

# M62216FP/GP

## Low Voltage Operation STEP-UP DC/DC Converter

REJ03D0845-0300

Rev.3.00

Jun 15, 2007

### Description

The M62216FP is designed as low voltage operation STEP-UP DC/DC converter.

This IC can operate very low input voltage (over 0.9 V) and low power dissipation. (circuit current is less than 850  $\mu$ A)

So, this IC suitable for power supply of portable system that using low voltage battery. (DRY battery, rechargeable battery)

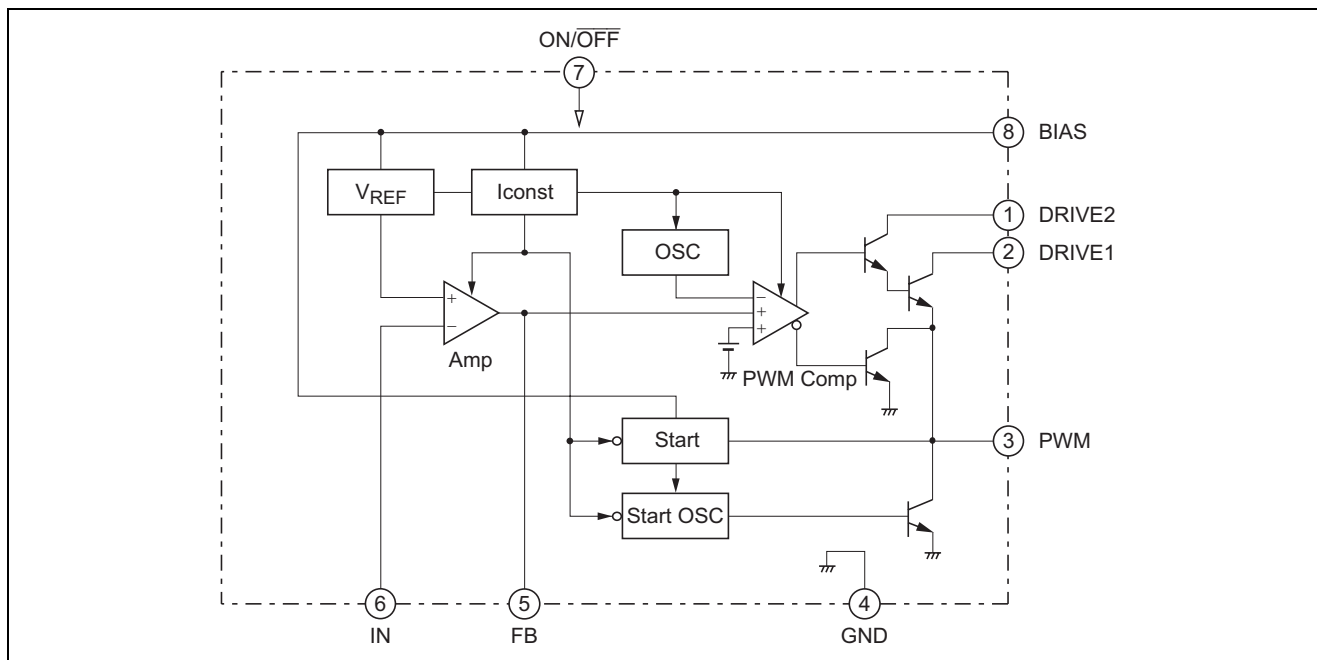
### Features

- Pre-drive type PWM output (Pre-drive only)
- Low voltage operation:  $V_{IN} = 0.9$  V min.
- Low current dissipation:  $I_B = 850$   $\mu$ A typ.
- Pre-drive output current can be adjusted
- Built-in ON/OFF Function:  $I_{B(OFF)} = 35$   $\mu$ A typ.
- Application for STEP-DOWN Converter can be used

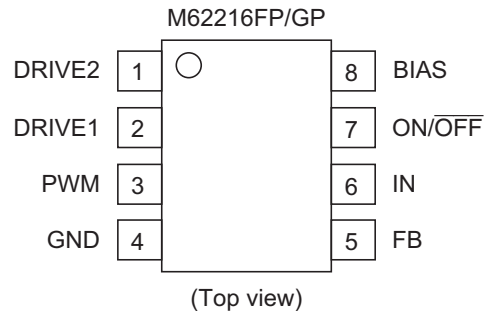
### Application

DC/DC Converter for portable sets of battery used

### Block Diagram



## Pin Arrangement



Outline: PRSP0008DE-C [FP] (recommend)  
PRSP0008DA-A (8P2S-A) [FP] (not recommend for new design)  
8P2X-A [GP]

## Absolute Maximum Ratings

(Ta = 25°C, unless otherwise noted)

Item	Symbol	Ratings	Units	Conditions
Input voltage	V <sub>IN</sub>	15.5	V	
Bias terminal supply voltage	V <sub>BIAS</sub>	15.5	V	
Drive1 terminal supply voltage	V <sub>DRIVE1</sub>	15.5	V	
Drive2 terminal supply voltage	V <sub>DRIVE2</sub>	15.5	V	
Drive1 terminal input current	I <sub>DRIVE1</sub>	100	mA	
Drive2 terminal Input current	I <sub>DRIVE2</sub>	10	mA	
Power dissipation	Pd	440 (FP) 250 (GP)	mW	Ta = 25°C
Operating temperature	Topr	-20 to +85	°C	
Storage temperature	Tstg	-40 to +150	°C	

## Electrical Characteristics

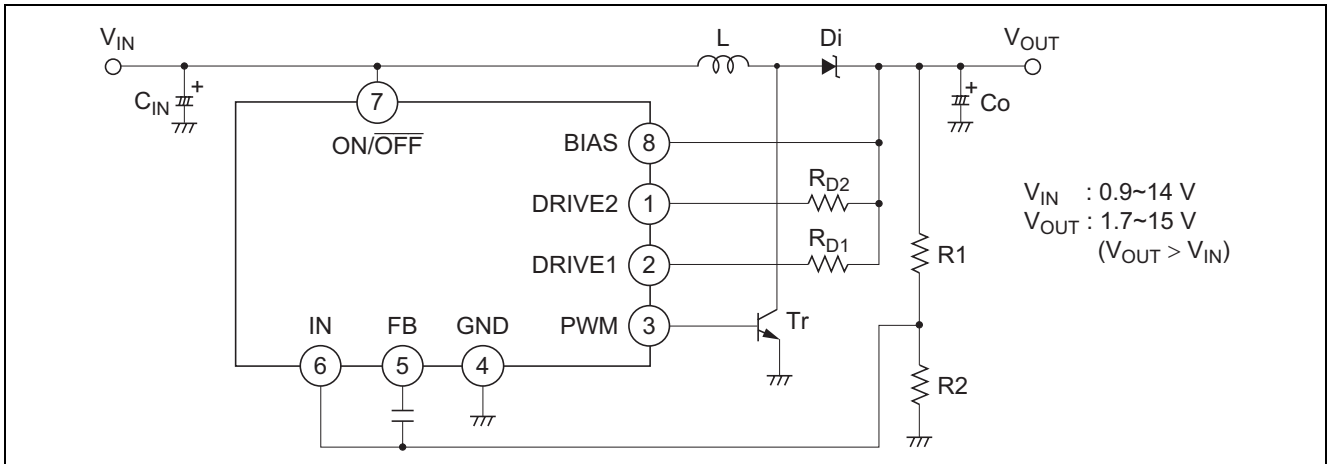
(Ta = 25°C, V<sub>IN</sub> = 1.7 V, V<sub>OUT</sub> = V<sub>BIAS</sub> = 3.0 V, unless otherwise noted)

Block	Item	Symbol	Limits			Units	Test Condition
			Min	Typ	Max		
All device	Input voltage range	V <sub>IN</sub>	0.9	—	15	V	
	BIAS voltage setting range*1	V <sub>BIAS</sub>	1.7	—	15	V	
	BIAS current	I <sub>B</sub>	—	850	1200	μA	
	BIAS current at off mode	I <sub>B (OFF)</sub>	—	35	47	μA	
Voltage reference	Reference voltage	V <sub>REF</sub>	1.20	1.26	1.32	V	Use internal amp as Buffer-amp
	BIAS voltage regulation of VREF	ΔV <sub>REF</sub>	—	10	30	mV	V <sub>BIAS</sub> = 1.7 to 15 V
Error Amp.	Input current	I <sub>IN</sub>	—	20	—	nA	I <sub>N</sub> = 1 V/IM
	Open loop voltage gain	A <sub>V</sub>	—	70	—	dB	f <sub>IN</sub> = 100 Hz, null amp operation
	FB terminal sink current	I <sub>FB+</sub>	260	800	—	μA	I <sub>N</sub> = 1.4 V, FB = 1.25 V/IM
	FB terminal source current	I <sub>FB-</sub>	30	45	60	μA	I <sub>N</sub> = 1.1 V, FB = 1.25 V/IM
Osc.	Oscillation frequency	f <sub>OSC</sub>	95	125	155	kHz	PWM terminal monitored
	Maximum on duty	DUTY <sub>max</sub>	82	87	92	%	PWM terminal monitored, I <sub>N</sub> = 1.1 V
Output	Saturation voltage between PWM Term. and DRIVE1 Term.	V <sub>sat1</sub>	—	0.25	0.5	V	I <sub>DRIVE1</sub> = 50 mA, I <sub>DRIVE2</sub> = 5 mA
	Saturation voltage between PWM Term. and DRIVE2 Term.	V <sub>sat2</sub>	—	1.0	1.2	V	
	Leak current of DRIVE1 terminal	I <sub>L1</sub>	-1	—	1	μA	I <sub>N</sub> = 1.4 V
	Leak current of DRIVE2 terminal	I <sub>L2</sub>	-1	—	1	μA	I <sub>N</sub> = 1.4 V
	Output low voltage of PWM terminal	V <sub>PWM (L)</sub>	—	0.03	0.3	V	I <sub>PWM</sub> = 1 mA
ON/OFF	Input current of ON/OFF terminal at on status	I <sub>ON</sub>	—	2	3	μA	
	Threshold voltage of ON/OFF terminal	V <sub>TH (ON)</sub>	—	0.65	0.75	V	

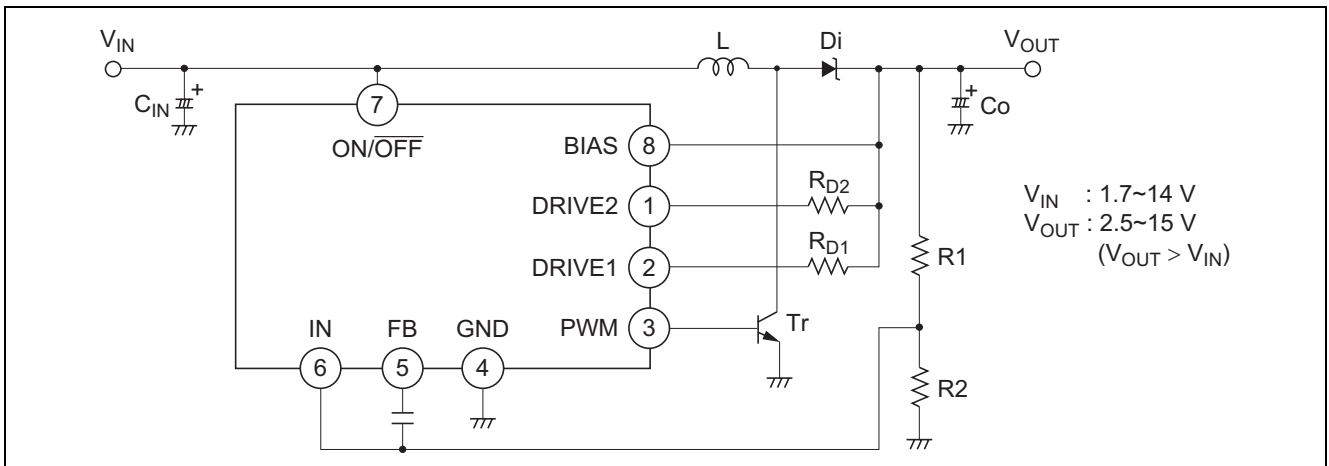
Note: 1. Setting range of BIAS voltage as same as setting range of output voltage.

## Application Circuit

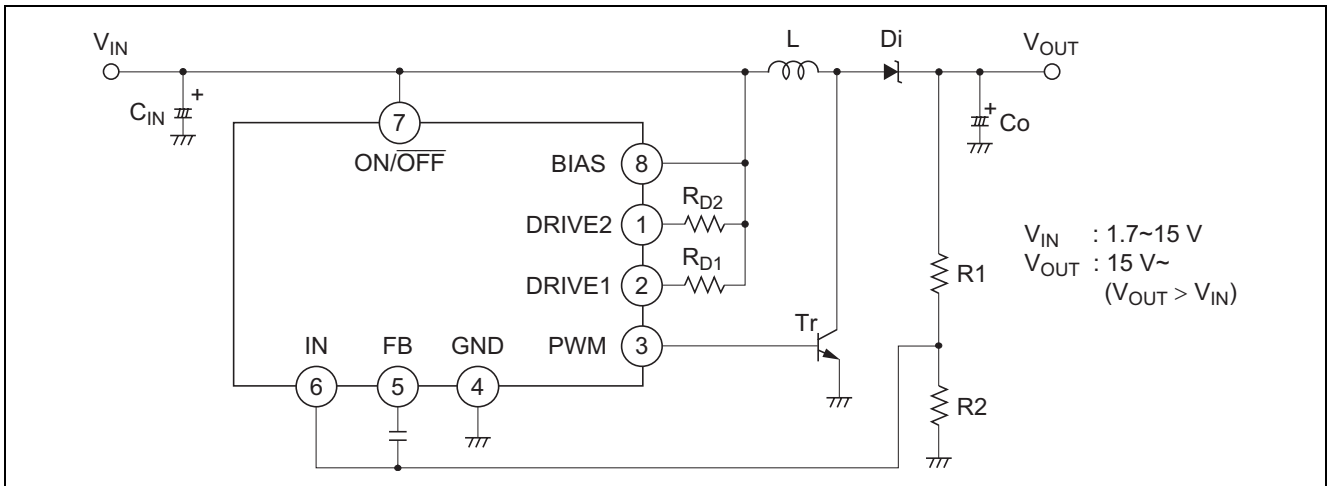
### (1) Standard application circuit



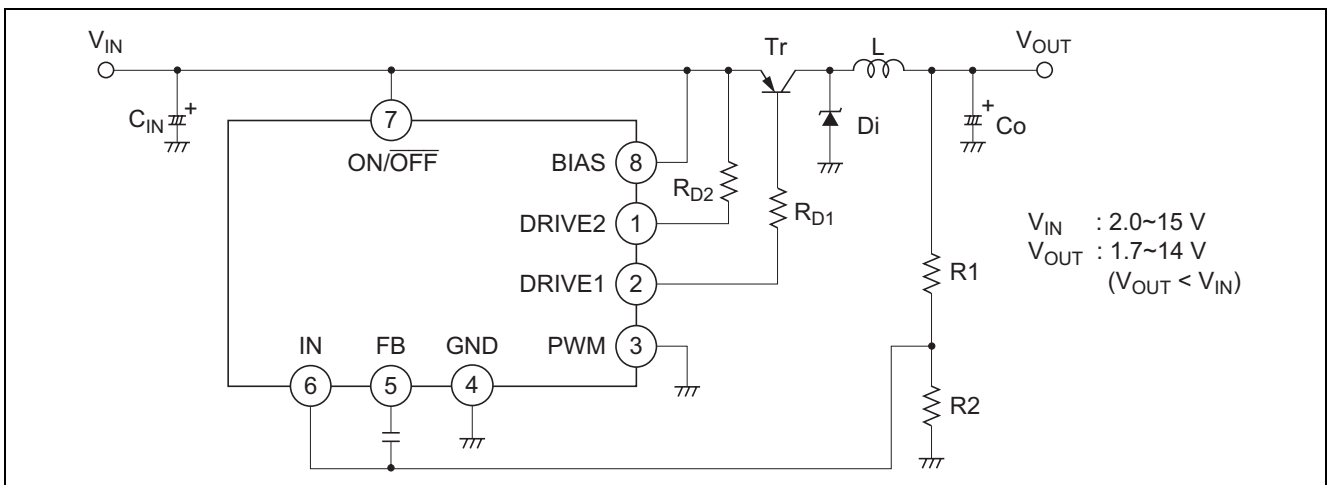
### (2) Application circuit 1 ( $V_{IN} \geq 1.7$ V)



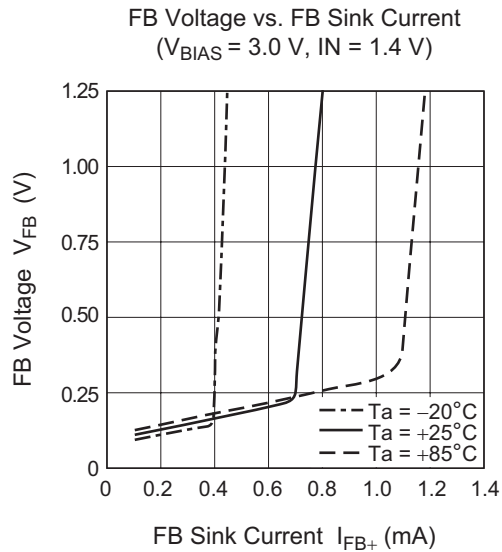
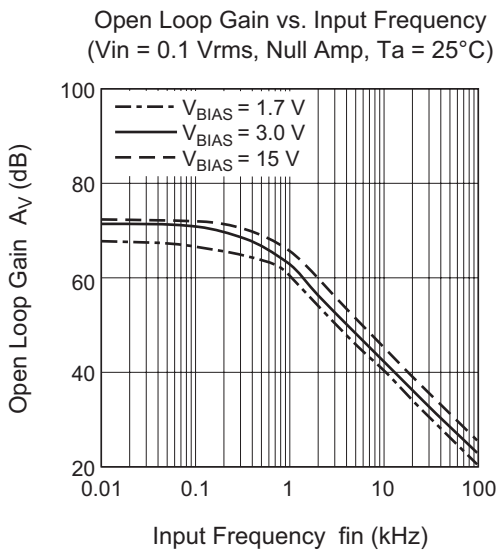
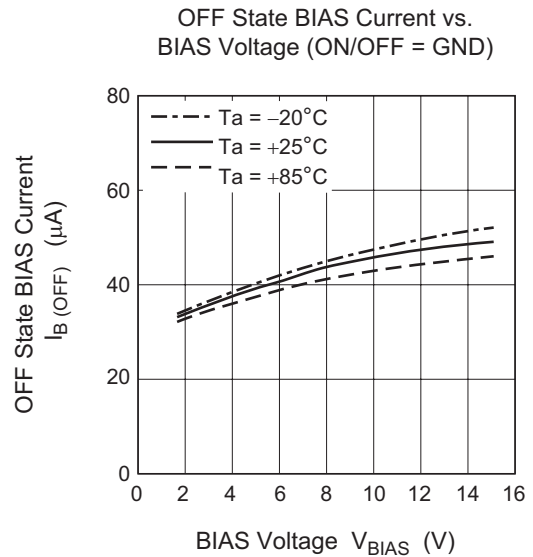
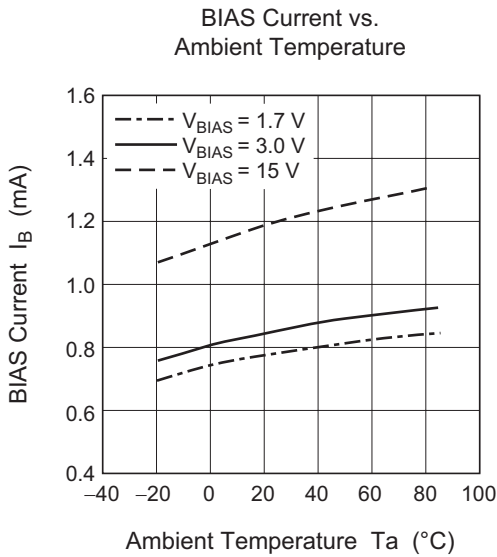
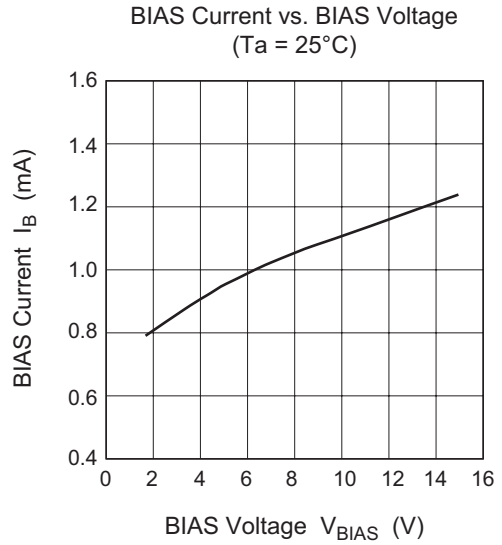
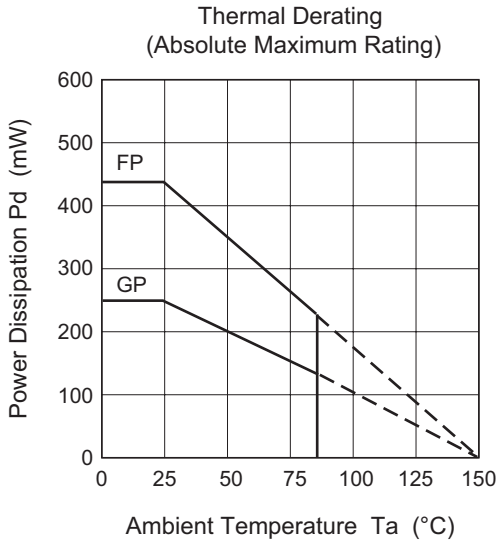
(3) Application circuit 2 ( $V_{OUT} > 15\text{ V}$ )

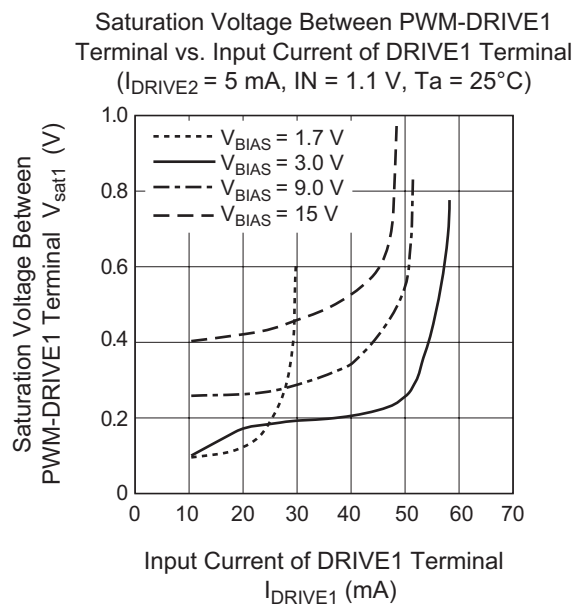
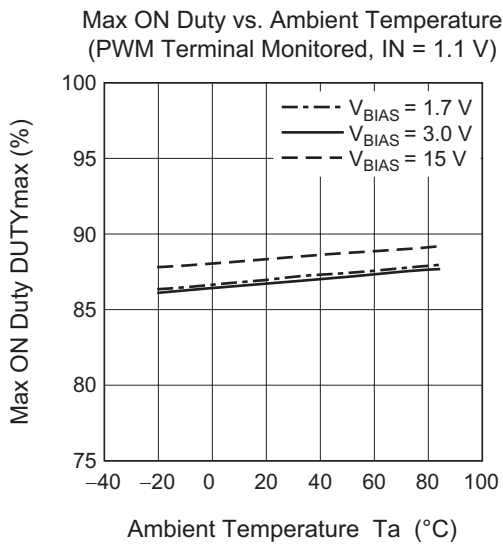
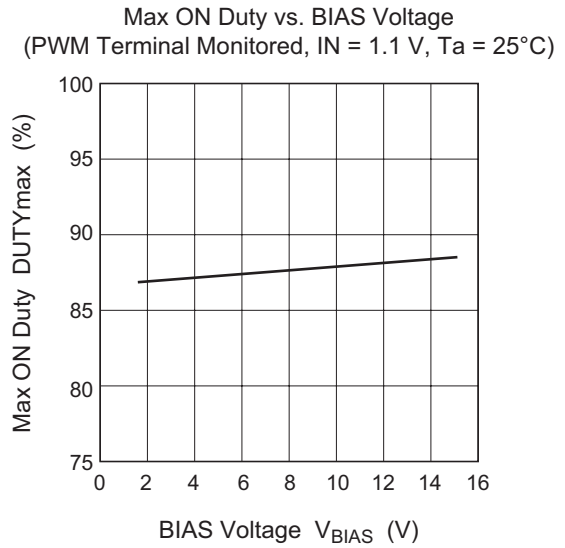
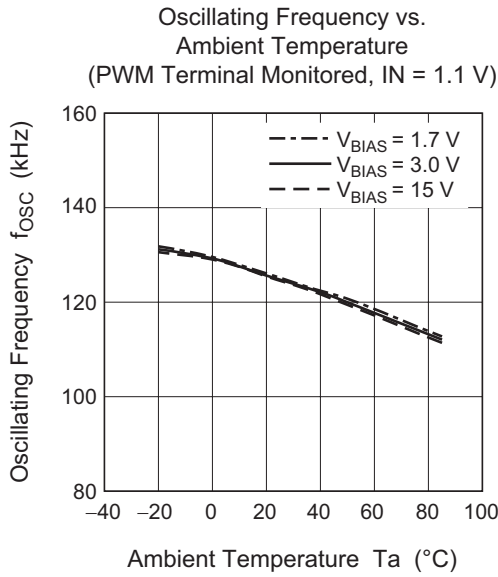
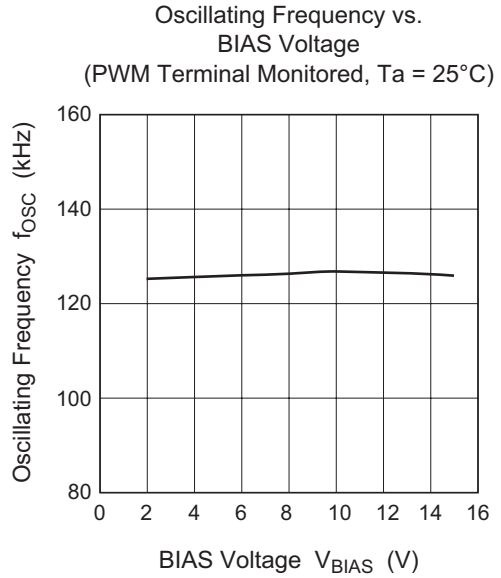
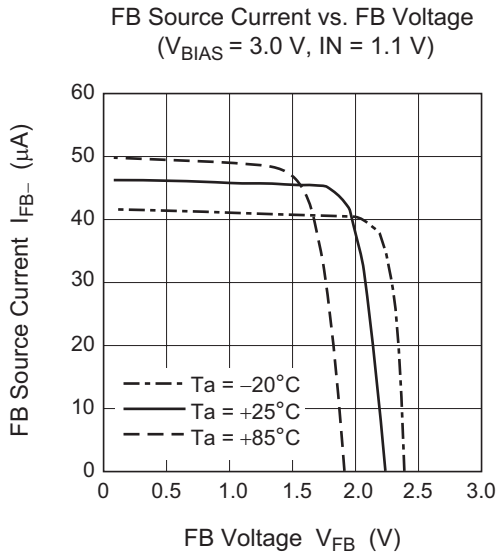


(4) Application circuit for STEP-DOWN circuit

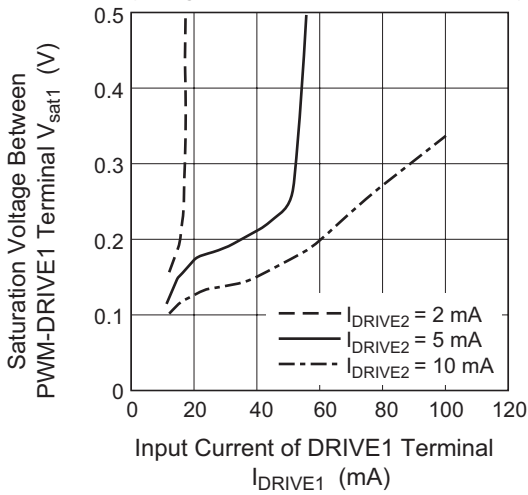


Typical Characteristics

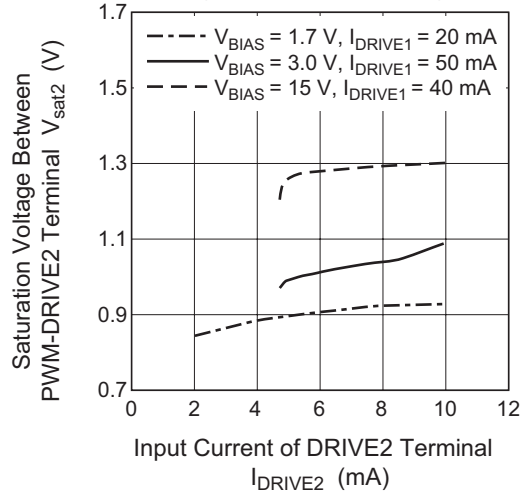




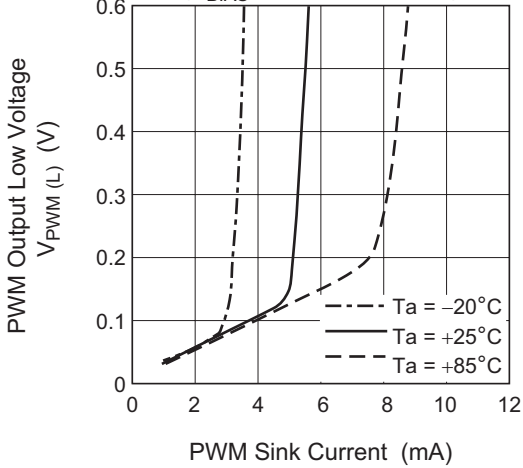
Saturation Voltage Between PWM-DRIVE1 Terminal vs. Input Current of DRIVE1 Terminal ( $V_{BIAS} = 3.0\text{ V}$ ,  $I_N = 1.1\text{ V}$ ,  $T_a = 25^\circ\text{C}$ )



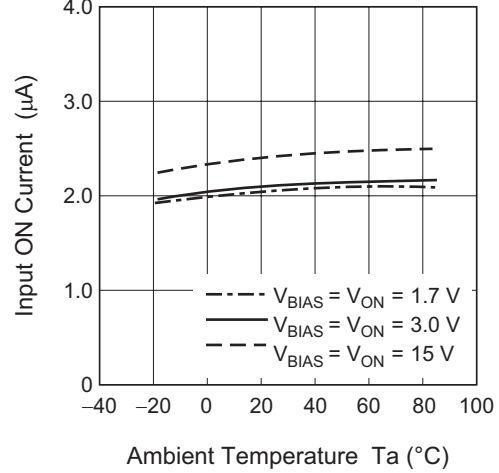
Saturation Voltage Between PWM-DRIVE2 Terminal vs. Input Current of DRIVE2 Terminal ( $I_N = 1.1\text{ V}$ ,  $T_a = 25^\circ\text{C}$ )



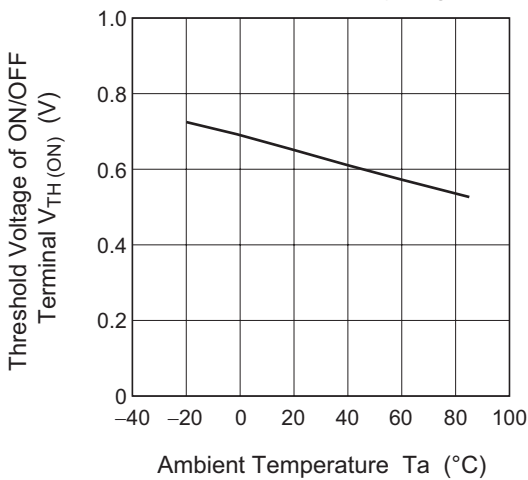
PWM Output Low Voltage vs. PWM Sink Current ( $V_{BIAS} = 3.0\text{ V}$ ,  $I_N = 1.4\text{ V}$ )



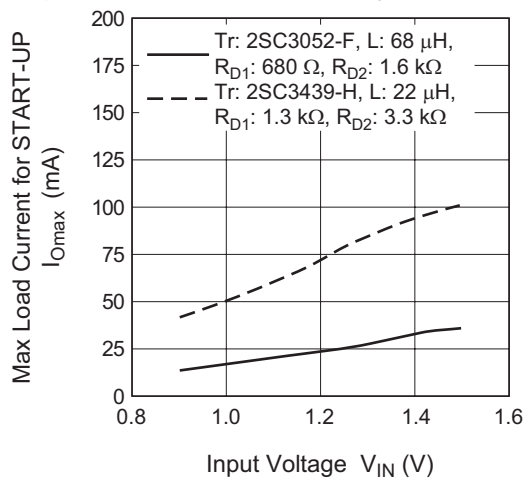
Input ON Current vs. Ambient Temperature



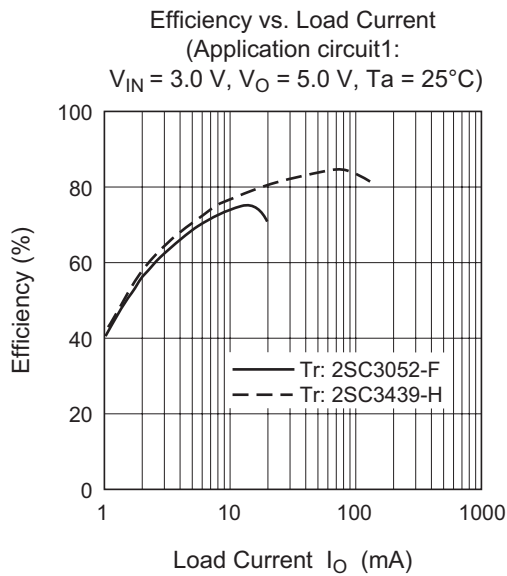
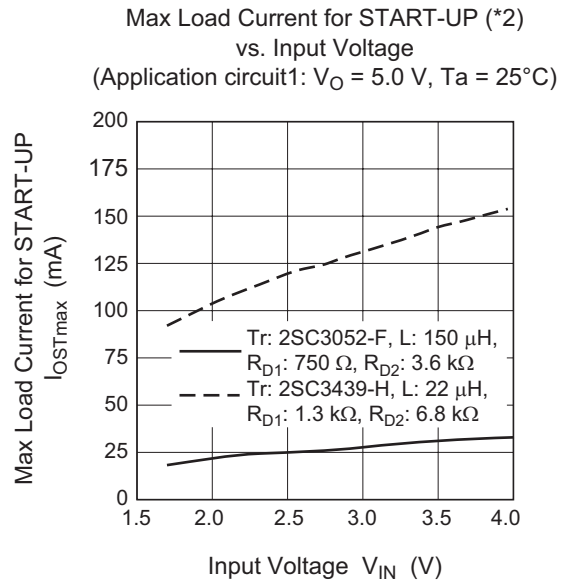
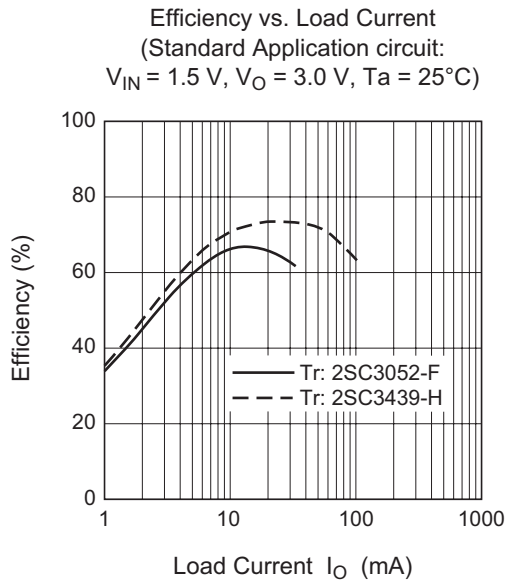
Threshold Voltage of ON/OFF Terminal vs. Ambient Temperature ( $V_{BIAS} = 3.0\text{ V}$ )



Max Load Current for START-UP(\*) vs. Input Voltage (Standard Application Circuit,  $V_O = 3.0\text{ V}$ ,  $T_a = 25^\circ\text{C}$ )







Notes: 1, 2. These characteristics show the maximum output load current when start-up.  
Therefore, output voltage can grown-up to setting voltage less than a curve in the graph when using these external components value.  
(2SC3052-F:  $h_{FE} = 250$  to  $500$ , 2SC3439-H:  $h_{FE} = 600$  to  $1200$ )

## Equation for Constants Calculation

Constants	Standard Application Circuit	Application Circuit 1	Application Circuit 2
$\frac{T_{ON}}{T_{OFF}}$	$\frac{V_O + V_F - V_{IN}}{V_{IN} - V_{CE(sat)}}$	$\frac{V_O + V_F - V_{IN}}{V_{IN} - V_{CE(sat)}}$	$\frac{V_O + V_F - V_{IN}}{V_{IN} - V_{CE(sat)}}$
$T_{ON} + T_{OFF}$	$\frac{1}{f_{OSC}}$	$\frac{1}{f_{OSC}}$	$\frac{1}{f_{OSC}}$
$T_{OFF(MIN)}$	$\frac{T_{ON} + T_{OFF}}{1 + \frac{T_{ON}}{T_{OFF}}}$	$\frac{T_{ON} + T_{OFF}}{1 + \frac{T_{ON}}{T_{OFF}}}$	$\frac{T_{ON} + T_{OFF}}{1 + \frac{T_{ON}}{T_{OFF}}}$
$T_{ON(MAX)}$	$\frac{1}{f_{OSC}} - T_{OFF(MIN)}$	$\frac{1}{f_{OSC}} - T_{OFF(MIN)}$	$\frac{1}{f_{OSC}} - T_{OFF(MIN)}$
$I_{pk}$	$2 \times \left(1 + \frac{T_{ON}}{T_{OFF}}\right) \times (I_O + I_B)$	$2 \times \left(1 + \frac{T_{ON}}{T_{OFF}}\right) \times I_O$	$2 \times \left(1 + \frac{T_{ON}}{T_{OFF}}\right) \times I_O$
$L(MIN)$	$\frac{(V_{IN} - V_{CE(sat)})^2 \times T_{ON(MAX)}^2 \times f_{OSC}}{2 \times V_O \times (I_O + I_B)}$	$\frac{(V_{IN} - V_{CE(sat)})^2 \times T_{ON(MAX)}^2 \times f_{OSC}}{2 \times V_O \times I_O}$	$\frac{(V_{IN} - V_{CE(sat)})^2 \times T_{ON(MAX)}^2 \times f_{OSC}}{2 \times V_O \times I_O}$
$R_1$	$\left(\frac{V_O}{V_{REF}} - 1\right) \times R_2$	$\left(\frac{V_O}{V_{REF}} - 1\right) \times R_2$	$\left(\frac{V_O}{V_{REF}} - 1\right) \times R_2$
$R_{D1}$	$\frac{V_O - (V_{BE} + V_{sat1})}{(I_{pk}/h_{FE}) \times A_1}$	$\frac{V_O - (V_{BE} + V_{sat1})}{(I_{pk}/h_{FE}) \times A_1}$	$\frac{V_{IN} - (V_{BE} + V_{sat1})}{(I_{pk}/h_{FE}) \times A_1}$
$R_{D2}$	$\frac{V_O - (V_{BE} + V_{sat2})}{(I_{pk}/h_{FE}) \times A_2}$	$\frac{V_O - (V_{BE} + V_{sat2})}{(I_{pk}/h_{FE}) \times A_2}$	$\frac{V_{IN} - (V_{BE} + V_{sat2})}{(I_{pk}/h_{FE}) \times A_2}$

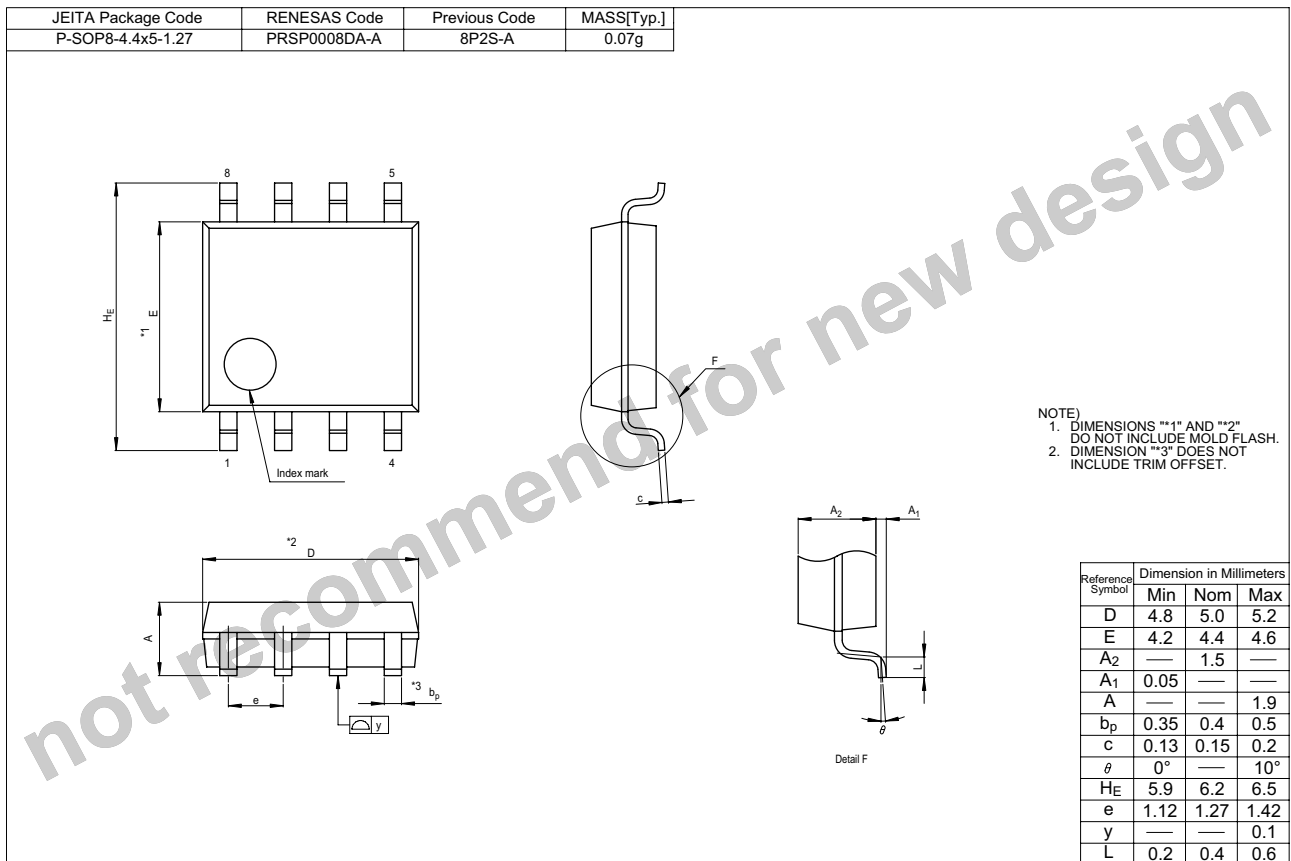
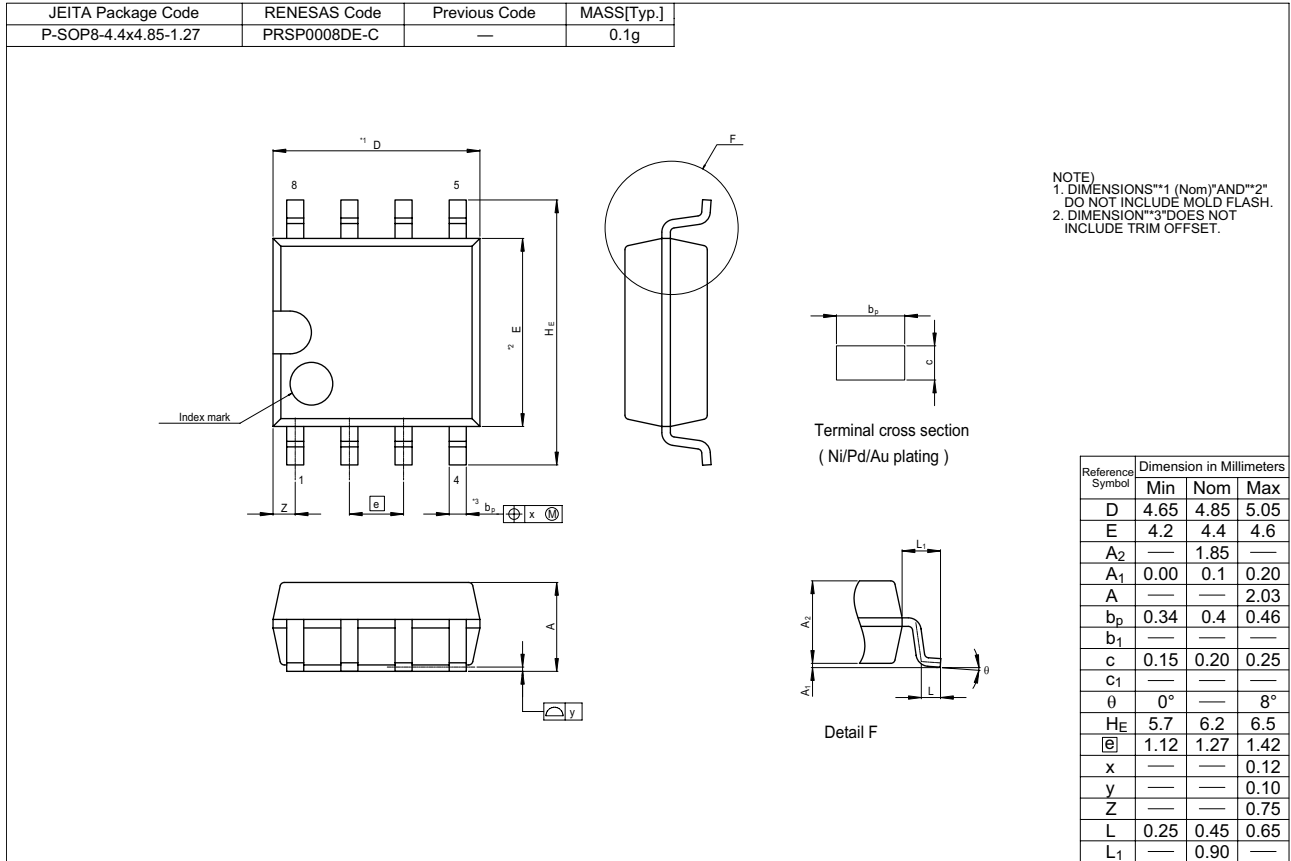
Constants	STEP-DOWN Circuit
$\frac{T_{ON}}{T_{OFF}}$	$\frac{V_O + V_F}{V_{IN} - V_{CE(sat)} - V_O}$
$T_{ON} + T_{OFF}$	$\frac{1}{f_{OSC}}$
$T_{OFF(MIN)}$	$\frac{T_{ON} + T_{OFF}}{1 + \frac{T_{ON}}{T_{OFF}}}$
$T_{ON(MAX)}$	$\frac{1}{f_{OSC}} - T_{OFF(MIN)}$
$I_{pk}$	$2 \times I_O$
$L(MIN)$	$\frac{(V_{IN} - V_{CE(sat)} - V_O) \times T_{ON(MAX)}}{\Delta I_O}$
$R_1$	$\left(\frac{V_O}{V_{REF}} - 1\right) \times R_2$
$R_{D1}$	$\frac{V_O - V_{BE} - V_{sat1}}{I_{pk}/h_{FE}}$
$R_{D2}$	$\frac{V_{IN} - V_{sat2}}{(I_{pk}/h_{FE}) \times A_3}$

## Note:

- $V_F$ : Forward voltage of external diode.
- $V_{CE(sat)}$ : Saturation voltage of external transistor.
- $V_{BE}$ : Voltage between Base - Emitter of external transistor.
- $h_{FE}$ :  $h_{FE}$  of external transistor at saturating.
- $A_1$ : Ratio of current into DRIVE1 terminal.  
( $A_1 = 0.8 \sim 0.9$ )
- $A_2$ : Ratio of current into DRIVE2 terminal.  
( $A_2 = 1 - A_1$ )
- $A_3$ : Ratio of current into DRIVE2 terminal.  
( $A_3 = 0.1 \sim 0.2$ )

- Set  $R_2$  to several  $k\Omega \sim$  several 10ths  $k\Omega$ .
- Set current into DRIVE2 terminal more than 100  $\mu A$ .  
( $I_{pk} / h_{FE}) \times A_2 \geq 100 \mu A$ , ( $I_{pk} / h_{FE}) \times A_3 \geq 100 \mu A$ )
- Set  $\Delta I_O$  to 1/5  $\sim$  1/3 of maximum load current
- The maximum rating of current of external parts (transistor, diode and inductor) are 1.5 to 2 times of  $I_{pk}$ .

Package Dimensions



Notes:

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