NEC

User's Manual

32-bit V850 ZigBee™ PRO Gateway Development Platform

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- Availability of related technical literature
- Development environment specifications (for example, specifications for third-party tools and components, host computers, power plugs, AC supply voltages, and so forth)
- Network requirements

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NEC Electronics Corporation
1753, Shimonumabe, Nakahara-ku,
Kawasaki, Kanagawa 211-8668, Japan
Tel: 044 4355111
http://www.necel.com/

[America]

NEC Electronics America, Inc.
2880 Scott Blvd.
Santa Clara, CA 95050-2554,
U.S.A.
Tel: 408 5886000
http://www.am.necel.com/

[Europe]

NEC Electronics (Europe) GmbH
Arcadiastrasse 10
40472 Düsseldorf, Germany
Tel: 0211 65030
http://www.eu.necel.com/

United Kingdom Branch
Cygnus House, Sunrise Parkway
Linford Wood, Milton Keynes
MK14 6NP, U.K.
Tel: 01908 691133

Succursale Française
9, rue Paul Dautier, B.P. 52
78142 Velizy-Villacoublay Cédex
France
Tel: 01 30675800

Tyskland Filial
Täby Centrum
Entrance S (7th floor)
18322 Täby, Sweden
Tel: 08 6387200

Filiale Italiana
Via Fabio Filzi, 25/A
20124 Milano, Italy
Tel: 02 667541

Branch The Netherlands
Steijgerweg 6
5616 HS Eindhoven,
The Netherlands
Tel: 040 2654010

[Asia & Oceania]

NEC Electronics (China) Co., Ltd
7th Floor, Quantum Plaza, No. 27
ZhiChunLu Haidian District,
Beijing 100083, P.R.China
Tel: 010 82351155
http://www.cn.necel.com/

NEC Electronics Shanghai Ltd.
Room 2511-2512, Bank of China
Tower,
200 Yincheng Road Central,
Pudong New Area,
Shanghai 200120, P.R. China
Tel: 021 58885400
http://www.cn.necel.com/

NEC Electronics Hong Kong Ltd.
12/F., Cityplaza 4,
12 Taikoo Wan Road, Hong Kong
Tel: 2886 9318
http://www.hk.necel.com/

NEC Electronics Taiwan Ltd.
7F, No. 363 Fu Shing North Road
Taipei, Taiwan, R.O.C.
Tel: 02 27192377

NEC Electronics Singapore Pte. Ltd.
238A Thomson Road,
#12-08 Novena Square,
Singapore 307684
Tel: 6253 8311
http://www.sg.necel.com/

NEC Electronics Korea Ltd.
11F., Samik Lavied'or Bldg., 720-2,
Yeoksam-Dong, Kangnam-Ku, Seoul,
135-080, Korea Tel: 02-558-3737
http://www.kr.necel.com/

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Chapter 1 V850 ZigBee PRO Gateway Development Platform

The *V850 ZigBee^{TM} PRO Gateway Development Platform* is the NEC Electronics 32-bit starter kit specifically designed for the development of wireless networking applications combined with Ethernet and Internet communications. The above platform can be used to design and develop high-end wireless networking, incorporating all the features of a fully compliant ZigBee^{TM} network. This development platform also has Ethernet and Internet capability which can support communications via WEB browser-based technology.

The development kit contains the TK-850/SG2+UZ evaluation board, which includes the V850ES/SG2, a 32-bit single-chip microcontroller of NEC Electronics, and the UZ2400 RF board of Uniband Electronic Corporation.

1.1 Features of the TK-850/SG2+UZ

Features of the TK-850/SG2+UZ CPU evaluation board are as follows.

- The evaluation board used the NEC Electronics 32-bit single chip microcontroller (µPD70F3281YGC). All of the ROM, RAM and peripheral circuit are efficiently built in one chip on a single board.
- High-speed operation is realized via the 20 MHz internal clock.
- 32.768 kHz sub-clock standard equipment
- The high speed RAM: 32 KB and the flash memory 384 KB are built into CPU chip.
- Hardware is ready to accommodate the 2.4 GHz transceiver UZ2400 RF board (Accordance with IEEE 802.15.4 ZigBee^{TM} Specifications for Low Rate Wireless Personal Area Networks) made by Uniband Electronic Corporation.
  (*http://www.ubec.com.tw/index.html*)
- Attached antenna Titanis made by Gigaant
  (*http://www.gigaant.com*)
- 17 I/O ports are equipped for expand use.
- On board temperature sensor S-8120C made by SII
  (*http://www.sii.co.jp*)
- The board itself is quite and easy to handle; the CPU board size is 91 mm x 62 mm, and 103 mm x 62 mm when the RF transceiver board is included.

Note Please inquire direct to the parts maker about specification of UZ2400 RF board, antenna and temperature sensor.

1.2 Package Content

The *V850 ZigBee^{TM} PRO Gateway Development Platform* consists of one TK-850/SG2+UZ development board and one 78K0_UZ_Stick which is configured to act as Air Sniffer hardware. Also supplied is the unlimited security

dongle for the V850 ZigBee^{TM} PRO stack and ZigBee^{TM} PRO Software Developers Kit (ZigBee^{TM} PRO SDK tools).

The following software is also supplied on the accompanying CDROM.

- IAR Embedded Workbench Kickstart edition 64KB code size limited
- WriteEZ1 Flash programming Software for the V850 microcontrollers
- IEEE 802.15.4 MAC libraries
- TCPIP libraries, Mail and Web application libraries
- Web Page Conversion Utility Program
- Sample Web to Wireless application program for the TK-850/SG2 +UZ board
- Compiled HEX file for remote TK-78K0/KF2+UZ wireless node (hardware not supplied)

1.3 System Requirements

Host PC   A PC supporting Windows 2000 or Windows XP for the IAR Systems Embedded Workbench Kickstart edition and the *V850 ZigBee™ PRO Gateway Development Platform*.

Pentium 200 MHz minimum, 128 MB of RAM, 256 colour display (1024 x 768), mouse, CD ROM drive and 200 MB of disk space are required to install the tool packages.

Host Interface   USB interface that enables communication based on USB (Version 1.1 or later)

Package Contents   Please verify that you have received all of the parts listed in the package contents list attached to the *V850 ZigBee™ PRO Gateway Development Platform*. If any parts are missing or seem to be damaged please contact the dealer from whom you received your *V850 ZigBee™ PRO Gateway Development Platform*.

Note   Updates for the IAR Embedded workbench for V850, documentation and/or utilities for the *V850 ZigBee™ PRO Gateway Development Platform* if available maybe downloaded from the NEC Electronics web pages at: *http://www.eu.necel.com/updates*

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1.4 Complementary ZigBee™ Development Platform and Hardware

Other evaluation boards and hardware available to develop a ZigBee^{TM} network from NEC Electronics:

- ZigBee^{TM} Starter Kit
 - 2 x 8-bit ZigBee^{TM} node boards TK-78K0/KF2+UZ

- IEEE 802.15.4 MAC libraries
- Sample programs
- IAR Embedded Workbench Kickstart Version
- Flash programmer for 78K0
- **Article code 78K0-ZIGBEE-SK**

- ZigBee^{TM} Premium Development Kit for 78K0
    - 4 x 8-bit ZigBee^{TM} node boards TK-78K0/KF2+UZ
    - 8-Bit USB ZigBee^{TM} node programmed as Air Sniffer
    - IEEE 802.15.4 MAC libraries
    - ZigBee^{TM} Stack
    - Unlimited ZigBee^{TM} license for the 78K0 family
    - GUI Tools (SDK)
    - Sample programs
    - IAR Embedded Workbench Kickstart Version
    - Flash programmer for 78K0
    - **Article code 78K0-ZIGBEE-PREM**

- ZigBee^{TM} Premium Development Kit for 78K0R
    - 4 x 16-bit ZigBee^{TM} node boards TK-78K0R/KG3+UZ
    - 16-bit USB ZigBee^{TM} node programmed as Air Sniffer
    - IEEE 802.15.4 MAC libraries
    - ZigBee^{TM} Stack
    - Unlimited ZigBee^{TM} license for the 78K0R family
    - GUI Tools (SDK)
    - Sample programs
    - IAR Embedded Workbench Kickstart Version
    - **Article code 78K0R-ZIGBEE-PREM**

- ZigBee^{TM} PRO Premium Development Kit for 78K0R
    - 4 x 16-bit ZigBee^{TM} node boards TK-78K0R/KG3+UZ
    - 16-bit USB ZigBee^{TM} node programmed as Air Sniffer
    - IEEE 802.15.4 MAC libraries
    - ZigBee^{TM} Stack
    - Unlimited ZigBee^{TM} license for the 78K0R family
    - GUI Tools (SDK)
    - Sample programs
    - IAR Embedded Workbench Kickstart Version
    - **Article code 78K0R-ZIGBEEPRO-PREM**

Additional single boards or modules can be purchased in case the customer needs additional hardware for Premium or Gateway kits:

- TK-850/SG2+UZ-EE
- TK-78K0/KF2+UZ-EE
- 78K0_UZ_Stick-EE
- TK-78K0R/KG3+UZ-EE
- 78K0R_UZ_Stick-EE

Chapter 2 Sample Program

The sample program provided permits the user to set up the following network where the TK-850/SG2+UZ board occupies the central position. The TK-850/SG2+UZ is already pre-programmed with the "mac_app.hex" file which utilises the following network configuration:
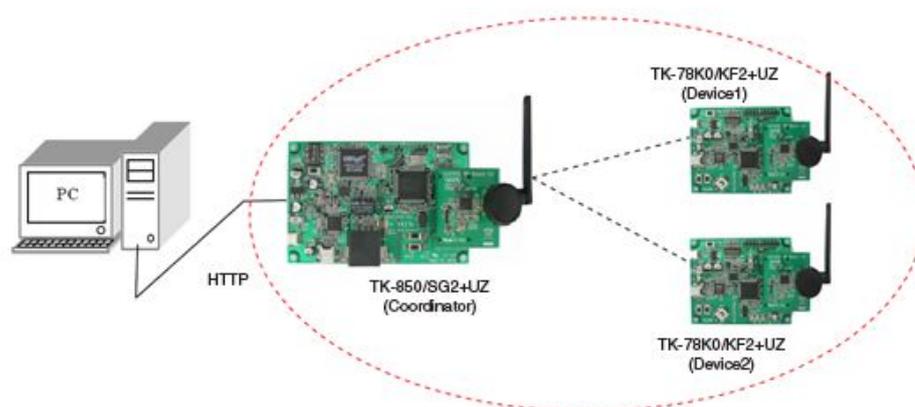
Figure 2-1   **System Configuration**

The sample application utilizes TCP/IP and HTTP communications on the TK-850/SG2+UZ board, and wireless communications of IEEE 802.15.4, between one TK-850/SG2+UZ board and up to 4 TK-78K0/KF2+UZ boards (not supplied).

The TK-850/SG2+UZ board is called "Coordinator" and the TK-78K0/KF2+UZ boards "Devices".

The following parts present firstly, the operation of the central board alone, and then the operation with the addition of TK-78K0/KF2+UZ boards.

2.1 Operational Procedure for the TK-850/SG2+UZ

If you intend to execute the sample program without using the debugger, set the mode switch as shown below, and then, make a hardware reset by pushing the reset switch.

Table 2-1   **Operation mode settings for the TK-850/SG2+UZ**

SW1 – 1, 2, 3 and 4	OFF
SW1 – 5, 6, 7 and 8	X

Connect your PC to the TK-850/SG2+UZ board with a LAN cable. The LAN cable should be a crossover cable if connected directly through to the PC or a straight cable if utilising normal network connections.

Apply the power source to the TK-850/SG2+UZ board (batteries or powered USB).

Some changes need to be made to your PC network settings: open [Control Panel] -> [Network Connections] -> [Local Area Connections] -> [Properties] -> [TCP/IP] -> [Properties] and set the following IP address and the subnet mask:

- IP address: 192.168.0.x.x can be any value between 1 to 99, or 101 to 25.
- Subnet mask: 255.255.255.0

Close the TCP/IP set up window.
Start you web browser, such as MS Internet Explorer.
Connect your browser to "http://192.168.0.100". You can modify the URL later by going to [Configuration] -> [Network]

You should see the following image in your browser.

You can come back to this image, anytime if you select [Display] -> [Network Configuration]. A pink line indicates a device is not connected.
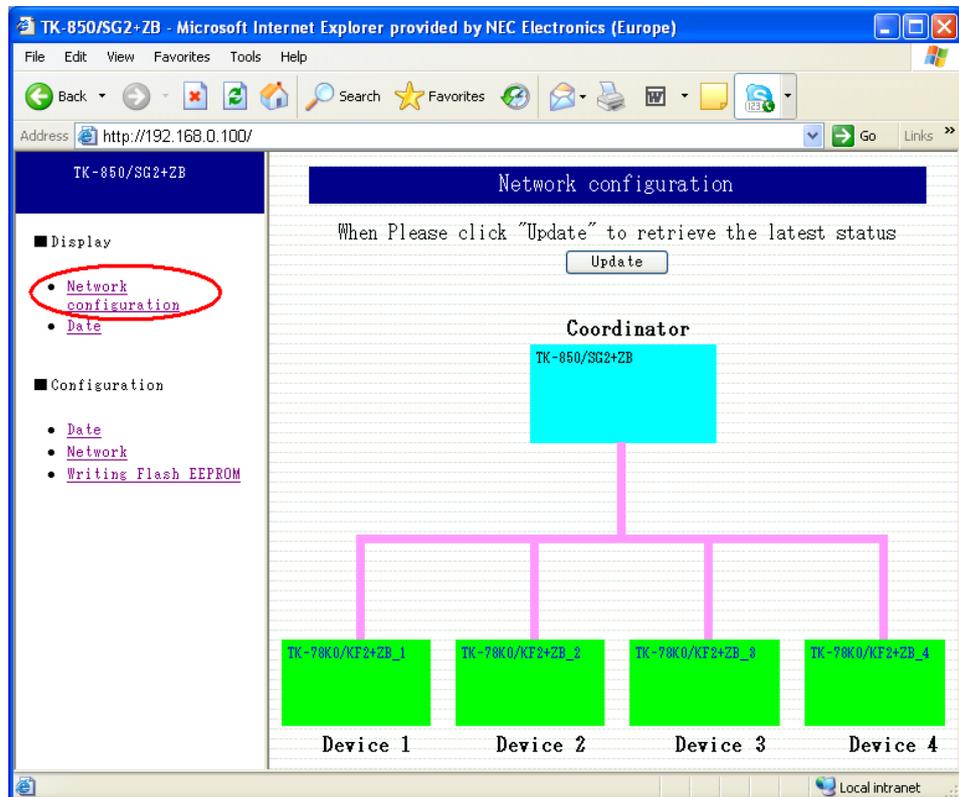
Figure 2-2 **Network configuration overview**

If you select [Display] -> [Date], you can find the time the sample program has. (The default time is 2000/01/01 00:00:00)
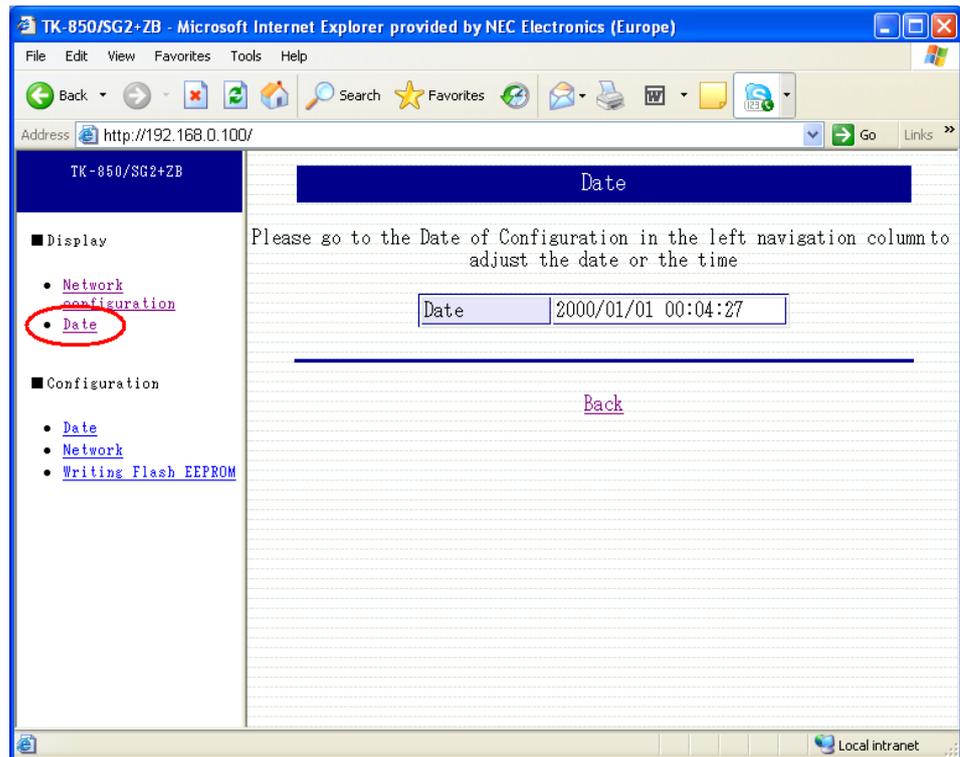
Figure 2-3   Date configuration screen

You can set the time by selecting [Configuration] -> [Date].

For example, if you want to set 9 minutes and 30 seconds past 9pm on April 11th in 2005, please input 20050411210930.
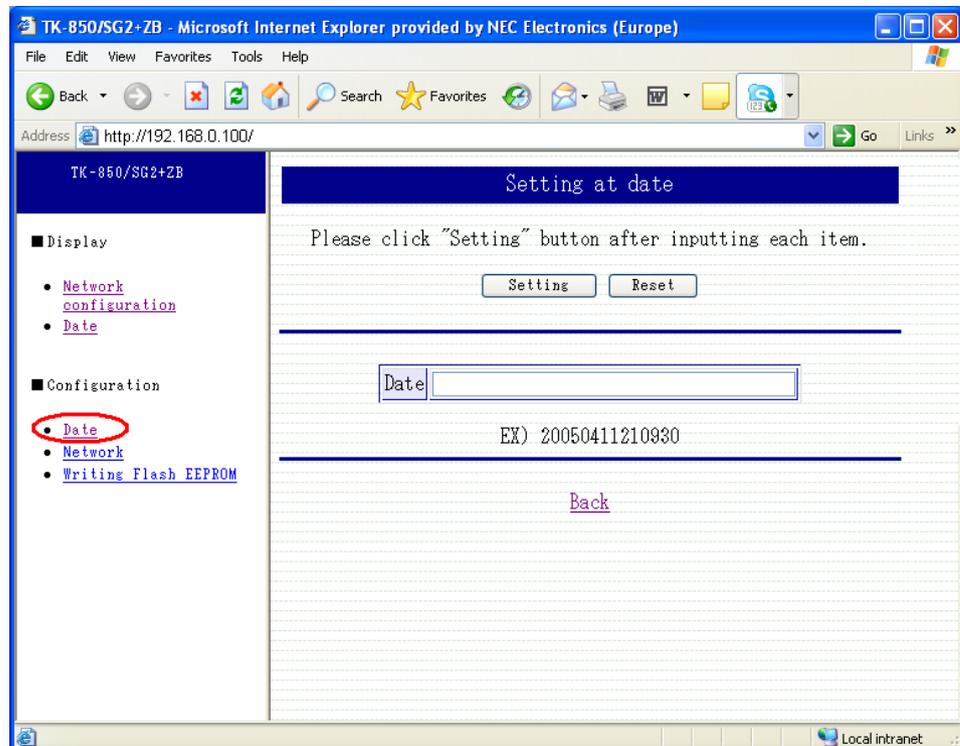
Figure 2-4   Configuration of the date

To setup networks, select [Configuration] -> [Network].

You can modify the network configuration in this window. However it will be adopted only after the new configuration is downloaded in the Flash EEPROM.
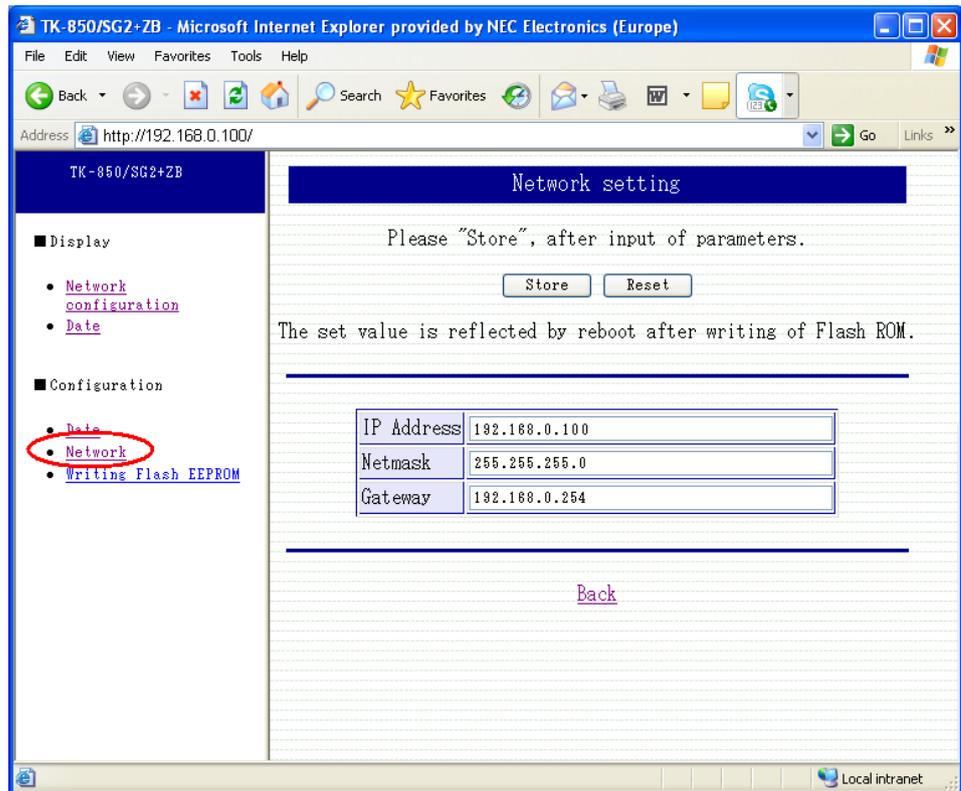
Figure 2-5   Configuration of the network parameters

You can open the Flash programming window by selecting [Configuration] -> [Writing Flash EEPROM].

Click the "Execution" button to store the current settings.
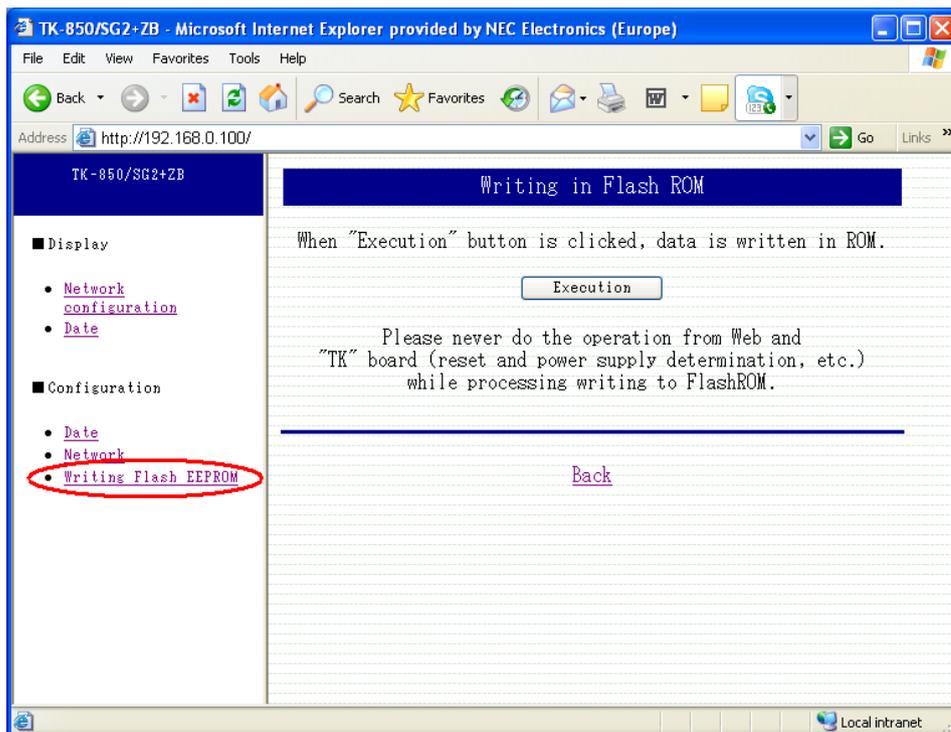
Figure 2-6   Saving the new parameters by writing in the MCU Flash memory

2.2 Operation Procedure with TK-78K0/KF2+UZ boards

Once the TK-850/SG2+UZ board is ready (section "*2.1 Operational procedure for the TK-850/SG2+UZ*"), the connection of the TK-78K0/KF2+UZ remote node (called Device) requires some settings.

You can write the sample programs to the 78K0/KF2 built-in flash memory by using the flash programming software WriteEZ3.

Set the switches of TK-78K0/KF2+UZ as shown in the following table:

Table 2-2   Flash programming mode settings for the TK-78K0/KF2+UZ

SW1	Bit 1	ON
	Bit 2	ON
	Bit 3	OFF
	Bit 4	OFF
	Bit 5	OFF
SW5		UART side

Using the Flash programmer WriteEZ3, load and write the file "mac78k0.hex" which can be found under the following directory on the CDROM:
<CD>\SamplePrograms\SamplePrograms\Demo_78K0
or can be found in the directory where they have been installed by the automatic process of the CDROM (see section "*6.2.3 Sample Program Installation*").

For further details, please refer to the documentation of the Flash programmer WriteEZ3, or to the documentation provided with the TK-78K0/KF2+UZ board.
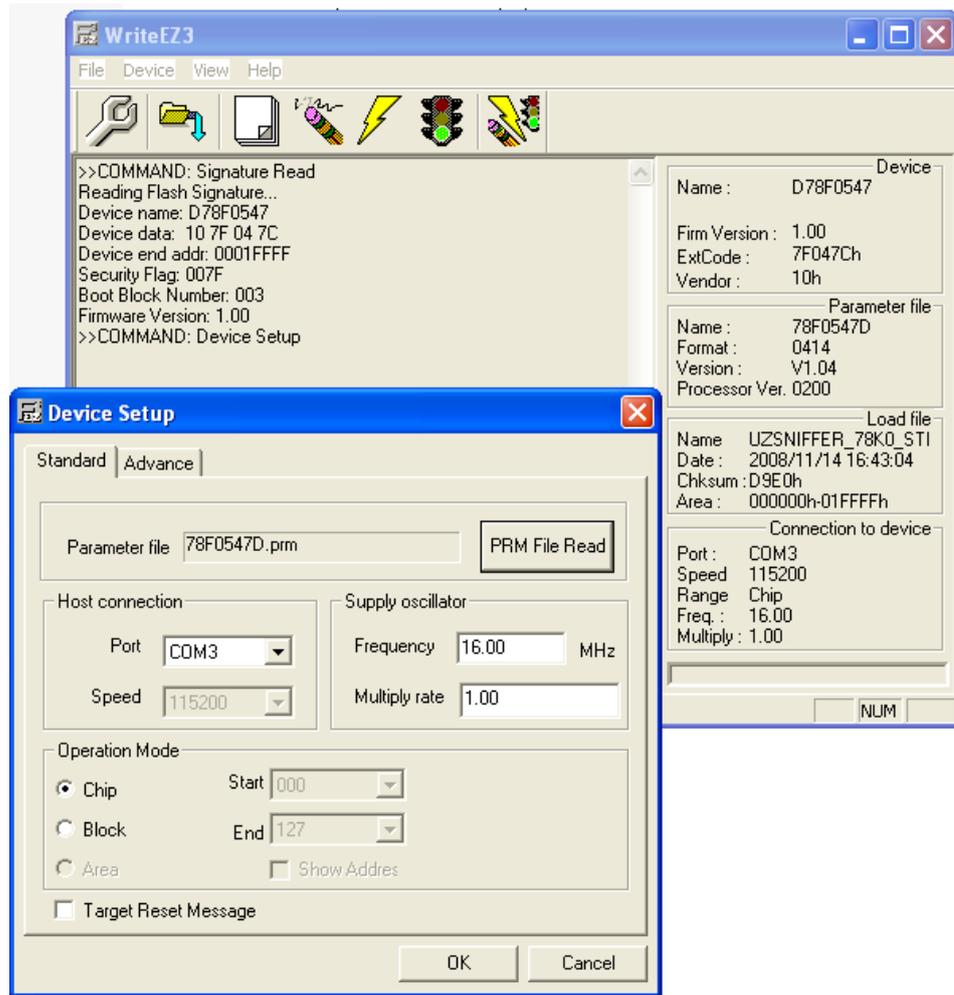
Figure 2-7   WriteEZ3 Device Setup

Write the same sample programs to the other TK-78K0/KF2+UZ boards.

Then, set the position of the switches as shown below:

Table 2-3   Operation mode setting for the TK-78K0/KF2+UZ

SW1 – 1, 2, 3, 4, 5, 6 and 7	OFF
SW1 - 8	ON
SW5	UART

When you run the application, you can run it as a stand-alone system by setting JP1 to 2-3 pin short and using a 6LR61 9V battery connected to CN2. For further details about the power supply settings, please refer to section "*3. Hardware specification*" .

Apply the relevant power supply source to the target boards.

If you select [Display] -> [Network Configuration] and if a Device is connected wirelessly, you can see the red line.
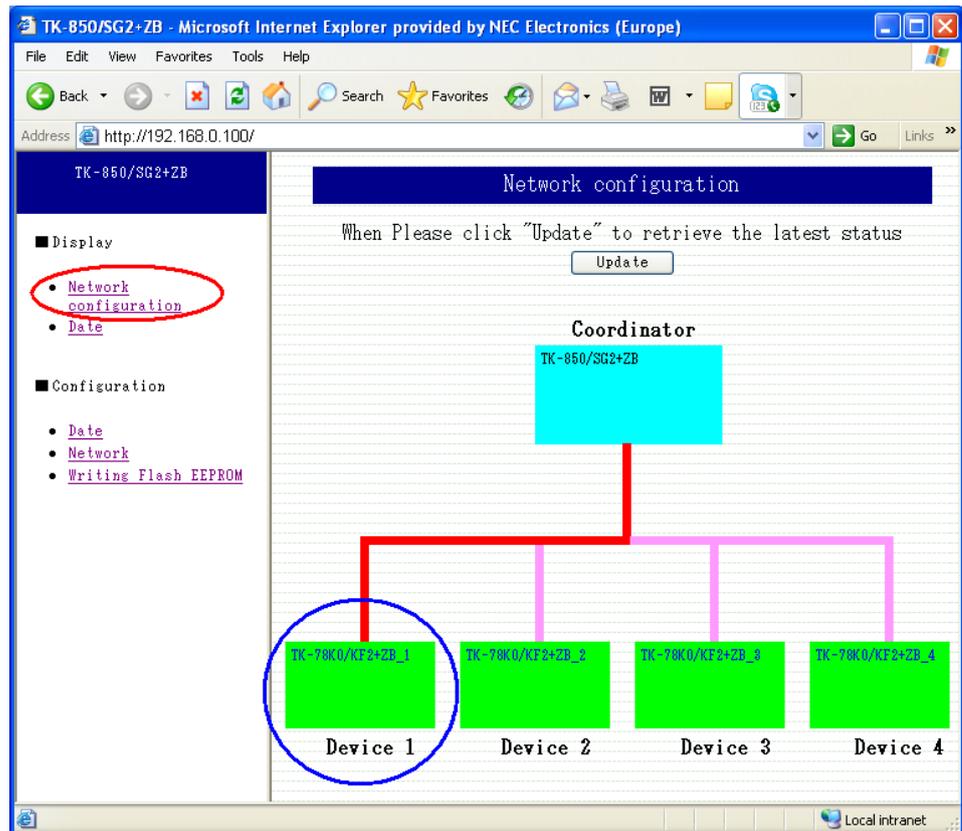
Figure 2-8   Network configuration overview (with a Device connected)

Up to 4 devices can be connected in the sample program. To display the latest status, click the "Update" button. The pink line indicates it is not connected.

The coordinator checks for a device every 30 seconds.

If you click a connected device (double click one of the device green box connected with a red line), you can find the following window.
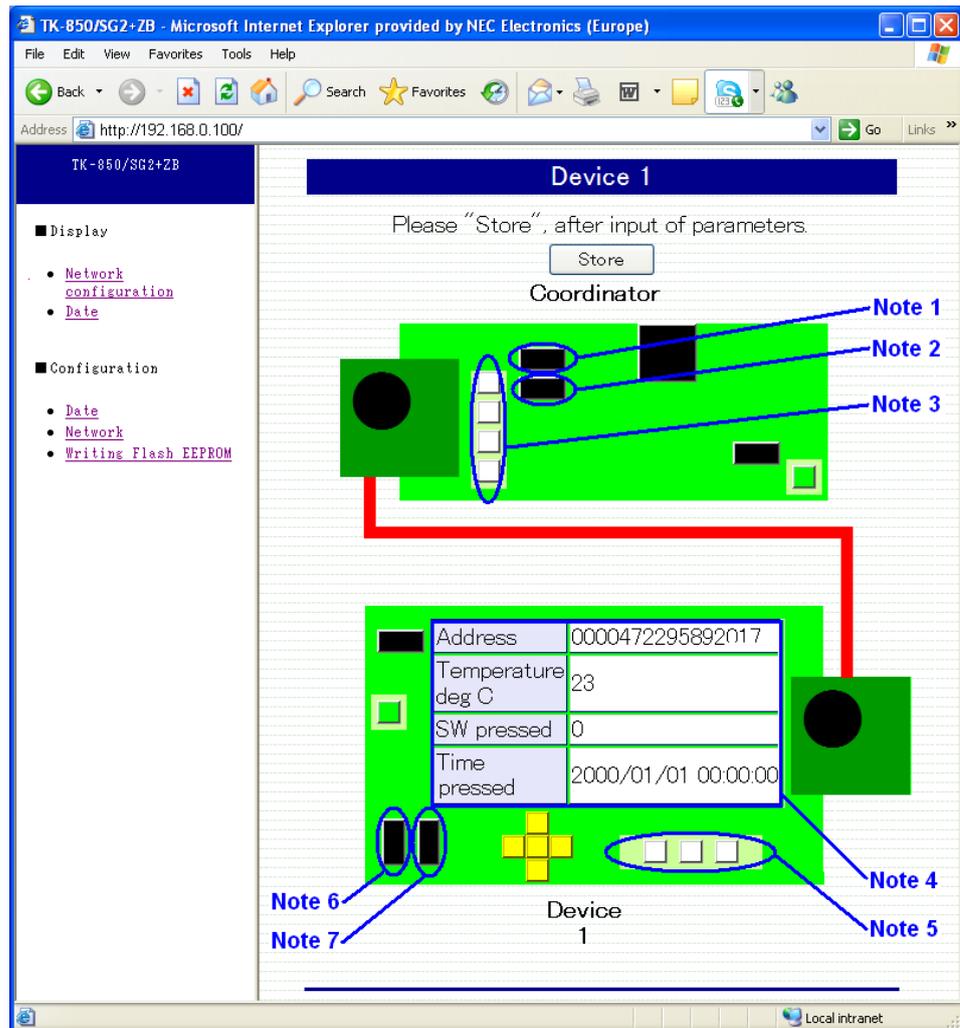
Figure 2-9   Details of a Device connection

The actions that can be performed via the WEB Browser interface are shown below.

Notes   1.   If you click the SW3 of the coordinator, LED3 on the physical Device 1 turns on, and then, off .
2.   If you click the SW2 of the coordinator, LED2 on the physical Device 1 turns on, and then, off.
3.   If you click any LEDs (LED1, LED2, LED3 or LED4), the corresponding LED on the physical board will turn on, and off.
4.   View of status information for the Device:
    •   Address: This is the MAC address of the Device in IEEE 802.15.4.
    •   Temperature: Measured on the Device
    •   SW pressed: Indicates which switch was pressed on the Device.
    •   Time pressed: Time stamp of the pressed switch.
5.   LEDs (LED2, LED3 or LED4) can be on and off.
6.   If the SW3 of the Device is clicked, LED1 of the coordinator is on and off. The information at the Note 4, SW pressed, and Time stamp, will be updated.
7.   If the SW4 of the Device is clicked, LED2 of the coordinator is on and off. The information at the Note 4, SW pressed, and Time stamp, will be updated.

To update to the latest status, click the "*Store*" button.

Following are the different operations that can be directly done on the board:

- On the TK-850/SG2+UZ board:
    - By pressing SW3 on the TK-850/SG2+UZ board, LED3 on the Device 1 becomes on and off.
    - By pressing SW2 on the TK-850/SG2+UZ board, LED2 on the Device 1 becomes on and off

- On a TK-78K0/KF2+UZ board:
    - By pressing SW3 on a TK-78K0/KF2+UZ board, LED1 of the coordinator becomes on and off.
    - By pressing SW4 on a TK-78K0/KF2+UZ board, LED2 of the coordinator becomes on and off.

Please note LED's manipulated on the board are not reflected on the Web browser.

If you click a device, not connected with a red line, you will see the following window.
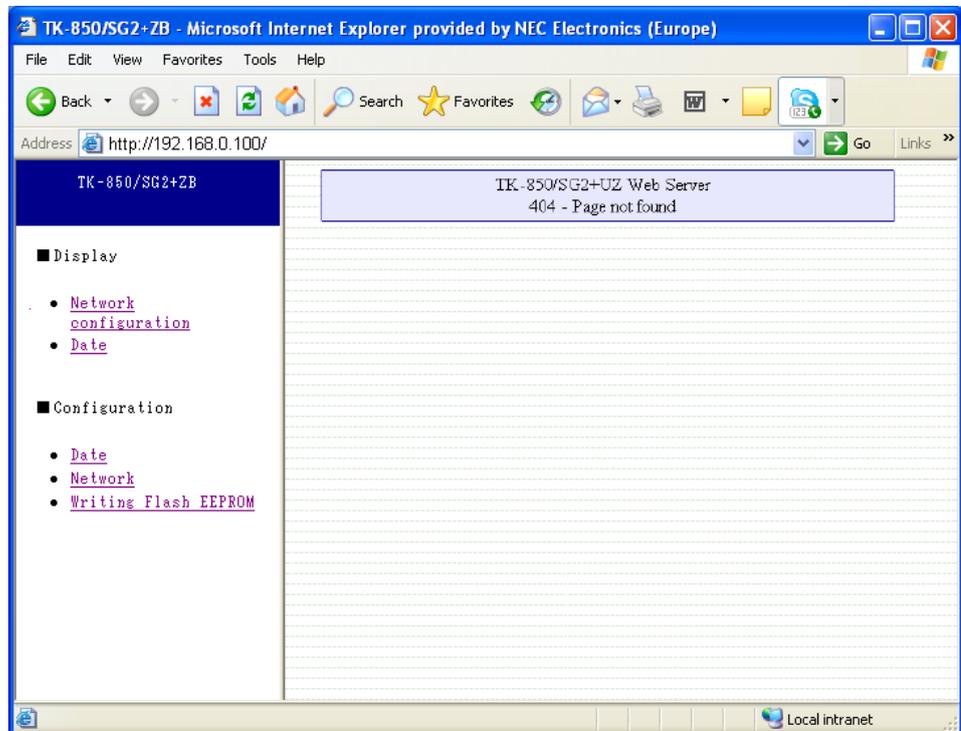
Figure 2-10   Default screen for a non-connected device

Chapter 3 Hardware specification

Table 3-1   General hardware features

Item		Details
CPU	Part number	µPD70F3281YGC-8EU
	Operation with main clock	20 MHz
	Clock	Main = 5 MHz Subclock = 32.768 kHz
	Internal flash memory	384 kB
	Internal RAM	32 kB
	Operation voltage	3.3 V
	I/O voltage	3.3 V
	Special mention	IIC included
		CAN included
USB interface		Mini USB x 1 channel
Serial interface		Equipped with Synchronous/Asynchronous header pin
Ethernet interface		RJ-45 (10/100M) 1Port MAC address setup = External EEPROM State indication LED = 2
CAN		T/H pattern for external connection
RF board		UZ2400 RF Board
Temperature sensor		Temperature sensor x 1
LED		Red x 4 : LED 1 - 4 = Multipurpose Green x 3 : - LED 5 = Power - LED 6 = LAN - LED 7 = LINK
Multipurpose input		4-bit Slide switch x 1 Push switch x 2
Reset Switch		Push switch x 1
N-WIRE/MiniCube interface		Not mounted
On board Flash memory writing		Possible
Power supply		5.0V (USB supply) or 6.0V (battery supply)

3.1 Terminal list

Terminal table of CN1, CN3 and CN4 of the CPU board.

Table 3-2   Connector CN1 terminal list

CN1	Signal name	Terminal CPU name at connection destination	Notes
1	VDD	VDD	
2	P36	P36/CTXD0/IETX0	

CN1	Signal name	Terminal CPU name at connection destination	Notes
3	P37	P37/CRXD0/IERX0	
4	P38	P38/TXDA2/SDA00	
5	P39	P39/RXDA2/SCL00	
6	P53	P53/SIB2/KR3/TIQ00/TOQ00/RTP03/DDO	Both use with N-Wire
7	P54	P54/SOB2/KR4/RTP04/DCK	Both use with N-Wire
8	P55	P55/SCKB2/KR5/RTP05/DMS	Both use with N-Wire
9	P70	P70/ANI0	
10	P71	P71/ANI1	
11	P72	P72/ANI2	
12	P73	P73/ANI3	
13	PCM1	PCM1/CLKOUT	
14	PCM2	PCM2/HLDAK	
15	PCM3	PCM3/HLDRQ	
16	PCT1	PCT1/WR1	
17	GND	GND	
18	PDH4	PDH4/A20	
19	GND	GND	
20	PDH5	PDH5/A21	
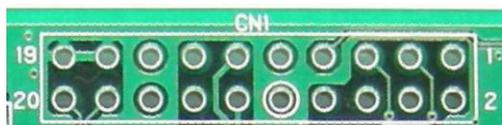
Figure 3-1 Connector CN1 pin configuration

Table 3-3 Connector CN3 terminal list

CN3	Signal name	Terminal CPU name at connection destination	Notes
1	GND	GND	
2			N.C.
3	VREG_EN	P02/NMI	Output from CPU
4			N.C.
5	RESn	P03/INTP0/ADTRG	Output from CPU
6	FIFO	P10/ANO0	Input to CPU
7			N.C.
8	FIFOP	P06/INTP3	Input to CPU
9			N.C.
10	CCA	P11/ANO1	Input to CPU
11			N.C.
12	SFD	P33/TIP01/TOP01	Input to CPU
13			N.C.
14	CSn	P34/TIP10/TOP10	Output from CPU
15			N.C.
16	SCLK	P42/SCKB0	Output from CPU

CN3	Signal name	Terminal CPU name at connection destination	Notes
17			N.C.
18	SI	P41/SOB0	Output from CPU
19	GND	GND	
20	SO	P40/SIB0	Input to CPU

Table 3-4   Connector CN4 terminal list

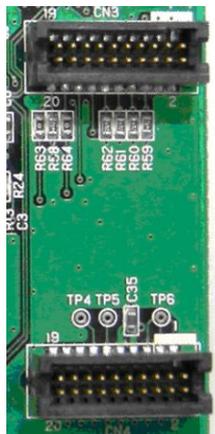| CN4	Signal name	Terminal CPU name at connection destination	Notes
1	TP6		
2	GND	GND	
3	TP6		
4	GND	GND	
5	TP6		
6	GND	GND	
7	3.3V		
8	GND	GND	
9	3.3V		
10	GND	GND	
11	TP5		
12	GND	GND	
13	TP4		
14	GND	GND	
15			N.C.
16	GND	GND	
17			N.C.
18	GND	GND	
19			N.C.
20	GND	GND	

Figure 3-2   Connector CN3 (top) and CN4 (bottom) pin configuration

3.2 Switches and LED

3.2.1 SW1, JP1

Bit1, 2, 3 and 4 of SW1 are dip switches for Operation Mode setting.

Bit5, 6, 7 and 8 of SW1 are connected to P74, P75, P76 and P77 for multipurpose input.

JP1 is a jumper to select a power source.
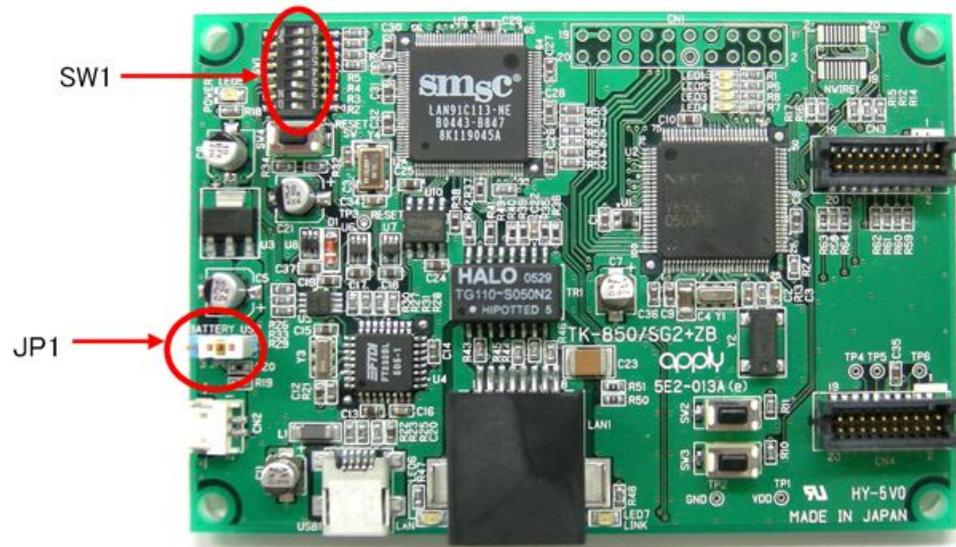
Figure 3-3   SW1 and JP1

3.2.1.1 Flash Programming Mode with WriteEZ1

The Flash memory of the V850ES/SG2 microcontroller (integrated in the TK-850/SG2+UZ board) can be programmed using the attached software WriteEZ1 in your PC, if the following switch and jumper settings are made.

Table 3-5   Flash programming mode settings for the TK-850/SG2+UZ

SW1	Bit 1	ON
	Bit 2	OFF
	Bit 3	ON
	Bit 4	ON
JP1		USB side (1-2-pin short)

3.2.1.2 On-chip debug Mode with the IAR TK-interface

The following setting activates the On-chip debug functions for the TK-850/SG2+UZ board.

Table 3-6   **On-chip debug mode settings for the TK-850/SG2+UZ**

SW1	Bit 1	ON
	Bit 2	ON
	Bit 3	ON
	Bit 4	OFF
JP1		USB side (1-2-pin short)

3.2.1.3 N-Wire Connecting Mode

Change to the following settings when you connect to N-Wire emulator to the TK-850/SG2+UZ board.

Table 3-7   **N-wire connecting mode settings for the TK-850/SG2-UZ**

SW1	Bit 1	ON or OFF [Note]
	Bit 2	OFF
	Bit 3	OFF
	Bit 4	OFF
JP1		USB side (1-2-pin short)

Note: Please set ON, if you make COM communication to host machine using the P30/TXDA0,P31/RXDA0 pin.

3.2.1.4 Normal Operation Mode

Change to the following settings when you execute the program normally. Select the power source chosen with the JP1.

Table 3-8   **Normal operation mode settings for the TK-850/SG2+UZ**

SW1	Bit 1	OFF
	Bit 2	OFF
	Bit 3	OFF
	Bit 4	OFF
JP1		USB powered (1-2-pin short) Battery powered with CN2 (2-3-pin short)

3.2.1.5 General purpose setting port

Bit 5, 6, 7 and 8 of SW1 are general purpose setting ports.
The port state is "Low" because it is connected to GND when the switch is ON.
The port state is "High" because it is connected to a 10kΩ pull-up resistor, when the switch is OFF.

Table 3-9   **Switch SW1 terminal list**

SW1	Signal name	Terminal CPU name at connection destination
Bit 5	P74	P74/ANI4
Bit 6	P75	P75/ANI5
Bit 7	P76	P76/ANI6
Bit 8	P77	P77/ANI7

3.2.2 SW2, SW3

SW2 and SW3 are push switches. They are connected to pull-up resistors, and their outputs go "Low", when they are pushed.

Table 3-10   **Switch SW2 and SW3 terminal list**

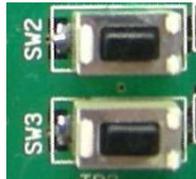| Switch	Signal name	Terminal CPU name at connection destination
SW2	P50	P50/TIQ01/TOQ01/RTP00/KR0
SW3	P51	P51/TIQ02/TOQ02/RTP01/KR1

Figure 3-4   **Switches SW2 and SW3**

3.2.3 SW4

SW4 is the reset switch. The TK-850/SG2+UZ board is reset when SW4 is pushed.

Figure 3-5   **Switch SW4**

3.2.4 LED5

The `Power LED' LED5 is activated when the power supply is turned on.

Figure 3-6   **LED5 as Power LED**

3.2.5 LED1, LED2, LED3 and LED4

LED1, 2, 3 and 4 are available for applications. To turn on a LED, set the output port to "Low".

Table 3-11   **LED 1, 2, 3 and 4 terminal list**

LED	Signal name	Terminal CPU name at connection destination
LED1	PDH0	PDH0
LED2	PDH1	PDH1
LED3	PDH3	PDH3

LED	Signal name	Terminal CPU name at connection destination
LED4	PDH2	PDH2

Figure 3-7   LED 1, 2, 3 and 4

3.3 LAN Controller

The TK-850/SG2-UZ board has a LAN controller, LAN91C113 made by SMSC.

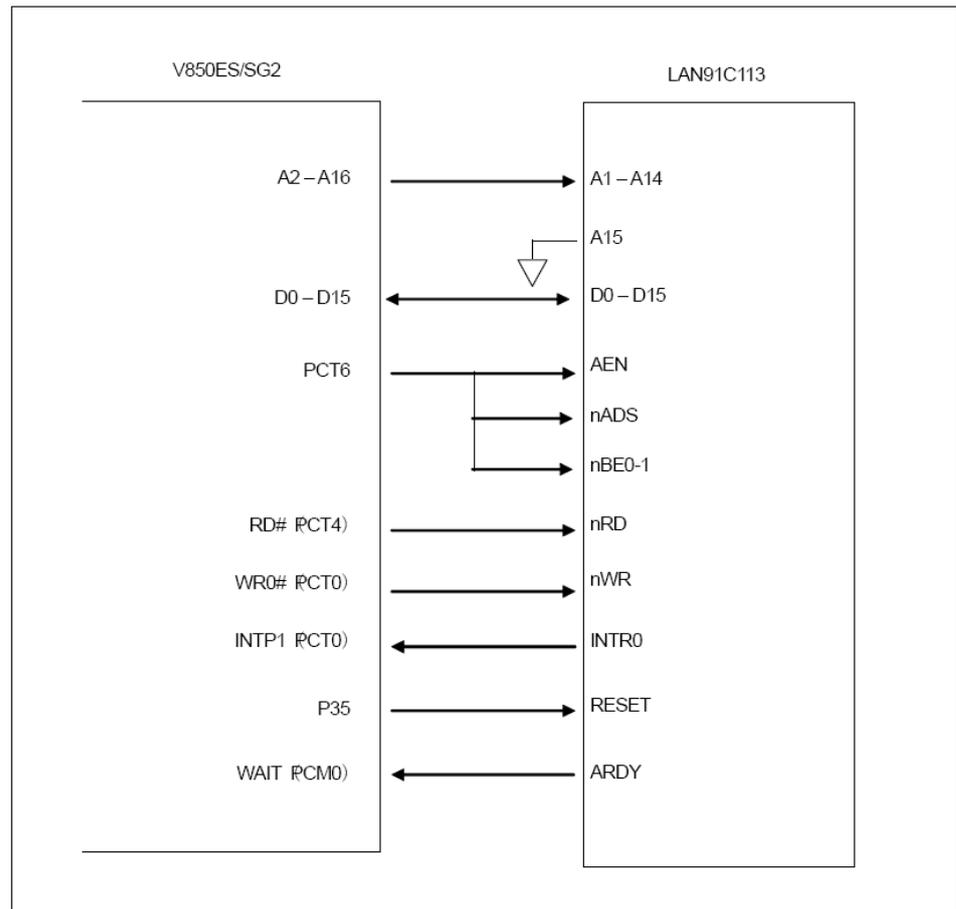### 3.3.1 Connection

Connection of CPU to LAN controller is below.

Figure 3-8   V850ES/SG2 and LAN controller pin connection

3.3.2 Reset of LAN Controller

P35 is used to reset the LAN controller. When P35 is Hi-z after CPU reset, the LAN controller will be in reset state. Before releasing the reset, please change the CPU port "Chip Select Signal (AEN,nADS)" and "Read/Write Signal" to be inactive level. And then drive the P35 to "Low". And release the reset.

The Ethernet MAC address is initialized by the contents of the serial EEPROM, after release of the reset.

3.3.3 Access to the LAN Controller

It is necessary to set the microcontroller to external bus mode to access the LAN controller. The external LAN controller is configured to operate in 16-bit (word) mode, and therefore, the external bus will need to be set-up for "word wide" read and write access modes.

3.4 Temperature Sensor

The TK-850/SG2+UZ board has a temperature sensor for measuring the ambient temperature of the PWB board. It is connected to the analogue input pin P79/ANI9 of the microcontroller.

- Temperature sensor S-8120C (Made by SII)
- Power supply of sensor : +3.3V
- Linear output voltage : -8.20mV/°C (from -20°C to 80°C)

Please refer to the datasheet for details.

3.5 Power Supply

There are two choices to supply power to the board, USB or a 6LR614 9V battery via CN2. Please refer to the following table for the jumper setting.

Table 3-12 **JP1 Setting for the power supply source**

JP1	USB Power	USB (1-2-pin short)
	Battery	CN2 (2-3-pin short)

Please replace the battery with a new one, if the voltage level goes down to 4.75V. Below the voltage level of 4.75V, functions of the board are not guaranteed. The battery voltage can be checked at the port as shown below.

Table 3-13 9V Battery checking

Signal name	Terminal CPU name at connection destination	Notes
BT_MONI	P78/ANI8	About 0.265 times of input power supply For instance If the battery level 6.0V: The level of the BT_MONI = 0.265x6.0 = 1.59(V) If the battery level is 4.75V: The level of the BT_MONI = 0.265x4.75 = 1.25(V)

Chapter 4 TK-850/SG2+UZ Data
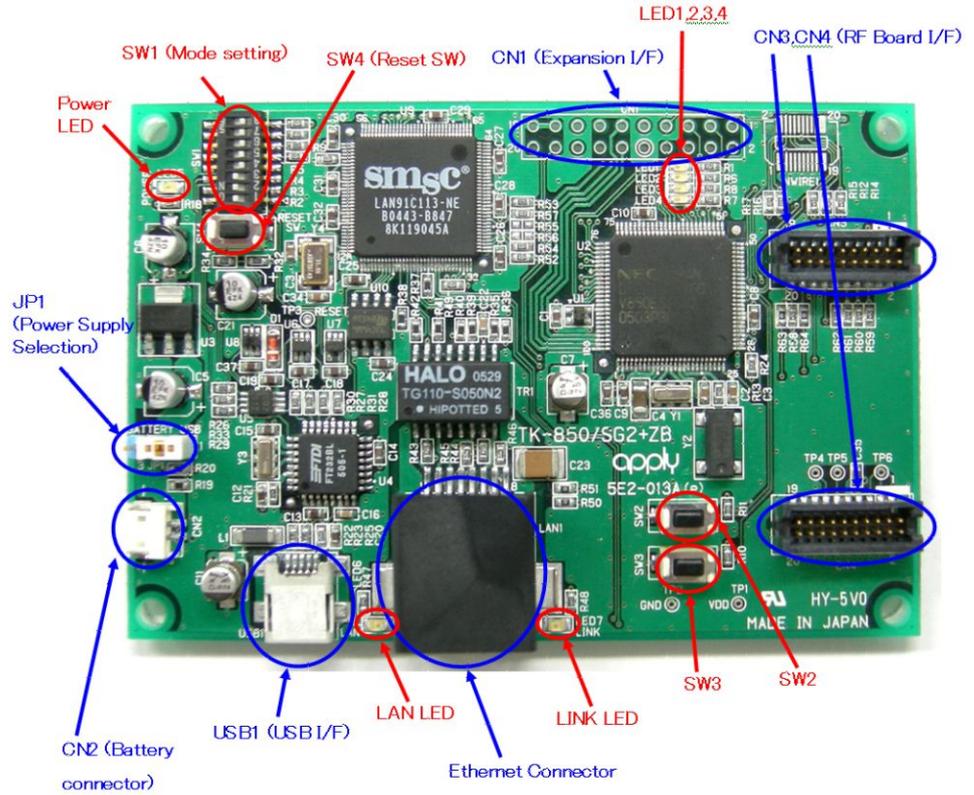
4.1 Parts Layout

Figure 4-1   Hardware overview of theTK-850/SG2+UZ board

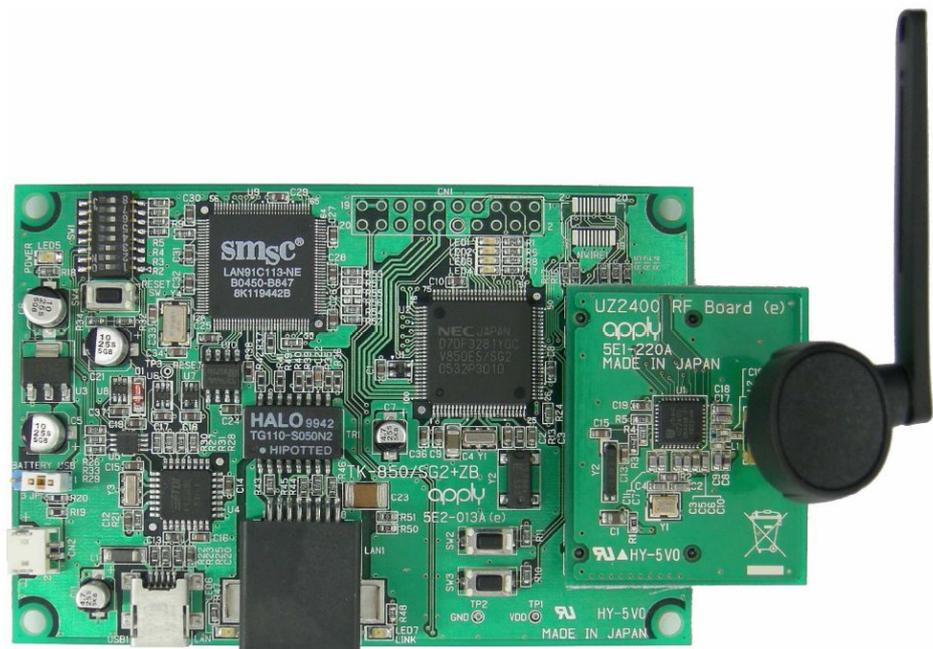## 4.2 RF Board connection figure

Figure 4-2   Overview of the connection of the RF board

Chapter 5 Programming the TK-850/SG2+UZ with WriteEZ1

WriteEZ1is the flash memory programming software which can erase and program directly the flash memory of the microcontroller of the board via the USB interface.

For details about the installation of the Flash Programmer WriteEZ1 software or about the driver required for use, please refer to the section "*6. V850 ZigBee Gateway Development Platform, Installation and Operation*"

To use WriteEZ1, please set the mode switch on the TK-850/SG2+UZ board as follows. Then, please connect the board to your PC with a USB cable.

Table 5-1 **Flash programming mode settings for the TK-850/SG2+UZ**

JP1		1-2-pin short (USB side)
SW1	Bit 1	ON
	Bit 2	OFF
	Bit 3	ON
	Bit 4	ON
	Bit 5	OFF
	Bit 6	OFF
	Bit 7	OFF
	Bit 8	OFF

Please start WriteEZ1 by selecting [Programs] -> [NEC Electronics Tools] -> [WriteEZ1] in your Windows [Start] menu.
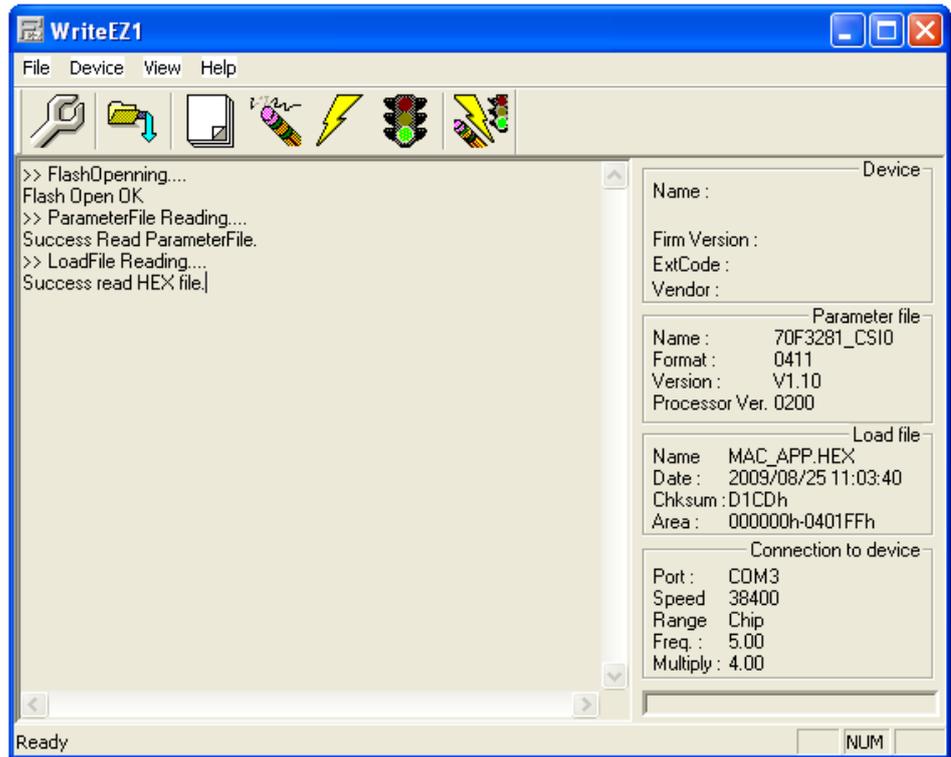
Figure 5-1   GUI interface of the Flash programmer WriteEZ1

Please select the "Setup" button in the menu bar or [Device] -> [Setup].
Then select the"PRM File Read" button.

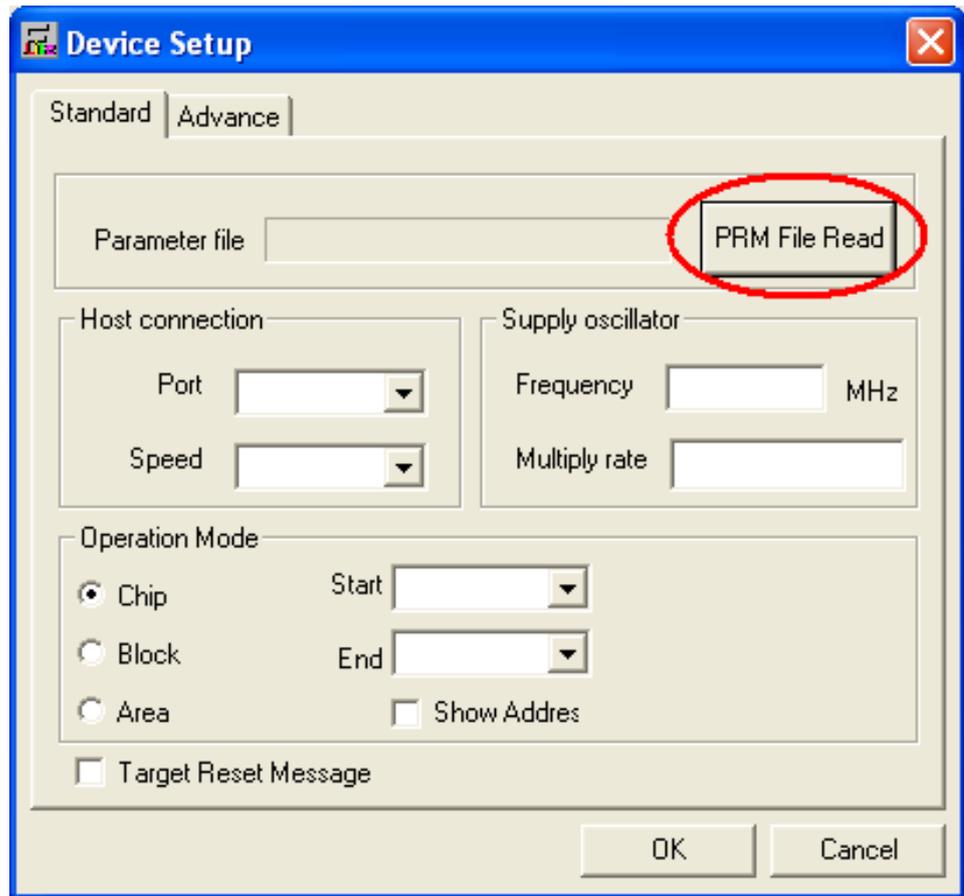**Figure 5-2   Device setup screen**

The PRM file contains the device-specific parameter required for programming.
You will also find the PRM files in the CDROM in the following directory:
<CD>\NEC Tools 32\PRM-70F3288_V111
Please select the following PRM file:
<CD>\NEC Tools 32\PRM-70F3288_V111\70F3281_CSI0.prm
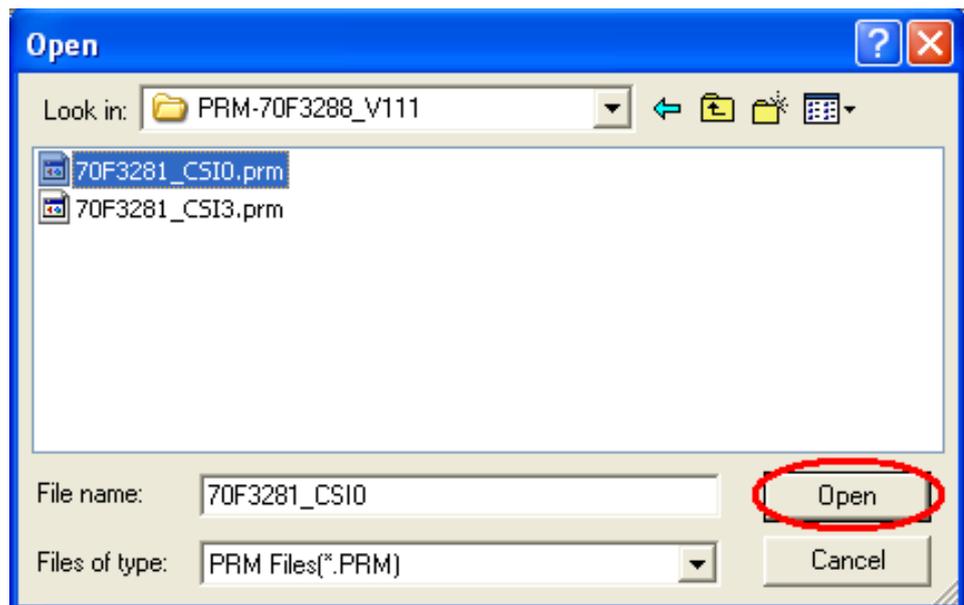
Figure 5-3   Choice of the parameter file PRM for the V850ES/SG2 microcontroller

Select the COM port number you connected your PC with the TK board. All of COM port numbers available on your PC will be displayed.
Set "Speed" to 38400, "Frequency" to 5.00, "Multiply rate" to 4.00.
Then, press "OK".
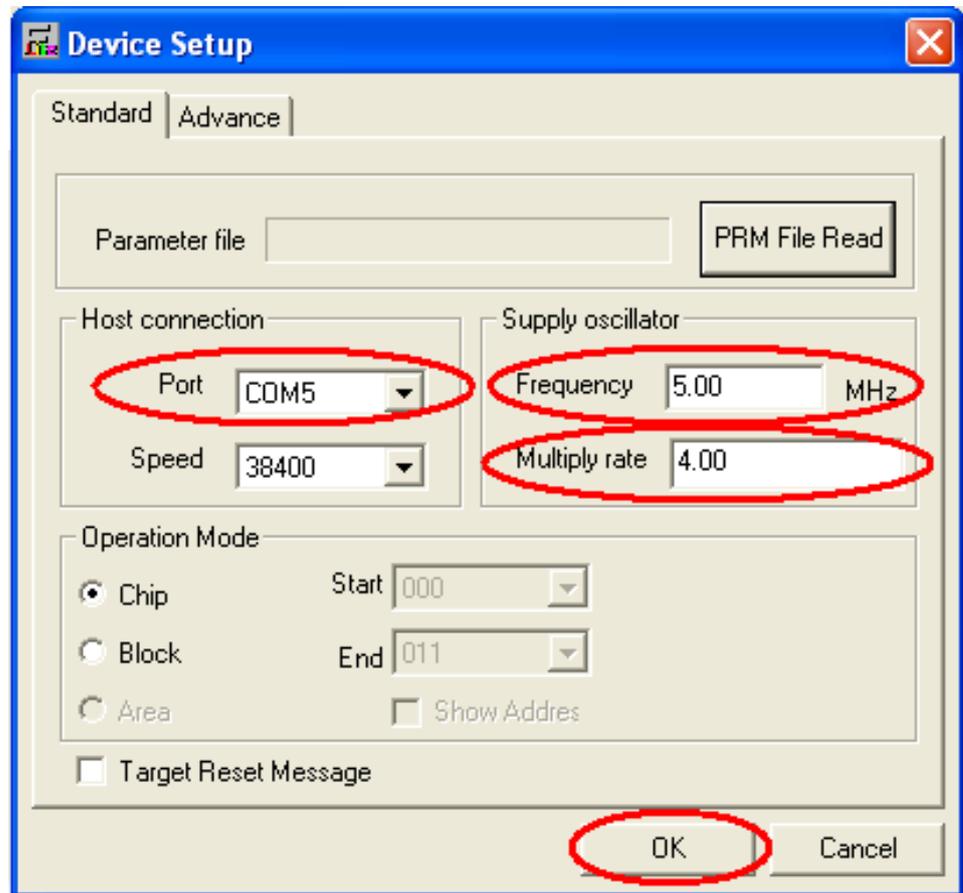
Figure 5-4   **Setting the parameters for the flash programming session**

Next, load the HEX file that you want to program to WriteEZ1. Click "Load" to open the file "mac_app.hex", which you created in the section "*7.4 Generating a Hex file for flash programming*".
When successfully loaded, "Success read HEX file." is displayed.
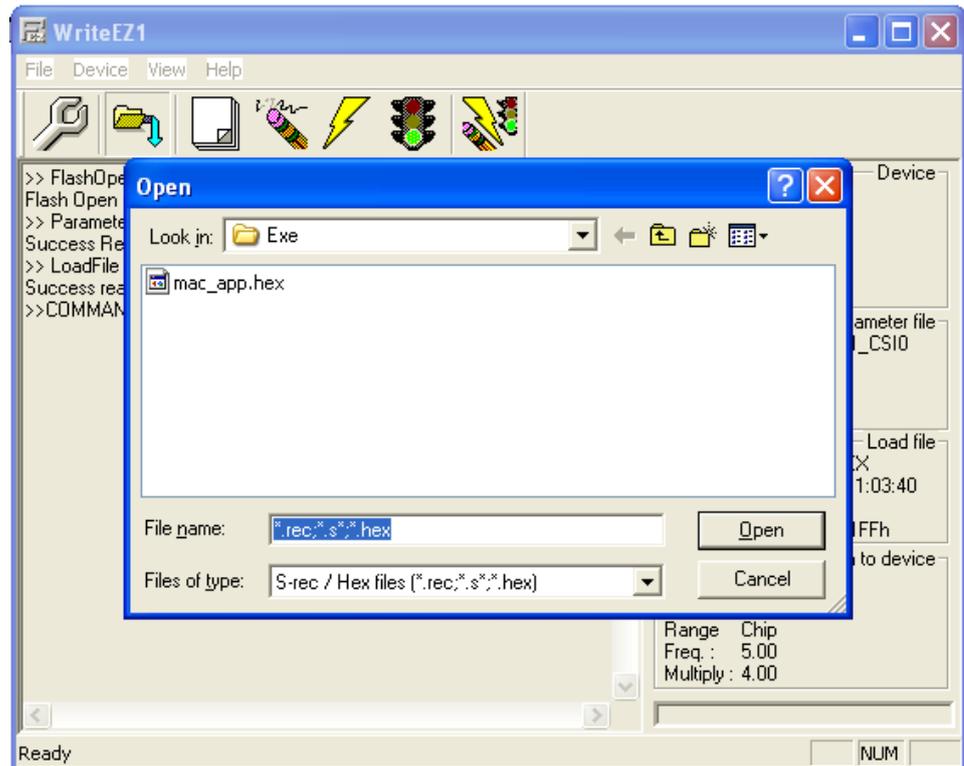
Figure 5-5   Loading the executable file .HEX

Next, write the programs by clicking "Auto procedure".
When "Auto procedure" is clicked, it processes the "Erase" and "Program" commands.
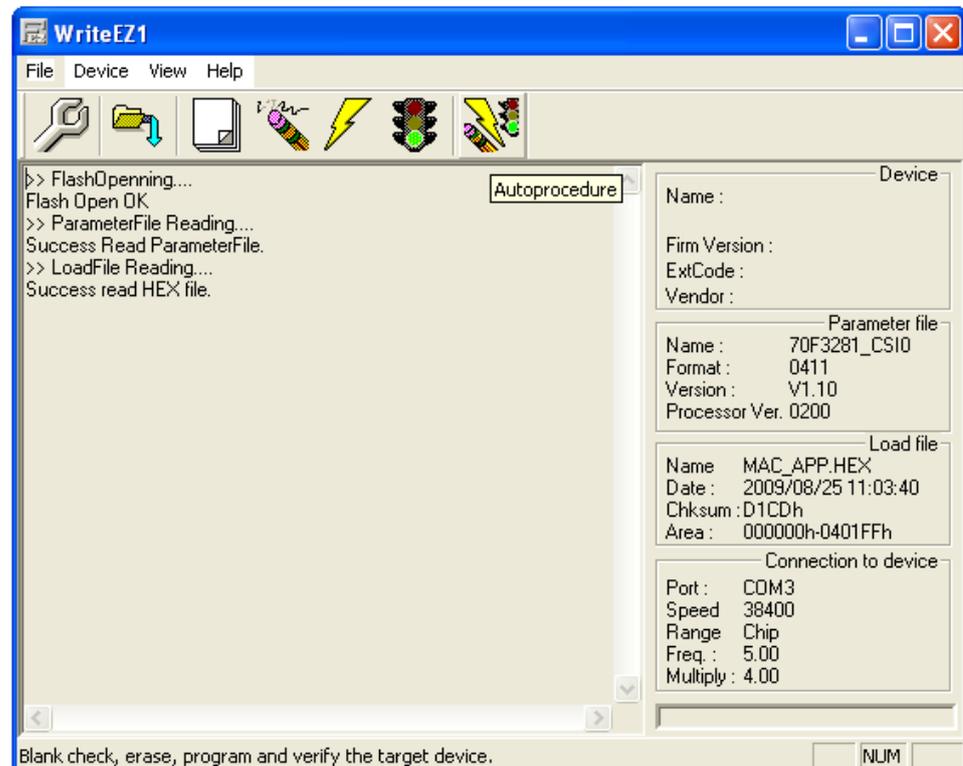
Figure 5-6   Starting the «Auto Procedure» to erase and program the Flash memory

When "Flash internal Verify OK!", is displayed it means the flash memory writing has successfully completed.

The programs are successfully written to the Flash memory of the V850/SG2 integrated in the board TK-850/SG2+UZ.
Disconnect the USB cable from TK-850/SG2+UZ board.

Chapter 6 V850 ZigBee Gateway Development Platform, Installation and Operation

The IAR Embedded Workbench including the C-SPY debugger allows the user to build and download application programs to the *V850 ZigBee*^{TM} *Gateway Development Platform*. As the communication interface between the PC host system and the *V850 ZigBee*^{TM} *Gateway Development Platform* board is USB, a USB interface line is needed. Before you can download and run a program, relevant software and hardware must be installed properly.

CDROM contents:

- IAR Embedded Workbench for V850 Kickstart version
- GUI Software for flash programming
- IEEE 802.15.4 MAC library
- Sample Programs
- Documentation

6.1 Hardware Installation

After unpacking *V850 ZigBee*^{TM} *Gateway Development Platform*, connect the board to your host computer using the provided USB interface cable. When *V850 ZigBee*^{TM} *Gateway Development Platform* is connected, the USB driver needs to be installed on the host machine. Please refer to the specific section "*6.3 USB Driver Installation*" .

6.2 Software Installation

The *V850 ZigBee*^{TM} *Gateway Development Platform* package comes with the following software demo packages:

- IAR Systems Embedded Workbench for V850 including C compiler, assembler, linker, librarian and IAR C-SPYdebugger / simulator
- GUI software for flash programming
- Sample programs

6.2.1 IAR Systems Embedded Workbench installation

The IAR Systems Embedded Workbench must be installed on your PC. For detailed installation hints, refer to the corresponding documentation of the IAR Embedded Workbench: "IAR Systems Embedded Workbench for V850 installation".

To install the IAR Systems Embedded Workbench for V850 including C-SPY debugger / simulator, select the AUTORUN program in the directory <CD>\IAR of the CDROM. The setup dialogues will guide you through the installation process.

6.2.2 GUI software WriteEZ1 for Flash Programming

The GUI software WriteEZ1 for flash programming is required to program the Nodes with the Sample Programs. To install the WriteEZ1, select the "setup.exe" program that can be found in the following directory in the CDROM provided: <CD>\NEC Tools 32\WriteEZ1. The setup dialogues will guide you through the installation process.

You will also need to install the USB driver required to emulate the UART communication (which is the only one supported for the flash programming interface) by the USB communication. Details about the installation procedure can be found in the section "*6.3 USB Driver Installation*" .

6.2.3 Sample Program Installation

To install the sample/demonstration program for the *V850 ZigBee^{TM} Gateway Development Platform* board, select the SETUP program in the directory <CD> \SamplePrograms\ of the CDROM. The setup dialogue will guide you through the installation process.

6.3 USB Driver Installation

In order to use the *V850 ZigBee^{TM} Gateway Development Platform* board for On-Chip debugging or FLASH programming, the USB driver needs to be installed on the host machine. Two different drivers need to be installed:

- the USB serial converter
- the USB serial port

Install the drivers according to the following procedure:

- • Installation on Windows 2000
- • Installation on Windows XP

6.3.1 Installation on Windows XP

When the *V850 ZigBee™ PRO Gateway Development Platform* board is connected with the host machine, the board is recognized by Plug and Play, and the wizard for finding new hardware is started. Check that "Install from a list or specific ..." is selected, then click Next >.

Figure 6-1   Found New Hardware Wizard 2 (Windows XP)

Check "Include this location in the search:" check box and browse to the NEC Tools 32\drivers_virtual_uart\FTDI folder.

Click "Continue Anyway" when prompted to the Windows XP certification compatibility.

Confirmation of USB Driver Installation

After installing the two types of drivers, check that the drivers have been installed normally, according to the procedure below. When using the board in combination with WriteEZ GUI, the information to be checked here is needed.

By clicking the "Device Manager" tab, check that the drivers are installed normally.
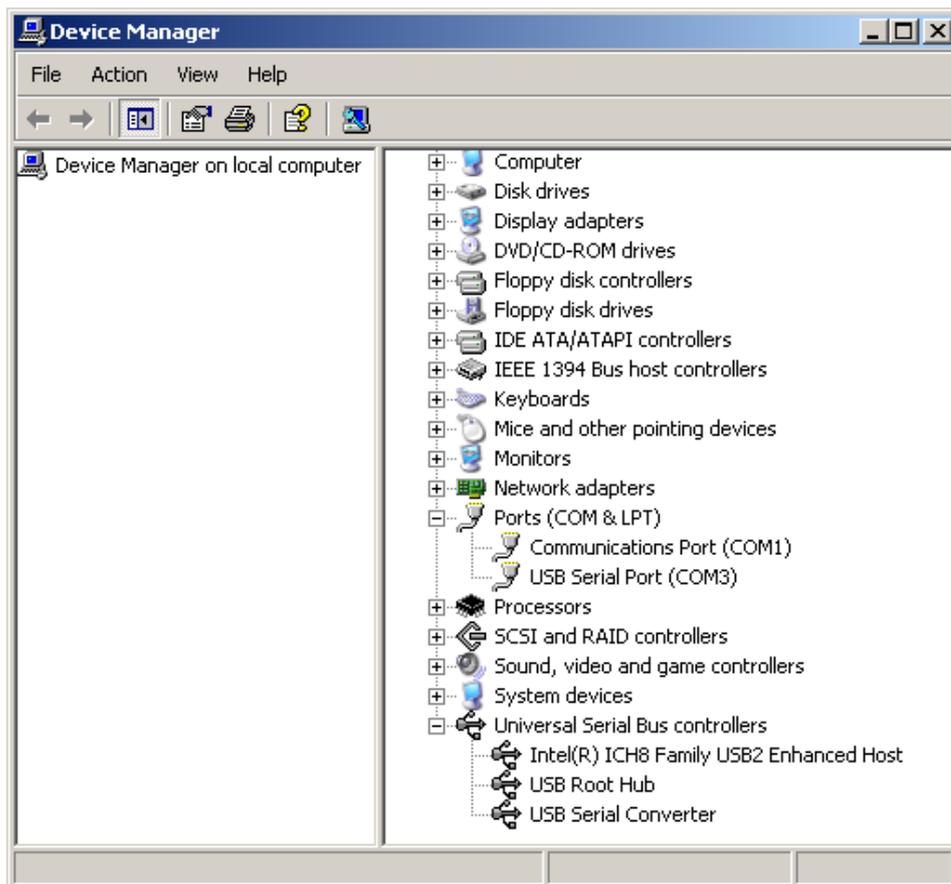
Figure 6-2   Device Manager

For Windows 2000/XP

Caution   Do not perform "Hardware Modification Scan" when communicating with the target device.

Remark   In the flash programming WriteEZ GUI port list box, the same communication port as COMxx of the USB Serial Port (in this case COM3 as shown in above screenshot) needs to be selected.

Chapter 7 IAR Sample Session

7.1 Sample Structure

The V850 ZigBee^{TM} Gateway sample projects for IAR Systems Embedded Workbench can be found directly in the CDROM in the folder:
<CD>\SamplePrograms\SamplePrograms, or can be found in the directory where they have been installed by the automatic process of the CDROM (see section *"6.2.3 Sample Program Installation"*).

The sample projects are using the following folder structure:
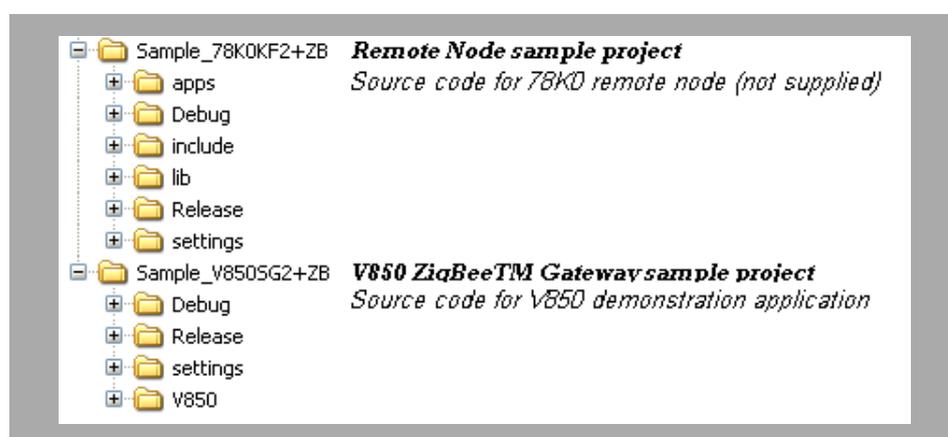

Figure 7-1 **Sample Programs project structure**

Below is the detailed structure of the V850 ZigBee^{TM} Gateway Sample Project

Figure 7-2 **Sample project structure**

Below is the detailed structure of the Web page file that can be found in the directory <CD>\Web page conversion program.
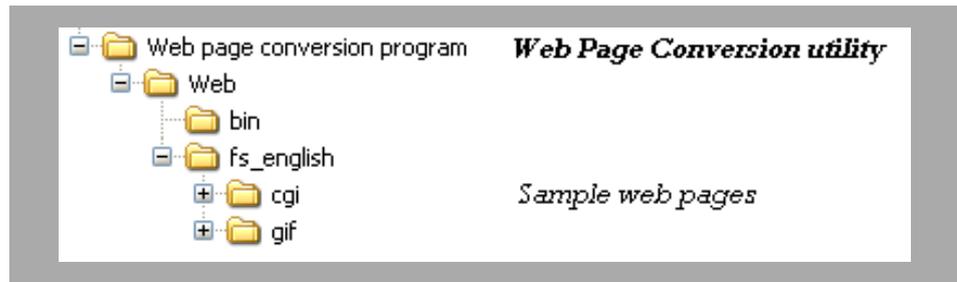
Figure 7-3   Web page file structure

To create your own application using the MAC & TCPIP-stack, please make a copy of the sample and use it as a template. All output files generated by the development tools are located in a subfolder using the name of the corresponding target. You can delete this folder before copying the sample application.

7.2 Project Loading

When everything is set up correctly the IAR Embedded Workbench can be started. To do so, start the Embedded Workbench from Windows [Start] menu -> [Programs] -> folder [IAR Systems] -> [IAR Embedded Workbench Kickstart for V850]. The following screen appears:
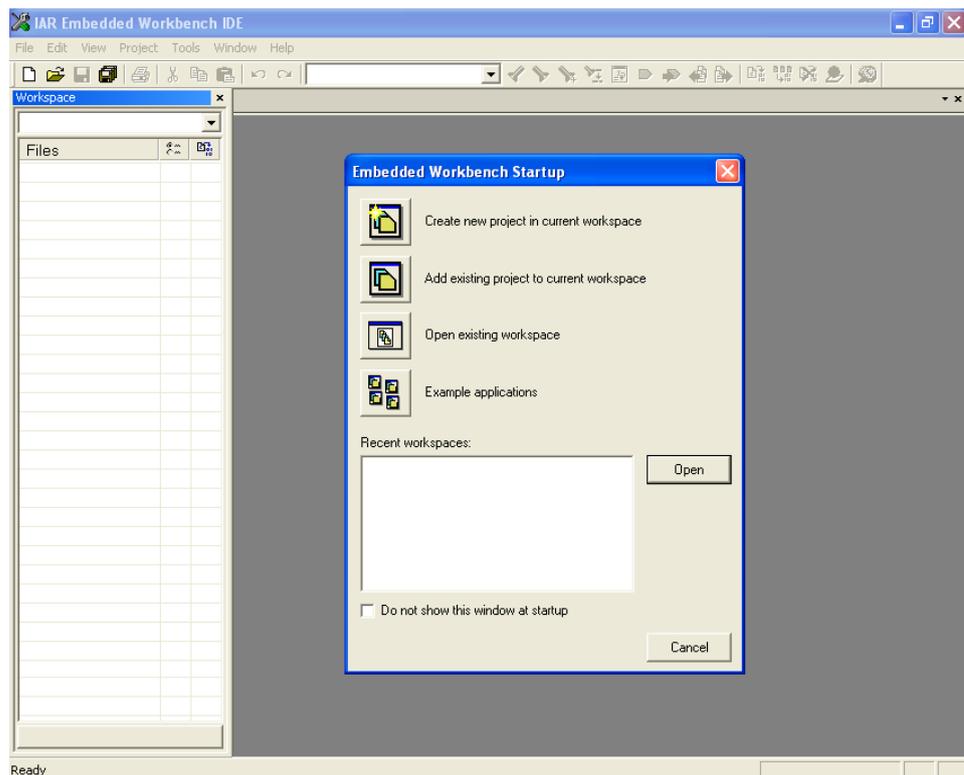
Figure 7-4   IAR Embedded Workbench startup screen

Now select the option [Open exiting workspace] from the [File] menu and locate the V850 ZigBee™ Gateway sample program in the folder "Sample_V850SG2 +ZB". You will find the IAR Workspace (*.eww) called "V850_UZ_SG2.eww" containing ready to use sample project.

Please load the sample workspace located in the "Sample_V850SG2+ZB" directory.
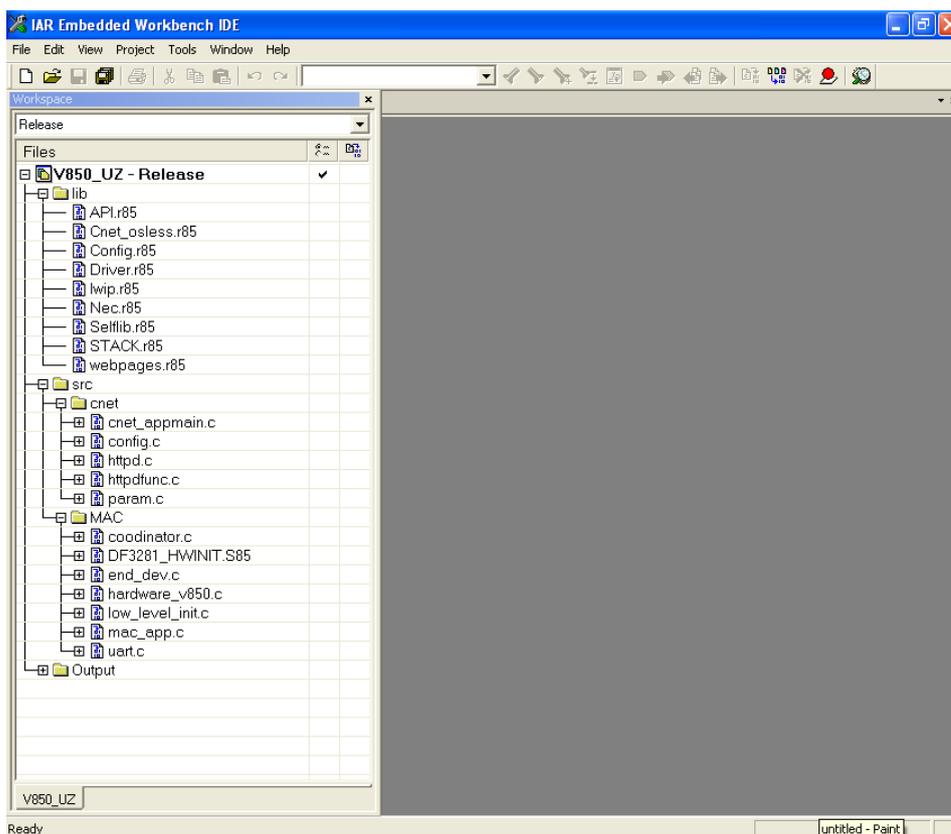
Figure 7-5   **Opening the V850_UZ Sample Project**

The above screen shows the sample project layout including the main system libraries (LIB group) and source files (SRC group). The CNET group contains the relevant application source files associated with the TCPIP libraries and the MAC group contains all the source files associated with the IEEE 802.15.4 library.

7.3   Sample Debug session using the TK interface

Before commencing a TK interface debugging session ensure that the USB driver has been correctly installed. The *V850 ZigBee[TM] Gateway Development Platform* uses a monitor program for debugging purposes. The communications between the starter kit and the IAR C-Spy debugger running on the PC is done via a standard UART / USB connection. The monitor program is automatically downloaded to the starter kit during connection therefore the user does not need to take core of the monitor program itself.

Monitor Resources

The following resources are utilised by the monitor program and cannot be used by the user program when debugging by the TK interface.

Table 7-1   **Resources used by the debugging monitor**

Device	UART for debugging	Interrupt control flags	Terminals used
V850ES/SG2 (µPD70F3281Y)	UARTD0	UD0RMK UD0SMK	P30/TxDD0 P31/RxDD0

Additionally, please note the following points:

- Do not change the control registers of UARTD0.
- Do not change or disable the interrupt control / mask flags of UARTD0.
- Do not change the port mode or port mode control registers for port bits P30 and P31.
- Debugging functions like forcible break (debugger stop command) do not operate normally in the following states where the clock supply to UARTD0 is disabled:
  - IDLE mode
  - STOP mode
  - Main oscillation (fx) is stopped.

Monitor Interrupt Vectors

The following interrupt vectors are used by the monitor program and cannot be used by the user program.

Table 7-2   **Monitor interupt vectors**

Device	Interrupt Vector Adress	Function
V850ES/SG2 (µPD70F3281Y)	0x0060-0x0063	DBTRAP debug interrupt vector
	0x02C0-0x02C3	UARTD0 receive interrupt vector
	0x02B0-0x02B3	UARTD0 status interrupt vector

Monitor Reset Vector

When a user program is downloaded by using the IAR C-SPY debugger, the reset vector (address 0x0000) of the user program is replaced by the one of monitor program. The debugger moves the reset vector of the user program automatically to address 0x0004. The correction of the relative jump address is also done automatically by the debugger.

Example:

0x0000	MOV	_start, R31
0x0006	JMP	R31
0x0008		

0x0000	JR monitor	
0x0004	MOV	_start, R31
0x000A	JMP	R31

Figure 7-6   **Monitor Reset**

Memory Area reserved for monitor

The monitor program is located in the highest FLASH block of the V850ES/SG2 device. Only 2 kB of memory are allocated by the monitor program.

Table 7-3   **Memory area reserved for monitor**

Device	Address range	Function
V850ES/SG2 (µPD70F3281Y)	ROM: 0x5F800 - 0x5FFFF RAM: 0xFFFF EFF0 - 0xFFFF EFFF	Reserved for monitor program

Moreover, the monitor reserves 10 bytes of the global stack area by halting the user program, caused by a forcible break (debugger stop command) or a software breakpoint.

Clock operation

After releasing a reset, the monitor program sets the operation clock of the CPU to the maximum speed of 20 MHz. The monitor program switches also to the maximum CPU speed of 20 MHz when releasing a forcible break (debugger stop command) or when the user program execution is stopped caused by a software breakpoint. After the user program execution is restarted (debugger go command), the monitor restores the previous CPU operation clock setting.

Note   Do not change the frequency of the external oscillator connected to the X1 and X2 pins.
The baud rate calculation for UARTD0 is based on a 4 MHz input frequency, otherwise no communication to the *V850 ZigBee^TM Gateway Development Platform* board can be established.

Other limitations

The watchdog timer can not be used. Please be sure to set the option bytes of the V850ES/SG2 device accordingly to allow the watchdog timer disable.

The forcible break (debugger stop command) can not be used when the global interrupts were disabled by the user program (DI instruction).

Debug sessions

The debug session is done directly by connecting the *V850 ZigBee^TM Gateway Development Platform* board to the host PC via the USB cable. The TK interface of IAR manages the debug session by using the serial interface that is connected to the USB connecter of the TK-850/SG2+UZ. When using the TK interface serial communications via UARTD0 is disabled to prevent a clash with the monitor program. A pre-processor directive has been employed to ensure that the relevant application code is disabled during a debug session. Please ensure that the HARDWARE_NOUART pre-processor option is set in [Project] -> [Options] -> [C\C++ Compiler] -> [Pre-processor] is set and, if necessary, rebuild the application prior to starting the debug session.
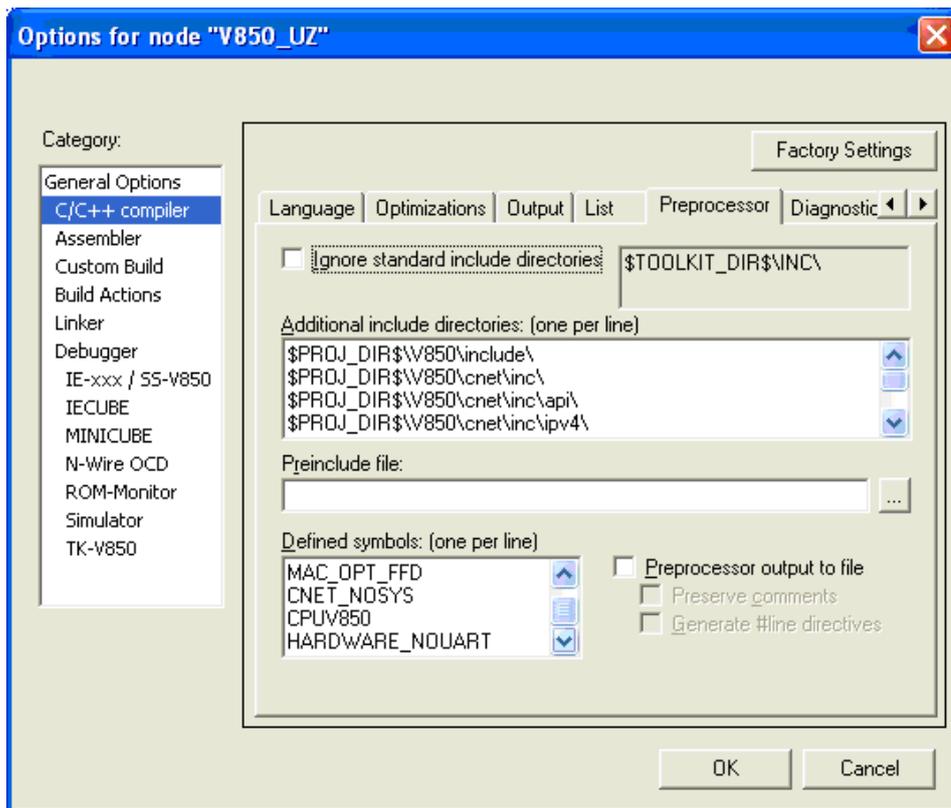
Figure 7-7 Settings of the «Pre-processor» options of the «C/C++ compiler»

Before starting a debug session, please check that the target board configuration is set according to the settings written in the *Table 3-6* "*On-chip debug mode settings for the TK-850/SG2+UZ*"

If the setting is correct, then connect the TK-850/SG2+UZ board to a USB port of your PC. Then you have to check the used communication port of the TK-V850 interface is set to the correct communications port setting. All debug targets use port COM3, but this may be different on other PC's. To check the actual used communication port, please open the Windows Device Manager:

Figure 7-8 Checking the port used in the «Device manager» of Windows

If necessary please select the correct communication port in the Embedded Workbench menu [Project] -> [Options] -> [Debugger] -> [TK-V850]:
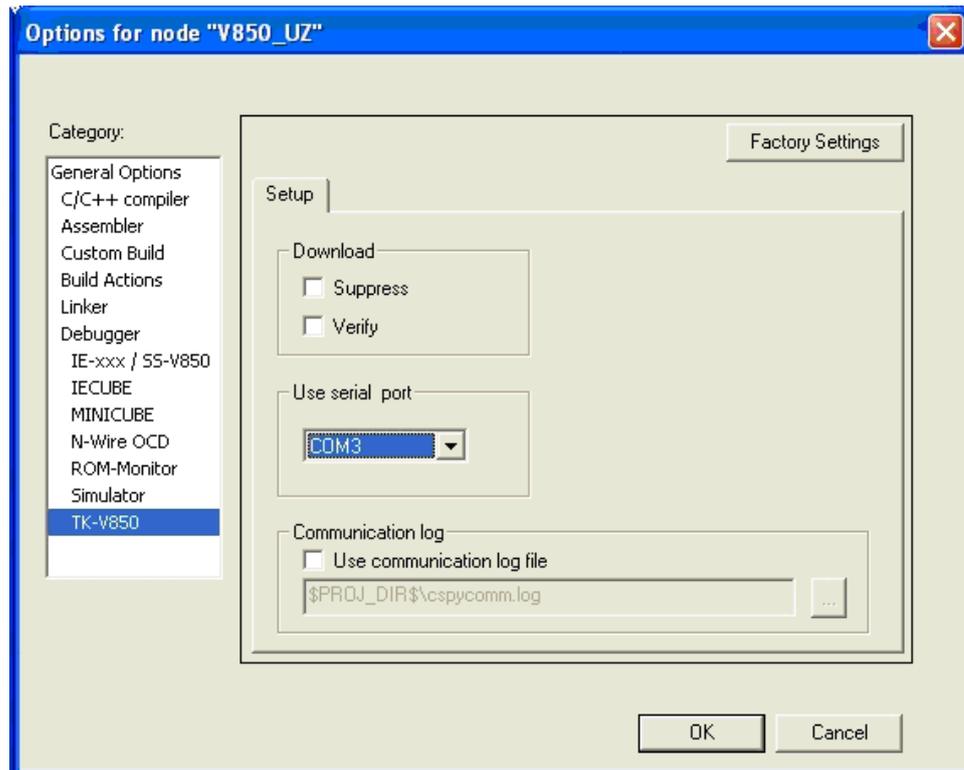
Figure 7-9   Configuration of the TK-V850 interface for on-chip debug mode

If all settings are correct then you can rebuild the project by selecting [Project] -> [Rebuild All] and start a debug session by selecting [Project] -> [Debug], or pressing the debugger-button in the menu bar:

Now the debugger is started and the demo project is downloaded to the TK-850/SG2+UZ board. The progress of downloading is indicated by blue dots in the TK-V850 Emulator window.
Please note that the download of larger executables can take some time.
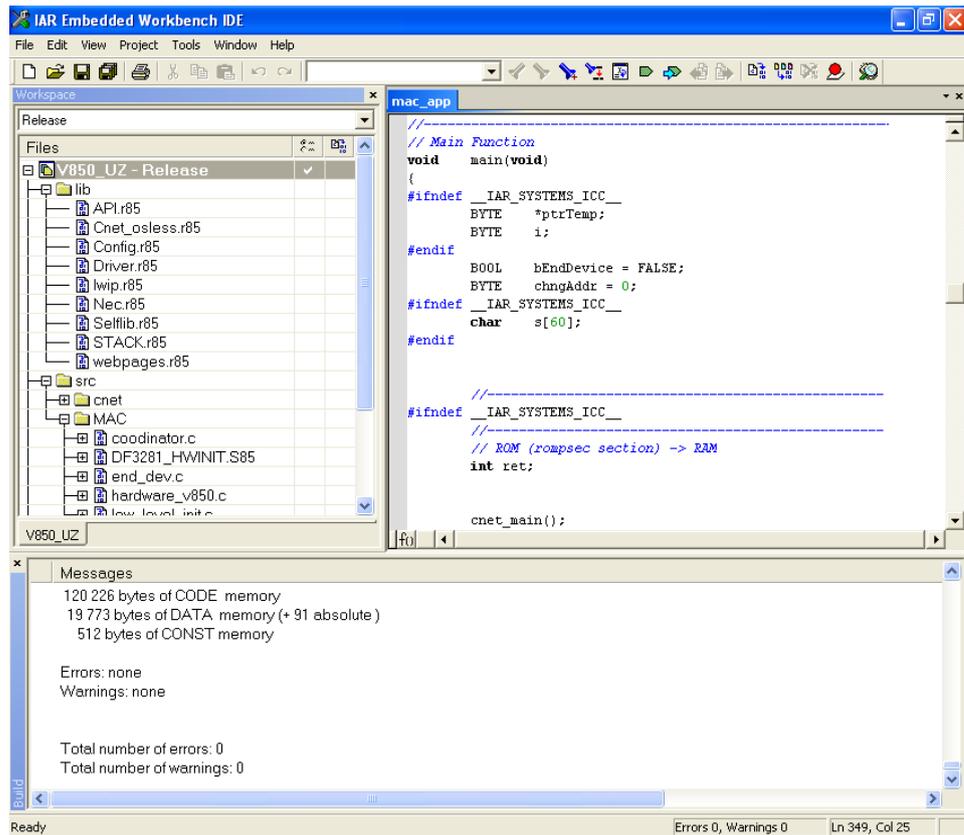
Figure 7-11   Downloading the sample application in the target device

After the download is completed, all debug features of IAR C-SPY debugger are available, i.e. Single Stepping, Step Over/-In/-Out, Go-Execution, Breakpoints, Register / Memory view etc.
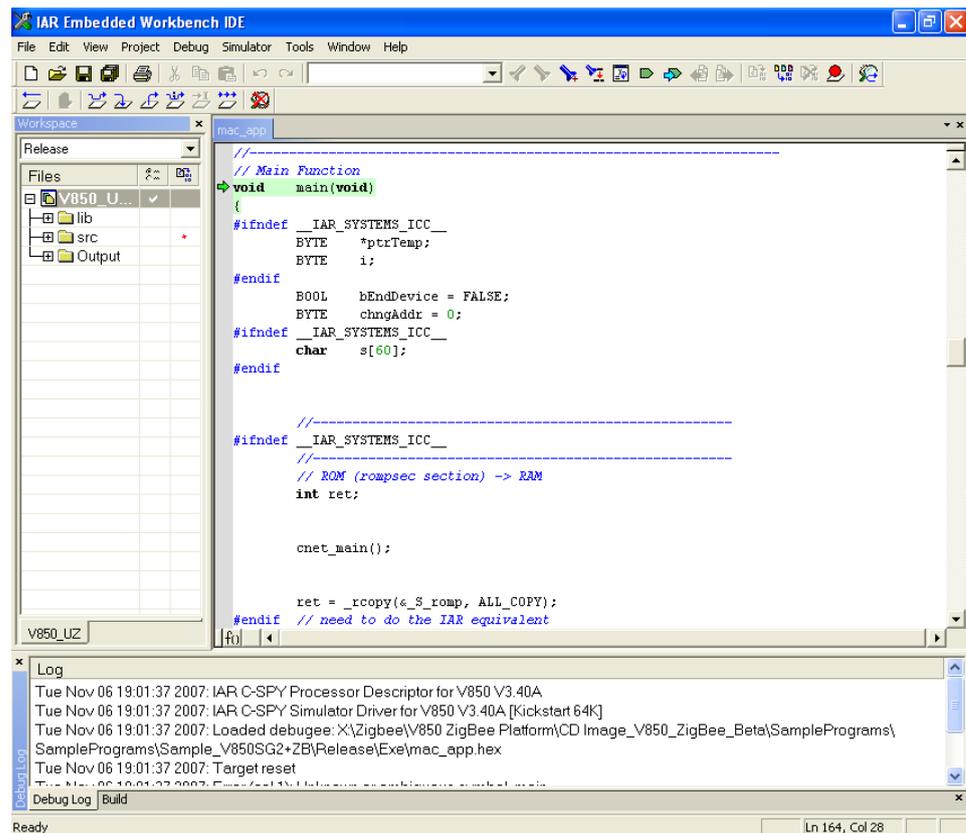
Figure 7-12   Debugging session with the Embedded Workbench C-Spy Debugger

To get more details on the debugger configuration and capabilities, please refer to the *"V850 IAR Embedded Workbench IDE User Guide"* and the *"V850 IAR C-SPY® Hardware Debugger Systems User Guide"*. Both manuals can be opened directly from the Embedded Workbench help menu:

You can find the PDF-files of the manuals in the subfolder V850\doc\ of your Embedded Workbench installation directory (e.g. C:\Program Files\IAR Systems \Embedded Workbench 4.0\V850\doc):

- EWV850_UserGuide.ENU.pdf
- EWV850_HWDebugUserGuide.ENU.pdf

7.4   Generating a Hex file for Flash programming

To generate a Hex-File for the FLASH–programmer please select the Target "Release" and rebuild the project. The generated Hex-File is located in the directory for "Executables/Libraries". All output-file-directories are defined in the Embedded Workbench menu [Project] -> [Options] -> [General Options] -> [Output]:
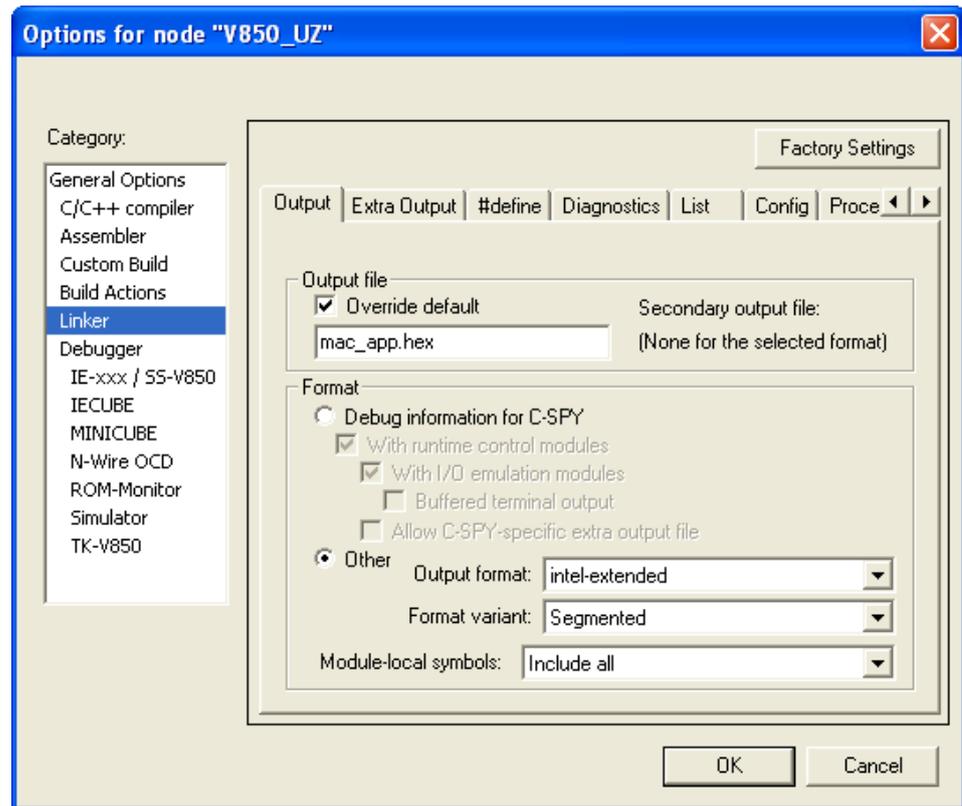
Figure 7-13   Settings to generate an HEX file output

Chapter 8 Sample Program

The V850 ZigBee^{TM} Gateway sample utilizes several complex libraries in order to provide a wireless-to-Ethernet gateway solution for application development. In this section, we will identify the key user configurable files that will allow the solution to be tailored to the user's application. However, it is recommended that the users familiarize themselves with the MAC and CNET library documentation.

8.1 User configurable network Parameters

Various network parameters will always be user specific and must be tailored to the user application; these user configurable parameters can be found in the "config.h" header file.

8.2 Libraries

The following provides a brief overview libraries supplied with the *V850 ZigBee^{TM} Gateway Development Platform*.

Table 8-1   Different libraries used

API.R85	API interface for the CNETTCPIP stack.
Cnet_osless.R85	Required to ensure correct operation of the TCPIP stack when No RTOS is employed.
Config.R85	Various system configuration utilities.
Driver.R85	Library for the Ethernet device driver.
NEC.R85	NEC Utilities and applications library.
Sellib.R85	Flash Self programming library.
Stack.R85	IEEE.802.15.4 MAC stack library.
Webpages.R85	Library containing the web pages, the web pages are also supplied as source code so that the user can modify the web pages. Care must be taken to use the same names for the web pages so that at link time the web page library is not called. Web pages can generate large code sizes so care must be in the design to ensure that the 64KB code size limit is not exceeded.

8.3 Embedded functions in Web Pages

All of the embedded functions that are called from the web interface can be found in the file *"httpdfunc.c"*; should the user wish to change the functionality of the web calls please modify the code appropriately.

A utility program is provided to convert web pages (see accompanying CNET user manual) to a large data array; this data is placed in a file called *"fsdata.c"*. After conversion this file needs to be modified with the following to ensure the web pages are located in the correct segment of memory.

```
#include «lwip/def.h»
#include «api/fsdata.h»
#pragma constseg=WEBPAGES // New line at the top of the fsdata.c file

#pragma constseg=default // New line at end of the fsdata.c file
```

8.4 System Initialization

```
                    ┌──────────────┐
                    │  Mac_app.c   │
                    │    Main()    │
                    └──────┬───────┘
                           │
                    ┌──────▼───────┐
                    │Initialize_Ports()│
                    └──────┬───────┘
                           │
                 ┌─────────▼──────────┐
                 │Hardware_Initialize()│
                 └─────────┬──────────┘
                           │
                  ┌────────▼─────────┐
                  │Initialise Variables│
                  │  & MAC address   │
                  └────────┬─────────┘
                           │
   No                ┌─────▼─────┐              Yes
 ◄─────────────────  │If enddevice│  ───────────────────►
 │                   └───────────┘                      │
 │                                                      │
┌▼──────────────┐                          ┌────────────▼──┐
│Set MAC address│                          │Set Unique MAC │
│and memory pools│                          │   Address    │
└───────┬───────┘                          └──────┬────────┘
        │              ┌──────────────┐           │
        └─────────────►│Initialise MAC│◄──────────┘
                       │layer with MAC│
                       │   address    │
                       └──────┬───────┘
                              │
   No                  ┌──────▼─────┐             Yes
 ◄───────────────────  │If enddevice│  ──────────────────►
 │                     └────────────┘                    │
┌▼──────────────┐                            ┌───────────▼──┐
│InitCoordinator()│                          │InitEndDevice()│
└───────┬───────┘                            └──────┬───────┘
        └──────────────┐        ┌────────────────────┘
                    ┌──▼────────▼──┐
          ┌────────►│  Main Loop   │
          │         │ While(TRUE)  │
          │         └──────┬───────┘
          │                │
          │         ┌──────▼───────┐   Wireless Communications
          │         │SK_Base_Main()│         Handler
          │         └──────┬───────┘
          │                │
          │   No    ┌──────▼─────┐   Yes
          │  ◄──────│If enddevice│──────►
          │  │      └────────────┘     │
          │ ┌▼──────────────┐   ┌──────▼─────┐
          │ │CoordinatorProc()│  │ EndDevProc() │
          │ └───────┬───────┘   └──────┬───────┘
          │         └─────────┬────────┘
          │              ┌────▼────────┐
          │              │cnet_appmain()│   TCPIP Stack Handler
          │              └─────┬───────┘
          └────────────────────┘
```
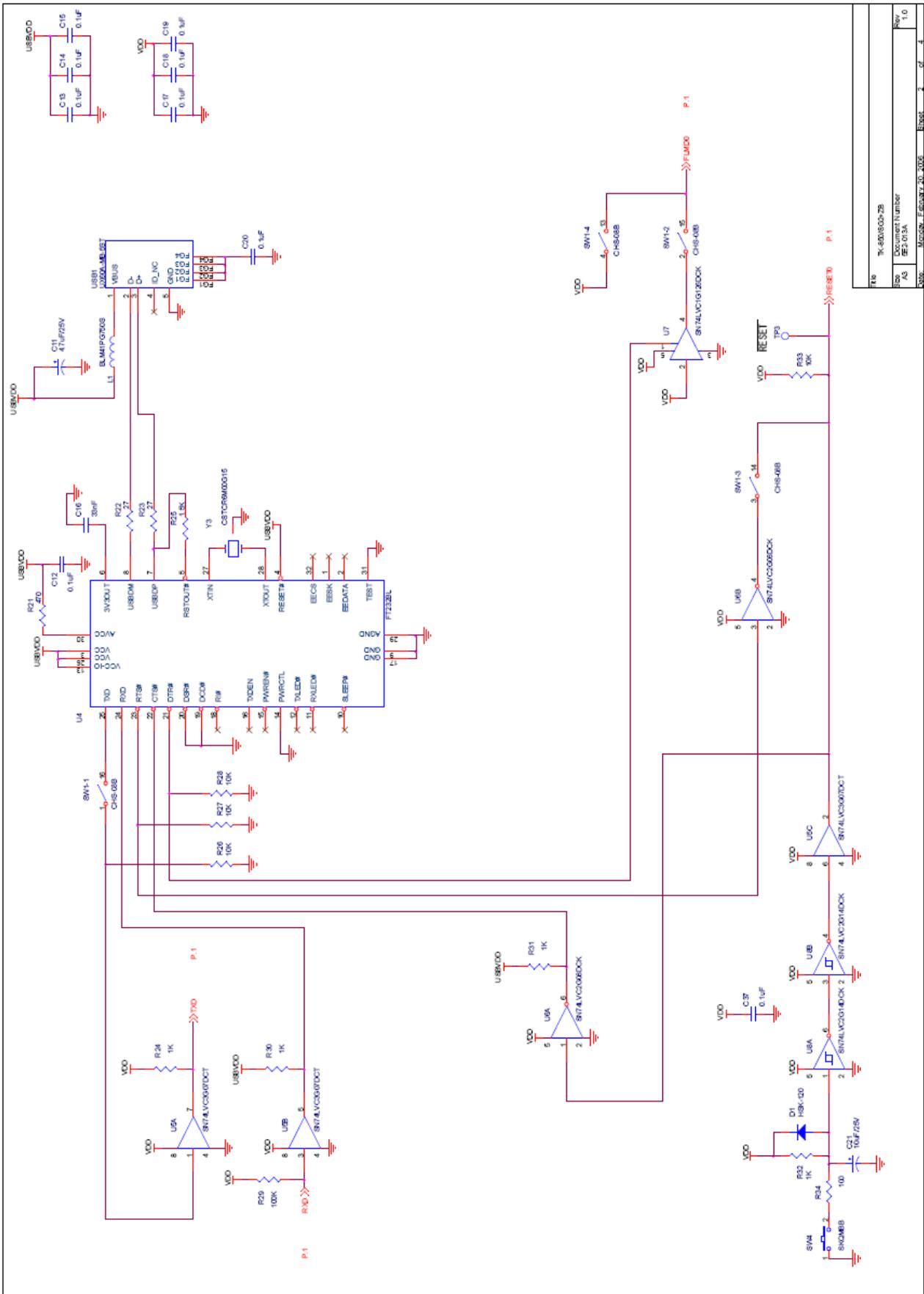
Chapter 9 Schematic Diagram TK-850/SG2+UZ

Figure 9-1   V850 ZigBee™ Gateway board schematics (1/4)

Figure 9-2   V850 ZigBee™ Gateway board schematics (2/4)
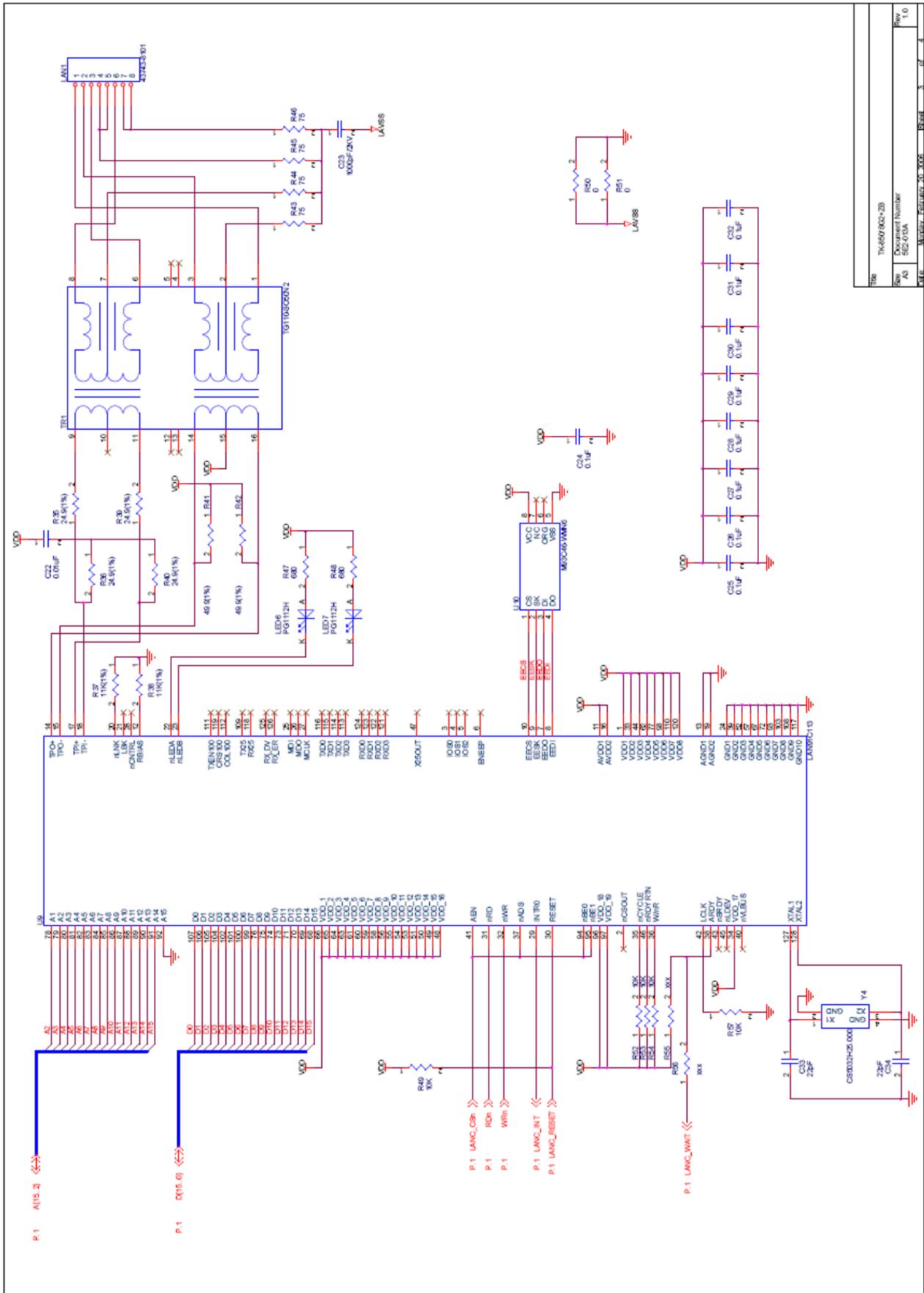
Figure 9-3   V850 ZigBee™ Gateway board schematics (3/4)
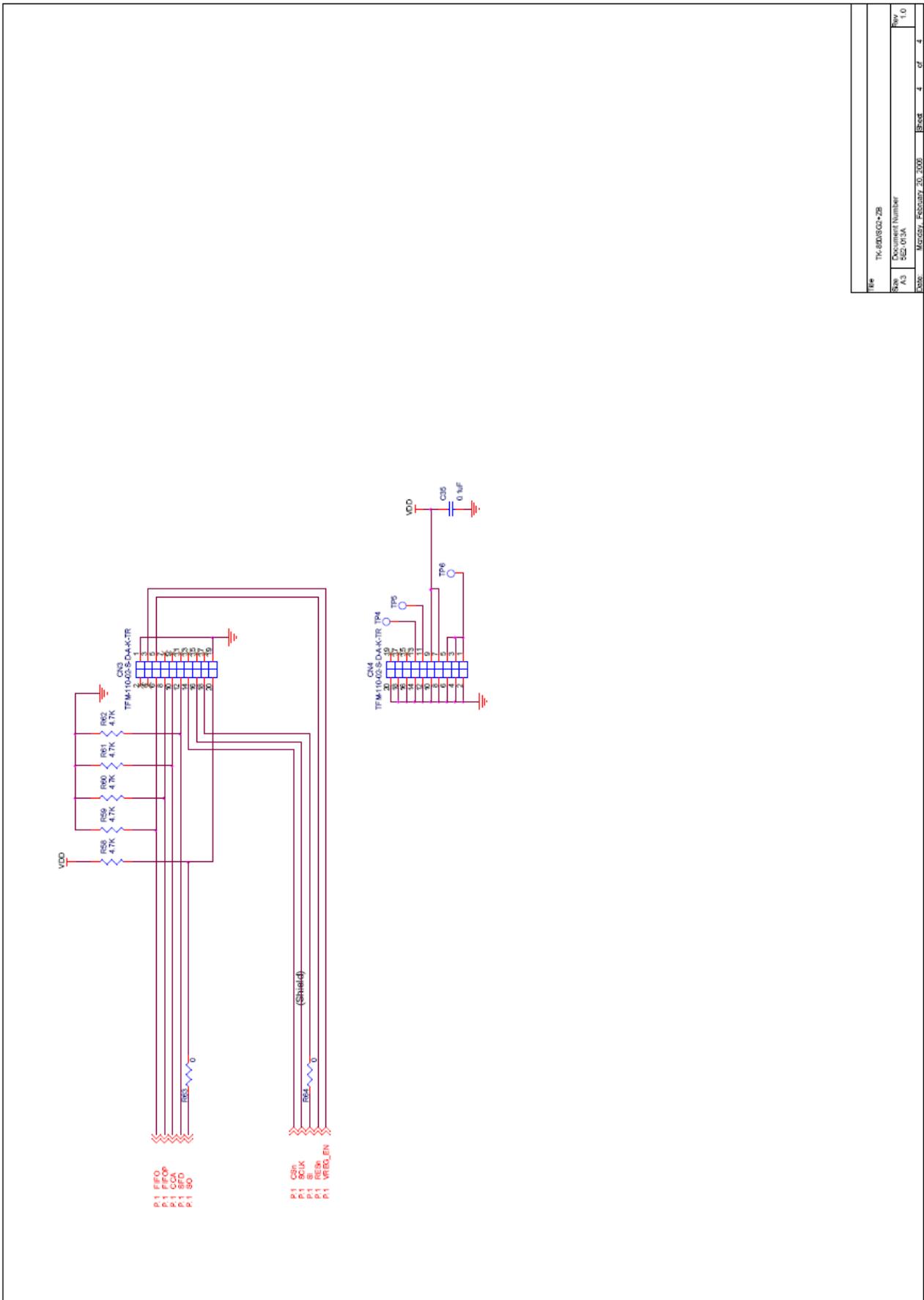
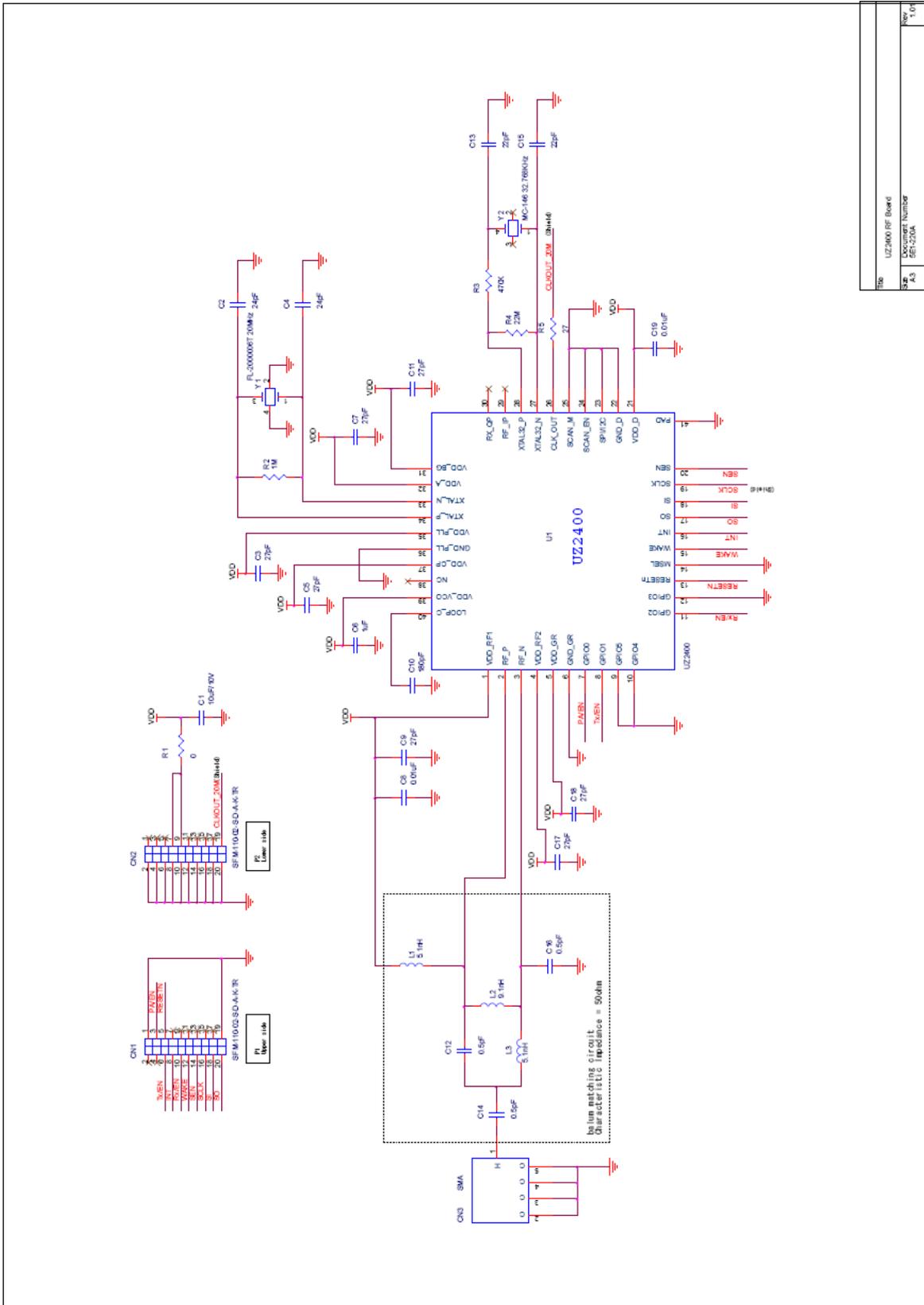**Figure 9-4   V850 ZigBee™ Gateway board schematics (4/4)**

Chapter 10 Circuit Diagram of UZ2400 RF Board

Figure 10-1   UZ2400 RF board schematics