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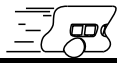
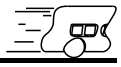


1 Introduction



The KoreIOLE board can be used as a KoreBot extension that provides several inputs and ouputs features. All digital IO can be used as low frequency PWM outputs as well as standard IO. A set of 10 bits, timestamped analog inputs can be polled consitently. For communication with other devices, the KoreIO can be used as brigde to an I2C bus. Many signals of korebot are avaible on the KoreIOLE, like PXA PWM, PXA TxD & Rxd, and PXA GPIO.

The KoreIOLE can receive commands from an I2C bus or a KoreBot.

2.1 Overview

The KoreIOLE hardware is composed of a main microcontroller, and a power outputs circuits.

The main microcontroller handles communication and most basic functions such a IO processing. Another main module is the power outputs circuits with transistors able to drive 1 Ampere through the designed board outputs.

The required connections to the board are defined by the required functions for a given application. Dip switches control the board I2C address. The main connector blocks on each side of the board provides conenctions to all the board features. Communication can go through the KB-250 extension bus connectors or throug the KoreIOLE connectors blocks.

Figure 2.2 describe the board main components.

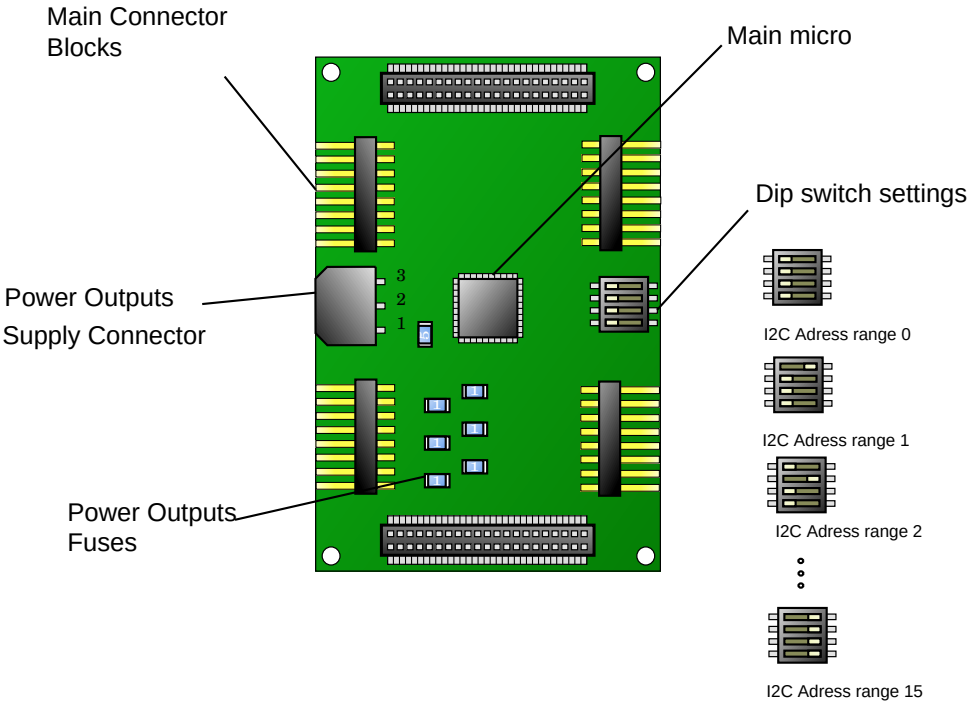


Figure 2.1: KoreIOLE hardware overview

2.1.1 Dip Switch Settings

The I2C address for the KoreIOLE is set with the dip swicth position at startup. The settings are described on figure 2.2. If the switch position is modified at run time, the address will not change until the next reset.

I2C Standalone : That mode is used to control the board from an I2C bus. The I2C bus is directly connected to the main microcontroller, and the I2C address is detailled in section 2.1.2. The KoreIO can be connecter to any I2C master as a standalone I2C device, for instance a KoreBot can be configured as an I2C master for the KoreIOLE.

2.1.2 Controller I2C Address

The four dip switch, as displayed on figure 2.2 are used to choose the I2C address for the controller. The address choice is usefull to stack up to 16 KoreIOLE together, using the same I2C bus.

Address range 0	0x40
Address range 1	0x41
Address range 2	0x42
...	
Address range 15	0x4F

2.1.3 Connector Blocks Connections

The KoreIOLE board provides 64 side connections to the various functions. The function for each connection is describe below.

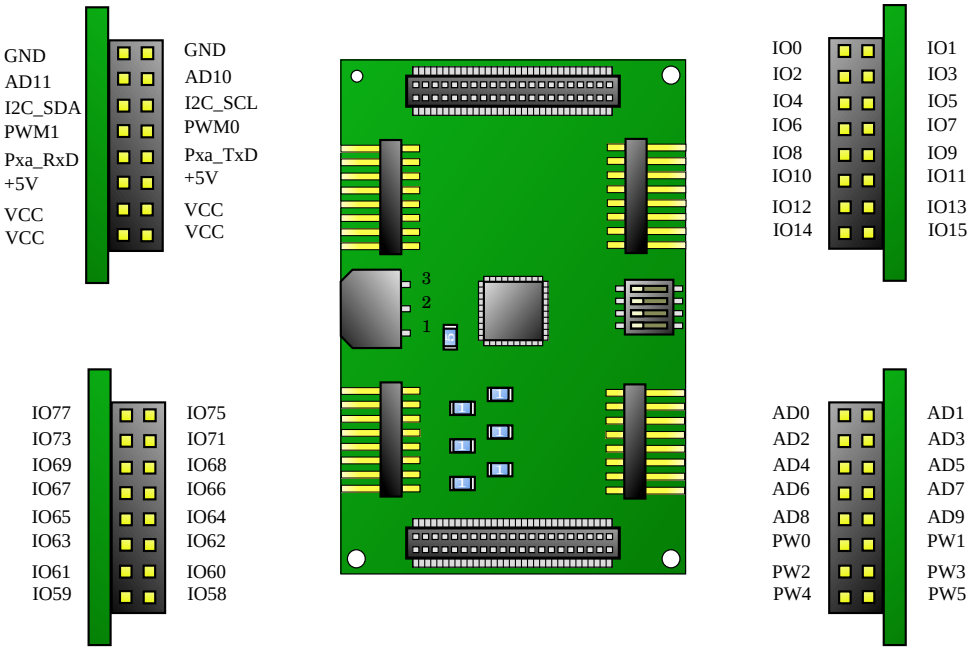


Figure 2.2: KoreIOLE hardware overview

Name	Function	Name	Function
AD0	Analog to Digital input 0	IO0	Digital IO 0
AD1	Analog to Digital input 1	IO1	Digital IO 1
AD2	Analog to Digital input 2	IO2	Digital IO 2
AD3	Analog to Digital input 3	IO3	Digital IO 3
AD4	Analog to Digital input 4	IO4	Digital IO 4
AD5	Analog to Digital input 5	IO5	Digital IO 5
AD6	Analog to Digital input 6	IO6	Digital IO 6
AD7	Analog to Digital input 7	IO7	Digital IO 7
AD8	Analog to Digital input 8	IO8	Digital IO 8
AD9	Analog to Digital input 9	IO9	Digital IO 9
AD10	Analog to Digital input 10	IO10	Digital IO 10
AD11	Analog to Digital input 11	IO11	Digital IO 11
		IO12	Digital IO 12
PW0	Power ouput 0	IO13	Digital IO 13
PW1	Power ouput 1	IO14	Digital IO 14
PW2	Power ouput 2	IO15	Digital IO 15
PW3	Power ouput 3		
PW4	Power ouput 4	IO58	KoreBot GPIO 58
PW5	Power ouput 5	IO59	KoreBot GPIO 59
		IO60	KoreBot GPIO 60
VCC	Power input	IO61	KoreBot GPIO 61
+5V	Main supply	IO62	KoreBot GPIO 62
GND	Board Ground	IO63	KoreBot GPIO 63
		IO64	KoreBot GPIO 64
PXA_TxD	KoreBot TxD	IO65	KoreBot GPIO 65
PXA_RxD	KoreBot RxD	IO66	KoreBot GPIO 66
		IO67	KoreBot GPIO 67
PWM0	KoreBot PWM signal 0	IO68	KoreBot GPIO 68
PWM1	KoreBot PWM signal 1	IO69	KoreBot GPIO 69
		IO71	KoreBot GPIO 71
I2C_SDA	I2C bus SDA	IO73	KoreBot GPIO 73
I2C_SCL	I2C bus SCL	IO75	KoreBot GPIO 75
		IO77	KoreBot GPIO 77

2.2 KoreIOLE Connections

The KoreIOLE requires a power supply connection and an external interface connection. The main external power supply may be necessary for power outputs and the connection is detailled in section 2.2.3. Another supply may be necessary for the electonics on the board. This supply is provided from the KoreBot when the KoreIOLE is used as an extension, but it is required for standalone use (see section 2.2).

The external interface depends on your configuration. The possibilities are:

- KoreBot connection for I2C
- Custom connection for a standalone I2C interface

How to Supply 5V for Electronics

The 5V supply for the electronics on the board can be provide by the KoreBot or an external +5V supply (see fig 2.3.

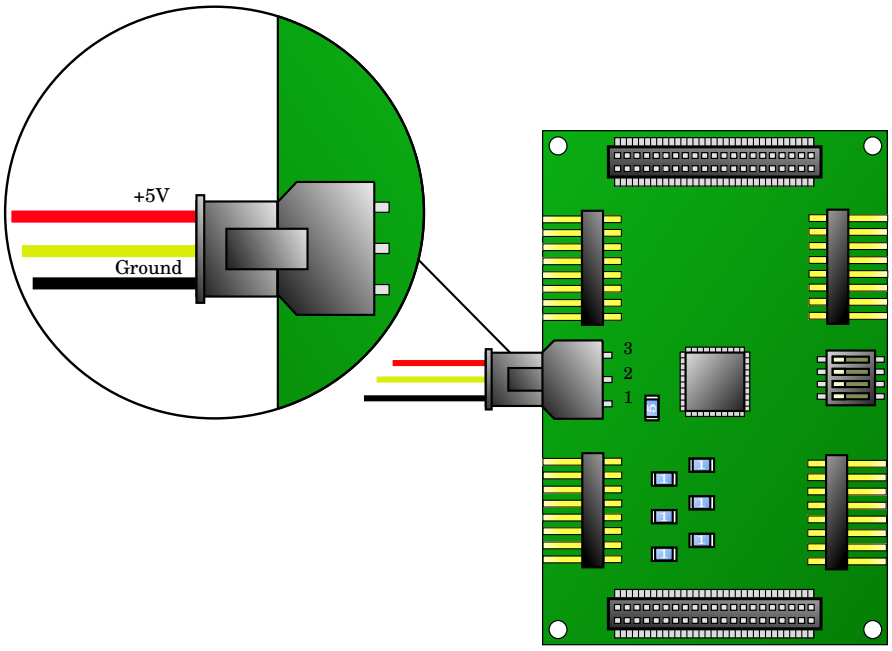


Figure 2.3: +5V external supply

2.2.1 KoreBot Connections

The KoreBot connection is pretty straightforward, the boards should be simply stacked together. The KoreBot will provide the electonics 5V supply, and only the power ouput supply should be added if necessary.

2.2.2 Standalone I2C Connections

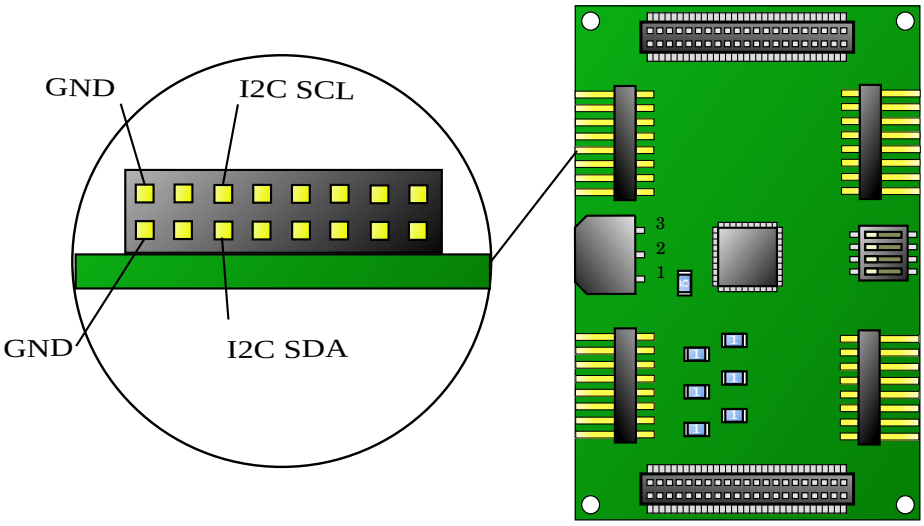


Figure 2.4: KoreIOLE I2C connections

The KoreIOLE can be connected to an external I2C bus and controlled as a standard I2C devices (see section 2.1.1 for details). Three signals (SDA, SCL and GND) are necessary to connect the I2C bus, they are displayed on figure 2.4.

The electronics supply must be provided separately.

2.2.3 Power Output Supply Connector

The supply is common for all power outputs thus they will provide the same voltage, and the maximum current per channel is 1A. For instance to provide 12V on each power output, the board should be connected to a 12V DC supply. The overall current that can be supplied by all the power outputs is of course limited by the external power supply capacity.

The main power connector will supply all the outputs, the voltage should match the application requirements, and stay within the accepted voltage range for the transistors. The connector pinout is detailed on figure 2.5.

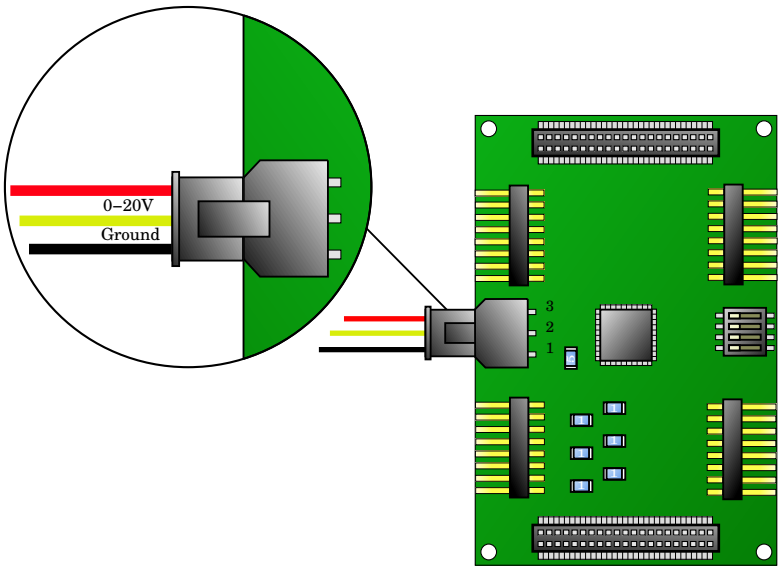


Figure 2.5: Power output supply connection

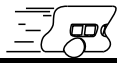
Voltage range	0-20V
Max global current	5A
Max current per channel	1A

2.3 Hardware Protection

2.3.1 Power Output Fuses

The power outputs are protected from overcurrent with dedicated fuses. Each channel is protected with a 1 Amps fuse, and the board is protected with a general 5 Amps fuse. Higher peak currents are normaly supported by the board and all its components, but continuous operations should respect these limits.

Please contact your K-Team dealer for support if a fuse replacement is required.



3.1 Digital Inputs and Outputs

The KoreIOLE board provides 16 digital IO, that can be individualy configured as outputs, inputs or PWM outputs. Each channel must be configured before being used, and the initial default configuration for all channels is as input.

3.1.1 Input Mode

This is the default mode for all channels. In this mode, a channel state can be read at any time. A zero will be returned if the applied voltage on this input is under 4.5V, and a one will be returned if the voltage is above this level. The board microcontroller might be damaged if a voltage over 5.5V is applied on any input pin.

Voltage threshold	4.5V
Maximum voltage	5.5V
Minimum voltage	0V

3.1.2 Output Mode

In this mode the voltage of any channel can be driven to 5V or forced to ground. The channel are TTL signals and cannot be used to supply power to external devices. The state of each channel can be reset to zero, set to one, or switched (refer to section 4.1.3).

High voltage	5V
Low voltage	0V

LED State Control

One of the LED on the KoreIOLE is user controlled. The LED state can be changed using the virtual IO 16, which is always configured as an ouput. This virtual IO can be accessed as any other IO, using the ouput control commands.

3.1.3 PWM Output Mode

Each channel can be configured to be used as a software emulated PWM generator. All the PWM mode channels will share the same frequency but the duty cycle can be set separately for each channel.

The signal frequency in Hertz can be changed by setting a 16 bit register, the minimum supported frequency is 20Hz and the maximum is 5000Hz. High frequencies might become less accurate because of the microcontroller limited computation speed.

The duty cycle ratio for each channel can be set from 1% to 100% with a 1% resolution. The duty cycle ratio value should be directly written to the corresponding 8bit register.

Max Frequency	5000 Hz
Min Frequency	20Hz
Resolution	1%

Servo Motor Control Mode

PWM channels can be configured in a special mode to control servo motors. If the PWM frequency is set to zero, the servo control mode will be enabled for all channels. The PWM frequency is forced to 50Hz for all channels, and the duty cycle ratio can then be set between 1% and 10% with a 0.04% resolution.

		period	**register value**
PWM frequency	50 Hz	20ms	NA
Min ratio	1%	0.2ms	1
Max ratio	10%	2ms	255

3.2 Analog Inputs

The KoreIOLE provides 12 analog inputs that are connected to a Analog to Digital converter. Each channel is connected to a 10bit DAC, and the values are timestamped to reconstitute the acquired signal properly. The timestamp is a 32bit value wich gives the number of milliseconds since the last timer restart.

The analog measurements are buffered and refreshed sequentialy every millisecond. For any given channel, a new measurement is available every 12 ms.

The maximum voltage which can be applied on a given input is 5V, any voltage over 5.5V applied on any input can seriously damage the microcontoller.

Max Voltage	5V
Min Voltage	0V
Resolution	0.005V

3.2.1 Analog Measurement Timer

Analog measurements are always timestamped using a dedicated timer 32 bit value. The timestamp give the elapsed time in mS since the last timer restart. The timer can be stopped, started and reset from the application.

3.3 Power Outputs

The KoreIOLE provides 6 power outputs. These outputs are digital and are controlling a transistor to drive up to 1A per channel, as displayed on figure 3.1.

Each channel can be switched on to supply an external device with the KoreIOLE supply as connected on the power output supply (see section 2.2.3). The channel can be switched off as well to become the equivalent of an open circuit.

A load should be connected between the KoreIOLE supply, which means any VCC signal on the connector blocks, and a PW channel. If the load is non reversible, the negative side should be connected to the PW channel and the positive side to the VCC signal.

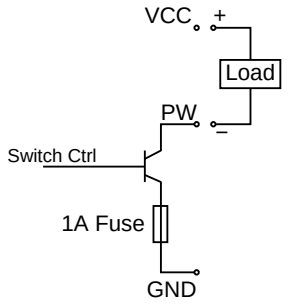
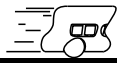


Figure 3.1: Power output diagram



4.1 General Purpose Inputs and Outputs

The processor of KoreBot has many GPIO. On the KoreIOLE 16 GPIO from the PXA are available (GPIO58 - 69, GPIO 71, GPIO 73, GPIO 75 & GPIO 77). These IO are +3.3V logic signals. Be carefule, don't connect an +5V (or greater) output signal to this IOs, this could cause several damage to the PXA.

4.1.1 PWM outputs

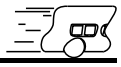
The PXA has two programmable PWM outputs, these two signals are available on KoreIOLE in a +5V logic state (PWM0 & PWM1).

4.1.2 RS232 bus

The main RS232 bus of KoreBot is avaible on KoreIOLE in a TTL +5V logic state (PXA_RxD & PXA_TxD).

4.1.3 I2C bus

The main I2C bus of the KoreBot (the one is connect to the KoreIOLE controler), is avaible on pin I2C_SDA and I2C_SCL (+5V TTL state). When no KoreBot is stacked on KoreIOLE, this signals are use to control the KoreIOLE.



A.1 Master Write Registers

Address	Valid Data	Description
0x01	0-100	Change PWM channel 0 ratio
0x02		Change PWM channel 1 ratio
0x03		Change PWM channel 2 ratio
0x04		Change PWM channel 3 ratio
0x05		Change PWM channel 4 ratio
0x06		Change PWM channel 5 ratio
0x07		Change PWM channel 6 ratio
0x08		Change PWM channel 7 ratio
0x09		Change PWM channel 8 ratio
0x0A		Change PWM channel 9 ratio
0x0B		Change PWM channel 10 ratio
0x0C		Change PWM channel 11 ratio
0x0D		Change PWM channel 12 ratio
0x0E		Change PWM channel 13 ratio
0x0F		Change PWM channel 14 ratio
0x10		Change PWM channel 15 ratio
0x19	0-15	Configure the given digital IO to input mode
0x1A	0-15	Configure the given digital IO to ouput mode
0x1B	0-15	Configure the given digital IO to pwm mode
0x1C	0-16	Reset to zero the given digital IO (16 = led)
0x1D	0-16	Set to one the given digital IO (16 = led)
0x1E	0-16	Change the state of the given digital IO (16 = led)

Address	Valid Data	Description
0x1F	0-255	Change the PWM frequency LSB
0x20	0-255	Change the PWM frequency MSB
0x22	0-5	Reset to zero the given Power output
0x23	0-5	Set to one the given Power output
0x24	0-5	Change the state of the given Power output
0x25	0-2	Analog measurement timer ctrl 0: reset the timer 1: stop the timer 2: start the timer

A.2 Master Read Registers

Address	Answer	Description
0x00	0-255	Read Firmware Version
0x01	0-1	Read Digital Input 0
0x02		Read Digital Input 1
0x03		Read Digital Input 2
0x04		Read Digital Input 3
0x05		Read Digital Input 4
0x06		Read Digital Input 5
0x07		Read Digital Input 6
0x08		Read Digital Input 7
0x09		Read Digital Input 8
0x0A		Read Digital Input 9
0x0B		Read Digital Input 10
0x0C		Read Digital Input 11
0x0D		Read Digital Input 12
0x0E		Read Digital Input 13
0x0F		Read Digital Input 14
0x10		Read Digital Input 15
0x11-16	6 bytes	Read Analog Input 0
0x17-1C	refer to	Read Analog Input 1
0x1D-22	section 3.2	Read Analog Input 2
0x23-28		Read Analog Input 3
0x29-2E		Read Analog Input 4
0x2F-34		Read Analog Input 5
0x35-3A		Read Analog Input 6
0x3B-40		Read Analog Input 7
0x41-46		Read Analog Input 8
0x47-4C		Read Analog Input 9
0x4D-52		Read Analog Input 10
0x53-58		Read Analog Input 11
0xF2	0-4	Read the Status value