

(12) **UK Patent Application** (19) **GB** (11) **2 424 286** (13) **A**

(43) Date of A Publication **20.09.2006**

(21) Application No: **0505657.7**
(22) Date of Filing: **18.03.2005**

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(51) INT CL:
G01R 21/00 (2006.01)

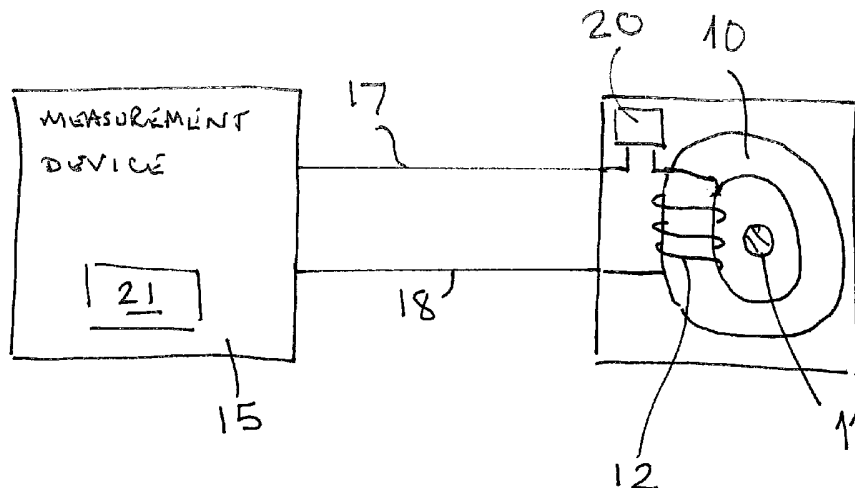
(52) UK CL (Edition X):
G1U UR2100

(56) Documents Cited:
GB 2280290 A **GB 2259779 A**
EP 1102072 A1 **US 5155747 A**
US 5124624 A **US 4933633 A**

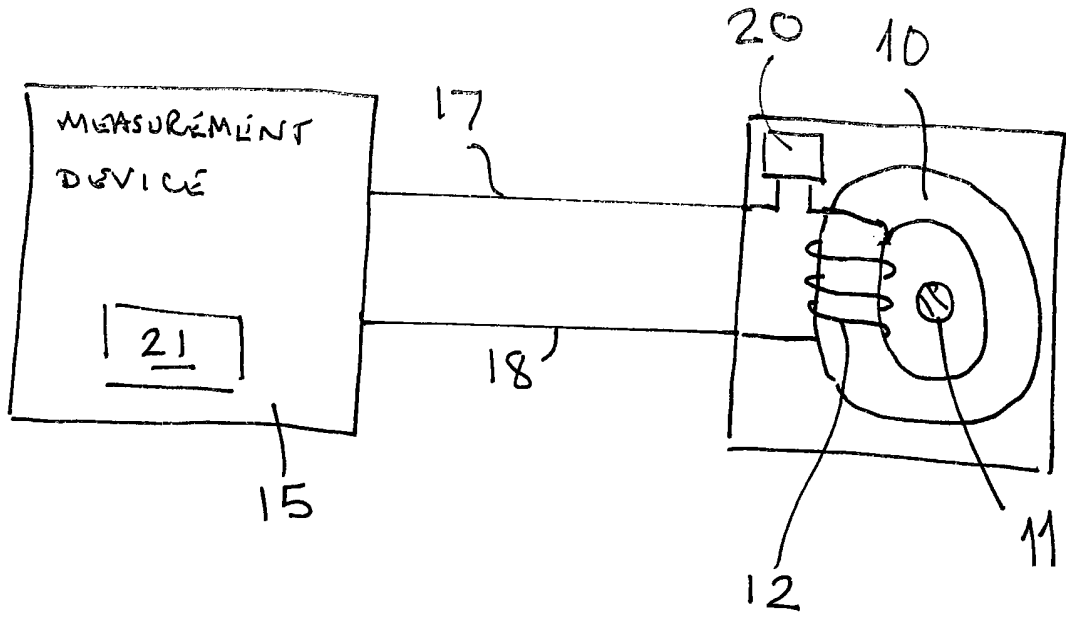
(58) Field of Search:
UK CL (Edition X) **G1U**
INT CL⁷ **G01R**
Other: **Online: EPODOC, WPI, TXTE**

(54) Abstract Title: **Tamper proof utility metering**

(57) In order to detect tampering in a utility metering arrangement employing a sensor eg a current transformer 10 remote from a measurement device 15, the sensor is provided with a signal generator 20 for injecting a monitor signal into the conductor 17 and 18 connecting the sensor to the measurement device. The measurement device is provided with a signal detector 21 for monitoring the input to the device for the presence of the monitor signal. Preferably, the monitor signal is an AC signal at a frequency close to mains frequency.



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TAMPER PROOF UTILITY METERING

The present invention relates to utility metering and more particularly to apparatus which meters consumption using a sensor remote from but coupled to a measurement
5 device.

Conventional domestic electricity supply is usually at low voltage and seldom consume more than 100A (200A in some countries). Utility meters for such supplies are constructed such that the measurement device and sensor are normally handled in a single sealed enclosure for reasons of security. Industrial supplies, in general, are either at high
10 voltage or at low voltage but draw high currents making it difficult to integrate the sensor within the meter. Such supplies usually deploy electricity meters that utilize a sensor e.g. in the form of a current transformer, for generating a sensed signal which is in a known relationship to the consumption of the utility to be metered. This sensed signal is then coupled to a separate measuring device usually by means of a wired connection. In some
15 installations, for example high voltage sub stations, the distance between the sensor and the meters may be substantially long.

While every effort is made to ensure the integrity of the connection between the sensor and the measurement device, unscrupulous persons often interfere with the connection in order to tamper with the measurement eg by bridging the connection,
20 breaking it or introducing an impedance so that a false measurement is made.

It is an object of the present invention to provide a utility metering arrangement which will permit monitoring of the connection between a remote sensor and a measurement device.

Preferably, an additional electrical signal of known characteristics is added to the
25 signal from the sensor and the measurement device monitors its input for the presence of the additional signal.

In order that the present invention be more readily understood, an embodiment thereof will now be described by way of example, with reference to the accompanying drawing which shows a block diagram of a utility metering arrangement according to the
30 present invention.

A preferred embodiment of the present invention is an electricity metering arrangement using a current transformer as the sensor. This embodiment is represented in

the drawing where a current transformer 10 is used to monitor current flowing in a mains cable 11. The transformer 10 has a secondary winding 12 which is connected to a measurement device 15 by conductors 17,18.

5 If a person wishes to tamper with the above arrangement, the vulnerable areas are the conductors 17,18 and their connections, if any with either the secondary winding of the current transformer 10 or the measurement device 15. Such tampering usually consists of full or partial bridging of the conductors 17 and 18 eg with an impedance of some sort so that the measurement device does not register the full current unit of current flowing in the mains cable 11.

10 In order to enable detection of when tampering occurs, we modify the current transformer arrangement to include a monitor signal generator 20 which is arranged to inject into one of the conductors 17,18 a monitor signal different to the mains frequency signal and to provide within the measurement device 15, a signal detector 21 for filtering out the signal generated by the signal generator 20. The variation of the monitor signal
15 indicates occurrence of tampering. It may be necessary to compare the received monitor signal with an acceptable threshold band around the ideal value in order to determine "variation". The degree of variation represents the degree of tamper with the circuit.

The monitor signal can be any suitable signal which can be discriminated from the mains frequency signal including a DC signal. However, we prefer to use an AC signal at
20 a frequency different, but not very far off, from the mains frequency, so that the impedance seen by it is not very different from the impedance seen by the mains. In this way, the measured reduction in signal is a reasonable measure of the reduction in the mains current and can be used to predict the error in measurement due to tamper. If a very high frequency signal is used, the monitor signal may not be divided significantly if the
25 tampering bridge is an inductive impedance, Similarly, if a very low frequency or DC is used as the monitor signal, then a capacitive tamper may remain undetected.

The monitor signal generator 20 is located in close proximity to the current transformer 10 by being arranged in a common housing and thus form part of the same
30 assembly. This avoids any spurious effects of the impedance from different kinds of circuits which are connected to the electricity meter. In particular, the location of the generator 20 does not require the impedance of the circuits connected to the electricity

meter to be known in order to detect tampering as would be the case if the monitor signal generator 20 was located in the meter itself.

5 The current transformer 10 determines the majority of the impedance and thus the location of the monitor signal generator in the current transformer provides for a more accurate detection arrangement regardless of the impedance of various kinds of circuits which are connected to the meter.

10 If desired, all the characteristics of the monitor signal such as amplitude, frequency and phase, may be known and then the signal detector 21 could be used to determine not just the absence of the monitor signal but also a measure of how much the monitor signal characteristics eg amplitude is less than the injected level of the characteristics in order to estimate how much the real mains current measurement has been reduced by tampering.

It is also possible to determine the date and time of tampering in the case where the tampering is intermittent.

15 The monitor signal generator is preferably powered from the current transformer and is contained, with the current transformer in a sealed unit so that its presence is not apparent.

CLAIMS:

1. A sensor for use with a remote measurement device, the sensor comprising means for generating a first electrical signal indicative to a quantity to be measured, and means
5 for generating a second electrical signal different to the first signal and for combining the first and second signals for transmission to the remote measurement device.
2. A sensor according to claim 1, wherein the means for generating the first electrical signal is a current transformer.
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3. A sensor according to claim 1 or 2 wherein the means for generating the second signal and the means for generating the first signal are contained in a common housing.
4. A sensor according to claim 1, 2 or 3, wherein the first signal is at mains
15 frequency and the second signal is different to mains frequency but close to it.
5. A measurement device for use with a remote sensor according to any one of claims 1 to 4, wherein a first signal detector is provided for detecting the first electrical signal from the sensor and a second signal detector is provided for monitoring the
20 presence of the second electrical signal.
6. A utility metering arrangement comprising a sensor according to any one of the claims 1 to 4 and a measurement device according to claim 5.
- 25 7. A utility metering arrangement substantially as hereinbefore described with reference to the accompanying drawing.



INVESTOR IN PEOPLE

Application No: GB0505657.7

Examiner: Ralph Cannon

Claims searched: All

Date of search: 10 June 2005

Patents Act 1977: Search Report under Section 17

Documents considered to be relevant:

Category	Relevant to claims	Identity of document and passage or figure of particular relevance
X	1, 3, 5, 6	GB 2259779 A (AMPY) figs. 1, 3 and related passages
X	1, 2, 3, 5, 6	US 4933633 A (ALLGOOD) figs. 1, 2, 26 related passages and col. 31 lines 1-5
X	1, 3, 5, 6	GB 2280290 A (SIEMENS) figs. 1-4 and related passages
X	1, 3, 5, 6	US 5155747 A (HUANG) figs. 4-6 and related passages.
X	1, 3, 5, 6	US 5124624 A (DE VRIES) figs. 1-3 and related passages.
X	1, 2, 3, 5, 6	EP 1102072 A1 (CORCORAN) figs 3-5 and related passages

Categories:

X	Document indicating lack of novelty or inventive step	A	Document indicating technological background and/or state of the art.
Y	Document indicating lack of inventive step if combined with one or more other documents of same category.	P	Document published on or after the declared priority date but before the filing date of this invention.
&	Member of the same patent family	E	Patent document published on or after, but with priority date earlier than, the filing date of this application.

Field of Search:

Search of GB, EP, WO & US patent documents classified in the following areas of the UKC^X :

GIU

Worldwide search of patent documents classified in the following areas of the IPC⁰⁷

G01R

The following online and other databases have been used in the preparation of this search report

Online: EPODOC, WPI, TXTE