



Instruction manual 854 Density option

Instruction manual 854 density option

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Preface

This instruction manual is intended for technicians involved in the commissioning and service of the density option of Honeywell Enraf Series 854 level gauges.

For installation and commissioning of the 854 level gauge please refer to the Installation guides of the 854 level gauges as well as to the instruction manuals. This manual only describes the commissioning of the density option. Refer also to the list of related publications in Appendix B.

Safety and prevention of damage

Refer to the safety chapter in the instruction manual and installation guide of the 854 level gauge for the safety aspects of the instrument and for personal safety and safety conventions.

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EC declaration of conformity

This instrument is in conformity with the protection requirements of EC Council Directive 89/336/EEC. The CE conformity marking fulfills the provisions of

EN 50081-2 Generic Emission Standard
EN 50082-2 Generic Immunity Standard
73/23 EEC Low Voltage Directive

when installed, maintained and applied according to the requirements as specified in this manual.

Additional information

Please contact Honeywell Enraf or its representative if you require any additional information.

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1 Introduction

1.1 Functional description

A special software package for density measurement is available for the 854 level gauge. This optional package offer the possibility to measure tank density profiles and interface density profiles.

Tank Profile (TP) density measurement offers the possibility to measure the density at ten spots in the product. The individual measurement locations are equally divided over the complete product height.

Interface Profile (IP) density measurement offers the possibility to access the density stratification at or around a specific interface-layer.

Tank profile density measurement offers high absolute density accuracy, while Interface Profile measurement offers high position accuracy.

After completion of a density profile measurement an average density is calculated.

Note:

Application of servo density measurement is restricted to 'clean', non-viscous products.

Absolute inaccuracies of less than 5 kg/m³ (0.31 lbs/ft³) for the Tank Profile density measurement, and 10 kg/m³ (0.62 lbs/ft³) for the Interface Profile measurement can be accomplished if the gauge is properly installed, calibrated and maintained.

1.2 Principle of operation

The 854 can be used for density measurement if the servo level gauge is equipped with the optional software. In addition to the software a density displacer with an increased volume (200 cm³) must be used.

Two standard stainless steel density displacers, with 43 mm and 90 mm outer diameter, are available.

They are applicable for a maximum working pressure of 20 bar (290 psi).

In order to obtain the average observed density, the displacer is positioned at 10 different positions, equally divided over a specified measuring height. The apparent weight of the displacer is measured. Knowing the volume and the weight of the displacer, the observed density can be calculated. An average density will be calculated over all measured densities. The density data is transferred via the Honeywell Enraf field bus.

2 Commissioning

2.1 Installation on the tank

Correct installation and calibration of the 854 is essential to obtain maximal accuracy of the density measurements.

- Check if the gauge is correctly installed and commissioned. Mind item **TT** (request by PET);
- Check the stability of the mounting of the 854. As all position changes of the 854 perpendicular on the shaft axes will introduce density deviation, the horizontal angle should not exceed $\pm 0.5^\circ$;
- Check whether the installed software supports density measurement.
This can be done using a PET and requesting item **SV**. The SPU software description should start with a 'C' (SPU **Cx.x**) or a 'D' (SPU **Dx.x**).

2.2 Calibration of the 854 level gauge (using a PET)

For information how to program items, refer to the instruction manual 854 level gauge or to the instruction manual of the 847 Portable Enraf Terminal (PET).

- Perform a balance test to check the unbalance of the measuring drum. Refer to the instruction manual of the 854 level gauge.

Note:

*The drum unbalance (**BU** - **BV**) should be within 3 grams. If the drum unbalance is more, check the drum for contamination. If the unbalance is still more than 3 grams, replace the drum bearings and check again. For details see the 854 instruction manual.*

- Calibrate the force transducer. This is required for the most accurate density measurement result. Refer to the instruction manual of the 854 level gauge.
- Check the displacer weight after the calibration of the force transducer. Refer to the instruction manual of the 854 level gauge.
It is recommended to weigh the displacer with the balance test and then request for the average unbalanced weight item **BW**.

Note:

The measured displacer weight should not differ more than 0.1 grams from the engraved displacer weight (0.1 gram measuring error by the displacer weight results in a density error of 0.5 kg/m^3).

If it is more than 0.1 grams, re-calibrate the force transducer and/or check the drum unbalance.

2.3 Selecting density dimension

When the density dimension has to be changed from default, all items with the density format have to be changed and the values must be converted to the new dimension.

Note:

*When the instrument is equipped with an XPU-2 board -software version (item **SV**) reads: XPU **Hx.x**- all dimension depended items will be automatically changed and the values will be automatically converted.*

Item	Name	Description
W2=	Protection level 2	Enter protection level 2
DI=	Density dimension	<p>Selects the density dimension and converts the format. This item contains one character, which can be:</p> <p>K : kg/m³;format: sign X X X X X separator X X A : °API; format: sign X X X X separator X X X L : lbs/ft³;format: sign X X X separator X X X X Default set on: K [kg/m³].</p>
..=	<i>format depended items</i>	<p>Not required with XPU-2 board and depended on installed option board. Program all density depended items to the new dimension. These items are: 28, DD, DL, DU and HD.</p>
EX	Exit	Exit protection level.

2.4 Setting of density items

The items mentioned in this section are common for the Tank Profile and Interface Profile measurement.

Item	Name	Description																
W2=	Protection level 2	Enter protection level 2.																
DW=	Displacer weight	Floating point format; units: gram. Enter the weight of the displacer. This is engraved on the displacer.																
DV=	Displacer volume	Floating point format; units: cm ³ . Enter the volume of the displacer. This is engraved on the displacer.																
		Note: <i>In high pressure applications (spheres or bullets), the displacer volume must be corrected for the nominal pressure. DV must be decreased with 0.04 cm³/bar (0.00276 cm³/psi).</i>																
WV=	Wire volume	Floating point format; units: cm ³ . The default value is 0.032 cm ³ /m (+.32000000E-01) Only in high pressure applications (spheres or bullets), item WV can be changed from the default to compensate for the hydrostatic deformation of the displacer (#0815.350). Refer to table below:																
		<table><tr><th>Product density [kg/m³]</th><th>WV [cm³/m]</th></tr><tr><td>500</td><td>+.30050000E-01</td></tr><tr><td>600</td><td>+.29660000E-01</td></tr><tr><td>700</td><td>+.29270000E-01</td></tr><tr><td>800</td><td>+.28880000E-01</td></tr><tr><td>900</td><td>+.28490000E-01</td></tr><tr><td>1000</td><td>+.28100000E-01</td></tr><tr><td>1100</td><td>+.27710000E-01</td></tr></table>	Product density [kg/m ³]	WV [cm ³ /m]	500	+.30050000E-01	600	+.29660000E-01	700	+.29270000E-01	800	+.28880000E-01	900	+.28490000E-01	1000	+.28100000E-01	1100	+.27710000E-01
Product density [kg/m ³]	WV [cm ³ /m]																	
500	+.30050000E-01																	
600	+.29660000E-01																	
700	+.29270000E-01																	
800	+.28880000E-01																	
900	+.28490000E-01																	
1000	+.28100000E-01																	
1100	+.27710000E-01																	
EX	Exit protection level.																	

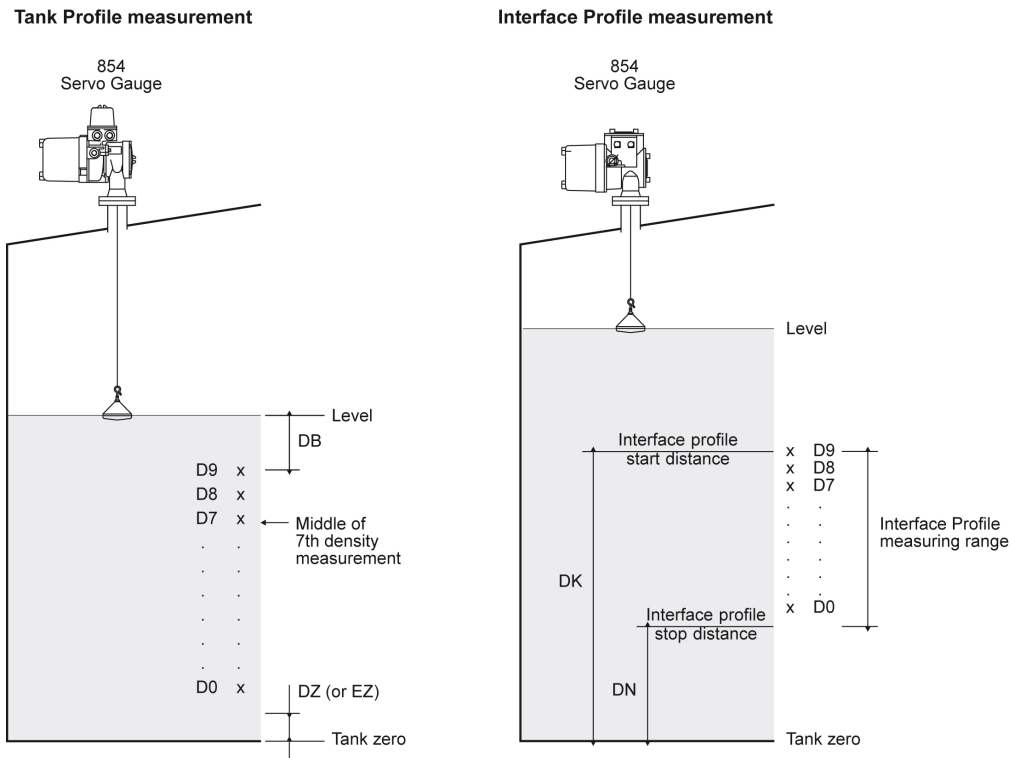


Figure 2.1 Tank Profile and Interface Profile density measurement

2.5 Settings for a tank profile measurement (command item TP)

The following items must be programmed before the 854 level gauge can perform a Tank Profile density measurement.

Item	Name	Description
W1=	Protection level 1	Enter protection level 1.
DB=	Density profile start distance	Format according to item LD. Refer to figure 2.1. The distance from the liquid surface till the middle point of the highest (D9) density measuring point. For a good density measuring result, DB is at least 0.3 m (1 ft).
DZ=	Default density stop distance	Format according to item LD. Refer to figure 2.1. The middle point of the lowest (D0) density measuring point. For a good density measuring result, DZ must be at least 0.2 m (8") above the motor limit switch low (item ML).
SD=	Scan direction	One ASCII character; either 'D' (default) or 'U'. Determines the direction in which a tank profile (or interface profile) is measured. D : from product surface downwards U : from bottom upwards

Note:

When also water bottom is measured, it is advised to set the scan direction upwards. Then the combined dip command directs the displacer downwards for water measurement, and on the way back, density is measured.

EX Exit Exit protection level.

2.6 Settings for an interface profile measurement (command item IP)

The following items must be programmed before the 854 level gauge can perform an Interface Profile density measurement. Refer to figure 2.1. The items are not protected.

Item	Name	Description
DK=	Interface density profile	Format according to item LD . An interface profile density start level measurement can be performed at any location in the tank. Interface profile start level DK specifies the highest interface level.
DN=	Interface density profile stop level	Format according to item LD . An interface profile density measurement can be performed at any location in the tank. Interface profile stop level DL specifies the lowest interface level.
SD=	Scan direction	One ASCII character; either 'D' (default) or 'U'. Determines the direction in which an interface profile (or tank profile) is measured. D : from DK level downwards U : from DN level upwards

2.7 Corrections

The density calculation by the 854 level gauge is as follows:

$$R_n = \frac{\text{Displacer weight} - \text{Wire tension} + \text{Wire weight}}{\text{Displacer volume} + \text{Immersed wire volume}} \times A1 \times 1000 + A2 + RF \quad [\text{kg/m}^3]$$

where:

R_n	=	measured servo density (n: 0 .. 9)
A1	=	density scale factor
A2	=	density offset factor [kg/m ³]
RF	=	ambient air density [kg/m ³]
Wire tension	=	tension in the measuring wire, measured by the force transducer

Items **A1** and **A2** are scale and offset factors which can be used in special applications to correct the servo density measurement. For instance: density measurement on cryogenic tanks to correct for the smaller displacer volume.

Item **RF** contains the ambient air density and is used to present the measured observed density as density in vacuum. If the density value is required as density in air, then item **RF** must be set to 0.

Item	Name	Description
W2=	Protection level 2	Enter protection level 2
A1=	Density scale factor	Floating point format; default value: +.10000000E+01.
A2=	Density offset factor	Floating point format; units: kg/m ³ . Default value: +.00000000E+00.
RF=	Ambient air density	Floating point format; units: kg/m ³ . Default value: +.12250000E+01. For density in vacuum: use the approximate air density in item RF . For density in air: set item RF to 0.
EXExit	Exit protection level.	

3 Operation

3.1 Display

For operation of the display and information on it, refer to the instruction manual of the 854 ATG level gauge, the 877 FDI or the 977 Tank Side Indicator.

The display format (item **DF**) for the servo density is: Format I.

3.2 Manual input

The default density stop distance can be overwritten by data item **EZ**. After a power down, or reset of the level gauge, the manual input data is lost.

Item	Name	Description
EZ	Density profile stop distance	Format according to item LD . Refer to the description at item DZ . EZ overwrites the DZ value. For SPU software versions 2.2 (and higher) the highest setting of EZ or DZ is used as density stop distance.

3.3 Data items, commands and error codes

Below, a summary is given of the data items, commands and applicable error codes:

Item	Description	
D0 .. D9	Measured / calculated data	Density innage levels; the calculated level midpoints at which the ten corresponding densities will be measured. The level values are preceded by two status characters (refer to sections 4.2).
R0 .. R9		Measured servo density values; the calculated densities at the ten corresponding levels. The density values are preceded by one status character (refer to section 4.2).
SC		Servo density request; the average value of the ten measured densities R0..R9. The status byte is the 'OR' function of the individual status bytes of R0..R9.
IP	Commands	Interface profile density scan; ten density measurements equally divided between distance DK to distance DN .
TP		Tank profile density scan; ten density measurements equally divided between distance DB below the liquid surface and distance DZ (or EZ).
ES FS	Error codes	Error SPU request Fatal SPU errors

4 Maintenance and trouble shooting

4.1 Maintenance

For information about maintenance, refer to the maintenance chapter of the 854 instruction manual.

With the density option it is recommended to check regularly (once or twice a year) the level gauge by means of a balance test and displacer weight command. If one or both tests are not within the specs, follow the recommendations as given in section 2.2.

4.2 Trouble shooting

The 854 level gauge is a self diagnostic instrument. Detected errors can be requested as items by the PET.

Item **ES** Error SPU request, contains an error code (last occurred error) of the servo processor unit.

Besides this error code, data items from the density measurement contain one or two status bytes, which also gives valuable information. These bytes are readable ASCII characters. However, most of them are bit coded. Appendix A contains an ASCII table for conversion of the status bits into the actual status.

An example for a bit coded status byte:

one (of the) status bytes reads: **F**;
 written out in bits (refer to Appendix A): **0100 0110**;
 (b7=0, b6=1, b5=0, b4=0, b3=0, b2=1, b1=1, b0=0).

Bit 7 is always a '0' and bit 6 is always a '1' to avoid 'control' characters.

Look up the relevant status byte in this section (e.g. with item **D0**) to determine the meaning of the bits which are set to '1'. Only the bits set to '1' represent an actual status.

SPU error code (item ES)

The SPU error code is a four-digit number. Some SPU error codes of item **ES**, related to the density measurement, are listed below with suggestions for solving the problem. For a complete overview, refer to "Item documentation for Honeywell Enraf series 854 level gauges" and in the help of the service program Ensite.

0000	No error	
0064	DW range error	Item DW set out of its limits (min.: 100 g; max.: 300 g).
0074	DV range error	Item DV set out of its limits (min.: 10 cm ³ ; max.: 1000 cm ³).
0364	WW range error	Item WW set out of its limits (min.: 0; max.: 5 g/m).
0414	RF range error	Item RF set out of its limits (min.: -5 kg/m ³ ; max.: 5 kg/m ³).
0511	DZ divide by zero error	An invalid value of item DZ caused this error; check item DZ .
0512	DZ floating point overflow error	An invalid value of item DZ caused this error; check item DZ .
0534	A1 range error	Item A1 set out of its limits (min.: 0.1; max.: 10).
0544	A2 range error	Item A2 set out of its limits (min.: -100 kg/m ³ ; max.: 100 kg/m ³).

Status bytes of items D0 .. D9

The density innage levels are preceded by two status bytes S1 and S2, which are bit coded. The meaning of the status information is:

Status byte 1 (S1):

- bit 0 : general fail / default setting
- 1 : no valid **Y4** level
- 2 : level / traject exceeds **MH** level
- 3 : level / traject exceeds **ML** level
- 4 : 0
- 5 : 0
- 6 : 1
- 7 : 0

Status byte 2 (S2):

- bit 0 : traject exceeds level **Y4**; **DB** too small (**TP** only)
- 1 : density traject stops below **DZ** or **EZ** (**TP** only)
- 2 : no valid **DK** and/or **DN** levels (**IP** only)
- 3 : 0
- 4 : 0
- 5 : 0
- 6 : 1
- 7 : 0

Status byte of items R0 .. R9 and SC

The measured servo density items are preceded by one status byte S0, which is bit coded. The meaning of this status information is:

Status byte 0 (S0):

- bit 0 : general fail / default setting
- 1 : measurement not completed
- 2 : 0 = Tank Profile **TP**
1 = Interface Profile **IP**
- 3 : no measuring point or measuring point out of range
- 4 : conversion overflow
- 5 : conversion underflow
- 6 : 1
- 7 : 0

Appendix A ASCII table

HEX	MSB				0	1	2	3	4	5	6	7
	BIT				6 5 4	6 5 4	6 5 4	6 5 4	6 5 4	6 5 4	6 5 4	6 5 4
	3	2	1	0	0 0 0	0 0 1	0 1 0	0 1 1	1 0 0	1 0 1	1 1 0	1 1 1
0	0	0	0	0	NUL	DLE	SP	0	@	P	`	p
1	0	0	0	1	SOH	DC1	!	1	A	Q	a	q
2	0	0	1	0	STX	DC2	"	2	B	R	b	r
3	0	0	1	1	ETX	DC3	#	3	C	S	c	s
4	0	1	0	0	EOT	DC4	\$	4	D	T	d	t
5	0	1	0	1	ENQ	NAK	%	5	E	U	e	u
6	0	1	1	0	ACK	SYN	&	6	F	V	f	v
7	0	1	1	1	BEL	ETB	'	7	G	W	g	w
8	1	0	0	0	BS	CAN	(	8	H	X	h	x
9	1	0	0	1	HT	EM	)	9	I	Y	i	y
A	1	0	1	0	LF	SUB	*	:	J	Z	j	z
B	1	0	1	1	VT	ESC	+	;	K	[	k	{
C	1	1	0	0	FF	FS	,	<	L	\	l	|
D	1	1	0	1	CR	GS	-	=	M	]	m	}
E	1	1	1	0	SO	RS	.	>	N	^	n	~
F	1	1	1	1	SI	US	/	?	O	—	o	DEL

Appendix B Related documents

Instruction manual series 854 ATG level gauge
Installation guide 854 Advanced Technology Gauge

Instruction manual series 854 XTG level gauge
Installation guide 854 XTG level gauge

Instruction manual 847 Portable Enraf Terminal

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