

EUROMAP 78.1

**Electrical Interface
between Injection Moulding Machines
and External Safety Devices with Double
Acknowledgement System**

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History

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Contents		Page
1	Introduction	4
1.1	Scope and Application	4
1.2	References	5
2	Description.....	5
2.1	Guard locking function	5
2.2	Double Acknowledgement	5
2.3	Plug and socket outlets.....	7
2.4	Contact specification	7
2.4.1	Emergency stop, safety device	7
2.4.2	Logical Signals	7
2.4.3	Reference potential	7
2.4.4	Performance levels of signals	8
2.5	Plug contact assignment.....	8
3	Sequence for guard locking.....	10
4	Schematic drawing of the interface.....	11
5	Compatibility between EUROMAP 78 and EUROMAP 78.1	12
6	Sources of supply	13

1 Introduction

1.1 Scope and Application

This EUROMAP recommendation defines the interface between an injection moulding machine (IMM) and an external safety device, e.g. doors in fences around an IMM, preventing access to the danger areas of the IMM where there is the possibility to reach into the area requiring a higher safety level as specified in ISO 20430:2020 "Plastics and rubber machines – Injection moulding machines – Safety requirements". This is intended to provide interchangeability.

EUROMAP 78.1 requires a two-channel safe signal in accordance with specified Performance Levels which can be delivered by a safety device and/or safety control unit.

The interface is only used for the connection between IMM and external safety device covering the hazards related to the IMM. It is a supplement to any interfaces between injection moulding machines and peripheral devices (e.g. EUROMAP 67) for the transmission of safety signals to the injection moulding machine.

It is assumed, that an external safety device is used in parallel to the machine door. It is the task of the machine control to check if the machine door is present/closed and locked (if applicable) or the safety signal from the interface is active before dangerous movements of the IMM are initiated.

This recommendation defines two subtypes:

- Subtype A: External safety device with guard locking
- Subtype B: External safety device without guard locking

EUROMAP 78.1 solves the potential problem of EUROMAP 78, which does not distinguish between a single and a double acknowledgement system. According to ISO 20430:2020, a double acknowledgement system becomes necessary when whole-body access to the mould area is possible and it is not possible to use presence detecting devices (e.g. machines with third platen or rotary table in the middle of the mould area). In this case, also the external safety device shall have a double acknowledgement system.

EUROMAP 78 and EUROMAP 78.1 use the same plug and EUROMAP 78.1 only adds the signals on pins a10, b10, a11, b4 to explicitly confirm the double acknowledgement system. The IMM decides if the confirmation of the double acknowledgement system is required or the signals included in EUROMAP 78 are sufficient.

In addition, recommendations are given for signal voltage and current levels.

This recommendation does not cover signals from the IMM to a handling device or other auxiliary equipment that is also protected by the external safety device. If safety signals are necessary for this equipment, this falls under the responsibility of the user/ integrator, especially for any modifications after delivery of the IMM.

1.2 References

Short name	Title	Version
ISO 20430	Plastics and rubber machines – Injection moulding machines – Safety requirements	2020
EN 61131-2	Programmable controllers – Part 2: Equipment requirements and tests	2007
EN ISO 13849-1	Safety of machinery – Safety-related parts of control systems – Part 1: General principles for design	2015
EN ISO 14119	Safety of machinery – Interlocking devices associated with guards – Principles for design and selection	2013
ISO/IEC 17025	General requirements for the competence of testing and calibration laboratories	2017
EUROMAP 67	Electrical Interface between Injection Moulding Machine and Handling Device / Robot	1.11 May 2015
EUROMAP 78	Electrical Interface between Injection Moulding Machines and External Safety Devices	1.1 October 2020

2 Description

The signals in both the injection moulding machine and the external safety device are given by contacts, e.g. contacts of relays or switches, semiconductors, etc. The contact making is either potential-free or related to a reference potential supplied to a contact of the plug mounted on the injection moulding machine (see tables 1 and 2).

2.1 Guard locking function

If an external safety device with guard locking is used the following requirements shall be met:

- the guard locking shall be designed for protection of a person as defined in 3.28 of EN ISO 14119;
- the unlocking function shall be a conditional unlocking as described in 4.3.1 of EN ISO 14119;
- for the guard locking device, well tried components in accordance with $PL_r = c$ (EN ISO 13849-1) shall be used;
- the guard locking function shall be monitored;
- the holding force of the guard locking shall be at least 1000 N.

2.2 Double Acknowledgement

EUROMAP 78.1 required the use of a double acknowledgement system according to ISO 20430:2020, Annex F.2.

A double acknowledgement system becomes necessary when whole-body access to the mould area is possible and it is not possible to use presence detecting devices (e.g. machines with third platen or rotary table in the middle of the mould area). In this case, also the external safety device shall have a double acknowledgement system.

If a single acknowledgement system is sufficient, the IMM can ignore the signals on pins a10, b10, a11, b4 and is then also compatible with external safety devices supporting EUROMAP 78 only.

A double acknowledgement system shall consist of a first acknowledgement switch 1 located inside of the protected area in full view of the mould area and a second acknowledgement switch 2 located

outside of the protected area and with an unobstructed view of this area which cannot be actuated from inside the protected area.

The start of a cycle shall be enabled only after the following sequence has been completed within a time interval fixed by the manufacturer depending on the size of the machine and distance between the two switches:

1. Actuation of first acknowledgement switch 1;
2. Close operator's gate or exit the protected area interrupting the light curtain;
3. Actuation of second acknowledgement switch 2.

Actuating the acknowledgement switches shall not initiate a hazardous movement.

A monitoring circuit shall be provided to check the operation of each acknowledgement switch. If improper operation or sequencing is detected, the cycle of the machine shall be inhibited and an alarm shall be activated. Automatic monitoring of the acknowledgement system may be carried out by the programmable controller.

If the external safety device has several doors, a common acknowledgement switch located inside the guarded area is permitted if the following conditions can be met:

- From the position of the switch, the operator has a full view of the protected area
- If more than one door is open, then the first acknowledgement switch inside the protected area shall be activated before closing each door.

Figure 1 shows the sequence of actuating the switches with common acknowledgement switch located inside the guarded area and several doors open. In this example the common acknowledgement switch shall be activated three times so that for each door the steps described above are fulfilled.

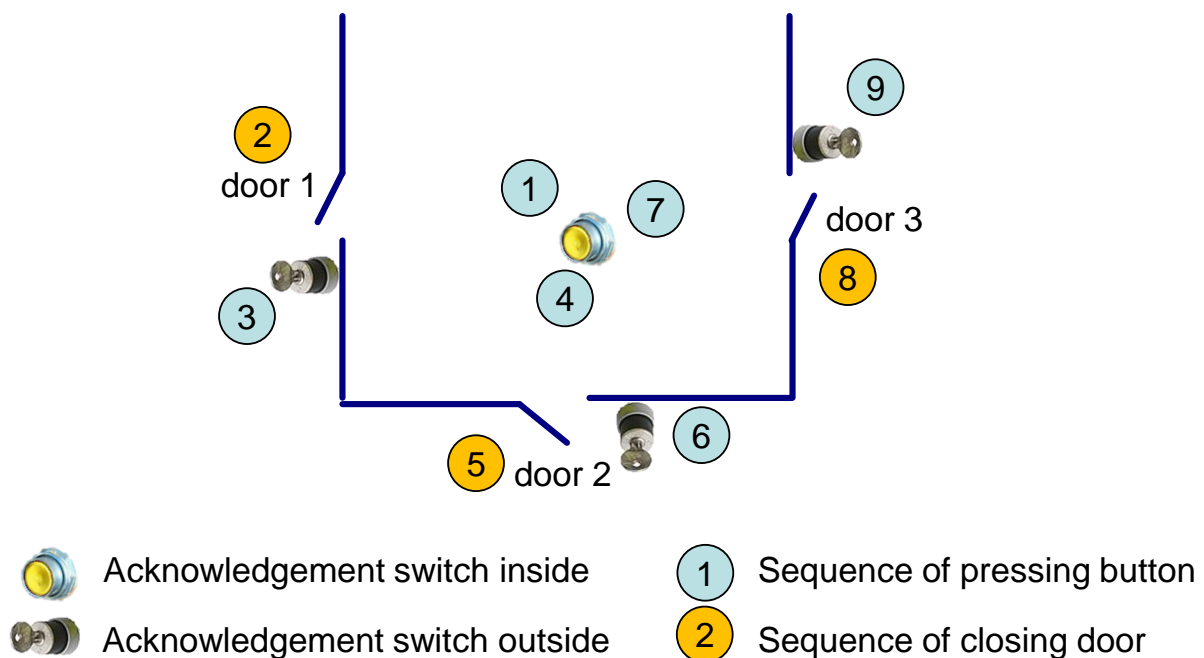


Figure 1: Sequence of actuating the switches with common acknowledgement switch located inside the guarded area and several doors open

2.3 Plug and socket outlets

The connection between the injection moulding machine and the external safety device is achieved by the plugs specified below. For the injection moulding machine (see Figure 3) and the external safety device (see Figure 2) the plug contacts should be capable of taking a minimum of 250 V and 10 A.

Arrangements of pins and sockets viewed from the mating side (opposite the wiring side)

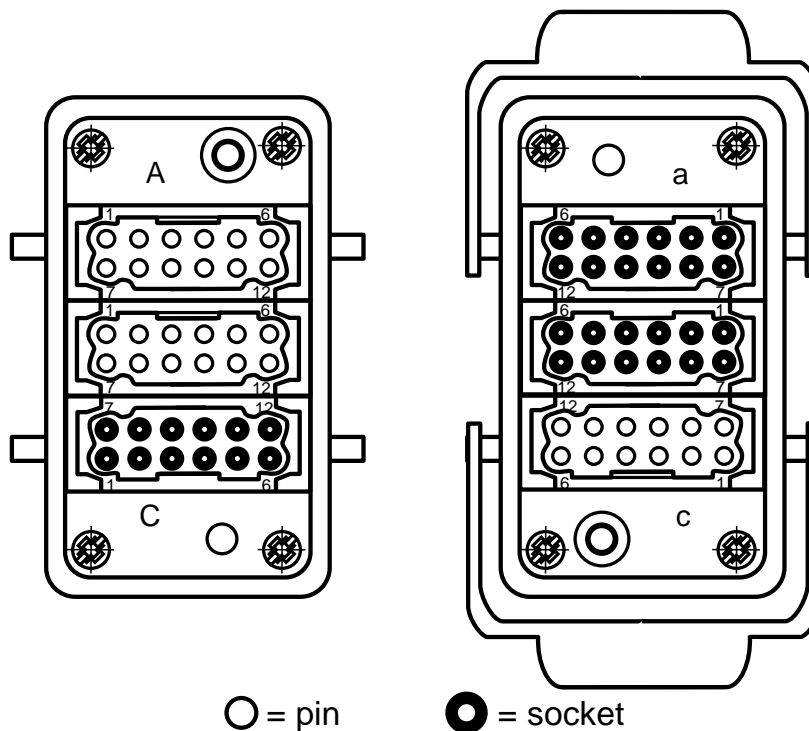


Figure 2: Plug on the external safety device

Figure 3: Plug on the injection moulding machine

2.4 Contact specification

2.4.1 Emergency stop, safety device

- The voltages of the signals must not exceed 50 V DC.
- A current of at least 6 mA must be maintained during signalling.
- The maximum current is 2 A.

2.4.2 Logical Signals

These signals shall be in accordance with clause 5.2.2.1 of EN 61131-2, Table 9, Type 2 or with clause 5.3.1 of EN 61131-2, Table 11, max. 0,1 A unless otherwise specified.

The signals can be provided from safety switches mounted directly on safety guards, or from other equipment (e.g. safety control devices).

2.4.3 Reference potential

- Voltage 18 – 36 V DC
- Overlaid ripple max. 2,5 V_{pp}
- Withstand against overvoltage up to 60 V for min.10 ms
- Current max. 2 A

2.4.4 Performance levels of signals

The signal "External safety devices closed" shall be in accordance with $PL_r = e$ (EN ISO 13849-1) or ISO 20430 clauses 4.1.4 and 4.2.

The "emergency stop signal" shall be in accordance with $PL_r = d$ (EN ISO 13849-1).

External safety devices purchased from a supplier shall be certified components according to $PL_r = e$.

External safety devices/system manufactured by the user/integrator shall be certified by a laboratory in accordance with ISO/IEC 17025:2017.

2.5 Plug contact assignment

Notes on the tables below:

- All signals except a1/a10, b1/b10, a2/a11, b2/b4 are the same as in EUROMAP 78
- All signals are continuous signals unless otherwise noted.
- The signals are conducted from the signal source to the respective pin.

**Table 1: Plug on the injection moulding machine
Signals from external safety device to IMM (female)**

Contact No. see fig. 2	Signal designation	Description	Subtype
a1/a7	External safety devices closed, acknowledged and guard locking active Channel 1	With safety guard closed and acknowledged the contact is closed. With safety guard NOT closed or NOT acknowledged the contact is open.	A
b1/b7	External safety devices closed, acknowledged and guard locking active Channel 2	With safety guard closed and acknowledged the contact is closed. With safety guard NOT closed or NOT acknowledged the contact is open.	A
a1/a10	Confirmation of double acknowledgement system Channel 1	Additional EUROMAP 78.1 signal confirming a double acknowledgement system Contact closed in addition to a1/a7 An injection moulding machine requiring a double acknowledgement system should wait for this signal. The signal can be generated by a bridge between contacts a7 and a10.	A
b1/b10	Confirmation of double acknowledgement system Channel 2	Additional EUROMAP 78.1 signal confirming a double acknowledgement system Contact closed in addition to b1/b7 An injection moulding machine requiring a double acknowledgement system should wait for this signal. The signal can be generated by a bridge between contacts b7 and b10.	A

Contact No. see fig. 2	Signal designation	Description	Subtype
a2/a8	External safety devices closed and acknowledged Channel 1	With safety guard closed and acknowledged the contact is closed. With safety guard NOT closed or NOT acknowledged the contact is open.	B
b2/b8	External safety devices closed and acknowledged Channel 2	With safety guard closed and acknowledged the contact is closed. With safety guard NOT closed or NOT acknowledged the contact is open.	B
a2/a11	Confirmation of double acknowledgement system Channel 1	Additional EUROMAP 78.1 signal confirming a double acknowledgement system Contact closed in addition to a2/a8 An injection moulding machine requiring a double acknowledgement system should wait for this signal. The signal can be generated by a bridge between contacts a8 and a11.	B
b2/b4	Confirmation of double acknowledgement system Channel 2	Additional EUROMAP 78.1 signal confirming a double acknowledgement system Contact closed in addition to b2/b8 An injection moulding machine requiring a double acknowledgement system should wait for this signal. The signal can be generated by a bridge between contacts b4 and b8.	B
a4	Status signal: External safety devices closed, acknowledged and locked (if applicable)	High level with safety guard closed. Low level with safety guard NOT closed. No safety signal; it can be used e.g. for user information	A / B
a3/a9	Emergency stop Channel 1	The switch contact shall be open when the emergency stop device of the external safety device is being actuated. Opening the switch contact causes emergency stop of the IMM.	A / B
b3/b9	Emergency stop Channel 2	The switch contact shall be open when the emergency stop device of the external safety device is being actuated. Opening the switch contact causes emergency stop of the IMM.	A / B
a5	Request signal	High level: Operator actuates a device (e.g. push button) on the external safety device in order to request access to the protected area. Minimum duration 100 ms	A
b6	Interface connected	High level: Interface connected Low level: interface NOT connected	A / B
a6	Supply from IMM	24 V DC – reference high level	A / B
a12	Supply from IMM	0 V – reference low level	A / B
b5/b11/b12	Spare	Not fixed by EUROMAP, manufacturer dependent.	A / B

**Table 2: Plug on the injection moulding machine
Signals from IMM to external safety device (male)**

Contact No. see fig. 2	Signal designation	Description	Subtype
c1/c7	Enabling release of guard locking	Open = opening NOT enabled Closed = opening enabled Maximum load 1A / 24V DC Only closed when the "Request signal" (a5) is at low level (see timing diagram) Note: Closed contact indicates that the injection moulding machine has reached the safe condition. The unlocking may be depending from other parameters	A
c3/c9	Indication of request	Closed: IMM has received the request (see a5) for the opening of the guard but has not reached the safe condition for enabling opening of the guard. May be used for a (blinking) signal lamp at the external safety device. Open when c1/c7 becomes closed	A
c2/c4/c8/c10	Spare	Reserved for future use by EUROMAP	A / B
c5/c6/c11/c12	Spare	Not fixed by EUROMAP, manufacturer dependent.	A / B

3 Sequence for guard locking

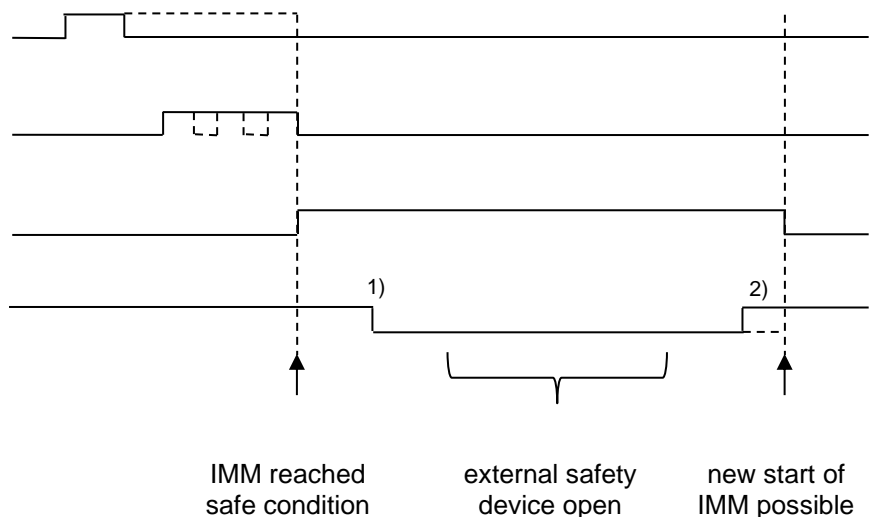
The following diagram shows the sequence for the signals related to guard locking:

a5: Request signal

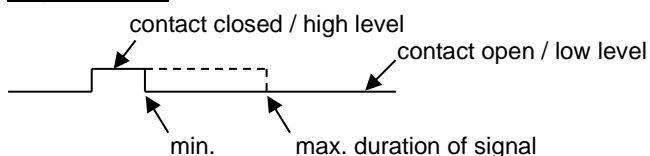
c3/c9: Indication of request

c1/c7: Enabling release of guard locking

a1/a7 + a1/a10 + b1/b7 + b1/b10:
External safety devices closed, acknowledged (double acknowledgement system) and guard locking active



Explanation:



1) The unlocking may be depending from other parameters. High signal c1/c7 only shows that the IMM is in a safe condition and allows the unlocking. Other devices protected by the guard may prevent immediate unlocking. The contacts for the signals a1/a7, a1/a10, b1/b7 and b1/b10 become open when the guard is really unlocked.

2) The locking may be forced by another device than the IMM before the IMM leaves the safe condition.

4 Schematic drawing of the interface

Figure 4 shows the schematic drawing according to EUROMAP 78.1 for an example with type A with guard locking, double acknowledgement system and all functions in one external device.

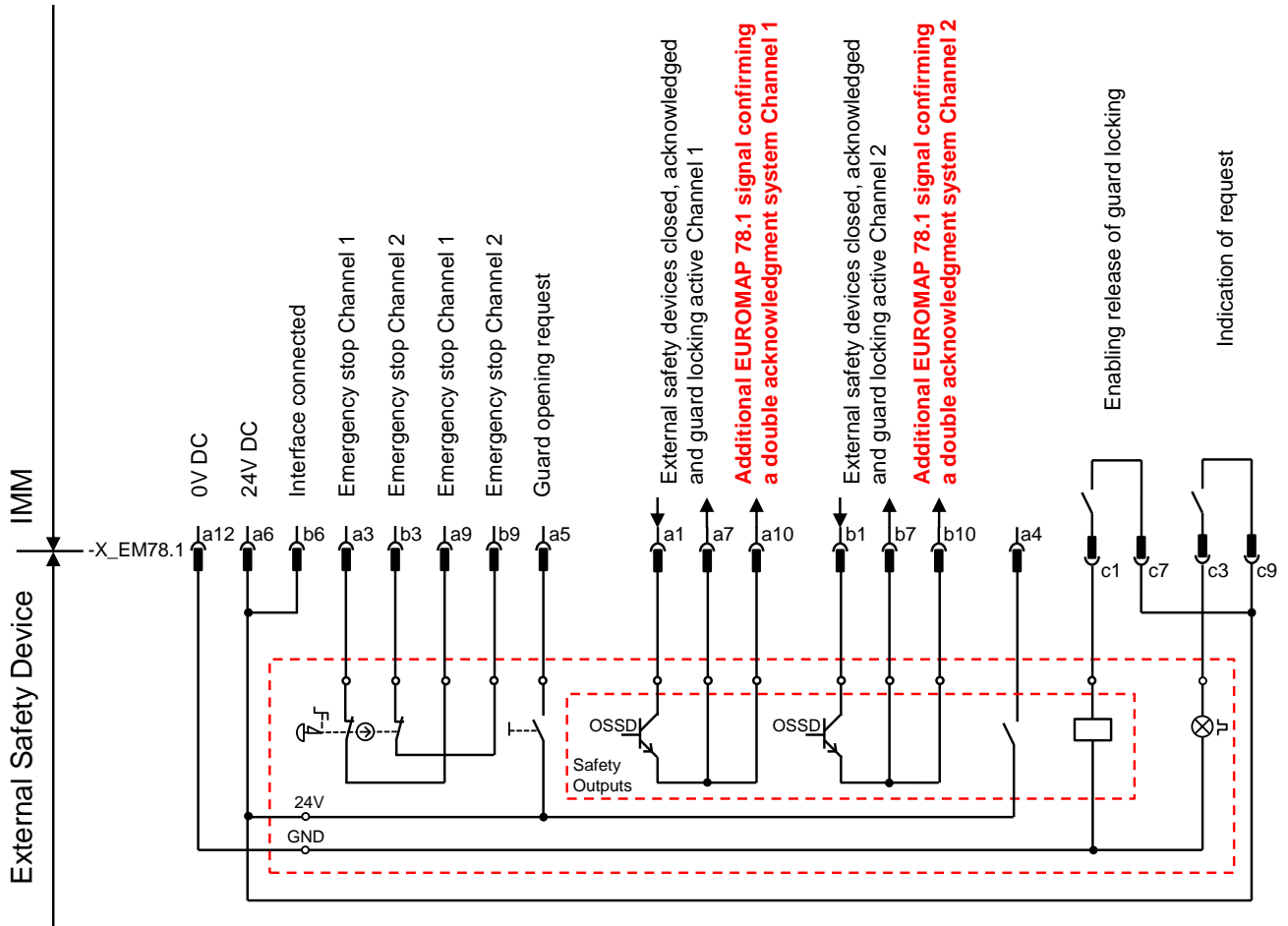


Figure 4: Schematic drawing of the interface (example)

Figure 5 highlights the additional signals defined by EUROMAP 78.1 for the confirmation that a double acknowledgement system is used:

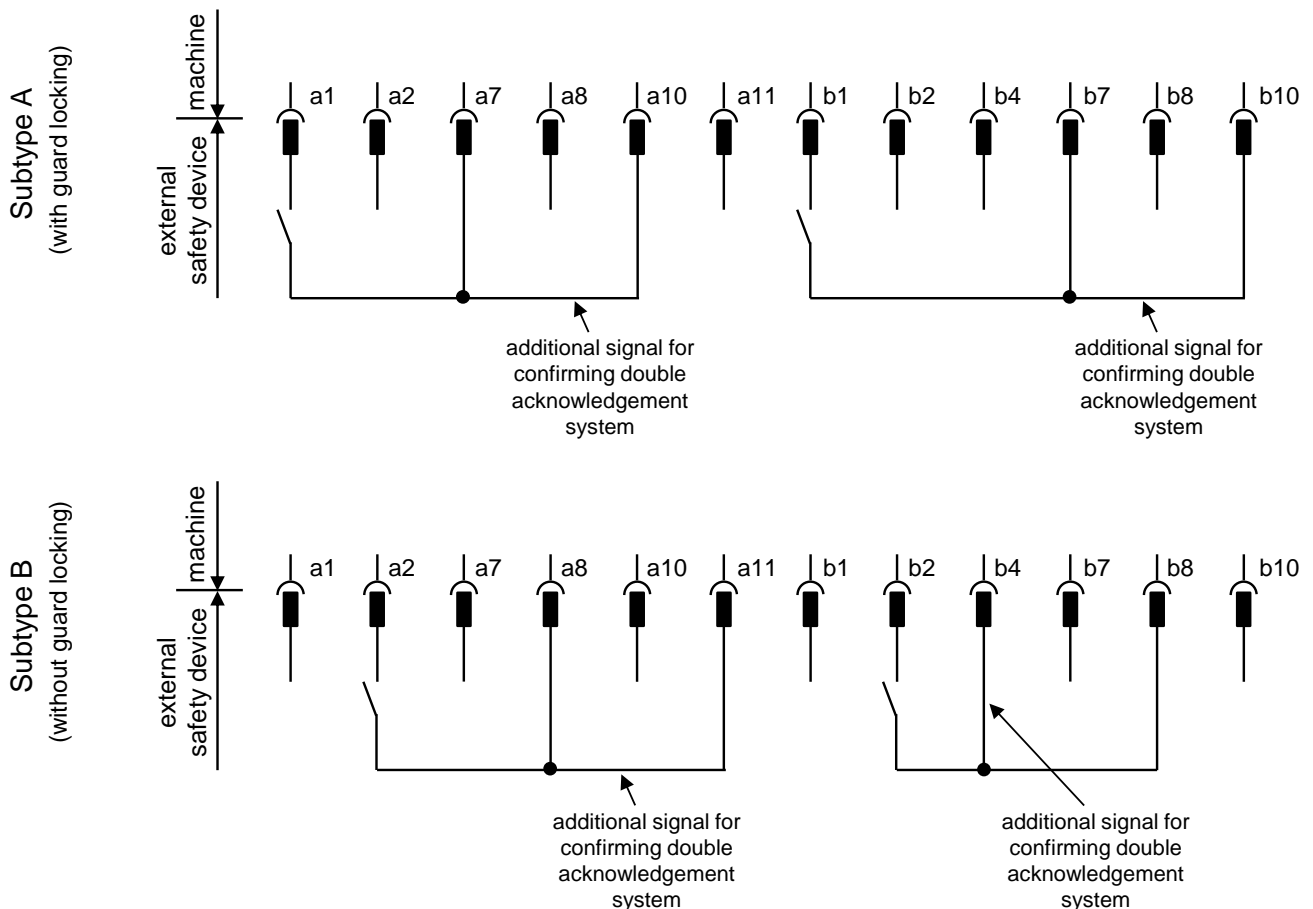


Figure 5: Additional signals for EUROMAP 78.1

5 Compatibility between EUROMAP 78 and EUROMAP 78.1

EUROMAP 78 and EUROMAP 78.1 use the same plugs.

EUROMAP 78 does not differentiate between single and double acknowledgement systems. As a result, the IMM is not informed if an external safety device with a lower safety level than required is used. An IMM can explicitly request the new signals defined in EUROMAP 78.1 to get the confirmation that a double acknowledgement system is installed.

By defining the confirmation of the double acknowledgement system as additional signals in EUROMAP 78.1 there are no compatibility problems between EUROMAP 78 and EUROMAP 78.1 if only a single acknowledgement system is needed. Also, an existing external safety device with double acknowledgement system using only EUROMAP 78 will work with an IMM which does not require the EUROMAP 78.1 signals.

The only incompatibility occurs, when an IMM requests the new EUROMAP 78.1 signals and the external safety device with EUROMAP 78 does not provide them. Even if the external safety device is equipped with a double acknowledgement system, it does not provide the new signals. In this case (and only in this case) it is permitted to retrospectively install bridges between the contacts a7/a10 and b7/b10 (subtype A) or respectively a8/a11 and b4/b8 (subtype B) after an appropriate risk assessment.

Table 3 summarizes the possible combinations:

Table 3: Compatibility between EUROMAP 78 and EUROMAP 78.1

		IMM with EUROMAP 78		IMM with EUROMAP 78.1
		<i>Single acknowledgement system sufficient</i>	<i>Double acknowledgement system required</i>	<i>Double acknowledgement system required</i>
External safety device with EUROMAP 78	<i>Single acknowledgement system existing</i>	Safe operation of the machine possible	Operation possible but safety requirements not met.	Safe operation of the machine not possible because external safety device does not meet requirements
	<i>Double acknowledgement system existing</i>	Safe operation of the machine possible (external safety device oversized)	Safe operation of the machine possible	Safe operation of machine not possible because external safety device does not deliver required signals → can be solved by bridging contacts
External safety device with EUROMAP 78.1	<i>Double acknowledgement system mandatory</i>	Safe operation of the machine possible (external safety device oversized)	Safe operation of the machine possible	Safe operation of the machine possible

6 Sources of supply

A list of suppliers for the plugs described in clause 2 can be downloaded from the following website:

<http://www.euromap.org/technical-issues/technical-recommendations>