NEW TECHNICAL SOLUTION FOR LIMITING CONSUMER'S CURRENT

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SUMMARY

This article describes a new technical solution for limiting big consumer's current, current on low-voltage and parts of middle voltage feeder (feeders in distribution substations 10 (20) /0,4kV).
Product of this new technical solution is device made with purpose to realize and/or to make equivalent of functions similar to those that over-current of middle voltage feeder relay does.
Functioning of this device is based on position reading of some pointers of analog ammeter with ''current'' scale and/or maxi graphic scale, measuring values of secondary current of corresponding current transformers.
Therefore, with continual tracking of some scale pointer positions of this measuring device, with support of at least two electric sensors (infrared detectors, inductive electric sensors..) placed on special made slots on tower (slots are made in front of the glass, along the line that makes instrument's scale) it is possible to detect characteristic current values.
Signals detected this way are further treated by control-logic unit (combination of electromehanical auxiliar relay and time relay as most elementary combinations).
This control-logic unit is used for controling switching equipment for overviewed lines and substations.
This article also describes logical algorithm that is necessary for proper functioning of device and possible solution interpretated as combination of electromehanical auxiliar relay and time relay. Device need to be supllied by 220V a.c.

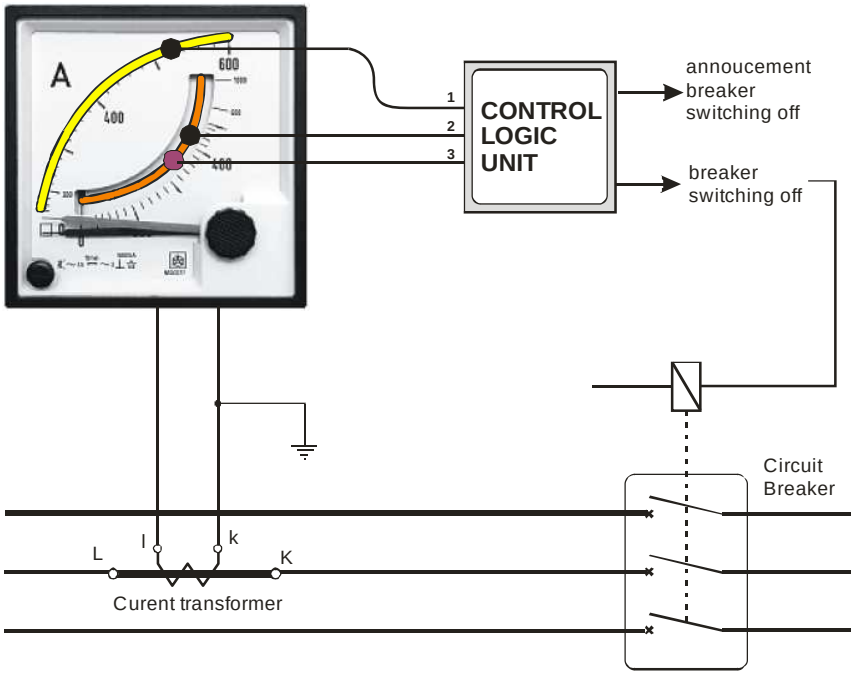
ABSTRACT

Consumers need for electrical energy becomes more significant this day. Relatively low price of electrical current contribute to this, as a fact that electrical current is the purest form of energy. In this circumstance appears a problem of rational use and limited ability of electrical power facilities to provide production of adequate amount of electrical current. Therefore, there is a need for limiting big consumer's current which can be resumed, due to abilities of electrical power facilities. There are large and /or group of small consumers (low – voltage or part of middle voltage feeder) which aim to legally

or illegally resume larger amount of instantaneous electrical current, despite allowed, by technical terms given by competent distributor. These situations, undoubtedly, cause problems within distribution electrical energy and often endanger stability of electrical power system or its parts, and as such are undesirable. There is a tendency, on the other hand, for delivering more electrical energy because, it's a sort of merchandise and all basic economic principles apply.
Described issue refer to finding more efficient way to punish ''undisciplined'' consumers and by that increase reliability of electrical system and to preserve quality of supplied energy.
Device that can solve described problem is expensive and that is the main cause of utterly rational implementation (usage). High costs of this device was primary motive to create new technical solution for limiting consumers instantaneous electrical current (or group of consumers) with small investments and adequate reliability.

DESCRIPTION OF TECHNICAL SOLUTION

As mentioned, basic idea was to design brand new device that would provide functions similar to over-current relay, and yet to have lower price. Working mode of this device is much more similar to over-current relay working mode, as it is illustrated on following picture 1.



Picture 1.

Hence, working mode for this device is based on detecting position ammeter scale pointer, placed into secondary side of current transformer. Detecting scale pointer position is completed by sensors like inductive or photoelectric sensors (depends of material that ammeter scale pointer is build) placed on front instrument glass.
Continual measuring (with ammeter over current transformer) and detecting of characteristic current values is done here.
On Picture 1. is illustrated technical solution for case of ammeter with momentary and maxi graphic scale and metallic scale pointer.
In this case, inductive sensors are used as electrical sensors, installed on specially made slots on instrument front glass.
Now it's possible to assign characteristic current values by shifting some of inductive sensors along made slots.
Information received from these sensors have binary form (logical 1 or logical 0). Hence, sensors can detect only if instrument scale pointer is or isn't below sensor. Information are processed further within Control Logic Unit and due to relation between assignment characteristic values and measured current values, decision is made (opening of circuit – breaker, signalization of exceeding values...).

DESCRIPTION OF CLU

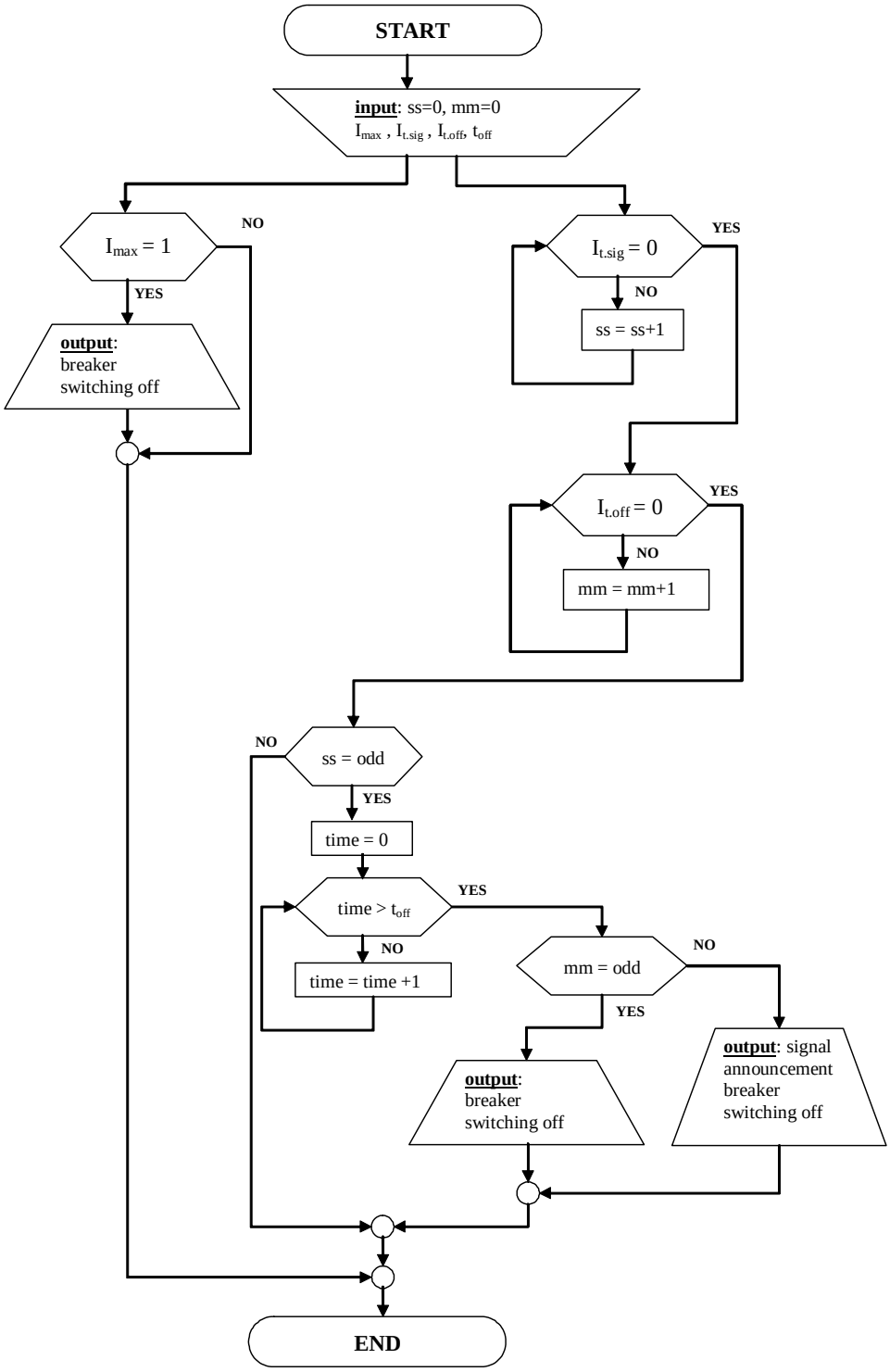
In purpose of better acquaintance with methodology applied in new technical solution (illustrated on Picture 1.) it's very important to explain working mode in details.
Thus, posted sensors (inductive sensors) detect only ''passing'' of instrument scale pointer. Practically, result is information in form of short – time impulse which appears at the moment of passing instrument scale pointer below sensor. Impulse continuance depends of scale pointer movement rapidity, respectively of current value increasing and instrument own responding time.
After detail analysis of all possible situations, there are three characteristic cases:

- Scale pointer (needle) ''pass'' below inductive sensor and return back henceforth defined time (current increase over assigned value but decrease before defined time)
- Scale pointer is below sensors (current is just over /or equal assigned value)
- Scale pointer ''pass'' below inductive sensor and return back after henceforth defined time (current increase over assigned current value and decrease after defined time)

In first case, inductive sensor after this activity of scale pointer as a result gives two impulses, one during current increasing and one during current decreasing. In second case, sensor result is one continual signal. In third case, sensor result is one signal. After first case results, CLU has no demand, but in second and third, CLU demands opening of circuit – breaker with defined time-delay.
Based on these criteria, logical diagram illustrated at Picture 2 is created. Following diagram represent CLU working steps. CLU input data are binary outputs of tree inductive sensors and assign time. Each of mentioned inductive sensors is placed in a way that is able to respectively assign thresholds for:

- Average 15-min current value
- Momentary effectual current value during which there is announcement of opening circuit – breaker
- And momentary effectual current value during which opening circuit-breaker happen

Assigned time represents time during which exceeding value of measured current is tolerated.
In the next chapter is analyzed case when 15-min current value increases over assigned and possibility of momentary opening circuit-breakers as a result.
Interesting situation happens during measuring and detecting position scale pointer which measure momentary effectual current value (two inductive sensors: sensor for alarm and sensor only for opening circuit-breakers). Hence, here occurs all three previous described cases and it's elementary to stop unnecessary opening circuit-breaker when fast and unexpected change of current value, happens. Conclusion is that opening circuit-breaker is wanted only when in assign period odd number of impulses appear.
In other terms, it is necessary to fulfill opening circuit – breaker each time when during defined time odd number of impulses or one continual impulse appear.

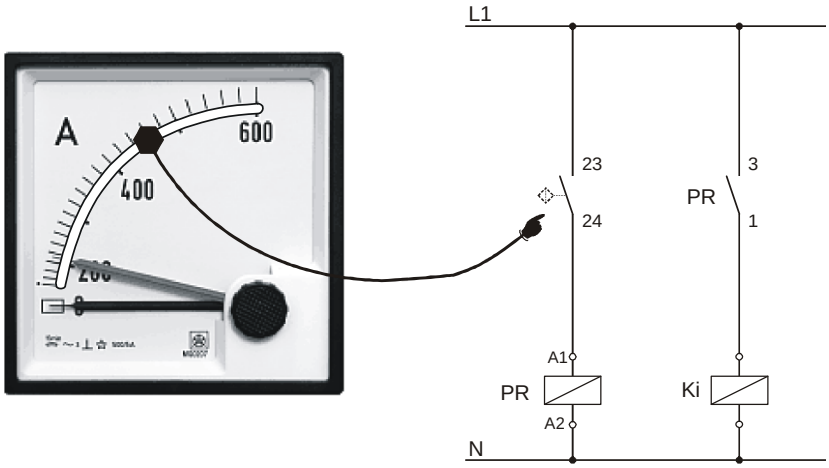


Picture 2.

- I_{max} – binary signal given by sensor that react on average 15-min effectual current value
- $I_{t.sig.}$- binary signal given by sensor that react when defined effectual current value is exceeded and means announcement of opening circuit – breaker
- $I_{t.off}$- binary signal given by sensor that react when defined effectual current value is exceeded and means opening of circuit – breaker
- I_{off}- opening circuit – breaker time delay (during this time exceeded current value is tolerated)

EXAMPLE OF PRACTICAL IMPLEMENTATION

Logical algorithm, on which CLU working mode is based on, shows that in case of exceeding value for average 15-min current value, momentary opening circuit – breaker is necessary. This directly follows from principle on which particularly current measuring is based on.
Therefore, value showed by instrument scale pointer represents average value of effectual current value for time period of 15-minute. Real measured value practically scale pointer shows 15-minute after.
In respect to this fact, on Picture 3 is illustrated less complicated technical solution, where all of CLU is created by using classical complete of electromehanical auxiliar relays.



Picture 3.

In illustrated technical solution, as current sensors, bimetal ammeter with maxi graphic scale is used. Inductive sensor is used as sensor that detects position of instrument scale pointer and it is installed on instruments front glass. Sensor is posted (placed) in specially made slots on glass that follows instrument scale and make possible relatively precise setting of thresholds.
When measured current value increase over defined, inductive sensor gives impulse over its own operating contact launch support relay PR, which further open circuit-breaker by sending impulse to spooler k_i.

CONCLUSION

In this paper is represented idea for new technical solution for limiting consumers current, acceptably by own functionality and adequate price in a way that can be implemented at big consumers, whenever if they are supplied by middle voltage or low voltage feeder. Methodology, on which device working mode is based on, lean on detecting scale pointer position with support of some inductive sensors. These sensors can be some photoelectric element, inductive sensor or similar, which in many things depends of ammeter construction and type of material that scale pointer is made of.
In paper is also described utterly simple way how to create power limiter for big consumers. Whole idea is based on detecting over-much current value with support of sensors and instrument scale pointer. This point to similarity with over-current relay. As in case of over-current relay, here also detecting over-much current value is present, measuring transformers and circuit-breaker are necessary. But in spite of this similarity in a way of working, it's necessary to say that this new device can not be used to replace over-current relay protection, but only as one specific type of big current limiter. Reason of this are bonded with accuracy, sensitivity, reliability and some specific qualities of new device.
Hence, quality of working mode for this device depends of class of accuracy, construction of ammeter, quality of inductive sensors, reliability of CLU and all of this factors dropout implementation of described technical solution.

KEY WORDS

- device for over current protection
- consumers consumption limiting
- increasing of senseability of fast over –current protection
- inductive sensor
- ammeter with ''current'' scale and maxigraphic scale

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