TesLorean Thermal Control Scheme

Purpose

Autonomous unit that controls the pumps/valves/fans/AC/Heater that route coolant around the TesLorean based on temperature readings and operational limits for each key module.

Primary Layout

The coolant flow layout has an Inner and Outer loop system.  The battery is on the inner loop and the motor is on the outer loop.  The outer loop is primarily charged with keeping the drive unit and charger cool enough.  The inner loop is charged with maintaining the operating temperature band of the Battery, using the Heater, Chiller, and accounting for heat from the DCDC converter.

Theory of Operation

Outer Loop : The drive unit (HSM module) sends out CAN messages indicating current temperatures.  The coolant pump (outer) is always running if the drive unit is activated or the charger is active.  The drive unit and charger (in this design) will not be active at the same time (charging is done stationary).  The diverter valve to send coolant to the radiator will only be active if drive unit or charger temperatures require it.  If the radiator is active, then the fans will be active also.

Inner Loop : The inner loop seeks to maintain the battery within temperature limits during operation of either the charger or the drive unit.  If the battery is too cold, the heater is activated to raise the coolant temp, in combination with the heat from the DCDC converter. If the battery is too hot, the chiller can be activated (requires the AC compressor to be running, at least 1 fan for the condenser, and the chiller solenoid).

Joined Loops : By default the inner and outer coolant loops are disconnected.  If the inner loop needs modest cooling (via the radiator), or the outer loop need aggressive cooling (via the chiller) the two systems can be connected (via the 4-way diverter valve).  This allows the inner loop access to the radiator, and the outerloop access to the chiller.

Thermal Limits

Min Max HiMax

Drive Unit n/a 120F 180F

Battery 50F 90F 110F

Charger n/a 100F 150F

DCDC n/a 100F 150F

States

* 3-Way Diverters (Open, Bypass)
* 4-Way Diverters (Separate, Joined)
* Pumps, Heater, Chiller (Off, On)
* Cooling Level Required (none, low, high)
* Heating Level Required (none, low, high)
* Fans (On, Off)

Status Changes

Inner Loop

Cooling Level

* Default : None
* Low : Battery temp OR DCDC temp > Max
* High : Battery temp OR DCDC temp > HiMax

Heating Level

* Default : None
* High : Battery temp < Min

Outer Loop

Cooling Level

* Default : None
* Low : Drive Unit OR Charger temp > Max
* High : Drive Unit OR Charger temp > HiMax

Rules of Unit Operation

Outer Coolant Pump

* Default : Always running when charger or drive unit activated

Inner Coolant Pumps

* Default : Always running when charger or drive unit activated

Radiator Diverter

* Default : Bypass
* Open : when Outer = Cooling

Chiller Solenoid AND AC Compressor

* Default : Off
* On : when Inner = Chilling and Cooling Level high
* Note : AC Compressor is PWM controlled (for AC cooling level required)

Coolant Diverter

* Default : Bypass
* On : when Inner = Chilling and Cooling Level high

Radiator Fans

* Default : Off
* On : when Outer = Cooling and Cooling level required high

Coolant Heater

* Default : Off
* On : when Inner = Heating and Heating Level high
* Note : Heater is PWM controlled (for heating level required)

4 Way Diverter

* Default : Separate
* Joined : AND
  + Inner Temp > Outer Temp (by X degrees?)
  + Inner Temp = Cooling low or high

Pseudo Code

Setup()

* Setup Serial port (for debugging info)
* Setup CAN link (single)
* Temperature Tracing Arrays
* Initial Power-up Status
  + Pumps Off
  + Valves in ByPass
  + Diverter in Separate
  + Chiller Solenoid Off
  + AC Compressor Off
  + Heater Off

Loop()

* Check In Coming CAN
  + Update internal variables for latest temp settings
  + Update tracking arrays with new data (replace aged data)
* Check temp limits and adjust model settings
* Update device state using rules  (pumps, valves, AC, heater) based on model states
  + Hysteresis checks
* Execute device status requests
  + Some may require several cycles (e.g. spin-up on the AC Compressor)
* Send Status CAN Messages

Temperature Reading Sources

* CAN\_TL BattCont 0x0111 Temp Warning (Codes and temps)
* CAN\_TL BattCont 0x0120 Pack temps and vols trend (CONFLICTED ID)
* CAN\_TL BattCont 0x0123 Battery Mod Temps (temps for all 8 modules)
* CAN\_TL Charger Info 0x0302 Bank temps 2 banks per module, 4 modules in pack
* CAN\_TL Charger Info 0x0460 Pack half temps, Temps from each pack half
* CAN\_DU HSR Info 0x0506 HSR\_DI\_temperature, 8 temps drive unit
* CAN\_DU HSR Info 0x0514 HSR\_DI\_temperature2, 8 inverter temps
* CAN\_DU HSR Info 0x0516 HSR\_DI\_maxT, 1 target temp, 4 max temps, and 1 flag