

# Minicon™ Reference Manual

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Note: This document applies to REV C of the board.



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## Overview

The Minicon board is a useful tool for embedded control and robotics projects for both students and hobbyists.

The Minicon's versatile design and programmable embedded microcontroller allows you to control different external devices and program the board for multiple uses. The board has many I/O connectors, power supply options, and supports a number of programming tools including ATMEL AVR® STUDIO 4, and WinAVR.

The Minicon has a number of connections for peripheral devices. Digilent peripheral modules (Pmods™) include H-bridges, analog-to-digital and digital-to-analog converters, a speaker, switches, buttons, LEDs, RS232 converters, screw terminals, BNC connectors, servo motors, and more.

Features include:

- ATmega168 microcontroller
- five 6-pin connectors for Digilent Pmod peripheral module boards
- four LEDs
- four mode select jumpers
- ESD protection for all I/O pins
- an on-board voltage regulator
- multiple, flexible power supply jumper options
- in-system programming support for the Digilent parallel JTAG cable or the Digilent USB JTAG/SPI cable.

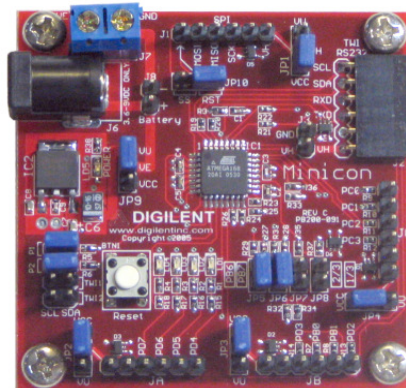


Figure 1  
Minicon Board

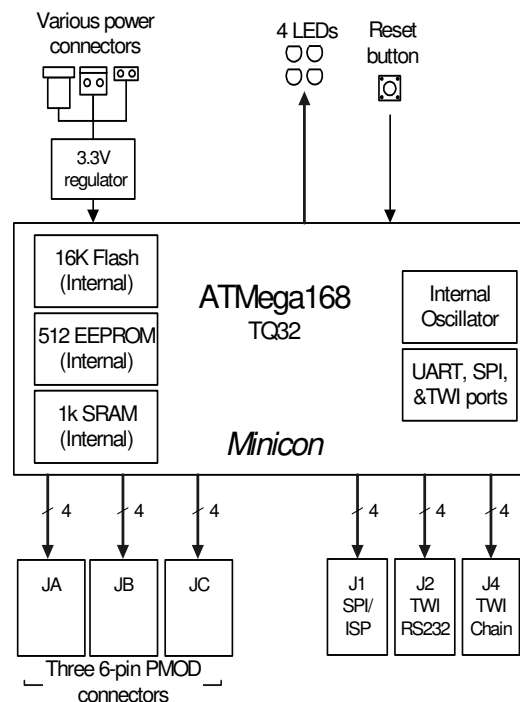


Figure 2  
Block Diagram

Features of the ATmega168 include:

- master/slave serial peripheral interface (SPI)
- programmable serial USART interface
- Atmel two wire serial interface (TWI)
- eight channel, 10-bit ADC
- two 8-bit timer/counters
- one 16-bit timer/counter
- 16KB program flash
- 512 byte EEPROM
- 1KB internal SRAM
- analog comparator.

For more information on the ATmega168 microcontroller, refer to the data sheet available at [www.atmel.com](http://www.atmel.com).

## Functional Description

The Minicon is designed for embedded control and robotic applications, as well as microprocessor experimentation. Embedded firmware, suitable for many applications, can be programmed into the Minicon's ATmega168 microcontroller.

The Minicon has a number of I/O connection options, and is specially designed to work with the Digilent line of peripheral modules (Pmods), which provide various input and output functions. For more information, see [www.digilentinc.com](http://www.digilentinc.com).

Programming the Minicon is accomplished using the Digilent AVR programmer (AVRP) application and a Digilent programming cable (use either the Digilent parallel JTAG cable or the Digilent USB JTAG/SPI cable). The programming cable is attached to the SPI connector, J1.

Jumper JP10 is used to select between programming mode and user mode. Place the shorting block on JP10 in the RST position for in-system-programming and in the SS position for user mode.

Connector J1 provides access to the master/slave SPI. SPI is a high-speed synchronous serial interface used by many serial peripheral devices, like A/D and D/A converters. The SPI interface is used both for in-system-programming the ATmega168, and for a user accessible SPI port. The Digilent PmodAD1 and PmodDA1 modules use the SPI interface. Connector J1 and the SPI interface are also used for in-system programming of the ATmega168 microcontroller.

Connectors J2 and J4 provide access to the Atmel TWI. The TWI is a medium speed (200-400 Kbps) serial bus that allows up to 128 devices to connect. Connector J4 is the TWI daisy-chain connector for connecting the Minicon into a TWI bus.

The ATmega168 microcontroller provides a USART that can be used for asynchronous or synchronous serial communications. However, the MiniCon doesn't provide for a crystal oscillator, and the internal RC oscillator isn't accurate enough for reliable asynchronous communications. It is sometimes possible to tune the oscillator using the calibration register to allow asynchronous communications to work.

The Minicon features a flexible power supply routing system with a number of options for powering the Minicon and any peripheral modules connected to it.

Four mode-select input jumpers and four LEDs are provided for application firmware.

## 6-pin Pmod Headers

The Minicon has five 6-pin header connectors for connecting to general-purpose, off-board digital I/O, or to specific ATmega168 features like analog-to-digital converters or pulse width modulators. Each 6-pin connector provides four signals, power, and ground. These connectors are specifically designed to work with the Digilent Pmod line of peripheral boards, but can be used to connect to any off-board I/O devices.

See Table 1 for more information on connecting peripheral modules and other devices to the Minicon. Table 1 shows the connectors with their designed base function and a map to the ATmega168 I/O ports. All I/O port pins can be used for general-purpose digital I/Os.

## Power Supply Connectors

The Minicon is rated for external power ranging from 3.6 to 9 volts DC. Using voltage outside this range could damage the Minicon and connected devices.

The Minicon can be powered from a power supply connected to one of three external power connectors, or it can be powered through any of the board's 6-pin Pmod headers. The three external power supply connectors are J6, J7, and J8.

Connector J6 is a 5.5mm x 2.1mm coaxial barrel connector. The AC power adapter, available from Digilent, is attached to this connector. This is useful for desktop development and testing where use of batteries is cost prohibitive. This connector is wired so that the center pin provides the

positive voltage and the outer shell is grounded.

Connector J7 is a two-pin screw terminal. This connector can be used with laboratory bench supplies, or for attachment to battery packs.

Connector J8 is a two-pin male header that provides an alternate connection to battery packs or other power sources. Digilent has available either two or three cell battery packs that can be attached directly to this connector.

Power supply connectors J6, J7, and J8 are connected in parallel. A power source should be connected to only one of these three connectors at a time.

**Warning: Use the proper polarity when connecting a power source to J7 or J8. A reversed connection will damage the board. The proper polarity is silk-screened on the board near each connector.**

The Minicon provides an on-board voltage regulator that produces the 3.3V operating voltage for the board. The VU power bus provides the input to the voltage regulator, and the VCC power bus is the regulated output. Jumper JP9 is used to route external power through the on-board regulator or to bypass the regulator.

The power supply connectors, J6, J7, and J8 are connected in parallel to the center pin, VE, on JP9. If the shorting block is placed in the VU position, the supplied voltage is routed through the voltage regulator and regulated to 3.3V to power the VCC bus. If the shorting block is placed in the VCC position, the supplied voltage is routed around the on-board regulator and powers the VCC bus directly. In this case, the supplied voltage must be externally

regulated to within the safe limits for the Minicon board itself and any connected peripheral boards.

The components on the Minicon will work with any regulated voltage between 2.7V and 5.5V. This allows direct connection of either two-cell alkaline, or three-cell alkaline, NiCd, or NiMh, or four-cell NiCd or NiMh battery packs.

**Warning: If the shorting block on JP9 is in the VCC position, connection of a power source with a voltage greater than 5.5V will damage the board.**

Each 6-pin Pmod connector provides four I/O signals, a power connection and a ground connection. A 3-pin jumper block associated with each connector is used to connect the power pin to either the VU bus or the VCC bus.

Each 6-pin header can be jumpered to provide either regulated or unregulated power to peripheral modules. There are labels on the Minicon near the jumper pins. Place the shorting block in the VCC position for regulated power, or in the VU position for unregulated power supply.

Connectors JA, JB, and JC each have a separate voltage bus selection jumper block (JP2, JP3, and JP4, respectively). The SPI connector (J1), the RS232/TWI connector (J2), and auxiliary power connector (J3), all share voltage bus selection jumper JP1. Auxiliary power connector J3 is provided as an alternative source for powering off-board peripherals.

Although the Minicon normally provides power to the Pmod connectors, power can be supplied to the Minicon from a Pmod connector. In this case, either the VU bus or the VCC bus will be powered from the

Pmod connector depending on how the associated three-pin power routing header is jumpered. However, it is very important to ensure that only one active power source is supplied to the board.

For information on how to set the jumper blocks for VU and VCC, see Table 2.

## Power Supply Monitor Circuit

The Minicon's microcontroller measures the power supply voltage on the VU power supply bus using the provided power supply monitor circuit. This is useful when powering the board from batteries as it allows the firmware running on the microcontroller to monitor the battery charge state.

The power supply monitor circuit is a voltage divider connected to analog input ADC7. The voltage divider divides the VU bus voltage by four, allowing monitoring of voltages within the full range of the power supply.

## Device Programming

The Minicon has one in-system programming connector, J1. The Digilent parallel JTAG cable or the Digilent USB JTAG/SPI cable can be used. When connecting the programming cables, ensure that the VCC and GND pin labels on the cable match the VCC and GND pins on the Minicon.

Programming can be accomplished using the Digilent AVR application, available by free download from the Digilent web site. It is also possible to configure the AVRDUDE programmer in the WinAVR release for in-system programming using the Digilent parallel JTAG cable. See the

documentation for these applications for more information on board programming.

Connector J1 is used both for in-system programming and for user access to the SPI controller. The jumper block JP10 is used to select between the two functions. The shorting block is placed in the RST position for in-system programming, and in the SS position for user access to the SPI port.

## AVR Clock Fuse Settings

AVR microcontrollers use control bits called fuses to set basic operating parameters for the device. The SPI controller uses the clock source set by the fuses for its clock. If the clock source fuses are set to select a clock source that doesn't exist on the board, the SPI controller won't work and it will no longer be possible to program the microcontroller via the in-system programming protocol. The Minicon can only use of the internal RC oscillator as the clock source.

If the external oscillator, or one of the crystal/resonator clock sources is selected, it may be possible to recover the board by applying a suitable clock signal to pin 1 of connector JP5. Pin 1 is the end closer to resistor R29. There is an applications note on the Digilent web site illustrating this technique for the Cerebot board.

In addition, the maximum SPI clock frequency is the selected clock frequency divided by four. If the 128KHz internal oscillator is selected as the clock source, the SPI clock would need to be set to a frequency of 32KHz or less. The Digilent programming cables do not support frequencies that low, so if the 128KHz internal oscillator is selected for the clock source, the board will no longer be

programmable using the Digilent programming cable.

## Two Wire Serial Interface

The Atmel TWI interface is a medium speed (400 Kbps), synchronous, serial, communications bus. The TWI interface supports master or slave operation with up to 128 devices on the bus. Each device is given a unique address, and the protocol has the ability to address packets to a specific device or to broadcast packets to all devices on the bus. For detailed information on configuring and using the two wire interface, see the ATmega168 data sheet at [www.atmel.com](http://www.atmel.com).

The Minicon has two ways to connect to a TWI bus. The TWI signals, SCL and SDA, are available on 6-pin connector J2, or on the TWI daisy chain connector J4.

Connector J4 has two positions for connecting to the TWI signals. By using two-wire cables (available separately from Digilent), a daisy chain of Minicons or other TWI-capable boards can be created.

The TWI bus is an open-collector bus. Devices on the bus actively drive the signals low. When no device is driving the lines low, pull-up resistors achieve the high state on the TWI lines. A single device on the TWI bus must provide the pull-up resistors.

The Minicon board has pull-up resistors that can be enabled or disabled via shorting blocks on the P1 and P2 positions on J4. The pull-ups are enabled by installing shorting blocks on P1 and P2, and are disabled by removing the shorting blocks. Both pull-ups should be enabled or disabled together. Only one device on the bus should have the pull-ups enabled.

## On-Board User I/O

The Minicon provides four on-board LEDs for user output, and four jumper blocks for user input.

The LEDs are connected to I/O Port D, bits 4-7 (PD4-PD7). These pins are shared with the four I/O signals of Pmod connector JA. An LED is turned on by writing the pin to logic 1 and turned off by writing the pin to logic 0.

In addition to the four LEDs, there are four jumper blocks, JP5-JP8, for user input. These are useful for providing mode select inputs to firmware running on the microcontroller.

Jumper blocks JP5 and JP6 are connected to I/O Port B, pins 6 and 7 (PB6 and PB7). When the shorting block is installed the pin will read as logic 0; when the shorting block is removed the pin will read as logic 1.

Jumper blocks JP7 and JP8 are connected through a voltage divider to analog input ADC6. If no shorting block is installed on either jumper, a voltage close to 0 will be read on the analog input. With a shorting block on JP7, a voltage close to 1.1 volts will be read, and with a shorting block on JP8, a voltage close to 2.2 volts will be read. If shorting blocks are installed on both JP7 and JP8, the voltage read will be about 2.2 volts.

**Table 1: 6-pin PMOD headers and SPI connection**

Pin	Description: All Pmod connector pins can be used for general purpose I/Os. The following descriptions are for use with specific Digilent Pmod modules:	Minicon Pmod header pins to ATmega168 ports/bit		
		Pin	Function	Port/bit
<b>JA</b>	<b>General purpose I/Os and on board LEDs</b>	1	PCINT20/XCK/T0	PD4
		2	PCINT21/OC0B/T1	PD5
		3	PCINT22/OC0A/AIN0	PD6
		4	PCINT23/AIN1	PD7
		5	GND	
		6	VCC	
<b>JB</b>	<b>H-bridge connection</b> This connector is for use with an H-bridge module. Pins 1 and 2 are the direction and enable signals for the H-bridge. Pins 3 and 4 are for encoder feedback.	1	INT0/PCINT18	PD2
		2	PCINT1/OC1A	PB1
		3	PCINT0/CLKO/PC1	PB0
		4	PCINT19/OC2B/INT1	PD3
		5	GND	
		6	VCC	
<b>JC</b>	<b>Analog input</b> This connector provides inputs to the analog to digital converter of the ATmega168.	1	ADC0/PCINT8	PC0
		2	ADC1/PCINT9	PC1
		3	ADC2/PCINT10	PC2
		4	ADC3/PCINT11	PC3
		5	GND	
		6	VCC	
<b>J1</b>	<b>SPI interface and in-system-programming</b> The SPI interface is accessed on J1 when the shorting block is in the SS position on JP10. Connector J1 is used for in-system-programming when the shorting block on JP10 is in the RST position.	1	PCINT2/SS/OC1B	PB2
		2	PCINT3/OC2A/MOSI	PB3
		3	PCINT4/MISO	PB4
		4	SCK/PCINT5	PB5
		5	GND	
		6	VCC	
<b>J2</b>	<b>Serial port communications and interrupts</b> The USART serial port and the ATMEL TWI interface can be accessed on J2.	1	ADC5/SCL/PCINT13	PC5
		2	ADC4/SDA/PCINT12	PC4
		3	RXD/PCINT16	PD0
		4	TXD/PCINT17	PD1
		5	GND	
		6	VCC	

**Table 2: Jumper Block Settings**

<b>Jumper</b>	<b>Function</b>
<b>JP1-4</b>	<b>6-pin Pmod headers</b> Any of the five 6-pin Pmod headers can use either regulated or unregulated power. To use regulated power place the jumper block over the center pin and the pin marked VCC. To use unregulated power, place the jumper block over the center pin and the pin marked VU. SPI connector J1 and RS232 connector J2 share jumper block JP1.
<b>JP5-6</b>	<b>User input jumpers</b> JP5 is connected to port B, pin 6. JP6 is connected to port B, pin 7.
<b>JP7-8</b>	<b>User input jumpers</b> These jumpers are connected through a voltage divider to analog input ADC6.
<b>JP9</b>	<b>Power supply selection</b> With a shorting block in the VU position, external power is routed through the on-board voltage regulator. With a shorting block in the VCC position, external power bypasses the on-board voltage regulator.