Subsystem	Module	Requirement	Verification	Points
Friendly Interrogator Unit	Laser Diode	Must be able to achieve 5 mW of power at source with a wavelength in the visible light spectrum from 620–750 nm (red).	1. Place laser on stable mount on lab surface. 2. Place optical power meter at short distance (distance may vary depending on unit) away from laser. 3. Ensure laser is in line with power meter by running string from source to detector. 4. Connect power and ground lines to laser and power on laser by connecting to constant 3.3V power source. 5. Measure power using equipment and compare to that of the desired value.	20
		Light from the beam must cover the area equivalent to a circle with a radius of at least 20 centimeters and no greater than 80 cm at the following distances, with optical adjustments allowed: - Short Range (50 m) - Medium Range (150 m) - Long Range (300 m)	1. Measure and label each distance on ground surface. 2. Setup target at desired location (1 out of 3 locations), being a 1.5 x 1.5 meter white, flat, square surface and measure out a circle with 20 cm radius, centered at the origin of the surface. 3. Place 4 photoreceivers on outer perimeter of 20cm circle. 4. Connect multimeter to output of photoreceivers 5. Setup laser on stable surface at source, and connect power line to 130 ohm resistor and ground line to GND. 6. Place string at base of laser and guide string to the origin of the target surface. This is to ensure that the laser is in line with the target and accurately hits your target. 7. Note the value on the multimeter 8. Power on laser by providing it a constant 3.3V power source. 9. Ensure the multimeter does not fall below the value noted in (7) for a period of 5 seconds. NOTE: 80cm is a very large radius, one that would not be achievable without a 20mW+ laser. Thus, we don't need to check the upper end of this requirement. See the tolerance analysis section for more information on the estimate beam radius	
Friendly Target Unit	Laser Photoreceiver	Must output a signals for each photoreciever that is greater than 0V but does not exceed 3.3V(i.e. 0< Vout < 3.3V).	1. Power up photoreceiver unit. 2. For each photoreceiver: 3. Place a digital multimeter on the output of the photoreceiver 4. Shine a 5mW laser directly onto the photoreceiver 5. Ensure the multimeter reading does not exceed 3.3V	20
		Must output signals for each photoreceiver that are high enough voltage to be registerred by the chosen MCU, and have a bandwidth of at least 40kHz.	1. Write software to probe the input ports of each photoreceiver on the MCU at 40kHz. The software will probe every 25 us and record the analog value of the photoreceiver signal 2. For each photoreceiver: 3. Shine a 75% duty cycle digital laser 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%	
	Power Module	Alkaline battery must maintain a steady voltage of 1.5V ± 5% and current up to 100mA for a period of 8 hours ± 5%.	1. Place power module on flat surface. 2. Connect multimeter in parallel to positive and negative terminals of battery source. 3. Read multimeter voltage and compare to that of 1.5V. 4. Connect 15 ohm resistor to positive and negative terminals to draw 100 mA from the circuit. 5. Leave connected for 8 hours. 6. Read multimeter voltage at the end of 8 hour period and compare to that of original voltage reading.	15
		Voltage regulator must be able to output a constant voltage of 3.3V with ± 0.3V deviation (i.e. 3.27V < Vout < 3.33V), with a current supply of max 100 mA.	1. Place voltage regulator connected to single AA alkaline battery on table. 2. Place multimeter in paralell with V_OUT and GND. 3. Read voltage and compare to 0.3V tolerance	

Friendly Interrogator/Target Unit		Must be able to supply 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 and note initial voltage output of voltage regulator by using multimeter. 4. Run all components for a period of 8 hours while monitoring equipment. 5. Record voltage output at end of 8 hour period and compare to that of 5% tolerance.	
	Real Time Clock (RTC)	Crystal oscillator must oscillate at a frequency of 32.768 kHz with a precision of ± 20 PPM.	1. Connect crystal oscillator circuit to both X_IN and X_OUT Ports on the MSP430 MCU. , 2. Write 0x20 to X_IN register. 3. Use a high precision frequency counter (HP53181A or eq.) to measure crystal PPM via the XOUT pin.	5
	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.	10
		Ability to control laser transmitter to send digital data at a frequency of at least 30 kHz (interrupts fired at every 25 microsecond. Sub-Requirement: Ability to maintain an RTC Clock with a tolerance of ± 10 seconds via generating interrupts at a rate of 1 second.	1. Connect MSP430 to breadboard and 2. Write software to trigger a high signal on any desired output pin using Timer_A3 at a rate of 30 kHz (25 microseconds). Alternate high and low signals to generate a square wave of period 50 microseconds (i.e. ON 25 microseconds OFF 25 microseconds). 3. Connect output pin of MSP430 to oscilloscope and compare square wave to that of desired interrupt rate. Sub-Requirement Verification: By verifying the first "main" requirement, this will inherantly verify the sub-requirement due to 25 microseconds being less than 1 second.	
	R.F. Transmitter/Receiver	Must be able to both transmit and receive at least 90% of 16-bit packets sent over a distance of 300 meters with a carrier frequency of 315 MHz ± 50 MHz.	1. Write software on an MCU attached to the transmitter to broadcast 16 bit packets with data values counting from 1 to 1000. 2. Write software on an MCU attached to the receiver to count the number of packets received for each data value counting from 1 to 1000. 3. Place the MCU/transmitter 300 m away from the MCU/receiver. 4. Run both software programs 5. Count the percentage of missed data values from 1 to 1000 and ensure it is less than 10%.	15
	System	Speed - The average human reaction time for visual stimulii is 190 milliseconds. A friendly target at 300 m should be marked friendly within 190 milliseconds so that, to a human user, it seems nearly instantaneous.	1. Upon completion of both friendly interrogator system and friendly target system place both systems at a distance of 300 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.	15
			Total System Point Allocation:	100