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ONTARIO HYDRO

RESEARCH DIVISION REPORT

To Mr. J.R. Leslie
Manager
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MONITORING OF CVTs IN HIGH-VOLTAGE STATIONS

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Equipment capable of measuring and monitoring the in-phase and quadrature voltage errors between CVTs in a high-voltage station is described. The monitoring of relative errors of CVTs is capable of detecting the failure of individual capacitor rolls in a CVT.

Equipment capable of monitoring the in-phase and quadrature errors of potential transformers has been of interest to this Department for determining the metering accuracy and the stability of CVTs/1,2/.

Recently, equipment of similar nature has been proposed as a monitor for detecting the failure of individual capacitor rolls in a CVT/3/. Another paper indicates that the failure of a capacitor roll is preceded by an increase in dissipation factor of the capacitor stack/4/. This should result in a change of phase error prior to the change of a ratio error when one of the capacitor rolls fails.

Although the detection of failed rolls is most important in CVTs used for metering applications, the errors resulting from these failures also change the reach of distance relays. The prompt detection of failures is also important because these may lead to other roll failures or to a catastrophic failure of the CVT.

Generally speaking, a CVT consists of a high voltage capacitor section C1 and a low voltage capacitor section C2. For 230 kV, C1 comprises of approximately 90 capacitor rolls, while C2 comprises of approximately 10 rolls. A failure of a roll in the C1 section results in a rise of output voltage of approximately one per cent. A failure of a roll in the C2 section results in a fall of output voltage of about ten per cent. A failure of a roll in the C2 section is also associated with a phase error, since the CVT becomes detuned by such a large change in capacitance.

Because of the large voltage change, failures in C2 are readily spotted. Similarly, failures in C1 are seldom noticed, because of the small voltage change.

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The equipment to be described is capable of measuring and providing outputs proportional to the in-phase (ratio) and quadrature (phase) differences between potential transformers or CVTs. The outputs can be used to operate alarms or to be continuously recorded using a suitable recorder.

The Equipment

A somewhat simplified diagram of the proposed instrument is shown in Figure 1. The instrument uses the input from the reference CVT or magnetic transformer to generate an in-phase and quadrature voltages of both sinusoidal and square wave shape. The sinusoidal voltages are used to correct or bias any ratio or phase errors between the test CVT and the reference CVT. The square waves are used to synchronously demodulate the residual voltage between the test CVT and the reference CVT into an in-phase and a quadrature components. These components can be delayed with a filter of long time constant before they are applied to the meter or recorder.

The outputs (P and Q) in Figure 1 give a voltage of 1 volt dc per volt of ratio or phase error ac, respectively. Potentiometers R_P and R_Q can provide a correction of ±10 per cent in ratio or phase between the reference and test CVTs. If R_P and R_Q are adjusted to give zero output at P and Q, then the approximate error of the test CVT can be determined from the dial readings of R_P and R_Q.

Discussion

The equipment described cannot, unfortunately, distinguish the difference between errors due to a capacitor roll failure from the errors due to meteorological changes. A trained observer, however, should have no difficulty in spotting a capacitor roll failure from a continuous record of the errors, and the permanent nature of the errors caused by the failure. The change in phase error prior to a change in ratio error, as indicated in Reference 4, should make the spotting of a failure rather easy.

With a large quantity of CVTs on Hydro's 230-kV system, there are probably some units that have failed capacitor rolls. With no suitable equipment available to them, the operating personnel have a difficulty in locating these failures. The equipment described in this report, in addition to detecting failed capacitor rolls, is capable of detecting malfunction of the tuning or magnetic units associated with each CVT.

Conclusions and Recommendations

The CVT monitoring equipment described in this report could become an important tool for the operating personnel in their efforts to maintain CVTs in good operating condition. In addition to monitoring failures of CVT components, the equipment can give long-term performance data on CVTs operating on Hydro's system.

It is recommended that a three-phase unit capable of monitoring two or more CVTs at the same time be procured and installed in a suitable station. The results of this initial investigation can then be used by ourselves or the operating personnel for determining the usefulness of the equipment.

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References

1. "Digital Recording of Ratio and Phase Angle During Capacitor Voltage Transformer Tests". Research Report No E69-48.

2. "Recording the Ratio and Phase Angle Errors of Potential Transformers". Research Report E72-41.

3. A. Otis, B. Renz and T.V. Schrader. "Voltage Comparator Makes CCVT Practical". Transmission and Distribution. November 1974.

4. H.R. Lucas. "Failure Detection on High-Voltage Coupling Capacitors". 1975 Doble Insulation Conference 42AIC75.

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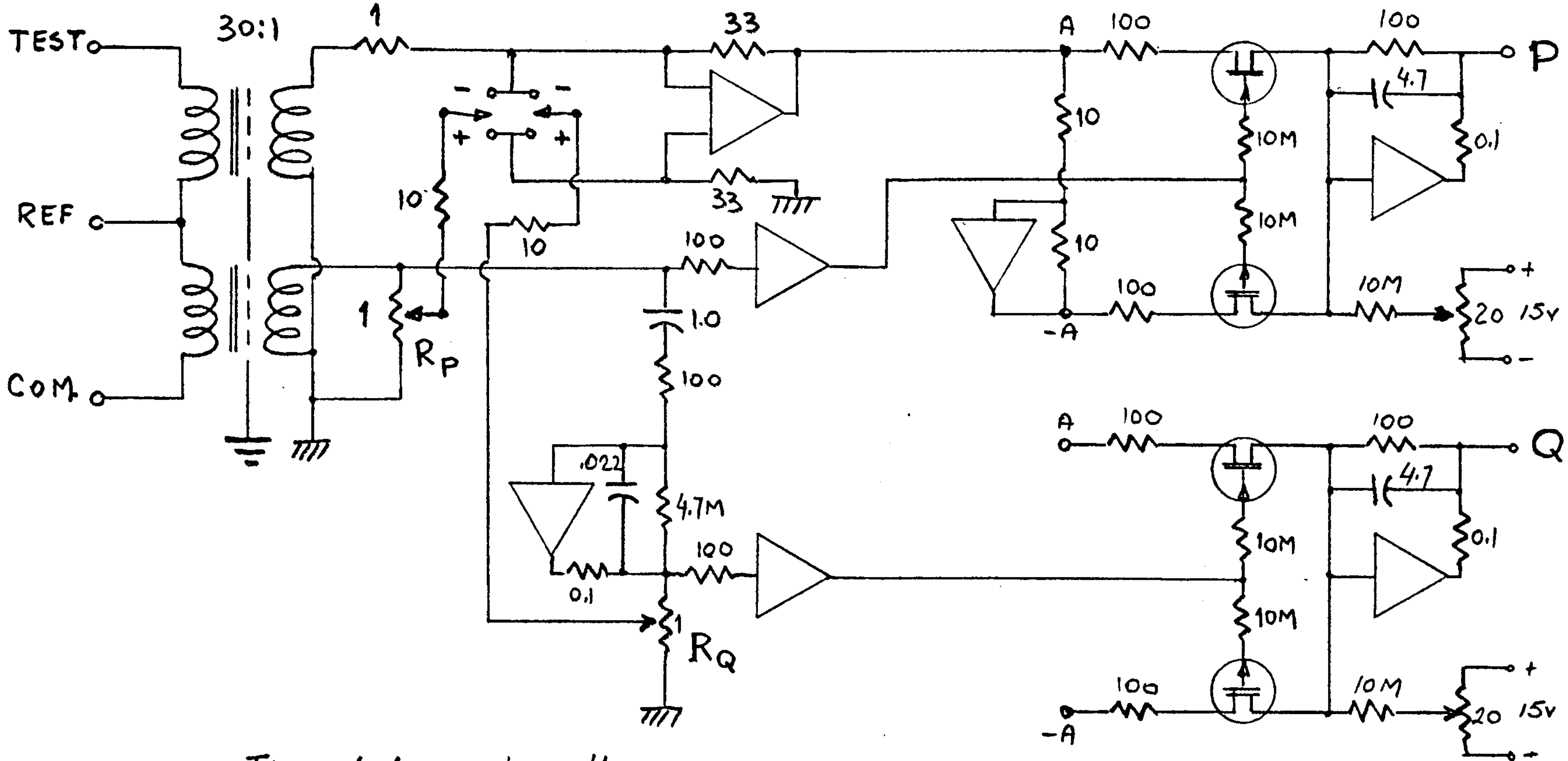
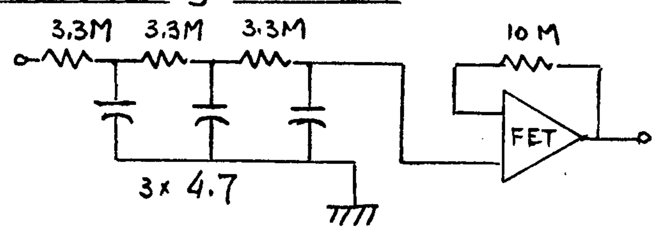


Time delay circuit.



P = Ratio Error Output
Q = Phase Error Output
Resistors in kΩ.
Capacitors in μF.

Figure 1

Potential Transformer Error Measuring Circuit.