

# **E11: Autonomous Vehicles**

## **Fall 2015**

### **Mudduino Reference**

Digital Pin #	Analog Pin #	Notes
0		Serial TXD – don't use
1		Serial RXI – don't use
2		Header D2
3		Team (0 = green / 1 = white) read only
4		Header D4, Buzzer
5		Header D5 / green LED / programming indicator
6		Left Motor Enable
7		Right Motor +
8		Left Motor -
9		Left Motor +
10		Header D10 / Servo (use Servo.write)
11		Right Motor Enable
12		Right Motor -
13		Header D13 / red LED
14	0	Distance Sensor

15	1	Header A1
16	2	Header A2
17	3	Header A3
18	4	Header A4, Reflectance Sensor
19	5	Header A5, Phototransistor

Notes:

- Atmega operating voltage: 5 V
- Maximum output current: 40 mA
  - A short circuit exceeding this current may destroy the Atmega output pin
- Digital pins 2 and 3 support external interrupts using `attachInterrupt()`
- Digital pins 3, 5, 6, 9, 10, and 11 may be operated as pulse-width modulated analog outputs using `analogWrite()`. Pins 6 and 11 are already devoted to adjustable motor power in this fashion.
- Pin 10 servo: `Servo.attach(10)` then `Servo.write(angle)`;  $0 \leq \text{angle} \leq 180$
- Digital pins 14-19 / analog pins 0-5 may be operated as analog inputs or digital I/Os
- `pinMode()`, `digitalRead()`, `digitalWrite()`, and `analogWrite()` refer to the digital pin number
- `analogRead()` reads the voltage at the specified analog pin number

### Mudduino 1.3 Schematic Bill of Materials for Mudduino 1.3

Subsystem/Part	Quantity	Supplier	Part Number	Cost (bulk)	Total Cost
<b>Mudduino</b>					
Mudduino 1.3 Printed Circuit Board	1	Advanced Circuits	P66545	9.55	\$9.55
12-pos Female header	2	Pololu	1030	\$0.63	\$1.26
reset switch	1	Digikey	SW400-ND	\$0.211	\$0.21
22 pF capacitor	2	Digikey	1429PH-ND	\$0.111	\$0.22
10 uF capacitor	2	Digikey	P828-ND	\$0.089	\$0.18
0.1 uF capacitor	2	Digikey	399-4266-ND	\$0.117	\$0.23
Red 5mm LED	1	Digikey	751-1141-ND	\$0.373	\$0.37
Green 5mm LED	1	Digikey	751-1153-ND	\$0.337	\$0.34
6 pin male header	1	Digikey	SAM1031-50-ND	\$2.272	\$0.28
3 pin male header	1	Digikey	SAM1031-50-ND	\$2.272	\$0.14
Right angled female header (20 pos)	1	Digikey	S5456-ND	\$1.276	\$1.28
3 pin female header	1	Digikey	3M9514-ND	\$0.54	\$0.54
L293D H bridge	1	Digikey	497-2936-5-ND	\$2.72	\$2.72
10k resistor	2	Digikey	CF14JT10K0CT-ND	\$0.029	\$0.06
160 Ohm resistor	1	Digikey	CF14JT160RCT-ND	\$0.020	\$0.02
200 Ohm resistor	2	Digikey	CF14JT200RCT-ND	\$0.022	\$0.04
Buzzer	1	Digikey	102-1153-ND	\$0.767	\$0.77
28-pin DIP Atmega 328 socket	1	Digikey	A100210-ND	\$0.296	\$0.30
16-pin DIP H bridge socket	1	Digikey	A100206-ND	\$0.131	\$0.13
7805 5V Voltage Regulator	1	Digikey	LM7805ACT-ND	\$0.468	\$0.47
16 MHz crystal	1	Digikey	631-1108-ND	\$0.375	\$0.38
3pos spdt slide switch	3	Digikey	679-1840-ND	\$0.750	\$2.25

2.1mm power jack	1	Digikey	CP-102A-ND	\$0.560	\$0.56
Atmega 328 chip (preprogrammed with Uno)	1	Sparkfun	DEV-10524	\$4.950	\$4.95
White 8mm LED	1	superbrightleds.com	RL8-W110-360	\$1.89	\$1.89
Green 8mm LED	1	superbrightleds.com	RL8-G50-360	\$1.49	\$1.49
USB to TTL FTDI Cable	1	Sparkfun	DEV-09718	\$17.95	\$17.95
<b>Sensors/Servos</b>					
Sharp GP2Y0A02YK0F Analog Distance Sensor (20-150 cm)	1	Pololu	1137	\$12.59	\$12.59
BPW77NA Phototransistor	1	Digikey	751-1020-ND	\$1.91	\$1.91
QRD1114 Reflectance sensor	1	Digikey	QRD1114-ND	\$1.31	\$1.31
3-pin JST PH-style cable	1	Pololu	117	\$0.89	\$0.89
220 ohm resistor	1	Digikey	CF14JT220RCT-ND	\$0.08	\$0.08
330 kOhm resistor	1	Digikey	CF14JT330KCT-ND	\$0.08	\$0.08
10 kOhm resistor	1	Digikey	CF14JT10K0CT-ND	\$0.029	\$0.03
4-pin male header	1	Digikey	SAM1031-50-ND	0.19	0.19
Omron Snap Action Switch	1	SparkFun	COM-00098	\$1.95	\$1.95
SG90 Servo	1	HobbyPartz	Servo_TPro-SG90	\$2.77	\$2.77
<b>Drive Train</b>					
Tamiya 89918 Double Gearbox Kit - Clear	1	Pololu	1677	\$7.85	\$7.85
Brushed DC Motor: 130-Size, 6V, 11.5kRPM, 800mA Stall	2	Pololu	1117	\$1.31	\$2.62
Tamiya 70145 Narrow Tire Set (2 tires)	1	Pololu	63	\$6.75	\$6.75
Pololu Ball Caster with 3/8" Metal Ball	1	Pololu	951	\$2.39	\$2.39
<b>Tools and Utilities</b>					
400-point breadboard	1	Pololu	351	\$3.38	\$3.38
Diagonal cutter	1	Jameco	179902	\$3.59	\$3.59
Wire cutter/stripper, 10-30 AWG	1	Jameco	78992	\$3.49	\$3.49
Chip puller (yellow)	1	Jameco	16838	\$1.49	\$1.49
Precision screwdriver set	1	Jameco	226094	\$2.95	\$2.95
Toolbox	1	Stockroom			
Wire 22AWG solid wire (100ft spool)	1	Jameco	36881	\$5.59	\$5.59
<b>Power System</b>					
NiMH 7.2 V Battery	1	BatterySpace.com	RC-HAA6R1WR22	\$15.95	\$15.95
Tamiya Battery Charger	1	BatterySpace.com	CH-UN123	\$18.95	\$18.95
2.1 mm power cable	1	Digikey	CP-2213-ND	\$3.33	\$3.33
<b>Chassis</b>					
3D printed chassis	1	HMC	N/A	\$20.00	\$20.00
Aluminum Female Threaded Hex Standoff, 1/4" Hex, 1-1/2" Length, 8-32 Screw Size	4	Mcmaster	91780A202	\$0.71	\$2.84
Multipurpose Aluminum (alloy 6061), 1/2" Square, 6" Length	1	Mcmaster	9008K23	\$15.08	\$0.30
Zinc-pltd Stil Pan Head Phillips Machine Screw, 8-32 Thread, 1/2" Length	9	Mcmaster	90272A194	\$2.85	\$0.26
Multipurpose Aluminum (Alloy 6061) .063" Thick, 12" X 12"	1	Mcmaster	89015K37	\$15.77	\$0.47
2-56 x 1/4" Phillips pan head machine screw	2	Mcmaster	90272A077	2.28/100	0.05
4-40 x 1/4" Phillips pan head machine screw	2	Mcmaster	90272A106	1.30/100	0.03
2-56 nut	4	Mcmaster	91841A003	2.77/100	0.11
4-40 nut	2	Mcmaster	91841A005	2.75/100	0.05
2-56 x 1/4" pan-head straight slot black nylon machine screw	2	Mcmaster	94735A177	4.96	0.10
				<b>Total Cost =</b>	<b>\$162.22</b>

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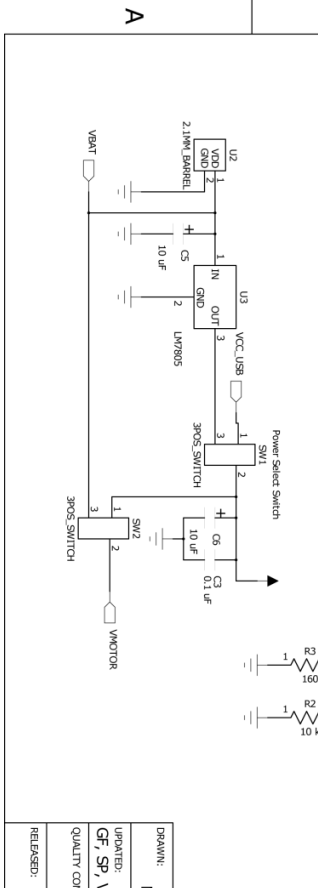
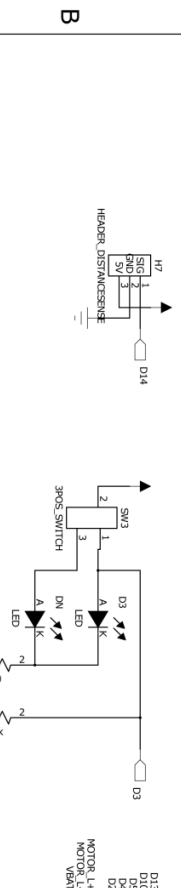
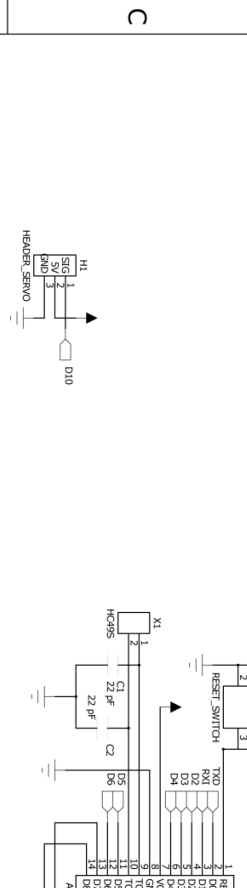
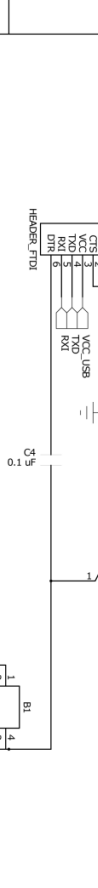
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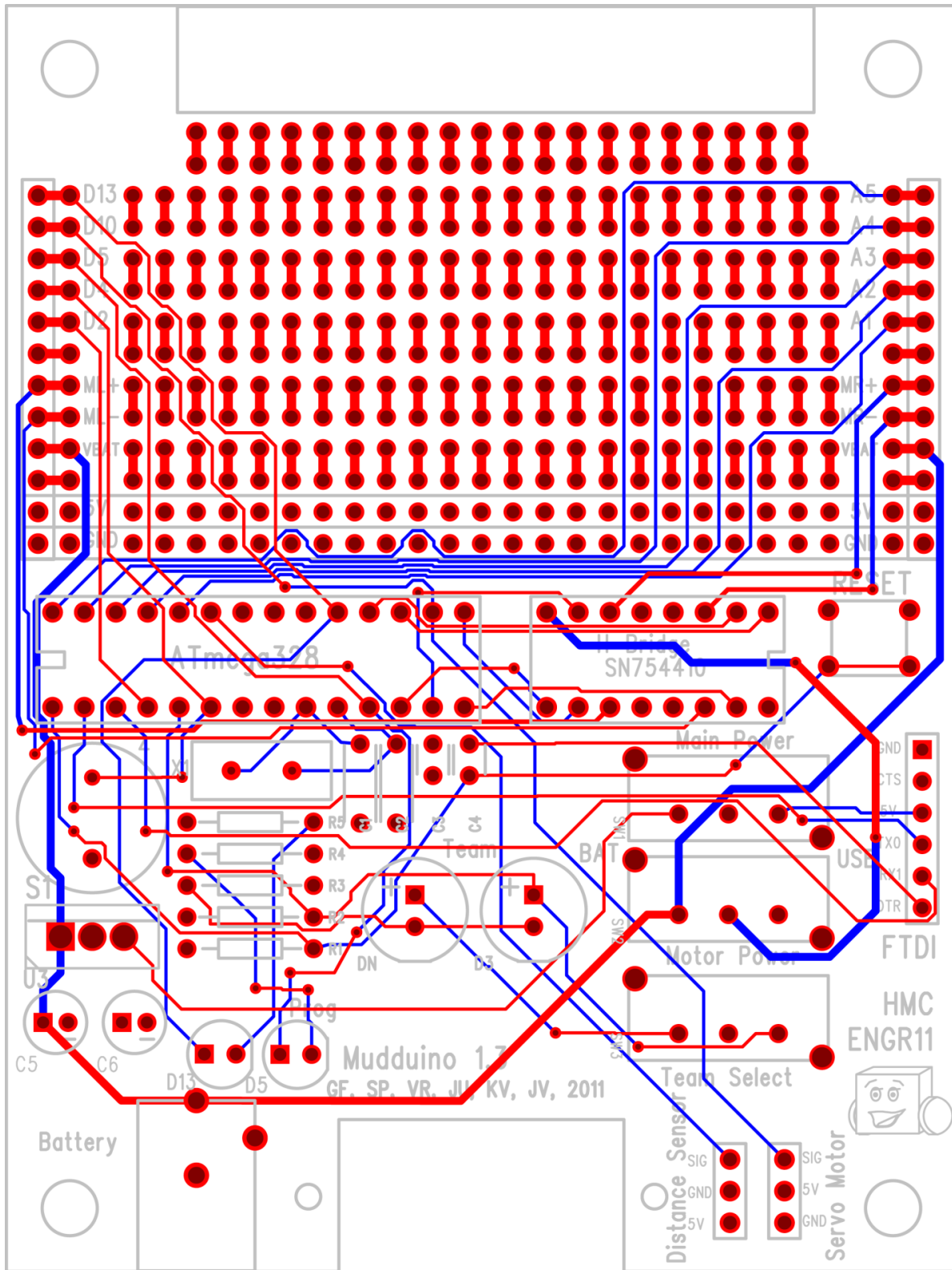
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REVISION RECORD			
LTR	ECD NO.	APPROVED:	DATE:

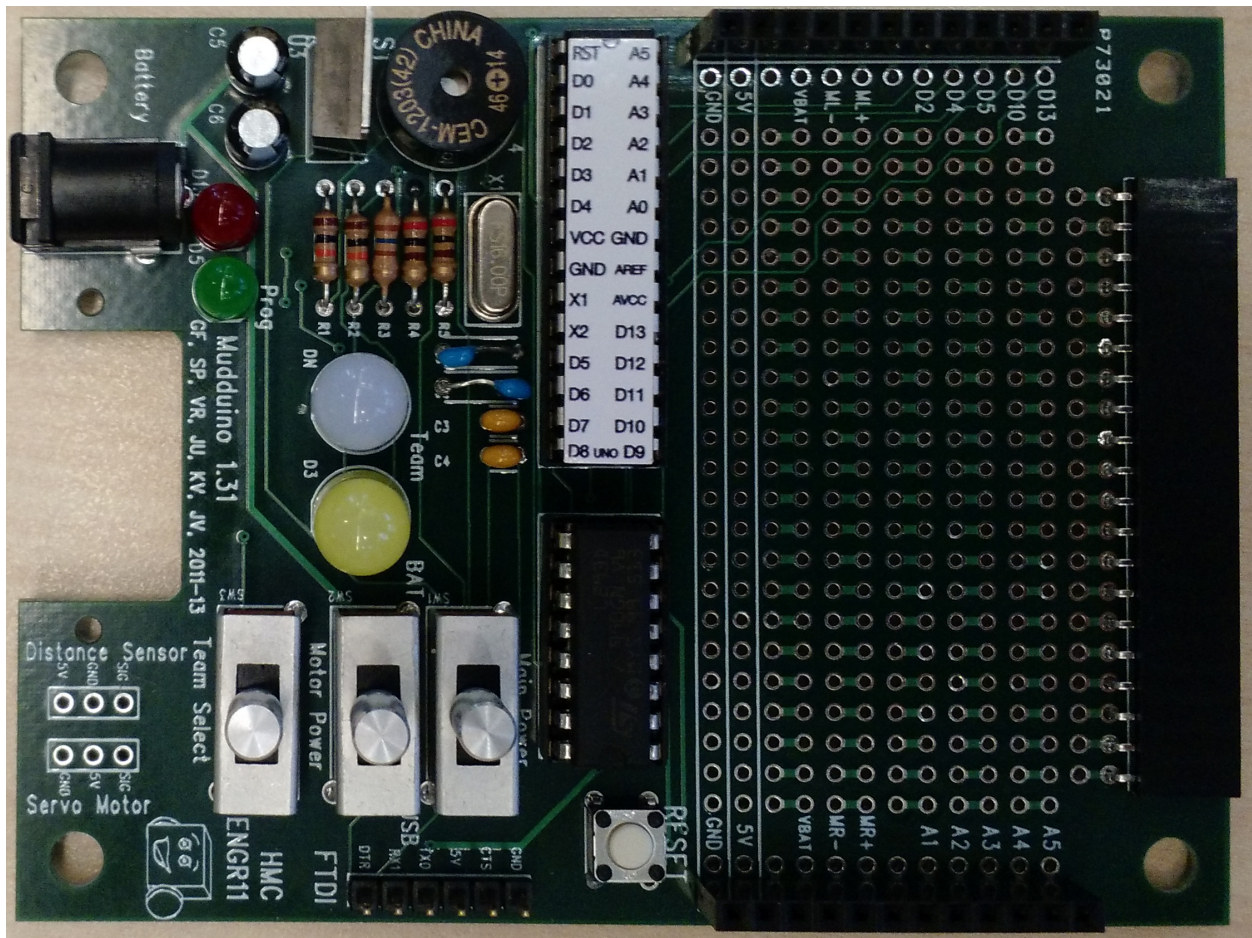


COMPANY:		HMC	
TITLE:		Muddino Schematic	
DRAWN:	MK & MO	DATED:	Summer 2010
UPDATED:	CF, SP, VR, JU, KY, JV	DATED:	Spring 2011
QUALITY CONTROL:		DATED:	
RELEASED:		DATED:	
SCALE:		1:1	
SHEET:		10 of 2	

CODE:	SIZE:	DRAWING NO.:	REV.:
ENGR11	B	Muddino	1.2



Mudduino Layout (component side wires red, solder side wires blue, silk screen gray)



Photograph of Assembled Mudduino Board