UL 325 Garage Door Safety Protocol

The **UL 325** (Underwriters Laboratories Standard for Safety) is the standard that governs all powered garage door and vehicular gate operators in North America. It **formally dictates the behavior of the motor and its sensors**, which is the core logic you need to model and verify.

Link to the technical data sheet

Core Safety Requirement

You can use the requirements of UL 325 specified in the technical data sheet. At least, you will model the system using two main interacting components:

1. **Controller (C):** Represents the user command interface (e.g., a phone app or a remote).
2. **Door Mechanism (D):** Represents the physical motor and sensors on the garage door.

The most critical and model-worthy requirement is the **Entrapment Protection**. Every modern garage door opener must have **two independent means** of preventing a person from being crushed:

1. **Primary Entrapment Protection (Inherent Reversal):** The motor operator must have a mechanism that measures the force needed to move the door. If the door encounters a substantial **obstruction** while closing (i.e., the force exceeds a safety limit), the mechanism must **automatically reverse** and open the door.
2. **Secondary Entrapment Protection (Non-Contact Sensor):** A non-contact sensor (usually a **photo-eye sensor**) must be installed no more than **6 inches (15 cm)** above the floor. If this light beam is broken while the door is closing, the motor must **immediately stop or reverse**.

Minimal set of variables and states:

Component	Variable	Type	Possible Values	Notes
Door	state	Enumeration	IDLE, OPENING, CLOSING, REVERSING	

Door	force_limit_exceeded	Boolean	true, false	Corresponds to **Primary Entrapment** (Inherent Sensor).
Door	photo_eye_broken	Boolean	true, false	Corresponds to **Secondary Entrapment** (External Sensor).
Controller	command	Enumeration	START_CLOSE, START_OPEN, STOP	Simplified user commands.

As an example, the following transitions are derived directly from the UL 325 requirements.

Trigger Condition	Action	UL 325 Compliance
D.state=CLOSING ∧ D.force_limit_exceeded=true	D.state ← REVERSING	Primary Entrapment Protection
D.state=CLOSING ∧ D.photo_eye_broken=true	D.state ← REVERSING	Secondary Entrapment Protection
D.state=CLOSING ∧ D.photo_eye_broken=true	D.state not= CLOSING	The door must not continue closing.