INSTRUCTION BOOK FOR STANDARD RATIO TRANSFORMER "RATIOTRAN"

SECTION I - GENERAL DESCRIPTION

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 IMPEDANCE

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 IMPEDANCE

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 usage 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 mea surements. 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 substitued 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 (Page 1, Page 2). 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 noticable saturation effect and will cause the accuracy to deteriorate. This is a core saturation phenonema and it will not permanently affect the accuracy of the RatioTran.

b. Voltage Limitations: Maximum RMS voltage which maybe 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 0.35F 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 may be 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 RatioTrans 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

RatioTrans 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 RatioTrans or a RatioTran and some other voltage divider. Two RatioTrans 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 equiped 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. OHMMETER 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 Rs. 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.

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GERTSCH STANDARD RatioTrans*

GENERAL:

Gertsch Standard Ratio Transformers (RatioTrans* also known as Gertsch Boxes* and DecaTrans*) are unique in the field of precision A.C. voltage dividers. Their inherent characteristics of high input impedance, low effective series impedance, and very low phase shift are basic factors which are recognized as being necessary for a good A.C. voltage divider. Performance, in fact, approaches that of the ideal divider.

ACCURACIES:

For the division of A.C. voltages, RatioTrans* are far superior to resistive dividers. This is due to extremely low phase shift characteristics (typical .05 milliradians for normal operation) and the advantages of uniform "shunt switching, multiple winding" techniques, covered by U.S. Patent No. 2,832,036. Accuracies of 0.001%, terminal linearities of 0.001%, and infinite resolution is obtainable with some units.

ACCURACIES UNDER LOAD CONDITIONS:

While the RatioTran* is designed basically for use in an unloaded condition for maximum accuracy, because of design parameters, reasonable loads may be applied. The resulting accuracy is a function of this load. With reference to the equivalent circuit Fig. 1, assuming an ideal transformer, looking into the arm, we see impedance (Ls and Rs) in series with the arm, which is due to leakage inductance, wiring resistance, switch resistance, potentiometer resistance and other stray circuit parameters. From these series impedances, the effect of loading upon the transformer, an overall accuracy can be calculated. Typical values of Rs and Ls are 3 ohms and 75 uh. In the assumption of the ideal transformer, the indicated unloaded accuracies apply at the arm of the assumed ideal transformer.

CONSTRUCTION:

The unique patented construction of Gertsch RatioTrans* provides "built in" performance factors which are most important when the units are used as an instrument, or incorporated into a system design. Some of these features are:

(1) Ability to maintain extreme accuracy with time. The units are essentially ageless devices, thus reducing costs for periodic check and recalibration.

(2) Ability to withstand environmental conditions. All units will operate properly over the temperature range of —15° to +80°C, and are not appreciably affected by extremes of altitude and humidity. All units will withstand normal shock and vibration requirements, consistent with their design usage.

(3) All units are adequately protected with fuses to prevent damage due to improper hook-up or excessive voltage or load applications.

BASIC TYPES:

RatioTrans* are available, as will be seen by a study of this catalog, in an almost unlimited variety of functional types and form factors. In the various standard "off-the-shelf" designs, ratios may be set by almost any method from the simplest manual in-line decade, to coaxial rotary set, to proportional shaft position, to remote binary selection. Many varieties of form factors, choice of switches, etc. are available within the various general types. Special RatioTrans* can be designed for incorporation into customer systems.

APPLICATIONS:

For use as a standard of ratio, the ratio arm of a bridge, A.C. potentiometer, for checking resolvers, servos, transformers, computers and so forth, the RatioTran* has no equal. *FOR MORE COMPLETE APPLICATIONS, REFER TO GERTSCH ENGINEERING BULLETINS ON RatioTrans* WHICH FORM SECTION NO. XI.*

EQUIVALENT CIRCUIT

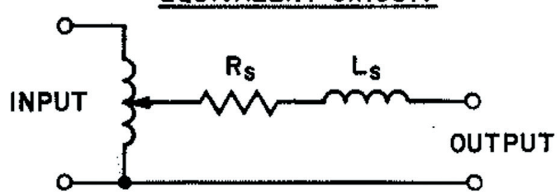

Figure I

* *Trademark*

SUMMARY OF RatioTran* MODELS

The various switch type models of Standard Ratio Transformers have been designed to cover specific applications. Functionally, all models are basically the same. The principal differences are in mechanical construction and such details as the type of switch, number of decades, degree of resolution, maximum input voltage allowable, form factor and other details sometimes important to the user.

The following table has been prepared, segregating the units into three basic classifications, according to their electrical performance to aid the user in selecting the proper unit for his particular application.

LOW VOLTAGE, HIGH FREQUENCY GROUP

Maximum input voltage 0.35 x F (350 volts max.) F=frequency in cps.

MODEL NO.	SWITCH TYPE	NO. OF DECADES	SIGNIFICANT FIGURES OF RESOLUTION	TYPE OF POTENTIOMETER	REMARKS
RT-1	Push Button	3	6	10 turn	Three decade unit with 10 turn potentiometer. Utilizes push button switches. For low voltage input over wide frequency range. Numbers engraved on push buttons.
RT-2	Push Button	5	5	None	Five decade unit. No potentiometer. For low voltage, wide frequency range use. Numbers engraved on push buttons.
RT-5	Rotary	5	6	1 turn	Five decade unit with one turn potentiometer. Extremely good resolution. Numbers available through window in panel. Most economical and proper instrument where high resolution, high accuracy and wide frequency range is desired.
RT-6	Rotary (Heavy Duty)	5	5	None	Five decade unit. No potentiometer. For low voltage, wide frequency use. Contains **heavy duty,** rotary switches with numbers on front panel.
RT-7	Rotary (Heavy Duty)	5	6	1 turn	Five decades and one turn potentiometer. Extremely good resolution. For low voltage, wide frequency range use. Numbers on front panel. **Heavy duty** rotary switches.
RT-10R	Rotary	3	6	10 turn	3½" High Rack Panel. For low voltage, wide frequency range. Low price. Terminals front and rear.
RT-11R	Rotary (Heavy Duty	5	6	1 turn	3½" High Rack Panel. Terminals front and rear.
RT-12R	Rotary (Heavy Duty)	5	6	1 turn	Militarized version of RT-11R. Glass epon switch insulation. Coils potted in epoxy resin.
RT-13R	Rotary (Heavy Duty)	5	5	None	3½" High Rack Panel. Terminals front and rear.
CRT-1 CRT-4	Coaxial	3	6	10 turn	Three decades with a 10 turn pot. Uses coaxial switches to conserve panel mounting space. For low voltage, high frequency use. Recommended where panel space and weight must be kept to a minimum. Servo mount.
CRT-2-3	Coaxial	3	5	1 turn	Same as CRT-1 except has 1 turn pot.
RRT-1 (302)	Shaft Driven	3	5	Interpolating	A 1000 turn sealed shaft driven unit designed particularly for positioning and calibration applications.
RRT-2 (303)	Shaft Driven	2	4	Interpolating	Same as RRT-1 except 100 turns.
SRT-1 (400)	Remote Sequential Stepping Relays	5	5	None	Uses 24V DC gold contact decade stepping relay switches for remote operation. Readout contacts provided.
BRT-1 (222)	18 bit binary remote relay operated	18 bit 6 octals	$\frac{1}{2^{18}}$	None	18 bit unit arranged in 6 octals. Gold contact relays designed to operate from IBM card or punched tape as a digital to analog converter. 24 V DC.
BRT-2 (309)	Binary to Decimal conversion unit. Remote relay control	3	3	None	Converts binary code to decimal, 3 decade. Contains phase inversion relay and readout contacts. 24 V DC.

* *Trademark*