Autonomous Refrigerator

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Introduction

Uses

Specimen and Culture Refrigerators can be found in many industries including

- Laboratory
- University
- Research Institution

Why Use Temperature Control?

- Culture Storage
- Experiment preparation
- Specimen harvesting
- Culture Growth
- Research
- Environmental Simulation

Possibilities

Temperature Control Drawbacks

- Requires expensive equipment
- Constant monitoring required
- Around the clock on-call researcher
- Need to work around specimen temperature
- Require constant sample checking

Drawbacks

INTRODUCING THE AUTONOMOUS REFRIGERATOR ROBOT

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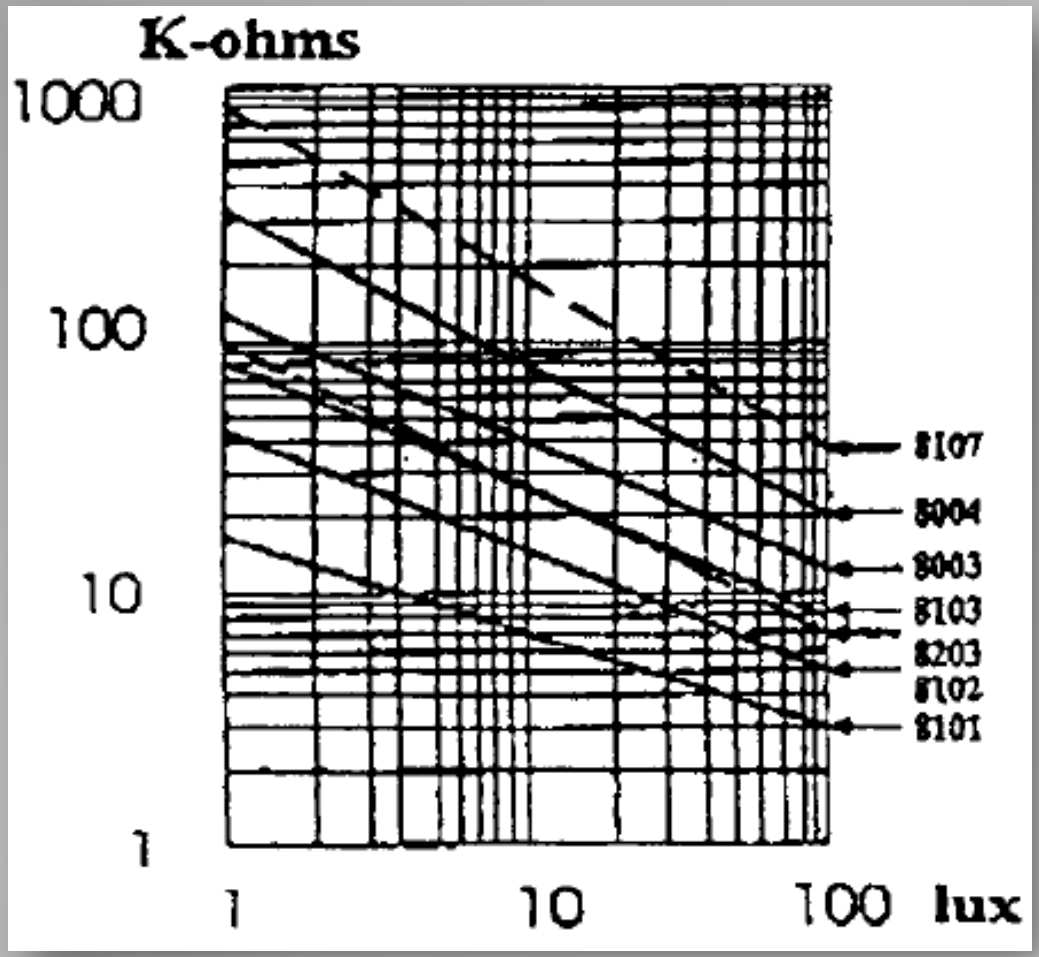
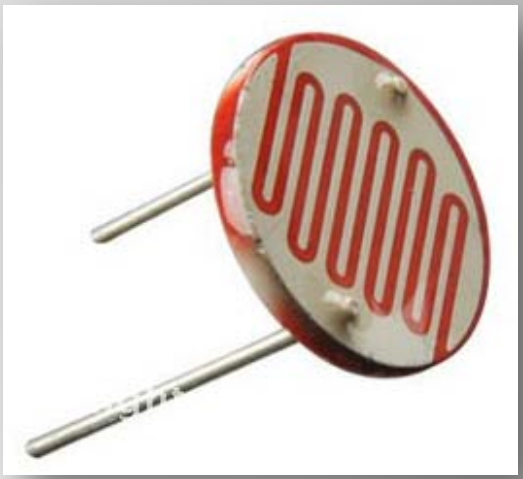
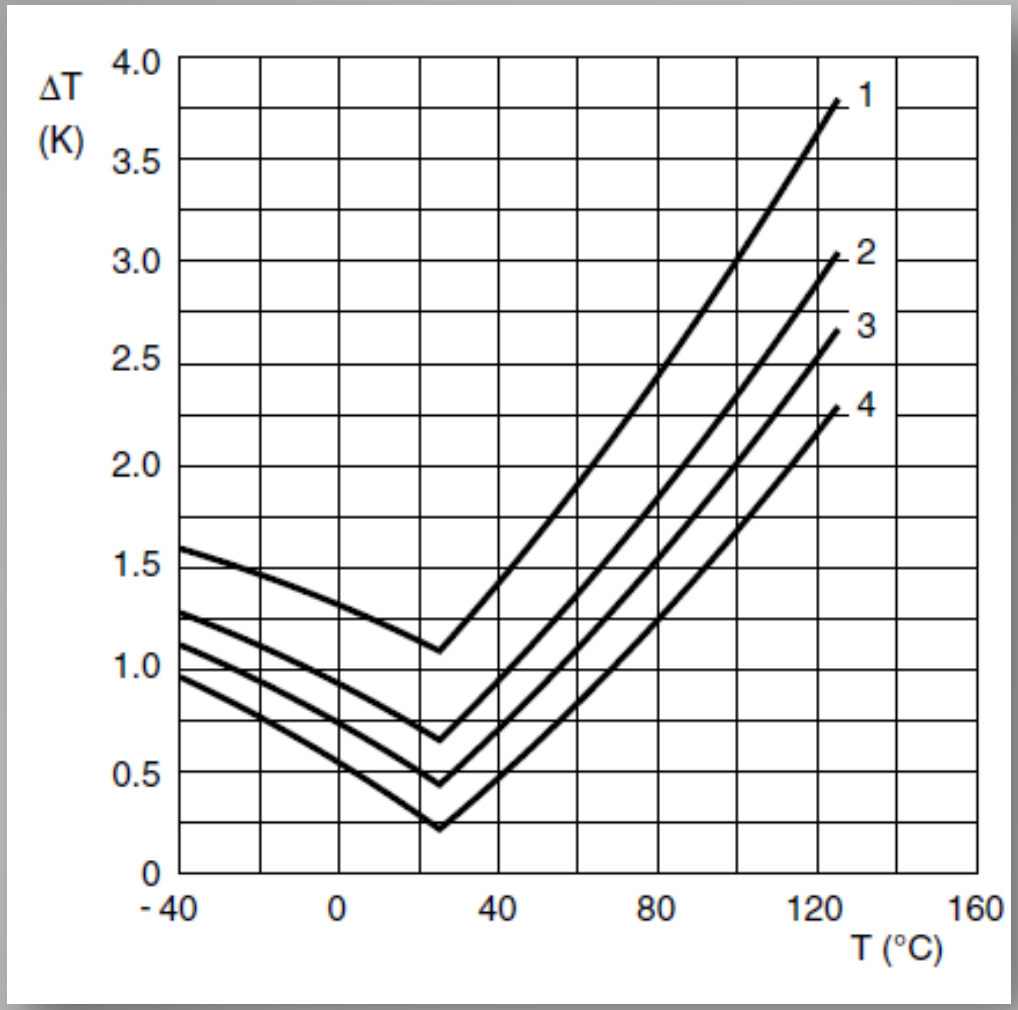
Components



Photoresistor

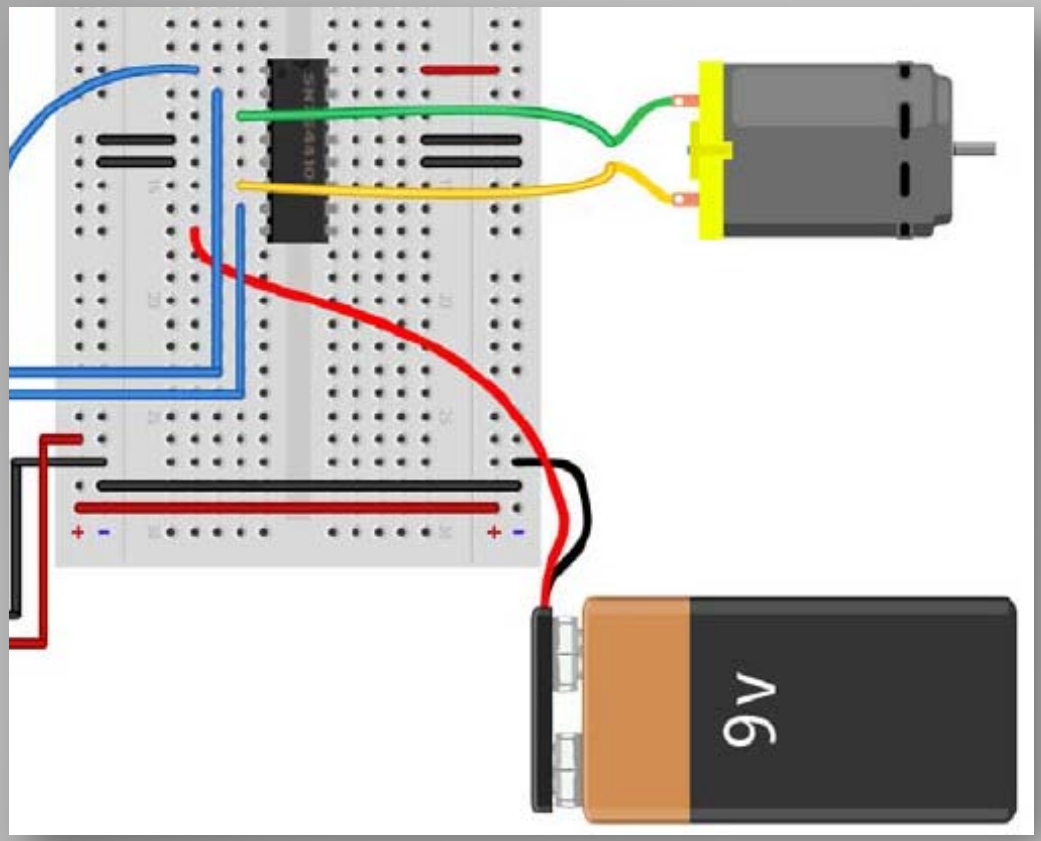
- Variable Resistor
- Changes Resistance with light





Thermistor

- Variable Resistor
- Changes Resistance with Temperature



H-Bridge

- Used to control a high current device
- Can control current in two directions for Dc motor control

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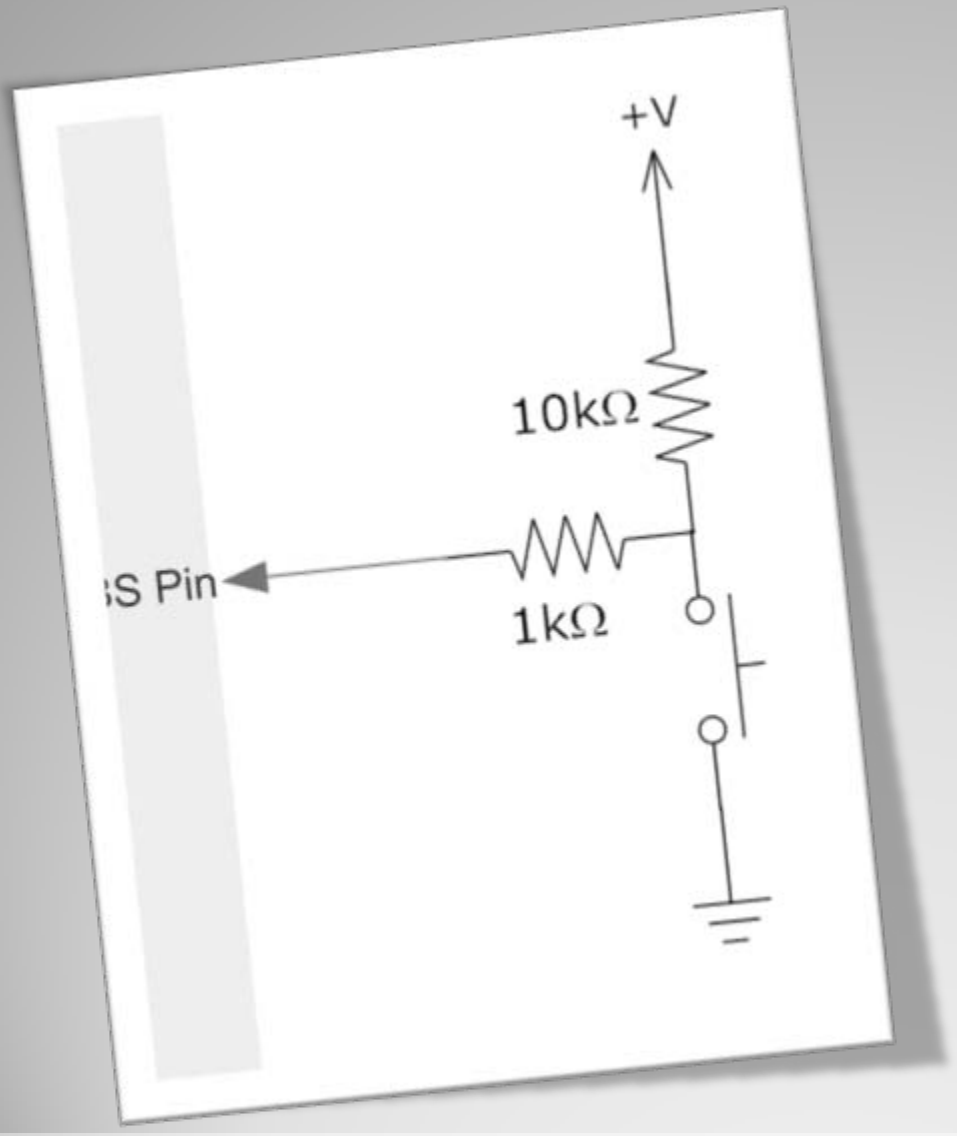
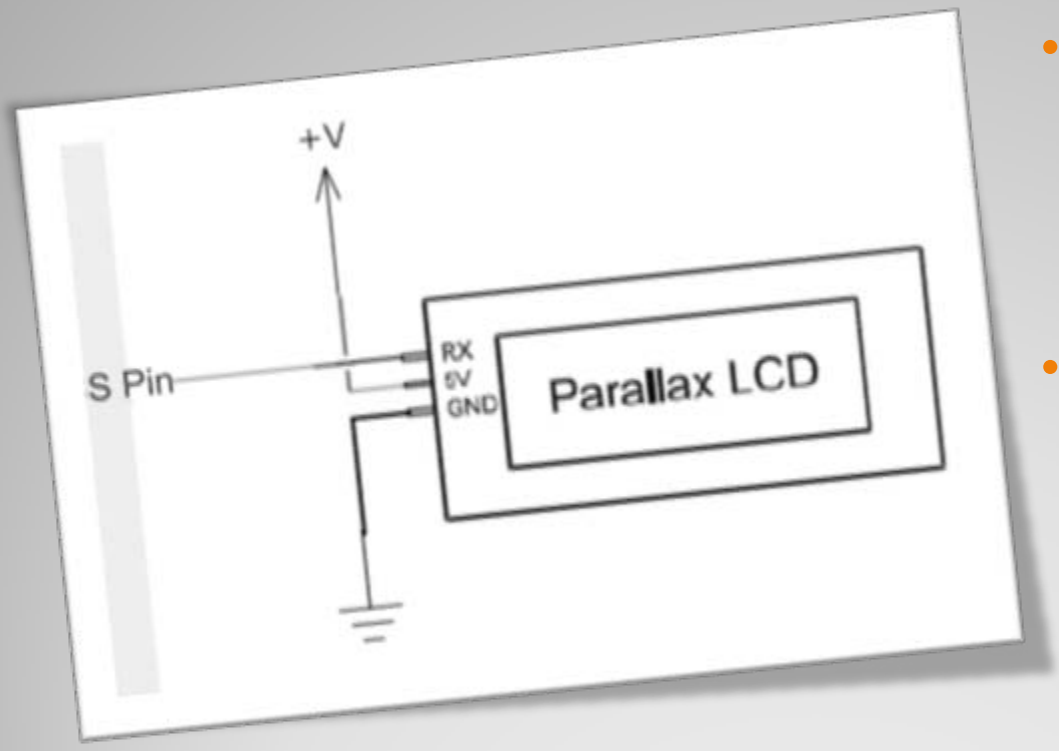


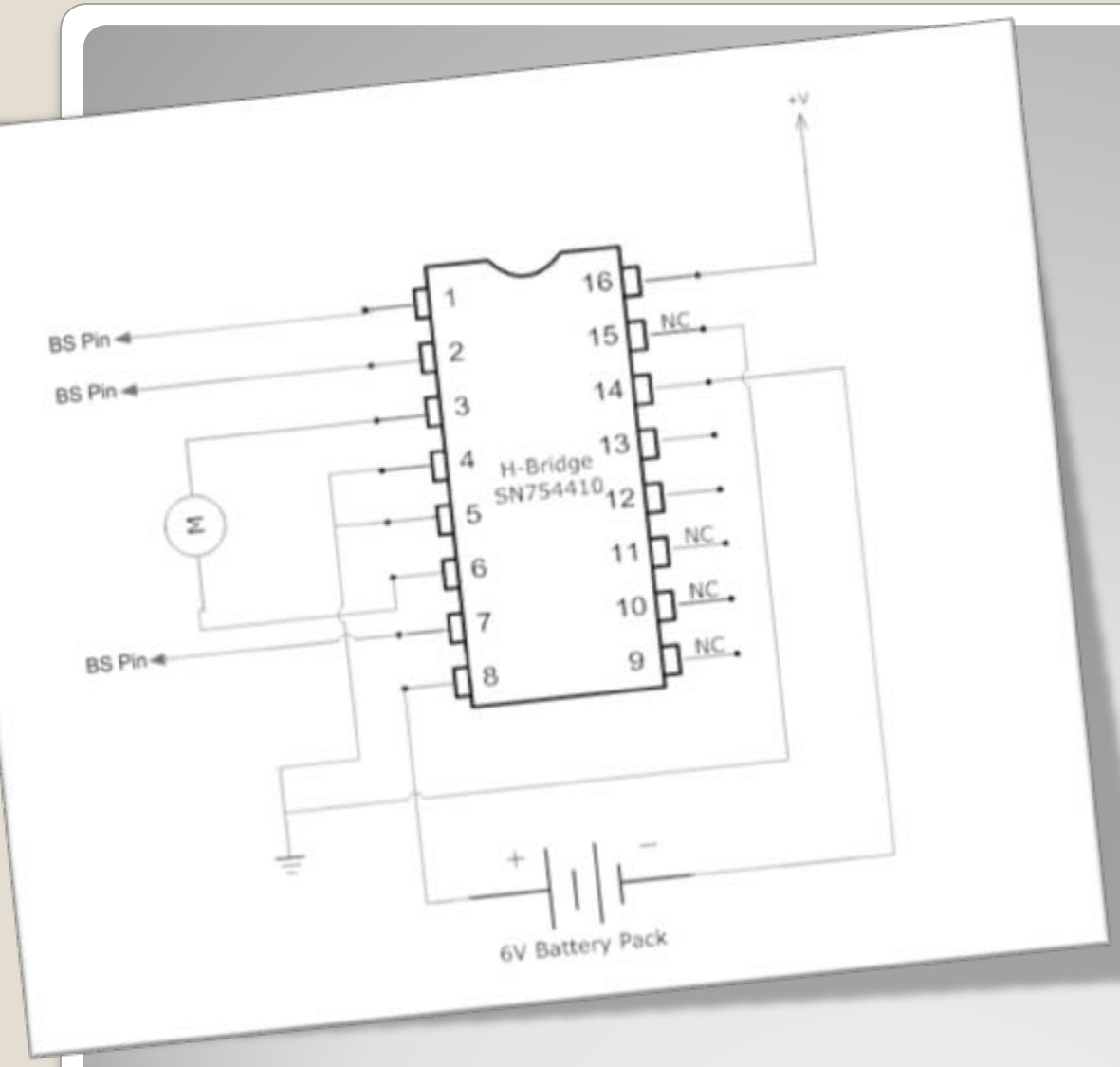
Button Circuit

- Vdd pulls the Basic Stamp normally high
- The switch is NO
- When the button is pressed the pin goes to ground and BS senses it as a low

Parallax LCD

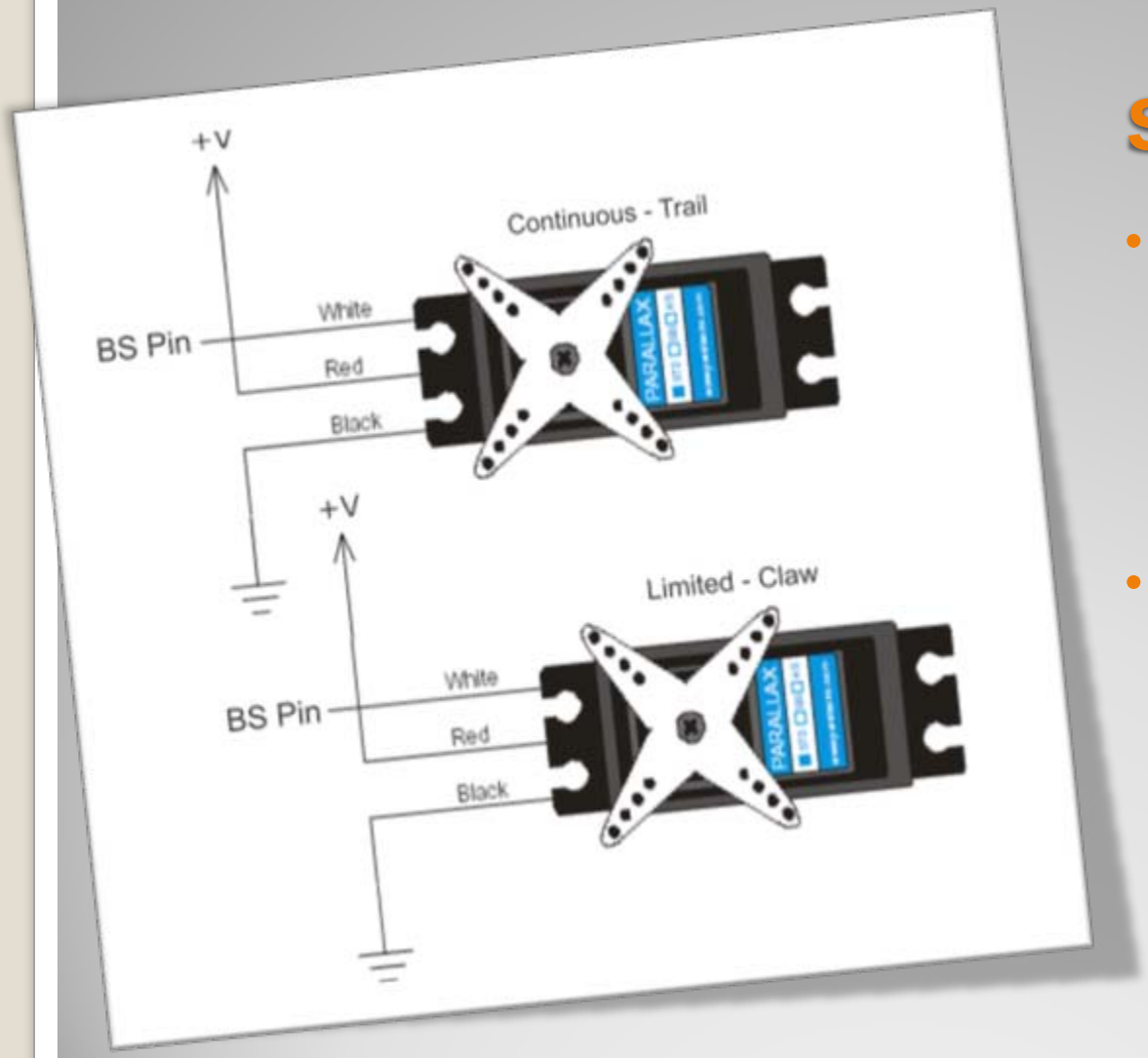


- Interacts with the Basic Stamp using only one Pin
- Can display information about program selection, can location and temperatures



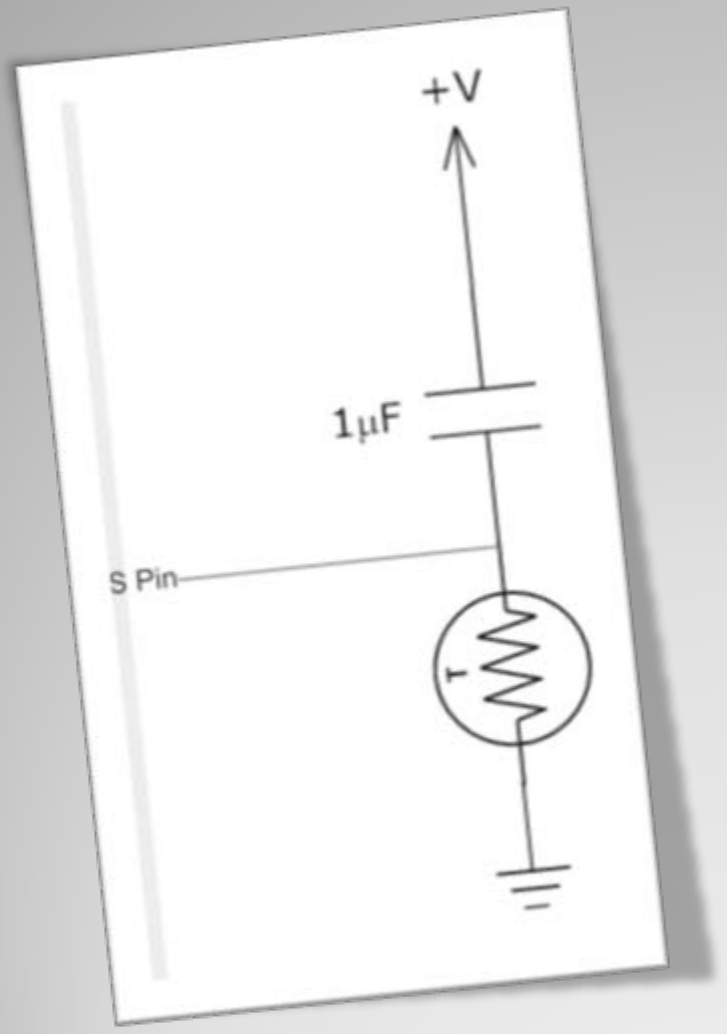
H-Bridge

- Uses 2 BS pins per motor
- Isolated BS voltage from external source
- External voltage needs to be higher than BS 5v to activate the MOFSETSs



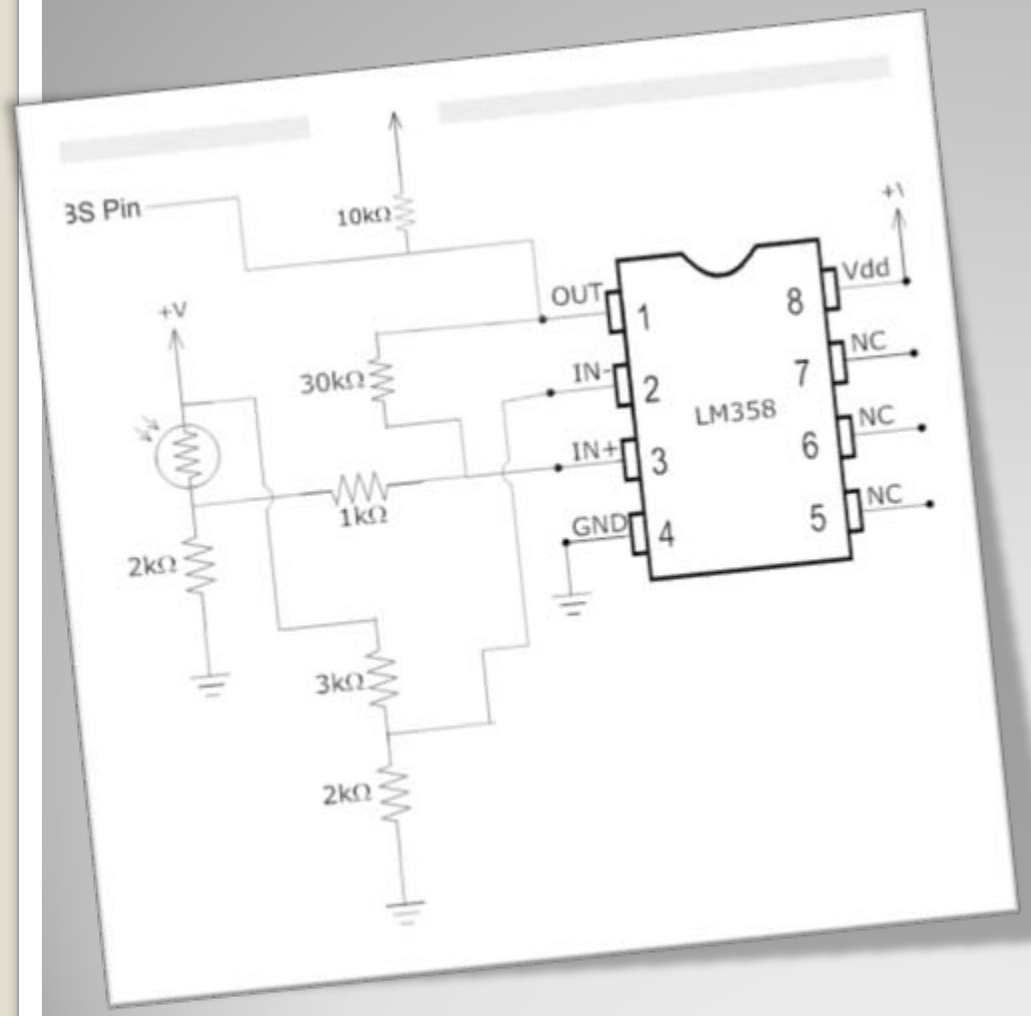
Servo Motors

- Can control speed, location and position with one BS pin
- Can operate using BS current and voltage



RC Circuit

- Used to measure the resistance of a variable resistor with basic stamp
- Used for photoresistor and thermistor
- Capacitor sizing is used to calibrate the range of resistance



Op-Amp

- Used in conjunction with the photoresistor
- Sends either Vss or Vdd to BS depending on resistance in the photoresistor
- Used to stop the robot quickly on the rails with only a small change in resistance

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Coding

Main

```
DO
   LOWERTEMP = 0
   COLDEST = 0
   GOSUB START
   GOSUB OPTION
   GOSUB CHECKCANS
   IF POSCANS = 0 THEN GOTO NOCANS
   IF FUNCTION = 1 THEN GOSUB GETCOLDEST
   IF FUNCTION = 2 THEN GOSUB FIRSTCOLD
   IF FUNCTION = 3 THEN GOSUB FREEZING
LOOP
```

- Sets values for important variables
- Calls starting functions
- Branches to selected option

Start

```
START:
PAUSETIME = 10
SEROUT LCDPIN, 84, [22, 12] 'ACTIVATE LCD, CLEAN SCREEN
PAUSE 5
SEROUT LCDPIN, 84, ["Select an", 13, "option:"]
GOSUB PAUSESUB
SEROUT LCDPIN, 84, [12]
PAUSE 5
SEROUT LCDPIN, 84, ["1:COLDEST CAN"]
GOSUB PAUSESUB
SEROUT LCDPIN, 84, [12]
PAUSE 5
SEROUT LCDPIN, 84, ["2:ANY COLD CAN"]
GOSUB PAUSESUB
SEROUT LCDPIN, 84, [12]
PAUSE 5
SEROUT LCDPIN, 84, ["3:CHECK FREEZING"]
GOSUB PAUSESUB
SEROUT LCDPIN, 84, [12]
PAUSE 5
SEROUT LCDPIN, 84, ["Press buttons", 13, "to select"]
GOSUB PAUSESUB
RETURN
```

- Shows the options
- Asks user to choose one

Option

```
OPTION:    'SELECTED INSTRUCTION

SEROUT LCDPIN, 84, [12]
PAUSE 5
SEROUT LCDPIN, 84, ["Function: ", DEC FUNCTION]

DO

  IF ( BUTTON1 <> PRVSVALUE1 ) AND (PRVSVALUE1 = 0)  THEN

    FUNCTION = FUNCTION + 1
    IF FUNCTION > 3 THEN FUNCTION = 1
    SEROUT LCDPIN, 84, [138, DEC FUNCTION]

  ENDIF
  PRVSVALUE1 = BUTTON1
  PAUSETIME = 2
  GOSUB PAUSESUB

LOOP UNTIL BUTTON2 = 0

SEROUT LCDPIN, 84, [12]
PAUSE 5
SEROUT LCDPIN, 84, ["Function", 13, "selected: ", DEC FUNCTION]

RETURN
```

- Reads buttons
- Displays the function selected

Check Cans

```
CHECKCANS:
  PAUSETIME = 1
  POSCANS = 0

  HIGH POS1
  GOSUB PAUSESUB
  RCTIME POS1, 1, TIME
  IF TIME > 500 THEN POSCANS = POSCANS | %1

  HIGH POS2
  GOSUB PAUSESUB
  RCTIME POS2, 1, TIME
  IF TIME > 10 THEN POSCANS = POSCANS | %10

  HIGH POS3
  GOSUB PAUSESUB
  RCTIME POS3, 1, TIME
  IF TIME > 500 THEN POSCANS = POSCANS | %100

  DEBUG DEC POSCANS,CR

RETURN
```

- Detects if there are cans in the positions
- Saves positions in variable POSCANS

Arm Down/Up

```
ARMDOWN:
HIGH CSARM
LOW PINARMUP
HIGH PINARMDOWN
IF HASCAN = 1 THEN
   PAUSETIME = 45
   GOSUB PAUSESUB
ELSE
   PAUSETIME = 53
   GOSUB PAUSESUB
ENDIF
LOW CSARM
LOW PINARMDOWN
RETURN
```

- Controls the DC motor of the arm
- Different time if holding can

Close/Open Claw

```
FOR X = 1 TO 100
  IF BUTTON3 = 0 THEN GOSUB EMERGENCY
  PULSOUT CLAW, 650
  PAUSE 20
NEXT
RETURN
```

- PWM pulses to control claw's servo

Pausesub

```
PAUSESUB:
FOR X = 1 TO PAUSETIME
  PAUSE 100
  IF BUTTON3 = 0 THEN GOSUB EMERGENCY
NEXT
RETURN
```

- Created to make possible the sensing of emergency button while pausing
- Pauses for 100 milliseconds and checks button

Get Coldest

```
IF POSITION = 1 AND POSITION <> (POSCANS & %1) THEN GOTO GETCOLDEST
IF POSITION = 2 AND POSITION <> (POSCANS & %10) THEN GOTO GETCOLDEST
IF POSITION = 3 AND POSITION > (POSCANS & %100) THEN GOTO TOSTART
```

- Piece of code similar in every function
- Checks if current position has can

Get Coldest

```
IF LOWERTEMP = 0 THEN
  LOWERTEMP = TEMP
  COLDEST = POSITION
ENDIF
IF TEMP > LOWERTEMP THEN
  LOWERTEMP = TEMP
  COLDEST = POSITION
ENDIF
```

- After sensing temperature, records it and position if lowest
- Variable Temp is related to time of RC circuit. The higher the value, lower the temperature

Get Coldest

```
IF POSITION = 1 THEN
  IF POSCANS > 1 THEN
    GOTO GETCOLDEST
  ELSE
    GOTO PICKCAN
  ENDIF
ENDIF
IF POSITION = 2 THEN
  IF POSCANS > 3 THEN
    GOTO GETCOLDEST
  ELSE
    GOTO PICKCAN
  ENDIF
ENDIF
IF POSITION = 3 THEN
    HASCAN = 0
    GOTO PICKCAN
ENDIF
```

- Checks if current position is last with cans
- If so, goes to pick can routine

Pick Can

```
IF POSITION = COLDEST THEN
   GOSUB ARMDOWN
   GOSUB CLOSECLAW
   HASCAN = 1
   GOSUB ARMUP
   GOTO TOSTART
ENDIF
```

- Checks if current position is position of coldest can
- If so, picks can and goes back to start position

First Cold Can

```
IF POSITION = 1 AND POSCANS = 1 THEN
  GOSUB NOCOLDCANS
  GOTO TOSTART
ENDIF
```

- Similar to get coldest
- Gets cold can as soon as it finds it
- If none is found displays message

Freezing

- Similar to previous
- Never gets a can
- Shows warn if temperature is below freezing temperature

```
IF TEMP > FREEZETEMP THEN
  SEROUT LCDPIN, 84, [12]
  PAUSE 5
  SEROUT LCDPIN, 84, ["WARNING!"]
  PAUSETIME = 10
  GOSUB PAUSESUB
  SEROUT LCDPIN, 84, [12]
  PAUSE 5
  SEROUT LCDPIN, 84, ["FREEZING CAN", 13, "ON POSITION ", DEC POSITION]
ENDIF
```

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Marketing / Conclusion

Improvements

- More compact design can be achieved with better materials
- All components need to be rated for colder temperatures
- A larger sample size will need to be able to be observed
- More precise temperature reading capabilities.

Improvements

- Additional sensors to make possible safe reset:
  - Claw state
  - Arm position
  - End of trail

Summary

- Increased productivity
- Lower operating costs for labs
- More precise readings
- Larger quantities capable of being observed

A product no lab will be without!!!

Thank you