# Power unit ICs for pagers

## BH6113FV / BH6114FV

The BH6113FV and BH6114FV are power unit ICs with a driver for VFM switching regulator controllers and vibrators, LEDs, and speakers, and a built-in battery ejection sensor. The BH6114FV is a BH6113FV with a modified DC / DC converter output voltage ($V_{OUT}$ = 2.7V).

●Applications
Pagers

●Features
1) Internal VFM-type CMOS switching regulator and drivers for four channels.
2) Equipped with a battery ejection sensor

●Absolute maximum ratings (Ta = 25°C)

| Parameter | Symbol | Limits | Unit |
|---|---|---|---|
| Power supply voltage | +B | −0.3～+6.0 | V |
| Driver output applied voltage | $V_{Max.}$ | −0.3～+7.0 | V |
| Power dissipation | Pd | 350* | mW |
| Maximum driver output current (1) | $I_{OM}1$ | 350 | mA |
| Maximum driver output current (2) | $I_{OM}2$ | 250 | mA |
| Maximum driver output current (3) | $I_{OM}3$ | 150 | mA |
| Maximum driver output current (4) | $I_{OM}4$ | 10 | mA |
| Operating temperature | Topr | −15～+60 | ℃ |
| Storage temperature | Tstg | −55～+125 | ℃ |

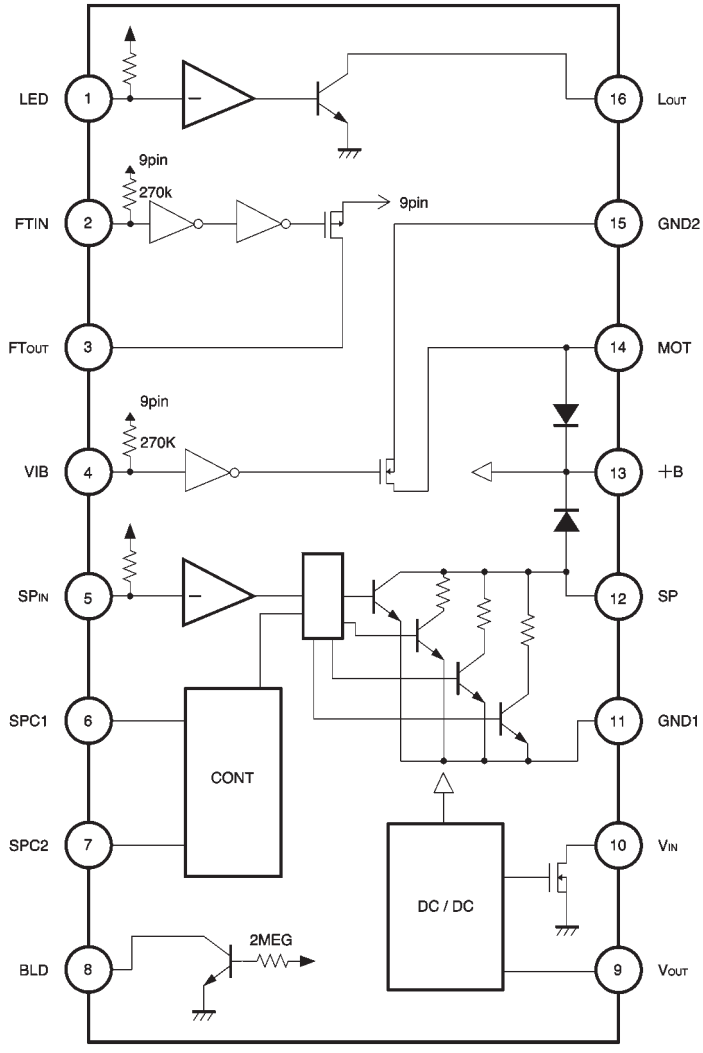
* Reduced by 3.5 mW for each increase in Ta of 1℃ over 25℃.

●Recommended operating conditions

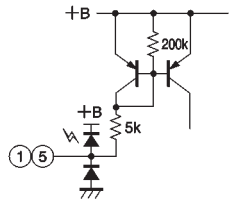
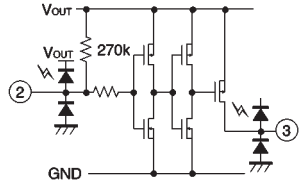
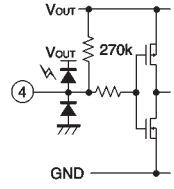
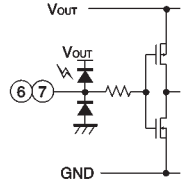
| Parameter | Symbol | Limits | Unit |
|---|---|---|---|
| Power supply voltage | +B | 0.9～1.7 | V |
| Driver unit operation frequency | $f_{drv}$ | DC～100* | kHz |

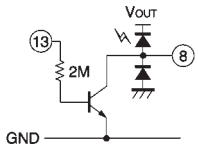
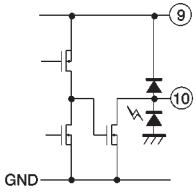
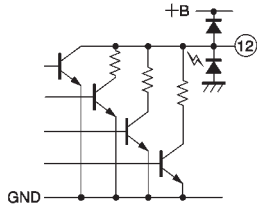
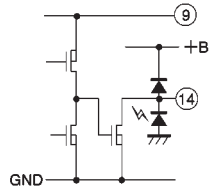
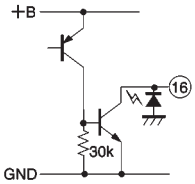
* The driver operation frequency does not include the motor unit.

●Block diagram

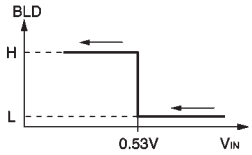


●Pin descriptions

| Pin No. | Pin name | I / O | Pin voltage | Internal equivalent circuit | Function |
|---|---|---|---|---|---|
| 11<br>15 | GND 1<br>GND 2 | I<br>I | GND | ——— | Grounding pin |
| 13 | +B | I | +B | ——— | Battery pin |
| 1<br>5 | LED<br>SPIN | I<br>I | +B (OPEN)<br>+B (OPEN) |  | Driver input pin<br>Low: act<br>High(OPEN): Output HIGH-Z |
| 2 | FTIN | I | —— |  | Driver input pin<br>Low: act<br>High (OPEN): Output HIGH-Z |
| 3 | FTOUT | O | —— | | Driver output pin (internal diode for surge absorption) |
| 4 | VIB | I | —— |  | Driver input pin<br>Low: act<br>High (OPEN): Output HIGH-Z |
| 6<br>7 | SPC 1<br>SPC 2 | I<br>I | —— |  | Volume control pin 1<br>Volume control pin 2<br>Low: act<br>OPEN: undefined<br>High: Output HIGH-Z |

| Pin No. | Pin name | I / O | Pin voltage | Internal equivalent circuit | Function |
|---|---|---|---|---|---|
| 8 | BLD | O | —— |  | Battery ejection voltage detection pin ∗1 (When battery is removed: HIGH) Current consumption 1.5 V system: 0.45 μA |
| 9 | VOUT | O | 3V |  | DC / DC converter output pin |
| 10 | VIN | I | —— | | DC / DC converter switching pin (internal rectifier diode) |
| 12 | SP | O | —— |  | Driver output pin |
| 14 | MOT | O | —— |  | Driver output pin |
| 16 | LOUT | O | —— |  | Driver output pin |

∗1 Operation theory for battery ejection circuit



●Electrical characteristics (unless otherwise noted, Ta = 25°C, + B = 1.5V)

| Parameter | | Symbol | Min. | Typ. | Max. | Unit | Conditions | Measurement Circuit |
|---|---|---|---|---|---|---|---|---|
| 〈Overall circuit〉 | | | | | | | | |
| Current dissipation | | $I_{IN}$ | — | 11 | 20 | μA | With no load on DC / DC converter and all drives off, BLDOUT=OPEN | Fig.1 |
| 〈DC-DC converter unit〉 | | | | | | | | |
| Output voltage | BH6113FV | $V_{OUT}$ | 2.90 | 3.00 | 3.10 | V | $I_{OUT}$=4.0mA | Fig.1 |
| | BH6114FV | | 2.63 | 2.70 | 2.77 | V | $I_{OUT}$=4.0mA | Fig.1 |
| Output voltage temperature change ratio | | $\triangle V_{OUT}$ | — | −0.2 | — | mV/℃ | Ta=−20～+65℃ | Fig.1 |
| Operation initiation power supply voltage | | $V_{ST}$ | — | 0.80 | 0.90 | V | $R_{OUT}$=680Ω, $V_{CC}$ ; 0V→1.7V | Fig.1 |
| Operation sustain power supply voltage | | $V_{hld}$ | — | 0.70 | 0.80 | V | $R_{OUT}$=680Ω, $V_{CC}$ ; 1.7V→0V | Fig.1 |
| Input voltage supply stability | | $\triangle V_{O1}$ | — | 10 | 100 | mV | $I_{OUT}$=4.0mA, $V_{CC}$ ; 0.9～1.7V | Fig.1 |
| Load regulation | | $\triangle V_{O2}$ | — | 5 | 100 | mV | $I_{OUT}$=2.0～4.0mA | Fig.1 |
| Oscillation duty ratio | | $Df_{Max.}$ | — | 85 | — | % | At maximum oscillation frequency | Fig.1 |
| Maximum oscillation frequency | | fosc | — | 100 | 140 | kHz | — | Fig.1 |
| Efficiency 1 (light load) | | η1 | 70 | 75 | — | % | $I_{OUT}$=100μA | Fig.1 |
| Efficiency 2 (medium load) | | η2 | 70 | 80 | — | % | $I_{OUT}$=1mA | Fig.1 |
| Efficiency 3 (heavy load) | | η3 | 70 | 80 | — | % | $I_{OUT}$=4mA | Fig.1 |
| 〈Battery ejection circuit unit〉 | | | | | | | | |
| BLD detection voltage | | $V_{BLD}$ | 0.48 | 0.53 | 0.58 | V | +B value at BLDOUT=1.35V, $R_{BLD}$=3MΩ | Fig.1 |
| Output high level voltage | | VOH | 2.7 | 3.0 | — | V | $R_{BLD}$=3MΩ | Fig.1 |
| Output low level voltage | | VOL | — | 0.1 | 0.4 | V | $R_{BLD}$=3MΩ | Fig.1 |
| 〈Vibrator control unit〉 | | | | | | | | |
| Maximum output drive system | | $I_{OM}1$ | 300 | — | — | mA | Vsat≦0.5V | Fig.1 |
| Drive output voltage | | Vsat1 | — | 0.18 | 0.36 | V | $I_{OUT}$=180mA | Fig.1 |
| Leakage current when off | | $I_{L}1$ | — | 0.0 | 5.0 | μA | $V_{OUT}$=5V | Fig.1 |
| 〈Speaker control unit〉 | | | | | | | | |
| Line current when off | | $I_{Q}2$ | 4.5 | 8.0 | 15.5 | mA | For loud volume | Fig.1 |
| Maximum drive current / loud volume | | $I_{OM}2$ | 200 | — | — | mA | Vsat≦0.5V | Fig.1 |
| Drive output voltage / loud volume | | Vsat2A | — | 0.10 | 0.20 | V | $I_{OUT}$=100mA (Z=1Ω) | Fig.1 |
| Drive output voltage / ordinary volume | | Vsat2B | 0.12 | 0.22 | 0.32 | V | $I_{OUT}$=10mA (Z=22Ω) | Fig.1 |
| Drive output voltage / medium volume | | Vsat2C | 0.10 | 0.19 | 0.30 | V | $I_{OUT}$=5mA (Z=38Ω) | Fig.1 |
| Drive output voltage / low volume | | Vsat2D | 0.03 | 0.11 | 0.23 | V | $I_{OUT}$=1mA (Z=110Ω) | Fig.1 |
| Leakage current when off | | $I_{L}2$ | — | 0.0 | 5.0 | μA | $V_{OUT}$=5V | Fig.1 |
| Input threshold level | | $V_{TH}2$ | +B −0.85V | — | — | V | — | Fig.1 |
| Input current | | $I_{IN}2$ | 11 | 23 | 35 | μA | $V_{IN}$=+B−0.85V | Fig.1 |

◎Not designed for radiation resistance.

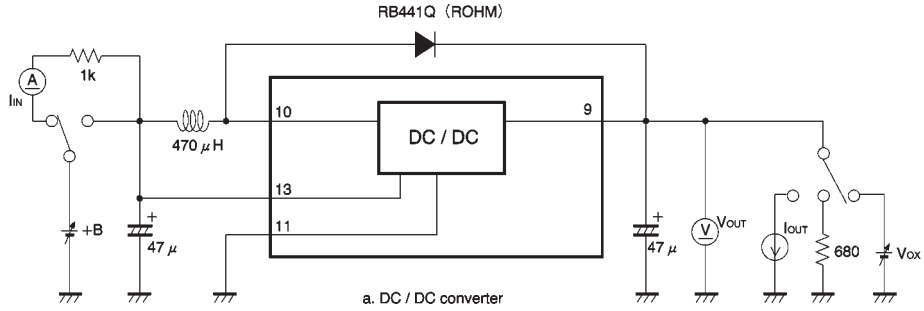
| Parameter | Symbol | Min. | Typ. | Max. | Unit | Conditions | Measurement Circuit |
|---|---|---|---|---|---|---|---|
| 〈LED control unit〉 | | | | | | | |
| Circuit current when on | $I_{Q3}$ | 2.5 | 4.5 | 8.0 | mA | — | Fig.1 |
| Maximum output drive current | $I_{OM3}$ | 100 | — | — | mA | Vsat≦0.5V | Fig.1 |
| Drive output voltage | Vsat3 | — | 0.1 | 0.2 | V | $I_{OUT}$=40mA | Fig.1 |
| Leakage current when off | $I_{L3}$ | — | 0.0 | 5.0 | μA | $V_{OUT}$=5V | Fig.1 |
| Input threshold level | $V_{TH3}$ | +B −0.85V | — | — | V | — | Fig.1 |
| Input current | $I_{IN3}$ | 11 | 23 | 35 | μA | $V_{IN}$=+B−0.85V | Fig.1 |
| 〈Photocoupler drive unit〉 | | | | | | | |
| Maximum output drive current | $I_{OM4}$ | 5 | — | — | mA | Vsat≦0.5V | Fig.1 |
| Drive output voltage | Vsat4 | — | 0.1 | 0.2 | V | $I_{OUT}$=3mA | Fig.1 |
| Leakage current when off | $I_{L4}$ | — | 0.0 | 5.0 | μA | $V_{OUT}$=5V | Fig.1 |
| Pull-up resistance 4 | $R_{IN4}$ | 190 | 270 | 350 | kΩ | — | Fig.1 |

◎Not designed for radiation resistance.

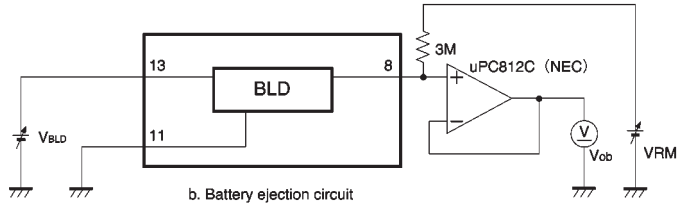
Speaker unit logic table

| Pin | Volume | | | |
|---|---|---|---|---|
| | High | Medium (high) | Medium (low) | Low |
| SPC1 | LOW | HIGH | LOW | HIGH |
| SPC2 | LOW | LOW | HIGH | HIGH |

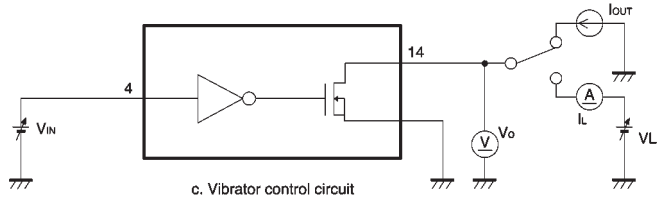
●Measurement circuits



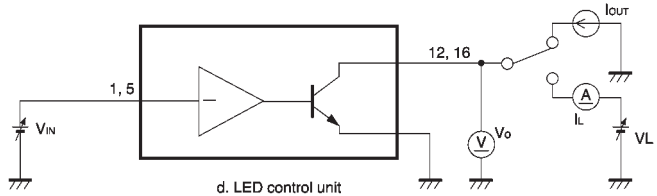

a. DC / DC converter



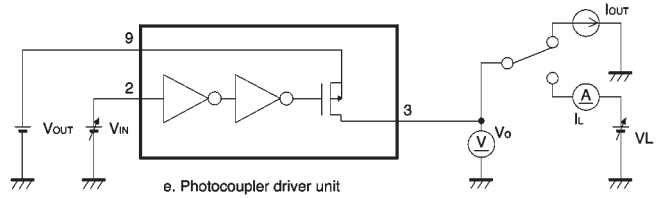

b. Battery ejection circuit




c. Vibrator control circuit




d. LED control unit
Speaker control unit




e. Photocoupler driver unit

Fig.1

●Application example

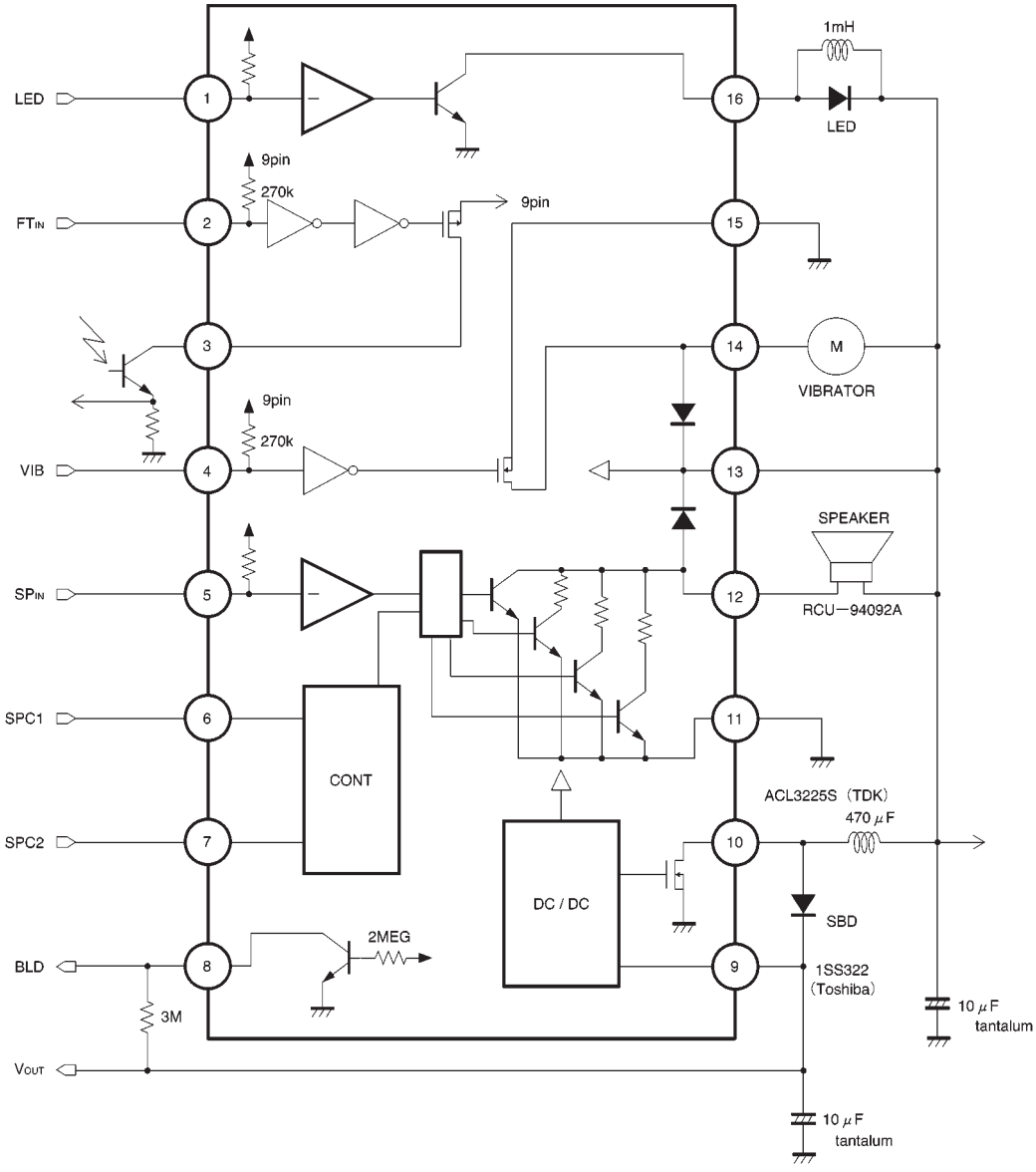



Fig.2

●Electrical characteristic curves

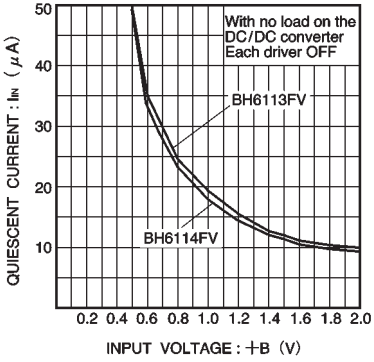



Fig.3 Quiescent current (at no load) vs.input voltage

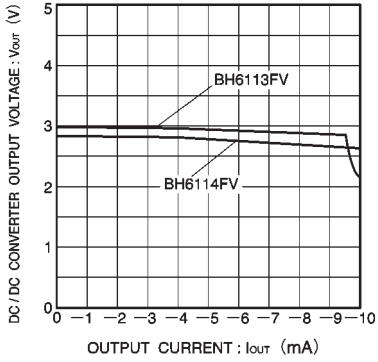



Fig.4 DC / DC converter unit: load regulation

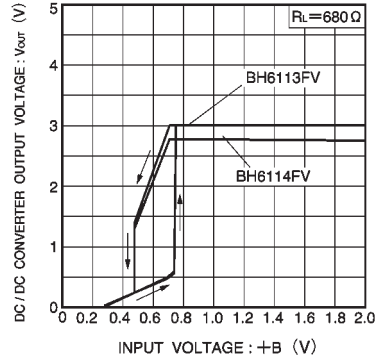



Fig.5 DC / DC converter unit: line regulation

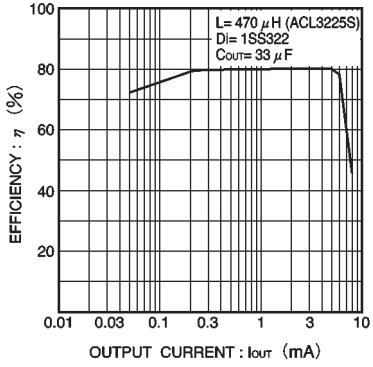



Fig.6 DC / DC converter unit efficiency vs. load current

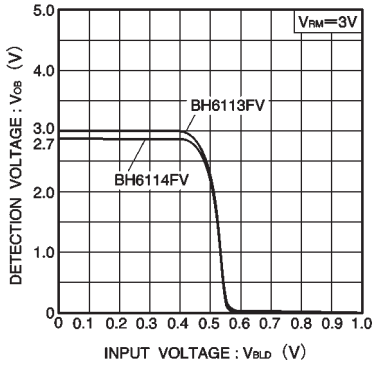



Fig.7 BLD detection voltage

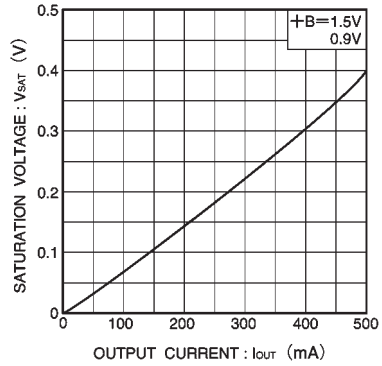



Fig.8 Vibrator control unit: saturation voltage vs. output current

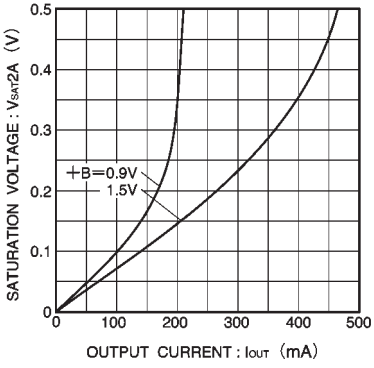



Fig.9 Speaker control unit (loud volume) : saturation voltage vs. output current

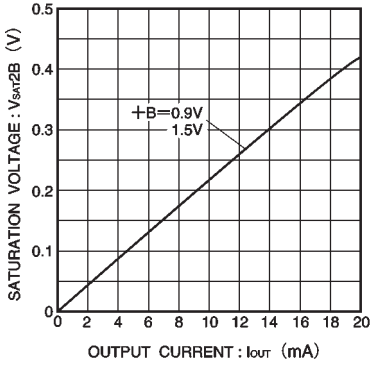



Fig.10 Speaker control unit (normal volume) : saturation voltage vs. output current

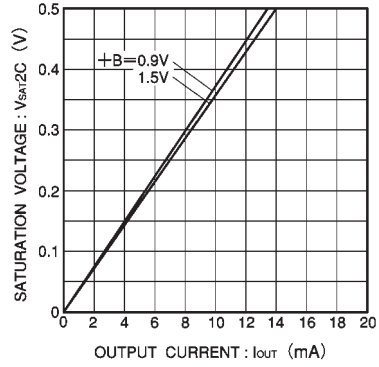



Fig.11 Speaker control unit (medium volume) : saturation voltage vs. output current

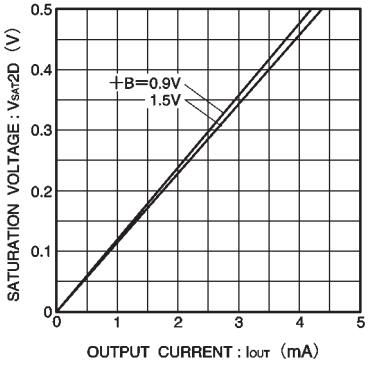



Fig.12 Speaker control unit (low volume) : saturation voltage vs. output current

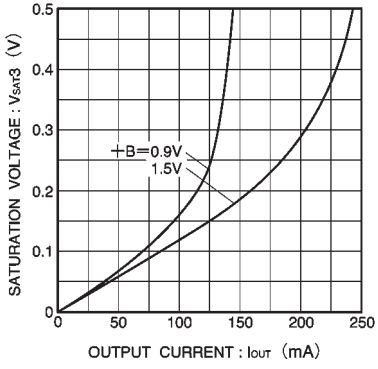



Fig.13 LED control unit: saturation voltage vs.output current

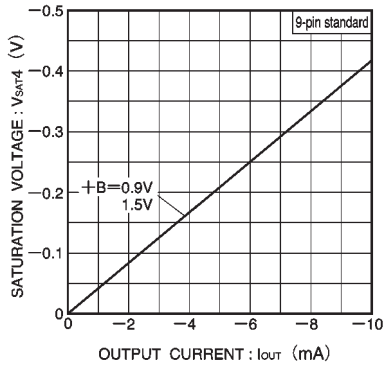



Fig.14 Photocoupler driver control unit : saturation voltage vs. output current

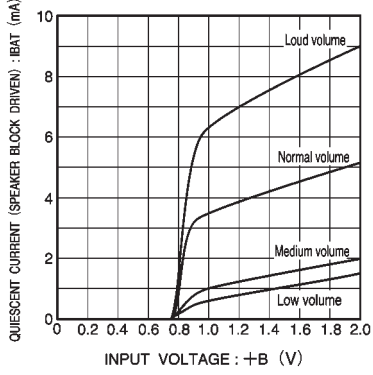



Fig.15 Speaker control unit: quiescent current (when on) vs.input voltage

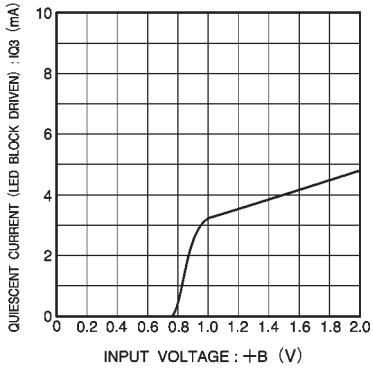
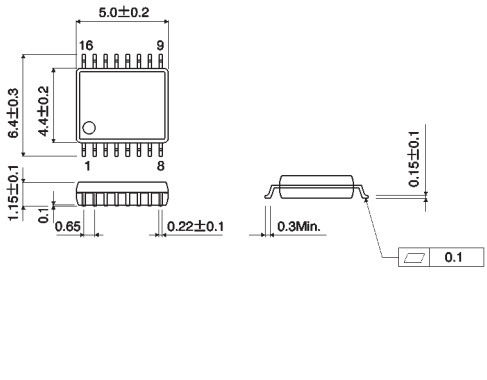



Fig.16 LED control unit: quiescent current (when on) vs. input voltage

●External dimensions (Units: mm)




SSOP-B16