



### **D.6.3.1. 1st proof of concept demonstrator of line fault detector**

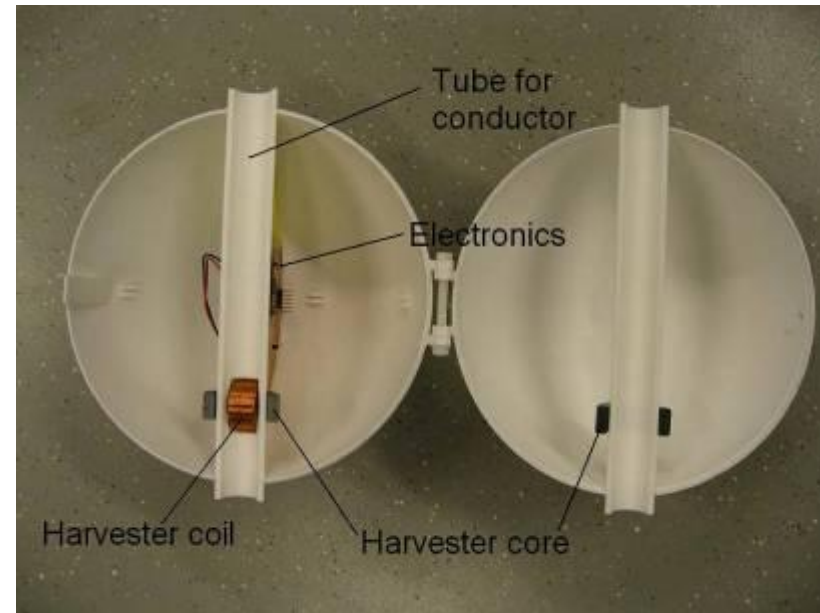
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## Line current indicator prototype

- Measures line current
- Intended use is on 20 kV power lines
- No battery changes needed because harvests operating energy from the power line using a current clamp
- Radio communication
- Folding snap-on structure
- Up to 20 mm  $\varnothing$  wires
- Cost of the single prototype €60, of which €35 consists of the radio (enclosure is not included)

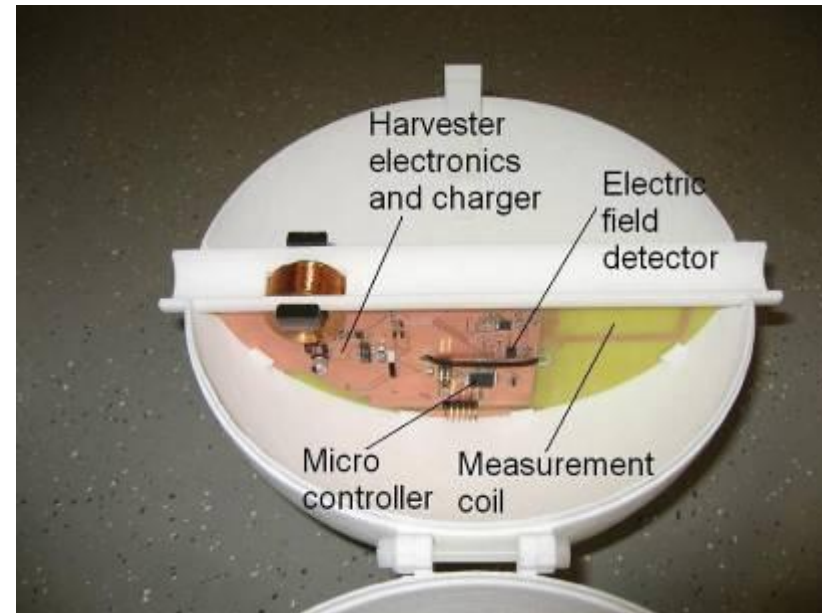


## Structure



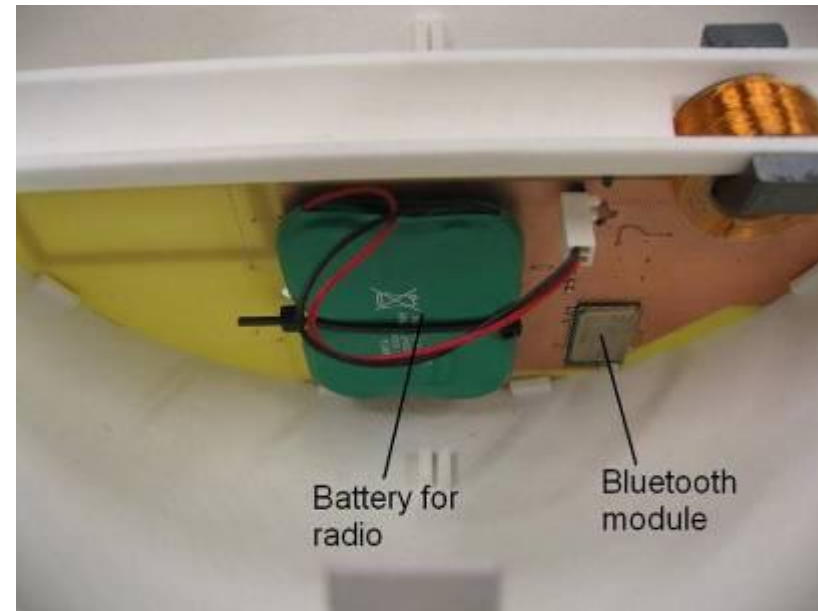
## Principle of operation

- Current measurement based a coil magnetometer
- Electric field is measured for coherent noise rejection
- Inductive battery charging based on energy harvesting from the power

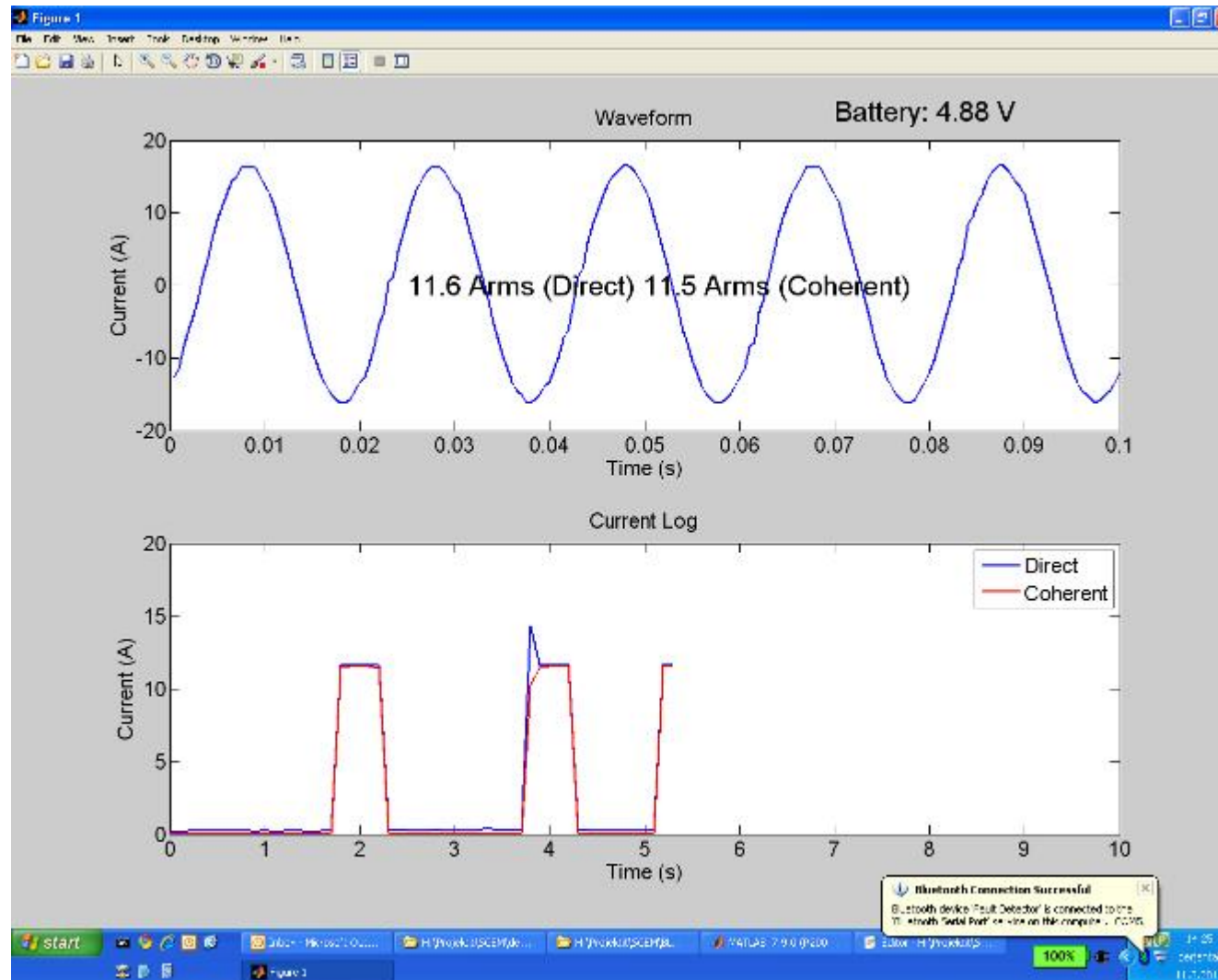


## Communication

- Data transmission by Bluetooth in this prototype
- Radio in final product will be changed to a more suitable type
- Battery for radio is charged with the harvester
- Alarm can be sent even when the current has stopped
- The device can operate for days using battery only (depends on the transmission interval)



## Demo software



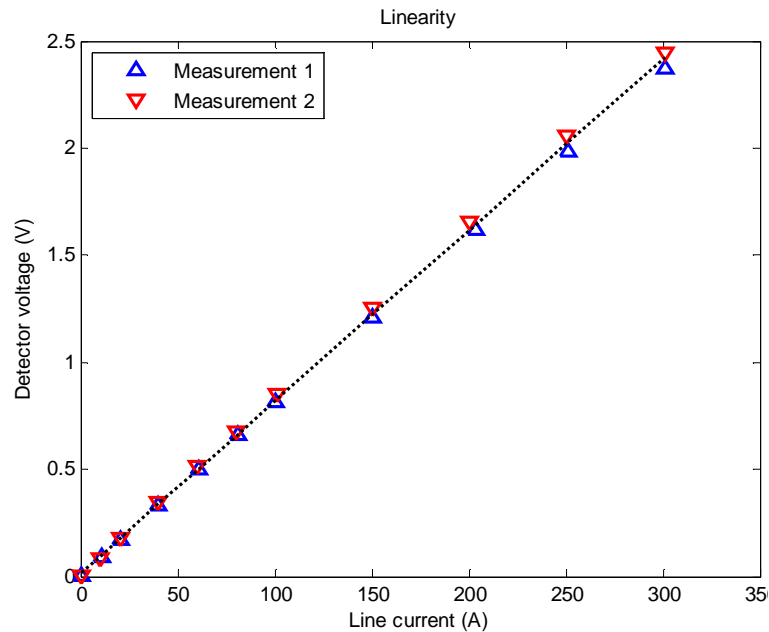


## Test measurement 1: High current setup

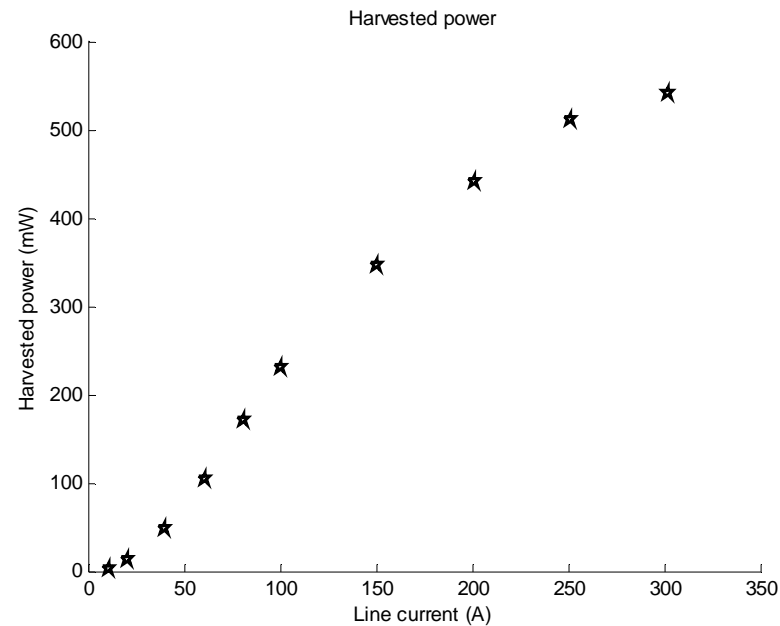
- Measurements done at MIKES
- Parameters measured
  - Linearity of current sensing
  - Error estimation of current sensing
  - Harvested power
- Line currents 10-300 A (voltage was low)
- Conductor diameter was 18 mm



## Test measurement 1: Results, linearity and harvested power



Linearity and sensitivity is good  
 $\pm 1\%$  full scale accuracy



Harvested power is more than adequate  
tens on mW on typical conditions



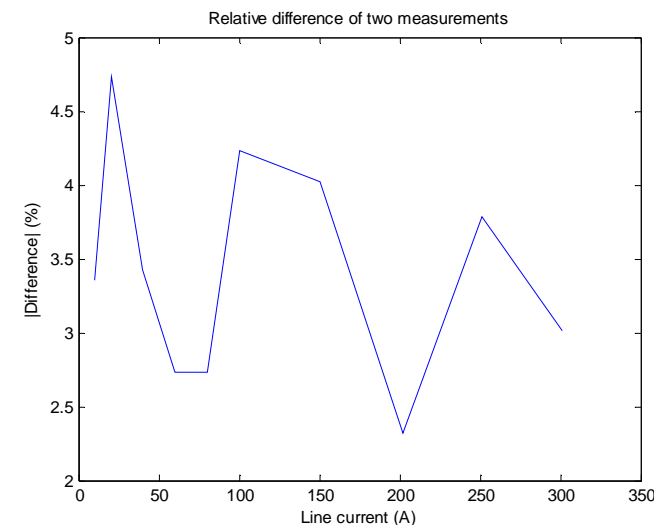
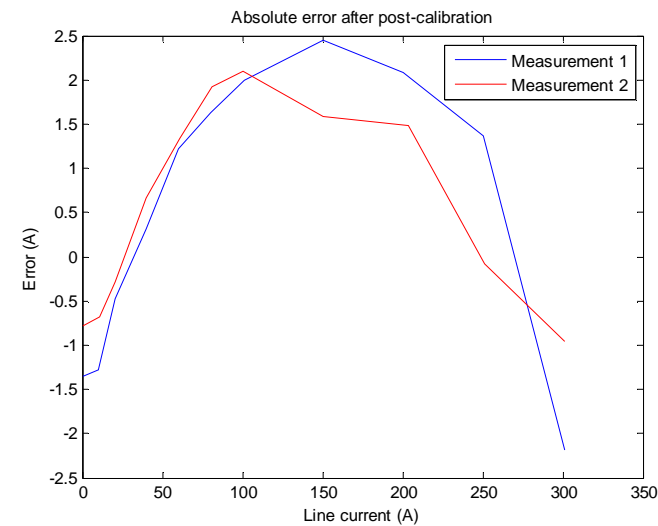
## Test measurement 1: Results, accuracy

### Non-linearity error

- After post-calibration the error is  $\pm 2.5$  A in a range of 10-300 A
- This corresponds to  $\pm 1\%$  full scale accuracy

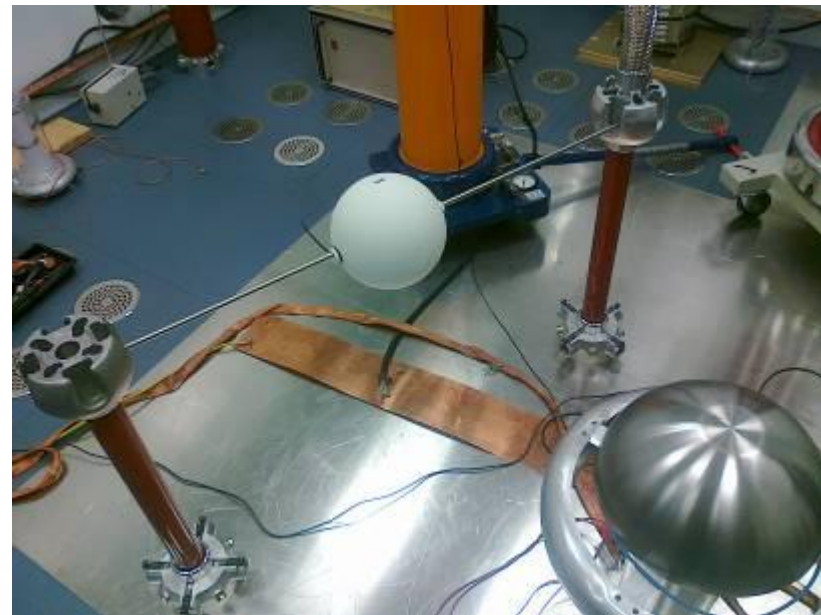
### Installation error

- The dominating error source is installation: it can cause 5% systematic gain error
- This is caused by small variations of the distance between the sensor and the line
- Can be improved with a tighter tube



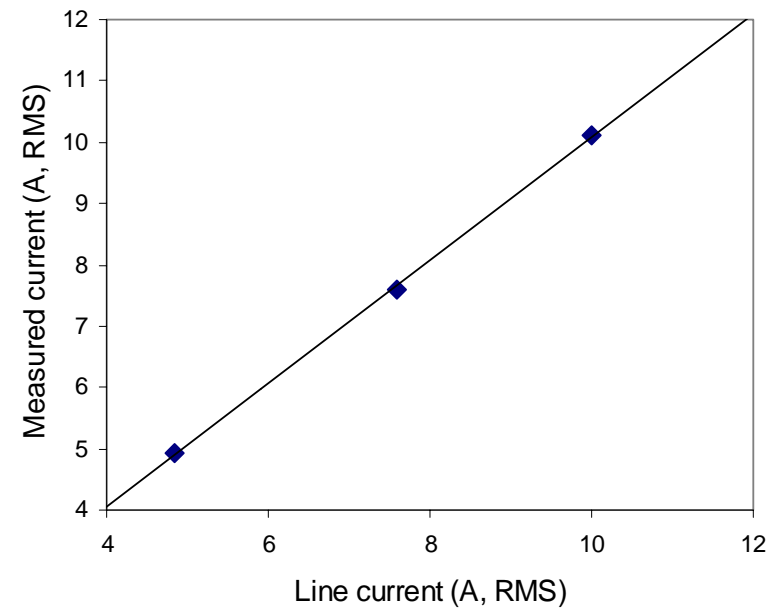
## Test measurement 2: High voltage setup

- Measurements done at MIKES
- Measured parameters
  - Survival test
  - Common mode error estimation
- Line voltages 5-20 kV, RMS
- No current in the line
- Device was mounted on a solid bar at a height of  $\approx 80$  cm from a ground plane
- Operation of the current measurement was verified after the high voltage test

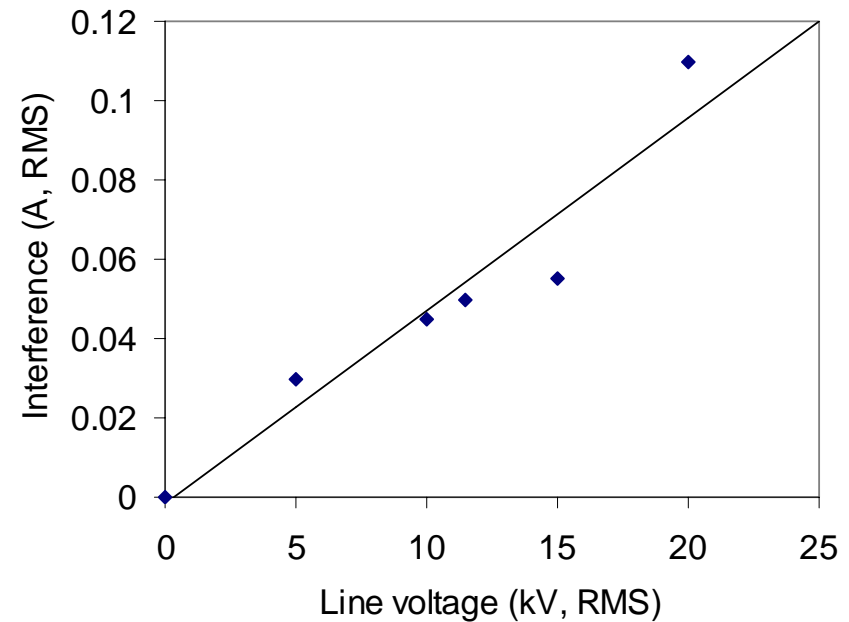
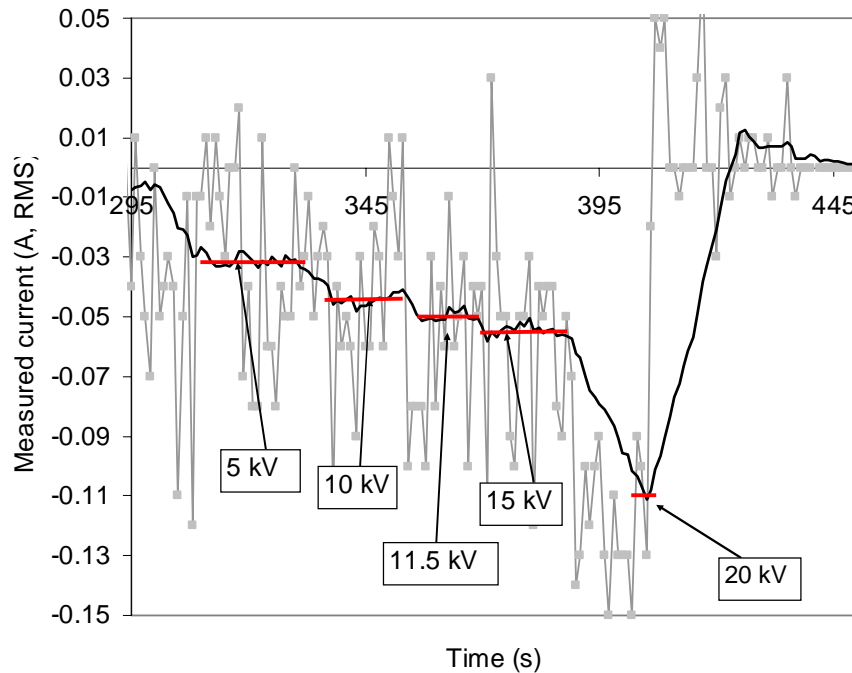


## Test measurement 2: Results, survival test

- The device did not break up to 20 kV RMS, less than 1 m distance from ground (extremely hard condition)
- Current measurement was still working and linear after the high voltage test



## Test measurement 2: Results, common mode error

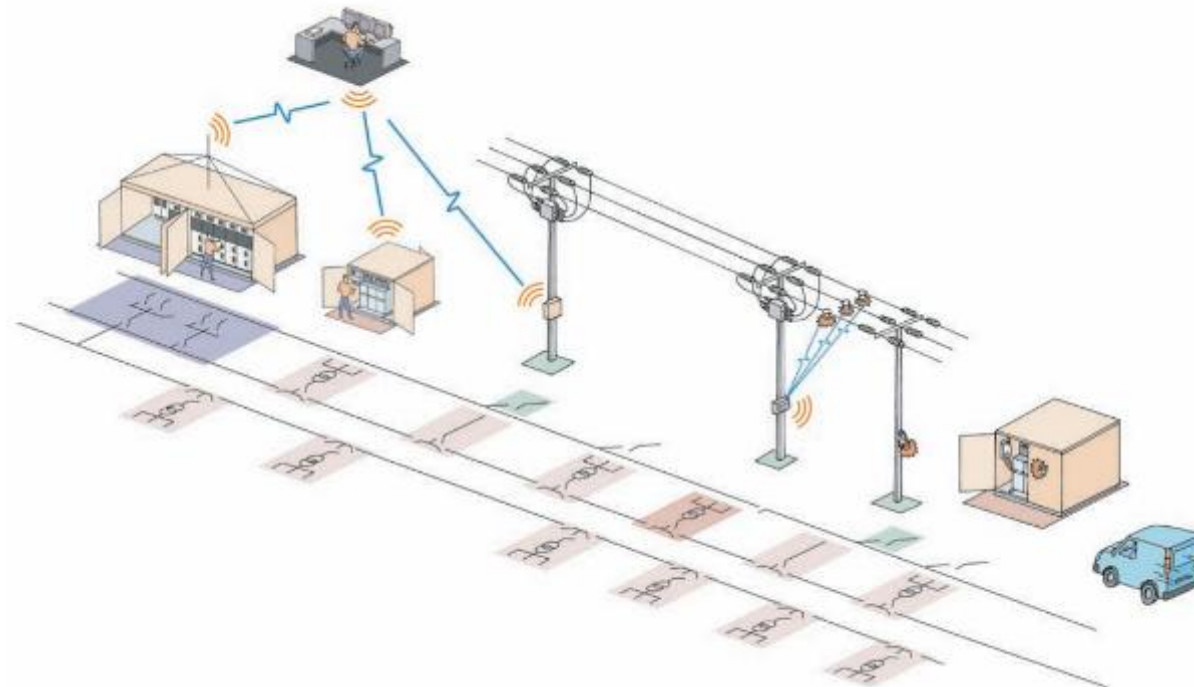


- Effect of common mode interference is very hard to detect because it is so small
- The error is order of 100 mA at 20 kV, RMS

## Similar product on the market



Flite16/G200



- [Flite](#) from Schneider Electric
- Clips on to the line
- Relies on **batteries**
- Transmits data using radios on the unit and on the poles
- No price information available

## Summary

- VTT line fault detector
  - is low cost
  - maintenance free (no battery change)
  - easy to install
- The operation has been tested in laboratory
  - excellent performance
  - excellent EM durability
- Field test will start Autumn 2011







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