Level Measurement Products – Point Level

Mechanical Point Level

- Advantage
  - A cost-effective solution for basic applications
  - Easy to set up with no calibration of the instrument required
  - The unique and robust design Siemens mechanical point level products is based on the experience of over 250,000 applications world wide
Level Measurement Products – Solids Only

SITRANS LPS 200 (Level Paddle Switch)
Electro-mechanical rotary paddle switch for level detection of powder and granular solids with bulk densities as low as 0.94 lbs per cubic foot

- Hinged measuring vane for lower densities and mounting through small process connections
- Installation through 1 ¼ “ NPT process connection
Level Measurement Products – Solids Only

SITRANS LPS 200 (Level Paddle Switch)

- Unique friction clutch mechanism to prevent motor damage
- Compact, extended models and cable extensions up to 33 ft (10m)
- High temperature model to 662°F (350° C)
- High pressure version to 145 psi (10 Bar)
Level Measurement Products – Solids Only

SITRANS LVS 200 (Level Vibrating Switch)
Electro-mechanical vibratory switch for level detection of powder and granular solids with bulk densities as low as 0.3 lbs per cubic foot
- Compact design
- Top, side, or angle mount
- Rotatable enclosure
- Self-cleaning fork
Level Measurement Products – Solids Only

**SITRANS LVS 200 (Level Vibrating Switch)**

- Options
  - Extended model up to 65 ft (20m)
  - Interface model with detection of solids in liquids
  - Buildup detection
  - Short fork option for short insertion
  - Remote electronics option
  - Lengths up to 65 feet.
Level Measurement Products – Solids Only

Mechanical Point Level

- Typical applications
  - Powders
  - Grains
  - Coffee
  - Animal feed
  - Detergent
  - Gypsum
  - Cement
  - Plastics
SITRANS LVL100 / LVL200 (Level Vibrating Liquid)
Electro-mechanical vibratory switch for level detection in liquids and slurries even in heavy viscous materials.

- Compact, modular design
- True plug & play
- Unaffected by foam
- Wear free Piezo drive
Level Measurement Products – Liquids Only

SITRANS LVL100 / LVL200 (Level Vibrating Liquid)

- Key features
  - Temperature to 482°F (250°C)
  - Pressure to 940 psi (65 bar)
  - Modular electronics
  - SIL2 qualified

- Key options
  - Extensions to 13 ft (4m)
  - Sanitary versions
Level Measurement Products – Point Level

Capacitance Point Level

- Siemens inverse frequency shift approach
  - Small level changes create a large frequency change
  - Accurate, reliable, and repeatable measurement where conventional devices fail

- Special features
  - Tip sensitive probes
  - Modular probe options for extensions and process connections
Level Measurement Products – Point Level

SITRANS CLS 100 (Capacitance Level Switch)
Compact 2-wire inverse frequency shift capacitance switch for level detection in constricted spaces, interfaces, solids, liquids, slurries, and foam

- -40 to 212°F (-40 to 100°C)
- 145 psi (10 bar)
- Loop powered (4 & 20 ma output)
- Sensitivity adjustment
- LED indication
Level Measurement Products – Point Level

SITRANS CLS 100 (Capacitance Level Switch)

- Options
  - General purpose and hazardous approvals
  - Dust-ignition proof
  - Intrinsically Safe
  - SensGuard for abrasive applications
  - Ryton or Kynar probes
  - IP68 (IP65 cable version)
SITRANS CLS 200 (Capacitance Level Switch)
Inverse frequency shift capacitance switch with a high level of chemical resistance; ideal for level detection of interfaces, solids, liquids, slurries, and foam, and for simple pump control

- -40 to 257°F (-40 to 125°C)
- Up to 365 psi (25 bar)
- 12 to 250V AC / DC
Level Measurement Products – Point Level

SITRANS CLS 200 (Capacitance Level Switch)

- Level detection independent of tank wall / pipe
- Sensitivity adjustment
- LED indication
- Multiple outputs
  - 1 form C (SPDT) relay
  - Solid-state switch
- Fully adjustable hysteresis
Level Measurement Products – Point Level

SITRANS CLS 200 (Capacitance Level Switch)

- Options
  - Profibus PA Digital Model
  - Rigid, cable, and sanitary
  - SensGuard for abrasive applications
  - Thermal isolator
  - General purpose and hazardous approvals
Level Measurement Products – Point Level

SITRANS CLS 300 (Capacitance Level Switch)
Inverse frequency shift capacitance switch for detecting solids, liquids, slurries, and interface in demanding conditions of elevated pressures, temperatures, and corrosive and abrasive materials
- -40 to 392°F (-40 to 200°C)
- -40 to 752°F (-40 to 400°C) (high temperature version)
- Up to 511 psi (35 bar)
- 12 to 250V AC / DC
Level Measurement Products – Point Level

SITRANS CLS 500 (Capacitance Level Switch)
Inverse frequency shift capacitance switch for detecting interfaces, solids, liquids, toxic and aggressive chemicals in critical conditions of extreme temperatures and extreme pressure
- -58 to 392°F (-50 to 200°C)
- -76 to 752°F (-60 to 400°C) (high temperature version)
Level Measurement Products – Point Level

SITRANS CLS 500 (Capacitance Level Switch)
Inverse frequency shift capacitance switch for detecting interfaces, solids, liquids, toxic and aggressive chemicals in critical conditions of extreme temperatures and extreme pressure

- Up to 2175 psi (150 bar)
- Up to 5004 psi (345 bar) (high pressure version)
- HART® compatible
ULS 200 (Ultrasonic Level Switch)
A non-contacting switch with two switch points for level detection of bulk solids, liquids, and slurries in a wide variety of industries; ideal for sticky or abrasive materials

- .8 to 9.8 ft (.25 to 3m) for solids
- 1 to 16.4 ft (.25 to 5m) for liquids
Level Measurement Products – Point Level

ULS 200

- Key Features
  - Two switch outputs for high-high, high-low, or low-low level alarms or pump-up / pump-down control
  - Integral temperature compensations
  - AC and DC versions available
  - Threaded and sanitary connections
  - Polycarbonate or aluminum enclosures
  - Easy, two-button programming
Level Measurement Products – Continuous Level

SITRANS LC 300 (Level Capacitance)
Inverse frequency shift capacitance level transmitter for liquids and solids applications; ideal for standard industrial applications in chemical, hydrocarbon processing, food and beverage, and mining, aggregates, and cement

- -40 to 392°F (-40 to 200°C)
- Up to 511 psi (35 bar)
- Up to 18 ft (5.5m) rod
- Up to 82 ft (25m) cable
Level Measurement Products – Continuous Level

SITRANS LC 300 (Level Capacitance)

- Key Features
  - Push-button calibration
  - Patented Active-Shield technology
  - Integrated local display
  - Highly accurate and reliable PFA-lined probes

- Power Specifications
  - 9 to 32 V DC any polarity, 2-wire current loop (9V @ 22mA)
Level Measurement Products – Continuous Level

SITRANS LC 500 (Level Capacitance)
Inverse frequency shift capacitance level and interface transmitter for extreme and critical process conditions, such as oil and liquified natural gas (LNG), toxic and aggressive chemicals and vapors

- -58 to 392°F (-50 to 200°C)
- -76 to 752°F (-60 to 400°C) (high temperature version)
Level Measurement Products – Continuous Level

SITRANS LC 500 (Level Capacitance)
Inverse frequency shift capacitance level and interface transmitter for extreme and critical process conditions, such as oil and liquified natural gas (LNG), toxic and aggressive chemicals and vapors

- Up to 2175 psi (150 bar)
- Up to 5004 psi (345 bar) (high pressure version)
- Other process pressure options
Basic Contacting Theories

Review

- Level technologies
  - Mechanical point level
  - Capacitance point level
  - Ultrasonic point level
  - Capacitance continuous level
Basic Non-contacting Theories

Non-contacting level products

- Easy to install
  - Installs from top – no need to drain or enter the vessel
  - No need to stop the process for installation, commissioning, troubleshooting, or maintenance
- Non-contacting + no moving parts = little or no maintenance
Basic Non-contacting Theories

Sound Waves

- Sound is a series of compression waves that travel through air or many other materials
  - Sound waves are caused by the vibrating of some object
  - Sound must cause another object to vibrate to be detected
Basic Non-contacting Theories

Microwaves

- Microwaves are a form of electromagnetic wave
- The electromagnetic spectrum is the range of all electromagnetic waves that include everything from radio waves to microwaves, infrared, ultraviolet rays, and gamma rays
- Microwaves travel at 186,000 miles per second, nothing travels faster
Basic Non-contacting Theories

Wave propagation

- Sound waves and microwaves have characteristics just like any other wave
  - Velocity
  - Wave Length
  - Frequency
  - Amplitude
Basic Non-contacting Theories

Wave propagation

- Velocity refers to the direction and speed of the signal.
- The speed of sound is determined by the:
  - Medium type (gas, water, solid)
  - Temperature of the medium
  - Medium stratification
  - Vacuum
- Microwave signal velocity remains constant without regard to atmospheric conditions.
Basic Non-contacting Theories

Signal wave velocity

- The relationship of time, speed, and distance
  - Accurate time measurement and consistent velocity are required for distance measurement

- Distance = \( \text{Velocity} \times \text{Time} \)
  - \( \frac{2}{2} \)

- Velocity = \( 2 \times \text{Distance} \)
  - \( \text{Time} \)
Basic Non-contacting Theories

The nature of sound

- The speed of sound through air is linearly related to air temperature
- All Siemens transducers are temperature compensated
- External temperature sensors are available for applications with rapid temperature changes

\[ V_{\text{sound in air}} \approx 331.4 + 0.6T_c \text{ m/s} \]
Basic Non-contacting Theories

The nature of sound

- The speed of sound through gases
  - $V$ is the velocity in m/sec
  - $\gamma$ is the adiabatic index (the ratio of specific heats, 1.4 for air)
  - $R$ is the gas constant (287 J/kgK for air)
  - $T$ is the absolute temperature in degrees Kelvin

$$V_{\text{sound in gas}} = \sqrt{\gamma RT}$$
Basic Non-contacting Theories

Advantages of radar

- Time of flight – uses the same distance formula as ultrasonics
- Signal processing built through years of ultrasonic application experience
- Stable performance – speed of light is relatively unchanged regardless of atmospheric conditions
- Siemens has a comprehensive line of radar products when radar technology is appropriate
Basic Non-contacting Theories

Advantages of ultrasonics

- Value – typically 20 to 30% less expensive than alternate non-contacting
- Proven performance in applications where the speed of sound is predictable
- Non-dependant of dielectric constant
- Remote mounting capabilities
Basic Non-contacting Theories

Choose a market leader of multiple technologies to ensure the right product for your application!
**Beam angles**

- Beam angle definition – Twice the angle at which off-axis transmission is 3dB less than, or half the power of, the transmission axis.
Basic Non-contacting Theories

Beam angles

- The diametrical measurement of the cone in degrees defines the half power beam angle
- Transducer face diameter and frequency wavelength are factors in beam angle
- 10 to 1 rule

\[
\begin{align*}
A_1 &= \pi (D_1 \tan \theta)^2 \\
A_2 &= \pi (D_2 \tan \theta)^2 \\
\text{Energy per unit area (E/A)} &= \frac{1}{(R_n \tan \theta)^2}
\end{align*}
\]
Basic Non-contacting Theories

Microwave beam angles

- Larger horn sizes result in smaller beam angles
- Microwave signal transmissions create an oval shaped footprint
- The straight sides of the oval are parallel to the conduit entry
- Turning the conduit entries parallel to the vessel wall will decrease wall interference
- 10:1 rule
Basic Non-contacting Theories

The ultrasonic transducer

- The primary active component for the transducer is the piezoelectric crystal that vibrates when subjected to alternating voltage
- When voltage is removed the vibration begins to decay
The ultrasonic transducer
- The inherent nature of the crystal and the surrounding transducer mass to continue vibrating
- This vibration is called “ringing”
- The time it takes for this ringing to stop is referred to as “ringdown”
Basic Non-contacting Theories

Process Intelligence

- The receiver must remain off during the signal transmission and ringdown.
- Since time is relative to distance, the ringdown time is commonly referred to as the blanking distance.
Basic Non-contacting Theories

Process Intelligence

- In an ultrasonic transducer the return signal causes the crystal to begin vibrating again
- In a microwave radar transmitter the return signal is sensed by the receiving circuitry
- The return signal is sent to the receiver for processing
Basic Non-contacting Theories

Process Intelligence

- Time Varying Threshold (TVT)
  - A reference to compare signals at different positions in time
  - A far signal will be weaker because it has traveled a greater distance

![Graph](image-url)

- Transmit Pulse
- Return Signal
- Blanking Distance
- Time Varying Threshold (TVT Curve)
Basic Non-contacting Theories

- Selecting the true material echo
  - Area – the measure of the area of each echo

![Graph showing Transmit Pulse, Return Signal, Blanking Distance, Time Varying Threshold (TVT Curve)]
Basic Non-contacting Theories

Process Intelligence

- Selecting the true material echo
  - Area – the measure of the area of each echo
  - Largest – the measure of the largest height of each echo

Diagram with labels:
- Transmit Pulse
- Return Signal
- 100dB
- 75dB
- 50dB
- 25dB
- 0dB
- 0ft, 5ft, 10ft, 15ft, 20ft, 25ft
- Blanking Distance
- Time Varying Threshold (TVT Curve)
Basic Non-contacting Theories

Process Intelligence

- Selecting the true material echo
  - Area – the measure of the area of each echo
  - Largest – the measure of the largest height of each echo
  - First – the measure of the first significant echo
Basic Non-contacting Theories

Process Intelligence
- Scoring each echo
  - Area – the measure of the area of each echo
  - Largest – the measure of the largest height of each echo
  - First – the measure of the first significant echo
Basic Non-contacting Theories

- Scoring each echo
  - Scores are calculated and added
  - The net Confidence is the value of the chosen echo minus the value of the next most significant echo

Process Intelligence
Basic Non-contacting Theories

Process Intelligence

- Auto False Echo Suppression
  - An undesired echo can be ignored by lifting the TVT curve at the position of the false echo
  - This can be done manually or by performing Auto False Echo Suppression

![Diagram showing obstructions and true echoes with dB levels and distance markers.](image)
Basic Non-contacting Theories

Process Intelligence

- Auto False Echo Suppression
  - An undesired echo can be ignored by lifting the TVT curve at the position of the false echo
  - This can be done manually or by performing Auto False Echo Suppression

![Graph showing obstructions and true echoes with blanking distance and time varying threshold (TVT Curve).](image)
Basic Non-contacting Theories

Mounting considerations
Basic Non-contacting Theories

Mounting considerations
1. Too close to side wall – interference from ladder rungs and support braces
Basic Non-contacting Theories

Mounting considerations

1. Too close to side wall – interference from ladder rungs and support braces
2. Correct installation – 1/3 the distance from the side wall, no obstructions
Basic Non-contacting Theories

Mounting considerations

1. Too close to side wall – interference from ladder rungs and support braces
2. Correct installation – 1/3 the distance from the side wall, no obstructions
3. Center of a parabolic tank – problems with secondary echoes
Basic Non-contacting Theories

Mounting considerations

1. Too close to side wall – interference from ladder rungs and support braces
2. Correct installation – 1/3 the distance from the side wall, no obstructions
3. Center of a parabolic tank – problems with secondary echoes
Basic Non-contacting Theories

Mounting considerations

1. Too close to side wall – interference from ladder rungs and support braces
2. Correct installation – 1/3 the distance from the side wall, no obstructions
3. Center of a parabolic tank – problems with secondary echoes
4. Obstruction from fill stream
Basic Non-contacting Theories

Mounting considerations

- All material levels should be considered when selecting mounting location
- Obstructions must be exposed before Auto False Echo Suppression can be performed
Basic Non-contacting Theories

Mounting considerations

- The sound path should be perpendicular to the monitored surface
- Flat for liquids and slurries
Basic Non-contacting Theories

Mounting considerations

- The sound path should be perpendicular to the monitored surface
  - Flat for liquids and slurries
  - Matching the angle of repose for solids
Basic Non-contacting Theories

Mounting considerations

- The sound path should be perpendicular to the monitored surface
  - Flat for liquids and slurries
  - Matching the angle of repose for solids
- Avoid proximity to high voltage or current wiring, high voltage or current contacts, and to variable frequency motor speed controllers
Auto False Echo Suppression

- In ultrasonic applications it is preferred to perform Auto False Echo Suppression with the vessel empty.

Careful not to map the bottom of the vessel!!
Basic Non-contacting Theories

Auto False Echo Suppression

- In microwave radar applications, it is preferred to perform Auto False Echo Suppression with one or two feet of material in the vessel.

Careful not to map the material level!
Basic Non-contacting Theories

Auto False Echo Suppression

- Radar signal will not penetrate metal tank bottom and will result in a strong signal return
- TVT curve is elevated above the average signal
Basic Non-contacting Theories

Auto False Echo Suppression

- When product is introduced some of the microwave signal will be absorbed by material penetration
- The return signal amplitude may not extend beyond the elevated TVT curve
Basic Non-contacting Theories

Auto False Echo Suppression

- When product is introduced some of the microwave signal will be absorbed by material penetration
- This results in a lower average signal amplitude
- When Auto False Echo Suppression is performed in this condition the TVT hovers closer to the signal curve
Basic Non-contacting Theories

Low Dielectric Material

- Radar signals may penetrate materials with low dielectric values
  - Oil
  - Hydrocarbons
- At lower material levels the metal tank bottom may provide a larger return signal than the material level
Basic Non-contacting Theories

Low Dielectric Material

- CLEF algorithm for low dielectric materials
- Level is selected based on the steepness of the CLEF line
Basic Non-contacting Theories

Low Dielectric Material

- Guided Wave Radar (GWR) used the principle of Time Domain Reflectometry (TDR)
- Pulses of high frequency energy are sent down a cable or rigid probe
- Signal profile is different than through air radar
- The higher the material dielectric constant the larger the signal return
Basic Non-contacting Theories

Review

- Special features of ultrasonic and radar technologies
  - Non-contacting
    - Ease of installation – no need to stop the process
    - Virtually maintenance free
  - Signal beam angles
  - Process Intelligence
    - Signal profiles
    - Algorithms
    - Auto False Echo Suppression
  - Mounting considerations
SIEMENS Process Sensors
Level Measurement Products

Ultrasonic Level Products
SIEMENS Process Sensors
Level Measurement Products

SITRANS Probe LU
The new and extremely experienced SITRANS Probe

- Two wire ultrasonic or radar level transmitter
- Used for the measurement of liquids or slurries
SITRANS Probe LU / LR

The new and extremely experienced SITRANS Probe

- Three measurement ranges
  - Ultrasonic – 20 ft (6 meters)
  - Ultrasonic – 40 ft (12 meters)
  - Radar – 65 ft (20 meters)

- Two process connections
  - Radar – 1 ½ inch
  - Ultrasonic – 2 inch
The new and extremely experienced SITRANS Probe

- HART compatible device
- SIMATIC PDM compatible
- Profibus PA option
The new and extremely experienced SITRANS Probe LU

- Uses the standard Siemens patented infrared hand-held programmer
- No need to open the enclosure
- No need to connect wires or plug in modules for local programming
- Standard local display
Key Features

- **Auto False Echo Suppression**
  - An undesired echo can be ignored by lifting the TVT curve at the position of the false echo.
  - This can be done manually or by performing Auto False Echo Suppression.
SIEMENS Process Sensors
Level Measurement Products
SITRANS LU01, LU02, LU10
SITRANS LU01 / LU02 / LU10

Long-range level monitor
- Liquids or solids to 200ft (60m)
- Assignable mA and relay outputs
- Communications options
  - Profibus DP
  - Modbus
  - Allen-Bradley Remote I/O
SITRANS LU01 / LU02 / LU10

Key Features

- Dual stage signal processing
  - Improves signal to noise ratio
SIEMENS Process Sensors
Level Measurement Products

MultiRanger 100 / 200
HydroRanger 200
MultiRanger / HydroRanger

The new standard for reliable level control

- Level only controller
  - Level
  - Distance
  - Space
- Multifunctional controller
  - Differential
  - Volume and pumped volume
  - Open channel flow
- Liquids or solids to 50ft (15m)
MultiRanger / HydroRanger

The new standard for reliable level control

- SIMATIC PDM for configuration and diagnostics
- On board Modbus RS-232 / RS-485
- Field installable communications
  - Profibus DP
  - Allen-Bradley Remote I/O
  - DeviceNet
Ultrasonic Level Products

Review

- **SITRANS Probe LU**
  - Simple level
  - Robust design
  - Process Intelligence

- **SITRANS LU01, LU02, LU10**
  - Long-range liquids and solids applications

- **MultiRanger 100/200 and HydroRanger 200**
  - Advanced pump controller
  - Process Intelligence
  - Ease of programming
SIEMENS Process Sensors
Level Measurement Products

Microwave Radar
SITRANS LG200

SITRANS LG 200 (Level Guided Wave)
Advanced loop-powered, guided wave radar level transmitter for liquids, slurries, interface, and bulk solids with a dielectric of 1.4 and higher
- .5 to 75 ft (0.15 to 22.5m)
- -320 to 800°F (-195 to 427°C)
- Full vacuum to 6250 psi (431 bar) (probe dependant)
SITRANS LG200

Key Features
- Coaxial, rigid, and flexible single or twin rods for many applications
- Unaffected by changes in density and dielectric properties
- Low dielectric measurement (1.4 and higher)
- Extreme conditions (pressures & temperatures)
- Intrinsically Safe, Explosion Proof, and Non-Incendive approvals
- HART compatible
SITRANS LG200

Key Application
- Displacer replacer
- Option for proprietary flanges used by major displacer manufactures
- Easy retrofit of high maintenance displacers
SIEMENS Process Sensors
Level Measurement Products

Microwave Radar for Solids Level Measurement
SITRANS LR260

Low cost, extremely reliable level measurement

- 2-wire, 25 GHz pulse radar
- Solids level measurement to 98ft (30m)
- Ideal for extreme dust and high temperatures to 392°F (200°C)
SITRANS LR260

Key Features

- **LUI (Local User Interface)** displays echo profiles for diagnostic support
- **Quick Start Wizard**
- **Process Intelligence** – advanced echo processing for unparalleled performance
- **Easy to install** – small horn and narrow beam angle allow installation practically anywhere on your vessel
Key Features

- **Auto False Echo Suppression**
  - An undesired echo can be ignored by lifting the TVT curve at the position of the false echo.
  - This can be done manually or by performing Auto False Echo Suppression.
Key Features

- Infrared handheld programmer for local operation
- HART device
- SIMATIC PDM compatible for configuration and diagnostics

Options

- Profibus PA communications
- Dust cover and air purge available
SIEMENS Process Sensors
Level Measurement Products

SITRANS LR460
SITRANS LR460

The workhorse for solids level measurement

- 4-wire, 24 GHz FMCW radar
- Solids level measurement to 329ft (100m)
- Ideal for extreme dust and low bulk density
- High temperatures to 392°F (200°C)
Key Features

- Process Intelligence – advanced echo processing for unparalleled performance
- Extremely high signal yields high performance (high signal to noise ratio)
- Virtually unaffected by dust or temperature changes
- Integrated Easy Aimer for optimizing signal on sloped surfaces
Key Features

- **Auto False Echo Suppression**
  - An undesired echo can be ignored by lifting the TVT curve at the position of the false echo.
  - This can be done manually or by performing Auto False Echo Suppression.

![Graph showing SITRANS LR460 Key Features](graph.png)
SITRANS LR460

Key Features
- Quick Start Wizard for set-up
- Infrared handheld programmer for local operation
- HART device
- SIMATIC PDM compatible for configuration and diagnostics

Options
- Profibus PA communications
- Dust cover and air purge available
Microwave Radar for solids applications

Typical Applications

- Refineries
Microwave Radar for solids applications

Typical Applications
- Refineries
- Mining
Microwave Radar for solids applications

Typical Applications
- Refineries
- Mining
- Power generation
Microwave Radar for solids applications

Typical Applications

- Refineries
- Mining
- Power generation
- Cement
Microwave Radar for solids applications

Typical Applications:
- Refineries
- Mining
- Power generation
- Cement
- Pulp & Paper
Microwave Radar for solids applications

Typical Applications
- Refineries
- Mining
- Power generation
- Cement
- Pulp & Paper
- Grain storage (greater than 30ft)
Microwave Radar for solids applications

Typical Applications
- Refineries
- Mining
- Power generation
- Cement
- Pulp & Paper
- Grain storage (greater than 30ft)
- Bulk storage (greater than 30ft)
Microwave Radar for solids applications

Typical Applications
- Refineries
- Mining
- Power generation
- Cement
- Pulp & Paper
- Grain storage (greater than 30ft)
- Bulk storage (greater than 30ft)
- Plastic pellets (greater than 30ft)
SIEMENS Process Sensors
Level Measurement Products

Microwave Radar for Liquids Applications
SIEMENS Process Sensors
Level Measurement Products
SITRANS LR250
SITRANS LR250

The newest innovation in liquids level measurement

- 2-wire, 25 GHz pulse radar
- Liquids level measurement to 66ft (20m)
- Ideal for small vessels and low dielectric media
- Process temperatures from -40 to 302°F (-40 to 150°C)
- Up to 580 psi (40 bar)
SITRANS LR250

Key Features

- LUI (Local User Interface) displays echo profiles for diagnostic support
- Level, space, distance, or volume measurement
- Easy to install, small horn sizes
- Flanged or threaded options
- Short blanking distance – 2” (50mm) from the end of the horn
SITRANS LR250

Key Features
- Quick Start Wizard for set-up
- Infrared handheld programmer for local operation
- SIMATIC PDM compatible for configuration and diagnostics

Options
- Profibus PA communications
Key Features

- **Volume Conversion**
  - Select the vessel shape
  - Enter the vessel volume
  - Any volumetric unit can be chosen
  - Defaults to 100 (%)
Key Features

- **Auto False Echo Suppression**
  - An undesired echo can be ignored by lifting the TVT curve at the position of the false echo.
  - This can be done manually or by performing Auto False Echo Suppression.

![Graph showing SITRANS LR250 features](image)
Key Features

- CLEF algorithm for low dielectric materials
- Level is selected based on the steepness of the CLEF line
Microwave Radar for liquids applications

Typical Applications

- Petrochemical refineries
Microwave Radar for liquids applications

Typical Applications
- Petrochemical refineries
- Oil & Gas storage
Microwave Radar for liquids applications

Typical Applications
- Petrochemical refineries
- Oil & Gas storage
- Chemical storage
Microwave Radar for liquids applications

Typical Applications

- Petrochemical refineries
- Oil & Gas storage
- Chemical storage
- Pulp & Paper
Microwave Radar for liquids applications

Typical Applications

- Petrochemical refineries
- Oil & Gas storage
- Chemical storage
- Pulp & Paper
- Water & Waste Water
Microwave Radar for liquids applications

Typical Applications
- Petrochemical refineries
- Oil & Gas storage
- Chemical storage
- Pulp & Paper
- Water & Waste Water
- Food & Beverage
Microwave Radar for liquids applications

Typical Applications

- Petrochemical refineries
- Oil & Gas storage
- Chemical storage
- Pulp & Paper
- Water & Waste Water
- Food & Beverage
- Brewing
Measurement and Program Modes

- Instrument powers up in Measurement Mode (Run Mode)
Measurement and Program Modes

- Instrument powers up in Measurement Mode (Run Mode)
- Press Mode to toggle between measurement and program modes
Local User Interface (LUI)
1. Toggle indicator for linear units or %
2. Selected operation: level, space, or distance
3. Measured value
4. Units of measure
5. Bar graph indicates level
Local User Interface (LUI)

6. Text area displays status message

7. Secondary region indicates on request electronics temperature, echo confidence, loop current, or distance

8. Device status indicator
Hand programmer functions

- Down arrow
  - Scroll to next menu or parameter
- Up arrow
  - Scroll to previous menu of parameter
Hand programmer functions

- **Right arrow**
  - To enter a parameter to view a current value
  - Press a second time to open Edit mode
  - After changing value press the right arrow a third time to accept the new value
Hand programmer functions

- Right arrow
  - To enter a parameter to view a current value
  - Press a second time to open Edit mode
  - After changing value press the right arrow a third time to accept the new value

- Left arrow
  - Open parent menu or back
Hand programmer functions

- Home Key
  - Press Home to return to the top level menu, MENU 1
Hand programmer functions

- **Home Key**
  - Press Home to return to the top level menu, MENU 1
- Press Mode to toggle back to the measurement mode
Master Reset

- Press Mode to select program mode
Master Reset

- Press Mode to select program mode
- Press Down Arrow until SERVICE is selected
SITRANS LR250

Master Reset

- Press Mode to select program mode
- Press Down Arrow until SERVICE is selected
- Press Right Arrow to enter Service Menu: DEVICE RESET should be selected
  - If not use the Up Arrow or Down Arrow to select it
**Master Reset**

- Press Mode to select program mode
- Press Down Arrow until SERVICE is selected
- Press Right Arrow to enter Service Menu: DEVICE RESET should be selected
  - If not use the Up Arrow or Down Arrow to select it
- Press Right Arrow again to view IDLE or DONE
Master Reset

- Press Right Arrow and select FACTORY DEFAULT
Master Reset

- Press Right Arrow and select FACTORY DEFAULT
- Press Right Arrow to perform reset to factory values
  - After a short time you will view IDLE or DONE in the display
**Master Reset**

- Press Right Arrow and select FACTORY DEFAULT
- Press Right Arrow to perform reset to factory values
  - After a short time you will view IDLE or DONE in the display
- Press Home to return to the top level menu, MENU 1
Master Reset

- Press Down Arrow and select FACTORY DEFAULT
- Press Right Arrow to perform reset to factory values
  - After a short time you will view IDLE or DONE in the display
- Press Home to return to the top level menu, MENU 1
- Press Mode to return to the measurement mode
Quick Start Menu

- Press Mode to select program mode
Quick Start Menu

- Press Mode to select program mode
- Enter the QUICK START Menu
Quick Start Menu

- The material is a low dielectric liquid
- Use a fast speed of response for classroom settings
- Measure in feet
- Measure level
- The Low Calibration Point is 20 feet from the process connection
- The High Calibration Point is 1 foot from the process connection
View a signal profile

- Navigate to the DIAGNOSTICS menu
- Enter ECHO PROFILE
Perform an Auto False Echo Suppression

- Navigate to the SETUP menu
- Enter DEVICE
- Enter INPUT
- Enter TVT SETUP
- Enter AUTO SUPP RANGE to enter and save the suppression range
- Enter AUTO ECHO SUPP
- Select and enter LEARN
Microwave Radar Products

Review

- Solids Level Radar
  - SITRANS LR260
    - Features & Benefits
    - Typical Applications
  - SITRANS LR460
    - Features & Benefits
    - Typical Applications
Microwave Radar Products

Review

- Solids Level Radar
  - SITRANS LR260
    - Features & Benefits
    - Typical Applications
  - SITRANS LR460
    - Features & Benefits
    - Typical Applications

- Liquids Level Radar
  - SITRANS LR250
    - Features & Benefits
    - Typical Applications
    - Quick Start Wizard
    - Viewed an echo profile
SIEMENS Process Sensors
Level & Weighing Technologies

Belt Scale Basic Theory
Belt Scale Theory

There are four essential components to any conveyor belt scale.

- Weigh Bridge
Belt Scale Theory

There are four essential components to any conveyor belt scale.

- Weigh Bridge
- Speed Sensor
Belt Scale Theory

There are four essential components to any conveyor belt scale.

- Weigh Bridge
- Speed Sensor
- Integrator
Belt Scale Theory

There are four essential components to any conveyor belt scale.

- Weigh Bridge
- Speed Sensor
- Integrator
- Conveyor
Belt Scale Theory

Integrator operation
- The design of all belt scales is based on the formula
  \[ \text{LOAD} \times \text{SPEED} = \text{RATE} \]
- Load units are in lbs / ft
- Speed units are in ft / minute

\[ \text{Pounds} \times \frac{\text{Feet}}{\text{Minute}} = \frac{\text{Pounds}}{\text{Foot}} \times \frac{\text{Minute}}{\text{Minute}} \]
Belt Scale Theory

Integrator operation
- The design of all belt scales is based on the formula

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\text{LOAD} \times \text{SPEED} = \text{RATE}
\]

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- Speed units are in ft / minute

\[
\text{Pounds} \times \frac{\text{Feet}}{\text{Minute}} = \text{Pounds} \frac{\text{Foot}}{\text{Minute}}
\]
Belt Scale Theory

Weigh bridge operation

- Strain gauge theory
  - A thin wire is coiled so that as the metal it is attached to is stretched the wire is made longer and thinner
  - The electrical resistance of the wire is related to the cross-sectional area of the wire
  - The change in resistance is proportional to the amount the load cell metal is flexed
Belt Scale Theory

Weigh bridge operation

- Load cell theory
  - Load cells are steel frames with strain gauges mounted at points where the load cell is designed to flex
  - The parallelogram load cell is designed for parallel sides to stay parallel and only vertical forces are measured
Belt Scale Theory

Shaft Mounted Speed Sensors

Speed sensor operation

- Shaft mounted speed sensor
  - A slotted disk rotates through an optical encoder
  - The slotted disk breaks the encoder light beam to produce an output pulse proportional to the speed of the shaft rotation
Belt Scale Theory

Trailing Arm Speed Sensors

Speed sensor operation

- Trailing arm speed sensor
  - A gear rotates near a proximity switch
  - As the teeth of the gear pass the proximity switch a pulse is generated
  - The output pulse is proportional to the speed of the belt
Belt Scale Theory

Integrator operation

- Receives material load information from the weigh bridge
- Receives belt speed information from the belt speed sensor
- Provides HMI information
  - Rate
  - Load
  - Speed
  - Total
SIEMENS Process Sensors
Level & Weighing Technologies
Belt Scale Products
Siemens MBS Weigh Bridge

- Unique modular design allows easy installation
- Easily retrofits to existing equipment
- Low cost
- Accuracy: 1% over 3:1 turndown
- Capacity up to 1600 TPH
- Belt speed up to 600 ft/min
Belt Scale Products

Siemens MUS Weigh Bridge

- Easy installation
- Easily retrofits to existing equipment
- Accommodates conveyor widths up to 48”
- Rugged nickel plated steel loadcells
- Accuracy: 0.5 to 1% over 4:1 turndown
- Capacity up to 5000 lbs/hr
- Belt speed up to 600 ft/min
Belt Scale Products

Siemens MSI Weigh Bridge

- Parallelogram loadcells allow high accuracy without the need for pivots or check rods
- Unique design allows easy installation
- Easily retrofits to existing equipment
- Stainless steel loadcells for maximum reliability
- Accuracy: 0.5% over 5:1 turndown
Belt Scale Products

Siemens MMI Weigh Bridge

- Unique cascading design allows increased accuracy by simply adding weigh bridges
- Stainless steel loadcells for maximum reliability
- Parallelogram loadcells allow high accuracy without the need for pivots or check rods
- NTEP approved
- Accuracy: 0.25% over 5:1 turndown
### Siemens MWL Test Weight Lifter

- Easy application of belt scale reference weights
- Easy to store drive handle that can be applied to left or right side
- Safely applies calibration weights from outside the conveyor
- Can be used with new and existing applications
- Modular construction, easily adaptable to different conveyor widths

**Belt Scale Products**

**Siemens MWL Test Weight Lifter**

**Easy application of belt scale reference weights**

**Easy to store drive handle that can be applied to left or right side**

**Safely applies calibration weights from outside the conveyor**

**Can be used with new and existing applications**

**Modular construction, easily adaptable to different conveyor widths**
Belt Scale Products

Siemens BW100 Integrator

- Basic integrator
- Multi field back lit display
- Analog output programmable for Rate, Load, or Speed
- 2 totalizer outputs for external totalizers
- Printer output
- 1 programmable relay
- Auto zero
Belt Scale Products

Siemens BW500 Integrator

- Full featured integrator
- Menu driven programming
- Analog and Totalizer outputs
- 2 built in PID control loops
- Built in batch controller
- 5 programmable relays
- Differential speed detection
- Buss communications
- Auto zero
- NTEP approved
Siemens Speed Sensors

- Siemens offers a full line of speed sensors to accommodate all customers needs
- Trailing arm speed sensors
  - Easy installation
  - IP65 rating
- Shaft mounted speed sensors
  - Hazardous area approvals available
  - High accuracy
Belt Scales

Typical Applications

- Inventory control in aggregate plants
- Feed rate control in cement plants
- Production control applications
  - Mining & Minerals
  - Pulp & Paper
- Blending applications
  - Water treatment – lime and sludge
  - Foundry – sand
  - Aluminum – raw materials
SIEMENS Process Sensors
Level & Weighing Technologies

Solids Flow Meter Products
Impact flow meters measure a continuous stream of dry granular solids.

- The material stream impacts a sensing plate.
- The weighing mechanism reacts only to the horizontal component of the impact force.
- The impact force is converted to an electrical signal and transmitted to the integrator.
- The integrator processes the signal and provides outputs.
Solids Flow Meter Products, Sensing Elements

Siemens E Series Impact Flow Meter

- Continuous in-line weighing
- Models available for maximum flow rates ranging from .5 to 300 TPH.
- Accuracy 1% over 3:1 turn down
- Dust tight installation
- Low Maintenance
Solids Flow Meter Products, Sensing Elements

Siemens V Series Impact Flow Meter

- Continuous in-line weighing
- Accuracy 1% over 3:1 turn down
- Models available for maximum flow rates ranging from .5 to 300 TPH.
- Dust tight installation
- Low Maintenance
- Minimal head room requirement
Solids Flow Meter Products, Sensing Elements

Siemens A Series Impact Flow Meter

- Continuous in-line weighing
- Accuracy 1% over 3:1 turn down
- Models available for flow rates ranging from .5 to 300 TPH.
- Dust tight installation
- Low Maintenance
- Designed to bolt directly to the discharge of an air slide
- Air separation baffles prevent errors caused by air movement
Solids Flow Meter Products, Integrator

Siemens SF500 Full Featured Impact Flow Meter Integrator

- Menu driven programming
- Analog and Totalizer outputs
- 2 built in PID control loops
- Built in batch controller
- 5 programmable relays
- Buss communications
- Linearizer
- Multi Span
Solids Flow Meters

Typical Applications

- Cement and flyash blending in a concrete plant
- Truck loadout in a grain process facility
- Feed rate control in a plastics plant
- Raw mill feed rate control in a cement plant
- Raw material blending in a metal processing plant
- Gypsum feed rate control in a board plant
SIEMENS Process Sensors
Level Measurement Products

Weigh Feeder Products
**Weigh Feeder Theory of Operation**

Weigh Feeders are feeders that control the rate based on weight:

- The speed sensor provides the belt speed to the integrator.
- The load on the belt is given to the integrator by the load cells.
- The integrator calculates a rate based on this information and compares it to the set point.
- The integrator provides a control signal to a motor speed control.
- The motor speed control increases or decreases the belt speed as required.
Siemens 400 Series Weigh Feeder

- Controls the rate of material movement
- 1000 to 20,000 lbs/hr
- Gravity take up
- Cantilevered design allow belt removal without removing structural steel
- Epoxy painted or stainless steel
- Slider frame for improved cleaning and less maintenance
- Fully enclosed or open
Siemens 600 Series Weigh Feeder

- Controls the rate of material movement
- 1000 to 80,000 lbs/hr
- Cantilevered design allow belt removal without removing structural steel
- Epoxy painted steel or stainless steel
- Fully enclosed or open
- Slider frame for improved cleaning and less maintenance
400 and 600 Series Weigh Feeders

Typical Applications

- Extruders in
  - Cereal
  - Snack Food
  - Pet Food
- Fruit and Nut Processing and Packaging
- Pebble Lime Feed for Slacker
- Dry Chemical Blending
- Fertilizer Blending
Weigh Feeder Products

Siemens 800 Series Weigh Feeder
- Controls the rate of material movement
- 5 to 80 TPH
- Cantilevered design allow belt removal without removing structural steel
- Epoxy painted mild steel
- Fully enclosed or open
- Optional clean-out devices
- Built with CEMA standard parts
Weigh Feeder Products

Siemens 1200 Series Weigh Feeder
- Controls the rate of material movement
- 10 to 300 TPH
- Cantilevered design allow belt removal without removing structural steel
- Epoxy painted mild steel
- Fully enclosed or open
- Optional clean-out devices
- Built with CEMA standard parts
800 and 1200 Series Weigh Feeders

Typical Applications
- Cement Processing
- Iron and Steel Smelting
- Coal Blending
- Mineral Processing
- Grain and Seed Processing
- Pulp and Paper Processing
Motion Sensing, Theory of Operation

Used to detect over or under speed of conveyors, rotary feeders, or bucket elevators.

Siemens motion probes utilize the principle of Faraday’s Laws of Electromagnetic Induction:

When a ferromagnetic object crosses a magnetic field, the lines of flux distort, generating a change in current.

This change in current is used to create a pulse.
Motion Sensing Products

Siemens MFA 4p Motion Failure Alarm

- Senses a ferrous target as it moves past the motion sensing probe
- 5 motion sensing probes available to meet the customers needs
- Selectable for over speed or under speed
- Range from 2 to 3000 pulses per minute
- Sensing gap up to 4”
Motion Sensing Products

Siemens Motion Sensing Probes for the Motion Failure Alarm

- MSP-1, Mini Probe
  - 1” diameter
- MSP-3, High Temp, Aluminum
  - -40° to 500° F
- MSP-9, Stainless Steel, High Temp
  - -40° to 500° F
- MSP-12, Standard Probe
- XPP5, Hazardous Area
  - CSA Rated for Class 1 Div 1 areas
Motion Sensing Products

Siemens Millpulse 600 Motion Sensor

- Switches current draw each time a ferrous object passes
- Ideally suited for PLC input
- Rugged fully potted aluminum body
- Two wire operation
- Up to a 4” sensing gap
Motion Sensing Products

Siemens ZSS, Zero Speed Switch

- Provides a relay output if a target does not pass the sensor for a set time.
- Jumper selectable for 5 or 6 second delay
- Up to a 1.5” sensing gap
- Rugged, fully potted phenolic body
- Alarm selectable for 5 seconds (12 ppm) or 10 seconds (6 ppm)
Motion Sensing

Typical Applications

- Detection of an increase or decrease in speed on:
  - Conveyor belts
  - Bucket elevators
  - Drag conveyors
  - Rotary feeder
  - Motor shafts
  - Screw conveyor flights
  - Driven pulleys
  - Fans
SIEMENS Process Sensors
Level & Weighing Technologies

Acoustic Sensing
Acoustic Sensing Theory of Operation

When metal is stressed there is an acoustic emission on the surface of the metal.

This acoustic emission is in the 75K to 175K Hz range, well above the audible range.

Because it is such a high frequency its propagation range is very short.

The Siemens AS 100 senses this frequency range and provide a signal proportion to that signal.
Acoustic Sensing Products

Siemens AS100, Acoustic Sensor
- Monitors stress in metal to indicate material flow or potential bearing failure
- Completely non invasive
- Screws on, weld on, or bond on
- Two sensitivity levels

Siemens CU02, Control Unit
- 4 to 20 ma output
- Two programmable relays
Acoustic Sensing

Typical Applications

- Torn bag detection on bag house dust collectors
- Plugged chute or plugged pipe detection
- Route verification of pneumatically conveyed powered materials
- Early indication of bearing failure
Frequency Hopping technology

- According to a number of reports, Austrian-born silver-screen actress Hedy Lamarr is given credit for the development of Frequency Hopping Spread Spectrum Technology.

- Before fleeing Occupied Austria and leaving her then husband, Fritz Mandl, who was an arms dealer to Germany, Lamarr came up with an idea for a radio controlled torpedo.
Frequency Hopping technology

- The original idea was found to be easily jammed and while working with composer George Antheil in London, they decided that if they could change the radio frequency randomly, the system would work.

- The two received a patent (Patent No. 2,292,387) for the “Secret Communications System” in August of 1942.
Wireless Technology

Why Use wireless technology

- Equipment in a remote location.
- Infrastructure does not allow for easy installation of cabling.
- Labor savings.
- Quicker installation.
- Reduction in installation costs.
- Extend the reach of your PLC or DCS system.
- Eliminate phone line charges.
Frequency Hopping technology

- The basic operation of the WiPS radios use Frequency Hopping Spread Spectrum (FHSS) technology.
- FHSS is regulated by the FCC in 47CFR15.247
- License Free Operation
- Max 1-watt of transmission power
- No more than 6-db antenna gain.
- 902 – 928 MHz Frequency
The Siemens WiPS Radio transmits the data packets in a pseudo random fashion across the 902 to 928 MHz band.

The Siemens WiPS Receiver is programmed with the “HOP PATTERN” of the transmitter so that it knows when and where to look for the transmitted signal.
Interference may knock an update down.

The next transmission is sent 37 mS later on the next frequency.
Wireless Technology

Frequency Hopping technology

- Since the Frequency Hopping pattern is pseudo random, the receiver has to be programmed with the hopping pattern of the transmitter.
- The HOP-KEY is used to program the receiver with the hopping pattern of the transmitter.
- The HOP-KEY is loaded in memory of the receiver.
Frequency Hopping technology

- Received Signal Strength (RSSI)
- All WiPS radios are equipped with the ability to measure the RSSI from the transmitter.
- Simply use a volt meter to measure the voltage from the RSSI port to power ground.
- A signal strength of 2.2 volts or greater is ideal.
- Voltages less than 1.5 volts and the signal is lost.
Wireless Technology

**WiPS-101**

- One-Way communication.
- Both the Transmitter and Receiver are DIN Rail mounted.
- Both the Transmitter and Receiver are 24 VDC powered.
- Can transmit:
  - 1 – 4-20mA
    - Output can be configured for a 2-wire or 4-wire device.
  - 2 – Digital contacts.
Wireless Technology

WiPS-102

- One-Way communication.
- The Transmitter is mounted via the ½” NPT conduit fitting.
- The Transmitter is 120 Vac powered.
- The Receiver is 24 VDC powered.
- Can transmit
  - 1 – 4-20mA
    - Output can be configured for a 2-wire or 4-wire device.
  - 2 – Digital contacts.
Wireless Technology

WiPS-103

- One-Way communication.
- The Transmitter is mounted via the ½” NPT conduit fitting.
- The Transmitter is 24 VDC powered.
- The Receiver is 24 VDC powered.
- Can transmit
  - 1 – 4-20mA
    - Output can be configured for a 2-wire or 4-wire device.
  - 2 – Digital contacts.
Wireless Technology

WiPS-200

- Two-Way communication.
- Multi-Point to Point communications.
- They can transmit and/or receive
  - Up to 34 Analog Signals
  - Up to 64 Digital Signals
  - Up to 12 Frequency Counter Signals.
- Can mix and match the expansion modules as needed for the application.
Wireless Technology

WiPS-200 – Radios
- Handle all the communications
- Is DIN Rail mounted
- The radio is 24 VDC powered.
- Has I/O on-board
  - 1 – Analog Input
  - 1 – Analog Output
  - 2 – Digital Inputs
  - 2 – Digital Outputs
- The Master Radio can support up to 8 Expansion modules.
Wireless Technology

WiPS-200 – Expansion Modules

- 4-Channel – Analog Input
- 4-Channel – Analog Output
- 8-Channel – Digital Input
- 8-Channel – Digital Output
- 2-Channel – Freq Counter Input
- 2-Channel – Freq Counter Output
- Combination Module
  - 1 – Analog Input
  - 1 – Analog Output
  - 2 – Digital Inputs
  - 2 – Digital Outputs
Wireless Technology

WiPS – DR300 & DR301 Radios

- Serial Data Radios
  - MODBUS RTU
  - Allen Bradley DF1
  - ASCII
  - RS232, 422 or 485

- Are programmed by the customer.

- Can be programmed as:
  - Master
  - Remote Transceiver
  - Repeater
Wireless Technology

WiPS – DR300 & DR301 Radios

- Can have up to 254 Remote Transceivers to 1 Master.
- Dependent on the amount of addresses available.
- No need for expansion modules on the Master.
- The Master Radio can operate at RS232 and the Remote Transceivers can operate at RS485 without the need for external converters.
Wireless Technology

WiPS – DR300 Radio

- Is DIN Rail mounted
- The radio is 24 VDC powered.
- Programmed by the customer.
- Typically used as Remote Transceivers
- Can support up to 8 expansion modules.
  - Any combination of input/output Analog/Digital/Frequency Counter as required by the application.
Wireless Technology

**WiPS – DR301 Radio**

- Is DIN Rail mounted
- The radio is 24 VDC powered.
- Programmed by the customer.
- Typically used as:
  - The Master Radio
  - As a Repeater.
  - Direct connection to field or other device that have MODBUS RTU communications available.
- Will not support expansion modules.
Wireless Technology

Antennas

- Siemens offers a full line of Omni and Yagi antennas, cables, surge arresters and cables.
- Omni Antennas are usually used at the Master Radio
- Yagi antennas are typically used for the Remote Transceivers.
  - Omni antennas broadcast in a 360° pattern.
  - Yagi antennas broadcast directionally.
Wireless Technology

Antennas

- FCC regulates the max gain of any transmitting antenna for license free transmissions to 6dB.
- Height must increase with range
  - 22 feet for 1 mile
  - 51 feet for 5 miles
  - 88 feet for 15 miles
- Proximity to other antennas
  - Generally 6 feet vertically or 10 feet horizontally
- STAY OUT OF THE RADIATION PATH OF ANY ANTENNA!!!