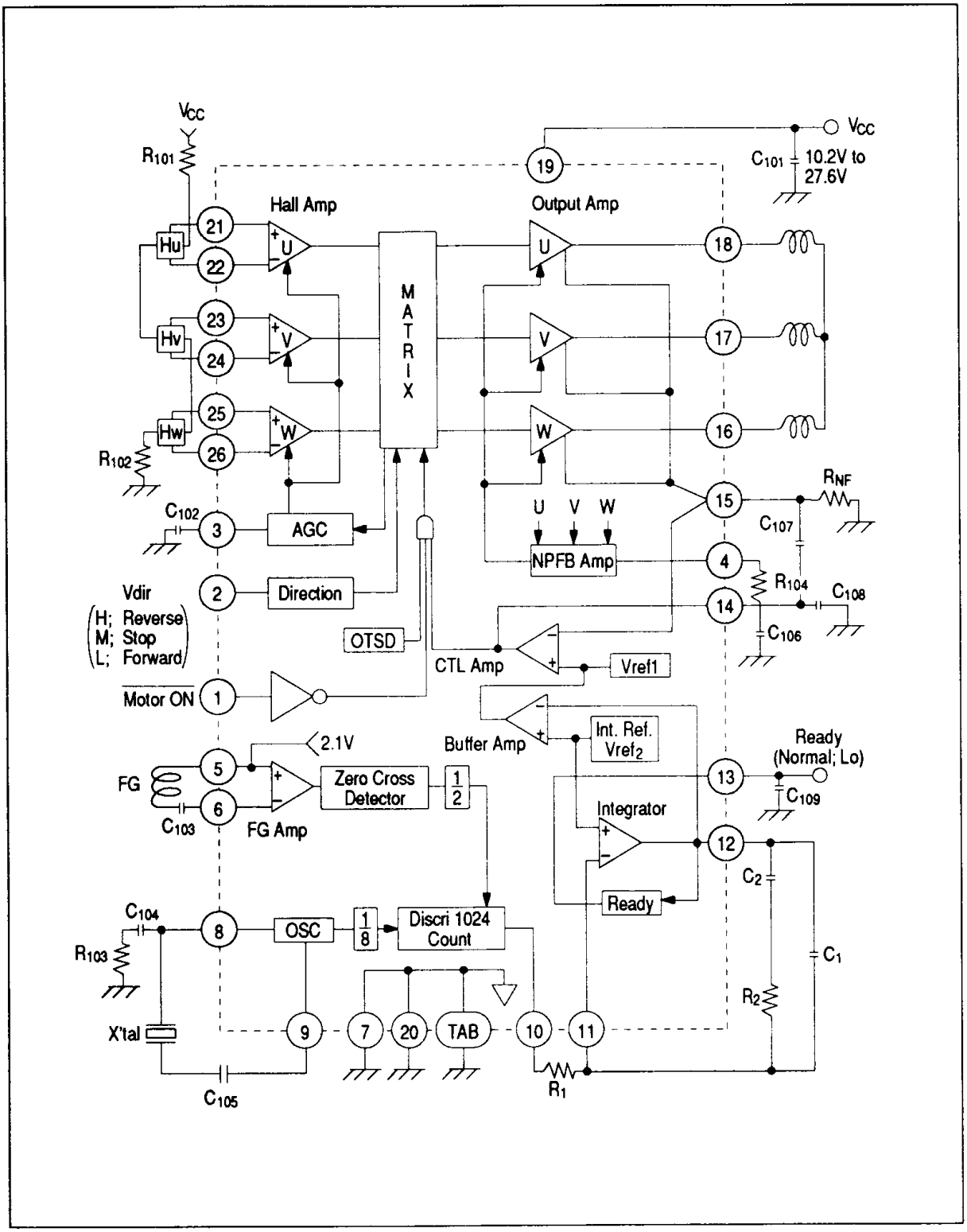


(MP-26DT)

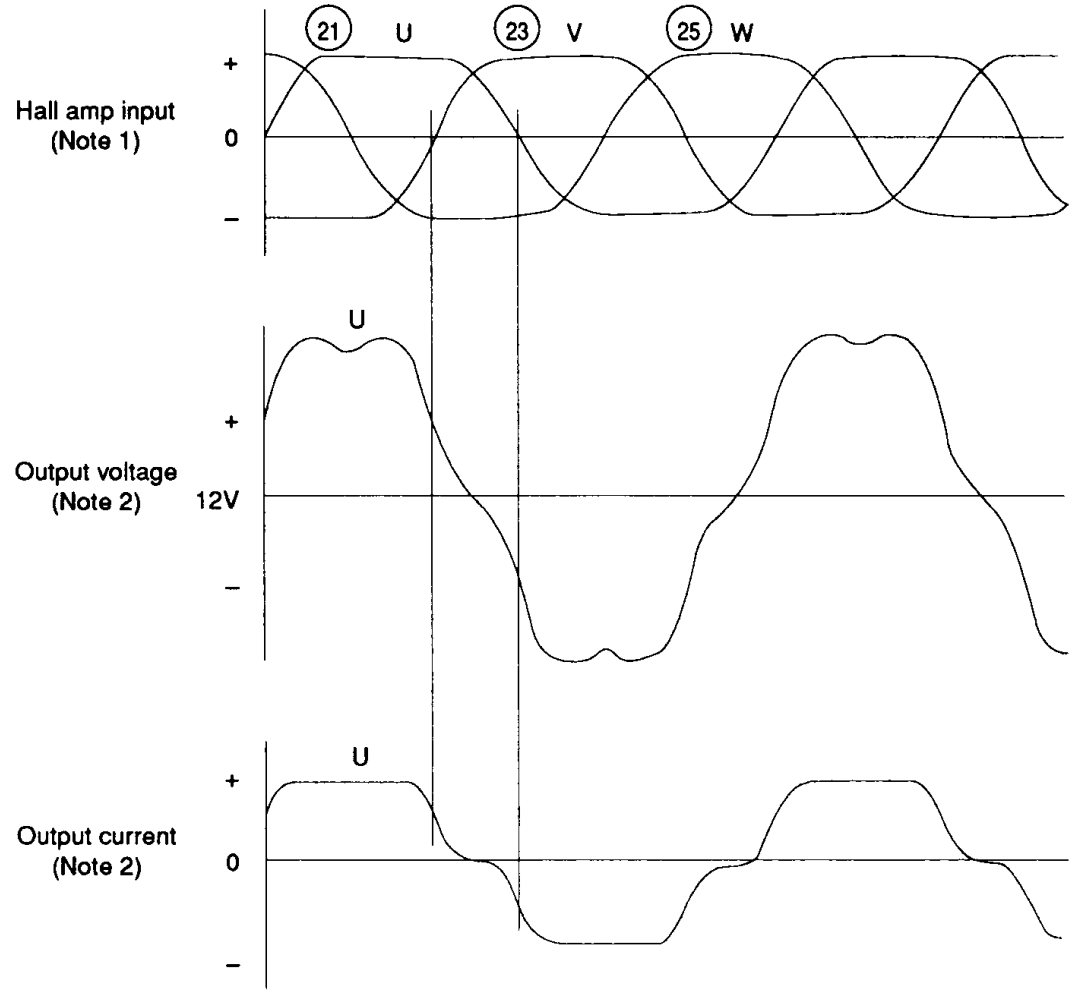
## Pin Arrangement



## Block Diagram



## Timing Chart (Forward Mode)




Notes: 1. Third harmonic distortion below 15 % is acceptable.
2. Only U phase is shown. Sign "+" shows current flowing from IC, "–" shows current flowing into IC.

**Table 1 External Component**

| Parts No. | Recommended Value | Purpose | Note |
|---|---|---|---|
| $R_{101}$, $R_{102}$ | — | Hall element bias | 1 |
| $R_{103}$ | 470 Ω | For oscillation stability | 2 |
| $R_{104}$ | 470 Ω | For stability | |
| $R_1$ | — | Integral constant | 3 |
| $R_2$ | — | Integral constant | 3 |
| $R_{NF}$ | 0.68 | Current sense | 4 |
| $C_{101}$ | ≥0.1 μF | Bypass | |
| $C_{102}$ | 0.047 μF | AGC filter | |
| $C_{103}$ | 0.1 μF | FG AC coupling | 5 |
| $C_{104}$ | 4700 pF | For oscillation stability | 2 |
| $C_{105}$ | 10 pF | AC coupling | |
| $C_{106}$ | 0.1 μF | Phase compensation for NPFB | |
| $C_{107}$ | 0.001 μF | Phase compensation for CTL amp | |
| $C_{108}$ | 0.1 μF | Phase compensation for CTL amp | |
| $C_{109}$ | 0.1 μF | Filter | |
| $C_1$ | — | Integral constant | 3 |
| $C_2$ | — | Integral constant | 3 |
| X'tal | — | Internal clock | 6 |

Notes:
1. Determine the value so that hall amp common mode voltage and differential voltage range within the spec.
2. Those components are not necessary when oscillation frequency is below 4MHz.
3. Following equations are guideline for determining the constant of components.

$\omega_o \leq \omega_{fg}/20$

$R_2/R_1=(2/9.55) \times (J\omega_o N_o R_{NF}/K_T V_{CC})$

$C_1=1/\sqrt{10}\ \omega_o R_2$

$C_2=10C_1$

$\omega_{fg}$ : Anguler freq. of FG(rad/s)
$N_o$ : Rotation number(rpm)
$J$ : Inertia moment(kg·cm$^2$)
$K_T$ : Torque constant(kg·cm/A)
$R_{NF}$ : Sensing resistor(Ω)
$V_{CC}$ : Supply voltage(V)

4. Current limit value is the following equation.
   $I_{omax}(A)=V_{ref1}(V)/R_{NF}(\Omega)$
5. See the following equation.
   $C_{103} \geq 1/1400\omega fg$
6. Relationship between FG frequency ffg and oscillation frequency fosc is as follows;
   fosc=4094ffg

**Table 2 Absolute Maximum Ratings (Ta=25 °C)**

| Item | Symbol | Ratings | Unit | Note |
|---|---|---|---|---|
| Supply voltage range | Vcc | 30 | V | 1 |
| Instanteneous output current | Iopeak | 1.0 | A | 2 |
| Output current | Io | 0.7 | A | |
| Input voltage | Vin | 0 to Vcc | V | 3 |
| Power dissipation | PT | 8 | W | 4 |
| Junction temperature | Tj | 150 | °C | 1 |
| Storage temperature | Tstg | –55 to +125 | °C | |

The absolute maximum ratings are limiting values, to be applied individually, beyond which the device may be permanently damaged. Functional operation under any of these conditions is not guaranteed. Exposing a circuit to its absolute maximum rating for extended periods of time may affect the device's reliability.

Notes: 1. Recommended operation voltage range is
   Vcc=10.2 to 27.6 V
   Tjopr=0 to 125 °C
2. Refer to ASO data.
3. Apply to PIN 21 to 26.
4. Value at Ttab=94 °C. Thermal resistance is as follows.
   θj-c=7 °C/W
   θj-a=15 °C/W (mounted on Fe metal PCB)

**Table 3 Electrical Characteristics (Ta=25 °C, Vcc=24 V)**

| Item | | Symbol | Min | Typ | Max | Unit | Test Conditions | Test Terminal | Note |
|---|---|---|---|---|---|---|---|---|---|
| Quiescent current | | Icco | — | 32 | 45 | mA | Vcc=27.6 V, Pin1=H | 19 | 1 |
| | | Icc | — | 32 | 45 | mA | Vcc=27.6 V, Pin1=L | | |
| Motor on | Input "L" level voltage | VIL1 | — | — | 1.5 | V | Motor on | 1 | |
| | Input "L" level voltage | VIH1 | 2.5 | — | — | V | Motor off | | |
| | Input current | II1 | — | — | ±10 | μA | VI=0 to 7 V | | |

**Electrical Characteristics(Ta=25 °C, $V_{CC}$=24 V) (cont)**

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Direction | Input "L" level voltage | $V_{IL2}$ | — | — | 1.0 | V | Forward | 2 | 2 |
| | Input middle voltage | Vim | 1.7 | — | 2.4 | V | Motor off | | |
| | Input "H" level voltage | $V_{IH2}$ | 3.0 | — | — | V | Reverse | | |
| | Input current | $I_{I2}$ | — | — | ±0.6 | mA | $V_I$=0 to 7 V | | 3 |
| Hall amp | Input resistor | $R_{HI}$ | 7 | 10 | 13 | kΩ | | 21 to 26 | |
| | Input common mode voltage | $V_H$ | 2.5 | — | Vcc −2.0 | V | | | |
| | Input difference voltage | $V_H$ | 70 | — | 210 | mVpp | | | |
| Output amp | Leak current | $I_{CER}$ | — | — | ±100 | μA | $V_{CE}$=30 V | 16 to 18 | |
| | Saturation voltage | Vsat1 | — | 2.6 | 3.2 | V | $I_O$=0.7 A | | 4 |
| | | Vsat2 | — | 2.0 | 2.3 | V | $I_O$=0.35 A | | |
| Integrator amp | Internal ref. voltage | Vref | 0.9 (Vcc/2) | Vcc/2 | 1.1 (Vcc/2) | V | | 11 | |
| | Input current | $I_{B1}$ | — | — | ±0.1 | μA | | | |
| | Output voltage swing | A+ | 0.55 | 0.7 | 0.85 | V | $I_R$=−0.1 mA | 12 | 5 |
| | | A− | −0.55 | −0.7 | −0.85 | V | $I_R$=0.1 mA | | |
| | Gain band width | BW | — | 500 | — | kHz | Gv=0 dB | | |
| Control amp | Voltage gain | Gct1 | — | −1.5 | — | dB | | 15 | 6 |
| | Internal rdf. voltage | Vref1 | 595 | 660 | 725 | mV | | | |
| FG amp | Input resistor | Rfg | 1.2 | 2 | 2.8 | kΩ | | 5, 6 | |
| | Input voltage | Vfg | 30 | — | 300 | mVpp | f=1 kHz | | |
| | Noise margin | nd | — | — | 10 | mVpp | f=1 kHz differential | | |
| | | nc | — | — | 1.0 | Vpp | f=1 kHz common | | |

**Electrical Characteristics(Ta=25 °C, Vcc=24 V) (cont)**

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Ready | Threshold voltage | $V_{THH}$ | — | Vref2 +0.35 | — | V | | 12 | 7 |
| | | $V_{THL}$ | — | Vref2 −0.35 | — | V | | | |
| | Output "H" level voltage | $V_{OH}$ | 3.6 | 4.0 | 4.4 | V | | 13 | |
| | Output "L" level voltage | $V_{OL}$ | — | 0.4 | 0.8 | V | | | |
| OSC | Maximum frequency | fosc | — | — | 8.0 | MHz | Use quartz | 9 | |
| | Frequency error | Δfosc | — | — | ±0.1 | % | Use quartz | | |
| Speed discri | Count | N | — | 1024 | — | — | | 10 | |
| | Output "H" voltage | $V_{dH}$ | Vcc −1.0 | — | — | V | Io=0.1 mA | | |
| | Output "L" voltage | $V_{dL}$ | — | — | 1.0 | V | Io=−0.1 mA | | |
| | Leak current | Idoff | — | — | ±0.1 | μA | | | |
| | Discri. gain | Kv | — | 0.12 | — | V/% | | | |
| | Operating frequency | fd | — | — | 8.0 | MHz | | 10 | 3 |
| OTSD operating temperature | | Tsd | 125 | 150 | — | °C | | | 4 |

Notes:
1. Measured at Synchronous state
2. See Figure 1.
3. See Figure 2.
4. Specified by the sum of the upper and lower saturation voltage.
5. Voltage from Vref2.
6. See Figure 3. $Gctl=20\log 10 \frac{\Delta V15}{\Delta V12}$
7. See Figure 4.

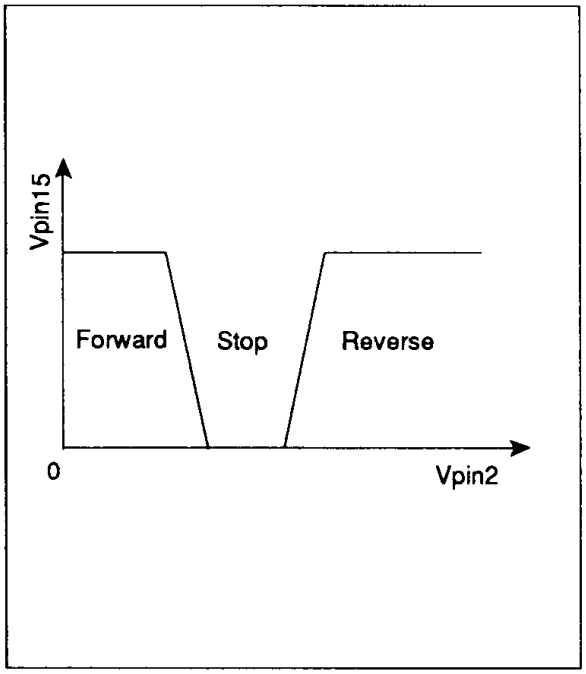



Figure 1

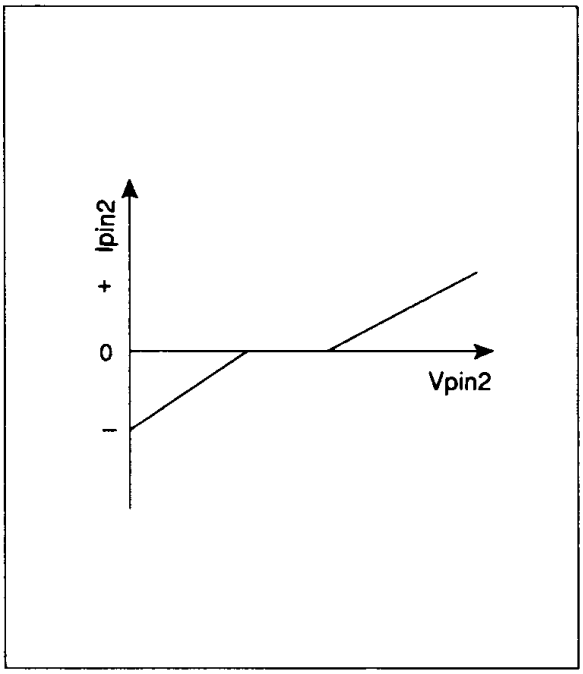



Figure 2

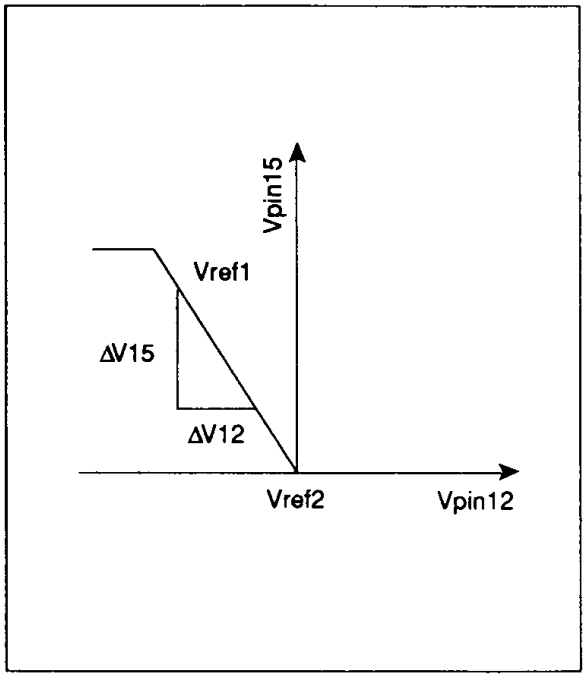



Figure 3

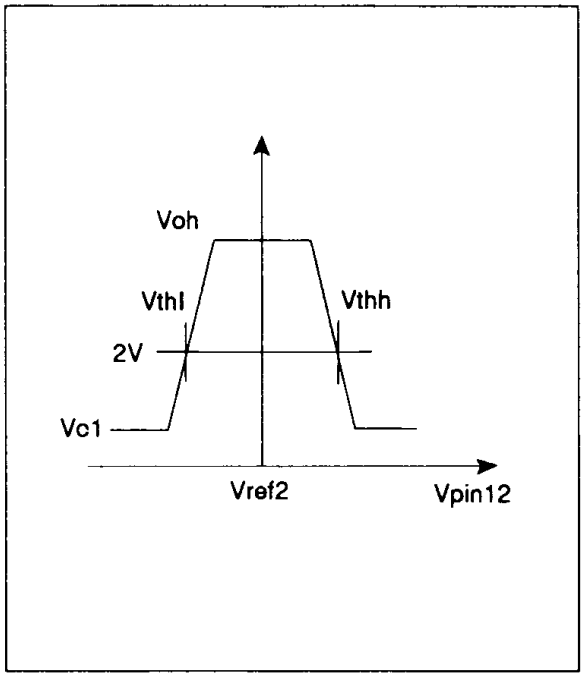



Figure 4

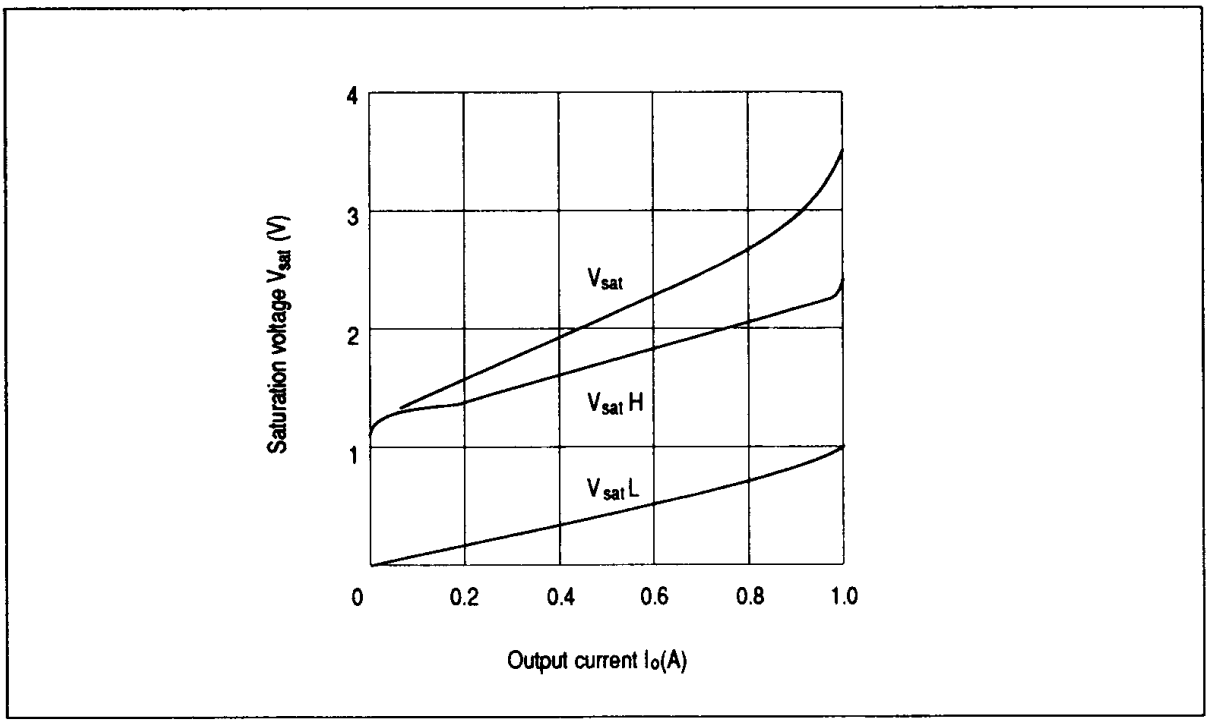



**Figure 5 Reference Data**
**Saturation Voltage vs. Output Current**

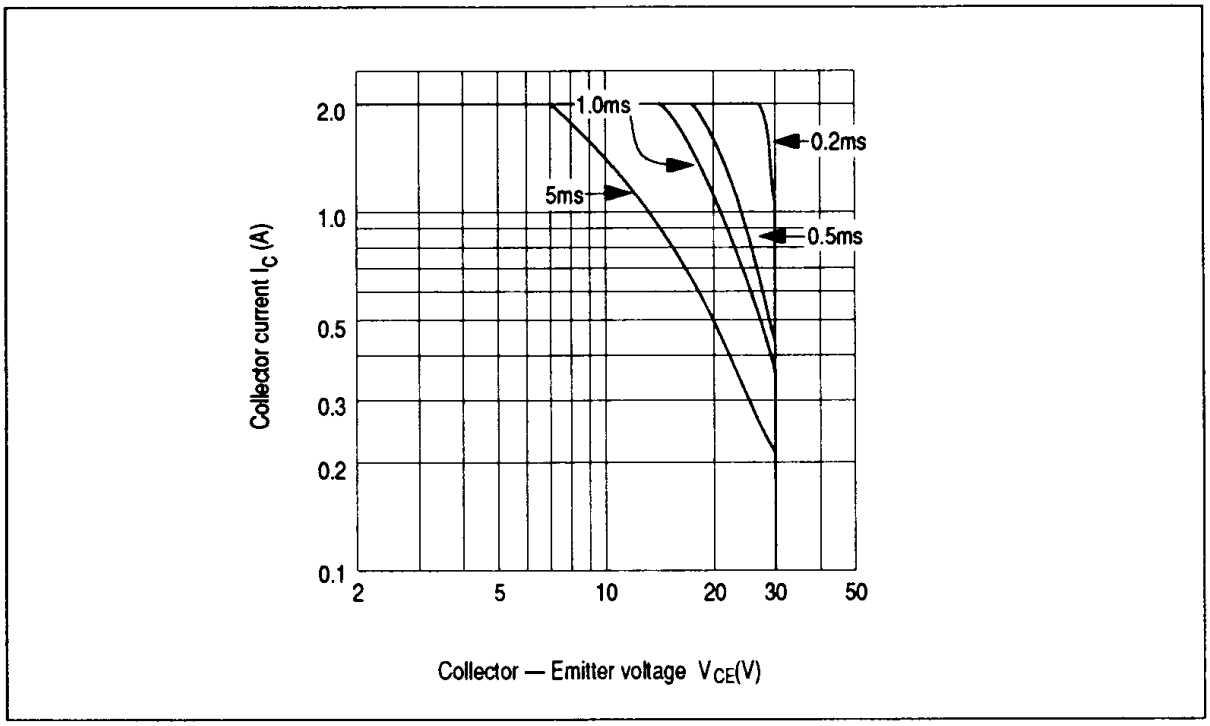



**Figure 6 Reference Data**
**Output Transistor ASO**