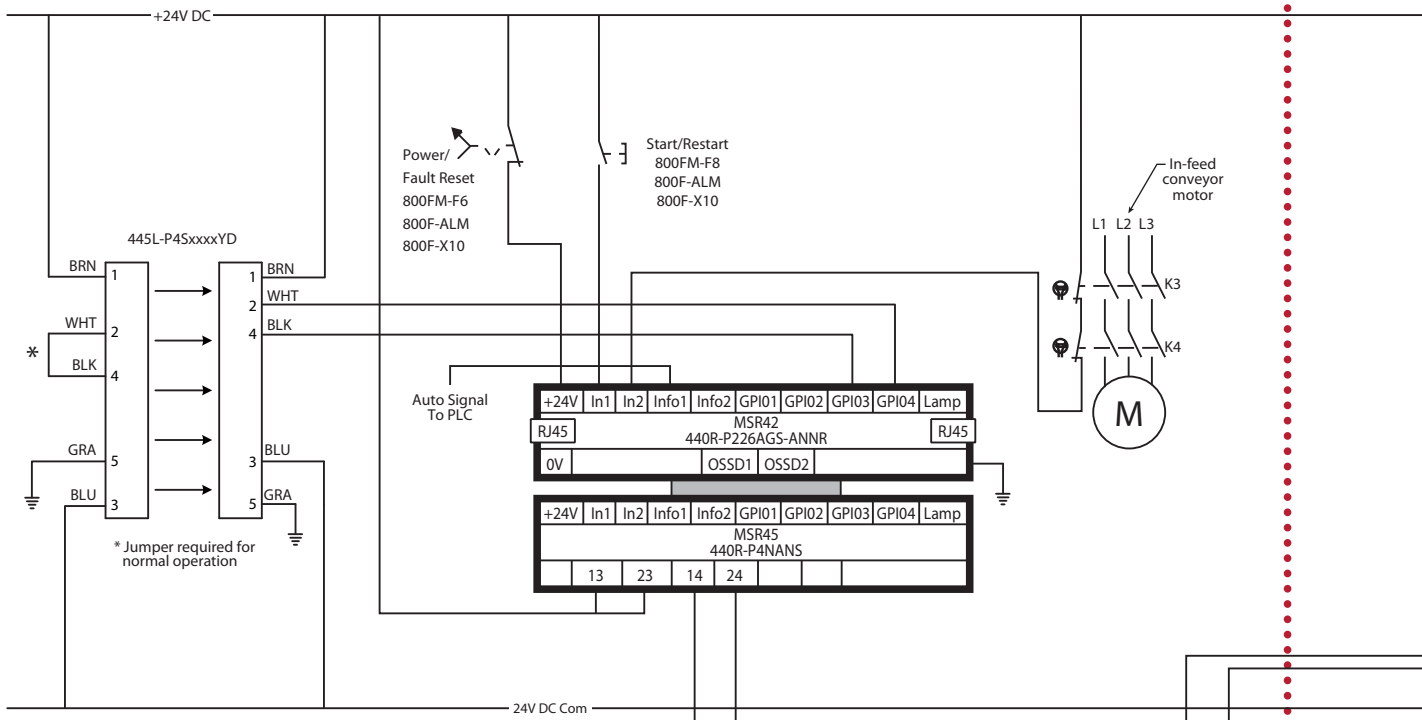
Allen-Bradley

Guardmaster®

Palletiser Functional Safety Specification

Non-muted Light Curtain (generally in-feed conveyor), pages 6...7



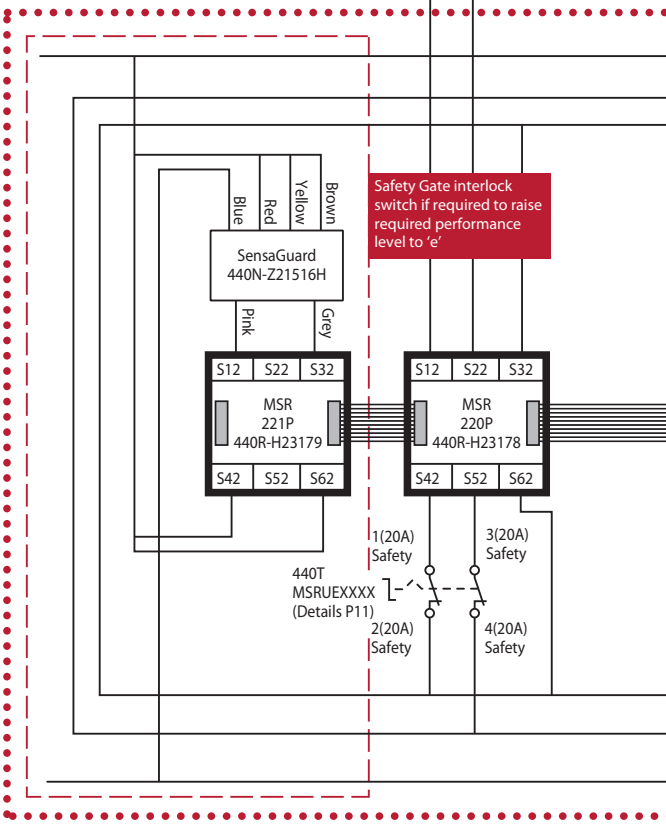
Overview

This document has been developed to provide guidance on the integration of a complete safety related control system for palletiser / depalletiser equipment. The specification covers the implementation from input devices to final power element.

The diagrams in this document should be used in conjunction with the additional recommendations detailed in:

- EN 60204-1 - Safety of machinery - Electrical equipment of machines
- EN 415-4 - Safety of packaging machines, Part 4 - palletisers and depalletisers

When implemented correctly the circuits described in this whitepaper will comply with the requirements for **PLe to EN ISO 13849-1; SIL 3 to IEC 62061; and category 4 to EN 954-1.**



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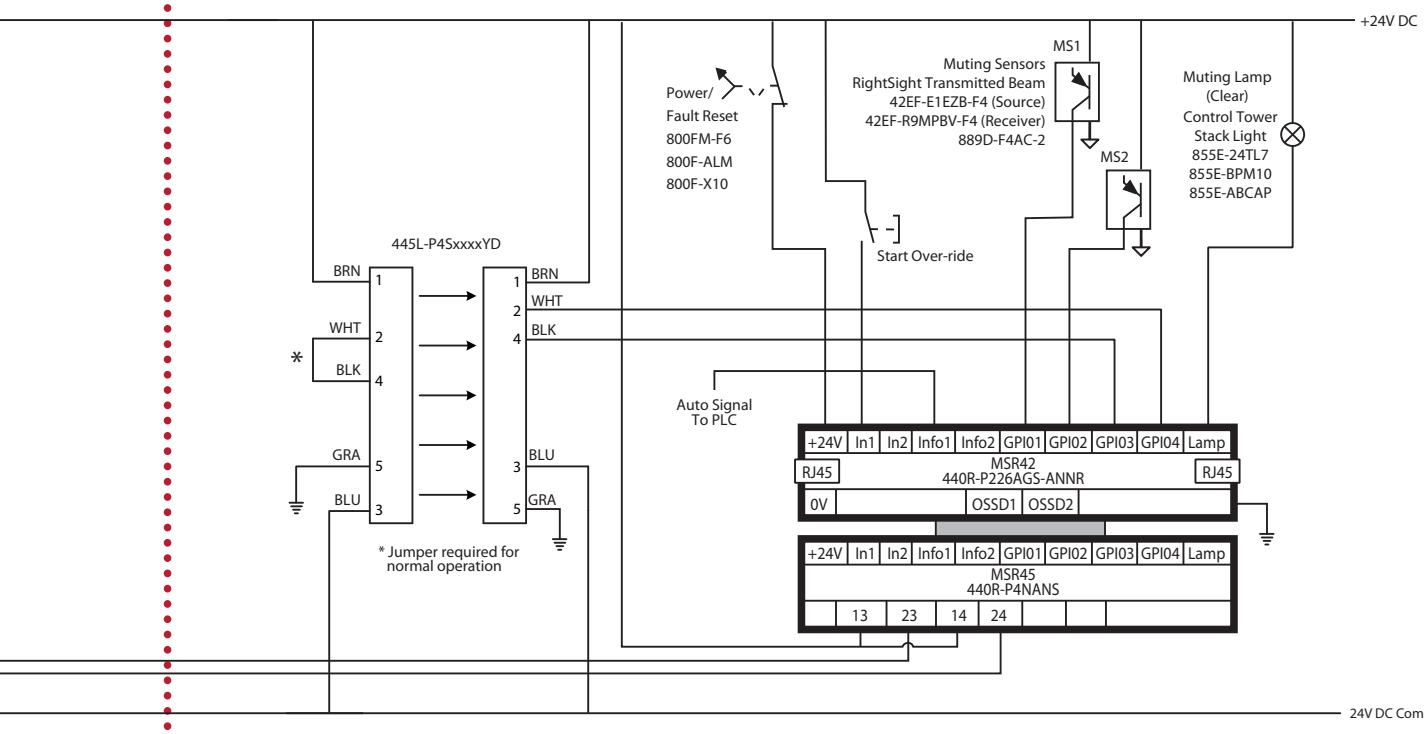
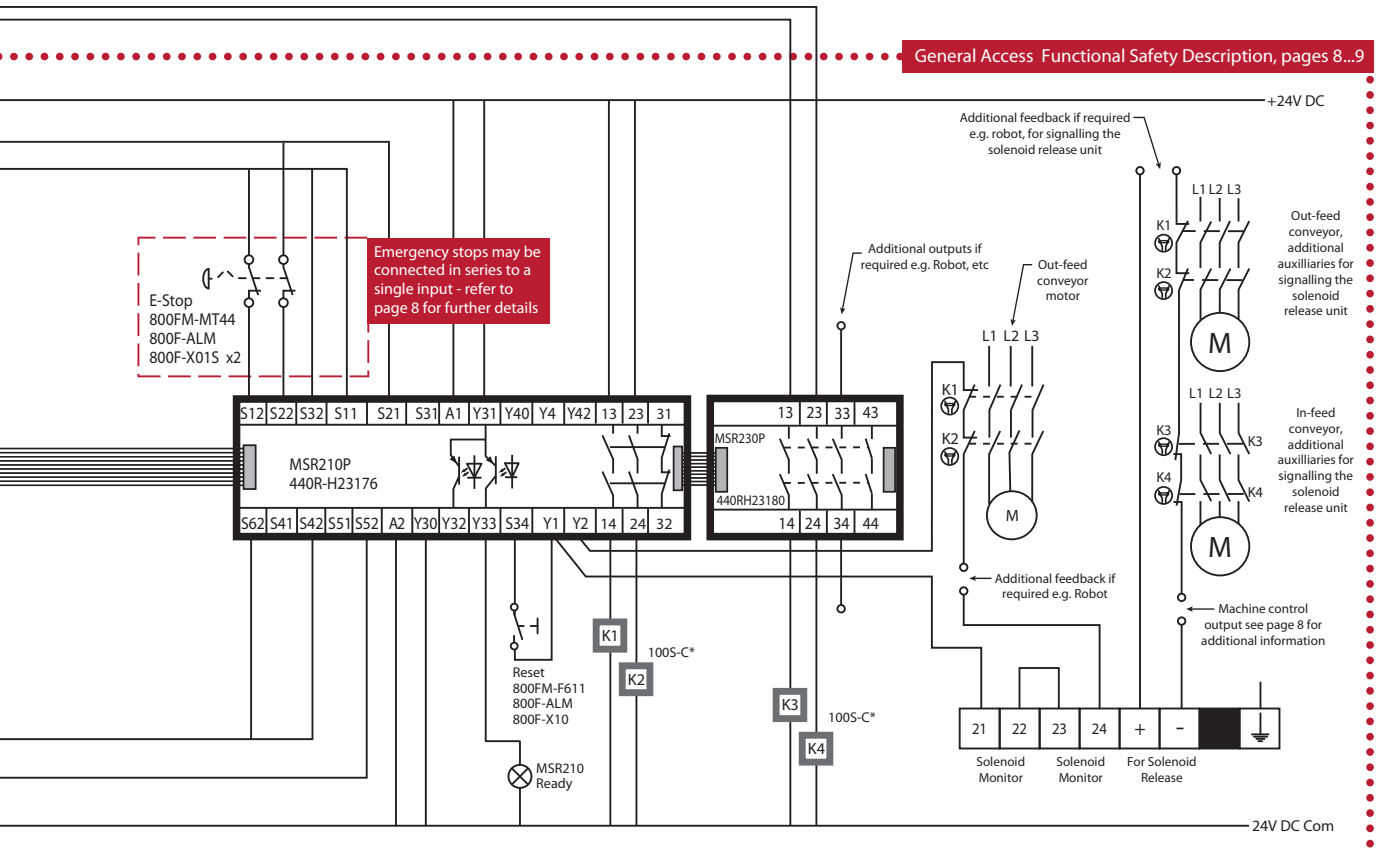
Muted Light Curtain (generally out-feed conveyor), pages 4...5



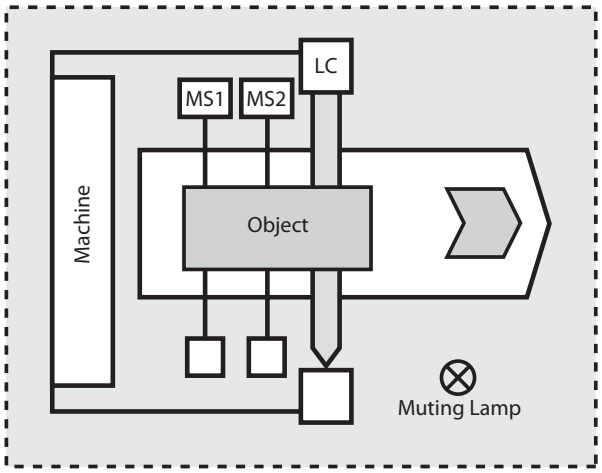
General Access Functional Safety Description, pages 8...9



Palletiser
Functional Safety Description

Circuit Status

The light curtain is clear. The muting sensors are clear. The outputs of the safety relay are de-energized, and the motor is off.



Uni-directional muting: Muting requires the material to break the beams and light curtain in a certain sequence: sensor MS1 first then MS2 and then the light curtain. Only if the beams are broken in sequence and then clear in sequence will the light curtain allow material through without initiating a machine stop.

Operating Principle

The MSR42 can be configured for automated conveyor applications, where an object moves through a light curtain out of a hazardous area. With L-type two sensor muting , the object can move only in one direction.

STARTING: Upon initial power-up, the start/restart button must be pressed to energize the outputs of the MSR42 and attached MSR45 extension relay. On the basis that all other conditions are clear this will start the motor.

MUTING: The object must block the sensor MS1 and then MS2 within the configured time limits prior to passing through the light curtain. The motor continues running during the muting operation.

STOPPING: Obstructing the light curtain without blocking sensors MS1 and MS2 de-energizes the MSR42/MSR45 outputs. After clearing the light curtain, press the start/restart button to re-energize the safety outputs of the MSR42/MSR45. Clearing the light curtain can also be managed by activating the override function (pressing the spring-loaded key).

Fault Detection

Upon power-up, the connected GuardShield light curtain, as well as the MSR42, performs internal checks. If OK and the protection field of the connected GuardShield light curtain is clear, the outputs will turn on after the start signal. For power up, the muting sensor can be blocked. If so the outputs can be turned on, but the muting process cannot be activated because the muting sequence is not adhered to. The blocking material must be transported backwards, clearing the sensors first, or must be transported forwards through the protection field using the override functionality.

While running, an incorrect sequence of the complete muting sequence (MS1->MS2->LC) or excessive time to move the object through the muting zone will de-energize the safety outputs of the MSR42/MSR45. The muting lamp blinks to indicate a fault has occurred. The exact fault can be read out using the USB-configuration tool.

If the override functionality is activated in the MSR42, a simple re-activation of the start button may be used to manually move material through the conveyor. The outputs of the MSR42 will then stay activated for the configured override time. If the protection field is cleared during that time the motor continues running. If the light curtain is still blocked after that time the MSR42 will deactivate the safety outputs.

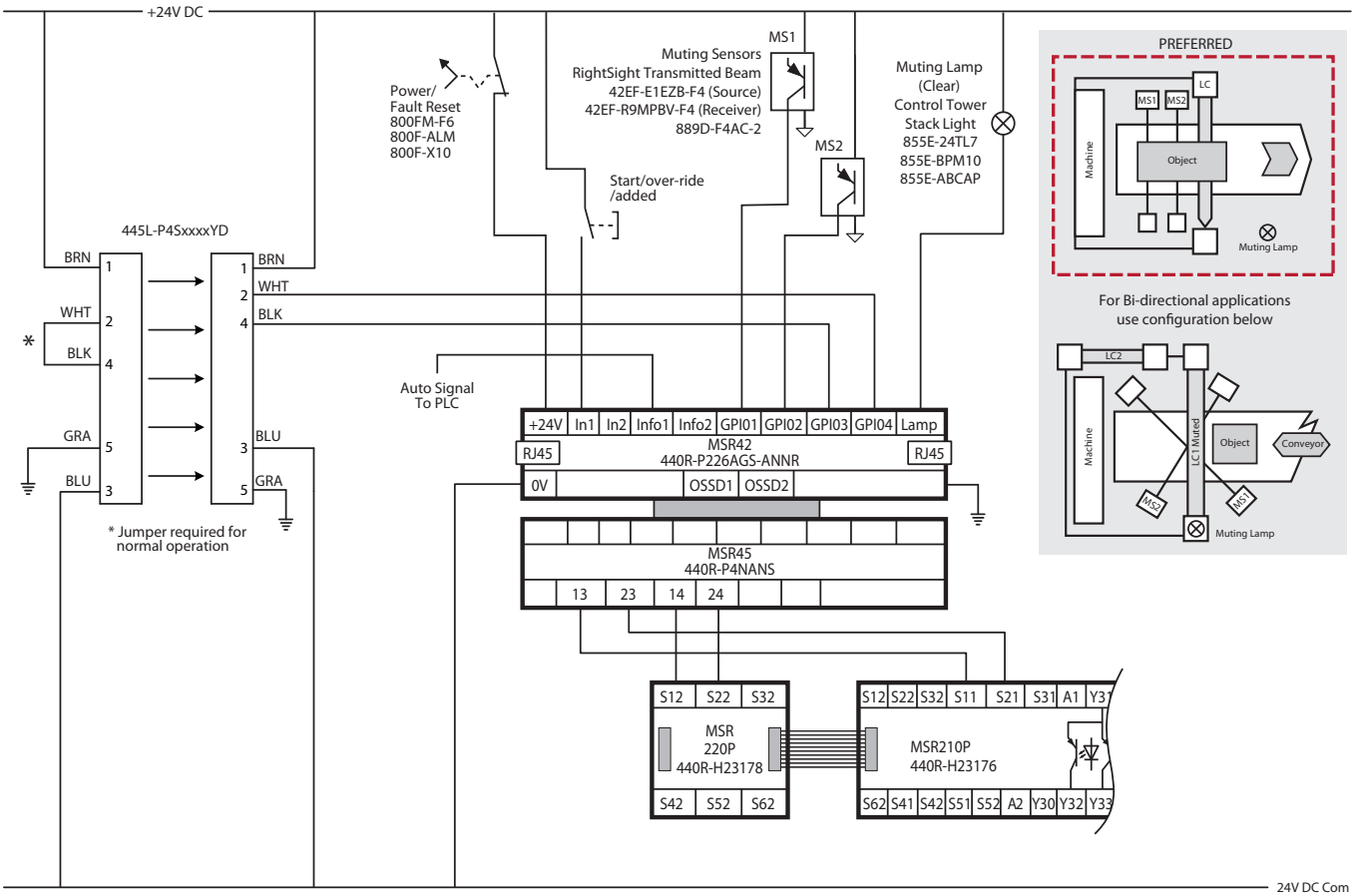
Under circumstances where openings in the muted material lead to a failure in the muting sequence, a muting sensor delay function can be activated in the MSR42 to accomodate the variability in the material.

The outputs of the MSR45 extension relay are connected to the MSR220P input module. The MSR210P base module monitors contactors K1 and K2 through the mechanically linked contacts connected in series. If one contactor welds or jams closed, the second contactor will stop the motor and the MSR210P will detect the fault at the next attempt to start the motor.

Ratings

This circuit meets the safety performance requirements of Category 4 of EN954-1:1998, PL e of EN ISO 13849-1 or SILcl 3 of IEC 62061.

This circuit executes a Category 0 stop.



Light curtain selection			
Protected Height (mm (in))	**14mm (0.55in)) Number of Beams**	**30mm (1.18in) Number of beams**	**Catalogue Number**
960 (37.8)	128	64	445L-P4*0960YD
1080 (42.5)	144	72	445L-P4*1080YD
1200 (47.2)	160	80	445L-P4*1200YD
1320 (52.0)	176	88	445L-P4*1320YD
1440 (56.7)	192	96	445L-P4*1440YD
1560 (61.4)	208	104	445L-P4*1560YD
1680 (66.1)	224	112	445L-P4*1680YD
1800 (70.9)	240	120	445L-P4*1800YD
1920 (75.6)	256	128	445L-P4*1920YD

* For 14mm resolution replace with an L and for 30mm resolution replace with an S. Example: 445L-P4S0600YD

Ie {A}	Contactor Selection		
AC-3	**AC-1**	**3ØkW (50 Hz)**	**Catalogue Number**
9	32	4	100S-C09**22BC
12	32	5.5	100S-C12**22BC
16	32	7.5	100S-C16**22BC
23	32	11	100S-C23**22BC
30	65	15	100S-C30**22BC
37	65	18.5/20	100S-C37**22BC
43	85	22	100S-C43**22BC
60	100	32	100S-C60**22BC
72	100	40	100S-C72**22BC
85	100	45	100S-C85**22BC

** To complete the Cat. No. select a coil voltage code from the table on page 13

Light Curtain Functional Safety Description

Circuit Status

The light curtain is unobstructed. The MSR42 outputs are off. The MSR210P and associated MSR230P outputs are off. The motor is ready to run.

Operating Principle

The MSR42 is a multi-function relay. In this application the in-feed conveyor is protected by a safety light curtain and the MSR42 is in a basic configuration. The outputs from the MSR42 are connected to the contactors K3 and K4 through the MSR230P expansion relay. If any of the inputs (muted safety light curtain, emergency stop(s), solenoid release switch or safety gate interlock switch if connected) are activated, the MSR230P will de-energise contactors K3 and K4 regardless of the state of the MSR42.

STARTING: Press the start button to energise the outputs of the MSR42. Press the reset button to energise the outputs of the MSR210P and start the motor.

STOPPING: Activating the light curtain de-energizes the MSR42 safety outputs and the motor coasts to a stop. After clearing the light curtain, press the start/ restart button to re-energize the safety outputs of the MSR42.

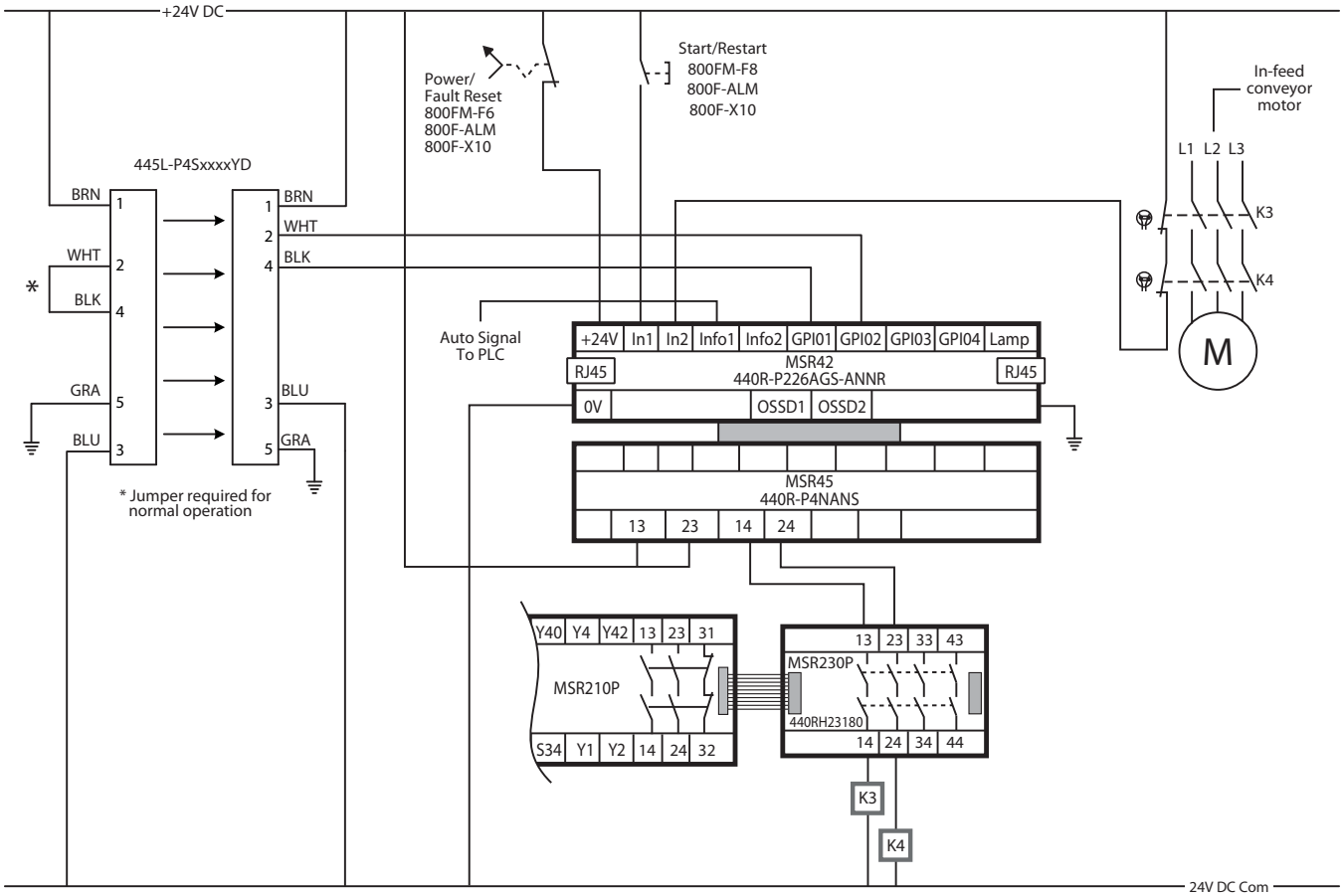
Fault Detection

Upon power-up, the connected GuardShield light curtain and the MSR42 perform internal checks. If OK and the protection field of the connected GuardShield light curtain is clear, the outputs will turn on in response to the start signal.

Ratings

This circuit meets the safety performance requirements of Category 4 of EN954-1:1998, PL e of EN ISO 13849-1 or SiLcl 3 of IEC 62061.

This circuit executes a Category 0 stop.



Light curtain selection			
Protected Height (mm (in))	**14mm (0.55in)) Number of Beams**	**30mm (1.18in) Number of beams**	**Catalogue Number**
960 (37.8)	128	64	445L-P4*0960YD
1080 (42.5)	144	72	445L-P4*1080YD
1200 (47.2)	160	80	445L-P4*1200YD
1320 (52.0)	176	88	445L-P4*1320YD
1440 (56.7)	192	96	445L-P4*1440YD
1560 (61.4)	208	104	445L-P4*1560YD
1680 (66.1)	224	112	445L-P4*1680YD
1800 (70.9)	240	120	445L-P4*1800YD
1920 (75.6)	256	128	445L-P4*1920YD

* For 14mm resolution replace with an L and for 30mm resolution replace with an S. Example: 445L-P4S0600YD

Ie {A}	Contactor Selection		
AC-3	**AC-1**	**3Ø kW (50 Hz)**	**Catalogue Number**
9	32	4	100S-C09**22BC
12	32	5.5	100S-C12**22BC
16	32	7.5	100S-C16**22BC
23	32	11	100S-C23**22BC
30	65	15	100S-C30**22BC
37	65	18.5/20	100S-C37**22BC
43	85	22	100S-C43**22BC
60	100	32	100S-C60**22BC
72	100	40	100S-C72**22BC
85	100	45	100S-C85**22BC

** To complete the Cat. No. select a coil voltage code from the table on page 13

General Access
Functional Safety Description

Circuit Status

The muted light curtain (out-feed conveyor) is unobstructed. The in-feed light curtain is unobstructed. The Solenoid switch inputs are also closed. The emergency stop is reset and the safety gate is closed. The MSR210 outputs are off. The out-feed/ in-feed conveyor motors are stopped.

Operating Principle:

The MSR200 is chosen as the safety relay for its modularity and ability to handle a variety of devices and to allow each device to be connected to an individual input. There is also the facility to add additional communication modules (not shown) to enable the transmission of individual status information to the machine control system.

The schematic shown opposite has a light curtain (out-feed conveyor) connected to its inputs through a mute controller. The sensaguard switch mounted on the gate access, in addition to the trapped key solenoid release unit, will allow the integrity to achieve PLe, according to EN ISO 13849-1, if required. Normally PLd will be adequate .The emergency stop(s) can be wired individually to input modules to give enhanced diagnostics if required. However, connection in series to achieve PLd will be adequate in most circumstances. The additional light curtain controller (in-feed conveyor) is connected through the MSR230P output module and acts as a permissive. If the emergency stop, or sensaguard/solenoid switch pairing are activated, these outputs will switch off regardless of whether the light curtain is obstructed or not.

STARTING:

Press the reset button to energise the outputs of the MSR210 and start the motor(s).

STOPPING:

Activating any one of the safety devices (light curtain, emergency stop, gate switch or solenoid release switch) de-energises the MSR210 outputs and the motor coasts to a stop. If a safety device is activated, the motor cannot restart.

Fault Detection

Upon successful completion of internal checks on power up, the MSR210P checks the input circuits. Short circuits from inputs to power, to ground, or to other inputs will be detected immediately by the MSR210P and will prevent energisation or will de-energise all of its outputs. If one of the 100S-C safety contactors (K1, K2, K3, etc) fails in an actuated state, the motor will be stopped by the redundant contactor. This type of fault will be detected by the MSR210P on the next attempt to start, and the MSR210P will not energise its outputs when the reset button is pressed.

Ratings

This circuit meets the safety requirements of PLe of EN ISO 13849-1, SILcL 3 of IEC 62061 and Category 4 of EN 954-1.

This circuit executes a Category 0 stop.

Solenoid Release Function

The machine control output for the solenoid release, shown opposite, is switched by the standard machine control.

To close this contact the control system will be signaled to stop (from an HMI, etc) and this contact would latch in.

The solenoid will be energised provided all the solenoid release auxiliaries are correct and the machine control output is present.

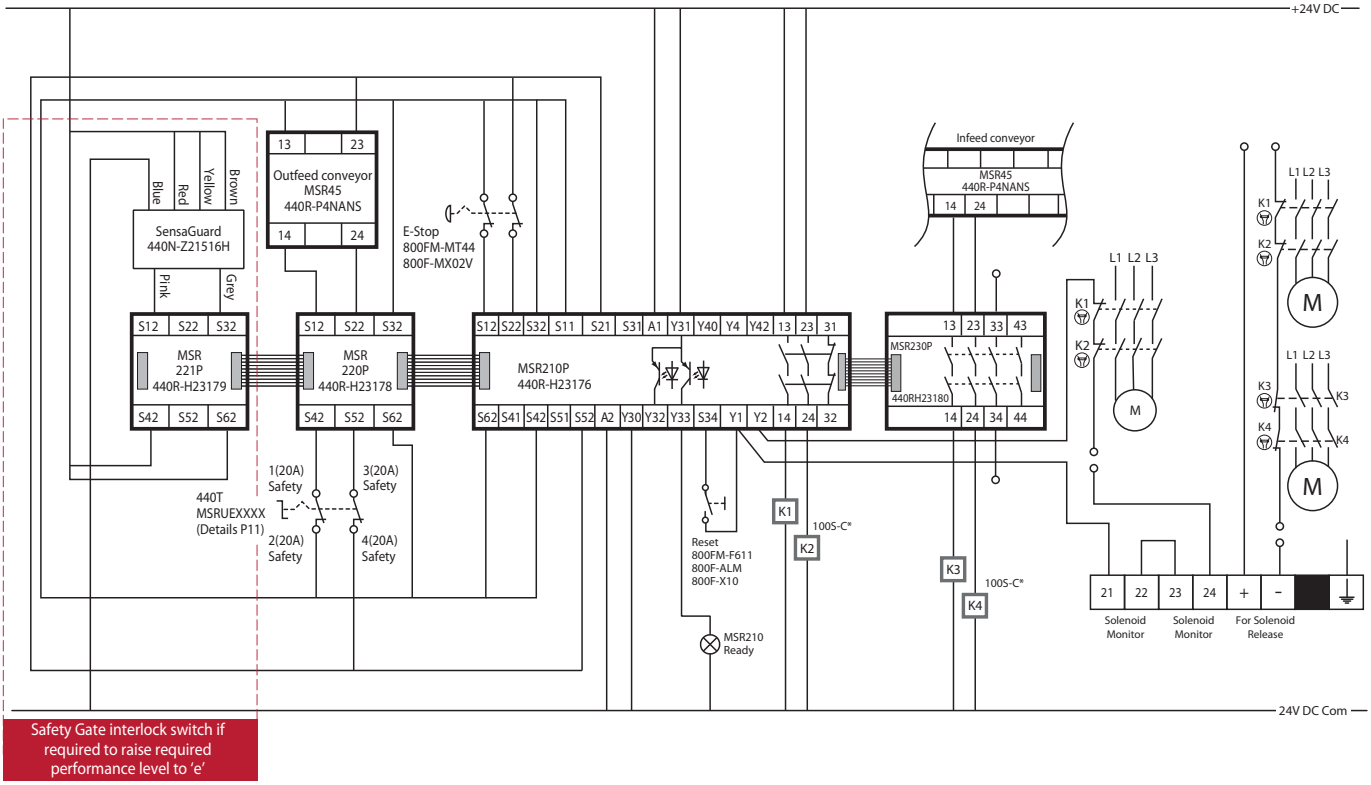
On turning the key in the solenoid release unit the solenoid release signal is de-energised, but allows the key to be re-inserted.

Provided all the auxiliaries in the reset loop to the MSR210P are in the correct state the machine can be reset.

The inputs to the standard PLC are as follows:

Contacts 31&32 on the MSR210P base unit (440R-H23176) would provide a N/C input to the standard PLC to signal a latch.

Contacts 5&6 on the solenoid release unit (440T-MSRUEXXXX) would provide a signal to the standard PLC to unlatch.



Light curtain selection			
Protected Height (mm (in))	**14mm (0.55in)) Number of Beams**	**30mm (1.18in) Number of beams**	**Catalogue Number**
960 (37.8)	128	64	445L-P4*0960YD
1080 (42.5)	144	72	445L-P4*1080YD
1200 (47.2)	160	80	445L-P4*1200YD
1320 (52.0)	176	88	445L-P4*1320YD
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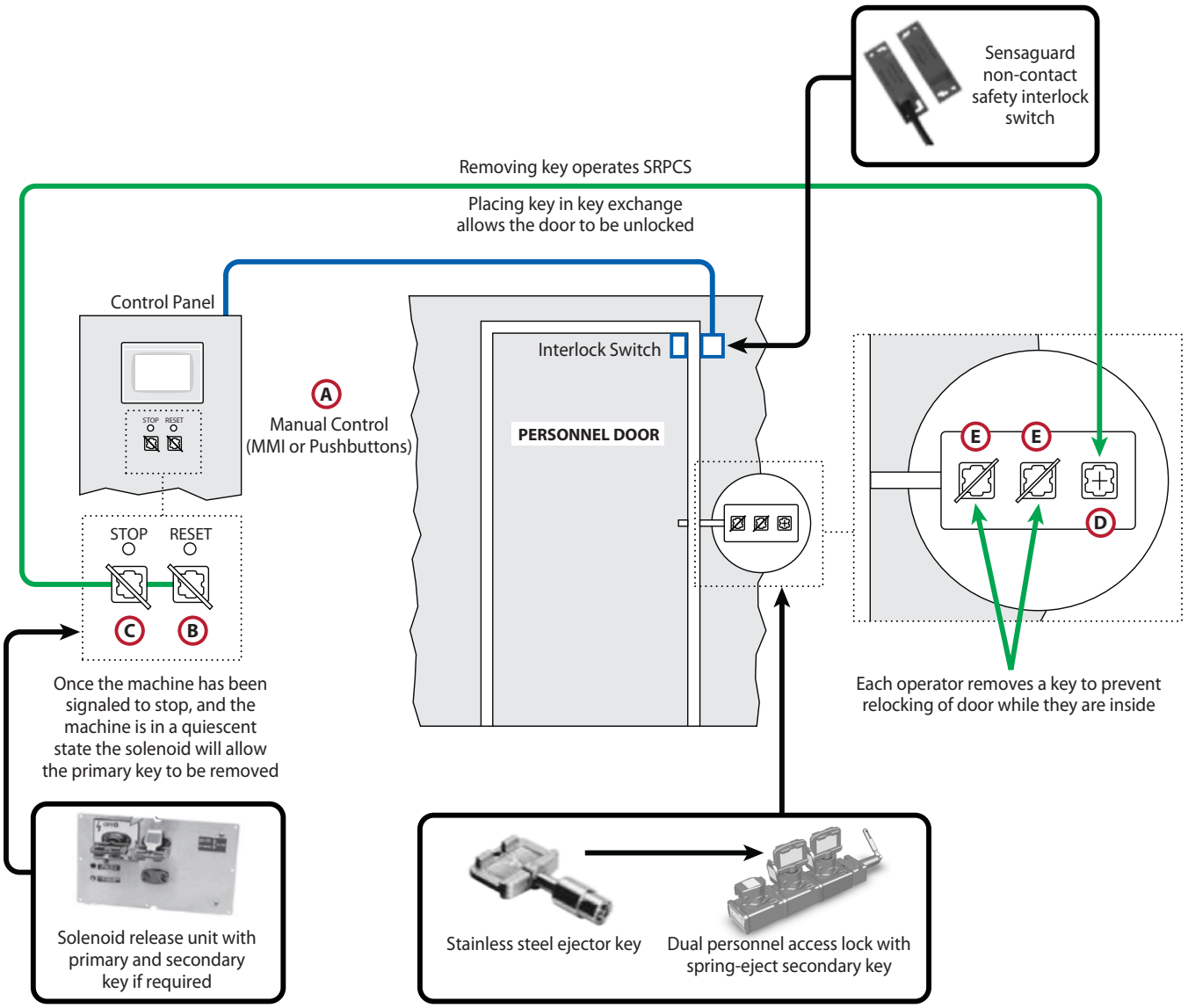
1560 (61.4)	208	104	445L-P4*1560YD
1680 (66.1)	224	112	445L-P4*1680YD
1800 (70.9)	240	120	445L-P4*1800YD
1920 (75.6)	256	128	445L-P4*1920YD

* For 14mm resolution replace with an L and for 30mm resolution replace with an S. Example: 445L-P4S0600YD

Ie {A}	Contactor Selection		
AC-3	**AC-1**	**3Ø kW (50 Hz)**	**Catalogue Number**
9	32	4	100S-C09**22BC
12	32	5.5	100S-C12**22BC
16	32	7.5	100S-C16**22BC
23	32	11	100S-C23**22BC
30	65	15	100S-C30**22BC
37	65	18.5/20	100S-C37**22BC
43	85	22	100S-C43**22BC
60	100	32	100S-C60**22BC
72	100	40	100S-C72**22BC
85	100	45	100S-C85**22BC

** To complete the Cat. No. select a coil voltage code from the table on page 13

Personnel Access
Functional Safety Description

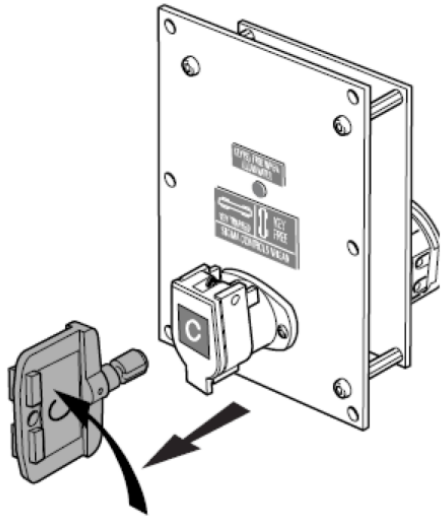


At least one interlocked moveable guard (personnel door) shall be provided to allow operators and maintenance staff to enter the danger zone. The design of the personnel door or its interlocking device shall minimise the risk of the door closing accidentally i.e. closing the door shall require a deliberate action.

The SRPCS for access shall be in accordance with the diagram left, and shall operate as follows:

A A manual control shall be supplied on the control panel which controls the machinery in the danger zone (this control can be by means of a pushbutton operator or HMI (Human Machine Interface). When this is operated the machinery in that danger zone shall assume a quiescent state.

B Once in this state and provided that all energy sources are isolated the control system shall allow the release of a key on the front of the control panel.



C If more than one access gate is required, an additional key can be incorporated if required. There shall be a unique key for each personnel gate. Removing the key initiates the SRPCS and puts the machinery in that danger zone into a safe state for entry.

D The control panel key can then be taken to the personnel gate and placed into a key exchange. This action unlocks the gate and releases a spring ejector key which the operator takes into the danger zone with him. This second key (personnel protection key) shall prevent the personnel door from being closed and locked behind him. It shall also prevent the re-insertion of the key required to allow the resetting and restarting the machinery in the danger zone.

E Two keys shall be available at the gate allowing two operators to enter the danger zone.

Resetting and restarting shall be at the control panel but shall only be possible after the correct reversal of the sequence described above has been followed, and provided the feedback loop containing the solenoid monitoring on the solenoid locking switch is correct.

Using this technique allows a maximum Performance Level of d (PLd) in accordance with BS EN ISO 13849:2008. If a PLe is required then an interlocking gate switch shall be used in accordance with drawing shown and the general access safety description. Generally, PLd is sufficient for NUK needs.

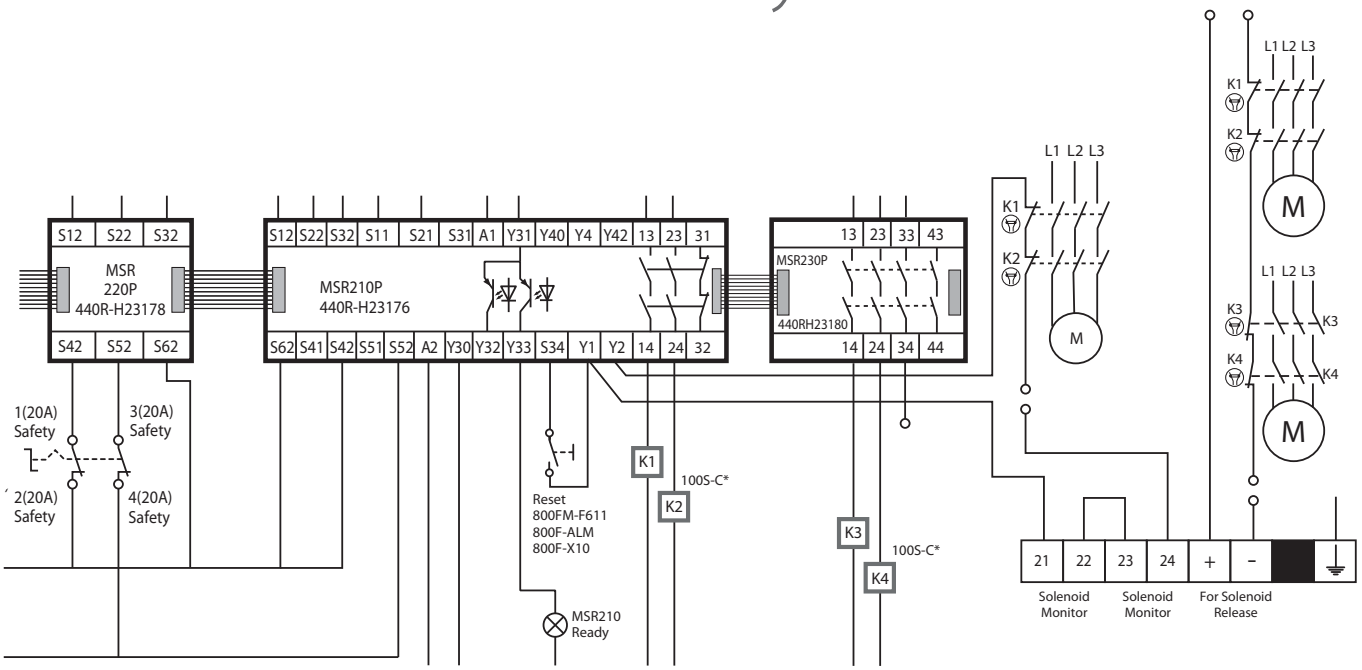
In the Health and Safety section of the Instruction Manual the following information shall be given:

i) It shall stress the importance of the operator taking the key with him into the machine (this is particularly important when more than one operator are within the palletiser) and not attaching the key to the guards e.g. with a piece of string.

ii) It shall state that in the event that more than two persons require access at any one time, then a specific risk assessment and method statement shall be drawn up to ensure that all those who have entered the danger zone have left it before the machinery is set in motion.

Solenoid release units - product selection			
Solenoid Voltage	**Contacts**	**Nominal Current**	**Catalogue Number**
24V DC	2 N.O. & 2 N.C.	20A	440T-MSRUE11ⓘ
	4 N.O.		440T-MSRUE10ⓘ
110 VAC	2 N.O. & 2 N.C.		440T-MSRUE22ⓘ
	4 N.O.		440T-MSRUE20ⓘ
230V AC	2 N.O. & 2 N.C.		440T-MSRUE33ⓘ
	4 N.O.		440T-MSRUE30ⓘ
110V DC	2 N.O. & 2 N.C.		440T-MSRUE44ⓘ
	4 N.O.		440T-MSRUE40ⓘ
	3 N.O. & 3 N.C.		440T-MSRUE46ⓘ
ⓘ Substitute the desired primary code for this symbol i.e. AA, AB, etc			

MSR200 connection details for solenoid release key



Access is only permitted if the palletiser out-feed contactors (K1&K2), in-feed contactors (K3&K4) and any additional feedback connections i.e. robot control have de-energised.

Provided that all the output devices have de-energised, the solenoid is energised allowing the control panel key to be removed (and any additional keys if multiple gates are present/required).

Once the solenoid is energised the key can be rotated to the off position. This disconnects contacts 1&2 and 3&4 on the isolator and switches the inputs on the MSR220P to "off" (effectively performing an emergency stop command).

The machine can only be energised provided all the control panel keys are inserted and rotated to the on position. On the basis that the solenoid monitoring contacts and any feedback connections are correct, the machine can then be restarted.

Coil voltage codes
Referenced from pages 5, 7 & 9

The Cat. No. as listed is incomplete. Select a coil voltage code from the table below to complete the Cat. No.
Example: 120V, 60 Hz: Cat. No. **100S-C09**404BC** becomes Cat. No. **100S-C09D404BC**

[V]	12	24	32	36	42	48	100	100-110	110	120	127	200	200-220	208	208-240
AC, 50 Hz	R	K	V	W	X	Y	KP	–	D	P	S	KG	L	–	–
AC, 60 Hz	Q	J	–	V	–	X	–	KP	–	D	–	–	KG	H	L
AC, 50/600 Hz	–	KJ	–	–	–	KY	KP	–	KD	–	–	KG	KL	–	–

[V]	220-230	230	230-240	240	277	347	380	380-400	400	400-415	440	480	500	550	600
AC, 50 Hz	F	–	VA	T	–	–	–	N	–	G	B	–	M	C	–
AC, 60 Hz	–	–	–	A	T	I	E	–	–	–	N	B	–	–	C
AC, 50/600 Hz	KL	KF	–	KA	–	–	–	–	KN	–	KB	–	–	–	–

[V]			9	12	24	36	48	60	64	80	110	115	125	220	230	250
100S-C09...C23	Standard	DC	ZR	ZQ	ZJ	ZW	ZY	ZZ	ZB	ZE	ZD	ZP	ZS	ZA	ZF	ZT
	With integrated diode		–	–	DJ	–	–	–	–	–	–	–	–	–	–	–

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