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# **The Design and Implementation of a Wireless CAN Bus Adapter and Power Pack**

## **Abstract**

The purpose of this project was to design and deliver an electrical package to Elmer's Manufacturing that replaced an existing wired controller area network (CAN) bus joystick with a wireless system. This package consisted of two parts: a transmitter that connected to the joystick providing power to it, and a receiver that connected to the hydraulic controller located on the grain cart. Elmer's Manufacturing proposed this project as a method to reduce the amount of physical connections within the cab of the tractor. This served to reduce the risk of an operator getting tangled or tripping over a wiring harness.

The joystick and transmitter were powered by a lithium ion polymer battery and various power distribution circuitry was designed to deliver power throughout the circuit. The receiver was powered by a grain cart and used a design similar to the transmitter for power distribution. The joystick transmitted data on the CAN bus. This data was read by the MCP2515 CAN controller and stored in buffers that were read by the MSP430 microcontroller. The microcontroller relayed the data to the nRF24L01+ wireless transceiver and then transmitted. When the receiving nRF24L01+ chip received the data, it converted it into a CAN message that was sent to the hydraulic controller on the grain cart.

The completed prototype was subjected to many tests. The results indicated a ~9.5-day standby battery life and a ~34-hour continuous use battery life. The components chosen were measured to have a maximum current draw of ~140mA. A useful range from the cab of the tractor to grain cart was confirmed to be ~30ft. An operating delay of approximately 29ms was achieved. Finally, an enclosure was designed using a reference provided by Elmer's Manufacturing that successfully fit within a cup holder. These results indicate all performance metrics were met which correlates to a successful completion of this project. However, there are suggestions for future considerations to improve the system.

In conclusion, the system was successfully designed and constructed and meets or exceeds all desired performance metrics.

### Performance Table

Group 4 was successful in designing and fabricating a wireless transmitter receiver pair that included a power pack. The system meets or exceeds all proposed design metrics which were selected by Group 4 and verified by the customer, Elmer's Manufacturing. Table 1 shows the proposed design metrics and how the system performed.

Table 1: Completed design metrics.

Performance Metric	Proposed Value	Tested Value
Range	Tractor Cab to Grain cart: ~30ft	Tractor Cab to Grain Cart: ~30ft
Battery Life (continuous use)	> 4 Hours	> 34 Hours
Battery Life (standby mode)	> 7 Days	> 9.5 Days
Operating Delay	< 500 ms	29 ms
Enclosure Size	<= 355 cm <sup>3</sup>	355 cm <sup>3</sup>
Discharge Rate	< 500mA	140mA (max)

## Budget

The total cost of this project was approximately \$1469.09. The approximation arose from the estimated values selected for the price of the joystick and falcon controller. A total of \$386.71 was paid for by the University of Manitoba and the remainder was supplied by Elmer's Manufacturing. Group 4 consisted of 4 members which equated to a budget of \$400. Therefore, with respect to the amount provided by the University of Manitoba, \$386.71, this project was completed under budget. Table 2 shows the final project budget compared to the proposed project budget.

Table 2: Comparison of proposed budget and actual project cost.

Proposed		Actual	
Description	Cost	Description	Cost
Microcontroller	\$7.66	Microcontroller	\$7.66
Wireless Modules	\$48.18	Wireless Modules	\$50.87
CAN Bus Transceiver Module	\$57.90	CAN Bus Transceiver Module	\$57.90
LiPo Battery	\$34.99	LiPo Battery	\$34.99
LiPo Battery Charger	\$26.95	LiPo Battery Charger	\$26.95
DC-DC Converters	\$16.76	Buck Converter	\$16.76
		Linear Regulator & MOSFET	\$18.27
2.45GHz RP-SMA Antenna	\$5.44	2.45GHz RP-SMA Antenna	\$6.72
PCB ( <i>Price Approximated</i> )	\$125	PCB ( <i>Price Approximated</i> )	\$80.00
Miscellaneous	\$16.22	Miscellaneous	\$51.46
		Taxes and Shipping ( <i>estimate</i> )	\$35.18
<b>Total Supplied by U of M</b>	<b>\$339.10</b>	<b>Total Supplied by U of M</b>	<b>\$386.71</b>
Joystick ( <i>estimate</i> )	\$500.00	Joystick and Falcon Controller ( <i>estimate</i> )	\$1000.00
Connectors	\$30.00	Connectors	\$82.38
Enclosure	\$40.00	Enclosure	\$0.00
		Taxes and Shipping ( <i>estimate</i> )	\$10.12
<b>Total Supplied by Elmer's Man.</b>	<b>\$570.00</b>	<b>Total Supplied by Elmer's Man.</b>	<b>\$1082.38</b>