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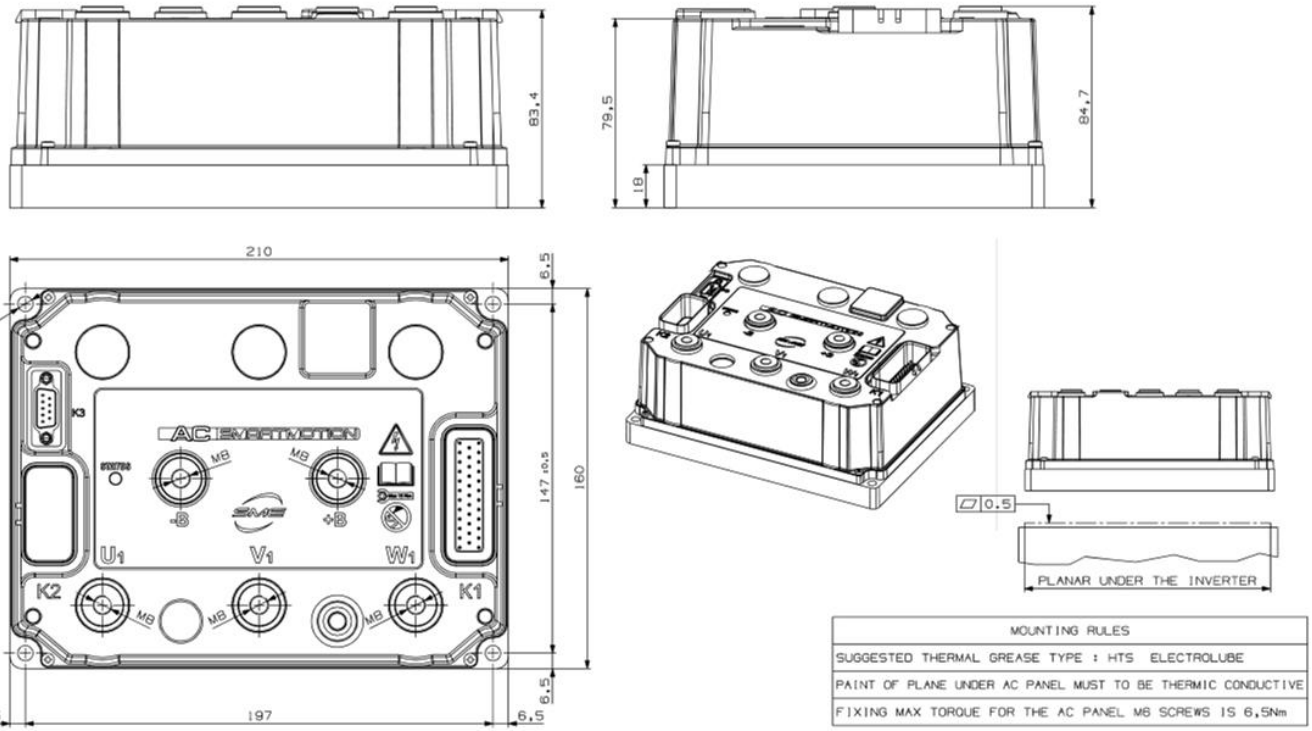
USER MANUAL

HYPER-DRIVE X1 INVERTERS

FOR USE WITH ***HYPER 9™*** & ***HYPER 9HV™ SYSTEMS***:



MOUNTING RULES
SUGGESTED THERMAL GREASE TYPE : HTS ELECTROLUBE
PAINT OF PLANE UNDER AC PANEL MUST TO BE THERMIC CONDUCTIVE
FIXING MAX TORQUE FOR THE AC PANEL M6 SCREWS IS 6,5Nm

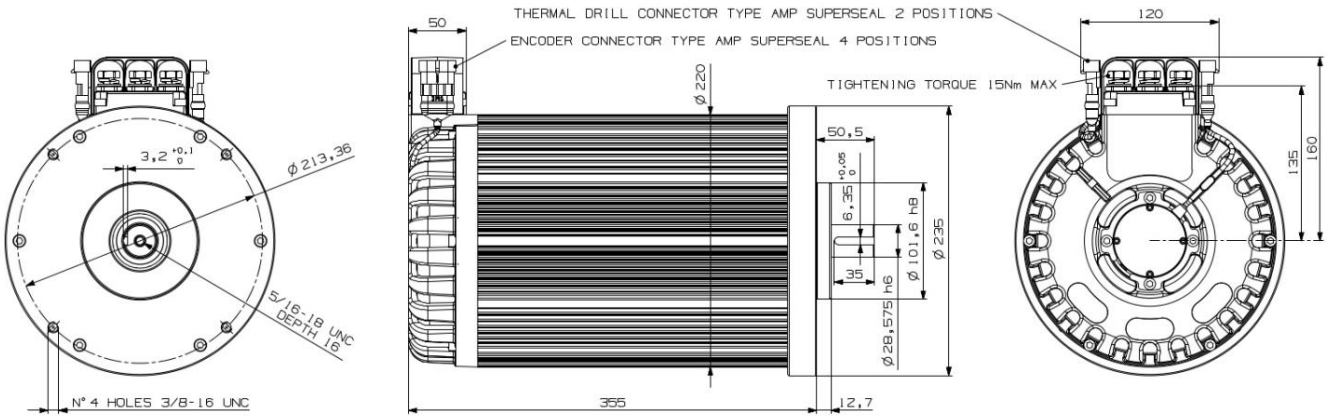


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TABLE OF CONTENTS

Inverter Models (ISOlated vs NON-ISOlated Logic) 5
Isolated 12V Logic 5
Non-Isolated logic 5
Photos of ISO vs NON-ISO Inverters 5
Warning and Caution 6
Safety Information 6
DISCLAIMER: 7
Standard K1 Wire Harness - Pinout 8
Wiring Diagram Overview 9
Important Note on Motor Calibration! 9
Isolated Logic - Standard Wiring Diagram 10
Non-Isolated Logic - Standard Wiring Diagram 11
Wiring Instructions - HyPer Motor Plugs 12
Motor Plug Pinout - HyPer Motors 13
Motor Encoder Pin Positions 13
4 Position Ampseal Connector 13
Motor Thermistor Pin Positions 13
2 Position ampseal Connector 13
ISOlated Logic - Main Contactor Wiring 14
12/24V Coil Driver, High Voltage Contacts, and Key Switch In 14
Isolated X1 Main Contactor Wiring 14
NON-ISOlated – Main Contactor Wiring 15
24/48V Coil Driver, High Voltage Contacts, and Key Switch In 15
NON-ISO Main Contactor wiring 15
Main Contactor – Internally Economized Option 16
HV Relay – Wiring Instructions 17
HV Relay Drawing 17
HV Relay Terminations 17
Pre-Charge Sequence 18
ISO Inverter Terminals 18
Compact Display - wiring instructions 19
Compact Display Mating Female Plug 19

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Compact Display - 8 Position Connector 19
Software Files 20
Download the Clone, Firmware, and SmartView for Your System: http://www.go-ev.com/downloads/clone_files.html 20
Pre-Startup Steps 22
application checks 22
QuickStart Guide – Wiring and Programming 22
Post-startup Steps 28
Battery Protection 28
Battery Mapping 30
Throttle Mapping 31
Brake Regen Mapping 32
Operating Profiles - Regen on Neutral 33
Neutral Torque Mapping 33
Tuning Regen On Neutral – Single Pedal Driving 33
Digital Outputs 36
Wiring 36
Configuration 36
Temperature Derating – X1 Inverter 38
Temperature Derating - HyPer Motor 38
CAN Network Configuration 39
Wiring 39
Configuration – CAN NEtwork Settings 40
Configuration – TPDO's 40
TPDO STRUCTURE 42
Node Data Type: 42
Node Data Type: 42
Inverter Information Data Type 44
Motor Information Data Type 44
Controller Specifications 46
Controller Communication 46
Controller EMC 46
Controller Safety Certification 46
Controller Operating Environment Specifications 46
Pre-Programmed I/O - HyPer-Drive Inverter 47

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Signal: Inputs and Outputs 47
Controller I/O Table 47
K1 Pin Functions For Non-programmed AC-X1 47
Datalogging 50
Datalogging Guide: 50
Troubleshooting - Diagnostic Codes 52
Fault Levels 52
Fault Code List 52
Additional Support 73

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INVERTER MODELS (ISOLATED VS NON-ISOLATED LOGIC)

This document covers all HyPer-Drive X1 Inverter models with nominal voltages ranging from 36V-144V. The terms Isolated Logic (**ISO**) vs Non-Isolated Logic (**NON-ISO**) are critical in identifying different ***HyPer-Drive™*** inverters types.

- **Isolated Logic:** The **ISO** logic board is energized with 12-24Vdc+. These inverters can be identified by their separate pre-charge terminal between the V-W terminals. **Catastrophic failure will occur if >24V is supplied to any K1 pin.**

- **Non-Isolated Logic:** The **NON-ISO** logic board is energized with Pack Voltage, in order to pre-charge and key on through the K1-24 pin. The controller then uses an internal transformer to supply the logic board with 12V. Thus, the **K1 circuit must be completely isolated from all other 12V circuits in the application.** These Inverters will have an indent for the pre-charge terminal between phases V-W, but the indent is not populated with a terminal.

ISOLATED 12V LOGIC

INVERTER TYPE	PART NUMBER	PRODUCT CODES	DC VOLTAGE RANGE (ABSOLUTE MIN-MAX)
HyPer-Drive ™ X144	SRIPM-X144	ACX1T50000I00 ACX1T50000I01	73V – 184V
HyPer-Drive ™ X1 ISO	SRIPM-X1iso	ACX1S75000I01	45V – 132V
HyPer-Drive ™ X1 ISO	SRIPM-X125	ACX1S25000I01	45V – 132V

NON-ISOLATED LOGIC

INVERTER TYPE	PART NUMBER	PRODUCT CODES	VOLTAGE RANGE (ABSOLUTE MIN-MAX)
HyPer-Drive ™ X1	SRIPM-X1	B00AC002200	52V – 130V
HyPer-Drive ™ X48	SRIPM-X48	ACX1Q60000001	22V – 68V

PHOTOS OF ISO VS NON-ISO INVERTERS

ISOLATED

NON-ISOLATED

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WARNING AND CAUTION

SAFETY INFORMATION

This is not an all-inclusive list. Use common sense and act responsibly, electric motor controllers and motors are extremely powerful and could cause death, dismemberment or other serious injury if misused or not safely handled!

Wear protective or safety equipment such as safety shoes, safety glasses and gloves when working with motors and controllers.

Remove all metal jewelry and metal objects from hands, wrist, fingers, etc. before working on any electric motor or controller.

Insulate any tools that are used in proximity to connection points that have any voltage potential to prevent shorts if the tool is accidentally dropped onto the terminals/connections.

Use caution when operating any controller or motor. If you're not sure what you're doing, or do not feel comfortable with the situation, find a knowledgeable person to advise you.

Make certain the motor and controller are disconnected from any power source before servicing. If any doubt exists of the voltage that might exist, measure with proper metering devices that are in good functional condition, and rated for the voltages that could exist.

Verify and re-verify proper wiring connections.

Take extreme caution around series-connected batteries to avoid placing hands across live connections. It is generally good practice to avoid the use of both hands when working around high voltage circuits. This reduces the risk of an accidental short across the chest cavity.

If working on an electric vehicle, make certain the vehicle is positioned securely with the drive wheels safely clear of the floor and blocked up so that the drive wheels cannot make contact with the floor under any circumstances. Block the non-drive wheels if they remain in contact with the floor so that the vehicle cannot roll in either direction.

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Motors and controllers must only be connected to a power source by knowledgeable and experienced personnel.

Running a motor without a load could result in harm to people or the motor. Absence of a load is considered misuse and could prove dangerous to anyone in the vicinity and void the motor warranty. When applying any power to motor, motor frame must be securely fastened in place as the toque will cause the motor to jump.

Portions of the motor or controller may become HOT and proper precautions must be taken.

Motors and controllers should never be operated beyond the limits established by the manufacturer.

Motors and controllers must not be modified in any manner; doing so will void warranty and could prove extremely dangerous.

Motors are heavy and are likely to become damaged if dropped, or cause damage to anything they fall upon (including people and body parts). Use extreme caution when working with motors!

Motors contain moving parts that could cause severe injury if the proper precautions are not taken. Never touch an operating motor.

Do not defeat any safety circuits or safety devices.

Under no circumstances should you push in any contactor of an electric vehicle while the drive wheels are in contact with the floor. Pushing in a contactor when the drive wheels are in contact with the floor can cause serious property damage, personal injury or death.

DISCLAIMER:

NetGain Motors, Inc. has no control of third-party installation procedure or the use of this motor and control system. Accordingly NetGain Motors, Inc. assumes no liability for vehicle functionality or safety during or after third party installation of the motor and controller. It is the responsibility of the vehicle designer and component installer to test and qualify their application and ensure proper safety and functionality. NetGain Motors, Inc assumes no responsibility for this product in any use.

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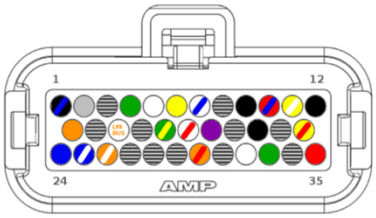
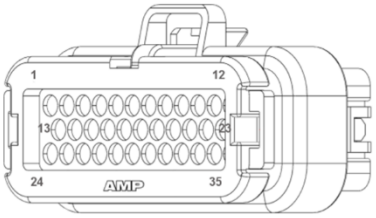
STANDARD K1 WIRE HARNESS - PINOUT

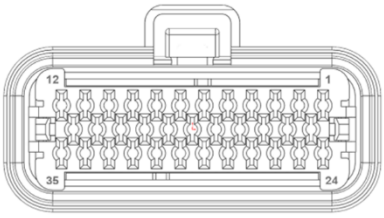
Figure 1 - Standard K1 Pinout Order Assignment

Ampseal 35 Pin Connector (K1 Plug):



(Wire End)

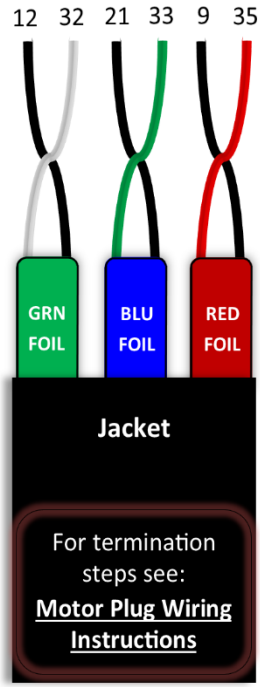




(Receptacle End)

Length	#	Function	Gauge	Color
11 ft	1	I/O Ground	18 AWG	BLK/BLU
11 ft	2	CAN Low	20 AWG	GRY
11 ft	4	Interlock	18 AWG	GRN
11 ft	5	Forward Switch	18 AWG	WHT
11 ft	6	Reverse Switch	18 AWG	YLW
11 ft	7	Clutch Switch	18 AWG	WHT/BLU
8 ft	9	Encoder Ground	20 AWG	BLK Under RED
11 ft	10	12V +	18 AWG	RED/BLU
11 ft	11	Throttle Wiper 1	18 AWG	YLW/WHT
11 ft	12	Analog Ground	18 AWG	BLK
8 ft	12	Thermistor Ground	20 AWG	BLK under GRN
11 ft	13	CAN High	**20 AWG**	ORG
11 ft	17	Throttle Wiper 2	18 AWG	GRN/YLW
11 ft	18	Profile 2 switch	18 AWG	WHT/RED
11 ft	19	Profile 3 Switch	18 AWG	PURP
8 ft	21	Encoder SIN1	20 AWG	BLK under BLU
11 ft	23	Brake Pot Wiper	18 AWG	YLW/RED
11 ft	24	Key Switch In	18 AWG	BLU
11 ft	25	Coil Return +	18 AWG	BLU/WHT
11 ft	26	Driver Out -	18 AWG	ORG/WHT
11 ft	30	Deceleration Lights	18 AWG	ORG/RED
8 ft	32	Motor Thermistor	20 AWG	WHT under GRN
8 ft	33	Encoder COS1	20 AWG	GRN under BLU
11 ft	35	5 Volt +	18 AWG	RED
8 ft	35	Encoder 5 Volt +	20 AWG	RED under RED

Motor Plug Multipair Cable



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WIRING DIAGRAM OVERVIEW

Before continuing any further, be certain you have identified your inverter type on Page 5. **From this point forward, you will need to know whether to use the instructions for ISO or NON-ISO logic boards. Important Notes:**

- Know the Voltage ranges for Inverter terminals and related components.
- Inverter must command a main contactor in the HV circuit. Before closing its main contactor, the Inverter must Precharge. For more information, see Isolated logic Main Contactor Wiring or NON-ISO X1 Main Contactor Wiring
- HV Relay wiring – an HV Relay is included in each Wire Harness Kit. This relay can be used as a Key Switch Relay for NON-ISO Inverters, or as a Precharge Relay for ISOLATED Inverters. For more information, see HV RELAY WIRING
- Please see the following instructions for adding and removing pins (part#770854-1) from the K1 Harness plug (Part#776164-1) - AMPSEAL Connector Instructions by TE Connectivity: https://www.youtube.com/watch?v=uXTkm_XV2OY
- It is best to remove the Wire Relief shroud (Part# 776463-1) from the K1 Ampseal plug to view wire position in the K1 Harness. This wire relief can be slid off the K1 plug after removing the 2 Phillips head screws from the shroud.
- The inverter's IP Rating is reduced and more susceptible to ingress when the K1 or K3 port are not sealed. Especially in wet or humid environments, it is important to seal these ports with the K1 plug, K3 cap, or serial cable.

IMPORTANT NOTE ON MOTOR CALIBRATION!

Your inverter's clone file must be calibrated to your motor before use. Please follow the Pre-Startup steps in your System's User Manual to commission the spin sensor before attempting to spin the motor. When you commission a spin sensor, you are calibrating the existing clone file for the individual motor it is controlling. This calibration is only stored within the clone file**. If your clone file is being modified, you must adhere to one of the following options:**

1. Modify the clone file that has already been commissioned to the motor by saving it from SmartView and re-loading it post-modification.

2. Copy all parameters from the commissioned clone file's ***Spin Sensor*** tab into the un-commissioned clone you are installing.

3. Commission the spin sensor again after installing a different clone file.

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ISOLATED LOGIC - STANDARD WIRING DIAGRAM

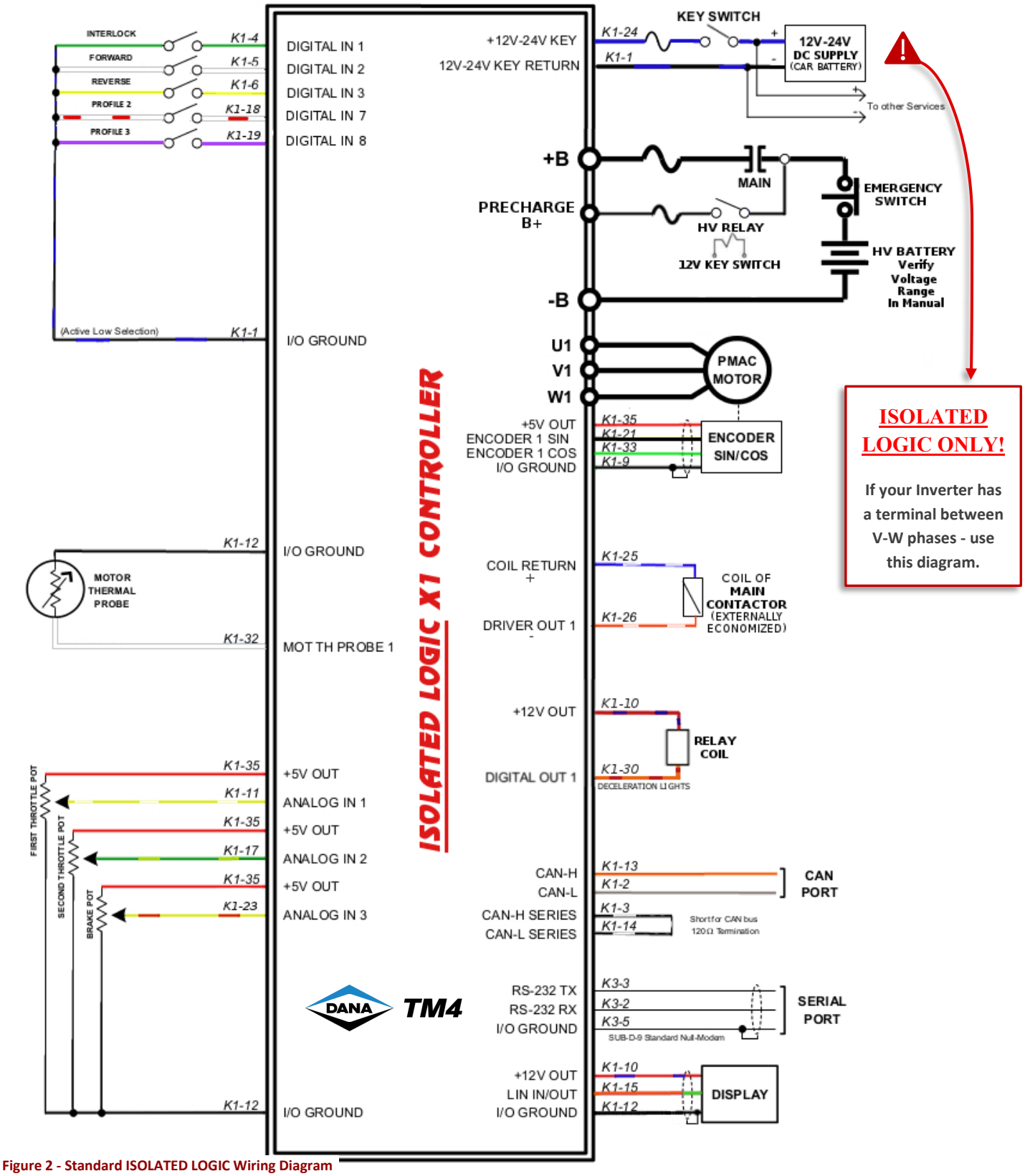

Figure 2 - Standard ISOLATED LOGIC Wiring Diagram

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NON-ISOLATED LOGIC - STANDARD WIRING DIAGRAM

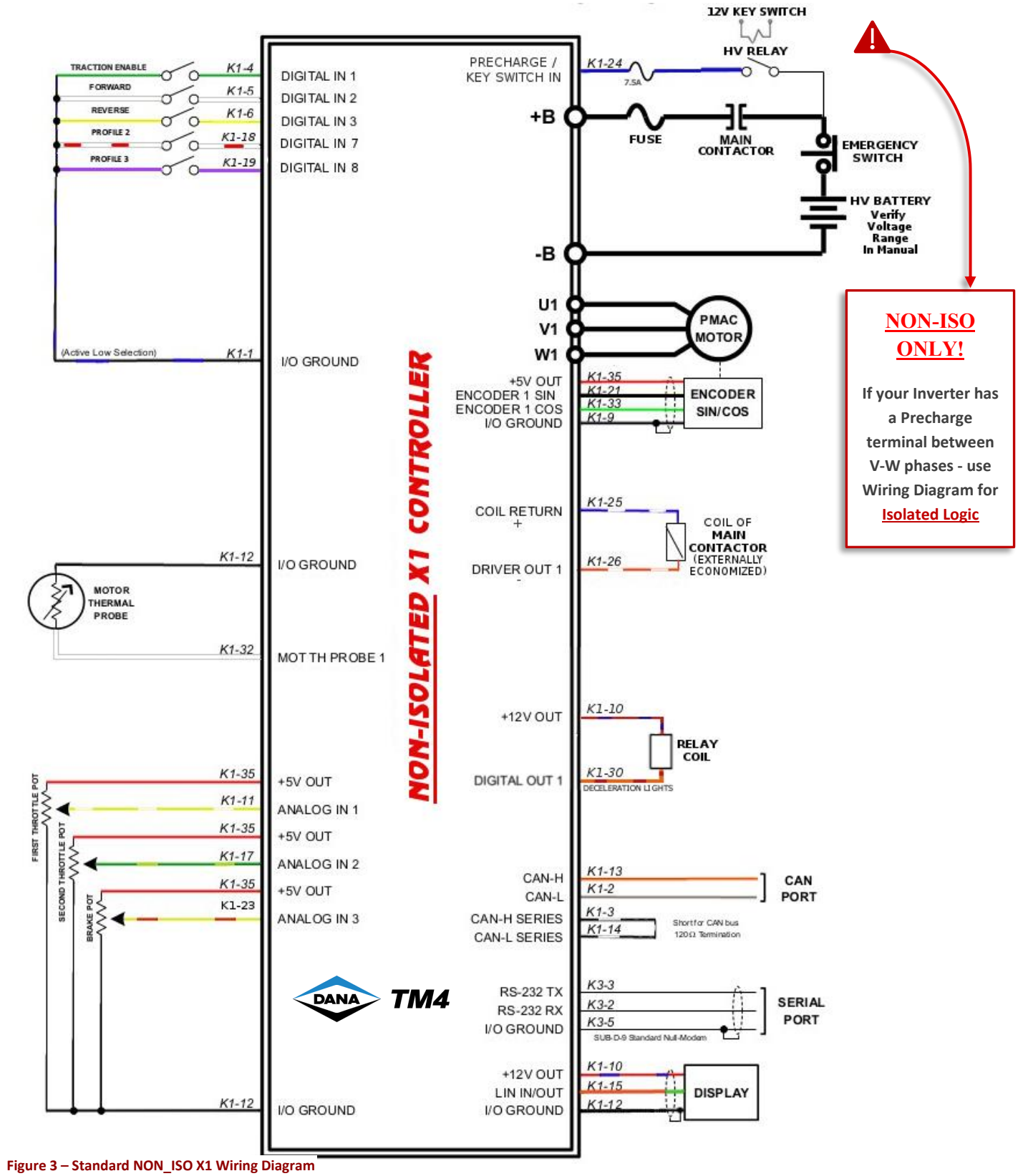

Figure 3 – Standard NON_ISO X1 Wiring Diagram

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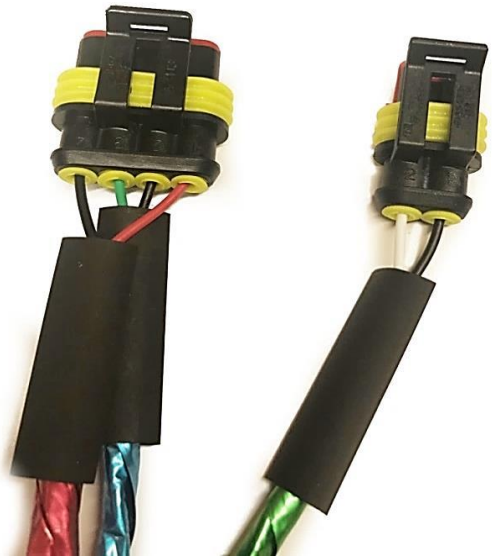
WIRING INSTRUCTIONS - HYPER MOTOR PLUGS



1. Choose a location to fasten the Male 4P and 2P Receptacles from your HyPer Motor.
2. Route multipair cable at least 6 inches from the motor case. Fasten this cable securely so it is restrained from movement. Line cable up with motor's Male Receptacles.
3. Using Cable Cutters - trim excess length from multipair cable, leave 4-6" extra to ensure cable will reach motor Receptacles.
4. Using a co-ax stripper or scissors – carefully strip multipair black jacket at least 4.5" from cable end. This length should allow 4P and 2P wires to reach their respective Receptacle. Be careful not to cut into the foil shielding or wire insulation underneath the jacket. A razor blade or X-acto knife can be used to carefully slice a relief strip down the stripped jacket length, so it can be easily removed.
5. Slide ½" diameter heatshrink over multipair cable. Slide heatshrink past the newly exposed foil, and rest heatshrink on remaining jacket material for future adhesion.
6. Slide ¼" diameter heatshrink over each of the 3 shielded twisted pairs. Rest heatshrink near jacket for future adhesion.
7. Peel back 1.5" of foil shield and plastic wrap.
8. Slide yellow Plug Seals onto each wire with the smaller diameter end of each Seal facing the wire end.
9. Strip ¼" of insulation from the end of each 20awg wire.
10. Using an Open Barrell Crimper for "Amp" brand Pins – Crimp the provided "Strip Pins" onto the copper of each wire.
11. Place pins in their proper position according to Motor Plug Pinout on the next page.
12. Fasten the red locking plate on the front of each plug. Verify all six pins are fully inserted.
13. Slide yellow Plug Seals into wire cavities.
14. Plug the newly assembled Plugs into the matching Male Plugs on your HyPer motor.
15. After the pre-start up steps are complete, and correct system operation is verified, apply heat to heatshrink using a heat gun. Adhere the heatshrink as close to the plug as possible without putting strain on the inserted wires.

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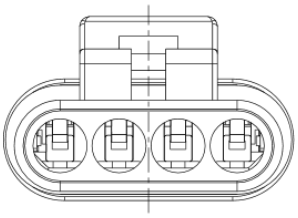
MOTOR PLUG PINOUT - HYPER MOTORS

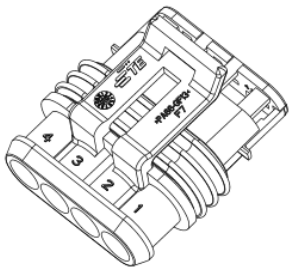
Important: The Motor Encoder must be mounted securely and restrained from movement. Keep Encoder wires as far as possible from High Voltage cables and the motor's field.

MOTOR ENCODER PIN POSITIONS

Included in HyPer System:
Amp Superseal 4 POS
Plug Part# **282088-1**
Pin Part# **282110-1**
Seal Part# **281934-2**



K1-9 K1-33 K1-21 K1-35

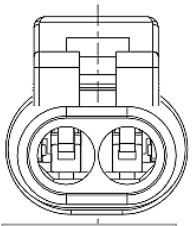


4 POSITION AMPSEAL CONNECTOR

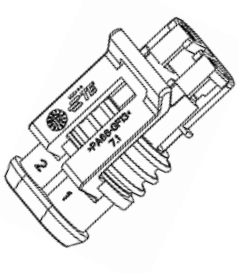
ENCODER PIN #	NAME	K1 POSITION
4	Encoder I/O Ground	K1-9
3	Encoder Cos 1	K1-33
2	Encoder Sin 1	K1-21
1	+5V	K1-35

MOTOR THERMISTOR PIN POSITIONS

Included in HyPer 9HV IS:
Amp Superseal 2 POS
Plug Part# **282080-1**
Pin Part# **282110-1**
Seal Part# **281934-2**



K1-32 K1-12



2 POSITION AMPSEAL CONNECTOR

THERMISTOR PIN #	NAME	K1 POSITION
2	Motor Thermistor	K1-32
1	Analog Ground	K1-12

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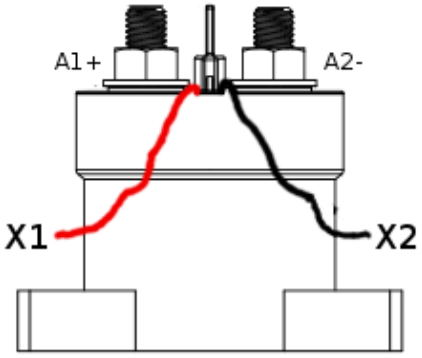
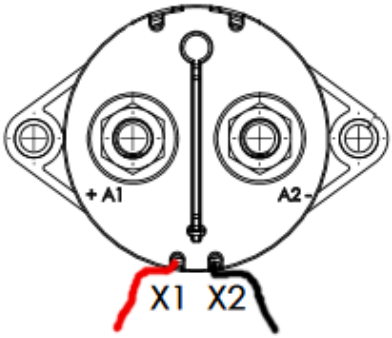
ISOLATED LOGIC - MAIN CONTACTOR WIRING

12/24V COIL DRIVER, HIGH VOLTAGE CONTACTS, AND KEY SWITCH IN

Required Contactor for ISOLATED LOGIC X1:

12V/24V Coil - External PWM
Part# **GV200PA-1 or Equivalent**





ISOLATED X1 MAIN CONTACTOR WIRING

CONTACTOR TERMINAL	NAME	INVERTER TERMINAL
X1	Coil Return (PWM)	K1-25
X2	Driver Output 1	K1-26
A1+	HV Battery+	B+ Precharge*
A2-	Controller HV+	B+ Terminal*

ALL HV circuit should include proper fuses and disconnect switches. 5A fuse is sufficient for Precharge circuit. Precharge circuits contain internal resistor.

The Precharge B+ Terminal can be hard wired to battery pack positive, or switched on via your key switch using the included HV Precharge relay:

1. *Hard wired: Precharge will always see voltage when the high voltage battery pack circuit is closed. This means less cycles of the controller's internal Precharge circuit. It will also leave a parasitic drain on your battery pack. If you will be certain to open a high voltage maintenance switch while leaving the vehicle unattended for weeks at a time, then this option will work well.*

2. *HV Precharge Relay: This will Precharge your controller upon startup every time. It will eliminate a parasitic drain on your High Voltage pack. The key switch must have an On position that energizes the HV Precharge Relay coil before the key is turned to the Start position, which will close 12V+ to K1-24.*

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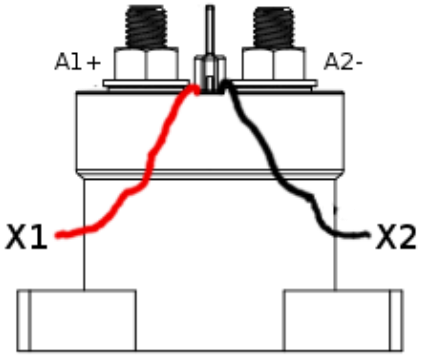
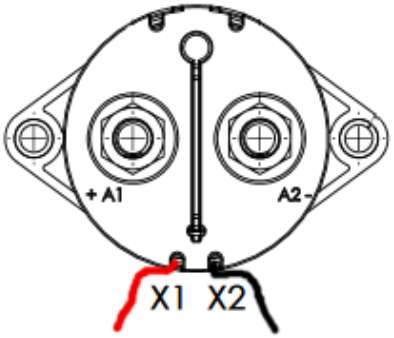
NON-ISOLATED – MAIN CONTACTOR WIRING

24/48V COIL DRIVER, HIGH VOLTAGE CONTACTS, AND KEY SWITCH IN

Required Contactor for NON-ISOLATED X1:

12V-96V Coil - External PWM
Part# **GV200QA-1 or Equivalent**





NON-ISO MAIN CONTACTOR WIRING

CONTACTOR TERMINAL	NAME	INVERTER TERMINAL
X1	Coil Return (PWM)	K1-25
X2	Driver Output 1	K1-26*
A1+	Battery + / Precharge	K1-24**
A2-	Controller HV+	B+

ALL HV circuit should include proper fuses and disconnect switches. 7.5A-10A fuse is sufficient for the NON-ISO Precharge & Logic circuit. Precharge circuits contain internal resistor.

** In our Standard NON-ISO X1 Clone files, Driver Output for the Main Contactor coil is configured for a 48Vd, externally economized coil. All Driver Outputs can be configured from 1-100% of pack voltage, at a PWM frequency of 125hz-1000hz. For more information, see Driver Outputs.*

*** NON-ISOLATED Inverters ONLY - full battery pack voltage is supplied to K1-24 (Key Switch In) when the Ignition Key is switched on. The K1 harness should not have any tie to chassis ground. The HV Key Switch Relay coil is energized by external 12V, but the HV relay connect pack voltage to K1-24 through its isolated Normally Open (NO) contacts. K1-24 is the only external voltage source in the K1 harness. The NON-ISO X1 logic board uses internal buck transformers to step down battery pack voltage from pin K1-24 to lower voltage for internal inputs and outputs. K1 Ground pins trace internally to the X1 inverter's B- terminal.*

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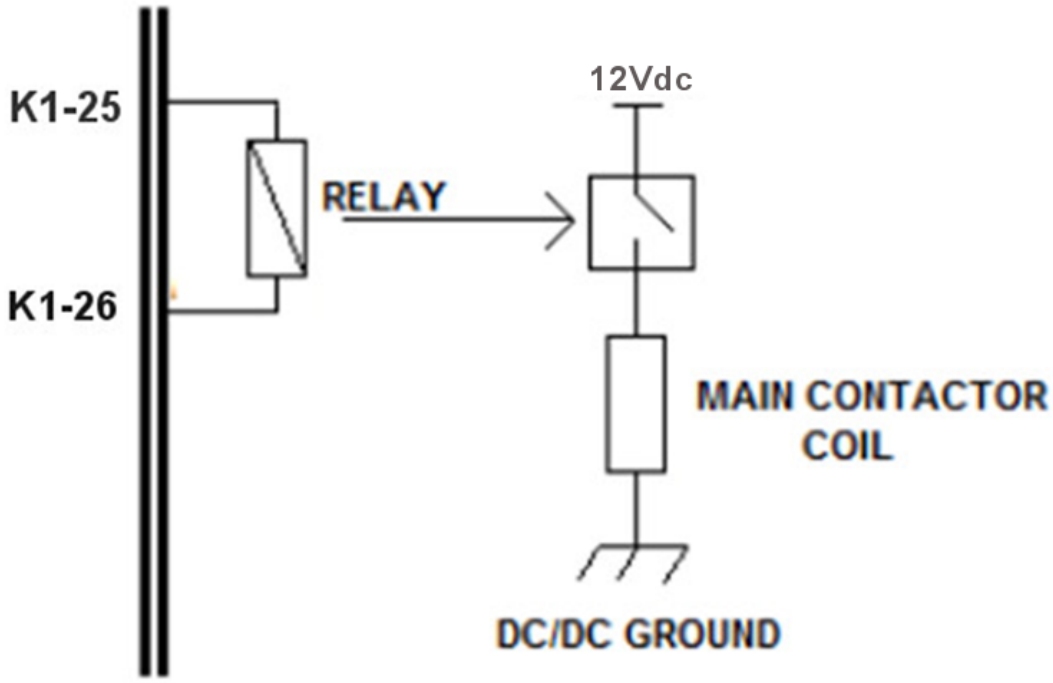
MAIN CONTACTOR – INTERNALLY ECONOMIZED OPTION

The Main Contactor Manager must energize a Contactor/Relay Coil with a PWM Output, rather than an on/off DC voltage. The manufacturer recommends using the X1 Driver Outputs to economize the main contactor coil's freewheeling diode. An externally economized main contactor is included with each HyPer System. For wiring and part# of your externally economized contactor, please see the two previous pages.

Using an **internally economized contactor** is possible. This requires a cascading relay whose coil is wired to K1-25 & K1-26, as shown in the diagram below. Your Clone File's Main Contactor voltages, frequency, and pull in time may require reconfiguration to match the specification of your cascaded relay:



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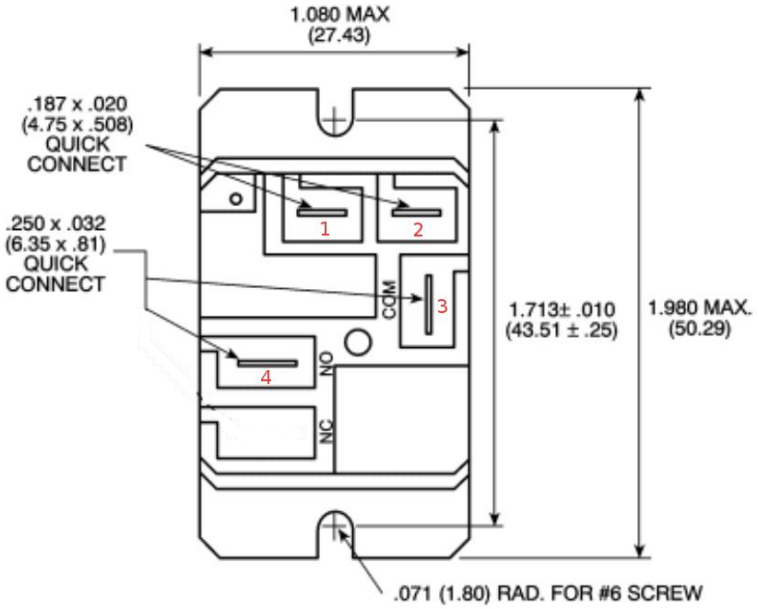
HV RELAY – WIRING INSTRUCTIONS

An HV Relay is included in all wire harness kits for both ISO and NON-ISO Inverters. This relay can be used for controller/inverter Precharge and/or Key Switch On. For more information on HV Relay wiring, please follow the Wiring Diagram and Main Contactor Wiring instructions for your inverter.

HV RELAY DRAWING

Optional for ISO X1,
Required for NON-ISO X1:

HV Relay
Part# **T9AP1D52-12 or Equivalent**



HV RELAY TERMINATIONS

HV RELAY TERMINAL	NAME	TERMINATION
4	NO	HV OUT to Inverter
3	COM	HV IN
2	12V Coil -	12V Key Switch -
1	12V Coil +	12V Key Switch +

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PRE-CHARGE SEQUENCE

The inverter's high voltage activation requires a specific sequence to prevent Precharge Faults or component damage.

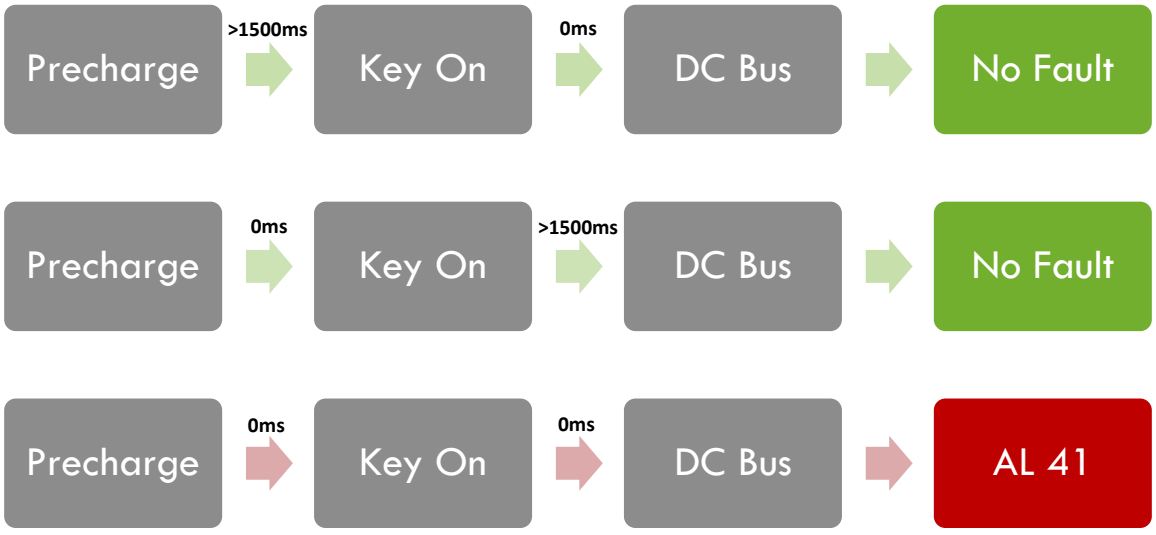
1. **Precharge:** High voltage is applied to the inverter's Precharge B+ terminal.
2. **Key On:** The inverter's logic control board is powered via K1-24.
3. **DC Bus:** The main contactor is energized, connecting high voltage to the DC bus terminals (B+ and B-).

ISO INVERTER TERMINALS		
TERMINAL	NAME	COMMANDED BY
Precharge B+	Precharge	HV Relay or Hardwired
K1-24	Key On	12V Relay
B+	DC Bus	Interlock, K1-25 & K1-26

A ~1500ms delay must be implemented between energizing the Precharge circuit and the DC Bus. This delay, often necessary in Isolated Logic inverters, allows the Precharge circuit to stabilize the DC bus voltage before full power is applied. The B- terminal serves as the common negative reference for both the Precharge and DC bus circuits.

The main contactor coil is driven by a PWM signal from the inverter's internal driver output (K1-25 & K1-26). Failure to complete the Precharge sequence before attempting to energize the contactor coil will result in *Fault # AL41*.

Default Clone file settings energize the main contactor (DC Bus) immediately after Logic Board Initialization. The Main Contactor Interlock setting allows any Digital Input to be assigned as a DC Bus engage/disengage switch. This enables concurrent Precharge and Key On Initialization, with an independent Digital Input for main contactor command.



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COMPACT DISPLAY - WIRING INSTRUCTIONS

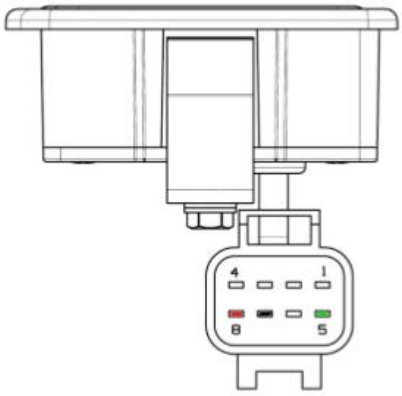


Figure 4 - Compact Display Male Connector

The K1-15 LIN-BUS wire is not installed in our standard wire harness. An Orange 18AWG Wire is included with each Compact Display. This wire is terminated with an Ampseal pin, it must be inserted in position K1-15 of the K1 Harness.

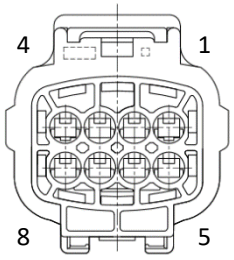
Please see the following instructions for adding and removing pins from the K1 Harness plug: https://www.youtube.com/watch?v=uXTkm_XV2OY

For more information, please see Compact Display User Manual.

COMPACT DISPLAY MATING FEMALE PLUG

Included with Compact Display:
Econoseal .070 MK-II 8 POS

Plug Part# **2822393-1 or 174982-2**
Pin Part# **171662-1 or 171630-1**
Locking Plate Part# **174983**



COMPACT DISPLAY - 8 POSITION CONNECTOR

POSITION	NAME	K1 POSITION
8	+12V Out	K1-10
7	I/O Ground	K1-12
6	Not Connected	N/A
5	LIN-BUS	K1-15
4	Digital Input 1	TBD
3	Digital Input 2	TBD
2	Digital Input 3	TBD
1	Digital Input 4	TBD

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SOFTWARE FILES

DOWNLOAD THE CLONE, FIRMWARE, AND SMARTVIEW FOR YOUR SYSTEM:

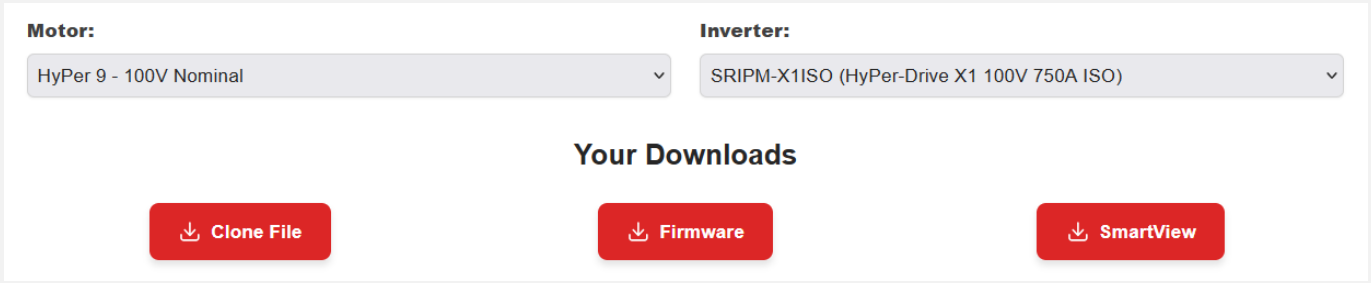
http://www.go-ev.com/downloads/clone_files.html

1. DOWNLOAD

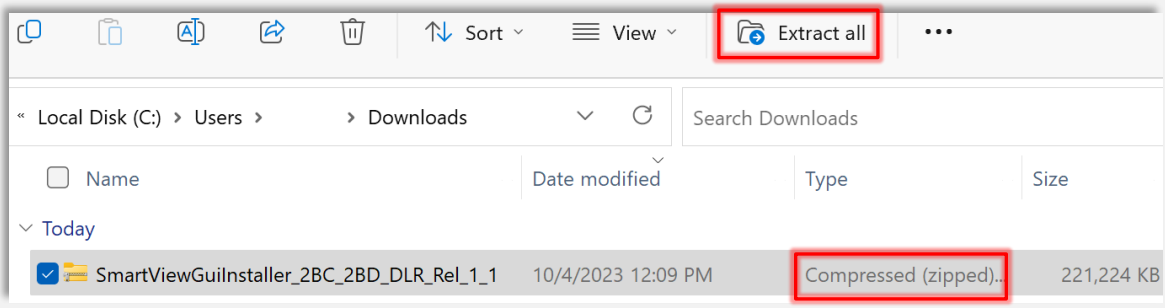
Each Motor and Controller/Inverter combination requires a specific composition of 3 software files that can be downloaded from the following link: http://www.go-ev.com/downloads/clone_files.html

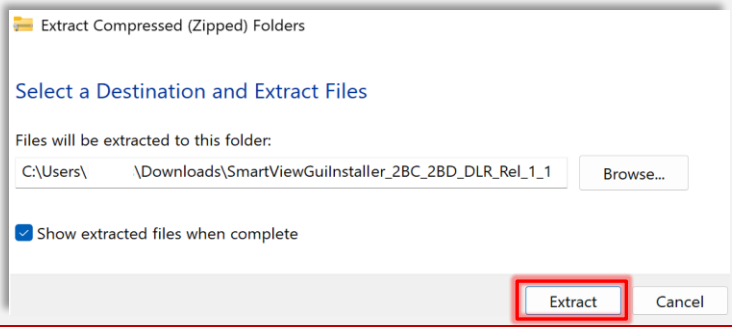
1. **Clone** File – The program file that sets the motor and inverter type, Input/Output functions, speed/torque paramters. Before running a motor for the first time, each clone file must be calibrated (commissioned) to that individual motor.
2. **Firware.bin** file: Enables the link between the inverter hardware and software.
3. **SmartView GUI interface** – Programming software used to install Firmware and manage Clone files.

Verify **your** motor type and inverter type, then select these options and download each resulting file.



2. EXTRACT





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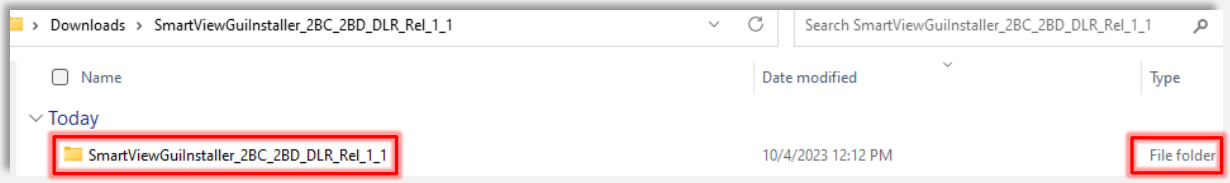
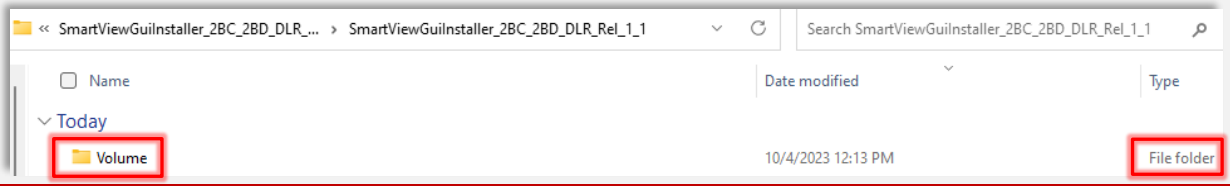
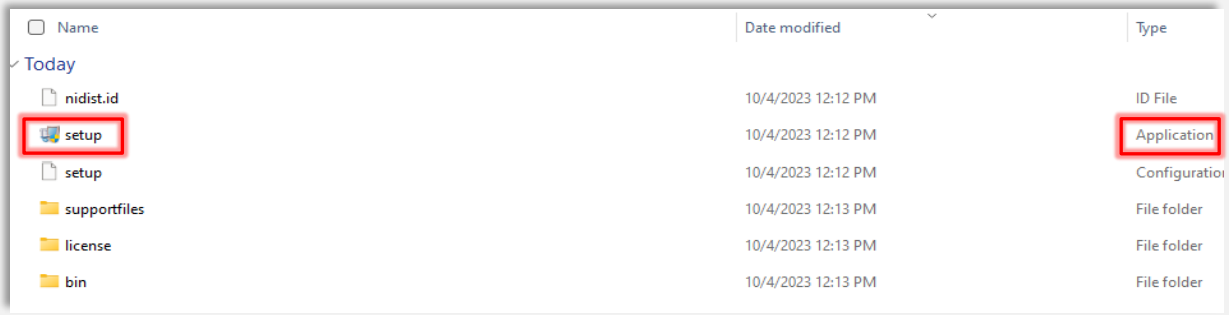
3. OPEN UNZIPPED FILE FOLDER



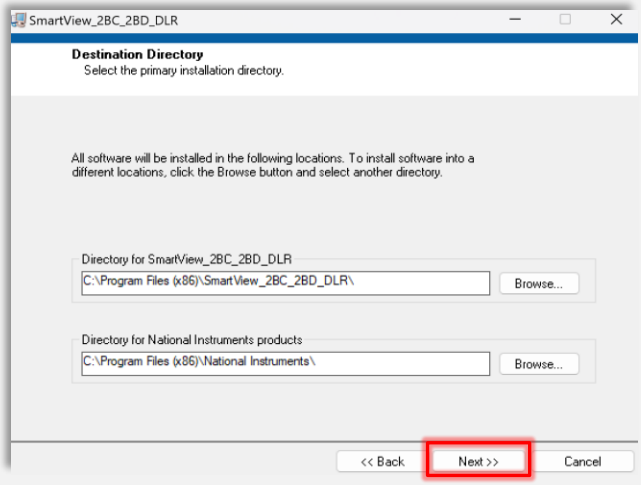
4. OPEN VOLUME FOLDER

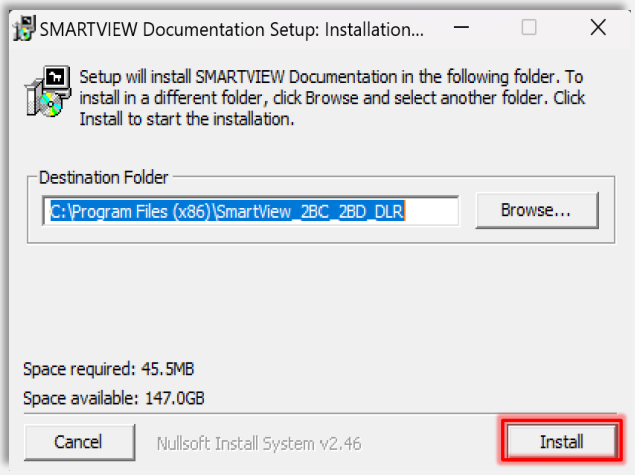


5. OPEN SETUP – APPLICATION



6. INSTALL





7. RESTART PC

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PRE-STARTUP STEPS

APPLICATION CHECKS

- **Be sure your vehicle's drive wheels are suspended from the ground upon initial powerup! Drive wheels MUST NOT be in contact with any surface upon initial power up.**
- **Controller MUST BE powered off at all times while working with the wire harness. DO NOT adjust Ampseal connectors or any wires while controller power is switched on.**
- **Open High Voltage disconnect switch while working with High Voltage cables.**
- **If a motor ever revs with no throttle applied, turn off the key switch immediately.**

QUICKSTART GUIDE – WIRING AND PROGRAMMING

The following step sequence may be essential to your system and the TAU SmartView program's operation. Please follow all steps carefully and in order. If a problem is encountered, ensure all steps were followed correctly. If all steps are correct and a problem persists, please see Additional Support.

1. Follow the **Wiring Diagram** supplied by your dealer, or the diagrams shown above on pages 10 and 11.
2. **Do not connect High Voltage** to B+ until steps 4-18 are complete. Keep this cable isolated to prevent short circuits, when the main contactor attempts to close, or leave It disconnected from the A2 terminal of the Main Contactor. Isolated and Non-Isolated inverters Require a connection between B- and HV Pack- to close the pracharge circuit.
3. **Do not connect U,V,W** motor leads until steps 4-18 are complete.
4. Before switching on the Controller/Inverter, **with all power off remove the 35pin connector**.
5. At the motor encoder's **4 Pin Ampseal** connector - ensure the wires and connectors are restrained from movement within the installation area. Also ensure that these wires are not routed near High Voltage cables or the motor's field. Then, verify correct wiring of the encoder. You can measure resistance or continuity between the female Encoder Pins and their corresponding female K1 pin, but do not stretch the female socket pins. Once a clone file is loaded onto you controller, you can view Encoder Signals as described in *Fault # AL30* on this manual's Fault Code List.
   i. **PIN1** is connected to **K1-35** (+5V Out).
   ii. **PIN2** is connected to **K1-21** (Encoder Sin 1).
   iii. **PIN3** is connected to **K1-33** (Encoder Cos 1).
   iv. **PIN4** is connected to **K1-9** (Encoder I/O Ground).
6. Check that **Contactor Positive Coil** is connected to **K1-25** (Coil Return).

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7. Check that **Contactor Negative Coil** is connected to **K1-26** (Driver Output 1). Verify part# of contactor in ISOLATED LOGIC Main Contactor Wiring or NON-ISO Main Contactor Wiring.

8. Connect Amp 35 pin connector to controller/inverter K1 port.
9.

   9a. ISO: Check 12V-24V conducts to **K1-24** (Key Switch In) when switching on the Key. Then turn power off. K1-24 is the **only** wire on the K1 harness that will see an input voltage. Do not connect High Voltage to K1-24 on inverters with Isolated Logic.

   9b. NON-ISO: Check that full HV battery pack voltage conducts to **K1-24** (Pre-Charge/Key Switch In) when switching on the Key. Then turn off and disconnect High Voltage from the controller. In Non-Isolated Logic Inverters only: K1-24 is the **only** wire on the K1 harness that will see high voltage.

10. If two serial cables were provided - couple the supplied Null Modem **Serial Cable** to the supplied **Serial-USB** Adapter.

11. Connect **USB** end to **PC** with TAU SmartView software installed. **Never plug another USB device into your PC while the X1 controller is plugged in.**

12. Connect female **Serial Cable** end to X1 controller's male serial **K3** port. **Always keep K3 port covered** with K3 cap or Serial Cable. The Inverter's serial port has low IP rating, damage will occur if liquid or condensation enters through the open K3 port.

13. Open TAU SmartView DLR Sys software.

14. Select **Connection** type: **Normal** or **Wired**. Then select the USB Port your device driver was installed on.
    i. Your **COM** port number set is listed in the Windows Device Manager.
    ii. Verify that the **COM** port number is not already used by another software when TAU SmartView is opened.

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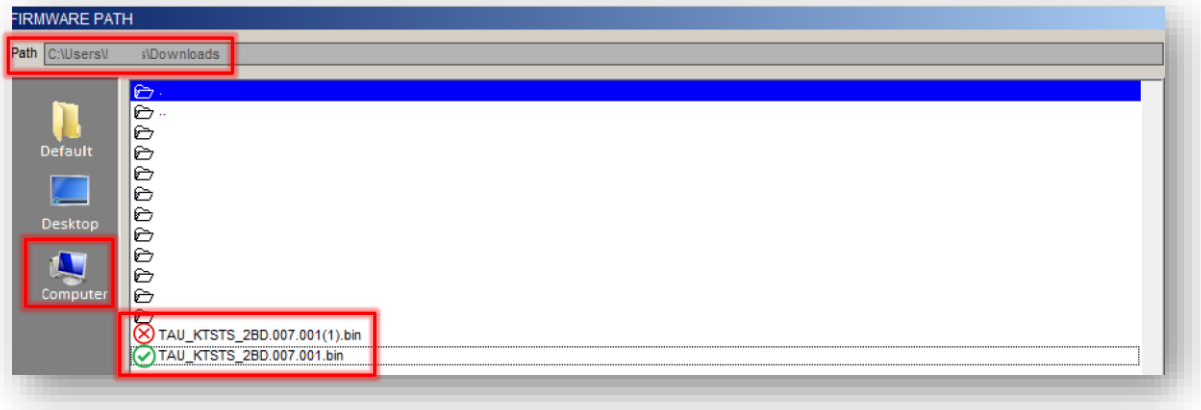
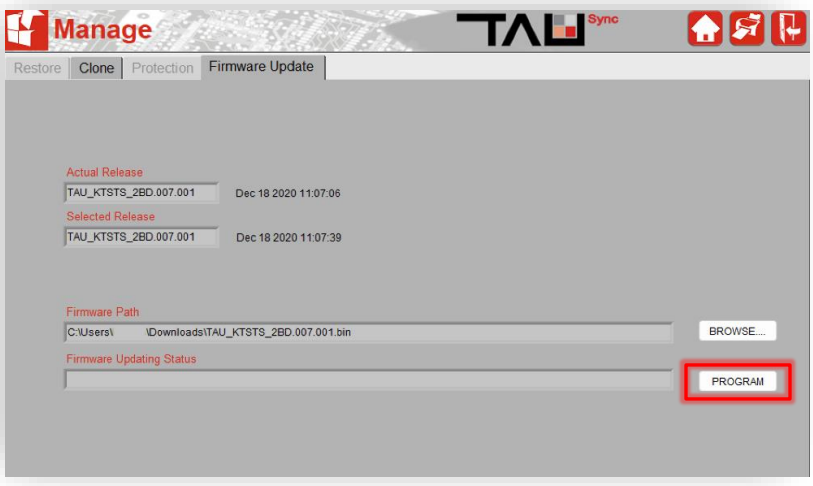
15. Verify vehicle is in **Neutral with wheels suspended from the ground**. Then switch on X1 controller via **Key Switch.** Some inverters arrive without firmware and require programming with the files downloaded from this manual's Software Files section. Other Inverters arrive pre-loaded with a generic clone file and firmware that must be overwritten with the files from this manual as well.
    i. If TAU SmartView does not populate a "***Manage***" block or "***Firmware Update***" tab after choosing your connection type, verify steps 9-15 are followed in order.
        a. If a Dialog Box prompts "GUI Version Mismatch" Click "**Okay**".

16. Once SmartView is communicating with the inverter, install the downloaded *.bin* **Firmware** by clicking on:
    i. ***Manage - Firmware Update***
    ii. Next to **Firmware Path**, Click **Browse**. Navigate to the location of your downloaded firmware file, then select the .bin file with the original file name. **SmartView is unable to load Firmware with modified file names, or sequential downloads with file name ending in (x).bin.** If no path was selected when downloading the file, the file will be in your "*Downloads*" folder. When browsing firmware path, you will only see files with the extension ".bin".



    iii. Once this .bin file is selected and shown in the ***Firmware Path***, Click ***PROGRAM*** and let progress load to 100%. If PC to Inverter connection is lost while load progress is between 0%-100%, the inverter will be placed back into "Boot Mode". While in Boot Mode, Firmware Update will be the only available page.



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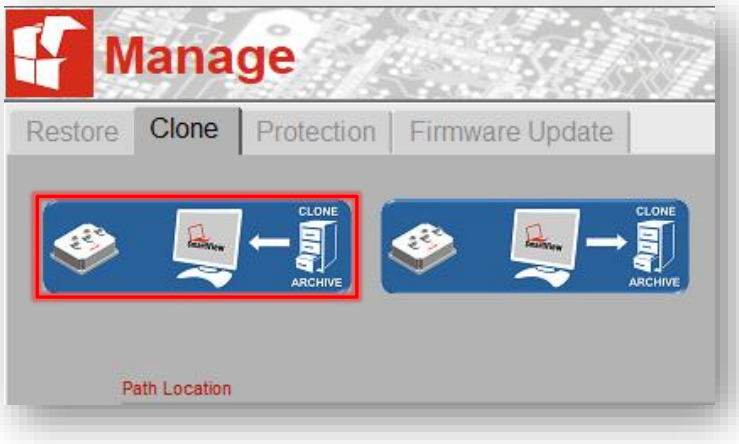
17. Install your motor's downloaded **Clone** file by clicking on:
    i. ***Manage – Clone***, and select the left icon to **Load** from file **archive to the inverter**. The right icon will allow you to save files from your inverter to your PC.



    ii. Navigate to the location of your downloaded Clone file. If no path was selected when downloading the file, the file will be in your "*Downloads*" folder. When browsing Clone path, you will only see files with the extension ".clon".
    iii. Select the .clon file matching your motor type and voltage.
    iv. Click **OK**, the clone file LOAD progress will reach 100%
    v. The Home screen should appear automatically with – ***Monitor, Diagnose, Configure, and Manage*** blocks.

18. With the Controller switched on at this point, you see active faults. If AL33 occurs, please ensure you've installed the correct clone file. Low voltage faults are to be expected, as high voltage is still disconnected. With TAU SmartView's home screen active, click:
    i. ***Monitor - Real-Time Data - Inputs*** –
        a. Check that by pressing the ***Throttle***, you are able to see the **Analog Input 1** value increase. If not, verify wiring.
        b. If a throttle other than NetGain's HEPA is being used, a **custom throttle map** is required to match your throttle. Please refer to Post Startup Steps to adjust the Throttle Mapping.

    ii. ***Monitor - Real Time Data - Inputs*** –
        a. Check that by selecting the ***Traction 1st Enabling***, the **Digital Input 1** (K1-4) is switched on (light green). If not, check the wiring. This input is commonly used to disable the motor with a charger interlock circuit. **The motor will only spin if:** Traction 1st Enabling **and** either direction (Forward or Reverse) are active.
        b.

    iii. ***Monitor - Real Time Data - Inputs*** –
        a. Check that by selecting the ***Forward*** Direction, the **Digital Input 2** (K1-5) switches on (light green). If not, check the wiring.

    iv. ***Monitor - Real Time Data - Inputs*** –

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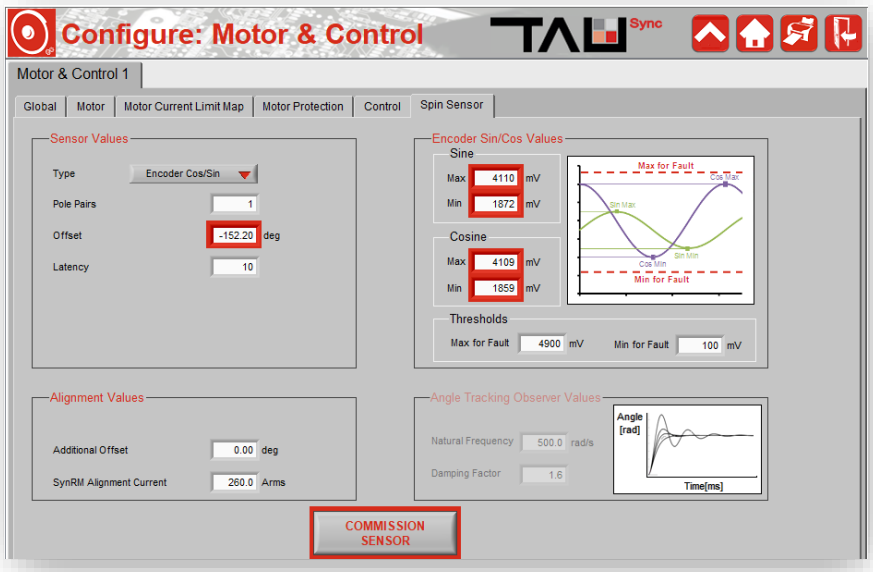
a. Check that by selecting the ***Reverse*** Direction, the **Digital Input 3** (K1-6) switches on (light green). If not, check the wiring.

v. ***Monitor - Real Time Data*** **- Inputs** –
   a. If a brake pressure transducer is installed, follow steps b. and c.
   b. check that by pressing the ***Brake***, you are able to see the **Analog Input 3** value increase. If not, check the wiring.
   c. With no pressure on the brake pedal, verify that the starting input value is **<900mV**. If starting value is >900mV, please refer to Post Startup Steps to adjust the Brake Mapping.

19. Once steps 4-18 are complete -
   i. **Turn off Key Switch, leaving High Voltage Supply Disconnected.**
   ii. Connect U-V-W cables to the ***HyPer 9*** ™ motor. **Be sure the vehicle's wheels are suspended from the ground.**
   iii. **Fasten High Voltage Battery** leads to the X1 controller's B+ and B- terminals according to the **Wiring Diagram**. HV battery voltage must be within the absolute range listed in Inverter Models chart.

20. **Commission the Spin Sensor!** (Calibrate your Encoder within your clone file)
   i. The spin sensor must be commissioned to properly calibrate the settings for your individual motor every time:
      a. A new clone file is installed onto your controller.
      b. A new motor is combined with an existing clone file.
   ii. ***Configure - Motor & Control - Spin Sensor*** **–** Click the **"Commission Sensor"** button. TAU SmartView will prompt that this must initiate 60 seconds from key on, click YES. The motor will spin slowly for about 1 minute, so please be sure it is safe to do so with minimal load (Neutral and/or wheels suspended off ground).



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iii. If commissioning fails, there is likely an **active fault** or **throttle request** that must be corrected. Commission failure could also be caused by incorrect encoder wiring, or crossed motor phase connections. Please, check them. Encoder Signals can be viewed under ***Monitor – Realtime Data – Inputs.*** Sin & Cos signals should always read between 1100mV-4200mV. If an Encoder Signal is outside this range, there is an open or short in the encoder circuit.

21. Once Commissioning is done, the system should now be fully operational. You can now attempt to spin the motor:
    i. Select the **Forward** Direction.
    ii. Press the **Throttle** and notice the Motor spinning.
    iii. Press the **Brake** and notice the Motor braking.
    iv. If the motor torque does not match Throttle position and Direction, **please ensure Step #20 is successfully complete.**
    v. The motor will only spin if: Traction 1st Enabling and either direction (Forward or Reverse) are active.

22. If the Motor is in **Blocked Rotor** condition (maximum Current and 0rpm, with possible high frequency noise), switch off the Controller. This means that the encoder wiring or motor phases are wrong. Please, check them.

23. Continue to Post-Startup Steps.

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POST-STARTUP STEPS

BATTERY PROTECTION

IMPORTANT SAFETY DISCLAIMER & NOTICE OF RESPONSIBILITY

The following instructions detail the configuration of the controller's voltage and current protection features. It is critical to understand that these controller-based settings are intended as a secondary, supplemental safety measure and should NEVER be considered the primary or sole protection for your battery pack.

A dedicated Battery Management System (BMS) is the appropriate and necessary device for primary battery protection, as it typically monitors individual cell voltages and temperatures. The controller's protection map primarily serves to protect the inverter itself from operating outside of safe voltage ranges and provides a redundant safety layer for the system.

The user is solely responsible for:

- Obtaining the correct technical specifications from the battery manufacturer's official datasheet.
- Accurately programming the UnderVoltage, OverVoltage, and current cutback settings according to those specifications.
- Verifying that a dedicated, properly configured BMS is in place as the primary protective device.

Failure to set these limits correctly based on your battery's specific chemistry and construction Incorrectly can cause disruptive vehicle shutdowns requiring a key-cycle restart, lead to permanent equipment damage, and potential for thermal events, including fire.

By proceeding with this configuration, you acknowledge that you understand these risks and confirm that the controller's settings are being used as a supplemental safety feature to a primary Battery Management System.

1. On the TAU SmartView DLR 2BD home screen, select ***Configure - System – Battery - Protection***.
2. The UnderVoltage and OverVoltage Limits are the Voltages that your battery pack should never exceed. Set these points which will trigger a Blocking level fault in the controller, thus cutting all battery current. These Limits must be **outside** the 0% and 100% SoC defined in your ***Datasheet*** tab. UnderVoltage Limit < 0% SoC, OverVoltage Limit > 100% SoC.
3. The goal of the UnderVoltage cutback is to limit Discharge current when the battery pack is at a low state of charge. The goal of the OverVoltage cutback is to limit Regen current when the battery pack is at a high state of charge. A proper Battery Protection Map will limit current to a point where the Blocking fault limit is never reached.
4. Set the Ending Cutback points (A & D) lower than the UnderVoltage and OverVoltage Limits. Then, adjust your Starting Cutback points (B & C) to map out a current derating structure that will protect your battery. The Cutback is the maximum % of current allowed at the ending cutback point.

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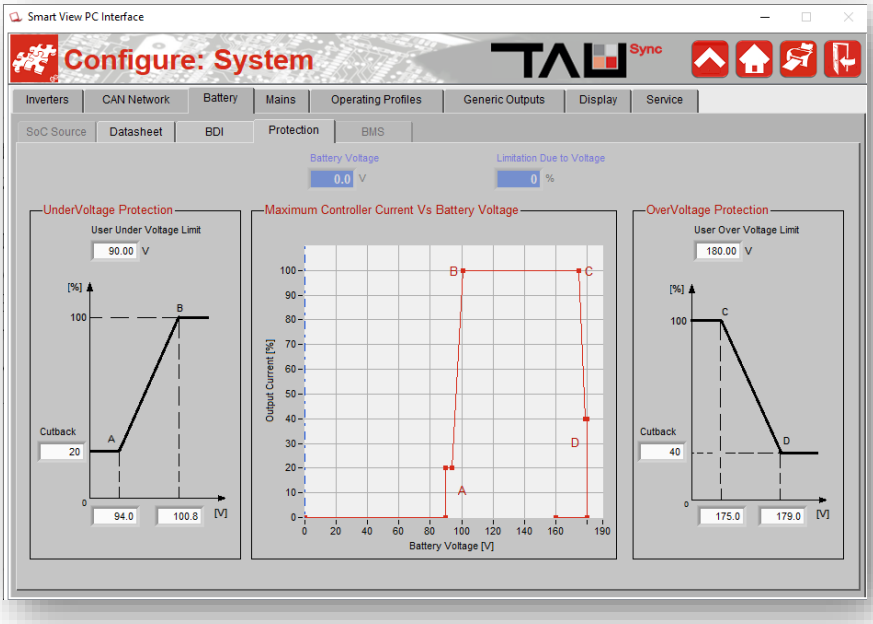

Figure 5 - Battery Protection

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BATTERY MAPPING

The controller can estimate a battery's state of charge (SoC) based off a specified Voltage Map. Follow the steps below to Map your battery pack SoC.

1. On the TAU SmartView DLR Sys home screen, **select *Configure - System – Battery - Datasheet***.
2. Under "Type" – select Lead Acid or User Defined.
3. Enter your Battery Pack's Capacity and Nominal Voltage.
4. Adjust the state of charge percentage levels based on the minimum and maximum charge values of your Battery Pack. **0% SoC value must be >1V higher than "User Under Voltage Limit" on the Protection** tab. **100% SoC value must be >1V lower than "User Over Voltage Limit" on the Protection**
5. In HyPer-Drive X144 Clone files, changing the Nominal Voltage from 144.00V will trigger an AL52 Wrong Parameter fault. If the nominal voltage is set to 144.00V, do not modify.

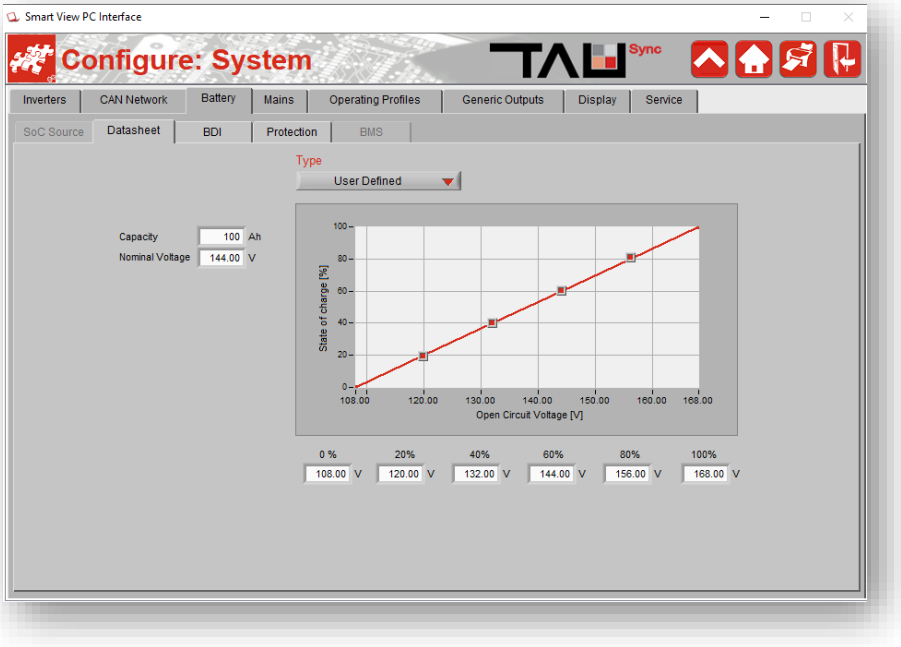

Figure 6 - Battery Datasheet

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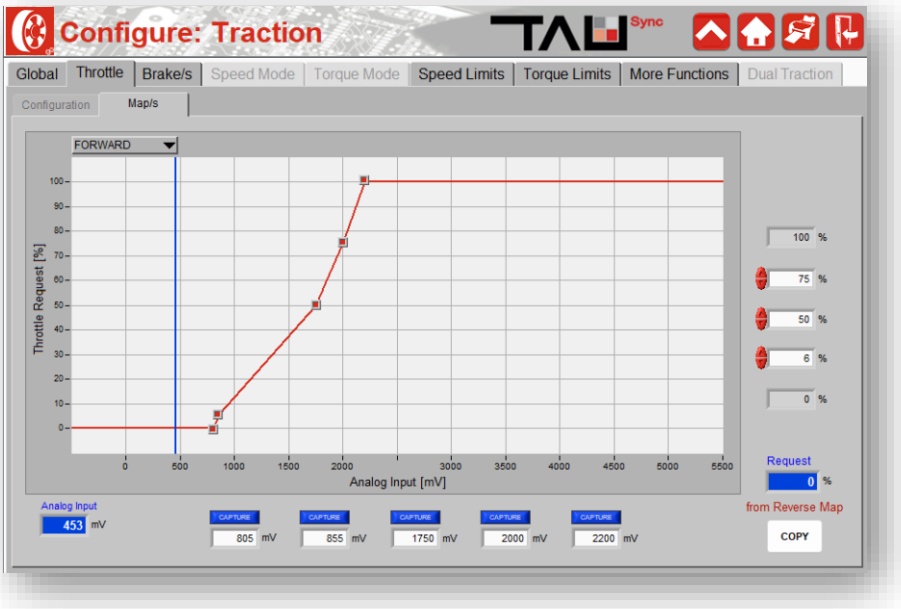
THROTTLE MAPPING

All HyPer-Drive controllers require throttle signal from a 0-5V or 0-12V potentiometer. HyPer 9HV Clone Files come pre-programmed with a throttle map for the Prius Hall Effect Pedal Assembly. This pedal provides an output of 1.60V-4.55V. A different potentiometer or pedal assembly will require different minimum and maximum input values be programmed. A user may map any 0-5V throttle pedal to their preference. Follow the steps below to Map your Throttle Pedal.

1. On the TAU SmartView DLR Sys home screen, select **Configure - Traction – Throttle - Map/s.**
2. View the Analog Input signal from the Throttle.
3. If you turn Off high voltage, and place the vehicle in Neutral – you can press on the Throttle pedal and note the change in this Analog Input mV value from fully depressed to fully pressed.
4. Adjust the Forward and Reverse maps accordingly, starting from the lowest left capture point, working right to the highest. You can copy the Forward map to Reverse map (or vise-versa) and adjust as needed. Your lowest mV torque request should be **>100mV higher than resting throttle** voltage.
5. A quick jump up to 4-9% torque helps to smooth out low torque jittering.
6. If you intend to implement Single Pedal Driving, leave >250mV between resting throttle and first torque request.



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BRAKE REGEN MAPPING

Dynamic Brake Pedal Regen is pre-programmed in all HyPer Motor Clone files. To utilize Dynamic Brake Pedal Regen, a Brake Pressure Transducer must be installed in the application. This Transducer sends a 0-5V signal that the controller is programmed to transfer into Brake Regen Torque. In our default clone files, any Brake Regen request will take priority over any throttle request. If the throttle and brake are applied together, motor torque will only be regenerative. The brake priority can be disabled in SmartView OEM, but this is not recommended.

Follow the steps below to Map your Brake Pedal Regen:

1. On the TAU SmartView DLR Sys home screen, select **Configure - Traction - Brake/s - Pedal/Handle Brake.**
2. View the Analog Input signal from the pressure transducer. If a transducer is wired, this should be above 300mV without any pressure on the brake pedal.
3. Press on the brake pedal and note the change in this Analog Input mV value.
4. Adjust the map accordingly, starting from the lowest left capture point, working right to the highest.

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OPERATING PROFILES - REGEN ON NEUTRAL

If the vehicle does not have a brake pressure transducer (or another type of 0-5V potentiometer to control regen), Dynamic Brake Pedal Regen cannot be used.

All systems have the option to use "Regen on Neutral", also known as Single Pedal Driving. Regen on Neutral features are programmed into all HyPer 9HV clone files, and do not require any additional components.

There are 3 separate operating profiles on each controller, each with a different Neutral Regen Torque percentage. These can be cycled through via:

1. The Compact Display's **(*E/S/H*)** button.
   or
2. **Selector Switches**. Latest Clone files are configured to toggle between Operating Profiles by Digital Input switches. The assigned inputs for these switches are K1-18 (Profile 2) and K1-19 (Profile 3). If both of these circuits are open, the controller defaults to Profile 1.

There three Regen on Neutral values shown below are pre-programmed into HyPer 9HV clone files. These values can be adjusted to suit user preference.

- Profile 1 ***E*** (End Regen) : 0% (Coast)
- Profile 2 ***S*** (Some Regen) : 28%
- Profile 3 ***H*** (High Regen) : 40%

NEUTRAL TORQUE MAPPING

Follow the steps below to adjust these Neutral Regen Torque values.

1. On the TAU SmartView DLR Sys home screen, select **Configure – Traction - Torque Limits - By Other**.
2. Under “Limit By Operating Profile” - adjust the Regen Torque by Neutral to suit your preference.

TUNING REGEN ON NEUTRAL – SINGLE PEDAL DRIVING

Single pedal driving can be configured by using instructions below. Setting up single pedal driving as shown will provide a smooth transition between Drive torque and Regen torque. It also allows you to control Regen torque with the throttle input. Without applying the Regen Torque Limit by Analog Input 1 (K1-11), the transition between drive torque and regen torque can be aggressive. Once this limit is applied, you must consider your throttle map and regen limit map linked, and they must be modified together.

1. Raise your first **Throttle** Request point **300-400mV** above your resting throttle input. We will use this threshold to feather in/out Regen torque between resting throttle and the first drive torque request. Copy to Reverse Map and adjust as desired. **SAVE**

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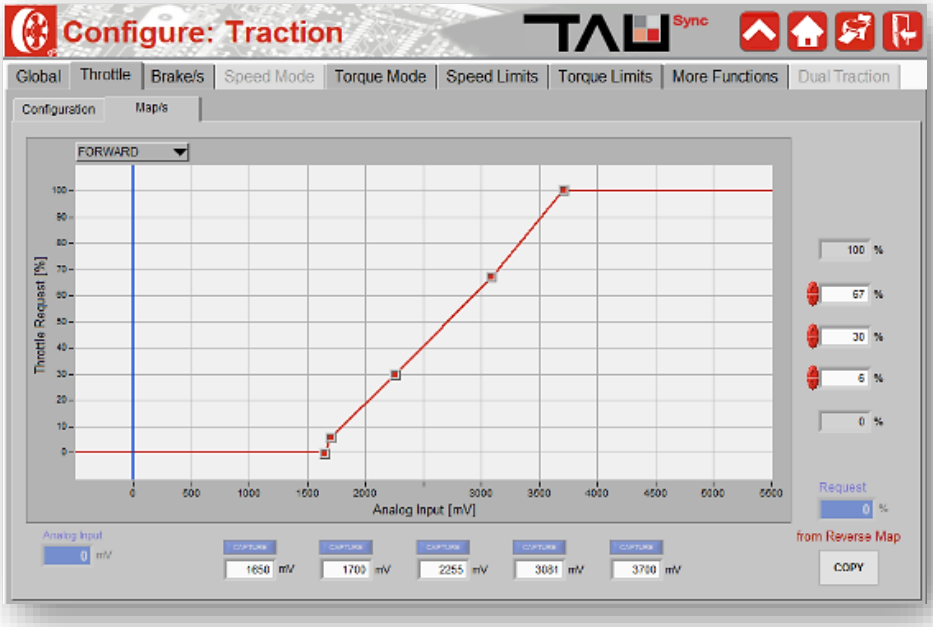
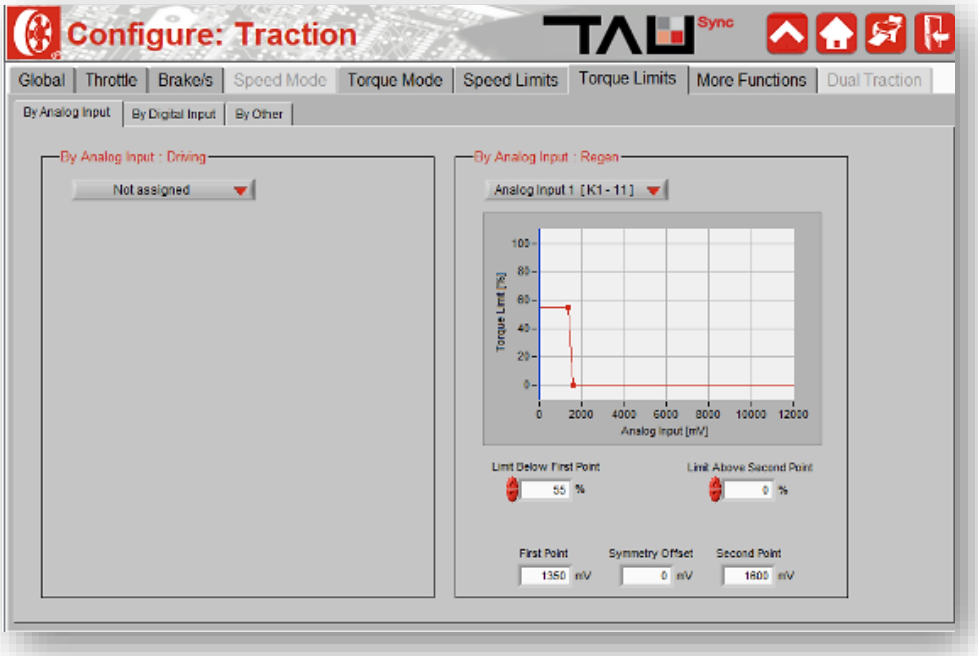


Pictured mV values are based on a 1,300mV resting throttle.

2. Assign a ***Torque Limit - by Analog Input*** for ***Regen*** *using:* Analog Input 1 [K1-11].



3. ***Symmetry offset***: Set to 0mV
4. ***Limit Below First Point:*** Set to Maximum Regen Torque in ***Torque Limits - By Other*** tabs. Setting ***First Point*** to 100% will not allow for utilization of the full map, this value is further limited ***By Operating***

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Profile (default: 1% on Profile 1, 28% on Profile 2, and 45% on Profile 3). Setting ***First Point*** to the highest profile % will allow full resolution of this analog limit while in the highest profile.

5. ***Limit Above Second Point****:* Set to 0%
6. ***First Point:*** Set to ~50mV above resting throttle
7. ***Second Point*** Set to >50mV below first drive torque request set in your ***Throttle Map***. A wider gap between ***Second Point*** and first torque request on ***Throttle Map*** will make it easier to find the throttle's 0% coasting torque by resting the throttle in this torque dead-band.
8. ***SAVE***

Additional Tips:

A wide band between ***First Point*** and ***Second Point*** will increase control over regen, but this is a trade-off, you must decrease the working throttle band. The First point must be adjusted in conjunction with the Forward & Reverse Throttle Maps as stated above.

Usually, 300mV worth of regen control provides a smooth transition between regen and drive torque, while also allowing the user to have some dynamic control over regen torque with the throttle pedal. As the throttle is released, Regen will ramp up to its max allowable torque. Then as the throttle position increases, the regen torque will decrease linearly before reaching 0% regen. After 0% regen is reached, drive torque initiates based on your throttle mapping. If regen is stopping you too quickly, the analog regen limit allows you to ease the regen torque by slightly increase throttle position, without applying forward torque to stop at the correct distance.

You may be able to access the ***Torque Mode*** tab immediately after saving this change. If so, you can edit the ramp in ***Rate*** of the torque limit by profile, but please **only modify** the ***Neutral Breaking Rate***, and by no more than ***5%*** at a time. **Do not decrease *Deceleration Rate* below *90%/s*. A deceleration rate >*90%/s* will allow a vehicle to stop appropriately after throttle is released. A deceleration rate <*90%/s* will cause a dangerous delay in deceleration.**

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DIGITAL OUTPUTS

The X1 controller can energize the coil of a relay (not included) using its Generic Outputs for up to two of the following functions: Warning Alarm, Brake Lights, Deceleration Lights, Motor and/or Controller Cooling.

WIRING

The Controller's digital output wires should be wired as shown below in Figure 8. A fault condition will occur if a Generic Output is assigned without the wiring to match.

Digital Outputs on Controller			
Pin	**Meaning**	**Pin**	**Meaning**
K1 - 10	+12V Common	**K1 - 31**	Digital Output 2 (Max 2A)
K1 - 30	Digital Output 1 (Max 2A)		

Wiring

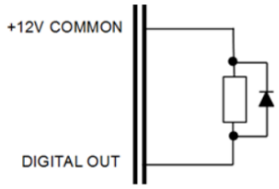

***Figure 15** – Digital Output Wiring*

Figure 7 - Generic Output Wiring

CONFIGURATION

1. On the TAU SmartView DLR Sys home screen, select **Configure - System – Generic Outputs**.
2. Select an Output Function from the drop-down list.

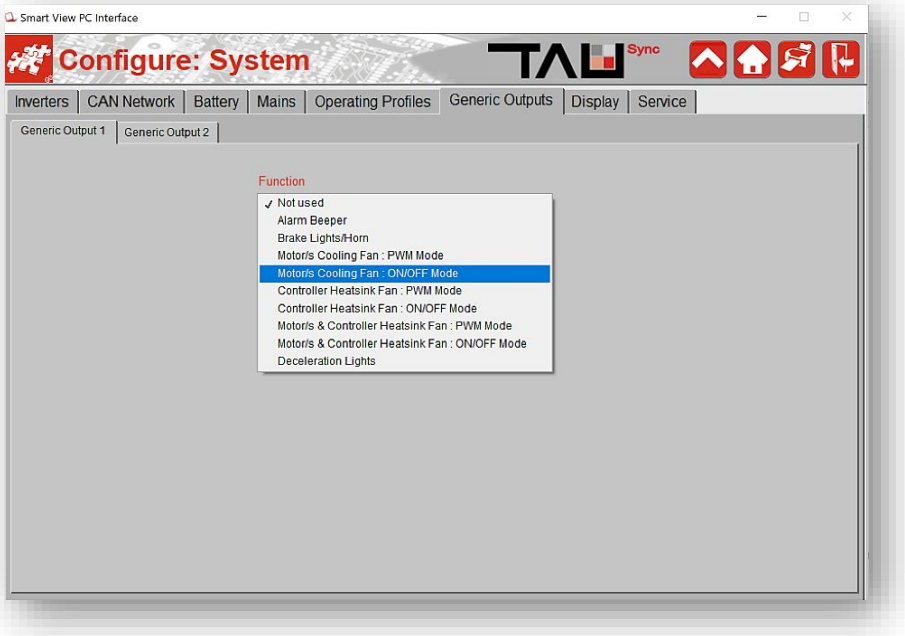

Figure 8 – Generic Outputs

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3. Select Digital Output 1 or 2.
4. *For an Alarm function*: Select at least one Activation Condition – On Active Fault, Low BDI (State of Charge), Reverse, Forward, Controlled Roll Off, Unsafe Parking.
5. *For a Lights/Horn function*: Select the circuit that is related to the indicator you wish to activate. i.e. Assuming our standard Wiring Diagram is used, Reverse lights would use Digital Input 3 [K1-6] as the Activation Switch.
6. *For a PWM Mode function*: Set the PWM Voltage (% of 12V, 50% = 6V) and Duty in milliseconds.
7. *For a Cooling Fan function*, set Activation and Deactivation Temps. This should be tuned to your application and environment, based on the Motor and Controller Temperature Derating specifications.
8. Save. A fault condition will occur if a Generic Output is assigned without the correct wiring to match.

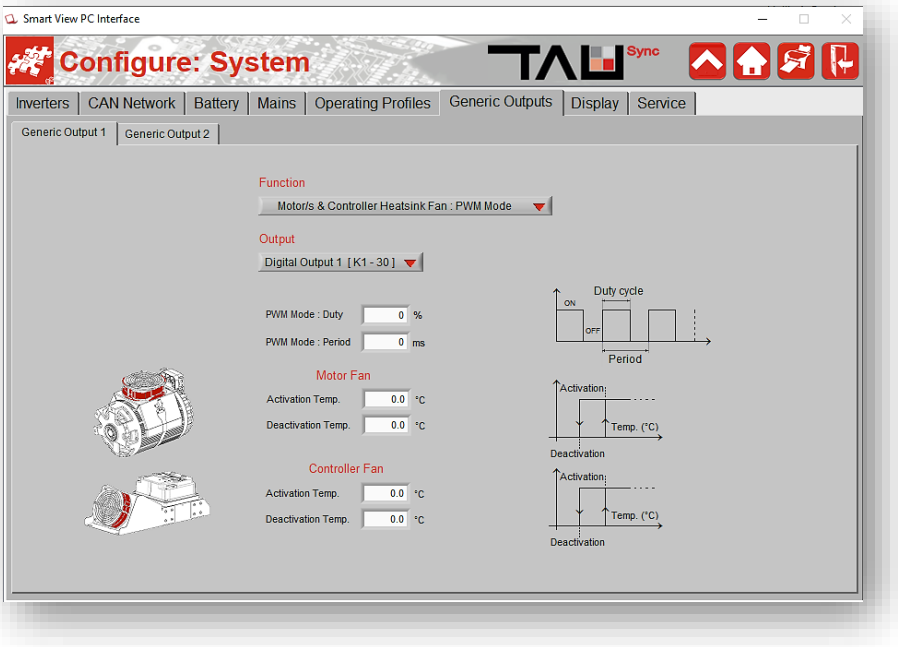

Figure 9 - Motor and Controller Cooling Fan

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TEMPERATURE DERATING – X1 INVERTER

To ensure proper protection from overheating, the controller is programmed to derate power based on heatsink temperature. Additional cooling methods, such as Liquid Cooling, may be required if your controller is overheating under normal operation.

Operating ambient temperature range: -40°C to +55°C

Linear power derating: +80°C (100% current) to +95°C (50% current)

Thermal shut down: +95°C

Suggested Cooling Activation: +55C*

Suggested Cooling Deactivation: +45C*

** Varies by application*

TEMPERATURE DERATING - HYPER MOTOR

The HyPer 9HV Motor contains Permanent Magnets. These magnets are rated up to a temperature of 170°C. To ensure proper protection from overheating the magnets, the controller is programmed to de-rate power based on the motor's temperature.

Operating ambient temperature range: -40°C to +120°C

Linear power derating: +135°C (100% current) to +155°C (30% current)

Thermal Shut Down: +165°C

Suggested Cooling Activation: +110C*

Suggested Cooling Deactivation: +90C*

** Varies by application*

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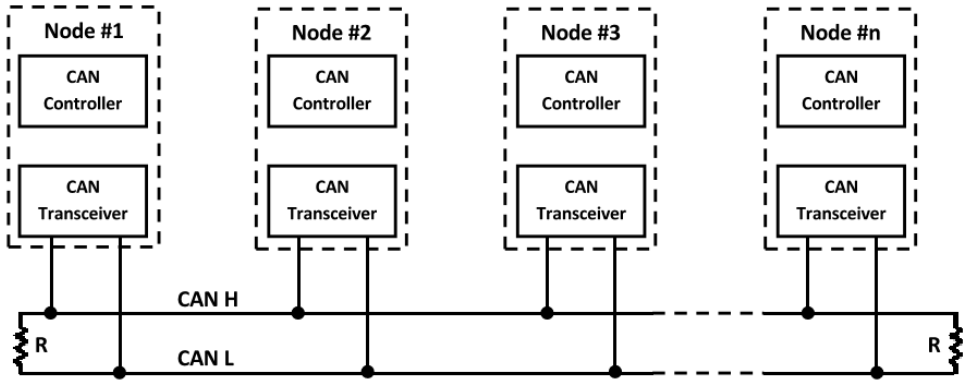
CAN NETWORK CONFIGURATION

WIRING

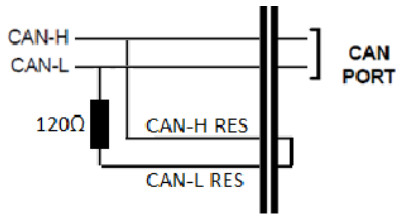
The High-Speed ISO 11898 Standard specifications are given for a maximum signaling rate of 1 Mbps with a bus length of 40m and a maximum of 30 nodes. It also recommends a maximum un-terminated stub length of 0.3m. The cable is specified to be a shielded twisted-pair with a 120Ω characteristics impedance (Z0). The Standard defines a single line of twisted-pair cable with the network topology as shown in the following picture:



In order to adapt the lines to a fixed impedance, the Bus is terminated at both ends with 120Ω resistors, avoiding reflections or other problems that can occur at high frequency of CAN (from 125KBaud to 1Mb). Placing these resistors on a node should be avoided since the bus line loses termination if the node is disconnected from the bus.

X1 ISO and NON-ISO CANBus pin positions are shown below. K1-13 & K1-14 are not populated in the Standard K1 Wire Harness. If your CANBus requires a termination at the inverter, please crimp two spare K1 pins (Included in your Motor Plug Kit) onto each end of a short jumper wire. Insert one end of this jumper wire into position K1-3, and the other end into K1-14.

Serial Pins on Controller			
Pin	**Meaning**	**Pin**	**Meaning**
K1 - 2	CAN - L	**K1 - 13**	CAN - H
K1 - 14	CAN - L RES	**K1 - 3**	CAN - H RES



WARNING: Before starting the system, check that all Nodes are properly connected to CANOpen network to avoid wrong net starting sequence or faults. The Baud Rate of all Nodes in the network must be the same.

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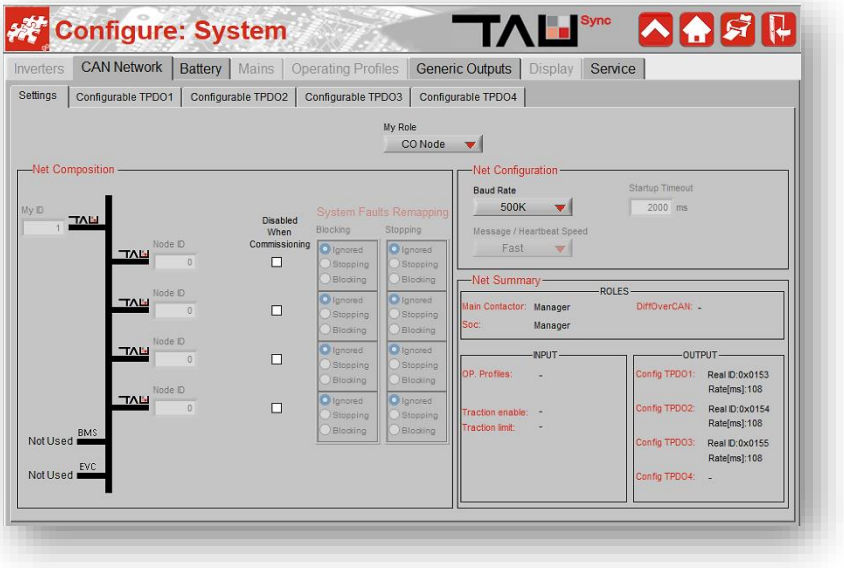
CONFIGURATION – CAN NETWORK SETTINGS

In order to configure any CAN settings in the inverter, you must first enable the CAN Network.



1. Under ***Configure – System – CAN Network***, change ***My Role*** to ***"CO Node".***
2. Click ***Save***. This will enable configuration of CAN settings.
3. Select the ***Baud Rate*** of all other nodes on the Bus.
4. SAVE

All Controllers in the network must send their presence and see each other's before the **Max Network Startup Time** in order to synchronize the CAN Network. Otherwise, a synchro failed fault will be signaled.

CONFIGURATION – TPDO'S

After enabling the CAN Network, you can customize up to four sets of 8-bytes of configurable TPDO, which can be used to send data to third party components like display or PC. The Baud Rate of the network is the same set in Network Configuration.

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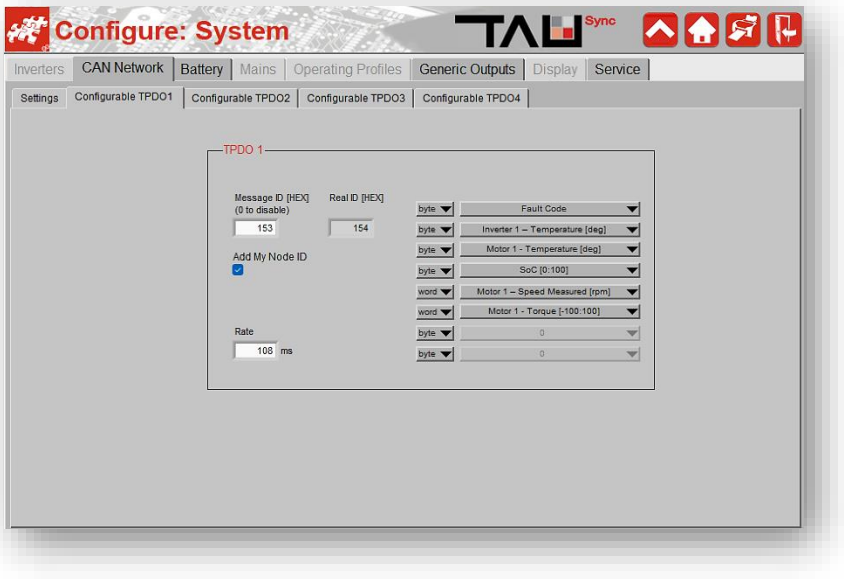

You can freely compose each configurable TPDO by setting three fields:

1. **ID:** The CAN message Identifier Code, You can add the value of the Node ID by checking the box under Message ID. The Message ID must be an HEX value **other than**:
   I. **0x080, 0x100 , 0x180, 0x280, 0x0380, from 0x0580 to 0x67F, 0x700, from 0x77F to higher values**.
   II. If the value is set to 0, the TPDO is disabled.

2. **Rate:** The Rate at which the message is sent. It is expressed in ms and the minimum permitted value is 20ms.

3. **Message:** The message is composed by 8 bytes. A list of available variables classified by size - word or byte can be found on the next page.

In the following example, you can see a real system configuration. In an electrical vehicle you usually need to see: Speed of the vehicle, Battery State of Charge, State of Brakes (available in System Flags), Active Fault Code.

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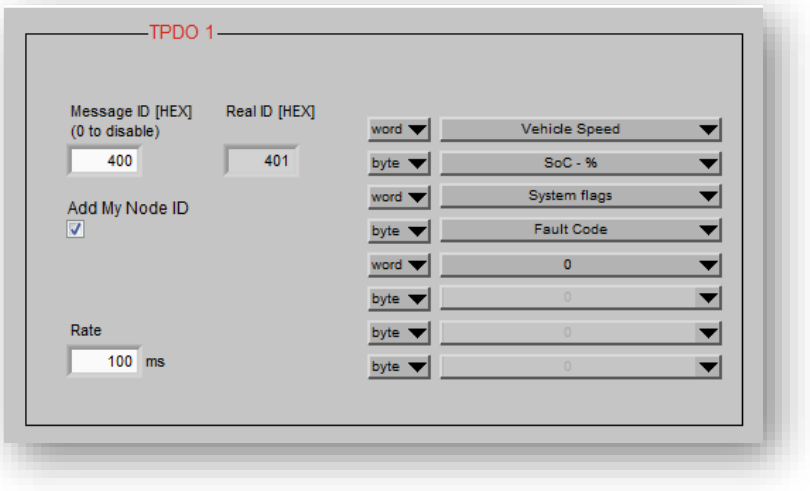
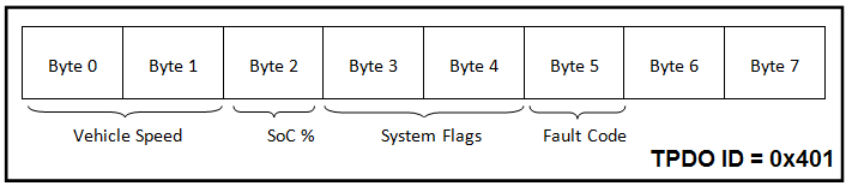


Your display configured to receive messages with the ID and the rate set on "Message ID" and "Rate" tabs, structured as follows:



WORD FORMAT: All words are sent in Little-endian format which reverses the order and stores the least significant byte at the lower memory address with the most significant byte being stored at the highest memory address.

TPDO STRUCTURE

TAU CAN Network provides four types of Data: Empty, Node, Motor, and Inverter. A list of all available TPDO's is shown below.

NODE DATA TYPE:

NAME	SIZE	UNIT	REMARKS	RANGE
Empty Byte	Byte	-	Empty byte introduced in the message	-
Empty Word	Word	-	Empty word introduced in the message	-

NODE DATA TYPE:

NAME	SIZE	UNIT	REMARKS	RANGE
Key Switch Voltage	Word	cV	Controller Supply Voltage	[-32768; +32767] ↔ [-327.68; +327.67]V

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DC Bus Voltage	Word	dV	Internal Capacitors Voltage	[-32768; +32767] ↔ [-3276.8; +3276.7]V
My Node DC Bus Current	Word	dA	Node DC Bus Current, estimated or sniffed from BMS (depending on configuration)	[-32768; +32767] ↔ [-3276.8; +3276.7]A
My Node DC Bus Current Abs	Word	dA	Abs of the Node DC Bus Current, estimated or sniffed from BMS (depending on configuration)	[0; +65535] ↔ [0; +6553.5]A
Vehicle Speed	Word	km/hx10	Vehicle Speed calculated based on the gear and wheel diameter set by user	[-32768; +32767] ↔ [-3276.8; +3276.7]km/h
Vehicle Speed Abs	Word	km/hx10	Vehicle Speed calculated based on the gear and wheel diameter set by user	[0; +65535] ↔ [0; +6553.5]km/h
Vehicle Speed	Word	km/hx16	Vehicle Speed calculated based on the gear and wheel diameter set by user	[-32768; +32767] ↔ [-2048; +2048]km/h
Vehicle Speed Abs	Word	km/hx16	Vehicle Speed calculated based on the gear and wheel diameter set by user	[0; +65535] ↔ [0; 4096]km/h
Vehicle Speed	Word	mphx10	Vehicle Speed calculated based on the gear and wheel diameter set by user	[-32768; +32767] ↔ [-3276.8; +3276.7]mph
Vehicle Speed Abs	Word	mphx10	Vehicle Speed calculated based on the gear and wheel diameter set by user	[0; +65535] ↔ [0; +6553.5]mph
Vehicle Speed	Word	mphx16	Vehicle Speed calculated based on the gear and wheel diameter set by user	[-32768; +32767] ↔ [-2048; +2048]mph
Vehicle Speed Abs	Word	mphx16	Vehicle Speed calculated based on the gear and wheel diameter set by user	[0; +65535] ↔ [0; 4096]mph
Battery SoC	Byte	%	State of Charge	[0; +100] ↔ [0; +100]%
Fault Code	Byte	-	Worst Faul Code active in the controller	[0; +150] ↔ [0; +150]
Fault Level	Byte	-	Worst Faul Level active in the controller	0 = Ready +1 = Blocking +2 = Stopping +3 = Limiting +4 = Warning
System Flags	Word	Bitmask	BIT0 SoC is Low For Traction BIT1 SoC is Low For Hydraulic BIT2 Reverse Direction Active BIT3 Forward Direction Active BIT4 Park Brake Active BIT5 Pedal Brake Active BIT6 Controller is in Overtemperature BIT7 Key Switch Overvoltage BIT8 Key Switch Undervoltage BIT9 Vehicle is Running BIT10 Traction is Enabled	0 = FALSE; 1 = TRUE

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			BIT11 Hydraulic is Enabled BIT12 Powering is Enabled BIT13 Powering is Ready BIT14 Powering is Precharging BIT15 Main Contactor Closing	
System Odometer - HIGH	Word	Dam	Most significant word of System odometer value	-
System Odometer - LOW	Word	Dam	Less significant word of System odometer value	-
System Key On Time	Word	Hour	System lifetime hours	[0; +65535] ↔ [0; +65535]Hour
System Key On Time	Byte	Minute	System lifetime minutes	[0; +255] ↔ [0; +255]Minute
System Key On Time	Byte	Second	System lifetime seconds	[0; +255] ↔ [0; +255]Second
Time To Service	Word	Hour	Remaining hours to maintenance/assistance	[0; +65535] ↔ [0; +65535]Hour
Time To Service	Byte	Minute	Remaining minutes to maintenance/assistance	[0; +255] ↔ [0; +255]Minute
Time To Service	Byte	Second	Remaining seconds to maintenance/assistance	[0; +255] ↔ [0; +255]Second

INVERTER INFORMATION DATA TYPE

NAME	SIZE	UNIT	REMARKS	RANGE
Inverter 1 - Temperature	Byte	°C	Inverter 1 temperature, with an offset of 40°C	[0; +255] ↔ [-40; +215]°C
Inverter 2 - Temperature	Byte	°C	Inverter 2 temperature, with an offset of 40°C	[0; +255] ↔ [-40; +215]°C

MOTOR INFORMATION DATA TYPE

NAME	SIZE	UNIT	REMARKS	RANGE
Motors Flags	Word	Bitmask	BIT0 Active Limitation of Motor1 BIT1 ChannelA of Motor1 Encoder BIT2 ChannelB of Motor1 Encoder BIT3 Motor1 in Overtemperature BIT4 Active Limitation of Motor2 BIT5 ChannelA of Motor2 Encoder BIT6 ChannelB of Motor2 Encoder BIT7 Motor2 in Overtemperature BIT8÷BIT15 Reserved	0 = FALSE; 1 = TRUE
Motor 1 - Temperature	Byte	°C	Motor 1 Temperature (offset of 40°C)	[0; +255] ↔ [-40; +215]°C

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Motor 1 - Throttle Request	Byte	%	Motor 1 Throttle Request	[-128; +127] ↔ [-100; +100]%
Motor 1 - Throttle Request Abs	Byte	%	Motor 1 Throttle Request Abs	[0; +255] ↔ [0; +100]%
Motor 1 - Current	Word	dArms	Motor 1 Phase Current	[-32768; +32767] ↔ [-3276.8; +3276.7]Arms
Motor 1 - Iq Reference	Word	dArms	Motor 1 Iq Reference Current	[-32768; +32767] ↔ [-3276.8; +3276.7]Arms
Motor 1 - Iq Reference Abs	Word	dArms	Motor 1 Iq Abs Reference Current	[0; +65535] ↔ [0; +6553.5]Arms
Motor 1 - Torque	Word	%	Motor 1 Torque	[-32768; +32767] ↔ [-100; +100]%
Motor 1 - Torque Abs	Word	%	Motor 1 Torque Abs	[0; +65535] ↔ [0; +100]%
Motor 1 - Speed Reference	Word	rpm	Motor 1 Speed Reference	[-32768; +32767] ↔ [-32768; +32767]rpm
Motor 1 - Speed Reference Abs	Word	rpm	Motor 1 Speed Reference Abs	[0; +65535] ↔ [0; +65535]rpm
Motor 1 - Speed	Word	rpm	Motor 1 Speed	[-32768; +32767] ↔ [-32768; +32767]rpm
Motor 1 - Speed Abs	Word	rpm	Motor 1 Speed Abs	[0; +65535] ↔ [0; +65535]rpm
Motor 1 - Operating Time	Word	Hour	Motor 1 Operating Time Hours	[0; +65535] ↔ [0; +65535]Hour
Motor 1 - Operating Time	Byte	Minute	Motor 1 Operating Time Minutes	[0; +255] ↔ [0; +255]Minute
Motor 1 - Operating Time	Byte	Second	Motor 1 Operating Time Seconds	[0; +255] ↔ [0; +255]Second

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CONTROLLER SPECIFICATIONS

CONTROLLER COMMUNICATION

- **RS-232**
- **Lin Bus**
- **CAN:**
  - **Protocol:** CAN Open
  - **Physical layer:** ISO11898-2
  - **Baud rates:** 1Mbps, 800kbps, 500kbps, 250kbps, 125kbps, 50kbps

CONTROLLER EMC

- **EN12895** (Industrial Trucks – Electromagnetic Compatibility)

CONTROLLER SAFETY CERTIFICATION

- **EN1175-1** (Safety of Industrial Trucks – Electrical Requirements)

The vehicle Owner takes full responsibility of the regulatory compliance of the vehicle system with the controller installed.

CONTROLLER OPERATING ENVIRONMENT SPECIFICATIONS

- **Storage ambient temperature range:** -40°C to +70°C
- **Operating ambient temperature range:** -40°C to +55°C
- **Heatsink operating temperature range:** -40°C to +95°C
  - **With linear derating:** +80°C to +95°C
- **Protection Level:** IP65
- **Vibration:** Tested under conditions suggested by EN60068-2-6 [5g, 10÷500Hz, 3 axes]
- **Shock & Bump:** Tested under conditions suggested by EN60068-2-27
- **Cold & Heat:** Tested under conditions suggested by EN60068-2-1

Mechanical size: 210 x 160 x 85 [mm] • Weight: 3.5 kg

Switching Frequency: 9 kHz

Internal Pre-charge Capacitance: 4428uF (*ACX1T50000I00 (144x500)*)

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PRE-PROGRAMMED I/O - HYPER-DRIVE INVERTER

SIGNAL: INPUTS AND OUTPUTS

- **Digital Inputs:** 9
- **Analog Inputs:** 5
- **Digital Outputs (ON/OFF):** 2
- **Driver Outputs (PWM):** 4
- **Motor Speed/Position Sensor Inputs:** 2 (A+B Channels/Sin+Cos Analog)

CONTROLLER I/O TABLE

Refer to following table for complete X1 controller I/O capabilities. For a pinout of the wire harness included in your HyPer System, refer to *Figure 2 – Standard Pinout Order Assignment*. The following table lists the controller's pre-programmed capabilities.

K1 PIN FUNCTIONS FOR NON-PROGRAMMED AC-X1

PIN	NAME	I/O	SPECIFICATION	TYPICAL FUNCTION
1	**GND**	I/O Ground	Do not exceed 0.5A	Negative Logic Supply
2	**CAN-L**	CAN BUS	CAN-BUS 1 MBit/s max	CAN L (No internal termination resistor)
3	**CAN-L RES**	CAN BUS	Connected to CAN-L with a series 120Ohm internal resistor	Termination resistor
4	**DIGITAL INPUT 1**	Digital Input	VL<=2V, VH>=4.5V Resistor pull-down(active high) or pull up(active low) ON rated voltage +12V/24V	Any Digital Input Function Main Contactor Interlock / Traction Enable
5	**DIGITAL INPUT 2**	Digital Input	VL<=2V, VH>=4.5V Resistor pull-down(active high) or pull up(active low) ON rated voltage +12V/24V	Any Digital Input Function Motor Forward Rotation
6	**DIGITAL INPUT 3**	Digital Input	VL<=2V, VH>=4.5V Resistor pull-down(active high) or pull up(active low) ON rated voltage +12V/24V	Any Digital Input Function Motor Reverse Rotation
7	**DIGITAL INPUT 4**	Digital Input	VL<=2V, VH>=4.5V Resistor pull-down(active high) or pull up(active low) ON rated voltage +12V/24V	Any Digital Input Function 0% Motor Regen / Clutch Switch
8	**DIGITAL INPUT 5**	Digital Input	VL<=2V, VH>=4.5V Resistor pull-down(active high) or pull up(active low) ON rated voltage +12V/24V	Any Digital Input Function
9	**I/O GROUND**	I/O Ground	Do not exceed 0.5A	Negative Logic Supply
10	**+12V OUT**	Supply Output	12V ±5% 200mA	12V+ Output
11	**ANALOG INPUT 1**	Analog Input	0÷12V 125KΩ pull-down	Any Analog Input Function Throttle Wiper 1 / Analog Regen Limit
12	**I/O GROUND**	I/O Ground	Do not exceed 0.5A	Negative Logic Supply

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13	**CAN H**	CAN BUS	1 MBit/s max	CAN H (No internal termination resistor)
14	**CAN-H RES**	CAN BUS	Connected internally to CAN-H	Connected to CAN-H
15	**LIN**	Com Input/Output	19.2KBit/s 12V 1,1KΩ Pull-up RX: VL<=3.0V dominant, VH>=7.0V recessive	LIN Display Connection
16	**DIGITAL IN 6**	Digital Input	VL<=2V, VH>=4.5V Resistor pull-down(active high) or pull up(active low) ON rated voltage +12V/24V	Any Digital Input Function
17	**ANALOG INPUT 2**	Analog Input	0÷12V 125KΩ pull-down	Any Analog Input Function
18	**DIGITAL IN 7**	Digital Input	VL<=2V ,VH>=4.5V Resistor pull-down(active high) or pull up(active low) ON rated voltage +12V/24V	Any Digital Input Function Profile 2 Active
19	**DIGITAL IN 8**	Digital Input	VL<=2V, VH>=4.5V Resistor pull-down(active high) or pull up(active low) ON rated voltage +12V/24V	Any Digital Input Function Profile 3 Active
20	**DIGITAL IN 9**	Digital Input	VL<=2V, VH>=4.5V Resistor pull-down(active high) or pull up(active low) ON rated voltage +12V/24V	Any Digital Input Function
21	**ENCODER 1A / ENCODER 1 Sin**	Peripheral Input	4V 470Ω pull-up, VL<=1.5V, VH>=3.4V / 0,5 – 4,5 mV input	Quad Encoder Channel A / Sin/Cos Encoder Sin
22	**ANALOG INPUT 3**	Analog Input	0÷12V 125KΩ pull-down	Any Analog Input Function
23	**ANALOG INPUT 4**	Analog Input	0÷12V 125KΩ pull-down	Any Analog Input Function Brake Wiper 1
24	**KEY SWITCH IN**	Supply Input	**ISO**: Max = 28Vdc , Min = 8Vdc **NON-ISO**: Inverter MinVdc, Inverter MaxVdc Supply consumption: logic board 2A max + coil return 8A max	ISO: Positive Supply of the Control Board. NON-ISO: Precharge & Positive Supply of the control section of the Control Board.
25	**COIL RETURN**	Supply Output	(+KEY ±0.3V) Do not exceed 8A	Positive Common of Auxiliary
26	**DRIVER OUTPUT 1**	PWM Output	Active low Internal diode to coil return	Main Contactor, Brake, Valve
27	**DRIVER OUTPUT 2**	PWM Output	Active low Internal diode to coil return	Main Contactor, Brake, Valve
28	**DRIVER OUTPUT 3**	PWM Output	Active low Internal diode to coil return	Main Contactor, Brake, Valve
29	**DRIVER OUTPUT 4**	PWM Output	Active low Internal diode to coil return	Main Contactor, Brake, Valve
30	**DIGITAL OUTPUT 1**	Digital Output	active low No internal diode to coil return	Buzzer-Fan-Deceleration Lights
31	**DIGITAL OUTPUT 2**	Digital Output	active low pull-down No internal diode to coil return	Buzzer-Fan-Deceleration Lights
32	**MOTOR THERMAL PROBE**	Analog Input	1KΩ pull-up	Motor Temperature Probe

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33	**ENCODER 1B / ENCODER 1 Cos**	Peripheral Input	4V 470Ω pull-up, VL<=1.5V, VH>=3.4V / 0,5 – 4,5 mV input	Quad Encoder Channel B / Sin/Cos Encoder Cos
34	**ANALOG INPUT 5**	Analog Input	0÷12V 125KΩ pull-down	Any Analog Input Function
35	**+5V OUT**	Supply Output	5V ±5% 200mA	5V+ Output

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DATALOGGING

HyPer-Drive Controllers offers a Datalogging feature via TAU SmartView software. Your Dealer may request Datalogs for troubleshooting purposes. You may wish to log data for your own interest. All Real-Time Data within the **Monitor** block can be logged at a maximum rate of 200ms (5hz).

DATALOGGING GUIDE:

1. On the TAU SmartView home screen, select **Monitor - Real-Time Data** - Select the Checkbox next to each parameter of interest. Toggle through multiple tabs and select Checkboxes as you go. A list of common troubleshooting parameters is provided in *Figure 11*.

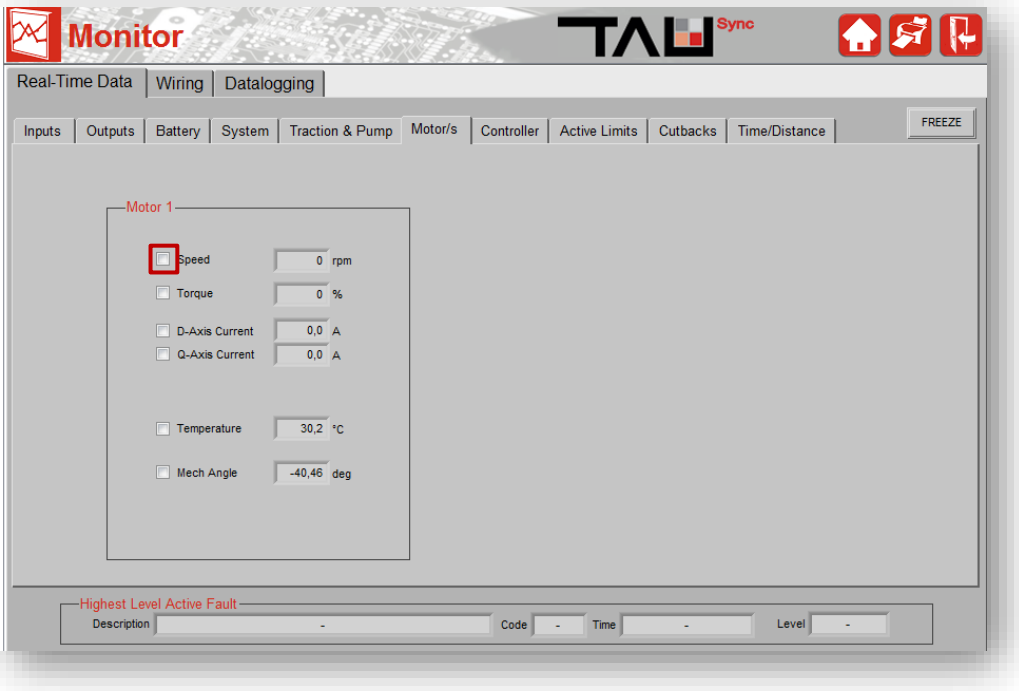

Figure 10 – Checkbox for Datalogging

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1. Once you have selected all parameters of interest, select the **Datalogging** tab.

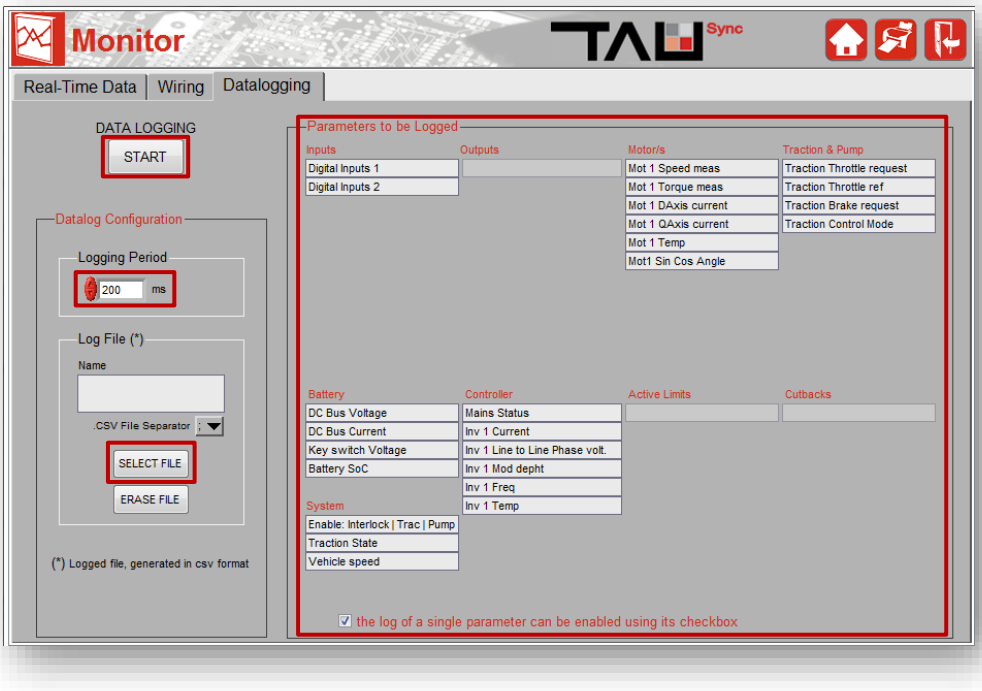

Figure 11 – Monitor - Datalogging Tab

2. Set your preferred "**Logging Period**" - The frequency at which each parameter will be logged.
3. Click "**SELECT FILE**" and choose a filename. It is usually best to include your motor serial#, today's date, and a two-word description of the reason for this Datalog.
4. Once you are prepared to record your datalog, click "**START**"
5. Begin your test run. Once testing is complete, click "**STOP**"
6. Datalog will be saved in .csv spreadsheet format. By default, it is usually saved on your computer's C: drive - Program files (x86) – SmartView - LogFiles.

Your Logfile can be viewed using a spreadsheet software. The opensource software "LibreOffice" is an option that opens the logfile in proper format. You can also attach this file in an E-mail addressed to the party whom it was requested by.

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TROUBLESHOOTING - DIAGNOSTIC CODES

The inverter may indicate Fault Codes ranging from al no.1 to al no.107. All inverter's have a physical LED or "Status" light near the B- and B+ terminals. When "Status" is Green, the inverter is Ready with no active faults. Any fault condition will illuminate the Red Status LED. If the system shuts down for an unknown reason, verify the color of your Status LED. If Status LED is off, the logic board does not have power.

If the controller is in a fault condition, the Diagnostic Code can be retrieved through your Compact Display, CANBUS Communication, or through any version of the TAU SmartView Software. A list of each code and its level is provided below. **For further information on these codes, please refer to the corresponding Fault # in the Fault Code List for troubleshooting steps.** This list is also available in TAU SmartView's Help section. While viewing active faults in SmartView's *Diagnose* block, click the in the lower right corner of the application to bring up the Help file's fault list.

- **Level:** Working conditions are indicated by different alarm levels, classified as follows, depending on their effects on the system:

FAULT LEVELS

LEVEL	PRIORITY	ACTION	ICON
Blocking	1 (HIGHEST)	• **Main Contactor:** Opened • **Motors:** Disabled • **Outputs:** Disabled	
Stopping	2	• **Main Contactor:** Closed • **Motors:** Stopped • **Outputs:** Enabled	
Limiting	3	• **Main Contactor:** Closed • **Motors:** Limited • **Outputs:** Enabled	
Warning	4 (LOWEST)	• **Main Contactor:** Closed • **Motors:** Enabled • **Outputs:** Enabled	
Ready	No Faults	• **Main Contactor:** Closed • **Motors:** Enabled • **Outputs:** Enabled	

FAULT CODE LIST

#	FAULT	DESCRIPTION	LEVEL
1	**Over Voltage**	**Symptom:** Key-Switch Voltage or Capacitors Voltage is above the maximum level allowed for the Controller. This value is obtained by hardware comparator and is not configurable.	Blocking

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		Possible causes: 1. Bad Battery wiring. 2. Battery resistance too high while regenerating. 3. Battery disconnected while regenerating. **Troubleshooting:** 1. Check if there's an incorrect wiring to Battery positive or negative terminals. 2. This alarm can be caused by the presence of regeneration currents; when your vehicle/application is on release or reverse braking rate, the Motors work as generators so Battery Voltage can exceed Over Voltage Limit. In that case, the Battery condition should be verified (if the battery is new, you need to do some charge-discharge cycles before reaching the rating declared by the manufacturer). If the Battery has a high internal resistance and it is not possible to change it, the solution may be to reduce the Braking and Reverse Rate. 3. Replace the Controller.	
2	**Under Voltage**	**Symptom:** Key-Switch Voltage or Capacitors Voltage is below the minimum level allowed for the Controller. This value is obtained by a hardware comparator and it's not configurable. **Possible causes:** 1. Bad Battery wiring. 2. Battery seriously damaged or exhausted. 3. Battery resistance too high. 4. Battery disconnected while driving. 5. Blown key-switch fuse. 6. External load drains power from Battery. **Test:** 1. Check for incorrect wiring to HV Battery. Commonly caused by loose/corroded terminals in the High Voltage circuit. 2. Verify condition of main fuse by measuring resistance across the fuse. 3. Verify Battery conditions: if the electrolyte inside is partially exhausted, an Under Voltage fault can sometimes be detected from the Controller; even in case of low Battery charge (<10%), high Acceleration Rate (i.e. both pump and drive motors working in full load conditions) could cause Battery Voltage exceed Under Voltage Limit. 4. Replace the Controller.	Blocking
3	**User Over Voltage**	**Symptom:** Key-Switch Voltage is above the maximum level defined by the user via related parameter. **Possible causes:** 1. Battery resistance too high while regenerating. 2. Battery disconnected while regenerating. 3. Too low Over Voltage Limit defined by the user. **Test:**	Blocking

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		1. Check if there's an incorrect wiring to Battery positive or negative terminals. 2. This alarm can be caused by the presence of regeneration currents; when your vehicle/application is on release or reverse braking ramp, the motors work as generators so Battery Voltage can exceed User Over Voltage Limit. In a case like that, the Battery condition should be verified (if the Battery is new you need to do some charge-discharge cycles before reaching the rating declared by the manufacturer). If the Battery has a high internal resistance and it is not possible to change it, the solution may be to reduce the Braking and Reverse Rate. 3. Verify the User Over Voltage Limit . 4. Replace the Controller.	
4	**User Under Voltage**	**Symptom:** Key-Switch Voltage is below the minimum level defined by the user via related parameter. **Possible causes:** 1. Battery seriously damaged or exhausted. 2. Battery resistance too high. 3. Battery disconnected while driving. 4. Blown key-switch fuse. 5. External load drains power from Battery 6. Too high voltage level defined by the user. **Test:** 1. Check if there's an incorrect wiring to Battery, or corroded positive or negative terminals. 2. Verify Battery conditions: if the electrolyte inside is partially exhausted, an User Under Voltage fault can sometimes be detected from the Controller; even in case of low battery charge (<10%), high Acceleration Rate (i.e. both pump and drive motors working in full load conditions) could cause Battery Voltage exceed User Under Voltage Limit. 3. Verify the User Under Voltage Limit. 4. Replace the Controller.	Blocking
5	**Inverter 1 Over Current**	**Symptom:** Inverter 1 phase current exceeded its current limit. This is not a configurable parameter. **Possible causes:** 1. External or internal short-circuit between U1, V1 or W1 phases. Can be caused by internal water damage. 2. Wrong Motor 1 Parameter/s. 3. Wrong Motor 1 Current Limit Map. 4. Inverter 1 power module damaged. **Test:** 1. Check if there's an incorrect wiring to Motor 1 phases. 2. Verify Motor Parameters. 3. Verify Motor Current Limit Map.	Blocking

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		4. Replace the Controller.	
6	Inverter 2 Over Current	**Symptom:** Inverter 2 phase current exceeded its current limit. This is not a configurable parameter. **Possible causes:** 1. External or internal short-circuit between U2, V2 or W2 AC motor's phases. 2. Wrong Motor 2 Parameter/s. 3. Wrong Motor 2 Current Limit Map. 4. Inverter 2 power module damaged. **Test:** 1. Check if there's an incorrect wiring to motor 2 phases. 2. Verify Motor Parameters. 3. Verify Motor Current Limit Map. 4. Replace the Controller.	Blocking
7	Not Assigned	-	-
8	Inverter 1 Over Temperature	**Symptom:** Inverter 1 power module temperature is above +100°C. **Possible causes:** 1. Operation in high temp environment. 2. Operation with high load. 3. Wrong installation of the controller heat sink. 4. Wrong working of controller cooling system. **Test:** 1. Verify if your environment temperature is within the working range. 2. Verify if your Controller is correctly sized for your load requests. 3. The alarm might be caused by an ineffective heating dissipation; verify the thermal coupling between the aluminum plate of Controller and your system ballast (or the correct functioning of the fan if a fin-tinned heatsink is used and if the heatsink is clean). The presence of the correct amount of thermal grease in the coupling is essential to ensure a correct heat exchange. 4. If the measured Inverter 1 temperature is slightly different from the effective Inverter 1 temperature, replace the Controller.	Blocking
9	Inverter 2 Over Temperature	Inverter 2 power module temperature is above +100°C. See AL8	Blocking
10	Inverter 1 High Temperature	**Symptom:** Inverter 1 power module temperature is above +80°C. **Possible causes:** 1. Operation in high temp environment. 2. Operation with high load. 3. Wrong Installation of the Controller heat sink. 4. Wrong working of Controller cooling system. **Test:**	Limiting

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		1. Verify if your environment temperature is within the working range. 2. Verify if your Controller is correctly sized for your load requests. 3. The alarm might be caused by an ineffective heating dissipation; verify the thermal coupling between the aluminum plate of Controller and your system ballast (or the correct functioning of the fan if a fin-tinned heatsink is used and if the heatsink is clean). The presence of the correct amount of thermal grease in the coupling is essential to ensure a correct heat exchange. 4. If the measured Inverter 1 temperature is slightly different from the effective Inverter 1 temperature, replace the Controller.	
11	**Inverter 2 High Temperature**	Inverter 2 power module temperature is above +80°C. See AL10	Limiting
12	**Inverter 1 Under Temperature**	**Symptom:** Inverter 1 power module temperature is below -40°C. **Possible causes:** Operation in low temp environment. **Test:** 1. Verify your environment temperature and bring the Inverter 1 temperature in the allowed working range. 2. Replace the Controller.	Blocking
13	**Inverter 2 Under Temperature**	Inverter 2 power module temperature is below -40°C. See AL12	Blocking
14	**Inverter 1 Current Sensor Fault**	**Symptom:** Current sensor of Inverter 1 measures an invalid offset at key on. **Possible causes:** 1. Leakage current due to Motor 1 stator short-circuit. 2. Controller's sensor faulty. **Test:** 1. Disconnect the Motor 1 from your Controller and cycle Key-Switch. If this fault no longer occurs it was due to a leakage current. 2. Replace the Controller.	Blocking
15	**Inverter 2 Current Sensor Fault**	Current sensor of Inverter 2 measures an invalid offset at key on. See AL14	Blocking
16	**Not Assigned**	-	-
17	**Inverter 1 Temp Sensor Fault**	**Symptom:** Difference between Inverter 1 and microprocessor temperature greater than 70°C. **Possible causes:** Inverter 1 internal temperature sensor is not connected or short-circuited. **Test:** If the Controller detects such a fault, replace it.	Stopping
18	**Inverter 2 Temp Sensor Fault**	Difference between Inverter 2 and microprocessor temperature greater than 70°C. See AL17	Stopping

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19	**Motor 1 Over Temperature**	**Symptom:** Motor 1 temperature is above the Motor 1 Over Temperature defined by the Motor Protection setting. Or, Motor Thermistor is disconnected. **Possible causes:** 1. Motor 1 temperature is too high. 2. Wrong Motor 1 thermal probe type or input. 3. Motor 1 thermal probe is not connected or its input is short-circuited. **Test:** Presence of fault with **hot motor**: 1. Verify the Over Temperature parameter set. 2. If the temperature value seems correct, verify if the Motor stator case are clean. 3. Choose a lower duty cycle for your operations. Presence of fault with **cold motor**: 1. Verify the Thermal Probe Type set. 2. With a handheld multimeter you have to measure the impedance between the two wires of the thermal probe (perform the measurement at standard ambient temperature). If the measure is different from the standard impedance shown in the thermal probe datasheet, you need to replace it. 3. Disconnect the thermal probe and check wiring insulation between signal and ground wire. 4. Replace the Controller.	Stopping
20	**Motor 2 Over Temperature**	Motor 2 temperature is above the Motor 2 Over Temperature defined by the user via related parameter. See AL19	Stopping
21	**Motor 1 High Temperature**	**Symptom:** Motor 1 temperature is above the motor Start Cutback Temperature defined by the Motor Protection Map. **Possible causes:** 1. Motor 1 temperature is too high. 2. Wrong Motor 1 thermal probe type or input. 3. Motor 1 thermal probe not connected or short-circuited input. **Test:** Presence of fault with **hot motor**: 1. Verify the Starting Cutback parameter set. 2. If the temperature value seems correct, verify if the Motor stator case are clean. 3. Choose a lower duty cycle for your operations. Presence of fault with **cold motor**: 1. Verify the Thermal Probe Type set. 2. With a handheld multimeter you have to measure the impedance between the two wires of the thermal probe (perform the measurement at standard ambient temperature). If the measure is different from the	Limiting

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		standard impedance shown in the thermal probe datasheet, you need to replace it. 3. Disconnect the thermal probe and check wiring insulation between signal and ground wire. 4. Replace the Controller.	
22	**Motor 2 High Temperature**	Motor 2 temperature is above the motor Start Cutback Temperature defined by the user via related parameter. See AL21	Limiting
23	**Motor 1 Temp Sensor Fault**	**Symptom:** Motor 1 temperature sensor value is out of permitted range. **Possible causes:** Motor 1 temperature sensor reads a not permitted value. **Test:** 1. With a handheld multimeter you have to measure the impedance between the two wires of the thermal probe (execute the measure at standard ambient temperature). If the measure is different from the standard impedance shown in the thermal probe datasheet, you need to replace it. 2. Disconnect the thermal probe and check wiring insulation between signal and ground wires	Limiting
24	**Motor 2 Temp Sensor Fault**	Motor 2 temperature sensor value is out of permitted range. See AL23	Limiting
25	**High Voltage**	**Symptom:** DC Bus Capacitor Voltage is above the Controller Starting Cutback Voltage defined by the user via related parameter. This fault can be expected if battery is at high SoC, it is an alert that regen current is limited due to high battery voltage. **Possible causes of unexpected occurrence:** 1. Battery resistance too high while regenerating. 2. Battery disconnected while regenerating. 3. Too low Starting Cutback Voltage Limit defined by the Battery Protection Map. **Test:** 1. Check if there's an incorrect wiring to Battery positive or negative terminals. 2. This alarm can be caused by the presence of regeneration currents; when your vehicle/application is on release or reverse braking ramp, the motors work as generators so Battery Voltage can exceed User Over Voltage Limit. In a case like that, the Battery condition should be verified (if the Battery is new you need to do some charge-discharge cycles before reaching the rating declared by the manufacturer). If the Battery has a high internal resistance and it is not possible to change it, the solution may be to reduce the Braking and Reverse Rate. 3. Verify the Controller Starting Cutback Voltage . 4. Replace the Controller.	Limiting

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26	**Low Voltage**	**Symptom:** DC Bus Capacitor Voltage is below the Controller Starting Cutback Voltage defined by the Battery Protection Map. This fault can be expected if battery is at low SoC, it is an alert that drive current is limited due to low battery voltage. **Possible causes of unexpected occurrence:** 1. Bad Battery wiring. 2. Battery seriously damaged or exhausted. 3. Battery resistance too high. 4. Battery disconnected while driving. 5. Blown Main fuse or key-switch fuse. 6. External load drains power from Battery. **Test:** 1. Verify Battery conditions: check if the internal electrolyte is partially exhausted. Even in case of low Battery charge (<10%), high Acceleration Rate (i.e., both pump and drive motors working in full load conditions) could cause Battery Voltage quickly decrease. 2. Verify the Controller Starting Cutback Voltage . 3. Replace the Controller.	Limiting
27	**Microprocessor Over Temperature**	**Symptom:** Microprocessor temperature is above 125°C. **Possible causes:** 1. Operation in high temp environment. 2. Operation with high load. 3. Wrong installation of the controller heat sink. 4. Wrong working of controller cooling system. 5. Microprocessor faulty. 6. Microprocessor temperature sensor faulty. **Test:** 1. Verify if your environment temperature is within the working range. 2. Verify if your Controller is correctly sized for your load requests. 3. The alarm might be caused by an ineffective heating dissipation; verify the thermal coupling between the aluminum plate of Controller and your system ballast (or the correct functioning of the fan if a fin-tinned heatsink is used and if the heatsink is clean). The presence of the correct amount of thermal grease in the coupling is essential to ensure a correct heat exchange. 4. Replace the Controller.	Blocking
28	**+5V Supply Failure**	**Symptom:** +5V supply is outside the +5V ± 10% range. **Possible causes:** 1. External load impedance on +5V output is too low. 2. +5V output damage caused by short with external voltage source. **Test:**	Blocking

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		1. Verify if the 5V output is in short circuit because of an incorrect encoder wiring. If so, correct the wiring. 2. Verify if the 5V output is in short circuit because the combined current of the devices applied to 5V exceeds the maximum current available indicated in the Controller User Manual. In that case, find and replace the defective device. 3. If a voltage out of allowed range is present on the terminal when all the loads are removed, replace the Controller.	
29	**+12V Supply Failure**	**Symptom:** +12V supply is outside the +12V ± 10% range. **Possible causes:** 1. External load impedance on. 2. +12V output damage caused by short with external voltage source. **Test:** 1. Verify if the 12V output is in short circuit because of an incorrect wiring. If so, correct the wiring. 2. Verify if the 12V output is in short circuit because the combined current of the devices applied to 12V exceeds the maximum current available indicated in the Controller User Manual. In that case, find and replace the defective device. 3. If a voltage out of allowed range is present on the terminal when all the loads are removed, replace the Controller.	Blocking
30	**Encoder 1 Fault**	**Symptom:** Sin/Cos inputs values are above/below the fault thresholds or spin sensor offset is not right. **Possible causes:** 1. Motor 1 encoder faulty wirings 2. Motor 1 encoder failure. 3. Motor 1 speed changes too quickly. 4. Electromagnetic noise on the Motor 1 sensor bearing. 5. Spin sensor offset is wrong. **Test:** 1. Check if the encoder 1 is correctly connected to the motor 1 itself, the 5-12V supply, GND, Sine and Cosine channels. 2. Make a cross-check of encoder 1 working conditions using SmartView. In Monitor – Realtime Data- Inputs. Verify the encoder sin/cos inputs change when rotating the Motor. If not, check the connections and measure sin/cos voltages. If the encoder 1 is correctly wired and supplied, but the sine/cosine don't change, replace the encoder 1. 3. Verify spin sensor mounting and repeat the **spin sensor commission** procedure. 4. If the wirings and signal are correct but diagnosis is not, replace the Controller.	Blocking
31	**Encoder 2 Fault**	Sin/Cos inputs values are above/below the fault thresholds. See AL30	Blocking

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32	**Driver Output 1 Open/Short**	**Symptom:** Driver Output 1 is either opened or short-circuited. **Possible causes:** 1. Drive Output wired to an internally economized contactor. 2. Open or short-circuit of Driver Output 1 load. 3. Driver Output 1 damaged. In this case, Driver Output 2, 3, or 4 can be assigned and wired in place of Driver Output 1. **Test:** 1. Verify Part# of Main Contactor. 2. If the Controller detects such a fault after the Key-Switch on, verify the wiring of the Driver Output 1.	Blocking
33	**Driver Output 2 Open/Short**	**Symptom:** Driver Output 2 is either opened or short-circuited. **Possible causes:** 1. Incorrect Clone file. Our default clones will not trigger this fault, as Driver Output 1 is the only Driver assigned. 2. Open or short-circuit of Driver Output 2 load. 3. Driver Output 2 damaged. **Test:** 1. Download and Install NetGain Clone for your Motor & X1 Inverter. 2. If the Controller detects such a fault after the Key-Switch on, verify the wiring of the Driver Output 2.	Blocking
34	**Driver Output 3 Open/Short**	Driver Output 3 is either opened or short-circuited. See AL33	Blocking
35	**Digital Output 1 Open/Short**	**Symptom:** Digital Output 1 is either opened or short-circuited. **Possible causes:** 1. Digital Output 1 has been assigned in Clone but not wired correctly. 2. Open or short-circuit of Digital Output 1 load. 3. Digital Output 1 damaged. **Test:** 1. If the Controller detects such a fault after the Key-Switch on, verify the wiring of the Digital Output 1.	Blocking
36	**Digital Output 2 Open/Short**	Digital Output 2 is either opened or short-circuited. See AL35	Blocking
37	**EEPROM Failure**	**Symptom:** Error during read/write operation in EEPROM memory. **Possible causes:** 1. Failure to read/write EEPROM memory. **Test:** 1. Load default values for EEPROM variables with SmartView, using the button "Restore Factory Settings" in Manage\Restore. 2. If this fault remains after 2 or more default restoring, replace the Controller.	Blocking

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38	**EEPROM Corrupted**	**Symptom:** Memory CRC doesn't match. **Possible causes:** 1. Wrong firmware version or parameters. **Test:** 1. Load default values for EEPROM variables with SmartView, using the button "Restore Factory Settings" in Manage\Restore. 2. Load the correct firmware for your application with SmartView. 3. If this fault remains after 2 or more default restoring, replace the Controller.	Blocking
39	**Driver Output 4 Open/Short**	Driver Output 4 is either opened or short-circuited. See AL33	Blocking
40	**Precharge Circuit Fault**	**Symptom:** Pre-charge of internal line capacitors is too fast or Capacitors Voltage is fixed to zero during Precharge. **Possible causes:** 1. Open Circuit or High Resistance in HV circuit. 2. Pre-charge circuit faulty. 3. Short on capacitors between +B and -B. 4. Power module short-circuit. **Test:** 1. Check all high voltage connectors and terminations in series with B+ & B-. 2. Check if the Main Contactor is closed even if the key is off. If so, replace the main contactor. 3. With SmartView, if: a. The coil is supplied simultaneously with the switch-on of the key (not delayed of 0,5-1s). b. The measurement with a tester shows an inverter voltage slightly different from the data visualized in Monitor. c. The inverter voltage remains at low voltage after 2s from on. 4. Replace the Controller.	Blocking
41	**Precharge Failed**	**Symptom:** Pre-charge phase fails to charge capacitors till the voltage level of key input. **Possible causes:** 1. Open Circuit or High Resistance in HV circuit. 2. External load in parallel with Inverter's capacitors. 3. Pre-charge circuit faulty. **Test:** 1. Check all high voltage connectors and terminations in series with B+ & B- 2. Verify that there's no external load in parallel with Precharge (K1-24 or B+ Precharge) & B-.	Blocking

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42	**Main Contactor Welded**	**Symptom:** Before closing the line contactor, internal capacitors are loaded for short time and voltage doesn't go down. **Possible causes:** 1. Line contactor contacts are welded in closed position. 2. Motor phases are not connected. 3. An external wiring is providing voltage to capacitors. **Test:** 1. Verify the good condition of your Main Contactor. 2. Connect Motor phases. 3. Verify if none of external wiring is providing voltage to the capacitors.	Blocking
43	**Main Contactor Did Not Close**	**Symptom:** The difference between Key-Switch and capacitors voltage is too high after the contactor has been powered. **Possible causes:** 1. Main Contactor did not close after contactor's coil has been powered. 2. Main Contactor coils are not connected. Or Main Contactor is Internally Economized. 3. +B fuse is blown. 4. Open Circuit or High Resistance in HV circuit. 5. A contactor in series with inverter Main Contactor is open. **Test:** 1. Verify the Part#, condition, and the correct wiring of your Main Contactor. 2. Check the status of the +B fuse. 3. Check all high voltage connectors, contactors, and terminations in series with B+ & B-	Blocking
44	**Interlock Disabled**	**Symptom:** Interlock input is not active and line contactor is open. **Possible causes:** 1. Interlock input is not active. 2. Incorrect Clone file. **Test:** 1. Verify the status of the digital input that you want to define as your Interlock Input and the correct wiring to the Controller. 2. With SmartView, in Monitor verify proper operation of the digital input associated to the Interlock input.	Stopping
45	**Static Return to Off Traction**	**Symptom:** One or more traction inputs are active at the key on, after an Emergency stop or a controlled stop procedure. **Possible causes:** 1. Incorrect Clone file. Can be configured, though default clones disable “Static Return to Off for Traction”. 2. Traction Throttle, Traction Inhibit or Direction Selector are active: a. At key on.	Warning

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		b. When the Traction Enable goes down. c. After the Emergency Reverse. d. After a controlled stop procedure. **Test:** 1. Verify correct clone file is installed. 2. Verify that, at key on, the Traction Throttle is not activated. 3. Verify that, at key on, the Traction Inhibit and the Direction Selector are not active. You can do that with SmartView in Monitor.	
46	**Static Return to Off Hydraulic**	**Symptom:** One or more Hydraulic/Pump inputs are active at the key on after a controlled stop procedure. **Possible causes:** 1. Hydraulic/Pump Throttle, Hydraulic/Pump Inhibit or Auxiliary Input are active at key on, when the Pump Enable goes down after a controlled stop procedure. **Test:** 2. Verify that, at key on, the Hydraulic/Pump Throttle is not activated. 3. Verify that, at key on, the Hydraulic/Pump Inhibit and the Auxiliary Input are not active. You can do that with SmartView in Monitor.	Warning
47	**Traction Throttle Fault**	**Symptom:** A fault condition of Traction Throttle is detected. **Possible causes:** 1. The voltage measured in the Traction Throttle circuit exceeds the calibration range values or if it doesn't, Traction Throttle voltage is within the working range when Inhibit Input isn't active. 2. Throttle Short or Open Circuit. 3. Throttle wired with reversed polarity. **Test:** 1. Verify if the potentiometer voltage is in the range of the calibration values and outside the wiper fault check that are set in SmartView OEM Version. If the potentiometer voltage is outside the correct calibration values check the wiring and the potentiometer output voltage. 2. Verify that the Inhibit Input goes high after before the first point of the Throttle Map . 3. In case of a correct wiring but incorrect output voltage, replace the potentiometer itself. 4. If the potentiometer output voltage is correct, the terminals of the connector are correctly wired to their correspondent inputs in potentiometer circuit but the measured value shown by the display is incorrect, replace the Controller.	Stopping
48	**Hydraulic Throttle Fault**	**Symptom:** A fault condition of hydraulic/pump throttle is detected. **Possible causes:**	Stopping

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		1. The voltage measured in the Hydraulic/Pump throttle circuit exceeds the calibration range values or if it doesn't, Hydraulic/Pump throttle voltage is within the working range when Inhibit Input isn't active. **Test:** 1. Verify if the potentiometer voltage is in the range of the calibration values and outside the wiper fault check. If not, configure your throttle with SmartView. If the potentiometer voltage is outside the right calibration values check the wirings and the potentiometer output voltage. 2. Verify that the Inhibit Input goes high after before the first point of the Throttle Map . 3. In case of a correct wiring but incorrect output voltage, replace the potentiometer itself. 4. If the potentiometer output voltage is correct, the terminals of the connector are correctly wired to their correspondent inputs in potentiometer circuit but the measured value shown by the display is incorrect, replace the Controller.	
49	**Brake Throttle Fault**	**Symptom:** A fault condition of Brake Throttle is detected. **Possible causes:** 1. The voltage measured in the Brake Throttle circuit exceeds the calibration range values or active Brake Throttle voltage is present when inhibit is open. **Test:** 1. Verify if the potentiometer voltage is in the range of the calibration values and outside the wiper fault check. If not, configure your Brake with SmartView. If the potentiometer voltage is outside the right calibration values check the wirings and the potentiometer output voltage. 2. In case of a correct wiring but incorrect output voltage, replace the potentiometer itself. 3. If the potentiometer output voltage is correct, the terminals of the connector are correctly wired to their correspondent inputs in potentiometer circuit but the measured value shown by the display is incorrect, replace the Controller.	Stopping
50	**Service Time Expired**	**Symptom:** Service timer has expired. **Possible causes:** 1. Service interval time has expired. **Test:** 1. With SmartView, reset the service timer in Monitor/Real-Time Data/Time-Distance.	Warning
51	**Low Battery State of Charge**	**Symptom:** Battery State of Charge estimated is lower than minimum value defined by the user via related parameter. **Possible causes:**	Limiting

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		1. Wrong Battery Parameters. 2. Battery State of Charge drops below the setting parameters. **Test:** 1. Verify Battery Parameters. 2. Check the battery level indication; if its value is below the BDI Low Reset Threshold, recharge the battery and check it. 3. If the battery is recharged and its voltage is ok but the display shows a discharge value, check with the tester the battery voltage; if it is different from the value reported on COMPACT display or on SmartView in Monitor , call service to trim again the battery measure.	
52	**Wrong Parameter**	**Symptom:** Parameter setting is out of the permitted range. **Possible causes:** 1. Wrong value of a parameter setting is entered. 2. Commonly seen after changes to Battery Protection/Mapping. See related pages in this manual. **Test:** 1. With SmartView in **Diagnose**: you can see which parameters are out of range. Adjust or revert them, SAVE, then cycle key switch. 2. Revert any recent parameter changes, or load original clone file and re-commission Spin Sensor.	Blocking
53	**Restart Required**	**Symptom:** Changed a parameter setting. This is normal to see after parameter changes are saved. **Possible causes:** 1. A parameter setting is changed and you need to restart the controller (Key off-on) for it to become effective. **Test:** 1. If the Controller detects such a fault, you only have to cycle the key switch once in order to make all of your adjustments effective. You can physically cycle the key, or click the flashing key button in the lower right corner of SmartView.	Blocking
54	**Can Bus Off**	**Symptom:** Bus off condition detected. **Possible causes:** 1. Short between L, H channels or H channel and GND of CAN driver. 2. Wrong cable wirings. 3. Wrong baud rate configuration of one node. **Test:** 1. Check the CAN wiring of all network nodes and the presence of two resistors of 120Ω connected to CAN H and CAN L wires, one at each end of the CAN wiring. If wired correctly, an impedance measurement at any point between CAN H and CAN L should read 60Ω. 2. Check if all network nodes are correctly powered up. 3. Verify that all network nodes have the same baud rate configuration.	Stopping

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55	**Can Open Circuit**	**Symptom:** Messages no longer received. **Possible causes:** 1. H or/and L channel not connected. 2. Wrong cable wirings. 3. All other nodes of the net not powered up. **Test:** 1. Check the CAN wiring of all the network nodes and the presence of two resistors of 120Ω connected to CAN H and CAN L wires, one at each end of the CAN wiring. If wired correctly, an impedance measurement at any point between CAN H and CAN L should read 60Ω. 2. Check if all network nodes are correctly powered up.	Stopping
56	**Can Bad Wiring or Short Circuit**	**Symptom**: Can bus synchronization phase failed or bus off condition detected. **Possible causes:** 1. Wrong cable wirings. 2. Wrong baud rate configuration of one node. 3. Short between L, H channels or H channel and GND of CAN driver. **Test:** 1. Check the CAN wiring of all network nodes and the presence of two resistors of 120Ω connected to CAN H and CAN L wires at the beginning and at the end of the CAN wiring in order to adapt the lines to a fixed impedance. If wired correctly, an impedance measurement at any point between CAN H and CAN L should read 60Ω. 2. Check if all network nodes are correctly powered up. 3. Verify with SmartView if all network nodes have the same baud rate configuration.	Blocking
62	**Net Timeout Heartbeat**	**Symptom:** At least one Heartbeat hasn't been received during the startup of the network or after the synchronization phase. **Possible causes:** 1. Temporary loss of communication. **Test:** 1. Check if all network nodes are correctly powered up, even after synchronization phase. 2. Verify to have the same Max Network Startup Time in all nodes of your network.	Stopping
63	**Net RPDO Timeout**	**Symptom:** At least one PDO hasn't been received. **Possible causes:** 1. Temporary loss of communication. **Test:** 1. Check if all network nodes are correctly powered up.	Stopping

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64	Main Contactor Close Command Timeout	**Symptom:** Pre-charge timer has expired before the master sends the power ready request. **Possible causes:** 1. 5 sec after pre-charge is ended up, the power line is not ready (for master). **Test:** 1. The Master must send the Power Ready Request within 5 seconds from the begin of Precharge Done phase otherwise this fault will happen. For detailed information read the Powering Procedure.	Blocking
65	Blocking Request From Master	**Symptom:** Fault Request is received from Master. **Possible causes:** Master has requested a fault condition. **Test:** If the Controller detects such a fault, check your Master configuration.	Blocking
66	Not Assigned	-	-
67	Net Startup Timeout	**Symptom:** The node hasn't been able to synchronize itself to the network. **Possible causes:** Net synchronization failure at startup. **Test: V**erify to have the same Max Network Startup Time in all nodes of your network.	Blocking
68	Net External Failure	**Symptom:** At least one Node has become not operational. **Possible causes:** Net synchronization lost. **Test:** Check the state of all network nodes.	Stopping
69	Net Mains Manager Wrong Sequence	**Symptom:** The Main Contactor Manager has executed a wrong powering procedure. **Possible causes:** A TAU Node, Helper or Follower for the Main Contactor Management, signals that the powering sequence made by the Manager is wrong. **Test:** 1. Verify that the main contactor is managed and commanded only by one Main Contactor Manager. It's highly recommended to set all the other network nodes as Helpers. 2. In all network nodes control their powering roles. For detailed information read the QuickStart of CO Network.	Blocking
70	Net Mains Manager Precharge Too Slow	**Symptom:** DC Bus Voltage will not increase after discharging phase.	Blocking

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		Possible causes: A TAU Node, Helper for the Main Contactor Management, signals that the Precharge phase has been too slow. **Test:** Check the powering roles of all network nodes.	
71	Net Mains Manager Closing Too Slow	**Symptom:** The main contactor doesn't close. **Possible causes:** A TAU Node, Helper for the Main Contactor Management, signals that the main closing phase has been too slow. **Test:** 1. Check the cable that commands the contactor from the Main Contactor Manager Node 2. Verify that the main contactor is managed and commanded only by one Main Contactor Manager.	Blocking
72	Net Mains Manager Powering Alarm	**Symptom:** At least one fault has occurred on Main Contactor Manager Controller. **Possible causes:** A TAU Node, Helper or Follower for the Main Contactor Management, signals that the Main Contactor Manager has the powering state machine alarmed. **Test:** Verify the Main Contactor Manager active faults.	Blocking
73	CO Synchro Failed	**Symptom:** At least one node of the network could be wrong configured or switched off. **Possible causes:** Net never synchronized. **Test:** 1. Verify the wiring of all network nodes. 2. Verify the correct supply of all network nodes. 3. Verify to have the same Max Network Startup Time in all nodes of your network.	Blocking
74	CO Synchro Lost	**Symptom:** At least one node of the network could be wrong configured or switched off during operation. **Possible causes:** Net synchronization lost. **Test:** If the Controller detects such a fault that can appear only during operation, you must verify the correct supply and wiring of all network nodes.	Stopping
75	Stopped For System Fault	**Symptom:** Node is stopped because another node has a stopping/blocking fault condition. **Possible causes:** Node Stopped for System Fault. **Test:**	Stopping

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		1. Solve the other node Fault condition. 2. Verify your System Faults Remapping in order to avoid undesired stopping fault conditions from the other network nodes.	
76	Blocked for System Fault	**Symptom:** Node is blocked because another node has a stopping/blocking fault condition. **Possible causes:** Node blocked for System Fault. **Test:** 1. Solve the other node stopping/blocking condition. 2. Verify your System Faults Remapping in order to avoid undesired blocking fault conditions from the other network nodes.	Blocking
77	BMS Wall Charge	**Symptom:** The TAU Node sets a blocking fault. **Possible causes:** The BMS is recharging the battery. **Test:** 1. Verify the condition that has caused this fault, signaled by your BMS. 2. If the BMS is not recharging the battery, verify the correct status of BMS PDO.	Blocking
78	BMS Stop	**Symptom:** The TAU Node sets a stopping fault. **Possible causes:** The BMS requires a system stop. **Test:** 1. Verify the condition that has caused this fault, signaled by your BMS. 2. If the BMS doesn't require a stop, verify the correct status of BMS PDO.	Stopping
79	BMS Fault	**Symptom:** The TAU Node sets a blocking fault. **Possible causes:** The BMS signals its faulty state. **Test:** 1. Verify the condition that has caused this fault, signaled by your BMS. 2. If the BMS doesn't signal a faulty state, verify the correct status of BMS PDO.	Blocking
80	BMS Limiting	**Symptom:** The TAU Node limits its current to the required value from BMS. **Possible causes:** The BMS requires a current limit. **Test:** 1. Verify the condition that has caused this fault, signaled by your BMS. 2. If the BMS doesn't require a current limit, verify the correct status of BMS PDO.	Limiting
81	Steering Sensor Fault	**Symptom:** A fault condition of steering sensor is detected.	Limiting

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		Possible causes: Steering sensor wiring/s (analog/digital) are not connected. **Test:** 1. Verify if the potentiometer voltage is in the range of the calibration values and outside the wiper fault check. If not, with SmartView, configure your steering sensor. If the potentiometer voltage is outside the right calibration values, check the wirings and the potentiometer output voltage. 2. In case of a correct wiring but incorrect output voltage, replace the steering sensor itself. 3. If the steering sensor output voltage is correct, the terminals of the connector are correctly wired to their correspondent inputs in potentiometer circuit but the measured value in the display is incorrect, replace the Controller.	
82	**CAN Protocol Run Time Error**	**Symptom:** Difference between the Control Mode set by GUI and the request made by CAN. **Possible causes:** Wrong CAN Request. **Test:** If the Controller detects such a fault, check the contents of the RPDO1.	Limiting
83	**Programming Required**	**Symptom:** A blocking fault is voluntary forced during the programming to disconnect the power from the Controller. **Possible causes:** Firmware Programming in progress.	Blocking
84	**DigInputs Overvoltage**	**Symptom:** Digital Input Supply Voltage is above the maximum level allowed for the Controller. This value is obtained by a hardware comparator and it's not configurable. **Possible causes:** Incorrect Wiring. **Test:** If the Controller detects such a fault, check the wiring of the Digital Inputs.	Blocking
85	**Inverter Model Not Supported**	**Symptom:** Inverter model is not supported by the firmware. **Possible causes:** Inverter model is not supported. **Test:** If the Controller detects such a fault, verify the firmware version loaded and/or update the correct firmware.	Blocking
97	**Commission In Progress**	**Symptom:** Motor spin sensor commission is in progress. **Possible causes:** Spin sensor commission is in progress.	Warning

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		Test: If the Controller detects such a fault, wait until the commission procedure is ended.	
98	**Commission End Success**	**Symptom:** Motor Spin sensor commission is ended successfully. **Possible causes:** Spin sensor commission ends successfully. **Test:** If the Controller detects such a fault, cycle key switch.	Stopping
99	**Commission End Errors**	**Symptom:** Motor spin sensor commission is ended with errors. **Possible causes:** Spin sensor commission end with errors. **Test:** If the Controller detects such a fault, cycle key switch and repeat the commission procedure.	Stopping
100	**Internal Software Fault 1**	**Symptom:** Internal Error. **Possible causes:** Internal software error/s. **Test:** 1. If CAN Network is enabled, set “Heartbeat” speed to “Slow”. 2. Load default values for EEPROM variables with SmartView, using the button "Restore Factory Settings" in Manage\Restore. 3. If this fault is still present, contact Dealer.	Blocking
101	**Internal Software Fault 2**	Internal Error. See AL100	Warning
102	**Internal Software Fault 3**	Internal Error. See AL100	Warning
103	**Internal Hardware Fault 1**	**Symptom:** Internal Error. **Possible causes:** Internal hardware error/s. **Test:** 1. Load default values for EEPROM variables with SmartView, using the button "Restore Factory Settings" in Manage\Restore. 2. If this fault is still present, contact Dealer.	Blocking
104	**Internal Hardware Fault 2**	Internal Error. See AL103	Blocking
105	**Internal Hardware Fault 3**	Internal Error. See AL103	Blocking
106	**Internal Hardware Fault 4**	Internal Error. See AL103	Blocking

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107	**Internal Software Fault 4**	Internal Error. See AL103	Blocking

ADDITIONAL SUPPORT

Hyperlinks in the list above can be viewed by clicking the link in the Diagnose tier of TAU SmartView's Help section. If you need additional support to solve Diagnostic Codes signaled by the firmware or strange behaviors of the vehicle, please contact your Authorized Dealer.

In order to make the collection of information faster, you must provide them:

1. **Product Code** of the Controller.
2. Clone file of the Controller.
3. Screenshots of the **About** Page in the Main Menu.
4. Screenshots of the **Active Faults** Tab in DIAGNOSE
5. Screenshots of the **Faults History** Tab in DIAGNOSE
6. Screenshots of the **Time/Distance** Tab in MONITOR

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