Watchdog Timer

HITACHI

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Description

The HA16103FPJ/FPK monolithic voltage control is designed for microcomputer systems. In addition to voltage regulator, it includes watch dog timer function, power on reset function, and output voltage monitor function.

It is suitable for battery use microcomputer systems.

Functions

- 5 V regulated power supply
- Power on reset pulse generator
- Watch dog timer
- Low voltage inhibit protection

Features

- Wide operational supply voltage range ($V_{CC} = 6$ to 40 V)
- Various control signals are generated when microcomputer system runaway occurs. (NMI signal and STBY signal are generated by detecting voltage level, and RES signal is generated by monitoring the time after NMI signal is detected)
- Regulated voltage, NMI detecting voltage, STBY detecting voltage are adjustable.
- At low voltage and re-start, the delay time of $\overline{\text{RES}}$ signal is adjustable
- Watchdog timer filtering uses the minimum clock input pulse width and maximum cycle detection method

Ordering Information

Type No.	Package
HA16103FPJ	FP-20DA
HA16103FPK	FP-20DA



Pin Arrangement



Pin Functions

No.	Pin Name	Description
1	NC	NC pin
2	P-RUN	P-RUN signal input pin for watchdog timer
3	Rf	Connect resistor Rf. Frequency bandwidth of the filter circuit depends on Rf
4	Cf	Connect resistor Cf. Frequency bandwidth of the filter circuit depends on Cf
5	R _R	Connect resistor R_R . Reset-signal power-on time depends on R_R
6	C _R	Connect resistor C_R . Reset-signal power-on time depends on C_R
7	GND	Ground
8	Voadj	5-V reference voltage fine-tuning pin. Connect a resistor between this pin and GND. The value of output voltage is given by $V_{OUT} = \{1 + 5.34/(R1 // 2.0)\} \times Voadj$ Unit for R1: k Ω
9	V _{OUT}	Connect the collector of an external PNP-type transistor. The pin supplies 5-V regulated voltage for internal circuit
10	NC	NC pin
11	NC	NC pin
12	V _{CONT}	The external PNP-type transistor's base control pin
13	V _{cc}	Supply voltage pin. Operating supply voltage range is 6.0 to 40 V.
14	C _{RES}	If the voltage of V _{OUT} pin declines to less than Detection voltage(1) (because of an instant power cut or other cause), $\overline{\text{NMI}}$ signals are generated. If $t_{\text{RES}} \approx 0.5 \cdot \text{Rf} \cdot C_{\text{RES}}$ (sec) has passed since then, $\overline{\text{RES}}$ signals are generated. If the voltage of V _{OUT} pin inclines to more than Detection voltage(1) (in case of re-start from LVI state), $\overline{\text{NMI}}$ signals are stop. $t_r \approx 0.5 \cdot \text{Rf} \cdot C_{\text{RES}}$ (sec) has passed since then, $\overline{\text{RES}}$ signals are stop. Connect capacitor C_{RES} between this pin and GND to adjust the $\overline{\text{RES}}$ signals delay time(t_{RES} , t_r). If delay time is unnecessary, make this pin open ($t_{\text{RES}} = 2 \mu \text{s typ.} t_r = 10 \mu \text{s typ.}$ at open)
15	V_{NMIadj}	$\overline{\text{NMI}}$ detection voltage fine-tuning pin. Connect a resistor between this pin and V _{OUT} pin or GND. The value of output voltage is given by V _{NMI} = {1 + (R2 // 25.5)/(R3 // 10.6)} × V _{NMIadj} . Unit for R2, R3: kΩ
16	NMI	NMI signal output pin. Connect to pin NMI of the microcomputer
17	RES	RES signal output pin. Connect to pin RES of the microcomputer
18	$V_{STBYadj}$	$\overline{\text{STBY}}$ detection voltage tuning pin. Connect a resistor between this pin and V _{OUT} or GND. The value of output voltage is given by V _{STBY} = 1.89 × {1 + 21/(7.9 + 8.85 // R4)} × V _{STBYadj} Unit for R4: kΩ
19	STBY	STBY signal output pin. Connect to pin STBY of the microcomputer
20	NC	NC pin

Block Diagram



Functional Description

Stabilized Power Supply Function

The stabilized power supply includes the following features:

- Wide range of operating input voltage from 6 V to 40 V to provide stabilized voltages
- Availability of any output current, by simply replacing the external transistor
- Fine adjustment of output voltage

Figure 1 shows the fine adjustment circuit of the output circuit. Select the resistor R1 as shown in equation 1.

Add a resistor between GND and Voadj to increase the output voltage.



Figure 1 Fine Adjustment Circuit of Output Voltage



Figure 2 Output Voltage Characteristic

Power-On Reset Function

The system contains the power-on reset function required when a microcomputer is turned on.

The reset period may be set with external components R_R and C_R . Equation 2 specifies how to determine the reset period (ton) and figure 3 shows the characteristic of the circuit.





Figure 3 Characteristic of Power-On Reset Circuit

Watchdog Timer Function

The system contains a bandpass filter for pulse width detection, which outputs a reset pulse when input pulses are not at the preselected frequency (at either a higher or lower frequency).

The RC characteristic of the bandpass filter may be set with external components Rf and Cf. Equation 3 specifies how to determine the minimum pulse width (tmin) for runaway detection of the bandpass filter, and figure 4 shows the characteristic of the filter.





Figure 4 Characteristic of Power-On Reset Circuit

Low Voltage Monitoring Function

The system contains a circuit to send a control signal to the microcomputer when the output voltage drops. The circuit includes the following features.

- Two-point monitoring of output voltage (V_{NMI} and V_{STBY})
- Availability of fine adjustment of Vth1 (V_{NMI}) and Vth2 (V_{STBY})
- Output of control signal in standby mode of microcomputer

Figure 5 shows the timing chart of control signals when the output voltage drops.

If the output voltage drops below Vth1 (4.60 V), the $\overline{\text{NMI}}$ signal rises to request the microcomputer to issue the $\overline{\text{NMI}}$ interrupt signal. The $\overline{\text{RES}}$ signal falls t_{RES} seconds after the $\overline{\text{NMI}}$ signal rises. If the output voltage drops further to below Vth2 (3.2 V), the $\overline{\text{STBY}}$ signal rises to enable the micro-computer to enter standby mode.



Figure 5 Timing Chart for Low Voltage Monitoring

Absolute Maximum Ratings ($Ta = 25^{\circ}C$)

		Rat	ings	
Item	Symbol	HA16103FPJ	HA16103FPK	Units
V _{cc} supply voltage	V _{cc}	40	40	V
Control pin voltage	V _{cont}	40	40	V
Control pin current	I _{cont}	20	20	mA
V _{out} pin voltage	V _{OUT}	12	12	V
Power dissipation	Ρ _τ	400* ¹	400*2	mW
Operating ambient temperature range	Topr	-40 to +85	-40 to +125	°C
Storage temperature range	Tstg	-50 to +125	-50 to +150	°C

Notes: 1. Value under Ta \leq 77°C. If Ta is greater, 8.3 mW/°C derating occurs.

2. Allowable temperature of IC junction part, Tj (max), is as shown below.

Tj (max) = θ j-a•Pc (max)+Ta

 (θ) -a is thermal resistance value during mounting, and Pc (max) is the maximum value of IC power dissipation.)

Therefore, to keep Tj (max) \leq 125°C, wiring density and board material must be selected according to the board thermal conductivity ratio shown below.

Be careful that the value of Pc (max) does not exceed that P_{T}



Electrical Characteristics (Ta = 25°C, V_{CC} = 12 V, V_{OUT} = 5 V)

HA16103FPJ/FPK

Item		Symbol	Min	Тур	Max	Unit	Test Condition
	Supply current	I _{CCL}	_	8	12	mA	V _{cc} = 12 V
Regulator	Output voltage	V ₀₁	4.80	5.00	5.20	V	$V_{cc} = 6 \text{ to } 17.5 \text{ V}$ $I_{OUT} = 0.5 \text{ A},$ $R_1 = 30 k\Omega$
		V _{o2}	4.70	5.00	5.30	V	V_{cc} = 6 to 17.5 V I _{OUT} = 1 A, R ₁ = 30 kΩ
	Line regulation	Voline	-50	—	50	mV	V_{cc} = 6 to 17.5 V I _{OUT} = 1 A, R ₁ = 30 kΩ
	Load regulation	Voload	-100	—	100	mV	I_{out} = 10 mA to 0.5 A, R ₁ = 30 kΩ
	Ripple rejection	R_{REJ}	45	75	—	dB	Vi = 0.5 Vrms, fi = 1 kHz, R ₁ = 30 kΩ
	Output voltage Temperature coefficient	$\delta V_{o} / \delta_{T}$	_	0.6	_	mV/°C	V_{cc} = 12 V, R ₁ = 30 k Ω
Clock input	"L"-input voltage	V _{IL}		_	0.8	V	
	"H"-input voltage	V _{IH}	2.0			V	
	"L"-input current	I _{IL}	-120	-60		μA	$V_{IL} = 0 V$
	"H"-input current	I _{IH}		0.3	0.5	mA	V _{IH} = 5 V

Item		Symbol	Min	Тур	Max	Unit	Test Condition
NMI output	NMI pin "L"-level voltage	V _{ol1}	_	_	0.4	V	I _{OL1} = 2 mA
	NMI pin "H"-level voltage	V _{OH1}		V ₀₁ (V ₀₂)	—	V	
	$\overline{\text{NMI}} \text{ function start} \\ V_{\text{OUT}} \text{ voltage}$	V _{NMI}		0.7	1.4	V	
STBY output	STBY pin "L"-level voltage	V_{OL2}		—	0.4	V	I _{0L2} = 2 mA
	STBY pin "H"-level voltage	V_{OH2}		V ₀₁ (V ₀₂)	—	V	
	$\begin{tabular}{c} \hline \hline STBY & function start \\ V_{out} & voltage \end{tabular}$	V_{STBY}	_	0.7	1.4	V	
RES output	RES pin "L"-level voltage	V _{ol3}	_	_	0.4	V	I _{0L3} = 2 mA
	RES pin "H"-level voltage	V_{OH3}	_	V ₀₁ (V ₀₂)	_	V	
	$\begin{tabular}{l} \hline RES \\ V_{out} \\ voltage \end{tabular}$	V_{res}	_	0.7	1.4	V	
	Power on time	t _{on}	25	40	60	ms	$Rf = 180 \text{ k}\Omega, R_R = 180 \text{ k}\Omega$
	Clock off reset time	t _{OFF}	80	130	190	ms	$^{}$ Cf = 0.01 μ F, C _R = 0.1 μ F
	Reset pulse "L"-level time	t _{RL}	15	20	30	ms	Rf = 180 kΩ, R _R = 180 kΩ Cf = 0.01 μF, C _R = 0.1 μF
	Reset pulse "H"-level time	t _{RH}	37	60	90	ms	Rf = 180 kΩ, R _R = 180 kΩ Cf = 0.01 μF, C _R = 0.1 μF
Low Voltage protecton	Detection voltage(1) V _{H1}	4.40	4.60	4.80	V	
	Detection voltage(1 Hysteresis width) V _{HYS1}	50	100	150	mV	
	Detection voltage(2) V _{H2}	2.9	3.2	3.5	V	
	Detection voltage(2 Hysteresis width) V _{hys2}	1.35	1.5	1.65	V	
	Reset inhibit pulse	t _{RES}	_	200		μs	C _{RES} = 2200 pF
	Delay time restart	t,	_	200	_	μs	C _{RES} = 2200 pF

Electrical Characteristics ($T_a = 25^{\circ}C$, $V_{CC} = 12$ V, $V_{OUT} = 5$ V) (cont)

Electrical Characteristics ($T_a = -40$ to $125^{\circ}C$, $V_{CC} = 12$ V, $V_{OUT} = 5$ V, R1 = 30 k) (cont)

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Item		Symbol	Min	Тур	Max	Unit	Test Condition
	Supply current	I _{CC1}		7	13	mA	
Regulator	Output voltage	V _{out1}	4.80	5.00	5.20	V	$V_{cc} = 6 \text{ to } 17.5 \text{ V}$ $I_{OUT} = 0.5 \text{ A}$
	Line regulation	Voline	-50	—	50	mV	$V_{cc} = 6 \text{ to } 17.5 \text{ V}$ $I_{out} = 0.5 \text{ A}$
	Load regulation	Voload	-100	_	100	mV	$I_{OUT} = 10 \text{ mA to } 0.5 \text{ A}$
Clock input	"L"-input voltage	V _{IL}	—	—	0.4	V	
	"H"-input voltage	V _{IH}	2.4	_		V	
	"L"-input current	I _{IL}	-120	-60	—	μΑ	$V_{IL} = 0 V$
	"H"-input current	I _{IH}	—	0.3	0.6	mA	$V_{IH} = 5 V$
NMI output	NMI pin "L"-level voltage	V _{oln}	_	—	0.5	V	I _{oL1} = 2 mA
	NMI pin "H"-level voltage	V _{OHN}	—	V_{out1}	—	V	
STBY output	STBY pin "L"-level voltage	V _{ols}	—	—	0.5	V	I _{0L2} = 2 mA
	STBY pin "H"-level voltage	V _{OHS}		V_{out1}		V	
RES output	RES pin "L"-level voltage	V _{olr}		_	0.5	V	I _{OL3} = 2 mA
	RES pin "H"-level voltage	V _{OHR}		V_{out1}		V	
	Power on time	t _{on}	25	40	60	ms	Rf = 180 kΩ, R_R = 180 kΩ
	Clock off reset time	t _{OFF}	70	130	200	ms	$Cf = 0.01 \ \mu F, C_{R} = 0.1 \ \mu F$
	Reset pulse "L"-level time	t _{RL}	15	20	30	ms	$ \begin{array}{l} Rf=\text{180 k}\Omega,R_{\scriptscriptstyle R}=\text{180 k}\Omega\\ Cf=\text{0.01 }\muF,C_{\scriptscriptstyle R}=\text{0.1 }\muF \end{array} $
	Reset pulse "H"-level time	t _{RH}	30	60	100	ms	Rf = 180 kΩ, R _R = 180 kΩ Cf = 0.01 μF, C _R = 0.1 μF
Low Voltage	Detection voltage(1)	V _{NMI}	4.35	4.60	4.85	V	
protecton	Detection voltage(2)	V _{STBY}	2.80	3.20	3.60	V	

Test Circuit



Sample Connection Circuit

Sample Connection Circuit between HA16103 and H8/532



Sample Connection Circuit between HA16103 and H8/532 (2)



Precautions

If the IC's ground potential varies suddenly by several volts due to wiring impedance (see figure 6), a false $\overline{\text{RES}}$ pulse may be output. The reason for this is that potentials in the $\overline{\text{RES}}$ pulse generating circuit change together with the V_{OUT}-GND potential. The reference potential of the comparator in figure 7 and the potential of the external capacitor have different impedances as seen from the comparator, causing a momentary inversion. The solution is to stabilize the ground potential. Two ways of stabilizing the IC's ground line are:

- Separate the IC's ground line from highcurrent ground lines.
- Increase the capacitance (Co) used to smooth the V_{OUT} output.



Figure 6 Typical Circuit



Figure 7 **RES** Comparator









Package Dimensions



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