Freescale Wireless Design Challenge – Entry # FZ1548

Electronic Scarecrow

For the past dozen years, I have lived in a small rural section of an otherwise urban area, with a forest for a backyard. Although there are many advantages of living in a natural setting, one of the more annoying problems comes from the steadily increasing population of wild animals looking for food in more populated areas. As housing developments take over what once were feeding grounds for wildlife, animals are becoming accustomed to eating whatever might be growing in a nearby garden.

The area where I live has a healthy deer population, which seems to be increasing every year. Several times a day I can look out a window and see them munching on anything from garden plants, hedges, and sometimes even dead leaves during the dry season in early Fall. Most of the conventional methods to keep them away no longer work, as they have become used to being around people, can jump over most fences, and are willing to put up with foul tastes or smells from deer repellents if they have no other source of food. One of my neighbors once got so frustrated that he even put up an electric fence, but even that didn't deter them! It appears the deer eventually get accustomed to whatever obstacles they encounter. The only way to scare them away is to startle them with something that they won't have a chance to get accustomed to.

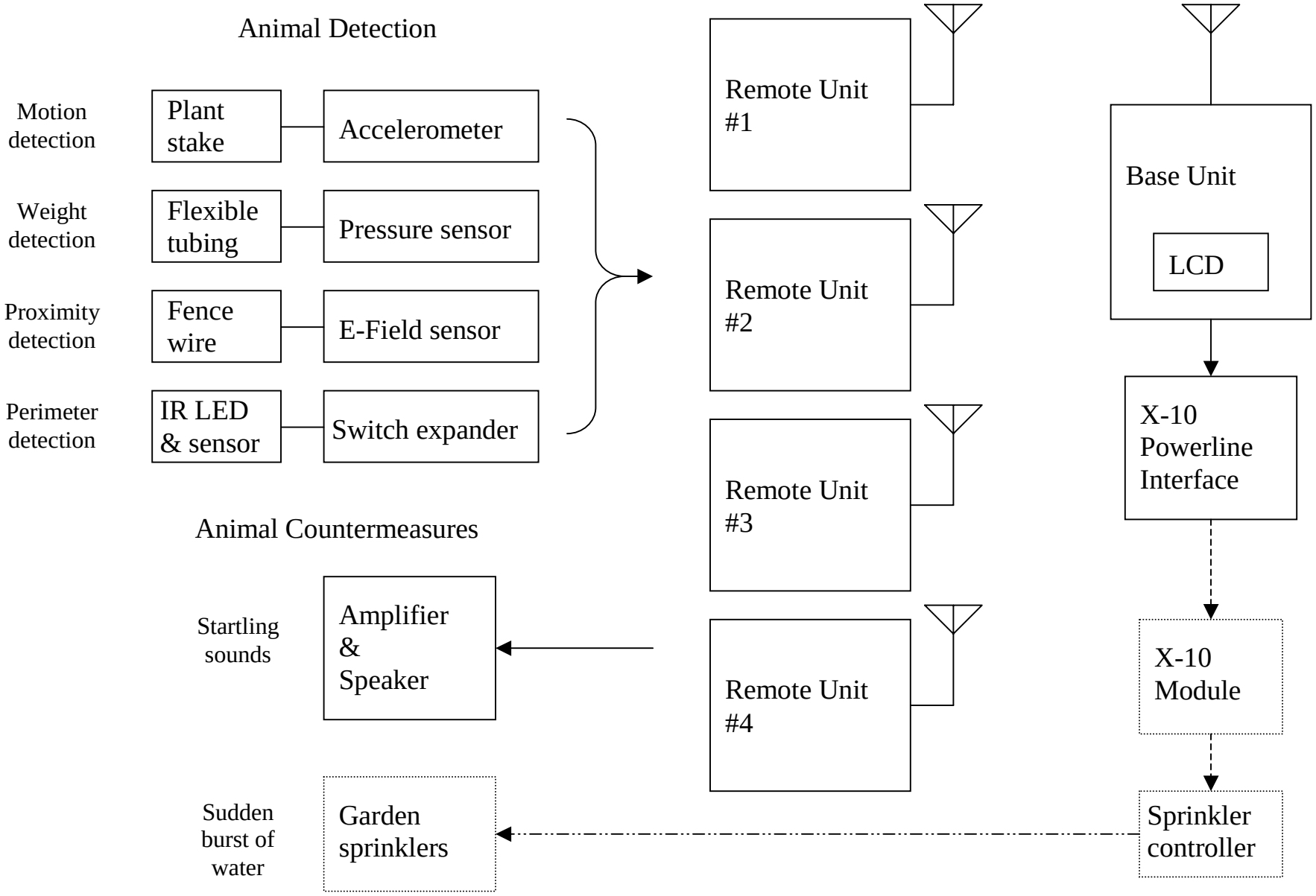
I had thought before about coming up with some technology-based method of scaring the deer away, but hadn't been able to figure out how to tie a network of sensors together without having to bury lots of cables. The Zigbee hardware seemed like the perfect solution, and the various sensors turned out to be just what I needed to detect a nearby animal.

The Electronic Scarecrow uses up to four Freescale SARD boards as remote stations, each connected to several sensors and powered by a NiCd battery pack charged by a photovoltaic array. These transmit to the base station's EVB board when an animal is detected. Then the base can activate various countermeasures, such as signaling to the SARD board to play a loud sound over an outdoor speaker, or sending a command over the power line using the X-10 protocol to a central sprinkler controller to activate the garden sprinklers for a few seconds.

Both remote and base stations are based on a Freescale MC13192 2.4 GHz transceiver controlled by a MC9S08GT16 MCU. The remote is dynamically configurable with up to two MMA6261Q accelerometers, a MMA1260D accelerometer or a MPXM2010GS pressure sensor, a MC33794 E-field sensor, a MC33993 switch expander connected to IR beam perimeter sensors, and a TDA2822M audio amplifier and speaker. The base has an LCD display and three pushbuttons used to configure and control the system, an X-10 powerline transmitter interface, and a serial port for downloading local and remote code updates and sound files.

Block Diagram
Overall System

Freescale Wireless Design Challenge Entry # FZ1548



Block Diagram
Base Unit

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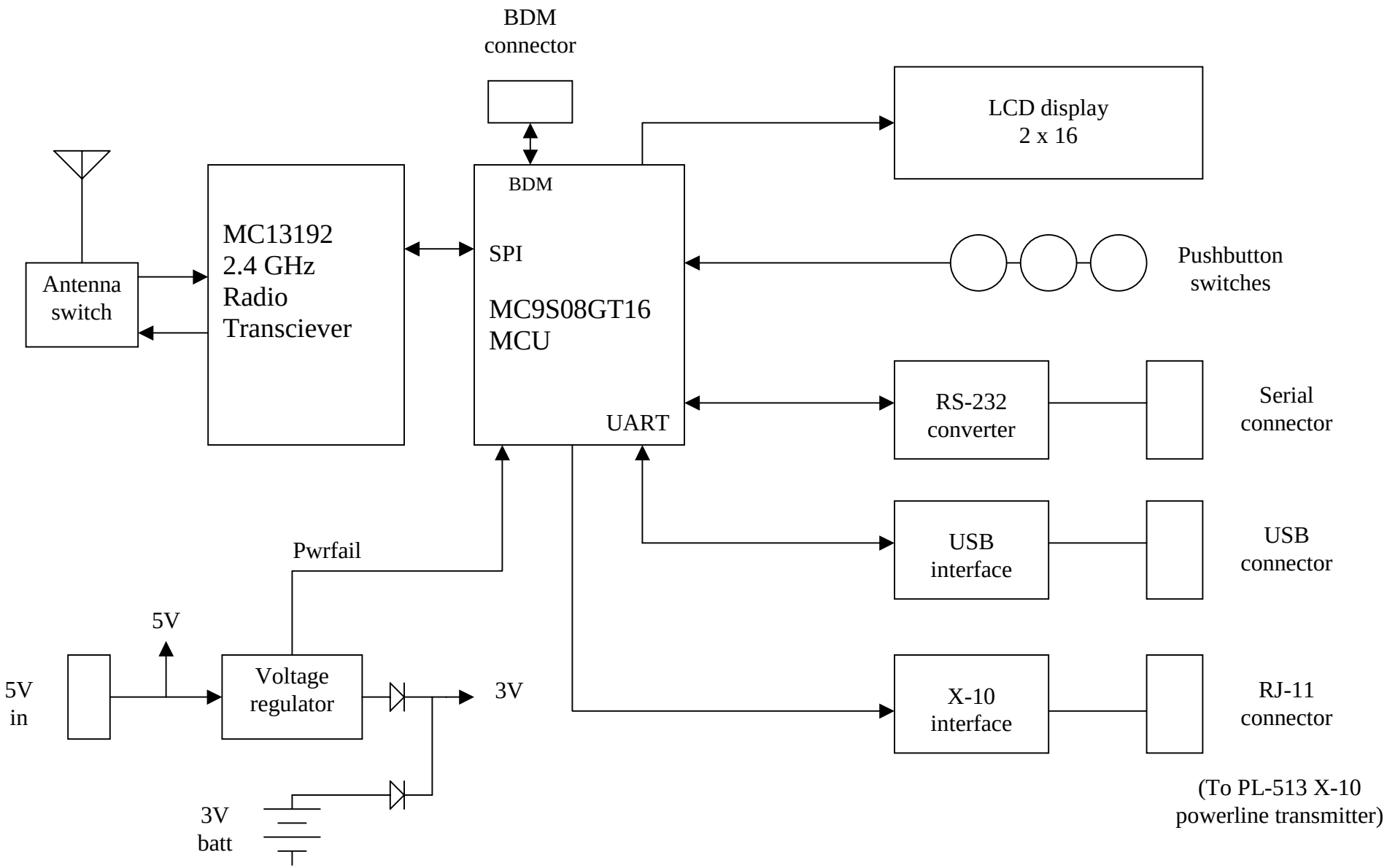
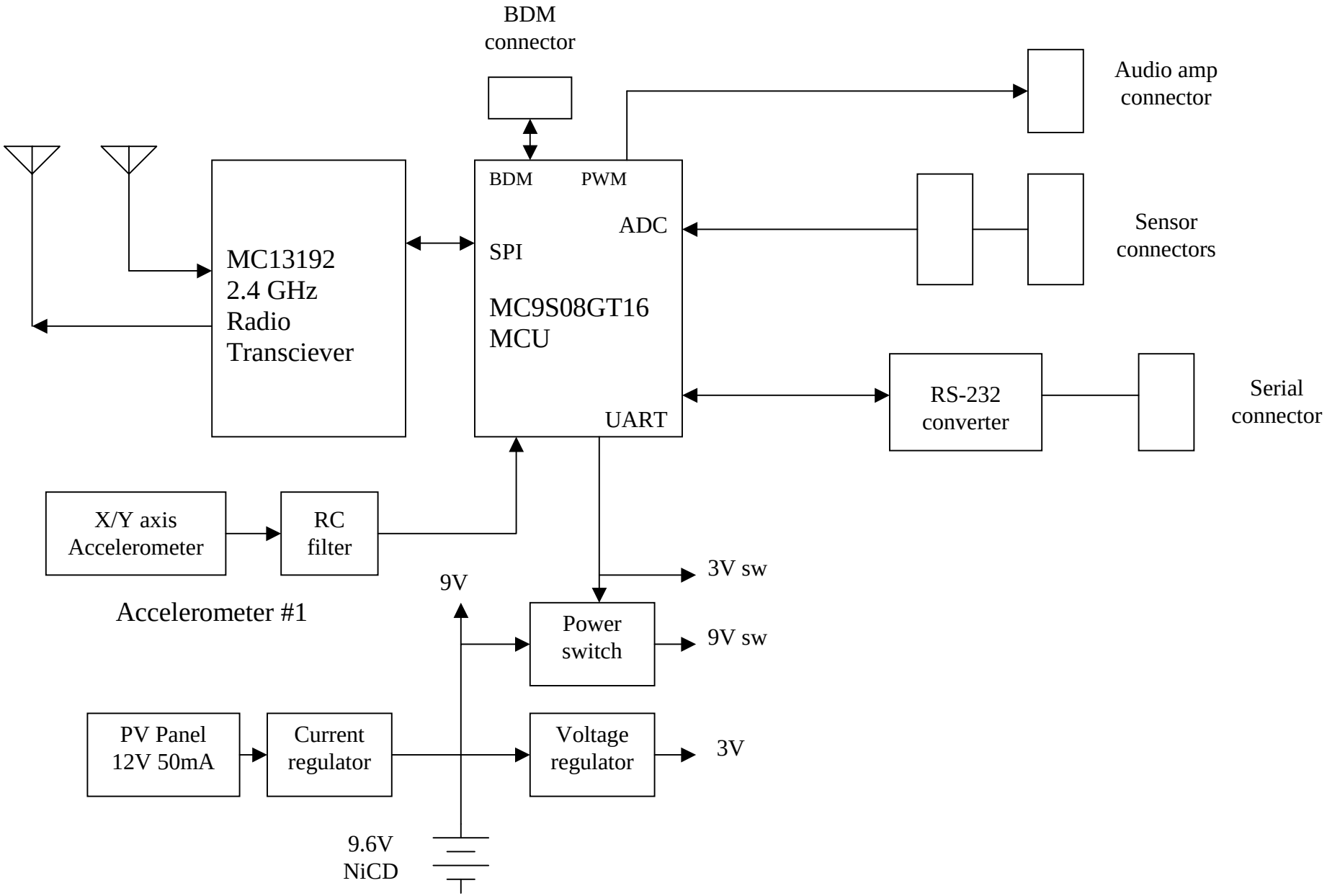


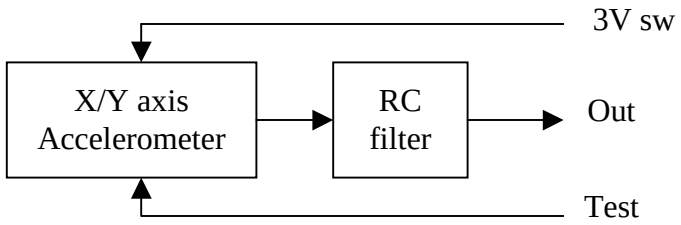
Block Diagram
Remote Unit

Freescale Wireless Design Challenge Entry # FZ1548

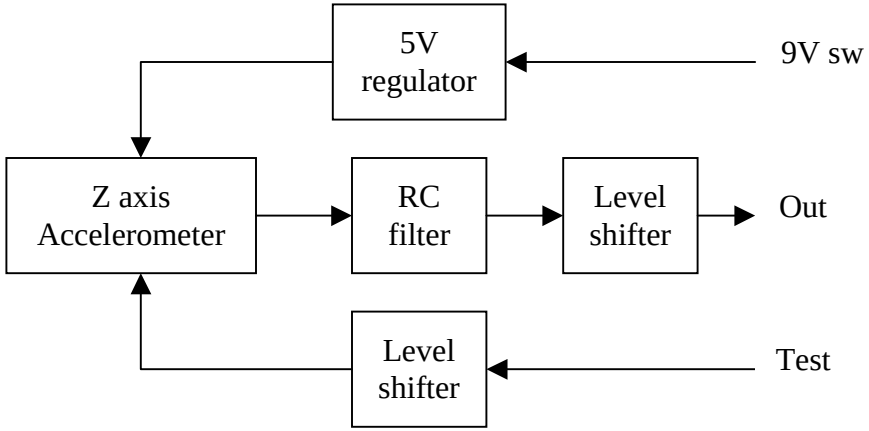


Block Diagram
Sensors

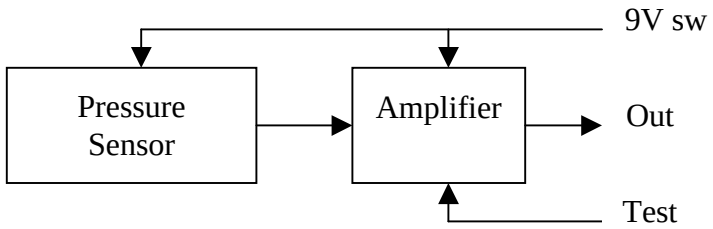
Freescale Wireless Design Challenge Entry # FZ1548



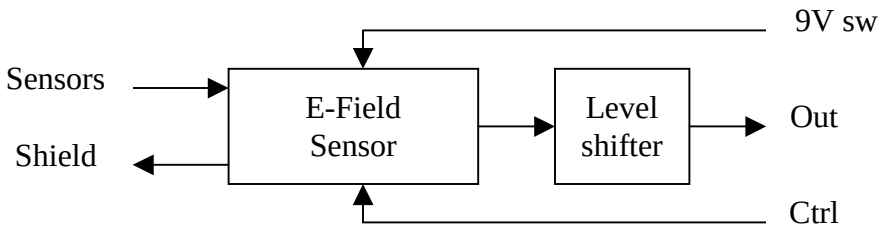
Accelerometer #2



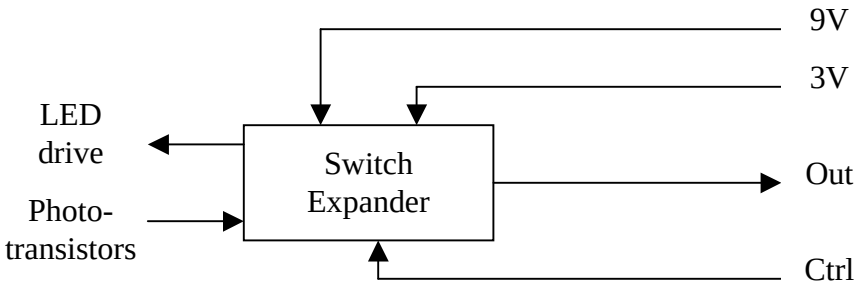
Accelerometer #3



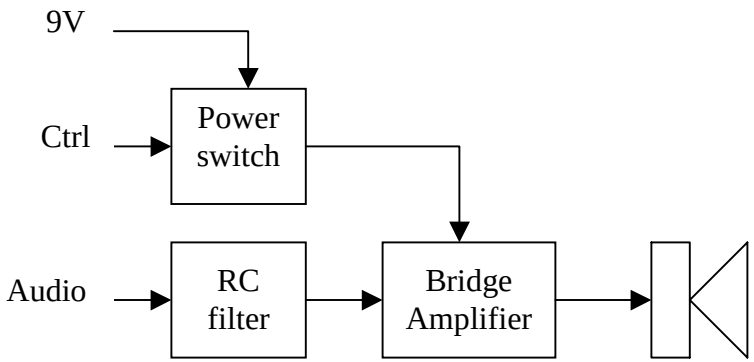
Pressure Sensor



E-Field Sensor

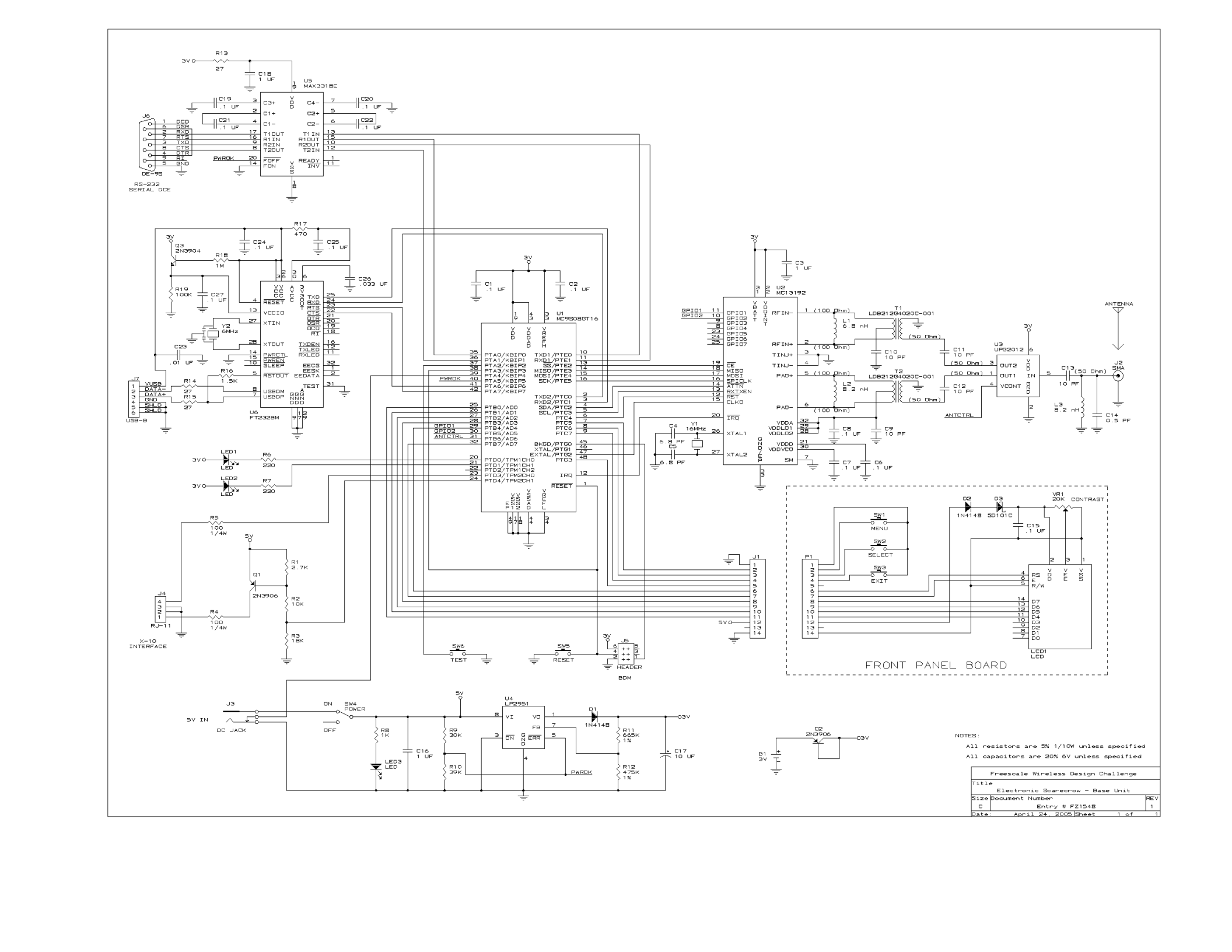


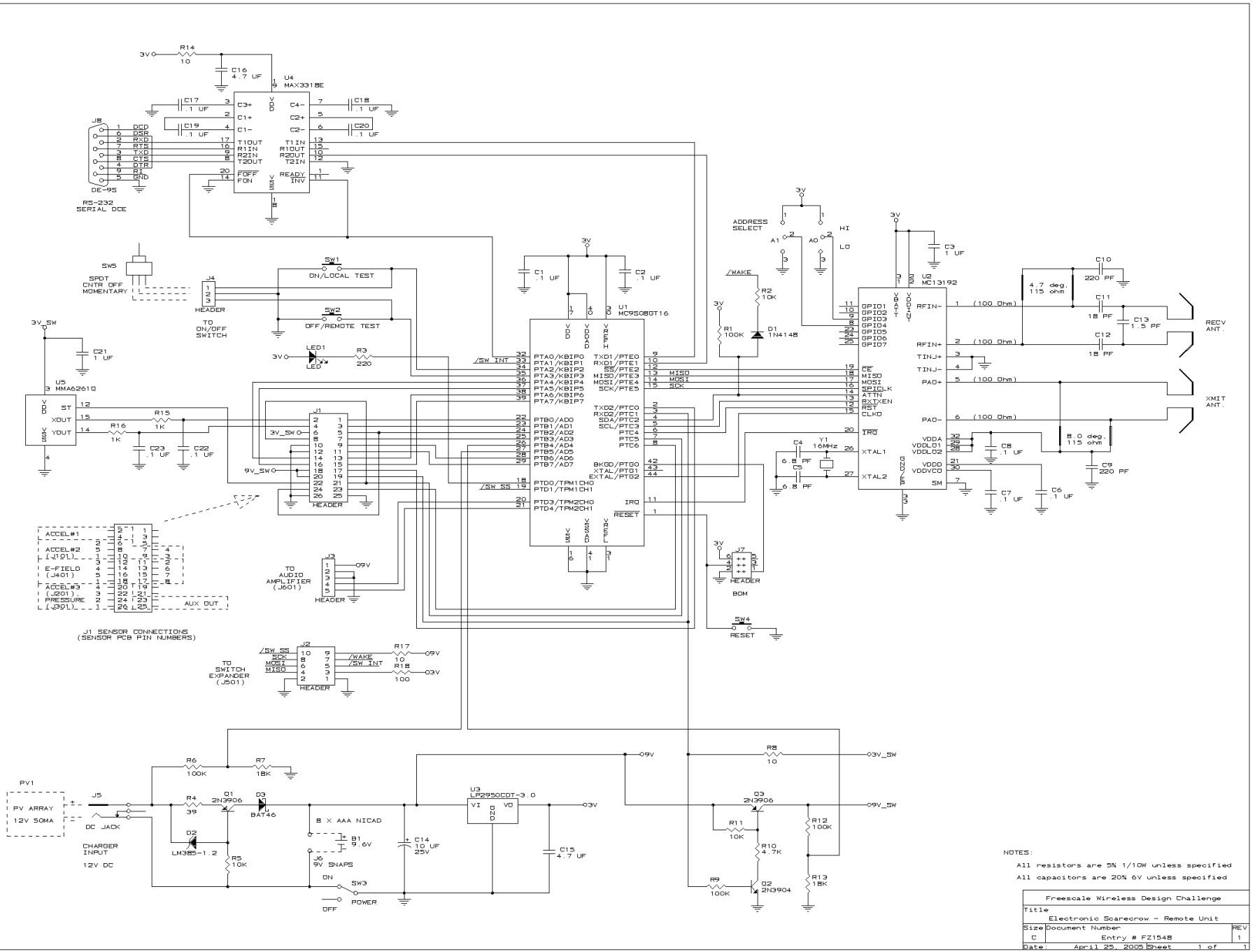
Switch Expander

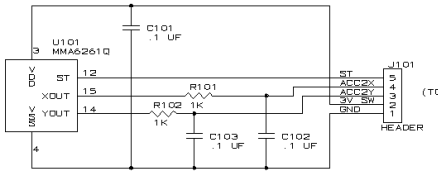


Audio Amplifier

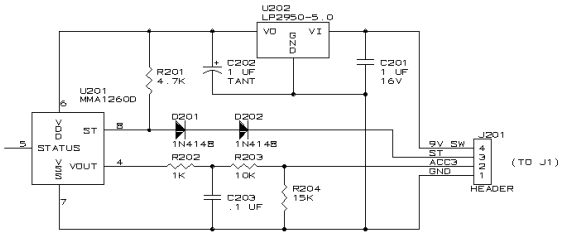
```
byte check_outputs (byte inputs)
{
	struct OUTTRIG *trigp;
	struct OUTPUT *outp;
	byte out_no, outputs, i, j;

	outputs = 0;

	for (out_no = 0; out_no != NOUTPUTS; out_no ++) {	// Check each output channel

		trigp = &out_trig[out_no];			// Get ptrs for faster access
		outp = &Outputs[out_no];
							// If output enabled, and sensor triggered & enabled
		if (outp->dev_type != DEV_TYPE_none && (inputs & outp->sns_sel) != 0) {

			trigp->rpt_dly = outp->rpt_dly;		// Init repeat delay time

			if ((inputs & trigp->sns_sel) != 0)	// If sensor was active before,
				trigp->sns_rpt ++;		//  then incr repeat count

			trigp->sns_sel |= inputs & outp->sns_sel;	// Save active sensor bits

			for (i = trigp->sns_sel, j = 0; i != 0; i >>= 1)// Count number of active sensors
				if (i & 1)
					j ++;

			if (j >= outp->sns_mult				// Do we have enough sensors,
			 && (byte) (trigp->sns_rpt + 1) >= outp->sns_rpt	//  and enough repeats,
			 && trigp->wait_dly == 0			//  and have waited long enough,
			 && (*(word *) &Time.hour) >= (*(word *) &outp->on_time)	// and are within the
			 && (*(word *) &Time.hour) <= (*(word *) &outp->off_time)) {//  activation window?

				trigp->sns_sel = 0;			// Clear the repeat stats
				trigp->sns_rpt = 0;
				trigp->rpt_dly = 0;

				Last_trig.time.hour = Time.hour;	// Update the activation stats
				Last_trig.time.min  = Time.minute;
				Last_trig.days = 0;

				if (Syscfg.enabled != 0) {		// Check master system enable flag

					outputs |= bit_mask (out_no);	// Now set the channel's output bit

					trigp->wait_dly = outp->wait_dly;	// Update the wait delay time
				}
			}
		}
	}
	return (outputs);					// Return with bitmask of triggered channels
}
```


RS-232
SERIAL DCE
X-10
INTERFACE
USB-B
FRONT PANEL BOARD
MENU
SELECT
EXIT
CONTRAST
ANTENNA
DC JACK
5V IN
POWER
ON
OFF
TEST
RESET
HEADER
BDM
NOTES:
All resistors are 5% 1/10W unless specified
All capacitors are 20% 6V unless specified
Freescale Wireless Design Challenge
Title
Electronic Scarecrow - Base Unit
Size
C
Document Number
Entry # FZ1548
REV
1
Date:
April 24, 2005
Sheet
1 of 1

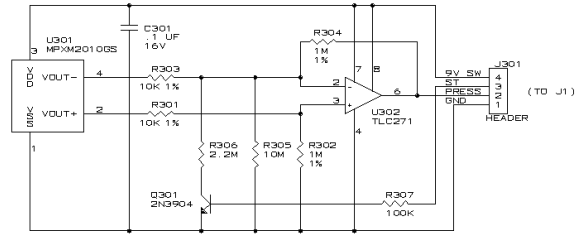

R14
10
C16
4.7 UF
U4
MAX3318E
C17
.1 UF
C18
.1 UF
C19
.1 UF
C20
.1 UF
J8
DE-9S
RS-232
SERIAL DCE
SW5
SPDT
CNTR OFF
MOMENTARY
J4
HEADER
TO
ON/OFF
SWITCH
SW1
ON/LOCAL TEST
SW2
OFF/REMOTE TEST
LED1
LED
R3
220
C1
.1 UF
C2
.1 UF
U1
MC9S08GT16
3V_SW
C21
1 UF
U5
MMA6261Q
R15
1K
R16
1K
C23
.1 UF
C22
.1 UF
J1
HEADER
9V_SW
J1 SENSOR CONNECTIONS
(SENSOR PCB PIN NUMBERS)
ACCEL#1
ACCEL#2
(J101)
E-FIELD
(J401)
ACCEL#3
(J201)
PRESSURE
(J301)
AUX OUT
TO
AUDIO
AMPLIFIER
(J601)
J3
HEADER
/SW INT
/SW SS
PTA0/KBIP0
PTA1/KBIP1
PTA2/KBIP2
PTA3/KBIP3
PTA4/KBIP4
PTA5/KBIP5
PTA6/KBIP6
PTA7/KBIP7
PTB0/AD0
PTB1/AD1
PTB2/AD2
PTB3/AD3
PTB4/AD4
PTB5/AD5
PTB6/AD6
PTB7/AD7
PTD0/TPM1CH0
PTD1/TPM1CH1
PTD3/TPM2CH0
PTD4/TPM2CH1
TXD1/PTE0
RXD1/PTE1
SS/PTE2
MISO/PTE3
MOSI/PTE4
SCK/PTE5
TXD2/PTC0
RXD2/PTC1
SDA/PTC2
SCL/PTC3
PTC4
PTC5
PTC6
BKGD/PTG0
XTAL/PTG1
EXTAL/PTG2
IRQ
RESET
ADDRESS
SELECT
A1
A0
HI
LO
/WAKE
R2
10K
R1
100K
D1
1N4148
U2
MC13192
GPIO1
GPIO2
GPIO3
GPIO4
GPIO5
GPIO6
GPIO7
CE
MISO
MOSI
SPICLK
ATTN
RXTXEN
RST
CLKO
IRQ
XTAL1
XTAL2
SM
RFIN-
RFIN+
TINJ+
TINJ-
PAD+
PAD-
VDDA
VDDD1
VDDD2
VDDD
VDDVCO
C3
1 UF
C10
220 PF
C11
18 PF
C13
1.5 PF
C12
18 PF
4.7 deg.
115 ohm
8.0 deg.
115 ohm
C9
220 PF
C8
.1 UF
C7
.1 UF
C6
.1 UF
C4
6.8 PF
C5
6.8 PF
Y1
16MHz
(100 Ohm)
RECV
ANT.
XMIT
ANT.
J7
HEADER
BDM
SW4
RESET
J2
HEADER
TO
SWITCH
EXPANDER
(J501)
R17
10
R18
100
PV1
PV ARRAY
12V 50MA
J5
DC JACK
CHARGER
INPUT
12V DC
R6
100K
R7
18K
R4
39
Q1
2N3906
D3
BAT46
D2
LM385-1.2
R5
10K
8 X AAA NICAD
B1
9.6V
J6
9V SNAPS
ON
SW3
POWER
OFF
C14
10 UF
25V
U3
LP2950CDT-3.0
C15
4.7 UF
R8
10
Q3
2N3906
R11
10K
R10
4.7K
R12
100K
R9
100K
Q2
2N3904
R13
15K
NOTES:
All resistors are 5% 1/10W unless specified
All capacitors are 20% 6V unless specified
Freescale Wireless Design Challenge
Title
Electronic Scarecrow - Remote Unit
Size
C
Document Number
Entry # FZ1545
REV
1
Date:
April 25, 2005
Sheet
1 of
1



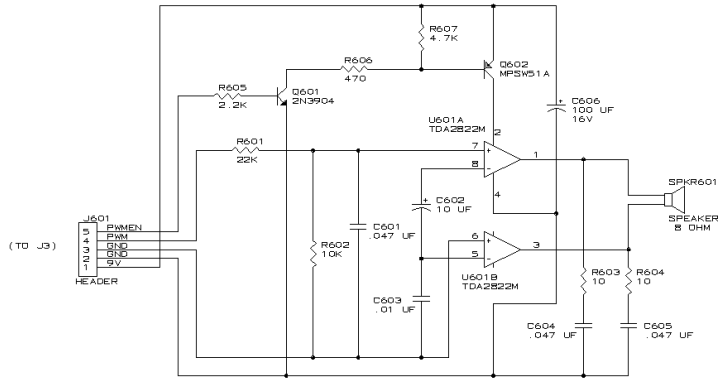
ACCELEROMETER #2



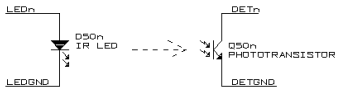
ACCELEROMETER #3

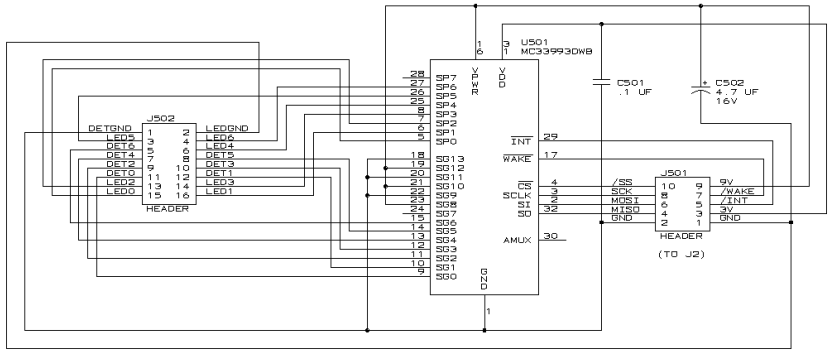


PRESSURE SENSOR

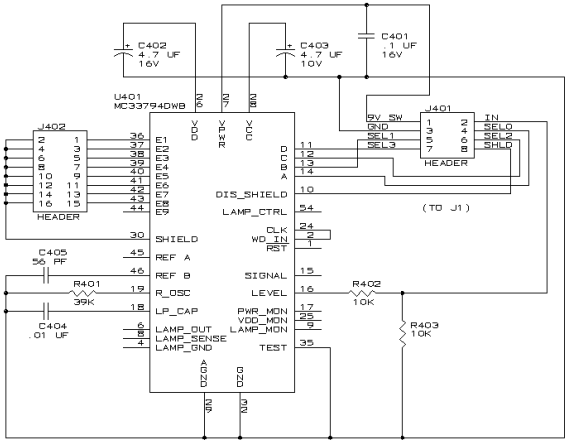


AUDIO AMPLIFIER





SWITCH EXPANDER



E-FIELD SENSOR

NOTES:

All resistors are 5% 1/10W unless specified

All capacitors are 20% 6V unless specified

Freescale Wireless Design Challenge		
Title: Electronic Scarecrow - Sensors		
Size: C	Document Number: Entry # FZ1548	REV: 1
Date: April 25, 2005	Sheet 1 of 1	