Group D, Fall 2010

Stephen Watson, Charles Logan, Joshua Guinn, Derrick Nelson

EVADE:
Emergency Vehicle Alert DEvice

EVADE: Emergency Vehicle Alert Device

Project Origination:

Have you ever:

– Heard the sirens, but not known where they were coming from?

– Been taken by surprise by an emergency vehicle and not had time to get out of the way?

– Not seen the lights or heard the siren until they are right behind you?

Then you understand the need for a more advanced warning system that can save time and lives.

EVADE: Emergency Vehicle Alert Device

Motivation:

The group was struck by the fact that more and more frequently emergency vehicles are not seen or are simply ignored by drivers on the road. This could be caused by better insulation that makes cars quieter, larger vehicles on the road creating a visual obstruction, or by increased distractions on the road like cell phones and loud music. In order to overcome these obstacles, an advanced alert system is needed that does not rely on line-of-sight or sirens and has the capability of capturing the driver's attention.

EVADE: Emergency Vehicle Alert Device

Goals:

The objective of the emergency vehicle alert device is to surpass the current obstacles for alerting drivers by transmitting a signal from the emergency vehicle that will be picked up by cars. This signal will trigger a visual alert to inform the driver what type of vehicle is approaching and from what direction. Simultaneously, the signal will quiet the interior of the car and play an audible alert message in both English and Spanish.

EVADE: Emergency Vehicle Alert Device

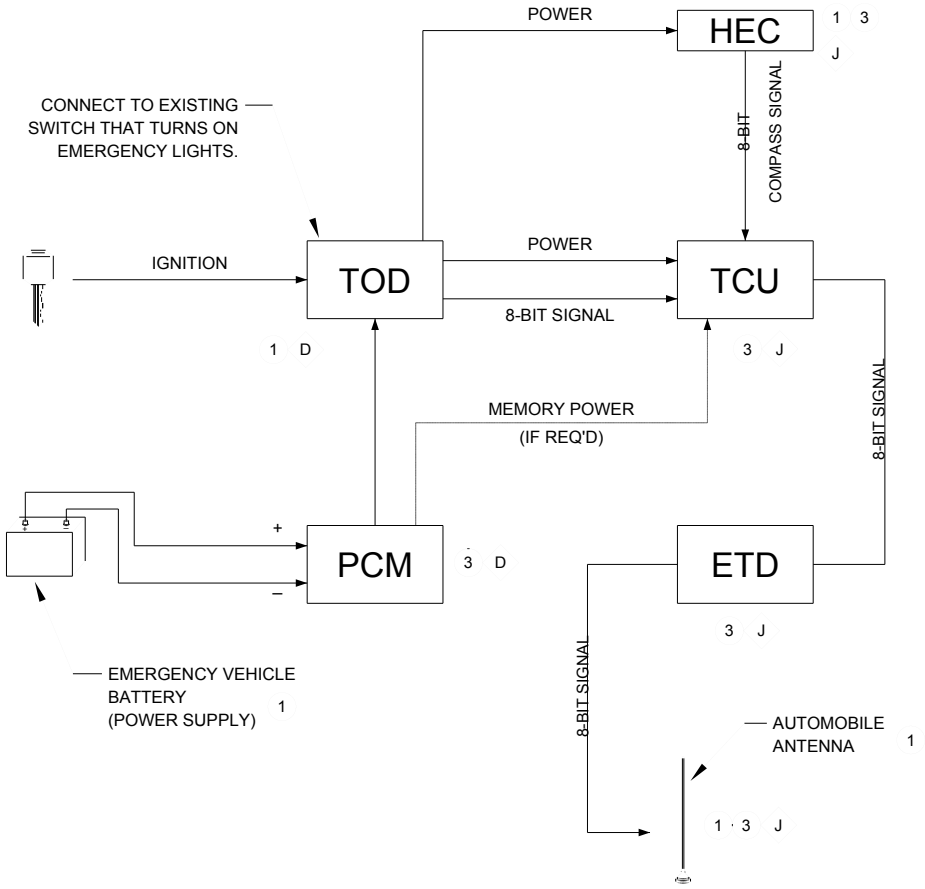
Basic Objectives:

EAT - Emergency Alert Transmitter:

- **Transmission begins simultaneously with lights and sirens**
- **Sends GPS and compass headings to determine approach direction.**
- **Transmission radius is large enough to provide the desired advanced alert.**
- **Does not inhibit normal vehicle operation or require extra work from driver.**
- **Does not put unusual strain on other vehicle components or battery.**

EVADE: Emergency Vehicle Alert Device

Emergency Alert Transmitter Block Diagram:



EVADE: Emergency Vehicle Alert Device

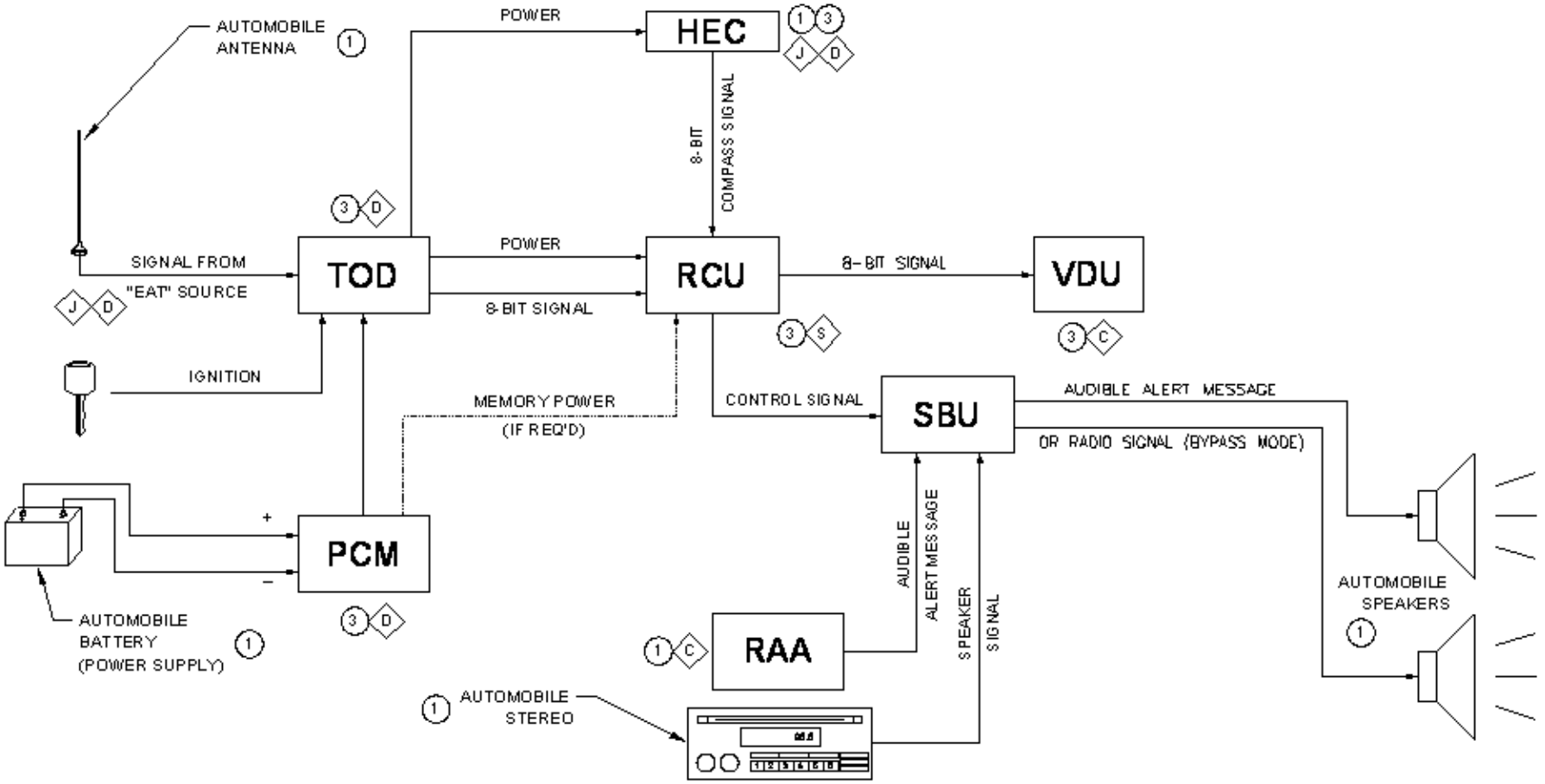
Basic Objectives:

EAR - Emergency Alert Receiver:

- **Automatically detects signal and alerts driver during normal operation.**
- **Allows normal operation of vehicle when signal not detected**
- **Shuts down stereo and plays audible alert message until vehicle is out of range, then resumes normal operation.**
- **Displays direction of approach to driver on a physical display screen.**
- **Uses low power that will not affect other systems in the car or strain battery supply levels.**

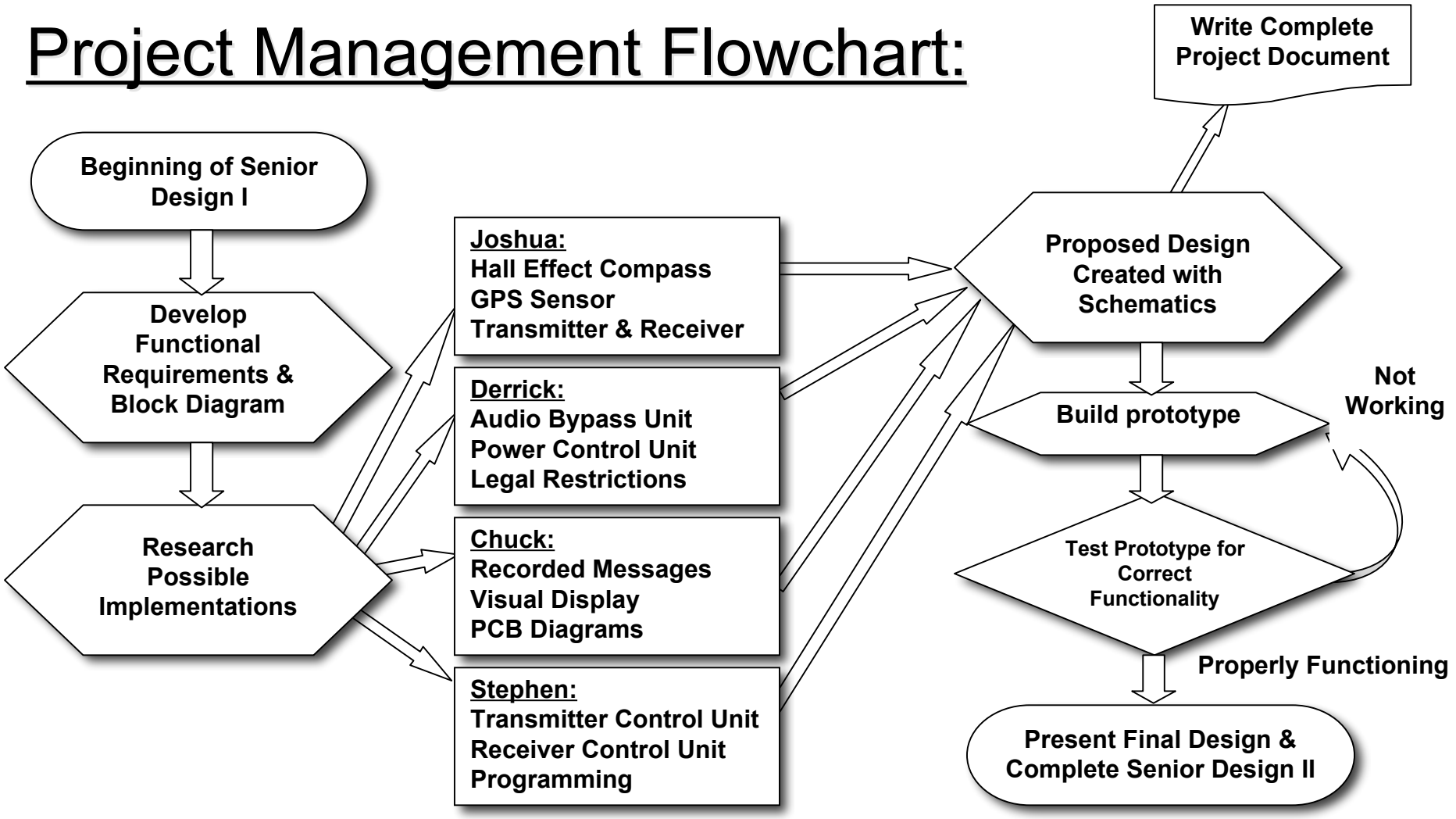
EVADE: Emergency Vehicle Alert Device

Emergency Alert Receiver Block Diagram:



EVADE: Emergency Vehicle Alert Device

Project Management Flowchart:

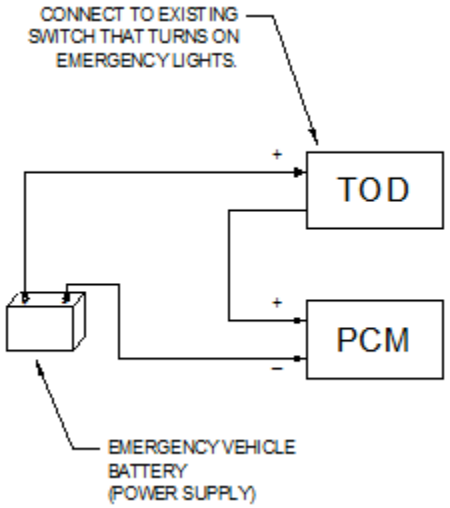


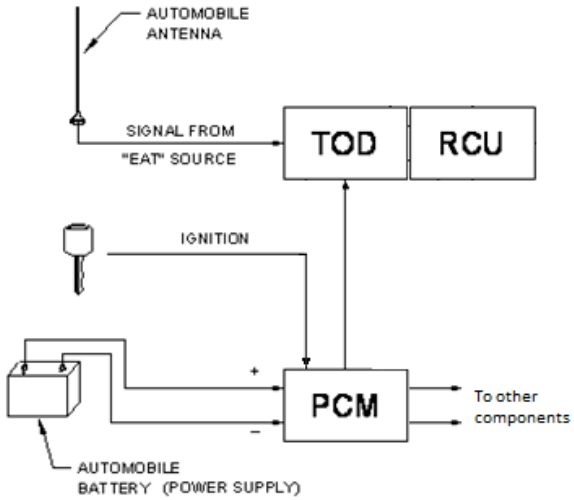

Subsystem #4 - Derrick Nelson
TOD – Turn-On Device
PCM – Power Control Module
SBU – Switching Bypass Unit

EVADE: Emergency Vehicle Alert Device
TOD

Turn-On Device:

- Initially conceived of as discrete modules for saving power
- TOD(EAT) – simple switch connected to emergency lights
- TOD(EAR) – incorporated into RCU for power saving and security (alert message authentication)





EVADE: Emergency Vehicle Alert Device PCM

PCM Design Objectives:

- Operate on standard 12V vehicle power
- Provide multiple voltage levels for various components
- Provide clean source of power for Tx and Rx components
- Operation
  - PCM(EAT) will operate only when emergency lights are active
  - PCM(EAR) will operate whenever the vehicle is running
- Design Decision – linear vs. switching regulators
  - Cost, efficiency/heat, noise

EVADE: Emergency Vehicle Alert Device PCM

Power Specifications:

EAT (Transmitter)			
Item	Voltage	Current	
GPS	3.3 V	40 mA	
PIC	1.8 – 3.6 V	250 mA (max)	
Xmitter	1.8 – 3.6 V	12.5 mA	
Xmitter amp	3.6 V	1300 mA (max)	
HEC	8 – 13 V	30 mA	
	3.3 V line	1.6 A	LM1086-3.3
	9 V line	30 mA	LF90AB

EAR (Receiver)			
Item	Voltage	Current	
GPS	3.3 V	40 mA	
PIC	1.8 – 3.6 V	250 mA (max)	
SBU (MUX)	5 V	~ 0 mA	
Receiver	4.8 – 5.5 V	3 mA	
VDU display (Lumex)	5 V	400 mA (max)	
VDU controller (Hitachi)	2.7 – 5.5 V	2 mA	
HEC	8 – 13 V	30 mA	
SBU amp	6 – 18 V	230 mA	
	3.3 V l ine	290 mA	LM1086-3.3
	5 V line	405 mA	REG13NA-5/3K
	9 V line	260 mA	LF90AB

EVADE: Emergency Vehicle Alert Device PCM

Voltage Regulators:

•3 regulators used to achieve the required voltage levels

- All Low Drop-Out voltage for efficiency
- Very clean output voltages

LF90AB (9V, STMicro.)

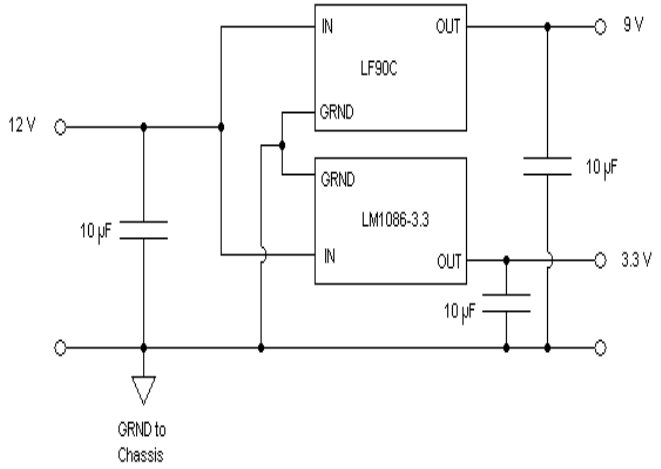
REG13NA-5/3K (5V, TI)

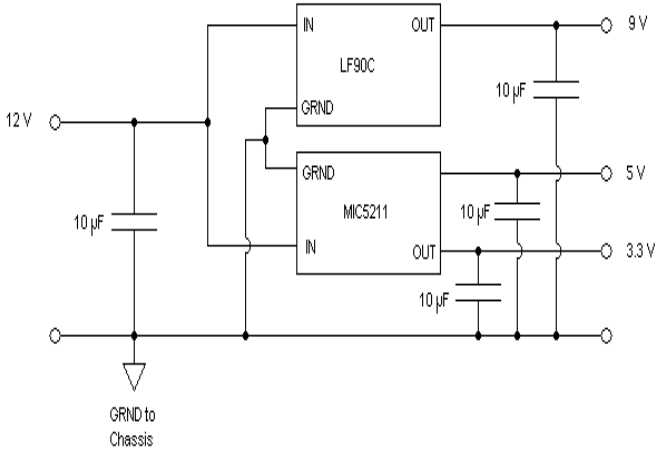
LM1086 (3.3V, National Semi.)

•Vin: 12V, filtered

•Vout: 3.3, 5, 9V; filtered

•Current Limits: Well above spec.

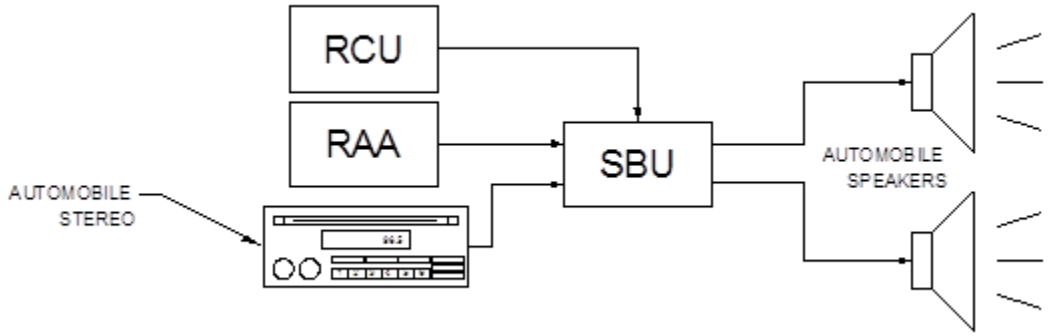




EVADE: Emergency Vehicle Alert Device
SBU

SBU Design Objectives:

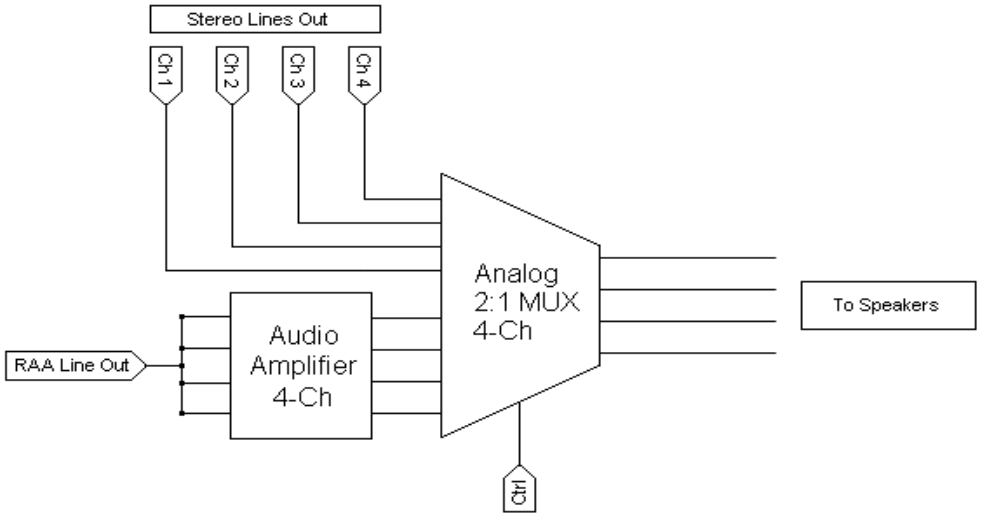
- Cause no distortion of stereo signal when EVADE not in use
- Completely and cleanly bypass stereo signal when in use
- Must operate whether the stereo system is in use or if it is off

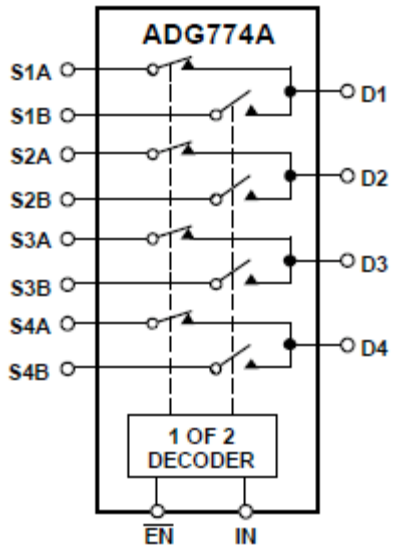


EVADE: Emergency Vehicle Alert Device
SBU

Signal Bypass:

- Bypass accomplished w/ 8:4 Analog MUX (per speaker pair)
  - ADG774A (Analog Devices)
  - Very low distortion < 0.3%
  - 6 ns turn-on
- Simple interface with the vehicle's speaker wires

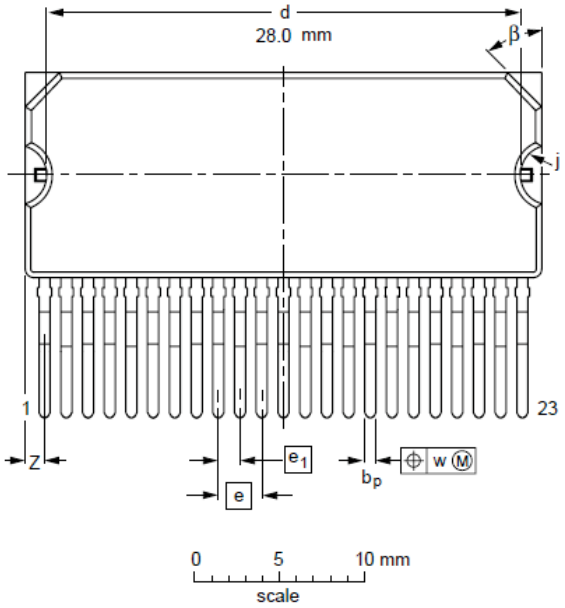


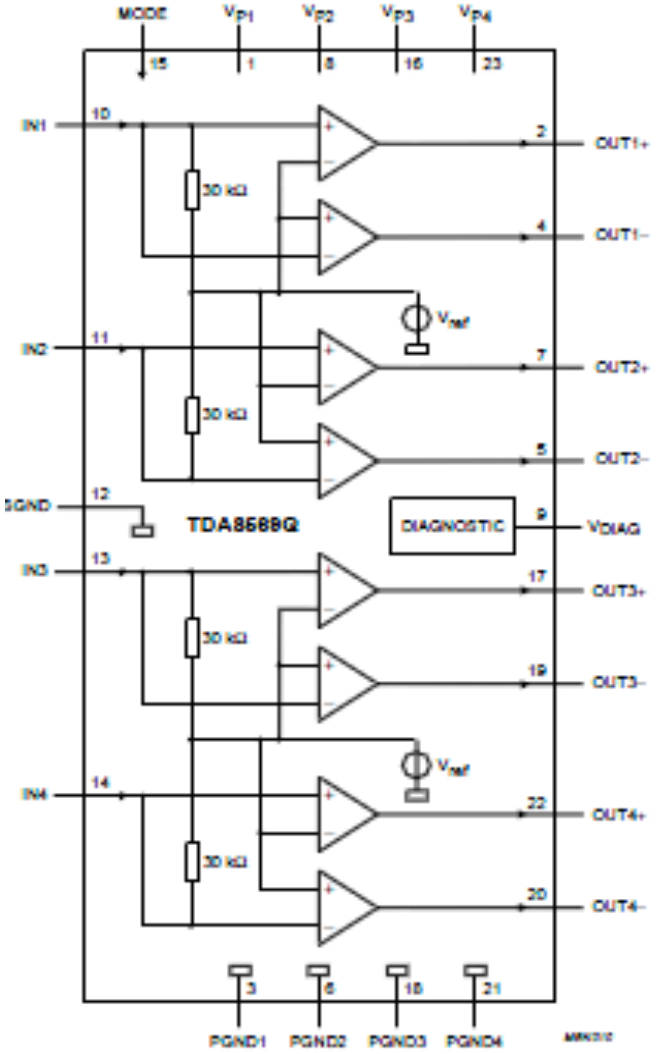


EVADE: Emergency Vehicle Alert Device
SBU

Signal Amplification:

- Amplifies RAA signal to drive speakers
  - TDA8569Q (Philips Semiconductors)
  - 4 x 40 W quad car radio power amplifier
  - Capable of driving 2 Ohm loads

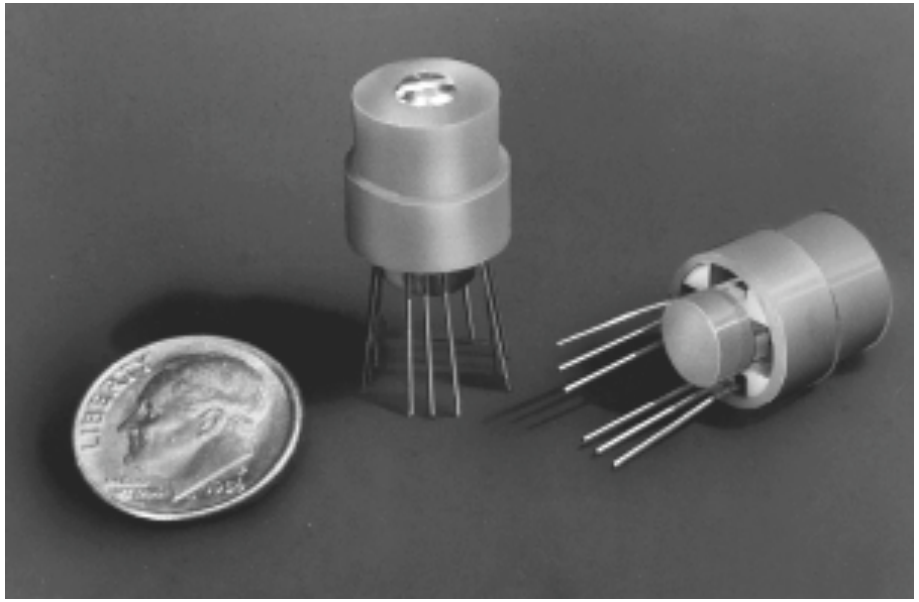





Subsystem #2 - Joshua Guinn
HEC/GPS – Hall Effect Compass & GPS
ETD – Emergency Transmission Device

EVADE: Emergency Vehicle Alert Device

Hall-effect Compass Characteristics



Operating voltage = 6 to 18 V

Operating Temp = -20 to 85ºC

About the size of a dime

.5 in diameter

.5 in tall

Weighs about 2.25 grams

12 pin layout

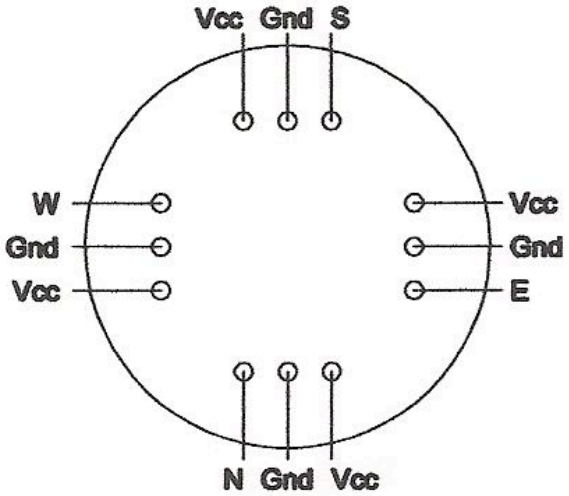
EVADE: Emergency Vehicle Alert Device

Output pin diagram

Vcc = 12 V input

Output will sink 25 mA @ 12 V

The output will switch so that no more than two adjacent output channels are out putting at any one time



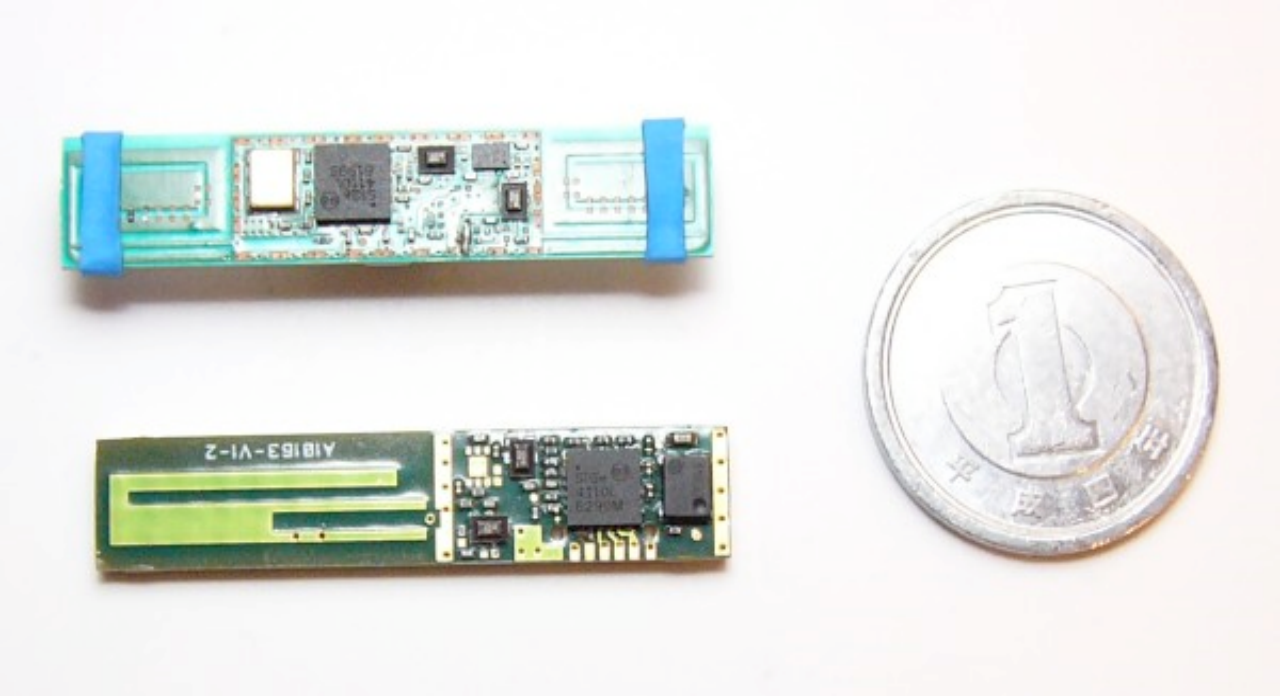
EVADE: Emergency Vehicle Alert Device

GPS Modules researched

General Characteristics	Orcam GPS36	Modulstek MG-S01SP	Antenova M10214-A1
Receiver Architecture	20 channels 1 satellite / channel L1 1575.42 MHz 1.023 MHz chip rate	20 channels 1 satellite / channel L1 1575.42 MHz 1.023 MHz chip rate	20 channels 1 satellite / channel L1 1575.42 MHz 1.023 MHz chip rate
Antenna	active or passive	built-in	built-in
Processor	ARM7 / TDMI	Atlas 1	UART
Data Output Protocol	SiRF Binary NMEA 0183	NMEA 0183	SiRF Binary NMEA 0183
Dimensions	25.4 x 22.86 x 3mm	19.0 x 19.0 x 6.5mm antenna 18 x 18 x 2mm	43 x 9 x 4mm with antenna

EVADE: Emergency Vehicle Alert Device

Antenova M10214-A1



EVADE: Emergency Vehicle Alert Device

GPS Output Protocal

SiRF binary vs. MNEA 0183

The SiRF binary protocol is already in a format that can easily be analyzed by the PIC processor while the NMEA 0183 protocol will need to be transformed into a format that can be analyzed by the PIC processor.

EVADE: Emergency Vehicle Alert Device

GPS Performance Characteristics

- Maximum altitude
  - 18,000 m
- Maximum velocity
  - 545 m/s
- Maximum acceleration
  - 4 g
- Position accuracy
  - 2.5 m
- Acquisition rate
  - < 35 sec cold start
  - < 1 sec hot start

EVADE: Emergency Vehicle Alert Device

GPS Power and Environmental Specifications

- Power supply
  - 3.3 to 5.5 V DC
- Main supply current
  - Acquiring 50 mA
  - Tracking 30 mA
- Operating temperature
  - -20 to 85ºC
- Storage temperature
  - -40 to 85 ºC
- Relative humidity
  - 5 to 95 %

EVADE: Emergency Vehicle Alert Device

Transmitters Researched

- MICRF112
- MICRF113
- MICRF405

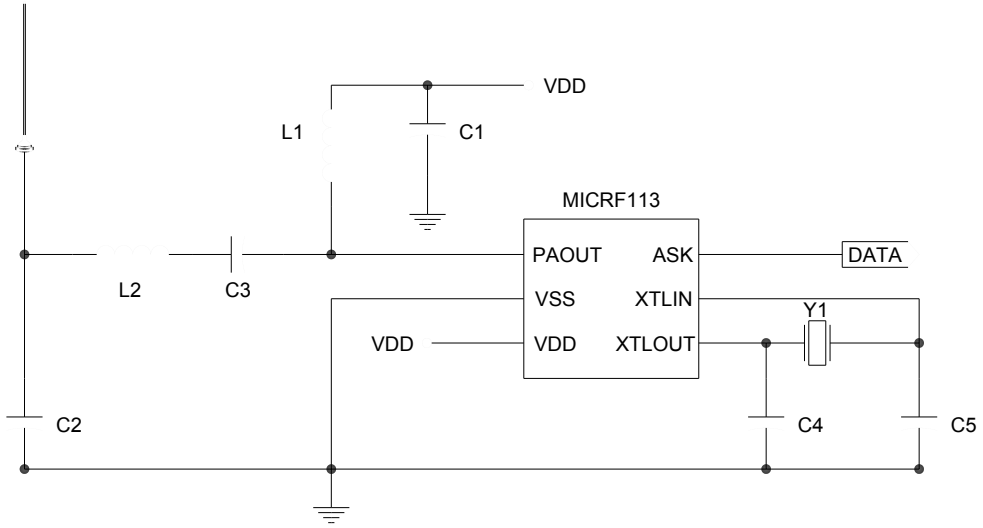
EVADE: Emergency Vehicle Alert Device

Transmitter Operating Ratings

- Supply voltage
  - 1.8 to 3.6 V
- Output power
  - 10 dBm
- Operating temperature
  - -40 to 125 ºC
- Programmable transmitter frequency
  - 300 to 450 MHz
- Data rate
  - 50 kbps

EVADE: Emergency Vehicle Alert Device

Transmitter Operating diagram



Crystal Oscillator	Y_1	9.84375 MHz
Capacitor	C_1	10 µF
Capacitor	C_2	6.8 pF
Capacitor	C_3	10 pF
Capacitor	C_4	18 pF
Capacitor	C_5	18 pF
Inductor	L_1	470 nH
Inductor	L_2	150 nH

Pin #	Pin Name	Pin Description
1	PAOUT	PA output
2	VSS	Ground
3	VDD	Voltage drain (input): positive power supply
4	XTLOUT	Crystal out (output): reference oscillator output connection
5	XTLIN	Crystal in (input): reference oscillator connection
6	ASK	ASK data input

EVADE: Emergency Vehicle Alert Device

Recievers researched

- MICRF002YM-SW48
- MICRF002YM-FS12
- MICRF002YM-FS24
- MICRF002YM-FS48

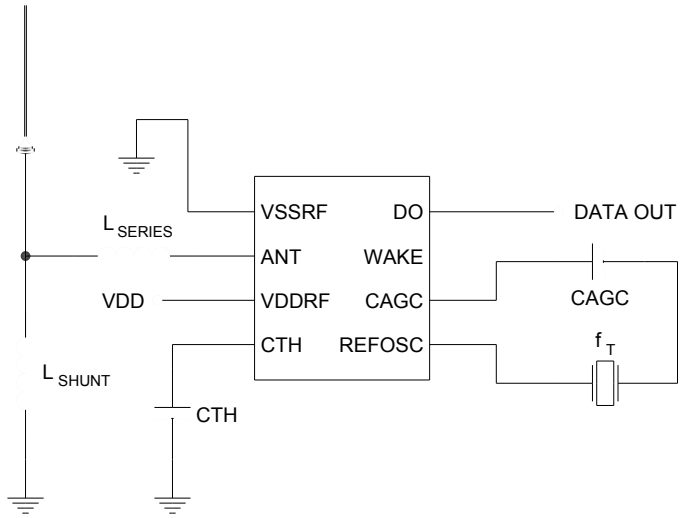
EVADE: Emergency Vehicle Alert Device

Receiver Operating Ratings

- Supply voltage
  - 4.75 to 5.5 V
- Receiver sensitivity
  - -97 dBm
- Operating temperature
  - -40 to 85 ºC
- Receiver frequency range
  - 300 to 440 MHz

EVADE: Emergency Vehicle Alert Device

Receiver Operating Diagram



Reference Oscillator	f_T	4.8970 MHZ
Capacitor	C_{TH}	0.047 µF
Capacitor	C_{AGC}	4.7 µF
Inductor	L_{SHUNT}	15 nH
Inductor	L_{SERIES}	68 nH


Subsystem #3 - Stephen Watson
TCU – Transmitter Control Unit
RCU – Receiver Control Unit

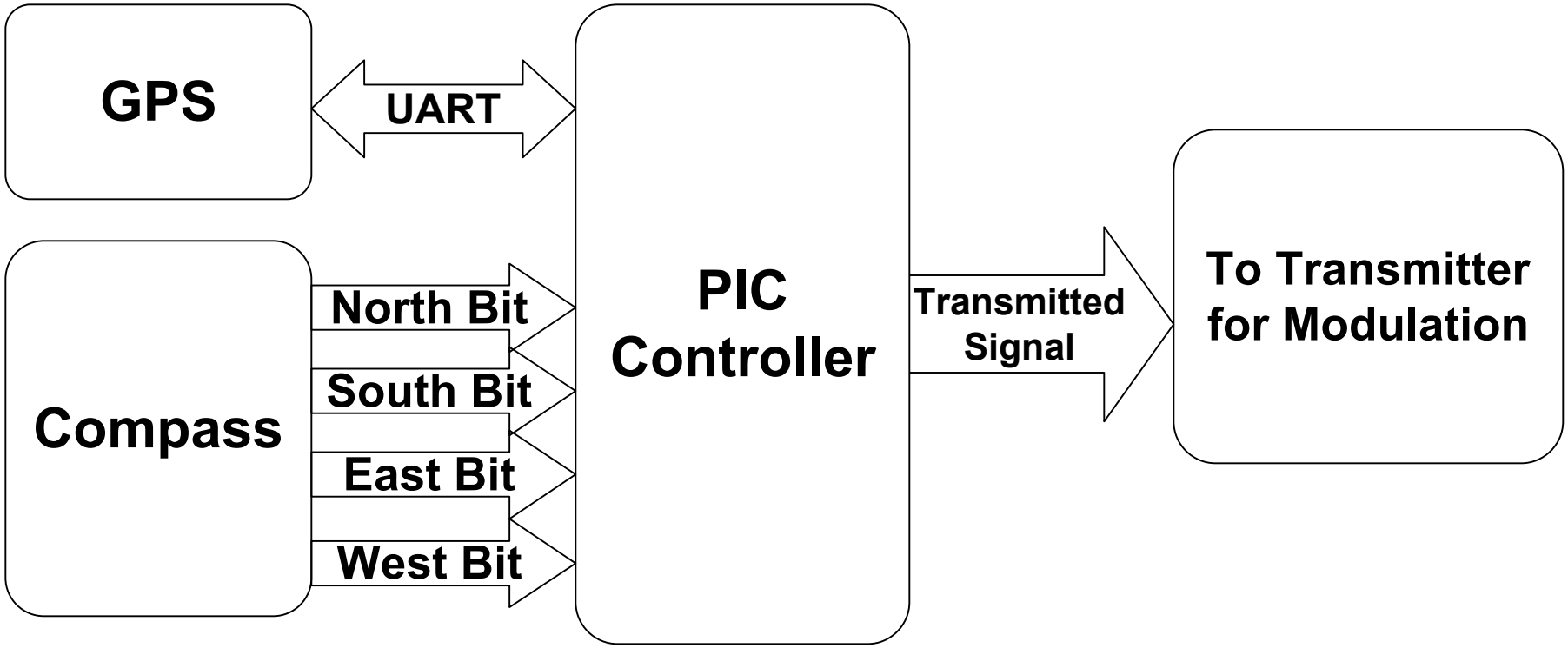
EVADE: Emergency Vehicle Alert Device

Function of the Transmitter Control Unit:

The transmitter control unit is essentially the brains behind the entire transmitter. It serves as the central hub that collects the information from the GPS and Hall effect compass and condenses the positional information as well as the vehicle type into a single signal which is broadcast to the receiver. The transmitter control unit is also required to create the time delays between transmissions so that signals do not overlap.

EVADE: Emergency Vehicle Alert Device

Block Diagram of Transmitter Control Unit:



EVADE: Emergency Vehicle Alert Device

Controller Selection:

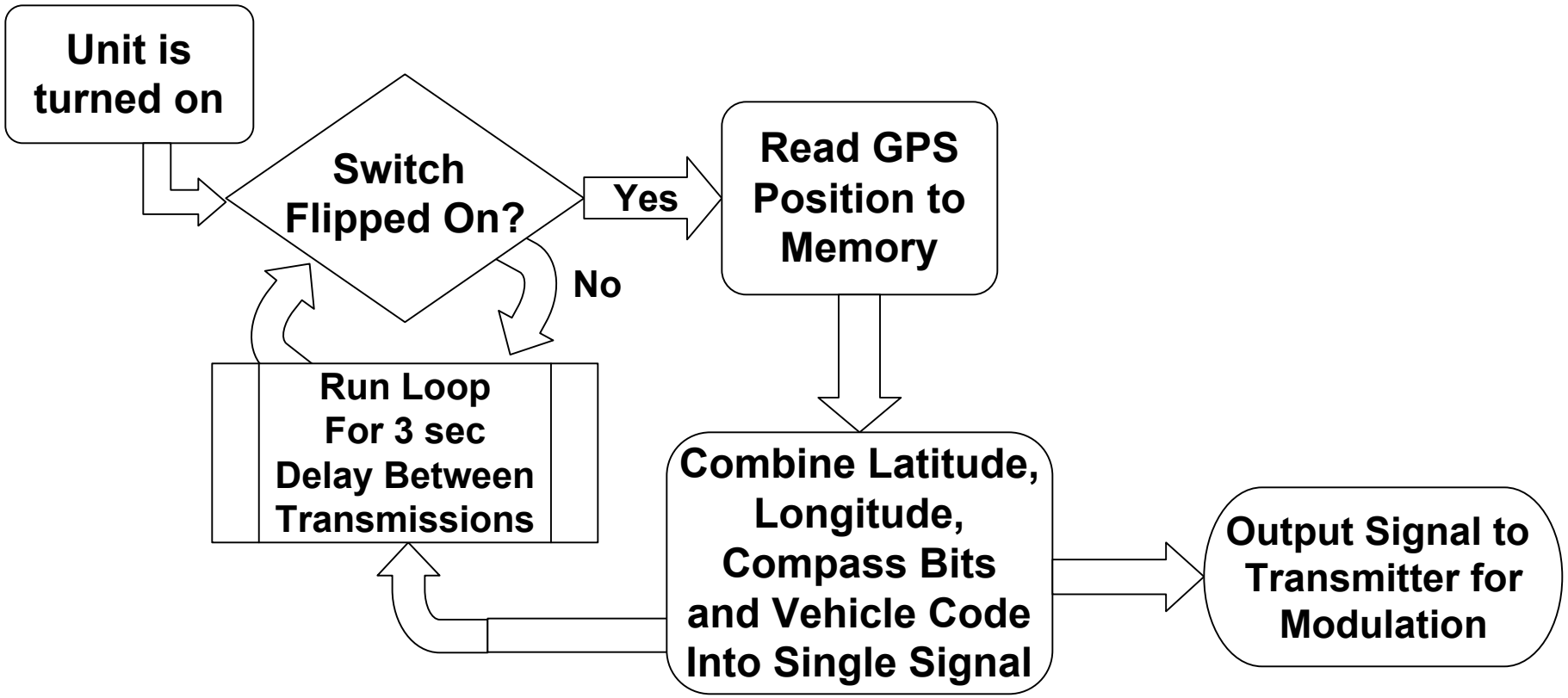
Research narrowed the choice of controller to a FPGA or PIC microcontrollers. With limited testing, PIC controllers were selected as the controller of choice.

Reasons for Choosing PIC:

- **Simplified programming in C**
- **Very inexpensive (with free sample parts)**
- **Easy to use serial protocol**
- **Numerous guides and sample code to assist with programming and debugging**

EVADE: Emergency Vehicle Alert Device

Programming Flowchart:



EVADE: Emergency Vehicle Alert Device

Transmission Delay:

- For a speed of 45 mph:

  45 mph => 66 ft/sec

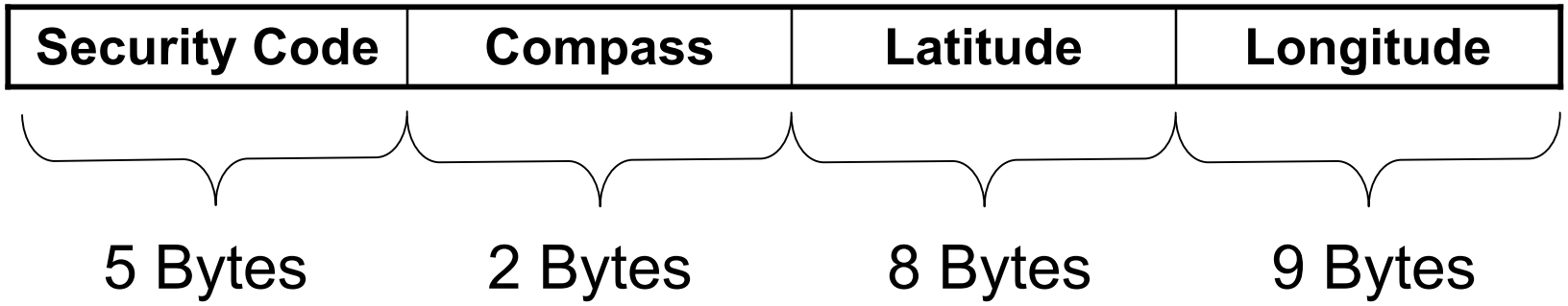
- For a three second delay:

  66 ft/sec x 3 sec = ~200 ft

- With the allowable test range by the FCC, this is the best delay period between transmissions.

EVADE: Emergency Vehicle Alert Device

Transmitted Data Format:



- The total number of bytes to transmit is well below the limit of the transmitter and receiver.

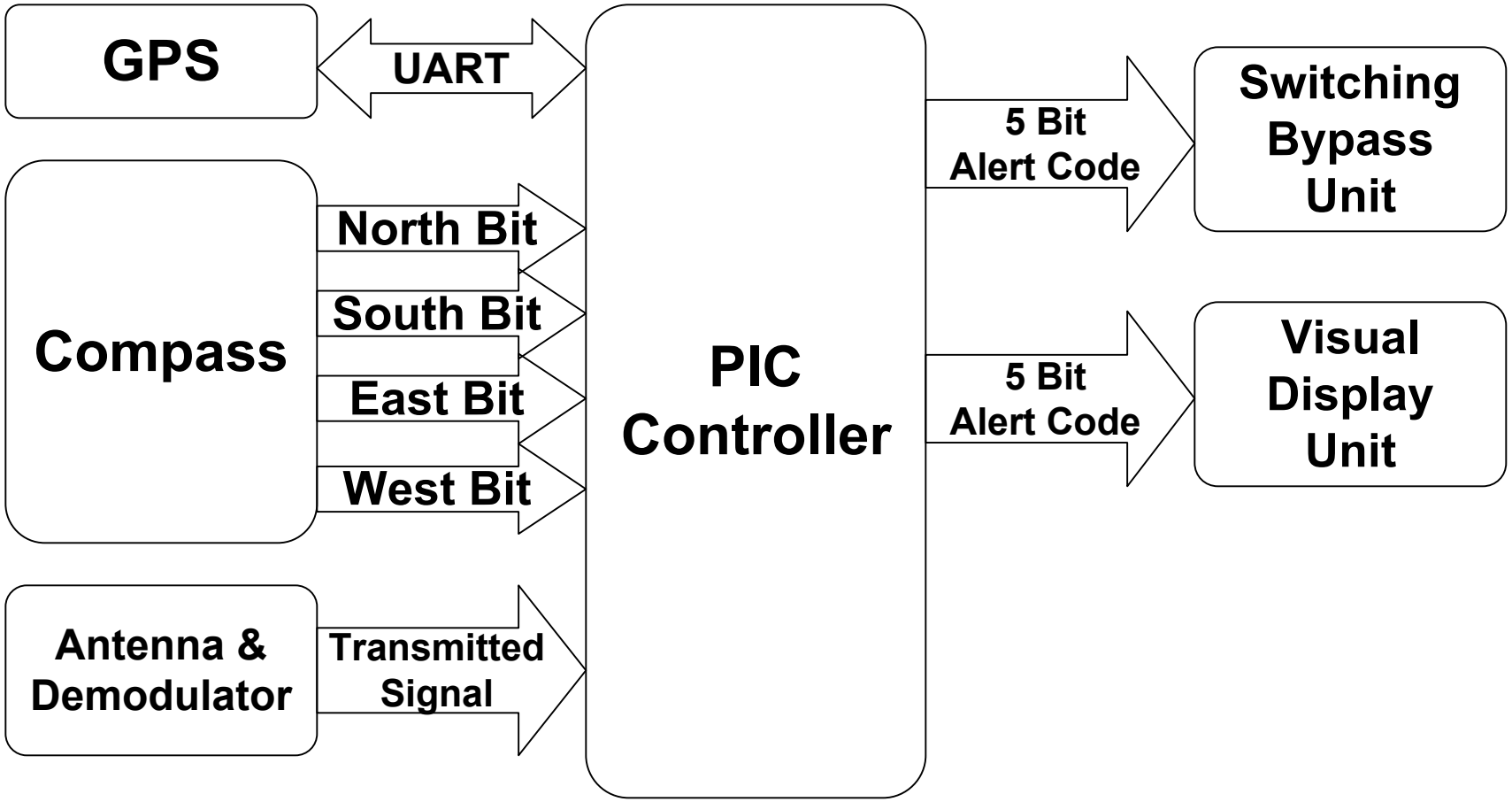
EVADE: Emergency Vehicle Alert Device

Function of the Receiver Control Unit:

The receiver control unit is the most fundamental processing unit of the entire project. As the central control unit, it is required to receive the demodulated transmission signal and properly extract the information. After storing this information, the receiver control unit must compare the positional information of the emergency vehicle with its own GPS coordinates and compass heading to determine if the vehicle paths will intersect and from what direction the emergency vehicle is approaching. The receiver control unit must then initiate the visual and audible alert systems.

EVADE: Emergency Vehicle Alert Device

Block Diagram of Receiver Control Unit:

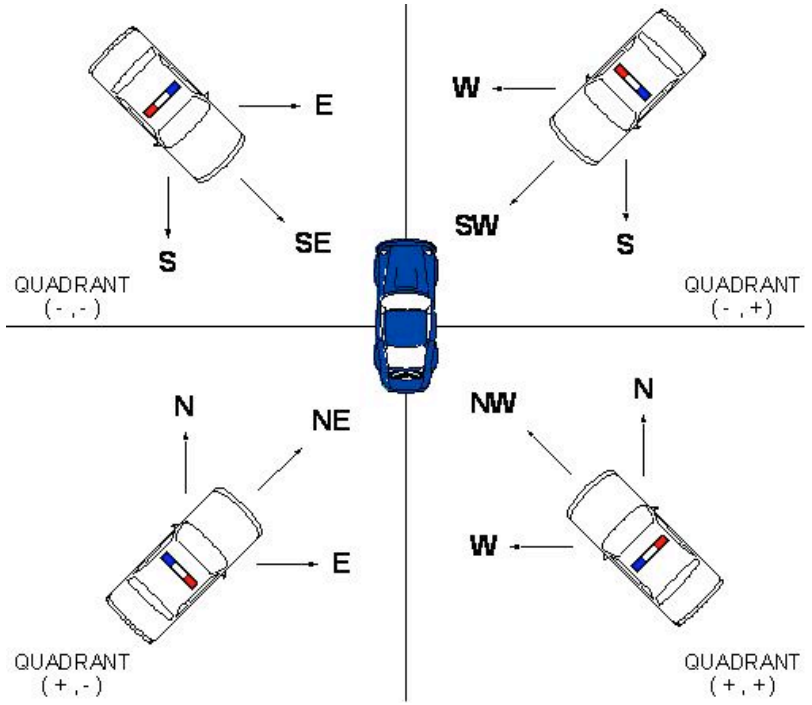


EVADE: Emergency Vehicle Alert Device

Directional Calculations:

In order to calculate the direction of the car relative to the emergency vehicle, the latitude (x value) and longitude (y value) for the emergency vehicle are subtracted from the latitude and longitude of the car.

Based on the whether the coordinates are +/-, the compass direction is used to determine if the vehicles will intersect. This is also used to determine the direction the emergency vehicle is approaching relative to the car.




Subsystem #4 - Charles Logan
RAA – Recorded Audible Alert
VDU – Visual Display Unit

EVADE: Emergency Vehicle Alert Device

RAA

Recorded Audible Alert (RAA):

The RAA provides the first method of alerting the driver by interrupting the audio playback of the car stereo and playing back an audible message indicating the emergency vehicle approach direction.

This system should allow normal audio playback under normal conditions and has the ability to store and playback the various alert messages

EVADE: Emergency Vehicle Alert Device

RAA2

Recorded Audible Alert (RAA):

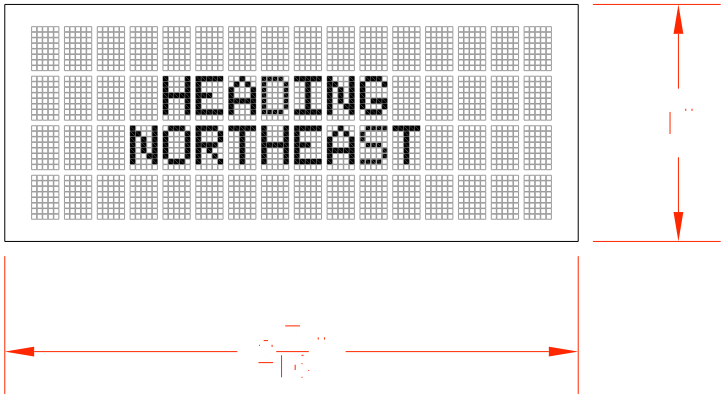
Although the RAA adds an advanced level warning system, this was decided as not adequate enough to alert all motorists, especially the hearing impaired.

A visual device was the next piece of the puzzle to be added.

EVADE: Emergency Vehicle Alert Device

VDU

Visual Display Unit (VDU)

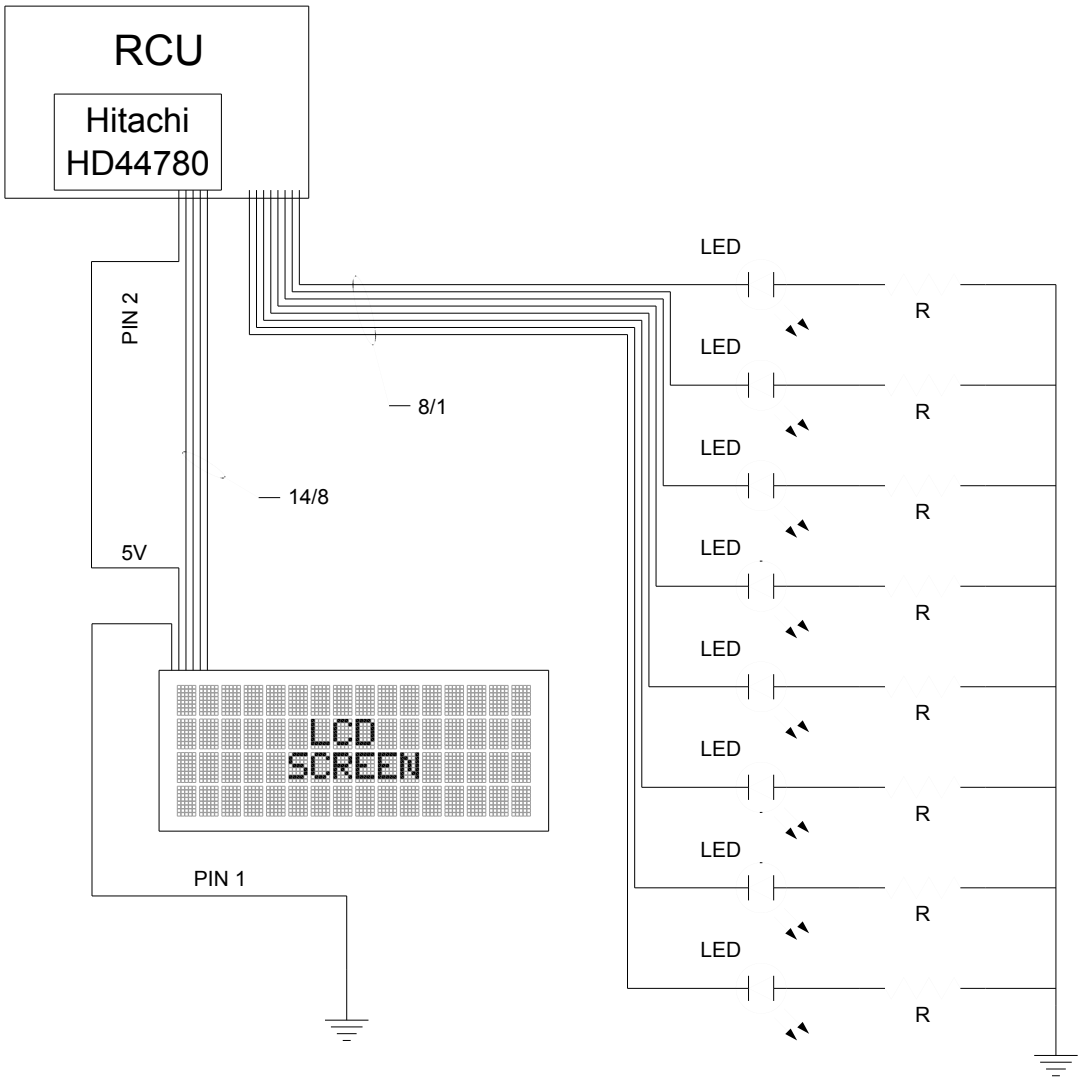


- 16x4 dot matrix LCD
- Display heading under normal operation
- Small size – mountable in dash.

EVADE: Emergency Vehicle Alert Device

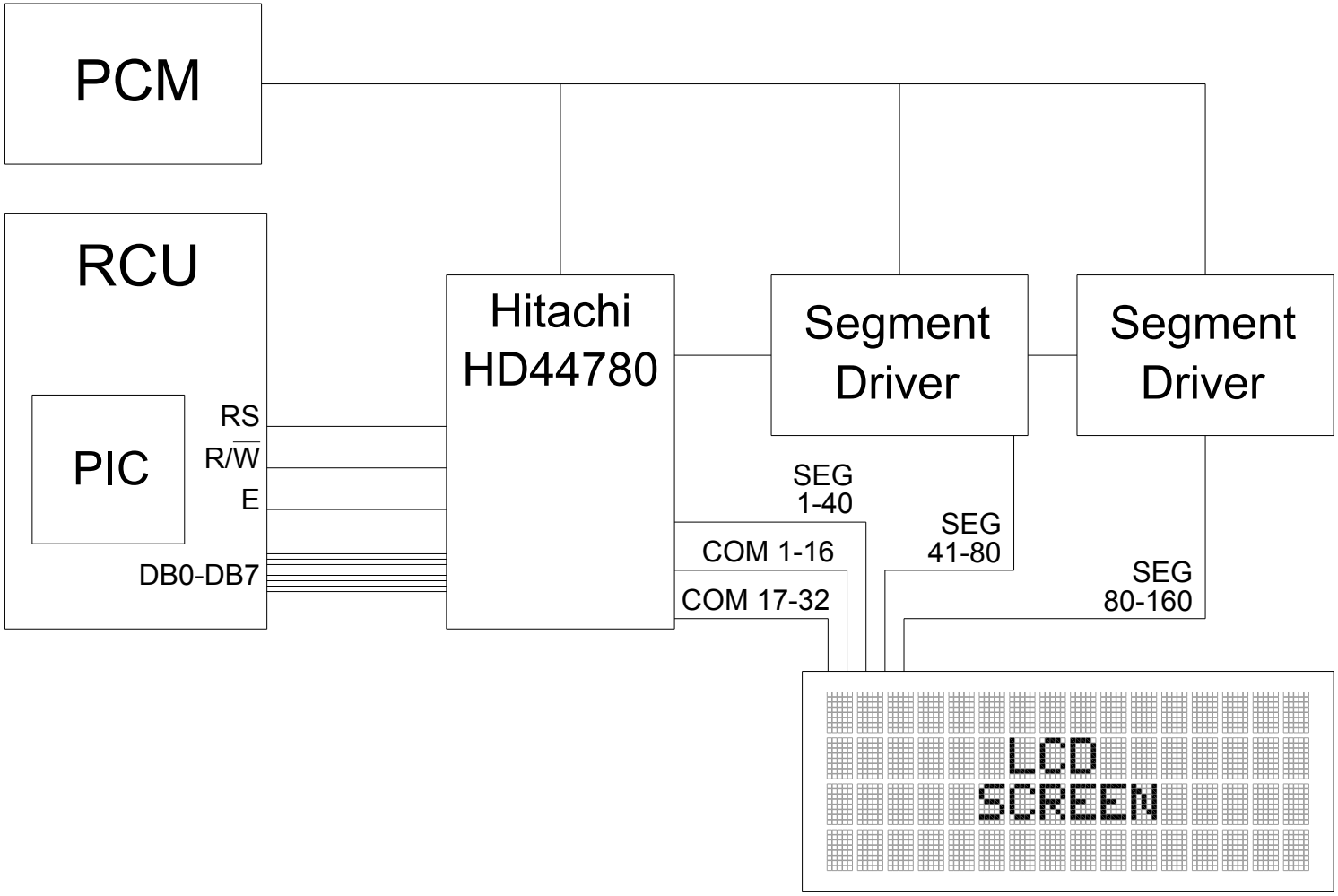
LCD Schematic

- The LCD Display will be driven by the Hitachi HD44780
- Signal for the LED's obtained from the RCU



EVADE: Emergency Vehicle Alert Device

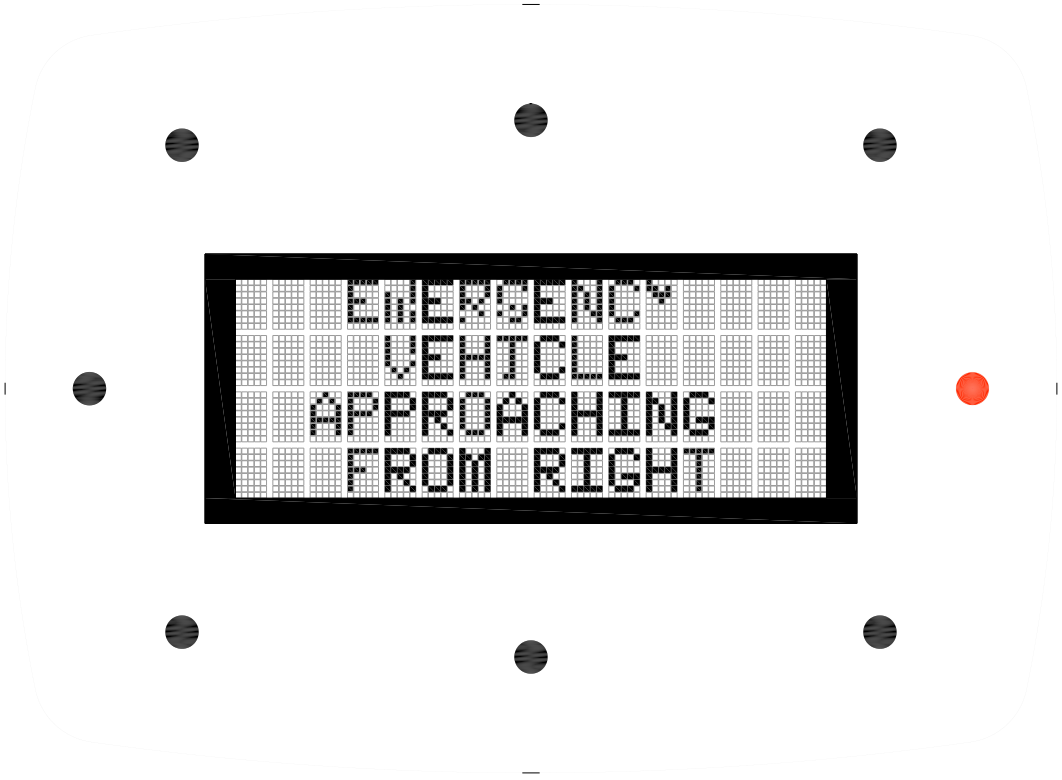
LCD2



EVADE: Emergency Vehicle Alert Device

VDU-LED

Visual Display Unit (VDU)



Under emergency conditions, an LED will blink to alert the motorist of the direction the emergency vehicle is approaching

EVADE: Emergency Vehicle Alert Device

Budget:

Module	Quantity	Unit Cost	Module Cost
Antenna	1	$20	$20
Car Stereo	1	Donated	Donated
Transmitter	1	$30	$30
Hall Effect Compass	2	$20	$40
Power Supply	2	$25	$50
Recorded Audio	1	Donated	Donated
Control Unit	2	$90	$180
Speakers	1	Donated	Donated
Display Screen and LEDs	1	$30	$30
Incidentals			$100
Anticipated Total Cost:			$450
Total Expected Cost (2X Buffer)			$900
Cost Per Group Member			$225

EVADE: Emergency Vehicle Alert Device

Milestones:

Tasks	Jan.	Feb.	Mar	April	May	June	July	Aug	Sept	Oct	Nov	Dec
Choose Project												
Develop Specs												
Research												
Documentation												
Order Parts												
Test Subsystems												
First Prototype												
Mid-term Demo												
Scenario Testing												
Final Prototype												
Present Project												
GRADUATE!												

EVADE: Emergency Vehicle Alert Device

Questions?