Training L2

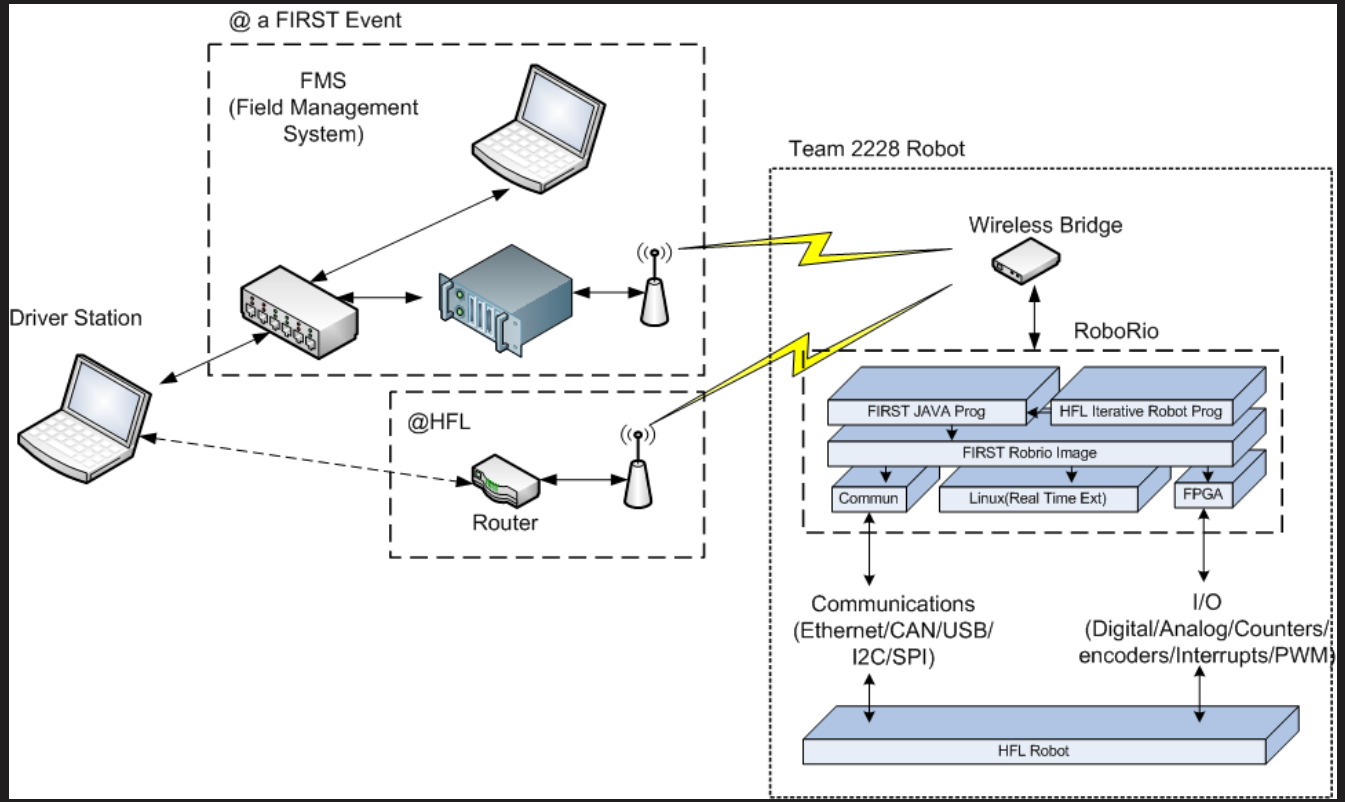
Software Environment

Objectives

Understand:

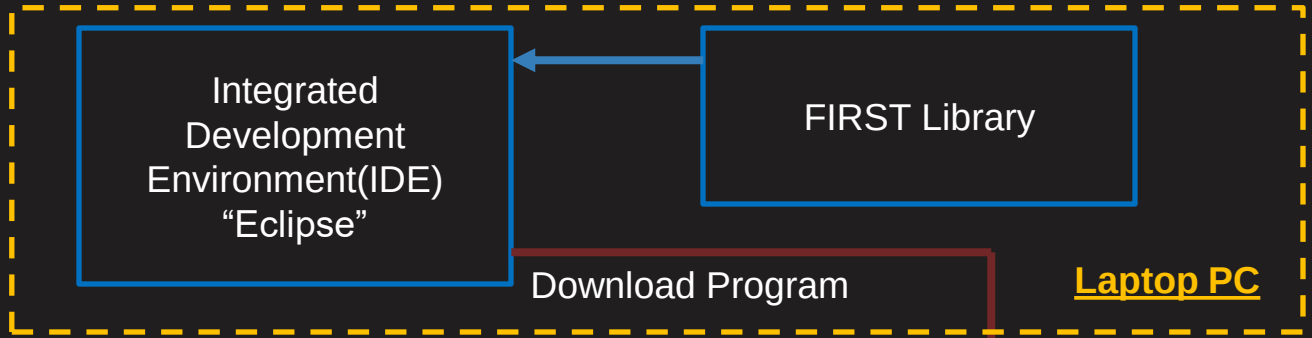
- ❑ Understand the software components
- ❑ Understand the hardware that software interfaces to
- ❑ Understand the communications types available

Block Dia: Hardware Structure for Software

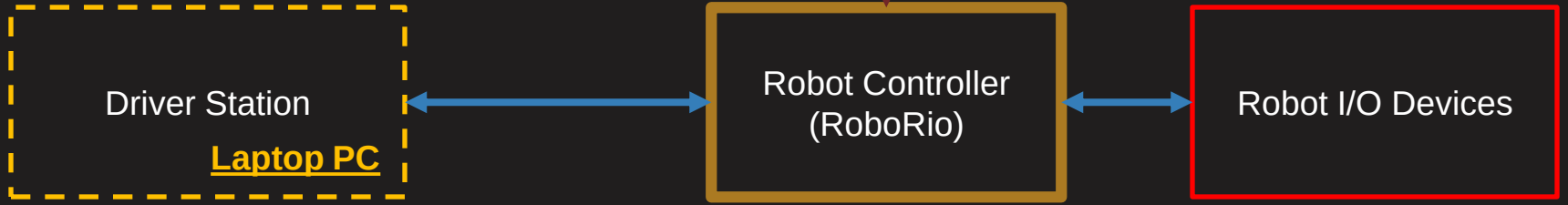


Software Components

Software Development:



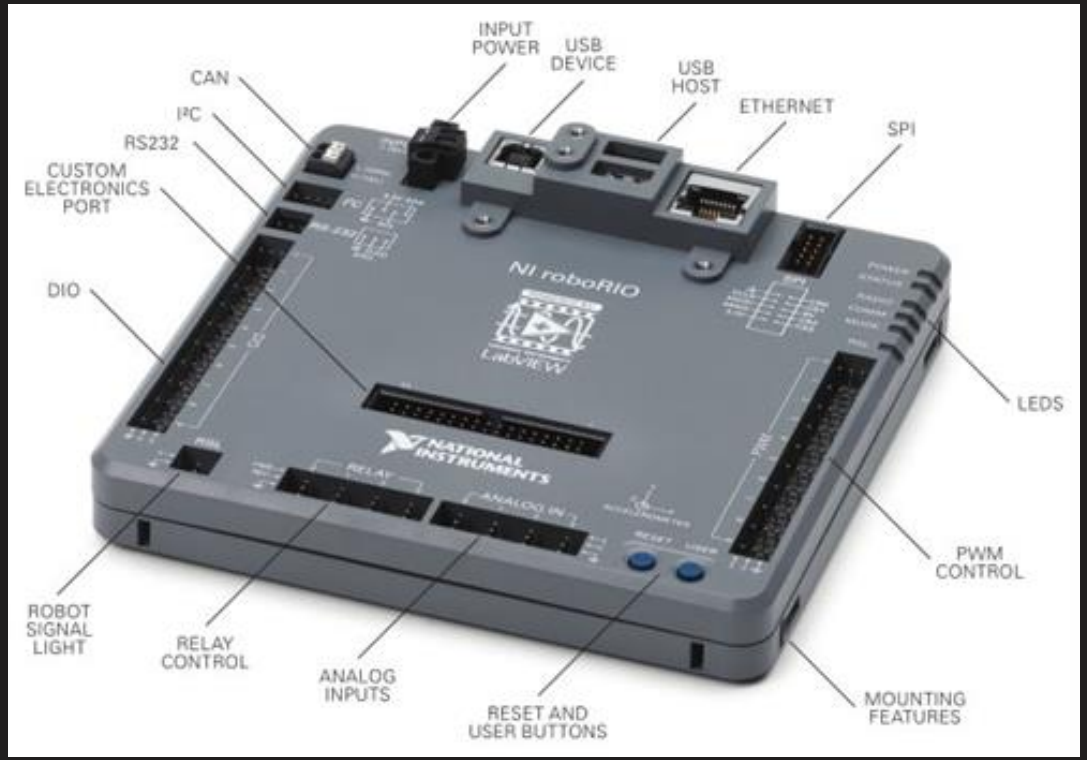
Software Execution:



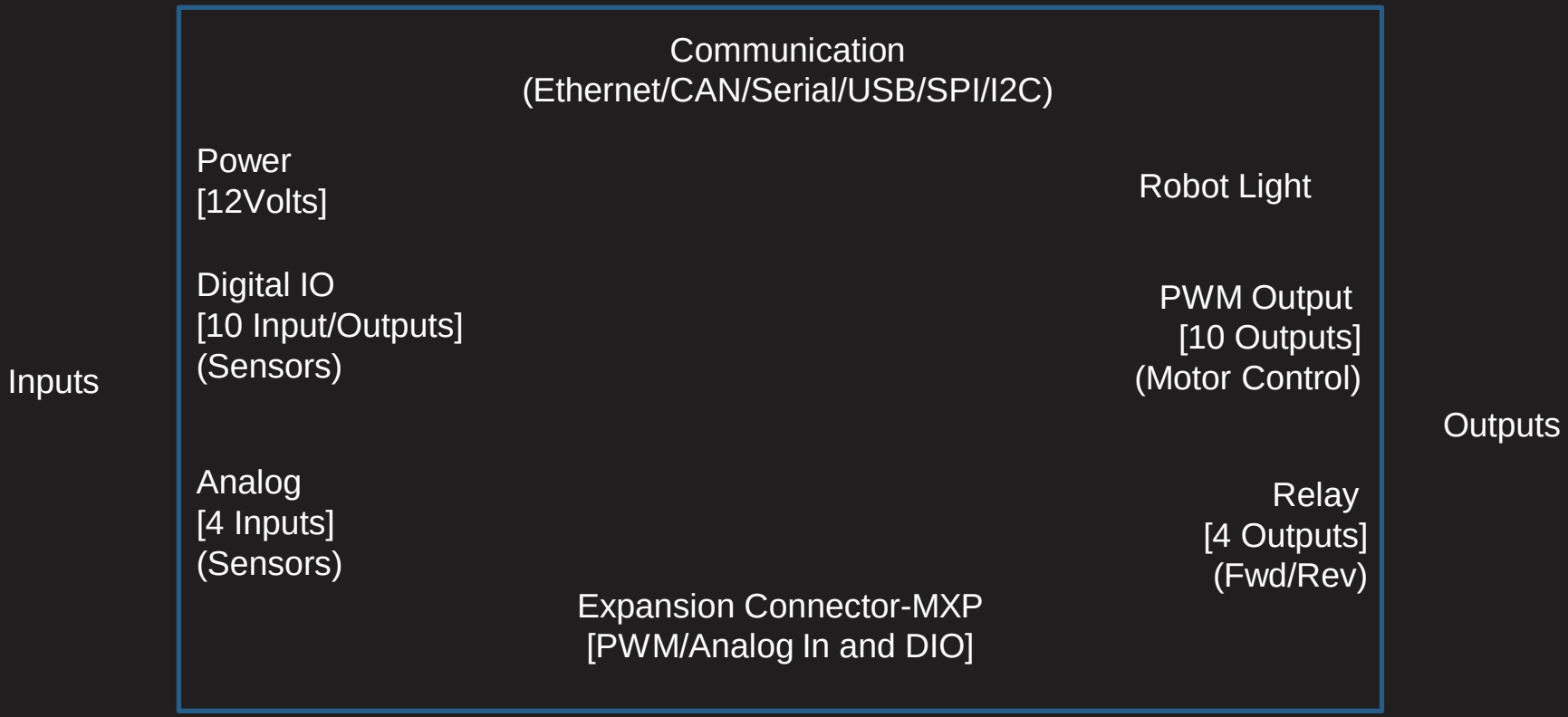
- Robot monitor
- Human input(Joy Stick / Switches)

- Robot Program

RoboRio Robot Controller Layout



Block Dia: RoboRio Controller



Expansion Connector(MXP) Definition

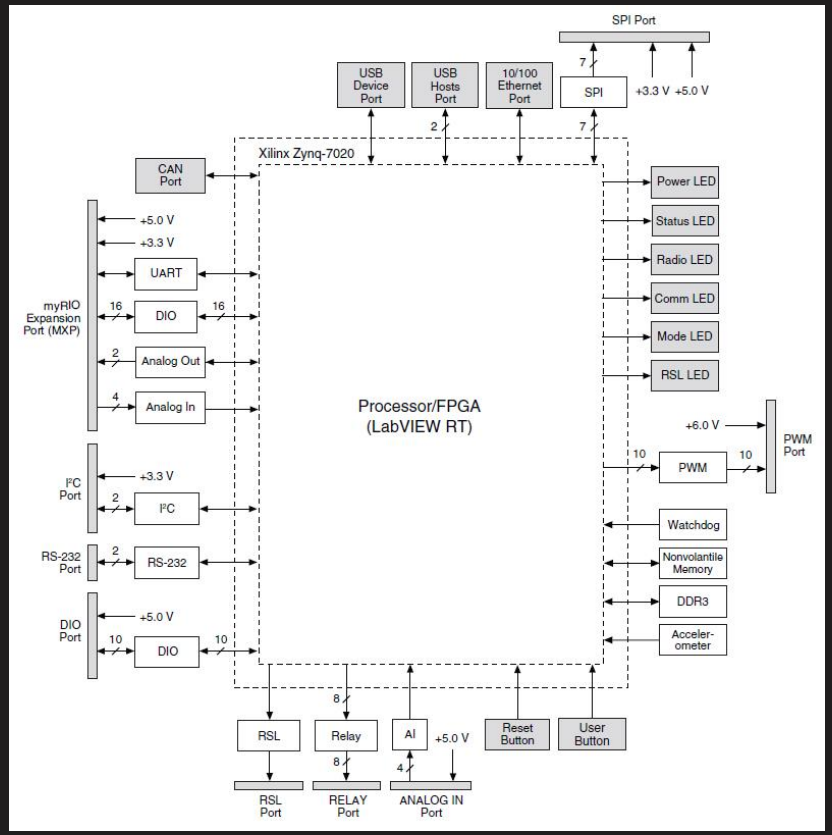
DIO 15 / I2C SDA	34	33	+3.3V
DIO 14 / I2C SCL	32	31	DIO 10 / PWM6
DGND	30	29	DIO 9 / PWM5
DGND	28	27	DIO 8 / PWM4
DIO 13 / PWM9	26	25	DIO 7 / SPI MOSI
DGND	24	23	DIO 6 / SPI MISO
DIO 12 / PWM8	22	21	DIO 5 / SPI CLK
DGND	20	19	DIO 4 / SPI CS
DIO 11 / PWM7	18	17	DIO 3 / PWM3
DGND	16	15	DIO 2 / PWM2
UART.TX	14	13	DIO 1 / PWM1
DGND	12	11	DIO 0 / PWM0
UART.RX	10	9	AI3
DGND	8	7	AI2
AGND	6	5	AI1
AO1	4	3	AI0
AO0	2	1	+5V

Features:

- Up to 16 Digital IO
- Up to 10 PWM
- Up to 1 SPI
- Up to 1 I2C
- Up to 1 Serial (Tx/Rx)
- 4 Analog Inputs
- 2 Analog Outputs
- 5/3.3 Volts Outputs

RoboRio FPGA Architecture

All I/O interfaces the software program through the RoboRio FPGA



FPGA- Field Programmable Gate Array (Programmable Logic)

Digital and Analog Input/Output(I/O)

Analog Channels

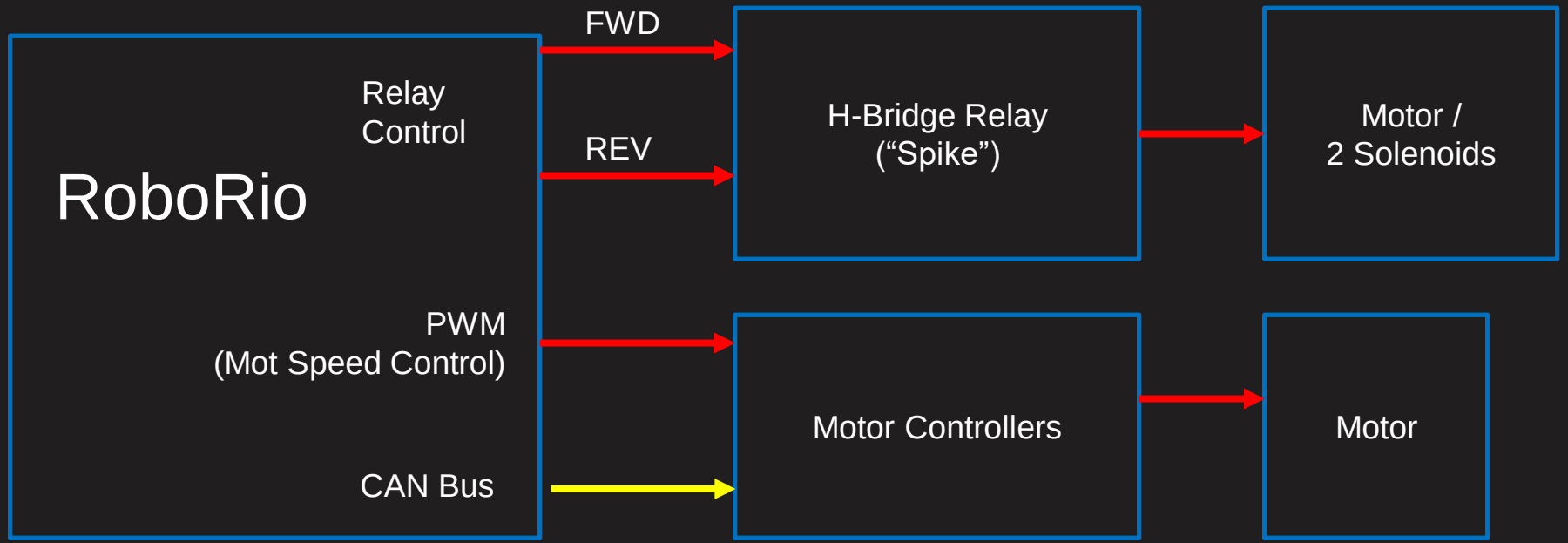
• Input-8 channels, 0 V–5 V, 12–bit, 500 kS/s aggregate

• Output-2 channels, 0 V–5 V, 12–bit, 340 kS/s simultaneous

Digital Channels

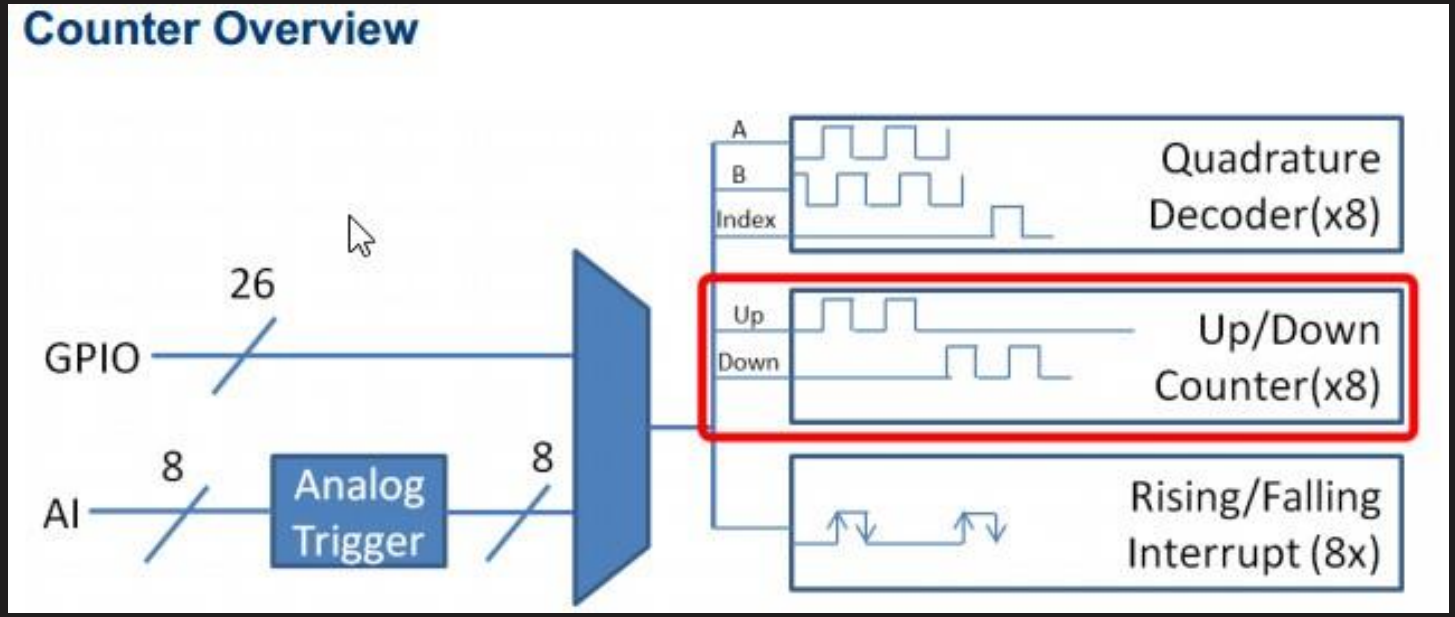
•10 DIO – input 5V LVTTL, output 3.3V LVTTL

Block Dia: RoboRio Motor/Solenoid Control



PWM- 5V output, 15ma source, 330Ohms output resistor, 6V/2.2A-gnd line
Relay- 5V output, 7.5 ma source, 680Ohms output resistor, 5V/1A-gnd line

RoboRio FPGA - Other Input Functions



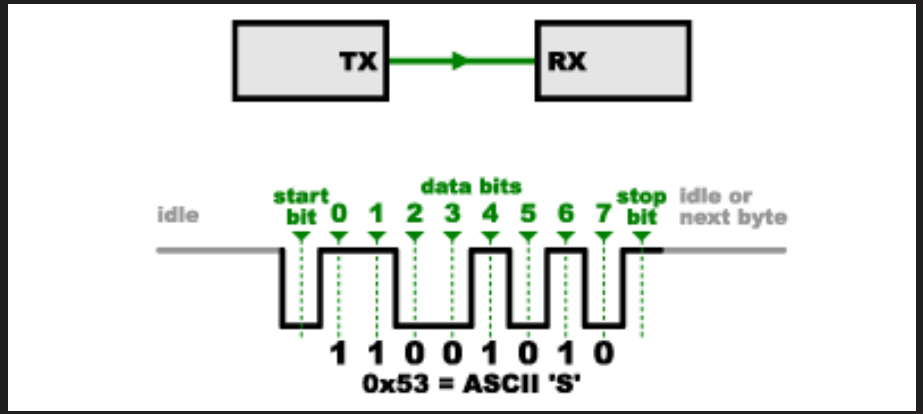
RoboRio – Communications Channels

RoboRio Serial Communications types:

- RS232(UART) (up to 115,200Baud, flow control)
- UART (up to 230,400Baud, flow control)
- USB (USB 2.0 – 900ma)
- Ethernet (10/100Mbit/s)
- 2-SPI (up to 4Mhz clock)
- 2-I2C (up to 400KHz)
- CAN (1Mbit/sec)

Serial Communications (RS232)

- Asynchronous serial decode of incoming data
- Baud rate: 110-115,200 bits/sec; typically set at 9600
- Decoding IC: Universal Asynchronous Receiver/Transmitter(UART)
- Recommended Standard #232(RS232) is a hardware protocol specification
- RS232 signal swing typically +9Volts to -9Volts, 60-100 ft cable distance
- RS485 Line Drive hardware; 1mile cable distance
- Packet length: 8-11bits



Universal Serial Bus(USB)

- **D**eveloped in the mid-1990s that defines the cables, connectors and protocols

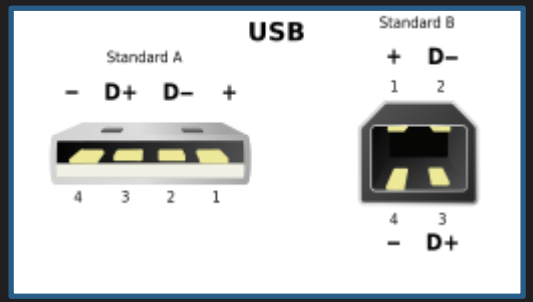
- Bit rate: USB1.0-1.5 to12Mbits/s; USB2.0-480Mbit/s; USB3.0-5Gbits/s; USB3.1-10Gbits/sec;

- Cable length 6-16ft

- Address capability for 127 devices

- Packet length 64-512 bits

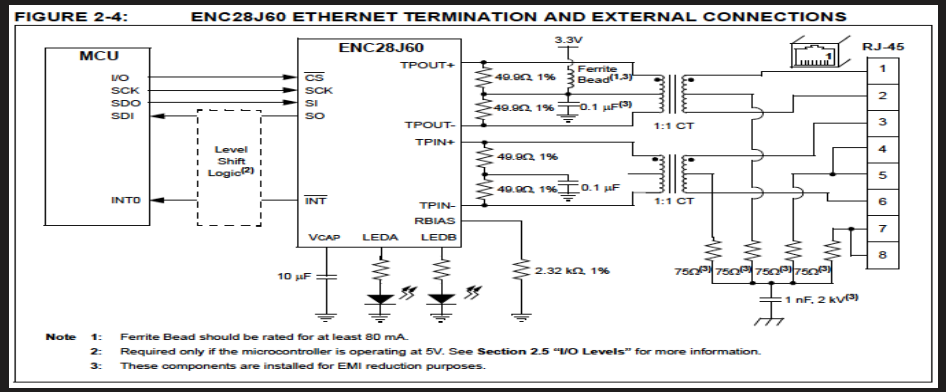
4 pin Connector:
1- Red -5V
2- White – D-
3- Green – D+
4- Black - Ground



Ethernet

- Ethernet was developed at Xerox PARC in 1974 by Robert Metcalfe based on ALOHAnet.
- Metcalfe started 3Com in June 1979. With Digital Equipment Corp(DEC), Intel and Xerox, Ethernet was promoted as a standard. Formal standard IEEE 802.3 published in 1983
- Bit rates: 10Mbit/s, 100Mbit/sec, 1000Mbit/s(1Gbit/sec)
- Packet length: 1500bits

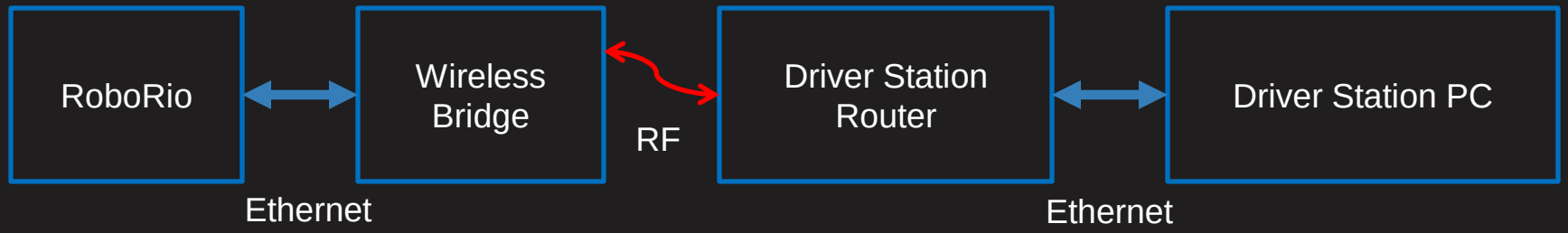
Hardware Example:



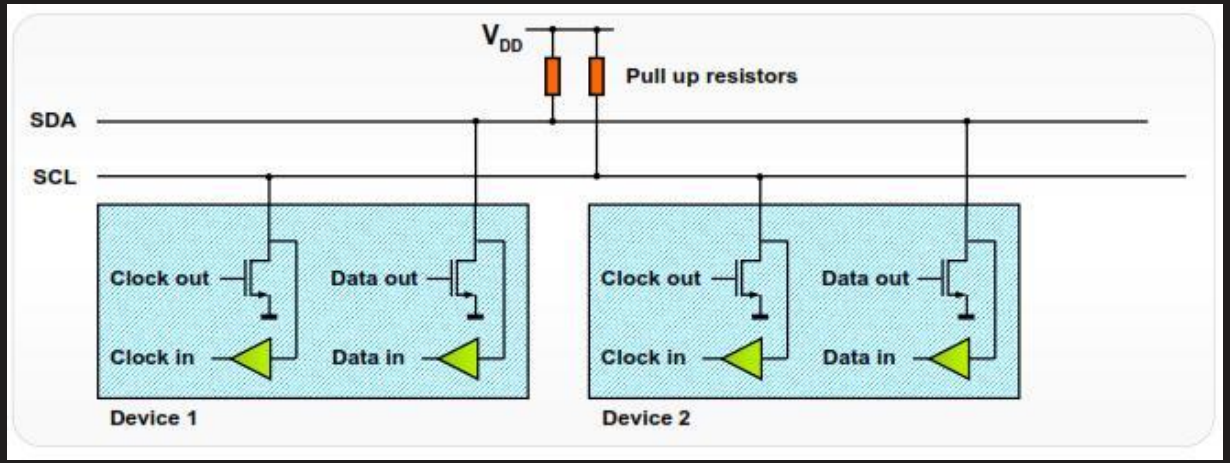
Wireless Bridge

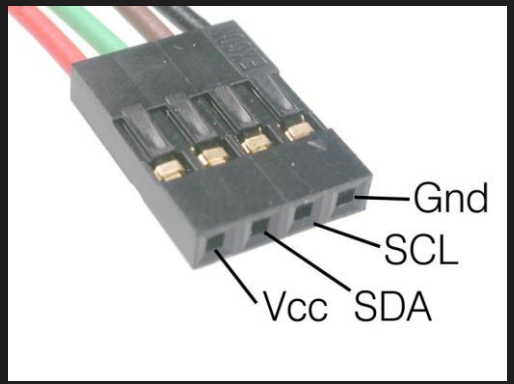
Features
- 2.4 and 5 GHz bands
- Ethernet 10/100T base
- Wireless access point

The D-Link Wireless Bridge provides a communication link between the driver station and the robot



Inter-Integrated Circuit Protocol (IIC or I2C)





- Invented by Philips Semiconductor (now NXP Semiconductor) in 1982.
- Bit rate .1 to 5Mbit/sec
- 127 addresses
- Packet: 9bits + n bytes*9bits

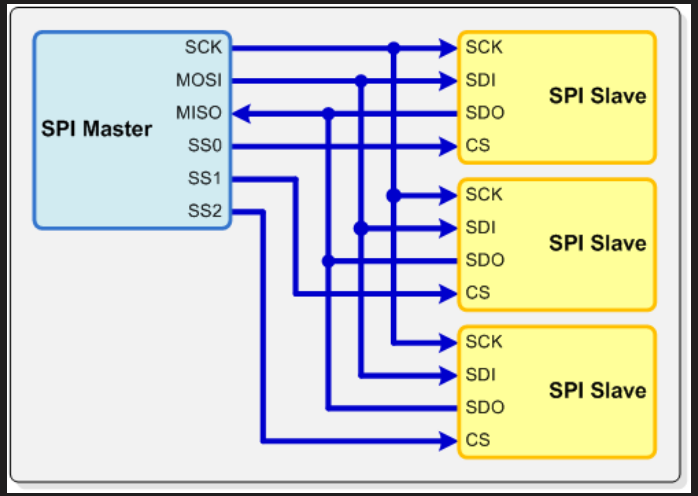
Serial Peripheral Interface (SPI)

The SPI bus specifies four logic signals:

- SCLK : Serial Clock (output from master).
- MOSI : Master Output, Slave Input (output from master).
- MISO : Master Input, Slave Output (output from slave).
- SS : Slave Select (active low, output from master)

•. Protocol flexibility-Not limited to 8-bit words-Arbitrary choice of message size, content, and purpose

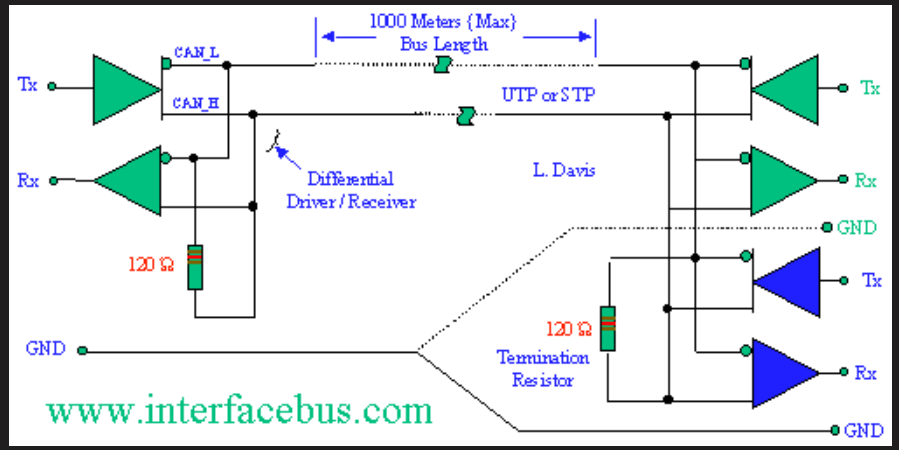
- Bit Rate: 12Mbits/sec to 80Mbits/sec



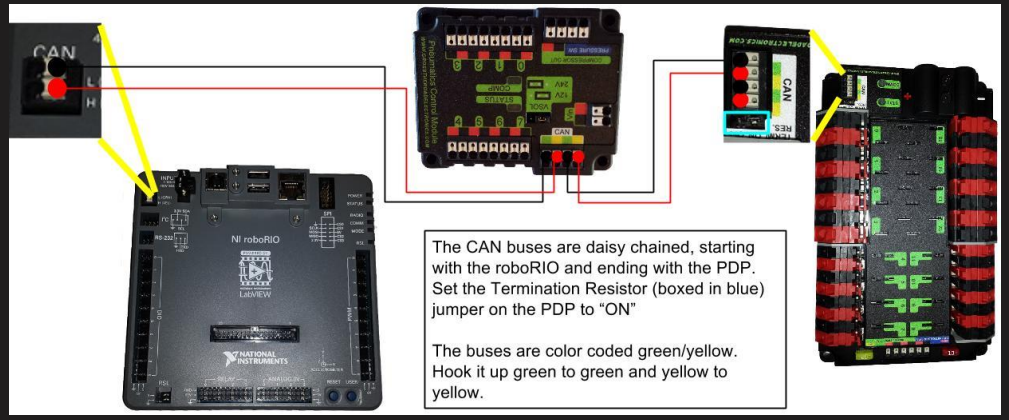
Controller Area Network (CAN)

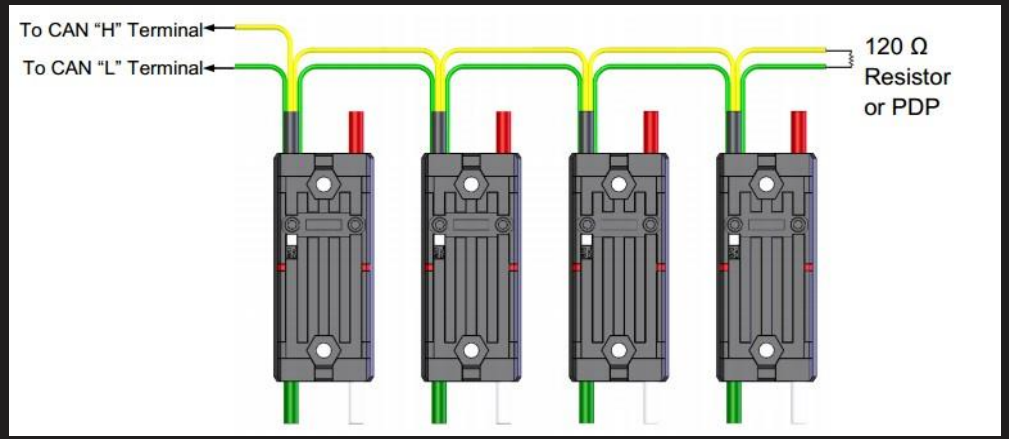
- Development in 1983 at Robert Bosch GmbH bus for automotive applications
- Message based protocol
- Bit rates: 50,100.500Kbits/sec, 1Mbit/sec
- Cable length: 40-1000m depending on bit rate
- Packet length: 108bits

- CAN_H – Yellow
- CAN_L - Green



FIRST CAN Bus Wiring: Controllers/ Motors





Revisions

V160611- RJV- Updated to Team 2228 format
V150914- RJV- Original