Nanocon™ Reference Manual

Revision: February 9, 2009
Note: This document applies to REV A-B of the board.

Overview

The Nanocon board is useful for embedded control and robotics projects for both students and hobbyists.

The Nanocon's versatile design and programmable 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 Nanocon 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 terminal connectors, BNC connectors, servo motors, and more. For more information see www.digilentinc.com.

Features include:

- ATmega168 microcontroller
- four 6-pin connectors for Digilent Pmod peripheral module boards
- four LEDs
- ESD protection for all I/O pins
- in-system programming support using the Digilent parallel JTAG cable or the Digilent USB JTAG/SPI cable.
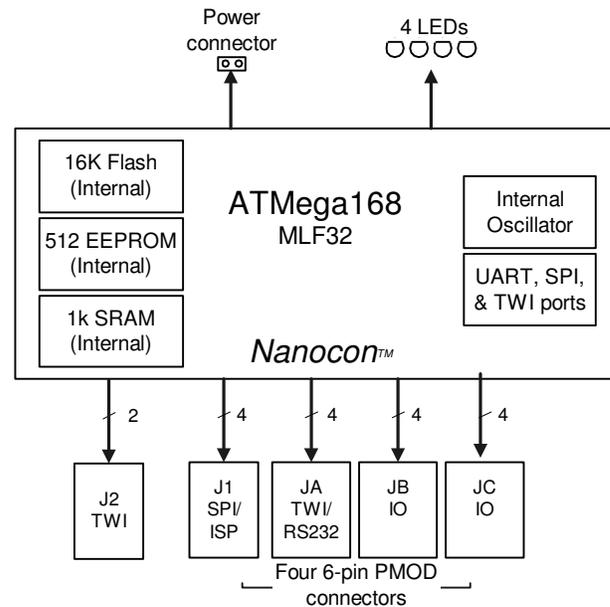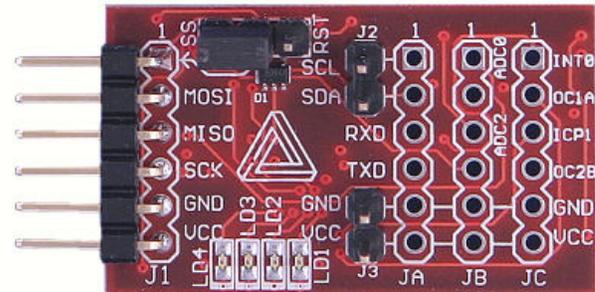
Nanocon Circuit Diagram

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.

Functional Description

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

Although the Nanocon can be used as a stand-alone microcontroller board, it is also designed to be part of a larger system using a distributed processing architecture. Connector J1 allows the Nanocon to be plugged directly into other Digilent microcontroller boards, such as the Cerebot™ or the Minicon™. Using a 6-wire cable and the Digilent Module Interface Board, it can be connected to a Digilent FPGA board.

The Nanocon can be programmed with firmware to perform local control functions. It can then be controlled by, and report back to, a higher level controller in the host controller board. For example, the

Nanocon could be programmed to perform closed-loop motor speed control. It could relieve extra work for the host processor, when performing the motor speed control, by processing commands from the host and controlling the motors itself.

Communication Options

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 JA and J2 provide access to the Atmel two-wire interface (TWI). The TWI is a medium speed (200-400 Kbps) serial bus that allows up to 128 devices to connect. Connector J2 can be used for continuing the TWI bus to other boards.

The ATmega168 microcontroller provides a USART that can be used for asynchronous or synchronous serial communications. However, the Nanocon 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.

6-Pin Pmod Headers

The Nanocon has four 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 Nanocon. Table 1 shows the connectors with their designed base function and a map to the ATmega168 I/O ports. All I/O port signal pins can be used for general-purpose digital I/Os.

Power Supply Connectors

The Nanocon is rated for external power ranging from 2.7 to 5.5 volts DC. Using voltage outside this range could damage the Nanocon and connected devices.

The Nanocon can be powered through any of the board's 6-pin Pmod headers or the J3 connector.

Each of these connectors provides a VCC and a ground pin. A power supply providing between 2.7 and 5.5 volts can be connected to the VCC pin on any one of these connectors.

When the Nanocon is plugged into another Digilent microcontroller or FPGA board, that board can power the Nanocon through the Pmod connector. The host board should be jumpered to provide 3.3V on the VCC pin of the Pmod connector being used. The Nanocon will then be powered by the host board's power supply, and will in turn provide power from the host board to any peripheral boards connected to the Nanocon's other Pmod connectors.

For standalone applications, the Digilent PmodREG1 is a voltage regulator module that can be used to supply the required operating voltage.

Device Programming

The Nanocon has one in-system-programming connector, J1. The Digilent programming cable is connected to J1. Either a parallel JTAG or USB JTAG/SPI cable can be used. When connecting the programming cable, ensure that the VCC and GND pin labels from the cable match to the VCC and GND pins on the Nanocon.

A power supply must be provided to the Nanocon when programming. The Digilent programming cable does not supply power to the board; the board it is plugged into powers the programming cable. The Digilent PmodREG1 voltage regulator module can be used, or any appropriately regulated power supply can be connected to J3. If the Nanocon is being used in conjunction with another Digilent board, such as the Cerebot or Minicon, these boards have connectors that can be used to supply power to the J3 connector on the Nanocon using a two-wire cable.

Programming can be accomplished using the Digilent AVRP 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 JP1 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 Nanocon can only use 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 JA. 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 .

The Nanocon has two ways to connect to a TWI bus. The TWI signals, SCL and SDA, are available on 6-pin connector JA or on the 2-pin connector J2.

Pins one and two of connector JA and connector J2 provide two positions for connecting to the TWI signals. By using two-wire cables (available separately from Digilent), a daisy chain of Nanocons 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 Nanocon provides pull-up resistors that are controlled by software. I/O port B, bits 6 and 7 (PB6 and PB7), is connected to the pull-up resistors. To enable the pull-ups, configure these pins as outputs and set the I/O port output bits to "1". To disable the pull-ups, configure these pins as inputs with the internal pull-ups disabled. Both TWI pull-ups should be enabled or disabled together. Only one device on the TWI bus should have pull-ups enabled.

A port bit is configured as an input or an output by setting the corresponding bit in the DDR register. The pin becomes an output by writing a "1" and an input by writing a "0". When a pin is configured as an input, an internal pull-up resistor is enabled by writing the corresponding output port bit to "1" and disabled by writing

it to "0". See the Atmel Atmega168 data sheet for more information.

On-Board User I/O

The Nanocon provides four on-board LEDs for user output. The LEDs are connected to I/O Port D, bits 4-7 (PD4-PD7). An LED is turned on by writing the pin to logic 1 and turned off by writing the pin to logic 0.

Table 1: Connectors

Pin	Description: All Pmod connector pins can be used for general purpose I/Os. The following descriptions are for used with specific Digilent Pmod modules:	Minicon Pmod header pins to ATmega168 ports/bit			
		Pin	Function	Port/bit	
JA	**Serial port communications** The USART serial port and the ATMEL TWI interface can be accessed on this connector.	1	ADC5/SCL/PCINT13	PC5	
		2	ADC4/SDA/PCINT12	PC4	
		3	RXD/PCINT16	PD0	
		4	TXD/PCINT17	PD1	
		5	GND		
		6	VCC		
JB	**Analog input** 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		
JC	**H-bridge connection** This connector is for use with an H-bridge module. For a single bridge module, pins 1 and 2 are the direction and enable signals for the bridge. Pins 3 and 4 are for encoder feedback. For a dual bridge module, pins 1 and 2 are the direction and enable signals for bridge 1, and pins 3 and 4 are direction and enable for bridge 2.	1	INT0/PCINT18	PD2	
		2	PCINT1/OC1A	PB1	
		3	PCINTO0/CLKO/ICP1	PB0	
		4	PCINT19/OC2B/INT1	PD3	
		5	GND		
		6	VCC		
J1	**SPI interface and in-system-programming** When the shorting block on JP1 is in the SS position, J1 is used for the SPI port. When the shorting block on JP1 is in the RST position, J1 is used for in-system-programming.	1	PCINT2/SS/OC1B	PB2	
		2	PCINT3/OC2A/MOSI	PB3	
		3	PCINT4/MISO	PB4	
		4	SCK/PCINT5	PB5	
		5	GND		
		6	VCC		
J2	**TWI connectors** The ATMEL TWI interface can be accessed on this connector.	1	ADC5/SCL/PCINT13	PC5	
		2	ADC4/SDA/PCINT12	PC4	