Safety cause and effect

Twin-line palletising cell · KUKA KR 210 R2700 extra · 26 Nov 2026 · Path2 design pack v1 · Concept – not for construction

Tag	Device	Location	Safety input	Safety function	PLr	Muting	Robot stop	Conveyors	Gripper	Beacon / lamp	Keeps running	Reset	Restart
ES01	Emergency stop, -X side	Outside -X side of fencing (FL1)	ES_CH1 / ES_CH2 (I200.0 / I200.1), in series with ES02, ES03, ES04	Emergency stop	PL d minimum (PL e if designed to it)	No	Stop 1 via the robot's e-stop input (Stop 0 or 1 allowed for an e-stop)	CV01, CV02 stop (ES_KM drops)	Holds: RB01_GRIP ($OUT[1]) is not switched by the stop. Single output, so monostable valve implied: on loss of 24 V or air, vacuum is lost and the load drops	None: no beacon output in the IO list	Nothing: the whole cell stops	Yes, manual: release ES01 (twist or pull), then press reset at the reset point outside the guarding	Separate start: RB01_START (Q100.0 -> $IN[1]) from the PLC after reset. Reset alone does not restart. Conveyors restart on their own auto or manual start
ES02	Emergency stop, +X side, in DR01 interlock	Integrated in DR01 door interlock	ES_CH1 / ES_CH2 (I200.0 / I200.1), in series with ES01, ES03, ES04	Emergency stop	PL d minimum (PL e if designed to it)	No	Stop 1 via the robot's e-stop input (Stop 0 or 1 allowed for an e-stop)	CV01, CV02 stop (ES_KM drops)	Holds: RB01_GRIP ($OUT[1]) is not switched by the stop. Single output, so monostable valve implied: on loss of 24 V or air, vacuum is lost and the load drops	None: no beacon output in the IO list	Nothing: the whole cell stops	Yes, manual: release ES02 (twist or pull), then press reset at the reset point outside the guarding	Separate start: RB01_START (Q100.0 -> $IN[1]) from the PLC after reset. Reset alone does not restart. Conveyors restart on their own auto or manual start
ES03	Emergency stop, -Y side	Outside -Y side of fencing (FL3)	ES_CH1 / ES_CH2 (I200.0 / I200.1), in series with ES01, ES02, ES04	Emergency stop	PL d minimum (PL e if designed to it)	No	Stop 1 via the robot's e-stop input (Stop 0 or 1 allowed for an e-stop)	CV01, CV02 stop (ES_KM drops)	Holds: RB01_GRIP ($OUT[1]) is not switched by the stop. Single output, so monostable valve implied: on loss of 24 V or air, vacuum is lost and the load drops	None: no beacon output in the IO list	Nothing: the whole cell stops	Yes, manual: release ES03 (twist or pull), then press reset at the reset point outside the guarding	Separate start: RB01_START (Q100.0 -> $IN[1]) from the PLC after reset. Reset alone does not restart. Conveyors restart on their own auto or manual start
ES04	Emergency stop, +Y side	Outside +Y side of fencing (FL4)	ES_CH1 / ES_CH2 (I200.0 / I200.1), in series with ES01, ES02, ES03	Emergency stop	PL d minimum (PL e if designed to it)	No	Stop 1 via the robot's e-stop input (Stop 0 or 1 allowed for an e-stop)	CV01, CV02 stop (ES_KM drops)	Holds: RB01_GRIP ($OUT[1]) is not switched by the stop. Single output, so monostable valve implied: on loss of 24 V or air, vacuum is lost and the load drops	None: no beacon output in the IO list	Nothing: the whole cell stops	Yes, manual: release ES04 (twist or pull), then press reset at the reset point outside the guarding	Separate start: RB01_START (Q100.0 -> $IN[1]) from the PLC after reset. Reset alone does not restart. Conveyors restart on their own auto or manual start
IL01	Door interlock, DR01 sliding door	DR01	IL_CH1 / IL_CH2 (I200.2 / I200.3), in series with IL02	Door interlock stop	PL d minimum (PL e if designed to it)	No	Stop 1 via the robot's safe stop input	CV01, CV02 stop (IL_KM drops)	Holds: RB01_GRIP ($OUT[1]) is not switched by the stop. Single output, so monostable valve implied: on loss of 24 V or air, vacuum is lost and the load drops	None: no beacon output in the IO list	Nothing in the robot cell: every safety input stops the one robot, there are no zones	Yes, manual: close the door, then press reset at the reset point outside the guarding	Separate start: RB01_START (Q100.0 -> $IN[1]) from the PLC after reset. Reset alone does not restart. Conveyors restart on their own auto or manual start
IL02	Door interlock, DR02 sliding door	DR02	IL_CH1 / IL_CH2 (I200.2 / I200.3), in series with IL01	Door interlock stop	PL d minimum (PL e if designed to it)	No	Stop 1 via the robot's safe stop input	CV01, CV02 stop (IL_KM drops)	Holds: RB01_GRIP ($OUT[1]) is not switched by the stop. Single output, so monostable valve implied: on loss of 24 V or air, vacuum is lost and the load drops	None: no beacon output in the IO list	Nothing in the robot cell: every safety input stops the one robot, there are no zones	Yes, manual: close the door, then press reset at the reset point outside the guarding	Separate start: RB01_START (Q100.0 -> $IN[1]) from the PLC after reset. Reset alone does not restart. Conveyors restart on their own auto or manual start
LC01	Light curtain, CV01 product opening	FL1 opening 800 mm	LC01_CH1 / LC01_CH2 (I200.4 / I200.5), own input; muting LC01_MUT1-4 (I200.6...I201.1)	Light curtain stop; Muting (product passes automatically)	PL d minimum (PL e if designed to it); PL d minimum, same as the curtain it mutes	Yes: LC01_MUT1-4. Product on CV01 passes without a stop; a stop if the field is broken outside a valid muting sequence or past the maximum muting time	Stop 1 via the robot's safe stop input	CV01, CV02 stop (LC_KM drops)	Holds: RB01_GRIP ($OUT[1]) is not switched by the stop. Single output, so monostable valve implied: on loss of 24 V or air, vacuum is lost and the load drops	None: no beacon or muting lamp output in the IO list	Nothing in the robot cell: every safety input stops the one robot, there are no zones	Yes, manual: clear the field, then press reset at the reset point outside the guarding	Separate start: RB01_START (Q100.0 -> $IN[1]) from the PLC after reset. Reset alone does not restart. Conveyors restart on their own auto or manual start
LC02	Light curtain, CV02 product opening	FL1 opening 800 mm	LC02_CH1 / LC02_CH2 (I201.2 / I201.3), own input; muting LC02_MUT1-4 (I201.4...I201.7)	Light curtain stop; Muting (product passes automatically)	PL d minimum (PL e if designed to it); PL d minimum, same as the curtain it mutes	Yes: LC02_MUT1-4. Product on CV02 passes without a stop; a stop if the field is broken outside a valid muting sequence or past the maximum muting time	Stop 1 via the robot's safe stop input	CV01, CV02 stop (LC_KM drops)	Holds: RB01_GRIP ($OUT[1]) is not switched by the stop. Single output, so monostable valve implied: on loss of 24 V or air, vacuum is lost and the load drops	None: no beacon or muting lamp output in the IO list	Nothing in the robot cell: every safety input stops the one robot, there are no zones	Yes, manual: clear the field, then press reset at the reset point outside the guarding	Separate start: RB01_START (Q100.0 -> $IN[1]) from the PLC after reset. Reset alone does not restart. Conveyors restart on their own auto or manual start

Basis

Stop category. safety_requirements.xlsx does not set a stop category per function. Its robot stopping time (500 ms placeholder) is for stop category 1, so every row here is Stop 1 (IEC 60204-1 9.2.2). An e-stop may be Stop 0 or Stop 1 (IEC 60204-1, ISO 13850).
Safety contactors. Which motors each safety contactor switches is not set in this design. The matrix assumes ES_KM, IL_KM and LC_KM each remove power from every conveyor motor inside the guarding. Confirm in the schematic.
Gripper. Holds: RB01_GRIP ($OUT[1]) is a robot output, not switched by the safety contactors, so it keeps its state through the stop (check on the controller). It is a single output, so a single-solenoid (monostable) valve is implied: if the 24 V IO supply or the air is lost, vacuum is lost and the load drops.
Operational stop. RB01_STOP (Q100.1 -> $IN[2]) is a stop over the fieldbus, not a safety function. It is not in the matrix.
PLr. As safety_requirements.xlsx gives it. Typical values for guidance. Your PLr comes from your own risk assessment (ISO 12100) and must be verified (ISO 13849-1/-2, e.g. in SISTEMA).

Pallet change, PO01 (the same for PO02)

As the design works now: changing a pallet stops the whole robot cell. Signals as the IO list names them.

Step	Do this	What happens
1	Robot fills PO01: 6 cases a layer x 1 layer = 6 cases.	The generated program runs the pattern on the taught pallet frame. It uses the gripper output only and does not wait on the handshake signals yet.
2	PLC counts layers from RB01_PLACED_PO01 ($OUT[7] -> I100.5).	Pallet full when the count reaches 1. The signal is in the IO list; the integrator adds it to the robot program.
3	PLC turns RB01_OK_PLACE_PO01 (Q100.6 -> $IN[7]) off.	The robot must not start another layer on PO01. Needs the handshake in the robot program.
4	Operator sees PO01 is full.	By eye: no pallet-full lamp or pallet-change request button in this design.
5	Operator opens DR01 (IL01).	IL01, IL02 are in series on one safety input (IL_CH1 / IL_CH2), so the safety PLC can't tell which door is open. The whole robot cell stops: robot Stop 1, IL_KM drops, conveyors CV01, CV02 stop. Work on PO02 stops too.
6	Gripper holds what it carries.	Holds: RB01_GRIP ($OUT[1]) is a robot output, not switched by the safety contactors, so it keeps its state through the stop (check on the controller). It is a single output, so a single-solenoid (monostable) valve is implied: if the 24 V IO supply or the air is lost, vacuum is lost and the load drops.
7	Forklift takes the full pallet out through DR01 and sets an empty pallet in place.	By eye: no pallet locating or pallet-present sensor in this design.
8	Everyone leaves the cell. Check nobody is inside. Close DR01.	Safety input healthy again. The cell stays stopped.
9	Press reset at the reset point outside the guarding.	IL_KM pulls in. Nothing moves. The reset button is not in the IO list yet.
10	Tell the PLC PO01 is new.	Layer count to zero and the robot program to the first case. No input for this in the design: add a pallet-changed confirm button or a pallet-present sensor.
11	Press start: RB01_START (Q100.0 -> $IN[1]).	Robot restarts; PLC turns RB01_OK_PLACE_PO01 back on. Conveyors restart on their auto signal.

Design note: zoned pallet change. A recommendation for the risk assessment, not a change to this design.

In this design every safety input stops the whole robot cell, so a pallet change stops production. To keep the robot working on PO02 while PO01 is changed, the cell would need:
1. A light curtain across each pallet face (or a door per pallet), each on its own dual-channel safety input: one safety input per zone, not doors in series.
2. A safety-rated way to keep the robot out of the open zone: safety-rated zone limits (KUKA SafeOperation, ABB SafeMove) or a fixed guard between the pallet zone and the robot. This is a safety function of its own (PL d minimum), configured and validated, and the ISO 13855 distances are rechecked to the zone limit.
3. Presence detection in the pallet zone the whole time someone is in it, so a person can't walk from the pallet zone to the robot (e.g. the curtain plus an area scanner on the floor).
4. A pallet-change request button and lamp per zone. The operator requests; the robot finishes the layer and leaves the zone; the PLC confirms with the lamp before the zone opens.
5. A pallet-changed confirm button (or pallet-present sensor) and a reset per zone, outside the zone, before the robot is let back in.
6. Validation of each new safety function (ISO 13849-2, ISO 10218-2).

Not in this design

Item	What is missing	Why it matters
Reset pushbutton	No reset input in the IO list. The safety requirements put the reset outside the cell with a clear view of it.	Every row needs a manual reset (ISO 13849-1, ISO 10218-2).
Robot safety interface	The robot's e-stop and safe stop inputs are named in the safety circuits but are not IO points in the IO list.	The robot stop in every row depends on them: add them as dual-channel or safe fieldbus signals.
Contactor feedback	ES_KM, IL_KM and LC_KM are 'with feedback' but no feedback (EDM) input is listed.	Without it a welded contactor is not detected before restart.
Beacon / stack light	No beacon, stack light or muting lamp output.	Nothing shows the operator that the cell is stopped, muted, or waiting for reset.
Pallet signals	No pallet-full lamp, pallet-change request, pallet-changed confirm or pallet-present sensor.	The pallet change has to be done by eye; see the pallet change sheet.
Robot pendant e-stop and enabling device	Part of the robot, not in the pack's safety IO.	Check the pendant e-stop also stops the conveyors (link it to the cell e-stop circuit).
Part gripped sensor	No vacuum switch or clamp sensor input for 'part gripped' (the gripper notes call for one).	The robot can't tell it has dropped or missed a part.