PMS5005 Sensing and Motion Controller
User Manual

Dr Robot®

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Related Document:

WiRobot SDK API Reference Manual

I.   Introduction

The PMS5005 Robot Sensing/Motion Controller can be used as sensing, control, motion execution, LCD display and wireless communication processing unit for various robotic applications. Its onboard firmware makes the low level function modules such as motor driver module and wireless communication module transparent to the users. A host (e.g. PC, DSP, or processor) will be used to communicate and control the PMS5005 for different applications through the UART (serial) interface. The system can help robotic and AI researchers and developers focus on the high level logic and algorithm design, and avoid the hassle of writing low level device drivers, standard control schemes and troubleshooting the electronic circuits. The ease of use, powerful functionality and onboard intelligence can eliminate design risk, streamline hardware and software development, and significantly shorten the time to delivery while effectively reducing the cost. Typical applications include humanoid robot, legged robot, wheel-based robot, robot head, robot arm and robot hand.

I.1.   PMS5005 Robot Sensing/Motion Controller Architecture

As shown in Figure I.1, the PMS5005 features functionalities required by most of the robotic applications, such as sensing, motion control, and data communication.

The PMS5005 contains the following features and capabilities:

- 40MIPS 16-bit fix-point hybrid DSP/MCU
- 36K x 16-bit words flash
- 2.5K x 16-bit words SRAM
- Build-in
    - A/D reference voltage monitoring
    - Over-heating sensor (x2)
    - System voltage monitoring (x1)
    - Watchdog timer (x1)
    - Full duplex UART (x2)
- Embedded firmware for configurable closed loop position, velocity, various sensor data acquisition, LCD graphic display, wired and wireless communication
- Interfaces to
    - MDM5253 DC motor driver module with position and current feedback (x2), which includes
        - General-purpose PWM DC motor interface (x6)
        - Motor current feedback interface (x6)
        - Potentiometer position feedback sensor interface (x6)
    - Quadrature encoder (x2)
    - Standard RC servo motor (x6)
    - DUR5200 Ultrasonic range sensor module (x6)
    - DHM5150 Human sensor module (x2)
    - DAT5280 Ambient temperature sensor module (x1)
    - GP2Y0A21YK Infrared range sensor (x1)
    - DTA5102 2 axis tilt/acceleration sensor module (x1)
    - Custom A/D (x 8 including 3 channels of optional battery voltage monitoring). It can connect to MSA3502 if signal amplifying is needed.
    - Custom digital input (x8)
    - Custom digital output (x8)
    - MGL5128 Graphic LCD display module (128 x 64) (x1)
    - MIR5538/5540 Full duplex infrared remote control and communication module (x1)
    - PMB5010 Multimedia controller (x1)
    - MCB3100 or MCB3101 Serial Bluetooth wireless module, or WFS802b WiFI serial Module, or MCR3210 RS232 interface module (x1)
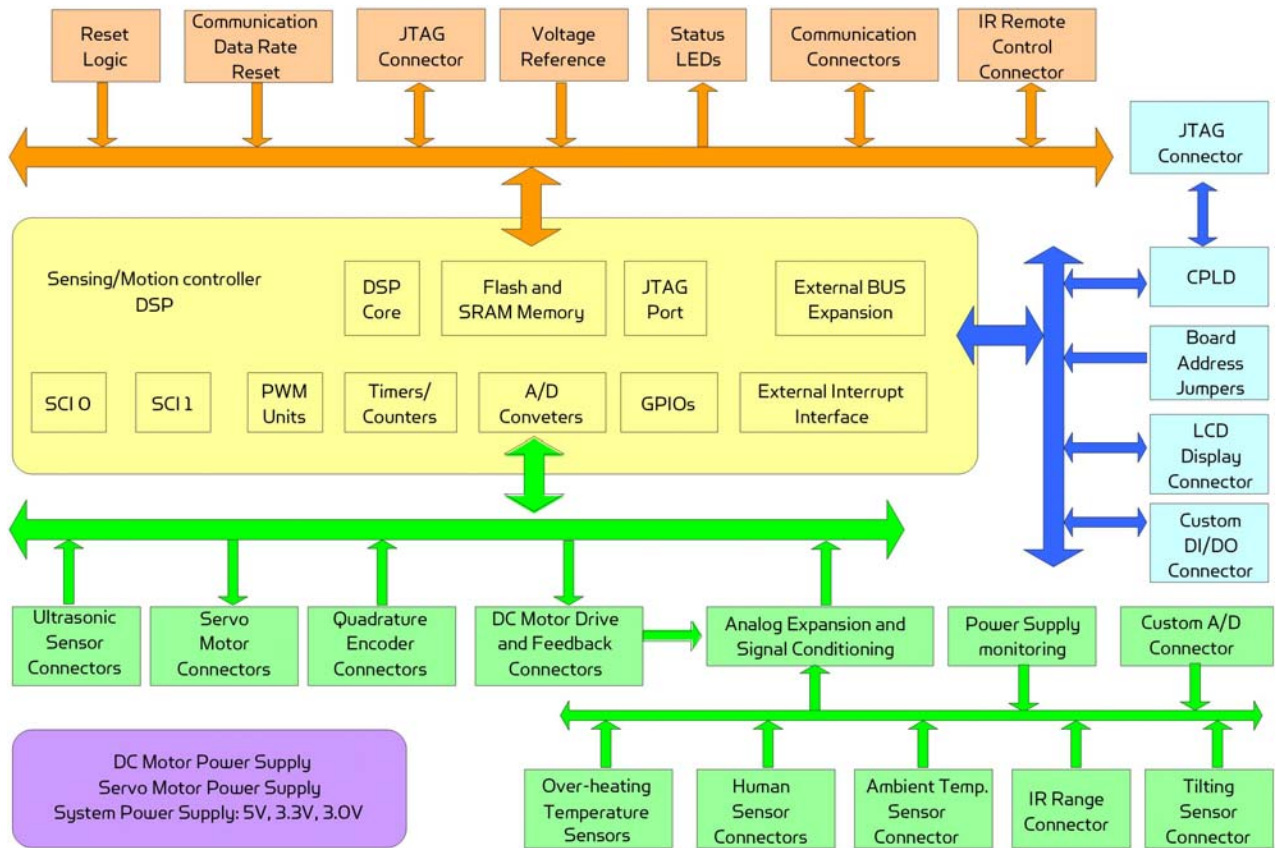
Figure I.1 Block Diagram of the PMS5005

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I.2.   PMS5005 Connectors and Jumpers

Figure I.2 shows the function and location of the connectors and jumpers on the PMS5005.
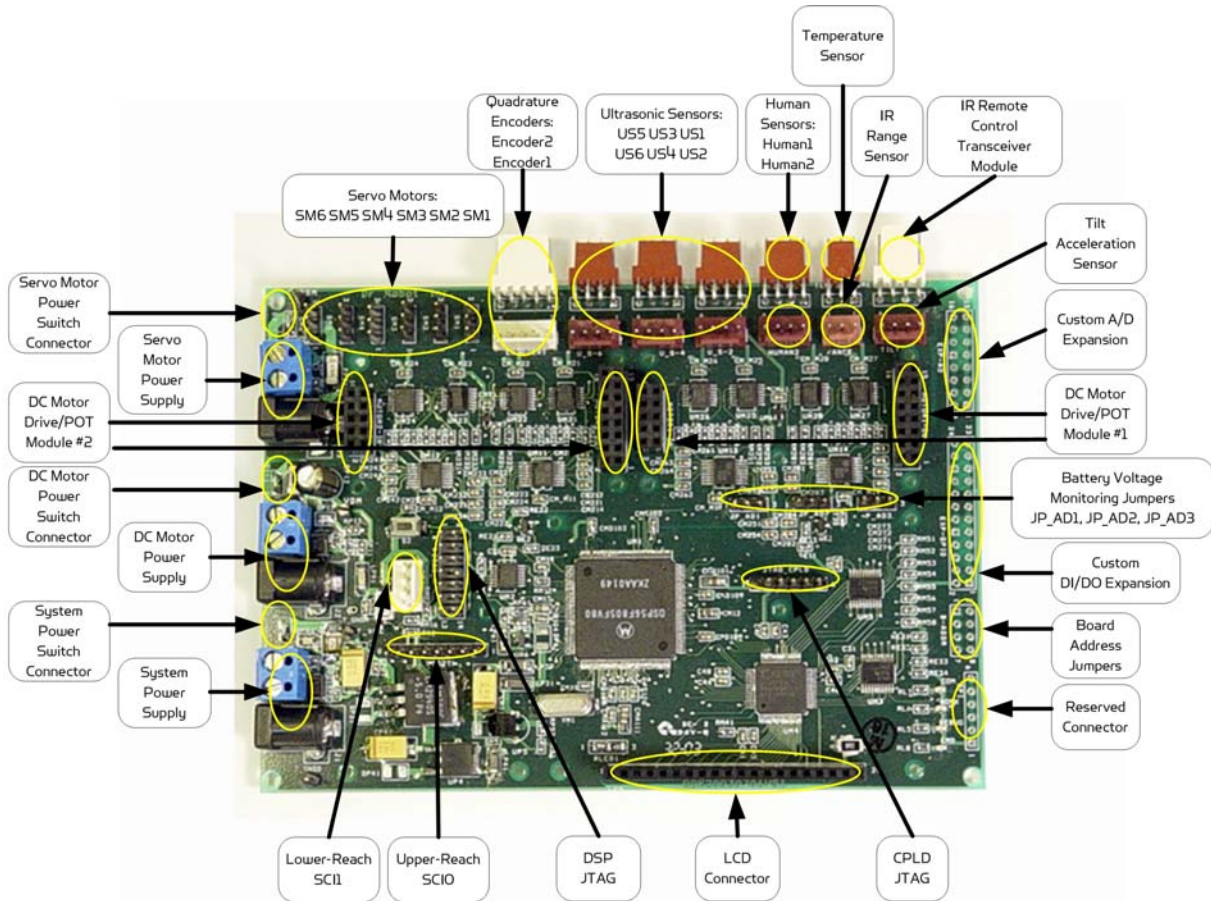

Figure I.2 PMS5005 Connector and Jumper Locations

Note that the size of the PCB board of PMS5005 is about 14.5cm x 10.2cm.

II.   Operations

The PMS5005 Robot Sensing/Motion Controller is designed to be running as part of the WiRobot system. The hardware preparation when using the PMS5005 is just simply connecting the relevant WiRobot modules to the relevant connectors on the PMS5005 board and setting the proper jumper configurations. Lower device-level operations are handled by the firmware embedded in PMS5005 controller with the following functions:

- Control 6 RC servos

- Driver for LCD display, 6 ultrasonic sensors, 2 human sensors, 1 infrared distance sensor, 1 temperature sensor, 1 tilt/acceleration sensor and 1 infrared remote sensor

- Can interface with different digital devices through the general digital input and output ports

- Can interface with different analog devices through the A/D ports

- Built-in voltage monitoring capability

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- Built-in 3 DC motor control schemes, including open-loop PWM control, closed-loop position control, and closed-loop velocity control. Closed-loop position and velocity control required the use of encoder or rotary sensor as the feedback device

Users can physically connect the PMS5005 to a host (e.g. PC, processor, or DSP) through null modem cable or serial wireless modules. By default, the PMS5005's UART setting is 115200, 8, N, 1 with hardware flow control. With this connection, there are two ways to communicate with the PMS5005:

1. Using WiRobot SDK Software (requires Microsoft platform): High level programs running on PC can communicate with the PMS5005 firmware using WiRobot SDK Component and supplied WiRobot Gateway program. Users simply need to make a function call in their programs to obtain sensor information or to control different devices (e.g. servos, DC motors, and etc.) without the needs to understand the communication details between PC and PMS5005. Please refer to the WiRobot SDK API Reference Manual for further information on programming.

2. Using PMS5005 Communication Protocol: A device (e.g. PC, processor, or DSP) can communicate with PMS5005 directly using packet-level commands. Such option has no requirement on the host and provides the freedom for users to choose their development platform.

II.1.   PMS5005 Power Supplies and Consumption

Up to three independent groups of power supply can be connected to the PMS5005 supporting board system circuits (System Power Supply), DC Motor Power Supply and Servo Motor Power Supply respectively. These power supplies could be connected to the PMS5005 either through the screw terminals or through the power jacks. Near each screw terminal, there is a connector port for connecting the power switch or emergency button for each power supply. By default, all three connector ports are connected together. If power switches are needed, you could disconnect the connection and add a switch in between for each connector port.

Table II.1 shows the specification of the power supplies. Refer to Section II.5 for the connections of the power jacks and terminals.

Table II.1 Specification of Power Terminals

Power Supply	Power Jack	Screw Terminals	Switch Connector	Voltage Range (V)	Max Peak Current (A)
System	J1	PSY	S1-0	5.5 – 7.2	N/A
DC Motor	J2	PDM	S1-1	6.0 – 25.0	12
Servo Motor	J3	PSM	S2-1	5.0 – 7.2	8

The system power supply is required at all time for the operation of this board and the power consumption of PMS5005 without connecting any peripheral modules is about 350mA using a 7.2V battery pack. We also recommend the use of three different power sources in powering the PMS5005 (System Power Supply, DC Motor Power Supply and Servo Motor Power Supply) since high power consumption devices (e.g. high torque servos) may affect the operation of voltage sensitive devices (e.g. sensors) due to voltage frustration.

Note: Please make sure that the DC motor power supply voltage does not exceed the maximum allowable voltage for the DC motors.

II.2.   PMS5005 Jumper Settings

The board address jumpers can be set to any value between 0 and 15. The board address is currently reserved for future use.

Table II.2 Board Address Jumpers B_ADDR

Bit	Pin	Value 1	Value 0

0 (LSB)	1, 2	open	1-2 short
1	3, 4	open	3-4 short
2	5, 6	open	5-6 short
3 (MSB)	7, 8	open	7-8 short

JP_AD1, JP_AD2 and JP_AD3 are used for enabling and disabling battery voltage monitoring. If the jumper is removed, the corresponding power supply monitoring and custom AD_IN will be disabled..

Table II.3 Battery Voltage Monitoring Jumpers

Jumper	Position	Battery Voltage Monitoring
JP_AD1	1-2	Enable system power supply monitoring
	2-3	Disable system power monitoring and connect Custom AD_IN1
JP_AD2	1-2	Enable DC motor power supply monitoring
	2-3	Disable DC motor power and connect Custom AD_IN2
JP_AD3	1-2	Enable servo motor power supply monitoring
	2-3	Disable servo motor power monitoring and connect Custom AD_IN3

II.3.   PMS5005 System Communication Connections

Under the WiRobot system architecture, all controllers are connected in a chain. There is one and only one host serving as the central controller. All other embedded controllers have at least two SCI ports for the system communications: upper-reach port and lower-reach port, with the direction respect to the central controller.

The system communication connection structure of the PMS5005 in the WiRobot system is shown in Figure II.1. PMS5005 can work solely in the WiRobot system or together with WiRobot Multimedia Controller PMB5010 when multimedia data (video and audio) is required in the system.
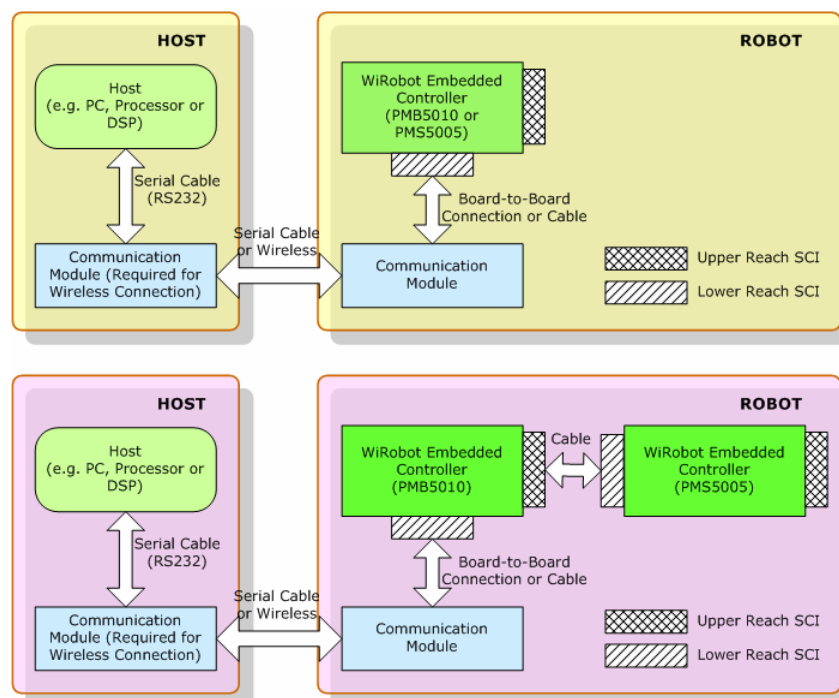

Figure II.1 WiRobot System Communication Architecture

The system communication connectors on the PMS5005 are described in Table II.4. Refer to Section II.5 for the definitions of the signals attached to the connector BTOOTH and SCI.

Table II.4 System Communication Connectors

Connector	Type	Description
BTOOTH	Upper Reach	SCI port with handshaking and control signals for both wired and wireless modules
SCI	Lower Reach	Two-wire serial communication interface (reserved for future use)

II.4. Connecting Peripheral Modules Supported by PMS5005

Table II.5 lists the WiRobot peripheral modules that can be directly connected to the PMS5005 board and supported by the firmware embedded in PMS5005. Refer to the relevant user manuals of these peripheral modules for the detailed technical information.

Table II.5 Peripheral Modules Supported by PMS5005

Peripheral Module	Connector	Max No.	Description
MCB3100 / MCB3101	BTOOTH	1	Bluetooth wireless communication module
MCR3210	BTOOTH	1	RS232 interface module
WFS802b	BTOOTH	1	WiFi serial module
DUR5200	US_1 – 6	6	Ultrasonic range sensor
DTA5102	TILT	1	2-Axis tilting and acceleration sensor
DHM5150	HUMAN1 – 2	2	Human motion sensor
DAT5280	TEMPERATURE	1	Ambient temperature sensor
MIR5538/5540	INFRAR	1	Infrared remote controller module
MDM5253	MOTOR1_IN, _OUT MOTOR2_IN, _OUT	2	3-channel DC motor driver module with position and current feedback
3rd party	SM1 - 6	6	3rd party servo motor
3rd party	ENCODER1 - 2	2	3rd party quadrature encoder
GP2Y0A21YK	RANGE	1	Infrared range sensor
MGL5128	LCD	1	Mono Graphic LCD display module, 128x64

II.5. Connecting DC Motors and Potentiometers to PMS5005

In order to connect DC motors and potentiometers to the PMS5005, MDM5253 (DC Motor Driver Module with Position and Current Feedback) is required. Each MDM5253 can control up to 3 DC motors and 3 potentiometers; and each PMS5005 can connect up to 2 MDM5253. The potentiometer can be used as the position feedback of the DC motor for precise position and velocity control. Connector MOTOR1-IN and MOTOR1-OUT on PMS5005 are used to connect to a MDM5253 for DC Motor 1, 2, 3 and Potentiometer 1, 2, 3; and connector MOTOR2-IN and MOTOR2-OUT are used to connect to a MDM5253 for DC Motor 4, 5, 6 and Potentiometer 4, 5, 6. For details on how to connect DC motors and potentiometers to the MDM5253, please refer to the MDM5253 User Manual.

II.6.   Connecting Custom Sensors/Devices to PMS5005

The PMS5005 has 8 digital inputs, 8 digital outputs and 8 custom A/D extensions. These ports can all be used to connect to different sensors or output devices. For example, user can connect gyroscope, more infrared distance sensors or other analog signal devices to PMS5005 by making use of the available A/D extensions. If a user just wants to have better infrared sensing capabilities in his / her robot, the PMS5005 can support up to 9 infrared distance sensors (GP2Y0A21YK) through its IR range sensor port and the 8 custom A/D expansions.

II.7.   Sample WiRobot Connection Using PMS5005

The following figure illustrates a simple way in using the PMS5005. Note that only a single 7.2V power source is used to supply power to the system and not all peripheral modules are connected to the PMS5005 in this figure.
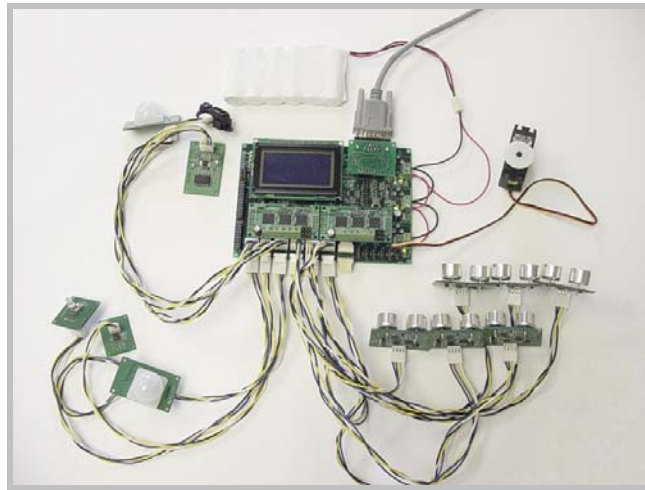

Figure II.2 Sample Connection of WiRobot PMS5005 with Different Peripheral Modules

II.8.   PMS5005 Connections

The definitions of the connector signals of the power supplies and the supported PMS5005 peripheral modules are listed in the following tables.

Table II.6 Connections of the Power Jacks and Terminals

Power Connection	Power Jack J1, J2, J3	Screw Terminal PSY, PDM, PSM
Positive Power Source	Center Pin	1
Power Supply Ground	Circle	2

Table II.7 Upper Reach Communication Port BTOOTH

Pin	Name	Signal Description
1	VCC	+3.3 V
2	RXD	Data receiving
3	TXD	Data transmitting
4	RTS	Request to send
5	CTS	Clear to send
6	GND	Power supply ground
7	COMRST	Reserved

8	BTIN	Reserved

Table II.8 Lower Reach Communication Port SCI

Pin	Name	Signal Description
1	VCC	+3.3 V
2	RXD	Data receiving
3	TXD	Data transmitting
4	GND	Power supply ground

Table II.9 Ultrasonic Range Sensor Connectors US_1 - 6

Pin	Name	Signal Description
1	VCCA	+5.0 V
2	URS	Ultrasonic echo receiving signal, active rising edge
3	UTE	Ultrasonic transmitting enable, active high
4	GND	Power supply ground

Table II.10 Tilt and Acceleration Sensor Connector TILT

Pin	Name	Signal Description
1	VCCA	+5.0 V
2	AYD	Y direction signal, analog 0 – 3.0V
3	AXD	X direction signal, analog 0 – 3.0V
4	GND	Analog ground

Table II.11 Human Motion Sensor Connectors HUMAN1 - 2

Pin	Name	Signal Description
1	VCCA	+3.0 V
2	HMS	Human motion signal, analog 0 – 3.0V
3	HAS	Human presence alarm, analog 0 – 3.0V
4	GND	Analog ground

Table II.12 Temperature Sensor Connector TEMPERATURE

Pin	Name	Signal Description
1	VCCA	+5.0 V
2	TVS	Temperature Data, analog 0 – 3.0V
3	GND	Analog ground

Table II.13 Infrared Remote Controller Connector INFRAR

Pin	Name	Signal Description
1	VCC	+3.3 V
2	IRX	Receiving from external device, digital
3	ITX	Transmitting to external device, digital
4	GND	Power supply ground

Table II.14 Servo Motor Connectors SM1 - 6

Pin	Name	Signal Description
1	SCL	Servo motor control
2	VSM	Positive servo motor power supply
3	GND	Servo motor power supply ground

Table II.15 Quadrature Encoder Connector ENCODER1 - 2

Pin	Name	Signal Description
1	ENCB	Channel B signal
2	VCC	+3.3V
3	ENCA	Channel A signal
4	ENCI	Index signal (reserved for future use)
5	GND	Power supply ground

Table II.16 Infrared Range Sensor Connector RANGE

Pin	Name	Signal Description
1	VCC	+5.0 V
2	RVS	Range data, analog 0 – 3.0V
3	GND	Analog ground

Table II.17 LCD Display Connector LCD

Pin	Signal	Description
1	VDD	+5.0V, power supply for logic
2	VSS	Power supply ground
3	Vo	LCD operating voltage
4	D0	Data bit 0
5	D1	Data bit 1
6	D2	Data bit 2
7	D3	Data bit 3
8	D4	Data bit 4
9	D5	Data bit 5
10	D6	Data bit 6
11	D7	Data bit 7
12	CS1	Column select 1 ~ 64
13	CS2	Column select 65 ~ 128
14	RESET	Reset input
15	R/W	Read/write
16	D/I	Data/Instruction indication
17	E	Enable
18	VEE	Negative voltage output
19	A	Power supply for LED backlight (+)
20	K	Power supply for LED backlight (-)

Table II.18 Custom A/D Expansion Connector EXP-AD

Pin	Signal	Description
1, 2, 3, 4	+ 3.0 V	Analog power supply, max. 40mA
5, 6, 15, 16	Ground	Analog ground
7	AD_IN1*	Analog 0 – 3.0V
8	AD_IN2*	Analog 0 – 3.0V
9	AD_IN3*	Analog 0 – 3.0V
10	AD_IN4	Analog 0 – 3.0V
11	AD_IN5	Analog 0 – 3.0V
12	AD_IN6	Analog 0 – 3.0V
13	AD_IN7	Analog 0 – 3.0V
14	AD_IN8	Analog 0 – 3.0V

*Note (Table II.18): When the relevant power supply voltage monitoring is enabled, AD_IN1, AD_IN2, AD_IN3 will be not available to the custom A/D expansions.

Table II.19 Custom Digital I/O Expansion Connector EXP-GPIO

Pin	Signal	Description
1, 2, 3, 4	+ 3.3 V	Positive power source, max. 100mA
5	D_OUT0	Digital out
6	D_OUT1	Digital out
7	D_OUT2	Digital out
8	D_OUT3	Digital out
9	D_OUT4	Digital out
10	D_OUT5	Digital out
11	D_OUT6	Digital out
12	D_OUT7	Digital out
13, 14, 15, 16	Ground	Power supply ground
17*	D_IN0	Digital in
18*	D_IN1	Digital in
19*	D_IN2	Digital in
20*	D_IN3	Digital in
21*	D_IN4	Digital in
22*	D_IN5	Digital in
23*	D_IN6	Digital in
24*	D_IN7	Digital in

- NOTE (Table II.19): These pins have been pulled-up to logic high (+ 3.3V) internally.

III. Procedure to upgrade the PMS5005 firmware

1. Download and save the latest PMS5005 firmware from www.DrRobot.com

2. Turn off PMS5005 and keep it off until step 9

3. Use a null modem cable to connect the PC to PMS5005 with a RS232 Interface Module (MCR3210) as shown in Figure III.1. All peripheral modules (e.g. sensors, motors, LCD and etc.) can still be plugged to the PMS5005 without affecting the upgrade process
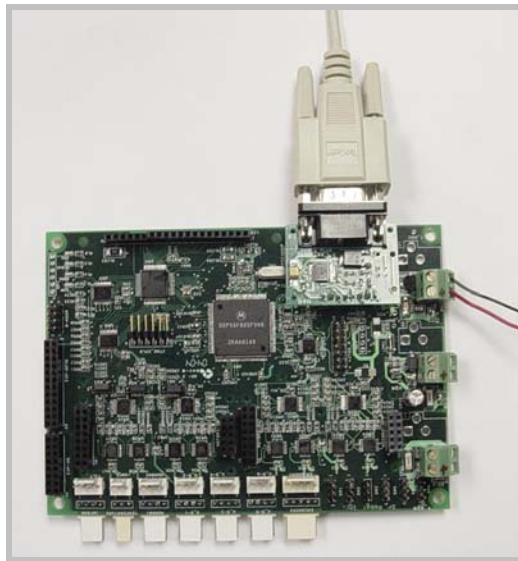

Figure III.1 Physical Connection

4. Close all WiRobot software on PC (e.g. WiRobot Gateway and all sample applications)

5. Start the hyper-terminal (which comes with MS Windows OS), give a name to this new connection and choose the COM port that is connected to the PMS5005 (normally COM1 or COM2) as shown in the following figure:
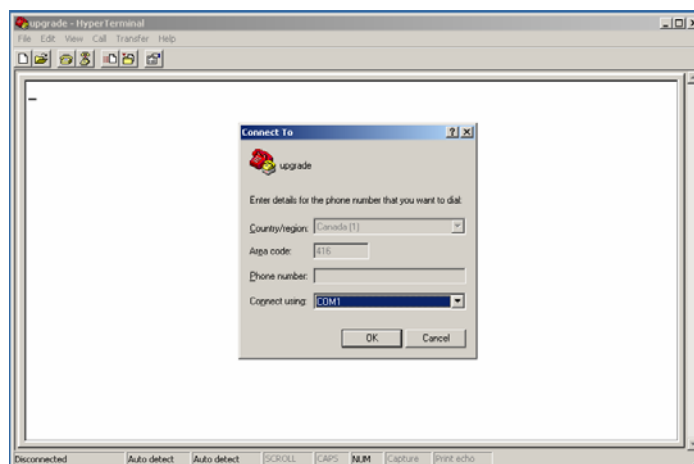
Figure III.2 Choosing COM Port Connection

6. Configure the COM port with the setting 115200, 8, N, 1, Xon/Xoff and turn on the "Echo typed characters locally" under Properties - > Settings -> ASCII Setup. If your PC is slow, you can turn off this "echo" option for shorter download time but you will not see the download process during the upgrade.
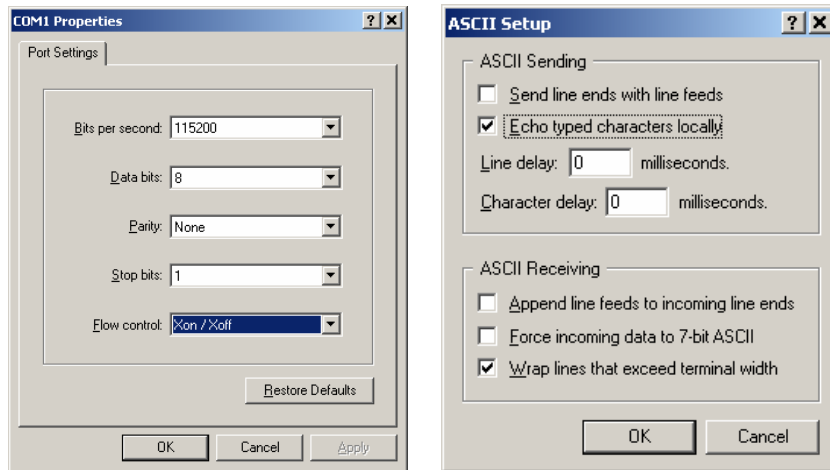
Figure III.3 COM Port Setting

7. The lower left corner of the hyper-terminal will show the connection status. If the hyper-terminal is still not connected, click the connect icon on the hyper-terminal to establish the connection (don't turn on the PMS5005 yet!).

8. Choose "Transfer -> Send Text File" from the toolbar and set "files of type" to ALL. Locate the PMS5005 firmware HEX file only by HIGHLIGHTING the file (e.g. PMS5005_v11.dri). Please make sure that you DON'T double click the file or click the "Open" button
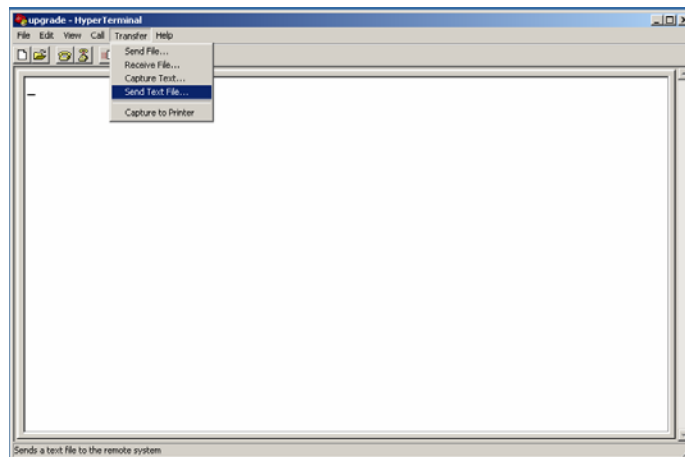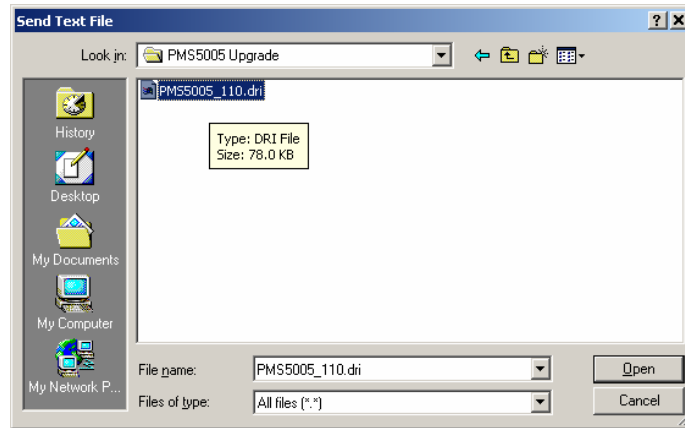
Figure III.4 Locating the HEX File

9. Please read step 10-13 ahead before turning on the PMS5005 in this step

10. After you turn on the PMS5005 (by connecting power to the system power), you should see the text "(c) 2000-2001 Motorola Inc. S-Record loader. Version 1.1" in the hyper-terminal as shown in the following figure:
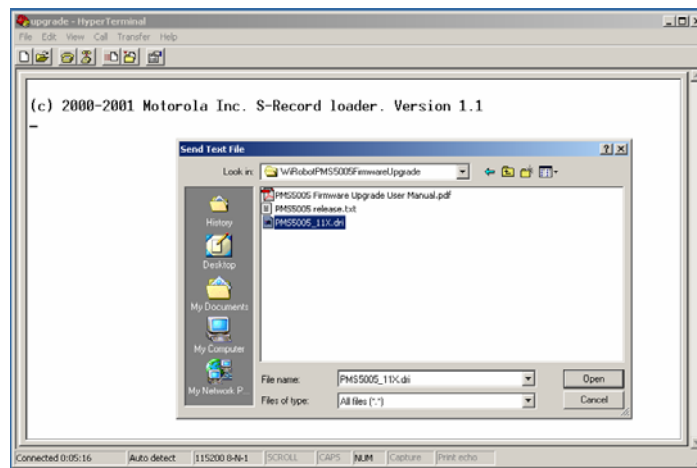

Figure III.5 Status after Turning on the PMS5005

11. Within 5 seconds (start counting when you turn on the PMS5005), you should click the "Open" button on the Hyper-terminal popup window. Firmware download will then start. If you fail to start the download within this period of time, the original firmware on PMS5005 will automatically start. You have to turn off the PMS5005, and repeat the download procedure again from Step 2

12. When the download is started, hex numbers will appear on the screen if you have turned on the "echo" option as described in step 6. Otherwise, you will not see anything but the download is still running. When the firmware download is completed (takes about 20-60 seconds, depending on the speed of your PC), you will see the "Application Started" keyword as shown in Figure III.6 no matter the "echo" option is turned on or off. The new downloaded firmware will automatically start in few seconds and you should see some un-recognized characters
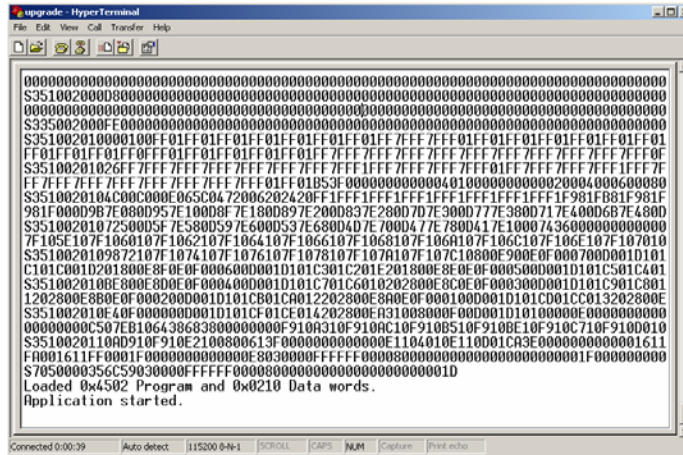
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Figure III.6 Successful PMS5005 Firmware Upgrade

13.   When the download is finished, you could disconnect the COM connection in the hyper-terminal, and re-start your PMS5005