# VISIONIFY AI SAFETY PLATFORM

## Hard-Stop Triggers, PLC Communication & Safety Zone Definition

**Step-by-Step Configuration Guide**

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**SAFETY-CRITICAL DOCUMENT**

Review and approval required before deployment in production environments.

# 1. Overview

This guide provides a complete, step-by-step procedure for configuring three core safety components of the Visionify AI Safety Platform:

- Hard-Stop Triggers — defining the conditions that initiate an immediate machine halt
- PLC Communication Setup — integrating Visionify with programmable logic controllers
- Safety Zone Definition — mapping physical areas to AI-monitored detection regions

> ⚠ **IMPORTANT**
> All configurations described in this document have direct impact on physical machine operation and worker safety. Changes must only be made by qualified personnel and validated in a test environment before production deployment.

## 1.1 Audience

This guide is intended for:

- Safety Engineers and OT/IT Integrators responsible for machine safety systems
- Automation Engineers configuring PLC and SCADA integrations
- Visionify Platform Administrators with system-level access

## 1.2 Prerequisites

Before beginning, ensure the following are in place:

- Visionify platform is installed and cameras are operational
- Network connectivity between the Visionify server and the PLC is confirmed
- PLC vendor documentation and IP/port configuration details are available
- Access to Visionify Admin Console (administrator credentials required)
- Safety zone floor plans or CAD drawings are available for reference

# 2. Configuring Hard-Stop Triggers

A hard-stop trigger instructs Visionify to send an immediate stop signal to connected machinery when a safety violation is detected. Correct configuration ensures that triggers fire accurately, without false positives that could interrupt production unnecessarily.

## 2.1 Understanding Hard-Stop Logic

Hard-stop triggers are based on detection events generated by the Visionify AI models. Each trigger consists of:

| Component | Description | Example |
|---|---|---|
| Trigger Event | The AI detection that activates the stop condition | Person in restricted zone |
| Confidence Threshold | Minimum AI confidence score (0–1.0) required to fire | 0.85 |
| Dwell Time | Continuous detection duration before signal is sent (ms) | 500 ms |
| Output Action | PLC signal or relay command sent upon trigger | Digital Output DO-01 HIGH |
| Reset Condition | Condition required to clear the stop state | Zone clear for 5 seconds |

## 2.2 Step-by-Step: Creating a Hard-Stop Trigger

**Step 1 — Open the Triggers Module**

1. Log in to the Visionify Admin Console.
2. Navigate to Safety Configuration → Triggers.
3. Click the "+ New Trigger" button in the top-right corner.

**Step 2 — Define the Detection Event**

4. In the Trigger Name field, enter a descriptive name (e.g., ZONE-A-INTRUSION-STOP).
5. From the Event Type dropdown, select the relevant AI model detection category:
   - Person Detection
   - PPE Violation
   - Forklift Proximity
   - Restricted Zone Breach
6. Select the Camera(s) that will monitor this trigger using the camera selector.

7. Select the Safety Zone(s) to associate with this trigger (configured in Section 4).

**Step 3 — Set Confidence and Dwell Parameters**

8. Set the Confidence Threshold. Recommended values:
   - General monitoring: 0.80
   - Hard-stop triggers (safety critical): 0.85 – 0.92
   - High-sensitivity environments: 0.92+
9. Set the Dwell Time. This prevents single-frame false positives:
   - Minimum recommended: 300 ms
   - Standard safety applications: 500 ms
   - High-speed machinery: 200 ms or less (use caution)

> ⚠ **CAUTION**
> Setting confidence thresholds below 0.80 significantly increases false-positive risk. Setting dwell times above 1,000 ms on high-speed machinery may be unsafe. Validate these values during commissioning.

**Step 4 — Assign Output Action**

10. Under Output Configuration, select the output channel that maps to your PLC or relay:
    - Digital Output (DO): Sends a HIGH/LOW signal on the configured I/O port
    - Modbus Register Write: Writes a value to a specified holding register
    - OPC-UA Node Write: Writes to a defined OPC-UA node
11. Specify the signal value and duration (e.g., DO-01 = HIGH for 5,000 ms).
12. Enable Latching if the stop state must be manually reset by an operator.

**Step 5 — Configure Reset Conditions**

13. Under Reset Conditions, choose one of the following:
    - Auto-Reset: Zone clears for a defined duration (e.g., 5 seconds)
    - Manual Reset: Operator must acknowledge via HMI or Admin Console
    - PLC Feedback: Reset is gated on a specific PLC input signal
14. Set the reset delay (minimum recommended: 2,000 ms).

**Step 6 — Save and Test**

15. Click Save Trigger.
16. Navigate to the Test & Simulate tab.
17. Use the Inject Test Event function to simulate the detection event.
18. Verify the correct PLC output is activated and the stop signal is received.

19. Document test results in your commissioning log.

> ✅ **BEST PRACTICE**
> Always assign a unique, descriptive trigger name that includes the zone ID and event type (e.g., ZONE-B-PPE-STOP). This simplifies troubleshooting and audit log review.

# 3. PLC Communication Setup

Visionify uses a webhook-based integration model for PLC communication. Rather than requiring Visionify to directly interface with each vendor's PLC protocol, customers download a PLC Template Application from the Visionify website, run it on their own infrastructure, and configure the webhook endpoint in the Visionify web app. This keeps Visionify's involvement minimal and gives customers full flexibility to adapt the stop logic to their specific PLC environment.

## 3.1 How It Works

The integration works in three stages. First, the customer downloads and runs the Visionify PLC Template Application on their local network — this app starts an HTTP server and exposes a webhook endpoint that Visionify can call. Second, the customer enters that webhook URL in the Visionify web app to connect the two systems. Third, when Visionify detects a safety event and fires a hard-stop trigger, it sends a POST request to the webhook endpoint; the template application receives the payload and executes the configured stop logic on the PLC.

Because the PLC stop logic lives in the customer's own template application, Visionify does not need to maintain individual modules for each PLC vendor or protocol. Customers retain full control to modify the template to match their specific hardware, communication library, and safety procedures.

## 3.2 Step 1 — Download and Run the PLC Template Application

**Download the Template**

20. Go to the Visionify website and navigate to Downloads → PLC Integration → PLC Template Application.
21. Download the latest release package (.zip) and extract it to the server or PC that has network access to your PLC.
22. Review the included README.md for system requirements (Python 3.9+ or Node.js 18+, depending on the variant chosen).

**Configure and Start the Application**

23. Open config.yaml and set the following parameters:
    - webhook_port: The port the app will listen on (default: 5000)
    - webhook_secret: A shared secret token used to authenticate incoming requests from Visionify
    - plc_host / plc_port: IP address and port of your PLC (used by the stop logic you will customise)
24. Start the application: run python app.py (or node app.js). The console will confirm the webhook server is listening (e.g., Webhook server running on http://0.0.0.0:5000).
25. Note the full webhook endpoint URL (e.g., http://192.168.1.50:5000/visionify/webhook) — you will enter this in the next step.

## 3.3 Step 2 — Configure the Webhook Endpoint in Visionify

26. Log in to the Visionify web app and navigate to Integrations → Webhook Settings.
27. Click Add Webhook and fill in the following fields:
    - Name: A descriptive label (e.g., MainLine-PLC-Webhook)
    - Endpoint URL: The full URL of your running template application (e.g., http://192.168.1.50:5000/visionify/webhook)
    - Secret Token: Must match the webhook_secret set in config.yaml
    - Events: Select Hard-Stop Trigger and any other event types the PLC should respond to
28. Click Save, then click Send Test Event. Visionify will POST a sample payload to the endpoint. A 200 OK response confirms the connection is working.

> ℹ️ **NOTE**
> Visionify authenticates webhook calls using a shared secret token in the X-Visionify-Signature request header. The template application validates this token before executing any PLC action. Do not expose the webhook endpoint to the public internet without additional network-layer security (VPN or firewall rules).

## 3.4 Step 3 — Customise the Stop Logic in the Template Application

The template application ships with a clearly marked stop_plc() function that is called whenever a valid hard-stop webhook payload is received. Customers edit this function to implement the appropriate communication with their PLC. The template includes commented example snippets for common approaches:

| Approach | What the customer implements | Example vendors |
|---|---|---|
| Modbus TCP write | Write a coil or holding register value using a Modbus library of their choice | Any Modbus-compatible PLC |
| EtherNet/IP tag write | Use a CIP/EtherNet'IP library to write a BOOL or DINT tag on the controller | Allen-Bradley, Rockwell |
| OPC-UA node write | Use an OPC-UA client library to write to a defined node in the server address space | Siemens, Beckhoff, universal |
| Digital output / relay | Toggle a GPIO or relay output on the host machine to send a hardwired stop signal | Hardware-agnostic |

After editing stop_plc(), save the file and restart the template application. No changes are required in Visionify — the webhook endpoint URL remains the same.

## 3.5 Verifying the Integration

29. In the Visionify web app, navigate to Integrations → Webhook Settings and confirm the status shows Active (green).
30. Use the Send Test Event function and check the template application's console log to confirm the payload was received and stop_plc() was called.
31. Verify the expected PLC output activates (check from the PLC's HMI or programming terminal).
32. Review the Webhook Delivery Log (Integrations → Webhook Settings → Delivery Log) for response codes and latency. All entries should show 200 OK with latency under 300 ms.

# 4. Safety Zone Definition

Safety zones define the physical regions within a camera's field of view that Visionify monitors for safety events. Accurate zone definition is critical to ensuring that hard-stop triggers fire for the correct areas and do not generate false positives from adjacent activity.

## 4.1 Zone Types

| Zone Type | Description | Typical Application |
|---|---|---|
| Restricted Zone | Area where human presence is prohibited during machine operation | Machine guarding, robot cells |
| Warning Zone | Buffer area; presence triggers alert but not immediate stop | Perimeter around restricted zones |
| PPE Zone | Area requiring specific PPE; violation generates alert or stop | Welding bays, chemical handling areas |
| Crossing Zone | Defined path for personnel; deviation triggers alert | Pedestrian walkways near forklifts |
| Exclusion Zone | Dynamic zone that expands/contracts based on machine state | Collaborative robot workspaces |

## 4.2 Step-by-Step: Defining a Safety Zone

**Step 1 — Select Camera and Open Zone Editor**

33. Navigate to Safety Configuration → Safety Zones.
34. Select the camera feed for the area you wish to configure.
35. Click Open Zone Editor. The live camera view will be displayed with a drawing overlay.

**Step 2 — Draw the Zone Boundary**

36. Select the Polygon Tool (recommended for irregular areas) or Rectangle Tool.
37. Click on the camera image to place zone boundary vertices. Guidelines for accurate placement:
    - Align zone boundaries with physical markers visible in the camera view (floor markings, barriers)
    - Ensure the zone covers the full physical area, including any visual occlusion margins
    - For restricted zones near machine pinch points, extend the zone boundary at least 500 mm beyond the physical guard line
38. Double-click to close the polygon and complete the zone shape.
39. Use the Edit Vertices tool to fine-tune boundary placement.

**Step 3 — Configure Zone Properties**

40. Enter a Zone Name using a consistent naming convention (e.g., ZONE-A-PRESS-RESTRICTED).
41. Select the Zone Type (see Section 4.1).
42. Set the Active Schedule:
    - Always Active: Zone is enforced 24/7
    - Shift-Based: Zone is only enforced during configured shift hours
    - Machine-State Linked: Zone is activated based on a PLC input signal (machine running)
43. Assign the Detection Models to run within this zone (e.g., Person Detection, PPE Detection).
44. Set the Minimum Detection Size to filter out small objects and reduce false positives.

**Step 4 — Configure Zone-Specific Sensitivity**

45. Set the Zone Sensitivity:
    - High: Detects partial entry into the zone (e.g., a foot crossing the boundary)
    - Standard: Detects when the centroid of a detected object enters the zone
    - Low: Triggers only when the full bounding box of a detected object is inside the zone
46. For hard-stop triggers, High or Standard sensitivity is recommended.
47. Enable Multi-Camera Fusion if multiple cameras cover the same zone to reduce blind spots.

> ℹ️ **NOTE**
> Multi-Camera Fusion requires that all participating cameras have overlapping fields of view and are calibrated relative to the same world coordinate reference. See the Camera Calibration Guide for setup instructions.

**Step 5 — Link Zone to Hard-Stop Triggers**

48. In the Zone Properties panel, navigate to the Linked Triggers tab.
49. Select all applicable hard-stop triggers that should fire when this zone is violated.
50. Review the trigger-zone matrix to confirm no unintended associations are present.
51. Click Save Zone.

**Step 6 — Validate Zone Accuracy**

52. With a safety observer present, perform a physical walk-test:
    - Have a person stand just outside the zone boundary and confirm no trigger fires
    - Have a person step inside the zone boundary and confirm the trigger fires within the configured dwell time
    - Test corner and edge cases where the boundary is closest to work areas

53. Review the Live Detection Overlay in the Admin Console to verify detections are correctly attributed to the zone.
54. Adjust zone boundaries or sensitivity settings if false positives or missed detections are observed.
55. Document all walk-test results and obtain sign-off from the safety engineer.

**CRITICAL**

Zone validation walk-tests MUST be performed with the machine in a safe state (de-energized or in a maintenance interlock mode). Do not perform live zone testing with machinery in automatic run mode.

# 5. End-to-End Integration Testing

After completing all configurations, perform a full end-to-end test to verify the entire signal chain from camera detection through to machine stop.

## 5.1 Integration Test Checklist

| Test Step | Expected Result | Pass / Fail |
|---|---|---|
| Person enters Restricted Zone | Hard-stop trigger fires within dwell time | |
| PLC receives stop signal | Machine enters stop state; PLC coil/tag activates | |
| Zone clears (auto-reset configured) | Stop signal clears after reset delay; machine re-enables | |
| Manual reset tested (if configured) | Machine does not re-enable until operator acknowledges | |
| PLC communication failure simulated | Visionify generates fault alert; safe-state behavior maintained | |
| Camera occlusion test | Occlusion detection alert generated within 30 seconds | |
| Multi-zone simultaneous breach | All linked triggers fire independently and correctly | |

## 5.2 Performance Benchmarks

The following response time benchmarks should be achieved during integration testing:

| Metric | Target Value | Maximum Acceptable |
|---|---|---|
| Detection-to-trigger latency | < 150 ms | 300 ms |
| Trigger-to-PLC signal latency | < 50 ms | 100 ms |
| End-to-end (detection to machine stop) | < 500 ms | 800 ms |
| PLC communication heartbeat interval | 1,000 ms | 2,000 ms |
| False positive rate (per shift) | < 1 per 8-hour shift | < 3 per 8-hour shift |

# 6. Troubleshooting

| Issue | Likely Cause | Resolution |
|---|---|---|
| Trigger fires excessively (false positives) | Confidence threshold too low or zone boundary too broad | Increase confidence threshold; refine zone boundary |
| Trigger never fires | Confidence threshold too high; zone does not cover area | Lower threshold slightly; re-validate zone placement |
| PLC not receiving stop signal | Network connectivity issue; incorrect register/tag mapping | Check PLC Status in Diagnostics; verify register map |
| High communication latency | Network congestion or PLC overload | Check network path; reduce polling frequency |
| Zone validation fails walk-test | Camera angle or lens distortion affecting zone accuracy | Recalibrate camera; adjust zone vertices |

**END OF DOCUMENT**

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