M16C/6C Group

USB External Circuit Example

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1. Abstract

This document describes the following examples of USB external circuits in the M16C/6C Group.

- Self-powered Mode Circuit (3.3 V)
- Self-powered Mode Circuit (5.0 V)
- Bus-powered Mode Circuit (3.3 V)
- Bus-powered Mode Circuit (5.0 V)

2. Introduction

The application example described in this document applies to the following microcomputer (MCU):

- MCU: M16C/6C Group

This program can be used with other M16C/6C Group MCUs which have the same special function registers (SFRs) as the above group. Check the manual for any modifications to functions. Careful evaluation is recommended before using the program described in this application note.

3. Self-powered Mode Circuit (3.3 V)

Figure 3.1 shows an example of a Self-powered Mode Circuit (3.3 V).

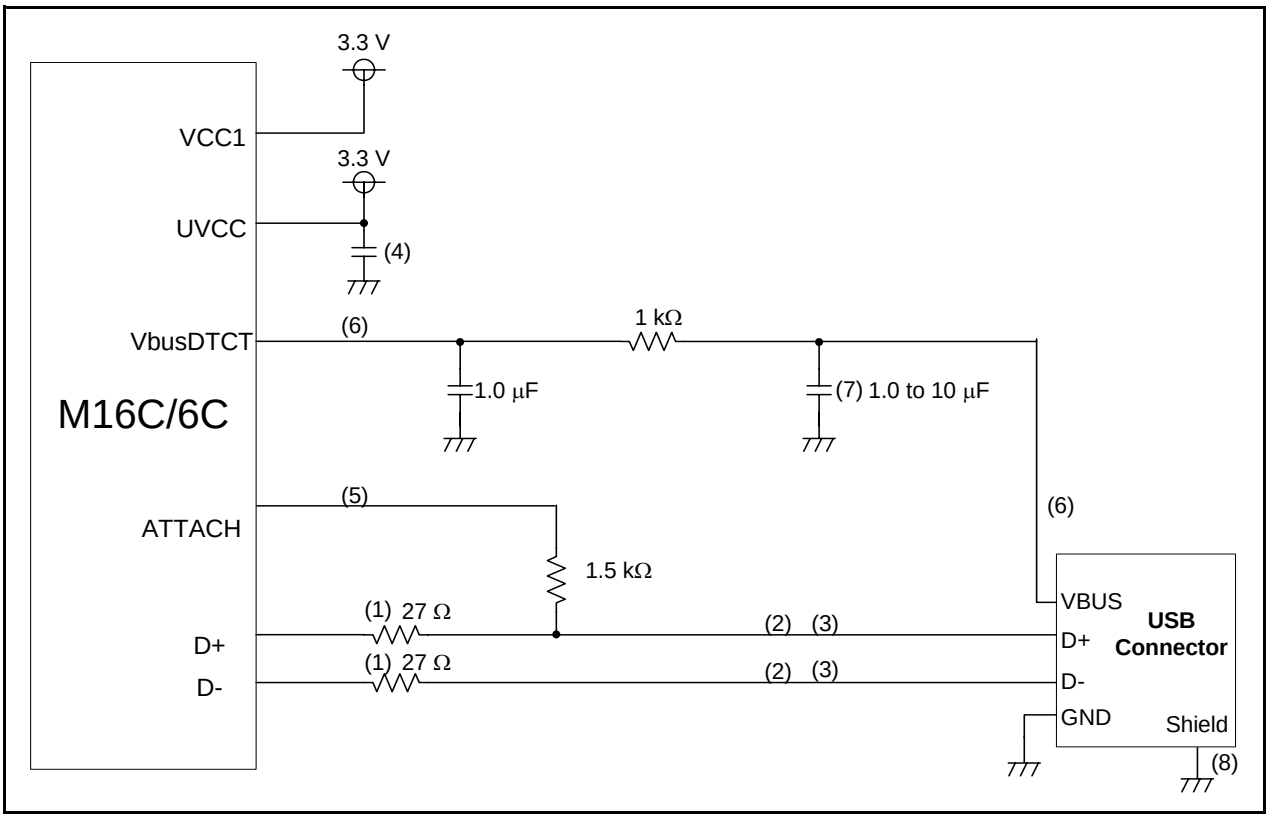

Figure 3.1 Self-powered Mode Circuit (3.3 V)

Set the following when using this example circuit:

- Set the PXXCON bit in the USBMC register to 1 (VDDUSBE bit enabled)
- Set the VDDUSBE bit in the USBMC register to 0 (UVCC pin input enabled)
- Set the PWMD bit in the USBCTLR register to 0 (self-power mode)

Note the items below when using a self-powered mode circuit (3.3 V). Numbers (1) to (8) correspond to (1) to (8) in Figure 3.1.

(1) Series resistors on D+/D- lines
Connect 27 Ω resistors in series on the D+/D- lines. Also, connect them as close as possible to the M16C/6C MCU.

(2) Wiring of D+/D- lines
Wire the D+/D- lines so that the differential impedance becomes recommended value of 90 Ω.
If there are difficulties in making the impedance closer, make the D+/D- lines closer together using wires that are as close to the same length as possible. Do not place wires near the signal of the noise source.

(3) Noise countermeasures on D+/D- lines
When it is necessary to take countermeasures against external surges and ESD noise, protect them with items such as surge protection diodes.
When using a coil to reduce wiring delay, pay careful attention not to disrupt the waveform.

(4) Bypass capacitor of the UVCC pin
When there are increased levels of high frequency noise, connect a bypass capacitor suitable for use with the generated high frequency.

(5) ATTACH pin
Make the wiring as short as possible. Do not extend it.

(6) Wiring of the VBUS line
When the VbusDTCT pin becomes low, the USB module is reset to the Powered state. Therefore, pay attention to the layout of wiring to prevent the noise.

(7) Capacitor on the VBUS line
Connect a 1 to 10 μF capacitor. When connecting a USB cable, as an overshoot may occur due to mismatched impedance, attach a filter circuit on the VBUS line.

(8) Shield of the USB connector
Connect a connector shield to the package GND or system GND.
If the shield causes a high level of noise or adversely affects the system, then use a countermeasure such as a power supply coil.

4. Self-powered Mode Circuit (5.0 V)

Figure 4.1 shows an example of a Self-powered Mode Circuit (5.0 V).

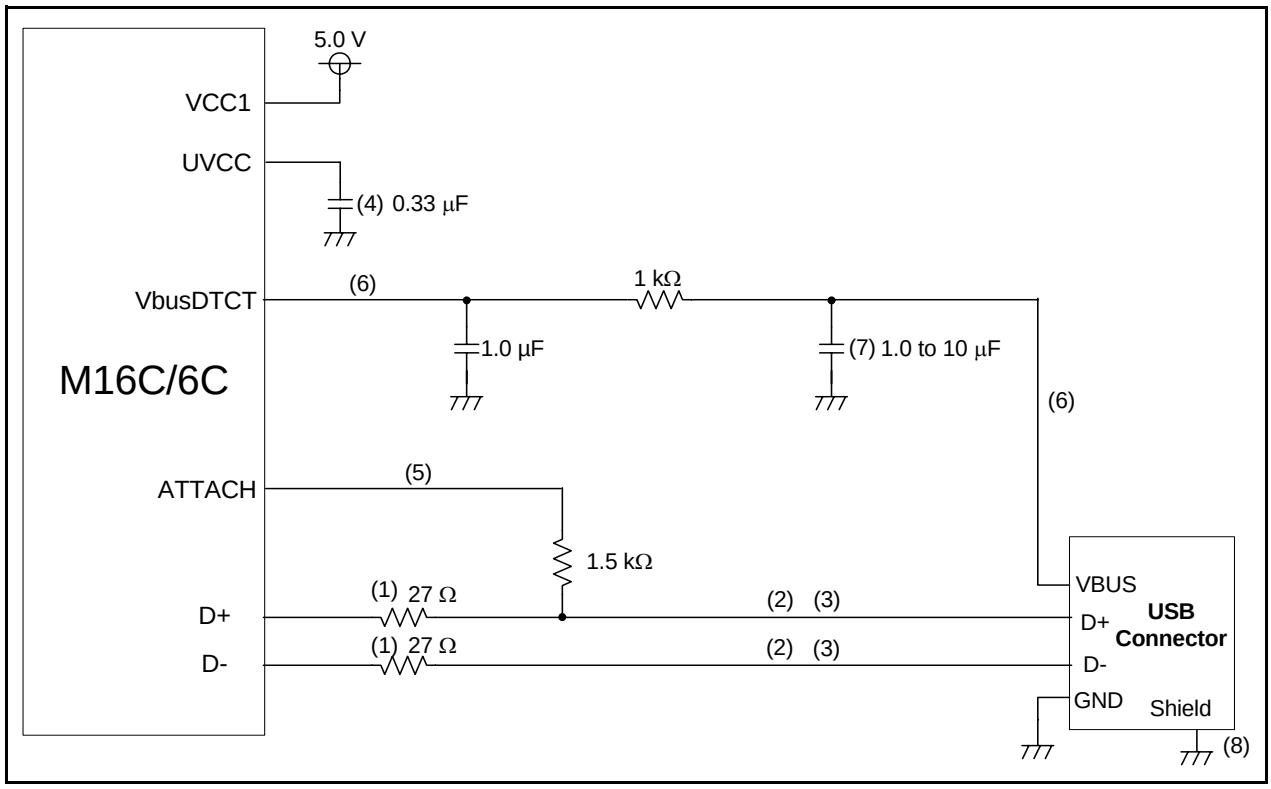

Figure 4.1 Self-powered Mode Circuit (5.0 V)

Set the following when using this example circuit:

- Set the CM14 bit in the CM1 register to 0 (125 kHz on-chip oscillator on)
- Set the PXXCON bit in the USBMC register to 1 (VDDUSBE bit enabled).
- Set the VDDUSBE bit in the USBMC register to 1 (3.3 V USB internal power supply supplied).
- Set the PWMD bit in the USBCTLR register to 0 (self-power mode).

Note the items below when using a self-powered mode circuit (5.0 V). Numbers (1) to (8) correspond to (1) to (8) in Figure 4.1.

(1) Series resistors on D+/D- lines
Connect 27 Ω resistors in series on the D+/D- lines. Also, connect them as close as possible to the M16C/6C MCU.

(2) Wiring of D+/D- lines
Wire the D+/D- lines so that the differential impedance becomes recommended value of 90 Ω.
If there are difficulties in making the impedance closer, make the D+/D- lines closer together using wires that are as close to the same length as possible. Do not place wires near the signal of the noise source.

(3) Noise countermeasures on D+/D- lines
When it is necessary to take countermeasures against external surges and ESD noise, protect them with items such as surge protection diodes.
When using the coil to reduce the wiring delay, pay careful attention not to disrupt the waveform.

(4) Bypass capacitor of the UVCC pin
When using the internal power supply for USB, connect a 0.33 μF capacitor between the UVCC pin and VSS with the shortest and thickest possible wiring.

(5) ATTACH pin
Make the wiring as short as possible. Do not extend it.

(6) Wiring of the VBUS line
When the VbusDTCT pin becomes low, the USB module is reset to the Powered state. Therefore, pay attention to the layout of wiring to prevent the noise.

(7) Capacitor on the VBUS line
Connect a 1 to 10 μF capacitor. When connecting a USB cable, as an overshoot may occur due to mismatched impedance, attach a filter circuit on the VBUS line.

(8) Shield of the USB connector
Connect a connector shield to the package GND or system GND.
If the shield causes a high level of noise or adversely affects the system, then use a countermeasure such as a power supply coil.

5. Bus-powered Mode Circuit (3.3 V)

Figure 5.1 shows an example of a Bus-powered Mode Circuit (3.3 V).

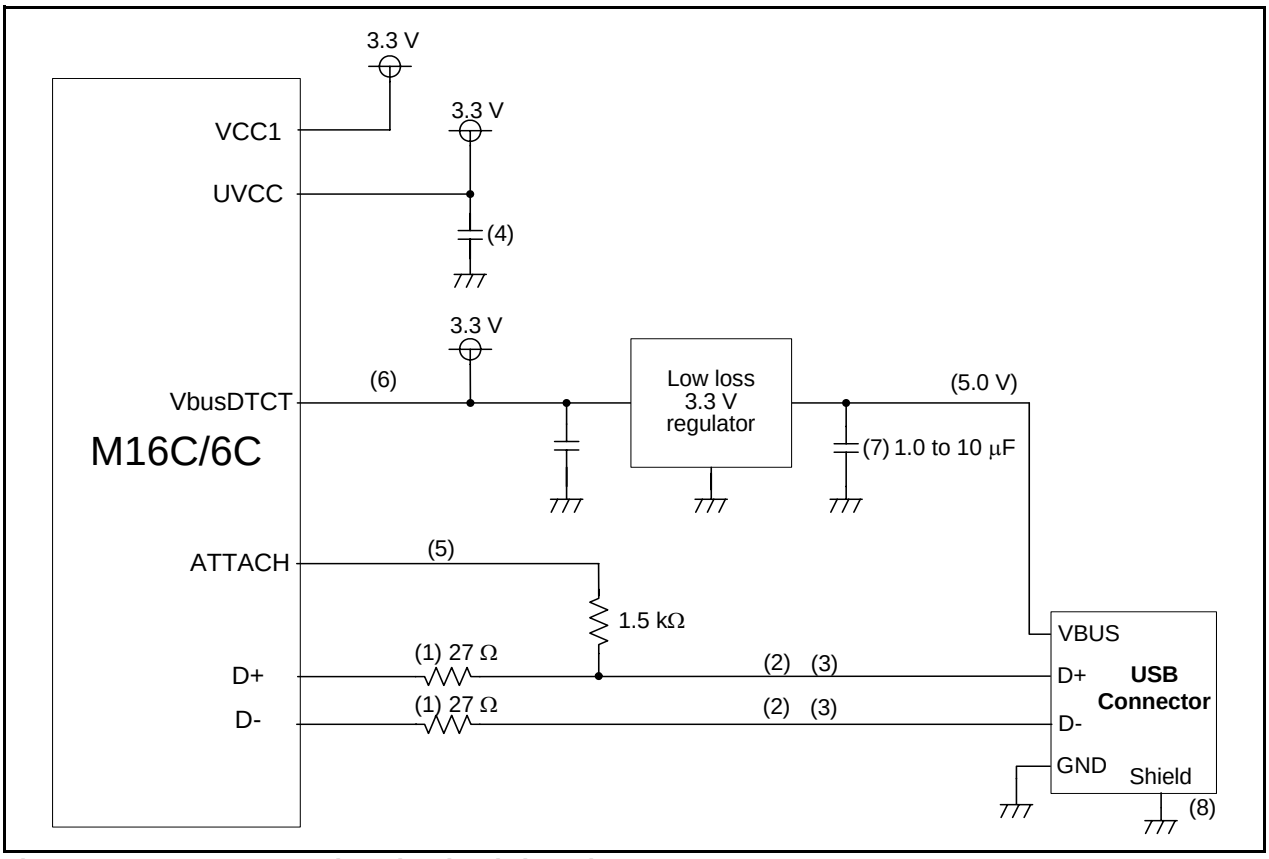

Figure 5.1 Bus-powered Mode Circuit (3.3 V)

Set the following when using this example circuit:

- Set the PXXCON bit in the USBMC register to 1 (VDDUSBE bit enabled).
- Set the VDDUSBE bit in the USBMC register to 0 (UVCC pin input enabled).
- Set the PWMD bit in the USBCTLR register to 1 (bus-power mode).

Note the items below when using a bus-powered mode circuit (3.3 V). Numbers (1) to (8) correspond to (1) to (8) in Figure 5.1.

(1) Series resistors on D+/D- lines
Connect 27 Ω resistors in series on the D+/D- lines. Also, connect them as close as possible to the M16C/6C MCU.

(2) Wiring of D+/D- lines
Wire the D+/D- lines so that the differential impedance becomes recommended value of 90 Ω.
If there are difficulties in making the impedance closer, make the D+/D- lines closer together using wires that are as close to the same length as possible. Do not place wires near the signal of the noise source.

(3) Noise countermeasures on D+/D- lines
When it is necessary to take countermeasures against external surges and ESD noise, protect them with items such as surge protection diodes.
When using the coil to reduce the wiring delay, pay careful attention not to disrupt the waveform.

(4) Bypass capacitor of the UVCC pin
When there are increased levels of high frequency noise, connect a bypass capacitor suitable for use with the generated high frequency.

(5) ATTACH pin
Make the wiring as short as possible. Do not extend it.

(6) Noise prevention of the VBUS line
When the VbusDTCT pin becomes low, the USB module is reset to the Powered state. Therefore, pay attention to the layout of wiring to prevent the noise.
If noise cannot be controlled, take measures such as applying an RC circuit or filter.

(7) Capacitor on the VBUS line
Connect a 1 to 10 μF capacitor. Total capacity should not exceed 10 μF when viewed from both sides of the Vbus pin on the USB connector and the VbusDTCT pin in the M16C/6C.

Current usable on the VBUS line
- Configured state from cable connection: 100 mA max.
- Configured state: 500 mA max.
- Suspend state

When remote wakeup is permitted: 2.5 mA max.
When remote wakeup is not permitted: 500 μA max.
When the Set_Configuration command is received, the MCU enters a Configured state.
These values are for reference only. They may change depending on the system component to be used.
When taking measures against surges, add the other system components.

(8) Shield of the USB connector
Connect a connector shield to the package GND or system GND.
If the shield causes a high level of noise or adversely affects the system, then use a countermeasure such as a power supply coil.

6. Bus-powered Mode Circuit (5.0 V)

Figure 6.1 shows an example of a Bus-powered Mode Circuit (5.0 V).

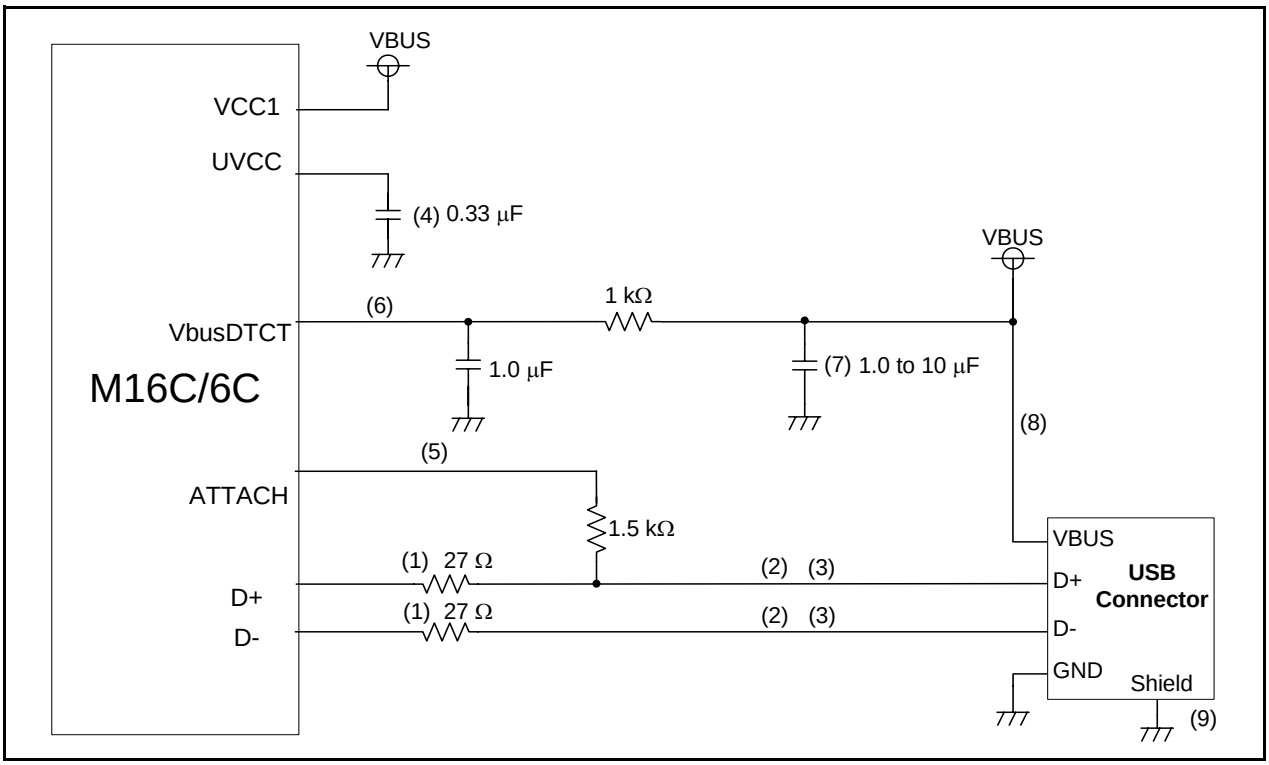

Figure 6.1 Bus-powered Mode Circuit (5.0 V)

Set the following when using this example circuit:

- Set the CM14 bit in the CM1 register to 0 (125 kHz on-chip oscillator on)
- Set the PXXCON bit in the USBMC register to 1 (VDDUSBE bit enabled).
- Set the VDDUSBE bit in the USBMC register to 1 (3.3 V USB internal power supply supplied).
- Set the PWMD bit in the USBCTLR register to 1 (bus-power mode).

Note the items below when using bus-powered mode circuit (5.0 V). Numbers (1) to (9) correspond to (1) to (9) in Figure 6.1.

(1) Series resistors on D+/D- lines
Connect 27 Ω resistors in series on the D+/D- lines. Also, connect them as close as possible to the M16C/6C MCU.

(2) Wiring of D+/D- lines
Wire the D+/D- lines so that the differential impedance becomes recommended value of 90 Ω.
If there are difficulties in making the impedance closer, make the D+/D- lines closer together using wires that are as close to the same length as possible. Do not place wires near the signal of the noise source.

(3) Noise countermeasures on D+/D- lines
When it is necessary to take countermeasures against external surges and ESD noise, protect them with items such as surge protection diodes.
When using the coil to reduce the wiring delay, pay careful attention not to disrupt the waveform.

(4) Bypass capacitor of the UVCC pin
When using the internal power supply for USB, connect a 0.33 µF capacitor between the UVCC pin and VSS with the shortest and thickest possible wiring.

(5) ATTACH pin
Make the wiring as short as possible. Do not extend it.

(6) Wiring of the VBUS line
When the VbusDTCT pin becomes low, the USB module is reset to the Powered state. Therefore, pay attention to the layout of wiring to prevent the noise.

(7) Capacitor on the VBUS line
Connect a 1 to 10 μF capacitor. Total capacity should not exceed 10 μF when viewed from both sides of the Vbus pin on the USB connector and the VbusDTCT pin in the M16C/6C.

Current usable on the VBUS line
- Configured state from cable connection: 100 mA max.
- Configured state: 500 mA max.
- Suspend state
  When remote wakeup is permitted: 2.5 mA max.
  When remote wakeup is not permitted: 500 μA max.
  When the Set_Configuration command is received, the MCU enters a Configured state.
  These values are for reference only. They may change depending on the system component to be used.
  When taking measures against surges, add the other system components.

(8) Note on the VBUS line
As noise contamination is possible when using the VBUS as the power supply, design the circuit to stabilize input voltage to the MCU. Also, design the circuit to protect the VBUS from inrush current and ESD caused by attaching/detaching the USB cable.

(9) Shield of the USB connector
Connect a connector shield to the package GND or system GND.
If the shield causes a high level of noise or adversely affects the system, then use a countermeasure such as a power supply coil.

7. Reference Documents

M16C/6C Group User's Manual: Hardware Rev.1.00
The latest version can be downloaded from the Renesas Electronics website.

Technical Update/Technical News
The latest information can be downloaded from the Renesas Electronics website.

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REVISION HISTORY	M16C/6C Group USB External Circuit Example

Rev.	Date	Description	
		Page	Summary
1.00	Jun 30, 2010	-	First Edition issued

General Precautions in the Handling of MPU/MCU Products

The following usage notes are applicable to all MPU/MCU products from Renesas. For detailed usage notes on the products covered by this manual, refer to the relevant sections of the manual. If the descriptions under General Precautions in the Handling of MPU/MCU Products and in the body of the manual differ from each other, the description in the body of the manual takes precedence.

1. Handling of Unused Pins

   Handle unused pins in accord with the directions given under Handling of Unused Pins in the manual.

   — The input pins of CMOS products are generally in the high-impedance state. In operation with an unused pin in the open-circuit state, extra electromagnetic noise is induced in the vicinity of LSI, an associated shoot-through current flows internally, and malfunctions occur due to the false recognition of the pin state as an input signal become possible. Unused pins should be handled as described under Handling of Unused Pins in the manual.

2. Processing at Power-on

   The state of the product is undefined at the moment when power is supplied.

   — The states of internal circuits in the LSI are indeterminate and the states of register settings and pins are undefined at the moment when power is supplied.

   In a finished product where the reset signal is applied to the external reset pin, the states of pins are not guaranteed from the moment when power is supplied until the reset process is completed.

   In a similar way, the states of pins in a product that is reset by an on-chip power-on reset function are not guaranteed from the moment when power is supplied until the power reaches the level at which resetting has been specified.

3. Prohibition of Access to Reserved Addresses

   Access to reserved addresses is prohibited.

   — The reserved addresses are provided for the possible future expansion of functions. Do not access these addresses; the correct operation of LSI is not guaranteed if they are accessed.

4. Clock Signals

   After applying a reset, only release the reset line after the operating clock signal has become stable. When switching the clock signal during program execution, wait until the target clock signal has stabilized.

   — When the clock signal is generated with an external resonator (or from an external oscillator) during a reset, ensure that the reset line is only released after full stabilization of the clock signal. Moreover, when switching to a clock signal produced with an external resonator (or by an external oscillator) while program execution is in progress, wait until the target clock signal is stable.

5. Differences between Products

   Before changing from one product to another, i.e. to one with a different part number, confirm that the change will not lead to problems.

   — The characteristics of MPU/MCU in the same group but having different part numbers may differ because of the differences in internal memory capacity and layout pattern. When changing to products of different part numbers, implement a system-evaluation test for each of the products.

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