

Team	Part	Function or Requirement	Potential Failure Modes	Potential Causes of Failure	Occurrence	End Effect on Product, User, Other Systems	Severity	Detection Method/ Current Controls	Detection	R P N	Actions Recommended to Reduce RPN	Action Item #	
Controls	WOCCS	Communicates wirelessly with LVE	Does not communicate with LVE	Broken Antenna	2	User will not have wireless control of the LVE	3	Controls Team	1	6	Careful handling	34	
				Board interference	2		3	Controls Team	2	12	Place Grounded Enclosure Around Boards	35	
				Improperly programmed	2		1	Controls Team	2	4	Test program prior to delivery to systems team	36	
	Controller	Provides User Interface	Fails to allow the user to control the device	Controller is broken	1	3	Controls Team	1	3	Careful handling	37		
				Joystick is too sensitive	2	1	Controls Team	2	4	Constant checking	38		
				Joystick is not sensitive enough	2	1	Controls Team	2	4		39		
	Diodes	Regulate Power	Fail to regulate power levels	Diode is bad	1	LVE does not receive adequate power supply	1	Controls Team	2	2	None	40	
				Excess of current traveling in the wrong direction burns out diode	1	1	Controls Team	2	2	Avoid motor stalling	41		
	Resistors	Protect LVE from Over-Current	Fails to protect LVE from over-current	H-bridge is broken	1	Minimal effects since the maximum current levels should remain low	2	Controls Team	1	2	Careful handling	42	
				Poor handling causes resistor to break	1		1	Controls Team	2	2		43	
	Capacitors	Filter Noise	Fail to filter noise	Too much current	1	Outputs to motors will be choppy	1	Controls Team	2	2	Avoid motor stalling, check for shorts	44	
				Poor handling causes capacitors to break	1		1	Controls Team	2	2	Careful handling	45	
				Fuses are not wired correctly	1		1	Controls Team	2	2	Reference Electrical Design Drawings	46	
	Fuses	Protect Motors from Over-Current	Does not protect motors from over-current	Wires are loose or broken	2	Motors and PBC would not function, LVE would be useless.	1	Controls Team	1	2	Careful handling	47	
				Frequent over-voltage	1		2	Controls Team	2	4	None: design flaw, improper battery	48	
				Loose/broken wires	2		1	Controls Team	2	4	Careful handling	49	
	H-Bridge	Regulates & Delivers Voltage to Motors	Fails to provide appropriate voltage to motors	Over-current	1	Motors receive no power and do not function	2	Controls Team	2	4	Avoid motor stalling	50	
				Over-heating	1		2	Controls Team	2	4	Avoid motor stalling	51	
				Improperly designed PCB layout	1		3	Controls Team	2	6	None	52	
	PCB	Interface between H-Bridge and Dev. Board	Fails to provide communication between H-br. and dev. board	Trace is scratched	1	LVE will not function as intended	3	Controls Team	3	9	Careful handling	53	
				PCB is broken	1		3	Controls Team	1	3		54	
				Loose/broken wires	2		1	Controls Team	1	2		55	
	Battery to PCB	Connects Power Supply to PCB	Does not provide power to PCB	Screws are over-tightened	1	Motors will not receive power and will not function	2	Controls Team	1	2	Tighten screws until the begin to resist	56	
				Board is broken	1		2	Controls Team	1	2		57	
				Prongs are bent	1		1	Controls Team	1	1		Careful handling	58
	Female Header Row	Connects Daughter Card to PCB	Doe not connect Daughter Card to PCB	Loose/broken wires	2	LVE will not function	1	Controls Team	1	1	Careful handling		59
					Board breaks		1	1	Controls Team	1			2
					Too much voltage		1	3	Controls Team	1		3	61
	Arduino Nano dev Board	Receives and processes commands from WOCCS	Fails to receive and process commands from WOCCS	Improperly programmed	2	User will not have wireless control of the LVE	2	Controls Team	2	4	Constant checking	62	
				Program Crashes	1		1	Controls Team	2	4	Test Program Prior to Delivery to Systems Team	63	
				Computer problems	2		2	Controls Team	1	2	Troubleshoot, verify program functionality	64	
	Software	Provides user interface	Fails to allow user to control LVE	Improperly programmed	2	User will have no way of controlling the LVE	1	Controls Team	2	4	Use a different computer	65	
				Program Crashes	1		1	Controls Team	2	4	Test Program Prior to Delivery to Systems Team	66	
				Computer problems	2		1	Controls Team	2	4	66		

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MSA Controls	Main Board	Provides servo power and the necessary connections to the control board for proper operation	Buck circuitry does not operate	IC Defect	1	Servos will not operate	2	MSA Controls	2	4	None	67									
				Missing or damaged components	2		2	MSA Controls	1	4	Careful handling	68									
				No power from battery	1	No MSA function at all	2	MSA Controls	1	2	Check battery connections, verify proper battery function	69									
				Battery voltage too low	1	Servos will not operate	2	MSA Controls	2	4	ICD	70									
				Battery voltage too high	1		2	MSA Controls	2	4	ICD	71									
				Battery leads not connected	2	No MSA function at all	1	MSA Controls	1	2	Double check all connections	72									
			Battery voltage too low	1	2		MSA Controls	2	4	ICD	73										
			No power from battery	1	2		MSA Controls	1	2	Check battery connections, verify proper battery function	74										
			Unable to send signals to IO board	IO ribbon cable not attached/attached correctly	2	No servo function	No MSA function at all (possible damage to the control board)	2	MSA Controls	2	4	ICD	75								
														Board defect	2	1	MSA Controls	1	2	Double check all connections	76
				Improper assembly/soldering	2		3	MSA Controls	2	12	Test before installing	77									
				Unable to receive commands from control board	UART cable not attached/reversed		2	No MSA function	No MSA function at all (possible damage to the control board)	2	MSA Controls	2	4	ICD	76						
					Board defect		2									1	MSA Controls	1	2	Double check all connections	79
					Board damage		2									2	MSA Controls	2	8	Test before installing	80
			Improper assembly/soldering		2	2	MSA Controls									1	4	Careful handling	81		
			IO Board	Enables access to control pins from the outside of the LVE	Does not actuate servos	IO ribbon cable not attached/attached correctly	2	Servos will not operate	1	MSA Controls	1	2	4	Double check all connections	83						
																Improper assembly/soldering	2	1	MSA Controls	2	4
			Arduino Pro Mini	Communicates between the control boards	Does not respond to commands from LVE Control	Installation is incorrect	2	No MSA function	1	MSA Controls	2	4	Reference manufacturing assembly sheet	85							
	Incorrect software installed	1				Limited or no MSA operation	2	MSA Controls	2	4	None	86									
	Improper voltage input (too high, too low)	2				No MSA function	3	MSA Controls	2	8	ICD	87									
	Manufacturing defect	2											3	MSA Controls	2	12	Test before installing	88			
	Does not send out proper signals for servo control	Unit is physically damaged			2	Limited or no MSA operation	Limited or no MSA operation	3	MSA Controls	1	6	Careful handling	89								
		Unit is damaged			2									3	MSA Controls	1	6	Careful handling	90		
		Incorrect software installed			1									2	MSA Controls	2	4	None	91		
		Manufacturing defect			2									3	MSA Controls	2	12	None	92		
	TVS Diodes	Protects circuitry from input voltages higher than 9V	Does not protect from transient voltage spikes	Manufacturing defect	1	Limited or no protection from over voltage condition.	2	MSA Controls	2	4	None	93									
				Improper assembly/soldering	1								1	MSA Controls	2	2	Use appropriate tools, let solder fully cool before handling	94			
	Schotky Diode	Used for Buck Circuit	Does not operate within specified parameters	Manufacturing defect	1	Buck circuitry may not work. Thus no servo operation.	1	MSA Controls	2	2	None	95									
				Improper assembly/soldering	1								1	MSA Controls	2	2	Use appropriate tools, let solder fully cool before handling	96			
	Resistors	Provide voltage to ICs	Measured value is not spec'ed value	Manufacturing defect	1	Buck circuitry may not work. Thus no servo operation.	1	MSA Controls	2	2	None	97									
				Improper assembly/soldering	1								1	MSA Controls	2	2	Use appropriate tools, let solder fully cool before handling	98			
	Capacitors	Used as noise bypass and bulk capacitance	Measured value is not spec'ed value	Manufacturing defect	1	Possible short to ground. No MSA function.	1	MSA Controls	2	2	None	99									
				Improper assembly/soldering	1								1	MSA Controls	2	2	Use appropriate tools, let solder fully cool before handling	100			
	Fuses	Protects circuitry from high currents	Does not provide enough current to the system	Manufacturing defect	2	Limited or no protection from over current condition.	2	MSA Controls	2	8	None	101									
				Improper assembly/soldering	2								2	MSA Controls	2	8	Use appropriate tools, let solder fully cool before handling	102			
	Inductor	Used for buck circuit	Measured value is not spec'ed value	Manufacturing defect	1	Limited or no MSA operation	1	MSA Controls	2	2	None	103									
				Improper assembly/soldering	1								1	MSA Controls	2	2	Use appropriate tools, let solder fully cool before handling	104			
	LED	Used for BUCK status	Does not light	Improper current limiting resistor	1	LED may burn out	1	MSA Controls	2	2	Double check resistor	105									
				Manufacturing defect	2								1	MSA Controls	1	2	None	106			
				Improper assembly/soldering	2	LED may not operate	1	MSA Controls	1	2	Use appropriate tools, let solder fully cool before handling	107									
				No power from buck circuitry	1								No LED light indication	1	MSA Controls	1	1	Check battery connections, verify proper battery function	108		

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MSA	Main Servo	Provides Movement to 4-bar linkage	Does not move 4-bar linkage	Broken/loose wires	2	User will not be able to lift and move the foam block.	1	MSA Team	1	2	Careful handling	109
				Servo is broken	1		2	MSA Team	1	2		110
				Links are too heavy	2		1	MSA Team	1	2	ICD, power calculations	111
				Gears are stripped	1		2	MSA Team	1	2	Proper connections, careful handling	112
	Claw Assembly	Grasps Foam Block	Fails to grasp foam block	Claw servo does not have enough power	1	User will not be able to lift and move the foam block.	2	ICD	1	2	ICD, power calculations	113
				Broken/loose wires	2		1	MSA Team	1	2	Careful handling	114
				Links are not sized properly	1		2	MSA Team	1	2	Mechanical calculations	115
	4-Bar Linkage	Lines up claw with foam block	Does not line up claw with block	Links bend or break	1	User will not be able to lift and move the foam block.	1	MSA Team	1	1	Material selection, load calculations, careful handling	116
				Main servo do not have enough power	1		2	ICD	1	2	ICD, power calculations	117
		Supports Claw Assembly	Fails to support the claw	Links bend or break	1		1	MSA Team	1	1	Material selection, load calculations, careful handling	118
	Base Plate	Mounts MSA to Chassis	Does not connect to chassis	Holes do not line up	1	MSA will have nothing to attach to and will not be able to function	2	ICD	1	2	ICD	119
				Not enough clearance for MSA base	2		1	ICD	1	2	ICD	120
		Supports MSA	Does not support MSA	Base plate breaks	1		2	MSA Team	1	2	Material selection, load calculations, careful handling	121