

Logging While Drilling

LWD 1

Positive Pulse

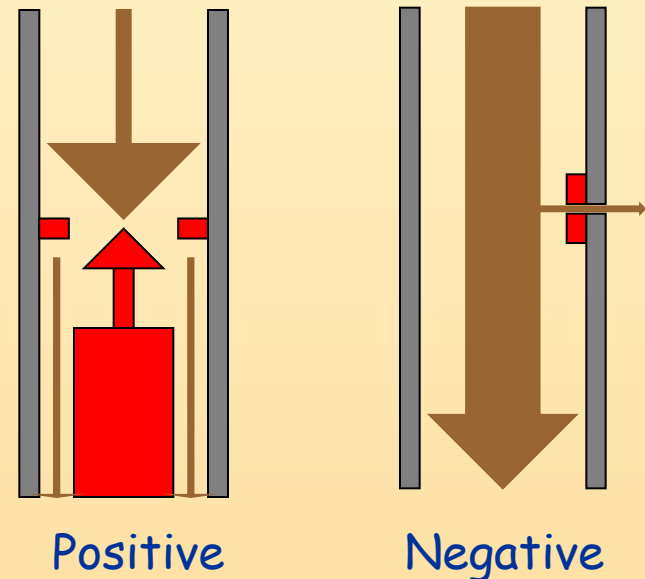
LWD System Overview Objectives

At the completion of this presentation you should be able to:

- 1. List the five component parts of an LWD system.**
- 2. Name the current surface computer and list one advantage over a previous surface computer.**
- 3. Describe the functions of a bus master.**
- 4. Name the two current directional probes.**
- 5. Identify the primary measurement of each sensor.**
- 7. Describe the difference between the negative and positive pulser valves.**

LWD System Overview

- How do we categorize our systems?
 - Type of pulser?
 - Positive pulse
 - Negative pulse

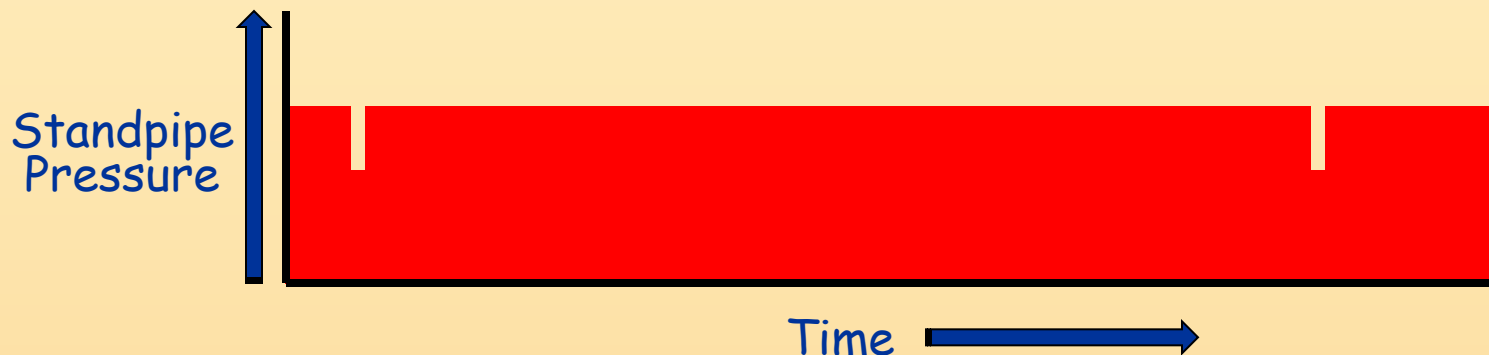


LWD System Overview

- **How do we categorize our systems?**
 - **Data encoding scheme?**
 - **Pulse Position Modulation**
 - **Manchester**

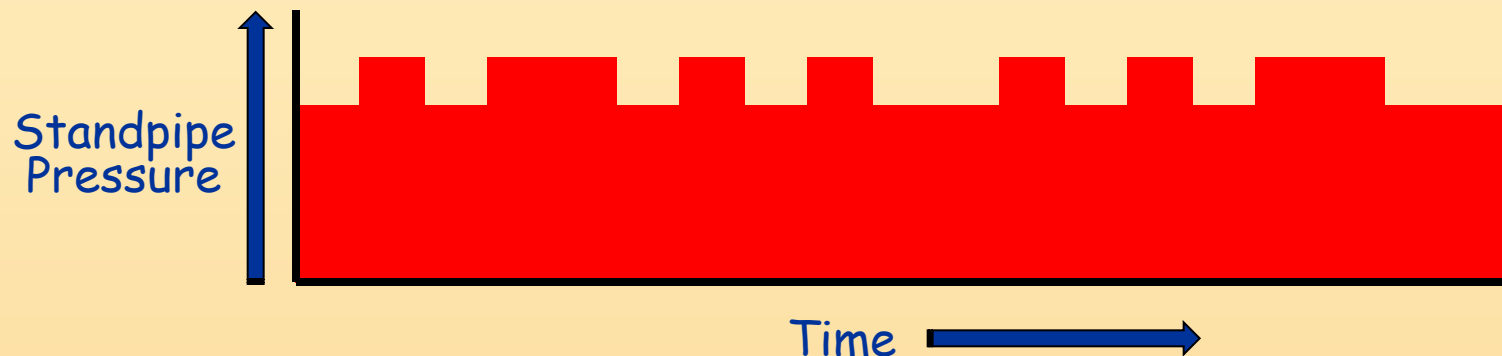
LWD System Overview

- How do we categorize our systems?
 - Pulse Position Modulation
 - Irregular time between pulses
 - Intermittent pulses



LWD System Overview

- How do we categorize our systems?
 - Manchester
 - Regular time between pulses
 - Continuous pulses

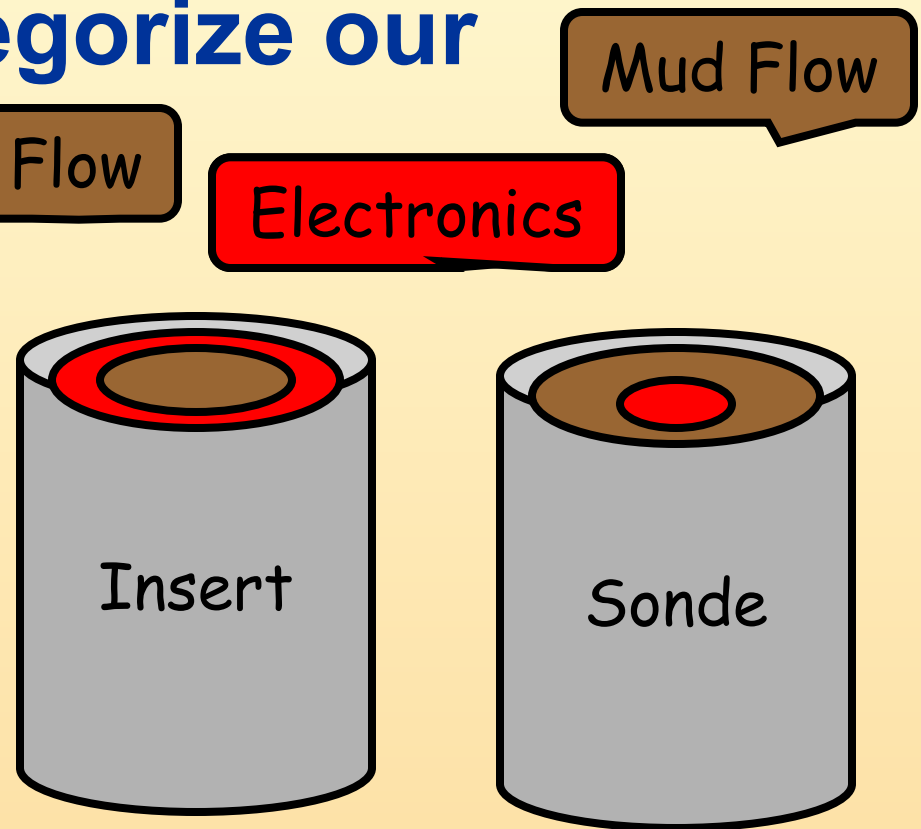


LWD System Overview

- How do we categorize our systems?

- Design of tools?

- Sonde based
 - Insert based



The LWD System

- **The five components of an LWD System:**
 - **Surface Computer**
 - **Downhole Computer - Bus Master**
 - **Directional Sensors**
 - **Formation Evaluation Sensors**
 - **Pulser**

Surface Computer

- **INSITE**
 - Continuing development
 - Windows NT soon Windows 2000
 - Supports MWD, LWD, SDL and more
 - Support for other Product Service Lines

Surface Computer

- **ISC**
 - **Development finished**
 - **DOS based**
 - **Supports MWD, LWD**
 - **Negative Pulse PPM and Positive Pulse Manchester**

Surface Computer

- **ADAC and Data Handler**
 - Development finished
 - DOS based
 - Supports LWD
 - Negative Pulse PPM

Surface Computer

- **MSC**
 - Development finished
 - Unix based
 - Supports Directional Only and Gamma
 - Positive Pulse Manchester

Surface Computer

- **PCDWD**
 - **DOS based**
 - **Supports Directional Only and Gamma**
 - **Positive Pulse Manchester**

Surface Computer

- **MPSR**
 - Development finished
 - Introduced in Mid 80's
 - Supports Directional Only
 - Positive Pulse Manchester

Downhole Computer Bus Master

- **What is a Bus Master?**
 - Controls other sensors
 - Stores data
 - Prepares data for transmission

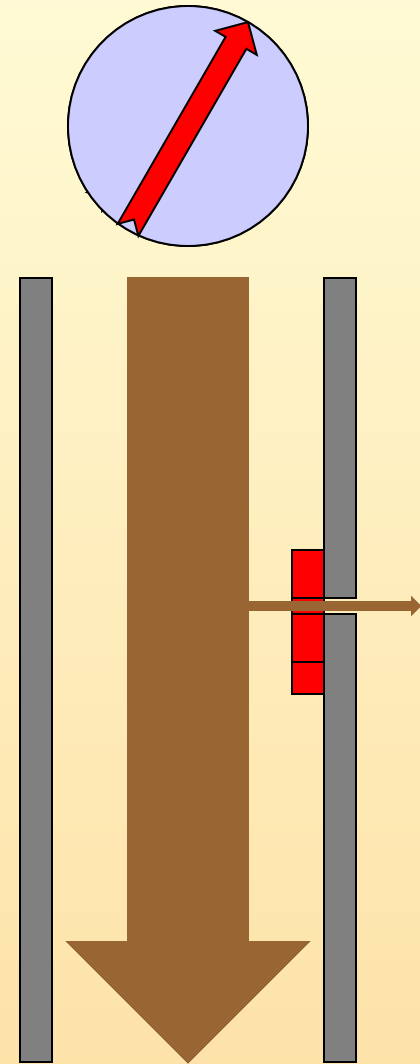
Downhole Computer Bus Master

- **Six current tools can act as a Bus Master**
 - **CIM Central Interface Module**
 - **HCIM H is the type of processor**
 - **TM Telemetry Module**
 - **PCD Pressure Case Directional**
 - **PCG Pressure Case Gamma**
 - **SP4 Slim Phase 4**

Pulsers

Negative Pulse

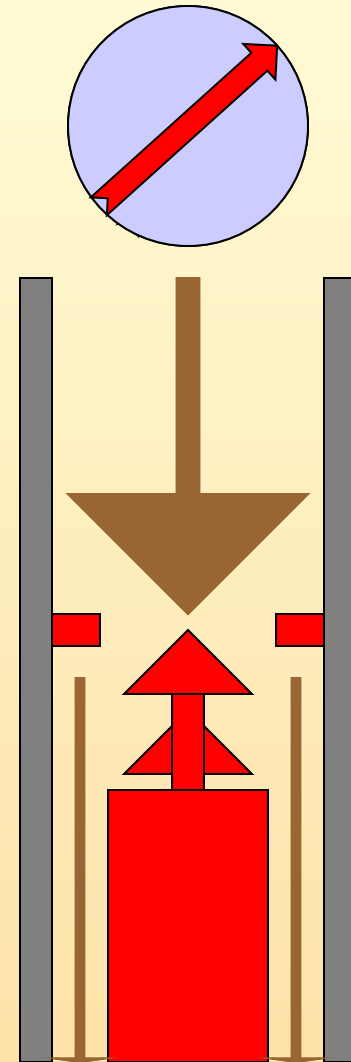
- Vents mud to the annulus
- Decreases internal drillpipe pressure
- Same pulser valve in 6 ³/₄", 8", 9 ¹/₂" collars
- Different insert for 9 ¹/₂" pulser



Pulsers

Positive Pulse

- Causes a restriction to mud flow
- Increases internal drillpipe pressure
- Same pulser in 3 1/2" to 10" collars
- Flow gear in 4 flow rate ranges



Directional Sensors

- **Six directional sensors**
 - **Sonde based**
 - **Two current sensors**
 - **Positive Pulse**
 - **PCD Pressure Case Directional**
 - **Positive and Negative Pulse**
 - **DM Directional Module**

Directional Sensors

- **Five directional sensors**
 - **Sonde Based**
 - **Three no longer built, but still used**
 - **Positive Pulse**
 - **DEP Directional Electronic Probe**
 - **DEP II Directional Electronic Probe II**
 - **Negative Pulse**
 - **PM Position Monitor**

Formation Evaluation Sensors

- **Sonde Based**

- **Gamma**

- **GM** **Gamma Module**
 - **PCG** **Pressure Case Gamma**

Formation Evaluation Sensors

- **Insert Based**
 - **Gamma**
 - **DGR Dual Gamma Ray**

Formation Evaluation Sensors

- **Insert Based**
 - **Resistivity**
 - **Electromagnetic Wave Resistivity**
 - EWR-S Shielded
 - EWR-P4 Phase 4
 - EWR-P4D Phase 4 Deep
 - SP4 Slim Phase 4

Formation Evaluation Sensors

- **Insert Based**

- **Other sensors**

- **Porosity**

- **BAT – Bi-modal AcousTic**

- **CNØ – Compensated Neutron Porosity**

- **CTN – Compensated Thermal Neutron
Porosity**

- **MRIL-WD– Magnetic Resonance Imaging
Logging While Drilling**

Formation Evaluation Sensors

- **Insert Based**
 - **Other sensors**
 - **Density**
 - SLD – Stabilized LithoDensity
 - ALD – Azimuthal LithoDensity
 - **Caliper**
 - ACAL – AcoustiCaliper
 - **Formation Pressure**
 - GeoTap LWD Formation Tester

Formation Evaluation Sensors

- **Insert Based**
 - **Other sensors**
 - **Drilling Efficiency**
 - WOB/TOB – Weight on Bit/Torque on Bit
 - PWD – Pressure-While-Drilling
 - DDS – Drillstring Dynamics Sensor
(Vibration)

Acronyms

3-1/8 in. EWR-Phase 4 – Electromagnetic Wave Resistivity Phase 4
ABI – At Bit Inclination
ACAL – AcoustiCaliper
ALD – Azimuthal LithoDensity
BAT – Bi-modal AcousTic
CNØ – Compensated Neutron Porosity
CTN – Compensated Thermal Neutron Porosity
DC – Driver Controller
DDS – Drillstring Dynamics Sensor
DEP II – Directional Electronic Probe II
DEP – Directional Electronic Probe
DGR – Dual Gamma Ray
DM – Directional Module
EWR-Phase 4 – Electromagnetic Wave Resistivity Phase 4
EWR-Phase 4D – Electromagnetic Wave Resistivity Phase 4 Deep
EWR-S – Electromagnetic Wave Resistivity Shielded

Acronyms

GM – Gamma Module
Man – Manchester encoding
MEP – Mud-pulse Electronic Probe
MRIL-WD – Magnetic Resonance Imaging Logging While Drilling
PCD-R – Pressure Case Directional Ruggedized
PCG-R – Pressure Case Gamma Ruggedized
PM – Position Monitor
PPM – Pulse Position Modulation encoding
PWD – Pressure-While-Drilling
SBM – Smart Battery Module
Scout Sonic
SDC – Smart Driver Controller
SLD – Stabilized Litho Density
SPC NGP – Sensor Pressure Case Natural Gamma Probe
TM – Telemetry Module
WOB/TOB – Weight on Bit/Torque on Bit