Vehicle Improvement Products

SmartWheel LIN Steering Wheel
Troubleshooting Guide

For use with:
Steering Wheels V44 Series,
Controller SM213

Published: 25 February 2011
Revised: 25 February 2011

Vehicle Improvement Products
SmartWheel Troubleshooting Guide

The following guide is for use with the VIP SmartWheel Series III SM213 Controller.

It is strongly recommended that this guide be read completely through prior to starting work. Doing so will speed diagnosing and repairing problems and help prevent damage to the SmartWheel and related systems.

Product description:
The basic system operation consists of the Master controller providing 12 Volts DC and ground, as well as a LIN bus line to the steering wheel switch electronics which respond with a specific LIN message to any switch press. The controller then decodes the message and takes the appropriate action - opening or closing a relay or sending a specific message to the radio.

Most Common Faults:
The following are examples of the most common problems and what to look for.

Problem	Cause
Marker and or Headlamps cycle on-off while in use.	Marker and or Headlamps drawing more than rated current than controller can handle (~10 amps max total for headlamps and/or running lamps, and ~10 amps max for marker lamps).
Wipers not functioning properly or other odd quirks in vehicle lighting or instrumentation	The most common problem with wipers and or lighting issues is poor ground(s). Please check grounds at accessories being driven by the controller (such as wiper motors, cruise control, lamps, etc.). The ground for these accessories should be tied to the nearest body/frame ground on vehicle. They should NOT use any ground(s) from the controller as their only ground.
Some of the radio functions seem to work randomly or don't work at all.	Some of the connections or wires in the radio interface/configuration connector (J5) are in poor condition.

Table 1

Vehicle Improvement Products
SmartWheel Troubleshooting Guide

LED Indicator
Check the status LED (Seen through hole in controller cover.)

LED Indicator	Status	
Indicator OFF	Ignition OFF or no power from battery	Verify battery (J2 pin 1) and ground (J2 pin 2) to the controller, verify that Ignition input (J2 pin 4) is > 10V.
Flashing Red	SmartWheel not detected	Verify good connections through the column. This consists of verifying if the clockspring connection is in good order. One simple way to test the clockspring is to rock/rotate the steering wheel right and left and see if there is intermittent operation of the steering wheel controls
Solid Red	Communication with SmartWheel OK	(Ignition ON, battery normal, no steering wheel switches depressed)
Orange (Red + Green)	Switch pressed on SmartWheel	Confirm that each function works using the indications described in the **In-Vehicle Tests** section. Most of the functions can be checked by using a multimeter on the relay contacts shown in the attached wiring diagram.

Table 2

Diagnostics:
Read through the entire procedure below and then proceed as directed.

- Verify battery, ignition and ground at the controller per the attached wiring diagram.
- To remove or install the horn pad in order to check connection from controller to switch pods, or to check switch pods please follow the instructions at the end of this troubleshooting guide (**Directions for Removing Horn Pad** section).
- J1, J3, J4 & J5 can be replaced during the diagnostics for troubleshooting if needed.

Initial In-Vehicle Test:
Proceed with these in the order in which they are listed prior to attempting any other in-vehicle tests.

- The ignition switch should be in the “OFF” position until directed otherwise.
- Disconnect connectors J1, J3, J4, J5, J6, J7, J8 and J9 from the Master controller.
- Make sure that +12Vdc power is present at J2 pin 1 on the Master controller. If not present, check the supply fuses or breakers and wiring.
- Turn ignition switch to the “ACCESORY” or “RUN” position, LED indicator should be flashing red. If not, replace Master controller.
- Measure the DC voltage at J1 pin 2 (Wheel Power) and J1 pin 3 (LIN Bus) on the Master controller. It should measure in the range of 10-12 Volts. If not, replace Master controller.
- Re-connect connector J1 to the controller.

- Remove the center pad from the Steering Wheel and disconnect the Steering Wheel from the clockspring (see **Directions for Removing Horn Pad** section).
- Verify that voltages in the clockspring connector match the values indicated in the table below (Table 3). If not, verify continuity and good connections through the column in each one of the wires.

Steering Wheel Connector Cavity		
Position	**Color Wire**	**Function**
A	Gray	Horn (0 V)
B	Red	Switch Pods Power (12 VDC)
C	Violet	LIN Bus (10-12 V)
D	Black	Ground (0 V)

Table 3

- Re-connect Steering Wheel to the clock-spring. LED indicator should be solid red and Steering Wheel backlight should be on. If backlight is on and LED indicator is flashing red, replace Master controller. If LED indicator is solid Red but no backlight, replace switch-pods on Steering Wheel.

In-Vehicle Tests:
Perform the above **Initial In-Vehicle Test** before attempting to perform these tests. Select these by function if problems are observed with a particular function.

- The ignition switch should be in the “OFF” position until directed otherwise.
- Make sure that connectors J3, J4, J5, J6, J7, J8 and J9 are disconnected from the Master controller.
- Connect J3 pin 12 to ground.
- After that, the ignition switch on the vehicle should be turned to the “ACCESORY” or “RUN” position, causing +12Vdc to be present at J2 pin 4 on the Master controller.

HORN TEST - Connect a low current test light or a voltmeter between a +12Vdc source and J2 pin 3 (Horn output) on the Master controller. Press the HORN bar on the Steering Wheel, voltage between +VDC source and J2 pin 3 should be ~12Vdc and the test light should light. If it doesn't, the Horn output on the Master is damaged (replace the Master controller).

HEADLAMP "OFF" TEST - With no switches pressed on the Steering Wheel and the dash Headlamp switch off, check for continuity between J2 pin 5 on the Master controller and J2 pin 6. If continuity does exist, the headlamp "off" circuitry on the Master is damaged (replace the Master controller).

HEADLAMP "ON" TEST - While the HEADLAMP FLASH switch on the Steering Wheel is pressed and the dash Headlamp switch off, check for continuity between J2 pin 5 on the Master controller and J2 pin 6. If continuity does not exist, the headlamp "on" circuitry on the Master is damaged (replace the Master controller).

MARKER LAMP "OFF" TEST - With no switches pressed on the Steering Wheel and the dash Headlamp switch off, check for continuity between J2 pin 7 on the Master controller and J2 pin 8. If continuity does exist, the marker lamp "off" circuitry on the Master is damaged (replace the Master controller).

MARKER LAMP "ON" TEST - While the MARKER LAMP FLASH switch on the Steering Wheel is pressed and the dash Headlamp switch off, check for continuity between J12 pin 7 on the Master controller and J2 pin 8. If continuity does not exist, the marker lamp "on" circuitry on the Master is damaged (replace the Master controller).

CRUISE "ON" TEST - Momentarily press the CRUISE "ON" switch on the Steering Wheel.
Because this is a latching function, the function should be active after the switch is released. Check for continuity between J3 pin 6 on the Master controller and J3 pin 8. If continuity does not exist, the cruise "on" circuitry on the Master is damaged (replace the Master controller).

CRUISE "OFF" TEST - Momentarily press the CRUISE "OFF" switch on the Steering Wheel.
Because this is a latching function, the function should be active after the switch is released. Check for continuity between J3 pin 6 on the Master controller and J3 pin 7. If continuity does not exist, the cruise "off" circuitry on the Master is damaged (replace the Master controller).

CRUISE "SET" TEST - With the CRUISE "SET" switch on the Steering Wheel not pressed check for continuity between J3 pin 5 on the Master controller and J3 pin 2. If continuity does not exist, the cruise "set" circuitry on the Master is damaged (replace the Master controller). While the CRUISE "SET" switch on the Steering Wheel is pressed check for continuity between J3 pin 5 on the Master controller and J3 pin 1. If continuity does not exist, the cruise "set" circuitry on the Master is damaged (replace the Master controller).

CRUISE "RESUME" TEST - With the CRUISE "RESUME" switch on the Steering Wheel not pressed check for continuity between J3 pin 5 on the Master controller and J3 pin 4. If continuity does not exist, the cruise "resume" circuitry on the Master is damaged (replace the Master controller). While the CRUISE "RESUME" switch on the Steering Wheel is pressed check for continuity between J3 pin 5 on the Master controller and J3 pin 3. If continuity does not exist, the cruise "resume" circuitry on the Master is damaged (replace the Master controller).

CRUISE "CANCEL" TEST - With the CRUISE "CANCEL" switch on the Steering Wheel not pressed check for continuity between J3 pin 9 on the Master controller and J3 pin 10. If continuity does not exist, the cruise "cancel" circuitry on the Master is damaged (replace the Master controller). While the CRUISE "CANCEL" switch on the Steering Wheel is pressed check for continuity between J3 pin 9 on the Master controller and J3 pin 11. If continuity does not exist, the cruise "cancel" circuitry on the Master is damaged (replace the Master controller).

WIPER "WASH" TEST - While the WIPER "WASH" switch on the Steering Wheel is pressed check for continuity between J4 pin 1 on the Master controller and J4 pin 7. If continuity does not exist, the wash pump output circuitry on the Master is damaged (replace the Master controller). In addition, check for continuity between J4 pin 6 on the Master controller and J4 pin 4. If continuity does not exist, the low speed wiper wash circuitry on the Master is damaged (replace the Master controller).

WIPER "LO/HI" TEST - Momentarily press the WIPER "LO/HI" switch on the Steering Wheel.
Because this is a latching function, the function should remain active after the switch is released. Check for continuity between J4 pin 4 and J4 pin 6 on the Master controller. If continuity does not exist, the continuous low speed wiper circuitry on the Master is damaged (replace the Master controller). Momentarily press the WIPER "LO/HI" switch again and check for continuity between J4 pin 5 and J4 pin 6 on the Master controller. If continuity does not exist, the continuous high-speed wiper circuitry on the Master is damaged (replace the Master controller). Subsequent presses of this switch will cause alternate continuity at the low speed (J4 pin 4 and J4 pin 6) or high-speed (J4 pin 5 and J4 pin 6) outputs on the Master controller.

WIPER "OFF" TEST - Momentarily press the WIPER "OFF" switch on the Steering Wheel.
Because this is a latching function, the function should be active after the switch is released. Check for no continuity between J4 pin 4 and J4 pin 6, Also between J4 pin 5 and J4 pin 6 on the Master controller. If continuity exists between any of these output pins, the wiper off circuitry on the Master is damaged (replace the Master controller). In order to check the dynamic braking circuitry after the WIPER "OFF" switch is pressed, check for continuity between J4 pin 4 and J4 pin 2 and also between J4 pin 12 and J4 pin 14. If continuity does not exist, the dynamic braking circuitry on the Master is damaged (replace the Master controller).

WIPER "VARIABLE" TEST – Thorough testing of the variable function is fairly complex and requires additional equipment. If all other functional wiper tests have been completed successfully, the only practical field test is to re-connect the wiper motor(s) and verify correct function operationally.
Operation of this switch initially causes the Low Speed Wiper outputs (J4 pin 4 & J4 pin 12) to be connected to +12Vdc Wiper Power (J4 pin 6 or pin 10) for one wipe. If the switch is pressed again within approximately 30 seconds, the Low Speed Wiper function will be activated again and will repeat at an interval determined by the time between the last two operations of the switch. Additional switch operations will shorten the cycle. Activation of any other wiper mode cancels the variable mode.
The effect for the driver is thus: In light rain or mist conditions the driver presses the switch once when the windshield first needs clearing. When the windshield again requires clearing the driver presses the button again - setting the time period between subsequent wipes to that required by current conditions. If the driver does not press the switch again within approximately 30 seconds of the initial press, there will be only one wipe. If the function is not as described, the variable delay circuitry on the Master is damaged (replace the Master controller).

RADIO FUNTIONS TEST – Connect J5 pin 1, 2 & 3 to ground. While pushing or pulling each one of the paddles in the Steering Wheel verify that voltages in the radio interface outputs (J5 pin 8 and J5 pin 9) match the values in the table below (Table 4). If they don't, the radio control circuitry on the Master is damaged (replace the Master controller).

Paddle	Action	Output voltage
Left switch pod		
Upper paddle	Pull	1Vdc (J5 pin 8)
	Push	2Vdc (J5 pin 8)
Lower paddle	Pull	3Vdc (J5 pin 8)
	Push	4Vdc (J5 pin 8)
Right switch pod		
Upper paddle	Pull	1Vdc (J5 pin 9)
	Push	2Vdc (J5 pin 9)
Lower paddle	Pull	3Vdc (J5 pin 9)
	Push	4Vdc (J5 pin 9)

Table 4

After test are completed:

- If necessary, reconnect the Steering Wheel to the column connector(s) and re-attach the center pad (see **Directions for Installing Horn Pad** section).
- Re-connect all connectors that may have been removed from the Master controller.

Vehicle Improvement Products
SmartWheel Troubleshooting Guide

Directions for Removing Horn Pad:

1. Remove Horn Pad by placing both hands on top of pad as shown below (Pic 1). Using your fingertips underneath the top leading edge of the horn pad (Pic 2) gently pull upward toward you. There are four posts securing the horn pad to wheel blocks, generally all four will release using the manner just described. DO NOT use a ripping motion to remove the pad, as it is possible to damage the posts. Remove the wire connected to the back of the horn pad.

Pic 1

Pic 2

Vehicle Improvement Products
SmartWheel Troubleshooting Guide

Directions for Installing Horn Pad:

1. Lay horn pad on top of steering wheel aligning the four posts of the horn pad directly on top of their respective mating holes. *Be sure to reconnect city horn wire lead to horn pad.* Using the palm of your hand gently tap each of the four corners of the horn pad starting with the lower right, then lower left, to upper right, finishing with upper left. (Refer to diagram 1). Do NOT attempt to snap all four retaining posts in at the same time by hitting steering wheel in center, damage may result.

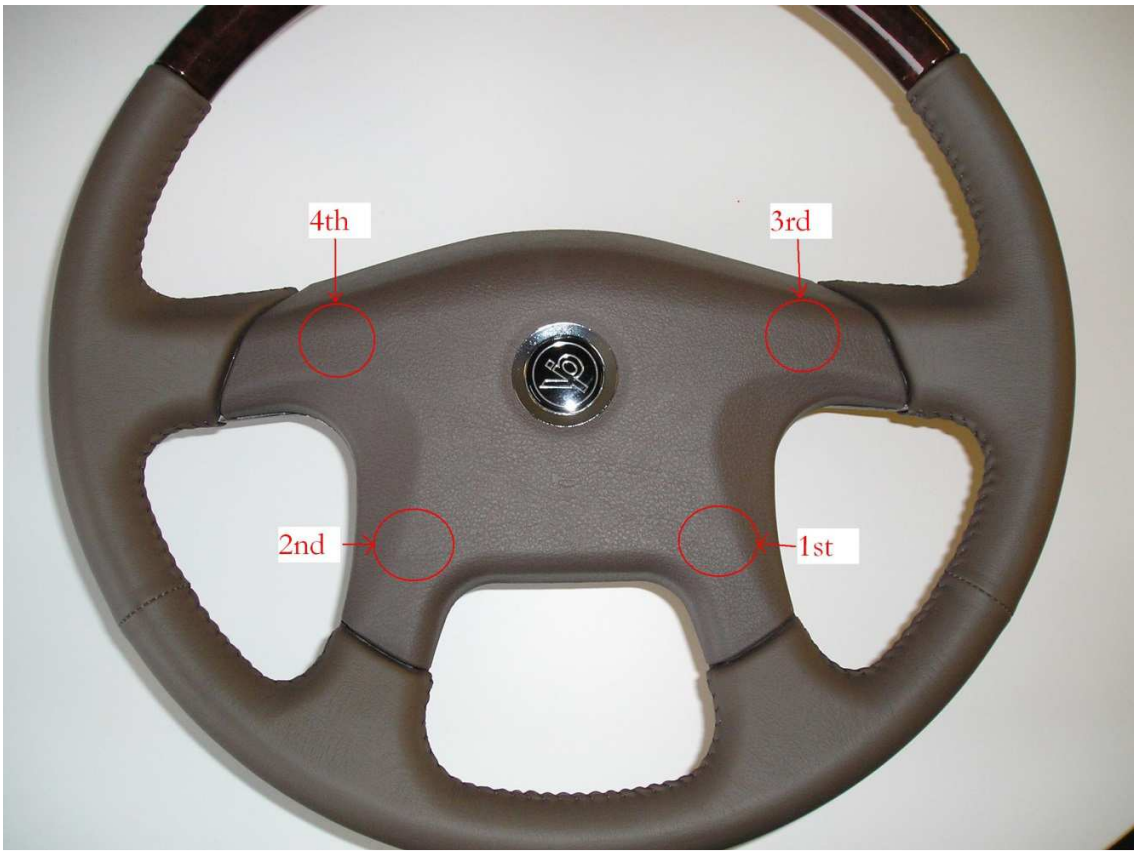


Diagram 1.

SM213 Control Module

Suggested Chassis Wiring

Circuits shown in control module are for reference only.

Control Module

J1 (2x3)
1 Horn Switch In
2 Wheel Power Out
3 LIN Data
4 Wheel Ground
5 Marker Lamp Sw In
6 Head Lamp Sw In

J2 (3x3)
1 +12V Battery In
2 System Ground
3 Horn Relay Out
4 Ignition In
5 Head Lamp Pwr In
6 Head Lamp Pwr Out
7 Mrkr Lamp Pwr In
8 Mrkr Lamp Pwr Out
9 DRL Lamp Out

J3 (3x4)
1 Cruise Set N.O.
2 Cruise Set N.C.
3 Cruise Resume N.O.
4 Cruise Resume N.C.
5 Cruise Common
6 Cruise Com/Ign/Gnd
7 Cruise On/Off N.C.
8 Cruise On/Off N.O.
9 Cruise Cancel Com
10 Cruise Cancel N.C.
11 Cruise Cancel N.O.
12 Option Select 1

J4 (3x5)
1 Wiper 1 Off Park
2 Wiper 1 Ground Ref
3 Wiper 1 Park
4 Wiper 1 Low
5 Wiper 1 High
6 Wiper 1 +12V Power
7 Wash Pump
8 Option 2 Select
9
10 Wiper 2 +12V Power
11 Wiper 2 High
12 Wiper 2 Low
13 Wiper 2 Park
14 Wiper 2 Ground Ref
15 Wiper 2 Off Park

J5 (3x3)
1 Radio Select A
2 Radio Select B
3 Radio Select C
4 HL/ML Current Limit
5
6
7 Radio Ground
8 Radio 1 Out
9 Radio 2 Out

J6 (2x3)
1 Twilight Switch
2 HL Switch In
3 HL Switch Ground
4 Twilight Sense A
5 Twilight Sense B
6 Instrument Lamp In

J7
J8
J9

SW4 Horn
K1A RELAY SPDT — Head Lamp
K1B RELAY SPDT — Mrkr Lamp
DRL DRIVE 70%
K2 RELAY SPDT Cruise On/Off
K3 RELAY SPDT Cruise Set
K4 RELAY SPDT Cruise Resume
K5 RELAY SPDT Cruise Cancel
Wiper 1 On/Off
K7A RELAY SPDT
K8A RELAY SPDT Wiper 1 Low/High
Wiper 2 On/Off
K7B RELAY SPDT
K8B RELAY SPDT Wiper 2 Low/High
K6 RELAY SPDT Wash Pump

(2x3) — J10 P10 — STEERING COLUMN — P11
SW2 Marker Lamps (1)
SW1 Head Lamps
Ignition
1A MAX CB9 Ignition
P2 (3x3)
+12V BAT
1A CB1 Module Power
1A MAX CB2 Horn Relay
3A TYP CB3 Horn
10A MAX CB4 Headlamps
10A MAX CB5 Marker Lamps
K10 RELAY SPDT — LS1 HORN — xA
K1 RELAY SPDT
K2 RELAY SPDT
(2)
SW3 High Low Beam
DS1 High Beam Lamp
DS2 High Beam Lamp
DS3 Low Beam Lamp
DS4 Low Beam Lamp
DS5 Marker Lamp
DS6 Marker Lamp

P3 (3x4)
Cruise Set N.O.
Cruise Set N.C.
Cruise Resume N.O.
Cruise Resume N.C.
Cruise Common
Cruise Common/Ign/Gnd
Cruise On/Off N.C.
Cruise On/Off N.O.
Cruise Cancel Common
Cruise Cancel N.C.
Cruise Cancel N.O.
Option 1 Select - See Table

P4 (3x5)
(8) (9)
Option 2 Select - See Table
High / Low / (Off Park) / Park / (On Park) / Ground Ref / Power Ground
M2 Wiper 1
M3 Wiper 2
M1 Washer Pump
10A MAX CB6 Wiper 1 Breaker
10A MAX CB7 Wiper 2 Breaker
+12V BAT

P7
P8
P9
20A MAX +12V BAT CB6 Wiper 1 Breaker
M1 Washer Pump 1
Optional wiring for single 10-20 A nominal wiper motor. Use Wiper Motor 1 only.

P5 (3x3)
Radio Select A
Radio Select B
Radio Select C
HL/ML Current Limit (2) (4) (8)
Radio Ground
Radio 1 Out
Radio 2 Out

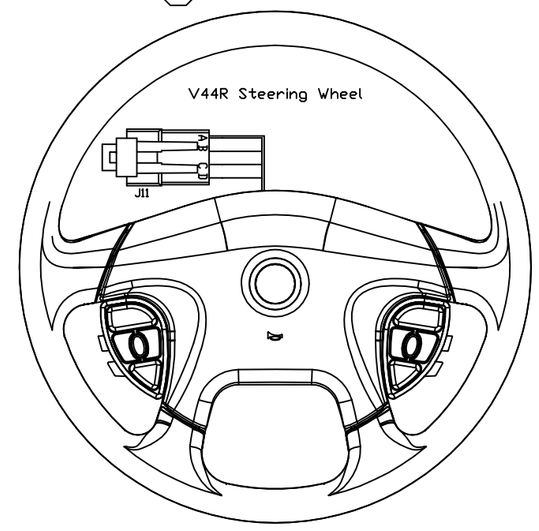
P6 (2x3)
Reserved for Future Use

Control Module Connectors (Harness side)
P1: AMP 1-480704-0 Housing
P2: AMP 1-480706-0 Housing
P3: AMP 1-480708-0 Housing
P4: AMP 1-480710-0 Housing
P1-P4: AMP 350689-3 20-18 AWG socket contact

P5: Tyco 172169-1
P6: Tyco 1721681
P5-P6: Tyco 770986-1 22 AWG socket contact

P7,P8,P9: 0.250" insulated female quick disconnect, 20 Amp

COLUMN CONNECTOR:
J10: PACKARD 12092163 Housing
PACKARD 12047581 AWG 20 Terminal



NOTES

1. Eliminate these two switches if modular lighting control is used on P6
2. Head lamp and marker lamp relays may be omitted if each respective load is 10 A total or less. Control module output is internally limited to 10 A HL/DRL and 10 A ML if current limit is enabled on J5.4 and wiring of lamps is as shown.

	HL/ML Current Limit
DISABLED	OPEN
ENABLED	V BATT
N/A	GROUND

3. Trailer lighting loads must always be relay isolated from chassis lighting and use separate breakers
4. Radio connection and operation information is provided as-is with no guarantee of function for any given radio. Radio manufactures' inputs and controls vary from year to year and model to model. It is the responsibility of the installer to verify the correct wiring and functionality of any given radio with this system. Installer assumes all liability for any damage to control module, radio, etc

RADIO CONNECTIONS (TYPICAL)	
RADIO GROUND	3.5 MM PLUG SLEEVE
RADIO 1 OUT	3.5 MM PLUG TIP
RADIO 2 OUT	3.5 MM PLUG RING

	RAD SEL A	RAD SEL B	RAD SEL C
JENSEN, KENWOOD, MAGNADYNE, PIONEER	See VIP document 001778-T1V-00.DOC for radio configuration		

5. The control module is designed to mount in the passenger compartment of the vehicle. The rated operating temperature range is -40 to +85 degrees C. The control module must not be exposed to the higher operating temperatures and moisture levels typical of the engine compartment or exposed areas of the vehicle.
6. Power ground for wiper motor(s) must always be provided by a chassis ground to the wiper motor case(s). The ground return to the control module is for dynamic braking and signal level reference only.
7. Circuit breaker ratings provided are typical or max allowable with appropriate wire selection. Proper wire and circuit protection is the responsibility of the installer. Unlabeled connections to controller other than wiper connections are rated for 1 A max.
8. Option selections are read on rising ignition.

Option 1 Select P3.12	V Batt	Diagnostic Mode
	Open	DRL Enable
	Ground	DRL Disable

Option 2 Select P4.8	V Batt	No HL W/Wipers
	Open	ML & HL W/Wipers
	Ground	HL W/Wipers

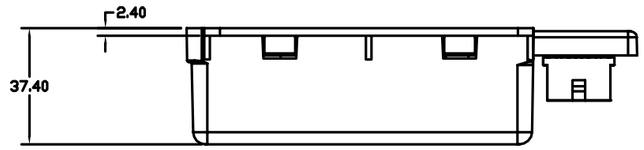
9. Single or dual wiper motors <= 10 A nominal use standard wiring through P4. Single wiper motor 10-20 A nominal use optional wiring through P4, P7, P8, P9.

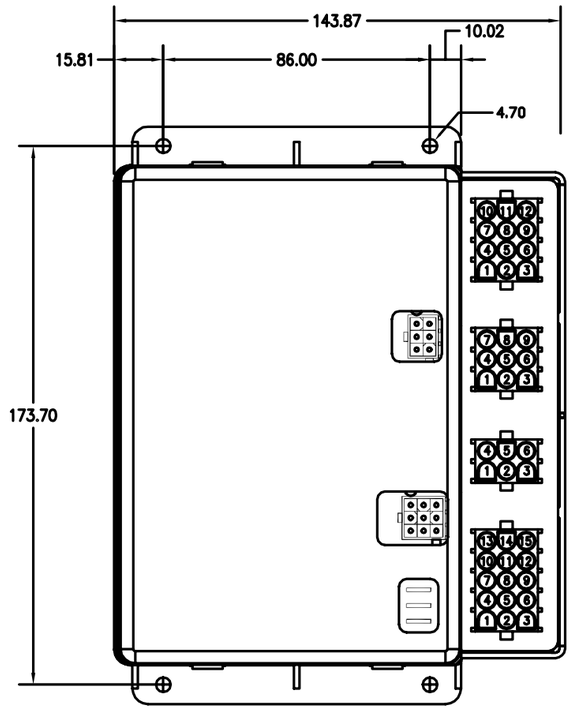
PART REV	DRW REV	DESCRIPTION	DATE
B	F	K5 Ref Wiring corrected	03-08-2011
B	E	Item Rev corrected	01-14-2011
A	D	Radio Table - Note 4 moved	08-05-2010
A	C	Revise P2.7, P2.8 wiring	06-06-2008
A	B	Revise Note 2, J5.4	05-01-2008
A	A	Release	04-23-2008

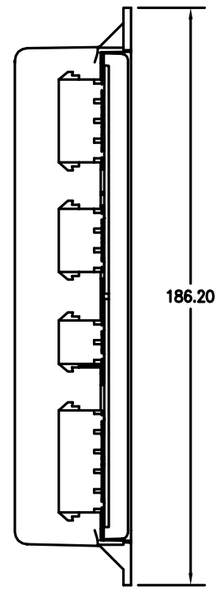
DIM PL	ENG	MM
X.	.060	1.524
.X	.030	.762
.XX	.010	.254
.XXX	.005	.127
ANGLES ± 2°		

VEHICLE IMPROVEMENT PRODUCTS INC.

DRAWN BY	TITLE	FILE NO.
DK	WIRING DIAGRAM, SM213	01778
DATE	SCALE	DRAWING NO.
02-15-2008	NONE	MPXW008
SIZE	ANTIOCH, IL USA (847)-395-7250	
C		







The control module is designed to mount in the passenger compartment of the vehicle. The rated operating temperature is -40 to +85 degrees C. It must not be exposed to the higher operating temperatures and moisture levels typical of the engine compartment.

3D ELECTRONIC SOLID MODEL DATA OF THIS PART IS AVAILABLE UPON REQUEST FROM VIP ENGINEERING

SOLID MODEL IS MASTER FOR ALL SURFACES AND NOMINAL DIMENSIONS. DRAWING IS MASTER FOR ALL TOLERANCES.

PART REV	DRV REV	DESCRIPTION	DATE
A	A	Release	10-31-08

DIM PL	ENG	MM
X.	.060	1.524
.X	.030	.762
.XX	.010	.254
.XXX	.005	.127
ANGLES ± 2°		

VEHICLE IMPROVEMENT PRODUCTS INC.

DRAWN BY	TITLE	FILE NO.
DLK	SM213 Installation	001778
DATE	SCALE	DRAWING NO.
10-31-08	1:1	001778-D1V
SIZE	ANTIOCH, IL USA (847)-395-7250	
D		