



EXPLORER AUTONOMOUS SYSTEMS

EXPLORER AUTONOMOUS SYSTEMS

Electrical Manual for Manufacturing and Repairs

Written by Rhylend Culver

Version 1.1

18 September, 2024

Last Revision: 19 September, 2024



EAS is proudly based in the United States of America

Wiring Standard

- Defined in this document are the types of wire that are to be used, conductor sizes and other standardized procedures for the manufacturing and maintenance of the EAS EXPL 1 Autonomous Boat. These selections are made in regards to amperage draw, cost and performance of applicable equipment. All selected wire and equipment stated should be 1:1 or close to the actual part being replaced. Links to what wire, equipment, and fuses may be provided if they are a more specialized part. Orange colored wire, 16ga and up is HIGH VOLTAGE and should not be replaced without proper knowledge and understanding of the use of that wire.
- These standards are not directly imposed by the USCG, or VEC. These standards are to be higher than those, as those are meant to serve as a minimum. No wire should be put into an area where pinching, chafing, scraping, or otherwise damage to the sheathing or conductor. All wires should be covered by heat shrink, or loom. No wire should be exposed directly. Electrical tape alone is not a sufficient cover for bare conductors. No conductor should produce sparks or shocks unless enclosed in an explosion proof container.

⚠ WARNING ⚠

HIGH VOLTAGE ARE VOLTAGES HIGHER THAN 48 VDC @ >10 AMPS
 ORANGE SINGLE WIRES **16 GAUGE AND UP** ARE HIGH VOLTAGE AND CAN BE **DEADLY**.
DO NOT REPLACE IF YOU DO NOT UNDERSTAND THE PURPOSE AND USE OF THAT WIRE.

Types of wire to be used

- **Data carrying wires** shall consist of 22 gauge 10 conductor cables with 3 sets of twisted pairs. 2 sets will be dual-conductor (*pink, light green*), (*orange, brown*), 1 set will be tri-conductor (*purple, black, gray*). The dual-conductor wire sets carry information for the onboard camera system. The tri-conductor wire will carry a ground, as well as a CAN HIGH and CAN LOW. (*Purple, CANH; Gray, CANL; Black, GND*). This is all standardized in the table below.

Color	Use	Gauge
Pink	CAMERA +	22
L. Green	CAMERA -	22
Orange	CAMERA +	22
Brown	CAMERA -	22
Purple	CAN High	22
Black	Ground	22
Blk w/ Wht	Ground	22
White	Per cable	22
Blu w/ Wht	Per cable	22
Red	Per cable	22
Gray	CAN Low	22

Note:

All “per cable” specific wires will have a tag on the two sides of the cable stating its unique identifier number. This identifier number can then be found in the service manual for further purpose of each wire.

Types of wire to be used cont.

- **Dual power shielded cables** shall consist of a 16 gauge 4 conductor wire. This wire will carry 2 independent grounds colored black. This cable will also carry a WHITE: 24v power, and a RED: 12v power. These specific power cables will be enclosed in a black wire loom. These are NOT deemed high voltage.
- **Power & CAN shielded cables** shall consist of a 16 gauge 4 conductor wire. This wire will carry 1 RED 12v power, 1 BLACK ground, as well as 1 BLACK CANL and 1 WHITE CANH. The 12v power and ground can be found by looking at the steel cutting cable in between the conductors. These cables will either be bare or enclosed in a green wire loom.
- **High Voltage cables** shall consist of ORANGE wire between 16 and 6 american wire gauge. These wires will carry anywhere from 48VDC to 72VDC. These cables are to be enclosed in a red wire loom, secured every 6 inches unless impractical.
- **Emergency lighting wires** shall consist of 16 gauge single wire in the following colors: black, purple, brown, red, gray, white, yellow, blue, green, pink, as well as translucent speaker wire. Wire colors for emergency lighting are listed in a table below as well as their intended use. Actual colors coming out of units may be different but these are the colors that are to be ran for each intended purpose. These wires are to be enclosed in a black braided loom.

Color	Use	Gauge
Black	Ground	18-16
Purple	Navigational lights	16
Pink	Emergency Response Lighting (agency colors)	16
Red	Solid Amber (Power on boat not activated)	16
White	Flood lighting (light pods)	16
Yellow	Single Flashing Amber (Power on boat activated)	16
Gray	Flood lighting (light bars)	16
Green	Color change (FENIEX)	16
Blue	Sync (FENIEX)	16
Speaker	Used for siren	14

Types of wire to be used cont.

- **Primary power cables** shall consist of RED cables 8 gauge and bigger. These cables are fused directly from the battery and run to a fuse block or timed shutdown device.
- **Secondary power cables** shall consist of RED cables 10 gauge and smaller. These cables are fused at the fuse block and run to provide constant power to devices.
- **Data connection wires** shall consist of any color wire, other than orange or black (those only can be used when high voltage or ground respectively). These wires run from microcontrollers, computers or other low voltage control devices to other low voltage control devices. These wires may be ran to relays and other devices for switching.

Note:

Any not mentioned cables, such as those that are terminated with USB or other common connectors are not mentioned due to the lack of needing to. Other non mentioned cables are those that are inside of electronic enclosures, and therefore are not the concern of this document.

Connection standards

- **Instrument bay connector** shall consist of D-Sub 25 pin connector. This connector is standardized and can be tapped into by any payload.

Pin	Pinout	Max Amperage
1	Ground	3amp
2	Ground	3
3	Connection Sense (when connected this is grounded)	N/A
4	12v Positive	3amp
5	12v Positive	3amp
6	5v Positive	3amp
7	Can High	300mA
8	Can Low	300mA
9	Analog input/output 1	40mA
10	Analog input/output 2	40mA
11	Analog input/output 3	40mA
12	Analog input/output 4	40mA
13	Analog input/output 5	40mA
14	Digital input/output 1	40mA
15	Digital input/output 2	40mA
16	Digital input/output 3	40mA
17	Digital input/output 4	40mA
18	Digital input/output 5	40mA
19	Future use	N/A
20	Future use	N/A
21	Future use	N/A
22	Future use	N/A
23	Future use	N/A
24	Ground	3amp
25	Ground	3amp

Connection standards cont.

- **Butt splice connectors** shall and can be used inside the boat. However they must be of the heatshrink type (that has a glue inside) as well as of the right size. (white: 26-22 awg, red: 22-18 awg, blue: 16-14awg, yellow 12-10 awg) Multiple wires inside of 1 butt connector may be allowed if the connector can crimp properly, pass a pull test wherein both sides of the splice can be pulled pre heat shrunk, as well as the lack of any visible conductor. Splices may not happen where the amperage exceeds that of the wire being spliced into. These connections must be wrapped in Scotch® Super 33+™ Professional Grade Vinyl Electrical Tape.



- **Wire to terminal connections** shall use the properly sized (red: 22-18 awg, blue: 16-14awg, yellow 12-10 awg) ring terminals (if supply) or fork terminal (if needing disconnecting frequently). Multiple conductors may be put into a single connector if criteria is met that is listed in the butt splice connector section.

Connection standards cont.

- **Wire to screw terminal connections** shall use the proper sized ferrule (if stranded wire) or soldered to prevent fraying and loss of individual conductor strands. These ferrules shall be crimped and pass a pull test wherein the conductor is pulled away from the ferrule itself.
- **Lug connections** shall use copper lugs, with the proper opening size appropriate for the mounting screw or fixture. These “lugs” are defined as any ring terminal designed for american wire gauge size 10 or bigger, constructed out of solid copper. These connections must be crimped and appropriate heat shrink must cover all but ¼in of the tube section and none of the ring section. These connections may be soldered or crimped, but must pass a pull test wherein the conductor is pulled away from the lug.
- **Wire to fuse block connections** shall use the proper size conductor for the fuse in place. The wire must be terminated with a ring terminal, attached to the fused section of the block. The attaching screw must be torqued, as well as secured with a locking washer/LOCTITE® THREADLOCKER BLUE 242® or other semi-permanent locking systems to prevent backing out of screws.

Electrical Safety Stickers

- These stickers are to be posted where dangerous or critical components are located. They are to notify the end user of potentially problematic or dangerous areas. These stickers are to be waterproofed, and cause damage to the underlying material if removed. They may not just only be stickers, they may be engraved or painted metal placards serving the same purpose. Additionally the boat must have a 2in tall by 4in wide metal placard on the exterior of the boat near the kill switch that displays the maximum voltage of the boat, battery chemistry and locations of the battery cutouts.
- **Stickers** shall be bright in color, clearly visible and waterproofed. These stickers shall cause damage or obvious signs of their removal. Examples of each category of sticker are below.

Symbol	Meaning
	- Electrical shock hazard. High voltage lines defined above are present or high voltage termination points (such as fuse blocks or batteries) are present.
	- Thermal (heat) hazard. Components such as the engine or onboard heaters may produce heat that is harmful or dangerous to the user.
Not Pictured	- These not pictured labels may include a radio frequency interference sticker, posted near the antennas and other radio equipment alerting of possible interference.