



Level Measurement

With

REFLEX RADAR

Why Radar Technology for Level Measurement ?

INSENSITIVE TO CHANGES IN

- ◆ Dielectric
- ◆ Pressure
- ◆ Vacuum
- ◆ Humidity
- ◆ Dust
- ◆ Viscosity
- ◆ Foam
- ◆ Temperature

THE ADVANTAGES ARE

- ◆ Measuring ranges up to 60m (option for 100m special)
- ◆ Versatile technology for Liquids, Slurries, Pastes and Solids.
- ◆ Display of Level, Distance or Volume
- ◆ Interface detection and Reverse Interface Detection on liquids.
- ◆ 2 wire loop powered 24vdc or 4 wire 110/230vac
- ◆ Hazardous area ATEX, EExd and EExia
- ◆ HART, Profibus (PA) and Foundation Fieldbus
- ◆ Suitable for narrow tanks with minimum fixed beam diameter.
- ◆ Unaffected by dust during fill or empty conditions.
- ◆ Immune to fill noise on solid products such as stone.
- ◆ Simple to install and retrofit with wide range of process connections
- ◆ Suitable for corrosive and acidic atmospheres
- ◆ High temperature and pressure options are available
- ◆ Remote or local programming and commissioning
- ◆ Suitable for detecting levels through surface foam
- ◆ Sealed Flange system allows removal in process

SUITABLE FOR ALL INDUSTRIES

- ◆ Petrochemical
- ◆ Food
- ◆ Chemical
- ◆ Paint
- ◆ Water & Waste
- ◆ Cement
- ◆ Asphalt
- ◆ Minerals
- ◆ Power Generation
- ◆ Steel
- ◆ Quarrying
- ◆ Powder

RADAR FOR A VARIETY OF APPLICATIONS

- ◆ Level Measurement
- ◆ Interface Measurement
- ◆ Distance Measurement
- ◆ Volume Measurement
- ◆ Reverse Interface Measurement

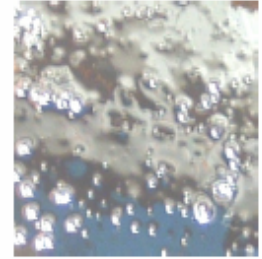
COST EFFECTIVE REPLACEMENT FOR

- ◆ Capacitance transmitters
- ◆ Hydrostatic transmitters
- ◆ Differential pressure transmitters
- ◆ Displacers

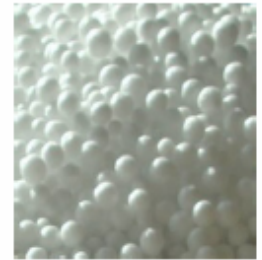
MANUFACTURED TO ISO9001-2000 Q.M.S.



Various units on final assembly and ready for test. The quality of all Hycontrol products is strictly monitored to conform to the ISO certification requirements.



Acids



Plastics



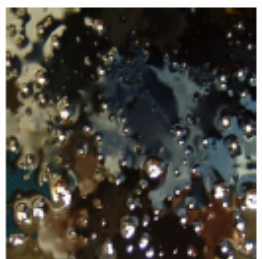
Grain



Powders



Flakes



Oils

Reflex VF Series Two and Four Wire TDR

The Reflex VF Series range of TDR products is ideal for the measurement of liquids, powders and granules to a range of 60m. Unaffected by pressure, temperature, viscosity, vacuum, foam, dust, changes in dielectric constant or coating of the probe, the VF Series can measure virtually any product in either Direct or TBF mode utilising any one of its seven probe types. (See page 6 for full option details)

REFLEX VF03 TWO WIRE TDR

- ◆ 24m Measuring Range
- ◆ 24 VDC Loop Powered
- ◆ 4/20mA Output
- ◆ Pressure up to 40 Bar
- ◆ Process Temperature to 600°C
- ◆ HART Protocol standard
- ◆ ATEX EExia Intrinsically Safe
- ◆ Multiple probe options
- ◆ 316 Stainless Steel Probe
- ◆ FEP Coating option
- ◆ Liquids and Solids



REFLEX VF04 FOUR WIRE TDR

- ◆ 60m Measuring Range
- ◆ 24 VDC or 110/230 VAC Four Wire
- ◆ Profibus PA, Fieldbus or HART
- ◆ Pressure up to 100 Bar
- ◆ Process Temperature to 600°C
- ◆ ATEX EExd Flameproof
- ◆ Direct or TBF Mode
- ◆ Interface Measurement
- ◆ Reverse Interface Measurement
- ◆ Hastelloy / PTFE Coating
- ◆ Liquids and Solids



OPERATING PRINCIPLE

Pulses of low power microwaves are sent along conductors. At the point where the waves meet the product surface, they are reflected by the product. The intensity of the reflection depends on the dielectric constant of the product. The higher the dielectric constant, the stronger the reflection will be, e.g. up to 80% reflection for water. The instrument measures the time between emission and reception which is proportional to the distance.

For TDR guided radar there are two different categories of product:

1 - Products with a dielectric constant $\epsilon_r \geq 1.8$

These applications work in "Direct Mode", which means that the reflection from the product surface is used directly for the measurement of the level. Two different applications are possible:

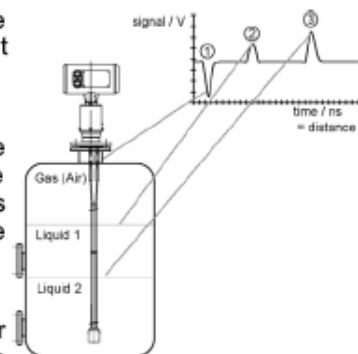
a) Level Measurement

The wave is reflected from the first product surface and is received by the receiver on the top of the tank. The wave travels along the conductor above the product at the speed of light and the return time of the wave pulse is directly proportional to the distance between the top of the tank and the surface of the product (level).

b) Interface measurement

Interface measurement can only be made if the first layer has a lower dielectric constant than the second and if the difference between the two dielectric constants is greater than 10.

For measuring interface level we use the residual wave after the first reflection. This part of the wave moves further down the conductors through the first product layer until reflected on the interface level. The speed of this wave depends on the dielectric constant of the first product. This means that we have to know the dielectric (ϵ_r) of this first layer to determine the interface level.



2 - Products with a dielectric constant $\epsilon_r < 1.8$

To measure the level of low dielectric products we use the Tank Bottom Following principle (TBF). The downward wave will first pass through the air at a known speed and then through the product at a speed depending on the dielectric constant of the product.

Since the return in air is calibrated; the difference in the two times is directly proportional to the product level in the tank.

As we are largely dependent on the dielectric constant, this method is less accurate than the direct mode method.

Reflex VG5XX Series FMCW Radar

THE ADVANTAGES OF FMCW RADAR

- ◆ Non-contact
- ◆ Aggressive liquids, hydrocarbons, toxic liquids and slurries
- ◆ Granulated material and most solids
- ◆ Range up to 40 metres (option for 100 metres)
- ◆ Unaffected by pressure, temperature, viscosity, foam or dust
- ◆ Available with Horn Wave Guide or Wave Stick antenna
- ◆ ATEX EExia intrinsically safe or EExd flameproof housings
- ◆ TBF mode available for low dielectric products
- ◆ ETS mode damps out unwanted reflection
- ◆ 1mm accuracy option

OPERATING PRINCIPLE

A radar signal is generated via an antenna, reflected by the target surface and received after a delay time t .

FMCW: Frequency Modulated Continuous Wave

FMCW radar uses a high frequency signal (~10GHz) which increases linearly by 1GHz during the measurement (frequency sweep) (1). The signal is emitted, reflected from the target surface and received at a time-delayed (2) frequency.

The difference, Δf , is calculated from the actual transmit frequency and the receive frequency (3). The difference is directly proportional to the distance measured i.e. a large frequency difference corresponds to a large distance, and vice versa.

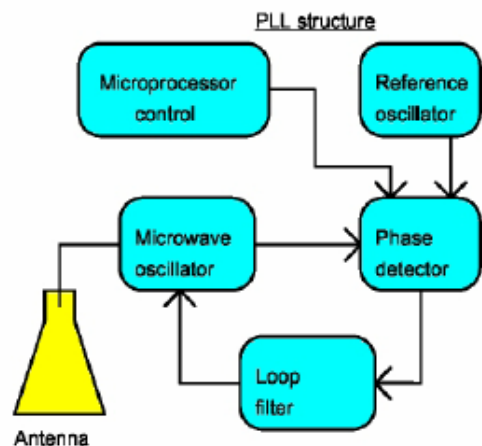
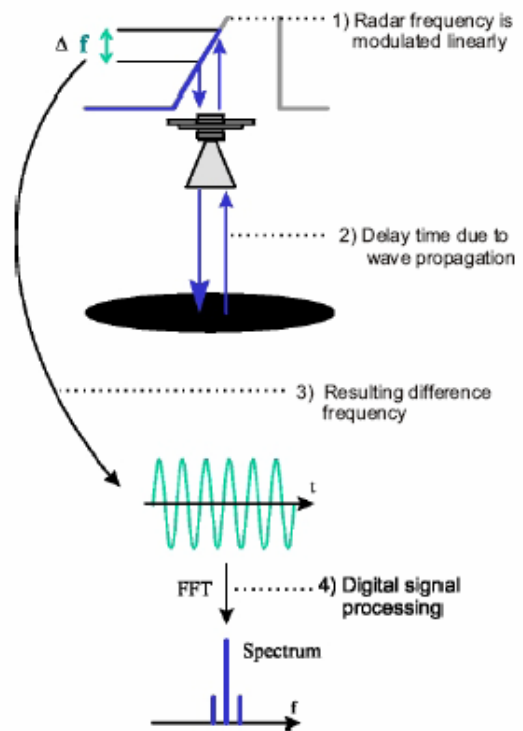
The frequency difference is transformed via a Fast Fourier Transformation (FFT) into a lower frequency spectrum and then the distance is calculated from this spectrum. The level results from the difference between the tank height and distance.

Linearity of frequency sweeps

The measuring accuracy of FMCW radar is determined from the linearity of the frequency sweeps and their reproducibility. The linearity correction is deduced via reference measurement of the oscillator. The non-linearity is corrected up to 98% (VG50/51/VG500). An immediate frequency regulation using PLL (phase locked loop) technology is necessary with the VG502 device because of the higher demand on the measuring accuracy.

Advantages of FMCW principle compared to Pulse Radar:

- ◆ Better reflection separation
- ◆ Reliable noise reduction
- ◆ Smaller beam angle
- ◆ Fewer disturbing reflections
- ◆ Smaller antenna diameter for same measuring range



Reflex VG5XX Series Two & Four Wire FMCW Radar

The Reflex VG Series of FMCW Radar products are unaffected by pressure, temperature, viscosity, vacuum, foam, dust or changes in dielectric constant. They can measure virtually any product in either Direct or TBF mode utilising either Horn, Wave Guide or Wave Stick antenna.

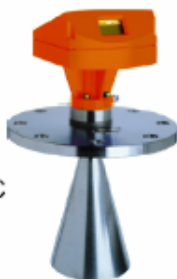
The unique Tank Bottom Following (TBF) mode in all the VG Series enables products with dielectric constants as low as 1.5 to be measured. For process vessels with complex internal structures the unique Empty Tank Spectrum (ETS) can be utilised to damp out all unwanted reflections from pipes, heating coils and agitators.

Where high precision is required the VG502 can measure to an accuracy of 1mm. For the measurement of solids the VG500 succeeds where other Radar products have failed. The FMCW VG Series is the answer to your level measuring requirements whether you use either the low cost two wire VG50 or VG51, ideal replacement for Displacers, Capacitive and Hydrostatic transmitters, or the more sophisticated four wire VG500, VG502 or VG510 for the more difficult applications.

TWO WIRE FMCW RADAR

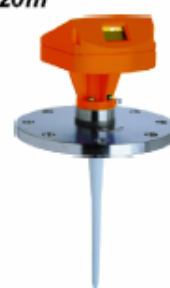
VG50 HORN - Range 20m

- ◆ EExia two wire
- ◆ HART
- ◆ Steam
- ◆ Foam
- ◆ Agitation
- ◆ Temperature up to 250°C
- ◆ Pressure up to 64 Bar
- ◆ Viscous liquids
- ◆ Dielectric greater than 2



VG51 WAVE STICK - Range 20m

- ◆ EExia two wire
- ◆ HART
- ◆ Small nozzle
- ◆ Corrosive liquids
- ◆ Clean liquids
- ◆ Temperature up to 150°C
- ◆ Pressure up to 16 Bar
- ◆ Dielectric greater than 4



FOUR WIRE FMCW RADAR

VG500 HORN - Range 40m (option 100m)

- ◆ Liquids & Solids
- ◆ EExd four wire
- ◆ HART & Profibus
- ◆ Foundation Fieldbus
- ◆ Steam & Foam
- ◆ Agitation
- ◆ Temperature up to 250°C
- ◆ Pressure up to 64 Bar
- ◆ Viscose liquids
- ◆ Dielectric greater than 2



VG510 WAVE STICK - Range 20m

- ◆ EExd four wire
- ◆ HART
- ◆ Profibus
- ◆ Foundation Fieldbus
- ◆ Small Nozzle
- ◆ Corrosive Liquids
- ◆ Clean Liquids
- ◆ Temperature up to 150°C
- ◆ Pressure up to 16 Bar
- ◆ Dielectric greater than 4



HIGH ACCURACY FMCW

VG502 HORN - has 1mm accuracy

- ◆ Liquids
- ◆ EExd four wire
- ◆ HART
- ◆ Profibus
- ◆ Foundation Fieldbus
- ◆ Temperature up to 250°C
- ◆ Pressure up to 64 Bar
- ◆ Viscous liquids
- ◆ Dielectric greater than 2
- ◆ 1mm Accuracy

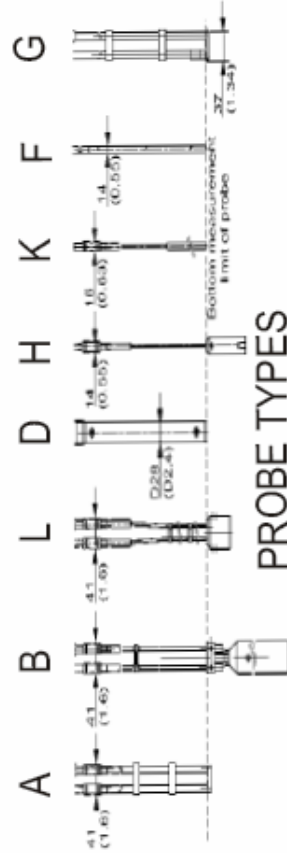


Note:

All of the above FMCW Radar units have been designed with service as a key parameter, especially for critical level applications, where it is not possible to open a tank or vessel once the units have been installed. However, the design of the sealed flange system allows removal of the electronic head whilst keeping the unit in service and the tank sealed. See diagram on page 7.

TDR Product Selector

Model	VF0301	VF0302	VF0303	VF0304	VF0306	VF044A	VF044B	VF044L	VF044D	VF044H	VF044K	VF044F	VF044G
Probe type	F	H	D	L	K	A	B	L	D	H	K	F	G
Principle	TDR	TDR	TDR	TDR	TDR	TDR	TDR	TDR	TDR	TDR	TDR	TDR	TDR
Process	Liquids	Liquids	Liquids	Liquids	Liquids	Liquids	Liquids	Liquids	Liquids	Liquids	Liquids	Liquids	Liquids
Medium	Solids*	Solids*	Solids	Solids	Solids	Solids	Solids	Solids	Solids	Solids	Solids	Solids	Solids
Range	3m	12m	6m	24m	24m	3m	30m	60m	6m	45m	30m	3m	6m
Application	Level	Level	Level	Level	Level	Level	Level	Level	Level	Level	Level	Level	Level
	Distance	Distance	Distance	Distance	Distance	Distance	Distance	Distance	Distance	Distance	Distance	Distance	Distance
	Volume	Volume	Volume	Volume	Volume	Volume	Volume	Volume	Volume	Volume	Volume	Volume	Volume
Mode	Direct	Direct	Direct	Direct	Direct	Direct.TBF	Direct.TBF	Direct.TBF	Direct	Direct.TBF	Direct.TBF	Direct.TBF	Direct
Accuracy													
Liquids	+/- 15mm	+/- 15mm	+/- 15mm	+/- 15mm	+/- 15mm	+/- 5mm	+/- 5mm	+/- 5mm	+/- 5mm	+/- 5mm	+/- 5mm	+/- 5mm	+/- 5mm
Solids	+/- 20mm			+/- 20mm	+/- 20mm	+/- 20mm	+/- 20mm	+/- 20mm		+/- 20mm	+/- 20mm	+/- 20mm	
Min Dielectric	2.1	2.1	1.4	1.8	2.1	1.8	1.8	1.8	1.4	2.1	2.1	2.1	1.8
Repeatability	+/- 2mm	+/- 2mm	+/- 2mm	+/- 2mm	+/- 2mm	+/- 1mm	+/- 1mm	+/- 1mm	+/- 1mm	+/- 1mm	+/- 1mm	+/- 1mm	+/- 1mm
P Max Bar	40	40	40	40	40	100	100	100	100	100	100	100	100
T Max C	200	200	200	200	200	200	200	200	200	200	200	200	200
Power Supply													
24 VDC	Yes	Yes	Yes	Yes	Yes	No	No	No	No	No	No	No	No
24 VAC/DC	No	No	No	No	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
110/230V AC	No	No	No	No	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Two Wire	Yes	Yes	Yes	Yes	Yes	No	No	No	No	No	No	No	No
Four Wire	No	No	No	No	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
4/20 HART	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
RS485	No	No	No	No	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Profibus PA	No	No	No	No	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Fieldbus	No	No	No	No	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
ATEX Approval	EExia	EExia	EExia	EExia	EExia	EExde	EExde	EExde	EExde	EExde	EExde	EExde	EExde
Integral LCD	No	No	No	No	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Min Process Con	1" BSP	1" BSP	1" BSP	2" ANSI	1.5" BSP	2" ANSI	2" ANSI	2" ANSI	1" BSP	1.5" BSP	1.5" BSP	1.5" BSP	2" ANSI

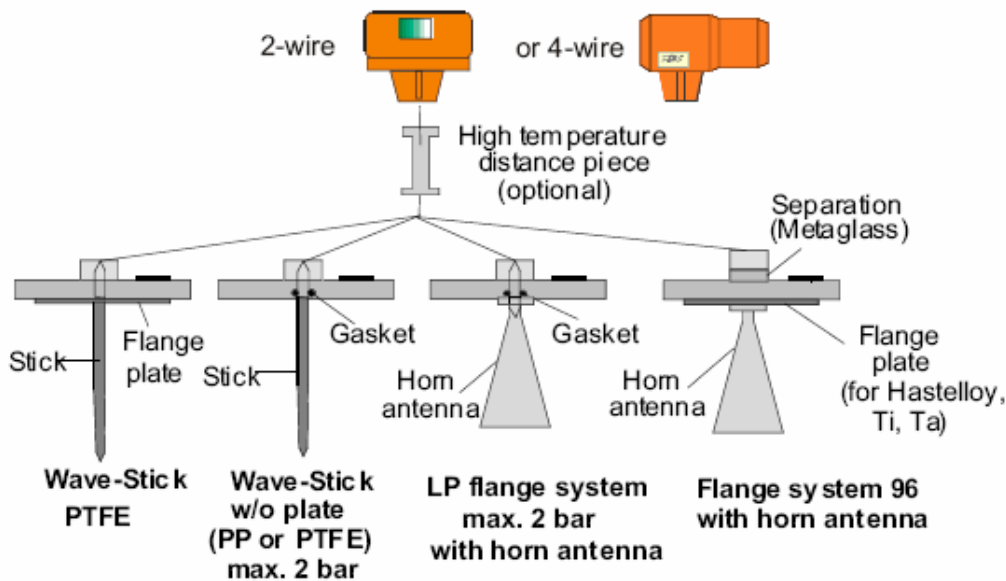


PROBE TYPES

FMCW Product Selector

Model	VG50	VG50	VG51	VG500	VG500	VG502	VG502	VG510
Antenna Type	Horn	Waveguide	Wavestick	Horn	Waveguide	Horn	Waveguide	Wavestick
Principle	FMCW	FMCW	FMCW	FMCW	FMCW	FMCW	FMCW	FMCW
Process Medium	Liquids	Liquids	Liquids	Liquids	Liquids	Liquids	Liquids	Liquids
Range	20m	6m	20m	40m	6m	35m	6m	20m
Application	Level	Level	Level	Level	Level	Level	Level	Level
	Distance	Distance	Distance	Distance	Distance	Distance	Distance	Distance
	Volume	Volume	Volume	Volume	Volume	Volume	Volume	Volume
Mode	Direct.TBF	Direct.TBF	Direct.TBF	Direct.TBF	Direct.TBF	Direct.TBF	Direct.TBF	Direct.TBF
Accuracy								
Liquids	+/- 0.3%	+/- 0.3%	+/- 0.3%	+/- 0.3%	+/- 0.3%	+/- 1mm	+/- 1mm	+/- 0.3%
Solids	No	No	No	*	No	No	No	No
Min Dielectric	2	1.5	4	2	1.5	2	1.5	4
Repeatability	+/- 1mm	+/- 1mm	+/- 1mm	+/- 1mm	+/- 1mm	+/- 1mm	+/- 1mm	+/- 1mm
P Max Bar	64	64	16	64	64	64	64	16
T Max C	250	250	150	250	250	250	250	150
Power Supply								
24 VDC	Yes	Yes	Yes	No	No	No	No	No
24 VAC/DC	No	No	No	Yes	Yes	Yes	Yes	Yes
110/230 AC	No	No	No	Yes	Yes	Yes	Yes	Yes
Two Wire	Yes	Yes	Yes	No	No	No	No	No
Four Wire	No	No	No	Yes	Yes	Yes	Yes	Yes
4/20 HART	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
RS485	No	No	No	Yes	Yes	Yes	Yes	Yes
Profibus PA	No	No	No	Yes	Yes	Yes	Yes	Yes
Fieldbus	No	No	No	Yes	Yes	Yes	Yes	Yes
ATEX Approval	EEExia	EEExia	EEExia	EEExde	EEExde	EEExde	EEExde	EEExde
Integral LCD	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Min Process Con	3" ANSI	3" ANSI	1.5" BSP	3" ANSI	3" ANSI	8" ANSI	3" ANSI	1.5" BSP

FLEXIBILITY BY MODULAR DESIGN



COMPLETELY SEALED FLANGE SYSTEM ALLOWS REMOVAL OF ELECTRONIC HEADS IN SERVICE.