Vapor Bus International
A Wabtec company

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CLASS™

INSTALLATION and SETUP USER MANUAL

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Referenced Documents:

CLASS™ Theory Of Operation:	TB08-05-096
CLASS™ Diagnostic Software:	TB08-05-097
CLASS™ Specifications and I/O:	TB08-04-019

1. Definitions

AUTHORIZE: Authorizing the door is done by the Controlling PLC activating the Enable input on CLASS™.

BIT: Built in Tests: Self Tests that CLASS™ runs on power-up.

CLASS™: Contact-Less Acoustic Sensing System.

DEAD ZONE: Any region in which an object is not detectable (and therefore cannot become a Target). There are typically four regions in which dead zones occur:

i. Within a short distance from the face of the sensor (typically 10-12 inches)
ii. Within a tolerance band around any existing Target
iii. Outside the sensing range of the sensor
iv. Regions ignored under program control (example: see MSU Limit)

DE-AUTHORIZE: De-authorizing the door is done by the Controlling PLC releasing the CLASS™ Enable input.

DFO: Door Fully Open (normally an 85º switch or proximity sensor)

DOU: Door Operator Unit – the device that opens the door

DNC: Door Nearly Closed (normally a 5° switch or proximity sensor)

DOR: Door Open Request – CLASS™ output to bus PLC

LPS, RPS, MSU: Left Panel Sensor, Right Panel Sensor, Middle Sensor Unit (Center Sensor)

PLC: The onboard bus computer that issues commands to CLASS™

TARGET: An object detected by CLASS™'s sensing system.

Fixed Target: a Target that is part of CLASS™'s "fixed" environment, i.e., always present. Fixed Targets may be permanently programmed by the installer or may be automatically determined by CLASS™ at turn-on

Acquired Target: a Target that is not "fixed"; typically a passenger.

2. System Overview

Vapor's Contact-Less Acoustic Sensing System - "CLASS™" - is designed to operate in public transportation environments, principally buses. It combines acoustic technology with signal processing techniques to enable passengers to initiate door opening and exit a vehicle without physical contact with the doors.

The CLASS™ system consists of three ultrasonic sensors and a signal processing and control unit (CLASS™ CONTROLLER). When activated, the sensors emit bursts of ultrasonic pulses to survey specific spaces within the doorway. The echoes received by the sensors are analyzed by the CLASS™ CONTROLLER to determine whether or not an object (typically a person) is present. When an object is detected, the CLASS™ CONTROLLER signals the door controls, which initiate the appropriate response.

CLASS™ can provide different functionality during each phase of door operation:

- When a door is enabled but still closed, CLASS™ can emulate a touch bar or touch tape for passenger actuation
- While a stream of passengers is exiting, CLASS™ can provide a "hold open" function
- While the doors are closing, CLASS™ can enhance the sensitive edge function

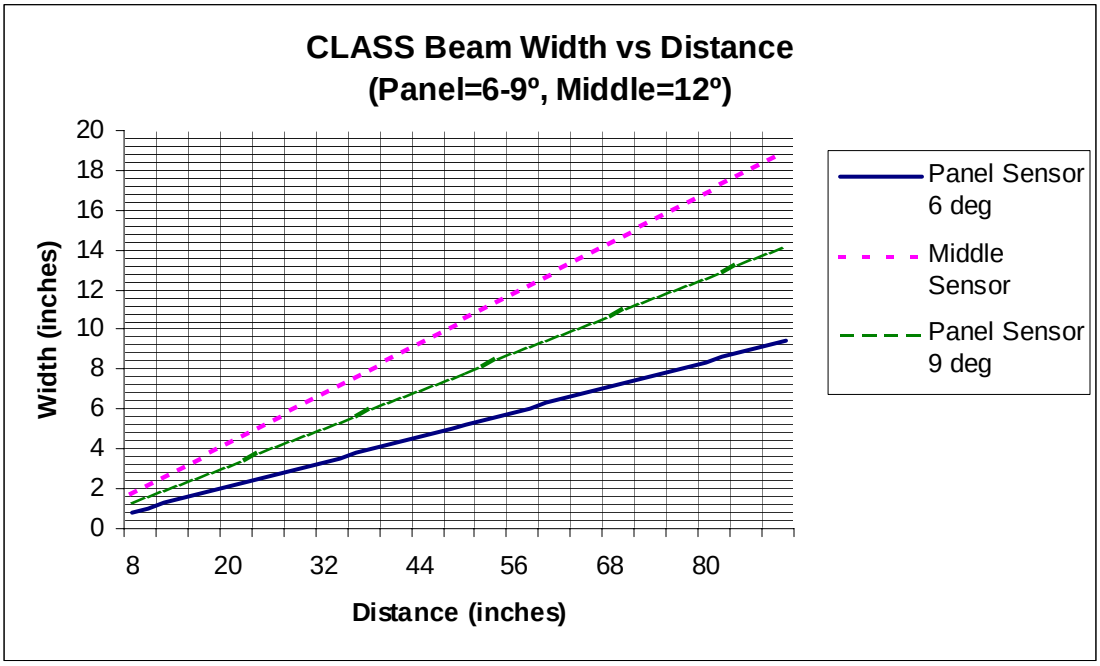
2.1 CLASS™ system components include the following:

- CLASS™ CONTROLLER
- Left Panel Sensor (LPS)
- Middle Sensor Unit (MSU)
- Right Panel Sensor (RPS)

The panel sensors (LPS, RPS) are directly mounted on each door panel. These sensors have a relatively narrow beam angle (approximately 6-9 degrees) and operate at a frequency of 150-170 KHz. Their functions are (1) to initiate door opening and (2) enhance the sensitive edge while closing. The center sensor (MSU) is typically located on the door header, approximately at the center of the doors. Its function is to monitor the door pathway while the doors are open to prevent premature closing. It has a wider beam angle (approximately 12 degrees) and operates at a frequency of 120 KHz.

When the sensors sense the presence of a passenger in the defined zones, and the door is authorized to open, the CLASS™ CONTROLLER sends a "Door Open Request" (DOR) signal to the Door Operator Unit (DOU). Once the passenger or passengers exit the doorway and the exit area is clear, the DOR signal is removed and the door is allowed to close.

The chart below shows the typical "Beam Width" (or cone diameter) vs. distance for CLASS™ transducers. Note that the Beam Width is approximate, that is, it is defined as point at which the sensitivity is one-half the on-axis value. So it is not a situation where an echo will be received in the beam but not outside it; instead, the echo amplitude will be more and more reduced as the distance from the center axis increases until it reaches a point where it is below threshold. The "effective" beam width depends on the strength of the transducer and the threshold value set in the CLASS™ parameters.



2.2 Door Movement

Figure 1 shows the basic movement pattern of the doors and indicates the sensors' zones. Figures 2, 3, and 4 show three-dimensional graphical depictions of the sensing zones in both door-closed and door-open positions.

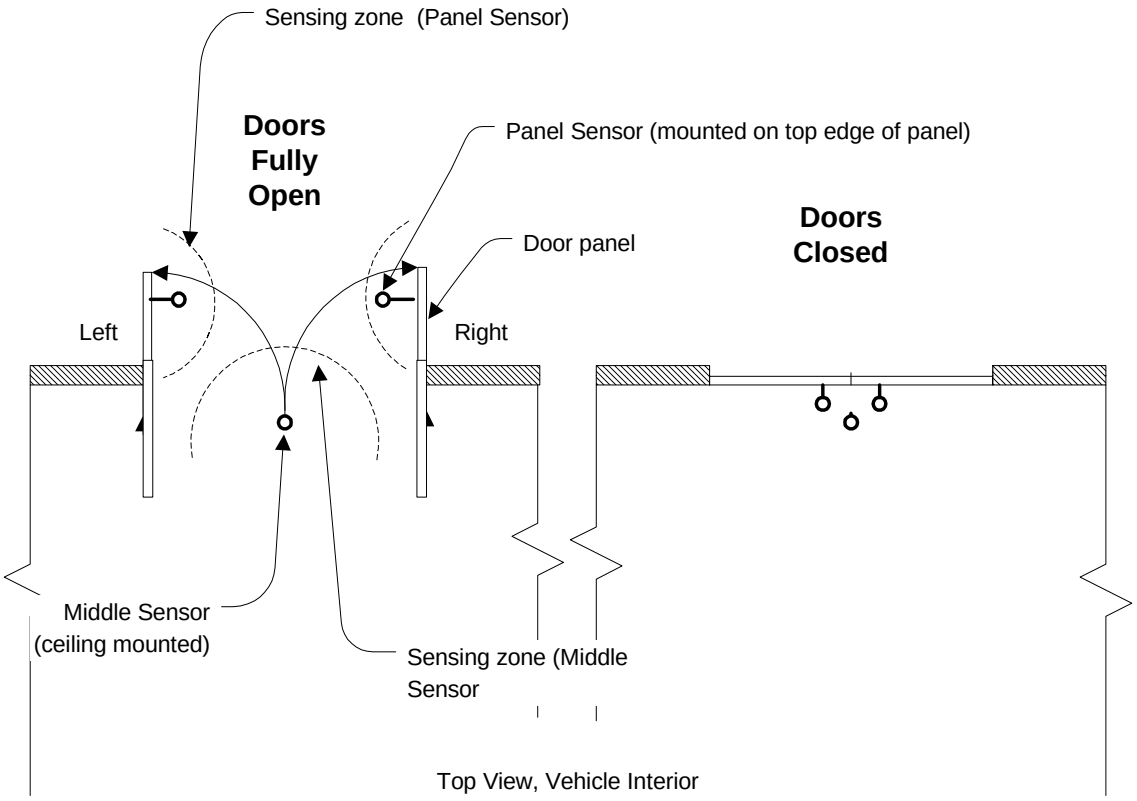


Figure 1: Sensors and Sensing Zones

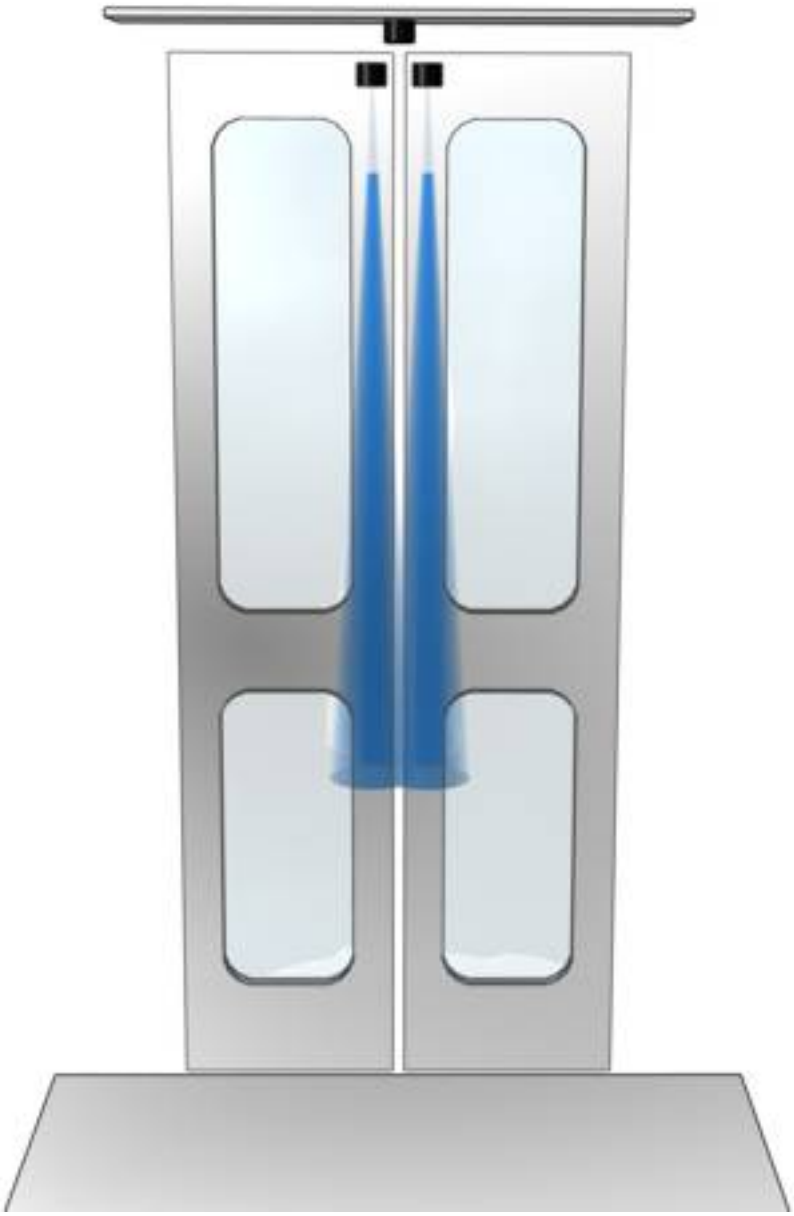


Figure 2: Doors Closed and Enabled

(Shading indicates active sensing regions)

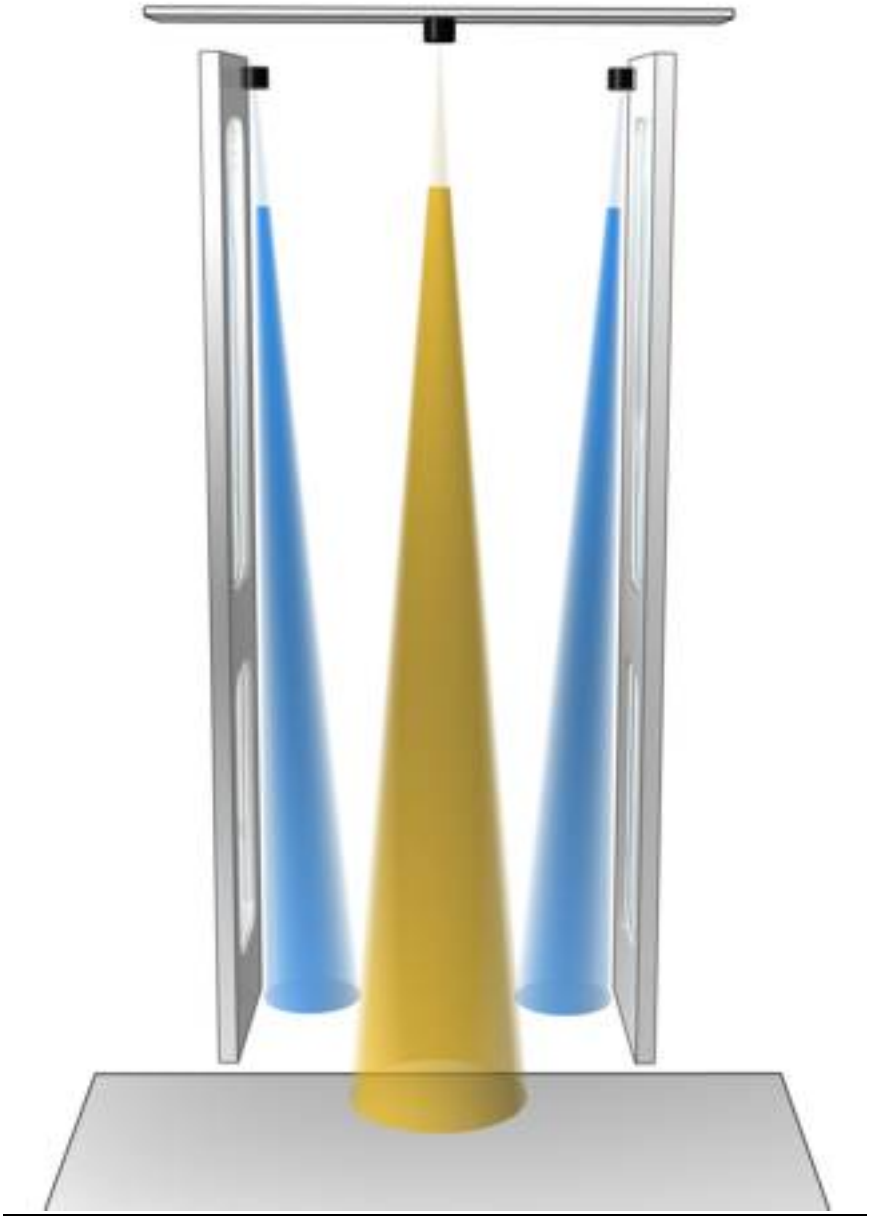


Figure 3: Doors Fully Open

(Shading indicates active sensing regions)

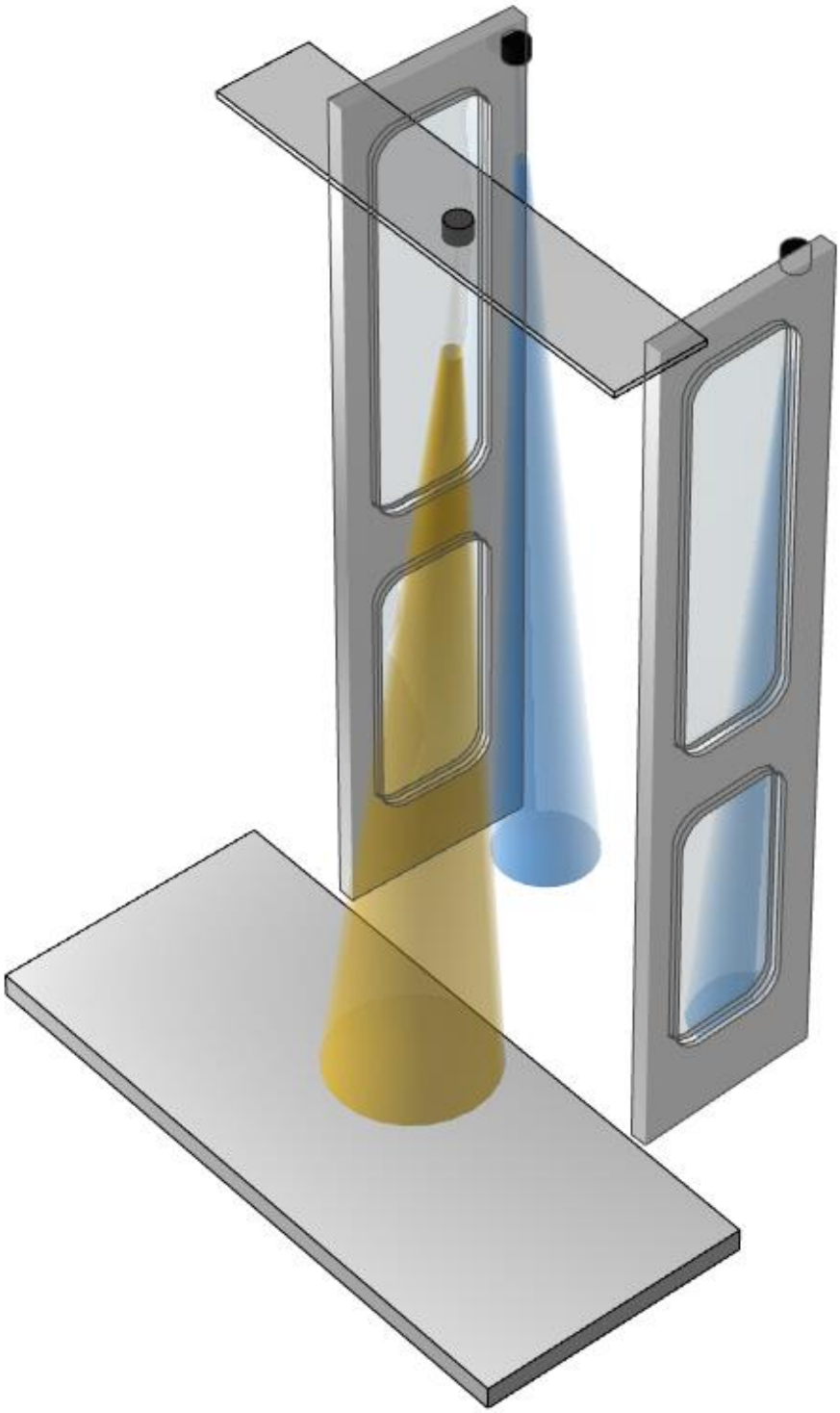


Figure 4: Doors Fully Open

(Shading indicates active sensing regions)

3. Description of Operation

3.1 System Block Diagram

The CLASS™ CONTROLLER contains the system's signal-processing and control electronics. It is connected to the bus as indicated in the block diagram in Figure 5.

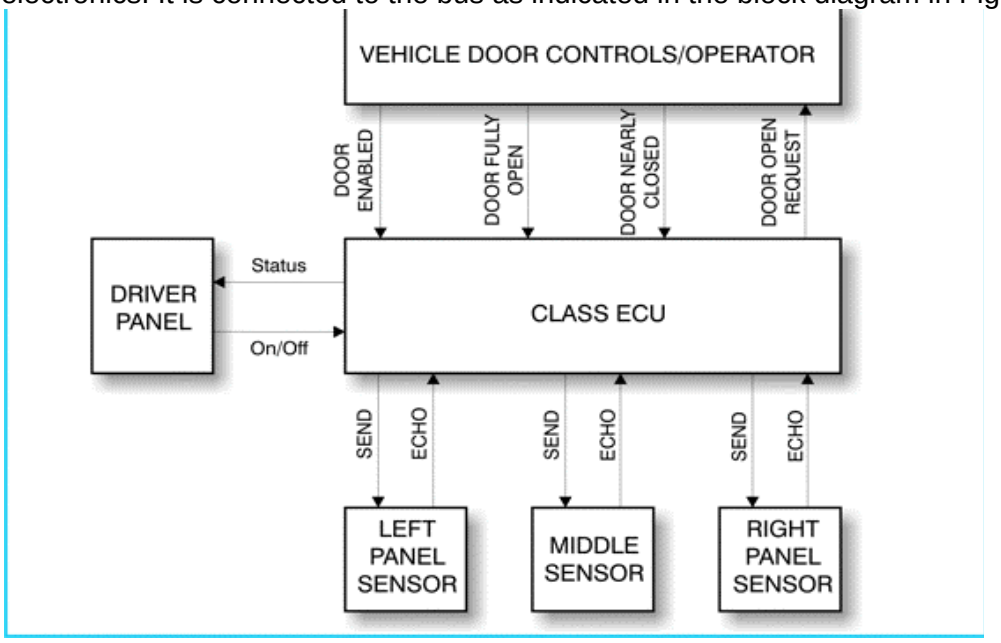


Figure 5: Interface Block Diagram

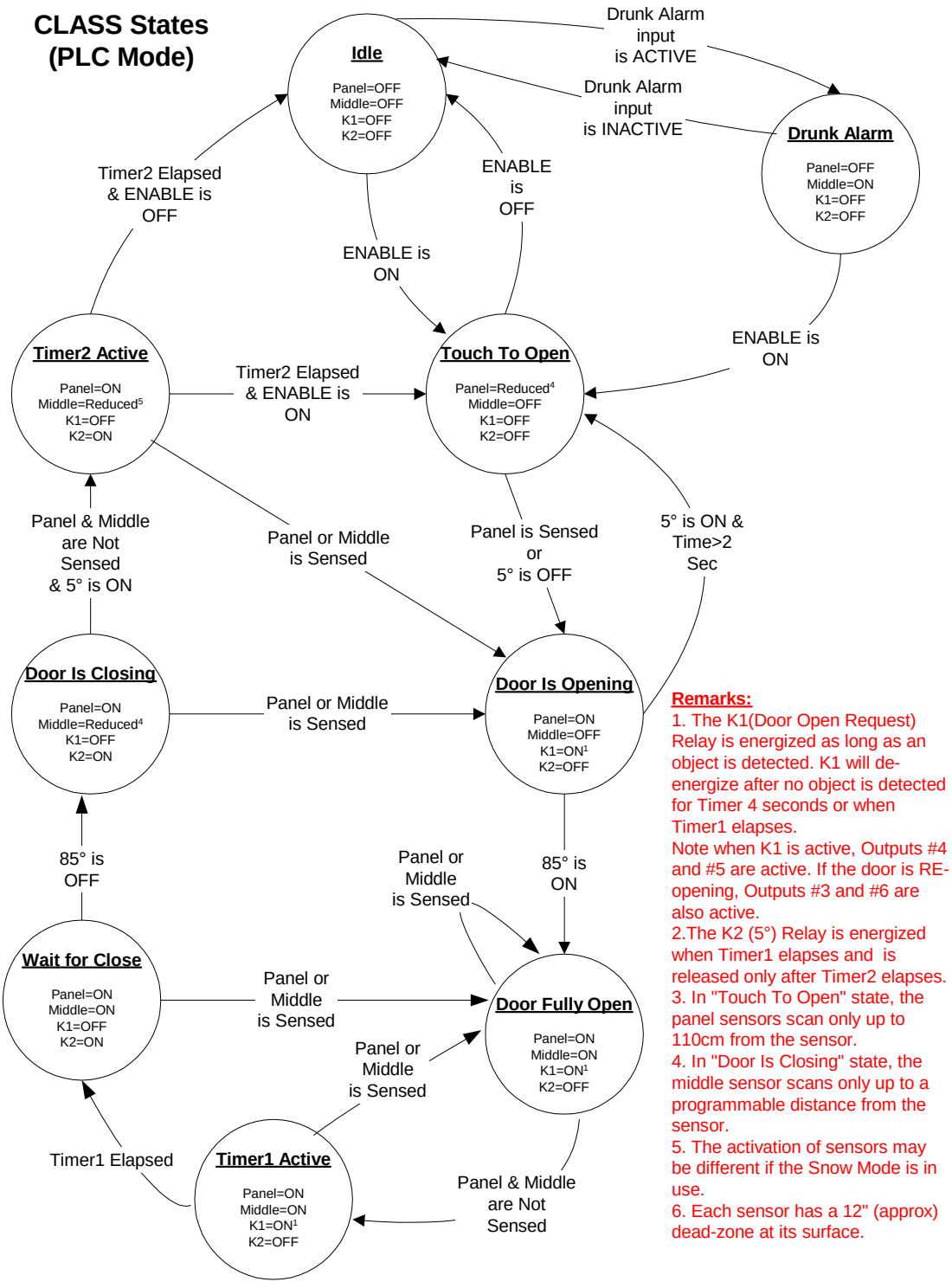
Signals and Descriptions

- DFO (85 Degree) — The Door Fully Open signal from the operator is active when the door panels are Fully Open.
- DNC (5 Degree) — The Door Nearly Closed signal from the operator is active when the door panels are almost Fully Closed.*
- OPEN — The Door Open Request becomes active when the CLASS™ CONTROLLER detects a target on an enabled door panel, and is routed to the bus PLC.
- ECHO — An analog signal representing the echo received by the sensor.
- ENABLE — The PLC indicates to the CLASS™ CONTROLLER that the door is enabled to respond to an Open Request.
- On/Off — A switch that controls the CLASS™ CONTROLLER power.
- SEND — A signal that turns on the sensor's ultrasonic pulse burst.
- STATUS — This signal turns on a light if the CLASS™ CONTROLLER malfunctions.

*Since the PLC is often programmed to ignore the touch bars once closing doors past the 5 degree position, the 5 degree signal from the door operator to the PLC may be rerouted through the CLASS™ CONTROLLER, allowing the controller to delay the 5 degree indication to the PLC long enough to ensure that if a target is detected, a re-open request can be acted upon.

3.2 Theory Of Operation

The CLASS™ state machine diagram is shown below. For a complete description of CLASS™ operation, refer to *CLASS™ Theory of Operation* (TB08-05-096)



Remarks:

1. The K1(Door Open Request) Relay is energized as long as an object is detected. K1 will de-energize after no object is detected for Timer 4 seconds or when Timer1 elapses.
   Note when K1 is active, Outputs #4 and #5 are active. If the door is RE-opening, Outputs #3 and #6 are also active.
2. The K2 (5°) Relay is energized when Timer1 elapses and is released only after Timer2 elapses.
3. In "Touch To Open" state, the panel sensors scan only up to 110cm from the sensor.
4. In "Door Is Closing" state, the middle sensor scans only up to a programmable distance from the sensor.
5. The activation of sensors may be different if the Snow Mode is in use.
6. Each sensor has a 12" (approx) dead-zone at its surface.

3.3 Diagnostic Software

For a complete description of CLASS™ diagnostic software, refer to *CLASS™ Diagnostic* (TB08-05-097).

4. CLASS™ CONTROLLER

4.1 CLASS™ CONTROLLER LEDs

The CLASS™ CONTROLLER LEDs are located on the top of the controller housing. Table 1 defines the color and function of the LED's.

LED	Color	Function
SYSTEM	Red	Power is ON
	Orange (Slow Flashing)	System is running (Calibration is complete)
	Orange (Fast Flashing)	Problem detected (BIT failure)
LPS	Green	LPS is Sending
	Orange	Target is detected by LPS
MSU	Green	MSU is Sending
	Orange	Target is detected by MSU
RPS	Green	RPS is Sending
	Orange	Target is detected by RPS

Table 1 – CLASS™ CONTROLLER LEDS

4.2 CLASS™ CONTROLLER Connectors

Figure 6 shows the location of connectors J1 and J2

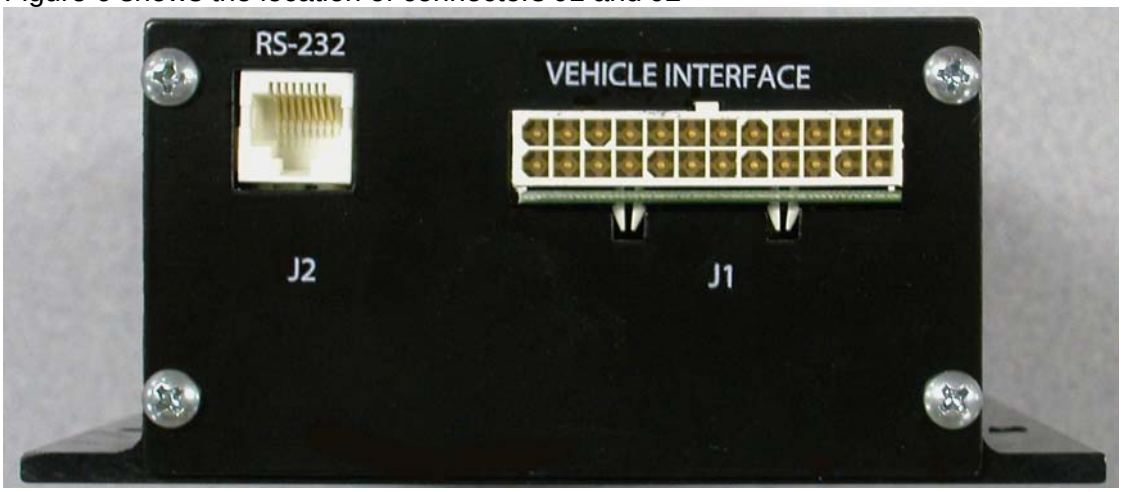


Figure 6: Interface

Tables 2 and 3 detail the CLASS™ CONTROLLER connector functions and pin definitions.

Table 2: J1 – Vehicle I/O Interface

Pin	Signal (WireName)	Function	Description
1	IN1 (DFO)	**Door Fully Open:** From Fully Open switch or sensor.	Bus System Voltage when door is fully open, open otherwise.
2	/IN1 (/DFO)	**Door Fully Open:** From Fully Open switch or sensor.	GROUND when door is fully open, open otherwise.
3	IN2 (DAI)	**"Drunk Alarm":** May be used to activate the selected sensor(s) (only when the door is NOT enabled) to allow detection of passengers in immediate vicinity of doorway ("Drunk Alarm" function).	Bus System Voltage when "drunk alarm" function is desired, open otherwise.
4	/IN2 (/DAI)	**"Drunk Alarm":** May be used to activate the selected sensor(s) (only when the door is NOT enabled) to allow detection of passengers in immediate vicinity of doorway ("Drunk Alarm" function).	GROUND when "drunk alarm" function is desired, open otherwise.
5	IN3 (DNC)	**Door Nearly Closed:** From 5° switch or sensor (connection removed from bus PLC if K2 is used.)	Bus System Voltage when door is nearly closed, open otherwise.
6	/IN3 (/DNC)	**Door Nearly Closed:** From 5° switch or sensor (connection removed from bus PLC if K2 is used).	GROUND when door is nearly closed, open otherwise.
7	IN4 (ENA)	**Enable:** From bus PLC when door is enabled (authorized).	Bus System Voltage when door is enabled, open otherwise.
8	/IN4 (/ENA)	**Enable:** From bus PLC when door is enabled (authorized).	GROUND when door is enabled, open otherwise.
9	/O1 (/STA)	**Status:** Active-low signal to turn on the Status LED if CLASS™ detects an internal malfunction.	GROUND when active; open otherwise.
10	/O2 (/DAO)	**"Drunk Alarm":** Active-low signal when a sensor detects a target. (Use in conjunction with DAI or /DAI).	GROUND when active; open otherwise.

11	/O3 (/RCY)	**Recycle Request:** Obstruction Recycle Request Output – to bus PLC, usually in parallel with sensitive edge	GROUND when active; open otherwise.
12	/O4 (/OPN)	**Open:** Door Open Request Output – to bus PLC, usually in parallel with touchtape/touchbar	GROUND when active; open otherwise.
13	O5 (OPN)	**Open:** Door Open Request Output – to bus PLC.	Bus System Voltage when active, open otherwise.
14	O6 (RCY)	**Recycle Request:** Obstruction Recycle Request Output – to bus PLC, usually in parallel with sensitive edge.	Bus System Voltage when active, open otherwise.
15	K2-C (K2C)	**5° degree Override In:** 5° signal from source (originally connected to bus PLC)	Same as active contact of 5 degree switch/sensor.
16	K2-N.C. (K2NC)	**5° Override Out:** 5° signal to PLC (rerouted through CLASS™)	Connected to K2-C when door is allowed to be de-authorized, open otherwise.
17	/TARGET (/TGT)	**/Target:** Provides an active low signal sufficient to drive a low-current indicator light. Active while any target is detected.	GROUND when active; open otherwise
18	POWER (PWR)	**Power:** Connect to power source near controller via On/Off switch (when optional power relay K3 is not used.)	Bus System Voltage when bus is ON.
19	K1-C (K1C)	**Open:** Used when a normally closed Open Request signal is required. Usually connected to local power, but can be connected to Ground if required by bus PLC	Bus System Voltage or GROUND as required.
20	K1-OUT (K1-O)	**Open:** Used when a normally closed Open Request signal is required. Output – to bus PLC (Polarity determined by K1-C; internally configurable as N.C.(default) or as N.O.)	*If N.C.:* Open when door open request is active, connected to K1-C otherwise. *If N.O.:* Connected to K1-C when door open request is active, Open otherwise.

21	Local 12/24 (SWPW) [optional components required]	**Optional:** used only when optional power relay K3 is used. Connect to power source near controller	Bus System Voltage when bus is ON.
22	On/Off 12 (ON12) [optional components required]	**Optional:** used only when optional power relay K3 is used. From On/Off switch connected to 12V nominal power	+12V when CLASS™ is to be ON, Open otherwise.
23	On/Off 24 (ON24) [optional components required]	**Optional:** used only when optional power relay K3 is used. From On/Off switch connected to 24V nominal power	+24V when CLASS™ is to be ON, Open otherwise.
24	GND (GND)	**Return** for Power	GROUND

Table 3: J2 – Diagnostic and Programming

Pin	Signal	Description
2	RCV	Data from CLASS™ to Diagnostic Computer
3	XMIT	Data from Diagnostic Computer to CLASS™
5	GND	Ground
4	/PSEN	Used to set controller firmware program mode. See CLASS Diagnostic (TB08-05-097)

Figure 7 shows the location of the J3, J4, J5, and J6 connectors

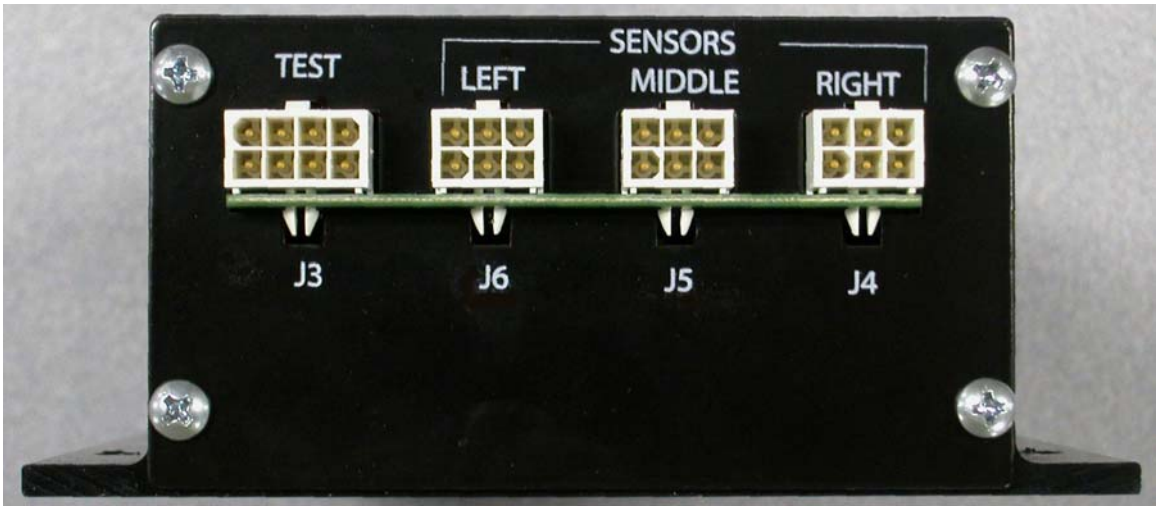


Figure 7: Connectors J3 – J6

Table 4: J6 – LPS, J4 – RPS

Pin	Signal	Description
1	Power	Provided by CLASS™ CONTROLLER
2	SEND	Controlled by CLASS™ CONTROLLER
3	GND	Provided by CLASS™ CONTROLLER
4	ECHO	Returned to CLASS™ CONTROLLER
5	Shield	Grounded at CLASS™ CONTROLLER
6	-	No Connection

Table 5: J5 - MSU

Pin	Signal	Description
1	-	No Connection
2	Shield	Grounded at CLASS™ CONTROLLER
3	ECHO	Returned to CLASS™ CONTROLLER
4	GND	Provided by CLASS™ CONTROLLER
5	SEND	Controlled by CLASS™ CONTROLLER
6	Power	Provided by CLASS™ CONTROLLER

Table 6: J3 – Test

Pin	Signal	Description
1	SEND	Use as scope trigger (identical to 4 & 5)
2	LPS Echo	Use to measure LPS echo
3	MSU Echo	Use to measure MSU echo
4	SEND	Use as scope trigger
5	SEND	Use as scope trigger
6	RPS Echo	Use to measure RPS echo
7	Gnd	Scope probe ground
8	Gnd	Scope probe ground

5.0 Installation

5.1 Mechanical

5.1.1 Sensor Alignment - Panel Sensors

The panel sensors have two functions: open the door, and protect the door's edge. So their positions should be as close as possible to the door edge without intruding into the non-metal zone. The sensor has about 12 inches of dead zone from its surface and the beam fan is a 3D cone; aligning the cone axis straight down (as shown below) allows sensing both the edge and the "touch-to-open" zone.

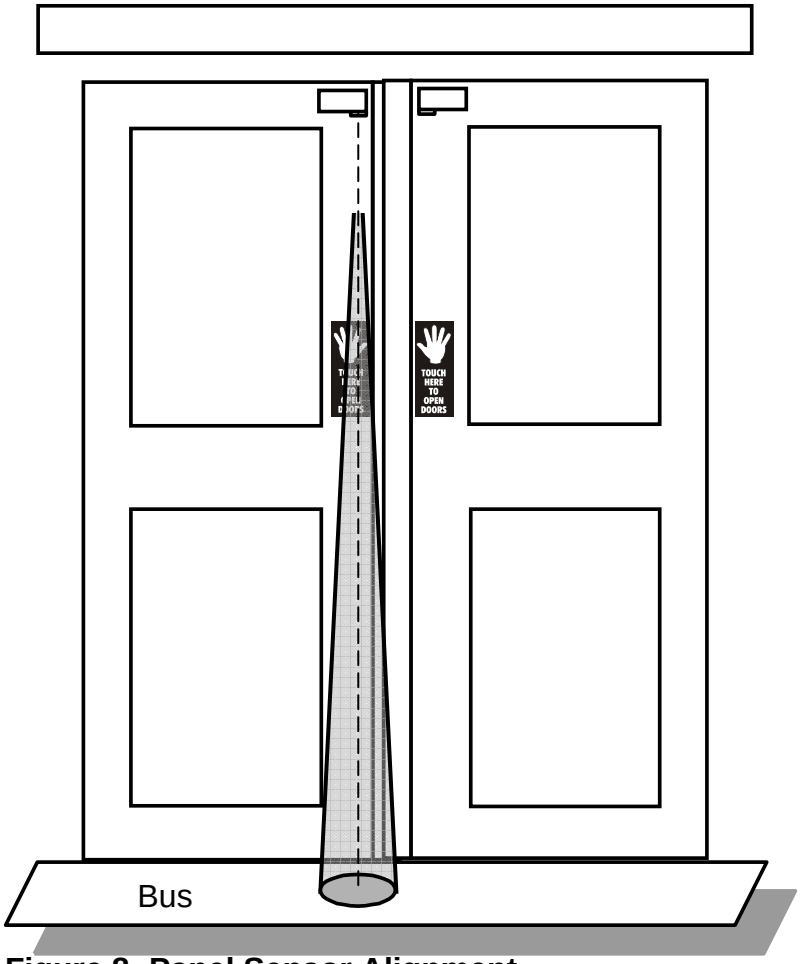


Figure 8: Panel Sensor Alignment

5.1.2 Sensor Alignment - Middle Sensor

Figure 9 shows the recommended alignment of the Middle Sensor on the bus floor with the door closed. The top of the drawing is the outside of the bus. It is suggested to point the beam slightly outside so it will protect exiting passengers but will not see farther objects (trees, poles, etc.).

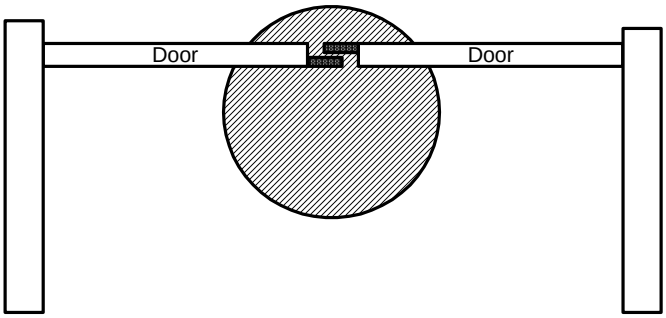


Figure 9: Middle Sensor Alignment

5.1.3 "Typical" Installation

The following instructions are for a typical installation. Specific details may be different for different buses; they depend on the type of bus, type of door, etc.

Preparation

Remove the Grab Handles and Touch Tape from the rear doors. Flange-locking bolts (5/16-18) attach the handles and require a 9/16" box or socket wrench for removal. The Touch Tape is secured by 4 small cross recessed screws, 2 at the top and 2 at the bottom, that are removed with a Phillips screw driver. The tape is also held by an aluminum track that the tape can be slid out of. Once the tape has been removed from the track, the attaching pop rivets can be removed by drilling through with a 1/8" inch diameter drill. Cut the wire of the touch tape, tape the live ends and remove to the connection point above the doors. Because of the routing of the wire along the path of the sensitive edge tubing, it may be best to cut the wire in the roller area accessed by removing the cover plate.

Sensor Mounting

Door Sensors

The door sensors should be attached to the upper leading (inboard) edge of the doors. There should be approximately ¼ inch from the top of the door to the top of the sensor bracket. The

bottom of both sensors should be the same distance from the floor for the installation of the sensors to several busses. The sensor is held to the bracket by a ¼-20 x .50 flathead screw. Lead the sensor cable out correct side of the sensor case (toward the bracket mounting holes). A 5/16" hole must be drilled through the roller bracket to route the sensor cables along with the sensitive edge tubing to where the controller will be mounted above the door operator. The sensor mounting brackets are attached to the door by ¼-20 RIVNUTS installed in the aluminum door extrusion. The brackets have counter-bored slots for side-to-side adjustment and to clear the flange of the RIVNUTS. Mark the location (centered in the slot width) for drilling the two holes in the extrusion when the bracket is held in the correct vertical position. The ¼-20 RIVNUTS are included in the sensor hardware kit with the brackets. Drill a .332/.338" diameter hole (use an 8.5mm (.3346") or a Q (.3320") letter drill) for installation. Use a B.F. Goodrich wrench type header tool number C-845-2520 to set the RIVNUT (available from Liberty Engineering in Chatsworth, California, phone 818-786-8111).

Attach the assembled sensor and bracket to each door using 2 ea. ¼-20 x .750 pan head screws, washers and lock washers. Apply 2 layers of heat shrink tubing 2.38" long tight to the sensor. Route the cable through the hole into the roller bracket and up to the controller area. Loosely tie (nylon wire tie) the cable to the sensitive edge tubing taking care to not pinch the plastic tubing.

Middle Sensor

The middle sensor is mounted to a bracket installed using Rivnuts into the bottom of the door operator base plate. Attach the sensor to the bracket using a ¼-20 x .50 pan head screw, washer and lock washer from the hardware kit. Position the sensor centered in the opening with the attaching screw to the outboard of the bus. Mark the holes of the bracket for drilling the base plate. Drill the holes for installing the ¼-20 Rivnuts after assuring that the door operator base plate is clear. Use the installation tool to attach the 2 Rivnuts. Use the 2 ea. ¼-20 x .75 pan head screws with lock washers and flat washers to attach the assembled sensor/bracket to the base plate. Use the existing wire hole or drill a 5/16" diameter hole to route the cable up to the controller mounting area. Apply 2 layers of heat shrink tubing and route the cable up to the controller.

Control Box Mounting

The Control Box is mounted to the bus structure above the door operator (inside the Air Conditioning Duct) via a mounting plate. Locate a section on the bus structure to drill 11/64" (.1719) diameter holes located from the mounting holes in the mounting plate. Select an area of the structure that picks up at least 3 of the 4 holes. Use the 10-32 self-tapping screws to mount the plate to the structure sheet metal. Secure the Control Box to the plate with 10-32 nuts and washers.

Light and Switch Mounting

The master Switch and Indication Light are mounted to the switch panel above the bus driver's seat located behind the cover. Mount the bracket behind the right side of the existing switch mounting bracket. Align the holes with the other switches if possible. After drilling through both brackets, attach with 2 ea. #6 or #8 sheet metal screws or pop rivets. The Light and Switch mounting holes should be aligned horizontally on the right with the attachment screws on the left side of the bracket. (Due to the geometry available, the mounting flange is not used and will be sticking towards the front of the bus.)

Mount the Switch in the left hole and the Light in the right hole. The Light has insulated Fast On spade terminals. The negative Light terminal is the insulated male ¼" Fast On and may need the

corners shaved by scraping with a knife blade to be able to fit through the .50" diameter mounting hole. Once the negative wire is routed through the hole, the positive lead can be threaded through and the Light can be snapped into the bracket.

Locate 24 V DC positive on terminal #2 of the terminal strip located behind the switches and connect to the Light positive lead and the common terminal of the Switch using 16 AWG wire. The terminal strip needs #10 ring tongue terminals, the Light needs an insulated ¼ Fast On male (to fit into a ¼" fast on female for the positive lead of the Light assembly) and the Switch connection needs a # 6 ring tongue terminal. On the door side of the bus, locate spare wires (#12 and #13) that are routed in the wire harness from over the front door to the back door area. Hook up the Light negative lead terminal to the #13 spare using 16 AWG wire. The negative terminal end of the Light will needs a ¼ Fast On female (to mate with the ¼" Fast On male of the Light lead) and the spare wire connection needs a 16AWG butt splice. The Switch needs to be hooked up to the # 12 spare using 16 AWG wire. The Switch connection terminal end needs a #6 ring tongue terminal and the spare wire end needs to be butt spliced to the spare wire.
For convenience the Vapor part numbers for the 16 AWG terminals are as follows:

P/N	*Description*
98010749	*Terminal, ¼ Fast On Male, Insulated*
98010749-01	*Terminal, ¼ Fast On Female*
98320180-20	*Terminal, # 6 Ring Tongue*
98320180-23	*Terminal, # 10 Ring Tongue*

Handle Installation

Attach the handle to the existing upper 5/16-18 RIVNUT (on the trailing edge of the door) and mark the location of the lower hole with the handle vertical. Drill a .413/.423 hole (use a letter Z (.4130) or a 27/64" (.4219) drill bit) for the RIVNUT. Install the 5/16" RIVNUT from the kit using a B.F. Goodrich wrench type header tool number C-722-3118.

Finishing

Patch the small rivet and screw holes in the door (from the touch strip mounting) and put in a flush plug in the wire hole after sizing the hole for the plug. Sand and repaint the repaired area with a semi-gloss black. Attach supplied labels (if appropriate) to the doors.

5.2 Electrical

5.2.1 Wiring Harness - Connections

Although the CLASS™ I/O requirements are well-defined, differences in bus wiring, types of controllers, polarities, etc. all contribute to the fact that each type of bus must be carefully assessed to ensure that the requirements of the I/O are correctly fulfilled. The following section describes the input, output, and power interface for the CLASS™ controller and provides a description of requirements and alternatives.

1. DEFINITIONS

1.1 Active: the “active” state of a signal is the state when the event of interest occurs. It is usually described by the name of the signal. As an example, for the “Fully Open” signal, the active state occurs when the door is fully open. When the door is not fully open, the signal is not active.

1.2 High-going: a signal is high-going when it is connected to a positive voltage (usually 24V) *when it is active*. (When it is not active it may be connected to GND or it may be open.) A signal which is high-going when active is also called an *active-high* signal.

1.3 Low-going: a signal is low-going when it is connected to GND *when it is active*. (When it is not active it may be connected to a high voltage or it may be open.) A signal which is low-going when active is also called an *active-low* signal.

Notes: All signal names below are as used on the CLASS™ interface harness, and are in **bold**. [Non-standard connections are in brackets.]

2. INPUTS

2.1 Input Signals
For the standard CLASS™ installation, inputs may be high-going or low-going when active. The appropriate input must be used for each case.

2.1.1. **IN1 (DFO)** - this input must be high when the door is fully open, and low or open otherwise. This signal is usually provided by a switch or proximity sensor on the baseplate. If a switch is used, make sure it closes to system high voltage when the door is fully open, and is open otherwise. If a proximity sensor is used, make sure that it is a PNP sensor. If an NPN sensor is used, or the switch connects to GND when the door is fully open, use **/IN1 (/DFO)** instead.

2.1.2. **IN2 (DAI)** – If IN2 becomes high when the door is not in operation, the sensor(s) will be turned on for use as a “drunk alarm”. This input is used together with OUT2, which will provide target detection status for the

drunk alarm and is intended for use by the bus PLC. If a low-going command is preferred, use **/IN2 (/DAI)** instead.

2.1.3. **IN3 (DNC)** - this input must be high when the door is fully closed, and low or open otherwise. This signal is usually provided by a switch or proximity sensor on the baseplate. If a switch is used, make sure it closes to a system high voltage when the door is fully closed, and is open otherwise. If a proximity sensor is used, make sure that it is a PNP sensor. If an NPN sensor is used, or the switch connects to GND when the door is fully open, use **/IN3 (/DNC) instead.** Note that not all buses have a 5° switch or sensor. For these buses a 5° switch is a required installation item.

2.1.4. **IN4 (ENA)** – this input must be high when the door is unlocked and/or enabled to be opened. When this input goes high, CLASS™ turns on its panel sensors and begins looking for targets. It is usually supplied from the positive side of the Green Light. If a low-going signal is all that is available, use **/IN4 (/ENA)** instead.

3. OUTPUTS
CLASS™ has both low-going and high-going outputs, depending on function. Both output types are open when not active.

3.1. **/O1 (/STA)** – this must be connected to the status light. If a spare wire is available, it may be used; if not, wires are added. The other side of the status light is connected to bus voltage (12V or 24V).

3.2. **/O2 (/DAO)** – this signal will be low when any sensor detects a valid target in Drunk Alarm mode. It is for use by the bus PLC with IN2

3.3. **/O3 (/RCY)** – this signal will be low when CLASS™ is requesting the PLC to re-open the door (similar to a sensitive edge). This output is used when the bus PLC logic does not respond to a touchtape input while the door is closing. See O6 for the active-high version of this signal.

3.4. **/O4 (/OPN)** - this signal will be low when CLASS™ is requesting the PLC to open the door (similar to a touchtape). See O5 for the active-high version of this signal.

3.5. **O5 (OPN)** – this signal will be high when CLASS™ is requesting the PLC to open the door (similar to a touchtape). If the bus PLC logic responds to to a touchtape input while the door is closing, it is also used when CLASS™ is requesting the PLC to re-open the door (similar to a sensitive edge). If not, O6 must also be used. See /O4 for the active-low version of this signal.

3.6. **O6 (RCY)** - this signal will be high when CLASS™ is requesting the PLC to re-open the door (similar to a sensitive edge). This output is used

when the bus PLC logic does not respond to a touchtape input while the door is closing. See /O3 for the active-low version of this signal.

3.7. **/TGT -** this signal is at GROUND when any sensor detects a target. It may be used to control an indicator light, but is not capable of driving a high-current load.

4. RELAY

4.1. Door Open Request (K1) – this relay is optionally available for non-typical requirements. The output terminal is by default configured as Normally Closed, although it may be reconfigured as Normally Open if necessary. K1 is active whenever /OUT4 is active.

4.1.1 **K1C** – Connect to system high voltage (12V or 24V) for an active-high request. Connect to GND for an active-low request
4.1.2 **K1-O** – This is the Door Open request output. Refer to paragraph 4.1 for connection details.

4.2. Fully-Closed Override
Normally, when the bus PLC receives the fully-closed signal, it releases interlocks and allows the bus to move. CLASS™ needs to have enough time after the door is fully closed, but prior to allowing the bus to move, to make sure that nothing is caught in the door (such as a purse strap, belt, etc). Relay K2 is used to delay the fully-closed switch information from reaching the bus PLC for that short time, just long enough for CLASS™ to ensure nothing is entrapped. Connecting K2 means that the original connection from the fully-closed switch to the PLC is broken and re-routed through K2 in the CLASS™ controller. Note that while this technique works well on a door with a differential engine, for an Air-Open Spring-Close door, the lock pawl will fall into the mechanically-locked position once the door is fully closed, and CLASS™ is not able to re-open the door, so K2 is not used.

4.2.1 **K2C** – connected to the output of the fully closed switch
4.2.2 **K2NC** – connected to where the output of the fully-closed switch used to be connected (typically to bus PLC).

5. POWER

5.1. **PWR** – this is normally connected to the N.O. terminal of the On/Off switch, whose Common terminal is connected to a local source of bus system voltage (12V or 24V).

5.2. SWPW - this switched power is connected to a local (near the rear door) source of bus system voltage (12V or 24V). This signal is used instead of Pwr (5.1) when the optional internal power relay (K3) is used.

5.2. **GND** – this is permanently connected to bus ground.

5.3. **On12** – When the optional internal power relay is used on a 12 Volt vehicle, it is controlled by this signal coming from the N.O. terminal of the On/Off switch. If On12 is used, PWR (5.1) is not used; SWPW (5.2) is used instead. The On/Off switch Common terminal is connected to bus system voltage (12V) via a wire from the same source as used for paragraph 5.2

5.4. **On24** – this is used similarly as On12, but for a 24V vehicle.

The following table lists “standard” connections and alternatives for “non-standard” connections

CLASS™ – Harness Connections for "Standard" and "Non-Standard" Bus

SIGNAL	J1	DESCRIPTION (STD Bus)	STANDARD	NON-STANDARD
POWER				
PWR	18	+11 to +29 VDC when CLASS™ is to be ON; 0 VDC when Bus is OFF	Connect to N.O. Contact of On/Off Switch (COM Contact of On/Off Switch connected to bus system voltage)	Use Local 12/24 and On/Off 12 or On/Off 24.
GND	24	Vehicle Ground	Connect to Bus Ground at rear door	Connect to Bus Ground at rear door
[Optional] SWPW	21	Local (rear door) source of power when optional power relay is used	Not Used	+11 to +29 VDC when CLASS™ is to be ON; 0 VDC when Bus is OFF
[Optional] On12	22	On/Off control when optional power relay is used – 12V vehicle	Not Used	Connect to N.O. Contact of On/Off Switch (COM Contact of On/Off Switch connected to Bus +12V)
[Optional] On24	23	On/Off control when optional power relay is used – 24V vehicle	Not Used	Connect to N.O. Contact of On/Off Switch (COM Contact of On/Off Switch connected to Bus +24V)
INPUTS TO CLASS™ (From Bus)				
IN1 (DFO) [Std] /IN1 (/DFO) [Non-Std]	1 2	High (+11-29V) when Door IS Fully Open; Low (GND or OPEN) when Door is NOT Fully Open	Use IN1. Connect to N.O Contact of Fully Open Switch (COM Contact of Fully Open Switch connected to +24V) or to output of Fully Open PNP Prox	Use /IN1. Connect to N.O Contact of Fully Open Switch (COM Contact of Fully Open Switch connected to GND) or to output of Fully Open NPN Prox.
IN2 (DAI) [Std] /IN2 (/DAI) [Non-Std]	3 4	High (+11-29V) to ACTIVATE Middle Sensor (when door is NOT enabled); Low (GND or OPEN) to DEACTIVATE Middle Sensor (when door is NOT enabled)	Optional - connect to PLC per Bus Builder instruction	Use /IN2
IN3 (DNC) [Std] /IN3 (/DNC) [Non-Std]	5 6	High (+11-29V) when door is open LESS than 5º; Low (GND or OPEN) when door is open GREATER than 5º	Connect to N.O Contact of Fully Closed Switch (COM Contact of Fully Closed Switch connected to +24V) or to output of Fully Closed PNP Prox	Use /IN3. Connect to N.O Contact of Fully Closd Switch (COM Contact of Fully Closed Switch connected to GND) or to output of Fully Closed NPN Prox.

SIGNAL	J1	DESCRIPTION (STD Bus)	STANDARD	NON-STANDARD
IN4 (ENA) [Std] /IN4 (/ENA) [Std]	7 8	High (+11-29V) when door IS enabled (unlocked); Low (GND or OPEN) when door is NOT enabled	Use IN4. Connect to “Green Light” (non-grounded side)	Use /IN4 when enable signal is low-going.
[Optional] K1C	19	High (+11-29V) when door open request requires SOURCE; Low (GND) when door open request requires SINK	Connect to +24V source at rear door for SOURCE	Connect to Ground for SINK. For non-PLC bus, connect to a signal that is active (+11-29V) ONLY when the door is enabled and safe to exit
K2C	15	Same as IN3 (DNC) – used to interrupt fully closed signal to bus	Disconnect wire from N.O Contact of Fully Closed Switch or Prox to Bus PLC (COM Contact of Fully Closed Switch connected to +24V). Connect K2C to cut end of wire leading to N.O Contact of Fully Closed Switch or to output of Fully Closed PNP Prox	Not Used (Typically not used for AOSC doors due to mechanical lock)
OUTPUTS TO BUS (From CLASS™)				
/O1 (/STA)	9	High (OPEN) when status light is OFF; Low (GND) when status light is ON	Connect to negative (non-24V) side of Status lamp	Same as STANDARD Bus
/O2 (DAO)	10	High (OPEN) when sensors do NOT detect a target (When activated by IN2); Low (GND) when a sensor detects a target (When activated by IN2)	Optional - connect to PLC per Bus Builder instruction	Not Used
/O3 (/RCY)	11	Low (GROUND) when door **re-**open request is ACTIVE; High (OPEN) when door **re-**open request is INACTIVE	Optional - connect to PLC per Bus Builder instruction	Not Used
/O4 (/OPN)	12	Low (GND) when door open request is ACTIVE; High (OPEN) when door open request is INACTIVE	Not Used	Active-low door open request – connect appropriately

SIGNAL	J1	DESCRIPTION (STD Bus)	STANDARD	NON-STANDARD
O5 (OPN)	13	High (Bus system voltage) when door open request is ACTIVE; Low (OPEN) when door open request is INACTIVE	Active-high door open request – connect at Bus/PLC touchtape input	Not Used
O6 (RCY)	14	High (Bus system voltage) when door **re-**open request is ACTIVE; Low (OPEN) when door **re-**open request is INACTIVE	Not Used	Connect to sensitive edge input when bus logic does not respond to touchtape while door is closing.
[Optional] K1-O	20	[K1-C] when door open request is ACTIVE; OPEN when door open request is INACTIVE	Connect to Touchtape input to Bus {LC	For non-PLC Bus: custom connection must be determined for each application. Discuss with Vapor Engineering.
K2NC	16	OPEN when CLASS™ Fully Closed is INACTIVE; CLOSED (to K2-C) when CLASS™ Fully Closed is ACTIVE	Disconnect wire from N.O Contact of Fully Closed Switch or Prox to Bus PLC. Connect K2-N.C. to cut end of wire leading to PLC	Not Used (Typically not used for AOSC doors due to mechanical lock)
/TGT	17	Low (GND) when any target is detected; High (OPEN) when no target is detected	Not Used	Connect to low-current (15 ma Typ) indicator connected to Bus system voltage

Note: Signals labeled as [Optional] require the use of optional components. Contact Vapor for further information.

5.2.2 Sensors – Connections

After Sensors are mounted and their cables are routed, terminate the cables with the pins, (Crimper: AMP # 90758-1) connectors, and hoods provided in Vapor Kit #50110187. Insert the pins into the connectors as follows (see pin insertion view below for pin location details):

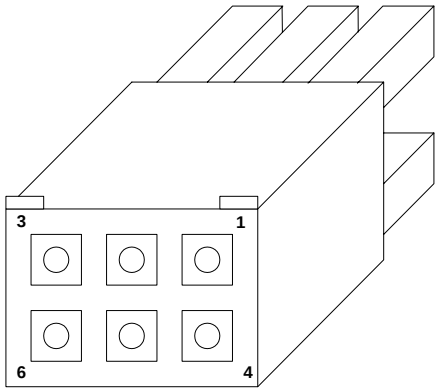
Panel Sensors (P4 & P6):

Pin #	Wire Colors (Beige cable)	Signal
1	Red	POWER
2	Green or Orange*	SEND
3	Black	GROUND
4	White or Brown*	ECHO
5	Shield	SHIELD

Center Sensor (P5):

Pin #	Wire Colors (Beige cable)	Signal
6	Red	POWER
5	Green or Orange*	SEND
4	Black	GROUND
3	White or Brown*	ECHO
2	Shield	SHIELD

* Sensor cable may be Red, Black, Orange, Brown, Shield or Red, Black, Green, White, Shield



Insert P4, P5, and P6 into J4, J5, and J6 respectively on the CLASS™ Control box, making sure that the connectors latch in place.

NEVER connect or disconnect sensors while power is applied to the CLASS™ controller.

6. Setup

6.1 Initial Measurements

Once the mechanical installation and electrical interface are complete, the next step is to determine and verify fixed targets. (Refer to TB08-05-097 for software instructions as necessary to use *CLASS™ Diagnostic*.)

6.1.1 Floor

a. At an absolute minimum, there must be a value for the distance to the floor from each sensor. Using a metric tape measure (or equivalent) measure the distance from the transmitting face (white circle) of each sensor to the floor in centimeters.
b. Connect the laptop to the CLASS™ Controller
c. Turn on the CLASS™ Controller.
d. Run *CLASS Diagnostic*.
e. Insert the measured floor values in the appropriate boxes.
f. Program the floor values into the CLASS™ Controller by selecting "*Save to EEPROM*"
g. Reset the CLASS™ Controller and see what other fixed targets appear in the boxes

6.1.2 Other Targets

Using an appropriate oscilloscope and adapter cable connected to the CLASS™ Controller, visually check for targets or possible targets. Check each sensor for targets through the door's full range of motion. (This is made easier by "dumping" the air and operating the door by hand, being careful to not introduce extra targets such as one's head, hand, etc.) Check both the single sensor operating by itself and also with the other two active. Any target seen with the oscilloscope should be evaluated for inclusion in the fixed target table. Evaluation includes verifying the source and location of any target and a decision regarding the target's echo amplitude. Any target whose amplitude is greater than 25% of the Vref Normal should be included in the table unless it can be physically eliminated. (Example: if Vref Normal is 2.0, enter any target greater than 0.5.) When entering the target, measure the actual distance to the target in centimeters and enter that value.

6.1.3 Other Settings

Once the targets are determined, review all the other settings and make any necessary changes.

6.1.4 Update

a. Once all settings are appropriate, upload the settings to the CLASS™ Controller ("*Save to EEPROM*") and reset it.

6.1.5 Test

Test the door for all phases of operation. See section 8 for acceptance testing or section 7 if necessary for troubleshooting.

7. Basic Operation and Troubleshooting

Notes:
1. All references to “P1-x” refer to the Vehicle Interface Harness connector to the CLASS™ controller mating connector J1, where ‘x’ is the pin location designator. (See Figure 6 or Table 2)
2. “System Voltage” refers to the operating voltage of the bus (typically +24V)
3. Measurements are with respect to P1-24 (*CLASS™ Ground*):

Process:

1. Make sure that the exit doors are CLOSED, and the doorway is CLEAR of any people or objects.

2. Turn on CLASS™ (usually by turning on the bus RUN switch and CLASS On/Off switch). Verify that the SYSTEM LED turns Red initially and then begins flashing Orange. If the SYSTEM LED does not turn on:
   Verify that the CLASS™ controller is receiving power (System Voltage) at P1-18 (*Pwr*). If power is not found at P1-18, verify that the On/Off switch is ON, verify the connection to the On/Off Switch, and verify the bus RUN switch is ON.

3. Unlock the exit door. (The Green Light should be ON.)

4. Verify that the SEND lights for LPS and RPS are ON.

5. If the SEND light is not ON:
   a. Verify that the CLASS™ controller is receiving power (System Voltage) at P1-7 (*ENA*) [or GND at P1-8 (/ENA)] .
      i. If power is not found at P1-8 (*ENA*), check that Green Light is ON, and verify the connection to the appropriate limit switch.
      ii. Verify that there is System Voltage at P1-5 (DNC) [or GND at P1-6 (*/DNC*)] from the Fully Closed Switch

6. If the SEND light is on, place an object in the beam area of the LEFT panel sensor, as follows:
   a. Make sure that the object is oriented so as to reflect sound back to the sensor.
   b. Make sure the object is at least 10” from the face of the sensor.
   c. Make sure the object is no more than 40” from the face of the sensor.
   d. If necessary, move the object slowly up or down to make sure it is not in a “dead zone”

7. Verify that the LPS orange light is ON when the object is in the sensor’s beam area.

8. If the LPS orange light is not ON:
    a. Verify that the sensor is transmitting ultrasound pulses by lightly placing a finger on the white circle at the face of the sensor. A slight vibration should be felt when the sensor is transmitting. (This vibration is not at the frequency of the ultrasound pulse; it is the repetitive “trigger” pulse, which occurs every 20-25 milliseconds when the sensor is transmitting.)
    b. If no vibration can be felt, verify that the sensor is correctly plugged into the controller and in the correct location. (See Figure 2)

9. If the LPS orange light goes ON, the door should have opened.
   If not:
    a. Verify the door is physically unlocked and capable of opening
    b. Verify that P1-13 (*OPEN*) is connected to the bus PLC at the appropriate input (usually the “touchbar” input) and is at System Voltage (referenced to Bus/PLC Ground) when the LPS orange light is ON.

10. Repeat steps 6-9 for the RIGHT sensor and RIGHT orange light.

11. Once the door is fully open, repeat steps 7-9 for the MSU and MSU orange light. The door must remain fully open while verifying the MSU. If necessary, block the door open and ensure that the fully open switch remains activated. Verify System Voltage is at P1-1 (*DFO*) [or GND is at P1-2 (*/DFO*)]

12. If the MSU orange light is not ON:
    a. In addition to the actions to step 8a and 8b, verify that the Fully Open switch is activated and the Fully Closed switch is deactivated.

8. CLASS™ Acceptance Test

1.1. Verify the bus is ON, the CLASS™ Power switch is OFF, and the driver's door control handle is in the Rear Door Closed position.

1.2. Turn on the CLASS™ Power switch while observing the LEDs on the CLASS™ controller housing.

1.2.1. Verify that the LEFT, CENTER, and RIGHT lights flash Green (SEND) at least once and Orange (DETECT) at least once.

1.2.2. After 1.2.1 is complete, verify the SYSTEM light is flashing Orange slowly (at approximately 1 Hz.) and all the other lights are OFF.

1.3. Move the driver's door control handle to the Rear Door Open position and ensure that the Green Light above the rear door is ON.

1.3.1. Verify that the at least the LPS and RPS lights on the CLASS™ controller housing are on (Green).

1.4. Place a hand in the area indicated to be used to open the door using the LPS.

1.4.1. Verify that the door opens.

1.5. Once the door opens fully, stand so as to be detected by the center sensor.

1.5.1. Verify that the MSU light turns Green when the door fully opens, and turns Orange while standing so as to be detected by the center sensor.

1.5.2. Verify that the door either remains open or, if it starts to close, reopens after closing partially. (Note that door behavior depends on PLC or Controller)

1.6. Move back to allow the door to close almost fully. Just before fully closing, place a hand so as to be detected by the left panel sensor. Verify that the door reopens. Repeat for the right panel sensor.

1.7. Repeat step 1.4 but for RPS

1.8. Repeat step 1.6, allowing the door to fully close before placing a hand under the sensor, and make sure to place the hand under the sensor more than 1 second after the door passes the 5º point. Verify that the door reopens. (Note that the Green light above the rear door must still be ON.)

1.9. Note: This step is optional, and not used if K2 functionality is not installed (typically K2 functionality is not used with A.O.S.C. doors). Repeat step 1.7, but with the driver's door control handle in the Rear Door Closed position, and making sure to place the hand under the sensor within less than 1 second of the door passing the 5º point. Verify that the door reopens.

1.10. Repeat step 1.9, but make sure to place the hand under the sensor more than 1 second after the door passes the 5º point. Verify that the door does NOT reopen and the SEND light on the CLASS™ controller housing is OFF.

Note: steps 1.8– 1.10 assume that Timer 2 is set to 1 second; adjust accordingly otherwise.

9. Specifications

9.1 Voltage and Current: Summary of Requirements and Specifications

A. Power - Vehicle supplied + 12V or +24V Nominal, requirements applied as follows:

1. Minimum Operating Voltage - 9VDC.
2. Nominal Operating Voltage - 12VDC or 24VDC
3. Maximum Operating Voltage – 30VDC.
4. Total System Power Consumption - 15W max.

B. K1 and K2: Dry contacts capable of driving up to 1 Amp load.

C. /O1 – /O4: Solid-state low-side output drivers, capable of sinking 500 mA to a load connected to vehicle power.

D. O5 – O6: Solid-state high-side output drivers, capable of sourcing 500 mA to a load connected to the vehicle power return.

E. /Tgt - Solid-state low-side output driver, capable of sinking 15 mA to a load connected to vehicle power.

9.2 Full Specifications

For complete specifications, see *CLASS™ Specifications & IO (TB08-04-019)*