



**FMCW RADAR TECHNOLOGY**

**AND**

**TIME DOMAIN REFLECTOMETRY (TDR)**

# 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 80m (option for 100m special)
- ◆ Versatile technology for Liquids, Slurries, Pastes and Solids.
- ◆ Display of Level, Distance or Volume
- ◆ Interface detection on liquids (eg, oil on water).
- ◆ 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 configuration
- ◆ Suitable for detecting levels through surface foam
- ◆ Sealed Flange system maintains system integrity

## 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
- ◆ Volume Measurement
- ◆ Interface Measurement
- ◆ Distance Measurement

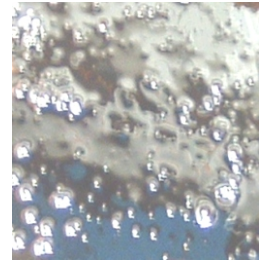
## COST EFFECTIVE REPLACEMENT FOR

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

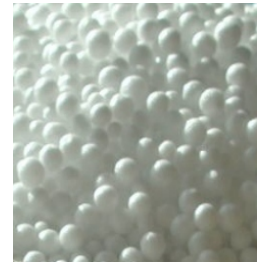
## MANUFACTURED TO ISO9001-2000 Q.M.S.



Various units on final assembly and ready to go for test. The quality of all Hycontrol products is strictly monitored to conform with our strict ISO quality requirements.



Acids



Plastics



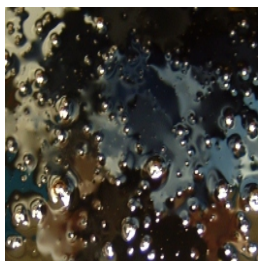
Grain



Powders



Flakes



Oils

# REFLEX VF SERIES TWO WIRE TDR

The Reflex VF Series range of TDR products is ideal for the measurement of liquids, powders and granules to a range of 35m. 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.

## 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 VF7 TWO WIRE TDR

- ◆ 35m Measuring Range
- ◆ 24 VDC Two Wire
- ◆ HART / PACTWARE / FIELDBUS
- ◆ Pressure up to 300 Bar
- ◆ Flange Temperature up to 300°C
- ◆ ATEX EExia / EExd Flameproof
- ◆ Capable of measuring low dielectric
- ◆ Interface Measurement
- ◆ Integral display and programmer
- ◆ High Accuracy 3mm std (2mm option)
- ◆ 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.

TDR guided radar can be used in two different modes :

### 1. Products with a dielectric constant $\epsilon_r \geq 1.6$

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).

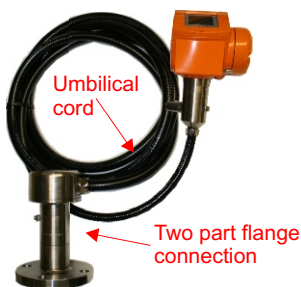
#### b) Interface measurement

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 ( $\epsilon_r$ ) of this first layer to determine the interface level.

### 2. Products with a dielectric constant $\epsilon_r > 1.4$

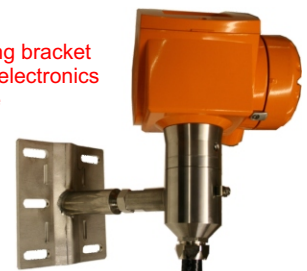
To monitor products with low dielectrics we utilise tank bottom following principle (TBF)

## REMOTE ELECTRONICS / HOUSING OPTION



The remote housing option is useful for displaying the contents of the vessel at ground level or for demanding applications where the electronics are best kept away from the tank. An example of this is in Nuclear applications where the electronics can be detached from the mechanical probe and placed outside of the high radiation area.

Mounting bracket to hold electronics in place



# REFLEX VG SERIES FMCW RADAR



A radar signal is generated via an antenna and transmitted down the vessel or tank which is then reflected by the target surface and received back at the antenna.

## **FMCW: Frequency Modulated Continuous Wave**

FMCW radar uses a high frequency signal, nominal 26Ghz which increases linearly during the measurement (frequency sweep) . The signal is emitted, reflected from the target surface and received at a time-delayed frequency.

The difference in this frequency is calculated from the actual transmit frequency and the receive frequency and this difference is directly proportional to the distance measured.

## **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

## THE ADVANTAGES OF FMCW RADAR

**NON-CONTACT LEVEL MEASUREMENT**

**SUITABLE FOR AGGRESSIVE MEDIA**

**MEASURES LIQUIDS, SOLIDS, POWDERS, GRANULES**

**RANGE UP TO 80 METRES (OPTION FOR 100m)**

**HIGH ACCURACY OPTIONS AVAILABLE (1mm)**

**VESSEL MAPPING REMOVES SPURIOUS SIGNALS**

**TBF MODE AVAILABLE FOR LOW DIELECTRIC PRODUCTS**

**UNAFFECTED BY PRESSURE, TEMPERATURE, VISCOSITY, FOAM OR DUST**

**AVAILABLE WITH HORN WAVE GUIDE, WAVE STICK OR DROP ANTENNA**

**MULTIPLE ATEX OPTIONS FOR EExia INTRINSICALLY SAFE & EExd FLAMEPROOF HOUSINGS**



# REFLEX VG 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, Wave Stick or Drop antenna.

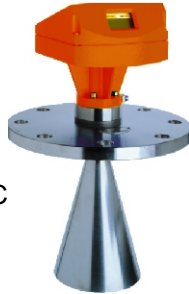
The unique Tank Bottom Following (TBF) mode in all the VG Series enables products with dielectric constants as low as 1.5 to be measured. For process vessels with complex internal structures the unique Empty Tank Spectrum (ETS) can be utilised to damp out all unwanted reflections from pipes, heating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

Where high precision is required the VG502 can measure to an accuracy of 1mm. For the measurement of solids the VG series 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 VG5XX and VG7 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



## TWO / FOUR WIRE FMCW RADAR

### VG6 DROP - Range 80m

- ◆ Solids only
- ◆ EExd \ EExia two wire
- ◆ HART
- ◆ Polypropylene antenna
- ◆ Steam & Foam
- ◆ Agitation
- ◆ Temperature up to 200°C
- ◆ Pressure up to 16 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 - Range 35m

- ◆ 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



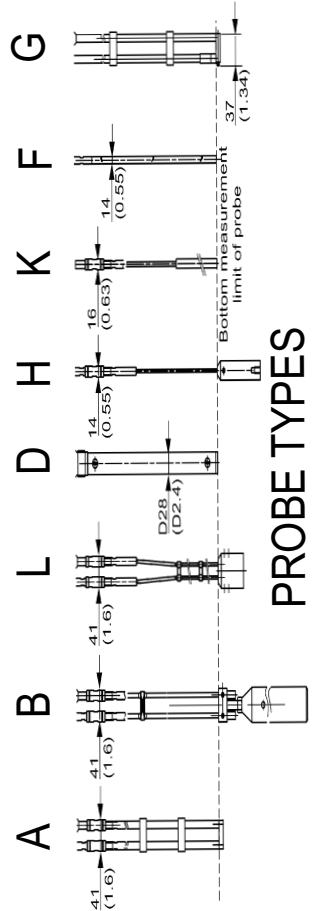
### VG7 HORN - Range 80m

- ◆ Liquids and solids
- ◆ EExd / EExia two wire
- ◆ HART 4-20mA output
- ◆ Dielectric greater than 2
- ◆ Temperature up to 200°C
- ◆ Pressure up to 40 Bar
- ◆ Viscous liquids
- ◆ Dielectric greater than 2
- ◆ 3mm Accuracy



# TDR PRODUCT SELECTOR

MODEL	VF0301	VF0302	VF0303	VF0304	VF0306	VF7000	VF7001	VF7002	VF7003	VF7004	VF7005	VF7006
Probe Type	F	H	D	L	K	F	A	D	H	K	G	H2mm
Process Connection (min)	1"	1"	1"	1 1/2"	1 1/2"	3/4"	1 1/2"	3/4"	3/4"	1 1/2"	1 1/2"	1/2"
Maximum Range (m)	3	12	6	24	24	4	4	6	35	35	8	35
Product	Liquids Solids	Liquids Solids*	Liquids	Liquids Solids	Liquids Solids	Liquids Solids	Liquids	Liquids	Liquids Solids	Liquids Solids	Liquids	Liquids
Measurement	Level	Level	Level	Level	Level	Level	Level	Level	Level	Level	Level	Level
	Distance	Distance	Distance	Distance	Distance	Distance	Distance	Distance	Distance	Distance	Distance	Distance
	Volume	Volume	Volume	Volume	Volume	Volume	Volume	Volume	Volume	Volume	Volume	Volume
Operating Mode	Direct	Direct	Direct	Direct	Direct	Direct/TBF	Direct/TBF	Direct	Direct/TBF	Direct/TBF	Direct/TBF	Direct/TBF
Accuracy +/- mm (Liquids)	5mm	5mm	5mm	5mm	5mm	3mm	3mm	3mm	3mm	3mm	3mm	3mm
Accuracy +/- mm (Solids)	20mm	20mm	20mm	20mm	20mm	20mm	20mm	20mm	20mm	20mm	20mm	20mm
Minimum Dielectric	2.1	2.1	1.6	1.8	2.1	1.6 / 1.1	1.6 / 1.1	1.4 / 1.1	1.6 / 1.1	1.6 / 1.1	1.6 / 1.1	1.6 / 1.1
Repeatability	2mm	2mm	2mm	2mm	2mm	1mm	1mm	1mm	1mm	1mm	1mm	1mm
Max Pressure (bar)	40	40	40	40	40	100	100	100	100	100	100	300
Maximum temperature (°C)	200	200	200	200	200	200	200	200	200	200	200	300
Power supply 24V DC	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
2-Wire device	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Output (4-20mA)	Yes	Yes	Yes	Yes	Yes	Yes*2	Yes*2	Yes*2	Yes*2	Yes*2	Yes*2	Yes*2
HART	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
PACTWARE	No	No	No	No	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes
RS485	No	No	No	No	No	No	No	No	No	No	No	No
Profibus PA	No	No	No	No	No	Option	Option	Option	Option	Option	Option	Option
Fieldbus	No	No	No	No	No	Option	Option	Option	Option	Option	Option	Option
ATEX EExia	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
ATEX EEExd	No	No	No	No	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes
HMI	No	No	No	No	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes



PROBE TYPES

**\*Note:** Hycontrol advise the use of 8mm cable for Solids applications due to the high loads and abrasive wear usually associated with these applications. However, for short cable length and light powders such as flour 4mm may be acceptable. The 2mm option is only for liquids.

# RADAR PRODUCT SELECTOR

MODEL	VG6006	VG600G	VG600P	VG600S	VG600T
Antenna	DN80	DN100	DROP	DROP	DROP
Connection Min	1	1½"	1½"	1½"	1½"
Range Max Mtrs	80	80	80	80	80
Application	Solids	Solids	Solids	Solids	Solids
Measuring	Level	Level	Level	Level	Level
	Distance	Distance	Distance	Distance	Distance
	Volume	Volume	Volume	Volume	Volume
Operating. Mode	Direct	Direct	Direct	Direct	Direct
Solids Accuracy	10mm	10mm	10mm	10mm	10mm
Liquids Accuracy					
Min Dielectric	1.5	1.5	1.5	1.5	1.5
Repeatability	5mm	5mm	5mm	5mm	5mm
Maximum Pressure (bar)	40	40	16	16	16
Maximum temperature (°C)	200	200	150	100	100
Power supply 24V DC	Yes	Yes	Yes	Yes	Yes
2-Wire Device	Yes	Yes	Yes	Yes	Yes
100~220VAC 4 wire unit	No	No	No	No	No
Output 4-20mA	Yes	Yes	Yes	Yes	Yes
HART	Yes	Yes	Yes	Yes	Yes
PACTWARE	Yes	Yes	Yes	Yes	Yes
RS485	No	No	No	No	No
Profibus PA	Optional	Optional	Optional	Optional	Optional
Fieldbus	Optional	Optional	Optional	Optional	Optional
ATEX options EExia	Yes	Yes	Yes	Yes	Yes
ATEX options EExd	Yes	Yes	Yes	Yes	Yes
HMI Display	Yes	Yes	Yes	Yes	Yes



VG6X SERIES  
DROP ANTENNA



VG6 SERIES  
HORN ANTENNA

MODEL	VG7004	VG7005	VG7003	VG50	VG51	VG502
Antenna	DN40	DN50	DN80	Horn	Wavestick	Horn
Connection Min	1½"	1½"	1½"	3" Flange	1½"	8" Flange
Range Max Mtrs	40	40	40	20	20	35
Application	Liquids	Liquids	Liqu/Sol	Liquids	Liquids	Liquids
Measuring	Level	Level	Level	Level	Level	Level
	Distance	Distance	Distance	Distance	Distance	Distance
	Volume	Volume	Volume	Volume	Volume	Volume
Operating. Mode	Direct/TBF	Direct/TBF	Direct/TBF	Direct/TBF	Direct/TBF	Direct/TBF
Solids Accuracy			10mm			
Liquids Accuracy	3mm	3mm	3mm	0.30%	0.30%	1mm
Min Dielectric	1.5	1.5	1.5	2	4	2
Repeatability	1mm	1mm	1mm	1mm	1mm	1mm
Maximum Pressure (bar)	40	40	40	64	16	64
Maximum temperature (°C)	200	200	200	250	150	250
Power supply 24V DC	Yes	Yes	Yes	Yes	Yes	No
2-Wire Device	Yes	Yes	Yes	Yes	Yes	No
100~220VAC 4 wire unit	No	No	No	No	No	Yes
Output 4-20mA	Yes	Yes	Yes	Yes	Yes	Yes
HART	Yes	Yes	Yes	Yes	Yes	Yes
PACTWARE	Yes	Yes	No	No	No	Yes
RS485	No	No	No	No	No	Yes
Profibus PA	Optional	Optional	Optional	Optional	Optional	Optional
Fieldbus	Optional	Optional	Optional	Optional	Optional	Optional
ATEX options EExia	Yes	Yes	Yes	Yes	Yes	No
ATEX options EExd	Yes	Yes	Yes	Yes	Yes	Yes
HMI Display	Yes	Yes	Yes	Yes	Yes	Yes



VG5XX SERIES  
HORN ANTENNA

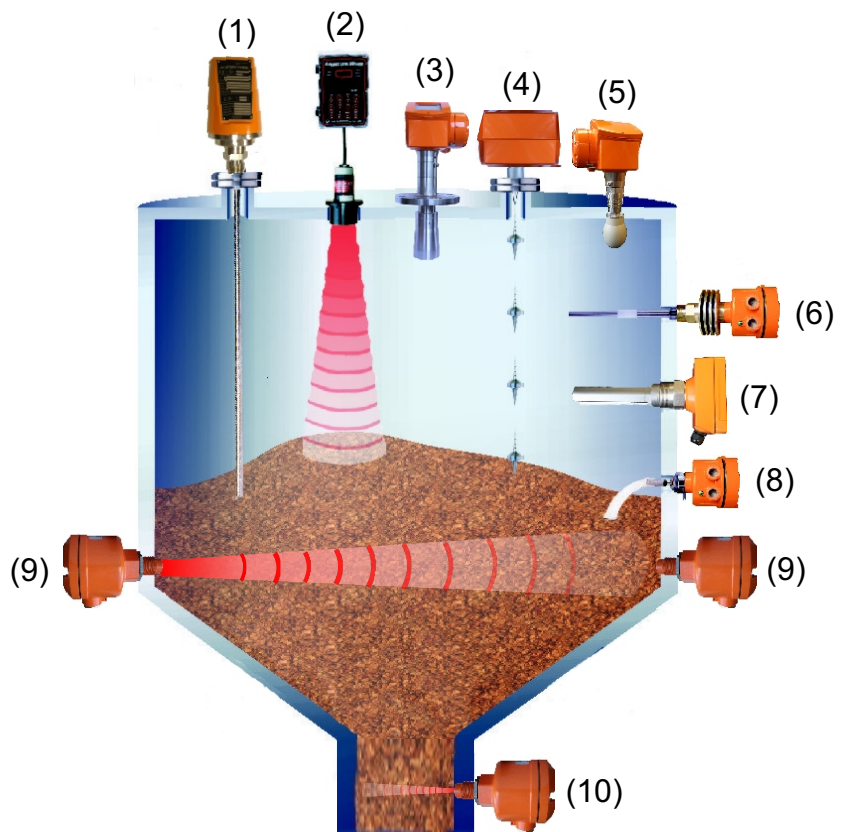


VG7X SERIES  
HORN ANTENNA

# HYCONTROL LEVEL TECHNOLOGIES

## Product Range For Solids :-

- (1) TDR Radar For Solids
- (2) Ultrasonic, 'Through Air'
- (2) 2 Wire Ultrasonic Transmitter
- (3) FMCW 2 Wire Radar
- (4) Continuous 'Servo' Level Indicator
- (5) FMCW 2 Wire Radar
- (6) Capacitance Level Switch
- (7) Vibrating Probe Level Switch
- (8) Rotating Paddle Level switch
- (9) Microwave Level Switch
- (10) Doppler Flow Switch



## Product Range For Liquids :-

- (1) By-Pass Level Indicator With Radar
- (2) TDR Radar For Liquids
- (3) 2 Wire Ultrasonic Transmitter
- (4) FMCW 'Horn' Radar 2 Wire
- (5) Magnetic Float Switches
- (6) FMCW 2 Wire Radar
- (7) Capacitance Level Switch
- (8) RF Admittance Level Switch
- (9) Side Mounting 316 SS Float Switch
- (10) Tuning Fork Level Switch
- (11) Tuning Fork Level Switch
- (12) Ultrasonics 'Through Wall'
- (13) Mini Magnetic Float Level Switch

