ADE-204-010

HA16103PJ/FPJ
Voltage Regulator Control IC for Microcomputer Systems

HITACHI

Preliminary
Rev. 1
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The HA16103PJ/FPJ 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.

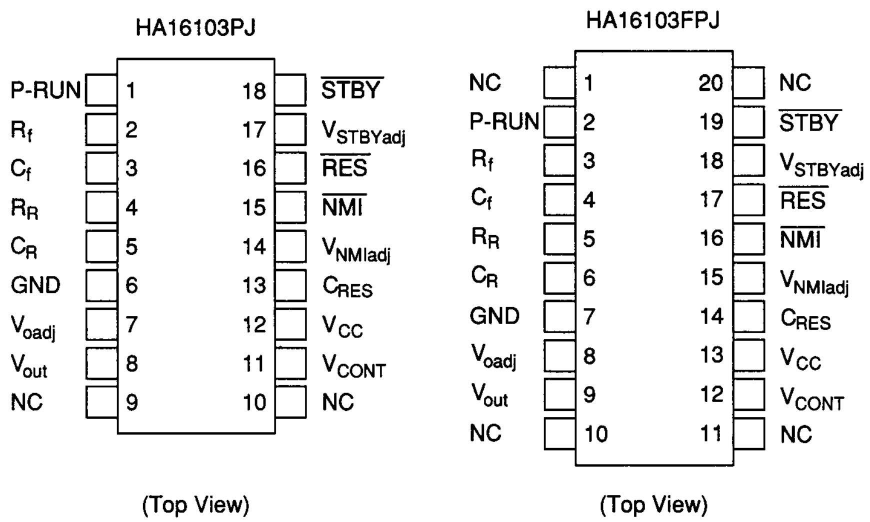
Functions

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

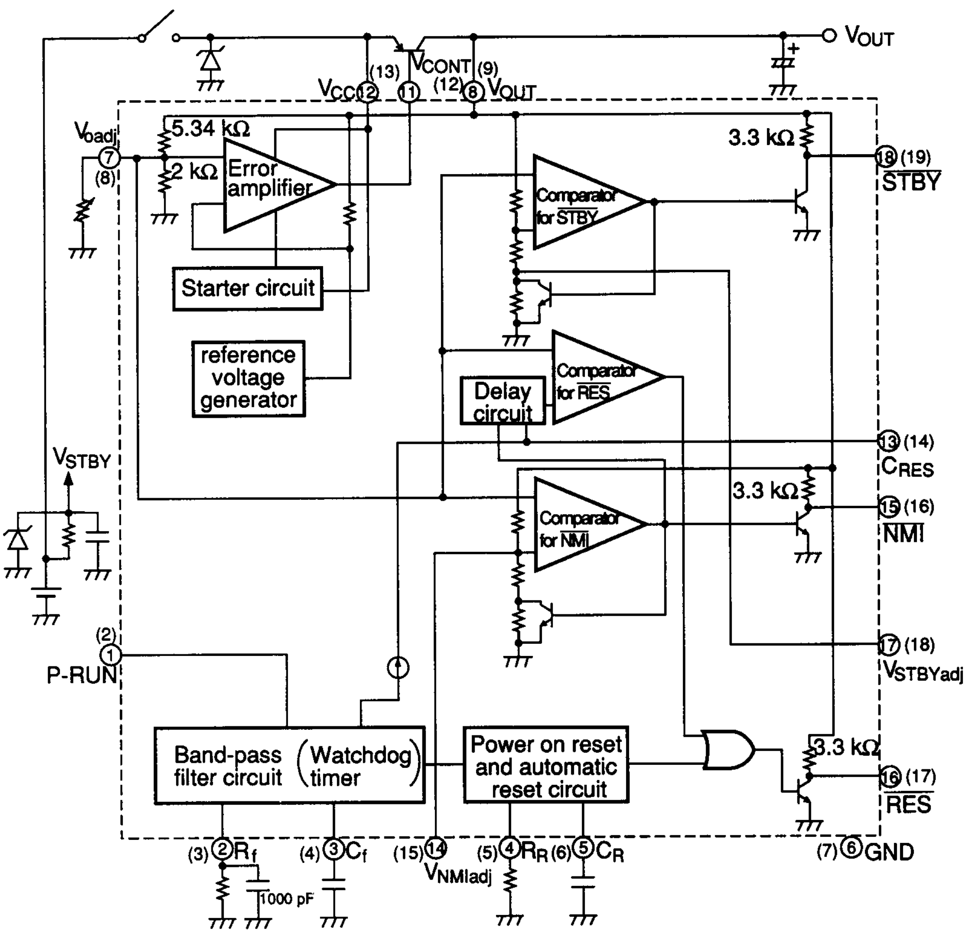
Features

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

Pin Arrangement



Block Diagram



The character in ( ) shows pin No. of SOP

Table 1 Pin Functions

Pin No.	Name	Description
(1)	NC	NC pin
1,(2)	P-RUN	P-RUN signal input pin for watchdog timer
2,(3)	R_f	Connect resistor R_f. Frequency bandwidth of the filter circuit depends on R_f
3,(4)	C_f	Connect resistor C_f. Frequency bandwidth of the filter circuit depends on C_f
4,(5)	R_R	Connect resistor R_R. Reset-signal power-on time depends on R_R
5,(6)	C_R	Connect resistor C_R. Reset-signal power-on time depends on C_R
6,(7)	GND	Ground
7,(8)	V_{oadj}	5-V reference voltage fine-tuning pin. Connect a resistor between this pin and GND. The value of output voltage is given by $V_{out} = \{1+5.34/(R1//2.0)\} \times V_{oadj}$ Unit for R1: kΩ
8,(9)	V_{out}	Connect the collector of an external PNP-type transistor. The pin supplies 5-V regulated voltage for internal circuit
9,(10)	NC	NC pin
10,(11)	NC	NC pin
11,(12)	V_{CONT}	The external PNP-type transistor's base control pin
12,(13)	V_{CC}	Supply voltage pin. Operating supply voltage range is 6.0 to 40 V
13,(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), $\overline{NMI}$ signals are generated. If $t_{RES} \fallingdotseq 0.5 \cdot R_f \cdot C_{RES}$(sec) has passed since then, $\overline{RES}$ 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), $\overline{NMI}$ signals are stop. $t_r \fallingdotseq 0.5 \cdot R_f \cdot C_{RES}$(sec) has passed since then, $\overline{RES}$ signals are stop. Connect capacitor C_{RES} between this pin and GND to adjust the $\overline{RES}$ signals delay time(t_{RES}, t_r). If delay time is unnecessary, make this pin open (t_{RES} = 2 µs typ. tr = 10 µs typ. at open)
14,(15)	V_{NMIadj}	$\overline{NMI}$ 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 $V_{NMI} = \{1+(R2//25.5)/(R3//10.6)\} \times V_{NMIadj}$. Unit for R2, R3: kΩ
15,(16)	$\overline{NMI}$	$\overline{NMI}$ signal output pin. Connect to pin $\overline{NMI}$ of the microcomputer
16,(17)	$\overline{RES}$	$\overline{RES}$ signal output pin. Connect to pin $\overline{RES}$ of the microcomputer
17,(18)	$V_{STBYadj}$	$\overline{STBY}$ detection voltage tuning pin. Connect a resistor between this pin and V_{out} or GND. The value of output voltage is given by $V_{STBY} = 1.89 \times \{1+21/(7.9+8.85//R4)\} \times V_{STBYadj}$ Unit for R4: kΩ
18,(19)	$\overline{STBY}$	$\overline{STBY}$ signal output pin. Connect to pin $\overline{STBY}$ of the microcomputer
(20)	NC	NC pin

The character in ( ) shows pin No. of SOP

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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 V_{oadj} to increase the output voltage.

$$R1 = 1/\{0.187(V_{out}/V_{oadj} - 1) - 0.5\} \quad \text{Equation 1}$$

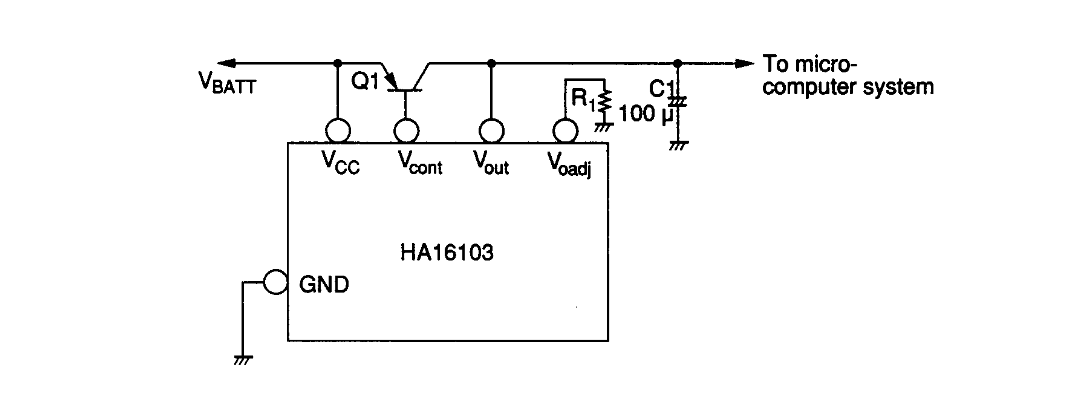


Figure 1 Fine Adjustment Circuit of Output Voltage

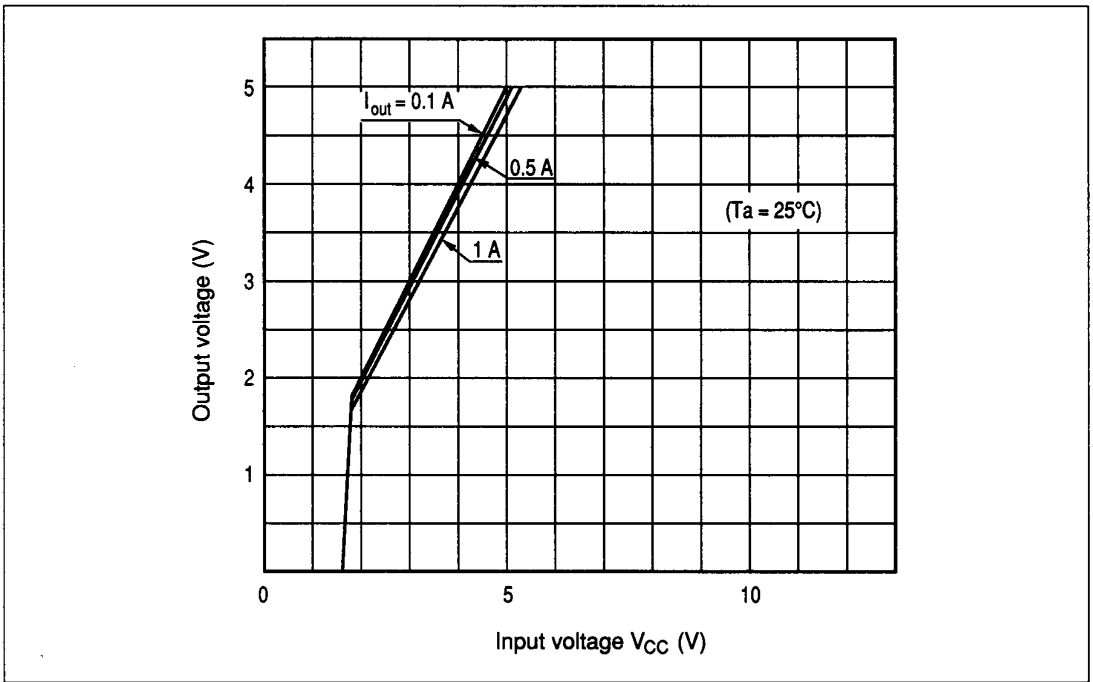
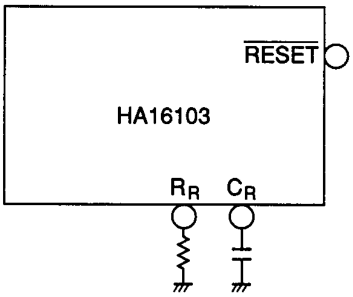


Figure 2 Output Voltage Characteristic

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.



$$t_{on} = C_R \times R_R \times 2.13 \text{ (s)} \qquad \text{Equation 2}$$

R_R: kΩ

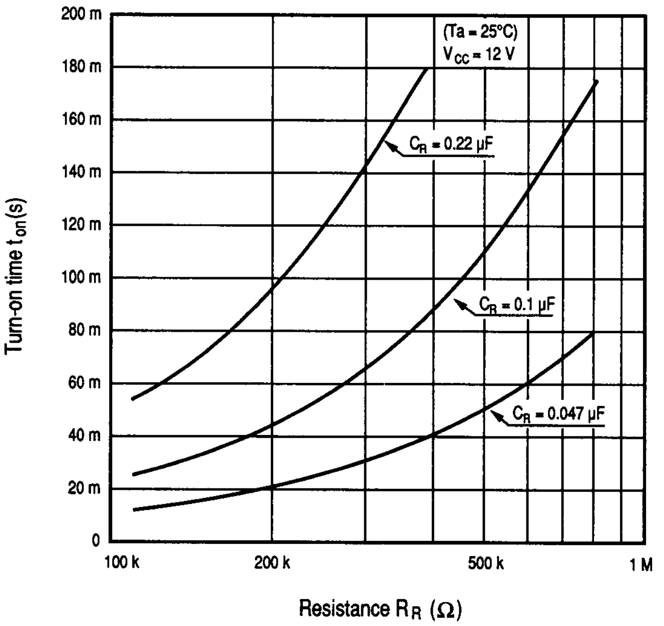


Figure 3 Characteristic of Power-On Reset Circuit

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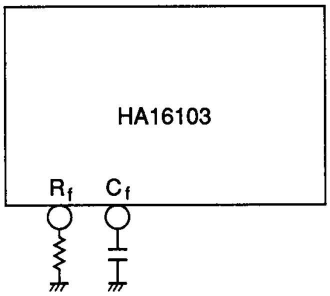
Watchdog Timer Function

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 R_f and C_f. 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.)



$$t_{min} = C_f \times R_f \times 0.11 \text{ (s)} \qquad \text{Equation 3}$$

R_f : kΩ

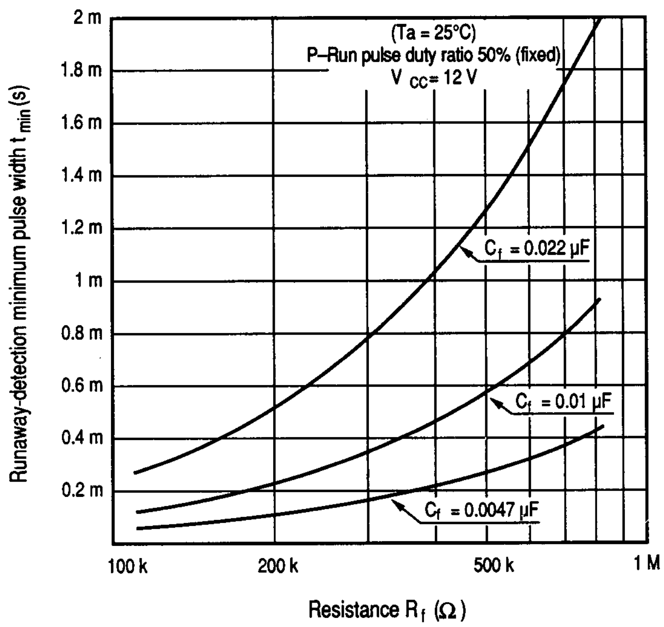


Figure 4 Characteristic of Power-On Reset Circuit

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 (Vth1 and Vth2)
- Availability of fine adjustment of Vth1 (VNM1) and Vth2 (VSTBY)
- 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 $\overline{NMI}$ signal rises to request the microcomputer to issue the $\overline{NMI}$ interrupt signal. The $\overline{RESET}$ signal falls t_{RES} seconds after the $\overline{NMI}$ signal rises. If the output voltage drops further to below Vth2 (3.2 V), the $\overline{STBY}$ signal rises to enable the microcomputer to enter standby mode.

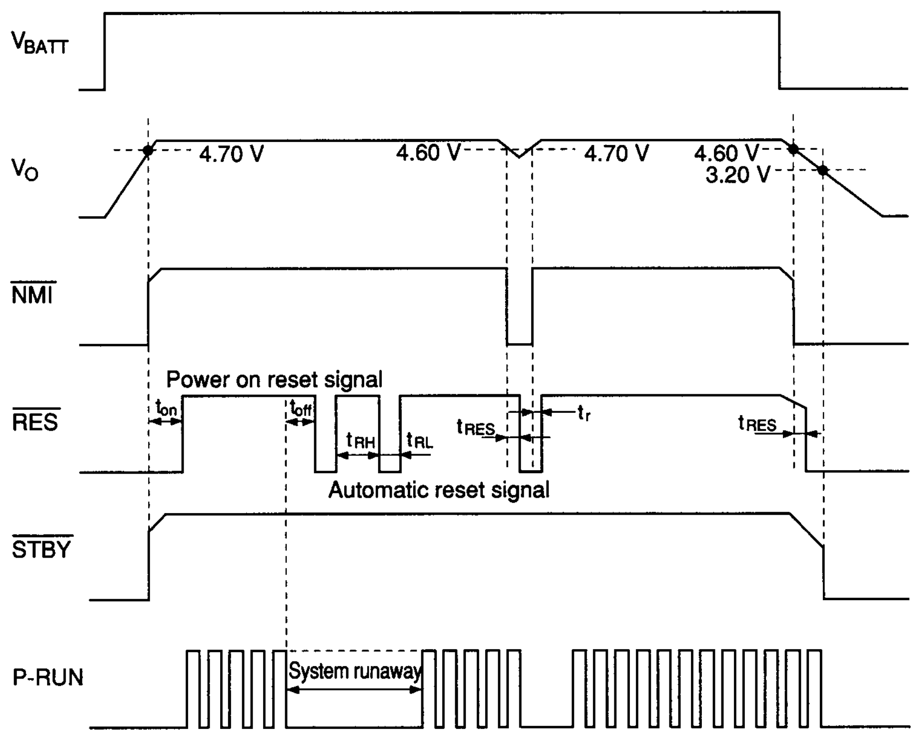


Figure 5 Timing Chart for Low Voltage Monitoring

Table 2 Absolute Maximum Ratings (Ta = 25°C)

Item	Symbol	Ratings HA16103PJ	HA16103FPJ	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	P_T	400*	400**	mW
Operating ambient temperature range	Topr	–40 to +85	–40 to +85	°C
Storage temperature range	Tstg	–50 to +125	–50 to +125	°C

* Value under Ta ≤ 77°C. If Ta is greater, 8.3 mW/°C derating occurs.

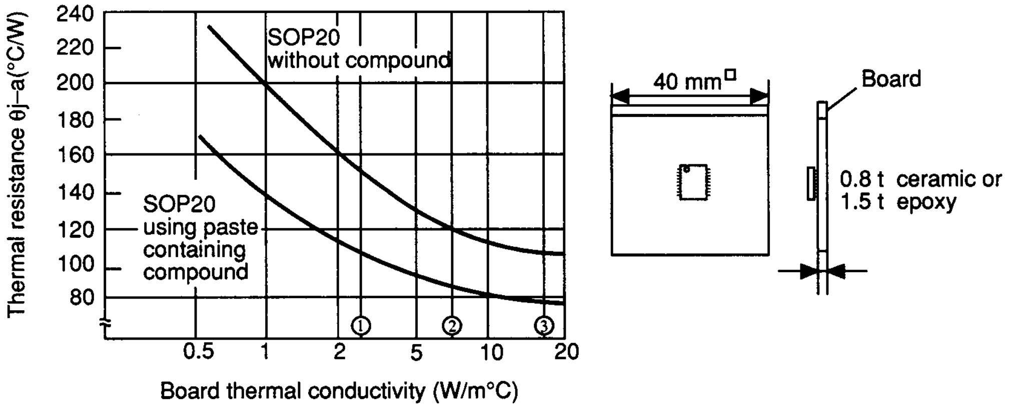
** Allowable temperature of IC junction part, Tj (max.), is as shown below.

Tj (max.) = θj–a•Pc (max.)+Ta

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

Therefore, to keep Tj (max.) ≤ 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.



① Glass epoxy board with 10% wiring density
② Glass epoxy board with 30% wiring density
③ Ceramic board with 96% alumina coefficient

Figure 6 Thermal Resistance of SOP

Table 3 Electrical Characteristics (Ta = 25°C, V_{DD} = 12 V, V_{out} = 5 V)

Items		Symbols	Min	Typ	Max	Units	Test Conditions
	Supply current	I_{CCL}	—	8	12	mA	V_{CC} = 12 V
Regulator	Output voltage	V_{O1}	4.80	5.00	5.20	V	V_{CC} = 6 to 17.5 V I_{OUT} = 0.5 A, R_1 = 30 kΩ
		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	V_{oline}	–50	—	50	mV	V_{CC} = 6 to 17.5 V I_{out} = 1 A, R_1 = 30 kΩ
	Load regulation	V_{oload}	–100	—	100	mV	I_{out} = 10 mA to 1.5 A, R_1 = 30 kΩ
	Ripple rejection	R_{REJ}	45	75	—	dB	V_i = 0.5 Vrms, f_i = 1 kHz, R_1 = 30 kΩ
	Output voltage Temperature coefficient	δVo/δT	—	0.6	—	mV/°C	V_{CC} = 12 V, R_1 = 30 kΩ
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
$\overline{\text{NMI}}$ output	$\overline{\text{NMI}}$ pin "L"-level voltage	V_{OL1}	—	—	0.4	V	I_{OL1} = 2 mA
	$\overline{\text{NMI}}$ pin "H"-level voltage	V_{OH1}	—	V_{O1} (V_{O2})	—	V	
	$\overline{\text{NMI}}$ function start V_{out} voltage	V_{NMI}	—	0.7	1.4	V	
$\overline{\text{STBY}}$ output	$\overline{\text{STBY}}$ pin "L"-level voltage	V_{OL2}	—	—	0.4	V	I_{OL2} = 2 mA
	$\overline{\text{STBY}}$ pin "H"-level voltage	V_{OH2}	—	V_{O1} (V_{O2})	—	V	
	$\overline{\text{STBY}}$ function start V_{out} voltage	V_{STBY}	—	0.7	1.4	V	

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Table 3 Electrical Characteristics (Ta = 25°C, V_{DD} = 12 V, V_{out} = 5 V) (Cont)

Items		Symbols	Min	Typ	Max	Units	Test Conditions
$\overline{RES}$ output	$\overline{RES}$ pin "L"-level voltage	V_{OL3}	—	—	0.4	V	I_{OL3} = 2 mA
	$\overline{RES}$ pin "H"-level voltage	V_{OH3}	—	V_{O1} (V_{O2})	—	V	
	$\overline{RES}$ function start Vout voltage	V_{RES}	—	0.7	1.4	V	
	Power on time	t_{ON}	25	40	60	ms	R_f = 180 kΩ, R_R = 180 kΩ, C_f = 0.01 µF, C_R = 0.1 µF
	Clock off reset time	t_{OFF}	80	130	190	ms	
	Reset pulse "L"-level time	t_{RL}	15	20	30	ms	R_f = 180 kΩ, R_R = 180 kΩ, C_f = 0.01 µF, C_R = 0.1 µF
	Reset pulse "H"-level time	t_{RH}	37	60	90	ms	R_f = 180 kΩ, R_R = 180 kΩ, C_f = 0.01 µF, C_R = 0.1 µF
Low Voltage Protection	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 pulse Delay time inhibit	t_{RES}	—	200	—	µs	C_{RES} = 2200 pF
	Reset pulse Delay time restart	t_r	—	200	—	µs	C_{RES} = 2200 pF

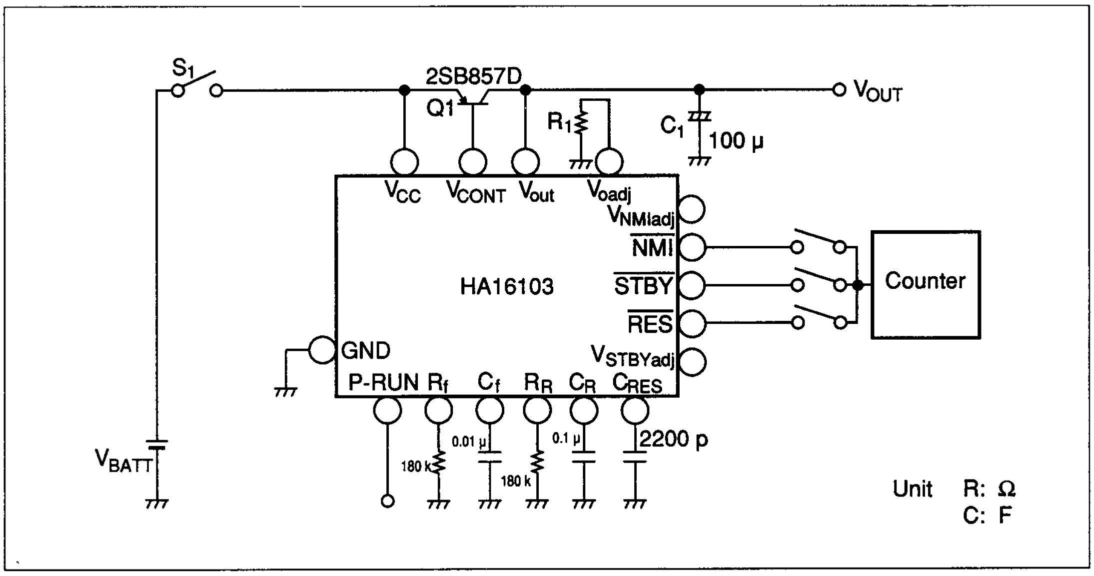


Figure 7 Test Circuit

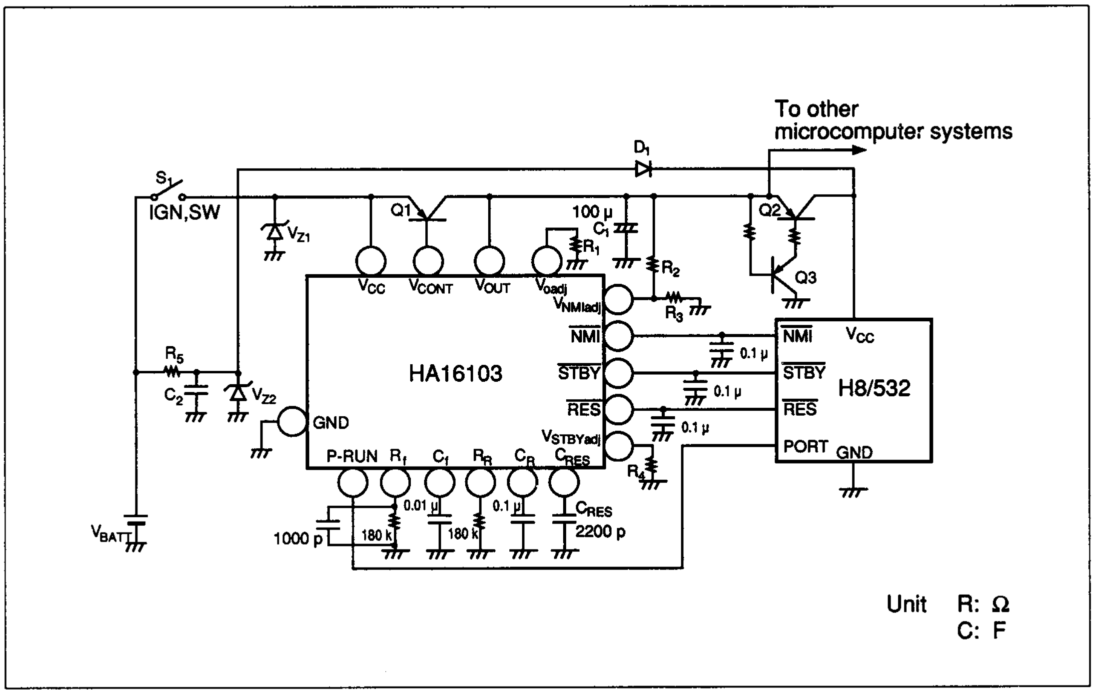


Figure 8 Sample Connection Circuit between HA16103 and H8/532 (1)

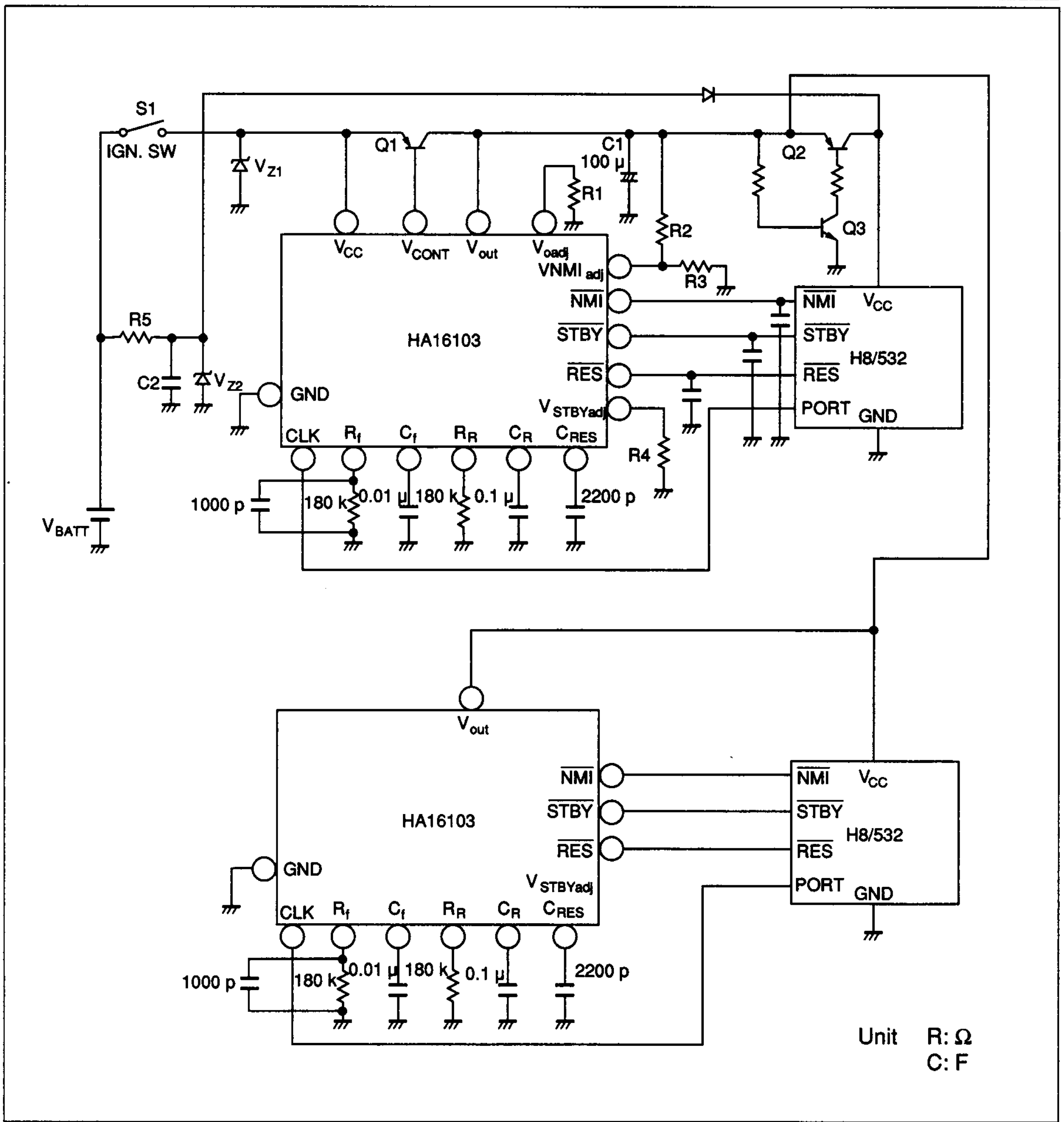


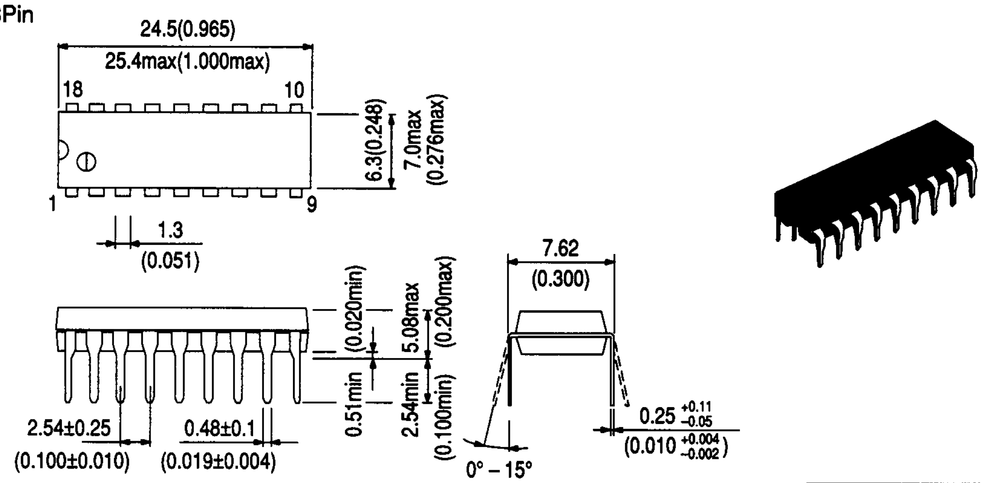
Figure 9 Sample Connection Circuit between HA16103 and H8/532 (2)

Package Dimensions

Unit: mm (inch)

• HA16103PJ

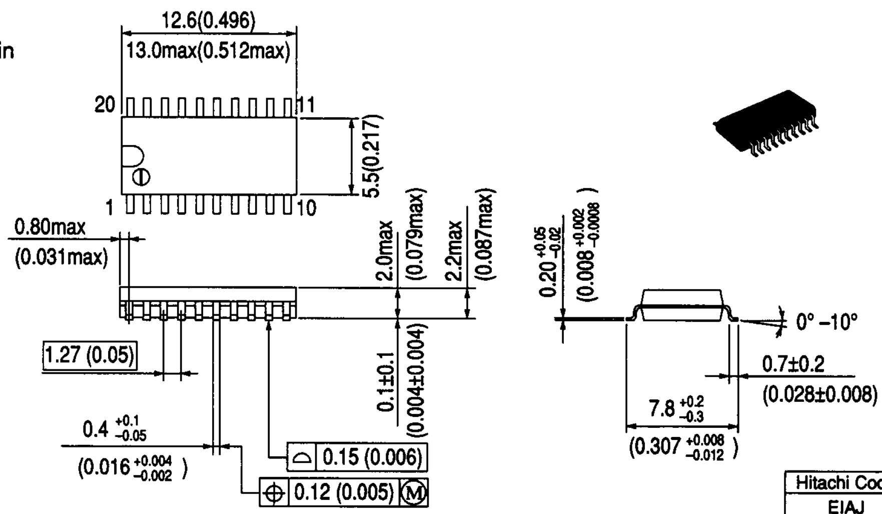
18Pin



Hitachi Code	DP-18A
EIAJ	SC-505-18B
JEDEC	—

• HA16103FPJ

20Pin



Hitachi Code	FP-20DA
EIAJ	SC-531-20
JEDEC	—

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