CONNECTOR HIGH CURRENT TEST

Purpose:

Test the current carrying capability of some popular connectors used in FRC.

The connectors/connections tested:

1. 12ga stranded wire (Alpha Wire PN: 6718 WH005) soldered lap joint approx. 3/8 long
2. Great Planes 4mm connector PN: GPMM3114 (male), GPMM3115 (female)
3. Integy XT-90
4. Integy XT-60
5. Wire nut, red, designed to mate 2-12ga wires
6. TE Connectivity ("Anderson style")
    a. Pin PN: 1744041-1
    b. Housing PN: 1445957-1
    c. Crimp tool used: Pro's Kit PowerPole Crimper PN: 902-337

Test equipment used:

Current source:
TDK Lambda GEN 20-76

Data acquisition:
National Instruments model USB-6259 16-bit /Multifunction DAQ

Test setup:

The connectors were wired in series using the 12ga wire and connected to the terminal of the current source. Kelvin connected wires were installed across each of the connections to measure the voltage drop generated by the current flow. The Kelvin leads were connected to the DAQ (fig 1 - 7).

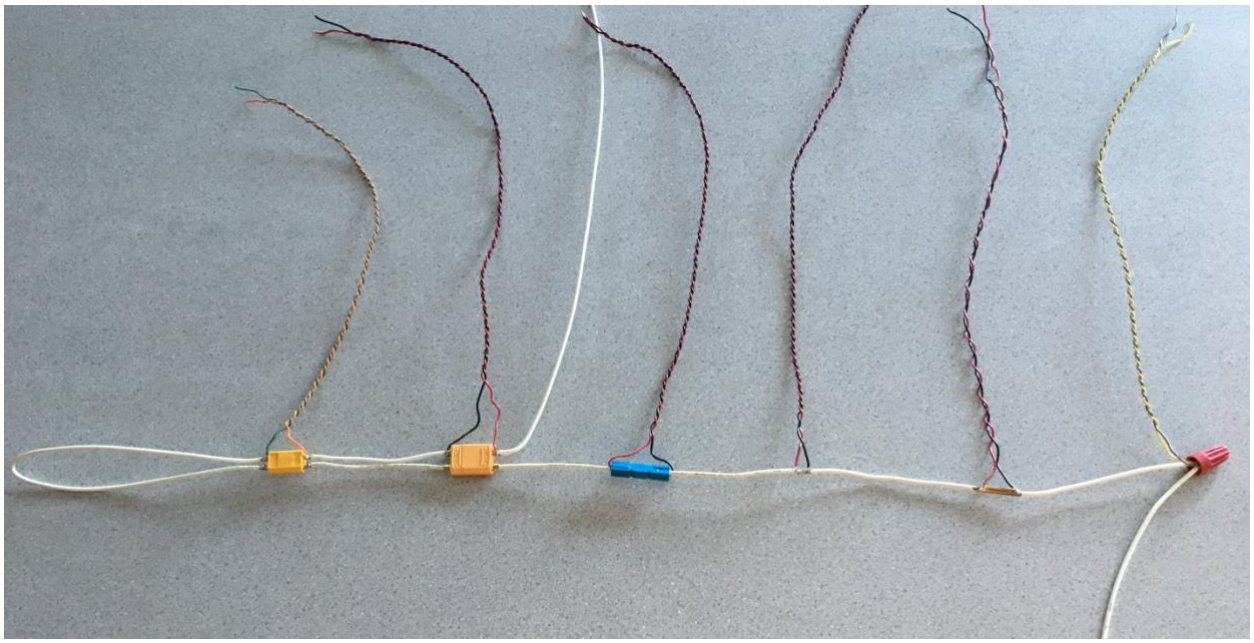

Fig. 1

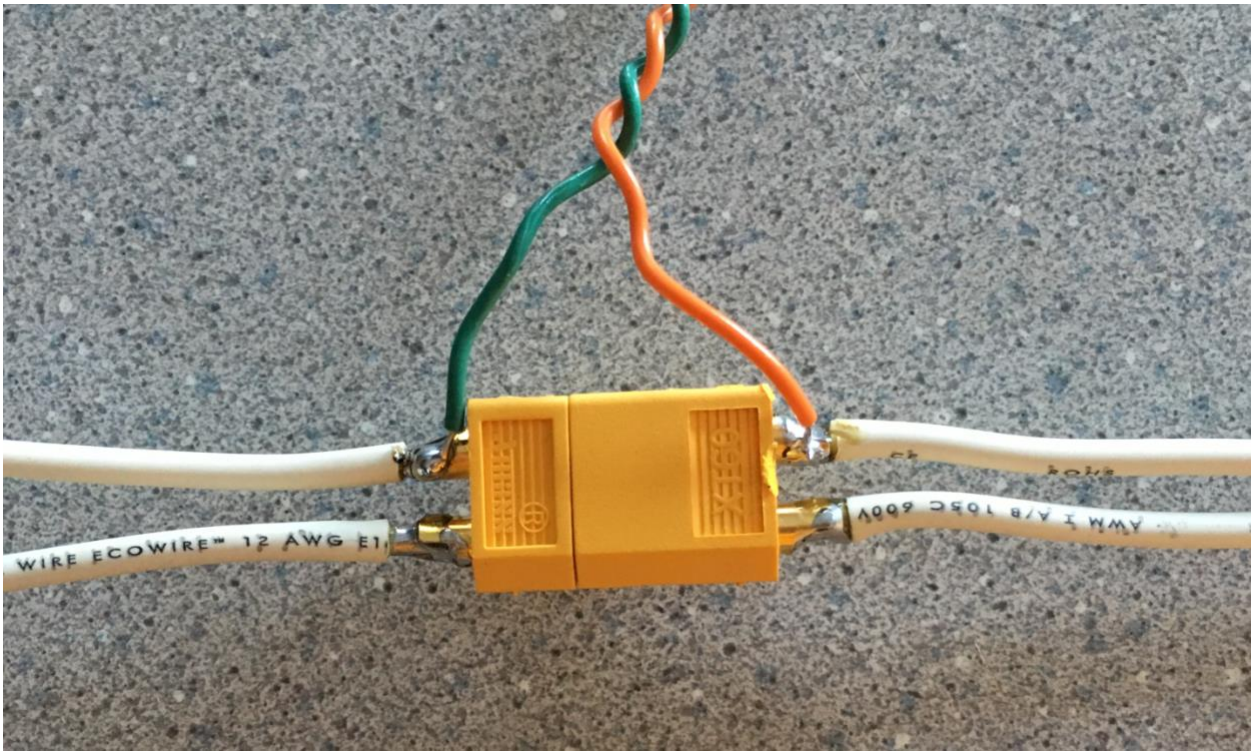

Fig. 2

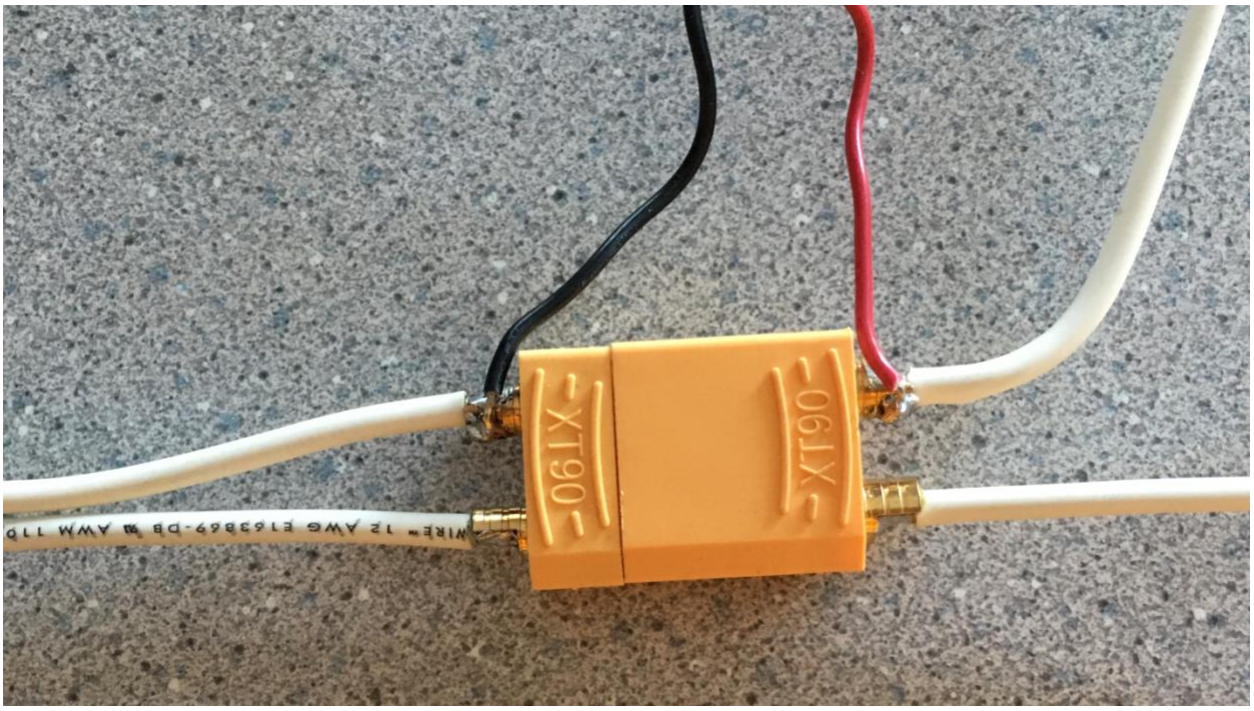

Fig. 3

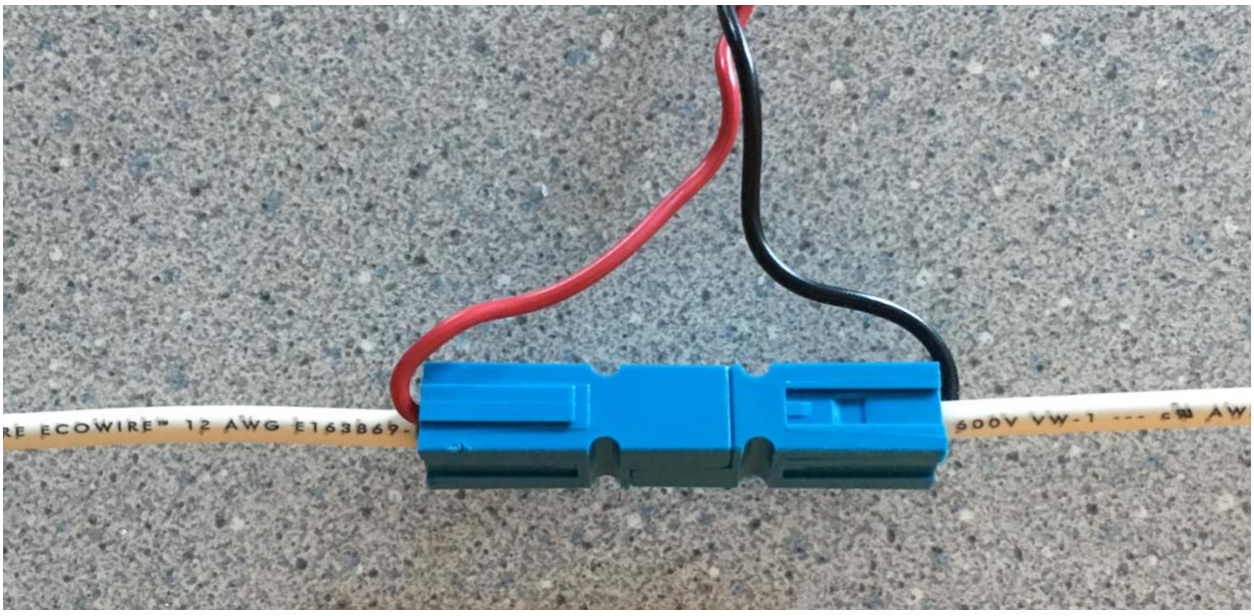

Fig. 4

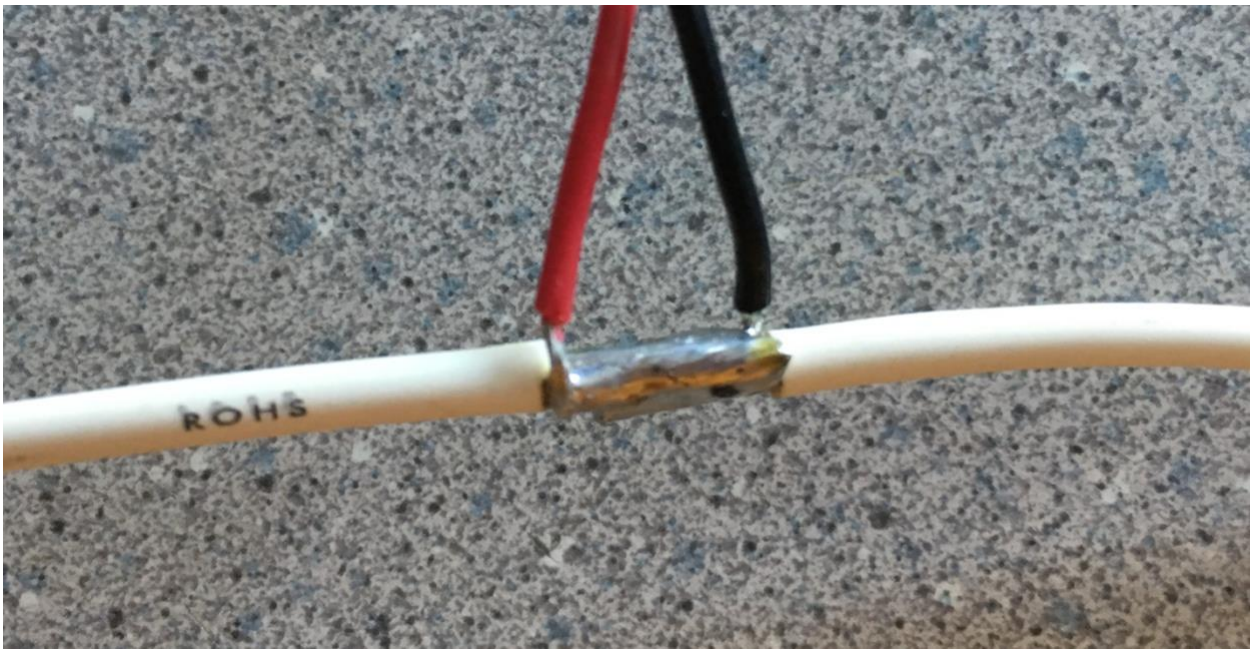

Fig. 5

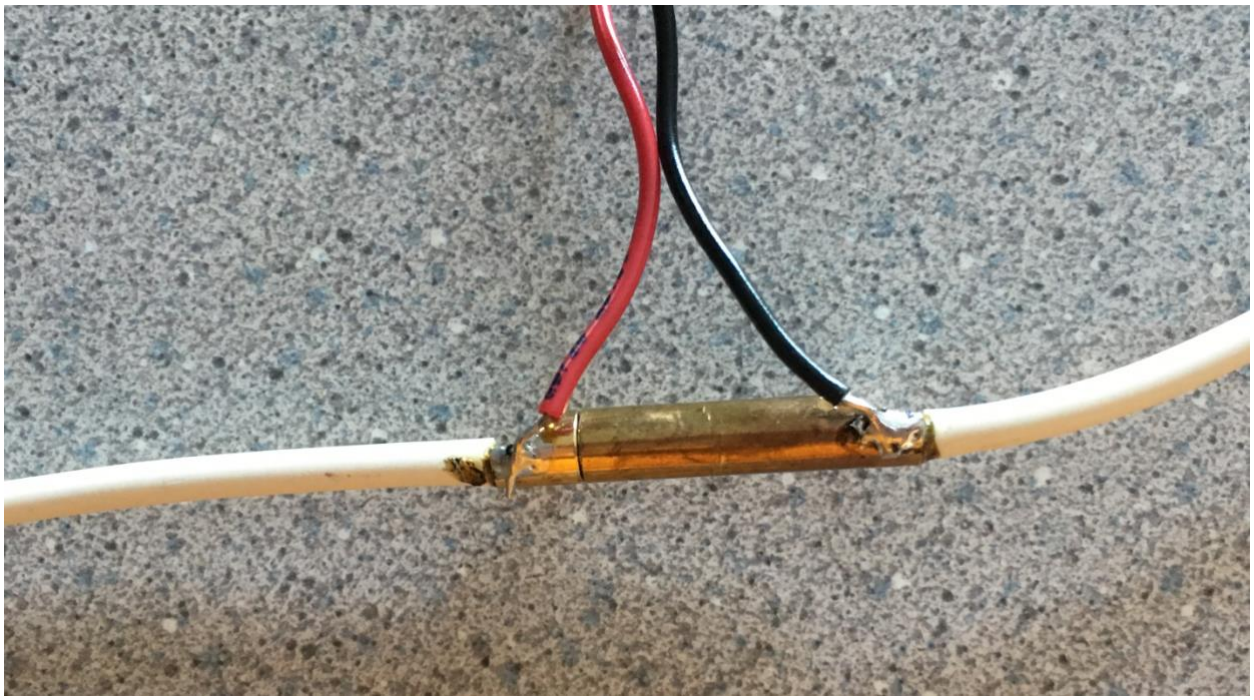

Fig. 6

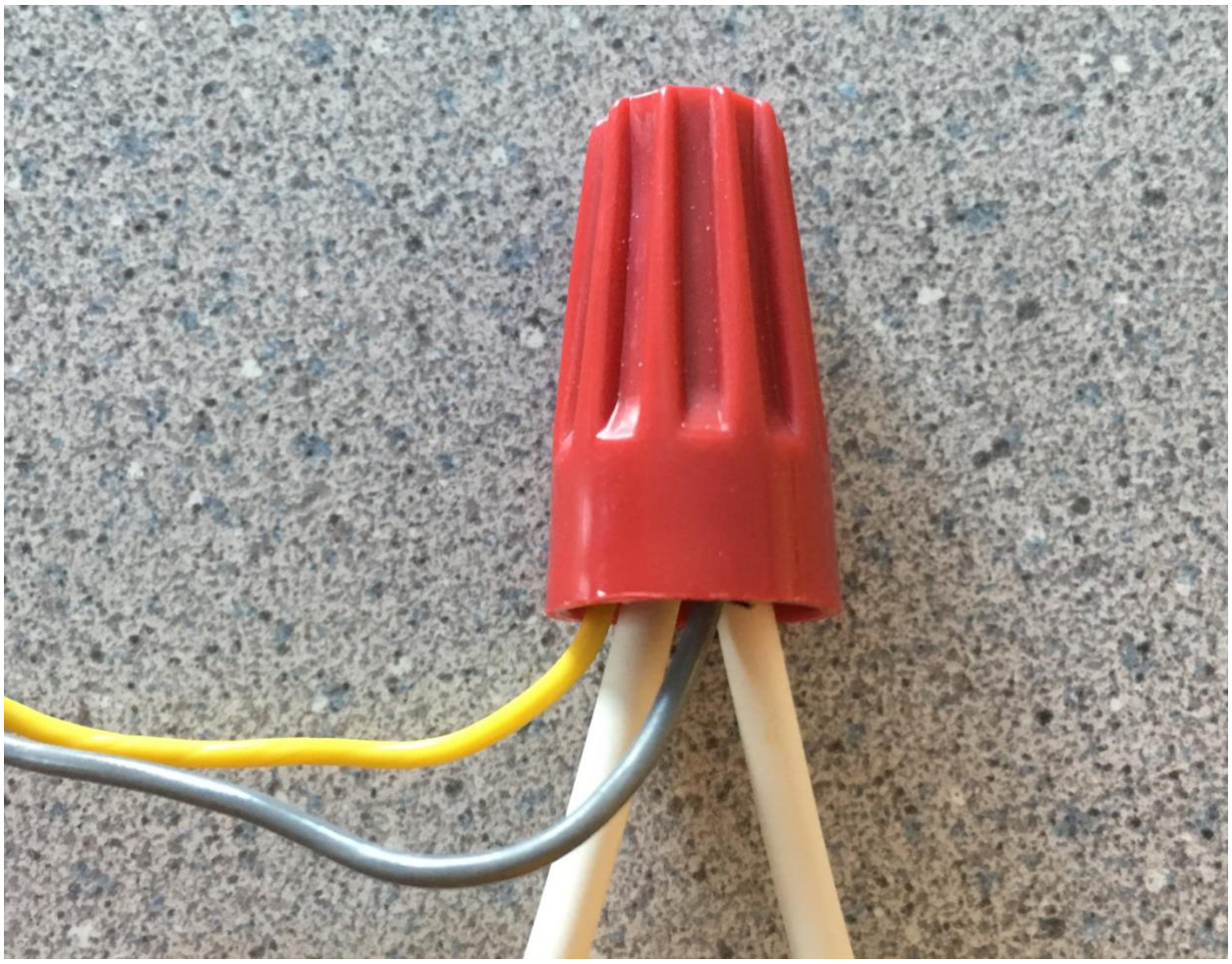

Fig. 7

Each connector was cycled (unplugged and plugged) 60 times before the test began. Current was stepped in 10 Amp increments starting at 10 Amps and going up to 70 amps. Each step was approximately 10 seconds in duration. During this time the voltage drops across all connectors were recorded at a 100ms rate and graphed (fig 8). The power dissipated through each connector was calculated and graphed (fig. 9).

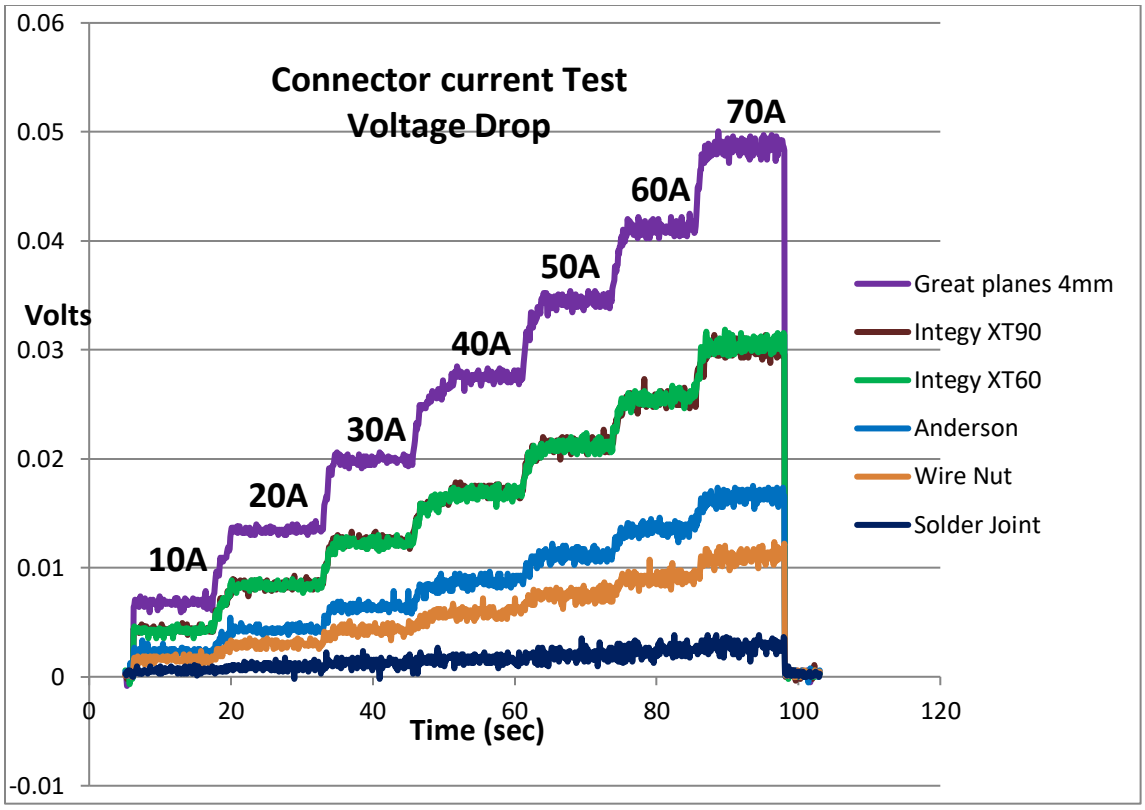
Connector current Test
Voltage Drop
Volts
Time (sec)
10A
20A
30A
40A
50A
60A
70A
Great planes 4mm
Integy XT90
Integy XT60
Anderson
Wire Nut
Solder Joint
0.06
0.05
0.04
0.03
0.02
0.01
0
-0.01
0
20
40
60
80
100
120

Fig. 8

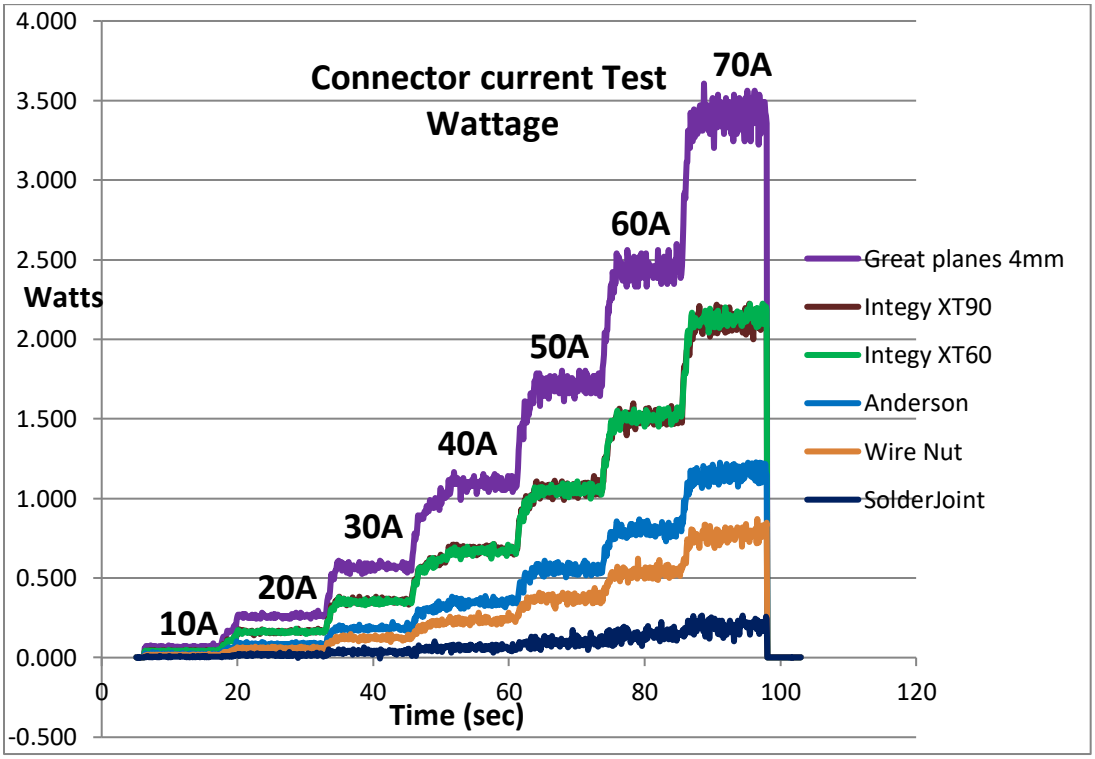
Connector current Test
Wattage
Watts
Time (sec)
10A
20A
30A
40A
50A
60A
70A
Great planes 4mm
Integy XT90
Integy XT60
Anderson
Wire Nut
SolderJoint
4.000
3.500
3.000
2.500
2.000
1.500
1.000
0.500
0.000
-0.500
0
20
40
60
80
100
120

Fig. 9

Notes:

1. The Anderson style used has a manufacture's rating of 30 Amps (per data sheet).
2. The XT-90 has a rating of 90 Amps (as advertised).
3. The XT-60 has a rating of 60 Amps (as advertised).
4. The Great Planes has a rating of 50 Amps (as advertised).
5. 12ga wire is considered safe up to 20 Amps continuous however it can be used at higher currents on an intermittent duty cycle.
6. The wire nut has a rating equal to the wire used with it.

Observations:

1. None of the voltage drops were significant enough to be alarming.
2. The wire got warm but not painful to the touch.
3. All the connectors got warm but not painful to the touch.
4. The connectors that felt the hottest was the XT-90 and XT-60 which makes sense since they had a high voltage drop and the current passed through it twice.

Conclusion:

All connectors functioned as expected and should be acceptable for the intermittent duty seen in FRC with the exception of the XT-60 which performed better than expected when compared to its big brother the XT-90. The test setup was checked and verified twice using different test equipment due to the voltage drop on the two connectors being nearly identical. The lap joint solder connection had the lowest voltage drop and was therefore the most efficient presenting the voltage for work, however the efficiency difference is negligible. Many teams don't view the solder joint as a connector since it does not connect and disconnect quickly. The decision to add connectors should be thought out since every connector adds another point of failure.

Other things to consider when choosing a connector are:

1. Security. Do they stay together when exposed to abuse?
2. Usability. Do they quickly disconnect and connect when you want them to?
3. Durability. Do they malfunction when exposed to abuse?
4. Ease of assembly. Do they assemble and disassemble easily and consistently?

It should be noted that quality of assembly can greatly affect the performance of any connector. Extreme care should be used during assembly. If crimped, the proper crimp tool and the proper pin should be used. If soldered, use a properly sized solder gun, the correct solder, and good soldering technique to make a good solder joint

Poorly assembled connectors can lead to a high resistance joint which can result in overheating of the connector or failure over time from movement or vibration. An example of poorly assembled Anderson style that had approximately 25 Amps continuous for 5 minutes (fig. 10 - 11).

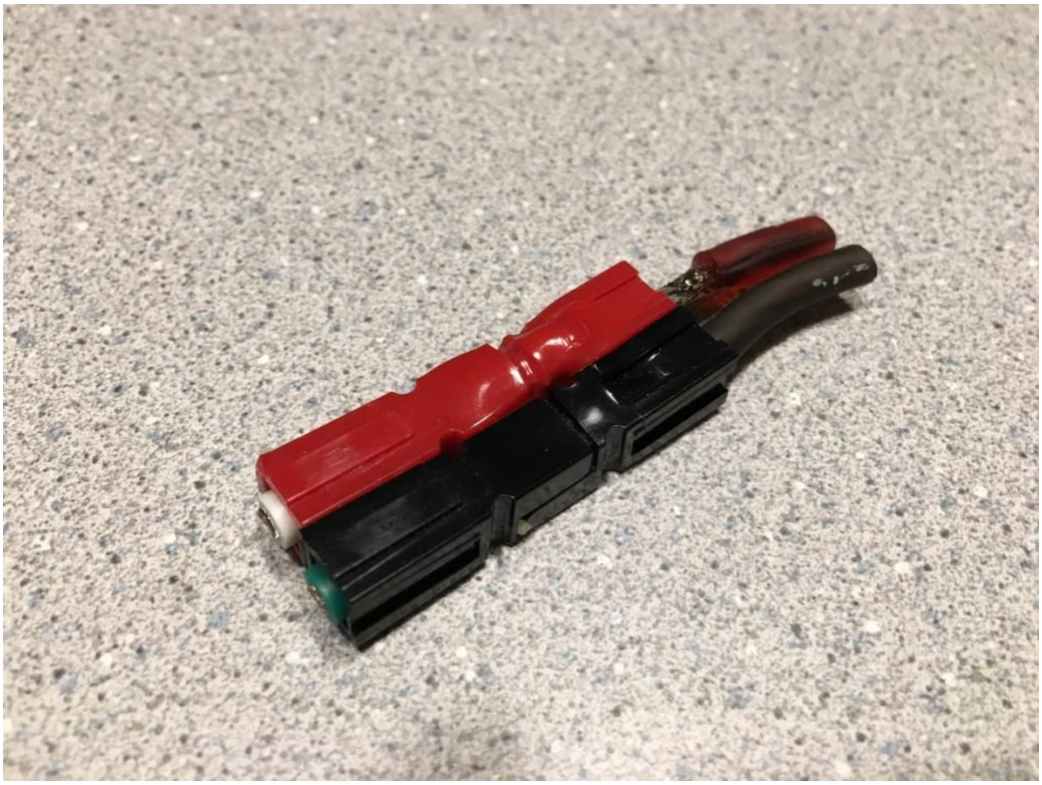

Fig. 10

Fig. 11

From observing the location of the heat damage, it appears this failure was caused by a poor crimp on the red wire.

There are two common problems with the Anderson style connector. One is the pin being incorrectly installed in the housing. Typically this is caused by pin deformation from an incorrect or improperly used crimp tool. The other is the crimp quality caused from an incorrect or improperly used crimp tool

Inspect the pin after crimping to verify that the crimp looks good and the pin isn't deformed. When the pin is inserted into the housing, verify that it locks into the housing as designed and there are no external forces pushing or moving the pin out of its designed location within the housing.

A common problem with soldered connectors is a poor quality solder joint. Make sure you have the correct tools, materials and skill set to ensure a good solder joint.

The XT-90 and XT-60 should be soldered with the mating connector installed. This will ensure that the pin being soldered doesn't get displaced if the plastic housing gets soft from the heat applied during the solder process.