



PSM INSTRUMENTATION LTD

MINI MINDER SERIES 2151 USER MANUAL

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Burrell Road Industrial Estate
Haywards Heath, West Sussex RH16 1TW, UK
Tel: +44 (0)1444 410040 Fax: +44 (0)1444 410121
[Http://www.psm-sensor.co.uk](http://www.psm-sensor.co.uk) E-mail: sales@psm-sensors.co.uk

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SECTION 1

INTRODUCTION

The Minder series 2151 provides comprehensive monitoring and control facilities for liquid storage vessels. It will interface with, and power all level transmitters in the PSM range as well as most other transmitters providing a standard signal output.

The unit has facilities to compensate for any shape of tank and correct any transmitter offsets to give a true volumetric display.

All the Mini Minders functions are fully software controlled. The user is able to set up or subsequently change all operational parameters using the four multifunction buttons on the front panel.

All of these operational parameters can have password protection to prevent unauthorised amendments.

SECTION 2

SPECIFICATION - Mechanical

Standard 96 x 48 mm . Total back of panel depth 210mm. Mounting (DIN panel housing): via 92 x 44 mm panel cutout.

Wall mounting: 238 x 185 x 115 mm depth.

Front panel display: 5 decade LED with 14.2mm characters.
Dedicated function LED annunciators to indicate setpoint status.

SPECIFICATION - Electrical

All terminations via terminal strips on rear of panel version and in a separate terminal enclosure on the wall mounting version.

Fuse: 500 mA 250 V ac located in rear panel mount unit and in terminal enclosure of wall mounting unit.

Mains Power requirement: 110/120/240 V 50/60Hz ac, 240Vdc. Specified at time of manufacture.

Input signals: 4 to 20 mA dc (standard).
Optional factory configured 0 to 5V, 1 to 5 V, 0 to 10 V dc, 0 to 1 mA dc.
The Mini Minder incorporates a 24 V dc power supply to drive the level transmitter which is selected/deselected by connecting the transmitter to the appropriate terminals.

Signal outputs: Up to 4 (STD supply 2) separate volt free relays with programmable setpoint hysteresis

and action. These may be for alarm or control function. A visual indication is provided by the status LED's. When set as control relays operation is automatic. In alarm mode they are acknowledged via the "ALARM" button on the front panel.

Contact rating: 240 V ac 3 amp Single pole change over volt free.

Analogue output: Optional isolated 4 to 20 mA via additional integral PCB maximum load 1000 ohms.

Communications: Optional RS232/485 serial port for communication to host computer. This may run set up and access the Mini Minder information using software provided by PSM. Multidrop communication is also possible. Where the serial communication option has been specified a supplement detailing its implementation will be included with this manual.

Environmental temp: Operational range 0 to +40 deg C, storage -30 to +50 deg C.

Humidity: No effect in the range 5 to 95% relative humidity non condensing.

SECTION 3

INSTALLATION - Mechanical

The panel mounting unit is housed in a standard 96 x 48 mm DIN case which requires a 92 x 44mm square panel cut out. Installation is achieved by simply sliding the unit through the cut out from the front, locating the clamps provided either side of the unit and tightening. Care should be taken not to over tighten these clamps.

The weatherproof wall mounting unit has 4 mounting brackets which should first be affixed to the unit, and then mounted on the wall.

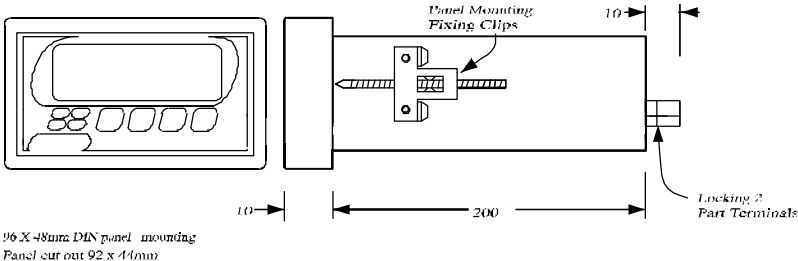
REFER TO DIAGRAM 1 FOR CLARIFICATION AND DIMENSIONS OF THE MOUNTING ARRANGEMENTS.

INSTALLATION - Electrical

The electrical connections on the panel mounting version are locking 2 - part terminals. These connections should be made to the plug before pushing it in. The terminal blocks have locating pins to prevent incorrect

2151 PANEL MOUNTING

Diagram 1



2152 WALL MOUNTING

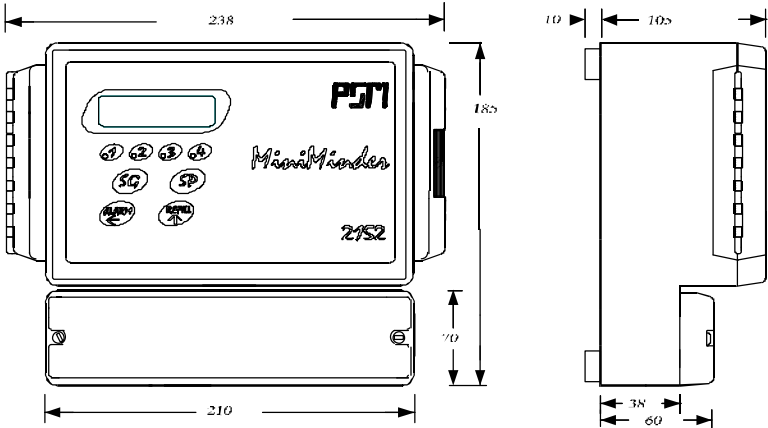
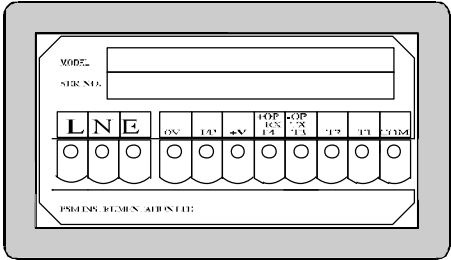


Diagram 2



2151/2 & Transmitter connection

Diagram 3

Transmitter driven by Mini Minder

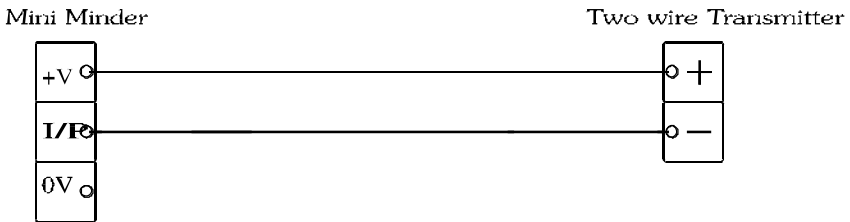
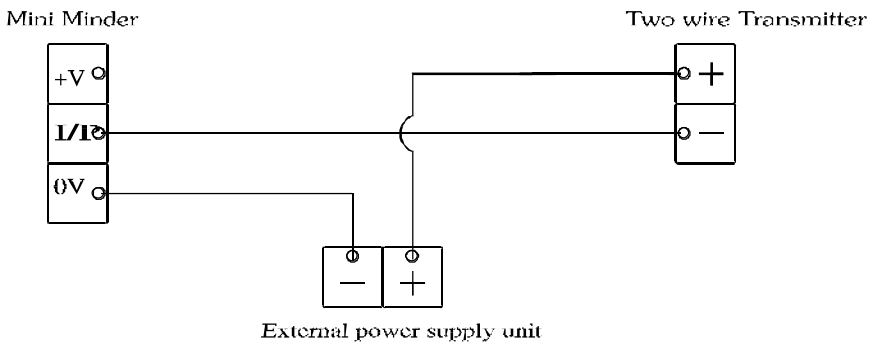


Diagram 4

Transmitter driven by external power source



location.

All terminations are clearly identified and are as shown in diagram 2.

- Input Signal:** Connection of the two wire signal from the transmitter depends on whether the unit is required to provide the transmitter power supply. Connections are shown in diagrams 3 and 4.
- Output signal:** Connect positive and negative as marked on unit terminations.
- Serial link:** This is an optional function. If fitted a supplement will have been included to cover its connection and operation.
- Relay connections:** Up to 4 control/alarm relays may be fitted. Relay outputs are single pole single throw with a shared common and may be set as normally closed or normally open

Terminals are identified as follows:

- COM = common
- T1 = relay/ alarm 1
- T2 = relay/ alarm 2
- T3 = relay/ alarm 3
- T4 = relay /alarm 4

- Power supply:** Before connection of the mains power supply to the unit ensure that the instrument operating voltage is the same as the supply to be connected.

SECTION 4

RUN MODE

This section describes the facilities and the operation of the Mini Minder when it is in '**Run Mode**', i.e. the normal operating mode.

Where the unit has been supplied factory configured this section should be read and fully understood prior to putting the unit into service. Where the unit has been supplied unconfigured the appropriate data must be entered as described in the section "Instrument Set Up & Calibration" before it can be operated.

The unit is equipped with four multifunction buttons which provide access to all facilities as described below.

Refill - When in run mode pressing of the '**refill**' button will display the volume required to fill the vessel to maximum capacity. This display is maintained only while the button is depressed.

N.B: REFILL QUANTITY IS SHOWN IN THE CURRENTLY SELECTED ENGINEERING UNIT.

SG - Pressing the '**SG**' button will display the value currently stored in the unit for specific gravity. While it is being displayed the value may be amended, (if this facility is currently enabled), to suit any changes in the liquid being monitored. If no changes are made within 5 seconds the unit reverts to normal operation.

To change the current SG the two buttons marked with the (↑)up and (←) left arrows are used. Pressing the button with the left arrow causes the least significant digit to flash. This digit is then the 'active' digit and its value may then be altered using the up arrow. Once this digit is correctly set, depressing the left arrow again caused the next digit to become the 'active' digit and this is then set in the same way. Once the correct value is set, depressing the SG button again will enter the changes and the unit will return to run mode. Allowing the unit to 'time-out' by making no adjustments for 5 seconds causes the original value to be retained and the unit will automatically return to run mode.

NB: FOR PLANT SAFETY THE FACILITY TO CHANGE THE SPECIFIC GRAVITY IN RUN MODE CAN BE ENABLED/DISABLED FROM WITHIN THE SET UP ROUTINE. VALID VALUES FOR SPECIFIC GRAVITY ARE WITHIN THE RANGE 0.5 TO 2.0. IT IS VITAL THAT THE CORRECT VALUE FOR THE FLUID BEING MEASURED IS ENTERED SINCE THIS IS ONE OF THE FACTORS USED IN DETERMINING THE VESSEL CONTENT.

SP - When in the run mode this button is used to examine or change the alarm or control setpoints. When the button is pressed once the display will show the current value for the high level setpoint in percent of tank volume. Further depression of the button will display the low, trip 3 and trip 4 settings respectively.

N.B. WHILST EXAMINING THE SETPOINTS THE OPERATION OF THE RELAYS IS SUSPENDED.

The unit indicates that it is in this mode by illuminating all four high, low, trip 3 and 4 LED's. The setpoint currently displayed is indicated by its LED annunciator flashing whilst the other three are steadily illuminated.

Setpoint values are changed using the arrow keys in the same manner as described for specific gravity adjustment. Any changes made are not accepted unless the SP button is pressed a fifth time to return to run mode. A 'time-out' of 5 seconds applies if no changes are made.

NB: FOR PLANT SAFETY THE FACILITY TO CHANGE SETPOINT VALUES IN THE RUN MODE CAN BE ENABLED/DISABLED IN THE SET UP ROUTINE.

Alarm - *This button is used to acknowledge alarm conditions as they occur. Upon the input signal exceeding the value entered in the setpoint and remaining outside this value for the period of time defined in the debounce setting, the appropriate LED annunciator will flash and the relay (if fitted) for that alarm will change over.*

Depression of the alarm button will acknowledge the alarm condition. This causes the relay to drop out and the LED annunciator to become constantly illuminated and remains so until the input signal returns to within the hysteresis defined for that alarm.

SECTION 5

INSTRUMENT SET UP & CALIBRATION

All configuration and operational parameters of the Mini Minder may be entered or subsequently amended by the user.

Parameters which are likely to change under normal operating conditions include specific gravity values and alarm/control setpoints. For changes to these refer to the previous section.

All other parameters are entered using a set parameter (SP) routine. To prevent unauthorised amendment a password is required before any changes can be made. As the unit is shipped from the factory the password is set to "12345" but since it can be amended careful note must be made of any changes.

N.B. WHEN THE UNIT IS IN THE SP MODE NO TIME-OUT APPLIES AND ALL RELAY CONTROL AND MONITORING FUNCTIONS ARE SUSPENDED. IT SHOULD BE ENSURED THAT THE VESSEL IS IN A STEADY STATE AND WILL REMAIN SO DURING CONFIGURATION SINCE IT IS NOT BEING MONITORED.

It is strongly recommended that because of the extensive facilities and as a result of the number of steps in the set up procedure, a safe record is kept of the value of all settings.

When entering SP mode the user is able to scan through the data without making changes until the relevant details are reached. Stepping through is achieved by depression of the button SP. At any time the user can quit the set parameter mode by depression of the button SG. This button also has the effect of saving any changes made.

N.B. ANY CHANGES MADE ARE NOT SAVED UNLESS THE SET PARAMETER MODE IS EXITED USING THE SG BUTTON.

Set parameter mode is entered as follows:

Depress button SP followed immediately by button SG, you will now be prompted for a password. It will also be noted at this stage that the 4 alarm/control LED's flash. This indicates that the set parameter mode has been entered and all monitoring/control operations are inhibited.

N.B. A TIME-OUT WILL APPLY AT THIS STAGE, AND IF A VALID PASSWORD IS NOT ENTERED WITH LESS THAN 5 SECOND INTERVALS BETWEEN BUTTON DEPRESSIONS, THE UNIT WILL RUN THROUGH A SELF CHECK ROUTINE AND THEN RETURN TO NORMAL OPERATION MODE. THIS IS ALSO THE CASE WHERE AN INCORRECT PASSWORD IS ENTERED.

Entry of the password is achieved by means of the two buttons marked up & left. The left arrow is used to select the active digit and the up arrow to increase or decrease its value. This procedure for entering data is common throughout setup.

When entering the password, for security only the active digit is visible.

Once the correct number has been entered, depress and hold button SP again and whilst it is depressed the legend "SP01" will be displayed. Once the button SP is released you will be in the set parameter mode and displaying the first parameter 'Display resolution'.

SET PARAMETERS AND EXPLANATORY NOTES

SP01 Display resolution. *Left arrow is used to scroll the display until the desired value is shown. Options range between 0.001 and 100 units.*

The value selected will depend upon the stability of the liquid level in the vessel (to eliminate flickering) and process requirements.

SP02 Filter Factor. This factor enables the effects of a fluctuating liquid level to be stabilised. Using the left & up arrow the appropriate value between 0 and 50 seconds may be entered. This factor is defined as the time taken for a unit to respond to a step in input to within 0.1% of its final value.

SP03 Multiplying factor. This multiplying factor relates the input signal to volumetric units. The number entered is either the full or usable tank capacity dependent upon what the display is required to show.

For example in a tank holding 6000 litres maximum the outlet pipe is at a point above the tank base equivalent to 248 litres:-

For a display of full capacity SP03 is entered as 6000.

For a display of usable capacity SP03 is entered as 6000 - 248 = 5752.

SP04 & 05 Range and Zero factors. The combination of these two parameters and the specific gravity are used to convert the signal from the level transmitter to a value of 0 to 100% liquid level over the actual tank depth. This corrected 0 to 100% value is then used in the units 'Look up' table facility (see SP26 to 47) to relate %liquid level to % tank volume, and finally multiplied by the tank capacity (SP03) to give a volumetric display.

The formula used for this correction is:-

$$\frac{(\% \text{ signal input})}{\text{SG} \times \text{SP05}} \times 100 + \text{SP04} = \% \text{ level}$$

Where

Signal input: The signal actually being provided by the level transmitter

SG: The specific gravity value entered into the unit (refer section

4 run mode)

SP04 (**Compensating factor**) corrects for negative or

positive offsets which are introduced where the transmitter is mounted above or below the tank empty point.

SP05 Compensating factor which enables the use of a "nominally" ranged level transmitter i.e., one having a range greater than the tank depth.

Values for SP04 and SP05 are calculated as shown in the following examples:

Full capacity Case example 1

Tank depth = 3000mm
Transmitter position = 250mm **above** tank base
Transmitter calibration = 0 to 4 metres Wg

$$SP04 = \frac{\text{Transmitter fitting height}}{\text{Tank depth}} \times 100 = \frac{250}{3000} \times 100 = 8.33$$

$$SP05 = \frac{\text{Tank depth}}{\text{Transmitter calibrated range}} \times 100 = \frac{3000}{4000} \times 100 = 75$$

Case example 2

Tank depth = 3000mm
Transmitter position = 250mm **below** tank base
Transmitter calibration = 0 to 4 metres Wg

$$SP04 = \frac{\text{Transmitter fitting height}}{\text{Tank depth}} \times 100 = \frac{250}{3000} \times 100 = 8.33$$

N.B. THIS IS A NEGATIVE VALUE BECAUSE 250MM OF LIQUID LEVEL IS TO BE SUPPRESSED, SINCE IT DOES NOT REPRESENT TANK CONTENT.

Usable capacity

If required the instrument can be set to display only the usable portion of the tanks capacity, i.e., from the outlet pipe upwards.

*Where this is the case the tank capacity SP03, will have been entered in usable terms. SP04 and SP05 are calculated as shown above with the exception that the **usable** tank depth instead of the full tank depth is used in the calculations.*

Notes on setting of SP05 and S.G.

The previous examples assume that the liquid level transmitter as also of PSM supply. Where this is the case it is PSM's policy to supply transmitters which are calibrated to operate over a standard "nominal" range (1,2,4,8 m Wg etc.) and to utilise the facilities of the Minder to

calibrate the system for a particular application. This approach greatly simplifies any replacement of transmitters as no recalibration is necessary. However, it may be in a particular installation that another manufacturers level transmitter is being used, or that a PSM unit has been calibrated to provide full output signal of 4 to 20 mA relative to the actual tank depth and specific gravity.

It is therefore most important to establish the exact calibration of the transmitter before attempting to configure the Minder.

For installations where the transmitter has been supplied ranged for the actual tank conditions then the scaling factors SP05 and S.G. on the Minder would not normally be used and should be left to their default values of SP05 = 100 and S.G = 1.00. If, however, the specific gravity of the liquid being monitored is likely to change in service, unless this is compensated for, will introduce an error. It is therefore possible to use SP05 and the S.G. parameters to provide the necessary correction. This is achieved in the same way as previously described.

The following example will clarify the procedure:

Tank depth = 3000mm

S.G. = 0.95

Transmitter calibrated range = 3000 x 0.95 = 2850mm Wg

$$\text{SP05} = \frac{\text{Tank depth}}{\text{Transmitter calibrated range}} \times 100 = \frac{3000}{2850} \times 100 = 105.26$$

The value for S.G. can now be entered as the actual value, i.e. 0.95. If the specific gravity of the fluid subsequently changes and the new value is entered the Mini Minder will automatically compensate accordingly.

Calculation of the value of any zero offset (SP04) is done in the normal way as described previously.

SP06 & 07 Not used

SP08 Software switches This parameter contains 8 software switches which can either be set as 'ON' or 'OFF'. They are employed to define the operation of the optional 3rd and 4th relays and optional facilities.

The switches are scrolled on the display using the left arrow and their settings are altered using the up arrow.

- SP08/1** Not used set to OFF.
SP08/2 This switch relates to optional relays 3 & 4. Where these are not fitted it has no effect.

When fitted the optional relays may be configured in a number of ways to provide either an alarm or control function.

Where only one additional relay is fitted (relay 3) and this is to be used for pump control, if SP02 is set 'ON' then both of the LED annunciators for trip 3 and 4 are used to indicate the pump status. Trip 4 LED will illuminate whilst the pump is running and trip 3 LED will illuminate when the liquid level is above the pump cut off point.

Using this option the operation of relay 3 is defined using Trip 4 (SP18) to define the cut in point (i.e. relay 3 energizes) and trip 3 (SP17) to define the pump cut off point (relay 3 de-energizes).

N.B. WHEN THIS OPTION IS USED THE HYSTERESIS SETTINGS FOR TRIP 3 AND 4 (SP13 AND SP14), AND THE SWITCHES SP08/3 TO SP08/6 ARE OVER-RIDDEN AND HAVE NO EFFECT.

WHERE BOTH RELAYS 3 AND 4 ARE FITTED SP08/2 IS SET 'OFF' AND THEIR FUNCTION IS DEFINED BY THE SETTINGS OF SWITCHES SP08/3 TO SP08/6.

SP08/3 This switch defines trip 3 as either a high or low level setpoint.
OFF - energizes relay on a **rising** input signal.
ON - energizes relay on a **falling** input signal.

SP08/4 This switch defines trip 4 as either a high or low level setpoint.
OFF - energizes relay on a **falling** input signal.
ON - energizes relay on a **rising** input signal.

SP08/5 This switch defines trip 3 as a control or alarm function.
OFF - Defines relay 3 as a **control** operation.
ON - Defines relay 3 as an **alarm** operation.

SP08/6 This switch defines trip 4 as a control or alarm function.
OFF - Defines relay 4 as a **control** operation.
ON - Defines relay 4 as an **alarm** operation.

SP08/7 Not used set to OFF

SP08/8 Not used set to OFF

SP09 Software switches. This parameter contains 8 software switches SP09/1 to SP09/8, their positions are set as described for SP08.

SP09/1 This switch is used to enable or disable all relays fitted, for example during site maintenance.

OFF - Disables all relay outputs.

ON - Enables all relay outputs

SP09/2 This parameter is used to enable or disable the facility of amending the S.G. value whilst in 'run mode'.

OFF - Prevents unauthorised changes to S.G. value.

ON - Enables alteration to S.G. value in run mode.

IRRESPECTIVE OF THE SETTING OF SP09/2, THE S.G. VALUE MAY STILL BE ENTERED/AMENDED AT SP21

SP09/3 This parameter is used to enable or disable the facility of amending the alarm setpoints in 'run mode'.

OFF - Prevents unauthorised changes to setpoint values.

ON - Enables the alarm setpoints to be altered in run mode.

SP09/4 This parameter defines the type of computation used in the "look up" table (SP26 to SP47) to convert the liquid level input to volumetric display. There are two types of computation:-

OFF - Employs a **10th order polynomial** correction method

ON - Employs a **linear interpolation** correction method

N.B.: THE TYPE OF COMPUTATION SELECTED DEPENDS ON THE SHAPE OF THE VESSEL TO BE CORRECTED. REFER TO PARAMETERS SP26 TO SP47 FOR GUIDANCE ON "LOOK-UP" TABLE CONFIGURATION.

10th order polynomial

To be used for spherical or horizontal cylindrical tanks with dished or flat ends. Look-up points should be equispaced over the entire level for best results.

Linear Interpolation

For all other tanks including vertical cylinders with dished or coned bottoms, linear tanks, or tanks with both linear and non-linear sections. Look-up points should be concentrated in the non-linear sections to provide the best correction.

SP09/5 This parameter is used to provide "FULL" and "EMPTY" messages

at 100% and 0% volume respectively. When the messages are disabled, the actual full and empty values will flash.

OFF - Disables the messages.

ON - Enables the messages

SP09/6 This parameter is used to provide "FAULT" and "O LOAD" where the input signal exceeds normal operational span by more than 25%.

OFF - Disables the messages.

ON - Enables the messages

SP09/7 This switch defines Trip 1 (high trip) as an alarm or control function

OFF - Control function.

ON - Alarm function.

SP09/8 This switch defines Trip 2 (low trip) as an alarm or control function

OFF - Control function.

ON - Alarm function.

SP10 Relay debounce setting. This setting is entered in seconds and is common to all relays when configured as alarm type. Debounce is defined as the delay period between an alarm condition occurring and the relay operating. It is used to eliminate spurious alarms where the tank head fluctuates under normal conditions.

SP11 Hysteresis setting for high alarm (trip 1). The hysteresis is defined as the difference between an alarm set point and its reset point. It is entered in percentage volume terms.

EXAMPLE: AN ALARM WHICH OPERATES AT 75% VOLUME ON RISE AND RESETS AT 70% VOLUME ON FALL HAS A 5% HYSTERESIS

SP12 Hysteresis setting for low alarm (trip 2). It is entered in percentage volume terms as described above

SP13 Hysteresis setting for trip 3. It is entered in percentage volume terms as described above.

SP14 Hysteresis setting for trip 4. It is entered in percentage volume terms as described above.

SP15 Set point for High alarm (Trip 1). This is the set point value and is entered in percent of tank volume

SP16 Set point for Low alarm (Trip 2). This is the set point value and is entered in percent of tank volume

SP17 Set point for Trip 3. This is the set point value and is entered in percent of tank volume

SP18 Set point for Trip 4. This is the set point value and is entered in percent of tank volume

SP19 Baud rate. This parameter defines the communication speed between the unit and a host computer. The appropriate speed is selected by toggling through the options displayed. This parameter is only employed where a serial communications port option is fitted.

SP20 Site Address code. This parameter is used to enter a unique code to identify itself when it is remotely addressed via the communications serial port.

SP21 Specific Gravity. This parameter is used to enter the specific gravity for the product being monitored. The ability to enter a S.G. at this parameter is always enabled. Where SP09/2 is set 'ON' it is also possible to set the S.G. whilst in 'run mode'.

SP22 Special functions. This parameter is reserved for special functions and no user adjustment is necessary or possible on the standard unit.

SP23 & 24 Not used

SP25 Changing password. This parameter enables the user password to be changed. The current password will be displayed and it may be amended in the normal way. Care must be taken to record any changes in a safe place. **The factory set password is 12345.**

N.B.: ENTRY OF 00000 DISABLES PASSWORD PROTECTION.

SP26 to 47 Tank shape data entry. These parameters are used to relate the liquid level signal from the transmitter to actual tank shape to provide a display in volumetric terms.

Parameters are arranged in two columns which provide a "**look-up**" table as shown below

	%LEVEL	%VOLUME	
	SP26 = 0	SP27 = 0	
	SP28 = 10	SP29 = 10	
	SP30 = 20	SP31 = 20	
	SP32 = 30	SP33 = 30	
	SP34 = 40	SP35 = 40	
Tank Full	SP36 = 50	SP37 = 50	Max Capacity
	SP38 = 60	SP39 = 60	
	SP40 = 70	SP41 = 70	
	SP42 = 80	SP43 = 80	
	SP44 = 90	SP45 = 90	
	SP46 = 100	SP47 = 100	

Before the "look-for a vessel the parameters correctly

setting up "up" table particular ensure that following have been set:-

SP04 and scaling factors

SP09/4 "Look-up" table equation types

& 05 Input

The Mlnder uses the "look-up" table as follows:-

The input signal from the level transmitter is corrected by parameters SP04 & 05, and the S.G. value. The resultant "% level" value is found in the first column and a comparison is made with the second column to determine the "% volume" at this level.

This value is then multiplied by the full tank capacity (SP03) and the result displayed in the selected engineering units.

Linear tanks

Where the relationship between liquid level and volume is linear, for example a level mounted rectangular vessel, no amendments are necessary and the standard default values may be used.

SP09/4 should be set ON

Non-linear tanks

Vessels in this category include horizontal cylinders and spherical tanks. To obtain the most accurate results it should be ensured that each increment in the % level column is as close as possible to the ideal 10% step.

SP09/4 should be set OFF

Example: This example relates to a level mounted flat ended horizontal cylinder.

The internal dimensions are:-

9118 mm length
2726 mm diameter

The total tank capacity (SP03) is 54000 litres and a tank sounding chart has been provided which relates liquid level to volume at 250 litre increments. To convert the information in this comparison chart into configuration data for the Minder, the following method is used:-

The values entered into the "% level " column relate to the actual depth of the liquid in the tank.

ie. SP26 = 0% - 0mm (tank empty)
 SP46 = 100% - 2726mm (tank full)

To determine the ideal calibration points the tank depth is simply divided by 10 to give 10 equal increments.

$$\text{e.g. Increment} = \frac{2726\text{mm}}{10} = 272.6\text{mm}$$

The ideal calibration points are then tabulated and by referring to the tank sounding chart the points which are closest to the ideal values are selected as well as the corresponding tank volume at these actual points.

As Follows:-

The figures in actual level and tank capacity columns above are then converted to a percentage (of the maximum value) then entered.

Tanks having both linear and non-linear sections

For vessels of this nature the linear interpolation computation method is be

Ideal calibration point in mms	Closest actual in mms from chart	Corresponding in litres from chart
0.0	0.0	0.0
272.6	270.16	2750
545.2	551.42	7750
817.8	817.06	13500
1090.4	1089.65	20000
1363.0	1360.77	26750
1635.6	1631.46	33500
1908.2	1913.39	40250
2180.8	2177.29	46000
2453.4	2453.75	51000
2726.0	2726.0	54000

*applied i.e. **SP09/4 should be ON.** This enables the look-up points to be concentrated in the non-linear sections of the vessel.*

An example of this type is a vertical cylindrical tank with a coned base. Within the coned base the liquid level / volume relationship is not linear, but it is linear in the straight section. This means it is only necessary to use two look-up points for the straight section, one at the top and one at the bottom, leaving nine points which can be concentrated in the coned section.

The following example illustrates this procedure.

Example Vertical cylinder straight length = 6500 mm
 Depth of cone = 1600 mm
 Internal diameter = 3200 mm

By calculation:

Volume of cone = 4289 litres
 volume of straight section = 52276 litres
 Total capacity (SP03) = 56565 litres

Since the linear section requires only 2 points, the remaining nine are concentrated into the cone as follows:-

Cone depth = 1600 mm

$$\frac{1600}{9} = 177.77 \text{ mm}$$

The level column is then as follows:

Having established the level increments the corresponding volumes are then either determined from the sounding table, or by calculation.

In this example the formula is:

Actual Level in mms	Corresponding % of Tank Depth
SP26 = 0.00	0.00
SP28 = 177.77	2.19
SP30 = 355.55	4.39
SP32 = 533.33	6.58
SP34 = 711.11	8.78
SP36 = 888.88	10.97
SP38 = 1066.66	13.17
SP40 = 1244.44	15.36
SP42 = 1422.22	17.56
SP44 = 1600.00	19.75
SP46 = 8100.00	100.00

$$\text{Volume of a cone} = \frac{\pi r^2 h}{3}$$

For installations where the liquid level/volume relationship is not known and cannot be calculated there is a final method of calibration, "self teach".

SELF TEACH

This method involves filling the vessel in accurately metered stages, noting the volume and level signal at each stage and then transferring these values

	Actual Volume	% of Volume
SP27	0	0.00
SP29	6	0.01
SP31	47	0.08
SP33	158	0.28
SP35	376	0.66
SP37	235	1.30
SP39	1271	2.25
SP41	2018	3.57
SP43	3012	5.32
SP45	4289	7.58
SP47	56565	100.00

into the Minder in the normal way.

To undertake self teach calibration only the following parameters need to be known:

- A *The tank type i.e. linear, non-linear or mixed.*
- B *The specific gravity.*
- C *The actual depth of liquid between tank empty and tank full, and where the transmitter is mounted, i.e. on, above or below the tank empty point.*

Method

- 1 *Ensure the tank is empty of fluid.*
- 2 *Enter the specific gravity of the fluid which will be used to perform the calibration.*
- 3 *Enter the set parameter mode and ensure that SP04 is set to 0.00 and SP05 is set to 100.00. These input scaling factors are not employed in this type of calibration.*
- 4 *Step through the set parameter mode to SP09/4. The position of this switch will depend on the shape of the tank.*

FOR SPHERICAL TANKS OR HORIZONTAL CYLINDERS WITH OR WITHOUT DISHED ENDS SP09/4 SHOULD BE OFF.

FOR LINEAR TANKS OR TANKS WITH BOTH LINEAR AND NON-LINEAR SECTIONS SP09/4 SHOULD BE ON.

- 5 *The next stage is to determine the ideal calibration points in terms of liquid level. This again depends upon the shape of the vessel, the setting of SP09/4 and the mounting point of the transmitter relative to the tank empty point.*

For tanks where SP09/4 is OFF the ideal calibration points are as follows:

Where the transmitter is installed in line with the tank base, the points are determined simply by dividing the tank depth by 10,

e.g. Tank depth = 6000mm

$$\text{Increments} = \frac{6000}{10} = 600\text{mm}$$

Where the transmitter is mounted below the tank base, the first increment is the distance up to the tank base. The remaining 9 are calculated by dividing the full tank depth by 9,

e.g. Tank depth = 6000mm
Transmitter = 400mm below base
First increment = 400mm

$$\text{Remaining } 9 = \frac{6000}{9} = 666.6\text{mm}$$

Where the transmitter is above the tank base the points are determined by dividing the distance between the transmitter and the tank full point by 10,

e.g. Tank depth = 6000mm
Transmitter = 400mm above base

$$\text{Increments} = \frac{6000 - 400}{10} = 560\text{mm}$$

For tanks which are a mixture of linear and non linear sections, i.e. SP09/4 is ON, the first point is again dependent upon the mounting position of the transmitter and is calculated as described previously. The positioning of the remaining 9 points is dependent upon the shape of the particular vessel being calibrated, and the following points should be observed:

The linear sections of the tank require only 2 points, one at the start and one at the end. The remaining points should then be equispaced through the non-linear section (or sections).

N.B.: THE ACCURACY OF THIS METHOD OF CORRECTION DEPENDS UPON SELECTING THE BEST POINTS. PSM WILL BE PLEASED TO PROVIDE GUIDANCE IN THIS RESPECT.

Filling the vessel

Having determined the calibration points and ensuring that the Minder is in run mode, the vessel is filled in stages to each calculated level point via an accurate flow meter. At each level after allowing the liquid to settle, the SG button followed immediately by the SP button is pressed. The display will then show the value to be used in the look-up table level column. This should be noted and alongside it the exact capacity recorded at that point.

Once the vessel is full the calibration points are entered into the Minder in the normal way. The "% Level" values are entered exactly as read on the display and the "% volume" values are calculated as follows:

$$\frac{\text{Value recorded}}{\text{Maximum value recorded}} \times 100$$

N.B. THE TOTAL VOLUME ENTERED AT THE LAST CALIBRATION POINT IS THE FIGURE WHICH MUST BE ENTERED AT SP03 (TANK CAPACITY).

It may be noted that the % level figure at tank full is less than 100%. This will occur when the transmitters calibrated range is higher than the tank depth and therefore its full output is not reached.

SP47 is the final configuration parameter and so after entering the appropriate data, set up mode is exited by pressing button "SG" which saves the programmed data.

SECTION 6

Instrument details

SP48 to 54 Read Only information. These parameters are 'read only'

information which is entered during factory set up and cannot be amended by the user. These parameters, if quoted to PSM, will confirm the exact model and type of the instrument together with its factory calibration and software variation No.

The parameters are as follows:-

SP48 Calibration zero -	Normally set to value of 0
SP49 Calibration span -	Normally set to value of 16000
SP50 Scale zero -	Normally set to value of 800
SP51 Scale span -	Normally set to value of 3200
SP52 Instrument serial number -	e.g.96002301
SP53 Issue date -	29045 (29/04/95)
SP54 Revision -	e.g. 1
SP55 Type -	e.g. 0

Depression of the button SP when SP55 is being displayed will cause the unit to prompt for another password. This password provides access to the factory set up of the unit and as such the user will not need to enter this mode or make any changes. At this point button SP will return the unit directly to normal run mode, or button SG will save any configuration 'changes' made to the parameters SP01 to SP47 then return to normal run mode.

SUMMARY OF SET UP PARAMETERS

SP/SG -	Prompt for password (factory set 12345)
SP01	Display resolution (0.001 to 100 units)
SP02	Display filter (0 to 50 seconds)
SP03	Tank capacity
SP04	Zero factor
SP05	Range factor
SP08/2	Set trip 3 OFF = As SP08/3 to 6 below, ON = Pump control
SP08/3	Trip 3 OFF = M.O.R., ON = M.O.F.

SP08/4 Trip 4 OFF = M.O.F, ON = M.O.R.
 SP08/5 Trip 3 OFF = control type, ON = alarm type
 SP08/6 Trip 4 OFF = control type, ON = alarm type
 SP09/1 Global relay ON = relays enabled, OFF = relays disabled
 SP09/2 S.G. changes in run mode ON = enabled, OFF = disabled
 SP09/3 Setpoint changes in run mode ON = enabled, OFF = disabled
 SP09/4 Look up formula OFF = 10th order polynomial, ON = Linear interpolation
 SP09/5 Full & Empty messages ON = enabled, OFF = disabled
 SP09/6 Fault & O'load messages ON = enabled, OFF = disabled
 SP09/7 Trip 1 operation ON = Alarm, OFF = control
 SP09/8 Trip 2 operation ON = Alarm, OFF = control
 SP10 Alarm/Control relay debounce (in seconds)
 SP11 Hysteresis (in % volume) trip 1 (high alarm)
 SP12 Hysteresis trip 2 (low alarm)
 SP13 Hysteresis trip 3
 SP14 Hysteresis trip 4
 SP15 Setpoint (in % volume) trip 1 (high alarm)
 SP16 Setpoint trip 2 (low alarm)
 SP17 Setpoint trip 3
 SP18 Setpoint trip 4
 SP19 Baud rate for serial port
 SP21 Specific gravity setting
 SP25 Change user password
 SP26-47 Look- up table coordinate points
 SP20,22 Reserved

SP06,07,08/1,08/7,08/8,23,& 24 Not used