Elmer’s Wireless Joystick
User Manual

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Specifications

Table 1: Proposed vs. Actual Performance Metrics

Performance Metric	Proposed Value	Actual Value
Range	Tractor Cab to Grain Cart ~ 30 ft	Tractor Cab to Grain Cart ~ 30 ft
Battery Life (Continuous)	> 4 Hours	> 34 Hours
Battery Life (Standby)	> 7 Days	> 9 Days
Operating Delay	< 500ms	29ms
Enclosure Size	≤ 355cm^3	355 cm^3
Discharge Rate	< 500mA	140mA (max)

The required range was a metric chosen by Elmer's Manufacturing to ensure that the wireless signal could reach the grain cart's receiver package from the wireless joystick package inside the tractor cab. This metric was tested at the Elmer's Manufacturing facility.

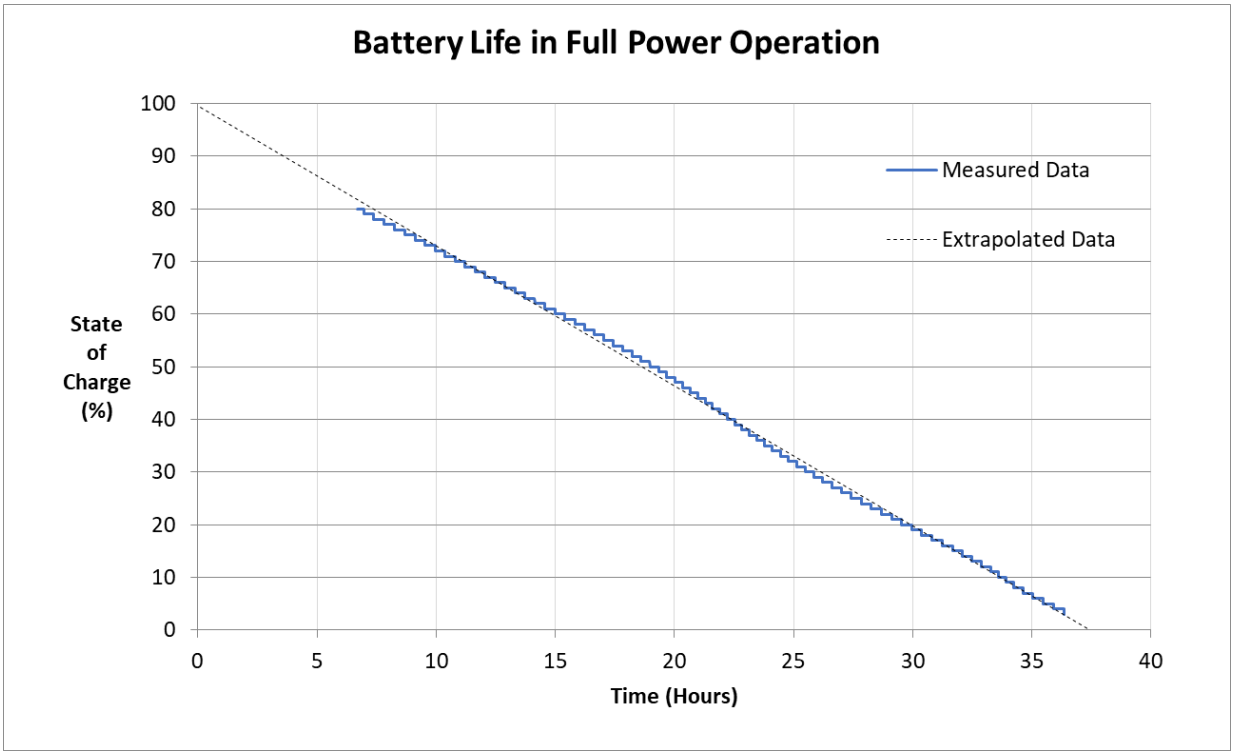


Figure 1: Measured Discharge Rate in Full Power Operation

The operational battery life was a metric chosen by Elmer's Manufacturing to satisfy a day of harvest. Operational battery life was tested by allowing the module to transmit for an extended period of time. State of charge was continuously monitored throughout the test. Figure 1 shows that a fully charged battery would last more than 34 hours.

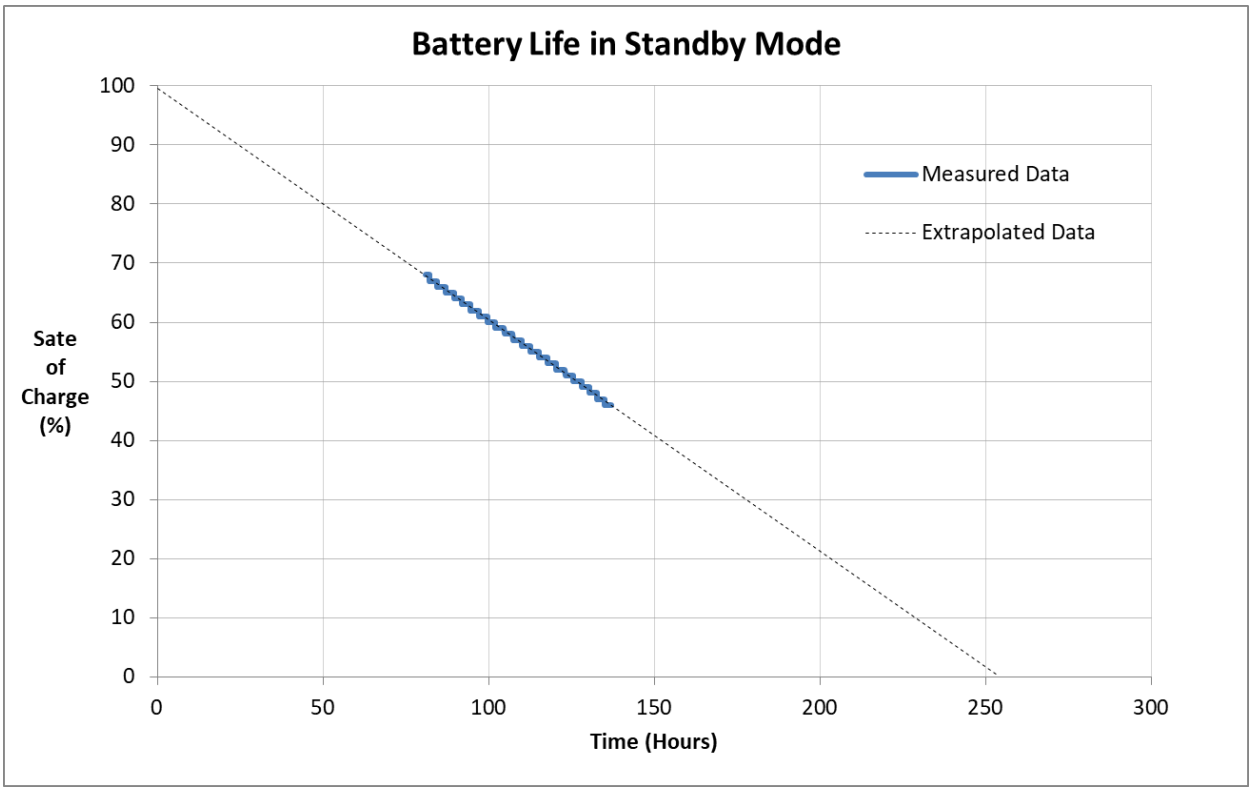


Figure 2:Measured Discharge Rate in Standby Mode

Battery life in sleep mode was required to last more than one week. This metric was chosen by Elmer's Manufacturing as it allowed the wireless joystick to go without charging for a few days without worrying about the battery depleting after each day. This feature was implemented by adding software that puts the transmitter to sleep. The power to the joystick is also cut off with an electrical switch. Testing was done similarly to the operational battery life; however, the modules were put to sleep and the joystick was unpowered. Testing showed that the sleep mode battery life was observed as greater than 9 days, which met the design metrics as shown in Figure 2.

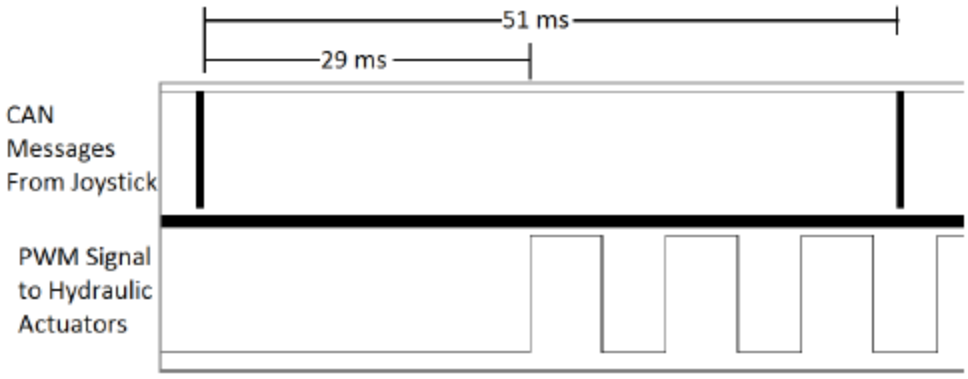


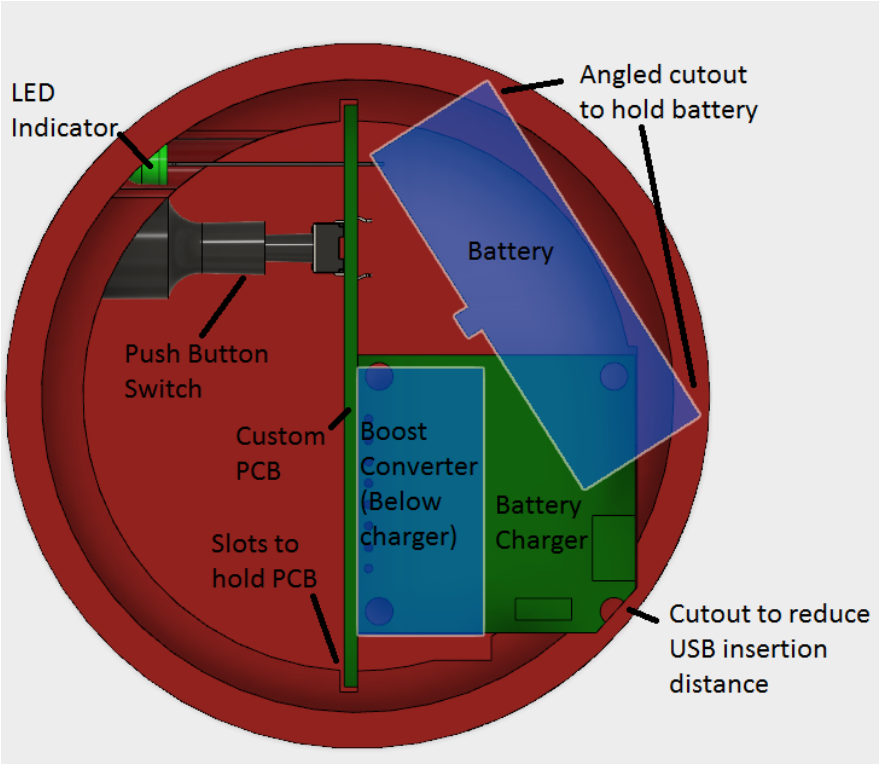
Figure 3: Measured Delay Between Button Press and Hydraulic Controller Output

Operational delay was considered to ensure that the wireless design did not introduce noticeable delay between the joystick operation and the hydraulic functions. This metric was determined to be 29ms by measuring the time between a button press on the joystick and an actuator signal from the hydraulic controller.

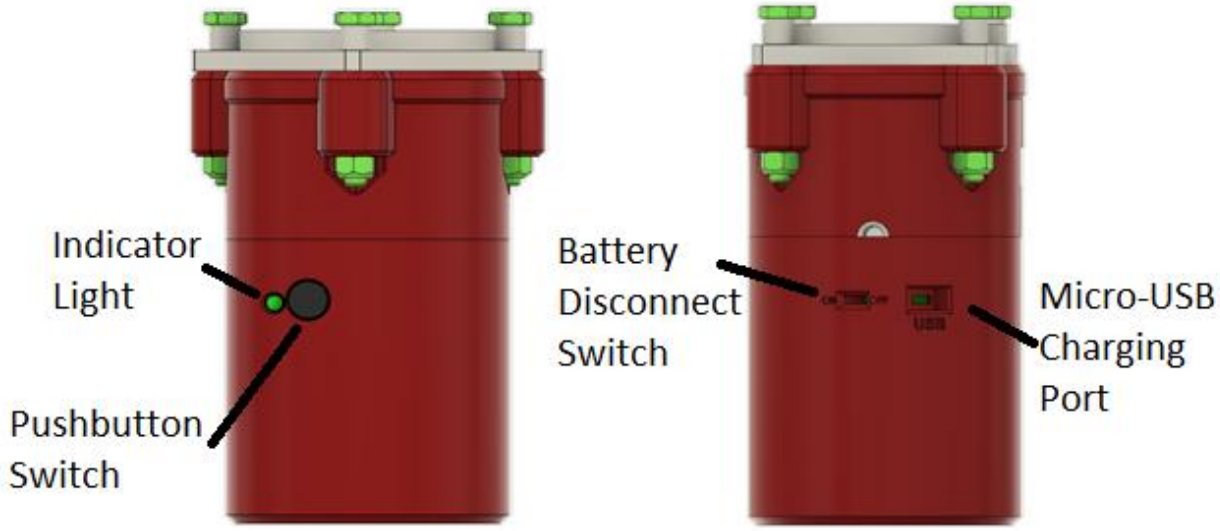
Enclosure size was a metric specified by Elmer's Manufacturing so that the wireless joystick could fit in a cup holder of the tractor cab. To meet this metric, the enclosure was designed around a reference provided by Elmer's Manufacturing. The receiver enclosure was designed to be mounted to the grain cart.

To allow for operation during charging, the discharge rate was required to be less than the charging rate supplied by micro-USB. The charger supports 500mA of charging current, and the maximum discharge current was 140mA. Therefore, the design goal of charging capabilities was met.

Operation:



(a)



(b)

Figure 4: Transmitter Enclosure Model. (a) Top View Inside Enclosure with Joystick Removed. (b) View of Exterior of Enclosure

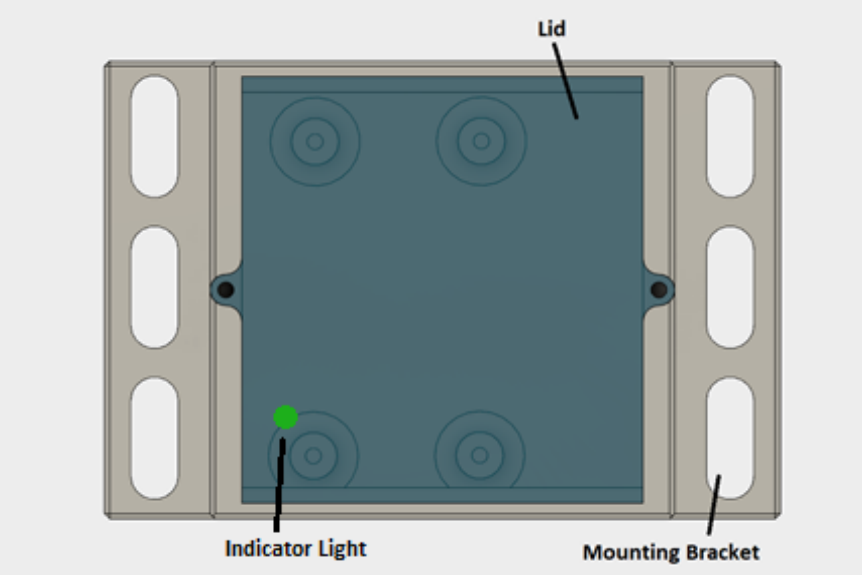


Figure 5: Top View of Receiver Enclosure

Full Power Operation, Not Charging:

During this state, the green light blinks once approximately every 2 seconds. The transmitter is transmitting during this state. This will continue until one of four things occurs:

- If the battery is disconnected, the modules do not operate.
- No user input for 5 minutes
- Push button is pressed and held for 5 seconds
- Battery life below 10%

When the first condition occurs, no power is supplied to the modules, and no operation occurs. During the next two conditions, the transmitter enters low power mode and can be woken up with a pushbutton press. The last condition requires the battery to be charged above 10% to resume use.

Full Power Operation, Charging:

During this state, the light fades green. The transmitter is transmitting during this state. This state continues to operate like the non-charging state, however is not put to sleep by user inactivity. Once unplugged, the transmitter enters the non-charging state.

SOC Check State

This state can only be entered while the battery is not charging. During this state, the light is on for three seconds and displays a colour according to the state of charge. While the battery is above 66%, the light displays green, if below 33%, red, and if in between 66% and 33%, displays yellow. This state is entered when a user holds down the pushbutton switch for one second. Once this state finishes, the transmitter packages return to the non-charging operation state.

Sleep Mode, Not Charging

During this mode, the transmitter is in low power and not transmitting. The transmitter will remain in this mode until a user presses the pushbutton switch. When the pushbutton is pressed, the transmitter is woken up and resumes transmitting.

Sleep Mode, Charging

This mode behaves similarly to the Sleep (Not Charging) state. The transmitter is being charged in this state.

Troubleshooting

Transmitter Issues

Table 2: Transmitter Issues and Solutions.

Issue	Solutions
Green indicator light not blinking During normal operation, the green light should either blink once every 2 seconds (not charging) or fade in and out (while charging)	Verify battery disconnect switch in in the ON position. The red light on the battery charging module should be ON Press the pushbutton to verify the transmitter has not entered sleep mode. The green light should now start blinking Plug in the micro-USB charger. The transmitter shuts down when the battery is below 10% charge to prevent damage Verify the 6-pin joystick connector is properly connected to the wiring inside the transmitter enclosure Verify all 5 wires of the screw terminal on the circuit board are installed as shown in the schematics below and the screws are tight
Battery not charging During normal battery charging, the green light will slowly fade in and out	Verify the micro-USB connector is properly inserted in the battery charger board. The blue light should be on whenever the micro-USB cable is plugged in and powered Verify the physical disconnect switch is in the ON position. The battery does not charge while the switch is OFF

Receiver Issues

Table 3: Receiver Issues and Solutions.

Issue	Solutions
No lights on receiver During normal operation, the light on the receiver should rapidly flash green (good connection) or red (no connection)	Verify the 2-pin connector from the receiver is properly plugged into the grain cart wiring harness Verify the grain cart has power supplied
Red light on Receiver A rapidly flashing red light on the receiver indicates that there is no connection between the transmitter and receiver	Verify the external antenna on the receiver is inserted and securely tightened Verify the transmitter is transmitting (see above sections)
Green Light on receiver but no auger movement A flashing green light on the receiver indicates that the receiver is correctly receiving messages from the transmitter	Verify the 3-pin connector from the receiver is correctly inserted into the 3-pin connector on the grain cart wiring harness Verify the 3 wires inside the receiver are correctly installed in the screw terminals as shown in the schematics below. Ensure the screws are tight Verify the hydraulics on the grain cart are active If available, use the Elmer's Manufacturing PC Tools software to verify the joystick is detected and no errors are present.

Parts List:

The following parts list contains all the required components for both the transmitter and receiver packages.

Table 4: Parts list.

Item	Quantity	Manufacturer Part Number	Vendor Part Number	Vendor
Microcontroller	2	MSP430G2553	296-28431-1-ND	Digikey
Wireless Module	1	WRL-00691	0293-SPF	Canada Robotix
Wireless Module w/ External Antenna	1	WRL-00705	1568-1296-ND	Digikey
CAN Bus Transceiver Module	2	MIKROE-986	1471-1324-ND	Digikey
Lithium-Ion Polymer (LiPo) Battery	1	0233-PRT	0233-PRT	Canada Robotix
Battery Babysitter LIPO Battery Charger	1	PRT-13777	1568-1404-ND	Digikey
20W Adjustable DC-DC Buck Converter	1	DFR0379	1738-1293-ND	Digikey
DC-DC Boost Converter	1	DFR0123	1738-1144-ND	Digikey
Linear Regulator	2	MCP1825S-3302E/AB	MCP1825S-3302E/AB-ND	Digikey
N-Channel MOSFET	1	IRL40B209	IRL40B209-ND	Digikey
Push button Switch	1	3-1825910-1	450-1643-ND	Digikey
2.45GHz RP-SMA Antenna	1	W1027	553-1310-ND	Digikey
3-Position Screw Terminal	1	1725669	277-1274-ND	Digikey
5-Position Screw Terminal	1	OSTVN05A150	ED10564-ND	Digikey
RGB LED	2	WP154A4SUREQBFZGW	754-1492-ND	Digikey
PCB (Price Approximated)	1	N/A	N/A	PCBWay
6 Pin Plug Deutsche Connector	1	DTM06-6S	571-DTM06-6S	Mouser
6 Pin Connector Wedge Lock	1	WM-6S	571-WM-6S	Mouser
Deutsche Socket Terminals (Loose)	6	1062-20-0222 (Loose Piece)	571-1062-20-0222-LP	Mouser
2 Pin Receptacle Deutsche Connector	1	DT04-2P	571-DT04-2P	Mouser
2 Pin Connector Wedge Lock	1	W2-P	571-W2-P	Mouser
3 Pin Receptacle Deutsche Connector	1	DT04-3P	571-DT04-3P	Mouser
3 Pin Connector Wedge Lock	1	W3P-1939	571-W3P-1939	Mouser
Deutsche Pin Terminals (Loose)	5	1060-16-0622 (Loose Piece)	571-1060-16-0622-LP	Mouser

Schematics

As shown below, is the wiring schematic for all modules used in the transmitter and receiver design.

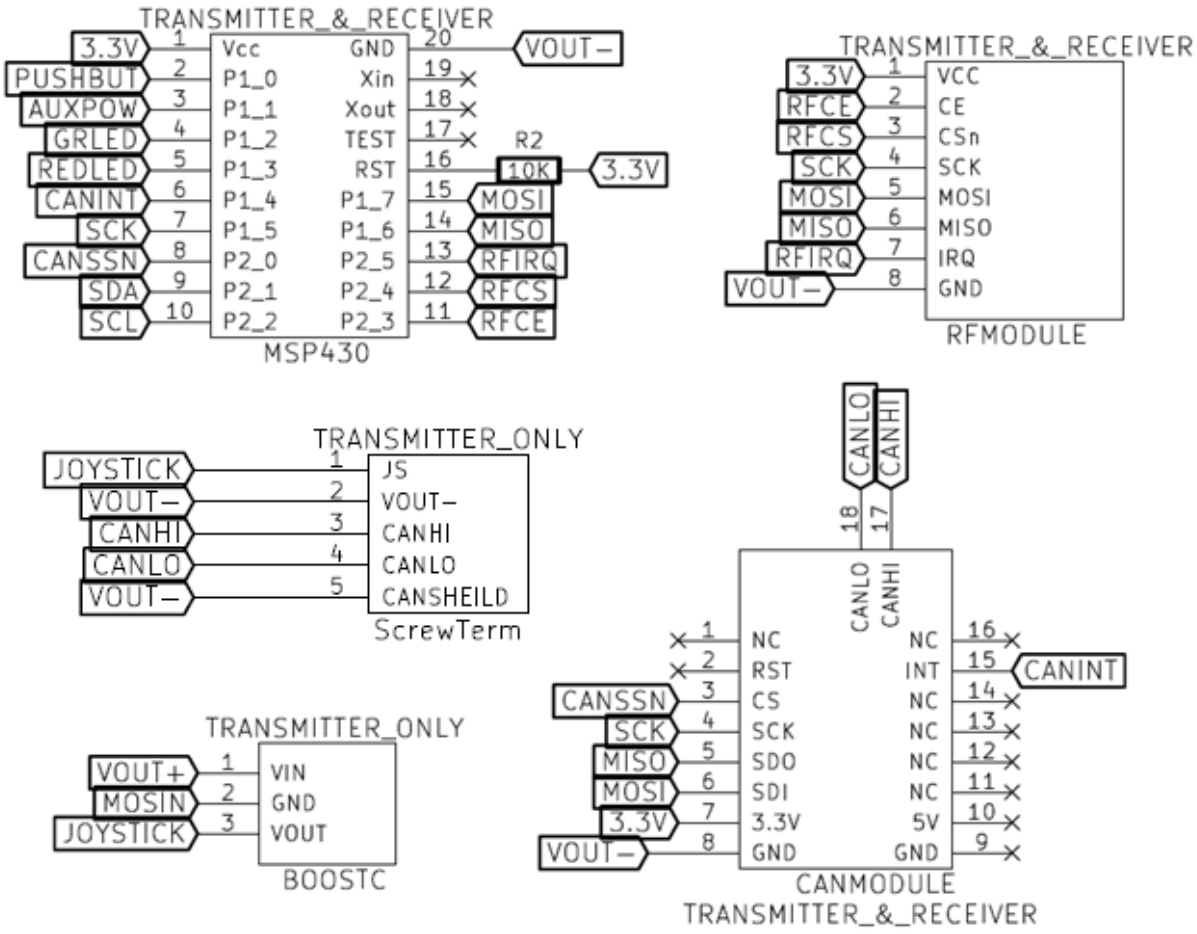


Figure 6: Schematic of the wireless package (part 1 of 2). Continued in Figure 7.

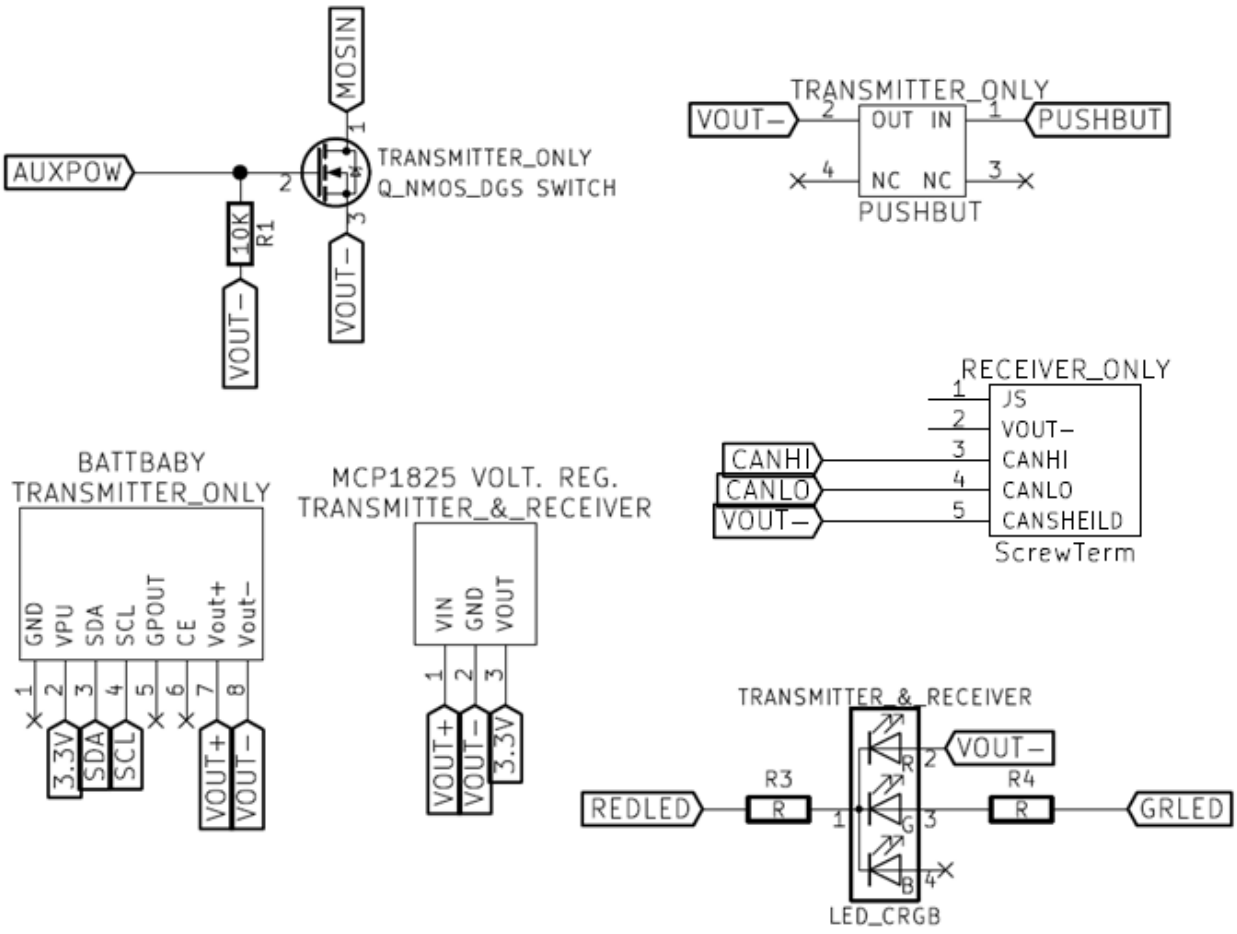


Figure 7: Schematic of the wireless package (part 2 of 2).