Create It Lab

RISE Conference
"Low Cost Electronics for STEM"

Richard St-Pierre & Dave Harmon

June 2012

Workshop Agenda

- Introduction / T.E.O.
- Simple Circuits /Demos
- Musica-Sci (STEAM) /Demos
- LAB eInstruments /Demos
- Hands On Project
- Learning to Solder
- Build ElectroScope
- Wrap up

Mission

Create It Lab is a volunteer organization working in conjunction with IBM's Technical Education Outreach Program.

The organization's mission is to provide an innovation-environment for K-12 students to explore physical sciences by building developmentally appropriate, motivational projects at very low cost.

Emphasis is placed on the Make-Measure-Model design methodology which provides the framework for creativity and empowers students by teaching fabrication skills.

Mission (Local details)

The core group has been developing and implementing STEM project-based learning units in a variety of Vermont schools and summer camps for well over 15 years. These units are generally 2 to 6 sessions long and begin with demos involving a discrepant event that illustrates a scientific phenomenon. The demos are followed by student-built projects which utilize the same phenomenon. Whenever possible, the product created during the project is available for the students to take home, show their friends and continue to investigate. We usually hold about 4 events every year. As an example, we held an event last spring at Essex High School where we demonstrated the interaction of electricity and magnetism. We then taught them how to solder by having them build simple electronic electrostatic sensors. Using that skill, the students then built their own speakers (from recycled materials) and amplifiers so they could listen to their tunes from their MP3 players without headphones.

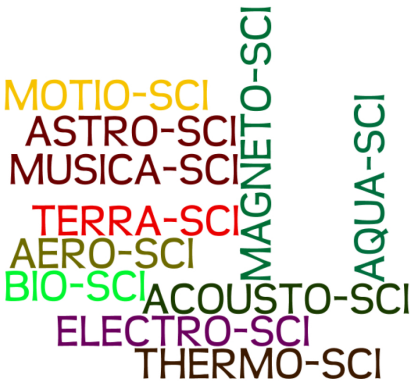
This fall, we integrated the Arts into STEM... STEAM, I suppose... by building electronic marimbas at Essex Middle School. The idea was to engage all the students, not just those who were naturally inclined toward the Sciences. We took the concept further by forming multidisciplinary teams to build each marimba and combining them into larger, 3-marimba teams which will compete for the title of 2011 Marimba Champions. Hopefully, the competition will provide additional motivation and excitement. We also introduced the concept of the product development cycle by holding brainstorming sessions in which the students identified possible marimba enhancements and then focused on those that were important to customers and also easy/cheap to implement. As a final experiment, we attempted to extend our presence in the classroom with Facebook, which allowed the students to interact with "experts" in all facets of the project and to provide them with reference materials. One unanticipated technology addition to the project was the discovery that IPAD/IPOD Apps could be effective tools for both tuning the instruments and learning music.

ELECTRONICS

Objectives

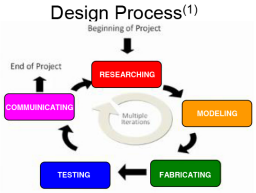
- Hands-on learning
- Design of 'give away' cost electronic projects
- Low cost electronics for science experiments
- Affordable LAB Instruments for science
- Data and measurement automation

Motivational Science Topics

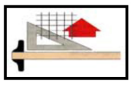


Design, Scientific & Problem Solving Processes

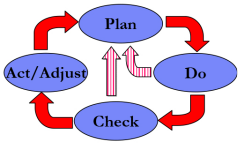
Design Process(1)



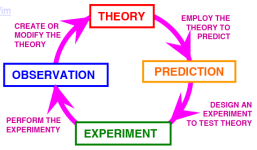
(1) Product Design Funda!, Importance of Research in Engineering Design, 4/23/12, http://www.productdesignfunda.com/technology/importance-of-research-in-engineering-design



Problem Solving Process



Scientific Process(2)

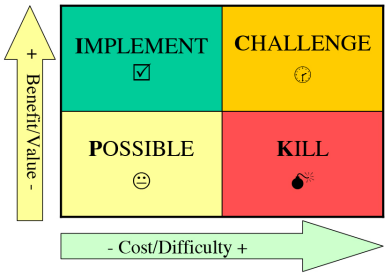


(2) Tomatosphere, The Scientific Method, 5/15/12, http://www.tomatosphere.org/teacher-resources/teachers-guide/principal-investigation/scientific-method.cfm

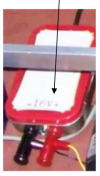
Design Decision Process

P.I.C.K Chart

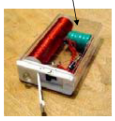
Which ideas should be chosen?



Re-Sci-cling



Housing your project makes it look and work better.



Using Household Materials

= low cost

Project List (with Approximate cost*)

- Static Force (PVC) $0.50
- ElectroScope kit $0.25
- Compass/Coil (wire) $5.00
- Simplest Motor $1.00
- Ring Flinger(wire) $20.00
- Magnet/Spool+LED $20.00
- Coin Launcher $20.00
- Jacobs Ladder (-OBT) $ 5.00
- Hold hands $ 5.00
- Wind/RPM (-PC fan) $ 5.00
- **T**i**M**o Ramp (ROMEO) $10.00
- **R**e**A**ction **T**imer $10.00
- Toothpic + LCD $5.00
- 9V battery clip board $0.25
- Battery eliminator 5V $1
- Joule Thief $2.50
- LED 'puck' $0.10
- Piezo Generator $1.50
- Speaker (mag+wire) $2
- **E**.**G**.**G** amplifier $5
- Strobe Light $5
- Pedometer $1
- Funk Generator $5
- Magnet drop (poles) $20
- **P**.**E**.**T**. (Large LED) $25

* Assumes some "ReSciCling" materials/qty

NOTES

NOTES

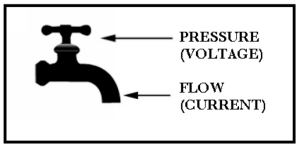
Electro-Sci & Magneto-Sci
Simple Circuits

What is Electricity ?

WATER ANALOGY (MODEL)

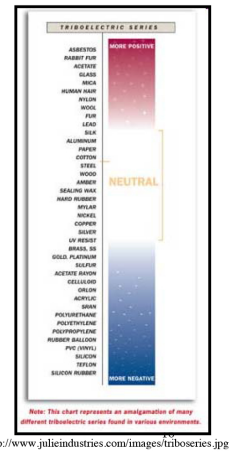
- Static Electricity
- Direct Current (DC)
- Alternating Current (AC)

Electric Circuit Units & Water Analogy



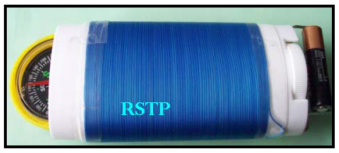
Pressure	= VOLTAGE	[Volt]	symbol **V**
Flow	= CURRENT	[Ampere]	symbol **I**
Size of pipe	= RESISTANCE	[Ohm]	symbol **R**

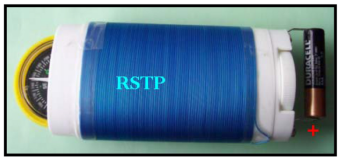
Circuit Basics – Charge Transfer



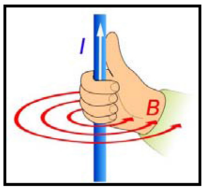
http://www.julieindustries.com/images/triboseries.jpg

Electric Current Creates Magnetism





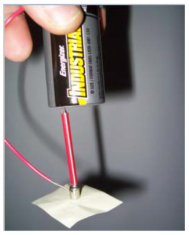
Demonstration of most basic principles.



Polarity reversed and

Compass changes direction

Simplest Motor



- "D" Cell
- 2 inch nail
- Rare earth magnet (strong)
- Short wire
- Piece of paper (to show motion)

Ring Flinger

A strong generated magnetic field allows **hands-on** feeling of the magnetic force. (60Hz)

Observe the resulting magnetic counter force from the magnetically induced currents.

Metal Ring flings off the top !

Soda can "levitates" defying gravity !

Some don't….. why ? ?

Magnetism Creates Electric Current

A Magnet passing next to a conductor generates an **<u>electric current</u>**

lighting an LED.

Electromagnetic Coin Launcher

50 Joules of energy into a small coil causes a metal coin to launch into the air.

A large magnetic field induces current in the coin

This current generates an opposite magnetic field.

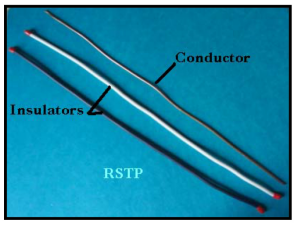
Different coins metallurgy affects launch behavior.

NOTES

Circuits Basics

- Conductors & Insulators
- Concepts of Closed Loop
- Series Circuits
- Parallel Circuits

Circuit Basics – Conductors & Insulators



What is Resistance [units: Ohms] ?

What is the resistance of a wire?

What is the resistance of an Insulator?

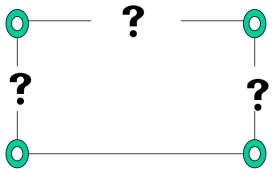
Is the human body a conductor or insulator?

Why does the spark start at the bottom?

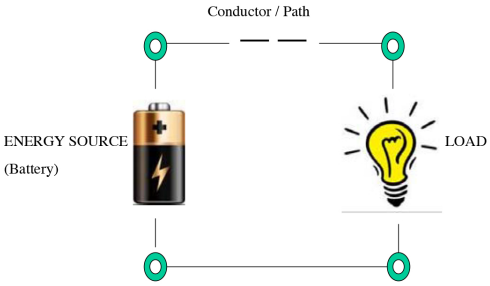
Why does the spark Rise?

NOTES

Basic Circuit Requirements

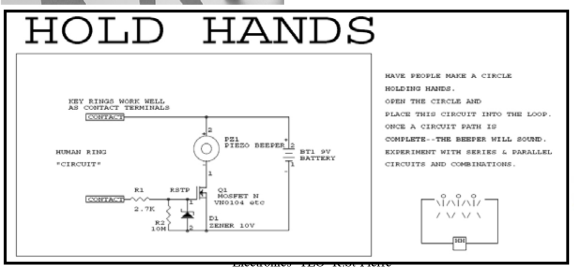


Basic Circuit Requirements



Hands ON Learning !

This simple beeper circuit allows a 'human chain' to demonstrate basic series and parallel circuits.



Low Cost Electronic Components and Circuits

Useful Tools

S.T.E.A.M possible resource suggestion
Soldering, Electronics, Robotics
Richard St-Pierre
January 2012

Disclaimers:

This information provided is offered as guideline only and on a personal basis, and in no way represents views or endorsement of my employer.

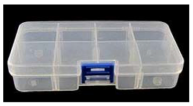
Supplier names/websites are provided as a starting point/example source to help locate the material. Costs are provided as guideline only. Suggestions list does not include all possibilities – customization may be required based on intended use and activities.

The following tables provide guidance for tools and supplies that could be useful for design activities used to develop skill in: Design, Soldering, Electronics, Robotics …

SOLDERING	BASIC	Cost	Type	Photo	Comments
Soldering iron	15-30Watts	$5-$20	Tool		2-5 Years life *Teflon cords much better !*
Soldering Stand		$5	Tool		Jameco
Soldering mat/ Goggles		$5-10	Tool/ Safety		Non-melt / surface/ metal etc
Solder Spool		$20	Supply		1 per classroom Lead free
Needle nose plier		$8	Tool		1 per team/kit
Wire Strippers		$10	Tool		1 per team/kit
Tweezers		$2	Tool		Optional
Solder Sucker		$10	Tool		Optional / shared

Additional tools, components

ELECTRONICS	BASIC	Cost	Type	Photo	Comments
Digital Multimeter DMM		$8-$20	Tool		HarbourFreight Goldmine-elec
Alligator clips		$3	Tool		Solder-less connections
LED 5mm	Red	$0.25	kit		
Resistor	100 ohms 1/4W	$0.05	kit		$4 per QTY 100
Resistor	1 kilohms	$0.05	kit		$4 per QTY 100
Wire			kit		Used Printer cable
Battery ("Wall wart")	9Volts		Supply		DC Power source (solar cells $2-5)
Battery Clip			kit		
ELECTRONICS	**ADV**	Cost			Suggestions
Transistor	2N2222 2N2907	$0.10 $0.10			NPN PNP
Resistors 1/4W	150,470, 1K,10K, 100K, 1M	$4(100)			Suggested values
Capacitors	10nF, 100nF 10uF,100uF	$0.10			Suggested values
Diode	1N4148	$0.10			
IC LM555	DIP 8	$1			Timer / Flasher
IC LM324	DIP 14	$1			Quad Amplifier
Breadboard (solder-less)	Prototype	$5-10			Wiring board
Breadboard wire		$7			Solid wire jumper kit
Others					Based on projects



Components

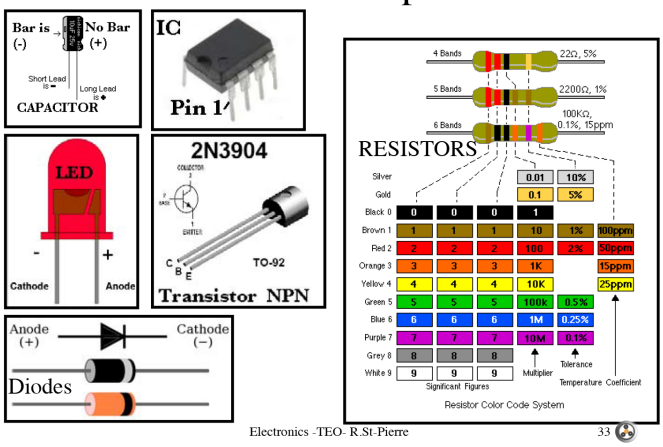
Many electronic products are discarded after a short use…

PERFECT, this is a great source of components for projects.

Answering machines, cordless telephones, clock radios, computer parts are a good source of components (and learning opportunity).

(!) REMOVE POWER before taking apart (!)

Common Components



Possible Sources of Components

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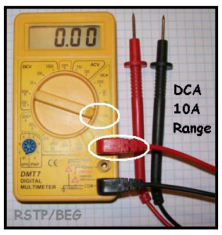
Supplier	URL	Type	Comments
DIGI-KEY	www.digikey.com	Electronics	
MOUSER	www.mouser.com	Electronics	
JAMECO	www.jameco.com	Electronics	
B.G.MICRO	www.bgmicro.com	Surplus	
SPARKFUN	www.sparkfun.com	Kits	
GOLDMINE	www.goldmine-elec.com	Surplus	
ALL ELECTRONICS	www.allelectronics.com	Surplus	
Harbour Freight	www.harbourfreight.com	Tools	
Radio Shack	www.radioshack.com	Local	

Getting the most of discarded Batteries – How to test them?

Is that battery 'good' – not sure?

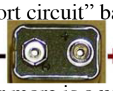
Many are discarded with useable life left (for many project).



Need a DMM (with **10A DC** range)

MUST move Red Plug on most DMM.

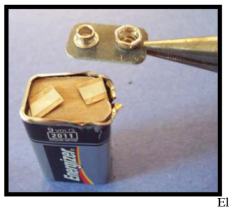
Measure "short circuit" battery current.

Black on (-)  RED on (+)

2 Amperes or more is a useable battery.

Save dead batteries for decapitation→

'Decapitating' 9V Batteries



Re-Sci-cling Battery Connectors

<Caution> Battery may still have 'juice'

<Caution> Sharp Metal edges

Uses as 'free' project connectors:

Battery power connectors (see projects)

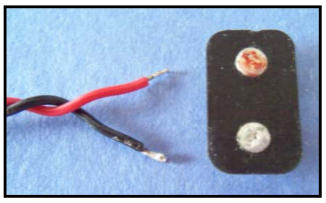
Simple circuit base for small projects.

Other circuit connections: speakers, LEDs

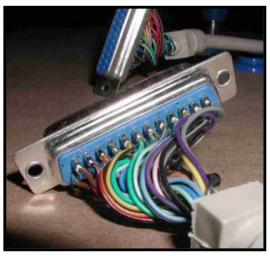
Practical workbench tool

Battery clip on a block
makes soldering easy & safe.

By: D.Harmon



Re-Sci-Cling
Low cost source of wire



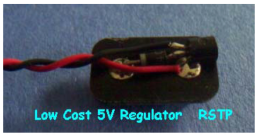
Old Printer (parallel port) cables
contain many colorful wires.
Perfect for electronic projects

<Caution>

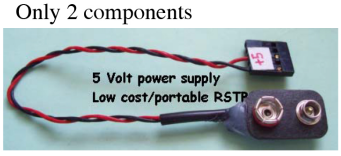
Use care when cutting open the cable outer cover with a sharp knife.

Simple Projects
(learning to solder)

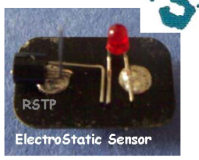
Only 1 Resistor

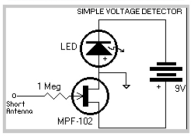


Only 2 components



Needed for many 5V projects

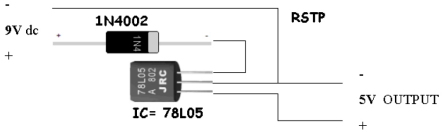




Eletrostatic Charge sensor,
http://www.eskimo.com/~billb/emotor/chargdet.html

Battery Eliminator Circuit

D1: Diode , 1N4002
U1: Voltage Regulator, 78L05 TO-92
9V Battery clip, wire, solder



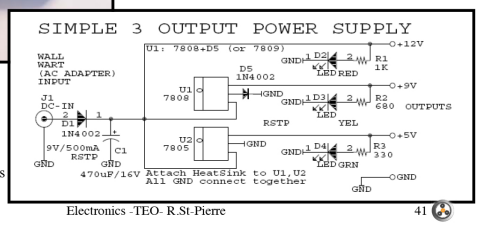
Low Cost Bench Power Supply

Provides (3) useful voltages:

5V, 9V and 12V

from a common Wall Wart

(AC adapter) {9V, 500 mA}

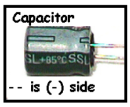


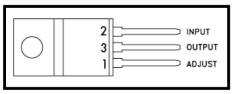
The AC adapter converts 117Vac into 12Vdc.

C1 acts as filter (reservoir).

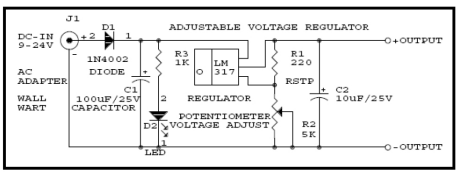
The circuit regulates (keeps constant) the output voltages at 5V, 9V and 12V.

Adjustable Power Supply (battery eliminator)



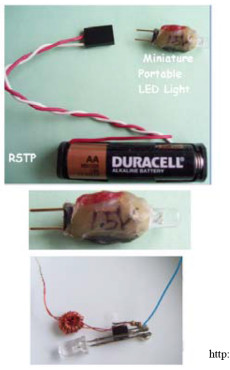


LM317 Regulator IC

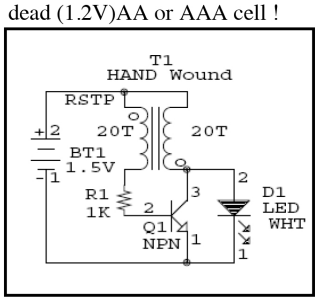


Schematic diagram – Adjustable Regulator

Joule Thief



Lights a White LED using almost dead (1.2V)AA or AAA cell !



http://talkingelectronics.com/projects/LEDTorchCircuits/LEDTorchCircuits-P1.html

LED Tester

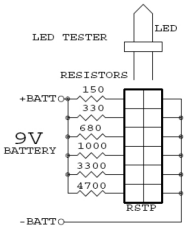
A very handy and simple test circuit →

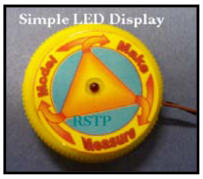
Using a 9V battery

A Simple LED circuit for testing.

(LED + 1K resistor)

Another tester version

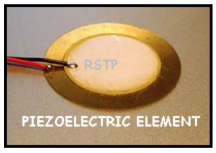




Graphics : D.Harmon

Musica-Sci
STEAM

Piezo Electric

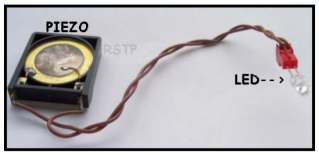


Learn about Piezo Electric Energy

Create Sound (beeper)

Generate Electricity

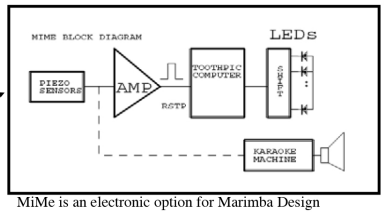
Measure vibrations



LED lights with a tap of a finger on Piezo Disc (generates electricity)

Marimba – MIME

{**M**usical **I**nstrument **M**icrocontroller **E**nhanced }



MiMe is an electronic option for Marimba Design

Electronic Marimba

Making Marimbas and music is a great way to learn about waves a sound.

Marimba: D.Harmon

If you can't play a song…

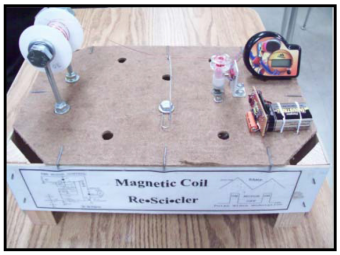
This computerized instrument guides you with an LED on each note/bar as you play.

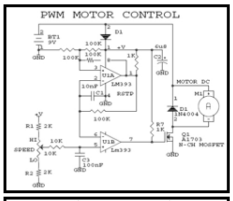
(Piezo sensor technology)

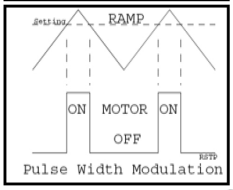
Make Speakers

"The Re-Sci-Cling Way"

Re-Sci-cler (aka *Citrus Apparatus*)







Pedometer counts the number of turns.

Used to make speaker coils and inductors.

Efficient PWM (pulse width modulation) speed control of the motor

E.G.G. Amplifier

"*Educational Gain Gadget*"

CNC machining: Bart Green

Listen to MP3

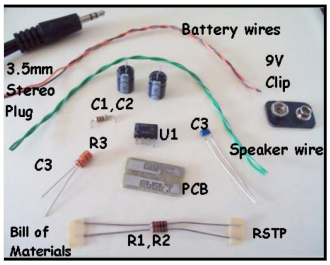
Boost signals

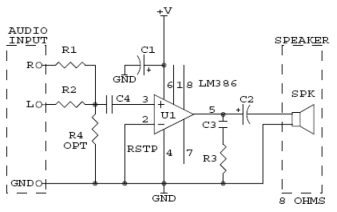
P.A. System

Intercom

Many more uses

E.G.G. Audio Amplifier





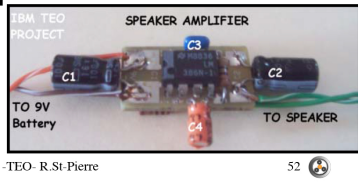
Schematic diagram

Low parts count

Easy to build

Enjoyable to use!

With "Egg Beater option"



Low Cost Electronic Lab Instruments

MilliGauss Meter

Low Cost Gauss Meter

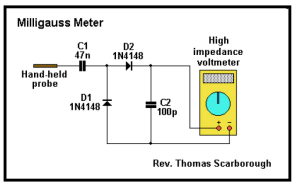
Measures Magnetic Field

(Circuit Inside Bottle Cap)

To obtain a very rough translation from millivolts to milligauss (the unit of magnetic field strength), divide the millivolts reading by four. [*]

For example, 1000mV will yield 250 milligauss

Up to **3** milligauss - Low electromagnetic radiation
25 milligauss - Significant electromagnetic radiation
100 milligauss - High electromagnetic radiation
250 milligauss - Maximum risk exposure



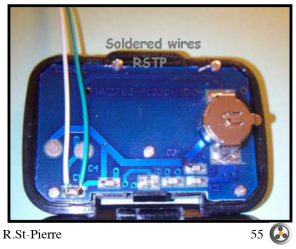
[*] http://www.diy-electronic-projects.com/p295-MILLIGAUSS-METER-

Pedometers

Had one of these ?

Stopped using it ?

Go find it ! Great Gazoo !



Simple Counter (4-5 digits)

Low power, Reset function

Simple switch closure input

Portable and low-cost instrument

Connect to internal inertia switch!

Coin Battery eliminator

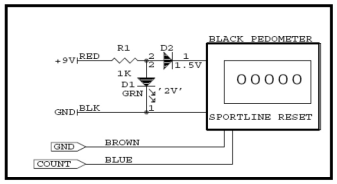
(Pedometer, and other 1.5V gadgets)

Gadget not working-Battery dead?

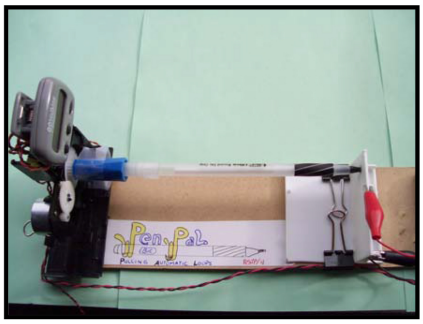
Can't find any replacement battery?

This circuit uses a regular 9Vbattery and adds an LED when in use.

LED acts as 2V regulator, D2 reduces it by 0.5V more.

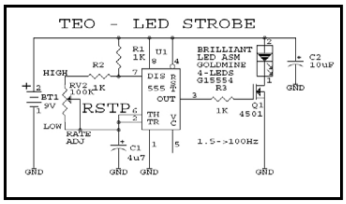


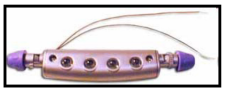
Pen Pal Coil Winder



Winds coils on a pen (using CD Rom parts)

LED STROBE LIGHT



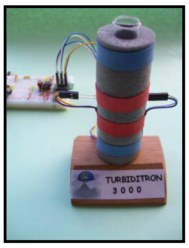


Observe standing waves

"Freeze" motion

1.5 to 100 Hertz Range

Learn Nyquist sampling Theorem



Turbiditron 3000

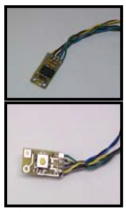
eWeek – "Smart Water" Activity

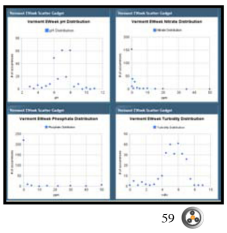
Turbitidy = Water Cloudiness Measurement

Water Quality, Water shed education

Google Mash-up Data collection

Smart Planet : "**I**nstrumented – **I**nterconnected – **I**ntelligent"





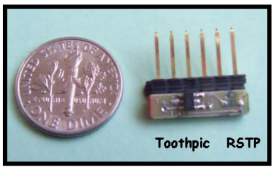
NOTES

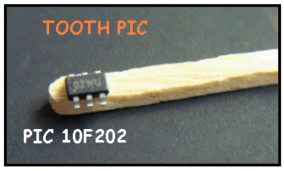
More Advanced Electronics

"TOOTHPIC"

SMALLEST EMBEDDED MICROCONTROLLER

TOOTHPIC- (More Advanced Level)





RISC Processor, 8bit data path

4MHz internal clock

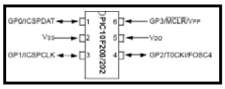
6 Pins (3 I/O, 1 Input)

512 Words of program Memory

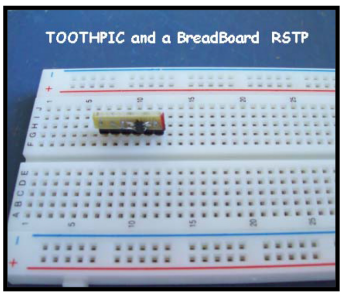
Many applications, very low cost

All for about 50 cents !

This **tiny** computer IC is programmed to do many tasks quickly.



Toothpic Microcontroller Projects

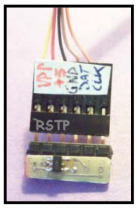


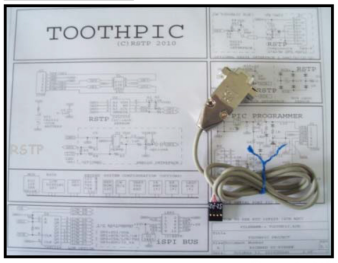
The "Toothpic" is inserted into a 'solderless' breadboard, for simple classroom experiments.

Other components are connected on the breadboard for endless circuit possibilities and experiments.

A computer is required to program this chip using an adapter device.

Toothpic Project Examples

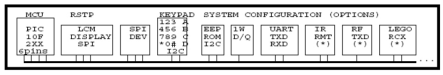




- Event Timer or Counter
- Frequency/Tone/Music Generator
- Voltmeter measurement, LAB instrument
- Data logger (store data then send to PC)
- Communication (infrared remote)
- Motor/Speed controller (R/C)
- Controller (menu and keypad)
- Random number generator
- Voice Synthesis (talking)
- Alarm system, robots…

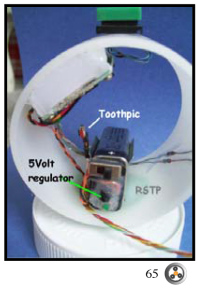
Toothpic Projects

Example Resource Library



Software Routines	Hardware Interfaces
SPI based LCD Displays	Single Digital Pin A/D
HEX BCD conversion	Single Digital I/O Pin Keypad
Multiply, Divide 16/32 bits	"HP88" Debug Aid
I2C BUS (Bit-banged)	Temperature sensor (low cost)
Frequency Generator	Resistance Measurement
Frequency Counter	Capacitance Measurement
Infrared Tx and Rx	Speech Synthesis (D/A based)
UART (bit-banged)	
Datalogger (EEPROM) *	

<add audio file>



RISC (**R**educed **I**nstruction **S**et **C**omputer)

Means only 33 commands to learn !

PIC10F200/202/204/206

TABLE 10-2: INSTRUCTION SET SUMMARY

Mnemonic, Operands		Description	Cycles	12-Bit Opcode MSb	12-Bit Opcode LSb	Status Affected	Notes
ADDWF	f, d	Add W and f	1	0001	11df ffff	C, DC, Z	1, 2, 4
ANDWF	f, d	AND W with f	1	0001	01df ffff	Z	2, 4
CLRF	f	Clear f	1	0000	011f ffff	Z	4
CLRW	—	Clear W	1	0000	0100 0000	Z	
COMF	f, d	Complement f	1	0010	01df ffff	Z	
DECF	f, d	Decrement f	1	0000	11df ffff	Z	2, 4
DECFSZ	f, d	Decrement f, Skip if 0	1(2)	0010	11df ffff	None	2, 4
INCF	f, d	Increment f	1	0010	10df ffff	Z	2, 4
INCFSZ	f, d	Increment f, Skip if 0	1(2)	0011	11df ffff	None	2, 4
IORWF	f, d	Inclusive OR W with f	1	0001	00df ffff	Z	2, 4
MOVF	f, d	Move f	1	0010	00df ffff	Z	2, 4
MOVWF	f	Move W to f	1	0000	001f ffff	None	1, 4
NOP	—	No Operation	1	0000	0000 0000	None	
RLF	f, d	Rotate left f through Carry	1	0011	01df ffff	C	2, 4
RRF	f, d	Rotate right f through Carry	1	0011	00df ffff	C	2, 4
SUBWF	f, d	Subtract W from f	1	0000	10df ffff	C, DC, Z	1, 2, 4
SWAPF	f, d	Swap f	1	0011	10df ffff	None	2, 4
XORWF	f, d	Exclusive OR W with f	1	0001	10df ffff	Z	2, 4
BIT-ORIENTED FILE REGISTER OPERATIONS							
BCF	f, b	Bit Clear f	1	0100	bbbf ffff	None	2, 4
BSF	f, b	Bit Set f	1	0101	bbbf ffff	None	2, 4
BTFSC	f, b	Bit Test f, Skip if Clear	1(2)	0110	bbbf ffff	None	
BTFSS	f, b	Bit Test f, Skip if Set	1(2)	0111	bbbf ffff	None	
LITERAL AND CONTROL OPERATIONS							
ANDLW	k	AND literal with W	1	1110	kkkk kkkk	Z	
CALL	k	Call Subroutine	2	1001	kkkk kkkk	None	1
CLRWDT		Clear Watchdog Timer	1	0000	0000 0100	$\overline{TO}$, $\overline{PD}$	
GOTO	k	Unconditional branch	2	101k	kkkk kkkk	None	
IORLW	k	Inclusive OR literal with W	1	1101	kkkk kkkk	Z	
MOVLW	k	Move literal to W	1	1100	kkkk kkkk	None	
OPTION	—	Load OPTION register	1	0000	0000 0010	None	
RETLW	k	Return, place Literal in W	2	1000	kkkk kkkk	None	
SLEEP	—	Go into Standby mode	1	0000	0000 0011	$\overline{TO}$, $\overline{PD}$	
TRIS	f	Load TRIS register	1	0000	0000 0fff	None	3
XORLW	k	Exclusive OR literal to W	1	1111	kkkk kkkk	Z	

Source: Microchip Datasheet

Example Toothpic Programming

- Assembler Programming example
- Wait 1 second routine

```
        ;-------------------
        ; WAIT 1 SEC  (4MHz)
        ;-------------------
        ; 10+4CNT0+1027CNT1+26
        ;-------------------
WAIT_1SEC MOVLW   d'177'
        MOVWF   CNT0
        MOVLW   d'205'
        MOVWF   CNT1
        MOVLW   3
        MOVWF   CNT2
WAIT_1A NOP
        DECFSZ  CNT0,f
        GOTO    WAIT_1A
        DECFSZ  CNT1,f
        GOTO    WAIT_1A
        DECFSZ  CNT2,f
        GOTO    WAIT_1A
        RETLW   0x00
```

```
        MOVLW   B'00001111'     ;all output Hi
        MOVWF   GPIO            ;before enabling drivers
        MOVLW   B'00000000'     ;GP2,1,0 as outputs 1:=Z 0:=drive
        TRIS    GPIO            ;enable output drivers
        MOVLW   B'11011111'
                ||||||||---Prescale- 000: 2   100: 32
                |||||||             001: 4   101: 64
                |||||||             010: 8   110: 128
                ||||||+-0:TMR0 1:WDT 011: 16  111: 256
                |||||+--------------- T0SE 0:=_\_ 1:= _/ Edge
                ||||+---------------- T0CS  0:=Int, 1:=Ext C1#(GP2)
                |||+----------------- *GPPU 0:=Pullup
                +++------------------ *GPWU 0:=WakeUp on Change
        OPTION
        ;*****************************
                M  A  I  N
MAIN    ;*****************************
        MOVLW   B'00001111'     ;all output Hi
        MOVWF   GPIO            ;before enabling drivers
        MOVLW   B'00000000'     ;GP2,1,0 as outputs 1:=Z 0:=drive
        TRIS    GPIO            ;enable output drivers
        MOVLW   B'11010100'
                ||||||||---Prescale- 000: 2   100: 32
                |||||||             001: 4   101: 64
                |||||||             010: 8   110: 128
                ||||||+-0:TMR0 1:WDT 011: 16  111: 256
                |||||+--------------- T0SE 0:=_\_ 1:= _/ Edge
                ||||+---------------- T0CS  0:=Int, 1:=Ext C1#(GP2)
                |||+----------------- *GPPU 0:=Pullup
                +++------------------ *GPWU 0:=WakeUp on Change
        OPTION
        ;*****************************

        ;-------------------------------
        ; INSERT YOUR PROGRAM HERE
        ;
        ;-------------------------------
        CALL    LCM_INIT
        CALL    WAIT_10MS
        ;--- PROGRAM LOGO ---
        CLRF    CNT0            ;offset = 0
MSG_LOGO1 MOVF  CNT0,w
        CALL    MSG_LOGO        ;returns char
        XORLW   0               ;test for Null
        BTFSC   STATUS,Z        ;Null term?
        GOTO    END_MSG1
        CALL    LCM_DAT         ;send char to LCM
        INCF    CNT0,f          ;next
        GOTO    MSG_LOGO1
END_MSG1  CALL  WAIT_1SEC
MAIN_LOOP

        END
```

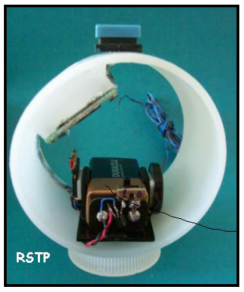

NOTES

A simple “Toothpic” Timer project

Liquid Crystal Display timing up to 1 second.

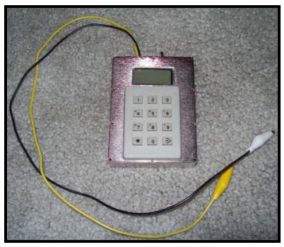
In 0.004 second interval, for events that occur quickly, and are difficult to time manually- with a stop watch. Optional computer data-link cable.

Toothpic Instrument Base



Reprogrammable for many projects and experiments.

Toothpic Frequency Generator



Frequency Generator

With numeric keypad entry

And LCD display

1 –to- 30,000 Hz

1 Hertz steps

Toothpic Micro Computer

(3) button control allows for more functions

A musical scale/octave generator to learn how sound is made & harmonics.(0.1Hz –to-30kHz)

Wind Speed Measurement

Re-sci-cle an old computer cooling fan into an accurate wind-speed meter (anemometer).

Uses the built-in Hall-effect sensor and fan rotor magnet for measurements.

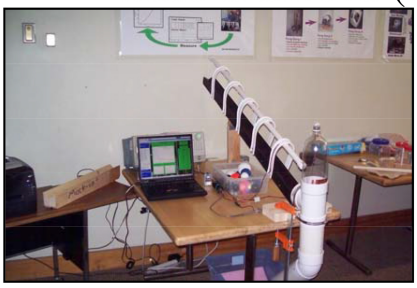
Toothpic Frequency / RPM Meter

Measure Frequency

Measure RPM

Measure Wind Speed

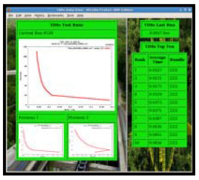
Time & Motion (TiMo)



Measuring a falling/rolling object accurately is tricky.

This ramp has 10 sensors at 10cm interval and measures to 0.004s each ball rolling by.

Graphing Software: Bart Green



Automatic data linked to a laptop computer
Allows students to focus on data analysis – rather than error prone data collection.
Large number of runs possible per class.

R.A.T. (Re-Action Timer)

Audio (Buzzer) or

Visual (LED)…

Which stimulus gives faster human response ?

Simple 'Toothpic' program measures human response time using an infrared beam.

P.E.T.
(Physics Experiment Timer)

Accurately measures time intervals

0.01 sec to 1 minute (60 sec).

Large bright display for

classroom visibility & readability.

Turns off display after a few seconds to save battery power.

Measure short time interval, which are difficult to time manually.

Projects In Development

- ☑ Coin Launcher
- Pong-o-meter
- Falling monkey
- Automated coil winder
- Bicycle wheel generator
- 3-D stepper/floppy (CNC)
- Rubens Tube (gas/non-gas)
- Speed of sound (dist meas)
- ☑ Faraday law (compass)
- ☑ LED Strobe light (stop motion)

- ☑ Mag drop => LED
- Linear Hall sensor
- String thing (PWM)
- Hula hoop (straw)
- Tuner (toothpic)
- Datalogger
- Door Touch Sensors
- Mag/shaker Flashlite
- Make your own guitar
- Bluetooth interface

PONG-O-METER

Large Visual 4 Foot Display "Voltmeter" .

Ball position represents the measurement value (input).

Classroom 'see' changing parameter as ball moves up/down.

Air flow from a Computer fan moves the bright Ping-Pong ball.

An infrared sensor monitors the location of the ball.

An analog signal is sent to a "toothpic" computer to regulate the fan and control the ball position.

This also demonstrates a closed-loop control system.

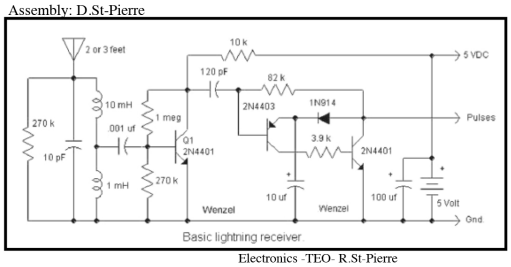
Lightning Detector

Detect Lightning miles away

Warning LED and BEEPER

Intermediate level electronics

Assembly: D.St-Pierre

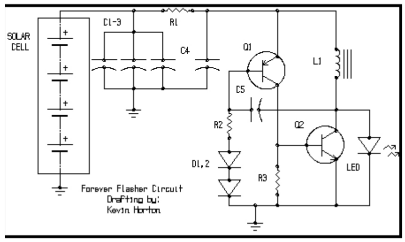


Circuit: www.techlib.com

Infinity Flasher

Solar powered flasher

Flashes day and night 'forever'



http://kevtris.org/Projects/led/flasher.html

CIRCUIT OPERATION:

Charge is collected in Capacitor C4.

Once C4 is full transistor Q1 can turn ON

which then turns ON transistor Q2.

Q2 stores energy in inductor L1 until it is full/saturated (stored in a magnetic field).

This signals Q1 via C5 to go OFF.

Q2 now turn OFF releasing the Energy of L1 into the LED! A bright pulse of light!

Robotics : Entry Level

{**BEAM** : **B**iology, **E**lectronics, **A**esthetics, **M**echanics}

http://www.beam-wiki.org/wiki/Main_Page

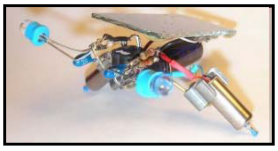
BEAM robotics basically starts from 3 philosophical tenets:

•Use minimalist electronics
This keeps complexity from "snowballing", and keeps costs down

•Recycle & reuse components out of technoscrap
This keeps things cheap, and avoids a lot of trips to parts stores; virtually all the parts required to make a BEAM robot can be found in broken electronics (ovens, walkman's, CD players, VCRs, pagers...).

•Solar power your critter if possible
While less powerful than even a small battery (and, up-front, more expensive), solar cell s last for years; solar-powered BEAMbots don't require constant battery replacements or down-time for battery recharging.

While BEAM robots are often simple (consisting of a solar cell , motor, 2 transistors , and capacitor), robots as complicated as 8-jointed, 4-legged walking spiders have been built using the principles of BEAM.



http://akapplegarth.us/uploads/images/projects/FRED/FREDFinal.jpg

ROBOTICS – Intermediate level = F.I.R.S.T.

http://encyclobeamia.solarbotics.net/articles/beam.html

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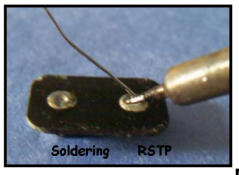
Learning to Solder

Most Electronic Projects need Soldering skills



Remember

SAFETY First

Use Eye protection

A soldering station is better for frequent use - fine tip is best - for small components

Teaching Soldering

Richard St-Pierre 2011

SAFETY	EQUIPMENT	PROCESS
Tip VERY HOT 700F = 360C	Soldering iron 25~40Watts	NOT Painting NOT Glueing Melting metals !
Safety Glasses	Stand for Iron	Heat <!>
Stand for Iron	Sponge, Glasses	Clean
Smoke/fumes	Solder (resin core)	Solder
Avoid Splashing	Side cutters	Cool
Clean Space	Solder Wick, Vice	<Cold Joints>
Power Cord-melting/loose hair!	Needle nose pliers Tweezers,	WASH HANDs

Read ALL Steps FIRST

SOLDERING STEPS

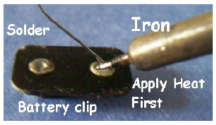
Richard St-Pierre 2011

1. Apply **Heat first** (Soldering iron =700F **!**)(Contact with metal) 5 sec
2. Apply (add) small amount of solder wire to connector. (NOT on iron)
3. KEEP Heat ON to allow solder wire to melt (flow) 2 sec
4. REMOVE Solder wire. (solder wire can get hot hold at >3" away)
5. After 2 more seconds REMOVE Heat (last)
6. Let **COOL** without moving component(s). 10 sec
7. Return Soldering Iron to its Stand

Keep practicing, good work !

☑ A good solder joint is SHINY

☒ A poor solder joint is CLOUDY



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Project List (with Approximate cost*)

- Static Force (PVC) $0.50
- ElectroScope kit $0.25
- Compass/Coil (wire) $5.00
- Simplest Motor $1.00
- Ring Flinger(wire) $20.00
- Magnet/Spool+LED $20.00
- Coin Launcher $20.00
- Jacobs Ladder (-OBT) $ 5.00
- Hold hands $ 5.00
- Wind/RPM (-PC fan) $ 5.00
- **TiM**o Ramp (ROMEO) $10.00
- **ReA**ction **T**imer $10.00
- Toothpic + LCD $5.00
- 9V battery clip board $0.25
- Battery eliminator 5V $1
- Joule Thief` $2.50
- LED 'puck' $0.10
- Piezo Generator $1.50
- Speaker (mag+wire) $2
- **E.G.G** amplifier $5
- Strobe Light $5
- Pedometer $1
- Funk Generator $5
- Magnet drop (poles) $20
- **P.E.T**. (Large LED) $25

* Assumes some "ReSciCling" materials/qty

"Low Cost Electronics for STEM" FEEDBACK RISE June 2012

(OPTIONAL INFORMATION) Occupation/Employer:_____

NAME :_____ E-mail:_____

Did you LEARN something new ? Y / N : _____

Which Part did you like BEST ?_____

Suggestion for a NEW TOPIC ?_____

Which TOPIC is of most interest ?_____

Would you like more information about a project ? _____

Which DEMO/PROJECT would you likely TRY (in class)? _____

Technical level of topics (simple) 1 2 3 4 5 6 7 8 9 10 (too much)

OVERALL Rating (circle) 1 2 3 4 5 6 7 8 9 10 (best)

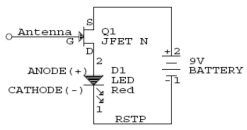
Suggestions / Comments:

_____

_____

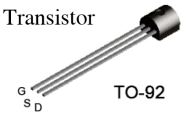
Thank You !

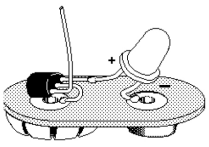
ElectroStatic Detector Project (red)

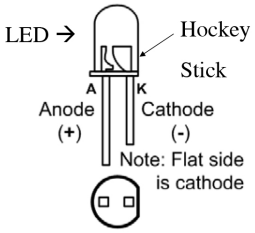


MPF102

Transistor



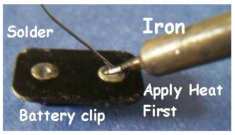




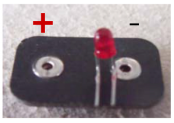
(-) (+)

Assembly Steps (red)

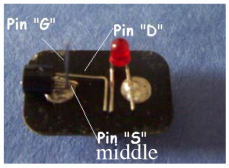
Read all steps first



- Plug **Battery Clip** on table connector
- Apply a bit of solder(heat) on Battery(-)
- Identify **LED (-)** (see Diagram on Page 1)
- **SOLDER** LED(-) to Battery Clip (-)



OK to cut wire leads shorter if needed.



- Transistor **FLAT** down
- Bend UP pin **"G"**
- Bend Under pin **"S"**
- Solder Middle pin **"S"**

- Solder Pin "D" to LED(+)
- DONE ! Great Job!
- **UNPLUG** Soldering IRON