

US50 SERIES - digital output - ultrasonic sensors

INSTRUCTION MANUAL

CONTROLS



Power ON/OFF LED (Green) – indicates the operating status of the sensor.

Power ON/OFF LED	Indicates
OFF	Power is OFF
ON Stable	Sensor is operating normally
Blinking @ 4Hz	Output is overloaded (RUN mode)
Blinking @ 2Hz	Transmit disabled

Signal LED (Red) – indicates the strength and condition of the sensor's incoming signal.

Signal status	Indicates
ON bright	Good signal
ON dim	Marginal signal strength
OFF	No signal is received*, or target is beyond the sensor's range limitations

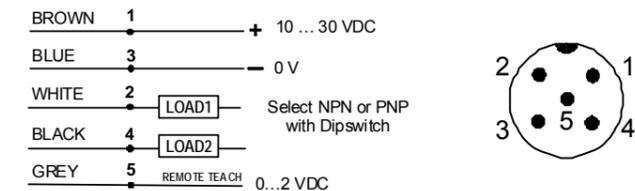
*If no signal is received, the output will react as if the target is beyond the far limit. In normally open mode, the outputs will be OFF. In normally closed mode, the outputs will be ON.

Output LEDs (Yellow or Red) – indicate the position of the target relative to the window limits.

Output/Teach LED	Indicates
ON Red (stable)	In Teach mode; waiting for first limit to be taught
ON Red (blinking)	In Teach mode; waiting for second limit to be taught
ON Yellow	Target is within window limits (normally open mode)
OFF	Target is outside window limits (normally open mode)

CONNECTIONS

5-POLE M12 CONNECTOR



PRINCIPLES OF OPERATION

Ultrasonic sensors emit one or multiple pulses of ultrasonic energy, which travel through the air at the speed of sound. A portion of this energy reflects off the target and travels back to the sensor. The sensor measures the total time required for the energy to reach the target and return to the sensor. The distance to the object is then calculated using the following formula:

$$D = \frac{ct}{2}$$

D = Distance from the sensor to the target
C = Speed of sound in the air
T = Transit time for the ultrasonic pulse

To improve accuracy, an ultrasonic sensor may average the results of several pulses before outputting a new value.

Temperature effects

The speed of sound is dependent upon the composition, pressure and temperature of the gas in which it is traveling. For most ultrasonic applications, the composition and pressure of the gas are relatively fixed, while the temperature may fluctuate. In air, the speed of sound varies with temperature according to the following approximation:

$$C_{m/s} = 20 \sqrt{273 + T_c}$$

C_{m/s} = Speed of sound in meters per second
T_c = Temperature in °C

The speed of sound changes roughly 1% per 6° C (10° F). QT50U series ultrasonic sensors have temperature compensation available, via the 8-pin DIP switch. Temperature compensation will reduce the error due to temperature by about 90%. **NOTE:** If the sensor is measuring across a temperature gradient, the compensation will be less effective.

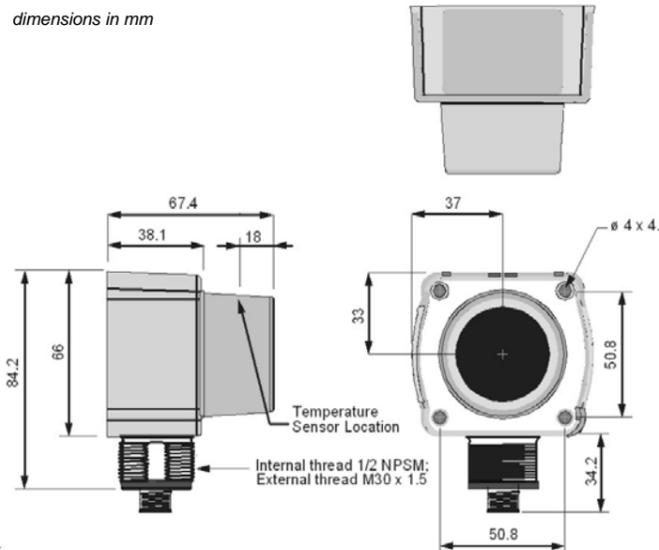
TECHNICAL DATA

Power supply:	10 ... 30 VDC reverse polarity protection
Ripple:	≤ 2 V _{pp}
Consumption (load current excluded):	100mA max. at 10V 40mA max. at 30V
Ultrasonic frequency:	75 kHz burst, rep. rate 96 ms
Digital output configuration:	NPN or PNP, selectable via DIP switch

Output ratings:	150 mA max. OFF-state leakage current: < 5 µA Output saturation NPN: < 200 mV @ 10 mA and <650 mV @ 150 mA Output saturation PNP: < 1.2V @ 10 mA and <1.65V @ 150 mA
Response time:	100 ms to 1600 ms
Operating distance (typical values):	200...8000 mm
Temperature effect:	Uncompensated: 0.2% of distance /°C Compensated: 0.02% of distance /°C
Hysteresis:	5 mm
Repeatability:	1 mm
Minimum reading window size:	20 mm
Indicators:	Power On LED (GREEN), Signal LED (RED), Output LED (bicolour YELLOW/RED)
Setting:	Teach-in push-button or remotely via TEACH input
Remote Teach:	Connect grey wire to 0 to +2 VDC; impedance 12KΩ
Delay at Power On:	1.5 sec
Operating temperature:	-20 ... 70 °C
Storage temperature:	-20 ... 70 °C
Maximum relative humidity:	100%
Vibrations:	0.5 mm amplitude, 10...55 Hz frequency, for every axis (EN60068-2-6)
Shock resistance:	11 ms (30 G) shock for every axis (EN60068-2-27)
Reference standard:	EN60947-5-2
Housing material:	ABS polycarbonate
Push-button material:	Polyster
Mechanical protection:	IP67
Connections:	M12 5-poles connector
Weight:	260 g

DIMENSIONS

dimensions in mm



SENSOR PROGRAMMING

Three TEACH methods may be used to program the sensor:
- Teach individual minimum and maximum limits.
- Use Auto-Window feature to center a sensing window around the taught position, or
- Simultaneously use Auto-Window and position a threshold for background suppression at the taught position.

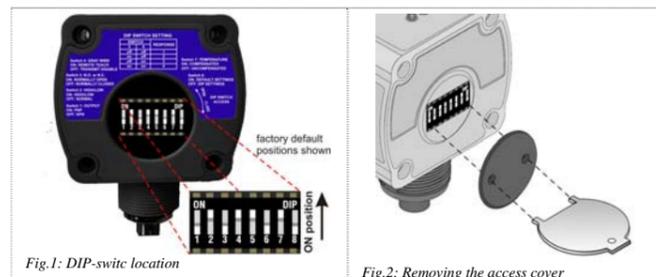
The sensor may be programmed either via its two push-buttons, or via a remote switch. Remote programming also may be used to disable the push-buttons, preventing unauthorized personnel from adjusting the programming settings. To access this feature, connect the grey wire of the sensor to 0-2VDC, with a remote programming switch between the sensor and the voltage.

NOTE: The impedance of the Remote Teach input is 12 kohm. Programming is accomplished by following the sequence of input pulses. The duration of each pulse (corresponding to a push-button "click"), and the period between multiple pulses, are defined as "T".

0.04 seconds < T < 0.8 seconds

Configuration

The US50 features an 8-pin DIP switch bank for user setup. The DIP switches are located behind the access cover on the back of the sensor as shown in Fig.2/3. A spanner tool is included with each sensor for removing the cover.



Tab.1: DIP Switch Settings

Switch	Function	Settings
1	PNP or NPN select	ON = Both outputs set for PNP OFF* = Both outputs set for NPN
2	Window / Fill level	ON = High / Low (fill level control) OFF* = ON/OFF (window)
3	Output operation	Window selected on Switch 2: ON* = Normally open OFF = Normally closed Fill selected on Switch 2: ON = Pump-in OFF = Pump-out
4	Teach/Disable control	ON* = Configured for remote teach OFF = Configured for transmit disable
5 and 6	Response (100 ms/cycle) 1 cycle 4 cycles* 8 cycles 16 cycles	Switch 5 OFF OFF ON* OFF* OFF OFF ON ON Switch 6 OFF OFF ON* OFF* OFF ON ON ON
7	Temperature compensation	ON* = Enabled OFF = Disabled
8	Factory calibration	ON = For factory calibration only; switch should be set to OFF for use OFF* = Dip-switch settings in use

* Factory default settings.

DIP-Switch selectable functions

Switch 1: Output Mode Select
ON = Both outputs set to PNP (current sourcing)
OFF = Both outputs set to NPN (current sourcing)
This switch configures the sensor internally to use either the PNP or NPN output configuration.

Switch 2: High/Low Level Control
ON = High/Low (fill level control)
OFF = ON/OFF (window)
This switch determines whether the sensor is in fill level control mode or normal ON/OFF mode. The fill level control is shown in figure . When switch 2 is ON, the switch 3 setting will determine whether the sensor is set up for pump-in or pump-out operation.

Switch 3: ON/OFF Mode
ON = Normally open (output is energized when the target is within window)
OFF = Normally closed (output is energized when the target is outside window)

Switch 4: Teach/Transmit Enable Control
ON = Grey wire configured for remote teach
OFF = Grey wire configured for transmit disable
High (5...30 VDC or open): Transmit Enabled (Power LED stable ON Green)
Low (0...2 VDC): Transmit Disabled (Power LED blinks at 2 Hz)

When Switch 4 is ON, the grey wire is used to teach the sensor's window limits. When Switch 4 is OFF, the grey wire is used to enable and disable the sensor's transmit burst. This function may be used when multiple sensors are operating I close proximity and may be vulnerable to cross-talk interference. A PLC can be used to enable the sensors one at a time to avoid cross-talk. When disabled, the sensor outputs will react as if no target is being sensed.

Switches 5 and 6: Response Speed Adjustment
The speed of the output response is set using DIP-switch 5 and 6 (see DIP switch settings Tab.1). There are four values for response speed, which relate to the number of sensing cycles over which the output value is averaged.

Switch 7: Temperature Compensation
ON = Temperature compensation enabled
OFF = Temperature compensation disabled
Changes in air temperature affect the speed of sound, which in turn affects the distance reading measured by the sensor. An increase in air temperature shifts both sensing window limits closer to the sensor. Conversely, a decrease in air temperature shifts both limits farther away from the sensor. This shift is approximately 3.5% of the limit distance for a 20° C change in temperature. With temperature compensation enabled (Switch 7 ON), the sensor will maintain the window limits to within 1.8 percent over the -20° to +70° C range.

Teaching minimum and maximum limits

The outputs are independent. To readjust minimum or maximum limits for either output, follow the teach procedure for that output only. Repeat the teach procedure for the other output, if used.

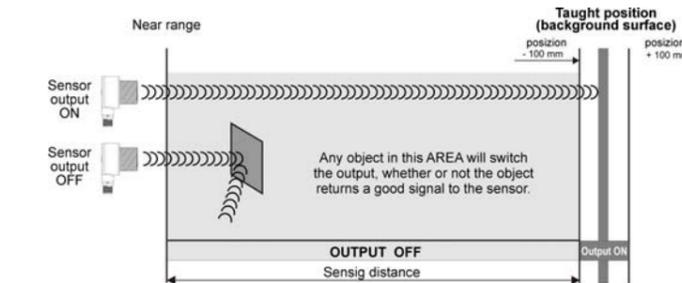
	Push-button	Procedure	Remote Wire 0.04 sec. < T < 0.8 sec.	Result
Program ming mode	Push and hold push-button for selected output	No action required	No action required	Corresponding output LED turns ON red Sensor waits for first limit
Teach first limit	Position the target for the first limit "Click" the same push-button	Position the target for the first limit Output 1 Single-pulse the remote line Output 2 Double-pulse the remote line	Position the target for the first limit Single-pulse the remote line Double-pulse the remote line	Sensor learns the first limit position LED for selected output changes to blinking red
Teach second limit	Position the target for the second limit "Click" the same push-button	Position the target for the second limit Single-pulse the remote line	Position the target for the second limit Single-pulse the remote line	Sensor stores both limits LED for selected output turns ON yellow

Teaching Limits Using the Auto-Window feature

Teaching the same limit twice for the same output automatically centers a 200 mm window on the taught position. The outputs are independent. To readjust a midpoint for either output, follow the teach procedure for that output only. Repeat the teach procedure for the other output, if used.



	Push-button	Procedure	Remote Wire 0.04 sec. < T < 0.8 sec.	Result
Program ming mode	Push and hold push-button for selected output	No action required	No action required	LED for the selected output turns ON red Sensor waits for first limit
Teach limit	Position the sensor for the midpoint of the sensing window "Click" the same push-button	Position the target for the midpoint of the sensing window Output 1 Single-pulse the remote line Output 2 Double-pulse the remote line	Position the target for the midpoint of the sensing window Single-pulse the remote line Double-pulse the remote line	LED for the selected output blinks red
Re-Teach limit	Without moving the target, "click" the button again	Without moving the target, single-pulse the remote line again	Without moving the target, single-pulse the remote line again	LED for the selected output turns ON yellow Sensor stores window for the selected output Sensor returns to RUN mode



Simultaneous Auto-Window/Background Suppression

Output 1: Auto-Window (automatically centers a 200 mm window on taught position)
Output 2: Background suppression (sensor ignores object beyond the taught position)
Taught position is identical for both outputs.
To adjust the background suppression limit (different from the limit for output 1), teach a new limit to output 2 using the Auto-Window. Output 2 will remain in background suppression mode until is taught new min/max limits.

	Push-button	Procedure	Remote Wire 0.04 sec. < T < 0.8 sec.	Result
Program ming mode	Push and hold Output 1 push-button "Click" Output 2 push-button	No action required	No action required	Output 1 LED turns ON red Output 2 LED turns ON red (both output LEDs should be ON red)
Teach limits to both outputs simultaneously	Position the target at the sensing window midpoint/suppression limit "Click" either push-button again	Position the target at the sensing window midpoint /suppression limit Triple-pulse the remote line	Position the target at the sensing window midpoint /suppression limit Triple-pulse the remote line	Both output LEDs blinks red
Teach limits to both outputs simultaneously	"Click" either button again	Single-pulse the remote line	Single-pulse the remote line	Both output LEDs turn ON yellow Sensor stores window on output 1 and suppression limit on output 2 Sensor returns to RUN mode

Push-button Lockout

Enables or disables the Keypad to prevent unauthorized personnel from adjusting the programming settings.

	Push-button	Procedure	Remote Line 0.04 sec. < T < 0.8 sec.	Result
Program ming mode	Not available via push-button	Not applicable	Four-pulse the remote line	Push-buttons are either enabled or disabled, depending on previous condition

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