Original instructions

Vital 1

Safety module



ABB AB / Jokab Safety Varlabergsvägen 11, SE-434 39, Sweden
www.abb.com/lowvoltage

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1 Introduction

Scope

The purpose of these instructions is to describe the safety module Vital 1 and to provide the necessary information required for installation and operation.

Audience

This document is intended for authorized installation personnel.

Prerequisites

It is assumed that the reader of this document has knowledge of the following:

- Basic knowledge of ABB/Jokab Safety products.
- Knowledge of machine safety.

Special notes

Pay attention to the following special notes in the document:

⚠ **Warning!**	Danger of severe personal injury! An instruction or procedure which, if not carried out correctly, may result in injury to the technician or other personnel.
Caution!	Danger of damage to the equipment! An instruction or procedure which, if not carried out correctly, may damage the equipment.
NB:	Notes are used to provide important or explanatory information.

2 Overview

General description

Vital 1 is a safety module that generates and monitors a dynamic safety signal, which makes it possible to achieve a redundant safety system that complies with PL e, category 4 using only a single dynamic safety signal. This allows quick and straightforward installation of the entire safety system.

The safety modules in the Vital series are intended for use with safety sensors designed for the dynamic safety circuit, such as the non-contact safety switch “Eden”, the safety light beam “Spot” and similar sensors that can be connected directly to Vital 1. Other safety sensors can easily be connected to the dynamic safety circuit through an adaptor unit. Adaptor units in the “Tina” series are available for a lot of different safety sensors.

Vital 1 has two safe relay outputs (both outputs consists of two relays connected in series) and a non-failsafe information output with customizable functionality.

Other features include:

- Manually supervised or automatic reset
- LED indication of:
  - Power
  - Dynamic signal status
  - Relay output status
- Detachable connection blocks

NB: Refer to section *Installation precautions* for important precautions when using safety light beam “Spot” together with Vital 1.

Safety regulations

⚠ Warning!

Carefully read through this entire manual before using the device.

The devices shall be installed by a trained electrician following the Safety regulations, standards and the Machine directive.

Failure to comply with instructions, operation that is not in accordance with the use prescribed in these instructions, improper installation or handling of the device can affect the safety of people and the plant.

For installation and prescribed use of the product, the special notes in the instructions must be carefully observed and the technical standards relevant to the application must be considered.

In case of failure to comply with the instructions or standards, especially when tampering with and/or modifying the product, any liability is excluded.

Function description

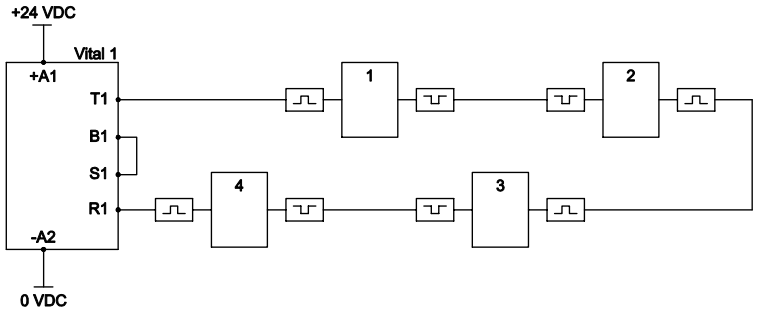
The safety is based on a dynamic safety circuit, using a single dynamic safety signal that is both generated and monitored within Vital 1. The function is described in three steps:

1. The dynamic safety signal is generated in the safety module and is transmitted to the first safety sensor through terminal T1 (transmitter).
2. All the safety sensors in the safety circuit are connected in series, i.e. the output signal from the first sensor is connected to the input of the next sensor. This procedure is repeated up to the last safety sensor, where instead the output signal is connected back to terminal R1 (receiver) on the safety module, closing the circuit.

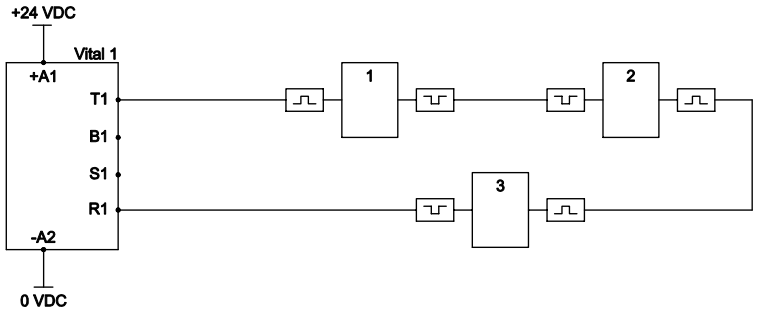
   Every time the dynamic signal passes through a safety sensor (or adapter unit if the safety sensor is not designed for the dynamic safety circuit) and the sensor is not interrupted, the signal is inverted. If the sensor is interrupted the dynamic signal will be interrupted and a static “low” signal (0 VDC) will be set as output from the sensor.
3. The dynamic safety signal connected back to R1 is monitored by the safety module. The safety relies on each of the sensors (or adapter units) to invert the signal and pass it through to the next sensor as long as the protection is not interrupted (e.g. when a safety switch is opened or a light beam crossed).

   Depending on the number of sensors in the safety circuit, the signal will be inverted an even or odd number of times when received and evaluated back at R1. Therefore, terminal S1 must be connected to B1 (+24 VDC) if an even number of sensors are connected to the dynamic safety circuit, making the safety module expect the dynamic safety signal to be inverted an even amount of times when the safety system is not interrupted. If an odd number of sensors are connected to the dynamic safety circuit, S1 must be disconnected.

The safety module will activate its safety outputs when the input at R1 is OK (correct dynamic signal, safety circuit “closed”) and when the module is reset (option for manual or automatic reset). If a safety sensor is interrupted, the dynamic signal will be interrupted and the safety module will deactivate the safety outputs. A short circuit over a safety sensor will also be detected as the dynamic signal will not be inverted as expected, making the safety module deactivate the safety outputs.



Vital 1 with an even number of sensors connected in series between T1 and R1. S1 connected to B1.



Vital 1 with an odd number of sensors connected in series between T1 and R1. S1 disconnected.

3 Connections

Vital 1 electrical connections



Upper connection block:
(7x terminals)

+A1: +24 VDC (external power supply)

S1: Connect to B1 if EVEN number of sensors are connected in series to Vital 1

B1: +24 VDC (sensor/unit power supply)

X1: Manually supervised reset

13: Relay output 1 (13-14)

X4: Automatic reset

23: Relay output 2 (23-24)

Lower connection block:
(7x terminals)

-A2: 0 VDC (external power supply)

T1: Dynamic signal output

B2: 0 VDC (sensor/unit power supply)

R1: Dynamic signal input

14: Relay output 1 (13-14)

Y14: Information output

24: Relay output 2 (23-24)

NB: Shielded cable is recommended between this unit and the rest of the safety circuit.

NB: A switch to determine the functionality of the information output is located on the inside of the housing and can be accessed by removing the top connection block. Information output functionality is described in the section *Output connections*.

⚠ **Warning!** All power to the device must be disconnected before the connection blocks may be removed.

⚠ **Warning!** The information channel output shall **never** be used for the safety purpose(s).

⚠ **Warning!** The safety loops shall **not** be used for purposes other than intended. All loading or tampering with loops can lead to serious risk of life.

⚠ **Warning!** Connection cables from ABB/Jokab Safety must be used in the safety circuit to ensure that no short circuits of two inverted or non-inverted signals are possible within the connection cables. If other cables are used, the installer must ensure that such short-circuits are not possible. Refer to EN ISO 13849-2 for details and support on how to achieve this.

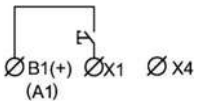
Reset connections

It is possible to choose manually supervised or automatic reset on Vital 1.

Warning!

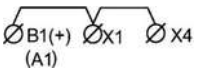
When manually supervised reset is used, the reset button must be placed such that:

- It is outside the hazardous area, and cannot be reached from inside the hazardous area.
- The entire hazardous area is visible from the reset button.



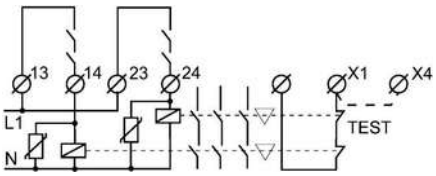
Manually supervised reset

The manually supervised reset contact connected to input X1 must be closed and opened in order to activate the relay outputs.



Automatic reset

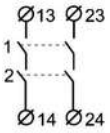
Automatic reset is selected when B1, X1 and X4 are connected. The relay outputs are then activated at the same time as the inputs.



Testing external contactor status

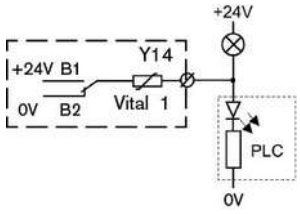
Contactors, relays and valves can be supervised by connecting 'test' contacts between B1 and X1. Both manually supervised and automatic reset can be used.

Output connections



Relay outputs

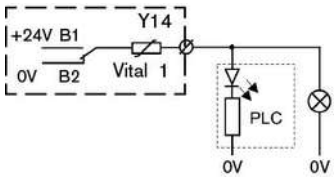
Vital 1 has two (2 NO) safety outputs. In order to protect the output contacts it is recommended that loads (inductive) are suppressed by fitting correctly chosen VDR's, diodes etc. Diodes are the best arc suppressors, but will increase the switch-off time of the load.



Information output, switch position 1 (towards middle)

In switch position 1 (original position) the relay output Y14 is connected internally to 0 V and +24 V in the following way:

- Y14 is internally closed to 0 V (B2) when Vital 1 has not been reset.
- Y14 is internally closed to +24 V (B1) when Vital 1 has been reset.



Information output, switch position 2 (towards edge)

In switch position 2 (function is for Start/Restart interlock, RES) the relay output Y14 is connected internally to 0 V and +24 V in the following way:

- Y14 is internally closed to 0 V (B2) when the dynamic safety circuit is open or when the dynamic safety circuit is closed and Vital 1 has been reset.
- Y14 is internally closed to +24 V (B1) when the dynamic safety circuit is closed but Vital 1 has not been reset (RES).

NB: If the safety light beam Spot 10/35 is connected to Vital 1, the information output switch must be in position 2.

NB: The switch used to set the information output functionality is located on the inside of the housing and can be reached by removing the top connection block.

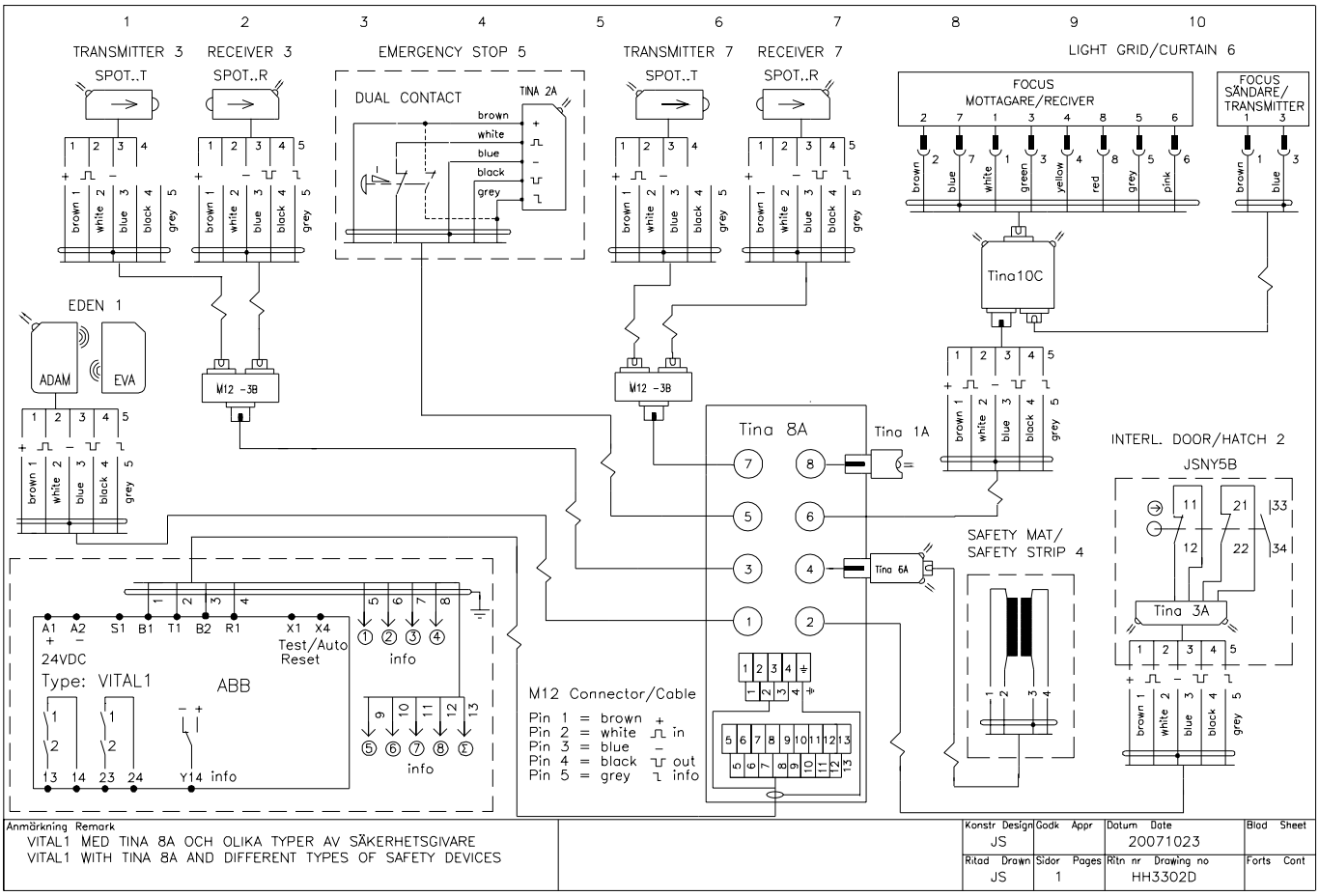
Warning! All power to the device must be disconnected before the connection blocks may be removed.

Connection of S1

S1 must be connected to B1 when an EVEN amount of sensors are connected to the Vital 1 dynamic safety circuit (i.e. the number of sensors in series between T1 and R1). S1 must be disconnected when an ODD amount of sensors are connected to the dynamic safety circuit.

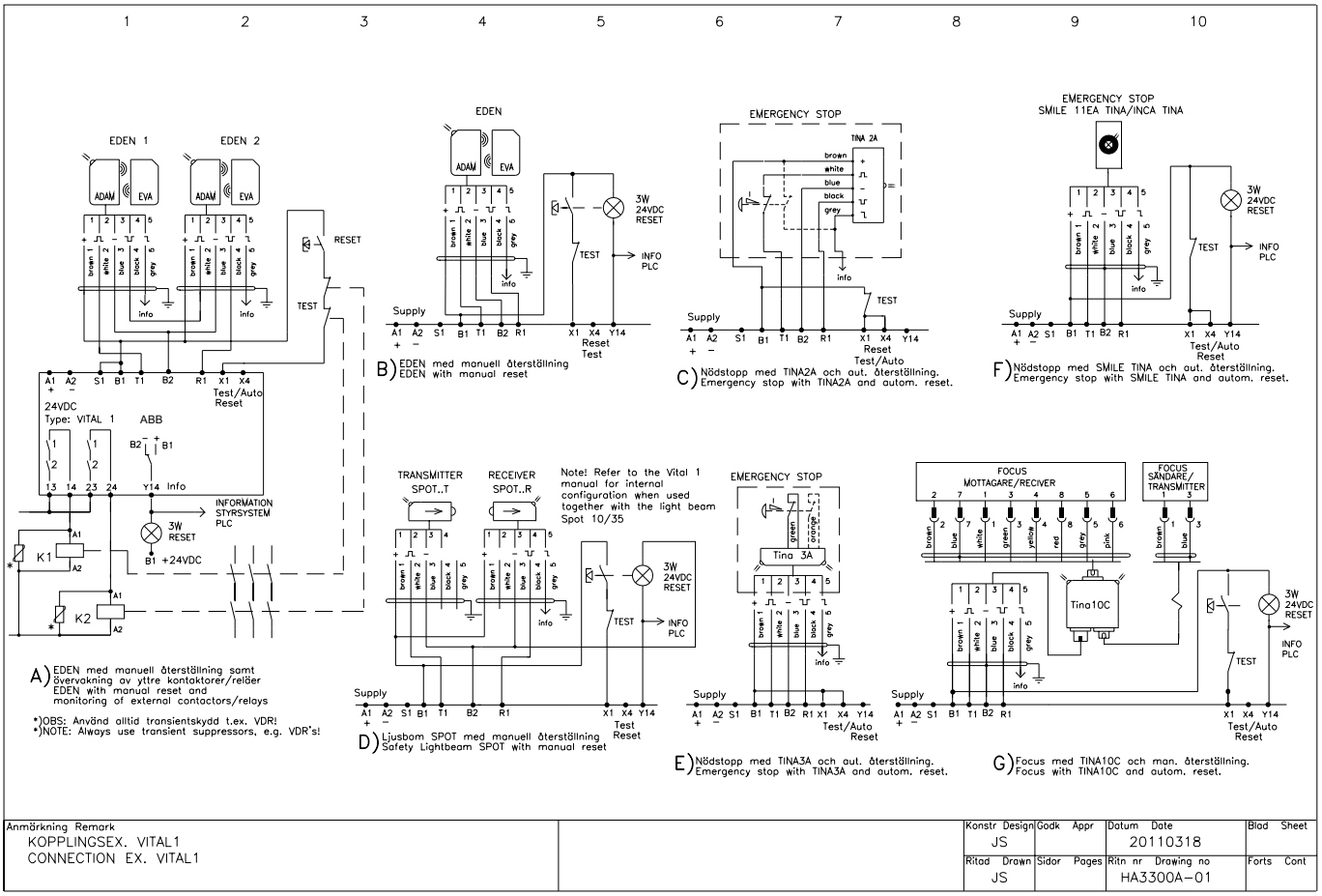
Connection examples

Connection example: Vital 1 with Tina 8A and different types of safety devices



Caution! All cable colours according to ABB/Jokab Safety standard cables.

Connection example: Vital 1 connected to different safety devices



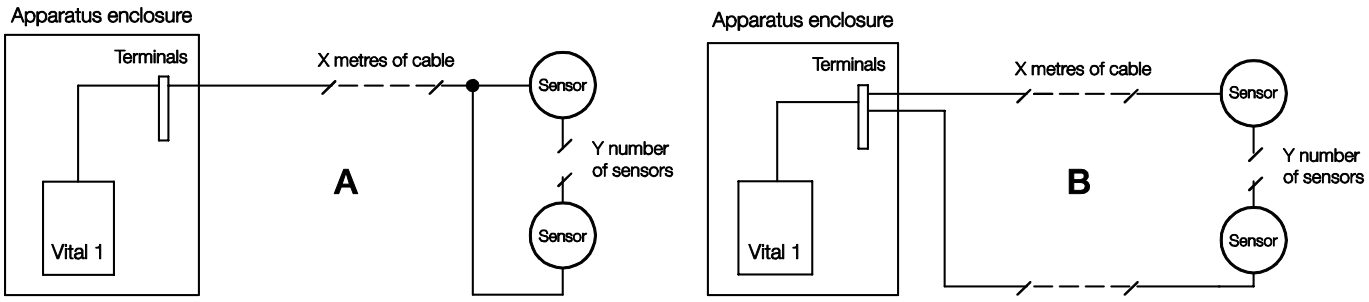
NB: If the safety light beam Spot 10/35 is connected to Vital 1, the information output switch must be in position 2. See section *Output connections* for further details.

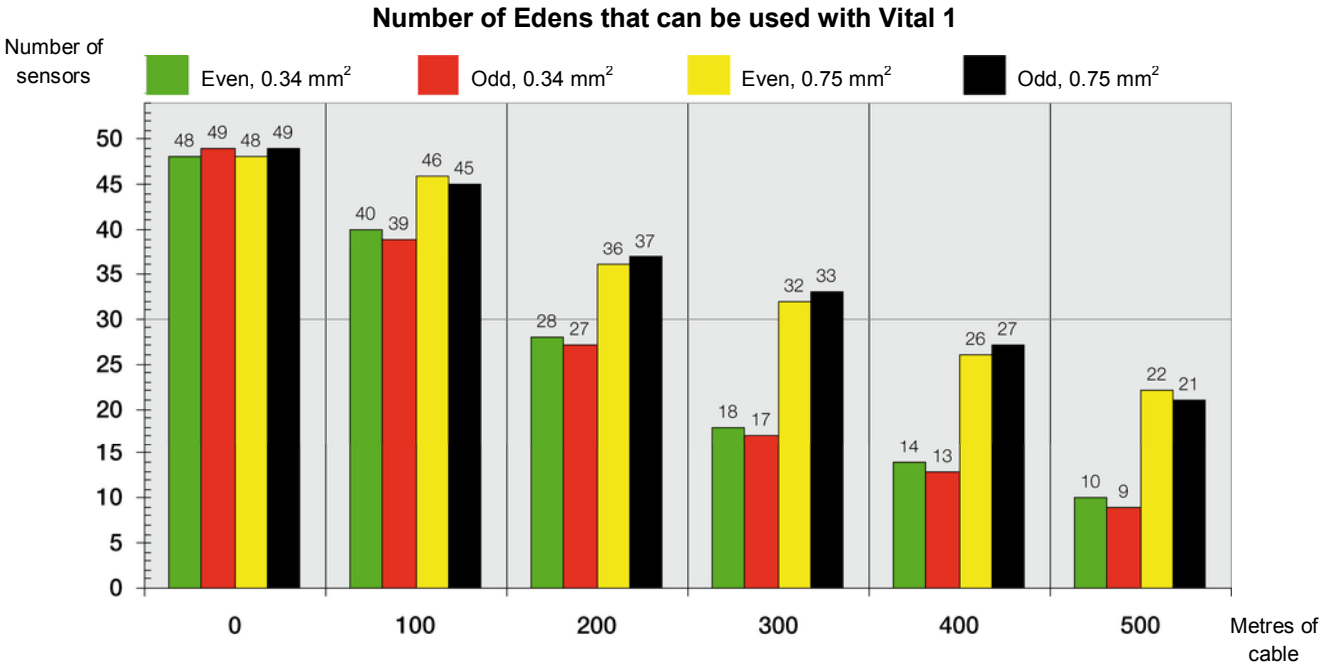
Caution! All cable colours according to ABB/Jokab Safety standard cables.

Number of Edens that can be used with Vital 1

The following table shows the number of Edens that can be connected to Vital 1 with the maximum voltage variation. The values have been established in a laboratory environment. The actual possible number of connected Edens may therefore differ from those given in the table. The values should be regarded as guidelines; ABB/Jokab Safety recommends a maximum of 30 Edens per Vital 1. The table was prepared according to measurements with connection example A. If connection example B and 0.34 mm^2 cable is used (with feed voltage from two directions), the values for 0.75 mm^2 in the tables are used.

NB: The PFH_d value calculated assume max 30 Eden sensors connected in series.

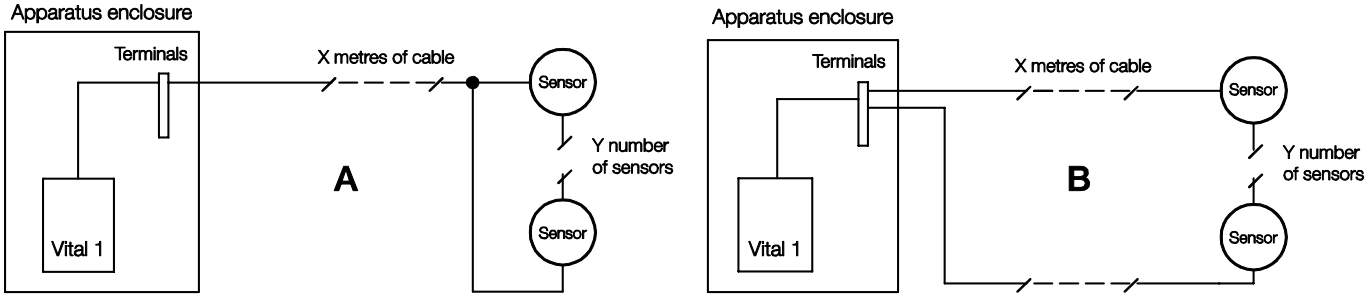


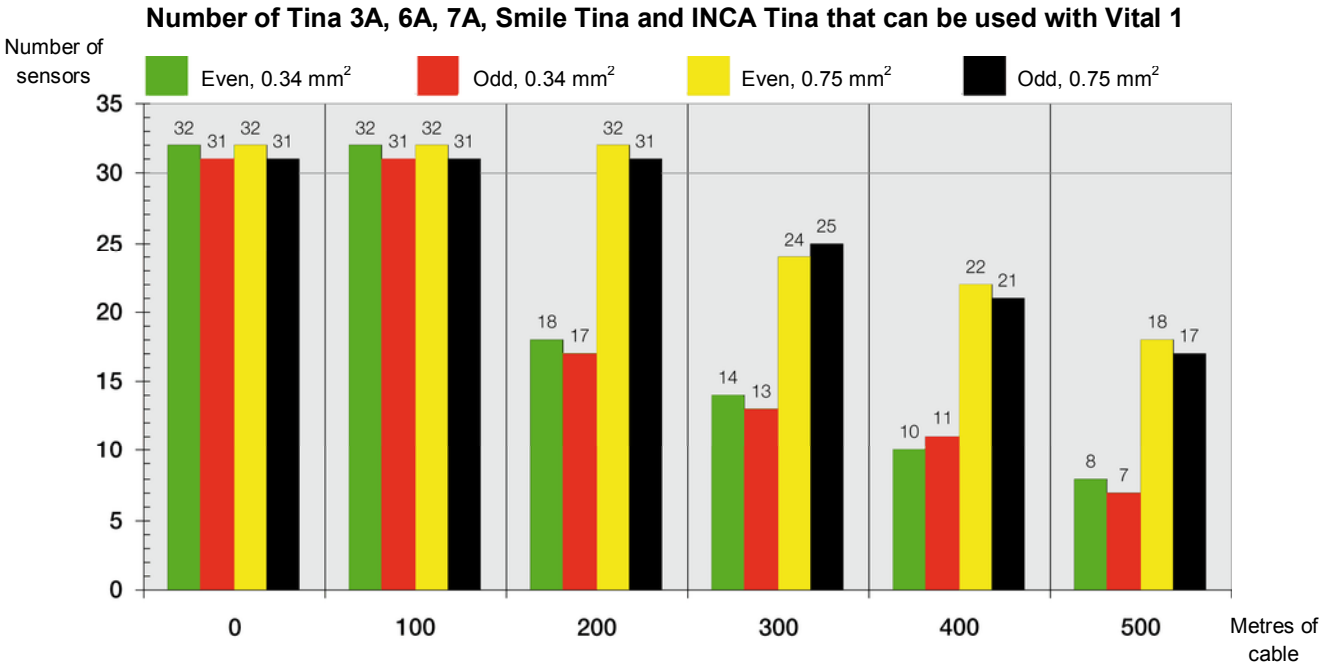


Number of Tina units that can be used with Vital 1

The following table shows the numbers of Tina 3A, Tina 6A, Tina 7A, Smile Tina and INCA Tina that can be connected to Vital 1 with the max voltage variation. The values have been established in a laboratory environment. The actual possible number of connected Tinas may therefore differ from those given in the table. The values should be regarded as guidelines; ABB/Jokab Safety recommends a maximum of 30 Tina units per Vital 1. The table was prepared according to measurements with connection example A. If connection example B and 0.34 mm^2 cable is used (with feed voltage from two directions), the values for 0.75 mm^2 in the tables are used.

NB: The PFH_d value calculated assume max 30 Tina connected in series.





Example connections of units and cable lengths to Vital 1

Three connection alternatives

To comply with PL e according to EN ISO 13849-1, the connection of sensor/adaptor units in the Vital safety circuit must be made as per the following connection examples.

Example 1

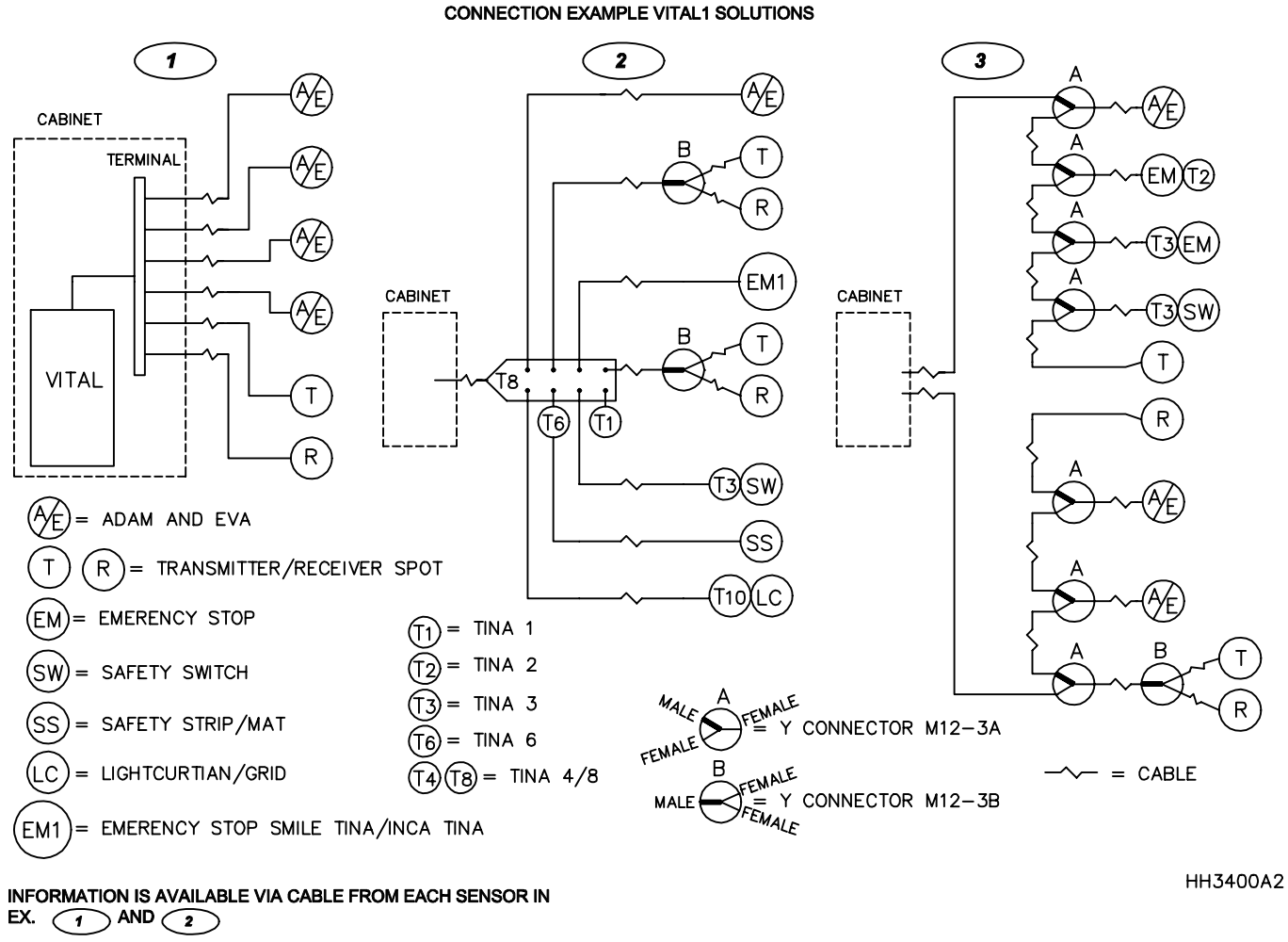
Use separate connection cables from each sensor/adaptor unit and connect them in series to create the Vital safety circuit through terminals in the control cabinet. Status information is available from each individual sensor at the terminal.

Example 2

Use Tina 4A/Tina 8A connection blocks to simplify the connection of externally installed sensors/adaptor units. Only Tina 4A/Tina 8A connection blocks may be used. Use of any other connection block is not recommended as it may not meet the requirements for the highest safety level. Status information is available from each individual sensor at the connection block.

Example 3

Use M12-3A and M12-3B “Y-connectors” to connect sensors/units in series or in parallel.



Cable lengths and number of sensor/adaptor units for the three connection examples

As a guideline value when determining the number of sensor/adaptor units that can be connected to a Vital 1 unit, one Spot T/R is equivalent to five Eden or Tina units. Units connected in parallel are equal to one unit in series. The following examples provide **guidelines** as to possible configurations and cable lengths using suitable cables.

Example 1

Up to 1000 metres of cable (0.75 mm^2 or 0.34 mm^2 conductors) in total can be connected to the sensors/units in this example. The connection is equivalent to 9 Eden or Tina units.

A maximum of 30 Eden or Tina units can be connected to the Vital 1 unit on a maximum cable length of 500 metres (0.75 mm^2 conductors) or 300 metres (0.34 mm^2 conductors).

Example 2

Up to 600 metres (0.75 mm^2 conductors) to Tina 8A and 10 metre cables type M12-C1012 (0.34 mm^2) to each sensor/unit connected to the Tina 8A. This connection example is equivalent to 17 Eden or Tina units.

A maximum of 3 Tina 8A units, equivalent to 27 Eden / Tina units (= 3 x 8 connected to Tina 8A + 3 Tina 8A) can be connected to one Vital 1 with a total cable length of 600 metres (0.75 mm^2). Up to 6 Tina 4A units can be connected to one Vital 1 (equivalent to 30 Eden/Tina units) with a total cable length of 600 metres (0.75 mm^2) to Tina 4A.

Example 3

Either 2 x 500 metre cables (0.75 mm^2) from the control cabinet and 10 metre cables (0.34 mm^2) to each sensor/unit **or** 2 x 10 metre cables (0.75 mm^2) from the control cabinet and 200 metre cables (0.75 mm^2) to each sensor/unit. The connection is equivalent to 16 Eden or Tina units.

A total of 30 Eden/Tina units can be connected using a maximum cable length of 1000 metres (0.75 mm^2) or 400 metres (0.34 mm^2). If the power supply is only fed from one direction (from one end of the network) the total cable length is reduced to approx 300 metres (0.75 mm^2) and 100 metres (0.34 mm^2).

Connection advice for dynamic sensors to Vital 1

Sensors can be connected in many different ways. Here is some advice that can make the connection better and more stable. The advice is general, but particularly applicable when using Tina 4A and Tina 8A units.

- Never have more than the recommended number of sensors in the circuit.
- If possible, use a switched mains power supply that can deliver stable 24 VDC.
- In the sensor system, use as short cables as possible.
- When connecting a Tina 4A or Tina 8A unit, the supply voltage at the terminal (out at the unit) must not be less than 20 VDC.
- Use shielded cable, preferably 0.75 mm^2 or thicker, from the apparatus enclosure and ground it at one end, for example at the apparatus enclosure and not at both ends.
- Do not route the signal wiring close to heavy current cabling or close to equipment that gives off a lot of interference, such as frequency converters for electric motors.
- Never connect “spare”, unnecessary conductors.
- If M12-3B units are used for connection of a parallel loop, with supply to the sensors from two directions, the loop must be as short as possible. This is because the conductors that are not being used are also connected, which increases the capacitive load, reducing the stability of the system.

4 Installation and maintenance

Installation precautions



First mount the unit to a 35 mm DIN rail, then install all cables to the terminals of the connection blocks (use max. tightening torque 1 Nm).

NB: Do not forget the S1 terminal if an even number of sensors are used (refer to *Output connections* above).

⚠ **Warning!** All the safety functions must be tested before starting up the system.

Precautions when using safety light beam Spot with Vital 1:

- The information output switch on Vital 1 must be in position 2. A yellow indication lamp must be connected to the information output and mounted where it is visible from the protected area. Refer to section *Output connections* for further details.
- Vital 1 must be installed within an electrical cabinet (or similar housing) with a minimum protection class rating of IP54.
- The information output signal from Spot must be connected to an indication lamp in such a way that it:
  - Lights green when Spot is OK (uninterrupted)
  - Lights red when Spot is interrupted

Maintenance

⚠ **Warning!**

The safety functions and the mechanics shall be tested regularly, at least once every year to confirm that all the safety functions are working properly (EN 62061:2005).

In case of breakdown or damage to the product, contact the nearest ABB/Jokab Safety Service Office or reseller. Do not try to repair the product yourself since it may accidentally cause permanent damage to the product, impairing the safety of the device which in turn could lead to serious injury to personnel.

Testing of the safety functions

Make sure the safety unit is working properly by following these steps:

- Control that the safety loop is working. The T (transmitter) LED should be turned ON.
- When all sensors are active and Vital 1 is reset, the R (receiver) and output relay LEDs should be turned ON.
- When the safety loop is interrupted the R (receiver) and output relay LEDs should turn OFF.

⚠ **Warning!** When Vital 1 has been inactive for an extended period of time (e.g. an extended machine downtime due to maintenance), the safety function(s) of each safety sensor on the dynamic safety circuit connected to Vital should be tested before restarting the system.

Troubleshooting

LED indication	Expected causes of faults	Checking and measures to take
-R LED turned OFF	Safety loop interrupted, no dynamic signal	Check if and why there is no dynamic signal
	S1 configured incorrectly	Configure S1 according to “Output connections” above.
-ON LED flashing	Input voltage below 18 V	Fix power supply
-R LED flashing	Defected dynamic signal input to unit (asymmetric pulses)	Check the dynamic input or the unit before

⚠ **Warning!** Replace a defect unit with a new one and **never** bypass the safety circuit.

5 Operation

LED indication

LED	Indication	Description
On:	ON	Supply voltage OK
	Flash	Supply voltage below 18 VDC or short circuit
	OFF	No supply voltage
T:	ON	Dynamic signal output – OK
	OFF	No dynamic signal output
R:	ON	Dynamic signal input – OK
	Flash	Defective dynamic signal input to unit (asymmetric pulses)
	OFF	No dynamic signal input
/ 1:	ON	Relay output no 1 activated
	OFF	Relay output no 1 not activated
/ 2:	ON	Relay output no 2 activated
	OFF	Relay output no 2 not activated

6 Technical data

Manufacturer	
Address	ABB AB / JOKAB SAFETY Varlabergsvägen 11 SE-434 39 Kungsbacka Sweden
Article number/Ordering data	Vital 1, ver. H (from 2011): 2TLA020052R1000

Power supply	
Operating voltage (to Vital, A1-A2)	24 VDC +15%, -15% (SELV/PELV)
Power supply to sensors/units (from Vital, B1-B2)	24 VDC nominal (depending on supply to A1-A2) Current limit: 1.8 A
Power consumption	Nominal, without load (min): 3 W Nominal, with load (max): 48 W
Reset input X1 (see section *Reset connections* above)	Supply for reset input: +24 VDC Reset current: 30 mA (inrush current 300 mA) Minimum contact closure time for reset: 150 ms
Max line resistance	150 Ω (at nominal voltage over X1)
External fuse	3 A (an external fuse should be fitted in the supply to A1)

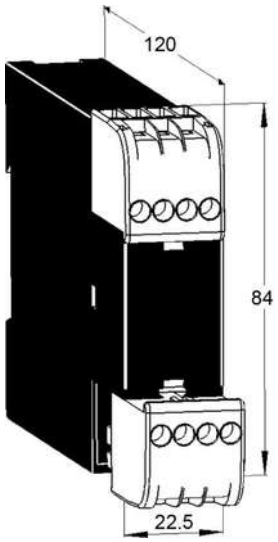
Relay outputs	
NO	2
Max switching capacity	Resistive load AC: 6 A / 250 VAC / 1500 VA Inductive load AC: AC15 240 VAC, 2 A Resistive load DC: 6 A / 24 VDC / 150 W Inductive load DC: DC13 24 VDC, 1 A
Minimum load	10 mA / 10 V
Contact material	AgCdO
Mechanical life	> 10^7 operations
External fuse (EN 60974-1)	6.3 A or 4 A slow
Relay information output, Y14 (changeover contact)	Max load: 200 mA (internal automatic fuse) See section *Output connections* for functionality.

General	
Protection class	Enclosure: IP40 Connection blocks: IP20
Ambient temperature	Storage/Operation: -10…+55°C
Humidity range	35 to 85 % (with no icing or condensation)
Connector	Two connection blocks with 7 terminals each (detachable) Max tightening torque: 1 Nm Max connection area: Solid conductors: 1 x 4 mm^2 / 2 x 1.5 mm^2 / 12 AWG Conductor with socket contact: 1 x 2.5 mm^2 / 2 x 1 mm^2 Dielectric strength: 2.5 kV (IEC 60664-1)
Connection of S1	Odd number of sensors: S1 not connected Even number of sensors: S1 connected to B1 (+24 VDC)
Mounting	35 mm DIN rail
Size	120 x 84 x 22.5 mm (L x W x H)
Weight	~ 220 g
Colour	Black and beige
Reaction time (in/out)	At power on: < 65 ms When activating (in-output): < 40 ms When deactivating (in-output): < 48 ms At power loss: < 55 ms
Minimum off time	80 ms

Safety / Harmonized Standards	
Conformity	European Machinery Directive 2006/42/EC CE EN ISO 12100:2010, EN 954-1:1996/EN ISO 13849-1:2008, EN 62061:2005, EN 60204-1:2006+A1:2009, EN 60664-1:2007, EN 61000-6-2:2005, EN 61000-6-4:2007, EN 61496-1:2004+A1:2008
EN 62061	SIL3, PFH_d: $2.74*10^{-8}$, $MTTF_d$ > 100 years
EN ISO 13849-1	Performance level: PL e, category 4 PFH_D: $2.74*10^{-8}$, $MTTF_d$ > 100 years
EN 954-1	Category 4
Certificates	TÜV Nord

Dimensions

Vital 1 dimensions



NB: All measurements in millimetres.

Intended use

This equipment is intended for (CSA/UL Requirement):

- Indoor use
- Altitude max 2000 m
- Maximum relative humidity 80% at max 31°C and decreasing linearly to 50% at 40°C.
- Pollution degree 2
- Installation category (overvoltage category) II: Local level, appliances, portable equipment, etc. with smaller transient overvoltage than installation category (overvoltage category) III.

This equipment is *not* to be used in *any* other way than stated in the technical description.

7 EC Declaration of conformity

EC Declaration of conformity

(according to 2006/42/EC, Annex2A)

We ABB AB JOKAB Safety Varlabergsvägen 11 SE-434 39 Kungsbacka Sweden	declare that the safety components of ABB make with type designations and safety functions as listed below, is in conformity with the Directives 2006/42/EC 2006/95/EC 2004/108/EC
Person authorised to compile the technical file	ABB AB JOKAB Safety Varlabergsvägen 11 SE-434 39 Kungsbacka Sweden

Product	**EC type-examination certificate**	**Serialnumber**
Safety module Vital 1, version H	44 205 11 372092 001	[000 – 000 ... 999-999]

EC type-examination	TÜV NORD CERT GmbH Langemarckstrasse 20 45141 Essen Germany Notified body No. 0044
Used standards	EN ISO 12100:2010, EN 954-1:1996/EN ISO 13849-1:2008, EN 62061:2005, EN 60204-1:2006+A1:2009, EN 60664-1:2007, EN 61000-6-2:2005, EN 61000-6-4:2007, EN 61496-1:2004+A1:2008

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Original

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