CrumbControl-1 V1.4 Infosheet

CrumbControl-1-1.4

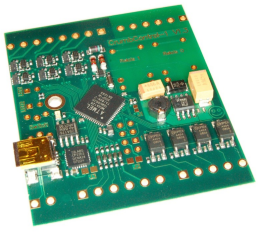
Tiny AVR based SPS-like Control Module with USB, RS485, Digital Out, Digital IN, Analog IN, Relais.

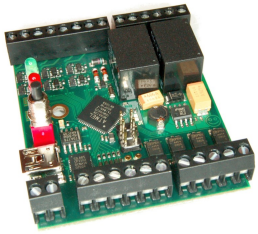
AVAILABLE MODULE OPTIONS

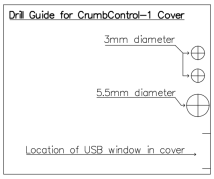
Module	Processor	RAM	EEPROM	Flash	Peripherals
CrumbControl-1 V1.4	ATmega128 preloaded chip45boot2 bootloader for USB flash upload!	4kB SRAM	4kB EEPROM	128kB Flash	- CP2102 USB-UART converter - mini USB B 5pin connector - RS485 transceiver - status LEDs and push button - 6x push-pull digital outputs (3A, 12A, 30V) - 4x isolated inputs - 5x analog inputs - 2x relais - 0.5A switching regulator (8-40V input)

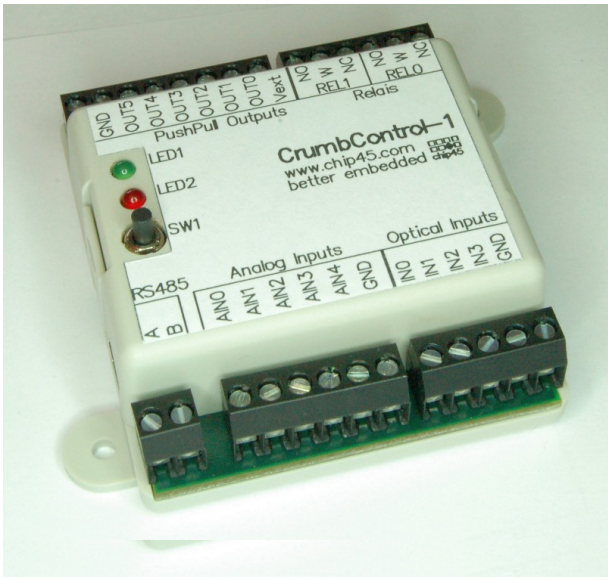
SCOPE OF DELIVERY

The CrumbControl-1 module comes as SMT assembled board plus a kit of screw terminals, relais, LEDs, push button, ISP header and plastic case included. The USB connector window on the left side is already machined in the cover and a drill guide for drilling the LED and switch holes plus top case label are available as 1:1 PDF prints.

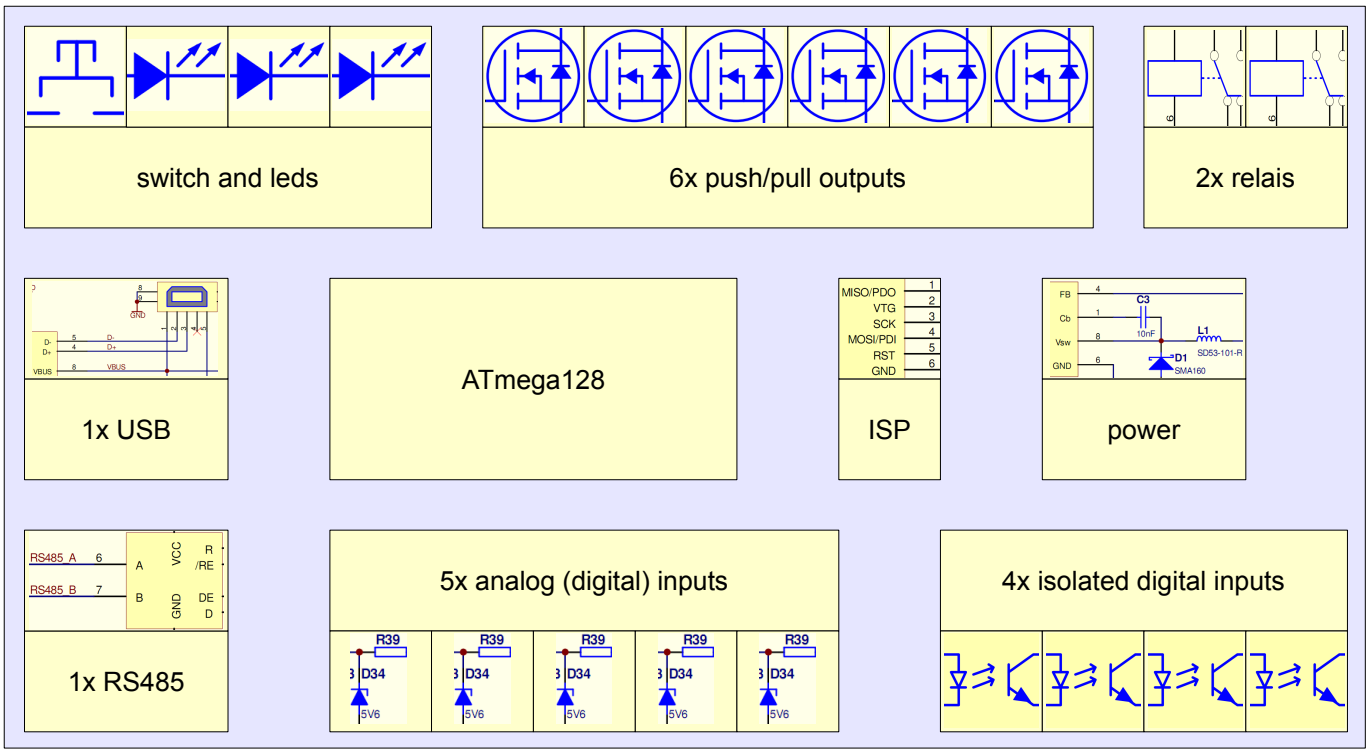








BLOCK DIAGRAM



POWER SUPPLY

The module is supplied from an onboard 5.0V step-down switching regulator, which provides high efficiency and low power dissipation loss at input voltages from 8V to 30V. The input voltage has to be connected to pin 1 of CON4, see connector description below, and is also used as the high side switching voltage for the digital push-pull outputs, see below.
For testing purposes or in case the push pull outputs are not used, the module can be supplied from USB bus. In that case, jumper J3 has to be closed.

If the internal +5V DC should be used for external applications, jumper J2 can be closed and VCC is available externally at the analog input terminal AIN4. Of course, AIN4 is no longer available as analog input and the ADC input of the MCU will always be read as 5V.

BUS INTERFACES

USB INTERFACE

A USB UART converter CP2102 by Silabs is connected to the MCU's USART0. A standard 5pin mini USB B connector is available onboard and allows for easy connection to a host PC. The CP2102 is always powered from USB bus. The USB driver for the CP2102 is available at http://www.silabs.com/products/interface/usbtouart.

PREINSTALLED BOOTLOADER

The module will be shipped with the latest version of the chip45boot2 bootloader preprogrammed. It allows for flash and eeprom programming over USB without the need for an ISP adapter. The bootloader is being enabled by a certain character sequence after reset, then automatically adjusts it's baudrate to the host PC's baudrate and shows a command prompt and is ready to work. See http://go.chip45.com/c45b2 for details on the chip45boot2 bootloader.

AUTO RESET FEATURE

To support easy usage of the chip45boot2 bootloader and since this bootloader is enabled by USB USART communication after reset, it is possible to automatically reset the module in the moment the virtual COM port on the host PC side is being opened by the bootloader PC application or by a terminal program. This is possible by closing jumper J1, which connects the CP2102's DTR signal through a capactor to the MCU's reset signal. DTR goes low when the virtual COM port is opened and the MCU ist automatically reset. This is a comfortable way of working with the module and the bootloader without the need for manually resetting the device for hex file upload!

RS485 INTERFACE

The module provides an RS485 interface which in connected to the MCU's USART1 on PORTE as well as PA0 to control the RS485 direction. The RS485 bus signals are available on terminals CON1, see connector description below. There is no termination resistor onboard, in case of long transmission lines, you might have to add a resistor externally, most simply by connecting a THT resistor together with the cables into the screw terminal.

DIGITAL / ANALOG INPUTS / OUTPUTS

DIGITAL PUSH-PULL OUTPUTS

Six push-pull (half bridge) MOSFET output drivers can switch each output both to high-side (Vextern) and low-side (GND) levels. Maximum high-side voltage is 30V, hence standard industrial 24V signals plus tolerance (28.8V) can be controlled.

Two push-pull outputs can be combined to form a full-bridge output stage for e.g. DC motor control (reversible). The high-side of the first three outputs OUT0, OUT1 and OUT2 is 16 bit PWM'able, i.e. three full-bridge drivers can be formed as OUT0+OUT3, OUT1+OUT4, OUT2+OUT5.

Maximum output current of the push-pull outputs is 3.2A / 12.8A (continous/pulse) for the high-side FET and 4A / 16A (continous/pulse) for the low-side FET.

Note: The push-pull outputs are not hardware-protected against turning on both high- and low-side FETs of a channel! In this case, a high current will flow through the FETs and might destroy the channel. This has to be assured in software!

See IO pin assignment section for MCU connection.

OPTICALLY ISOLATED INPUTS

Four optocouplers provide four isolated (2.5kV) input terminals. See IO pin assignment section for MCU connection. A 1kOhms series resistor is used to limit optocoupler diode forward current to 25mA max. (24V +/-20% input voltage) and provides slight low-pass filtering with a 100nF capacitor.

ANALOG INPUTS

The full-scale input voltage range of the five analog input terminals (AIN0 - AIN4) can be selected between 5V and 10V in two groups (AIN0-3 and AIN3-4). By using the MCU's internal 2.56V reference as analog reference voltage, also 2.56V full-scale range is possible. The ADC resolution is 10 bit with a +/-2 LSB accuracy.

The analog input signals can also be used as digital input signals. Since the MCU's ADC inputs are over-voltage protected by 5.6V zener diodes, high voltages than 5V may be applied. With 5V full-scale range set, a valid high is read from 3V on and with 10V full-scale range set, a high is read from 6V on.

RELAIS OUTPUTS
Two SPDT relais are available to switch isolated and high voltage (1A / 125AC, 1A / 30VDC) signals. See IO pin assignment section for MCU connection.

STATUS LEDS AND PUSH-BUTTON SWITCH

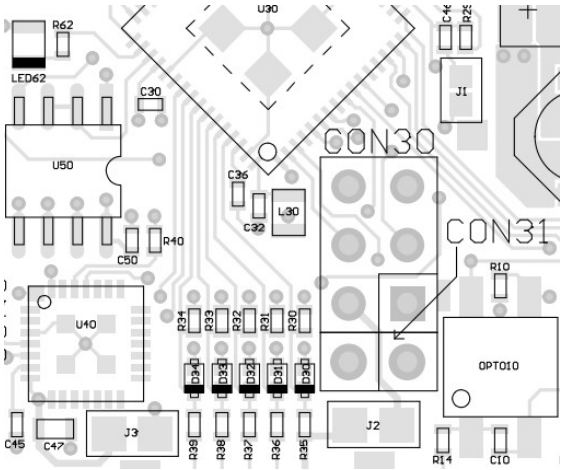
A green and a red 3mm diameter LED are included in the kit, as well as a push-button switch, which is located beside the LEDs and pulls an MCU's IO pin to ground when pressed. See IO pin assignment section for MCU connection.

ISP CONNECTOR

A standard 6-pin Atmel ISP connector is available on the module (CON30).

V1.3 of the CrumbControl-1 had a layout bug, see old infosheet for details!

V1.4 has fixed this bug and the ISP header can be used without restrictions. See picture right for location of the ISP header CON30.



EXPANSION CONNECTOR

Right beside the ISP connector a 2-pin I²C connector is located (CON31), see picture above. Together with the signals of the ISP connector, an 8-pin expansion connector is formed, which allows connection of other modules by SPI (using one of the I²C signals as chip select) or I²C.

SYSTEM CLOCK

The module comes with a 14.74MHz ceramic resonator preinstalled and the fusebits are set accordingly.

MCU IO PIN ASSIGNMENT

The following table shows, which input/output peripherals are connected to what MCU signal. The code sample contains a hardware.h header file, which provides these connections as #define macros.

function	MCU pin	signal name	internal	external
push-pull output signals	PC0	OUT0_LO	high: low-side FET of OUT0 is ON	terminal OUT0 is connected to GND
			low: low-side FET of OUT0 if OFF	no connection of terminal OUT0
	PC1	OUT0_HI	high: high-side FET of OUT0 is ON	terminal OUT0 is connected to Vextern
			low: high-side FET of OUT0 if OFF	no connection of terminal OUT0
	PC2	OUT1_LO	same as above for OUT1	same as above for OUT1
	PC3	OUT1_HI	same as above for OUT1	same as above for OUT1
	PC4	OUT2_LO	same as above for OUT2	same as above for OUT2
	PC5	OUT2_HI	same as above for OUT2	same as above for OUT2
	PC6	OUT3_LO	same as above for OUT3	same as above for OUT3
	PC7	OUT3_HI	same as above for OUT3	same as above for OUT3
	PA7	OUT4_LO	same as above for OUT4	same as above for OUT4
	PA6	OUT4_HI	same as above for OUT4	same as above for OUT4
	PA5	OUT5_LO	same as above for OUT5	same as above for OUT5
	PA4	OUT5_HI	same as above for OUT5	same as above for OUT5
	OCR3C	OUT0_HI	PWM control of OUT0 high side FET	terminal OUT0 is PWM modulated with Vextern
	OCR3B	OUT1_HI	PWM control of OUT1 high side FET	terminal OUT1 is PWM modulated with Vextern
	OCR3A	OUT2_HI	PWM control of OUT2 high side FET	terminal OUT2 is PWM modulated with Vextern
	When using PWM to control high-side FETs, make sure, that corresponding PCn IO pins are tristate (set DDRC bits to input)!!!			

function	MCU pin	signal name	internal	external
optically isolated inputs	PB0	IN0	open emitter output of the IN0 optocoupler, pulled low by a 10k resistor	isolated input IN0, when driven high externally, MCU IO pin is read high
	PB4 (*)	IN1	same as above for IN1	same as above for IN1
	PB6	IN2	same as above for IN2	same as above for IN2
	PB7	IN3	same as above for IN3	same as above for IN3

(*): The MCU pin assignment of signal IN1 has been changed from hardware version V1.3 (PB1) to V1.4 (PB4). Take that into account, when porting software from V1.3 to V1.4!

function	MCU pin	signal name	internal	external
analog inputs	ADC0	ADC1	analog input voltage of AIN4 after a switchable 1:2 voltage divider and zener diode	analog input terminal AIN4 is read by ADC0
	ADC1	ADC2	same as above for AIN3	same as above for AIN3
	ADC2	ADC3	same as above for AIN2	same as above for AIN2
	ADC3	ADC4	same as above for AIN1	same as above for AIN1
	ADC4	ADC5	same as above for AIN0	same as above for AIN0
	PF5	ADC_RANGE12	tristate: 5V full-scale range of AIN3, AIN4 low: 10V full-sale range of AIN3, AIN4	
	PF6	ADC_RANGE345	tristate: 5V full-scale range of AIN2-AIN0 low: 10V full-sale range of AIN2-AIN0	
	Analog input signals can be read as digital input signals PF0-PF4, see text section above.			

function	MCU pin	signal name	internal	external
relais outputs	PG0	REL0	high: coil of relais REL0 is activated	terminal W of relais 0 is connected to terminal NO
			low: coil of relais REL0 passive	terminal W of relais 0 is connected to terminal NC
	PG1	REL1	same as above for REL1	same as above for relais 1

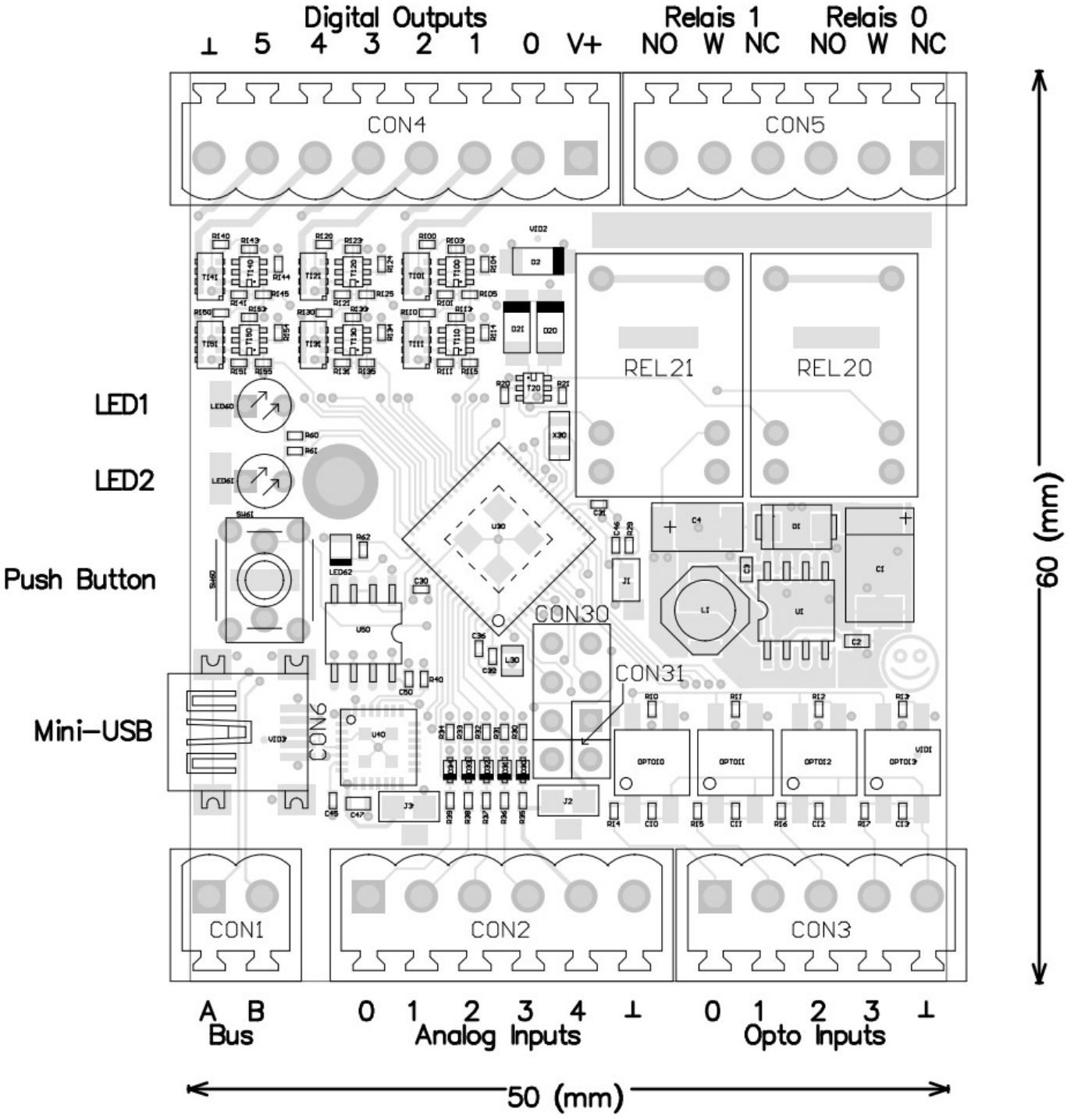
function	MCU pin	signal name	internal	external
LEDs and push-button	PA1	LED_ONBOARD	high: onboard LED is turned off	n/a
			low: onboard LED in turned on	
	PA2	LED_RED	same as above for red LED	control of red 3mm LED
	PA3	LED_GREEN	same as above for green LED	control of green 3mm LED
	PE7 INT7	SWITCH	high: switch is not pressed	status of push-button switch is read by MCU
			low: switch is pressed	

function	MCU pin	signal name	internal	external
bus interfaces	RXD0	RXD_USB	TXD signal (data out, PC to MCU) of the CP2102 USB uart converter	
	TXD0	TXD_USB	RXD signal (data in, MCU to PC) of the CP2102 USB uart converter	
	RXD1	RXD_RS485	R signal of the RS485 transceiver (bus to MCU)	
	TXD1	TXD_RS485	D signal of the RS485 transceiver (MCU to bus)	
	PA0	DIR_RS485	high: MCU send data to bus	direction control of the RS485 transceiver
			low: MCU receive data from bus	

CONNECTORS AND DIMENSIONS

The following picture shows the top side of the module with the pinout and position of all connectors, LEDs, switch and IO signals, as well as all SMT components indicated.

The terminals and bus connectors are also labeled on the bottom side of the PCB for easy reference.



DESIGN AND HANDLING GUIDELINES

This module – just like any other semiconductor devices – is susceptible to damage by ESD. Suitable precautions should be taken when handling and transporting devices. The possible damage to devices depends on the circumstances of the handling and transporting, and the nature of the device. The extent of damage can vary from immediate functional or parametric malfunction to degradation of function or performance in use over time. Devices suspected of being affected should be replaced.

OPERATING CHARACTERISTICS

Symbol	Parameter	Condition	Min	Typ	Max	Units
Vextern	External Supply Voltage				30	V
Vcc	Internal Supply Voltage			5.0	6.0	V
Icc	Power Supply Current (Icc strongly depends on CPU activity, like frequency, power saving modes, etc. as well as external circuitry, io pin input and output current, etc. The values denoted here are for reference only and can differ from final application vallues. The values for RS485 depend on bus termination resitance and can vary from the listed values.)	module only, no external connections, Vextern = 24VDC		40		mA
		relais coil current (per relais!)		+20		mA
T	Operating Temperature (industrial temperature range on request)		-20		+70	°C
V_{DSS}	push-pull driver drain-source voltage				30	V
I_D I_{DP}	push-pull driver output current	high-side, continous			3.2	A
		high-side, pulse			12.8	A
		low-side, continous			4	A
		low-side, pulse			16	A
Vrms	optical inputs isolation voltage	1 minute			2500	V
Vanalog	analog input voltage (analog input voltage may be up to 30V, but any voltage higher than 5V/10V right will be read as ADCMAX)	5V full-scale range			5.5	V
		10V full-scale range			11	V

SAMPLE CODE

A sample AVR-Studio project with C-functions and macros for access of the external IO peripheral of the module is available on the product's download page:
http://shop.chip45.com/AVR-ATmega-Xmega-Control-Modules/Downloads

DEVELOPMENT TOOLS

The free WinAVR C/C++ compiler toolset provides a powerful and stable development environment, which is nicely integrated into Atmel's AVR-Studio development suite. Please visit the following pages for more details:

- Atmel AVR Studio: http://www.atmel.com/dyn/products/tools_card.asp?tool_id=2725
- WinAVR compiler toolset: http://winavr.sourceforge.net/

WHAT ELSE DO YOU NEED?

- To use the bootloader comfortably from a Windows PC application, see www.chip45.com/info/chip45boot2.html for the latest version of the chip45boot2 GUI application.
- If you prefer ISP programmieing, you need an ISP adapter for in-system programming of the MCU, see www.chip45.comAVR-ISP-Programmer-Adapter for suitable devices.
- Windows and Mac users need the latest USB driver for the CP2102 USB UART converter (see CP2102 homepage at https://www.silabs.com/products/interface/usbtouart)
- A development environment and compiler/assembler (see above DEVELOPMENT TOOLS)

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