SARGENT & LUNDY ENGINEERS CHICAGO

Calc. For Separation of Class 1E and non-Class 1E Circuits in 1E22-S004		Calc. No. 1980-B
X Safety-Related	Non-Safety-Related	Rev. 0 Date 10-11-83
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Client ILLINOIS POWER COMPANY	Prepared by P. H. Buckner EPED	Date 10-11-83
Project CLINTON UNIT 1	Reviewed by A. K. Klotz EPED	Date 10-17-83
Proj. No. 4536-00 Equip No. 1E22-S004	Approved by Mark Y. for EPED	Date 10-17-83

DIVISION RESPONSIBLE: EPED
FILE NUMBER: 1980
REVIEW METHOD USED: BY DETAIL REVIEW Method

PURPOSE: The purpose of this calculation is to determine whether or not separation violations exist in Switchgear 1E22-S004, Bus 1C1.

REFERENCES:

1. Drawings:

	Number		Revision
a	E02-1AP12-007	Relaying and Metering	J
b	E02-1AP12-008	Relaying and Metering	J
c	E02-1AP12-015	Relaying and Metering	J
d	E02-1AP12-016	Relaying and Metering	G
e	E02-1HP99-106	Schematic	E
f	E02-1HP99-107	Schematic	D
g	E02-1HP99-108	Schematic	E
h	E03-1E22-S004-01	Wiring	C
j	E03-1E22-S004-02	Wiring	A
k	E03-1E22-S004-06	Wiring	C
l	E03-1E22-S004-07	Wiring	D
m	E03-1E22-S004-08	Wiring	D
n	828E537AC SH6	General Electric Elementary Diagram	7
p	828E537AC SH7	General Electric Elementary Diagram	7
q	828E537AC SH8	General Electric Elementary Diagram	7

2. Cable Tabulation, Cables per Equipment "L" Report, dated October 5, 83 based on Cable Tabulation dated October 1, 83

3. S2L Standard ESA-115 "Standard Reference for Short-Time Current Carrying (Melting) Capacity of Wire and Cable (6-1-36) (reaffirmed 1-8-79)

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DISCUSSION:

The cables per equipment report lists all cables running to equipment 1E22-S004. Only seven cables are not Class 1E, Division 3, as represented by segregation codes P3E, C3E, and K3E. Those seven cables and pertinent information about them are:

Cable Number	Seg	Other End Equipment	Function	Schematic* Diagram	Wiring** Diagram
1HP01B	K1B ✓	1C91-P004 ✓	Computer Data Input	-106 ✓	-07
1HP01F	C1B ✓	1PL90J ✓	CT secondary to relay panel	-106 ✓	-07
1HP01H	C1B ✓	1PL90J ✓	Interlock closing RAT feeder	-106 ✓	-07
1HP02B	C1B ✓	0PL91J ✓	CT secondary to relay panel	-108 ✓	-08
1HP02D	K1B ✓	1C91-P004	Computer Data Input	-108 ✓	-08
1HP02K	C1B ✓	0PL91J	Interlock closing ERAT feeder	-108 ✓	-08
1HP06F	K1B ✓	1C91-P004	Computer Data Input	-107 ✓	-07

* Schematic diagram numbers listed are page numbers. For complete drawing numbers, add prefix E02-1HP99-. Schematics 106, 107, & 108 are based on GE Elementary Diagram 828E537AC sheets 6, 7, and 8 respectively.

** Wiring diagram numbers listed are sheet numbers. For complete drawing numbers, add prefix E03-1E22-S004-.

This calculation will consider the cables and their circuits in groups by function.

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Calcs. For		Calc. No. 19BD-8
		Rev. 0 Date 10-11-83
Safety-Related	Non-Safety-Related	Page 3 of 14

Client		Prepared by	Date
Project		Reviewed by	Date
Proj. No. 4536-00	Equip. No.	Approved by	Date

A. Cables 1HP01F and 1HP02B

These cables connect current transformer secondaries to differential relays protecting the buses between the RAT and ERAT transformers and Bus 1C1. The relays are located in non-safety-related panels 0PL91J and 1PL90J. Therefore the function of these cables is non-safety-related. These cables' circuits are shown as non-safety-related on the schematic and relaying and metering diagrams.

These cables are analyzed in calculation 19BD-5, which concluded that the separation provided now is adequate.

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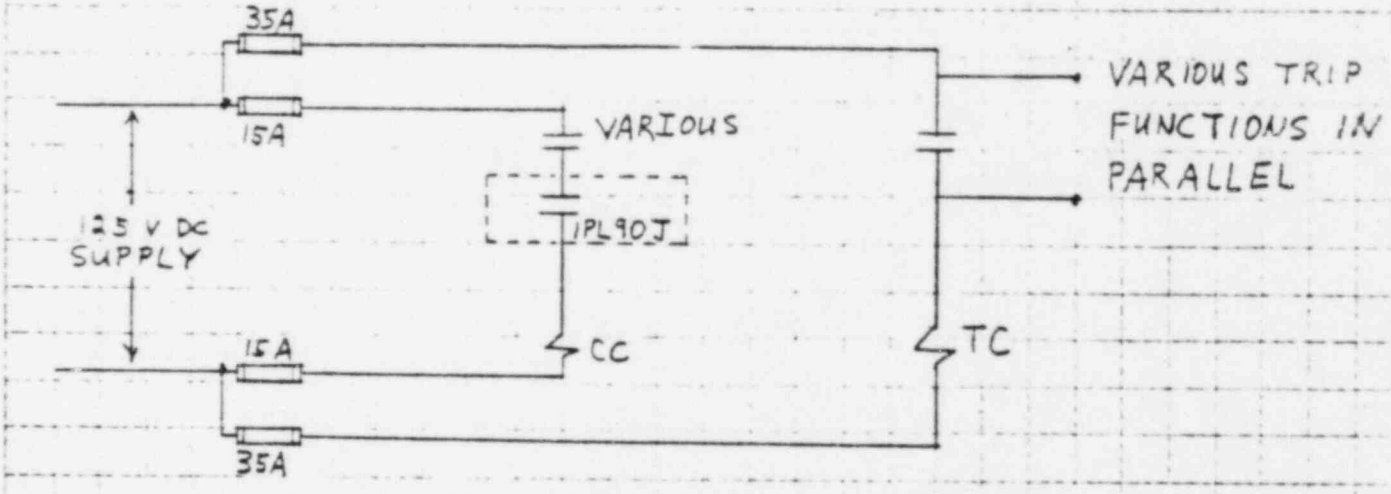
B. Cables 1HP01H and 1HP02K

These cables bring in interlocks in the closing circuits of the RAT feeder breaker and ERAT feeder breaker. The circuit is approximately represented by the following sketch:



The only safety related function of these two breakers, (RAT and ERAT feeder breakers) is to trip when called on to trip by relays protecting the Safety-related 4160 Volt Bus. The interlocks are administrative in nature, preventing backfeeding the RAT and ERAT transformers when they are locked out. The interlock contacts are physically located at non-safety-related relay panels 1PL90J and 0PL91J. Therefore the function of cables 1HP01H and 1HP02K is non-safety-related.

The 15 ampere fuses in the closing circuits can serve as isolation devices if open circuits, short circuits, or "strange voltages" occurring on

the cables or at relay panels do not cause an inability to perform the safety-related function.

1. Open circuits - If an open circuit occurs in the closing circuit of the breaker, the breaker won't close when called on. However, these are the RAT feeder and ERAT feeder breakers, and they don't have a requirement for safety-related ability to close. Their only safety-related requirement is to trip when called on to protect the 4160 Volt bus and permit the Diesel generator to close in and carry the bus's load. Therefore an open circuit will not cause an inability to perform the breaker's safety-related function.

2. Short circuits - Some of the contacts in the circuit are momentary contacts of the operator's control switch. Therefore, short circuiting of contacts will usually have no resultant action. A mistaken control switch operation by the operator could cause the breaker to close, but the safety-related overcurrent relays on the breaker would trip the breaker.

   Short circuiting of these cables to any other circuit will be analyzed under "Strange voltages" below.

3. "Strange voltages" - This description applies to any voltage which could become connected to any conductor in the cable or any part of the circuit connected to it in the non-safety-related panel. The two cables are both designated C1B segregation code. As such they are run in

conduits and cable trays with other control cables at the 120VAC and 125 VDC level. Thus events such as fires at the non-safety-related relay panel or in the cable trays or conduits would only result in 120VAC or 125VDC being imposed on the circuit. If that occurred, the closing circuit fuses would blow and prevent the 120VAC or 125VDC source from getting onto the tripping circuit, the part of the circuit that must survive such events able to function.

The tripping circuit has 35 ampere fuses, compared to the 15 ampere fuses of the closing circuit. Thus even under "sneak circuit" conditions that might occur under various short circuit events, the closing circuit fuses will blow first, leaving the tripping circuit intact and ready to perform the breaker's only safety-related function, tripping in response to the relays.

Since the closing circuit and tripping circuit conductors downstream of the 15 ampere and 35 ampere fuses respectively are bundled together inside the switchgear, and the tripping circuit performs the only safety-related function, it must be shown that the closing circuit cannot harm the tripping circuit thermally. The graph on page 10 shows the characteristic of the 15 ampere fuses compared to the melting characteristic of the #14 AWG copper wiring of the control circuits inside the switchgear. The graph shows generous clearance.* Therefore, voltage sources imposed on the non-safety-related cable or the circuit in the relay panel will be cleared before they can damage the closing circuit's conductors, much less cause damage to the tripping circuit's conductors adjacent in the bundle.

Therefore, "strange voltages" imposed on the non-safety-related cable or the circuits connected to it in the non-safety-related relay panel will not cause an inability to perform the breaker's safety-related function.

Therefore cables 1HP01H and 1HP02K, designated C1B segregation category and routed as such, have no separation violations.

* We have extrapolated the characteristic of a 15 ampere fuse on the graph from the manufacturer's data. However, there is generous clearance to the characteristic of a 30 ampere fuse from manufacturer's data. Therefore the generous clearance to any characteristic for a 15 ampere fuse would be justified.

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Calcs. For

Safety-Related | Non-Safety-Related

Calc. No. 19E0-6
Rev. 0 Date 10-11-82
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Client
Project
Proj. No. 4526-00 Equip. No.

Prepared by Date
Reviewed by Date
Approved by Date

C. Cables 1HP01B and 1HP02D

These cables connect low level instrumentation circuits from transducer/voltage developing resistor networks in the switchgear to the plant computer. The circuits are designated "associated" on the GE elementary diagrams and S&L schematics. Associated circuits run from the voltage developing resistor networks to control room panel meters. The cables for these circuits, 1HP01D and 1HP02F, are presently designated K3E. Because no safety-related function is performed and the transmitters are designated associated on the drawings, the cables will be downgraded from K3E to K3A and the dotted lines separating "3A" from "3A" (no separation required) will be removed from the S&L relaying and metering diagrams.

Assuming all other parts of the circuit are "associated," the voltage-developing resistor networks and the transducers may be considered isolation devices. See Calculation 19E0-2, which analyzed the transducers in a similar application, and the attached catalog data sheet GEA-9801A which show that the transducers in 1E22-S004 function as isolators.

Therefore the voltage-developing resistor networks isolate the non-safety-related cables 1HP01B and 1HP02D from the associated circuits.

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Due to the low voltage and current levels present in the transmitter output circuits, cable insulation provided is sufficient to maintain separation inside the switchgear.

CONCLUSION:

Sufficient separation is provided for cables 1HP01B and 1HP02D by various means.

D. Cable 1HP06F

The function of this cable is to transmit the output signal from a transmitter/voltage developing resistor network to the computer. There are no "associated" signals taken from the resistor network for this signal. As discussed above, the transducer and resistor network function as the isolator.

Due to the low energy level present in the transmitter/resistor networks, the insulation of the cable is sufficient and it may travel with the safety-related cables in the equipment 1E22-S004.

Separation is provided on the field side of the terminal block by training or enforcement of Specification K-2799 Article 1001.2d.

CONCLUSION:

Sufficient separation is provided on cable 1HP06F by various means.

Calculation M-00-
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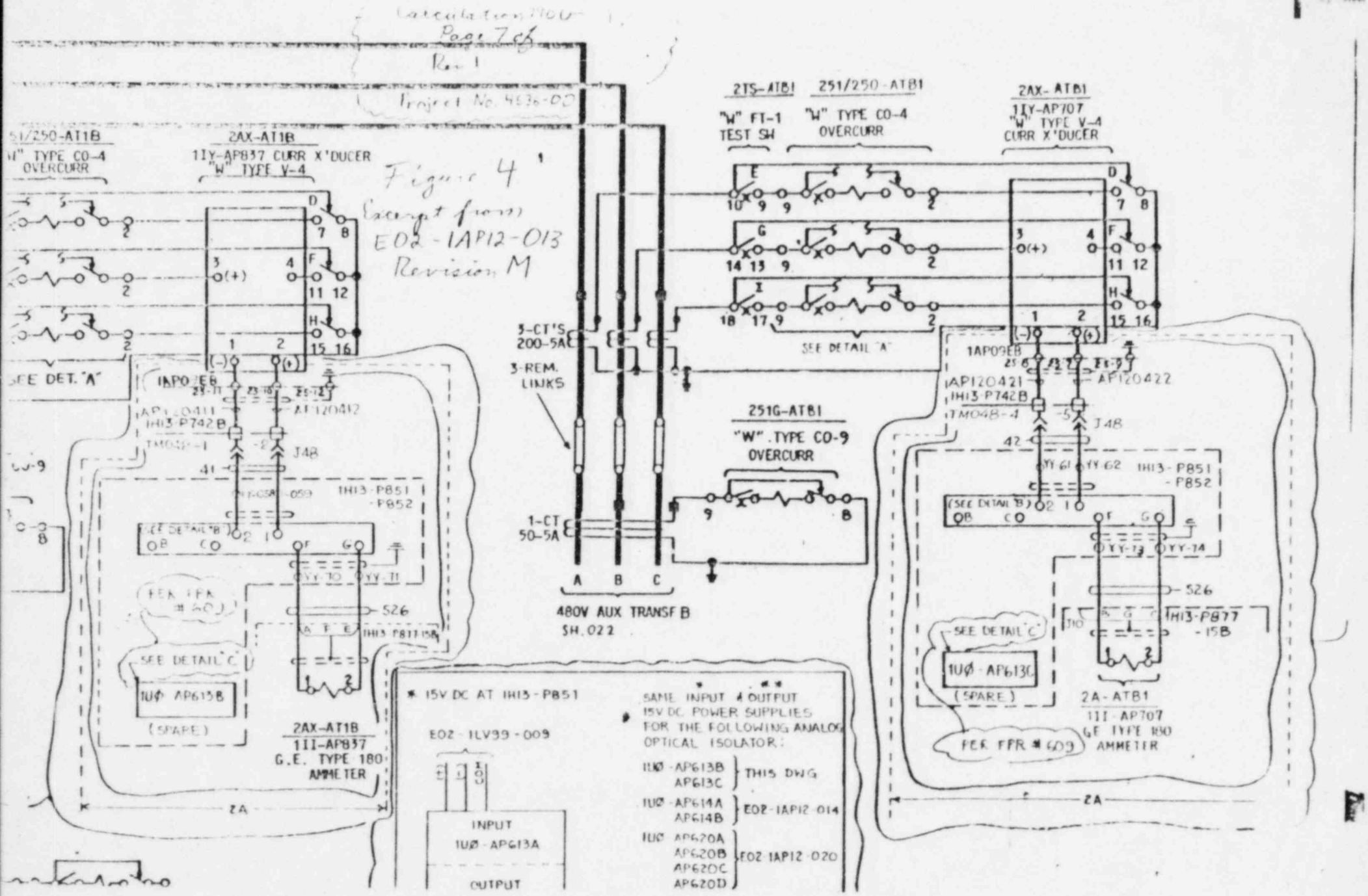
Figure 4
Excerpt from
E02-1AP12-013
Revision M



GENERAL ELECTRIC

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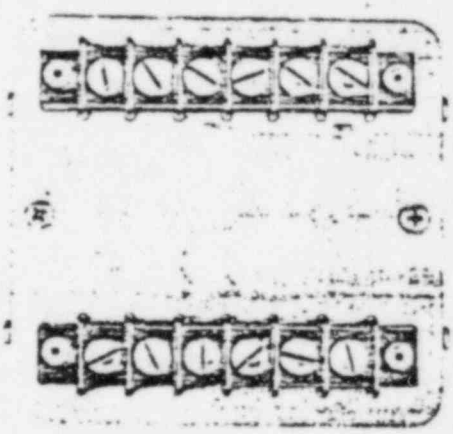
4536-00 Rev. 0 Date: 10-11-89

GENERAL ELECTRIC'S NEW TYPES 4723 & 4724 ELECTRONIC WATT & VAR TRANSDUCERS FOR THREE-PHASE AND SINGLE-PHASE SYSTEMS

- New Compact Size
- Totally Electronic Design
- Excellent Operating Temperature Performance (does not use Hall Effect Devices)
- Virtually Eliminates Drift and Stability Problems
- High Accuracy with Distorted Wave Forms
- Outstanding Load Rejection
- Meets IEEE SWC Test
- Readily Interchanged Electrically & Mechanically with Type 4701



FUNCTIONS

General Electric Type 4723 & 4724 Watt and Var Transducers are compact totally-electronic instruments designed to provide a dc current output proportional to an ac power input.

DESCRIPTION AND BENEFITS

These devices employ electronic computation circuits that set a new industry standard for operating accuracy and stability, yet they are competitively priced with transducers using conventional Hall Effect measuring circuit techniques.

The total electronic design of these transducers serves to virtually eliminate two major problems typically encountered with conventional transducers: (1) the influence of operating temperature when measuring forward or reverse power flow; (2) uncertain long-term stability and drift. The electronic circuits of the transducers make it possible to guarantee a temperature influence of less than ±0.5% over a range of −20°C to +65°C. Its long-term stability permits users to greatly extend calibration schedules.

The Watt Transducers are furnished in four basic models for application in single-phase and three-phase 50 or 60 Hz power systems. The Var Transducers are also furnished in four basic models for similar applications. The primary difference from the watt units is an internal 90° phase-shifting network that permits measurement of reactive power flow without requiring costly external phase-shifting transformers.

The standard output of both the Watt and Var Transducers is a dc current that is proportional to the ac input power. The polarity is positive for unity power factor in the watt units, and positive for lagging power factor in the var units. The current source concept employed in these transducers provides capability for long-distance transmission of the output to remote series-connected meters, data converters, recorders, and other miscellaneous loads. Any load resistance from short circuit to 10K ohms may be applied without affecting accuracy.

An option is available to provide a dc voltage output signal for these transducers.

The transducers are housed in rugged drawn-steel enclosures with welded-on mounting plates. The entire circuitry may be pulled by removing four easily accessible screws without dismounting the enclosure from its panel.

GENERAL APPLICATIONS

panelboards & switchboards • control equipment • telemetering equipment • engine-generator sets • motor-generator sets • furnaces and ovens • computers • missile ground-support equipment • nuclear control systems • power monitors • turbine control.

The Type 4723 and 4724 Watt and Var Transducers are capable of driving any indicating instrument or direct-acting and potentiometric recorder. Devices most commonly used are Types DB-16, 18, 30, and 40 switchboard instruments; Type 180 Edgewise; Type 195 or Type 196 meter relays; BIG LOOK • and HORIZON LINE • panel meters; and CH and CF recorders. For detailed information concerning application, operation, and calibration of these transducers, please request a copy of GET-6522. Watt and Var Transducers are used by OEM's, utilities, contractors, and industrial manufacturers.

GENERAL SPECIFICATIONS TYPE 4723 WATT TRANSDUCERS

CATALOG NUMBERS	50-472315MNDD	50-472320MNDD	50-472325MNDD	50-472330MNDD
Number of Elements	1 1/2	2	2 1/2	3
Application	1-phase or 3-phase 3-wire balanced load	3-phase 3-wire unbalanced load	3-phase 4-wire balanced voltage	3-phase 4-wire unbalanced load
Full-Scale Calibration, Watts Single-Phase Connection Three-Phase Connection	 ±500 ±1000	 — ±1000	 — ±1500	 — ±1500
Potential Input, Nominal (External Power Option)[2] Overload Withstand, Continuous Burden, Maximum (External Power Option)[2]	85-150 vac (0-150 vac) 175 vac 4 va (1 va)	85-150 vac (0-150 vac) 175 vac 4 va (1 va)	85-150 vac (0-150 vac) 175 vac 4 va (1 va)	85-150 vac (0-150 vac) 175 vac 4 va (1 va)
Current Input, Nominal Overload Withstand, Continuous Overload Withstand, 1 Second Burden, Maximum	0-6.25 a 10 a 250 a 0.25 va	0-6.25 a 10 a 250 a 0.25 va	0-6.25 a 10 a 250 a 0.25 va	0-6.25 a 10 a 250 a 0.25 va
Output, Full Scale	±1 ma dc	±1 ma dc	±1 ma dc	±1 ma dc
Accuracy, % of F.S.*	±0.5%	±0.5%	±0.5%	±0.5%
Operating Temperature Range	−20 to +65°C	−20 to +65°C	−20 to +65°C	−20 to +65°C
Temperature Influence, Maximum	±0.5%	±0.5%	±0.5%	±0.5%
Operating Humidity	0-90%	0-90%	0-90%	0-90%
Output Load	0-10KΩ	0-10KΩ	0-10KΩ	0-10KΩ
Output Ripple, Peak	<1%	<1%	<1%	<1%
Response Time (to 99%)	<400 ms	<400 ms	<400 ms	<400 ms
Frequency, Nominal (Optional Frequency)[3]	60 Hz (50 Hz)	60 Hz (50 Hz)	60 Hz (50 Hz)	60 Hz (50 Hz)
Power Factor Range	Unity to Lead or Lag zero			
Dielectric Test, Vrms	1500	1500	1500	1500
Surge Withstand	Withstands IEEE SWC Test, 2.5KV crest value, 1.5 M Hz oscillatory decay			
Size	See outline dimensions			
Calibrate Adjustment[1] (Optional Calib. Range)[2] (Optional Calib. Range)[2]	±10% (50 to 125%) (75 to 200%)			
Zero Adjustment	±2%			
Special Requirements	Consult Factory			
Weight	3 lbs/1.35 kg	3.6 lbs/1.6 kg	3.6 lbs/1.6 kg	4.2 lbs/1.58 kg

CATALOG NUMBERS FOR OPTIONS

1. External Power Option:
   First letter in Cat. No. may be specified as follows:
   M- Standard - 85 to 150 vac potential.
   D- 0-150 vac potential input. An external power source of 120 vac 5 va is required for this option.

2. Frequency Option:
   Second letter in Cat. No. may be specified as follows:
   N- Standard 60 Hz
   D- 50 Hz