To our customers,

Old Company Name in Catalogs and Other Documents

On April 1st, 2010, NEC Electronics Corporation merged with Renesas Technology Corporation, and Renesas Electronics Corporation took over all the business of both companies. Therefore, although the old company name remains in this document, it is a valid Renesas Electronics document. We appreciate your understanding.

Renesas Electronics website: http://www.renesas.com

April 1st, 2010
Renesas Electronics Corporation

Issued by: Renesas Electronics Corporation (http://www.renesas.com)

Send any inquiries to http://www.renesas.com/inquiry.

Notice

1. All information included in this document is current as of the date this document is issued. Such information, however, is subject to change without any prior notice. Before purchasing or using any Renesas Electronics products listed herein, please confirm the latest product information with a Renesas Electronics sales office. Also, please pay regular and careful attention to additional and different information to be disclosed by Renesas Electronics such as that disclosed through our website.
2. Renesas Electronics does not assume any liability for infringement of patents, copyrights, or other intellectual property rights of third parties by or arising from the use of Renesas Electronics products or technical information described in this document. No license, express, implied or otherwise, is granted hereby under any patents, copyrights or other intellectual property rights of Renesas Electronics or others.
3. You should not alter, modify, copy, or otherwise misappropriate any Renesas Electronics product, whether in whole or in part.
4. Descriptions of circuits, software and other related information in this document are provided only to illustrate the operation of semiconductor products and application examples. You are fully responsible for the incorporation of these circuits, software, and information in the design of your equipment. Renesas Electronics assumes no responsibility for any losses incurred by you or third parties arising from the use of these circuits, software, or information.
5. When exporting the products or technology described in this document, you should comply with the applicable export control laws and regulations and follow the procedures required by such laws and regulations. You should not use Renesas Electronics products or the technology described in this document for any purpose relating to military applications or use by the military, including but not limited to the development of weapons of mass destruction. Renesas Electronics products and technology may not be used for or incorporated into any products or systems whose manufacture, use, or sale is prohibited under any applicable domestic or foreign laws or regulations.
6. Renesas Electronics has used reasonable care in preparing the information included in this document, but Renesas Electronics does not warrant that such information is error free. Renesas Electronics assumes no liability whatsoever for any damages incurred by you resulting from errors in or omissions from the information included herein.
7. Renesas Electronics products are classified according to the following three quality grades: "Standard", "High Quality", and "Specific". The recommended applications for each Renesas Electronics product depends on the product's quality grade, as indicated below. You must check the quality grade of each Renesas Electronics product before using it in a particular application. You may not use any Renesas Electronics product for any application categorized as "Specific" without the prior written consent of Renesas Electronics. Further, you may not use any Renesas Electronics product for any application for which it is not intended without the prior written consent of Renesas Electronics. Renesas Electronics shall not be in any way liable for any damages or losses incurred by you or third parties arising from the use of any Renesas Electronics product for an application categorized as "Specific" or for which the product is not intended where you have failed to obtain the prior written consent of Renesas Electronics. The quality grade of each Renesas Electronics product is "Standard" unless otherwise expressly specified in a Renesas Electronics data sheets or data books, etc.

   "Standard": Computers; office equipment; communications equipment; test and measurement equipment; audio and visual equipment; home electronic appliances; machine tools; personal electronic equipment; and industrial robots.

   "High Quality": Transportation equipment (automobiles, trains, ships, etc.); traffic control systems; anti-disaster systems; anti-crime systems; safety equipment; and medical equipment not specifically designed for life support.

   "Specific": Aircraft; aerospace equipment; submersible repeaters; nuclear reactor control systems; medical equipment or systems for life support (e.g. artificial life support devices or systems), surgical implantations, or healthcare intervention (e.g. excision, etc.), and any other applications or purposes that pose a direct threat to human life.
8. You should use the Renesas Electronics products described in this document within the range specified by Renesas Electronics, especially with respect to the maximum rating, operating supply voltage range, movement power voltage range, heat radiation characteristics, installation and other product characteristics. Renesas Electronics shall have no liability for malfunctions or damages arising out of the use of Renesas Electronics products beyond such specified ranges.
9. Although Renesas Electronics endeavors to improve the quality and reliability of its products, semiconductor products have specific characteristics such as the occurrence of failure at a certain rate and malfunctions under certain use conditions. Further, Renesas Electronics products are not subject to radiation resistance design. Please be sure to implement safety measures to guard them against the possibility of physical injury, and injury or damage caused by fire in the event of the failure of a Renesas Electronics product, such as safety design for hardware and software including but not limited to redundancy, fire control and malfunction prevention, appropriate treatment for aging degradation or any other appropriate measures. Because the evaluation of microcomputer software alone is very difficult, please evaluate the safety of the final products or system manufactured by you.
10. Please contact a Renesas Electronics sales office for details as to environmental matters such as the environmental compatibility of each Renesas Electronics product. Please use Renesas Electronics products in compliance with all applicable laws and regulations that regulate the inclusion or use of controlled substances, including without limitation, the EU RoHS Directive. Renesas Electronics assumes no liability for damages or losses occurring as a result of your noncompliance with applicable laws and regulations.
11. This document may not be reproduced or duplicated, in any form, in whole or in part, without prior written consent of Renesas Electronics.
12. Please contact a Renesas Electronics sales office if you have any questions regarding the information contained in this document or Renesas Electronics products, or if you have any other inquiries.

(Note 1) "Renesas Electronics" as used in this document means Renesas Electronics Corporation and also includes its majority-owned subsidiaries.

(Note 2) "Renesas Electronics product(s)" means any product developed or manufactured by or for Renesas Electronics.

HA16103FPJ/FPK

Watchdog Timer

REJ03F0140-0300
(Previous: ADE-204-010B)
Rev.3.00
Jun 15, 2005

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

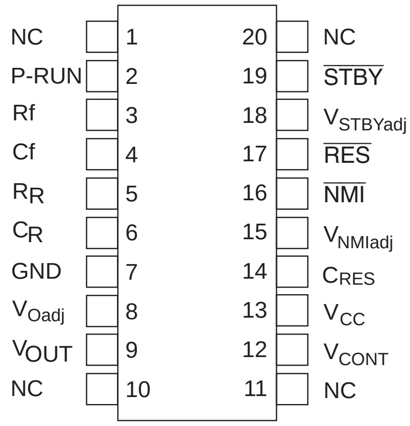
Features

- Wide operational supply voltage range (V_{CC} = 6 to 40 V)
- Various control signals are generated when microcomputer system runaway occurs. ($\overline{\text{NMI}}$ signal and $\overline{\text{STBY}}$ signal are generated by detecting voltage level, and $\overline{\text{RES}}$ signal is generated by monitoring the time after $\overline{\text{NMI}}$ signal is detected)
- Regulated voltage, $\overline{\text{NMI}}$ detecting voltage, $\overline{\text{STBY}}$ 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 Code (Previous Code)
HA16103FPJ	PRSP0020DD-A (FP-20DA)
HA16103FPK	PRSP0020DD-A (FP-20DA)

Pin Arrangement

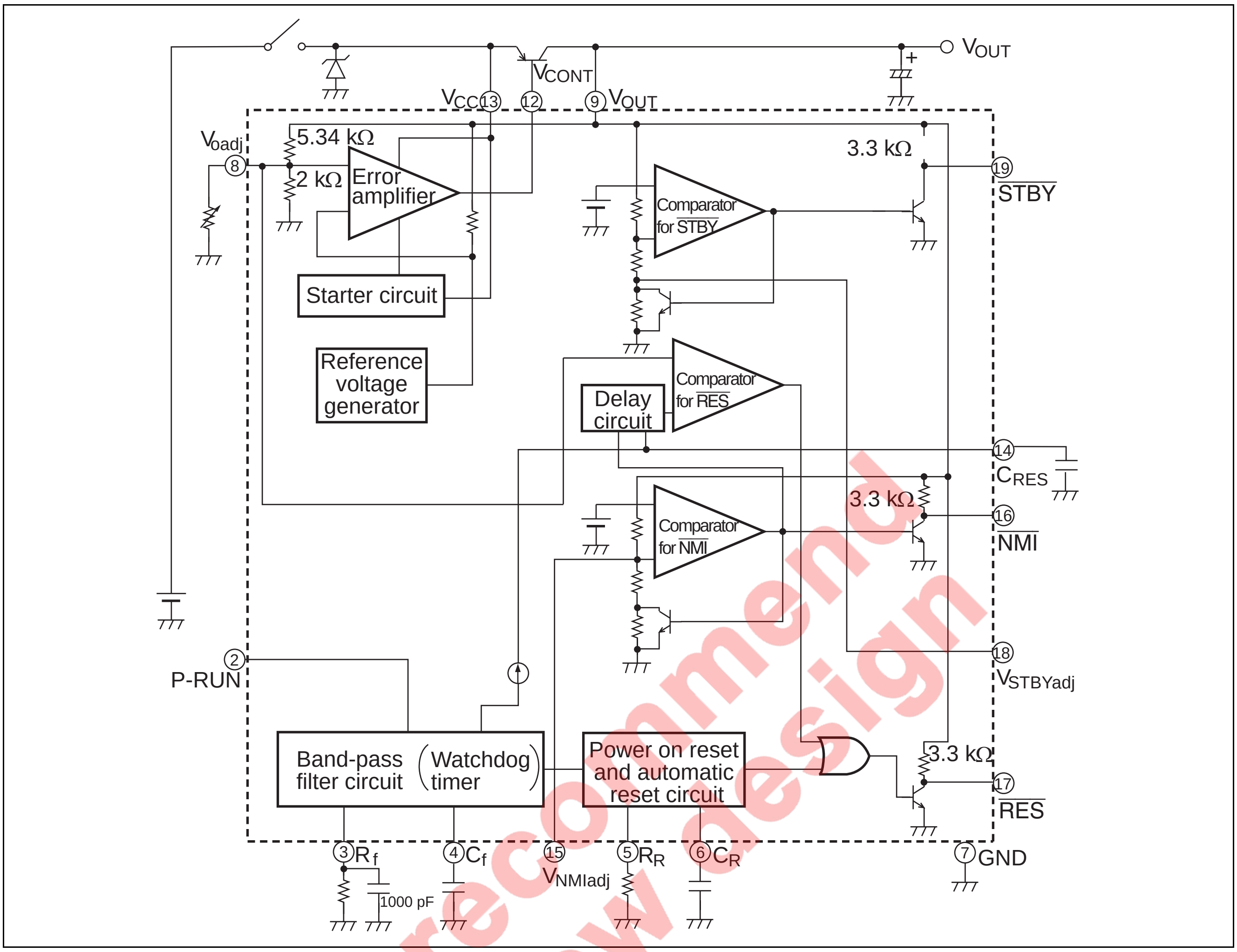


(Top view)

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)} × Voadj Unit for R1: kΩ
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), $\overline{NMI}$ signals are generated. If t_{RES} ≈ 0.5•Rf•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 ≈ 0.5•Rf•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. t_r = 10 µs typ. at open)
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)} × V_{NMIadj}. Unit for R2, R3: kΩ
16	$\overline{NMI}$	$\overline{NMI}$ signal output pin. Connect to pin $\overline{NMI}$ of the microcomputer
17	$\overline{RES}$	$\overline{RES}$ signal output pin. Connect to pin $\overline{RES}$ of the microcomputer
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 × {1 + 21/(7.9 + 8.85 // R4)} × $V_{STBYadj}$ Unit for R4: kΩ
19	$\overline{STBY}$	$\overline{STBY}$ signal output pin. Connect to pin $\overline{STBY}$ of the microcomputer
20	NC	NC pin

Block Diagram



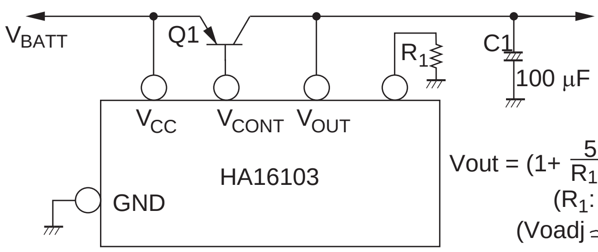
Functional Description

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.



$$Vout = \left(1 + \frac{5.34}{R_1 // 2.0}\right) \times Voadj \cdots \text{Equation 1}$$

$(R_1\text{: k}\Omega)$

$(Voadj \simeq 1.31V)$

Figure 1 Fine Adjustment Circuit of Output Voltage

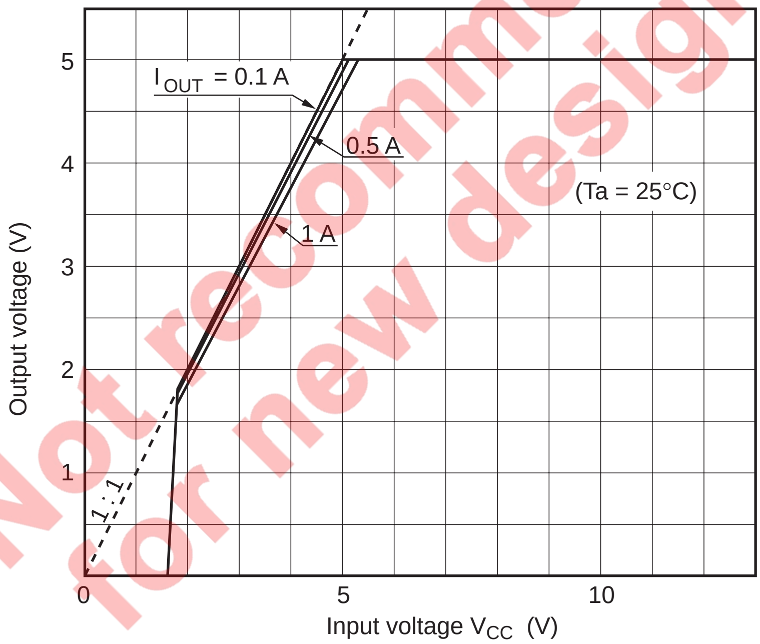
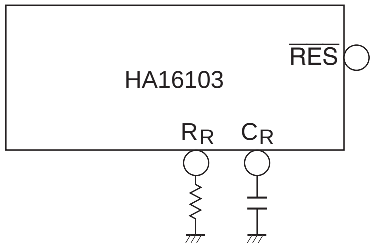


Figure 2 Output Voltage Characteristic

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.



$$t_{on} = 0.46 \times C_R \times R_R \times Vout(s) \cdots \text{Equation 2}$$

R_R: Ω

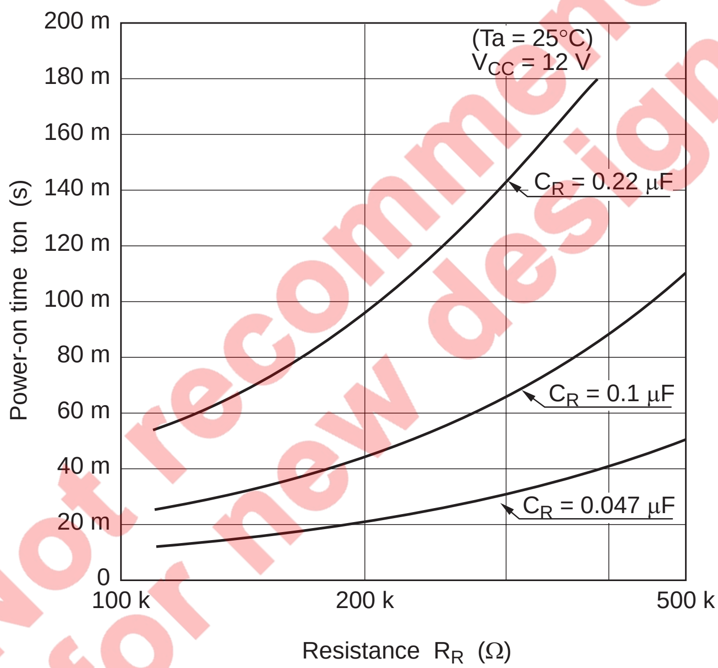
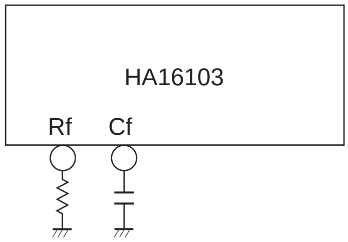


Figure 3 Characteristic of Power-On Reset Circuit

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.



tmin = Cf x Rf x 0.11 (s) · · · · Equation 3

Rf : Ω

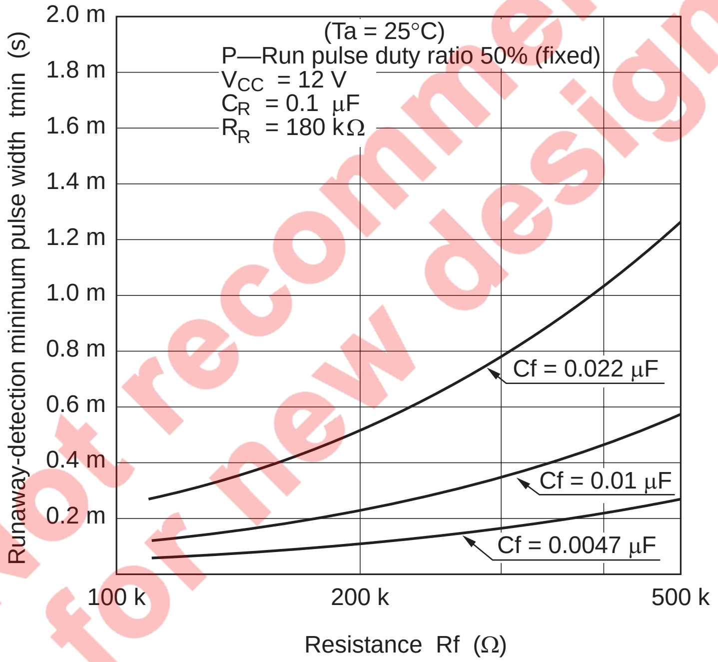


Figure 4 Characteristic of Power-On Reset Circuit

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.

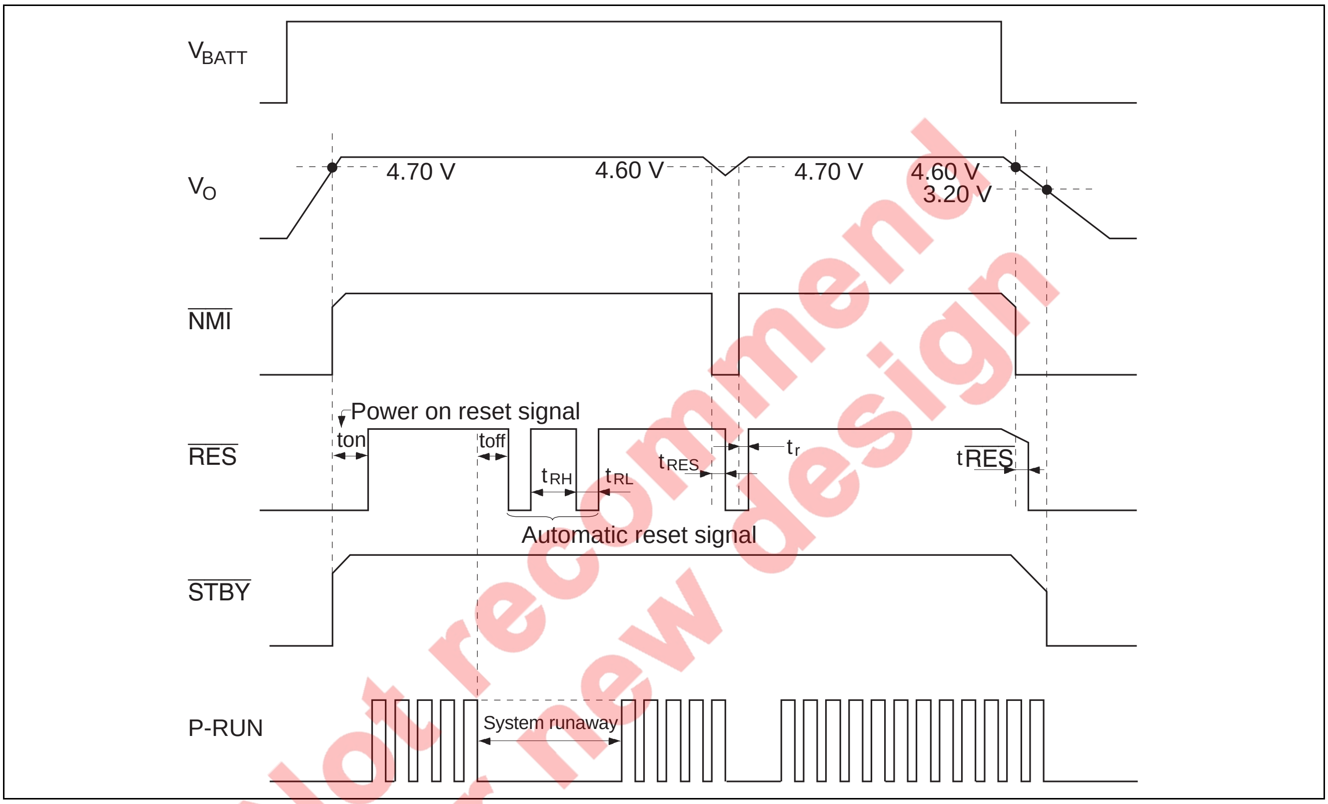


Figure 5 Timing Chart for Low Voltage Monitoring

RENESAS

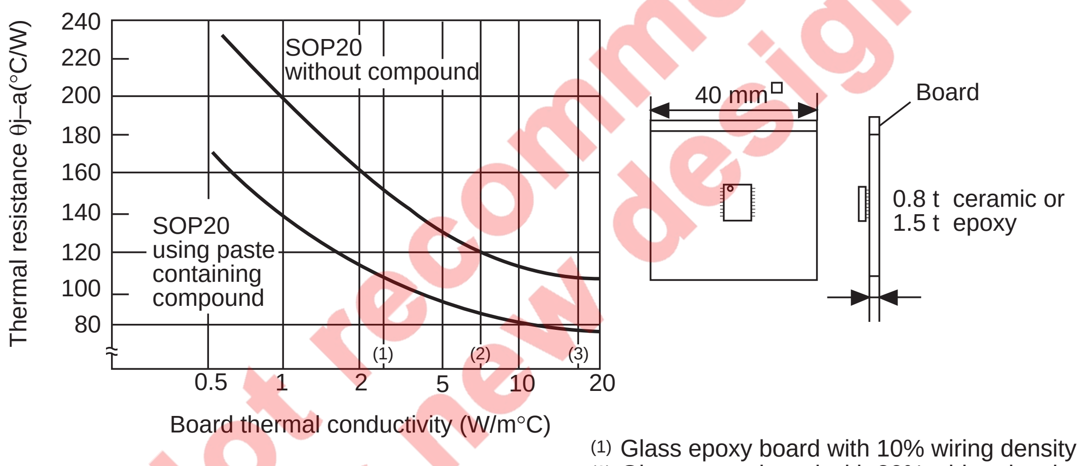
Absolute Maximum Ratings

(Ta = 25°C)

Item	Symbol	Ratings		Units
		HA16103FPJ	HA16103FPK	
VCC supply voltage	V_{CC}	40	40	V
Control pin voltage	V_{CONT}	40	40	V
Control pin current	I_{CONT}	20	20	mA
VOUT pin voltage	V_{OUT}	12	12	V
Power dissipation	P_T	400*[1]	400*[2]	mW
Operating ambient temperature range	Topr	–40 to +85	–40 to +125	°C

Notes: 1. Value under Ta ≤ 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) = 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 PT.



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

RENESAS

Electrical Characteristics

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

HA16103FPJ/FPK

Item		Symbol	Min	Typ	Max	Unit	Test Condition
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	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 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	
$\overline{\text{RES}}$ output	$\overline{\text{RES}}$ pin "L"-level voltage	V_{OL3}	–	–	0.4	V	I_{OL3} = 2 mA
	$\overline{\text{RES}}$ pin "H"-level voltage	V_{OH3}	–	V_{O1} (V_{O2})	–	V	
	$\overline{\text{RES}}$ function start V_{OUT} voltage	V_{RES}	–	0.7	1.4	V	
	Power on time	t_{ON}	25	40	60	ms	Rf = 180 kΩ, R_R = 180 kΩ
	Clock off reset time	t_{OFF}	80	130	190	ms	Cf = 0.01 µF, C_R = 0.1 µF
	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

Electrical Characteristics (cont.)

(T_a = 25°C, V_{CC} = 12 V, V_{OUT} = 5 V)

Item			Symbol	Min	Typ	Max	Unit	Test Condition
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 pulse Delay time	inhibit	t_{RES}	–	200	–	µs	C_{RES} = 2200 pF
		restart	t_r	–	200	–	µs	C_{RES} = 2200 pF

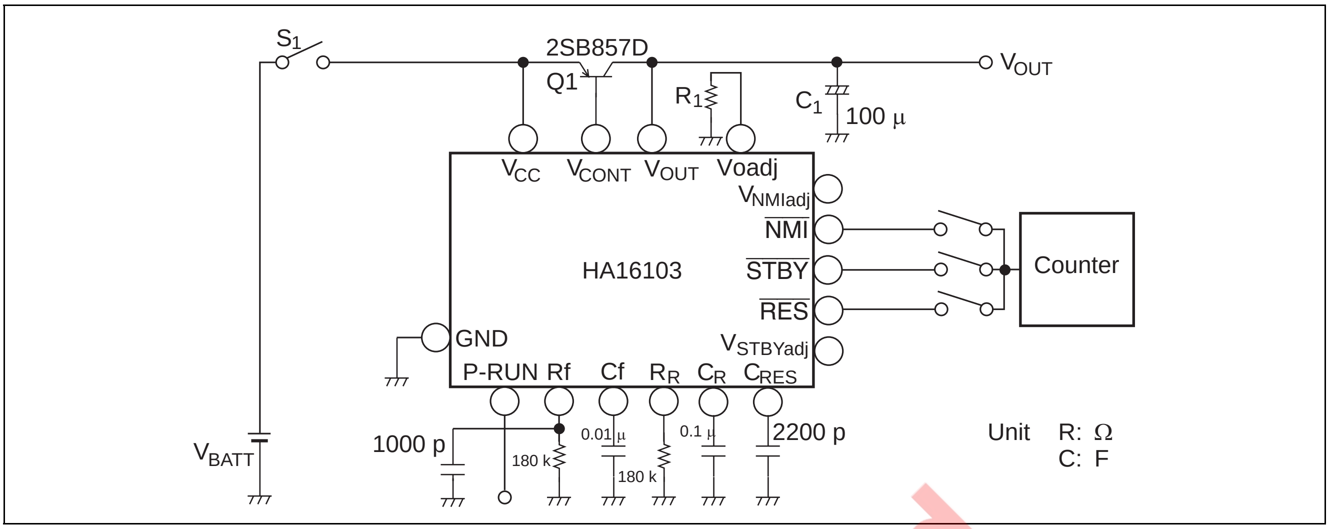
(T_a = –40 to 125°C, V_{CC} = 12 V, V_{OUT} = 5 V, R1 = 30 kΩ)

HA16103FPK

Item		Symbol	Min	Typ	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 to 17.5 V I_{OUT} = 0.5 A
	Line regulation	Voline	–50	–	50	mV	V_{CC} = 6 to 17.5 V I_{OUT} = 0.5 A
	Load regulation	Voload	–100	–	100	mV	I_{OUT} = 10 mA to 0.5 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	–	µA	V_{IL} = 0 V
	"H"-input current	I_{IH}	–	0.3	0.6	mA	V_{IH} = 5 V
$\overline{\text{NMI}}$ output	$\overline{\text{NMI}}$ pin "L"-level voltage	V_{OLN}	–	–	0.5	V	I_{OL1} = 2 mA
	$\overline{\text{NMI}}$ pin "H"-level voltage	V_{OHN}	–	V_{OUT1}	–	V	
$\overline{\text{STBY}}$ output	$\overline{\text{STBY}}$ pin "L"-level voltage	V_{OLS}	–	–	0.5	V	I_{OL2} = 2 mA
	$\overline{\text{STBY}}$ pin "H"-level voltage	V_{OHS}	–	V_{OUT1}	–	V	
$\overline{\text{RES}}$ output	$\overline{\text{RES}}$ pin "L"-level voltage	V_{OLR}	–	–	0.5	V	I_{OL3} = 2 mA
	$\overline{\text{RES}}$ 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 Cf = 0.01 µF, C_R = 0.1 µF
	Clock off reset time	t_{OFF}	70	130	200	ms	
	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}	30	60	100	ms	Rf = 180 kΩ, R_R = 180 kΩ Cf = 0.01 µF, C_R = 0.1 µF
Low Voltage protecton	Detection voltage(1)	V_{NMI}	4.35	4.60	4.85	V	
	Detection voltage(2)	V_{STBY}	2.80	3.20	3.60	V	

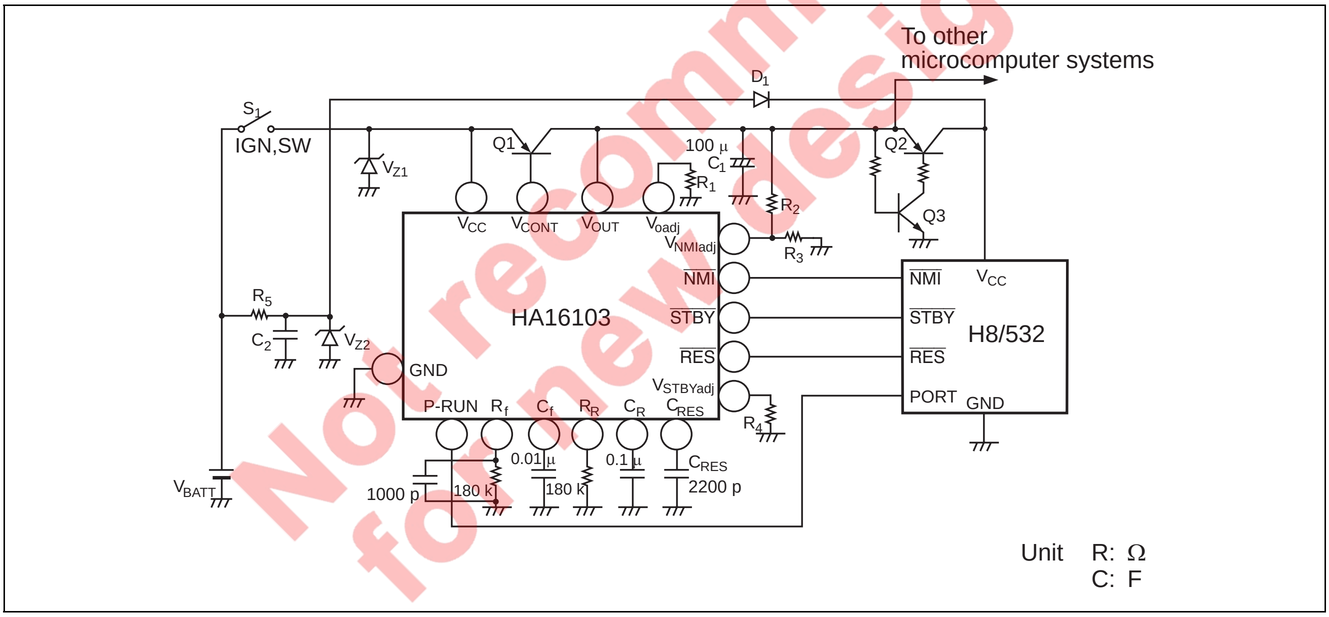
RENESAS

Test Circuit

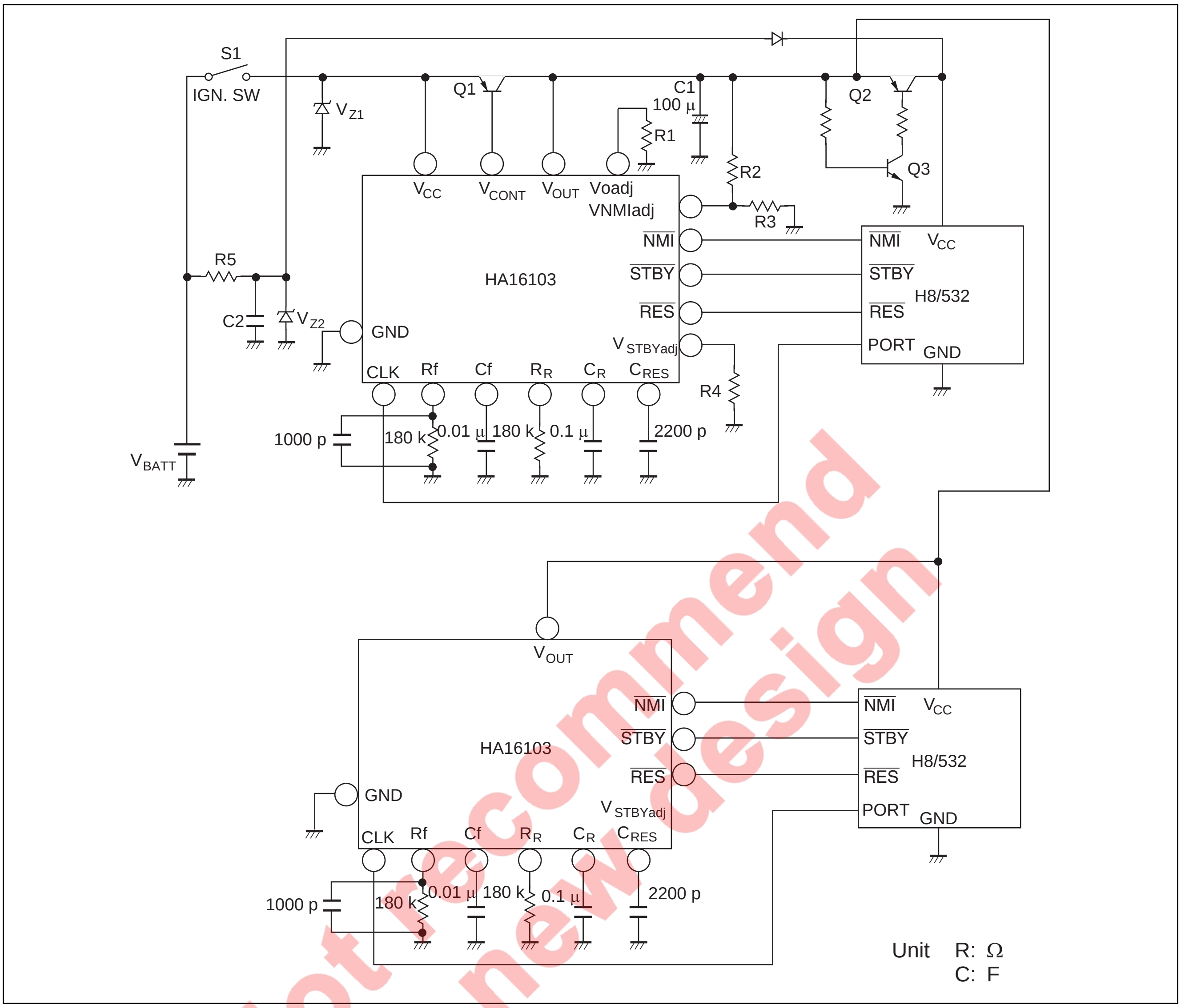


Sample Connection Circuit

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 $\overline{RES}$ pulse may be output. The reason for this is that potentials in the $\overline{RES}$ 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.

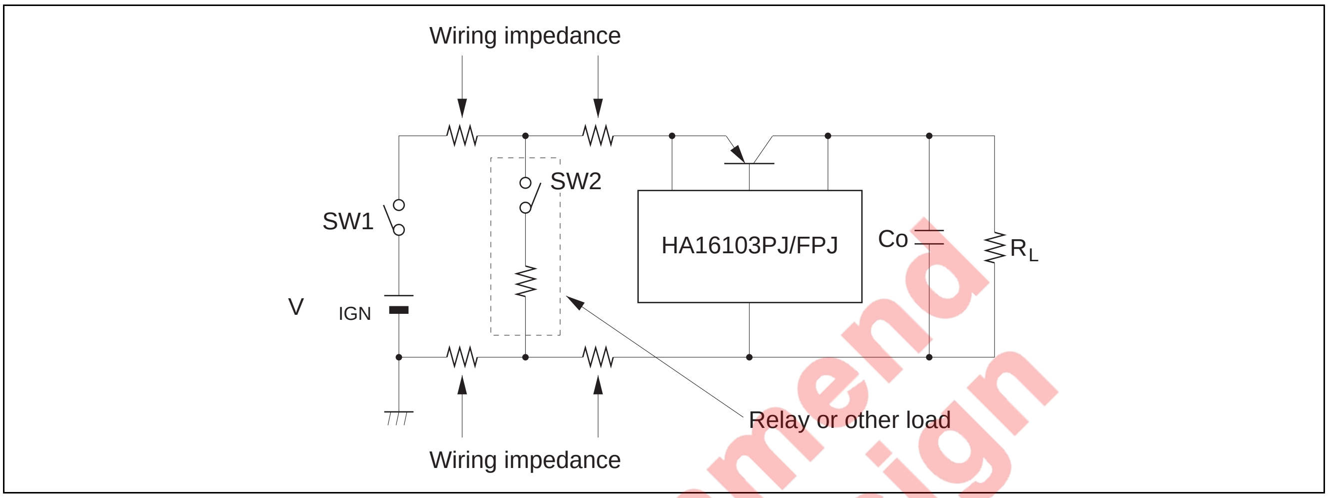


Figure 6 Typical Circuit

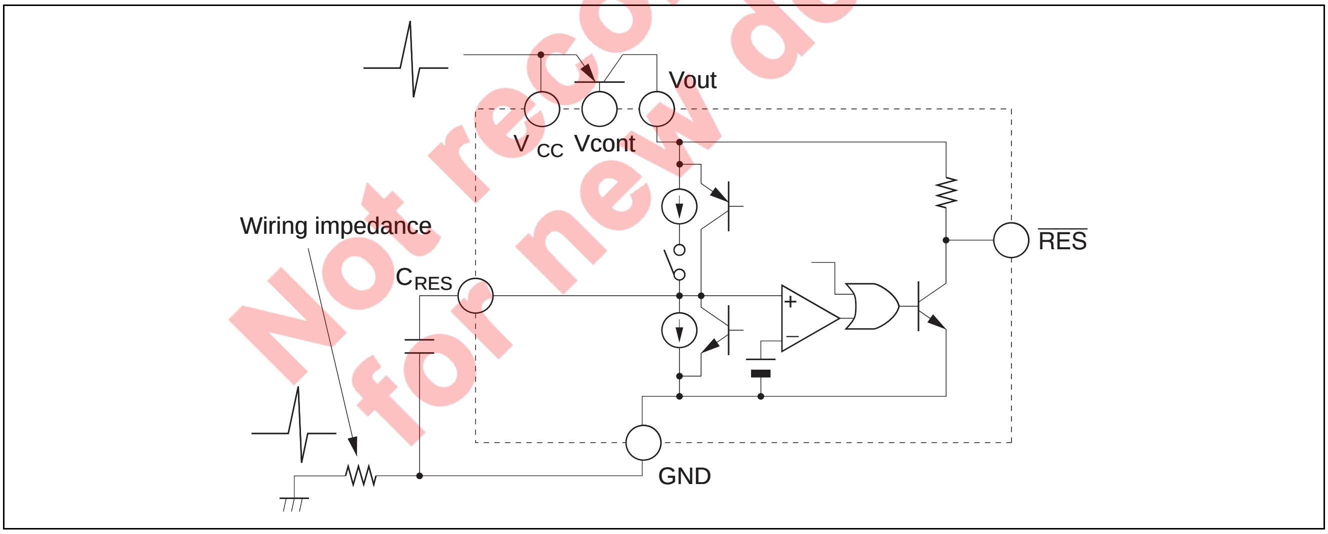
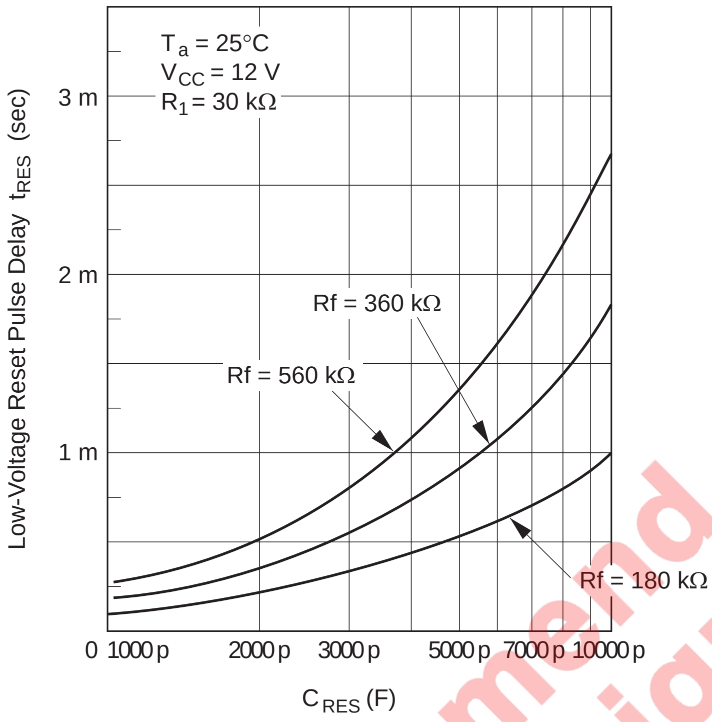


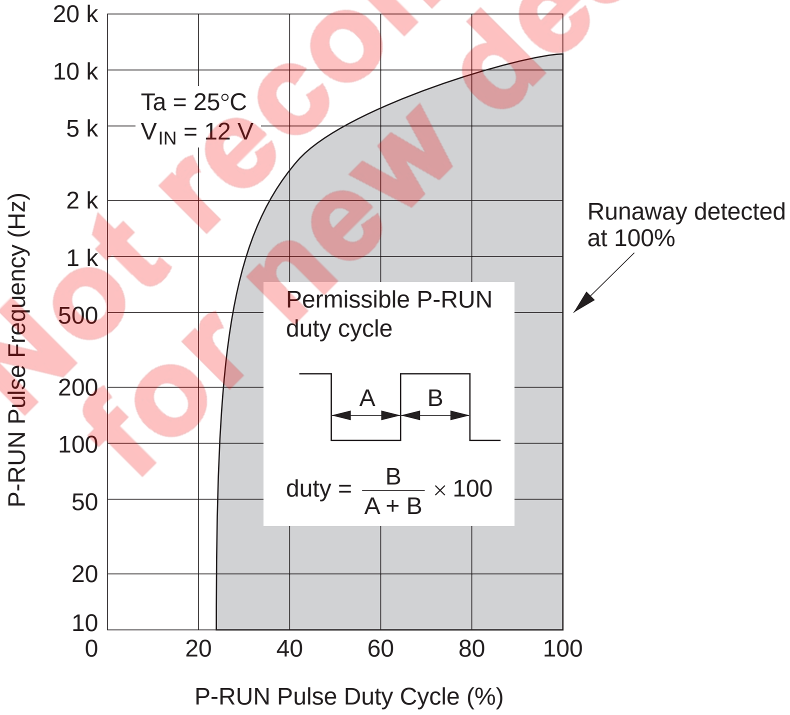
Figure 7 $\overline{RES}$ Comparator

• Low-voltage inhibit section

Low-Voltage Reset Pulse Delay vs. C_{RES}

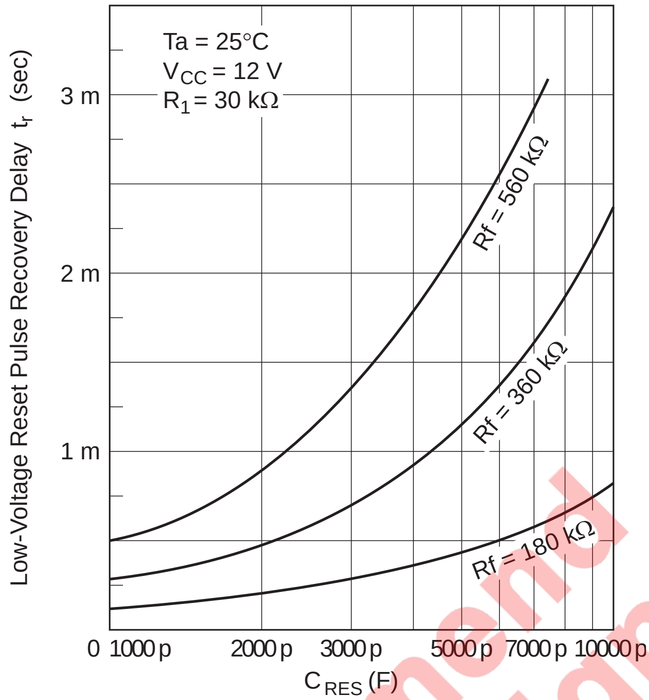


Permissible P-RUN Pulse Duty Cycle vs. P-RUN Pulse Frequency



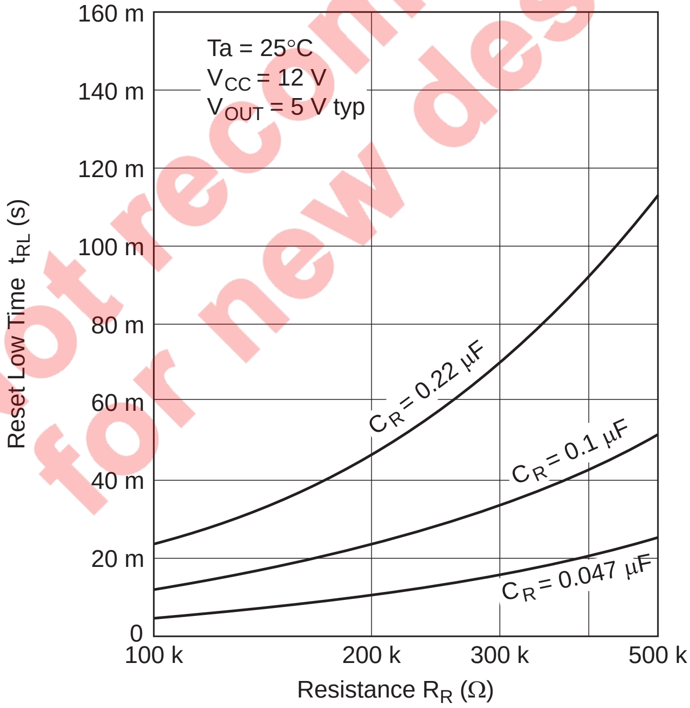
- Low-voltage inhibit section

Low-Voltage Reset Pulse Recovery Delay vs. C_{RES}

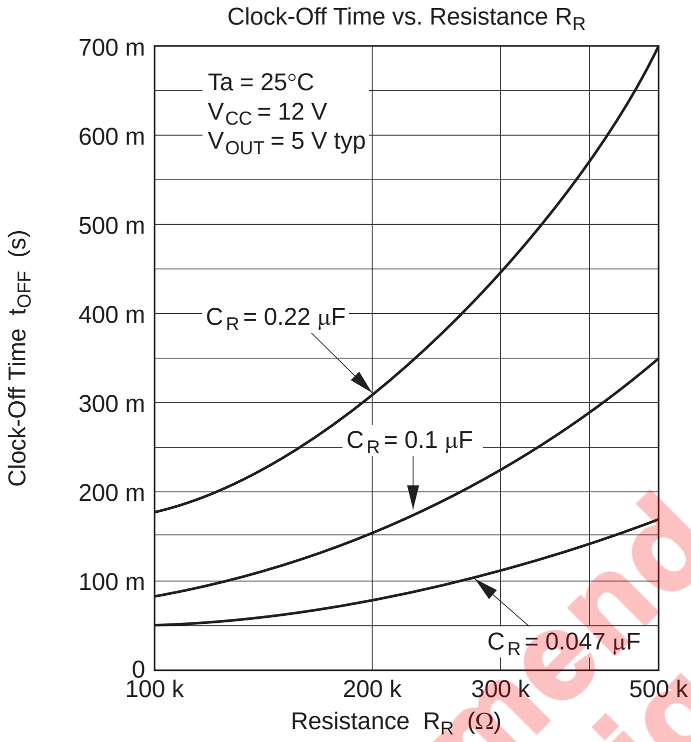


- Power-on and auto-reset section

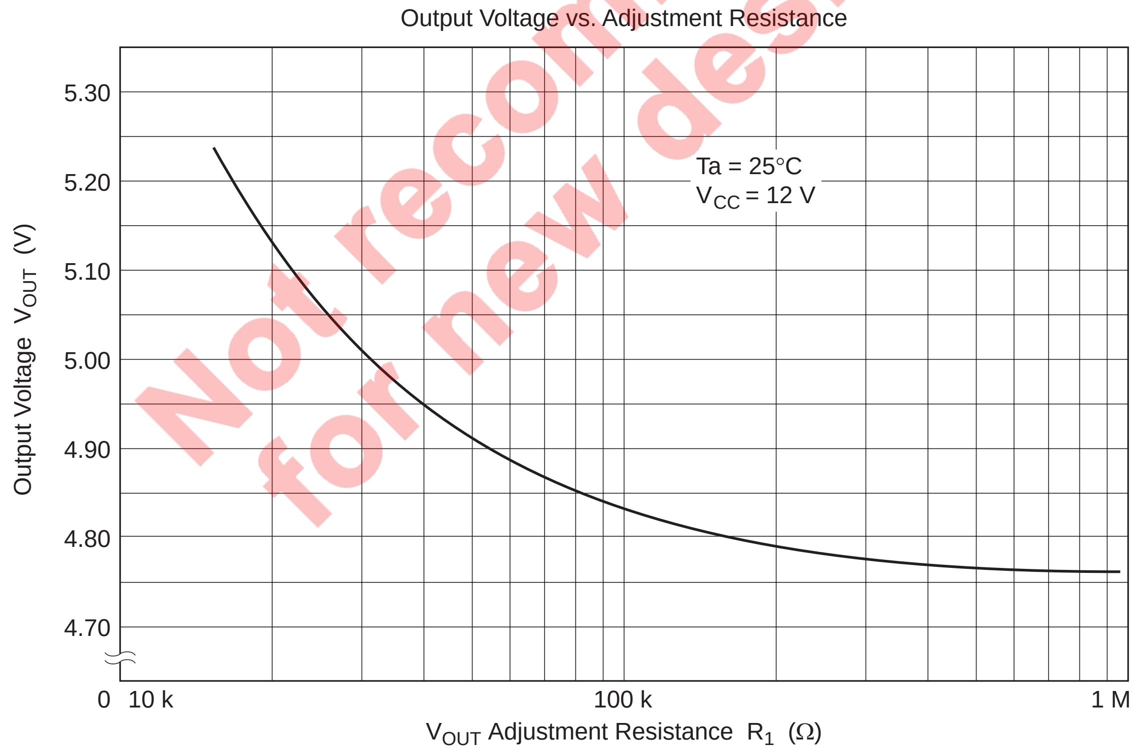
Reset Low Time vs. Resistance R_R



• Power-on and auto-reset section

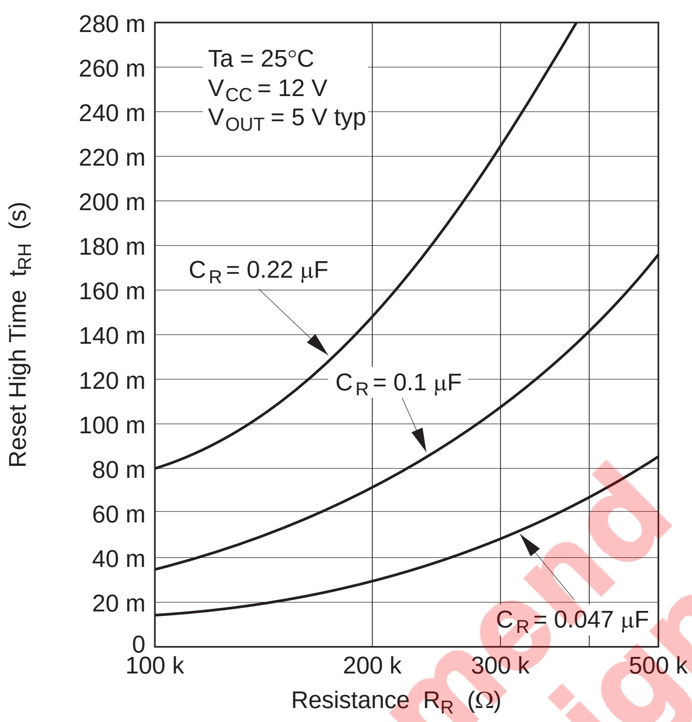


• Vref section



• Power-on and auto-reset section

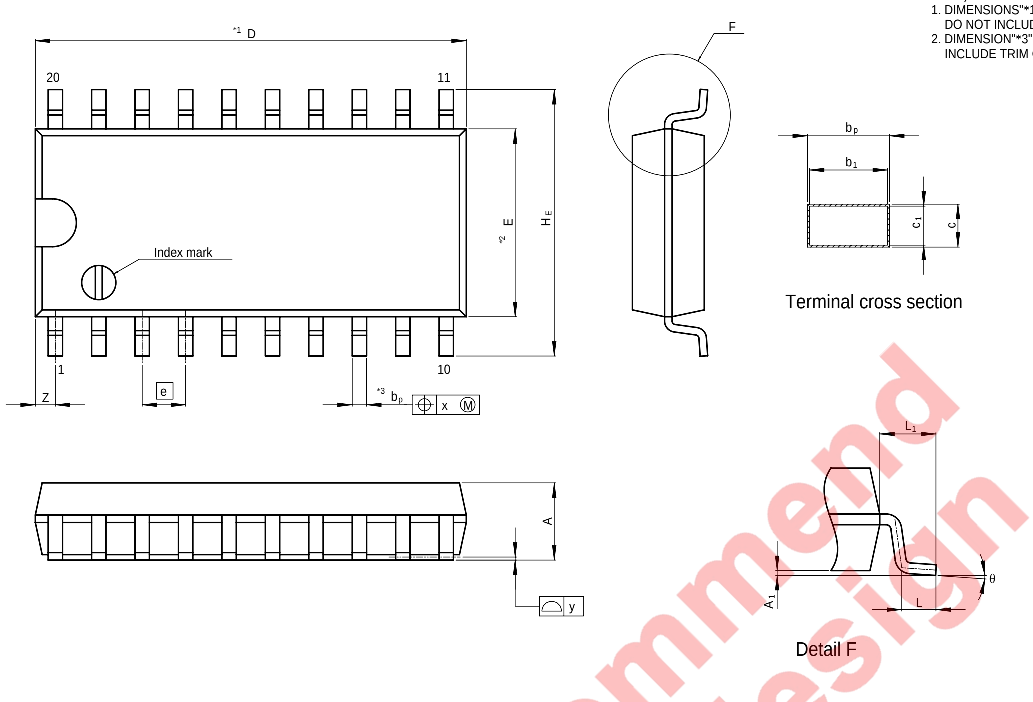
Reset High Time vs. Resistance R_R



Package Dimensions

JEITA Package Code	RENESAS Code	Previous Code	MASS[Typ.]
P-SOP20-5.5x12.6-1.27	PRSP0020DD-A	FP-20DA	0.31g

NOTE)
1. DIMENSIONS"*1 (Nom)"AND"*2" DO NOT INCLUDE MOLD FLASH.
2. DIMENSION"*3"DOES NOT INCLUDE TRIM OFFSET.



Reference Symbol	Dimension in Millimeters		
	Min	Nom	Max
D	—	12.6	13
E	—	5.5	—
A_2	—	—	—
A_1	0.00	0.10	0.20
A	—	—	2.20
b_p	0.34	0.42	0.50
b_1	—	0.40	—
c	0.17	0.22	0.27
c_1	—	0.20	—
θ	0°	—	8°
H_E	7.50	7.80	8.00
e	—	1.27	—
x	—	—	0.12
y	—	—	0.15
Z	—	—	0.80
L	0.50	0.70	0.90
L_1	—	1.15	—

Renesas Technology Corp. Sales Strategic Planning Div. Nippon Bldg., 2-6-2, Ohte-machi, Chiyoda-ku, Tokyo 100-0004, Japan

RENESAS SALES OFFICES

http://www.renesas.com

Refer to "**http://www.renesas.com/en/network**" for the latest and detailed information.

Renesas Technology America, Inc.
450 Holger Way, San Jose, CA 95134-1368, U.S.A
Tel: <1> (408) 382-7500, Fax: <1> (408) 382-7501

Renesas Technology Europe Limited
Dukes Meadow, Millboard Road, Bourne End, Buckinghamshire, SL8 5FH, U.K.
Tel: <44> (1628) 585-100, Fax: <44> (1628) 585-900

Renesas Technology Hong Kong Ltd.
7th Floor, North Tower, World Finance Centre, Harbour City, 1 Canton Road, Tsimshatsui, Kowloon, Hong Kong
Tel: <852> 2265-6688, Fax: <852> 2730-6071

Renesas Technology Taiwan Co., Ltd.
10th Floor, No.99, Fushing North Road, Taipei, Taiwan
Tel: <886> (2) 2715-2888, Fax: <886> (2) 2713-2999

Renesas Technology (Shanghai) Co., Ltd.
Unit2607 Ruijing Building, No.205 Maoming Road (S), Shanghai 200020, China
Tel: <86> (21) 6472-1001, Fax: <86> (21) 6415-2952

Renesas Technology Singapore Pte. Ltd.
1 Harbour Front Avenue, #06-10, Keppel Bay Tower, Singapore 098632
Tel: <65> 6213-0200, Fax: <65> 6278-8001

Colophon 2.0