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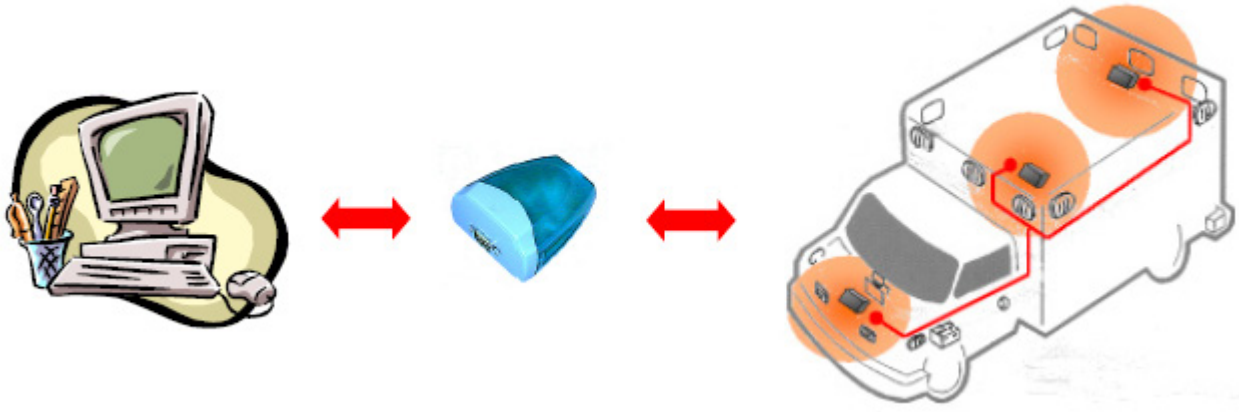

V-MUX®

Input/Output Relationships Report

July 2015

V-MUX System Report Documents -- Inputs and Outputs

The V-MUX system is created by the OEM builder and can be referenced with a spreadsheet document.

The Microsoft Excel® program is used to create these spreadsheets. Two main reference documents will be created for you to use:

- The Input/Output Nodal Specification
- The Nodal Relationships Specification

Inputs -- **Top-level Headings**

"Node" -- The V-MUX node for this list is identified by node number within the full system of 1-32 and node type.

Example:
System ID = Node 1
Type = Hercules-04

The suffix '-04' indicates that by sub-type this is a fourth generation Hercules node

"Digital Inputs" -- This list consists of the wired inputs from On/Off switches.

Digital Inputs			Node 1 (Hercules-04)			Location: Center-Front
Ch #	Pin #	OEM Wire	Name	On State	Type	Comments
1	34	HEADLT SW: YELLOW	HL Low Beam	Ground	Latching N/O	
2	35	HEADLT HI SW: BLUE	HL High Beam	Ground	Latching N/O	
3	17	BACKUP LT SW: WHITE	Reverse	Ground	Latching N/O	
4	18	TURN SW LFT: ORANGE	Turn Signal Left	Ground	Latching N/O	
5	19	TURN SW RT: RED	Turn Signal Right	Ground	Latching N/O	
6	20	MARKER LT SW: BROWN	Marker Lamps	Ground	Latching N/O	
7	8	IGN SW: GREEN	Ignition	Ground	Latching N/O	
8	21	PUMP SHIFT: WHITE	Pump Mode	+Batt	Latching N/O	
9	33		Input 9	Ground	Latching N/O	
10	16	PUMP IN GEAR SW: WHITE	Pump Engaged Detect	+Batt	Latching N/O	
11	6		Input 11	Ground	Latching N/O	
12	2		Input 12	Ground	Latching N/O	
13	9		Input 13	Ground	Latching N/O	
14	10		Input 14	Ground	Latching N/O	
15	22	Q2B SW: ORANGE	Mechanical Siren Activate	Ground	Latching N/O	
16	23		Input 16	Ground	Latching N/O	

"Location" -- Indicates where in the vehicle the node is located.

Coordinate options
x-location: Left, Center, Right
y-location: Front, Mid Front,Mid, Mid Rear, Rear

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Inputs -- Second-level Headings

"Ch #" -- The input channel as listed in the design software. This column is not relevant to service-level troubleshooting.

"Pin #" -- The physical pin assignment on the harness connector to the node. This is relevant to service-level troubleshooting.

"OEM Wire" -- Indicates any color or other tags on the harness wire for the circuit. In other words, visual guides for circuit trouble-shooting.

"On State" -- The signal polarity that indicates the switch circuit is 'On'.

- +Batt = Battery positive (+)
- Ground = Battery negative (-)
- +Batt or Ground = Bipolar (+ or -)
- Not +Batt = Ground or Open circuit
- Not Ground = +Batt or Open circuit
- Floating = Open circuit

"Type" -- Switch type: Latching or Momentary

- 'N/O' = switch is Normally Open
- 'N/C' = Normally Closed

Digital Inputs			Node 1 (Hercules-04)			Location: Center-Front
Ch #	Pin #	OEM Wire	Name	On State	Type	Comments
1	34	HEADLT SW: YELLOW	HL Low Beam	Ground	Latching N/O	
2	35	HEADLT HI SW: BLUE	HL High Beam	Ground	Latching N/O	
3	17	BACKUP LT SW: WHITE	Reverse	Ground	Latching N/O	
4	18	TURN SW LFT: ORANGE	Turn Signal Left	Ground	Latching N/O	
5	19	TURN SW RT: RED	Turn Signal Right	Ground	Latching N/O	
6	20	MARKER LT SW: BROWN	Marker Lamps	Ground	Latching N/O	
7	8	IGN SW: GREEN	Ignition	Ground	Latching N/O	
8	21	PUMP SHIFT: WHITE	Pump Mode	+Batt	Latching N/O	
9	33		Input 9	Ground	Latching N/O	
10	16	PUMP IN GEAR SW: WHITE	Pump Engaged Detect	+Batt	Latching N/O	
11	6		Input 11	Ground	Latching N/O	
12	2		Input 12	Ground	Latching N/O	
13	9		Input 13	Ground	Latching N/O	
14	10		Input 14	Ground	Latching N/O	
15	22	Q2B SW: ORANGE	Mechanical Siren Activate	Ground	Latching N/O	
16	23		Input 16	Ground	Latching N/O	

Additional helpful information may be put here.

The center column: "Name" or "Command"

if using

- **Input/Output datasheet >> "Name"** -- The functional name of the input. This usually defaults to be identical with **Command** but the OEM designer can edit the name field to be any text.

- **Relationships Datasheet >> "Command"** -- The actual V-MUX Command that the input causes the node to issue onto the network.

"Analog Inputs" -- This list consists of the wired inputs from variable 0-5 V sensors, such as Temperature

Input/Output datasheet -- Name and Value Range

"Name" -- The functional name of the sensor input.
"Value Range" -- The physical range of the sensor -- for example, a Temperature range. There may or may not be an implied decimal point within the range

Input/Output datasheet --'Name' and 'Value Range'

Analog Inputs						
Ch #	Pin #	OEM Wire	Name	Value Range		Comments
1	31		System Voltage	0	188	
2	32	AMB TEMP: ORANGE	AMB TEMP	-36	311	MiniNodeDelphiTemp(F)
3	15		Input 19			
4	5		Input 20			

Relationships Datasheet -- Threshold Command with On and Off Thresholds

"Threshold Command" -- If a sensor reaches a certain defined value, called the Threshold, this is the V-MUX Command that the node issues onto the network.
"On Threshold" -- The physical value that issues the Command ON
"Off Threshold" -- The physical value that issues the Command OFF

Relationships datasheet -- 'Threshold Command' with 'On' and Off values

Analog Inputs						
Ch #	Pin #	OEM Wire	Threshold Command	On Threshold	Off Threshold	Comments
1	31		Low Voltage	157	159	
2	32	AMB TEMP: ORANGE	Ambient Temp Switch	27	23	MiniNodeDelphiTemp(F)
3	15		(none)			
4	5		(none)			

Amperage capacities of the Output channels

Output channels are rated to a steady state Amperage limit.

- **"High capacity"** delivers 10.5 or 13 Amp/channel at +VBATT polarity -- Hercules, 8x16 nodes
- **"Medium capacity"** delivers 7.5 Amp/channel at +VBATT polarity -- Mini 4x12 node
- **"Low capacity"** = delivers 4 Amp/channel at +VBATT polarity -- Hercules node
- **"Ground Outputs"** = delivers 4 Amp/channel at -GND polarity -- Hercules, 8x16 nodes

Example: Hercules node outputs listed in sections based by Amps capacity.

"Amps" -- Indicates expected device Amp load at steady state.

"Max Amps" -- Indicates the Amp limit at steady state.

High Capacity Outputs			Node 1 (Hercules-04)					Location: Center-Front
CH #	Pin #	OEM Wire	Name		Amps	Max Amps	Priority Shedding	Comments
1	R	HEADLT LO LFT: ORANGE	HEADLT LO LFT		4	10.5	No Shed	
2	S	HEADLT LO RT: YELLOW	HEADLT LO RT		4	10.5	No Shed	
3	F	HEADLT HI LFT: BLUE	HEADLT HI LFT		8	10.5	No Shed	
4	T	HEADLT HI RT: BLUE	HEADLT HI RT		8	10.5	No Shed	
5	G	WARN 1: ORANGE	WARN 1		4	10.5	No Shed	NON-FLASHING
6	U	WARN 2: RED	WARN 2		4	10.5	No Shed	NON-FLASHING
7	H		Output 7			10.5	No Shed	
8	V	A/C COMP: ORANGE	A/C COMPRESSOR		2	10.5	1 (12.5 V)	
9	L		Output 9			10.5	No Shed	
10	B	ENG COMPT LT: WHITE	ENG COMPT LT		2	10.5	No Shed	
11	M	WARN 4: BLUE	WARN 4		4	10.5	No Shed	NON-FLASHING
12	C	WARN 3: GREEN	WARN 3		4	10.5	No Shed	NON-FLASHING
13	N	Q2B SOL: WHITE	Q2B SOL		1	10.5	No Shed	
14	D		Output 14			10.5	No Shed	
15	O		Output 15			10.5	No Shed	
16	P		Output 16			10.5	No Shed	
				Total	46			
Low Capacity Outputs								
CH #	Pin #	OEM Wire	Name		Amps	Max Amps	Priority Shedding	Comments
17	Q	OK TO PUMP: GREEN	OK TO PUMP		1	4	No Shed	
18	E	123-PUMP MODE INPUT: G	PUMP MODE INPUT 123		1	4	No Shed	PUMP MODE REQ
19	A	PTO LT: RED	PTO LT		1	4	No Shed	
20	J	AER PTO LT: BLUE	AER PTO LT		1	4	No Shed	
21	W		Output 21			4	No Shed	
22	X	FUEL PRIME: YELLOW	FUEL PRIME		1	4	No Shed	
23	K		Output 23			4	No Shed	
24	Z	INTERAXLE VLV: BLUE	INTERAXLE VLV		1	4	No Shed	
				Total	6			
Ground Outputs								
CH #	Pin #	OEM Wire	Name		Amps	Max Amps	Priority Shedding	Comments
25	14		Output 25			4	No Shed	
26	11	122-PUMP ENABLE: YELLOW	122-PUMP ENABLE		1	4	No Shed	TO TRANS
				Total	1			

Load Management of the Output channels

"Priority Shedding" -- Indicates at which voltage threshold the channel will be shut down by the node load manager. Each V-MUX node has its own built-in Load Manager and Load shedding is on a per channel basis as set by the OEM designer.

"No shed" : the output is not Load Managed.

Otherwise, for a 12 Volt System

1 (12.5 Volt)	5 (10.9 Volt)
2 (12.1 Volt)	6 (10.5 Volt)
3 (11.7 Volt)	7 (10.1 Volt)
4 (11.3 Volt)	8 (9.7 Volt)

High Capacity Outputs			Node 1 (Hercules-04)					Location: Center-Front
CH #	Pin #	OEM Wire	Name		Amps	Max Amps	Priority Shedding	Comments
1	R	HEADLT LO LFT: ORANGE	HEADLT LO LFT		4	10.5	No Shed	
2	S	HEADLT LO RT: YELLOW	HEADLT LO RT		4	10.5	No Shed	
3	F	HEADLT HI LFT: BLUE	HEADLT HI LFT		8	10.5	No Shed	
4	T	HEADLT HI RT: BLUE	HEADLT HI RT		8	10.5	No Shed	
5	G	WARN 1: ORANGE	WARN 1		4	10.5	No Shed	N
6	U	WARN 2: RED	WARN 2		4	10.5	No Shed	N
7	H		Output 7			10.5	No Shed	
8	V	A/C COMP: ORANGE	A/C COMPRESSOR		2	10.5	1 (12.5 V)	
9	L		Output 9			10.5	No Shed	
10	B	ENG COMPT LT: WHITE	ENG COMPT LT		2	10.5	No Shed	
11	M	WARN 4: BLUE	WARN 4		4	10.5	No Shed	N
12	C	WARN 3: GREEN	WARN 3		4	10.5	No Shed	N
13	N	Q2B SOL: WHITE	Q2B SOL		1	10.5	No Shed	
14	D		Output 14			10.5	No Shed	
15	O		Output 15			10.5	No Shed	
16	P		Output 16			10.5	No Shed	
				Total	46			

if set for for a 24 Volt System

1 (25.2 Volt)
2 (24.4 Volt)
3 (23.6 Volt)
4 (22.8 Volt)
5 (22.0 Volt)
6 (21.2 Volt)
7 (20.4 Volt)
8 (19.6 Volt)

Low Capacity Outputs								
CH #	Pin #	OEM Wire	Name		Amps	Max Amps	Priority Shedding	Comments
17	Q	OK TO PUMP: GREEN	OK TO PUMP		1	4	No Shed	
18	E	123-PUMP MODE INPUT: G	PUMP MODE INPUT 123		1	4	No Shed	PUMP MODE REQ
19	A	PTO LT: RED	PTO LT		1	4	No Shed	
20	J	AER PTO LT: BLUE	AER PTO LT		1	4	No Shed	
21	W		Output 21			4	No Shed	
22	X	FUEL PRIME: YELLOW	FUEL PRIME		1	4	No Shed	
23	K		Output 23			4	No Shed	
24	7	INTERAXLE VLV: BLUE	INTERAXLE VLV		1	4	No Shed	
				Total	6			

Ground Outputs								
CH #	Pin #	OEM Wire	Name		Amps	Max Amps	Priority Shedding	Comments
25	14		Output 25			4	No Shed	
26	11	122-PUMP ENABLE: YELLOW	122-PUMP ENABLE		1	4	No Shed	TO TRANS
				Total	1			

The Output List of a Relationship datasheet

Output Channel Relationships

"Relationships" -- Lists the set of V-MUX Commands that logically combine to control the output channel. The Commands may be from various sources. Here are a few examples:

- Wired switch inputs (Ex: **Park Brake** On/Off)
- Wired sensors with defined thresholds (Ex: 12.6 Volt = **Low Voltage**)
- CAN/J1939 signals (Ex: **Check Engine**)
- User inputs (Ex: **E Warning Lights** On/Off)

More than one Command may control an output and the logical relationship between the listed Commands is important. The entire Relationships list must evaluate as logically TRUE before the Output will turn On.

Logic used with a single Command or the leading Command of a list:
<ON> : TRUE if item is logically 'On', 'True'
<NOT> : TRUE if item is logically 'Off', 'False' (Ex: a released Park Brake is <NOT> Park Brake)

A note about NOT. Any <NOT> Command that does not lead the Relationships list must be preceded by a logical separator such as <AND>. This is an important rule.

Logic used with two or more Commands:
<AND> : TRUE if both items are 'On', 'True'
<OR> : Inclusive OR. TRUE if either or both items are 'On', 'True'
<XOR> : Exclusive OR. TRUE if either but not both items are 'On', 'True'

Output Relationships

High Capacity Outputs			Node 1 (Hercules-04)		
CH #	Pin #	OEM Wire	Name	Priority Shedding	Relationships
1	R	HEADLT LO LFT: ORANGE	HEADLT LO LFT	No Shed	<NOT> HL High Beam <AND> HL Low Beam Level1: <ON> Ignition <NOT> Park Brake
2	S	HEADLT LO RT: YELLOW	HEADLT LO RT	No Shed	<NOT> HL High Beam <AND> HL Low Beam Level1: <ON> Ignition <NOT> Park Brake
3	F	HEADLT HI LFT: BLUE	HEADLT HI LFT	No Shed	<ON> HL High Beam <AND> <NOT> HL Low Beam Level1: <ON> E Emergency Master
4	T	HEADLT HI RT: BLUE	HEADLT HI RT	No Shed	<ON> HL High Beam <AND> <NOT> HL Low Beam Level1: <ON> E Emergency Master
5	G	WARN 1: ORANGE	WARN 1	No Shed	<ON> E Emergency Master <AND> E Secondary
6	U	WARN 2: RED	WARN 2	No Shed	<ON> E Emergency Master <AND> E Secondary
7	H		Output 7	No Shed	(None)
8	V		Output 8	No Shed	(None)
9	L		Output 9	No Shed	(None)
10	B	ENG COMPT LT: WHITE	ENG COMPT LT	No Shed	<ON> Cab Ajar
11	M	WARN 4: BLUE	WARN 4	No Shed	<ON> E Emergency Master <AND> E Secondary
12	C	WARN 3: GREEN	WARN 3	No Shed	<ON> E Emergency Master <AND> E Secondary
13	N	Q2B SOL: WHITE	Q2B SOL	No Shed	<ON> Mechanical Siren Activate <AND> E Emergency Master

The Output List of a Relationship datasheet

Output Channel Relationships -- Relationship Levels

"Relationship Levels" are a method by which an Output channel may change behavior depending on the inputs that are True at any one instant. For example:

- to change between steady and flashing mode
- to change between full and partial intensity (change PWM rate)
- to change an On or Off delay timer

Example: Channels 1,2 pins R,S = Headlight, Lowbeam, Left/Right ("HEADLT LO LFT", "HEADLT LO RT")
The normal mode is to turn HL Low Beam On at full intensity unless High Beam is On.

TOP LEVEL MODE: <NOT> HL High Beam <AND> HL Low Beam

Level 1 mode is to run HL Low Beam as Daytime Running Lights at partial intensity (PWM % is not shown)

SUB LEVEL 1 MODE: <ON> Ignition <AND> <NOT> Park Brake

There may be several defined levels. If more than one level is True at the same time, any upper level will supersede any lower level. So in this example a headlight in partial 'Daytime' mode could be switched instantly into full intensity Low Beam.

Example

Top Level ⟶ <NOT> HL High Beam <AND> HL Low Beam

Sub Level ⟶ Level1: <ON> Ignition <AND> <NOT> Park Brake

High Capacity Outputs			Node 1 (Hercules-04)		
CH #	Pin #	OEM Wire	Name	Priority Shedding	Relationships
1	R	HEADLT LO LFT: ORANGE	HEADLT LO LFT	No Shed	<NOT> HL High Beam <AND> HL Low Beam Level1: <ON> Ignition <NOT> Park Brake
2	S	HEADLT LO RT: YELLOW	HEADLT LO RT	No Shed	<NOT> HL High Beam <AND> HL Low Beam Level1: <ON> Ignition <NOT> Park Brake
3	F	HEADLT HI LFT: BLUE	HEADLT HI LFT	No Shed	<ON> HL High Beam <AND> <NOT> HL Low Beam Level1: <ON> E Emergency Master
4	T	HEADLT HI RT: BLUE	HEADLT HI RT	No Shed	<ON> HL High Beam <AND> <NOT> HL Low Beam Level1: <ON> E Emergency Master
5	G	WARN 1: ORANGE	WARN 1	No Shed	<ON> E Emergency Master <AND> E Secondary
6	U	WARN 2: RED	WARN 2	No Shed	<ON> E Emergency Master <AND> E Secondary
7	H		Output 7	No Shed	(None)
8	V		Output 8	No Shed	(None)
9	L		Output 9	No Shed	(None)
10	B	ENG COMPT LT: WHITE	ENG COMPT LT	No Shed	<ON> Cab Ajar
11	M	WARN 4: BLUE	WARN 4	No Shed	<ON> E Emergency Master <AND> E Secondary
12	C	WARN 3: GREEN	WARN 3	No Shed	<ON> E Emergency Master <AND> E Secondary
13	N	Q2B SOL: WHITE	Q2B SOL	No Shed	<ON> Mechanical Siren Activate <AND> E Emergency Master