

Original instructions

HD5-S

Three-position device



Read and understand this document

Please read and understand this document before using the products. Please consult your ABB Electrification Sweden AB representative if you have any questions or comments.

Suitability for use

ABB Electrification Sweden AB shall not be responsible for conformity with any standards, codes, or regulations that apply to the

combination of products in the customer's application or use of the product. At the customer's request, ABB Electrification Sweden AB will provide applicable third-party certification documents identifying ratings and limitations of use that apply to the products. This information by itself is not enough for a complete determination of the suitability of the products in combination with the end product, machine, system, or other application or use.

The following are some examples of applications for which attention must be given. This is not intended to be an exhaustive list of all possible uses of the products, nor is it intended to imply that the uses listed may be suitable for the products:

- Outdoor use uses involving potential chemical contamination or electrical interference, or conditions or uses not described in this document.
- Nuclear energy control systems, combustion systems, railroad systems, aviation systems, medical equipment, amusement machines, vehicles, and installations subject to separate industry or government regulations.
- Systems, machines, and equipment that could present a risk to life or property.

Please know and observe all prohibitions of use applicable to the products.

NEVER USE THE PRODUCTS FOR AN APPLICATION INVOLVING SERIOUS RISK TO LIFE OR PROPERTY WITHOUT ENSURING THAT THE SYSTEM AS A WHOLE HAS BEEN DESIGNED TO ADDRESS THE RISKS, AND THAT THE ABB Electrification Sweden AB HD5-S_Original_Instructions_(EN)_revB_2TLC010052M0201IS PROPERLY RATED AND INSTALLED FOR THE INTENDED USE WITHIN THE OVERALL EQUIPMENT OR SYSTEM.

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1. INTRODUCTION

Purpose

The purpose of this document is to describe the functions and to provide instructions for installation, operation, maintenance and troubleshooting of the three-position device.

Intended audience

This document is aimed at planners, as well as specialist staff working in assembly and maintenance. In addition, this operating manual is aimed at users who have received training and authorization, from the operator of the facility, in relation to these devices, how to handle them, and the hazards they pose.




Reading prerequisites

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

- Basic knowledge of ABB Electrification Sweden AB products
- Knowledge of safety products
- Knowledge of safety control devices with functions relevant to safety
- Knowledge of related facilities

Warning symbols

The following warning symbols are used in this document:

	Attention!	Danger of personal injury! Failure to follow instructions or work sequences properly may result in personal injury.
	Caution	Risk of damage to the equipment! Failure to follow instructions or work sequences properly may result in damage to the equipment.
	Note	Notes are used to provide important or explanatory information.

2. SAFETY

Intended use

HD5 is a three-position device designed for use in hazardous areas where alternative protective devices are not possible or practical.

The device must be connected to a suitable safety controller with inputs for dual-channels and short circuit protection. Additionally, the machinery or the equipment causing the potential danger needs to be put in jog position or otherwise restricted in movement, speed, temperature, etc.

The operator pushes the large black button to a middle position in order to allow a movement. In case of danger, the operator will either release the button or squeeze it to its bottom position and the machine will stop. Some models offer additional top and front buttons to control a non-safe signal, e.g. move forward and/or backward.

Correct use

The protective function of the safety device is only safe if the safety controller is correctly connected and configured.

Obey the following conditions to prevent misuse and cause danger:

- Make sure that these instructions are included together with the documentation of the system to which the protective device is attached to.
- Make sure that these instructions always are available for the operators.
- The three-position device must only be used after it has been selected refereed to related instructions, relevant standards, rules and regulations for labor protection and safety at work, and when installation, connection, check and start-up are done by an approved person.
- The three-position device must be connected and started according to its specifications, for example the technical data.
- The three-position device must be connected so that its safety related capacity meets or exceed the performance level (PL) or safety integrity level (SIL) that has been estimated in the risk analysis.
- The three-position device must not be modified. If the design or the functions are changed the protective function can be damaged and the warranty of the three-position device is not applicable.
- Repair and exchange of parts of the three-position device is not permitted.
- The three-position device must be tested regularly by an approved person.
- The three-position device must be exchanged within a mission time 20 years, due to requirement in EN ISO 13849-1. Depending on the use (calculation of T_{10D} , se 6. Performance Level (PL) Calculation), the three-position device might have to be exchanged within a shorter time than 20 years.

Foreseeable misuse

- Other use than defined as correct use and foreseeable misuse, or which is beyond that use, is considered as incorrect use.
- The three-position device is not by itself a complete protective device.
- The three-position device is not intended for use in explosive or easily flammable adjacent air.

Approved person

An approved person must have ...

- a suitable technical education.
- knowledge about rules and regulations for occupational safety, safety at work, safety technology and how to estimate the safety of the machine.
- received instructions from the person that is responsible for the installation and operation of the three-position device and the device/machine which it is connected to.

See Chapter Intended use and Chapter Correct use for further information.

Safety precautions

The following safety precautions must be followed during installation, operation, maintenance and troubleshooting.

General safety information



Attention!

- Carefully read through this entire manual before using the product.
- Always respect the documented minimum or maximum values of the product.
- For installation and prescribed use of the product, the special notes in these instructions must be carefully observed and the technical standards relevant to this product must be considered.
- This product must be installed by a trained electrician following applicable safety regulations, standards and the machine directive.
- Failure to comply with these 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.
- In case of failure to comply with these instructions or the applicable standards, especially when tampering with and/or modifying the product, liability is excluded.
- The safety functions of the product must be tested before the system is put in operation.
- The safety functions of the product must be tested after installation or replacement of components or cables.
- The safety functions and the mechanics of the product must be tested regularly to confirm that all the safety functions are working properly.
- In case of breakdown or damage to the product, contact ABB Electrification Sweden AB. Do not try to repair the product. It might accidentally cause permanent damage, impairing the safety of the product and in turn lead to serious personnel injuries.

Disposal



The three-position device shall be disposed in accordance with WEEE directive, 2012/19/EU.

3. PRODUCT DESCRIPTION

HD5

HD5 is a three-position device designed for use in hazardous areas where alternative protective devices are not possible or practical.

The device must be connected to a suitable safety controller with inputs for dual-channels and short circuit protection. Additionally, the machinery or the equipment causing the potential danger needs to be put in jog position or otherwise restricted in movement, speed, temperature, etc.

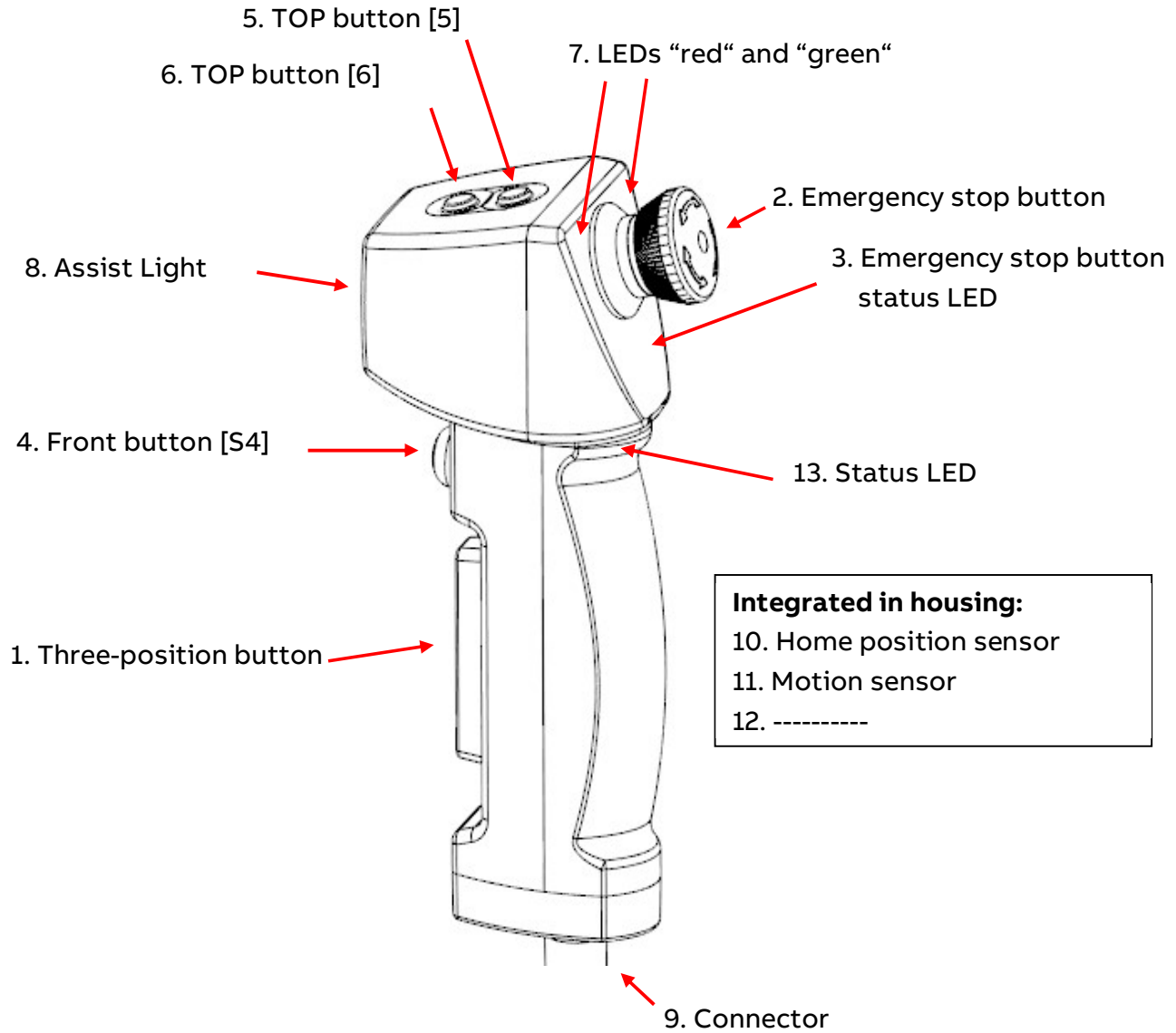
The operator pushes the larger black button to a middle position in order to allow a movement. In case of danger, the operator will either release the button or squeeze it to its bottom position and the machine will stop. Some models offer additional top and front buttons to control a non-safe signal, e.g. move forward and/or backward.

Product range

The HD5-S product range includes the following models.

	Function	HD5-S-102	HD5-S-104	HD5-S-111
1	Three-position button	Yes	Yes	Yes
2	Emergency stop button	No	No	Yes
3	Emergency stop button status LED	No	No	Yes
4	Front button [S4]	Yes	Yes	Yes
5	Top button [S5]	No	Yes	Yes
6	Top button [S6]	No	Yes	Yes
7	LEDs red and green	Yes	Yes	Yes
8	Assist Light	No	No	Yes
9	Connector	M23-12 pin	M23-12 pin	M23-19 pin
10	Home position sensor	No	No	Yes
11	Motion sensor	No	No	Yes
12	-----	-----	-----	-----
13	Status LED Power	No	No	Yes

* position-no., regarding to the picture on next side



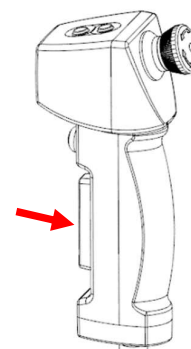
4. FUNCTION DESCRIPTIONS

Three-position button

The three-position button provides signals, which:

- When activated, allow the machine or equipment to be activated using a separate start control signal.
- When deactivated, initiate a stop function which prevents the machine or equipment from starting.

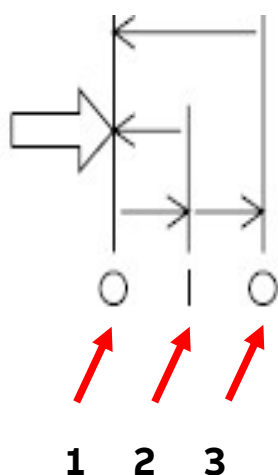
Two three-position switches are used and controlled simultaneously to create a two-channel architecture.



An important feature of the three-position button is that when it is released from position 3, the ON position is never reached, i.e. the contacts remain open. The three-position button always go back to position 1 when released.

The three-positions functionality:

Position 1 (O):	OFF mode	the button is not pressed, contacts are open.
Position 2 (I):	ON mode	the button is pressed in the middle position, contacts are closed
Position 3 (O):	OFF mode	the button is fully pressed to bottom position, contacts are open.



Note on operation

To ensure a correct and safe operation, the three-position button must be pressed to the middle position with two or three fingers.



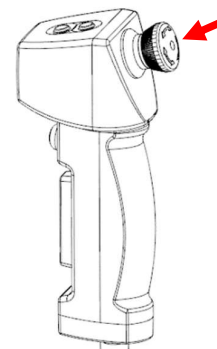
Emergency stop button

The built-in emergency stop button has two force guided normally closed contacts.

The emergency stop button shall initiate an emergency stop function, thereby removing energy to the hazardous functions in the event of emergency.

The holders developed for this three-position device allow for the emergency stop button to be pressed when the three-position device is placed in the holder.

LEDs integrated in the housing indicate the status of the emergency stop button.



Note on safe actuation

To allow for the emergency stop button to operate safely, we recommend using the holders designed for this three-position device. See the accessories section.





Attention!

Caution should be exercised in relation to three-position devices that are connected, as standard, using a connector. Be aware of the following items:

- The correct function of the emergency stop must be checked monthly!
- The emergency stop function must always be functional and should have priority over all other functions and operations in all operating modes of the machine without affecting any system intended to release trapped persons.
- No start command (whether intentional, unintentional or unexpected) should be able to affect working processes that were stopped by initiating the emergency stop function until the emergency stop function has been reset manually.
- If it is possible to remove emergency stop buttons (e.g. portable programming devices) or shut down sections of a machine, it must be ensured that operational and non-operational emergency stop buttons are not mixed.

Emergency stop LED

A row of LEDs is integrated in the housing, below the emergency stop button.

Red LED row	
Green LED row	



Note to visualize

The LED's below the emergency Stop Button change the color in depending of the switch Position button.

Front button

The front button is located above the three-position button. The button is user-defined and can be controlled via wiring.



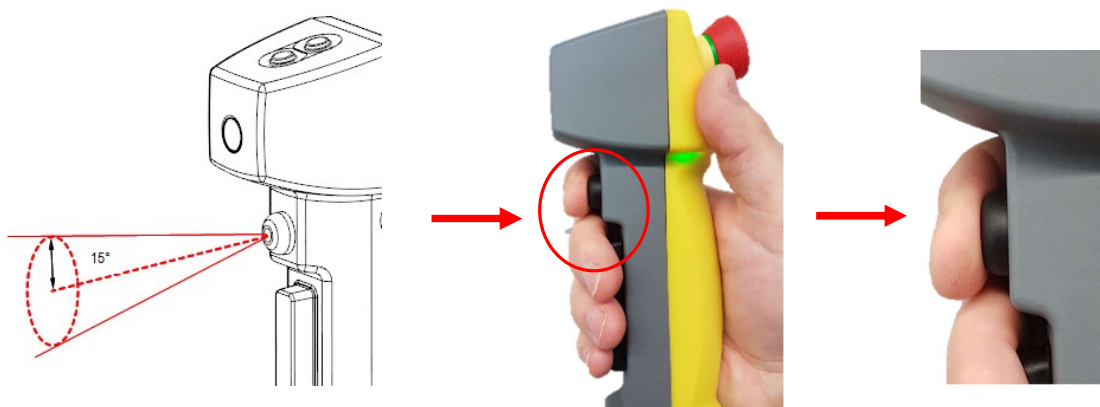
Attention!

This signal is not failsafe and must not be used for a safety function.



Note on activation of front button

The button must be pressed down vertically. If the angle exceeds 15° when actuating the switch, the switch contact may be damaged, reducing its lifetime (number of switching cycles).



Top buttons

The two top buttons are located at the top part of the HD5. The buttons are user-defined and can be controlled via wiring.

Button [S5] is marked -

Button [S6] is marked +



Attention!

This signal is not failsafe and must not be used for a safety function.



Signal LED

A green and a red LED are integrated in the housing, above the emergency stop button. The LEDs are user-defined and can be controlled via wiring.



Home position sensor

This function provides information as to whether the three-position device is in its holder.

The home position sensor delivers a +24 VDC output when the HD5 is in place in the active holder (HD5-M-001). The holder is available as an accessory.



Attention!

This signal is not failsafe and must not be used for a safety function.

Motion sensor

The motion sensor delivers a +24 VDC output when small movements/vibrations are detected. The movements are natural when the device is being held in one hand and can be used to prevent improper use of the device, e.g. by keeping the three-position buttons in the middle position using a rubber band, cable tie or similar.



Attention!

This signal is not failsafe and must not be used for a safety function.

Status LED Power

The green LED is on, when the enabling device is with correct power connected. The LEDs are positioned in a way that means they are not directly visible when the enabling device is placed in the holder intended for this purpose. Reason on their position is, that it isn't possible to confused you with other visually signals.



Assist Light

The assist Light is in the front of the HD5 and can be used for short periods when the ambient light is insufficient.



Note on duty cycle

- For ambient temperatures $\leq 35^{\circ}\text{C}$, the flashlight should never be used longer than 15 min at a time and max 60% on-time
- For ambient temperatures over 35°C , the flashlight should never be user more than 10 min at a time and max 40% on-time

On-time percentage = $[\text{on time} / (\text{on time} + \text{off time})] \times 100$



Caution

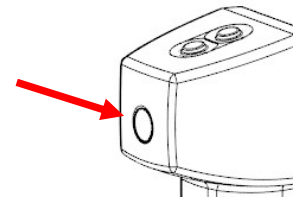
The increased heat can damage the device. Make sure to comply to the above requirements.

If the device had stopped working because of temperature rise, it will work again once the values have dropped below the limits. However, there may still be damage to the electronics and a reduction in product lifetime.



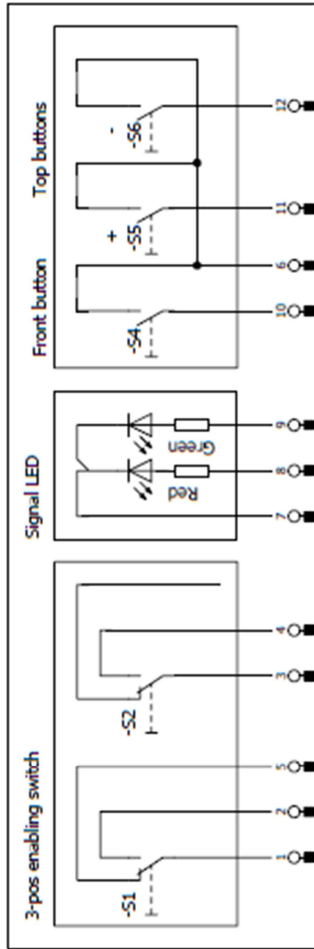
Attention! Hazards arising from glare

Avoid looking directly into the lens of the assist light. Looking directly into the lens, and the glare effect which may result from it, can sometimes impair vision, cause irritation, and result in accidents.

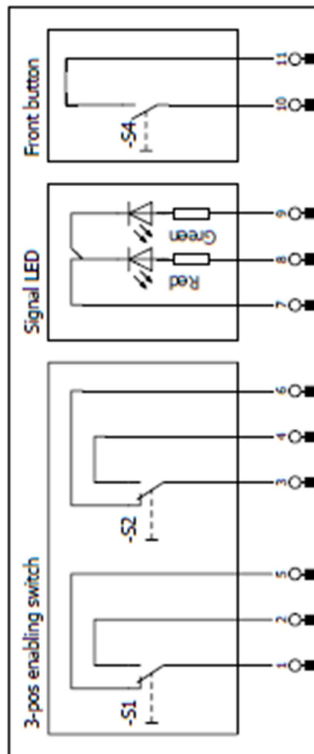


5. CONNECTIONS HD5

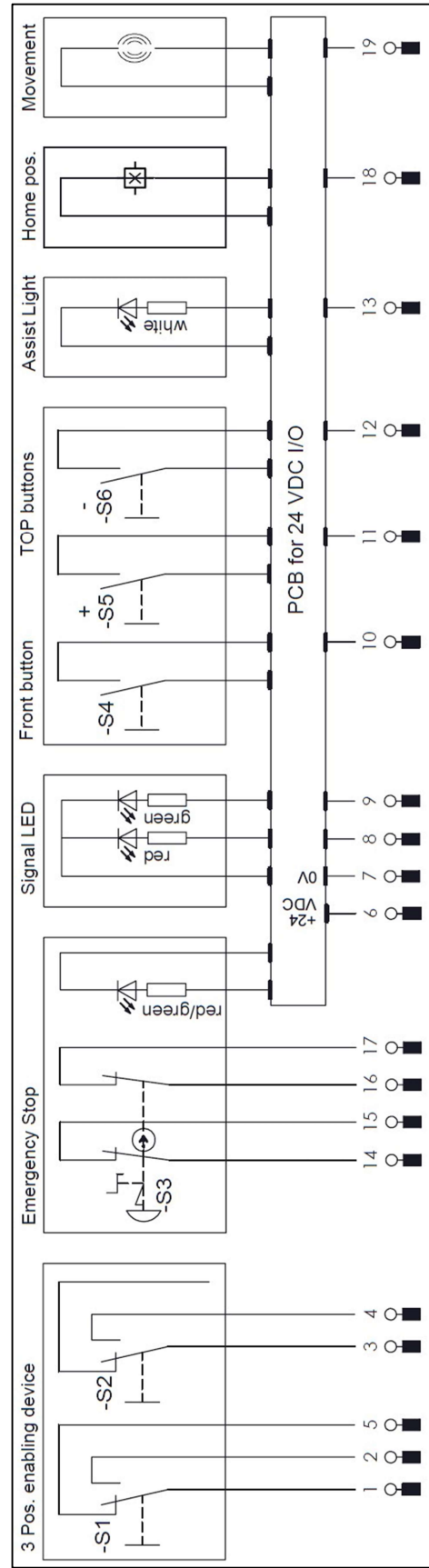
HD5-S-104



HD5-S-102



HD5-S-111



6. PERFORMANCE LEVEL (PL) CALCULATION

Response time

The response time for enabling function is according to the logic unit/safety PLC that is used. If HD5, with a cable with a maximum length of 30 m, is used with the safety PLC Pluto the actual response time from when the button of the HD5 is released or fully pressed to the bottom position will be the response time of Pluto.

Safety function – three-position device

Example according to EN ISO 13849-1

HD5-S can be connected to any safety controller with inputs for dual-channels and short circuit protection. In order to reach P Le / Category 4 for a safety function with HD5, the safety controller need to fulfil PL e/category 4. Performance Level is to be calculated according to the requirements of EN ISO 13849-1. A diagnostic coverage of 99% is to be met by direct monitoring of the contacts in HD5, see “Connection example of safety controller”. Other safety devices shall not be connected in series with the contacts from HD5 to the controller.

To fulfil PL e, MTTF_D shall be High, i.e. no less than 30 years per channel. The B_{10D} for the contacts (see 10. Technical data) are given according to the following:

B_{10D}: 2 x 10⁶, position 1 → position 2 → position 1

B_{10D}: 968,000, position 1 → position 3 → position 1

In order to fulfil the mission time of 20 years the T_{10D}=0,1 x MTTF_D needs to be 20 years, giving that the MTTF_D needs to be at least 200 years. With these data, the maximum n_{op} can be calculated to 132 operations/day (365 working days). In the very most cases the three-position device button is released, instead of pressed to position 3, i.e. the B_{10D} is 2x10⁶, giving a maximum n_{op} of 273 operations/day using the function (EN ISO 13849-1, C7):

$$MTTF_D = \frac{T_{10D}}{0,1} = \frac{B_{10D}}{0,1 \times n_{op}}$$

If a larger number of operations is required, a T_{10D} of 20 years will not be fulfilled and the three-position device must be exchanged in order to keep the Performance Level e.

When using safety PLC Pluto, the relevant pre-certified function block shall be used. All relevant requirements of EN ISO 13849-1 needs to be fulfilled.

Example according to EN 62061

The lambda value needed is calculated as

$$\lambda_D = 0,1 \times C / B_{10D}$$

Where C is the number of operations per hour.

With the B_{10D}=2x10⁶ and C=11,375/hour (equals 273 operations/day as in the calculations according to EN ISO 13849-1) will result in a λ_D of 5,7·10⁻⁷.

Basic subsystem architecture B (single fault tolerance without diagnostic) is used with β=0,02 and a worst case T₁=8760 h (even if the function is proofed every time it is used).

$$\lambda_{DB} = (1-\beta)^2 \times \lambda_D^2 \times T_1 + \beta \times \lambda_D \text{ (simplified due to same } \lambda \text{ of both channels)}$$

This gives a PFH_D=1,4·10⁻⁸. When comparing the result with table 3 in EN 62061 this shows that SIL3 is fulfilled.

Safety function – emergency stop

When calculating the PL for the E-stop function the $MTTF_D$ shall be calculated with the B_{10D} . For the emergency stop button (see 10. Technical data) it is given according by the following:

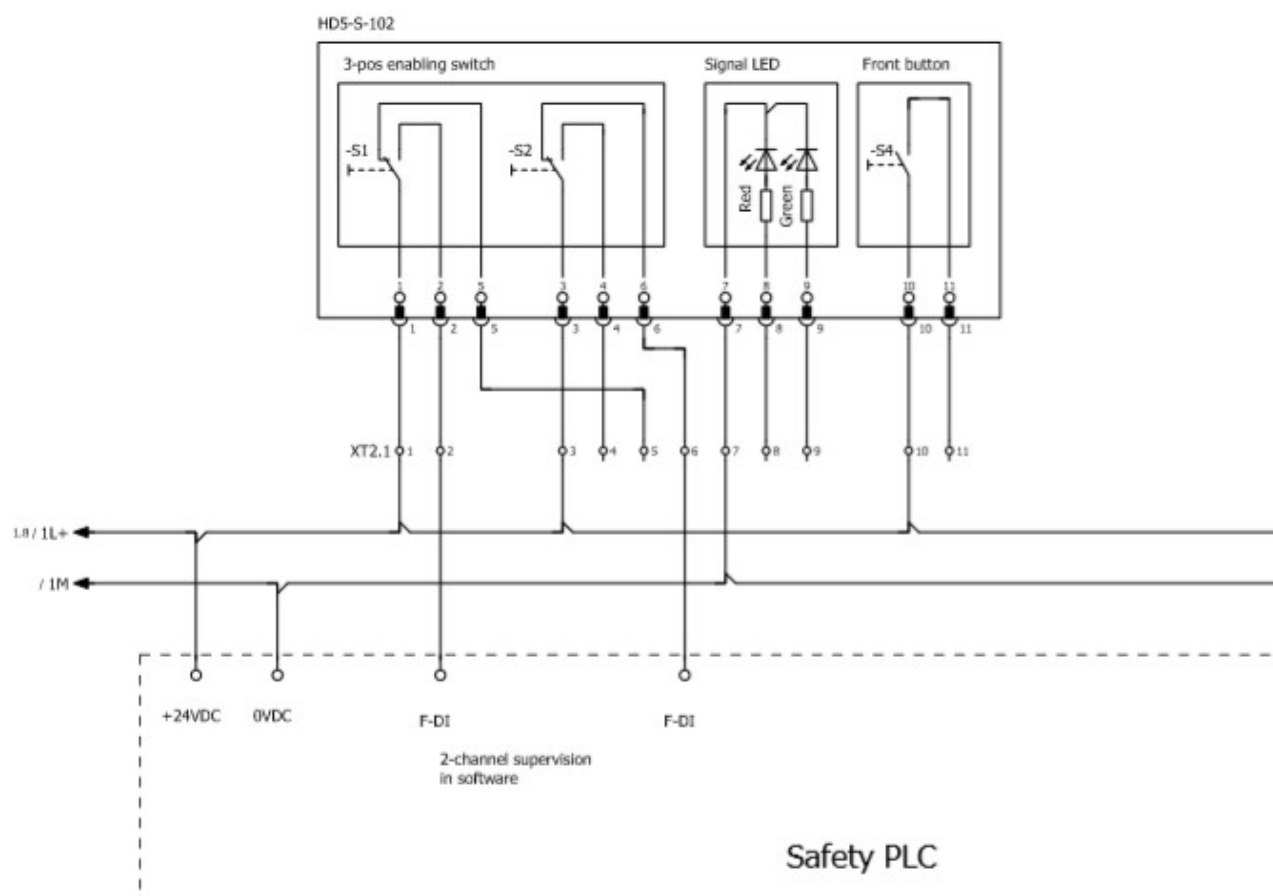
B_{10D} : 250.000

If an n_{op} of 365 is assumed the $MTTF_D$ will be 6849 years, i.e. $MTTF_D$ =High.

When using safety PLC Pluto, the relevant pre-certified function block shall be used.

All relevant requirements of EN ISO 13849-1 needs to be fulfilled.

Connection example to a safety controller



7. INSTALLATION

This chapter contains information about the installation procedures for the three-position device.

- Connect the cable to the control device and connect the HD5 to the cable.
- Mount the holder
- Make sure that the three-position device is completely in the holder.
- Make sure that the connection cable is an original cable from ABB and protected from mechanical damage to ensure highest safety and reliability.
- Make sure that the cable carrying the control signals from the three-position device is physically separated from cables that carry power.



Attention!

Installation shall be done by an approved person. See Chapter Approved person for more information.

- The position should be selected in view of ergonomic and safety relevant aspects.
- Other protective measures must be taken in order to protect other people in the same or in adjacent hazardous areas.
- The safety functions of the product must be tested before the system is put in operation.
- The safety functions of the product must be tested after installation or replacement of components or cables.
- The safety functions and the mechanics of the product must be tested regularly to confirm that all the safety functions are working properly.



Attention!

in accordance to the national electrical codes, cables that carry power (mains power lines, power circuits with a high di/dt, switch-mode converters, power-regulation control devices) and cables that carry control signals must be physically separated.

The connection cable of this device carries control signals and must be laid in the cable area for control signals.

Otherwise, a risk of material damage or personal injury cannot be ruled out!



8. MAINTENANCE

The three-position device itself does not require any maintenance in addition to regular functional testing and cleaning.

The emergency stop safety function must be checked monthly. All safety functions and mechanisms must be tested regularly, at least once a year, to confirm that all the safety functions are working as they should. Depending on the application, machine manufacturers may stipulate requirements for shorter maintenance intervals. If this is the case, such requirements should be given priority. As a rule, it is recommended to document all maintenance work.

To ensure that command buttons continue to function in the long term, it is advisable to regularly wash them with a soft cloth and a standard (soap-based) multi-purpose cleaner.

The connection cable must be inspected regularly and replaced in case of damage. Make sure that the cable is an original cable from ABB to ensure highest safety and reliability.



Caution

The degree of protection of the three-position device specified in the data sheet must be met during cleaning.

The operating surfaces are made of soft, elastic and very thin material designed to be hard wearing. Using abrasive cleaning agents or sharp-edged tools can weaken or penetrate the surface, which results in the protection class being lost in a relatively short space of time. (Dirt and moisture may penetrate the housing) The use of cleaning agents containing solvents should be avoided. This is not only to protect the surfaces, but also to protect the health of employees.



Attention!

If the device is not working or is damaged, the device must immediately be put out of service. Please contact your regular contact for maintenance work or your nearest ABB customer service or dealer. Do not attempt to repair the product yourself. Any attempt to interfere with the device will result in a loss of warranty. A damaged product can affect the function and the safety and how it functions, which may lead to serious injury.

9. MODEL OVERVIEW, ACCESSORIES

HD5-S-xxx

Type	Article number	Description
HD5-S-102	2TLA023001R0000	3-pos button, 1 front button
HD5-S-104	2TLA023001R0200	3-pos button, 1 front button, 2 top buttons
HD5-S-111	2TLA023001R0100	3-pos button, 1 front button, 2 top buttons, Emergency stop, flashlight, motion sensor, home position sensor



HD5-S-102



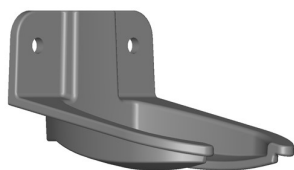
HD5-S-104



HD5-S-111

HD5 accessories

Type	Article number	Description	Suitable for
HD5-M-001	2TLA920509R0001	Active holder	HD5-S-111
HD5-M-002	2TLA920509R0002	Passive holder	Any type of HD5
JSD-TK5-12	2TLA930050R0000	Cable 5m/ 12 pin	HD5-S-102/104
JSD-TK10-12	2TLA930051R0000	Cable 10m/ 12 pin	HD5-S-102/104
JSD-TK100S-12	2TLA930034R0000	Spiral Cable 1/5m / 12 pin	HD5-S-102/104
JSD-TK5-19	2TLA930057R0000	Cable 5m/ 19 pin	HD5-S-111
JSD-TK10-19	2TLA930058R0000	Cable 10m/ 19 pin	HD5-S-111



HD5-M-00x



(JSD-) TKx-xx



(JSD-) TKxxS-xx



Note „HD5-M-00X“

To guarantee all safety functions of HD5 when it is in holder, it is urgent to ensure that the holder is securely fastened.



Note „JSD-TKx-xxx“

When screwing or loosening the plug connection, to ensure, that twisting the installed plug connector is excluded. If necessary, suitable measures must be taken to prevent rotation.

10. TECHNICAL DATA

Manufacturer	
Address	ABB Electrification Sweden AB SE-721 61 Västerås, Sweden
Power supply	
Operational voltage	+24 VDC
Overall power consumption	<150 mA
General	
Protection class	IP65
Ambient temperature during operation	-10°C (no icing) up to +55°C
Ambient temperature storage	-20°C (no icing) up to +70°C (no direct sunlight)
Dimensions	185x75x55mm
Weight	approx. 200 g without connection cable
Material	Housing: Fiberglass reinforced plastic, PPH G30 Additional buttons: TPE Three-position button: TF4STE_B102 Holders: Fiberglass reinforced plastic, PPH G30
Actuating force enabling button	approx. 20 N, 1 → 2 approx. 45 N, 2 → 3
Actuating force additional buttons	approx. 3 N, additional buttons 1 and 2 approx. 7 N, additional buttons 3 and 4
Mechanical /electrical durability of enabling button	1 x 10 ⁶ switching cycles, position 1 → position 2 1 x 10 ⁵ switching cycles, position 2 → position 3
Mechanical reliability B _{10D} , enabling button	B _{10D} : 2 x 10 ⁶ , position 1 → position 2 → position 1 B _{10D} : 968,000, position 1 → position 3 → position 1
Mechanical /electrical durability of emergency stop button	5 x 10 ⁴ switching cycles
Mechanical reliability B _{10d} , emergency stop button	B _{10D} : 250,000
Mechanical durability of additional button 1	2 x 10 ⁶ switching cycles
Mechanical durability of additional buttons 2/3/4	5 x 10 ⁴ switching cycles
Connection	M23 connector

Information for use in USA/Canada (UL)	
Ambient temperature for operation	-10°C (no buildup of ice) up to +50°C (no direct sunlight)
Enclosure	Type 1
Electrical supply	The device shall be supplied from an isolating transformer having a secondary overcurrent protective device that complies with UL 248 to be installed in the field rated max 4 Ampere. a) Max. 5 A for voltages 0-20 V (0-28.3 V peak), or b) 100/Vp for voltages of 20-30 V (28.3-42.4 V peak).
Supply Voltage HD5-S-xxx	20.4 to 27.6 VDC, supplied from Class 2 or LVLC
Overall Current consumption	< 150mA
For devices with field wiring leads smaller than AWG 26 following statement shall be provided on a separate sheet or on the device packaging:	Field wiring leads smaller than AWG 26 need to be terminated in a terminal block or similar connection device or shall be prepared by a wire termination.

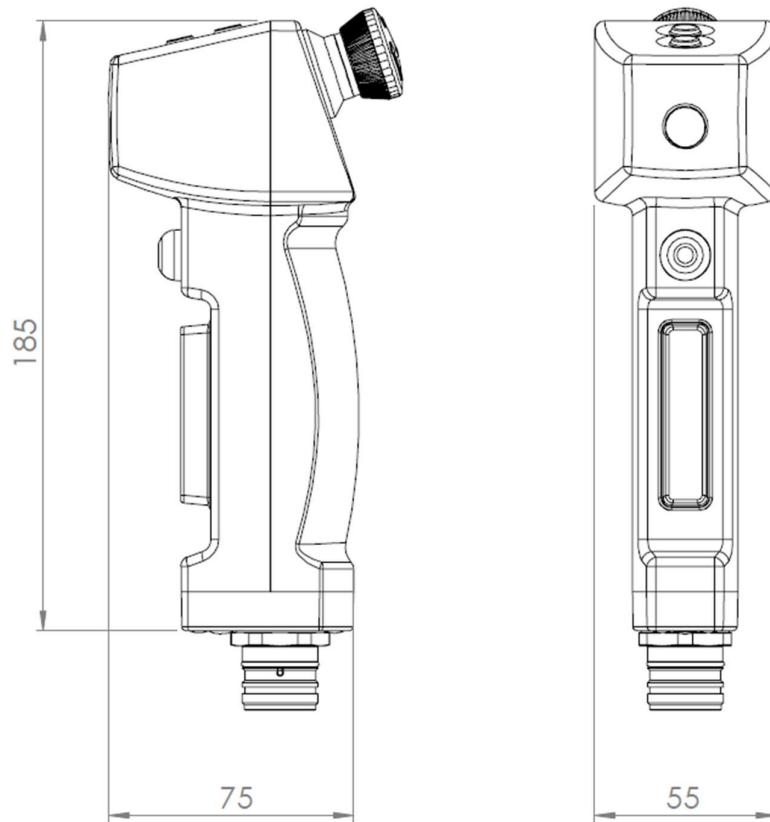
Information for use in UK	
Importer address	ABB Ltd Tower Court, Coutaulds Way Foleshill Enterprise Park, Coventry CV6 5NX, United Kingdom

Safety / Harmonized Standards	
2006/42/EC – Machines, 2014/30/EU – EMC, 2011/65/EU – RoHS2, 2015/863-RoHS3 EN ISO 12100-1:2010, EN ISO 13849-1:2015, IEC 62061:2005+A1:2012+A2:2015, EN 60204-1:2018	
Up to SILCL 3	Up to PL e, category 4
UL/CSA 60947-5-1	
UL/CSA 60947-5-5	only for models with integrated E-Stop button
Certificates	
TÜV Süd	cULus

11. DIMENSIONS

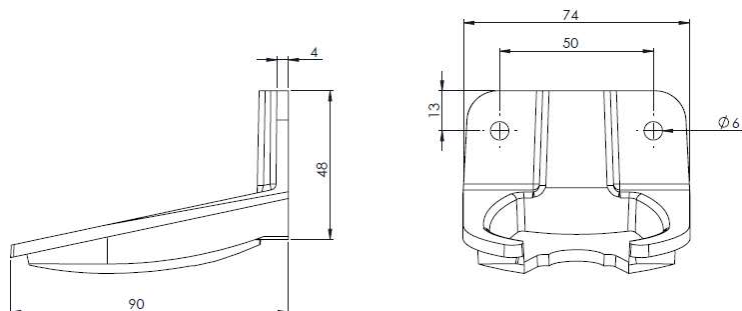
Three position device HD5-S-xxx

All dimensions are in millimeters (mm)



Holder HD5-M-00x

All dimensions are in millimeters (mm)



12. EC DECLARATION OF CONFORMITY



	
EC Declaration of conformity (according to 2006/42/EC, Annex 2A)	
We ABB Electrification Sweden AB SE-721 61 Västerås, Sweden	declare that the safety components of ABB AB manufacture with type designations and safety functions as listed below, are in conformity with the Directives 2006/42/EC – Machines 2014/30/EU – EMC 2011/65/EU – RoHS2 2015/863 – RoHS3
Authorised to compile the technical file	ABB Electrification Sweden AB SE-721 61 Västerås, Sweden
<u>Product</u> Three position device, HD5-S-102, -104, -111	<u>Certificate</u> Z10 049833 0027 Rev.00
Certification body	TÜV Süd Product Service GmbH Ridlerstrasse 65 80339 Munich Germany
Used harmonized standards	EN ISO 12100-1:2010, EN ISO 13849-1:2015, EN ISO 13849-2:2012, EN 62061:2015, EN 60204-1:2006+A1:2009, EN 61000-6-2:2005, EN 61000-6-3:2007
	
Magnus Backman R&D Manager Västerås 2020-11-23	

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