Technical Operator's Manual
IP2030/OM
March 2006

MCU900 Series

MCU900 Industrial Transmitter Control Units

MCU900 is the generic name used in this manual for the MCU900 range of control units comprising:

MCU901	: MCU901 24V
MCU902	: MCU902 24V
MCULOG	: MCULOG 24V

mobrey

EMERSON
Process Management

www.mobrey.com

Mobrey pursues a policy of continuous development and product improvement. The specification in this document may therefore be changed without notice.

Contents

Figures

Tables

Chapter 1 About this manual

1.1 Who should read this manual?

This is the operating manual for the **MCU900** family, comprising **MCU901**, **MCU902** and **MCULOG** control units. It has been written for those who commission systems, for operation staff and for anyone who provides support.

Installation instructions of the MCU900 Series Control Unit are supplied in a separate manual (IP2030/IM). This manual assumes that the control unit and transducer have been installed and cabled in accordance with the **product installation manuals** and the **product safety manuals**.

Note: If you are unfamiliar with the MCU900 family, or just need a reminder, you are recommended to read Chapters 2 and 3 before advancing to later chapters.

1.2 Operating language

The MCU Control Unit can be programmed to display text in other languages. To change the language on the MCU display, refer to Section 5.2.

1.3 Other associated manuals

The following associated manuals are also available in paper and electronic formats:

IP2030/IM	Mobrey MCU900 Series Industrial Transmitter Control Unit – installation and maintenance instructions
IP2040/IM	Mobrey MSP900SH Series Level Transmitter – installation and maintenance instructions
IP2040/OM	Mobrey MSP900SH Series Level Transmitter – Technical operator’s manual
IP2030/SI	Safety instructions for the MCU900 family
IP2040/SI	Safety Instructions for the MSP900SH-A
IP2040/QS	Quick-start for MSP-USTD1 and MSP-USTD2 Systems
IP2041/QS	Quick-start for MSP-DIF1 and MSP-DIF2 Systems
IP2042/QS	Quick-start for MSP-ULOG1 and MSP-ULOG2 Systems
IP2044/QS	Quick-start for FLOW LOG control unit and MSP900** transmitter

Chapter 2 About The MCU900 Family

2.1 Introduction

The **MCU900 family** has:

- Full support for **MSP900 Series** ultrasonic transmitters – measuring level by default
- Support for other HART protocol and 4-20mA loop-powered transmitters
- a 4-line LCD display with back light – displays both text and graphical information
- a 6 button keypad
- an LED indicator
- an intuitive menu system – for setting up
- **2** digital inputs (voltage-free contacts) for triggering various activities (e.g. displaying a message)
- **5** relay outputs (e.g. for controlling pumps, indicating alarms, etc.)
- a single 4-20mA output proportional to the calculated value.

All setting up is achieved from the **front panel** of the control unit.

2.2 The Control Unit

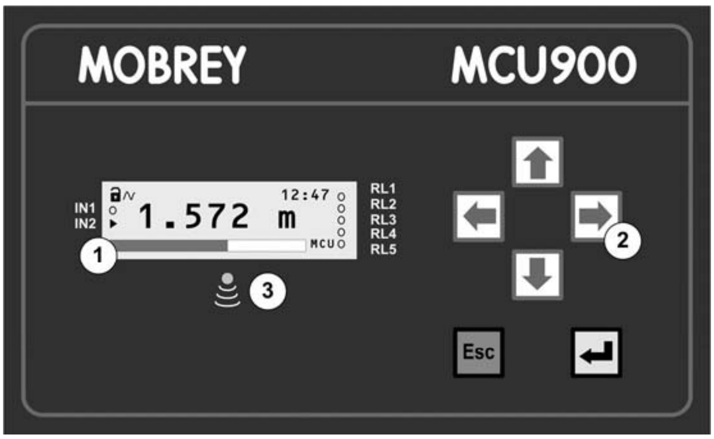
There are two varieties of control unit: the **MCU***W** (wall mounted version) and the **MCU***P** (panel mounted version). A full technical specification is provided in the Appendix F of this manual.

Figure 1: MCU900W – Wall mounted version

Figure 2: MCU900P – Panel mounted version

2.3 Front Panel Features

The **front panel** fascia is illustrated in Figure 3. It comprises keypad, a liquid crystal display and a status LED.



① 4-line back-lit LCD display.
② Keypad with 6 function buttons.
③ Status LED – flashes once per second if operating correctly.

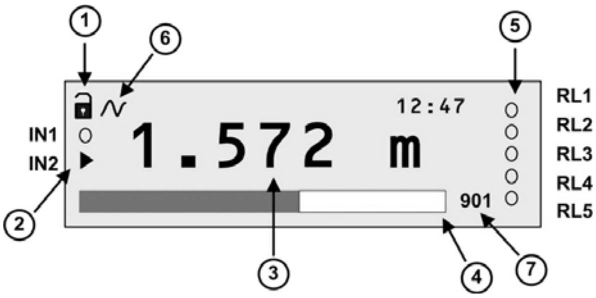
Figure 3: Front panel features

2.3.1 The Display

The display is a 4-line, back-lit, liquid crystal display that can display both text and graphical information.

The **primary display** is presented once power-up and self-checks are complete. The factory default display features a digital clock, a measured variable, icons and a bar graph. It can be configured to show other information.

Each member of the MCU900 family has some variations, as can be seen in the following illustrations:



Key to figure:

1. Off-line/on-line status. (Locked padlock = on-line) (See Section 5.1.5.)
2. Digital input status. (o = inactive, ▸ = active)
3. Measured variable (PV) and units of measurement.
4. Bar graph of 4-20mA output of MCU901.
5. Relay (RL) status: o = de-energised, ▸ = energised (or **A**, **S**, **T** – see Section 5.8.3.)
6. Digital communication in progress. (Absent if idle)
7. Shows model type – alternates between “MCU” and “901”

Figure 4: MCU901 Primary Display

Key to figure:

1. Off-line/on-line status. (Locked padlock = on-line) (See Section 5.1.5.)
2. Digital input status. (o = inactive, ▸ = active)
3. Measured variable (PV) and units of measurement.
4. Bar graph of 4-20mA output of MCU902.
5. Relay (RL) status: o = de-energised, ▸ = energised (or **A**, **S**, **T** – see Section 5.8.3.)
6. Digital communication in progress. (Absent if idle)
7. Vertical bars on graphic indicate which transmitters are allocated. (i.e. left bar = Tx1 and right bar = Tx2.)
8. Shows which transmitter is communicating (Tx1 or Tx2).
9. Shows model type – alternates between “MCU” and “902”

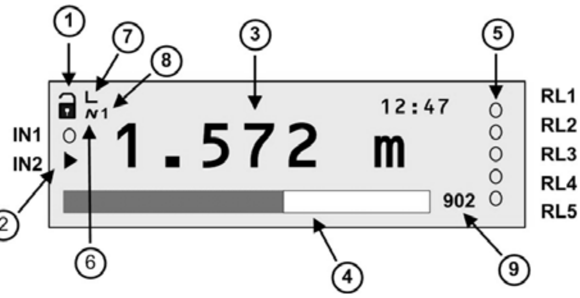
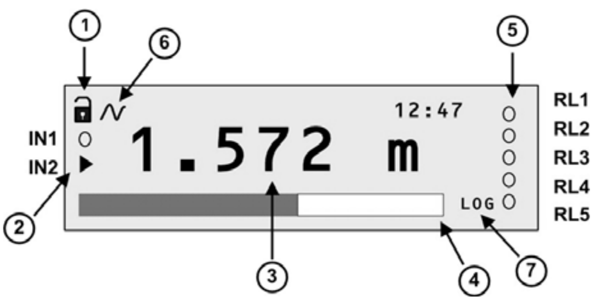


Figure 5: MCU902 Primary Display



Key to figure:

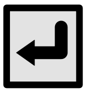
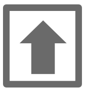
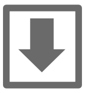
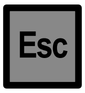
1. Off-line/on-line status. (Locked padlock = on-line) (See Section 5.1.5.)
2. Digital input status. (o = inactive, ▸ = active)
3. Measured variable (PV) and units of measurement.
4. Bar graph of 4-20mA output of MCULOG.
5. Relay (RL) status: o = de-energised, ▸ = energised (or **A**, **S**, **T** – see Section 5.8.3.)
6. Digital communication in progress. (Absent if idle)
7. Shows model type – alternates between “MCU” and “LOG” (unless data logging)

Figure 6: MCULOG Primary Display

2.3.2 The Keypad

The membrane keypad comprises **6** function buttons. They are used for navigating a hierarchical menu system and for viewing/editing application parameters. A summary of each keypad function is provided in Table 1.

Table 1: Keypad function summary

BUTTON	WHAT THE BUTTON DOES
	Referred to as the '**ENTER'** button. When the primary display is shown, press this button to access the **hierarchical menu system**. At other times, it is for selecting menu options. Also, it is used for confirming an edited parameter value/option.
	Referred to as the '**UP-ARROW**' button. Whilst navigating a display, it is for moving up a line. At other times, it is for scrolling up though the multiple-choice list of a parameter.
	Referred to as the '**DOWN-ARROW**' button. Whilst navigating a display, it is for moving down a line. At other times, it is for scrolling down though the multiple-choice list of a parameter.
	Referred to as the '**RIGHT-ARROW**' button. It is for moving across a line, to the right, to other text or another character.
	Referred to as the '**LEFT-ARROW**' button. It is for moving across a line, to the left, to other text or another character.
	Referred to as the '**ESCAPE**' button. When navigating the menu, pressing it will return you to the previous menu level. At other times, e.g. editing a parameter, it is for restoring a parameter value/option to the setting prior to when editing started.

2.3.3 The Status LED

The Status LED is positioned just below the LCD. It flashes once a second to indicate that the MCU Control Unit and transmitters are operating correctly. If there are operating system difficulties, such as overheating, the LED is constantly red.

Table 13 in Appendix E has a column, "Status LED", which shows what alarms and faults will affect the LED.

2.4 Diagrams in this manual

Most of the diagrams and examples given in this manual assume use of the MCU Control Unit with Mobrey's MSP900SH ultrasonic level transmitter, unless otherwise stated.

Chapter 3 Getting Started

This chapter deals with switching on the MCU Control Unit for the first time since leaving the factory. The unit will have MCU901 (Single Transmitter), MCULOG (Single Transmitter, Data Logging) or MCU902 (Dual Transmitters) software.

3.1 Switching on the MCU901/MCULOG

The MCU Control Unit takes the input from one HART compatible transmitter or one transmitter with a 4-20mA output. MCU901 and MCULOG support level, content and flow measurements. MCULOG software has data logging support.

After completing the installation of both MCU Control Unit and the transmitter in full accordance with the product installation manuals, the next stage is to switch-on. Apply power to switch-on the MCU Control Unit.

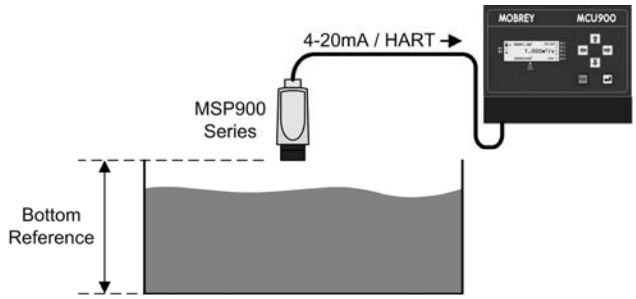


Figure 7: MCU Control Unit with one transmitter

The factory default is for the MCU Control Unit to automatically locate a **HART** compatible transmitter, which may have any polling address in the range 0 to 15.

Note: If a transmitter is not connected, the primary display will appear after a few seconds, but showing a PV of zero.

If a **non-HART** 4-20mA transmitter is connected, the MCU Control Unit will poll up to address 15 and then report that no transmitter was found. The primary display will appear after a few seconds, but showing a PV of zero. It is then necessary to manually re-configure the unit for the 4-20mA input rather than a digital input – see Chapter 5.

A **HART** transmitter will normally be located within 30 - 40 seconds. When found, it will automatically be designated **Ch1** (Transmitter #1) and automatically assigned to **MCU Channel 1**.

However, unless the poll address was zero (factory default), prompts then appear for changing the poll address and the tag name; this is optional and using the yellow (**ENTER**) button will continue to start-up process. During this time, the MCU Control Unit will read parameters from the HART transmitter and make them available in the hierarchical menu.

If it is not located, follow the guidance in Section B.1 of Appendix B.

Note: If being used for the first time with a **MSP900 Series** transmitter, it will prompt for the **Bottom Reference** of the transmitter and then automatically set-up the transmitter 4-20mA output span over this range. **If you do not want to commission the system now, simply switch off the power – the same prompt will then re-appear when switching on the next time.**

If you are commissioning the system, edit the Bottom Reference with the arrow buttons and then press the yellow button to confirm the value. The Bottom Reference can be changed at a later stage but it is better to get it correct now. Should you press the red (**ESC**) button, the MCU Control Unit will continue and the Bottom Reference prompt will re-appear when switching on the next time.

Once the start-up is completed, the primary display should appear showing a measurement e.g. depth of the liquid in the tank. The value on the primary display is the PV (Primary Variable).

Whenever the MCU Control Unit is switched off and then on, it will re-establish digital communications with the HART transmitter and then the primary display will appear. If wanting to replace the transmitter at any time, see Appendix B.

Now, turn to Chapter 4 or Chapter 5 to continue from here.

3.2 Switching on the MCU902

The MCU902 Control Unit takes the input from **two** HART transmitters and will perform various calculations to create a single sum, difference or product of the two inputs.

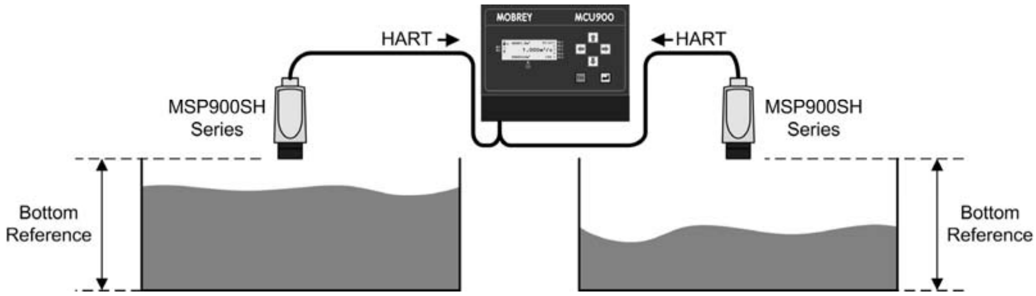


Figure 8: MCU Control Unit with two transmitters

The transmitters **must be** HART compatible for the MCU902 to operate. In addition, it is **important** to ensure that the transmitters are connected in the correct manner and sequence.

> **Note:** If using a MSP900 Series ultrasonic transmitter, refer to Section 3.4 in the product installation manual IP2030/IM for complete details of this procedure.

After completing the installation of both MCU Control Unit and the **first transmitter only**, the next stage is to apply power to switch on the unit.

The factory default is for the MCU Control Unit to automatically locate a **HART** compatible transmitter, which may be at any polling address in the range 0 to 15. The HART transmitter will normally be located within 30 - 40 seconds, unless there is a problem with the terminal connections (or cable), or the transmitter is faulty. If not located, the 'MCU TRANSMITTER' Wizard starts; follow the guidance in Section B.1 of Appendix B.

When found, it will automatically be allocated a unique address, usually "1", by the MCU Control Unit, overwriting the existing HART transmitter poll address, and will be designated **Tx1** (Transmitter #1). Tx1 will then be automatically assigned to **MCU Channel 1**.

> **Note:** If a transmitter is not connected, the primary display will appear after a few seconds, but showing a PV of zero.

Stage 1 – First Transmitter Connected Only

Once the first transmitter is allocated, the MCU902 will read parameters from the transmitter and then make them available in the menu system.

> **Note:** If being used for the first time with a **MSP900 Series** transmitter, it will prompt for the **Bottom Reference** of the transmitter and then automatically set-up the transmitter 4-20mA output span over this range. **If you do not want to commission the system now, simply switch off the power – the same prompt will then re-appear when switching on the next time.**
>
> If you are commissioning the system, edit the Bottom Reference with the arrow buttons and then press the yellow button to confirm the value. The Bottom Reference can be changed at a later stage but it is better to get it correct now. Should you press the red (**ESC**) button, the MCU Control Unit will continue and the Bottom Reference prompt will re-appear when switching on the next time.

Once the start-up is completed, the primary display should appear, showing the reading from the first transmitter. The value on the primary display is the PV (Primary Variable).

Stage 2 – Second Transmitter Connected Only

Turn off the power to the MCU902 and **disconnect** the first transmitter. Now connect the second transmitter, routing the transmitter cable through the gland next to the 'first transmitter' gland.

Note that the transmitter can be connected to the same MCU902 terminals as the first transmitter. Alternatively, an optional external junction box can be used (customer supplied). See installation manual IP2030/IM for details.

With the transmitter connected, turn on the power to the MCU902. The MCU902 will check to find any transmitters connected; this may take 30-40 seconds. The new transmitter will automatically be allocated a unique address, usually "2", by the MCU902 control unit, overwriting the existing transmitter address, and will be designated **Tx2**. Tx2 (Transmitter #2) will then be automatically assigned to **MCU Channel 2**.

> **Note:** If being used for the first time with a MSP900 Series transmitter, it will prompt for the **Bottom Reference** of the transmitter and then automatically set-up the transmitter 4-20mA output span over this range. **If you do not want to commission the system now, simply switch off the power – the same prompt will then re-appear when switching on the next time.**
>
> If you are commissioning the system, edit the Bottom Reference with the arrow buttons and then press the yellow button to confirm the value. The Bottom Reference can be changed at a later stage but it is better to get it correct now. Should you press the red (**ESC**) button, the MCU unit will continue and the Bottom Reference prompt will re-appear when switching on the next time.

Stage 3 – Both Transmitters Connected

Turn off the power to the MCU902 and reconnect the first transmitter, routing the transmitter cable through the first gland again. Both transmitters are now connected to the single pair of transmitter input terminals of the MCU Control Unit. Turn on the power again. Now, continue with the commissioning.

When the MCU Control Unit is next switched off and then on, it will re-establish digital communications with the HART transmitters and then the primary display will appear.

Note that the top left corner now shows communications with both transmitters by alternating "1" and "2" next to the digital communications icon.

The actual PV shown on the display remains that of Tx1, which is the factory default condition. You will be able to change this to another value, usually the sum, difference or product of the two transmitter readings at a later stage. See application examples in Appendix D.

If wanting to replace a transmitter at any time, see Appendix B.

Now, turn to Chapter 4 or Chapter 5 to continue from here.

Chapter 4 About the menu system

Chapter 4 is intended for those who are not familiar with, or need a reminder of, the menu system of the MCU Control Unit.

4.1 How to navigate the menu system

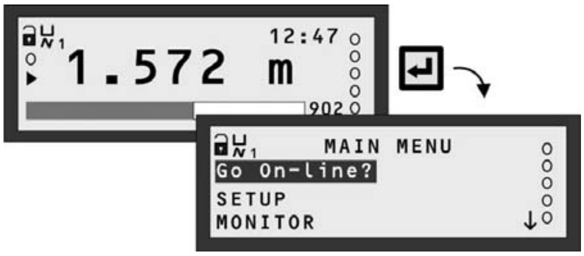
If you wish to have a quick tour of the menu system, follow instructions in this section, otherwise feel free to explore on your own. Should you get lost, use the **ESC** button repeatedly until the primary display re-appears.

1. Ensure that the **primary display** is visible.

(If already within the menu system, hold down the **ESC** button for 5 seconds and then proceed to Step 3.)

2. Press the yellow (**ENTER**) button *once* to display the top level of the menu system.

This is the **MAIN MENU**.



(Display for MCU902 shown here)

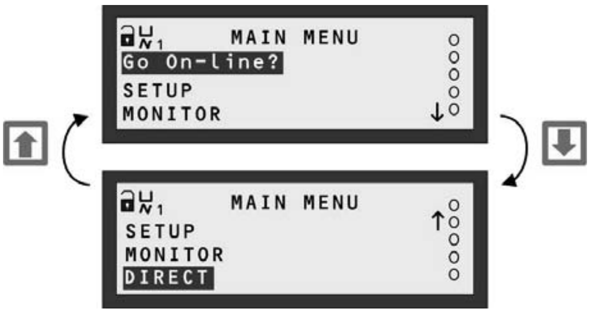
3. Navigation of the menu system is achieved by using the **ARROW** buttons, the yellow (**ENTER**) button, and the **ESC** button. The **ESC** button returns you to the previous menu level.

4. The highlighted (blinking) text indicates what menu option will be selected if the yellow (**ENTER**) button was pressed now. Do not press it yet.

(Do not worry if it says “Go Off-line” instead of “Go On-line”.)

5. The ↓ indicates that there a further menu options available, accessible by using the **DOWN-ARROW** button.

An ↑ indicates that there a further menu options available, accessible by using the **UP-ARROW** button.



6. Now use the **UP-ARROW** button to highlight the menu option “Go On-line?” (or “Go Off-line?”).

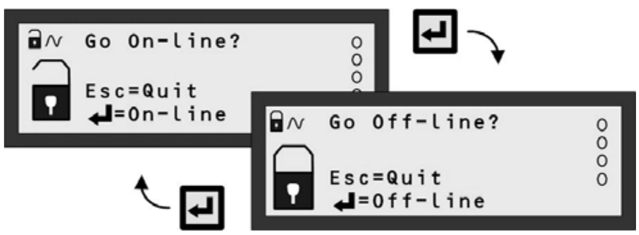
7. Press the **ENTER** button *once* to select it.

8. Use the **ENTER** button to toggle between on-line and off-line modes. (See picture inset, right)

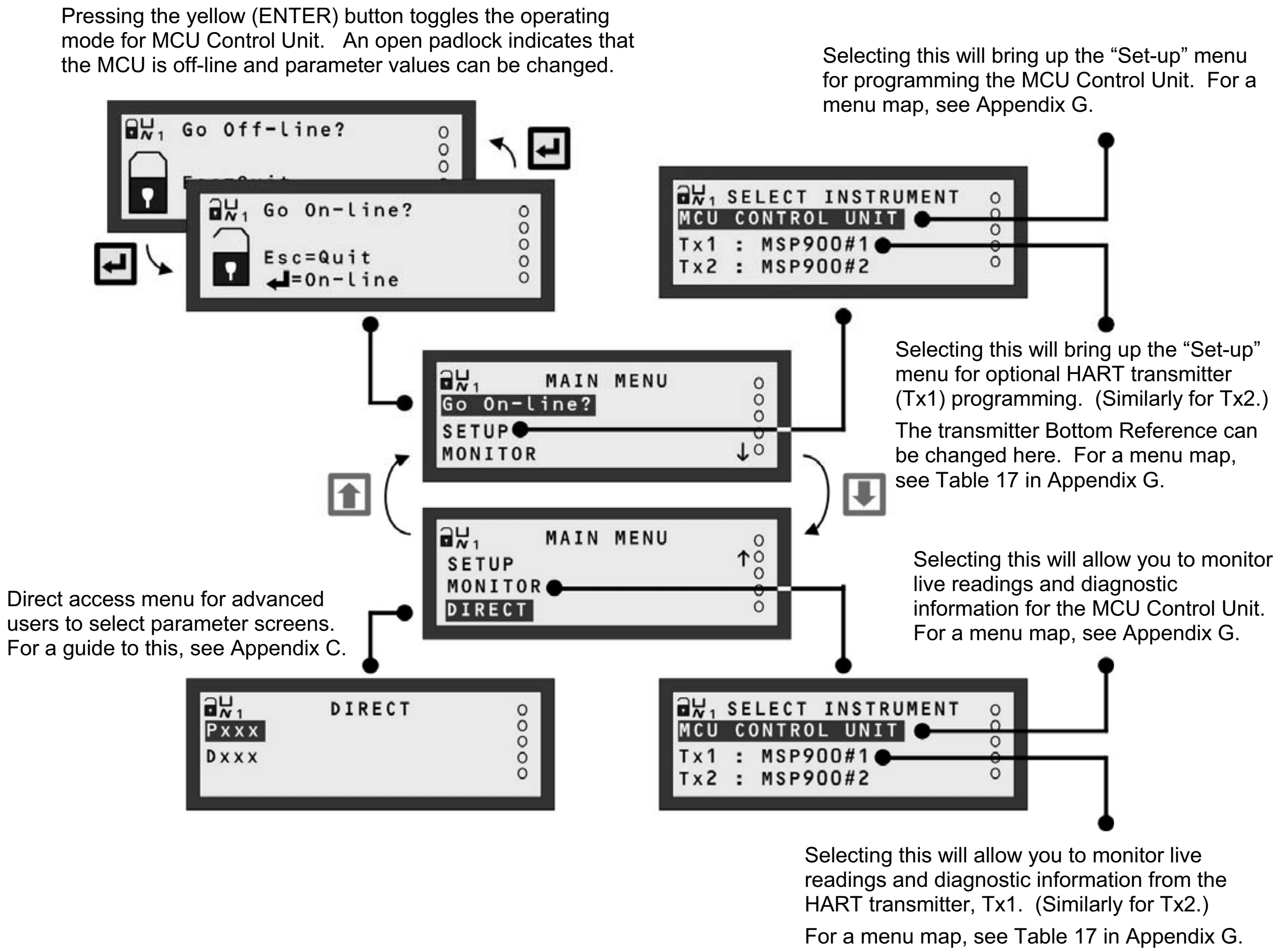
9. With the screen displaying “Go On-line?” on the top line, press the **ESC** button *once* to exit to the menu.

If the MCU Control Unit is configured and outputs are connected up to equipment e.g. a pump, use caution!

“On-line” and “off-line” are operating modes for the MCU that affect outputs. For details, turn to Section 5.1.5.



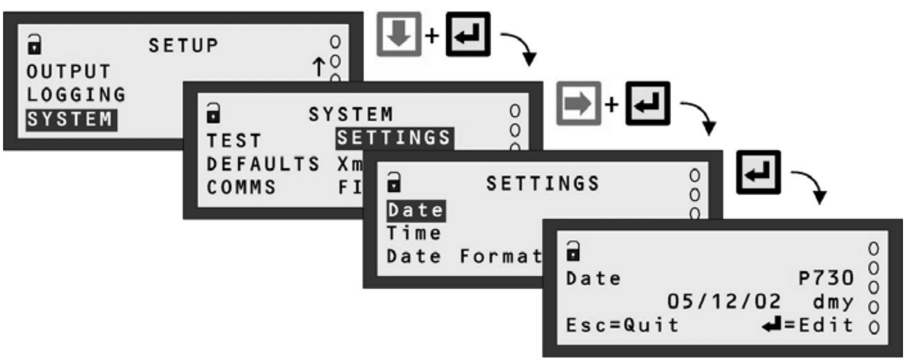
10. The **Main Menu** sits above a series of sub-menus.



Note: MCU902 menus are shown here. MCU901 and MCULOG do not have support for two HART transmitters

Figure 9: Main Menu Overview

11. Within the menus, there are also **parameter screens** for programming – setting up for an application, adjusting default settings, etc. – and for **displaying** information.



Note: MCU902 menus are shown here. MCU901 and MCULOG menus may differ.

Figure 10: Example of a parameter screen

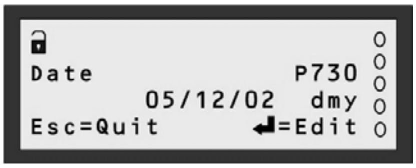
4.2 About parameter screens

To understand how to **edit** a parameter, such as the calendar date, follow the instructions in this section, otherwise feel free to continue to Chapter 5.

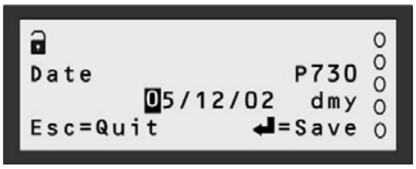
1. Navigate to the “Date” parameter screen, as guided in Step 11 of the Section 4.1.

2. On entering *any* parameter screen, it is always in **View Mode**.

3. Guidance for what to do now is on the line 4 of the screen. In **View Mode**, the **ESC** button returns you to the menu.



Parameter Screen (View Mode)



Parameter Screen (Edit Mode)

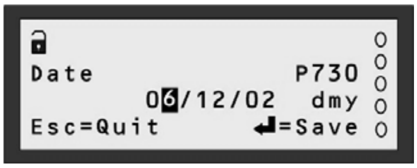
4. To enter **Edit Mode**, press the yellow (**ENTER**) button as guided on the last line of the display.

The **0** is highlighted to show that the digit can be edited now. Also, note that on line 4 of the display, “Edit” has changed to “Save”.

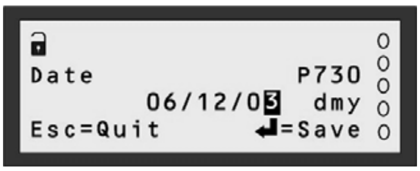
(You can press the **ESC** button at any time to return to View Mode. This will also restore the original setting.)

5. Press the **RIGHT-ARROW** button *once* to highlight the **5**. (If you go too far to the right, use the **LEFT-ARROW** button to move back to the 5.)

6. Press the **UP-ARROW** button *once* to change the **5** to a **6**. (If you go beyond the 6, use the **DOWN-ARROW** button to decrease the number. Alternatively, keep using the **UP-ARROW** button to see what happens.)



Changed the 5 to a 6



Changed the 2 to a 3

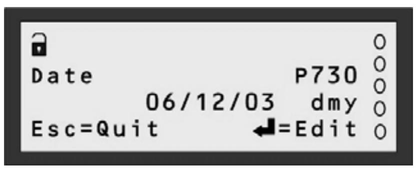
7. Press the **RIGHT-ARROW** button until the **2** is highlighted. (If you go too far to the right, continue to use the **RIGHT-ARROW** button.)

8. Press the **UP-ARROW** button *once* to change the **2** to a **3**. (If you go beyond the **3**, use the **DOWN-ARROW** button to decrease the number. Alternatively, keep using the **UP-ARROW** button.)

9. Press the yellow (**ENTER**) button *once* to save the new date and return to View Mode.

Note that on display line 4, “Save” has changed back to “Edit”.

10. Press the **ESC** button once to return to the SETTINGS menu. Continue on to Chapter 5.



New date saved

Chapter 5 Programming

Chapter 5 assumes a working knowledge of the front panel features and the menu system.

5.1 Before you begin…

Before embarking on programming (configuring) the MCU Control Unit, it is recommended that you have a working knowledge of important features and programming philosophies.

All setting up is achieved from the front panel of the MCU Control Unit; this includes optional adjustments to the set-up of a HART compatible transmitter.

5.1.1 Parameters

The MCU Control Unit has menu-based parameters for **programming** – setting up for an application, adjusting default settings, etc. – and for **viewing** information.

Parameters are populated throughout the menu system. They are grouped in sub-menus, which are organised by association with a specific function or application. Each parameter has a unique 3-digit identification number, prefixed by a 'P' – if programmable - or a 'D' – if for display purposes only. Full menu maps are provided in Appendix G.

With some experience, it becomes easy to locate parameters. Alternatively, parameters can be accessed directly by knowing their unique 3-digit identification number. (See Appendix C for details.)

To make programming of functions and applications easier, various Wizards are provided – See Section 5.1.3.

5.1.2 Menu Navigation

In this chapter, a simple notation has been used to guide you to a particular menu screen or parameter screen. This avoids the need for detailed navigation instructions.

Consider the navigation instructions to be followed before arriving at the DIRECT menu. For the purpose of this example, the starting point is the primary display.

In the notation form this is simply:
1. Navigate to **MAIN MENU / DIRECT**

Without the notation, this translates into these instructions:
1. Press the **ENTER** button to display the "MAIN MENU" screen.
2. Press the **DOWN-ARROW** button repeatedly until "DIRECT" is blinking.
3. Press the yellow (**ENTER**) button *once*.

If **square brackets** are used in a part of the menu notation, e.g. **MAIN MENU / SETUP / [MCU CONTROL UNIT]**, it signifies that the bracketed menu does not appear in all circumstances. Typically, if there are no HART transmitters, the "SELECT INSTRUMENT" screen will never appear as there is no need to differentiate between MCU Control Unit and HART transmitter – the menu that appears then is for the MCU Control Unit.

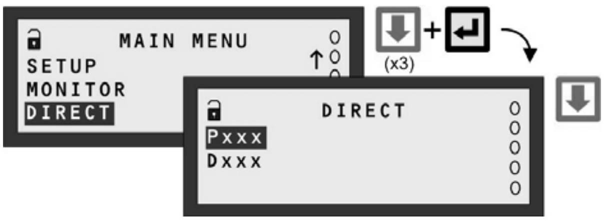


Figure 11: Navigating to the DIRECT menu

5.1.3 Wizards

Programming is best achieved through easy-to-follow Wizards. They are simply a sequence of on-screen prompts, allowing you to easily set-up an individual function or a large application without fuss.

There is a collection of Wizards for most functions and applications. They are selected and started through the menu system. Look out for how to use these Wizards in later sections.

Wizard hints:
- Display line 4 normally instructs what will occur when pressing the **ESC** button and **ENTER** button.
- Arrow buttons scroll through multiple-choice options and edit values.
- The yellow (**ENTER**) button confirms an edited option/value and then displays the next prompt.

5.1.4 Approach to setting-up

To make setting-up straightforward, proceed in a structured manner: -

First Step

Put the MCU Control Unit off-line (see **Modes of operation** below). The factory default is for it to be on-line.

Comfort settings

This includes how to switch off the keyboard sound, setting the date/time, and changing language – Section 5.2.

Inputs

This includes setting-up the MCU Channels to obtain PV (Primary Variable) values from a transmitter. Also, includes how to allocate actions to digital inputs (IN1 and IN2) – Sections 5.3 and 5.5.

Application

This includes further processing of PV values to get content (volume) and flow rate values, which can be shown on the Primary Display – see Section 5.4. In addition, a Totaliser function can be set-up – see Section 5.10.

Outputs

This includes setting-up the 4-20mA Current Output (Section 5.7) and Relays (Section 5.8).

Other features

This includes configuring Data Logging, Alarm handling, the Primary Display, Serial Communications and Pin Security.

Final Step

Put the MCU Control Unit on-line (see **Modes of operation** below). For checks (e.g. Auto-Cycle), diagnostics and faultfinding, see Chapter 6.

5.1.5 Modes of operation

There are two operating modes: **on-line** and **off-line**.

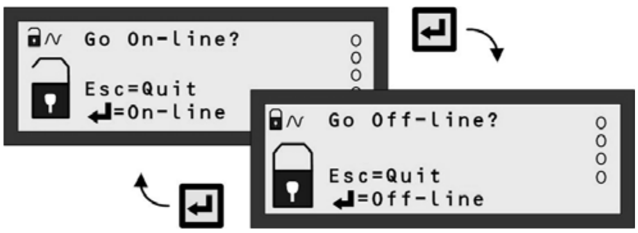


Figure 12: How to toggle between on-line and off-line

An open padlock icon indicates the MCU Control Unit is presently in the **off-line** mode. In this mode, the unit can be programmed providing that you know the security PIN (if set-up). Additionally, the 4-20mA output is **frozen** and all relays are **frozen** unless allocated to totalising and sampler duties.

A closed padlock icon indicates that the MCU Control Unit is presently in the **on-line** mode. In this mode, most of the unit **cannot be programmed**. However, you will be prompted to go off-line if you attempt to programme whilst in this mode and providing that you know the security PIN (if set-up). Additionally, the 4-20mA output and all relays are **enabled**.

5.1.6 Unit Security

By default, security restrictions are switched off and the user has access to all set-up parameters. Once programming is complete, a PIN security code can be used to prevent unauthorised access. For details, refer to Section 5.13.

5.1.7 If you get into difficulties…

There is trouble-shooting information in Chapter 6. Alternatively, the MCU Control Unit can be re-set to the factory defaults as guided in Appendix A.

5.2 Comfort settings

Prior to setting up, it is advisable to check the settings of these parameters and, if necessary, make changes. This includes setting the time and date, switching off the keypad sound and changing language.

Menu: MAIN MENU / SETUP / [MCU CONTROL UNIT /] SYSTEM / SETTINGS

Setting the real-time clock

P730 Date
The date format is determined by **P734**.

P731 Time
The 24-hour clock format is supported.

P734 Date format (Default setting is "dd/mm/yy")
Choose between "dd/mm/yy", "yy/mm/dd" and "mm/dd/yy".

Keypad Sound

P735 Keypad Sound (Default setting is "On")
If you want the keypad sound switched off, select "Off" from the multiple-choice list.

Language

P737 Language (Default setting is "English")
If you wish to change the language used on-screen, there is a choice of other languages.

5.3 Transmitter inputs to the MCU

This section explains the operation of the **MCU input channels**. If using the “Duty” wizard to set-up the MCU Control Unit, the wizard will automatically calculate and populate all necessary parameters of the input channels, and so you skip Sections 5.3 and 5.4.

What to do

On this page, follow the guidance for the particular MCU Control Unit that you have (e.g. MCU901). It will direct you to the ‘setting-up’ pages in Section 5.3 that are appropriate for your particular system.

Note: If you want to set-up or view parameters of a MSP900 Series transmitter (e.g. Bottom Reference), you should mainly refer to the manual IP2040/OM. For a limited guide, see also Chapter 6 and Appendix G of this manual.

MCU901 or MCULOG

If you have a MCU901 or MCULOG, there is support for **one** transmitter only. Consequently, there is a single channel and it is **MCU Channel 1**. In Table 2, identify the type of transmitter connected and refer to the corresponding sections.

Table 2: MCU Channel Setting-up Sections (MCU901/MCULOG)

Type of Transmitter	Instructions
4-20mA	• Set-up MCU Channel 1 as guided in Section 5.3.1.
HART	• Set-up MCU Channel 1 as guided in Section 5.3.3

MCU902

If you have a MCU902, there is support for up to **two** transmitters – *but not two 4-20mA transmitters*. Consequently, there are two channels and they are **MCU Channel 1** and **MCU Channel 2**.

Table 3: MCU Channel Setting-up Sections (MCU902)

Transmitter 1	Transmitter 2	Instructions
4-20mA	(None)	• Set-up MCU Channel 1 as guided in Section 5.3.1. *
HART	HART	• Step 1 of 2: Set-up MCU Channel 1 as guided in Section 5.3.3. • Step 2 of 2: Set-up MCU Channel 2 as guided in Section 5.3.4.

* If a single transmitter is to be used to supply measurements to both MCU Channels (1 and 2), also see Section 5.3.2.

5.3.1 Setting up MCU Channel 1 for a 4-20mA input

This section is applicable if a transmitter with a 4-20mA output is connected. MCU901 and MCULOG support the connection of a **single** 4-20mA transmitter – **do not connect a second 4-20mA transmitter**.

It is imperative at this stage to ensure that the MCU units of PV are set-up correctly. Navigate now to **P200** and select the required units.

Note: The "Duty" Wizard is recommended for configuring an application after P111 is configured (Appendix D.)

> To configure parameter **P111** for analogue measurements, do the following:
> **1.** Navigate to the Ch1 I/P Source menu for parameter **P111**.
> **2.** Select "mA in 1" from the option list.

Figure 13 illustrates an overview of the data flow through MCU Channel 1.

Analogue measurements are presented to the MCU Control Unit as a 4-20mA signal (mA input), and pass through a conditioning (to remove spikes) and damping stage. The mA input damping can be set using **P321**.

The signal is then checked to ensure it is within the expected range (3.7mA to 20.75mA). Signals outside this range cause an alarm condition, which may be externally signalled using an MCU relay – see **P545** in Section 5.9.2.

By default, the mA signal (readable on **D840**) is normalised into a percentage in the range 0 - 100% (readable on **D842**), where 4mA is 0% and 20mA is 100% (although in practise the MCU can process mA input values in the range 3.8mA to 20.5mA : -1.25% to +103.125%).

P112 is a +ve or -ve % input offset for optimal adjustment of the normalised percentage i.e. D802 = D842 + P112. As an example, this feature may be used to accommodate a standing value of level in a tank. The output is readable on **D802** and is the Tertiary Value (TV) of the MCU.

P114 is not applied when the PV units (see **P200**) are configured to be "%" i.e. D801 = D802.

If the MCU PV units have been changed from a percentage (see **P200**), the 4-20mA signal is still normalised into a percentage as shown on **D802**. However, a value entered into **P114** will change the signal from a % value to a new scaled value, typically in level units where:

$$D801 = \frac{D802}{100} \times P114$$

The value of **D801** is the Secondary Value (SV) of the MCU.

The level measurement can be converted into a content (or flow) measurement by using a selected profile calculation (**P113**). The programming details for various supported profiles can be found in Section 5.4.

P117 is a low cut-off parameter that allows the user to force the channel 1 output (**D851**) to be zero when the calculated value falls below a user defined value:

P117	Channel 1 Output Action
+ve value	Drop immediately to zero.
None	Continue measuring.
0.0	Hold output at zero.
-ve value	Rise immediately to zero.

This feature is particularly useful in an Open Channel Flow application (OCF) where a small standing or remaining liquid level in the channel would cause continued totalising of flow when no actual flow exists. For example, set **P117** to a +ve (positive) value of flow units, usually around 2% of maximum flow, to overcome this problem.

P210 allows the user to apply damping to the calculated value of **D851**.

The final output of MCU Channel 1 is readable on **D800** and is the PV of the MCU, which is shown on the display.

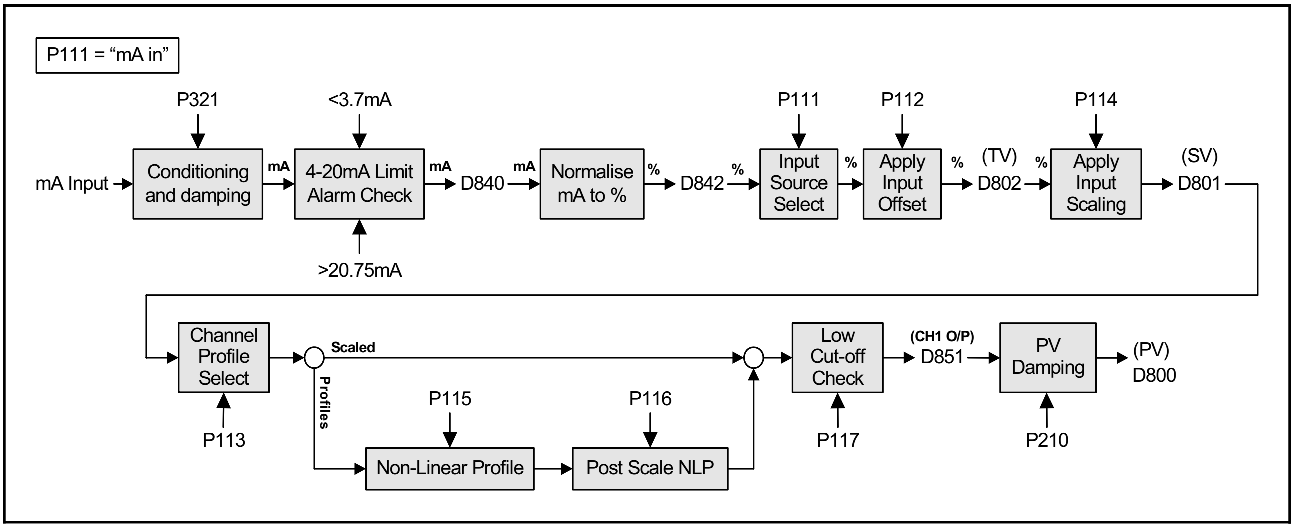


Figure 13: mA Transmitter Input - Process Blocks and Parameters (MCU Channel 1)

Notes:

Optional damping of mA readings: **mA** = [mA_{before} + ((mA_{now} - mA_{before})/(1+10 * **P321**))], ten times a second.[1]

P111	MCU Channel 1 input source – select "mA In 1" from list of options. (All other options are for HART.)
P112	MCU Channel 1 input offset – use for optional ± adjustment to the **D842** value.
P113	MCU Channel 1 profile selection. Keep the "Scaled" option unless requiring a profile calculation (Section 5.4.)
P114	MCU Channel 1 scaling factor – for scaling the **D802** value into required units (**P200**) *
P117	MCU Channel 1 low cut-off – use for forcing **D800** to zero while **D851** is less than **P117**
P20x	Displayed measurement units – **P200** for PV (D800), **P201** for SV (D801) and **P202** for TV (D802)
P210	Optional damping of PV where **D800** = [$D800_{before}$ + (($D800_{now}$ - $D800_{before}$)/(1+10 * **P210**))], ten times a second.

For use of **P115** and **P116**, refer to Section 5.4.

D800 is the PV (Process Variable) value of the MCU Control Unit.
D801, D802, D840 and D842 are intermediate results. (They are useful for trouble-shooting – see Chapter 6.)

* If PV value is liquid level, set **P114** to the level measurement represented by the 20mA output from transmitter.

[1] The primary display information is refreshed twice a second.

5.3.2 Setting up MCU Channel 2 for a 4-20mA input (MCU902 only)

The MCU902 supports the connection of a **single** 4-20mA transmitter – **do not connect a second 4-20mA transmitter.**

This section is applicable if a transmitter with a 4-20mA output is connected and supplying the same analogue measurements to both MCU channels – this may be appropriate in some applications, perhaps where an offset is used.

It is imperative at this stage to ensure that the MCU units of PV are set-up correctly. Navigate now to **P200** and select the required units.

Note: the "Duty" Wizard is recommended for configuring an application after P121 is configured (Appendix D.)

To configure parameter **P121** for analogue measurements, do the following: **1.** Navigate to the Ch2 I/P Source menu for parameter **P121**. **2.** Select "mA in 1" from the option list.

Figure 14 illustrates an overview of the data flow through MCU Channel 2.

Analogue measurements are presented to the MCU Control Unit as a 4-20mA signal (mA input), and pass through a conditioning (to remove spikes) and damping stage. The mA input damping can be set using **P321**.

The signal is then checked to ensure it is within the expected range (3.7mA to 20.75mA). Signals outside this range cause an alarm condition, which may be externally signalled using an MCU relay – see **P545** in Section 5.9.2.

By default, the mA signal (readable on **D840**) is normalised into a percentage in the range 0 - 100% (readable on **D842**), where 4mA is 0% and 20mA is 100% (although in practise the MCU can process mA input values in the range 3.8mA to 20.5mA : -1.25% to +103.125%).

P122 is a +ve or -ve % input offset for optimal adjustment of the normalised percentage i.e. D802 = D842 + P122. As an example, this feature may be used to accommodate a standing value of level in a tank. The output is readable on **D802** and is the Tertiary Value (TV) of the MCU.

P124 is not applied when the PV units (see **P200**) are configured to be "%" i.e. D801 = D802.

If the MCU PV units have been changed from a percentage (see **P200**), the 4-20mA signal is still normalised into a percentage as shown on **D802**. However, a value entered into **P124** will change the signal from a % value to a new scaled value, typically in level units where:

$$D801 = \frac{D802}{100} \times P124$$

The value of **D801** is the Secondary Value (SV) of the MCU.

The level measurement can be converted into a content (or flow) measurement by using a selected profile calculation (**P123**). The programming details for various supported profiles can be found in Section 5.4.

P127 is a low cut-off parameter that allows the user to force the channel 2 output (**D852**) to be zero when the calculated value falls below a user defined value:

P127	Channel 2 Output Action
+ve value	Drop immediately to zero.
None	Continue measuring.
0.0	Hold output at zero.
-ve value	Rise immediately to zero.

This feature is particularly useful in an Open Channel Flow application (OCF) where a small standing or remaining liquid level in the channel would cause continued totalising of flow when no actual flow exists. For example, set **P127** to a +ve (positive) value of flow units, usually around 2% of maximum flow, to overcome this problem.

P210 allows the user to apply damping to the calculated value of **D852**.

The final output of MCU Channel 2 is readable on **D800** and is the PV of the MCU, which is shown on the display.

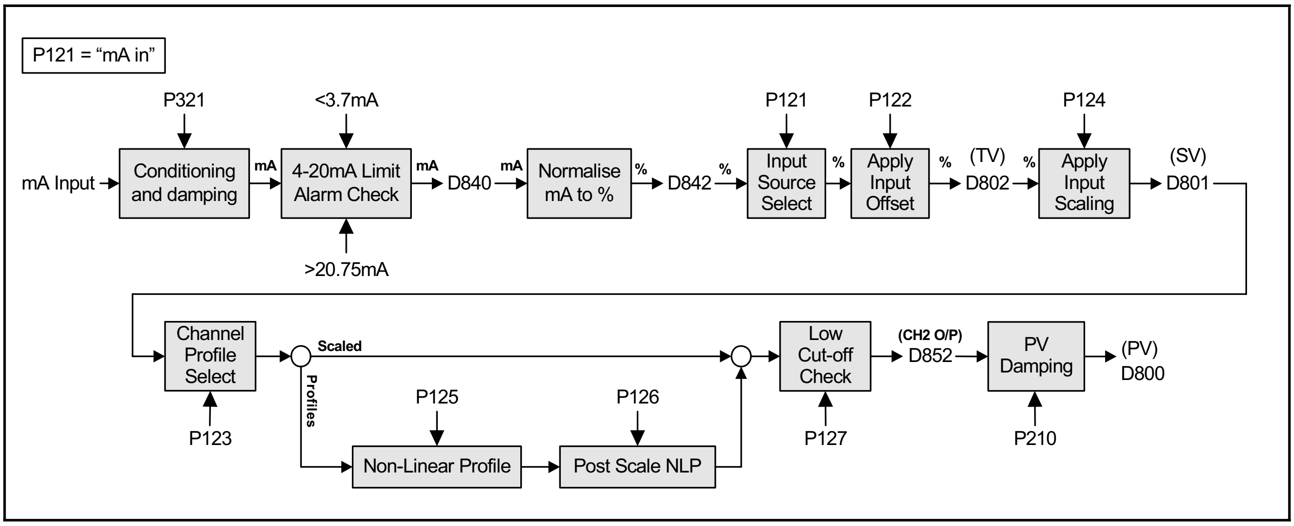


Figure 14: mA Transmitter Input - Process Blocks and Parameters (MCU Channel 2)

Notes:

Optional damping of mA readings: **mA** = [mA_{before} + ((mA_{now} - mA_{before})/(1+10 * **P321**))], ten times a second[2]

P121 MCU Channel 2 input source – select “mA In 1” from list of options. (All other options are for HART.)
P122 MCU Channel 2 input offset – use for optional ± adjustment to the **D842** value.
P123 MCU Channel 2 profile selection. Keep the “Scaled” option unless requiring a profile calculation (Section 5.4.)
P124 MCU Channel 2 scaling factor – for scaling the **D802** value into required units (**P200**) *
P127 MCU Channel 2 low cut-off – use for forcing **D800** to zero while **D851** is less than **P127**
P20x Displayed measurement units – **P200** for PV (D800), **P201** for SV (D801) and **P202** for TV (D802)
P210 Optional filtering of PV where **D800** = [$D800_{before}$ + (($D800_{now}$ - $D800_{before}$)/(1+10 * **P210**))], ten times a second

For an explanation of **P125** and **P126**, see P115 and P116 in Section 5.4.

D800 is the PV (Process Variable) value of the MCU Control Unit
D801, D802, D840 and D842 are intermediate results. (They are useful for trouble-shooting – see Chapter 6.)

***** If PV value is the liquid level, set **P124** to the level measurement represented by the 20mA output from transmitter.

[2] The primary display information is refreshed twice a second.

5.3.3 Setting up MCU Channel 1 for a HART input

This section is applicable if a HART transmitter is connected.

Note: The "Duty" Wizard is recommended for configuring an application – see Appendix D.

The HART transmitter digitally communicates pre-calculated values of the four variables (PV, SV, TV and FV) to the MCU. The values are received continuously by the MCU Control Unit and stored in parameters **D900** to **D903**. Parameter **P111** nominates one of these four variables to be the **source** for the PV value of MCU Channel 1.

Figure 15 illustrates an overview of the data flow through the channel.

P112 is a +ve or -ve % input offset for optimal adjustment of the normalised percentage i.e. D802 = D842 + P112. As an example, this feature may be used to accommodate a standing value of level in a tank. The output is readable on **D802** and is the Tertiary Value (TV) of the MCU.

Where pre-calculated **content** or **flow** values are coming from the transmitter, **P113** need only be set to "scaled". In such a case, parameter **P114** is used only to adjust the value into units that match the display units you may have changed (**P200**).

Where pre-calculated **level** values are coming in from the HART transmitter, **P113** can be set to "scaled" if wanting just level measurement; use **P114** as above. Otherwise, **P113** can be set to a **profile** for generating content or flow values. For the programming details involving various supported profiles, refer to Section 5.4.

P117 is a low cut-off parameter that allows the user to force the channel 1 output (**D851**) to be zero when the calculated value falls below a user defined value:

P117	Channel 1 Output Action
+ve value	Drop immediately to zero.
None	Continue measuring.
0.0	Hold output at zero.
-ve value	Rise immediately to zero.

This feature is particularly useful in an Open Channel Flow application (OCF) where a small standing or remaining liquid level in the channel would cause continued totalising of flow when no actual flow exists. For example, set **P117** to a +ve (positive) value of flow units, usually around 2% of maximum flow, to overcome this problem.

P210 allows the user to apply damping to the calculated value of **D851**.

The final output of MCU Channel 1 is readable on **D800** and is the PV of the MCU, which is shown on the display.

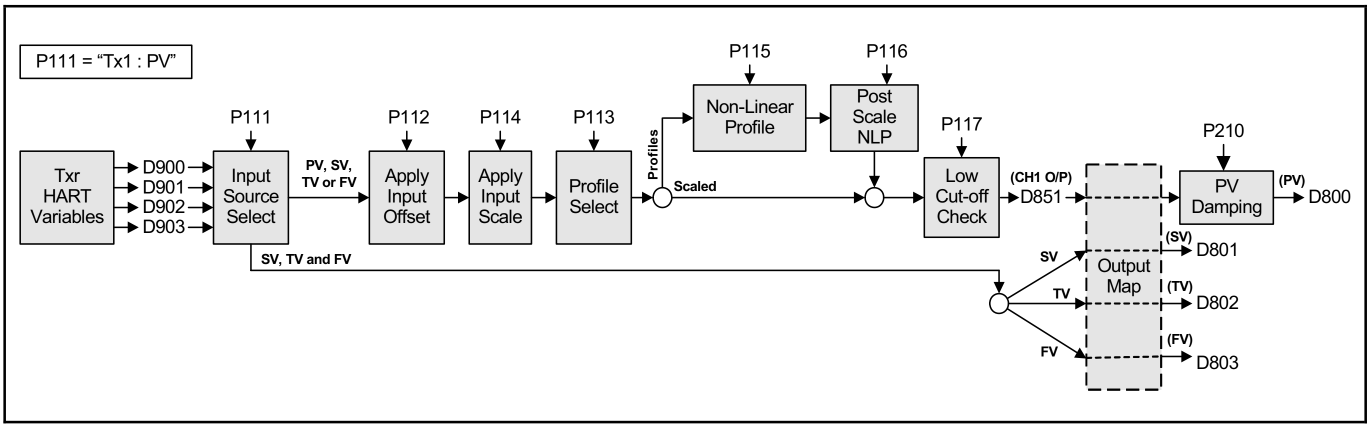


Figure 15: HART Input - Process Blocks and Parameters (MCU Channel 1)

Notes:

Parameters from the HART transmitter are available via the MCU Control Unit from **P000** to **P099** and **D900** to **D999**. They are accessible from the DIRECT menu and the MONITOR menu, selectable from the main menu.

D900 'Primary Variable' value from HART transmitter
D901 'Secondary Variable' value from HART transmitter
D902 'Tertiary Variable' value from HART transmitter
D903 'Fourth Variable' value from HART transmitter

P111 MCU Channel 1 input source – select which HART Variable is to be the ‘input source’.
P112 MCU Channel 1 input offset – use for optional adjustment to the value from the nominated ‘input source’.
P113 MCU Channel 1 profile selection. Keep the “Scaled” option unless requiring a profile calculation (Section 5.4.)
P114 MCU Channel 1 scaling factor – for scaling the ‘input source’ value into required units (**P200**) *****
P117 MCU Channel 1 low cut-off – use for forcing **D800** to zero whenever **D851** is less than **P117**
P20x Displayed units – **P200** for PV (D800), **P201** for SV (D801), **P202** for TV (D802) and **P203** for FV (D803).
P210 Optional damping of PV where **D800** = $[D800_{before} + ((D800_{now} - D800_{before})/(1+10 * \mathbf{P210}))]$, ten times a second.[3]

For an explanation of **P115** and **P116**, see Section 5.4.

D800 is the PV (Process Variable) value of the MCU Control Unit
D801 value is the same value as **D901**
D802 value is the same value as **D902**
D803 value is the same value as **D903**

***** If PV value is the volume of liquid in a linear vessel, see Section 5.4.1 for use of parameter **P114**.

[3] The primary display information is refreshed twice a second.

5.3.4 Setting up MCU Channel 2 for a HART input (MCU902 only)

This section is applicable **only** if a second HART transmitter is connected to the MCU902.

Note: The “Duty” Wizard is recommended for configuring an application – see Appendix D.

The HART transmitter digitally communicates pre-calculated values of the four variables (PV, SV, TV and FC) to the MCU. The values are received continuously by the MCU Control Unit and stored in parameters **D900** to **D903**. Parameter **P121** nominates one of these four variables to be the source for the PV value of MCU Channel 2.

Figure 16 illustrates an overview of the data flow through channel 2.

P122 is a +ve or -ve % input offset for optimal adjustment of the normalised percentage i.e. D802 = D842 + P122. As an example, this feature may be used to accommodate a standing value of level in a tank. The output is readable on **D802** and is the Tertiary value of the MCU.

Where pre-calculated **content** or **flow** values are coming from the transmitter, **P123** need **only** be set to “scaled”. Parameter **P124** can be used only to adjust the value into alternative units that match the display units you may have changed (**P200**).

Where **level** values are coming in from the HART transmitter, **P123** can be set to “scaled” if wanting just level measurement, otherwise **P123** can be set to a profile for generating content or flow values. For the programming details involving various supported profiles, refer to Section 5.4.

Parameter **P150** determines how corresponding values from MCU Channels 1 and 2 are processed – sum, difference or product calculation – before being output to parameters **D800** - **D803** (‘Answers’). **P150** can also allow values from a MCU Channel 1 to go straight to D800 - D803; the factory default is for MCU Channel 1 (“Ch1”) to do this.

P127 is a low cut-off parameter that allows the user to force the channel 2 output (**D852**) to be zero when the calculated value falls below a user defined value:

P127	Channel 2 Output Action
+ve value	Drop immediately to zero.
None	Continue measuring.
0.0	Hold output at zero.
-ve value	Rise immediately to zero.

This feature is particularly useful in an Open Channel Flow application (OCF) where a small standing or remaining liquid level in the channel would cause continued totalising of flow when no actual flow exists. For example, set **P127** to a +ve (positive) value of flow units, usually around 2% of maximum flow, to overcome this problem.

P210 allows the user to apply damping to the calculated value of **D852**.

The final output of MCU Channel 1 is readable on **D800** and is the PV of the MCU, which is shown on the display.

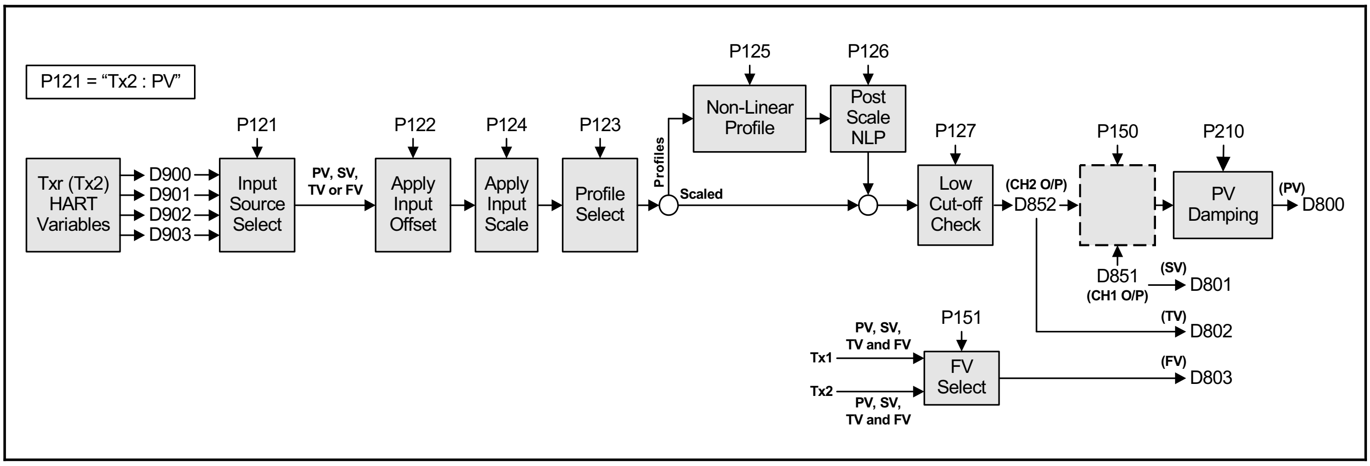


Figure 16: HART Input - Process Blocks and Parameters (MCU Channel 2)

Notes:

Parameters from the HART transmitter are available on the MCU Control Unit from **P000** to **P099** and **D900** to **D999**. They are accessible from the DIRECT menu and the MONITOR menu, selectable from the main menu.

D900 ‘Primary Variable’ value from HART transmitter
D901 ‘Secondary Variable’ value from HART transmitter
D902 ‘Tertiary Variable’ value from HART transmitter
D903 ‘Fourth Variable’ value from HART transmitter

P121 MCU Channel 2 input source – select which HART Variable is to be the ‘input source’.
P122 MCU Channel 2 input offset – use for optional adjustment to the value from the nominated ‘input source’.
P123 MCU Channel 2 profile selection. Keep the “Scaled” option unless requiring a profile calculation (Section 5.4.)
P124 MCU Channel 2 scaling factor – for scaling the ‘input source’ value into required units (**P200**) *
P127 MCU Channel 2 low cut-off – use for forcing **D800** to zero while **D852** is less than **P127**
P20x Displayed units – **P200** for PV (D800), **P201** for SV (D801), **P202** for TV (D802) and **P203** for FV (D803).
P210 Optional filtering of PV where **D800** = [$D800_{before}$ + (($D800_{now}$ - $D800_{before}$)/(1+10 * **P210**))], ten times a second.[4]

For an explanation of **P125** and **P126**, see P115 and P116 in Section 5.4.

D800 is the PV (Process Variable) value of the MCU Control Unit
D801 value is the same value as **D851**
D802 value is the same value as **D852**
D803 value is the same value as the transmitter variable that is selected by **P151**

***** If PV value is the volume of liquid in a linear vessel, see Section 5.4.1 for use of parameter **P114 (CH1) / P124 (CH2)**.

[4] The primary display information is refreshed twice a second.

5.4 Profile Calculations for Contents and Flow Applications

The MCU Control Unit can use level measurements to calculate the **content** in linear or non-linear shaped closed-vessels. In addition, **flow** in open-channels can be calculated and totalled. The MCU Control unit has a library of **pre-programmed** profiles and supports a user-defined profile.

You are strongly recommended to use the "Duty" wizard for setting up content and flow applications, as this will automatically calculate and populate the relevant parameters. The wizard will guide you through all the setting up and populate parameters with values and settings. Appendix D has a variety of example applications that are set-up using the "Duty" wizard.

The data flow diagrams in Section 5.3 show how the various parameters are used to calculate the final MCU PV.

5.4.1 Linear Profile (Content from Level)

Parameter **P113** must be set to "Scaled", which establishes that the relationship between the liquid level and the content (PV value) derived from that level is linear.

For the linear profile, e.g. **vertical cylinder** or **rectangular** vessel, parameter **P114** either defines the maximum content (if 4-20mA transmitter used) or area of the vessel's cross-section (if HART transmitter used). The PV value (**D800**) for the content is then calculated as the live level measurement multiplied by the value in parameter **P114**.

5.4.1.1. Standard 4-20mA input (Data flow diagram Figure 13)

- **P200** (units) must have changed from "%" to the required units of measurement.
- **P114** is used to define maximum contents of the linear profile vessel.
- The PV value (**D800**) is calculated using: D800 = P114 x (D802 ÷ 100)
- Note that **P115** and **P116** are bypassed in this scenario.

5.4.1.2. HART digital input (Data flow diagram Figure 15)

- **P200** (PV units) must be set to the required units of measurement.
- **P114** is used to define the contents of the linear vessel per unit of level measurement. If the input from the HART transmitter is in metres, the value of P114 is the contents of the vessel per metre of height. If the input from the HART transmitter is in feet, the value of P114 is the contents of the vessel per foot of height.
- The PV value (**D800**) is calculated using: **D800** = (**P114** x Level measurement). [5]
- Note that **P115** and **P116** are bypassed in this scenario.

5.4.2 Non-linear Profiles (Content from Level)

Non-linear profiles for content:

- Horizontal cylinder with flat ends.
- Spherical vessel.
- Horizontal cylinder with domed ends.
- Special (plotted).

The MCU Control Unit has a library of non-linear profiles, some of which are shown below. Once a profile is selected through parameter **P113**, the MCU automatically recalls the profile from memory and populates **P115**. The standard non-linear profiles require an input signal over the range 0 - 1.0. Parameter **P114** is therefore used to scale the input signal over the range 0 - 1.0, as described in Sections 5.4.2.1 and 5.4.2.2.

5.4.2.1. Standard 4-20mA input (Data flow diagram Figure 13)

- **P200** (PV units) must have changed from "%" to the required units of measurement.
- The transmitter's 4-20mA output should be scaled to give a 4-20mA signal over the full height of the vessel, in which case **P114** may be left at the default value of 1.0.
- If the transmitter's 4-20mA output **is not** scaled to give a 4-20mA signal over the full height of the vessel, **P114** must be used to re-scale the signal ready for input to the NLP calculation.
  For example, if the maximum current input is below 20mA for a full vessel, say 18mA, re-scale using **P114**, calculating: **P114** = (Current span ÷ Actual current span) = 16 ÷ (18-4) = 1.143

[5] Level measurement from the transmitter after any input offset has been applied.

- Refer now to Section 5.4.2.3.

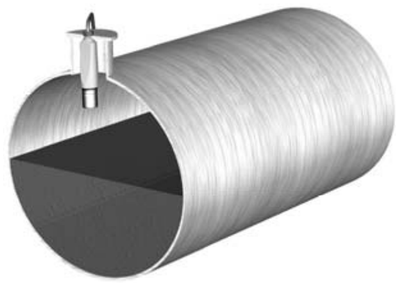
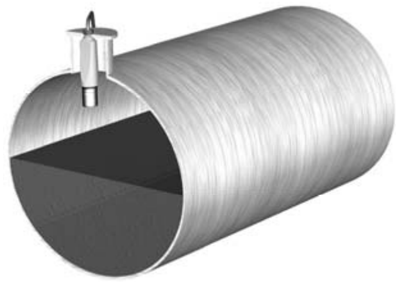
5.4.2.2. HART digital input (Data flow diagram Figure 15)

- **P200** (PV units) must be set to the required units of measurement.
- The maximum value of level from the HART transmitter must be equal to the height of the liquid when the vessel is full.
- The level measurement, after any input offset has been applied, must be re-scaled to the range 0 - 1.0 ready for input to the NLP calculation. For example, if the level measurement range is 0 - 4.0, then **P114** = (1.0 ÷ 4.0) = 0.25.
- Refer now to Section 5.4.2.3.

5.4.2.3. Non-linear Profile (NLP) calculation

With **P113** set to the NLP required and **P114** correctly calculated, **P115** will have been automatically programmed with the correct NLP. **P116** is always programmed with the maximum contents of the vessel in the units chosen (**P200**).

Some examples of popular NLP applications are shown below:

P113 = “Spherical”  **P114** = (1.0 ÷ Diameter of tank) **P115** = MCU plotted profile of tank ***** **P116** = Full volume of ideal spherical tank	**P113** = “Horiz Cyl Flat” (Horizontal Cylinder, Flat) (slope ignored)  **P114** = (1.0 ÷ Diameter of tank) **P115** = MCU plotted profile of vessel ***** **P116** = Full volume of ideal cylindrical of diameter
P113 = “Conical” ******  **P114** = (1.0 ÷ Maximum level) **P115** = MCU plotted profile of vessel ***** **P116** = Full volume	**P113** = “Horiz Cyl Dome” (Horizontal Cylinder, Domed) (slope ignored)  **P114** = (1.0 ÷ Diameter of tank) **P115** = MCU plotted profile of vessel ***** **P116** = Full volume

***** The non-linear profile is plotted automatically when editing **P113** manually or when using the “Duty” wizard.
****** **P115** is plotted with a simple cone if **P113** edited manually.

5.4.2.4. Using the 21-point manual (DIY) plot feature in a contents application

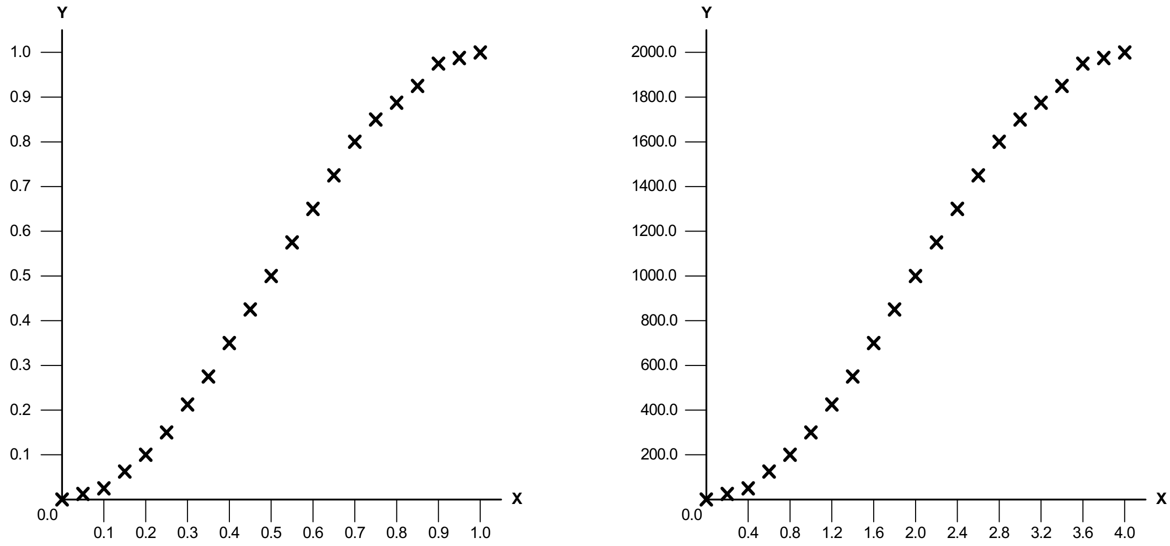
When parameter **P113** is set to be “special”, parameter **P115** (CH1 NLP Data) is used for defining a **21-point** look-up table that represents the non-linear profile of a vessel that is not in the MCU library.

Each point is a Cartesian co-ordinate (X, Y). The X points are at user-defined intervals, typically in equal increments (5%) of maximum height. The **X** value represents a level. The **Y** value is the corresponding volume.

Alternatively, these values may be entered in actual level (e.g. in metres) and volume (e.g. m^3) in which **P114** and **P116** are *both* 1.000. The volume is derived from the plotted profile using interpolation between the plot points.

The **X** and **Y** values may be ‘normalised’ (range 0 to 1). In this case, the volume is derived from automatic linearisation of the profile using the live level measurements that are pre-‘normalised’ (0 to 1) by **P114**. A Post Scale NLP (**P116**) must then be applied to the result of linearisation to obtain the volume for the PV.

P115 = MCU Plotted Profile for “Spherical”



Normalised units (range 0 to 1) **Actual level (X) and volume (Y) units**

How to edit the ‘look-up’ table (P115):

(**Note:** Parameter **P113** must be set to be “Special”.)

1. Navigate to the **P115** parameter screen, as guided in Figure 17 (below).
2. Press the **ENTER** button *once* to select point 0. (Before editing, you can use the **DOWN-ARROW** button to page down to another point or use the **ESC** button to return to the menu.)
3. With the “**X0:**” text highlighted, use the **RIGHT-ARROW** button to move across to the **X0** value.
4. Use the arrow buttons to edit the **X0** value.
5. Press the **ENTER** button *once* to confirm the new **X0** value.
6. With the “**Y0:**” text highlighted, use the **RIGHT-ARROW** button *once* to move across to the **Y0** value.
7. Use the arrow keys to edit the **Y0** value.
8. Press the **ENTER** button *once* to confirm the new **Y0** value.
9. To re-edit **X0** and **Y0**, press the **ENTER** button and repeat as before. Otherwise, use the **DOWN-ARROW** button to display the page with **X1** and **Y1**. (The parameter number **P115** does not change until beyond **X20, Y20**.)
10. Repeat for all points in the profile. To return to the menu at any time, use the **ESC** button.

Table 4: Factory Default 21-Point Look-up Table Values (P115)

	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
X	0.0	0.2	0.4	0.6	0.8	1.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Y	0.0	0.2	0.4	0.6	0.8	1.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

Notes:

- It is not necessary to define all points. However, an X value of 0.0 terminates the profile (unless it is point X0, Y0).
- Whilst editing, the **ESC** button can be used to abort editing and restore the original value; it needs to be pressed again to move back to the ‘X’ or ‘Y’ text.

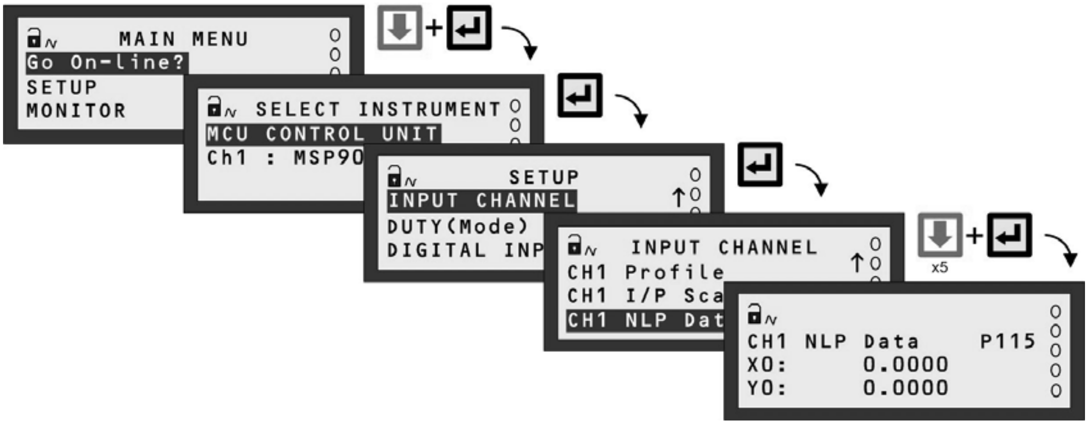


Figure 17: Navigation to P115 parameter screen

5.4.3 Non-linear Profiles (Flow from Level)

Standard non-linear profiles for flow:

- Flume 3/2
- V-Notch 5/2
- Manning formula
- Special (plotted)

Note: The "Duty" wizard is the easiest way to set-up a flow measurement application – see Appendix D.

The MCU Control Unit has a library of profiles for open-channel flow measurement, two of which are illustrated in Section 5.4.3.3.

When selecting "V Notch", "Flume/Weir" or "Manning" through parameter **P113**, the MCU Control Unit automatically populates parameter **P115** with a look-up table for the non-linear profile.

The standard flow profiles require an input signal in the range 0 - 1.0. Parameter **P114** is therefore used to scale the input signal over the range 0 - 1.0 as described in Sections 5.4.3.1 and 5.4.3.2 (below).

5.4.3.1. Standard 4-20mA input (Data flow diagram Figure 13)

P200 (PV units) must have been changed from "%" to the required units of measurement.

The transmitter's 4-20mA output should be scaled to give a 4-20mA signal over the full level range expected in the flow channel. If this is the case, parameter **P114** may be left at the default value of 1.0.

If the transmitter's 4-20mA output is not scaled over the full level range of the liquid in the channel, **P114** must be used to re-scale the signal ready for input to the NLP calculation. For example, if the maximum current input is below 20mA for the maximum height of liquid in the channel, say 12mA, re-scale via **P114**:

P114 = (Current span ÷ Actual current span) = 16 ÷ (12-4) = 2.0

Refer now to Section 5.4.3.3.

5.4.3.2. HART digital input (Data flow diagram Figure 15)

P200 (PV units) must be set to the required units of measurement.

The maximum value of level from the HART transmitter must be equal to the maximum height of the liquid in the channel.

The level measurement must be re-scaled to the range 0 - 1.0 ready for input to the NLP calculation. For example, if the level measurement range is 0 - 1.5m, parameter **P114** = (1.0 ÷ 1.5) = 0.667

Refer now to Section 5.4.3.3.

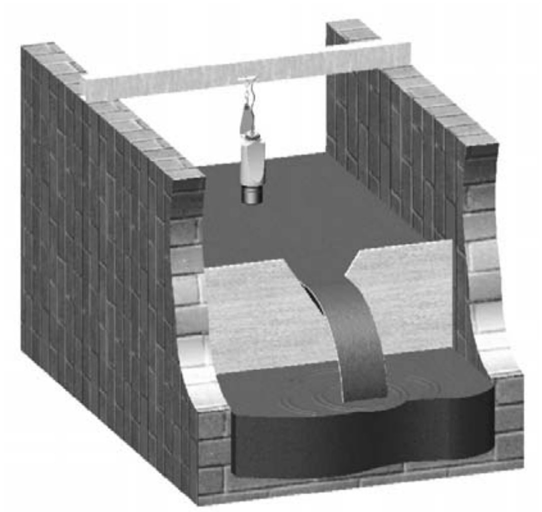
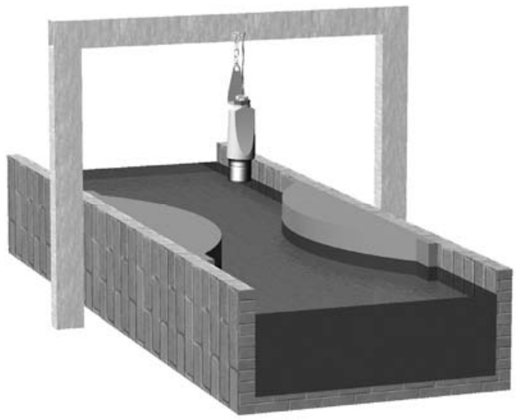
5.4.3.3. Non-linear Profile (NLP) calculation

With **P113** set to the NLP required and **P114** correctly calculated, **P115** will have been automatically programmed with the correct NLP.

P116 is always programmed with the maximum flow expected in the channel, which will occur at the maximum liquid level in the channel.

The PV value (**D800**) for the flow rate is derived by applying the profile to the normalised transmitter input and then scaling by **P114** and **P116**.

Some examples of popular open-channel flow (OCF) structures are given below.

P113 = "V-Notch 5/2" (Weir using 5/2 power law) (To BS3680)	**P113** = "Flume (3/2)" (using 3/2 power law) (To BS3680)
	
P114 = (1.0 ÷ Maximum height of liquid) **P115** = MCU plotted profile of channel * **P116** = Maximum flow at maximum height (**P114**)	**P114** = (1.0 ÷ Maximum height of liquid) **P115** = MCU plotted profile of channel * **P116** = Maximum flow at maximum height (**P114)**

***** The non-linear profile is plotted automatically when editing **P113** manually or when using the "Duty" wizard.

5.4.3.4. Pre-programmed flat and parabolic flumes

The MCU Control Unit supports a number of **flat** and **parabolic** flumes that may be of use. When selecting one of the flumes through **P113**, the MCU Control Unit uses **P115** in a different way to that when a plotted NLP is required. For these flumes, **P115** is used to store pre-defined values for the flow calculation where flow **Q** is given by:

$$Q = k \times (h \times mul)^{Pwr}$$

where **h** is the height of liquid in the channel, and **k** and **Pwr** are factors. This version of the more standard "Q=k x h^{Pwr}" flow formula allows the entering of a multiplier (**mul**) to account for irregularities or errors in the flow structure, and should only be used where such errors can be quantified.

The flow units (**P200**) for the flumes are fixed as m^3/hr, hence **P116** is automatically populated with a value of 3600.

Factors **k**, **mul** and **Pwr** are fixed values for each flow structure and are shown in Table 5 (below); they are stored in parameter **P115**. Depending on the derivation of **k** and the level units, the **h** value is scaled by the multiplier (mul) of 0.01 (cm to m).

Experienced users may wish to edit the values of **k**, **mul** or **Pwr** for specific applications. To edit these values, set **P113** to be "Flume***" and then edit **P115** as appropriate. Use the keypad's **DOWN-ARROW** to display the **mul** value.)

Table 5: Pre-programmed flat and parabolic flumes and flow calculation factors

Profile (P113)	K (P115)	Pwr (P115)	Mul (P115)	P116
Flume Flat 1	0.1347877	1.5	0.01	3600.0
Flume Flat 2	0.1782664	1.5	0.01	3600.0
Flume Flat 3	0.3134177	1.5	0.01	3600.0
Flume Flat 4	0.5417157	1.5	0.01	3600.0
Flume Flat 5	0.8111058	1.5	0.01	3600.0
Flume Flat I	0.1322	1.5	0.01	3600.0
Flume Flat II	0.1777	1.5	0.01	3600.0
Flume Flat III	0.21758	1.5	0.01	3600.0
Flume Flat III bis	0.32835	1.5	0.01	3600.0
Flume Flat III ter	0.272	1.5	0.01	3600.0
Flume Flat IV	0.3521726	1.5	0.01	3600.0
Flume Flat V	0.442932	1.5	0.01	3600.0
Flume Flat V bis	0.4005	1.5	0.01	3600.0
Flume Flat VI	0.4990569	1.5	0.01	3600.0
Flume Flat VII	0.6237	1.5	0.01	3600.0
Flume Flat VIII	0.88116	1.5	0.01	3600.0
Flume Flat VIII bis	0.798	1.5	0.01	3600.0
Flume Flat IX	1.065186	1.5	0.01	3600.0
Flume Flat IX bis	0.8148	1.5	0.01	3600.0
Flume Flat X	1.3222761	1.5	0.01	3600.0
Flume Flat X bis	1.609	1.5	0.01	3600.0
Flume Flat X ter	1.064884	1.5	0.01	3600.0
Flume Flat XI	1.65099	1.5	0.01	3600.0
Flume Parabolic 1	0.39885	2.3	0.01	3600.0
Flume Parabolic 2	0.44187	2.3	0.01	3600.0
Flume Parabolic 3	0.46362	2.2	0.01	3600.0
Flume Parabolic 4	0.54419	2.2	0.01	3600.0
Flume Parabolic 5	0.61851	2.1	0.01	3600.0
Flume Parabolic 6	0.71726	2.1	0.01	3600.0
Flume Parabolic 7	0.77152	2.1	0.01	3600.0
Flume***	(User)	(User)	(User)	3600.0

Note: When a flume is selected from this list, the MCU Control Unit also populates parameters **P401** (4-20mA) and **P530** (totaliser units of m^3)

5.4.3.5. Other flow calculations of the form Q=k x h^{Pwr} (e.g. Parshall flumes)

When the flow law is of the form Q=k x h^{Pwr} and the structure does not match one of the pre-programmed flat or parabolic flumes, set **P113** to be "Flume***".

This setting is appropriate for Parshall flumes (see Table 6.), as it allows the entry of custom values in **P115** for **k** (default value 0) and **mul** (default value 0.2) in the formula Q = k x (h x mul)^{Pwr}.

Select the appropriate values from Table 6 and enter them into parameter **P115**. Then, ensure that appropriate units are selected (**P200**).

IMPORTANT NOTE: The value for "mul" in the flow formula must be set to 1.0 for Parshall flumes. Ensure it is changed from the default value of 0.2 to 1.0. Note that the DOWN-ARROW button must be used to display "mul" on the MCU display when editing **P115**.

Table 6: Standard values for Parshall flumes

(Assuming the liquid height in the flume is being measured in feet.)

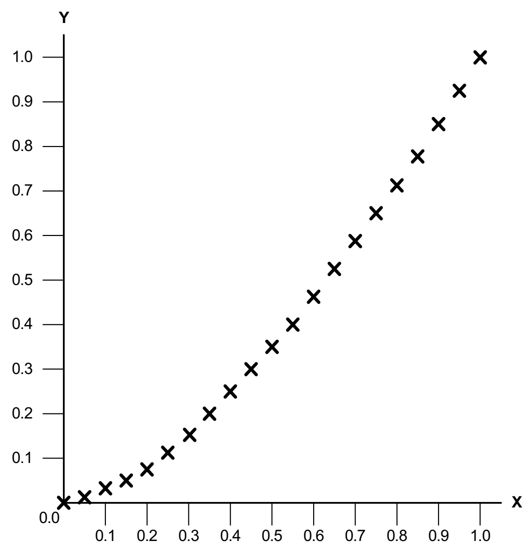
Parshall Flume Size	Pwr	K Factor				
		Imperial flow Readout			Metric flow readout	
		CFS	GPM	MGD	L/s	M^3/hr
1 in.	1.550	0.338	151.7	0.2184	60.36	217.3
2 in.	1.550	0.676	303.4	0.4369	120.7	434.6
3 in.	1.547	0.992	445.2	0.6411	176.5	635.5
6 in.	1.580	2.06	924.5	1.331	381.2	1372
9 in.	1.530	3.07	1378	1.984	525.4	1927
1 ft. *	1.522	4	1795	2.585	690.9	2487
1½ ft.	1.538	6	2693	3.878	1056	3803
2 ft. *	1.550	8	3590	5.17	1429	5143
3 ft. *	1.566	12	5386	7.756	2184	7863
4 ft. *	1.578	16	7181	10.34	2954	10630
5 ft. *	1.587	20	8976	12.93	3732	13440
6 ft. *	1.595	24	10770	15.51	4521	16280
8 ft. *	1.607	32	14360	20.68	6115	22010
10 ft.	1.600	39.38	17672	25.456	23403.8	84256
12 ft.	1.600	46.756	20982	30.224	27989.8	100766
***** The factors for these profiles are already pre-programmed into the MCU; simply select the relevant Parshall flume size from the list offered (**P113**). For other sizes, simply enter the factors once P113 is set to "Flume***".						

5.4.3.6. Using the 21-point manual (DIY) plot feature in a flow application

When parameter **P113** is set to "Special", parameter **P115** is used for defining a 21-point look-up table that represents the flow profile of the channel. The flow profile is established by entering the flow/liquid height relationship as a series of Cartesian co-ordinates.

An example for a 3/2 flume is shown below, with normalised data used.

P115 = MCU Plotted Profile for "Flume (3/2)"



Normalised units (range 0 to 1)

The X points are at user-defined intervals, typically in equal (5%) increments of height. However, this may be changed if it is required to concentrate points at a particular level in the channel of flow structure. The Y points are the corresponding flow rates.

Enter data in either normalised form or in actual level/flow units.

For further details of programming the 21 points, refer to Section 5.4.2.4.

5.5 Digital Inputs IN1 and IN2

Digital inputs **IN1** and **IN2** can be individually set-up to perform an action whenever they are activated.

> **Note:** Digital input status icons are shown on the left-hand side of the primary display: o = inactive or ▸ = active.
> In addition, parameter **D835** shows the status of the inputs: active (**1**) or inactive (**0**). First digit represents **IN1**.

How to allocate an action to IN1 or IN2

1. Navigate to: MAIN MENU / SETUP / [MCU CONTROL UNIT /] DIGITAL INPUT>

2. Select a 'Digital Input' menu: Action, Delay or On-State,

3. Allocate a function by editing the **Action** select parameter – **P340** for IN1 or **P345** for IN2
Table 7 (below) lists all the options and explains their purpose

4. If you require a delay *before* an action is performed, edit the **Delay** parameter – **P341** for IN1 or **P346** for IN2
The parameter value format is **m:s** (**m**inutes and **s**econds)

5. To change the logic of the input for triggering an action, edit the **On State** parameter – **P342** (IN1) or **P347** (IN2).
Options are "Closed" (active when voltage-free contact is closed: default setting) and "Open" (active when open).

Table 7: Digital Input Actions

Action	Action that occurs while digital input is active
Free	Digital Input has no allocated action. (Default).
Alarm	Forces an alarm condition, which is indicated if specified in the ALARM menu. For information about alarms and features they affect, see Section 5.9.
Go Offline	Changes the operating mode to off-line (open padlock).
Hold Totaliser	Freezes the internal totaliser.
Hold MCU PV	Prevents the PV value (**D800**) from being updated while the digital input is active.
Suppress Alarm	The Alarm relay is held on. If the digital input is active when an alarm condition is present, a message is displayed indicating the alarm is being overridden.
Display Msg	Displays a user-defined message (**P241**).
Log Input	When the next logging interval elapses, flag the data logged as a 'bad sample' if the digital input has been active. **(MCULOG only)**
Pump-down	Invoke a pump-down operation – see Section 5.8.18 for details.
Lock Params	Prevent 'P' prefixed parameters from being edited.

5.6 Logging (MCULOG Only)

Menu: MAIN MENU / SETUP / [MCU CONTROL UNIT /] LOGGING

5.6.1 Overview

MCULOG will log up to **4,800** events, where an event is the value of a parameter at regular intervals. The parameter to be logged is the one selected for the middle section of the primary display – see Section 5.11. This parameter is typically the **Primary Variable** (PV).

If the MCULOG has been set-up to totalise the parameter value, the daily value of the totaliser at midnight is also logged. Up to **60** midnight totalised values will be held in memory. (This is in addition to the memory for 4,800 events.)

In addition, the maximum instantaneous value of the parameter recorded in each 24-hour period is logged.

Logged data may be downloaded at any time using the **RS232 data port socket** provided – see IP2030/IM for connection details. Users will normally download data using a PC with logger software **Mobrey Log-View**.

For details on Mobrey Log-View, see data sheet IP122. Also, see Section 5.12 for serial communication parameters.

The MCULOG gives a visual indication that logging of data is underway by flashing the "LOG" text in the bottom, right-hand corner of the primary display. (If logging is not underway, the text alternates between "MCU" and "LOG".)

5.6.2 P590: Logging Interval

The logging interval is user-defined (**P590**). An interval value of 15 minutes will log the parameter value at 15-minute intervals, which equates to 50 days elapsed time.

5.6.3 P591: Fast Log Mode

Should the (logged) parameter value exceed a user-entered value (**P591**), the MCULOG automatically moves to a **fast log mode** and then logs the PV once every minute until the PV falls below that user-entered value. Fast log values are tagged so that they are easily identified when examining logged data via Mobrey Log-View.

5.6.4 P593: Low Memory Alarm

The user may allocate an alarm to indicate when the memory remaining falls to a user-defined percentage (**P593**). The user must also set the action to be taken when this occurs. A choice of activating a relay, driving the output current to a set level or doing both is available (**P542**).

If no action is taken, the memory will fill and then either logged data will be overwritten or the logging will stop, as determined by parameter **P592**.

Parameter **D846** shows the percentage of free memory remaining for data logging.

5.6.5 P592: Do/Do not Overwrite Old Data

Once the logging memory is full, there is a choice to continue logging, in which case the earliest data is overwritten, or logging may be stopped at that time.

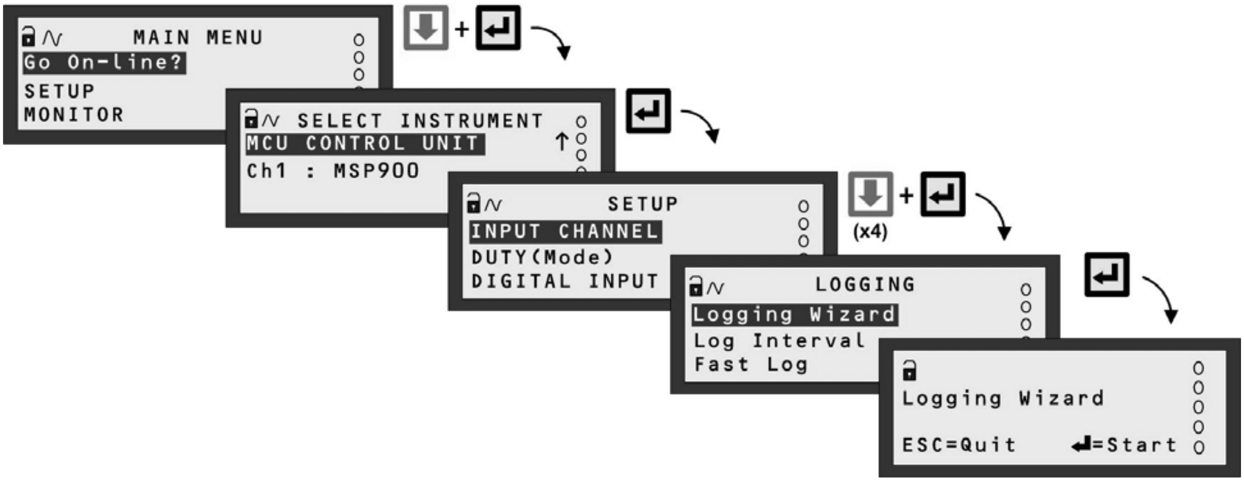
5.6.6 Starting, stopping and resetting the logger

To start logging, simply change the logging interval (**P590**) from 0 to the interval required. Logging is now activated.

To stop logging, simply change the logging interval (**P590**) back to 0. **Note, when the logging interval is re-set, all logged data will be cleared from the logging memory.**

Changing the logging interval from 0 to a logging interval in minutes will clear all data logged (i.e. clear the 4800 event-memory plus the 60 midnight totals).

Changing the log interval from a non-zero interval (e.g. 15 minutes) to a **new** non-zero interval (e.g. 5 minutes) will clear the 4800 event-memory).



Note: The SELECT INSTRUMENT menu does not appear when there are no HART transmitters.

Figure 18: Navigating to the LOGGING Menu

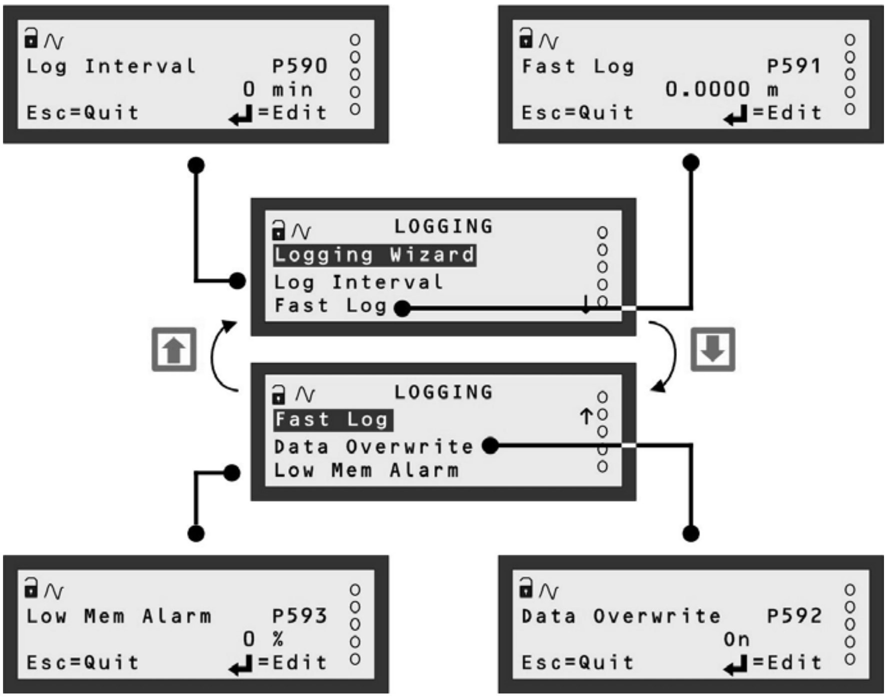


Figure 19: Menu Map for LOGGING screens

5.6.7 Logging Wizard - Logging of level measurements

The Logging Wizard is the easiest way to configure a data logging application *after* the main duty (e.g. level) is set-up.

Consider data logging of the PV value (**D800**) every **5** minutes, whereby the PV value is a level measurement in metres. When the level measurement is at one metre or more, the **Fast Log Mode** is required to activate. When the memory is full, old data is **overwritten**.

1. Navigate the menu system to get to the "Logging Wizard" screen, as guided in Figure 18.

2. Start the "Logging " Wizard by pressing the yellow (**ENTER**) button *once*.

3. Work through the "Duty" Wizard prompts (Figure 20) until completion; this occurs when the menu system re-appears. Keypad hints, for the illustrated Wizard sequence on the next page, are provided alongside the prompts. If applicable, adapt the example to suit your application.

4. Circled numbers in the illustrated Wizard sequence relate to these notes:
   ① Press the yellow (**ENTER**) button *once*
   ② Set the logging interval to once every 5 minutes (see **P590**)
   ③ Set Fast Log Mode to activate at one metre or more (see **P591**). Units are dependent on PV units (**P200**).
   ④ Select the "None" option if no digital inputs are to be configured.

5. Return to the main menu by holding the **ESC** button for a few seconds, releasing it when the main menu appears. Next, go on-line by selecting the "Go on-line" menu option and then pressing the **ENTER** button *once*. Finally, press the **ESC** button repeatedly until the primary display appears. You will now see "LOG" flashing on the primary display to indicate logging is underway.

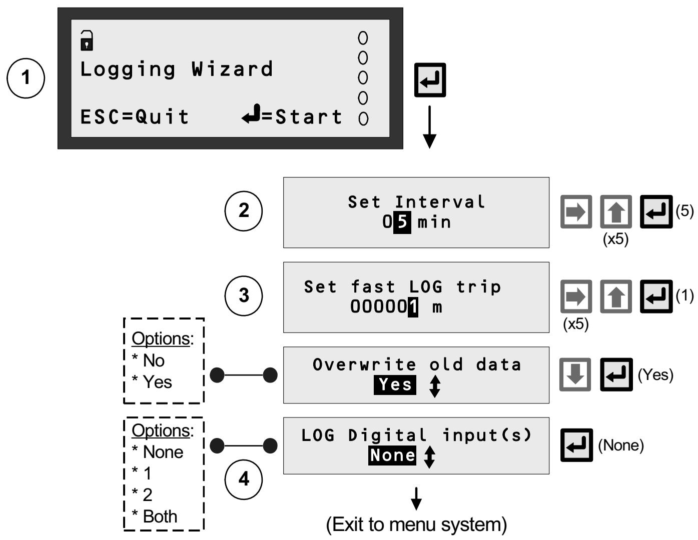


Figure 20: Logging Wizard – Logging of level measurements

5.6.8 Logging Wizard - Logging of flow measurements

The Logging Wizard is the easiest way to configure a data logging application *after* the main duty (e.g. flow) is set-up.

Consider data logging of the PV value (**D800**) every **15** minutes, where the PV value is a flow measurement in cubic metres per second. When the flow measurement is at **1** cubic metre per second or more, the **Fast Log Mode** is required to activate. When the memory is at 90% of capacity, a **relay** is activated instead of overwriting old data.

1. Navigate the menu system to get to the "Logging Wizard" screen, as guided in Figure 18.

2. Start the "Logging " Wizard by pressing the yellow (**ENTER**) button *once*.

3. Work through the "Duty" Wizard prompts (Figure 21) until completion; this occurs when the menu system re-appears. Keypad hints, for the illustrated Wizard sequence on the next page, are provided alongside the prompts. If applicable, adapt the example to suit your application.

4. Circled numbers in the illustrated Wizard sequence relate to these notes:

① Press the yellow (**ENTER**) button *once*

② Set the logging interval to once every 15 minutes (see **P590**)

③ Set Fast Log Mode to activate at 1 m^3/s or more (see **P591**). Units are dependent on PV units (**P200**).

④ Relay 4 is to activate when there is a low memory condition (see Section 5.6.4)

⑤ Low memory condition when memory is at 90% of capacity; i.e. 10% remaining.

5. Return to the main menu by holding the **ESC** button for a few seconds, releasing it when the main menu appears. Next, go on-line by selecting the "Go on-line" menu option and then pressing the **ENTER** button *once*. Finally, press the **ESC** button repeatedly until the primary display appears. You will now see "LOG" flashing on the primary display to indicate logging is underway.

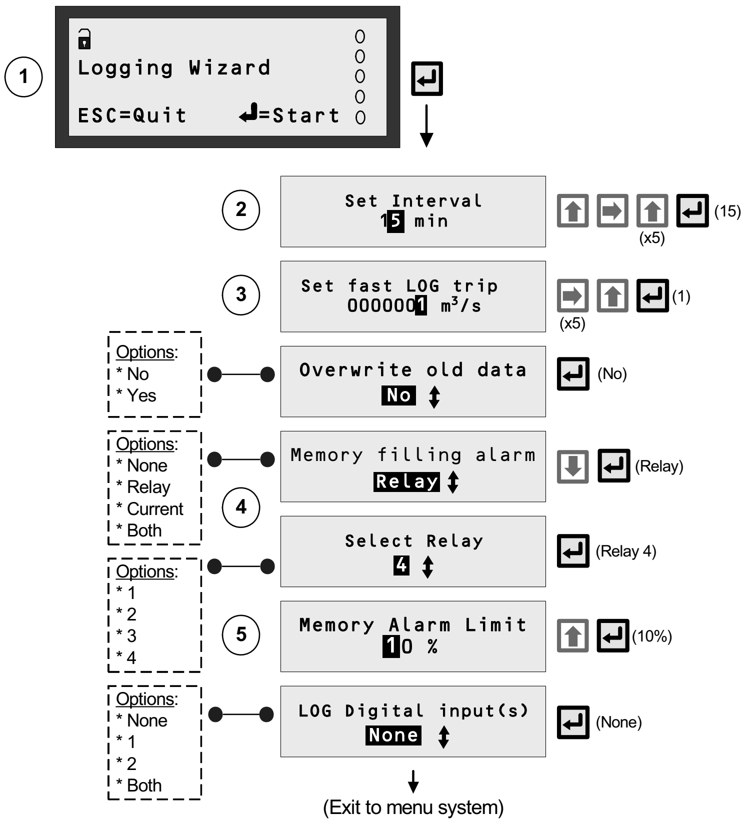


Figure 21: Logging Wizard – Logging of flow measurements

5.7 Current Output

Note: The current output of the MCU Control Unit is FROZEN when the unit is in the "off-line" mode.

5.7.1 The MCU Current Output Channel

The MCU Current Output channel is for transmitting the PV value (**D800**) as a 4-20mA signal.

For example, consider a PV value of 5 metres and the PV range is 0 to 10 metres. This would mean 0 metres is represented by a 4mA signal (0%), 10 metres is represented by 20mA signal (100%) and 5 metres is represented by a 12mA signal (50%). Therefore, the Current Output channel would output the PV value as a 4-12mA signal.

Programming involves specifying the PV range with low range (minimum) and upper range (maximum) values.

Menu: MAIN MENU / SETUP / [MCU CONTROL UNIT /] OUTPUT / CURRENT OUTPUT

P400 Low Range Val (Factory default is 0.0)
This is the PV value represented by 4mA.

P401 Up Range Val (Factory default is 100.0)
This is the PV value represented by 20mA.

P402 Alarm Actions (Factory default is 3.6mA)
Optional parameter for determining how an alarm, if selected in the ALARM menu, is indicated on the Current Output channel. Options for parameter **P402** are:

"3.6mA" – clamp current output at 3.6mA to force a low current limit alarm,
"21mA" – clamp current output at 21mA to force high current limit alarm or
"Hold" – freeze the current output at the present value.

Alarms and alarm indication methods are as explained in Section 5.9. See also Appendix E for summary of reporting methods for Alarms.

Note: There is an alarm condition when the current output has reached the linear limit of ≤ 3.8mA or ≥ 20.5mA.

5.7.2 P210: PV Damping (Factory default is 0)

The MCU current output is proportional to the calculated PV.

It is possible to apply damping to the MCU PV using **P210**, which will have the effect of damping the current output.

5.8 Relays

Note: All relay states are FROZEN when the MCU Control Unit is in the "off-line" mode.

Menu Navigation List: (for locating relay parameters)

1. Menu: MAIN MENU / SETUP / [MCU CONTROL UNIT /] OUTPUT / RELAY
2. Menu: MAIN MENU / SETUP / [MCU CONTROL UNIT /] DUTY(Mode) / OVERRIDES
3. Menu: MAIN MENU / SETUP / [MCU CONTROL UNIT /] DUTY(Mode) / CUSTOM

5.8.1 Overview of Relay Functions

Relay outputs 1 to 4 are normally On Point/Off Point control relays which may be used to start/stop pumps or open/close valves at different levels. They normally energise at one level and de-energise at a different level. For further details, see Section 5.8.5.

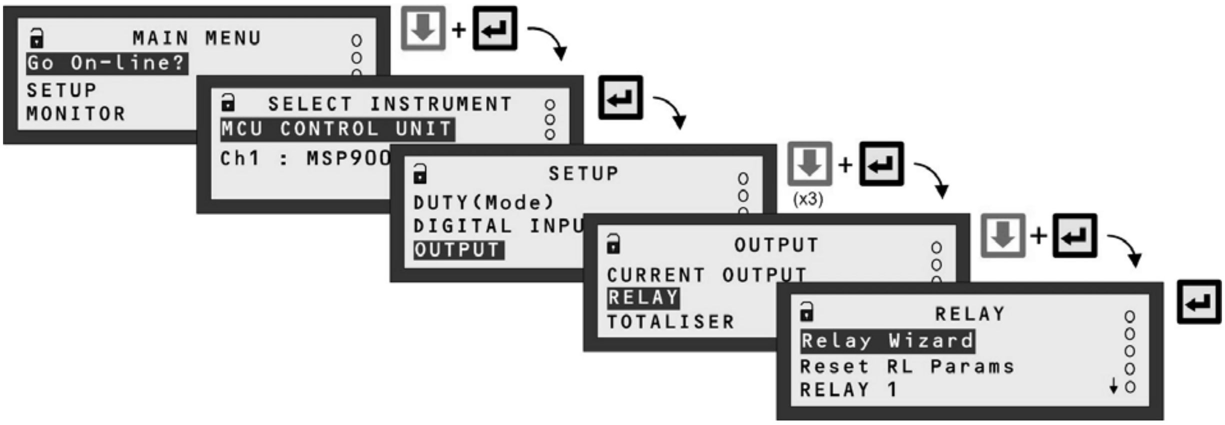
Alternatively, they can be programmed as out-of-limit alarms; they energise between defined points and will de-energise outside those points. They may also be programmed to perform a variety of auto-sequences and auxiliary functions, such as pump-down operations, pump rotations to equalise wear, and de-sludge/cleaning. For further details, see Section 5.8.7.

Relay output 5 is normally a fail safe fault relay but may be re-allocated to another duty.

Note: Relays are frozen while the MCU Control Unit is off-line, preventing all relay operations apart from Totaliser and Sampler relays.

5.8.2 Relay Wizard

Relay outputs can be set-up easily using the **"Relay" Wizard**, accessible by navigating to the RELAYS menu screen. The Wizard also forms a part of the **"Duty" Wizard** (Appendix D).



Note: The SELECT INSTRUMENT menu is skipped automatically if there are no HART transmitters. MCU901 screens shown.

Figure 22: Navigating to the RELAY Screen

5.8.3 Relay (RL) Status

The relay status icons on the primary display have the following meanings:

▸	= energised	Relay is presently energised.
0	= de-energised	Relay is presently de-energised.
A	= Alarm	Relay is allocated to alarm duty – see Section 5.9 for details of alarms.
S	= Sampler	Relay is allocated to sampling duty.
T	= Totalising	Relay is allocated to totalising duty.

5.8.4 Relay parameter reset

To reset **all** relay parameters to their factory defaults, do the following:

1. Navigate to: MAIN MENU / SETUP / [MCU CONTROL UNIT /] OUTPUT / RELAY / Reset RL Pararams
2. If you wish to proceed, press the yellow (**ENTER**) button *once*. (Otherwise, use the **ESC** button to exit to the menu).
3. Wait until the "Please wait…" message disappears.
4. Press the **ESC** button to return to the menu.

Note: Setting the relays to their factory default state in this way does **NOT** reset any other parameters to their default state.

5.8.5 On/Off Point Control

Relay outputs 1 to 4 can be set-up to be On Point and Off Point control relays:

Menu: MAIN MENU / SETUP / [MCU CONTROL UNIT /] OUTPUT / RELAY

Relay 1 (RL1)	If mode is "Set Point" (**P410**) – relay energised at **P411** (On) and de-energised at **P412** (Off)
Relay 2 (RL2)	If mode is "Set Point" (**P420**) – relay energised at **P421** (On) and de-energised at **P422** (Off)
Relay 3 (RL3)	If mode is "Set Point" (**P430**) – relay energised at **P431** (On) and de-energised at **P432** (Off)
Relay 4 (RL4)	If mode is "Set Point" (**P440**) – relay energised at **P441** (On) and de-energised at **P442** (Off)

In a basic emptying application, the On point (e.g. **P411**) is programmed to be *greater than* the Off point (e.g. **P412)**. Relay 1 in this case will energise when the PV value (**D800**) exceeds the On point (**P411**) and de-energise when the PV value drops below the Off point (**P412**).

In a basic filling applications, the On point (e.g. **P411**) is programmed to be *less than* the Off point (e.g. **P412**). Relay 1 in this case will energise when the PV value (**D800**) drops below the On point (**P411**) and de-energise when the PV value rises above the Off point (**P412**).

When the relay mode is "Set Point" (as above), the PV value is used to control the relays. There are set point modes for the SV value (**D801**), TV value (**D802**) and FV value (**D803**). For details of these, see Section 5.3.

5.8.6 Relay Safeguard Options

Menu: MAIN MENU / SETUP / [MCU CONTROL UNIT /] OUTPUT / RELAY

P413 RL1 Min On (Factory default: 0:00 m:s)
Defines the minimum time (minutes and seconds) that relay **RL1** will stay energised before de-energising. This is an optional override (safeguard) to allow sufficient time for connected equipment to respond.

P414 RL1 Max On (Factory default: 0:00 m:s)
Defines the maximum time (minutes and seconds) that relay **RL1** will stay energised before de-energising. This is an optional override (safeguard) to prevent overuse of connected equipment.

P415 RL1 Min Off (Factory default: 0:00 m:s)
Defines the minimum time (minutes and seconds) that relay **RL1** will stay de-energised before energising. This is an optional override (safeguard) to avoid overuse of connected equipment.

P423 to **P425** are the equivalents for relay RL2
P433 to **P435** are the equivalents for relay RL3
P443 to **P445** are the equivalents for relay RL4
P453 to **P455** are the equivalents for relay RL5

5.8.7 Alternative Duties

Relays can perform alternative duties beside the "On/Off point control" operation described in Section 5.8.5.

Menu: MAIN MENU / SETUP / [MCU CONTROL UNIT /] OUTPUT / RELAY

P410	Relay 1 Mode	(Factory default is "None")
P420	Relay 2 Mode	(Factory default is "None")
P430	Relay 3 Mode	(Factory default is "None")
P440	Relay 4 Mode	(Factory default is "None")
P450	Relay 5 Mode	(Factory default is "Fault")

Table 8 lists all relay modes (duties) and what they do. Relay modes automatically enable and disable special control functions, special alarms and pumped volume totalising as shown in Table 9. Descriptions of the relay modes and the auxiliary functions follow Table 9.

Table 8: Relay Modes

Relay Mode	Purpose of Relay Mode	Auxiliary functions (Table 9)
“None”	Relay is not used.	No
“Set point SV”	On/Off Point Control using SV (**D801**) – see Section 5.8.5.	**Yes**
”Set point TV”	On/Off Point Control using TV (**D802**) – see Section 5.8.5.	**Yes**
”Set point FV”	On/Off Point Control using FV (**D803**) – see Section 5.8.5.	**Yes**
”Assist”	Duty Assist – On/Off Point Control (Section 5.8.5) and Auto Sequence (Section 5.8.15)	**Yes**
”Stby com off”	Duty Standby, Common Off – see Section 5.8.8 and Auto Sequence (Section 5.8.15)	**Yes**
”Stdby split off”	Duty Standby, Split Off – see Section 5.8.9 and Auto Sequence (Section 5.8.15)	**Yes**
”Digital Input 1”	Relay energises while Digital Input 1 (IN1) is active.	**Yes**
”Digital Input 2”	Relay energises while Digital Input 2 (IN2) is active.	**Yes**
”Sampler”	Relay outputs sampler pulses – see “Sampler Relay” Section 5.8.11.	No
”RoC”	Relay is energised if the Rate of Change of the PV is out-of-limits – see Section 5.8.14.	**Yes**
”Digital input 1+2”	Relay is energised while Digital Input 1 (IN1) and 2 (IN2) are both active.	**Yes**
”Off”	Relay is always de-energised.	No
”Set Point”	On/Off Point Control using PV (**D800**) – see Section 5.8.5. No auto sequencing.	**Yes**
”Desludge”	To set-up the de-sludge operation, use the “Custom” section 5.8.19.	**Yes**
”Alarm”	Relay is allocated to alarm indication duty – see Section 5.9 for details of alarm handling.	**Yes**
“Totaliser”	Relay outputs totaliser pulses – see “Totaliser Relay**”** Section 5.8.10.	No
“Totaliser 1 ”	Relay outputs totaliser 1 pulses – see “Totaliser Relay**”** Section 5.8.10. (On MCU902).	No
“Totaliser 2 ”	Relay outputs totaliser 2 pulses – see “Totaliser Relay**”** Section 5.8.10. (On MCU902).	No
“Fault“	Indicate fault condition by de-energising relay – see “Fault Relay“ Section 5.8.12.	No
“Cleaning“	To set-up a cleaning operation, use the “Custom” section 5.8.19.	No
“PV limits“	Relay energises while PV value (**D800**) is within limits – see Section 5.8.13.	**Yes**
“On“	Relay is always energised.	No

Table 9: Auxiliary functions that are valid for a given relay mode

Relay mode	Special control functions						Special alarms					Totaliser
	SET POINTS	**AUTO SEQUENCE**	**ENERGY SAVING**	**SCUM LINE**	**PUMP DOWN**	**CUSTOM**	**RELAY OPs**	**RELAY RUN TIME**	**NO ACTIVITY**	**RISING LEVEL**	**PUMP EFFICIENCY**	**PUMPED VOLUME**
None												
Set Point (SV)	Y		Y	Y	Y		Y	Y	Y		Y	
Set Point (TV)	Y		Y	Y	Y		Y	Y	Y		Y	
Set Point (FV)	Y		Y	Y	Y		Y	Y	Y		Y	
Assist	Y	Y	Y	Y	Y		Y	Y	Y	Y	Y	Y
Standby, Common Off	Y	Y	Y	Y	Y		Y	Y	Y	Y	Y	Y
Standby, Split Off	Y	Y	Y	Y	Y		Y	Y	Y	Y	Y	Y
(All digital input modes)							Y	Y	Y			
Sampler												
Rate of Change	Y						Y	Y	Y			
Off												
Set Point (PV)	Y		Y	Y	Y		Y	Y	Y		Y	
De-sludge	Y					Y	Y	Y	Y			
Alarm	Y											
Totaliser												
Fault												
Cleaning												
PV Limits	Y						Y	Y	Y			
On												
	See Section 5.8.5	**See Section 5.8.15**	**See Section 5.8.16**	**See Section 5.8.17**	**See Section 5.8.18**	**See Section 5.8.19**	**See Section 5.8.20**	**See Section 5.8.21**	**See Section 5.8.23**	**See Section 5.8.23**	**See Section 5.8.24**	**See Section 5.8.25**

Key: "Y" indicates that that auxiliary function is valid for that mode of relay operation, otherwise the auxiliary function is inhibited.

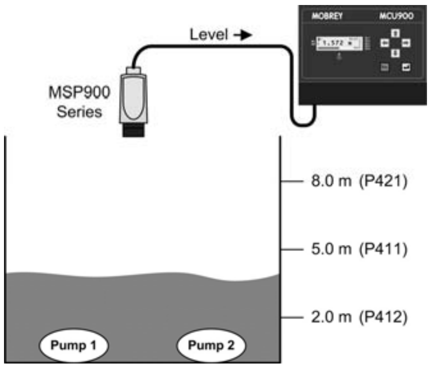
5.8.8 Standby, Common Off Relay

This function requires two or more **Standby, Common Off** mode relays **– only one is energised at any one time**. The On/Off points of a relay are utilised as set points. To illustrate how the function works, here are two examples of applications. To keep this simple, the auto-sequencing options are not considered.

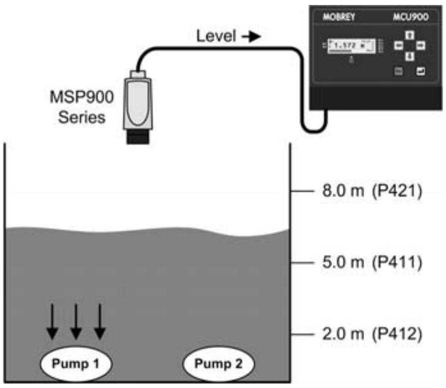
<u>Wet Well Application (Emptying due to rising level)</u>

Consider an application with two relays, **RL1** and **RL2**, connected to individual pumps in a Wet Well. The PV value (**D800**) is a liquid level measurement in metres.

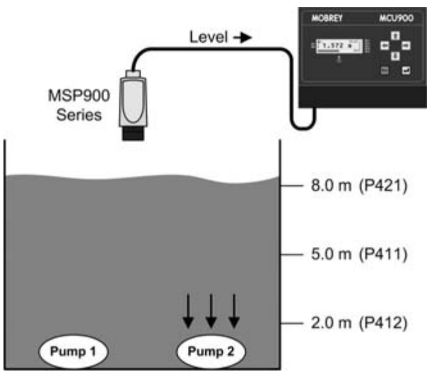
Initially, both pumps are off since the liquid level is at a satisfactory level, which in this case is below 5 metres.



When the measured level exceeds **5** metres (**P411**, On point), the relay **RL1** will be energised to start **Pump 1**.



If the measured level exceeds **8** metres (**P421**, On point), the relay **RL2** will be energised to start **Pump 2**. Relay **RL1** is then de-energised to switch off **Pump 1**.



In an emptying application, the *Common Off point* is **always** the Off point of the **Standby, Common Off** mode relay with the **lowest** On point, which in this example is **P412** of Relay **RL1** at **2** metres

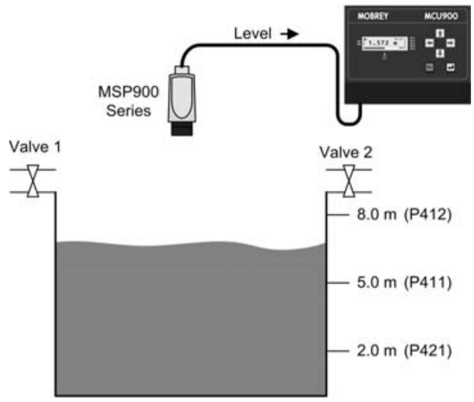
Pump 2 continues to pump until the measured level falls below **2** metres (**P412**, Common Off), at which relay **RL2** will de-energise to switch off **Pump 2**.

However, if **Pump 1** kept the measured level below **8** metres, it would stay switched on until the level is **2** metres. (Safeguards to prevent over-use of the pump are in Section 5.8.6.)

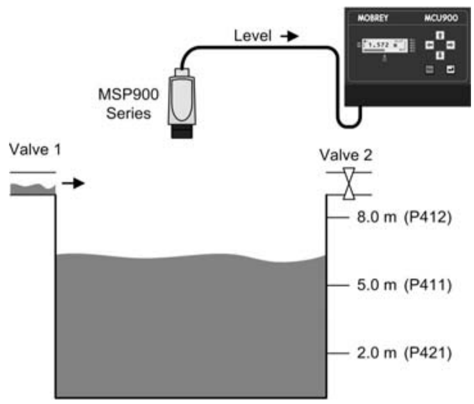
<u>Filling Tank Application</u>

Consider an application with two relays, **RL1** and **RL2**, connected to individual valves controlling the delivery of liquid into a tank. In addition, the PV value (**D800**) is a liquid level measurement in metres.

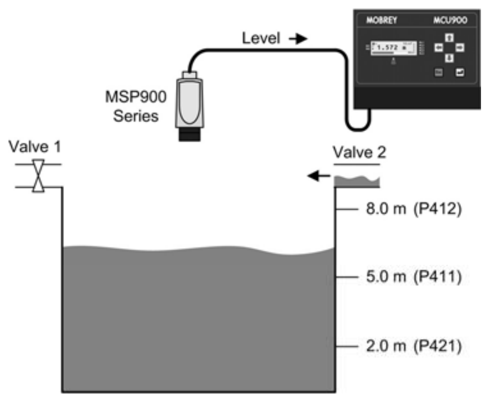
Initially, both valves are closed since the liquid level is at a satisfactory level, which in this case is above **5** metres.



When the measured level falls below **5** metres (**P411**, On point), the relay **RL1** will be energised to open **Valve 1**.



However, if the measured level falls below **2** metres (**P421**, On point), the relay **RL2** will be energised to open **Valve 2**. Relay **RL1** is de-energised to close **Valve 1**.



In a filling application, the *Common Off point* is **always** the Off point of the **Standby, Common Off** mode relay with the **highest** On point, which in this example is **P412** of Relay **RL1**.

When the measured level rises above **8** metres (**P412**, Common Off), the relay **RL2** will de-energise to close **Valve 2**.

However, if the measured level did not fall below **2** metres, the relay **RL1** would remain energised to keep **Valve 1** open until the level rises to **8** metres. (Safeguards to prevent overuse of the relay (valve) are in Section 5.8.6.)

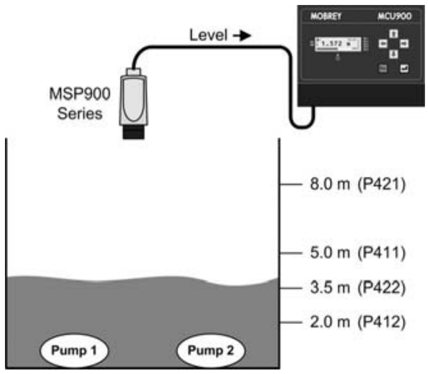
5.8.9 Standby, Split Off Relay

This function requires two or more **Standby, Split Off** mode relays **– only one is energised at any one time**. The On/Off points of a relay are utilised as set points but their usage does differ to their parameter descriptions. To illustrate how the function works, here are two examples of applications. To keep this simple, auto sequencing is not considered.

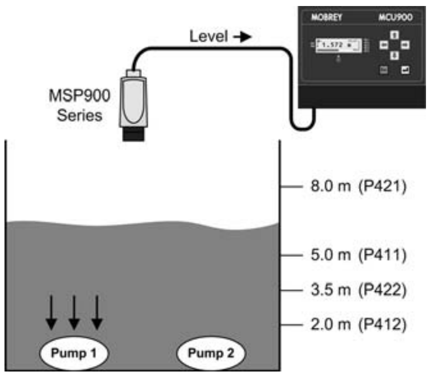
Wet Well Application (Emptying due to rising level)

Consider an application with two relays, **RL1** and **RL2**, connected to individual pumps in a Wet Well. In addition, the PV value (**D800**) is a liquid level measurement in metres.

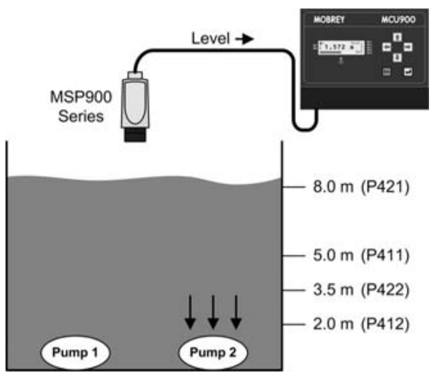
Initially, both pumps are off since the liquid level is at a satisfactory level, which in this case is below 5 metres.



When the measured level exceeds **5** metres (**P411**, On point), the relay **RL1** will be energised to start **Pump 1**.



If the measured level exceeds **8** metres (**P421**, On point), the relay **RL2** will be energised to start **Pump 2**. Relay **RL1** is then de-energised to switch off **Pump 1**.



When the measured level falls below **3.5** metres (**P422**, Off point), relay **RL2** will de-energise to switch off **Pump 2**. Relay **RL1** is then energised to start **Pump 1** again.

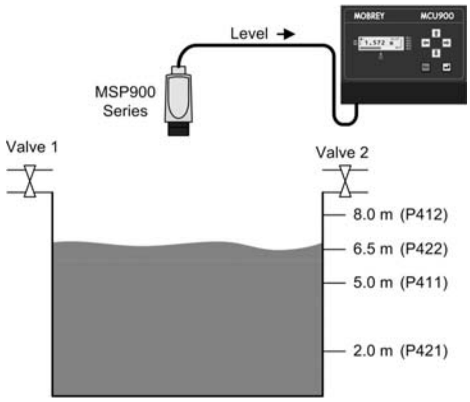
When the measured level falls below **2** metres (**P412**, Off point), relay **RL1** will de-energise to switch off **Pump 1**.

However, if **Pump 1** kept the measured level below **8** metres, it would stay switched on until the level is **2** metres. (Safeguards to prevent overuse of the pump are in Section 5.8.6.)

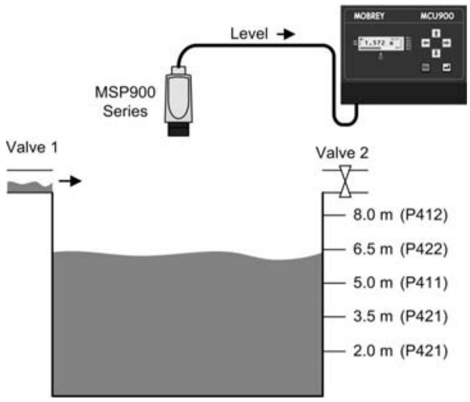
Filling Tank Application

Consider an application with two relays, **RL1** and **RL2**, connected to individual valves controlling the delivery of liquid into a tank. In addition, the PV value (**D800**) is a liquid level measurement in metres.

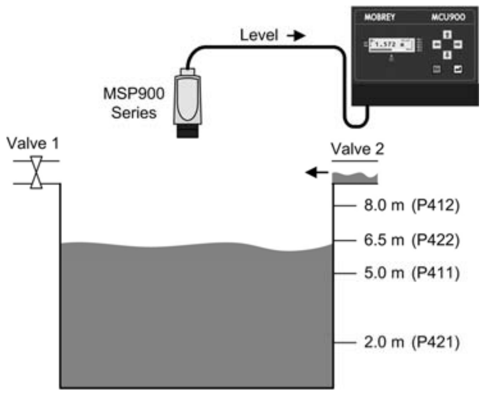
Initially, both valves are closed since the liquid level is at a satisfactory level, which in this case is above **5** metres.



When the measured level falls below **5** metres (**P411**, On point), the relay **RL1** will be energised to open **Valve 1**.



However, if the measured level falls below **2** metres (**P421**, On point), the relay **RL2** will be energised to open **Valve 2**. Relay **RL1** is de-energised to close **Valve 1**.



When the measured level rises above **6.5** metres (**P422**, Off point), the relay **RL2** will de-energise to close **Valve 2**. Relay **RL1** is then energised to open **Valve 1**.

When the measured level rises to **8** metres (**P412**, Off point), the relay **RL1** de-energises to close **Valve 1**.

However, if the measured level did not fall below **2** metres, the relay **RL1** would remain energised to keep **Valve 1** open until the level rises to **8** metres. (Safeguards to prevent overuse of the relay (valve) are in Section 5.8.6.)

Note: For optional auto-sequences, see Section 5.8.15.

5.8.10 Totaliser Relay

Menu: MAIN MENU / SETUP / [MCU CONTROL UNIT /] OUTPUT / TOTALISER

Each time the internal totaliser count (**D828**) increments, a relay may be allocated to provide a pulse. The duration of the pulse may set via **P534**.

P534 Totaliser Pulse Width (Factory default is 100)
The duration controls both the 'On' time and the 'Off' time – i.e. the pulse width – and may be set to a value between 10ms and 2.5 seconds in steps of 10ms.

If the totaliser count is running faster than the relay can produce pulses, an internal accumulater stores the excess pulses; they will be produced by the Totaliser relay once the totaliser count rate reduces.

5.8.11 Sampler Relay

Sampler relays output pulses at a slower rate than a Totaliser relay. The Sampler relay can be used as a coarse totaliser or as a trigger to an external event.

Menu: MAIN MENU / SETUP / [MCU CONTROL UNIT /] OUTPUT / TOTALISER

P535 Sampler Factor (Factory default is 0)
This is for defining the frequency of the Sampler pulse. For example, a value of 100 means that the Sampler relay outputs a single pulse for every 100th increment to the Totaliser Count (**D828/D829**). The pulse width is the same as selected for the Totaliser relay (**P534**). For information on setting up the totaliser, see Section 5.10.

5.8.12 Fault Relay

A Fault relay is de-energised when a particular fault condition exists. Parameter **D831** is a fault report and shows a list of active faults. Appendix E has a summary of reporting methods for faults.

Menu: MAIN MENU / SETUP / [MCU CONTROL UNIT /] OUTPUT / FAULT

P560 System Fault (Factory default is "Both")
The Fault relay is de-energised when there is a system fault and the option selected is "Both" or "Relay".

P561 CU Temp Fault (Factory default setting is "None")
The Fault relay is de-energised if the temperature of the CPU rises above 65°C, and the option selected is "Both" or "Relay". Parameter **D844** shows the operating temperature of the MCU Control Unit.

P562 Xmtr Fault (Factory default setting is "None")
The Fault relay is de-energised when the transmitter signals a fault and the option selected is "Both" or "Relay".

Faults can be indicated on the Current Output if you select the "Current" or "Both" options. See also the Alarm Action parameter (**P402**) description in Section 5.7.

5.8.13 PV limits Relay

This relay mode uses the On/Off points (e.g. **P411** and **P412**) as an **Alarm relay**. The points are used as limits for the PV value (**D800**). Limit values can be in any order – the relay is energised while the PV value exceeds the higher limit value or while it is below the lower limit value.

5.8.14 Rate of Change Relay

A rate of change value for the parameter **D800** (PV value) is calculated every **5** seconds in units of PV per minute:

$$\mathbf{D809} = (PV_{now} - PV_{5\ seconds\ ago}) * 12$$

The On and Off points of a **Rate of Change** (RoC) mode relay are used as high and low limits for **D809**. Limit values are in units of PV per minute (PV/min) and can be in any order – the relay is energised while **D809** exceeds the higher limit value or falls below the lower limit value.

Typically, where the PV value is a liquid level measurement, the RoC relay can be used to warn of a quickly rising (or falling) liquid level. Alternatively, the **RoC** mode relay can be used for controlling the rate of liquid flow.

Also, see Sections 5.8.24 and 5.8.25 for further uses of **D809**.

5.8.15 Auto-Sequence

(Special Control Function, Table 9, Section 5.8.7)

Optional rotation of leading (most used) relay can be applied to **Assist** or **Standby** mode relays, but not both. To use these options, two or more relays must have the same mode. The lowest numbered relay is initially the lead relay.

Note: rotation of relays is performed without the actual swapping of values between relay parameters.

P270 Auto Seq Enable (Factory default is "Off")
Select a rotation auto-sequence. All options are summarised in Table 10 (below).

P271 Auto Seq Qual (Factory default is 0)
This defines the threshold to be established (e.g. how many times, ratio of starts, etc.) before applying an auto-sequence to rotate the 'lead' to the next relay with the same mode.

Table 10: Auto-Sequence Options

Option	Rotation basis
Standby Starts	For **Standby** mode relays only – rotation is based on how many times the 'leading' relay has been energised compared to parameter **P271**.
Stdby On Time	For **Standby** mode relays only – rotation is based on the hours that the 'leading' relay has been energised compared to parameter **P271**.
Stdby Ratio T	For 2 **Standby** mode relays only – rotation is based on the ratio of ON time for 2 relays compared to **P271**. *****
Stdby Ratio S	For 2 **Standby** mode relays only – rotation based on the ratio of starts (times energised) compared to **P271**. *****
Assist Starts	Rotation of 'leading' **Assist** relay is based on how many times it has been energised compared to **P271**.
Assist On Time	Rotation of 'leading' **Assist** relay is based on the hours that it has been energised compared to **P271**.
Assist Ratio T	For 2 **Assist** relays only – rotation based on the ratio of ON time for the 2 relays compared to **P271. ***
Assist Ratio S	For 2 **Assist** relays only – rotation based on the ratio of starts (times energised) compared to **P271. ***
Off	No rotation required.

***** Ratio is based on the first two lowest numbered relays with the same mode.

5.8.16 Energy Saving

(Special Control Function, Table 9, Section 5.8.7)

P275 Engy Save Strt (Factory default is 0:00 h:m)
Set the time of day at which selected relays (**P276**) will energise until each relay Off Point is reached. The energy saving start time is valid for one minute; if missed by the MCU Control Unit being off-line, no action is taken when subsequently put back on-line.

P276 Engy Save RL (Factory default is 00000)
Select relays for the operation associated with parameter **P275**. Each digit represents a relay. Relay **RL1** is selected by editing the first digit to be a "1". Similarly, relay **RL5** is selected with the fifth digit. To de-select a relay, change the appropriate digit back to a "0".

5.8.17 Scum line prevention

(Special Control Function, Table 9, Section 5.8.7)

P277 Scum line var (Factory default is 0.0)
This parameter defines the maximum overall variance in the programmed On/Off point of selected relays (**P278**). The variance is in the units of the On/Off point, spaced in 10 equal increments *inside* the On/Off points. Each time the selected relays (**P278**) de-energise, the variance moves on an increment.

P278 Scum line RL (Factory default is 00000)
Select relays for the operation associated with parameter **P277**. Each digit represents a relay. Relay **RL1** is selected by editing the first digit to be a "1". Similarly, relay **RL5** is selected with the fifth digit. To de-select a relay, change the appropriate digit back to a "0".

5.8.18 Pump-down

(Special Control Function, Table 9, Section 5.8.7)

Normally, when pumping out a wet-well, the lowest Off point ('pump off' level) will be a fixed level above the Bottom Reference point. However, it is sometimes required to make the pumps continue to run for a period past the Off point or run down to the Bottom Reference Point. This will clear the sump of sludge that may have collected at the bottom.

Pump-down can be initiated automatically at pre-set intervals. A digital input can also initiate pump-down at any time and this will re-set the interval before the next pump-down. For details on configuring a digital input, see Section 5.5.

Pump-down will automatically stop when the parameter **D800** (PV) is zero or after 20 minutes (maximum) if a pump-down duration (**P274**) has not been programmed, whichever is the shorter period.

P272 Pump down RL (Factory default is 00000)
This is for allocating individual relays to pump-down duty. However, the mode of the relay must be Set point, Assist or Standby. Each of the five digits represents a relay. Relay RL1 is selected by editing the first digit to a "1". Similarly, relay RL5 is selected by editing the fifth digit. To de-allocated, edit the appropriate digit back to a "0".

P273 Pump down Int (Factory default is 000:00 h:m)
This defines a fixed interval (hours and minutes) between pump-downs.

P274 Pump down Dur (Default setting is 00:00)
This defines the period (hours and minutes) that the relay will remain energised for the pump-down. (Safeguards may extend or reduce this period – see Section 5.8.6 for details.)

D845 Next pump-down h:m (Display 000:00 if pump-down is in progress or it is not used)
This shows the time remaining before the next pump-down is invoked.

5.8.19 Custom

(Special Control Function, Table 9, Section 5.8.7)

Menu: MAIN MENU / SETUP / [MCU CONTROL UNIT /] DUTY(Mode) / CUSTOM

P250 Start On (Factory default is "None")
Relay energises when the criteria, as set by an option code, is true. See Table 11.

P251 Stop On (Factory default is "None")
Relay de-energises when the criteria, as selected by an option code, is true. See Table 11.

P252 Stop If (Factory default is "None")
Relay de-energises when the criteria, as selected by the option code, is true. See Table 11. **This is a fail-safe for P251**.

P253 Start Time (Factory default is "7:00" – i.e. 7AM)
This defines the clock time that a Custom relay operation will begin (if **P250** = "Time") or end (if **P251** = "Time").

P254 Interval (Factory default is "1:00" – i.e. 1 hour and 0 minutes)
This is for defining the interval for repeating a Custom relay operation.

P255 and **P256** are for setting up a second starting time and an associated interval.

P257 Max Retries (Factory default is 10)
This defines the maximum number of failed attempts to perform Custom relay operations before it is deemed an alarm condition. This situation can occur if the MCU Control Unit is off-line, preventing all Custom relay operations from starting. In addition, it can occur when the maximum On time (relay safeguard, Section 5.8.6) for a relay prevents a Custom relay operation from completing. For alarm indication options, see Section 5.9.

Table 11: P250/P251/P252 Options

Options *	Purpose	P250	P251	P252
None	Switched off	Yes	Yes	Yes
Time	**P253** and **P254** determine when the relay is to be energised.	Yes	Yes	-
PV > Level	While PV value (**D800**) is greater than On point for relay, energise relay	Yes	-	-
PV < Level	De-energise relay when PV value (**D800**) less than the On point for relay	-	Yes	Yes
Ext Trig	Energise a relay only while a digital input is active. This does not require Digital Input IN1 or IN2 to be allocated an action.	Yes	Yes	-
Ext Trig **X**s	If Digital Input is active, energise relay *after* **X** seconds delay. This does not require Digital Input IN1 or IN2 to be allocated an action.	-	-	Yes

***** Abbreviations: "Ext Trig" = External Trigger (Digital Input)

Note: For any of the alarms below to be indicated by a relay or current output, an indication method must be selected. (See Section 5.9.2 for details.)

5.8.20 Relay Operations Alarm

(Special alarm, Table 9, Section 5.8.7)

P491 RL operations (Factory default is 0)
It is an alarm condition when the number of operations of a specified relay (**P492**) exceeds the number in **P491**. For alarm indication options, see Section 5.9.

P492 RL ops rly sel (Factory default is "Disabled")
Select the relay for the monitoring operation associated with parameter **P491**.

Relay operation counters are parameters **D811** to **D815**, located in the MONITOR menu – see Section 6.1.

5.8.21 Relay Run Time Alarm

(Special alarm, Table 9, Section 5.8.7)

P493 RL runtime (Factory default is 0:00 h:m = OFF)
It is an alarm condition when a specified relay (**P494**) has been energised for longer than the period (hours and minutes) defined by **P493**. For alarm indication options, see Section 5.9.

P494 RL run rly sel (Factory default is "Disabled")
Select the relay for the monitoring operation associated with parameter **P493**.

Run time counters for all relays are **D821** to **D825**, located in the MONITOR menu – see Section 6.1.

5.8.22 No Activity Alarm

(Special alarm, Table 9, Section 5.8.7)

P497 No Activity Del (Factory default is 0:00 h:m)
It is an alarm condition if there is no relay activity for the period (hours and minutes) defined by parameter **P497**. This is to be used with parameter **P498**. The alarm condition is cleared when any monitored relay is energised. For alarm indication options, see Section 5.9.

P498 No Activity RL (Factory default is 00000)
Select relays for monitoring operation associated with relay inactivity. Each digit represents a relay. Relay **RL1** is selected for monitoring by editing the first digit to be a "1". Similarly, relay **RL5** is selected with the fifth digit. To de-select a relay, change the appropriate digit back to a "0". This parameter is to be used with parameter **P497**.

5.8.23 Rising Level Alarm

(Special alarm, Table 9, Section 5.8.7)

P490 R Lev alrm del (Factory default is 0:00 m:s)
The rising level alarm requires at least one **Assist** or **Standby** relay.

If *any* **Standby** relay is energised, monitoring of the rising level is enabled. However, in the case of **Assist** relays, they must all be energised for monitoring of the rising level to be enabled.

Once the monitoring is enabled, a timed delay (**P490**) starts. After the delay time (**P490**) and the level is still rising, there will be a 'Rising Level' alarm condition if the **Rate of Change of the PV** is *positive*. The alarm stops when the Rate of Change of the PV is *negative*, indicating a falling level.

For the Rising Level Alarm to be indicated by a relay or the Current Output, a method must be selected – see Section 5.9. Also, see Section 5.8.14 for details of the Rate of Change calculation.

5.8.24 Pump Efficiency Alarm

(Special alarm, Table 9, Section 5.8.7)

The pump efficiency feature allows you to indicate an alarm (**P550**, **P4x1**) if the calculated pump efficiency falls below a defined limit (**P495**).

P495 Pump effy limit (Factory default is 0% = OFF)
It is an alarm condition if the calculated pump efficiency falls below the limit defined by **P495** in %. The pump efficiency calculation is based on the Rate of Change of the MCU PV and is independently monitored for each selected relay (**P496**), For alarm indication options, see Section 5.9.

P496 Pump effy RL (Factory default is 0000)
Select relays for monitoring operation associated with the pump efficiency limit. Each digit represents a relay. Relay **RL1** is selected by editing the first digit to be a "1". Similarly, relay **RL4** is selected with the fourth digit. (Relay **RL5** does not support this feature.) To de-select a relay, change the appropriate digit to a "0". This parameter is to be used with parameter **P495**.

Pump efficiency values for relays are saved in **D861** to **D864**, located in the MONITOR menu – see Section 6.1.

Pump Efficiency Explanation:
Pump efficiency (PE) is calculated based upon the rate of Change (RoC) of the MCU PV whilst any single pump is on.

The pump efficiency value, (D86*, where * is the number of the associated pump relay 1 - 4) is calculated only whilst that pump is operating. The calculations will pause when the pump stops or when other pumps start. Calculations re-start when the relevant pump starts again.

To calculate the pump efficiency, the MCU assumes that liquid continues to enter the well or tank during pump operation at the rate just prior to the pump starting.

The MCU continuously calculates the RoC of the PV, making a new measurement every 5 seconds, as described in Section 5.8.14. Once the selected pump starts, the MCU will monitor and record the *change* in RoC over the next 5 measurements. Over the next 9 pump starts, a further 9 change of RoC values are stored such that the MCU can then calculate an average value in change of RoC. This average value, "RoC_{100}" is then taken as being equivalent to the pump operating at 100% efficiency. A value of 100% is then stored in D86*.

Each pump start, and change in RoC thereafter, is used in a rolling average calculation for a new average value in change of RoC, RoC_{new}, which is then compared to the previous value "RoC_{100}" and a new PE percentage value calculated using:

$$PE\ \% = (RoC_{new} / RoC_{100}) * 100$$

If the resulting percentage is greater than 100%, then the RoC_{100} is updated to the new value and the PE re-stated as 100% based on this new value.

If the resulting percentage is less than 100%, then the PE is calculated as above and stored in D86*

If the PE is below the limit set (P495), the PE alarm condition is true - to indicate an alarm by relay or current output, a method must be selected - refer to Section 5.9.

Note: the alarm condition is automatically cleared if the calculated PE rises above the limit (P495) by 5% or more.

5.8.25 Pumped Volume Totalising

(Totaliser Option, Table 9, Section 5.8.7)

This function may be used to determine the total throughput of a well.
Note: The "Totaliser" Wizard can be used to set-up Pumped Volume Totalising – see Section 5.10.5.

The MCU Control Unit monitors what goes into the well when no pumps are running. It calculates the Rate of Change (RoC) of PV every 5 seconds and then converts it to a Rate of Change per minute for displaying as parameter **D809**.

When a pump is turned on, the MCU Control Unit assumes that the rate of inflow remains the same as it was just before starting the pumps. The RoC value (**D809**) is frozen whilst the pumps are on, i.e. when any **Assist** or **Standby** relay is energised.

In order to totalise pumped volume, the PV value (**D800**) must be in volume units so that the RoC value is in volume units per minute. The MCU Control Unit integrates this volume every second and increments the totaliser for every integer unit.

Therefore, if the RoC value (**D809**) is $12m^3$ per minute and the total factor (**P530**) is set to 1.0 (m^3), the Totaliser Count (**D828**) will increment every **5** seconds ($1/12^{th}$ of a minute = 5 seconds).

Menu: MAIN MENU / SETUP / [MCU CONTROL UNIT /] OUTPUT / TOTALISER

P530 Total factor (Factor default is 0.0)
One count is added to the Totaliser Count (**D828**) for a quantity of liquid as defined by this parameter.

P531 Total units (Factory default is "None")
Pumped Volume Totalising is selected by the totaliser units (**P531**) being set to "PVol". (This parameter defines the display units for parameter **D828**).

Note: For other associated parameters, see Section 5.10.

5.9 About Alarms

5.9.1 Alarms

The MCU Control Unit can detect the following alarm conditions:

- PV value out-of-limits
- Current Output saturated (≤ 3.8mA or ≥ 20.5mA)
- Logging memory full (MCULOG only)
- Digital input is configured to force an alarm when active
- Maximum number of failed Custom relay operation attempts
- Current Input saturated (≤ 3.7mA or ≥ 20.75mA)
- Rising liquid level
- Relay operation count limit exceeded
- Relay run time limit exceeded
- Low pump efficiency
- Relay inactivity

Parameter **D830** shows a list of active alarms. In addition, alarms are indicated by means of one or more **Relays**, the **Current Output** or both – see below. Appendix E has a summary of reporting methods for alarms.

5.9.2 Alarm indication selection

For each alarm listed in Section 5.9.1, there is a dedicated parameter in the ALARM menu for selecting the method of indication for that alarm.

Menu: MAIN MENU / SETUP / [MCU CONTROL UNIT /] OUTPUT / ALARM

P540 PV Over Limits (Factory default is “None”)
Select the indication method for the alarm condition that occurs if the PV value is outside pre-set limits.
See also Section 5.8.13.

P541 mA Out Sat (Factory default is “None”)
Select the indication method for the alarm condition that occurs if the Current Output is ≤ 3.8mA or ≥ 20.5mA

P542 Log mem filling (Factory default is “None”)
Select the indication method for the alarm condition that occurs if the available logging memory is low. See also Section 5.6.4.

P543 Digital Input (Factory default is “None”)
Select the indication method for the alarm condition that only occurs if a digital input is configured to force this alarm **and** that digital input is active – see Section 5.5.

P544 Max retries (Factory default is “None”)
Select the indication method for the alarm condition that only occurs if a Custom relay operation is unable to complete as specified, even after a pre-set number of attempts (**P257**). See also Section 5.8.19.

P545 mA In Sat (Factory default is “None”)
Select the indication method for the alarm condition that occurs if the Current Input is ≤ 3.7mA or ≥ 20.75mA.

P547 Rising Level (Factory default is “None”)
Select the indication method for the alarm condition that occurs if the PV value is increasing (or decreasing) at a rate that exceeds is a programmed threshold. See also Section 5.8.23.

P548 Relay Ops (Factory default is “None”)
Select the indication method for the alarm condition that occurs if a relay operation counter exceeds a pre-set limit.
See also Section 5.8.20.

P549 Relay run time (Factory default is “None”)
Select the indication method for the alarm condition that occurs if a relay is energised for longer than a pre-set period.
See also Section 5.8.21.

P550 Pump efficiency (Factory default is “None”)
Select the indication method for the alarm condition that occurs if the calculated pump efficiency falls below a pre-set limit. See also Section 5.8.24.

P531 No activity (Factory default is “None”)
Select the indication method for the alarm condition that occurs if any selected relay is de-energised for longer than a pre-set period. See also Section 5.8.22.

Options for parameters **P540** to **P551** are:

- None - if the alarm will not to be indicated
- Both - alarm will be indicated by Relay Output (see below) and Current Output
- Current - alarm will be indicated by the Current Output
- Relay - alarm will be indicated by Relay Output (see below)

If the indication method for a particular alarm is a **Relay Output** (e.g. RL1), the **mode** of a relay (e.g. **P411**) must first be set to the “Alarm” option. After this is set-up, all ‘Alarm duty’ relays are **energised** while the alarm condition exists. When there is no alarm condition (or the alarm condition has ceased), ‘Alarm duty’ relays are de-energised.

More than one Relay Output can be allocated to alarm duty, if required. On the primary display, the relay status icon shows an “**A**” if it is allocated to alarm duty and the relay is energised.
(Full information on relays is in Section 5.8.)

If the indication method is the **Current Output**, parameter **P402** is used to determine how the Current Output will indicate an alarm condition – see Section 5.7 for alarm action options.

5.10 About Totalising

5.10.1 Totalising on the MCU901/LOG

The MCU901/LOG Control Unit has one internal, 8-digit, totaliser, which is updated several times per second.

A Totaliser relay can be configured to output a pulse for *each* increment (by one) to the Totaliser Count parameter. For information on setting up a relay to output ‘totaliser’ pulses, see Sections 5.8 and 5.10.6.

If the PV value is a volumetric flow rate (e.g. m^3/hour), the totaliser can **accumulate** this volume of flow, therefore giving the total volume throughput.

For totalising examples, see Section 5.10.6. Note that totalisers are set-up to operate with an input of PV in units/<u>second</u>.

Menu: MAIN MENU / SETUP / [MCU CONTROL UNIT /] OUTPUT / TOTALISER

P530 Total factor (Factor default is 0.0)
One count is added to the Totaliser Count (**D828**) for a quantity of liquid as defined by this parameter. The display unit of measurement for **D828** is defined by parameter **P531**.

P531 Total units (Factory default is “None”)
This parameter defines the units for the Totaliser Count (**D828**). If requiring **Pumped Volume Totalising**, see Section 5.8.25.

P534 Pulse Width (Factory default is “100ms”)
A Totaliser relay is energised for a programmed duration (**P534**) each time the Totaliser Count (**D828**) is incremented. Parameter **P534** controls the ‘On’ time and ‘Off’ time – i.e. the pulse width – and may be a value of between 10ms and 2.5s, changeable in steps of 10ms.

The rate at which the unit can output a totaliser pulse is entirely dependent on the pulse width. Parameter **P534** also determines the width of a pulse that is output by a Sampler relay – see Section 5.10.4.

Menu: MAIN MENU / MONITOR / [MCU CONTROL UNIT /] READINGS / TOTALISER

D828 Totaliser
This parameter displays the Totaliser Count. To add this to the primary display, see Section 5.11.

5.10.2 Totalising on the MCU902

The MCU902 has two independent, internal, 8-digit, totalisers – Totaliser 1 and Totaliser 2 – which are updated several times per second.

A Totaliser relay can be configured to output a pulse for each increment (by one) to the Totaliser 1 or 2 Count parameter. For information on setting up a relay to output ‘totaliser’ pulses, see Sections 5.8 and 5.10.6.

Totaliser 1 is dedicated to totalising the PV value (**D800**). When the PV value is a volumetric flow rate (e.g. m^3/hour), the totaliser can **accumulate** this flow, therefore giving the total volume throughput.

Totaliser 2 operates in the same way as Totaliser 1, but will count the parameter selected by **P536**. Parameter **P536** offers a choice of PV, SV, TV and FV.

For totalising examples, see Section 5.10.6.

Menu: MAIN MENU / SETUP / [MCU CONTROL UNIT /] OUTPUT / TOTALISER

P530 Total 1 factor (Factor default is 0.0)
One count is added to the Totaliser Count (**D828**) for a quantity of flow as defined by this parameter. The unit of measurement for **D828** is defined by parameter **P531**.

P531 Total 1 units (Factory default is “None”)
This parameter defines the units for the Totaliser 1 Count (**D828**). If requiring **Pumped Volume Totalising**, see Section 5.8.25.

P532 Total 2 factor (Factor default is 0.0)
One count is added to the Totaliser 2 Count (**D829**) for a quantity of liquid as defined by this parameter. The unit of measurement for **D829** is defined by parameter **P533**.

P533 Total 2 units (Factory default is “None”)
This parameter defines the units for the Totaliser 2 Count (**D829**). If requiring **Pumped Volume Totalising**, see Section 5.8.25.

P534 Pulse Width (Factory default is "100ms")
A Totaliser relay is energised for a programmed duration (**P534**) each time a Totaliser Count (**D828/D829**) is incremented. Parameter **P534** controls the 'On' time and 'Off' time – i.e. the pulse width – and may be a value of between 10ms and 2.5s, changeable in steps of 10ms.

The rate at which the unit can output a totaliser pulse is entirely dependent on the pulse width. Parameter **P534** also determines the width of a pulse that is output by a Sampler relay – see Section 5.10.4.

P536 Totaliser 2 Source (Factory default is "None")
If requiring Totaliser 2, select a parameter to be totalised.

Menu: <MAIN MENU>/<MONITOR>/[<MCU CONTROL UNIT>]/<READINGS>/<TOTALISER>

D828 Totaliser 1
This parameter displays the Totaliser 1 Count. To add this to the primary display, see Section 5.11.

D829 Totaliser 2
This parameter displays the Totaliser 2 Count. To add this to the primary display, see Section 5.11.

5.10.3 Resetting the totaliser

To re-set a totaliser to zero, display the Totaliser Count parameter (e.g. **D828**) and then press the button that corresponds to the "Reset" option on display line 4.

5.10.4 Sampler Relay Output

A Sampler mode relay can be used as a coarse totaliser or as a trigger to an external event. They output a pulse at a slower rate than a Totaliser relay.

Parameter **P535** is a Sampler Factor that defines the frequency of the Sampler pulse. For example, a value of 100 means that the Sampler relay outputs a single pulse for every 100^{th} increment to the Totaliser Count (**D828/D829**). The pulse width is the same as selected for the Totaliser relay (**P534**).

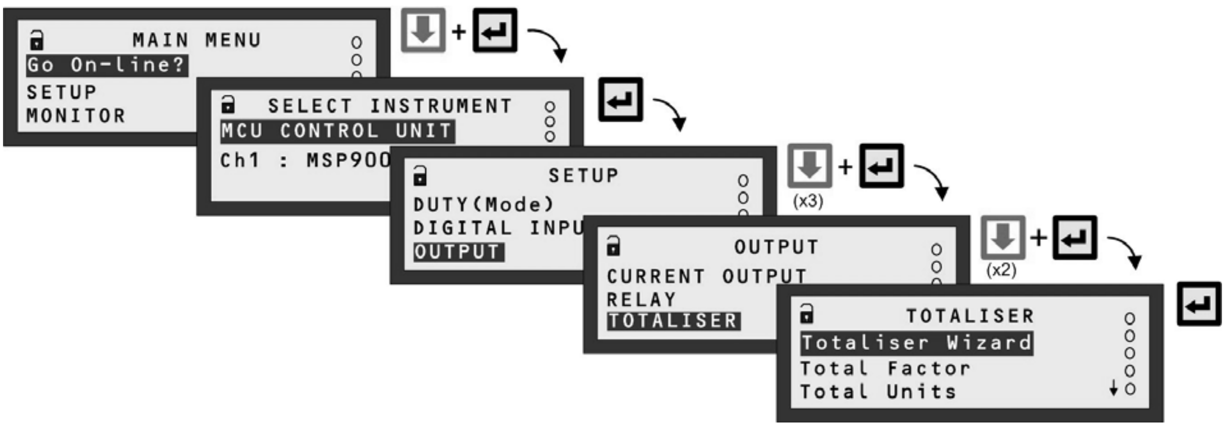
For information on setting up a Sampler relay, see Sections 5.8 and 5.10.6.

5.10.5 Totaliser Wizard

A Totaliser can be set-up easily using the **"Totaliser" Wizard**, accessible by navigating to the TOTALISER menu screen.

The Wizard requires the totaliser source parameter (e.g. PV value) to have suitable units selected (e.g. m^3/hour). Otherwise, it will display a 'invalid units' message and then exit to the menu upon pressing the appropriate button.

Section 5.10.6 features examples using this Wizard.



Note: The SELECT INSTRUMENT menu is skipped automatically if there are no HART transmitters. MCU901 screens shown.

Figure 23: Navigating to the TOTALISER Menu

5.10.6 Totalising examples

Note: The totalisers are set-up to operate with an input of flow in units of flow/second.

Example 1

Consider a flow measurement application where the **PV** value is a flow rate in units of **litres per second** and the maximum flow rate is **200** litres per second.

For the Totaliser to count *every* **m^3** (1000 litres), the Totaliser Factor (**P530/P532*)*** must be set to **1000** and the Totaliser Units (**P531/P533**) must be set to m^3.

The MCU Control Unit will then add **1** to the Totaliser Count (**D828/D829**) for every 1000 litres that flows. The Totaliser Count (**D828/D829**) will be automatically displayed in m^3 by setting the Totaliser Units.

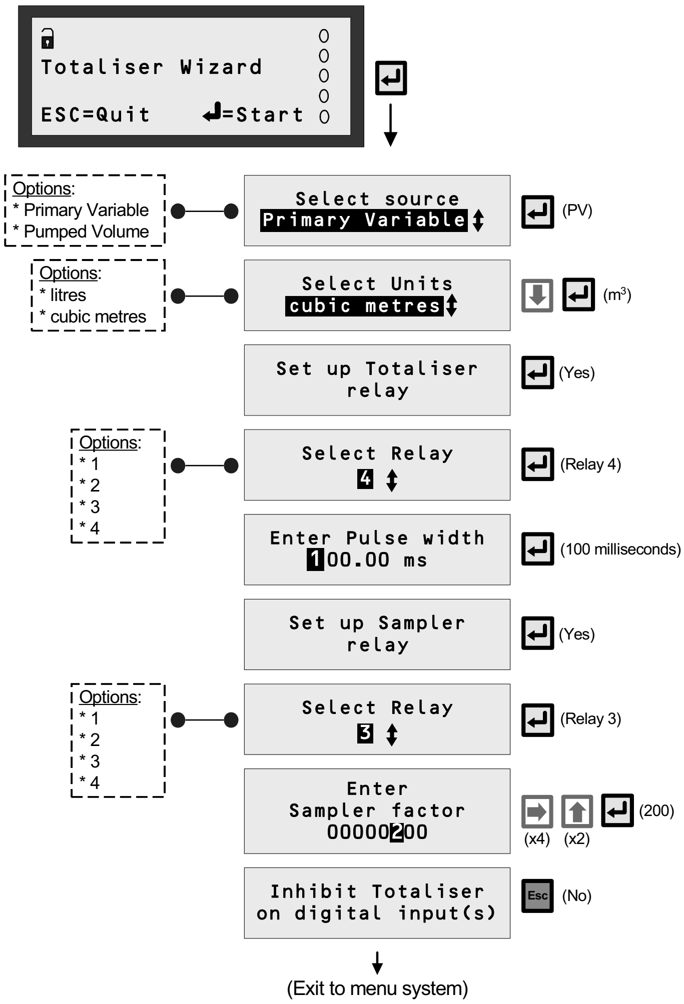
Figure 24 shows how the **"Totaliser" Wizard** can be used to set-up this totalising example. It is assumed the PV value is a flow rate in units of litres per second, which can be set-up using the **"Duty" Wizard** [6] – see Appendix D.

In addition, for this example:

- Relay **4** (RL4) will be a **Totaliser relay** and output a **100 millisecond** pulse (**P534**) for *every* **m^3** added to the Totaliser Count. (To set-up this manually, see Section 5.8.)

- Relay **3** (RL3) will be a **Sampler relay** that will output a pulse for *every* **200th m^3** added to the Totaliser Count. (To set-up this manually, see Section 5.8.)

- The Totaliser will **not freeze** while a digital input is active.



Note: MCU901 version of "Totaliser" Wizard shown here.

Figure 24: Totaliser Wizard - Example 1

[6] For convenience, the "Totaliser" wizard appears during the "Duty" wizard.

Example 2

Consider a flow measurement application where the **PV** value is a flow rate in units of **cubic metres per hour** (m^3/hour).

As the totalisers are set-up to operate with an input of flow in units of flow/second, the input of m^3/hour in this example must be scaled. This is achieved by multiplying the totaliser factor, 1.0 in this example, by 60 x 60 to get flow in units of flow/second.

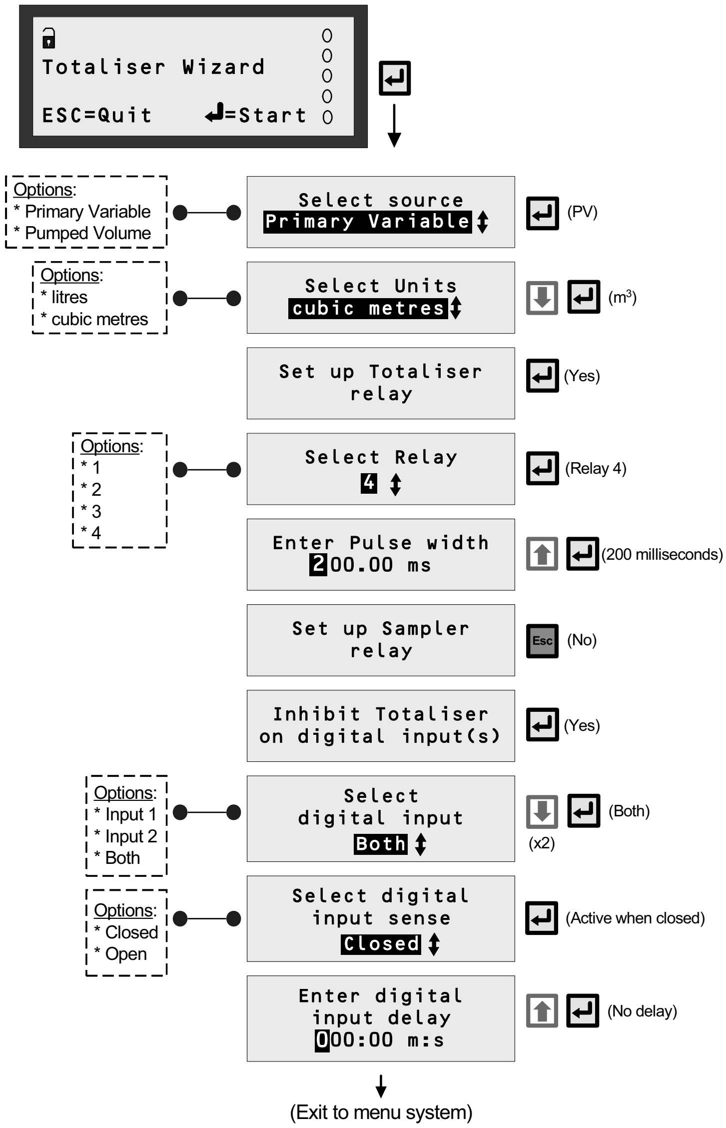
For the Totaliser to count *every* **100 m^3**, the Totaliser Factor (**P530/P532)** must be set to **3600** (1 x 60 x 60) and the Totaliser Units (**P531/P533**) must be set to m^3.

The MCU Control Unit will then add **1** to the Totaliser Count (**D828/D829**) for every 100 cubic metres that flows. The Totaliser Count (**D828/D829**) will be automatically displayed in m^3 by setting the Totaliser Units.

Figure 25 shows how the **"Totaliser" Wizard** can be used to set-up this totalising example. It is assumed the PV value is a flow rate in units of cubic metres per hour, which can be set-up using the **"Duty" Wizard** [7] – see Appendix D.

In addition, for this example:

- Relay **4** (RL4) will be a **Totaliser relay** and output a **200 millisecond** pulse (**P534**) for every **100 m^3** added to the Totaliser Count. (To set-up this manually, see Section 5.8.)
- No **Sampler relay** is required.
- The Totaliser will freeze *immediately* when *any* digital input is active i.e. when the voltage-free contact is closed. (To set-up this manually, see Section 5.5.)



Note: MCU901 version of "Totaliser" Wizard shown here.

Figure 25: Totaliser Wizard - Example 2

[7] For convenience, the "Totaliser" wizard appears during the "Duty" wizard.

5.11 Primary Display Options

The factory default configuration of the primary display can be changed to show different graphic and text information. Three areas of the primary display can be re-configured:

- Upper display
- Middle display
- Lower display

In addition, the number of decimal places and the back light operation can be adjusted.

Menu: MAIN MENU / SETUP / [MCU CONTROL UNIT /] OUTPUT / DISPLAY

P570 Display Upper (Factory default is "P731-Time")
Select a parameter from the multiple-choice list of parameters – see Table 12 below. For example, you can display the Totaliser count when "D828-Totaliser" is selected. If it will fit, the clock time will also be displayed alongside the selected parameter.

P571 Display Middle (Factory default is "D800-PV")
Select a parameter from the multiple-choice list of parameters – see Table 12 below. For example, you can display the (MCU) SV value when "D801-SV" is selected.

P572 Display Lower (Factory default is "Bargraph", representing the 4-20mA output of the MCU)
Select a parameter from the multiple-choice list of parameters – see Table 12 below. For example, you can display a user-defined message (**P241**) when the 'P241' option is selected.

P573 Decimal places (Factory default is 3)
Use this to adjust the number of decimal places. Range 0 to 5. Alternatively, select "Disabled" (Auto) for the MCU Control Unit to automatically choose the number of decimal places for a displayed parameter value.

P575 Back light (Factory default is "On")
Select from "On" (always on), "Off" (always off) or "Auto" (goes on when using keypad; goes off after 5 minutes of inactivity).

Table 12: Primary Display Parameter Selection

P570/P571/P572 Options	Parameter
None	(Nothing selected)
D800-PV	(MCU) PV value
D801-SV	(MCU) SV value
D802-TV	(MCU) TV value
D803-FV	(MCU) FV value
D805-%mA Out	Percentage of current output (4-20mA span)
D806-mA Output	Actual current output
D809-RoC	Rate of Change of PV value
D828-Totaliser	Totaliser value
D828-Totaliser 1	Totaliser 1 value (MCU902 only)
D829-Totaliser 2	Totaliser 2 value (MCU902 only)
D821-RL1 RTime	Running time for relay **RL1** if energised
D822-RL2 RTime	Running time for relay **RL2** if energised
D823-RL3 RTime	Running time for relay **RL3** if energised
D824-RL4 RTime	Running time for relay **RL4** if energised
D825-RL5 RTime	Running time for relay **RL5** if energised
D840-mA Input	Actual current input
D844-Internal °C	Temperature of MCU Control Unit
D846	Logging memory remaining
D900-PV In	Transmitter PV (Primary Variable)
D901-SV In	Transmitter SV (Secondary Variable)
D902-TV In	Transmitter TV (Tertiary Variable)
D903-FV In	Transmitter FV (Fourth Variable)
P240-Descript	Free-form description
P241-Message	Free-form message
P242-Tag	Free-form tag name
P730-Date	Date
P731-Time	Time of day
Bargraph	Bar graph of 4-20mA output of MCU – for lower display only

5.12 Serial Communications

This section is applicable if an RS232 serial port of a communication device (e.g. PC) is connected to the RS232 terminals of the MCU Control Unit or data download socket of the MCULOG. (For connections details, refer to IP2030/IM).

Menu: MAIN MENU / SETUP / [MCU CONTROL UNIT /] OUTPUT / SYSTEM / COMMS

P710 Address (Factory default is 0)
Leave this at the factory default setting.

P711 Interface (Factory default is "Log download" for MCULOG, "RS232 HART" for MCU901/902)
Choose between "Log download" (if using MCULOG and Log-View), "RS232 HART" (if using H-Conf401 software) or "None".

P712 Baud Rate (Factory default is "1200" or "9600)
This must be the same as set for the RS232 serial port of the communication device. Range is 1200 to 115200.

P713 Start Bits (Factory default is 1)
This must be the same as set for the RS232 serial port of the communication device. Range is 0 to 9.

P714 Data Bits (Factory default is 8)
This must be the same as set for the RS232 serial port of the communication device. Range is 0 to 9.

P715 Parity (Factory default is "Even")
This must be the same as set for the RS232 serial port of the communication device. Options are "Even", "Odd" or "None".

P716 Stop Bits (Factory default is 1)
This must be the same as set for the RS232 serial port of the communication device. Range is 0 to 9.

5.13 PIN Security

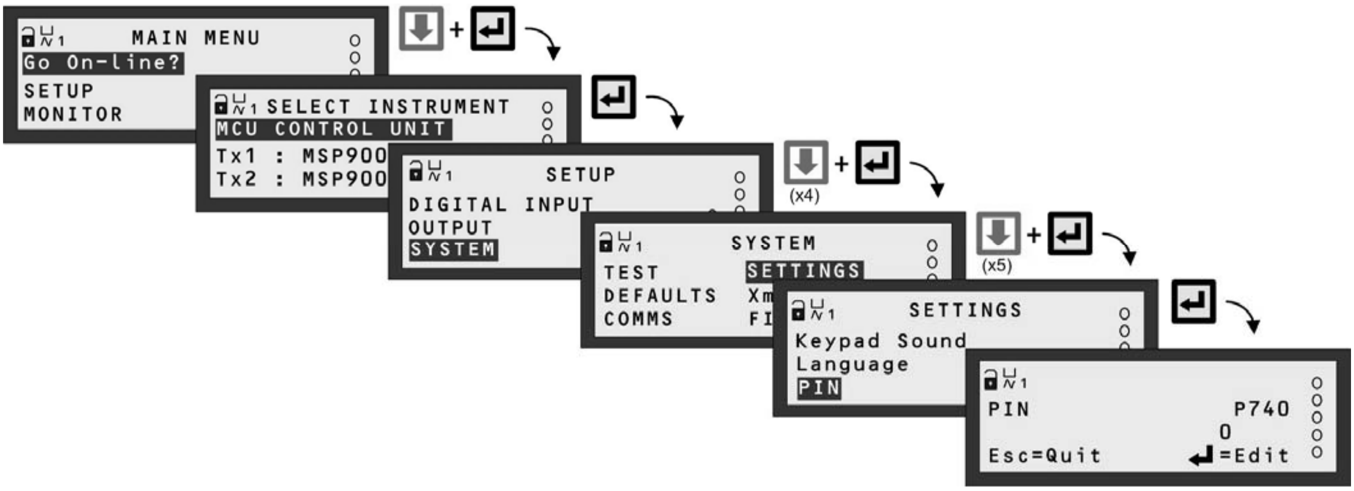
Personal Identification Number (PIN) security prevents unauthorised people from programming the MCU Control Unit. Typically, this is set-up when all the other programming has been completed. As with bankcards, there is one PIN number.

The factory default is for PIN security to be inactive. To activate, navigate the menu system to the **PIN** screen and edit a **4-digit** personal identification number (PIN) that you want. The PIN is edited with the arrow keys and confirmed with the **ENTER** key; the 4-digit PIN will then be replaced by **"- - - -"** to indicate that PIN security is active. (By default, the PIN is a "0" if inactive).

Once PIN security is activated, a prompt for the PIN will appear when needed for an activity, such as starting a Wizard. If correctly entered, no further PIN requests are made **unless** the "Cancel Password" option is selected from the MAIN MENU screen. This menu option appears only after correctly entering the PIN; the option disappears when selected, therefore making the MCU Control Unit secure and will prompt for the PIN when needed.

If the PIN number has been forgotten, contact Mobrey for assistance.

Please ensure that you have the serial number of the MCU Control Unit available. It is located in the menu system at MAIN MENU / [MCU CONTROL UNIT /] SETUP / SYSTEM / FIXED / Serial No.



Note: The SELECT INSTRUMENT menu is skipped automatically if there are no HART transmitters. MCU902 screens shown.

Figure 26: Navigating to the PIN set-up screen

Chapter 6 Checks, Diagnostics and Fault-finding

Chapter 6 is a guide to health check matters, which includes MCU tests, Current Input and Output calibration, live readings and diagnostic information for the MCU Control Unit and for HART compatible transmitters.

In addition, there is a guide to fixed details of the MCU Control Unit e.g. Serial Number.

6.1 Health Check – MCU Control Unit

6.1.1 Auto-Cycle (Self-Test)

Menu: MAIN MENU / SETUP / [MCU CONTROL UNIT /] SYSTEM / TEST / AUTO-CYCLE

The Auto-Cycle (or Self-Test) function is selected by pressing the yellow (**ENTER**) button at the AUTO-CYCLE screen. To start the Auto-Cycling, press the **UP-ARROW** button *once*.

When started, the **PV value** is driven up to the *maximum* value (**P401**) and then driven down to the *minimum* value (**P400**), continuously, therefore exercising the Current Output and relays. It always begins at the 4mA point.

The operating mode of the MCU Control Unit may Off-line or On-line, although the outputs are frozen when Off-line. During this Auto-Cycling, MCU operations continue as normal, e.g. totalising and, if supported, data logging.

A single cycle of this takes approximately 100 seconds to complete. To pause the cycle at any time, press the **UP-ARROW** button *once*. When paused, pressing the **UP-ARROW** button *once* will resume the cycle.

To quit the Auto-Cycling at any time, even when paused, use the **ESC** button *once* to exit immediately to the primary display. Upon exiting, the PV value immediately takes on the value based on the transmitter inputs.

6.1.2 Display Test

Menu: MAIN MENU / SETUP / [MCU CONTROL UNIT /] SYSTEM / TEST / DISPLAY

The Display Test function is started by pressing the yellow (**ENTER**) button at the DISPLAY screen.

When started, a pre-defined pattern sequence exercises all the LCD pixels. After a few seconds, the test ends by displaying the MCU model code and software version number.

To re-run the Display Test, press the yellow (**ENTER**) button again. Otherwise, use the **ESC** button to exit to the menu.

6.1.3 Current Input Calibration

Menu: MAIN MENU / SETUP / [MCU CONTROL UNIT /] SYSTEM / TEST / CURRENT INPUT

<u>4mA Input Calibration</u>

Step 1: Apply 4mA to the Current Input
Step 2: Select the “4mA In Adjust” menu option (from the above menu)
Step 3: Press the yellow (**ENTER**) button once

<u>20mA Input Calibration</u>

Step 1: Apply 20mA to the Current Input
Step 2: Select the “20mA In Adjust” menu option (from the above menu)
Step 3: Press the yellow (**ENTER**) button once

6.1.4 Fixing The Output Current

Menu: MAIN MENU / SETUP / [MCU CONTROL UNIT /] SYSTEM / TEST / CURRENT OUTPUT

<u>Set Current to fixed output, temporarily</u> (**P702**)

Step 1: Select the “Set Current” menu option (from the above menu)
Step 2: Edit a suitable mA value (in the range 4-20mA)
Step 3: Save the mA value to then fix the Current Output at that level

Pressing the **ESC** button will exit to the menu and restore the Current Output to the level appropriate for the PV value.

6.1.5 Current Output Calibration

Menu: MAIN MENU / SETUP / [MCU CONTROL UNIT /] SYSTEM / TEST / CURRENT OUTPUT

4mA Output Calibration (**P700**)

Step 1: Select the “4mA Out Adjust” menu option (from the above menu)

Step 2: Measure the output current

Step 3: If the output current is not 4mA, edit the existing value to be the actual mA reading and then save it.

20mA Output Calibration (**P701**)

Step 1: Select the “20mA Out Adjust” menu option (from the above menu)

Step 2: Measure the output current

Step 3: If the output current is not 20mA, edit the existing value to be the actual mA reading and then save it.

6.1.6 Monitoring The MCU Control Unit Readings

Menu: MAIN MENU / MONITOR / [MCU CONTROL UNIT /] READINGS

Answers

D800 PV ANSWERS / PV
This is the live PV (Process Variable) value as seen in Section 5.3.

D801 SV ANSWERS / SV
This is the live (MCU) SV value as seen in Section 5.3.

D802 TV ANSWERS / TV
This is the live (MCU) SV value as seen in Section 5.3.

D803 FV ANSWERS / FV
This is the live (MCU) FV value as seen in Section 5.3

D804 Ullage
This is an indication of by how much a vessel or open-channel falls short of being full. It is calculated as the difference between the upper range value (URV) of the Current Output and the PV value i.e. **D804** = (**P401** - **D800**)

D805 % Current Output ANSWERS / % Current Out
This is the percentage of actual current from the 4-20mA output of the MCU Control Unit. **Note:** The current output is frozen when the MCU Control Unit is in the Off-line operating mode.

D806 Current O/P ANSWERS / Current Output
Actual current output from the 4-20mA output of the MCU Control Unit. **Note:** The current output is frozen when the MCU Control Unit is in the Off-line operating mode.

Rate of change

D809 Rate of change Rate of Change
This displays the calculated Rate of Change of the PV value. See also Section 5.8.14 for use of parameter **D809**.

Relay

D811 RL1 Ops RELAY / RELAY OPERATIONS
Displays the number of operations carried out by relay **RL1**. It can be re-set to zero by pressing the yellow (**ENTER**) button when displaying **D811**. The operation count is used by the **Relay Operations Alarm** (Section 5.8.20).

D812 to **D815** are the operation counters for other relays.

D820 Relay Status RELAY / Relay Status
This indicates whether relays are energised (**1**) or de-energised (**0**). First digit represents Relay **RL1**.

D821 RL1 Run-Time RELAY / RELAY RUN TIME
Displays the total time that relay **RL1** has been energised for the present relay operation. It is reset to 0 hours and 0 minutes when it is de-energised. Parameter **D821** is used by the **Relay Run Time Alarm**.

D822 to **D825** are the running times for the other relays.

Totaliser (MCU901/MCULOG)

D828 Totaliser Totaliser
This displays the Totaliser Count. Also, see Section 5.10 for details of totalising.

<u>Totaliser</u> (MCU902)

D828 Totaliser 1 Totaliser
This displays the Totaliser 1 Count. Also, see Section 5.10 for details of totalising.

D829 Totaliser 2 Totaliser
This displays the Totaliser 2 Count. Also, see Section 5.10 for details of totalising.

<u>Alarm Report</u>

D830 Alarm Report
This is for viewing active alarms. The highest priority alarm listed first. Use the **UP/DOWN-ARROW** buttons to scroll through list if more than one alarm exists. If there are no live alarms, **D830** shows the word “none”. **See also Appendix E for** a summary of other reporting methods for Alarms.

<u>Fault Report</u>

D831 Fault Report
This is for viewing active faults. The highest priority fault listed first. Use the **UP/DOWN-ARROW** buttons to scroll through list if more than one fault exists. If there are no live faults, **D831** shows the word “none”. **See also Appendix E for** a summary of other reporting methods for Faults.

6.1.7 Diagnostic data available from the MCU Control Unit

Menu: MAIN MENU / MONITOR / [MCU CONTROL UNIT /] DIAGNOSTICS

<u>I/P Status</u> (Input Status)

D835 Input Status
This indicates whether digital inputs are active (**1**) or inactive (**0**). First digit represents the state of Digital Input **IN1**.

<u>Current I/P</u> (Current Input)

D840 Current I/P
This shows the actual input current. For the purpose for parameter **D840**, see Section 5.3.

<u>mA Input</u>

D842 mA Input %
This shows the percentage of actual current input. For the purpose for parameter **D842**, see Section 5.3.

<u>CU Temperature</u>

D844 CU Temperature
This shows the operating temperature of the MCU Control Unit. If above 65°C, it is a fault condition – see Section 5.8.12.

<u>Next Pump down</u>

D845 Next Pump down
This shows the time remaining before the next pump-down is invoked. See also Section 5.8.18 for pump-down details.

<u>Free Memory</u> (MCULOG only)

D846 Free Memory
This shows the percentage of free memory remaining for data logging. See also Section 5.6.4.

<u>Date of Change</u>

D848 Date of Change
This shows the date on which a MCU Control Unit parameter was last edited.

<u>1st Pwr Date</u>

D849 1st Pwr Date
This shows the date on which the MCU Control Unit was first powered-up.

<u>Channels</u>

D851 CH1 Output
This shows the MCU Channel 1 output value. See also see Section 5.3.

D852 CH2 Output
This shows the MCU Channel 2 output value on a MCU902. See also Section 5.3.

<u>Pump Efficiency</u>

D861 Pump effy RL1
This shows the pump efficiency percentage for relay **RL1** – see “Pump Efficiency Alarm” Section on Section 5.8.24.

D862 to **D864** show the pump efficiencies for the relays **RL2**, **RL3** and **RL4**. (Relay **RL5** does not support this.)

6.1.8 Fixed data of the MCU Control Unit

The values of the following parameters may be requested from you if you ever contact the Customer Support Group of the factory:

Menu: MAIN MENU / MONITOR / [MCU CONTROL UNIT /] SYSTEM / FIXED

D750 Model Code
This is the model number of your MCU Control Unit (e.g. MCU901WX-A)

D751 Serial Number
This is the unique serial number of your MCU Control Unit.

D752 H/W Revision
This is the issue number for the particular build of your MCU Control Unit.

D753 S/W Revision
This is the issue number of the software release that is running on your MCU Control Unit.

6.2 Health Check – Mobrey's MSP900 Series of HART Transmitter

This section is for health checking Mobrey's HART transmitters. Note that all parameters mentioned here relate specifically to the MSP900 Series of transmitters.

For a full menu map of these HART transmitter parameters and more, see also Table 17 in Appendix G.

6.2.1 Readings From The Transmitter

Menu: MAIN MENU / MONITOR / Transmitter Tag / READINGS

Variables

D900 Xmtr PV ("Live" PV measurement in metres or feet)
Primary Variable values from the HART transmitter.

D901 Level (SV) ("Live" level measurement in metres or feet)
Secondary Variable values from the HART transmitter.

D902 Range (TV) ("Live" distance measurement in metres or feet)
Tertiary Variable values from the HART transmitter.

D903 Xducer Temp ("Live" temperature measurement in °C or °F)
Fourth Variable values from the HART transmitter.

Current

D906 Current Output (Live measurement in mA)
Displays the actual current output from the HART transmitter.

D905 % Current Out (Live %)
This displays the percentage of current output from the HART transmitter.

6.2.2 Diagnostics Available From the Transmitter

Menu: MAIN MENU / MONITOR / Transmitter Tag / DIAGNOSTICS

Diagnostics

D910 Target Range (Live measurement in metres or feet)
This displays the live distance to target.

D911 Echo Size (Live %)
This displays the strength of the return echo on a scale of 0 to 100%.

D912 Echo Success (Live %)
This indicates 100% unless echoes are being lost. Generally, echo loss may be due to the positioning of the transmitter, obstructions, poor surface conditions, etc. Refer to the product installation manual for further guidance.

D913 Target Echoes (Live maximum value of 3)
This is the number of recognised echoes within the **measurement range** shown in Figure 27.

D914 Speed of Sound (Value in m/s or ft/s)
This displays the speed of sound in metres per second or feet per second, as applicable.

D915 Xducer Temp (Live measurement in °C or °F)
This is the temperature from the HART transmitter.

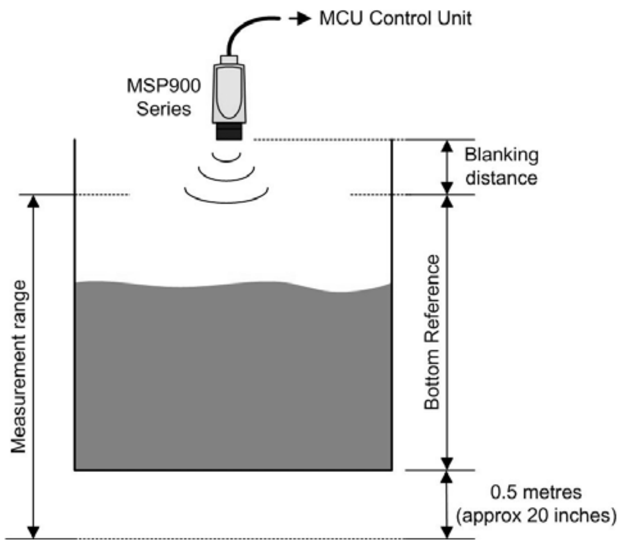
D916 Xducer Freq (Value in kHz)
This is the operating frequency of the transmitter, which is fixed at the time of manufacture.

History

P003 Date of Change (Date)
View the date on which the transmitter tag or description was changed.

P046 Max Temp (Value in °C)
This is the record of a maximum temperature in excess of 50°C.

P047 Min Temp (Value in °C)
This is the record of a minimum temperature below -10°C.



Note: To locate the Blanking Distance and Bottom Reference parameters of the HART transmitter, see Table 17 in Appendix G

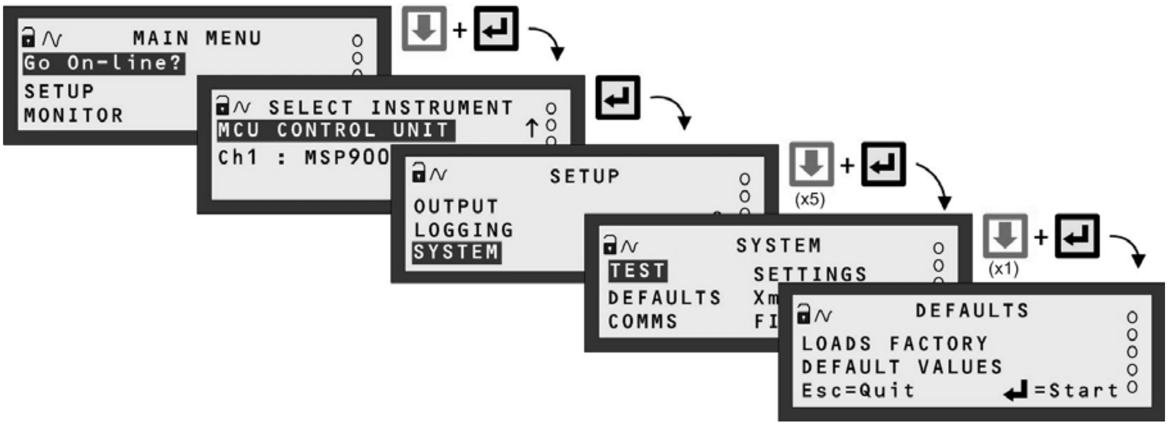
Figure 27: Measurement range in which echoes may be found

Appendix A Restoring Factory Defaults

Use the following sequence to restore the MCU Control Unit to the **factory defaults**, erasing all user entered data:

- Use the “Remove” option of the ‘MCU TRANSMITTER’ Wizard for all connected transmitters (Appendix B). This will clear the MCU memory of any transmitter data that has been uploaded from a HART transmitter.
- Navigate to the DEFAULTS menu, as guided in Figure 28 (Below).
- Press the yellow (**ENTER**) button *twice* and then wait for a short beep.
- Switch-off the MCU Control Unit.
- Disconnect the second transmitter (MCU902 only).
- Turn to Chapter 3 to start again.

Note: The factory defaults may not be the same as the settings when shipped from the factory. It is advisable to keep a record of settings, if possible.



Note: The SELECT INSTRUMENT menu is skipped automatically if there are no HART transmitters. MCULOG screens shown.

Figure 28: Navigating to the DEFAULTS menu

Appendix B Using the ‘MCU Transmitter’ Wizard

Appendix **B** is a guide to the ‘MCU TRANSMITTER’ Wizard, which can be used to **find, remove** and **clone** HART transmitters.

B.1 When the ‘TRANSMITTER’ Wizard is needed

Appearing during start-up of MCU Control Unit

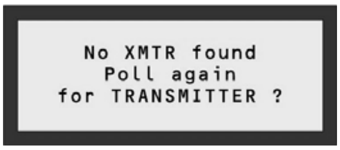
The ‘MCU TRANSMITTER’ Wizard, “Xmtr Wiz”, appears during start-up when a transmitter is **not known** by MCU Control Unit and **P111**/**P121** is set to a digital (HART) input, but then subsequently not found.

The cause may be any of the following:

- the transmitter is not HART compatible e.g. a transmitter with a 4-20mA output,
- the transmitter is incorrectly connected to the “CURRENT INPUT” terminals on the MCU Control Unit
- faulty transmitter cable or
- the transmitter itself is faulty

> **Note:** If *any* 4-20mA transmitter or HART transmitter is connected when the MCU Control Unit is configured for a 4-20mA input, the Wizard will never appear and the set-up is as guided in Section 5.3.

If there are **no transmitters** cabled to a **new** (or re-set) MCU Control Unit, the Wizard will also appear during start-up. It will report no transmitters connected, pause for a few seconds and then complete the start-up. The Wizard responds in exactly the same way when the transmitter is incorrectly connected to a MCU Control Unit, the cabling is faulty or the transmitter itself has a fault. (Check the connections and then re-start the MCU Control Unit.)



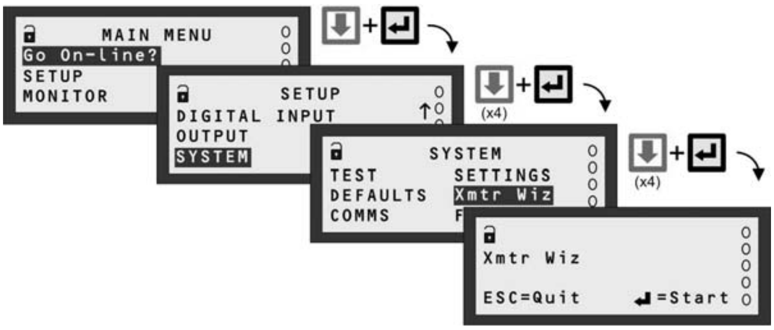
When a **HART** transmitter is connected for the **first time** and MCU Control Unit **is configured for a digital input**, the Wizard process is automatic, requiring little or no intervention as described in Chapter 3. Once known to the MCU Control Unit, the HART transmitter is remembered even after switching the power off. Subsequent powering off and on then involves a short, automatic process of re-establishing digital communications before completing a normal start-up.

However, if a remembered HART transmitter is then disconnected, the Wizard will report no transmitters connected and then complete the start-up. Subsequent re-connection of the transmitter will not have any further consequences, unless *another* transmitter is connected – see “Cloning” section B.5 to avoid this.

If *any* **4-20mA** transmitter is connected when the MCU Control Unit is configured for a **digital input**, the Wizard process is automatic, requiring no intervention as described in Chapter 3. However, unlike a HART transmitter, the MCU Control Unit does not need to remember it since the unit is then re-configured for the 4-20mA input.

Manually starting the Wizard

The ‘TRANSMITTER’ Wizard, “Xmtr Wiz”, can also be started manually. It is located by navigating the menu system as shown in Figure 29. (If the primary display is showing, press the yellow **ENTER** button first.)



Note: The menus shown are for the MCU902

Figure 29: How to find the 'TRANSMITTER' Wizard

The manual option is required if you want to:

- **Find** a HART transmitter – *Turn to sections B.2 and B.3*
- **Remove** all reference to a HART transmitter before disconnection – *Turn to section B.4.*
- **Clone** a HART transmitter (save/restore on-board settings) – *Turn to section B.5.*

If there are **no transmitters** cabled to the MCU Control Unit, the Wizard will report this fact after a few seconds and then exit to the SYSTEM menu screen. The Wizard responds in the same way when the transmitter is incorrectly connected to the MCU Control Unit, the cabling is faulty or the transmitter itself has a fault.

B.2 Finding a HART Transmitter (MCU901 or MCULOG)

Figure 30 shows how the 'TRANSMITTER' Wizard is **started manually** and then used to locate a HART transmitter with **any polling address** in the range 0 to 15. When found, it is designated **Tx1** and allocated to **MCU Channel 1**. There is an option to edit the tag name.

Note: The sequence will appear as illustrated by following the keypad hints shown alongside the prompts.

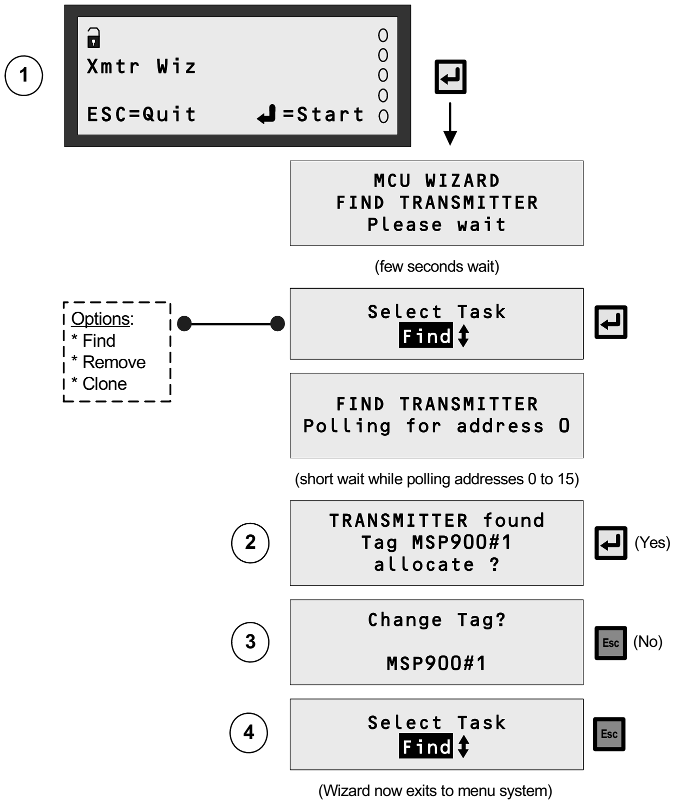


Figure 30: How to find a HART transmitter (MCU901/MCULOG)

Notes associated with the circled numbers are as follows:

① Navigate to the Wizard as guided in Figure 29.

② Pressing 'No' will result in re-polling addresses 0 to 15. If a transmitter is found, the "allocate?" prompt appears again. Otherwise, the Wizard reports "no transmitter found" and allows re-polling or an exit to the menu system.

③ Pressing the yellow **ENTER** button ('Yes') will allow editing of the tag name by using the arrow keys.

④ Allows you to select another task or exit the menu system.

B.3 Finding a HART Transmitter (MCU902 Only)

Figure 31 shows how the ‘TRANSMITTER’ Wizard is **started manually** and then used to locate a HART transmitter with any polling address in the range 0 to 15. When found, it is designated **Tx1** or **Tx2**, depending on whether another transmitter is known by the MCU Control Unit. There is an option to edit the tag name and manually allocate Tx1 (or Tx2) to **MCU Channel 1** or **2**.

Note: The sequence will appear as illustrated by following the keypad hints shown alongside the prompts.

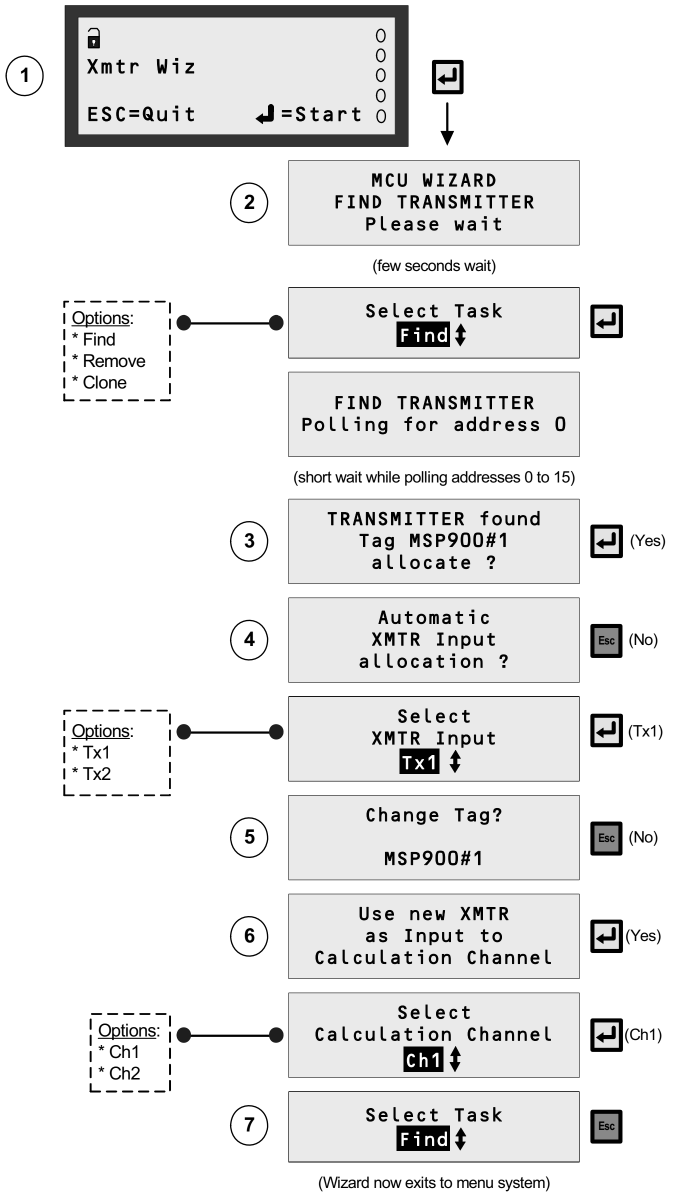


Figure 31: How to find a HART transmitter (MCU902 only)

Notes associated with the circled numbers are as follows:

① Navigate to the Wizard as guided in Figure 29.

② Pressing ‘No’ will result in re-polling addresses 0 to 15. If a transmitter is found, the “allocate?” prompt appears again. Otherwise, the Wizard reports “no transmitter found” and allows re-polling or an exit to the menu system.

③ Pressing the yellow **ENTER** button ('Yes') will automatically designate the transmitter ‘Tx1’ if it is the first one known to the MCU Control Unit. Otherwise, the transmitter is automatically designated ‘Tx2’.

④ Pressing the yellow **ENTER** button ('Yes') will allow editing of the tag name by using the arrow keys.

⑤ Pressing ‘No’ will result in the “Select Task” prompt appearing, allowing re-polling. However, to find the same HART transmitter again, the Wizard must be re-started.

⑥ Allows you to select another task or exit the menu system.

B.4 Removing a HART Transmitter

The “Remove” function is typically used prior to disconnection of a HART transmitter. Figure 32 illustrates the Wizard sequence for removing all references to a HART transmitter that was designated **Tx1**.

If there are no ‘remembered’ HART transmitters prior to using the “Remove” function, the Wizard immediately reports “No TRANSMITTER selected” and prompts for another task.

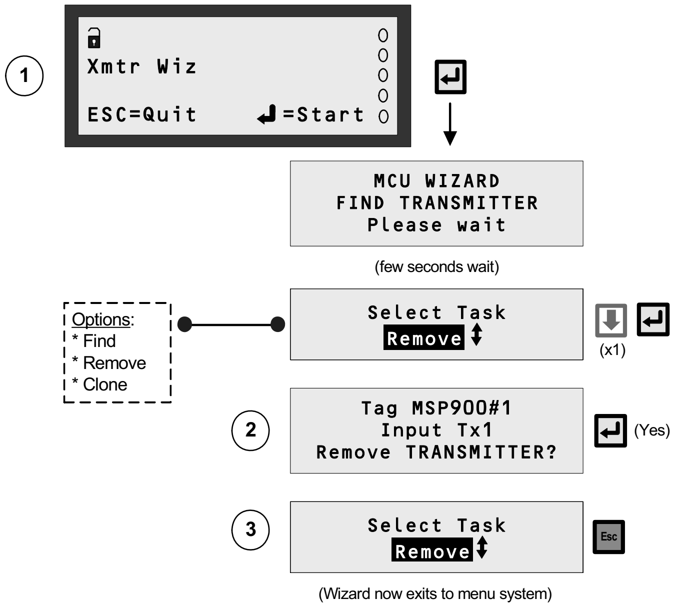


Figure 32: How to remove all reference to HART transmitter

Notes associated with the circled numbers in Figure 32 are as follows:

① Navigate to this Wizard as guided in Figure 29.

② In the case of the MCU902, the second transmitter (Tx2) can only be ‘removed’ after Tx1.

③ Allows you to select another task or exit the menu system. (The “Find” function will re-find the HART transmitter.)

B.5 Cloning of a HART Transmitter

This feature can be used to save a HART transmitter configuration and download it to another HART transmitter of the same type.

Figure 33 illustrates how the on-board settings of a HART transmitter (Tx1) can be **saved** and then **restored** to another connected HART transmitter (Tx2).

Once **saved**, the MCU Control Unit will remember the **saved parameters** even if power is lost. So, you may save the parameters, power-off, replace a transmitter, power-on and then **restore parameters** to that new transmitter.

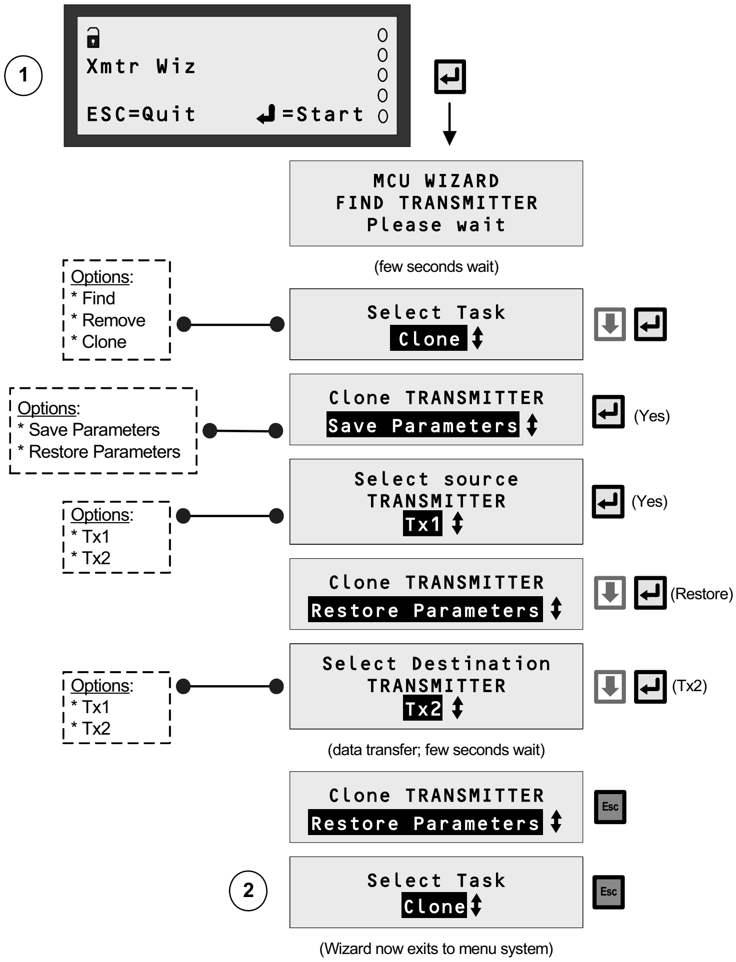


Figure 33: How to clone a HART transmitter

Notes associated with the circled numbers in Figure 33 are as follows:

① Navigate to this Wizard as guided in Figure 29.

② Allows you to select another task or exit the SYSTEM menu.

Appendix C The DIRECT Menu

C.1 The DIRECT Menu – fast access to parameter screens

The "DIRECT" menu screen is selectable from the MAIN MENU. It features a method for **fast access** to parameter screens. This is an ideal facility for those who want to check parameter settings without traversing the menu system. All that is required is the entry of the 3-digit identification (ID) number for a parameter, as found in Appendix G.

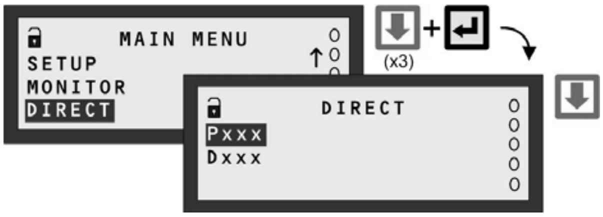


Figure 34: Navigating to the DIRECT menu

Both 'P' and 'D' prefixed parameters can be accessed, but through separate selection screens. At the DIRECT menu screen, a selection must first be made which is based on the parameter prefix – see Figure 35.

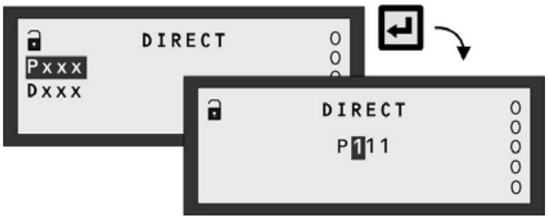


Figure 35: DIRECT menu – Pxxx or Dxxx Selection

Once a selection is made, the unique 3-digit identification number of the parameter is edited using the arrow buttons. Pressing the **ENTER** button will then bring up the parameter screen, unless it is unavailable.

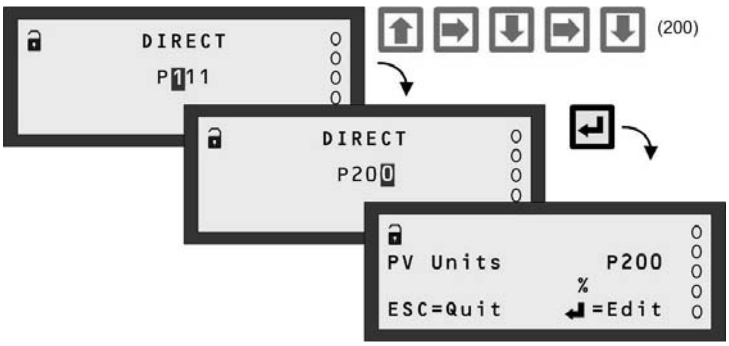


Figure 36: DIRECT menu – Pxxx Editing (Parameter Exists)

When a parameter is unavailable, the nearest numbered parameter is displayed instead. However, pressing the **ESC** button takes you back to the previous screen, allowing you to re-edit the number and try for another parameter screen. This is also convenient for when checking on more than one parameter.

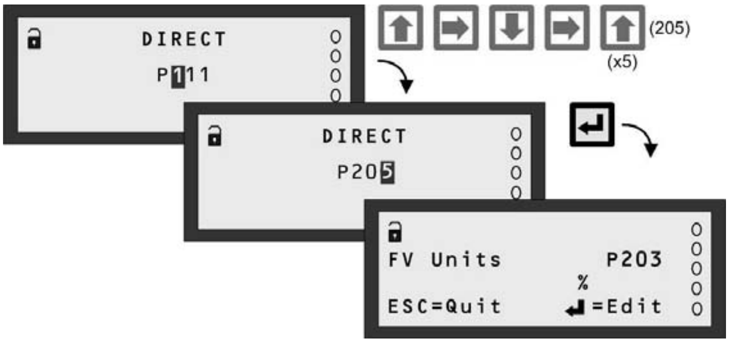


Figure 37: DIRECT menu – Pxxx Editing (No Such Parameter)

In addition, whilst displaying a parameter screen, you may use the **UP-ARROW** or **DOWN-ARROW** buttons to scroll through adjacent parameter screens. (Watch the parameter ID number change).

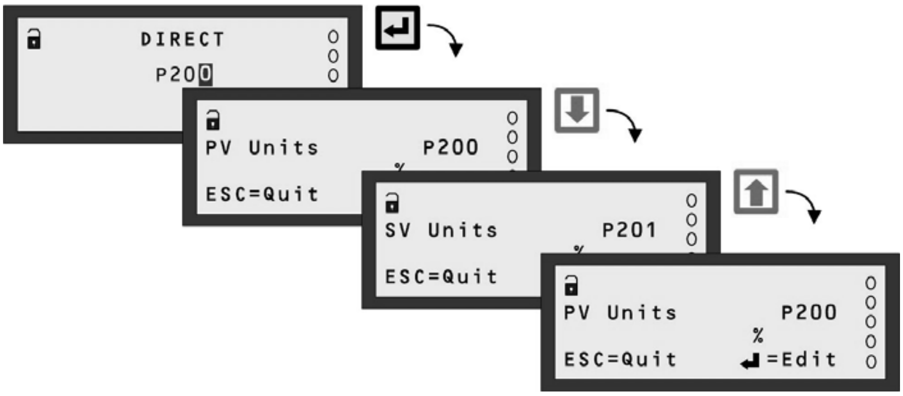


Figure 38: DIRECT menu – Pxxx Scrolling

You can still use the **ESC** button to return to the Pxxx or Dxxx screen at any time. Once finished with the direct access facility, use the **ESC** button until you are returned to the MAIN MENU.

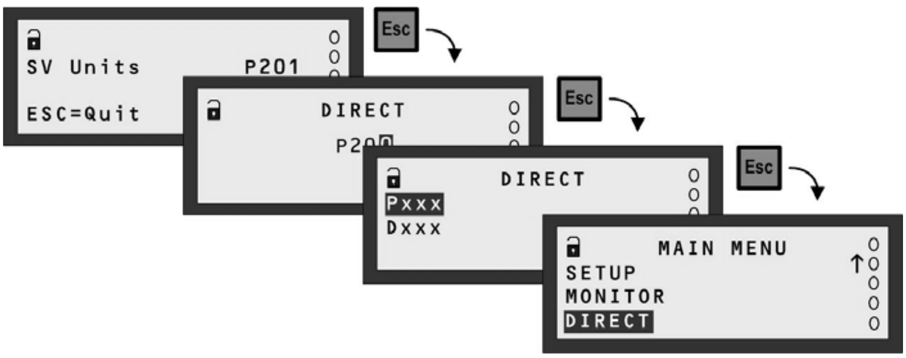
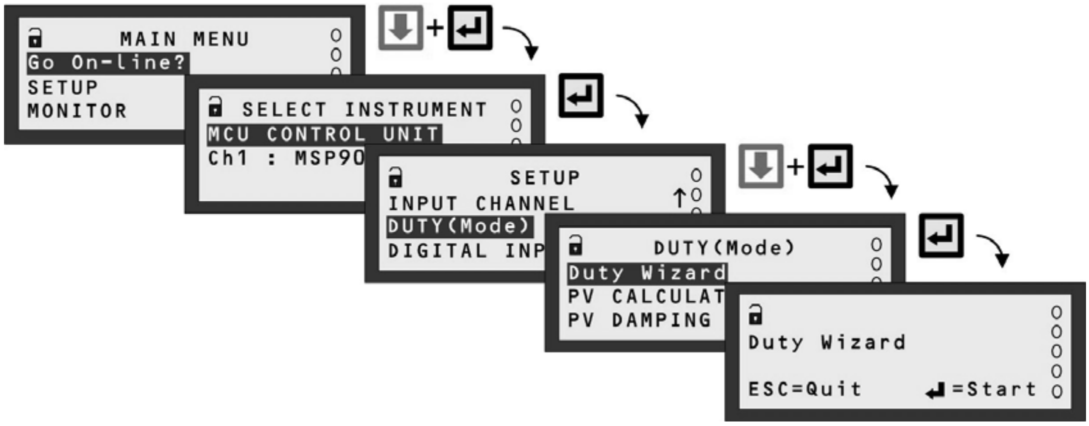


Figure 39: DIRECT menu – Return to the menu system

Appendix D The DUTY Wizard

Appendix D is a guide to using the "Duty" Wizard, which is the **recommended** method for setting up applications.

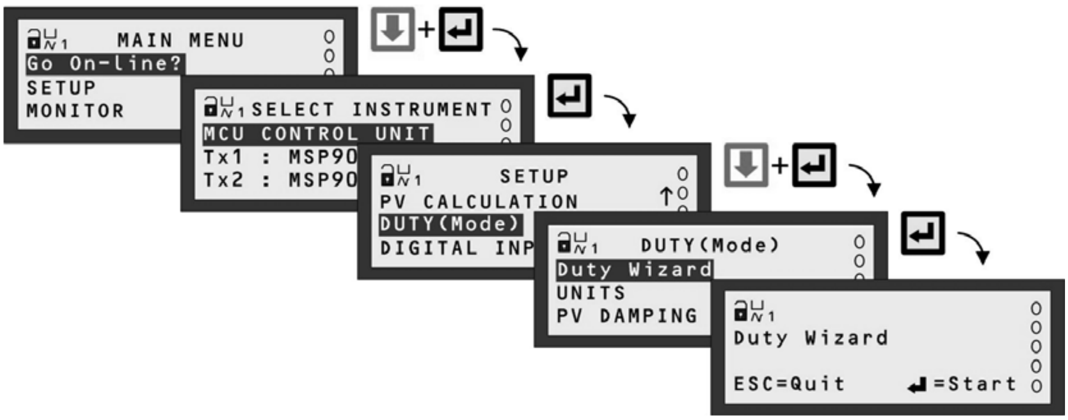
D.1 How to find the DUTY Wizard on the MCU901/MCULOG



Note: Menus may vary from those illustrated here. The SELECT INSTRUMENT menu does not appear when there are no HART transmitters.

Figure 40: Navigating to the DUTY Wizard (MCU901/MCULOG)

D.2 How to find the DUTY Wizard on the MCU902



Note: Menus may vary from those illustrated here. The SELECT INSTRUMENT menu does not appear when there are no HART transmitters.

Figure 41: Navigating to the DUTY Wizard (MCU902)

D.3 DUTY Wizard: Level from a Level Transmitter (MCU901/LOG Only)

Note: ensure that MCU Channel 1 is set-up appropriately *before starting* the Duty Wizard

1. With power on and the transmitter giving a 4-20mA or HART signal to the MCU Control Unit, you can now configure the MCU Control Unit for an application. **This application example is for level measurement.**

Requirements

Live level measurement in units of metres over a range of 0 to 11.7 metres. Energise relay RL1 while level exceeds 9 metres and then de-energise the same relay when level falls below 9.5 metres.

Input Data

Tank Shape: Linear (e.g. Square)

Bottom Reference: 12 metres

The transmitter is supplying the live level measurements in units of metres.

2. Navigate the menu system to get to the “Duty Wizard” screen.

3. Start the “Duty” Wizard by pressing the yellow (**ENTER**) button *once*.

4. Work through the “Duty” Wizard prompts (Figure 42 or Figure 43) until completion; this occurs when the menu system re-appears. Keypad hints, for the illustrated Wizard sequence on the next page, are provided alongside the prompts. If applicable, adapt the example to suit your application.

5. Circled numbers in the illustrated Wizard sequence relate to these notes:

① Select “Level” from the multiple-choice list.

② Set-up the 4-20mA input span with a level range (e.g. 0 to 11.7 metres)

③ Set-up the 4-20mA output span with a level range (e.g. 0 to 11.7 metres)

④ Set-up relay RL1 to be energised whenever the measured level exceeds a pre-set level and de-energises below another pre-set level, as defined at these prompts.

⑤ Optional overrides to prevent individual relays from being energised for too little time or too much time.

⑥ Option to set-up further relays.

6. Return to the main menu by holding the **ESC** button for a few seconds, releasing it when the main menu appears. Next, go on-line by selecting the “Go on-line” menu option and then pressing the **ENTER** button *once*. Finally, press the **ESC** button repeatedly until the primary display appears. The level measurement will be live on the primary display.

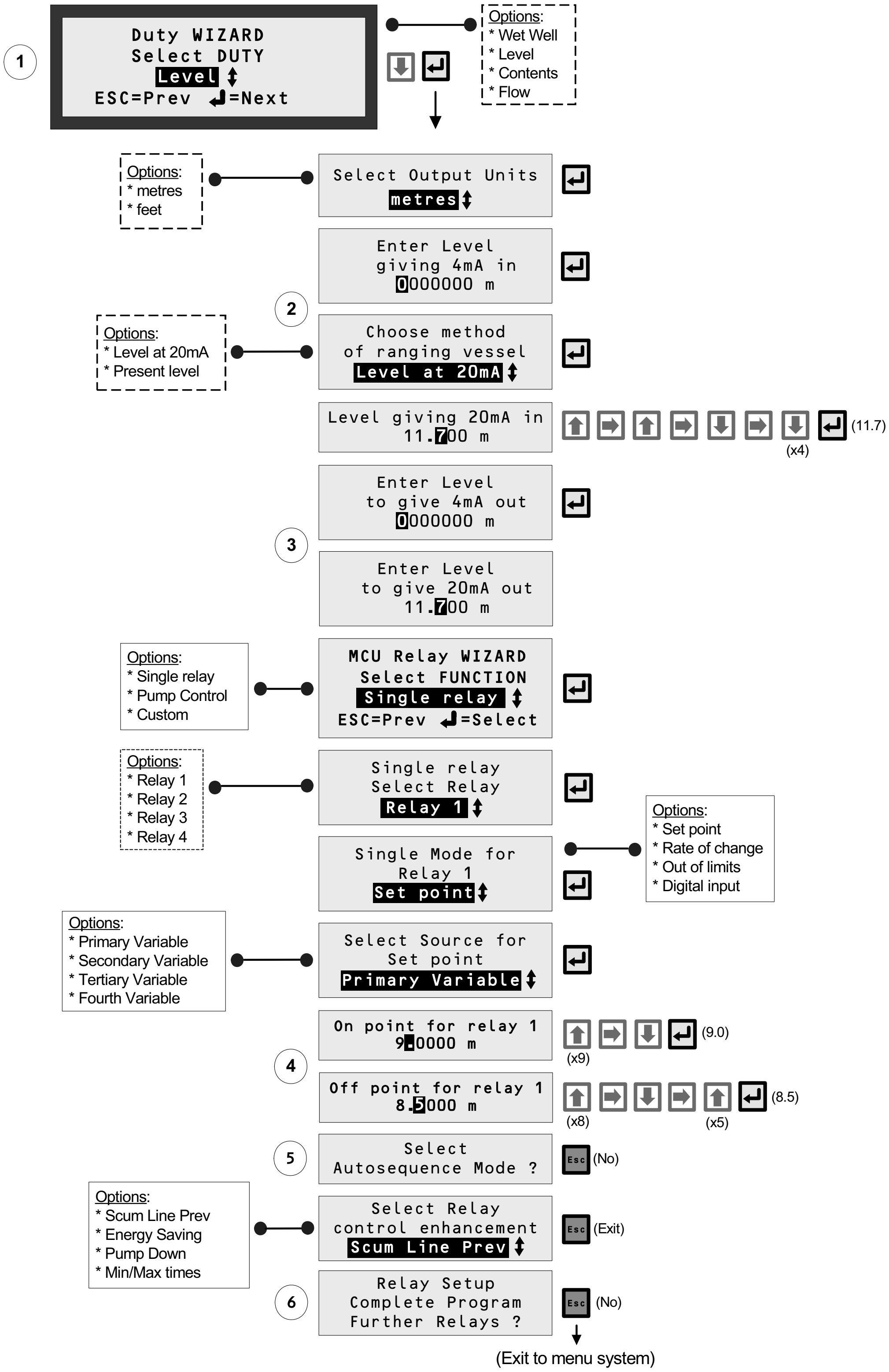


Figure 42: Application/Duty: Level Measurement using a 4-20mA Level Transmitter

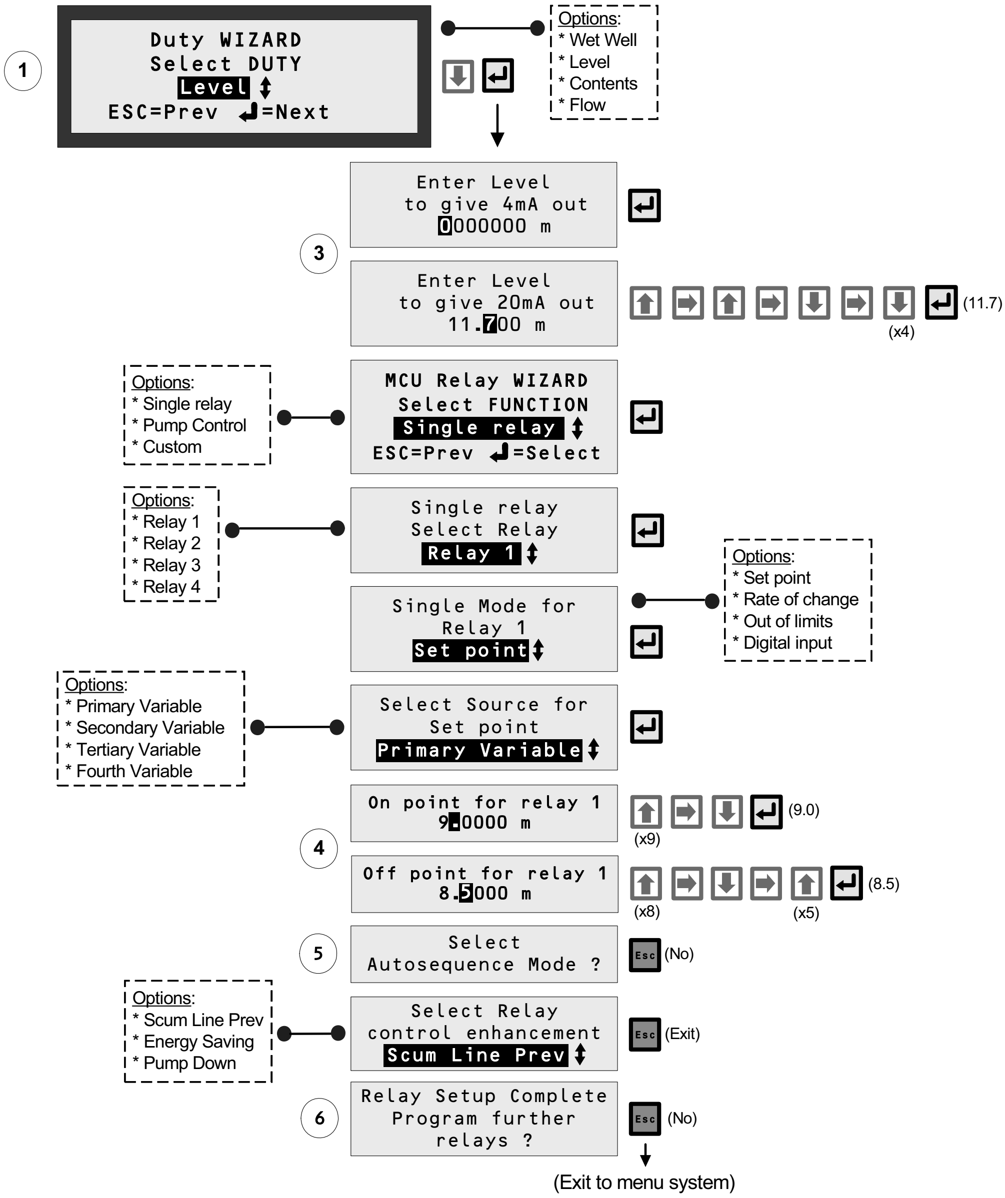
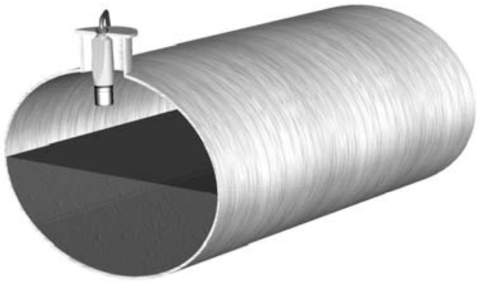


Figure 43: Application/Duty: Level Measurement using a HART Transmitter

D.4 DUTY Wizard: Content from a Level Transmitter (MCU901/LOG Only)

Note: ensure that MCU Channel 1 is set-up appropriately *before starting* the Duty Wizard

1. With power on and the transmitter giving a 4-20mA or HART signal to the MCU Control Unit, you can now set-up the MCU Control Unit for an application.



Requirement

Live contents measurement in units of litres.

Input Data

Tank Shape: horizontal cylinder with flat ends.
Tank Diameter: 2.5 metres.
Tank Length: 5 metres.

The transmitter is supplying live level measurements in units of metres.

2. Navigate the menu system to get to the "Duty Wizard" screen.

3. Start the "Duty" Wizard by pressing the yellow (**ENTER**) button *once*.

4. Work through the "Duty" Wizard prompts (Figure 44 or Figure 45) until completion; this occurs when the menu system re-appears. Keypad hints, for the illustrated Wizard sequence on the next page, are provided alongside the prompts. If applicable, adapt the example to suit your application.

5. Circled numbers in the illustrated Wizard sequence relate to these notes:

① Select "Contents" from the multiple-choice list.

② The required tank shape is a pre-programmed shape from the MCU Control Unit library.

③ Maximum contents as calculated by MCU Control Unit. It can be edited here if required.

④ Set-up the 4-20mA output span with a content range (e.g. 0 to 24,543.5 litres)

⑤ Set-up relay RL1 to be energised whenever the measured content falls below 2000 litres and de-energises on rising above 2500 litres, as defined at these prompts.

⑥ Option for relay auto-sequencing.

⑦ Option to set-up further relays.

6. Return to the main menu by holding the **ESC** button for a few seconds, releasing it when the main menu appears. Next, go on-line by selecting the "Go on-line" menu option and then pressing the **ENTER** button *once*. Finally, press the **ESC** button repeatedly until the primary display appears. The level measurement will be live on the primary display.

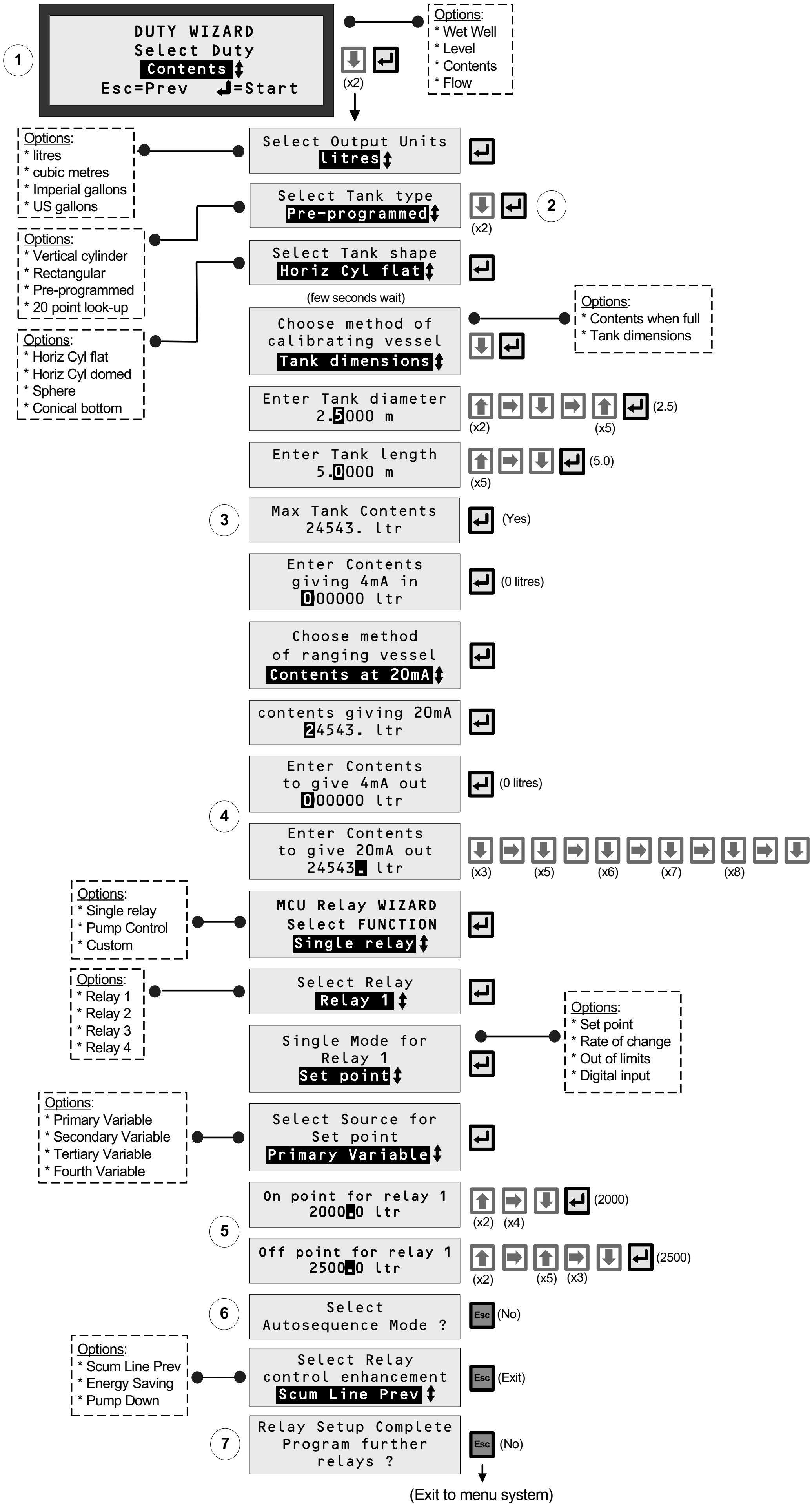


Figure 44: Application/Duty: Contents measurement using a 4-20mA Level Transmitter

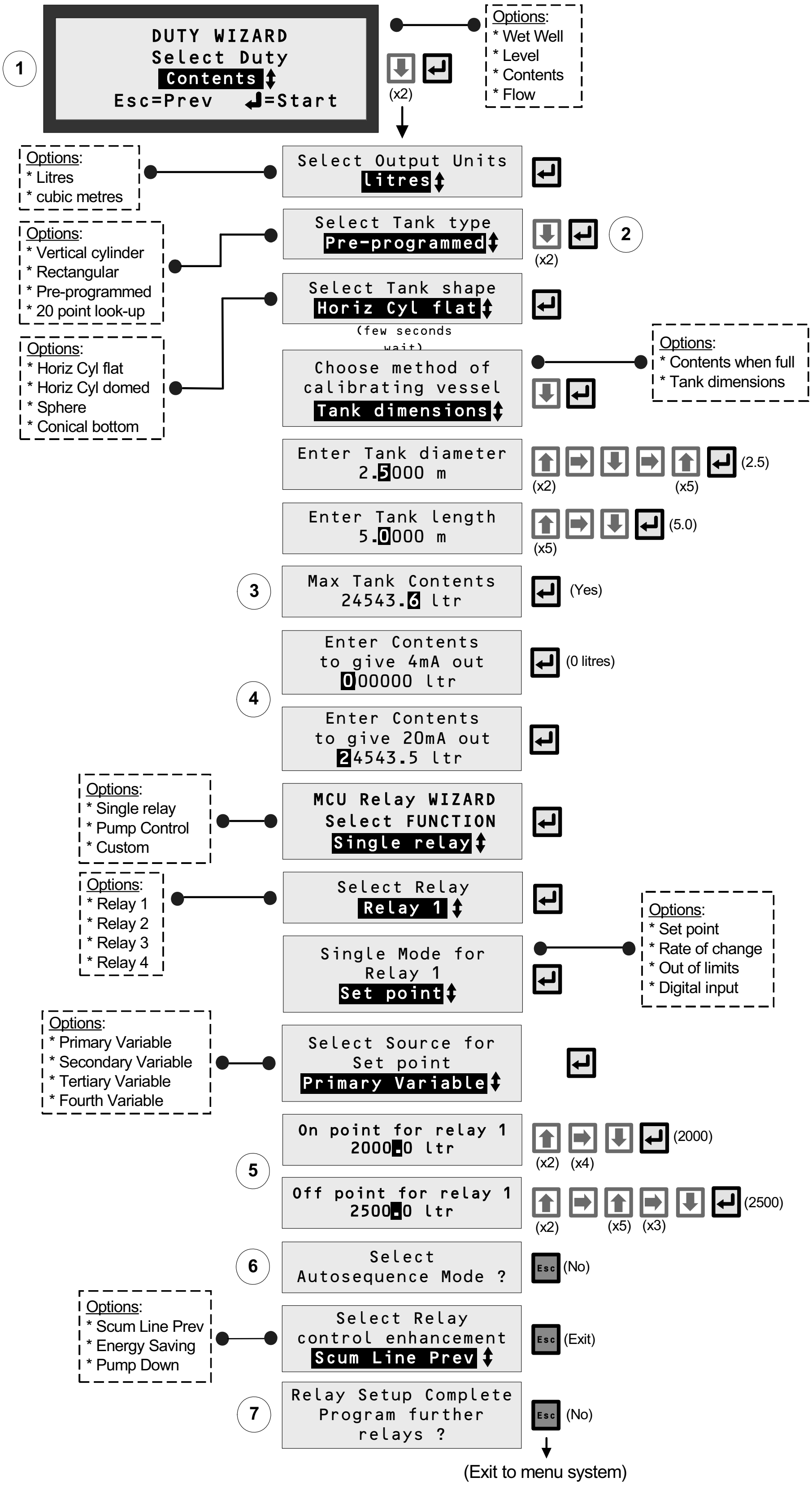
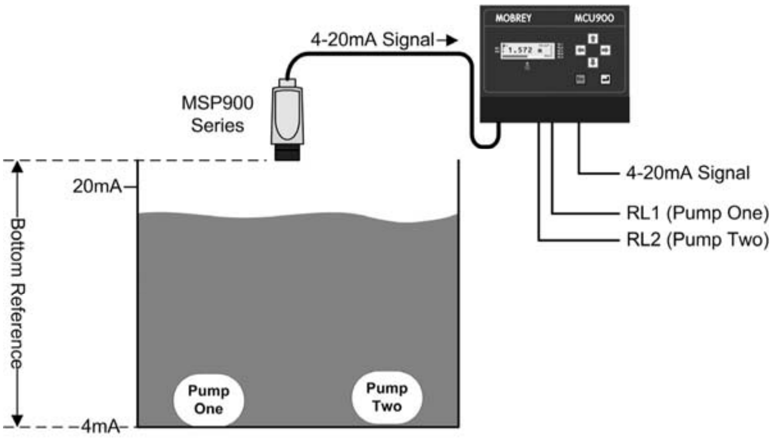


Figure 45: Application/Duty: Contents measurement using a HART Transmitter

D.5 DUTY Wizard: Wet Well Control (MCU901/LOG Only)

Note: ensure that MCU Channel 1 is set-up appropriately *before starting* the Duty Wizard.

1. With power on and the transmitter giving a 4-20mA or HART signal to the MCU Control Unit, you can now configure the MCU Control Unit for an application. **This application example is for a Wet Well with pump control.**



Requirement

- Live measurement in units of metres.
- Emptying application with **2 pumps**
- RL1 On at 2.0m at and Off at 0.5m
- RL2 On at 3.8m and Off at 3.3m
- Additional relay functions: None

Input Data

- Tank Shape: Square
- Bottom Reference: 5 metres

The transmitter is supplying the live level measurements in units of metres.

2. Navigate the menu system to get to the "Duty Wizard" screen.

3. Start the "Duty" Wizard by pressing the yellow (**ENTER**) button *once*.

4. Work through the "Duty" Wizard prompts (Figure 46 or Figure 47) until completion; this occurs when the menu system re-appears. Keypad hints, for the illustrated Wizard sequence on the next page, are provided alongside the prompts. If applicable, adapt the example to suit your application.

5. Circled numbers in the illustrated Wizard sequence relate to these notes:

① Select "Wet Well" from the multiple-choice list.

② Set-up the 4-20mA input span with a level range (e.g. 0 to 4.7 metres)

③ Set-up the 4-20mA output span with a level range (e.g. 0 to 4.7 metres)

④ Set-up of On and Off points for Relay 1 (Pump 1) and Relay 2 (Pump 2).

⑤ Options for switching lead pump according to specified criteria (e.g. number of times used).

⑥ Option to set-up further relays.

6. Return to the main menu by holding the **ESC** button for a few seconds, releasing it when the main menu appears. Next, go on-line by selecting the "Go on-line" menu option and then pressing the **ENTER** button *once*. Finally, press the **ESC** button repeatedly until the primary display appears. The level measurement will be live on the primary display.

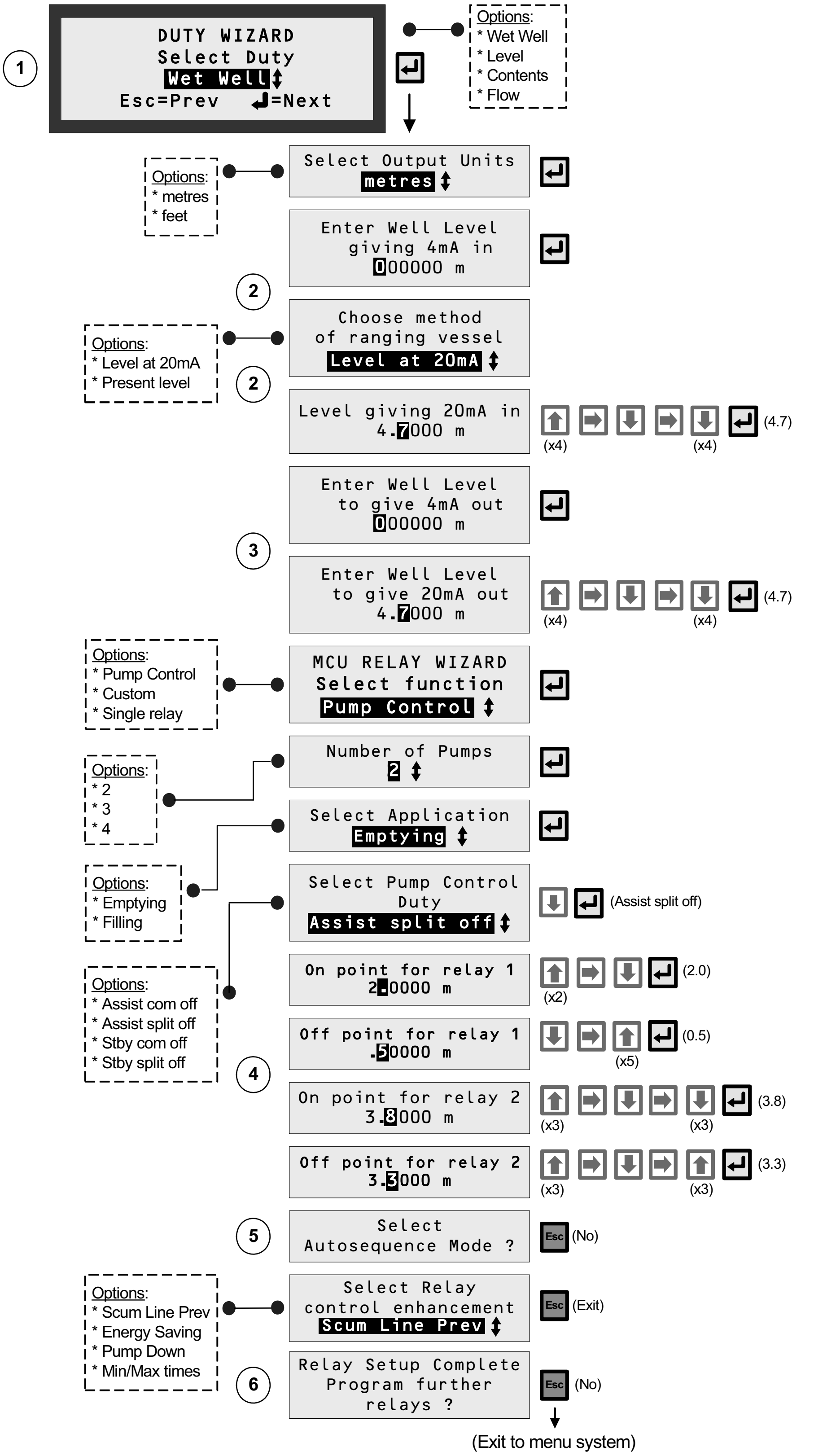


Figure 46: Application/Duty: Wet well control using a 4-20mA Level Transmitter

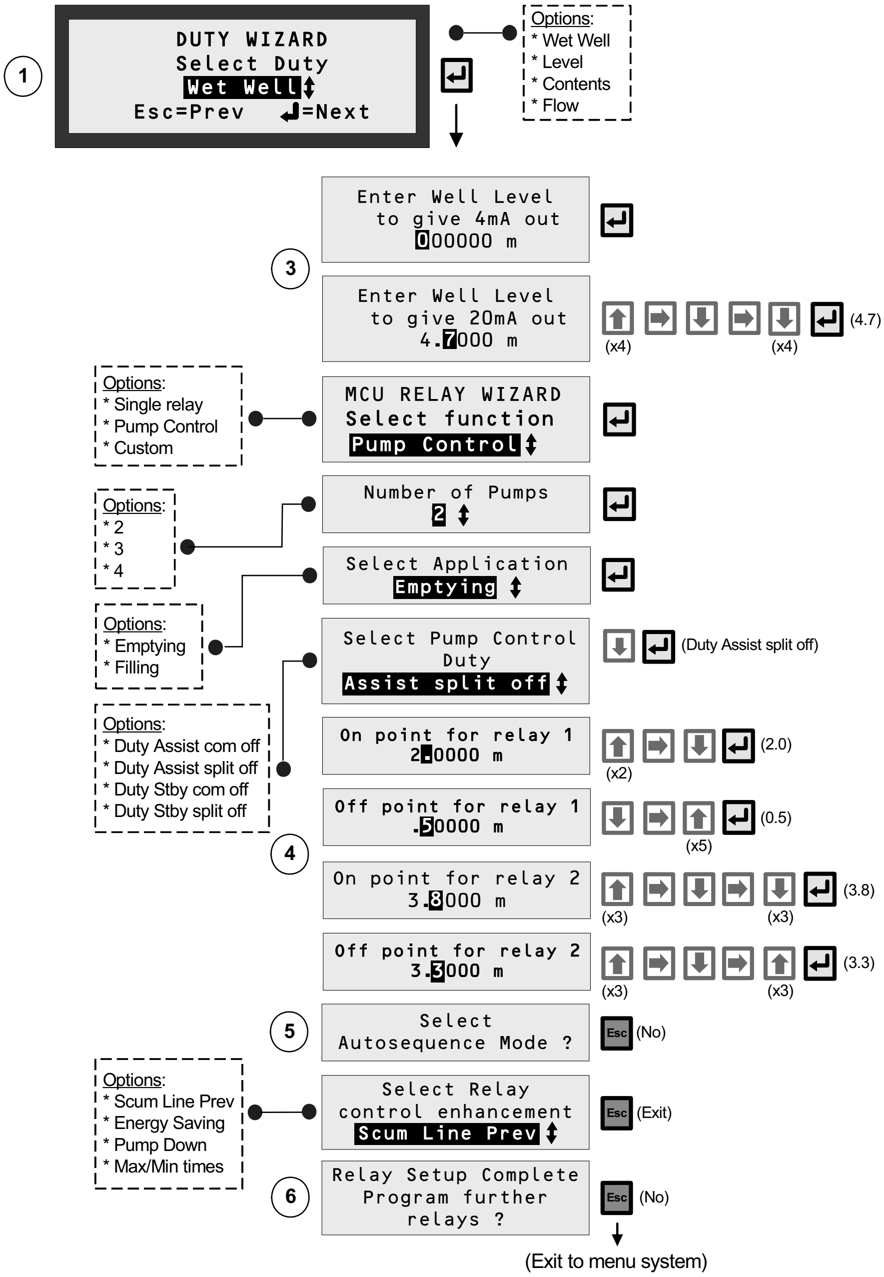
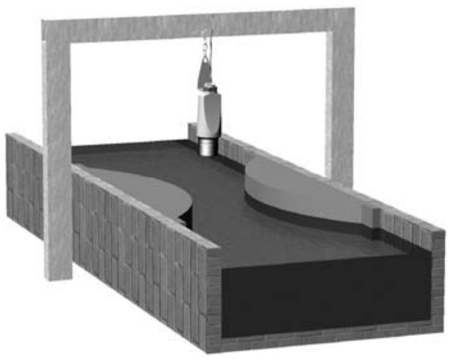


Figure 47: Application/Duty: Wet well control using a HART Transmitter

D.6 DUTY Wizard: Flow Measurement (MCU901/LOG Only)

Note: ensure that MCU Channel 1 is set-up appropriately *before starting* the Duty Wizard.

1. With power on and the transmitter giving a 4-20mA or HART signal to the MCU Control Unit, you can now configure the MCU Control Unit for an application. **This application example is for flow measurements.**



Requirement
Live flow measurements in units of cubic metres per second.
Totalised flow in cubic metres per second.

Input Data
Channel Shape: Flume
Maximum depth: 1 metre
Maximum rate: 1 cubic metre per second

The transmitter is supplying live level measurements in units of metres.

Output Data
The MCU Control Unit will be calculating the flow rate.

2. Navigate the menu system to get to the "Duty Wizard" screen.

3. Start the "Duty" Wizard by pressing the yellow (**ENTER**) button *once*.

4. Work through the "Duty" Wizard prompts (Figure 48 or Figure 49) until completion; this occurs when the menu system re-appears. Keypad hints, for the illustrated Wizard sequence on the next page, are provided alongside the prompts. If applicable, adapt the example to suit your application.

5. Circled numbers in the illustrated Wizard sequence relate to these notes:

(Figure 48)

① Select "Flow" from the multiple-choice list.

② Enter the maximum rate of flow.

③ Option of registering flow as 0 m^3/s on the MCU while the measured flow rate is below a programmed cut off.

④ Set-up the 4-20mA output span with a flow rate range (e.g. 0 m^3/s to 1 m^3/s)

⑤ Option to set-up a relay to output (100ms) pulses representing the totalised flow.

(Figure 49)

① Select "Flow" from the multiple-choice list.

② Enter the maximum rate of flow.

③ Enter the present height of maximum flow in the Flume.

④ Option of registering flow as 0 m^3/s on the MCU while the measured flow rate is below a programmed cut off.

⑤ Set-up the 4-20mA output span with a flow rate range (e.g. 0 m^3/s to 1 m^3/s)

⑥ Option to set-up a relay to output (100ms) pulses representing the totalised flow.

6. Return to the main menu by holding the **ESC** button for a few seconds, releasing it when the main menu appears. Next, go on-line by selecting the "Go on-line" menu option and then pressing the **ENTER** button *once*. Finally, press the **ESC** button repeatedly until the primary display appears. The flow measurement will be live on the primary display.

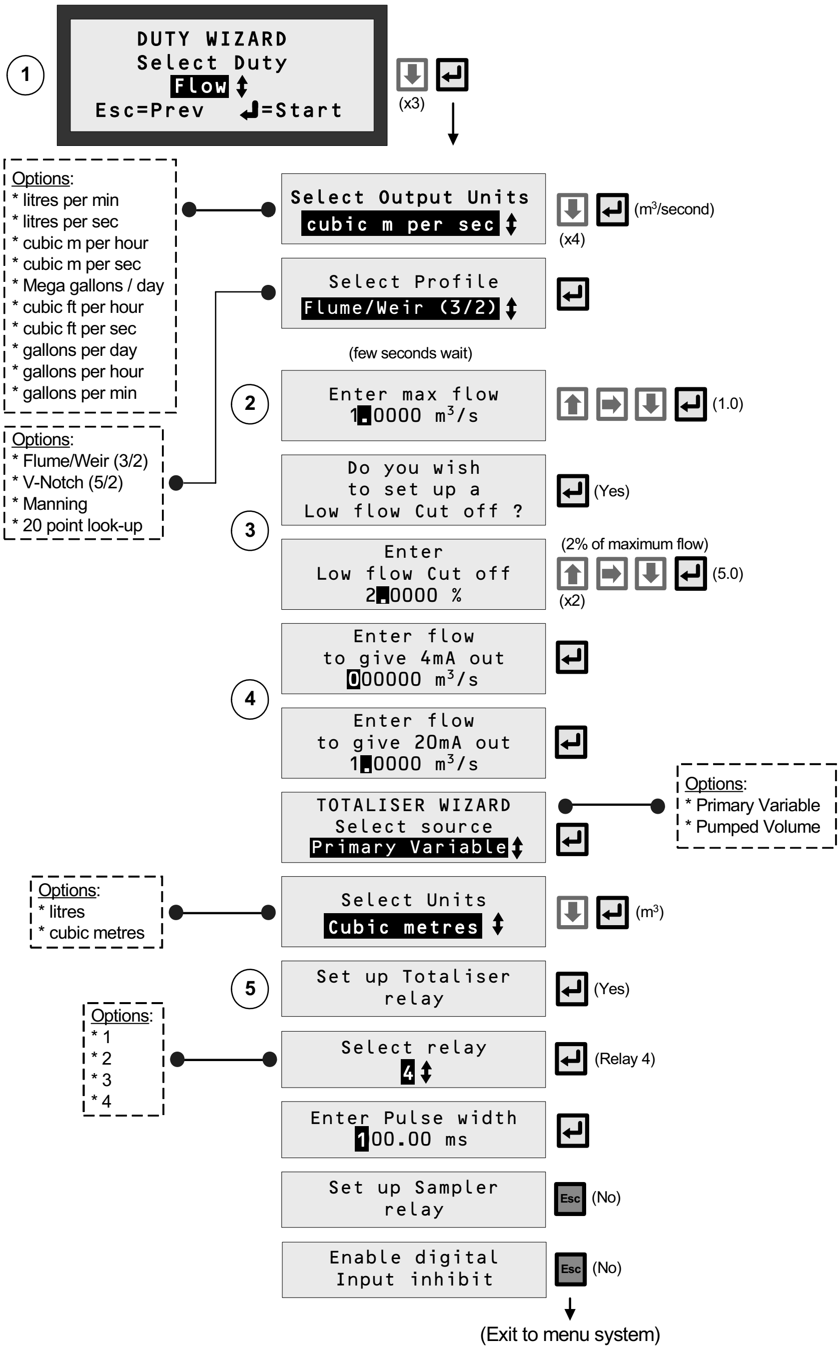


Figure 48: Application/Duty: Flow measurement using a 4-20mA Level Transmitter

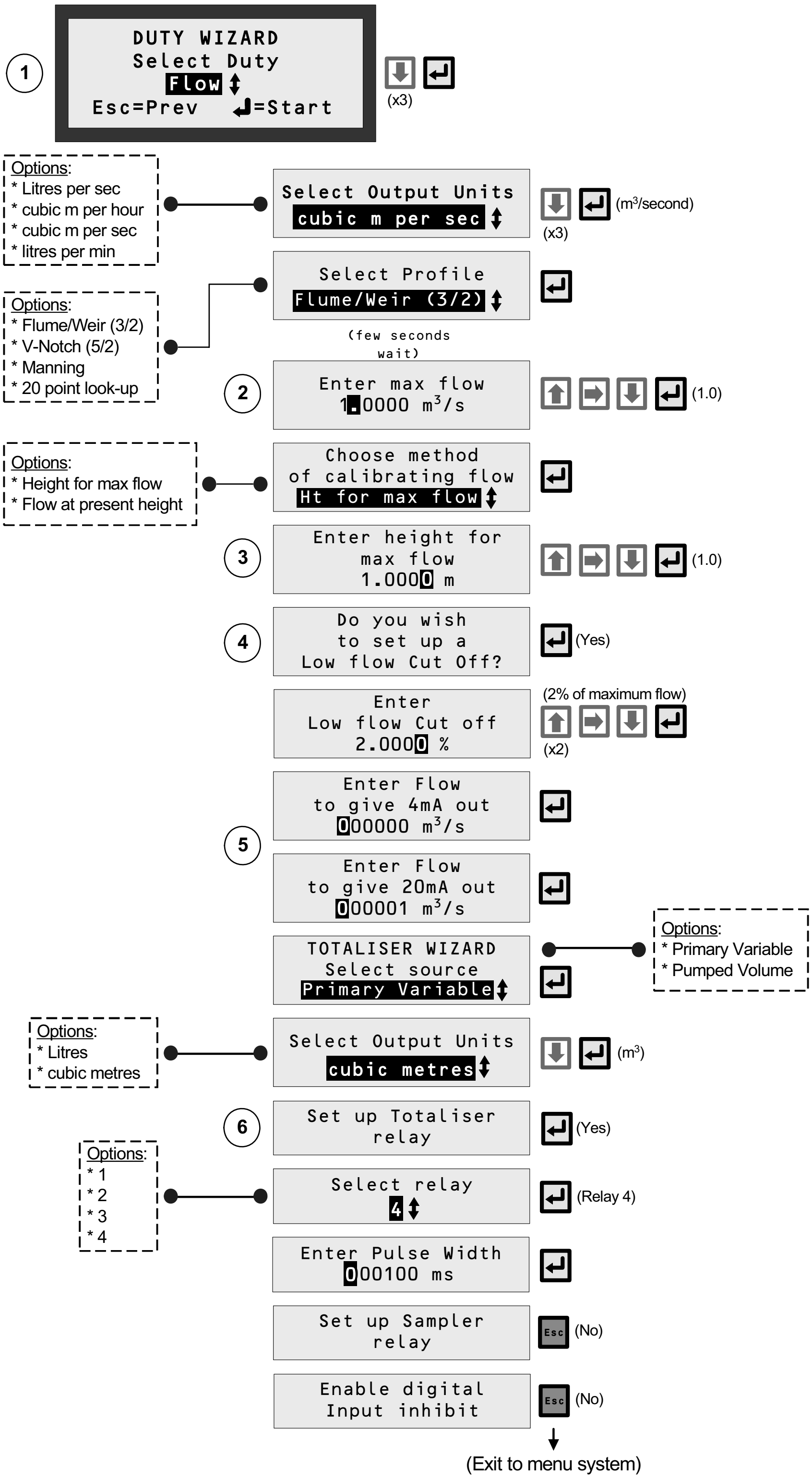
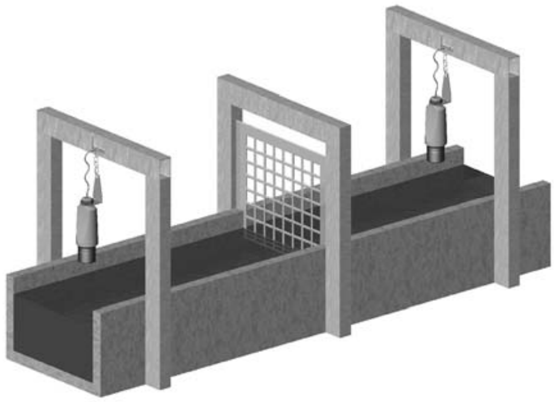


Figure 49: Application/Duty: Flow measurement using a HART Level Transmitter

D.7 DUTY Wizard: Level difference across a screen (MCU902 Only)

Note: ensure that MCU Channels 1 and 2 are set-up appropriately *before* starting the Duty Wizard.

1. With power on and the HART transmitters communicating with the MCU902 unit, you can now configure the MCU902 for an application. **This application example is for level differential across a screen.**



Requirements

- **2** HART transmitters.
- Measure the level each side of a screen and compute the difference in level across the screen.
- Activate a relay once the difference reaches 0.5m, with a relay differential of 0.4m, and give a 4-20mA signal proportional to a level difference of maximum 1m.

Input Data

- Depth of inlet is 4.5m. The transmitters are supplying the live level readings each side of the screen in metres.

2. Navigate the menu system to get to the "Duty Wizard" screen.

3. Start the "Duty" Wizard by pressing the yellow (**ENTER**) button *once*.

4. Work through the "Duty" Wizard prompts (Figure 50) until completion; this occurs when the menu system re-appears. Keypad hints, for the illustrated Wizard sequence on the next page, are provided alongside the prompts. If applicable, adapt the example to suit your application.

5. Circled numbers in the illustrated Wizard sequence relate to these notes:

① Select "Difference" from the multiple-choice list.

② Set-up the 4-20mA output span with a level range (e.g. 0 to 1.0 metres)

③ Set-up a relay – the relay RL1 is energised whenever the measured level exceeds a pre-set level and de-energises below another pre-set level, as defined at these prompts.

④ Optional auxiliary functions can be selected.

⑤ Option to set-up further relays.

6. Return to the main menu by holding the **ESC** button for a few seconds, releasing it when the main menu appears. Next, go on-line by selecting the "Go on-line" menu option and then pressing the **ENTER** button *once*. Finally, press the **ESC** button repeatedly until the primary display appears. The flow measurement will be live on the primary display.

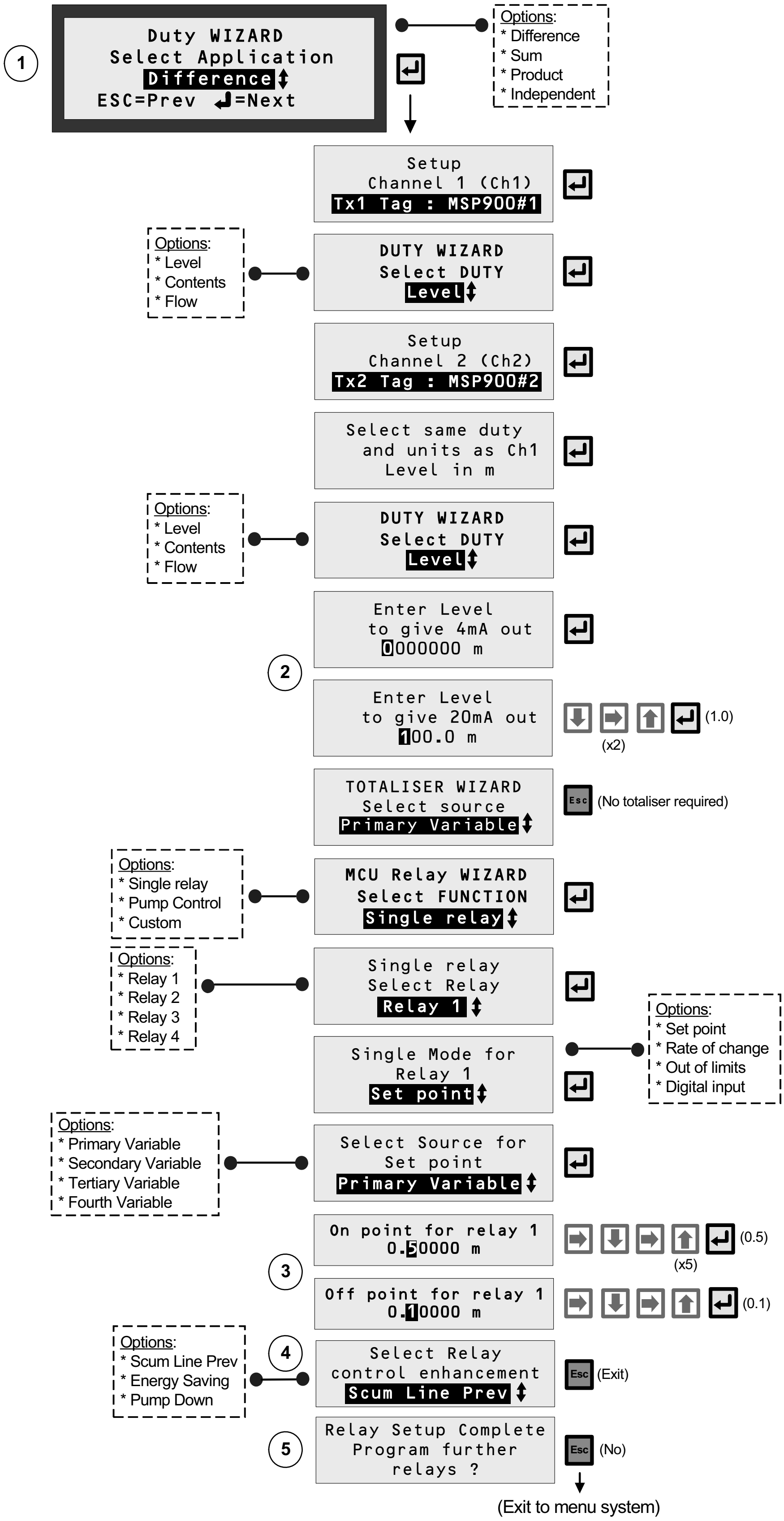
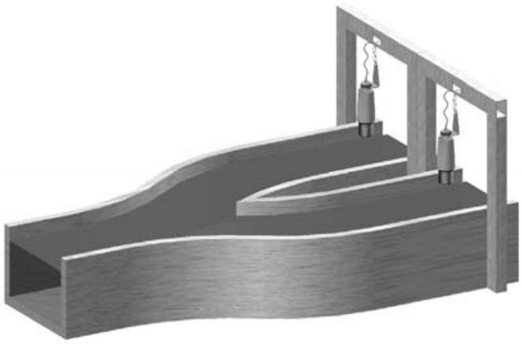


Figure 50: Application/Duty – Level Difference across a screen using Duty Wizard (and 2 HART transmitters)

D.8 DUTY Wizard: Sum of two flows in two inlet channels (MCU902 Only)

Note: ensure that MCU Channels 1 and 2 are set-up appropriately *before* starting the Duty Wizard.

1. With power on and the HART transmitters communicating with the MCU902 unit (see previous pages), you can now set-up the MCU902 for an application. **This application example is for the sum of two flows.**



Requirement

- 2 HART transmitters.
- Measure flow in each channel and sum the flows to give a total flow into works.
- Readout totalised flow into works and give a 4-20mA signal proportional to flow between 50 litres and 12,000 litres/min.
- Activate low flow cut off if flow in either channel is less than 50 litres/min.

Input Data

- Two channels are identical flat plate weir flow structures and the HART transmitters are supplying the live level readings from each channel in metres using a bottom reference of 1.0 m.
- Maximum flow of 5975 litres/min occurs at 0.6 metres level.

2. Navigate the menu system to get to the "Duty Wizard" screen.

3. Start the "Duty" Wizard by pressing the yellow (**ENTER**) button *once*.

4. Work through the "Duty" Wizard prompts (Figure 51) until completion; this occurs when the menu system re-appears. Keypad hints, for the illustrated Wizard sequence on the next page, are provided alongside the prompts. If applicable, adapt the example to suit your application.

5. Circled numbers in the illustrated Wizard sequence relate to these notes:

① Select "Flow" from the multiple-choice list.

② Enter the maximum rate of flow.

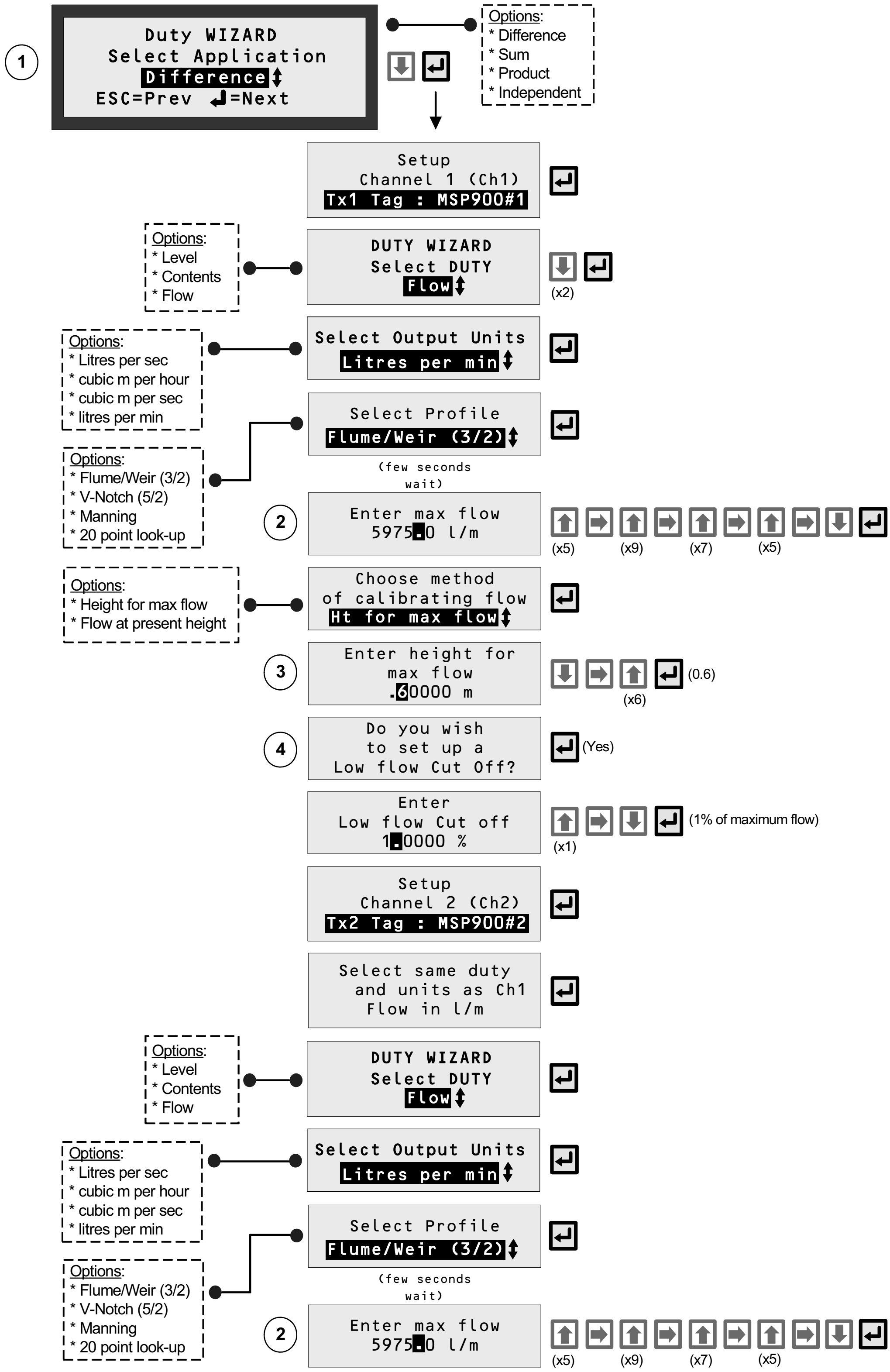
③ Enter the height that relates to the maximum flow in the Flume.

④ Option of registering flow as 0 l/m on the MCU902 while the measured flow rate is below a programmed cut off.

⑤ Set-up the 4-20mA output span with a flow rate range (e.g. 50 l/m to 12,000 l/m)

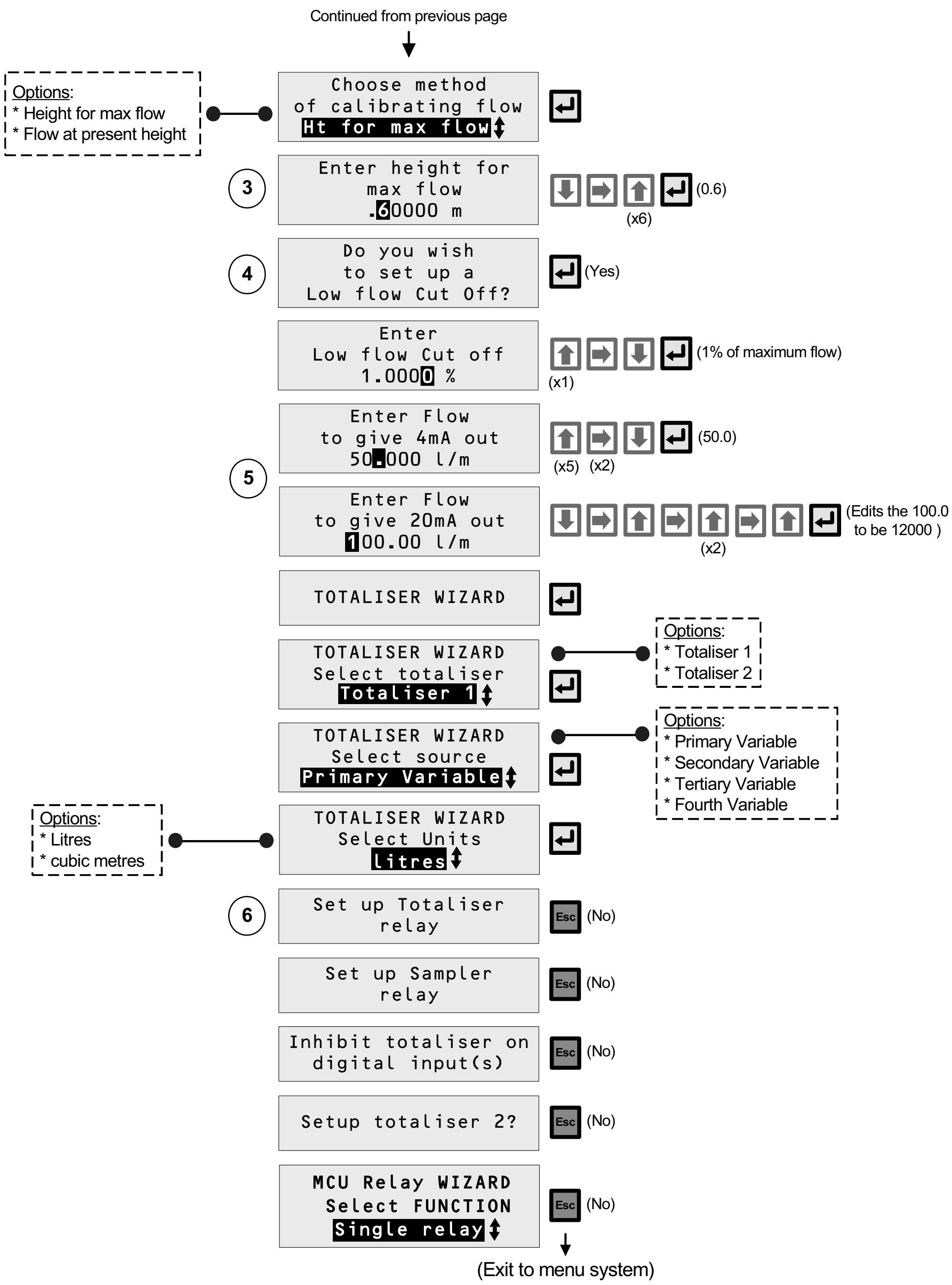
⑥ Option to set-up a relay to output (100ms) pulses, where 1 pulse is output for a user-defined flow volume through the channel.

6. Return to the main menu by holding the **ESC** button for a few seconds, releasing it when the main menu appears. Next, go on-line by selecting the "Go on-line" menu option and then pressing the **ENTER** button *once*. Finally, press the **ESC** button repeatedly until the primary display appears. The flow measurement will be live on the primary display.



(PART 1 OF 2)

Figure 51: Application/Duty – Sum of flow in two inlet channels using 2 HART transmitters



(DUTY/APPLICATION – SUM OF FLOW IN TWO INLET CHANNELS - PART 2 OF 2)

Appendix E Reporting of Alarms and Faults

Table 13: Reporting of Alarms and Faults

CATEGORY	SOURCE	CAUSE	AS SEEN ON DISPLAY	Status LED	Primary Display	Pxxx Screen	Relay	Current Output	Alarm Report (D830)	Fault Report (D831)
ALARM	MCU	PV out-of-limits	PV OL				✓	✓	✓	
		Current Output ≤ 3.8mA or ≥ 20.5mA	mA Out Sat				✓		✓	
		Logging Memory almost full	Log Mem Filling				✓	✓	✓	
		Digital input #1 and/or #2 active	Digital_input #1 and/or #2				✓	✓	✓	
		Custom relay operation retries exceeded	Max Retries				✓	✓	✓	
		Current input saturated < 3.7mA	mA In1 Low				✓	✓	✓	
		Current input saturated > 20.75mA	mA In1 High				✓	✓	✓	
		Rising level despite relays on	Rising level				✓	✓	✓	
		Relay number of operations exceeded	Relay operations				✓	✓	✓	
		Relay runtime exceeded	Relay run time				✓	✓	✓	
		Pump efficiency below limit	Pump efficiency				✓	✓	✓	
		No activity of Control Relay	No activity				✓	✓	✓	
	XMTR	Communication Error	Comms Error			✓				
		Invalid Selection	Invalid Select			✓				
		Passed Parameter too Large	Too Large			✓				
		Passed Parameter too Small	Too Small			✓				
		Too Few Data Bytes Received	Too Few Bytes			✓				
		Transmitter Specific Command Error	Xmtr Specf Err			✓				
		In Write-Protect Mode	Write Protect			✓				
		Access Restricted	Access Restrtd			✓				
		Busy	Busy			✓				
		Command Not Implemented	Invalid request			✓				
		Transmitter PV out of limits	Xmtr PV OL						✓	
		PV Analogue Output Saturated	Xmtr PV Out Sat						✓	
		Non PV out of Limits	Xmtr Non-PV OL						✓	
FAULT	MCU	ROM Checksum Error	ROM CKS Error	✓	✓		✓	✓		✓
		RAM Test Error	RAM Test Error	✓	✓		✓	✓		✓
		Real Time Clock fault	Clock fault	✓	✓		✓	✓		✓
		EEPROM Signature Error	EEPROM Sig err	✓	✓		✓	✓		✓
		EEPROM Checksum Error	EEPROM CKS err	✓	✓		✓	✓		✓
		ADC Error	ADC Error	✓	✓		✓	✓		✓
		No Response from Instrument (for >1 min)	No Response (128)		✓	✓	✓	✓		✓
		Locked out by Bus Activity (for >1 min)	Locked Out (129)		✓	✓	✓	✓		✓
		Control Unit Temperature out of limits	CU Temp OL		✓		✓	✓		✓
	XMTR	Field Device Malfunction	Xmtr Fault (130)		✓		✓	✓		✓

Key: ✓ = yes, XMTR = transmitter, MCU = MCU Control Unit

Appendix F MCU900 Technical Specification

F.1 External connections

Refer to IP2030/IM for all connections details and safety information. You can make the following types of connection to the MCU900 family of control units:

• INPUTS	Analogue or HART (digital)	Input from transmitters which continuously measure parameters e.g. liquid level and transmit measurements as analogue or digital HART signals
	Digital	Voltage-free contact closure for triggering actions or indicating a change of status
• OUTPUTS	Analogue	Output from MCU900 to other devices that require 4-20mA analogue signals
	Relay	For output to equipment such as pump controllers or electro-mechanical totalisers
• COMMUNCTIONS	Serial port	For receiving from and sending information to other devices connected to MCU900
• POWER SUPPLY	Input only	AC or DC

F.2 Specification

Environmental

• Ambient temperature		-40°C to +55°C
• Relative humidity	Wall mount Panel mount	≤ 100% ≤ 90% non-condensing
• Electrical safety		EN61010-1
• Enclosure rating	Wall mount Panel mount	IP65 indoor/outdoor IP40 indoor mount. (IP65 if with optional hood)
• Vibration	Control Room Field Mounted	0.1 – 200Hz, 0.5g acceleration 0.1 – 200Hz, 1.0g acceleration, 200 – 2000Hz, 0.5g acceleration
• Installation category		III : Supply voltage < 127Vac – IEC664 II : Supply voltage < 254Vac – IEC664
• Pollution degree		2 – IEC664
• Maximum altitude		2000 metres
• Approvals		ATEX Coding II (1) G CENELEC Coding [EEx ia] IIC -40°C to +55°C
• EMC	Emissions Immunity	EN50081-1 (Commercial, Domestic and Light industrial) EN50082-2 (Industrial)

General

• Construction materials	Wall mount	Polycarbonate enclosure and cover (Black) 304SS cover fixing screws UV resistant Polycarbonate membrane keypad Nylon cable glands and blanking plugs
	Panel mount	Polyphenylene enclosure and cover (Black) Carbon Steel / Zinc plated fascia fixing screws UV resistant Polycarbonate membrane keypad Nylon + PBT terminal blocks with plated fittings
• Dimensions	Wall mount	213mm wide x 185mm high x 84mm deep
	Panel mount	Panel cut-out : 138mm wide x 68mm high Allow 165mm clearance behind panel
• Weight	Wall mount	1.4kg (mains unit) or 1.0kg (DC unit)
	Panel mount	1.2kg (mains unit) or 0.8kg (DC unit)
• Cable entry	Wall mount	5 positions pre-drilled. 2 glands and 3 blanking plugs provided
	Panel mount	Cage clamp terminal block at rear Maximum 2.5mm^2 cable

Power Supply

Refer to IP2030/IM for all connections details and safety information.

• AC input	Supply voltage	115V or 230V ac +/- 15% (switch selectable)
	Supply frequency	50 or 60Hz
	Power consumption	10VA nominal. 18VA maximum
	Fuse	200mA(T), 5 x 20mm, 250V
• DC input	Supply voltage	15 to 30V dc, 30V dc maximum
	Power consumption	9w maximum

Display

	Type	Dot matrix LCD, 32 x 122 pixels, back lit
	Location	Integrated into enclosure
	LED	Single red LED

Inputs

Refer to IP2030/IM for all connections details and safety information.

• Digital input	Quantity	2
	Type	Voltage-free contact closure
• Current Input	Quantity	1
	Type	4 - 20mA (Earth referenced in MCU) or HART Digital communications (Rev. 5)

Outputs

Refer to IP2030/IM for all connections details and safety information.

• Current output	Quantity	1
	Signal range (nominal)	4 - 20mA
	Output range (linear)	3.8 - 20.5mA. (Alarm current of 3.6 or 21mA – user-selectable)
	Load	R_{max} is 1 KΩ
	Resolution	12-bit
	Regulation	< 0.1% over load change from 0 to 600Ω
	Isolated	Isolated from other terminals to 500V dc
	Update rate (software)	5 Hz
• Relays	Quantity	5
	Type	SPCO
	Rating	5A at 240V ac

Communications

Refer to IP2030/IM for all connections details and safety information.

• Serial Communications	1 Serial Port	RS232 full duplex Maximum baud rate is 19k2

Appendix G Menus and Parameters

Appendix G contains the menu system maps for the MCU901, MCU902, MCULOG and the MSP900 Series ultrasonic transmitters. Use Table 14 to determine which menu system maps are applicable to your MCU Control Unit.

Table 14: Applicable Menu System Maps

MCU Control Unit	MSP900 Series Transmitter Connected	Applicable Menu Maps
MCU901	Yes	Table 15 and Table 17
MCU901	No	Table 15
MCU902	Yes	Table 16 and Table 17
MCU902	No	Table 16
MCULOG	Yes	Table 15 and Table 17
MCULOG	No	Table 15

Table 15: MCU901/MCULOG Menus and Parameters

MAIN MENU	Menu Level 1	Menu Level 2	Menu Level 3	Parameter Number	Parameter Name	Units	Factory Default	Min.	Max.	Reference Pages
Cancel Password					Cancel Password	-	-	-	-	68
Go Offline ?					Go Online/Offline ?	-	-	-	-	22
SETUP *	INPUT CHANNEL			P111	MCU Channel 1 Input Source	-	Tx1 : PV	-	-	25, 29
				P321	MCU Current Input 1 Damping	sec	5	0	99.9	25 - 31
				P112	MCU Channel 1 Input Offset	-	0	-	-	25, 29
				P113	MCU Channel 1 Profile	-	Scaled	-	-	25, 29
				P114	MCU Channel 1 Input Scale Factor	-	1	-	-	25, 29, **33** - **37**
				P115	MCU Channel 1 Non-Linear Data	-	0	-	-	25, 29, **33** - **37**
				P116	MCU Channel 1 Post Scale	-	1	-	-	25, 29, **33** - **37**
				P117	MCU Channel 1 Low Cut-off	as P201	AUTO	-	-	25, 29
	DUTY(Mode)				Duty Wizard	-	0	-	-	Appendix D
		UNITS		P200	PV Units	-	%	-	-	25 - 31, 44 - 45
				P201	SV Units	-	%	-	-	25 - 31
				P202	TV Units	-	%	-	-	25 - 31
				P203	FV Units	-	°C	-	-	29 - 31
		PV DAMPING		P210	Output PV Damping	s	0	-	-	25 - 31
				P240	Description	-	MCU CONTROL	-	-	66
				P241	Message	-	MESSAGE	-	-	41, 66
				P242	Tag Number – Control Unit	-	MSP2000	-	-	66
		CUSTOM		P250	Start On	-	None	0	4	57
				P251	Stop On	-	None	0	3	57
				P252	Stop If	-	None	0	253	57
				P253	Start Time	hh.mm	07:00	-	-	57
				P254	Interval	hh.mm	01:00	-	-	57
				P255	Start Time #2	hh.mm	00:00	-	-	57
				P256	Interval #2	hh.mm	00:00	-	-	57
				P257	Max Retries	-	10	0	250	57, 60
		OVERRIDES		P270	Auto Sequence Enable	-	Off	-	-	56
				P271	Auto Sequence Qualifier	-	0	-	-	56
				P272	Pump-down Relay	-	0	-	-	57

* Selecting the SETUP menu presents a SELECT INSTRUMENT screen if a HART transmitter is known to the MCU Control Unit. If this happens, select MCU CONTROL UNIT to see Menu Level 1 options. If you select a HART transmitter ‘tag’, see Table 17.

MAIN MENU	Menu Level 1	Menu Level 2	Menu Level 3	Parameter Number	Parameter Name	Units	Factory Default	Min.	Max.	Reference Page(s)
				P273	Pump-down Interval	hh.mm	00:00	-	-	57
				P274	Pump-down Duration	hh.mm	00:00	-	-	57
				P275	Energy Saving Start Time	hh.mm	00:00	-	-	56
				P276	Energy Saving Relay Select	-	0	-	-	56
				P277	Scum Line Prevention variance	-	0	-	-	56
				P278	Scum Line Prevention relay	-	0	-	-	56
	DIGITAL INPUT	DIGITAL INPUT 1		P340	Digital Input 1 Action	-	Free	-	-	41
				P341	Digital Input 1 Delay	mmm:ss	000:00	-	-	41
				P342	Digital Input 1 On State	-	Closed	-	-	41
		DIGITAL INPUT 2		P345	Digital Input 2 Action	-	Free	-	-	41
				P346	Digital Input 2 Delay	mmm:ss	000:00	-	-	41
				P347	Digital Input 2 On State	-	Closed	-	-	41
	OUTPUT	CURRENT OUTPUT		P400	Lower range value	as P200	0	-	-	46
				P401	Upper range value	as P200	100	-	-	37, **46**
				P402	Alarm action	-	3.6mA	-	-	**46**, 61
		RELAY			Relay Wizard	-	0	-	-	47
					Reset RL Params			-	-	48
			RELAY 1	P410	Relay 1 Mode	-	None	-	-	48
				P411	Relay 1 ON Point	as P200	0	-	-	**48**, 51, 53
				P412	Relay 1 OFF Point	as P200	0	-	-	**48**, 51, 53
				P413	Relay 1 Minimum ON Time	mmm:ss	000:00	-	-	48
				P414	Relay 1 Maximum ON Time	mmm:ss	000:00	-	-	48
				P415	Relay 1 Minimum OFF Time	mmm:ss	000:00	-	-	48
			RELAY 2	P420	Relay 2 Mode	-	None	-	-	48
				P421	Relay 2 ON Point	as P200	0	-	-	**48**, 51, 53
				P422	Relay 2 OFF Point	as P200	0	-	-	**48**, 51, 53
				P423	Relay 2 Minimum ON Time	mmm:ss	000:00	-	-	48
				P424	Relay 2 Maximum ON Time	mmm:ss	000:00	-	-	48
				P425	Relay 2 Minimum OFF Time	mmm:ss	000:00	-	-	48
			RELAY 3	P430	Relay 3 Mode	-	None	-	-	48
				P431	Relay 3 ON Point	as P200	0	-	-	48
				P432	Relay 3 OFF Point	as P200	0	-	-	48
				P433	Relay 3 Minimum ON Time	mmm:ss	000:00	-	-	48

MAIN MENU	Menu Level 1	Menu Level 2	Menu Level 3	Parameter Number	Parameter Name	Units	Factory Default	Min.	Max.	Reference Page(s)
				P434	Relay 3 Maximum ON Time	mmm:ss	000:00	-	-	48
				P435	Relay 3 Minimum OFF Time	mmm:ss	000:00	-	-	48
			RELAY 4	P440	Relay 4 Mode	-	None	-	-	48
				P441	Relay 4 ON Point	as P200	0	-	-	48
				P442	Relay 4 OFF Point	as P200	0	-	-	48
				P443	Relay 4 Minimum ON Time	mmm:ss	000:00	-	-	48
				P444	Relay 4 Maximum ON Time	mmm:ss	000:00	-	-	48
				P445	Relay 4 Minimum OFF Time	mmm:ss	000:00	-	-	48
			RELAY 5	P450	Relay 5 Mode	-	Fault	-	-	48
				P451	Relay 5 ON Point	as P200	0	-	-	48
				P452	Relay 5 OFF Point	as P200	0	-	-	48
				P453	Relay 5 Minimum ON Time	mmm:ss	000:00	-	-	48
				P454	Relay 5 Maximum ON Time	mmm:ss	000:00	-	-	48
				P455	Relay 5 Minimum OFF Time	mmm:ss	000:00	-	-	48
			ALARM	P490	Rising level alarm delay	mmm:ss	000:00	-	-	58
				P491	Relay operations alarm limit	-	0	-	-	58
				P492	Relay operations relay select	-	Disabled	-	-	58
				P493	Relay runtime alarm limit	hh.mm	00:00	-	-	58
				P494	Relay runtime relay select	-	Disabled	-	-	58
				P495	Pump efficiency limit	-	0	-	-	58
				P496	Pump Efficiency relay select	-	0	-	-	58
				P497	No activity delay	hh:mm	00:00	-	-	58
				P498	No activity relay	-	0	-	-	58
		TOTALISER			Totaliser Wizard	-	0	-	-	**63**
				P530	Totaliser Factor	-	0	0	-	37, **62**
				P531	Totaliser Units	-	None	-	-	62
				P534	Totaliser Pulse width	ms	100	10	2500	62
				P535	Sampler Factor	-	0	0	-	55
		ALARM		P540	PV Out of Limits	-	None	-	-	60
				P541	Current Output Saturated	-	None	-	-	60
				P542	Logging Memory Filling	-	None	-	-	42, **60**
				P543	Digital Input Active	-	None	-	-	60
				P544	Maximum number of retries	-	None	-	-	60
				P545	Current Input Saturated	-	None	-	-	60

MAIN MENU	Menu Level 1	Menu Level 2	Menu Level 3	Parameter Number	Parameter Name	Units	Factory Default	Min.	Max.	Reference Page(s)
				P547	Rising level	-	None	-	-	60
			RELAY	P548	Relay operations	-	None	-	-	60
				P549	Relay runtime	-	None	-	-	60
				P550	Pump efficiency	-	None	-	-	60
				P551	No activity	-	None	-	-	61
		FAULT		P560	System Fault	-	Both	-	-	55
				P561	Control Unit Temperature over Limits	-	None	-	-	55
				P562	Transmitter Fault	-	Both	-	-	55
		DISPLAY		P570	Display Select 1 (upper)	-	P731-Time	-	-	66
				P571	Display Select 2 (mid)	-	D800-PV	-	-	66
				P572	Display Select 3 (lower)	-	Bargraph	-	-	66
				P573	Decimal places	-	3	-	-	66
				P575	Back light On/Off	-	On	-	-	66
	LOGGING				Logging Wizard	-	0	-	-	43 - 45
				P590	Logging interval	min	0	0	99	42 - 45
				P591	Fast logging select mode	as P200	0 (=Off)	0	-	42 - 45
				P592	Do/Do not overwrite old data	-	On	-	-	42 - 45
				P593	Low Memory Alarm Threshold	%	0	0	99	42 - 45
	SYSTEM	TEST	AUTO-CYCLE		Self Test	-	-	-	-	69
			DISPLAY		Display Test	-	-	-	-	69
			CURRENT INPUT		4mA input adjust	-	-	-	-	69
					20mA input adjust	-	-	-	-	69
			CURRENT OUTPUT	P700	4mA output adjust	-	-	-	-	70
				P701	20mA output adjust	-	-	-	-	70
				P702	Set Current	mA	0	-	-	69
		DEFAULTS			LOAD DEFAULTS	-	-	-	-	75
		COMMS		P710	Communications Address (of unit)	-	0	0	15	67
				P711	Interface Type	-	(“Log..” / “RS232”)	-	-	67
				P712	Baud Rate	-	9600 or 1200	-	-	67
				P713	Number of Start Bits	-	1	1	2	67
				P714	Number of Data Bits	-	8	7	8	67
				P715	Parity of Data	-	Odd	-	-	67
				P716	Number of Stop Bits	-	1	1	2	67
		SETTINGS		P730	Date	-	(Factory set)	-	-	23

MAIN MENU	Menu Level 1	Menu Level 2	Menu Level 3	Parameter Number	Parameter Name	Units	Factory Default	Min.	Max.	Reference Page(s)
				P731	Time	-	-	-	-	23
				P734	Date format	-	dd/mm/yy	-	-	23
				P735	Keypad Sound On/Off	-	On	-	-	23
				P737	Language	-	English	-	-	23
				P740	Personal Identification Code	-	0000	-	-	68
					Xmtr Wizard	-	0	-	-	Appendix B
		FIXED		D750	Model Code	-	(Factory set)	-	-	72
				D751	Serial Number – Control Unit	-	(Factory set)	-	-	72
				D752	Hardware Revision	-	(Factory set)	-	-	72
				D753	Software Version	-	(Factory set)	-	-	72
			HART	D760	Manufacturer's Code	-	Sol. Mobrey	-	-	72
				D761	Unique ID	-	(Factory set)	-	-	-
				D762	Universal Command Revision	-	5	-	-	-
				D763	Transmitter Spec. Command Rev.	-	1	-	-	-
				D764	Preamble Bytes	-	5	-	-	-
				D765	Flags	-	1	-	-	-
MONITOR *	READINGS	ANSWERS		D800	Primary Variable	as P200	-	-	-	25 - 31, 70
				D801	Secondary Variable	as P201	-	-	-	25 - 31, 70
				D802	Tertiary Variable	as P202	-	-	-	25 - 31, 70
				D803	Fourth Variable	as P203	-	-	-	25 - 31, 70
				D804	Ullage	as P200	-	-	-	70
				D805	% Current Output	%	-	-	-	70
				D806	Current output	mA	-	-	-	70
				D809	Rate of Change	PV/min	-	-	-	**55**, 59, 70
		RELAY	RELAYOPERATIONS	D811	Relay 1 Operations	-	0	-	-	**58**, 70
				D812	Relay 2 Operations	-	0	-	-	**58**, 70
				D813	Relay 3 Operations	-	0	-	-	**58**, 70
				D814	Relay 4 Operations	-	0	-	-	**58**, 70
				D815	Relay 5 Operations	-	0	-	-	**58**, 70
				D820	Relay Status	-	-	-	-	70
			RELAY RUN TIME	D821	Relay 1 runtime	hh:mm	-	-	-	**58**, 70
				D822	Relay 2 runtime	hh:mm	-	-	-	**58**, 70
				D823	Relay 3 runtime	hh:mm	-	-	-	**58**, 70

* Selecting the MONITOR menu presents a SELECT INSTRUMENT screen if a HART transmitter is known to the MCU Control Unit. If this happens, select MCU CONTROL UNIT to see Menu Level 1 options.

MAIN MENU	Menu Level 1	Menu Level 2	Menu Level 3	Parameter Number	Parameter Name	Units	Factory Default	Min.	Max.	Reference Pages
				D824	Relay 4 runtime	hh:mm	-	-	-	**58**, 70
				D825	Relay 5 runtime	hh:mm	-	-	-	**58**, 70
				D828	Totaliser 1 Value	As P531	-	0	0	55, **62**, 70
				D830	Alarm report	-	None	-	-	60, **71**, 105
				D831	Fault report	-	None	-	-	55, **71**, 105
	DIAGNOSTICS			D835	Digital input status	-	-	-	-	**41**, 71
				D840	Current input	mA	-	-	-	**25**, **27**, 71
				D842	Current input %	%	-	-	-	**25**, **27**, 71
				D844	Temperature of Control Unit	°C	-	-	-	**55**. 71
				D845	Time to next Pump Down	hh:mm	-	-	-	**57**, 71
				D846	Logging Memory Free	%	-	-	-	**42**, 71
				D848	Date of Last Change	dmy	--/--/--	-	-	71
				D849	Date of 1st Power-On	dmy	--/--/--	-	-	71
		CHANNELS		D851	MCU Channel 1 Output	As P201	-	-	-	25, 29, 31
		PUMP EFFICIENCY		D861	Pump efficiency RL1	%	-	-	-	58
				D862	Pump efficiency RL2	%	-	-	-	58
				D863	Pump efficiency RL3	%	-	-	-	58
				D864	Pump efficiency RL4	%	-	-	-	58
DIRECT	Pxxx				-	-	-	-	-	Appendix C
	Dxxx				-	-	-	-	-	Appendix C

Table 16: MCU902 Menus and Parameters

MAIN MENU	Menu Level 1	Menu Level 2	Menu Level 3	Parameter Number	Parameter Name	Units	Default	Min	Max	Reference Pages
Cancel Password					Cancel Password	-	-	-	-	68
Go Offline ?					Go Online/Offline ?	-	-	-	-	22
SETUP *	PV CALCULATION	CHANNEL 1		P111	MCU Channel 1 Input Source	-	Tx1 : PV	0	250	25, 29
				P112	MCU Channel 1 Input Offset	-	0	-	-	25, 29
				P113	MCU Channel 1 Profile	-	Scaled	1	6	25, 29
				P114	MCU Channel 1 Input Scale Factor	-	1	-	-	25, 29, **33** - **37**
				P115	MCU Channel 1 Non-Linear Data	-	0	-	-	25, 29, **33** - **37**
				P116	MCU Channel 1 Post Scale NLP	-	1	-	-	25, 29, **33** - **37**
				P117	MCU Channel 1 Low Cut-off	as P201	AUTO	-	-	25, 29
		CHANNEL 2		P121	MCU Channel 2 Input Source	-	Tx2 : PV	0	250	27, 31
				P122	MCU Channel 2 Input Offset	-	0	-	-	27, 31
				P123	MCU Channel 2 Profile	-	Scaled	1	6	27, 31
				P124	MCU Channel 2 Input Scale Factor	-	1	-	-	27, 31
				P125	MCU Channel 2 Non-Linear Data	-	0	-	-	27, 31
				P126	MCU Channel 2 Post Scale NLP	-	1	-	-	27, 31
				P127	MCU Channel 2 Low Cut-off	as P202	AUTO	-	-	27, 31
				P150	Output Mapping	-	Ch1	0	251	31
				P151	MCU Fourth Variable Source	-	Tx1 : FV	11	251	31
				P321	Current Input 1 Damping	sec	5	0	99.9	25 - 27
	DUTY(Mode)				Duty Wizard	-	0	-	-	Appendix D
		UNITS		P200	PV Units	-	%	6	251	**25** - **31**, 44 - 45
				P201	SV Units	-	%	6	251	25 - 31
				P202	TV Units	-	%	6	251	25 - 31
				P203	FV Units	-	°C	6	251	29 - 31
		PV DAMPING		P210	Output PV Damping	s	0	-	-	25 - 31
				P240	Description	-	MCU CONTROL	-	-	66
				P241	Message	-	MESSAGE	-	-	41, 66
				P242	Tag Number – Control Unit	-	MSP2000	-	-	66
		CUSTOM		P250	Start On	-	None	0	4	57
				P251	Stop On	-	None	0	3	57

***** Selecting the SETUP menu presents a SELECT INSTRUMENT screen if a HART transmitter is known to the MCU Control Unit. If this happens, select MCU CONTROL UNIT to see Menu Level 1 options. If you select a HART transmitter ‘tag’, see Table 17.

MAIN MENU	Menu Level 1	Menu Level 2	Menu Level 3	Parameter Number	Parameter Name	Units	Default	Min	Max	Reference Pages
				P252	Stop If	-	None	0	253	57
				P253	Start Time	hh.mm	07:00	-	-	57
				P254	Interval	hh.mm	01:00	-	-	57
				P255	Start Time #2	hh.mm	00:00	-	-	57
				P256	Interval #2	hh.mm	00:00	-	-	57
				P257	Max Retries	-	10	0	250	57, 60
		OVERRIDES		P270	Auto Sequence Enable	-	Off	0:00	###	56
				P271	Auto Sequence Qualifier	-	0	-	-	56
				P272	Pump-down Relay	-	0	-	-	57
				P273	Pump-down Interval	hh.mm	00:00	-	-	57
				P274	Pump-down Duration	hh.mm	00:00	-	-	57
				P275	Energy Saving Start Time	hh.mm	00:00	-	-	56
				P276	Energy Saving Relay Select	-	0	-	-	56
				P277	Scum Line Prevention variance	-	0	-	-	56
				P278	Scum Line Prevention relay	-	0	-	-	56
	DIGITAL INPUT	DIGITAL INPUT 1		P340	Digital Input 1 Action	-	Free	0	10	41
				P341	Digital Input 1 Delay	mmm:ss	000:00	-	-	41
				P342	Digital Input 1 On State	-	Closed	0	1	41
		DIGITAL INPUT 2		P345	Digital Input 2 Action	-	Free	0	10	41
				P346	Digital Input 2 Delay	mmm:ss	000:00	-	-	41
				P347	Digital Input 2 On State	-	Closed	0	1	41
	OUTPUT	CURRENT OUTPUT		P400	Lower range value	as P200	0	-	-	46
				P401	Upper range value	as P200	100	-	-	37, **46**
				P402	Alarm action	-	3.6mA	1	3	**46**, 61
		RELAY			Relay Wizard	-	0	-	-	47
					Reset RL Params					48
			RELAY 1	P410	Relay 1 Mode	-	None	0	23	48
				P411	Relay 1 ON Point	as P200	0	-	-	**48**, 51, 53
				P412	Relay 1 OFF Point	as P200	0	-	-	**48**, 51, 53
				P413	Relay 1 Minimum ON Time	mmm:ss	000:00	-	-	48
				P414	Relay 1 Maximum ON Time	mmm:ss	000:00	-	-	48
				P415	Relay 1 Minimum OFF Time	mmm:ss	000:00	-	-	48

MAIN MENU	Menu Level 1	Menu Level 2	Menu Level 3	Parameter Number	Parameter Name	Units	Default	Min	Max	Reference Pages
			RELAY 2	P420	Relay 2 Mode	-	None	0	23	48
				P421	Relay 2 ON Point	as P200	0	-	-	**48**, 51, 53
				P422	Relay 2 OFF Point	as P200	0	-	-	**48**, 51, 53
				P423	Relay 2 Minimum ON Time	mmm:ss	000:00	-	-	48
				P424	Relay 2 Maximum ON Time	mmm:ss	000:00	-	-	48
				P425	Relay 2 Minimum OFF Time	mmm:ss	000:00	-	-	48
			RELAY 3	P430	Relay 3 Mode	-	None	0	23	48
				P431	Relay 3 ON Point	as P200	0	-	-	48
				P432	Relay 3 OFF Point	as P200	0	-	-	48
				P433	Relay 3 Minimum ON Time	mmm:ss	000:00	-	-	48
				P434	Relay 3 Maximum ON Time	mmm:ss	000:00	-	-	48
				P435	Relay 3 Minimum OFF Time	mmm:ss	000:00	-	-	48
			RELAY 4	P440	Relay 4 Mode	-	None	0	23	48
				P441	Relay 4 ON Point	as P200	0	-	-	48
				P442	Relay 4 OFF Point	as P200	0	-	-	48
				P443	Relay 4 Minimum ON Time	mmm:ss	000:00	-	-	48
				P444	Relay 4 Maximum ON Time	mmm:ss	000:00	-	-	48
				P445	Relay 4 Minimum OFF Time	mmm:ss	000:00	-	-	48
			RELAY 5	P450	Relay 5 Mode	-	Fault	0	23	48
				P451	Relay 5 ON Point	as P200	0	-	-	48
				P452	Relay 5 OFF Point	as P200	0	-	-	48
				P453	Relay 5 Minimum ON Time	mmm:ss	000:00	-	-	48
				P454	Relay 5 Maximum ON Time	mmm:ss	000:00	-	-	48
				P455	Relay 5 Minimum OFF Time	mmm:ss	000:00	-	-	48
			ALARM	P490	Rising level alarm delay	mmm:ss	000:00	-	-	60
				P491	Relay operations	-	0	-	-	60
				P492	Relay operations relay select	-	Disabled	0:00		42, **60**
				P493	Relay runtime	hh.mm	00:00	-	-	60
				P494	Relay runtime relay select	-	Disabled	0:00	5	60
				P495	Pump efficiency limit	-	0	-	-	60
				P496	Pump Efficiency relay select	-	0	-	-	58
				P497	No activity delay	hh:mm	00:00	-	-	58

MAIN MENU	Menu Level 1	Menu Level 2	Menu Level 3	Parameter Number	Parameter Name	Units	Default	Min	Max	Reference Pages
				P498	No activity relay	-	0	-	-	58
		TOTALISER			Totaliser Wizard	-	0	-	-	**63**
				P530	Totaliser 1 Factor	-	0	0	-	37, **62**
				P531	Totaliser 1 Units	-	None	6	251	62
				P532	Totaliser 2 Factor	-	0	0	-	37, **62**
				P533	Totaliser 2 Units	-	None	6	251	62
				P536	Totaliser 2 Source	-	None	-	-	62
				P534	Totaliser Pulse width	ms	100	10	2500	62
				P535	Sampler Factor	-	0	0	-	55
		ALARM		P540	PV Out of Limits	-	None	0	3	60
				P541	Current Output Saturated	-	None	0	3	60
				P542	Logging Memory Filling	-	None	0	3	42, **60**
				P543	Digital Input 1 Active	-	None	0	3	60
				P544	Maximum number of retries	-	None	0	3	60
				P545	Current Input Saturated	-	None	0	3	60
				P547	Rising level	-	None	0	3	60
			RELAY	P548	Relay operations	-	None	0	3	60
				P549	Relay runtime	-	None	0	3	60
				P550	Pump efficiency	-	None	0	3	60
				P551	No activity	-	None	0	3	61
		FAULT		P560	System Fault Alarm	-	Both	0	3	55
				P561	Control Unit Temperature over Limits	-	None	0	3	55
				P562	Transmitter Fault	-	Both	0	3	55
		DISPLAY		P570	Display Select 1 (upper)	-	P731-Time	0	44	66
				P571	Display Select 2 (mid)	-	D800-PV	0	44	66
				P572	Display Select 3 (lower)	-	Bargraph	0	44	66
				P573	Decimal places	-	3	0	251	66
				P575	Backlight On/Off	-	On	0	2	66
	SYSTEM	TEST	AUTO-CYCLE		Self Test	-	-	-	-	69
			DISPLAY		Display Test	-	-	-	-	69
			CURRENT INPUT		4mA input adjust	-	-	-	-	69
					20mA input adjust	-	-	-	-	69

MAIN MENU	Menu Level 1	Menu Level 2	Menu Level 3	Parameter Number	Parameter Name	Units	Default	Min	Max	Reference Pages
			CURRENT OUTPUT	P700	4mA output adjust	-	-	-	-	70
				P701	20mA output adjust	-	-	-	-	70
				P702	Set Current	mA	0	-	-	69
		DEFAULTS			LOAD DEFAULTS	-	-	-	-	75
		COMMS		P710	Comms Address	-	0	0	15	67
				P711	Interface Type	-	RS232 HART	0	5	67
				P712	Baud Rate	-	1200	0	8	67
				P713	No. of Start Bits	-	1	1	2	67
				P714	No. of Data Bits	-	8	7	8	67
				P715	Parity of Data	-	Even	0	2	67
				P716	No. of Stop Bits	-	1	1	2	67
		SETTINGS		P730	Date	-	(Factory set)	-	-	23
				P731	Time	-	-	-	-	23
				P734	Date format	-	dd/mm/yy	1	3	23
				P735	Keypad Sound On/Off	-	On	0	1	23
				P737	Language	-	English	0	6	23
				P740	Personal Identification Code	-	0000	-	-	68
					Xmtr Wizard	-	0	-	-	Appendix B
		FIXED		D750	Model Code	-	(Factory set)	-	-	72
				D751	Serial Number – Control Unit	-	(Factory set)	-	-	72
				D752	Hardware Revision	-	(Factory set)	-	-	72
				D753	Software Version	-	(Factory set)	-	-	72
			HART	D760	Manufacturer's Code	-	Sol. Mobrey	-	-	-
				D761	Unique ID	-	(Factory set)	-	-	-
				D762	Universal Command Revision	-	5	-	-	-
				D763	Transmitter Spec. Command Rev.	-	1	-	-	-
				D764	Preamble Bytes	-	5	-	-	-
				D765	Flags	-	1	-	-	-
MONITOR *	READINGS	ANSWERS		D800	Primary Variable	as P200	-	-	-	25 - 31, 70
				D801	Secondary Variable	as P201	-	-	-	25 - 31, 70
				D802	Tertiary Variable	as P202	-	-	-	25 - 31, 70
				D803	Fourth Variable	as P203	-	-	-	25 - 31, 70

* Selecting the MONITOR menu presents a SELECT INSTRUMENT screen if a HART transmitter is known to the MCU Control Unit. If this happens, select MCU CONTROL UNIT to see Menu Level 1 options. If you select a HART transmitter 'tag', see Table 17.

MAIN MENU	Menu Level 1	Menu Level 2	Menu Level 3	Parameter Number	Parameter Name	Units	Default	Min	Max	Reference Pages
				D804	Ullage	as P200	-	-	-	70
				D805	% Current Output	%	-	-	-	70
				D806	Current output	mA	-	-	-	70
				D809	Rate of Change	PV/min	-	-	-	**55**, 59, 70
		RELAY	RELAY OPERATIONS	D811	Relay 1 Operations	-	0	-	-	**58**, 70
				D812	Relay 2 Operations	-	0	-	-	**58**, 70
				D813	Relay 3 Operations	-	0	-	-	**58**, 70
				D814	Relay 4 Operations	-	0	-	-	**58**, 70
				D815	Relay 5 Operations	-	0	-	-	**58**, 70
				D820	Relay Status	-	-	-	-	70
			RELAY RUN TIME	D821	Relay 1 runtime	hh:mm	-	-	-	**58**, 70
				D822	Relay 2 runtime	hh:mm	-	-	-	**58**, 70
				D823	Relay 3 runtime	hh:mm	-	-	-	**58**, 70
				D824	Relay 4 runtime	hh:mm	-	-	-	**58**, 70
				D825	Relay 5 runtime	hh:mm	-	-	-	**58**, 70
				D828	Totaliser 1 Value	P531	-	0	0	55, **62**, 70
				D829	Totaliser 2 Value	P533	-	0	0	55, **62**, 70
				D830	Alarm report	-	None	-	-	60, **71**, 105
				D831	Fault report	-	None	-	-	55, **71**, 105
	DIAGNOSTICS			D835	Digital input status	-	-	-	-	**41**, 71
				D840	Current input	mA	-	-	-	**25**, **27**, 71
				D842	Current input %	%	-	-	-	**25**, **27**, 71
				D844	Temperature of Control Unit	°C	-	-	-	**55**. 71
				D845	Time to next Pump Down	hh:mm	-	-	-	**57**, 71
				D846	Logging Memory Free	%	-	-	-	**42**, 71
				D848	Date of Last Change	dmy	--/--/--	-	-	71
				D849	Date of 1st Power-On	dmy	--/--/--	-	-	71
		CHANNELS		D851	Channel 1 output	P201	-	-	-	25, 29, 31
				D852	Channel 2 output	P202	-	-	-	27, 31
		PUMP EFFICIENCY		D861	Pump efficiency RL1	%	-	-	-	58
				D862	Pump efficiency RL2	%	-	-	-	58
				D863	Pump efficiency RL3	%	-	-	-	58

MAIN MENU	Menu Level 1	Menu Level 2	Menu Level 3	Parameter Number	Parameter Name	Units	Default	Min	Max	Reference Pages
				D864	Pump efficiency RL4	%	-	-	-	58
DIRECT	Pxxx				-	-	-	-	-	Appendix C
	Dxxx				-	-	-	-	-	Appendix C

Table 17: MCU Control Unit Menus and Parameters for a connected MSP900 Series Transmitter

Note: For information on these parameters, refer to MSP900 Series operating manual (IP2040/OM). See also Chapter 6 of this manual.

MAIN MENU	Menu Level 1	Menu Level 2	Menu Level 2	Parameter Number	Parameter Name	Units	FACTORY DEFAULTS								
							MSP900SH			MSP900GH			MSP400RH		
							m	ft	in	m	ft	in	m	ft	in
SETUP *	DUTY			P010	Bottom Reference	m/ft/in	12.0	40.0	480.0	11.0	36.0	432.0	11.0	36.0	432.0
				P011	Tank Shape	-	Linear	Linear	Linear	Linear	Linear	Linear	Linear	Linear	Linear
				P013	PV Scale Factor	-	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
				P014	Profile Height	m/ft/in	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
		NLP CURVE		P030	Profile Point 1	%	10	10	10	10	10	10	10	10	10
				P031	Profile Point 2	%	20	20	20	20	20	20	20	20	20
				P032	Profile Point 3	%	30	30	30	30	30	30	30	30	30
				P033	Profile Point 4	%	40	40	40	40	40	40	40	40	40
				P034	Profile Point 5	%	50	50	50	50	50	50	50	50	50
				P035	Profile Point 6	%	60	60	60	60	60	60	60	60	60
				P036	Profile Point 7	%	70	70	70	70	70	70	70	70	70
				P037	Profile Point 8	%	80	80	80	80	80	80	80	80	80
				P038	Profile Point 9	%	90	90	90	90	90	90	90	90	90
				P039	Profile Point 10	%	100	100	100	100	100	100	100	100	100
				P000	Message	-									
				P001	Tag	-									
				P002	Description	-	MSP900 XMTR			MSP900 XMTR			MSP400 XMTR		
	PV CALC			P012	Primary Variable Units	-	m	ft	in	m	ft	in	m	ft	in
	OUTPUT	CURRENT		P015	Upper range value	L000	11.55	39.0	468.0	10.55	34.5	414.0	10.55	34.5	414.0
				P016	Lower range value	L000	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
				P020	Damping	sec	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0
				L000	Range Value Units	-									
		RELAYS	RELAY 1	P070	Relay 1 mode	-							Set point		
				P071	Relay 1 PV ON Point	(as PV)							0.0	0.0	0.0
				P072	Relay 1 PV OFF Point	(as PV)							0.0	0.0	0.0
			RELAY 2	P073	Relay 2 mode	-							Fault/Setpoint		
				P074	Relay 2 PV ON Point	(as PV)							0.0	0.0	0.0

* Selecting the SETUP menu presents a SELECT INSTRUMENT screen if a HART transmitter is known to the MCU Control Unit. Select the HART transmitter tag to see Menu Level 1 options. However, if no HART transmitters are connected, see the other Menu and Parameter tables in Appendix G.

MAIN MENU	Menu Level 1	Menu Level 2	Menu Level 2	Parameter Number	Parameter Name	Units	FACTORY DEFAULTS								
							MSP900SH			MSP900GH			MSP400RH		
							m	ft	in	m	ft	in	m	ft	in
				P075	Relay 2 PV OFF Point	(as PV)							0.0	0.0	0.0
	ENGINEERING			P021	LE Delay	sec	900	900	900	900	900	900	900	900	900
				P022	LE Action	-	Hold	Hold	Hold	Hold	Hold	Hold	Hold	Hold	Hold
				P023	Blanking	m/ft/in	0.3	1.0	12.0	0.45	1.5	18.0	0.45	1.5	18.0
				P024	Speed of Sound	m/s or ft/s	331.8	1088.6	13063	331.8	1088.6	13063	331.8	1088.6	13063
				P025	Temperature	C or F	Auto	Auto	Auto	Auto	Auto	Auto	Auto	Auto	Auto
				P026	Threshold	%	Auto	Auto	Auto	Auto	Auto	Auto	Auto	Auto	Auto
		ADVANCED		P041	Pulse Repetition	sec	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
				P042	Echoes Needed	-	4	4	4	4	4	4	4	4	4
				P043	Threshold 1 Time	ms	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0
				P044	Target Pulses	-	Auto	Auto	Auto	Auto	Auto	Auto	Auto	Auto	Auto
				P045	Target Frequency	kHz	Auto	Auto	Auto	Auto	Auto	Auto	Auto	Auto	Auto
				P049	Spike Rejection	-	0	1	2	3	4	5	6	7	8
	SYSTEM				AUTO CYCLE	-	-								
					LOAD DEFAULTS	-	-								
				L200	Base Units	-									
		FIXED		P004	Final Assembly Number	-	as applicable			as applicable			as applicable		
				P005	Serial Number	-	as applicable			as applicable			as applicable		
				P970	Front face material	-	PVC	Kynar	Kynar	PVC	Kynar	Kynar	PVC	Kynar	Kynar
			HART	D949	Model Code	-	51	52	53	51	52	53	51	52	53
				D950	HART Device Code	-	46	46	46	46	46	46	46	46	46
				D951	Comms Address	-	(ex-factory = 0)			(ex-factory = 0)			(ex-factory = 0)		
				D952	Hardware Revision	-	as applicable			as applicable			as applicable		
				D953	Software Version	-	as applicable			as applicable			as applicable		
				D960	Manufacturer's Code	-	Mobrey			Mobrey			Mobrey		
				D961	Unique ID	-	as applicable			as applicable			as applicable		
				D962	Universal Cmd Rev	-	5	5	5	5	5	5	5	5	5
				D963	Transmitter Spec. Cmd Rev	-	as applicable			as applicable			as applicable		
				D964	Response Preamble	-	5	5	5	5	5	5	5	5	5
				D965	Transmitter Flags	-									

MAIN MENU	Menu Level 1	Menu Level 2	Menu Level 2	Parameter Number	Parameter Name	Units	FACTORY DEFAULTS								
							MSP900SH			MSP900GH			MSP400RH		
							m	ft	in	m	ft	in	m	ft	in
MONITOR *	READINGS	VARIABLES		D900	Primary Variable	m/ft/in									
				D901	Level (SV)	m/ft/in									
				D902	Range (TV)	m/ft/in									
				D903	Transducer Temperature	C or F									
		CURRENT		D906	Current output	mA									
				D905	% Current Output	%									
				D908	Relay Status	-									
	DIAGNOSTICS			D910	Target Range/Dist. to Target	m/ft/in									
				D911	Echo Size	%									
				D912	Echo Success Rate	%									
				D913	Target Echoes	-									
				D914	Speed of Sound	m/s or ft/s									
				D915	Transducer Temperature	C or F									
				D916	Transducer Frequency	kHz									
		HISTORY		P003	Date of Change	dmy	1/1/02	1/1/02	1/1/02	1/1/02	1/1/02	1/1/02	1/1/02	1/1/02	1/1/02
				P046	Maximum Temperature	°C	50	50	50	50	50	50	50	50	50
				P047	Minimum Temperature	°C	-10	-10	-10	-10	-10	-10	-10	-10	-10

* Selecting the MONITOR menu presents a SELECT INSTRUMENT screen if a HART transmitter is known to the MCU Control Unit. If this happens, select the HART transmitter 'tag' to see Menu Level 1 options. However, if no HART transmitters are connected, see the other Menu and Parameter tables in Appendix G.

Appendix H Support for HART Transmitters

The MCU Control Unit is able to accept digital data from any HART compatible transmitter. However, the MCU is not Device Descriptor (DD) based, and so will only fully support transmitters that have been factory programmed into the MCU on-board library.

Support for the Universal and Common Practice commands of all other HART transmitters is provided in accordance with HART practice.

H.1 Fully Supported Transmitters

Fully supported transmitters, where all parameters of the transmitter are accessible for reading and writing by the MCU Control Unit:

- Mobrey transmitter MSP900SH
- Mobrey transmitter MSP900GH
- Mobrey transmitter MSP400RH
- Mobrey transmitter MSP100

H.2 Support for Universal and Common Practice Commands

The table (below) shows the supported Universal and Common Practice commands for all HART transmitters.

Universal Commands:

#0 Read unique identifier.
#1 Read primary variable.
#2 Read loop current and percent of range.
#3 Read dynamic variables and loop current.
#6 Write polling address.
#11 Read unique identifier.
#12 Read message.
#13 Read tag, descriptor, date.
#14 Read primary variable transducer information.
#15 Read device information.
#16 Read final assembly number.
#17 Write message.
#18 Write tag, descriptor, date.
#19 Write final assembly number.

Common Practice commands:

#33 Read device variables
#34 Write primary variable damping value
#35 Write primary variable range values
#36 Set primary variable upper range value
#37 Set primary variable lower range value
#40 Enter/exit fixed current mode
#41 Perform self test
#42 Perform device reset
#43 Set primary variable zero
#44 Write primary variable units
#45 Trim loop current zero
#46 Trim loop current gain
#47 Write primary variable transfer function
#48 Read additional device status
#49 Write primary variable transducer serial number
#50 Read dynamic variable assignments
#51 Write dynamic variable assignments

MCU900 Series

Mobrey Measurement
158 Edinburgh Avenue,
Slough, Berks, UK, SL1 4UE
T +44 (0) 1753 756600
F +44 (0) 1753 823589
mobrey.sales@EmersonProcess.com
www.mobrey.com

Mobrey Inc
19408 Park Row, Suite 320,
Houston, TX 77084 USA
T +281 398 7890
F +281 398 7891
mobrey.sales@EmersonProcess.com
www.mobrey.com

001

Mobrey SA-NV	Belgium	tel: 02/465 3879
Mobrey Ltd	China	tel: 021 6232 7972
Mobrey GmbH	Deutschland	tel: 0211/99 808-0
Mobrey SA	France	tel: 01 30 17 40 80
Mobrey sp z o o	Polska	tel: 022 871 7865
Mobrey AB	Sverige	tel: 08-725 01 00