The C-Kore Subsea TDR

Automated Cost-Effective and Reliable Subsea Testing
C-Kore
Introduction

Greg Smith

• General Manager
• Working with C-Kore for 8 years
• Frequently supported products in the field
C-Kore
Contents

Introduction
TDR Theory
C-Kore vs Traditional
Fault-Finding Case Study
Introduction
C-Kore Applications

Subsea Tools for:

- Installation/Commissioning
- Fault-finding Operations
- Down-hole Testing
C-Kore
Subsea Testing Tools

Cable Monitor (IR & Continuity)
Subsea TDR
Pressure Monitor
Subsea Modem
C-Kore Development

Started in 2010

Cable Monitor Prototype Trials

2011

Cable Monitor Released

2015

Cable TDR Prototype Trials

2017
C-Kore
TDR Specification

Specification

Range of over 20km
Precision of 10cm
Gain up to +52dB
Automated pulse and step modes
Results

All results datalogged

Built-in analysis tools with C-Kore result viewer

Easy report generation
Time Domain Reflectometry
TDR Theory of Operation

• Operation:
  • Transmits an **electrical pulse** and measures **reflections** (similar to sonar)

• Identifies:
  • Distance to end of line / discontinuity
  • Type of *discontinuity* / termination
TDR Reflection
Impedance Change
TDR Reflection
Impedance Change

Time = Distance to fault

Time = Distance to line end
TDR Reflection
Further Examples

- Open conductor
- Shorted conductor
- Tap
- Splice
- Water ingress
- Wet splice / water
- Split / resplit
- Splitter
- Frayed cable
TDR Deployment
Traditional Method

1. Vessel arrives in field
2. ROV launched
3. Downline deployed (move to safe distance)
4. ROV derigs and connects downline
5. TDR testing from back-deck

Downline Issues:
- Impedance mismatch at interfaces
- Extra attenuation (reduced range)
- Operator skill under time pressure
- Quality of saved data
1. Vessel arrives in field
2. ROV launched
3. ROV connects and triggers C-Kore TDR

C-Kore Benefits:
Matched impedance (no extra reflections)
Direct measurement (see extra detail)
Automated and repeatable
Interactive result analysis
Case Study: Fault-Finding
Case Study
Fault Finding

Background

LIM shows IR failure on one channel

Some spare cables available

If umbilical failed (suspected) will need to decide repair vs replace
Case Study
Fault Finding

Supplied in small peli-case

Deploy in work basket or tooling tray

Simplify Subsea Testing
Usage

Test routine pre-programmed for simple subsea deployment

Connect directly to subsea equipment, no downlines required

Trigger measurement with light sensor, proximity sensor or schedule
Case Study
Fault Finding

Platform

Dynamic Umbilical (4 Cables)

Static Umbilical (3 Cables)

SDU

W1, W2

Static Umbilical (2 Cables)

SDU

W3, W4

Static Umbilical (2 Cables)

W5
Case Study
Fault Finding

Dynamic Umbilical (4 Cables)

Static Umbilical (3 Cables)

C-Kore Cable Monitor: IR Measurement

SDU

W1

W2

Static Umbilical (2 Cables)

W3

W4

W5

Static Umbilical (2 Cables)
Case Study
Fault Finding

Platform

Dynamic Umbilical (4 Cables)

SDU

Static Umbilical (3 Cables)

W1

W2

Static Umbilical (2 Good Cables)

W5

Static Umbilical (2 Cables)

SDU

W3

W4

Simplify Subsea Testing
Case Study
Fault Finding

Platform

Dynamic Umbilical (4 Cables)

Static Umbilical (3 Cables)

SDU

W1

W2

Static Umbilical (2 Good Cables)

W5

Static Umbilical (2 Cables)

SDU

W3

W4

Simplify Subsea Testing
Case Study
Fault Finding

Platform

Dynamic Umbilical (4 Cables)

Static Umbilical (3 Cables)

SDU

W1

W2

Static Umbilical (2 Good Cables)

W5

Static Umbilical (2 Cables)

SDU

W3

W4

Simplify Subsea Testing
Case Study
Fault Finding

Platform

Dynamic Umbilical (4 Cables)

Static Umbilical (3 Cables)

SDU

W1

W2

Static Umbilical (2 Good Cables)

SDU

W3

W4

Static Umbilical (2 Cables)

W5
Case Study
Fault Finding

Platform

Dynamic Umbilical (4 Cables)

Static Umbilical (3 Cables)

SDU

W1
W2

Static Umbilical (2 Good Cables)

W3
W4

Static Umbilical (2 Cables)

W5

Simplify Subsea Testing
Case Study
Fault Finding

Platform

Dynamic Umbilical
(4 Cables)

Static Umbilical
(3 Cables)

SDU

W1  W2

Static Umbilical
(2 Good Cables)

W3  W4

W5

Static Umbilical
(2 Cables)
Case Study
Fault Finding

Platform

Dynamic Umbilical (4 Cables)

SDU

Static Umbilical (3 Cables)

W1

W2

Static Umbilical (2 Good Cables)

W5

Static Umbilical (2 Cables)

W3

W4

Simplify Subsea Testing
Case Study
Fault Finding

Platform

Dynamic Umbilical (4 Cables)

Static Umbilical (3 Cables)

SDU

W1

W2

Static Umbilical (2 Good Cables)

W5

Static Umbilical (2 Cables)

W3

W4
Case Study
Fault Finding

Platform

Dynamic Umbilical (4 Cables)

Static Umbilical (3 Cables)

SDU

W1 W2

Static Umbilical (2 Good Cables)

SDU

W5

Static Umbilical (2 Cables)

W3 W4
Case Study
Fault Finding

Platform

Dynamic Umbilical (4 Cables)

Static Umbilical (3 Cables)

SDU

W1

W2

Static Umbilical
(2 Good Cables)

W5

Static Umbilical
(1 Bad Cable)

W3

W4
Case Study
Fault Finding

Platform

Dynamic Umbilical (4 Cables)

Static Umbilical (3 Cables)

SDU

W1
W2

C-Kore Cable TDR: For fault location

Static Umbilical (2 Good Cables)

W3
W4

SDU

Static Umbilical (1 Bad Cable)

W5

TDR

Simplify Subsea Testing
Case Study
Fault finding with Subsea TDR

IR fault identified using C-Kore Cable Monitor on infield umbilical

Location will decide repair or replacement

C-Kore Cable TDR used to determine location
Case Study
Fault finding with Subsea TDR

Baseline measurement
Measurement on cores with good IR
EFL to umbilical connection seen in impedance at beginning of graph
Umbilical trace then flat showing no further discontinuities
Case Study
Fault finding with Subsea TDR

Fault measurement
Measurement on cores with low IR
EFL to umbilical connection seen in impedance at beginning of graph
Discontinuity seen at 270m indicating fault location
Case Study
Fault Finding

Platform

Dynamic Umbilical (4 Cables)

Static Umbilical (3 Cables)

SDU

W1

W2

Static Umbilical (2 Good Cables)

SDU

W3

W4

Static Umbilical (1 Bad Cable)

W5
Case Study
Fault Finding

Platform

Dynamic Umbilical (4 Cables)

C-Kore Cable Monitor: IR Measurement

Static Umbilical (3 Cables)

SDU

W1

W2

Static Umbilical (2 Good Cables)

W3

W4

Static Umbilical (1 Bad Cable)

W5

Simplify Subsea Testing
Case Study
Fault Finding

Platform

Dynamic Umbilical
(2 Good Cables)

Static Umbilical
(3 Cables)

SDU

W1

W2

Static Umbilical
(2 Good Cables)

W3

W4

W5

Static Umbilical
(1 Bad Cable)
Case Study
Fault Finding

Platform

Dynamic Umbilical
(2 Good Cables)

Static Umbilical
(3 Cables)

SDU

W1
W2

Static Umbilical
(2 Good Cables)

W3
W4

Static Umbilical
(1 Bad Cable)

W5
Case Study
Fault Finding

Platform

Dynamic Umbilical
(2 Good Cables)

Static Umbilical
(2 Bad Cables)

SDU

W1
W2

Static Umbilical
(2 Good Cables)

W5

Static Umbilical
(1 Bad Cable)

W3
W4
Case Study
Fault Finding

Platform

Dynamic Umbilical
(2 Good Cables)

SDU

W1

W2

Static Umbilical
(2 Bad Cables)

Static Umbilical
(1 Bad Cable)

W3

W4

Static Umbilical
(2 Good Cables)

W5

Dynamic Umbilical
(2 Good Cables)
Case Study
Fault Finding

- Platform

Dynamic Umbilical (2 Good Cables)

TDR

C-Kore Cable TDR: For fault location

SDU

Static Umbilical (2 Bad Cables)

W1

W2

Static Umbilical (2 Good Cables)

W4

W3

Static Umbilical (1 Bad Cable)

W5

Dynamic Umbilical (2 Good Cables)
Case Study
Fault Finding

Dynamic Umbilical (2 Good Cables)

TDR shows faults in middle of cable length

Static Umbilical (2 Bad Cables)

Again, TDR shows faults in middle of cable length

Static Umbilical (2 Good Cables)

Static Umbilical (1 Bad Cable)

W1

W2

W3

W4

W5

Platform

SDU

TDR

Simplify Subsea Testing
Pre-programmed test routine removes the need for skilled TDR operator.

No downline deployment / recovery time. No waiting for platform testing.

Measurements made directly subsea. No errors from impedance mismatches.
Case Study
Fault Finding

Cost savings
• Vessel Time
• Personnel and Equipment

C-Kore’s Subsea TDR First Deployment Achieves Cost-savings for Nexen

C-Kore Systems delivered their new subsea Time Domain Reflectometry (TDR) unit to Nexen for a fault finding operation on the Telford field in the North Sea. This unique technology localises and identifies faults subsea, giving operators detailed insight to the health of their subsea fields without the need for downtimes. Extra insight means sizable savings on field maintenance costs.

“Collaborating with Nexen, we developed a subsea TDR unit that will allow us to perform TDR testing in a way that is not intrusive, giving our customers more data to determine the condition of their subsea equipment. This will enhance our programs, saving them significant money on the bottom line,” says John Green, CEO of C-Kore.

The C-Kore TDR has been tested in harsh environments, allowing it to work under challenging conditions. The system is designed to be easy to use and can be deployed quickly, allowing engineers to perform TDR testing in a matter of minutes. This makes it a powerful tool for identifying and correcting faults in subsea equipment.

“Having a unit that can perform TDR testing is a huge benefit for our subsea operations. We can now perform testing on subsea equipment without having to shut down the field, which saves us a lot of money,” says Mike Johnson, Manager, Well Integrity for Nexen.

The C-Kore subsea TDR technology is a game-changer for the subsea industry, and we are excited to see how it will benefit our customers in the future.”
Simplifying Subsea Testing

Thank You, Any Questions?