

KCAP400

RF Capacitance Level Switch

For single setpoint, dual
setpoint pump controls
K-TEK Products



Introduction

This operating instruction manual provides the following information:

- Dimensions—see page 4
- Installation instructions—see page 5
- Calibration and setup—see page 7
- Troubleshooting—see page 17

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1. INTRODUCTION

1.1 Description

The KCAP400 is a RF Capacitance switch which can be used for point level detection in both solids and liquids. Its wide variety of available probe types, including the three element design, and the KSHIELD technology will allow the switch to adapt to fit many different applications. The KCAP400 software contains an option for three different operating modes; single point, dual point and, pump control. Its rugged construction allows it to withstand the rigors of just about any industrial environment.

1.2 Theory of operation

Every material has a relative permittivity or dielectric constant. A basic capacitance switch uses this dielectric constant to complete a capacitance circuit between a sensor and a reference. The presence of a material creates a shift in the received capacitance causing the switch to activate. While these basic capacitance style switches are useful, the presence of buildup on the probe can cause the unit to fail.

The KSHIELD technology of the KCAP400, along with the three-element probe design, will void out the effects of buildup. By utilizing a second capacitance circuit the buildup can be compensated for in the reference capacitance and point level detection can be maintained.

The software of the KCAP400 will allow the detection of two different capacitance values. This feature allows the relays to be set for two different switch points. When the switch points are coupled to each other, the KCAP400 can act as a pump control device.

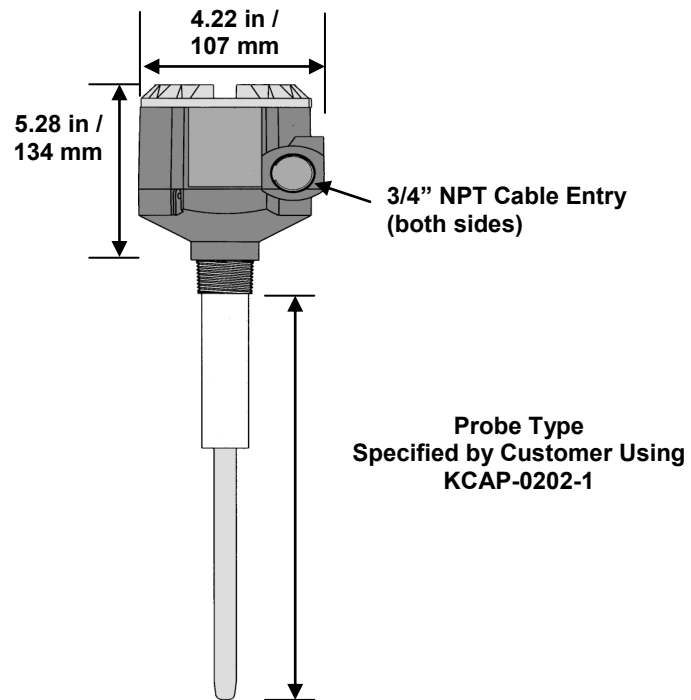
1.3 Features

- Liquids and Bulk Solids
- KSHIELD™ Sensing Probes and Electronics that Provide Immunity to Build Up
- Integral and Remote Electronics Available
- Easy Set Up Via External Magnet or Pushbuttons
- Housing with Glass Viewing Cover
- Wide Variety of 2-Element and 3-Element Sensing Probes Available (450°F / 3000 psig)
- Field Selectable Modes of Operation:
 - Single Set Point (Horizontal or Vertical Installations)
 - Dual Set Point (Vertical Installations Only)
 - Pump Control (Vertical Installations Only)

1.4 Options

- **316L SS enclosure**
- **External “Alarm” Indicating Lamp**
- **Custom Insertion Lengths to 1800 in / 45720 mm**
- **Industry Standard Bulk Solids Mounting Plate**
- **Process Connections: 3/4”NPT, 1 1/4”NPT, 1 1/2”NPT and Custom Flanges**

2. DEMINSIONS



3. INSTALLATION

3.1 General

After unpacking the unit, inspect it for any evidence of shipping damage. Any claims for damage due to shipping must be filed with the carrier who handled the package(s).

- Select a mounting location for the switch and the sensor probe. Your unit may be the integral mounting option or the remote mounting option. The integral mounting unit consists of a single enclosure that includes the electronic module and the sensor probe. The remote mounting unit consists of two enclosures, one containing the electronic module and the other containing the sensor probe.
- Be sure that there is sufficient clearance around the mounting position to allow for the turning radius of the switch or remote sensor enclosure as the unit is screwed into place. Also, in the case of rigid probes, allow sufficient room above the vessel entry to be able to insert the probe into the opening of the vessel.
- The thread size of the vessel coupling should be 3/4" NPT for most probes. Certain special applications may utilize couplings of different sizes.
- The information included on the label should be visible. If necessary to make it readable, clean the label using a cloth soaked with either water or isopropyl alcohol.
- CAUTION: When making the opening in the vessel, observe all safety requirements of the area in which the work is being done. Be especially careful when working with pressure vessels.

The Model KCAP400 unit may not work properly if:

- The material dielectric constant is less than 1.4.
- There is a conductive bridge between probe and vessel wall,
- The unit does not have a good ground connection.
- Probe insulation is damaged.
- Probe is located near a material fill line.
- Probe is mounted improperly.

The Model KCAP400 unit may be damaged if:

- Temperature in the Model KCAP400 housing exceeds appropriate limits.
- The process temperature exceeds the probe's operating limits.
- The electronics module is subjected to excessive vibration or shock.
- Vessel pressure exceeds process operating pressure rating of probe.

CAUTION: If any of the above statements apply to your application, do not install the switch until you contact your local representative or the ABB factory for further instructions.

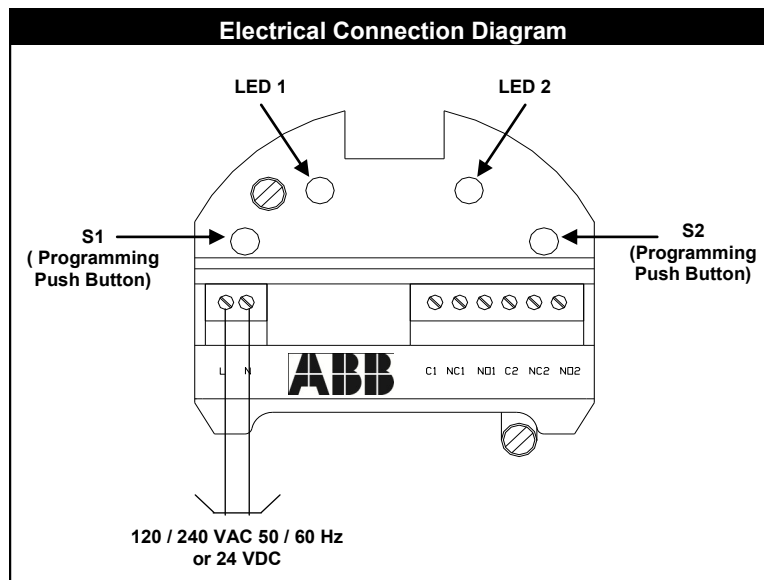
3.2 Recommendations

Integral units

- Install the switch into the vessel coupling and connect conduit between the switch and the supply source as required.
- Be sure the conduit is suitable for the environment in which the units are to be used.

Remote units

- Install the remote sensor probe into the vessel coupling. Select a suitable location for the instrument housing that allows convenient access for calibration.
- Connect conduit between the remote sensor housing and the instrument housing.
- Connect the RG62 type coaxial cable assembly supplied with the unit from the remote probe to the instrument input.
- Connect conduit between the switch and the supply source as required. Be sure the conduit is suitable for the environment in which the units are to be used.



Due to the extremely wide range of control and/or alarm applications in which the unit may be used, it is not possible to show all conceivable wiring diagrams. Consult your representative or ABB factory if further assistance is needed.

3.3 CAUTION

Be sure that all wiring and conduit conforms to the requirements of the National Electrical Code and any enforcing authorities or agencies having jurisdiction over the installation. Be sure that any special conditions, such as areas having explosion hazards, are given full consideration.

- After installing and wiring, it is necessary to calibrate the unit to the particular vessel and material that will be measured, using the standard calibration procedure.
- The KCAP400 has a reset capability to restore the factory default values, which can be done by pressing "S1" and "S2" at the same time for holding the magnet on the "X" position for 30 seconds. The current level of the tank is chosen as the new set point. See RESET in Section 4.2 for details of this procedure.

Both liquid and dry products have dielectric values. The KCAP400 RF Switch is designed to monitor levels of liquid and dry products with a stable dielectric constant greater than 1.4.

4. CALIBRATION and SETUP

4.1 Accessing Setup Adjustments

Calibration of the KCAP400 may be achieved using a magnet positioned on the housing or by means of the pushbuttons on the module. In the following operations, pushbuttons will correspond to magnet position as follows:

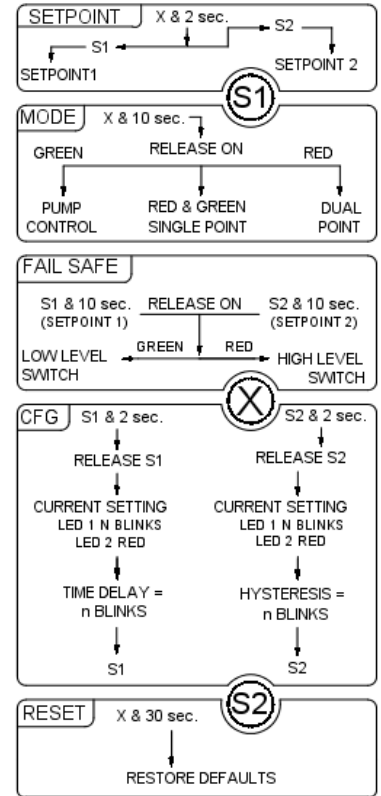
- X position = S1 and S2 buttons simultaneously
- S1 position = S1 button only
- S2 position = S2 button only

During normal operation, LED1 will light either red or green based on the settings of the switch.

4.2 Default Settings / Reset

Each KCAP400 will be supplied with the following default settings:

- Time Delay = Instant
- Sensitivity = Med
- Mode = Dual Set Point
- Fail Safe Mode = Low Level (Both Switches)
- Setpoints = Current Level (Both Switches)



To restore the default settings, place the magnet on the "X" position for 30 seconds. The following sequence of lights will be observed:

TABLE 1		
OPERATION	LED 1	LED 2
NORMAL	GREEN or RED	GREEN or RED
X = 30 SECONDS	OFF	OFF
	GREEN	GREEN
	RED	RED
	RED	GREEN
	GREEN	GREEN
	RED	RED
	RED	GREEN
	GREEN	GREEN
REMOVE	OFF	OFF

When both LED's turn off the second time, remove the magnet. The KCAP400 will be restored to normal operation with the default settings. The sensed capacitance at the moment the magnet is removed will become the setpoint for both relays.

4.3 Operating Modes

4.3.1 Selecting an Operating Mode

The KCAP400 is equipped with 3 different operating modes Single Setpoint, Dual Setpoint, and Pump Control. Each operating mode will have its' own set of guidelines for relay operation. To access the different modes, place the magnet on the "X" position for approximately 10 seconds. Remove the magnet when the LED configuration which corresponds to the operating mode is reached, per Table 2. This light sequence will cycle through twice and the Operating Mode required may be selected on either cycle.

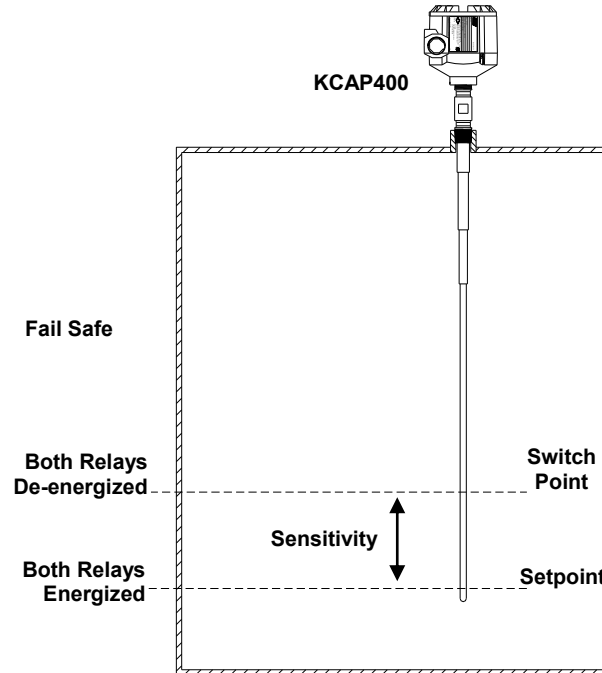
Note: Bare rod probes installed in metallic vessels may be used in dielectrics higher than 10 as Single Setpoint devices only. Single Setpoint units may be installed horizontally or vertically. Dual Setpoint and Pump Control units may only be installed vertically.

TABLE 2		
OPERATION	LED 1	LED 2
NORMAL	GREEN or RED	GREEN or RED
X = 10 SECONDS	OFF	OFF
REMOVE FOR PUMP CONTROL	GREEN	GREEN
REMOVE FOR DUAL SETPOINT	RED	RED
REMOVE FOR SINGLE SETPOINT	RED	GREEN

4.3.2 Single Setpoint Mode

In Single Setpoint Mode, both relays will act as one based on a single capacitance value. When the sensed capacitance eclipses the switch point both relays will activate or deactivate depending on the Fail Safe Setting. The settings for Fail Safe, Sensitivity, and Time Delay will affect the operation of both relays in the same manner.

To calibrate Setpoint 1, proceed to Section 4.4



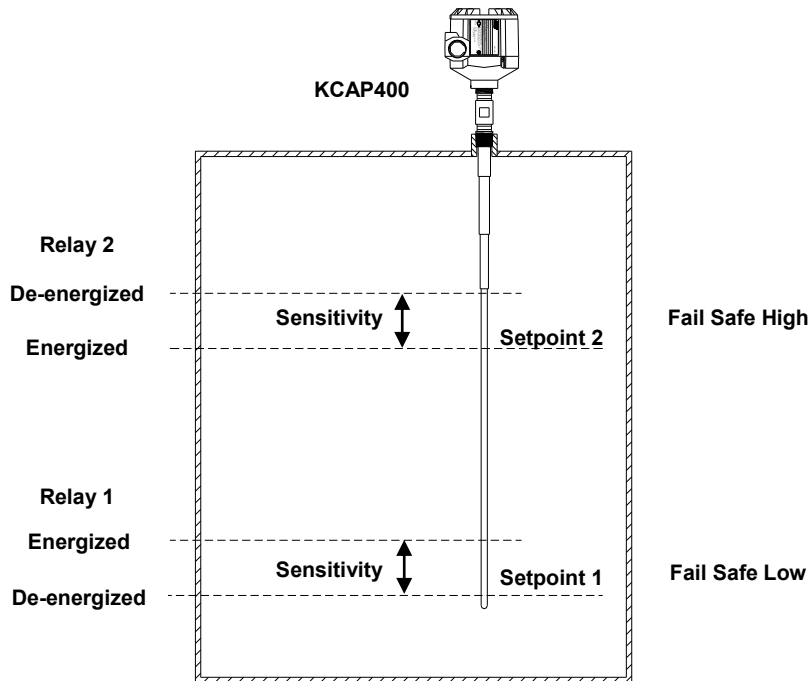
If a KCAP400 is switched from Dual Set Point to Single Setpoint Mode the value of Setpoint 1 will be maintained, along with its Fail Safe Mode, Sensitivity, and Time Delay. Setpoint 2 will, in effect, be turned off and its' settings will be stored in memory.

If the KCAP400 is switched from Pump Control Mode to Single Setpoint Mode, the value of Setpoint 1 will be maintained and Setpoint 2 will be turned off. The original settings for Fail Safe Mode, Sensitivity, and Time Delay for Setpoint 1 will become active. If these settings were never adjusted, the default settings will apply.

4.3.3 Dual Setpoint Mode

Dual Setpoint Mode is the default mode of the KCAP400. Dual Setpoint Mode will allow the activation of each relay at a different level or capacitance. Relay 1 will react to Setpoint 1. Relay 2 will react to Setpoint 2. Each Setpoint will have the same Sensitivity and Time Delay but each Setpoint will have its' own Fail Safe Mode. If the unit is Reset, both setpoints will be calibrated to the sensed capacitance at the time the Reset takes place.

To calibrate Setpoint 1 and Setpoint 2, proceed to Section 4.4.



If the KCAP400 is switched from Single Setpoint Mode to Dual Setpoint Mode, Setpoint 2 will become active, along with the stored value for its' Fail Safe Mode. Setpoint 2 will have the same Sensitivity and Time Delay as Setpoint 1. If Setpoint 2 has not been calibrated, the default values from stored memory will apply.

If the KCAP400 is switched from Pump Control Mode to Dual Setpoint Mode, both setpoints will remain active at their current values. The Time Delay will remain the same. The Fail Safe and Sensitivity will be reset to the original value for each setpoint. If the settings of the Fail Safe and Sensitivity were not changed from the default, the default settings will apply.

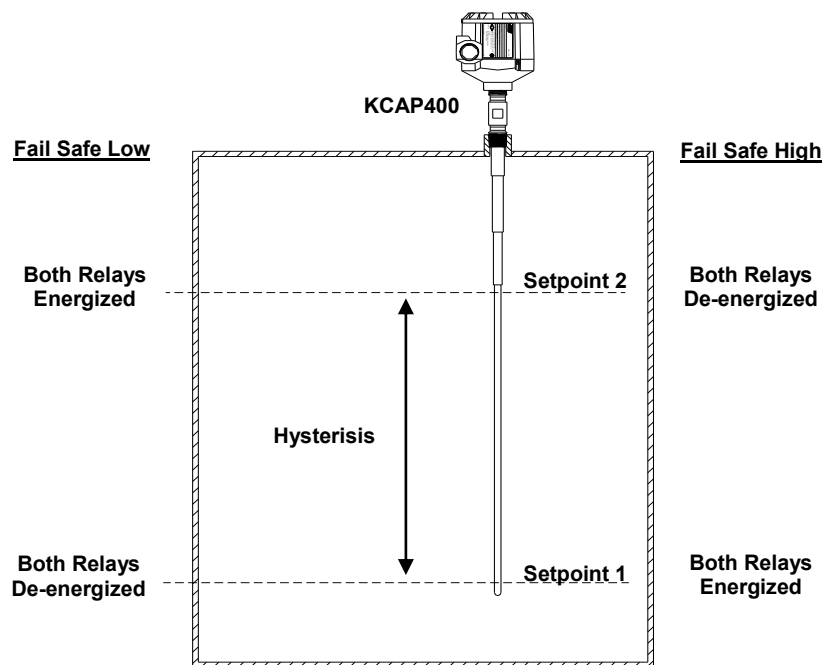
4.3.4 Pump Control

Pump Control Mode utilizes two setpoints to control both relays simultaneously. In this mode, a control area is established between the two setpoints. The difference between the setpoints will become the hysteresis of the control function and take the place of the Sensitivity function in the switch. Any Sensitivity setting will be stored in memory and not used. The Fail Safe Mode will determine if the switches will energize at the top or bottom setpoint. The Time Delay will remain active and affect both setpoints.

The KCAP400 has the wiring connections for NO and NC contacts as well as the ability to reverse its relay action. Before the switch is set and wired for Pump Control it may be useful to analyze the entire control function of the switch. If the switch were to lose power for some reason, the relays would de-energize. Ask the following questions before wiring and setting the switch:

1. Is the switch going to control a pump in or pump out function?
2. If you were to lose power to the switch, do you want the pump to continue running or turn off?

Note: *When wiring the KCAP400 for Pump Control Operation, the relays of the KCAP400 should not be wired directly to the motor of the pump. An independent motor starter relay whose contacts match the pump specifications and whose coil rating matches the specifications listed in Section 2.2 should be used between the pump and the switch.*



If the KCAP400 is changed from Dual Setpoint Mode to Pump Control Mode, the Setpoints and the Time Delay will remain at their current settings. The Sensitivity / Hysteresis will become the difference between the switches.

If the KCAP400 is changed from Single Setpoint Mode to Pump Control Mode the following will occur: Setpoint 1 will remain the same. Setpoint 2 will become active as either a previously stored value or the default value. The Time Delay will remain unchanged. The Sensitivity / Hysteresis will become the difference between the switches.

4.4 Setpoint Calibration

A typical application will require the switch to activate when the measured product reaches a certain level on the probe. To set the action of the switch for this application, mount and wire the switch in its permanent location. With product touching the probe at the desired setpoint level, place the calibration magnet on the "X" position for more than 1 but less than 6 seconds. When both LED's turn off, move the magnet to the "S1" position for 2 seconds, then remove. The KCAP400 will then return to normal operating mode with the new set point. The following sequence of lights will be observed during this operation :

TABLE 3		
OPERATION	LED 1	LED 2
NORMAL	GREEN or RED	GREEN or RED
1 SECOND < X < 6 SECONDS	OFF	OFF
S1	GREEN	OFF
	GREEN or RED	GREEN or RED

This procedure will establish Setpoint 1 as the sensed capacitance of the switch at the moment the magnet was placed on "S1". When the sensed capacitance reaches this Setpoint plus the Sensitivity capacitance, the switch will activate. If a Setpoint is calibrated without product touching the probe, the switch will activate when the product level reaches the end of the probe.

Note: When using a bare probe installed in a metallic vessel, a setpoint for a dielectric higher than 10 on may only be set at the end of the probe.

To calibrate Setpoint 2, establish a level on the probe where the switching operation should take place. Hold the magnet on the "X" position for more than 1 but less than 6 seconds. When both LED's turn off, move the magnet to "S2" position for 2 seconds, then remove. The KCAP400 will then return to normal operating mode with the new set point.

TABLE 4		
OPERATION	LED 1	LED 2
NORMAL	GREEN or RED	GREEN or RED
1 SECOND < X < 6 SECONDS	OFF	OFF
S2	OFF	GREEN
	GREEN or RED	GREEN or RED

Note: When using a bare probe installed in a metallic vessel measuring a dielectric higher than 10, Setpoint 2 will act the same as Setpoint 1 regardless of the level on the probe at the time of calibration.

Note: If a steady level cannot be established on the probe, the setpoints can be calibrated on-the-fly. The setpoints will be established as the sensed capacitance when the magnet is removed from the housing.

4.5 Fail Safe / Relay Operation

The default setting for the Fail Safe or Relay Operation of the KCAP400 will be Low. This means each relay will be de-energized when the level is below the setpoint and energize when the switch point is reached. Setting the Fail Safe to High will cause to the relays to be energized when the level is below the setpoint and de-energize when the switch point is reached.

To select the Fail Safe for Setpoint 1, place the magnet in the “S1” position for 10 seconds. The following sequence of lights will be observed:

TABLE 5		
OPERATION	LED 1	LED 2
NORMAL	GREEN or RED	GREEN or RED
S1 = 10 SECONDS	OFF	OFF
REMOVE	“GREEN or RED”	OFF
“ _ “ - indicates a blinking LED		

Removing the magnet when LED1 is *green* will set the Fail Safe for Setpoint 1 to Low. Removing the magnet when LED1 is *red* will set the Fail Safe for Setpoint 1 to High.

To select the Fail Safe for Setpoint 2, place the magnet in the “S2” position for 10 seconds. The following sequence of lights will be observed:

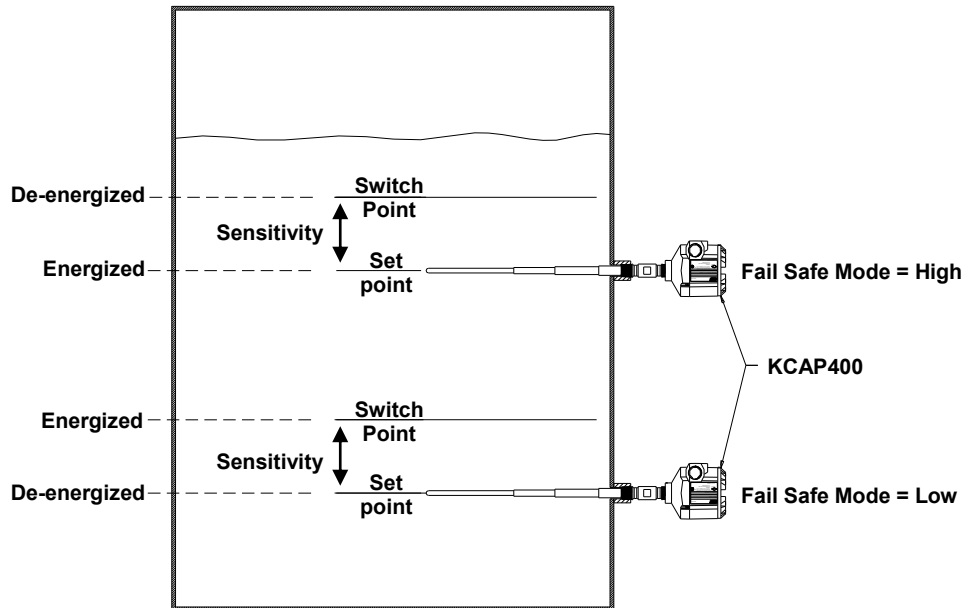
TABLE 6		
OPERATION	LED 1	LED 2
NORMAL	GREEN or RED	GREEN or RED
S2 = 10 SECONDS	OFF	OFF
REMOVE	OFF	“GREEN or RED”
“ _ “ - indicates a blinking LED		

Removing the magnet when LED2 is *green* will set the Fail Safe for Setpoint 2 to Low. Removing the magnet when LED1 is *red* will set the Fail Safe for Setpoint 2 to High.

If the KCAP400 is in Single Setpoint or Pump Control Mode, the Fail Safe setting for Setpoint 1 will apply to both relays. Follow the procedure for setting the Fail Safe of Setpoint 1 when operating in these modes.

4.6 Sensitivity / Hysteresis

The Sensitivity adjustment of the KCAP400 provides a buffer to the sensed capacitance to prevent erratic or faulty switching during normal operation. The Sensitivity will be set at a default value of 6pF. This means a change of 6pF from the setpoint will be required to activate the relay. The relay will reset to its original position when the sensed capacitance falls back to 1/3 of the Sensitivity (2pF on default) from the Setpoint. This setting will allow switching in most applications. In applications of higher dielectric materials, it may be necessary to decrease the sensitivity to prevent false indications.



Setting the Fail Safe to High on the Upper Switch will cause the relays to de-energize when the sensed capacitance reaches the Setpoint plus the Sensitivity. The relays will energize after the sensed capacitance moves down past 1/3 of the Sensitivity plus the Setpoint.

Setting the Fail Safe to Low on the Lower Switch will cause the relays to energize when the sensed capacitance reaches the Setpoint plus the Sensitivity. The relays will de-energize after the sensed capacitance moves down past 1/3 of the Sensitivity plus the Setpoint.

To access the Sensitivity Setup Mode, place the magnet on “S2” for more than 1 second but less than 6 seconds. The following sequence of LED’s will be observed :

TABLE 7		
OPERATION	LED 1	LED 2
NORMAL	GREEN / RED	GREEN / RED / OFF
1 SECOND < S2 < 6 SECONDS	OFF	OFF
	RED	“GREEN”
	OFF	OFF
S2 PER TABLE 7	OFF	“GREEN”
“ _ “ - indicates a blinking LED		

While LED1 is lit red, LED2 will blink the current Sensitivity per Table 8.

TABLE 8			
LED 2 BLINKS	1	2	3
pF	1.5	6	32
SENSITIVITY	HIGH	MED	LOW

Once the number of blinks corresponding to the required Sensitivity is reached, place the magnet on the “S2” position. The Sensitivity will be set, and the KCAP400 will return to normal operation.

If a Sensitivity is not selected, the KCAP400 will return to its current settings without affecting a change.

Note: *When the KCAP400 is operating in Pump Control Mode, the Sensitivity setting will be turned off. The difference between the two setpoints will become the Sensitivity or Hysterisis of the Pump Control.*

4.7 Time Delay

The KCAP400 with its default settings will activate the relays instantaneously when the switch point has been reached. In certain applications it may be necessary to delay the action of the relays in the switch. If this is desired, a Time Delay for the relays can be set. To enter the Time Delay Setup Mode, place the magnet on "S1" for more than 1 second but less than 6 seconds then. The following sequence of LED's will be observed:

TABLE 9		
OPERATION	LED 1	LED 2
NORMAL	GREEN or RED	OFF
1 SECOND < S1 < 6 SECONDS	OFF	OFF
	"GREEN"	RED
	OFF	OFF
S1 per Table 5	"GREEN"	OFF
" " - indicates a blinking LED		

While LED2 is lit *red*, LED1 will blink the current Time Delay setting per Table 10.

TABLE 10			
LED 1 BLINKS	1	2	3
SECONDS	0	5	15

After LED2 turns "off", LED1 will blink in correspondence to the different Time Delay settings per Table 7. When the desired Time Delay is reached, place the magnet on the "S1" position. The Time Delay will be set and the KCAP400 will return to normal operation. If a time delay is not selected, the KCAP300 will return to its current operating mode without changing the current Time Delay setting.

During normal operation of the switch if a Time Delay is selected other than 0 seconds, LED1 will change color when the switch point has been reached. The relays will respond after the elapsed Time Delay on both energize and de-energize actions.

5.0 TROUBLESHOOTING

5.1 Symptoms and Remedies

Any failure of the KCAP400 can be defined as a negative reaction to an action. Each failure will have certain symptoms, which can direct the user to a possible cause and eventual remedy.

SYMPTOMS	POSSIBLE CAUSE	REMEDY
KCAP400 does not detect material.	Bad ground connection.	Ensure proper grounding of the switch.
	Sensitivity set too low.	Follow procedure 4.6 to increase sensitivity.
	Damaged electronics.	Replace electronics module and recalibrate.
	Improper Probe for Dielectric.	Consult factory for proper probe recommendation.
Unstable relay action.	Bad ground connection.	Ensure proper grounding of the switch.
	Sensitivity set too high for high dielectric.	Follow procedure 4.6 to decrease sensitivity.
	Radio frequency interference.	Ensure housing cover is completely screwed into housing.
		Ensure proper grounding of the switch.
	Agitation or waves in liquid.	Follow procedure 4.7 to increase Time Delay.
		Modify or change mounting to eliminate effects of fluid motion.
	Lack of available power to switch.	Ensure proper input voltage and wattage per section 2.2.
Damaged electronics.	Replace electronics module and recalibrate.	
Relays are fully activating but resulting actions are wrong.	Setpoints not calibrated.	Follow procedure 4.4 to calibrate setpoints.
	Operating Mode not set correctly	Follow procedure 4.3.1 to set Operating Mode.
	Improper Time Delay	Follow procedure 4.7 to correct Time Delay.
	Fail Safe Mode not set correctly	Follow procedure 4.5 to select proper Fail Safe Mode.
	KCAP400 wired incorrectly	Ensure wiring for selected operation.

5.2 Warranty Statement

5 YEAR WARRANTY FOR:

KM26 Magnetic Liquid Level Gauges, Buoyancy Level Switches (LS20, MS50, MS10 & MS8), Magnetic Level Switches (MS30, MS21, MS40, MS41, PS35 & PS45), EC External Chambers and ST95 Seal Pots.

3 YEAR WARRANTY FOR:

KCAP300 & KCAP 400 capacitance switches.

2 YEAR WARRANTY FOR:

AT100 and AT200 series transmitters; VF20 and VF30 vibrating fork switches; RLT100 and RLT200 reed switch level transmitters; TX, TS, TQ, IX and IM thermal dispersion switches; MT2000 radar level transmitters; KP paddle switches; A02, A75 & A77 RF capacitance level switches and A38 RF capacitance level transmitters.

1 YEAR WARRANTY FOR:

KM50 gauging device; AT500 and AT600 series transmitters; LaserM and SureShot series laser transmitters; LPM 100 and 200 series digital indicators; DPM100 digital indicators; APM100 analog indicators; KVIEW series digital indicators and controllers; SF50 and SF60 vibrating fork switches, KB Electro-Mechanical Continuous Measuring Devices, KSONIK ultrasonic level switches, transmitters & transducers.

SPECIAL WARRANTY CONSIDERATIONS:

ABB will honor OEM warranties for items not manufactured by ABB (i.e. Palm Pilots).

ABB will repair or replace, at ABB's election, defective items which are returned to ABB by the original purchaser within the period specified above from the **shipment date** of the item and which is found, upon examination by ABB, to its satisfaction, to contain defects in materials or workmanship which arose only under normal use and service and which were not the result of either alterations, misuse, abuse, improper or inadequate adjustments, applications or servicing of the product. **ABB's warranty does not include onsite repair or services.** Field service rates can be supplied on request.

If a product is believed to be defective, the original purchaser shall notify ABB and request a Returned Material Authorization before returning the material to ABB, with transportation **prepaid** by the purchaser. (Request door to door delivery via New Orleans International Airport located in Louisiana, USA.) The product, with repaired or replaced parts, shall be returned to the purchaser at any point in the world with transportation prepaid by ABB for best-way transportation only. ABB is not responsible for expedited shipping charges. If the product is shipped to ABB freight collect, then it will be returned to the customer freight collect.

If inspection by ABB does not disclose any defects in material or workmanship, ABB's normal charges for repair and shipment shall apply (minimum 100.00 USD).

The materials of construction for all ABB products are clearly specified and it is the responsibility of the purchaser to determine the compatibility of the materials for the application.

THE FOREGOING WARRANTY IS ABB'S SOLE WARRANTY AND ALL OTHER WARRANTIES EXPRESSED, IMPLIED, OR STATUTORY, INCLUDING ANY IMPLIED WARRANTY OF MERCHANTABILITY OF FITNESS FOR A PARTICULAR PURPOSE, ARE EXCLUDED AND NEGATED TO THE MAXIMUM EXTENT PERMITTED BY LAW. NO PERSON OR REPRESENTATIVE IS AUTHORIZED TO EXTEND ANY OTHER WARRANTY OR CREATE FOR ABB ANY OTHER LIABILITY IN CONNECTION WITH THE SALE OF ABB'S PRODUCTS. THE REMEDIES SET FORTH IN THIS WARRANTY ARE EXCLUSIVE OF ALL OTHER REMEDIES AGAINST ABB. ABB SHALL NOT BE LIABLE FOR ANY CONSEQUENTIAL, INCIDENTAL, OR SPECIAL DAMAGES OF ANY KIND. ABB'S SOLE OBLIGATION SHALL BE TO REPAIR OR REPLACE PARTS (FOUND TO BE DEFECTIVE IN MATERIALS OR WORKMANSHIP) WHICH ARE RETURNED BY THE PURCHASER TO ABB.

5.3 Company Information

For advanced troubleshooting information or repairs, contact the ABB Factory:

Service Department
Email: service@ktekcorp.com
Tel. (225) 673-6100
1-800-735-5835
Fax (225) 673-2525
18321 Swamp Road
Prairieville, Louisiana 70769 USA

Contact us

ABB Inc.

18321 Swamp Road
Prairieville, LA 70769 USA
Phone: +1 225 673 6100
Service: +1 225 677 5836
Fax: +1 225 673 2525
Service e-mail: service@us.abb.com

www.abb.com/level

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