Subsystem	Module	Requirement	Verification	Points
Friendly Interrogator Unit	Laser Transmitter	Light from the laser must register a signal that can be detected by a photodiode at the following ranges: - Short Range (5 m) - Medium Range (15 m) - Long Range (30 m)	1. Measure and label each distance on ground surface. 2. Place 1 photoreceiver at target location. 3. Connect multimeter to output of photoreceivers. 4. Setup laser on stable surface at source, and connect directly to a lab bench power supply at 3.3V. 5. Note the value on the multimeter as the base/reference voltage. 6. Aim laser at target photoreceiver, using the red dot for guidance. 7. Confirm that the multimeter is displaying a voltage larger than that of the voltage measured in step 5. The voltage should be larger than the fluctuation from noise.	3
		Must have adjustable focus to achieve a spot radius ranging from 1.33 mm to 8mm at a distance of 5 m from the source.	1. Place the laser in a vice on a lab bench to hold it steady. 2. Place a sheet of paper or cardboard upright 2 m from the lens of the laser. This will be used as a backdrop for the light from the laser. 3. Connect the positive and negative leads of the laser to a lab power source. 4. Provide 3.3V to the leads using the power source. 5. Place a mark at the center of the current spot of the laser on the backdrop. 6. Place marks 1.33 mm and 8 mm from the center mark on the backdrop. 7. Adjust the focus of the laser so that the edge of the laser's spot ends at the 1.33 mm mark. 8. Adjust the focus of the laser so that the edge of the laser's spot ends at the 8mm mark (expanding to hit the areas between 1.33mm and 8mm).	5
		Laser must have ability to be sourced by a 3.3V amplitude 5kHz square wave.	1. Test with breadboard and signal generator. 2. Connect laser to appropriate circuit including resistor, NPN transistor and source signal. 3. Generate a 3.3V amplitude 5kHz square wave with a signal generator. 4. Connect op-amp and photoreceiver circuit to opposite end of breadboard. 5. Measure output voltage of photoreceiver with oscilloscope. 6. Confirm that output voltage of photoreceiver is 5kHz.	1
Friendly Target Unit	Laser Photoreceiver	Op-amp must amplify voltage received by photodiode enough to be registered by the and not exceed the maximum for the MCU (i.e. 0 < Vout < 3.7) with the 5mW laser incident on the photodiode from 10cm with the tightest divergence, the voltage should be between 2 and 3.7V	1. Power up photoreceiver unit. 2. Place a digital multimeter on the output of the photoreceiver. 3. Shine a 5mW laser directly onto the photoreceiver from 10 cm away. 4. Ensure the multimeter reading does not exceed 3.7V. 5. Ensure the multimeter reading does not fall below 2.0V.	9
		Photodiode must have ability to detect laser pulses at a bandwidth of at least 5kHz and must have ability to detect 90% ± 5% of packets sent to it.	1. Write software to probe and record the analog value at the input ports of each photoreceiver on the MCU at 5kHz. 2. For each photoreceiver: 3. Shine a 75% duty cycle red light at the photoreceiver for 10s. 4. Establish a cutoff voltage value where a high can be distinguished from a low. EG any signal greater than 1V is a 1, less than 1V is a 0. 5. Using the cutoff voltage established in (4), calculate the duty cycle of the probed values over the 10s 6. The duty cycle calculated in (5) should be between 74 and 76%	
Both F.I. Unit and F.T. Unit	Power Module	Voltage regulator must be able to output a constant voltage of 3.3V with ± 0.1V deviation (i.e. 3.2V < Vout < 3.4V), with a current supply of max 100 mA.	1. Place voltage regulator connected to the lab bench power source. Supply 6V. 2. Place multimeter in parallel with V_OUT and GND. 3. Read voltage and compare to 0.3V tolerance	5
		Must be able to supply at least 3.3V for a period of 8 hours ± 5%.	1. This verification requires both the friendly interrogator unit and the friendly target unit to be tested separately due to the different current consumptions on both. 2. Independently, on two separate circuits, connect all required components to each power module, so for example, for the friendly interrogator unit, connect the R.F. Receiver, MCU, and laser. 3. Power all components on using a lab bench power source. 4. Note the current usage on the lab bench power source. 5. Ensure that, given the capacity of the power module for field use, this current can applied for 8 hours ± 5%.	

Both F.I. Unit and F.T. Unit	Real Time Clock (RTC)	Local clock on independent units must be synced to within ±10 seconds.	1. Write software to generate interrupts at 1 second intervals on both units. 2. Connect both MCUs to oscilloscope and note frequency of interrupts. 3. Confirm that both rates of interrupts are identical. 4. Once software written for entire system, confirm that "seconds" variable is within a 10 second tolerance, by randomly sampling both units.	1
	Microcontroller (MCU)	Ability to both take input from digital source and output data in a digital form. A logic "high" cooresponds to 3.0V ± 10% and a logic "low" cooresponds to 0V ± 10%.	1. Power MCU appropriately. 2. Write software to set a two independent output pins to a logic "high" and logic "low" respectively. 3. Measure output voltage of pins and compare to that of 3.0V and 0.0V.	3
		Ability to control laser transmitter to send digital data at a frequency of at least 5 kHz (interrupts fired at every 0.2 ms).	1. Connect MSP430 to breadboard and power. 2. Write software to trigger a high signal on any desired output pin using Timer_A3 at a rate of 5 kHz (.2 ms). 3. Connect output pin of MSP430 to oscilloscope and compare square wave to that of desired interrupt rate.	
	R.F. Transmitter/Receiver	Must be able to both transmit and receive at least 90% of 8-bit packets sent over a distance of 5 meters with a carrier frequency of 315 MHz ± 50 MHz.	1. Write software on an MCU attached to the transmitter to broadcast 8 bit packets with data values staying constant. 2. Write software on an MCU attached to the receiver to count the number of packets received. 3. Place the MCU/transmitter 5 m away from the MCU/receiver. 4. Run both software programs. 5. Count the percentage of missed data values is less than 10%.	7
	Laser Transmitter/Receiver	At least 90% of transmitted laser packets must be received by the photoreciever at 5 m.	1. Measure and label 5m ground surface. 2. Setup target at 5m. 3. Place 1 photoreceiver on the target. 4. Connect microcontroller to the photoreceiver output. 5. Setup laser on stable surface at source, and connect power and ground leads to a lab power source. Power at 3.3V. 6. Using the laser spot as a visual guide, aim the laser at the photoreceiver and secure it in place. 7. Run a 5kHz signal through the laser broadcasting 8-bit packets and count the total number of packets missed over a period of time. 8. Use the microcontroller to ensure at least 90% of those packets are received.	9
	Speed of System	A friendly target at 5 m should be marked friendly within 190 milliseconds.	1. Upon completion of both friendly interrogator system and friendly target system place both systems at a distance of 5 meters apart. 2. Write software to keep track of time between when the operator switches on the laser until the friendly target acknowledgment signal is received from the target. 3. Store this result in a register upon testing. 4. Compare to that of the desired value of 190 milliseconds.	7
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