Logging While Drilling

LWD 1
Positive Pulse

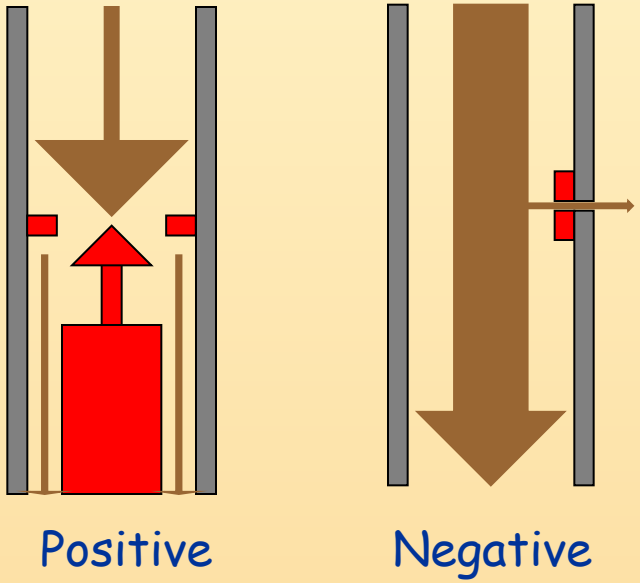
LWD System Overview Objectives

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

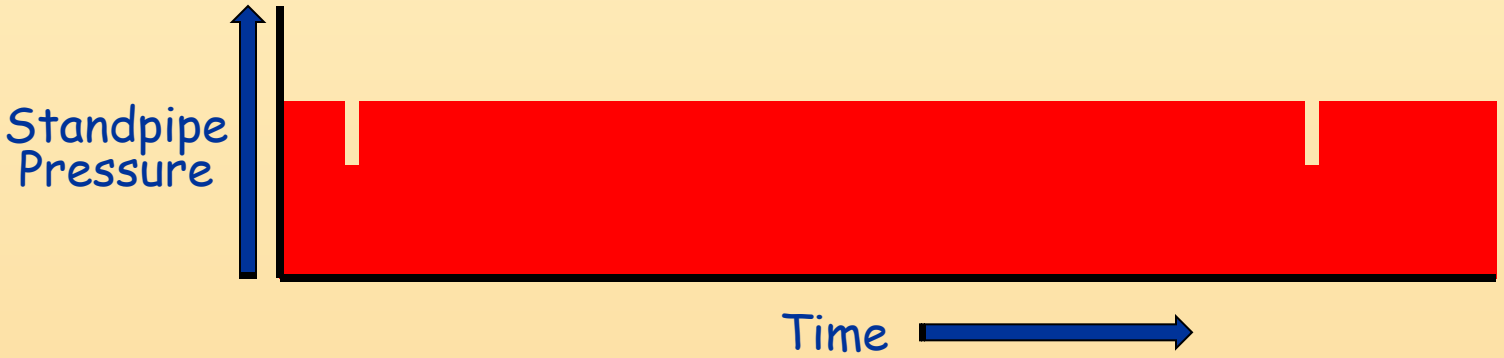


LWD System Overview

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

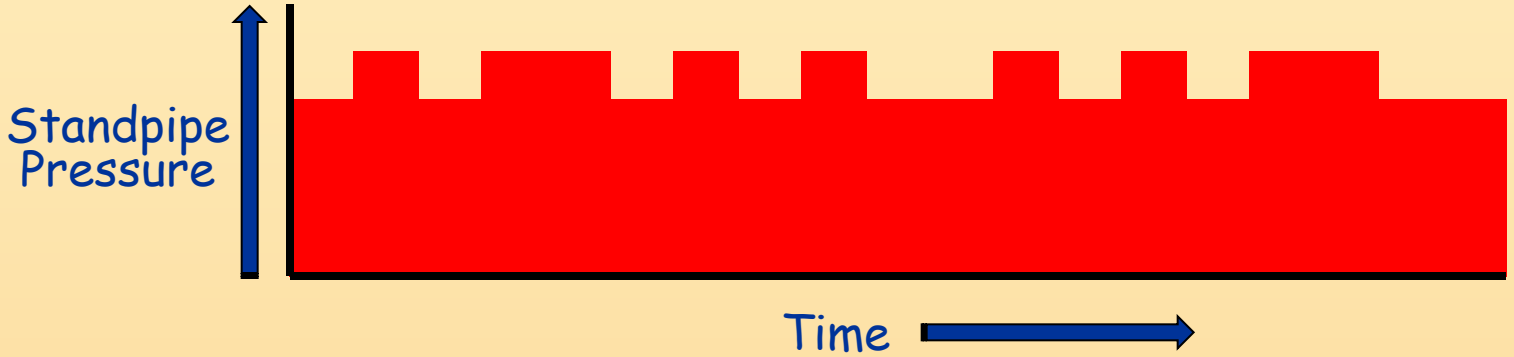
LWD System Overview

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



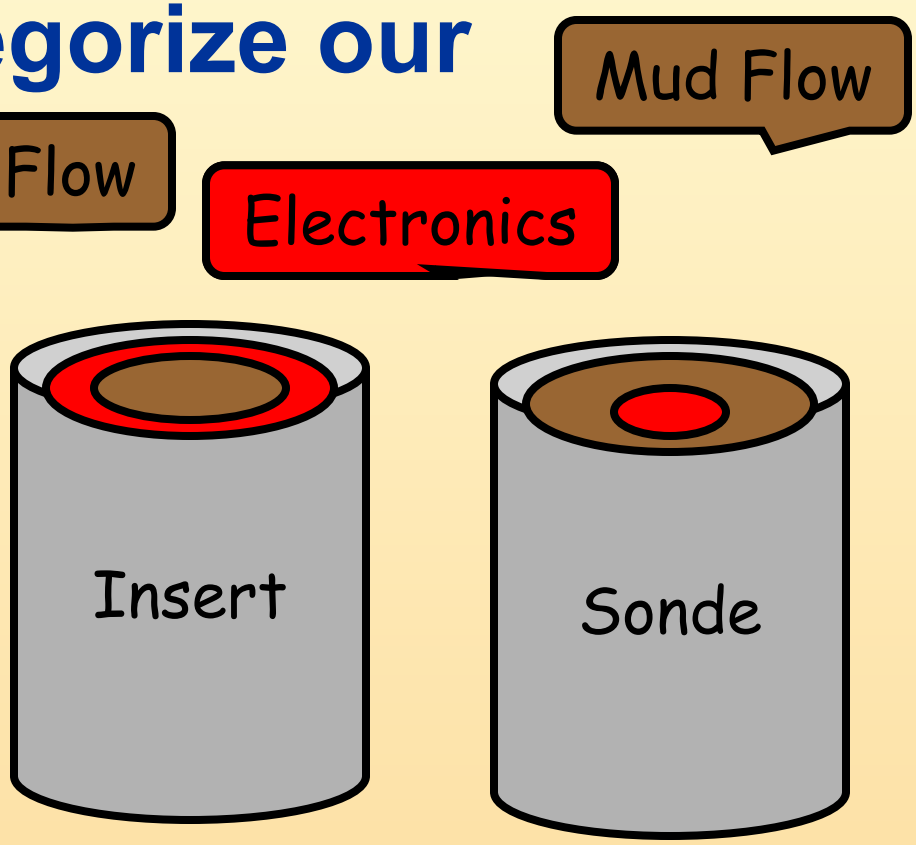
LWD System Overview

- 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

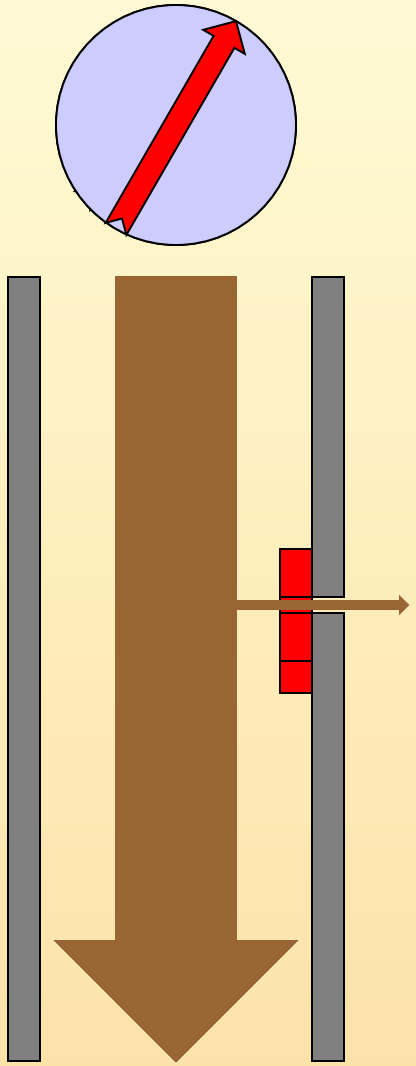
Downhole Computer Bus Master

- 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

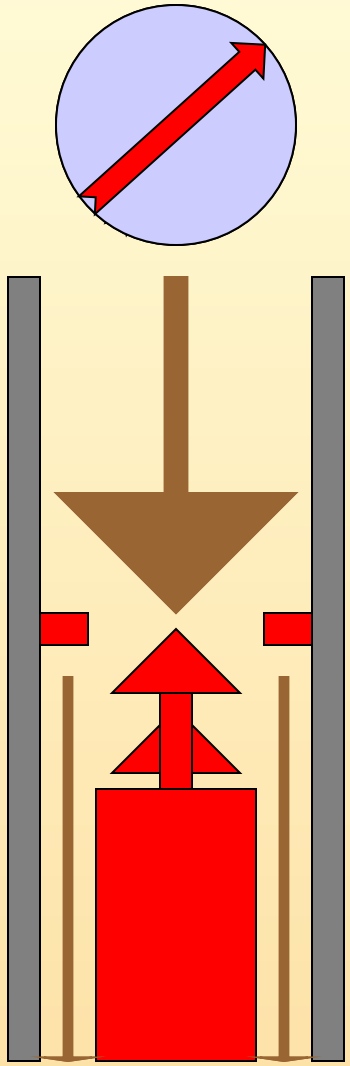
- –Vents mud to the annulus
- –Decreases internal drillpipe pressure
- –Same pulser valve in 6 $^{3}/_{4}$", 8", 9 $^{1}/_{2}$" collars
- –Different insert for 9 $^{1}/_{2}$" pulser



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