# RTC180

## Computer/Controller

## Technical Manual

REV 1.0

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## Introduction

The Micromint RTC180 is a single-board computer/controller featuring a new-generation 8-bit microprocessor which maintains software compatibility with the Zilog Z80 while incorporating advanced design features in a single 68-pin PLCC package. Configured primarily for embedded control, the RTC180 uses the same vertical stacking I/O expansion bus as Micromint's RTC31/52 controller board. All of Micromint's RTC expansion boards are compatible with the RTC180.

The RTC180 ROM monitor provides the system designer with a host of low-level development aids while the BASIC-180 multitasking BASIC compiler speeds high-level development of lightning-fast code right on board.

## RTC180 Technical Specifications

* Hitachi HD64180 microprocessor running at 9.216 MHz. Supports a superset of the Z80 instruction set
* Up to 96K bytes total memory on-board (32K EPROM, 32K static RAM, and 32K of either static RAM or EPROM
* 1024 bits (64 bytes x 16 bits) EEPROM
* Two asynchronous serial ports (one full-duplex RS-232, one half-duplex RS-485)
* Eight-channel, 8-bit or eight-channel, 10-bit analog-to-digital converter
* Three 8-bit parallel I/O ports (24 bits)
* Three predecoded expansion board select lines
* On-board memory management unit, 2-channel DMA controller, 2 counter/timers, and 12 interrupt sources
* Requires just +5V (RS-232 voltages generated on-board)
* Measures 3.5" x 4.5" (RTC-Plus form factor)

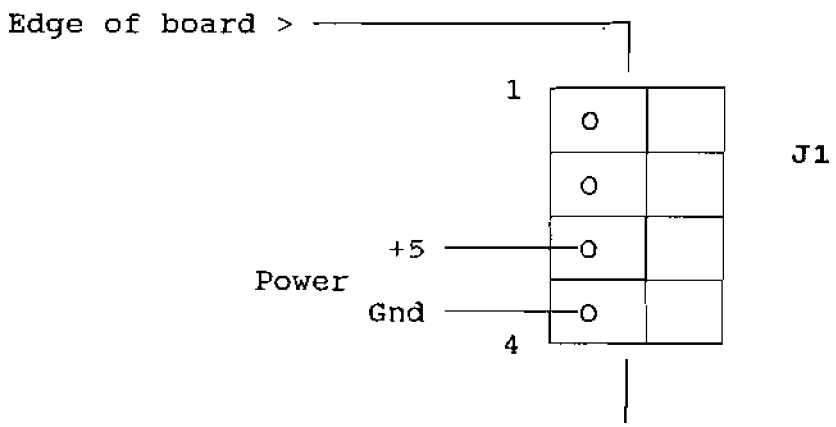
## Setting Up Your RTC180

Very few connections are required to bring up a functional RTC180 development system, with the minimum connections being to a terminal and a power supply.

### Power

The RTC180 requires a minimum of 300 mA at +5V ±5% for a fully populated board (all components installed including 96K of memory). Less current is required for a board with fewer components installed (e.g., without the RS-485 driver or less memory). Voltages necessary for RS-232 operation are generated on the board.

Power can be connected to the RTC180 in one of two ways: through the power pins on J1 or through the RTC bus. If you purchased the RTC180 with quick-disconnect headers, a mating connector and pins are included for J1 connection. If the board has screw terminals, simply insert wires in the top of the connector at J1 and tighten the side screws. The following top view of J1 should be used to properly connect the computer to your power supply. **Be sure to double check your connections before applying power to the RTC180! It is very easy to connect the power to J1 backwards. Boards damaged by incorrect power connections are not covered under warranty.**




If you plan to power your RTC180 through the RTC bus connectors, be sure to follow the connection instructions supplied with the board to which power will be connected. In no case should power be applied directly to the pins of the RTC bus connectors on the RTC180 board.

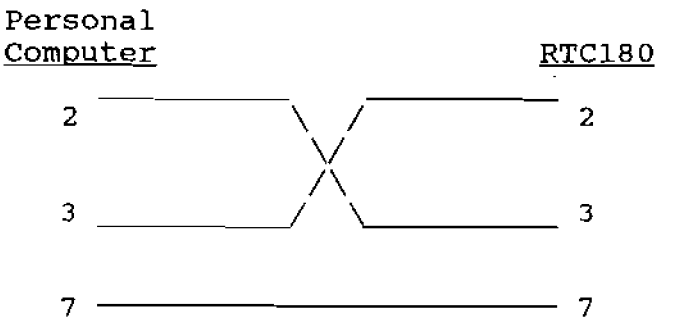
When plugging other RTC boards into the RTC180, be sure to line the keys up properly. **Plugging a board into the RTC180 backwards may damage the board. A board damaged by plugging it in backwards is not covered under warranty, so exercise appropriate care.**

**Terminal**

Any standard RS-232 serial terminal can used as a console device for the RTC180. Alternatively, a personal computer using communication software and a serial port can be used as a console device.

The RTC180 has a 16-pin Berg-type header (JP3) used to connect with the console device. An adapter cable which goes from the Berg header to a standard DB-25 is useful for making the connection. Micromint sells such a cable. If you'd prefer to construct one, please refer to the "Serial I/O" section later in this manual for a detailed description of JP3. With the adapter cable in place, a straight-through DB25-to-DB25 cable can be used to connect a terminal to the RTC180.

The same cabling is necessary in most cases when a personal computer is used with terminal emulation software. In some cases, though, a swap or "null modem" cable must be used. The minimum requirements for this cable are that pins 2 and 3 should be swapped and pin 7 should pass straight through. The following diagram shows this minimum cable:




Please refer to the "Serial I/O" section later in this manual if your terminal requires additional handshaking lines.

When installed, the RTC180 monitor will automatically detect the baud rate being used by the terminal as long as it's one of the following: 19200, 9600, 2400, 1200, or 300. We recommend setting your terminal for 9600 bps until your system is set up and working. Additionally, be sure your terminal (or communication software) is set up with the following parameters: 8 data bits, 1 stop bit, no parity, and CR (not CR/LF) generated when

"Return" is pressed. If your terminal doesn't allow parity to be turned off, 7 data bits and space (clear) parity should also work.

**Powering it up**

Once everything has been connected, double check all the connections. Turn on the power to the terminal first and let it warm up. Next, turn on the power to the RTC180. If the ROM monitor is installed, the terminal is set up for 9600 bps, and everything is connected properly, the string "RTC180" should be displayed on the terminal screen. Press "Return" once or twice and the monitor banner should come up on the screen. Your RTC180 system is now working. You should now refer to either the RTC180 monitor manual or (if BASIC-180 is installed) the BASIC-180 manual for instructions on how to proceed.

If your terminal is set for something other than 9600 bps, you should get a few "garbage" characters on the screen when you first apply power to the RTC180. This is what "RTC180" transmitted at 9600 bps looks like at whatever baud rate you're using. Pressing "Return" once or twice tells the RTC180 what baud rate you're really using and the monitor banner should come up as described above, but at the baud rate you're using.

If "RTC180" isn't displayed when power is applied, or there is no response to repeated presses of the "Return" key, reset the board by shorting the pins of J3 and try again. If there is still no response, check all connections once again including the power and terminal cables. If you still can't get your RTC180 to respond, you may call our technical support staff at (203) 871-6170.

## RTC180 Hardware

The hardware on the RTC180 can be broken into three sections: the HD64180 microprocessor, memory, and I/O. Each of these sections will be discussed in turn.

## HD64180 Processor

The power of the RTC180 is made possible by the Hitachi HD64180--a microcoded execution unit based on advanced CMOS manufacturing technology. It provides the benefits of high performance, reduced system cost, and low-power operation while maintaining compatibility with the large base of industry-standard 8-bit software.

Performance is derived from a high clock speed, instruction pipelining, and an integrated Memory Management Unit (MMU). The instruction set is a superset of the Z80 instruction set; twelve new instructions include hardware multiply, bit comparisons, and a SLEEP instruction for low-power mode.

Compared with the Z80 in the same way the 80188 is compared with the 8088, system costs are reduced because many key system functions have been included on-chip. Besides the MMU, the HD64180 boasts a two-channel Direct Memory Access Controller (DMAC), wait-state generator, dynamic-RAM refresh, two-channel Asynchronous Serial Communication Interface (ASCI), Clocked Serial I/O (CSIO), two-channel 16-bit Programmable Reload Timer (PRT), a versatile 12-source interrupt controller, and a "dual" (68xx and 80xx families) bus interface, all on one 68-pin chip.

The HD64180 comprises five functional blocks:

- Central Processing Unit: The CPU is microcoded to implement an upward-compatible superset of the Z80 instruction set. Besides the twelve new instructions, many instructions require fewer clock cycles for execution than on a standard Z80.

- Clock Generator: The clock generator produces the system clock from an external crystal or external clock input. The clock is programmably prescaled to generate timing for the on-chip I/O and system support devices.

- Bus State Controller: The bus state controller performs all status/control bus activity. This includes external bus cycle wait-state timing, RESET\, DRAM refresh, and master DMA bus exchange. It generates "dual" bus-control signals for compatibility with both 68xx and 80xx family devices.

- Interrupt Controller: The interrupt controller monitors and prioritizes the four external and eight internal interrupt sources. A variety of interrupt response modes are programmable.

- Memory Management Unit: The MMU maps the CPU's 64K-byte logical address space into a 1-Megabyte physical address space. The MMU organization preserves software object code compatibility while providing extended memory access and uses an efficient "common area/bank area" scheme. I/O accesses (64K-port I/O space) bypass the MMU.

The integrated I/O resources make up the remaining four functional blocks:

- Direct Memory Access Controller: The two-channel DMAC provides high-speed memory-to-memory, memory-to-I/O, and memory-to-memory-mapped I/O transfer. The DMAC features edge- or level-sense request input, address increment/decrement/no-change, and (for memory-to-memory transfer) programmable burst or cycle-steal transfer. In addition, the DMAC can directly access the full 1M-byte physical address space and transfers (up to 64K bytes in length) can cross 64K-byte boundaries.

- Asynchronous Serial Communication Interface: The ASCI provides two separate full-duplex UARTs and includes a programmable baud rate generator, modem control signals, and a multiprocessor communication format. The ASCI can use the DMAC for high-speed serial data transfer, reducing CPU overhead.

- Clocked Serial I/O Port: The CSIO provides a half-duplex clocked serial transmitter and receiver. This can be used for simple, high-speed connection to another microprocessor or microcomputer.

- Programmable Reload Timer: The PRT contains two separate channels, each consisting of 16-bit data and 16-bit timer reload registers. The timebase is divided by 20 (nonprogrammable) from the system clock and one PRT channel has an optional output allowing waveform generation.

Note: The HD64180 Microprocessor Data Book is available from Micromint for $10 plus shipping.

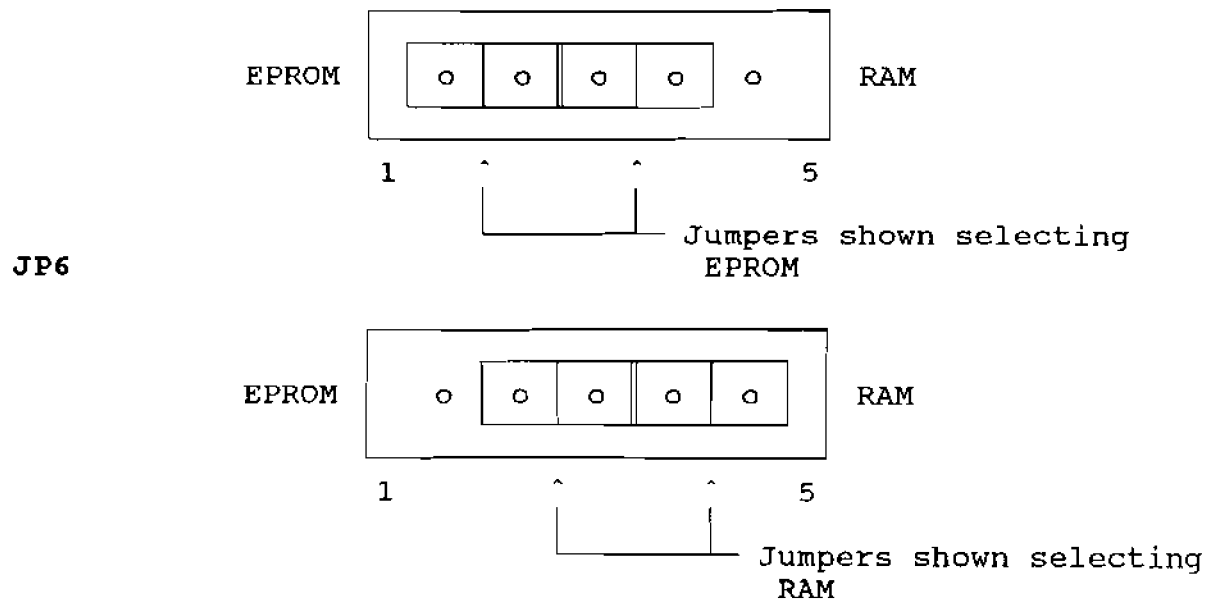
## Memory

The RTC180 allows the use of up to 96K bytes of memory on the main board. In most controller applications, 64K is sufficient, however 96K is available for larger applications. Memory may not be expanded beyond 96K. The RTC expansion bus may only be used for I/O expansion and all system memory must be on the processor board.

### EPROM/Static RAM

There are three 28-pin sockets on the RTC180 board (U9-U11). A 27256 (27C256) EPROM must be plugged into socket U9 and a 62256 static RAM chip must be plugged into socket U11. Socket U10 may contain either a static RAM chip or an EPROM. Both types of chips contain 32K bytes of storage and are the only kinds of memory that will work. It isn't possible to use, say, a 27512 EPROM.

The 5-pin jumper header next to socket U10 (JP6) determines whether an EPROM or a RAM chip is installed in that socket. When there is one jumper between pins 1 and 2 and a second jumper between pins 3 and 4, that socket is set for EPROM operation. To use the socket with a RAM chip, the jumpers must be moved so they connect pins 2 and 3 and pins 4 and 5. The RTC180 is shipped from the factory with U10 (JP6) set up for RAM operation. The following shows how JP6 is set up:



The first socket (U9) is mapped to physical address 00000H. Socket U10 is mapped 32K above that at physical address 08000H. Finally, socket U11 is mapped at physical address 18000H. Note that there is a 32K gap between sockets U10 and U11 to provide compatibility with software developed for the BCC180. It is up to whatever program is running to determine how the HD64180's memory management unit (MMU) maps the logical address space into the physical address space.

The default configuration of the RTC180 monitor maps the entire first socket to the first 32K bytes in the logical address space. The other 32K bytes of space is mapped to U11. See the monitor manual for more details about changing active banks while in the monitor and the HD64180 data book for details about configuring the on-board MMU under program control (specifically, the CBAR, CBR, and BBR registers).

**NOTE: A 32K-byte 62256 static RAM chip must be installed in socket U11 in order for the RTC180 monitor and the ROM-based version of BASIC-180 to function properly.**

## Wait States and Refresh

The HD64180 processor has, among other things, an on-board wait-state generator. It's possible to set anywhere from 0 to 3 memory wait states and from 1 to 4 I/O wait states. Memory wait states are dealt with in this section. See the "Input/Output" section for I/O wait state details.

EPROMs and static RAM chips rated for an access time of 150 ns or better can be used with zero memory wait states on a 9.216-MHz RTC180. Memory chips slower than this will need wait states. EPROMs with 200-ns access times need one wait state. The RTC180 monitor defaults to two memory wait states to allow for slow EPROMs. See the RTC180 monitor manual for details on how to change this default.

Since the RTC180 contains only static memory devices, the HD64180's on-board DRAM refresh circuits may be disabled to eliminate the overhead of DRAM refresh. The HD64180's RCR register should be initialized to zero (as shown in the following code segment) by any program responsible for setting up the processor after a reset. See the HD64180 data book for more details about the RCR register.

| **BASIC-180** | **Assembly** |
|---|---|
| 100 OUT $36,$00 | LD A,00H |
| | OUT0 (36H),A |