RICOH

T-57-11 EK-070-9205

RF5C133

DC/DC MULTI•POWER SUPPLY

RF5C133 is a power circuit controller IC containing three CMOS process DC/DC converter control circuit systems (two ON-time control PWM systems and one OFF-time control VFM system).
With additional components, can RF5C133 configure three SWR systems to generate the CPU power supply voltage, charging voltage, or circuit power supply voltage from AC adapters, dry batteries, or rechargeable batteries. Furthermore, RF5C133 has the following six functions:

1. With the built-in power supply voltage detector, RF5C133 outputs low voltage alarms for dry or rechargeable batteries and for the CPU power supply. (Alarms for batteries are output in frequencies. A V/F converter converts the voltages into frequencies.)
2. RF5C133 controls the charging of rechargeable batteries by AC adapter output. The batteries are charged by a constant current initially, then by a constant voltage after the upper limit voltage is reached. The values for the constant current and voltage are specified externally. While the batteries are being charged, RF5C133 outputs charge indication signals. Upon detection of a low charge current, RF5C133 stops the signals.
3. To protect the charge system, RF5C133 detects and latches output overcurrents and set heating (an external diode must be added externally) and sends alarms. The alarms are released at the rising edge of charge control input signals.
4. The power saving function turns off the circuit power supply voltage generator.
5. RF5C133 can be soft-started to prevent rush current occurring when the output in the circuit or charge system rises.
6. RF5C133 can operate based solely on the internal clock. After self-activation, external sync clocks can be input.

■ FEATURES

- Step-up, step-down, and inversion DC/DC converters can be easily designed by combining RF5C133 with coils, capacitors, and diodes.
- Low current consumption..... 25 μA (Typ., stand-by)
- High efficiency ..... 70% to 80% (Typ., depends on circuit configuration)
- Accurate output voltage ..... ±5%
- Small temperature drift of output voltage . ±100 ppm/°C
- Package ..... 24-pin shrink SOP

■ APPLICATIONS

Voltage control for portable CD players, electronic book players, video equipment, notebook personal computers, and other battery-operated equipment.

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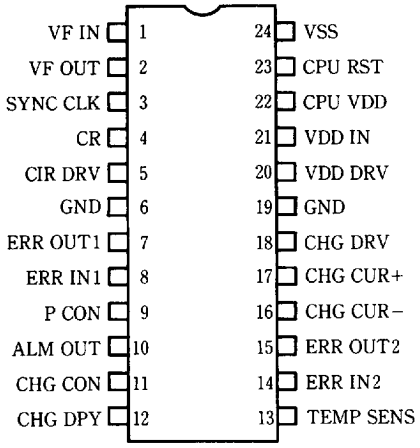
■ PIN CONFIGURATION



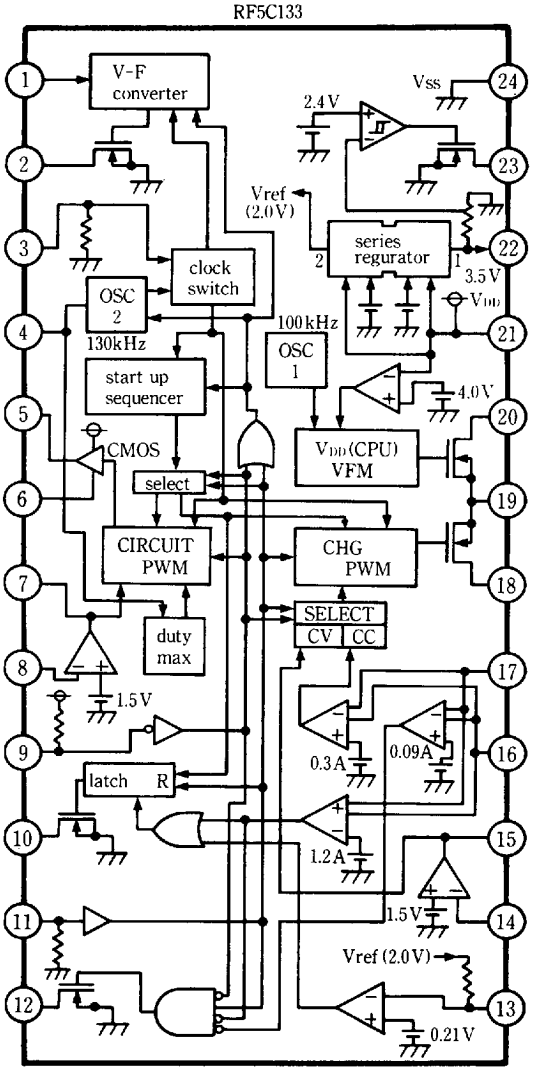
■ PIN DESCRIPTION

To use pins marked *, pull up the signals to the "H" level.

Pin No.	Pin Name	Signal Name	I/O	Description
1	VF IN	VF Converter	Input	Connect to the positive pole of a dry or rechargeable battery. During operation of the circuit or charge system, the potential of the dry or rechargeable battery is detected at this pin.
2	VF OUT *	VF Converter	Nch Open Drain Output	The potential (1.8 to 3.3 V) detected at VF IN is converted into a frequency (1/(4096 × 32) to 1/(4096 × 2) of the external or internal clock OSC2) and output through this pin.
3	SYNC CLK	Synchronized Clock	Input	To synchronize the operation of circuit or charge SWR with an external clock, sync clock signals are input through this pin (176 kHz). The external and built-in clocks are switched automatically. A pull-down resistor is built in.
4	CR	CR	Input	Use an external CR to specify the oscillating frequency for the circuit or charge systems or to specify the maximum duty of the circuit system.
5	CIR DRV	Circuit SWR Drive	CMOS Output	Through this pin, the driver transistor for the circuit SWR is driven by ON-time control PWM.
6	GND		GND	This is the power grounding pin to feed the source current to CIR DRV.
7	ERR OUT1	Error Amp. Output 1	Output	The error output of the circuit power supply voltage is amplified and output through this pin. To adjust the feedback constant, use the C and R externally attached between ERR IN1 and this pin.
8	ERR IN1	Error Amp. Input 2	Input	The error voltage of the circuit power supply voltage is detected at this pin. To specify the circuit power supply voltage, use an external resistor.

Pin No.	Pin Name	Signal Name	I/O	Description
9	P CON	Power Save Switch	Input	When P CON = "H", the circuit power supply voltage generator circuit stops. A pull-up resistor is built in.
10	ALM OUT *	Alarm	Nch Open Drain Output	When a 1 overcurrent or 2 TEMP SENSE input abnormality (of the AC adapter output) is detected and latched, an alarm is output through this pin.
11	CHG CON	Charge Control	Input	When CHG CON = "H", charging is possible. The ALM OUT output is reset at the rising edge of CHG CON = "L" → "H". A pull-down resistor is built in.
12	CHG DPY *	Charge Display	Nch Open Drain Output	When a normal charge current is detected while CHG CON = "H", signals are output through this pin.
13	TEMP SENS	Temperature Sence	Input	This pin is used to feed a forward current to an external diode. According to the temperature characteristics of the VF of the diode, abnormal heat is detected. A regulated current source from internal Vref (2 V) is built in.
14	ERR IN2	Error Amp. Input 2	Input	The error voltage of the charge power supply voltage is detected. To specify the voltage and temperature characteristics of the charging source, add an external resistor and diode.
15	ERR OUT2	Error Amp. Output 2	Output	The error voltage of the charge power supply voltage is amplified and output through this pin. To adjust the feedback constant, use the C and R externally attached between ERR IN and this pin.
16	CHG CUR–	Charge Current (–)	Input	The current of the charge system is detected at this pin. Attach an external resistor (0.5Ω) between CHG CUR+ and this pin to detect the current.
17	CHG CUR+	Charge Current (+)	Input	The current of the charge system is detected at this pin. Attach an external resistor (0.5Ω) between CHG CUR– and this pin to detect the current.
18	CHG DRV	Charge SWR Drive	Nch Open Drain Output	Through this pin, the driver transistor for the charge SWR is driven by ON-time control PWM.
19	GND		GND	This is the power grounding pin to feed the source current to the charge system and CPU power supply drive.
20	VDD DRV	VDD SWR Drive	Nch Open Drain Output	Through this pin, the SWR for the self-bias and CPU power supply system is driven by OFF-time control VFM.
21	VDD (IC)	VDD (IC)	Input	The voltage obtained by SWR through VDD DRV (Typ. 4.0 V) is input to this pin. This voltage is used as the potential of the IC board (IC power supply potential).
22	CPU VDD	CPU Power Supply	Output	A constant voltage (Typ. 3.5 V), obtained by stepping down the VDD (IC) voltage with a series regulator, is output through this pin.
23	CPU RST *	CPU Reset	Nch Open Drain Output	The CPU VDD output voltage is detected at this pin. When the voltage becomes lower than the specified value (Typ. 2.4 V), signals are output through this pin.
24	VSS	VSS (IC)	GND	This is the internal logic grounding of the IC. Connect to the grounding.

■ BLOCK DIAGRAM



■ DESCRIPTION

1. Internal Oscillator

OSC1 (OSC1 and OSC2 are asynchronous.)

OSC1 is an oscillator circuit using a ring oscillator. (Typ. 100 kHz, ON-time duty is Typ. 65%.)

- OSC1 generates clock signals for VDD (CPU) VFM operation. The VDD (CPU) PWM operation generates the power supply voltage (VDD) for RF5C133 between the external diode and capacitor.
- OSC1 is activated by applying the minimum operating voltage or a higher voltage to the VDD (IC) pin ㉑

OSC2

OSC2 is an oscillator circuit by means of external C and R. (Typ. 130 kHz)

- OSC2 generates clock signals for the PWM operation of the circuit and charge systems.
- Connect C and R between CPU VDD ㉒ and VSS ㉔. C = 470 pF (±5%) and R = 18 kΩ (±0.5%).
- OSC2 is activated when P CON ⑨ is set to "L" or CHG CON ⑪ is set to "H".

2. Clock Switch

This circuit switches internal and external clocks. (OSC2 → SYNC CLK)

- To synchronize the PWM operation of the circuit and charge systems with an external clock, input external clock signals to SYNC CLK pin ③. (Typ. 176 kHz)
- Upon detection of the rising edge of external clock signals ("L" → "H"), the clock for the IC is switched from the internal clock (Typ. 130 kHz) to an external clock (Typ. 176 kHz).

3. Start-up Sequencer

The start-up sequencer prevents the rush current from entering the coil when the circuit or charge SWR is activated.

- The circuit SWR is soft-started when P CON ⑨ goes "L".
- The charge SWR is soft-started when CHG CON ⑪ goes "H".
- When P CON ⑨ = "L" and CHG CON ⑪ = "H" compete, priority is given to the first to be input.
- If the interval between the two inputs is within 252.1 msec, the two outputs change simultaneously. See the table below.
- If the interval between the two inputs is over 252.1 msec, output for the later input starts after a delay of 0 to 252.1 msec.
- The table below shows the change of driver output duty at OSC2 = 130 kHz.

Time after Priority Signal Input (OSC2 CLK)	Driver Output Duty Ratio
0 ~ 252.1 msec (4096 × 8 CLKS)	OFF
252.1 ~ 283.6 msec (4096 × 9 CLKS)	1/8
283.6 ~ 315.1 msec (4096 × 10 CLKS)	2/8
315.1 ~ 346.6 msec (4096 × 11 CLKS)	3/8
:	:
(MAX. 504.1 msec, 4096 × 16 CLKS)	Normal PWM Wave Form

4. Circuit PWM

The circuit PWM circuit controls the circuit SWR ON-time.

- To determine the circuit constant, externally attach resistors R1, R2, R3, R4, and R5 and capacitor C1.
- The PWM circuit detects the error between the circuit voltage *R1/(R1 + R2) and the reference voltage in the IC (Typ. 1.5 V), and amplifies the error voltage by multiplying by R5/R3. Then, based on the voltage integrated by the time constant of C1 x R4, PWM control is performed.
- The above voltage is compared with the CLOCK SWITCH output voltage. The CIR DRV output is set to ON while the above voltage is higher than the clock switch output voltage. The ON-timing for the output is synchronized with the clock switch output.
- The maximum duty (at maximum load) is determined by external C7 and R12.
  When C7 = 470 pF and R12 = 18 kΩ
  Maximum duty = 84% (at 176 kHz external clock)
  Maximum duty = 62% (at 130 kHz internal clock)
- The audio PWM circuit is activated when P CON ⑨ is set to "L".
- The C-MOS output is used as the driver of the audio PWM circuit.
- The mask option can be used to invert the output signals. This does not affect the drive performance.
- To soft-start the audio PWM circuit, use the start-up sequencer.
- During stand-by, the CIR DRV output ⑤ impedance becomes high.

5. V–F Converter

The V–F converter converts the voltage applied to the VF IN 1 pin into a frequency during operation of the circuit or charge SWR.

- The V–F converter becomes operable when the P CON ⑨ = "L" or CHG CON ⑪ = "H".
- The output "H" width is fixed to 4096 times the external or internal clock (OSC2) cycle.
- When P CON ⑨ = "H" and CHG CON ⑪ = "L" simultaneously, the VF OUT ② output impedance becomes high.

VF IN 1 Input Voltage	VF OUT 2 Output Frequency	2 Output Duty
3.3 ~ V	"H" ; Nch Output OFF	1
3.2 ~ 3.3 V	Clock frequency x 1/(4096 x 2)	1/2
3.1 ~ 3.2 V	Clock frequency x 1/(4096 x 3)	1/3
3.0 ~ 3.1 V	Clock frequency x 1/(4096 x 4)	1/4
2.9 ~ 3.0 V	Clock frequency x 1/(4096 x 5)	1/5
2.8 ~ 2.9 V	Clock frequency x 1/(4096 x 6)	1/6
2.7 ~ 2.8 V	Clock frequency x 1/(4096 x 7)	1/7
2.6 ~ 2.7 V	Clock frequency x 1/(4096 x 8)	1/8
2.5 ~ 2.6 V	Clock frequency x 1/(4096 x 9)	1/9
2.4 ~ 2.5 V	Clock frequency x 1/(4096 x 10)	1/10
2.3 ~ 2.4 V	Clock frequency x 1/(4096 x 11)	1/11
2.2 ~ 2.3 V	Clock frequency x 1/(4096 x 12)	1/12
2.1 ~ 2.2 V	Clock frequency x 1/(4096 x 13)	1/13
2.0 ~ 2.1 V	Clock frequency x 1/(4096 x 14)	1/14
2.9 ~ 2.0 V	Clock frequency x 1/(4096 x 15)	1/15
1.8 ~ 1.9 V	Clock frequency x 1/(4096 x 16)	1/16
1. ~ 1.8 V	"L" ; Nch Output ON	0

6. Temperature Sensor

The temperature sensor detects heating of the set using the Vf temperature characteristics of the external diode.

- A regulated current source from Vref in the IC (2 V) is built in (Typ. 100 μA).
- Approximate VF temperature characteristics of the external diode (sample DAN202U, If = 100 μA, measured values)

Ambient Temperature	VF
25°C	495 mV
50°C	432 mV
75°C	368 mV
100°C	302 mV
125°C	247 mV
150°C	171 mV

- With the target detection voltage value of 210 mA, high temperatures between 100 and 170°C (range of dispersion) are detected.
- When Vf becomes lower than the detection voltage, the ALM OUT pin output ⑩ is latched to "L".
- The temperature sensor is activated when the CHG CON is set to "H". Detection is enabled after completion of soft-start.

7. Charge Current Sensor

The charge current sensor detects abnormal charge currents flowing from the charging source to the rechargeable battery.

- Attach external resistor R8 (0.5Ω) between input pins ⑯ and ⑰.
- Completion of charging is detected when the voltage drop at R8 becomes 0.045 V or less (90 mA). Upon detection of 0.045 V or a lower voltage, the CHG DPY output ⑫ goes OFF.
- Output from CHG DPY ⑫ is possible even when PCON ⑨ is set to "L".
- Overcurrent during charging is detected when the voltage drop at R8 becomes 0.6 V or more (1.2 A). Upon detection of 0.6 V or a higher voltage, the ALM OUT output ⑩ is latched to "L".
- During soft-start, overcurrent is not detected.
- For the sensor to operate, the voltage at input pins ⑯ and ⑰ must be 0.5 V to VDD + 0.3 V.
- If pins ⑯ and ⑰ may have a higher potential than pin ㉑, an external resistor of 1 to 10 kΩ must be attached to input pins ⑯ and ⑰ to limit the board current flowing into the IC.

8. Charge PWM

The charge PWM circuit controls the charge SWR ON-time.

- To determine the circuit constant, externally attach resistors R6, R7, R8, R9, R10, and R11, capacitor C6, and diodes D2 and D3. The diode is used for adjusting the temperature characteristics of the charge power supply voltage.

- The PWM circuit detects the error between (charge power supply voltage − Vf·D2 − Vf·D3)×R6/(R6+R7) and the reference voltage in the IC (Typ. 1.5 V), and amplifies the error voltage by multiplaying by R11/R9. Then, based on the voltage integrated by the time constant of C6 × R10, PWM control is performed.
- The above voltage is compared with the CLOCK SWITCH output voltage. The CHG DRV output is set to ON while the above voltage is higher than the CLOCK SWITCH output voltage. The ON-timing for the output is synchronized with the clock switch output.
- The maximum duty (at maximum load) is 100%.
- The charge PWM circuit is activated when CHG CON ⑪ is set to "H". To soft-start the audio PWM circuit, use the start-up sequencer.
- When P CON ⑨ = "H" and CHG CON ⑪ = "H" simultaneously, RF5C133 enters charge mode and starts constant current charging (300 mA). During charging, the charge power supply voltage is varied to maintain the voltage drop at R8 at 0.15 V. When the charge power supply voltage exceeds the specified voltage, RF5C133 is automatically switched to constant voltage mode.
- When P CON ⑨ = "L" and CHG CON ⑪ = "H" simultaneously, RF5C133 enters constant voltage operation mode and feeds current to the circuit directly from the charge power supply. When the rechargeable battery and the AC adapter is used at the same time, current is fed to the circuit while the battery is charged.
- When CHG CON ⑪ = "L", the charge PWM circuit is disabled.

9. VDD (for CPU) PWM

The VDD PWM circuit controls the VDD DWR OFF-time.

- The VDD PWM circuit is activated by applying the minimum operating voltage or a higher voltage to the VDD IN ㉑ pin.
- After activation, the VDD PWM circuit fetches a self-rectified voltage at the VDD IN ㉑ pin and uses it as the power supply voltage.
- If the VDD voltage becomes lower than the detection voltage (fixed to Typ. 4.0 V by a built-in resistor), the VDD DRV ⑳ output goes ON.
- The output ON timing is synchronized with the OSC1 output.

10. Series Regulator (for CPU)

The series regulator steps down the VDD IN voltage and outputs a constant potential.

- The series regulator steps down the VDD IN ㉑ voltage and outputs a constant voltage through CPU VDD ㉒
- The output voltage is fixed by a built-in resistor. (Typ. 3.5 V)

11. Voltage Detector (for CPU)

The voltage detector detects drops in the CPU power supply voltage.

- When the CPU power supply voltage drops to the detection voltage or lower, the CPU RST output goes ON.
- The detection voltage is fixed by a built-in resistor. (Typ. 2.4 V)

■ ABSOLUTE MAXIMUM RATING

Parameter	Symbol	Rating	Unit
Power Supply Voltage	VDD	−0.3 ~ 6	V
Output Voltage 1. CMOS Output 2. Nch Open Drain Output	 VOUT1 VOUT2	 VSS−0.3 ~ VDD+0.3 VSS−0.3 ~ 12	 V V
Input Voltage CMOS Input	 VIN	 VSS−0.3 ~ VDD+0.3	 V
Coil Drive Output Current 1. Circuit (Circuit PWM Output) 2. Charge (CHG. PWM Output) 3. CPU (VDD. PWM Output)	 IOUT1 IOUT2 IOUT3	 MAX. 200 MAX. 200 MAX. 100	 mA mA mA
Power Consumption	Pd	MAX. 500	mW
Operating Ambient Temperature	Topr	−30 ~ 80	°C
Storage Temperature	Tstg	−40 ~ 125	°C
Soldering Temperature	Tsolder	260°C 10 sec	

■ RECOMMENDED OPERATING CONDITION of RF5C133 and EXTERNAL CIRCUIT

	Parameter		MIN.	TYP.	MAX.	Unit
Input Power	A/C Adapter Output Voltage			5		V
	Dry Battery Output Voltage			3		V
	Storage Battery Output Voltage			4		V
Output Power	0. Internal Power Supply Voltage (Self-Generated)			4		V
	1. Circuit 1	Power Supply Voltage		5.8		V
	(External Tr. necessary)	Power Supply Current		70		mA
	Circuit 2	Power Supply Voltage		3.5		V
	(External Tr. necessary)	Load Current		100		mA
	2. Charge	Power Supply Voltage		5		V
	(External Tr. necessary)	Load Current		300		mA
	3. CPU	Power Supply Voltage		3.5		V
		Load Current		10		mA

■ ELECTRICAL CHARACTERISTICS

V_{DD} = 4.0V, 0°C ≦ Ta ≦ 70°C, the TYP values are measured at 25°C.

1. INTERNAL OSCILLATOR (Associated Pin No. ⑲ ⑳ ㉑ ㉔, ④⑤⑥⑨㉑㉔)

Parameter	Symbol	Condition	MIN.	TYP.	MAX.	Unit
OSC1 Oscillation Start Voltage	V_{OSC1st}	V_{DD} Rise		0.65	1.8	V
OSC1 Oscillation Frequency	f_{OSC1}	Ta = 25°C	90	100	110	kHz
OSC1 Oscillation Duty	D_{OSC1}		60	65	70	%
OSC2 Oscillation Start Voltage	V_{OSC2nd}	V_{DD} Rise		1.35	1.8	V
OSC2 Oscillation Frequency	f_{OSC2}	C7 = 470pF, R12 = 18 kΩ	100	130	160	kHz

2. CLOCK SWITCH (Associated Pin No. ④⑤⑥⑨㉑㉔)

Parameter	Symbol	Condition	MIN.	TYP.	MAX.	Unit
Esternal Clock Frequency	fCLK		160	176	193	kHz

3. START UP SEQUENCER (Associated Pin No. ④⑤⑥⑨㉑㉔)

Parameter		Symbol	Condition	MIN.	TYP.	MAX.	Unit
SOFT START Valid Range	(Start)	t_{ST}	OSC2 = 130 kHz	242	252	262	ms
	(End)	t_{END}	OSC2 = 130 kHz	484	504	524	ms

4. CIRCUIT PWM (Associated Pin No. ④⑤⑥⑦⑧⑨㉑㉔)

Parameter	Symbol	Condition	MIN.	TYP.	MAX.	Unit
Error Amp. Input Voltage Range	V_{INTER1}		0		V_{DD}	V
Error Amp. Input Reference Voltage	V_{REFER1}		1.4	1.5	1.6	V
Error Amp. Output Voltage	V_{OUTER1}		0		V_{DD}	V
PWM Driver Supply Voltage Range	V_{DRV1}		GND		V_{DD}	V
PWM Driver Nch ON Voltage	V_{OL1}	Iol = 50 mA		0.22	0.5	V
PWM Driver Pch ON Voltage	V_{OH1}	Ioh = −5 mA	V_{DD}-0.5	V_{DD}-0.25	V_{DD}	V

5. V–F CONVERTER (Associated Pin No. ①②③⑨㉑㉔)

Parameter	Symbol	Condition	MIN.	TYP.	MAX.	Unit
Input Voltage Range	V_{INVF}		0		V_{DD}	V
Detect Voltage Set Range	V_{DVF}		1.8		3.3	V
Detect Voltage Set Step	V_{UNITVF}		0.09	0.1	0.11	V
Output Frequency Range	fVF	CLK = OSC2/4096 (kHz)	CLK/16		CLK/2	kHz
Output ON Voltage	V_{DLVF}	Iol = 5 mA		0.3	0.5	V

6. TEMPERATURE SENSOR (Associated Pin No. ⑩ ⑪ ⑬ ㉑ ㉔)

Parameter	Symbol	Condition	MIN.	TYP.	MAX.	Unit
Input Const. Current	ITMP	TEMP SENS ⑬ = 0V	50	100	200	μA
Input "L" Detect Voltage	VDTMP		0.155	0.21	0.265	V
Detect Voltage Hysteresis Width	ΔVDTMP		10.5	21	42	mV

7. CHARGE CURRENT SENSOR (Associated Pin No. ⑨⑩ ⑪ ⑫ ⑬ ⑯ ⑰ ㉑ ㉔)

The current values are transformed into the voltage fall through the external resistance and shown as below.

Parameter	Symbol	Condition	MIN.	TYP.	MAX.	Unit
Charge Detect Current	VDCMIN		0.027	0.045	0.063	V
Charge Detect Current Hysteresis Width	ΔVDCMIN		3	6	12	mV
Over Current Detect	VDCMAX		0.5	0.6	0.7	V
Over Current Detect Hysteresis Width	ΔVDCMAX		30	60	120	mV
Input Voltage Range	VINCUR		0.5		VDD+0.3	V

8. CHARGE PWM (Associated Pin No. ⑪ ⑭ ⑮ ⑯ ⑰ ⑱ ⑲ ㉑ ㉔)

Parameter	Symbol	Condition	MIN.	TYP.	MAX.	Unit
Error Amp. Input Voltage Range	VINER2		0		VDD	V
Error Amp. Input Reference Voltage	VREFER2		1.4	1.5	1.6	V
Reference Voltage for Const. Current	VREFCC	R8 = 0.5Ω	0.12	0.15	0.18	V
Error Amp. Output Voltage Range	VOUTER2		0		VDD	V
PWM Output Supply Voltage Range	VDRV2		0		10	V
PWM Output ON Voltage	VDL2	Iol = 50 mA		0.22	0.5	V
PWM Output Leakage Current	IOH2			0.01	10	μA

9. VDD (for CPU) PWM (Associated Pin No. ⑲ ⑳ ㉑ ㉔)

Parameter	Symbol	Condition	MIN.	TYP.	MAX.	Unit
PWM Output Supply Voltage Range	VDRV3				10	V
Output Voltage	VOUTVDD		3.9	4.0	4.1	V
PWM Driver ON Voltage	VOL3	Iol = 50 mA		0.22	0.5	V
PWM Driver Leakage Current	VOH3			0.01	10	μA

10. SERIES REGURATOR (for CPU) (Associated Pin No. ㉑ ㉒ ㉔)

Parameter	Symbol	Condition	MIN.	TYP.	MAX.	Unit
Output Voltage (㉒ Pin)	VCPUVDD		3.4	3.5	3.6	V
Input/Output Voltage Difference	VDIF	IRL = −10 mA		0.5		V
Load Stability	ΔVCPU	−30 mA ≦ IRL ≦ 0 mA		35	100	mV

11. VOLTAGE DETECTOR (for CPU) (Associated Pin No. ㉑ ㉒ ㉓ ㉔)

Parameter	Symbol	Condition	MIN.	TYP.	MAX.	Unit
Input Voltage Range	VINRST		0		VDD	V
Input "L" Detect Voltage	VDRST		2.3	2.4	2.5	V
Detect Voltage Hysteresis Width	ΔVDRST		60	120	240	mV

12. INPUT SIGNAL

Pin including Input Pull-Up Resistance (Associated Pin No. ⑨ : 250 kΩ poly-Si resistance)

Parameter	Symbol	Condition	MIN.	TYP.	MAX.	Unit
"H" Input Voltage	VIM1		0.8VDD		VDD	V
"L" Input Voltage	VIL1		0		0.2VDD	V
"H" Input Current	IIH1	VDD = 4.0V, Vih = 4.0V		0.01	1	μA
"L" Input Current	IIL1	VDD = 4.0V, Vil = 0V	8	16	32	μA

Pin including Pull-Down Resistance (Associated Pin No. ③ ⑪ : 250 kΩ poly-Si resistance)

Parameter	Symbol	Condition	MIN.	TYP.	MAX.	Unit
"H" Input Voltage	VIH2		0.8VDD		VDD	V
"L" Input Voltage	VIL2		0		0.2VDD	V
"H" Input Current	IIH2	VDD = 4.0V, Vih = 4.0V	8	16	32	μA
"L" Input Current	IIL2	VDD = 4.0V, Vil = 0V		0.01	1	μA

13. OUTPUT SIGNAL

Nch Open-Drain Output (to CPU) (Associated Pin No. ② ⑩ ⑫ ㉓)

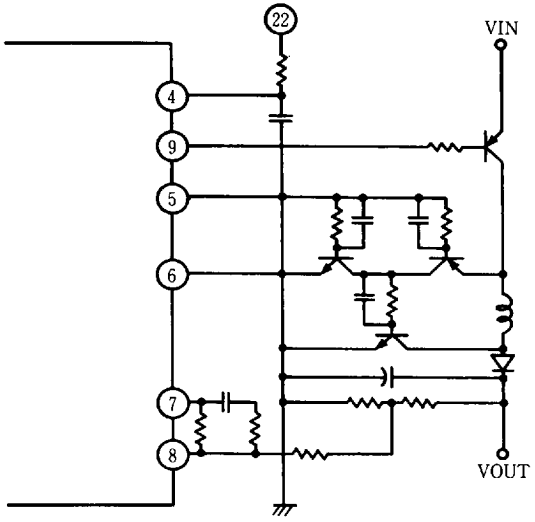
Parameter	Symbol	Condition	MIN.	TYP.	MAX.	Unit
Output ON Voltage	VOL4	Iol = 5 mA		0.3	0.5	V
Output Supply Voltage	VDRV4	(MAX = VDD for ㉓ pin)	0		10	V
Output Leakage Current	IOH4			0.01	5	μA

14. IC TOTAL (Associated Pin No. ⑨ ⑪ ㉑ ㉔)

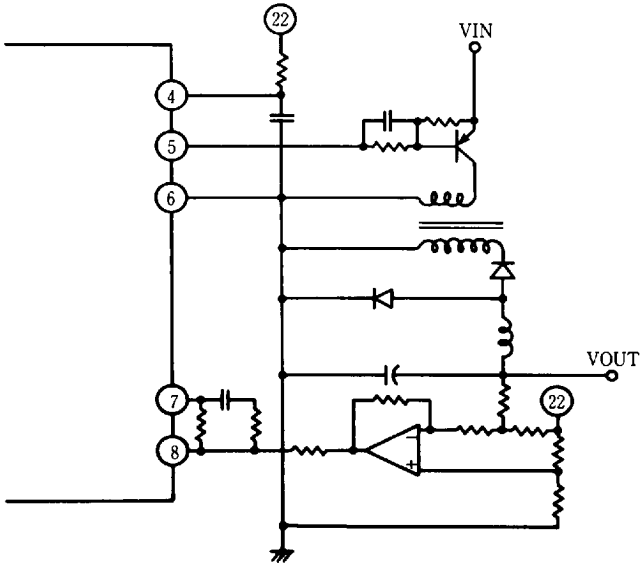
Parameter	Symbol	Condition	MIN.	TYP.	MAX.	Unit
Min. Operating Voltage	VINMIN			1.2	1.8	V
Max. Operating Voltage	VINMAX		6			V
Current Consumption * Ta = 50°C	IS	Vin = 2.0V, L = 120μH, C = 22μF PCON = H, CHGCON = L, No Load		25	* 60	μA
** Except for Output Driver SINK Current	IDD	Vin = 2.0V, L = 120μH, C = 22μF PCON = L, CHGCON = H, No Load		** 400	** 1000	μA

EXTERNAL CIRCUIT

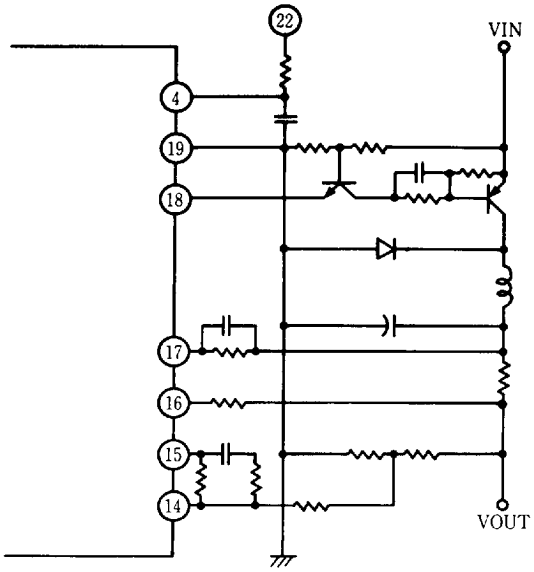
1. CIRCUIT STEP-UP DC/DC CONVERTER



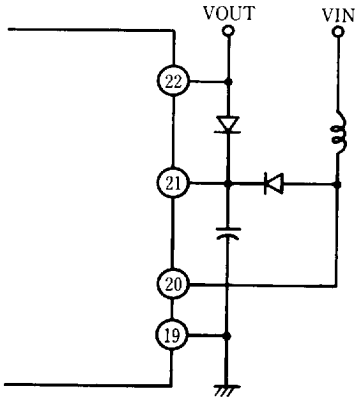
2. CIRCUIT POLARITY INVERSE DC/DC CONVERTER



3. CHARGE-UP STEP-DOWN DC/DC CONVERTER



4. CPU STEP-UP/STEP-DOWN DC/DC CONVERTER



■ **PACKAGE DIMENSION** (Unit : mm)