Consumers Power Company

Palisades Plant - Docket 50-255

Engineering Analysis EA-83-SRO-005

"Additional Resistive Isolation Devices for the RPS/F&P Computer Interconnections"

April 18, 1983

27 Pages

Consumers Power Company

NUCLEAR OPERATIONS DEPARTMENT
Engineering Analysis Work Sheet

EA – 83-SRO-005
Sheet 1 of 11

Title ADDITIONAL RESISTIVE ISOLATION DEVICES FOR THE RPS/F+P COMPUTER INTERCONNECTIONS.

Performed by S R Oakley Date 3/18/83

References

R L Muzzi Technical Review by 4/18/83 Date

I. PURPOSE

TO DETERMINE THE EFFECT OF CREDIBLE FAILURES, AS DEFINED IN IEEE STANDARDS 279-1971 AND 384-1977, IN CABLES AND CONDUCTORS THAT TRANSMIT RPS PARAMETERS TO THE FISCHER + PORTER PLANT COMPUTER.

II SCOPE

THE THREE RPS CIRCUITS UNDER INVESTIGATION PROVIDE VOLTAGE INPUT SIGNALS TO THE F+P PLANT COMPUTER IN CONTROL PANEL C-06. THE RPS LOOPS ARE SAFETY-RELATED WHILE THE PLANT COMPUTER IS NON-SAFETY RELATED FOR THE SUBJECT INPUTS. THE SCHEMATIC DIAGRAM ON PAGE 2 SHOWS THE GENERAL CONFIGURATION OF INSTRUMENT LOOPS.

FOUR POSSIBLE CREDIBLE FAILURES WILL BE EXAMINED. THOSE FAILURES ARE; SHORT CIRCUITS, OPEN CIRCUITS, GROUNDS, AND THE APPLICATION OF THE MAXIMUM CREDIBLE VOLTAGE. ALSO TO BE CONSIDERED IS THE SINGLE FAILURE OF THE ISOLATION DEVICE AND THE EFFECT OF THAT FAILURE ON THE SAFETY-RELATED CIRCUITS.

THE TYPE OF ISOLATION DEVICES THAT WILL BE UTILIZED ARE 100K Ω RESISTORS PLACED IN SERIES WITH THE VOLTAGE INPUT TO THE F+P COMPUTER AS SHOWN ON PAGE 2. THE PHYSICAL LOCATION OF THE DEVICES WILL BE IN CONTROL PANEL C-12 AS CLOSE AS PRACTICABLE TO THE VOLTAGE DROPPING RESISTORS.

Consumers Power Company

NUCLEAR OPERATIONS DEPARTMENT
Engineering Analysis Work Sheet

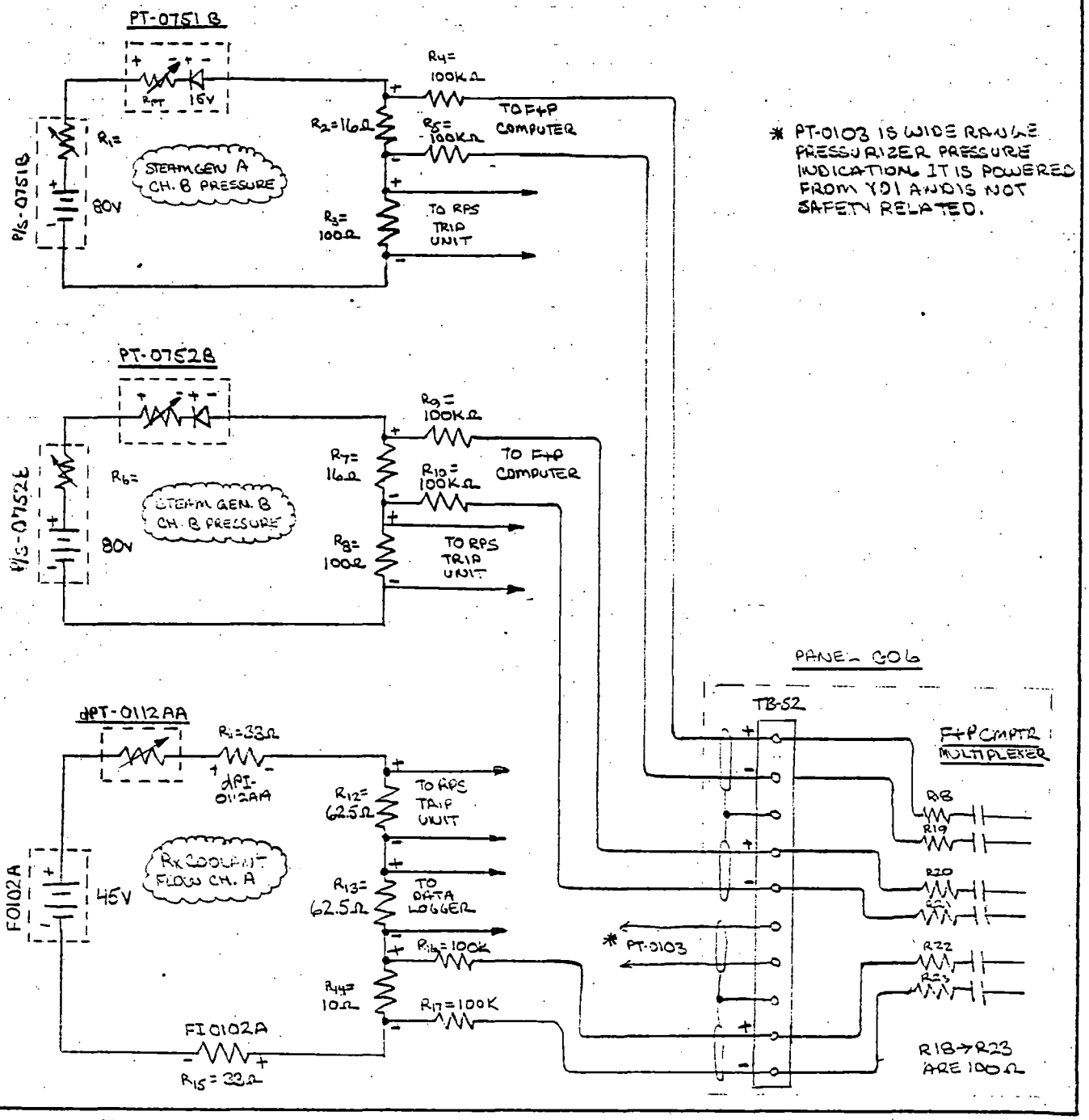
EA – 83-SRD-005
Sheet 2 of 11

Title: ADDITIONAL RESISTIVE ISOLATION DEVICES FOR THE RPS/F+P COMPUTER INTERCONNECTIONS

Performed by: S R Oakley Date: 3/18/83

References:

Technical Review by: Robert Murgi Date: 4/18/83



* PT-0103 IS WIDE RANGE PRESSURIZER PRESSURE INDICATION. IT IS POWERED FROM Y01 AND IS NOT SAFETY RELATED.

Form 3119 3-82

Title ADDITIONAL RESISTIVE ISOLATION DEVICES FOR THE RPS/F+P COMPUTER INTERCONNECTIONS

Performed by SR Dahle Date 3/18/83

References

RF Munn Technical Review by 4/18/83 Date

III REFERENCES

(1) IEEE STANDARD 279-1971 " CRITERIA FOR PROTECTION SYSTEMS FOR NUCLEAR POWER GENERATING STATIONS".

(2) IEEE STANDARD 384-1981 " CRITERIA FOR INDEPENDENCE OF CLASS 1E EQUIPMENT AND CIRCUITS".

(3) STEAM GENERATOR PRESSURE LOOP.
- A. SCHEMATIC DIAGRAM E-83 (ATTACHMENT 4)
- B. PT-0751B, PT 0752B ACCORDING TO DRAWING 2966-D-3134 THESE ARE FOXBORO MODEL M/611 (ATTACHMENT 5)
- C. P-0751B, P-0752B ACCORDING TO DRAWING 2966-D-3134 THESE ARE FOXBORO MODEL M/610A (ATTACHMENT 5)
- D. FOXBORO DATA SHEETS FOR THE MODEL M/610A POWER SUPPLY SHOW R1 (R6), OF SCHEMATIC SHEET 2, SET TO PROVIDE TRANSMITTER LOOP LOAD OF 600Ω.
- E. ATTACHMENT 5 PAGE 2 SHOWS THAT THE TRANSMITTER WILL REGULATE ITS OUTPUT PROPORTIONAL TO THE INPUT AS LONG AS LOOP RESISTANCE IS BOUNDED BY 600Ω +10%, -20%.

(4) REACTOR COOLANT FLOW LOOP
- A. SCHEMATIC DIAGRAM E96 SH4 (ATTACHMENT 4)
- B dPT-0112AA ACCORDING TO DRAWING M211 SH 01-9 (ATTACHMENT #6) IS A ROSEMOUNT MODEL 1152 HP.
- C. DRAWING 2966-D-3112 SHOWS dPI-0112AA & FI-0102A AS SIGMA M/N 9223-E-00 (ATTACHMENT #7). SIGMA DATA SHEETS SHOW RESISTANCE TO BE 40Ω FOR 1mA SPAN & 5Ω FOR 100mA SPAN. WITH A SUPPLY VOLTAGE OF 45 VOLTS THE INPUT RESISTANCE FOR A 16mA SPAN (4-20 mA) IS ≈ 33Ω (SEE ATTACHMENT #3)

Title ADDITIONAL RESISTIVE ISOLATION DEVICES FOR THE RPS/F+P COMPUTER INTERCONNECTIONS

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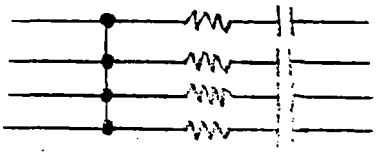
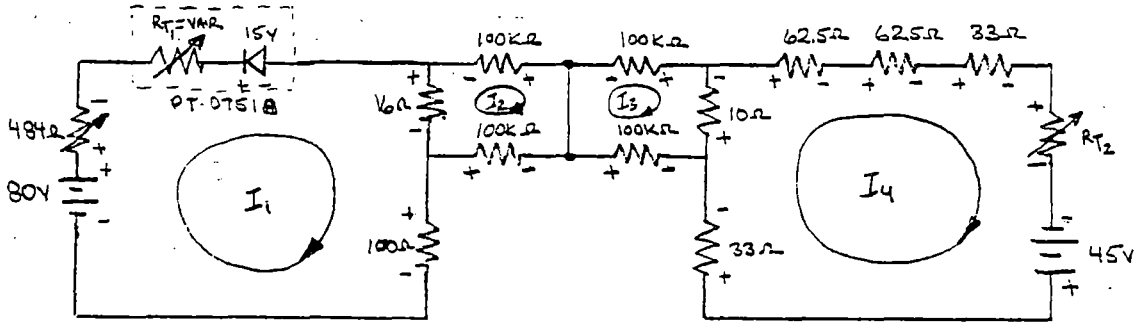
IV CREDIBLE FAILURE TYPE 1 - SHORT CIRCUITS

A.) SHORT OF ANY 2 CONDUCTOR CABLES AT THE INPUT OF THE F+P COMPUTER



THE RESULTING CIRCUIT WOULD BE AS FOLLOWS



INITIAL CONDITIONS – $I_1 = 30\,mA$ THEN $R_{T_1} = \frac{80-15}{30\times10^{-3}} - (484+100+16) = 1567\,\Omega$

$I_4 = 12\,mA$ THEN $R_{T_2} = \frac{45}{12\times10^{-3}} - (33+10+62.5+62.5+33) = 3549\,\Omega$

THE EFFECT OF SHORTING 2 CABLES IS DETERMINED USING MESH CURRENT ANALYSIS.

LOOP 1 $80 = 2151(I_1) + 16(I_1 - I_2) + 15$

LOOP 2 $0 = 16(I_2 - I_1) + 200K(I_2)$

LOOP 3 $0 = 200K(I_3) + 10(I_3 - I_4)$

LOOP 4 $45 = 10(I_4 - I_3) + 3150(I_4)$

THE ABOVE EQUATIONS INDICATE THAT THERE IS NO MUTUAL CURRENT FLOW BETWEEN THE TWO CIRCUITS. IE. NO POTENTIAL DIFFERENCE AT THE POINT OF THE SHORT

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IV CREDIBLE FAILURES TYPE 1 CONT...

SOLVING THE EQUATIONS FOR THE LOOP CURRENTS YIELDS THE FOLLOWING VALUES,

$I_2 = 2.40 \times 10^{-6} A = .00240 mA$

$I_1 = 30.0 mA$

$I_3 = 6.00 \times 10^{-7} A = .000600 mA$

$I_4 = 12.0 mA$

AS CAN BE SEEN FROM THE ABOVE CALCULATIONS THAT SHORTING THE CONDUCTORS AT ANY POINT BETWEEN THE RPS ISOLATION RESISTORS AND THE MULTIPLEXER INPUT IN THE F+P COMPUTER WILL HAVE NO EFFECT ON THE SAFETY RELATED CIRCUIT. THE SLIGHT DECREASE IN LOAD RESISTANCE (APPROX. .0080%) IS COMPENSATED FOR BY THE TRANSMITTER.

THE TRANSMITTERS ARE CURRENT SENSING DEVICES THAT COMPARE THE LOOP CURRENT WITH THE SENSED PARAMETER (PRESSURE, LEVEL, etc...) IF IN PROPER CALIBRATION THE TRANSMITTER WILL ADJUST ITS INTERNAL VARIABLE RESISTANCE TO MAINTAIN THE PROPER LOOP CURRENT PROPORTIONAL TO THE SENSED PARAMETER. THE DATA SHEETS FOR THE FOXBORO M611 XMITTER SHOW (ATACH 6) THAT THE TRANSMITTER WILL MAINTAIN ITS OUTPUT PROPORTIONAL TO INPUT OVER A LOAD RANGE OF 600Ω +10%, -20%. ACCORDING TO THE ROSEMOUNT SPECIFICATION, THE MODEL 1152HF TRANSMITTER IS NOT AFFECTED BY CHANGES IN LOAD PROVIDING THE TOTAL LOOP RESISTANCE DOES NOT INCREASE ABOVE THE VALUE SPECIFIED ON THE LOAD LIMITATIONS CURVE (SEE ATTACHMENT #1)

Title ADDITIONAL RESISTIVE ISOLATION DEVICES FOR THE RPS/F+P COMPUTER INTERCONNECTIONS

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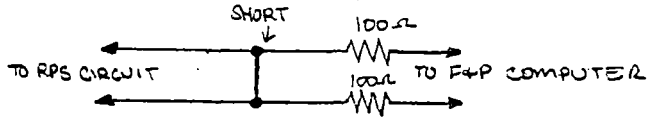
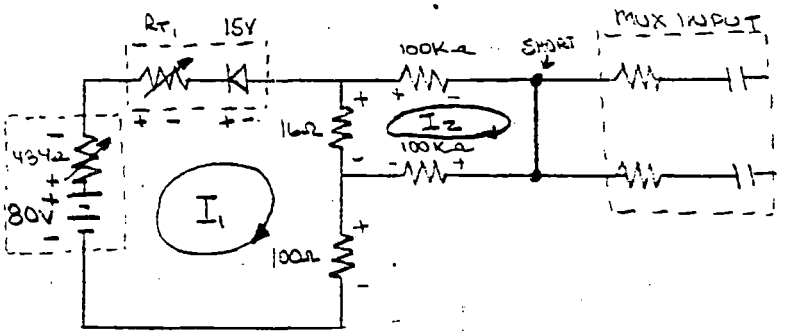
IV CREDIBLE FAILURE TYPE 1- CONT...

B.) A SHORT ACROSS THE TWO CONDUCTORS OF THE FIELD CABLE IN ONE CIRCUIT.



THE RESULTING EQUIVILENT CIRCUIT WOULD BE:



TYPICAL STM GEN PER CIRCUIT

IT IS APPARENT THAT THIS CONFIGURATION IS EQUIVALENT TO THE CIRCUIT OF II PART A AND THAT THERE WOULD BE NO EFFECT ON THE CIRCUIT FROM A SHORT ACROSS THE FIELD CABLE TO THE F+P COMPUTER.

Title ADDITIONAL RESISTIVE ISOLATION DEVICES FOR THE RPS/F+P COMPUTER INTERCONNECTIONS

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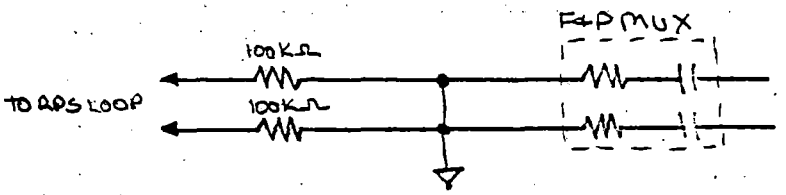
IV CREDIBLE FAILURES TYPE 1- CONT...

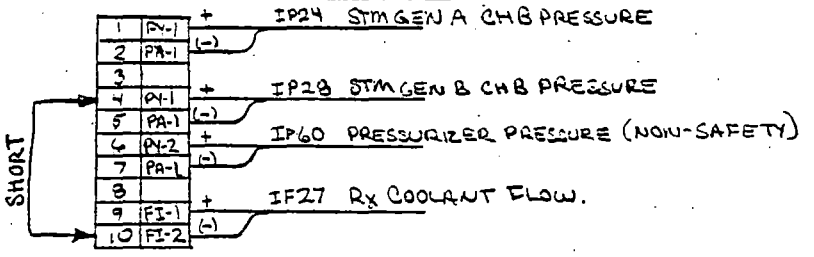
C.) A SHORT TO GROUND ACROSS TWO CONDUCTORS OF THE FIELD CABLE FROM THE RPS CIRCUIT TO THE F+P COMPUTER.



AS THE POWER SUPPLIES AND THE CIRCUITS THEMSELVES ARE ISOLATED FROM GROUND (i.e. FLOATING) THE RESULT WOULD BE THE SAME AS DESCRIBED IN IV PART A. GROUNDING THE LOOPS AT ANY POINT (INCLUDING A SINGLE CONDUCTOR FAULT TO GROUND) WILL HAVE NO EFFECT ON THE RPS CIRCUIT SINCE THERE IS NO RETURN PATH FOR THE FAULT CURRENT.

D) SHORT OF ANY TWO CONDUCTORS AT THE INPUT TERMINAL BLOCK OF THE F+P COMPUTER.

TB 52 @ C06-2 (DWG E-615 SH 3)



BECAUSE FOUR CABLES ARE TERMINATED ON ONE TERMINAL BLOCK IN CLOSE PROXIMITY TO ONE ANOTHER THERE IS THE POSSIBILITY THAT TWO TERMINAL POINTS MAY BE SHORTED

CONT...

Title ADDITIONAL RESISTIVE ISOLATION DEVICES FOR THE RPS/ F+P COMPUTER INTERCONNECTIONS

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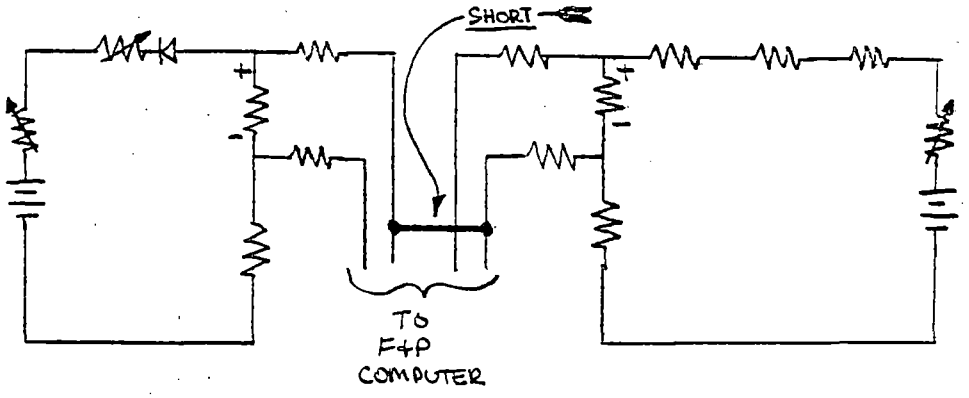
IV CREDIBLE FAILURES TYPE 1

D) CONT...

...TOGETHER DURING A MAINTENANCE ACTIVITY.

THE RESULTING CONFIGURATION WOULD BE:



AS STATED EARLIER THE RPS CIRCUITS ARE ISOLATED FROM GROUND AND, THEREFORE, A SINGLE SHORT ACROSS ANY TWO CONDUCTORS AT TB-52 WOULD HAVE NO EFFECT ON THE RPS CIRCUITS. THIS IS BECAUSE THERE IS NO RETURN PATH FOR THE SHORT CIRCUIT CURRENT.

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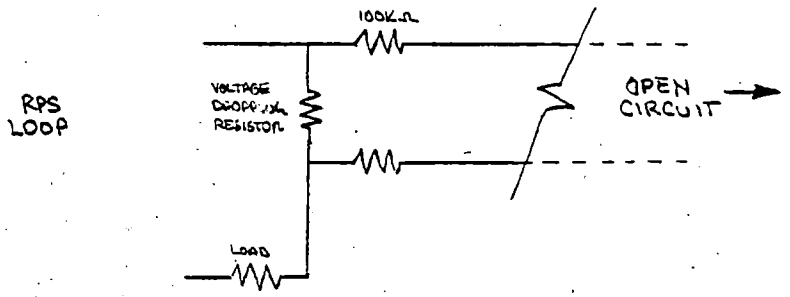
[signature] Technical Review by Date 4/13/83

I. CREDIBLE FAILURE TYPE 2- OPEN CIRCUIT

AN OPEN CIRCUIT AT THE OUTPUT OF THE RESISTIVE TYPE ISOLATION DEVICE WOULD HAVE NO EFFECT ON THE SAFETY RELATED RPS LOOP. AN OPEN CIRCUIT WOULD REMOVE THE INPUT FROM THE F+P PLANT COMPUTER. THE SHUNT CURRENT THAT WOULD NORMALLY FLOW THROUGH THE F+P COMPUTER INPUT (CURRENT LESS THAN 10^{-9} AMPERES) WOULD THEN FLOW THROUGH THE VOLTAGE DROPPING RESISTOR IN THE RPS LOOP. AS DESCRIBED IN II PART A THE TRANSMITTER WILL ADJUST ITS VARIABLE RESISTANCE TO MAINTAIN A LOOP CURRENT PROPORTIONAL TO THE INPUT PARAMETER.



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VI. CREDIBLE FAILURE TYPE 3 - MAXIMUM CREDIBLE VOLTAGE

A) AC VOLTAGE

THE LARGEST AC VOLTAGE USED IN THE F+P CABINET IS 120 V DLTS. HOWEVER, AS DESCRIBED IN THE F+P MANUAL, ATTACHMENT #2, THE LOW LEVEL ANALOG SIGNALS ARE ARE LOCATED AT LEAST 6 FEET FROM A PARALLEL LENGTH OF AC POWER CABLE AND AC MACHINERY. THE AC TERMINAL BLOCKS ARE SEPERATE FROM THE BLOCKS WHERE THE RPS SIGNALS TERMINATE. IN VIEW OF THE INTERNAL CABINET WIRING PRACTICES IT IS NOT PROBABLE THAT 120 VAC WOULD BE APPLIED TO THE RPS LOOPS. THIS SCENARIO IS, THEREFORE, NOT CONSIDERED CREDIBLE.

FURTHERMOR, SINCE THE RPS LOOPS FLOAT ABOVE GROUND, SHORTING ONE SIDE OF A 120 VAC SOURCE (OR OF ANY OTHER VOLTAGE SOURCE) WILL HAVE NO EFFECT ON THE LOOP.

B) DC VOLTAGE

THE F+P INPUT CIRCUITRY UTILIZES THREE DC VOLTAGES, +15, -15, +5. THE MOST PROBABLE FAILURE THAT WOULD APPLY THE MAXIMUM DC VOLTAGE TO THE RPS LOOP WOULD BE A SHORT ACROSS THE DIODE (CR4) LOCATED AT THE A/D INPUT. SEE ATTACHMENT #8. THIS WOULD RESULT IN APPLYING +16 VDC TO THE INPUT CIRCUITRY AND BACK THROUGH THE MUX. THE EQUIVILENT

CONT...

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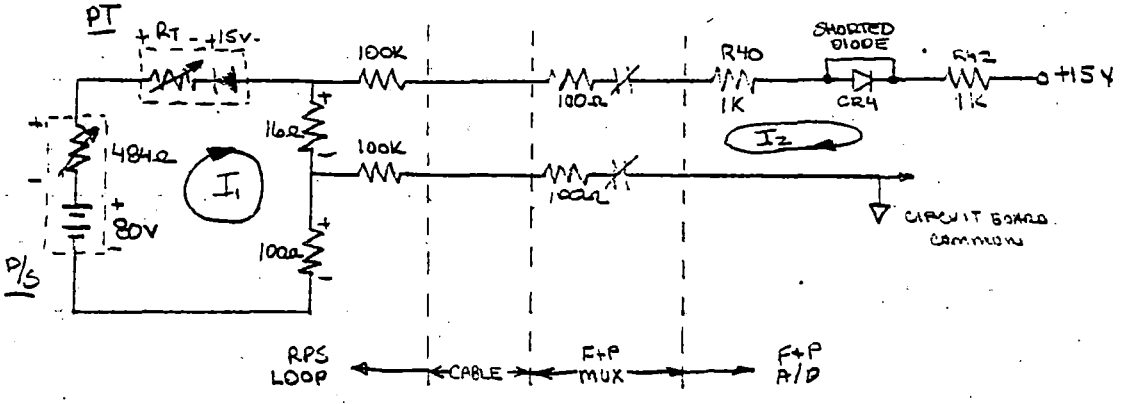
VI CONT...

B) DC VOLTAGE CONT...

CIRCUIT IS SHOWN BELOW. (FOR A TYPICAL RPS LOOP)



ASSUME INITIAL CONDITION OF 30mA SO R_T = 1567Ω

LOOP MESH CURRENT ANALYSIS YIELDS:

LOOP 1 $80-15 = I_1(484+1567+16+100) - I_2(16)$

LOOP 2 $15 = -I_1(16) + I_2(1K+1K+100+100K+16+100K+100)$

THE RESULTING CURRENT WOULD BE (SOLVING EQUATIONS SIMULTANEOUSLY)

$I_2 = .0000766 \cong 0mA$

$I_1 = .0300 = 30.0mA$

IT IS APPARENT FROM THE ABOVE ANALYSIS THAT APPLICATION OF THE MAXIMUM CREDIBLE DC VOLTAGE WILL HAVE NO DISCERNABLE EFFECT ON THE SAFETY RELATED RPS LOOP.

Overpressure Effect

2000 psig overpressure will cause a zero shift of less than ± 0.25% of Upper Range Limit for Range Codes 3 & 4 (Only Range 4 for AP); less than ± 1.0% of Upper Range Limit for Range Code 5; less than ± 3.0% of Upper Range Limit for Range Codes 6 & 7; less than ± 6.0% of Upper Range Limit for Range Code 8; less than ± .5% of Upper Range Limit for Range Code 9 up to 4500 psig (For GP only).

Power Supply Effect

Less than 0.005% of span per volt.

Load Effect

No load effect other than the change in voltage supplied to the transmitter.

Mounting Position Effect

Zero shift of up to 1 inch H_2O which can be calibrated out: No effect in plane of diaphragm. No span effect.

Performance Specifications Model 1152DP and 1152HP

(Zero-based ranges, Reference Conditions)

Accuracy including effects of linearity, hystersis and repeatability

Model 1152DP: ± 0.2% of calibrated span for Range Codes 3, 4, 5; ± 0.25% for Range Codes 6, 7, 8.
Model 1152HP: ± 0.25% of calibrated span (all Range Codes)

Dead Band

None

Stability

±0.25% of Upper Range Limit for 6 months.

Temperature Effect at Maximum Span (e.g. 0-150 in. for 0-25/150 in. H_2 range)

Zero Error: ± 0.5% of span per 100° F.
Total Effect including Span and Zero Errors: ± 1.0% of span per 100° F.
(Note: Double the specified effect for Range Code 3)

Temperature Effect at Minimum Span (e.g. 0-25 in. for 0-25/150 in. H_2O range)

Zero Error: ± 3.0% of span per 100° F.
Total Effect including Span and Zero Errors: ± 3.5% of span per 100° F.
(Note: Double the specified effect of Range Code 3)

Overpressure Effect

Model 1152DP: 2000 psi overpressure will cause a zero shift of less than ± 0.25% of Upper Range Limit (Range Codes 3, 4); less than ± 1.0% of Upper Range Limit (Range Code 5); less than ± 3.0% of Upper Range Limit (Range Codes 6 and 7); less than ± 6.0% of Upper Range Limit (Range Code 8).
Model 1152HP: 4500 psi overpressure will cause a zero shift of less than ± 1.0% of Upper Range Limit (Range Code 4); less than ± 2.0% of Upper Range Limit (Range Code 5); less than ± 5.0% of Upper Range Limit (Range Codes 6, 7).

Static Pressure Effect

Model 1152DP Zero Error: ± 0.25% of Upper Range Limit per 2000 psi (Range Codes 4, 5); ± 0.5% of Upper Range Limit per 2000 psi (Range Codes 3, 6, 7, 8).
Span Error: −1.0±0.25% of reading per 1000 psi (Range Codes 4, 5, 6, 7, 8); −1.5±0.25% of reading per 1000 psi (Range Code 3).
Model 1152HP Zero Error: ± 2.0% of Upper Range Limit per 4500 psi (all Range Codes).

Span Error: −1.0±0.25% of reading per 1000 psi (all Range Codes).

Span error is systematic and can be calibrated out for a particular pressure before installation.

Power Supply Effect

Less than 0.005% per volt.

Load Effect

No load effect other than the change in voltage supplied to the transmitter.

Mounting Position Effect

Zero shift of up to 1 in. H_2O which can be calibrated out. No span effect. No effect in plane of diaphragm.

Physical Specifications All Models

Materials of Construction
Isolating Diaphragms and Drain/Vent Valves: 316SS
Process Flanges: 316SS
Non-wetted O-Rings: Ethylene Propylene and Buna-N
Fill Fluid: Silicone Oil
Flange Bolts: Plated Alloy Steel, per ASTM A-540
Electronics Housing: Low-copper aluminum, epoxy polyester painted or austentic stainless steel.
Process Connections: 1/4-18 NPT

Electrical Connections: 1/2-14 NPT conduit. Test jack type screw terminals.
Weight: 12 lbs. with aluminum housing; 16 lbs. with stainless steel housing, excluding options.

Functional Specifications Model 1152AP and 1152GP

Ranges
(3) 0-5/30 in. H_2O (GP Units Only)
(4) 0-25/150 in. H_2O; 0-2/11 in. HgA
(5) 0-125/750 in. H_2O; 0-10/55 in. HgA
(6) 0-17/100 psig/psia
(7) 0-50/300 psig/psia
(8) 0-170/1000 psig/psia
(9) 0-500/3000 psig (GP Units Only)

Output
4-20 mADC

Power Supply
External power supply required, up to 45 VDC. Transmitter operates on 12 VDC with no load for E output code. 15 VDC for A and D output codes.

Span and Zero
Continuously adjustable externally.

Elevation and Suppression
Output Codes A and D: Maximum zero elevation: down to 0.5 psia for compound ranges (for Model 1152GP). Maximum zero suppression: 100% of calibrated span. End points cannot exceed ±100% of Upper Range Limit.

Output Code E: Maximum zero elevation: 600% of calibrated span. Maximum zero suppression: 500% of calibrated span. Calibrated span cannot exceed ±100% of Upper Range Limit.

Temperature Limits
−20 to 200° F Amplifier operating
−20 to 220° F Sensing Element operating.
−60 to 250° F Storage

Overpressure Limits
Operating within specifications from 0.5 psia to 2000 psig (Range Codes 3, 4, 5, 6, 7, 8); 4500 psig (Range Code 9); without damage to transmitter.

Humidity Limits
0-100% RH

Turn-on Time
2 seconds. No warmup required.

Damping
Output Code A: Nominal fixed response times of 0.3 seconds (Range Code 3), 0.2 seconds (Range Code 4, 5), and 0.1 seconds (Range Codes 6, 7,

Output Code D: 4-position variable time constant switch for nominal response times of 2.0 seconds, 1.0 seconds, 0.5 seconds, or as above.

Output Code E: Time constant continuously adjustable between 0.2 and 1.67 seconds.

Functional Specifications Model 1152DP and 1152HP

Ranges
(3) 0-5 to 0-30 in. H_2O (DP Units Only)
(4) 0-25 to 0-150 in. H_2O
(5) 0-125 to 0-750 in. H_2O
(6) 0-17 to 0-100 psi
(7) 0-50 to 0-300 psi
(8) 0-170 to 0-1000 psi (DP Units Only)

Output
4-20 mADC

Power Supply
External power supply required, up to 45 VDC. Transmitter operates on 12 VDC with no load for E output codes; 15 VDC for A and D output codes.

Span and Zero
Continuously adjustable externally.

Elevation and Suppression
Output Codes A and D: Maximum zero elevation and suppression: 150% of calibrated span (Range Codes 3, 4, 5) or 50% of calibrated span (Range Codes 6, 7, 8). End points cannot exceed ±100% of Upper Range Limit.

Output Code E: Maximum zero elevation: 600% of calibrated span. Maximum zero suppression; 500% of calibrated span. Calibrated span cannot exceed ±100% of Upper Range Limit.

Temperature Limits
−20 to 200° F Amplifier operating.
−20 to 220° F Sensing Element operating.
−60 to 250° F Storage

Static Pressure and Over Pressure Limits
Model 1152DP: 0.5 psia to 2000 psig static pressure for operation within specifications. 2000 psig overpressure on either side without damage to the transmitter.

Model 1152HP: 0.5 psia to 4500 psig static pressure for operation within specifications. 4500 psig overpressure on either side without damage to the transmitter.

Humidity Limits

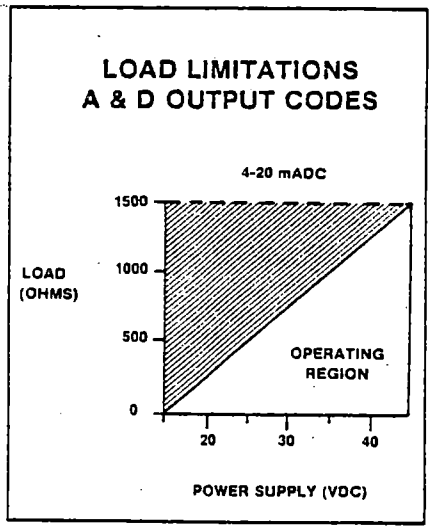
Volumetric Displacement
Less than 0.01 cubic inches.

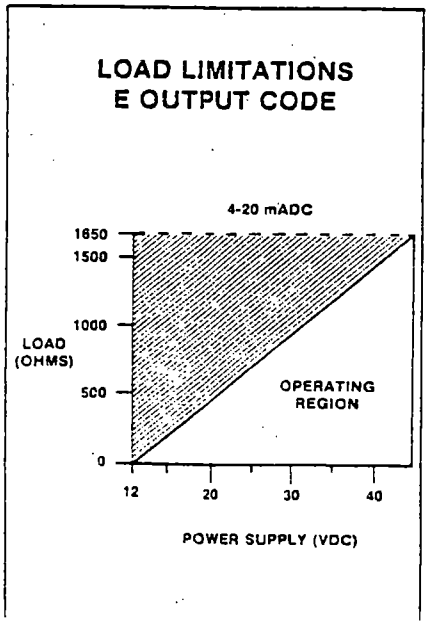
Turn-on Time
2 seconds. No warmup required.

Damping
Output Code A: Nominal fixed response times of 0.3 seconds (Range Code 3), 0.2 seconds (Range Codes 4, 5), and 0.1 seconds (Range Codes 6, 7, 8).

Output Code D: 4-position variable time constant switch for nominal response times of 2.0 seconds, 1.0 seconds, 0.5 seconds or as above.

Output Code E: Time constant continuously adjustable between 0.2 and 1.67 seconds.





b) High level analog signals (1 volt to 10 volts) are transmitted over twisted pairs which may be cabled with other pairs carrying a similar voltage level and current levels less than 100 MA. Shielding is not required except as noted below.

c) Analog signals are not transmitted in the same cable as digital signals.

d) Analog signal cables are located at least six feet from a parallel length of AC power cable and from AC machinery.

e) If signal cables are located in a high electromagnetic field area, they are run in ferrous conduit which is insulated from ground at the signal source end only. The conduit is not connected to the system cabinet.

f) If signal cables are located in a high electro-static field area, or close to AC power cables or digital signal carrying cables, they may be constructed with a conducting shield insulated with an overall jacket. Provisions are made to connect the shield to ground or to the computer (but not both) at the time of system startup.

g) Digital signals are transmitted over twisted pairs which may be cabled with other pairs carrying like signals. The cable does not carry AC power. Shielding is not required.

h) Pulse inputs are transmitted in the same cable as other digital signals. Twisted pairs are required.

2.3.3 AC Power Wiring

a) It is recommended that system power should be provided from an independent isolation transformer located as close to the system as practical. The transformer primary shield should be connected to the primary low side and the secondary shield connected to the system ground.

b) A circuit breaker is connected between the isolation transformer and the system AC input connections.

c) The isolation transformer must not supply power to any device other than the system cabinet. Peripheral devices such as typewriter, card punches, etc., must be connected to other power sources.

d) The system requires 117 volts AC ±10%, 60 Hz.

S195,#2

FISCHER + PORTER MANUAL
SERIES 3000 DATA SYSTEM
GPCo VENDOR FILE # M1-PA SH 1070

SIGMA INSTRUMENTS, INC
9223-E INDICATING CONTROLLER
INSTRUCTION MANUAL # H-697
CPCO VENDOR FILE # M-201 SH 7D

EA-83-SRO-005
ATTACHMENT 3

H697

1.0 Specifications

1.1 Model 9223-E Electrical Characteristics

Input: Specified on meter scale. For example: 10-50 Ma DC.

Output: Sigma 67R4 relay; 5 amperes at 120 VAC resistive; 2.5 amperes at 240 VAC resistive; 3 amperes at 28 VDC resistive. Consult factory for ratings for inductive loads. Life in excess of 200,000 operations at maximum rating.

Number of contacts: SPDT on standard units; DPDT on special order.

Internal Resistance: Approximately 40 ohm for 1 MA span to approximately 5 ohm for 100 Ma span.

Power: 120 VAC ± 10%, 60 Hz. at 6 VA

1.2 Model 9223-E Performance Characteristics

1.2.1 Vertical Mounted

Indicator Accuracy: ½% of Full Scale at standard conditions

Indicator Accuracy: 1% of Full Scale, 15-55°C

Indicator Repeatability: ½% of Full Scale

Set Point Accuracy: 2% of Full Scale.

Set Point Repeatability: 1/3% of Span

Set Point Differential: ½% of Span typical

Response: 1 sec. max., critically damped

Operating Temperature: -10 to 60°C

Max. Allowable Temperature: -10 to +60°C

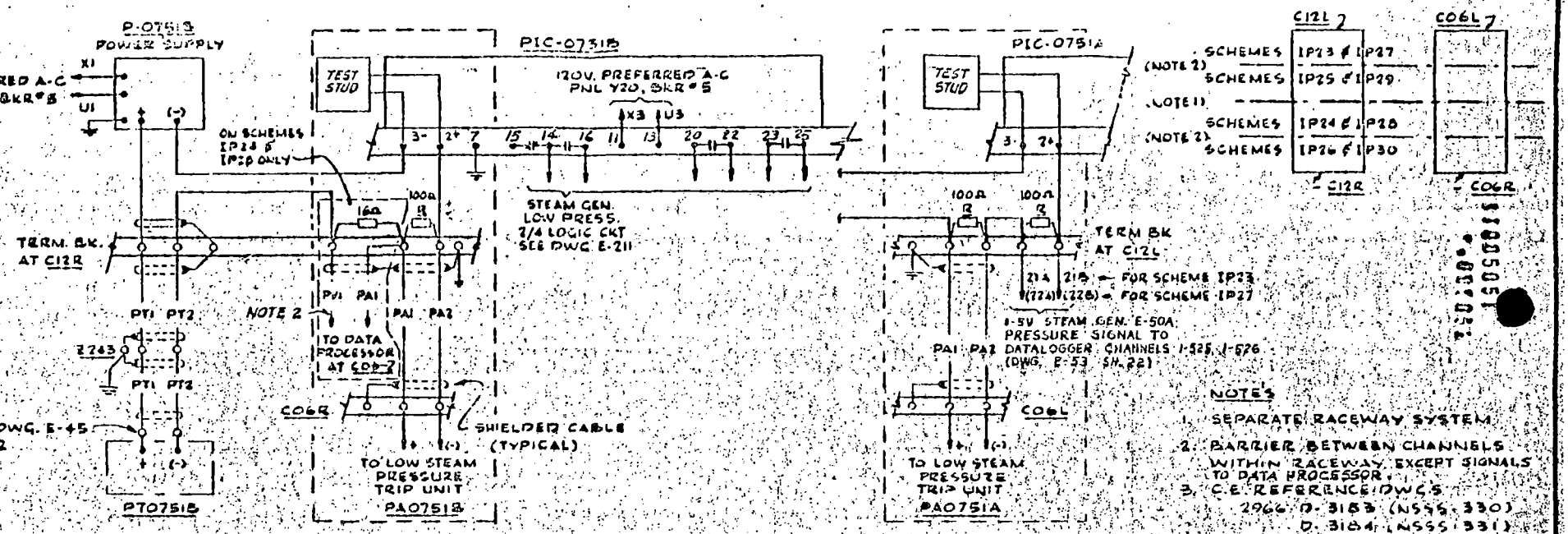
Photo Sensor Life: Greater than 200,000 hours.

1.3 Model 9223-E Physical Characteristics

Mounting: Flush Panel

Material: Case - Steel, Green enamel finish
Bezel - Cast aluminum
Face - Glass

P20465553



STEAM GENERATOR E50A LOW PRESSURE CIRCUIT NO. 2

SCHEME IP24
(COMMON FOR ALL SCHEMES EXCEPT SCHEME IP23 & IP27)

CIRCUIT NO. 1

SCHEME IP23
(SCHEME IP27 SIMILAR)

NOTES

1. SEPARATE RACEWAY SYSTEM.
2. BARRIER BETWEEN CHANNELS WITHIN RACEWAY, EXCEPT SIGNALS TO DATA PROCESSOR.
3. C.E. REFERENCE DWGS
   - 2966-D-3183 (NSSS-330)
   - D-3184 (NSSS-331)
   - D-3185 (NSSS-339)
   - D-3186 (NSSS-340)

ADAPTER TABLE

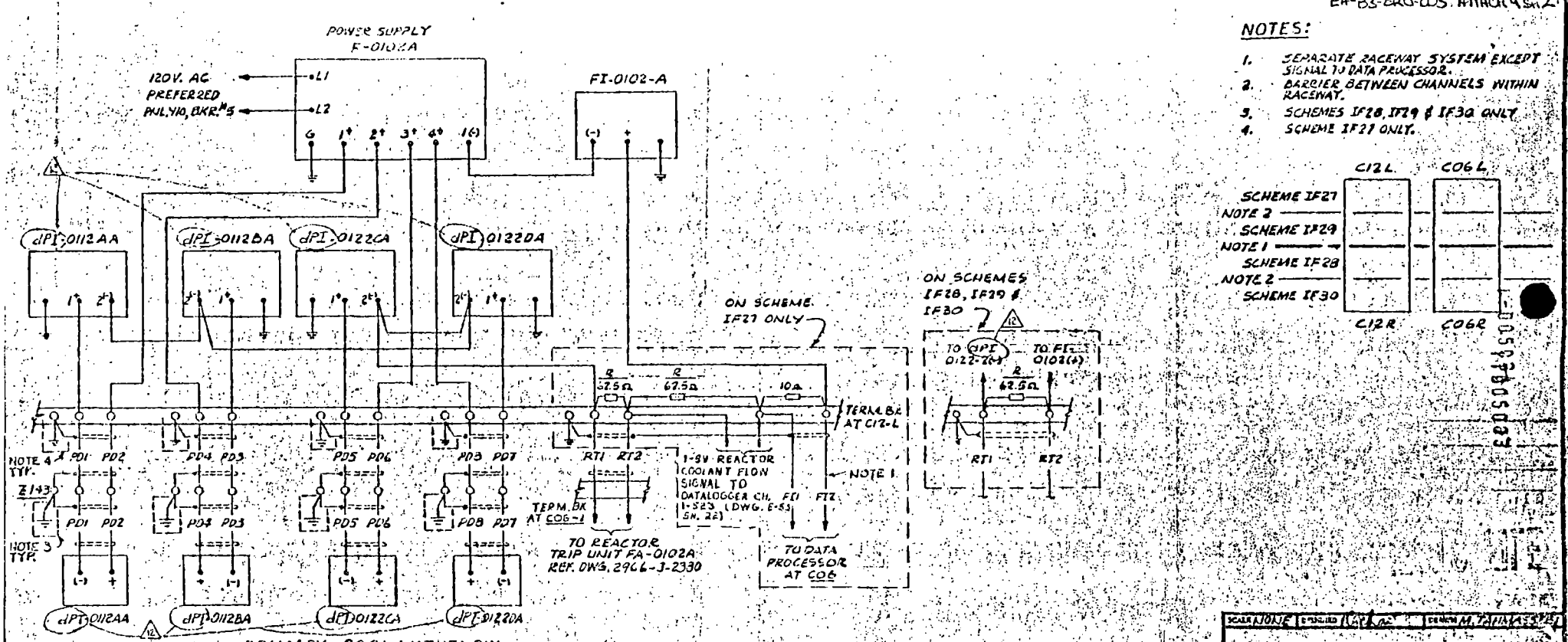
STEAM GEN. NO.	CKT. NO.	SCHEME NO.	PREFERRED A-C PNL.	PREFERRED A-C BKR.	PRESS. TRANSMITTER	PRESS. IND. CONTROLLER P & IPC	PRESS. IND. CONTROLLER LOC.	REACTOR TRIP UNIT NO.	REACTOR TRIP UNIT LOC.	CONTAINMENT PENETRATION CANISTER NO.	120V. A-C SUPPLY WIRES	EVENTS RECORDER SCHEME
E50A	1	IP23	Y10	5	PT07518A	07518	C12L	PA07518A	C06L	Z143	X1, U1, X3, U3	IG01
	2	IP24	Y10	5	PT07518B	07518	C12L	PA07518A	C06L	Z243	X1, U1, X3, U3	IG02
	3	IP25	Y20	5	PT07518C	07518	C12L	PA07518C	C06L	Z146	X1, U1, X3, U3	IG03
	4	IP26	Y20	5	PT07518D	07518	C12R	PA07518D	C06R	Z246	X1, U1, X3, U3	IG04
E50B	5	IP27	Y10	5	PT07518A	07518	C12L	PA07518A	C06L	Z143	X2, U2, X4, U4	IG01
	6	IP28	Y20	5	PT07518B	07518	C12R	PA07518B	C06R	Z243	X2, U2, X4, U4	IG02
	7	IP29	Y20	5	PT07518C	07518	C12L	PA07518C	C06L	Z146	X2, U2, X4, U4	IG03
	8	IP30	Y10	5	PT07518D	07518	C12R	PA07518D	C06R	Z246	X2, U3, X4, U4	IG04

BECHTEL COMPANY

PALISADES PLANT
CONSUMERS POWER COMPANY

SCHEMATIC DIAGRAM
STEAM GENERATOR
PRESSURE INSTRUMENTATION

JOB NO.	DRAWING NO.	SHT.
8938	E-83	2



PRIMARY COOLANT FLOW
SCHEME IF27

REF. CE DWG. 2966-D-3112 & 2966-D-3216
FP 5135-N555-285-365

NOTES:

1. SEPARATE RACEWAY SYSTEM EXCEPT SIGNAL TO DATA PROCESSOR.
2. BARRIER BETWEEN CHANNELS WITHIN RACEWAY.
3. SCHEMES IF28, IF29 & IF30 ONLY.
4. SCHEME IF27 ONLY.

ADAPTER TABLE

DESCRIPTION	SCHEME	DIFFERENTIAL PRESSURE TRANSMITTER (dP T)				DIFFERENTIAL PRESSURE INDICATORS (dPD)				FLOW INDIC. FI	LOC.	120V. PREF. AC. PNL. NO.	BKR. NO.	PENETRATION CANISTER NO.	PWR. SUPPLY
PRIMARY COOLANT FLOW CHANNEL 1	IF27	0112AA	0112BA	0122CA	0122DA	0112AA	0112BA	0122CA	0122DA	0102A	C13L	Y10	5	Z143	F-0102A
PRIMARY COOLANT FLOW CHANNEL 2	IF28	0112AB	0112BB	0122CB	0122DB	0112AB	0112BB	0122CB	0122DB	0102B	C13R	Y20	5	Z243	F-0102B
PRIMARY COOLANT FLOW CHANNEL 3	IF29	0112AC	0112BC	0122CC	0122DC	0112AC	0112BC	0122CC	0122DC	0102C	C12L	Y30	5	Z146	F-0102C
PRIMARY COOLANT FLOW CHANNEL 4	IF30	0112AD	0112BD	0122CD	0122DD	0112AD	0112BC	0122CD	0122DD	0102D	C12R	Y40	5	Z246	F-0102D

SCALE NONE | DESIGNED [illegible] | DRAWN M. PALMATEER

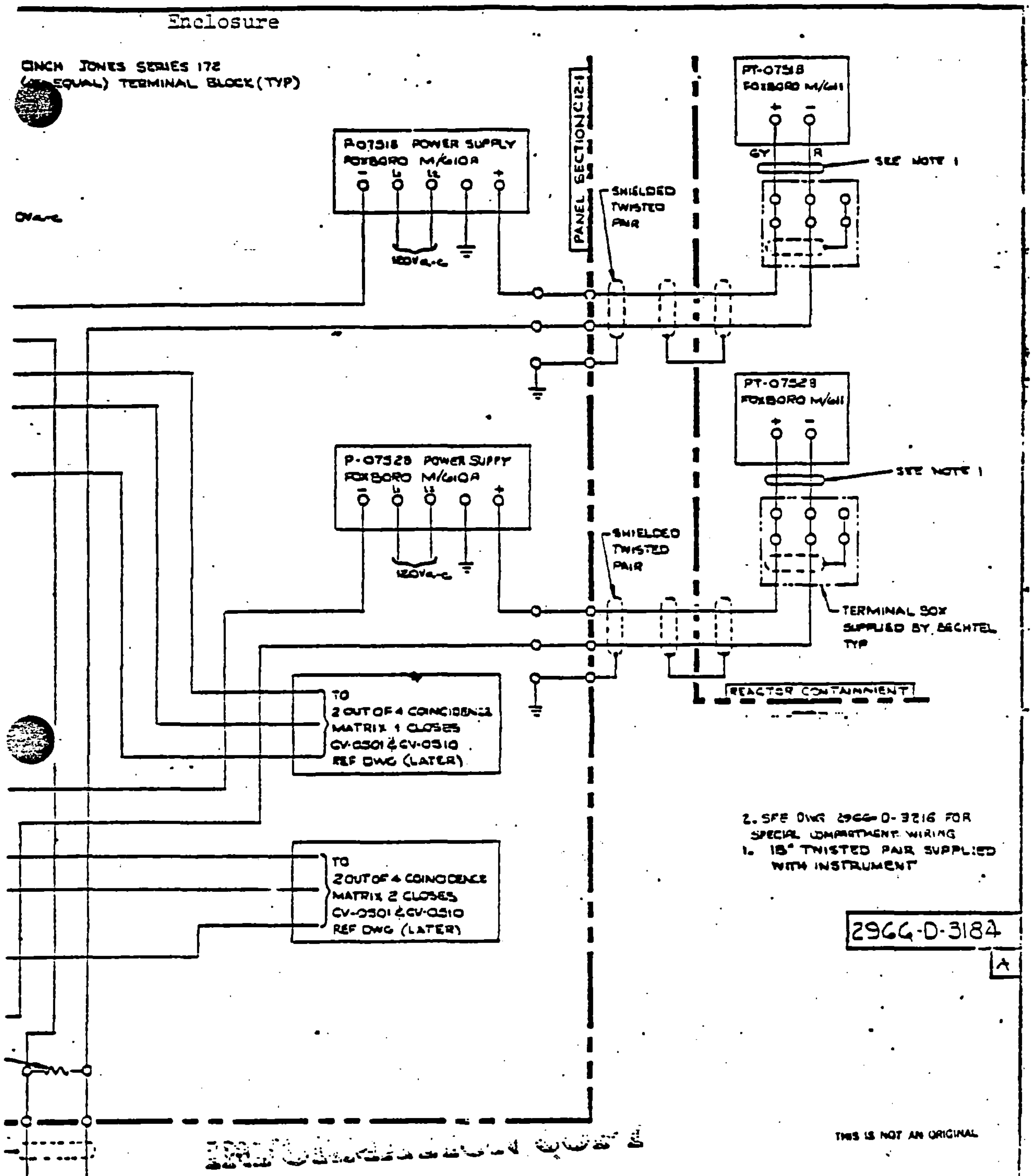
BECHTEL COMPANY

PALISADES PLANT
CONSUMERS POWER COMPANY

SCHEMATIC DIAGRAM
PRIMARY LOOP
INSTRUMENTATION

JOB NO.	DRAWING NO.	
8935	E-96	SHEET 4 OF [illegible]

12



THIS IS NOT AN ORIGINAL

GROY 222 * M1-MB Sh 3184 - A

DESCRIPTION			
72 & REDRAWN PER REVISION REST 2966-276	11/68	4/68	

MACHINING TOLERANCES UNLESS OTHERWISE SPECIFIED

NEXT ASSY:
FINAL ASSY:
SUPERSEDES:
SUPERSEDED:
DO NOT SCALE DWG. | CALC. WT.:
SCALE: | ACT. WT.:

COMBUSTION ENGINEERING, INC. NUCLEAR WINDSOR, CONNECTICUT

INTERCONNECTION DIAGRAM CHANNELS L-07518, L-07528 P-07518 & P-07528

2966-D-3184 A

SHEET OF

RECORD OF TELECON

Date: 10/9/81 Time: 0830 Hrs By: K A Hart

Who Talked To: John Rowe His (Her) Dept: Application Engrg

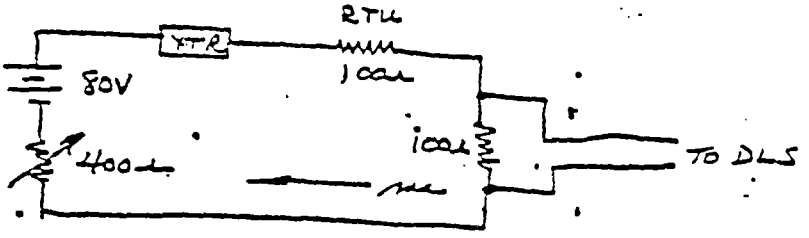
Company: Foxboro Company
Foxboro, Massachusetts

Phone: AC 617 No 543875
Ext —

Subject: Output Capability of Foxboro Type M611 Force-Balanced Pressure Transmitters.

Topics Discussed:

According to Mr. Rowe, the subject transmitter will regulate its output such that it remains proportional to its input pressure regardless of the change in transmitter loop load as long as that change in load is bounded by 600Ω +10% -20%. Therefore, in the steam generator pressure loop described (see item below) adding at the DLS switch (100Ω) would reduce the transmitter's loop resistance to 500Ω and the transmitter output would be unaffected.



Specifications

P1855257

Measurement Range:

Capsule Designation	A	B	C	D
Range Limits, psi	−15 to +350	−15 to +750	−15 to +1500	−15 to +3000
Span Limits, psi	25 to 250	50 to 500	100 to 1000	200 to 2000
Max. Overrange, psi	500	1000	2000	4000

The instrument span may be elevated or depressed up to 300 percent of span. Additional elevation up to 1000 percent of span is available with an optional elevation kit. In either case, the span plus the elevation or depression must not exceed the range limits of the capsule.

Output: 10-50 ma d-c into 600 ohms +10% −20%
Accuracy: ±0.5 percent of span
Working Temperature Limits for Transmitter Body: −40 F to +250 F
Ambient Temperature Limits for Amplifier: −20 F to +160 F
Power Supply: 63-95 volts d-c, 60 ma
Process Connection: ¼-inch or ½-inch NPT
Electrical Connections: Two 18-inch leads from hole tapped for ½-inch conduit
Weight: 20 lb
Power Consumption: 5 va d-c maximum
Process Connection Block: Forged Type 316 Stainless Steel
Topworks Cover: Cast aluminum, watertight
Bellows Capsule: Type 316 Stainless Steel

— INSTRUMENT MOUNTING —

The transmitter may be mounted in any position. The transmitter cover must be hand tightened only, to provide a watertight seal.

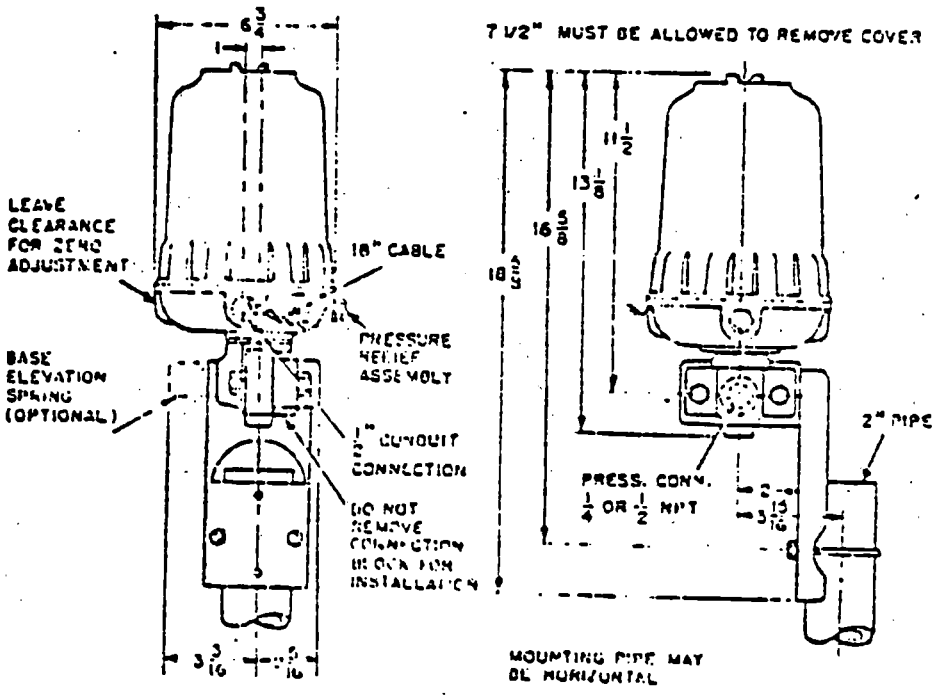


Fig. 3

EA-83-SRO-005
ATTACH 5. PAGE 4 OF 5

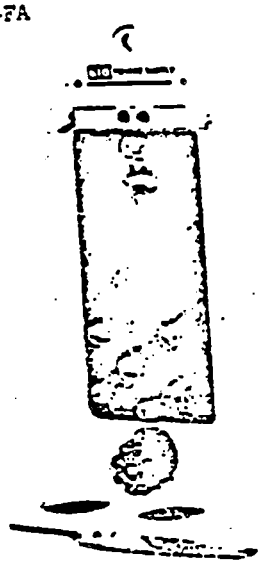
MODEL 610A POWER SUPPLY

Part Number NO-140-FA

The Model 610A Power Supply is designed to furnish power to a single electronic force-balance transmitter.

The power supply employs a conventional circuit in which full wave rectification occurs across the diode bridge. See schematic on Page 3. Filtering is accomplished by Capacitors C1, C2 and Resistor R1. Resistors R2 and R3 serve to improve voltage regulation by acting as a bleeder across the output of the power supply. Potentiometer R4 is a load resistor used to adjust the system loop resistance to 600 ohms.

For mounting information, refer to Instruction 13-260.



Back Mounted

Specifications

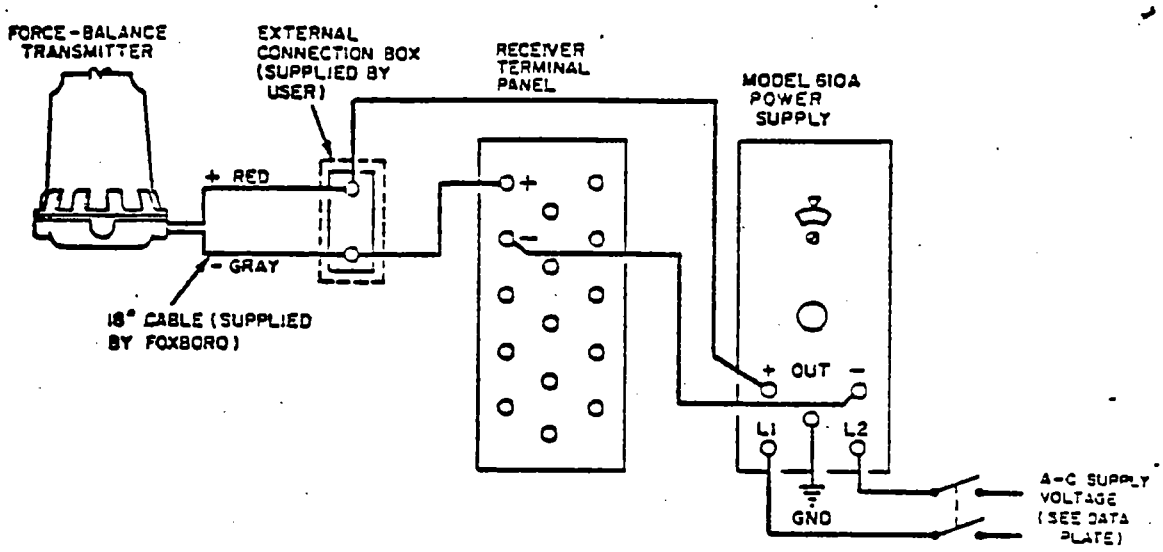
Output Voltage:	80 volts d-c nominal. With load potentiometer set to zero: 34 volts d-c at 10 ma 76 volts d-c at 30 ma
A-C Supply Voltage:	100, 115, 220, 230 volts a-c +10%, 50 or 60 cps
Power Requirements:	8 watts (11 va) at 60 cps 8 watts (14 va) at 50 cps
Ambient Temperature Limits:	40 to 140 F
Electrical Classification:	General Purpose or Division 2

Printed in U.S.A.

The Foxboro Company
Foxboro, Mass., U.S.A.

FOXBORO

EA-83-SRO-005
ATTACH 5 PAGE 5 OF 5



Wiring

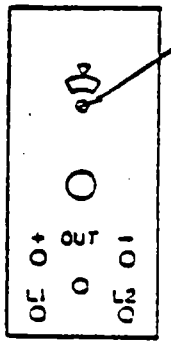
Load Adjustment

Output load resistance must be 600 ohms -10 -20 percent.

1. Using the table below, determine the output load resistance by summing the input resistances of all receivers in the loop. Include the resistance of the transmission line if it is appreciable. Do not include the resistance of the transmitter. Use an ammeter to measure the resistance of any receiver not listed in the table.

ELECTRONIC CONSOTROL INSTRUMENTS IN LOOP	INPUT RESISTANCE
Controllers	100 ohms
Alarms	100 ohms
Recorders	200 ohms
Model 65 Indicators	1-5 ohms
#20 Transmission Cable	20 ohms/1000 ft of 2 conductor cable

2. Set the LOAD ADJUSTMENT dial to the difference between the resistance determined in Step 1 and 600 ohms.



				SETPOINT								
	TI-0112HACE	C12-3	PRI. LOOP 1 HOT LEG M-201	SHEET 9 ICE-7 1705451			—	RANGE: 515-615°F	120V. A.C.	E-96 SH	—	SIGMA, 3223-E-00
	TT-0112HA	C12-7		SHEET 2 ICE-2 9300550			—				—	GE-MAC NYII, TYPE 550
	TE-0112HA	CONT		SHEET 1 1703781	NSSS-30 NSSS-1247		M-17				E-351	200Ω PLATINUM RTD
	PY-0112A	RACK		SHEET 49 ICE-2 9300550			—		120V. A.C.		—	GE MAC, TYPE 563-05
	TI-0112HB	C12-3		SHEET 9 ICE-7 1705451			—	RANGE: 515-615°F			—	
	TT-0112HB	C12-7		SHEET 2 ICE-2 9300550			—				—	
	TE-0112HB	CONT		SHEET 1 1703781	NSSS-30 NSSS-1247		M-17				E-351	
	PY-0112B	RACK		SHEET 49 ICE-2 9300550			—		120V. A.C.		—	
	TI-0112HC	C12-3		SHEET 9 ICE-7 1705451			—	RANGE: 515-615°F			—	
	TT-0112HC	C12-7		SHEET 2 ICE-2 9300550			—				—	
	TE-0112HC	CONT		SHEET 1 1703781	NSSS-30 NSSS-1247		M-17				E-351	
	PY-0112C	RACK		SHEET 49 ICE-2 9300550			—		120V. A.C.		—	
	TI-0112HD	C12-3		SHEET 9 ICE-7 1705451			—	RANGE: 515-615°F			—	
	TT-0112HD	C12-7		SHEET 2 ICE-2 9300550			—				—	
	TE-0112HD	CONT		SHEET 1 1703781	NSSS-30 NSSS-1247		M-17				E-351	
	PY-0112D	RACK		SHEET 49 ICE-2 9300550			—		120V. A.C.		—	
△6	I/I-0112HD	C12-7		M345			—			E96.SH.6	2966-E-2846	DEVAR INC. TYPE 18-119 ISOLATED TRANSMITTER
△6	I/I-0112HC	C12-7		M345			—			E96.SH.6	2966-E-2846	
	dPI-0112AA	C12-3	PRI. COOLANT-LOOP 1A	SHEET 22 ICE-7 1705451			—	SCALE RANGE: -2-0-65 PSIG	120V. A.C.	E-96 SH 4	—	SIGMA, 3223-E-00
△5	dPT-0112AA	CONT.		SHEET 20 M1-M-8		M-400-6	M-17	SCALE RANGE: 0-65 PSI			E-350	ROSEMOUNT, 1152 HP
	dPI-0112AB	C12-3		SHEET 22 ICE-7 1705451			—				—	SIGMA, 3223-E-00
△5	dPT-0112AB	CONT.		SHEET 20 M1-M-8		M-400-6	M-17				E-350	ROSEMOUNT, 1152 HP
	dPI-0112AC	C12-3		SHEET 22 ICE-7 1705451			—				—	SIGMA, 3223-E-00
△5	dPT-0112AC	CONT.		SHEET 20 M1-M-8		M-400-6	M-17				E-350	ROSEMOUNT, 1152 HP

REV.	DATE	DESCRIPTION	BY			
4	4-24-79	ADDED ENGINEER PRINT NOS.	JRZ			
3	11-15-78	REVISED LOOP TAGS	JLF			
6	1-12-81	ADDED I/I-0112HD & I/I-0112HC PER FC464		GJN	CJV	FR 05 AIP RLR
5	10-28-77	REPLACED TRANSMITTERS PER SFC 77-01	FGB	L	EKL	APPR. WM
0	10-14-76	ISSUED FOR CONSTRUCTION	KAN			X

INSTRUMENT INDEX

[illegible] POWER COMPANY

[illegible] PLANT

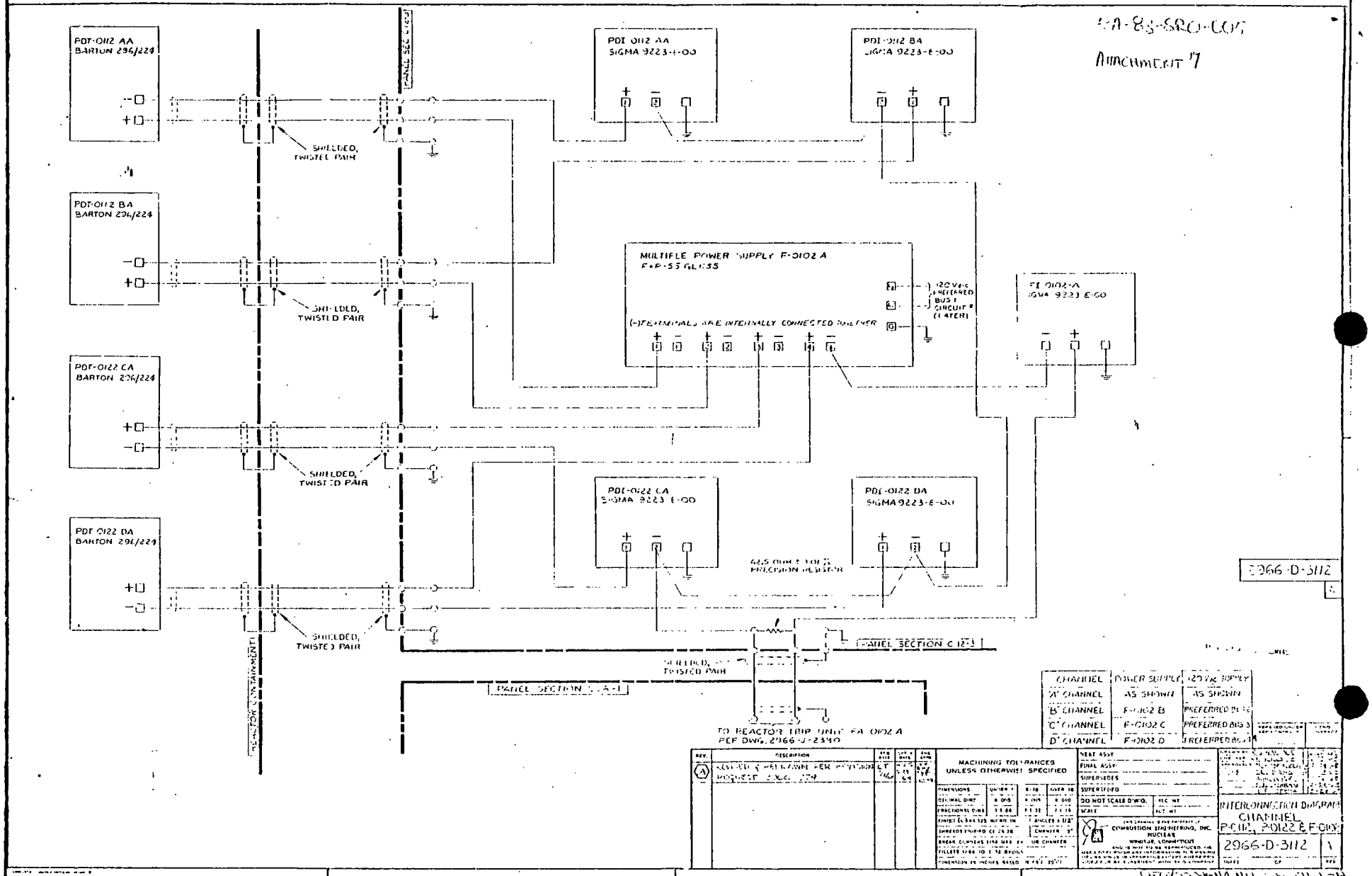
JOB NO. 5935

DRAWING NUMBER 5935 M-311 SH. 01-9 9

REV. 6

EA-83-SRD-005

ATTACHMENT #6



EA-83-SRO-005

ATTACHMENT 7

2966-D-3112

CHANNEL	POWER SUPPLY	120 VAC SUPPLY
'A' CHANNEL	AS SHOWN	AS SHOWN
'B' CHANNEL	F-0102 B	PREFERRED BUS 2
'C' CHANNEL	F-0102 C	PREFERRED BUS 3
'D' CHANNEL	F-0102 D	PREFERRED BUS 4

REV.	DESCRIPTION	ITR DATE	CHK'D	ENG APPR.
A	REVISED & REDRAWN PER REVISION REQUEST 2966-1274	6-5-86		

MACHINING TOLERANCES UNLESS OTHERWISE SPECIFIED

NEXT ASSY
FINISH
SUPERSEDES
SUPERSEDED
DO NOT SCALE DWG.
SCALE

COMBUSTION ENGINEERING, INC. NUCLEAR WINDSOR, CONNECTICUT

INTERCONNECTION DIAGRAM CHANNEL P-0112, P-0122 & F-0102

2966-D-3112

SERIES 3000 ANALOG-TO-DIGITAL CONVERTER

INTRODUCTION

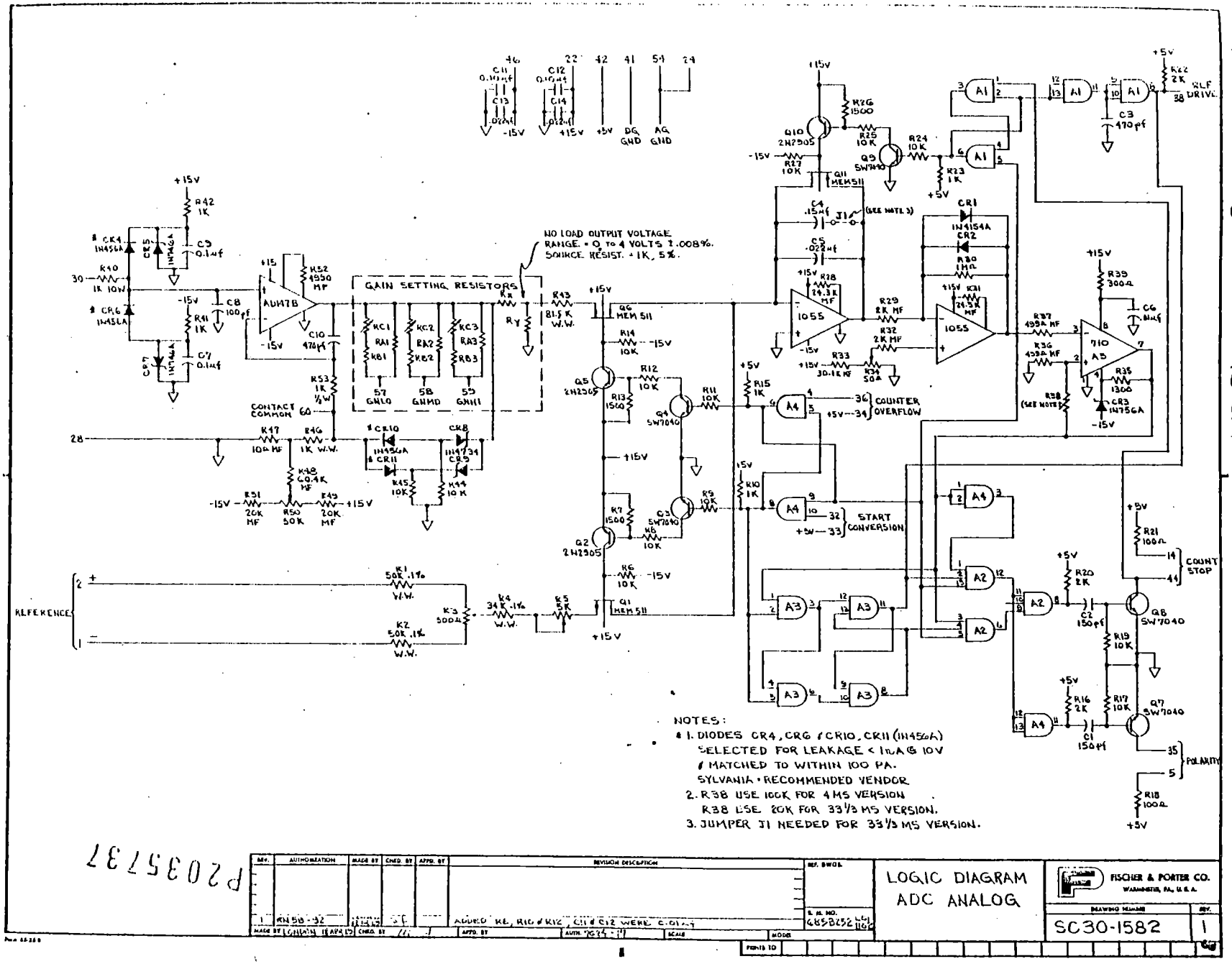
The F&P Series 3000 Analog-to-Digital Converter (ADC) is designed to measure process input signals under adverse environmental conditions and electrical noise. Excellent noise rejection is achieved by use of extremely high input impedance (both normal mode and common mode), and dual slope integration techniques. The high normal mode input impedance is obtained by the use of a FET (Field Effect Transistor) amplifier which exhibits more than 10^9 ohms input impedance (refer to Specifications Section). To obtain the high common mode impedance, the entire measuring circuit is isolated from ground and guarded. By using an especially designed power transformer having low stray interwinding capacity, the total input common mode equivalent impedance is represented by less than 100 pfd. Control signals between the isolated measuring circuit and the digital logic is by way of small pulse transformers and relays, in order to maintain the low capacity rating.

The measuring technique (dual slope integration) consists of applying the input signal to a highly accurate solid-state integrator, for a precise period of time. In the standard version, this period is chosen to be exactly one cycle of the power line frequency (50 or 60 cps) for 16-2/3 ms integration time. The average value contributed by AC pickup is therefore theoretically zero and for that reason does not affect the reading (a high-speed version of the ADC provides a 2 ms integration time). The dual slope portion of the circuitry then switches out the input signal and switches in a precise reference voltage. The reference voltage causes the output of the integrator to ramp back to zero at a fixed rate. The time for the output to reach zero is proportional to the charge obtained from the input integration cycle. Thus, by using the same integrator and the same components to measure the input signal and the reference signal, any long term drift or instability is cancelled out.

The entire ADC consists of 4 printed circuit boards located in the Multiplexer Cabinet. Power for the digital circuitry is derived from the system logic supplies and the floating circuitry is driven from 117 VAC, through the special power transformer.

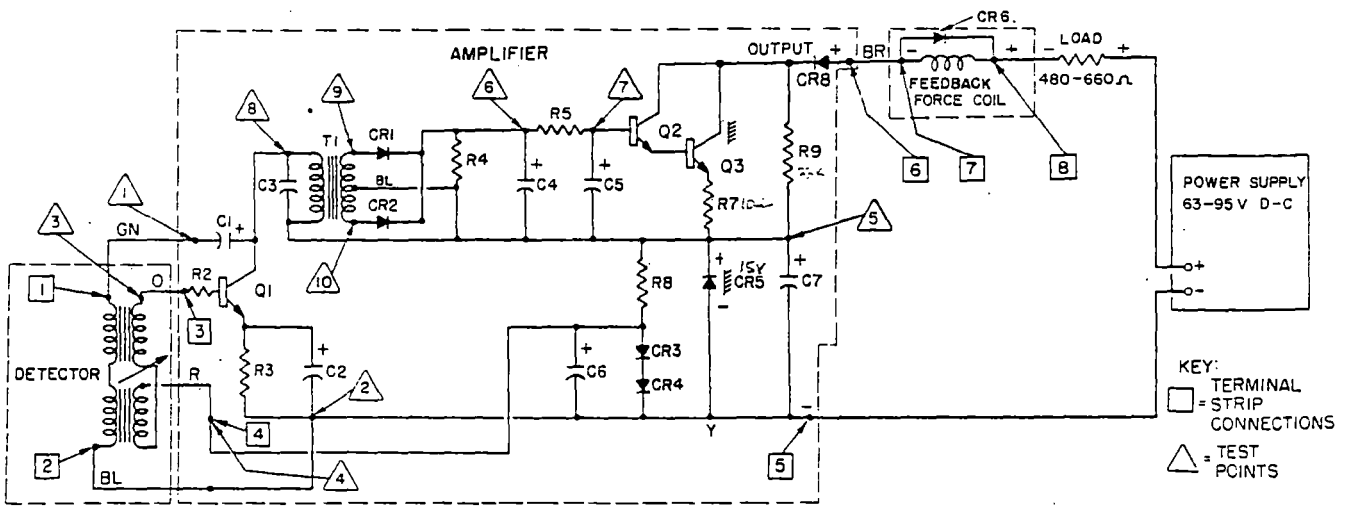
The Printed Circuit Boards are:

1. Power Supply - Floating supplies for amplifiers, gates and references: + and - 15 VDC, +5 VDC and 6.2 VDC reference.
2. Analog Board - Contains all of the measuring circuitry and amplifiers.



P2035737

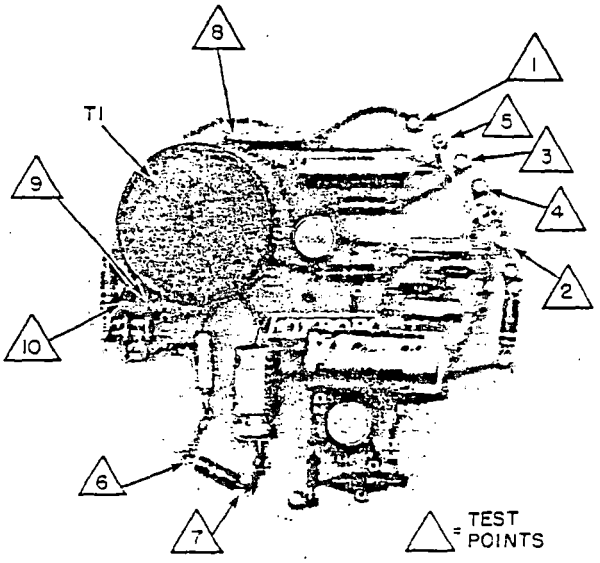
Amplifiers Manufactured Since August '66
(Part N-119-XY)



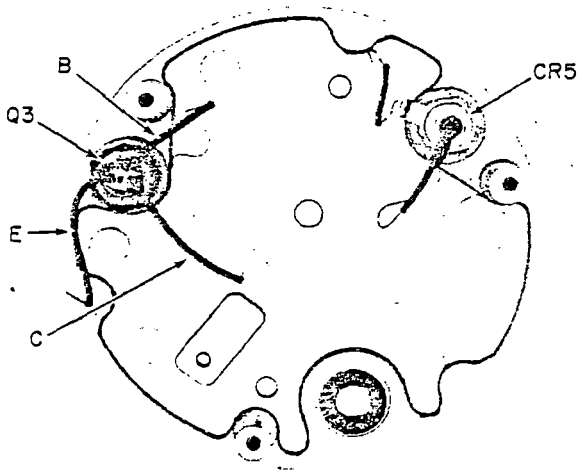
Item	Description	Part No.
C1, C2, C4, C6	Capacitors, tantalum, 1.2 μf ±10%, 35 volts	N-119-MB
C3	Capacitor, tubular, 0.033 μf ±20%, 100 volts	E-123-KY
C5	Capacitor, tantalum, 325 μf ±10%, 6 volts	N-119-NN
C7	Capacitor, electrolytic, 10 μf −10% +100%, 25 volts	N0-148-AF
R2	Resistor, carbon, 150 ohms ±5%, ½ watt	N-110-LZ
R3	Resistor, carbon	Selected
R4, R5	Resistors, carbon, 10K ±5%, ½ watt	E-102-CS
R7	Resistor, carbon, 10 ohms ±5%, ½ watt	N-110-CT

Item	Description	Part No.
R8, R9	Resistors, carbon, 22K ±10%, ½ watt	K-109-BF
CR1, CR2, CR3, CR4, CR8	Diodes, silicon, Type 1N645	N-109-FF
CR5	Diode, Zener, Type 1N1595A, 15 V	N-120-FK
CR6	Diode, silicon, Type 1N645 (See Note) (Diode CR6 added in October 1967)	N-109-EZ
Q1	Transistor, Type 2N656 (Oscillator)	N-119-MA
Q2, Q3	Transistors, Type SP4415	N0148MB
T1	Transformer	N-119-LZ or N-119-XE

NOTE: With instruments listed for use in intrinsically safe loops (Type T instruments), Diode CR6 must be present across the feedback force coil, and any replacement of transistors must be with the same types.



Component Panel



Base