Today's plan:

- Announcements
- Integer declaration
- Motors, Servos, etc
- Sensors
- Serial communication
- Controlling things with the microcontroller

No labs or lectures next week

Test on Tuesday March 3rd, 2026. Make sure that you have all you might need on your computer. External connections might be slow!

Before the next labs (week of February 24) please make sure to submit the plan for your project. We can discuss it during labs.

Lecture test
On March 3rd (not Feb 24th)

I will bring to class or describe a MSP430 based system doing something. It will only use hardware used in the manual parts 1 to 9. You will have to specify all the connections (list them) and write a program in C which will run this system as shown.

You will be using your computer with all the programs you have written or tested as well as any notes or texts and the lab manual and lectures. You will submit your program as a pdf file on Canvas when the time is up (no later). 10% penalty per minute!

Its all on the honor system, you will be expected to switch off any communication programs including email, texting and so on, on your computer. Searching and connecting to AI is allowed.

Preparation for the test

If you did all the parts of the manual 1-9 and understand how all the parts were connected, how they work and how the codes work you are fully prepared!

Part 9 of the lab manual

1. Sorry about my component mistake! I should have consulted AI earlier. It was due to your question that I realized my mistake!
2. Part 9 is most likely the first part of the lab, which would be really difficult to do without AI.
3. Think about the prompts carefully. The AI easy available to us works great with text, tables and lists but is very slow and very often wrong in generating images. So ask for list of connection rather than diagram. Simple search will give you a pinout.
4. Use dabble as a terminal but keep in mind that is generates characters not numbers. But getting a program which converts 3 characters say 120 into a number 120 is easy.

Characters and numbers

ASCII TABLE

Decimal	Hex	Char	Decimal	Hex	Char	Decimal	Hex	Char	Decimal	Hex	Char
0	0	[NULL]	32	20	[SPACE]	64	40	@	96	60	`
1	1	[START OF HEADING]	33	21	!	65	41	A	97	61	a
2	2	[START OF TEXT]	34	22	"	66	42	B	98	62	b
3	3	[END OF TEXT]	35	23	#	67	43	C	99	63	c
4	4	[END OF TRANSMISSION]	36	24	$	68	44	D	100	64	d
5	5	[ENQUIRY]	37	25	%	69	45	E	101	65	e
6	6	[ACKNOWLEDGE]	38	26	&	70	46	F	102	66	f
7	7	[BELL]	39	27	'	71	47	G	103	67	g
8	8	[BACKSPACE]	40	28	(	72	48	H	104	68	h
9	9	[HORIZONTAL TAB]	41	29	)	73	49	I	105	69	i
10	A	[LINE FEED]	42	2A	*	74	4A	J	106	6A	j
11	B	[VERTICAL TAB]	43	2B	+	75	4B	K	107	6B	k
12	C	[FORM FEED]	44	2C	,	76	4C	L	108	6C	l
13	D	[CARRIAGE RETURN]	45	2D	-	77	4D	M	109	6D	m
14	E	[SHIFT OUT]	46	2E	.	78	4E	N	110	6E	n
15	F	[SHIFT IN]	47	2F	/	79	4F	O	111	6F	o
16	10	[DATA LINK ESCAPE]	48	30	0	80	50	P	112	70	p
17	11	[DEVICE CONTROL 1]	49	31	1	81	51	Q	113	71	q
18	12	[DEVICE CONTROL 2]	50	32	2	82	52	R	114	72	r
19	13	[DEVICE CONTROL 3]	51	33	3	83	53	S	115	73	s
20	14	[DEVICE CONTROL 4]	52	34	4	84	54	T	116	74	t
21	15	[NEGATIVE ACKNOWLEDGE]	53	35	5	85	55	U	117	75	u
22	16	[SYNCHRONOUS IDLE]	54	36	6	86	56	V	118	76	v
23	17	[END OF TRANS. BLOCK]	55	37	7	87	57	W	119	77	w
24	18	[CANCEL]	56	38	8	88	58	X	120	78	x
25	19	[END OF MEDIUM]	57	39	9	89	59	Y	121	79	y
26	1A	[SUBSTITUTE]	58	3A	:	90	5A	Z	122	7A	z
27	1B	[ESCAPE]	59	3B	;	91	5B	[	123	7B	{
28	1C	[FILE SEPARATOR]	60	3C	<	92	5C	\	124	7C	|
29	1D	[GROUP SEPARATOR]	61	3D	=	93	5D	]	125	7D	}
30	1E	[RECORD SEPARATOR]	62	3E	>	94	5E	^	126	7E	~
31	1F	[UNIT SEPARATOR]	63	3F	?	95	5F	_	127	7F	[DEL]

What terminal sends if we send 120?

It sends 3 bites:

49

50

48

One needs to convert them to digits and assemble the number.

Confusion in int declaration

Int declaration for MSP means 16 bits integer.

If you want to make sure that a variable has certain length and is unsigned use for example:

uint8_t a=126; //a is an unsigned 8 bit integer

Notice that it can only represent the numbers between 0 and 255

uint16_t b=12600 ; //b is an unsigned 16 bit integer

It can represent the numbers between 0 and 65536

Math results on integers

- uint16_t b=(a/100)*1500;
- If a = 20 what is the result?
- 0 not 300!
- Use:
- uint16_t b=a*15; //instead!

Sensors and Actuators

Actuators

- Servo motors
- Stepper motors
- DC motors
- Relays,
- Solenoids
- “Robot” platforms

Available sensors:

- Optical sensors
- Temperature
- Humidity
- Magnetic field
- Pressure
- Distance
- Position and bend
- Accelerometer
- Gyroscope
- Alcohol
- GPS
- Infrared
- Infrared camera sensor
- Heart beat and blood oxygenetion

Motors, Servos, etc

- Servo motors
- AC and DC motors
- Stepper motors
- Solenoids
- Relays
- Solid-state relays

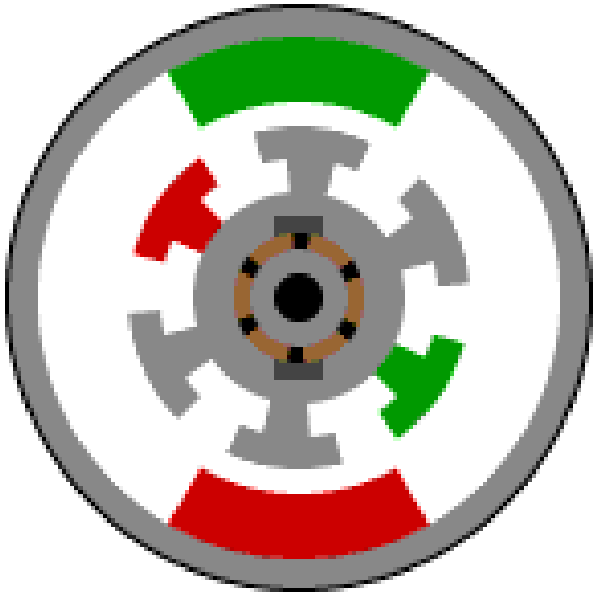
Motors: Servos

photo from Hobby Servo Fundamentals by Darren Sawicz

PWM signal to is setting the position of the arm
Typical range of movement 0-180 degrees
Typical PWM period of 20 ms with duty cycle of 1ms to 2 ms (1.5 ms is the center).
Fo example:
At 1ms duty cycle the arm will be pointing to the left at 1.5 ms it will be pointing up and at 2 ms it will point to the right and by changing duty cycle you can place it anywhere in between.
Connecting wire colours often: red = +5 V, black = ground, white = PWM control.
Position depends on length of on-pulse.

Contains a DC motor, gearing, a potentiometer and control electronics.
The average PWM voltage is compared to the position, as measured by the potentiometer. The control electronics then drive the motor forward or backward to set the angle as requested.

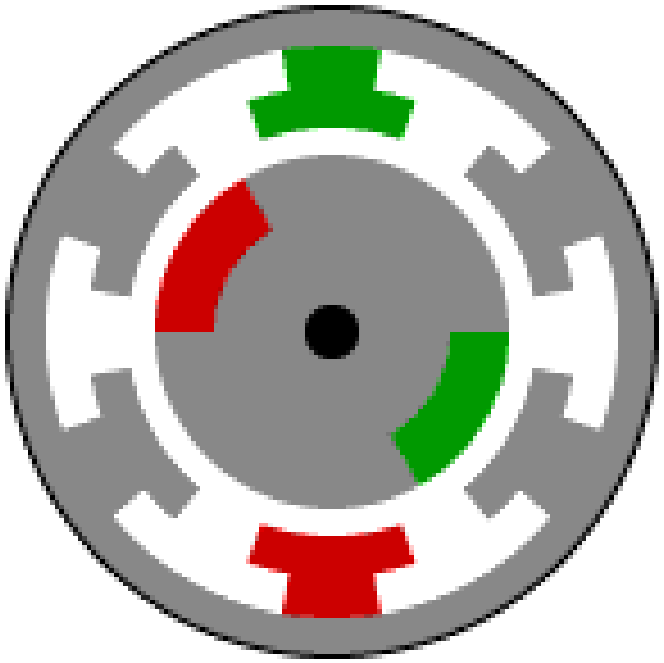
Motors: DC or AC motors



Electromagnets on rotor (moving part)
Magnets or electromagnets on stator (stationary part)

http://www.freescale.com/webapp/sps/site/overview.jsp?code=WBT_MOTORDCTUT_WP

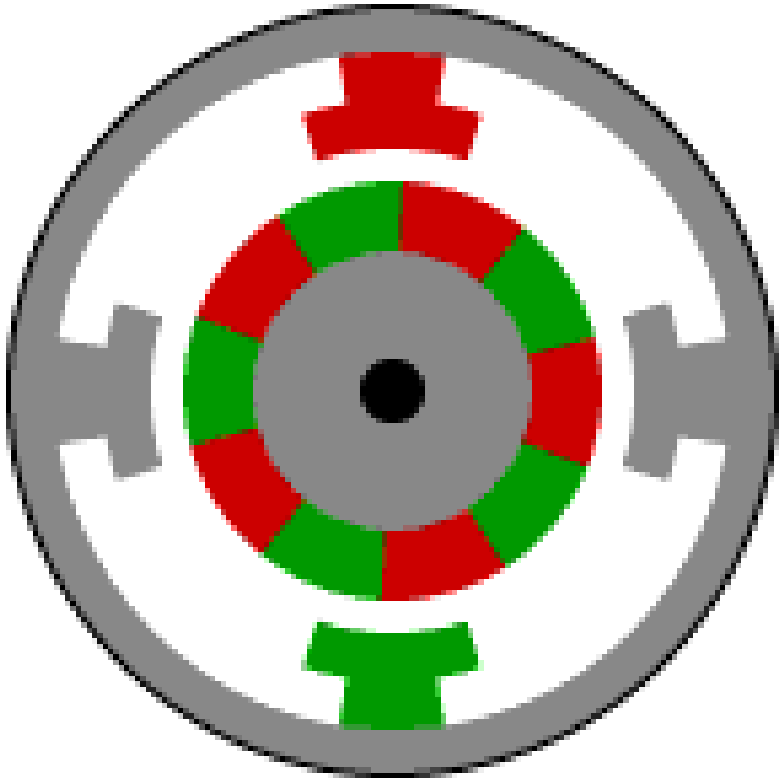
Motors: Brushless DC motors



Magnets on rotor (moving part)
Electromagnets on stator (stationary part)

http://www.freescale.com/webapp/sps/site/overview.jsp?code=WBT_MOTORBLDCTUT_WP

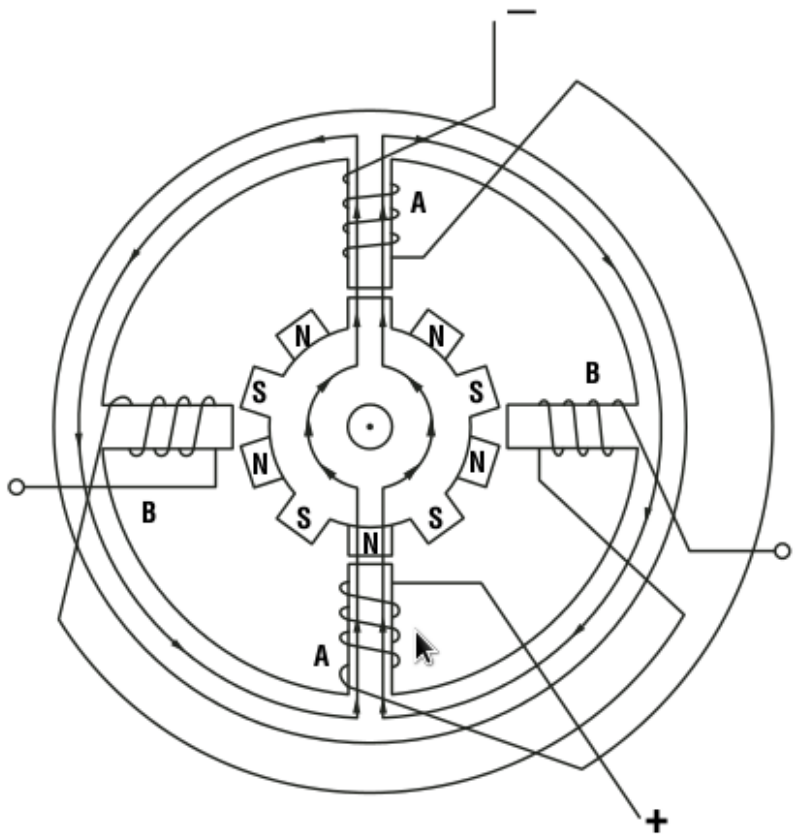
Motors: Stepper motors



Fixed step size, often 200 steps per revolution. It moves only one step per one pulse coming from the electronics.

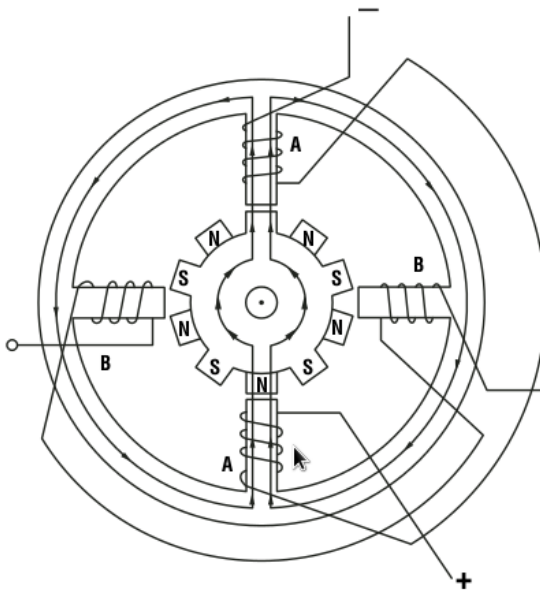
http://www.freescale.com/webapp/sps/site/overview.jsp?code=WBT_MOTORSTEPTUT_WP

Motors: Stepper motors

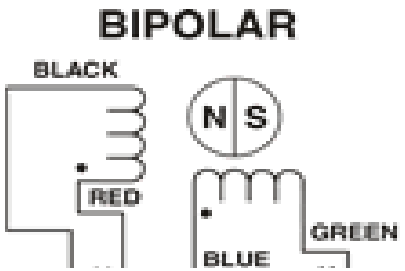


From: Introduction to Step Motors, Applied Motion Products. http://www.omega.ca/auto/pdf/REF_IntroStepMotors.pdf

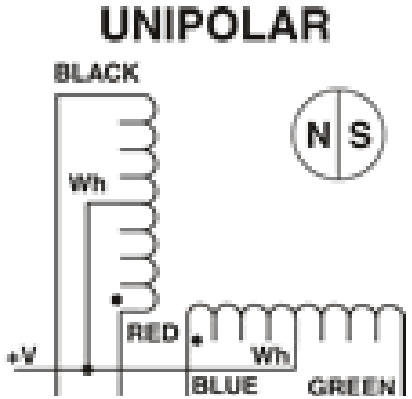
Motors: Stepper motors



Unipolar vs bipolar windings:



4 wires (usually)

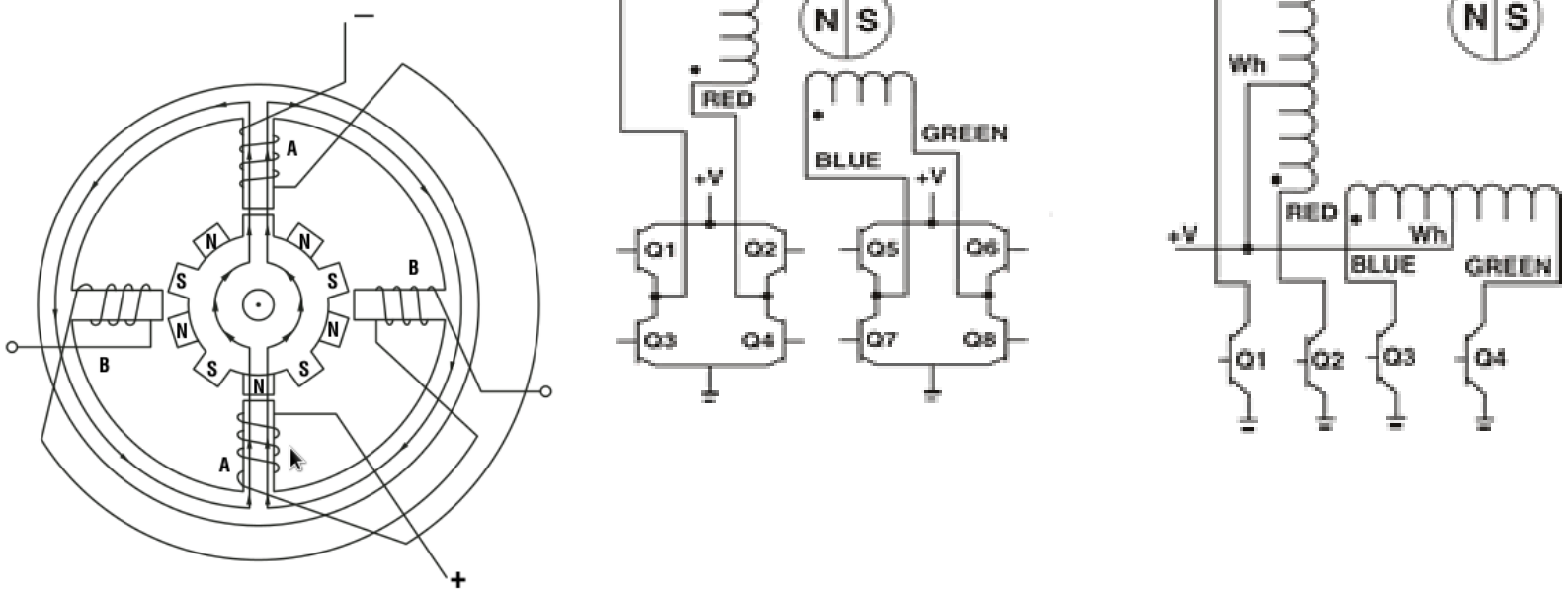


Unipolar stepper (5, 6 or 8 wires)

http://www.haydonkerk.com/Resources/StepperMotorTheory/tabid/192/Default.aspx

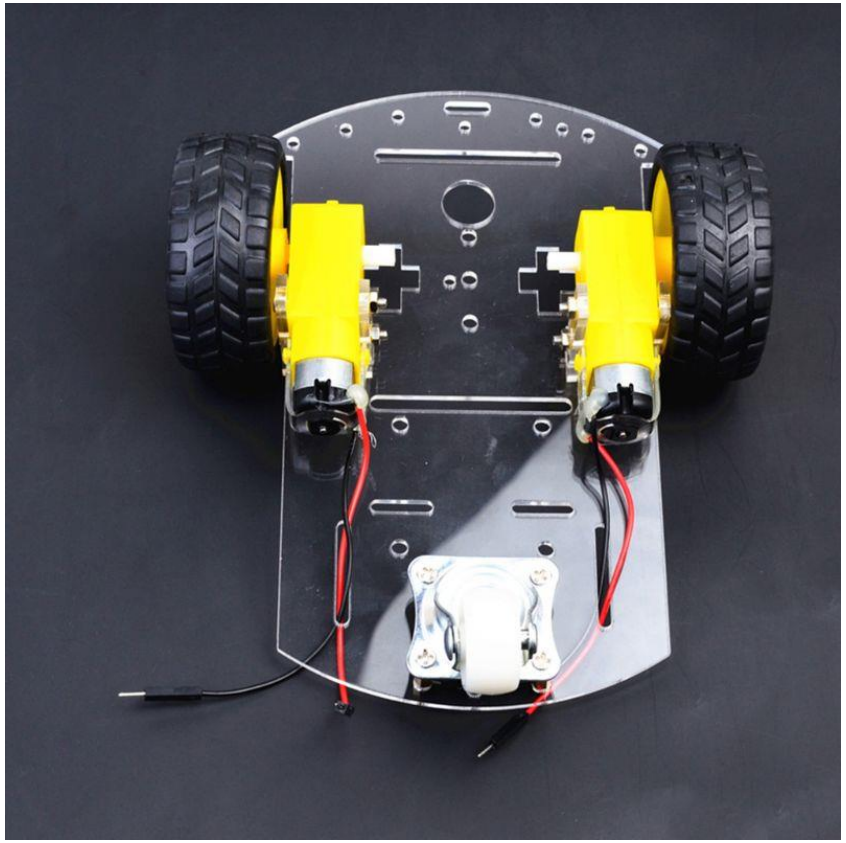
Motors: Stepper motors

Unipolar vs bipolar windings:



http://www.haydonkerk.com/Resources/StepperMotorTheory/tabid/192/Default.aspx

“Robot” platforms



Available sensors:

- Optical sensors
- Temperature
- Humidity
- Magnetic field
- Pressure
- Distance
- Position and bend
- Accelerometer
- Gyroscope
- Alcohol
- GPS
- Infrared
- Infrared camera sensor
- Heart beat and blood oxygenetion