

Flat Radar Level Sensor

MRF-10

Installation & Operation Manual

TOKYO
KEIKI

Safety Cautions





The caution message shown in the User's Guide is defined as follows:

The following safety precautions contain important information pertaining to the safe use of the Radar Level Gauge. Read this text carefully and make sure to fully understand its contents before installing and operating this equipment. Follow directions given herein at all times when operation. TOKYO KEIKI INC. is not at all liable for an injury and/or a damage resulting from misuse of this equipment by the user that is contrary to these cautionary notes.

For quick reference, store this manual in a designated location with easy access (preferably near the equipment).

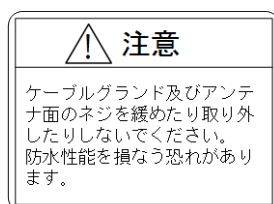
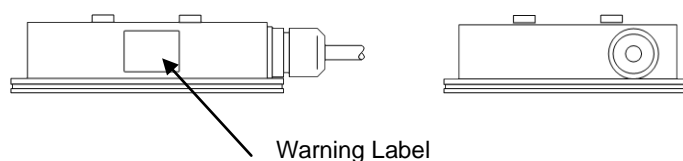
In this manual and on the equipment, the following safety symbols are used to ensure the equipment is used safely and to protect operators and property from possible hazards or damage. Read the explanations below carefully and familiarize yourself with the symbols before reading the manual.

Safety symbols

 DANGER	Indicates that incorrect usage can result directly in death or serious injury to the operator.
 WARNING	Indicates that incorrect usage may result in loss of life or serious injury to the operator.
 CAUTION	Indicates that incorrect usage may result in injury to the operator or damage to the equipment.
	Indicates referring to information for usage of the function or features. (Put on the equipment)

[Warning Label]

Indicates that incorrect usage may result in death or serious injury to the operator.



Left warning label means

Caution

Do not remove cable glands or any screws that attached with main unit. In case of removal it, main unit can not satisfy performance of protection class.

Usage Precautions

This instrument is used to measure level height by means of microwave. For safe usage and optimum performance of the radar level sensor, always operate the instrument according to the usage precautions below.



CAUTION

1. Failure to comply with one or more of the following conditions may result in poor measurement performance or incorrect measurement values.
 - Use an appropriate power supply rated for the voltage range designated in the specifications.
 - Do not subject the main unit to vibration or mechanical shock.
 - Place the main unit, transducer and cable in a location without noise interference.
 - Use the equipment within the predetermined ambient temperature and humidity range.
2. If the signal level is below the minimum detection requirement of the instrument, the alarm will be reported through analog output in accordance with alarm setting.
3. Be sure to use the instructions in the Manual when changing settings on the main unit. Incorrect settings will result in poor performance or incorrect measurement values (output signals).
4. Do not modify or disassemble the unit. Such actions may result in electrical shock or equipment damage.
5. If this Operation manual is lost, contact the nearest dealership.

Introduction

Thank you for your selecting our radar level sensor.

This Manual includes detailed explanations regarding safety cautions, structure, set up, operation, troubleshooting, and maintenance of the radar level sensor.

Read this manual carefully before operation to ensure an adequate understanding of the equipment.

Proper use of the Operation Manual

The following points must be observed:

CAUTION

1. Carefully read the Manual. The contents of this Manual are very important and should be read completely.
2. Store the Manual in a safe location. The Manual is essential for appropriate operation of the equipment. Store the manual in a safe and accessible location. The storage location and person in charge should be determined after careful consideration.
3. Ensure that the Manual is supplied to the operator of the equipment. The representative or dealer of this equipment must provide this Manual to the user who will actually operate the equipment.
4. The Manual must be replaced if lost or damaged. If the Manual is lost, contact the representative. A new manual is available for purchase.
5. Ensure that the warning label is properly attached. If the warning label is illegible or has come off, contact the manufacturer to purchase a new label.

Precautions regarding the Manual

This Manual was written in accordance with the standard specifications of the original instrument.

In case of discrepancies between written specifications and approved drawings, the drawings should be given precedence.

Restrictions and precautions necessary to maintain the equipment

The following items must be observed in order to maintain the equipment.

CAUTION

1. Do not drop or bump the unit and the transducer.
2. Do not use the unit in environmental conditions (ambient temperature, ambient humidity) other than those prescribed in this manual.
3. Do not use the unit with a power supply other than the one prescribed in this manual.
4. Do not use damaged or worn-out cables (power cables, coaxial cables, signal cables).
5. Under no circumstances attempt to modify or disassemble the instrument. Contact the manufacturer in the event of a malfunction.
6. Do not remove cable glands or any screws that attached with main unit. In case of removal it, main unit can not satisfy performance of protection class.
7. Do not modify or disassemble the unit. Such actions may result in electrical shock or equipment damage.
8. Do not use the unit and/or accessories in restricted hazardous areas.

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1. Product Description

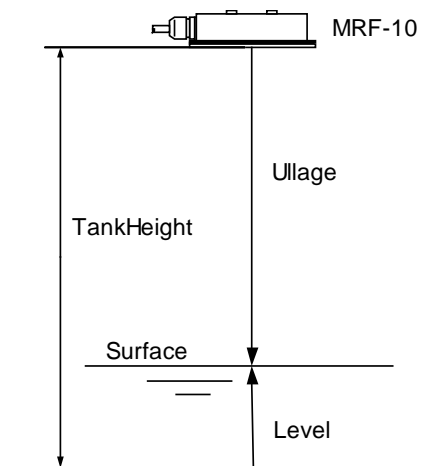
1.1 Features

The MRF-10 is a loop-powered radar level gauge, which can be installed easily in a variety of applications. The MRF-10 employs a non-contact radar level gauging principle based on pulsed microwave signals and is suitable for level measurement in applications such as liquids, pastes and slurries.

MRF-10 uses 5.8GHz low power pulsed microwave. It provides good measurement stability, because propagation of microwaves is less affected by change of temperature, pressure or gas conditions in tank.

1.2 Measuring Principle

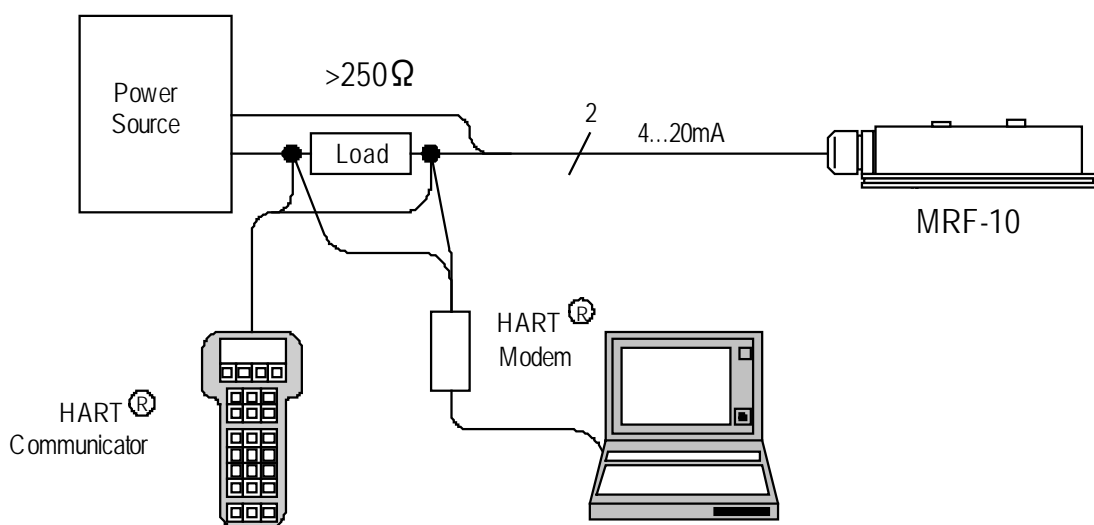
The MRF-10 level gauge utilizes the time-of-flight measurement principle involving short microwave pulses. Installed at the top of tanks or channels, it emits short microwave pulses toward liquids or pastes. Reflected microwave signals from the surface are received by the antenna, and processed by electronics. The time from transmission to reception is determined by the microprocessor and converted as distance from the transmitter to the liquid surface (ullage) with output of the calculated level from the measured ullage (Level = Tank Height – Ullage).



1.3 System configuration

MRF-10 can be configured with remotely from a personal computer via a modem or a handheld terminal.

The MRF-10 is required to connect to a PLC or power supply unit.



2. Mechanical Installation

2.1 Requirements

Please regard to following points to install MRF-10 transmitter head.

- (1) Directivity angle of microwave
MRF-10 has elliptical (oval) directivity of microwave as below Fig. 2.1-1.
Please refer to chapter 2.3 example of recommended installation to install transmitter head properly.

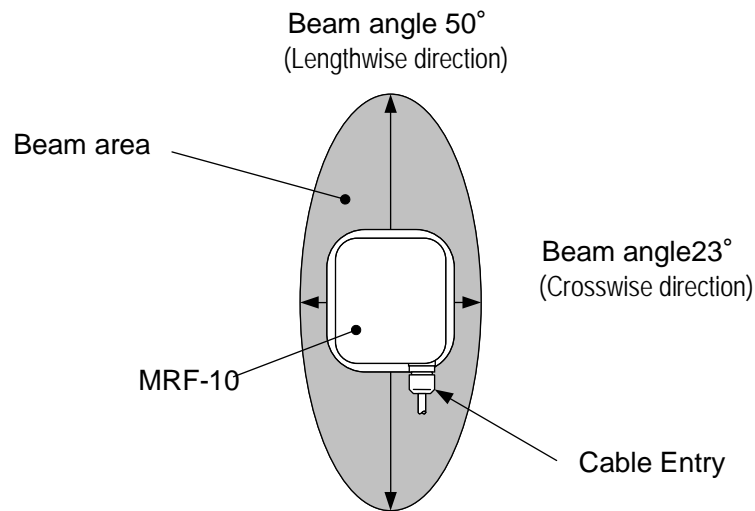


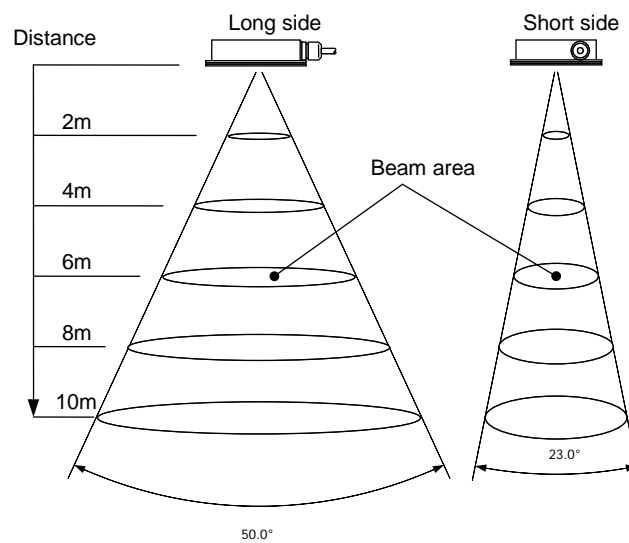
Fig. 2.1-1 Beam angle

- (2) Free space requirement
The transmitter should be mounted so that no obstacles are present in the radar beam. Obstacles in the radar beam may reduce the measuring range.
Please refer to list 2.2-1.
- (3) Mounting allowance
Center of microwave radiation must be vertical against target fluid surface.
Allowance of the mounting angle should be +/- 1 degree.

2.2 Beam area in the measuring range

List 2.2-1 : Beam angle & Beam area (* -3dB Half-power beam angle)

Distance (m)	Beam area (m)	
	Lengthwise direction (cable direction) Beam angle* =50°	Crosswise direction Beam angle* =23°
2	1.9	0.8
4	3.7	1.6
6	5.5	2.4
8	7.5	3.3
10	9.3	4.1



[Key factors for measurement]

1. Compared to calm fluid surfaces, measuring ranges of turbulent surfaces are reduced due to poorer reflection.
2. Deposit buildup on the antenna, foaming on liquid surfaces, powder granules in air suspension and other interior tank conditions may affect measuring range and performance.
3. Obstructions in the microwave radiating area or target fluid surface areas less than the radiating area will reduce microwave reflection and decrease and narrow the measurable range.
4. Measurable range may be varied when area of target fluid surface is smaller than radiated beam area.

2.3 Recommended installation example

Following installation examples are recommended installations.

(1) Installation for water channel

Install MRF-10 lengthwise direction of transmitter head to be same direction of flow direction as below.

Also please keep the required free space from the wall.

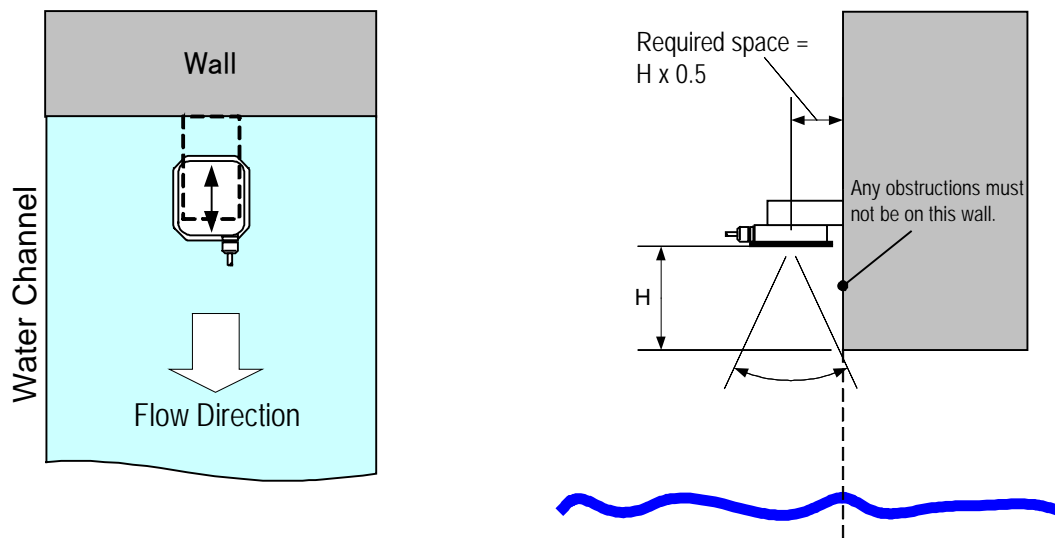


Fig. 2.3-1 example of wall side mounting installation

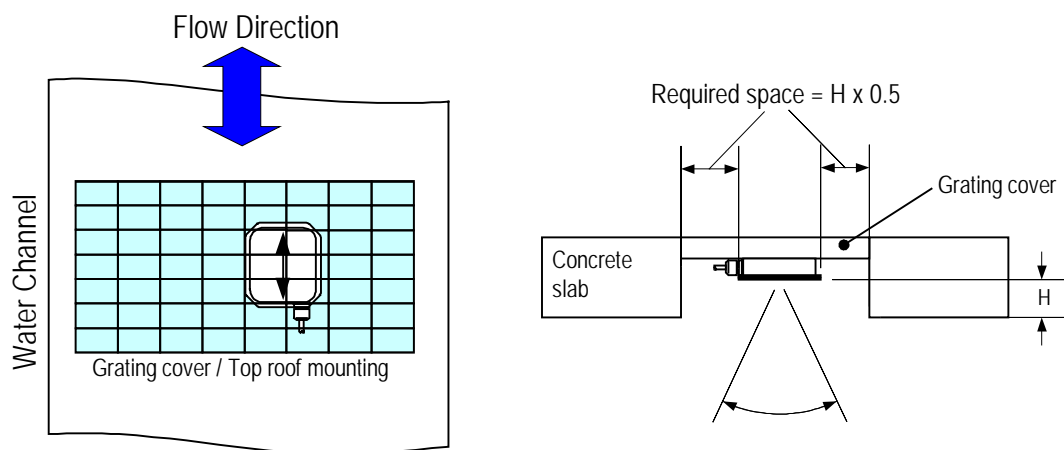


Fig. 2.3-2 example of top roof mounting installation below grating cover

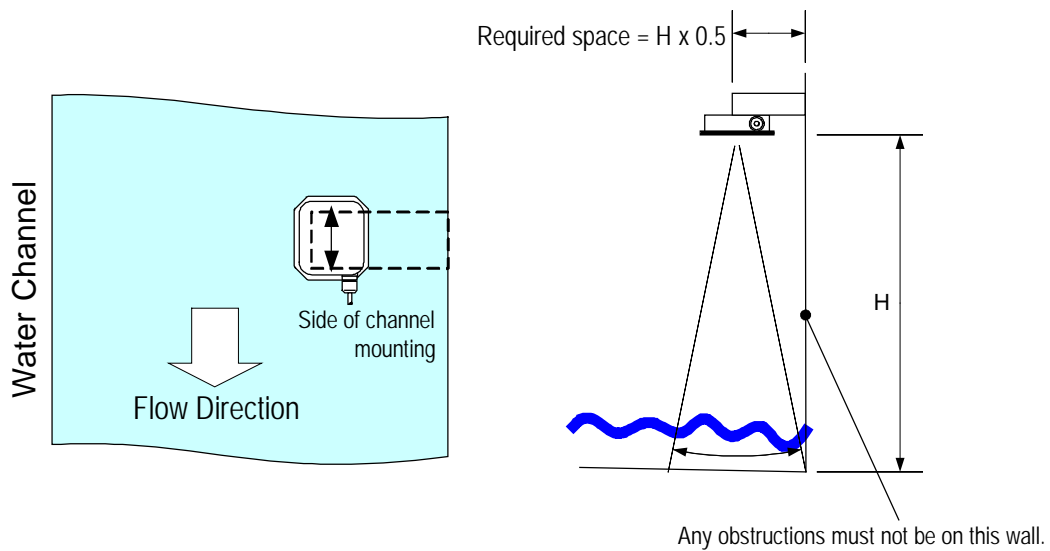


Fig. 2.3-3 example of wall side mounting installation for Inlet water level measurement

(2) Installation for storage Tank

Please avoid installing MRF-10 at the very center of tank, because the reflection of side beam will affect stable measurement.

Besides, please set the lengthwise direction of MRF-10 install to be parallel against the nearest tank wall. In such case, required free space to the nearest tank wall will be more than “measuring range x 0.2”.

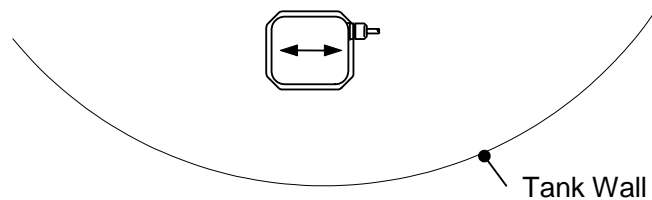


Fig. 2.3-4 example of tank installation

Note


Any obstructions, which set as parallel to fluid surface in, the radiated beam area may contain big disturbance noise.

In such case, reflection plate will be one of the solutions to reduce its reflection.

3. Electrical Installation

3.1 Wiring connection

(1) Transmitter side

	Caution
Do not remove cable glands or any screws that attached with main unit. In case of removal it, main unit can not satisfy performance of protection class.	

Any cable work must be done at the end side of cable, not at the cable entry of the main unit.
If cable extension is required, please use chemical binder at the end of cable to keep water protection class.

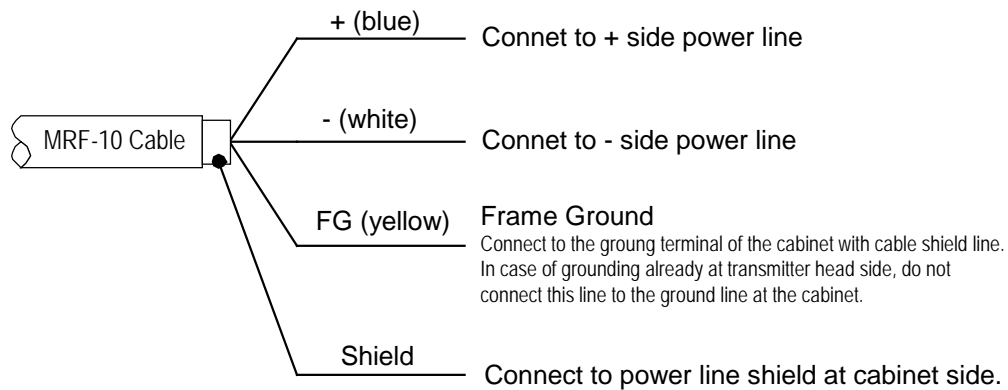


Fig. 3.1.1-1 wiring connection

- FG (frame ground) must be connected to ground line with cable shield as below.

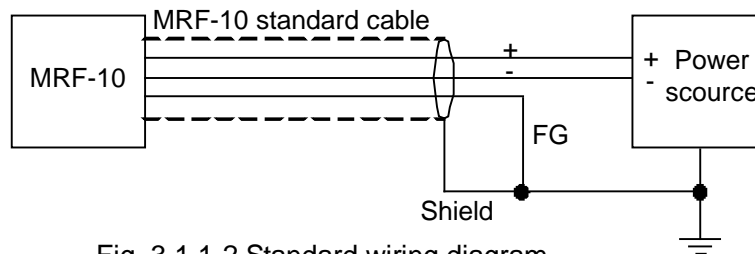


Fig. 3.1.1-2 Standard wiring diagram

(2) Connection for commissioning software

Sample connection for commissioning software through PC is indicated as below Fig.3.1.2-1.

Any analog recorder can be connected instead of Hart modem.

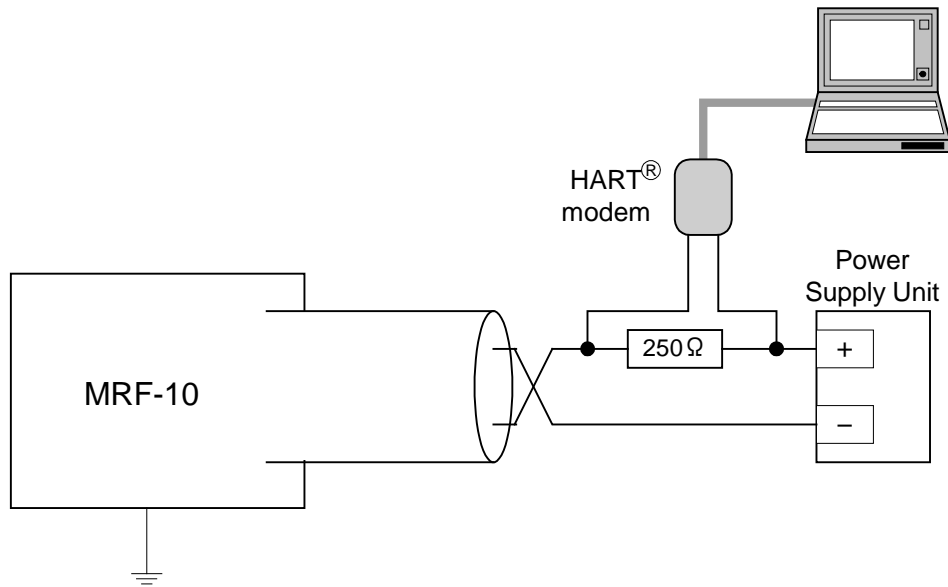


Fig. 3.1.2-1 Connection to commissioning software

3.2 Cables

Requirement

Use shielded twisted cable 2-core or 3 core.
Cross-sectional area of conductor is 0.2 ...2.5mm².
(AWG24 ...14)
Recommended cable; KNEE-SB (1.25sq x 3C, OD 9mm)

3.3 Load

Minimum load for HART®

250 Ω

Maximum load

340 Ω (at DC24V)

3.4 Power supply

Requirement

16...36VCD

Current capacity

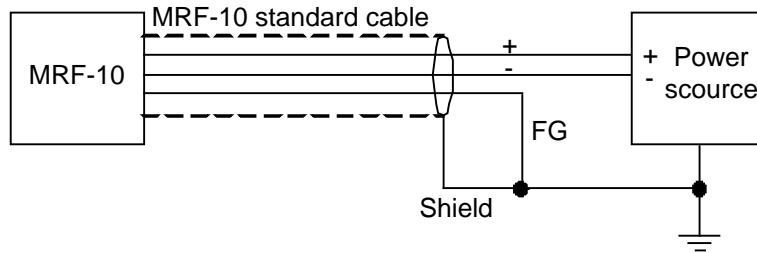
22mA

3.5 Grounding

The terminal must be connected to earth ground prior to connection to any other equipment. The grounding resister should be less than 100 ohm.

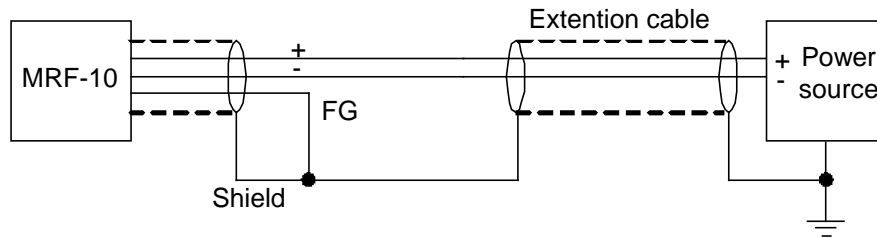
(1) Example of connecting only with attached standard cable or extended with 3-core shielded cable

Please connect with shield & FG line to grounding line at power source side as below.



(2) Extended 2-core cable with shield

Please connect shield line to FG line at connection part, then grounding at power source side as below.

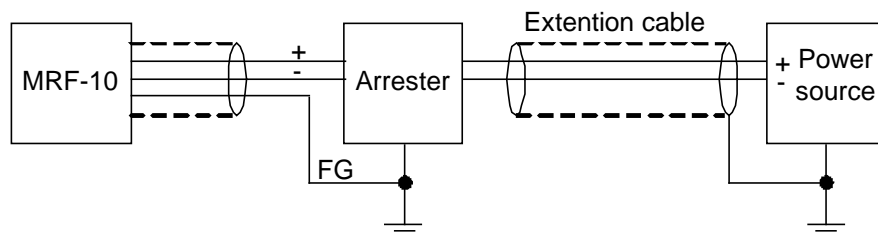


(3) With lightning arrester

Please connect only FG line to arrester grounding line.

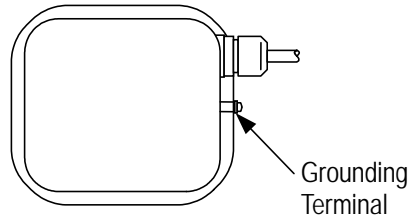
The shield of extension line should be taken at ground line of power source side as below.

The lightning arrester should be installed near-by MRF-10 transmitter head.

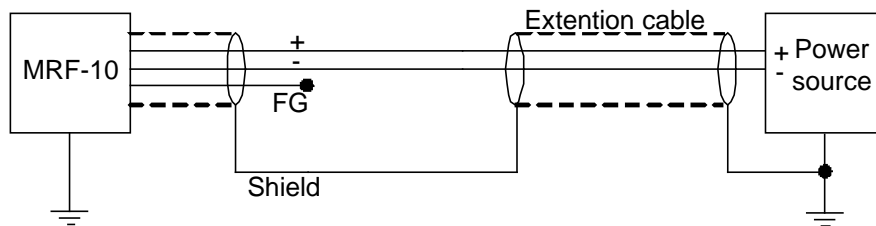
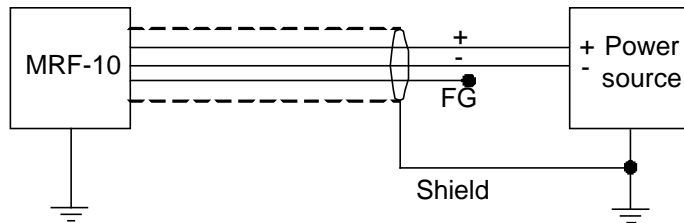


(4) When base of the mounting position made by metal parts which connected with the grounding line already.

Please connect the grounding terminal near by cable entry to the ground.



Do not use FG line, only with cable shield connects to grounding line as below.



4. Commissioning

4.1 Working Conditions

Microsoft Windows 2000 / XP

Personal Computer which can activate HART modem

HART Modem (* We have checked following products in the market.)

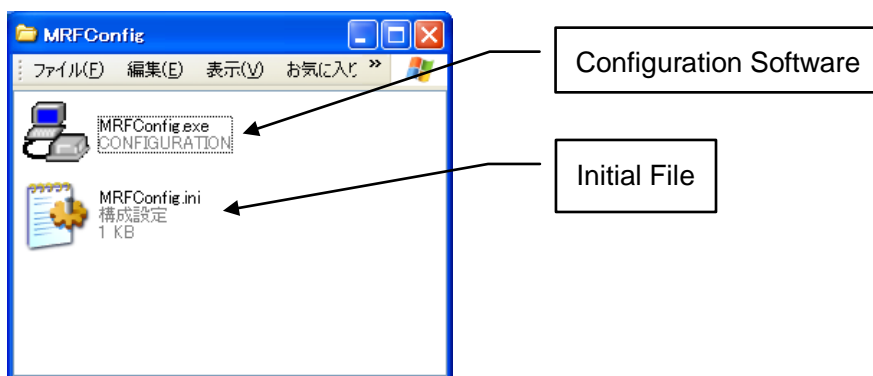
Maker : MAC Tek

Modem : VIATOR RS232 HART Interface (Model 010001)
VIATOR USB HART Interface (Model 010031)

4.2 Produced file

MRFCConfig.exe : Main program of configuration software

MRFCConfig.ini : Initial File (When the configuration software was quitted, this file is automatically created.)



Note

This software has no installer. Hence, please copy all files to any folder.



Caution

Carefully read this manual prior to use this software because incorrect operation will cause malfunction and/or breakdown.

This software is subject to change for upgrade without prior notice

4.3. Connection

This sensor can setup by dedicated software on Notebook PC that connects with HART modem.

As Fig1.1, HART modem connects with both end of load resistor.

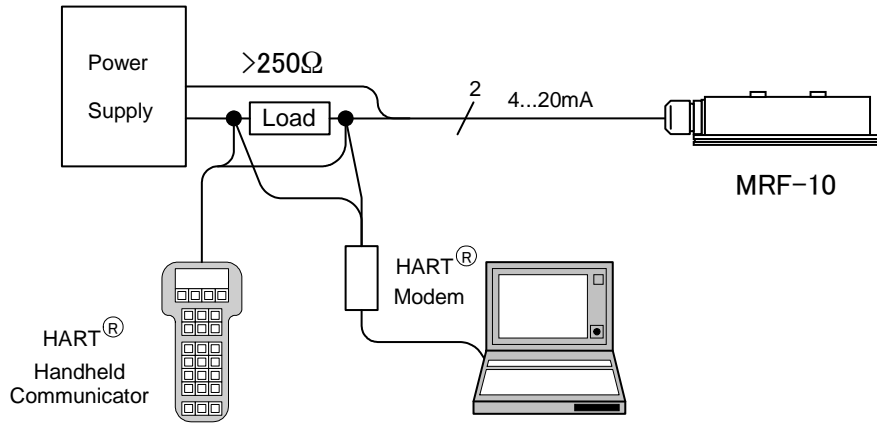


Fig. 1.1 Wiring

4.4 Initial Setup

(1) Startup Screen

Fig. 4.4-1 is Start-up Screen.

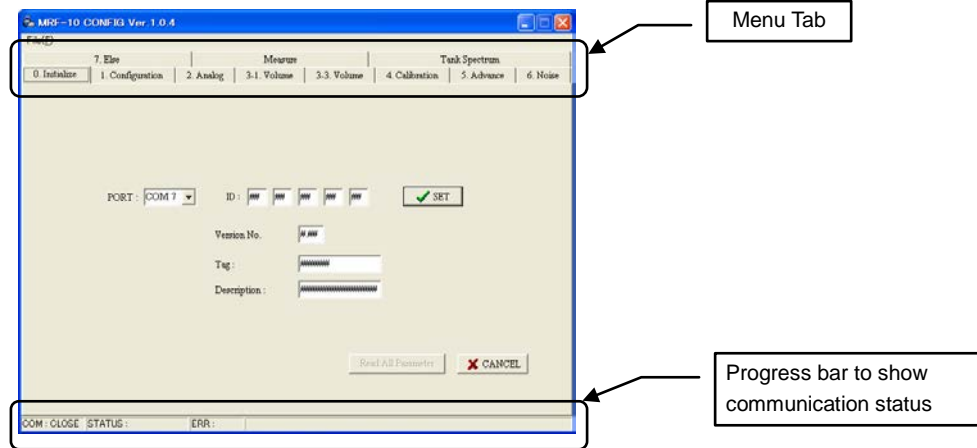


Fig. 4.4-1 Start-up Screen

Menu Tab in Fig. 4.4-1 can select each kind of parameter.

Progress bar at the lower-end of window shows communication status.

Fig. 4.4-2 is the progress bar under communication (online).



Fig. 4.4-2 Progress bar

(2) Reading HART ID

Get HART ID from MRF-10.

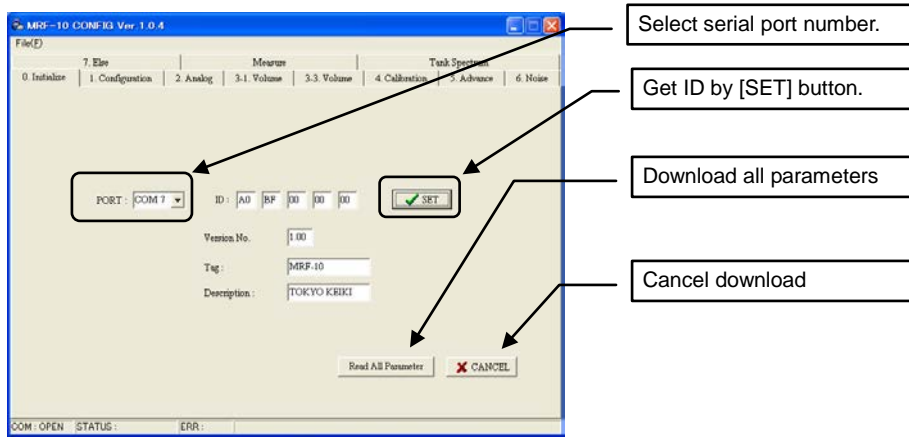


Fig. 4.4-3 Start-up Screen after getting HART ID

Select serial port No. that connected with HART modem from PORT column in Fig. 4.4-3 at first.

Secondly, click **[SET]** button and download HART ID from the sensor.

After download of HART ID, individual ID and software version No. will be filled in each column. All communication with MRF-10 will use this ID.

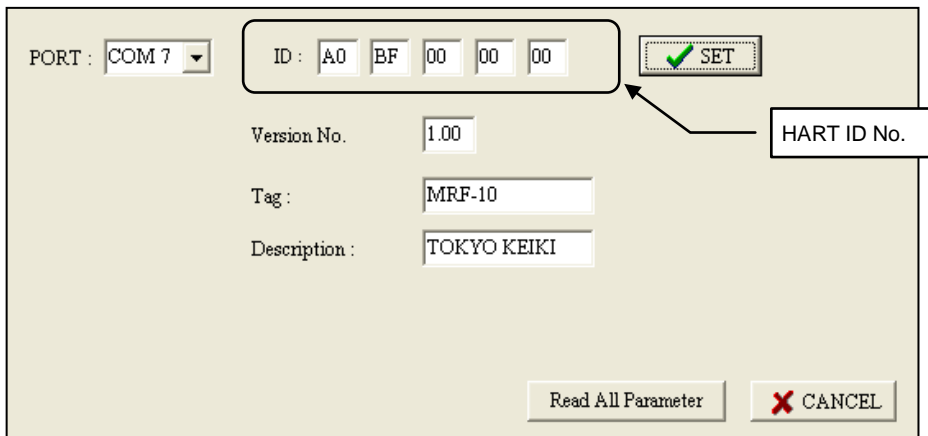


Fig. 4.4-4 After getting HART ID

[SET] button: Retrieve HART ID from the sensor.

[Read All Parameter] button: Retrieve all parameters from the sensor at one time.

[Cancel] button: Interrupt communication with the sensor on the way.

(3) Message after data communication

After completion of data communication between the sensor and PC, a message window will appear as Fig. 4.4-5.



Fig. 4.4-5 The message of Successful Communication

In case of communication failure or time-out error, the status will indicate **FAIL** or **TIME OUT** as Fig. 4.4-6.

These messages are mostly caused by improper connection of HART modem or there is a possibility of noise on communication pathway. Please check each condition.

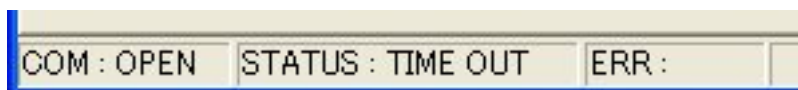
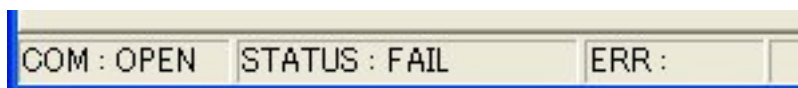
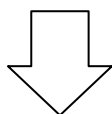
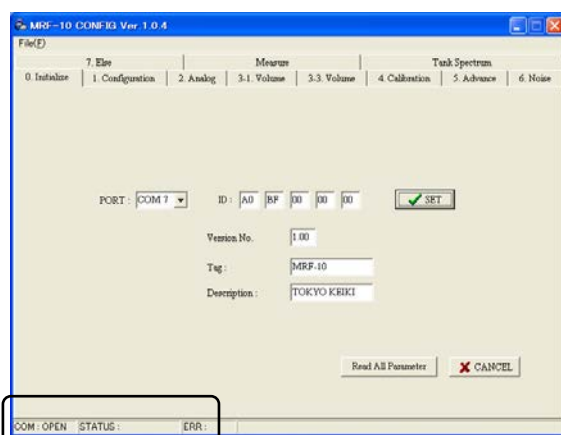


Fig. 4.4-6 Status Indication by communication failure or timeout

4.5. Basic Operation

(1) Read Parameter

It shows how to read configuration parameters on the screen of “1.Configuration” for example.

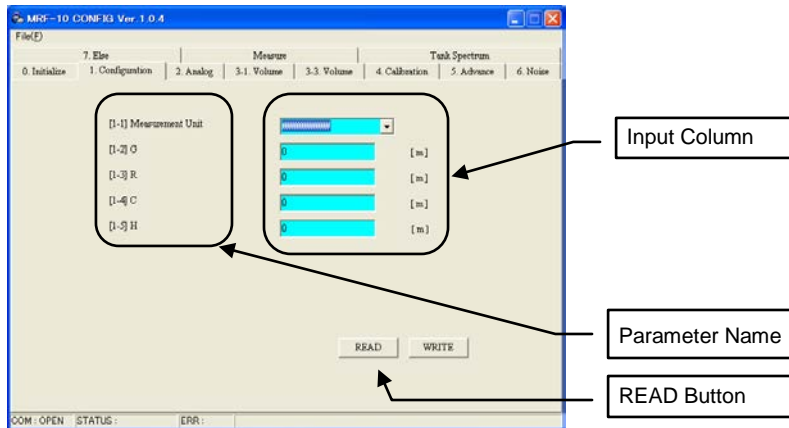


Fig. 4.5-1 Screen of “1.Configuration” before “READ”

Configuration Screen will be shown by click a tab of “1.Configuration” as Fig. 3.1.

Watery blue column means the parameter was not read yet.

[READ] button make start to retrieve all parameters that are on the screen from the sensor. In Fig. 4.5-1, [1-1] ~ [1-5] will be downloaded.

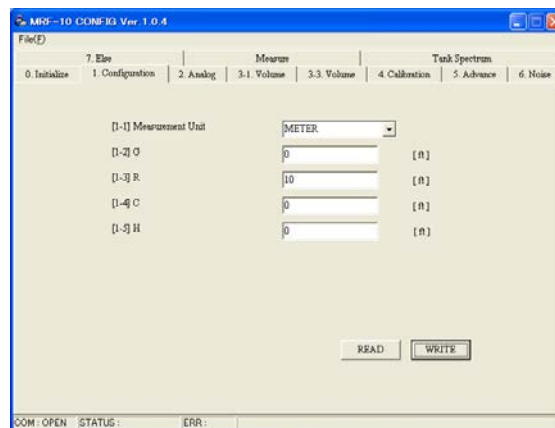


Fig. 4.5-2 Screen of “1.Configuration” after “READ”

After finish the download of parameters, each column's color will be white as Fig. 4.5-2.

When it is necessary to retrieve other parameters, please select another menu tab and click **[READ]** button same as the above.

(2) Rewrite of Parameters

It shows how to change configuration parameters on the screen of “1.Configuration” for example.

*[Note] When changing parameter, it is necessary to retrieve parameters by clicking **[READ]** button prior to parameters change. There is a possibility of malfunction if any parameter was changed without retrieving parameter.*

The column that was changed inside value or item choice will be light blue color.

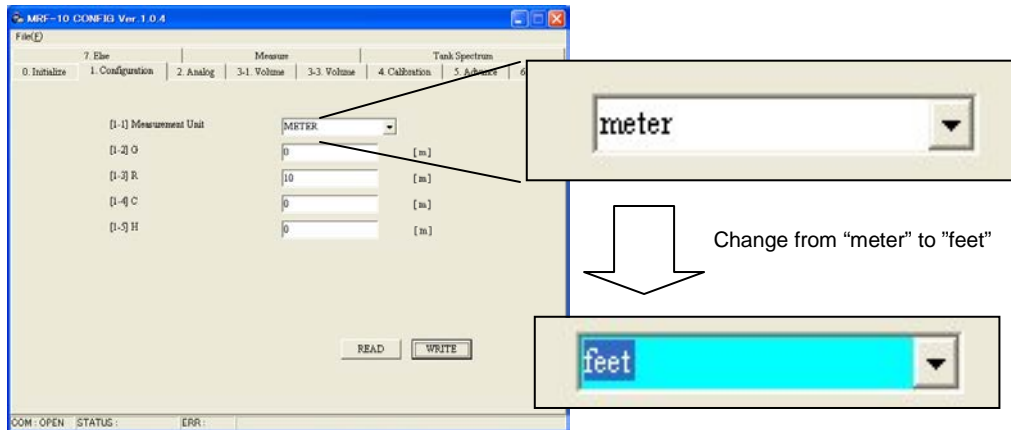


Fig. 4.5-3 Parameter change by Combo Box

As Fig. 4.5-3, Combo Box can select listed items. When item was selected, the column's color will be changed to light blue.

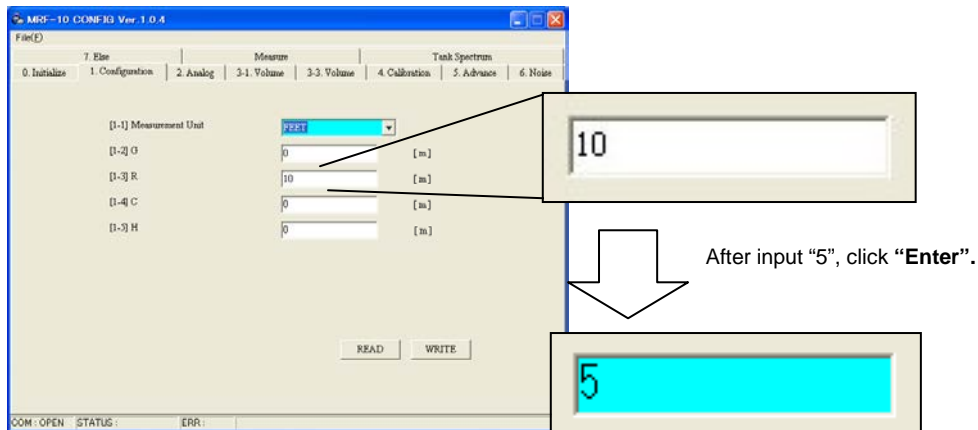


Fig. 4.5-4 Parameter change by value input

As Fig. 4.5-4, when overwrite new value, click **Enter** key of PC. After that, text box's color will be changed to light blue.

After changing parameters, click **[WRITE]** button in order to upload latest parameters to MRF-10. After completion of data transferring, all columns' color will be changed to white as Fig. 4.5-5.

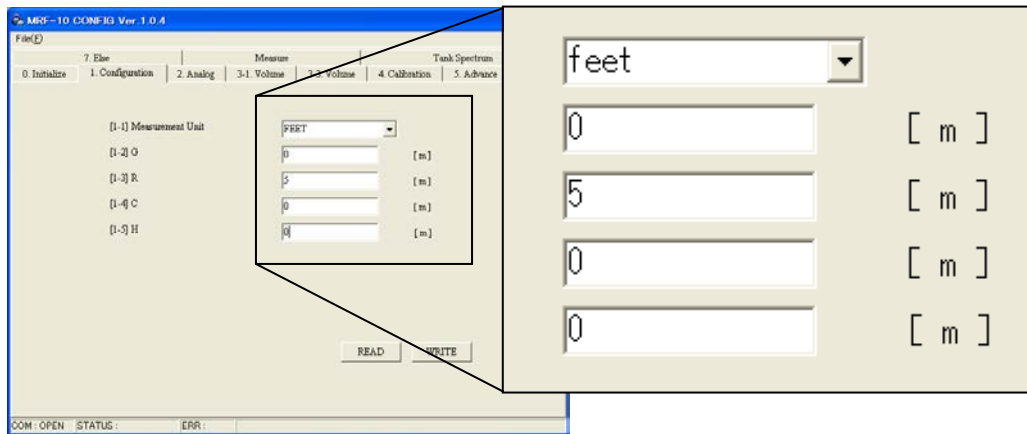


Fig. 4.5-5 After uploading changed parameters

That is all how to change parameters. When the other parameters in other screen are changed, repeat same operations after select other tabs.

4.6 Measuring Value

(1) Monitoring of measuring value

Measuring value can monitor by HART communication. Select "Measure" tab and the menu shows as Fig. 4.6-1.

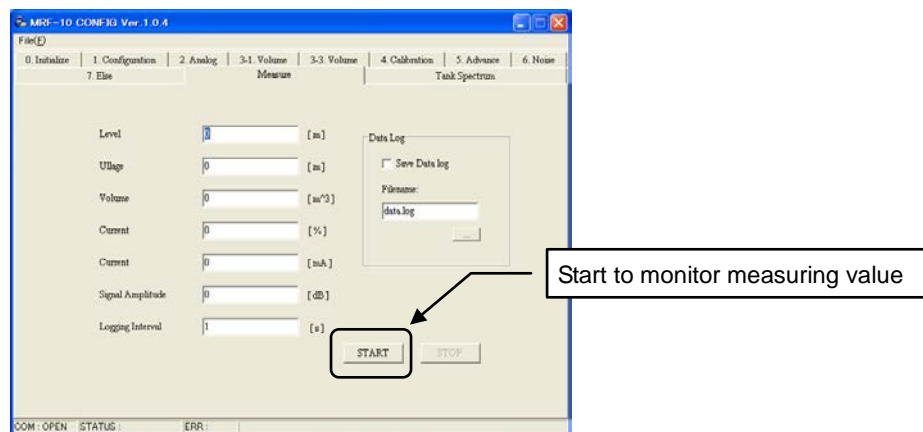


Fig. 4.6-1 Screen of "Measure" for monitoring measurement

This screen can indicate the value of Level, Ullage (Distance), Volume, Current (% and mA) and Signal Amplitude in real time. "Current" shows in accordance with the selected parameter in **[2-1] Analog Output Parameter**.

[START] button : Monitoring starts. All value will be refreshed at every 1s.

[STOP] button : Monitoring stops.

(2) Logging the measured data

Real time logging is available. In order to use logging function, check the box of “Save Data Log” and input logging interval as Fig. 4.6-2.

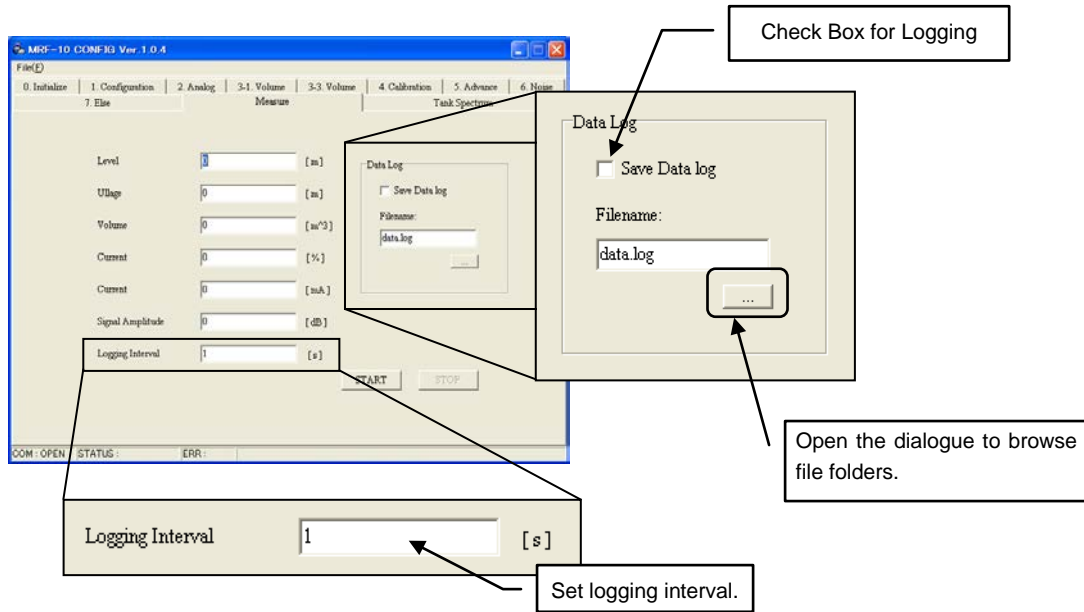


Fig. 4.6-2 Logging setup

[...] button can open a dialogue (Fig. 4.6-3) to browse & create a save file. Please input file name and select repository here.

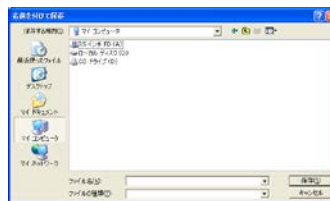


Fig. 4.6-3 Dialogue to save logging data

After the above setup, logging will be started by clicking **[START]** button while displaying measured values.

4.7 Tank Spectrum

This function can monitor signal strength and conditions in measuring range.

(1) Plotting Tank Spectrum

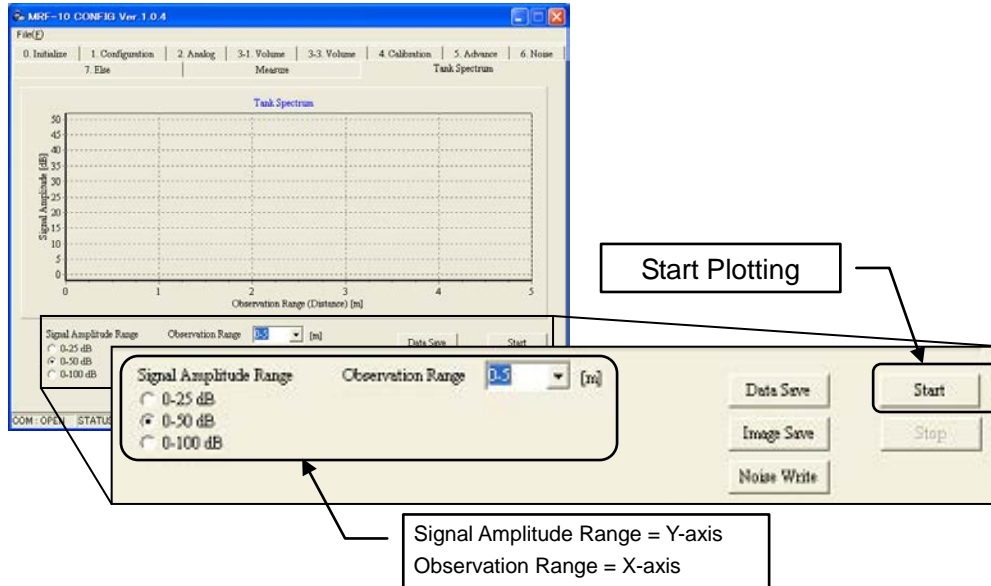


Fig. 4.7-1 Tank Spectrum Screen

The screen of Tank Spectrum will be active by clicking “Tank Spectrum” tab as Fig. 4.7-1. Before clicking **[Start]**, select **Signal Amplitude Range** (Y-axis) and **Observation Range** (X-axis).

After completion of data communication, the chart of Tank Spectrum will be plotted as Fig. 4.7-2.

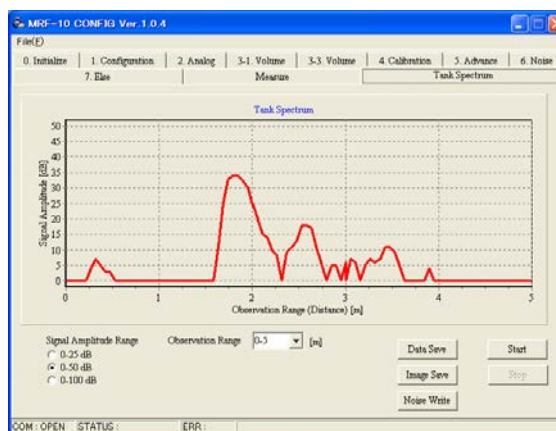


Fig. 4.7-2 Plotted Tank Spectrum

(2) Zoom-in a part of spectrum

As Fig. 5.3, hold down the left button of mouse and drag the mouse pointer from upper-left-end to lower-right-end of the area that is zoomed in.

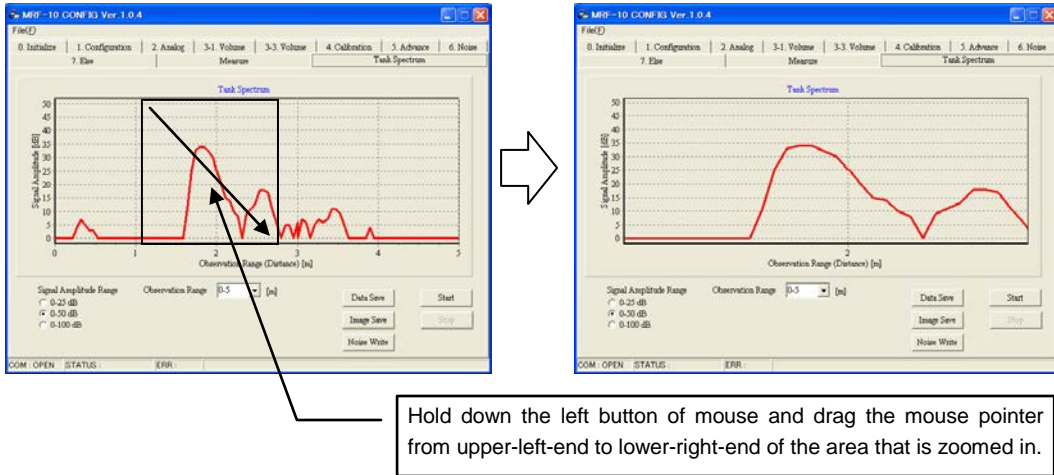


Fig. 4.7-3 Zoom-in a part of spectrum

As Fig. 4.7-4, hold down the left button of mouse and drag the mouse pointer from lower-right-end to upper-left-end of the area that was zoomed in.

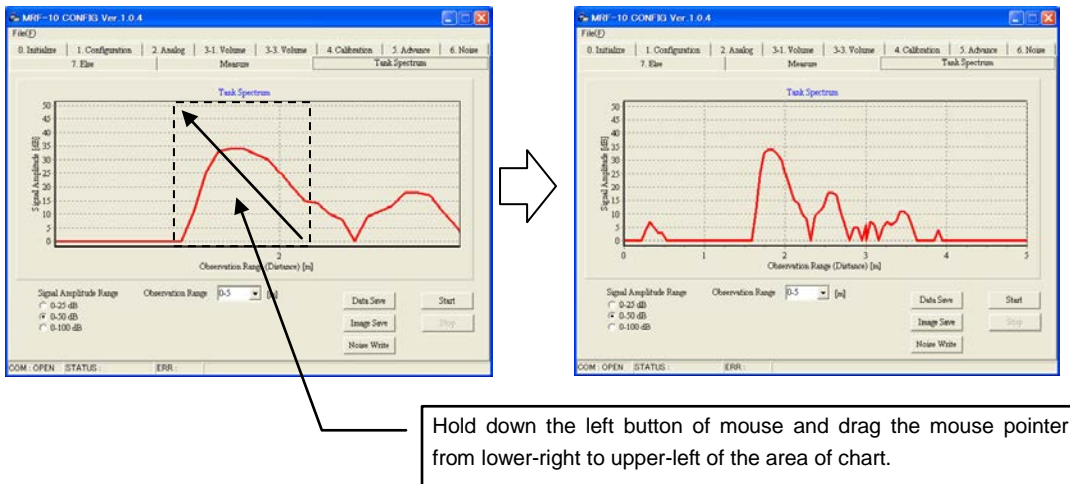


Fig. 4.7-4 Zoom-out operation

(3) Save spectrum data

Tank spectrum can save as image data and text data individually.

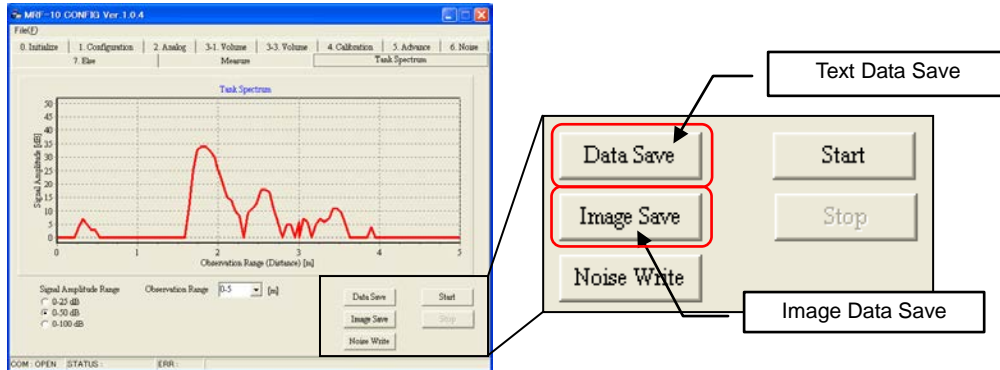


Fig. 4.7-5 Data Save

As Fig. 4.7-5, this menu provides two data format to save by CSV (Clicking **[Data Save]**) or Bitmap (Clicking **[Image Save]**).

[Data Save] button can open a dialogue (Fig. 4.7-6) to browse & create a save file. Please input file name and select repository here.

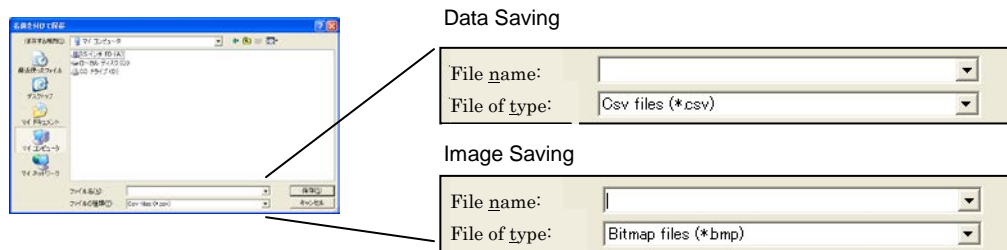


Fig. 4.7-6 Dialogue to save Spectrum Data

Fig. 4.7-7 is a sample of Image Data. (.bmp)

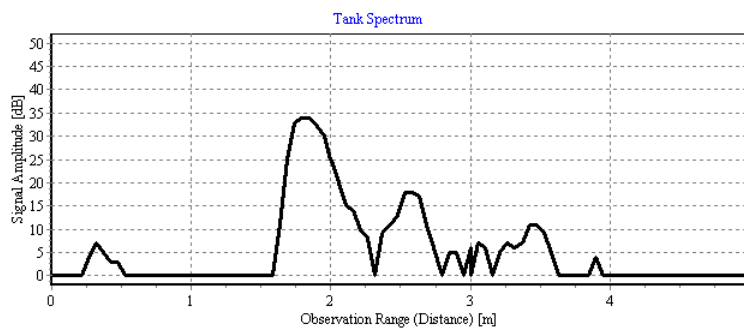


Fig. 4.7-7 Sample of Image Data

4.8 Noise Table

Noise Table can plot on the chart of tank spectrum.

[Note] When plotting Noise Table, it is necessary to retrieve the data by clicking **[READ]** button in the menu of “6. Noise” prior to plotting the table.

(1) Plotting points

After retrieving data of Noise Table, the table will be shown by blue line as Fig. 4.8-1.

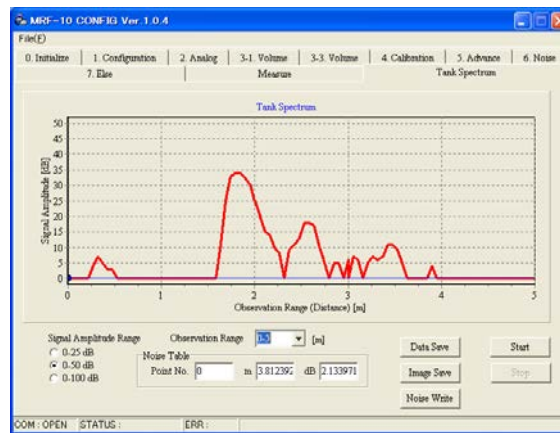


Fig. 4.8-1 Noise Table (No points)

In order to plot a point, right-click on the plotting point. Then, so right-click-menu will be opened as Fig. 4.8-2, select “ADD” to plot a blue point.

These blue points can drag in the chart area by mouse operation.

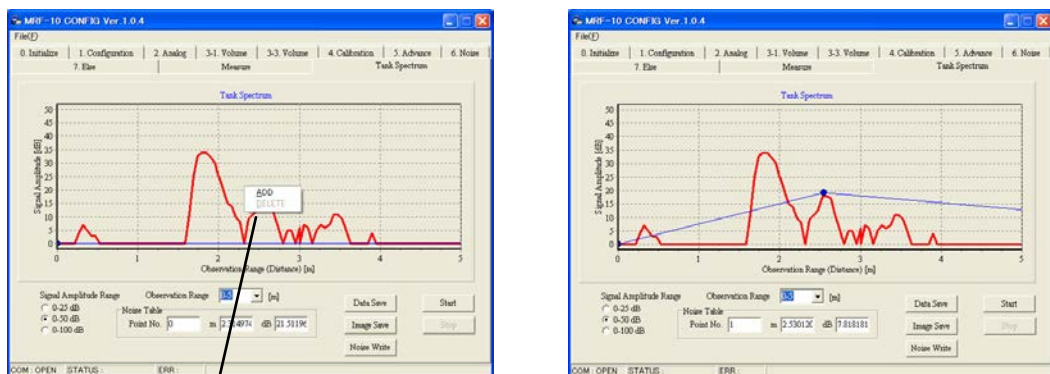


Fig. 4.8-2 Point Plotting for Noise Table



Right-Click-menu

Repeat the above procedure to complete Noise Table. Fig. 4.8-3 is an example of completed Noise Table.

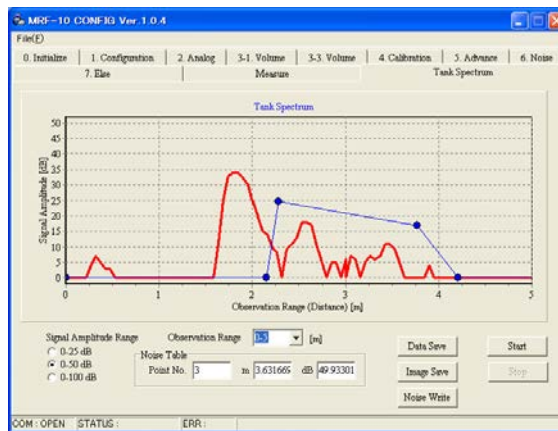


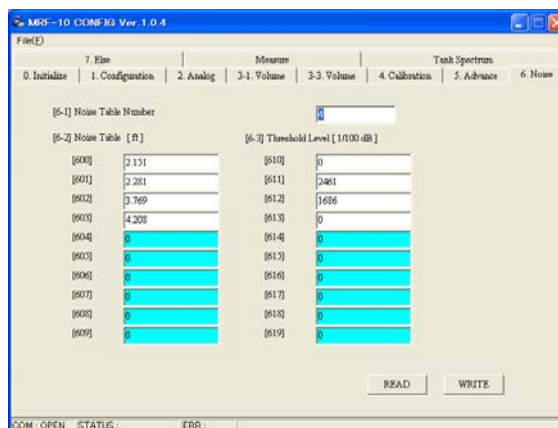
Fig. 4.8-3 Sample of Noise Table

After all plotting, click **[Noise Write]** button to upload the data to MRF-10.



Fig. 4.8-4 Uploading of Noise Table data

After uploading, all data can be shown in the menu of "6. Noise". The data can be inputted and adjusted in this menu also.



(2) Deleting Data from Noise Table

In order to delete a point, right-click on the blue point that should be deleted. Then, so right-click-menu will be opened as Fig. 4.8-6, select “DELETE” to erase the blue point.

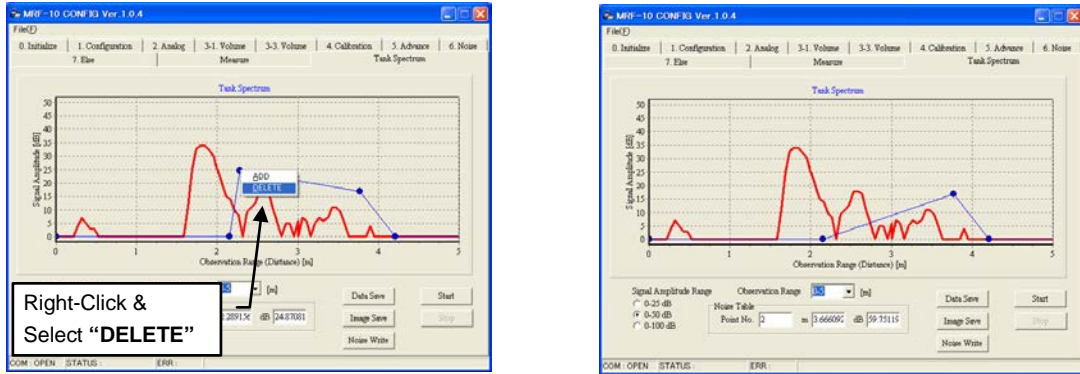


Fig. 4.8-6 Delete a point

After deleting, click **[Noise Write]** button to upload the data to MRF-10. After uploading, all data can be shown in the menu of “6. Noise”. The deleted data was eliminated from this list as Fig. 4.8-7.

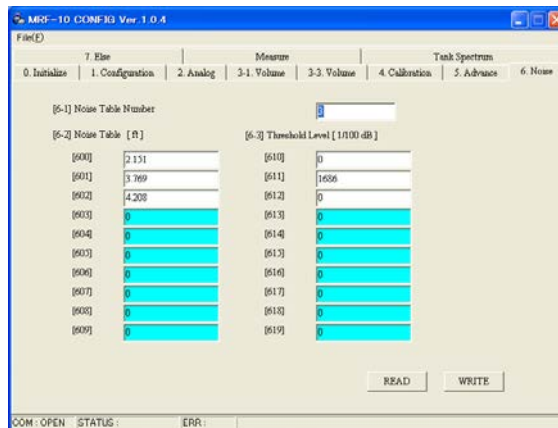


Fig. 4.8-7 The data of Noise Table after deleting

With the above procedures, this manual comes to the end of lecture for cardinal operation.

4.9 Parameter instructions

- shaded areas indicate default settings.

[1--] CONFIGURATION Settings

[1-1] Measuring Unit

Value	Description
m	Sets display in Metric units
ft	Sets display in Feet units

Note: When 'Measuring Unit' is changed, units of other parameters also change.

[1-2] G parameter (distance between flange reference point and measuring reference point)

Parameter	Default Value	Description
-3.000-3.000	0.000	$R+C-G \leq 20$ (Parameter range in metric [m] units)

If measurement unit is [ft], display will be converted to show 'feet' units.

[1-3] R parameter (Measurement range)

Parameter	Default Value	Description
0.000-13.000	10.000	$R+C-G \leq 10$ (Parameter range in metric [m] units)

If measurement unit is [ft], display will be converted to show 'feet' units.

[1-4] C parameter (Below measurement range)

Parameter	Default Value	Description
0.000-10.000	0.000	$R+C-G \leq 10$ (Parameter range in metric [m] units)

If measurement unit is [ft], display will be converted to show 'feet' units.

[1-5] H parameter (Deadband)

Parameter	Default Value	Description
0.000-13.000	0.000	Parameter range in metric [m] units

If measurement unit is [ft], display will be converted to show 'feet' units

[2--] ANALOG Settings

[2-1] Analog output parameter

Parameter	Description
Level	Level value converted to 4-20 mA
Ullage	Ullage value converted to 4-20 mA
Volume	Volume value converted to 4-20 mA
Amplitude	Signal strength amplitude value converted to 4-20 mA

[2-2] Minimum output (4 mA)

Parameter	Output	Default Value	Description
-3.000-13.000	Level	0.000	Parameter range in metric [m] units
-3.000-13.000	Ullage	0.000	Parameter range in metric [m] units
0.000-100.000	Volume	0.000	[%]
0.000-100.000	Amplitude	0.000	[dB]

When [ft] units are selected for “Level” or “Ullage” display, parameter range is calculated in ‘feet’.

[2-3] Maximum output (20 mA)

Parameter	Output	Default Value	Description
-3.000-13.000	Level	10.000	Parameter range in metric [m] units
-3.000-13.000	Ullage	10.000	Parameter range in metric [m] units
0.000-100.000	Volume	100.00	[%]
0.000-100.000	Amplitude	100.00	[dB]

When [ft] units are selected for “Level” or “Ullage” display, parameter range is calculated in ‘feet’.

[2-4] Alarm selection

Parameter	Value	Description
0	High output	22 mA alarm output
1	Low output	3.9 mA alarm output
2	Hold output	Hold last value

[2-5] Fixed current output setting

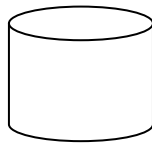
Parameter	Value	Description
0	Measuring Value	[mA]
3.900-22.000	Fixed current	Any current value selectable

[3--] Volume Setting

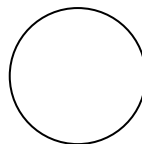
[3-1] Linearization Selection

Parameter	Description
Not Calculated	
Linear	Vertical Cylinder
Spherical	
Cylindrical	Horizontal Cylinder
User Tank Table	

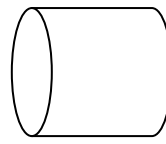
Tank Configurations



Linear



Spherical



Cylindrical

[3-2] Linearization Point Number

Parameter	Default Value	Description
0-20	0	Input required no. of points for table

[3-3] Level point ([300] ~ [319])

Parameter	Default Value	Description
-3.000-13.000	0.000	Parameter range in metric [m] units

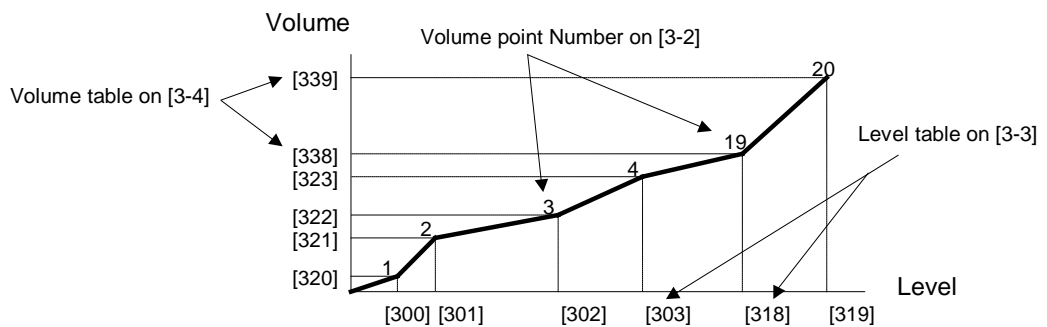
If measurement unit is [ft], display will be converted to show 'feet' units

[3-4] Volume point ([320] ~ [339])

Parameter	Default Value	Description
0-99999.99	0.000	

Display will be converted to the volumetric unit setting under [3-9].

If you create a volumetric table incorporating settings [3-2] ~ [3-4], you can produce a line chart such as that shown below which enables you to quickly calculate level and volumetric values.



Level and Volume correlation on the user tank table

[3-5] Delete all tables

Parameter	Value	Description
Off	Do not delete	
On	Delete all	Setting "1" clears table

[3-6] Diameter of the tank

Parameter	Default Value	Description
0.000-10.000	1.000	Parameter range in metric [m] units

If measurement unit is [ft], display will be converted to show 'feet' units.

[3-7] Length of the tank

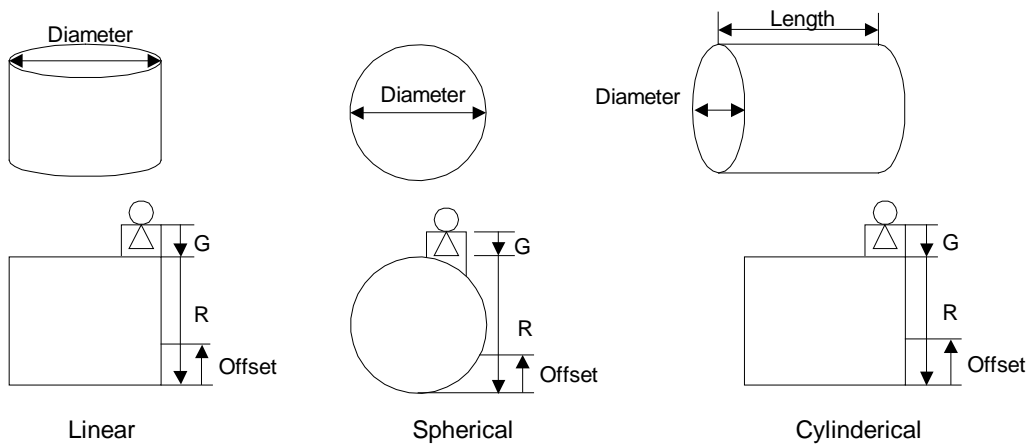
Parameter	Default Value	Description
0.000-10.000	1.000	Parameter range in metric [m] units

If measurement unit is [ft], display will be converted to show 'feet' units.

[3-8] Offset level

Parameter	Default Value	Description
-3.000-13.000	0.000	Parameter range in metric [m] units

If measurement unit is [ft], display will be converted to show 'feet' units.



[3-9] Volume unit

Parameter	Value
m ³	Cubic meter
Gallons	US Gallons (1m ³ = 264.17 gal)
Barrels	Barrel (1m ³ = 6.290 bbl)
Ft ³	Cubic feet (1m ³ = 35.31 ft ³)

[4--] Calibration

[4-1] 4mA Calibration

Parameter	Default Value	Description
3.50-4.50	4.00	In fixed current output mode with current set at 4mA, input ammeter reading.

[4-2] 20mA Calibration

Parameter	Default Value	Description
15.00-25.00	20.00	In fixed current output mode with current set at 20mA, input ammeter reading.

[4-3] Offset Calibration

Parameter	Default Value	Description
-1.00-1.00	0.00	Parameter range in metric [m] units

If measurement unit is [ft], display will be converted to show 'feet' units.

[4-4] Span Calibration

Parameter	Default Value	
0.90-1.10	1.00	

[5--] Advanced Setting

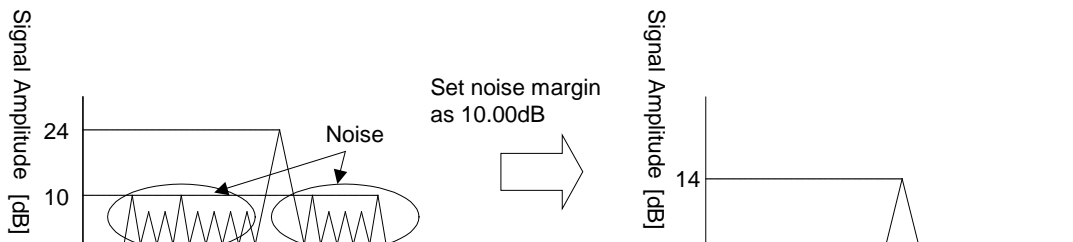
[5-1] Averaging Time

Parameter	Default Value	Description
1-120	10	Measuring value is averaged in accordance with [sec] setting

[5-2] Noise Margin

Parameter	Default Value	Description
0-100.00	3.00	Noise is eliminated in accordance with [dB] setting

When noise level is high, noise can be masked by attenuating the signal gain.



[5-3] Search Delay

Parameter	Default Value	Description
1-120	120	Time delay after loss of echo until restart in accordance with [sec] setting.

[5-4] Alarm Delay

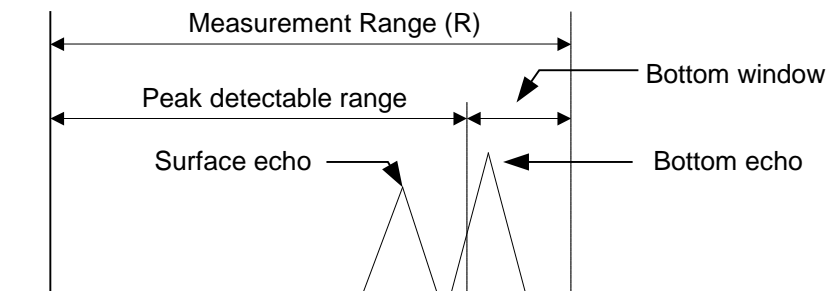
Parameter	Default Value	Description
1-120	120	Time delay after loss of echo until alarm sounds in accordance with [sec] setting.

[5-5] Bottom Window

Parameter	Default Value	Description
0-0.5	0	Parameter range in metric [m] units

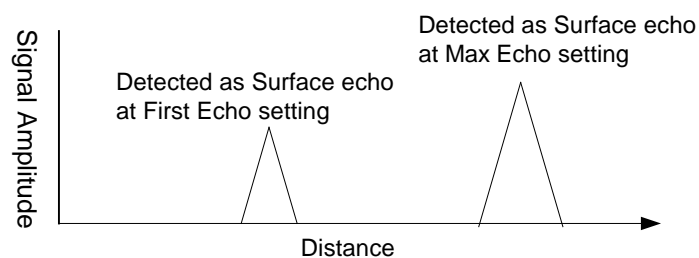
If measurement unit is [ft], display will be converted to show 'feet' units.

Valid only when [5-7] is set at "0".



[5-6] First Echo Flag

Parameter	Description
Max Echo	Max strength echo defined as surface echo
First Echo	First echo defined as surface echo



[5-7] Bottom Visible

Parameter	Description
Bottom Visible	When tank bottom echo is larger than surface echo (such as with oil fluids). Effective against echo misdetection.
Bottom Invisible	When tank bottom echo is smaller than surface echo (such as with water, setting "Bottom Invisible", invalidates this function.

[6--] Noise

[6-1] Noise table number

Parameter	Default Value	Description
0-10	0	Input required no. of points for table

[6-2] Noise table ([600] ~ [609])

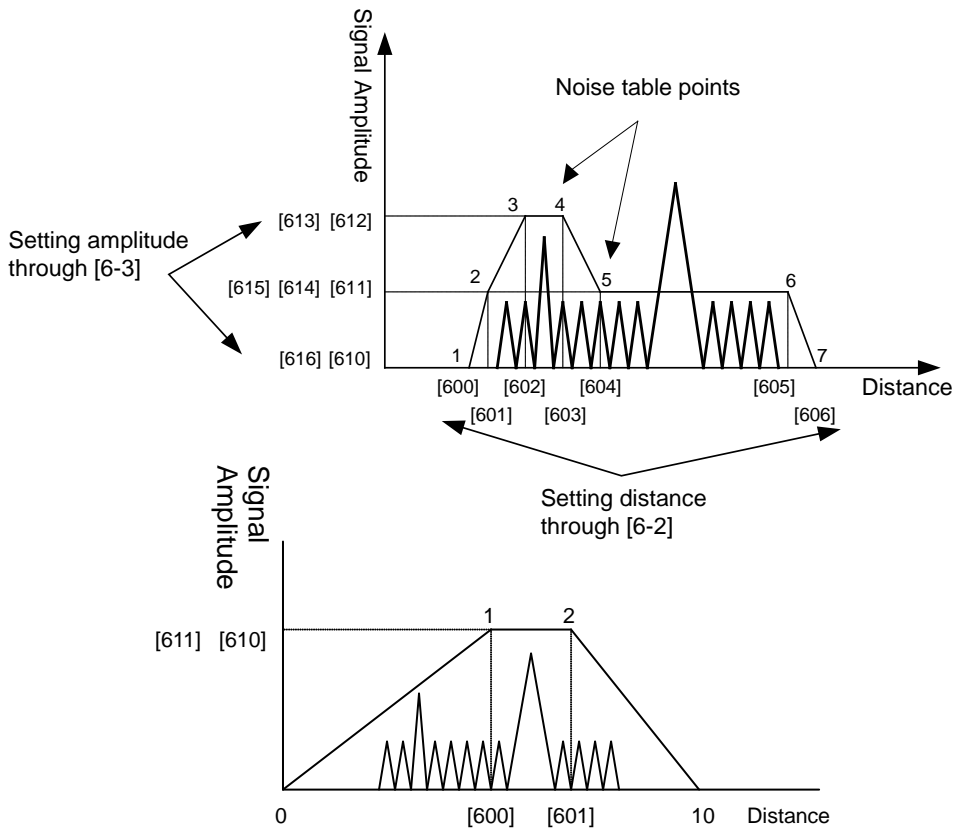
Parameter	Default Value	Description
0.000-10.000	0.000	Noise position by distance Parameter range in metric [m] units

If measurement unit is [ft], display will be converted to show 'feet' units.

[6-3] Amplitude threshold ([610] ~ [619])

Parameter	Default Value	Description
0-100.00	0.00	[dB]

If you create a noise table incorporating settings [6-1] ~ [6-3], you can produce a line chart such as that shown below which enables you to eliminate lower signal strength noises below the line.



Amplitude at distance 0m and 10 m is set at 0 dB as default.

[6-4] Delete All

Parameter	Value	Description
0	Do not delete	
1	Delete All	Then set Q'ty of noise table as "0".

[7--] Other

[7-1] Re-search

Parameter	Value	Description
SET	Research	Mandatory surface echo re-search

[7-2] Parameters Reset

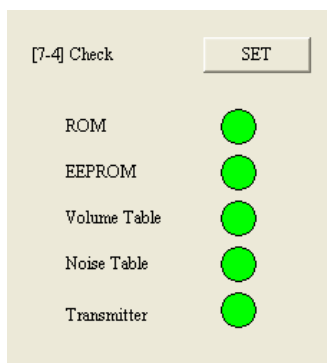
Parameter	Value	Description
SET	Initialization	Initialized by "1" setting

[7-3] Hardware Reset

Parameter	Value	Description
SET	Reset	Setting "1" executes hardware reset

[7-4] Self-check

Parameter	Value	Description
SET	Self-check	Execute self-check. Check parameters are as follows, - ROM - EEPROM - Volume table - Noise table - Transmitting gain



In case of RED lamp turns on the "Volume Table" or "Noise Table", please check setting parameters again. Any contradictions may be happened.

In case of RED lamp turns on the "ROM", "EEPROM" or "Transmitter", it might be caused by any breakdown on the circuit. Please contact with the nearest dealership.

5 Setup

5.1 Basic Parameters

Following parameters must be inputted to measure properly.

Tank Dimensions	G (Offset Distance from Hand-dipping point to Reference Point [MRF-10's face].)
	R (Distance from Hand-dipping point to level zero.)
	C (Measuring range that is lower than level zero.)
	H (Dead band)

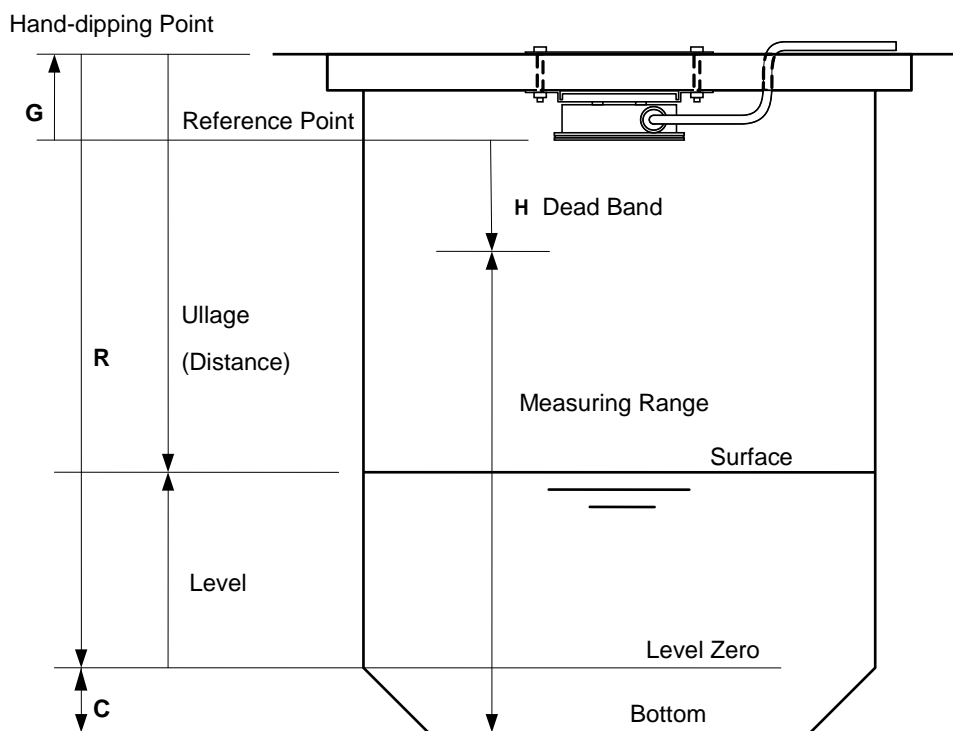


Fig. 5.1-1 Basic Parameters for Measurement

5.2 Negative level measurement

Value "C" defines below zero level. When "C" values are set, the Hart communicating PC will show negative values, if the level is below level zero.

[Note] If 4mA corresponds to Lv 0m, analog output will be maintained at 4mA even if measurement values fall below Lv 0m.

5.3 Avoiding disturbance echoes

There are two ways to avoid the disturbance echo problem.

(1) Dead Band (=“H”)

When there are disturbance echoes in the near zone such as stairs at the top of the tank, the gauge may capture and interpret these echoes as coming from the liquid surface.

Set up “H” to avoid this problem.

All echoes within this area would be outside of the measuring range and ignored.

(2) Noise Table

If there are disturbance echoes in the effective measuring range and the gauge tracks such echoes, set up “Noise Table” parameters.

You can adjust the threshold level for sections of the measurement range with these parameters.

“Noise Table” parameters are comprised of ullage points and threshold values. Up to 10 points of values can be established respectively with linear interpolation between points. (Amplitude at distance 0m and 10 m is set at 0 dB as default.)

If disturbance echoes are tracked, you should first check the ullage and the amplitude level with the configuration software.

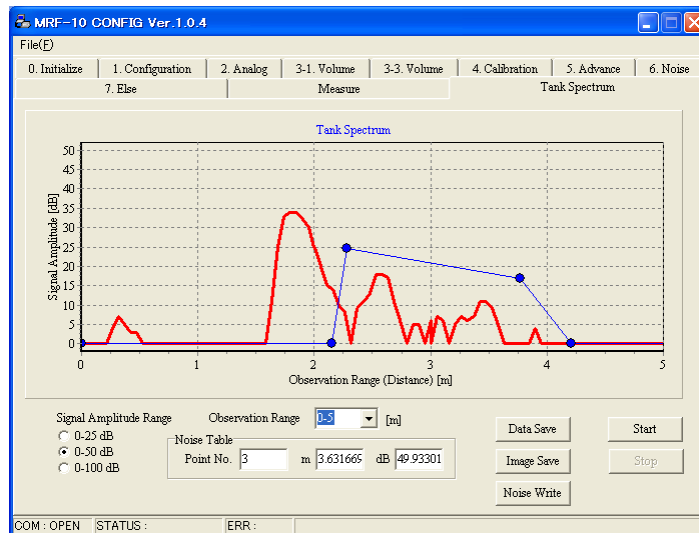
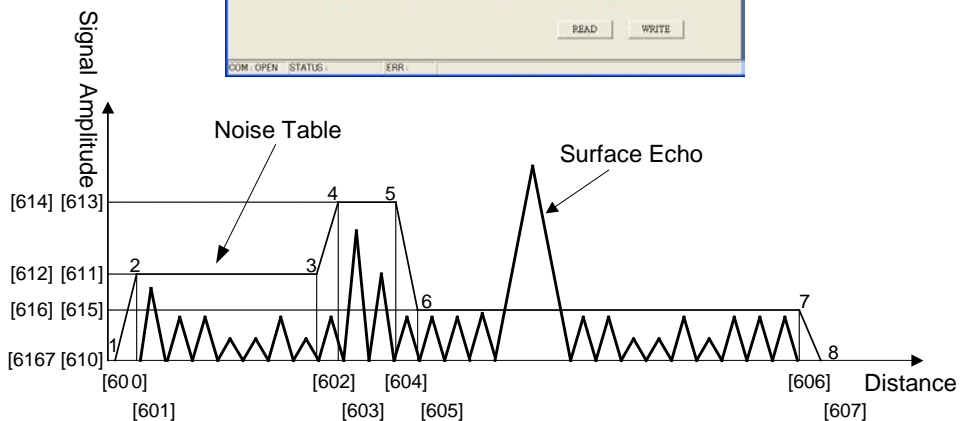
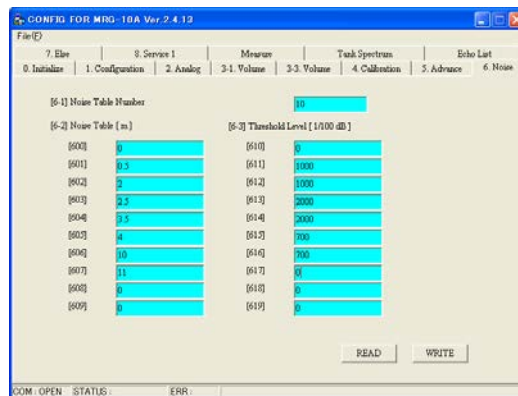


Fig. 5.3-1 Tank Spectrum of inside tank

Please refer to 4.9-[6] “Noise Table” and use commissioning software to input noise data.

[How to create a noise table]

- 1) Open Menu tab [6-1] and then set the noise table number (maximum 10 points).
 - 2) Open Menu tab [6-2], and set distance parameters into the data field in accordance with selected numbers. (For example, if “10” is set at [6-1], you will need to set data [600]~[609] for distance values.)
 - 3) Set distance data for [600], and push “ENTER key” of PC to complete the entry. Similarly set distance values for [601]...[609].
 - 4) After completing input of distance values, the next step is entering amplitude values.
 - 5) Open Menu tab [6-3] and set threshold level parameters into the data fields in accordance with selected numbers. For example, if “10” is set at [6-1], you will need to set data [610]~[619] for amplitude values.)
 - 6) Amplitude points must correlate to the distances defined under [6-2]. Select table address (ex. [610]) and enter amplitude data, then push “ENTER key” of PC to complete the entry. Similarly, set amplitude data for [611]...[619].
 - 7) After setting all data, then click “WRITE”.
- Setting of distance data must be in ascending order, that is, from shortest to longest distance. Noise table error and noise table malfunction will occur if settings are mis-ordered. Error status will appear under [7-3]

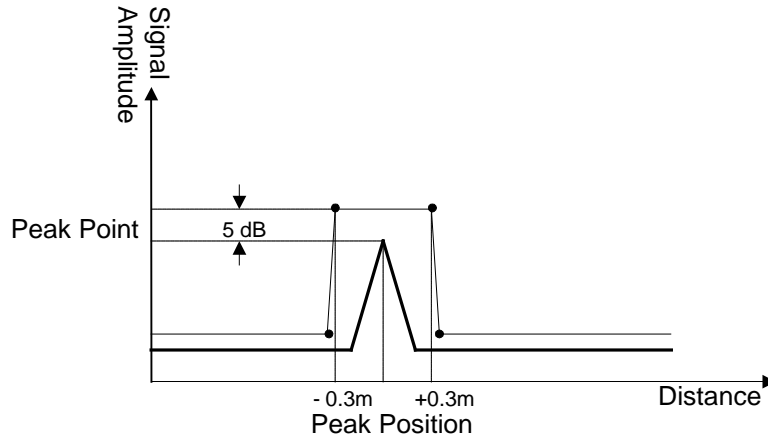


Example of a noise table is shown above. All noise lower than the noise threshold line will be ignored.

[One point advice regarding noise table input procedure]

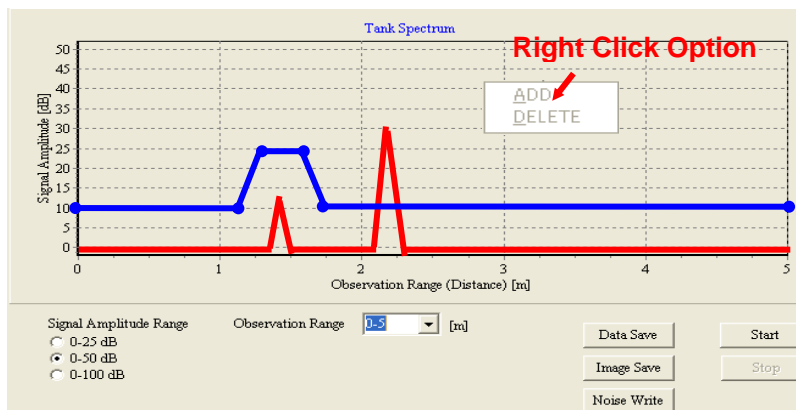
It is necessary to provide some allowance around the echo peak and a margin of threshold for noise amplitude. These are $\pm 0.3\text{m}$ and $+5\text{dB}$ respectively.

Noise Table point “n” must also be nearer than next Noise Table point “n+1”. If this rule is not maintained, noise table errors will occur and this function will become invalid.



Also by using the PC configuration software, you can add or change the position of the noise table with a right click.

- 1) On the “Tank Spectrum” tab, when the “START” button is clicked, you may view the red line wave form data from the main unit as shown below.
- 2) If you would like to set the noise table manually, right click and select “ADD” at designated points for the new table. Also the table (points) can be moved by a left-click and dragging.
- 3) After the noise table is set, click the “Noise Write” button to complete.



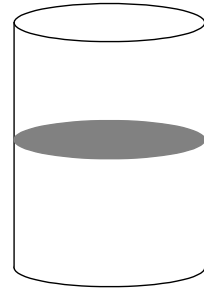
5.4 Volume calculation

There are 4 types of volume calculations which are set up by the Linearization Selection parameter.

(1) Defined tanks

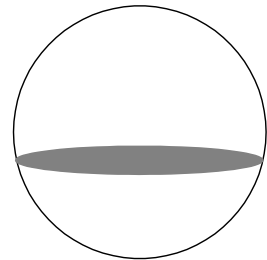
- Linear Tank (Vertical Cylinder Tank)

Volume is calculated from diameter, offset level and measured level. Diameter is the diameter of the tank and offset level is the measurement level compensation factor.



- Spherical Tank

Volume is calculated from diameter, offset level and measured level. Diameter is the diameter of the sphere and offset level is the measurement level compensation factor.



- Cylindrical Tank (Horizontal Cylinder Tank)

Volume is calculated from diameter, length, offset level and measured level. Diameter is the diameter of the tank and offset level is the measurement level compensation factor. Length is the horizontal length of tank as shown.



[How to set parameters]

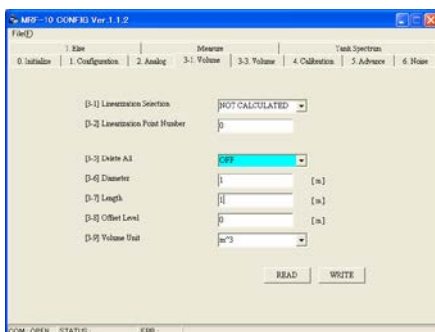
1. Select tank form at [3-1] "Linearization Selection" from above selectable tank figures.
2. Input following parameters, then push "Write".

[3-6] Tank "Diameter"

[3-7] Tank "Length"

[3-8] Offset level

[3-9] Volume unit



[3-1] Linearization Selection	NOT CALCULATED	
[3-2] Linearization Point Number	0	
[3-5] Delete All	OFF	
[3-6] Diameter	1	[m]
[3-7] Length	1	[m]
[3-8] Offset Level	0	[m]
[3-9] Volume Unit	m ³	

(2) User defined tank

- Tank Table

It is possible to set up 20 points each for level and volume respectively in the Tank Table which are linearly interpolated between points.

More than two points must be input to set up the Tank Table. (Tank Table Error)

Four volume units can be selected - cubic meter, gallons, barrels and cubic feet.

[How to create the volume table]

1) Select "User Tank Table" for menu tab [3-1].

2) Set the required number of point settings for Menu tab [3-2]. (Max 20 points.)

3) Open Menu tab [3-3]. Select point and set level parameters into the data field in accordance with the selected numbers. (e.g. when setting 20 points at [3-2], [300]~[319] can be set.)

4) Input Level data then, enter values for [300] ~ [319].

5) After completing input of Level data, the next step is entering the Volume data.

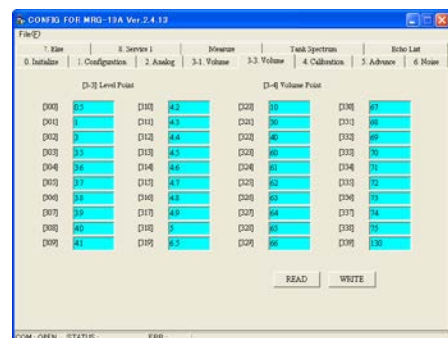
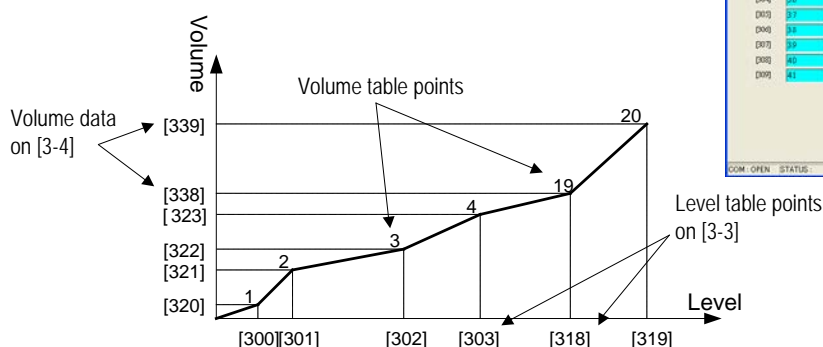
6) Then Open Menu tab [3-3], and set the volume parameters into the data fields in accordance with the selected numbers. (e.g. when setting 20 points" at [3-2], [320]~[329] can be set.)

7) Volume point must correlate to the level data defined under [3-2]. Select table address (ex. [320]), enter volume data to complete entry. Similarly, enter data for [321]...[329].

8) After setting all data, then click "WRITE".

Note

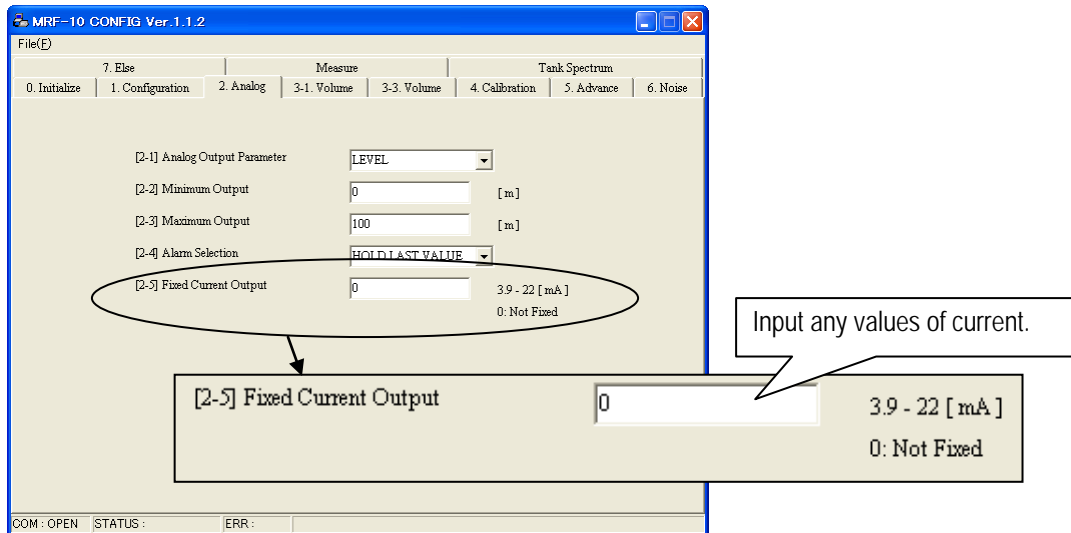
Setting of distance data must be in ascending order, that is, from shortest to longest distance. Volume table error and volume table malfunction will occur if settings are mis-ordered. Error status will appear under [7-3]



5.5 Analog value compensation

(1) Analog check

Input designated value at [2-5] “Fixed Current Output”, then monitored on multi-meter like analog current meter.

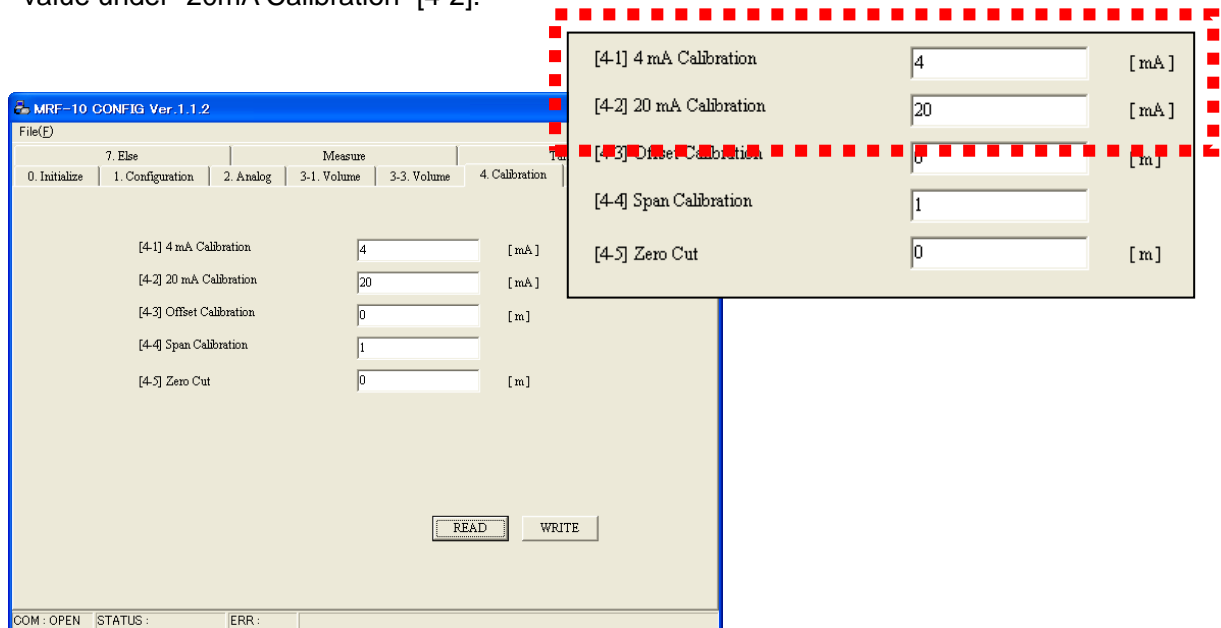


(2) Analog calibration

When analog output current is not correct, revise the value in the following manner.

Input “4.000mA” under “Fixed Current Output” [2-5], then input the measured current value under “4mA Calibration” [4-1].

Input “20.000mA” under “Fixed Current Output” [2-5], then input the measured current value under “20mA Calibration” [4-2].



5.6 Measuring value compensation

Offset level from reference point and scale factor are adjusted under [4-3] "Offset Calibration" and [4-4] "Span Calibration". If there is a difference between the Tank ref. point and the MRF-10 ref. point, you can input "G" for calibration [1-4].

Parameter	Value	Unit
[4-1] 4 mA Calibration	4	[mA]
[4-2] 20 mA Calibration	20	[mA]
[4-3] Offset Calibration	0	[m]
[4-4] Span Calibration	1	
[4-5] Zero Cut	0	[m]

5.7 Bottom recognition

Tank bottom recognition is necessary for measurement of low reflection targets such as oil surfaces. In such cases, the smaller amplitude echo from liquid surface reflections is concealed in the larger echo from the tank bottom and the gauge can not distinguish the surface reflection echo from the bottom echo.

[5-7] "Bottom Visible" and [4-5] "Zero cut" parameters of the gauge function to avoid the tracking of bottom echoes. Initial settings of these parameters are [5-7] "Bottom Visible" and [4-5] "Zero cut" as 0m.

The gauge outputs level value as the bottom level, when the surface echo is in the low cut area. However when the level is higher and the surface echo is not in the low cut area, the gauge can distinguish surface echoes from bottom echoes. On the other hand, if bottom echoes cannot be discerned in high reflection targets such as water, the "Bottom Visible" parameter should be set at "Bottom Invisible" to eliminate any bottom echo from dead-band (Zero Cut).

[4-1] 4 mA Calibration	4	[mA]
[4-2] 20 mA Calibration	20	[mA]
[4-3] Offset Calibration	0	[m]
[4-4] Span Calibration	1	
[4-5] Zero Cut	0	[m]

6 Technical Information

6.1 Main unit specification

(1) Overview

Measuring principle	Microwave Pulse Echo
Operating frequency	5.8 GHz
Half-power beam width	Lengthwise : 50 deg Crosswise : 23deg
Transmitting power	less than 35 μ V/m at 3m
Measuring range	Max. 10 m (33')

(2) Power

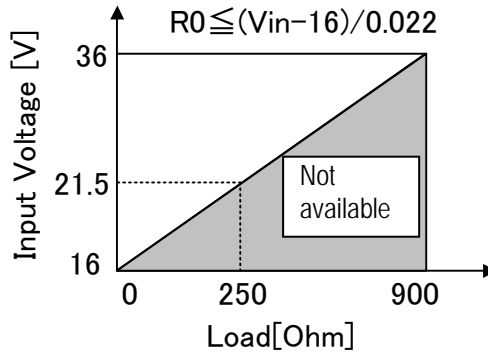
Supply voltage	16..36 VDC
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(3) Output

Variable	Ullage / Level / Volume / Current / Signal amplitude/Volume Max
Unit	Level, Ullage : m/ft Volume : % Current : mA Amplitude : dB
Signal type	Analog 4..20 mA, HART
Resolution	• Analog: 4 μ A • Digital: 1 mm (0.04")
Update time	1 s
Averaging time	1..120 s
Signal on alarm	Hold/Low(3.9mA)/High(22 mA)

Load

Minimum load is 250 Ω for HART communication



(4) Accuracy

Measured error *)	±5 mm (0.2")	(0.1m up to 5m)
	±10 mm (0.4")	(5m up to 10m)
Linearity *)	less than ±10 mm (0.4")	
Repeatability *)	±1 mm (0.04")	
Ambient temperature effect	±0.01% / 10 K	

*) : Free-space reflection from flat metal surface, ambient temperature 25 °C (77 °F), atmospheric pressure.

6.2 Environment resistance

Ambient temperature	-20..70 °C (-40..158 °F)
Storage temperature	-40..80 °C (-40..176 °F)
Degree of protection	IP68 (under water 10m / 24hours)
Vibration resistance	IEC 68-2-6 /1G
Harmonized standard (Immunity)	EN 61000-4-4 EN 61000-4-6
Lightening Arrester	IEC 61000-4-5 (Level 4) (Common mode 4kV / Normal mode 2kV)

6.3 Construction

(1) Cable Connection

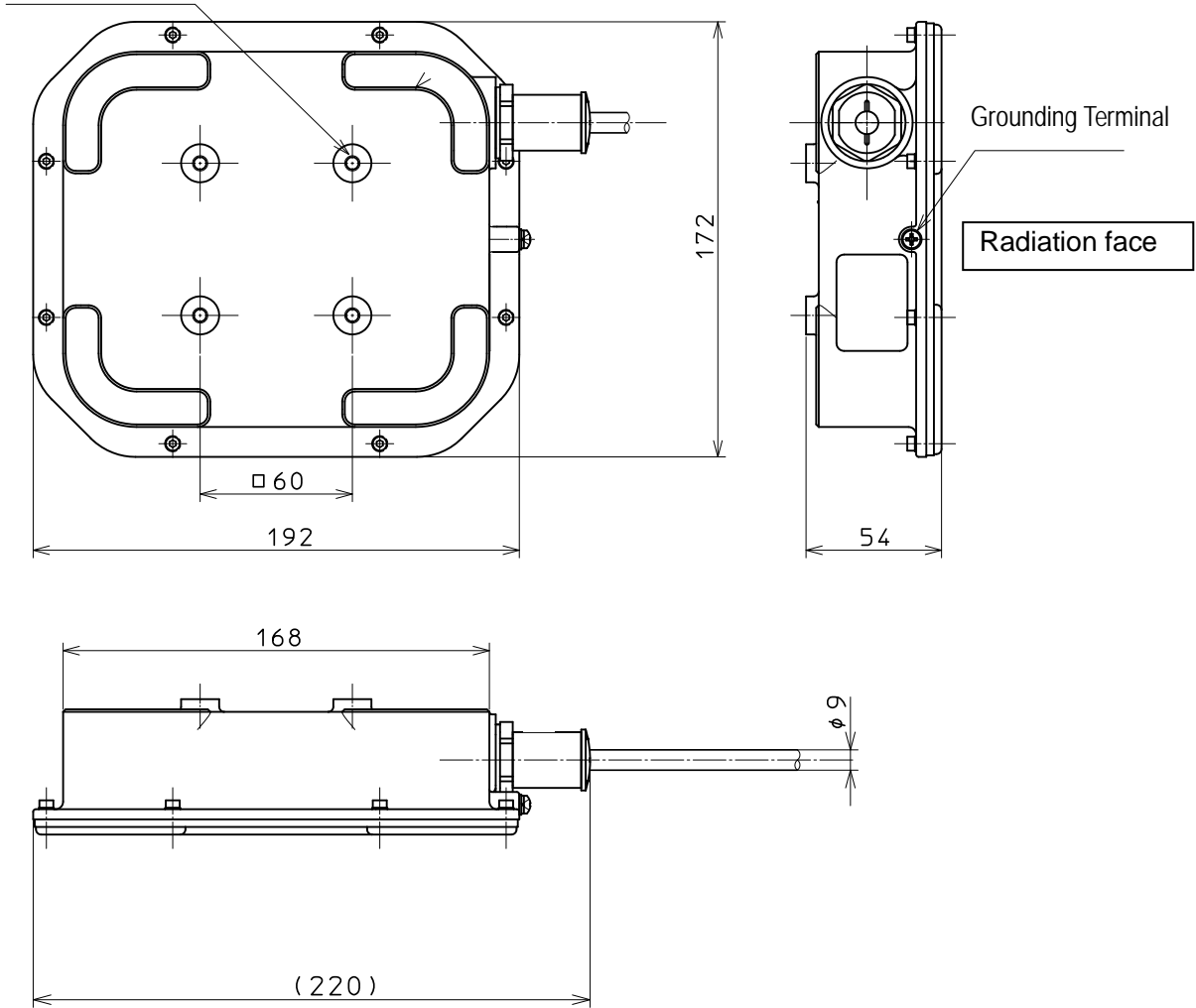
Cable type	Shielded twisted 3-cores Cross-section area of cable: 0.2..2.5 mm ² , (AWG24..14)
Cable Length	10m

(2) Material and Mass

Transmitter Case	Stainless steel Di-cast SCS-14
Antenna face panel	For sewer: PVC For open ditch: PC
Mass	2.7kg (except attached cable)

6.4 Dimension (mm)

4-M6 (depth: 5.5)



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Flat Radar Level Sensor
Installation & Operation Manual

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(Specifications are subject to change without notice.)