ServoMini™ Reference Manual

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

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Overview

The Digilent ServoMini board is useful for programmable control of up to eight RC servos for both students and hobbyists.

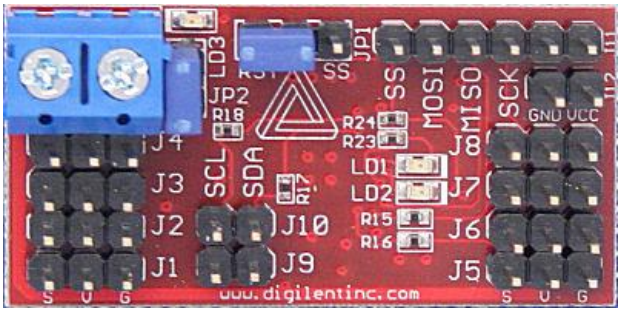
The ServoMini's versatile design and programmable microcontroller allows you to implement your own algorithms to control up to eight RC servos. This allows you to decide what method of control may be best suited for your application.

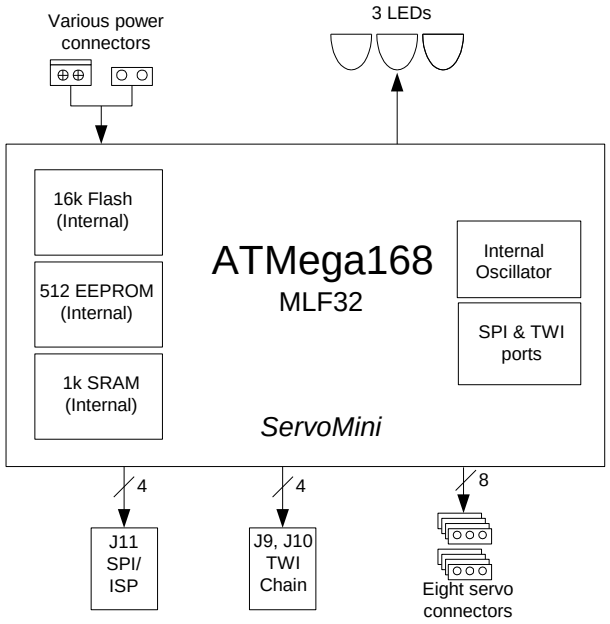
The ServoMini can establish serial communication with other devices using TWI protocol from Atmel, or SPI. This enables you to use the ServoMini as a slave device, freeing up the workload of the master device. Using TWI, many ServoMinis can be linked onto a communication bus, giving it the ability to expand with your needs.

The ServoMini can be powered using the screw terminal connector, the SPI port or J12. It supports a number of programming tools including Atmel AVR® Studio 4, and WinAVR. The device can be programmed using one of Digilent's programming cables.

Features include:

- ATmega168 microcontroller
- three 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
- support for up to eight RC servos
- jumper selectable dedicated servo power supply
- TWI bus daisy chain connectors





ServoMini Circuit Diagram

Features of the ATmega168 include:

- 16KB program flash
- 512 byte EEPROM
- 1KB internal SRAM
- master/slave serial peripheral interface (SPI)
- Atmel two wire serial interface (TWI)
- 10-bit ADC analysis of the AVR power supply along with the servo power supply
- two 8-bit timer/counters
- one 16-bit timer/counter

For more information about the ATmega168, refer to the data sheet available at www.atmel.com.

Functional Description

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

Although the ServoMini can be used as a stand-alone microcontroller board, it is also designed to be part of a larger system using distributed processing architecture. Connectors J9 and J10 allow it to be connected to a serial data bus using Atmel's TWI protocol. In this case the ServoMini can receive instructions, such as desired positions for any of its eight servos, and then it can interpret that data as the designer sees fit. It can also transmit data, such as battery voltage information, for processing by another microcontroller.

The ServoMini's firmware could also be designed to monitor a few servo channels coming from an RC receiver and drive servos based on those pulse-widths. By doing this, the ServoMini could be used as a servo mixer or to control servos based on a custom algorithm. The ServoMini's servo driving ability is only limited by the user's imagination.

RC servos use a pulse-width modulated signal (PWM) to control the servo position. The 8-bit and 16-bit timers in the AVR microcontroller are able to generate PWM signals using the output-compare registers, but only six PWM signals can be generated this way. It is also possible to use timer interrupts to control the servo timing. This allows a single timer (preferably the 16-bit timer) to control the signal timing for all eight servo connectors. The *ServoMini Reference Design* available at www.digilentinc.com illustrates using timer interrupts to control signal timing for the PWM signals to control RC servos.

Power Supply Options

When a shorting block is installed on JP2, the servos will share the same power supply as the ServoMini's processor. Power can be applied via the screw terminal connector, via connector J12 or pins 5 and 6 of the SPI connector, J11. The Atmega168 processor is rated for operation from 2.7 to 5.5 volts DC. Using a voltage outside this range could damage the ServoMini.

Alternatively, if jumper JP2 is removed, the servos must have their own independent power supply connected to the screw terminals and the ServoMini's processor must be powered using either J12 or the SPI port.

Device Programming

The ServoMini has one in-system-programming connector, J11. The Digilent programming cable is connected to J11. Either a parallel JTAG or USB JTAB/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 ServoMini.

A power supply must be provided to the ServoMini 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 J12. If the ServoMini 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 J12 connector on the ServoMini 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 J11 is used for both 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 Servo Mini 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 connectors J9 or J10. 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 ServoMini connects to a TWI bus through the 2-pin connector, J9 and J10. Attaching these pins to a shared communications bus can create a daisy chain of ServoMinis or other TWI-capable boards.

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 ServoMini provides pull-up resistors that are controlled by software. I/O port B, bits 6 and 7 (PB6 and PB7), are 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 ServoMini provides three on-board LEDs for user output. LEDs LD1 through LD3 are connected to PB0, PB1 and PD3 respectively. An LED is turned on by writing the pin to logic 1 and turned off by writing the pin to logic 0.

Location	Description	Pin	Function	Port/bit
J1	**Servo 1**	S	ADC0	PC0
J2	**Servo 2**	S	ADC1	PC1
J3	**Servo 3**	S	ADC2	PC2
J4	**Servo 4**	S	ADC3	PC3
J5	**Servo 5**	S	AIN1	PD7
J6	**Servo 6**	S	AIN0	PD6
J7	**Servo 7**	S	T1	PD5
J8	**Servo 8**	S	XCK/T0	PD4
J9 & J10	**TWI connectors** The ATMEL TWI interface can be accessed on this connector	1	ADC5/SCL/PCINT13	PC5
		2	ADC4/SDA/PCINT12	PC4
J11	**SPI interface and in-system-programming** When the shorting block on JP1 IS IN THE SS position, J11 is used for the SPI port. When the shorting block on JP1 is in the RST position, J11 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	
J12	**Power supply** When JP2 is shorted, J12 supplies power to both the MiniServo's processor and the servos. When JP2 is left open, J12 only supplies power to the processor.	1	GND	
		2	VCC	
J13	**Screw terminal Power supply** When JP2 is shorted, J13 can supply power to both the processor and the servos. When JP2 is left open, J13 becomes the dedicated servo power supply.	1	SVCC	
		2	GND	
LD1	**LED 1**		ICP1	PB0
LD2	**LED 2**		OC1A	PB1
LD3	**LED 3**		INT1	PD3
	Programmable TWI pull-ups	1	XTAL1/TOSC1	PB6
		2	XTAL2/TOSC2	PB7

Table 1 I/O Connections