Standalone Subsea Data Monitoring System

Pei AN¹, Neil Willis² and Steve Hatton³
2H Offshore Engineering Limited, www.2hoffshore.com

Presented at
the 6th Underwater Science Symposium
Aberdeen University, Scotland, UK 3rd to 6th April 2003

1.0 INTRODUCTION

A standalone data logger is a data-capturing device that, once initialised, can automatically log data and store it in its on-board memory. After a data logging session is completed, data stored in memory can be downloaded into a computer for analysis to provide information on the history of parameters or events.

Typically a standalone data logger consists of a central processor unit (CPU), analogue to digital converter, data memories and other support electronics. It can accept signal from various sensors such as accelerometers, strain gauges, displacement sensors, inclinometers and pressure gauges etc..

One example of standalone data logging in the offshore oil production industry is to record riser displacements as the result of vortex induced vibration (VIV) or drilling process. Standalone motion loggers are attached to risers over a lengthy period of time to record motion. This can provide vital information on the fatigue life of the riser.

Standalone data logging is not real-time data logging. Data can only be viewed and analysed after the data is downloaded into a computer. However, it can provide economical and rapid instrumentation deployment, with simple interfaces and minimal impact on platform equipment.

2.0 2H STANDALONE DATA LOGGER

By harnessing the latest developments in electronic and sensor technologies, the 2H logger is a start-of-the-art standalone monitoring device that integrates sensors, logger, batteries and memory disk into a compact package (Figure 2). It is a cost effective solution for standalone data monitoring applications.

Figure 1 - 2H subsea data logger inside the casing

Figure 2 - 2H data logger main board

¹ Pei AN, Principle Engineer, 2H Offshore Engineering Limited, anp@2hoffshore.com
² Neil Willis, Principle Engineer, 2H Offshore Engineering Limited, willisn@2hoffshore.com
³ Steve Hatton, Director, 2H Offshore Engineering Limited, hattons@2hoffshore.com
The logger can be contained in a rugged pressure casing and used for the harshest environment and the most demanding applications (Figure 3). They can also be integrated into customised casings.

It consists of the following functional parts:

- Micro-controller
- Temperature compensated precision real-time clock (+/- 1 minute drift per year)
- SmartMedia memory card to achieve massive data storage
- 8 channel, 12-bit analogue to digital converter (0 to 2.5V input range)
- RS232 interface for PC communications during initialisation
- Lithium Batteries

The logger has some unique features. Ultra low power consumption is one of the important features of this logger. It uses the latest low-power electronic components (including memory) and adopts an intelligent power management scheme. When no data is logged, the data logger can go to sleep mode and switch off the power supply to all sensors to minimise power consumption. The data logger itself has a typical sleep mode current consumption of 2 mA and a wake up current consumption of 5 mA. Before a data logging session, the data logger wakes up and supplies the power to the sensors. The makes the logger most suitable for battery operations.

The logger provides massive memory space by using a SmartMedia memory disk as its data storage. The current maximum acceptable size is 128 Mbyte and the data logger will be compatible with any future SmartMedia development.

The third feature is that the logger is compact and lightweight. The Logger board measures 10 cm long, 5 cm width and 3 cm height.

The deployment of the data logger is straight forward, and consists of the following steps:

- Connect to a computer (Figure 4) for initialisation using special software. Users can choose logging frequencies, logging modes and logging start time, etc
- After initialisation, the logger can be dispatched to designated locations.
- Data logger will automatically start the data logging session and data will be logged and stored in the mode specified by the users
After the data logging session, the data logger can be retrieved and data on the SmartMedia memory disk is downloaded into a computer.

Data is analysed.

3.0 SENSOR MODULES

There is a wide range of advanced sensors available in the market that can be integrated easily with the 2H data logger. Typically, these sensors consist of a sensing element and integrated amplifier & conditioning circuits. The sensor requires a single rail power supply and the output from the sensors is simply an electrical voltage or current. The sensors utilise latest sensor technologies to achieve low power consumption and high performance. Some examples are shown below:

- Micro-electronic machined (MEMS) accelerometers
- Inclinometers
- Angular velocity sensors (MEMS Gyroscopes)
- Linear displacement gauges (LVDTs)
- Pressure sensors (silicon sensors)
- Temperature sensors
- Load sensors for tension and compression

4.0 APPLICATIONS

2H standalone data loggers have been used in numerous applications.

4.1 Riser VIV measurement of subsea structures

2H standalone data loggers have been used to record pipeline movement as the result of vortex induced vibration (VIV), which may cause severe damage to the structure and shorten its working life.

Each motion logger has a three-dimensional accelerometer sensor package and battery pack. They are fully enclosed in a rugged casing and are attached to the riser via a holder, from which loggers can be deployed or retrieved by ROVs (Figure 5).

After data is downloaded from the data logger, the accelerations in 3 directions are calculated. From these acceleration measurements, displacement is calculated and its effect on the fatigue life of the structure is calculated.
4.2 Inclination measurements

Using inclinometers, 2H standalone data loggers were used to measure inclination of the riser in 2 directions (Figure 6).

4.3 Tension on riser tethers

Using a shackle load cell, the 2H data loggers were converted into a tension monitoring device for riser tethers (Figure 7).

4.4 Capturing transient voltage spikes

Voltage spikes in the power supply line often cause malfunctioning of electrical devices in a plant. A transient voltage data logger is a modified 2H standalone data logger that is able to capture transient voltage spikes occurred in the power supply lines (see Figure 8).

5.0 CONCLUSION

The 2H standalone data logger is a state-of-the-art and cost effective data capture device, featuring a massive on-board memory, low power consumption and compactness. Integrated with various modern sensors available in the market, the logger can log a wide variety of physical parameters.

In the offshore oil and gas industry, for which the logger was primarily designed, this facility has already assisted in providing empirical data to prove equipment fit-for-purpose, and to improve and streamline design for subsequent engineering projects.
2H Subsea Standalone Data Monitoring System

Pei AN, Neil WILLIS, Steve HATTON

6th SUT symposium
University of Aberdeen
3rd-6th April 2003

Presented by Dr. Pei An
2H Offshore Engineering Ltd
UWG Group
www.2hoffshore.com
1. Real-time and Standalone data logging  
2. 2H Subsea standalone data monitoring system  
3. Sensor modules  
4. Applications  
5. Conclusion
1. **Real-Time or Standalone data logging**

   • **Real-time data logging**
     – Catch data instantly (real-time)
     – Provide real-time data for operators
     – Need hardwired/wireless link between logger and sensors
     – Difficult to deploy and high cost

   • **Standalone data logging**
     – Catch data after a logging session
     – Provide historical data
     – Standalone data logger
     – Easy to deploy and low cost
2H Subsea Standalone Data Monitoring System

Real-time logging

Subsea structure

Electrical or optical cables

Hardwired Sensors

Sensors with acoustic modem

Modem at surface

Subsea structure
Stand-alone logging

Initialisation

Download

Data analysis

ROV deployment

Logger retrieval

Logging...

Logger installation
2. **2H Subsea Standalone Data Monitoring System**

A data capturing device that, after initialised, can log data automatically and store them in its on-board memory.

After a data logging session is completed, data stored in memory can be downloaded into a computer for analysis to provide information on the history of parameters.
2H Subsea Data Logger

The power to measure
Specifications

- Programmable using a special software
- Programmable logging frequency
- Programmable logging modes
- Programmable launch time

- 8 analogue inputs, 12-bit (0-2.5V)
- 2 Digital inputs/outputs
- 128 Mbyte on-board memory (SmartMedia card)
- RS232 connection to host PC
- Temperature-compensated real time clock
- Low power electronics
- Intelligent power management for sensors
Host PC program
Deployment configuration

Self-contained standalone data logging system

Retrievable standalone data logging system with local sensors (actual format may vary)

- Standalone data logger
- ROV mateable connector
- Sensor casing
- Other sensors
- Termination box
- Underwater penetrations
3. **Sensor modules**

Many sensors nowadays are highly integrated devices that includes sensing circuits, signal conditioning and amplification circuits together in one package. They allow easy integration with 2H loggers

- Temperature
- Pressure
- Acceleration
- Inclination
- Angular velocity
- Linear displacement
- Load
- And many more
**2H Subsea Standalone Data Monitoring System**

**T**
- **Temperature sensors**
  - Thermocouples
  - Semiconductor sensors

**P**
- **Pressure sensors**
  - Water depth sensors
  - Miniature sensors
2H Subsea Standalone Data Monitoring System

**g**

- Acceleration sensors
  - MEMS g sensors
  - High precision g sensors

**θ**

- Inclination sensors
Angular rate sensors

MEMS Gyro sensors

Linear Displacement

Linear potentiometers

Miniature LDVTs
Load sensors

- Strain gauges
- Shackle load cells

Other sensors

- Light
- Magnetic
- PH
- Conductance
- Fluid velocity
4. Applications

Allegheny riser monitoring (BP)

Donggala riser monitoring (TFE)

STRIDE JIP open water test
Heave compensator test (Halliburton)

Riser tension monitoring (BHP)

Voltage spike recorder (Cableform)
Tether tension monitoring (BP, CSO)

- Two shackle load cells
- Two standard shackle
- One 2-plane inclinometer box
- One logger cradle
- One retrievable logger & 2-plane inclinometers
5. **Conclusion**

2H standalone data logger is the state-of-the-art and cost effective data capture device, featuring a massive on-board memory, lower power consumption and compactness.

Integrated with various modern sensors available in the market, the logger can log various physical parameters.