Kenworth HVAC Systems

Mobile Air Conditioning Society Worldwide

2017 Convention

KENWORTH

MACS MOBILE AIR CONDITIONING SOCIETY WORLDWIDE

Topics

- Introductions
- System Components
- Kenworth Electrical
- Truck System Information
- B-Cab
- T2000/T700
- NGP 680/880
- Testing/Troubleshooting
- Scan Tool
- K Series Medium Duty
- T Series Medium Duty
- KIMS

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Who is PACCAR/Kenworth

PACCAR is the corporate umbrella for truck, and supply related manufacturing companies, headquartered in Bellevue, Washington. Initially manufactured railroad cars and logging equipment, starting in 1905.

Heavy-duty truck manufacturing market segments:

- Kenworth Motor Truck Company, USA, in 1945
- Peterbilt Motors Company, USA, in 1958
- Dart Truck Company, USA, in 1958
- Foden Trucks UK in 1981
- DAF Trucks N.V. in 1996
- Leyland Trucks UK in 1998

Truck Subsidiaries:

- Kenworth Mexicana VILPAC 1966
- Kenworth Australia, in 1970
- Paccar Engine Manufacturing NA, in 2010

Kenworth Models

Class 8 – Heavy Duty, Off Highway

+80,000# GVWR

2.3m (Wide Cab)

- T2000 - > T700: No longer produced

1.9m B-Cabs

- T800, W900, T600 -> T660, C500, C550, T440, 963

2.1m Next Generation Product (NGP)

- Kenworth: T680, T880
- Peterbilt: 579, 567

COE

- K500: Off highway ONLY
- K100: No longer produced

MONSTER TRUCK: up to 400,000# GVWR

- 963/965: Off highway ONLY – modified B-Cab electrics

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Kenworth Models

Class 7, 6 & 5 – Medium Duty
33,000# – 16,001# GVWR

- **T370, T270, T170**
  Conventional Cab,
  Built in Saint Therese, Canada
  - **T370 Class 7: 26,001 - 33,000# GVWR**
  - **T270 Class 6: 19,501 - 26,000# GVWR**
  - **T170 Class 5: 16,001 – 19,500# GVWR**

Simplified B-Cab Electrical System

- **K370, K270 (LFNA: LF North America)**
  COE, Cab built in Holland,
  Assembled onto chassis in Mexico
  - **K370 Class 7: 26,001 - 33,000# GVWR**
  - **K270 Class 6: 19,501 - 26,000# GVWR**
  - **Use DAVIE 4 to service cab's electrical**

24VDC– Cab
12VDC– Chassis

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Kenworth/Peterbilt Model Comparison

Models	Production Built Dates	Engine Emissions Level
PB: 357, 378, 379, 385, 386 **KW:** C500, T600, T800, W900, Off-Highway	2004 - 2006	1998, 2004
PB: 365, 367, 384, 386, 388, 389 **KW:** C500, T440/T470, T660, T800, W900, Off-Highway	2007 - 2009	2007
PB: 387 **KW:** T2000	2008 - 2009	2007
PB: 325, 330, 337, 348, 587	2010 - 2011	2010
KW: T170, T270, T370, T700	2010 - present	
PB: 325, 330, 337, 348	2012 - present	
PB: 587	2012	
PB: 365, 367, 384, 386, 388, 389	2010 - 2012	2010
KW: C500, T440/T470, T660, T800, W900, Off-Highway	2010 - present	
PB: 579 **KW:**T680	2012 - present	
PB: 365, 367, 384, 386, 388, 389		
PB: 587	2013 - present	2013

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System Components

Mechanical Components

Most current applications use Sanden, compressors.

SD5H14 and SD7H15

Mechanical Components

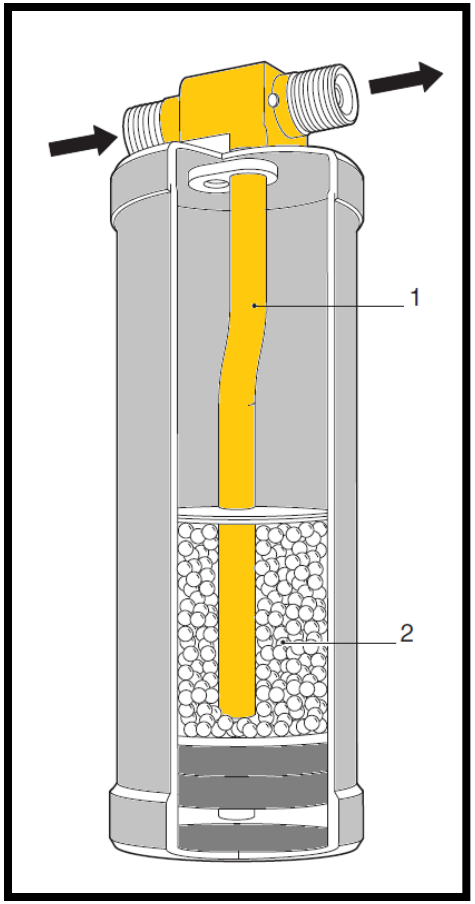
Condenser, sized per application parameters.

Mechanical Components

Receiver-Drier:

Normal application, absorbs system moisture and also filters and stores the liquid coolant

Uses either XH7 or XH9 desiccant package.



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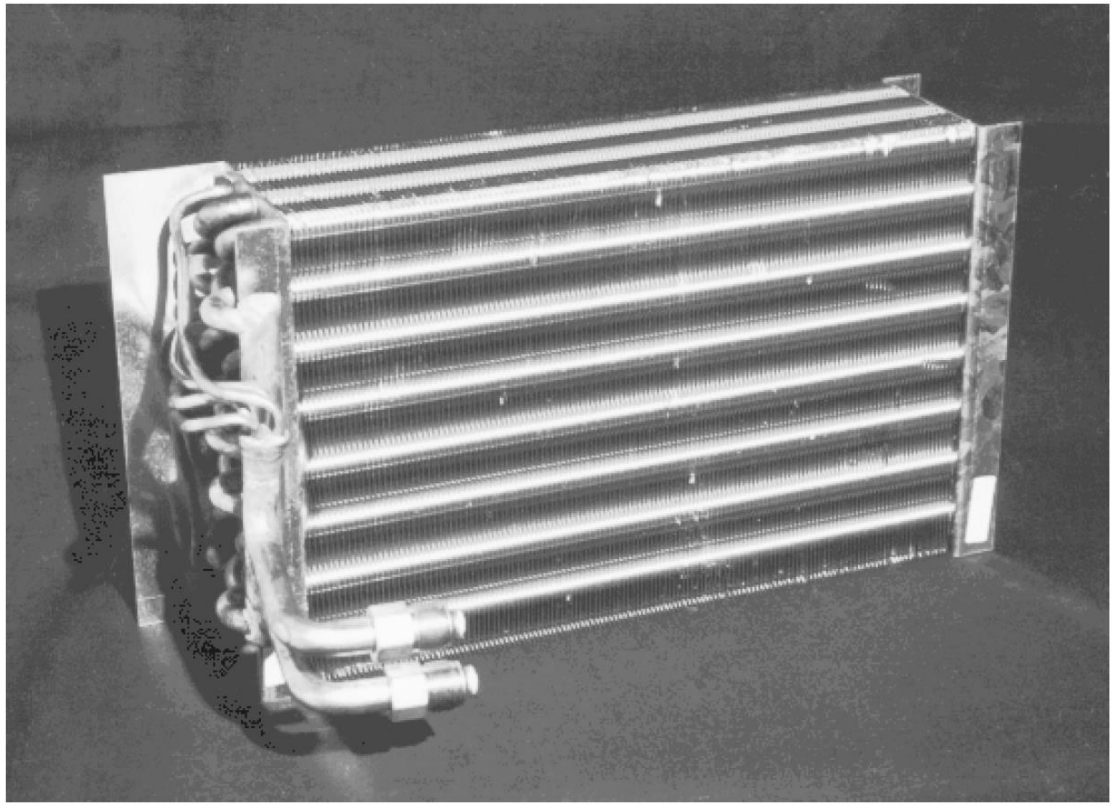
Mechanical Components

Expansion Valve

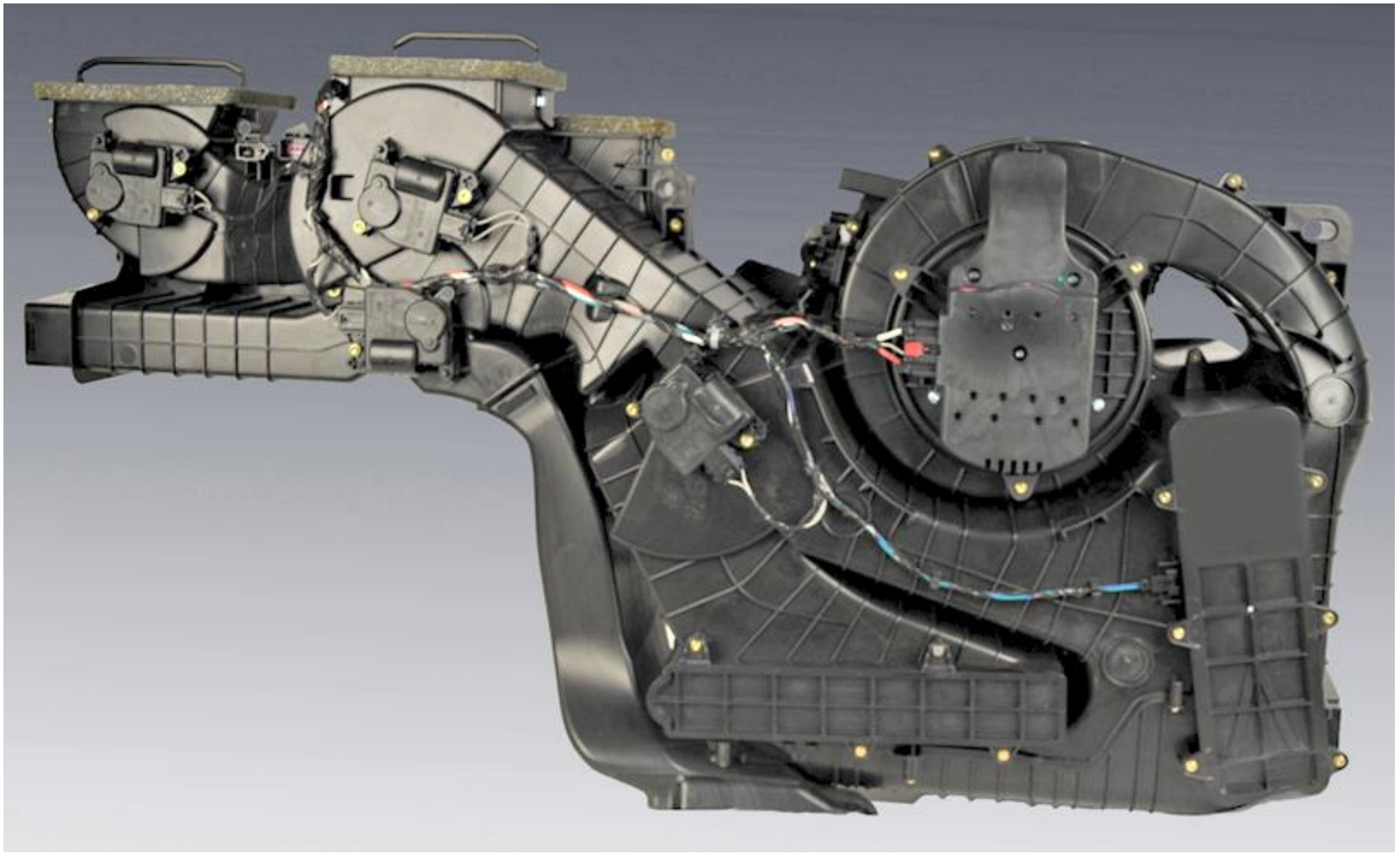
Mechanical Components



Evaporator:

- Changes low pressure liquid into a low pressure gas by absorbing heat from cab air

Mechanical Components



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Mechanical Components

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Electrical Systems

CAN Electrical Systems Definitions

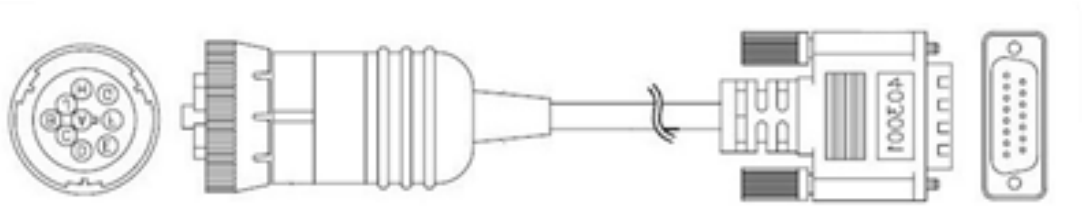
Definitions

Instrumentation Control Unit (ICU) – 1st generation ***Instrumentation-only*** Multiplex

Cab Electronic Control Unit (CECU) – 2nd generation Multiplex, includes systems other than instrumentation. CECU's variants relate to vehicle model and the engine emissions standard. Identifying which CECU in the vehicle helps determine what features are present and also aids in troubleshooting.

North American MultipleXing (NAMUX) - The CAN electrical architecture used by Kenworth and Peterbilt Divisions.

Electronic Service Analyst (ESA) - Software Program needed for all CAN system malfunction code reading and service related operations. NEXIQ scan tool used with ESA software.



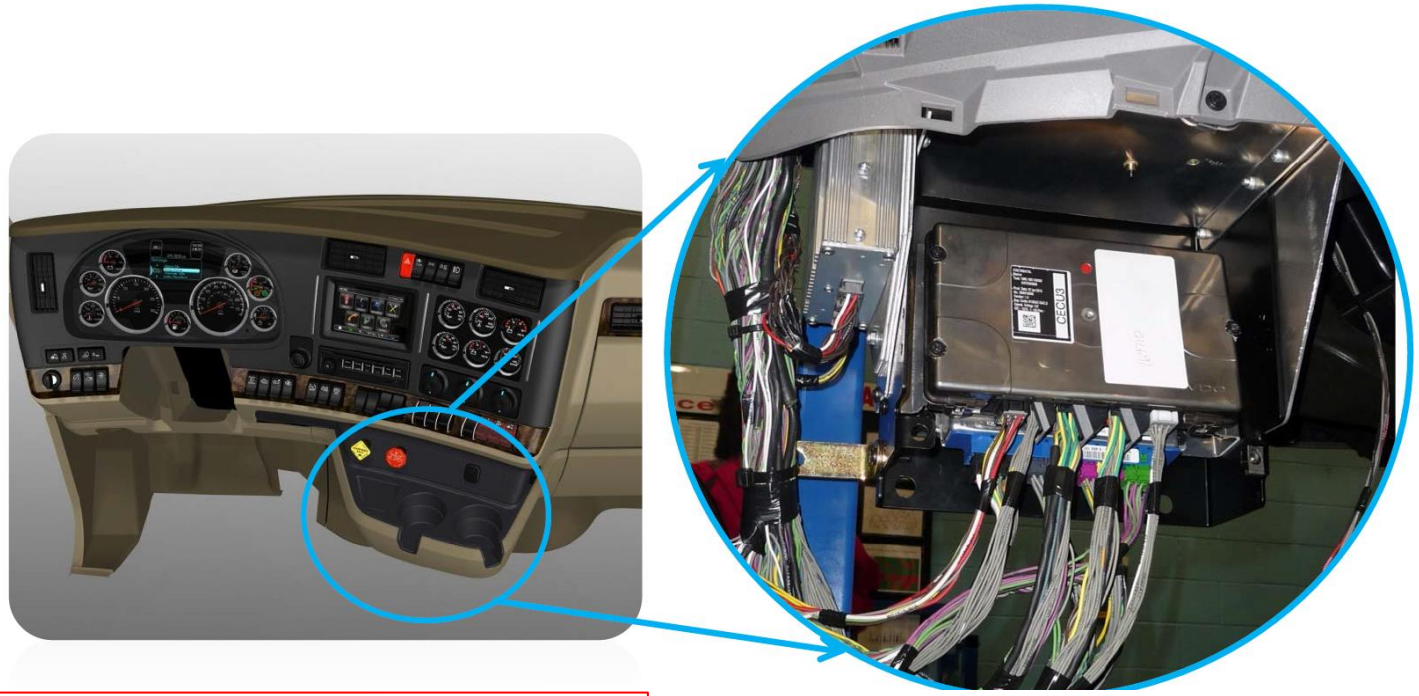
Kenworth Electrical Systems – 2 Iterations

- **Traditional Electrical Systems:**
  - (Legacy - thru - 2004) – KM815001
- **CAN Based Instrumentation:**
  - ICU – NAMUX (2005-2007) – KM815054/PM819010
  - CECU – NAMUX2 (2007-2010) – KM815054/PM819010
    - Service manual change, see page 38/39
- **CECU3 – NAMUX3/ NAMUX4 (2010 – Present) w/Chassis Node**

  B-Cab = NAMUX 3 – KM815056 (includes DTC codes)

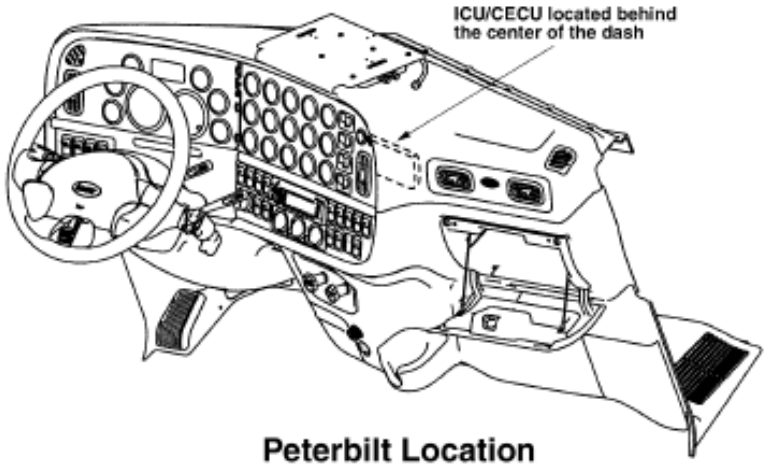
  NGP = NAMUX 4 - KM815057 (includes DTC codes)

Electrical - Typical ICU/CECU Locations



Note: T2000 and T700 is at the front of the passenger footwell.

2010 emissions compliantT170, T270, T370 medium duty, is behind the lower center of the dash panel. Peterbilt versions, behind the top center of the dash panel.



Peterbilt Location

Electrical - 1st Iteration

Standard Electrical Systems – 1st Iteration

Original Circuit Wiring Key for production prior to phase out for CAN thru 2004

Example: C17SR

Function . . . . . C = Components
Circuit Number . . . . . 17 = Starter Solenoid
Destination or Purpose . . . . SR = Starter

Brief Examples of Each Category Definition

FUNCTION LETTER	DESCRIPTION
C	Components
E	ECU / Electronic Control
G	Gauges
GND	Ground

10

320

Circuit No.	Circuit Description	Color Code
Gnd	Ground	ATA White
1.	Tail and Park Lamps	ATA Brown
2.	Stop Lamps	ATA Red
3.	Marker & Clearance Lamps	ATA Black

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Destination or Purpose

A	
ABS	Anti-Lock Brake
AC	Air Conditioning
AD	Air Dryer
AF	Accessories Feed

Models Covered by Elect Wiring Key—T2000, T6/T8/T4, W900B,C500B, K100E

Service Manual KM815001

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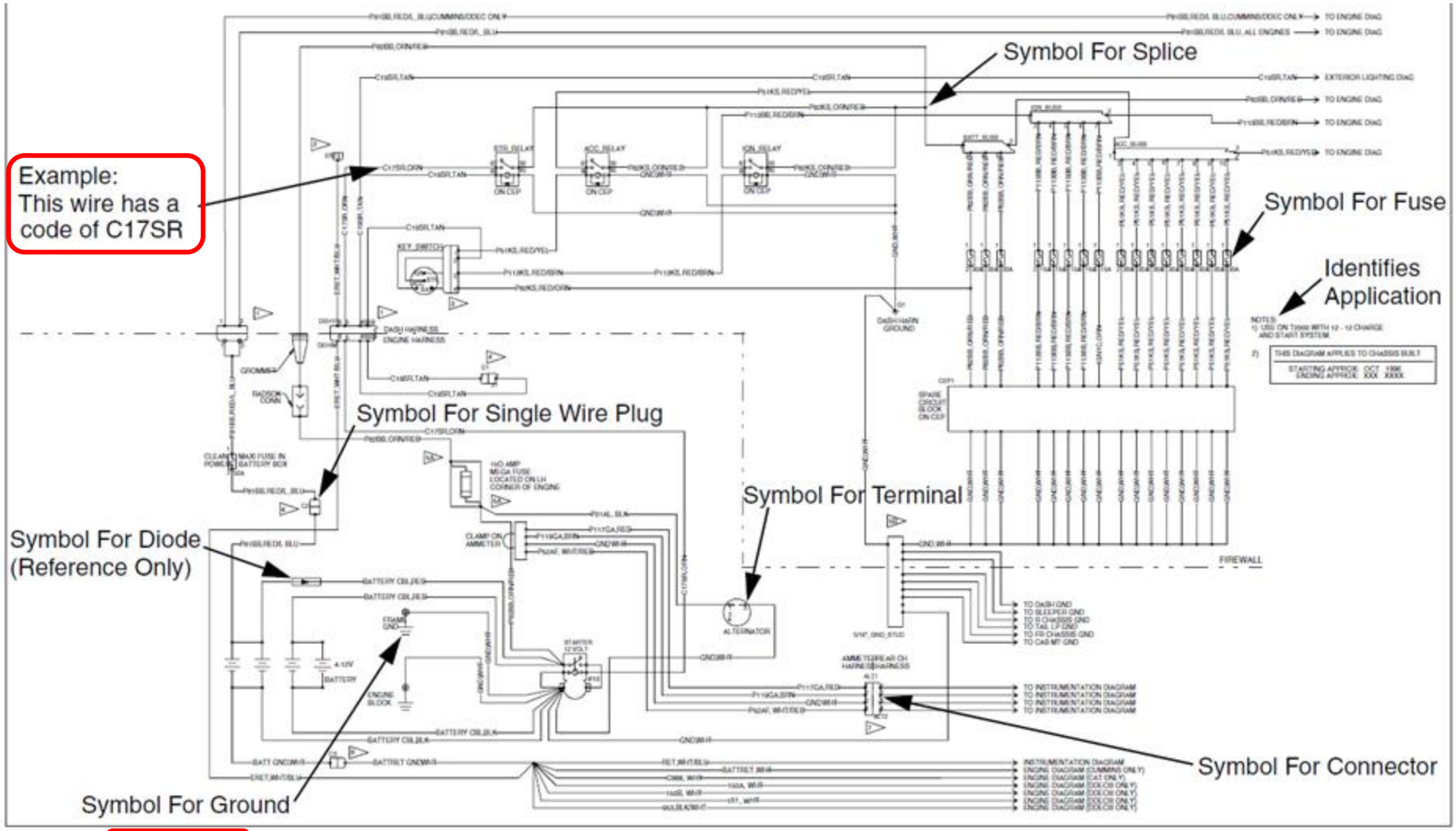
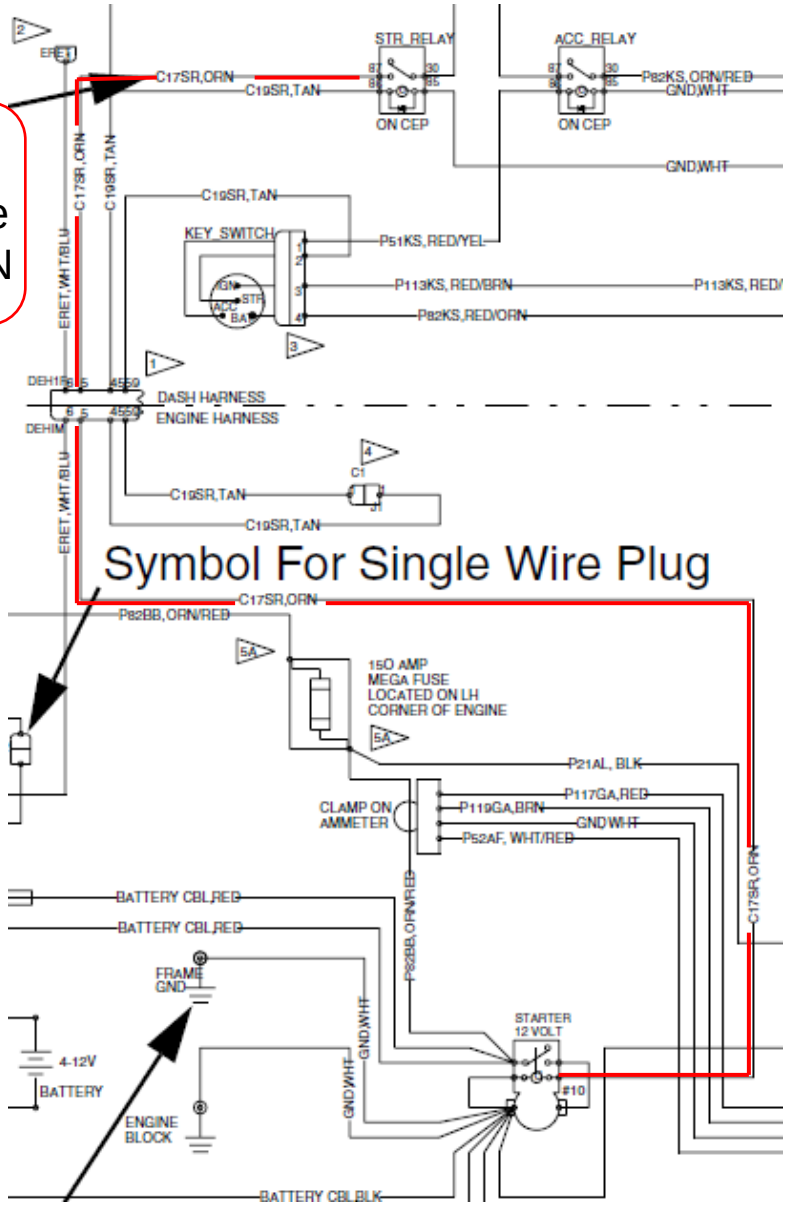
Electrical - 1st Iteration



Electrical - 1st Iteration

Example: this wire has a code of C17SR, ORN



Electrical - 1st Iteration

Electrical Circuit Matrix

See "Electrical Circuit Matrix" on previous page for instructions on how to identify circuit number and name.

Stripe	Solid Color														
	Black	Blue	Brown	Green	Gray	Lt. Blue	Lt. Green	Orange	Pink	Purple	Red	Tan	Violet	White	Yellow
Black	3 21 22 ALTI PCB	108	37	34 76	27 28 29	30	98	111	53		6 49	72		52	33 166
Blue		4 103 104 105 106 107	215 308		173		56	64 226	50		68 120	223	163	RET	47 169
Brown			1 119	58		44	320	139	245		113		155	174	200 248
Green	71 75 304	208	45 129	36 157 186	138 201	97		74 140	65	204	147 118	23	162	11	32 70
Gray	137	78	127 132	135	13 69	311	317	133			8 183			131	CAP
Lt. Blue	306	109	309 110	101	63 177	5		229	249	203	81	86 92		178	SPS
Lt. Green	95	205	310 216		136	313	18	244		233	231	222	232	144	170
Orange	84 305	77 247	158	43 152	134	314	122	17 143 IGN			80		164	175 220	168
Pink	307	24	SPE	94	60	315	184		25 SPR	154	39			ERET	199
Purple				238	239	316	319	172	153	9	228	221		180 219	31
Red	148 192 195 303	150 190 207	128 194	42 191 210	16 182	91	99	82 141	116	90	2 117 181 BAT 123	73		54 100 193	38 62
Tan	230	SPC	83	46		93 85				237	14	19 59		179	171
Violet			156	246	176						40 126		26	OATI	151
White	112 115 301	7 206	159 41	12		318	124 102	160 88	79	10 236	48 234	114	66 235	61 145 146 GND V 187	167 87
Yellow	302	55 196	89 217 312	211	149 15 202	20	96 125	161 198		57	51 197 240	67	165 241	OAT2	35 121 142 ACC 185

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Kenworth Wire Numbering System

P12HN – Kenworth Circuit Code

Circuit function - P

Circuit number

Color of the wire

Destination of circuit or purpose of the circuit

Using Electrical Circuit Matrix

Kenworth Wire Numbering System

Example: P12HN

Circuit function - P

FUNCTION LETTER	DESCRIPTION
C	Components
E	ECU / Electronic Control
G	Gauges
GND	Ground
H	Heating / Air Conditioning
L	Lighting
P	Power
PCB	Power from Spare Circuit Breaker
R	Relay
S	Spare

P - identifies circuit function: Power

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Kenworth Wire Numbering System

Example: P12HN

Circuit function

Circuit number - 12

Color of the wire

Destination of the circuit or purpose of the circuit

Using Electrical Circuit Matrix

KENWORTH

Kenworth Wire Numbering System

Example: P12HN

Circuit number -

Color of the wire

12 - Identifies circuit color: Green/White

12 - Identifies circuit description: Horn Relay Hot

Electrical: Electrical System

Circuit No.	Circuit Description	Color Code
Gnd	Ground	ATA White
1.	Tail and Park Lamps	ATA Brown
2.	Stop Lamps	ATA Red
3.	Marker & Clearance Lamps	ATA Black
4.	Hot Wire for Auxiliary Devices on Trailer	ATA Blue
5.	Head Lamps	Lt. Blue
6.	Low Beam	Red/Black
7.	High Beam	Blue/White
8.	Control Circuit for Accessory Relays	Red/Gray
9.	LH Road or Fog Lamp	Purple
10.	RH Road or Fog Lamp	Purple/White
11.	Horn Relay Ground	White/Green
12.	Horn Relay Hot	Green/White
13.	Panel Lamps	Gray
14.	Flood or Loading Lamp	Red/Tan

Circuit No.	Circuit Description	Color Code
32.	Service Brake Sense	Yellow/Green
33.	Left Front Directional Signal Lamp	Yellow/Black
34.	Right Front Directional Signal Lamp	Green/Black
35.	Left Rear Directional Signal Lamp	ATA/Yellow
36.	Right Rear Directional Signal Lamp	ATA/Green
37.	Idle Validation Off	Brown/Black
38.	Idle Validation Signal	Yellow/Red
39.	Hot Feed Line to Pressure Auxiliary Switch	Red/Pink
40.	Return Line from Pressure Auxiliary Switch	Red/Violet
41.	Sanders	Brown/White
42.	Radio Receiver	Green/Red
43.	Radio Transmitter	Green/Orange
44.	Differential Lock	Lt. Blue/Brown
45.	Fifth Wheel Lock	Brown/Green
46.	Low Air	Green/Tan

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Kenworth Wire Numbering System

Example: P12HN

Circuit function

Circuit number

Color of the wire

Destination of the circuit or purpose of the circuit - HN

Using Electrical Circuit Matrix

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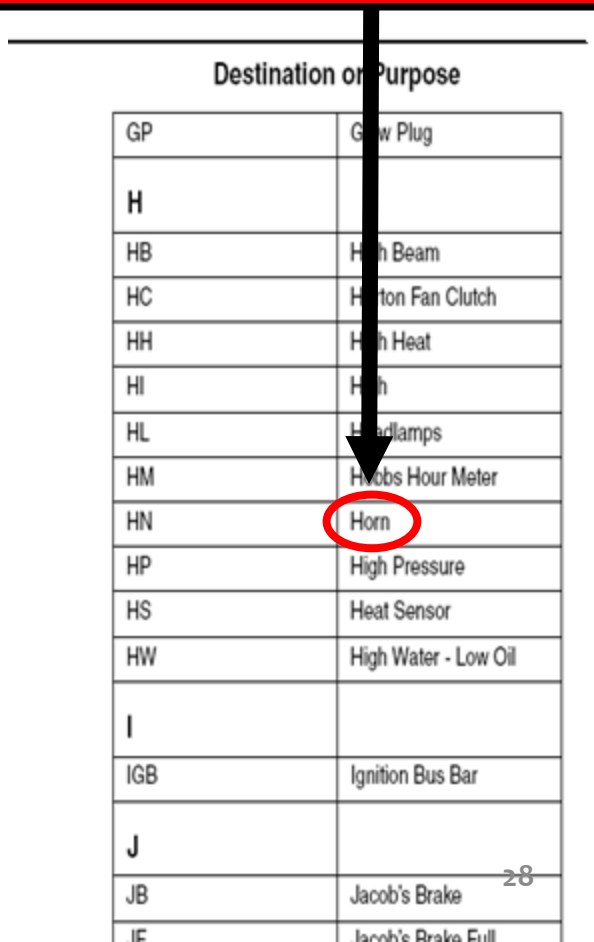
Kenworth Wire Numbering System

Example: P12HN

Circuit purpose – HN

HN - identifies circuit destination or purpose:

Horn



Destination or Purpose

GP	Glow Plug
H	
HB	High Beam
HC	Horton Fan Clutch
HH	High Heat
HI	High
HL	Headlamps
HM	Hobbs Hour Meter
HN	Horn
HP	High Pressure
HS	Heat Sensor
HW	High Water - Low Oil
I	
IGB	Ignition Bus Bar
J	
JB	Jacob's Brake
JF	Jacob's Brake Full

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Kenworth Wire Numbering System

Example: GREEN / WHITE

Circuit function

Circuit number

Color of the wire

Destination of the circuit or pur

Using Electrical Circuit Matrix

Electrical Circuit Matrix

See "Electrical Circuit Matrix" on previous page for instructions on how to identify circuit number and name

Stripe	Solid Color														
	Black	Blue	Brow	Green	Gray	Lt. Blue	Lt. Green	Orange	Pink	Purple	Red	Tan	Violet	White	Yellow
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Yellow	302	55 196	89 217 312	211	149 15 202	20	96 125	161 198		57	51 197 240	67	165 241	OAT2	35 121 142 ACC 185

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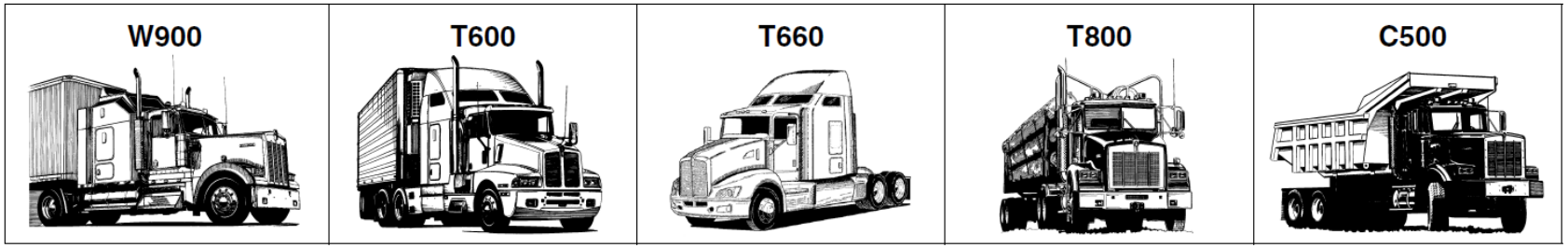
Electrical – CAN Code Designations



PACCAR Electrical Circuit Code Designations

- Multiplex migration began in 2004 in models T600, T660, T800, W900, C500 and Off-Highway models with instrumentation.
- Crossover trucks use a mixture of original circuit designations for existing electrical truck and chassis components, while “phasing” in the PACCAR circuit numbering system to support the multiplexed instrumentation
- *Circuits numbers and alpha characters used to identify each circuit are much different than in our legacy circuit wiring key*

Service Manual KM815052

Electrical – Can Systems

2005-2010 Multiplex, with ICU, CECU, CECU2, and CECU3 w/o Chassis Node Circuit Code Numbering and Abbreviations

Example: YEL 2111

YEL— Function: The first three alpha characters represent the color of the wire and define the primary electrical function of the circuit.

2111— Component: The four-digit circuit code describes the component or component subsystem that the wire supports. The components and subsystems are grouped hierarchically.

For example, in the lighting category:

- A general, lighting only circuit is labeled *XXX*2000.
- A less general, headlamps only circuit is labeled *XXX*2100.
- A more specific, low beam headlamps only circuit is labeled *XXX*2110.
- A very specific, left low beam headlamp circuit is labeled *XXX*2111.

Electrical – 2nd and Later Iterations

Circuit Code Numbering and Abbreviations

Example: YEL 2111

Insulation Color	Color Code	Electrical Function
Red with white stripe	R/W*XXXX*	Direct battery power
Red	RED*XXXX*	Protected battery power
Orange	ORN*XXXX*	Ignition Accessory Start power
Yellow	YEL*XXXX*	Activated power
Brown	BRN*XXXX*	Indicator illumination Backlit illumination
Black	BLK*XXXX*	Load return
Gray	GRA*XXXX*	Control
Violet	VIO*XXXX*	Reference voltage
Light blue	BLU*XXXX*	Sensor signal
Light green	GRN*XXXX*	Sensor common not connected directly to ground
White	WHT*XXXX*	Ground

Table 1: Color Codes

Number	Category
*XXX*0000 through *XXX*0999	General
*XXX*1000 through *XXX*1999	Power supply
*XXX*2000 through *XXX*2999	Lighting
*XXX*3000 through *XXX*3999	Power train
*XXX*4000 through *XXX*4999	Instrumentation, MMI
*XXX*5000 through *XXX*5999	Safety systems
*XXX*6000 through *XXX*6999	Convenience, Security
*XXX*7000 through *XXX*7999	HVAC
*XXX*8000 through *XXX*8999	(Category not Defined)
*XXX*9000 through *XXX*9999	Trailer/Customer/Bodybuilder

Table 2: Circuit Code General Categories

Additional Wiring Detail Tables

Table 3: Data-Bus Wire Color

Table 4: Trailer/Body Builder Circuits

Table 5: Circuit Code Master List

CAN Communication

How many individual CANs may be found on a Kenworth?

- B-Cab? **Seven**
- T680/880? **Eight**
- New in 2016 **GREEN** 9 Pin
  - Onboard Diagnostic (O-CAN) to allow direct communication from DAVIE (scan tool) to the PCI

Aftertreatment (A-CAN)	**Engine (E-CAN)**
Body Builder (B-CAN) optional	**Frame (F-CAN)**
Cab (C-CAN) *[T680/880]*	**Instrumentation (I-CAN)**
Diagnostic (D-CAN)	**Vehicle (V-CAN)**

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CAN Wire Numbering System

Example:

YEL5971

Table 1 Color Codes

PACCAR Electrical Circuit Code		
Insulation Color	Color Code	Electrical Function
Red w/ white stripe	R/WXXXX	Direct battery power
Red	REDXXXX	Protected battery power
Orange	ORNXXXX	Ignition, Accessory, Low Voltage Disconnect, StartPower
Yellow	YELXXXX	Activated Power
White	WHTXXXX	Ground
Black	BLKXXXX	Load Retun
Gray	GRAXXXX	Control
Brown	BRNXXXX	Indicator Illumination Backlit Illumination
Violet	VIOXXXX	Reference Voltage or +5VDC or Sensor Power
Light Blue	BLUXXXX	Sensor Signal
Light Green	GRNXXXX	Sensor common or Sensor Ground

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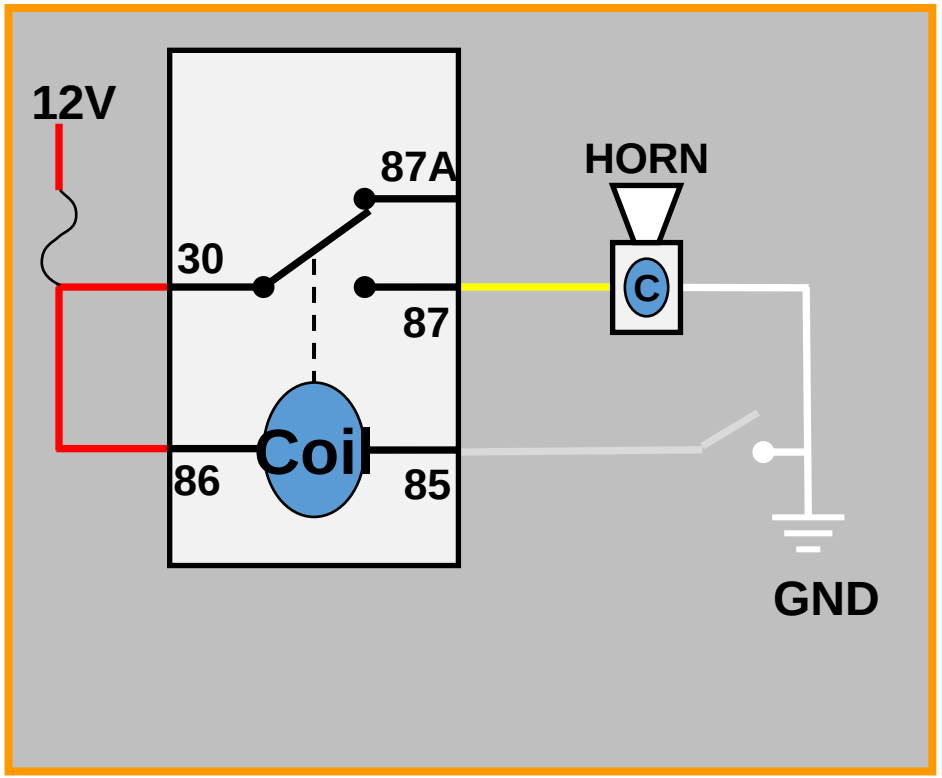
PACCAR Wire Numbering System

Example: YEL5971

PACCAR Electrical Circuit Code		
Insulation Color	Color Code	Electrical Function
Red w/ white stripe	R/WXXXX	Direct battery power
Red	REDXXXX	Protected battery power
Orange	ORNXXXX	Ignition, Accessory, Low Voltage Disconnect, StartPower
Yellow	YELXXXX	Activated Power
White	WHTXXXX	Ground
Black	BLKXXXX	Load Retun
Gray	GRAXXXX	Control
Brown	BRNXXXX	Indicator Illumination Backlit Illumination
Violet	VIOXXXX	Reference Voltage or +5VDC or Sensor Power
Light Blue	BLUXXXX	Sensor Signal
Light Green	GRNXXXX	Sensor common or Sensor Ground

Using the color you can identify the circuit's FUNCTION

Red, Yellow, Gray and White are illustrated below



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CAN Wire Numbering System

Data-Bus Wire Color

Most common:

- J1939, YEL & GRN
- J1587/1708, VIO & GRN
- Single-wire, BLU

Table 3 — Data-Bus Wire Color		
Color Low side	**Color** High side	**DATA Bus**
Light Green	Violet	SAE J1587 & J1708
Light Green	Orange	SAE J1922
Light Green	Yellow	SAE J1939
Light Green	Red	OEM, Private bus
Light Green	Gray	CAN
-	Light blue	Single-wire bus

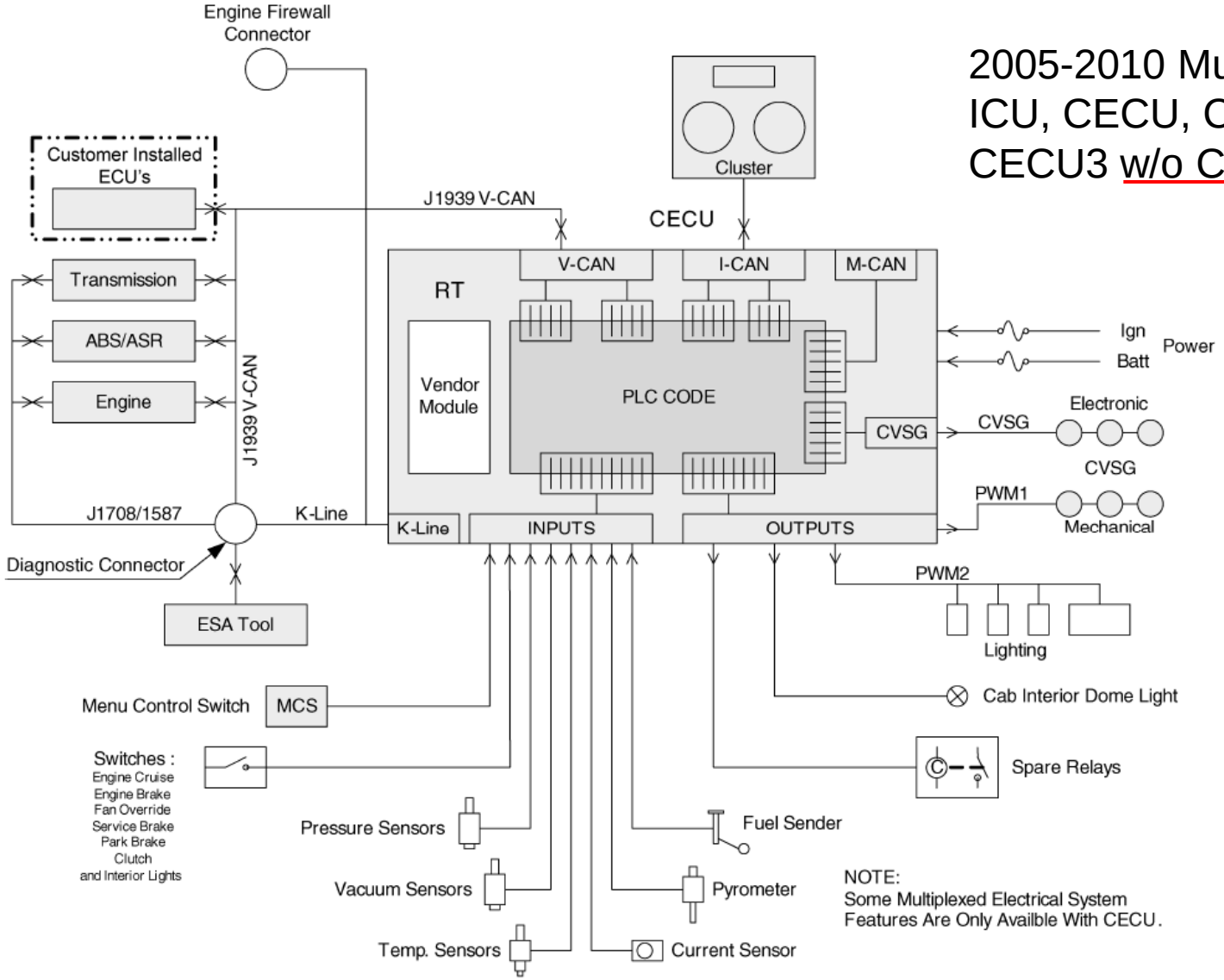
CAN Wire Numbering System

Trailer/Body Builder Circuits

These are only on trailer circuits inside the green, yellow trailer cable jackets and special body builder circuits.

Table 4 — Trailer/Body Builder Circuits	
Color	**Electrical Function**
White	Ground
Black	Clearance, ID, Marker lamps
Yellow	Left turn lamps
Red	Stop lamps
Light green	Right turn lamps
Brown	Tail lamps
Light blue	ABS power, Auxiliary

Electrical – CAN Iterations



2005-2010 Multiplex, with ICU, CECU, CECU2, and CECU3 w/o Chassis Node

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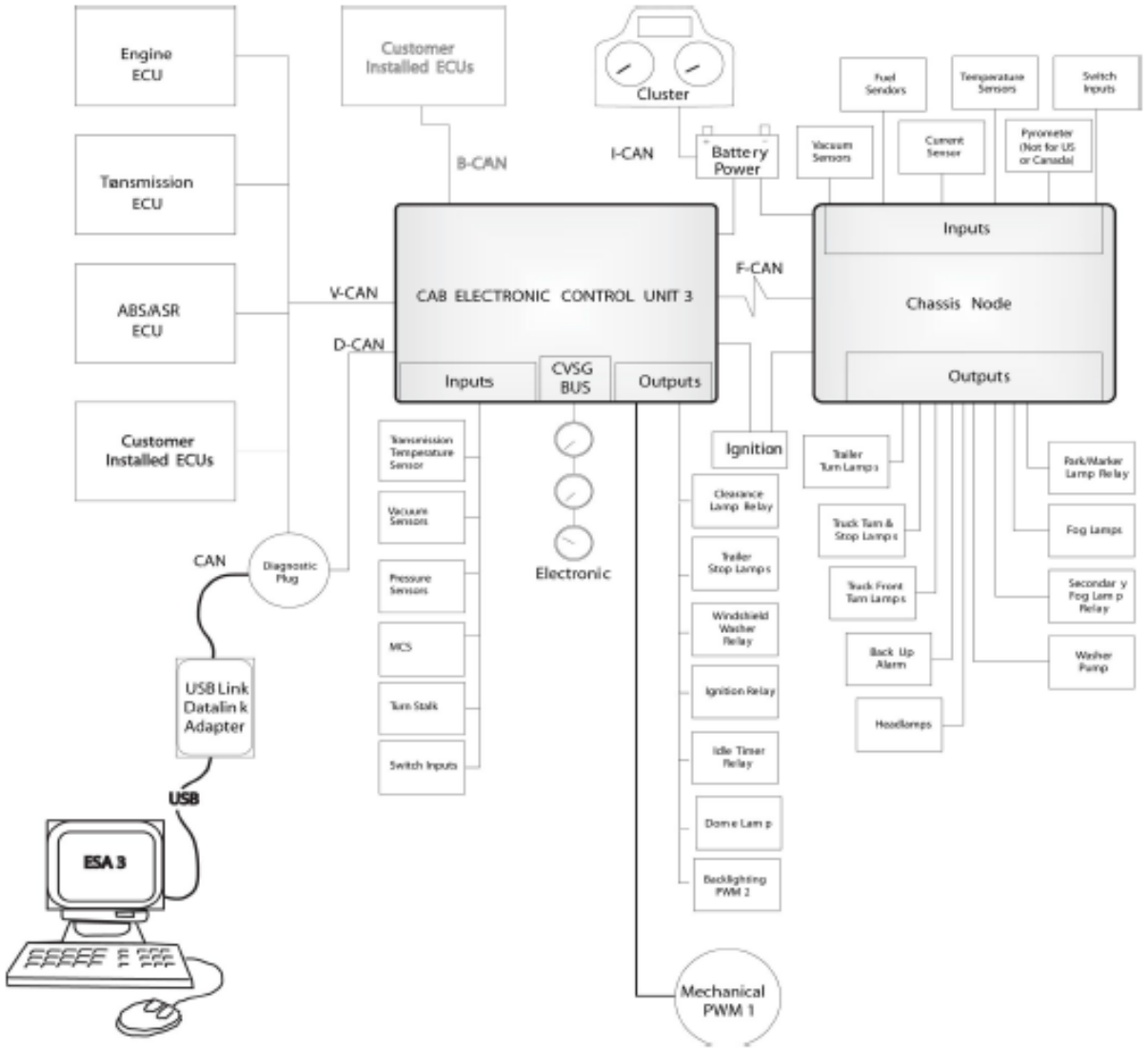
Service Manual KM815054/PM819010

Electrical – Latest CAN Iteration

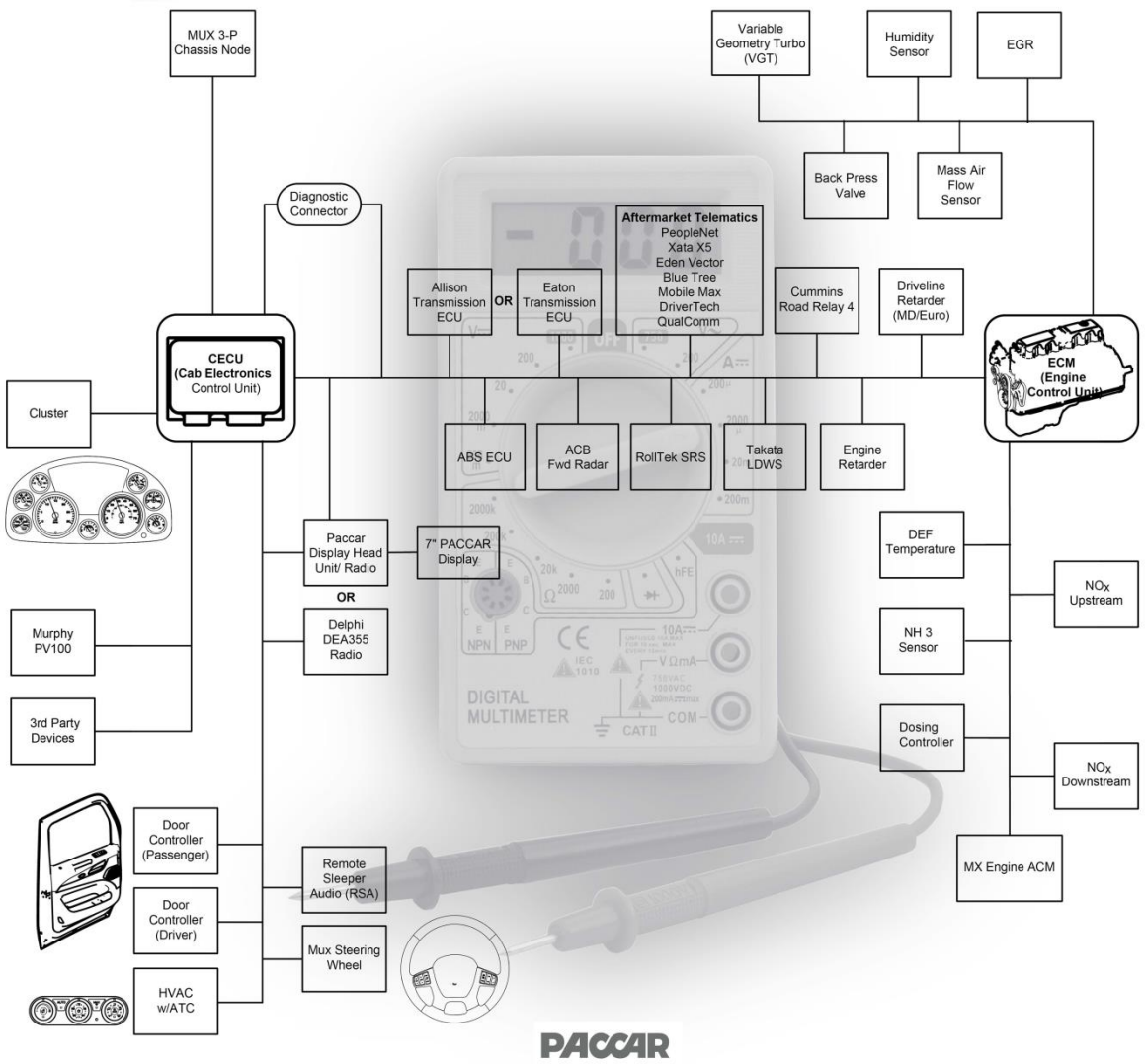


2010 Multiplexed Electrical System Service Manual — CECU3 w/Chassis Node

B-Cab = NAMUX 3

Service Manual KM815056/PM819003

Electrical – Latest CAN Iteration



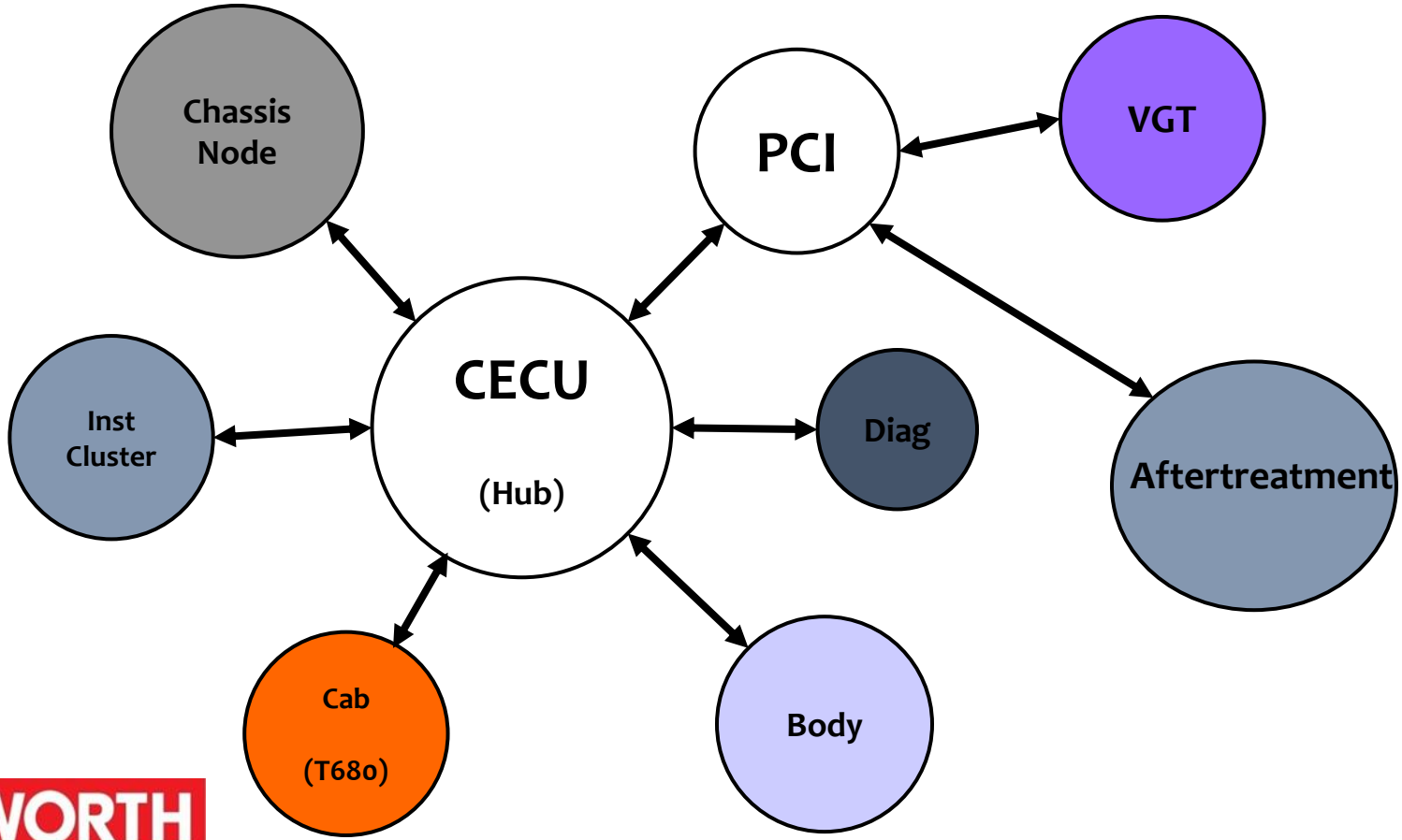
2012 Multiplexed Electrical System Service Manual — (P30-1011)

NGP = NAMUX 4

Service Manual KM815057/PM819023

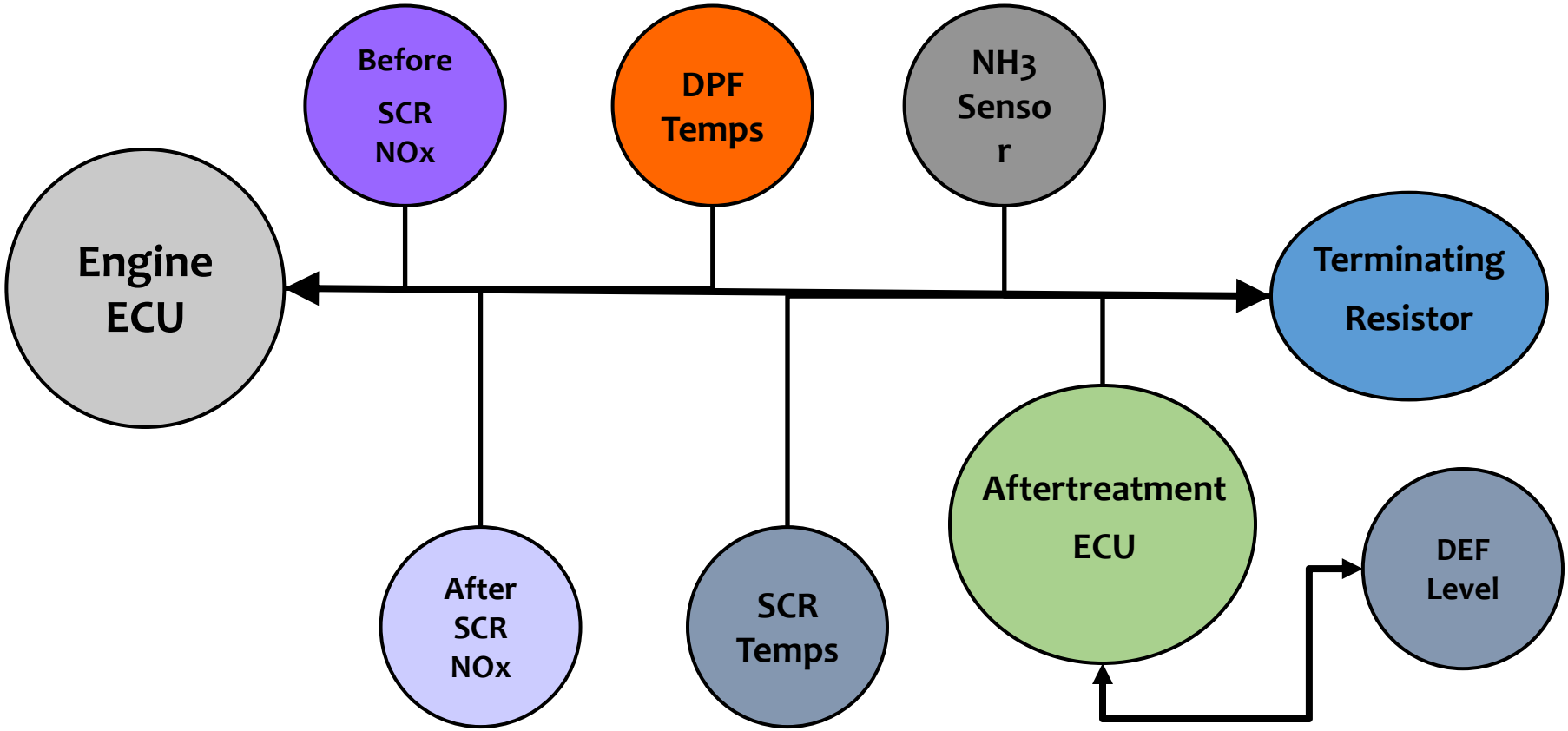
CAN – Hub and Spoke

Central hub receives and relays information between different devices that are on separate CANs



CAN – Architecture

Local CAN architecture (A-CAN)



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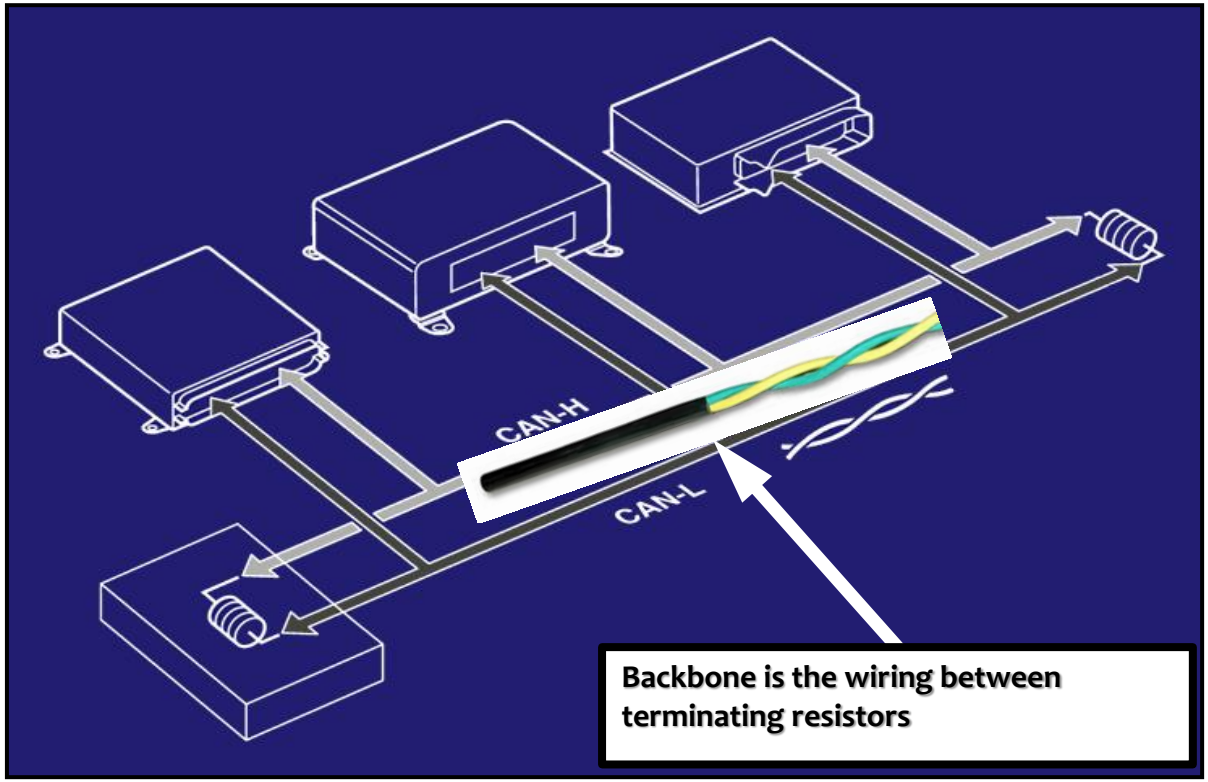
CAN – Backbone

Backbone

- Wiring between terminating resistors
  - One backbone for each CAN on the truck
  - Not one backbone for the whole truck

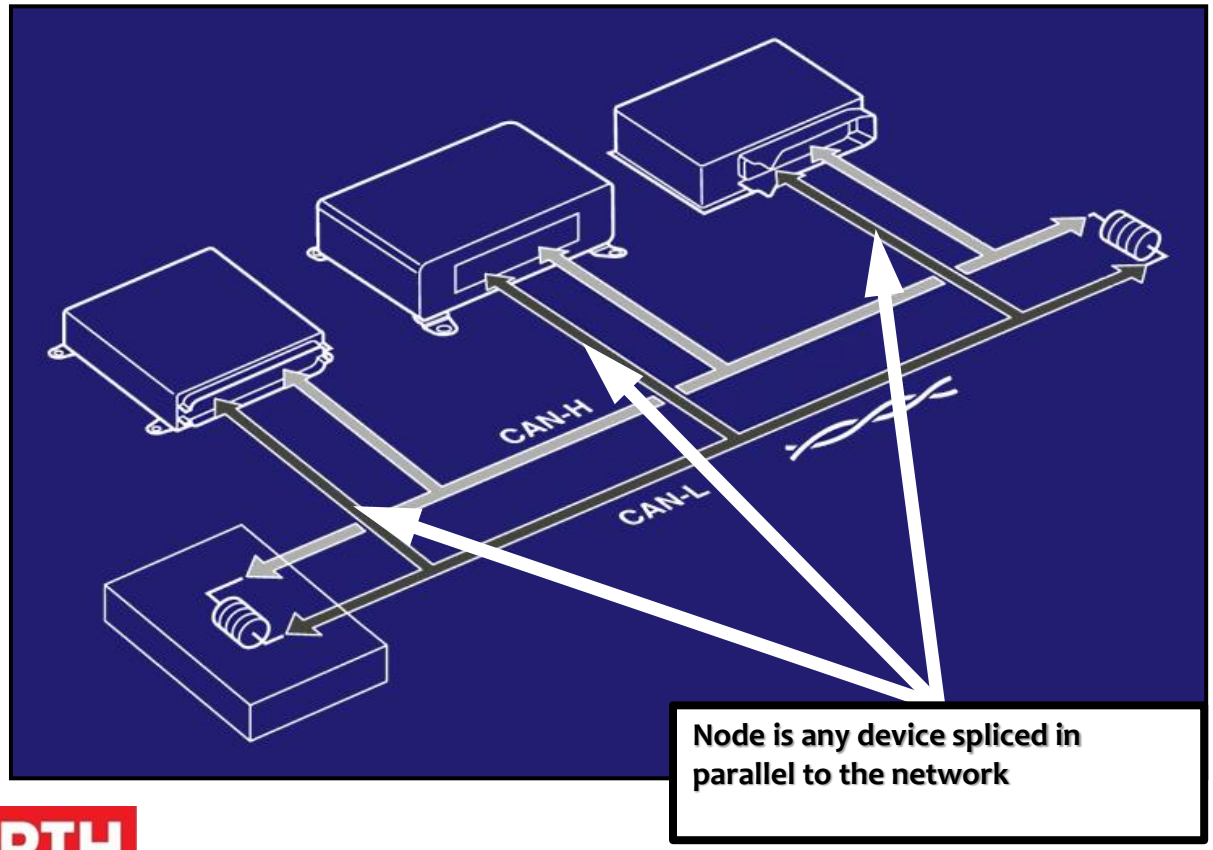


KENWORTH

CAN – Node

Node

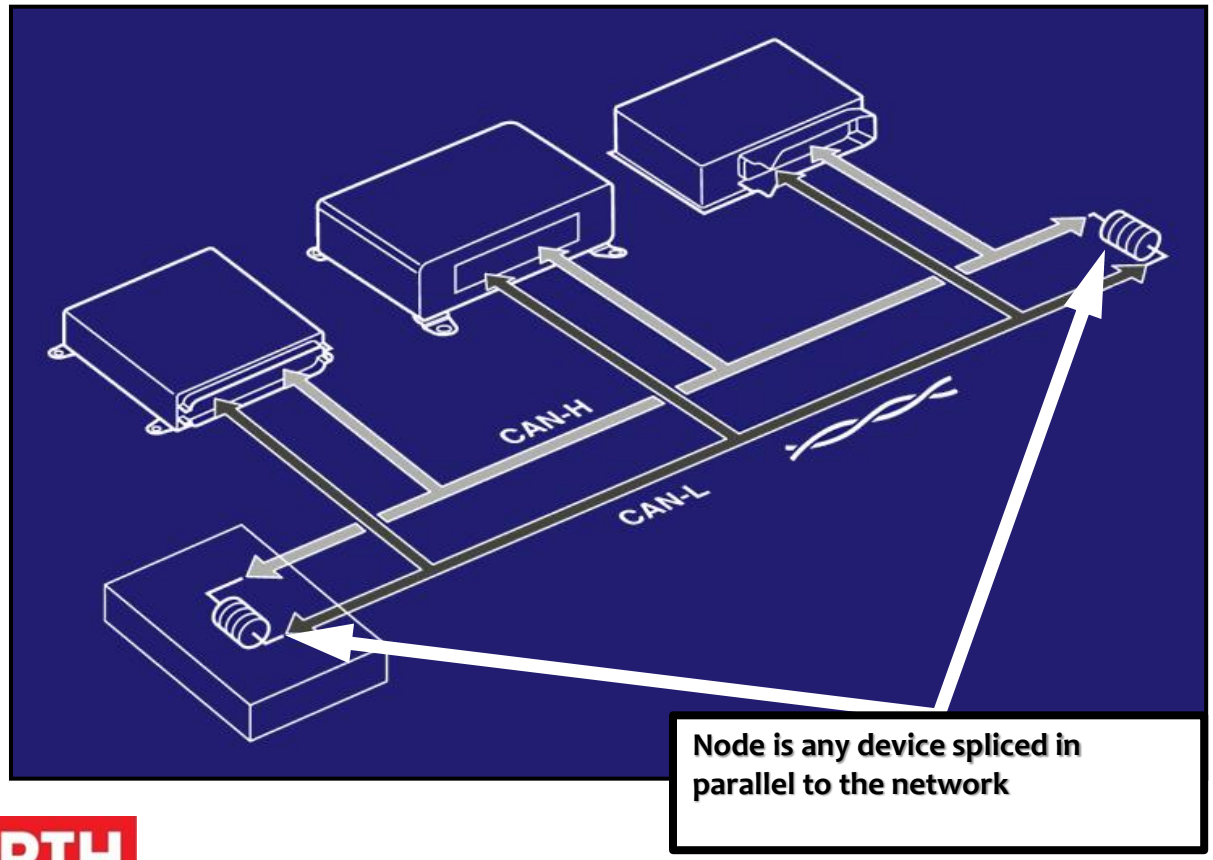
- Device spliced in parallel to the backbone, this includes wiring from splice to the device



CAN – Resistors

Terminating Resistor

- **Resistor placed at one end of the backbone**
- **Can be in the harness or inside of an ECU**



KENWORTH

J1939 – Details

Local ECUs are connected to a backbone circuit

- Backbone will be a twisted pair of yellow and green wires **between** the terminating resistors
  - CAN Hi Yellow
  - CAN Lo Light Green
  - Why twisted?

- Any EMI affects both wires

KENWORTH

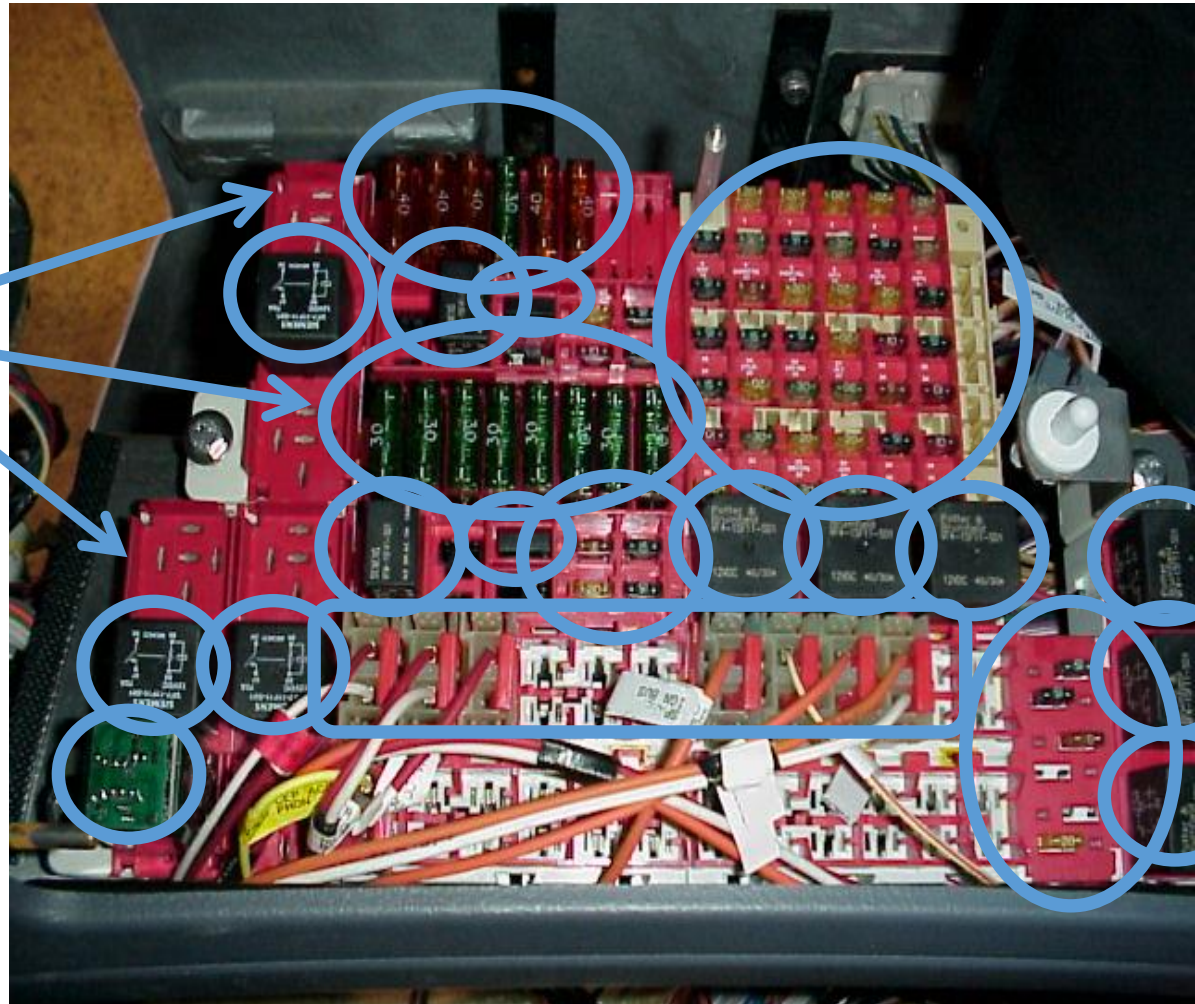
Power Distribution Centers

Class 8 – Heavy Duty

- **Wide Cab**
  - T2000
  - T700

Part of IP Harness

Access: remove glove box



E-Blocks

(16) MAXI fuses

(55) Mini fuses

(4) Diodes

(3) 70A Relays

(11) ISO Relays

(4) Half ISO Relays

(1) Flasher

(12) Spare Power taps

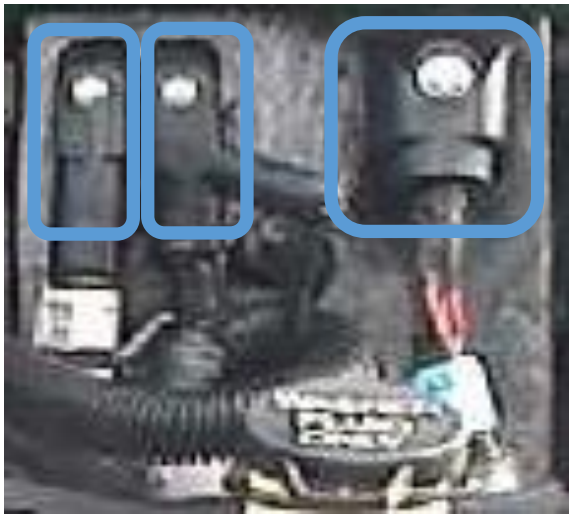
KENWORTH

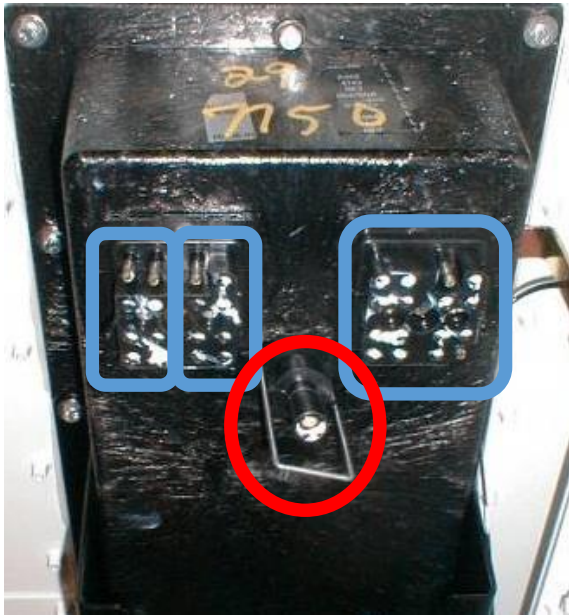
Power Distribution Centers

Class 8 – Heavy Duty, Off Highway

- **B-Cab - Pre 2001:** KM815020
  - T800, W900, T600, C500
  - KM815020, Service Manual

- **Engine side molded connectors:**
  - Chassis Harness (1) 16-way
  - Trailer Harness (1) 8-way
  - Headlamp Harness (1) 8-way
  - Power Feed Harness (1) 1-way





KENWORTH

Power Distribution Centers

Class 8 – Heavy Duty, Off Highway

- **B-Cab - Pre 2001:**
  - T800, W900, T600, C500
  - KM815020, Service Manual

- **Cab side molded connectors:**
  - IP Harness (11) 8-ways
  - Spare BATT power strip

Cab Side View

Half of the cover's vents open to the top, letting in water/snow.

Check bottom row of fuses & relays.

KENWORTH

Power Distribution Centers

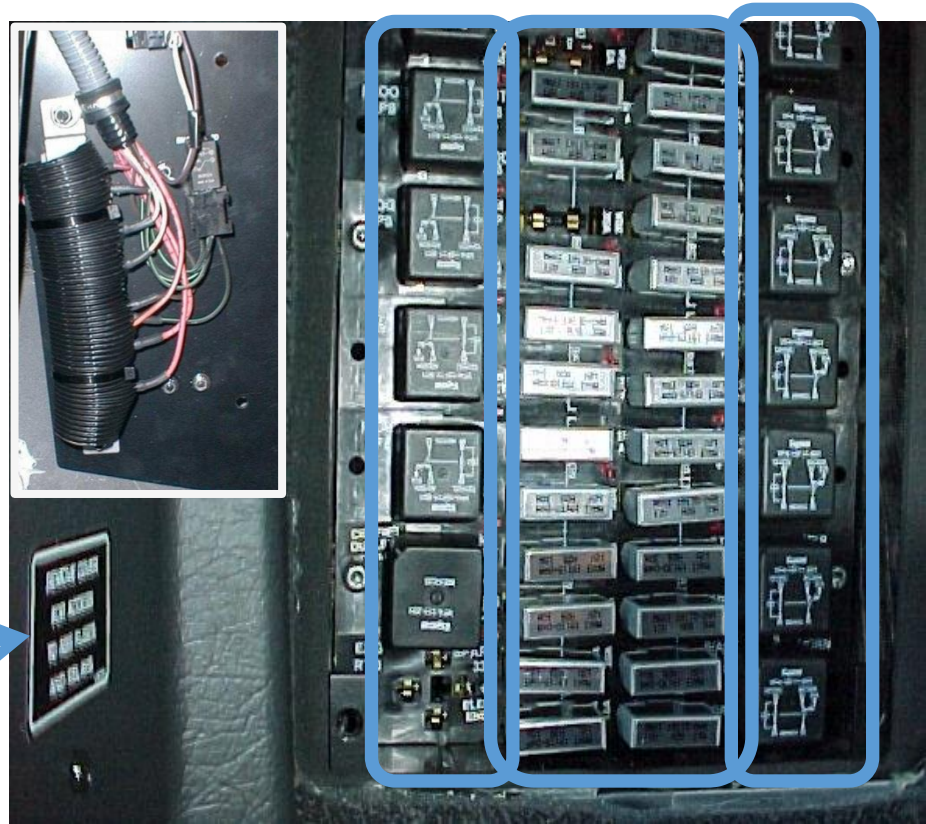
Class 8 – Heavy Duty, Off Highway

- **B-Cab - Pre 2001:**
  - T800, W900, T600, C500
  - KM815020, Service Manual

(26) ATO Fuses or
Type 1 Circuit Breakers (before 2001)
Type 2 Circuit Breakers (after 2001)
(14) ISO Relays
(1) Flasher
(1) HVAC Shorting Relay (after 2000)

Relays and circuit breakers in
Driver's side kick panel

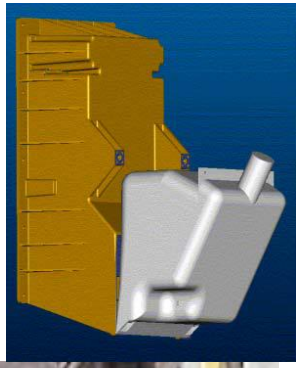
Cab Side View



KENWORTH

Power Distribution Centers

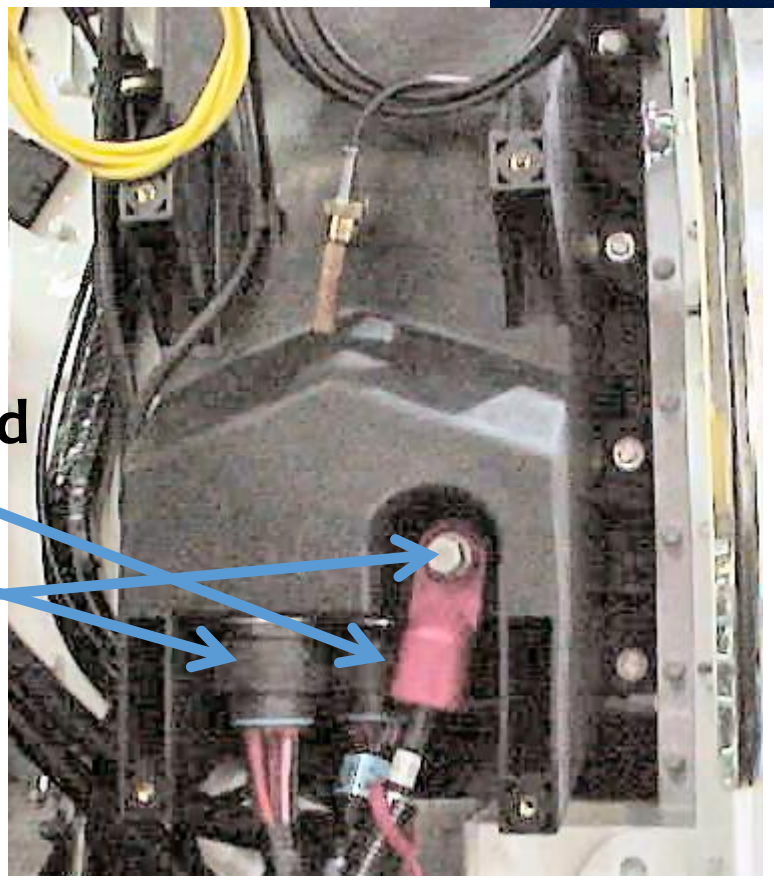
Class 8 – Heavy Duty, Off Highway



- **B-Cab - Post 2001:**
  - T8, W9, T6, C5, T440
  - KM815055, Service Manual

Engine side connections:

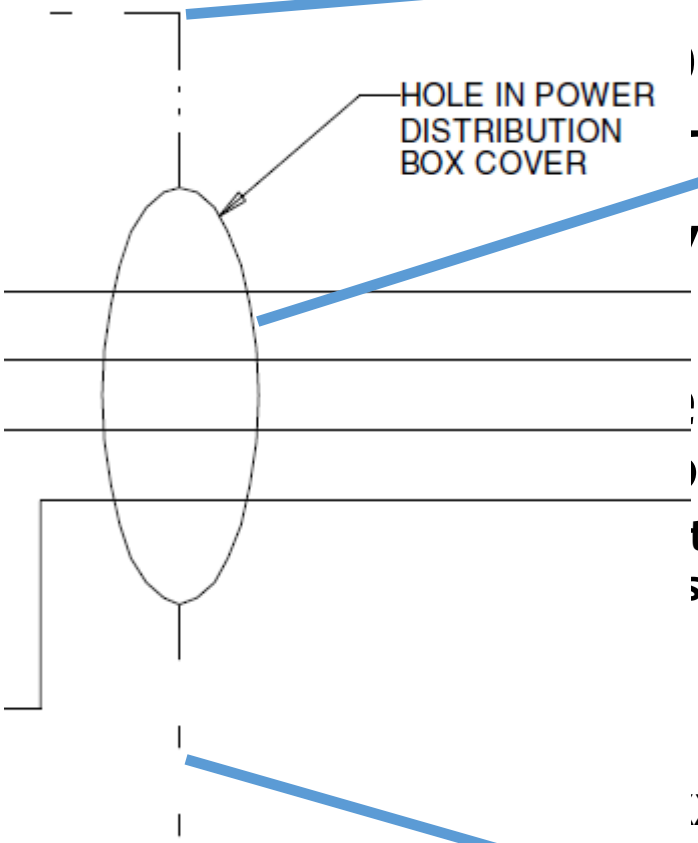
- Chassis Harness, bottom rear
  - (1) Deutsch HDP30 29-way
- Trailer Harness, bottom forward
  - (1) Deutsch HDP30 9-way
- Power Feed Harness, on box
  - (1) Battery cable terminal



KENWORTH

Power Distribution Centers

Class 8 – Heavy Duty, Off Highway



1:

T440

vice Manual

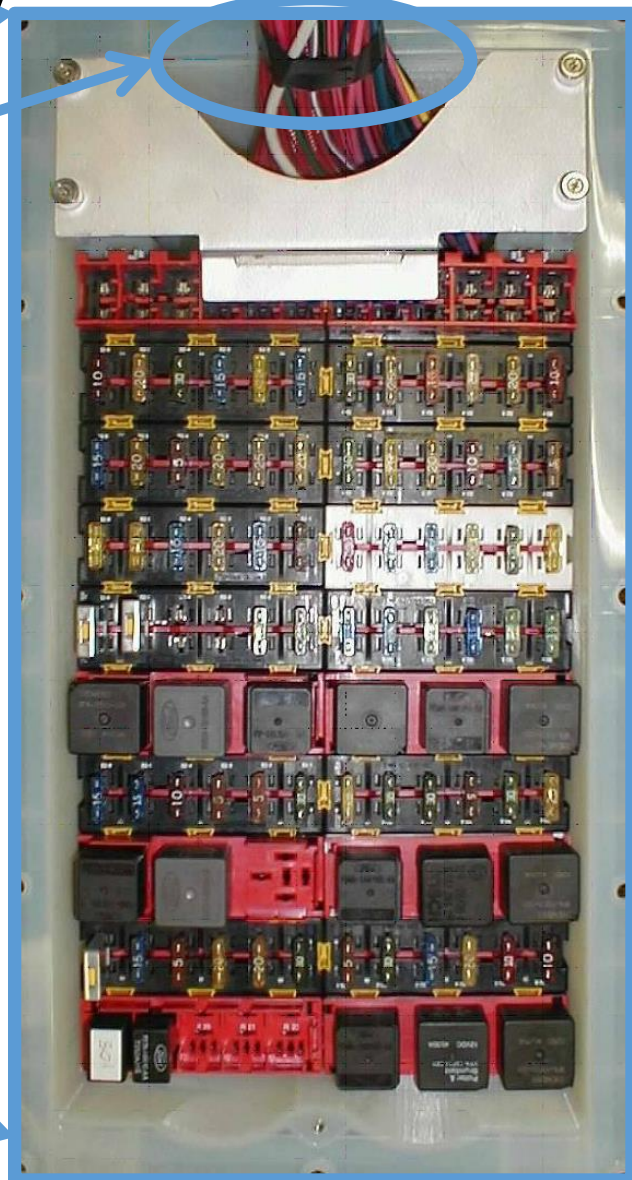
ss

edal

th metal panel

snapped on cover

XXX

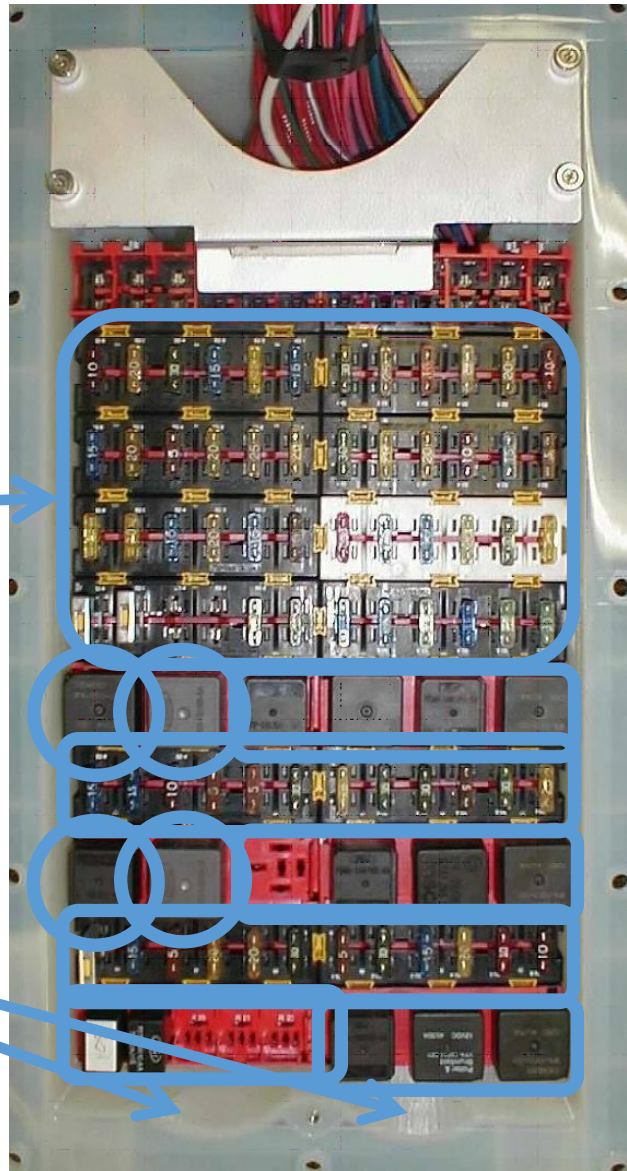


KENWORTH

Power Distribution Centers

Class 8 – Heavy Duty, Off Highway

- **B-Cab - Post 2001:** KM815055
  - T8, W9, T6, C5, T440
  - KM815055, Service Manual



E Blocks

Go to 92-4319 IP Harness drawing

(60) ATO fuses and Type II Circuit breakers

Find CEP (central electrical panel) connector part number: _____

(2) 70A Relays: coils controlled by key switch

(13) ISO Relays

Look up in ServiceNet.

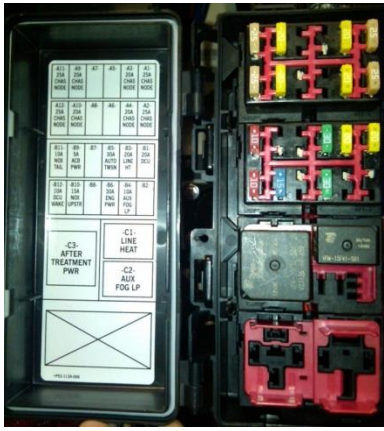
(5) Half ISO Relays

Depressions let water out

KENWORTH

Power Distribution Centers

Class 8 – Heavy Duty, Off Highway

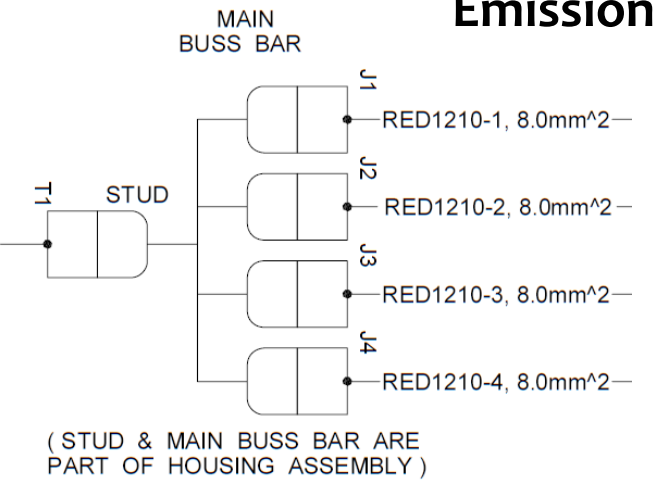


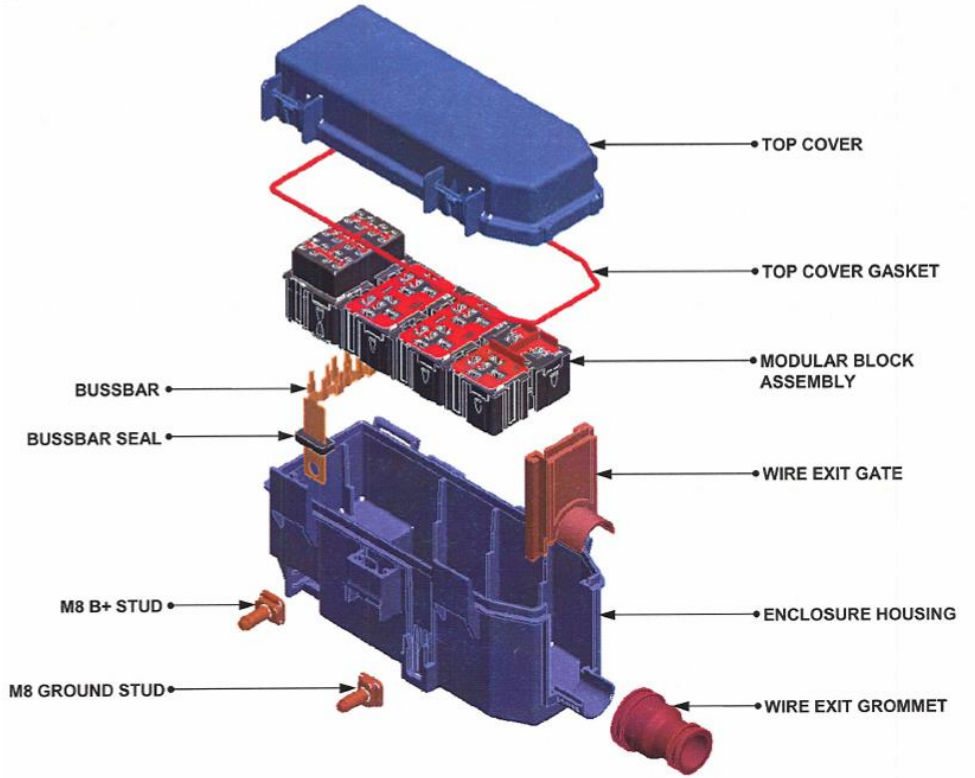
- **B-Cab – 2010 and on:**
  - T8, W9, T6, C5, T440
- **Chassis Load Center**

  Content varies

  Engine Type

  Emission Level





KENWORTH

Power Distribution Centers

Class 8 – Heavy Duty, Off Highway

- NGP: T680, T880, 579, 567

Class 7, 6, 5 – Medium Duty

- T370, T270, T170

TIB 34-051 – Probing guide for these load centers

DO NOT USE a test lamp or VOM probes in forked terminals!

- Use MINI fuse cut in half or a blown fuse!
- Use Power Probe #AA4, www.powerprobe.com

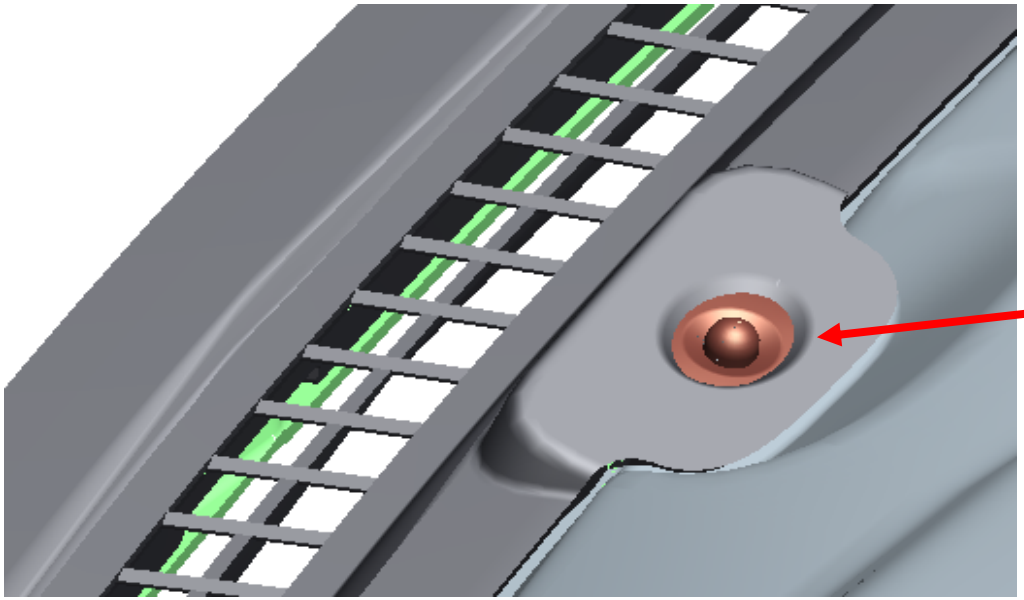
GOOD

NO Repair

BAD

KENWORTH

Sun Load Sensor - DTC919



Sensor resistance across pins A and B is 150K to 190K with no direct sun light

Sensor should have 5 volts to sensor and 0 to 5 volt signal from sensor

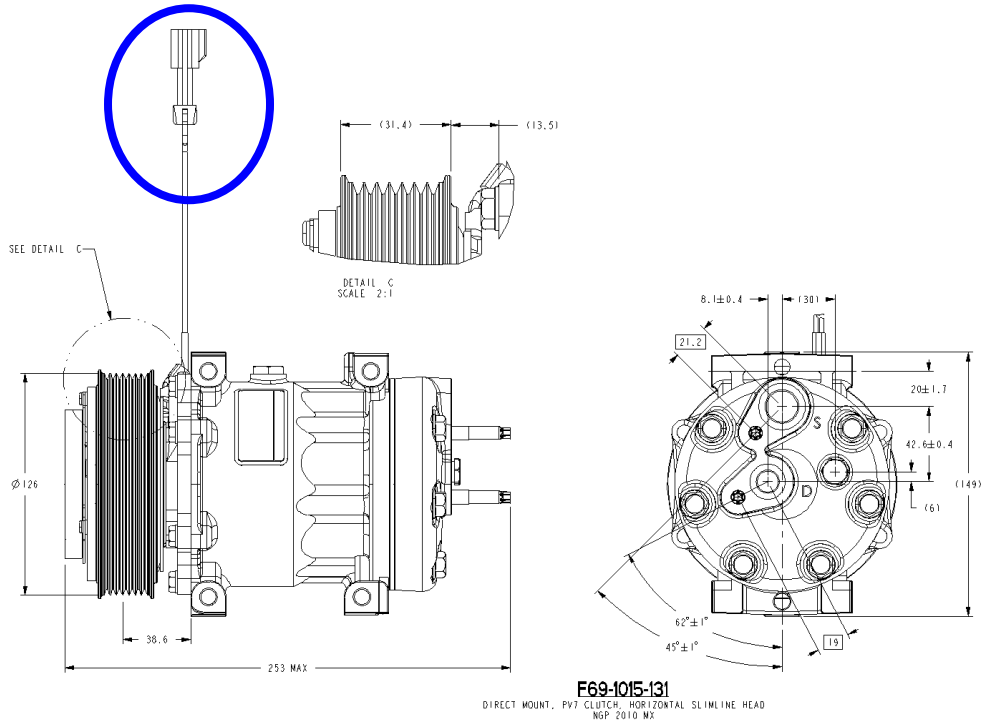
Check continuity of wires between sensor and HVAC control head connector

Sun Load Sensor

Secure sensor wiring harness connector to prevent it from falling down into the dash!

KENWORTH

Compressor Clutch Relay Circuit - DTC 876



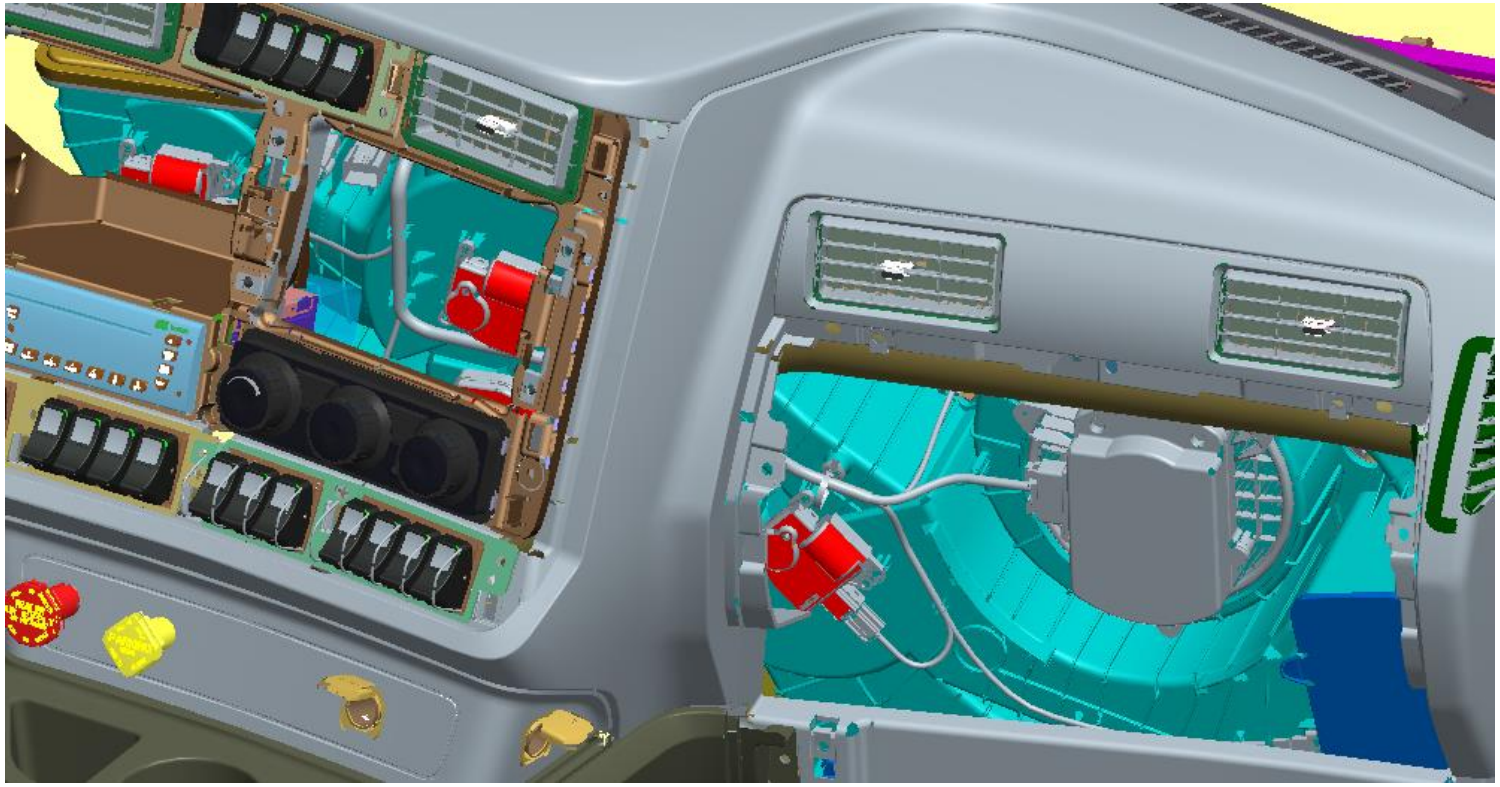
- Check clutch resistance between A and B – **2.8 to 4.4 ohms in clutch**
- Check mating connector (A = Gnd and B = 12 V input – need **at least 11.5 volts for clutch to operate properly.**
- Check control circuit to relay in PDC

Outside Air Temperature (OAT) Sensor

Temp (deg C)	Min Resistance (kOhms)	Nom Resistance (kOhms)	Max Resistance (kOhms)
-40	315.108	336.479	358.975
-35	228.013	242.682	258.063
-30	166.804	176.976	187.599
-25	123.302	130.422	137.829
-20	92.054	97.083	102.294
-15	69.376	72.957	76.654
-10	52.758	55.329	57.972
-5	40.469	42.327	44.23
0	31.298	32.65	34.03
5	24.401	25.391	26.397
10	19.173	19.902	20.641
15	15.17	15.71	16.255
20	12.089	12.491	12.895
25	9.7	10	10.3
30	7.797	8.055	8.315
35	6.309	6.532	6.757
40	5.132	5.324	5.519
45	4.202	4.368	4.537
50	3.459	3.602	3.748
55	2.861	2.986	3.113
60	2.38	2.488	2.599
65	1.989	2.083	2.179
70	1.67	1.752	1.836
75	1.408	1.48	1.554
80	1.192	1.255	1.32
85	1.015	1.07	1.127

- Negative Temperature Coefficient (NTC) Sensor
- Located on driver's side mirror
- Check dash display to confirm sensor functioning relative to ambient temperature

Cab Actuators



- DTC 3981 - panel mode actuator
- DTC 3986 - temperature actuator
- DTC 3984 - fresh / recirc actuator
- DTC 520196 - defrost mode actuator
- DTC 520197 - floor mode actuator

KENWORTH

Access to Service Information

Unfortunately due to purely commercial nature of HD and off road, plus high RD and now governmental regulation costs, access to service information is strictly controlled.

Kenworth's primary responsibility is to provide it's Dealers with up to the moment information to fulfill warranty responsibilities.

Secondary service information access is available, in various levels and costs to:

- Fleets
  - Direct
  - Dealer Sponsored
- Independent Service Providers
- Colleges and Technical Schools
- Body Builders

Access to Service Information

- Paccar, as with all HD manufacturer's, is very protective of it's intellectual information. It does, however, realize that a legitimate need for service information exists outside the Dealer environment.
- The single "best" approach for ISPs to service information is to develop a working relationship with your local KW/PB dealer.
- Dealer Sponsored Fleet
  - Service Information not for sale otherwise
  - ESA/Davie Software/Scan Tool
  - Parts
- Fleet Web ECAT (subscription cost type arrangement)
  - Service Information, bulletins, specs, and Wiring Diagrams
- Colleges & Technical Schools
  - Get a Dealer Sponsored Fleet Designation
  - Full access to information, diagrams, flat rate times, etc
- Right to Repair Policy
  - Yet to be completed
  - Will change policies outlined above

Truck System Information

“B” Cab (1.9m cab)
W900 / T440 / T660 / T800 / C500 / 963

KENWORTH

Kenworth Models

Class 8 – Heavy Duty:

- B-Cab Series: T440, C500, T600 -> T660, T800, W900

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Kenworth Models

- Monster Trucks: Off highway heavy duty up to 400,000# GVW

KENWORTH

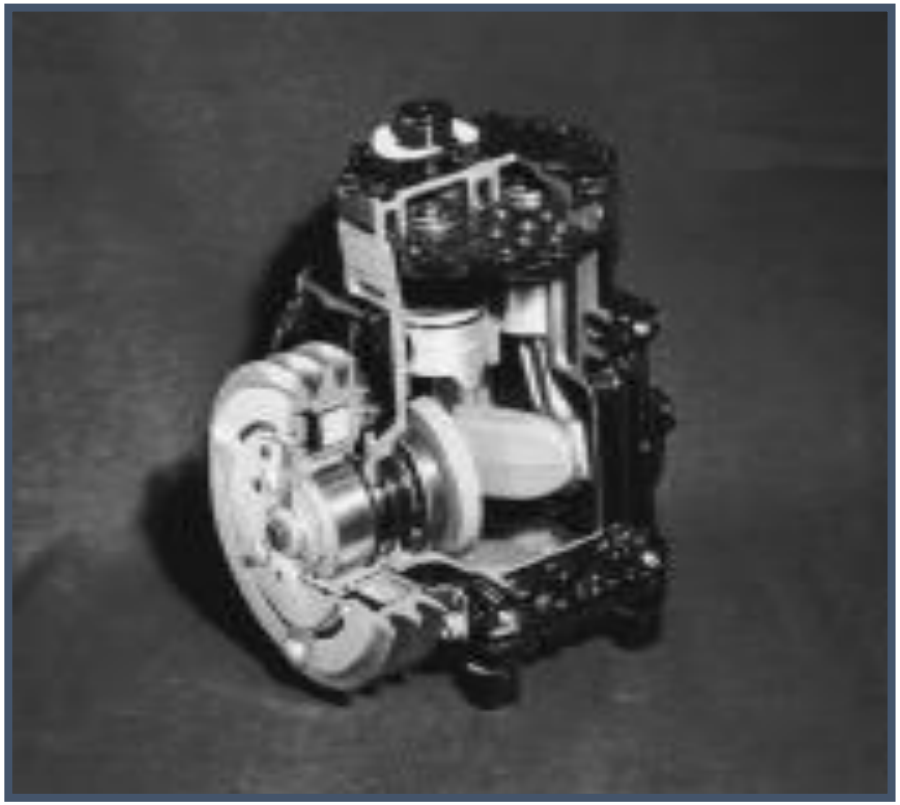
B-Cab: Apr 1994 to Feb 2001

- Pneumatic (air) actuated mode controls
- Cable actuated heater control valve
- 3 Blower fan speeds (Low, Med, High) controlled by a resistor block
- 1 HVAC Relay (coil grounded through fan switch)
- Binary Pressure Switch

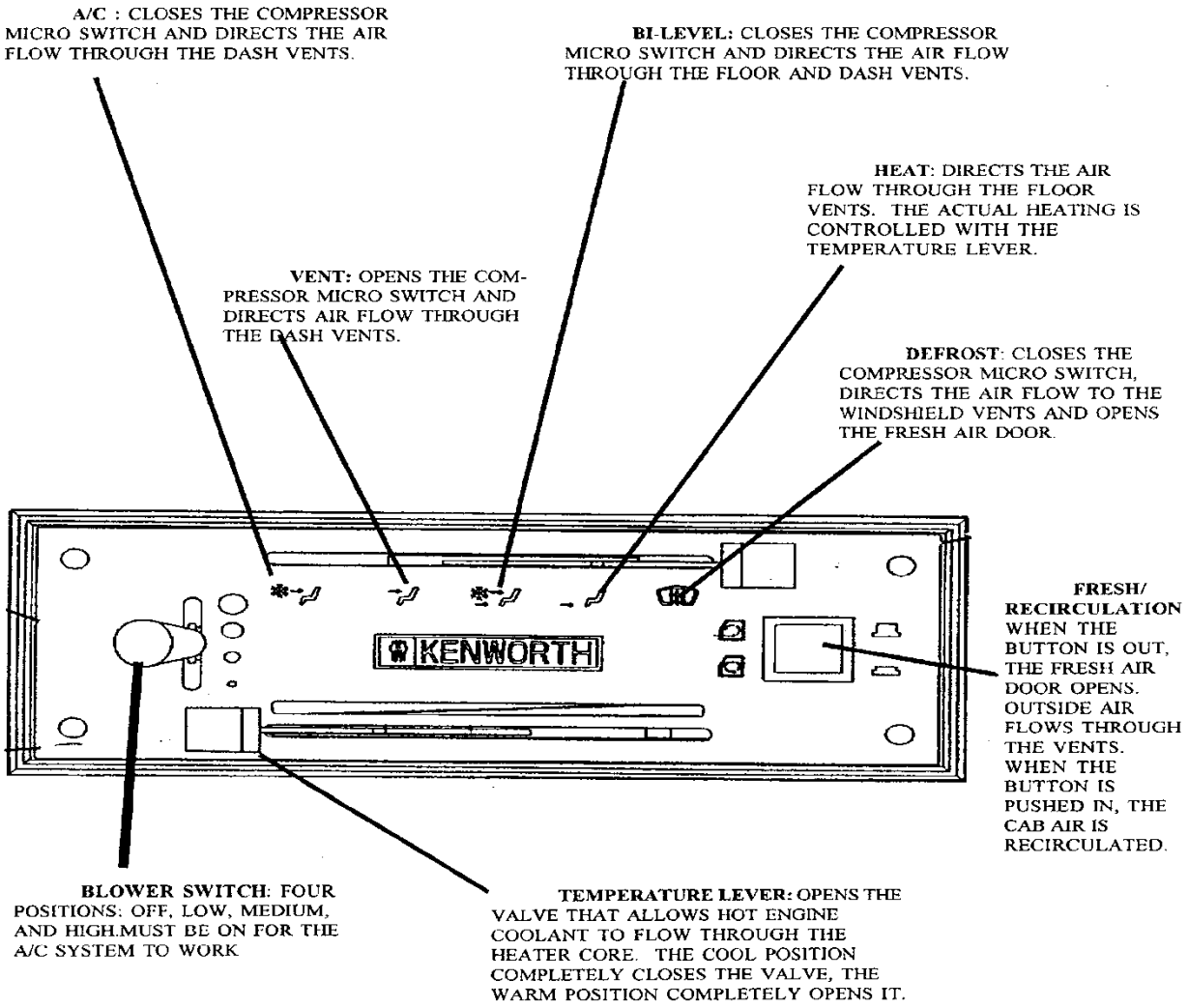
Early Climate Control Compressor

Standard Piston Type Compressor

- Pistons lubricated with oil from bottom of the case
- Oil level should be measured each time the system is opened
- Vertical Mount, curved dip stick
- Horizontal mount, straight dip stick
- **Discontinued standard use in 2001, * limited use for some export, non-emission apps. going forward**

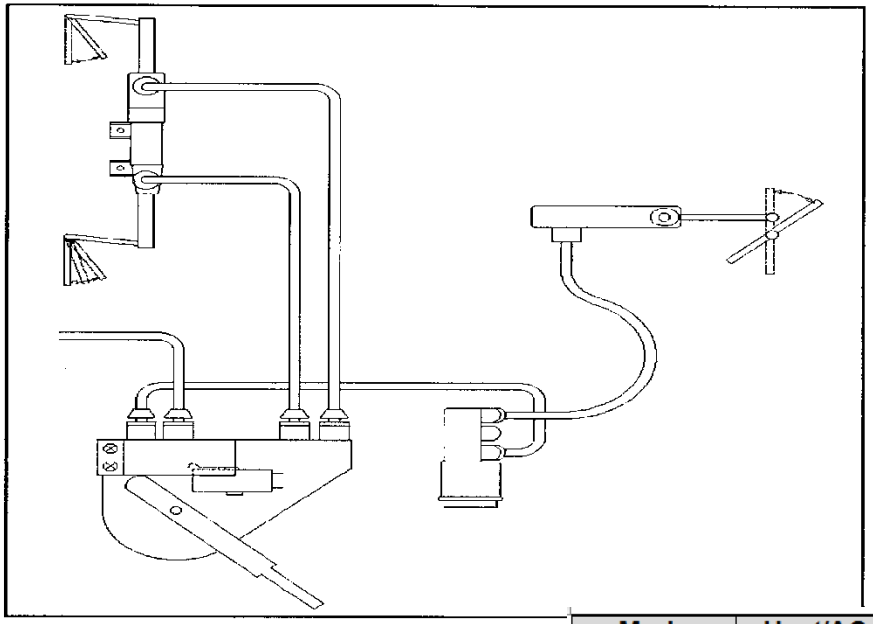


B-Cab Controls



Used on B-Cab from 1995 to 2001.

Actuator Control



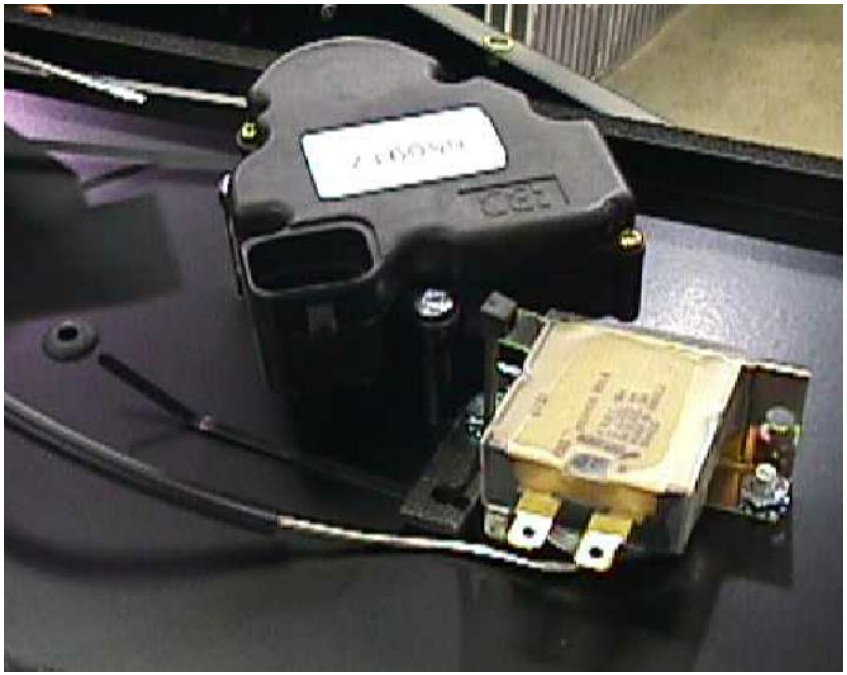
Early B-CAB uses a pneumatic pressure system for door and vent controls

Year range:

1995 to 2001

Mode Control Position	Heat/AC Air to Cylinder Door	AC/Defrost Air to Cylinder/Door	Fresh/Recirc Air to Cylinder/Door	Compressor Clutch Microswitch
A/C	***No* Pressure/** Closed	**Pressure/** Closed	**Pressure/** Closed	**Closed**
Vent	***No* Pressure/** Closed	**Pressure/** Closed	Optional	**Open**
Bi-Level	**Pressure/ 1/2 Open**	**Pressure/** Closed	Optional	**Closed**
Heat	**Pressure/** Open	**No Pressure/** Open	Optional	**Open**
Defrost	***No* Pressure/** Open	**No Pressure/** Open	**No Pressure/** Open	**Closed**

Freeze Switch

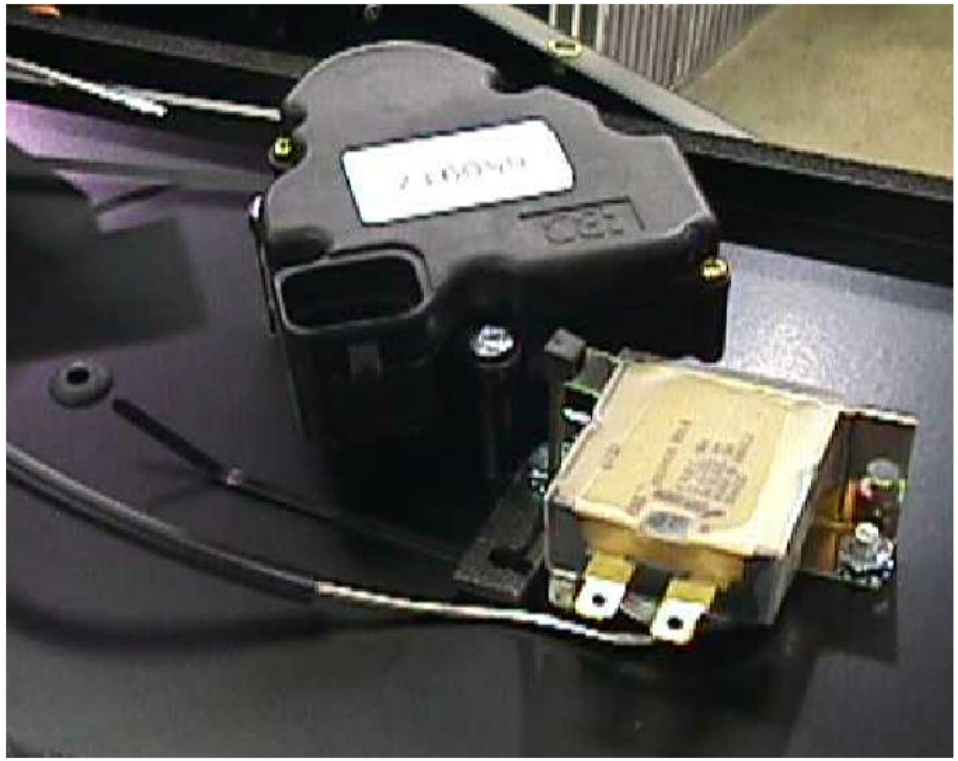


Both B-Cab and T2000 use the freeze switch in the ground side of the HVAC relay control circuit. The freeze switch *opens* at **31.5° F** and *closes* at **40°F**.

(The B-Cab freeze switch is located in the blower housing, on the engine side of the fire wall)

KENWORTH

Testing Thermostatic Switch (N/C)



If freeze switch fails closed, compressor runs all the time and never cycles – evaporator eventually freezes up

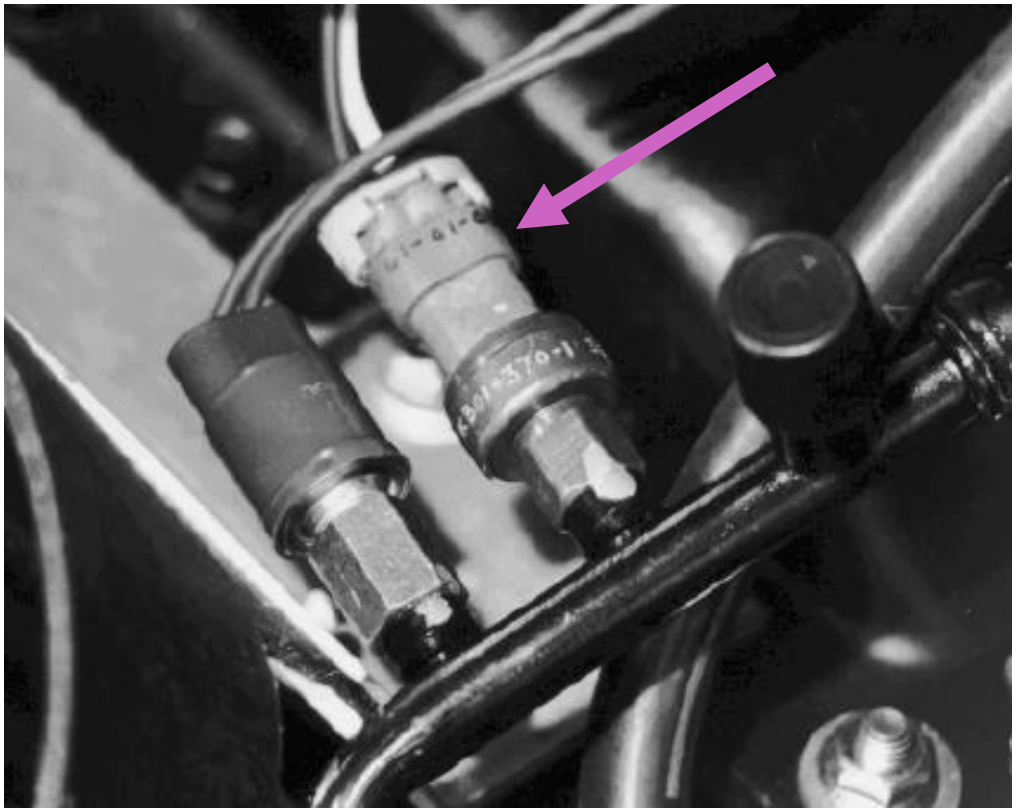
If freeze switch fails open, the compressor will never engage.

If wrong calibration, we will not meet duct temperature

Pressure Switch

B-Cab uses a binary cutout switch on the power side of clutch:

- Low pressure setting **opens at 26 psi**
- High pressure setting **opens at 400 psi**



B-Cab HVAC Changes By Years

- April 1994 to Feb. 2001: use W/D's R115-5646, sleeper P94-1333
- March 2001 to Dec 2001 (**two HVAC relays and electronic controls & actuators**): use W/D P94-1084
- Dec 2001 to June 2004 (**two HVAC relays and electronic controls & actuators**): use W/D P94-1391
- July 2004 to Jan 2007 (**added in the linear power module and electronic actuated water valve (NBI):** DO NOT use P94-1459, use P94-1587. Sleeper use P94-1478
- NAMUX 2 with 07 emissions engine (**eliminated binary switch and added in high and low pressure switches at expansion valve**): use P94-1698
- **Changed to NAMUX 3 for 2010 engines and sleeper:** use P94-1852 / P94-1958

Operating Temperatures

CONVENTIONAL MODELS WITHOUT SLEEPER

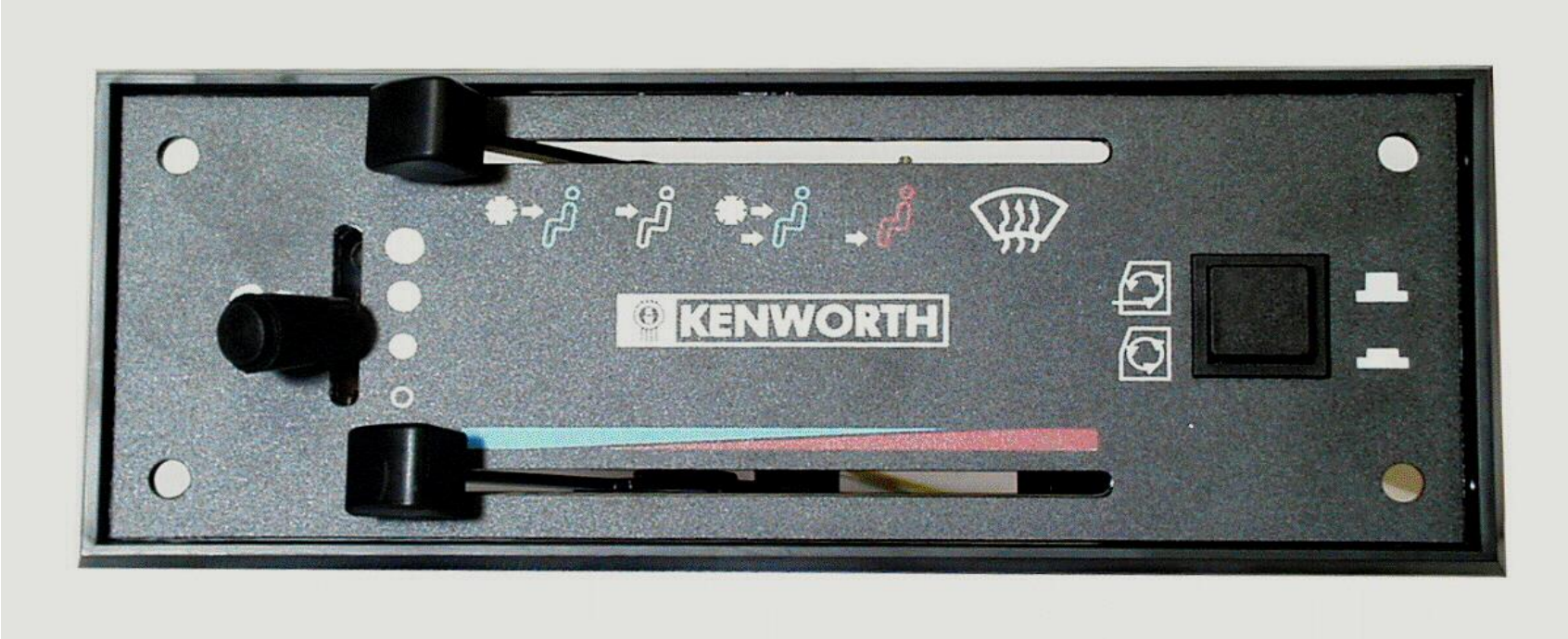
Outside Temperature in Degrees F.	Center Duct Temperature	High Side Gauge Reading (PSI)	Low Side Gauge Reading (PSI)
70	43 - 49	95 - 130	7 - 14
80	47 - 51	100 - 135	10 - 17
90	53 - 57	120 - 155	14 - 21
100	59 - 63	155 - 185	19 - 26
110	65 - 69	185 - 205	24 - 31
High Humidity Adjustment	0 - 15	No change	High side of range

If the humidity is over 70%, the duct temperatures will be from normal to 15° higher

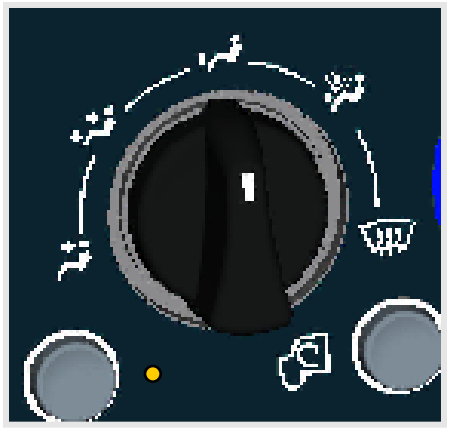
B-Cab: Mar 2001 to Dec 2001

- Electrically actuated mode controls
- Cable actuated heater control valve
- 3 Blower fan speeds (Low, Med, High) controlled by a resistor block
- 2 HVAC Relays
- Binary Pressure Switch

Blower Controls



Mode Actuator Specifications



Face Mode, Position 1
11 – 12 volts – signal wire to ground

Bi-Level Mode, Position 2
9 to 10 volts – signal wire to ground

Floor Mode, Position 3
6 – 7 volts – signal to ground

Blend Mode, Position 4
2.5 – 3.5 volts signal to ground

Defrost Mode, Position 5
0 to 1 volts – signal to ground

Fresh Air Position (+) 11-12 volts (A to B)

Recirc. Position (-) 11-12 volts (A to B)

B-Cab: Dec 2001 to June 2004

- Electrically actuated mode controls
- Cable actuated heater control valve
- 3 Blower fan speeds (Low, Med, High) controlled by a resistor block
- 2 HVAC Relays
- Binary Pressure Switch

Hot Water Valve

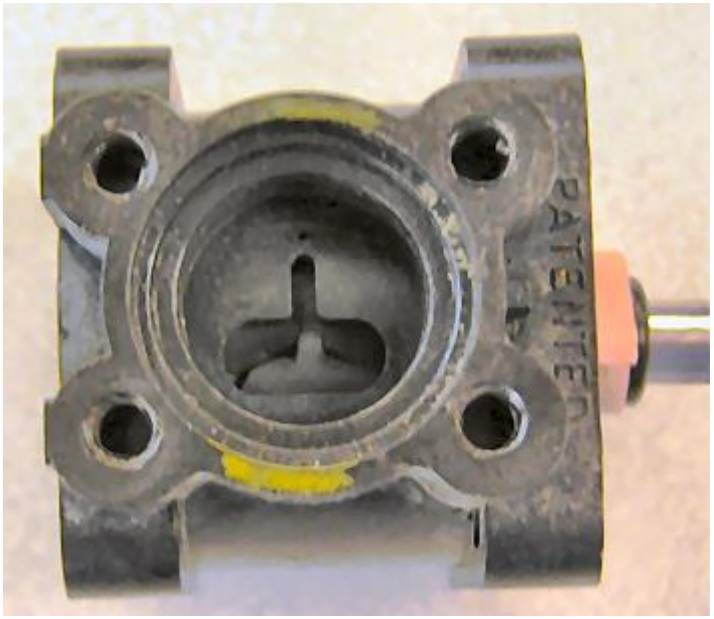
Kenworth utilizes hot water valves in many HVAC systems, with two basic types: Cable operated and Electronic

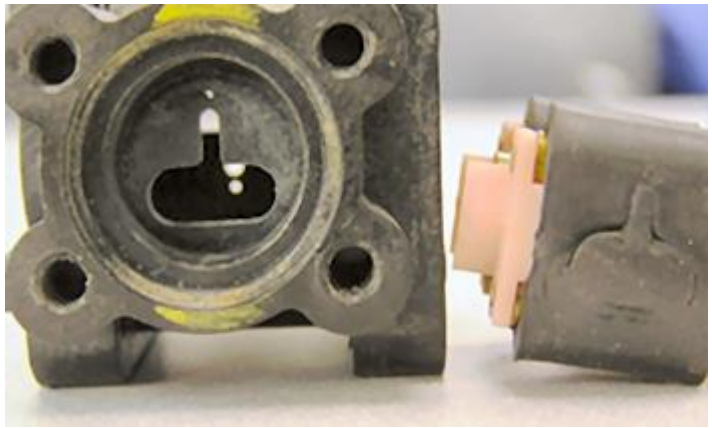
Cable Operated – T-Series M/D prior to Jan 2016, K-Series M/D, B-Cab prior to July 2004

Electronic – B-Cab after July 2004, T-Series M/D after Jan 2016

Common Issue - Water Valves Leaking

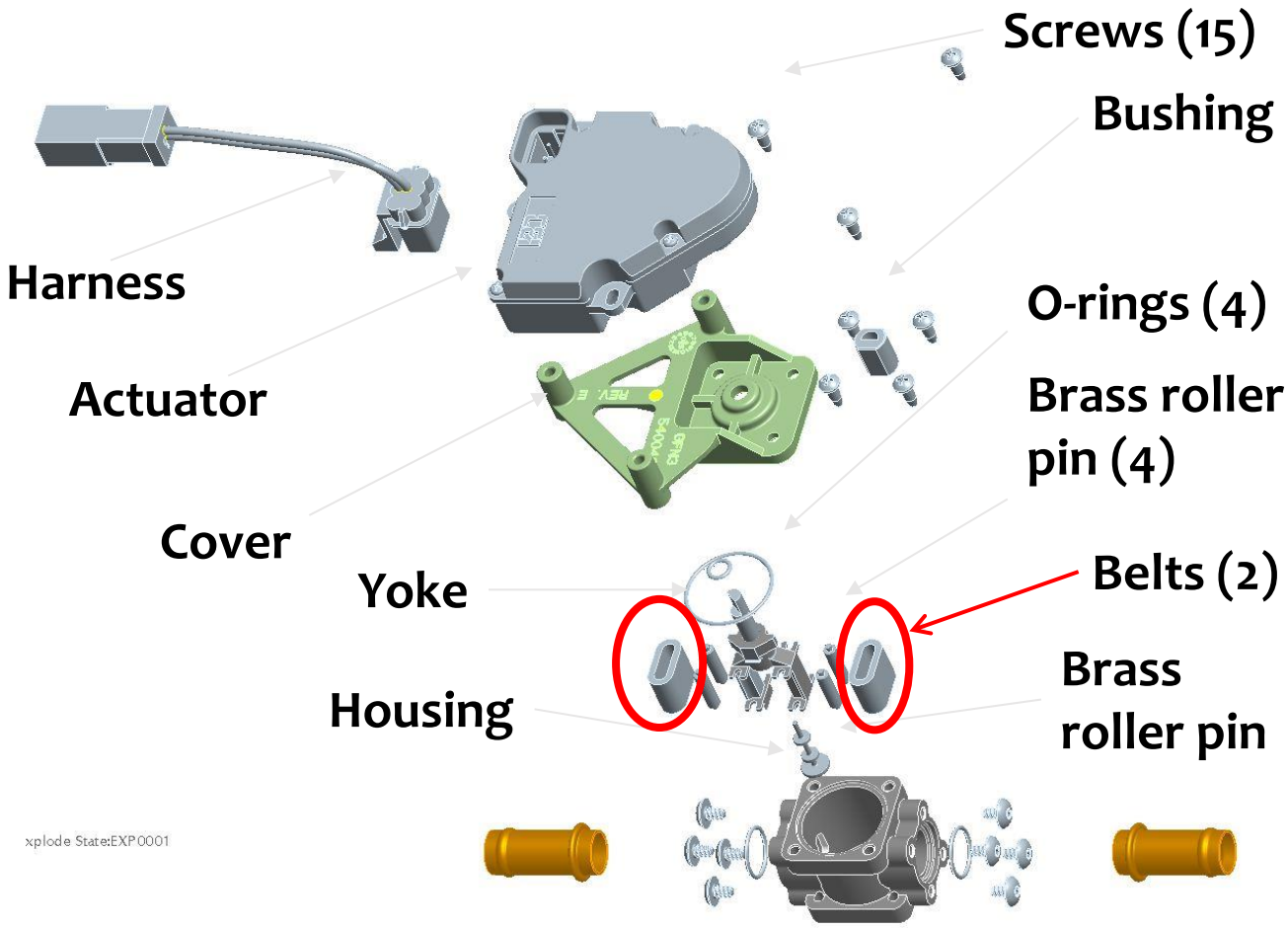
- Complaint
  - Water valve rubber seal becomes wedged in valve which doesn't allow the driver to shut off the heat
- Cause
  - Coolant or Coolant Additives causes rubber to swell
  - Chassis Affected
    - Legacy models
- Correction
  - Revised part implemented
  - Gen 2 valve does not have a belt to swell, the housing has a material developed specifically for Organic Acid Technology (OAT) coolant which eliminated stripping/cracking
  - Gives enhanced performance using with all typical automotive coolants, at elevated temperatures and pressures commonly seen in emissions engines





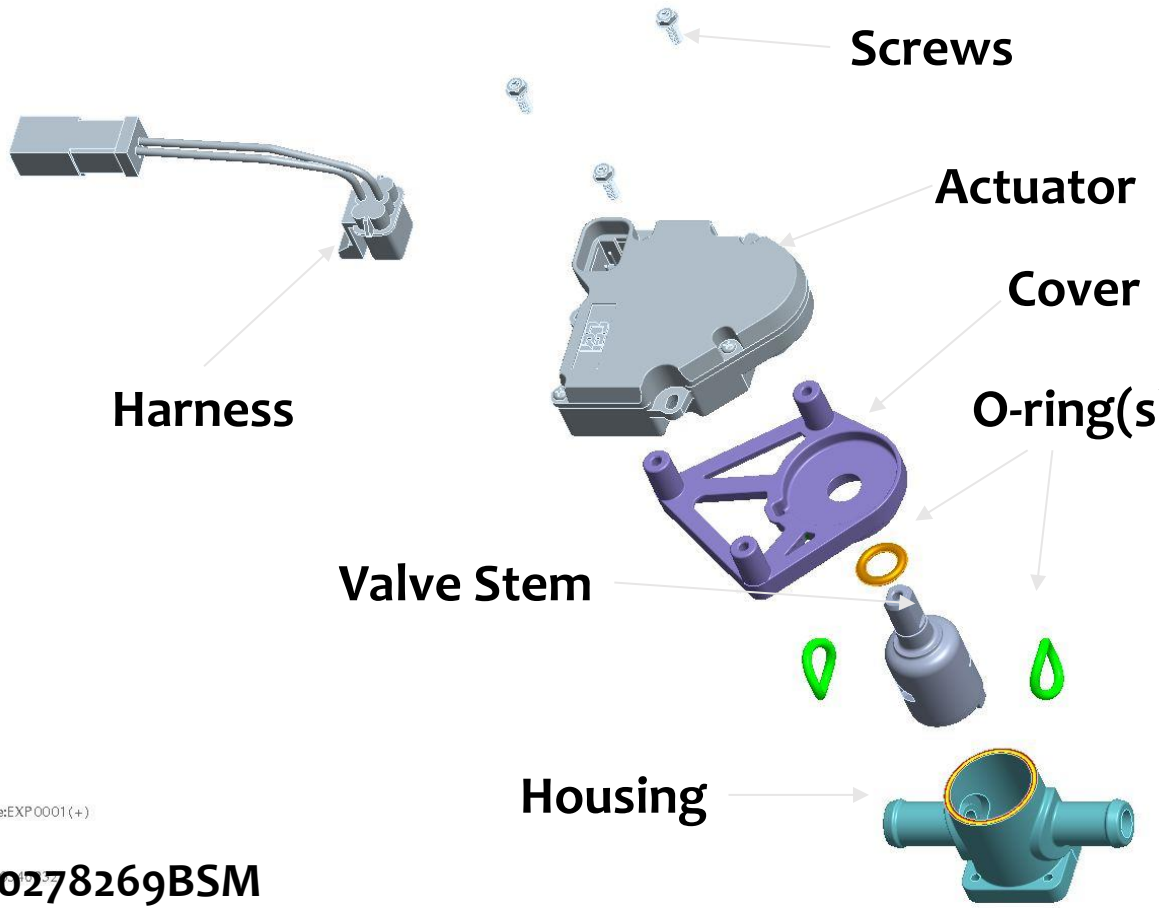
Early Heater Control Valve - Belt Style

34 Components



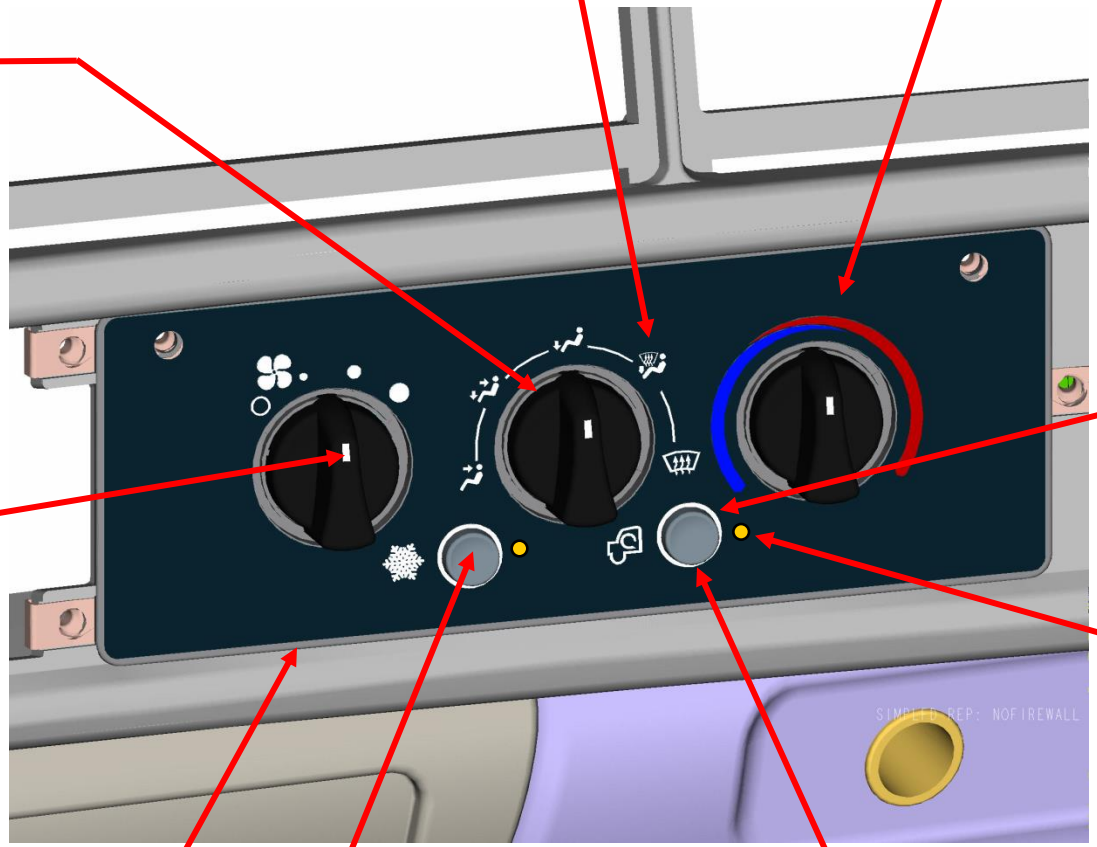
Heater Control Valve Components – Gen II

11 Components



Part # 1000278269BSM

HVAC Control Panel



NEW MIXED-MODE DEFROST / FLOOR

HOT WATER VALVE CONTROL, CABLE DRIVEN WITH RACK AND PINION

ELECTRIC ACTUATED MODE CONTROL

ROTARY KNOBS WITH BACK LIGHTING

BACKLIT RINGS FOR NIGHT VISIBILITY

AMBER INDICATOR LIGHTS

TABS ON BOTTOM SNAP INTO DASH

A/C ON/OFF SWITCH

ELECTRIC ACTUATED RECIR/FRESH AIR SWITCH

KENWORTH

Kenworth HVAC Systems

- B-Cab HVAC Upgrade Changes
- March 5, 2001 through December 2001

P. D. Box Changes

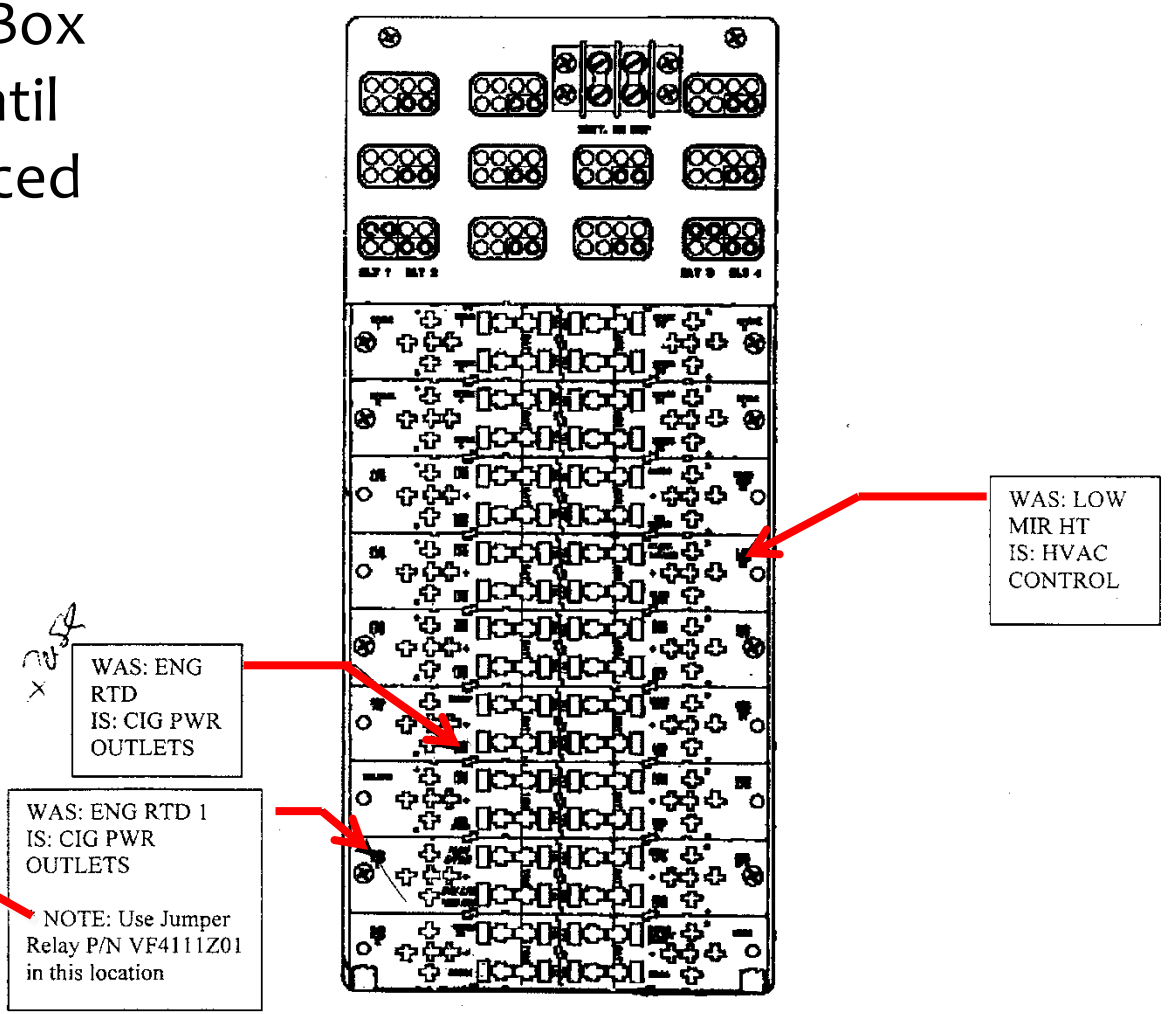
The functions of two relay positions have changed:

1. The ENG RTD 1 relay position has been relabeled as “Cig. Pwr. Outlet” This jumper wire (P/N VF4111Z01) now powers the cigar lighter and power wells in the cup holder. NOTE: The control circuit (85 & 86) is a live circuit and so if the jumper is replaced with a standard relay, the circuit will work but there will be a milliamp parasitic draw all the time

2. The LOW MIR HT. Relay is relabeled “HVAC Control” and powers the HVAC Control Head and electronic actuators. The Cab A/C relay still controls HVAC clutch as it previously did.

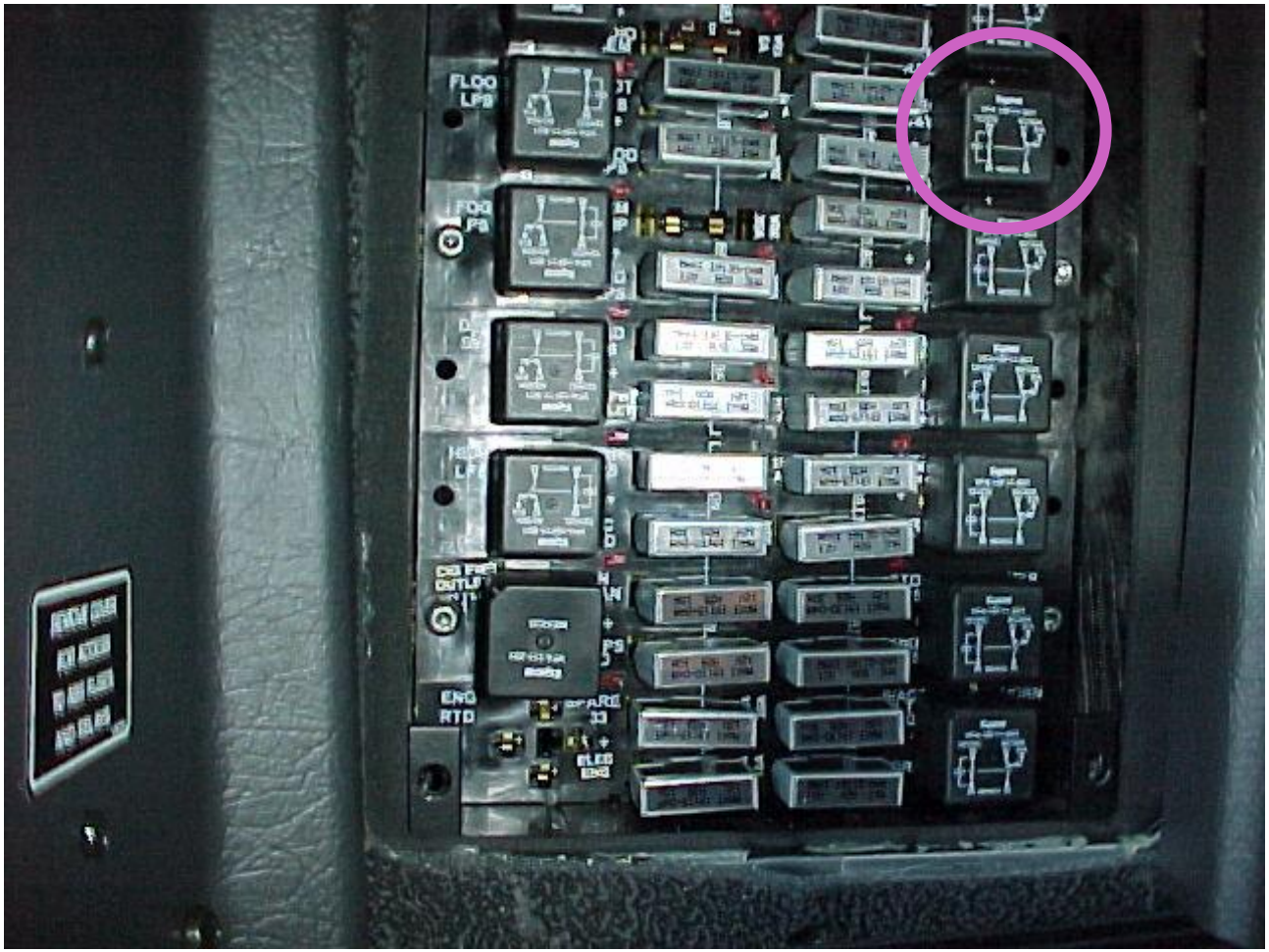
P.D. Box

B Cab Upgrade to PD Box from March 3, 2001 Until CEP Style was introduced December 2001



HVAC-Relay

B-CAB - Sends Power To The A/C Clutch



B-Cab: July 2004 to Jan 2007

- Electrically actuated mode controls
- Electrically actuated heater control valve
- 2 HVAC Relays
- Linear Power Module
- Binary Pressure Switch

Electronic Hot Water Valve

Five Wire Electronic Actuator

Linear Power Module

- Check for a varying voltage on the gray control wire when the fan speed knob is moved on the control head.
- Voltage on the black wire should also vary in conjunction with the fan speed knob and gray control wire.
- **During fan operation, there may be voltage on the cooling rods, depending upon fan speed setting.**

Replaces the Resistor Block / Thermal Fuse

B-Cab: NAMUX 2 with '07 Emissions Engine

- Electrically actuated mode controls
- Electrically actuated heater control valve
- 2 HVAC Relays
- Linear Power Module
- High & Low Pressure Switches

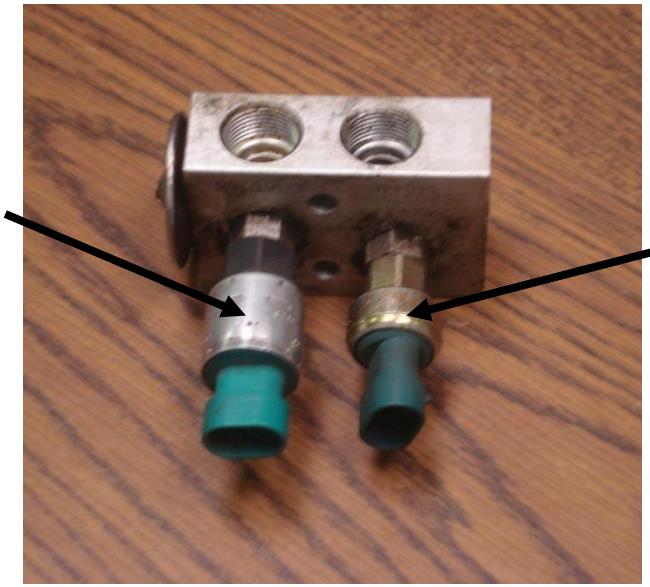
B-Cab low pressure switch

(2007 – present)

- Cut out = 10 +/- 4 PSI
- Cut in = 30 +/- 4 PSI

Faster cycle times in cooler weather because low pressure switches off compressor before freeze switch reaches set point

Low Pressure switch



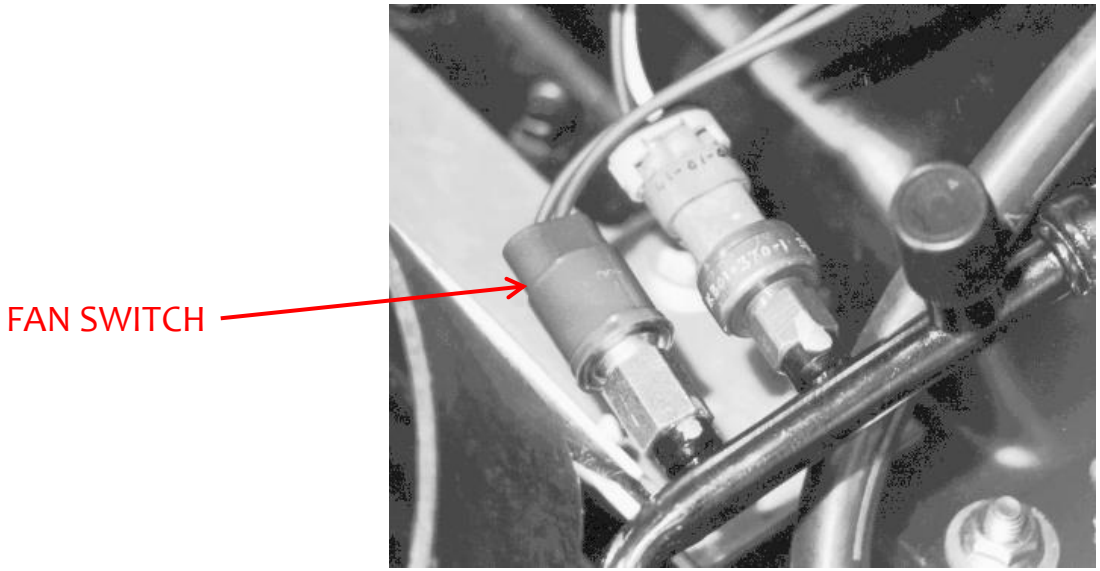
High Pressure switch

Fitting Assembly Torque: 3-5 Nm (27-44 in. lbs.)

B-Cab Fresh Air Filter

KENWORTH

Engine Fan Override Switch



- The fan switch engages the electric engine fan when **high side pressures exceeds 275±10 psi.**

- The fan switch disengages the electric engine fan when the **high side pressures fall below 230±10 psi.**

- Fan switches on COE models, off highway models and with roof-mounted condensers may use a fan switch with higher set points. This reduces fan operation because of a slightly more efficient condenser which causes slightly lower operating pressures.

Engine Fan Override Switch

Fan Logic for Cat and Cummins are opposite (Cat - Closed and Cummins - Open)

Connect wire to 3 J for Cat engines

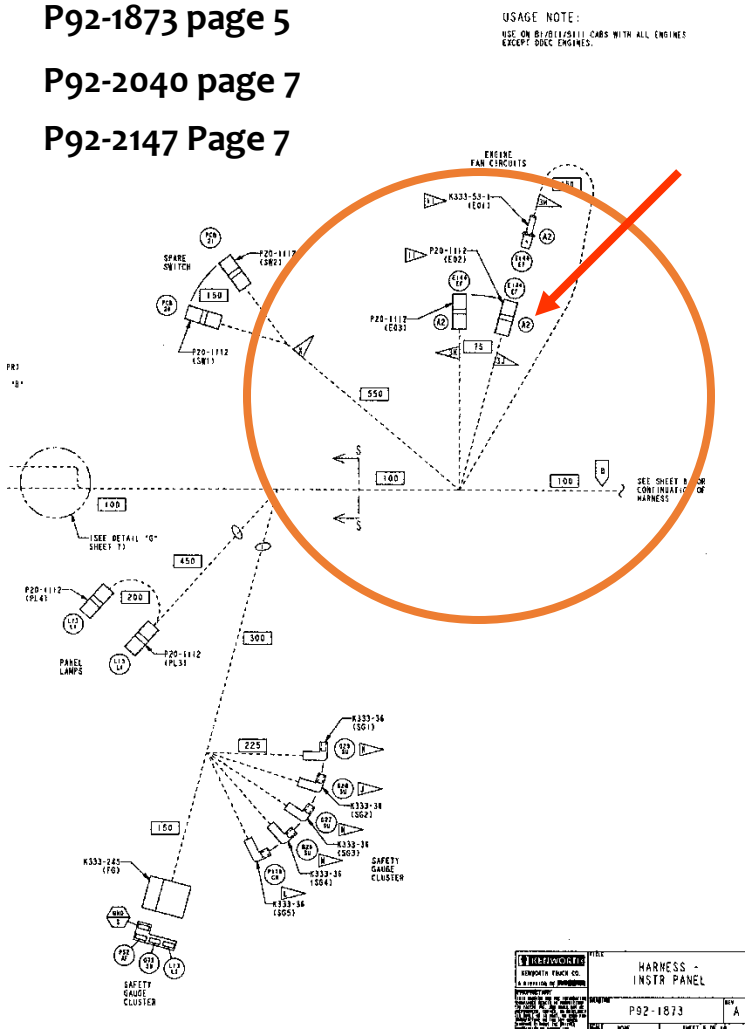
Connect wire to 3 K for Cummins engines

Note : Connector is found behind the safety gauge panel.

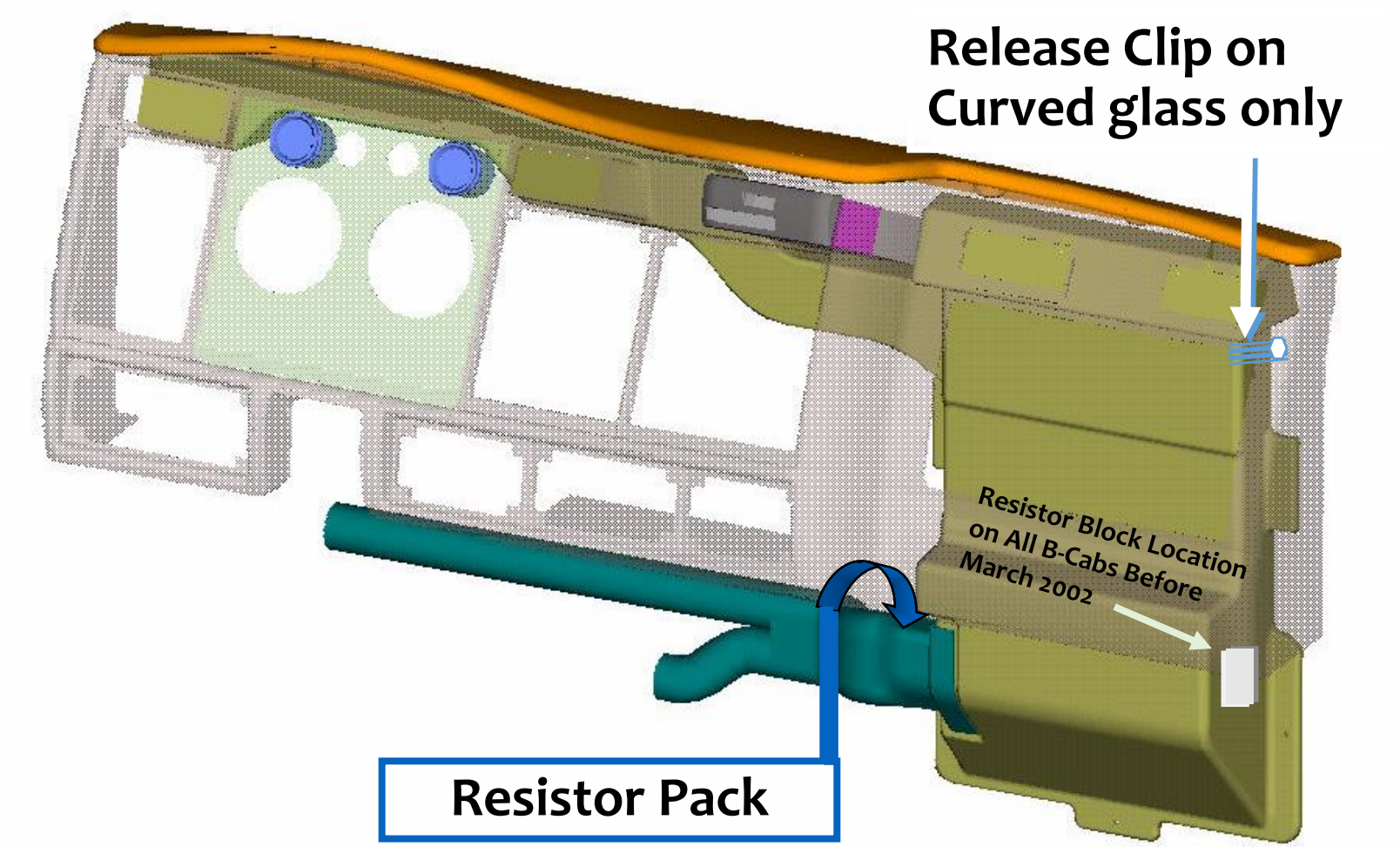
P92-1873 page 5

P92-2040 page 7

P92-2147 Page 7

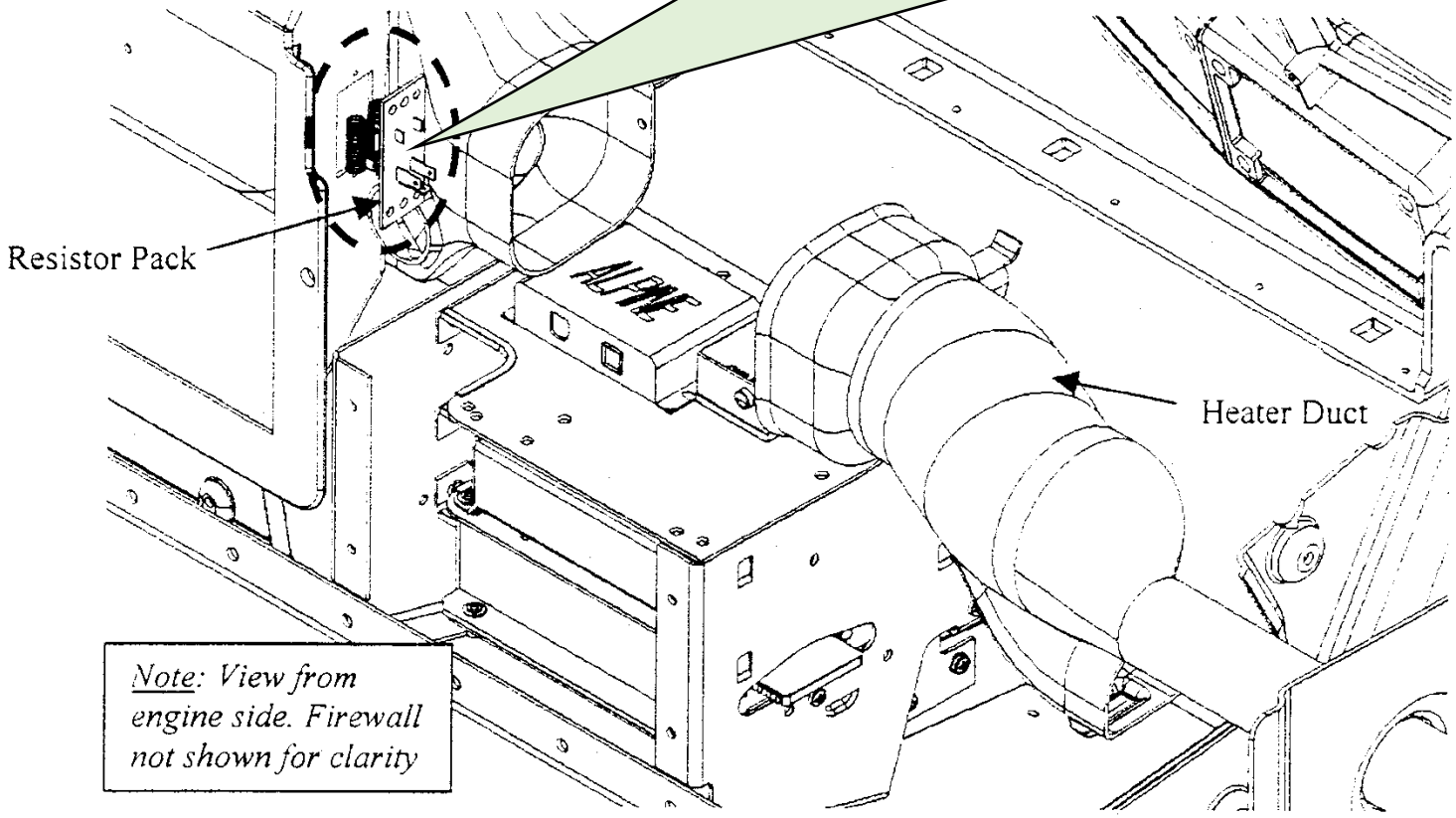


HVAC Duct Work



Resistor Pack Location

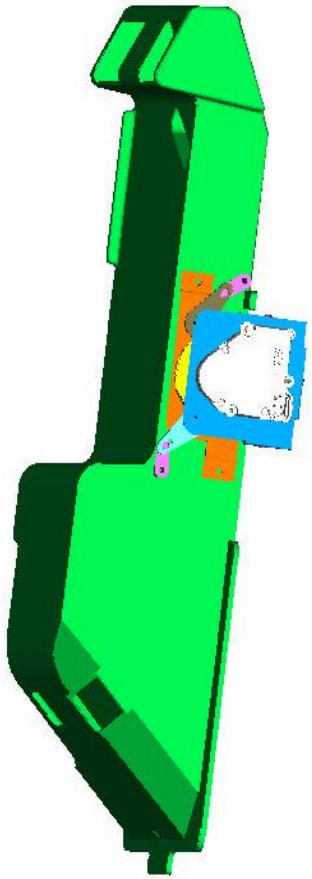
Viewing the Resistor Pack from the firewall

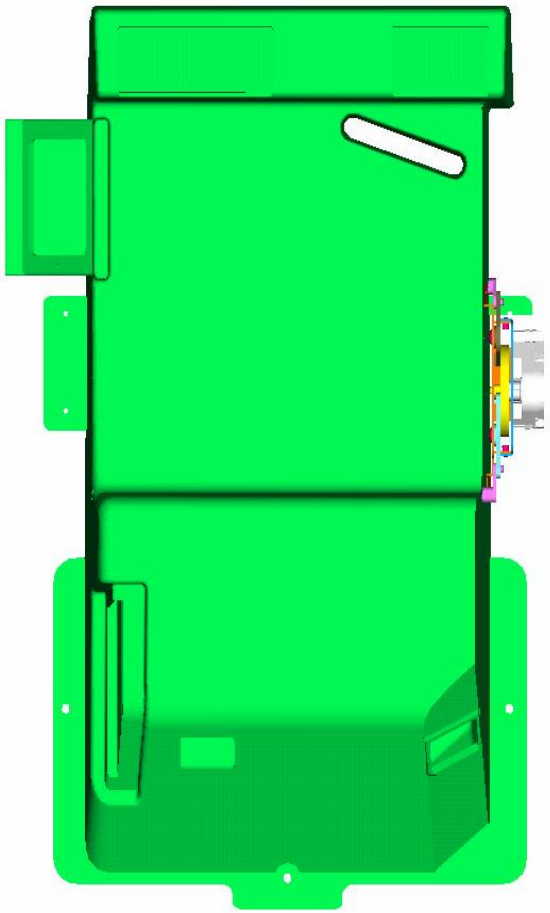


Driver's side here

* Must remove cup holder to get at resistor pack. Slide heater duct towards Driver's Side

Mode Door Actuator





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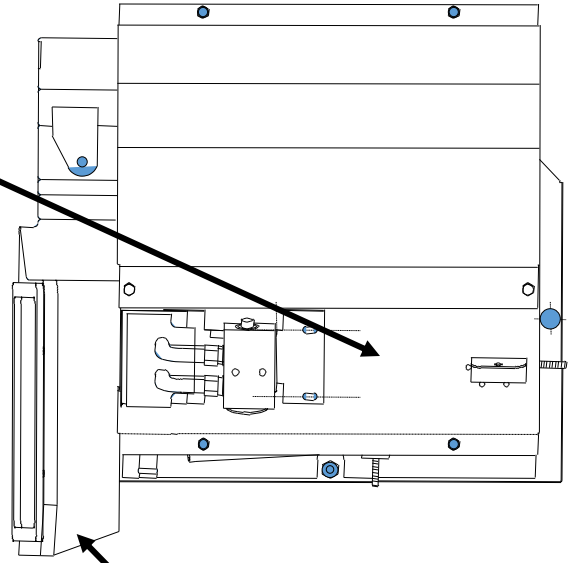
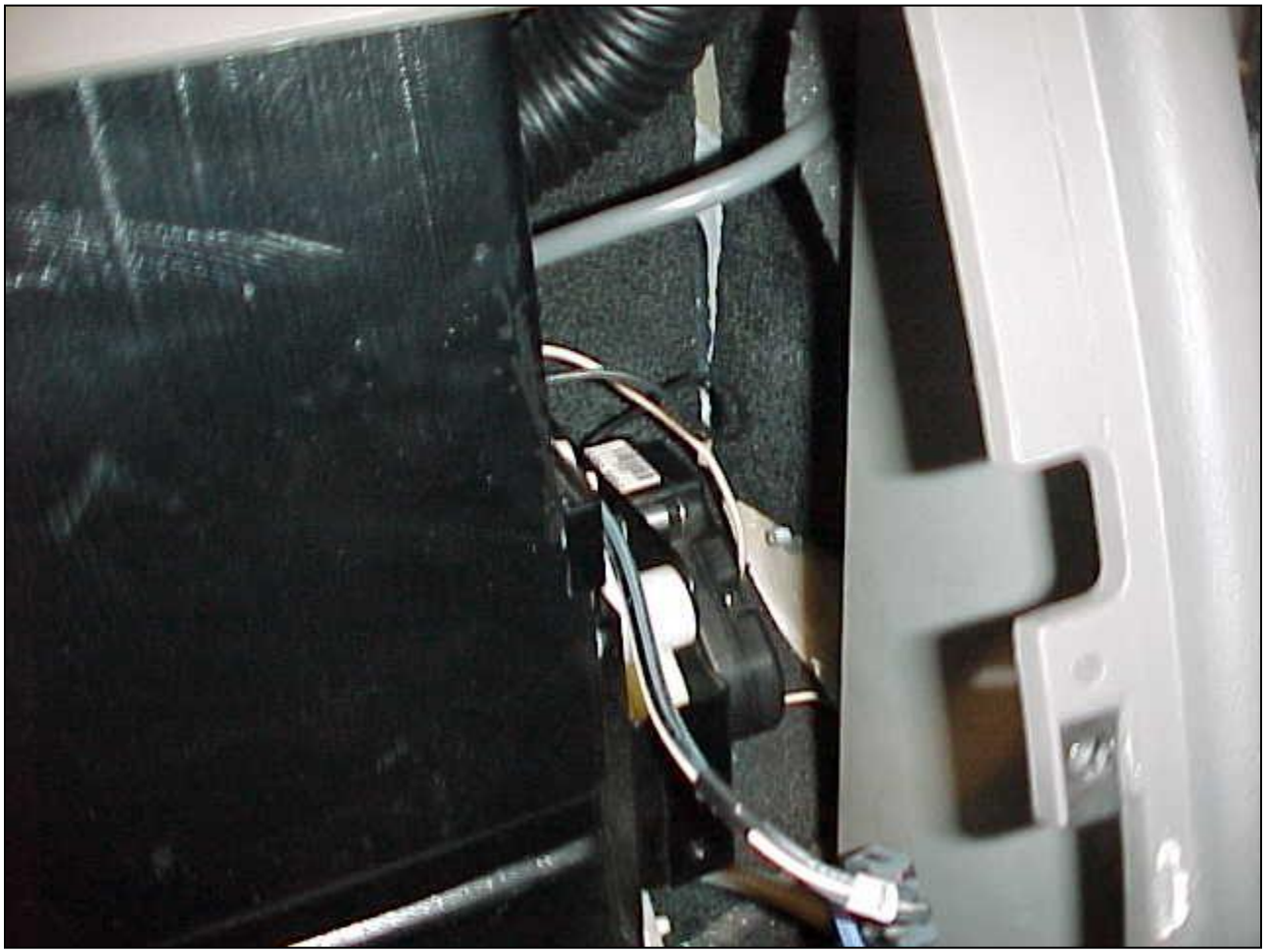
HVAC Unit – Under Hood

Electric Fresh Air/Recirc Actuator
Rated At 221°F



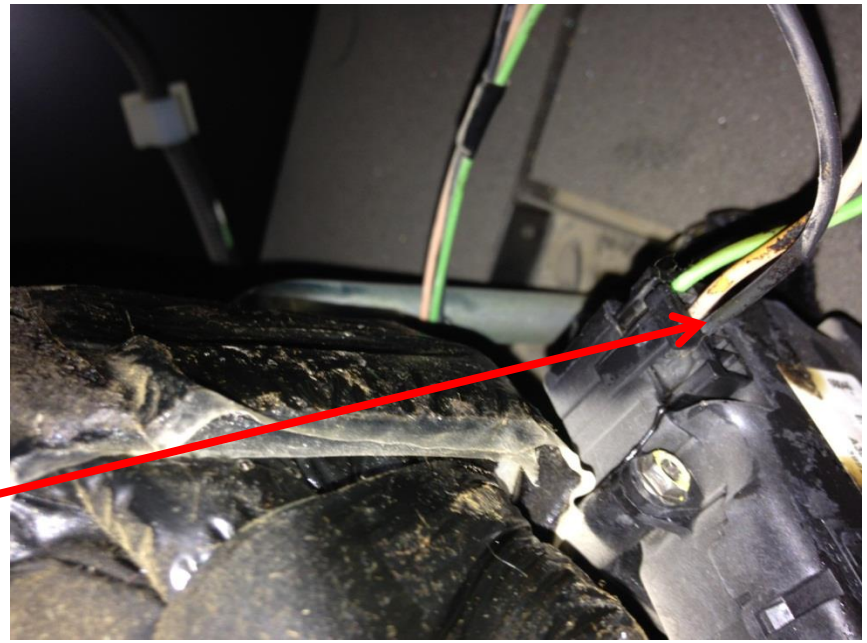
High Density Polyethylene Fresh Air Duct Rated @ 190°F

Electronic Mode Actuator - Behind Glove Box



Sleeper Troubleshooting – Temp Sensor Check

Blow gently on sensor and watch to see that voltage goes up and returns when you stop.



Have voltmeter in C77 SU wire and to ground, to check voltage change when blowing on Temp sensor

Sleeper Troubleshooting Rocker Switch

Rocker Switch - H124AC = 12 volt supply (top)

GND = ground (bottom terminal)

C77SU = control voltage (center)

If the switch is in “AUTO” (or open) the voltage is controlled by the module.

If switch is in “MAX HEAT” C77SU is switched to Gnd.

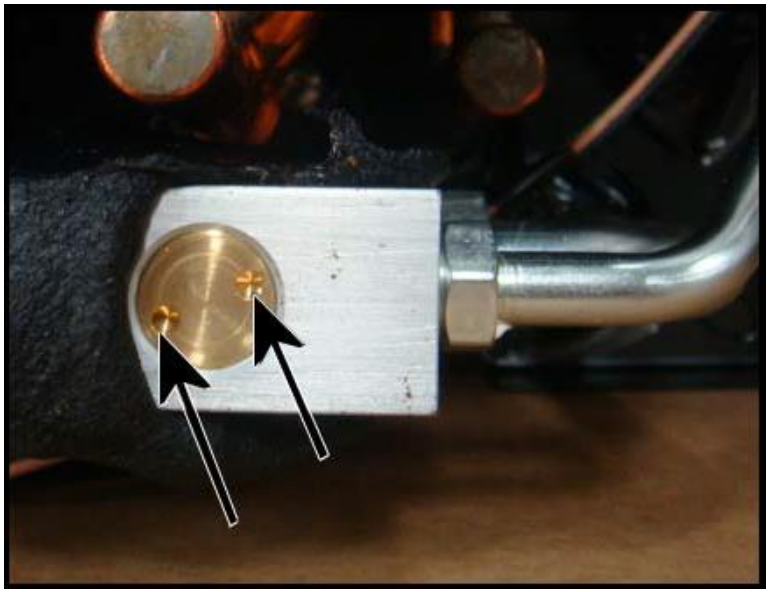
If switch is in “MAX A/C” C77SU power goes through a 1500 ohm resistor.

TIB 01-057 Sleeper HVAC Expansion Valve

If there is no green mark, cut and peel the black insulating tape from the end of the expansion valve on the side facing UP (the end without the large round disk).

If there is a brass set plug with two drilled removal tool holes, **replace the expansion valve.**

Note: Very Short Production, probably not seen in aftermarket repair facilities after warranty.



TIB 01-058 A/C Charge Label

- A/C Charge Label on C500, T800 and W900 Day Cab Chassis, built between 04/14/09 – 09/10/12.

Some customers may realize improved A/C performance with a refrigerant charge and future recharge to current specifications. **Kenworth has subsequently determined that a more optimal charge is 3lb-7oz to 3lb-8oz, instead of the original 4lb-0oz.**

B-Cab: NAMUX 3 with 2010 Emissions

(Current Production Configuration)

- Electrically actuated mode controls
- Electrically actuated heater control valve
- 2 HVAC Relays
- Linear Power Module
- High & Low Pressure Switches

R-134a Refrigerant Considerations

- Kenworth uses HNBR O-rings (Hydrogenated Nitrite Butadiene Rubber) (may be tinted green). Lubricate O-rings with system specific oil.

- Require special oil - Either POE (Early Climate Control Compressors) or PAG (Sanden Compressors). Oil used should not be intermixed.

- DO NOT lubricate slim-line seals on T680/T880 and T-series MD with oil. These must be installed on clean, dry fittings.

B-Cab Component Oil Charge

Component	Oil Charge
Evaporator	2 ounces
Compressor	2 – 4 ounces (**drain compressor- balance)
Condenser	1 ounces
Receiver Dryer	0.5 to 1.5 ounces
AC Lines	.5 - 1 ounce per line

A/C System Oil Charge Issues

Oil charge imbalance is one of the most frequently seen problems HD systems.

Signs of potential A/C system oil over-charge include:

- Poor or marginal performance
- Low side line, after evaporator core, sweating
- Excessive oil drained when recovering refrigerant
- History of repeated compressor replacement
- Early compressor failure

T2000 / T700

Kenworth Models

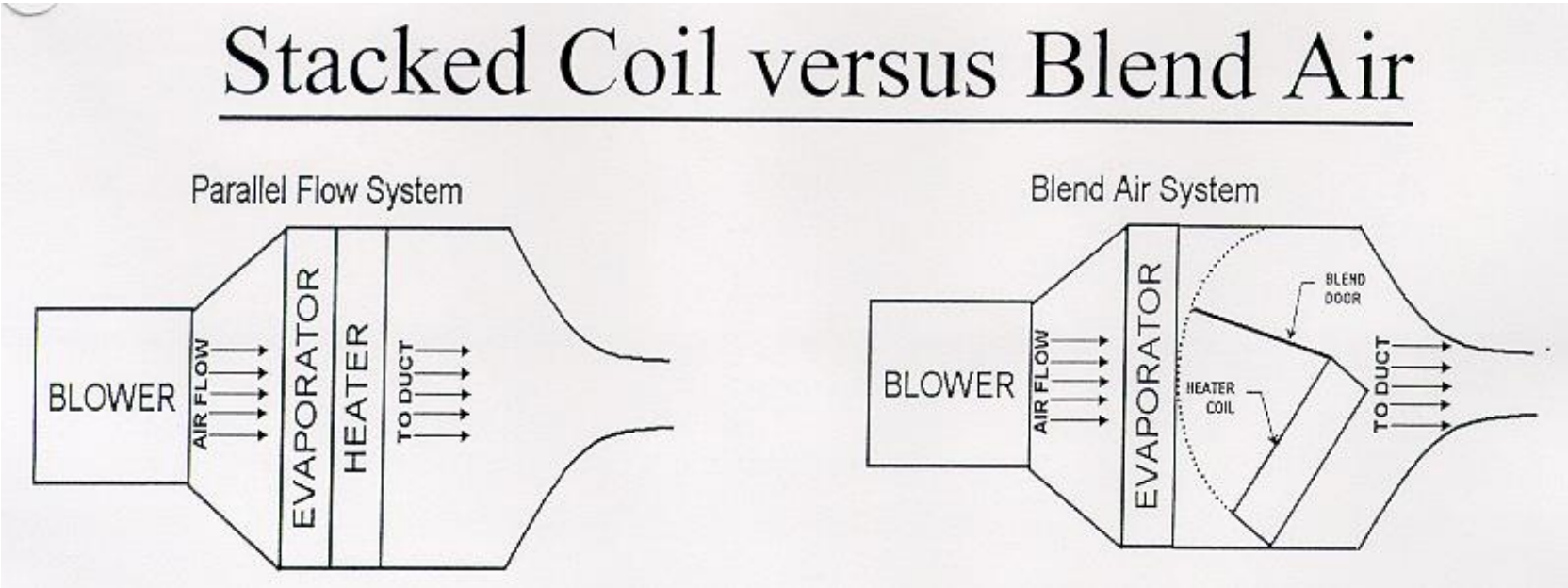
Wide Cab T2000 - > T700

No longer being produced

HVAC Changes By Years

- 1996 to Oct. 26, 1998 has APADS (**A/C Protection and Diagnostics System**): use P94-1125
- APADS Bypass: use P94-1224
- Oct 28,1998 to 2009 factory installed non–APADS: use P94-1105
- T2000 with NAMUX 2: use P94-1567
- T700: use P94-1944

Heater and A/C Operation



"B" Cab System

T2000 System

(T2000 and T700 use a Bergstrom system)

APADS System

September 1, 1996 through October 26, 1998

First rudimentary full climate control system

Automatic Temperature Control

No A/C switch on the control panel

APADS Bypass

Most APADS Systems Updated (TIB 01-42B)

A/C switch on the right side of the control panel

Non-APADS

October 27, 1998 to NAMUX 2

A/C switch on the left side of the control panel

Control Circuit for the BY-PASS

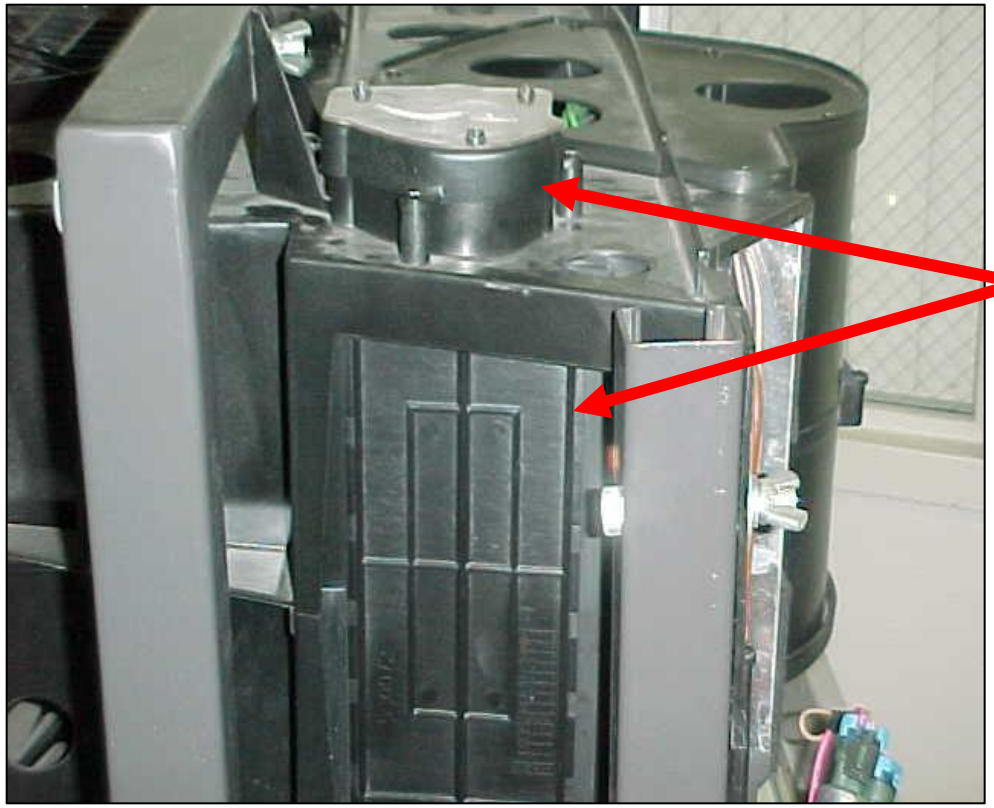
- T2000 (APADS By-Pass) TIB 01-42A

- When removing APADS, the C102ACP is connected to the P30CHD changing the High PSI Switch, Low PSI Switch, and the Freeze Switch to power side of the control circuit.

Blower Controls

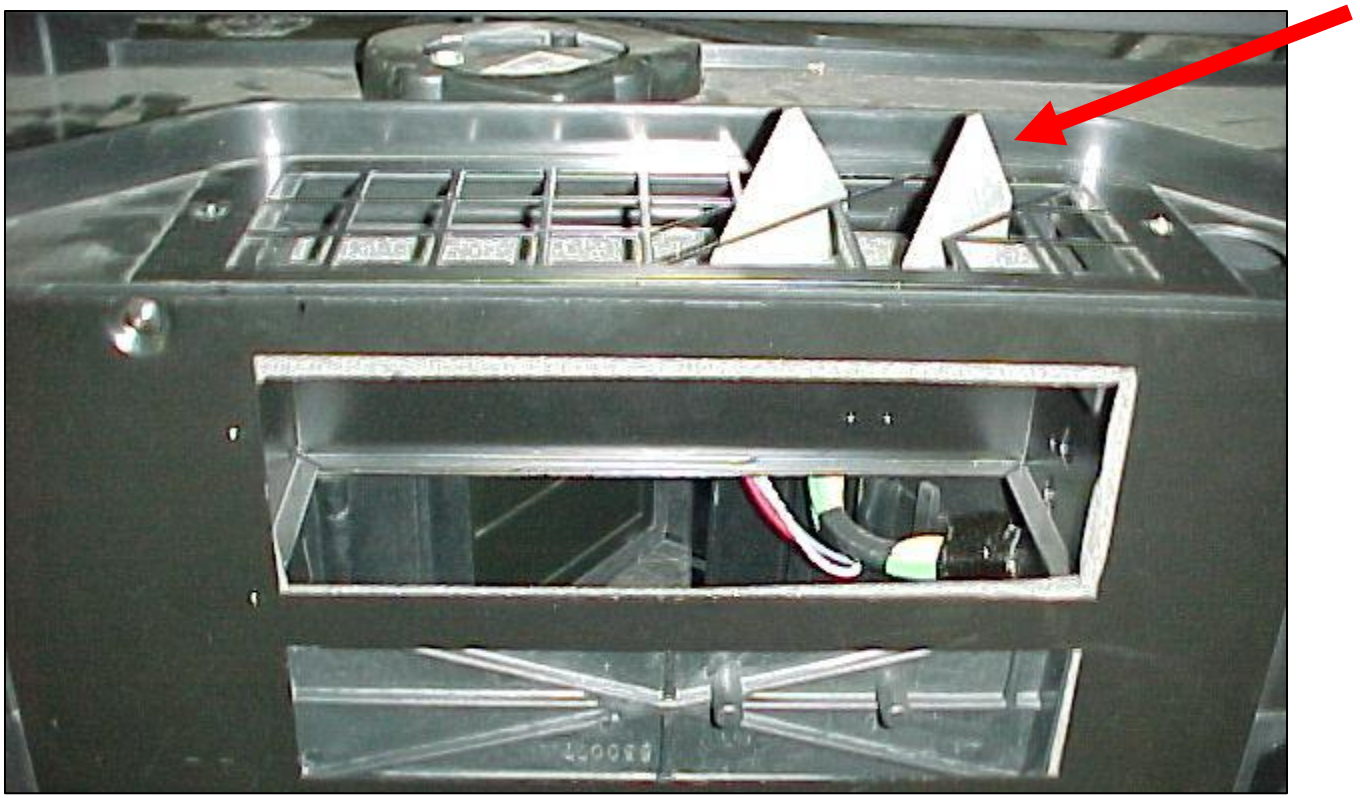
The T2000 has the cab blower circuit wired up as ground side switching and sleeper blower circuit is the opposite - power side switching.

Fresh Air Door Control



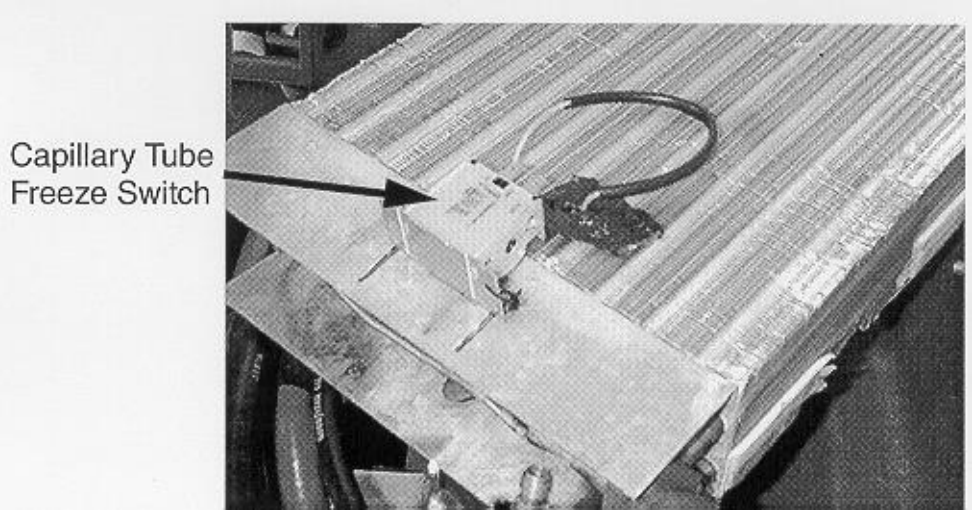
T2000 - uses an electric actuator to control fresh air door using voltages of 12V and <1V

Mode Control Doors



Put unit into defrost mode before removing unit from under dash, as the tabs will be damaged during removal otherwise.

Freeze Switch

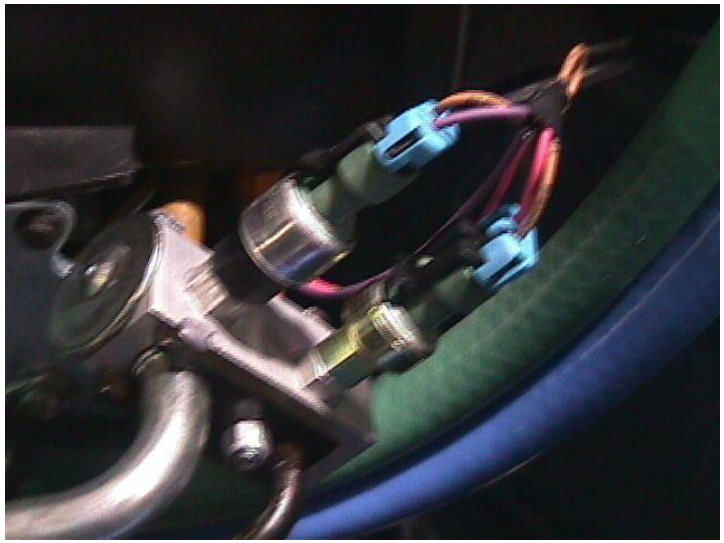


Both B-Cab and T2000 trucks use a freeze switch in the ground side of the HVAC relay control circuit

Freeze switch opens at 31.5°F and closes at 40°F

Pressure Switches

T2000 - Uses low and high pressure switches in the relay control ground circuit. (Similar to B-Cab after 2007)



- **Low pressure settings opens at 10 +/- 4 psi**
- **High pressure setting opens at 350 +/- 20 psi**

T2000 w/NAMUX 2

- Electrically actuated mode controls
- 4 Blower fan speeds (Low, Med-lo, Med, High) controlled by a resistor block
- 1 HVAC Relay
- High & Low Pressure Switches
- Fan Switch

Operating Temperatures

T2000 R-134a Ambient Sweep Data

Outside Air Temp.(Deg F)	Cab Unit Center Duct Outlet Temp.	Discharge Pres.(psig)	Suction Pres.(psig)
70	48-53	110-135	14-30
80	50-55	130-145	22-28
90	55-60	150-165	25-31
100	58-63	170-185	28-34
110	62-67	215-230	33-39

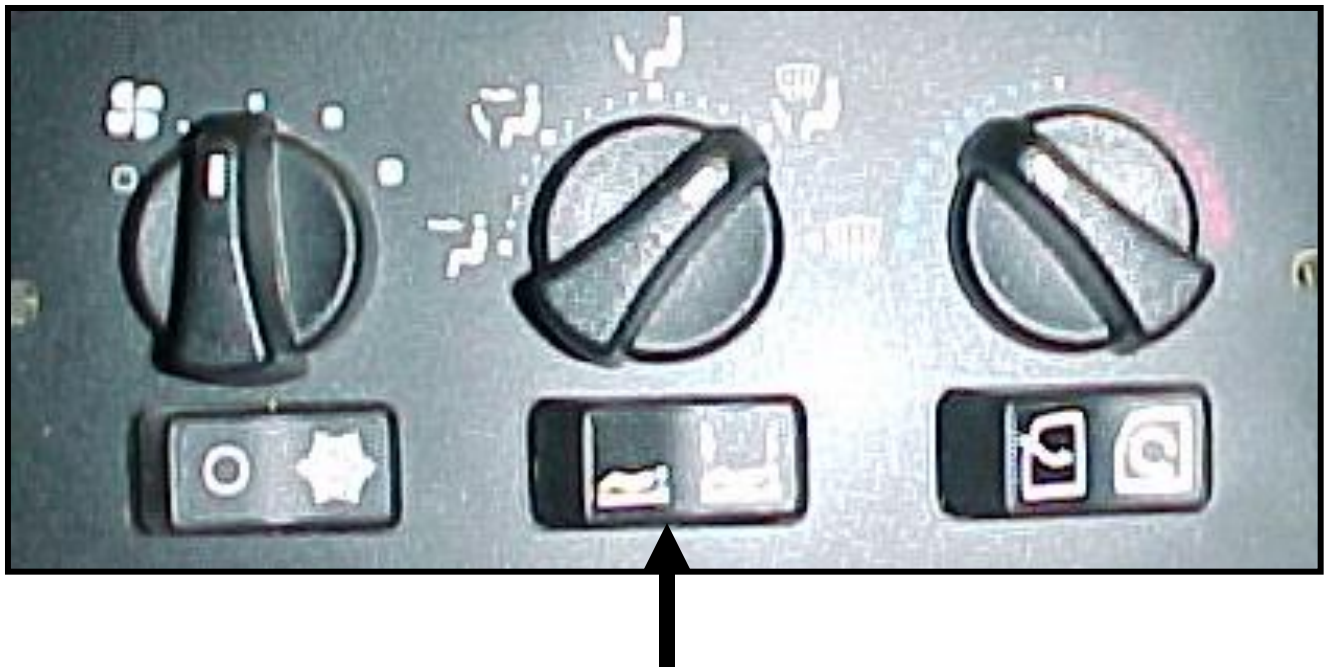
Outside Air Temp.(Deg F)	Bunk Unit Lower Duct Outlet Temp.	Discharge Pres.(psig)	Suction Pres.(psig)
70	43-48	110-135	14-30
80	45-50	130-145	22-28
90	50-55	150-165	25-31
100	53-58	170-185	28-34
110	56-61	215-230	33-39

Engine Fan on Manual

Engine RPM @ 1500

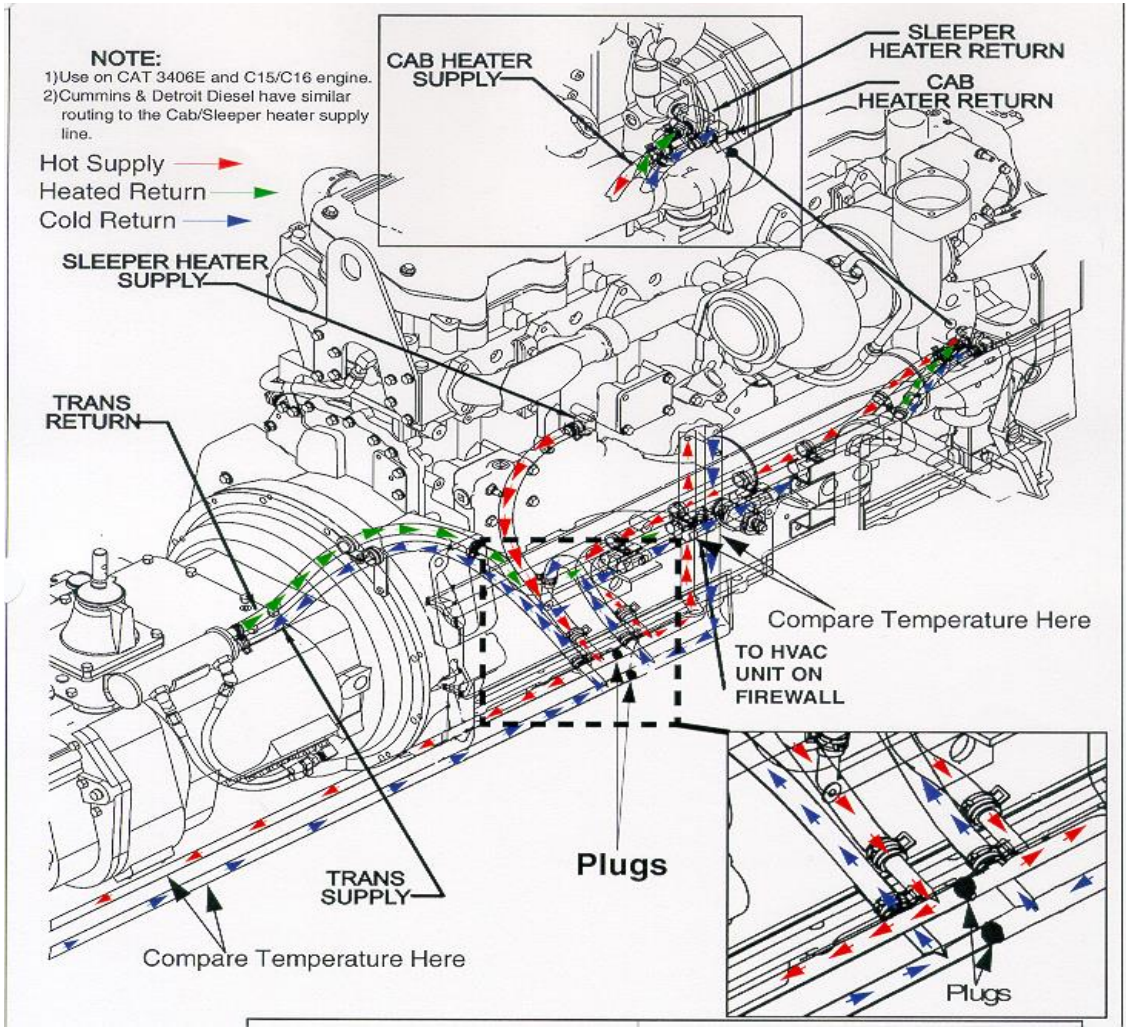
Doors and Windows Open

Sleeper Control



The Sleeper Rocker Switch controls power to the Sleeper Control Panel through circuit number P124SHA.

T2000 Sleeper Heater Lines



*** No Heat From Cab and/or Sleeper**

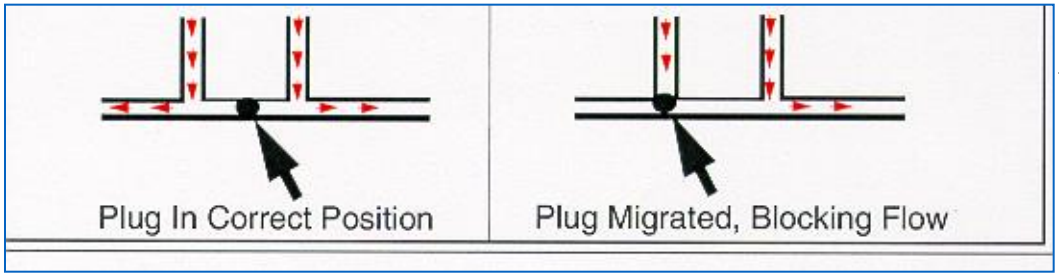
TIB 01 - 43

1. Run engine to operating temperature

2. Turn Cab & Sleeper heater controls to maximum heat position - (Do not select Defrost Mode, A/C will cycle and heat up the A/C lines as well).

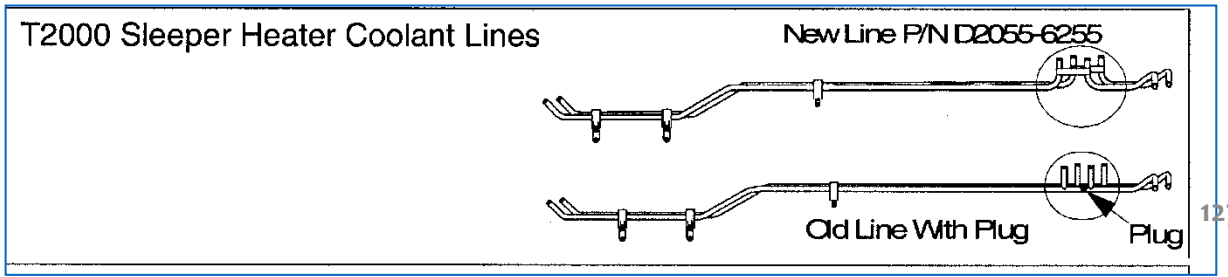
3. If no heat blows from cab or sleeper heater vents, check for heated coolant flow through supply lines.

4. If cab and sleeper heater supply lines are at operating temperature and about the same temperature, then coolant flow may be the problem. Verify correct operation of HVAC controls and blend air door operation.



Problem

Cure



T2000 Wrap Up

- Why spend time covering an almost 20 yr old truck system??
- There are still a small number of trucks still working every day with full OE APADS
- A significant number of trucks still in service with TIB converted APADS systems
- Most importantly, the TIB converted APADS systems became the basis for the T700 model truck A/C system

T700 (All Years)

- Electrically actuated mode controls
- 4 Blower fan speeds (Low, Med-lo, Med, High) controlled by a resistor block
- 1 HVAC Relay
- High & Low Pressure Switches
- Fan Switch

T680/T880
(2.1m Cab)

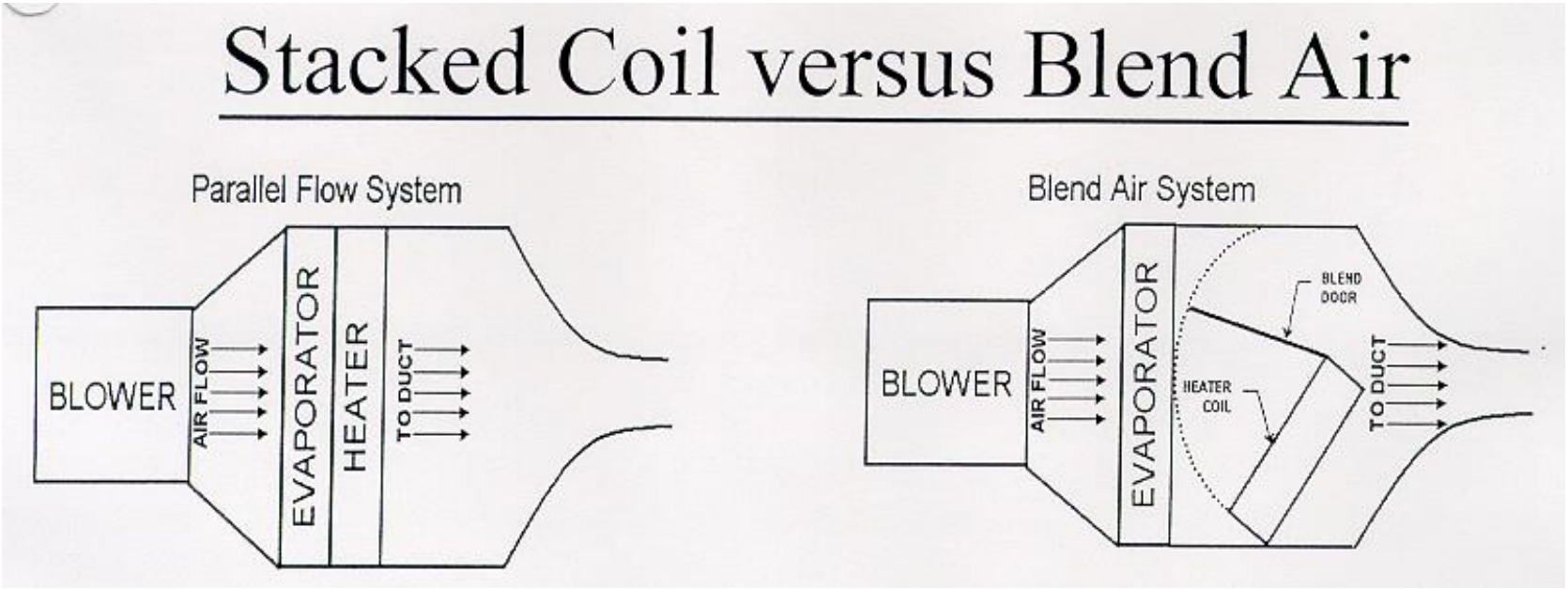
Kenworth Models

NGP (Next Generation Product)

Kenworth: T680, T880/Peterbilt: 579, 567

KENWORTH

Heater and A/C Operation



"B" Cab System

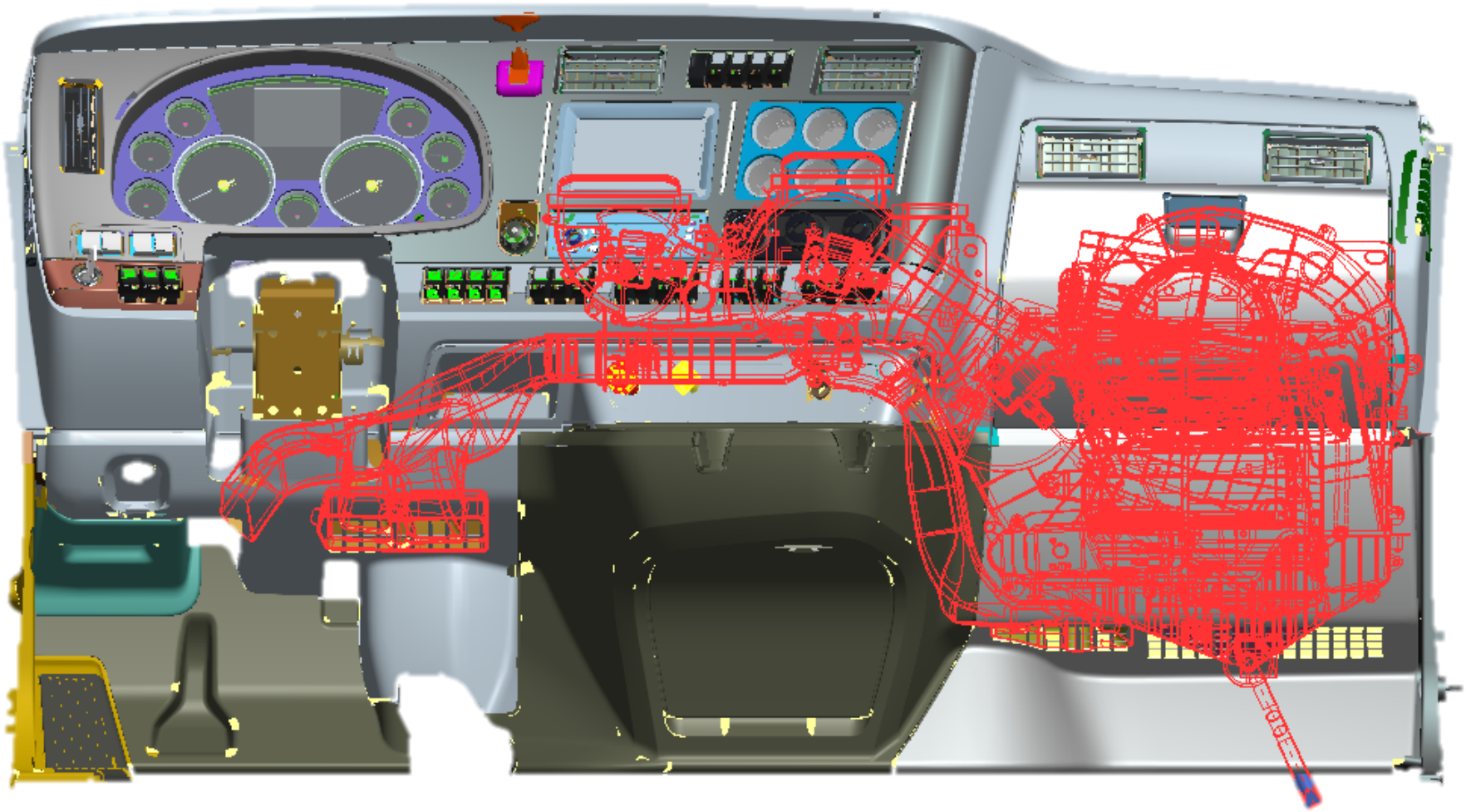
T680/T880 uses a Behr system

HVAC Electrical Components

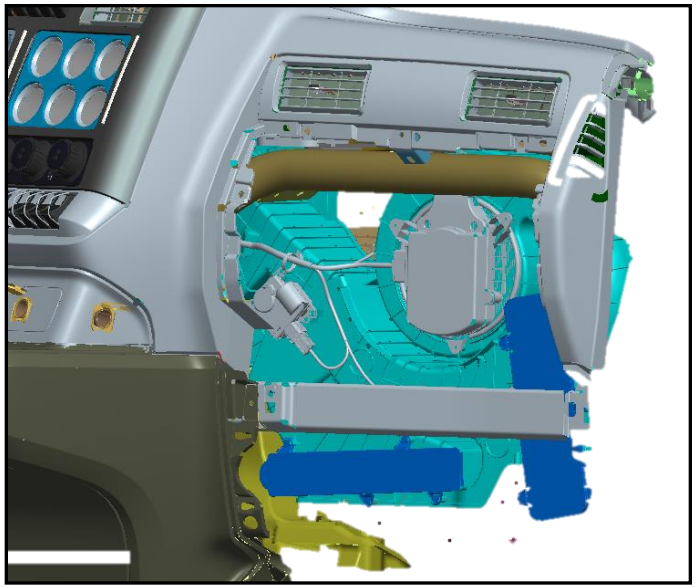
Component	B Cab	NGP	
Compressor	Sanden	Sanden	
AC Relay	Yes Controls power to clutch	Yes Controls power to clutch	
High Pressure switch	2007 emissions engines	No	
Low Pressure switch	2007 emissions engines	No	
Binary Switch	1994 - 2006	No	
Blower Fan switch	yes	yes	
Blower motor	Yes	Yes – but	Direct DC Current
Resistor block with thermal fuse	Cab till 2002 – then linear power module	linear power module	Still used on all sleeper modules
Freeze switch	Yes	No	
Engine fan switch	Yes	No	

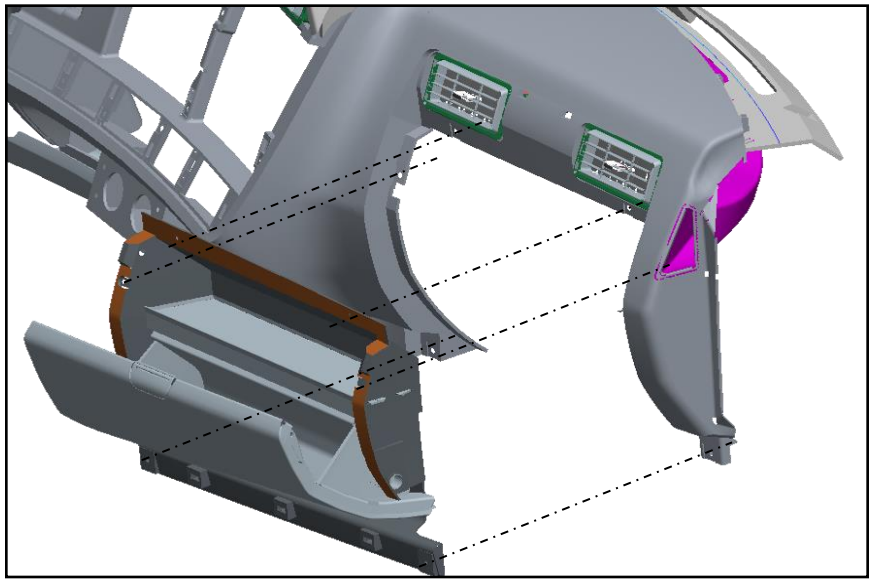
KENWORTH

Cab HVAC



Cab HVAC Service Location

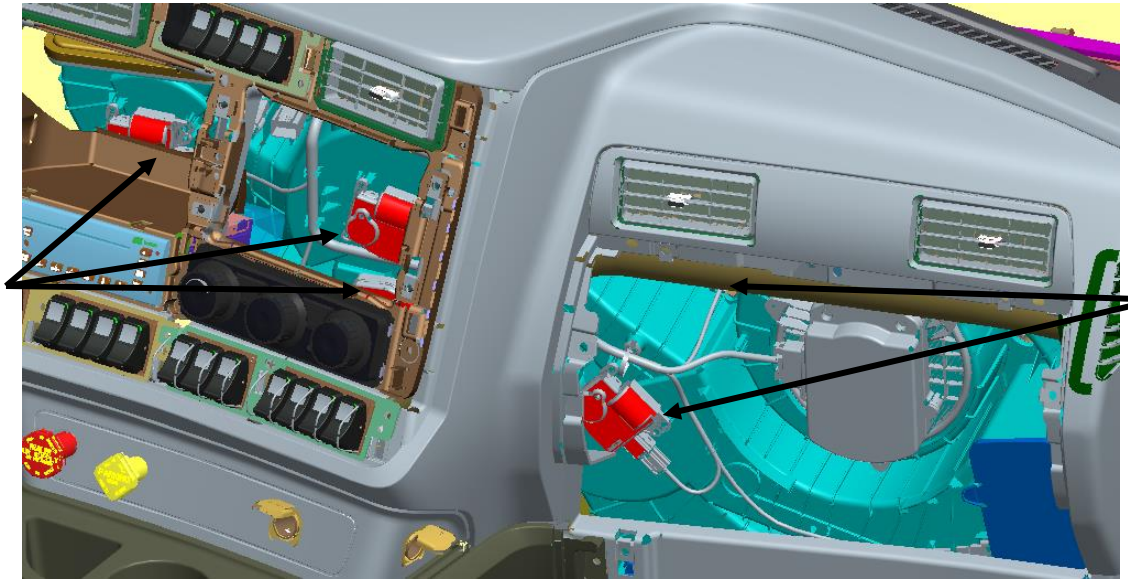




- HVAC Components Are Serviced By Removing The Glove Box And Dash Trim.
  - Blower Motor, Actuators, Heater Core, Evaporator, Freeze Sensor, Air Filter.
- Components Not Serviceable Through Glove Box Opening.
  - Plastic Housings, Air Directing Doors, Foam Seals, IP Ducts.

Actuator Service

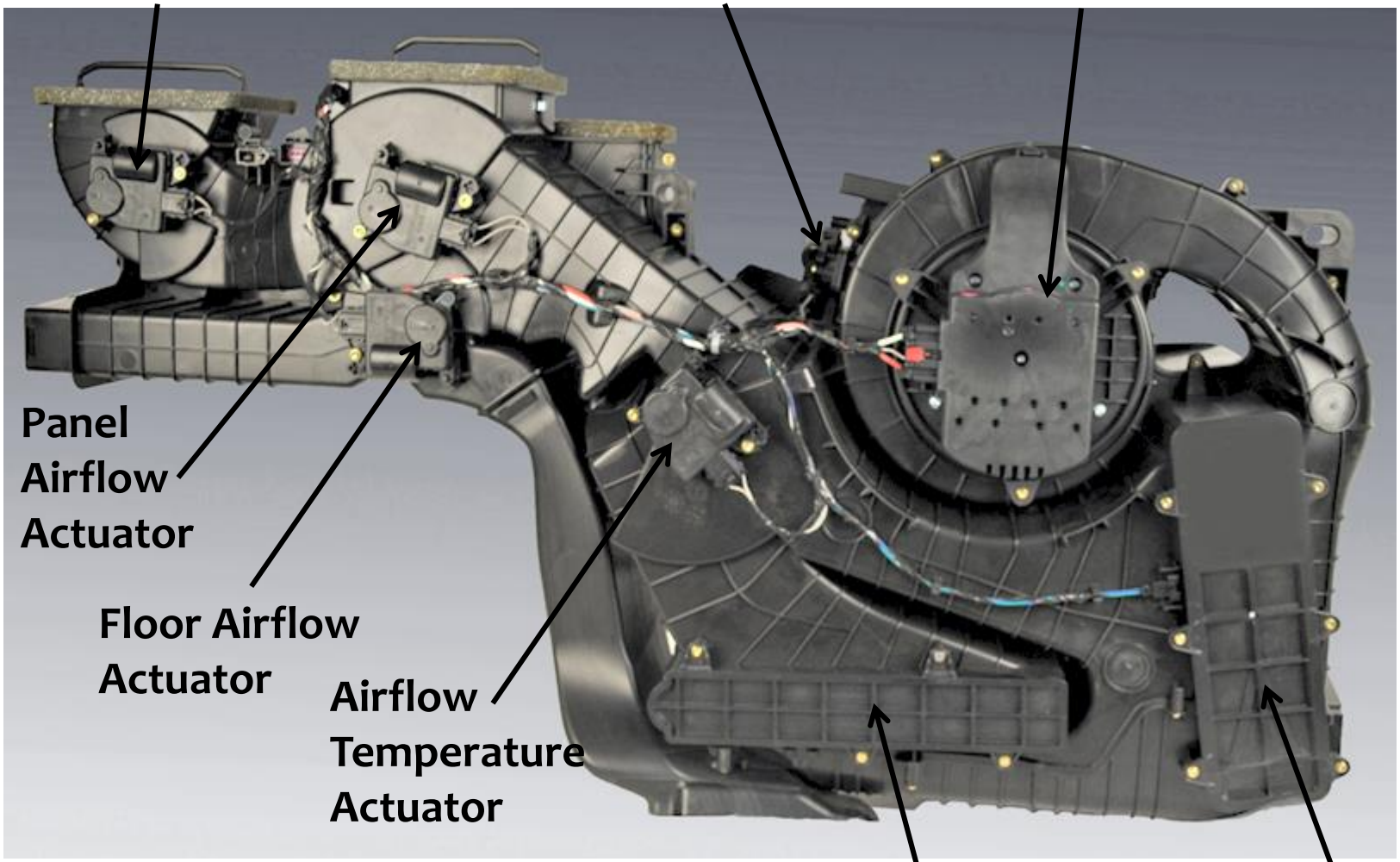
Actuators In Red



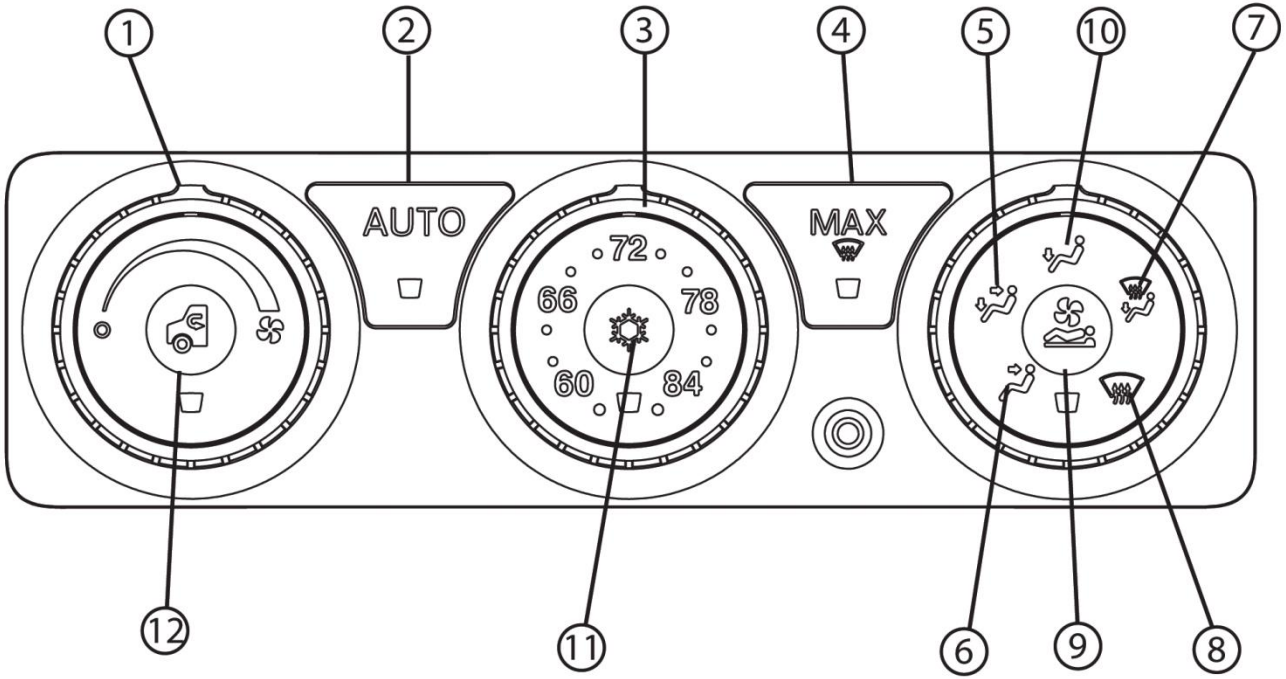
Actuators In Red

- Disconnect battery power from HVAC.
- Remove glove box & b-panels to access actuators.
- Disconnect the wire harness connector.
- Remove (2) T-20 torx screws.
- Replace actuator and connect wire harness.
- Replace trim panels.
- Connect battery power and listen for HVAC to calibrate.

Cab HVAC Unit

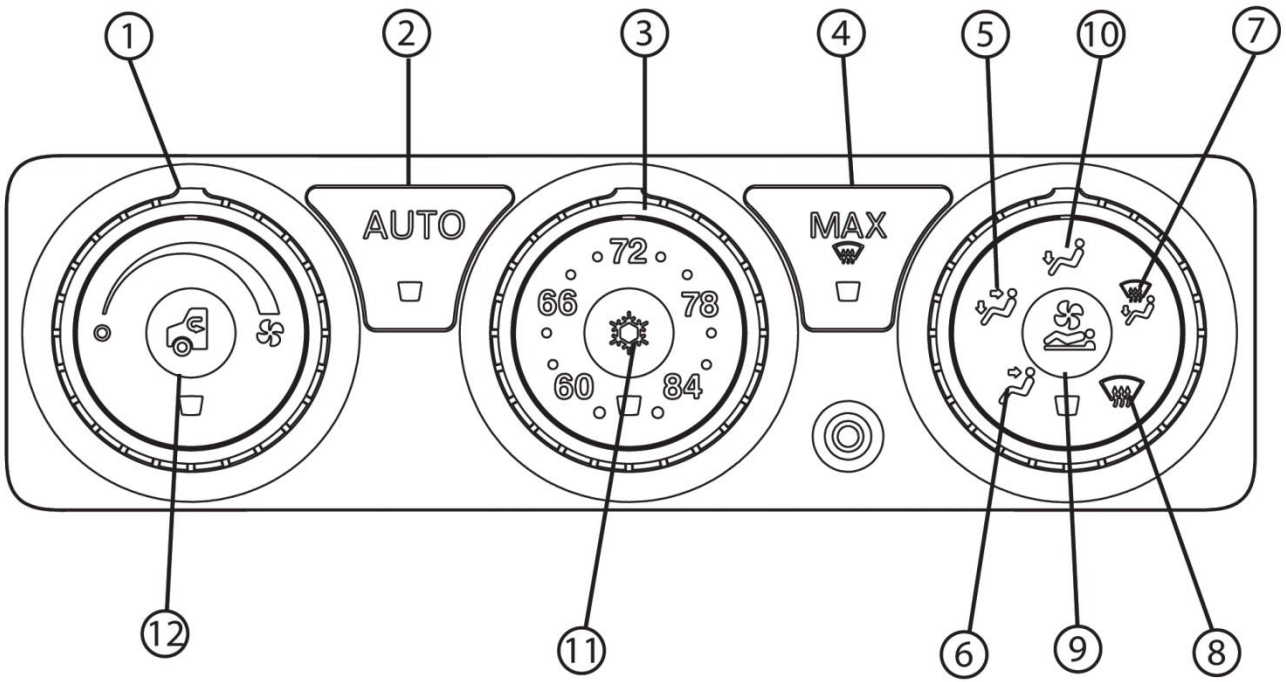


KW Cab Control With Bunk Override



1. Fan Control Dial
2. AUTO Mode
3. Temperature Control Dial
4. Defrost Button
5. Dash & Floor
6. Dash

KW Cab Control With Bunk Override



7. Floor & Defrost

8. Defrost

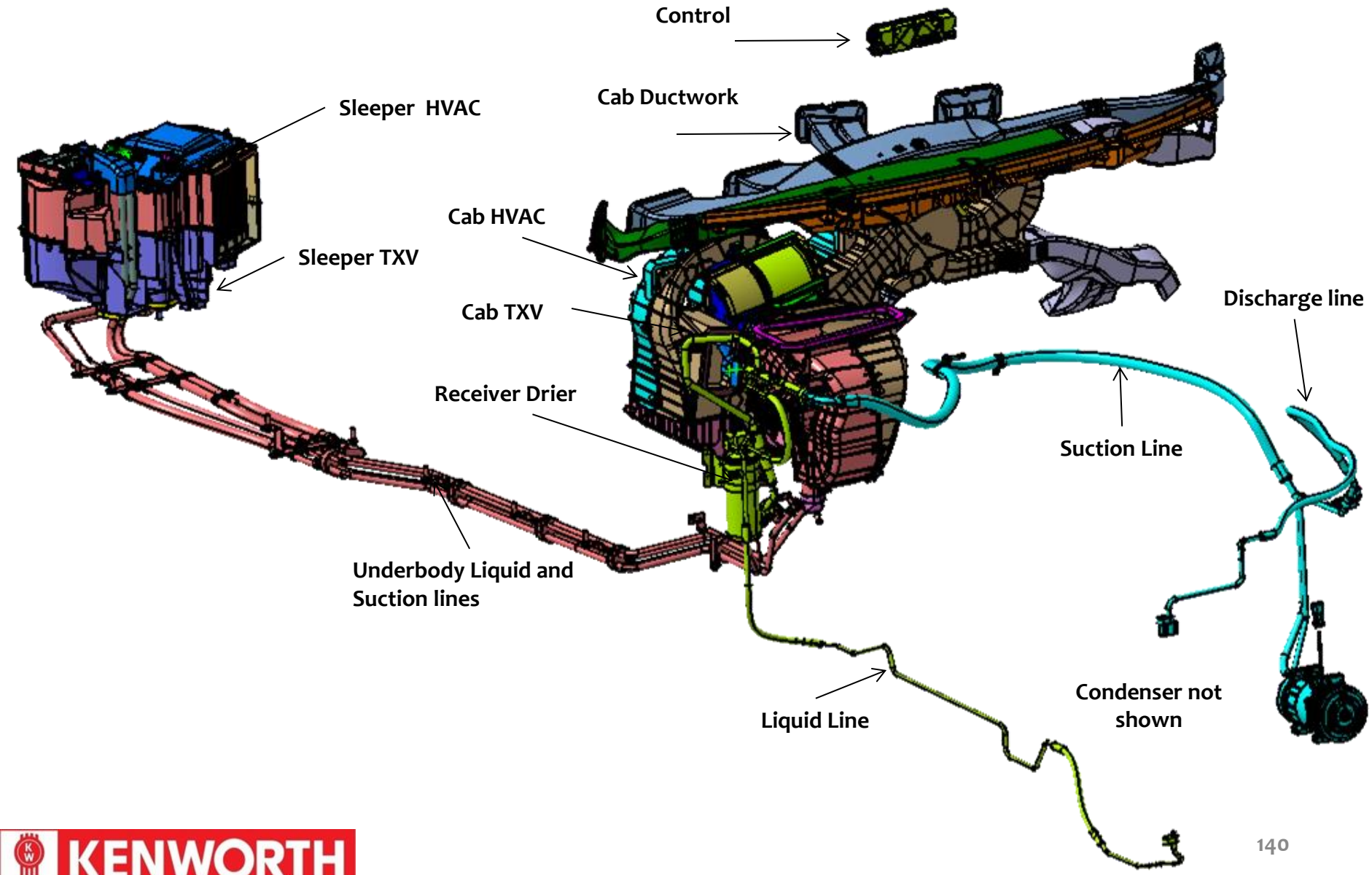
9. Sleeper Override (if equipped)

10. Floor

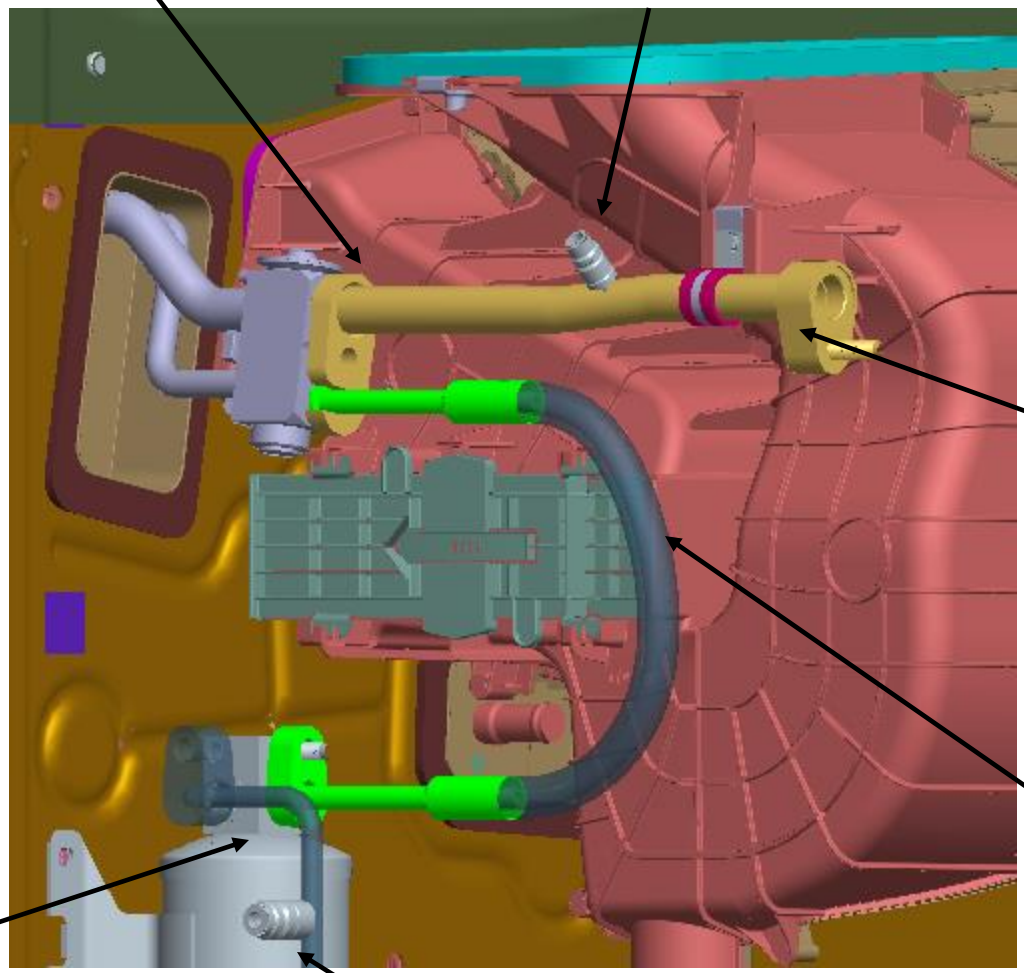
11. Air Conditioner Enable

12. Fresh Air / Recirculate

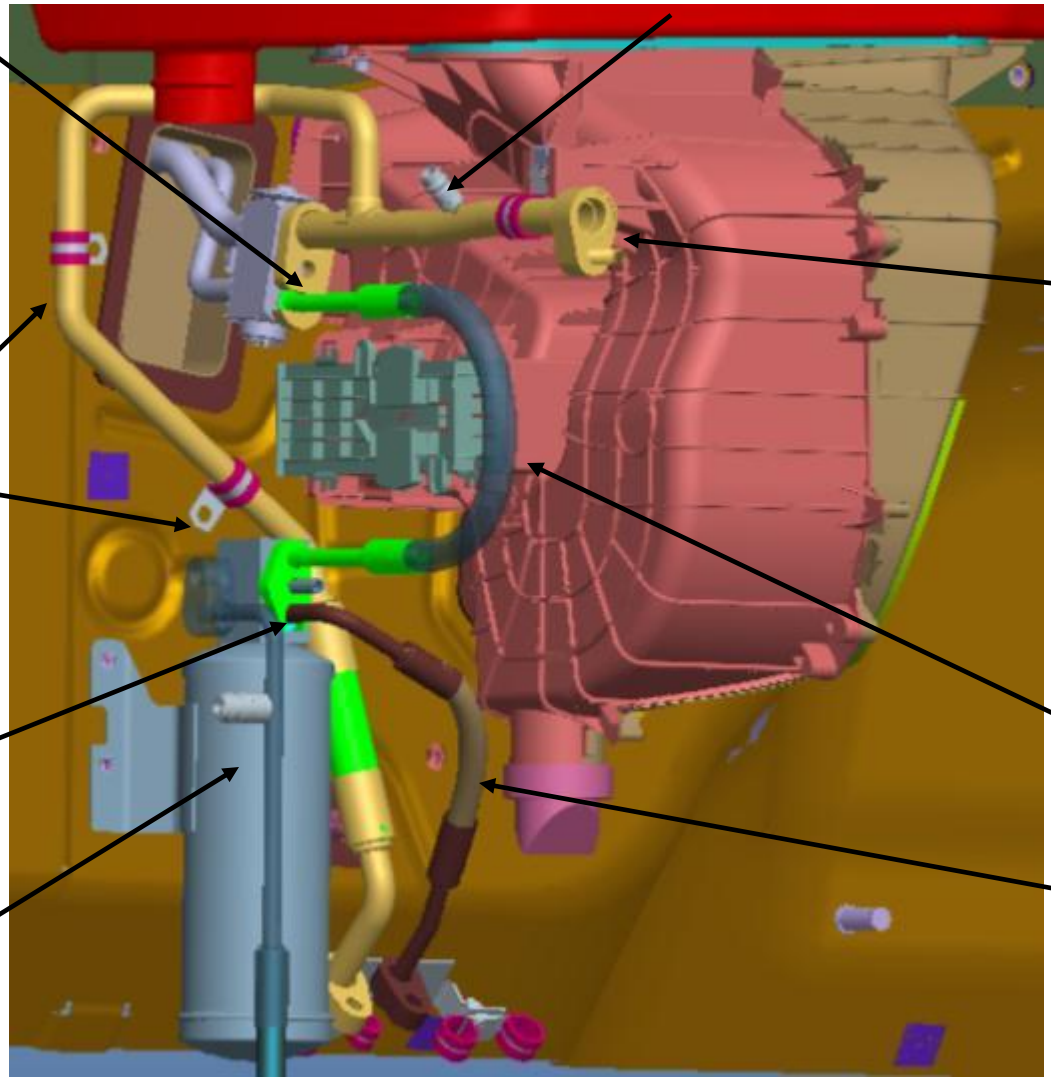
NGP HVAC System



Firewall – Cab Only, HVAC R-134a Lines



Firewall – Cab & Sleeper, HVAC R-134a Lines



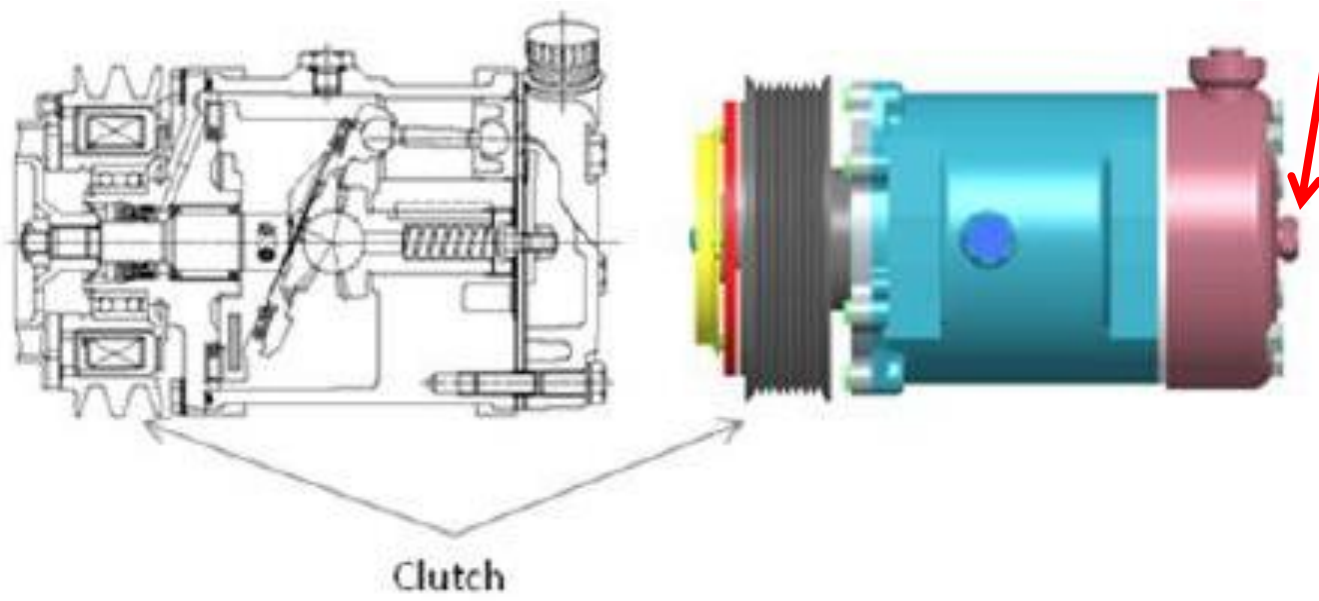
HVAC - Cab and Sleeper

- Cab
  - ATC – Automatic Temperature Control (temperature, mode and fan speed)
  - Long-life Brushless DC (BLDC) blower motor – double current component life
  - Lightweight Aluminum Heater Core - serviced thru glove box

- Sleeper
  - Register positioning optimizes sleeper airflow
  - Filtered & re-circulated air (like home A/C) used to maximize heating / cooling performance
  - Uses an additional recirculation filter in sleeper

Sanden Compressor

- Same Sanden compressor as today
  - Slimline seal technology added to NGP

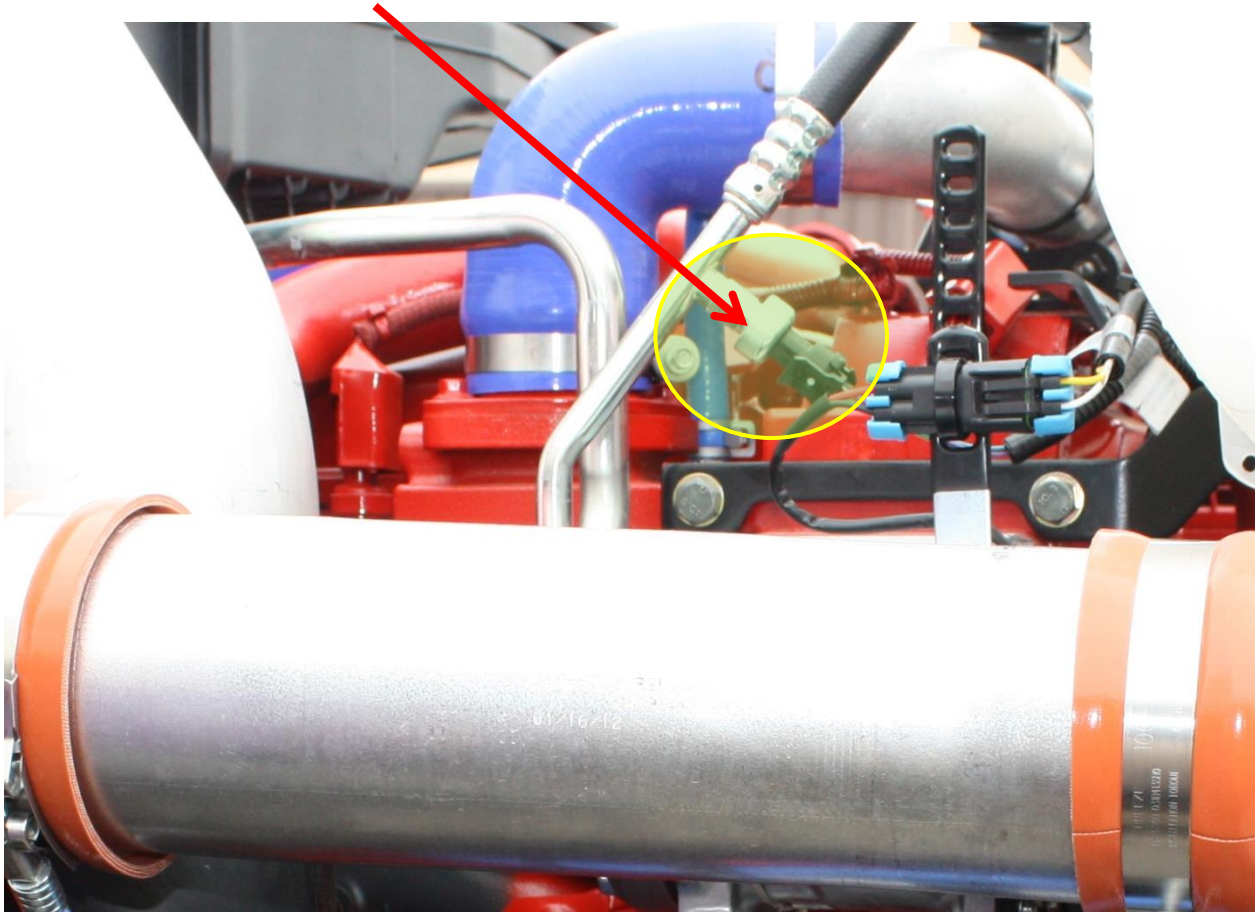


Discharge Pressure Transducer

Acts as a combination high/low pressure clutch switch. It will disable compressor when pressure is above 424 psi or too low.

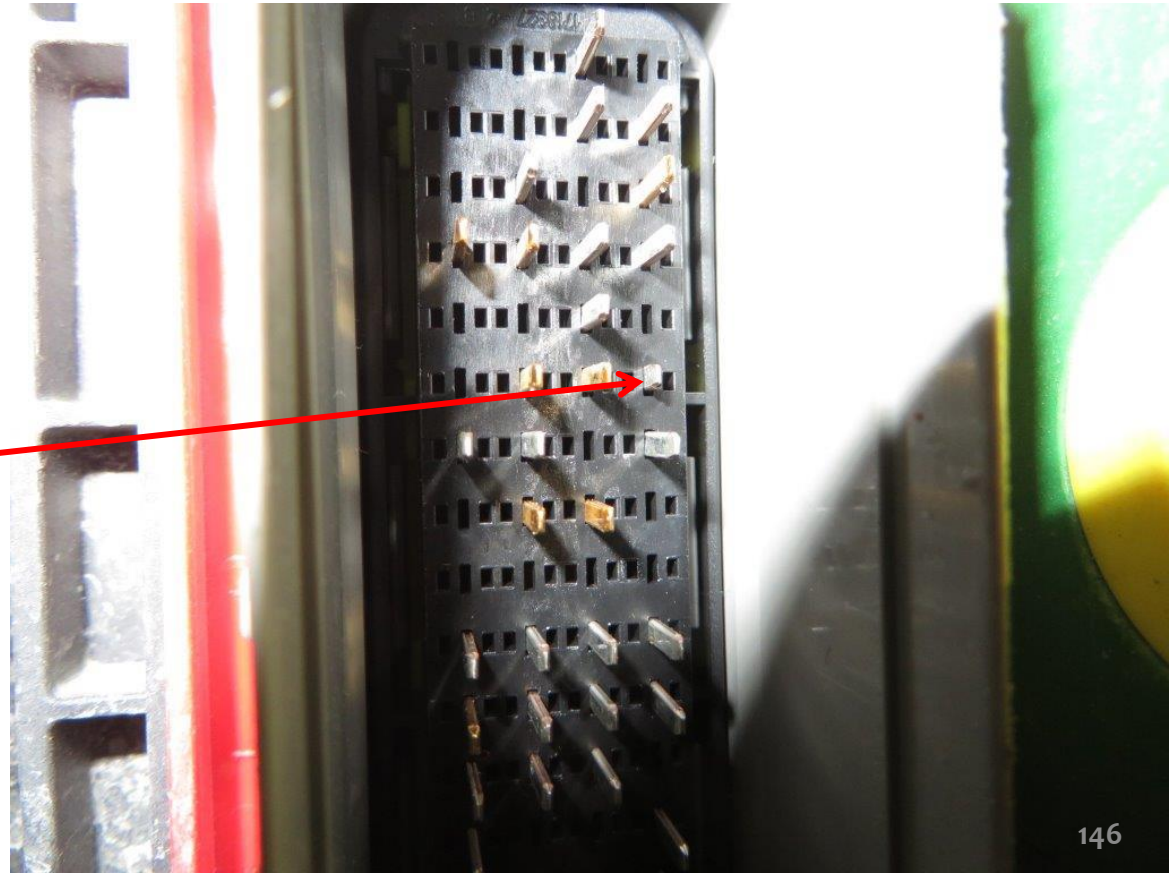
Based on an algorithm using vehicle speed, pressure reading and ambient temp over 3 to 5 key cycles.

Discharge Pressure Transducer



No fault codes for any HVAC issues

A/C would not cool because compressor would not engage. ESA showed Pressure transducer pressure at 427 PSI.



Transducer wires at fire wall connector

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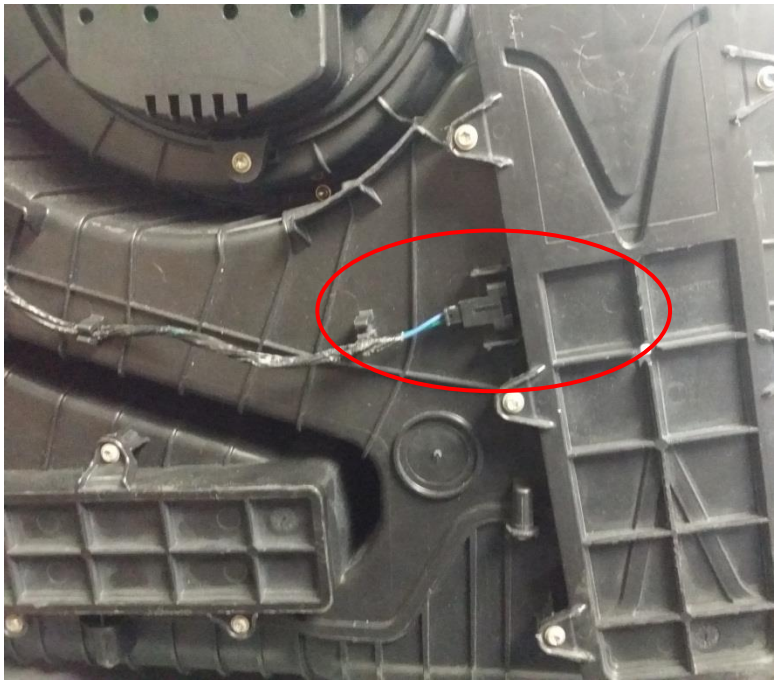
Evaporative Thermistor

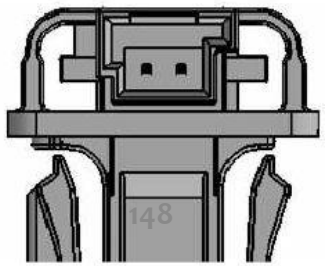


Settings are approx. 39°F (4°C) and 46°F (8°C)

A/C Evaporator Sensor Resistance Values

Temp [°F]	R min [Ω]	R nom [Ω]	R max [Ω]	Temp [°F]	R min [Ω]	R nom [Ω]	R max [Ω]	Temp [°F]	R min [Ω]	R nom [Ω]	R max [Ω]
32	7200	9000	10800	54	3947	4934	5920	76	2259	2824	3389
33	6999	8749	10498	55	3844	4805	5766	77	2206	2757	3308
34	6804	8505	10206	56	3745	4681	5617	78	2153	2691	3229
35	6615	8269	9923	57	3648	4560	5472	79	2101	2626	3152
36	6432	8039	9647	58	3555	4443	5332	80	2051	2564	3076
37	6254	7817	9381	59	3464	4330	5196	81	2002	2502	3003
38	6082	7602	9122	60	3376	4220	5064	82	1954	2443	2931
39	5915	7394	8872	61	3290	4112	4935	83	1908	2385	2862
40	5754	7192	8631	62	3207	4008	4810	84	1863	2329	2795
41	5599	6998	8398	63	3125	3907	4688	85	1820	2274	2729
42	5447	6809	8171	64	3047	3808	4570	86	1777	2221	2665
43	5301	6626	7951	65	2970	3713	4455	87	1736	2170	2604
44	5158	6448	7737	66	2896	3620	4344	88	1695	2119	2543
45	5020	6275	7530	67	2824	3530	4236	89	1656	2070	2484
46	4885	6107	7328	68	2755	3443	4132	90	1618	2022	2427
47	4755	5944	7133	69	2686	3358	4029	91	1580	1975	2371
48	4629	5786	6943	70	2620	3275	3930	92	1544	1930	2316
49	4507	5633	6760	71	2555	3194	3833	93	1509	1886	2263
50	4388	5485	6582	72	2493	3116	3739	94	1474	1843	2211
51	4273	5341	6410	73	2432	3040	3648	95	1440	1800	2160
52	4161	5202	6242	74	2373	2966	3559	-	-	-	-
53	4053	5066	6079	75	2315	2894	3473	-	-	-	-

R min and R max values for the Evaporator Sensor are given a ±20% tolerance to account for variations in measurement equipment



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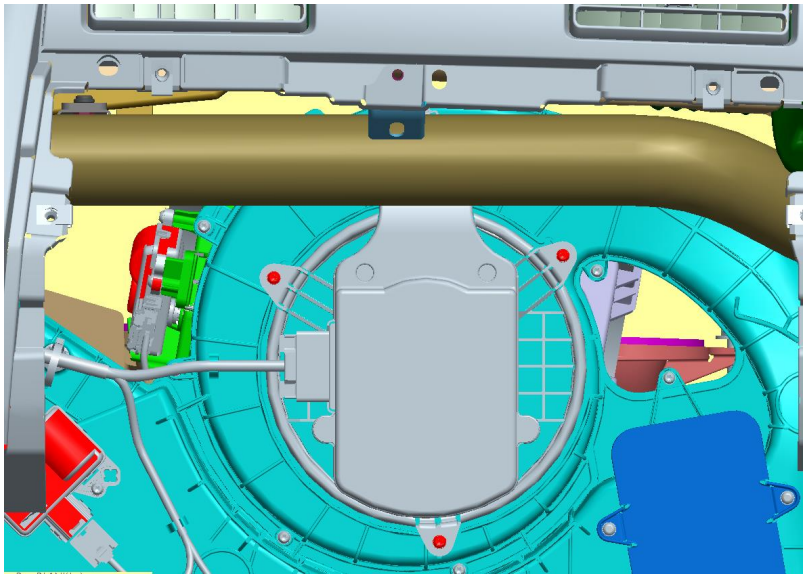
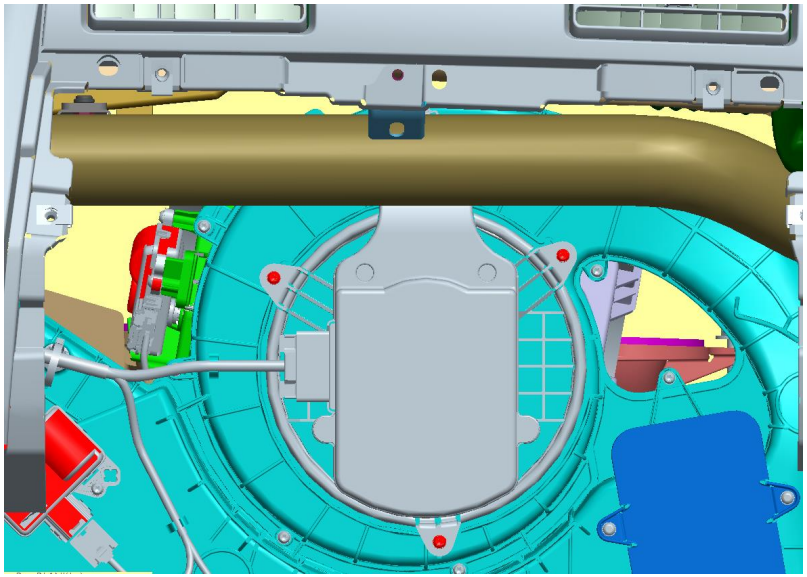
Cab HVAC Blower Motor



- Brushless DC Motor
- Integrated Linear Power Module is cooled by system air flow through vented cover.
- Thermally Protected - maximum temperature of 221°F (105°C)

Cab HVAC Blower Motor

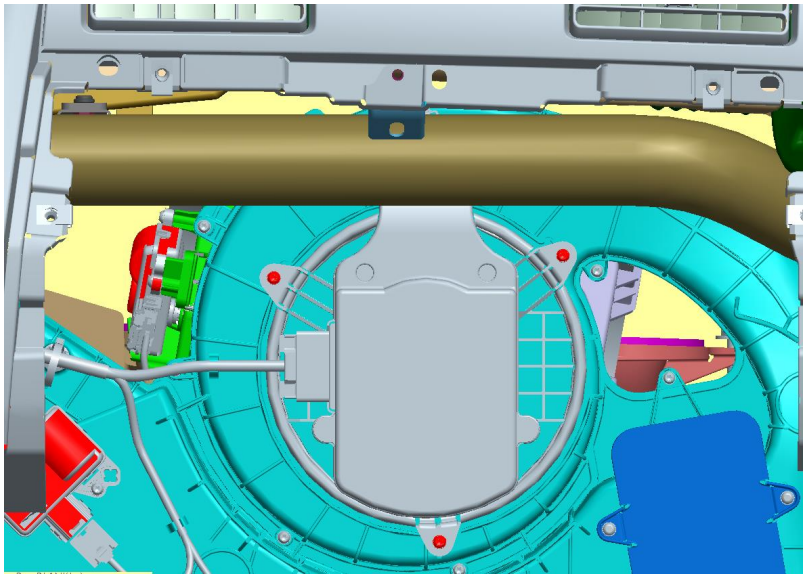


- The fan speed is controlled by a 35Hz PWM signal provided by the control head. Voltage on this wire varies with the position of the fan knob from ~12V @ low to >1 V @ max.

- This is similar to the LPM control signal on the B-Cab models.

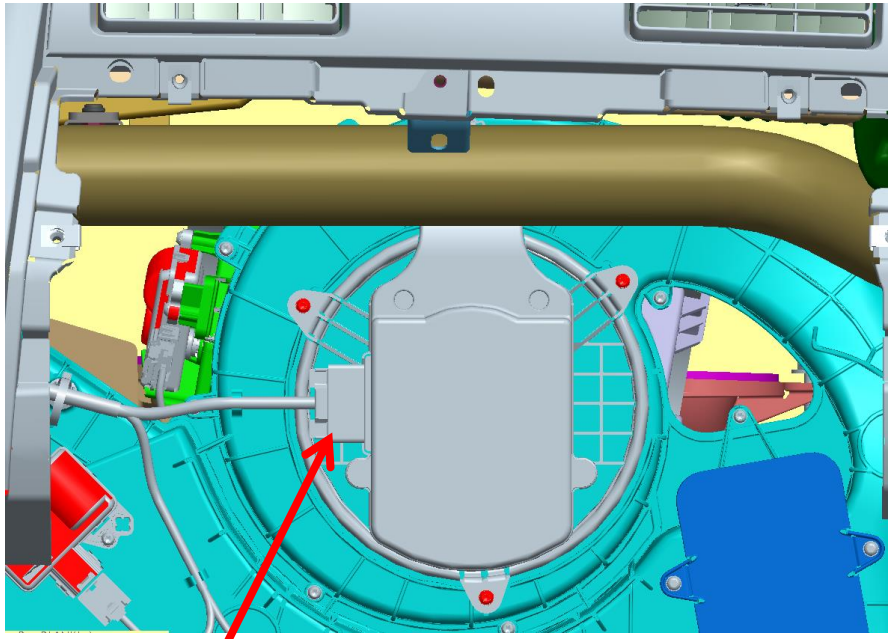
- **Do all diagnostic testing in cab with wires connected normally, DO NOT bench test.**

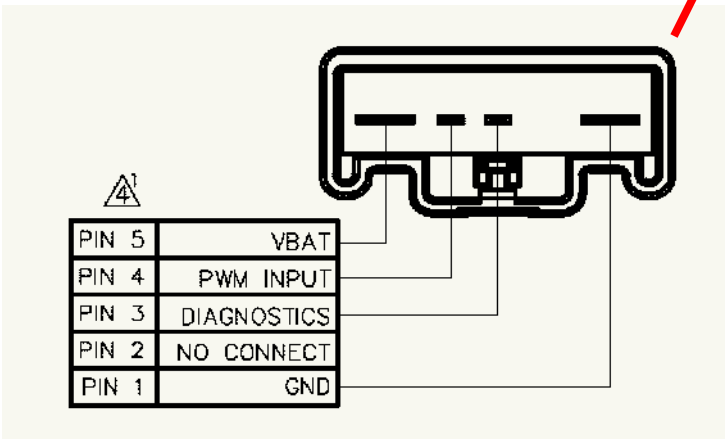
Cab HVAC Blower Motor - DTC 1553



- **Check blower operation in manual mode**
- **Check for good power and ground at blower motor connector pins 5 (V bat) and pin 1 (Gnd)**
- **You *can not* check resistance test through Cab DC motor**
- **Check wiring continuity between control head and signal wire**

Testing Brushless Blower



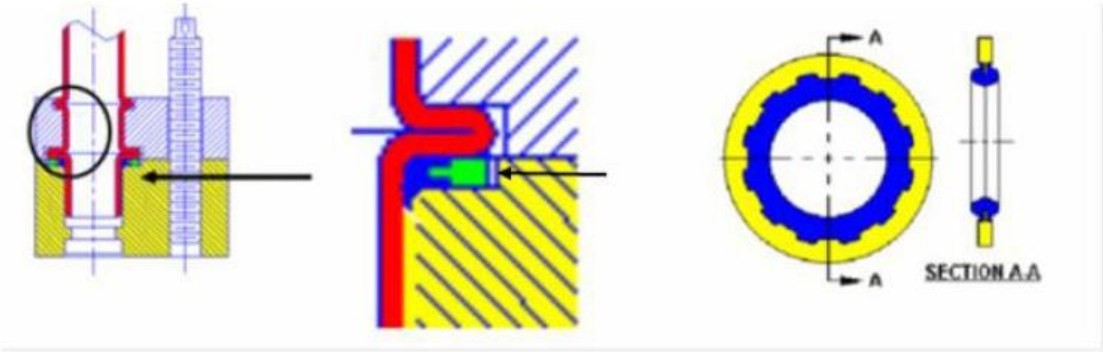


Multi meter have negative lead in pin 1 and have the positive lead at PWM input pin 4 to check for 35hz signal

Slim Line Seals

- Slimline seal technology instead of O-rings
- Superior sealing properties to O-rings
- Slimline technology decrease the leakage rate by more than 50%.
- Slimline seals at ALL A/C connections

Slim Line Seal



Per Parker Engineering (manufacturer of the seals), these are not to be lubricated during installation.

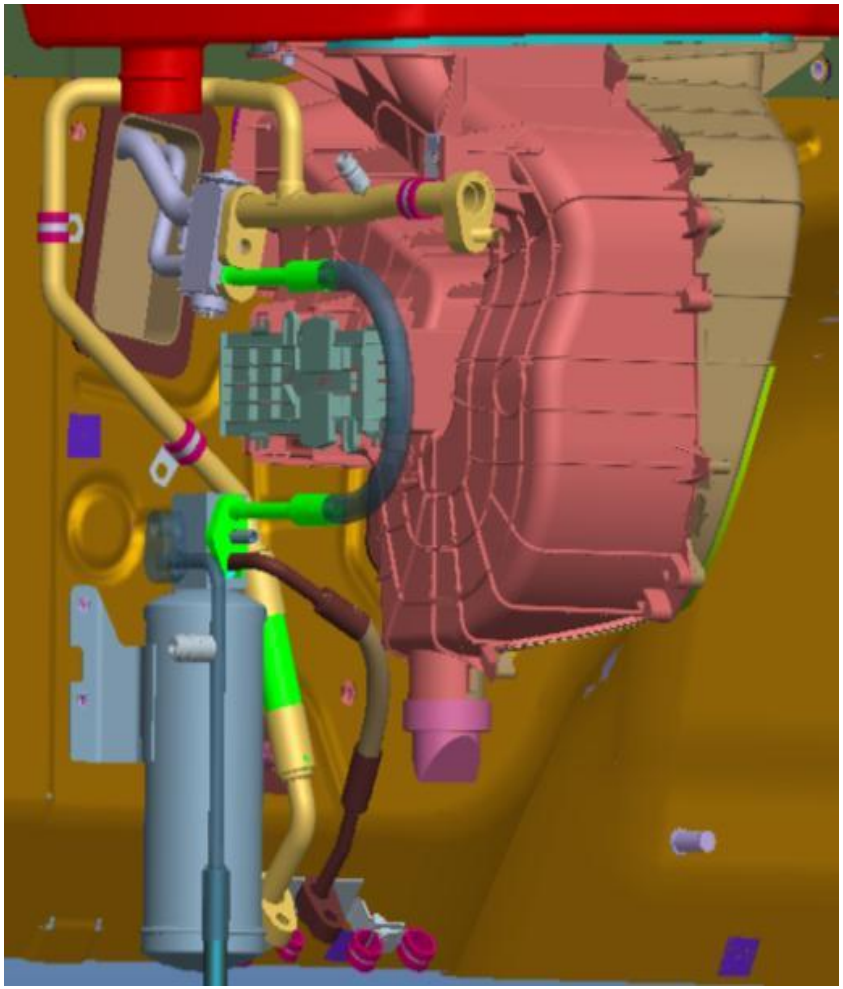
Expansion Valve HVAC Lines - Torque

Component	Torque	
Expansion valves to evaporator bolts	3.3 lb-ft ± 0.3	4.5 Nm ± 0.5
All other AC connections	15.5 lb-ft ± 2.2	21 Nm ± 3

PACCAR Evaporator Line Twist

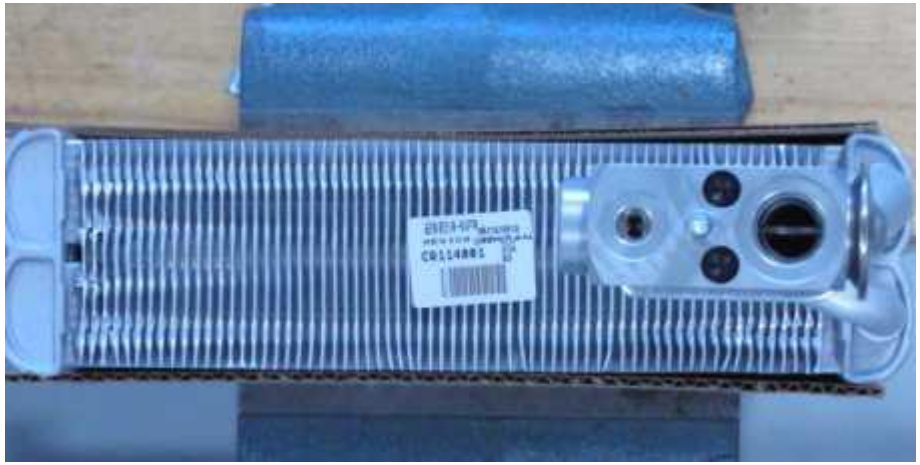
Bench Top Vice With Evaporator Secured

Hand Held Torque Wrench



PACCAR Evaporator Line Twist

21Nm (per spec) applied to line fastener nut without securing TXV will result in ~10-15 degree movement of TXV due to the liquid and suction lines relative to evaporator moving.



Starting Position of TXV Relative to Evaporator Before Torque Applied

Finished Position of TXV Relative to Evaporator after Torque Applied

Parts pressure tested using 250psi of Nitrogen and being held under water for 30 minutes to review for air-bubbles (an indication of a leak) There were no leaks But -

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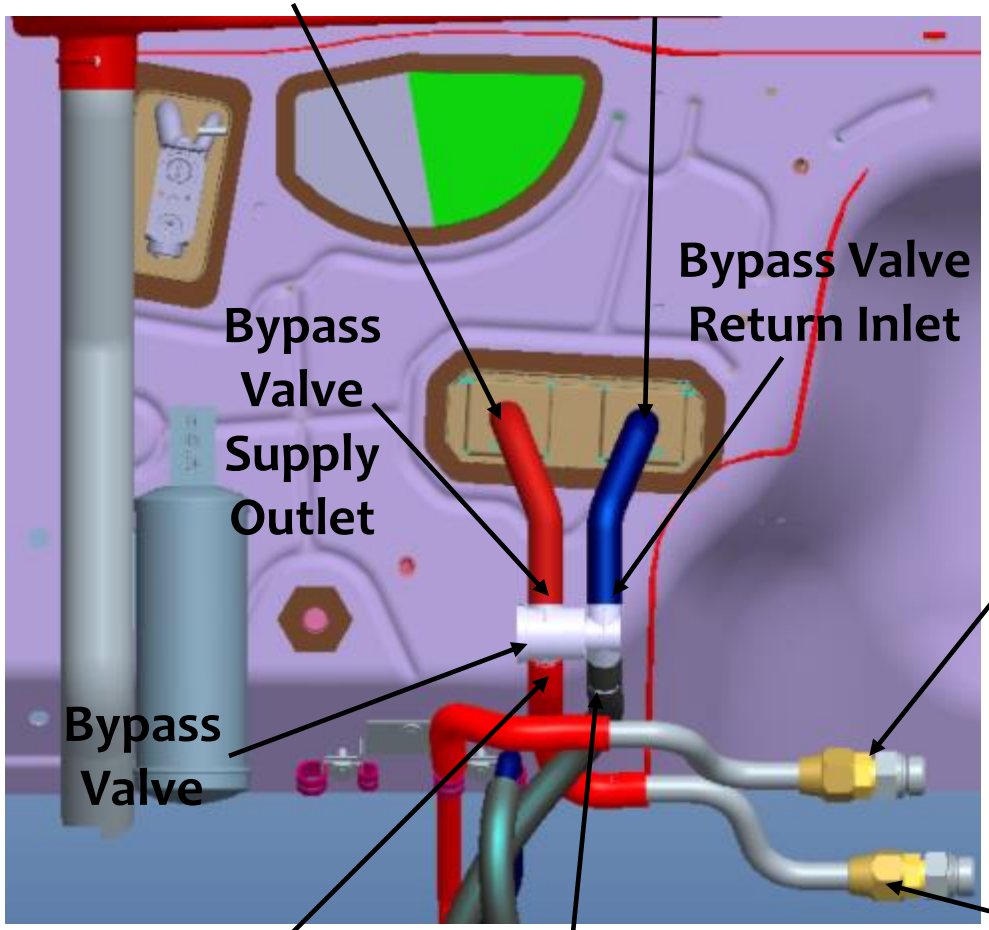
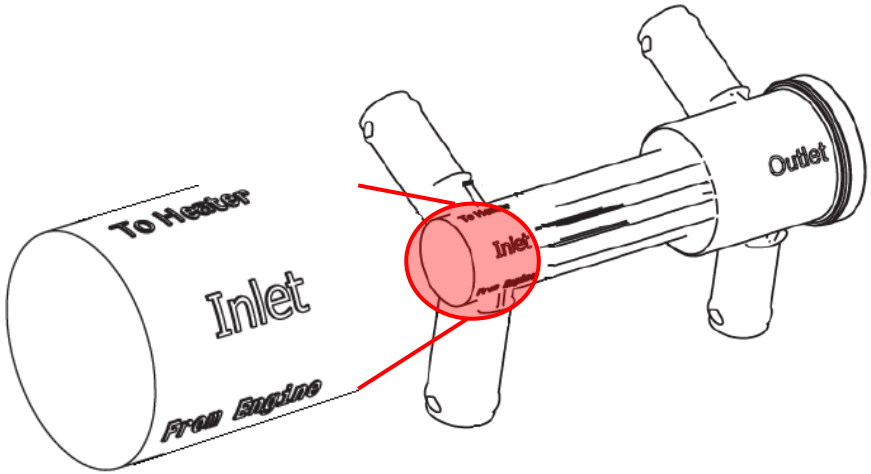
Firewall – Cab & Sleeper, Heater Lines

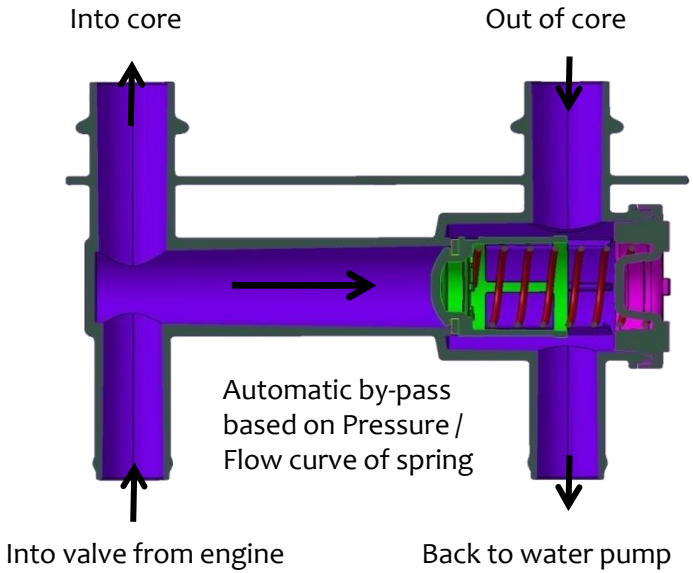
Front View



Cab Heater By-Pass Valve

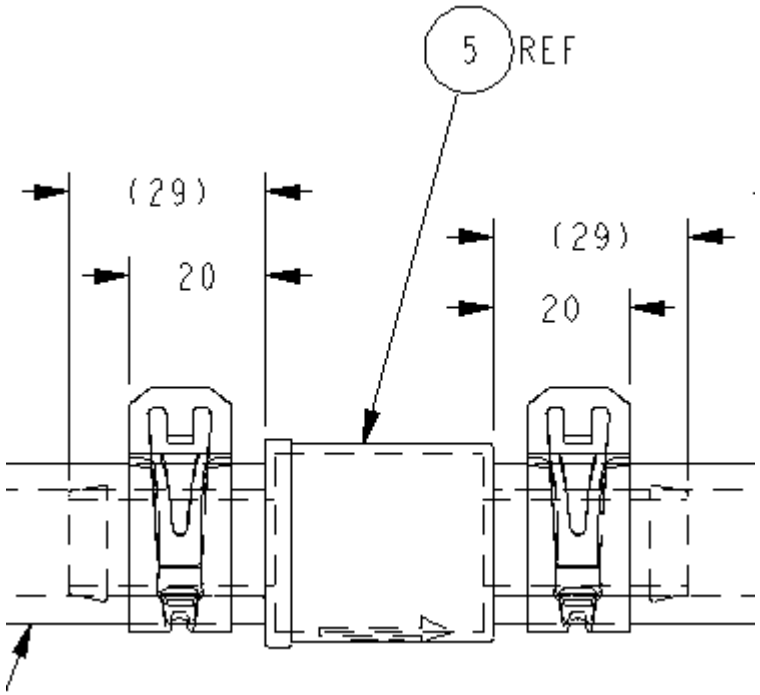
- Protects heater core from high coolant pressure/flow (max is 6.5 GPM).
  - Maximizing Life Of Heater Core.
  - Allows Flow Up To A Defined Point.
- Valve is flow directional.
- Valve is serviceable as complete assembly.





Sleeper Heater Flow Restrictor

- The flow restrictor reduces the velocity of coolant restricting coolant flow to less than 5.5 gpm to eliminate cavitation of the sleeper heater core
- Located under sleeper, in the coolant line.



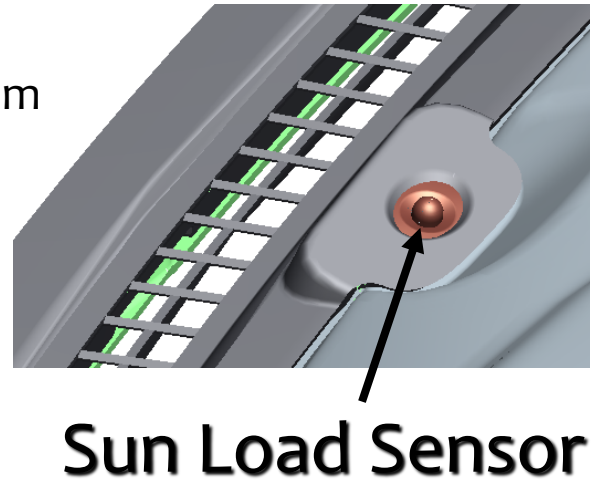
HVAC System Protection

- **Pressure Transducer**
  - Clutch Disengages at 424 psi (29.3 bar) Locks out compressor at 430 psi (29.6 bar)
  - The fan clutch is requested on at 330 psi (22.8 bar) and requested off at 235 psi (16.4 bar)
- **Evaporator Thermistor**
  - Mounted in the HVAC unit
  - Clutch Disengages if evaporator temp is 39°F (~4°C) or lower. Clutch is allowed to come back on when evaporator temperature reaches 46°F (~8°C.)
- **Compressor Pressure Relief Valve (PRV)**
  - Not a serviceable component - part of the compressor
  - Relief Valve vents the system at 508-595 psi

Other Sensors

- Cabin Air Temperature Sensor
  - Integrated Thermal Optical Sensor, (ITOS sensor)
  - Located on the control head

- Sun Load Sensor
  - Located on driver's side of dash panel
  - This sensor measures the intensity of the sun and influences temperature control of the HVAC system
  - Do not block this sensor



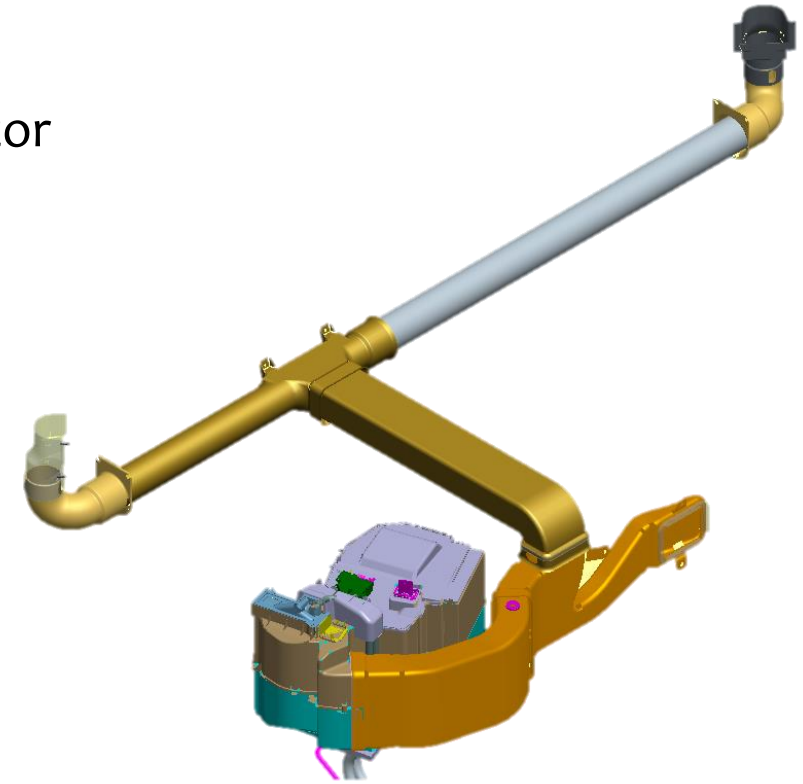
Other Components

- Outside Air Temperature Sensor (OAT)
  - Located on the bottom of the driver's mirror
- Resistor
  - For the sleeper HVAC unit only
  - Is used to control blower speed by varying the voltage to the blower motor

    Thermal limiter is set at 363°F (184°C)

Sleeper HVAC Overview

- Plastic Housings
- Aluminum Heat Exchangers
- DC Blower Motor With Resistor
- Pleated Air Filter
- 1 Electric Actuator
- Air Temperature Sensor
- TXV
- Service Cover



Sleeper HVAC Components

Sleeper HVAC Control

Fan Control A/C Enable Temperature Control

Note: Sleeper AC function will not work without the sleeper enable button pushed on the *cab* HVAC control head.

The Sleeper Control Head "ENABLE" button provides a ground signal to the Cab Control Head.

Performance Testing & Mechanical Troubleshooting


And then the #@$&*
thing just quit working

Repair Strategy

- **Verify Complaint**
- **Visual Inspection**
- **Record Pressures & Temperatures**

Determine if the problem is Mechanical or Electrical!

If it is a Mechanical problem:

- **Recover Refrigerant**
- **Make System Repairs**
- **Evacuate the System**
- **Recharge the System**
- **Performance Testing**

Normalized Resting Pressures

RESTING PRESSURE-is the pressure when the AC system has been turned off for 15-20 minutes and equalized. (Chart 7-13)

ARE THE PRESSURES EQUAL ? : Unequal pressures usually means that a restriction in the system is preventing the high side pressure from flowing into the low side when the clutch is off.

High pressure - means the system is contaminated (usually with air)

Low pressure - usually means most of the refrigerant has leaked out. Charge with at least 50 PSI and leak test. (KM811231)

Resting Pressures

AMBIENT TEMPERATURE ° F	SYSTEM PRESSURE psi		AMBIENT TEMPERATURE ° C	SYSTEM PRESSURE Kpa
45	40.0		7.2	5.8
50	45.4		10	6.6
55	51.2		12.7	7.4
60	57.4		15.5	8.3
65	64.0		18.3	9.3
70	71.1		21.1	10.3
75	78.6		23.9	11.4
80	86.7		26.7	12.6
85	95.2		29.4	13.8
90	104.3		32.2	15.1
95	113.9		35	16.5
100	124.1		37.8	18
105	134.9		40.6	19.6
110	146.3		43.3	21.2

Operating Temperatures

CONVENTIONAL MODELS WITHOUT SLEEPER

Outside Temperature in Degrees F.	Center Duct Temperature	High Side Gauge Reading (PSI)	Low Side Gauge Reading (PSI)
70	43 - 49	95 - 130	7 - 14
80	47 - 51	100 - 135	10 - 17
90	53 - 57	120 - 155	14 - 21
100	59 - 63	155 - 185	19 - 26
110	65 - 69	185 - 205	24 - 31
High Humidity Adjustment	0 - 15	No change	High side of range

* THE HUMIDITY IS OVER 70% THE DUCT TEMPERATURES WILL BE FROMTHE SAME AS IN THE MASTER TABLE TO 15 DEGREES MORE

Performance testing:

Fan on high

Doors or windows open

Switch on fresh air

Manual over ride switch on (Engine fan running)

Run engine at 1500 rpm

Leak Testing

1. Make sure A/C system has at least 50 psi refrigerant charge.

2. Make sure detector is rated for type of refrigerant used.

3. Calibrate tester close to where you will be working

4. Hold the tip about 1/2” below where you want to test and move the tip slowly (moving too fast may push R-134a away).

5. Follow the entire route of the A/C system

6. Test the evaporator by using the blower to clear out residual R-134a, then wait about 5 min. for more to accumulate and check by inserting test probe under a dry drip tube.

Leak Testing (Nitrogen)

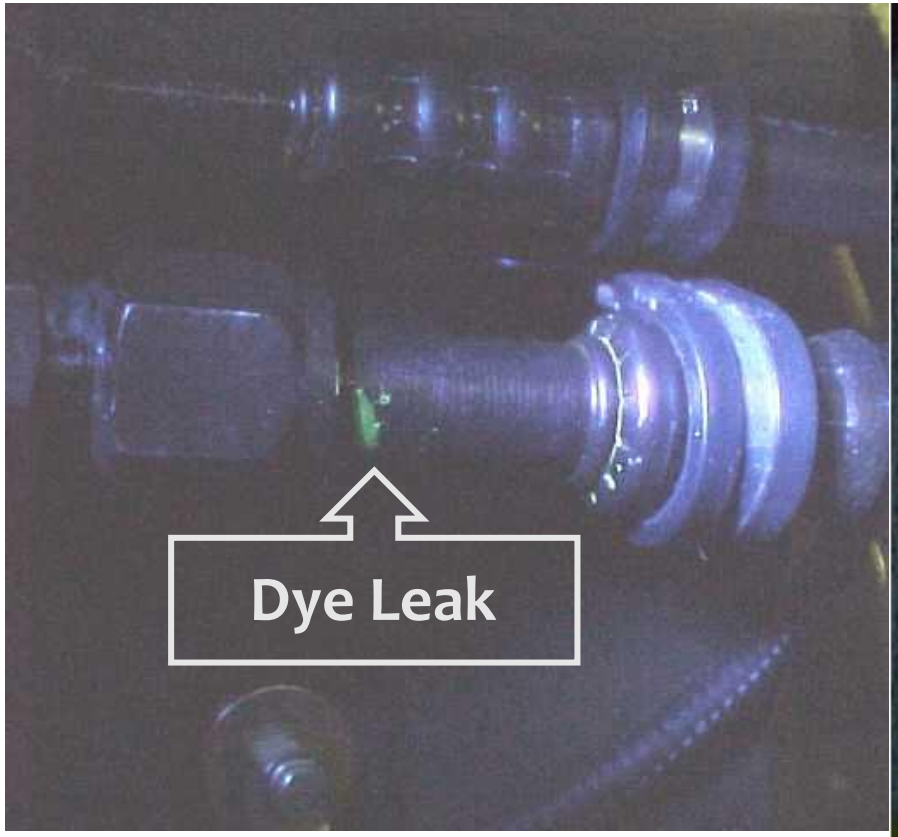
1. Nitrogen should be used to charge the A/C system, then use soap solution to look for leaks.

2. Shop air should NEVER be used to check for leaks. Compressed air can inject moisture into the system, damage system components, and possibly cause bodily injury.

3. After charging the system with approximately 60-70 (* 200 max) psi of nitrogen, apply the soap bubble solution to all connections.

4. Bubbles will be generated at any leak site(s).

TIB 01-48 Leak Detection Fluorescent Dye



Dye wafer - Factory
Installed since 10/29/01

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Performance Test - Compressor

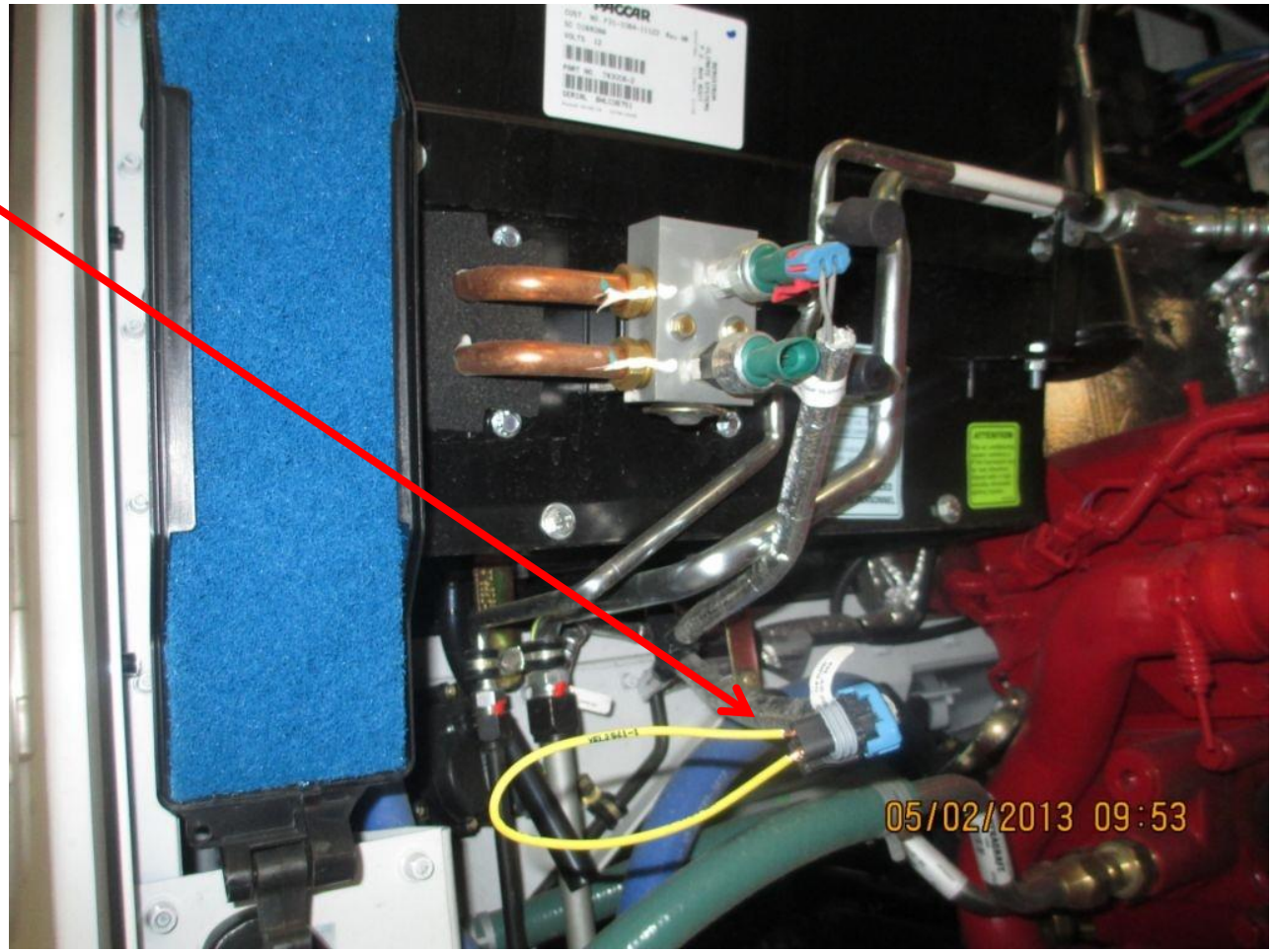
Fast compressor cycling can be caused by:

- system overcharge
- system contamination
- system undercharge
- bad freeze switch
- checking system at cooler temperatures

Faster cycling times are caused by low pressure side reaching low pressure switch cut out pressures under low load conditions (low ambient temperatures) . Sanden recommends no more than 4 clutch cycles per minute and the suction pressure to be 7 psi or above.

Performance Test - Compressor

It is OK to bypass low pressure switch to do performance test once you are sure system is approximately at right charge.



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System Troubleshooting

GAUGE READINGS	THERMOMETER READINGS	POSSIBLE OBSERVATIONS	POSSIBLE CAUSES	FURTHER TROUBLESHOOTING
High Side: low Low Side: low	high to little below ambient	Almost no R-134a in the system. Oil drips below fittings.	Low R-134a due to leak, lack of maintenance or undercharging	Thorough leak detector test
High Side: low Low Side: very low	ambient	Binary switch open/ compressor not running. Oil drips below fittings.	No R-134a due to leak or lack of maintenance	Thorough leak detector test
High Side: high Low Side: high	ambient or warm	High side hoses hot.	Condenser improperly aligned Overcharged R-12 contamination	Condenser inspection Recover and recharge Recover and dispose of contaminated R-12
High Side: high Low Side: normal to low	ambient or warm	High side hoses or condenser with hot and cool spots.	Condenser blocked Hose or condenser blockage	Condenser inspection: check for spot it changes from warm to cool. Inspect Hoses for restriction
High Side: low Low Side: high	ambient to warm	Compressor belt shiny. Compressor clutch not engaging. Compressor making noise.	Compressor belt loose or worn Compressor clutch not engaging Compressor failing	Compressor inspection. Electrical test of clutch and clutch circuit.
High Side: high Low Side: low to very low	high to a little below ambient	Normal sight glass. Compressor running, not cycling. Moisture indicator pink.	Blocked or failed expansion valve	Check sleeper unit Warm the expansion valve/ evaporator. Bench Test the expansion valve.
High Side: normal to high Low Side: low to very low	high to a little below ambient	Compressor running, not cycling. Frost on low side hoses.	Low side hose blocked/ kinked	Inspect hoses.
High Side: normal Low Side: high	high to ambient	Compressor running, not cycling. Low side hoses sweating.	Expansion valve failed open	Warm the evaporator/ expansion valve. Bench test the expansion valve.
High Side: normal Low Side: normal to low	high	Compressor running, not cycling	Coolant leaking through heater core Freeze switch stuck closed Evaporator fins clogged	Measure duct temperature with AC off. Electrical test freeze switch. Warm evaporator with a heater. Physically inspect evaporator core.
High Side: low Low Side: high	high	Compressor clutch not engaging	Binary switch low pressure cut-out point too high	Check refrigerant charge level. Electrical test of binary switch.

Evaporator Performance

Check the evaporator performance after the first fifteen (15) minutes of operation.

- Operate truck with windows rolled down.
- Insert thermometer in center vent while A/C system is operating. Compare reading to chart to see if within specs.
  - A general rule is the difference between ambient and duct temp should be 25 - 30 °f.
- As a secondary check, compare evaporator lines - there should be about a 5 - 15°f differential. (Temperature differential is very dependent upon ambient conditions, temperature & humidity).
- Check air flow through evaporator for debris or clogged cabin air filter (usually normal pressures)
- Check evaporator drains to make sure water is dripping and evacuator valves are on.

Condenser Performance

- Check temperature in (top) and out (bottom) - should be 10 to 15 degree difference. Too much temperature drop could indicate a restriction. Remember, the temperature change is not as important as confirming a state change in the refrigerant.
- Check air flow and obstructions (oil coolers and winter fronts), bent fins, bent tubes and tight fittings
- Check to see if engine fan comes on, and at the right pressures
- Check to see that the hood closed correctly.

Saturation Point of Refrigerant

Many refrigerant gauge sets have an inner scale that reads the saturation (boiling) point of the refrigerant.

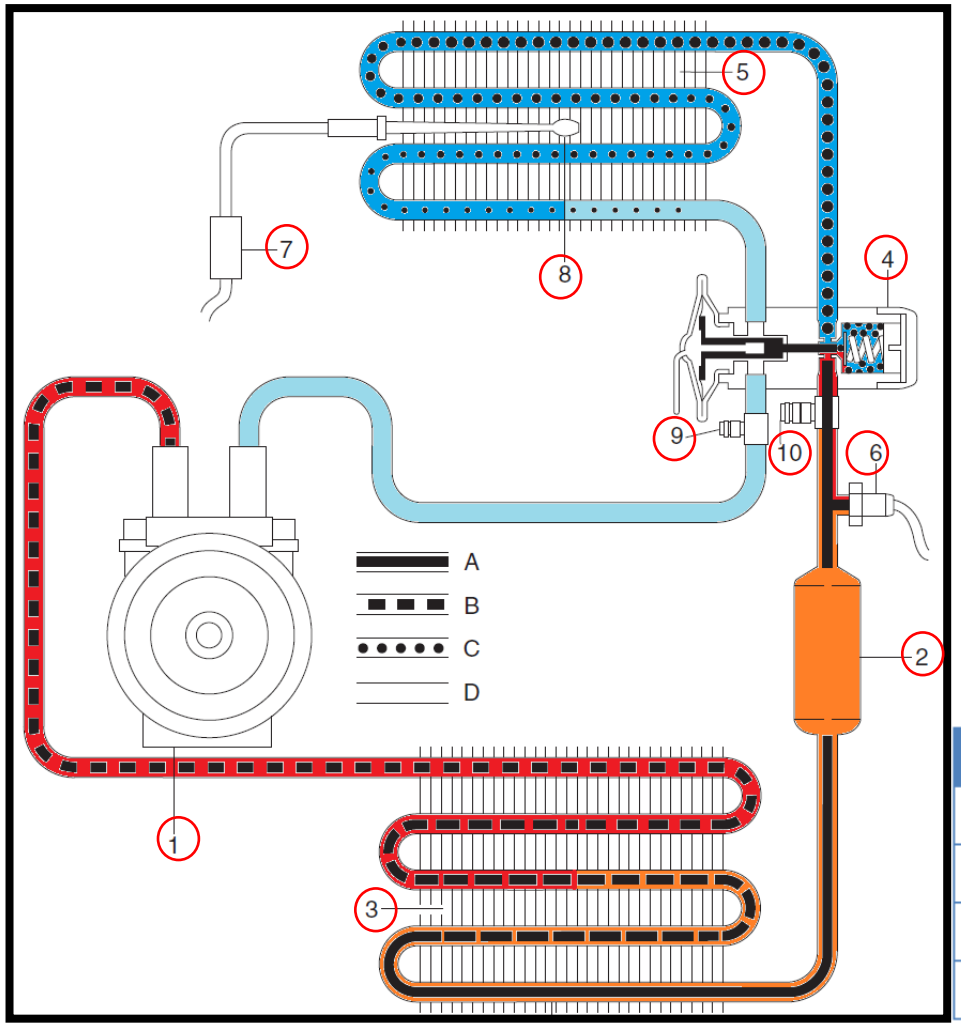
For the purposes of condenser and evaporator testing, use an average value based on the pressures during compressor cycles. (High side for condenser, Low side for evaporator)

Example: Gauge reads between 100 and 300 PSI during compressor cycling. Using an average of 200 PSI for the high side pressure, from outer scale – refrigerant changes state at 132 degrees F (inner scale) – use this temp for condenser performance testing.

High Side Pressure Chart

High side pressure	Temperature at which change of state occurs
90 psi	83 degree F
125 psi	100 degree F
150 psi	115 degree F
175 psi	125 degree F
200 psi	130 degree F
225 psi	138 degree F
250 psi	146 degree F

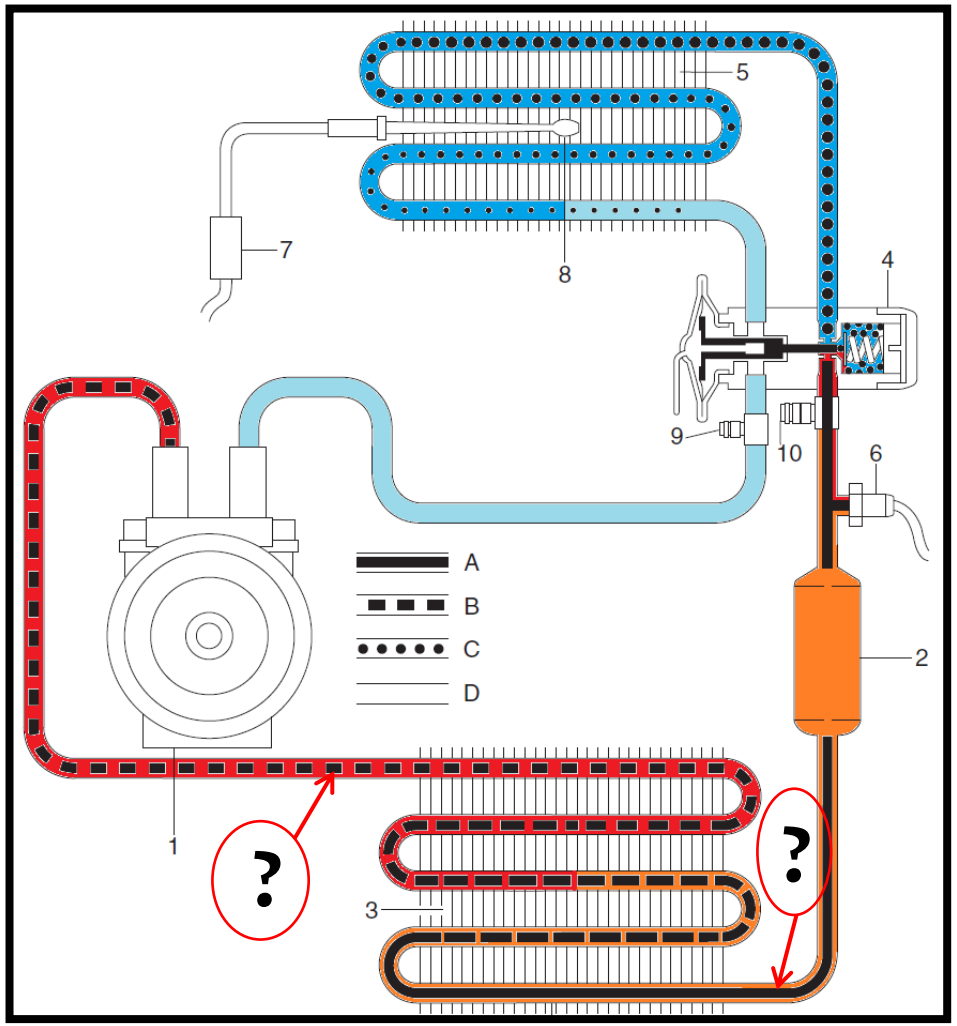
Inspecting the A/C System by Temperatures



- When the system is functioning correctly:
  - The pipe between the evaporator (5) and the compressor (1) should be cold
  - The pipe between the compressor (1) and the condenser (3) should be hot
  - The pipe between the condenser (3) and the evaporator (5) (via the dryer 2) the pipe temperature should be between hot and cold.

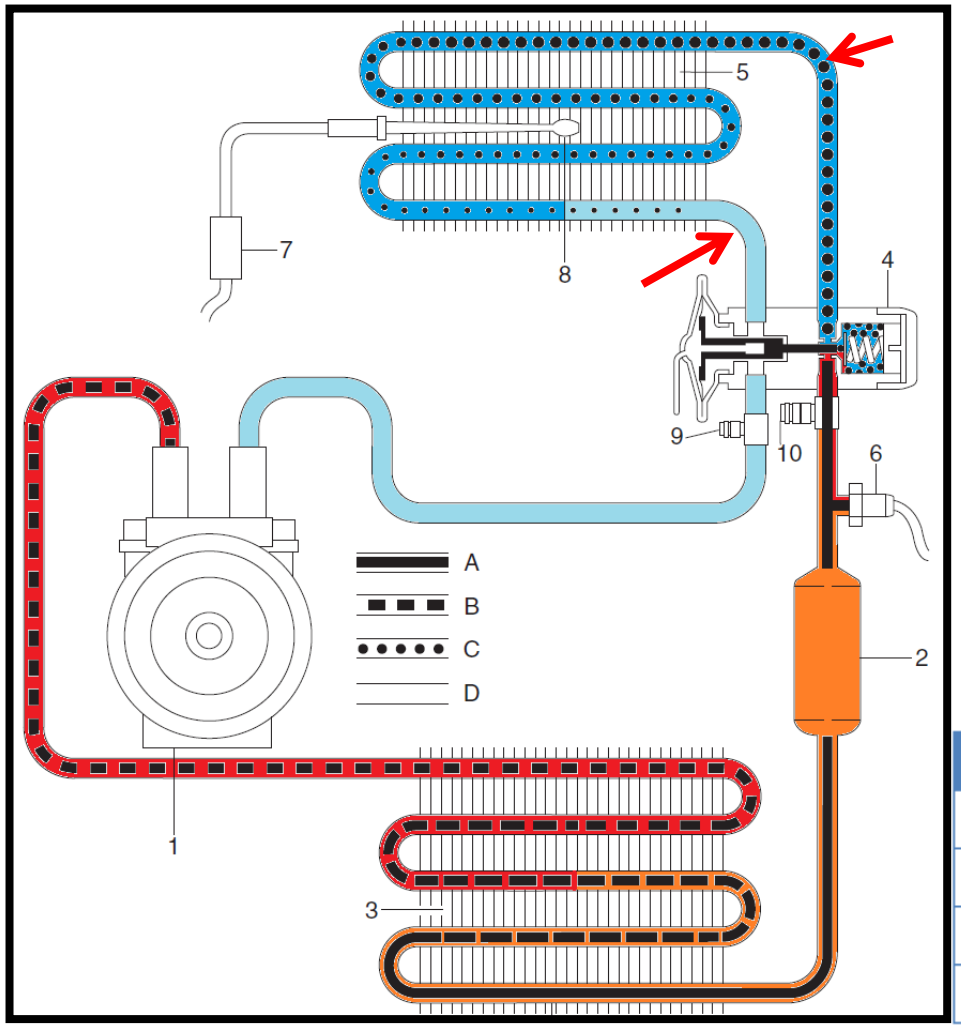
A/C R134-a Status
A: High pressure, liquid
B: High pressure, gaseous
C: Low pressure, liquid
D: Low pressure, gaseous

Inspecting the A/C System by Temperatures



- Based on the average high side pressure:
  - the temperature of the high pressure line should be above the saturation temperature entering the condenser
  - the temperature of the high pressure line should be below the saturation temperature leaving the condenser.
  - THIS IS CRITICAL for system performance.

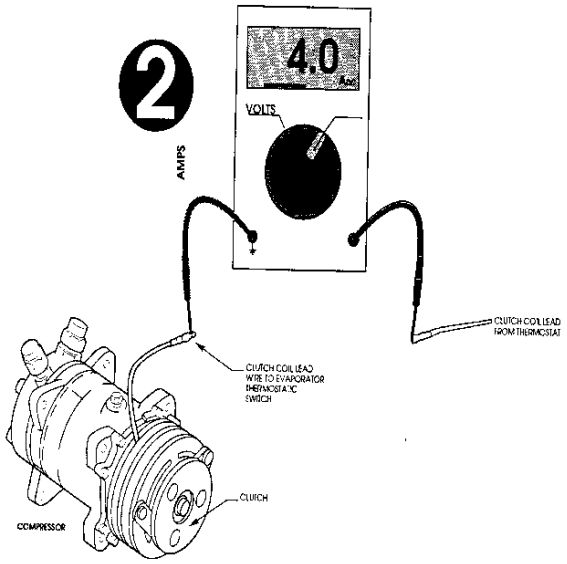
A/C System Temperature Inspection



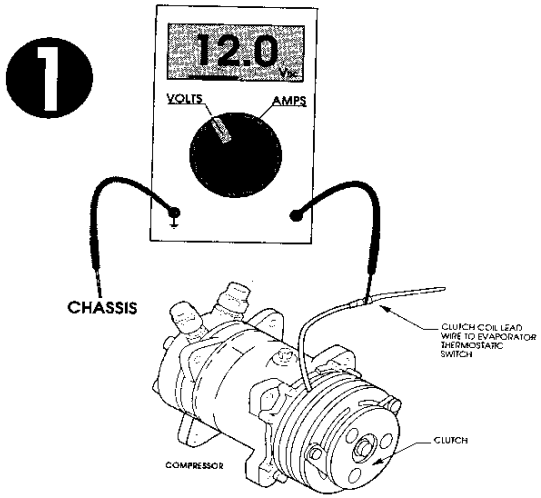
- There should be a ~10 degree F change across the evaporator core inlet and outlet pipes. (This can vary based on where the temperature readings are taken relative to the TXV.)
- The temperature drop from the center vent should be at least 20 degrees F.

A/C R134-a Status
A: High pressure, liquid
B: High pressure, gaseous
C: Low pressure, liquid
D: Low pressure, gaseous

Compressor Clutch Performance

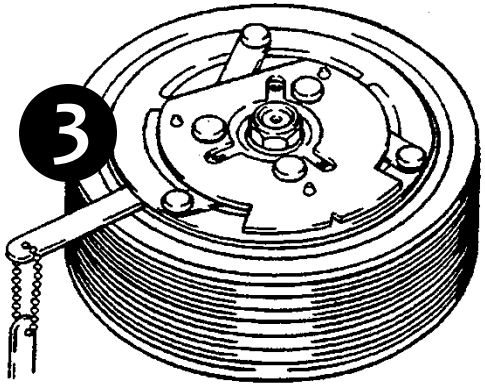


1. Measure available voltage at the clutch (SYSTEM VOLTAGE or above 11.5 volts)



2. Measure current draw. (3.6 to 4.2 amps at 12 volts)

3. Measure Clutch air gap should be 0.016 - 0.031 inch.



Operational Modes – Automatic (ATC)

- The controller will regulate cabin comfort automatically with inputs from:
  - ITOS (in-cab temp) sensor
  - Sun Load Sensor
  - CECU via C-CAN (incl. coolant temp, outside air temp, engine coolant temp, engine speed, vehicle speed)
- The control will have a full automatic mode, temperature, and fan operation once the ATC has been activated.

Operational Modes – Automatic (ATC)

- The controller will regulate cabin comfort automatically with inputs from:
  - ITOS (in-cab temp) sensor
  - Sun Load Sensor
  - CECU data via C-CAN
    - coolant temp
    - outside air temp
    - engine coolant temp
    - engine speed
    - vehicle speed
- The control will have a full automatic mode, temperature, and fan operation once the ATC has been activated.

Operational Modes – Semi-Automatic

- When the HVAC control is placed in Automatic Mode, it is possible to manually override either the fan speed or the mode setting (floor, panel, bilevel, etc...).
- During the semi-automatic mode, the manually-overridden function will maintain its state whereas all other functions will vary based off of the ATC-logic in order to attain the operated requested conditions.
    - Please note that the manual override of both the fan speed and the mode setting will result in the control head returning to a full manual functioning.
    - It should also be noted that the override of the A/C function will place the control head in full manual mode.
    - Selecting the recirculation function makes no functional mode change.

Operational Modes – 30% Recirculation

- When in "Fresh Air" manual mode, and the ambient temperature is below 23°F (-5°C), recirculation door will be set to provide 30% recirculated air to assist with heater performance.
- Normal operation will return when ambient temperature is above 32°F (0°C).
- Manual over ride (100% recirculation) is permitted.
- No other mode, including ATC, is impacted.

Operational Modes - Manual

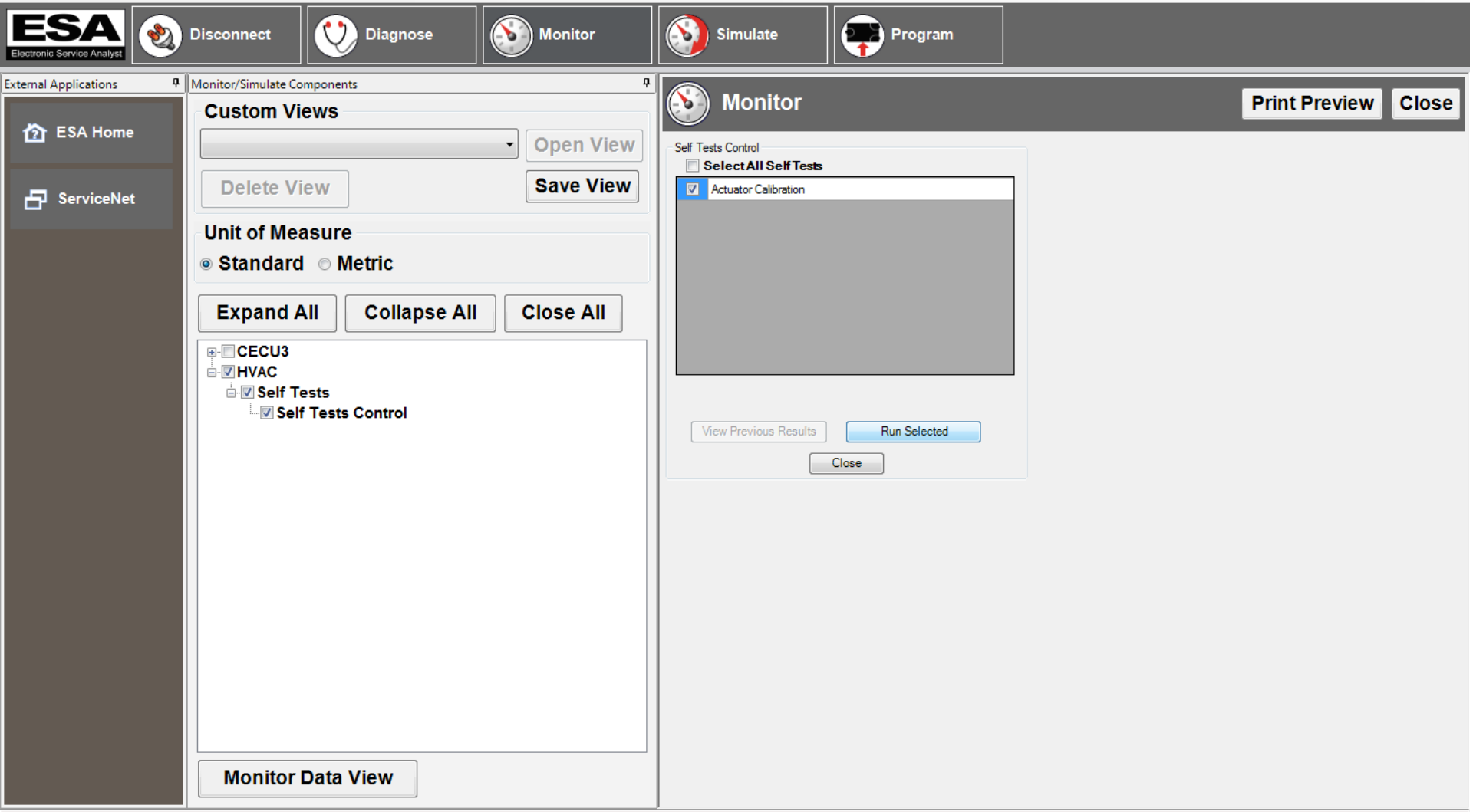
- The HVAC module will keep the following constant:
  - blower speed,
  - mode position (panel, floor, etc..)
  - recirculation (fresh air or recirculated air)
  - compressor operation.
- The temperature door is able to reset it's position, to meet the operator-requested temperature
- The temperature door position is fixed, when the temperature knob is set to max hot or cold. These are the only conditions where the HVAC operates in a true "manual" fashion.

ESA Scan Tool Monitors

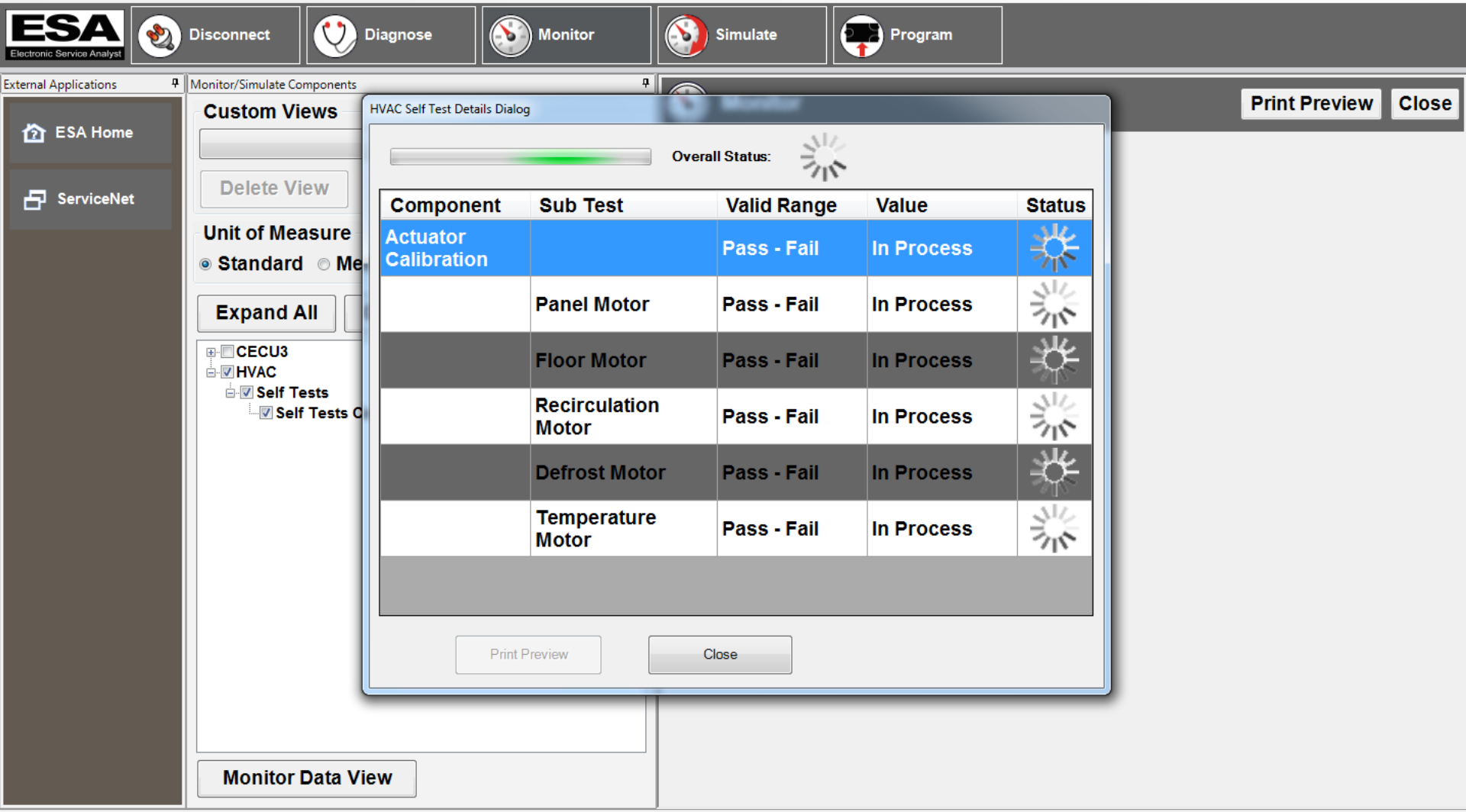
ESA Monitors

- HVAC Switch On/Off
- A/C Compressor Outlet Pressure – Pressure the HVAC control head is seeing from Pressure transducer
- Fan Percent On – engine fan request
- Requested Fan Speed – the position of the fan knob
- Temperature Knob Percent Open – the position of the temperature knob

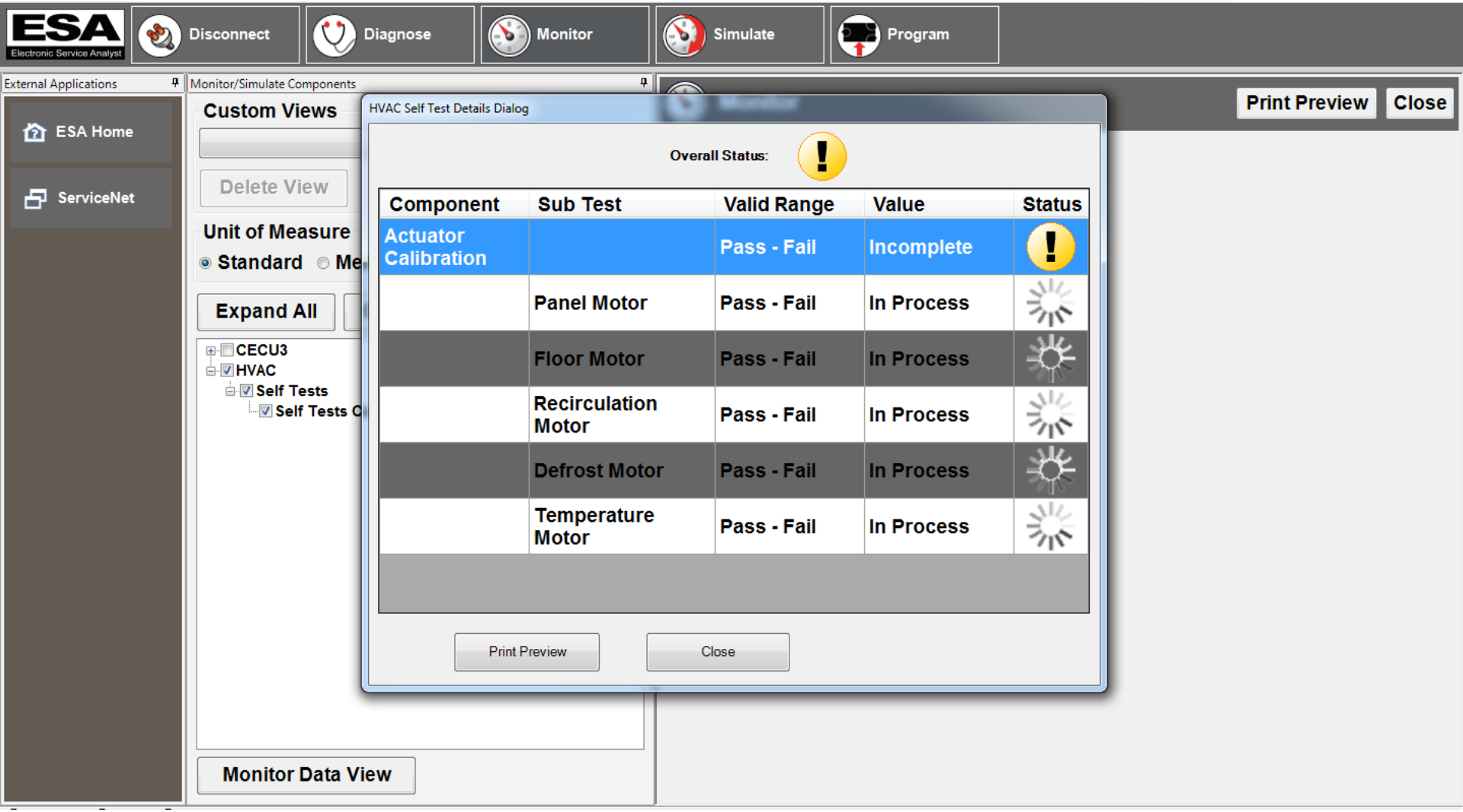
ESA Interface



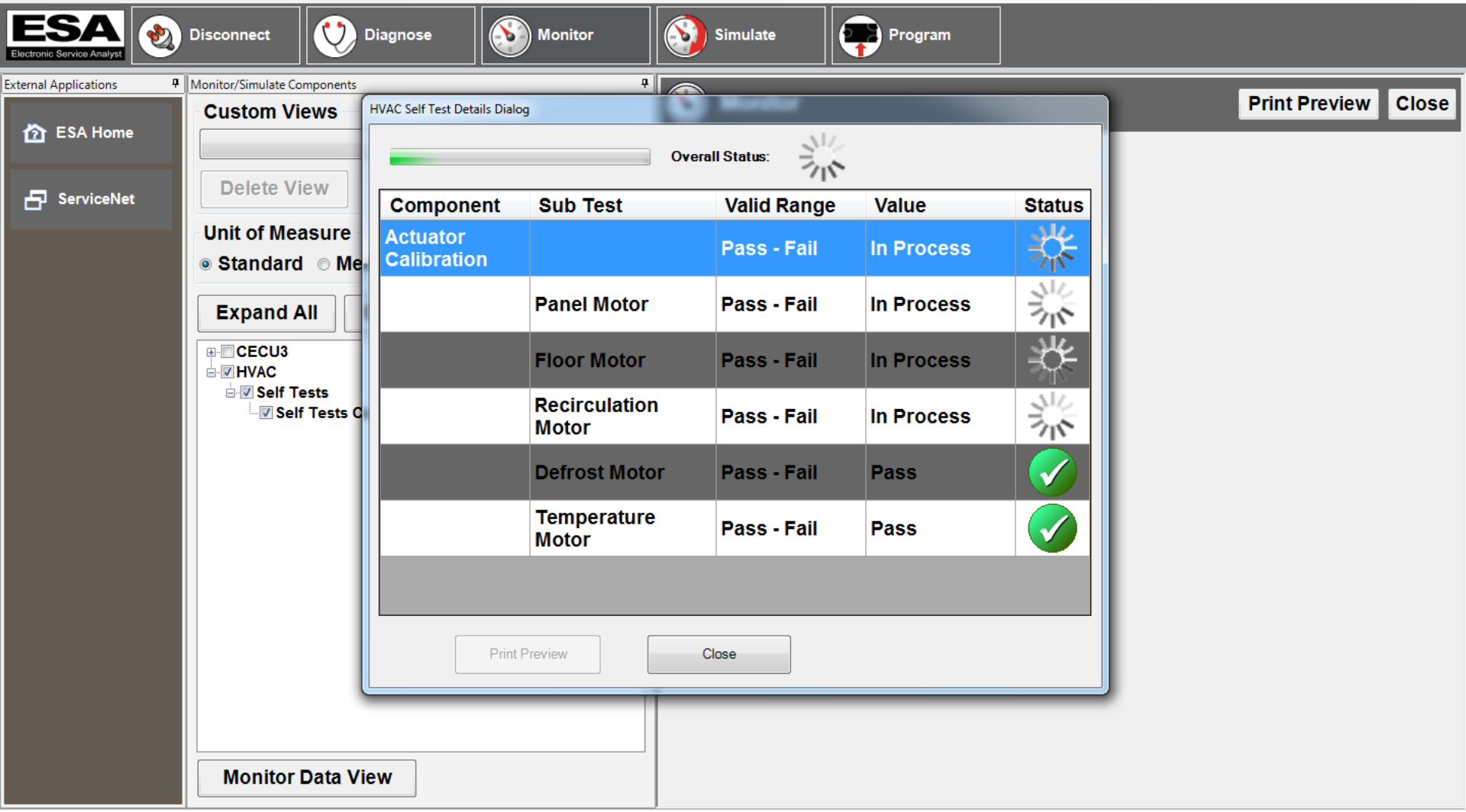
ESA Interface



ESA Interface



ESA Interface



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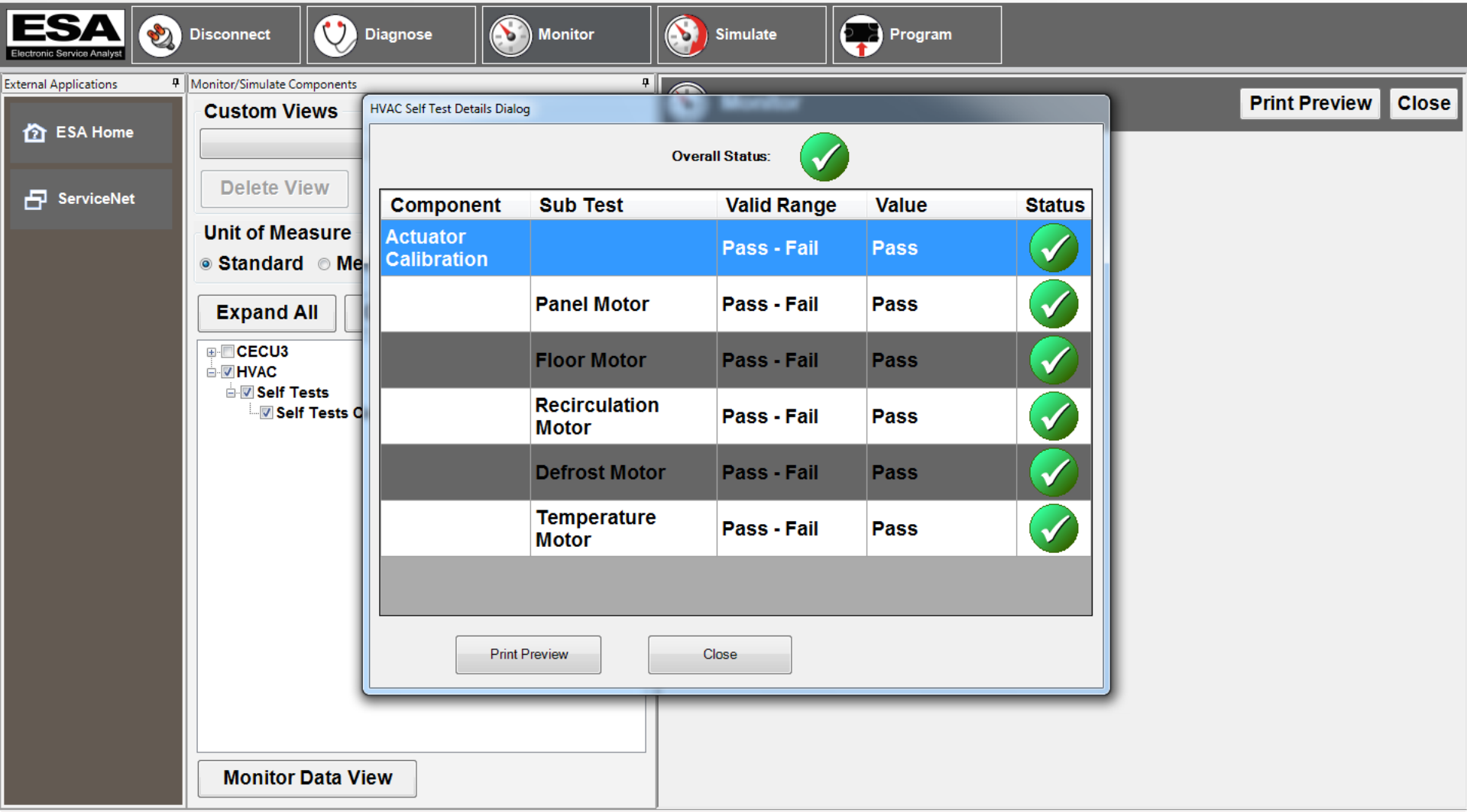
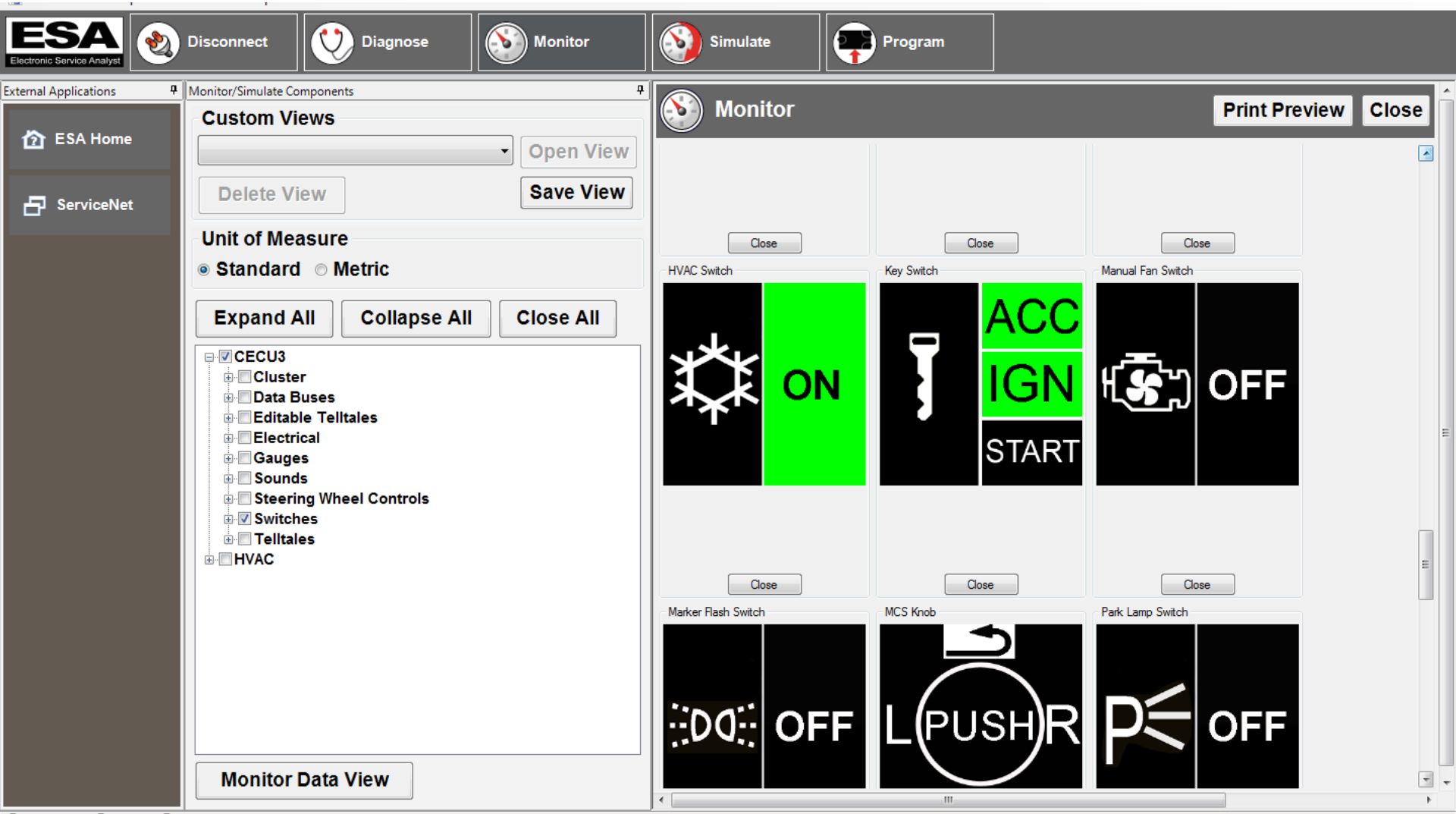
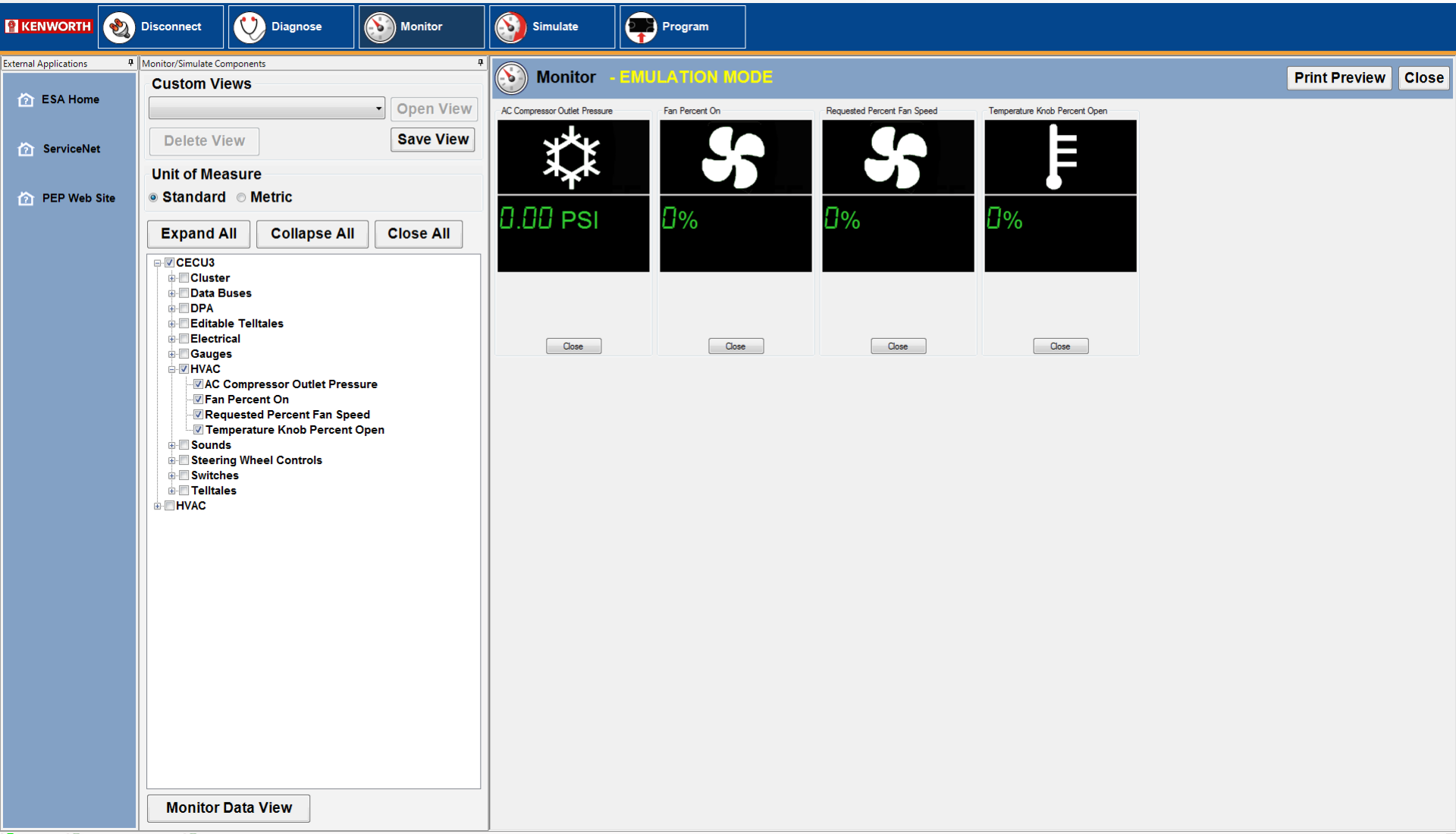


ESA Interface



ESA Interface



K370/K270 Cab Over Engine
Medium Duty Trucks

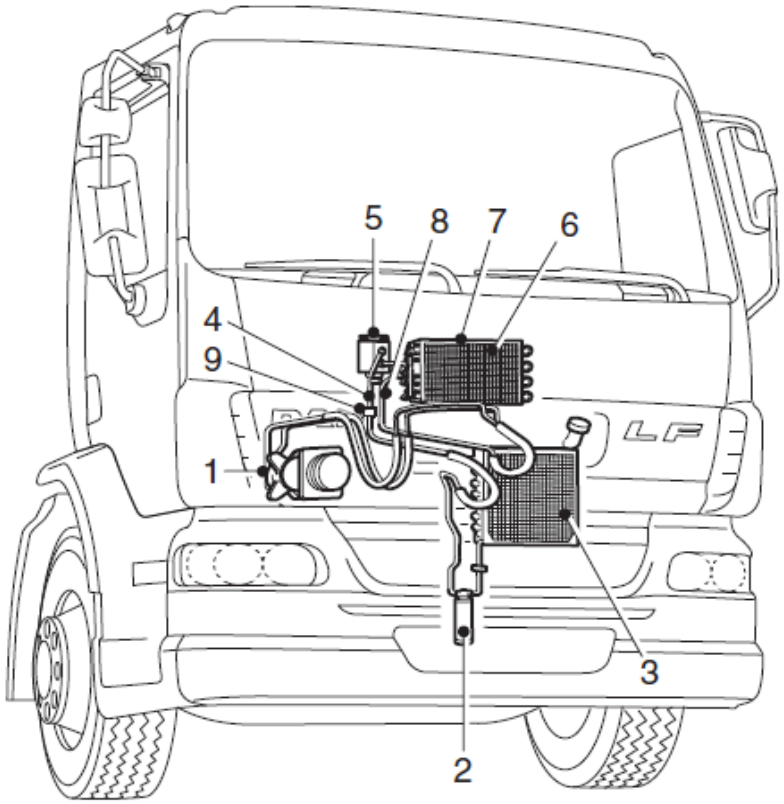
KENWORTH

Kenworth COE Medium Duty Models

COE Medium Duty Class 5, 6, 7 – K Series

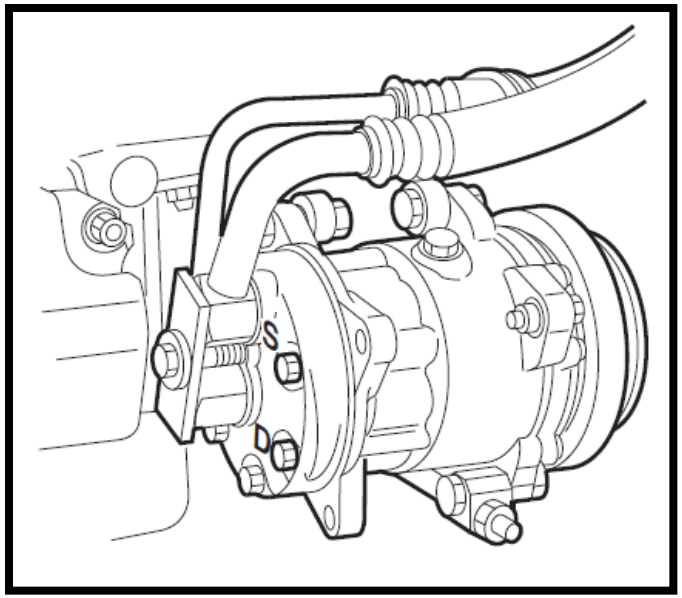
HVAC System Layout

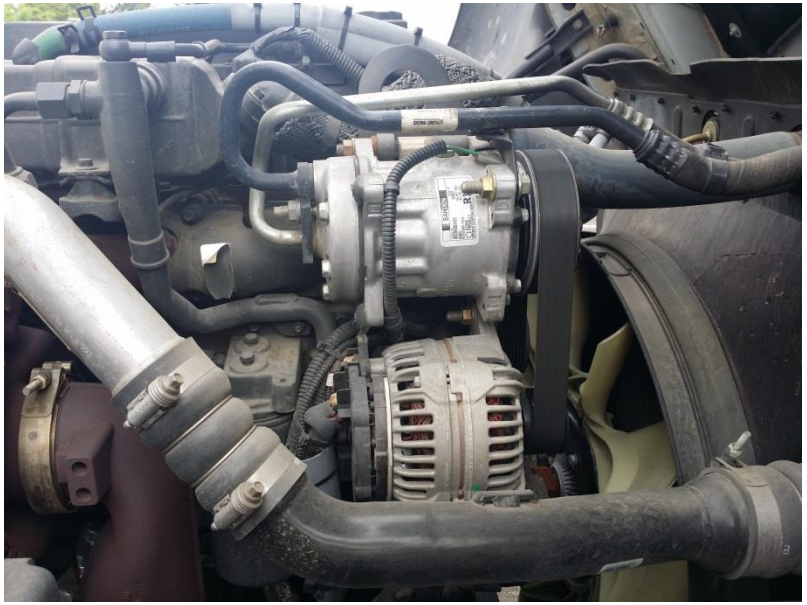
Pos	Description
1	Air conditioning compressor
2	Dryer
3	Condenser
4	Service valve, high-pressure side
5	Expansion valve
6	Evaporator
7	A/C compressor temp. switch (sited at the rear of the evaporator)
8	Service valve, low-pressure side
9	Air conditioning Switch. high/low press



The air conditioning system is a closed system filled with R134a refrigerant. The A/C Includes a 24V Compressor.

24V Compressor





Sanden Compressor uses a 24 volt clutch

24 Volt A/C Compressor Clutch Specifications

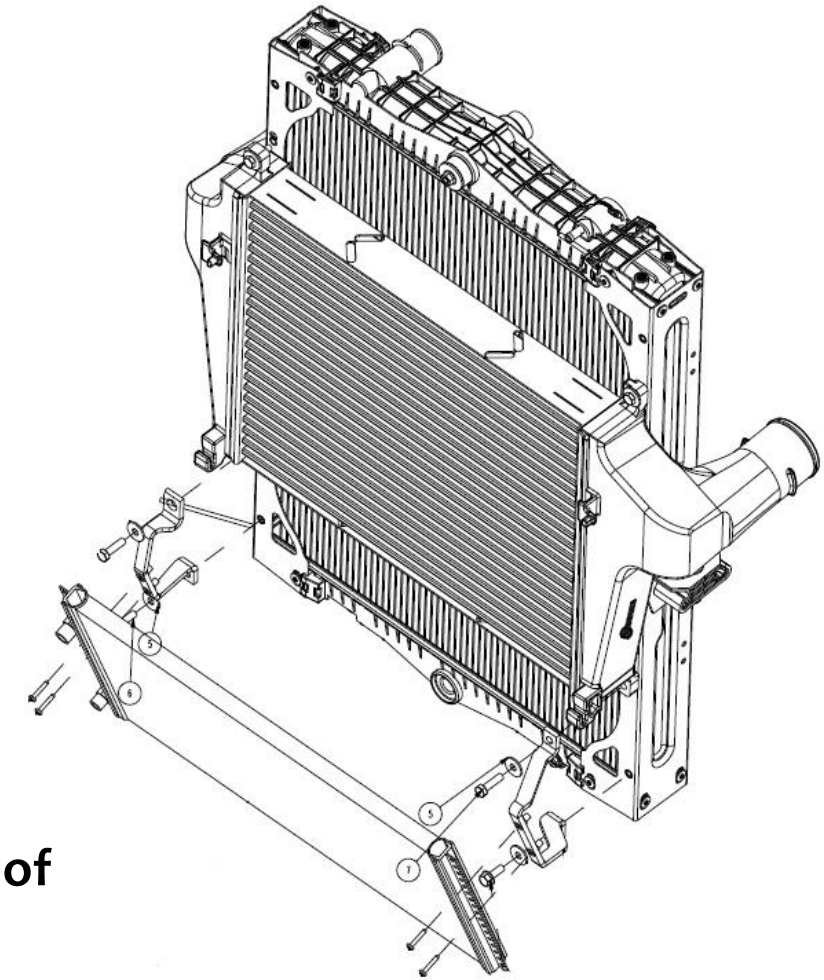
- Confirm that the clutch is receiving 22.5 V (minimum) for 24 V system engagement
- 24 Volt coil resistance should measure between 14.5 Ω and 18.2 Ω @ room temperature
- Air gaps exceeding 0.051” (1.3 mm) can prevent engagement. Specification is 0.016" - 0.031" (0.4 - 0.8mm).

HVAC System Oil Capacities

Filling Capacities	
A/C system coolant capacity	2 lbs (900 grams)
Compressor oil type	PAG oil
System oil capacity	6 oz (175 cc)

Compressor oil refilling quantity when replacing:	
dryer	0.6 oz (20 cc)
condenser	1.7 oz (50 cc)
evaporator	1.3 oz (40 cc)
compressor	4.6 oz (135 cc)
pipe	0.6 oz (20 cc)

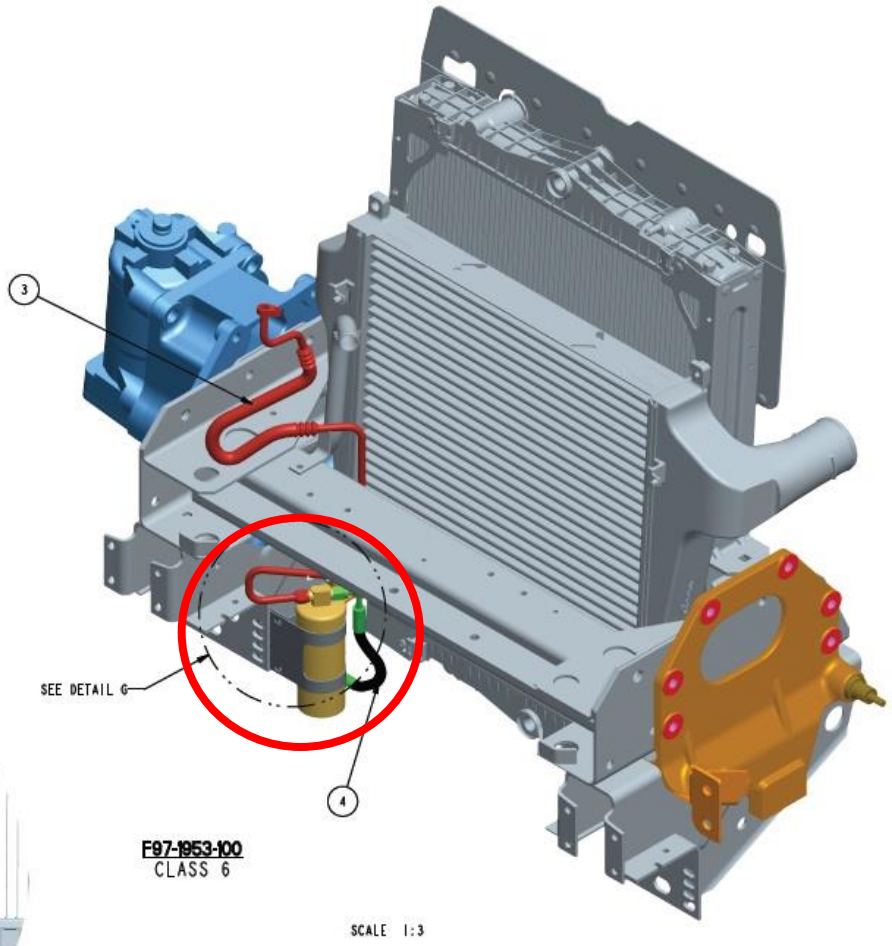
Condenser Location

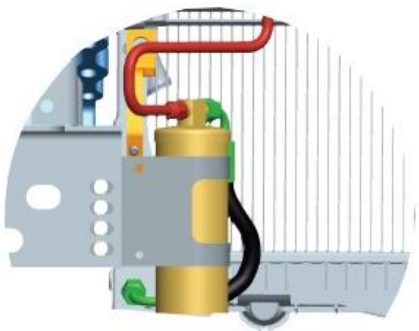


Note: Due to the low mount design of the condenser, road debris buildup inspection is an initial diagnostic step

Receiver-Drier Locations

LFNA Class 6



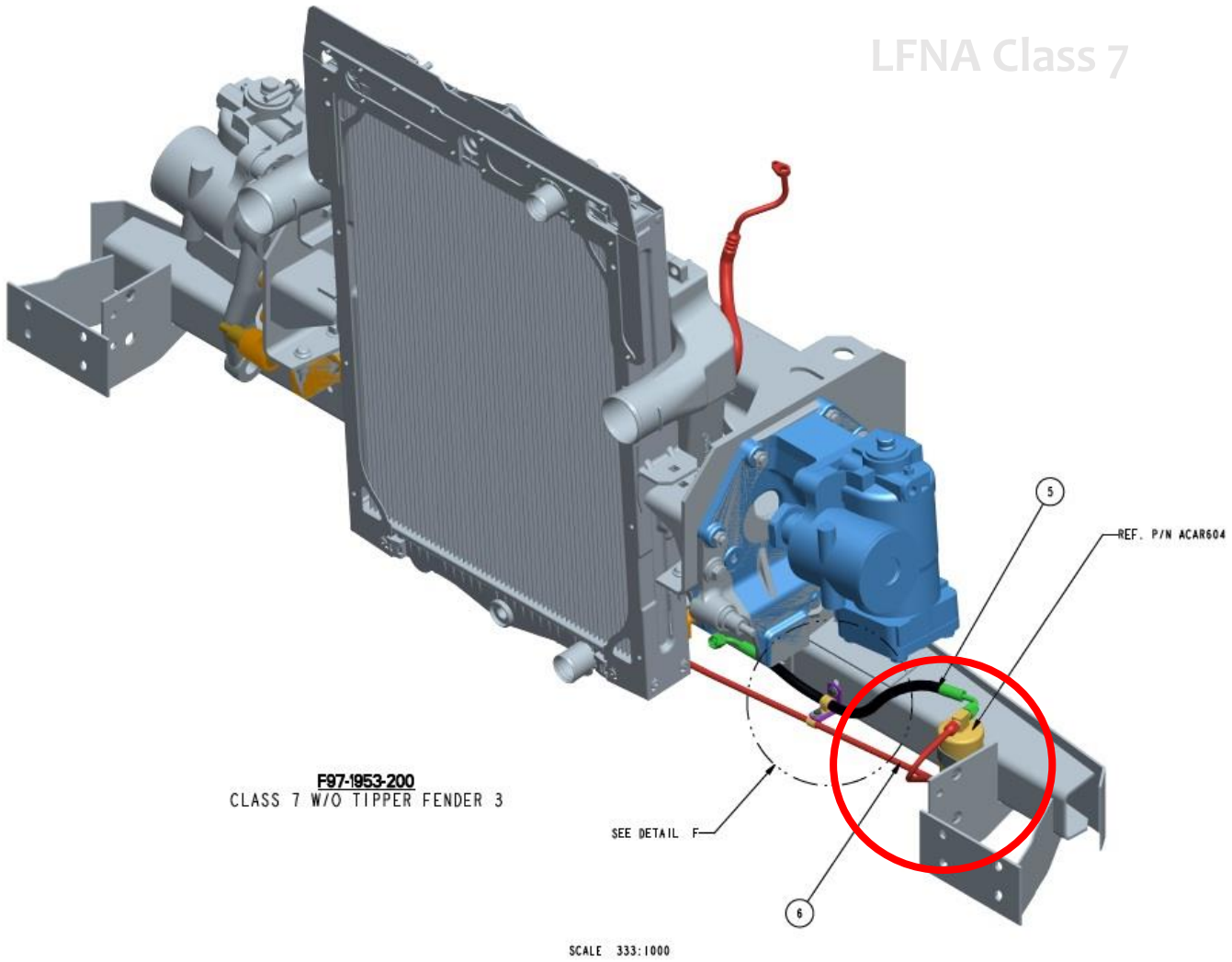


DETAIL G
SCALE 1:2
(VIEW ROTATED FOR CLARITY)

KENWORTH

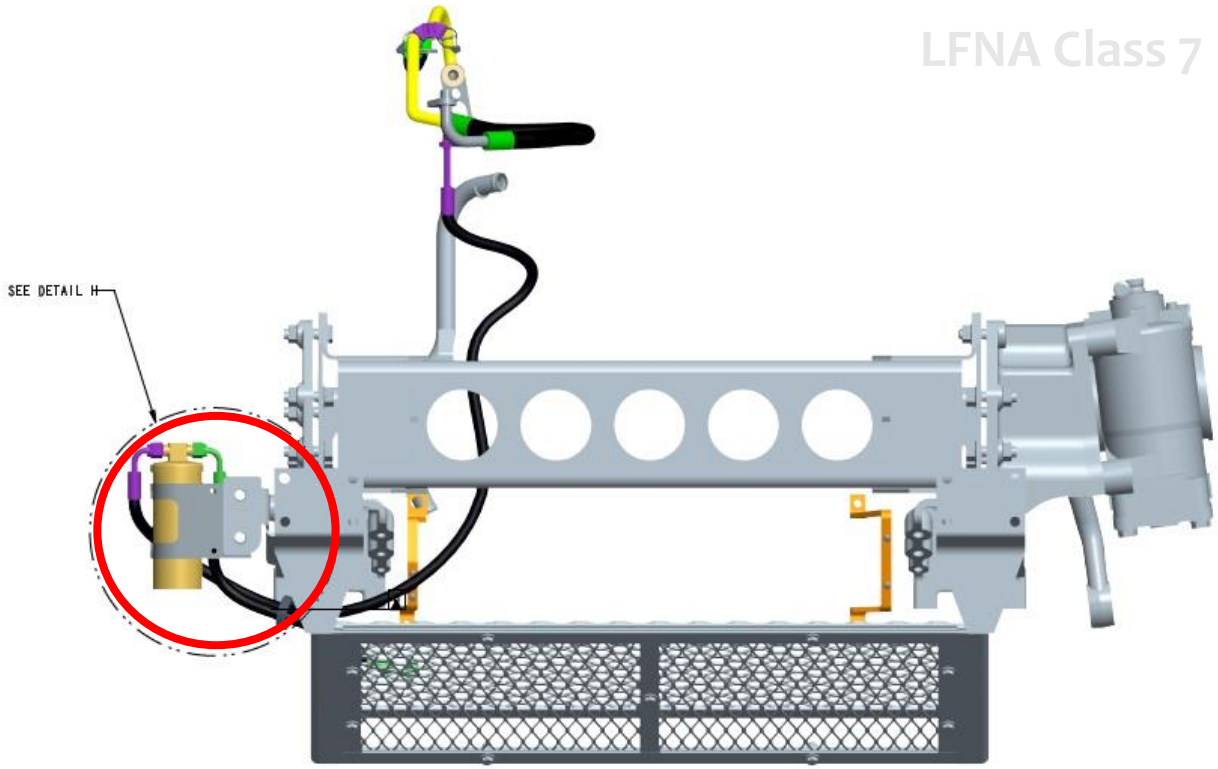
Receiver-Drier Locations

LFNA Class 7

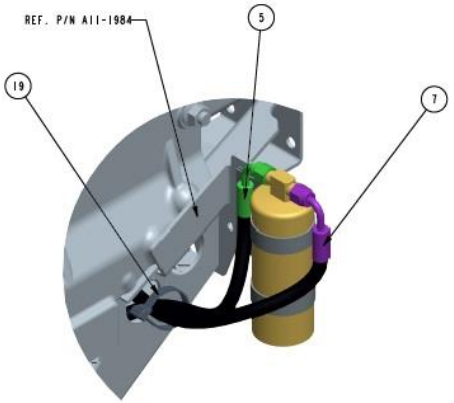


Receiver-Drier Locations

LFNA Class 7



F97-1953-300
CLASS 7 W/ TIPPER FENDER 3
SCALE 333:1000

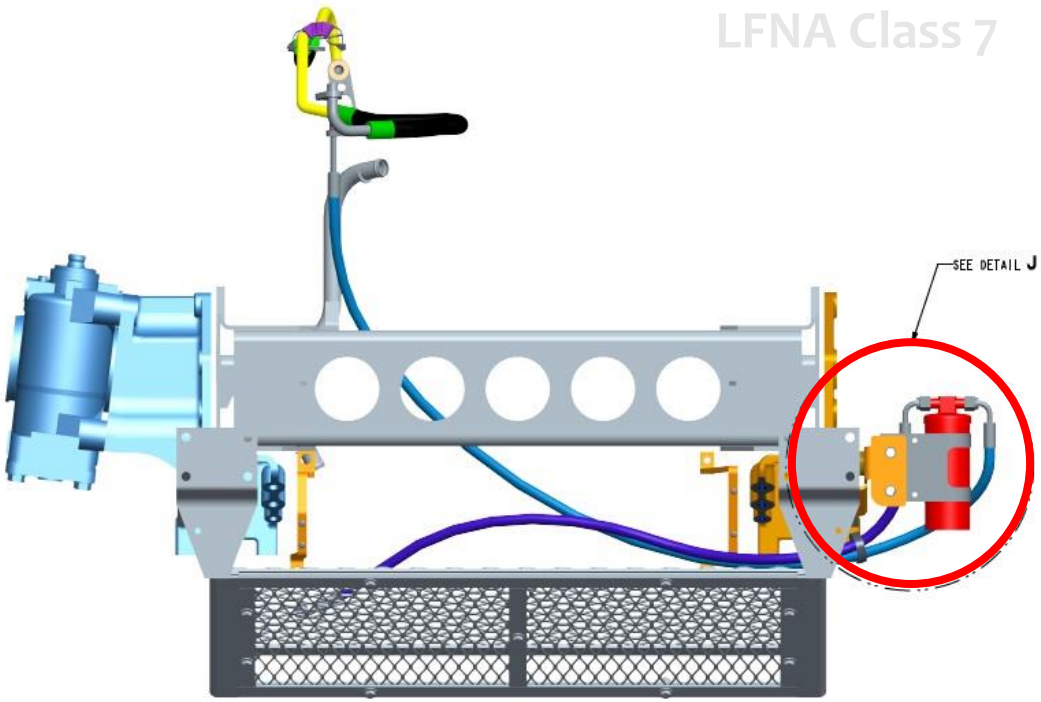


DETAIL H
SCALE 1:2
(VIEW ROTATED FOR CLARITY)

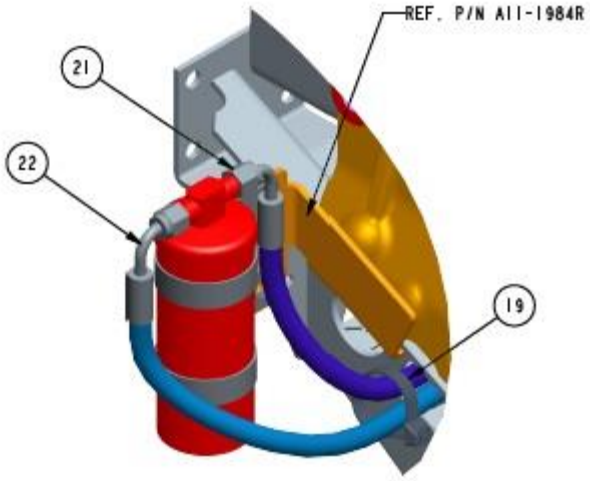
KENWORTH

Receiver-Drier Locations

LFNA Class 7

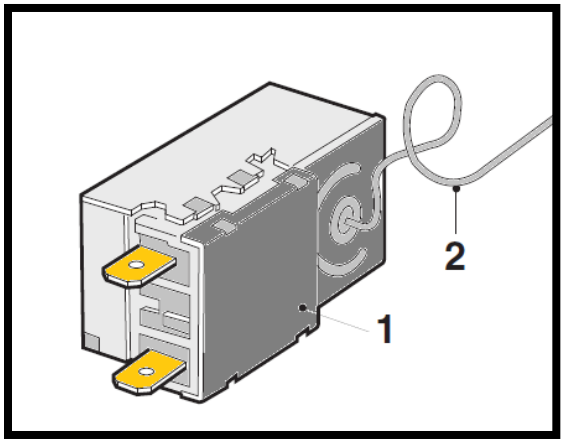


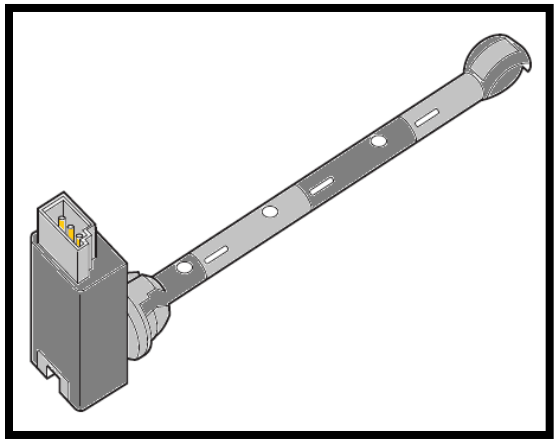
F97-1953-400
CLASS 7 SWEEPER RH DRIVE
SCALE 1:3



DETAIL J
SCALE 1:2
(VIEW ROTATED FOR CLARITY)

Evaporator Temperature Controls





- Temperature Switch
  - Cut-out temperature of compressor ≤36 °F (≤2 °C)
  - Cut-in temperature of compressor ≥+45 °F (≥+7 °C)

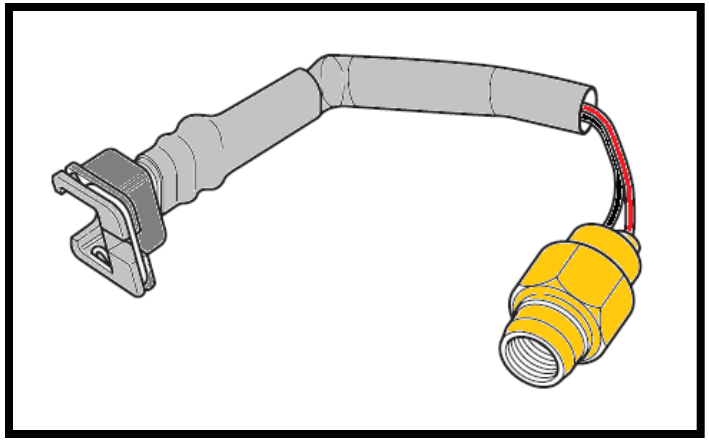
- Temperature Sensor
  - Cut-out temperature of compressor ≤+32 °F (≤+2 °C)
  - Cut-in temperature of compressor ≥+45 °F (≥+7 °C)

Temperature Sensor Fuse

NOTE

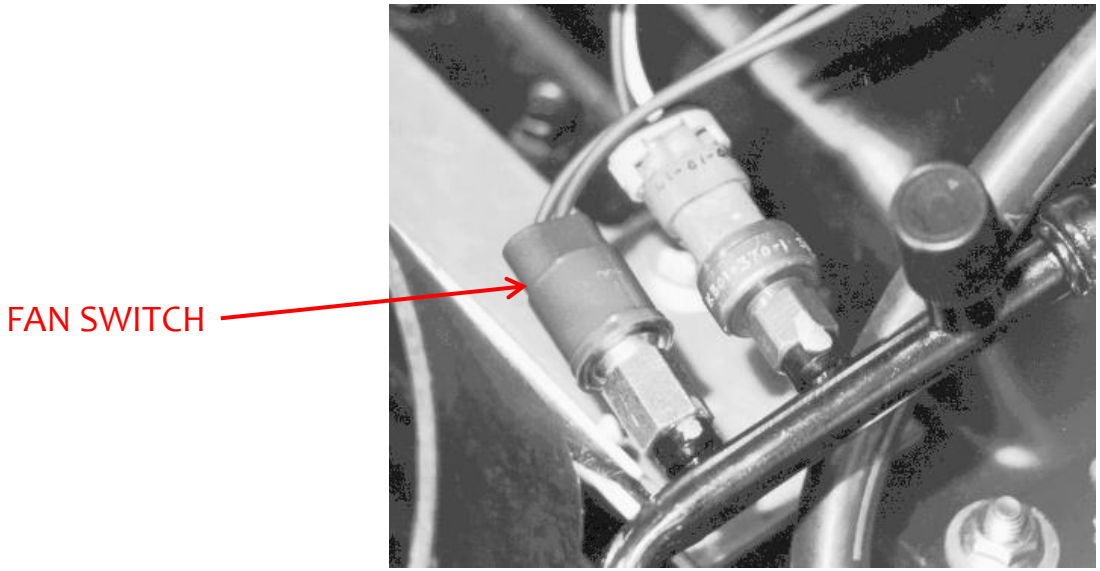
In some vehicles, the temperature sensor has a 5-A fuse. This fuse is located in the cable harness of the temperature sensor.

High/Low Pressure Cut-out Switch



- System pressure at which the compressor is deactivated
  - <29 psi and >464 psi (<2 bar and >32 bar)

Engine Fan Override Switch

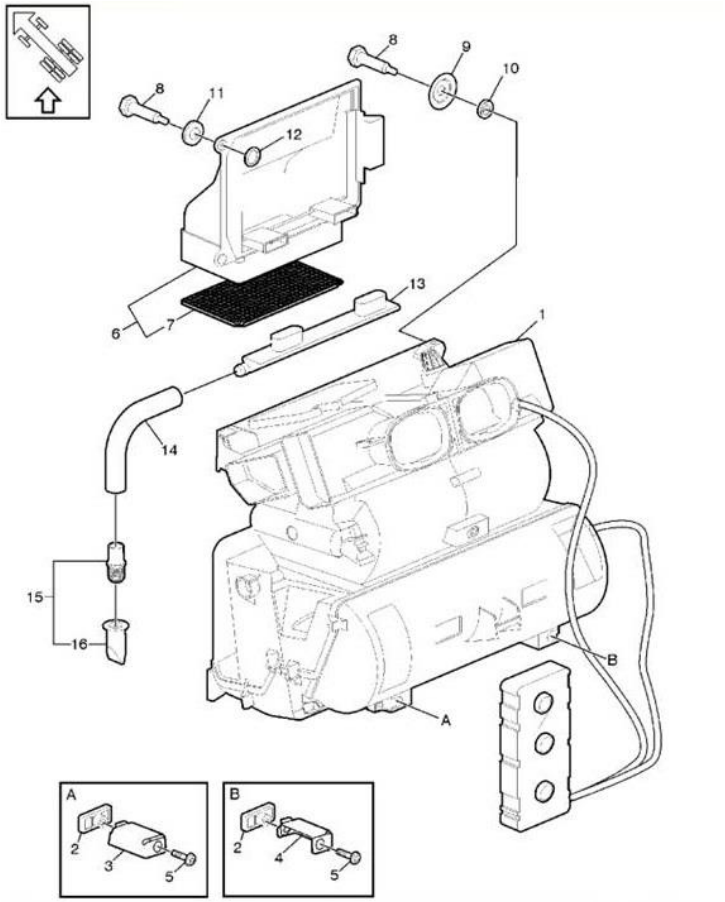


- The fan switch engages the electric engine fan when **high side pressures exceeds 275±10 psi.**

- The fan switch disengages the electric engine fan when the **high side pressures fall below 230±10 psi.**

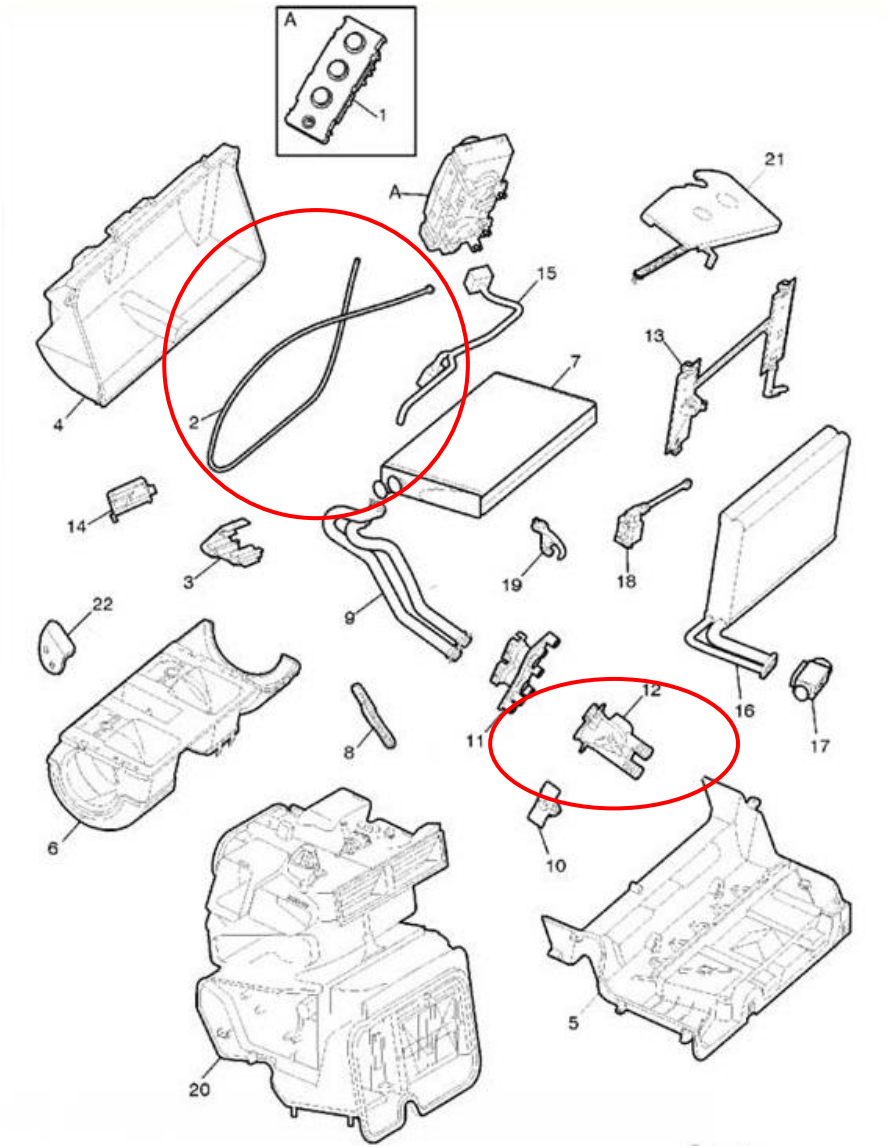
- **COE, off highway, and models with roof-mounted condensers may use a fan switch with higher set points.** This reduces fan operation because of a slightly more efficient condenser which causes slightly lower operating pressures.

HVAC Control Panel

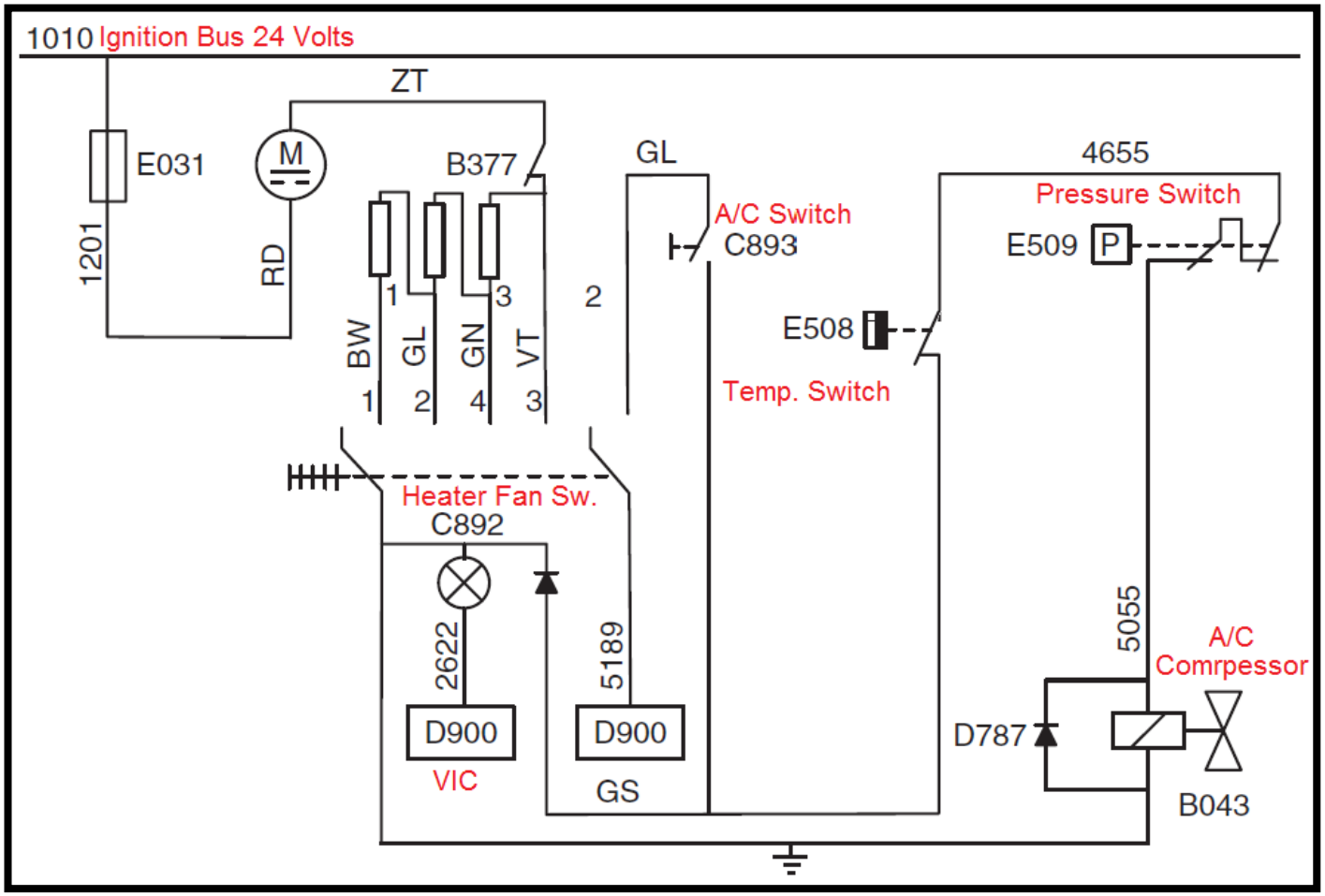


HVAC Heater Valve

Coolant flow to the heater core is controlled by a cable operated heater valve.



A/C System Operation - Electrical Circuit



The Compressor is energized by VIC via Temperature Switch and Pressure Switch . The VIC communicates with the engine ECU via V-CAN, and will de-energize the A/C circuit (GRA5189-0) when coolant temp goes above 216°F (102°C) and re-energize it when coolant drops below 208°F (98°C).

T170/T270/T370
Medium Duty Trucks

Kenworth Medium Duty Models

Medium Duty Class 5, 6, 7 – T Series

T-Series M/D HVAC

- NAMUX 2 for 2010 engines: use P94-1912

- NAMUX 2 for 2016/2017 engines: use S92-1117
  (until S94-1007 is released)

T-Series M/D - NAMUX 2 with 2010 Emissions

(Pre- 1/11/2016)

- Electrically actuated mode controls
- Cable actuated heater control valve
- 3 Blower fan speeds (Low, Med, High) controlled by a resistor block
- 3 HVAC Relays
- High & Low Pressure Switches

KIMS
(Kenworth Idle Management System)

Kenworth Idle Management System

T680 ADVANTAGE

Maximum Fuel Efficiency

KENWORTH

To drive a truck efficiently, you need real-time information – especially true today when drivers must track the performance of fuel, vehicle and safety systems on the go. The new Kenworth Driver Performance Center offers, at a glance, everything you need to know about operating in the sweet spot between performance and efficiency. Truck diagnostics and performance indicators pop up to alert the driver with real-time feedback. Trip details and multi-route comparisons allow them to maximize performance every day.

KENWORTH IDLE MANAGEMENT SYSTEM

Kenworth's factory installed battery based anti-idle system is designed to help long-haul fleets in hot and cold climates reduce idling time and fuel usage without compromising performance. As a split system, Kenworth's factory installed option provides one of the smallest footprints in the industry, allowing for maximum storage under the bunk. It also features on-board diagnostics, full automatic temperature control in AC and heating modes, a digital LCD display that makes it easier for drivers to the control the unit, and provides battery monitoring capabilities.

The compact brushless DC compressor and evaporator assembly is conveniently located in the sleeper storage area.

The remote condenser with brushless fan assembly is installed centrally on the upper exterior wall for optimum performance.

The user interface control with a LCD display provides automatic temperature control in both A/C and Heating modes.

Four Group 31 AGM batteries electrically isolated from the truck serve as starting batteries to power the system. The system includes battery monitoring capabilities.

KENWORTH

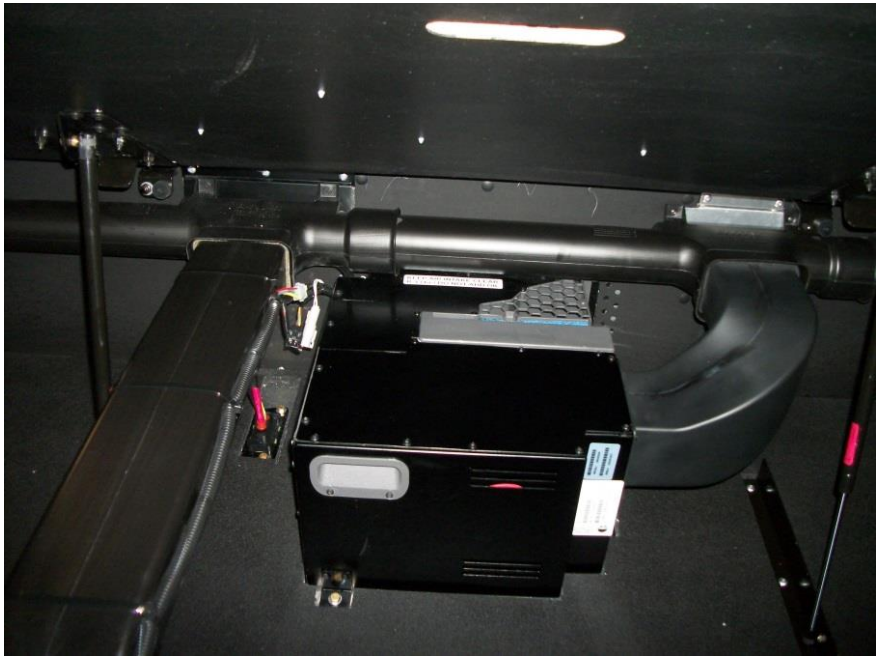
Kenworth Idle Management System

- KIMS SOP – February 3, 2014
  - Available on Model T680
  - Peterbilt SmartAir launched July, 2013, all models 48” sleepers and larger
- PACCAR product is identical with the exception of condenser location, external refrigerant lines, and user interface
- Weight is listed at 565 lbs – weight exemption 550 lbs

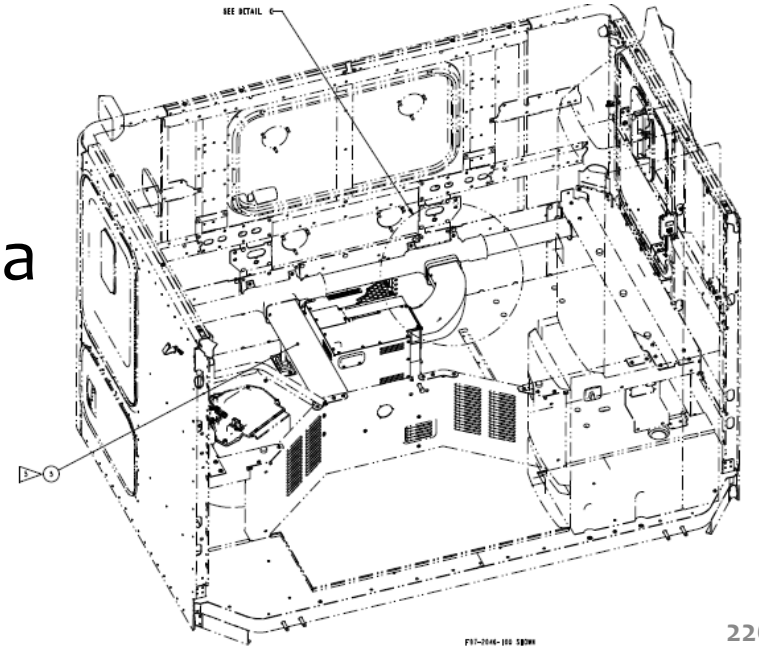
KIMS Features

- Engine-off No-Idle Operation only
  - Ignition Interlock
- Compliments standard sleeper HVAC
- Separate battery bank: 4 Deep cycle AGM
- Alternator requirement-300 amp
- 300 Amp Battery Separator
- Battery Management System (BMS)
- Duct gravity doors
- Vehicle insulation upgrade

KIMS Components



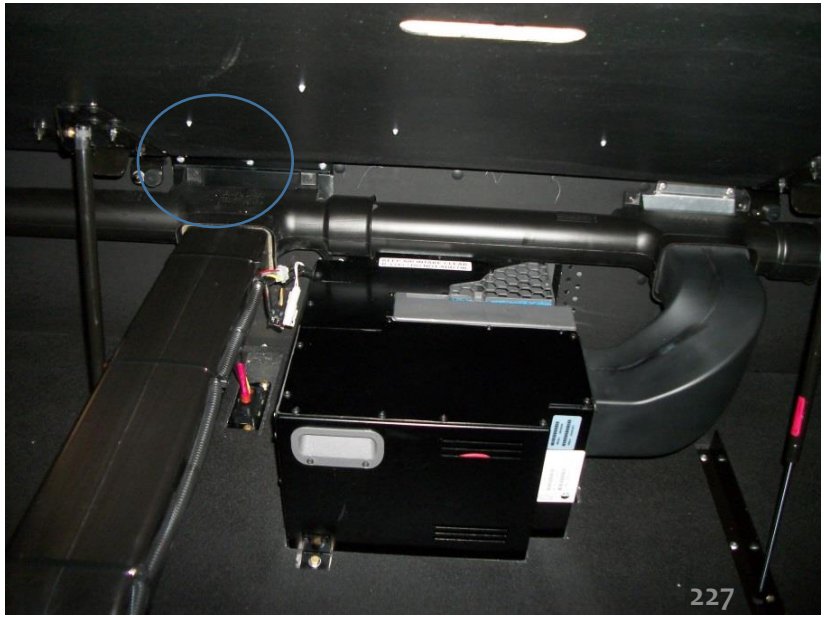
- The main unit resides under the sleeper bunk and contains the system's evaporator, blower, compressor and the air filter.



Since it's integrated, it has a very small under-bunk footprint to maintain storage space for drivers.

Gravity Door

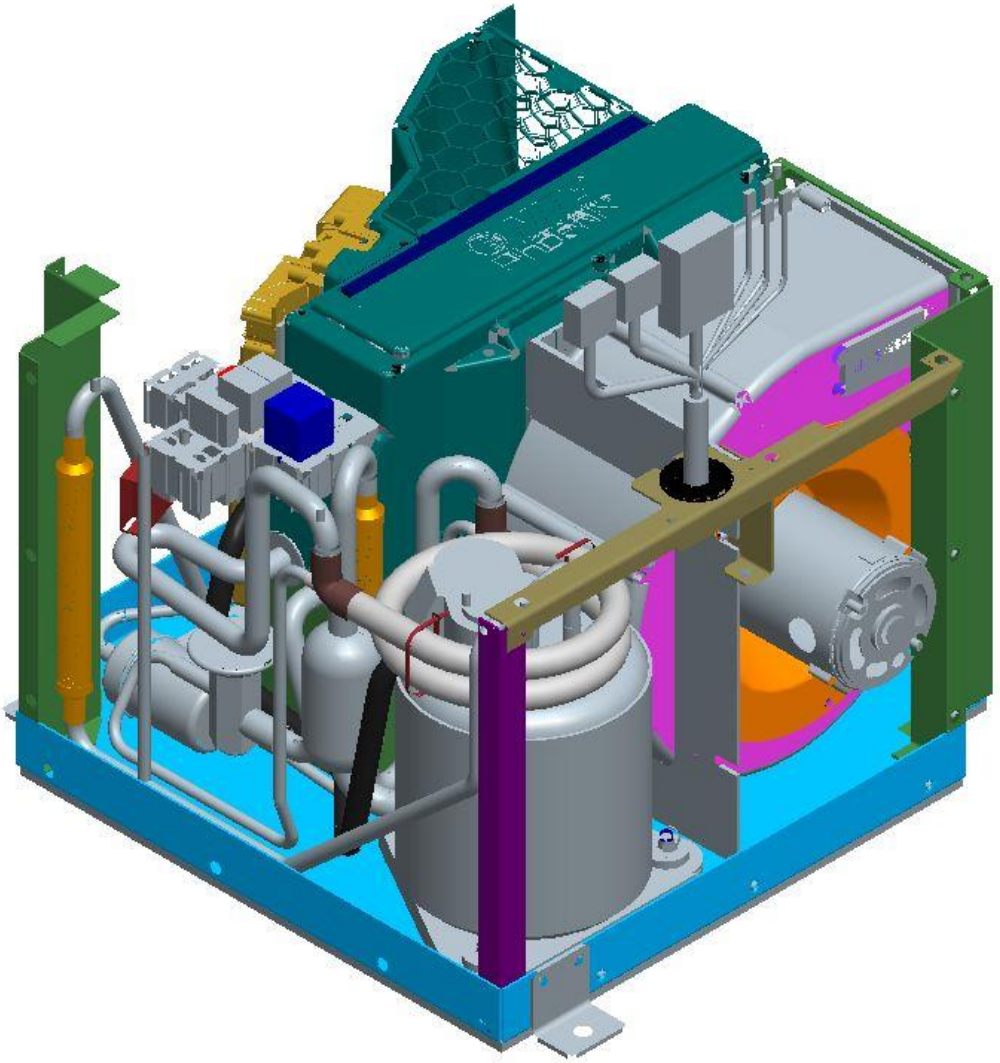
- The gravity door is located in the fore/aft factory duct in the T680.
- This keeps the KIMs system air from flowing back into the OE unit.



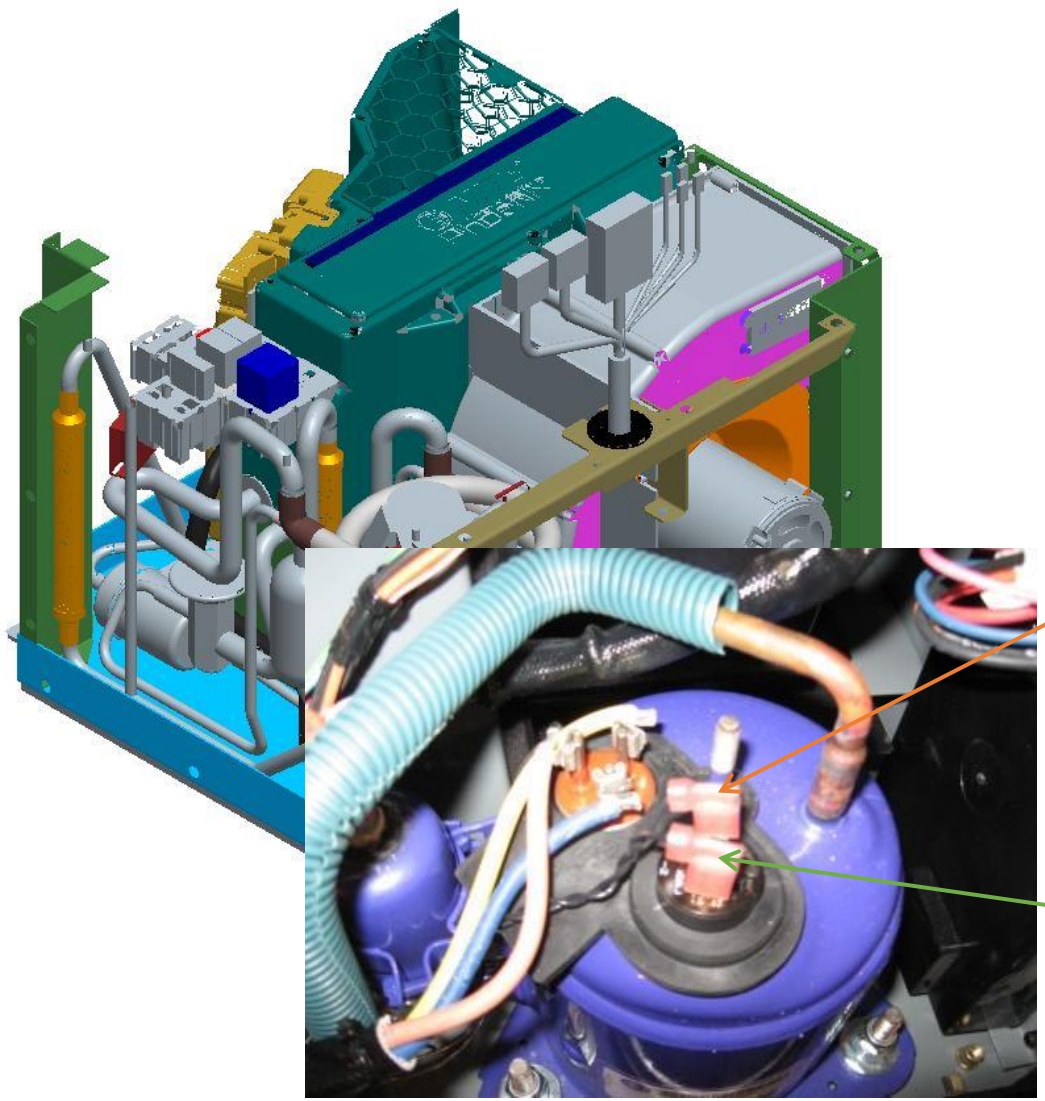
KENWORTH

KIMS System Overview

- Sealed Electric Compressor
- Evaporation Coil
- Suction Line Heat Exchanger
- Blower Motor Assy.
- Electrical Center
- Serviceable Filter



Sealed Compressor



Compressor uses PVE oil only. Never contaminate with PAG oil

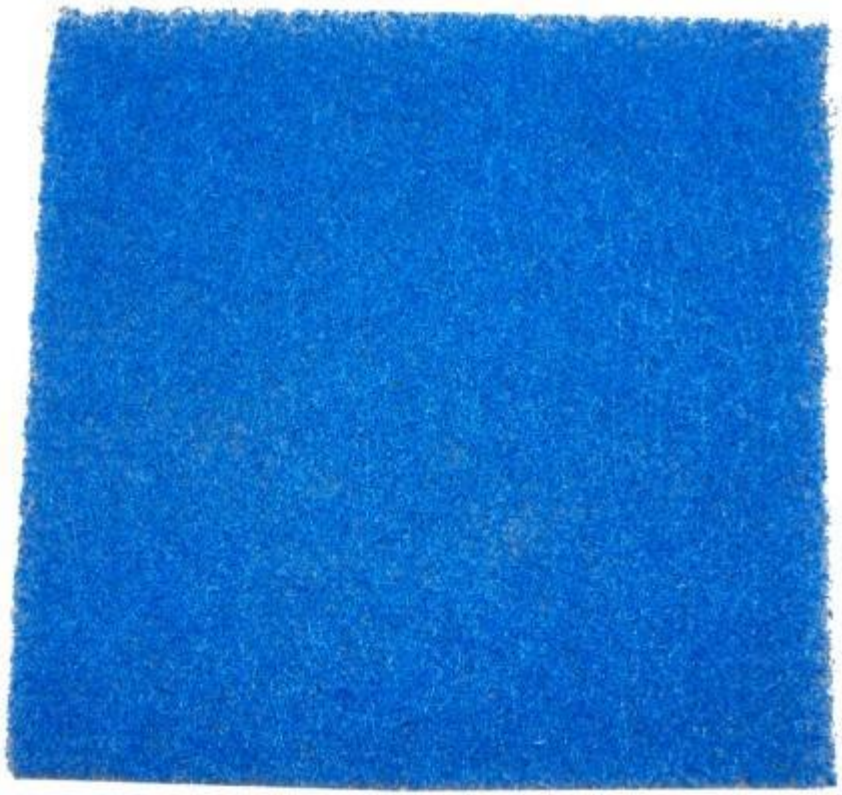
System can be evacuated and charged up to 3 times (21 oz or 1.31 lbs)

High Pressure switch normally closed - will open if pressure gets too high (non serviceable)

Thermal limit switch – normally closed and auto reset to protect compressor from high temperatures

KENWORTH

Evaporator Inlet Filter



- This filter protects the evaporator coil from dust and debris. It is washable and should be serviced periodically during routine maintenance.
- When necessary, Check Filter indicator will notify you that the Evaporator filter must be cleaned or changed.
- To reset Check Filter: at screen 1 press and hold enter button for 3 seconds.

Discharge Temperature Sensor

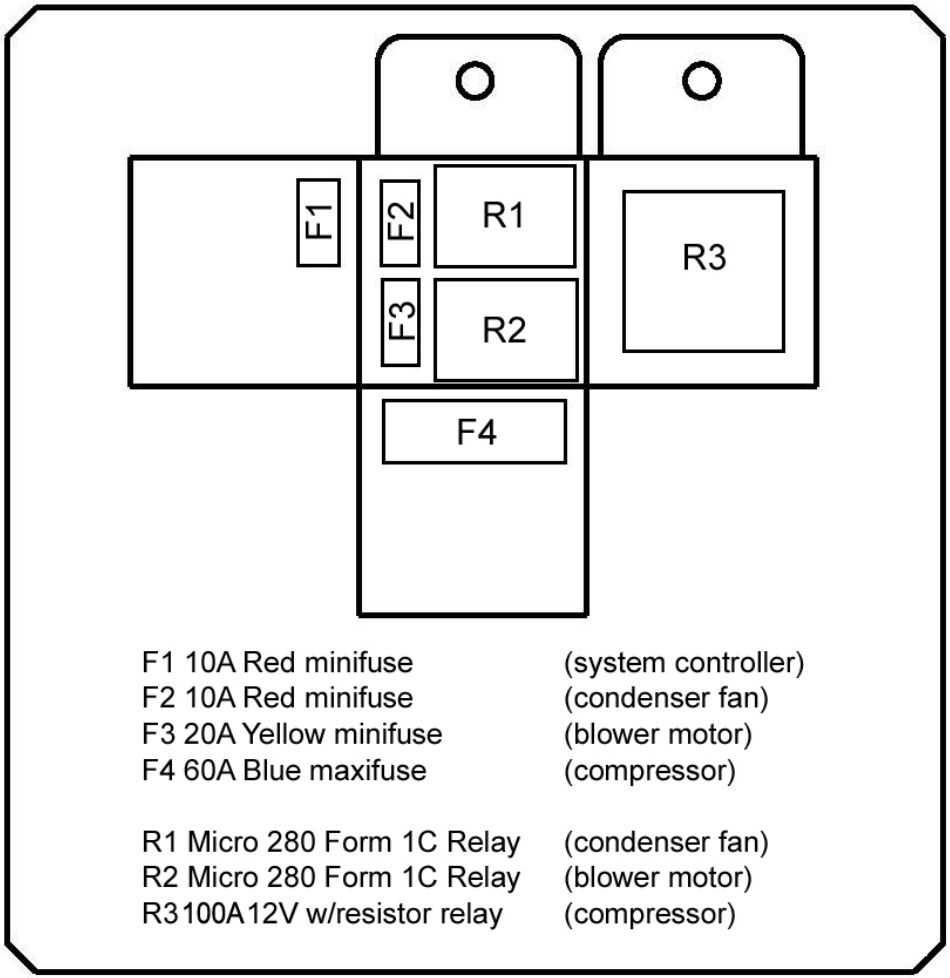
a.k.a. “the Freeze Switch”:

This sensor monitors the evaporator outlet temperature as it enters the vehicle duct system.

Linear Power Module

This module controls the amount of voltage delivered to the evaporator blower creating variable blower speeds. It is located in the return air in front of the evaporator coil.

Electrical Center



F1 10A Red minifuse	(system controller)
F2 10A Red minifuse	(condenser fan)
F3 20A Yellow minifuse	(blower motor)
F4 60A Blue maxifuse	(compressor)
R1 Micro 280 Form 1C Relay	(condenser fan)
R2 Micro 280 Form 1C Relay	(blower motor)
R3 100A 12V w/resistor relay	(compressor)

KIMS External Condenser

- The condenser is mounted to the exterior of the rear sleeper wall.

KIMS External Condenser

- Brushless motor construction
- Quiet airflow characteristics

KENWORTH

KIMS Batteries

Battery Separator Solenoid

Four auxiliary batteries are mounted on the exterior of the vehicle, to power the system in addition to the starting batteries.

KENWORTH

KIMS Batteries

Typical Installation

The four auxiliary batteries are installed in the passenger side step assembly. This may relocate the SCR & DPF assemblies to the area between the frame rails.

Battery Management System

This device monitors the auxiliary batteries for state of charge, communicates with the KIM system and controls the battery separator solenoid.

LED light on this device indicates power to the device and does not provide diagnostics. Power inputs to this device are fuse protected.

If one of the BMS fuses blows, the solenoid will disengage.

Battery Separator Solenoid

- This device connects the truck batteries to the Aux batteries. When the starting batteries are at or above 13.2 volts, the battery management device will engage the solenoid to allow the alternator to charge the auxiliary batteries.

- When the voltage drops to or below 12.5 volts the battery management system will disengage the solenoid to prevent the truck starting batteries from being discharged below the engine start level.

KIMS User Interface

- User Interface features:
  - Default home screen
    - Temp set point, mode
  - Blower speed control
  - Battery “state of charge” level

KIMS User Interface

Icons indicate:

- Fan Speed
- Accumulative hours since last reset
- System error
- Temperature (60 – 85 degrees F)
- Auto temperature control
- Heat manual system mode
- Cool manual system mode
- Check filter – clean or inspect
- Battery health – charge status of auxiliary batteries

KIMS User Interface

- The user interface has a display screen on the top and 4 buttons on the bottom.
- The left button turns the unit on and off.
- The right button is the enter button and is used to select the setting to be changed.
- The up and down arrows allow the user to change system settings.

Turning on the system

Turning the system on requires one of these :

- Key switch in the off position
- Key switch in the accessory position
- Note: There is a 5 to 6 second delay when you key on and back off for system to shut down completely

The system will not turn on if the switch is in the IGN (on) position or the engine is running

KIMS Operation Tips

- Before operating the KIMS HVAC unit, **the sleeper interior temperature should first be brought to the desired temperature with the engine running, and the bunk curtain open.**
- The KIMS HVAC system is designed to maintain an established comfortable bunk temperature while the engine is off and **the bunk curtain is closed.**

KIMS Tech Tips

- Once the truck is shut down, the driver simply uses the control panel in the sleeper to maintain temperature control
- As a safeguard, the system features integrated power management to maximize cooling performance.

Retrieving Service Faults

- To enter SERVICE MODE: Push both the ON/OFF and ENTER button simultaneously, at any time.
- Display will show service indicator and a code #1- #2- #3. Use up and down arrows to scroll through the Fault Codes.
- DTC 01 - Evaporator sensor open or shorted high
- DTC 02 - Evaporator sensor shorted low
- DTC 03 - High pressure switch open or shorted high

KIMS w/ KW Auto-Start

The systems are largely independent and they don't communicate directly with each other. But here is how they work together:

KIMS is powered from the truck Auxiliary (Aux) batteries.

- **KIMS will draw the Aux batteries down to 0% state of charge (SOC) (approx 11.3 V) if Auto Start is not present or enabled**

Auto Start monitors the truck Auxiliary batteries.

- **If enabled, Auto Start will start the truck when Aux batteries reach 20%**
- **The batteries will continue charging until the Aux batteries reach 80% then engine will shut down.**
- **KIMS will continue to run during auto start engine run**
    - **KIMS shuts off if the key is in IGN to prevent KIMS from being left running while the truck is being driven. This shutoff does not apply to Auto Start events**

Conclusion

This concludes the presentation.

Thank you for your attention!

Questions?

KENWORTH

Conclusion