STB Self-Checking Optical Touch Buttons†

Self-Checking Ergonomic Actuating Devices

Features

- Diverse-redundant microcontroller-based photoelectric touch buttons
- Continuous internal self-checking operation
- Ergonomically designed to eliminate hand, wrist and arm stresses associated with repeated switch operation; require no physical pressure to operate
- Immune to ambient light, EMI and RFI interference
- High excess gain cuts through heavy contamination
- Yellow field cover included
- LED power, output and fault indicators

†U.S. Patent(s) issued or pending

Models

Model	Cable*	Upper Housing	Supply Voltage	Output Type	DUO-TOUCH® SG Compatibility
STBVP6 **STBVP6Q** **STBVP6Q5**	4-wire 2 m (6.5') integral cable 4-Pin Mini-style QD 4-Pin Euro-style QD	Polysulfone	10 to 30V dc	Complementary PNP	AT-FM-10K Two-hand control module
STBVR81 **STBVR81Q** **STBVR81Q6**	5-wire 2 m (6.5') integral cable 5-Pin Mini-style QD 5-Pin Euro-style QD		20 to 30V ac/dc	Two Individual Complementary Relays (see Figure 4)	
STBVP6L **STBVP6LQ** **STBVP6LQ5**	4-wire 2 m (6.5') integral cable 4-Pin Mini-style QD 4-Pin Euro-style QD	Polycarbonate	10 to 30V dc	Complementary PNP	
STBVR81L **STBVR81LQ** **STBVR81LQ6**	5-wire 2 m (6.5') integral cable 5-Pin Mini-style QD 5-Pin Euro-style QD		20 to 30V ac/dc	Two Individual Complementary Relays (see Figure 4)	

* 9 m cables are available by adding suffix "**W/30**" to the model number of any cabled STB (e.g., **STBVP6 W/30**).
A model with a QD connector requires a mating cordset; see page 10.

⚠ WARNING . . . Not a Stand-Alone Safety Device

STB Series Touch Buttons are self-checking ergonomic actuating devices, but are not, by themselves, safety devices. To be used in a safety application, two STBs must be interfaced with a type IIIC two-hand-control module, such as the Banner AT-FM-10K, in order to meet all relevant safety requirements of the appropriate standards.

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STB Series Self-Checking Optical Touch Buttons

⚠ Important ... read this before proceeding!

The user is responsible for satisfying all local, state, and national laws, rules, codes, and regulations relating to the use of this product and its application. Banner Engineering Corp. has made very effort to provide complete application, installation, operation, and maintenance instructions. Please direct any questions regarding the use or installation of this product to the factory applications department at the telephone numbers or address shown on the back cover.

The user is responsible for making sure that all machine operators, maintenance personnel, electricians, and supervisors are thoroughly familiar with and understand all instructions regarding the installation, maintenance, and use of this product, and with the machinery it controls. The user and any personnel involved with the installation and use of this product must be thoroughly familiar with all applicable standards, some of which are listed below. Banner Engineering Corp. makes no claim regarding a specific recommendation of any organization, the accuracy or effectiveness of any information provided, or the suitability of the provided information for a specific application.

Applicable U.S. Standards

ANSI B11 Standards for Machine Tools

Contact: Safety Director, AMT – The Associations for Manufacturing Technology, 7901 Westpark Drive, McLean, VA 22102, Tel: 703-893-2900

NFPA79 Electrical Standard for Industrial Machinery

Contact: National Fire Protection Association, 1 Batterymarch Park, P.O. Box 9101, Quincy, MA 02269-9101, Tel: 800-344-3555

ANSI/RIA R15.06 Safety Requirements for Industrial Robots and Robot Systems

Contact: Robotic Industries Association, 900 Victors Way, P.O. Box 3724, Ann Arbor, MI 48106, Tel: 734-994-6088

Applicable International Standards

ISO 12100-1 (EN292-1) Safety of Machinery – Basic Concepts, General Principles for Design, Part 1: Basic Terminology, Methodology

ISO 12100-2 (EN 292-2) Safety of Machinery – Basic Concepts, General Principles for Design, Part 2: Technical Principles and Specifications

IEC/EN60204-1 Electrical Equipment of Machines: Part 1: General Requirements. (Also request a type "C" standard for specific machinery.)

ISO 13849-1 (EN954-1) Safety of Machinery – Related Parts of Control Systems: Part 1 General Principles for Design

ISO 13856-1 (EN1760-1) Safety of Machinery – Pressure-Sensitive Protective Devices: General Principles for Design and Testing

Contact: Global Engineering Documents, 15 Inverness Way East, Englewood, CO 80112-5704, Tel: 800-854-7179

Overview

STB Self-Checking Optical Touch Buttons are touch-activated photoelectric devices designed to replace capacitive touch switches and mechanical push buttons. Their outputs activate while a finger is in the "touch area" (yoke) of the switch, interrupting the button's infrared sensing beam.

Banner STB Series buttons are ergonomically designed to eliminate the hand, wrist, and arm stresses associated with mechanical push buttons. They require absolutely no physical pressure to operate. LED indicators light when power is on and outputs are activated.

All models are immune to EMI, RFI, and ambient light interference. STBs have either a black polysulfone or red polycarbonate upper housing (depending on model) and yellow PBT base. Environmental considerations for use of the two types differ; see specifications. The 30 mm threaded base on all models provides easy mounting and easy retrofitting into existing applications. Rugged yellow polypropylene (TP) field covers are supplied with all models to prevent inadvertent switch actuation due to objects (such as loose clothing or debris) which might accidentally block the sensing beam. The polypropylene material is capable of absorbing high impact (even at low temperatures) and is highly resistant to abrasion and to damage by most chemicals.

STB Self-Checking Optical Touch Buttons are identical in fit, form and function with the proven and popular OTB Series buttons. The dual-microcontroller internal design of the new buttons, however, allows the hookup to a Banner DUO-TOUCH SG Two-Hand-Control Safety Module, or other two-hand-control designed to meet Type IIIC requirements per EN 574 (requiring 1 normally open and 1 normally closed contact per input channel). These microcontrollers perform a continuous self-check. The emitter is continuously pulsed, and receiver response is checked accordingly by the microcontrollers. STB Series Touch Buttons are designed to immediately detect any internal component failure, go into a lockout mode, and indicate the failure with a flashing green Fault LED.

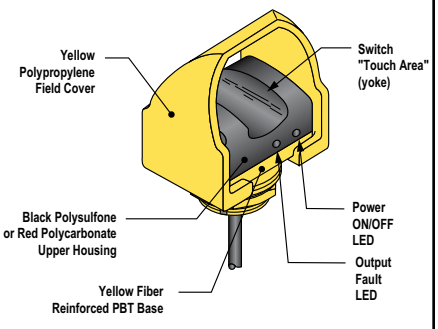


Figure 1. STB Touch Button features

⚠ WARNING . . .

Point-of-Operation Guarding

When properly installed, a two-hand-control system using STB Touch Buttons as the actuating devices provides protection only for the hands of the machine operator. It may be necessary to install other guarding devices, such as safety light screens and/or hard guards, to protect personnel from hazardous machinery. **Failure to install appropriate point-of-operation guards on hazardous machinery can result in a dangerous condition which could lead to serious injury or death.**

The STB outputs are not monitored by the STB circuitry, and have no external device monitoring feedback. Output monitoring must be accomplished by using an external device, such as a Type IIIC Two-Hand-Control module.

STB Series Touch Button LED Indicators

Power On (green): Steady ON when power is applied

Output, Fault (green): Steady ON when button is activated
OFF when button is not activated
Flashing when a fault condition is detected

⚠ CAUTION . . . Install Hand Controls to Prevent Accidental Actuation

Total protection for the two-hand-control system from "defeat" is not possible. However, the user is required by OSHA regulations to arrange and protect hand controls to minimize possibility of defeat or accidental actuation.

⚠ WARNING . . . Location of Touch Button Controls

Hand controls must be mounted a safe distance from moving machine parts, as determined by OSHA Regulation CFR 1910.217 (c) (3) (vii) and (viii). It must not be possible for the operator or other non-qualified persons to relocate them. **Failure to establish and maintain the required safety distance could result in serious injury or death.**

⚠ WARNING . . . Safety Systems Used for Two-Hand-Control

In a two-hand-control/trip system that incorporates STB Touch Buttons as the actuation devices and functions as a safeguard, **the anti-tiedown and simultaneity monitoring functions should not be performed by a non-safety-related device** (e.g., a PLC or PC). Per OSHA 29CFR1910.211(d)(62), **the "safety system must...operate together as a unit, such that a single failure or single operating error will not cause injury to personnel due to point-of-operation hazards."**

Refer to the appropriate standard to determine the requirements of a two-hand-control/trip system when used for safeguarding. See page 2 for a partial list of standards.

Installation

STB Series Self-Checking Touch Buttons were designed primarily to provide the self-checking function required in control-reliable machine cycle initiation applications. However, STBs are suitable for use anywhere mechanical push buttons or the original OTB Touch Buttons are being used today.

Both the solid-state and relay-output versions have complementary outputs and can be connected to switch power to equipment as long as the STB's switching voltage and current limits are not exceeded (see output ratings, page 6).

STBs must be connected to a type IIIC Two-Hand-Control circuit module, in most cases, when used to initiate potentially dangerous machine cycles.

Mechanical Installation

OSHA and ANSI require that the hand controls be mounted to protect them from accidental or unintentional operation. Use shields, covers, rings, collars, dividers, or similar protection to prevent accidental switch actuation and to discourage use of forearms or elbows. European standard EN 574 includes a detailed discussion of approaches to protection of hand controls.

The hand controls must be arranged to require the use of both hands for simultaneous actuation. They must be located far enough apart so that the operator cannot operate both hand controls by the use of one arm.

Figure 2 shows two methods for mounting the STB Touch Buttons. When mounted on top of the control bar, the protective field covers should be in place, as shown. For added protection, mount the STB Touch Buttons sideways under and behind a protective hood, rather than on top of the bar. This side mount prevents the operator from positioning and leaving an object in the path of the beam, intentionally bypassing the safeguard.

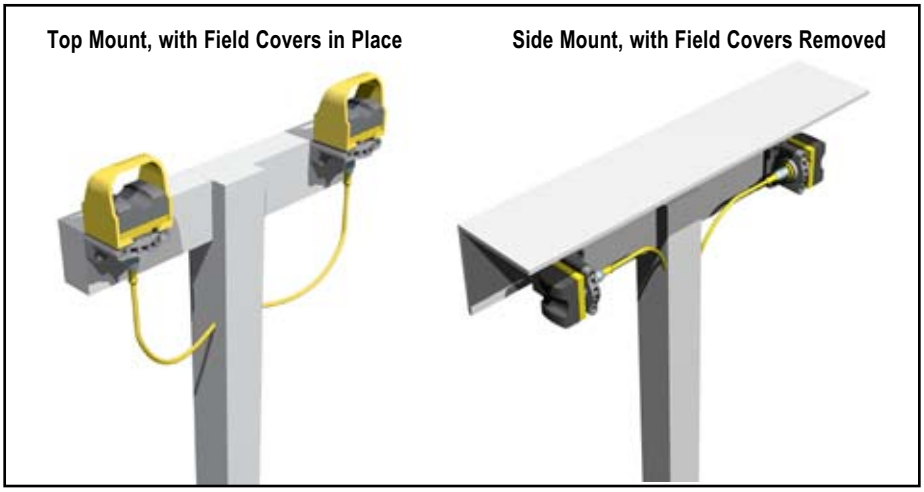


Figure 2. Install STB Buttons so that they are protected to prevent defeat or inadvertent actuation

Separation Distance

Both hand controls must be located far enough away from the nearest hazard point that the operator cannot reach the hazard with a hand or other body part before the hazardous motion ceases (ANSI B11.19, 4.2.4.3.2). This is the "separation distance," and may be calculated as follows [see OSHA CFR 1910.217 (c) (3) (vii) & (viii)].

For Part-Revolution Clutch Machinery

Where the machine and its controls allow the machine to stop motion during the hazardous portion of the machine cycle, use the following formula:

$$D_S = K \times (T_S + T_r + T_h)$$

For Full-Revolution Clutch Machinery

Where the machine and its controls are designed to complete a full machine cycle, once activated, use the following formula:

$$D_S = K \times (T_m + T_r + T_h)$$

For both formulas:

- D_S = the separation distance in inches,
- K = 63" per second (the hand speed constant currently accepted by OSHA; see NOTE 1, below),
- T_S = the stop time (in seconds) of the machine, measured from the application of the "stop" signal to the final ceasing of all motion, including stop times of all relevant control elements, and measured at maximum machine velocity (see NOTE 2, below),
- T_r = the response time of the Two-Hand-Control safety module as measured from the time either hand disengages a hand control
- T_h = the response time of the slowest hand control (from the time when a hand disengages that control until the switch opens; see NOTE 3, below)
- T_m = the maximum time (in seconds) the machine takes to cease all motion after it has been tripped. For full-revolution clutch presses with only one engaging point, Tm is equal to the time necessary for one and one-half revolutions of the crankshaft. For full-revolution clutch presses with more than one engaging point, Tm is calculated as follows:

  $T_m = (\,^1/_2 + {}^1/_N) \times T_{cy}$

  where:

  - N = number of clutch engaging points per revolution
  - T_{cy} = time (in seconds) necessary to complete one revolution of the crankshaft

NOTES:

1. The OSHA-recommended hand speed constant **K** has been determined by various studies, and although these studies indicate speeds of 63"/sec to over 100"/sec, they are not conclusive determinations. The employer should consider all factors, including the physical ability of the operator, when determining the value of **K** to be used.
2. T_S is usually measured by a stop-time measuring device. If the specified machine stop time is used, add at least 20% as a safety factor to account for brake system deterioration. If the stop-time of the two redundant machine control elements is unequal, the slower of the two times must be used for calculating the separation distance.
3. T_h is usually insignificant for purely mechanical switches. However, T_h should be considered for separation distance calculation when using electronic or electromechanical (i.e. powered) hand controls.

Example Separation Distance (D_S) Calculation

The following example illustrates the use of the formula to calculate separation distance for a part-revolution clutch machine. This example uses 0.50 seconds as a typical value for T_S and 0.025 seconds for T_r and T_h:

- K = 63" per second,
- T_S = 0.50 seconds (measured by a stop-time measuring device)
- T_r = 0.025 seconds
- T_h = 0.025 seconds
- D_S = $K \times (T_S + T_r + T_h)$
  = 63" (0.50 + 0.025 + 0.025)
  = 35"

In this example, both hand controls must be located no closer than 35" from the nearest hazard point.

⚠ WARNING . . . Safety Systems Used for Two-Hand-Control

In a two-hand-control/trip system that incorporates STB Touch Buttons as the actuation devices and functions as a safeguard, **the anti-tiedown and simultaneity monitoring functions should not be performed by a non-safety-related device** (e.g., a PLC or PC). Per OSHA 29CFR1910.211(d)(62), **the "safety system must...operate together as a unit, such that a single failure or single operating error will not cause injury to personnel due to point-of-operation hazards."**

Refer to the appropriate standard to determine the requirements of a two-hand-control/trip system when used for safeguarding. See page 2 for a partial list of standards.

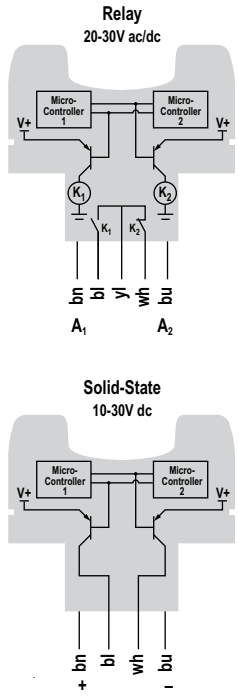
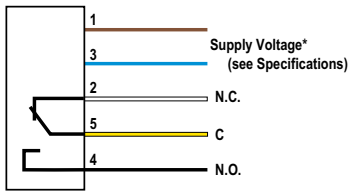


Figure 3. STB Touch Button block diagrams

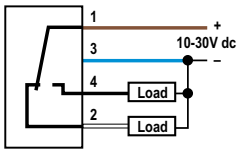
Electrical Installation

Cabled models only are shown. Quick-disconnect hookups are functionally identical.

Electromechanical Relay Output Models



PNP (Sourcing) Solid-State Output Models



*** NOTE: Connection of dc power is without regard to polarity.**

Key 1 = Brown 2 = White 3 = Blue
4 = Black 5 = Gray or Yellow

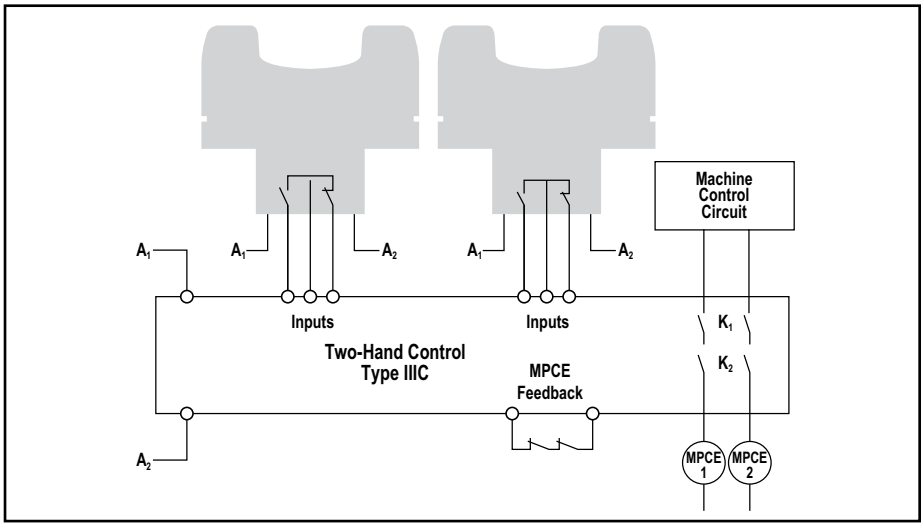


Figure 4. Generic interface of a relay-output STB Touch Button to a type IIIC two-hand-control module

Repairs

NOTE: Do not attempt any repairs to the STB Touch Buttons. They contain no field-replaceable components. Return them to the factory for warranty repair or replacement.

If it becomes necessary to return an STB Touch Button to the factory:

1. Contact the Banner Factory Application Engineering Group at the address or at the numbers listed at the bottom of the back page. They will attempt to troubleshoot the system from your description of the problem. If they conclude that a component is defective, they will issue an RMA (Return Merchandise Authorization) number for your paperwork, and give you the proper shipping address.
2. Pack the components carefully. Damage which occurs in return shipping is not covered by warranty.

STB Series Self-Checking Optical Touch Buttons

Specifications

Supply Voltage and Current	**STBVP6 Models:** 10 to 30V dc **STBVR81 Models:** 20 to 30V ac/dc
Supply Protection Circuitry	Protected against transient voltages and reverse polarity
Output Configuration	**STBVP6 Models:** Complementary PNP (sourcing) open-collector transistors **STBVR81 Models:** Complementary electromechanical relays
Output Rating	**STBVP6 Models (solid-state outputs):** **Maximum load:** 150 mA **On-state saturation voltage:** ≤ 15V @ full load **Off-state leakage current:** < 1 µA **STBVR81 Models (electromechanical relays):** **Maximum switching voltage:** 125V dc/150V ac **Maximum switching current:** 1A **Maximum resistive power:** 30W dc/60VA ac **Mechanical life of relays:** 10^9 cycles **Electrical life of relays:** 1.5 x 10^5 cycles at 1 amp, 24V resistive
Output Protection Circuitry	All models protected against false pulse on power-up. Models with solid-state outputs have overload and short-circuit protection.
Output Response Time	20 milliseconds ON/OFF
Indicators	**2 green LED indicators:** **Power:** ON – power applied **Output/fault:** ON – button is activated OFF – button is deactivated Flashing – internal fault or blocked button on power-up detected
Construction	Totally encapsulated, non-metallic enclosure. Black polysulfone or red polycarbonate upper housing (see Application Notes below); fiber-reinforced PBT polyester base. Electronics fully epoxy-encapsulated. Supplied with polypropylene (TP) field cover.
Environmental Rating	Meets NEMA standards 1, 3, 4, 4X, 12 and 13; IEC IP66
Connections	PVC-jacketed 2 m (6.5') cables or QD fitting, depending on model. Accessory QD cables required for QD models; see Accessories, page 9. **STBVP6 Models:** 4-wire (4-pin Mini-style or Euro-style QD) **STBVR81 Models:** 5-wire (5-pin Mini-style or Euro-style QD) Integral 9 m (30') cables are also available; see model selection chart, page 1.
Ambient Light Immunity	Up to 100,000 lux
EMI/RF Immunity	Immune to EMI and RFI noise sources, per IEC 947-5-2.
Operating Conditions	**Temperature:** 0º to +50º C (+32º to +122º F) **Maximum relative humidity:** 90% @ +50º C (non-condensing)
Application Notes	**Environmental considerations for models with polysulfone upper housings:** The polysulfone upper housing will become brittle with prolonged exposure to outdoor sunlight. Window glass effectively filters longer wavelength ultraviolet light and provides excellent protection from sunlight. Avoid contact with strong alkalis. Clean periodically using mild soap solution and a soft cloth. **Environmental considerations for models with polycarbonate upper housings:** Avoid prolonged exposure to hot water and moist high-temperature environments above 66º C (150º F). Avoid contact with aromatic hydrocarbons (such as xylene and toluene), halogenated hydrocarbons and strong alkalis. Clean perodically using mild soap solution and a soft cloth.

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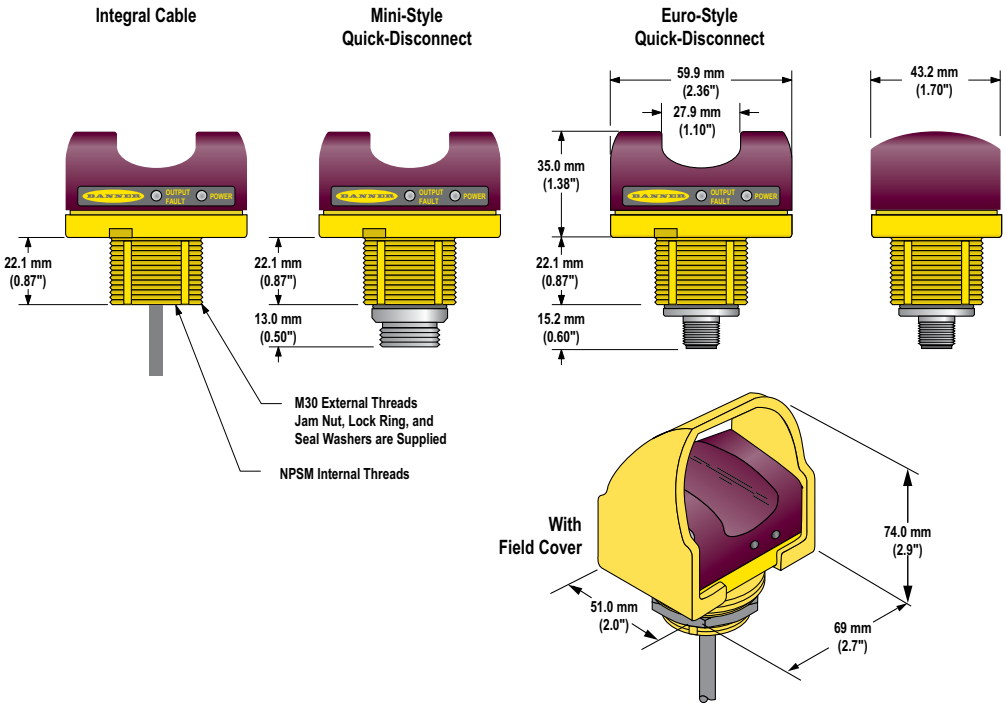
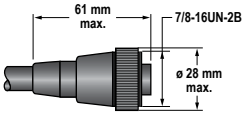
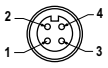
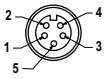
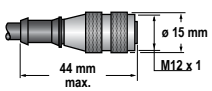
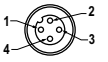
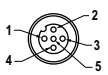
Dimensions



Accessories

Quick-Disconnect (QD) Cordsets

Style	Model	Length	Used With	Dimensions	Pinout
4-Pin Mini Female Straight	**MBCC-406** **MBCC-412** **MBCC-430**	2 m (6.5') 4 m (12') 9 m (30')	STB Mini-Style QD models with PNP outputs		 1 = Brown 2 = White 3 = Blue 4 = Black
5-Pin Mini Female Straight	**MBCC-506** **MBCC-512** **MBCC-530**	2 m (6.5') 4 m (12') 9 m (30')	STB Mini-Style QD models with electromechanical relay outputs		 1 = Brown 2 = White 3 = Blue 4 = Black 5 = Yellow
4-Pin Euro Female Straight	**MQDC-406** **MQDC-415** **MQDC-430**	2 m (6.5') 5 m (15') 9 m (30')	STB Euro-Style QD models with PNP outputs		 1 = Brown 2 = White 3 = Blue 4 = Black
5-Pin Euro Female Straight	**MQDC1-506** **MQDC1-515** **MQDC1-530**	2 m (6.5') 5 m (15') 9 m (30')	STB Euro-Style QD models with electromechanical relay outputs		 1 = Brown 2 = White 3 = Blue 4 = Black 5 = Gray

STB Series Self-Checking Optical Touch Buttons

Mounting Brackets

SMB30MM	• 30 mm • 12-gauge stainless steel • Curved mounting slots for versatile orientation • Clearance for M6 (1/4") hardware	
SMB30SC	• 30 mm swivel bracket • Black reinforced thermoplastic polyester • Includes stainless steel mounting and swivel locking hardware	
SMB30A	• 12-gauge stainless steel • Accommodates 30 mm threaded-barrel-style sensor • Allows ± 15º of lateral movement	
SMBAMS30P	• 12-gauge 300 series stainless steel • Flat SMBAMS series bracket • Use for mounting 30 mm barrel-style sensor on the edge of a surface • Allows > 90º of rotation	
SMBAMS30RA	• 12-gauge 300 series stainless steel • Right-angle SMBAMS series bracket • Accommodates 30 mm threaded barrel • Allows > 90º of rotation	

For bracket dimensions, visit www.bannerengineering.com.

WARRANTY: Banner Engineering Corp. warrants its products to be free from defects for one year. Banner Engineering Corp. will repair or replace, free of charge, any product of its manufacture found to be defective at the time it is returned to the factory during the warranty period. This warranty does not cover damage or liability for the improper application of Banner products. This warranty is in lieu of any other warranty either expressed or implied.

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