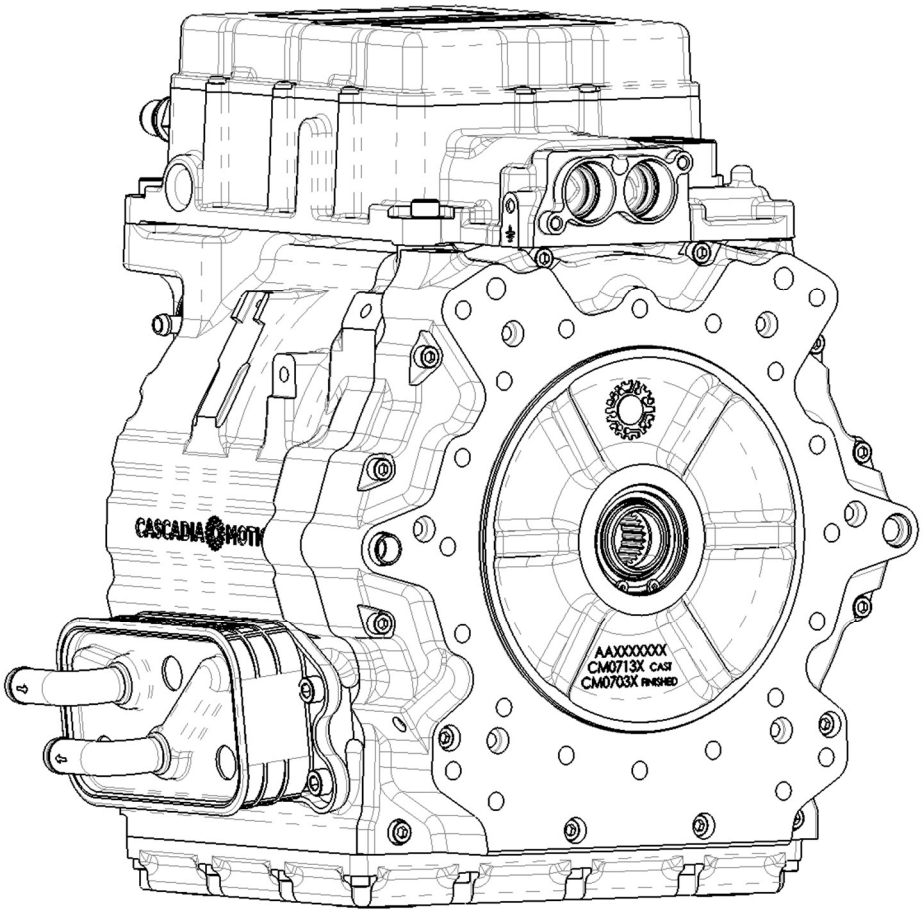


IM-225

INTEGRATED MODULE

CASCADIA MOTION

Section 1: Supporting Documents

- Please refer to https://www.cascadiamotion.com/documents for additional documentation to support this manual. Specific useful documents are listed below.
    - PM/RM Family Hardware Manual
    - PM/RM Family Software Manual
    - Cascadia Motion CAN Protocol

Section 2: Technical Specifications

Technical Specifications	
Type:	Borg Warner HVH250-115
Maximum Voltage	480VDC (iM225DX-D) 860VDC (iM225DZ-S)
Peak Torque	>500 Nm
Peak Power	225kW
Continuous Torque	230 Nm
Continuous Power	110-135 kW
Max Speed	12000 RPM
Weight	65.8 kg
Max Coolant Temp	60°C (Peak performance below 60°C, Mild Derate 60-80°C, No Torque at 100°C)
Coolant Flow Rate	12 LPM (max continuous)
Rotor Inertia:	0.085 Kg.m^2
Center of Gravity	See Figure 8.1, 8.5

Table 2.1 Technical Specifications

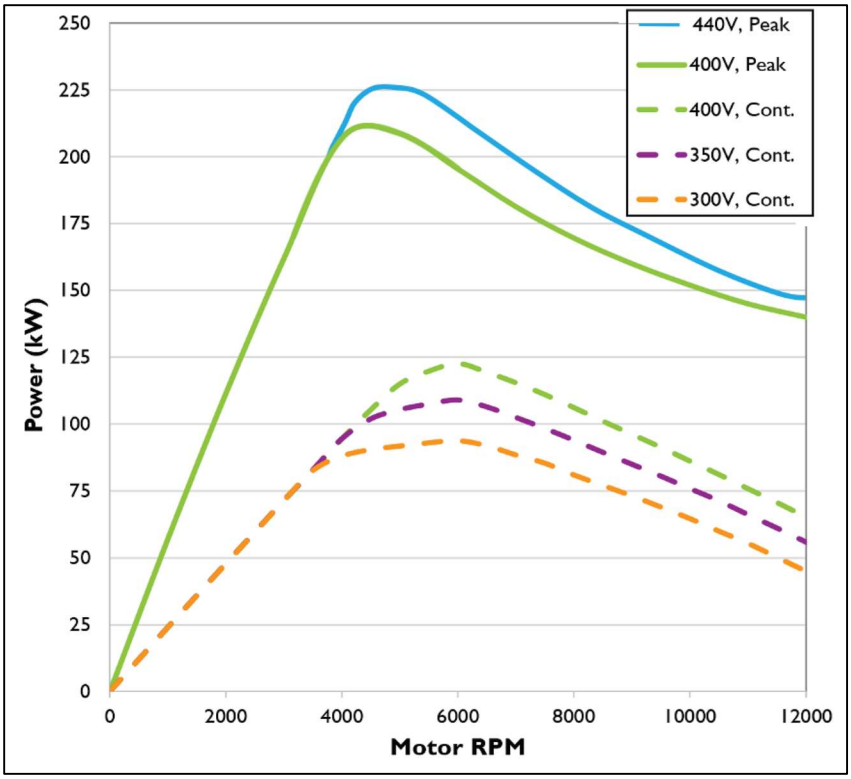


Figure 2.1 Power Curve

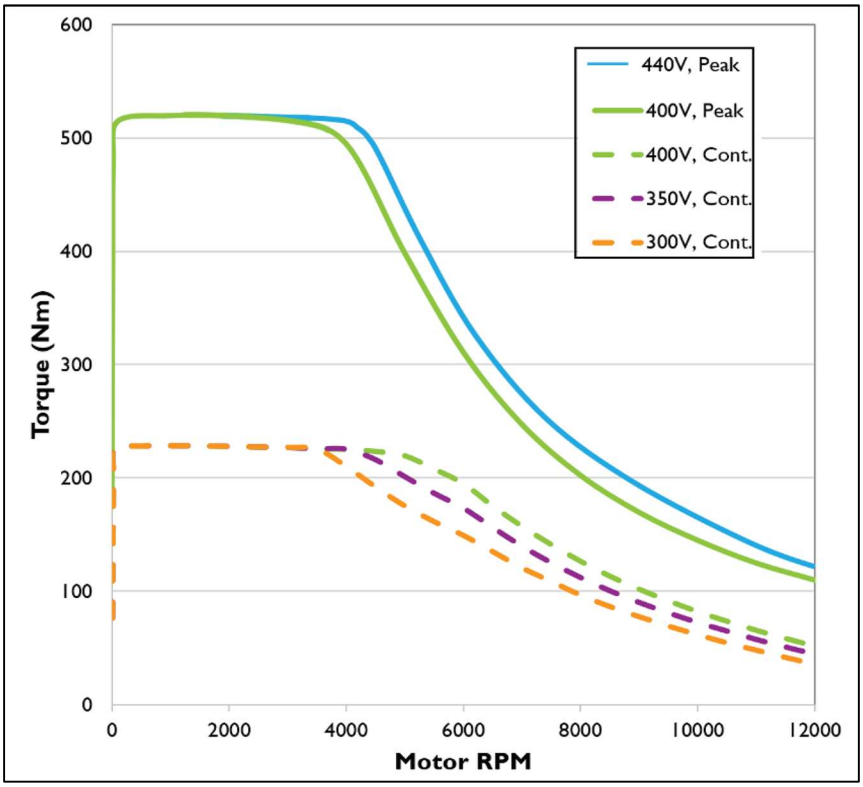


Figure 2.2 Torque Curve (iM2250DX-D shown, iM225DZ-S are similar but at higher voltage)

Section 3: Oiling

All iM225 units are shipped filled with oil. Procedures below for reference.

Approved Oils

- Dexron VI ATF (Preferred)
- Transynd ATF (Synthetic Formulation Of Dexron VI Made By Mobil 1)
- Shell Spirax S6 ATF A295 – Made By Shell For ATF Application
- Lubrizol OS183539V
- BASF (Manual Transmission Fluid)

Oil Fill/Procedure

1. Remove drain plug & drain motor of oil. See Figure 7.3.
2. Install drain plug. Torque to 20 N·m (15 ft·lbf)
3. Remove oil fill cap. See Figure 7.2
4. Fill with 1.8L of approved oil.
5. Install oil fill cap. Torque to 20 N·m (15 ft·lbf).
6. Inspect sight glass to verify oil is present.
7. Spin motor to circulate the oil.
8. Oil level in sight glass to be observed at ¼ - ½ on level ground after spin.

Oil Pressure Sensor

- ACDelco 12677836 pressure sensor.
- Mating Connector: Aptiv p/n 15477863 or 12078090, 3-way Black GT150 Female Connector.
- Wire seal as required for the wire size.
- Crimp Contact as required for the wire size.
- Torque to 20 N·m (15 ft·lbf).
- See Table 3.1 for temperature sensor calibration values. (not needed if wired to CM200 inverter)
    - Pin 1: Analog ground (Connect to K4 on CM200)
    - Pin 2: 5V supply (Connect to K3 on CM200)
    - Pin 3: Analog Output Signal (Connect to E4 on CM200)

Pressure (psi) vs Voltage Values			
Pressure	**Voltage**	**Pressure**	**Voltage**
0	0.5	70.3	2.67
4.9	0.67	81.1	3
15.7	1	91.9	3.33
26.5	1.33	103.0	3.67
37.6	1.67	113.8	4
48.4	2	124.5	4.33
59.2	2.33	130	4.5

Table 3.1 Pressure Sensor Calibration

Oil Pump

- Unless otherwise specified the pump components will be installed so that oil is pumping when the motor is rotating in its forward (counterclockwise (CCW)) rotation. See Figure 3.1.
- Oil will not pump when the motor is rotating in reverse (CW) rotation.
- It is approved to spin the motor in the reverse rotation for light duty short duration events.

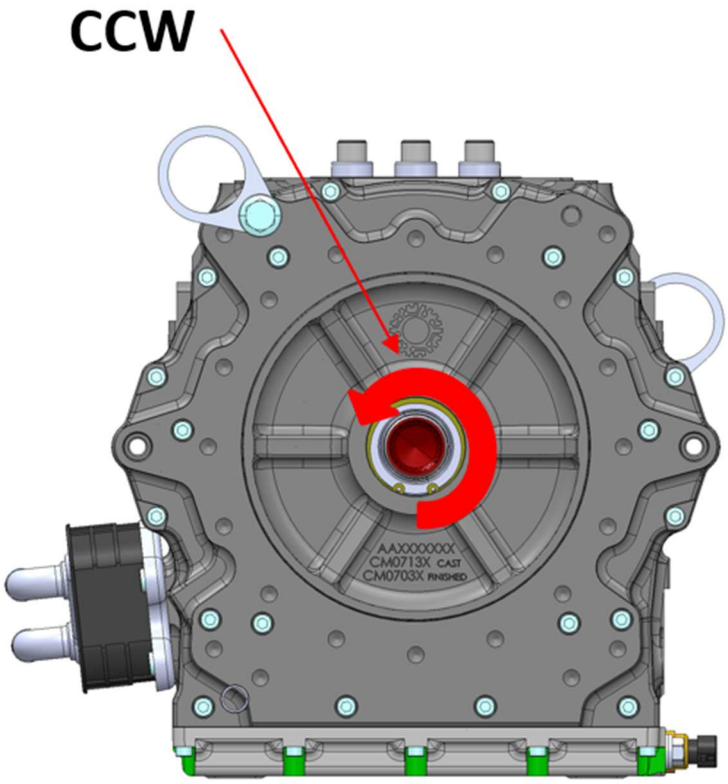


Figure 3.1 Standard Oil Pumping Rotation

Instruction – Oil Pump Reversal

- If the customer requires a CW pumping rotation, follow the instruction below.

1. Remove 4 M6 Screws
    a. See Figure 3.2
2. Remove Pump Cover and o'ring.
    a. The pump may want to come out with the cover. Be careful not to drop.
    b. See Figure 3.3
3. Remove reversing ring.
    a. Use m5X0.8 screws and tapped holes if needed.
    b. The pump may want to come out with the cover. Be careful not to drop.

c. See Figure 3.4

4. For CW rotation reinstall reversing ring so that the dowel pin installs into the bore **NOT** marked with an “F”
5. Reinstall pump cover, o’ring & m6 screws.
    a. Replace oring (Mcmaster 9452K128)
    b. Torque 4x m6 screw to 8.1 Nm

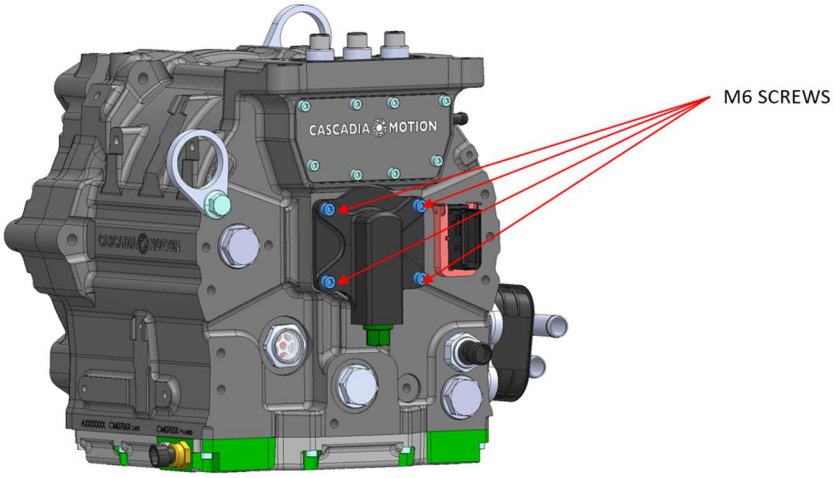


Figure 3.2 Step 1, Reverse Pumping Direction

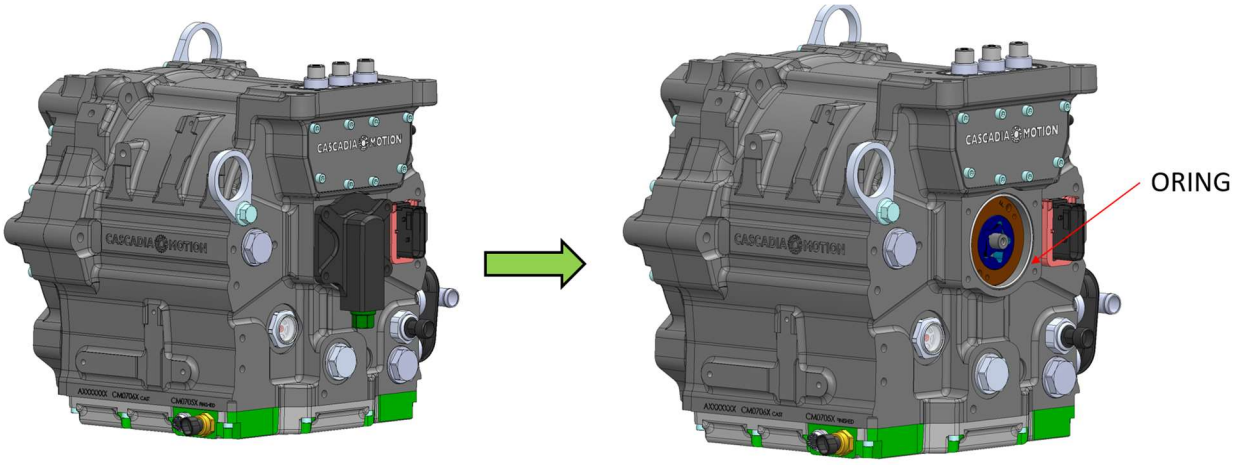


Figure 3.3 Step 2, Reverse Pumping Direction

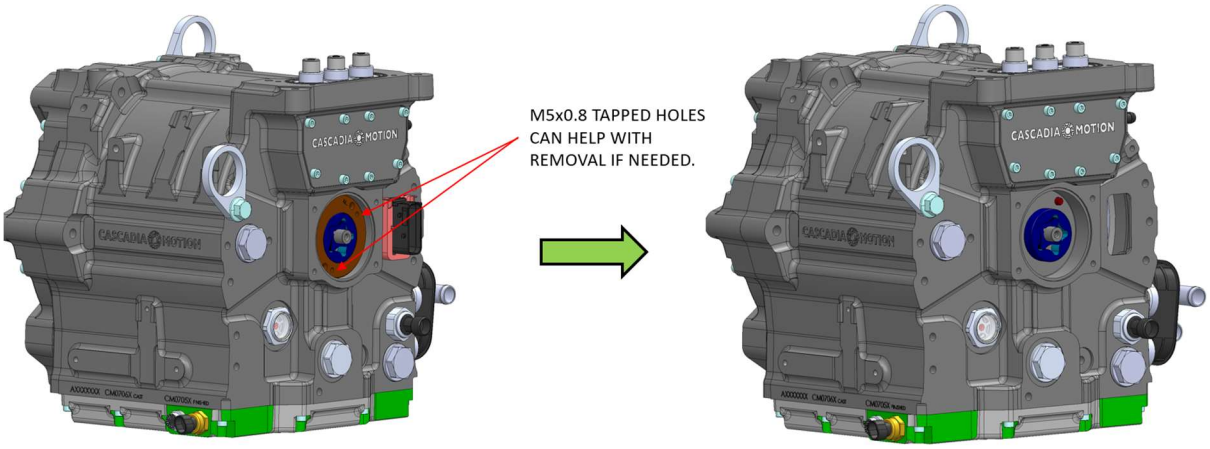


Figure 3.4 Step 3, Reverse Pumping Direction

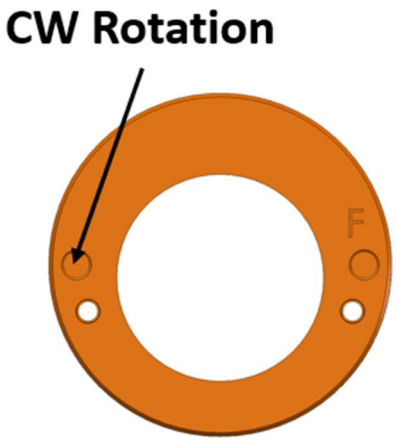


Figure 3.5 Step 4, Reverse Pumping Direction

Instruction – Activating the Reversing Ring

- **THE ACTIVE REVERSING RING FEATURES ARE IN "BETA-TEST" AND SHOULD ONLY USED BY CUSTOMERS WHO HAVE THE ABILITY TO MONITOR OIL PRESSURE.**
    - **CUSTOMER SHALL PERFORM MULTIPLE FORWARD AND REVERSE MANEUVERS TO VERIFY OIL IS BUILDING PRESSURE IN BOTH CW & CCW ROTATION.**
    - **OIL COOLING IS NEEDED FOR HIGH TORQUE LONG DURATION EVENTS ONLY.**
    - **NO OIL PRESSURE FOR SHORT DURATION LOW TORQUE EVENTS IS ACCEPTABLE.**

1. Follow steps 1-3 from the "Oil Pump Reversal" instructions.
2. Reinstall reversing ring so that the dowel bores and letter "F" are facing outward. See Figure 3.6.
3. Reinstall pump cover, o'ring & m6 screws.
    a. Replace oring (Mcmaster 9452K128)
    b. Torque 4x m6 screw to 8.1 Nm

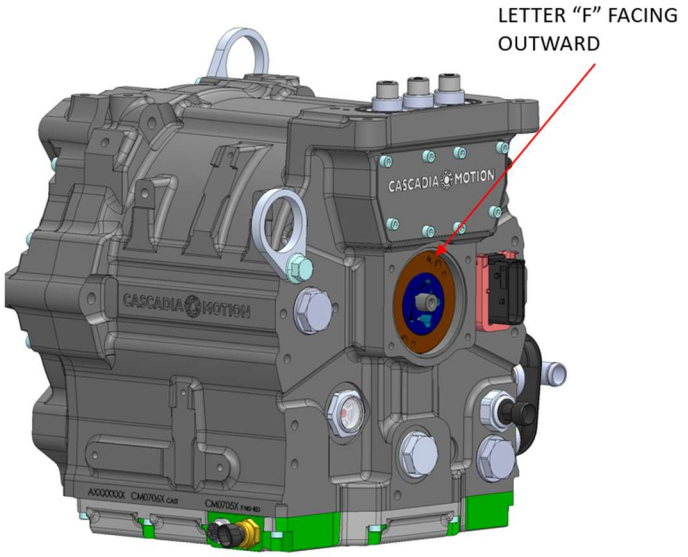


Figure 3.6 Step 2, Activating Reversing Ring

Notes

- Motor to be shipped with oil unless notified otherwise (check sight glass to be sure).
- The vent is located on the back of the motor (see Figure 7.2). Connect remote mounted oil breather tank to 5/16” barbed fitting.

Section 4: Cooling System

Description

Cooling of the integrated module is achieved by use of radiator, coolant pump and water-to-oil heat exchanger. The coolant loop is described as follows:

1. Coolant is plumbed from the customer-furnished coolant pump (or can be purchased from Cascadia Motion as optional equipment) to the inverter. The direction of flow in/out of the inverter coolant ports (See Figure 7.2) is not specified and either plumbing orientation is approved.
2. From the inverter the coolant is plumbed to the inlet port of the motor-mounted (included) heat exchanger. See figure 7.4.
3. From the heat exchanger the coolant is plumbed to the customer-supplied radiator where it is conditioned and returned to the inverter.

4. Use of a coolant reservoir is generally necessary within this cooling loop to accommodate expansion/contraction and de-aeration.
5. Consider off-level operation angles of the vehicle and make sure that the coolant pump inlet stays always primed with fluid.
6. CAUTION: the inverter will be damaged if it is run at any significant current without cooling fluid

Specification

- The motor is oil-cooled but in most cases that oil circuit will be 'invisible' to the user. Internal oil flow rate increases with speed up to ~6000rpm and then plateaus at 18 LPM.
- Coolant (e.g. 50/50% ethylene glycol & water) flow rate: 12 LPM required at max continuous (100kW) operation.
- Coolant temperature to inverter: 60 ˚C max to achieve required cooling for 100kW sustained power. Lower water temperature allows higher continuous power.

Cooling System Connections

- 2x 5/8" hose barbs on the back side of the inverter are standard equipment. See figure 7.2.
- 2x 5/8" barb connections on the heat exchanger See figure 7.4.

Auxiliary Oil Pump Connections

- 1x -12 ORB (capped) has been provided for additional scavenge from the motor to auxiliary oil pump. See Figure 7.2. Torque to 20 N·m (15 ft·lbf).
- 1x -10 ORB (capped) has been provided for auxiliary oil feed from the auxiliary pump to motor. See Figure 7.2 Torque to 20 N·m (15 ft·lbf).
- Auxiliary pump may be recommended to achieve more motor cooling for special high load/low speed applications. Contact Cascadia Motion engineering for pump recommendations if you find to be in need of special solutions.

Oil Temperature Sensor

- ACDelco 213-4514 Temperature Sensor. See Figure 7.2
- Mating connector: Delphi 12124076 (body/seal) with 12162194 terminals
- Torque to 20 N·m (15 ft·lbf)
- See Table 4.1 for temperature sensor calibration values. (not needed if wired to CM200 inverter)
    - Pin 1: Analog Output Signal (Connect to B4 on CM200)
    - Pin 2: Analog Ground (Connect to K4 on CM200)

Temperature vs Resistance Values					
C	F	OHMS	C	F	OHMS
150	302	47	30	86	2238
140	284	60	25	77	2796
130	266	77	20	68	3520
120	248	100	15	59	4450
110	230	132	10	50	5670
100	212	177	5	41	7280
90	194	241	0	32	9420
80	176	332	-5	23	12300
70	158	467	-10	14	16180
60	140	667	-15	5	21450
50	122	973	-20	-4	28680
45	113	1188	-30	-22	52700
40	104	1459	-40	-40	100700
35	95	1802			

Table 4.1 Temperature Sensor Calibration

Coolant System Pressure Drop

Pressure Drop Across the Heat Exchanger (WEG 50/50)

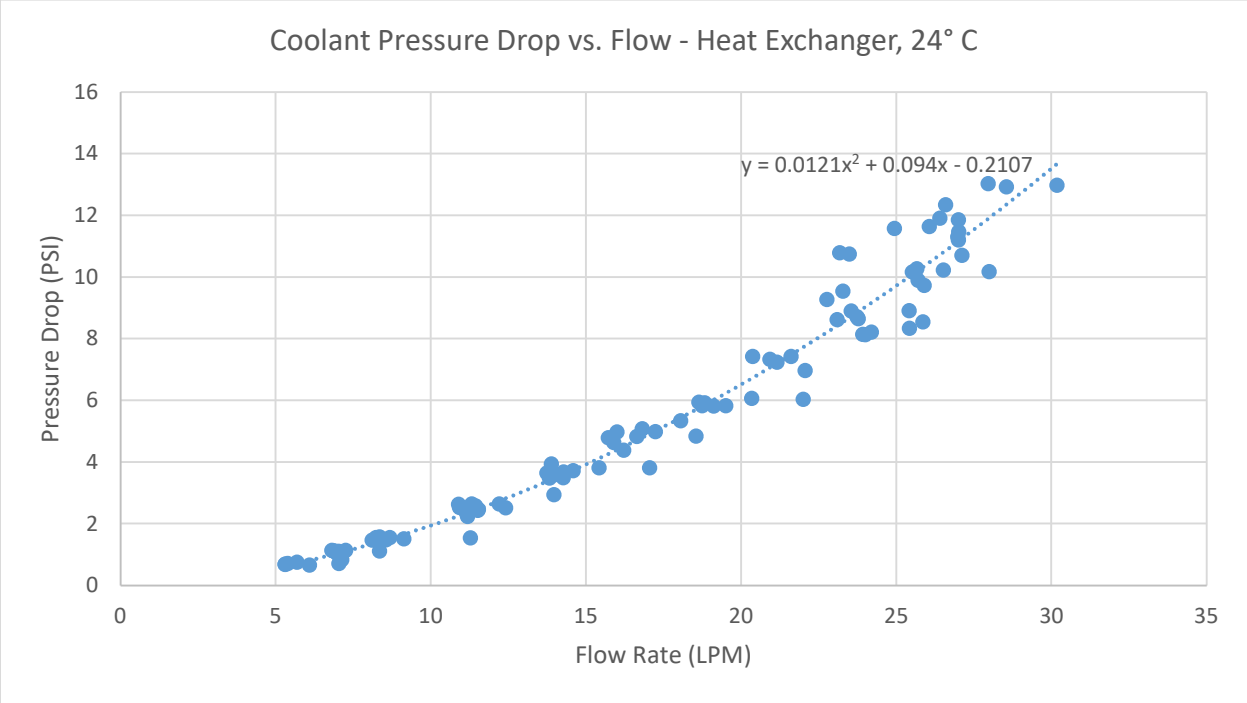


Figure 4.1, Pressure Drop, Heat Exchanger

Pressure Drop Across the Inverter (WEG 50/50)

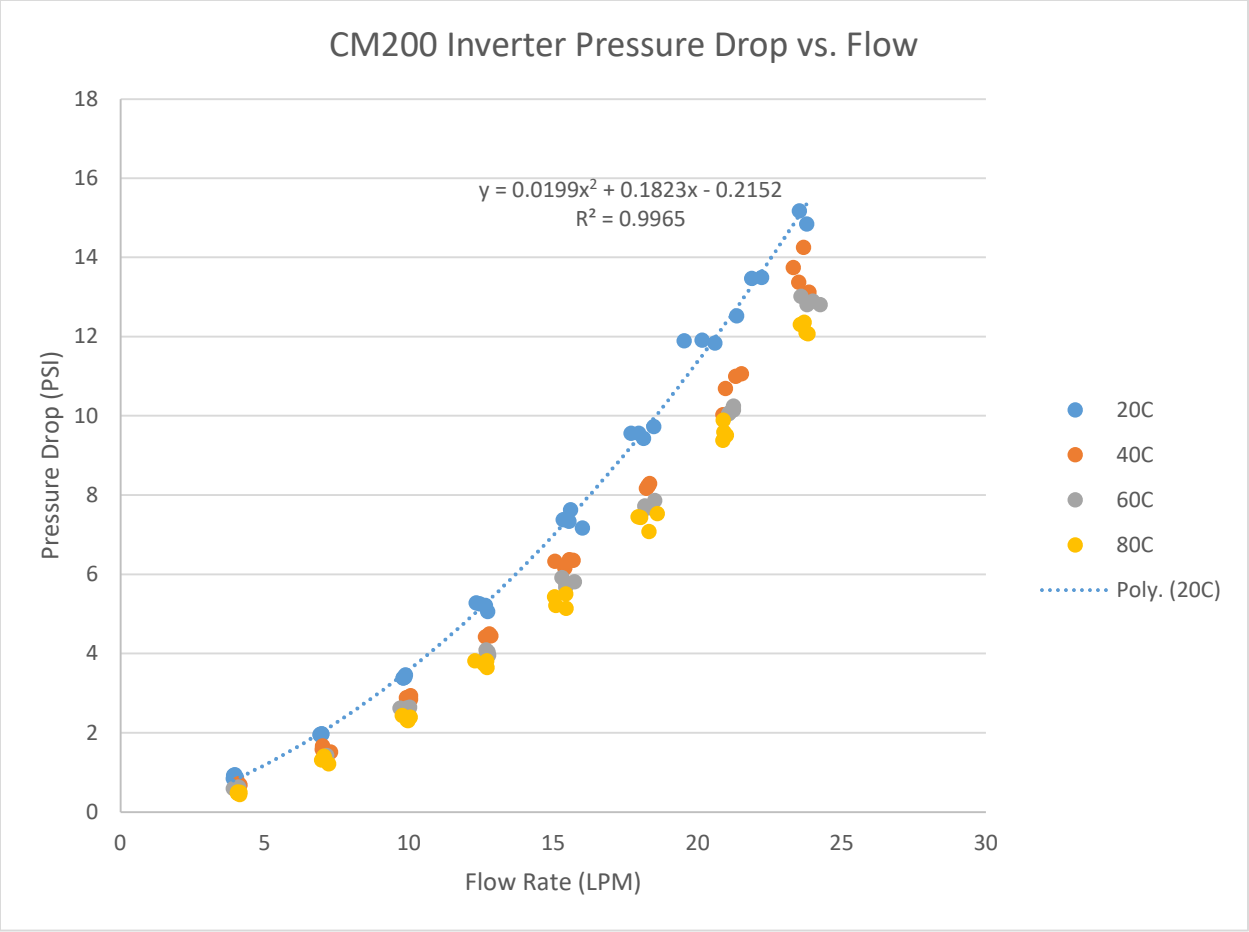


Figure 4.2, Pressure Drop, Inverter

Section 5: Wiring

Warning:

- Do not remove High Voltage Cover or Inverter (see Figure 7.2). Repairs to high voltage components to be performed by authorized personnel only.

Motor Resolver Connector Mating Connector Information:

- Kit of all of the components below, Cascadia Motion p/n: G1-0010-01
  - TE 1-1563759-1 (18 pin plug)
  - TE 1241381-3 (Contact AMP MCP 1.5K 17-20AWG)
  - TE 963530-1 (Seal Wire AMP MCP 1.5K 1.4-1.9mm)
  - TE 963531-1 (Seal AMP MCP 1.5K Plug)

Inverter to motor, low voltage connections:

Motor pin	Function	CM200DX or DZ Pin
9	Temperature sensor #1 (AIN2)	C4
18	Temperature sensor #1 (AGND)	A4
8	Temperature sensor #2 (AIN3)	DX-D: D4 DZ-S: Not connected
17	Temperature sensor #2 (AGND)	DX-D: A4 DZ-S: Not connected
5	Resolver shield ground	G1
6	N/C	N/C
3	Resolver Signal Cos Low , /Cos	C1
12	Resolver Signal Cos Hi, Cos	D1
2	Resolver Signal Sin Low , /Sin	A1
11	Resolver Signal Sin Hi, Sin	B1
1	Resolver Excitation Negative signal, /Exc	F1
10	Resolver Excitation Positive signal, Exc	E1
Shield	Resolver shield ground	G1

Table 5.1 Low Volt Pinout Motor/Inverter

Inverter Connectors (High Voltage DC and Low Voltage)

- Refer to inverter Hardware Manual on the Cascadia Motion web site for low voltage connections.
- Refer to figure 5.2 for HV DC connections and keying information

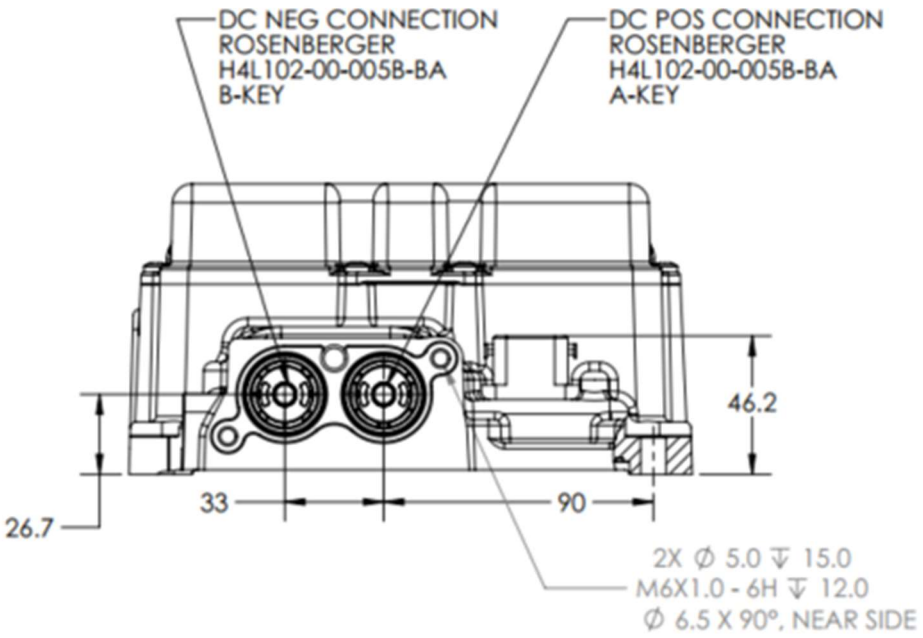


Table 5.2 High Voltage connections to inverter

Installation Notes

- Use 20AWG 4 pair twisted pair/shielded wire for resolver connections.
- There is no connection for wire shielding on the motor side (inside the motor). Shield of shielded wire to be connected to inverter per Table 5.1. Shield should not be connected to the housing of the motor.
- Low volt cable to be kept separated from high voltage cables.

Section 6: Inverter configuration

The inverter resolver calibration and EEPROM configuration has been performed from the factory. In the case you need to re-do the resolver calibration, please see the resolver calibration manual.

For reference, the Motor Type EEPROM settings for the iM225DX-D are below:

iM225DX-D: Motor type: 21

iM225DZ-S: Motor type 34

Section 7: Drive Spline Data

See Detail L for shaft dimensional information.

INTERNAL INVOLUTE SPLINES DATA

FILLET ROOT SIDE FIT, TOLERANCE CLASS - 5H
SIMILAR TO ANSI B92.2M-1980 (R1989)

NUMBER OF TEETH	24
MODULE	1.000
PRESSURE ANGLE	30.0°
PITCH DIAMETER (REF)	24.000
BASE DIAMETER (REF)	20.785
MAJOR DIAMETER	26.04 - 25.80
MINOR DIAMETER	23.28 - 23.09
FOR DIAMETER (MIN.)	25.20
CIRCULAR TOOTH SPACE MIN. EFFECTIVE	1.571
CIRCULAR TOOTH SPACE MAX. ACTUAL	1.626
FILLET RADIUS MINIMUM	N/A
PIN DIAMETER	2.000
MEASUREMENT BETWEEN PINS (REF)	20.695 - 20.626

Table 7.1 Drive Spline Data

Section 8: External Features and Connection Points

See Figures 8.1-8.4 for explanation of the integrated modules external features.

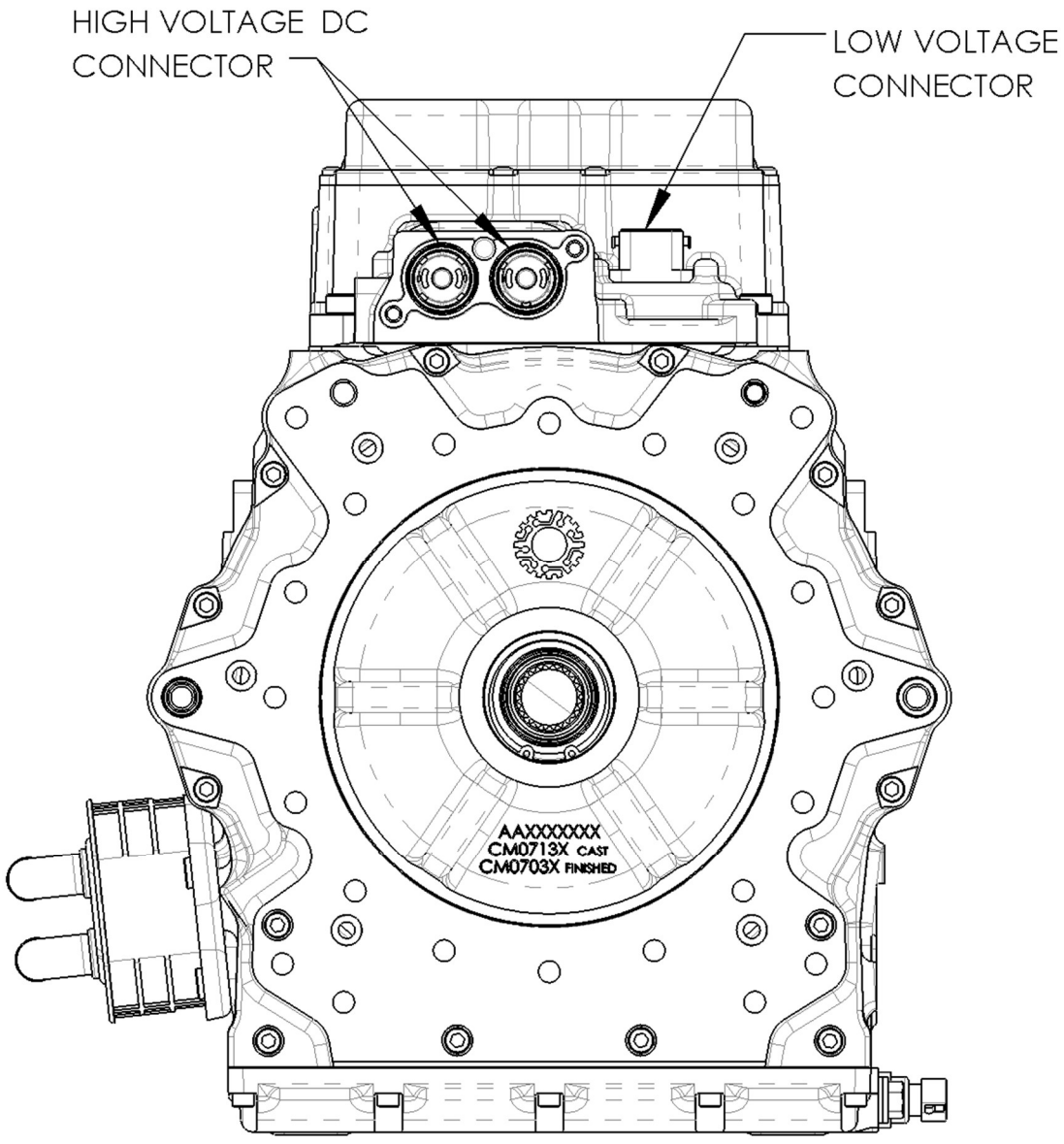


Figure 8.1 External Features, Front

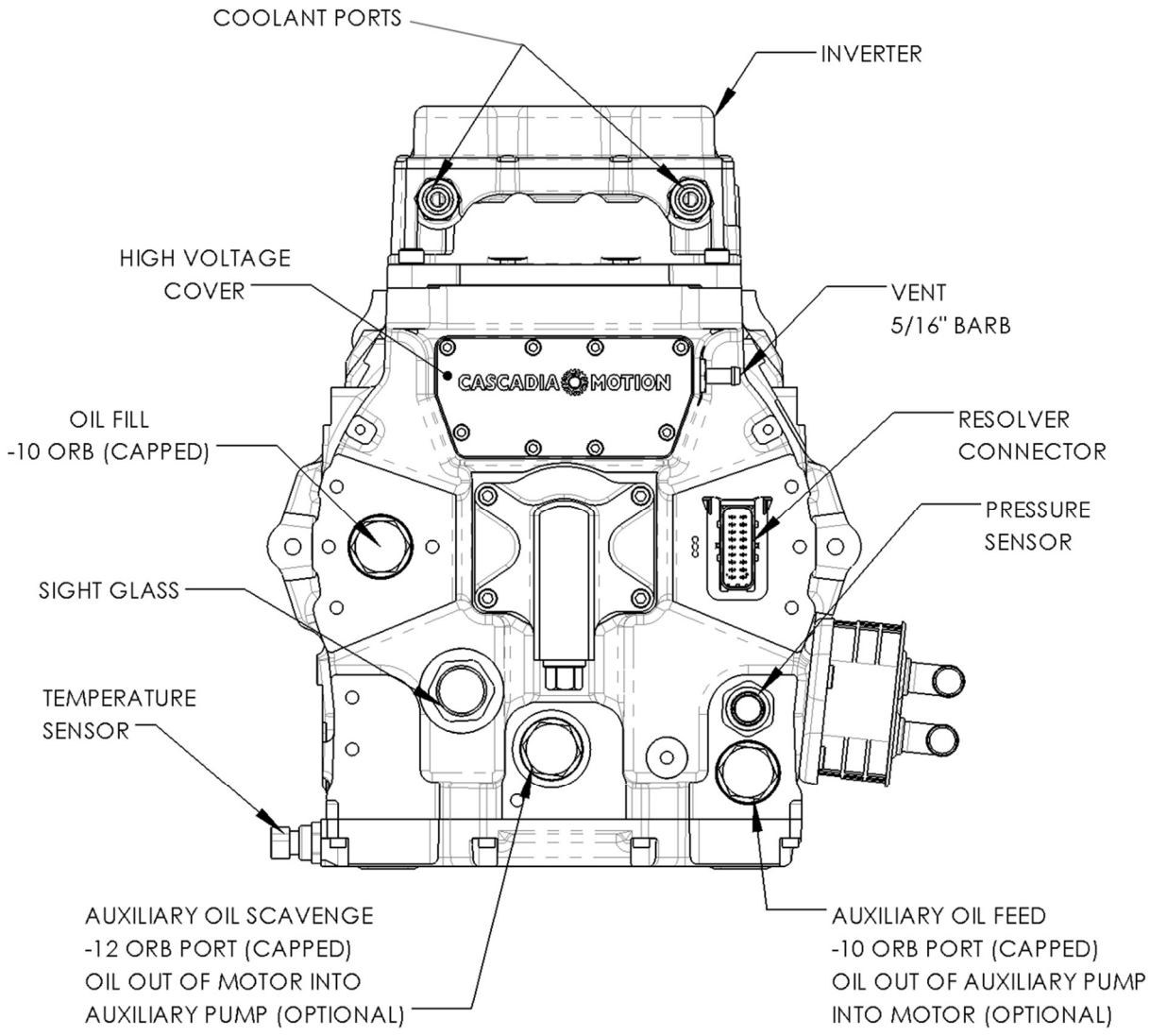


Figure 8.2 External Features, Rear

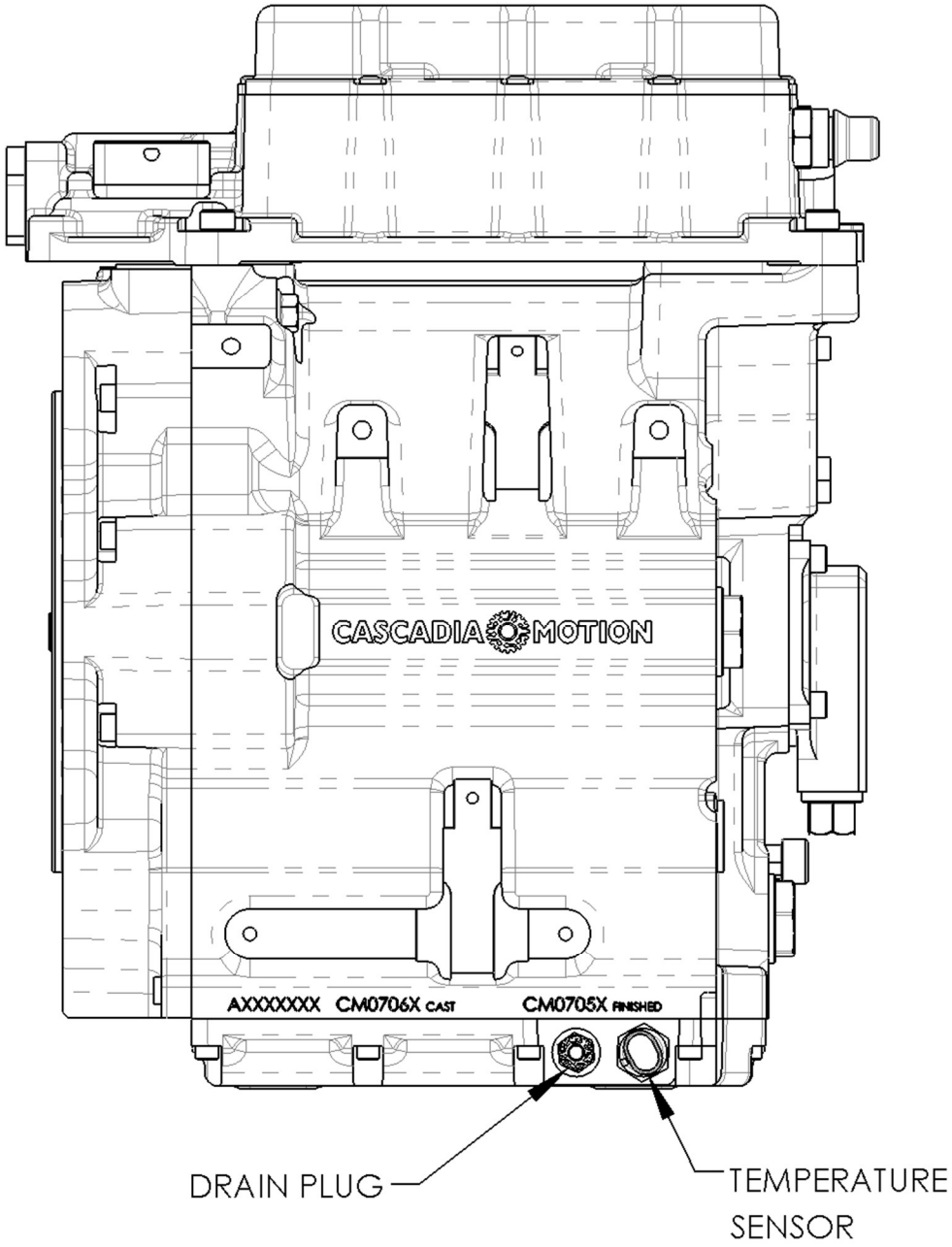


Figure 8.3 External Features, Left

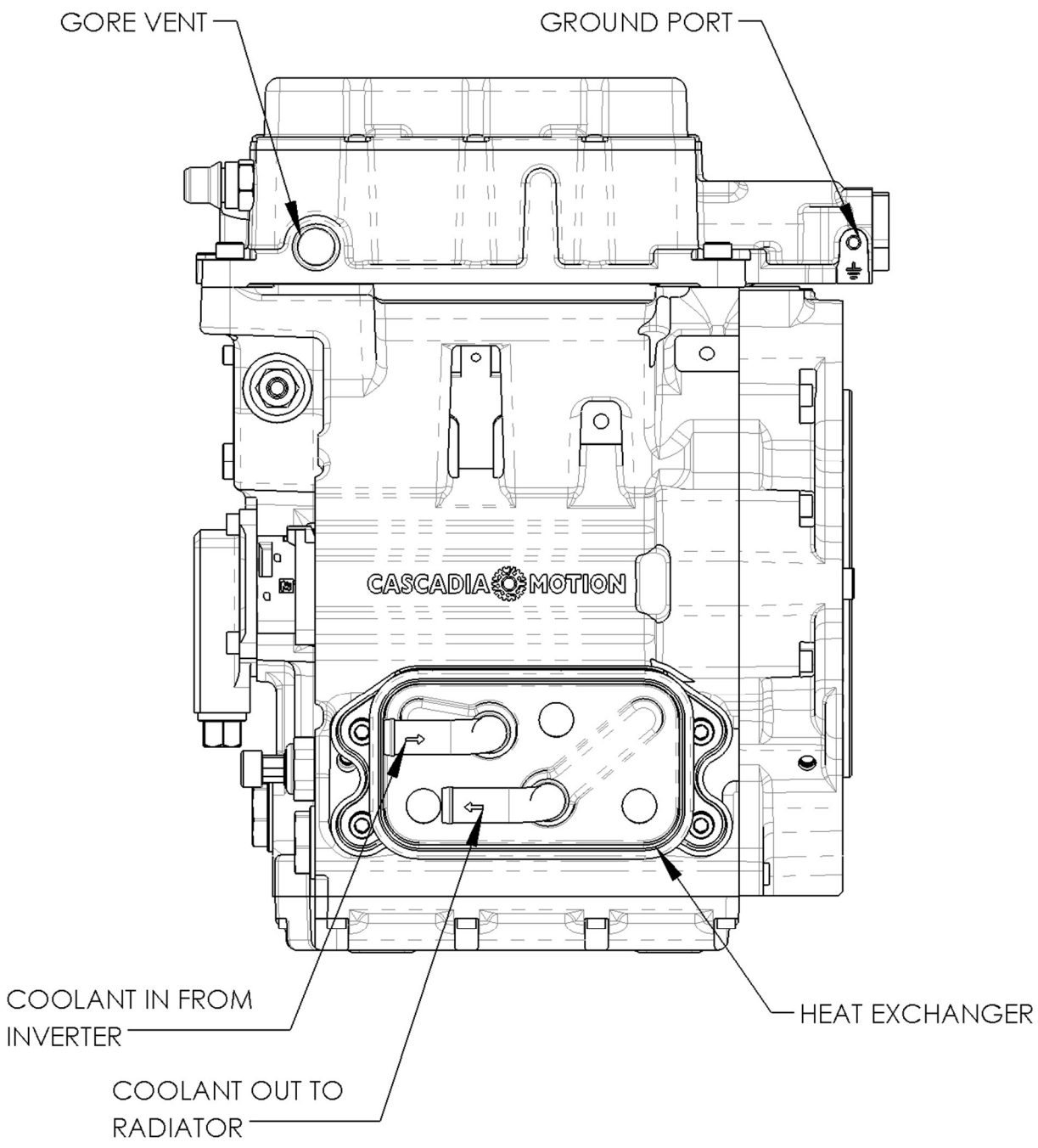


Figure 8.4 External Features, Right

Section 9: Mounting

Customer Interface Features

- Several features are provided for the mounting of a transmission to the integrated module.
    - Pilot diameter. See Figure 8.5
    - 2 dowel hole locations. See Figure 8.1 and Section G-G.
    - 3 transmission connection bolt patterns. See Figure 8.1
        - 6-bolt Cascadia Motion bolt pattern
        - 16-bolt 'Remy pattern' (e.g. 31-03 connection)
        - 4-bolt Porsche transaxle (e.g. G50 series) pattern
- Six rear motor mount locations (three per side) are provided at centerline and 32.35mm above and below centerline. See Figure 8.2.

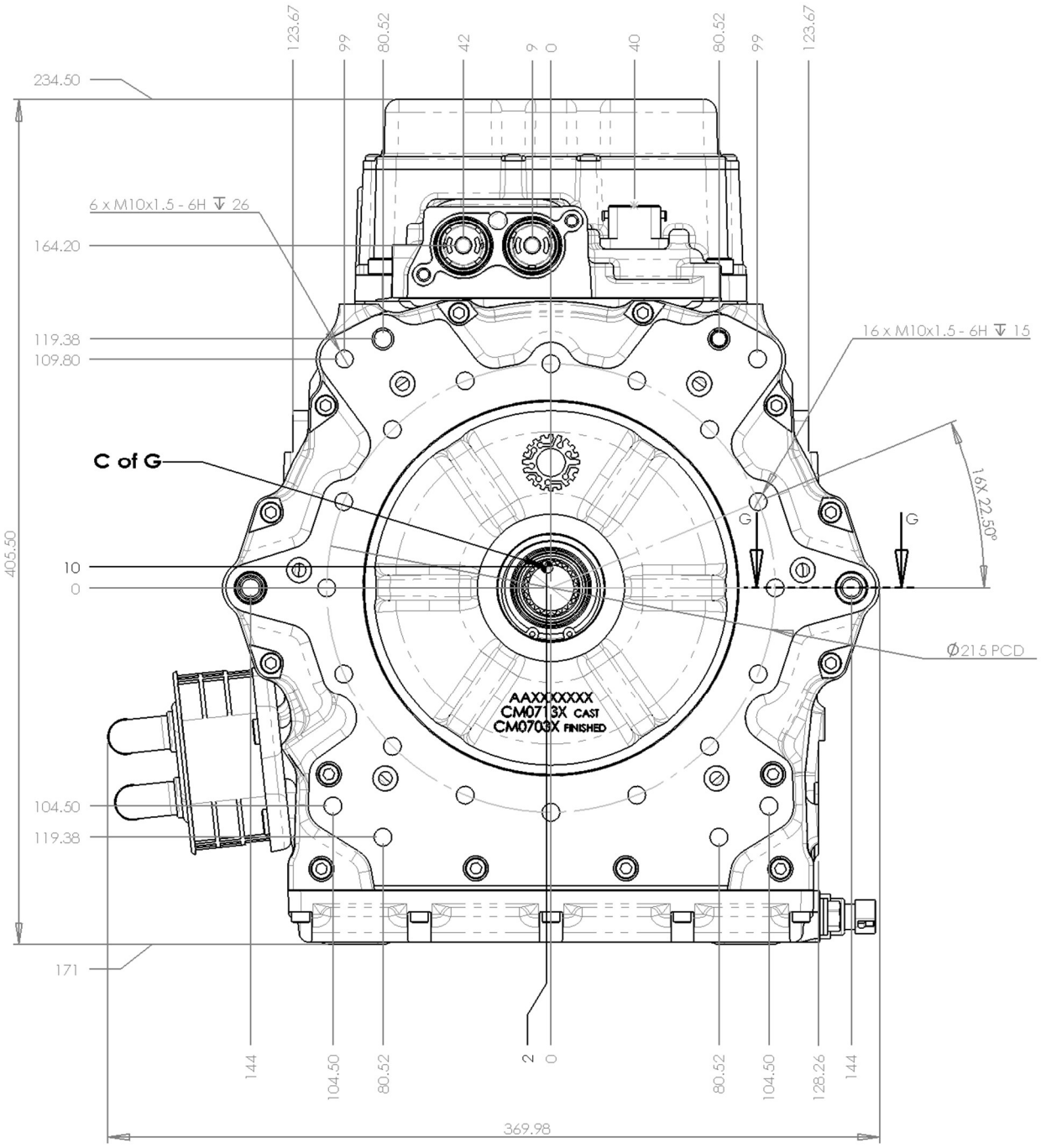


Figure 9.1 Customer Interface Features, Front

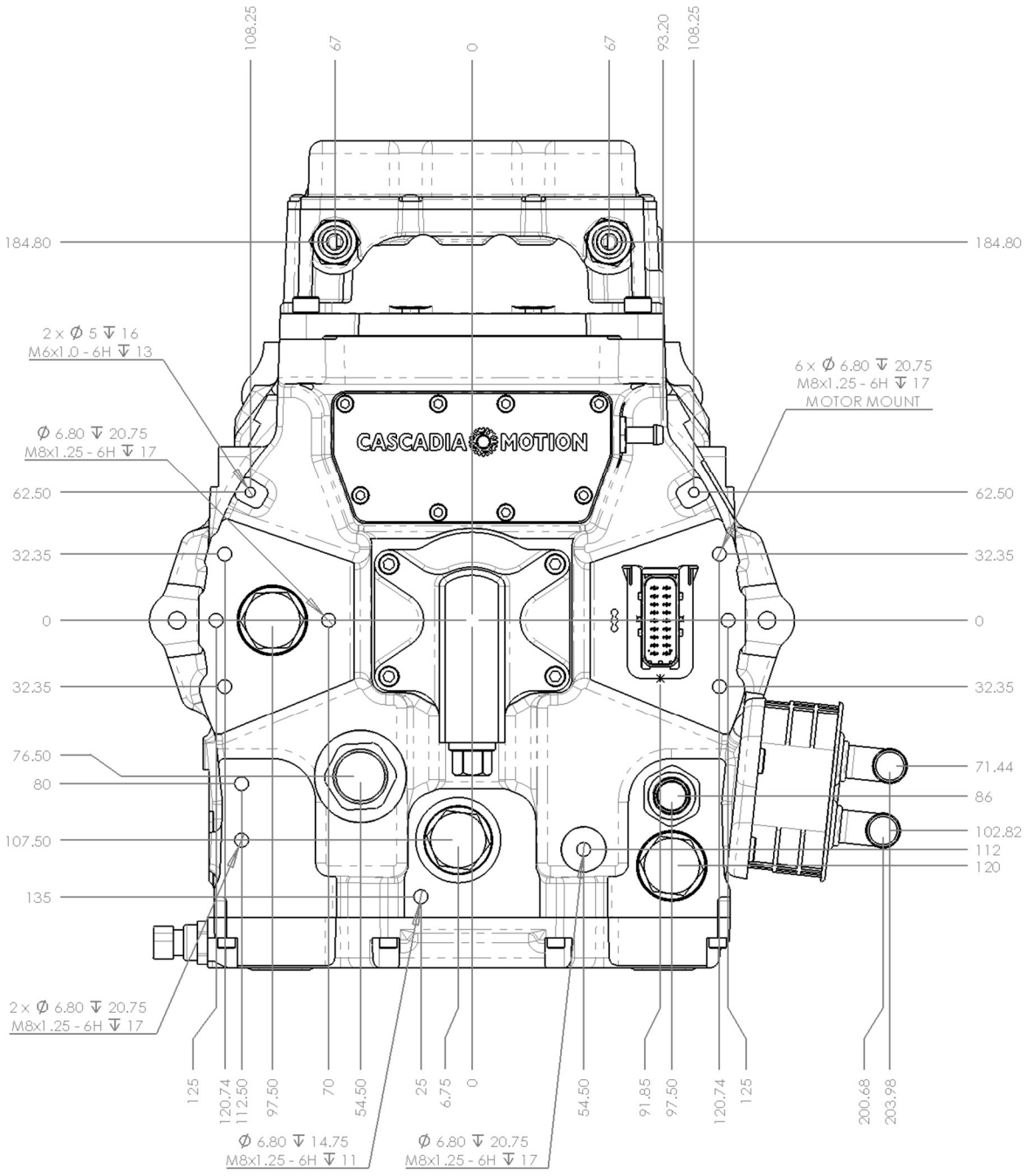


Figure 9.2 Customer Interface Features, Rear

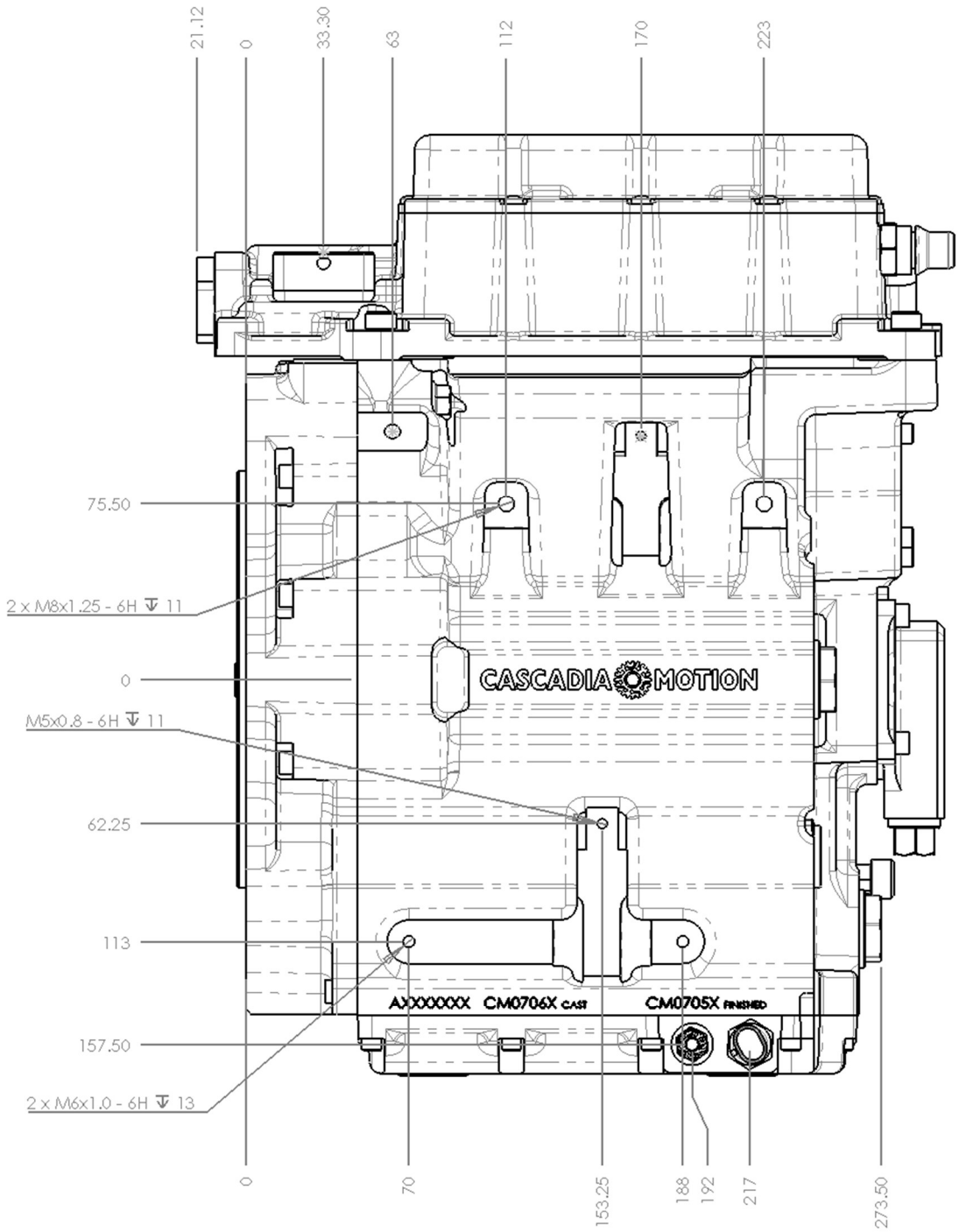


Figure 9.3 Customer Interface Features, Left

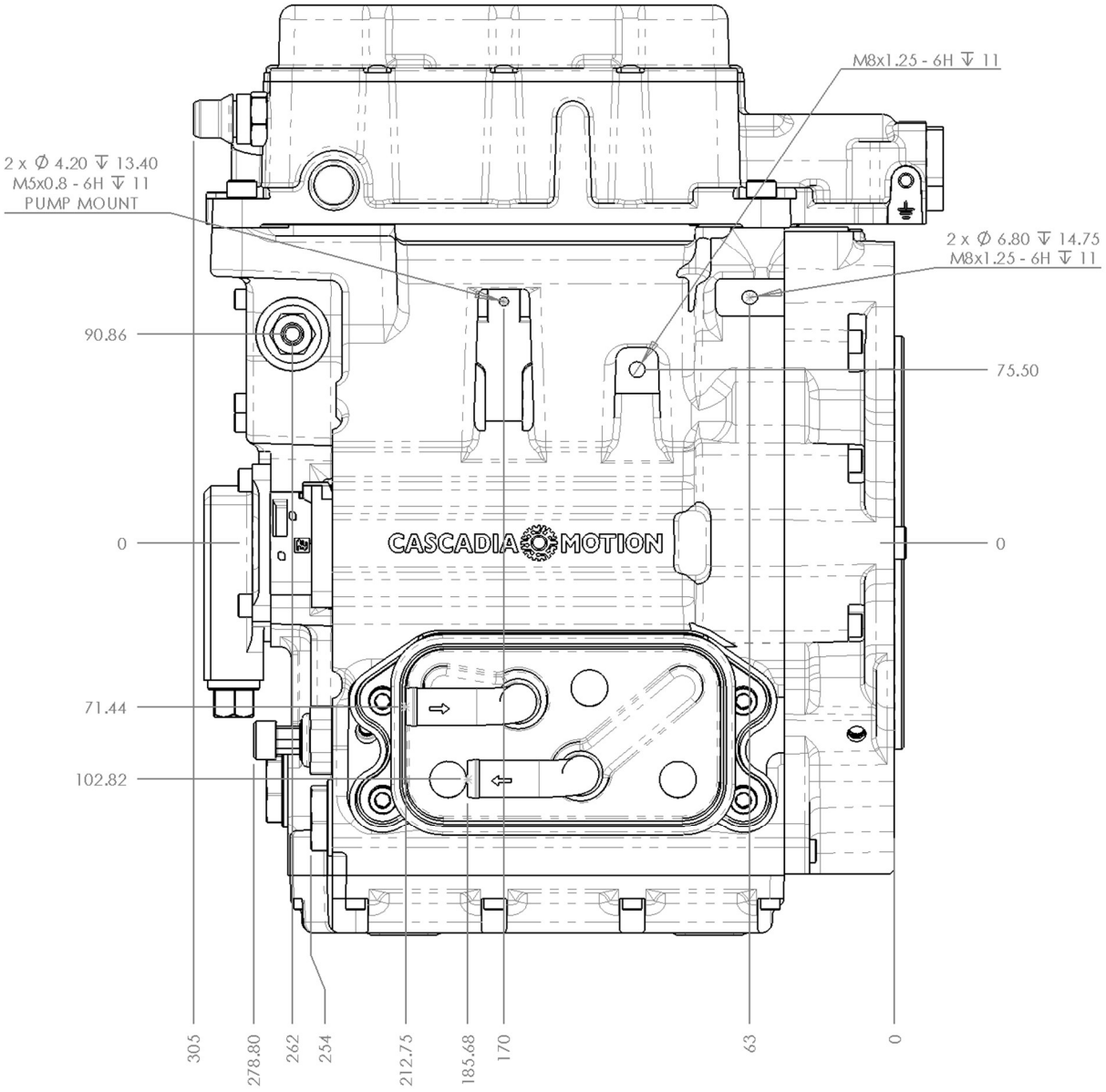


Figure 9.4 Customer Interface Features, Right

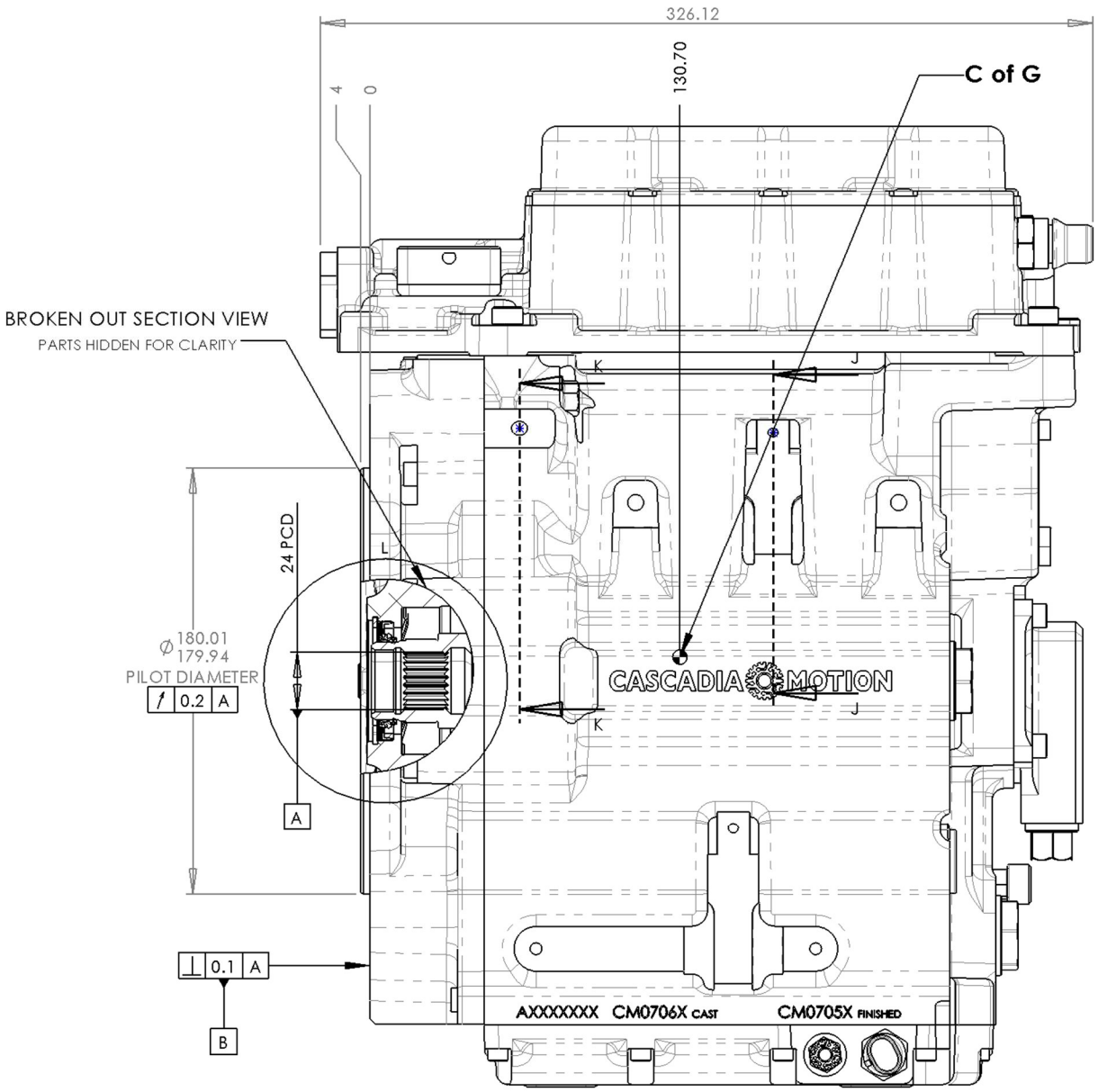
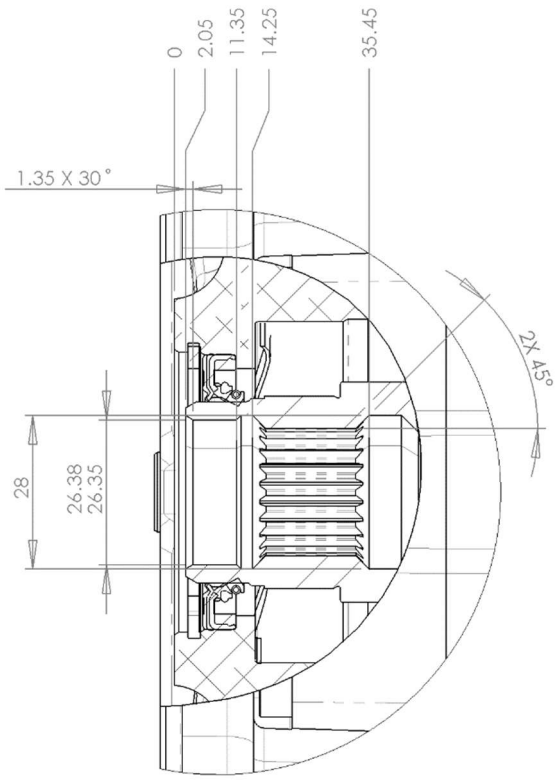
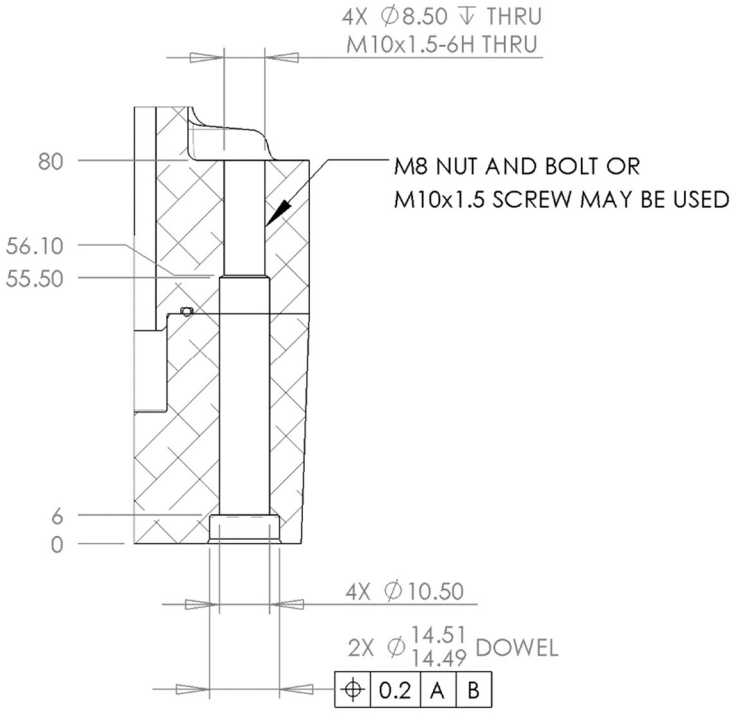


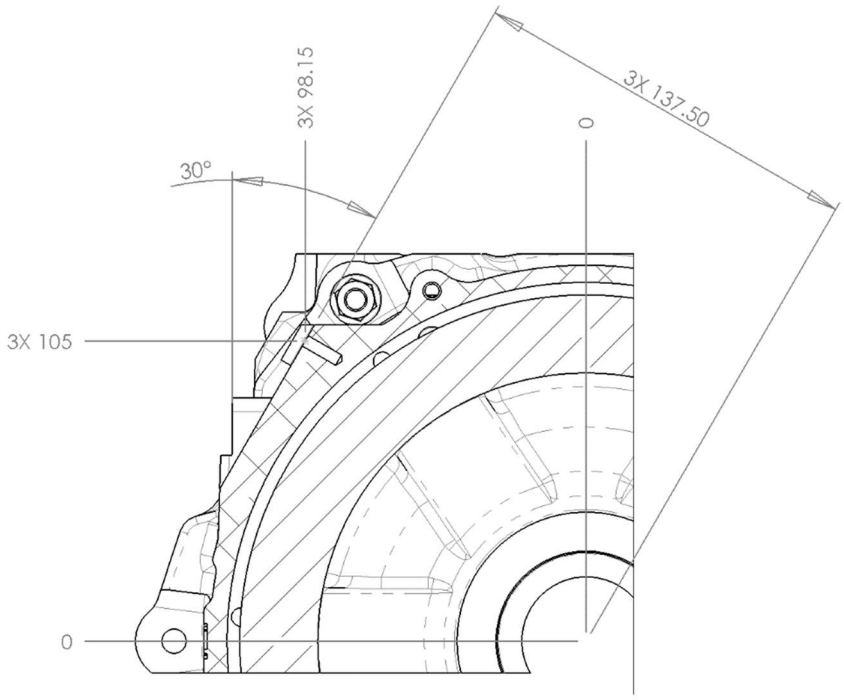
Figure 9.5 Customer Interface Features, Left Detail



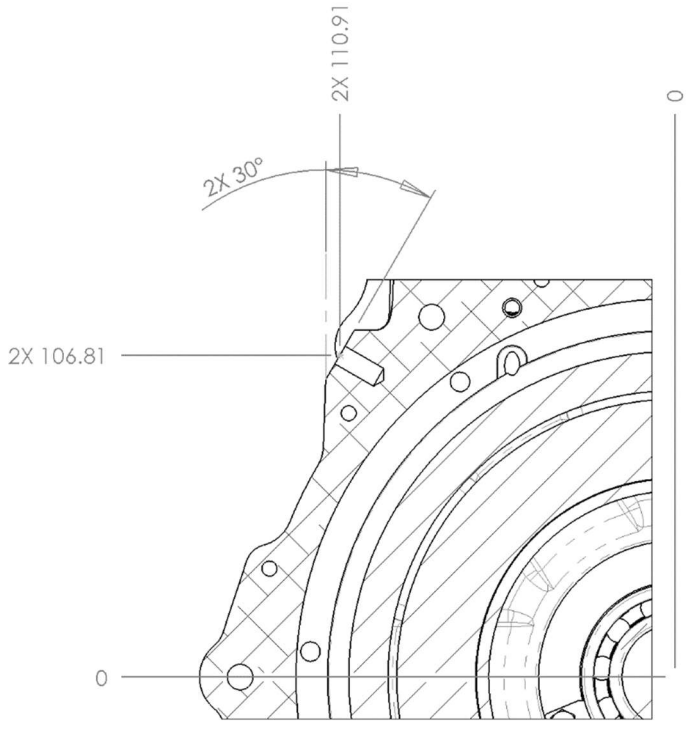
Detail L, Shaft



Section G-G – Through Hole Detail, Mounting



Section J-J – Pump Mount



Section K-K, Routing & Clipping Pad