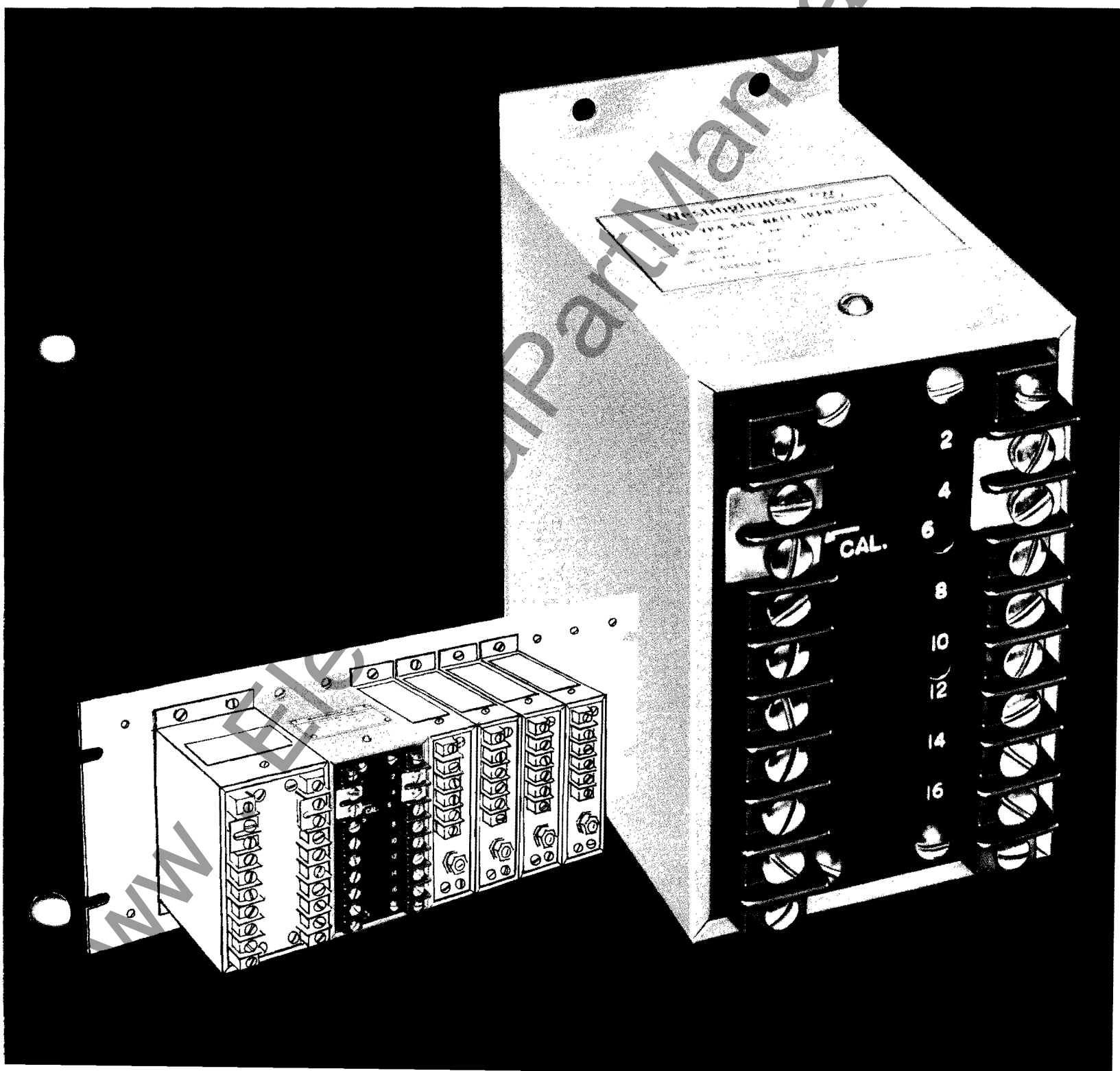
Westinghouse Electric Corporation
Relay-Instrument Division
Newark, New Jersey 07101

43-871 D WE A
Descriptive Bulletin

April, 1975
New Information
E, D, C/2043/DB

Load-independent (constant current)
Output ½% Accuracy Class

Type V-4 Watt and Var Transducers



Application
Type V-4 watt and var transducers convert current and voltage input signals from a power system into dc output signals proportional to the true power or the reactive power on that system. Output polarity changes with direction of power flow. The outputs can be utilized by computers, control and data systems or by analog or digital instruments.

The watt transducers are identified as type VP4-846 and the var transducers as type VV4-846.

Operation
These transducers employ the time-division multiplication principle. The measuring circuitry generates a train of pulses whose height is proportional to current and whose length is proportional to voltage. The area of each pulse is proportional to the power flowing within the duration of each pulse. There are many pulses per cycle. Integrating these pulses, therefore, yields a rate of flow of power. The circuitry presents this in the form of a proportional dc signal.

The signal is passed through an amplifier to convert it to a load-independent (constant-current) output.

Var transducers are similar to the watt transducers except that the potentials are shifted 90° by means of an internal R-C network.

Features
Westinghouse is a major supplier of the apparatus and the systems which control electrical power systems. They are, consequently, especially knowledgeable of the actual needs in the accessories for such systems.

Time-Division Multiplier
This circuitry employs complementary MOS digital integrated circuits for superior accuracy, linearity and stability.

Printed Circuit Construction
All components are mounted on printed circuit boards of a glass-epoxy. This material possesses great strength; it does not support fungus growth; it has a high resistance to damage due to a re-soldering of parts during repair or modification under field conditions. All circuit boards are accessible for repair. This is especially important in the case of the power supply and amplifier board which is exposed to externally-caused damage from accidental misconnection to sources beyond the level of the inherent protective circuitry.

Plug-in Integrated Circuits
All amplifiers and multipliers are IC's for consistency in performance with plug-in mounting for convenience in servicing.

Convertible Power Supply
Jumpers are supplied on the terminal block of each transducer to connect the power supply source to the measured potential transformer circuit. With jumpers removed the transducer may be operated from a separate control power source. Thus, only one style transducer need be used to serve both functional requirements.

Amplifier Protective Circuit
The output amplifier is protected from damage due to inadvertently applied voltages or induced surges on the output leads. The amplifier can withstand the application across its terminals of a surge equivalent to the SWC test, and the short-time (approximately 5 minutes) application of 120 volts ac in the event of miswiring.

Radio-Frequency By-Pass
Each transducer contains by-pass circuitry to give the device a relatively high immunity to radio frequency interference (RFI).

Modular Design
The case represents the best possible compromise between the requirements of the various mounting methods normally used.

a) Unistrut® channel.
b) Standard relay rack panels.
c) Standard rack unit mounting strip.
d) Pre-drilled channel.
e) Pre-drilled panel.

The basic module is 1½ inches wide and uses 5¼ inch vertical distance between mounting holes as suggested by an IEEE proposed standard. Watt and Var transducers are made in modules (3 inches) with the same 5¼ inch mounting dimension. The horizontal holes are arranged so that any array of transducers can be mounted side-by-side with pre-drilled mounting holes on 1½ inch centers. If rack unit mounting strip is used there will be a ¼ or ½ inch space between units. A 19 inch rack will mount a full set of watt, var, voltage and current transducers for a three-phase line (see Page 1). There is no interaction between transducers regardless of mounting space.

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Terminal Blocks
Molded terminal blocks with #8-32 screws to accept wire sizes up to #12 in lugs to ⅜ width.

Temperature Stability
Low temperature coefficient resistors and zener diodes are used to obtain a low temperature influence without resorting to the resistor-thermistor compensation schemes which were needed on the Hall generator transducers. Good temperature performance is designed in, and not compensated in.

Adjustments
Models are available with both a ±10% and a 0 – 110% output adjustment capability. Because of the grade of amplifier used it has not been necessary to limit the adjustment range in order to maintain a reasonable accuracy at the low end. The calibration control is a 20-turn potentiometer accessible from the top of the case. Any element trimming and phase shifting adjustments are accessible from the outside of the case. These are bench type adjustments. These trimmers are accessible from the top in watt transducers and the bottom in var transducers. Inasmuch as the multiplier circuit has a relatively high output, no zero adjustment is ever necessary. This is in contrast to the Hall type which does require a zero adjuster because the low output of the Hall circuitry necessitates a high-gain amplifier.

Surge Withstand Capability (SWC)
Experience in the application of solid-state devices to power system control circuits has shown the need for integral surge protection circuitry. The major concern has been in the protection of solid-state protective relays from damage or malfunction under transient surge conditions. Relay engineers have adopted SWC specification in IEEE Standard 472-1974 (ANSI C37.90a, 1974).

In designing the V-4 transducers Westinghouse was able to draw upon the knowledge of its static relay design and application engineers. In so doing it became apparent that the relay SWC specification was not completely adequate as a standard for transducers. Relays terminate in a switching circuit while transducers terminate in a precision amplifier of much lower capacity. Relays cannot tolerate a transient which would cause a false trip while a transducer output may be momentarily affected so long as the unit is not damaged.

The IEEE standard defines the test wave and locates the test points on a relay, Westinghouse has adopted the same test wave but has defined the application points in terms of a transducer, making certain that all critical areas are tested and that the tests, as performed, are valid.

The Surge Withstand Test which all Westinghouse V-4, 60 Hz transducers will meet is:

1. SWC Test Wave: An open circuit oscillatory wave, 1.0 to 1.5 MHz, 2.5 to 3.0 KV crest value of the first half-cycle peak decaying to 50% of the initial crest value in 6.0 microseconds or longer. Surge generator terminal

impedance 150 ohms. Test waves are applied at the rate of not less than 50 tests per second for not less than 2.0 seconds.

2. Test Procedure: The transducer is terminated into a resistor with a value equal to the maximum rated load resistance condition. Surge voltage is then applied.

a) Between case and power supply to all other ac terminals tied together.

b) Between case and each dc output terminal.

c) Between each ac input terminal and each dc output terminal.

d) Between each ac circuit element and every other ac circuit element.

e) Across the dc output.

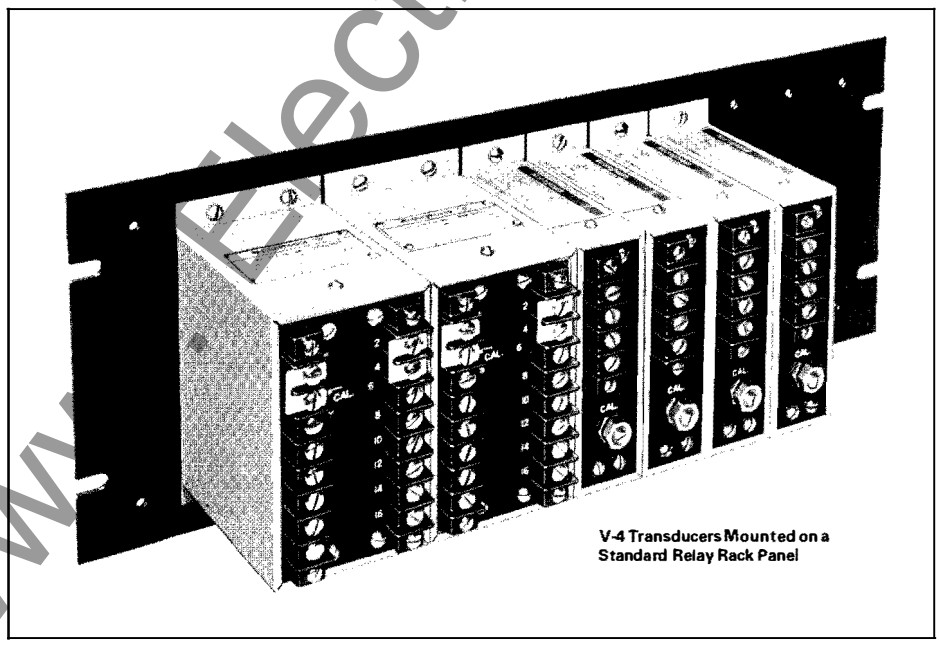
The transducer is considered to have passed the test if it continues to operate normally with no change in calibration.

Accuracy
The linearity of the V-4 watt and Var transducers is 0.1% at reference conditions. (This is sometimes referred to as 0.1% accuracy/linearity, but this is a coined term which can be misleading). The Westinghouse transducers are rated at their operating accuracy of 0.5% which includes the entire range of any combinations of influences which might reasonably be expected in actual service.

Long-Term Stability
A stability of at least 0.25% per year is anticipated based on experience with similar circuitry and published data on components.

Specifications

Watt Transducer	Type VP4-846
Var Transducer	Type VV4-846
2-Element	For 3-phase, 3-wire
2½-Element	For 3-phase, 4-wire
Input Watts/Vars	
2-Element	1000
2½-Element	1500
Input Current, ac	5A
Input Voltage, ac	120V
Input Frequency	60 Hz
Output current, dc	0-±1 mA
Output Load Resistance	0-10,000 Ohms
Linearity at Reference Conditions (stated as a percent of rated output)	±0.1% max.
Reference Conditions:	
Input Current	0-6.5A
Temperature	23°C
Power Factor	1.0
Input Voltage	120V
Frequency	60 Hz
Load	5000 ohms
Power Supply	120 V
Operating Accuracy (Under operating conditions stated as a percent of rated output)	
With +10% Calibration Range	±0.5%
With 0-110% Calibration Range	±0.6%
Operating Conditions:	
Input Current	0-6.5A
Temperature	23±13°C
Power Factor	Any
Input Voltage	75-132V
Frequency Watt	±1 Hz
Var	±.07 Hz
Load	0-10,000 ohms
Power Supply	85-135V
3rd Harmonic Content	0-3%



V-4 Transducers Mounted on a Standard Relay Rack Panel

Extreme Influences (Percent of Rated Output)

Current Linearity, 0-10A	±0.3%
Voltage Linearity, 0-140V (with external power supply to amplifier)	±0.1%
Power Factor 1-0-1, lag or lead	
Watt	±0.2%
Var	±0.1%
Temperature, −20 to +65°C	
+10% Cal. Adj.	
Typical	±0.25%
Maximum	±0.5%
0-110% Cal. Adj.	
Typical	±0.5%
Maximum	±1.0%
Frequency	
Watt 60±10 Hz	±0.1%
Var 60±0.1 Hz	±0.15%
Current Waveform 0-40% Third Harmonic Content, Watts Only	±.25%

Other Operating Characteristics

Output Adjustment	±10%
Optional Output Adjustment	0-110%
Ripple (peak-to-peak of rated output)	1.0%
Response Time (to 99% of rated output)	400 m sec
Power Supply	85-135V, 50-400 Hz

Burden

Current Circuit	0.2VA at 1.0 PF
Potential Circuit	0.3VA at 0.5 PF
Power Supply	4VA at 0.75 PF

Withstand Capability

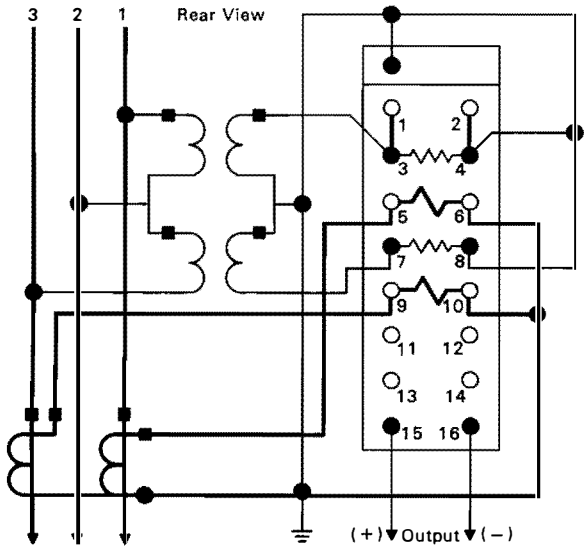
Storage Temperature	−40 to 100°C
Overload, Current	10A continuous 250A 1 sec/hr
Overload, Voltage	150V continuous
Dielectric Test	1500V
Surge	IEEE Std. 472 - 1974 (ANSI C37.90a - 1974)
Output	120V ac 5 Min.

Weight: Watt & Var 2¼ lb. (1 kg) Net 3¼ lb. (1.5 kg) Shipping

Further Information
Prices: Price List 43-870
Applications: Application Data 43-870
Instructions: IL 43-861.1
Current and Voltage Transducers (Constant Current): Descriptive Bulletin 43-875
Other Transducers
Descriptive Bulletin 43-861-1% Low-Output
Descriptive Bulletin 43-840-½% Watt Low-Output
Descriptive Bulletin 43-841-½% Frequency
Descriptive Bulletin 43-842-½% Pulse
Descriptive Bulletin 43-844 – Current and Voltage Teleductor

Schematic Diagrams

2 Element 3 Phase 3 Wire



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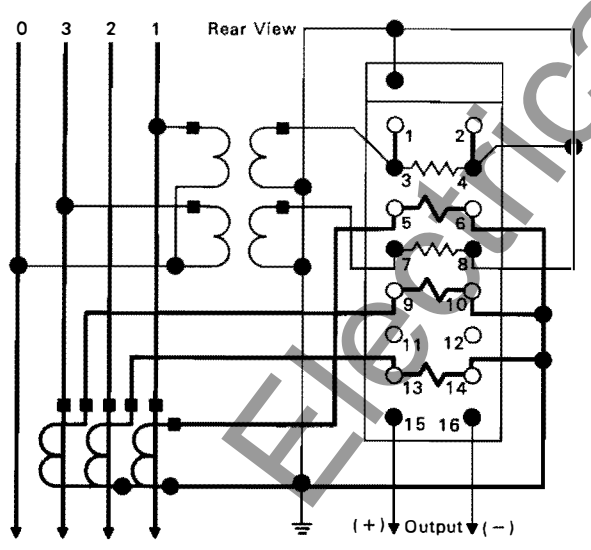
Sub 4

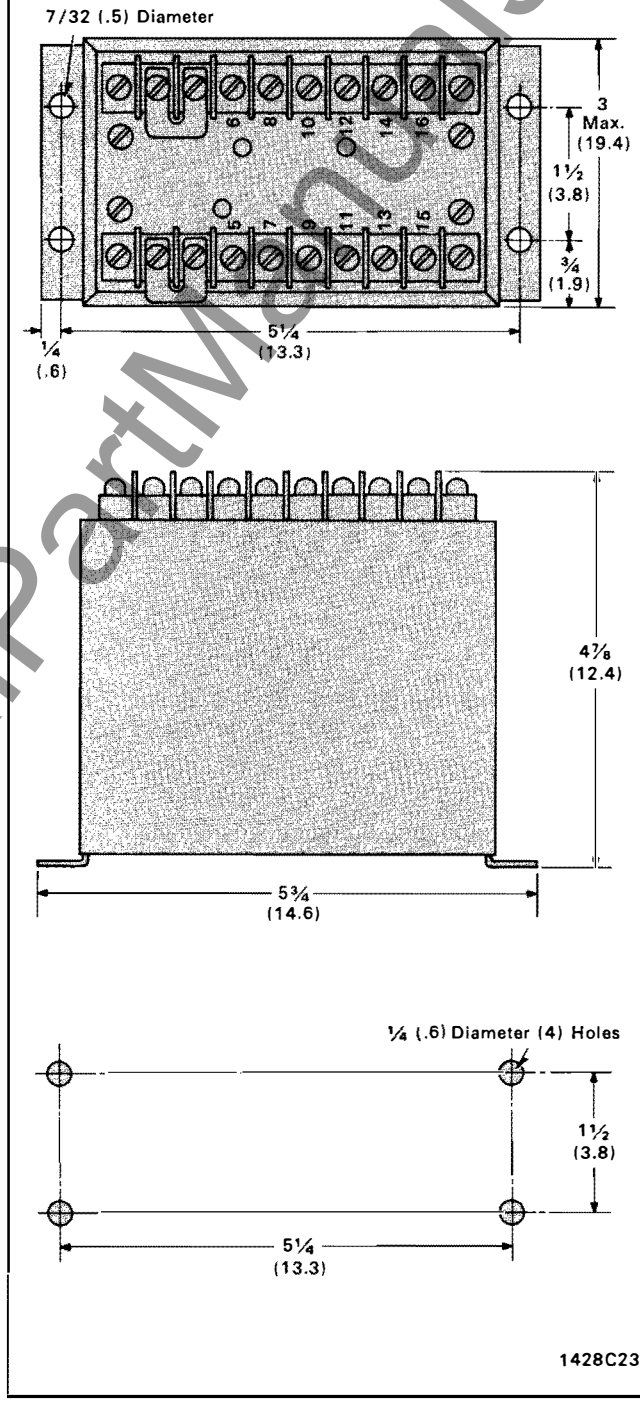
2½ Element 3 Phase 4 Wire



3503A76
Sub 3

Var Output Is Positive for Lagging Var Flow
For Separate Excitation of Power Supply
Remove Links Between Terminals 1-3 and 2-4
Then Connect 120 Vac 50-400 Hz to Terminals 1-2

Dimensions in Inches (Centimeters)



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