Mobrey Ultrasonic Systems

Level and Flow Control for The Water Industry

Mobrey MSP ultrasonic systems have a long and successful history in the demanding applications found in the water and waste water treatment industry. This latest range of products follows on from the highly respected MSP90 products, and is built around a powerful new microprocessor, giving increased functionality and an easy to use intuitive Human Machine Interface (HMI).

A system comprises a 4-20mA loop powered transmitter and a multi-function control unit with integral programming keypad, eliminating the need for handheld programmers. The control unit, which powers the transmitter, monitors the loop current and is available in wall or panel mounting options. The whole system carries an ATEX II (1) G, certificate for use in Zone 0 areas, reducing installation and wiring costs.

Additionally ultrasonic transmitters are FM IS certified and control units are UL certified.

This modular concept allows selection of the most suitable instrumentation:

- Ultrasonic level transmitter
- Wall mount control unit
- Panel mount control unit.

These systems have a 4-20mA output and also include many new features designed specifically with the requirements of the industry in mind:

- Wet well level and pump control systems, open channel flow
  - Control up to four pumps in duty/assist or duty/standby mode with optional pump duty rotation.
  - May also be configured as a contents / volumetric measurement or open channel flow measurement system.
- Differential / summing capability
  - Computes difference in readings between two input signals to control screen backwash routines.
  - Will also sum two readings to total contents in two vessels or flow in two channels.
- Open channel flow and logging system
  - Calculates flow in an open channel in accordance with BS3680 Pt. 4, ISO1438/1 and ISO4359.
  - Logging of up to 7000 samples with programmable interval and automatic fast log on exceptional event, plus 2 totalizers for daily and cumulative flow totalization.

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Operation

Ultrasonic transmitters send a pulse of ultrasound down to the liquid surface and detect the reflected echo. An internal microprocessor, which is pre-programmed with the speed of sound, can then translate the time taken for the pulse to be returned into the distance between the transmitter face and the liquid surface. An integral temperature sensor in the transmitter compensates for temperature change effects on the speed of sound in the ullage space. Having established this basic distance, the transmitter calculates the depth of liquid and sends this information back to the control unit as a HART digital or 4-20mA signal proportional to level.
The control unit uses this information to drive control relays which can be freely assigned by the operator. Alternatively, tank contents or volumetric flow in an open channel flow application can be calculated. There are 5 built-in relays and a 4-20mA current output. A clear 4 line display on the unit shows the measured variable or may be programmed to show other operational information. A bar graph representation of the current output and relay status are also displayed.

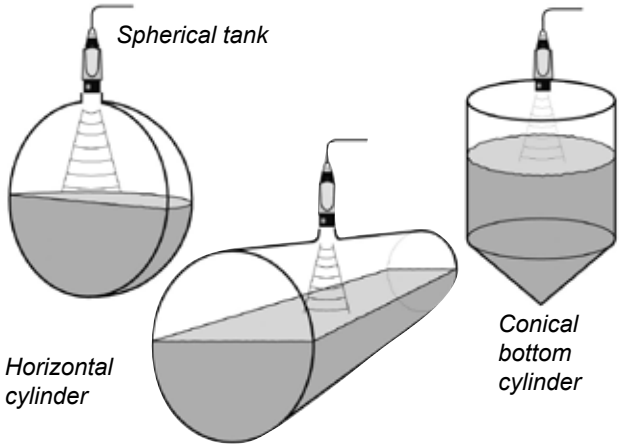
Programming is simple and efficient using the integral membrane keypad on the fascia of the control unit. The menu structure is easy to navigate and Mobrey “Wizards” are built-in to make configuration fast and error free.

Typical Applications

Tank Contents System

The MSP tank contents system has several of the most popular tank shapes pre-programmed so that the tank contents/volume can be calculated.
These include:

- Vertical cylinder
- Horizontal cylinder
- Horizontal cylinder with domed ends
- Conical bottom cylinder
- Spherical tank



A scaling factor may be entered to allow the display to show contents in any volumetric units chosen, many of which are pre-programmed. Units of measure are shown on the display.
Other special tank shapes are accommodated by using the 20 point look-up table. The user simply enters the volume at each of 20 user selectable points over the height of the tank and the system will inter-polate to show volume at any level. Control relays and the 4-20mA output may be driven by the level reading or volume calculation. The display can be configured to show both level and volume, or the ullage volume above the liquid in the tank.

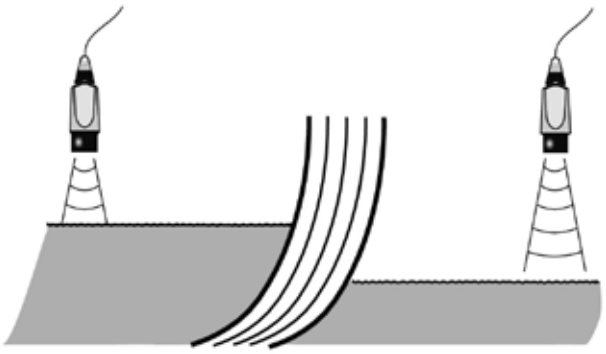
Differential Level System

It is sometimes necessary to know the difference in two levels, for example, across an inlet screen where the level difference is an indicator of the state of the screen.

The MSP differential level system is designed to operate with two HART level transmitters, and can be programmed to perform calculations on the two input signals –

- Level, contents/volume or flow under transmitter 1
- Level, contents/volume or flow under transmitter 2
- Level difference between transmitter 1 and 2
- Sum of the level, contents or flow under both transmitters

The control relays and current output can driven by any of these functions, and the display can be configured to show the reading of each transmitter plus either the difference or the sum of the readings. The MSP transmitters used in this application are HART/SMART and are connected in series on a simple two wire bus.



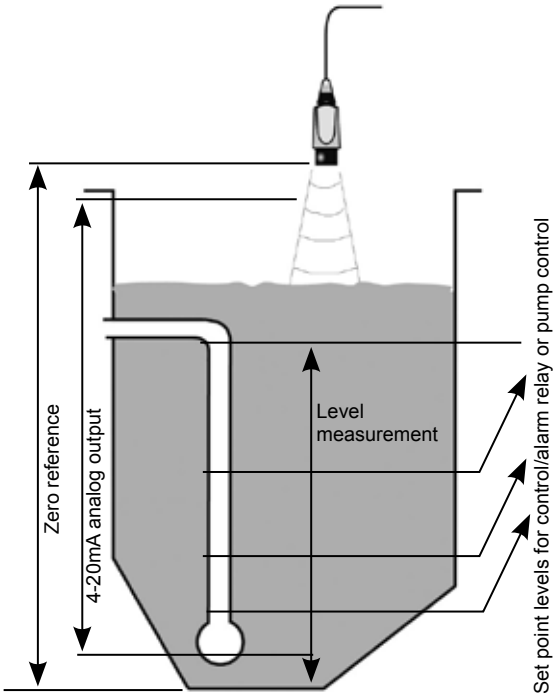
Differential level

Typical Applications

Pump Control System

The transmitter is mounted over the liquid surface using the 1" threaded connection provided.
A locking backnut and bracket is supplied which facilitates mounting the transmitter from a spar or strut above the sump. If a hydrostatic head pressure transmitter is used for level sensing, the transmitter is usually suspended in or clamped to the bottom of the sump.

The cable provided is run back to the control unit, which may be mounted up to 165ft (50m) away either inside or outside. Having connected the two wire transmitter cable to the appropriate terminals in the control unit and connected the power supply, the system is ready for programming with the details of the application.
Programming is simple and efficient using the membrane keypad on the fascia of the control unit and the “Wet-well wizard” in the menu.



Pump Control Relays and Functionality

The MSP pump control system has 5 relays which may be allocated to control or alarm duty, all programmed independently and all freely assignable. To meet the needs of the water industry, the following features are provided as standard:

- All relays have an adjustable band with user defined on/off points
- Up to 4 pumps can be controlled using 4 of the relays, either in standard sequential mode or in one of the popular control routines:
- Duty / Standby
- Duty / Assist
- Pumps can have common or independent off levels
- Choice of manual select or auto-sequence for the lead pump
- Scum line prevention routine to vary trip points and avoid scum build up
- Real time clock allows override of control routine to empty sump during low cost electricity periods
- Time delay between relay-on signals prevents electrical or hydraulic overload
- User defined periodic pump down routine and frequency to empty sump
- Relay energised or “run times” are logged and stored to enable monitoring of pump run times.
- Calculation of pumped volume allows pump efficiency to be monitored and reported should efficiency fall below a user defined value.

Other Relay Functions

The 5th relay is normally a failsafe alarm relay (loss of echo, mains failure or other system fault) but may be re-programmed as a standard alarm or control relay. Any relay can be programmed as a rate of rise or rate of fall alarm, temperature, level, contents/volume or flow out of limits alarm or pump efficiency alarm.

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Open Channel Flow Measurement

The flow in an open channel may be derived by measuring the liquid level upstream of a weir or flume of a standard design.

V notch weir: Typical 5/2 power law

Venturi flume: Typical 3/2 power law

In OCF applications, the level transmitter is mounted upstream of the channel restriction or obstruction in accordance with the recommended standards. These standards also define the relationship between the liquid level at that point and the flow through the channel.

The popular V-notch weir (5/2), Venturi flume (3/2) and Parshall flow laws which have been used for many years are pre-programmed in the MCU900 control unit, along with other popular flow laws. Where flow measurement has to be in accordance with BS3680 or the Environmental Agency requirements (EA consented flows), the MCU900 has a 20 point look-up table which can be programmed with a dedicated stage discharge curve for the flow structure.

If the user does not have the curve available, these can be calculated for you for certain structures based on dimensional and flow data provided by the user. A data sheet is produced detailing all of the MCU900 parameters and their values which require programming, together with a projection of the uncertainty for the specific application.

Structures for which discharge curves can be provided include:-

- V-Notch
- Venturi flumes
  - Rectangular - Semi-circular - Trapezoidal
- Triangular profile (Crump) weirs
- Broad crested weirs
- Flat V weirs
- Parshall flumes
- Manning formula
  - Round pipe
  - Rectangular channel

MCU Flow Logging System

In many instances, it is required that the flow and totalized flow be logged for download at a later date. The MSP flow logging system has an on-board logger which can log up to 7000 samples at user definable intervals. In the event of flow exceeding a limit value, fast logging is automatically triggered until the flow reverts to normal. In addition, 365 daily totalized flow values are also logged along with the maximum instantaneous flow during each 24 hour period. A second totaliser is provided to totalise cumulative flow through the flow structure. All data is real time stamped and stored for download via an RS232 connection on the control unit.

Data can be collected using a portable PC, and is easily stored and manipulated using the Mobrey LogView Windows software.

Functionality

The MCU900 control relays may be allocated as flow rate alarms or may be selected to operate as a pulse output to an external totaliser. There is also the facility to allocate a relay as a low-flow cut off so that totalization errors are avoided in very low flow conditions. The current output is proportional to flow rate and is used for remote monitoring, telemetry or local recorders.

The system will totalise flow and show both instantaneous flow and totalized flow on the display, in different units of measurement if required.

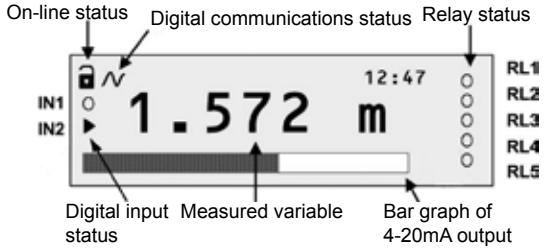
There is also the facility to connect up to two digital (voltage free contact) inputs to the system which may be used to inhibit measurement or force alarms or other routines to start upon external signals.

Programming The MSP System

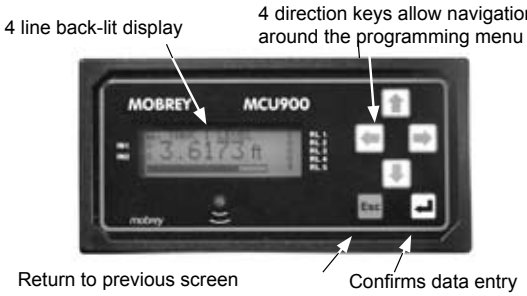
The system is easily programmed using the membrane keypad on the fascia of the control unit – no handheld programmer is necessary.

A user friendly menu structure is employed, guiding the user through the steps needed to ensure correct operation. This Human Machine Interface (HMI) is common to other Mobrey products, so the operator does not have to learn and remember a variety of programming techniques. When used with a Mobrey HART compatible ultrasonic level transmitter, the MCU control unit keypad is also used to configure the transmitter and set the 4-20mA current input range.

With standard 4-20mA transmitters, the 4-20mA range is fixed and the MCU control unit is simply programmed to operate over all or just a portion of the current input.



Four line display (metric display shown)



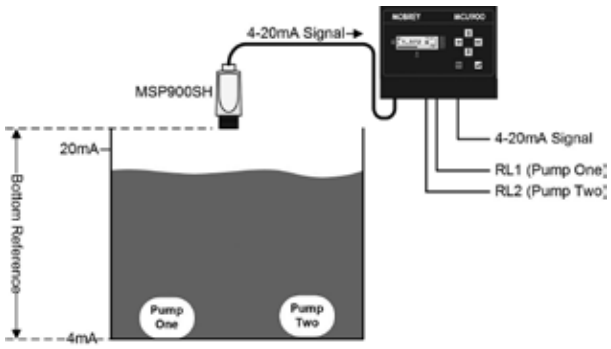
Front panel display and keypad (imperial display shown)

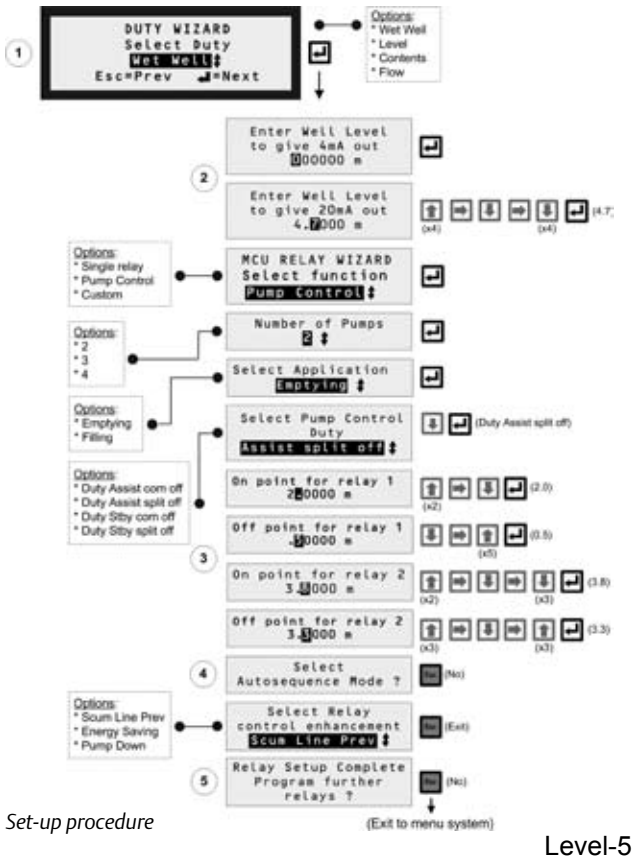
For the more involved applications, such as pump control using control routines or open channel flow measurement, the control unit will offer “Wizard” assistance to ensure all the necessary data is entered in the correct memory locations.

The control unit is fitted with a clear back-lit four line display which is used to present the operator with programming and set-up options. Once commissioning is complete, the display will show the measured variable such as level or flow, a bar graph representation of the current output and the status of all input and outputs. Alternatively, the display can be configured to show a multitude of other information as the operator chooses.

Easy to Follow 'Quick Start' Set-Up Instructions

Each system is supplied with a highly visual 'quick-start' manual which guides the user through the 'Wizard' set-up procedure. See diagram right.





Set-up procedure

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MCU900W Series Wall Mounting Control Units

Housed in a tough NEMA4 or IP65 Polycarbonate enclosure, the control unit can be mounted either inside or outside. All wiring terminals and mains selector switch (115 or 240V ac) are accessed by removing the lower terminal box lid, leaving the main electronics compartment undisturbed.
The enclosure is pre-drilled with 5 cable entries (M20) and glands and blanking plugs are supplied.

MCU900P Series Panel Mounting Control Units

All of the MCU functionality is available in a small panel mounting format. Extending just 6.3 inches (163 mm) into the panel, connection is made to two part terminal blocks on the rear of the unit.
Please note that if several units are mounted in the same panel, allow room for air to circulate between units. An air circulation fan is recommended for installations of 3 or more units in the same panel.

Features
- Wizard assisted simple menu programming
- Clear visual output using back-lit LCD display
- Patented echo recognition software techniques to ensure reliable level tracking. Includes tools to deal with stirrers, agitated surfaces, false echoes and other common application problems.
- Pre-programmed linearization functions, plus a 20 point user programmable curve facility.
- Auto-test routine to simulate liquid level rising and falling such that all alarms and outputs are tested. Includes a set-current option to test other loop instrumentation.

Inputs
- Any 4-20mA signal from a transmitter. The MCU will power a 24V dc transmitter with a max load of 25mA, or can accept input from a separately powered transmitter. Transmitters may be located in a hazardous area as the power supply is fully protected. No additional safety barriers are required. Alternatively, the unit will accept a digital input from a HART/SMART transmitter and allow access to Universal and some Common Practice commands.
- 2 Voltage free contact closure digital inputs.
- Mains power, 115V ac or 230V ac or 24V dc.

Outputs
- 4-20mA current output proportional to measured variable. May be scaled over the whole or part of the range, and can be profiled or scaled to suit.
- 4 control relays, user selectable as alarm, control or fault duty. Full range of pre-programmed pump control routines.
- 5th Relay, normally a fail safe fault relay, but may be re-allocated to alarm duty.
- A relay may be allocated to give a pulsed output based on totalized flow through an open channel flow structure.

MSP900SH Series Ultrasonic Level Transmitters

These 24V dc loop powered transmitters are factory sealed and fitted with cable ready to install on aqueous applications. Manufactured from UPVC, the transmitter is designed to give a HART digital output and 4-20mA output proportional to liquid level (or distance to level). Power is supplied by the control unit, and the transmitter is configured with the application details using the control unit keypad or HART communicator.

MSP900FH Series Ultrasonic Level Transmitter for Open Channel Flow Measurement

These transmitters are similar to the MSP900SH series above, and are fitted with a special external temperature reference sensor MSP-RTP. The MSP900FH transmitter is recommended on open channel flow applications where accurate and repeatable temperature measurement is required to maintain the highest possible level accuracy. This is critical on applications such as small weirs and flumes where temperature measurement errors can have a significant effect on the calculated flow.

Controller technical specification		
Electrical	**ATEX certified**	**UL Certified**
Supply	AC: 98 - 132V ac, 198 - 254V ac 50/60Hz, Power consumption: 10VA nom, 18VA max. DC: 15-30V dc / 9W max.	As ATEX N/A
Current input	4-20mA and / or HART Digital comms (Rev. 5) Supplies 23 Volts from 400Ω source resistance	✓
Trigger inputs	2 voltage free contact closures	✓
Current output	4-20mA isolated into 1 Kohm (12 bit)	✓
Relays	5 SPCO, 5A at 240V ac	✓
Cable entry	5 positions pre-drilled. 2 glands and 3 blanking plugs provided	✓
Cable connection	*Wall mount*: Cage clamp terminal blocks in separate terminal compartment *Panel mount:* 2 part cage clamp terminal blocks at rear	✓
Mechanical		
Material	*Enclosure & keypad:* Polycarbonate	✓
Size	*Wall mount:* 8.72" (213mm) wide x 7.28" (185mm) high x 3.3" (84mm) deep *Panel mount:* Cut out 5.47" (139mm) wide x 2.7" (69mm) high. Allow 6.5" (165mm) clearance behind panel	12"w x 12"h x 5.2"d (300mm x 300mm x 133mm)
Enclosure rating	*Wall mount:* IP65 indoor/outdoor *Panel mount:* IP42 (indoor mount); IP65 Hood kit available	NEMA4X
Environmental	Installation category: 115V: Cat.III, 230V: Cat.II Pollution degree: 2 Altitude: 2000m/6500ft max. Relative humidity: 100%	✓ ✓
Temperature	-40°F to +130°F (-40°C to +55°C) (Use of an air circulation fan is recommended if 3 or more panel mounting units are installed in the same cabinet)	✓
Approvals	ATEX II (1) G [EEx ia] IIC	CL1 Div1 Groups A, B, C, D CL1 Zone 0 IIC -40°F to +130°F (-40°C to +50°C)

Transmitter technical specification	
Range	1 to 39ft (0.3 to 12m)
Power supply	24V dc 2 wire loop powered
Output	4-20mA
Digital Comms.	HART / SMART, Profibus
Ambient temperature	-40° to +140°F (-40° to +60°C)
Maximum temperature	-40° to +140°F (-40° to +60°C)
Operating pressure	0bar to +3bar / +43psi
Material of construction	UPVC (Stabilised)
Rating	NEMA 6P (IP68) 12ft / 3m
Cable	2 core screened
Cable sheath	PVC
Cable length	9, 26, 65 or 164ft (3, 8, 20 or 50m). All cables may be shortened or extended on site.
Mounting	1" NPT, 1" BSPP + bracket
Certification	ATEX II 1 G EEx ia IIC T6 CSA Ex ia IIC T6 FM CL1 Div1 Grps A, B, C, D CL1 Zone 0 AEx ia IIC T6

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Ordering Information
Select the most appropriate transmitter and a control unit from the tables below.

Ultrasonic level transmitters		
MSP900S		Ultrasonic level transmitter for Open Channel Flow, range 39ft (12m), PVC construction
MSP900F		Ultrasonic level transmitter, range39ft (12m), PVC construction Supplied with MSP-RTP remote temperature sensor with 10ft (3m) cable
	H	HART digital communications
	P	Profibus PA digital communications (not available on MSP900FH)
	A	ATEX/CSA certified II 1G/EEx ia IIC T6 1" BSPP + bracket in 316SS
	U	FM/CSA certified CL1 Div1 Grps A, B, C, D 1" NPT + bracket in 316SS
	/3	10ft (3m) of factory fitted PVC sheathed instrument cable
	/8	26ft (8m) of factory fitted PVC sheathed instrument cable (Profibus models only)
	/20	64ft (20m) of factory fitted PVC sheathed instrument cable (MSP900SH/FH versions)
	/50	163ft (50m) of factory fitted PVC sheathed instrument cable

Control units		
MCU901		Control unit for pump control, level, contents & flow duty
MCU902		Control unit for differential level or summated flow duty
MCU90F		Control Unit with on-board logging capability for open channel flow duty
	WX	Wall mounting enclosure
	PX	Panel mounting format
	-A	ATEX certified II (1) G [EExia]IIC : IP65 enclosure
	-U	UL certified CL1 Div1 Grps A, B, C, D : NEMA 4X enclosure (Wall mount only)

Accessories	
MSP-BRK4	316 Stainless steel bracket for mounting or suspending MSP900SH transmitter. (Supplied as standard with MSP900SH)
MSP-FLG4	2" ANSI #150 / DN50 PN16 combined flange in PVC for mounting MSP900SH transmitter
MSP-LogView	PC windows based software for data collection, concatonation and manipulation of logged data. Allows trending, graphical and tabular display of data.

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