HARDWARE DOCUMENTATION

ELCANO HIGH-LEVEL SYSTEM REDESIGN

ELCANO ITEMS: HL PCB v3.0

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Table of Contents

Acronyms and Abbreviations

EE	Electrical Engineering
GPS	Global Positioning System
HL	High-level
HW	Hardware
IC	Integrated Circuit
INU	Inertial Navigation Unit
LL	Low-level
PCB	Printed Circuit Board
SW	Software

Introduction

This document serves as the hardware documentation for the EE capstone project that took place over the quarters of Winter 2018 through Spring 2018. The goal of the capstone project was to redesign both the SW and HW portions of the HL system. This redesign allowed the C6, C4, and C3 processors to be combined into one processor to create a more efficient HL system overall. The main HW tasks included researching to accommodate legacy components of the present HL system, implementing future items such as CAN bus support and a gyroscope, creating a new HL circuit schematic, and designing a new PCB for the new HL system.

HL Features

Arduino Due

The main processor of the new HL system. It provides 32-bit processing with an 84 MHz clock speed. The Due has a 3.3V operating voltage, so care must be taken when interfacing with 5V systems.

Logic Level Shifter

A TXS0108E breakout was used as a general-purpose logic level shift to allow 5V systems to be safely connected to 3.3V systems.

CAN Bus Transceiver

The MCP2551 CAN transceiver by Microchip is needed to translate the signals from the Due's CAN bus to a proper differential voltage.

C7 Vision Connector

The UART1 line allows for serial communication to a Raspberry Pi unit running as the C7 processor.

Sensors and Breakout Boards

MicroSD Breakout

The Adafruit MicroSD breakout board allows a MicroSD card to be interfaced with the HL system. It is connected via the SPI protocol.

Optical Flow Sensor

The ADNS3080 optical flow sensor adds odometry through a visual technique like the method used in a computer optical mouse. The sensor is connected via the SPI protocol.

GPS Breakout

The Adafruit GPS breakout board provides the HL system with the current position information. An external antenna may be connected to allow better communication with the satellites. The GPS is connected via UART.

Compass Breakout

The Adafruit LSM303 compass breakout brings an accelerometer and magnetometer to the HL system. These components are used as the INU. It is connected via I2C.

Gyroscope Breakout

The Adafruit L3GD20H breakout board brings a triple-axis gyro to be implemented in the INU. It may be connected via I2C or SPI. The default connection in the HL PCB is set for I2C communication.

Legacy Items

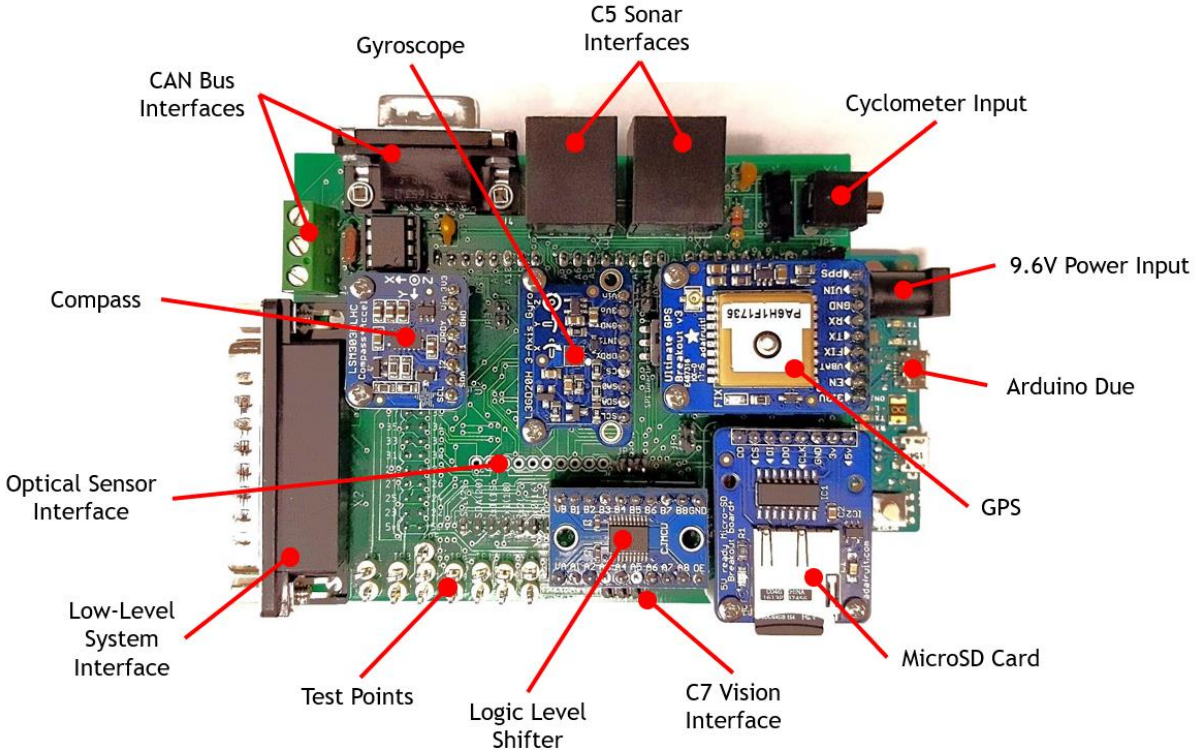
Audio Jack

A 2.5mm audio jack allows for a cyclometer input to the HL system. Future Elcano plans move the cyclometer input to the LL system.

C5 system

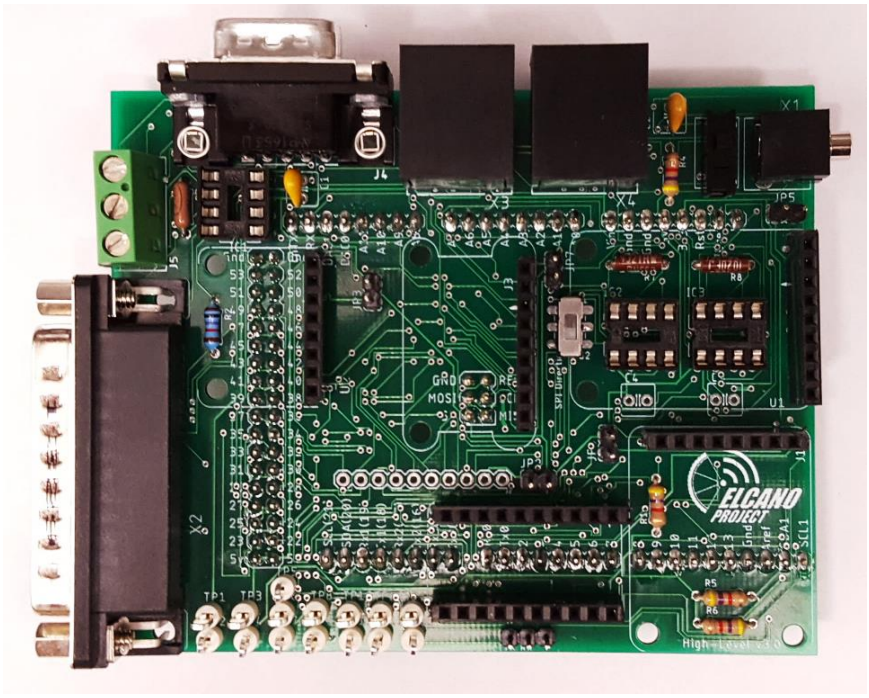
The sonar-based C5 system is on its way to becoming depreciated. Its SPI connection interferes with the main processor of the HL system since the C5 system expects to be the SPI master. A switch is used to toggle between the C5 being the SPI master or the HL main processor. The connection requires DS8921 differential line splitters.

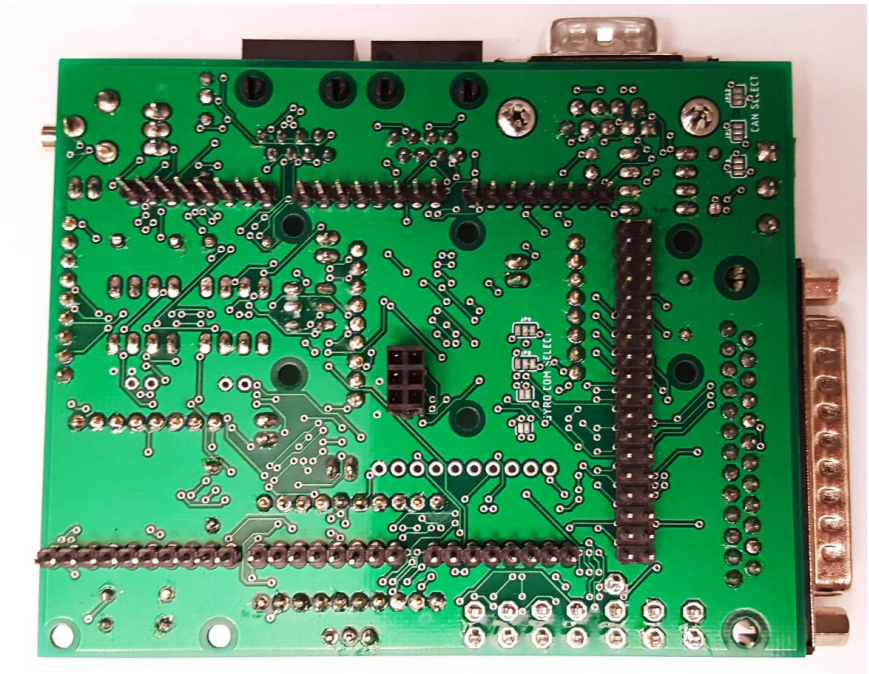
The new HL PCB v3



Assembling the HL PCB v3

Solder the PCB to match the two images below. Add the three ICs, five header jumpers, and breakout boards afterward. The breakout boards have mounting holes to allow a screw, nut, and standoffs to secure them to the HL PCB.





Configuring the HL PCB v3

Sensor Power

The five header jumpers near the MicroSD, optical mouse, GPS, compass, and gyro are used to connect the breakouts to a power rail. Remove the jumpers to disable the breakout.

Click Source Selection

The S1 switch is used to select the source of the click signal either from the audio jack or the 25 pin D-Sub connector. Having S1 in the DOWN position connects the audio jack to the HL system. Having S1 in the UP position connects the signal from the D-Sub to the HL system.

C5 to HL SPI Master Selection

The S2 switch is used to select the SPI master for the connection between C5 and the HL system. Having S2 in the UP position connects the HL system as the master. Having the S2 in the DOWN position connects the C5 processor as the master.

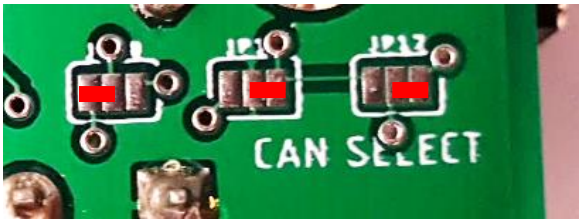
Gyro Communication Method

The Adafruit L3GD20H gyro can be connected to the HL system via I2C or SPI. The communication interface is set by the JP1, JP6, JP8, and JP9 solder jumper pads on the schematic. By default, the HL PCB already has the I2C connections set and no further action is needed. If an SPI connection is desired, then cut the bridges on JP8 and JP9. Afterward, solder the other traces on JP8, JP9, JP1, and JP6. From the image below of the bottom of the PCB, the red traces are pads that need to be joined together and the blue traces need to be cut to establish SPI communication instead of I2C.

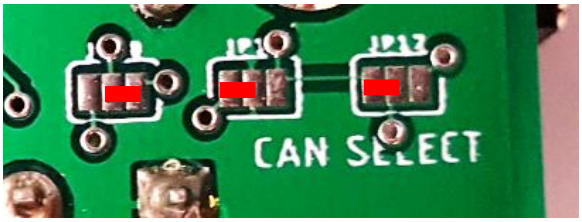
SPI Configuration for gyro

CAN Bus Mode Selection

The CAN bus connection on the HL system has two modes: CAN Analyzer and OBDII. Solder the jumpers according to the images below. The red traces are pads that need to be joined together.



CAN Analyzer Mode



OBDII Mode

Appendix

Reference Material

Arduino Due – Product Link

MicroSD Breakout – Product Link

Optical Flow Sensor – Information Link

GPS – Product Link

Compass – Product Link

Gyroscope – Product Link

Logic Level Converter – Product Link

CAN Transceiver – Product Link

Differential Line Driver – Product Link

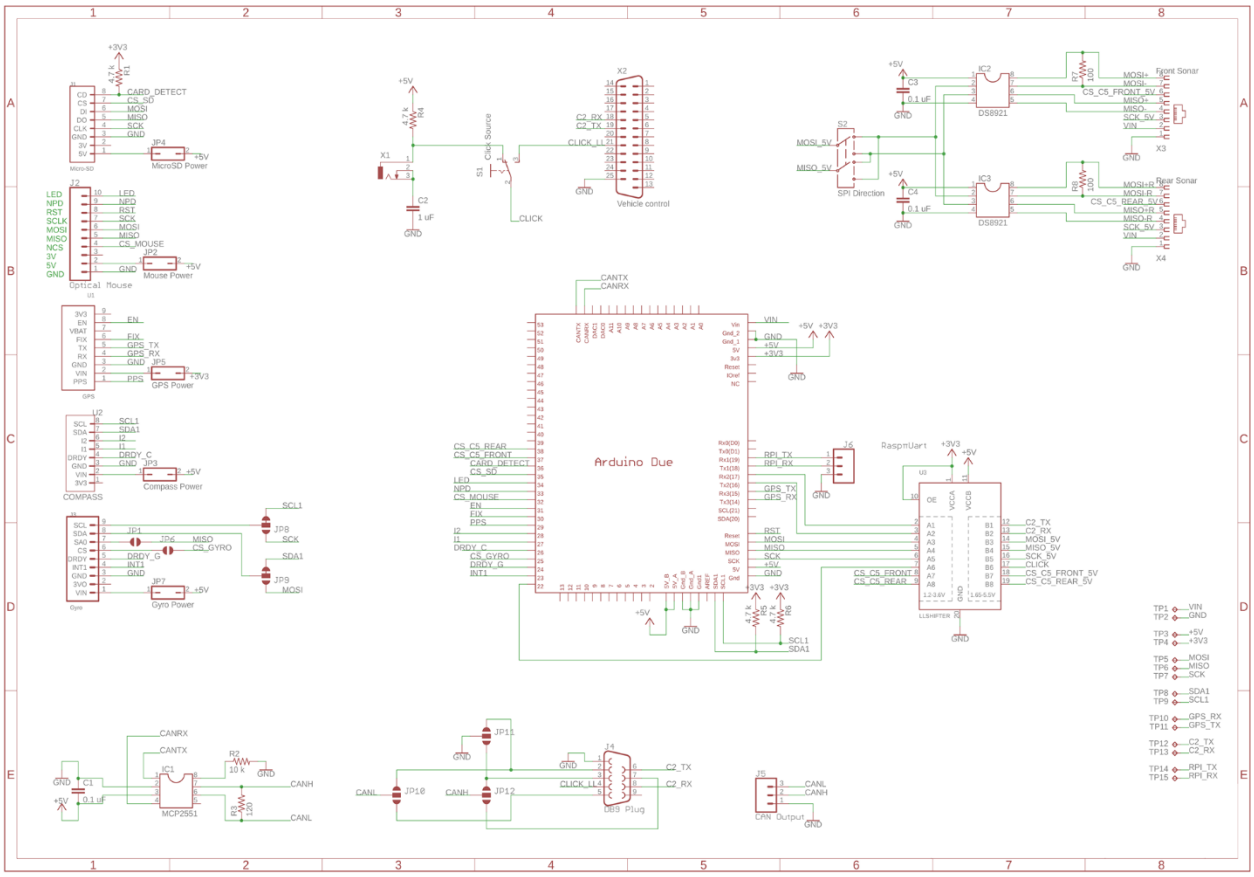
Bill of Materials

Please open ***HL PCB v3.0 BOM.xlsx*** for a more detail view.

#	Item	Value	Quantity	Reference Designator	Notes
1	Resistor	4.7 kΩ	4	R1 R4 R5 R6	
2	Resistor	10 kΩ	1	R2	
3	Resistor	120 Ω	1	R3	Optional depending on CAN bus application
4	Resistor	100 Ω	2	R7 R8	
5	Capacitor	0.1 uF	3	C1 C3 C4	
6	Capacitor	1 uF	1	C2	
7	MCP2551	-	1	IC1	CAN Bus tranciever
8	DS8921	-	1	IC2 IC3	Differential Line Driver and Receiver Pair
9	Arduino Due	-	1	-	https://store.arduino.cc/usa/arduino-due
10	MicroSD Breakout	-	1	J1	https://www.adafruit.com/product/254
11	Optical Mouse Sensor	-	1	J2	http://ardupilot.org/copter/docs/common-mou
12	GPS Breakout	-	1	U1	https://www.adafruit.com/product/746
13	Compass Breakout	-	1	U2	https://www.adafruit.com/product/1120
14	Gyro Breakout	-	1	J3	https://www.adafruit.com/product/1032
15	TXS0108E Breakout	-	1	-	Logic Level Shifter (5V to 3.3V)
16	DB9 Male Connector	-	1	J4	
17	DB25 Male Connector	-	1	X2	
18	2.5mm Audio Jack	-	1	X1	
19	Phoenix Terminal Connector	-	1	J5	Three terminal
20	RJ45 Connector	-	2	X3 X4	
21	SPDT Switch	-	1	S1	
22	DPDT Switch	-	1	S2	
23	Test Points	-	15	TP1-15	
24	MicroSD Card	-	1	-	
25	GPS SMA to uFL Adapter	-	1	-	Optional
26	GPS Antenna	-	1	-	Optional
27	Jumpers	-	5	-	
28	Female Headers	-	As Required	-	
29	Male Headers	-	As Required	-	
30	2 Row Headers	-	As Required	-	
31	IC Sockets	-	3	-	
32	7/16" Standoff	-	8	-	
33	#2-56 Nuts	-	8	-	
34	#2-56 x 3/4 Screws	-	8	-	

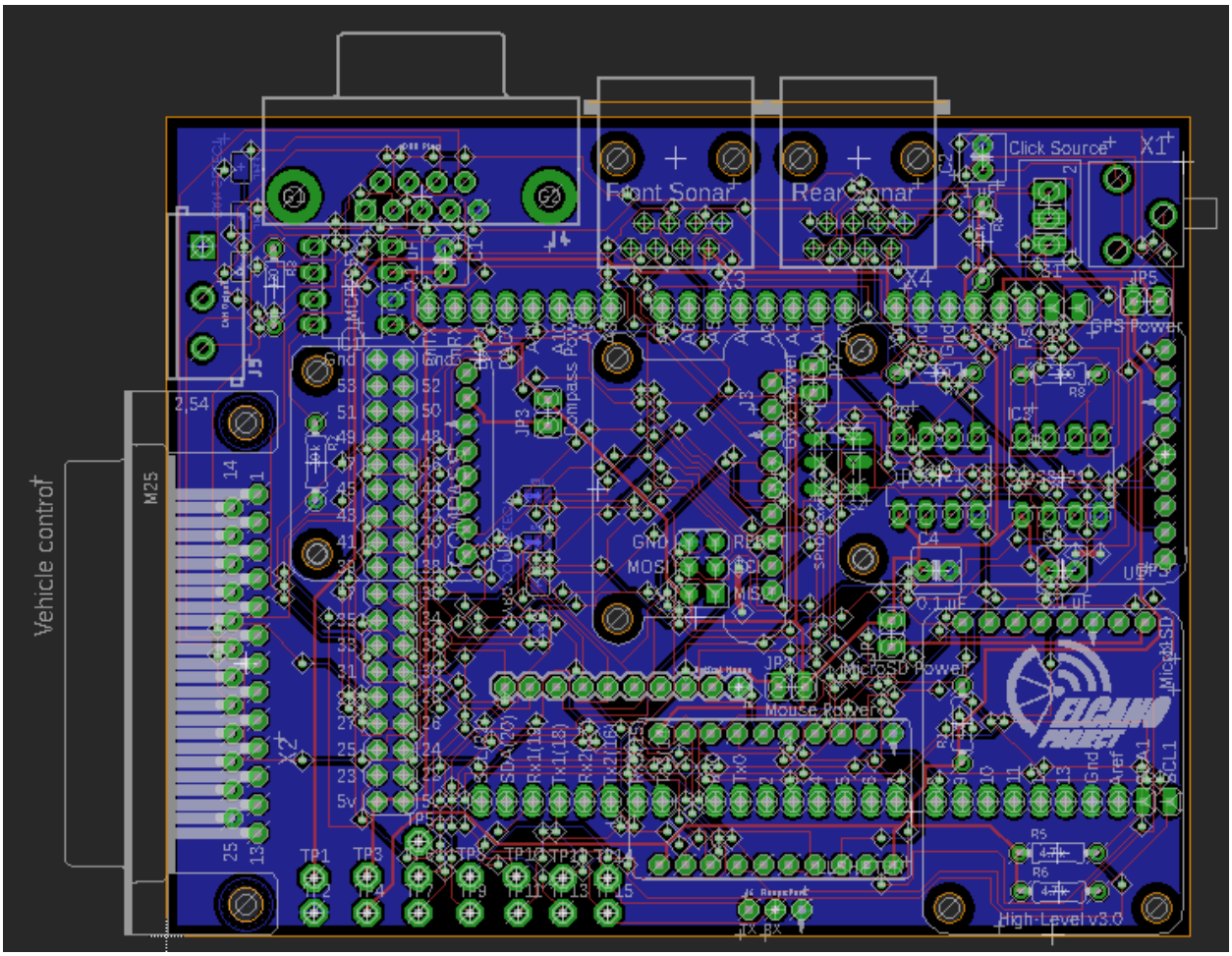
HL PCB v3.0 Schematic

Please open ***High-Level PCB v3.0.sch*** for a more detailed view.



HL PCB v3.0 Board Layout

Please open ***High-Level PCB v3.0.brd*** for a more detailed view.



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