

THE APPLICATION  
OF TECHNOLOGY



## DJ-1000 HV Cable On-line Monitoring and Fault Location System

# Kehui International



Kehui International,  
Hertford, UK

The word Kehui, literally means the Application of Technology in the Chinese language. This phrase perfectly defines the company's commitment to technological innovation, which it achieves whilst striving for the highest levels of quality.

The company was founded in 1991 as a joint venture with a major US organisation, before becoming independent in 2005. It has utilised the best of Asian, European and American expertise to develop a selection of cable and transmission line fault locators, as well as equipment for the automation of electrical distribution systems and its range of switched reluctance motors.



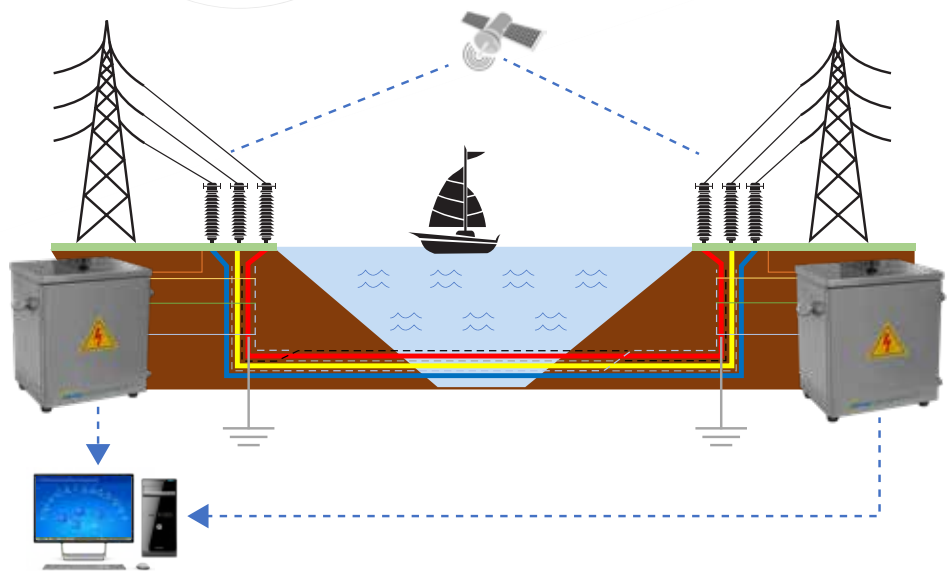
Kehui factory,  
Zibo, China

# DJ-1000 Overview

Transmission systems are at the heart of the power network and their availability is essential to the reliability of the system. The use of cables on transmission systems is becoming increasingly common, which can make the location of faults on the system difficult to locate.

The DJ-1000 uses travelling wave technology, coupled with an extremely high sampling rate, to provide an accurate fault location. The system is also capable of identifying and locating sheath faults and monitoring the load.

It is applicable to HV AC cables, including underground, underwater and hybrid systems.

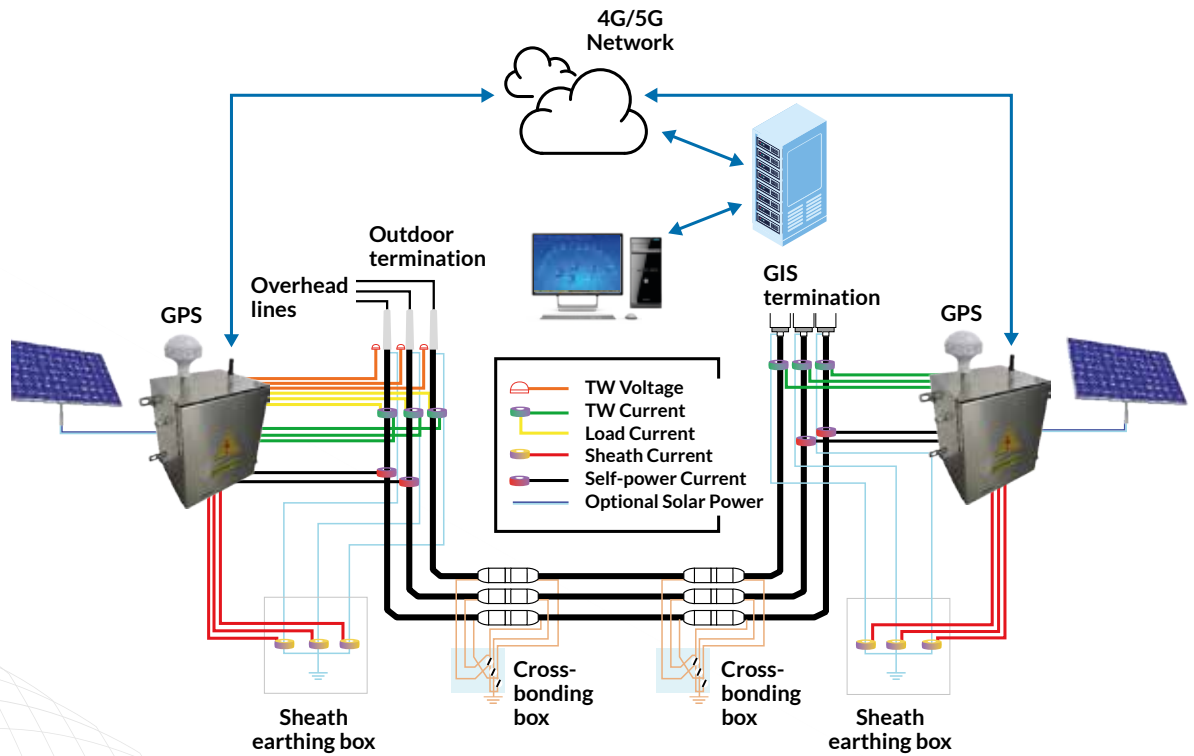


# Benefits of the DJ-1000

- High performance capture of travelling wave signals for fault location.
- Resolution of less than 4m, with 50MHz per channel sampling rate.
- High precision GPS time synchronisation with 20ns accuracy.
- High fidelity reproduction of travelling wave signals.
- Fundamental frequency current measurement, for load monitoring and faulty section identification, using the current differential principle.
- Sheath fault detection using sensitive current measurement.
- Indoor and outdoor, non-intrusive installation.
- Self-power from the phase current and/or mains or solar power.
- Communication to the Master station over the 4G/5G network.

# System Description

The DJ-1000 system consists of a number of DJ-100 devices, a master station and accessories including sensors, GPS antennae, optional solar panels etc. The master station communicates with the DJ-100 devices in the field, through the 4G/5G mobile network. It performs fault location calculations, on-line load monitoring and data analysis for the cable network.



The diagram shows the interfaces of a typical system between an outdoor cable and overhead line terminal and an indoor GIS cable terminal. CTs monitor the sheath earth currents, whilst sensors monitor the load and look for the arrival of current and/or voltage travelling waves. Power is provided by CTs around two phases of the cable, by solar panel, or the AC mains.

# Sensors



Travelling wave voltage sensor

AC Power coupling CT

Travelling wave and load current sensors

Sheath current sensor

# Fault Location

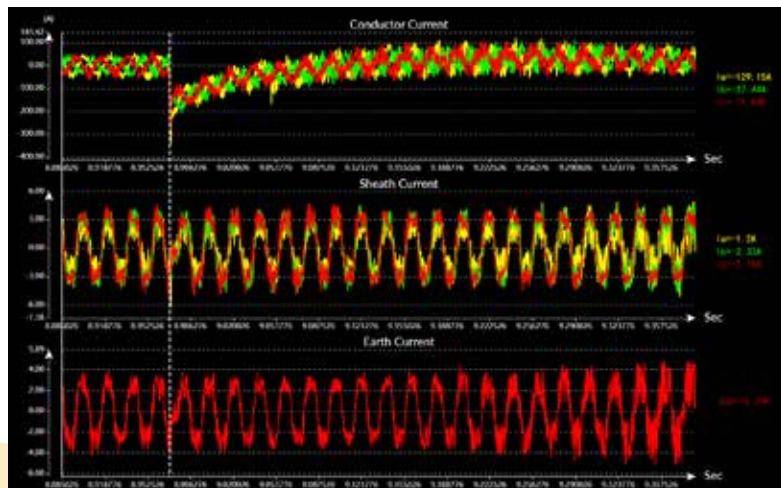
The DJ-1000 uses single and double-ended travelling wave principles to determine the distance to the fault. High frequency travelling waves are captured by six analogue channels for the three-phase voltages and currents. The 50MHz sampling rate, and 20ns GPS clock, facilitate a fault location resolution of 4m. The wide-bandwidth voltage and current sensors minimise the rise time of the signal. Triggers can be achieved very close to the fault inception, thus further enhancing the accuracy. When the DJ-1000s at the ends of the cable section trigger, the precise time-tags of the trigger and the travelling wave waveforms are sent to the master station which makes the fault location calculations, with the results provided on the user interface (below).



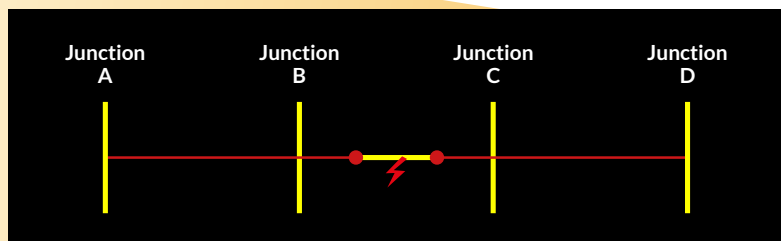
# Load Monitoring and Faulty Section Identification

Three analogue channels monitor the 3-phase load currents, with a sampling rate of 6.4kHz. They are used for continuous load monitoring and disturbance recording. Each trigger produces a record of 0.5s duration, which can be used to assess the cause of a fault. The data from the DJ-100s at different nodes are time-synchronised through GPS, allowing current differential protection principles to be used to identify the cable section where the fault occurred.

Load Current record



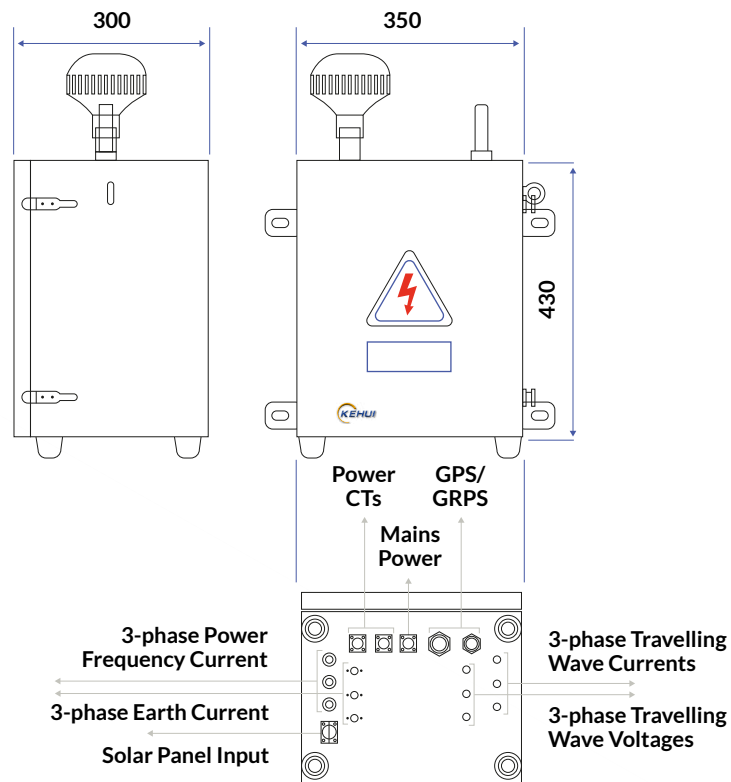
Faulted section indication



# Sheath Fault Detection

Three analogue channels are dedicated to monitor the 3-phase sheath currents plus their summated current, with a sampling rate of 6.4kHz. The nominal sheath currents under healthy conditions, are just a few amperes. Excessive sheath current indicates there is an abnormality and the ratio of sheath current to the load current is used for fault detection. If the ratio is above a settable threshold, there will be an alarm and a disturbance record will be taken. The currents are summated in the software, eliminating the balanced nominal sheath currents and identifying any load imbalance.

## Dimensions and Connections



## Scope of supply

- DJ-100 HV cable monitoring and fault location device
- 3-phase current sensors for load and travelling waves
- 3-phase travelling wave voltage sensors (optional)
- 3-phase sheath current sensors
- Solar panel (optional)
- AC power coupling CTs (optional)
- GPS antenna
- Service manual
- Master station software

**DJ-1000 Technical data****Travelling Wave Fault Location**

Number of travelling wave analogue channels	3 (phase currents) + 3 (phase voltages)
Travelling wave sampling frequency	50MHz
GPS timing accuracy	20ns
Fault location resolution	4m
Number of power frequency analogue channels	3 (phase currents) + 3 (sheath currents)
Power frequency sampling frequency	6.2kHz
Power frequency disturbance record length	500ms

**Voltage sensors (travelling wave)**

Measurement accuracy	5%
Measurement bandwidth	1kHz to 10MHz
Cable operating voltage range	100V to 500kV
Installation method (voltage sensor)	Outdoor overhead line to cable terminals

**Current sensors (travelling wave and load)**

Measuring range (travelling wave)	10mA to 1000A
Measuring range (load)	10A to 5000A
Measurement bandwidth (travelling wave)	1kHz to 10MHz
Measurement bandwidth (load)	20Hz to 100Hz
Measurement accuracy (travelling wave)	5%
Measurement accuracy (load)	1%
Installation method	Clip-on CT, indoor or outdoor installation
Load sensor internal diameter	200mm

**Sheath current sensor**

Measurement accuracy	0.5%
Measuring range	0 to 300A
Installation method	Clip-on CT, indoor or outdoor installation
Sheath current sensor internal diameter	60mm

**Power Supply**

Mains power supply	AC 220V $\pm$ 20%
Power from cable load; current range	30A to 1000A
Power from cable load; Installation method	Clip-on CT, indoor or outdoor installation
Solar panel	18V, 180W
Battery (2 sets) for solar power back-up	12V 20AH (40AH total) lithium-ion

**Environmental**

Maximum temperature	-20oC to 70oC
Humidity	5% to 95%RH
Altitude	$\leq$ 3000m
Atmospheric pressure	80 kPa to 106kPa
Insulation withstand level	DC 10kV/1min
Ingress protection	IP54

**Physical characteristics**

Dimensions (main unit)	350 x 300 x 430mm
Weight (main unit)	34Kg



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