To our customers,

____________
Old Company Name in Catalogs and Other Documents
____________

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

April 1st, 2010
Renesas Electronics Corporation

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

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This manual explains the sample program functions of the asynchronous serial interface A (UARTA) for the V850E/IA4 microcontroller.

The explanations are based on usage with the V850E/IA4 microcontroller. Refer to this manual when using the V850E/IA3, V850ES/IK1, and V850ES/IE2 microcontrollers.

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NOTES FOR CMOS DEVICES

1. VOLTAGE APPLICATION WAVEFORM AT INPUT PIN
Waveform distortion due to input noise or a reflected wave may cause malfunction. If the input of the CMOS device stays in the area between VIL (MAX) and VIH (MIN) due to noise, etc., the device may malfunction. Take care to prevent chattering noise from entering the device when the input level is fixed, and also in the transition period when the input level passes through the area between VIL (MAX) and VIH (MIN).

2. HANDLING OF UNUSED INPUT PINS
Unconnected CMOS device inputs can be cause of malfunction. If an input pin is unconnected, it is possible that an internal input level may be generated due to noise, etc., causing malfunction. CMOS devices behave differently than Bipolar or NMOS devices. Input levels of CMOS devices must be fixed high or low by using pull-up or pull-down circuitry. Each unused pin should be connected to VDD or GND via a resistor if there is a possibility that it will be an output pin. All handling related to unused pins must be judged separately for each device and according to related specifications governing the device.

3. PRECAUTION AGAINST ESD
A strong electric field, when exposed to a MOS device, can cause destruction of the gate oxide and ultimately degrade the device operation. Steps must be taken to stop generation of static electricity as much as possible, and quickly dissipate it when it has occurred. Environmental control must be adequate. When it is dry, a humidifier should be used. It is recommended to avoid using insulators that easily build up static electricity. Semiconductor devices must be stored and transported in an anti-static container, static shielding bag or conductive material. All test and measurement tools including work benches and floors should be grounded. The operator should be grounded using a wrist strap. Semiconductor devices must not be touched with bare hands. Similar precautions need to be taken for PW boards with mounted semiconductor devices.

4. STATUS BEFORE INITIALIZATION
Power-on does not necessarily define the initial status of a MOS device. Immediately after the power source is turned ON, devices with reset functions have not yet been initialized. Hence, power-on does not guarantee output pin levels, I/O settings or contents of registers. A device is not initialized until the reset signal is received. A reset operation must be executed immediately after power-on for devices with reset functions.

5. POWER ON/OFF SEQUENCE
In the case of a device that uses different power supplies for the internal operation and external interface, as a rule, switch on the external power supply after switching on the internal power supply. When switching the power supply off, as a rule, switch off the external power supply and then the internal power supply. Use of the reverse power on/off sequences may result in the application of an overvoltage to the internal elements of the device, causing malfunction and degradation of internal elements due to the passage of an abnormal current. The correct power on/off sequence must be judged separately for each device and according to related specifications governing the device.

6. INPUT OF SIGNAL DURING POWER OFF STATE
Do not input signals or an I/O pull-up power supply while the device is not powered. The current injection that results from input of such a signal or I/O pull-up power supply may cause malfunction and the abnormal current that passes in the device at this time may cause degradation of internal elements. Input of signals during the power off state must be judged separately for each device and according to related specifications governing the device.
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INTRODUCTION

Cautions 1. Download the program used in this manual from the NEC Electronics Website (http://www.necel.com/).

2. When using this sample program, reference the following startup file and link directive file and adjust them if as necessary.
   • Startup file: IA4_start.s
   • Link directive file: IA4_link.dir

Conventions

The function lists are structured as follows.

Hardware name (symbol)

<table>
<thead>
<tr>
<th>Function</th>
<th>Function description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Function name</td>
<td>Name of sample function</td>
</tr>
<tr>
<td>Argument</td>
<td>Type and overview of argument</td>
</tr>
<tr>
<td>Processing content</td>
<td>Processing content of sample function</td>
</tr>
<tr>
<td>SFR(s) used</td>
<td>Register name and setting content</td>
</tr>
<tr>
<td>call function(s)</td>
<td>Name and function of call function(s)</td>
</tr>
<tr>
<td>Variable(s)</td>
<td>Type, name, and overview of variable(s) used in sample function</td>
</tr>
<tr>
<td>Interrupt(s)</td>
<td>Name of function</td>
</tr>
<tr>
<td>Interrupt source(s)</td>
<td>Name</td>
</tr>
<tr>
<td>File name</td>
<td>Name of corresponding sample program file</td>
</tr>
<tr>
<td>Caution(s)</td>
<td>Caution(s) upon function usage</td>
</tr>
</tbody>
</table>

Interrupt function

<table>
<thead>
<tr>
<th>Function name</th>
<th>Name of interrupt function</th>
</tr>
</thead>
<tbody>
<tr>
<td>Processing content</td>
<td>Processing content of interrupt function</td>
</tr>
<tr>
<td>SFR(s) used</td>
<td>Register name and setting content</td>
</tr>
<tr>
<td>call function(s)</td>
<td>None</td>
</tr>
<tr>
<td>Variable(s)</td>
<td>Name of variable, function</td>
</tr>
<tr>
<td>File name</td>
<td>Name of corresponding sample program file</td>
</tr>
<tr>
<td>Caution(s)</td>
<td>None</td>
</tr>
</tbody>
</table>
**Product Differences**

The differences between the V850E/IA4 and the V850E/IA3, V850ES/IK1, and V850ES/IE2 related to the asynchronous serial interface A (UARTA) are shown below.

<table>
<thead>
<tr>
<th>Item</th>
<th>V850E/IA4</th>
<th>V850E/IA3</th>
<th>V850ES/IK1</th>
<th>V850ES/IE2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Channel</td>
<td>2 channels (of which 1 channel has an alternate function as CSIB)</td>
<td>2 channels (of which 1 channel has an alternate function as CSIB)</td>
<td>2 channels</td>
<td>2 channels</td>
</tr>
<tr>
<td>Base clock (fUCLK)</td>
<td>fXX/2, fXX/4, fXX/8, fXX/16, fXX/32, fXX/64, fXX/128, fXX/256, fXX/512, fXX/1024, fXX/2048, fXX/4096</td>
<td>fXX/2, fXX/4, fXX/8, fXX/16, fXX/32, fXX/64, fXX/128, fXX/256, fXX/512, fXX/1024, fXX/2048, fXX/4096</td>
<td>fXX, fXX/2, fXX/4, fXX/8, fXX/16, fXX/32, fXX/64, fXX/128, fXX/256, fXX/512, fXX/1024, fXX/2048</td>
<td>fXX, fXX/2, fXX/4, fXX/8, fXX/16, fXX/32, fXX/64, fXX/128, fXX/256, fXX/512, fXX/1024, fXX/2048</td>
</tr>
</tbody>
</table>

**Remark**  
*fXX:* Peripheral clock frequency
**Related Documents**

The related documents indicated in this publication may include preliminary versions. However, preliminary versions are not marked as such.

### Documents related to V850E/IA3, V850E/IA4, V850ES/IK1, and V850ES/IE2

<table>
<thead>
<tr>
<th>Document Name</th>
<th>Document No.</th>
</tr>
</thead>
<tbody>
<tr>
<td>V850E1 Architecture User’s Manual</td>
<td>U14559E</td>
</tr>
<tr>
<td>V850E/IA3, V850E/IA4 Hardware User’s Manual</td>
<td>U16543E</td>
</tr>
<tr>
<td>V850ES Architecture User’s Manual</td>
<td>U15943E</td>
</tr>
<tr>
<td>V850ES/IK1 Hardware User’s Manual</td>
<td>U16910E</td>
</tr>
<tr>
<td>V850ES/IE2 Hardware User’s Manual</td>
<td>U17716E</td>
</tr>
<tr>
<td>Inverter Control by V850 Series Vector Control by Hole Sensor Application Note</td>
<td>U17338E</td>
</tr>
<tr>
<td>Inverter Control by V850 Series Vector Control by Encoder Application Note</td>
<td>U17324E</td>
</tr>
<tr>
<td>Inverter Control by V850 Series 120° Excitation Method Control by Zero-Cross Detection Application Note</td>
<td>U17209E</td>
</tr>
<tr>
<td>Manual for Using Sample Program Functions Serial Communication (UARTA) (V850E/IA3, V850E/IA4, V850ES/IK1, V850ES/IE2) Application Note</td>
<td>This manual</td>
</tr>
<tr>
<td>Manual for Using Sample Program Functions DMA Functions (V850E/IA3, V850E/IA4) Application Note</td>
<td>U18235E</td>
</tr>
<tr>
<td>Manual for Using Sample Program Functions Timer ENC (V850E/IA3, V850E/IA4) Application Note</td>
<td>U18240E</td>
</tr>
<tr>
<td>Manual for Using Sample Program Functions Clock Generator (V850E/IA3, V850E/IA4, V850ES/IK1, V850ES/IE2) Application Note</td>
<td>U18242E</td>
</tr>
</tbody>
</table>
Asynchronous serial interface A (UARTAn) \( (n = 0, 1) \)

<table>
<thead>
<tr>
<th>Function</th>
<th>Performs continuous UARTA0 transmission/reception.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Function name</td>
<td>uarta_main</td>
</tr>
<tr>
<td>Argument</td>
<td>None</td>
</tr>
<tr>
<td>Processing content</td>
<td>Performs transmission/reception for ten times using UARTA0. Stores received data in ( \text{buf}_r ), and transmitted data in ( \text{buf}_t ).</td>
</tr>
<tr>
<td>SFRs used</td>
<td>UA0REIC: 0x07 (Clears UARTA0 reception error interrupt request signal (INTUA0RE), releases mask, sets to priority level 7.)</td>
</tr>
<tr>
<td></td>
<td>UA0TIC: 0x07 (Clears UARTA0 transmission enable interrupt request signal (INTUA0T), releases mask, sets to priority level 7.)</td>
</tr>
<tr>
<td></td>
<td>UA0RIC: 0x07 (Clears UARTA0 reception end interrupt request signal (INTUA0R), releases mask, sets to priority level 7.)</td>
</tr>
<tr>
<td>Call functions</td>
<td>uarta_port_set, uarta_set, uarta_start, uarta_receive_end, uarta_send_end, uarta_end</td>
</tr>
<tr>
<td>Variables</td>
<td>unsigned char ( \text{buf}_t []): Transmit data storing buffer</td>
</tr>
<tr>
<td></td>
<td>unsigned char ( \text{buf}_r []): Receive data storing buffer</td>
</tr>
<tr>
<td></td>
<td>volatile unsigned char count_tx: Transmission count variable</td>
</tr>
<tr>
<td></td>
<td>volatile unsigned char count_rx: Reception count variable</td>
</tr>
<tr>
<td></td>
<td>unsigned char count: Transfer data generating variable</td>
</tr>
<tr>
<td>Interrupts</td>
<td>uarta_error, uarta_int_send, uarta_int_receive</td>
</tr>
<tr>
<td>Interrupt sources</td>
<td>INTUA0RE, INTUA0T, INTUA0R</td>
</tr>
<tr>
<td>File name</td>
<td>uarta.c</td>
</tr>
<tr>
<td>Caution</td>
<td>None</td>
</tr>
</tbody>
</table>

| Function name     | uarta_port_set                                    |
| Processing content| Sets alternate-function pin to UARTA0 I/O pin.     |
| SFR used          | PMC3: 0x03 (Sets TXDA0 output and RXDA0 input.)   |
| Call function     | None                                              |
| Variable          | None                                              |
| File name         | uarta.c                                           |
| Caution           | None                                              |
### Function: uarta_set

**[Processing content]** Sets UARTA0 control register. Sets baud rate to 9,600 (bps).

**[SFRs used]**
- UA0CTL1: 0x03 (Sets baud rate to 9,600 (bps).)
- UA0CTL2: 0xD0 (Sets baud rate to 9,600 (bps).)
- UA0OPT0: 0x14 (Sets to ordinary output of transfer data, ordinary input of transfer data.)
- UA0CTL0: 0x8A (Enables UARTA0 operation, sets to MSB first, and sets odd parity to output data, character length of 8 bits, and stop bit length of 1 bit.)

**[call function]** None

**[Variable]** None

**[File name]** uarta.c

**[Caution]** None

### Function: uarta_start

**[Processing content]** Enables transmission/reception and writes data to UA0TX register.

**[SFRs used]**
- UA0CTL0.UA0TXE: 1 (Enables transmission operation.)
- UA0CTL0.UA0RXE: 1 (Enables reception operation.)
- UA0TX: Transmit data register

**[call function]** None

**[Variables]**
- volatile unsigned char count_tx: Transmission count variable
- unsigned char buf_tx[]: Transmit data storing buffer

**[File name]** uarta.c

**[Caution]** Set UA0RXE and UA0TXE bits to 1 after setting UA0CTL.UA0PWR bit to 1.

### Function: uarta_receive_end

**[Processing content]** Disables reception operation.

**[SFR used]**
- UA0CTL0.UA0RXE: 0 (Disables reception operation.)

**[call function]** None

**[Variable]** None

**[File name]** uarta.c

**[Caution]** None
### Function uarta_send_end

**Processing content**
Disables transmission operation.

**SFR used**
UA0CTL0.UA0TXE: 0 (Disables transmission operation.)

**Call function**
None

**Variables**
None

**File name**
utra.c

**Caution**
None

### Function uarta_end

**Processing content**
Disables operation of UARTA0.

**SFR used**
UA0CTL0.UA0PWR: 0 (Disables operation of UARTA0.)

**Call function**
None

**Variables**
None

**File name**
utra.c

**Caution**
None

### Interrupt function

**Function name**
utra_int_send

**Processing content**
Writes transmit data to transmit data register.

| Stops transmission operation if number of transmissions and counts match. |

**SFR used**
UA0TX Transmit data register

**Call function**
None

**Variables**
unsigned char buf_tx[]: Transmit data storing buffer
volatile unsigned char count_rx: Transmission count variable

**File name**
utra.c

**Caution**
None
<table>
<thead>
<tr>
<th>Function name</th>
<th>uarta_int_receive</th>
</tr>
</thead>
<tbody>
<tr>
<td>Processing content</td>
<td>Writes receive data to receive data register.</td>
</tr>
<tr>
<td></td>
<td>Stops and disables reception operation if number of receptions and counts match.</td>
</tr>
<tr>
<td>SFR used</td>
<td>UA0RX Receive data register</td>
</tr>
<tr>
<td>call function</td>
<td>None</td>
</tr>
<tr>
<td>Variables</td>
<td>unsigned char buf_rx[]: Receive data storing buffer</td>
</tr>
<tr>
<td></td>
<td>volatile unsigned char count_rx: Reception count variable</td>
</tr>
<tr>
<td>File name</td>
<td>uarta.c</td>
</tr>
<tr>
<td>Caution</td>
<td>To stop reception operation, set UA0PWR bit to 0 after setting UA0RXE and UA0TXE bits to 0.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Function name</th>
<th>uarta_error</th>
</tr>
</thead>
<tbody>
<tr>
<td>Processing content</td>
<td>Clears error flag when reception error occurs.</td>
</tr>
<tr>
<td>SFRs used</td>
<td>UA0STR.UA0PE: 0 (Clears parity error flag.)</td>
</tr>
<tr>
<td></td>
<td>UA0STR.UA0FE: 0 (Clears framing error flag.)</td>
</tr>
<tr>
<td></td>
<td>UA0STR.UA0OVE: 0 (Clears overrun error flag.)</td>
</tr>
<tr>
<td>call function</td>
<td>None</td>
</tr>
<tr>
<td>Variable</td>
<td>None</td>
</tr>
<tr>
<td>File name</td>
<td>uarta.c</td>
</tr>
<tr>
<td>Caution</td>
<td>None</td>
</tr>
</tbody>
</table>
Asynchronous serial interface A (UARTAn) (1/4)

void uarta_main()
{
    DI           // Disables maskable interrupt request
    count_tx = 0  // Initializes transmission count
    count_rx = 0  // Initializes reception count
    uarta_port_set() // Alternate-function pin setting function
    uarta_set()    // UARTA0 control register setting function
    count = 0      // Initializes count for transmission data generated
    while (1){
        if (count > TX_SIZE){
            count = 0;
        }
        if (count > TX_SIZE){
            buf_tx[count] = count + 1;
            count++;
        }
        UAR0REIC = 0x07;  // Clears INTU0RE interrupt request signal, releases mask, sets to priority level 7
        UAR0TIC = 0x07;   // Clears INTU0T interrupt request signal, releases mask, sets to priority level 7
        UAR0RIC = 0x07;   // Clears INTU0R interrupt request signal, releases mask, sets to priority level 7
        EI             // Enables maskable interrupt request
        uarta_start();  // UARTA0 operation start function
    }
}
Asynchronous serial interface A (UARTAn) (2/4)

Checks reception count

UARTA0 reception operation disable function

Checks transmission count

UARTA0 transmission operation disable function

Checks reception and transmission count

UARTA0 operation disable function
Asynchronous serial interface A (UARTAn) (3/4)

Alternate function pin setting function

```
uarta_port_set

PMC3 |= 0x03

ret
```

Sets alternate-function pin to TXDA0 output and RXDA0 input

UARTA0 control register setting function

```
uarta_set

UA0CTL1 = 0x03

UA0CTL2 = 0x00

ret
```

Sets baud rate to 9,600 bps

UARTA0 transfer operation start function

```
uarta_start

UA0TXE = 1

UA0RXE = 1

count_tx++

ret
```

Enables transmission operation

Enables reception operation

```
UA0TX = buf_tx[0]

UARTA0 reception operation disable function

```
uarta_send_end

UA0TXE = 0

ret
```

Outputs transfer data normally

Inputs transfer data normally

Enables UARTA0 operation

Sets transfer direction to MSB first

Sets parity selection to odd parity

Sets data length to 8 bits

Sets stop bit to 1 bit

UARTA0 transmission operation disable function

```
uarta_receive_end

UA0RXE = 0

ret
```

Disables reception operation

```
UA0PWR = 0

UARTA0 operation disable function

```
uarta_end

UA0PWR = 0

ret
```

Disables UARTA0 operation
Asynchronous serial interface A (UARTAn) (4/4)

INTUA0T interrupt

INTUA0T interrupt function

UARTAn

uarta_int_send

count tx<TX_SIZE

No

Checks transmission count

Writes to UA0TX register

UA0TX = buf_fx[count_tx]

count_tx++

Increments transmission count

INTUA0R interrupt

INTUA0R interrupt function

uart_int_receive

buf_rx[count_rx] = UA0RX

count_rx++

Increments reception count

INTUA0RE interrupt

INTUA0RE error interrupt function

uarta_error

UA0PE = 0

Clears parity error flag

UA0FE = 0

Clears framing error flag

UA0OVE = 0

Clears overrun error flag

retn
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