

# 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

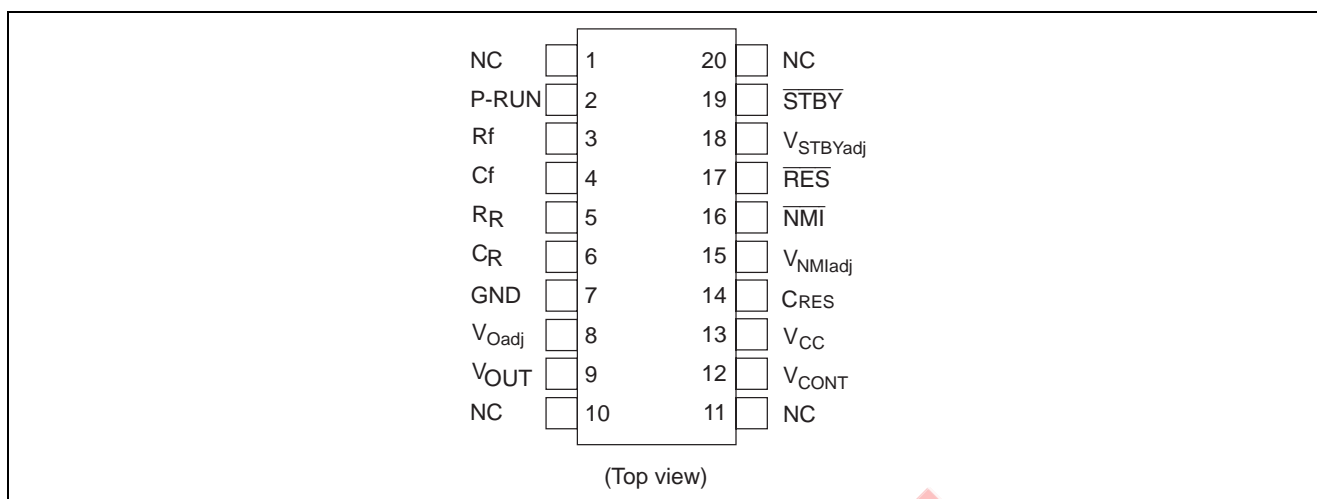
### Features

- Wide operational supply voltage range ( $V_{CC} = 6$  to 40 V)
- Various control signals are generated when microcomputer system runaway occurs. ( $\overline{NMI}$  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

### Ordering Information

| Type No.   | Package Code (Previous Code) |
|------------|------------------------------|
| HA16103FPJ | PRSP0020DD-A (FP-20DA)       |
| HA16103FPK | PRSP0020DD-A (FP-20DA)       |

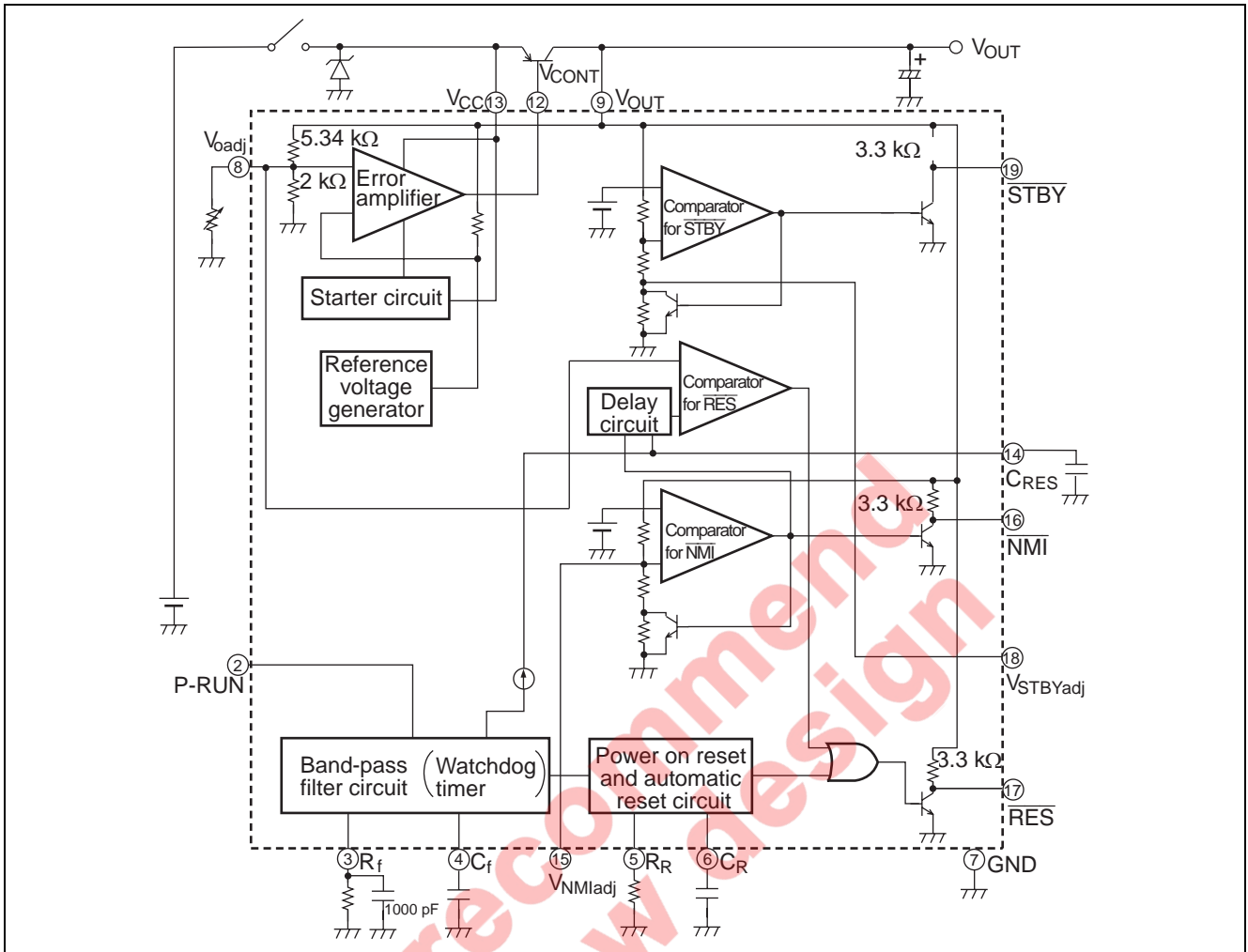
## Pin Arrangement



## Pin Functions

| No. | Pin Name             | Description  |
|-----|----------------------|--|
| 1   | NC                   | NC pin   |
| 2   | P-RUN                | P-RUN signal input pin for watchdog timer  |
| 3   | R <sub>f</sub>       | Connect resistor R <sub>f</sub> . Frequency bandwidth of the filter circuit depends on R <sub>f</sub>  |
| 4   | C <sub>f</sub>       | Connect resistor C <sub>f</sub> . Frequency bandwidth of the filter circuit depends on C <sub>f</sub>  |
| 5   | R <sub>R</sub>       | Connect resistor R <sub>R</sub> . Reset-signal power-on time depends on R <sub>R</sub>   |
| 6   | C <sub>R</sub>       | Connect resistor C <sub>R</sub> . Reset-signal power-on time depends on C <sub>R</sub>   |
| 7   | GND                  | Ground   |
| 8   | V <sub>Oadj</sub>    | 5-V reference voltage fine-tuning pin. Connect a resistor between this pin and GND. The value of output voltage is given by<br>$V_{OUT} = \{1 + 5.34/(R1 // 2.0)\} \times V_{Oadj}$ Unit for R1: kΩ  |
| 9   | V <sub>OUT</sub>     | 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 <sub>CONT</sub>    | The external PNP-type transistor's base control pin  |
| 13  | V <sub>CC</sub>      | Supply voltage pin. Operating supply voltage range is 6.0 to 40 V.   |
| 14  | C <sub>RES</sub>     | If the voltage of V <sub>OUT</sub> pin declines to less than Detection voltage(1) (because of an instant power cut or other cause), NMI signals are generated.<br>If t <sub>RES</sub> ≈ 0.5•R <sub>f</sub> •C <sub>RES</sub> (sec) has passed since then, RES signals are generated.<br>If the voltage of V <sub>OUT</sub> pin inclines to more than Detection voltage(1) (in case of re-start from LVI state), NMI signals are stop. t <sub>r</sub> ≈ 0.5•R <sub>f</sub> •C <sub>RES</sub> (sec) has passed since then, RES signals are stop. Connect capacitor C <sub>RES</sub> between this pin and GND to adjust the RES signals delay time(t <sub>RES</sub> , t <sub>r</sub> ). If delay time is unnecessary, make this pin open (t <sub>RES</sub> = 2 μs typ. t <sub>r</sub> = 10 μs typ. at open) |
| 15  | V <sub>NMIadj</sub>  | NMI detection voltage fine-tuning pin. Connect a resistor between this pin and V <sub>OUT</sub> pin or GND. The value of output voltage is given by<br>$V_{NMI} = \{1 + (R2 // 25.5)/(R3 // 10.6)\} \times V_{NMIadj}$ 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 <sub>STBYadj</sub> | STBY detection voltage tuning pin. Connect a resistor between this pin and V <sub>OUT</sub> or GND. The value of output voltage is given by<br>$V_{STBY} = 1.89 \times \{1 + 21/(7.9 + 8.85 // R4)\} \times V_{STBYadj}$ 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

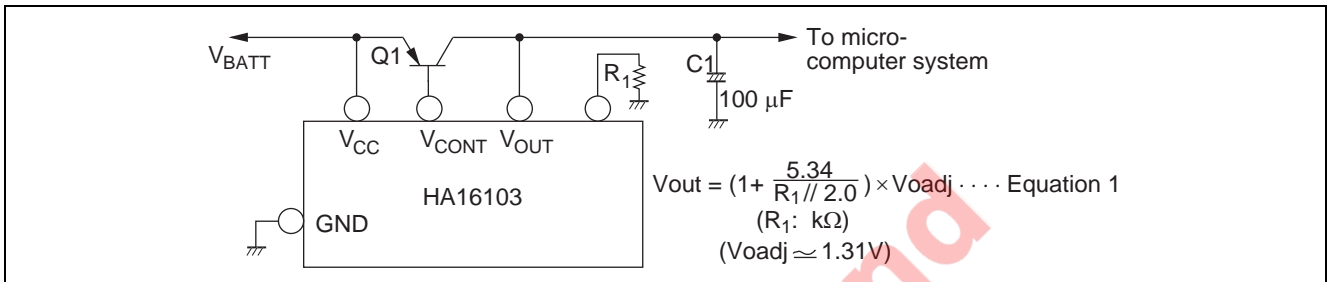
### Stabilized Power Supply Function

The stabilized power supply includes the following features:

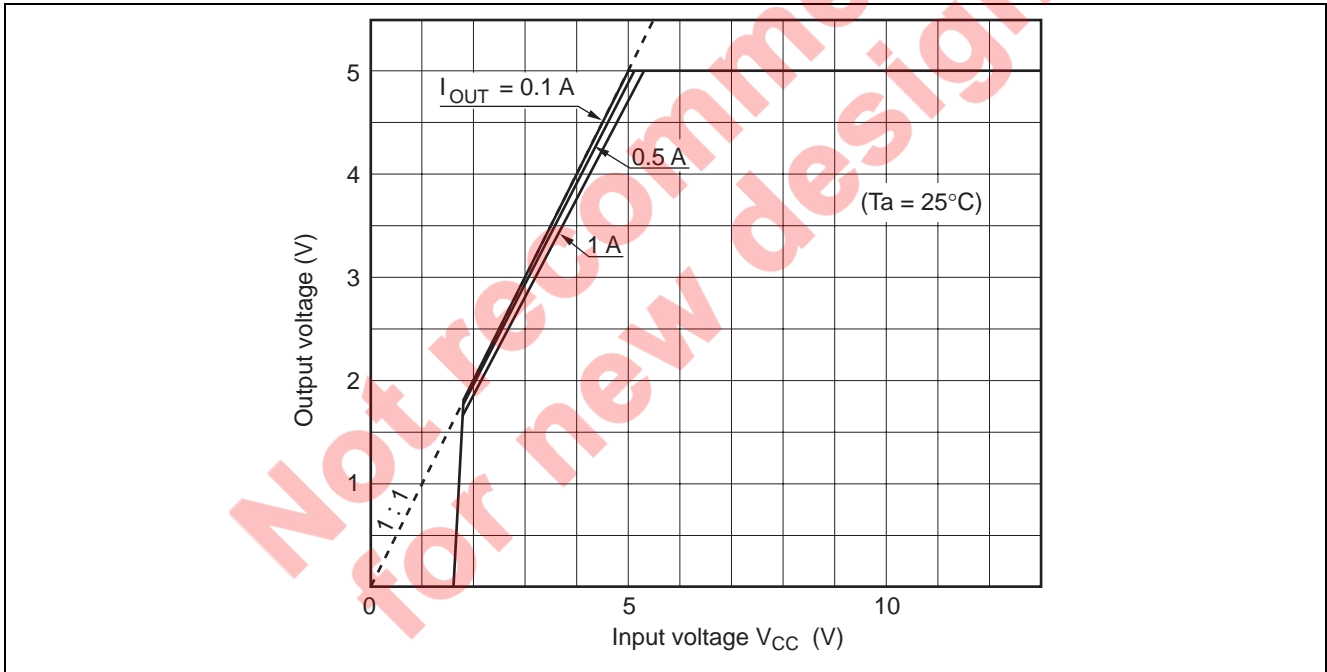
- Wide range of operating input voltage from 6 V to 40 V to provide stabilized voltages
- Availability of any output current, by simply replacing the external transistor
- Fine adjustment of output voltage

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**

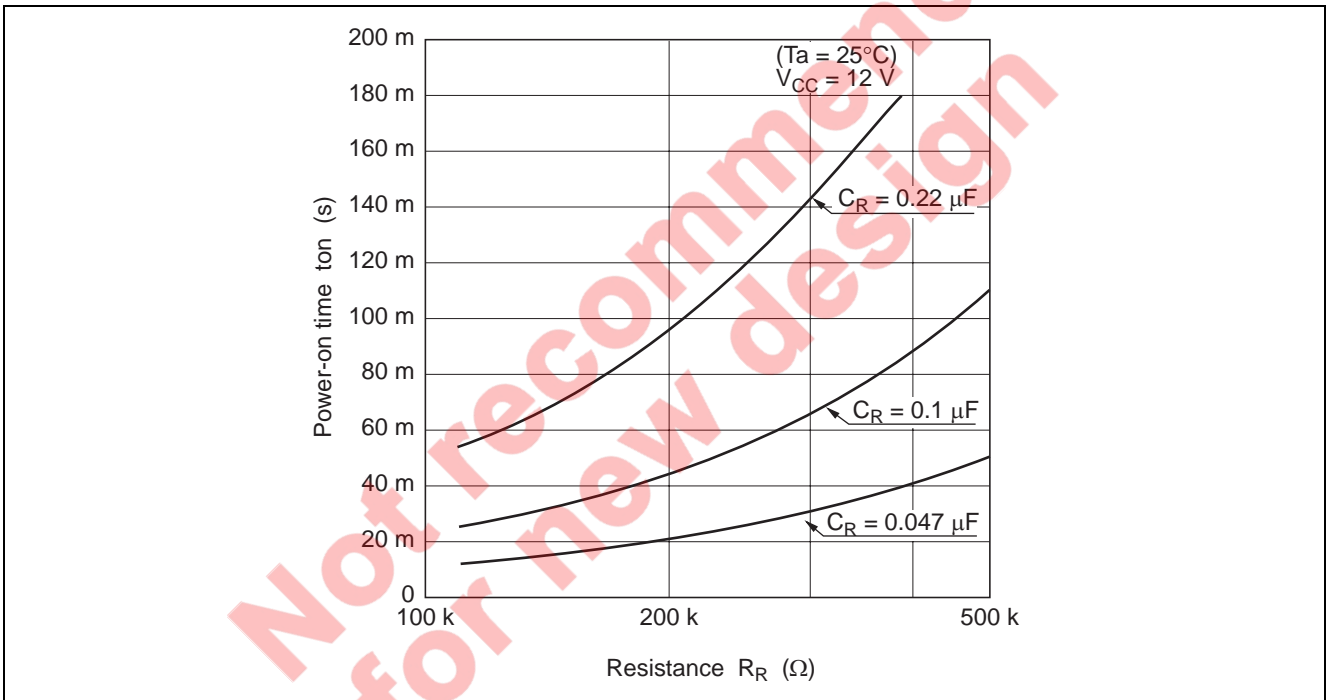
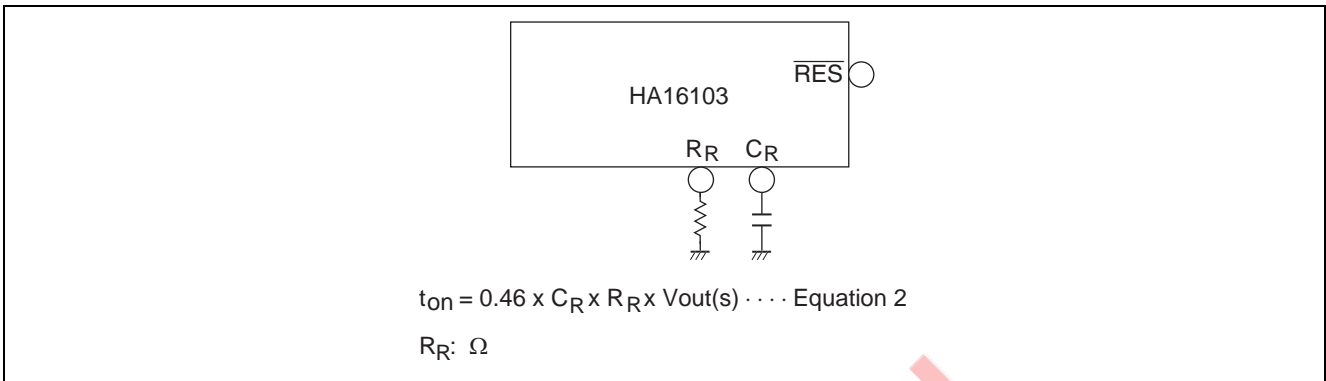


**Figure 2 Output Voltage Characteristic**

**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 ( $t_{on}$ ) and figure 3 shows the characteristic of the circuit.

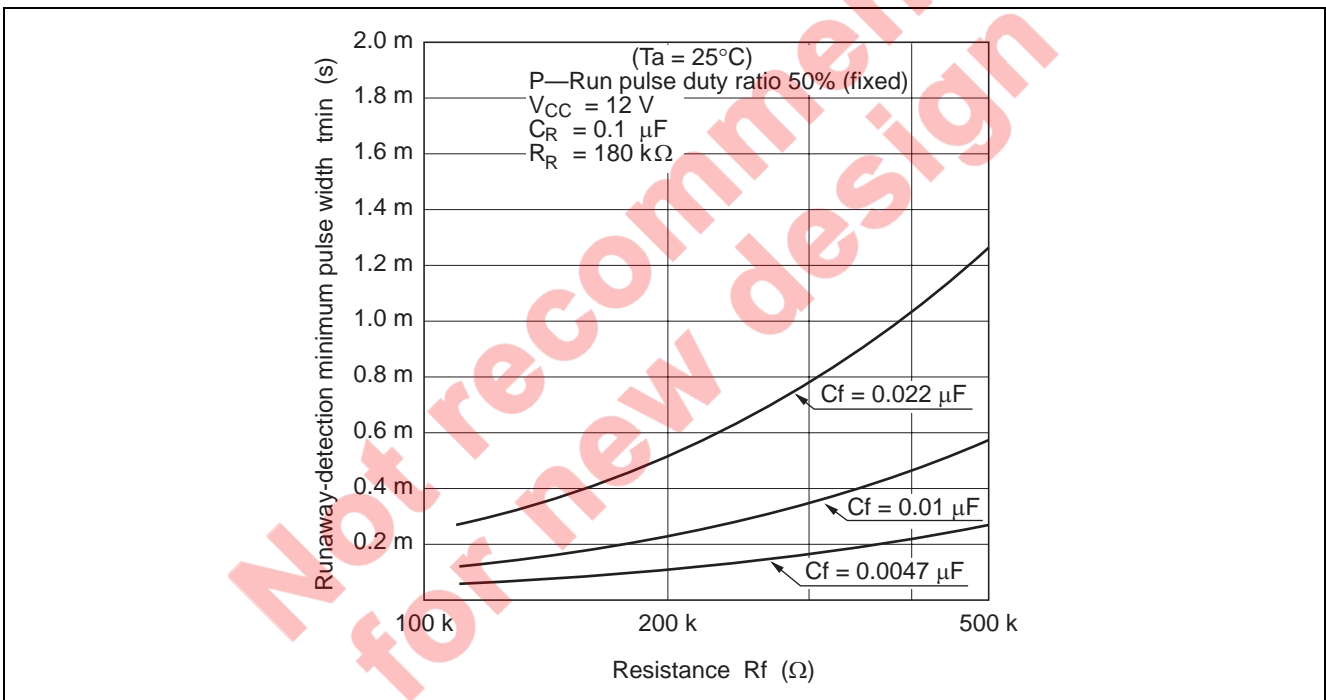
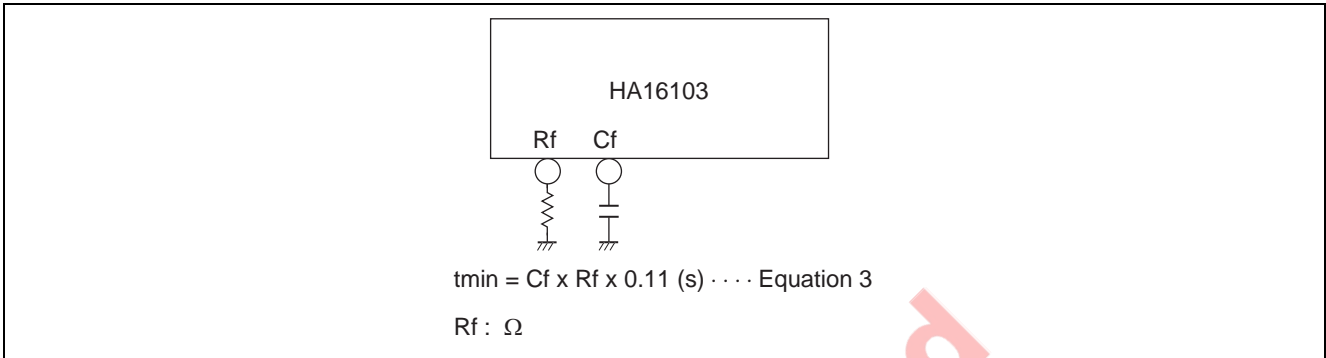


**Figure 3 Characteristic of Power-On Reset Circuit**

**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**

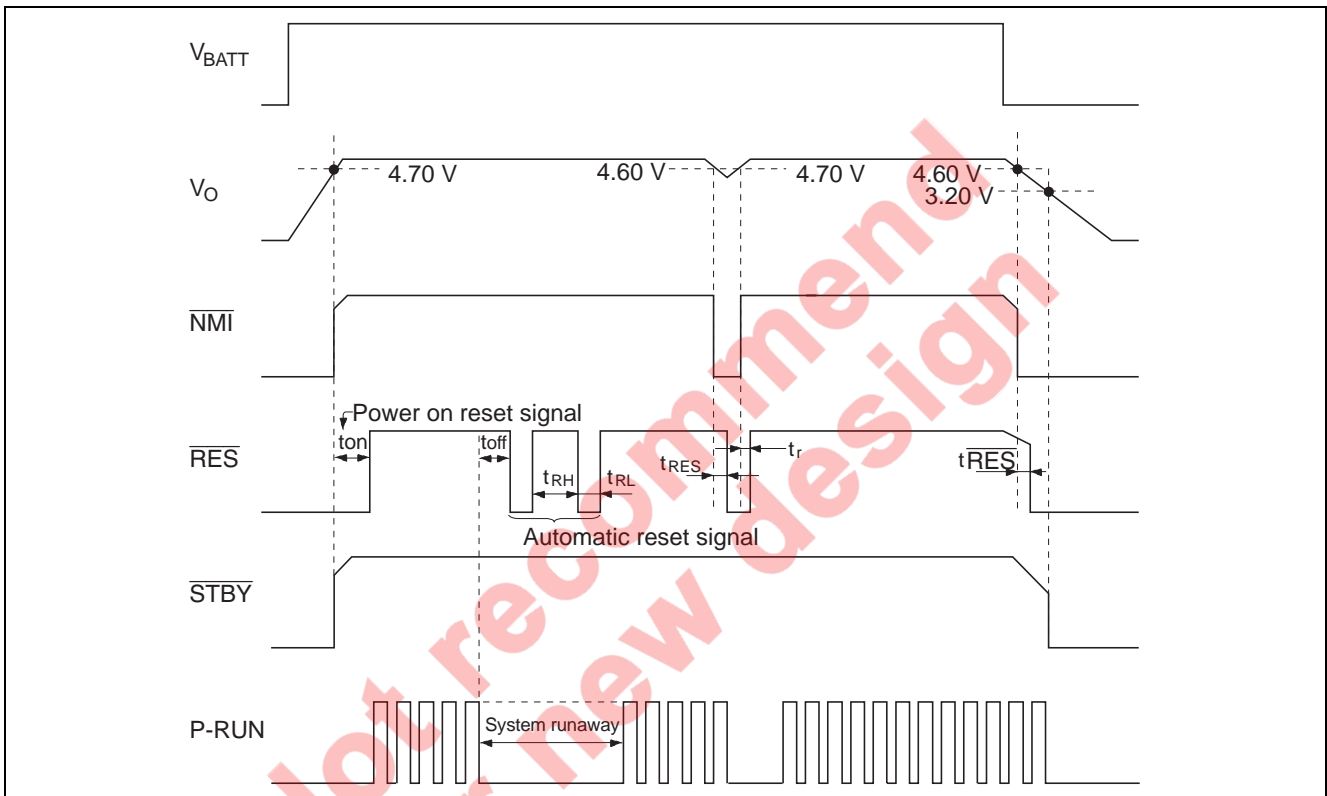
**Low Voltage Monitoring Function**

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  $V_{th1}$  ( $V_{NMI}$ ) and  $V_{th2}$  ( $V_{STBY}$ )
- 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  $V_{th1}$  (4.60 V), the  $\overline{NMI}$  signal rises to request the microcomputer to issue the  $\overline{NMI}$  interrupt signal. The  $\overline{RES}$  signal falls  $t_{RES}$  seconds after the  $\overline{NMI}$  signal rises. If the output voltage drops further to below  $V_{th2}$  (3.2 V), the  $\overline{STBY}$  signal rises to enable the micro-computer to enter standby mode.



**Figure 5 Timing Chart for Low Voltage Monitoring**

**Absolute Maximum Ratings**

(Ta = 25°C)

| Item                                | Symbol            | Ratings           |                   | Units |
|-------------------------------------|-------------------|-------------------|-------------------|-------|
|                                     |                   | HA16103FPJ        | HA16103FPK        |       |
| VCC supply voltage                  | V <sub>CC</sub>   | 40                | 40                | V     |
| Control pin voltage                 | V <sub>CONT</sub> | 40                | 40                | V     |
| Control pin current                 | I <sub>CONT</sub> | 20                | 20                | mA    |
| VO <sub>UT</sub> pin voltage        | V <sub>OUT</sub>  | 12                | 12                | V     |
| Power dissipation                   | P <sub>T</sub>    | 400* <sup>1</sup> | 400* <sup>2</sup> | 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.

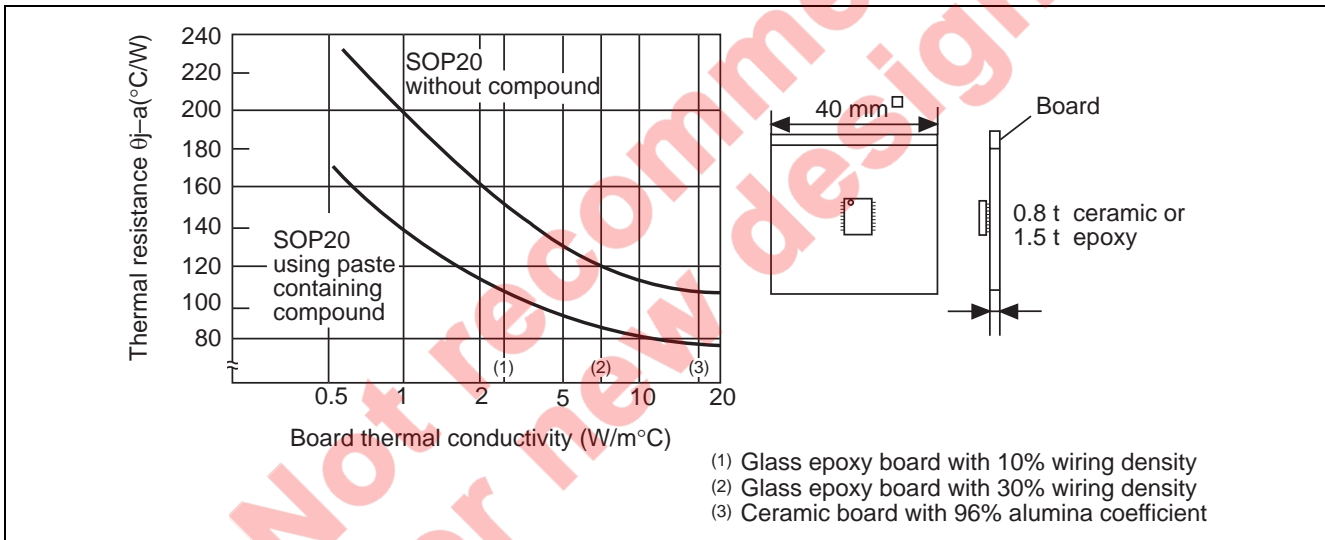
2. Allowable temperature of IC junction part, Tj (max), is as shown below.

$$T_j(\text{max}) = \theta_{j-a} \cdot P_c(\text{max}) + T_a$$

(θ<sub>j-a</sub> is thermal resistance value during mounting, and P<sub>c</sub> (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 P<sub>c</sub> (max) does not exceed that P<sub>T</sub>.





## Electrical Characteristics

(Ta = 25°C, V<sub>CC</sub> = 12 V, V<sub>OUT</sub> = 5 V)

## HA16103FPJ/FPK

| Item           |   | Symbol              | Min  | Typ                                   | Max  | Unit  | Test Condition  |
|----------------|---|---------------------|------|---------------------------------------|------|-------|---|
| Supply current |   | I <sub>CCL</sub>    | –    | 8                                     | 12   | mA    | V <sub>CC</sub> = 12 V  |
| Regulator      | Output voltage                                  | V <sub>O1</sub>     | 4.80 | 5.00                                  | 5.20 | V     | V <sub>CC</sub> = 6 to 17.5 V<br>I <sub>OUT</sub> = 0.5 A,<br>R <sub>1</sub> = 30 kΩ                  |
|                |   | V <sub>O2</sub>     | 4.70 | 5.00                                  | 5.30 | V     | V <sub>CC</sub> = 6 to 17.5 V<br>I <sub>OUT</sub> = 1 A, R <sub>1</sub> = 30 kΩ                       |
|                | Line regulation                                 | V <sub>oline</sub>  | –50  | –                                     | 50   | mV    | V <sub>CC</sub> = 6 to 17.5 V<br>I <sub>OUT</sub> = 1 A, R <sub>1</sub> = 30 kΩ                       |
|                | Load regulation                                 | V <sub>oload</sub>  | –100 | –                                     | 100  | mV    | I <sub>OUT</sub> = 10 mA to 0.5 A,<br>R <sub>1</sub> = 30 kΩ  |
|                | Ripple rejection                                | R <sub>REJ</sub>    | 45   | 75                                    | –    | dB    | V <sub>i</sub> = 0.5 V <sub>rms</sub> ,<br>f <sub>i</sub> = 1 kHz, R <sub>1</sub> = 30 kΩ             |
|                | Output voltage<br>Temperature<br>coefficient    | δV <sub>O</sub> /δT | –    | 0.6                                   | –    | mV/°C | V <sub>CC</sub> = 12 V, R <sub>1</sub> = 30 kΩ  |
| Clock input    | “L”-input voltage                               | V <sub>IL</sub>     | –    | –                                     | 0.8  | V     |   |
|                | “H”-input voltage                               | V <sub>IH</sub>     | 2.0  | –                                     | –    | V     |   |
|                | “L”-input current                               | I <sub>IL</sub>     | –120 | –60                                   | –    | μA    | V <sub>IL</sub> = 0 V   |
|                | “H”-input current                               | I <sub>IH</sub>     | –    | 0.3                                   | 0.5  | mA    | V <sub>IH</sub> = 5 V   |
| NMI output     | NMI pin<br>“L”-level voltage                    | V <sub>OL1</sub>    | –    | –                                     | 0.4  | V     | I <sub>OL1</sub> = 2 mA   |
|                | NMI pin<br>“H”-level voltage                    | V <sub>OH1</sub>    | –    | V <sub>O1</sub><br>(V <sub>O2</sub> ) | –    | V     |   |
|                | NMI function start<br>V <sub>OUT</sub> voltage  | V <sub>NMI</sub>    | –    | 0.7                                   | 1.4  | V     |   |
| STBY output    | STBY pin<br>“L”-level voltage                   | V <sub>OL2</sub>    | –    | –                                     | 0.4  | V     | I <sub>OL2</sub> = 2 mA   |
|                | STBY pin<br>“H”-level voltage                   | V <sub>OH2</sub>    | –    | V <sub>O1</sub><br>(V <sub>O2</sub> ) | –    | V     |   |
|                | STBY function start<br>V <sub>OUT</sub> voltage | V <sub>STBY</sub>   | –    | 0.7                                   | 1.4  | V     |   |
| RES output     | RES pin<br>“L”-level voltage                    | V <sub>OL3</sub>    | –    | –                                     | 0.4  | V     | I <sub>OL3</sub> = 2 mA   |
|                | RES pin<br>“H”-level voltage                    | V <sub>OH3</sub>    | –    | V <sub>O1</sub><br>(V <sub>O2</sub> ) | –    | V     |   |
|                | RES function start<br>V <sub>OUT</sub> voltage  | V <sub>RES</sub>    | –    | 0.7                                   | 1.4  | V     |   |
|                | Power on time                                   | t <sub>ON</sub>     | 25   | 40                                    | 60   | ms    | R <sub>f</sub> = 180 kΩ, R <sub>R</sub> = 180 kΩ  |
|                | Clock off reset time                            | t <sub>OFF</sub>    | 80   | 130                                   | 190  | ms    | C <sub>f</sub> = 0.01 μF, C <sub>R</sub> = 0.1 μF   |
|                | Reset pulse<br>“L”-level time                   | t <sub>RL</sub>     | 15   | 20                                    | 30   | ms    | R <sub>f</sub> = 180 kΩ, R <sub>R</sub> = 180 kΩ<br>C <sub>f</sub> = 0.01 μF, C <sub>R</sub> = 0.1 μF |
|                | Reset pulse<br>“H”-level time                   | t <sub>RH</sub>     | 37   | 60                                    | 90   | ms    | R <sub>f</sub> = 180 kΩ, R <sub>R</sub> = 180 kΩ<br>C <sub>f</sub> = 0.01 μF, C <sub>R</sub> = 0.1 μF |

## Electrical Characteristics (cont.)

(T<sub>a</sub> = 25°C, V<sub>CC</sub> = 12 V, V<sub>OUT</sub> = 5 V)

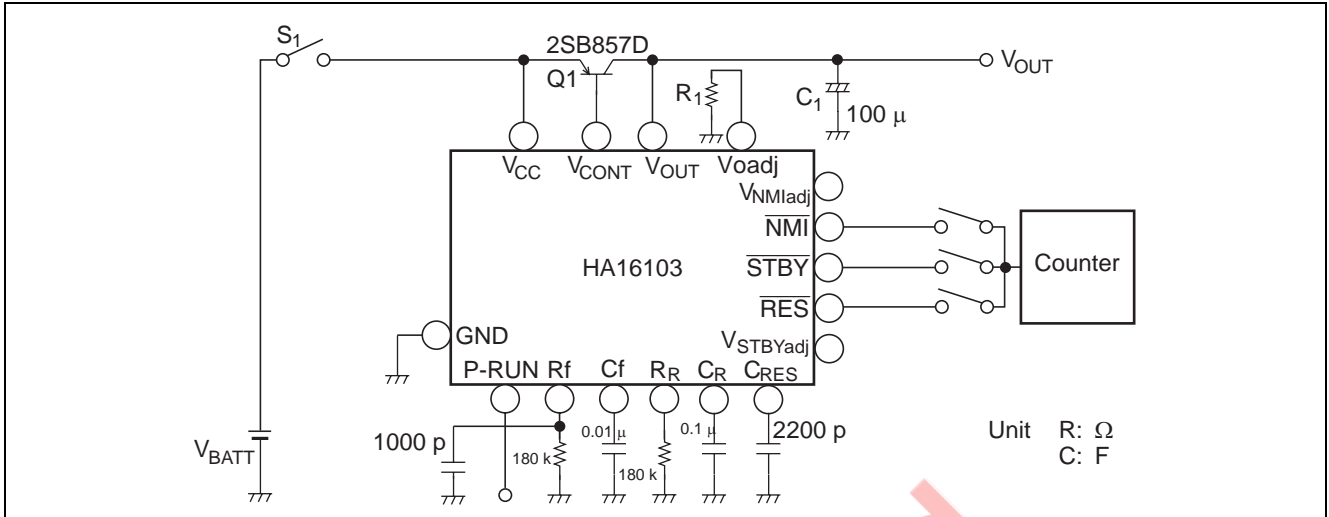
| Item                  |                                       | Symbol            | Min              | Typ  | Max  | Unit | Test Condition             |
|-----------------------|---------------------------------------|-------------------|------------------|------|------|------|----------------------------|
| Low Voltage protecton | Detection voltage(1)                  | V <sub>H1</sub>   | 4.40             | 4.60 | 4.80 | V    |                            |
|                       | Detection voltage(1) Hysteresis width | V <sub>HYS1</sub> | 50               | 100  | 150  | mV   |                            |
|                       | Detection voltage(2)                  | V <sub>H2</sub>   | 2.9              | 3.2  | 3.5  | V    |                            |
|                       | Detection voltage(2) Hysteresis width | V <sub>HYS2</sub> | 1.35             | 1.5  | 1.65 | V    |                            |
|                       | Reset pulse Delay time                | inhibit           | t <sub>RES</sub> | –    | 200  | –    | μs                         |
| restart               |                                       | t <sub>r</sub>    | –                | 200  | –    | μs   | C <sub>RES</sub> = 2200 pF |

(T<sub>a</sub> = –40 to 125°C, V<sub>CC</sub> = 12 V, V<sub>OUT</sub> = 5 V, R<sub>1</sub> = 30 kΩ)

## HA16103FPK

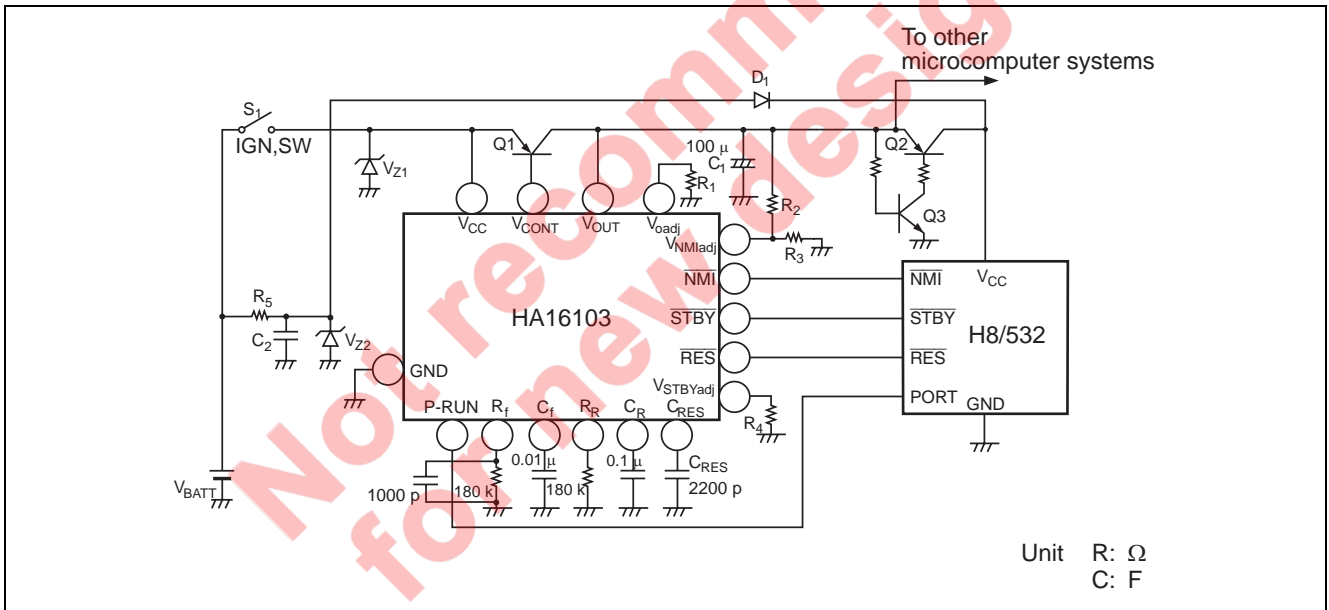
| Item                  |                            | Symbol             | Min  | Typ               | Max  | Unit | Test Condition  |
|-----------------------|----------------------------|--------------------|------|-------------------|------|------|---|
| Supply current        |                            | I <sub>CC1</sub>   | –    | 7                 | 13   | mA   |   |
| Regulator             | Output voltage             | V <sub>out1</sub>  | 4.80 | 5.00              | 5.20 | V    | V <sub>CC</sub> = 6 to 17.5 V<br>I <sub>OUT</sub> = 0.5 A   |
|                       | Line regulation            | V <sub>oline</sub> | –50  | –                 | 50   | mV   | V <sub>CC</sub> = 6 to 17.5 V<br>I <sub>OUT</sub> = 0.5 A   |
|                       | Load regulation            | V <sub>oload</sub> | –100 | –                 | 100  | mV   | I <sub>OUT</sub> = 10 mA to 0.5 A   |
| Clock input           | “L”-input voltage          | V <sub>IL</sub>    | –    | –                 | 0.4  | V    |   |
|                       | “H”-input voltage          | V <sub>IH</sub>    | 2.4  | –                 | –    | V    |   |
|                       | “L”-input current          | I <sub>IL</sub>    | –120 | –60               | –    | μA   | V <sub>IL</sub> = 0 V   |
|                       | “H”-input current          | I <sub>IH</sub>    | –    | 0.3               | 0.6  | mA   | V <sub>IH</sub> = 5 V   |
| NMI output            | NMI pin “L”-level voltage  | V <sub>OLN</sub>   | –    | –                 | 0.5  | V    | I <sub>OL1</sub> = 2 mA   |
|                       | NMI pin “H”-level voltage  | V <sub>OHN</sub>   | –    | V <sub>OUT1</sub> | –    | V    |   |
| STBY output           | STBY pin “L”-level voltage | V <sub>OLS</sub>   | –    | –                 | 0.5  | V    | I <sub>OL2</sub> = 2 mA   |
|                       | STBY pin “H”-level voltage | V <sub>OHS</sub>   | –    | V <sub>OUT1</sub> | –    | V    |   |
| RES output            | RES pin “L”-level voltage  | V <sub>OLR</sub>   | –    | –                 | 0.5  | V    | I <sub>OL3</sub> = 2 mA   |
|                       | RES pin “H”-level voltage  | V <sub>OHR</sub>   | –    | V <sub>OUT1</sub> | –    | V    |   |
|                       | Power on time              | t <sub>ON</sub>    | 25   | 40                | 60   | ms   | R <sub>f</sub> = 180 kΩ, R <sub>R</sub> = 180 kΩ  |
|                       | Clock off reset time       | t <sub>OFF</sub>   | 70   | 130               | 200  | ms   | C <sub>f</sub> = 0.01 μF, C <sub>R</sub> = 0.1 μF   |
|                       | Reset pulse “L”-level time | t <sub>RL</sub>    | 15   | 20                | 30   | ms   | R <sub>f</sub> = 180 kΩ, R <sub>R</sub> = 180 kΩ<br>C <sub>f</sub> = 0.01 μF, C <sub>R</sub> = 0.1 μF |
|                       | Reset pulse “H”-level time | t <sub>RH</sub>    | 30   | 60                | 100  | ms   | R <sub>f</sub> = 180 kΩ, R <sub>R</sub> = 180 kΩ<br>C <sub>f</sub> = 0.01 μF, C <sub>R</sub> = 0.1 μF |
| Low Voltage protecton | Detection voltage(1)       | V <sub>NMI</sub>   | 4.35 | 4.60              | 4.85 | V    |   |
|                       | Detection voltage(2)       | V <sub>STBY</sub>  | 2.80 | 3.20              | 3.60 | V    |   |

Test Circuit

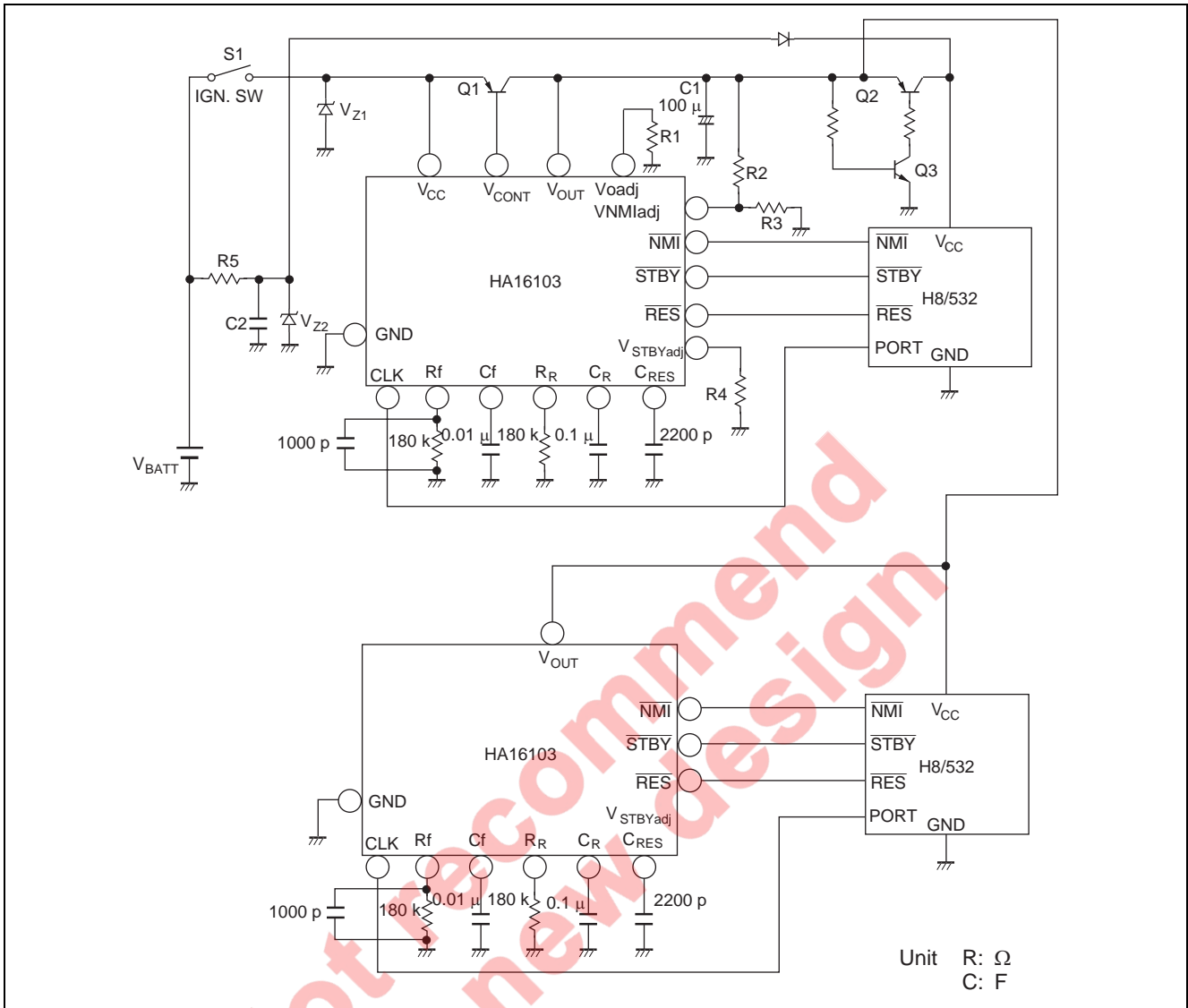


Sample Connection Circuit

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  $V_{\text{OUT}}$ -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 high-current ground lines.
- Increase the capacitance ( $C_0$ ) used to smooth the  $V_{\text{OUT}}$  output.

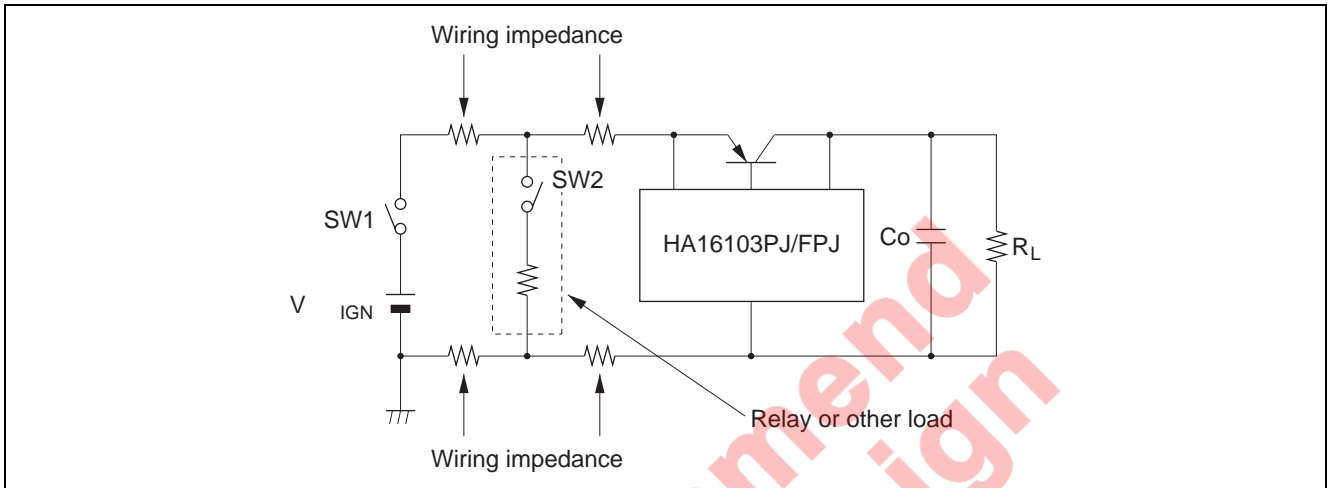


Figure 6 Typical Circuit

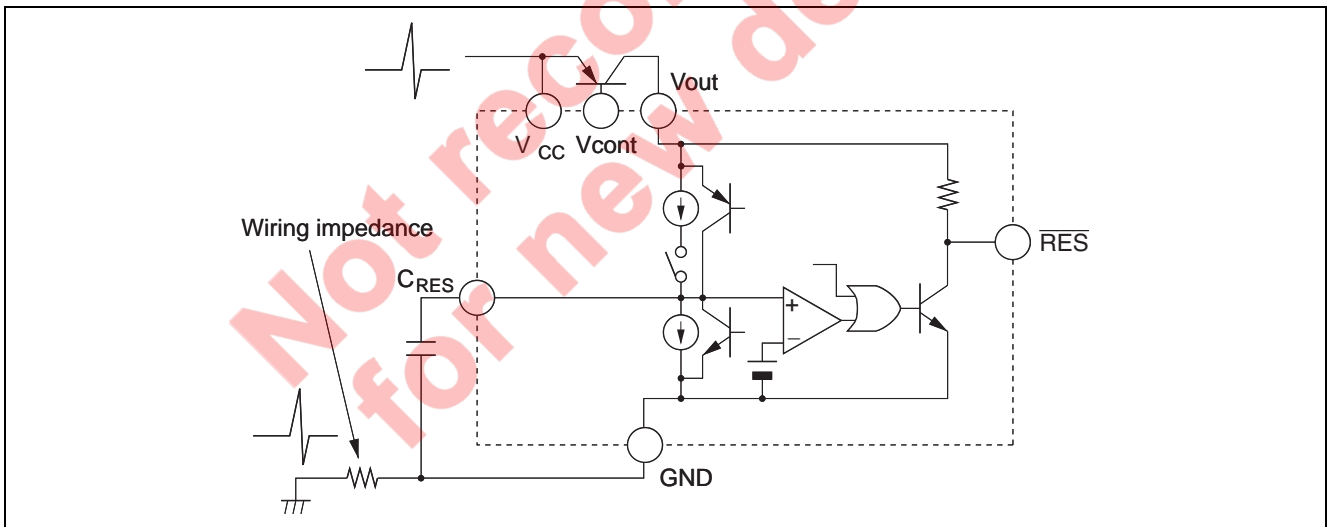
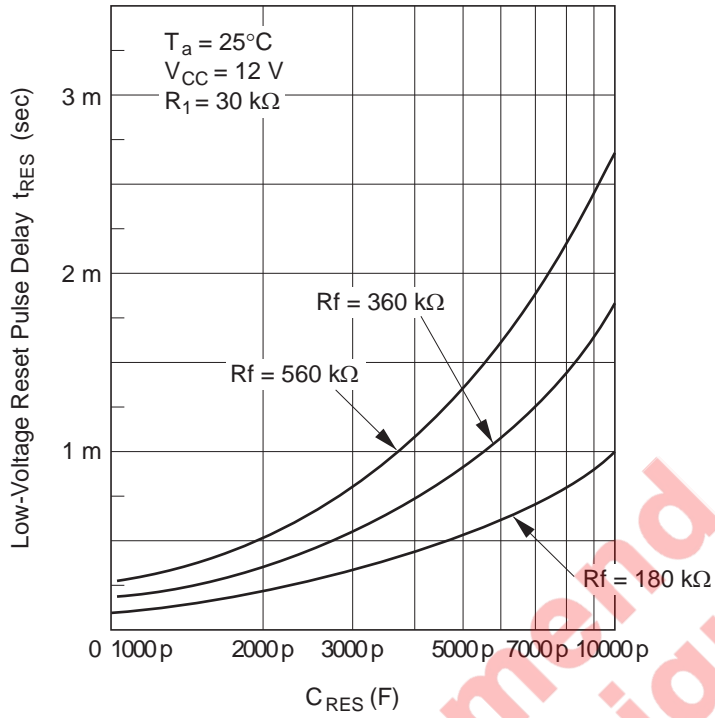


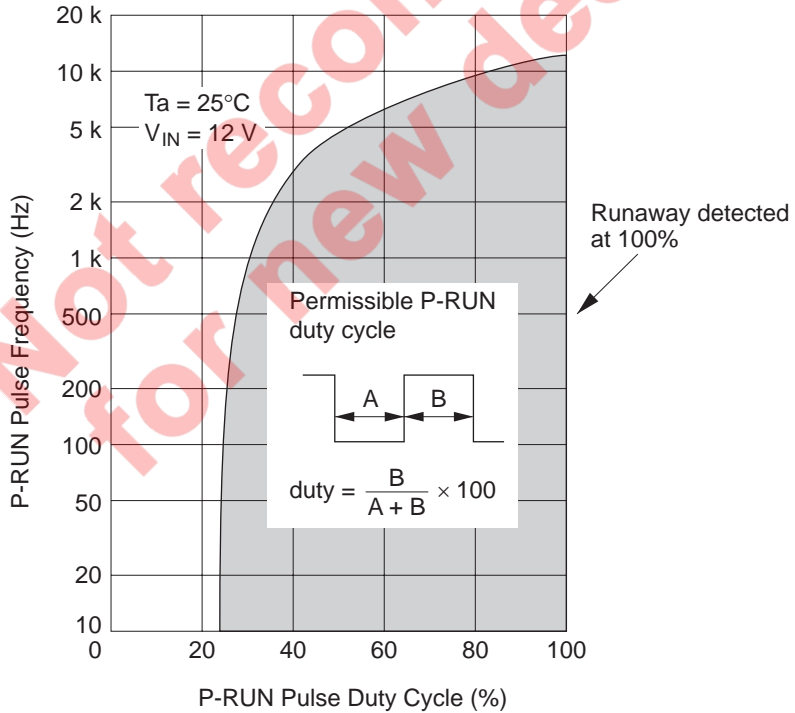
Figure 7  $\overline{\text{RES}}$  Comparator

• Low-voltage inhibit section

Low-Voltage Reset Pulse Delay vs. C<sub>RES</sub>

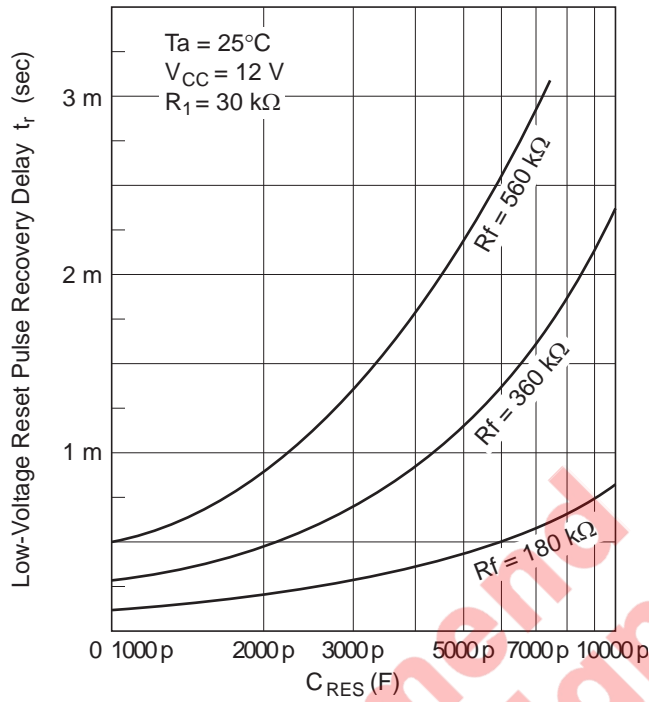


Permissible P-RUN Pulse Duty Cycle vs. P-RUN Pulse Frequency



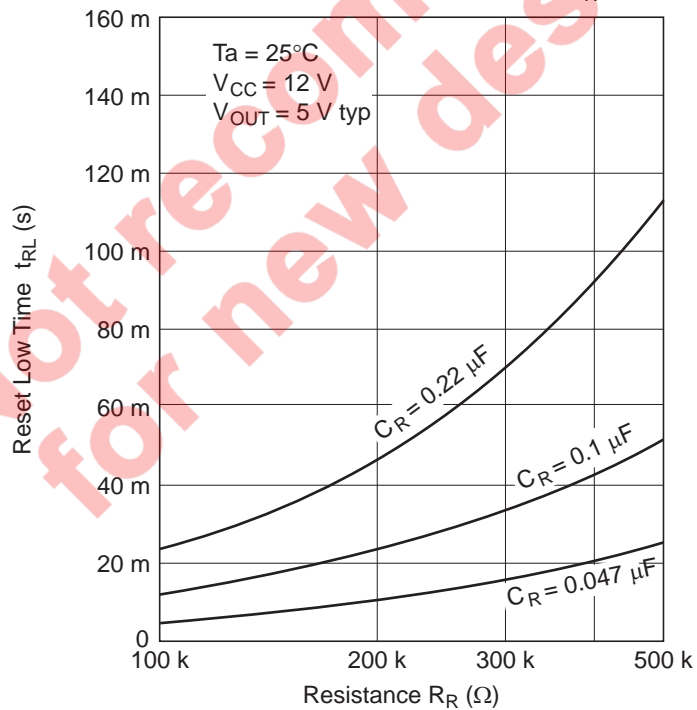
• Low-voltage inhibit section

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

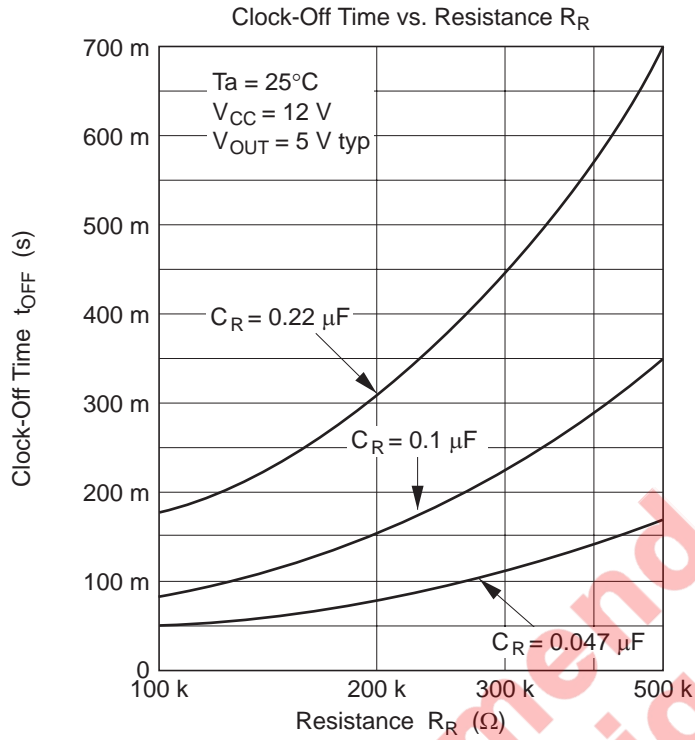


• Power-on and auto-reset section

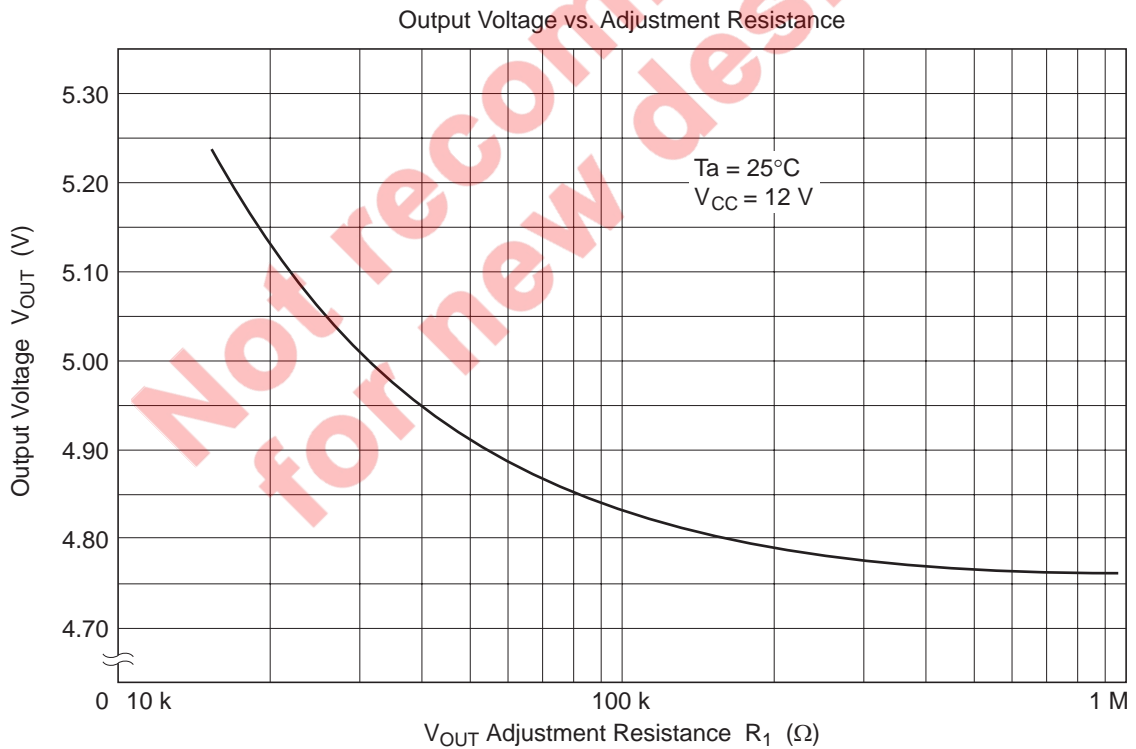
Reset Low Time vs. Resistance  $R_R$



• Power-on and auto-reset section



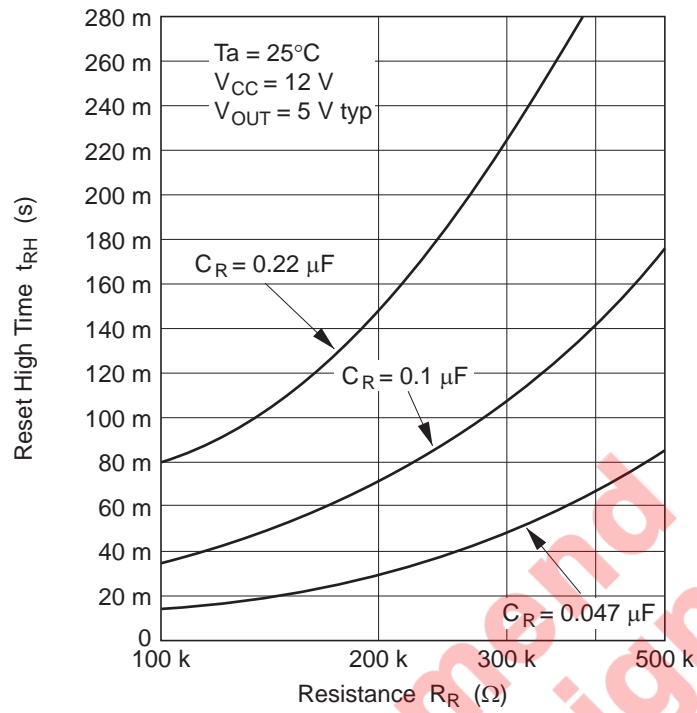
• Vref section





• Power-on and auto-reset section

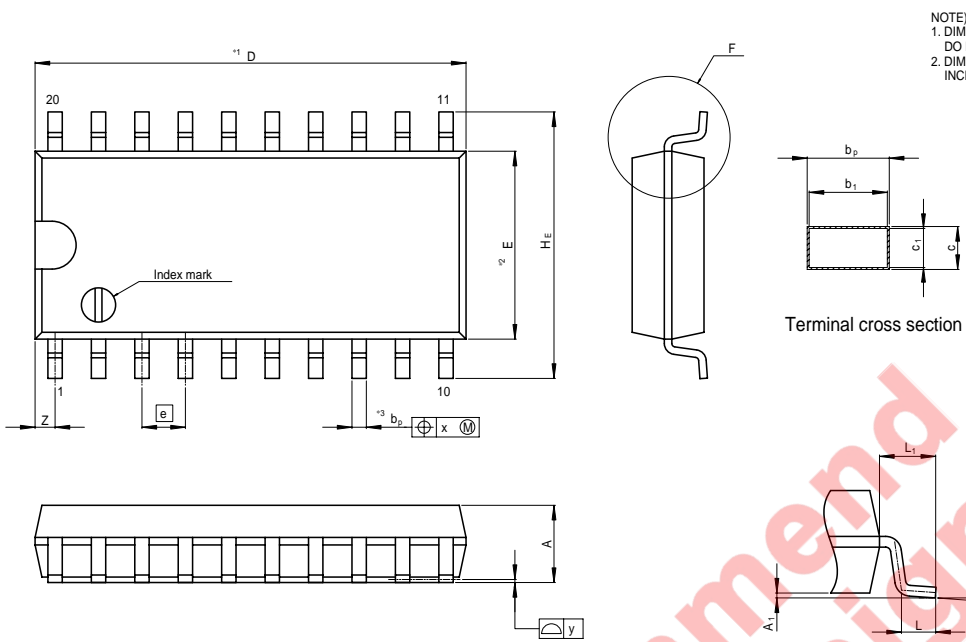
Reset High Time vs. Resistance  $R_R$



Not recommended for new design

Package Dimensions

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



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

Terminal cross section

Detail F

| Reference Symbol | Dimension in Millimeters |      |      |
|------------------|--------------------------|------|------|
|                  | Min                      | Nom  | Max  |
| D                | —                        | 12.6 | 13   |
| E                | —                        | 5.5  | —    |
| A <sub>2</sub>   | —                        | —    | —    |
| A <sub>1</sub>   | 0.00                     | 0.10 | 0.20 |
| A                | —                        | —    | 2.20 |
| b <sub>p</sub>   | 0.34                     | 0.42 | 0.50 |
| b <sub>1</sub>   | —                        | 0.40 | —    |
| c                | 0.17                     | 0.22 | 0.27 |
| c <sub>1</sub>   | —                        | 0.20 | —    |
| θ                | 0°                       | —    | 8°   |
| H <sub>E</sub>   | 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 <sub>1</sub>   | —                        | 1.15 | —    |

Not recommended for new design

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