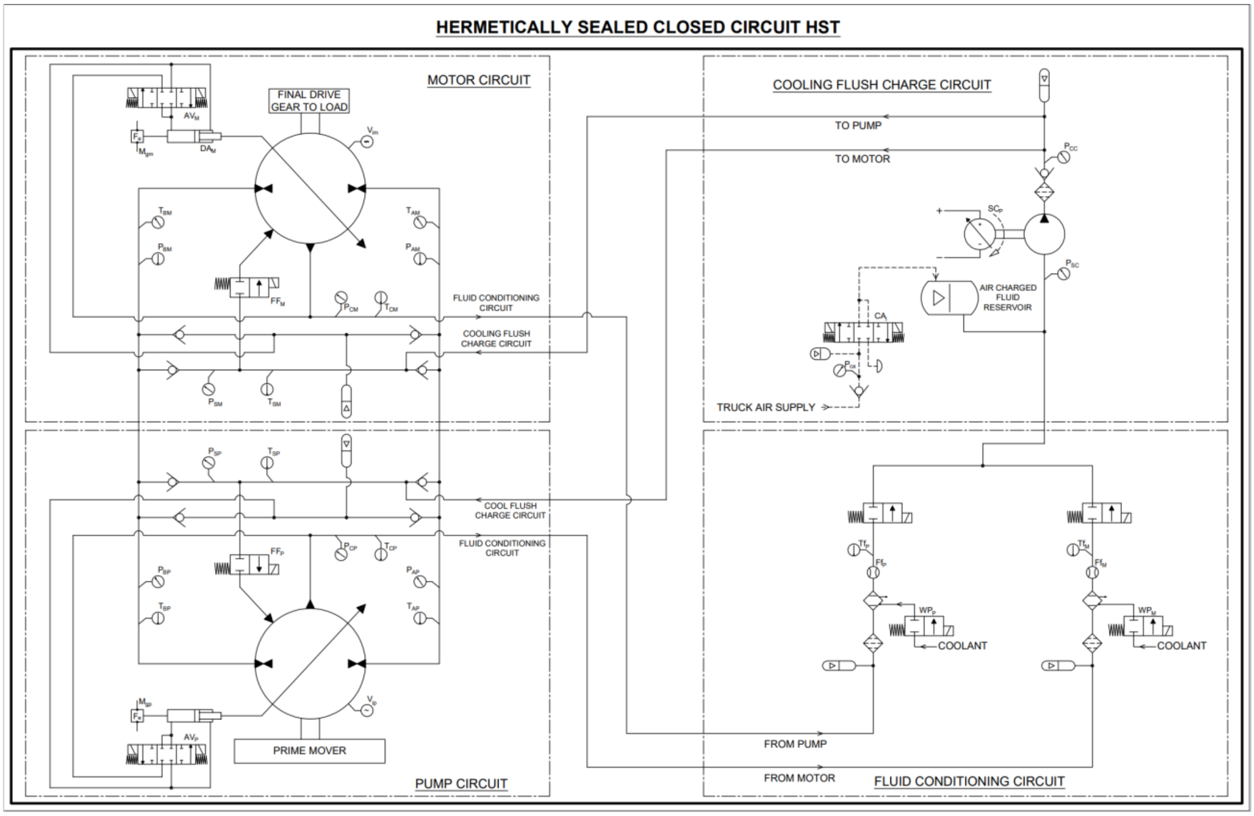
Fast Sled Propulsion (7/30/2023 by FSP Staff)

Hermetically Sealed – Fluid Circuit HST

Note: ***Click on the superscript notations in the paragraphs below to bring up the respective Bibliography segment. To return to that specific paragraph section, click on the same enlarged notation within the Bibliography.***



AIR CHARGED RESERVOIR

By utilizing the compressed air already available in trucks for functions such as brakes, an air charged sealed hydraulic reservoir can be maintained for the flexibility in its fluid volume while staying at a specified set pressure. This pressure, which is then at the return line to the Charge pump will prevent suction cavitation and can be kept below the Charge Pump maximum allowable range for intake pressure. This functional capability ensures the fluid is never exposed to the atmosphere, and fluid volume changes can be easily managed during the progressive movements of the HST (Hydrostatic Transmission).[A1]

HIGHER CORE PRESSURE

For Fluid conditioning, maintaining a higher core pressure at the pump and motor enhances the ability to push fluid effectively and efficiently through heat exchangers and filters that are in the return line path from the core. Valves regulate this core pressure according to control logic, and relief fluid goes into the air charged reservoir of the charge circuit as needed to control and maintain this core pressure.[B1]

APPRECIATING ALL THOSE SENSORS

By strategically placing sensors in proximity to each of the four functional circuit centers and their actuators, data can be created not only for computing accurate function control commands - but also archived for later reference. Sensor redundancy is essential for error checking to ensure measurement reliability and for the purpose of comparing archived data. Archived data is valuable not only to help flag service intervals but, also for knowing the limits on warranty coverage and, for planning improvements in future versions of manufacturing showing where good adjustments can be made.

Each of the four function centers (Pump, Motor, Cooling Flush Charge, Fluid Conditioning) can be designed for positioning and operation like plug and play components, providing advantages for service and assembly layout. Companies like Celera [C1] specialize in positional and rotational sensors required for the pump and motor, among others. Additionally, in line with modern use of hydraulic controls via electronic circuits, temperature and pressure sensors are installed at every branch, often with redundancy for error checking. Vibration and noise sensors are strategically placed in key positions to gather data for assessing functional stability, service requirements, and wear calculations.[C2]

OPTIMIZING CHARGE PUMP EFFICIENCY

The capability of an electric-over-hydraulic charge pump to perform multiple functions alongside flush-fill valves, not only adds to efficiency of operation but also ensures that the transmission's pump and motor will never turn the shafts or move the parts without there being pre-existing charge pressure in the lines and core pressure within the actuators. This approach tremendously reduces wear and tear while enhancing overall performance. All in addition to the cooling flush function needed to maintain operating temperature per the below.[D1]

MULTI-PURPOSE FLUSH-FILL VALVES

These typical Flush-Fill valves will take the conditioned cooled fluid coming from the charge pump and inject that into the core of the unit, with one valve dedicated to the pump and another to the motor. This operation will maintain the specified operating temperature, which is continuously monitored by sensors.

Further benefits of using the above is that during cold temperatures the heat exchangers can reverse their operation to heat the fluid and the charge pump then supplies this warm fluid through the flush-fill valves into the pump and motor cores - before any movement or higher pressures come into play. As rotation then starts to occur, this warmed, pressurized fluid circulates in the lines, effectively prewarming and pressurizing the transmission before startup, thus preserving the long-term durability of the transmission components.[E1]

USING SYSTEM PRESSURE FOR DISPLACEMENT BIAS

The HST here uses system high pressure in the pump and motor actuator rams as a constant force applied to the small area side of the ram piston. This serves as an automatic bias and stabilizer for the displacement adjustment. Only the pressure on the large area side of the actuator displacement ram piston will be adjusted by the displacement control valve in accordance with the program algorithm that specifies what movement is to happen at each moment of time. This configuration allows for sensitive and precise displacement control, particularly at high output and high rates of change.[F1]

THE BLACK BOX OF DATA HISTORY

In addition to the sensor data archived, a comprehensive historical data repository, often referred to as the ‘Black Box’, retains various other crucial information for each operational device throughout its service life. This can include records of current environmental conditions, fluid viscosity calculations, commands issued to controllers, and commands to valves. Identifying the time lag between command values and sensor data can be highly informative and very valuable for refining program algorithms, and for predicting wear and service requirements as usage hours accumulate over time.

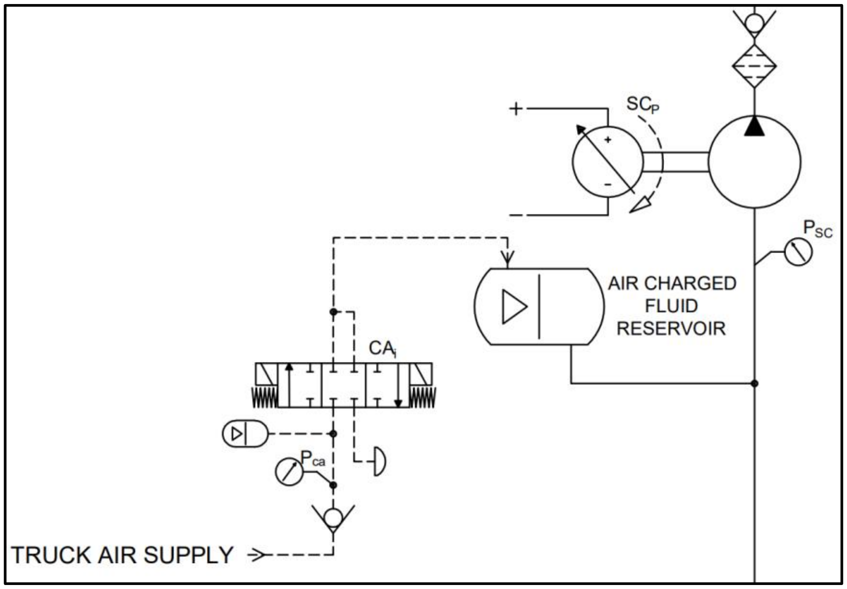
Furthermore, monitoring changes in the pressure and flow in and out of filters provides valuable insights into the progressive reduction of filter capacity, aiding in the timely replacement flagging for these.

Moreover, from a warranty standpoint, this historical data offers insights into whether the unit has been operating beyond specified limits for its peak functions, which, if the case, could potentially void the warranty according to the conditions specified there for its usage.

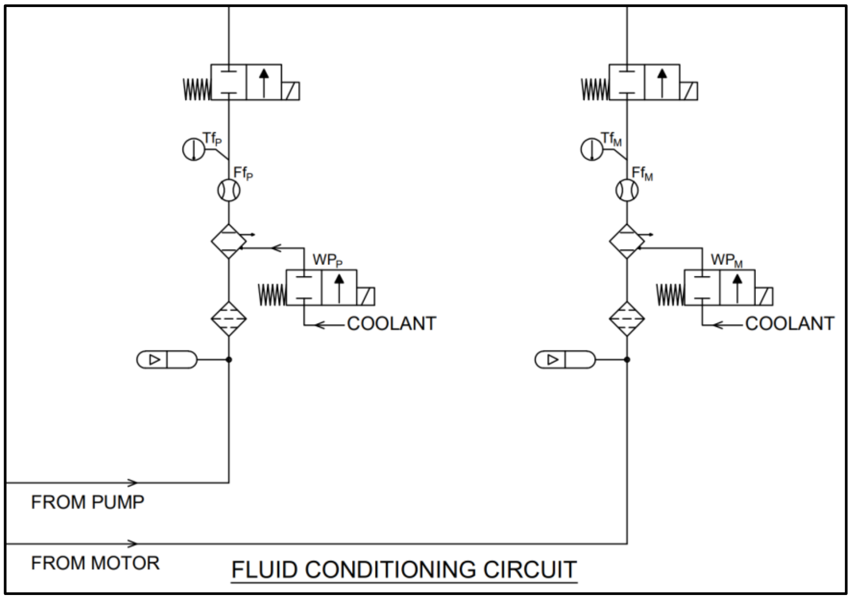
Bibliography

(Tables, Graphs, References, Calculations)

A1



B1



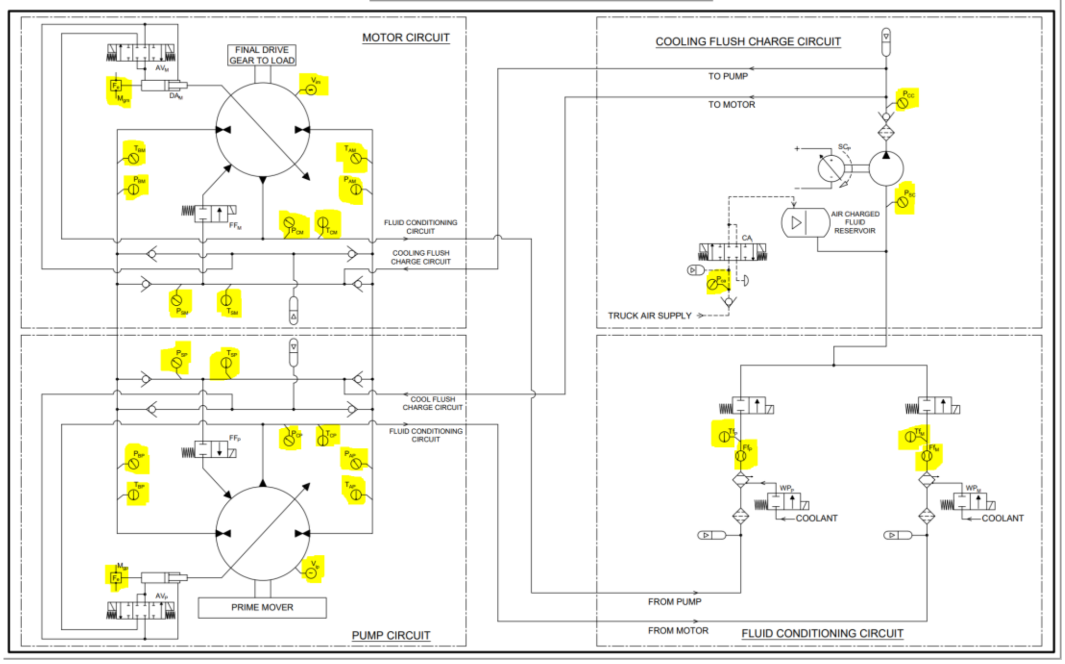
https://t20e.net

C1

[Precision motion control solutions | Celera Motion, A Novanta Company](#)
[Robust Angular Position Measurement | Extreme Environments (celeramotion.com)](#)
[Specialist Vehicles - Celera Motion](#)

C2

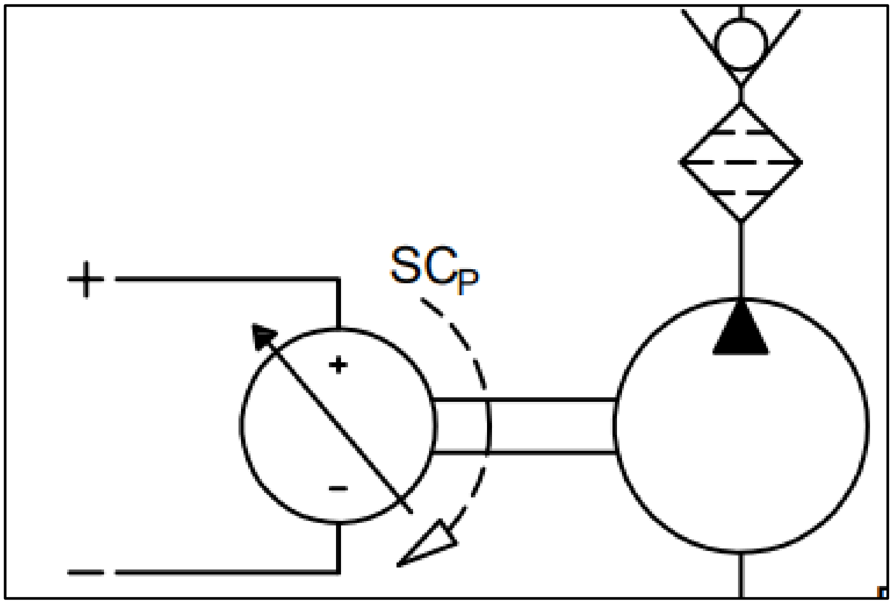
HERMETICALLY SEALED CLOSED CIRCUIT HST



27 Sensors shown of all types

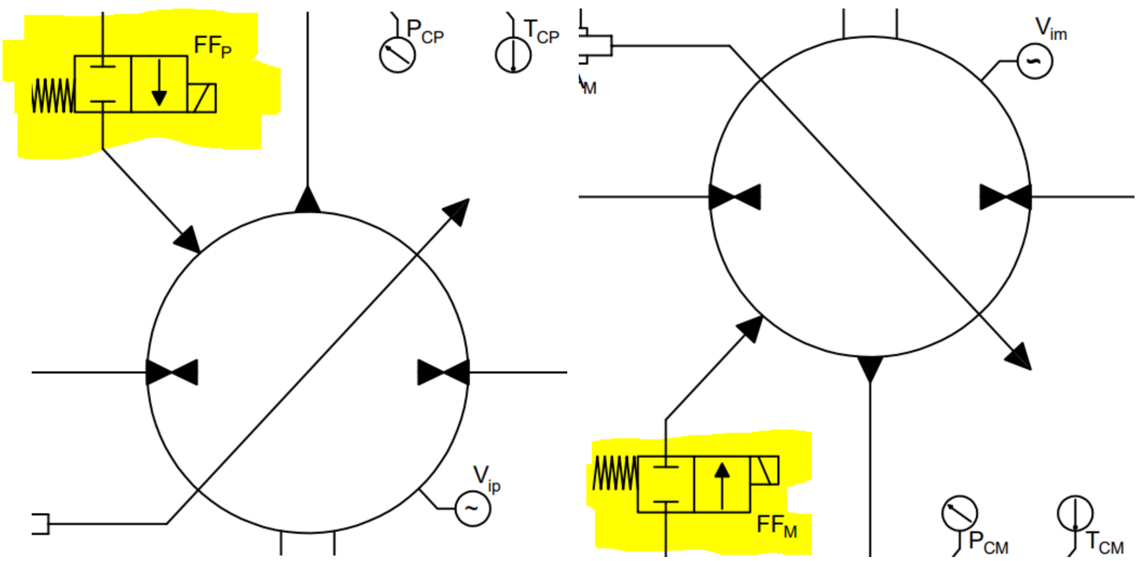
ALL OPERATIONAL SENSORS AND REDUNDANTS TO COLLECT DATA FOR OPERATING HST	
MGp	magneto stricture for Pump reading RPM's and Displacement position
MGm	magneto stricture for Motor reading RPM's and Displacement position
Tsm	Temperature sensor Super charge at the Motor
Tsp	Temperature sensor Super charge at the Pump
Psm	Pressure sensor Super Charge at the Motor
Psp	Pressure sensor Super Charge at the Pump
Pap	Pressure sensor Line A at the Pump
Pam	Pressure sensor Line A at the Motor
Tap	temperature sensor Line A at the Pump
Tam	temperature sensor Line A at the Motor
Pbp	Pressure sensor Line B at the Pump
Pbm	Pressure sensor Line B at the Motor
Tbp	Temperature sensor Line B at the Pump
Tbm	Temperature sensor Line B at the Motor
Pcp	Pressure sensor in Core at the Pump
Pcm	Pressure sensor in Core at the Motor
Tcp	Temperature sensor in Core at the Pump
Tcm	Temperature sensor in Core at the Motor
Vip	Vibration/Noise sensor at the Pump
Vim	Vibration/Noise sensor at the Motor
Tfp	Temperature sensor end of Fluid conditioning for Pump
Tfm	Temperature sensor end of Fluid conditioning for Motor
Ffp	Flow sensor end of Fluid conditioning for pump
Ffm	Flow sensor end of Fluid conditioning for motor
Psc	Pressure sensor at Reservoir & Suction intake of the Charge pump
Pcc	Pressure sensor at Case relief output of the Charge pump
Tca	Truck Compressed air pressure available at Reservoir valve.

D1



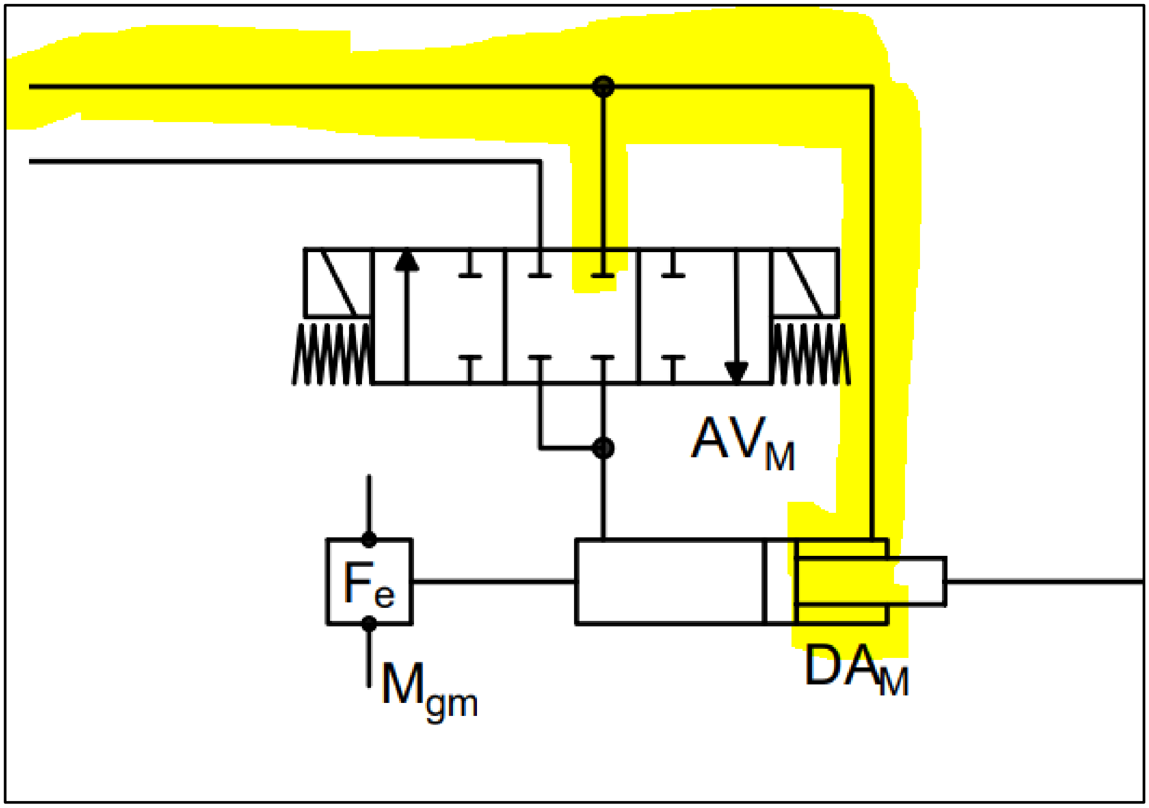
Electric Over Hydraulic Charge Pump

E1



Flush-Fill Valves

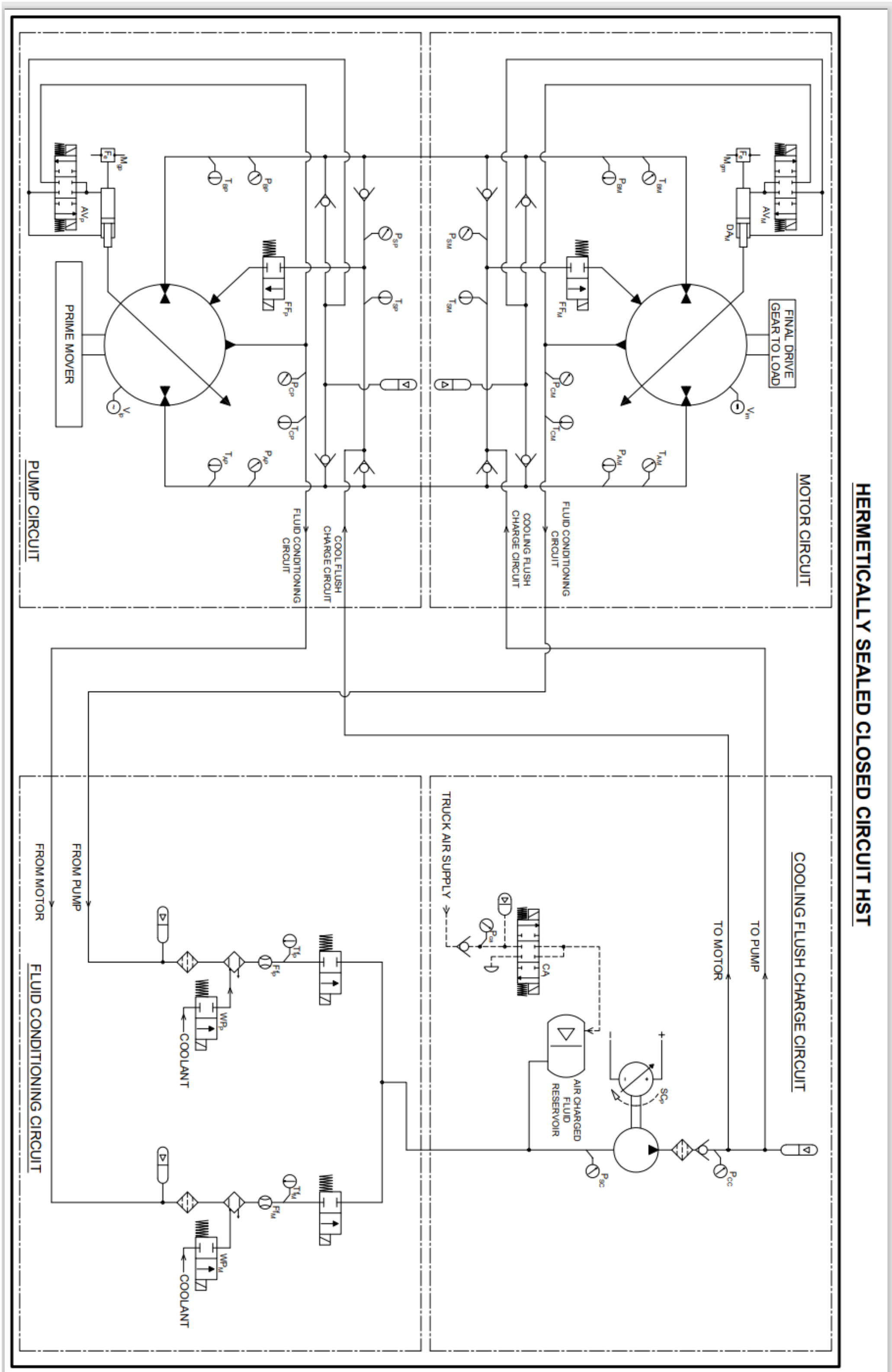
F1



System Pressure as Displacement Bias

ALL OPERATIONAL MECHANISMS TO CONTROL		
AVp	The Valve that determines displacement for the pump [KEEPER OF THE PSI]	
		determined by Algorithm with primary input from pressure in working line needing to follow algorithm
AVm	The Valve that determines displacement for the Motor [KEEPER OF THE FLOW]	
		determined by Algorithm with primary input from operator input - deciding for more or less power to the load
		[TAKING ALL INFLUENCERS INTO ACCOUNT FROM SENSORS ABOVE THROUGH ALGORITHIM]
FFp	The Valve that determines Flush Fill into the Pump	
		primary signal from Core Temperature sensor - for temp control
FFm	The Valve that determines Flush Fill into the Motor	
		primary signal from Core Temperature sensor - for temp control
CVp	The Valve that is normally closed but opens per algorithm for Core pressure control in the pump (i.e. 260 psi)	
		flow out is influenced by pressure drop from filter and heat exchanger
CVm	The Valve that is normally closed but opens per algorithm for Core pressure control in the Motor (i.e. 260 psi)	
		flow out is influenced by pressure drop from filter and heat exchanger
WPm	Cooling water flow to heat exchanger for Motor	
		determined by temperature differentials in Core & Lines & output temp after heat exchanger
WPp	Cooling water flow to heat exchanger for Pump	
		determined by temperature differentials in Core & Lines & output temp after heat exchanger
SCp	Super Charge Electric over Hydraulic pump (STEPPER MOTOR ENERGIZING CYCLES)	
		turning off and on this pump according to Algorithm set point for Super Charge line pressure (i.e. 650 psi)
CAi	Air from Truck compressor controlling flow into and out of Reservoir bladder isolation area for set point on Reservoir fluid pressure	
		from algorithm reading Charge Pump case pressure
		and maintaining some set point below that for Charge pump suction feed and operation

https://t20e.net



Full Circuit Diagram Enlarged

