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INSTRUCTION BOOK
FOR
STANDARD RATIO TRANSFORMER
"RATIOTRAN"

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The catalog included in this instruction book gives mechanical and electrical characteristics including voltage and frequency limitations for standard models. RatioTran and Bridge Transformers. The following technical bulletins are in the catalog.

BULLETIN NO.	SUBJECT
1.	Theoretical Analysis of Accuracy of Ratio Transformers
2.	Use of Gertsch Standard Ratio Transformers for Low Impedance Voltmeter Calibration
3.	Accuracy Calculations for Gertsch Standard Ratio Transformers
4.	Use of RatioTrans in Bridge Circuits
5.	Measuring Small Phase Angles
6.	The Rotary RatioTran
7.	Use of Gertsch Rotary RatioTran for Calibration of Precision Potentiometers

SECTION I - GENERAL DESCRIPTION

A. Gertsch Products RatioTrans are high precision AC Voltage Dividers. They have the following useful features.

1. EXTREME ACCURACY

The Gertsch RatioTran series of voltage dividers is based on the use of toroidal auto transformers designed for maximum accuracy of voltage ratio. Magnetic flux in the toroidal core links all turns of the transformer and induces the same voltage in each turn.

2. ACCURACY NOT AFFECTED BY AGE

The turns ratio of the transformer will not change with age. Changes in winding resistance have only a negligible effect on voltage ratio. Damage to the transformer will usually result in complete failure rather than deterioration of accuracy.

3. HIGH INPUT IMPEDENCE

The magnetizing inductance of a RatioTran is very large and the power loss in the transformer is very small, therefore if the output of the RatioTran is not loaded, the transformer itself presents a high impedance to the source.

4. LOW OUTPUT IMPEDENCE

If driven from a constant voltage source the RatioTran presents an impedance of only a few ohms as seen at the output terminals. This characteristic is useful in calibrating volt meters since loading effects can often be neglected. It is also useful in bridging applications since electrostatic shields may be connected to this low impedance point to minimize electrostatic pickup and capacitive loading of an unknown divider.

5. MECHANICAL RUGGEDNESS

All models of the Gertsch RatioTrans are designed to withstand years of continuous useage without maintenance.

SECTION II - OPERATION AND LIMITATIONS

A. AC BRIDGING

A RatioTran may be used in a bridge circuit for precise measurement of the voltage ratio of unknown dividers. To realize the ultimate accuracy available from the RatioTran it is usually necessary to balance the bridge within a very small error voltage. To accomplish this, a high gain amplifier is usually required on the null detector side of the bridge. An AC VTVM can usually be used. If noise or harmonics of the bridge frequency prevent accurate balancing of the bridge, these voltages can be reduced by tuning the null detector. A tuned circuit can be used at the input of a VTVM or other null amplifier. Several types of audio frequency filters and tuned volt meters are commercially available. One type of tuned volt meter is commonly used in microwave standing wave ratio measurements. These devices are usually tuned to 400 or 1000 cycles. They have adequate sensitivity for most AC bridging applications.

The basic bridge circuits are shown in Engineering Bulletin No. 4, which is part of the RatioTran Catalog included in this instruction book. Any type of unknown voltage divider may be substituted for the resistive divider shown in these circuits. Auto transformers, two winding transformers, synchros, resolvers, and resistive attenuators can be calibrated in this manner.

The RatioTran should normally be operated as a stepdown auto transformer. If it is necessary to operate as a stepup transformer, the potentiometer on the RatioTran should be turned to one end of its range, if the unit used has a potentiometer. The accuracy of the unit will always be less as a stepup transformer than as a stepdown voltage divider. The accuracy will rapidly become worse as the stepup ratio becomes larger. At a stepup ratio of two, the accuracy will probably be no better than a .01%.

It is possible to measure the phase angle of an unknown voltage divider in a bridge circuit by the method described in our Engineering Bulletin No. 5. This is included in the RatioTran Catalog.

B. METER CALIBRATION

If the voltage into a RatioTran is adjusted for a precisely known value, the output may be used to provide known voltages for meter calibration. A wide range of calibration points can be covered without changing the input voltage to the RatioTran. With vacuum tube volt meters, or rectifier type meters, the voltage drop in the RatioTran caused by loading can usually be neglected.

If low impedance instruments such as dynamometers or thermocouple meters must be calibrated, a bridge circuit can be constructed to provide a precisely known voltage to the meter under test without loading the RatioTran. This method is described in Engineering Bulletin No. 2 in the RatioTran catalog. Engineering Bulletin No. 3 gives information on loaded and unloaded accuracy of the RatioTran which is also applicable to this problem.

C. LIMITATIONS

a. No direct current should be applied to the RatioTran. Currents larger than 1 MA. D.C. will cause noticeable saturation effect and will cause the accuracy to deteriorate. This is a core saturation phenomenon and it will not permanently affect the accuracy of the RatioTran.

b. Voltage Limitations:

Maximum RMS voltage which may be applied to RatioTran is limited to 350 volts to avoid possible insulation breakdown. Voltage may be limited to less than this value by core saturation. The maximum voltage which can be handled before saturation occurs is proportional to frequency. Two different sizes of transformers are used in the manually switched RatioTrans. The smaller transformer saturates at $.35F$ where F is frequency in cycles per second. This would be approximately 20 volts at 60 cycles and 140 volts at 400 cycles. The larger transformer saturates at $2.5F$. This is 150 volts at 60 cycles. RatioTrans using the large transformer are most accurate in the vicinity of 60 cycles. Their accuracy deteriorates rapidly above 1000 cycles due to relatively large leakage inductance and stray capacity/ RatioTrans using the small transformer are most accurate in the vicinity of 400 cycles. These

transformers maybe used from 50 to 3000 cycles with normal rated accuracy provided voltage limits are not exceeded. A reduced accuracy specification is listed in the catalog for frequencies from 3000 to 10,000 cycles. Use above 10,000 cycles is not recommended. No accuracy ratings are published for frequencies above 10,000 cycles since units of the same type will differ considerably from each other in this frequency range. Deterioration of accuracy at high frequencies is caused by leakage inductance and stray capacity. The exact value of these quantities varies from one transformer to another because of differences in relative position of wires on the transformer core.

SECTION III - TESTING AND MAINTENANCE

A. FUSES

All manually switched RatioTran contain fuses to protect the instrument against accidental overloads. On most models fuse posts are provided on the front panel. On others the fuses are inside the case and the instrument must be opened to replace fuses. Size 3AG 1-1/2 amp. slow blow fuses should be used. Use of smaller fuses or fuses other than the slow blow type may cause some loss of accuracy by introducing additional resistance in the circuit. 3AG 1/2 amp. fuses are used to protect the output circuits of models 1 and 10 because of the higher resistance potentiometers in these units.

B. TESTING

RatioTran are not affected by age and do not require periodic calibration. This is because the voltage ratio of the unit is controlled by turns ratio of the transformer. This is something that will not change with age. Small changes in winding resistance have a negligible effect on ratio accuracy. Any periodic tests conducted on these units should be designed mainly to detect noise or improper operation of the switches and potentiometers. Three methods of testing RatioTran are listed below:

1. BRIDGING

An AC bridge maybe constructed using two RatioTran or a RatioTran and some other voltage divider. Two RatioTran can be checked against each other in this manner. Go through each decade one step at a time comparing one divider against the other. Also run the potentiometer of the RatioTran across its range if the unit is equipped with a potentiometer. Look for noisy switch contacts and noisy potentiometer contacts while making this test.

2. AC VOLTAGE TEST

Connect a known source of AC voltage to the input of the RatioTran and measure the voltage across the output terminals with an AC vacuum tube volt meter. Go through each step of each decade and run the potentiometer from one end to the other if there is one. The voltage readings will give an approximate check on ratio and any poor contacts will cause fluctuation fo the VTVM.

3. OHM METER TESTS

Short the input terminals of the RatioTran. Measure the

resistance across the output terminals with an ohm meter. Go through each step on each decade and run the potentiometer across its range if there is one. The maximum value of resistance observed on any step should not exceed the value given for that particular model in the RatioTran catalogue for R_g . Poor contacts will cause fluctuation of the ohm meter needle.

C. MAINTENANCE

1. SWITCHES

If high resistance or noisy switch contacts are found in a RatioTran the unit may be opened and the switches may be cleaned and lubricated. In the case of the models 6, 7, 8, 9, 11, 12, and 13, that is, models using heavy duty stud contact switches, the switch contact pressure may be adjusted if necessary. This is done by loosening the set screw holding the switch wiper assembly to the switch shaft and moving the wiper assembly along the shaft. This operation may be required because of contact wear after the switches have run to a very large number of operations. The switches used in other models of the manually switched RatioTran cannot be adjusted and must be replaced if they are still noisy after being cleaned and lubricated. If possible the unit should be returned to the factory to have switches replaced so that it can be completely checked out after this operation. If a switch must be replaced in the field extreme care should be taken to see that all leads are placed in the correct position on the new switch. Voltage ratio should be checked with the new switch in each position to be sure all leads are in the correct position. These same precautions should be observed if a potentiometer must be changed.

SECTION IV - MAINTENANCE PARTS LIST

This list includes only parts which may be replaced in the field without loss of accuracy.

NO. REQ'D PER UNIT													DESCRIPTION	GERTSCH PT. NO. OR VENDOR AND DESIGNATION
RatioTran Model														
1	2	3	4	5	6	7	8	9	10	11	12	13		
1	2	2	2	2	2	2	2	2	1	2	2	2	Fuse, 3AG, 1-1/2 Amp slow blow Fuse: 3AG 1/2 amp.	Littelfuse #31301.5 Littelfuse #312.500,
5	5	5	5	5	5	5	5	5	5	5	5	5	Binding post	Gen. Radio Type 938-A
4	4	4	4	4	4	4	4	4	4	4	4	4	Binding Post In sulator	Gen. Radio Type 928-Z
1									1				Potentiometer: 10 turn 25 Ohms	Helipot #25-AZ
			1	1		1		1		1	1		Potentiometer: 1 turn 5 Ohms	*RV-5
3	5	5											Switch: Push Button, 2 Pole 10 position	Oak #63398-130
			5	5									Switch: Rotary, Wafer type, 2 Pole 10 Position	Oak #66788-F2C
									3				Switch: Rotary, Wafer Type, 2 Pole 10 Position	*SW-1
					1	1	1	1		1	1	1	Switch, Rotary, Stud Contact type, Wired with Transient Suppressing Resistors	*SW-4-1
					2	3	2	3		3	3	2	Switch, Rotary, Stud Contact Type, Wired with Transient Suppressing Resistors	*SW-4-2
					2	1	2	1		1	1	2	Switch, Rotary Stud Contact Type, Wired with Transient Suppressing Reisitors	*SW-4-3

* Gertsch Products Inc. Part No.