

Standard Operating Procedure: Palletizing System

Model: KUKA KR 700 PA Palletizing Robot with Stretch Wrapper

Document ID: SOP-PALLET-001
Equipment ID: PALLETIZER-01, PALLETIZER-02, WRAPPER-01
Version: 1.0
Effective Date: January 16, 2026
Classification: Critical Equipment
Location: Enterprise B / Site1 / Palletizing / Palletizer01

Quick Reference for AI Agents

Equipment Type: Robotic Palletizer with Stretch Wrapper
Criticality Level: HIGH - Production Critical
MQTT Topic Path: Enterprise B/Site1/palletizing/palletizer01/
Key Metrics: Pallets/Hour, Cycle Time, Wrap Efficiency, Robot Utilization
Common Issues: Pattern errors, wrap failures, robot faults, pallet jams

1. Equipment Overview

1.1 Purpose

The Palletizing System receives packed cases from packaging lines, arranges them in configured patterns on pallets, and wraps completed pallets for shipping. The system includes robotic palletizers, stretch wrappers, and manual palletizing stations.

1.2 Equipment Specifications

Specification	Value
Robot Model	KUKA KR 700 PA
Payload Capacity	700 kg
Reach	3,320 mm
Palletizing Speed	12-15 pallets/hour
Pallet Sizes	1000x1200mm (EUR), 1016x1219mm (US)
Max Stack Height	2,000 mm
Case Weight Range	5-30 kg
Wrapper Model	Robopac Helix HS50
Wrap Speed	25-35 RPM
Film Width	500mm

Specification	Value
Power Requirements	480V, 3-phase, 60Hz, 45kW

1.3 System Components

Component	Asset ID	Function	MQTT Path
Robot	55	Pick and place cases	.../palletizer01/robot/
Wrapper	56	Stretch wrap pallets	.../palletizer01/wrapper/
Pallet01	57	Pallet station 1	.../palletizer01/pallet01/
Pallet02	58	Pallet station 2	.../palletizer01/pallet02/

2. Safety Requirements

2.1 Personal Protective Equipment (PPE)

PPE Item	Required For	Standard
Safety Glasses	All operations	ANSI Z87.1
Steel-toe Boots	All operations	ASTM F2413
High-Visibility Vest	Floor operations	ANSI Class 2
Hard Hat	Under robot envelope	ANSI Z89.1

2.2 Robot Safety Zones

Zone	Description	Access
Red Zone	Robot work envelope	NO ACCESS when running
Yellow Zone	Pallet exchange area	Caution, reduced speed
Green Zone	Operator station	Normal access

2.3 Safety Interlocks

Interlock	Condition	Action
Light Curtain	Beam broken	Robot stop
Safety Gate	Open	Robot stop, wrapper stop
E-Stop	Activated	All systems stop
Robot Fault	Error detected	Controlled stop
Overload	Weight exceeded	Reject case

2.4 Lockout/Tagout (LOTO) Points

LOTO Point	Location	Energy Type
Robot Controller	Control cabinet	Electrical 480V
Wrapper Main	Wrapper panel	Electrical 480V
Pneumatic Supply	Air manifold	Pneumatic 6 bar
Conveyor Drives	Motor starters	Electrical

3. Operating Procedures

3.1 Pre-Startup Checklist

1.

Verify LOTO removed and equipment released

2.

Check robot teach pendant secured

3.

Verify safety light curtains functional

4.

Check pallet supply (minimum 10 pallets)

5.

Verify stretch film loaded

6.

Check case infeed conveyor clear

7.

Confirm pallet pattern selected

8.

Verify robot home position

9.

Check gripper condition

10.

Test emergency stops

11.

Verify forklift access clear

12.

Confirm work order in system

3.2 Startup Procedure

1.

Power On - Turn on robot controller, wait for boot (60 sec)
2.

Home Robot - Execute homing sequence from teach pendant
3.

Select Pattern - Choose pallet pattern on HMI
4.

Load Pallet - Place empty pallet on station 1
5.

Enable Robot - Switch to AUTO mode, enable drives
6.

Start Production - Press START, robot begins cycle

3.3 Normal Operation Monitoring

Key Parameters to Monitor:

Parameter	MQTT Topic	Normal Range	Warning	Critical
Pallets/Hour	.../palletizer01/metric/input/rateactual	12-15	<10	<8
Robot OEE	.../palletizer01/robot/metric/oeo	>90%	85-90%	<85%
Wrapper OEE	.../palletizer01/wrapper/metric/oeo	>95%	90-95%	<90%
Cycle Time	.../palletizer01/processdata/cycletime	<5 min	5-6 min	>6 min

Parameter	MQTT Topic	Normal Range	Warning	Critical
State	.../palletizer01/processdata/state/name	Running	Idle	Down
Cases Stacked	.../palletizer01/processdata/count/outfeed	Increasing	Stalled	N/A
Pallets Complete	.../palletizer01/metric/input/countoutfeed	Increasing	Stalled	N/A

4. Troubleshooting Guide

4.1 Common Problems and Solutions

Problem: Robot Fault / Stopped

Symptoms:

- Robot not moving
- Fault light on controller
- Error on teach pendant

Diagnostic Steps:

1. Check teach pendant for error code
2. Check safety circuits → Light curtain, gates
3. Check robot position → May be at limit
4. Check gripper → Vacuum or mechanical issue
5. Check case on gripper → May have dropped
6. Check communication → PLC to robot

Common Robot Fault Codes:

Code	Description	Action
R001	Axis limit reached	Jog to safe position
R002	Collision detected	Check path, clear obstruction
R003	Gripper fault	Check vacuum, sensors
R004	Communication loss	Check network cable
R005	Overload	Reduce payload, check case weight
R006	Emergency stop	Investigate, reset when safe

Problem: Pallet Pattern Incorrect

Symptoms:

- Cases not aligned
- Pattern doesn't match specification
- Unstable pallet

Diagnostic Steps:

1. Verify correct pattern selected → Check HMI
2. Check case dimensions → Match to pattern
3. Check gripper alignment → Calibrate if needed
4. Verify pallet position → Check centering
5. Check robot calibration → May need recalibration

Resolution Actions:

Root Cause	Action	Time Est.
Wrong pattern	Select correct pattern	2 min
Case size mismatch	Update pattern or reject	10 min
Gripper drift	Recalibrate gripper	30 min
Robot calibration	Full calibration	2 hours

Problem: Wrapper Not Wrapping Properly

Symptoms:

- Film breaking
- Loose wrap
- Film not attaching

Diagnostic Steps:

1. Check film roll → Replace if low
2. Check film tension → Adjust pre-stretch
3. Check film tail attachment → Clean hot wire
4. Check turntable speed → Adjust RPM
5. Check wrap pattern → Verify top/bottom wraps
6. Check pallet height → May exceed limit

Resolution Actions:

Root Cause	Action	Time Est.
Film empty	Replace roll	5 min
Tension wrong	Adjust pre-stretch %	5 min

Root Cause	Action	Time Est.
Hot wire dirty	Clean cutting wire	10 min
Pattern wrong	Adjust wrap recipe	5 min

4.2 Alarm Code Reference

Code	Priority	Description	Immediate Action
PAL-001	CRITICAL	Robot E-stop	Investigate cause
PAL-002	HIGH	Robot fault	Check teach pendant
PAL-003	HIGH	Gripper fault	Check vacuum/sensors
PAL-004	MEDIUM	Case jam	Clear infeed
PAL-005	MEDIUM	Pallet full	Exchange pallet
PAL-006	LOW	Pallet low	Replenish pallets
WRP-001	HIGH	Film break	Rethread film
WRP-002	MEDIUM	Film low	Prepare new roll
WRP-003	HIGH	Wrapper fault	Check wrapper

4.3 Detailed Error Code Resolution Procedures

PAL-001 - Robot Emergency Stop (CRITICAL Priority)

Trigger Condition: Robot E-stop activated or safety system triggered

Root Causes:

- Operator pressed E-stop
- Light curtain breached
- Safety gate opened
- Robot controller fault

Step-by-Step Resolution:

1. DO NOT APPROACH ROBOT until confirmed safe
2. Identify E-stop source:
 - Check teach pendant display for fault
 - Check safety PLC status on HMI
 - Physically check all E-stop buttons
3. If light curtain triggered:
 - a. Ensure area is clear of personnel
 - b. Check for objects in light curtain path
 - c. Clean light curtain lenses
 - d. Verify alignment (check indicator lights)
4. If safety gate opened:

- a. Close and latch gate properly
 - b. Check gate interlock switch
5. If operator E-stop:
 - a. Interview operator for reason
 - b. Investigate any safety concern
 - c. Document in safety log
6. To reset:
 - a. Clear the triggering condition
 - b. Release E-stop button (pull and twist)
 - c. On teach pendant: Press RESET
 - d. On HMI: Safety → Reset Safety Circuit
 - e. Robot will require re-homing
7. Re-home robot:
 - a. Teach pendant → Menu → Home Position
 - b. Press and hold enabling switch
 - c. Press START – robot moves to home
 - d. Verify home position reached
8. Resume production:
 - a. Switch to AUTO mode
 - b. Press CYCLE START

SAFETY: All personnel must be outside safety zone before reset

PAL-002 - Robot Fault (HIGH Priority)

Trigger Condition: Robot controller detects operational fault

Root Causes:

- Axis limit reached
- Collision detected
- Motor overload
- Encoder error
- Communication loss

Step-by-Step Resolution:

1. Check teach pendant for specific fault code
2. Common KUKA fault codes:

 AXIS LIMIT (Motion error):
 - a. Robot reached software or hardware limit
 - b. On teach pendant: Jog robot away from limit
 - c. Check if path was obstructed
 - d. May need to adjust program points
 COLLISION (External force detected):
 - a. Robot detected unexpected resistance
 - b. Check for obstacles in work area
 - c. Check if case was mispositioned

- d. Inspect gripper for damage
- e. Clear area and reset

MOTOR OVERLOAD:

- a. Check payload – is case too heavy?
- b. Check for mechanical binding
- c. Reduce speed temporarily
- d. Check motor temperature

ENCODER ERROR:

- a. Check encoder cables
- b. May need mastering procedure
- c. Call maintenance for encoder issues

COMMUNICATION LOSS:

- a. Check network cable to robot
- b. Check PLC communication status
- c. Restart robot controller if needed

3. To reset fault:

- a. Teach pendant → Fault Reset
- b. If fault persists, power cycle controller

4. After reset:

- a. Jog robot manually to verify motion
- b. Run at reduced speed initially
- c. Monitor for recurring faults

Escalation: If fault recurs 3 times, call KUKA support: 1-866-873-5852

PAL-003 - Gripper Fault (HIGH Priority)

Trigger Condition: Gripper vacuum loss or case detection failure

Root Causes:

- Vacuum leak
- Vacuum pump failure
- Case not detected
- Sensor failure
- Gripper damage

Step-by-Step Resolution:

1. Robot will stop with case (may be holding or dropped)
2. Check gripper status on HMI:
 - Vacuum level (should be -0.5 to -0.7 bar)
 - Case detect sensor status
3. If VACUUM LOW:
 - a. Check vacuum pump running (listen for pump)
 - b. Check vacuum hose connections

- c. Inspect gripper suction cups:
 - Look for tears or cracks
 - Replace damaged cups
 - d. Check vacuum filter (clean/replace)
 - e. Check for air leaks in gripper
4. If CASE NOT DETECTED:
 - a. Check case presence sensor
 - b. Clean sensor lens
 - c. Verify sensor alignment
 - d. Test sensor manually (block/unblock)
5. If case was dropped:
 - a. Remove dropped case from area
 - b. Check case condition
 - c. Inspect gripper for damage
6. To reset:
 - a. Ensure gripper is empty
 - b. HMI → Robot → Gripper → Reset
 - c. Test gripper: Manual → Vacuum On/Off
 - d. Verify vacuum holds (place test case)
7. Resume production

Spare Parts: Suction cups (4 per gripper), vacuum filter, proximity sensor

PAL-004 - Case Jam at Infeed (MEDIUM Priority)

Trigger Condition: Case not detected at pick position within timeout

Root Causes:

- Case stuck on conveyor
- Multiple cases bunched
- Conveyor stopped
- Sensor blocked

Step-by-Step Resolution:

1. Robot will wait at home position
2. Check infeed conveyor:
 - a. Is conveyor running?
 - b. Are cases moving?
 - c. Is there a physical jam?
3. If conveyor stopped:
 - a. Check conveyor motor status
 - b. Check for E-stop on conveyor
 - c. Restart conveyor
4. If cases jammed:
 - a. Stop conveyor
 - b. Remove jammed cases
 - c. Check case condition (damaged?)
 - d. Check conveyor guides – too tight?

- e. Restart conveyor
5. If cases bunched:
 - a. Cases arriving faster than robot picks
 - b. Slow upstream equipment
 - c. Or increase robot speed if possible
6. If sensor issue:
 - a. Clean case detect sensor
 - b. Check sensor alignment
 - c. Verify sensor detects case properly
7. Clear alarm:
 - a. HMI → Alarms → PAL-004 → Acknowledge
 - b. Robot will resume when case detected

Throughput Balance: Ensure upstream rate \leq robot capacity (15 pallets/hr \times cases/pallet)

WRP-001 - Film Break (HIGH Priority)

Trigger Condition: Film tension lost or film not detected

Root Causes:

- Film roll empty
- Film caught on pallet
- Pre-stretch too high
- Film quality issue

Step-by-Step Resolution:

1. Wrapper will stop mid-cycle
2. Pallet may be partially wrapped
3. Check film status:
 - a. Is film roll empty? → Replace roll
 - b. Is film broken? → Rethread
 - c. Is film tangled? → Clear tangle
4. If film caught on pallet:
 - a. Cut film to free wrapper
 - b. Remove loose film from pallet
 - c. May need to manually complete wrap
5. To rethread film:
 - a. Open wrapper guard
 - b. Pull film from roll
 - c. Thread through pre-stretch rollers
 - d. Thread through film carriage
 - e. Attach to film clamp
 - f. Close guard
6. Adjust pre-stretch if breaking frequently:
 - a. HMI → Wrapper → Pre-stretch
 - b. Reduce by 10% (e.g., 250% → 225%)
 - c. Higher pre-stretch = more breaks
7. Check film quality:

- a. Is film from approved supplier?
- b. Check film thickness (20–23 micron)
- c. Check for damage to roll
8. Resume wrapping:
 - a. HMI → Wrapper → Resume Cycle
 - b. Or start new cycle if pallet removed

Film Specifications: 500mm width, 20-23 micron, 250% pre-stretch capable

WRP-003 - Wrapper Fault (HIGH Priority)

Trigger Condition: Wrapper mechanical or electrical fault

Root Causes:

- Turntable motor fault
- Film carriage fault
- Top clamp fault
- Encoder error

Step-by-Step Resolution:

1. Check HMI for specific fault:

TURNTABLE FAULT:

- a. Check turntable motor status
- b. Check VFD for fault code
- c. Check turntable rotation (not obstructed)
- d. Check encoder on turntable
- e. Reset VFD if needed

FILM CARRIAGE FAULT:

- a. Check carriage motor
- b. Check carriage rails (lubricated?)
- c. Check limit switches (top/bottom)
- d. Manually move carriage to verify free

TOP CLAMP FAULT:

- a. Check clamp cylinder
- b. Check air supply to clamp
- c. Check clamp sensors
- d. Manually test clamp operation

CUT/SEAL FAULT:

- a. Check hot wire temperature
- b. Check wire condition (replace if broken)
- c. Check film clamp operation

2. General reset procedure:

- a. Clear any physical obstruction

- b. HMI → Wrapper → Reset Fault

c. Run manual cycle to test

d. Resume automatic operation

3. If fault persists:

a. Power cycle wrapper controller

b. Check all connections

c. Call maintenance

Maintenance Contact: Robopac support: 1-800-762-6722

5. Pallet Patterns

5.1 Standard Patterns

Pattern ID	Case Size	Cases/Layer	Layers	Cases/Pallet
PAT-001	12-pack	8	6	48
PAT-002	24-pack	5	5	25
PAT-003	6-pack	12	8	96
PAT-004	Mixed	Variable	Variable	Variable

5.2 Pattern Selection

HMI → Production → Pallet Patterns → Select Pattern
Verify: Case size, layer count, total cases, stack height

6. Preventive Maintenance

6.1 Daily Tasks (Operator)

- ☐ Visual inspection of robot and wrapper

☐ Check gripper condition

☐ Verify film supply

☐ Check pallet supply

☐ Clean sensors and light curtains

☐ Document any issues

6.2 Weekly Tasks (Maintenance)

- ☐ Lubricate robot joints (if required)

☐ Check gripper vacuum levels

- ☐ Inspect conveyor belts
- ☐ Test safety interlocks
- ☐ Check wrapper pre-stretch rollers
- ☐ Review alarm history

6.3 Monthly Tasks

- ☐ Robot calibration check
- ☐ Gripper seal replacement
- ☐ Wrapper film carriage inspection
- ☐ Electrical connection check
- ☐ Safety system audit

6.4 Annual Tasks

- ☐ Full robot calibration
- ☐ Gearbox oil change
- ☐ Complete safety certification
- ☐ Control system backup
- ☐ Performance validation

7. MQTT Data Points for Monitoring

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{
  "equipment": "palletizer01",
  "location": "Enterprise B/Site1/palletizing/palletizer01",
  "components": {
    "robot": {
      "assetId": 55,
      "displayName": "Robot",
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        "oeo": "Enterprise
B/Site1/palletizing/palletizer01/robot/metric/oeo",
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  "pallet02": {
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    "basePath": "Enterprise B/Site1/palletizing/palletizer01/pallet02/"
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  "palletizermanual02": {
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    "basePath": "Enterprise B/Site1/palletizing/palletizermanual02/"
  },
  "palletizermanual04": {
    "displayName": "West Robot 2nd Stacker",
    "basePath": "Enterprise B/Site1/palletizing/palletizermanual04/"
  }
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}
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8. Performance Targets

Metric	Target	Minimum
Robot OEE	>92%	85%
Wrapper OEE	>95%	90%
Pallets/Hour	14	10
Cycle Time	<4.5 min	<6 min
Film Usage	<250g/pallet	<300g
Pattern Accuracy	100%	99%

Document Control

Version	Date	Author	Changes
1.0	2026-01-16	Engineering	Initial release