# ABOUT THE EXAMINATION OF AN ALTERNATIVE TECHNIQUE
# OF THE MOTOR LOAD ACCORDING TO THE RESONANCE LOAD

Hironobu Igarashi[1] and Takanori Sato[1] Kousuke Kurokawa[2]

[1] Japan Electrical Safety & Environment Technology Laboratories.5-14-12, Yoyogi, Shibuyaku, Tokyo 151-8545 Japan
[2] Tokyo University of Agriculture and Technology. 2-24-16 Naka－cho , Koganei 184-8588 Japan

The islanding phenomenon is generated by the load with the resurrection energy. The kind of the resurrection load has the resonance load and the motor load, etc. It turns out that the load that generates a lot of islanding phenomena is a motor load in those a lot of kinds of loads from our experiment result. To confirm we were loads where the characteristic of the motor load being able to generate the islanding phenomenon most in this experiments, the characteristic of the motor load was replaced with a linear load and it verified it to a linear load like the resonance load. Moreover, it was assumed that the inductivity load characteristic of the motor load was substituted and it matched and it examined it.

**Keywords**: Islanding, islanding phenomenon, motor load, resonance load

## FOREWORD

### General

Recently, the concern for global environmental concerns such as global warming has spread between general people.

Therefore, the photovoltaic generation system for the house is paid to attention as a clean energy source from which $CO_2$ is not exhausted to the power generation of the electric power. The Grid connect type is most popular photovoltaic generation system.

The Grid connect system is a system that can do the selling of electricity to a power company of the remainder of the electric power used at the power generation electric power and home to the general electric utility. It is necessary to set up the islanding detection device to the selling of electricity to a power company situation the general electric utility of the electric power in which electricity is generated in the photovoltaic generation system. Because it is necessary to detect the power failure due to the accident that occurs in the power line in the electric power company, to stop the power generation of the photovoltaic generation system, and to prevent the electric shock.

However, it is rugged and it might be difficult to detect the power failure of the electric power company the islanding detection device by the influence of the load with the resurrection energy.

Authors were confirmed the motor load was generated of the state of the islanding from the resonance load and verified whether to obtain the comparable result when the inductivity load of a linear load substituted[1] and the motor load this time.

## STUDY OF RESONANCE LOAD AND MOTOR LOAD

### Resonance load by IEC standard

The resonance load by the IEC standard is a resonance load in which an inductivity load, a capacitive load, and the resistance load are connected in parallel. The size of the inductivity load of the resonance load is requested by the expression (1). Moreover, a capacitive load equal with the inductivity load is prepared. To consume the active power that the power conditioner outputs, the same resistance load as the declared power is connected. Therefore, amount PqL of the inductivity load becomes 2.6kVar obtained from the expression (1).

$$P_{qL} = Q_f \times P_{EUT} \qquad (1)$$

$P_{qL}$ : inductive load [VARL ]

$P_{EUT}$ : Rated power of power conditioner

$Q_f$ : 0.65

### Comparative study of resonance load and motor load

The resonance load and the motor load have a regenerative energy. The islanding detection device generates the islanding phenomenon by the influence of the energy discharged from the resurrection load. Therefore, it is necessary to clarify the energy of the resonance load and the motor load. Moreover, it is necessary to measure the load it with the same amount of the resurrection energy to prove the influence of the regenerative energy given to the islanding detection device and to prove. Therefore, the energy discharge time was measured by the following methods by using the circuit chart shown in Fig. 1 and 2.

1. Parallel resistance load (R) is increased from 0 to 4000W at the time of each carving 100W, and it is assumed the following procedures of ② -④ and repeats.
2. Switch SW$_{CB}$ is opened according to the timing of t=0.
3. Voltage V1 between lines measures time ΔX(Sec)

that decreases up to 20V.

4. The electric energy amount consumed by the parallel resistance load is requested.



V$_1$ : AC Voltmeter
M : Motor Load
R : Resistance Load

Fig. 1.Measurement circuit at energy discharge time motor load



V$_1$ : AC Voltmeter
L : Reactor Load
C : Capacitor Load
R : Resistance Load

Fig. 2.Measurement circuit at energy discharge time resonance load

**Result of measurement**

The measurement result at the energy discharge time became a result as shown in Figure 3.



Fig. 3 Measurement result at energy consumption time.

It turned out the measurement result that the rotation machine load 170W was the same as the energy discharge time of the resonance load. However, it was assumed that the amount of energy was requested by the expression (2) from equal uncertain even if the energy discharge time was the same the amount of energy.

$$J = R \times \int i^2 dt \qquad (2)$$

J : Amount of electric energy [J]

R : Resistance [Ω]

i : Current A that flows to resistance [A]

The energy discharge characteristic was shown that it became a result as shown in Figure 4 and the resonance load was equal to the motor load 170W, and result the same as the measurement result of the energy discharge time. Moreover, the difference of the energy discharge characteristic that was not able to be confirmed at the energy discharge time was able to be confirmed from the point where the parallel resistance load had exceeded 1000W. As for this phenomenon, the one that the current that flowed to parallel resistance increased is thought as a factor by the resonance of parallel resistance and each load.



Fig. 4 Calculation result of amount of energy discharge.

**Alternative examination of motor load by linear load**

The motor load is thought to be the same characteristic as the inductivity load when driving under no load. Therefore, the current and the voltage of the characteristic of the motor load of 170W were measured and arithmetic was done from the measurement result to the amount of the inductivity load. As a result, it turned out that the motor load of 170W had the reactive power of 180Var. The load in which the inductivity load for 180Var was added to the resonance load and the motor load of 170W respectively was made. The islanding test used the load in which the inductivity load for 180Var was added to each load. Fig.5 shows the islanding test circuit.



V$_1$ : AC Voltmeter    A$_1$ : AC Ammeter
W$_e$ : AC Wattmeter    W$_{ry}$ : Vary Meter
CPT : AC PT         ACCT : ACCT
R$_{ASC}$ : LOAD

Fig.5 Islanding test circuit.

**Result of islanding test**

It was able to be confirmed to the experiment result the generation of the islanding phenomenon in this load balance condition of both loads. Table 1 is an islanding experiment result of adding the inductivity load of 180Var to the resonance load. The value is time until stopping detecting the islanding phenomenon. Moreover, when the detection value of the islanding phenomenon has stopped exceeding one second, it judges as an islanding and the numerical value is not filled in. Table 2 is an experiment result of adding the inductivity load of 180Var to the motor load.

Table 1. Islanding detection time of resonance load plus 180Var inductivity load.

| Unit [mS] | | Reactive power （Var） | | | | |
|---|---|---|---|---|---|---|
| | | −10% | −5% | 0% | +5% | +10% |
| Active power （W） | −10% | 663.3 | Islanding | 676.9 | 640.8 | 646.2 |
| | −5% | 627.9 | Islanding | Islanding | 639.8 | 616.8 |
| | 0% | 633.7 | Islanding | Islanding | 667.0 | 619.1 |
| | +5% | 672.2 | Islanding | Islanding | 670.0 | 632.7 |
| | +10% | 690.1 | 798.1 | Islanding | 675.1 | 649.5 |

Table 2. Islanding detection time of motor load plus 180Var inductivity load.

| Unit [mS] | | Reactive power （Var） | | | | |
|---|---|---|---|---|---|---|
| | | −10% | −5% | 0% | +5% | +10% |
| Active power （W） | −10% | 618.0 | Islanding | Islanding | Islanding | 626.0 |
| | −5% | 665.0 | 702.0 | 686.0 | 691.0 | 647.0 |
| | 0% | 628.0 | Islanding | Islanding | 719.0 | 626.0 |
| | +5% | 675.00 | Islanding | Islanding | 688.0 | 601.0 |
| | +10% | 649.0 | Islanding | Islanding | 649.0 | 623.0 |

However, we show the islanding experiment result of doing in the past only by the motor load in Table 3.

Table 3. Islanding detection time limit by motor load (170W)

| Unit [mS] | | Reactive power （Var） | | | | |
|---|---|---|---|---|---|---|
| | | −10% | −5% | 0% | +5% | +10% |
| Active power （W） | −10% | 655.0 | Islanding | 743.0 | 702.8 | 637.8 |
| | −5% | 644.6 | 684.8 | Islanding | Islanding | Islanding |
| | 0% | 628.3 | Islanding | Islanding | Islanding | 650.8 |
| | +5% | 641.6 | Islanding | Islanding | Islanding | 621.6 |
| | +10% | 647.6 | 726.6 | Islanding | Islanding | 619.6 |

Only the motor load is generated when the experiment results of doing only by the motor load in experiment result and Table 3 where the resonance load in Table 2 was combined with the motor load are compared and more islanding phenomena are generated. islanding detection time of resonance load plus 180Var inductivity load. When the factor to generate the islanding phenomenon that is the characteristic of the motor load that the influence by the resonance loads originally has been erased, this test result is surmisable.

**Summary**

This result of reviews were compared by adding the amount of the inductivity load of equal to the motor load amount to the resonance load, and experimenting on the islanding prevention with resonance load 2.6kVar as an alternative load of the motor load.

As a result, even if the inductivity capacity of the motor load was able to be shown simply as a linear load of the inductivity load because a lot of islanding phenomena were generated in the case only of the rotation machine load, it turned out to differ from the factor to generate the islanding phenomenon though the thing that almost the same islanding phenomenon as both load condition is generated was confirmed.

**References**

[1] Hironobu Igarashi: "The tests of islanding have an influence on motor", Proc for 2005 National Convention Record IEE Japan, No.6-192, p.341~342 (2005)