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THEORY OF OPERATION

CLASS™ (CONTACT-LESS ACOUSTIC SENSING SYSTEM)

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Related Documents:

| | |
|--------------------------------|-------------|
| CLASS™ Installation and Setup: | TB08-03-192 |
| CLASS™ Diagnostic Software: | TB08-05-097 |
| CLASS™ Specifications and I/O: | TB08-04-019 |

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1.0 DEFINITIONS

CLASS™: Contact-Less Acoustic Sensing System.

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

DFC: Door Fully Closed.

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

TTO: Touch-To-Open state (Door is enabled; awaiting passenger activation)

DOC: Door Open Command. (CLASS™ Enable)

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

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

PLC: The Bus's onboard computer that issues commands to CLASS™

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

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

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.

Acquired Target: a Target that is not "fixed". Typically a passenger.

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 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 Detection Limit)

LOW DUTY-CYCLE MODE: Activated for short bursts at recurring intervals instead of continuously.

DOOR OPEN REQUEST: A CLASS™ output (resulting from a detected target) to the bus PLC requesting opening of the door. Three physical outputs are available for use:

- Door Open Request Low (a solid-state switch closure to Ground)
- Door Open Request High (a solid-state switch closure to positive supply)

- K1 Door Open request Relay (the common may be connected as desired; the output may be configured as normally open or normally closed).
-

1.1 SETTABLE PARAMETERS

LPS Fixed Objects: Distance in centimeters (cm) from the face of the Left Panel Sensor (LPS) to the “fixed” object. The first object must be the distance to the floor. (NOTE: if the Acoustic Algorithm is enabled, the second object in the table must be the measured distance to the LPS’s “cooperative object” – see below). There are 6 LPS Fixed Object parameters; all 6 must be filled even if by a ‘0’

Default: 187,85,0,0,0,0

Range: 8-254 Note: 0 indicates no object.

RPS Fixed Objects: Distance in centimeters (cm) from the face of the Right Panel Sensor (RPS) to the “fixed” object. The first object must be the distance to the floor. (NOTE: if the Acoustic Algorithm is enabled, the second object in the table must be the measured distance to the RPS’s “cooperative object” – see below). There are 6 RPS Fixed Object parameters; all 6 must be filled even if by a ‘0’

Default: 187,85,0,0,0,0

Range: 8-254 Note: 0 indicates no object.

MSU Fixed Objects: Distance in centimeters (cm) from the face of the Middle Sensor Unit (MSU) to the “fixed” object. The first object must be the distance to the floor. There are 6 MSU fixed Object parameters; all 6 must be filled even if by a ‘0’

Default: 199,0,0,0,0,0

Range: 8-254 Note: 0 indicates no object.

Hold Open Timer1: The time in units of 1/10 second that the Door Open Command will remain active *after* the door reaches DFO (the 85° point on opening).

Default: 1.0 second

Range: 0.1 seconds – 9.9 seconds

Hold Active Timer2: The time in units of 1/10 seconds that the CLASS™ unit will remain active (and able to reopen the door) after the door reaches DNC (the 5° point on closing).

Default: 1.0 second

Range: 0.1 seconds – 9.9 seconds

Mode: CLASS™ has two mode of operation, Test and Normal.

Test: Test mode is to be used when reading and/or setting CLASS™ parameters, changing operational characteristics, monitoring sensors, etc.

Normal: This is the normal operational mode.

Default: Normal

Range: Normal/Test

TempComp Mode: (alternately referred to as “Acoustic Algorithm”) When enabled, the TempComp Mode enables the CLASS™ system to improve its accuracy by measuring the temperature of the air near its sensors. Use of this algorithm requires that a “cooperative object” (a fixed object whose distance to the sensor is accurately known) be available for each panel sensor; its distance from the sensor has to be the second object of the respective sensor’s fixed objects table.

Default: Disabled.

Range: Enable/Disable

Snow Mode: (alternately referred to as “Rain/Snow Algorithm” or “Vref Algorithm”) When enabled, Snow Mode provides a way for CLASS™ to dynamically reduce its sensitivity to help deal with a target that occurs after turn-on initialization, such as that which might occur due to a build-up of wet snow on the door panels.

Default: Disabled.

Range: Enable/Disable

Periodic Report: When the periodic report is enabled, CLASS™ will output a constant data stream detailing its system states and operation. This is to be used only for advanced troubleshooting. **IMPORTANT: make sure to leave the Periodic Report in DISABLED mode when testing and/or setup is complete.**

Default: Disabled.

Range: Enable/Disable

Target Reporting: When Target Reporting is enabled and any target is detected, CLASS™ will supply a data stream to a laptop identifying the sensor that saw the target and the calculated distance (in centimeters) to that target.

IMPORTANT: make sure to leave Target Reporting in DISABLED mode when testing and/or setup is complete.

Default: Disabled.

Range: Enable/Disable

Open Limit Timer3: The time in seconds that the CLASS™ unit will allow the door to remain open before activating the Vref (Rain/Snow) response, starting when the door reaches DFO (the 85° point on opening) (NOTE: only applicable if the Snow Mode is enabled)

Default: 4 seconds

Range: 4 seconds – 20 seconds

Open Request ON Time: The minimum time that the Door Open Command will remain active. This parameter is normally used only when NOT in Relay Mode. The time the Door Open Command remains active depends on the setting of the Open Request OFF Time.

If the Open Request OFF Time is set to zero, the Door Open Request will be continuously active while any target is detected. Once the target is removed, the Door Open Request will remain active for the Open Request ON Time.

If the Open Request OFF Time is set to a non-zero value, while any target is detected the Door Open Request will be active for the Open Request ON Time, then be inactive for the Open Request OFF Time, then repeat.

Once the target is removed, the Door Open Request will remain active for the Open Request ON Time.

Default: 0.30 seconds

Range: 0.01 to 1.00 seconds

Open Request OFF Time: the time the Door Open Request will be forced inactive even if a target is present.

Default: 0 seconds

Range: 0 to 2 seconds

Panel Detection Limit: The maximum distance from the Panel sensors (in centimeters) at which the Panel sensors will detect a target while the door is nearly closed (5° switch is active), if Panel Target Reduction Mode is on. This is used to prevent the Panels from “seeing” extra targets while the doors are closed.

Default: 110cm

Range: 30cm to [LPS or RPS Floor value (whichever is smaller)] cm

MSU Detection Limit: The maximum distance from the MSU (in centimeters) at which the MSU will detect a target while the door is closing (< 85° on closing). This is used to prevent the MSU from “seeing” brushes, etc.

Default: 90cm

Range: 60cm to [MSU Floor] cm

Vref Calibration: The signal level above which an echo will be considered a target. Note this value applies ONLY during the calibration sequence (turn-on detection of Fixed Targets).

Default: .5 volts

Range: .1 volts – 4.9 volts

Vref Normal: The signal level above which an echo will be considered an Acquired Target. This value applies in Normal mode, and determines the overall sensitivity of the CLASS™ detection – the lower the value, the greater the sensitivity.

Default: 2 volts

Range: .1 volts – 4.9 volts

Door Recycle Limit: The number of times the door will be allowed to recycle open before dynamically reducing sensitivity. Applicable only if the Snow Mode is ENABLED.

Default: 3

Range: 3 - 10

Drunk Alarm: activates the Drunk Alarm mode using either the MSU, the Panel Sensors, or all, in various combinations and with selectable ranges.

Default: Off

Range: Off, Full MSU, Full Panels, Full All, 110cm MSU, 110cm Panels, 110cm All

Full: indicates that the sensor will accept targets all the way to the floor.

110cm: indicates that the sensor will only accept targets within 110 centimeters of the sensor.

High Drunk Alarm Out: Normally, CLASS outputs are *active-low* (switched to ground). When **High Drunk Alarm Out** is enabled, the Recycle Request output is used for the Drunk Alarm function; its output is *active-high* (switched to bus supply voltage).

Note the Recycle Request function is inactive when **High Drunk Alarm Out** is enabled; the /Recycle Req output, which is *active-low*, remains active.

Default: Disabled.

Range: Enable/Disable

Relay Mode: Set CLASS™ for use with non-PLC controlled buses.

Default: Disabled.

Range: Enable/Disable

1S Mode: When enabled, 1S Mode disables the BIT tests on the panel sensors. (This only to be used for a “single-sensor” installation.)

Default: Disabled.

Range: Enable/Disable

No 5 Degree Open Mode: Prevents a Door Open Request caused by opening the door past 5°.

Default: Disabled.

Range: Enable/Disable

Long MSU Ignore Mode: Ignores the MSU after 30 seconds of the MSU continuously holding the door open. The MSU will be ignored until the door is shut.

Default: Disabled.

Range: Enable/Disable

MSU Target Reduction Mode: Prevents the MSU from adding fixed targets below the MSU detection limit during calibration.

Default: Disabled.

Range: Enable/Disable

MSU TTO Mode: activates the MSU in the TTO state so that it may respond to a passenger's request to open the door. (When not enabled, the MSU does not activate until the door reaches fully open.)

Default: Off.

Range: Off, On (110cm), On (60cm)

No Floor TTO Mode: Allows loss of floor detection by either panel sensor to be considered a target.

Default: Disabled.

Range: Enable/Disable

No Floor DFO MSU Mode: Allows loss of floor detection by the MSU while the door is fully open to be considered a target.

Default: Disabled.

Range: Enable/Disable

No Floor Closing MSU Mode: Allows the absence of an echo from the floor to be interpreted as a target by the MSU, but ONLY during the time that the door is closing.

Default: Disabled.

Range: Enable/Disable

5 Degree Enables CLASS™: Normally CLASS™ is enabled by one of Enable inputs becoming active. When this mode is enabled:

1. Opening the door past 5° (deactivating the 5° switch) will also enable CLASS™.
2. Any target acquired in the *Door Is Opening* state will cause a door open request as long as the Enable inputs are NOT active.

Example use: With the emergency pulled and the door partially opened, CLASS™ will be enabled and able to send door open requests.

Default: Disabled.

Range: Enable/Disable

Panel Target Reduction: When this mode is enabled:

1. Panel sensor targets that are below the Panel Detection limit will not be added to the fixed target table during power-on calibration.
2. Panel sensors will only detect Targets above (higher up on the door than) the Panel Detection Limit while the door is nearly closed (5° switch is active.)

Default: Disabled.

Range: Enable/Disable

UnFiltered Mode: When this mode is enabled the six percent required between acquired targets is disabled during power-up Calibration Sequence.

NOTE: This is for use during installation to look for multiple targets that may be near each other. This is not for normal operation.

Default: Disabled.

Range: Enable/Disable

TURN-ON INITIALIZATION

2.1 When the master run switch is placed in the "run" position, the CLASS™ controller:

- 2.1.1 Boots-up and runs the BIT (Built In Tests)
- 2.1.2 Reads and checks the Parameters from EEPROM.
- 2.1.3 Runs a Calibration Sequence on the Sensors that looks for the floor and for more Fixed Targets.
- 2.1.4 Sends out a serial report. This report contains status information about CLASS™.

2.2 Built in Test (BIT)

All tests are executed on power-up. The system performs periodic BITs when in idle states, but not all BITs are performed at these times. Table 1 describes the BITs and their times of execution.

Test Definitions:

- 2.2.1 RAM: Memory addresses will be tested by writing to and reading data back from memory.
- 2.2.2 CPU: Tested by executing an arithmetic operation.
- 2.2.3 Voltages: Checked by the CPU's A-to-D module.
- 2.2.4 System Vref: Verified by the CPU's A-to-D module.
- 2.2.5 Floor Check: Verifies sensor functionality by looking for the floor as a Target.

| | Power-Up | Periodic |
|-----------------|----------|----------|
| RAM | √ | - |
| CPU | √ | √ |
| +5V | √ | √ |
| +12V | √ | √ |
| MSU Floor Check | √ | - |
| LPS Floor Check | √ | - |
| RPS Floor Check | √ | - |

Table 1 - Periodic and Power-Up BITS

The software will issue a “Pass” or “Fail” statement for each test after receiving three consecutive identical results. The results of the tests are sent out the serial port on boot-up. Whenever one of the tests is failed, the CLASS™ Status light will be turned on, and the SYSTEM light (on the controller housing) will flash rapidly.

2.3 Parameter Check

All parameters are checked. The parameters are checked to see if they’re in the proper range. (See 1.1 Parameters) If a parameter is not in the correct range its default value is used and a fault message is sent out the RS232 port during the report stage of boot-up.

2.4 Calibration Sequence

Calibration Sequence is performed solely after power-up (never periodically). The purpose of the Calibration Sequence is for CLASS™ to learn and memorize fixed targets and to verify sensors can “see” the floor.

General Description of the Calibration Sequence:

CLASS™:

- 2.4.1 Transmits a few pulses on each sensor separately.
- 2.4.2 Receives the echoes from each sensor and then assigns a floor value for each sensor.
- 2.4.3 Compares the newly found floor value to the table value.
- 2.4.4 If the new floor value is within tolerance of the table value, it is accepted. Otherwise it issues a warning indication by turning on the CLASS™ Status Light and rapidly blinking the System LED.
- 2.4.5 CLASS™ then transmits a few pulses on all sensors together.
- 2.4.6 It memorizes any targets from step 2.4.5 as Fixed Targets.

***NOTE: The CLASS™ system will ignore objects within the tolerance band of any Fixed Targets found during the calibration sequence
(See Dead Zone)***

2.5 Serial Report

CLASS™ sends out a report about all current Fixed Targets, including any found in the Calibration Sequence. It also sends the results of all the BIT Tests, the version of the firmware, the operating modes, the current parameters, and any fault indication.

3.0 MODES OF OPERATION

3.1 *Idle*

- 3.1.1 While idling CLASS™ runs the periodic BIT Tests.
- 3.1.2 Once the Enable signal is received from the PLC, CLASS™ changes from the *Idle* state to the *Touch to Open* state.

3.2 *Touch to Open (Door Authorized/Enabled)*

- 3.2.1 Once CLASS™ enters the *Touch to Open* state it activates the panel sensors. The panel sensors scan up to 110cm for a target from either sensor.
- 3.2.2 If the PLC deactivates the enable input, CLASS™ returns to the *Idle* state.
- 3.2.3 Once a target is sensed or the DNC input is turned off, CLASS™ outputs to the PLC (via the K1 Relay, Output #4 or Output #5) a request to open the door.

3.3 *Door Is Opening*

- 3.3.1 Once in the *Door Opening* state the CLASS™ controller continues to signal for the door to fully open.
- 3.3.2 Once the DFO (85°) input indicates the door is fully open the controller changes to the *Door Fully Open* state.
- 3.3.3 If CLASS™ does not receive the DFO within two seconds and the DNC is still active, the CLASS™ controller changes back to the *Touch to Open* state.

3.4 *Door Fully Open*

- 3.4.1 Once in the *Door Fully Open* state CLASS™ turns on the MSU (center sensor) and the Panel Sensors to their full detection range (as determined by the floor distance in the parameter table). If K1 (Door Open request Relay), Output #4 or Output #5, are not on, they are turned on.
- 3.4.2 If neither the Center nor the Panel sensors detect an Acquired Target, CLASS™ changes to the *Timer1 Active* state.

3.5 *Timer1 Active*

- 3.5.1 Once in *Timer1 Active* state, Timer1 starts counting.
- 3.5.2 If an Acquired Target is detected by any of the sensors, CLASS™ changes back to the *Door Fully Open* state.

- 3.5.3 If a target is not detected by the time Timer1 reaches its set value (parameter), CLASS™ changes state to *Wait for Close*.

3.6 Wait for Close

- 3.6.1 In the *Wait for Close* state CLASS™ turns on the K2 (5 Degree) relay and turns off the K1 (door open request) relay, Output #4, and Output #5 (if still on).
- 3.6.2 If an Acquired Target is detected by any of the sensors, CLASS™ changes back to the *Door Fully Open* state.
- 3.6.3 If no target has been detected and the DFO (85°) signal deactivates, CLASS™ will change to the *Door Is Closing* state.

3.7 Door Is Closing

- 3.7.1 In the *Door Is Closing* State all the sensors are still on but the MSU (Center Sensor) detection range is now reduced to the range set by the MSU Limit Detection parameter. (The beam continues to the floor but objects in the beam beyond the MSU Limit are ignored.)
- 3.7.2 If an Acquired Target is detected by any of the Sensors, CLASS™ changes back to the *Door Is Opening* state, and outputs #3, #4, #5 and #6 are turned ON.
- 3.7.3 If no Target is detected when the DNC (5°) becomes active the CLASS™ changes to the *Timer2 Active* State.

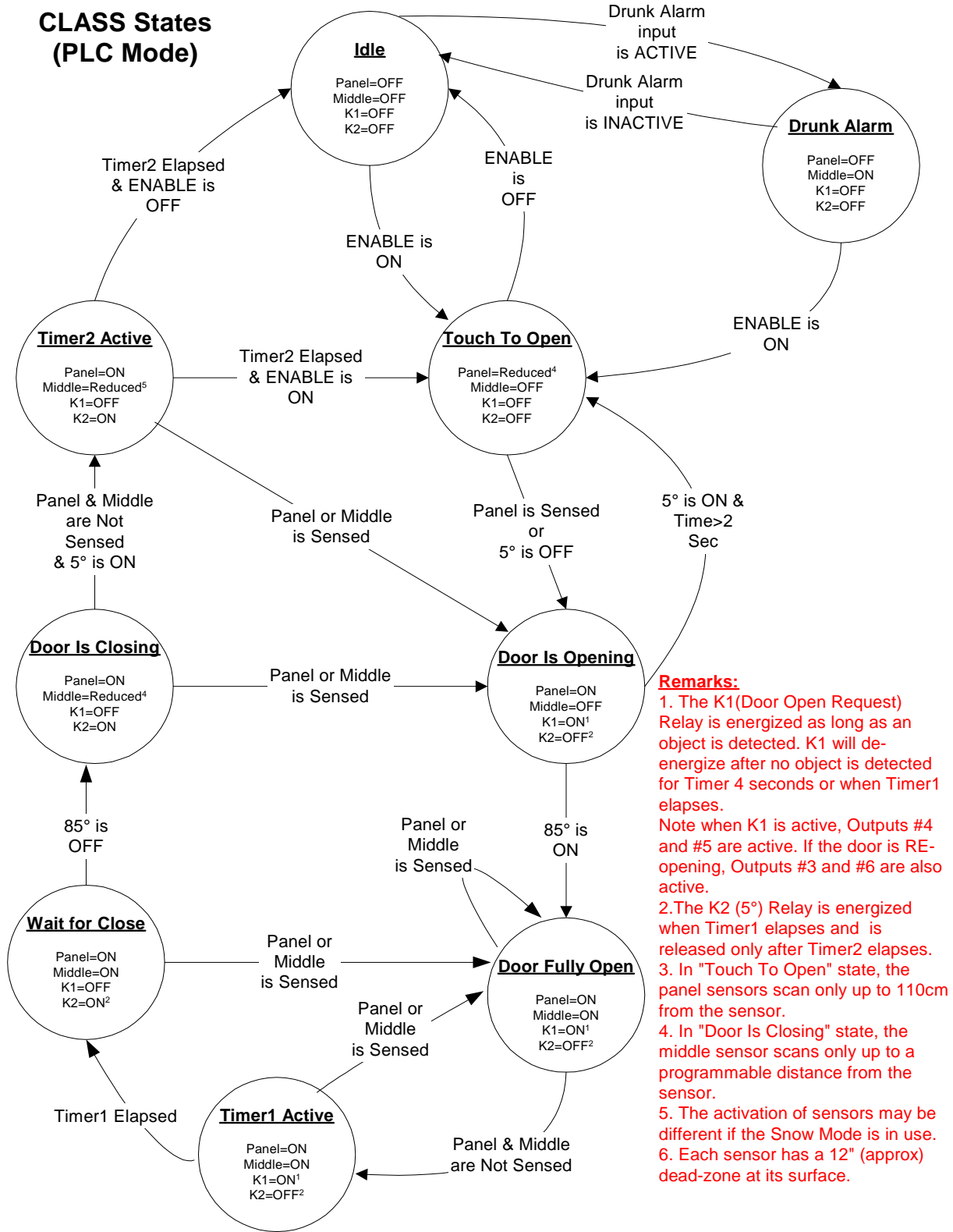
3.8 Timer2 Active

- 3.8.1 Once in *Timer2 Active* state, Timer2 starts counting.
- 3.8.2 If an Acquired Target is detected by any of the Sensors, CLASS™ changes back to the *Door Is Opening* state, and outputs #3, #4, #5 and #6 are turned ON.
- 3.8.3 If a target is not detected by the time Timer2 reaches its set value (parameter), if the PLC has deactivated the Enable input CLASS™ changes to the *Idle* state, otherwise CLASS™ changes to the *Touch to Open* state.

3.9 “Drunk Alarm”

- 3.9.1 “Drunk Alarm” is enabled by activating Input #2 (or /Input #2) while CLASS™ is in the *Idle* State. Once the state is enabled, CLASS™ turns on the panel sensors, the center sensor, or both (depending on the parameters) in *Low Duty-Cycle Mode*.
- 3.9.2 If an enabled sensor detects a Target CLASS™ turns on output #2.
- 3.9.3 If Input #2 (or /Input #2) is deactivated CLASS™ returns to the *Idle* state. If Input #4 (or /Input #4) is activated (Enable) CLASS™ changes from the “*Drunk Alarm*” state to the *Touch to Open* state.

CLASS States (PLC Mode)



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.

Fig 1: States and Transitions Overview

4.0 CLASS™ I/O AND OPERATIONAL INDICATORS

Note: Signal/WireName shown in brackets when appropriate

4.1 Output #1 (Status Light) [/STA]

The CLASS™ Status Light indicates CLASS™'s current status. When the light is on CLASS™ has a malfunction. Any fault during BIT will cause the light to go on. If CLASS™ Status Light is flashing constantly, it indicates that there is a problem with the door such as too much snow on its surface. (Constant flashing can only occur with Snow mode active.)

4.2 LPS LED

Off: LPS is not active.
Green: LPS is actively sending.
Orange: LPS detects a Target.

4.3 RPS LED

Off: RPS is not active.
Green: RPS is actively sending.
Orange: RPS detects a Target.

4.4 MSU LED

Off: MSU is not active.
Green: MSU is actively sending.
Orange: MSU detects a Target.

4.5 SYSTEM LED

Off: CLASS™ power is OFF.
Red: CLASS™ power is ON.
Orange(slow blink): System is running (Calibration is complete).
Orange(fast blink): BIT failure indication.

4.6 K1 (Door Open Request Relay) [K1C & K1-O]

The K1 Relay is used to request the PLC to open (or hold open) the door. Normally used where an open circuit is required for proper operation.

4.7 K2 (5° Override Relay) [K2C & K2NC]

The K2 (5° Override Relay) is used to override the DNC (5°) switch to allow CLASS™ to be able to reopen the door during the Timer2 Active state. (Many PLCs disable the touch tape/touch bar input after the DNC (5°) switch becomes active.)

4.8 Output #2 (Drunk Alarm Output) [/DAO]

In the Drunk Alarm mode: when a Target is sensed by the enabled sensor(s), Output #2 will turn ON, otherwise it remains OFF.

4.9 Output #3 (Door Recycle Request) [/RCY]

Output #3 will turn ON when the Door Open Request occurs in the *Door is Closing State*. This output is normally connected in parallel with a sensitive edge

- 4.10 Output #4 (Door Open Request) [/OPN]**
Output #4 will turn ON and OFF simultaneously with the K1 Door Open Request Relay. This output is used to request the PLC to open (or hold open) the door.
- 4.11 Output #5 (Door Open Request) [OPN]**
Output #5 will turn ON and OFF simultaneously with the K1 Door Open Request Relay. This output is used to request the PLC to open (or hold open) the door.
- 4.12 Output #6 (Door Recycle Request) [RCY]**
Output #6 will turn ON when the Door Open Request occurs in the *Door is Closing State*. This output is normally connected in parallel with a sensitive edge
- 4.13 /TARGET (Target Detected) [/TGT]**
When any of the sensors detects a Target, */Target* is active, otherwise */Target* remains off.
- 4.14 Input #1 and /Input #1` (DFO or 85° Switch) [DFO & /DFO]**
Active when the door is fully open.
- 4.15 Input #2 and /Input #2 (“Drunk Alarm”) [DAI & /DAI]**
This input can be used to turn on the either MSU (center sensor) or the panel sensors or both, while the CLASS™ controller is in the *Idle* state. The sensor(s) then can be used to check the stepwell while the door is shut. If an Acquired Target is detected, Output #2 is activated. Output #2 is OFF otherwise. If the door is Enabled, CLASS™ will switch to *Touch to Open* and Input#2 will be ignored until CLASS™ returns to the *Idle* state.
- 4.16 Input #3 and /Input #3 (DNC or 5° Switch) [DNC & /DNC]**
Active when the door is (nearly) closed.
- 4.17 Input #4 and /Input #4 (DOC or Enable) [ENA & /ENA]**
Causes CLASS™ to switch from the *Idle* state to the *Touch to Open* state.
- 4.18 Polarities**
- 4.14.1 Inputs #1-4 are active when high (> 4 V)
 - 4.14.2 /Inputs #1-4 are active when low (< 1 V)
 - 4.14.3 Outputs #1-4 are active when low (< 1 V)
 - 4.14.4 Outputs #5-6 are active when high (Bus system voltage)
 - 4.14.5 /Target is active when low (< 1 V)
 - 4.14.6 K1 may be configured for active high or active low
 - 4.14.7 K2 is a normally-closed contact in series between the DNC (5° sensor) and the bus PLC; polarity follows that of the DNC

5.0 Modes

5.1 Snow Mode: (alternately referred to as “Vref Algorithm”)

The purpose of the Snow mode is to keep CLASS™ from holding the door open when new “Fixed” Targets are introduced into its environment after turn-on calibration. (This may occur, for example, due to a severe snow buildup on the door panel.) When enabled, the Snow mode allows CLASS™ to dynamically reduce its sensitivity, gradually decreasing the sensitivity while continuing to monitor the sensors, and finally close the door

This mode has two entry conditions; either one is sufficient for initiating the mode:

1. One of the sensors has an object overflow (too many targets detected). A severe rain/snow condition may cause this phenomenon. Each sensor can accept up to 6 Acquired Targets.
2. The doors remain open beyond Timer3’s parameter length in seconds. Timer3 starts counting down when the doors pass DFO (85 degree switch), and stops counting and resets when Timer2 ends. During counting, if the MSU (Center Sensor) detects a Target, Timer3 stops counting and resets.

Once the mode is initiated, the two following actions occur:

1. The firmware starts raising Vref in gradual steps when objects are detected by either of the panel sensors. This causes the sensor’s sensitivity to be reduced and attempts to eliminate the target generated by the rain/snow.
2. The Vref increment occurs in the next two time cycles: If there is a constant object, Vref increases every 0.1 second. If the door starts to close and then recycles, Vref increases every time an object is detected.
3. If raising the Vref has eliminated the object’s detection as an Acquired Target, the doors will close, and the firmware will remain with the altered (increased) Vref.

Important: the system will return to its default values only when it returns to the idle state.

- If raising the Vref has not eliminated the object’s detection as an Acquired Target on both panel sensors and the Vref limit is reached (currently at 3 volts), CLASS™ masks (ignores) both panel sensors, restores the original Vref value, and continues with the MSU (Center Sensor) only.
- In this case, CLASS™ tries to close the door while counting the recycles (if any). The recycle limit can be set via the *CLASS™ Diagnostic*.
- If the doors succeed in fully closing, CLASS™ continues running as set until returning to the *Idle* state (the *Idle* state restores all the default values, original Vref and no masks). The system will continue using the MSU (Center Sensor) only until it returns to the *Idle* state
- If the doors do not succeed in closing even after all these changes (including maximum door recycles with the MSU), the driver’s CLASS™ Status LED will begin flashing, indicating that CLASS™ has a malfunction and all the sensors are masked. Normal operation is returned when the Enable input is deactivated, returning the system to the *Idle* state.

This algorithm is implemented in parallel to the normal states. If the sensitivity reduction on the panel sensors fails to allow closing the door, then the system operates with the same states but with only the MSU.

5.2 TempComp Mode: (alternately referred to as “Acoustic Algorithm”): When enabled, the TempComp mode allows the CLASS™ system to improve its accuracy by measuring the temperature of the air near its sensors. Use of this algorithm requires that a “cooperative object” (a fixed object whose distance to the sensor is accurately known) be available for each panel sensor; its distance from the sensor must be entered as the second Target in the respective sensor’s fixed objects table.

The purpose of the TempComp mode is to decrease the size of the tolerance band around any existing Target (and thus the size of the “Dead Zone”). The size of the tolerance band around fixed targets is normally $\pm 6\%$ of the distance to the fixed target. The acoustic algorithm can reduce the dead zones to as little as $\pm 2\%$. This reduction is intended to allow for better coverage of a door.

5.3 Relay Mode: When enabled, Relay mode holds the door open request outputs (i.e. K1, output #4 & #5) active until the door is completely open and until Hold Open Timer 1 has expired. Relay mode is used on buses that are not controlled by a bus computer or PLC.

5.4 1S Mode: When enabled, 1S Mode disables the BIT tests on the panel sensors. This mode is only to be used for a “single-sensor” installation.

5.5 No 5 Degree Open Mode: When enabled, the de-activation of the 5-degree switch will not cause a door open request. CLASS™ will still change to the Door is Opening state when the 5-degree switch de-activates.

5.6 Long MSU Ignore Mode: The purpose of Long MSU Ignore Mode is to prevent the MSU from holding the door open indefinitely. When enabled, after 30 seconds of continuous MSU target detection in the Door Fully Open State, the MSU will be ignored until the door is closed. Once the door is closed, the MSU will return to normal operation.

5.7 MSU Target Reduction Mode: When enabled, this mode causes the MSU to only sense a target as far as the MSU Detection Limit during the Calibration Sequence. This allows targets further down to be ignored, reducing the amount of targets in the MSU’s target table.

5.8 MSU TTO Mode: When enabled, the MSU is turned on in *Touch to Open* state, allowing for a larger sensing area for door opening. The MSU senses targets as far as either 110cm (from the surface of the MSU) or the MSU Detection Limit (whichever is smaller).

5.9 No Floor TTO Mode: Normally, targets are detected by presence of an echo from that specific target. No Floor TTO mode allows an absence of an echo from the floor to be interpreted as a target. (This might occur if a sensor’s sound pulse is “blocked” by a passenger’s gloved hand, for example. The underlying assumption is that the floor

should always be seen when the door is enabled; if it is not seen, it is because a passenger wishes to exit.)

When enabled, No Floor TTO Mode operates in addition to standard target echo detection. (So the gloved hand can block the floor echo, or its echo can be sensed as a target – either will trigger a response.)

- 5.10 No Floor DFO MSU Mode:** When enabled, this mode allows the absence of the floor echo to be interpreted as a target by the MSU, but **ONLY** during the time that the door is fully open. This works in conjunction with standard target echo detection.
- 5.11 No Floor Closing MSU Mode:** When enabled, *No Floor Closing MSU* mode allows the absence of an echo from the floor to be interpreted as a target by the MSU, but **ONLY** during the time that the door is closing. When enabled, *No Floor Closing MSU* operates in addition to standard target echo detection.
- 5.12 Drunk Alarm:** When enabled, activates the Drunk Alarm mode using either the MSU, the Panel Sensors, or all, in various combinations and with selectable ranges.
- 5.13 5° Enables CLASS:** Normally CLASS™ is enabled by one of Enable inputs becoming active. When this mode is enabled:
- Opening the door past 5° (deactivating the 5° switch) will also enable CLASS™.
 - Any target acquired in the *Door Is Opening* state will cause a door open request as long as the Enable inputs are **NOT** active. (Normally, in the *Door Is Opening* state with Enable active, target acquisition will not cause door open requests to be issued since the door is already in the process of opening.)

Example uses:

- Driver-controlled door (no Enable signal available)
 - With the emergency pulled and the door partially opened, CLASS™ will be enabled and able to send door open requests.
- 5.14 Panel Target Reduction:** When this mode is enabled:
- Panel sensor targets that are below the Panel Detection limit will not be added to the fixed target table during power-on calibration.
 - Panel sensors will only detect Targets above (higher up on the door than) the Panel Detection Limit while the door is nearly closed (5° switch is active.)
- 5.15 UnFiltered Mode:** When this mode is enabled the six percent required between acquired targets is disabled during power-up Calibration Sequence.
NOTE: This is for use during installation to look for multiple targets that may be near each other. This is not for normal operation.

6.0 Advanced Modes

- 6.1 Drunk Alarm Always On:** When enabled, *Drunk Alarm Mode* will always be hardware-enabled.

Usage: This eliminates the need to connect the DAI or /DAI input to enable the Drunk Alarm function, and thus allows the use of the DAI or /DAI input for other functionality. Note that the Drunk Alarm function may still be enabled or disabled by use of the CLASS™ Diagnostic software.

- 6.2 High Noise Mode:** When enabled, this mode changes the power-up calibration sequence so that learned targets must be seen in 3 of 4 pulses (similar to normal mode) instead of 1 of 4 pulses. This mode also widens the tolerance within which the floor must be seen.

Usage: This mode provides increased random-noise rejection and makes it easier for sensors to “see” the floor, especially in a high-noise environment.

- 6.3 MSU 5 deg Pullup Mode:** When enabled, when the door operator’s 5 deg switch is active, the MSU will not detect targets beyond the *MSU 5 deg Detection Limit*. Also, during calibration, targets beyond the *MSU 5 deg Detection Limit* are not added to the table.

Usage: useful when there are MSU targets which are seen only when the door is nearly closed. Similar to *MSU Target Reduction*, but active only when nearly closed.

- 6.4 MSU 5 deg Detection Limit:** -- Distance in cm for *MSU 5 deg Pullup Mode*.
Usage: see *MSU 5 deg PullUp Mode*.

- 6.5 Panel 85 deg Pullup Mode:** When enabled, when the door is not in the full open position, Panel sensors will not detect targets beyond the *Panel Pullup Limit*. Also, during calibration, targets beyond the *Panel Pullup Limit* are not added to the table.

Usage: useful when a panel sensor sees a target only when the door is not fully open.

- 6.6 Panel Pullup Limit:** -- Distance in cm for *Panel 85 deg PullUp Mode*.

Usage: see *MSU 5 deg PullUp Mode*.

6.7 AutoReset Timer Mode: When enabled, will automatically Reset (and thus re-learn any new targets) on a timed basis. Operation: 24 hours from the previous reset, CLASS™ verifies that the doors are closed, and checks to see if the doorway is clear by looking for targets. If the doors are closed and there are no targets over a one-minute period, CLASS™ will Reset. If there are targets or the door is not closed, CLASS™ waits 10 minutes and then retries. This repeats until successful.

Usage: for systems in which CLASS™ power is infrequently turned off (such as LRVs).

6.8 Fault Holds Door Open: Any BIT fault (on power-up or Reset) will cause CLASS™ to activate all Door Open Request outputs. These will stay active until the next Reset. Usage: most useful on multi-door vehicles (such as LRVs) as an easily visible fault indication.

6.9 Move Floor [DA Pullup/Move Floor]: When enabled, this mode allows the distance from the MSU to the floor to be changed during operation by the *Drunk Alarm* input. Operation: when the *Drunk Alarm* input is high, and the system is IDLE, CLASS™ changes the Floor value (the first MSU entry) to the *DA PullUp Limit*. When the *Drunk Alarm* input is low, and the system is IDLE, the floor reverts to its original value. The *Drunk Alarm* input can be inverted with the Push Button Invert option. Note the *Drunk Alarm* input is redefined for this usage when this option is enabled. Enable *Drunk Alarm Always ON* if Drunk Alarm functionality is desired.

Usage: vehicles with extendable platforms (which change floor distances)

6.10 Long TTO Mode: When enabled, CLASS™ will allow continuous energization of its sensors in the TTO (Touch-To-Open) state for two minutes. After that time, the appropriate sensors will be energized in *Low Duty-Cycle Mode*. Once the door starts to open, CLASS™ will resume normal continuous energization of its sensors. Note that when the sensors are in the reduced duty-cycle mode, detection of a target may require 2 to 3 seconds.

Usage: increases operating life of CLASS™ sensors when the door is enabled for long periods.

6.11 Long DFO Mode: When enabled, CLASS™ will allow continuous energization of its sensors in the DFO (Door Fully Open) state for 30 seconds (as long as no targets are detected). After that time, the appropriate sensors will be energized in *Low Duty-Cycle Mode*. If a target is detected or the door starts to close, CLASS™ will resume normal continuous energization of its sensors.

Usage: increases operating life of CLASS™ sensors when the door is held open for long periods.

6.12 No-HoldOpen Mode: When enabled, if a target is continuously detected by the MSU for a ½ second, the MSU will then ignore the target for 3 seconds while the door is closing.

Usage: allows the door to “nudge” obstructions in an attempt to close.

6.13 TTO Sensitivity Mode: When enabled, when the door is the TTO state the sensitivity threshold will change from VREF Normal to VREF TTO. The sensitivity threshold changes back to VREF Normal in other states.

Usage: allows increased sensitivity to TTO.

6.14 VREF TTO: VREF sensitivity threshold level used when the door is in TTO (Touch-To-Open) state when using TTO Sensitivity Mode.

Usage: see *TTO Sensitivity Mode*.

6.15 DFO Sensitivity Mode: When enabled, when the door is fully open the sensitivity threshold will change from VREF Normal to VREF DFO. The sensitivity threshold changes back to VREF Normal in other states.

Usage: allows increased sensitivity at DFO.

6.16 VREF DFO: VREF sensitivity threshold level used when the door is in the DFO (Door Fully Open) state when using DFO Sensitivity Mode.

Usage: see *DFO Sensitivity Mode*.

6.17 MSU Ringdown Mode: When enabled, allows increased MSU Ringdown time (increases MSU dead zone). MSU Ringdown time can be adjusted from 1.75ms (30cm) to 2.5ms (42cm) via the *Ringdown Limit*.

Usage: prevents the MSU from “seeing itself” as a target due to long ringdown times.

6.18 Ringdown Limit: The amount of time until the MSU is allowed to detect targets. The allowable range is from 1.75ms (30cm) to 2.5ms (42cm).

Usage: see *MSU Ringdown Mode*.

6.19 Easy Floor Mode: When enabled, if a sensor sees any target or objects (not just the floor), that sensor will pass its sensor test. Note this includes targets already in the target table.

Usage: useful when using *High Noise Mode* to avoid incorrect sensor failures.

6.20 No Opening Req Mode: When enabled, CLASS™ will not request the door to open in the Door is Opening State.

Usage: For driver controlled CLASS™ systems in which *5 degree Enables CLASS™* is in use and the standard Enable input (*ENA* or */ENA*) is not being used (no external wiring connection to that input).

6.21 Mockup Mode: – For use ONLY with a standalone CLASS™ controller mockup. This mode uses CLASS™ outputs to drive white and green lights.
**** Do not use Mockup Mode on transit vehicles. ****

6.22 Drunk Alarm TTO Mode: When enabled, activating the Drunk Alarm input (either *DAI* or */DAI*) will cause the CLASS™ controller to issue a door open request.

Usage: allows reconfiguring the Drunk Alarm input for another purpose (typically push-button door open for a Mockup).
Enable *Drunk Alarm Always ON* if Drunk Alarm functionality is desired.

6.23 Push Button Invert: When enabled, inverts the Drunk Alarm Inputs in software.

7.0 DIAGNOSTICS

7.1.1 Diagnostics are provided via *CLASS™ Diagnostic*. *CLASS™ Diagnostic* is used for programming of CLASS™ parameters and operating the system in test mode. See the CLASS™ Diagnostic help files for more information.

7.1.2 CLASS™ Diagnostic:
Filename: Classdiag.exe Vapor P/N: 50320053

CLASS™ Diagnostic help:

PC-based version:
Filename: Class_Diagnostic.chm Vapor P/N: 50420231

Printed version
Filename: Class Diagnostic.pdf Vapor P/N: TB08-05-097