RU450-SP
User's Manual

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RIGEL CORPORATION
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1 OVERVIEW

The RU450-SP is very low-cost embedded controller for the ultra-high-speed DS89C450 microcontroller. The RU450-SP complements the line of MCS-51 single-chip mode products from Rigel Corporation. This line includes the R-51SP, R-51SD and the R-420SP.

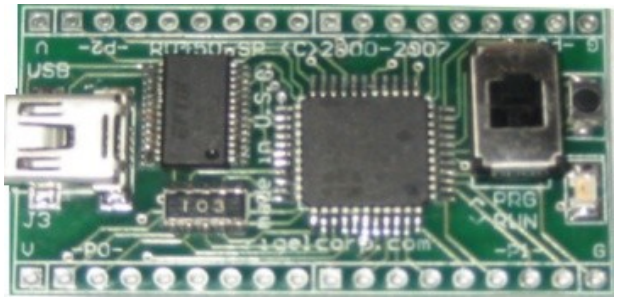
The RU450-SP has a mini USB port, similar to those used on MP3 players and cameras. The USB port communications is used for both programming the board, and for communications to be performed by the downloaded application. Moreover, the board may be run from the USB power, eliminating the need for an external power supply.

The RU450-SP is intended to be embedded into an end product. Connections for the ports may be made through sockets, headers, or straight soldering into the ports.

The combination of the DS89C450 used with the Rigel Corporation's Reads51 software allows the microcontroller to be programmed and run in the single-chip mode. That is, the board will run code from internal ROM, using the on-chip RAM. Software for the boards can be written, edited, compiled and downloaded using Reads51. There is an industrial-grade slide switch that determines if the microcontroller is in the program mode or in the run mode. For OEM applications, the board may be populated without the slide switch.

The RU450-SP is ideal for:

- Noisy environments, e.g., industrial automation, automotive control.
- Low-cost general control as a high-powered replacement for the various BASIC controllers.
- Classroom and educational use, e.g., robotics, mechatronics projects.
- OEM subsystems (see Section 5 for OEM customization options).



(Board dimensions 1.8 by 1.0 inch, 4.6 by 2.5 cm)

Board features:

- On-board serial-to-USB converter that appears as a VCP (Virtual Communications Port) to the PC.
- Industrial-grade program/run slide switch.
- Industrial-grade reset push button.
- Power LED.
- 24MHz CPU clock (up to 24 MIPS).

Processor features:

- On-Chip Memory
    - 64Kb Flash memory
    - 1 Kb XMOV-type RAM
    - In-Application Programmable

    - In-System Programmable through the USB port
- 80C52 Compatible
    - 8051 Pin and Instruction Set Compatible
    - Four Bidirectional, 8-Bit input/output ports
    - Three 16-Bit timer-counters
    - 256 Bytes of scratch-pad RAM
- Power-Management Mode
    - Programmable clock divider
    - Automatic hardware and software exit
- ROMSIZE Feature
    - Selects Internal Program Memory Size from 0 to 64kB
    - Allows Access to Entire External Memory Map
    - Dynamically Adjustable by Software
- Peripheral Features
    - Two full-duplex serial ports (one used for the USB)
    - Programmable watchdog timer
    - 13 interrupt sources (6 external interrupts)
    - Five levels of interrupt priority
    - Power-fail reset
    - Early warning power-fail interrupt
    - Electromagnetic interference (EMI) reduction

2 SOFTWARE

The Reads51 integrated development environment (IDE) may be used for code development and programming the RU450-SP. Software for the boards can be written, edited, compiled and downloaded using Reads51. Reads51 supports code generation for the single-chip mode and on-board programming of the DS89C450 using the USB port on the RU450-SP board.

2.1 System Requirements

All of Rigel's software is designed to work with an IBM PC or compatible, Pentium 120MHz or better, running Windows 95, 98, 2000, ME, NT, Windows XP and Vista. The newest versions of our software are always available to download off our web site, www.rigelcorp.com. We encourage you to check our web site often to keep up-to-date.

2.2 Software Installation

The latest version of Reads51 may be downloaded from Rigel's website www.rigelcorp.com. Go to the **Downloads | Download 8051 Software** and click on the .exe file you wish to install. The program will then download to your computer. Follow the standard install directions that come up on screen.

2.3 Reads51

Reads51 is an integrated development environment (IDE) that has a source code editor, an assembler, a Small-C compatible compiler, and an OMF-51 linker. Reads51 allows you to download directly to the RU450-SP from the TTY window. Refer to the RU450-SP User's Manual section 4.1 for details.

3 BOARD CONNECTIONS

There are several alternate ways to connect the RU450-SP board to the application. The USB connection suffices to power, program and run the board. In general, there are port connections, power connections, and communications connections. These categories are presented below.

The port connections to the RU450-SP board are made through the terminals placed along the edges of the boards. These terminals may be left as open holes and the application signals may be directly soldered to the terminals. Alternatively, the terminals may be populated by headers or sockets, and the application signals may be applied through mating connectors. The headers or sockets may be connected from the top or the bottom of the boards. Moreover, straight or right-angle connectors may be used. These options are intentionally left open to provide the maximum level of flexibility in the physical assembly of the final product.

3.1 Power Connections

The RU450-SP board uses the USB port, J3, to supply the 5-Volt power needed to operate the board. In addition, there are several VCC (+5V) and GND (ground) terminals available on the port terminals placed along the two longer sides of the board. These are convenient if a single harness for power and port signals is to be used. For mobile applications, you may use four 1.5V batteries in series to generate a 6V DC supply. Then use one or two diodes in series to drop the voltage.

3.2 Communications

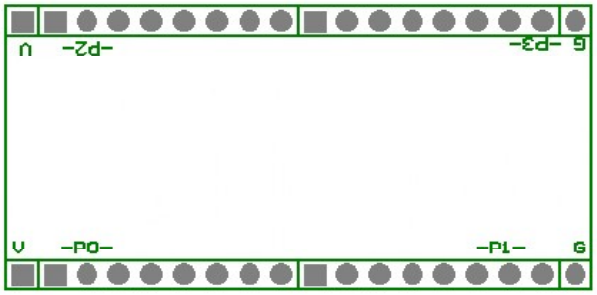
The board uses a serial-to-USB converter to connect the RS232 port of the microcontroller to the USB port, J3. This port is used to program the DS89C450. The board uses the FTDI232R for serial-to-USB conversion. FTDI232R drivers allow the PC to recognize the USB connection as a Virtual Communications Port (VCP).

The microcontroller has a second asynchronous serial port running at TTL levels. If this port is to be used with an RS232 port, then an external voltage level converter is needed.

3.3 Input/Output Ports

The RU450-SP input/output ports are directly connected to the ports of the microcontroller. The MCS-51 ports are quasi-bi-directional ports. They use pull-up resistors to be at logic level high. When used as inputs, the external signal must ground the port for the microcontroller to read a logic level low. Refer to the 8051 data books for more information. Several examples are also provided in the textbooks by Rigel Press (www.rigelcorp.com/rigelpress/).

The four ports of the 89C450 are available on the top and bottom edges of the board. There are eight terminals for each of the ports P0 to P3. A square pad indicates port bit 0 for each port. In addition to the port bits, each side has an additional terminal for VCC (marked 'V') and serial port signals, including the ground (marked 'G') signal.



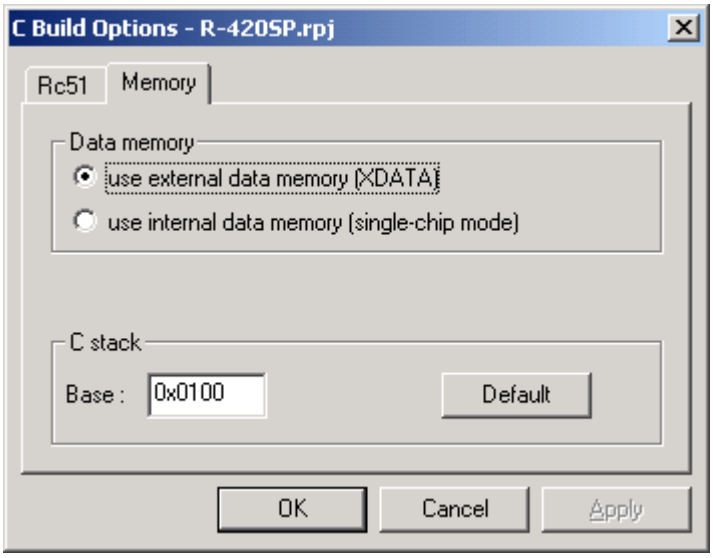
4 PROGRAMMING THE 89C450

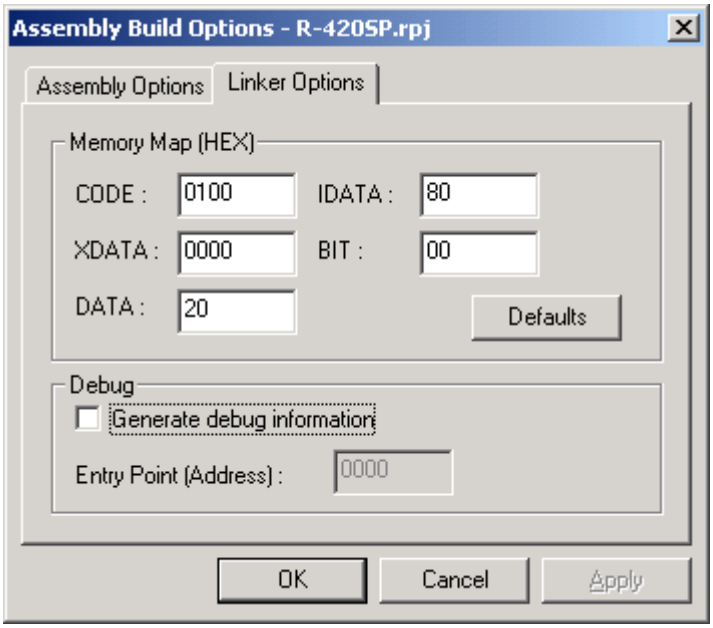
The board is placed in the program mode by moving the slide switch (S1) to the upper position marked "<PRG>." Once the board is programmed the switch should be moved to the operating position marked "<RUN>" and the power cycled.

Refer to the C-language examples in Reads51 to see how the internal XDATA RAM of the DS89C450 is enabled. Once you develop your code, you may download it to the board using the Reads51 TTY window. Place the board in the program (PGM) mode and press the "enter" key. The DS89C450 internal "ROM LOADER" monitor program answers with a prompt. Note that the DS89C450 monitor extracts the Baud rate from the received character. Refer to the DS89C450 data sheet to see what Baud rate – crystal frequency combinations are supported. In general a Baud rate of 38400 or below would work.

Once the internal monitor program answers with the prompt, use the monitor command 'K' to erase internal memory. That is, press 'K' and enter. Refer to the DS89C450 data sheet for a complete set of monitor commands. Then enter the load command 'L' (and enter). This places the monitor in the download state. It expects code in the Intel Hex format. Use the Reads51 "Tools -> Download ASCII file" command to download your program to the board. Note that the "Options->TTY Options" dialog has three fields related to the ASCII downloads. You may specify a delay after each character and each line of ASCII text. (The hex file is ASCII text.) You may also instruct the Reads51 down-loader to wait for an acknowledgement character before sending the next line of text. The DS89C450 monitor returns a 'G' (for good record) when it is ready for the next line. It is recommended that you set the character delay to 0 (no delay).

Use the Reads51 to communicate with the board. Note that the 89C450 internal XDATA RAM is only 1K. The settings below reserve the first 256 bytes (0x100) for global variables, and the remaining 768 bytes (0x300) for the C-stack. That is, the C-stack starts at 0x100.





Include a start-up module in your project. This module must be named “c0.src.” Enable the internal XDATA RAM in the start-up code. That is, set the PMR (0xC4) to 1. The project RU450-SP shows the compiler and linker settings. It also includes the start-up code.

5 OEM OPTIONS

Below are the more popular OEM options. Contact Rigel Corporation for other custom options.

1. The boards may be populated with any 8051 microcontroller in the 44-pin TQFP package.
2. The boards may be factory programmed.
3. The boards may be populated with the specific connectors needed by the application (right-angle, upright, locking, male, female, etc.)
4. The program/run slide switch may be left out.
5. The reset pushbutton slide switch may be left out.
6. The power LED may be left out.
7. The USB port may be left out.

6 RU450-SP Parts List

Quantity	Part	Designator
2	100nF capacitors	C1, C2
1	4.7 uF capacitor	C3
3	10nF by-pass capacitors	C4, C5, C6
1	10K Resistor Network (common)	R1
1	10K Resistor Network (isolated)	R2
1	680 Ohm resistor	R3
1	BAV70, Transistor	D1
1	LED	D2
1	PushButton	S2
1	Slide Switch	S1
1	USB Connector	J3
2	1X18Header	J4, J5
1	FT232R	U1
1	DS89C420	U2

7 Board Overlay