

OFFICIAL PUBLICATION

TR-500

TECHNICAL REFERENCE

MULTI-WEAPON SIMULATION SYSTEM (MWSS)

MilesTag™

Electronic Tactical Infrared Combat Systems

Revision 08

Firmware Version 5.20 build 10

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CHANGE NOTES

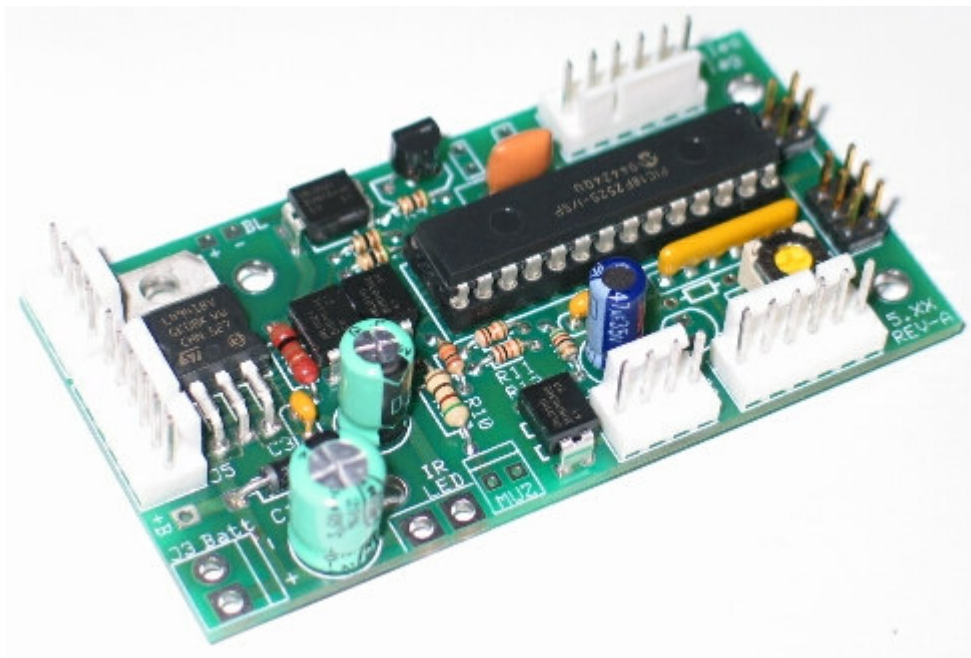
- 14 Mar 06 Changed part number: Main Board, .156 Locking Header, 2-pin
Old part = Molex KK, .156 (Mouser Part # 538-26-61-4020)
New part = Amp MTA, .156 (Mouser Part # 571-6412082)
- 17 Mar 06 Changed part number: Main Board, U1, Microcontroller (CPU)
New part = PIC18F2525-I/P (Digikey Part # PIC18F2525-I/SP-ND)
(Not currently stocked by Mouser)
- 17 Mar 06 Note: A lot of supplier part numbers have been changing over the last few months/weeks,
apparently due to the RoHS compliance efforts. Occasionally parts are discontinued and
substitute parts must be found. We will try to keep the parts list as current as possible, but
you may find that a part number shown is obsolete. Be sure to check the manufacturer's
datasheet before using a cross-referenced part number.
- 24 May 06 Updated some obsolete part numbers and pricing.
Fixed minor typographical errors.
Added part substitution info to the Parts List and Circuit Description (*pg 18, 19*).
- 21 Jun 06 Added schematics and parts layout for 5.XX Main Board Rev-B.
Note: The new Main Boards (Rev-B) and ISD Boards will be manufactured using a lead-
free process (RoHS compliant).

READ THIS FIRST

The MilesTag™ infrared gaming system is one of the most advanced do-it-yourself electronic projects you will find. But it is probably not an ideal project for anyone just getting started in electronics. Before attempting to build this system, you should already have a good understanding of electronics theory, circuit assembly and digital circuit troubleshooting. You should also have good printed-circuit soldering skills as well as the required soldering equipment and tools. It is beyond the scope of this manual to cover these subjects in detail. We have attempted to provide as much information as possible for you to successfully build and operate your own MilesTag system, but there are no step-by-step assembly instructions provided. If you are new to electronics, you may want to get some practice first by building a few small electronic kits like those available from Ramsey Electronics or Jameco Electronics. It is also very helpful if you become familiar with the Microchip (www.microchip.com) PIC series of FLASH reprogrammable microcontrollers and related programming procedures. We will provide occasional firmware updates via the MilesTag web site that require the use of a PIC programmer or a Boot Loader.

CAUTION! Many of the electronic components used in the MilesTag system are “static-sensitive” and require appropriate electrostatic discharge (ESD) handling precautions (grounded wrist straps, ant-static packaging, ESD-safe soldering iron, etc.). These components are easily damaged or destroyed by improper handling, storage or soldering techniques. Refer to the manufacturer’s datasheets or other documentation for specific handling and storage requirements for each component. You can also do an internet search for general information on ESD procedures and precautions.

PARTS LISTS: We have provided detailed parts lists for most of the board-mounted components. In some cases a recommended supplier and part number is also shown. Estimated pricing is included for **reference only** as this can change frequently. Some components can be substituted for a similar device, but you should check the data sheet to ensure proper physical size and specifications. Depending on the supplier, there may be a minimum order requirement and some individual components must be ordered in quantities of 10 or more.



WARRANTY INFORMATION

No warranty or guarantee exists beyond that provided with the product at the time of purchase. In most cases this warranty will only cover defects in materials and workmanship of the purchased item for a limited period of time. Any system or component failures due to physical abuse (intentional or accidental), improper use/connection, improper handling, improper soldering techniques, damaged/bent component pins, etc. are not covered. Determination of the cause of failure is at the sole discretion of the seller. All repair- or replacement-related shipping costs, including insurance, are the responsibility of the buyer. Non-warranty items, and partially assembled kits returned for testing or repair may be subject to labor fees of \$40/hr. This is in addition to the cost of any parts required. Repair fees will be pre-approved by the buyer before any repairs are performed. Items covered by warranty may be repaired or replaced at the discretion of the seller. If you have questions, please contact us.

TECHNICAL SUPPORT

Please feel free to email us if you have problems, questions, comments or suggestions. However, our ability to provide technical assistance via email is very limited. Please be patient as we cannot answer all requests for support immediately. Priority is given to individuals who have purchased pre-assembled modules.

We can not provide technical support or troubleshooting assistance related to the PicBasic Pro compiler or any specific PIC programming devices and related software (including the Tiny Bootloader). Please contact the manufacturers or authors directly. Some PicBasic Pro assistance may be found here:

<http://www.picbasic.co.uk/forum/>

For the fastest technical assistance on the MilesTag system, please post your questions and/or comments on the MilesTag sub-forum at **Laserforums**.

<http://www.laserforums.com>

CONTACT INFORMATION

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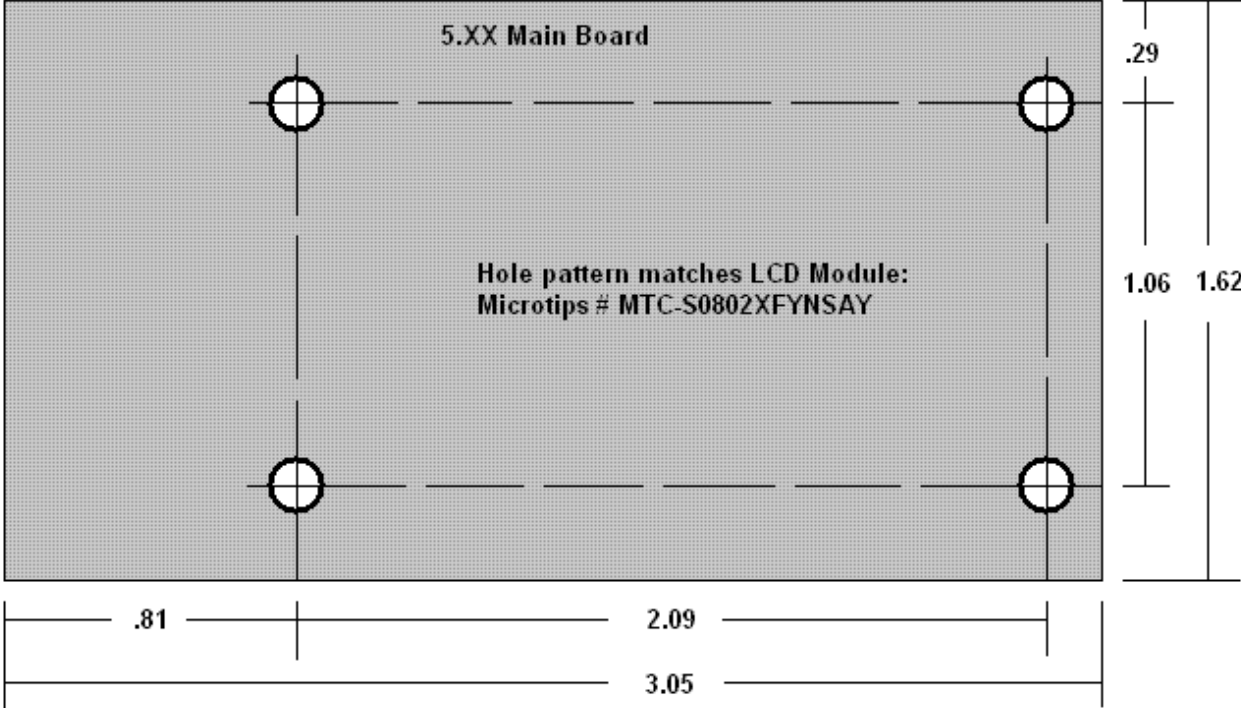
Email: milestag@lasertagparts.com

Website: <http://www.lasertagparts.com>

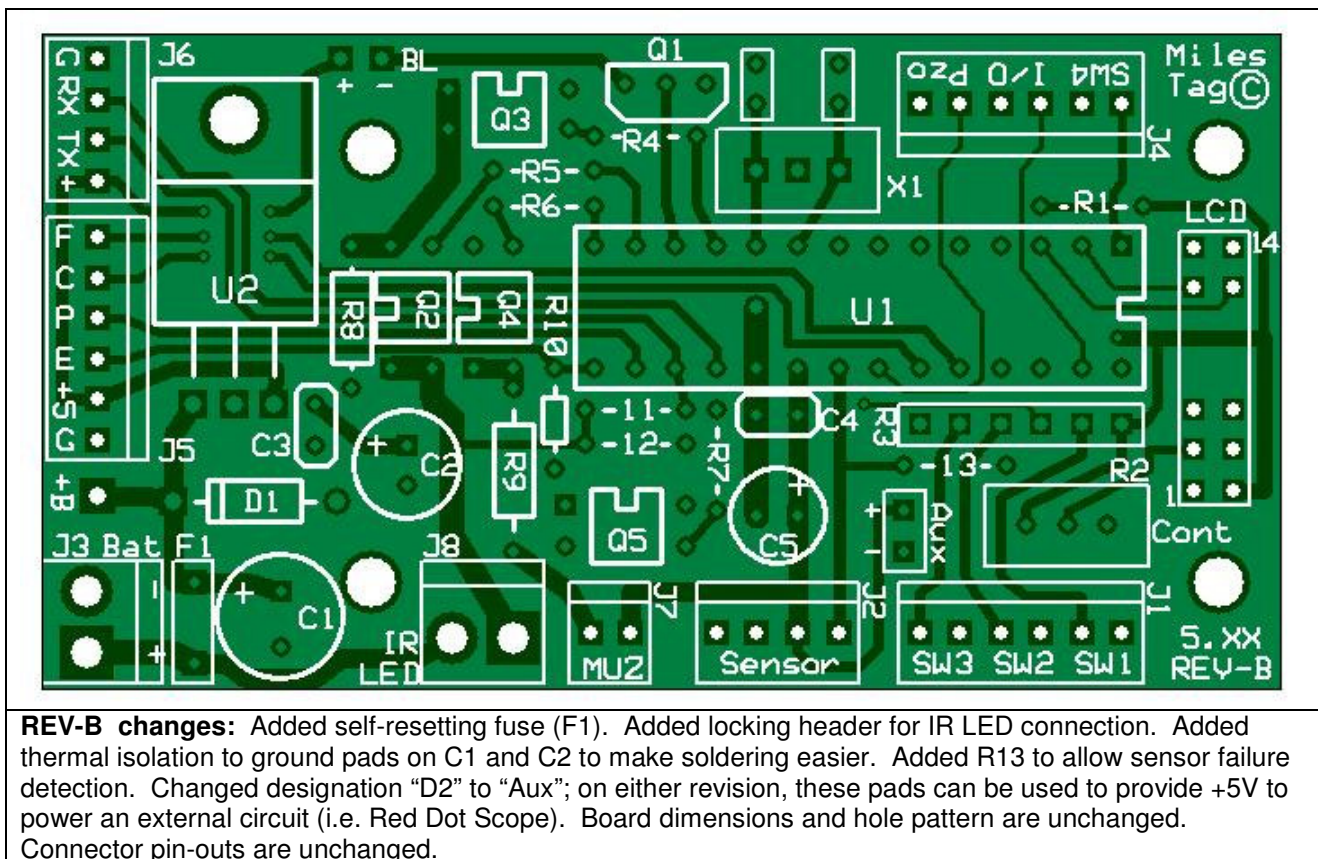
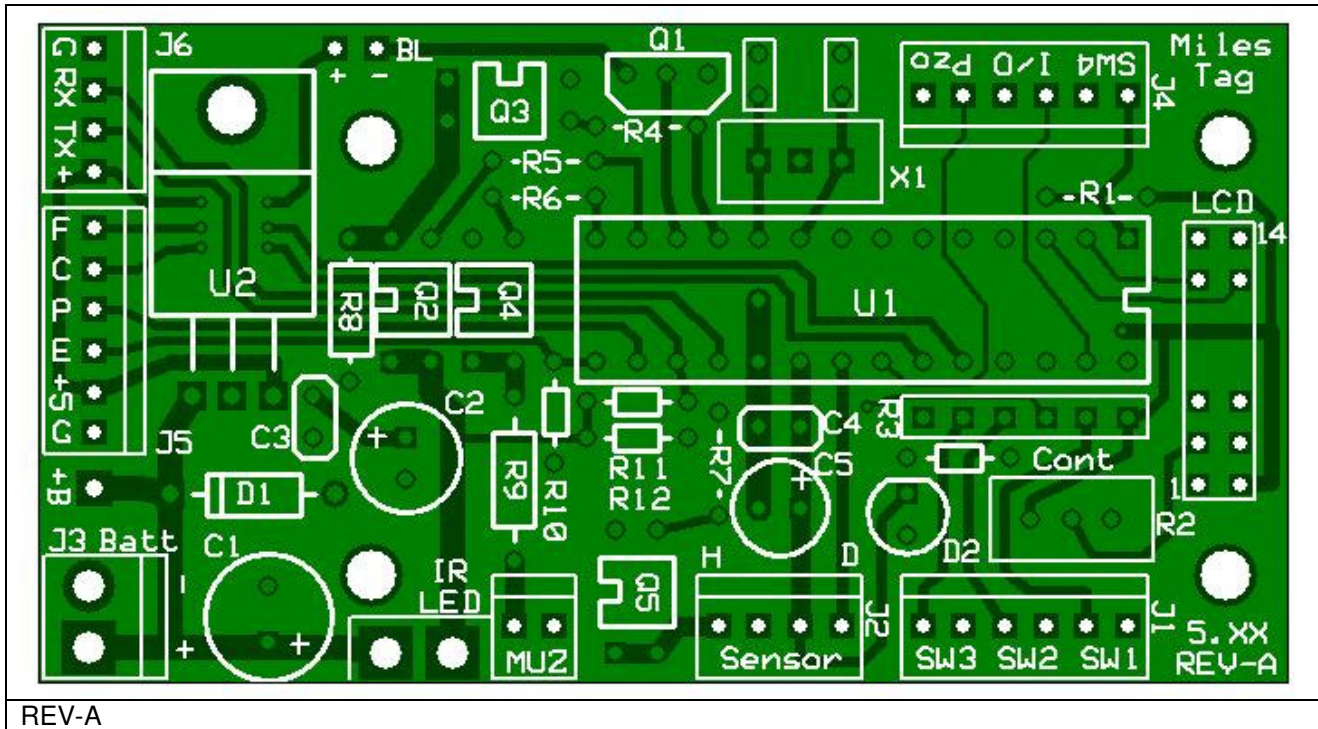
Main Board Interface Reference

Connector	Pin	ID	Function	uC	Notes
J1	1	SW1	Ground		
	2		Digital Input/Output	RB7	10K pull up
	3	SW2	Ground		
	4		Digital Input/Output	RB5	10K pull up
	5	SW3	Ground		
	6		Digital Input/Output	RB4	10K pull up
J2	1	D	Digital Input/Output	RB0	Sensor Data, INT0
	2		+5V Power Output		
	3		Ground		
	4	H	Output, FET drive (active low)	(RB6)	Hit LED, 500mA
J3	1	+	Power Input, Battery Positive		+7.2V
	2	-	Power Input, Battery Negative		Ground
J4	1	Pzo	Ground		
	2		Digital Input/Output	RB1	Piezo, INT1
	3	I/O	Ground		
	4		Digital Input/Output	RB6	Used by Hit LED
	5	SW4	Ground		
	6		Digital Input (active low)	RE3	5.1K pull up
J5	1	+	+5V Power Output		
	2	TX	Digital Input/Output, Hardware USART	RC6	USART TX
	3	RX	Digital Input/Output, Hardware USART	RC7	USART RX
	4	G	Ground		
J6	1	G	Ground		
	2	+5	+5V Power Output		
	3	E	Digital Input/Output	RC3	ISD EOM
	4	P	Digital Input/Output	RC4	ISD PD
	5	C	Digital Input/Output	RB2	ISD CE
	6	F	Digital Input/Output	RB3	ISD FF
MUZ	1		+5V Power Output		
	2		Output, FET Drive (active low)	(RC3)	Muz LED, 100mA
IR LED	1		Output, FET Drive (active low)	(RC2)	IR LED, 2.5 A
	2		+7.2V Power Output		
BL	1	+	+5V Power Output		
	2	-	Output, FET Drive (active low)	(RC1)	Backlight, 150mA
LCD	1		Ground		
	2		+5V Power Output		
	3		0 to +5V Output (from R2 trimmer)		
	4		Digital Input/Output	RA5	LCD RS
	5		Ground		
	6		Digital Input/Output	RA4	LCD EN
	11		Digital Input/Output	RA0	LCD DB4
	12		Digital Input/Output	RA1	LCD DB5
	13		Digital Input/Output	RA2	LCD DB6
	14		Digital Input/Output	RA3	LCD DB7

MAIN BOARD DIMENSIONS & HOLE PATTERN



MAIN BOARD PARTS LAYOUT



MAIN BOARD PARTS LIST

Part ID	Description	Mouser Part #	Price	Part Substitutions
U1	PIC18F2525 microcontroller	PIC18F2525-I/SP	6.11	None
(U1)	28-pin SDIP IC socket, machine pin	575-199328	1.09	Any 28-pin IC socket, .3" wide
U2	LM4941, 5V Low Dropout Regulator	511-L4941BV	.77	*LM7805
F1	Self Resetting Fuse, 1.85A	650-RUE185	.66	
R1	Resistor, 5.1K ohm, 1/8W	299-5.1K-RC	.08	**Any close value (i.e. 4.7K ohm)
R2	Potentiometer, trimmer, 20K ohm	652-3296W-1-203LF	2.20	**Any close value (i.e. 25K ohm)
R3	Resistor, SIP, 10K ohm	652-4606X-1LF-10K	.19	†Any 10K ohm, 6-pin SIP
R4, 5, 6, 7	Resistor, 51 ohm, 1/8W	299-51-RC	.08	**Any close value (i.e. 56 ohm)
R8	Resistor, 100 ohm, 1W	594-5073NW100R0J	.16	**Any close value
R9	Resistor, 33 ohm, 1/4W	291-33-RC	.07	**Any 33 ohm resistor, 1/4 W
R10, 11, 12	Resistor, 10K ohm, 1/8W	299-10K-RC	.08	**Any 10K ohm resistor, 1/8 W
R13	Resistor, 200K ohm, 1/8W	299-200K-RC	.08	**Any 200K ohm resistor, 1/8 W
C1	††Capacitor, Electrolytic, 220uF, 25V	140-XRL25V220-RC	.12	220uF to 330uF, 16V to 35V
C2	††Capacitor, Electrolytic, 100uF, 16V	140-XRL25V100-RC	.09	47uF to 100uF, 10V to 25V
C5	††Capacitor, Electrolytic, 47uF, 10V	140-XRL16V47-RC	.06	22uF to 47uF, 10V to 25V
X1	Resonator, 8Mhz, 3-pin	520-ZTT800MT	.40	**Any 8MHz res w/ built-in caps
Q1	2N7000	512-2N7000	.13	Any 2N7000 transistor
Digikey Part #				
Q2, 3	FET, 4-pin DIP, 2.5A	IRLD024PBF-ND	1.23	None
Q4, 5	FET, 4-pin DIP, 1A	IRLD110PBF-ND	.94	None
D1	Diode, 1N4001	1N4001DICT-ND	.26	Any 1N4001 diode
D2	<i>no component</i>			
C3, 4	††Capacitor, Ceramic, 0.1uF, 25V	399-4151-ND	.16	Any 0.1uF capacitor

* +5V regulator, TO-220 case (system must use 8.4V or 9.6V battery with 7805 regulator).

** Ensure correct lead spacing/hole pattern.

† Must have single common pin.

†† Okay to use higher voltage rating. Ensure correct lead spacing and size.

‡ Estimated Price.

ADDITIONAL 5.XX PARTS (REFERENCE)

Part ID	Description	Mouser Part #	Price	Part Substitutions
LCD	LCD, 8x2 Characters, w/ backlight	668-C-S0802XFYNSAY	8.93	Any HD44780 compatible LCD
IR LED	Infrared LED, 20 degree beam	782-TSAL6100	.16	Any IR LED, 940nm
Muzzle LED	Ultra-bright LED, Yellow	78-TLHE5800	.18	Any ultra-bright LED
Piezo	Piezo buzzer, 5VDC, continuous	256-PB113A	2.77	Any continuous tone Piezo
IR resistor	15 ohms, 1W	594-5073NW15R00J	.16	‡ Any 5.1 ohm to 15 ohm resistor
LED Bezel	Bezel, 5mm, black	351-1000	1.10	optional
PCB headers	(7 each) friction-lock headers	(see wiring info)		
Mating connectors	Molex KK, connector housings and terminals	(see wiring info)		
Trigger Button	SPST, momentary, normally open		1.00	
Reload Button	SPST, momentary, normally open		1.00	
Mode Button	SPST, momentary, normally open		1.00	
Key Switch	SPST or SPDT, key operated		5.00	
Charging Jack	DC power jack, 2.5mm, switched	163-4305	1.44	optional
Battery Pack	7.2VDC, NiMH, 2000mAH	RC Car or Airsoft battery	20.00	NiMH or NiCad, ≥1500mAH
Misc	Battery charger, gun casing, lens assembly, wire, solder.			

Highlighted items are **included** with the **5XX-MOD** (pre-assembled 5.XX Main Board).

‡ IR resistor value is determined by the desired IR LED current. Just use "Ohm's Law":

$$(\text{Battery Voltage} - 2) / \text{Current} = \text{Resistor Value}$$

750 mA:

$$(7.2 - 2) / .750 = 6.8 \text{ ohms}$$

1.0 Amp:

$$(7.2 - 2) / 1.0 = 5.1 \text{ ohms}$$

etc

MAIN BOARD ASSEMBLY NOTES

Caution: Electrostatic discharge (ESD) can destroy some components. Use ESD precautions.

Caution: Only use a soldering iron and tip designed for PC board work. Use small gauge (.031) solder.

Caution: Voltage regulator's case (TO-220) MUST be insulated from the PC board (see diagram).

Recommended Assembly Sequence

Resistors (R1, R4–R12)

1N4001 (D1)

FETs (Q2–Q5)

Regulator (U2)

Ceramic Capacitors (C3, C4)

28-Pin Socket

SIP Resistor (R3)

Resonator (X1)

2N7000 (Q1)

Trim Pot (R2)

Capacitors (C1, C2, C5)

Headers (J1–J6, MUZ)

Observe orientation !!!

Observe orientation.

Bend TO-220 leads carefully, insulate case from PC Board

Observe orientation, do not install processor yet.

Observe orientation (dot near uC pin 28).

Observe orientation.

Observe polarity.

After soldering, carefully clean the solder side of the PC board with an acid brush and electronic flux remover or isopropyl alcohol.

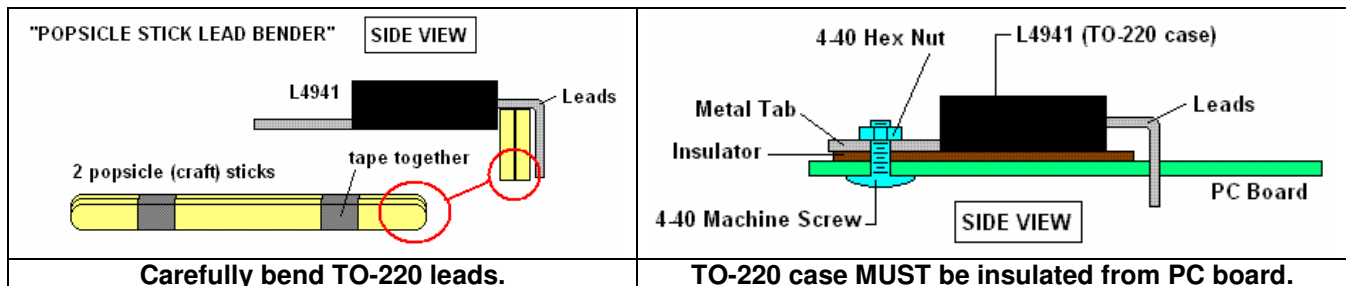
BEFORE APPLYING POWER, carefully inspect the board with a magnifier. Check for solder bridges, excessive solder, cracks in solder, dull solder appearance. Rework any bad solder joints as necessary.

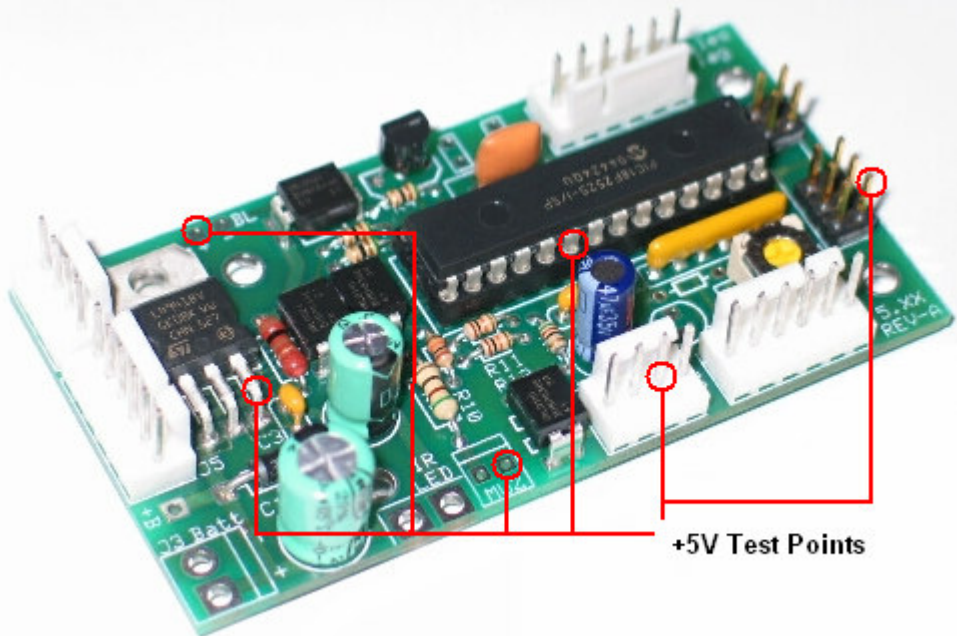
Perform voltage checks with a meter BEFORE installing the 18F2525 processor.

CAUTION: Be careful not to damage any pins when installing the 18F2525. Also observe the orientation carefully. Damage from bent pins is not covered under warranty.

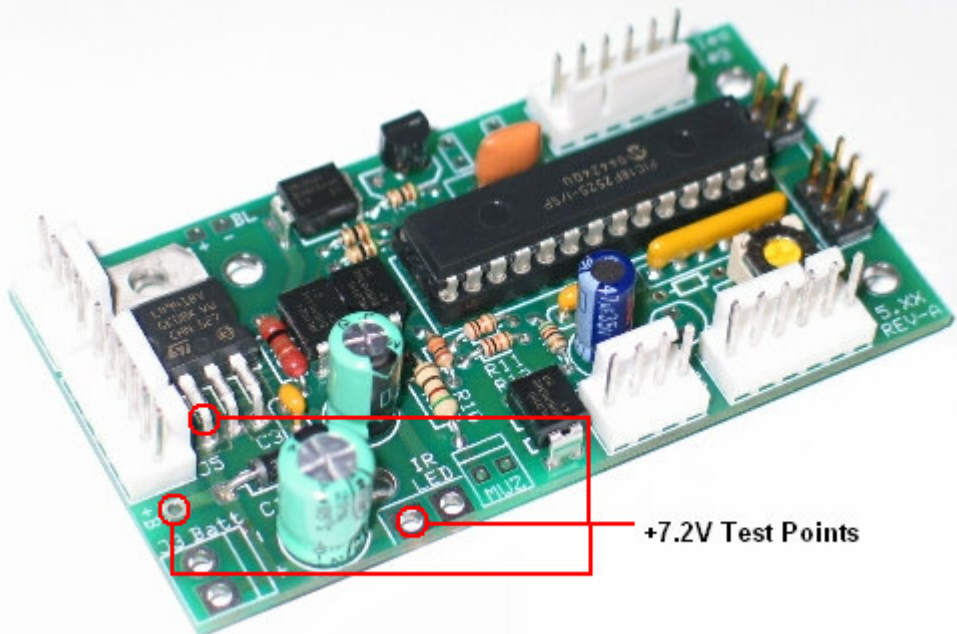
Take your time and check your work carefully. If the Main Board is assembled correctly it WILL WORK.

Refer to the Troubleshooting section in the 5.XX Operations Guide.



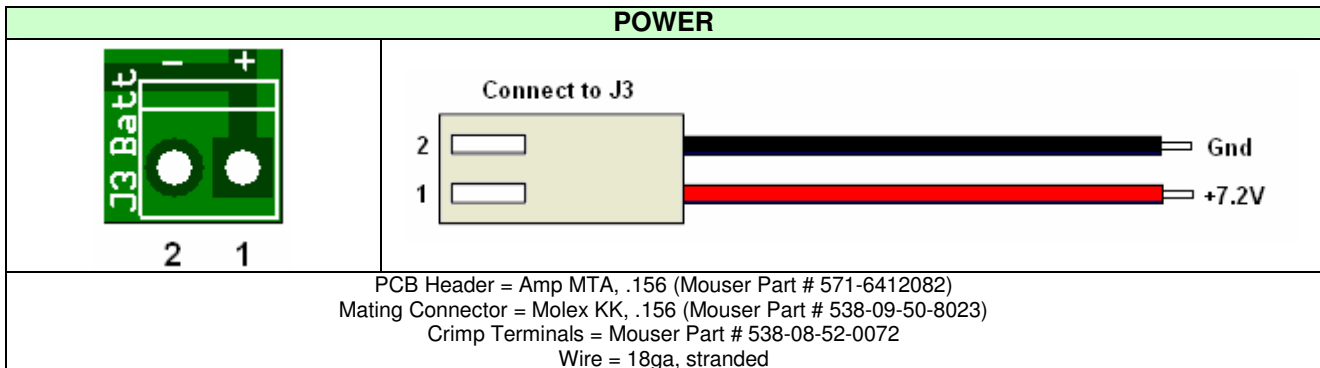
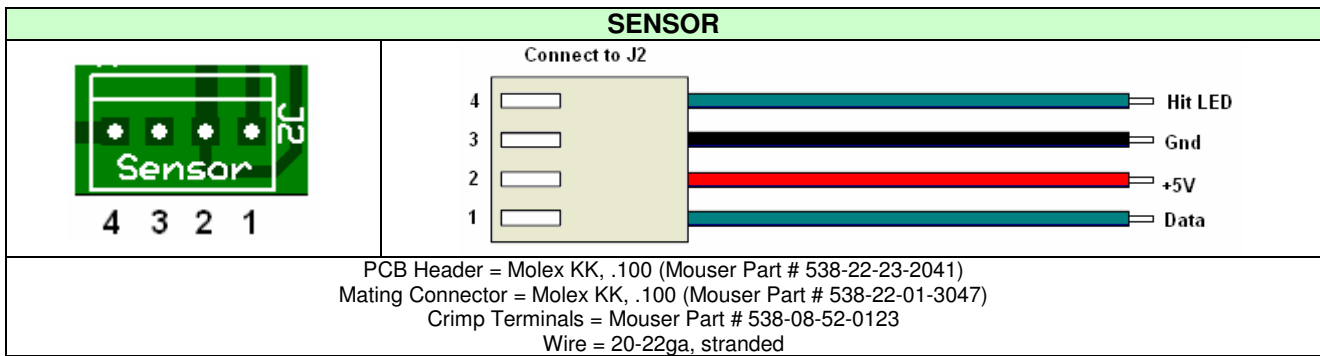
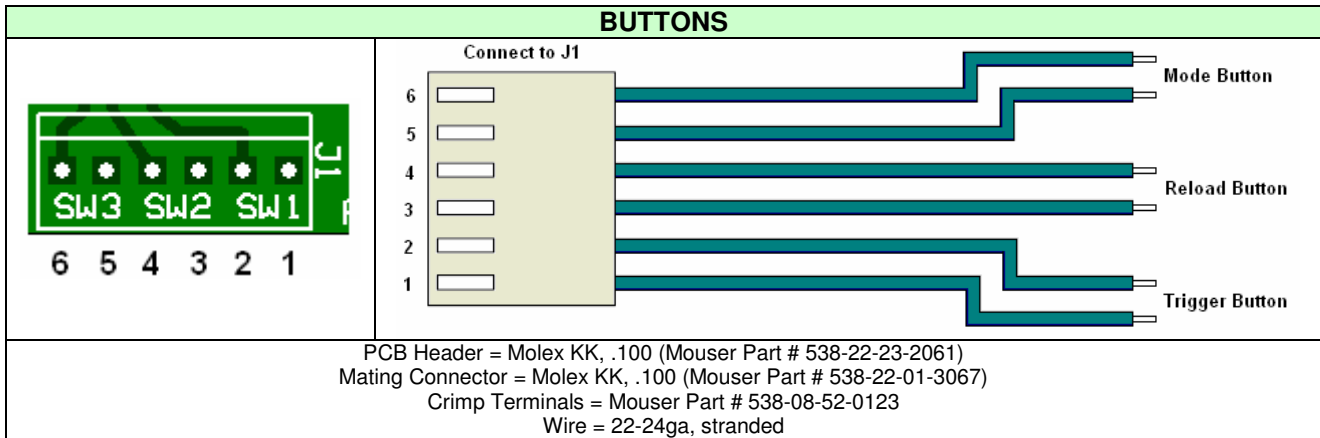


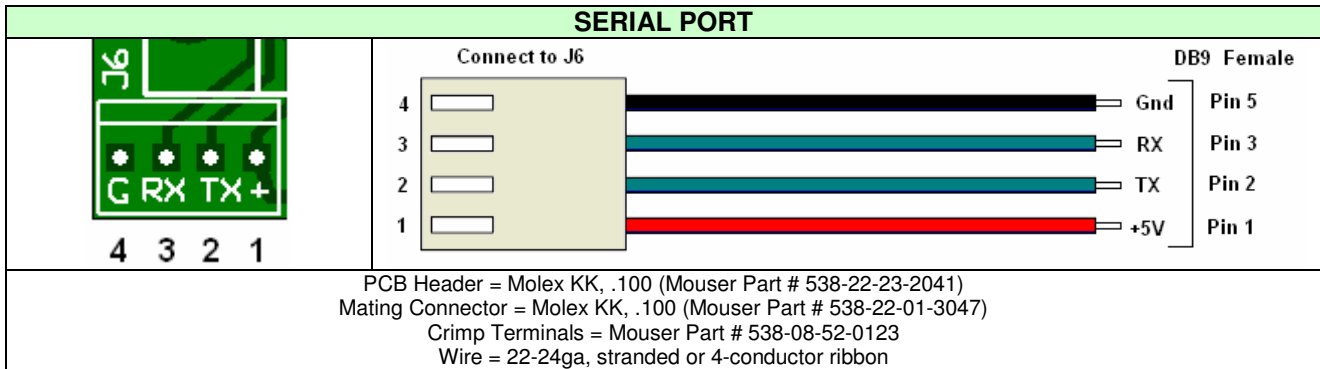
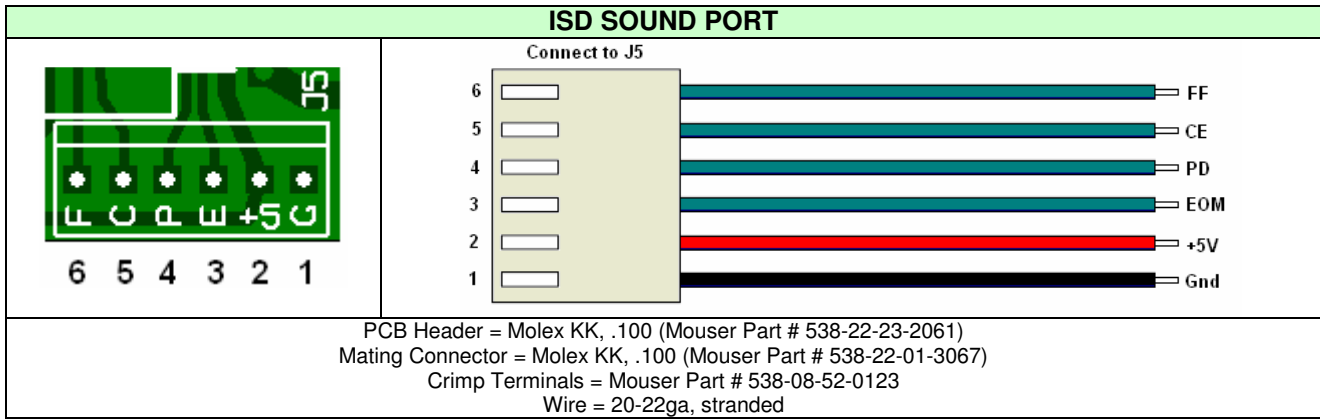
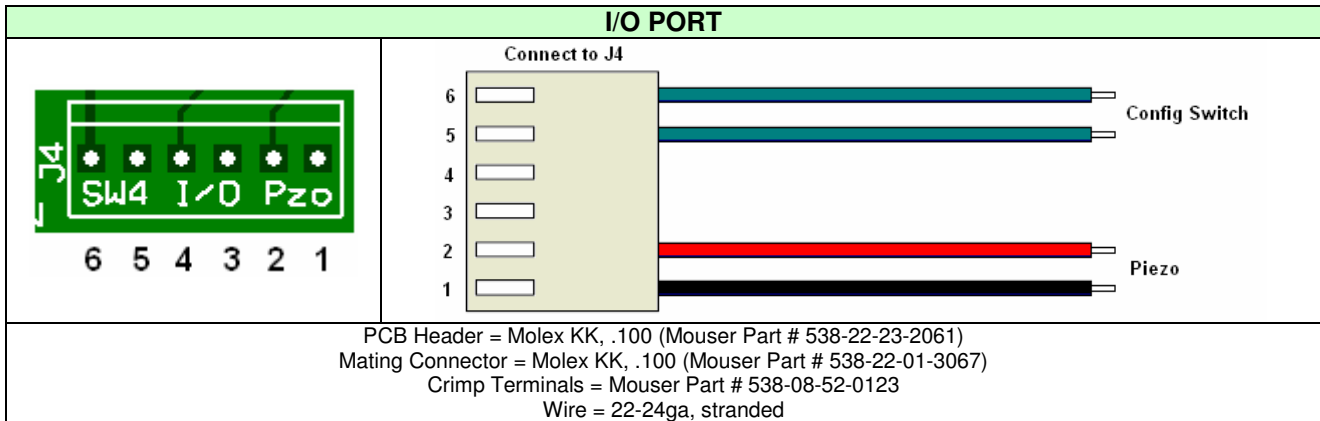
Test points for regulated +5V from the L4941. Perform initial voltage tests prior to installing the 18F2525 processor. This helps prevent damage to the processor in case of a problem. (Some connectors have not been installed in this photo.)



Test points for unregulated 7.2V (or Battery Voltage).

MAIN BOARD WIRING CONNECTIONS



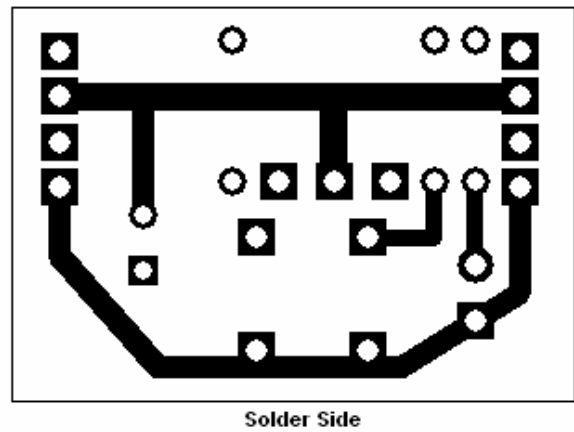
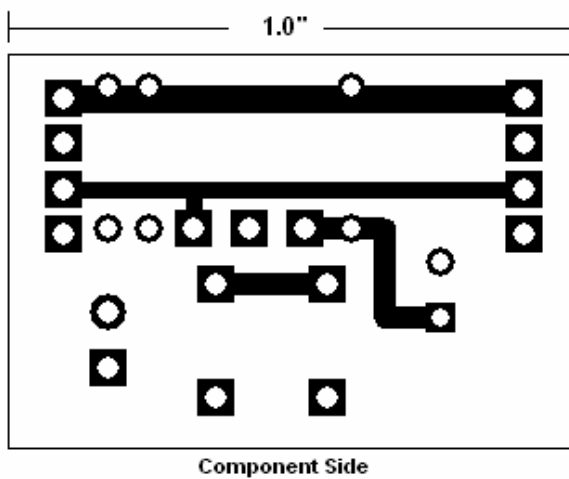
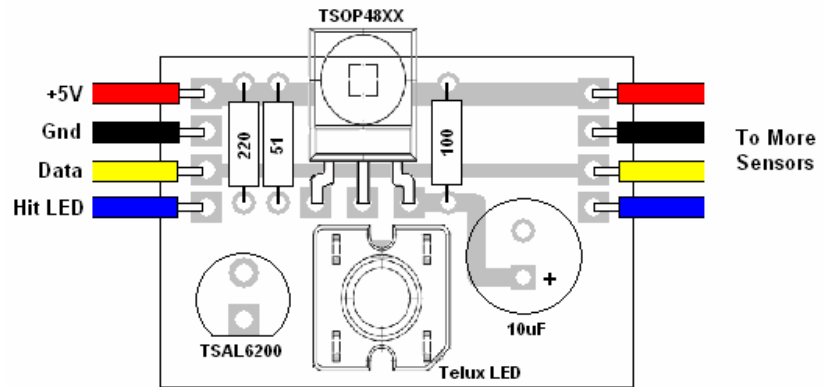
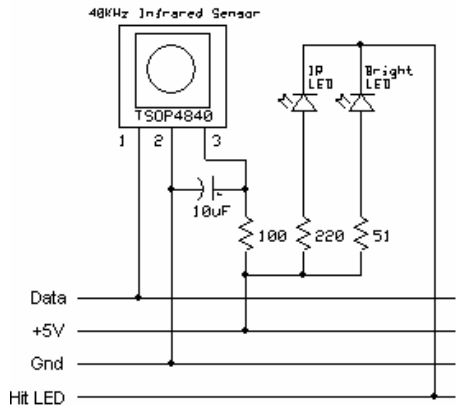


LCD DISPLAY	
<p>PCB Header = 2x2, .100 and 2x3, .100 Mating Connector = IDC 2x7, .100 (Mouser Part # 649-71600-314) Wire = 14-conductor ribbon cable, .05 pitch</p>	

MUZ (MUZZLE FLASH LED)	
<p>PCB Header = Molex KK, .100 (Mouser Part # 538-22-23-2021) Mating Connector = Molex KK, .100 (Mouser Part # 538-22-01-3027) Crimp Terminals = Mouser Part # 538-08-52-0123 Wire = 20-22ga, stranded</p>	

Wiring Connections (These wires must be soldered)	

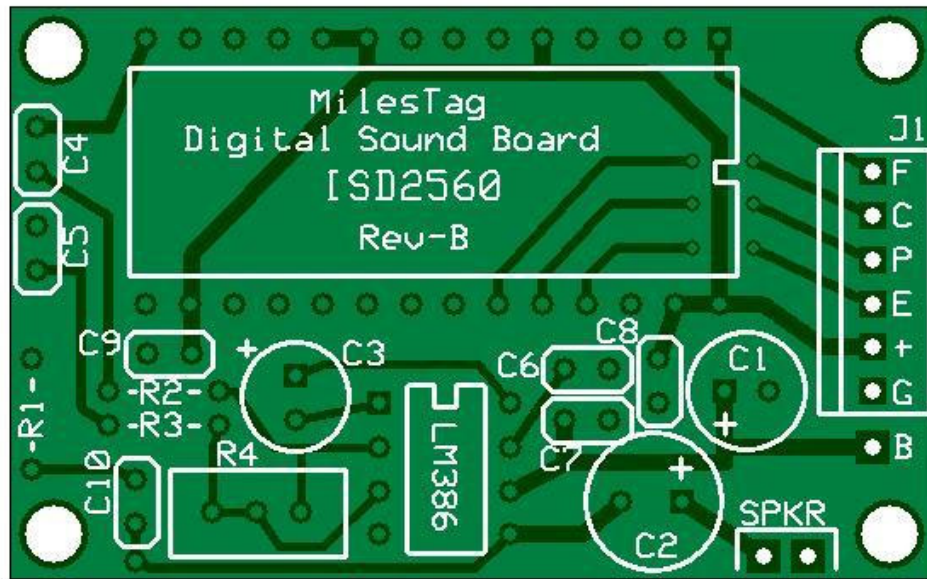
HEAD SENSOR - NEW DESIGN (Recommend using a minimum of 3 sensors on a headband or hat.)



PARTS LIST

Quantity	Description	Mouser Part #	Est. Price
1	TSOP4840, Vishay 40KHz IR Receiver	782-TSOP4840	1.08
1	Resistor, 220, 1/8W, 5%	299-220-RC	.08
1	Resistor, 51, 1/8W, 5%	299-51-RC	.08
1	Resistor, 100, 1/8W, 5%	299-100-RC	.08
1	LED, infrared emitter, high-power	782-TSAL6400	.21
1	LED, TELUX, red non-diffused, super bright	78-TLWR7900	.29
1	Capacitor, 10uF, electrolytic	140-XRL16V10	.06

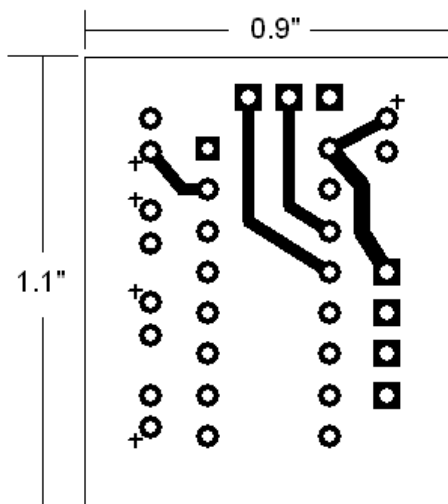
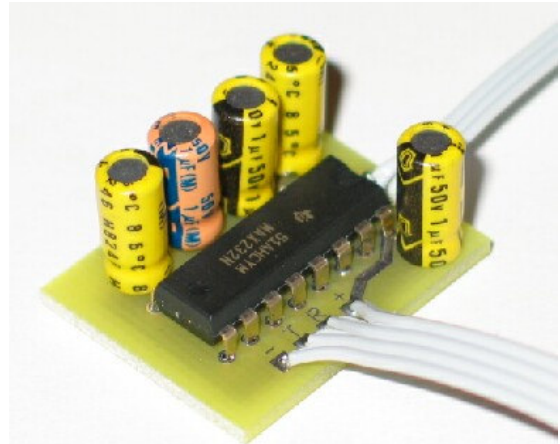
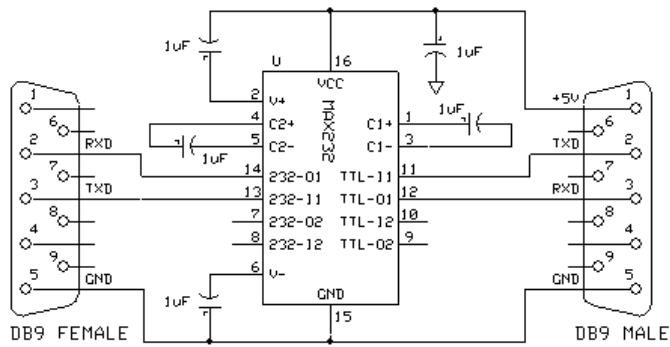
ISD SOUND BOARD



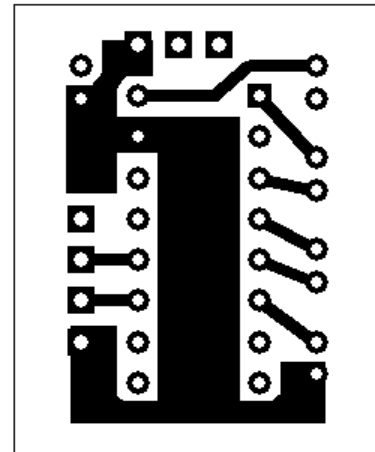
SOUND BOARD PARTS LIST

Part ID	Description	Digikey Part #	Price	Part Substitutions
U1	ISD2560, Recordable Sound IC	ISD2560PY-ND	11.98	None
C4,5,6,7,8,9	Capacitor, Ceramic, 0.1uF	399-4151-ND	.16	Any .1uF ceramic cap
		Mouser Part #		
(U1)	Socket, 28-pin, .6 width	575-199628	.62	Similar socket, or ZIF socket
U2	LM386, Audio Amplifier	513-NJM386BD	.45	Any LM386 variant
J1	Locking Header, 6 pins	538-22-23-2061	.60	Similar connector
R1	Resistor, 10 ohm, 1/8 Watt, 5%	299-10-RC	.08	
R2, R3	Resistor, 680K, 1/8 Watt, 5%	299-680K-RC	.08	
C3	Capacitor, 10 uF, electrolytic	140-XRL16V10	.06	Close value
C1	Capacitor, 100 uF, electrolytic	140-XRL25V100	.12	Close value
C2	Capacitor, 220 uF, electrolytic	140-XRL25V220	.12	Close value
C10	Capacitor, .047 uF, ceramic	75-1C10X7R473K050B	.19	Close value
R4	Potentiometer, trimmer, 100K	652-3296W-1-104	2.20	

PC SERIAL INTERFACE (for boot loader)



Printed Circuit Artwork (Component Side)

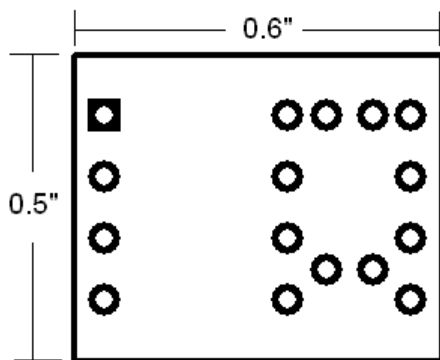
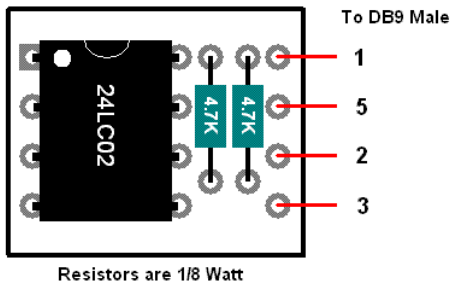
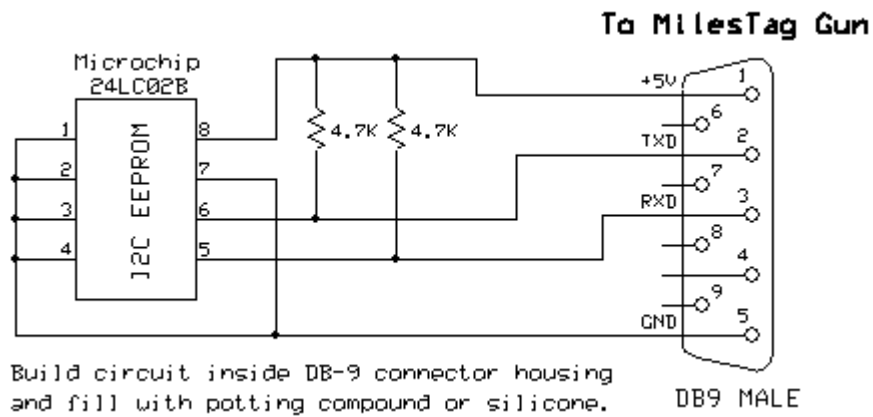


Printed Circuit Artwork (Solder Side)

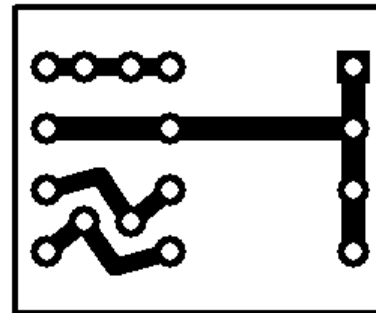
Note: This circuit can be constructed using perf board, vector board or a similar method.

PARTS LIST			
Quantity	Description	Mouser Part #	Est. Price
1	MAX232 Serial Interface Chip, 16-pin DIP	595-MAX232N	.95
5	Capacitor, 1uF, electrolytic	75-515D50V1.0	.12
1	DB9 Connector, Male, solder cup	156-1209	.61
1	DB9 Connector, Female, solder cup	156-1309	.66

I2C SECURITY KEY (can also function as Player Data Storage Device)



Printed Circuit Artwork (Component Side)



Printed Circuit Artwork (Solder Side)

PARTS LIST			
Quantity	Description	Mouser Part #	Est. Price
1	Microchip Serial EEPROM, 2K (256 x 8), 8-pin DIP	579-24LC02B-I/P	.45
2	Resistor, 4.7K, 1/8W, 5%	299-4.7K-RC	.08
1	DB9 Connector, Male, solder cup	156-1209	.61
1	DB9 Housing, black plastic	156-2010	.65

SCHEMATICS

Circuit Description – Main Board

U1 - Microchip PIC18F2525 microcontroller. Also referred to as a "PIC micro", or "PIC". This is the "brains" of the MilesTag system. The MilesTag firmware is programmed into the PIC's EEPROM program space and the program is executed at 2 million instructions per second (8MHz oscillator). [SUB PART: NONE](#)

U2 - LM4941 voltage regulator. It regulates the input battery voltage (7.2V to 12V) to provide +5V to the rest of the circuit. It is a "Low-Dropout" or "LDO" regulator so it can provide a stable 5V output at lower input battery voltages than standard regulators. A standard 7805 regulator requires an input of at least 7.5V for stable operation. The LM4941 will operate with an input of 5.5V. This is important when using 7.2V NiCad battery packs which only provide about 6.0V at the end-of-discharge. [SUB PART: Not recommended, but the voltage regulator can be replaced with 7805 if an 8.4V to 9.6V battery pack is used.](#)

NOTE: Interestingly, I found that the LM4941 kept my test circuit (processor, LCD and sound board) operating happily with only 4V input. I had accidentally let the battery discharge too far and only realized because the LCD contrast was becoming too dim. I do not recommend running the circuit below 5.5V for any reason, but this demonstrates the superior stability of this regulator.

X1 - 8MHz ceramic resonator with built-in capacitors. This provides a stable time-base for the processor's oscillator. The PIC18F2525 is capable of operating at 8MHz using it's internal oscillator, but the resonator is much more accurate. The PC Board allows you to alternatively install an 8MHz crystal and capacitors if desired. [SUB PART: See 18F2525 datasheet for suitable 8MHz ceramic resonator or crystal and caps. Most 3-pin 8MHz ceramic resonator w/built-in caps should work.](#)

Q1 - 2N7000 MOSFET transistor. It is used as a "logic-controlled switch" to turn the LCD backlight on and off. The Gate of the 2N7000 is tied to RC1. When RC1 output is "high", it places 5V on the Gate and turns the transistor ON. This provides a path to ground for the LCD backlight turning it ON. [SUB PART: NONE](#)

Q2 - IRLD024 "logic-level" HEXFET. It is operated as a high-speed, high-current switch to modulate the Infrared LED by turning it on and off. The Gate of Q2 is controlled by RC2 which is the output of a Pulse Width Modulation (PWM) generator operating at 40KHz (alt 38KHz/56KHz). This provides the 40KHz infrared carrier signal. [SUB PART: NONE](#)

NOTE: It is important to use the "logic-level" FETs as they are optimized for operation with 5V logic circuits. Standard devices (i.e. those starting with "IRF") require 10V gate signal to fully turn the FET on. Whereas the logic-level FETs will be fully ON at 4.5V. If the device is not fully ON, then its internal resistance (on-resistance) will be proportionally higher and some of the power intended for driving your LEDs will be lost as heat in the FET.

Q3 - IRLD024 "logic-level" HEXFET. It is also operated as a high-current switch to adjust the drive current through Q2. When Q3 is OFF, the current through Q2 (and the Infrared LED) is limited by R8 (roughly 50 to 60 milliamps max). When Q3 is ON, the current through Q2 (and the infrared LED) is only limited by the external current-limiting resistor. This allows switching to low-current drive for short range transmissions which can be useful for longer data communications packets (i.e. Cloning) that might otherwise overstress the Infrared LED if run at full power, or it can be used to simulate short-range weapons or control functions (i.e. Medic, Armorer transfers). [SUB PART: NONE](#)

Q4 - IRLD110 "logic-level" HEXFET. It is used to pulse a Super Bright LED on and off in order to simulate "Muzzle Flash". [SUB PART: IRLD024](#)

Q5 - IRLD110 "logic-level" HEXFET. It is used to pulse the Hit LEDs. [SUB PART: IRLD024](#)

D1 - 1N4001 rectifier diode. Provides protection to the circuit in the event of reverse battery polarity. D1 is normally reverse-biased. If reverse voltage is applied to the circuit, then D1 will be forward-biased shunting the voltage through the fuse. The excessive current will trip fuse F1 before any serious damage occurs to the battery pack or the circuit (hopefully). This arrangement allows reverse-protect with NO loss of input voltage headroom. [SUB PART: NONE](#)

D2 - 5V (resistored) LED. *This component is optional.* It is used as a 5V power indicator on the circuit board, or it could be extended to the external casing as a power indicator. Omitting D2 will reduce overall power consumption by about 20mA. This doesn't seem significant until you consider that the rest of the circuit (including LCD and ISD sound module) only draws about 10mA in standby operation. Installing D2 may double or triple your standby battery consumption. **D2 is omitted on the Rev-B PCB and renamed "Aux".**

F1 - Self-resetting "poly fuse". In the event of an over-current condition, or if reverse polarity power is applied to the circuit, F1 will open and remain open until power is removed. Once power is removed and the fault is corrected, the fuse will reset itself. This provides protection to the battery pack and eliminates the need to replace standard fuses.

R1 - pull-up resistor for the Configuration Switch. [SUB PART: Any 4.7K or 5.1K resistor \(or close value\), 1/8 watt.](#)

R2 - 20K trimmer potentiometer used to control the LCD display's contrast. SUB PART: any 10K to 25K trimmer that will fit correctly on the PCB, or you can extend wires from PCB to a panel mount potentiometer.

R3 - SIP resistor. It provides required pull-ups for Port B inputs. SUB PART: Any 10K 5-pin or 6-pin SIP resistor with single common.

R4-R7 - 51 ohm resistors. These resistors help to prevent oscillations when driving MOSFET gates directly from the microcontroller logic outputs. SUB PART: Any 51 ohm or 56 ohm resistor (or close value), 1/8 watt.

R8 - current limiter for the Infrared LED during low-power transmissions. It is bypassed by Q3 (see above) for high-power transmissions. SUB PART: Any ½ watt or ¼ watt resistor (check lead spacing). Value is determined by desired LED current for "low power".

R9 - current limiter for the Muzzle Flash LED. SUB PART: Any ½ watt or ¼ watt resistor (check lead spacing). Value is determined by desired LED current.

R10 - pull-down resistor. When the ISD Board is NOT connected, R10 ensures that a "logic low" (0V) is seen on input RC4. When the ISD Board is connected, the EOM line forces RC4 to a "logic-high" (5V) (it is an active-low signal). This way, the controller can determine whether or not the ISD Board is connected when the system is powered on. SUB PART: Any 10K resistor (or close value), 1/8 watt.

R11 and **R12** allow input RC6 to monitor the Infrared LED. In normal operation, R12 allows a very small current to flow continuously through the Infrared LED. The resulting voltage drop across R12 is seen as a "logic high" at RC6. R11 simply prevents any excessive voltage from reaching RC6. If the Infrared LED becomes disconnected or burns out (due to age or excessive current), RC6 will be "pulled low" by R12. This allows the processor to instantly signal any failure in the Infrared LED. SUB PART: Any 10K resistor (or close value), 1/8 watt.

NOTE: This "failure detection" is a vital feature as the limits of the Infrared LED are often stressed in Laser Tag designs to gain maximum power and range. It can be very difficult or impossible to test and troubleshoot the Infrared LED in the field, due to the fact that it emits an "invisible" light. You might not even know that your LED has failed in the middle of a game. It's far better to have the peace of mind that your LED is actually operating when you pull the trigger.

C1 - power supply input filter. This prevents fluctuations in the battery output from affecting the LM4941 regulator input. SUB PART: Any electrolytic capacitor, 220uF or greater, 16V or greater (check component size and lead spacing to ensure it will fit the PCB).

C2 - power supply output filter. It is also required to ensure stable operation of the LM4941 regulator. SUB PART: Any electrolytic capacitor, 100uF or greater, 10V or greater (check component size and lead spacing to ensure it will fit the PCB).

C3 - noise bypass filter. It also lowers the equivalent series resistance (ESR) of C2. SUB PART: Any ceramic capacitor, .1uF, 25V or greater (check component size and lead spacing to ensure it will fit the PCB).

C4 - noise bypass filter required for U1. SUB PART: Any ceramic capacitor, .1uF, 25V or greater (check component size and lead spacing to ensure it will fit the PCB).

C5 - power filter for the external sensors. SUB PART: Any electrolytic capacitor, 33uF or greater, 10V or greater (check component size and lead spacing to ensure it will fit the PCB).

OTHER PART SUBSTITUTIONS

TSAL6100: Okay to try just about any 940nm infrared LED. Check datasheets for max continuous and pulsed current ratings. Try to select a beam angle that matches your lens setup.

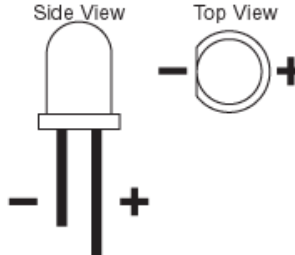
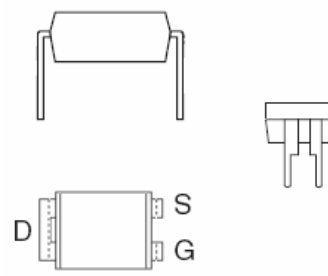
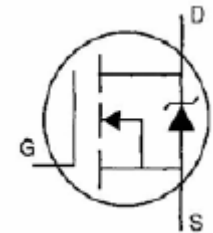
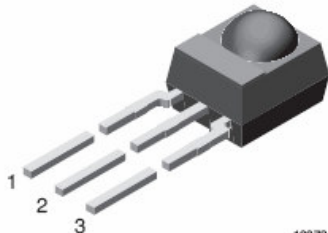
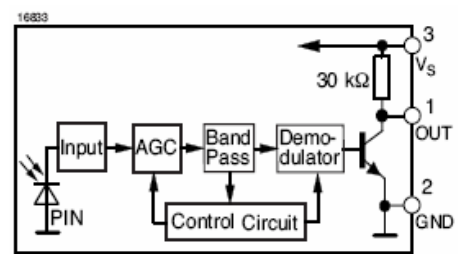
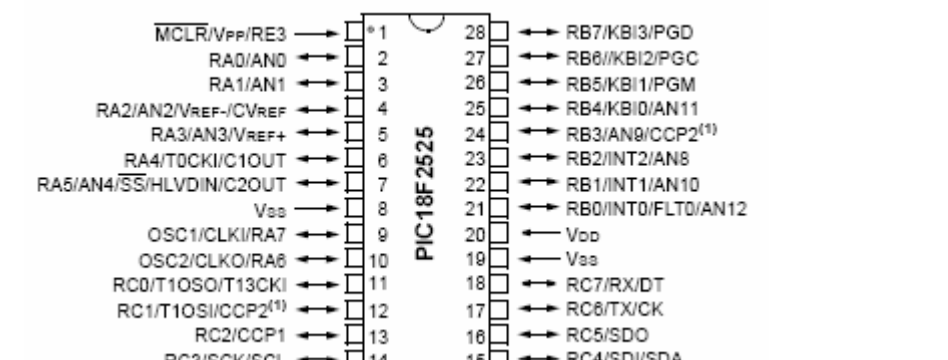
TSOP4840 (TSOP4856): Okay to try any 3-pin integrated IR receiver/demod (Panasonic, LiteOn, Vishay, etc). Choose device with appropriate carrier frequency (40KHz or 56KHz) or as close as possible. Check datasheet to ensure correct pinout if you are using the MilesTag sensor PCB.

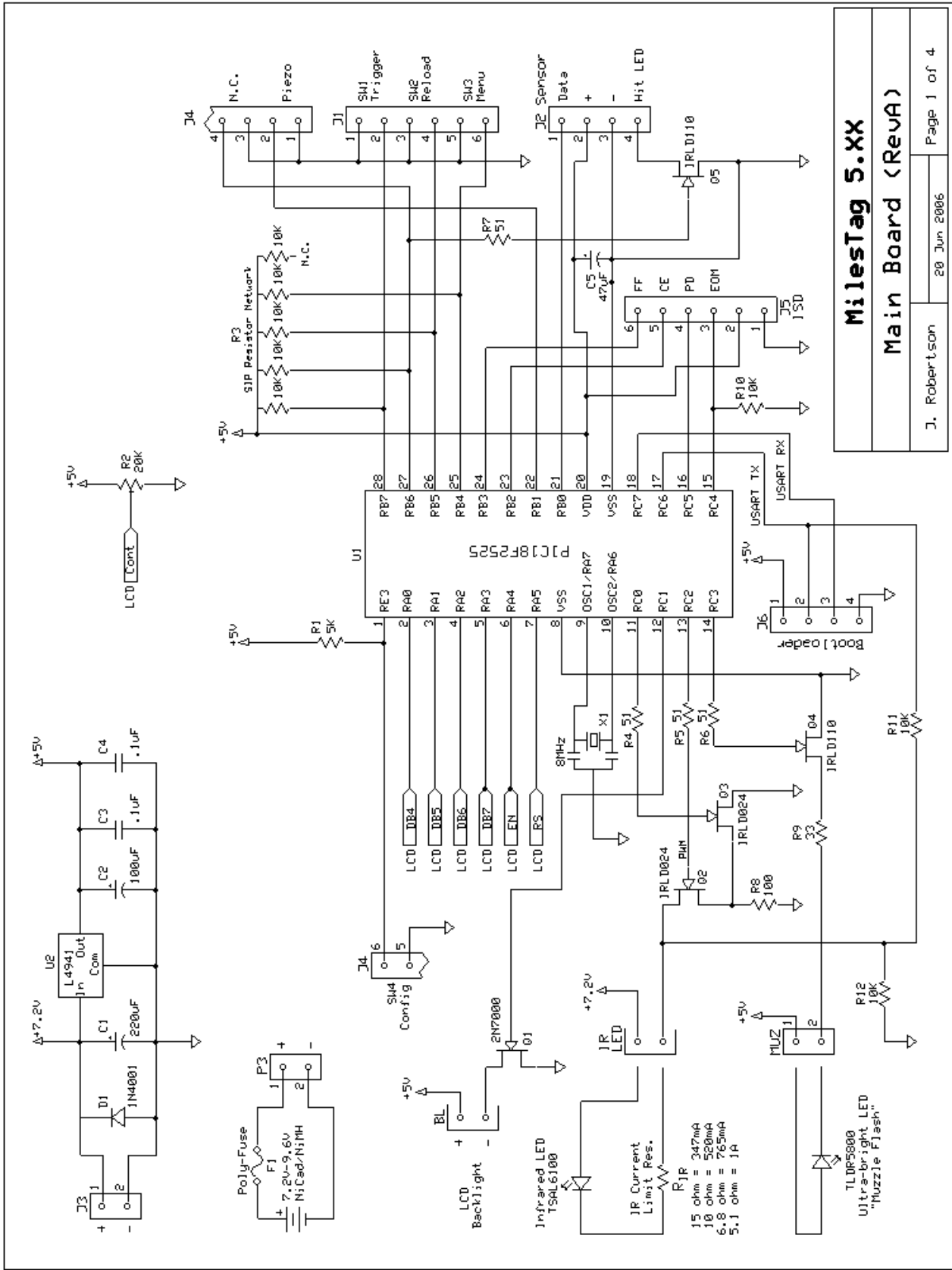
Muzzle Flash LED: Any "ultra-bright" or "super-bright" type LED. Usually these are rated at 1000 mcd or greater and have a clear lens/casing. Select color as desired.

Battery Pack: Any 7.2V rechargeable NiCad or NiMH battery pack. Recommend 1500mAH or greater capacity. These battery packs are typically used for Airsoft and RC cars, so they are available from most hobby retailers.

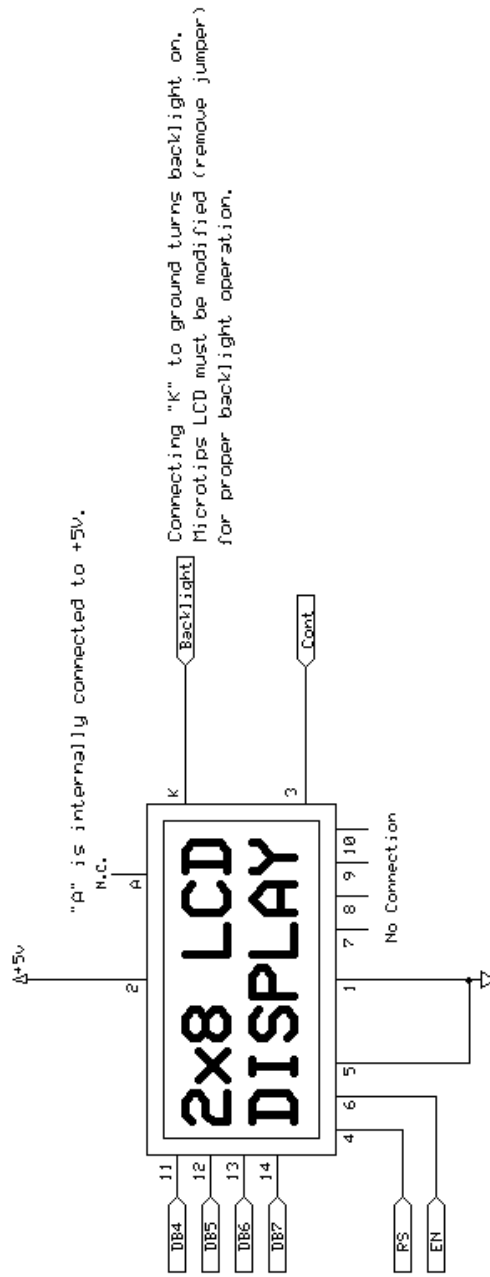
PB113A Piezo: Any piezo buzzer with built-in driver circuit. Must generate a continuous tone when 5VDC is applied. Should be <10mA draw (3-5mA is typical). Many suitable devices are rated 3-20VDC input with 2KHz to 5KHz output. Available from most electronic retailers or surplus retailers.

COMPONENT REFERENCE

<p>LED</p>	<p>LED Polarity</p> <p>Side View Top View</p> 	
<p>IRLD110 IRLD024</p>	<p>4-Pin Dip (HEXDIP®)</p> 	
<p>TSOP48XX</p>	 <p>16672</p>	
<p>PIC18F2525</p>	 <p>MCLR/VPP/RE3 → *1 28 → RB7/KBI3/PGD RA0/AN0 ↔ 2 27 → RB6//KBI2/PGC RA1/AN1 ↔ 3 26 → RB5/KBI1/PGM RA2/AN2/VREF-/CVREF ↔ 4 25 → RB4/KBI0/AN11 RA3/AN3/VREF+ ↔ 5 24 → RB3/AN9/CCP2⁽¹⁾ RA4/T0CKI/C1OUT ↔ 6 23 → RB2/INT2/AN8 RA5/AN4/SS/HLVDIN/C2OUT ↔ 7 22 → RB1/INT1/AN10 Vss → 8 21 → RB0/INT0/FLT0/AN12 OSC1/CLKI/RA7 ↔ 9 20 → VDD OSC2/CLKO/RA6 ↔ 10 19 → Vss RC0/T1OSO/T13CKI ↔ 11 18 → RC7/RX/DT RC1/T1OSI/CCP2⁽¹⁾ ↔ 12 17 → RC6/TX/CK RC2/CCP1 ↔ 13 16 → RC5/SDO RC3/SCK/SCL ↔ 14 15 → RC4/SDI/SDA</p>	



Microtips 8 x 2 LCD module, part # S0802XFGNSAY
 Verify pinout on mfr datasheet if different LCD is used.



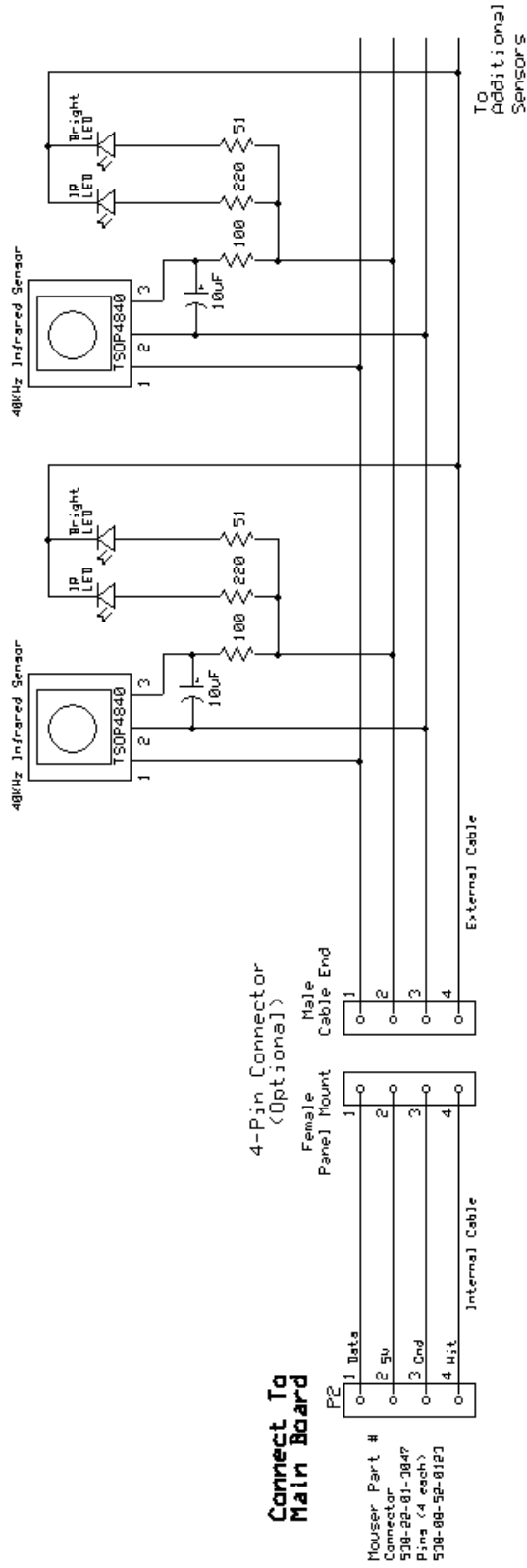
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LCD Display

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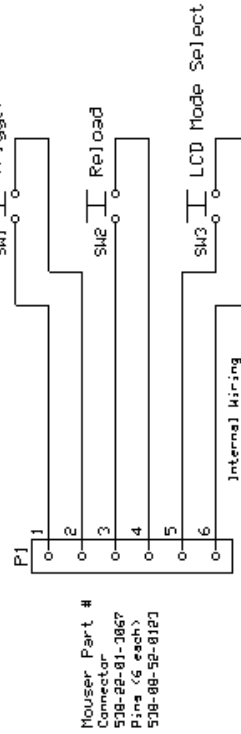
HEAD SENSORS

Recommend using 3 sensors on a hat or headband for 360-degree coverage. Additional sensors may be connected in parallel. Sensors can also be mounted on the gun if desired.



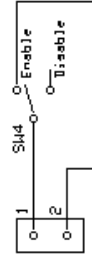
SWITCHES

Connect To Main Board



Buttons are SPST, Momentary, Normally Open

Config: SPDT or SPST Key-operated Switch



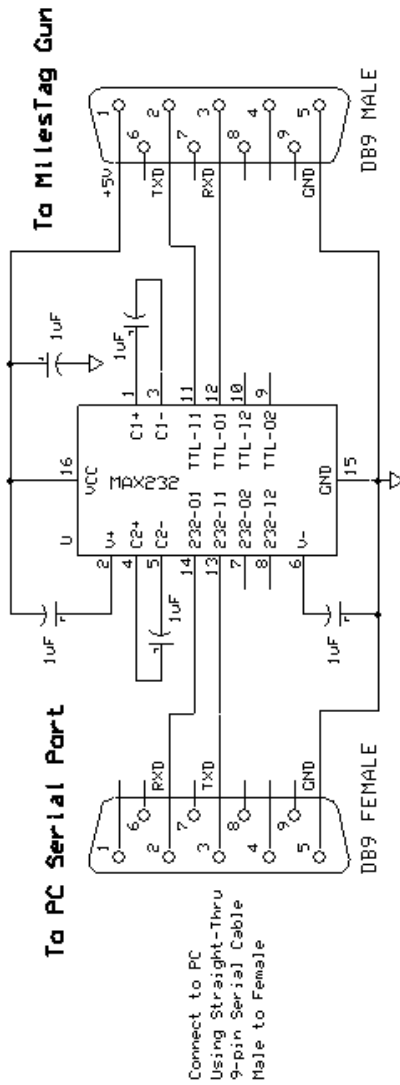
Config Key may not be required if "Electronic Security Key" is used

MilestTag 5.XX

Sensors / Switches

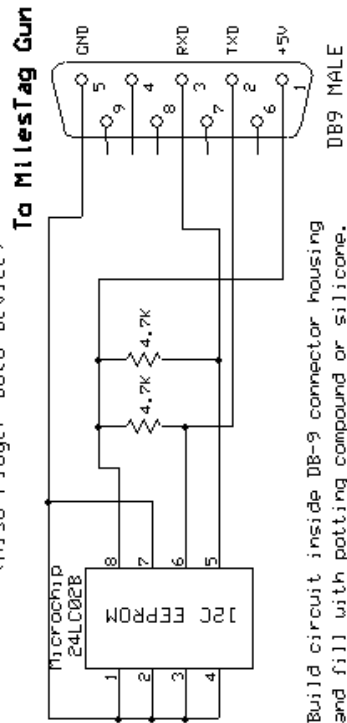
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BOOTLOADER ADAPTOR

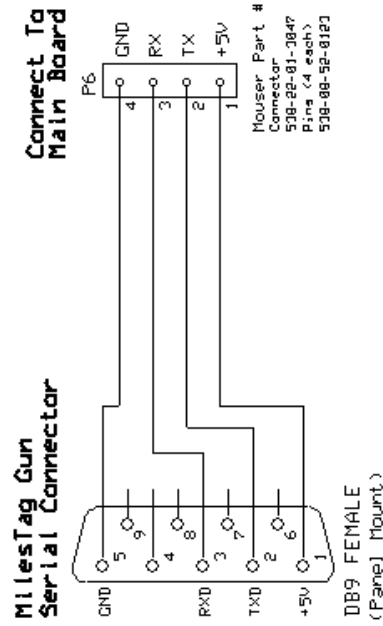


ELECTRONIC SECURITY KEY

(Also Player Data Device)



INTERNAL CABLE



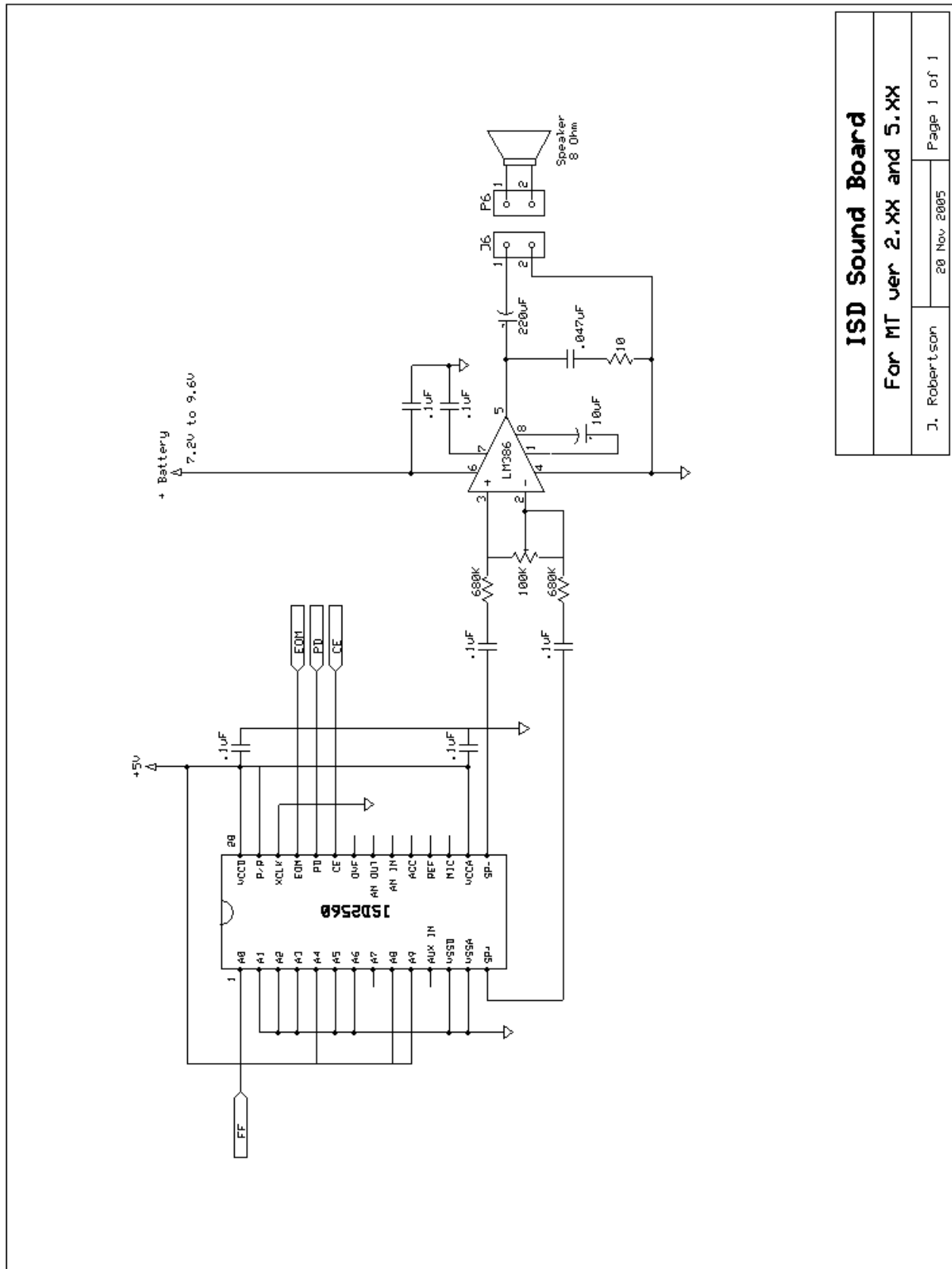
Millestag 5.XX

Serial Port Devices

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ISD Sound Board

For MT ver 2.XX and 5.XX

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PIC PROGRAMMING

Here are some links to help you gain understanding of the Microchip PIC microcontrollers and some of the available programming languages/tools:

<http://www.microchip.com>
<http://www.melabs.com>
<http://www.rentron.com>
<http://www.etc.ugal.ro/cchiculita/software/picbootloader.htm>
<http://www.mecanique.co.uk/code-studio/>

There are also a number of books available that explain PIC micros and programming in PIC Basic.

Here is the list of the equipment/software that I use to develop the MilesTag system:

Programming Software:

PIC Basic Pro compiler (2.45a)	\$ 249.95	http://www.melabs.com
Microcode Studio IDE (free version)		http://www.mecanique.co.uk/code-studio/
MPASM assembler (free download)		www.microchip.com
Tiny PIC Bootloader (free download)		

Programming Hardware:

MeLabs Serial Programmer	\$ 119.95	http://www.melabs.com
USB to Serial adapter cable	\$ 15.00	any computer store
Serial boot loader adaptor	\$ 5.00	home built

ADDITIONAL RESOURCES

PCB and Schematic Design:

Express PCB (free download)	http://www.expresspcb.com
Express Schematic (free download)	http://www.expresspcb.com

Electronic Components:

Jameco	http://www.jameco.com
Mouser	http://www.mouser.com
Digikey	http://www.digikey.com
Parts Express	http://www.digikey.com

Aluminum and Plastic:

Online Metals	http://www.onlinemetals.com
TAP Plastics	http://www.tapplastics.com
Home Depot	
Lowe's Home Improvement	

Metalworking Tools (bending brakes, shears, tap/die sets, etc):

Harbor Freight Tools	http://www.harborfreight.com
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Battery Packs and Chargers:

Tower Hobbies
Radio Shack