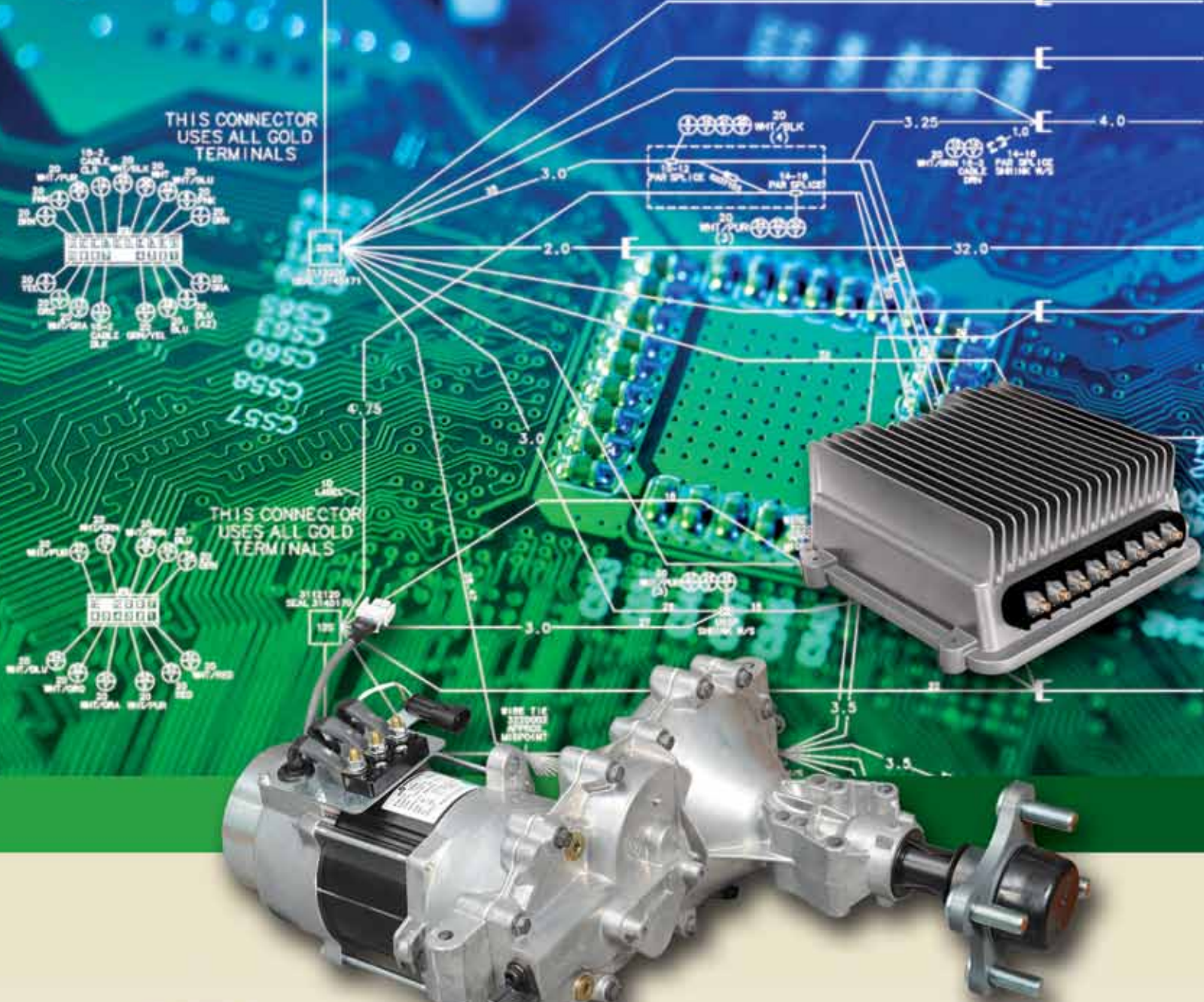


THIS CONNECTOR  
USES ALL GOLD  
TERMINALS

THIS CONNECTOR  
USES ALL GOLD  
TERMINALS



**SMARTTEC**®

by **HYDRO-GEAR**

[www.hydro-gear.com](http://www.hydro-gear.com)

# Hydro-Gear®



Headquartered in Sullivan, IL, Hydro-Gear is a global leader in the design and manufacture of precision drive systems. Working in partnership with OEMs worldwide, Hydro-Gear produces an extensive line of high-performance, efficient hydrostatic transmissions and transaxles; gear reduction drives; variable displacement piston pumps and wheel motors; electric drive systems, and infinitely variable transmissions for industrial, commercial, and consumer markets. With multiple manufacturing sites and global operations, Hydro-Gear's goal is to ensure our products and services meet our customers' rigorous requirements and exceed their expectations.



***Forward Motion Through Forward Thinking***

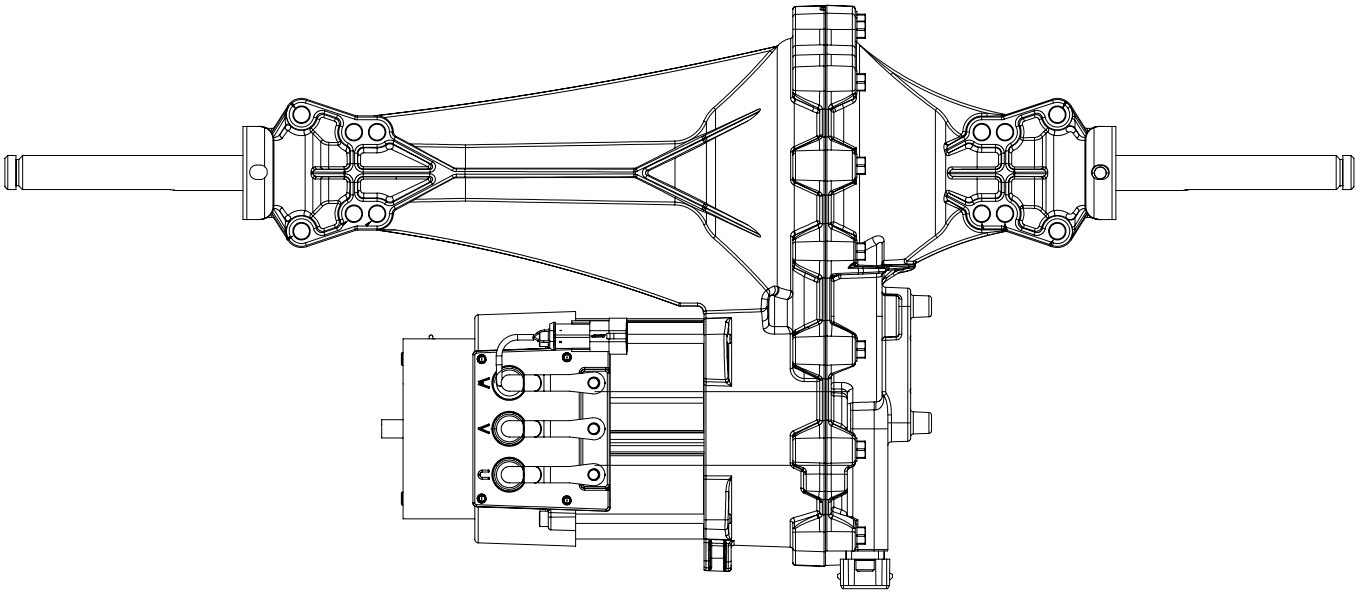


# Contents

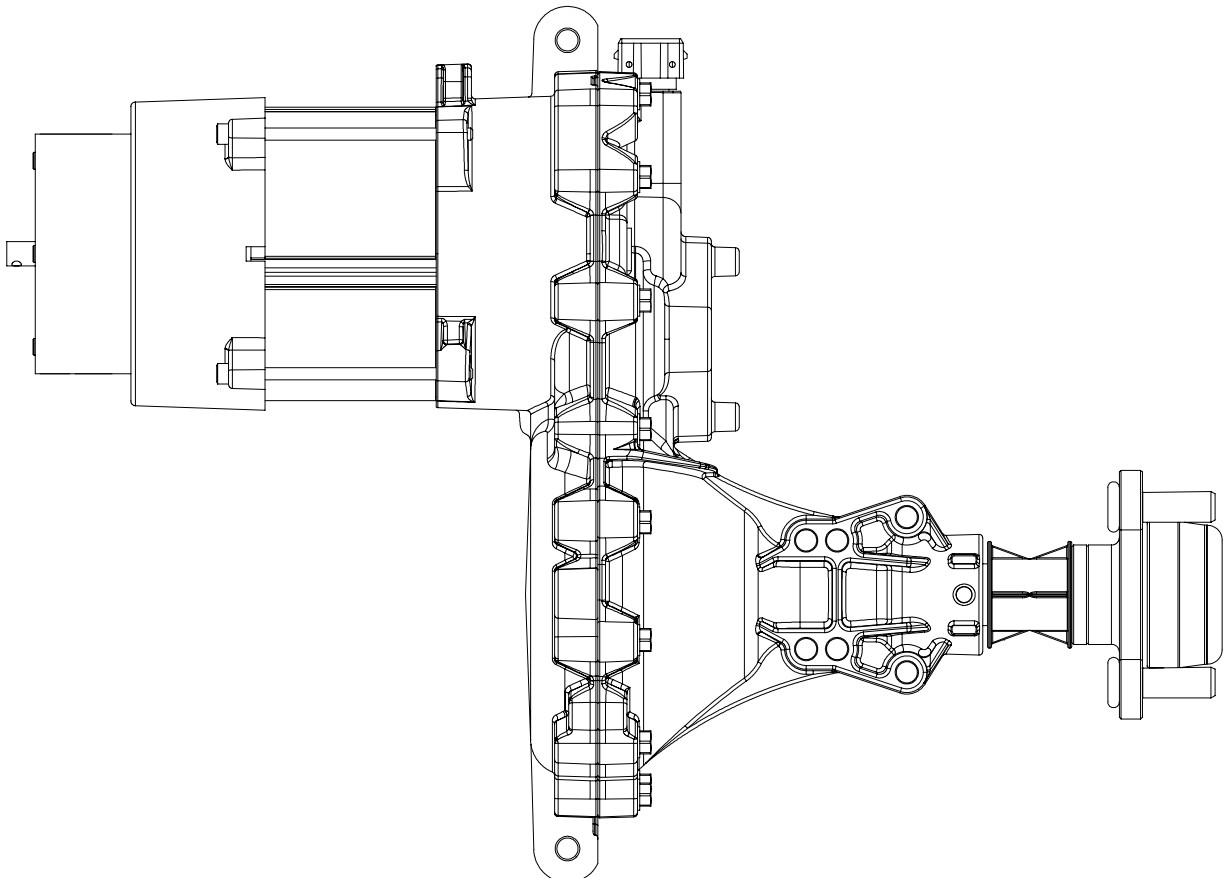
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# SMARTEC® Drive System Components

## SMARTEC® LT Transaxle

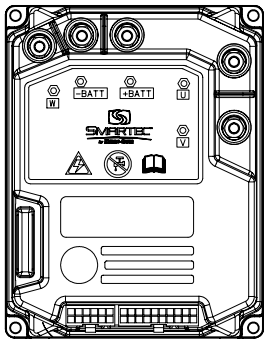


## SMARTEC® ZT Transaxle

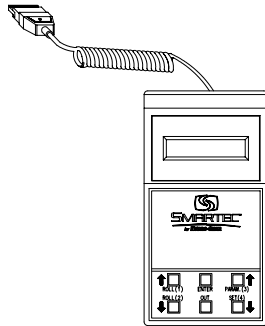


# SMARTEC® Drive System Components

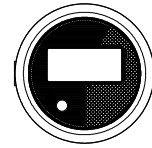
## SMARTEC® LT System



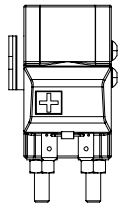
Traction Controller



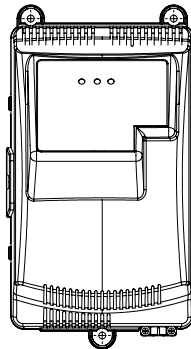
Hand-Held Console



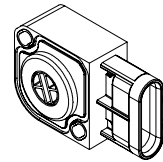
Multi-function Digital Interface



Single Pole Contactor

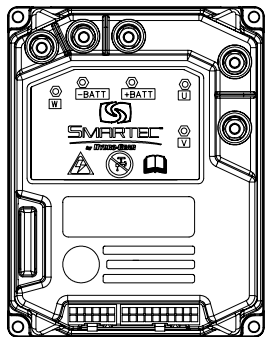


Charger

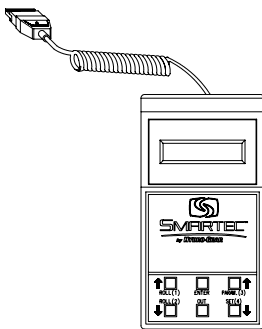


Accelerator Sensor

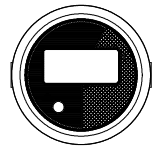
## SMARTEC® ZT System



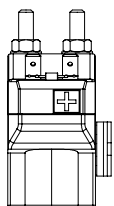
Traction Controller (X2)



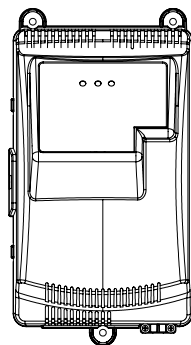
Hand-Held Console



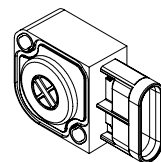
Multi-function Digital Interface



Double Pole Contactor

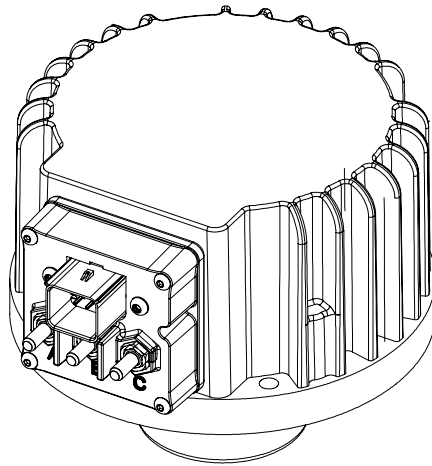


Charger

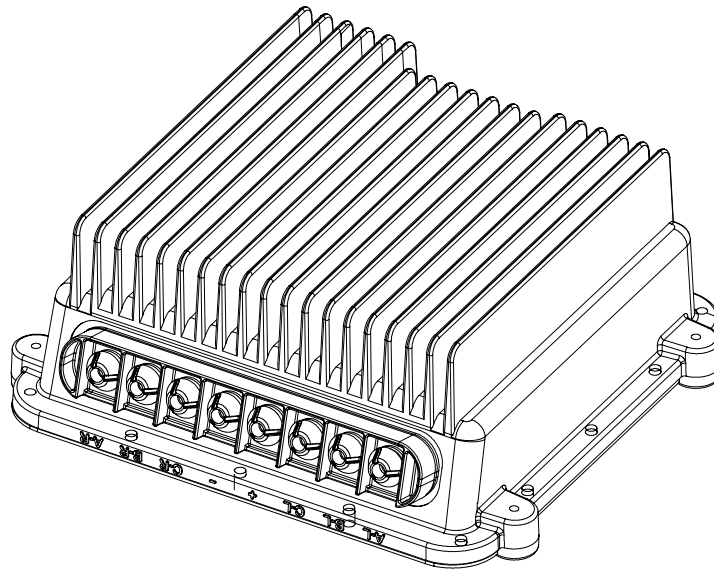


Accelerator Sensor (X2)

# SMARTEC® Deck System



**Deck Motor**

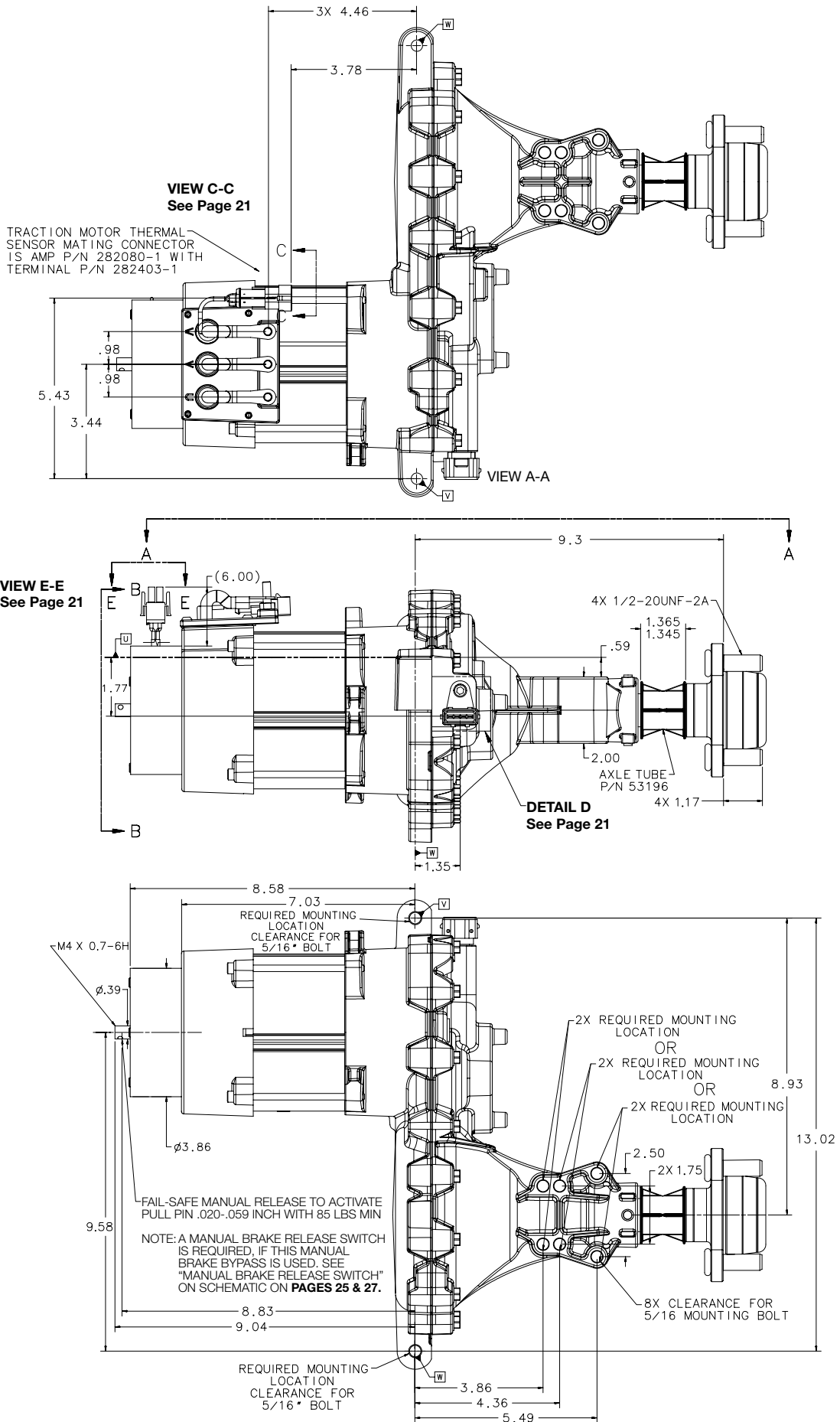


**Deck Motor Controller**

# Specifications

		LT	ZT
Overall Transaxle Reduction		45.11:1	45.11:1
System Voltage			
Nominal Battery Voltage	VDC	48	48
Maximum	VDC	55	55
Minimum	VDC	42	42
Axle Speeds (OEM programmable)			
Maximum Transport	rpm	133	133
Work Speed	rpm	0 - 133	0 - 133
Output Torque			
Intermittent	lb-ft [Nm]	322 [437]	322 [437]
Continuous	lb-ft [Nm]	80 [108]	80 [108]
Weight on Tire			
Maximum with 15" tire	lb [kg]	694 [315]	340 [154]
Maximum with 18" tire	lb [kg]	694 [315]	340 [154]
Axle Shaft Diameter	in [mm]	0.75 [19]	1.00 [25.4]
Axle Shaft End		Keyed	4 - Bolt Flange
Parking Brake Type		Electric Fail-Safe	Electric Fail-Safe
Weight of Unit w/oil	lb [kg]	41 [18.5]	37 [16.8]

# Zero Turn Transaxle Reference Dimensions

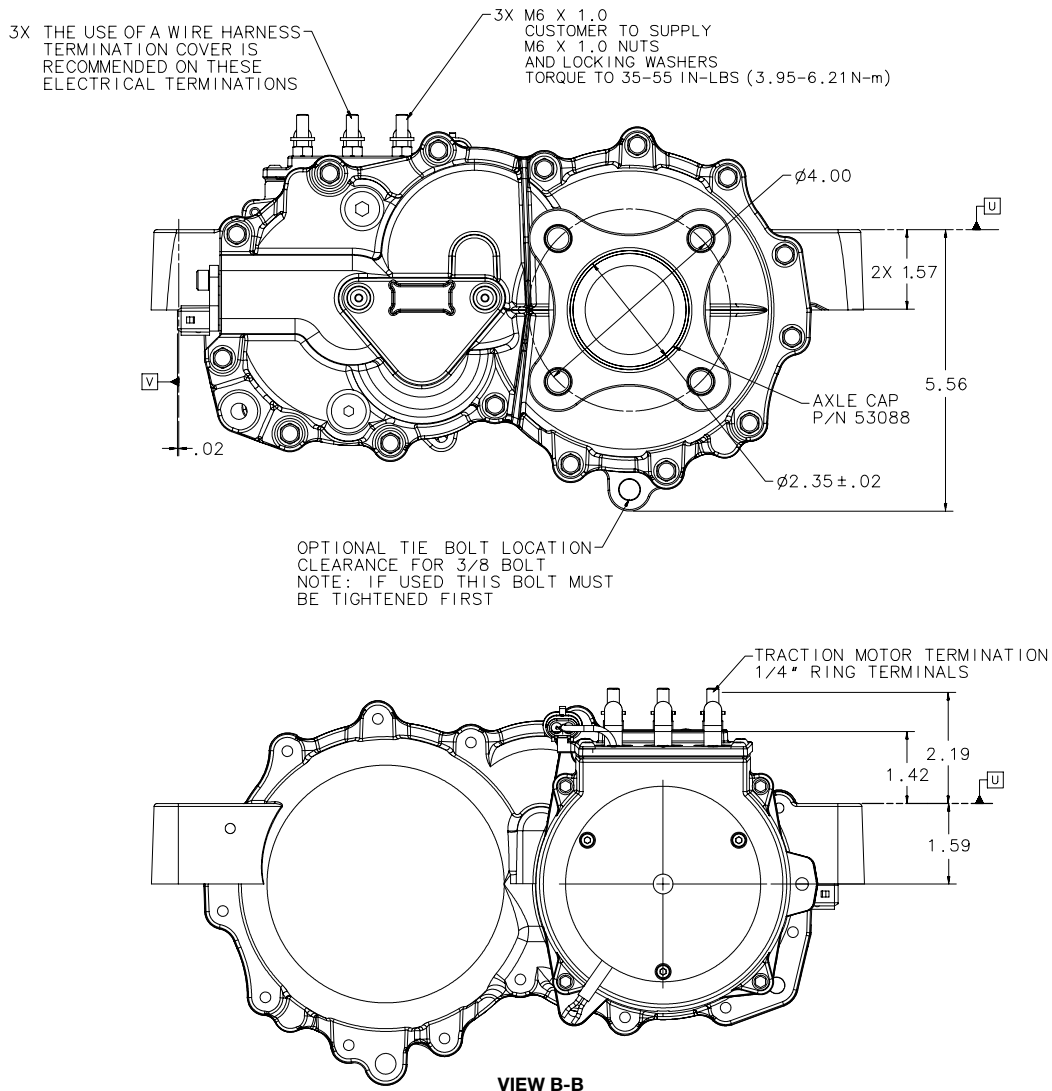




# Zero Turn Transaxle Reference Dimensions

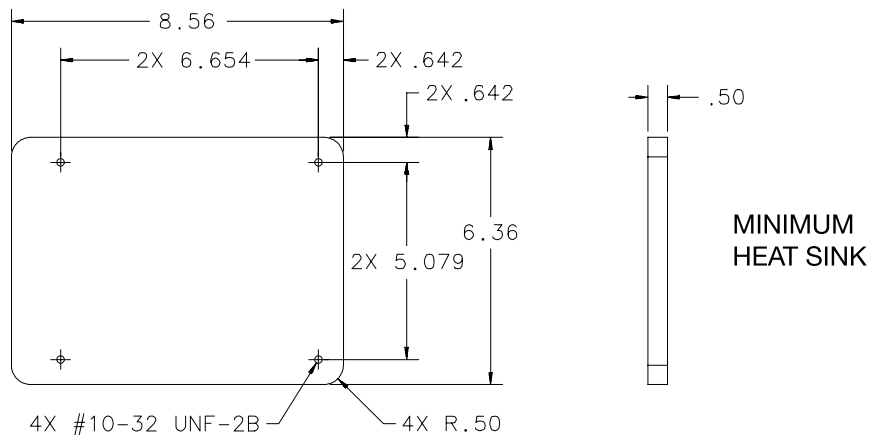
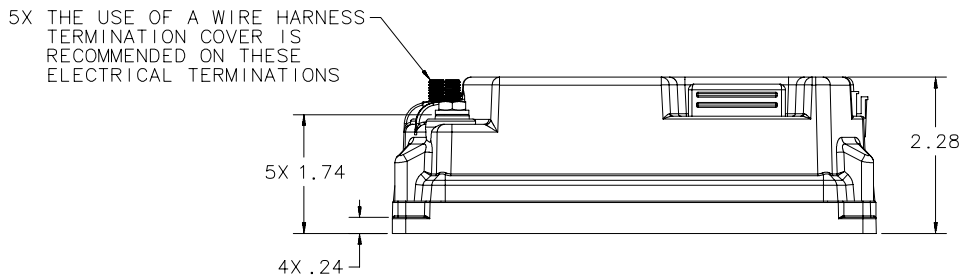
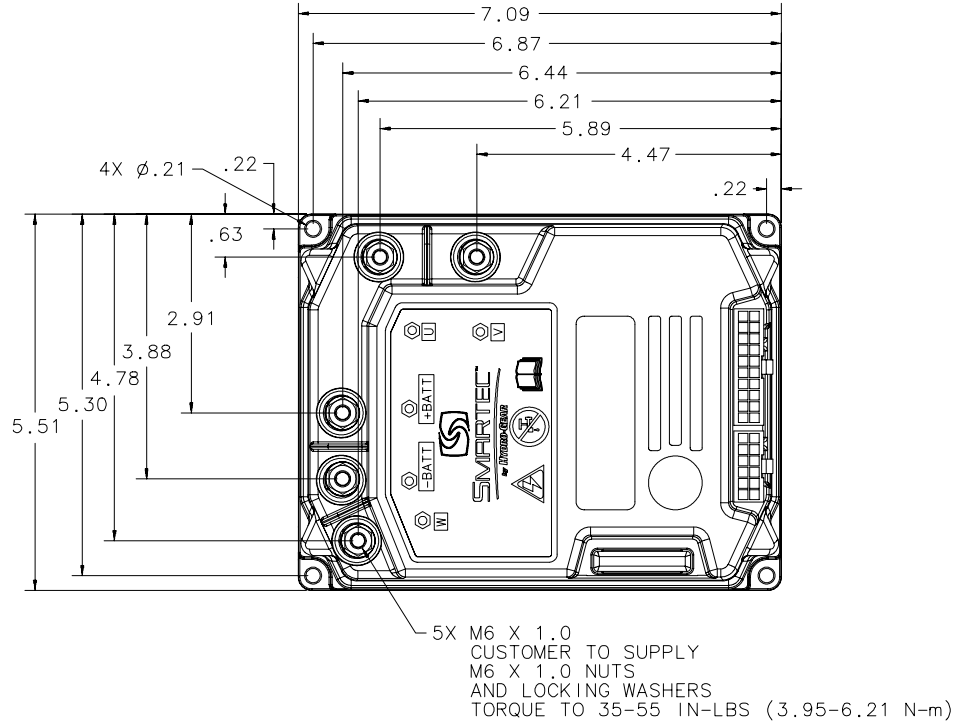
## TECHNICAL DATA:

MAX. VEHICLE WEIGHT INCLUDING 200 LB OPERATOR AND 50% FULL BAGGER: ≤ 1000 LBS	
MAX WEIGHT ON DRIVE TIRES	680 LBS
TIRE SIZE	18 INCH MAX.
CONTINUOUS OPERATING TORQUE	80 FT-LBS
PEAK TORQUE	322 FT-LBS
TRANSAXLE IP RATING	64
ELECTRIC MOTOR IP RATING	54



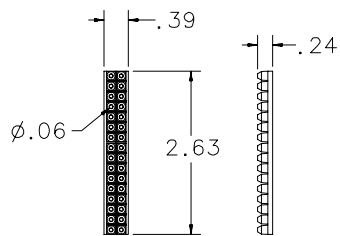
# Traction Controller - ZT Drive System

The SMARTEC® system uses one traction controller per AC motor. A typical zero turn or two motor drive system requires two traction controllers. Each controller is capable of 125 amp maximum output and feature built-in temperature protection.

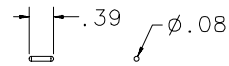


**Heat Sink P/N 54103**

# Traction Controller - ZT Drive System



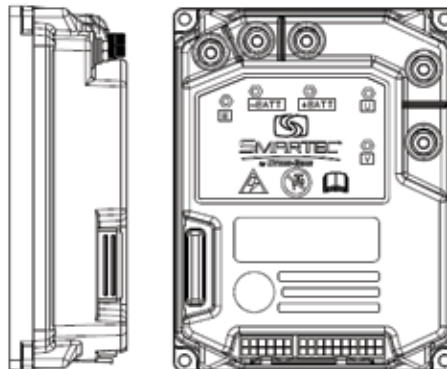
Wire Seal P/N 53135



Cavity Plug P/N 53159

WARNING: GOLD TERMINALS  
MUST MATE TO GOLD TERMINALS  
AND TIN TO TIN. PLEASE VERIFY  
THIS IN ALL HARNESSSES.

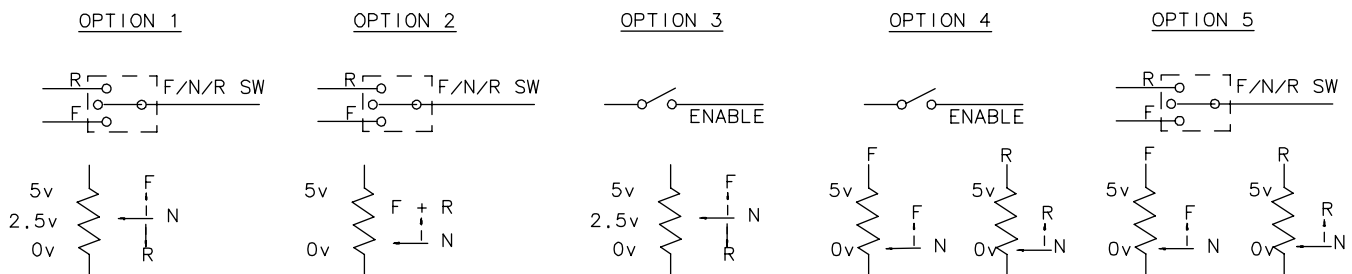
SEE BELOW FOR SUGGESTED  
MOUNTING POSITION



# Traction Controller Technical Information (ZT)

## TECHNICAL DATA

1. APPLICATION: Consumer ZT riders and walk behinds.
2. MOUNTING REQUIREMENTS
  - a. The connector side of the traction controller must be protected from being sprayed with direct water pressure. SMARTEC® traction controller cover P/N 52953 is available to help protect the controller.
  - b. It is recommended the traction controller be mounted in a vertical or standing position with the A and B connectors at the bottom. It could also be mounted horizontally with the heat sink facing up and all connectors facing earth.
  - c. The minimum heat sink is an unpainted aluminum plate approximately (5.7" x 7.9" x 0.5"). Applying thermal grease or a thermal transfer pad between the traction controller mounting plate and the heat sink is required to facilitate acceptable heat transfer rates.
  - d. The minimum heat sink specified is for a machine weight of approximately 660 lbs (300kg) running a drive cycle of mowing, level 66.67%, turning 6.67%, transporting 8.33%, 10° climb 5%, 17° climb 1.11%, towing sweeper 5.56% and towing a cart 6.67% on a 100°F ambient temperature day. The goal is to achieve temperature stabilization without exceeding 78°C (172.4°F) internal temperature of the traction controller.
3. SPECIFICATIONS
  - a. Controls a single SMARTEC® Electric ZT Transaxle. Two controllers required per vehicle.
  - b. Internal hour meter can be displayed on the SMARTEC® Vehicle display P/N 53143.
  - c. Weight: 3.2 lbs each
  - d. Voltage: 48VDC
  - e. Operating/switching frequency: 8kHz
  - f. Ambient temperature range: -20°F to 110°F
  - g. Maximum controller temperature: 212°F
  - h. Throttle
    - i. THROTTLE OPTIONS



### ii. POTENTIOMETER

1. SMARTEC® offers a complete solution for option 3 (SMARTEC® P/N 53517 left side accelerator and 53518 right side accelerator).
2. The throttle unit can consist of a potentiometer or a hall effect device. The sensor should be a 3-wire configuration. Potentiometer value should be in the 0.5 - 10 kΩ range; generally, the load should be in the 1.5mA to 30mA range. Faults can occur outside this range.
3. The procedure for calibrating the controller with the minimum and maximum useful throttle range is carried out using the Hydro-Gear® calibration tool P/N 53096. This procedure will be required on every vehicle manufactured prior to initial operation.

### iii. MICROSWITCHES

1. The throttle microswitches must have a contact resistance lower than 0.1Ω and a leakage current lower than 100uA.
2. With full load connected, the voltage between the switch contacts must be lower than 0.1V.
3. The microswitches send a voltage signal to the traction controller when a drive request is made.

# Traction Controller Technical Information (ZT)

## 4. VEHICLE PERFORMANCE PARAMETERS

- a. A traction controller vehicle model number will be assigned to each unique set of vehicle performance parameters.
  - i. Traction controller vehicle model numbers will be assigned by SMARTEC® as required. The model numbers will be a 5 digit number consisting of a sequence of digits ranging from 1 to 4.
  - ii. This model number will be entered into each vehicle's traction controller upon initial power up using the SMARTEC® calibration tool P/N 53096.

## 5. WIRE HARNESS REQUIREMENTS

- a. It is necessary to use a main contactor in-line to both controller's +48 volt power inputs to protect the controllers against reverse battery polarity and for safety reasons.
- b. Connector "A" Mating connector is Molex P/N 0039012120 with Molex terminal P/N 5556 gold plated.
- c. Connector "B" Mating connector is Molex P/N 0039012200 with Molex terminal P/N 5556 gold plated.
- d. Connector "A" and "B" require wire seal SMARTEC® P/N 53135 (one 32 hole wire seal will be cut to create both connector seals).
- e. All empty connector cavities must be plugged using SMARTEC® connector cavity plug P/N 53159.
- f. All controller bolt connections require 1/4" (6mm) ring terminals.
- g. All wires connected to connectors "A" and "B" must be 20 AWG minimum.
- h. All wires connected to -B, +B, U, V, W, and all wires connected between the batteries must be 5 AWG (.0125in<sup>2</sup> [16mm<sup>2</sup>] cross sectional area) minimum.
- i. For optimum controller performance, the cables to the battery should be run side by side and as short as possible.
- j. Can-bus wiring must be shielded, with shield tied to vehicle chassis or battery ground. Can-bus wiring must **not** be routed along power wires. Can-bus wires may cross power wires perpendicularly but may not run in parallel.

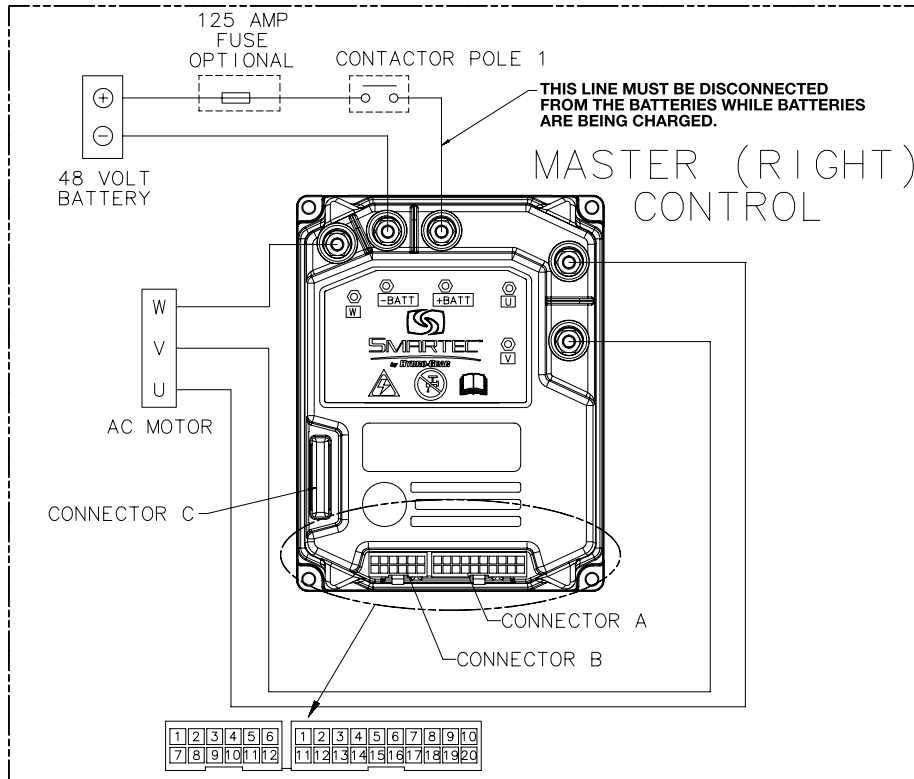
## 6. PROTECTION FEATURES

- a. Protection against accidental start.
- b. If the controller temperature exceeds 173°F, the maximum current is reduced in proportion to the thermal increase. The control will shutdown completely if the temperature reaches 212°F.
- c. If movement is commanded with no response, the vehicle will shut down.
- d. Low battery shutdown - 80% discharge.

## 7. EMI TESTING

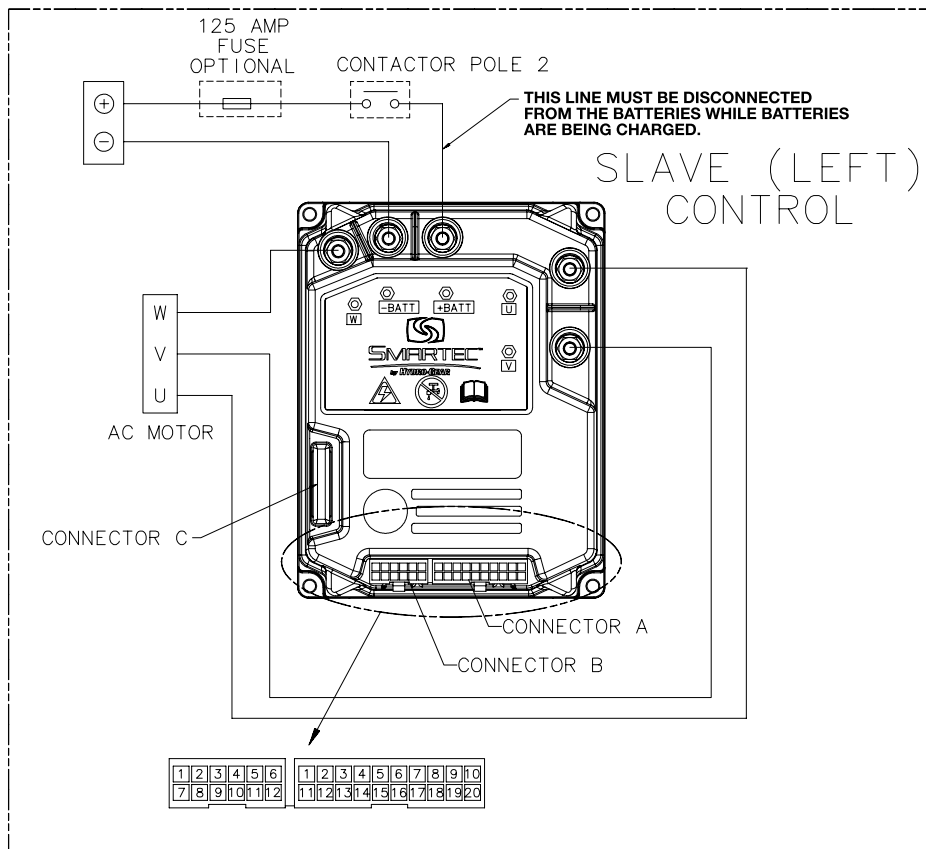
- a. It is recommended that complete EMC and EMI testing of all vehicles be performed before production release.

# Traction Controller Technical Information (ZT)



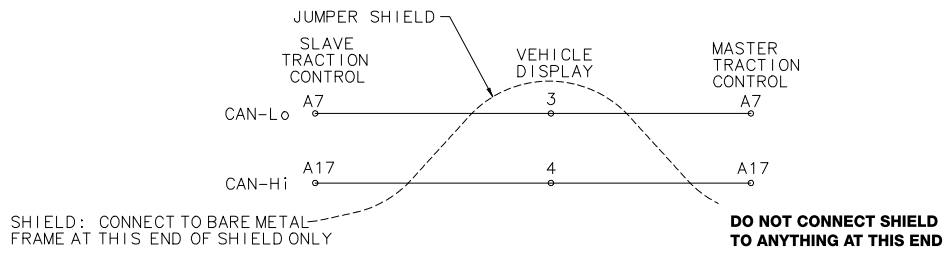
CONNECTOR	MATING CONNECTOR	WIRE SEAL
A	MOLEX P/N 0039012120 WITH MOLEX TERMINAL P/N 5556 GOLD PLATED	SMARTEC P/N 53135
B	MOLEX P/N 0039012200 WITH MOLEX TERMINAL P/N 5556 GOLD PLATED	SMARTEC P/N 53135
C	SMARTEC HAND-HELD CONSOLE	N/A

**NOTE: ALL EMPTY CONNECTOR CAVITIES MUST BE PLUGGED USING SMARTEC CONNECTOR CAVITY PLUG P/N 53159**



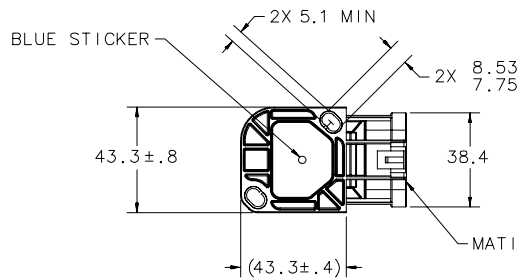
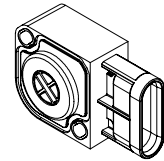
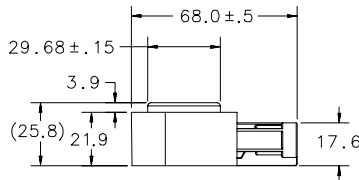
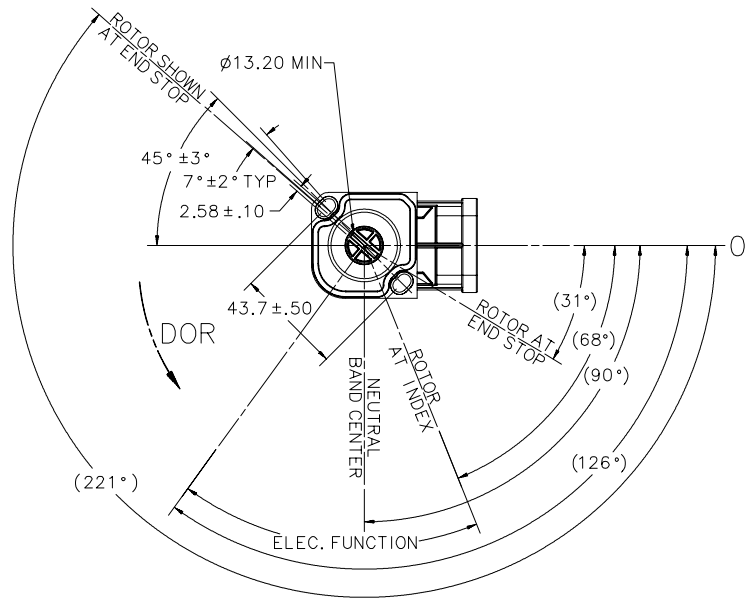
# Traction Controller Technical Information (ZT)

**CAN BUS WIRING REQUIREMENT: SLAVE CONTROL AND MASTER CONTROL MUST BE AT OPPOSITE ENDS OF DAISY CHAIN WIRING, EXACTLY AS SHOWN.**



WARNING: GOLD TERMINALS MUST MATE TO GOLD TERMINALS AND TIN TO TIN. PLEASE VERIFY THIS IN ALL HARNESSSES.

# Accelerator Sensor (ZT-Left Side)

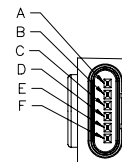
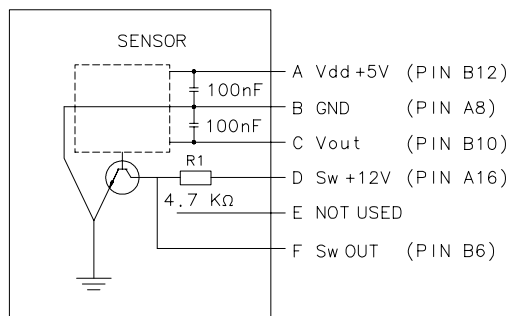


MATING CONNECTOR: Delphi 15397577  
 MATING PIN: 15326426  
 WIRE SEAL: 15366021-B  
 SECONDARY LOCK: 15317363  
 WIRE: USE 20 AWG

## Left Sensor Accelerator w/Internal Switching P/N 53517

**WARNING: GOLD TERMINALS  
 MUST MATE TO GOLD TERMINALS  
 AND TIN TO TIN. PLEASE VERIFY  
 THIS IN ALL HARNESSSES.**

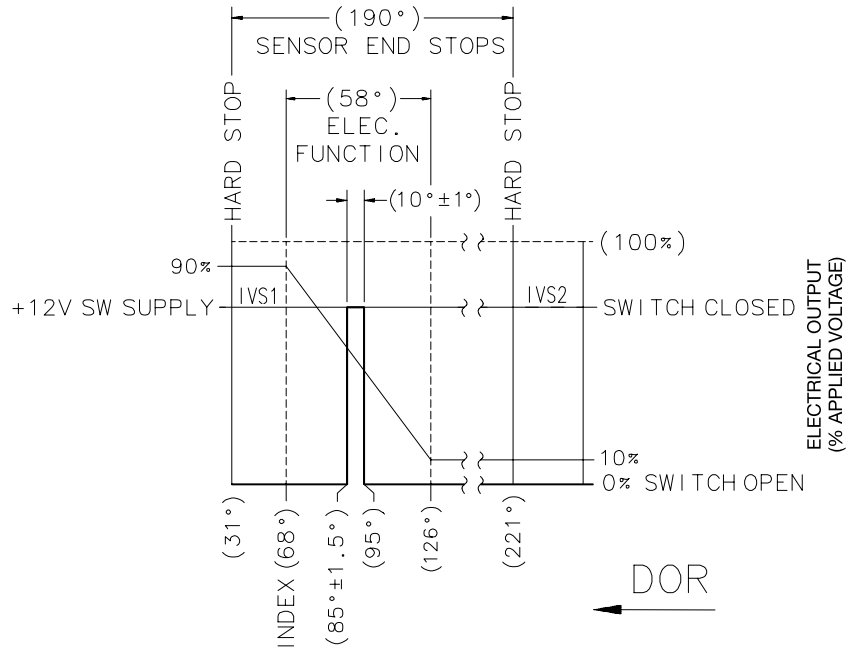
### Electrical Schematic





# Accelerator Sensor (ZT-Left Side)

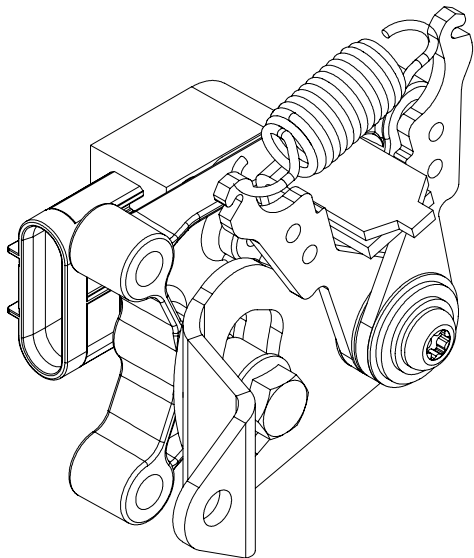
## Electro-Mechanical Graph For Sensor With Switching



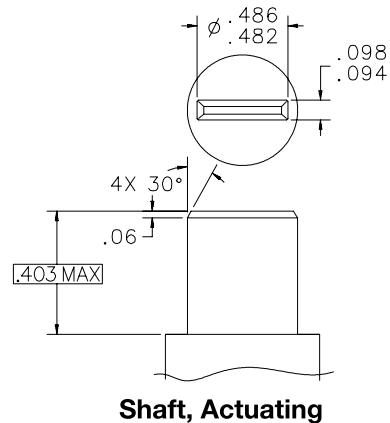
### SENSOR MOUNT POSITION VERSUS WIRING:

Per the electrical output graphs, the voltage output varies high to low as the sensor slot is rotated clockwise when looking into the drive slot. In this configuration, the forward direction is counterclockwise and reverse is clockwise relative to the neutral alignment position. The electrical wiring schematics apply when the sensors are mounted in a manner that produces the rotation as defined.

Note: Sensors can be mounted in an opposing orientation that results in a reverse of the voltage output as shown in the schematics. When sensors are mounted in this manner it will be necessary to correct this by modifying the controller default hardware setting.

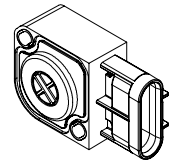
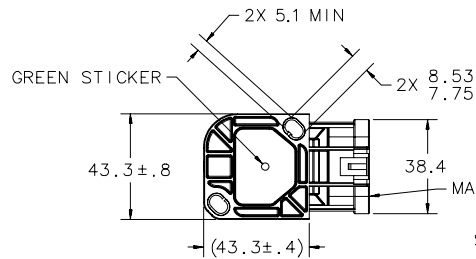
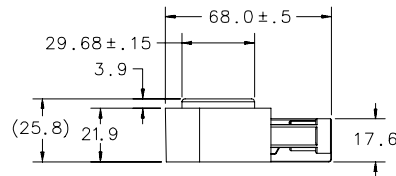
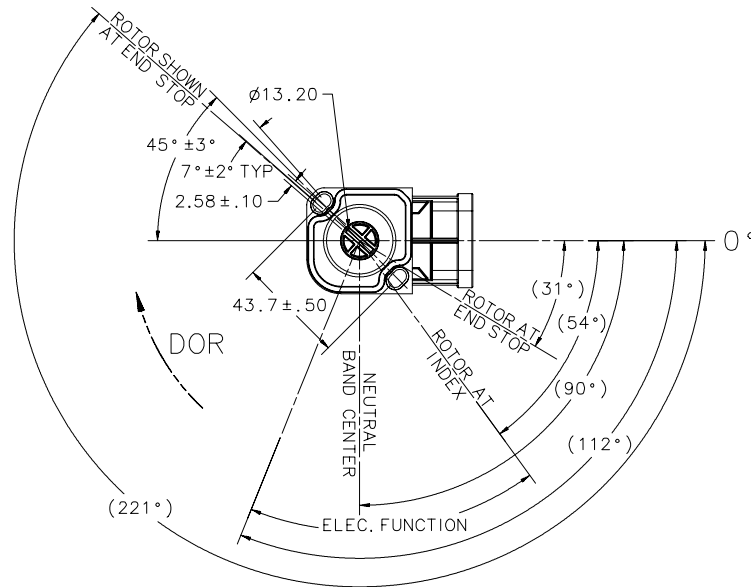


**Accelerator Sensor RTN Kit  
P/N 72258**



**Shaft, Actuating**

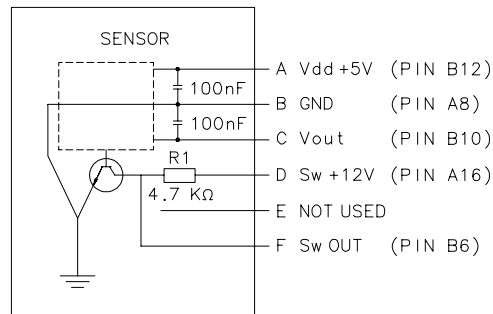
# Accelerator Sensor (ZT-Right Side)



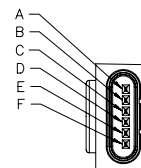
MATING CONNECTOR: Delphi 15397577  
 MATING PIN: 15326426  
 WIRE SEAL: 15366021-B  
 SECONDARY LOCK: 15317363  
 WIRE: USE 20 AWG

**Right Sensor Accelerator w/Internal Switching  
 P/N 53518**

## Electrical Schematic

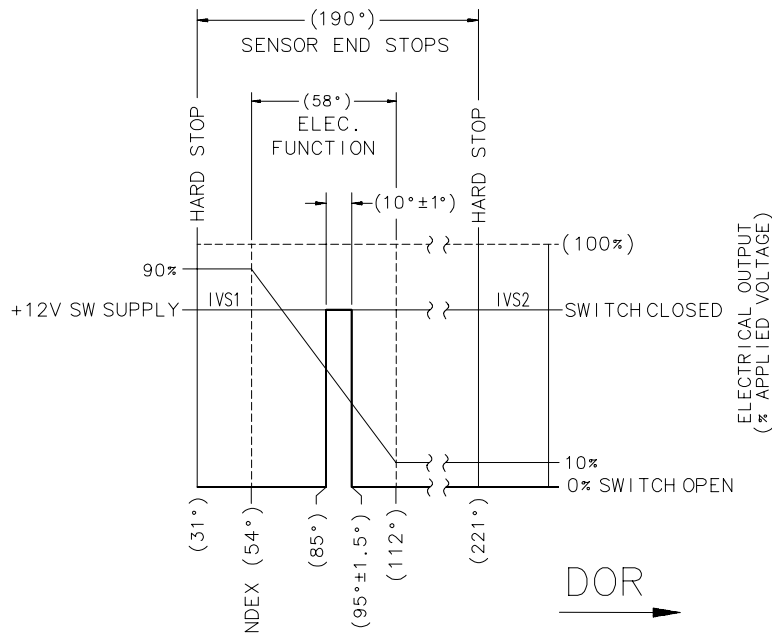


**WARNING: GOLD TERMINALS  
 MUST MATE TO GOLD TERMINALS  
 AND TIN TO TIN. PLEASE VERIFY  
 THIS IN ALL HARNESSSES.**



# Accelerator Sensor (ZT-Right Side)

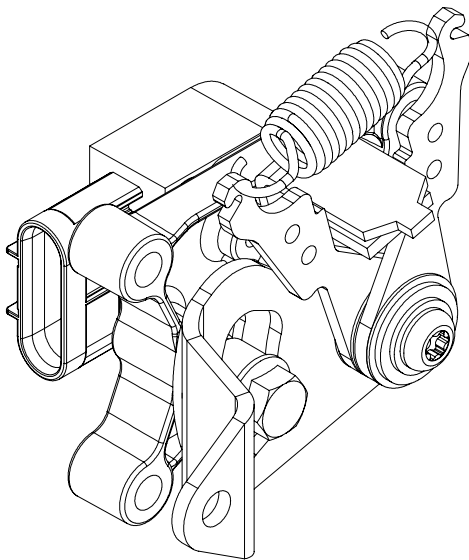
## Electro-Mechanical Graph For Sensor With Switching



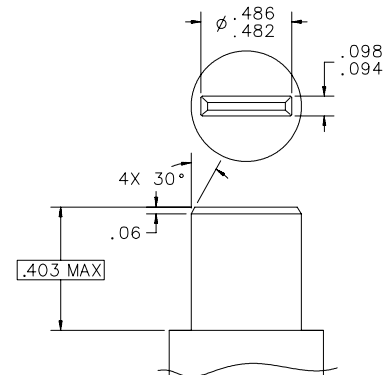
### SENSOR MOUNT POSITION VERSUS WIRING:

Per the electrical output graphs the voltage output varies high to low as the sensor slot is rotated clockwise when looking into the drive slot. In this configuration the forward direction is counterclockwise and reverse is clockwise relative to the neutral alignment position. The electrical wiring schematics apply when the sensors are mounted in a manner that produces the rotation as defined.

Note that sensors can be mounted in an opposing orientation that results in a reverse of the voltage output as shown in the schematics. When sensors are mounted in this manner it will be necessary to correct this by modifying the controller default hardware setting.

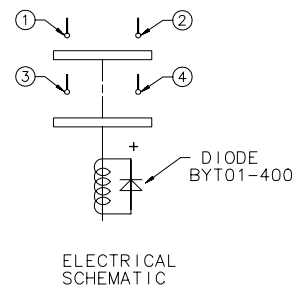
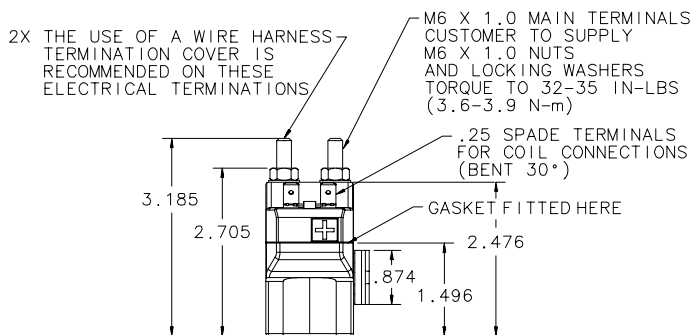
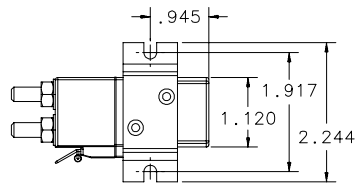
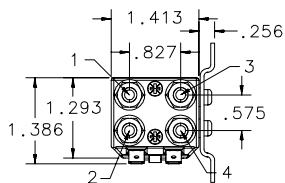


**Accelerator Sensor RTN Kit  
P/N 72257**



**Shaft, Actuating**

# Contactor - ZT System



## DOUBLE POLE CONTACTOR P/N 53110

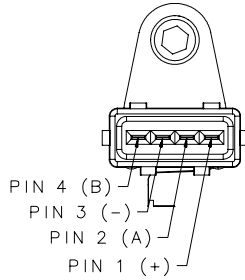
### NOTES:

1. Contactor Enclosure Rating: IP65.
2. Performance Data:
  - Maximum Recommended Coil Voltage:  $\leq 28$  V, 300mA
  - Mechanical Life:  $> 5000$  cycles
  - Drop-Out Time (N/O Contacts to Open):  $\leq 50$ ms
  - Both Contacts Normally Open
3. Part to be used in conjunction with Smartec Electric Drive Traction Controller P/N 53318.

# Connectors - ZT System

## SPEED SENSOR

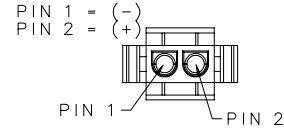
MATING CONNECTOR: AMP C-282192  
 MATING PINS: AMP 929940-1  
 WIRE SEAL: AMP 828904-1  
 WIRE: USE 20 AWG



**DETAIL D**

## BRAKE CONNECTOR

MATING CONNECTOR:  
 HOUSING (FEMALE): AMP 350778-1  
 SOCKET (FEMALE): AMP 926895-1  
 WIRE SEAL: AMP 794270-1  
 WIRE: USE 20 AWG

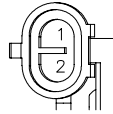


**VIEW E-E**

## THERMAL SENSOR CONNECTION

1 = PIN 1 WHITE (-)  
 2 = PIN 2 RED (+)

MATING CONNECTOR: AMP 282080-1  
 MATING PIN: AMP 282403-1  
 WIRE SEAL: AMP 281934-2  
 WIRE: USE 20 AWG

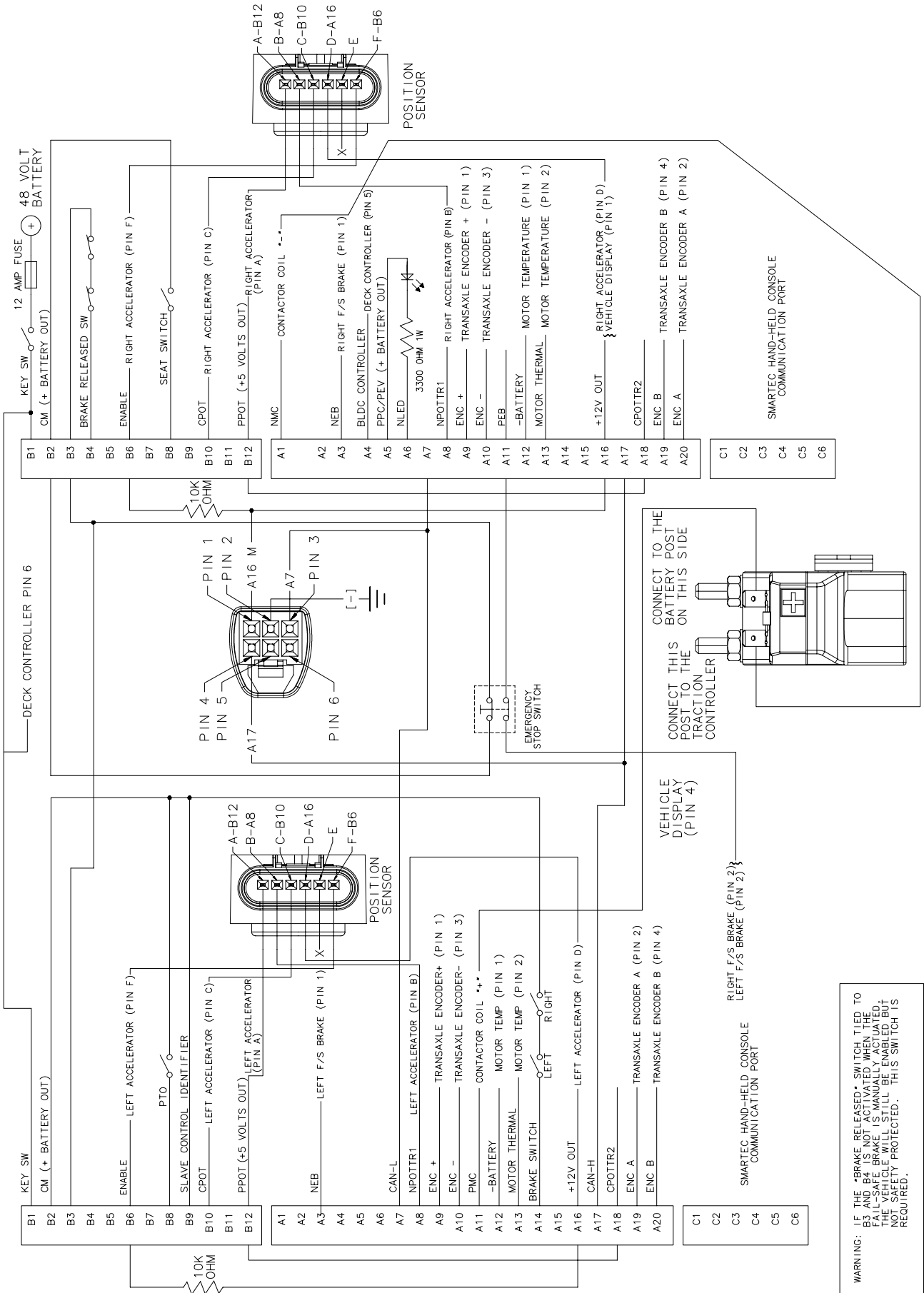


**VIEW C-C**

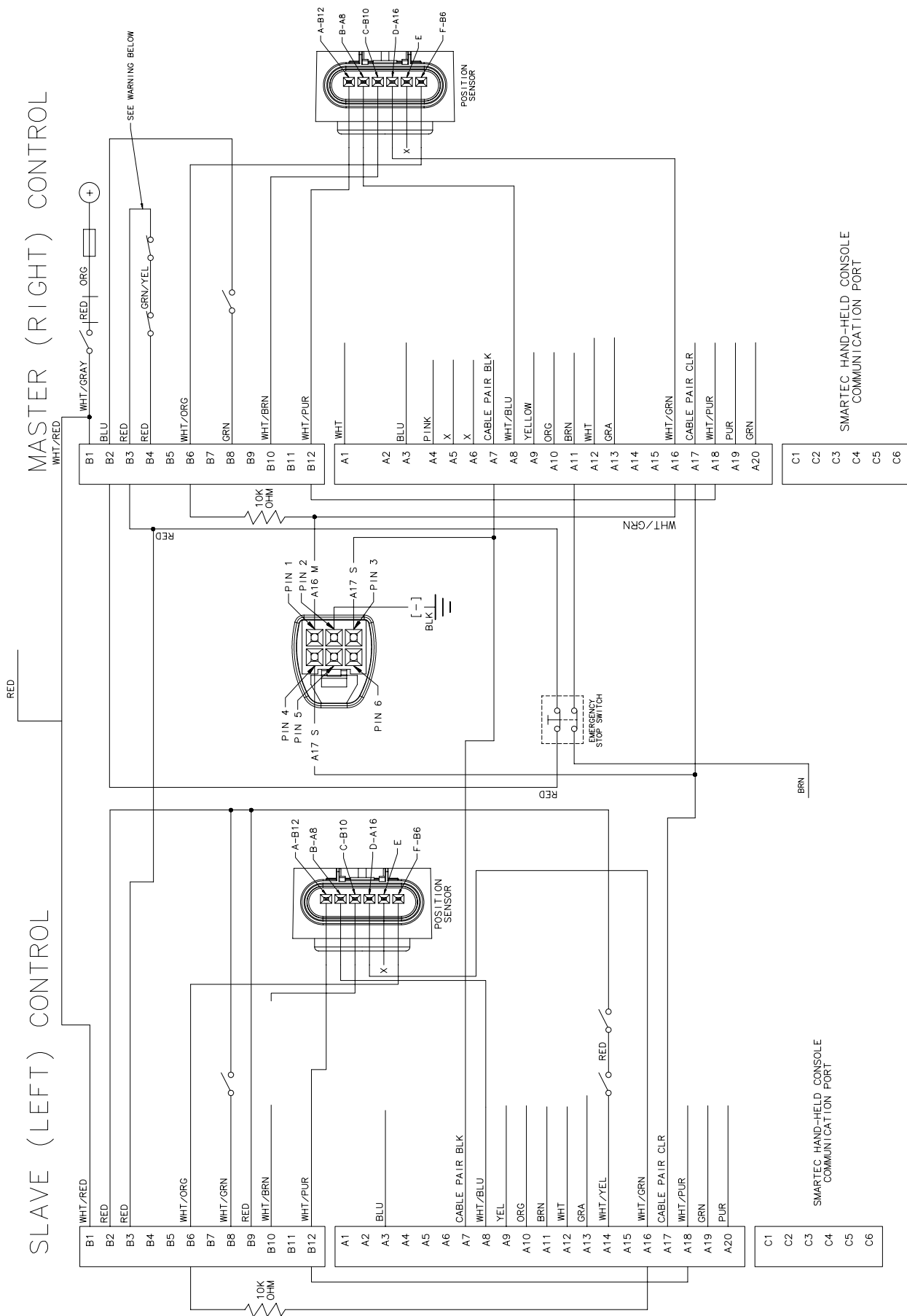
# Traction Controller Wire Harness - ZT

## SLAVE (LEFT) CONTROL

## MASTER (RIGHT) CONTROL



# Traction Controller Wire Harness Color Chart - ZT

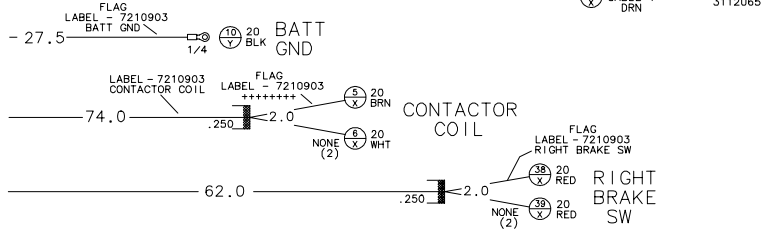
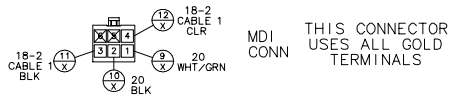
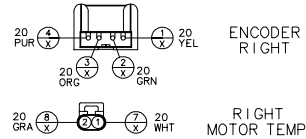
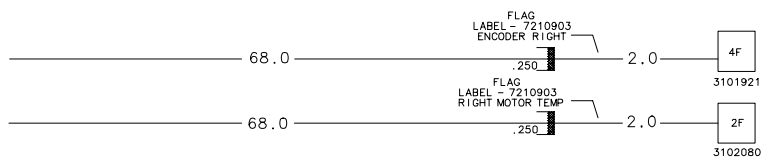


SMART-TEC ZT WIRING HARNESS COLOR CHART



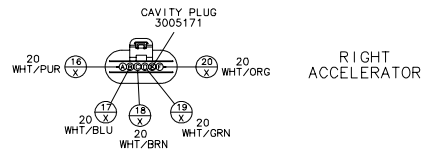


# Right Side Wire Harness Layout - ZT



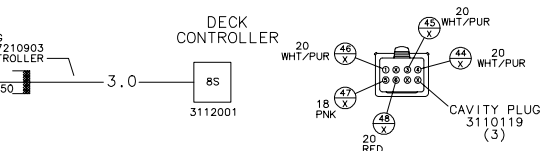
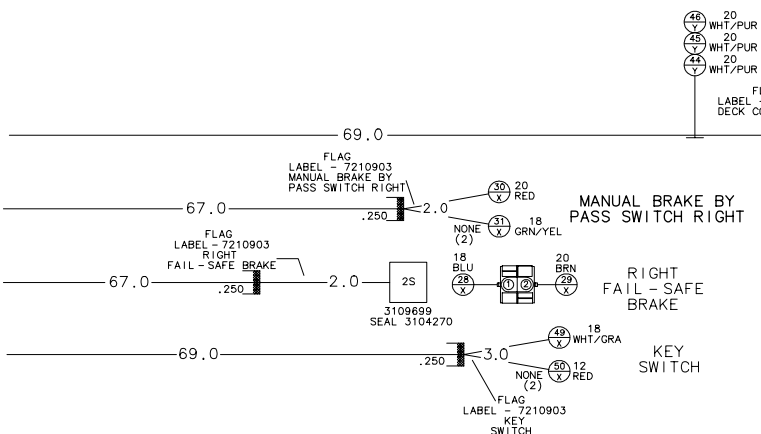
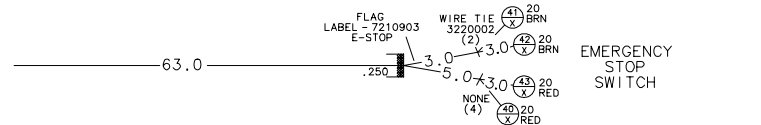
## NOTES:

1. HRNS is braided.
2. Shrink W/S on all splices.
3. See Harness layout detail **page 27**.

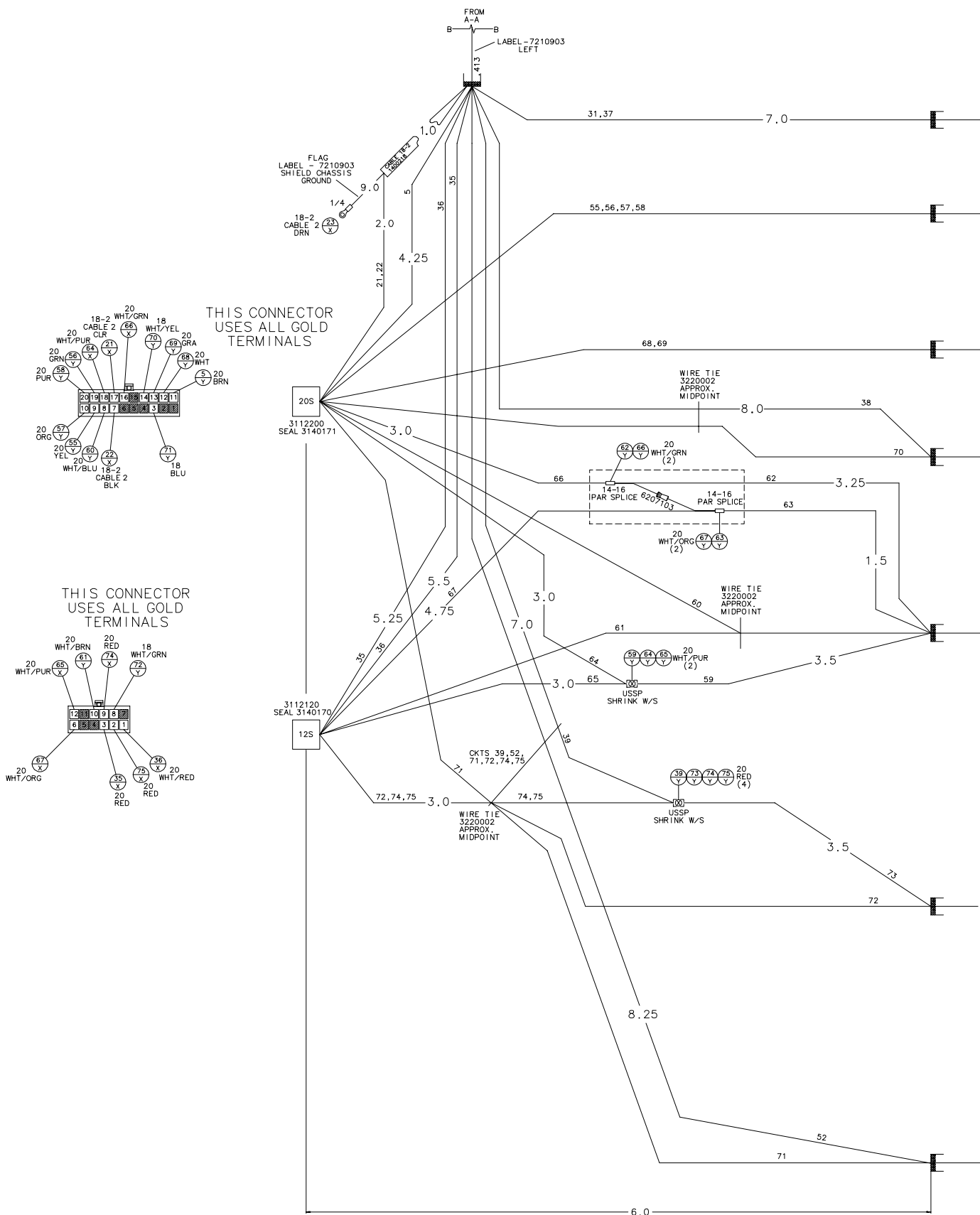


## NOTES:

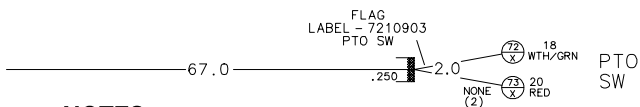
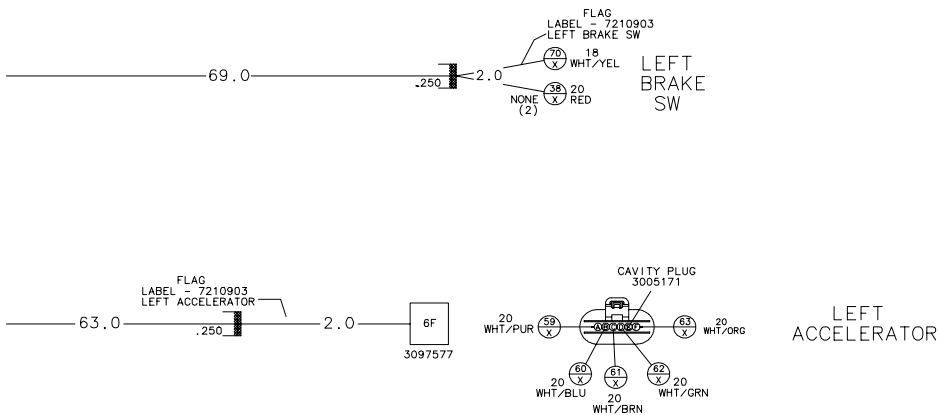
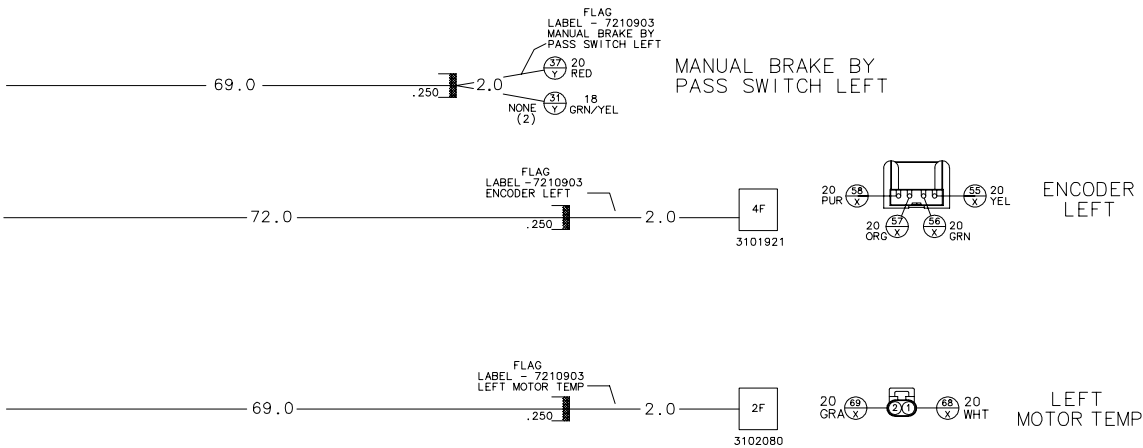
1. Dimensions are in inches.
2. Wire dimensions are to wire ends. Harness dimensions are to end of covering, between breakout centers, and to side of covering for breakout lengths.
3. See circuit chart for circuit details.
4. Harness covering is convoluted conduit.
5. Tape conduit at ends and breakouts.
6. Connector details shown from wire entry end.
7. All notes are for standard HRNS assembly unless otherwise specified.



# Left Side Wire Harness Layout - ZT

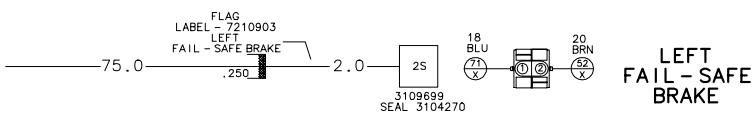


# Left Side Wire Harness Layout - ZT



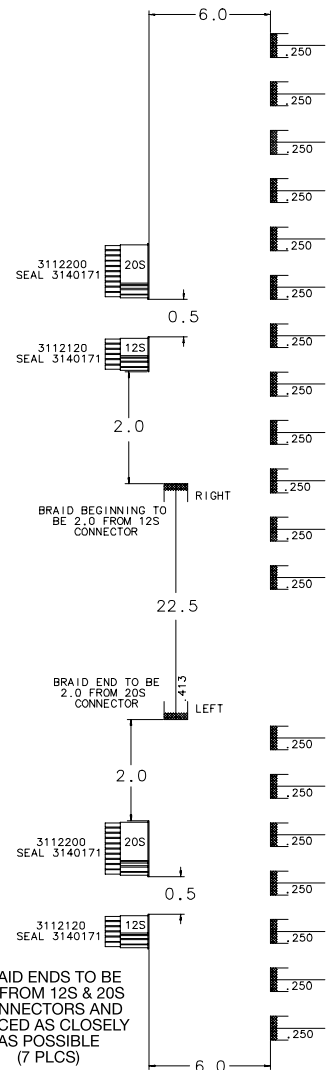
## NOTES:

1. Dimensions are in inches.
2. Wire dimensions are to wire ends. Harness dimensions are to end of covering, between breakout centers, and to side of covering for breakout lengths.
3. See circuit chart for circuit details.
4. Harness covering is convoluted conduit.
5. Tape conduit at ends and breakouts.
6. Connector details shown from wire entry end.
7. All notes are for standard HRNS assembly unless otherwise specified.

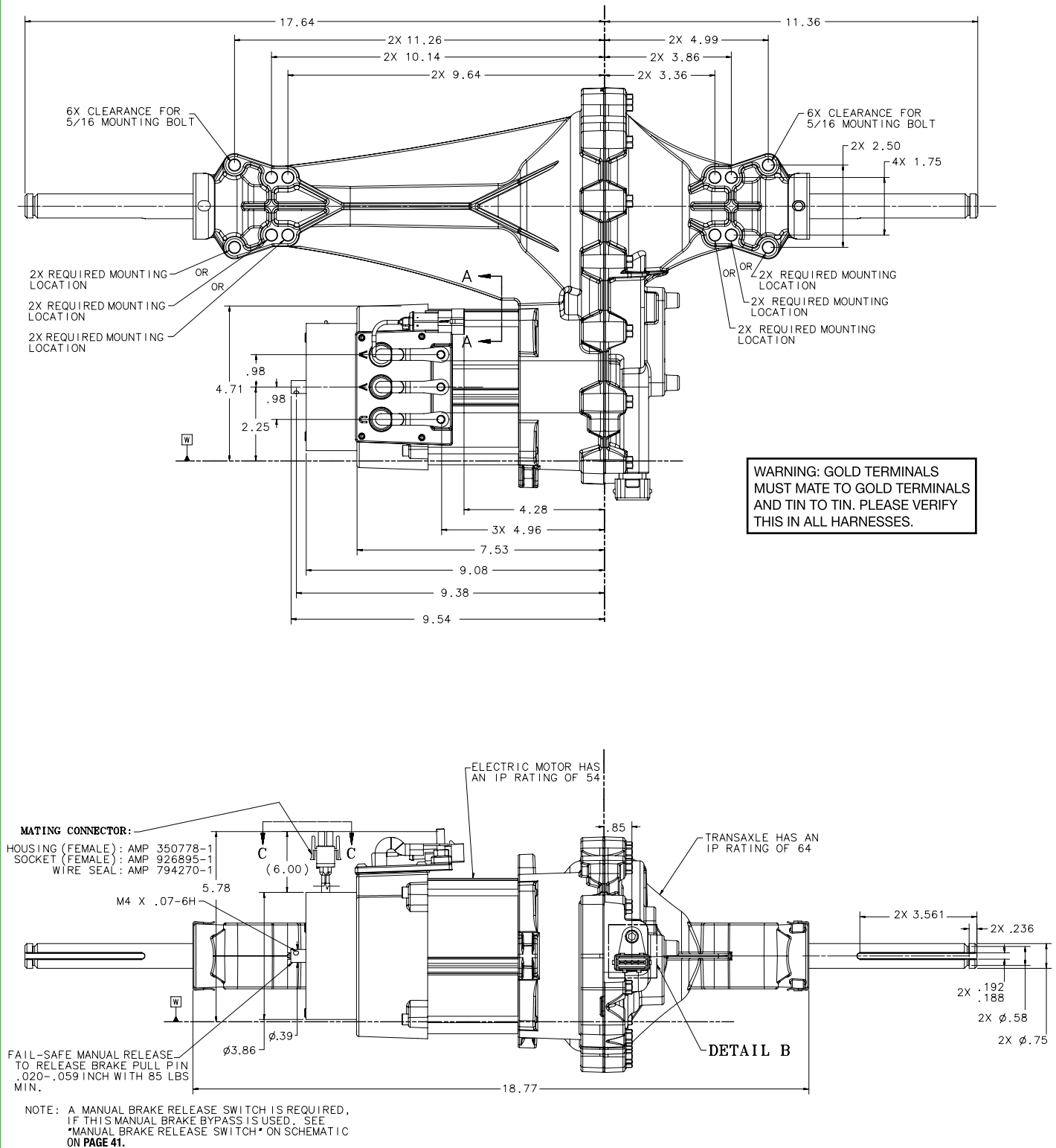


## HARNES LAYOUT DETAIL

BRAID ENDS TO BE 6.0 FROM 12S & 20S CONNECTORS AND SPACED AS CLOSELY AS POSSIBLE (12 PLCS)



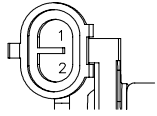
# Single Drive Transaxle Reference Dimensions



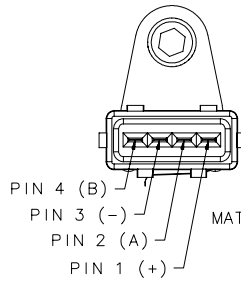
# Single Drive Transaxle Reference Dimensions

MOTOR TEMPERATURE SENSOR CONNECTION  
 1 = PIN 1 WHITE (-)  
 2 = PIN 2 RED (+)

MATING CONNECTOR: AMP 282080-1  
 MATING PIN: AMP 282403-1  
 WIRE SEAL: AMP 281934-2  
 WIRE: USE 20 AWG



VIEW A-A

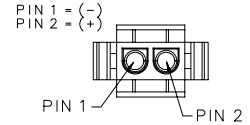


**SPEED SENSOR**  
 MATING CONNECTOR: AMP C-282192  
 MATING PINS: AMP 929940-1  
 WIRE SEAL: AMP 828904-1  
 WIRE: USE 20 AWG

DETAIL B

**BRAKE CONNECTOR**  
 MATING CONNECTOR:

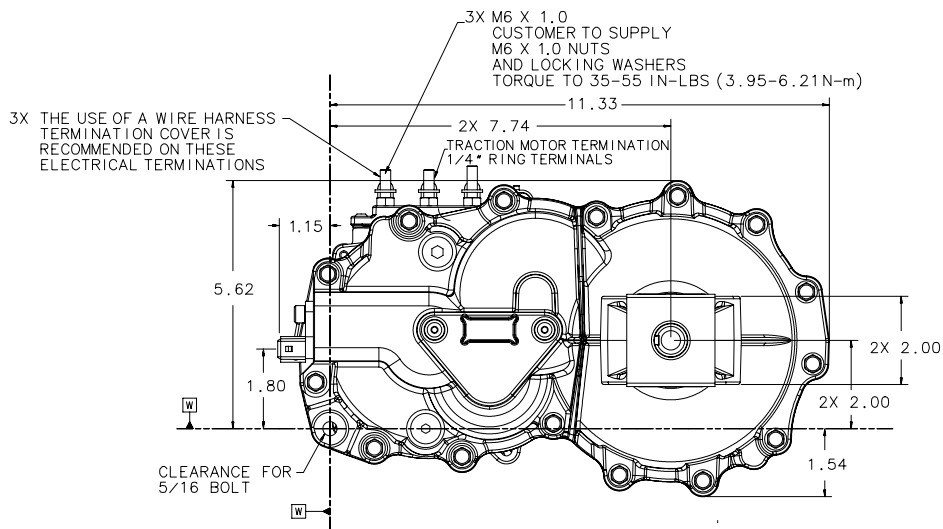
HOUSING (FEMALE): AMP 350778-1  
 SOCKET (FEMALE): AMP 926895-1  
 WIRE SEAL: AMP 794270-1  
 WIRE: USE 20 AWG



VIEW C-C

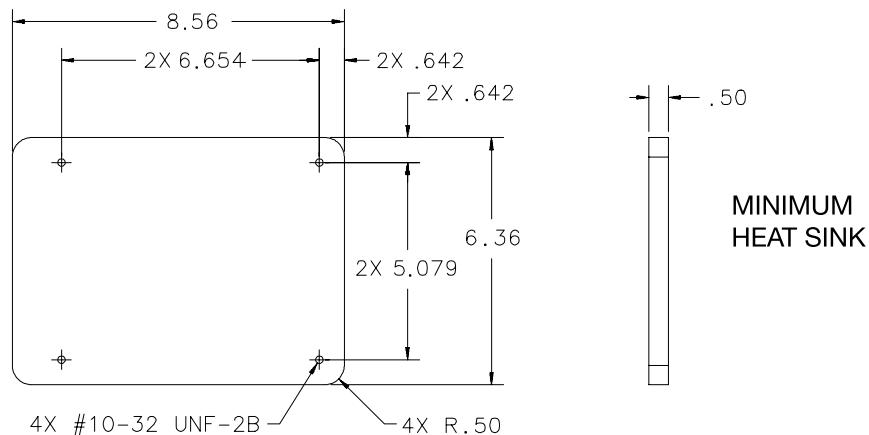
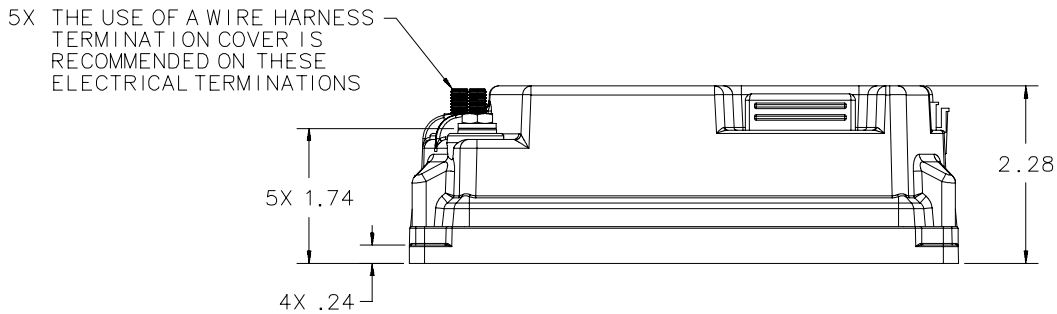
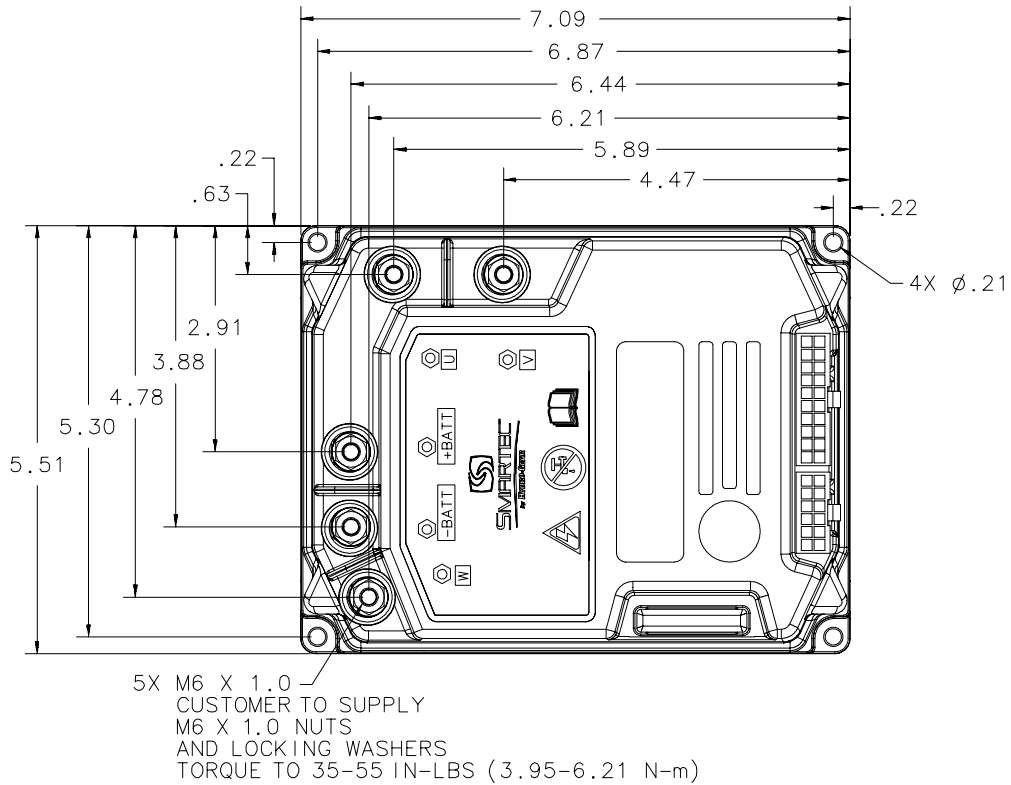
## TECHNICAL DATA:

MAX. VEHICLE WEIGHT INCLUDING 200 LB OPERATOR AND 50% FULL BAGGER:	≤ 1000 LBS
MAX WEIGHT ON DRIVE TIRES	694 LBS
TIRE SIZE	18 INCH MAX.
CONTINUOUS OPERATING TORQUE	80 FT-LBS
PEAK TORQUE	322 FT-LBS
TRANSAXLE IP RATING	64
ELECTRIC MOTOR IP RATING	54



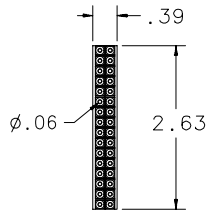
# Traction Controller - LT Drive System

The SMARTEC® LT or one motor drive system requires one traction controller. The controller is capable of 125 amp maximum output and features built in temperature protection.

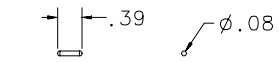
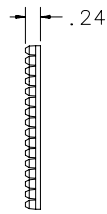


**Heat Sink P/N 54103**

# Traction Controller - LT Drive System



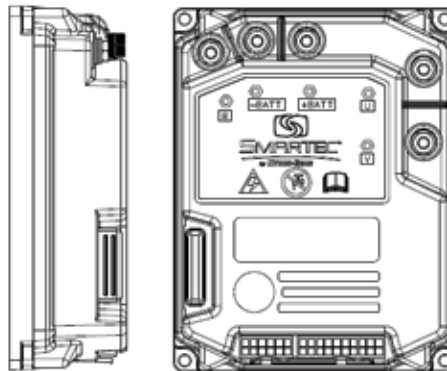
**Wire Seal P/N 53135**



**Cavity Plug P/N 53159**

WARNING: GOLD TERMINALS  
MUST MATE TO GOLD TERMINALS  
AND TIN TO TIN. PLEASE VERIFY  
THIS IN ALL HARNESSES.

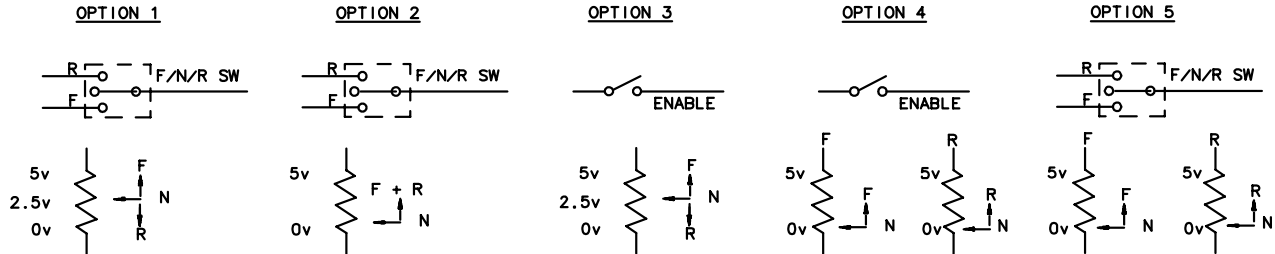
SEE BELOW FOR SUGGESTED  
MOUNTING POSITION



# Traction Controller Technical Information (LT)

## TECHNICAL DATA

1. APPLICATION: LT
2. MOUNTING REQUIREMENTS
  - a. The connector side of the traction controller must be protected from being sprayed with direct water pressure. SMARTEC® traction controller cover P/N 52953 is available to help protect the controller.
  - b. It is recommended the traction controller be mounted in a vertical or standing position with the A and B connectors at the bottom, or horizontally, with the heat sink facing up and all connectors facing earth.
  - c. The minimum heat sink is an unpainted aluminum plate approximately 5.7" x 7.9" x 0.5". Apply thermal grease or a thermal transfer pad between the traction controller mounting plate and the heat sink to facilitate acceptable heat transfer rates.
  - d. The minimum heat sink specified is for a machine weight of 680 lbs (300kg) running a drive cycle of mowing, level 66.67%, turning 6.67%, transporting 8.33%, 10° climb 5%, 17° climb 1.11%, towing sweeper 5.56% and towing a cart 6.67% on a 100°F ambient temperature day. The goal is to achieve temperature stabilization without exceeding 78°C (172.4°F) internal temperature of the traction controller.
3. SPECIFICATIONS
  - a. Controls a single SMARTEC® Electric LT Transaxle.
  - b. Internal hour meter can be displayed on the SMARTEC® Vehicle display P/N 53143.
  - c. Weight: 3.2 lbs
  - d. Voltage: 48VDC
  - e. Operating/switching frequency: 8kHz
  - f. Ambient temperature range: -20°F to 110°F
  - g. Maximum controller temperature: 212°F
  - h. IP 54
  - i. Throttle
    - i. THROTTLE OPTIONS



### ii. POTENTIOMETER

1. SMARTEC® offers a complete solution for option 3 (SMARTEC® P/N 53419).
2. The throttle unit can consist of a potentiometer or a fall effect device. The sensor should be a 3-wire configuration. Potentiometer value should be in the 0.5 - 10 kΩ range; generally, the load should be in the 1.5mA to 30mA range. Faults can occur if it is outside this range.
3. The procedure for calibrating the controller with the minimum and maximum useful throttle range is carried out using the SMARTEC® calibration tool P/N 53096. This procedure will be required on every vehicle manufactured, prior to initial operation.

### iii. MICROSWITCHES

1. The throttle microswitches must have a contact resistance lower than 0.1Ω and a leakage current lower than 100uA.
2. With full load connected, the voltage between the switch contacts must be lower than 0.1v.
3. The microswitches send a voltage signal to the traction controller when a drive request is made.



# Traction Controller Technical Information (LT)

## 4. VEHICLE PERFORMANCE PARAMETERS

- a. A traction controller vehicle model number will be assigned to each unique set of vehicle performance parameters.
  - i. Traction controller vehicle model numbers will be assigned by SMARTEC® as required. The model numbers will be a 5 digit number consisting of a sequence of digits ranging from 1 to 4.
  - ii. This model number will be required to be entered into each vehicle's traction controller, upon initial power up, using the SMARTEC® calibration tool P/N 53096.

## 5. WIRE HARNESS REQUIREMENTS

- a. It is necessary to use a main contactor in-line to the controller's +48 volt power input to protect the controller against reverse battery polarity and for safety reasons. SMARTEC® offers a main contactor P/N 53082.
- b. Connector "A" Mating connector is molex P/N 0039012120 with molex terminal P/N 5556 gold plated.
- c. Connector "B" Mating connector is molex P/N 0039012200 with molex terminal P/N 5556 gold plated.
- d. Connector "A" and "B" require wire seal SMARTEC® P/N 53135 (one 32 hole wire seal will be cut to create both connector seals).
- e. All empty connector cavities must be plugged using SMARTEC® connector cavity plug P/N 53159.
- f. All controller bolt connections require 1/4" (6mm) ring terminals.
- g. All wires connected to connectors "A" and "B" must be 20 AWG minimum.
- h. All wires connected to -B, +B, U, V, W, and all wires connected between the batteries must be 5 AWG (.0125in<sup>2</sup> [16mm<sup>2</sup>] cross sectional area) minimum.
- i. For optimum controller performance, the cables to the battery should be ran side by side and as short as possible.
- j. Can-bus wiring must be shielded, with shield tied to vehicle chassis or battery ground. Can-bus wiring must "not" be routed along power wires. Can-bus wires may cross power wires perpendicularly, but may not run in parallel.

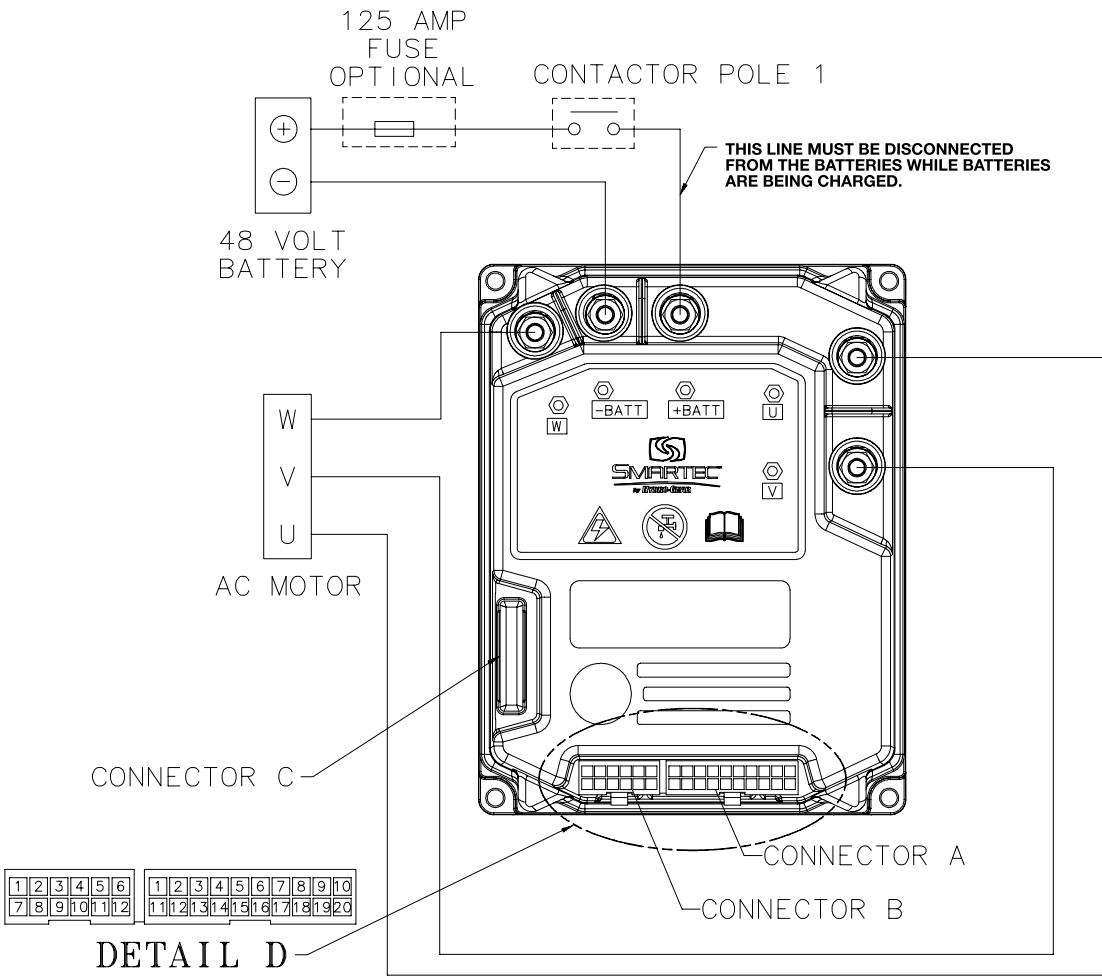
## 6. PROTECTION FEATURES

- a. Protection against accidental start.
- b. If the controller temperature exceeds 173°F, the maximum current is reduced in proportion to the thermal increase. The control will shutdown completely if the temperature reaches 212°F.
- c. If movement is commanded with no response, the vehicle will shut down.
- d. Low battery shutdown - 80% discharge

## 7. EMI TESTING

- a. It is recommended that complete EMC and EMI testing of all vehicles be performed before production release.

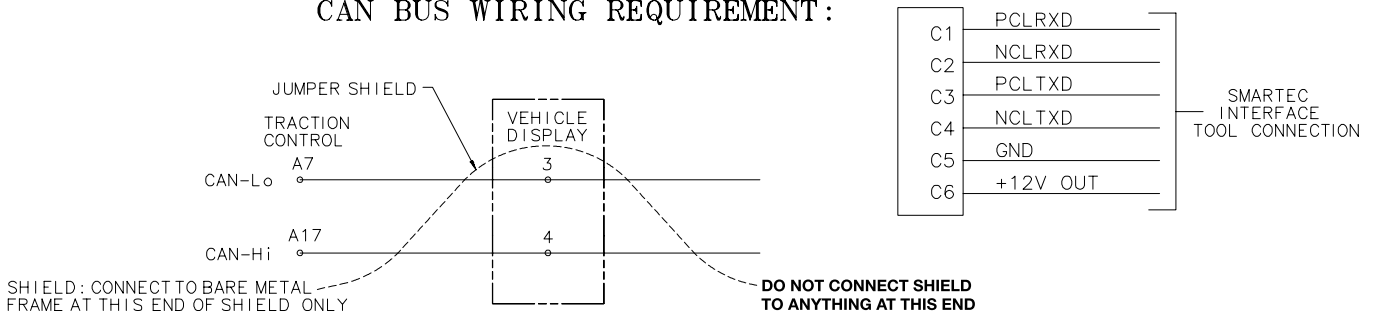
# Traction Controller Technical Information (LT)



CONNECTOR	MATING CONNECTOR	WIRE SEAL
A	MOLEX TERMINAL P/N 39-00-0164-5556 GSPL	SMARTeC P/N 53135
B	MOLEX TERMINAL P/N 39-00-0164-5556-GSPL	
C	SMARTeC HAND-HELD CONSOLE (53096)	N/A

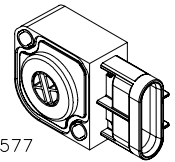
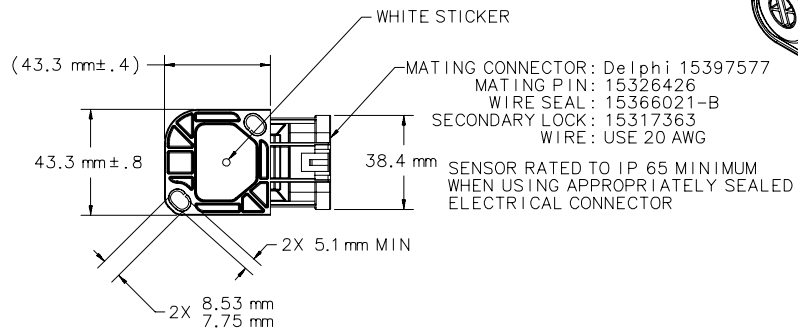
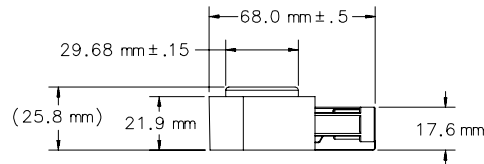
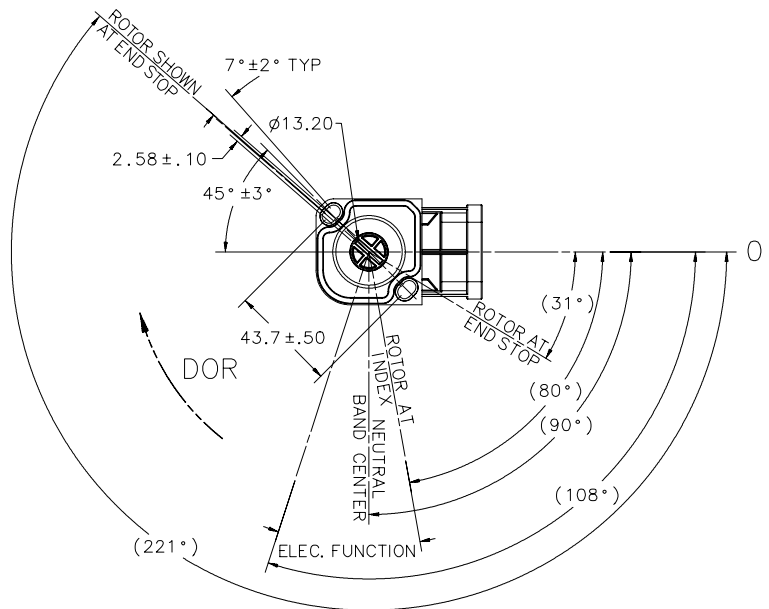
**NOTE: ALL EMPTY CONNECTOR CAVITIES MUST BE PLUGGED USING SMARTeC CONNECTOR CAVITY PLUG P/N 53159**

## CAN BUS WIRING REQUIREMENT:



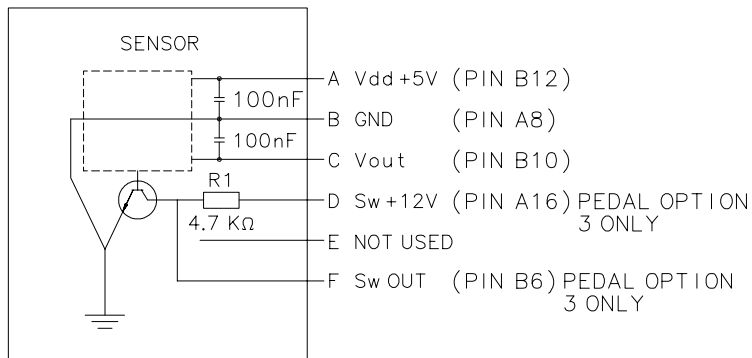
**WARNING: GOLD TERMINALS MUST MATE TO GOLD TERMINALS AND TIN TO TIN. PLEASE VERIFY THIS IN ALL HARNESSSES.**

# Accelerator Sensor (LT)



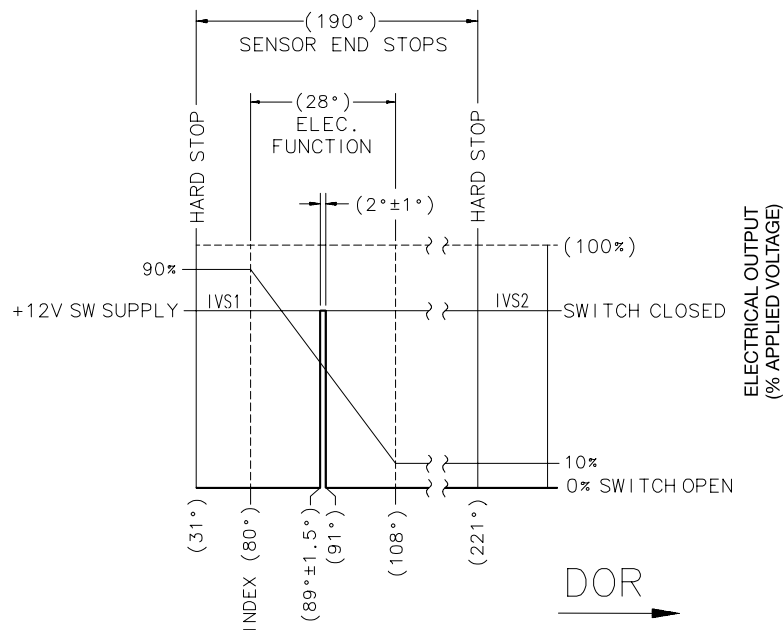
## Sensor, Accelerator W/Internal Switching P/N 53419

### Electrical Schematic



# Accelerator Sensor (LT)

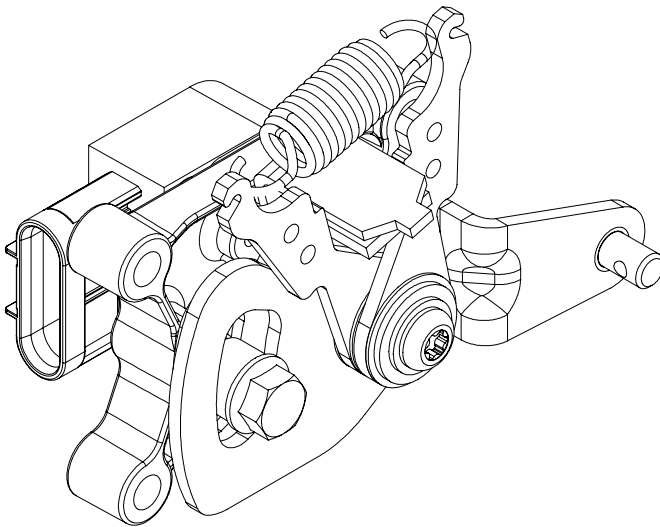
## Electro-Mechanical Graph For Sensor With Switching



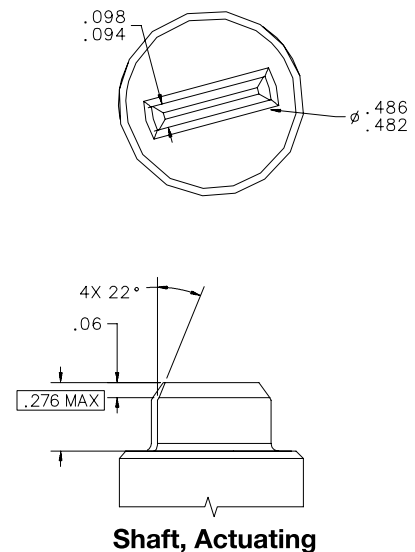
### SENSOR MOUNT POSITION VERSUS WIRING:

Per the electrical output graphs, the voltage output varies high to low as the sensor slot is rotated clockwise when looking into the drive slot. In this configuration, the forward direction is counterclockwise and reverse is clockwise relative to the neutral alignment position. The electrical wiring schematics apply when the sensors are mounted in a manner that produces the rotation as defined.

Note: The sensors can be mounted in an opposing orientation that results in a reverse of the voltage output as shown in the schematics. When sensors are mounted in this manner it will be necessary to correct this by modifying the controller default hardware setting.

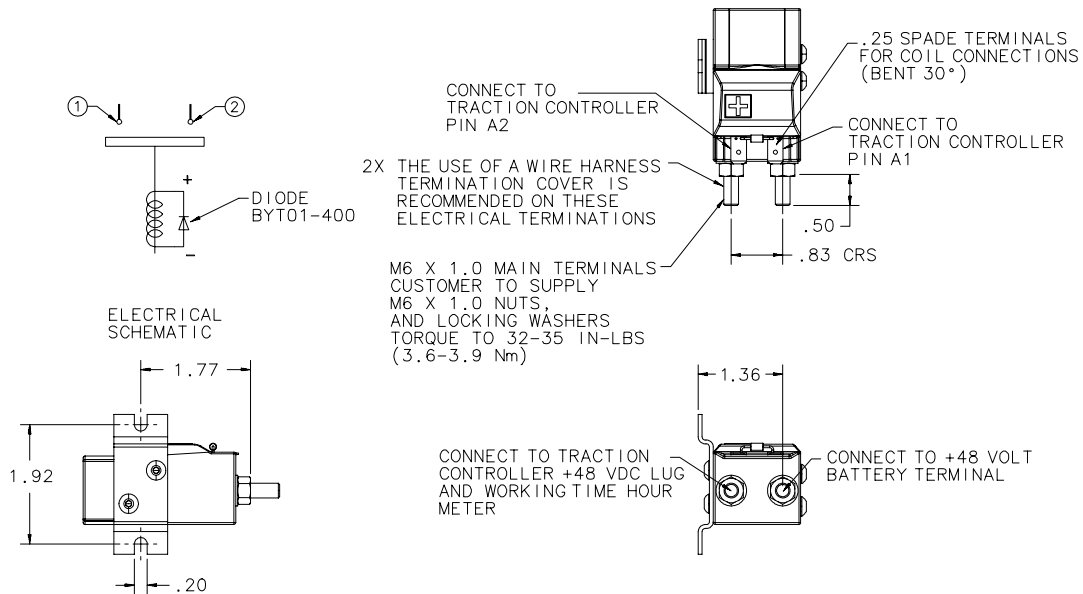


**Accelerator Sensor RTN Kit  
P/N 71904**



**Shaft, Actuating**

# Contactor - LT System

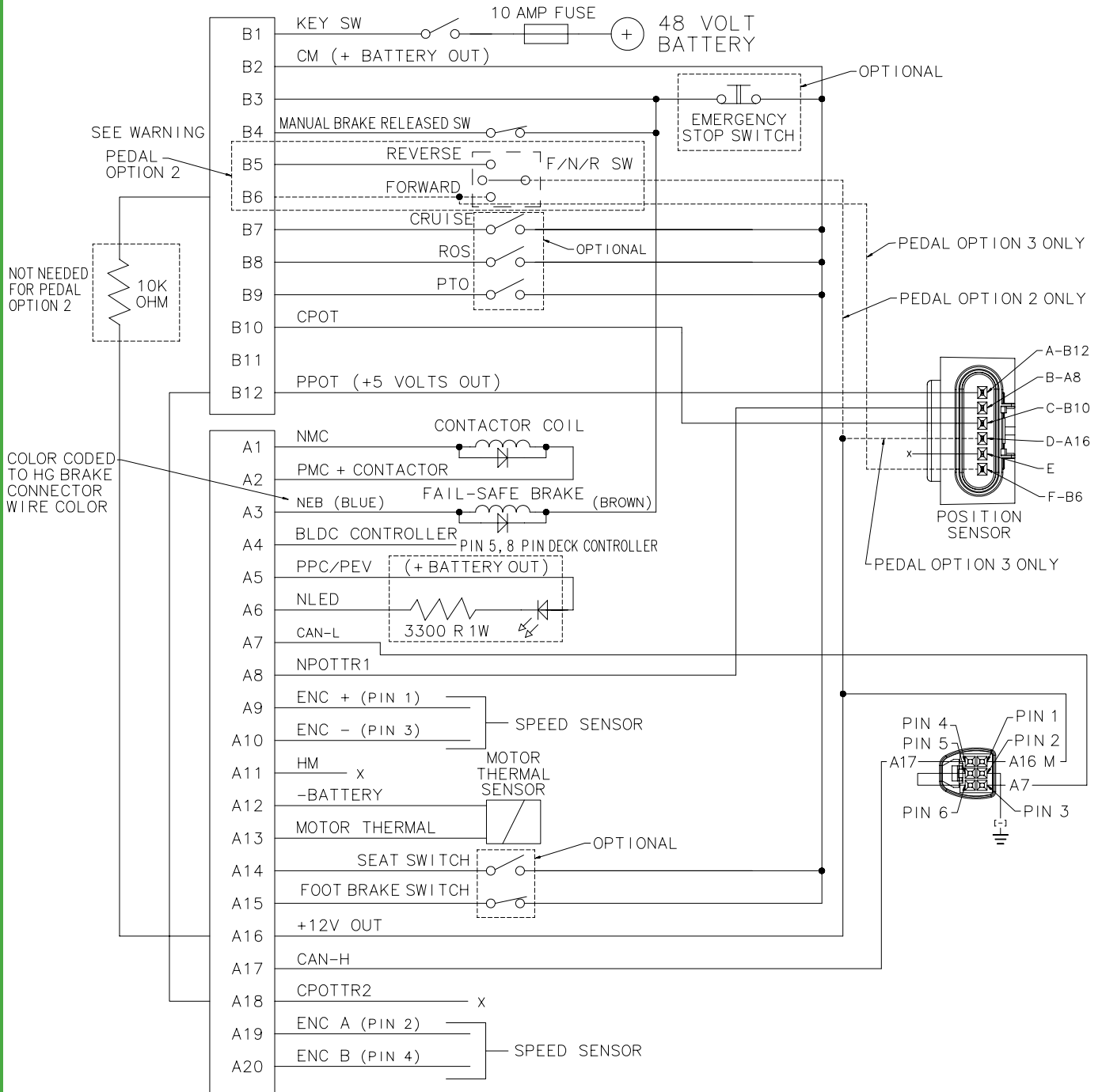


## SINGLE POLE CONTACTOR P/N 53082

### NOTES:

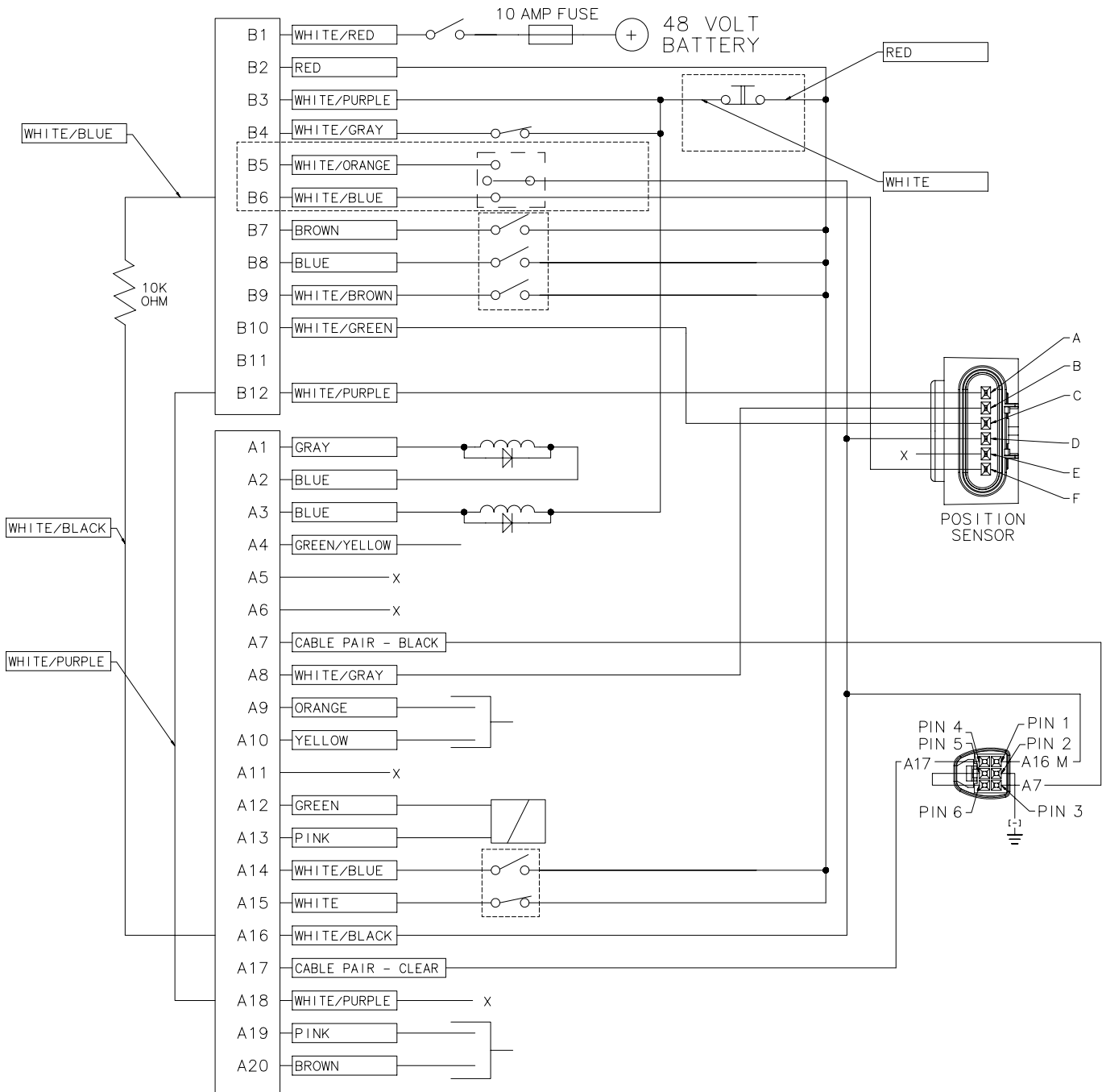
1. Contactor Enclosure Rating: IP65
2. Performance Data:
  - Maximum Recommended Coil Voltage:  $\leq 28\text{ V}$ , 300mA
  - Mechanical Life:  $> 5000$  cycles
  - Drop-Out Time (N/O Contacts to Open):  $\leq 50\text{ms}$
  - Main Contactor Current Rating: 80A Continuous  
150A Peak
3. Part to be used in conjunction with Smartec® Electric Drive Traction Controller P/N 53317.

# SMARTEC® LT Wiring Schematic

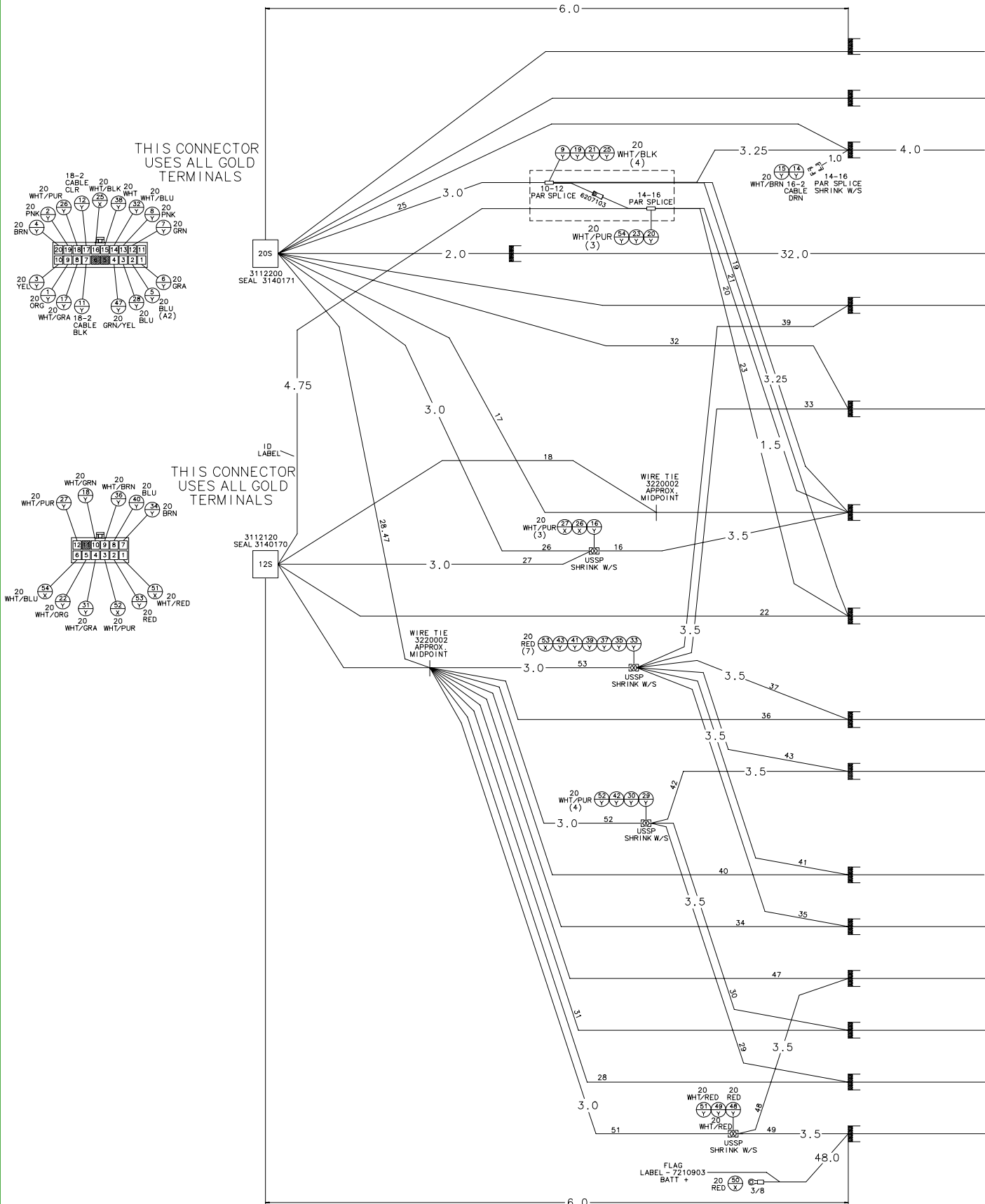


# SMARTEC® LT

## Wiring Harness Color Chart Schematic

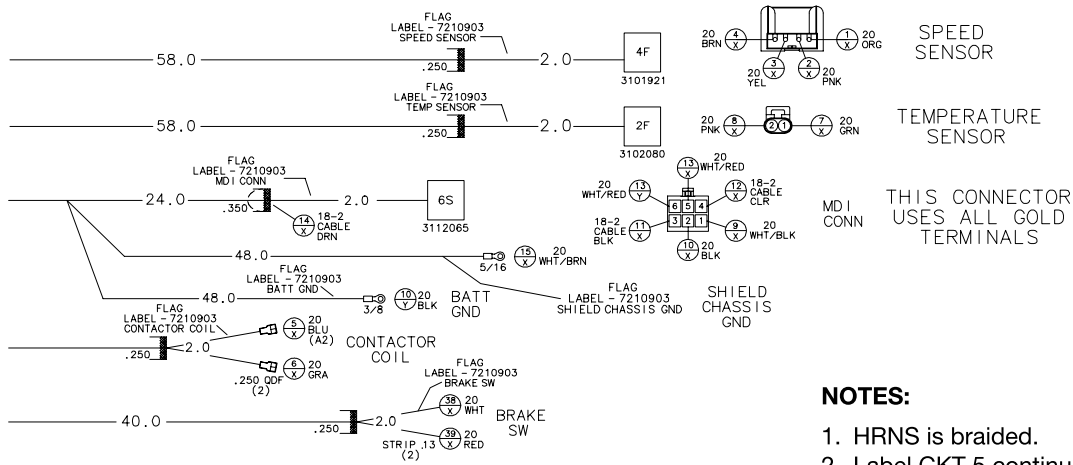


# Wire Harness Layout - LT



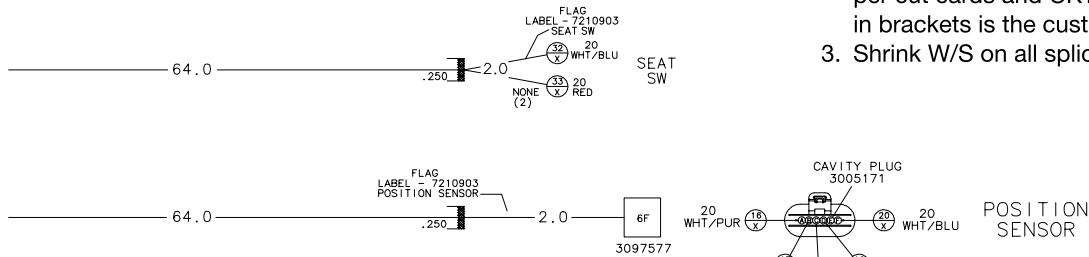


# Wire Harness Layout - LT



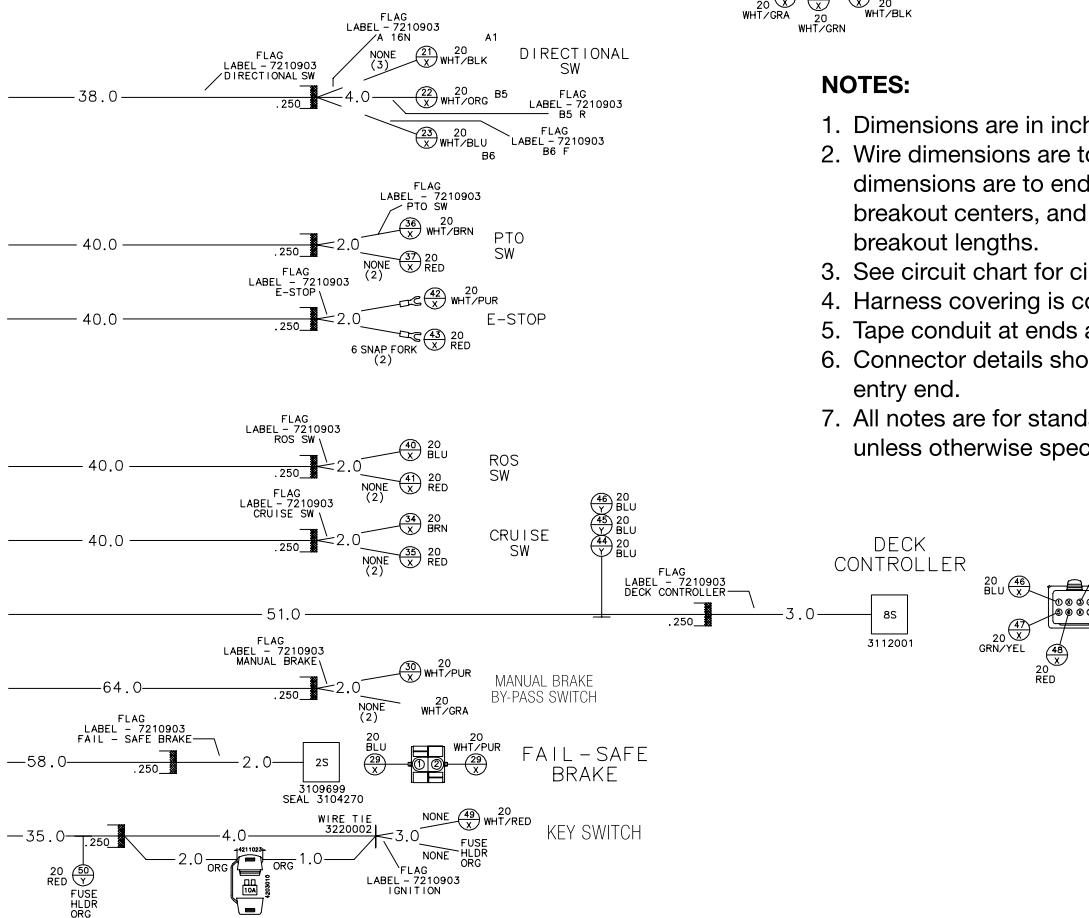
### NOTES:

1. HRNS is braided.
2. Label CKT 5 continuously every 2.0" per cut cards and CKT chart. The number in brackets is the customer label number.
3. Shrink W/S on all splices.

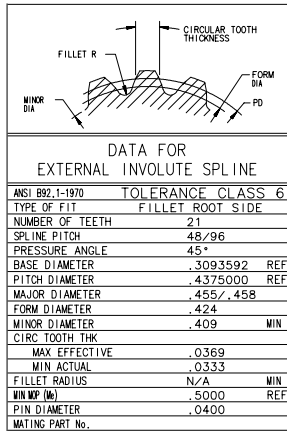


### NOTES:

1. Dimensions are in inches.
2. Wire dimensions are to wire ends. Harness dimensions are to end of covering, between breakout centers, and to side of covering for breakout lengths.
3. See circuit chart for circuit details.
4. Harness covering is convoluted conduit.
5. Tape conduit at ends and breakouts.
6. Connector details shown from wire entry end.
7. All notes are for standard HRNS assembly unless otherwise specified.



# 1.7 Kilowatt AC Motor



SPLINE 1

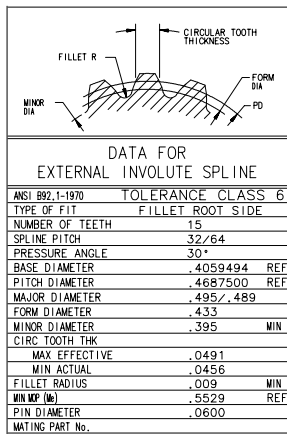
## TEST DATA:

RESISTANCE TEST (Ohms) AT 25°C	
MIN	MAX2
0.0135Ω	0.0175Ω

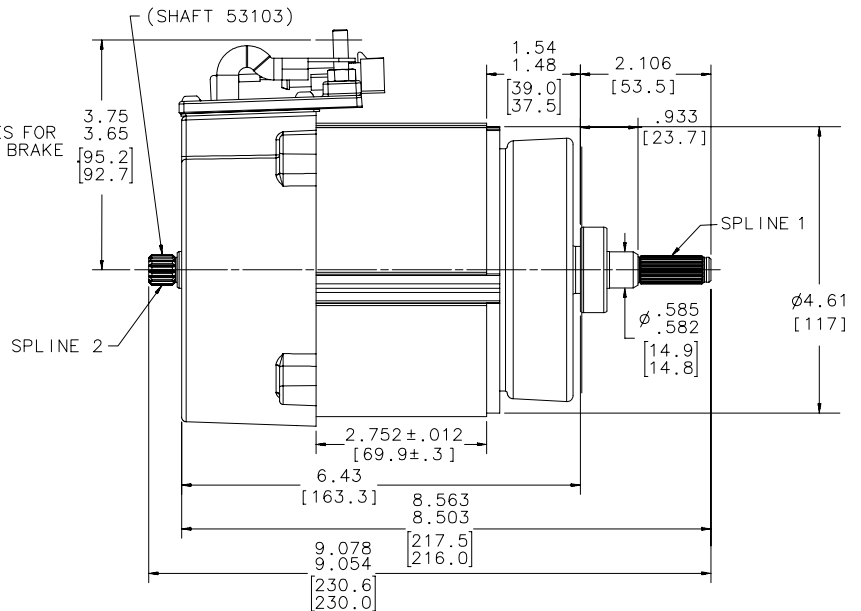
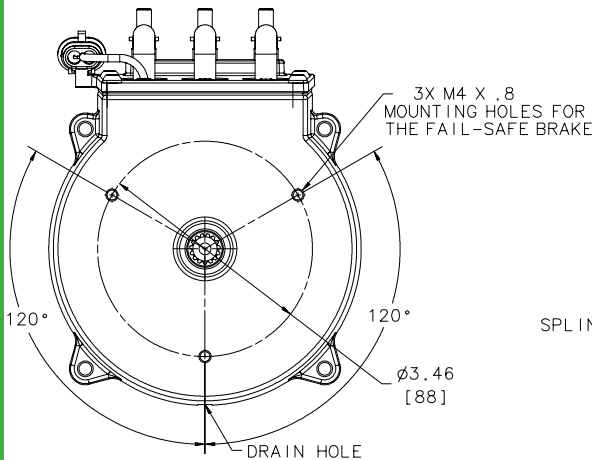
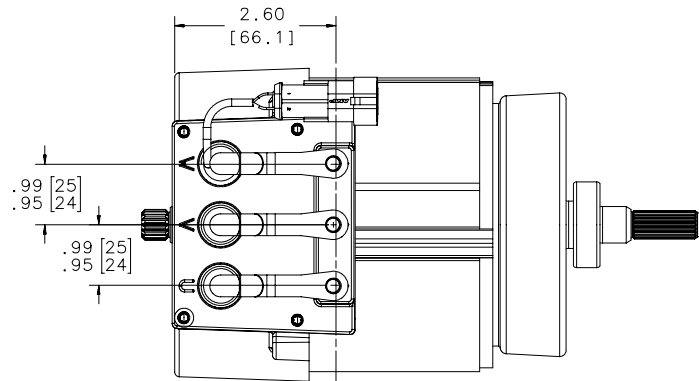
MEGGER TEST (500V MEGOHM METER)	
MOHMS (MIN)	VOLTAGE
100	500

HIPOT TEST (1000V, 2mA AT 50 HZ FOR 2 SECONDS)		
	MIN	MAX
LEAKAGE (mA)	0	2
VOLTAGE (VAC)	1000	

INDUCTANCE TEST		
(L-L)	MIN	MAX
R <sub>AB</sub>	90 mH	112 mH
R <sub>BC</sub>	90 mH	112 mH
R <sub>CA</sub>	90 mH	112 mH



SPLINE 2

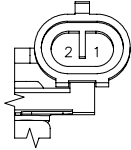
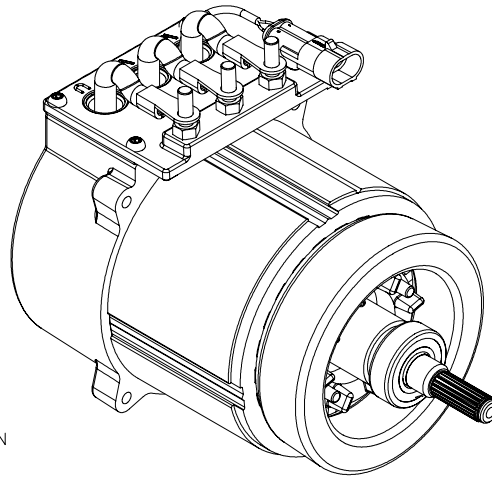


**1.7 KW AC INDUCTION MOTOR  
P/N 52958**

# 1.7 Kilowatt AC Motor

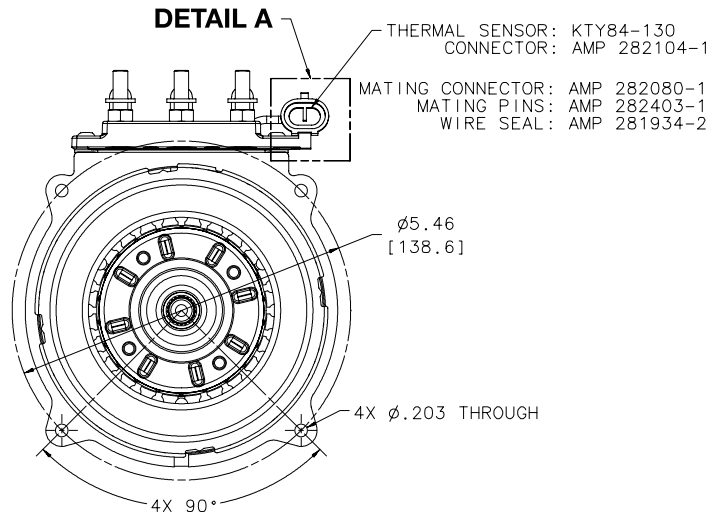
## NOTES:

1. Motor Type: 3 Phase AC Induction
2. System Voltage: 48 VDC
3. Motor Voltage: 33 VRMS
4. Speed Range: 0 to 6000 RPM
5. Continuous maximum torque is 3.4 FT-LBS (1.7kW or 2.2 HP)
6. Typical duty cycle: 3685 RPM 1.84 LB-FT
7. Input frequency range: 0 to 200 HZ
8. Efficiency:  $\geq 85\%$
9. Over Temp protection required by using KTY84-130 Temp Sensor
10. Motor Enclosure rating: IP-54
11. Required Motor Life Expectancy:  $\geq 500$  hours
12. 1/4" ring terminals are to be used to connect to the motor.



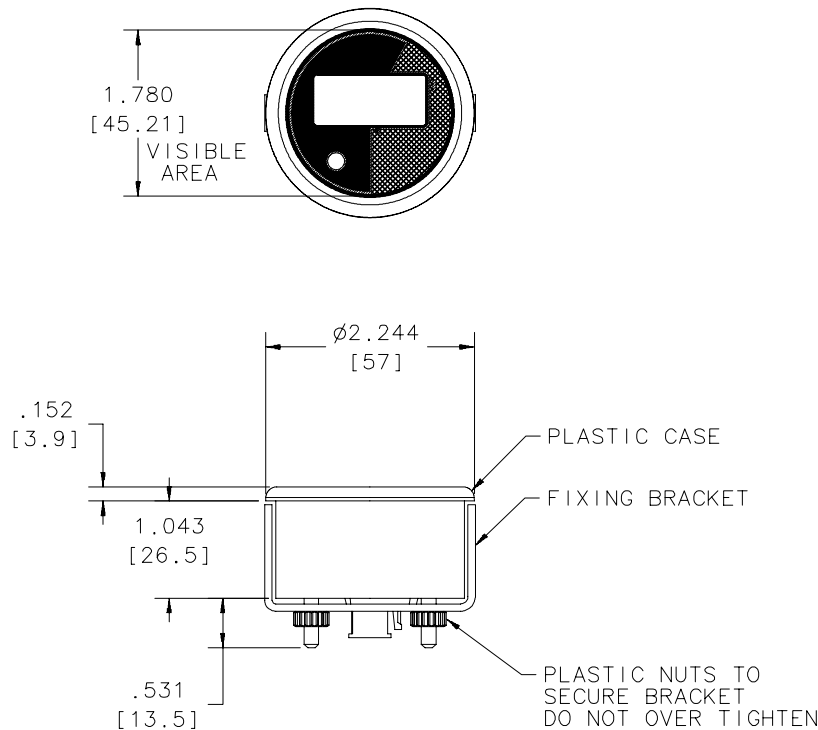
THERMAL SENSOR CONNECTION  
 1 = PIN 1 WHITE (-)  
 2 = PIN 2 RED (+)

**DETAIL A**



# Multifunction Digital Interface

Digital Display part number 53143.



## APPLICATION:

The vehicle display is a multifunctional dash-mounted unit which communicates via can-bus link with the traction controller to display battery state of charge, maintenance due reminders, operation hours, and vehicle alarms.

**Battery State** - traction controller monitors battery state of charge and displays this value on the digital interface.

**Hour Meter** - traction controller counts either key-on hours or working hours and stores this value in permanent memory.

**Maintenance** - Maintenance interval reminders are displayed on the digital interface.

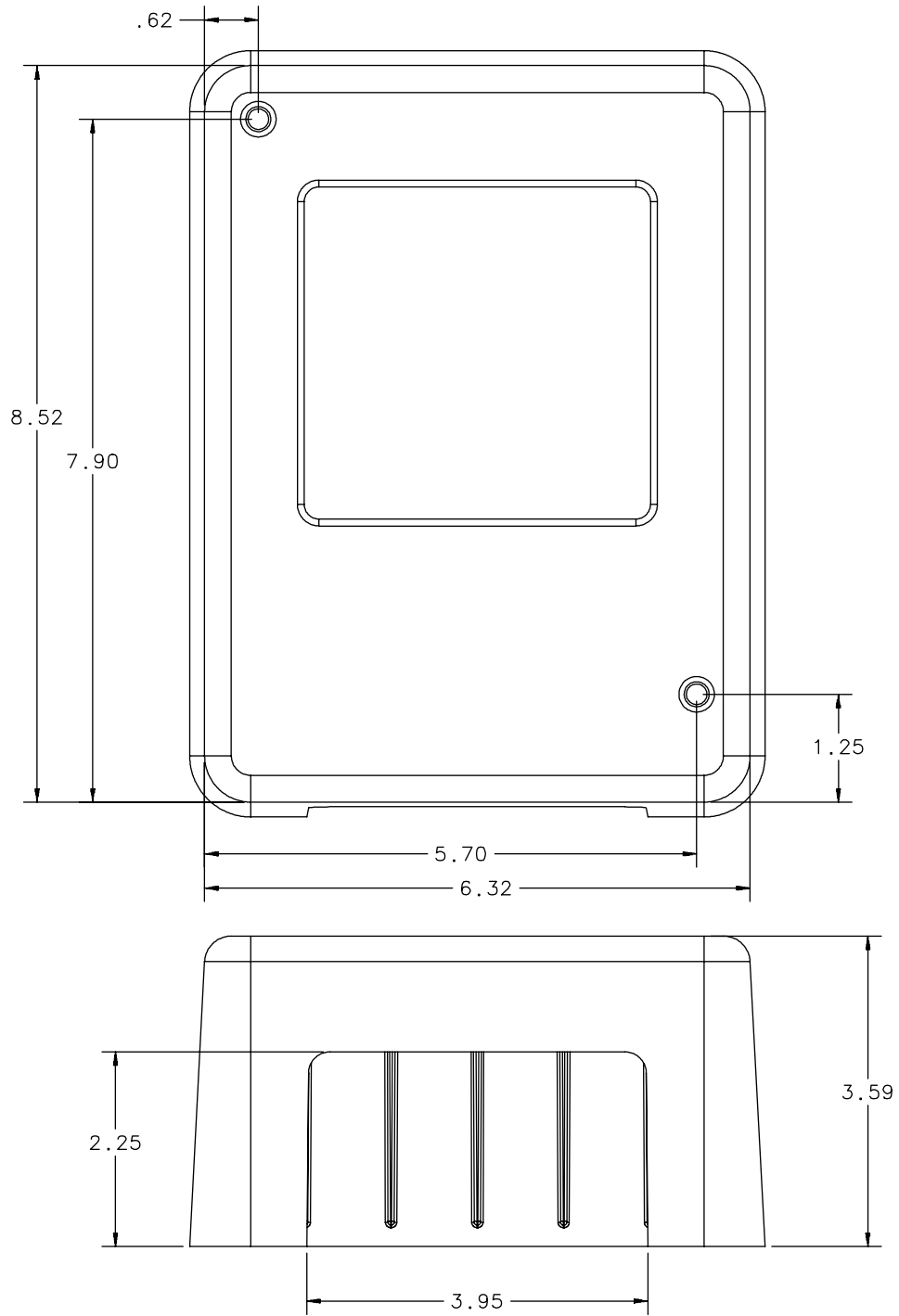
**Alarm Display** - Traction controller alarms are displayed on the digital interface.

**Environment** - The display is sealed to IP-64.

**Interface** - The SMARTEC® display uses a 6 pin Molex mini-fit, jr. connector molded into the case. Vehicle wire harness will need molex mini fit connect 6 pin receptacle (5557), with female crimp terminals (5556 Gold Plated). Use 20 AWG wire.

CONNECTOR PIN OUT:  
PIN 1 = +12V (A16)  
PIN 2 = CONTROLLER - BATT  
PIN 3 = CANL (A7)  
PIN 4 = CANH (A17)  
JUMPER PIN 5 TO PIN 6  
MUST USE A SHIELDED TWISTED PAIR CABLE FOR THE WIRES USED ON PIN 3 & PIN 4. SHIELDING TO BE ATTACHED TO VEHICLE FRAME AT ONE END ONLY. SEE CAN-BUS WIRING REQUIREMENT SCHEMATIC ON **PAGE 34**.

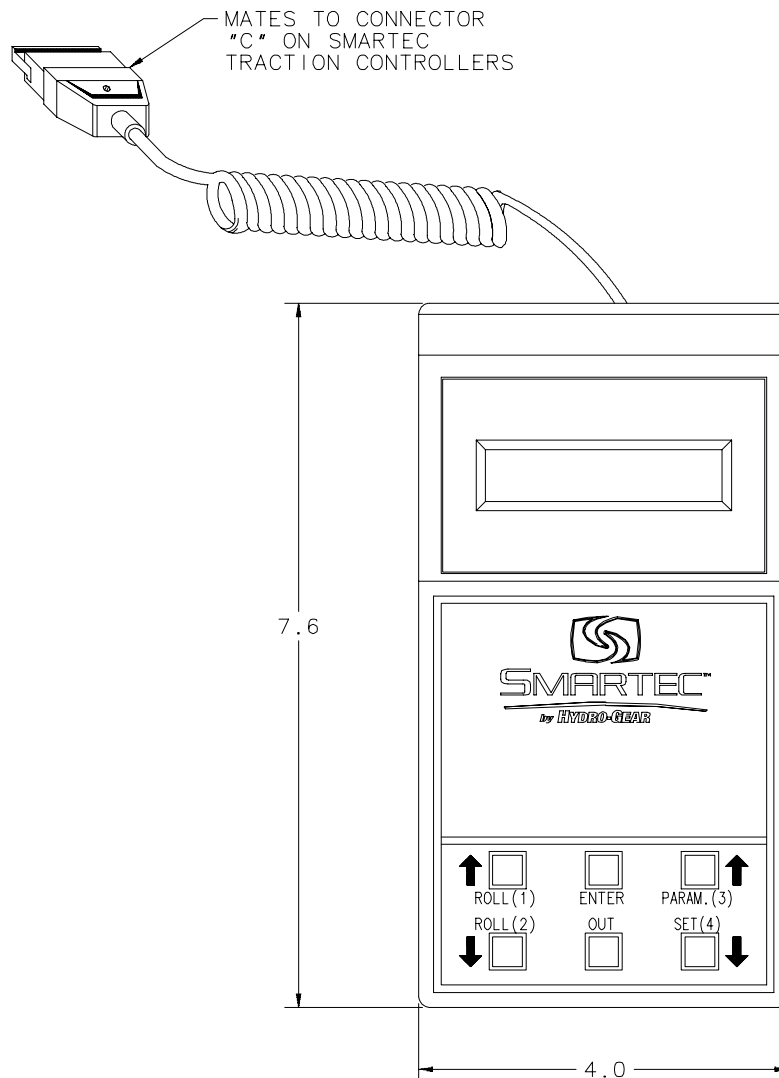
# Traction Controller Cover



Traction Controller Cover  
P/N 52953

# Interface Tool

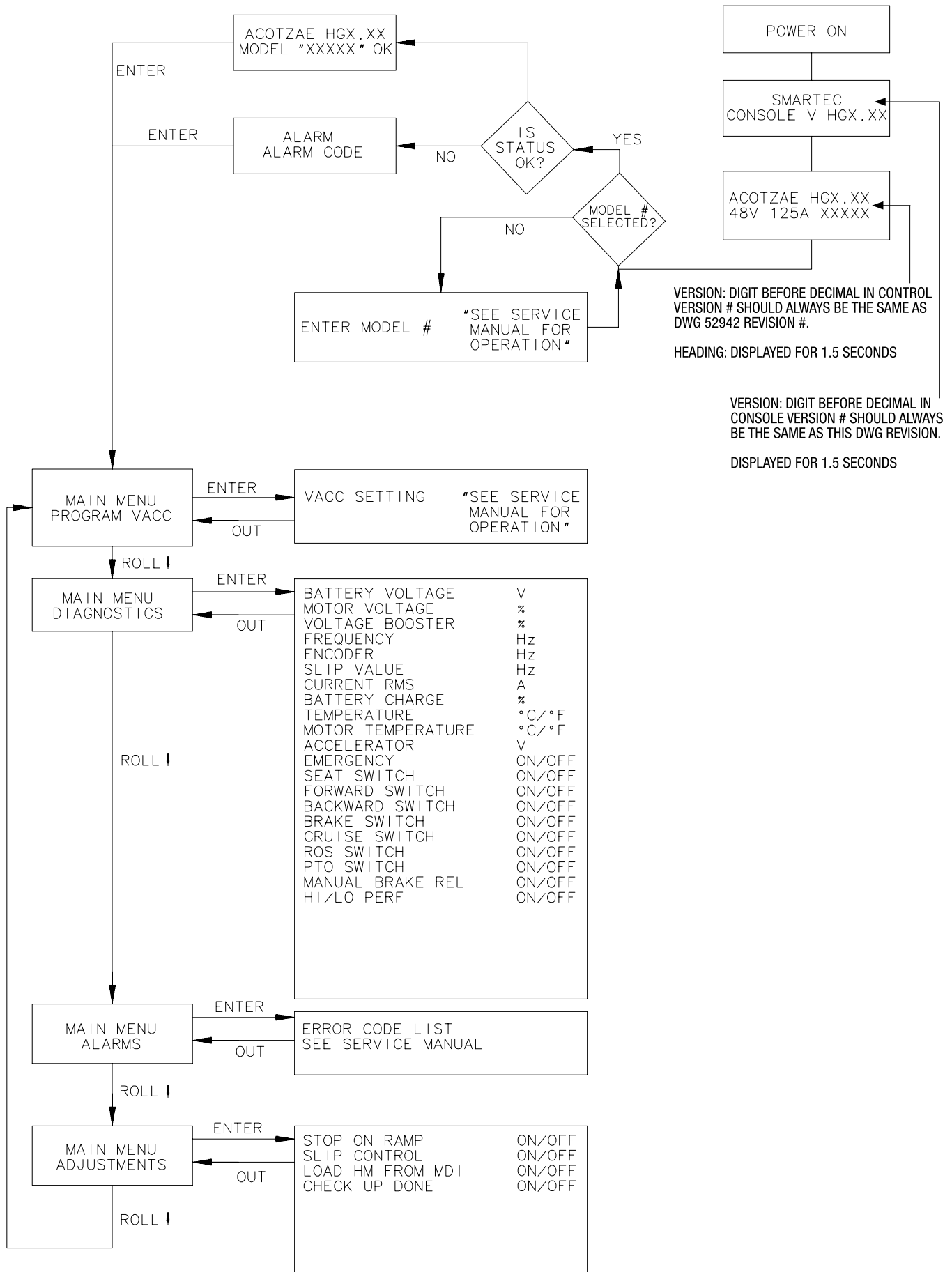
Interface tool part number 53096.



## TECHNICAL DATA

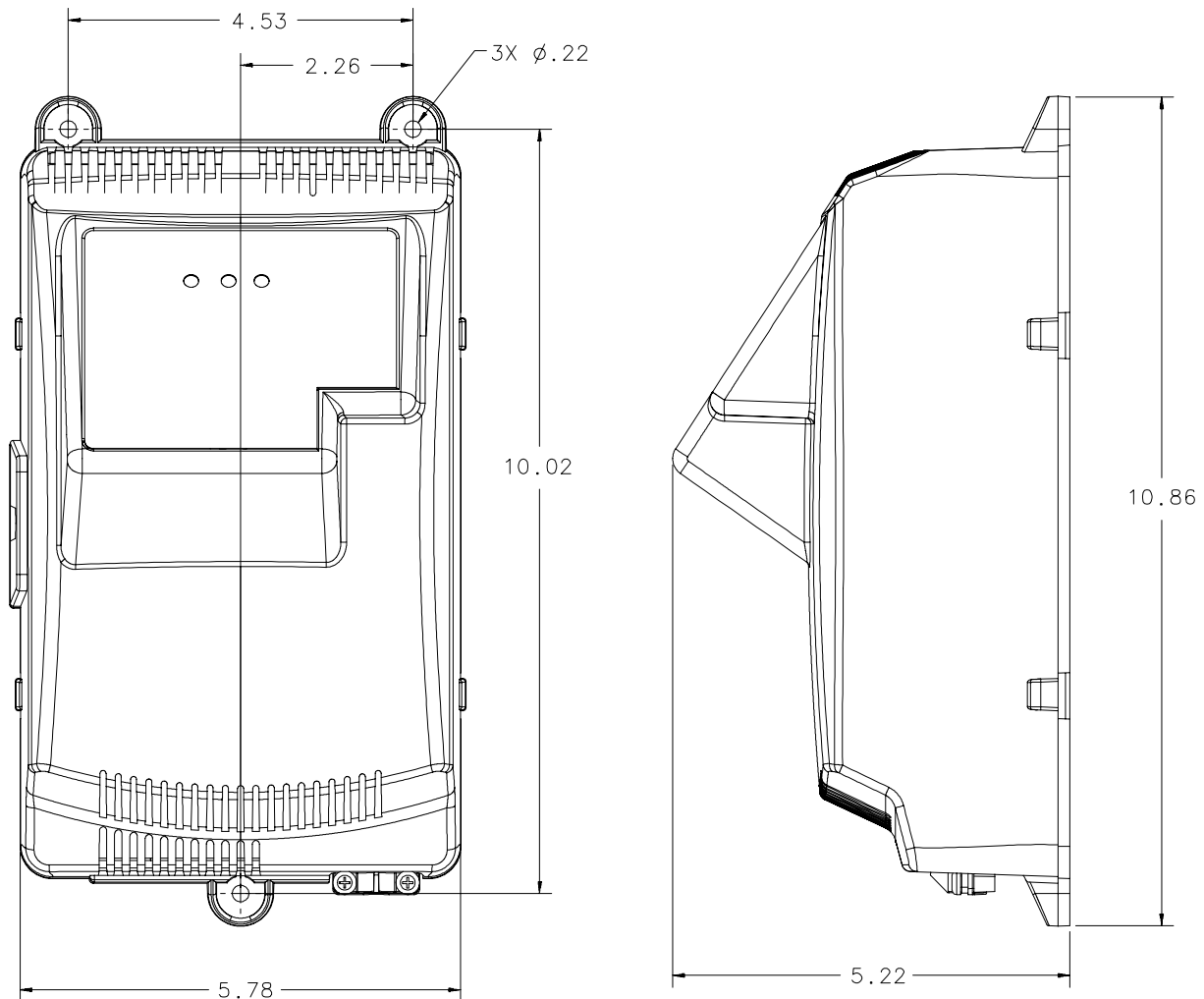
APPLICATIONS: Electric drive OEM vehicle calibration tool.  
Electric drive service dealer diagnostics tool.

# Interface Tool Map



# Battery Charger

The SMARTEC® battery charger is a “smart charger” designed to remain connected to the batteries when the machine is not in use. The charger monitors the voltage and will not overcharge your batteries.



100-240 VAC CHARGER  
P/N 53693 FOR LEAD ACID BATTERIES  
P/N 53694 FOR AGM BATTERIES

## SPECIFICATIONS:

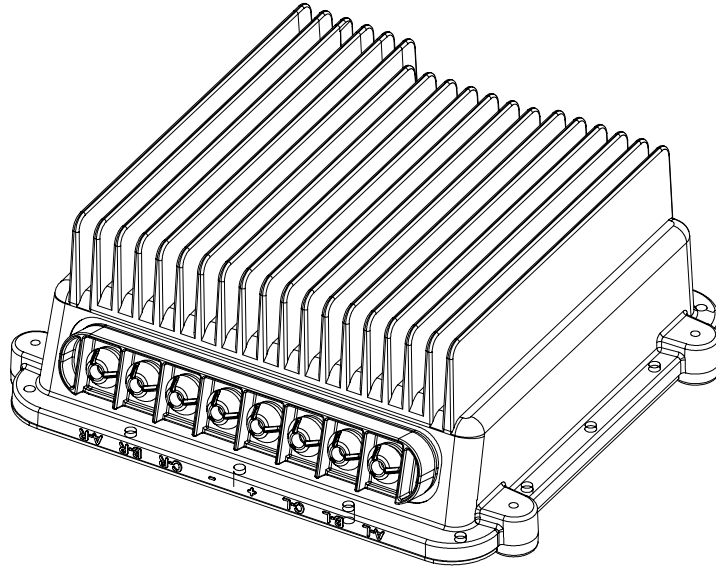
Model .....	HF1-NA
Input Voltage Range.....	120-240V AC
48V DC - 10a Output (<10 Hour Charge)	
AC Line Frequency .....	50/60 Hz
Maximum AC Input Current .....	7 Amps AC
Maximum DC Current .....	10 Amps DC
Switching Frequency .....	50 kHz
Operating Temperature Range.....	-20°F to 113°F (-28°C to 45°C)
DC Output Cable .....	SJT 10' (3.05m) Long 2x 14 AWG
DC Output Cable Connector .....	Anderson Connector SB50G
DC Side Black Wire.....	-ve
DC Side White Wire .....	+ve
AC Input Cable.....	SJT Cord 3x 18 AWG 11" (25 cm) Long
AC Input Plug.....	IEC Socket
AC Cordset .....	6' (1.88 m) Long 3x 18 AWG
AC Cordset Plug .....	NEMAS-15P
Rubber feet and hardware packaged in a bag and supplied with charger for optional table top or wall mount.	



# Deck Controller

SMARTEC® deck controller right side discharge part number 53283.

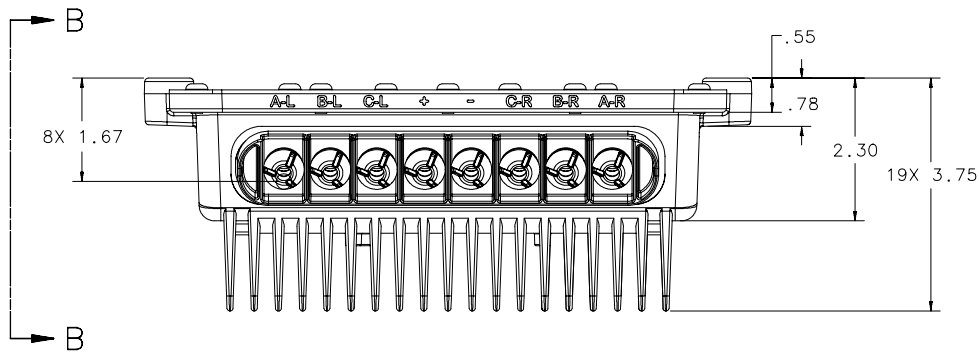
SMARTEC® deck controller center discharge part number 53992.



## TECHNICAL DATA:

1. Input Voltage: 48 VDC
2. Controller is designed to work with a maximum of two 53316 motors.
3. Maximum Case Temp is 212°F.
4. Max continuous current: 32 AMPS/Side.
5. Enclosure rating: IP 65
6. Ambient Operating Temperature: -10 to 110°F (-23 to 43°C)
7. Controller must be mounted under vehicle with the entire housing exposed to 3 MPH airflow (minimum) in the mounting orientation shown.

# Dual 1.5 kW BLDC Motor Controller

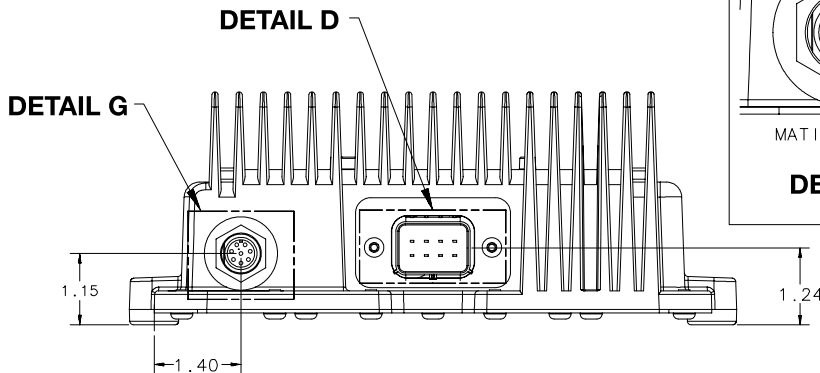
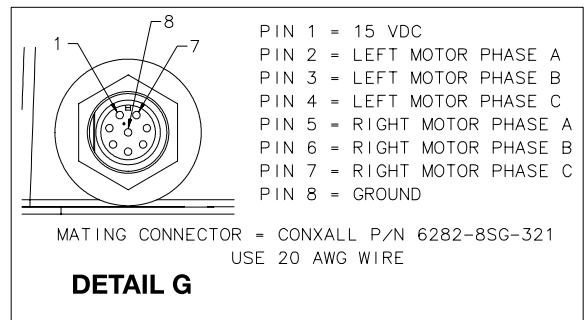
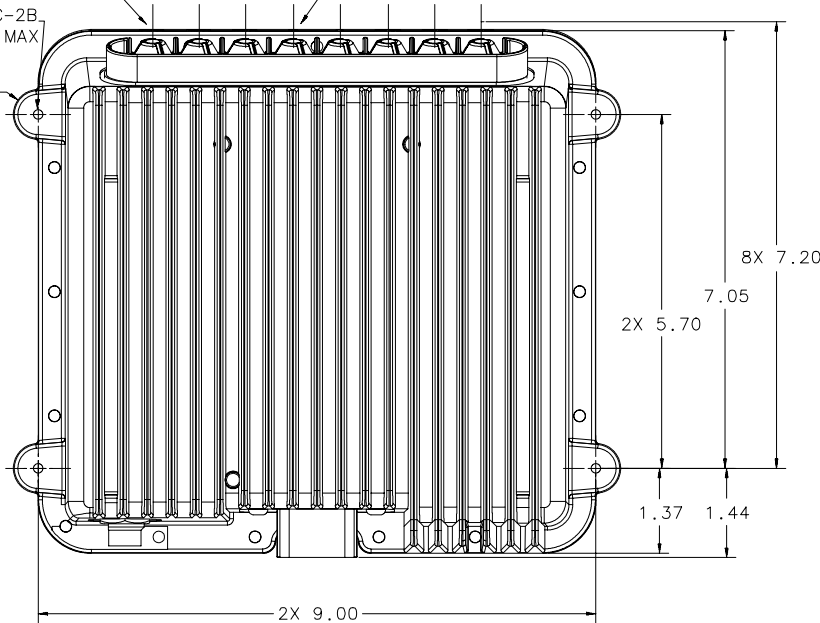


8X M6 X 1.0  
CUSTOMER TO SUPPLY  
M6 X 1.0 NUTS,  
AND LOCKING WASHERS  
TORQUE TO 35-55 IN-LBS

4X 1/4-20UNC-2B  
TORQUE 130 IN-LBS MAX

4X  $\phi$ .800

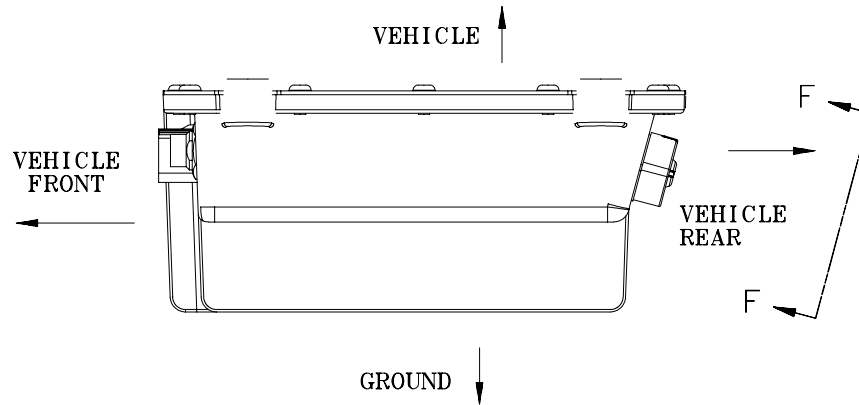
8X THE USE OF A WIRE HARNESS  
TERMINATION COVER IS  
RECOMMENDED ON THIS  
ELECTRICAL TERMINATION



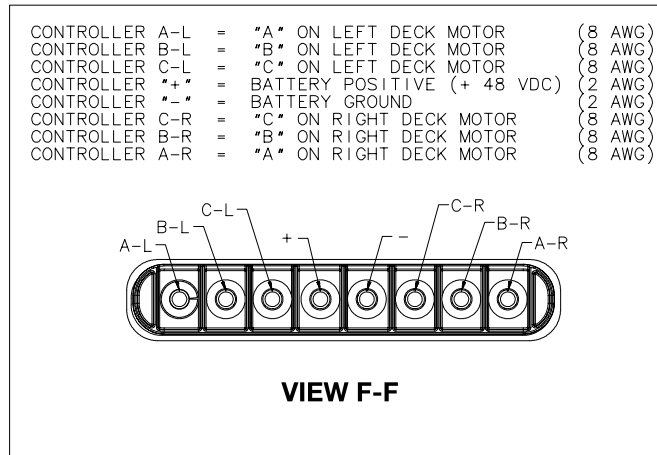
**Dual 1.5 kW BLDC Motor Controller  
Center Discharge  
P/N 53992**

**Dual 1.5 kW BLDC Motor Controller  
Right Side Discharge  
P/N 53283**

# Dual 1.5 kW BLDC Motor Controller



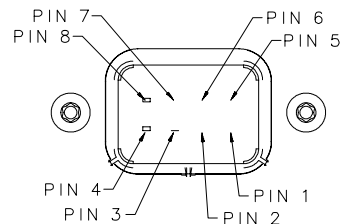
REQUIRED MOUNTING ORIENTATION  
**VIEW B-B**



**VIEW F-F**

- PIN 1 = JUMPER PIN 1,3,4  
 PIN 2 = (OPTIONAL) CONTACTOR COIL GROUND  
 (THE + VOLTAGE FOR CONTACTOR COIL  
 IS TO BE WIRED DIRECTLY TO THE  
 BATTERIES)  
 PIN 3 = JUMPER PIN 1,3,4  
 PIN 4 = JUMPER PIN 1,3,4  
 PIN 5 = PTO ON (MASTER TRACTION CONTROL PIN A4)  
 PIN 6 = IGNITION (KEY ON)  
 PIN 7 = NO CONNECTION  
 PIN 8 = NO CONNECTION

**SEE DETAIL C  
 ON PAGE 52 FOR  
 6 PIN CONNECTOR  
 DETAILS**

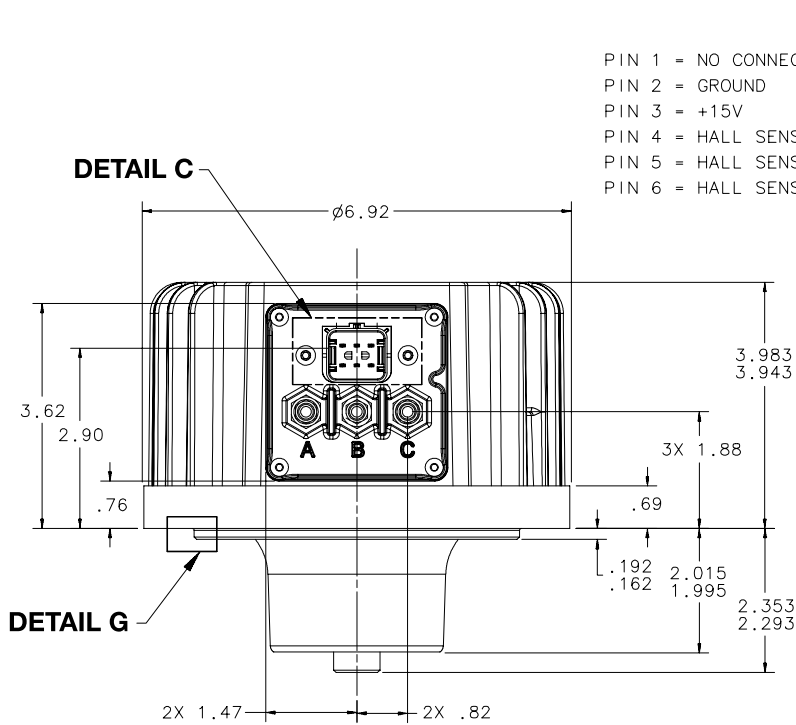


**DETAIL D**

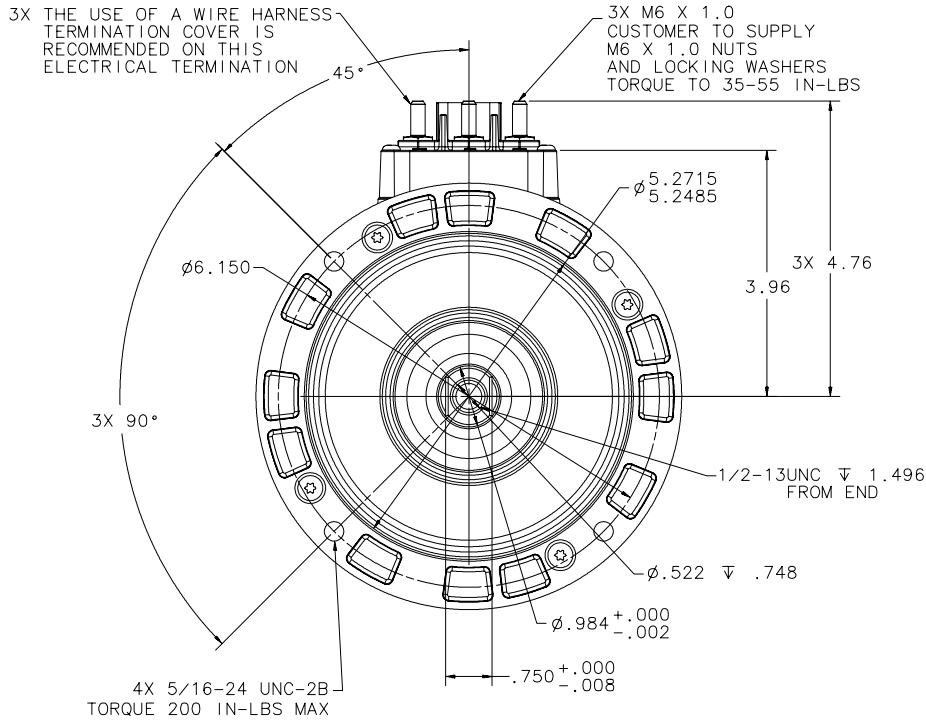
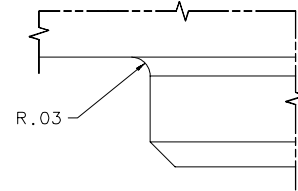
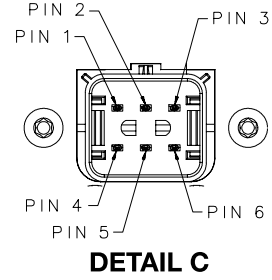
A SINGLE 8 PIN MOLEX CONNECTOR P/N 19427-0017 IS USED ON THE DECK CONTROLLER FOR ALL SIGNAL CIRCUITS: THE MATING WIRE HARNESS CONNECTOR IS MOLEX P/N 19418-0001 WITH MOLEX TERMINAL P/N 19420-0002. USE 20 AWG WIRE.

# 1.5 kW BLDC Motor

6 PIN MOLEX CONNECTOR P/N 19429-0036 WITH TERMINAL P/N 19417-0048 IS USED ON BOTH DECK MOTORS. THE MATING CONNECTOR IS MOLEX P/N 19418-0011 WITH MOLEX TERMINAL P/N 19420-0010 (PACKAGE TYPE) OR P/N 19420-0002 (REEL TYPE). USE 20 AWG WIRE.

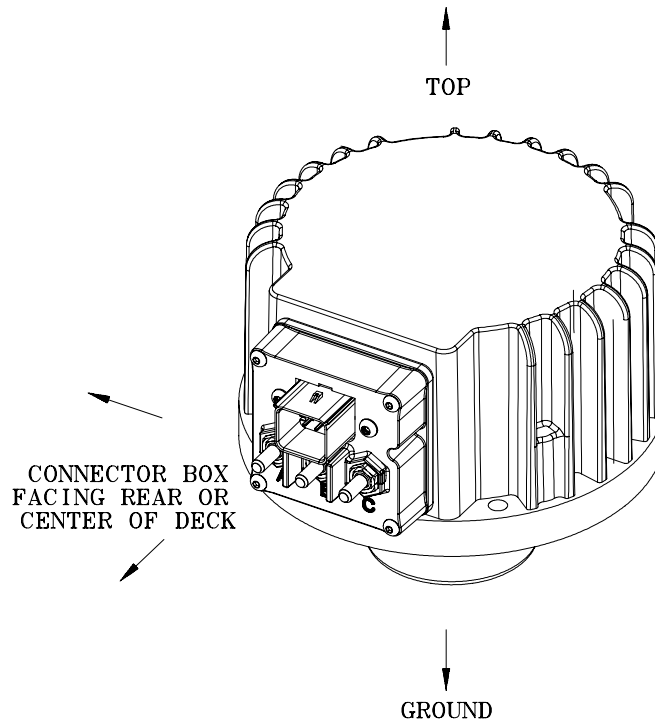


- PIN 1 = NO CONNECTION
- PIN 2 = GROUND
- PIN 3 = +15V
- PIN 4 = HALL SENSOR A
- PIN 5 = HALL SENSOR B
- PIN 6 = HALL SENSOR C



**1.5 kW BLDC Motor  
P/N 53316**

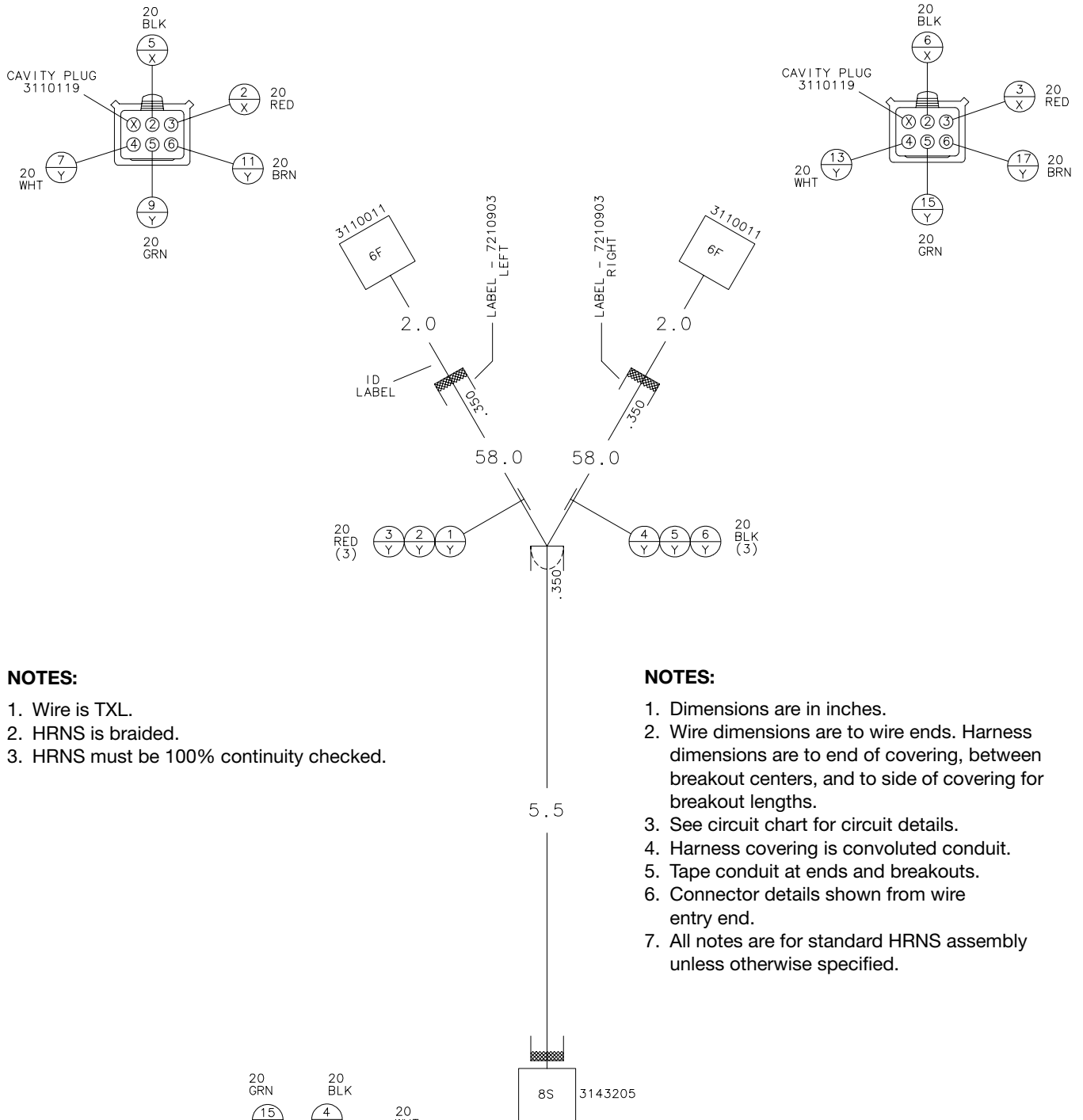
# 1.5 kW BLDC Motor



## TECHNICAL DATA:

1. Brushless DC Motor (BLDC)
2. System Voltage: 48 VDC
3. Continuous Input Power:  $\geq 1.5$  kW (2 HP)
4. Peak Output Power:  $\geq 3$  kW (4 HP)
5. Operating/Switching Frequency: 16.6 kHz
6. Motor Speed: 1500 RPM to 2900 ( $\pm 5\%$ )
7. Max Continuous Current: 32 Amps/Motor
8. Over Temperature Protection: Maximum Case Temp is 290°F
9. Motor Enclosure Rating: IP 65
10. Ambient Operating Temperature: -10 to 110°F (-23 to 43° C)
11. The 3 phase 8 AWG motor leads (A, B, C) need to connect to the respective A, B, C terminals on the controller, using 1/4" ring terminals on both ends.
12. Motors must be mounted on top of the deck with the entire housing exposed to 1 MPH airflow (minimum) in the mounting orientation shown.

# Dual 1.5 kW BLDC Motor/Controller

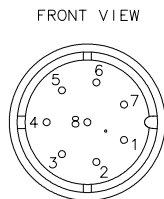
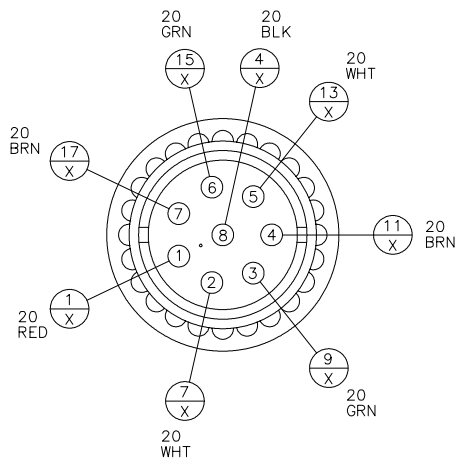


**NOTES:**

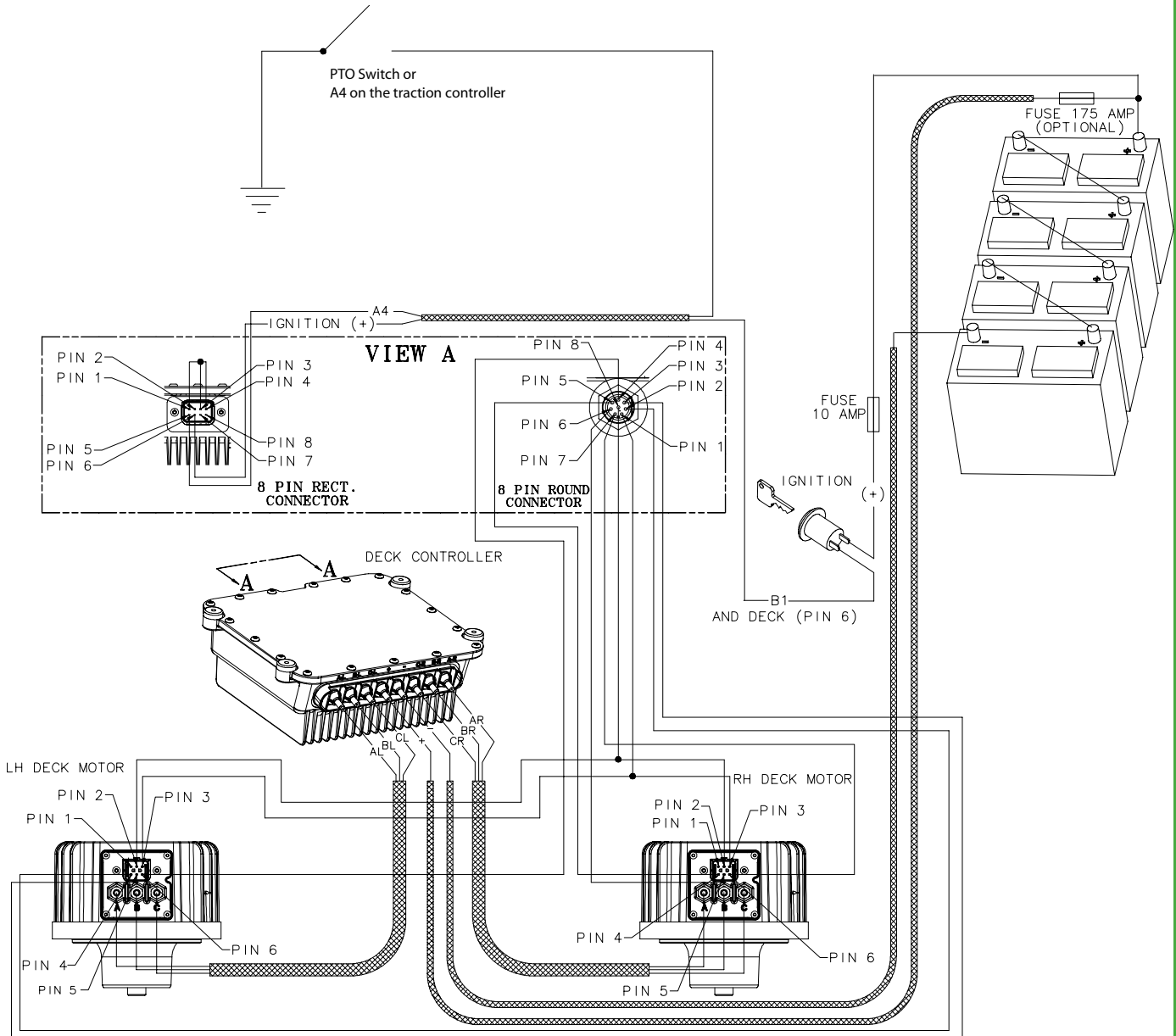
1. Wire is TXL.
2. HRNS is braided.
3. HRNS must be 100% continuity checked.

**NOTES:**

1. Dimensions are in inches.
2. Wire dimensions are to wire ends. Harness dimensions are to end of covering, between breakout centers, and to side of covering for breakout lengths.
3. See circuit chart for circuit details.
4. Harness covering is convoluted conduit.
5. Tape conduit at ends and breakouts.
6. Connector details shown from wire entry end.
7. All notes are for standard HRNS assembly unless otherwise specified.

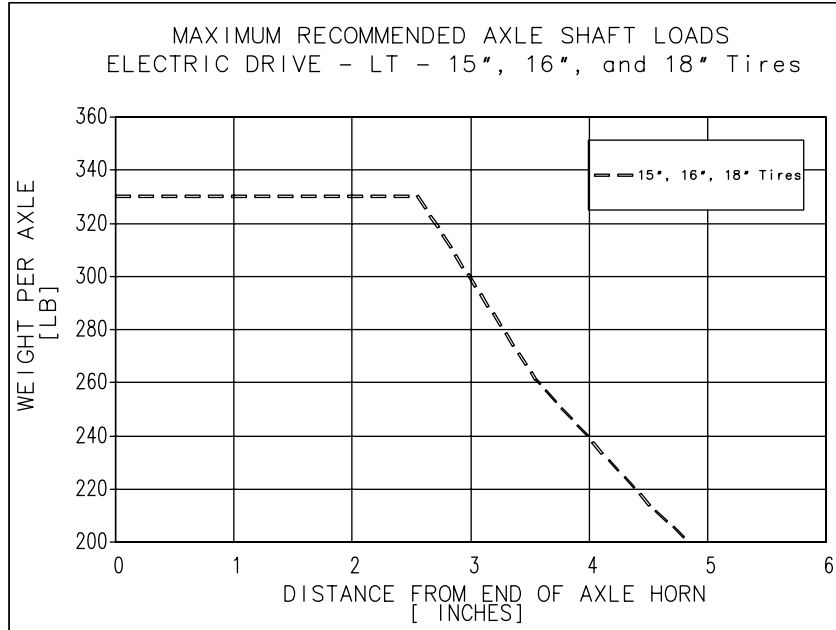


# Dual 1.5 kW BLDC Motor/Controller

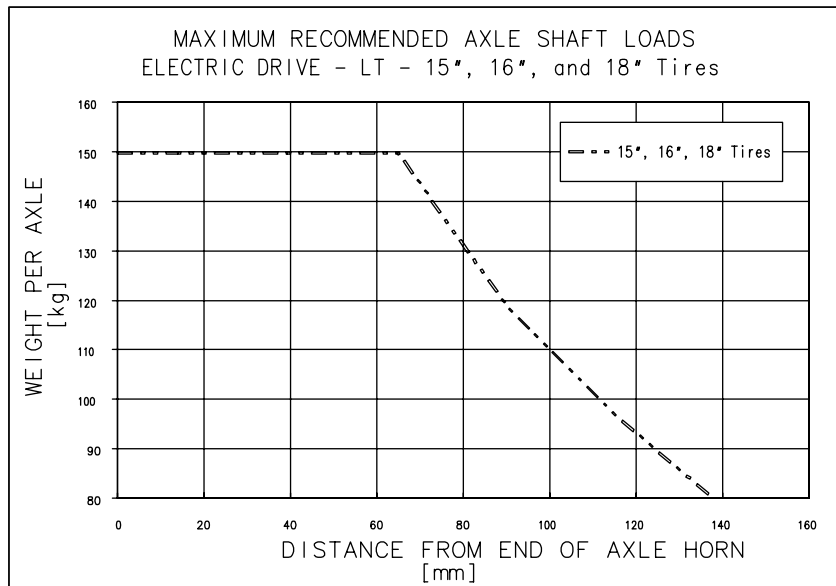


# LT Maximum Recommended Axle Shaft Loads

TIRE SIZE (IN)	OVERALL RATIO	MAXIMUM WEIGHT ON DRIVE TIRES (LBS)	CONTINUOUS OPERATING TORQUE (FT-LB)	PEAK TORQUE (FT-LB)
18"	45.11	694	80	322
16"	45.11	694	80	322
15"	45.11	694	80	322



TIRE SIZE (IN)	OVERALL RATIO	MAXIMUM WEIGHT ON DRIVE TIRES (kg)	CONTINUOUS OPERATING TORQUE (N-m)	PEAK TORQUE (N-m)
18"	45.11	315.0	109	437
16"	45.11	315.0	109	437
15"	45.11	315.0	109	437







# Glossary and Acronyms

**Accelerator** - An electric sensor that replaces the trunnion arm and mechanical linkage function found in a traditional hydrostatic drive system.

**AGM** (Batteries) - Absorbed Glass Mat.

**Amperage** – The strength of an electric current measured in amperes.

**AWG**- American Wire Gauge is a standardized wire gauge system used predominantly in the United States and Canada for the diameters of round, solid, nonferrous, electrically conducting wire.

**BLDC**- Brushless Direct Current.

**BMS**- Battery Management System.

**CAN** - Control Area Network; a communication protocol for active components in a system.

**Can-Bus**- Communication vehicle for a message based protocol for Control Area Network (CAN).

**CKT**- Circuit.

**CM**- Common (connection for +48 volts).

**Contact Resistance**- The amount of resistance present in a connector or terminal that would allow voltage to be dropped or lost across the connection.

**Contactors** - An electromagnetic switch device (a relay) used for switching an electrical circuit.

**Continuity** – The ability of a conductor to pass an electrical current from point A to point B.

**CPOT**- Accelerator Potentiometer Wiper.

**CPOTTR2**- The second available Accelerator Potentiometer Wiper.

**Daisy Chain Wiring**- Wiring a two or more components in series.

**DOR**- Direction of Rotation of the accelerators.

**Drop Out Time**- The time it takes for normally open contacts to open on the main contactor.

**EMC**- Electromagnetic Compatibility (Equipment characteristic not to generate Electromagnetic Interference (EMI) above a certain limit AND not to be affected or disturbed by EMI).

**EMI**- Electromagnetic Interference.

**ENC**- Encoder.

**Hall Effect Device**- A device that converts magnetic signals into electrical signals.

**Heat Sink** - A metallic heat exchanger designed to absorb and dissipate excess heat from a device in a circuit.

**Heat Transfer Rate**- The time in which heat from one device transfers to another device such as a heat sink.

**HIPOT test (AC motor)- High Potential test** -A test that applies a high voltage to the motor and checks to see if there is any shorts to the stator through the insulation.

**HM**- Hour meter.

**HRNS**- Harness.

**IP Rating**- Ingress Protection rating.

**Inductance Test (AC motor)**- Measures the inductance of the motor windings to be within a certain limit.

**Jumper Shield**- The wire shield around the Can bus lines that helps with noise or interference.

**kW**- Kilowatt

**Leakage Current**- The amount of allowable current to be detected during the HIPOT test.

**Megger Test (AC motor)**- A test that checks for a minimum acceptable level of resistance for the motor construction under test with a high voltage applied.

**NEB**- Neutral return or negative side for the failsafe brake.

**NLED**- Neutral return or negative side for the light emitting diodes (LED's).

**NMC**- Neutral return or negative side of the contactor.

**NPOTTR1**- Neutral return or negative side of the accelerator potentiometer.

**Peak Torque**- The maximum output torque available

**PMC**- Positive side of contactor.

**Potentiometer** – A mechanical variable resistor.

# Glossary and Acronyms (continued)

**PPC/PEV-** Positive side of light emitting diodes (LED's).

**PPOT-** Power supplied to the accelerator potentiometer.

**PTO-** Power take-off.

**PWM-** Pulse width modulation.

**Resistance** - Is the level of opposition to current flow in an electrical system, measured in Ohms.

**Resistance Test (AC motor)** – A test to measure the acceptable amount of resistance between the different phase coil windings.

**RMS-** Root-Mean-Square (power measurement).

**ROS** – Reverse Operating System.

**Temperature Stabilization** – When a product or a components temperature stops rising during a test.

**TXL** –Specified automotive wire type.

**VAC** – Volts Alternating Current.

**VDC** – Volts Direct Current.

**Voltage** – Is a measurement of the electrical energy in a circuit at a given point; measured in volts.

**VRMS** – Root-Mean-Square voltage.

**W/S-** With seal.



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