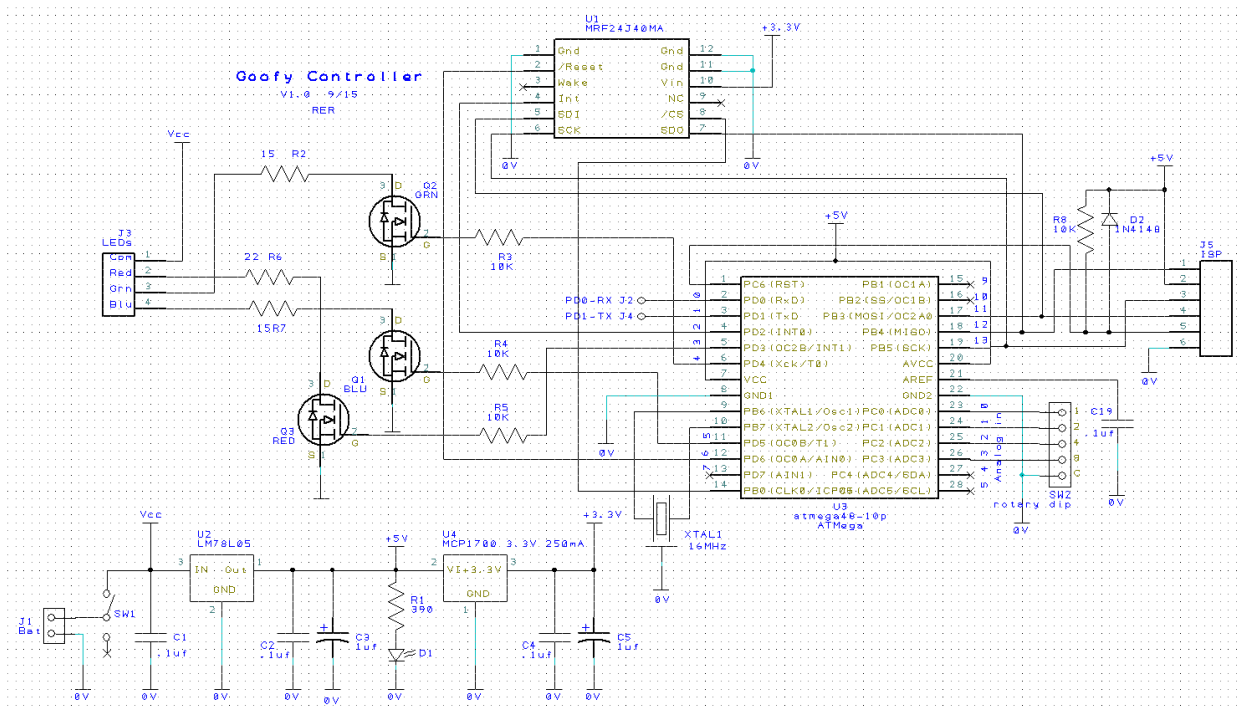
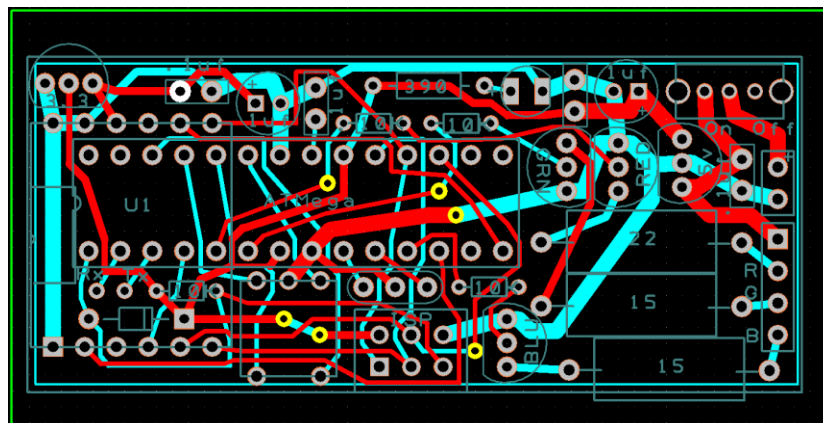


Documentation of Design

- Schematic for Circuit Board

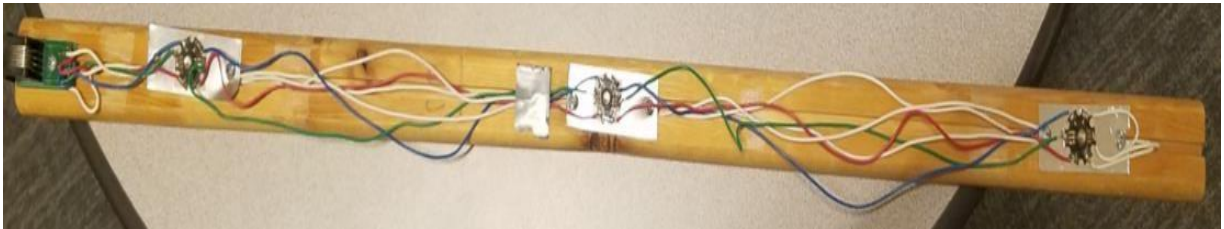


- PCB Design for Circuit



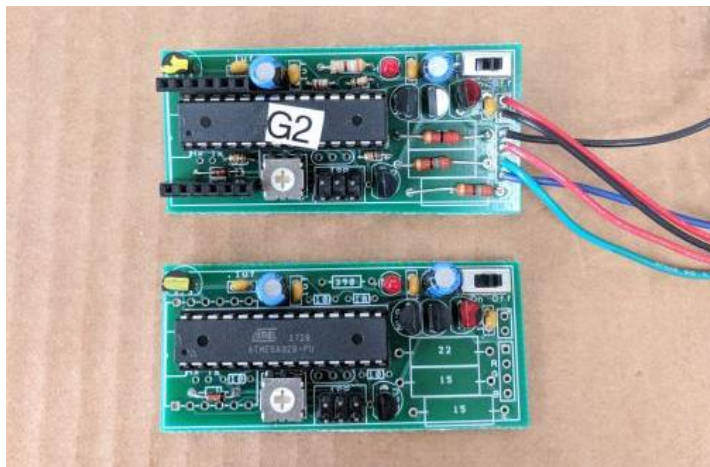
- LightBar

- Lightbar designed similar to original *Tower of Lights* one



- LED Driver Circuit

- Similar to *Goofy Glasses* circuit (top), ours (bottom)



- Towerplayer program

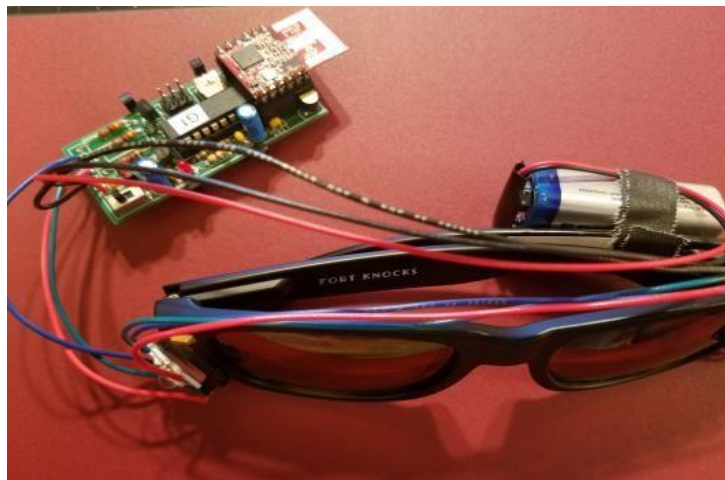
- Modified *towerarduino.ino*,
towerplayer.cpp

towerarduino

```
1 #include <SPI.h>
2
3 #include <twrlightsavr.h>
4 // #include <avr/interrupt.h>
5
6 // #include "twrlights.h"
7
8 int inByte = 0;    // for incoming serial data
9
10 // Buffer info - packet looks like $data%, where data is BUFFSZ long
11 #define STARTBYTE '$'
12 #define ENDBYTE '%'
13 #define BUFFSZ 60
14 uint8_t inbuff[BUFFSZ];
15 uint8_t gotfirst;
16 uint8_t gotlast;
17 int nbytesread;
18
19 #define TEST 1
20 // The following is 60 bytes for testing sending integrity
21 char testdata[] = "ABCDEFGHJKLMNOPQRSTUVWXYZ1234567890abcdefghijklmnopqrstuvwxyz";
22
23 // TowerLights "standard" SPI pins
24
25 #define DATAPIN 6
26 #define CLOCKPIN 7
```

- LED

- Functioning on *Goody Glasses* with 9V Battery

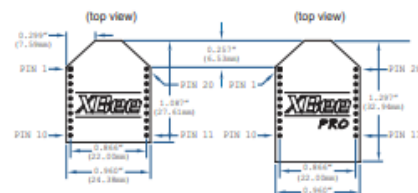
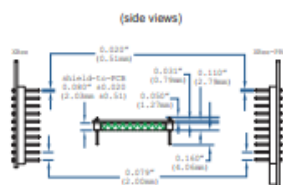
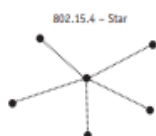


Data Sheets:

- Xbee Transmitter

Platform	XBee® 802.15.4 (Series 1)	XBee-PRO® 802.15.4 (Series 1)	XBee-PRO® XSC
Performance			
RF Data Rate	250 kbps	250 kbps	10 kbps / 9.6 kbps
Indoor/Urban Range	100 ft (30 m)	300 ft (100 m)	Up to 1200 ft (370 m)
Outdoor/RF Line-of-Sight Range	300 ft (100 m)	1 mi (1.6 km)	Up to 6 mi (9.6 km)
Transmit Power	1 mW (+0 dBm)	60 mW (+18 dBm)*	100 mW (+20 dBm)
Receiver Sensitivity (1% PER)	-92 dBm	-100 dBm	-106 dBm
Features			
Serial Data Interface	3.3V CMOS UART	3.3V CMOS UART	3.3V CMOS UART (5V Tolerant)
Configuration Method	API or AT Commands, local or over-the-air	API or AT Commands, local or over-the-air	AT Commands
Frequency Band	2.4 GHz	2.4 GHz	902 MHz to 928 MHz
Interference Immunity	DSSS (Direct Sequence Spread Spectrum)	DSSS (Direct Sequence Spread Spectrum)	FHSS (Frequency Hopping Spread Spectrum)
Serial Data Rate	1200 bps - 250 kbps	1200 bps - 250 kbps	1200 bps - 57.6 kbps
ADC Inputs	(6) 10-bit ADC inputs	(6) 10-bit ADC inputs	None
Digital I/O	8	8	None
Antenna Options	Chip, Wire Whip, U.F.L. & RPSMA	Chip, Wire Whip, U.F.L. & RPSMA	Wire Whip, U.F.L. RPSMA
Networking & Security			
Encryption	128-bit AES	128-bit AES	No
Reliable Packet Delivery	Retries/Acknowledgments	Retries/Acknowledgments	Retries/Acknowledgments
IDs and Channels	PAN ID, 64-bit IEEE MAC, 16 Channels	PAN ID, 64-bit IEEE MAC, 12 Channels	PAN ID, 32-bit Address, 7 Channels
Power Requirements			
Supply Voltage	2.8 - 3.4VDC	2.8 - 3.4VDC	3.0 - 3.6VDC
Transmit Current	45 mA @ 3.3VDC	215 mA @ 3.3VDC	265 mA typical
Receive Current	50 mA @ 3.3VDC	55 mA @ 3.3VDC	65 mA typical
Power-Down Current	<10 uA @ 25° C	<10 uA @ 25° C	45 uA pin Sleep
Regulatory Approvals			
FCC (USA)	OUR-XBEE	OUR-XBEEPRO	MCQ-XBEEEXSC
IC (Canada)	4214A-XBEE	4214A-XBEEPRO	1846A-XBEEEXSC
ETSI (Europe)	Yes	Yes* Max TX 10 mW	No
C-TICK Australia	Yes	Yes	No
Telec (Japan)	Yes	Yes*	No

* XBee-PRO 802.15.4 TX Power restricted to 10 mW in Europe and Japan.



- Atmega 328P

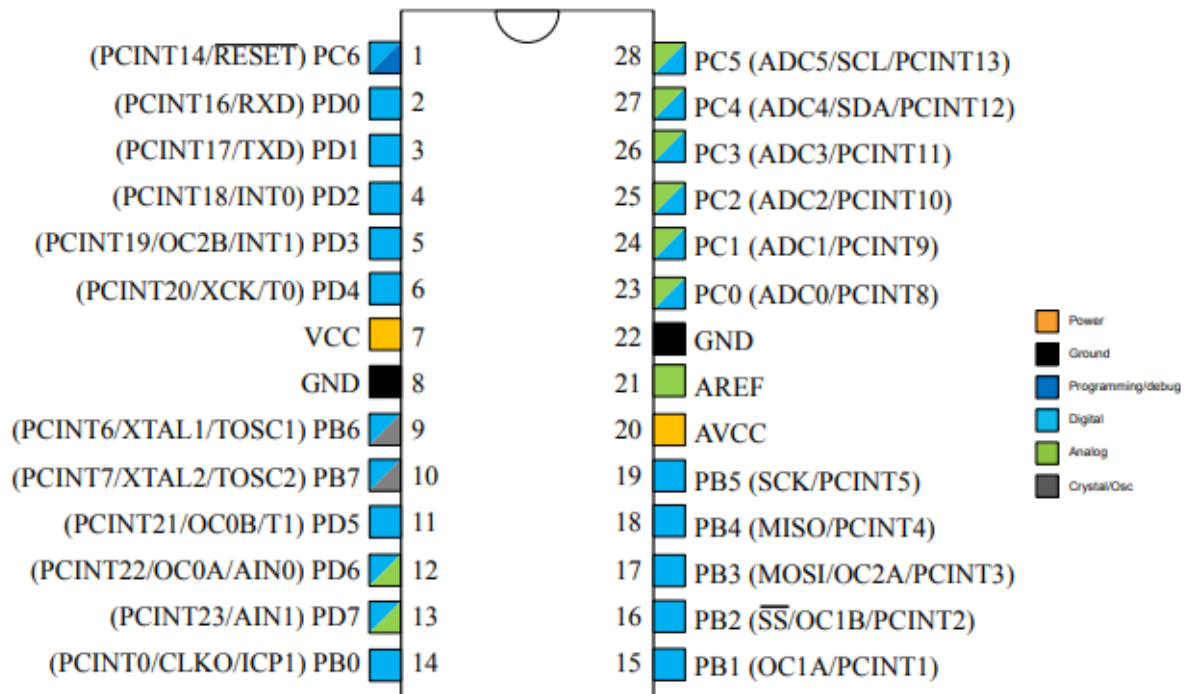
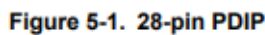
Configuration Summary

Features	ATmega328/P
Pin Count	28/32
Flash (Bytes)	32K
SRAM (Bytes)	2K
EEPROM (Bytes)	1K
Interrupt Vector Size (instruction word/vector)	1/1/2
General Purpose I/O Lines	23
SPI	2
TWI (I ² C)	1
USART	1
ADC	10-bit 15kSPS
ADC Channels	8
8-bit Timer/Counters	2
16-bit Timer/Counters	1

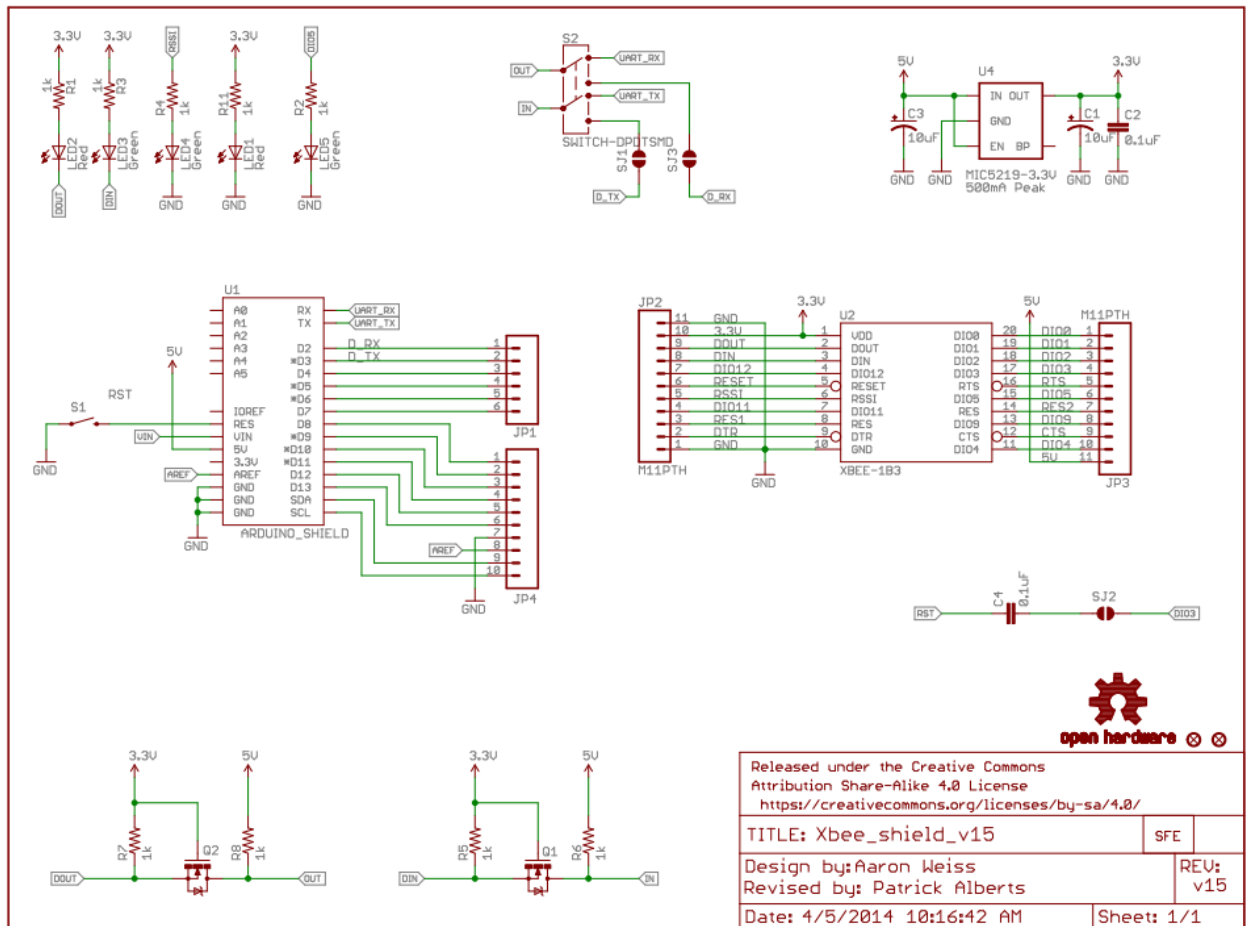
and support a real Read-While-Write Self-Programming mechanism. There is a separate Boot Loader Section, and the SPM instruction can only execute from there. In , there is no Read-While-Write support and no separate Boot Loader Section. The SPM instruction can execute from the entire Flash.

Speed [MHz] ⁽³⁾	Power Supply [V]	Ordering Code ⁽²⁾	Package ⁽¹⁾	Operational Range
20	1.8 - 5.5	ATmega328-AU ATmega328-AUR ⁽⁵⁾ ATmega328-MMH ⁽⁴⁾ ATmega328-MMHR ⁽⁴⁾⁽⁵⁾ ATmega328-MU ATmega328-MUR ⁽⁵⁾ ATmega328-PU	32A 32A 28M1 28M1 32M1-A 32M1-A 28P3	Industrial (-40°C to 85°C)

Figure 4-1. Block Diagram



- Xbee Shield



- 9V Battery

PRODUCT DATASHEET

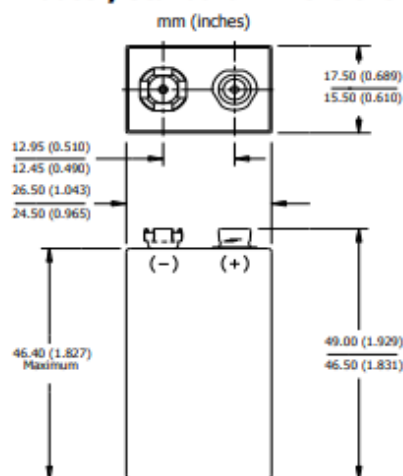
Energizer

ENERGIZER L522

Ultimate Lithium



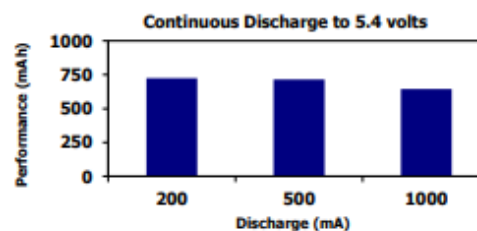
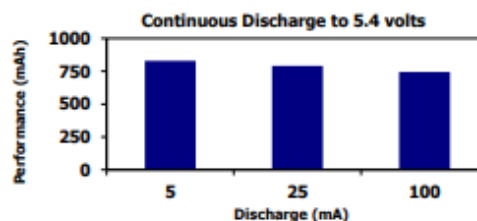
Industry Standard Dimensions



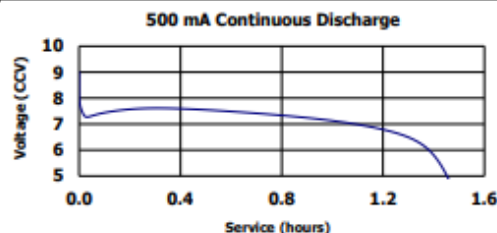
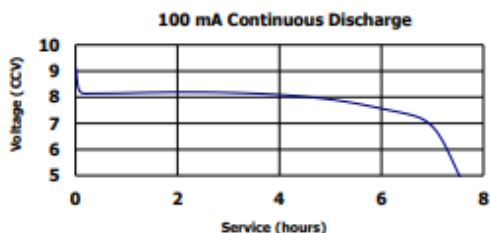
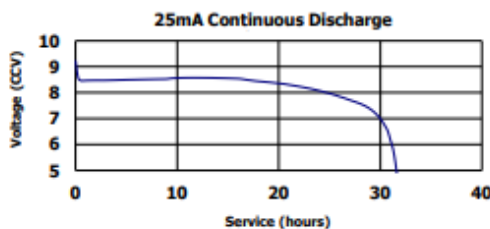
Specifications

Classification:	Lithium 9V
Chemical System:	Lithium-Manganese Dioxide (Li/MnO ₂)
Designation:	ANSI-1604LC
Nominal Voltage:	9.0 volts
Operating Temp:	-40°C to 60°C (-40°F to 140°F)
Storage Temp:	-40°C to 60°C (-40°F to 140°F)
Max Discharge :	1000 mA continuous
Safety Features:	Positive Temperature Coefficient Switch (PTC) Burst Proof Venting Holes
Typical Weight:	33.9 grams (1.2 oz.)
Typical Volume:	21.4 cubic centimeters (1.3 cubic inch)
Jacket:	Plastic Label
Terminal:	Miniature Snap
Shelf Life:	10 Years
Typical Li Content:	1.35 grams (0.048 oz.)

Milliamp-Hours Performance (21°C)



Typical Discharge Performance (21°C)



Important Notice

This datasheet contains typical information specific to products manufactured at the time of its publication.
Contents herein do not constitute a warranty and are for reference only.