To all our customers

Regarding the change of names mentioned in the document, such as Mitsubishi Electric and Mitsubishi XX, to Renesas Technology Corp.

The semiconductor operations of Hitachi and Mitsubishi Electric were transferred to Renesas Technology Corporation on April 1st 2003. These operations include microcomputer, logic, analog and discrete devices, and memory chips other than DRAMs (flash memory, SRAMs etc.) Accordingly, although Mitsubishi Electric, Mitsubishi Electric Corporation, Mitsubishi Semiconductors, and other Mitsubishi brand names are mentioned in the document, these names have in fact all been changed to Renesas Technology Corp. Thank you for your understanding. Except for our corporate trademark, logo and corporate statement, no changes whatsoever have been made to the contents of the document, and these changes do not constitute any alteration to the contents of the document itself.

Note : Mitsubishi Electric will continue the business operations of high frequency & optical devices and power devices.

Renesas Technology Corp.
Customer Support Dept.
April 1, 2003

M62216FP/GP

Low Voltage Operation STEP-UP DC-DC Converter

DESCRIPTION

The M62216FP is designed as low voltage operation STEP-UP DC-DC converter.
This IC can operate very low input voltage (over 0.9V) and low power dissipation (circuit current is less than 850µA).
So, this IC suitable for power supply of portable system that using low voltage battery (DRY battery, rechargeable battery).

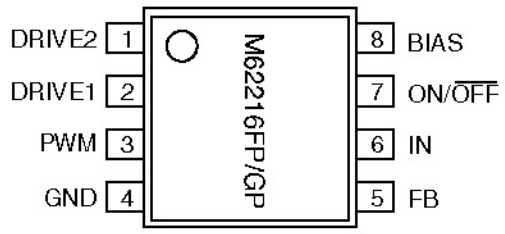
FEATURES

- Pre-Drive type PWM output (Pre-Drive only)
- Low voltage Operation ••••••••••••• VIN=0.9V min.
- Low Current Dissipation ••••••••••••• IB=850µA typ.
- Pre-Drive output current can be adjusted
- Built-in ON/OFF Function •••••••••• IB(OFF)=35µA typ.
- Application for STEP-DOWN Converter can be used

APPLICATION

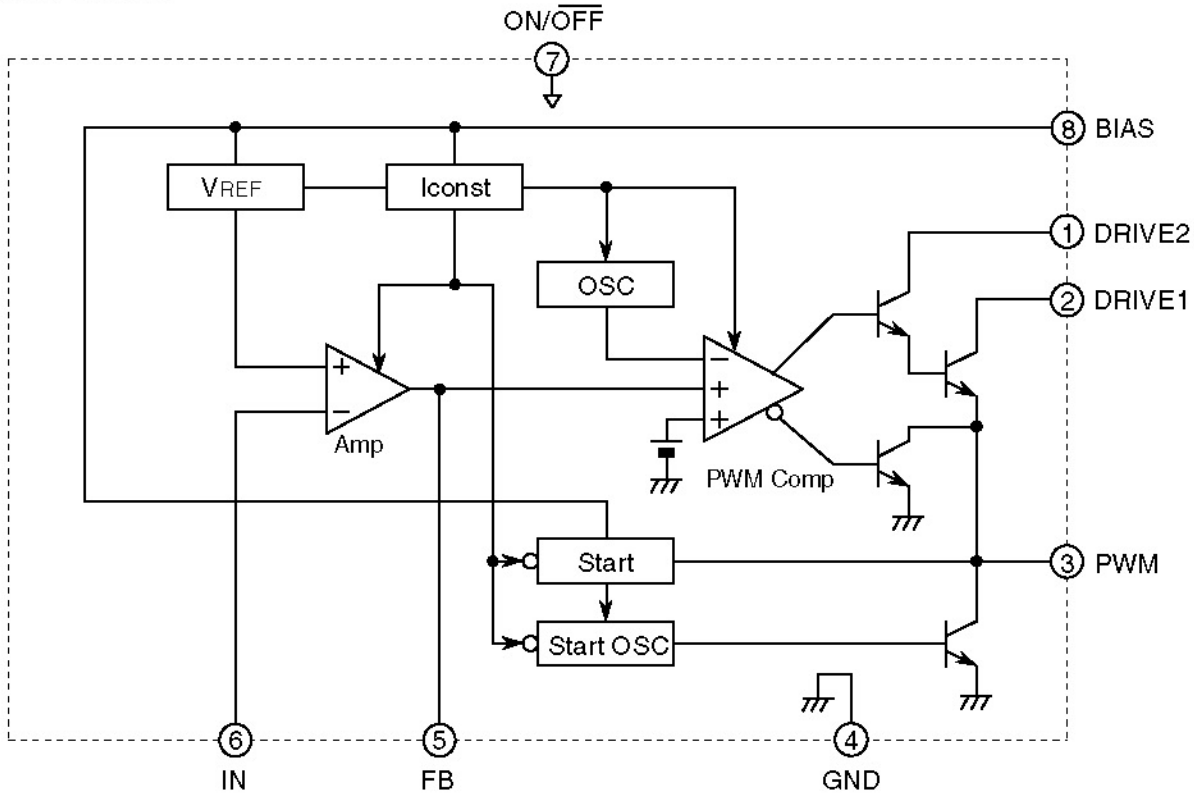
DC-DC Converter for portable sets of battery used

PIN CONFIGURATION(TOP VIEW)



OUTLINE: 8P2S-A(FP)
8P2X-A (GP)

BLOCK DIAGRAM



ABSOLUTE MAXIMUM RATINGS (Ta=25°C , unless otherwise noted)

Symbol	Parameter	Condition	Ratings	Unit
VIN	Input Voltage		15.5	V
VBIAS	Bias Terminal Supply Voltage		15.5	V
VDRIVE1	Drive1 Terminal Supply Voltage		15.5	V
VDRIVE2	Drive2 Terminal Supply Voltage		15.5	V
IDRIVE1	Drive1 Terminal Input Current		100	mA
IDRIVE2	Drive2 Terminal Input Current		10	mA
Pd	Power Dissipation	Ta=25°C	440 (FP) 250 (GP)	mW
Topr	Operating Temperature		-20 ~+85	°C
Tstg	Storage Temperature		-40 ~+150	°C

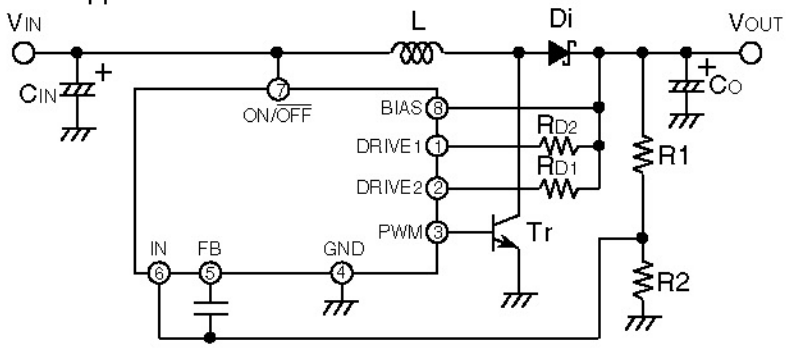
ELECTRICAL CHARACTERISTICS (Ta=25°C, VIN=1.7V, VOUT=VBIAS=3.0V, unless otherwise noted)

Block	Symbol	Parameter	Test Condition	Limits			Unit
				Min.	Typ.	Max.	
All Device	VIN	Input Voltage Range		0.9		15	V
	VBIAS	BIAS Voltage Setting Range *1		1.7		15	V
	IB	BIAS Current			850	1200	μA
	IB(OFF)	BIAS Current at OFF Mode			35	47	μA
Voltage Reference	VREF	Reference Voltage	Use internal amp as Buffer-amp	1.20	1.26	1.32	V
	ΔVREF	BIAS Voltage Regulation of VREF	VBIAS=1.7~15V		10	30	mV
Error Amp.	IIN	Input Current	IN = 1V / IM		20		nA
	AV	Open Loop Voltage Gain	fIN = 100Hz , Null Amp Operation		70		dB
	IFB+	FB Terminal Sink Current	IN = 1.4V , FB = 1.25V / IM	260	800		μA
	IFB-	FB Terminal Source Current	IN = 1.1V , FB = 1.25V / IM	30	45	60	μA
Osc.	fosc	Oscillation Frequency	PWM Terminal Monitored	95	125	155	kHz
	$DUTY_{max}$	Maximum ON Duty	PWM Terminal Monitored , IN = 1.1 V	82	87	92	%
OUTPUT	Vsat1	Saturation Voltage between PWM Term. and DRIVE1 Term.	IDRIVE1=50mA, IDRIVE2=5mA		0.25	0.5	V
	Vsat2	Saturation Voltage between PWM Term. and DRIVE2 Term.			1.0	1.2	V
	IL1	Leak Current of DRIVE1 Terminal	IN = 1.4V	-1		1	μA
	IL2	Leak Current of DRIVE2 Terminal	IN = 1.4V	-1		1	μA
	VPWM(L)	Output Low Voltage of PWM Terminal	IPWM = 1mA		0.03	0.3	V
ON/OFF	ION	Input Current of ON/$\overline{OFF}$ Terminal At ON Status			2	3	μA
	VTH(ON)	Threshold Voltage of ON/$\overline{OFF}$ Terminal			0.65	0.75	V

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

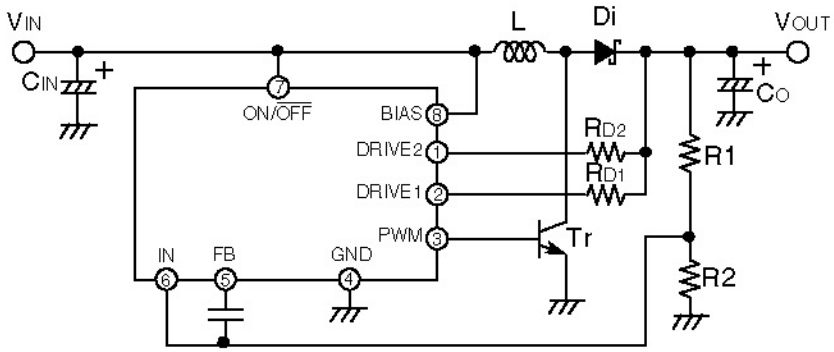
Application circuit

(1). Standard Application circuit



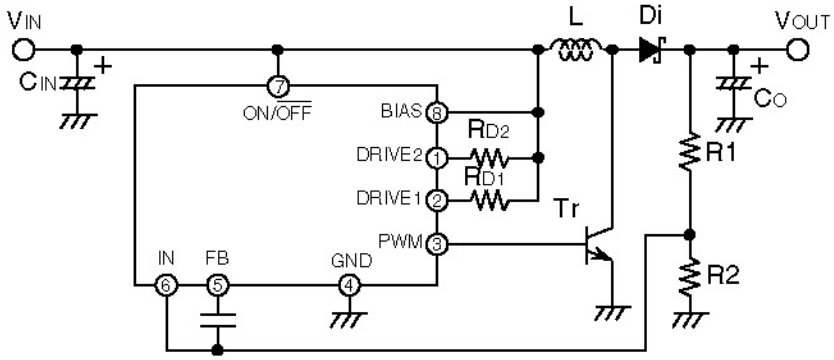
VIN : 0.9 ~ 14V
VOUT : 1.7 ~ 15V
(VOUT > VIN)

(2). Application circuit 1 (VIN ≥ 1.7V)



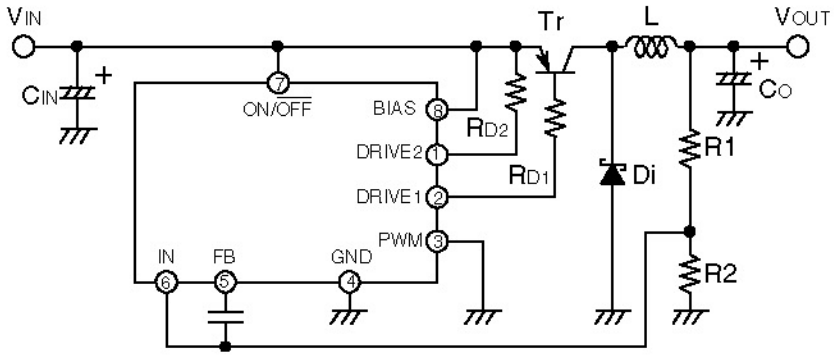
VIN : 1.7 ~ 14V
VOUT : 2.5V ~ 15V
(VOUT > VIN)

(3). Application circuit 2 (VOUT > 15V)



VIN : 1.7 ~ 15V
VOUT : 15V ~
(VOUT > VIN)

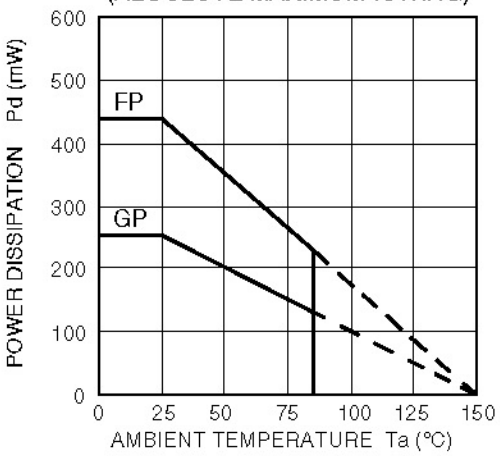
(4). Application circuit for STEP-DOWN Circuit



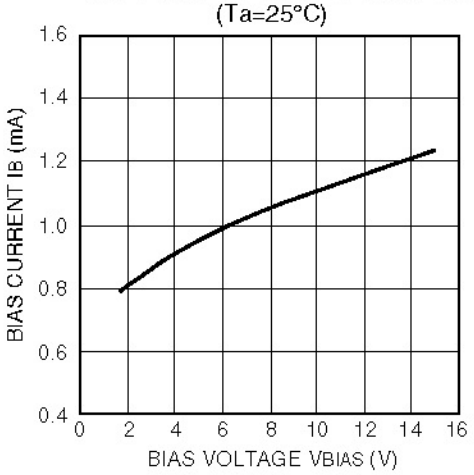
VIN : 2.0 ~ 15V
VOUT : 1.7V ~ 14V
(VOUT < VIN)

TYPICAL CHARACTERISTICS

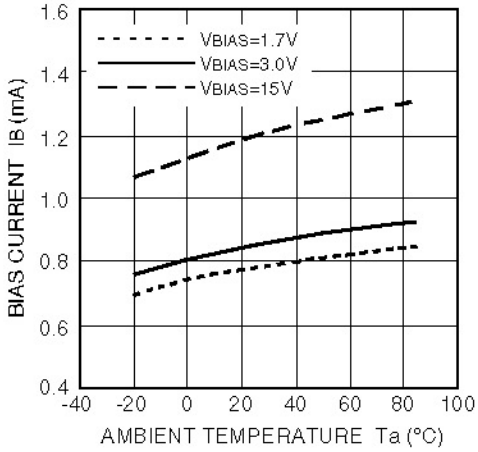
THERMAL DERATING
(ABSOLUTE MAXIMUM RATING)



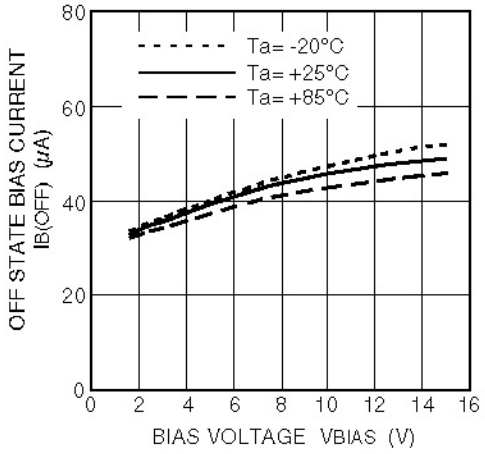
BIAS CURRENT vs. BIAS VOLTAGE
(Ta=25°C)



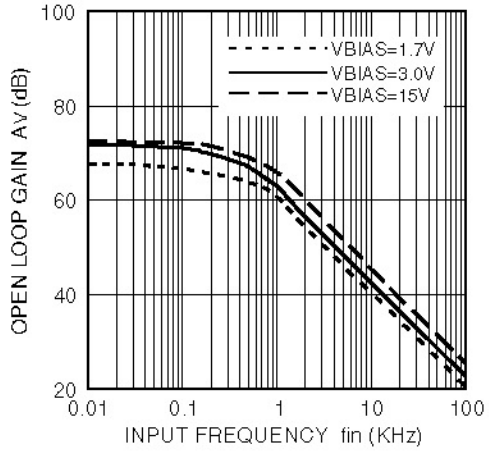
BIAS CURRENT vs. AMBIENT
TEMPERATURE



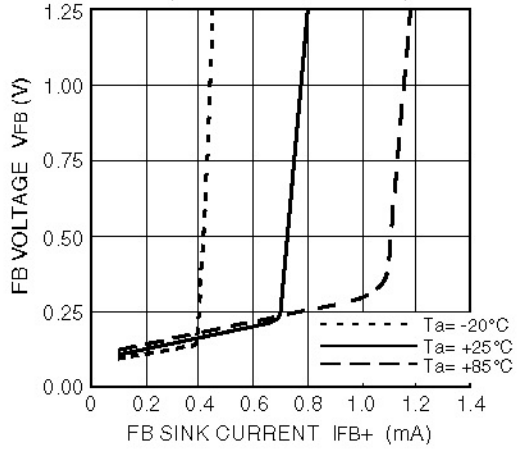
OFF STATE BIAS CURRENT vs.
BIAS VOLTAGE (ON/OFF=GND)



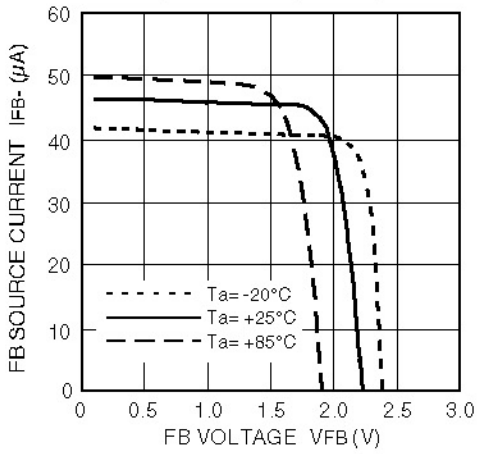
OPEN LOOP GAIN vs. INPUT FREQUENCY
(Vin=0.1Vrms , Null Amp , Ta=25°C)



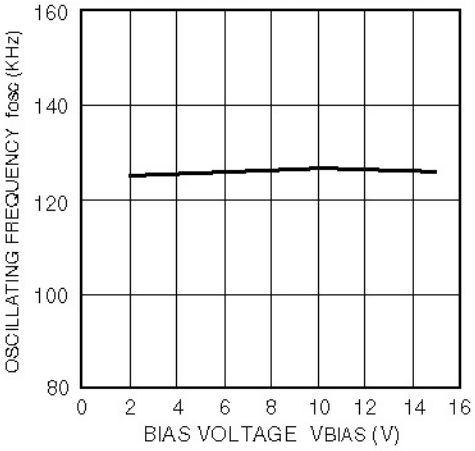
FB VOLTAGE vs. FB SINK CURRENT
(VBIAS=3.0V, IN=1.4V)



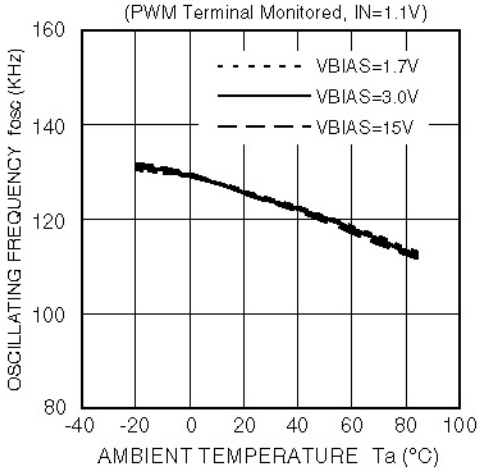
FB SOURCE CURRENT vs. FB VOLTAGE
(VBIAS=3.0V, IN=1.1V)



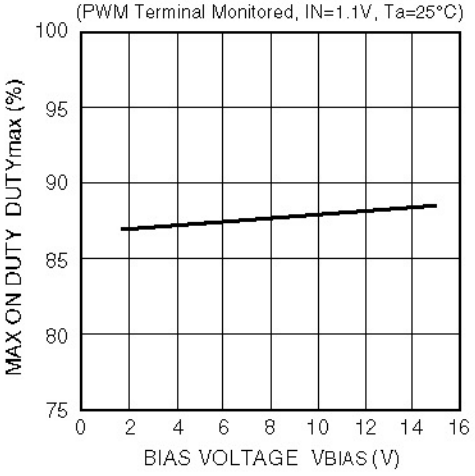
OSCILLATING FREQUENCY vs.
BIAS VOLTAGE
(PWM Terminal Monitored , Ta=25°C)



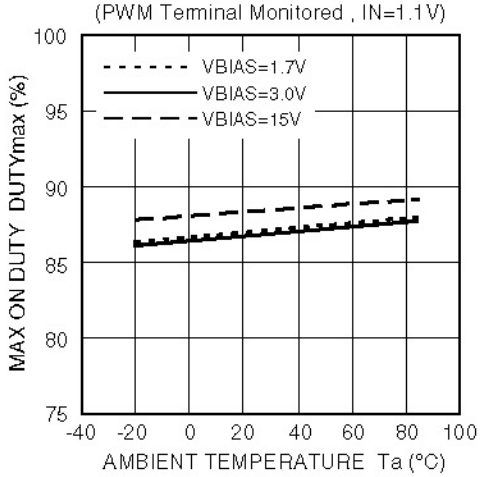
OSCILLATING FREQUENCY vs.
AMBIENT TEMPERATURE
(PWM Terminal Monitored, IN=1.1V)



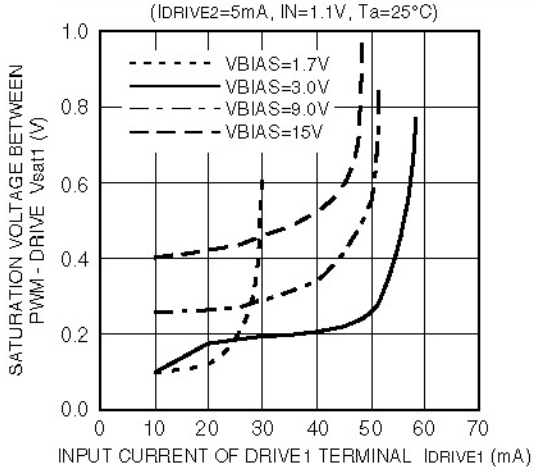
MAX ON DUTY vs. BIAS VOLTAGE
(PWM Terminal Monitored, IN=1.1V, Ta=25°C)



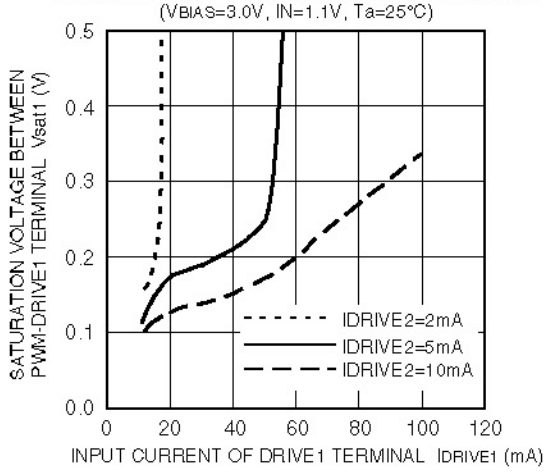
MAX ON DUTY vs. AMBIENT TEMPERATURE
(PWM Terminal Monitored , IN=1.1V)



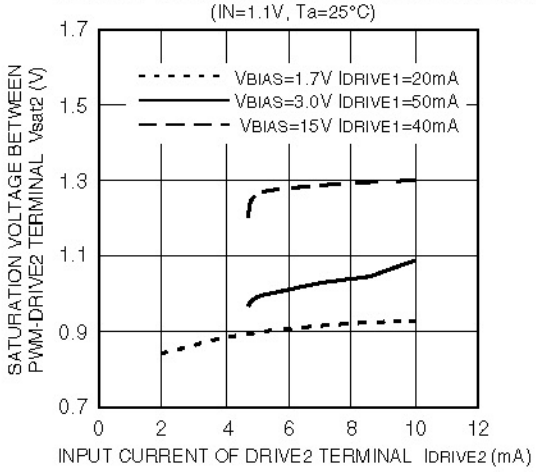
SATURATION VOLTAGE BETWEEN PWM-DRIVE1
TERMINAL vs. INPUT CURRENT OF DRIVE1 TERMINAL
(I_{DRIVE2}=5mA, IN=1.1V, Ta=25°C)



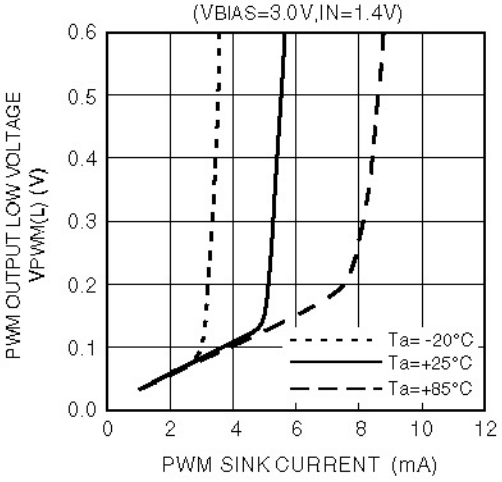
SATURATION VOLTAGE BETWEEN PWM-DRIVE1 TERMINAL vs. INPUT CURRENT OF DRIVE1 TERMINAL
(VBIAS=3.0V, IN=1.1V, Ta=25°C)



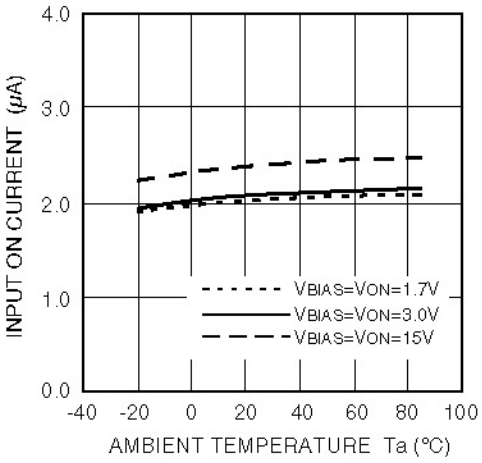
SATURATION VOLTAGE BETWEEN PWM-DRIVE2 TERMINAL vs. INPUT CURRENT OF DRIVE2 TERMINAL
(IN=1.1V, Ta=25°C)



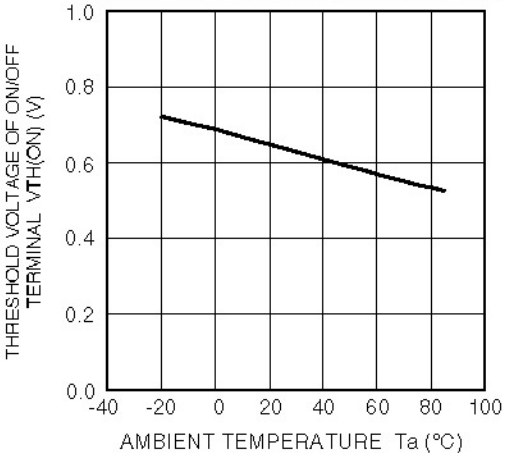
PWM OUTPUT LOW VOLTAGE vs. PWM SINK CURRENT
(VBIAS=3.0V,IN=1.4V)



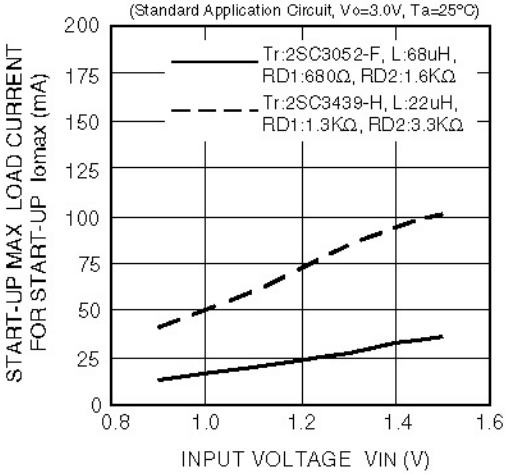
INPUT ON CURRENT vs. AMBIENT TEMPERATURE



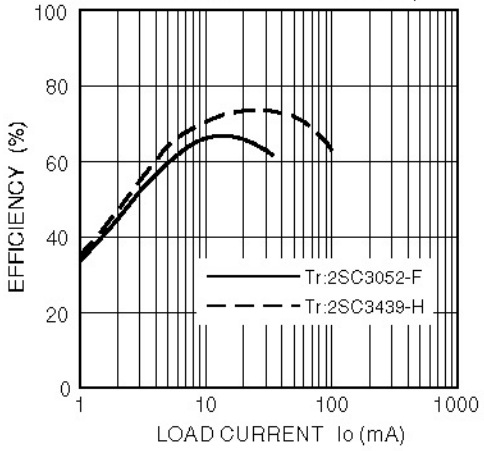
THRESHOLD VOLTAGE OF ON/OFF TERMINAL vs. AMBIENT TEMPERATURE (VBIAS=3.0V)



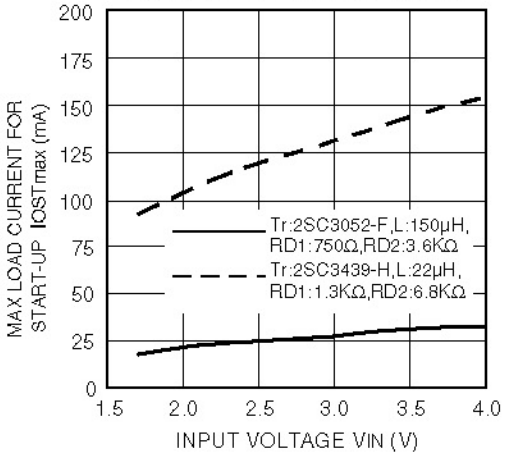
MAX LOAD CURRENT FOR START-UP(*1) vs. INPUT VOLTAGE
(Standard Application Circuit, Vo=3.0V, Ta=25°C)



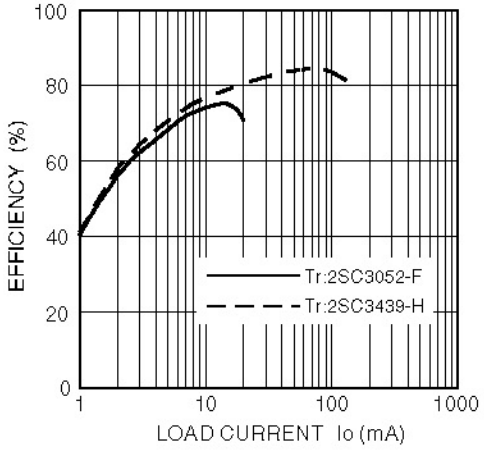
EFFICIENCY vs. LOAD CURRENT
(Standard Application circuit:
VIN=1.5V,Vo=3.0V, Ta=25°C)



MAX LOAD CURRENT FOR START-UP(*2)
vs. INPUT VOLTAGE
(Application circuit 1: Vo=5.0V, Ta=25°C)



EFFICIENCY vs. LOAD CURRENT
(Application circuit 1: VIN=3.0V,Vo=5.0V, Ta=25°C)



*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 : hFE=250 ~ 500, 2SC3439-H : hFE=600 ~ 1200)

Equation for Constants Calculation

Constants	Standard Application Circuit	Application Circuit 1	Application Circuit 2
$\frac{TON}{TOFF}$	$\frac{VO + VF - VIN}{VIN - VCE(sat)}$	$\frac{VO + VF - VIN}{VIN - VCE(sat)}$	$\frac{VO + VF - VIN}{VIN - VCE(sat)}$
TON+TOFF	$\frac{1}{fosc}$	$\frac{1}{fosc}$	$\frac{1}{fosc}$
TOFF(MIN)	$\frac{TON + TOFF}{1 + \frac{TON}{TOFF}}$	$\frac{TON + TOFF}{1 + \frac{TON}{TOFF}}$	$\frac{TON + TOFF}{1 + \frac{TON}{TOFF}}$
TON(MAX)	$\frac{1}{fosc}$ - TOFF(MIN)	$\frac{1}{fosc}$ - TOFF(MIN)	$\frac{1}{fosc}$ - TOFF(MIN)
Ipk	$2 * \left(1 + \frac{TON}{TOFF}\right) * (Io + IB)$	$2 * \left(1 + \frac{TON}{TOFF}\right) * Io$	$2 * \left(1 + \frac{TON}{TOFF}\right) * Io$
L(MIN)	$\frac{(VIN - VCE(sat))^2 * TON(MAX)^2 * fosc}{2 * Vo * (Io + IB)}$	$\frac{(VIN - VCE(sat))^2 * TON(MAX)^2 * fosc}{2 * Vo * Io}$	$\frac{(VIN - VCE(sat))^2 * TON(MAX)^2 * fosc}{2 * Vo * Io}$
R1	$\left(\frac{Vo}{VREF} - 1\right) * R2$	$\left(\frac{Vo}{VREF} - 1\right) * R2$	$\left(\frac{Vo}{VREF} - 1\right) * R2$
RD1	$\frac{Vo - (VBE + Vsat1)}{(Ipk / hFE) * A1}$	$\frac{Vo - (VBE + Vsat1)}{(Ipk / hFE) * A1}$	$\frac{VIN - (VBE + Vsat1)}{(Ipk / hFE) * A1}$
RD2	$\frac{Vo - (VBE + Vsat2)}{(Ipk / hFE) * A2}$	$\frac{Vo - (VBE + Vsat2)}{(Ipk / hFE) * A2}$	$\frac{VIN - (VBE + Vsat2)}{(Ipk / hFE) * A2}$

Constants	STEP-DOWN Circuit
$\frac{TON}{TOFF}$	$\frac{VO + VF}{VIN - VCE(sat) - Vo}$
TON+TOFF	$\frac{1}{fosc}$
TOFF(MIN)	$\frac{TON + TOFF}{1 + \frac{TON}{TOFF}}$
TON(MAX)	$\frac{1}{fosc}$ - TOFF(MIN)
Ipk	$2 * Io$
L(MIN)	$\frac{(VIN - VCE(sat) - Vo) * TON(MAX)}{\Delta Io}$
R1	$\left(\frac{Vo}{VREF} - 1\right) * R2$
RD1	$\frac{Vo - VBE - Vsat1}{Ipk / hFE}$
RD2	$\frac{VIN - Vsat2}{(Ipk / hFE) * A3}$

Notice)
- VF : Forward voltage of external diode.
- VCE(sat) : Saturation voltage of external transistor.
- VBE : Voltage between Base - Emitter of external transistor.
- hFE : hFE of external transistor at saturating.
- A1 : Ratio of current into DRIVE1 terminal. (A1 = 0.8 ~ 0.9)
- A2 : Ratio of current into DRIVE2 terminal. (A2 = 1 - A1)
- A3 : Ratio of current into DRIVE2 terminal. (A3 = 0.1 ~ 0.2)
- Set R2 to several KΩ ~ several 10ths kΩ.
- Set current into DRIVE2 terminal more than 100μA. (Ipk / hFE) * A2 ≥ 100μA, (Ipk / hFE) * A3 ≥ 100μA,.
- Set ΔIo to 1/ 5 ~ 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 Ipk.