INSTALLATION • OPERATION • MAINTENANCE

INSTRUCTIONS

WATT TRANSDUCER TYPE VP - 840

The Type VP-480 Watt Transducer is a completely static device which produces a d-c output directly proportional to the a-c power appearing at its input. This proportionality is maintained with reversal of power flow — the d-c output changes polarity accordingly.

THEORY OF OPERATION

The Type VP-840 Hall Watt Transducer consists of a thin wafer of polycrystalline Indium Arsenide mounted in the air gap of a magnetic circuit and other associated static circuit components necessary to produce a D-C output proportional to the product of two electrical inputs. It utilizes the Hall Effect principle, which states that if a current-carrying conductor is placed in a magnetic field, a potential difference is produced at points opposite each other on the edges of the conductor. The magnitude of this potential difference is directly proportional to the product of the current in the conductor, the flux normal to the plane of the conductor, and the cosine of the phase angle between the current and the flux.

By making the flux proportional to the alternating current in the a-c circuit and the current through the Hall wafer proportional to the alternating voltage, a Hall output waveform is produced containing a d-c component and a double-frequency a-c component.

$$V_H = KEI \cos \theta - KEI \cos (2wt + \theta)$$

The d-c component, EI cos θ, is directly proportional to the true power (watts) in the a-c circuit and is, therefore, a measure of that power. The double-frequency component, EI cos $(2wt + \theta)$, is proportional to the volt-amperes in the a-c circuit. Its frequency is twice that of the a-c circuit.

Because the Hall Wafer is a semiconductor which has an inherent response of up to one megacycle, the d-c output of the VP-840 transducer is proportional to the instantaneous power in the a-c circuit being metered. This makes the transducer ideally suited to measurements of power transients when used in conjunction with oscillographic recorders.

The indium arsenide Hall element, like most semiconductor compounds, exhibits a negative temperature coefficient. The Hall output decreases with increasing temperature. Therefore, all VP-840 Watt Transducers include temperature compensation in the form of a thermistor-resistor network in series with the output loop. The purpose of this compensation is to maintain constant current through the output loop at any temperature within the specified operating range.

In addition to the normal 120 cycle component appearing in the transducer output when used on 60 cycle applications, a small amount of 60 cycles may also appear in the output waveform. This 60 cycle component, called the null voltage, is due to the fabrication difficulties encountered in connecting the Hall output leads to the indium arsenide wafer. For zero null voltage, the output leads must be connected exactly to equipotential points on opposite edges of the wafer.

However, since only the d-c component of the Hall output is of importance in the measurement of watts, the 60 cycle null component does not introduce any errors. If the single phase VP-840 transducer is used in conjunction with oscillographic equipment, the full output waveform will be recorded. The 60 cycle component will appear as difference in magnitude between alternate peaks of the 120 cycle component.

SUPERSEDES I.L. 43-840.2A
*Denotes change from superseded issue.

EFFECTIVE MARCH 1962

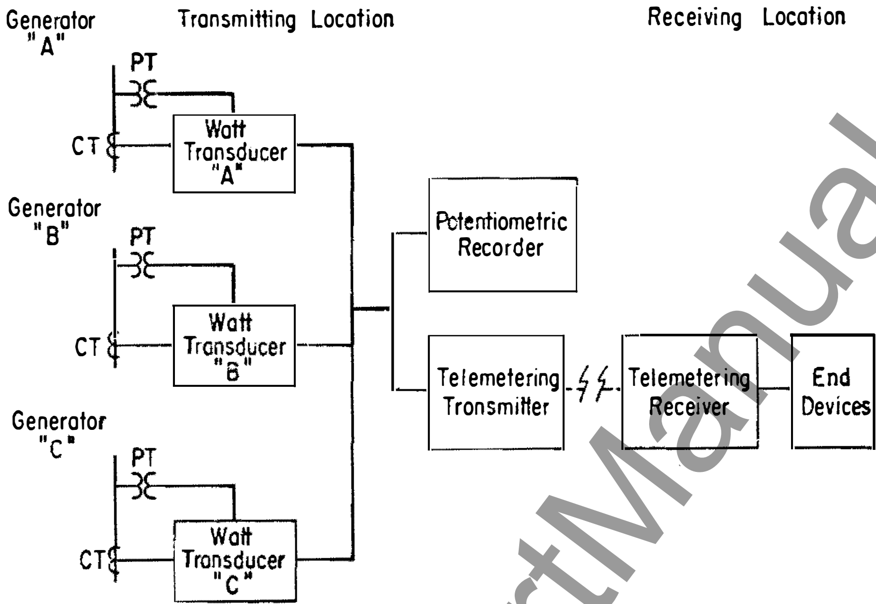


Fig. 1. Typical Totalizing and Telemetering Application Using Type VP-840 Watt Transducers

APPLICATION

The Type VP-840 Hall Watt Transducer is available for single-phase, 3-phase 3-wire, or 3-phase 4-wire applications with or without filter. Transducers without filters are used to operate low impedance devices such as direct-acting instruments and magnetic amplifiers where the 120 cps ripple is not objectionable. These devices must present an impedance of exactly 50 ohms DC resistance to the output terminals of the transducer. The load resistance must have a low temperature coefficient.

Transducers with filters are used for operation of high (50,000 ohms or better) impedance devices such as most telemetering transmitters, high gain servo-amplifiers, or potentiometric type recorders. These transducers are suited to totalizing and all other applications where thermal converters are presently used.

With external phase-shifting transformers, or with suitable cross-phasing, the Type VP-840 Hall Watt Transducer can be used to measure or totalize reactive power.

VP-840 Hall Watt transducers with or without filters for 3-phase 3-wire applications consist of two independent single phase elements with their outputs connected in series internally and housed in a single case. Transducers for 3-phase 4-wire applications consist of two elements connected in the classic 2½ element configuration common in wattmeters and watthour meters. In this transducer, the two elements are not electrically independent since the third current circuit is introduced as an additional winding on each element's current electromagnet. The accuracy for this type of transducer is subject to the same balanced voltage restrictions associated with other 2½ element metering.

True three element metering of 3-phase 4-wire power can be obtained by using three single phase VP-840 Transducers with their outputs connected in series additive. In this arrangement, the outputs of single phase transducers with filters can be added directly. For single phase transducers without filters, each transducer must be terminated in its own 50 ohm load and the millivolt drops across these terminations may now be added.

Figure 1 shows a typical watt transducer application involving totalizing and telemetering.

CONSTRUCTION

Mechanical

All parts are mounted directly on aluminum plates which are fastened together by means of aluminum posts in a modular type of assembly. The complete assembly is housed in a switchboard type instrument case for behind the panel mounting. The indium arsenide Hall generator is held in the air gap of the magnetic structure by encapsulation.

The outline and drilling plan for the VP-840 transducer is shown in Figure 22.

Electrical

The internal circuit schematics for the various types of VP-840 Watt Transducers available are shown in Figures 7 through 12. Static electronic components are used throughout.

All the circuits of the transducer are electrically isolated from the power circuit being measured. Isolation of the voltage circuit is provided by an internally mounted step-down transformer while two series connected coils on the transducer's magnetic structure provide isolation for the current circuit.

VP-840 internal components are housed in a steel case which provides effective shielding from external magnetic fields.

Electrical Connections

External connections are made to screw type terminals on a molded base. The external connection diagrams for the various types of VP-840 transducers are shown in Figure 13 through 18.

CALIBRATION

Since the VP-840 Transducer has no moving parts, vacuum tubes, or thermal elements, no periodic maintenance is required. All VP-840 Transducers are factory calibrated to the customer's individual requirements and no further attention in this respect is needed on the part of the customer. However, if periodic checking is required or if a change in input to output ratio is necessitated by changes in instrument transformer ratios, the following calibration procedure is recommended.

The equipment needed for field calibration should include a precision wattmeter, a potentiometer, and a suitable regulated power source (voltage and current at unity power factor). Regulation is required for the power source, since the response of the VP-840 is nearly instantaneous. The transducer output will follow even minor power fluctuations of very short duration.

VP-840 With Filter

The potential circuits must be energized at rated voltage for a minimum of one hour before any checks are made. Also, if the transducer has been subjected to extreme temperature conditions, sufficient time must be allowed for it to stabilized at room temperature.

To check calibration, apply full-scale single-phase test watts to the transducer at rated voltage and measure the DC millivolt output on a potentiometer. The full-scale single-phase test watts are determined as follows:

Single phase VP-840 — nameplate watt rating
3 phase 3 wire VP-840 — 1/2 nameplate watt rating
3 phase 4 wire VP-840 — 1/4 nameplate watt rating

Polyphase transducers are checked on single phase by connecting current circuits in series and potential circuits in parallel.

To facilitate changes in the input to output ratio, VP-840 transducers with filters include an output adjustment in the form of two wire-wound potentiometers — one a coarse control and one a fine control. These controls permit adjustments from 0 to 110% of full-rated output at full-rated input. Access to the controls is made by removing the cover plate which serves as the mounting surface. This exposes the slotted shafts of the potentiometers for convenient screwdriver adjustment. The potentiometers also have shaft-locking nuts to assure permanence of final adjustment. The lock nuts must be loosened when making output adjustments. The combination of coarse and fine control permits output settings to within 0.05 millivolts.

Final calibration check should be made with cover plate on.

VP-840 Without Filter

The calibration checking procedure for this type of transducer is the same as that for the filtered type except for the following. Since the standard termination for transducers without filters is 50 ohms, a fixed 50 ohm ±0.1% resistor of low temperature coefficient wire must be connected across the output terminals at all times during test. This is important, since the factory calibration was performed with a 50 ohm termination. This is also the way this type of transducer is used in a system.

VP-840 Transducers without filters do not contain output adjusting potentiometers. Therefore, no convenient means is available for changing the input to output ratio. If a change in this ratio is necessary, an adjustment of the fixed resistor in the potential circuit is required. In no case must this resistance be decreased more than 10%. No limit is placed on the amount that the resistance is increased. Increasing the potential circuit resistance decreases the output at rated input. (If the potential circuit resistance is doubled, the output will be approximately half the original value.)

MAINTENANCE

Since the type VP-840 Watt Transducer is an all-static device, there are no moving parts to inspect or maintain.

RENEWAL PARTS

Repair work can be done most satisfactorily at the factory. However, some interchangeable parts can be supplied to customers who are equipped for doing repair work. When ordering parts, always give the complete nameplate data.

RATINGS

The standard voltage rating for the type VP-840 transducer is 120 volts. Rated input for the 120 volt, 5 ampere transducer is 500 watts per element. Current ratings from 50 milliamperes to 10 amperes are available.

Rated output is the d-c output obtained at rated input. The maximum rated output that can be obtained for the single phase or 2 element transducer is 50 millivolts per element. Maximum rated output for 2½ element transducers is 100 millivolts per rated 3 phase 4 wire input.

CHARACTERISTICS

Average performance characteristics for the VP-840 transducer are shown in Figures 2 through 6. Unless otherwise specified, the characteristics are based on tests at standard reference conditions (rated voltage, rated frequency, and an ambient temperature of 25°C).

The voltage characteristic in Figure 5 shows the effect of saturation of the current circuit since in order to hold rated voltamperes constant as the voltage is decreased, the current must increase proportionally. As the current rises above 125% of the rated value, saturation of the current's electromagnet starts to become appreciable. If, however, the voltamperes were decreased in the same proportion as the voltage, the transducer would exhibit every little voltage error down to zero volts.

The average characteristics in Figures 2 through 6 apply for both single phase an polyphase transducers.

SPECIFICATIONS

Accuracy	— ±0.5% of standard rated output at standard reference conditions.
Temperature	— ±1.0% of standard rated output output over the temperature range from 0 to 65 degrees centigrade.
Response Time	— Without filter: a few microseconds. — With filter:-0.05 seconds.
Insulation Test	— 1800 volts between independent circuits. — 2600 volts from terminals to case.
Weight	— 2 to 3½ pounds net.
Burden (per element)	— Current coils at rated current: 2VA at 20% Power Factor. — Potential circuit at rated voltage: 1VA at Unity Power Factor.
Power Factor	— ±1% of standard rated output at 50% Lead or Lag.

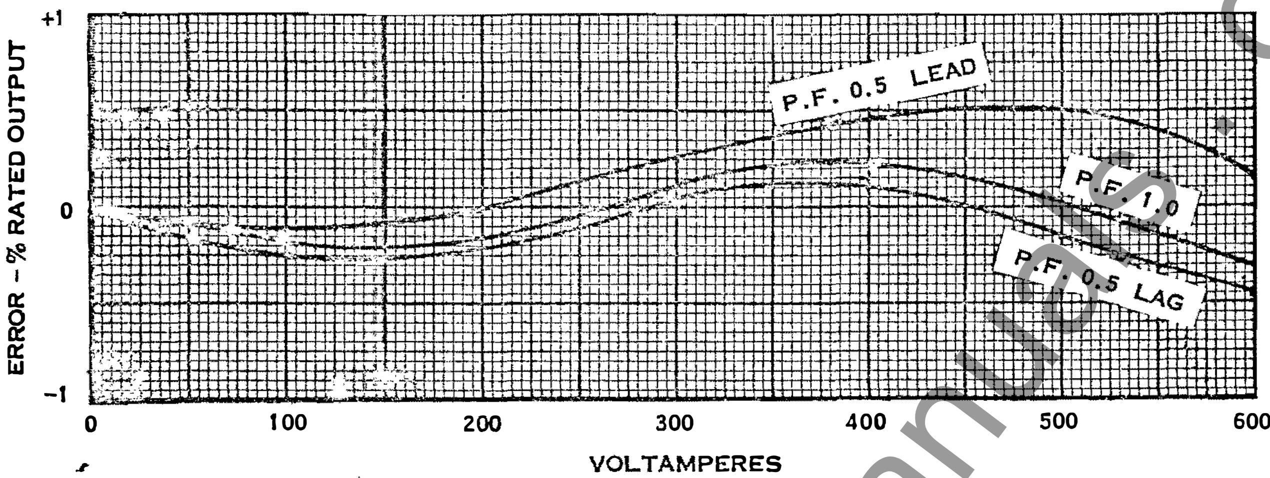


Figure 2 - Load Curves

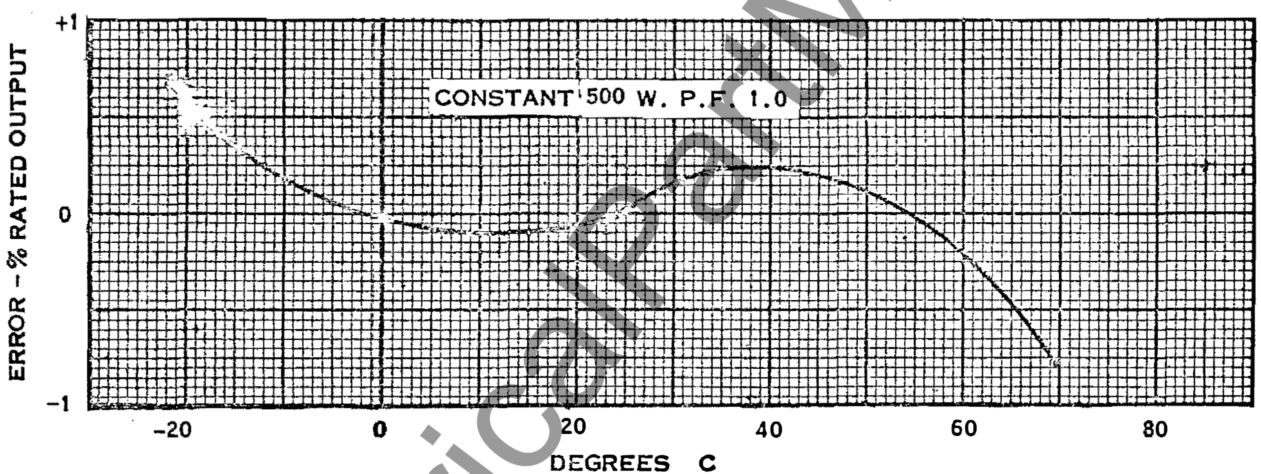


Figure 3 - Ambient Temperature Characteristic

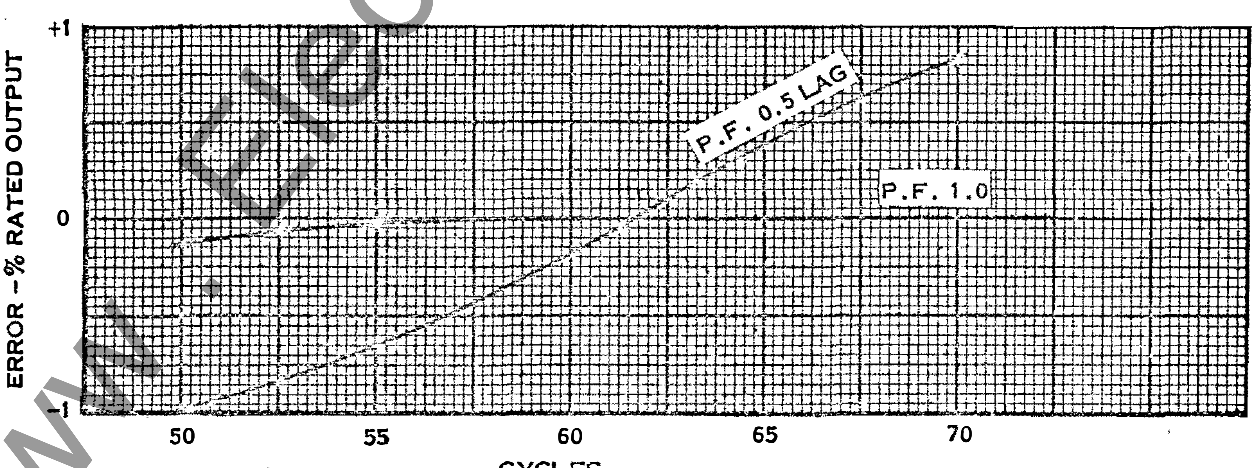


Figure 4 - Frequency Characteristic at Constant voltamperes

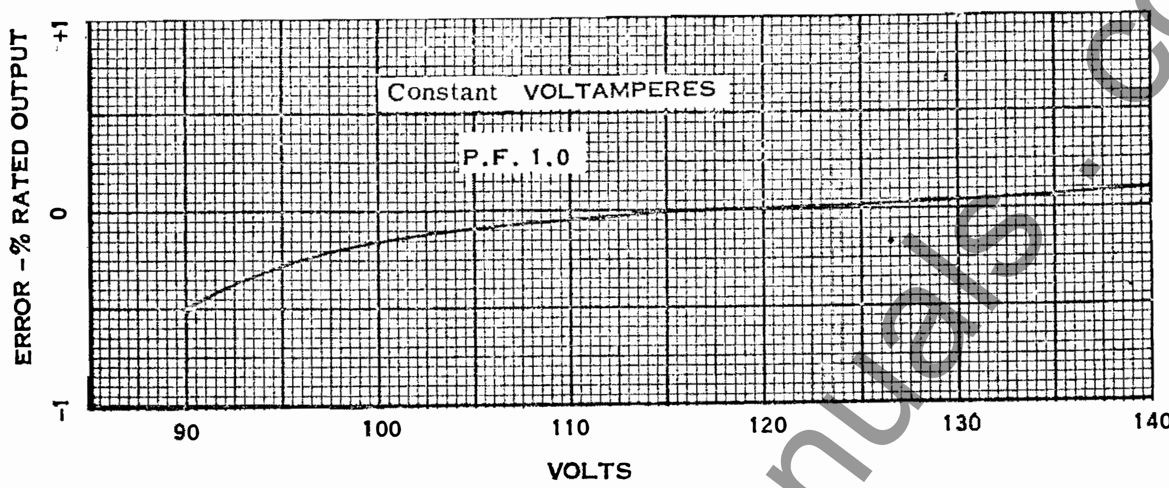


Figure 5 - Voltage Characteristic

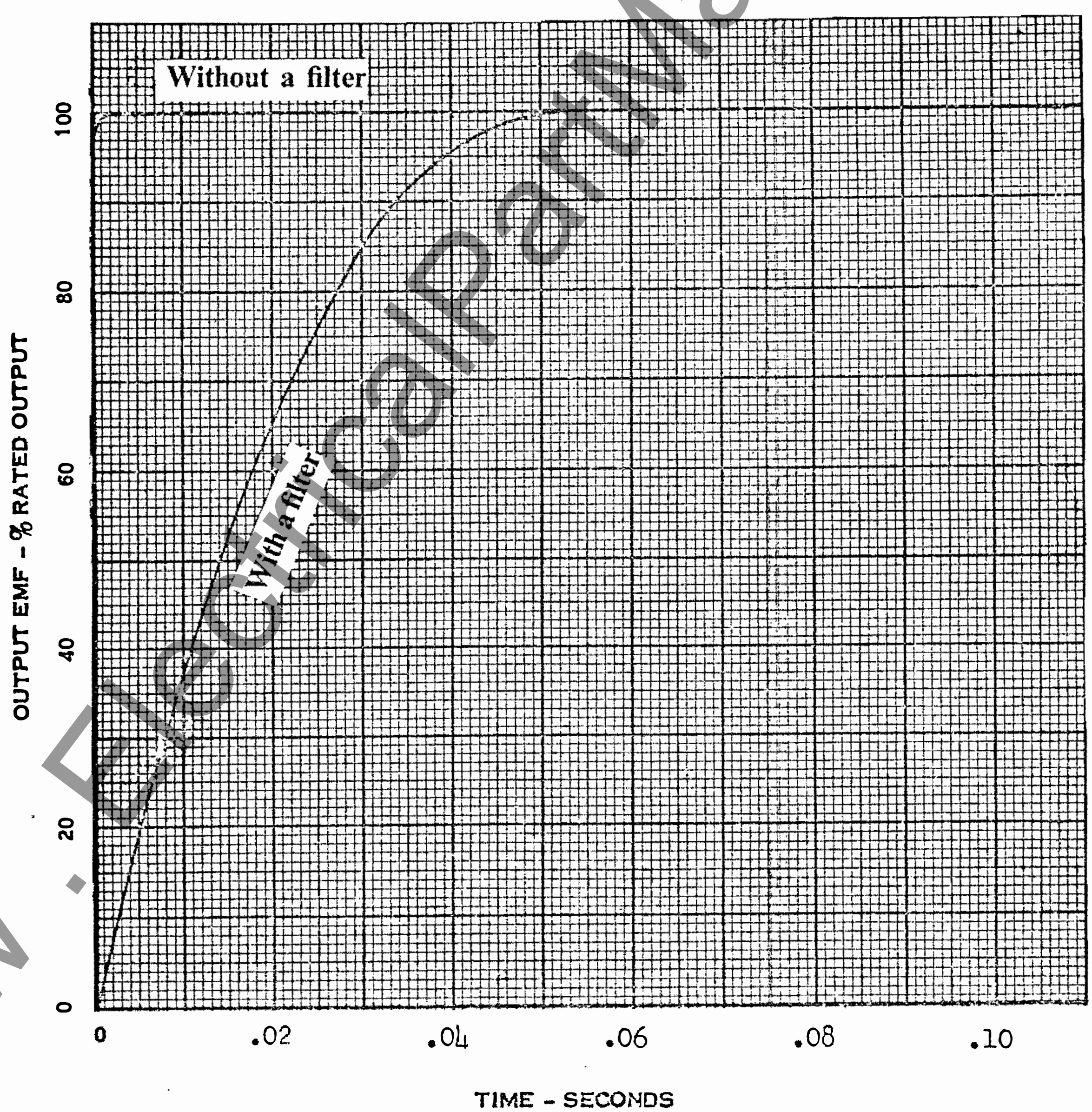


Figure 6 - Response Time Characteristic

INTERNAL SCHEMATICS

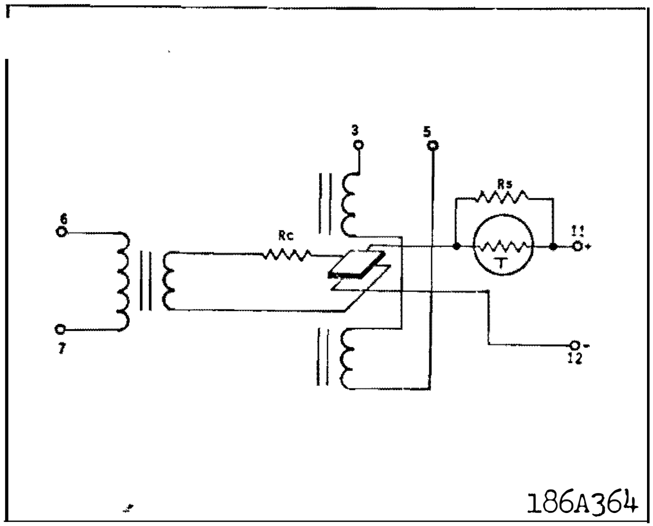


Fig. 7. Single phase transducer without filter

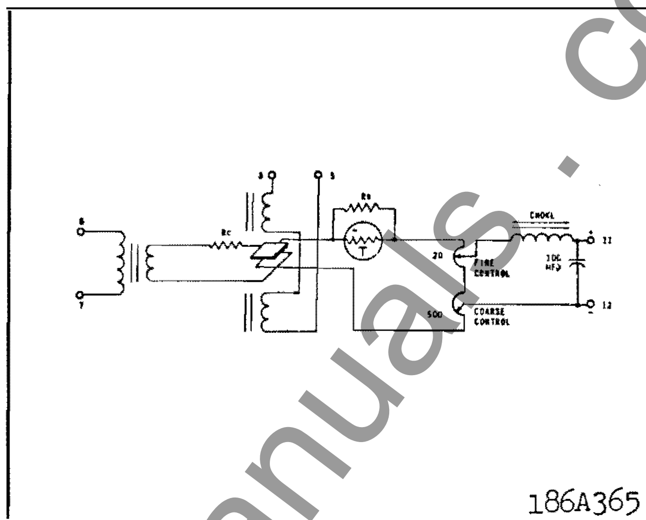


Fig. 8. Single phase transducer with filter

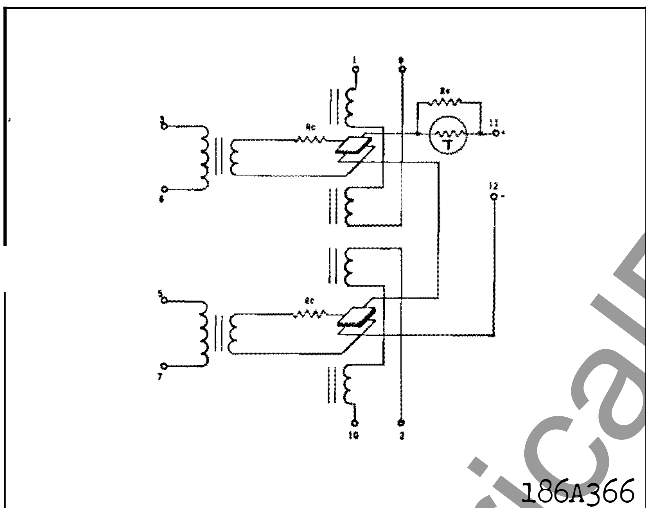


Fig. 9. 3 phase 3 wire transducer without filter

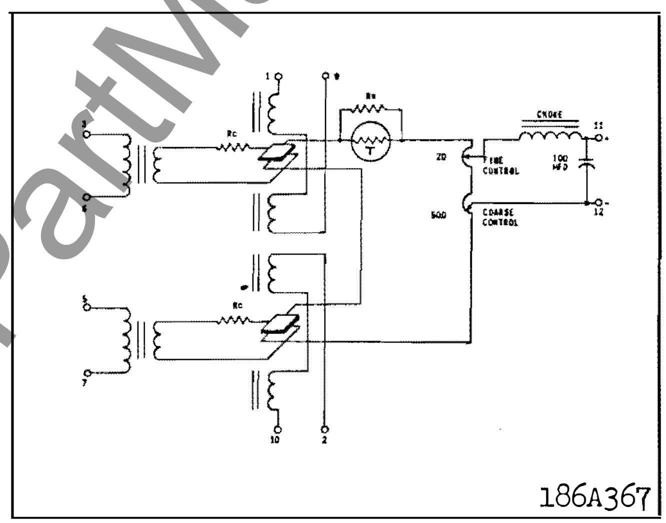


Fig. 10. 3 phase 3 wire transducer with filter

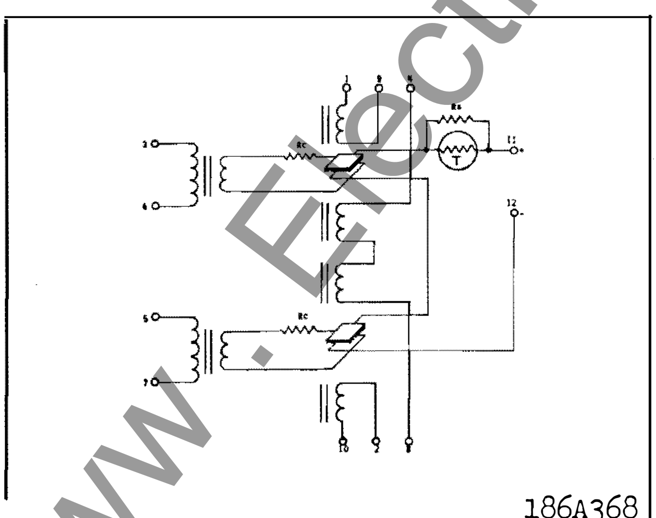


Fig. 11. 3 phase 4 wire transducer without filter

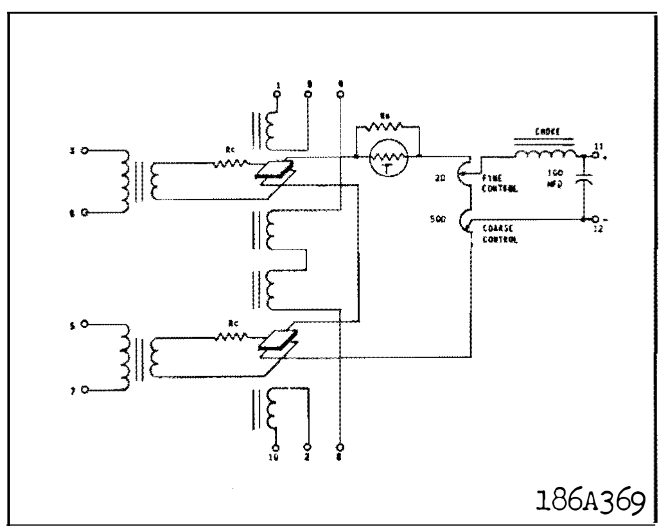


Fig. 12. 3 phase 4 wire transducer with filter

EXTERNAL CONNECTIONS

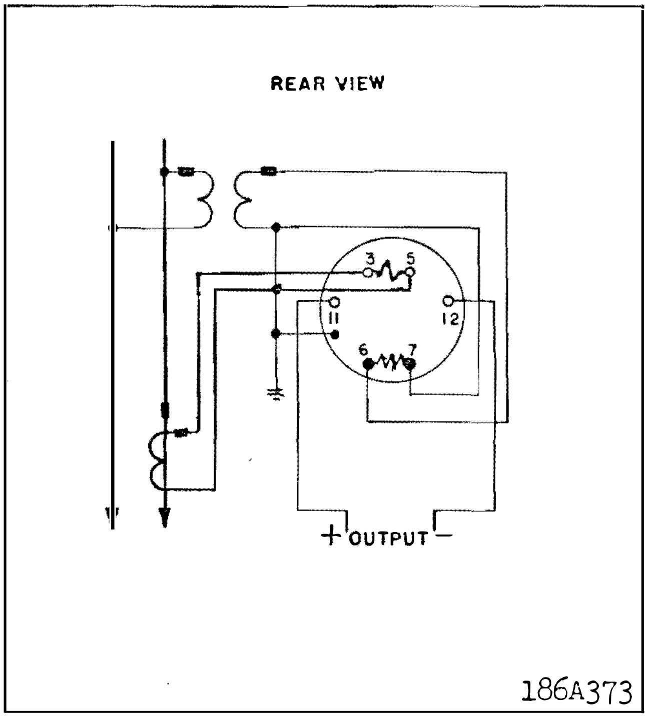


Fig. 13. Single phase watt transducer

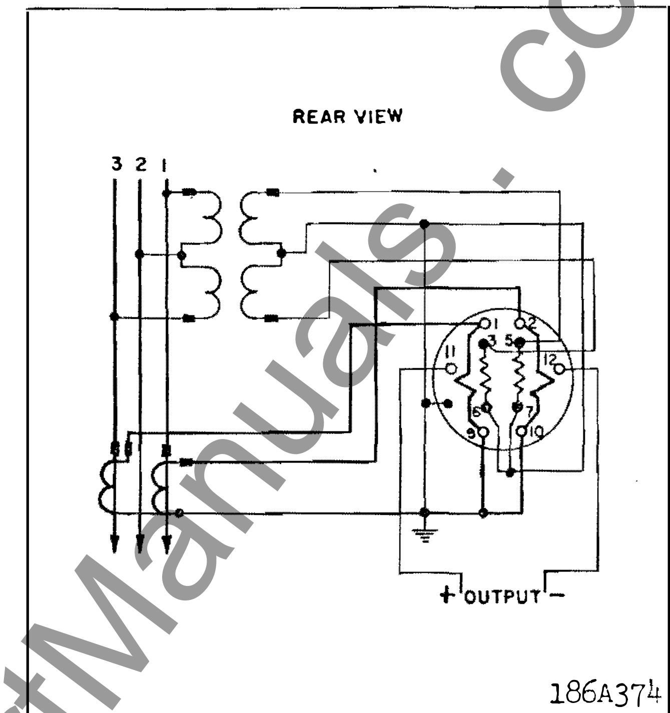


Fig. 14. 3 phase 3 wire watt transducer

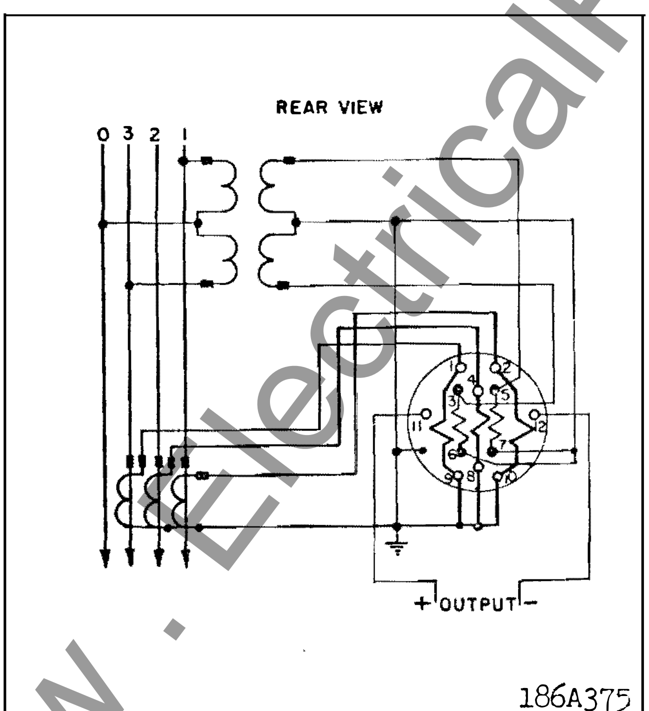


Fig. 15. 3 phase 4 wire watt transducer

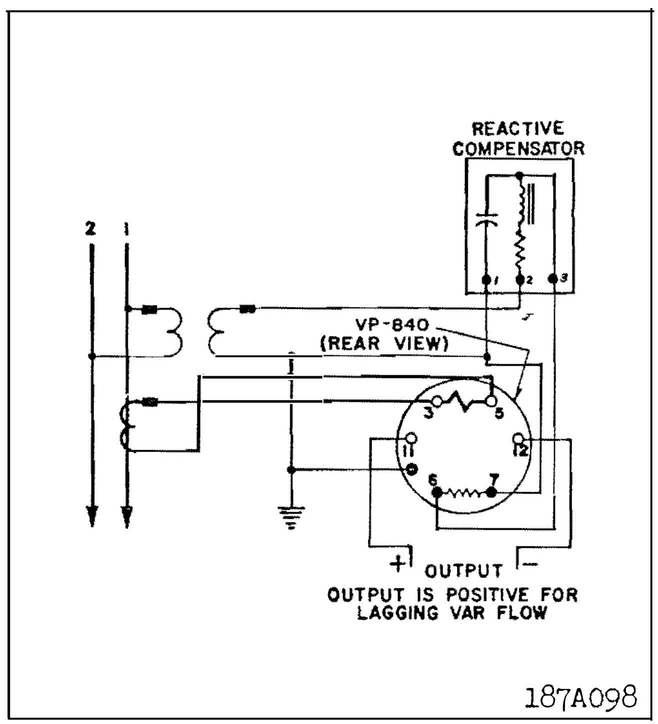


Fig. 16. Single phase VAR transducer

INTERNAL SCHEMATICS

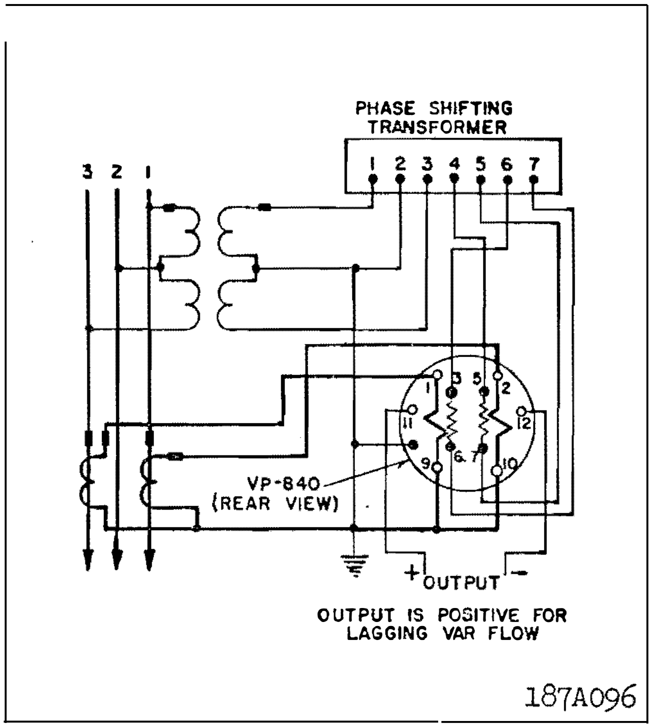


Fig. 17. 3 phase 3 wire VAR transducer

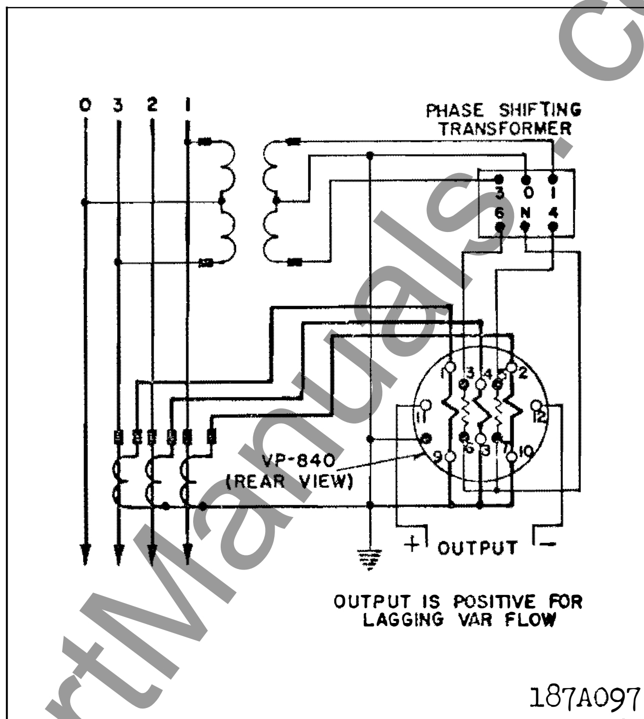


Fig. 18. 3 phase 4 wire VAR transducer

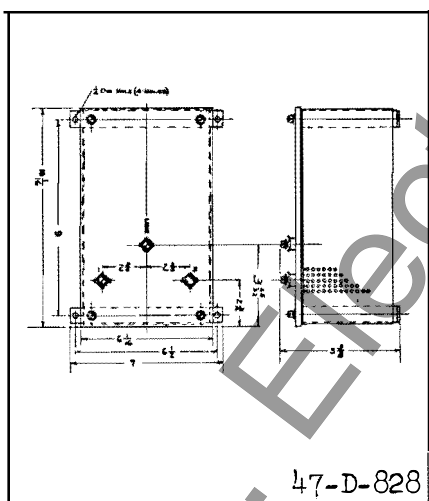
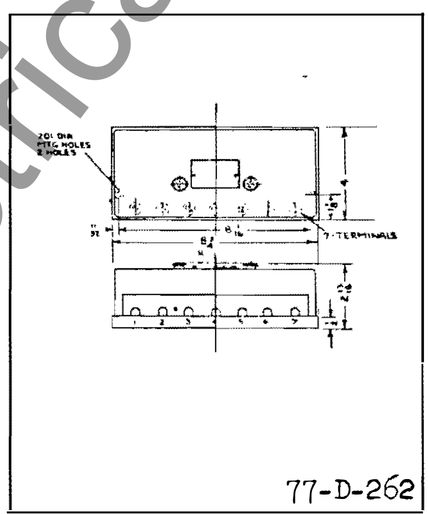


Fig. 19. Outline and drilling plan for Reactive Compensator used with single phase VAR transducer



* Fig. 20. Outline and drilling plan for Phase Shifting Transformer used with 3 phase 3 wire VAR transducer

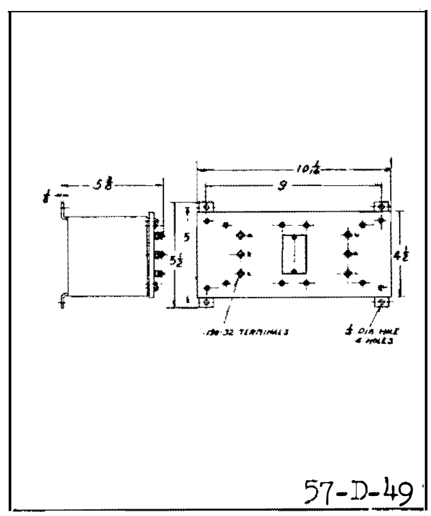
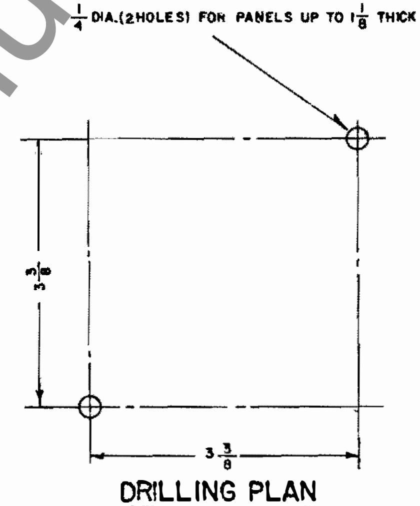


Fig. 21. Outline and drilling plan for Phase Shifting Transformer used with 3 phase 4 wire VAR transducer

LINE NO.	TYPE	TRANSDUCER TYPE	TERMINALS IN POSITION NUMBER	TERM. TH'D.	DIM. A
1	VP-840	SINGLE ELEMENT WATT TRANSDUCER WITH OR WITHOUT FILTER	3-5-6-7-11-12	.190-32	3.906
2	VP-840	DOUBLE ELE. WATT-TRANSDUCER WITHOUT FILTER 2CC	1-2-3-5-6-7-9-10-11-12	.190-32	3.906
3	VP-840	DOUBLE ELE. WATT-TRANSDUCER WITHOUT FILTER 3CC	1-2-3-4-5-6-7-8-9-10-11-12	.190-32	3.906
4	VP-840	DOUBLE ELE. WATT-TRANSDUCER WITH FILTER 2CC	1-2-3-5-6-7-9-10-11-12	.190-32	5.484
5	VP-840	DOUBLE ELE. WATT-TRANSDUCER WITH FILTER 3CC.	1-2-3-4-5-6-7-8-9-10-11-12	.190-32	5.484
6	VR-840	FREQUENCY TACHOMETER	1-2-3-5-6-7	.190-32	3.906



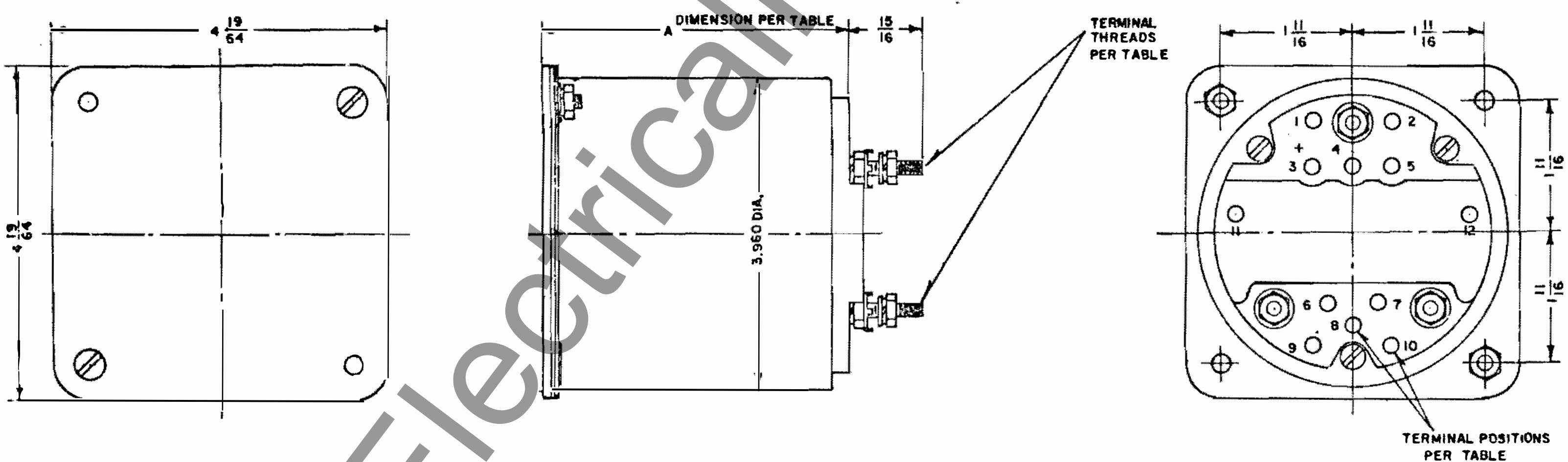


Fig. 22. Outline and Drilling Plan

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