NRC QUESTIONS REGARDING SONGS 1 ATWS FROM SUBMITTAL of JANUARY 29, 1988

1. General

a) Under "BACKGROUND," reference is made to TMI upgrades of the auxiliary feedwater system. Have these upgrades been applied to AFW Train B? Describe what they consist of and how are they compatible with AMSAC requirements.

Response:

The AFWS has been upgraded to provide two independent and redundant trains for reliability; Trains A and B. Each actuation train receives independent level signals from three narrow range level transmitters, one on each steam generator. The level signals for Train A are generated from LT-2400A, B & C. The level signals for Train B are generated from LT-3400A, B & C. When the level in any of the three steam generators reaches 5% of narrow range and is decreasing, the associated bistable trips to provide a signal to the 2 out of 3 logic circuitry. If 2 out of 3 generators generate a low level signal to one train, that actuation train will initiate its respective AFWS train. As required by the ATWS rule, the AFWS Train B detects loss of heat sink, initiates AFW flow on low steam generator level and is independent of the Reactor Protection System. This existing AFW circuitry is similar to the Westinghouse generic AMSAC Logic # 1.

b) Describe the relationship between all the various AFW systems in use or planned for use at the station.

Response:

As described above, the AFWS has two independent and redundant trains. After the Cycle X refueling outage, each train will meet (1) the minimum AFW flow required for decay heat removal following design basis events; (2) maximum AFW flow allowed based on water hammer mitigation, pump run-out, core cooldown and containment pressure considerations; and (3) adequate redundancy so as to avoid a single active component/system failure that would prevent the AFWS from operating within its required flow limits. This work is being done to meet our NRC commitments as part of the TMI Lessons Learned requirements.

c) What are the setpoints for the steam generator low-low level trip for AFW-B? (Relate to the requirements of WCAP-10858-P-A, Rev. 1)

Response:

AFW Train B actuates at 5% of steam generator narrow range. WCAP-10858-P-A, Rev. 1 establishes a variable range equivalent to that for the reactor trip input for this parameter. However, SONGS 1 does not utilize steam generator level for a reactor trip input. Therefore, the variable range will be maintained consistent with AFWS requirements.

d) The submittal does not mention the SG blowdown and sample line isolation valves. Describe how these valves will be affected by the AMSAC.

Response:

The SG blowdown lines now are configured to automatically isolate on an AFW actuation signal as a result of our water hammer incident on November 21, 1985. The preliminary design does not include isolation of sample lines since it is expected that our Cycle X modifications described above will be able to provide 100% of the required AFW flow, without isolating the SG sample lines. However, this will be confirmed once the AFWS modifications are complete.

e) Section 5.0, Page 2-8, of WCAP-10858-P-A, Rev. 1, states that AMSAC shall provide a backup to the RPS. Describe how this is accomplished by using AFW Train B.

Response:

The AFWS uses low steam generator level as the initiating parameter. This parameter is not an input to the SONGS 1 Reactor Protection System. AFWS Train B will initiate a turbine trip by energizing a new redundant turbine trip solenoid on low steam generator level. Any failure in the RPS, including power failure will not affect the AFWS Train B. Thus, the SONGS 1 ATWS mitigation circuitry will initiate a turbine trip and actuate auxiliary feedwater flow independent of the RPS. This backup to the RPS will ensure RCS pressure is maintained within allowable values in the event of an ATWS.

f) Section 11.0, Page 3-7, of WCAP-10855-P-A, Rev. 1, describes the required AMSAC time response. How does the AFW Train B time response compare to the time response requirements?

Response:

An actual AFW Train B response time test has not been performed. However, since the AFWS is an electronic state of the art system, the time to actuate the AFWS on low steam generator is on the order of a few hundred milliseconds including output relays. The new Diverse Turbine Trip (DTT) will not affect the present AFWS response time. In regards to the DTT, the difference in turbine trip response time compared to the RPS initiated turbine trip will be primarily due to the response differences of the measured process parameters (e.g., steam/feedflow in the RPS, vs. steam generator level in the AFWS). The required ATWS response time of 30 seconds is much greater than the expected AFWS response time.

2. Diversity

a) Describe the degree of diversity that exists between the Foxboro Spec 200 equipment and the Foxboro Spec 200 Micro equipment.

Response:

The Spec 200 micro control system utilizes a microprocessor-based control card which may be configured to incorporate multiple control functions from a menu of many possible control functions. The Spec 200 micro control card is an entirely new generation compared to the Spec 200 control cards. This results in a high degree of diversity between the control cards of these two systems. However, both systems employ the same input/output and power distribution components which are of a proven and reliable design. Although our original design description indicated any future RPS instrumentation and logic additions or replacements would employ Spec 200 micro, it is noted that there are no firm plans to replace the E and H line Foxboro RPS control equipment in the near future.

b) Describe the degree of diversity that exists between the pressure transmitters (and associated current loop equipment) used in AFW Train B and the RPS.

Response:

The AFWS transmitters are environmentally qualified state of the art Foxboro transmitters. The RPS transmitters are the older Foxboro models compatible with the existing Foxboro E and H line instrumentation. However, as stated in the NRC Safety Evaluation for the WOG "AMSAC Generic Design Package" (NRC letter dated September 22, 1986), diversity of AMSAC sensors from RPS sensors is not required. The RPS process control consists of 1958 design vintage Foxboro E and H line components whereas the AFWS process control equipment consists of modern Foxboro Spec 200 equipment which represent an entirely new generation of process control electronics modules. Thus, the RPS and AFWS process control equipment have a high degree of diversity.

c) Describe the diversity that exists between the pressure transmitters (and associated current loop equipment) used in AFW Train A and AFW Train B.

Response:

The same type of Foxboro transmitters and process control equipment are used in both trains. However, all transmitters are environmentally qualified. Additionally, any failure in Train A will not affect Train B since both trains are independent from each other.

3. Logic Power Supply

a) Provide details (including drawings) on the separation that exists between the RPS logic power supplies and the AFW Train B logic power supply.

Response:

SONGS 1 train separation is maintained at the 4kV and lower voltage levels. The details of the RPS logic power supplies and the AFW Train B power supplies are illustrated on the enclosed electrical one-line diagram 5146828-25. The specific bus assignments are discussed in the ATWS Mitigation Design Description provided in SCE's letter dated January 29, 1988.

b) Can the P-7 signal be disabled by the manual reset when the signal is above 10% reactor power? How are the manual resets controlled?

Response:

No. The reset affects only the signal latch within the DTT logic, and cannot override or block the P-7 input signal. The reset will be procedurally controlled consistent with other actions required when reducing power below the P-7 setpoint.

c) The new Turbine Trip solenoid is a non-1E device. Describe the type of isolation used between this device and the Class 1E circuits with which it interfaces and discuss qualification per Appendix A of the NRC SER on WCAP-10858-P-A.

Response:

The solenoid will be isolated using Consolidated Controls Corp. (CCC) isolation relays, if it is determined necessary by a 10 CFR 50.49(b)(2) analysis. The analysis will be done during the final ATWS engineering. Information concerning the CCC isolator qualification and testing was submitted to the NRC on February 29, 1988.

4. Safety-Related Interface

a) Describe the existing RPS applicable safety criteria and its documented location, i.e., FSAR, TS. Provide information to ensure that the RPS will continue to meet all existing applicable safety criteria subsequent to the installation and implementation of AMSAC.

Response:

The Reactor Protection System safety criteria is provided in the SONGS 1 FSA, Section 5.2. In addition, Limiting Conditions for Operation and Surveillance requirements for RPS instrumentation and controls are provided in the Technical Specifications. The Reactor Protection System was further evaluated for single failure considerations as part of the SONGS 1 "Reactor Protection System Single Failure Analysis" provided to the NRC by letter dated March 11, 1987. The ATWS Mitigation System circuitry and operation will be incorporated in the updated SONGS 1 FSAR. After implementation of the Cycle X AFWS modifications, the AFWS will ensure an acceptable system available for the required emergency conditions listed in Item 1.b above.

The proposed AMSAC design will not revise any existing RPS function. The interface of the AMSAC with the RPS is limited to the P-7 permissive which will be obtained through a qualified isolation device. Therefore, the RPS will continue to meet all existing applicable safety criteria.

b) Define all Class 1E to non-Class 1E interfaces for AMSAC and show their location on Attachment 1 to your January 29, 1988 submittal. Address qualification of the isolators in accordance with Appendix A to the NRC SER on WCAP-10858-P-A.

Response:

The interfaces are isolated by four isolators as shown on Attachment 1. Three isolators are used to isolate the non-safety related annunciator from the ATWS circuitry. The fourth isolator, between the P-7 output and the set/reset gate will be added to prevent any faults or malfunctions in the RPS from precluding an ATWS turbine trip. As discussed in Item 3.c above, an additional isolator will be added to isolate the new DTT solenoid if the 10 CFR 50.49(b)(2) analysis to be performed as part of the final design determines it necessary. Information concerning the qualification and testing of the isolators was provided to the NRC on February 29, 1988.

c) Expand on the DTT qualification. Relate to the classification of AFW Train B (Class 1E) equipment.

Response:

All new ATWS equipment will have the same qualification as the existing AFWS qualification. The AFWS is qualified in accordance with IEEE 323-1974 and IEEE 344-1975. An exception to this is the new turbine trip solenoid. The solenoid will be safety related. However, since it is not required to function during design basis accidents, the solenoid will not be environmentally and seismically qualified for such events. A safety evaluation in accordance with 10 CFR 50.49(b)(2) will be performed to prevent any failure of 10 CFR 50.49(b)(1) equipment due to the malfunction of the turbine trip solenoid.

5. Quality Assurance

a) The submittal states that compliance to GL 85-06 is not required. Describe the QA that is being used, i.e., 10 CFR 50, Appendix B and relate to each specific criterion of GL 85-06.

Response:

The SCE QA program for the San Onofre Nuclear Generating Station complies with 10 CFR 50 Appendix B. These requirements will be applied to the ATWS mitigation circuitry in lieu of having a unique QA program for AMSAC.

6. Maintenance Bypass

a) Section 14.0, Page 3-9, of WCAP-10858-P-A, Rev. 1, states that removal of one AMSAC SGLL input circuit should be accomplished by placing that circuit in the tripped mode. Discuss how the SONGS-1 AMSAC design complies with this requirement.

Response:

As previously discussed, SONGS 1 has two independent and redundant trains. Both trains are qualified in accordance with IEEE 323-1974 and IEEE 344-1975. Any individual SGLL signal is detected and alarmed in the main control room. Technical Specification Table 3.5.7-1 requires that an inoperable SGLL channel be placed in the tripped condition within one hour or an operator shall assume continuous surveillance and actuate manual initiation of auxiliary feedwater, if necessary. Since the AFWS-Train B SGLL inputs and AFW actuation logic will also provide for the AMSAC function, the above requirement will be met by virtue of the existing Technical Specification requirements.

b) Discuss the controls or procedures that are in effect when the entire AFW Train B is removed from service.

Response:

The Technical Specifications require AFWS Train A to be operational if Train B is removed from service. If AFWS Train B is not operational within 72 hours, the plant must be in HOT STANDBY within the next 6 hours and in HOT SHUTDOWN within the following 6 hours as described above.

c) Discuss the control room indication and annunciation of all bypasses as it relates to the AFW Train B safety function and the apparent parallel AMSAC function.

Response:

Due to the testing method of the AFWS a DTT bypass is required. The AFWS system is tested by simulating SGLL and operating the entire AFWS including the pump(s). AFWS flow to the SGs is prevented by closing manually operated block valves (pump flow recirculation is in effect during this testing). A DTT bypass will be provided to prevent a turbine trip during this testing. This bypass will be annunciated in the control room. In addition, the DTT bypass handswitch will be backlit to indicate the bypass condition.

d) Expand on the bypass of the DTT circuit for AFW testing purposes.

Response:

The AFWS is tested one train at a time at power from end-to-end, i.e., by injecting signals at the input to the process control equipment that simulate steam generator low levels and allowing the entire AFWS to respond including actual starting and running of the AFW pumps. This makes a DTT bypass mandatory in order to allow testing of the AFWS and

AMSAC at power without tripping the turbine. A manual bypass switch will be provided which will also be backlit when the DTT is bypassed. In addition, this condition will be annunciated in the main control room.

7. Operating Bypass

a) What signals can inhibit or enable the P-7 and under what conditions? Compare the use of P-7 to the WCAP-10858-P-A, Rev. 1 recommendation for the use of the turbine impulse pressure signal permissive.

Response:

P-7 is in effect (blocks at-power trips) when 3 out of 4 Power Range Channels are less than 10% power /AND/ Main Turbine First Stage Pressure is less than 10% Load /AND/ there is no Loss of Power on Buses 1C and 2C.

P-7 is inhibited (places at power trips in service) when 2 out of 4 Power Range Channels are greater than or equal to 10% Load or Main Turbine First Stage Pressure is greater than or equal to 10% Load or there is a Loss of Power on Buses 1C & 2C.

b) Describe any inhibits or enables associated with the AFW Train B logic circuits or actuation circuits. Provide logic drawings to support this information.

Response:

There are no inhibits or enables associated with the AFW Train B logic circuits or enable circuits. All that is required to actuate the AFW train B is steam generator low level and Train B power. The AFW-Train B logic is illustrated on drawing 451256-1 attached.

c) Are there other AFW Train B operating bypass and status indications that are not shown or discussed? If so, provide details.

Response:

Yes. Both Trains A and B have sufficient instrumentation and indication in the control room to provide the operators with equipment status and control capability from the control room. Indication includes Train status, pump and valve status, pump suction/discharge pressures, Steam generator and AFW tank levels, and AFW flows. In addition, the following Train B alarms are in the main control room: AFWS Train B initiated, Low pump suction pressure, AFWS Train B out-of-service, flow regulating valves out of position, pump turbine tripped, and AFW tank low level.

d) Discuss the indication and annunciation of the AMSAC bypasses, i.e., location, annunciator window(s).

Response:

All the required controls, including indication and annunciation, will be located on the main control room panel (C71) which is dedicated for the AFWS. The annunciator windows for the AFWS and ATWS alarms are on the upper portion of the panel directly above the AFWS controls and indicators. As discussed previously, the DTT bypass will be indicated by a backlit hand switch and the bypass will also be annunciated. In addition, annunciation will be provided for AMSAC disarmed, i.e., no P-7 permissive, and for DTT trip. The annunciator for AFW-Train B out-of- service will be modified to also include AMSAC out-of-service. All indication will meet the human factors guidelines consistent with those developed as part of the SONGS 1 Control Room Design Review.

8. Means for Bypassing

a) This section reflects the capability for the removal of individual input channels, while the Maintenance Bypass section states that single channels cannot be placed in the tripped mode (requires removal of complete train). Clarify this apparent difference and relate to the requirements of WCAP-10858-P-A, Rev. 1.

Response:

As a matter of clarification, individual SGLL inputs to the AFW Train B/ AMSAC actuation logic can be placed in the tripped mode. As previously discussed, the Technical Specifications governing the AFWS require an inoperable channel to be placed in the tripped condition within one hour. However, the AFWS utilizes a two Train configuration. In SCE's January 29, 1988 submittal, it was indicated that no maintenance bypass switches would be provided for the AFW Trains. Consequently, tripping of an AFW Train would result in initiation of that train. Therefore, maintenance on an AFW Train (other than the SGLL inputs) would require removal of the entire train from service.

b) The WCAP specifically prohibits the use of certain methods for bypassing. Discuss why the disallowed methods for bypassing (lifting leads, etc.) are being used (relate to TMI/AFW upgrade) and provide justification for this deviation.

Response:

The WCAP does not allow for lifting of leads during testing or bypassing. Our TMI AFW modifications were not performed to meet the ATWS Rule (10 CFR 50.62). The configuration will be modified to eliminate the need to lift leads for testing. The engineering for permanently installed jacks to eliminate lifting leads is now in progress as part of the SONGS 1 AFWS modifications. Means for bypassing will be provided by a permanently installed switch in accordance with human factors guidelines.

c) Describe the use and function of the permanently installed jacks to be implemented for testing. When are these jacks to be installed?

Response:

The jacks will be permanently installed on the current-to-voltage converters (I/Vs) (input device to the process control system) in each SG level loop. During normal operation these jacks will have no function in the loop. During testing, the jacks will block the SG level transmitter signal and will be capable of receiving a simulated SG low level. From that point on, the entire train is checked including the pumps. The I/V supplier provides these jacks as options to the I/Vs. These modifications are scheduled for implementation during the Cycle 10 refueling outage as part of the AFWS modification.

9. Manual Initiation

a) Describe how the DTT will be manually initiated.

Response:

During normal operation when the P-7 (inhibit) signal is armed, the existing AFWS Train B manual actuation switches will be used for manual initiation of AFWS Train B and DTT. To meet human factors and to prevent any unnecessary turbine trips, the switch engravings will clearly show the double function. Additionally, to prevent any inadvertent trip the actuation switch will have a cover over it with the engraving on top.

10. Electrical Independence

a) Will the electrical isolators used in the AMSAC be diverse from the RPS? (Describe how diversity will be obtained.)

Response:

SCE's experience with the isolators currently used at SONGS demonstrates an acceptable level of reliability with these isolators. For this reason, SCE does not consider it necessary to use a different type of isolator for the ATWS mitigation system. Consequently, the same type of isolator may be in use in both the RPS and the ATWS mitigation circuitry. This is consistent with the NRC Safety Evaluation provided in the September 22, 1986 letter, which states AMSAC isolation devices are excluded from the requirement to be diverse from RPS isolation devices.

11. Equipment Qualification

a) What is the EQ status of the DTT?

Response:

The new safety-related equipment (and existing safety related equipment) will be EQ in accordance with IEEE 323-1974. The new equipment that is not required to be SR, will be similar to equipment presently installed in the SCE system which per previous experience is highly reliable. As described in 4.c an exception to the safety related equipment is the DTT solenoid valve which will not be EQ.

b) Discuss the EQ status of the parts of the AFW "B"/DTT that are not subjected to a harsh environment.

Response:

All safety-related equipment is qualified in accordance with IEEE 323-1974. However, it is noted that in accordance with current regulatory guidance for applicability of 10 CFR 50.49, EQ of mild environment equipment is not required.

12. Testability at Power

a) Provide additional discussion related to the capability for testing the AMSAC during reactor operation.

Response:

As previously discussed, the AFWS-Train B is tested monthly at power. Since the AMSAC will share the same actuation circuitry, it too will be tested. A DTT bypass is planned so testing of the AFWS Train B/AMSAC will not trip the turbine. In addition, it is intended to monitor the new trip solenoid valve field wiring during bypass by allowing a trickle current to flow through the solenoid circuit without actuating the trip valve. However, details will be determined during final design.

b) State the at-power test frequencies.

Response:

The SONGS 1 Technical Specification surveillances require that the AFWS be tested monthly. To ensure the reliability of the AFWS the following is required:

Each AFWS pump shall be demonstrated operable by testing each pump in accordance with Section XI of the ASME Boiler and Pressure Vessel Code and applicable Addenda as required by 10 CFR 50.55a(g), except where specific written relief has been granted by the NRC.

At least once per 31 days an inspection shall be made to verify that each non-automatic valve in the emergency flow path that is not locked, sealed, or otherwise secured in position is in its correct position.

Each AFWS pump and automatic valve shall be demonstrated operable at least once per 18 months.

After installation of the ATWS mitigation circuitry, testing will be performed as part of the AFWS Train B electronic loop testing. Currently, this is done at least once per 31 days.

c) When are complete end-to-end tests to be performed, i.e., from sensor through the final AMSAC actuation devices?

Response:

The AFWS is tested end-to-end every 31 days to meet the above testing requirements. Note that test signals are injected at the control room process control electronics rack. Consequently, transmitter and field wiring to the control room are not verified during this test.

d) Describe when and how the DTT circuits will be tested.

Response:

At least every 31 days during the AFWS surveillance testing, the DTT circuitry, up to but not including the new turbine trip solenoid, shall be tested. The new turbine trip solenoid will be tested during plant shutdowns. The surveillance frequency will be determined as part of the final engineering design but will not exceed a refueling interval frequency.

e) Discuss the control room indication during testing as related to AMSAC, i.e., "AMSAC DISABLED."

Response:

As previously discussed, during testing of AFWS-Train B/AMSAC the bypass switch will be operated. The switch will be backlit during bypass and an annunciation of bypass condition will be provided in the main control room.

f) Discuss the control room annunciation scheme as related to AFW ECCS and AMSAC functions.

Response:

The AFWS-Train B annunciation includes main control room alarm windows for AFW initiated, out of service, low pump suction pressure regulating valves out of position, pump turbine tripped and AFW tank low level. The DTT circuitry will provide additional alarm windows for bypass, DTT disarmed (i.e., no P-7 permissive) and DTT trip actuated. The AFWS-Train B out of service alarm will also serve to identify AMSAC out of service.

13. Completion of Mitigative Actions

a) Provide a description of how the mitigative action goes to completion upon AMSAC initiation.

Response:

On SG low level, the AFWS will initiate AFW flow to the SG meeting all the requirements listed on Item 1.b. Upon actuation of the AFWS train B and above 10% reactor power, the new turbine trip solenoid valve will be energized causing a turbine trip. The AFW activation and DTT functions once initiated will proceed to completion. Deliberate operator action is required to reset the P-7 permissive input to DTT and to reset the AFW actuation signal.

b) Provide a description of the required reset of the plant systems actuated by the AMSAC.

Response:

There will be two momentary reset switches for plant systems actuated by the AMSAC. Each switch will reset its respective latch. The switches will be for resetting the following signals: 1) AFWS Train B actuation (existing since implementation of the TMI modifications) and 2) DTT manual bypass.

14. Technical Specifications

a) AFW Train B is a safety-related system. Describe how AFW Train B/AMSAC will be covered by the TS, LCOs, or emergency procedures.

Response:

The existing Technical Specifications for the AFWS include provisions for periodic surveillance and testing for AFWS components. In addition, Limiting Conditions for Operation are provided to ensure proper compensatory measures are taken in the event of inoperability of system components. Because the ATWS Mitigation System is initiated from AFW Train B, no additional surveillance requirements or LCO's are considered necessary. The existing requirements will ensure the operability of the ATWS Mitigation System is maintained.

b) It appears that the DTT is a safety-related system. Describe the controlling procedures for the DTT system.

Response:

As discussed in response to Item 5, the SCE QA Program will be applied to the ATWS Mitigation System. The SCE QA Program is in compliance with 10 CFR 50, Appendix B. Consequently, the DTT will be designed, procured, installed and controlled as a safety related system in accordance with Appendix B requirements. The DTT will be initiated from AFW Train B. The existing Technical Specifications for the AFW system will maintain the operability of the DTT circuitry up to the new turbine trip solenoid. As discussed in response to Item 12.d, the new turbine trip solenoid will be tested during plant shutdowns. The surveillance frequency will be determined as part of the final engineering design but will not exceed a refueling interval frequency. SCE does not consider it necessary to incorporate testing requirements for the DTT solenoid into the technical specifications.

c) Describe what credit is taken for AFW Train B in the safety analysis.

Response:

The AFW Train B must be operable on loss of AFW Train A. As discussed in Item 1.b, AFW Train B must be capable of meeting the minimum and maximum AFW flow required for decay heat removal following design basis events and single failure criteria.

d) Describe how the existing safety analysis will be affected by assigning AFW Train B to perform the AMSAC function.

Response:

The performance of the AMSAC function by AFW-Train B will not impact the safety analysis. The addition of the DTT circuitry including new trip solenoid valve will not affect the safety analysis since it has already considered a turbine trip.

ADDITIONAL COMMENTS SUBMITTED MARCH 7, 1988

The following list of comments/questions were generated from a review of the licensee's submittal of March 7, 1988, covering the qualification testing of the electrical isolation devices to be used in the plant-specific AMSAC design.

1. The submittal did not specify where in the AMSAC each type of isolation device was going to be used (between safety related and non-safety related portions). Provide information showing:

   a) the interface locations and type of device at the location, and

   b) the specific Class 1E and non-Class 1E ports of the device.

   Response:

   a) Four isolation devices are planned as part of the DTT circuitry. Three of the four isolators will be used to isolate DTT annunciation inputs. These are for the bypass, disarmed and trip functions. The fourth isolator will be used at the interface with the RPS for the P-7 permissive to the DTT circuitry. As previously discussed, a 10 CFR 50.59(b)(2) evaluation will be performed as part of final design to determine if an isolation device is required for the new turbine trip solenoid valve. The isolation device proposed for each of these functions is the CCC isolation relay 8N13. For the annunciator circuits, the isolation relay coil will be energized from the Train B 125 VDC bus. The isolation relay output contacts will be connected to the nonsafety-related annunciator system. The details of the isolation relay electrical connections for the P-7 permissive interface are not complete. These will be determined during final design, along with the isolation relay for the new turbine trip solenoid valve if required.

b) The ports of the proposed isolator are shown on the attached "Isolation Relay Assembly 8N13" drawing. The ports for the relay coil are terminals 6 and 7. The ports for the isolated contact outputs are terminals 1, 2, 3 and 10, 11, 12. The Class 1E ports for the annunciator functions are the coil terminals 6 and 7. The Non-Class 1E ports are terminals 1, 2, 3 and 10, 11, 12. The Class 1E and Non-Class 1E ports for the other functions which require or may require isolation will be determined during final design of the AMSAC/DTT circuitry.

2. Information was supplied showing that the maximum credible fault (MCF) voltage used in the testing of the isolators exceeded that to which the isolators could be exposed to in the AMSAC. Provide similar information with respect to the potential MCF current that could be associated with the MCF voltage.

Response:

A treatment of maximum credible fault (MCF) current analogous to that provided for MCF voltage is not provided since credit is taken for circuit overcurrent protective devices which function to limit the magnitude of postulated MCF current. These devices also limit the time during which such current flows to a very short period since the control circuits under consideration employ overcurrent protective devices with low current-time fault clearing characteristics. As such, the i^2t heat energy generated by postulated MCF current through the isolator is not significant and will not impair the isolation function. The control circuit overcurrent protection serves not only to protect the isolation relay components, but all control circuit wiring and devices such as lamps, resistors, switches, relay coils and relay contacts. It is also noted that IEEE Standard 384-1981 allows verification of maximum credible voltage or current in the determination of acceptability for an electrical isolation device for instrumentation and control circuits (see Section 7.2.2.1 of IEEE 384).

3. It appears from the test report that the CCC relay Model 8N13 was not tested by applying the MCF voltage/current to the non-Class 1E side of the relay in the transverse mode while monitoring the Class 1E side of the relay for any perturbations. Provide summary test data to verify that the appropriate MCF tests were performed.

   Response:

   No test data is available in the qualifying document furnished by the vendor. But the insulation tests between the relay coil and contacts, and also between all terminals connected together and ground at 1700V RMS, show no apparent evidence of current leakage or insulation breakdown in the relay socket.

   Based on the above insulation tests, it can be assumed that there will be no adverse effect on the energized relay coil or the Class 1E side of the relay when the MCV voltage/current is applied to the non-Class 1E side.

4. Provide test configuration schematics of the tests performed on the Model 8N13.

   Response:

   Test configuration schematics of the tests performed on the Model 8N13 isolation relay are included on the attached Schematics 1 and 2.

5. From the responses to Item 7, it appears that Class 1E power is being applied to the non-Class 1E side of an isolator (8N13). Re-examine the isolator circuits and verify that Class 1E power is being applied to the Class 1E side of the isolator.

Response:

For the annunciator functions, only Class 1E power is being applied to the relay coil. All contacts are on the non-Class 1E side of the isolator and they provide annunciator inputs. The configuration for isolation of the P-7 permissive will be determined as part of final design, as well as that for the new turbine trip solenoid valve if required.

NRC QUESTIONS REGARDING SONGS 1 SPDS FROM SUBMITTAL OF APRIL 1, 1988

By letter dated May 18, 1988, the NRC requested the following information regarding the Safety Parameter Display System (SPDS) isolation devices. SCE intends on using the same isolation devices in the SPDS and the ATWS Mitigation System. Therefore, this information is being provided with our response to questions regarding the ATWS Mitigation System.

1. Provide a description/wiring diagram of ECEP 9206 which was used to modify the Foxboro 2AO-VAI isolator.

   Response:

   The attached Foxboro Bulletins SI-1-01762, TI-2AO-130, and MI-2AO-130 provide the requested description and wiring information for the analog signal isolator.

2. For the Consolidated Controls Corporation (CCC) Isolation Relay 8N13 verify that the test fault was applied to the non-1E side.

   Response:

   As stated in the accompanying SCE response to NRC questions/comments on the proposed ATWS Mitigation System design, the test fault was applied 1) between the coil terminals (shorted together) and the contact terminals (shorted together), and 2) between contact terminals (shorted together) and the frame which was at ground potential. Based on these configurations the test fault was applied to the non-1E side of the relay.

3. The April 1, 1988 letter stated that the test voltages exceeded the voltages that the isolation devices could be subjected to during a fault. For all three devices specify the maximum current that is available in the equipment housing these devices.

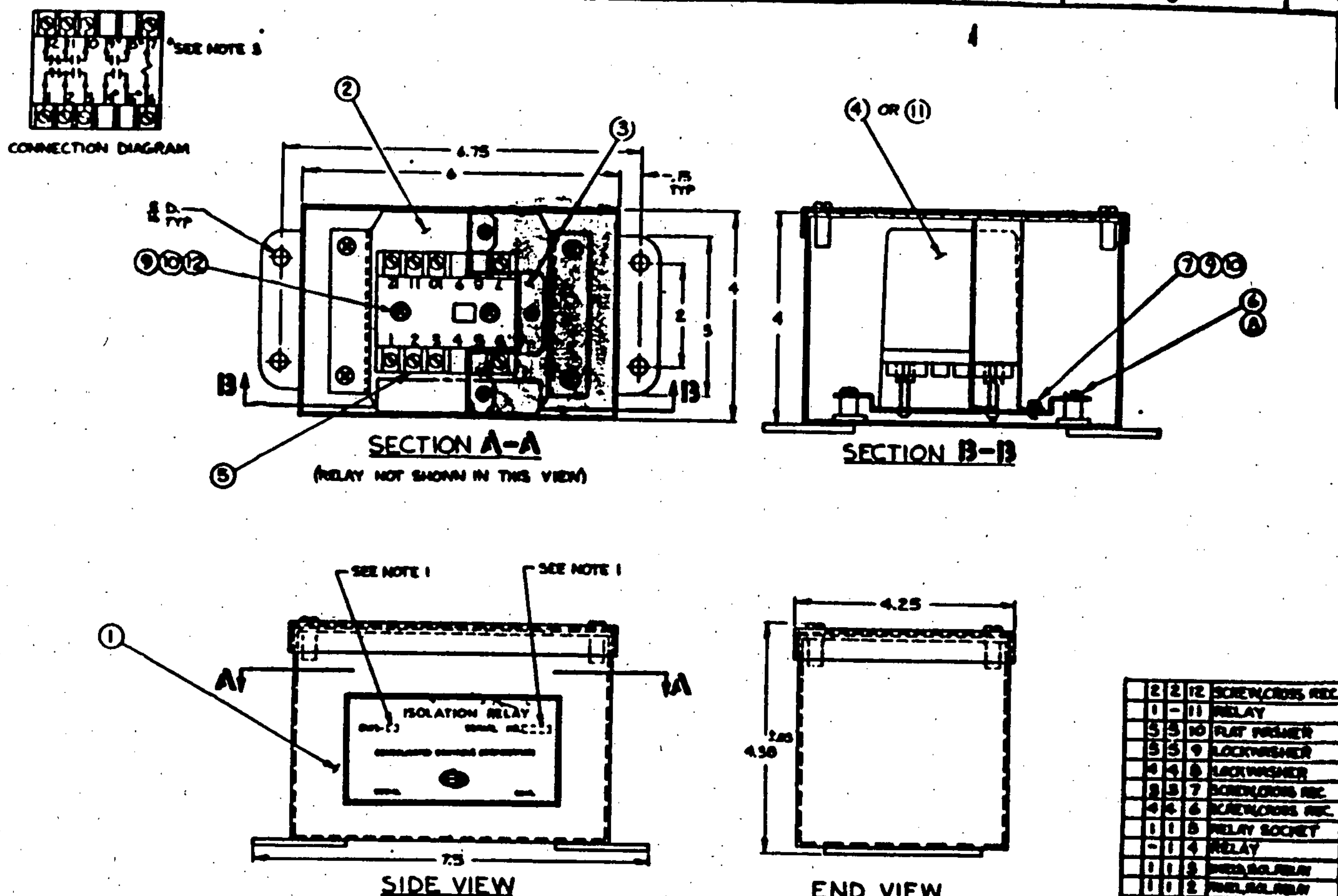
Response:

The maximum available voltages in the Spec 200 cabinet based upon the 2APRS power supply is plus 15 VDC. The DC current is limited to 5A by design and fused at 15 A. The 2 APRS power supply operates on 120 VAC limited by associated supply circuit fuses and breakers.

4. Specify the current levels which were used for all three devices in the fault testing. For example, the Foxboro 2AO-VAI was tested with 600 VAC across the output leads. We requested that the current level for the test also be reported.

Response:

As stated in the accompanying SCE response to NRC questions/comments on the proposed ATWS Mitigation System design, only measurement of the maximum credible voltage was monitored with no consideration to the maximum credible current. Based on IEEE standards, measurement of maximum credible voltage or current is acceptable in qualification of an electrical device for instrumentation and control circuits (see IEEE Standard 384-1981, Section 7.2.2.1).

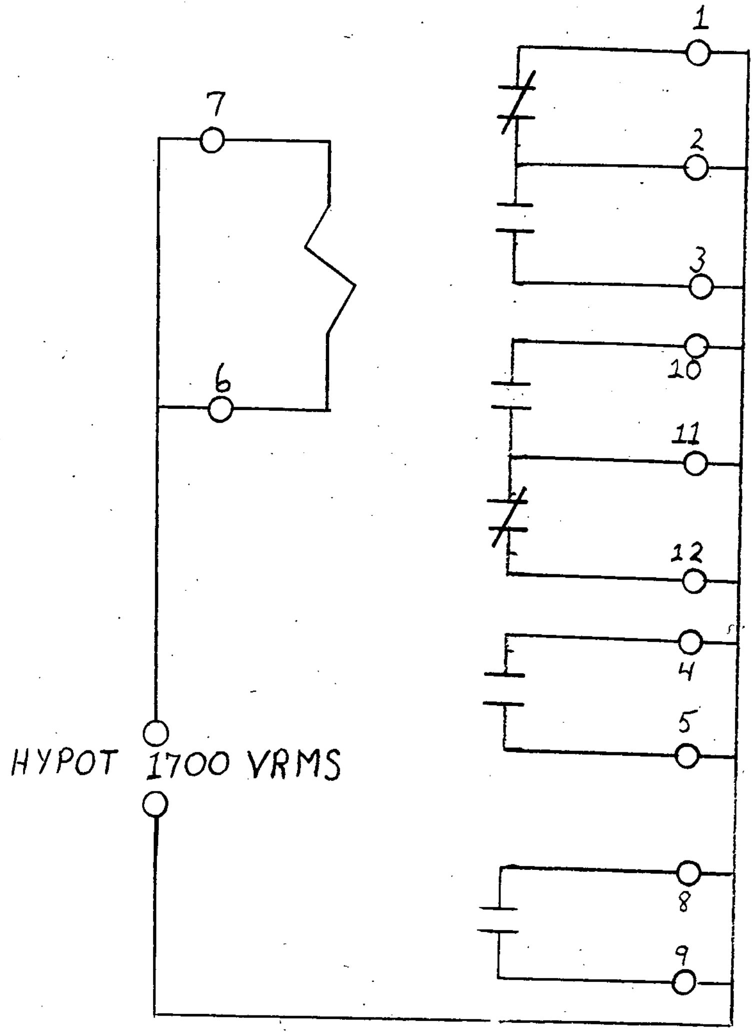


NOTES:
1. MARKING: AT FINAL ASSY RUBBER STAMP APPLICABLE DASH NO. & SERIAL NO. IN APPROX LOCATION SHOWN, USING BLACK INK, .12 HIGH CHARACTERS.
2. AT TIME OF INSTALLATION, CUSTOMER WILL DRILL & PUNCH TO LOCATE CONDUIT.
3. TERMINALS 4,5,8 & 9 CANNOT BE USED IF ISOLATION IS TO BE MAINTAINED. SCREWS ARE NOT PROVIDED IN THESE TERMINALS.
4. FOR QUALITY CONFORMANCE TEST PROCEDURE SEE KEZ 1515.

2	2	12	SCREW, CROSS REC.	–	MS35206-25			6-32 X 3/16
1	–	11	RELAY	C	[illegible] A			48 VDC
5	5	10	FLAT WASHER	–	[illegible]-5			#6
5	5	9	LOCKWASHER	–	[illegible]			#6
4	4	8	LOCKWASHER	–	[illegible]			#10
3	3	7	SCREW, CROSS REC.	–	[illegible]			[illegible]
4	4	6	SCREW, CROSS REC.	–	[illegible]			[illegible]
1	1	5	RELAY SOCKET	C	KX291A			
–	1	4	RELAY	C	[illegible] B			120 VAC
1	1	3	[illegible] ISOL. RELAY	C	[illegible]			
1	1	2	PANEL, ISOL. RELAY	C	[illegible] 287			
1	1	1	BOX, ISOLATION RELAY	A	KAL [illegible]			

ISOLATION RELAY ASSY

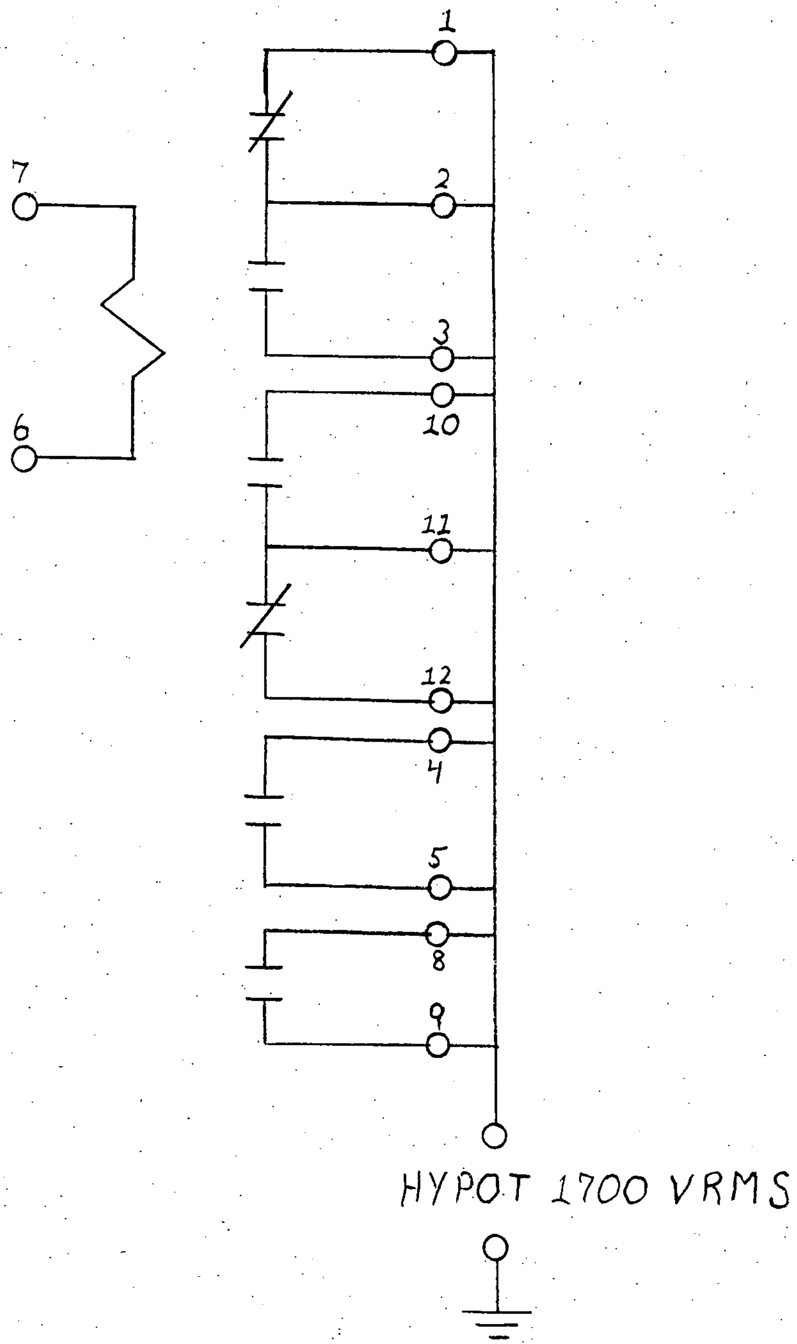
D 02790 8N13



Schematic 1

Model 8N13 Test Configuration

Test Coil to Contacts



Schematic 2

Model 8N13 Test Configuration

Test Contacts to Ground

ALSO SEE MI 2AO-130 & TI 2AO-130

Instruction

Supporting Literature
Dwg. 10102FY
MI 2AO-130

SI
1-01762
May 1979

CUSTOM MODEL 2AO-VAI OR N-2AO-VAI VOLTAGE-TO-CURRENT CONVERTER MODIFIED TO FUNCTION AS A VOLTAGE-TO-VOLTAGE CONVERTER WITH 0 TO 10 VOLT OUTPUTS

(N-ECEP-9206)

AT02AF-411-HM
CJ22CA-411-HM
AA02-215-HM

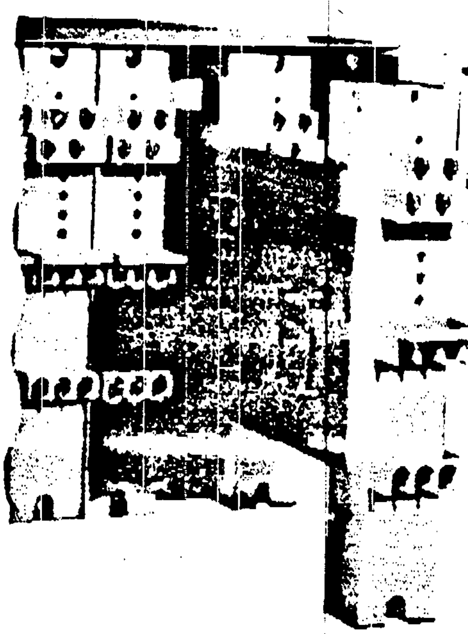


Fig. 1

RECEIVED CDM
FEB 03 1987
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The Model Code 2AO-VAI (or N-2AO-VAI) modified by N-ECEP 9206 is offered for nuclear Class 1E safety related service based on type testing. The test results are provided in Foxboro documents QOAAA20, Part 1 (seismic) and QOAAB44 (performance). These documents are available for purchase from The Foxboro Company.

General

This Custom Model 2AO-VAI Voltage-to-Current Converter has been modified to function as a Voltage-to-Voltage Converter. To accomplish this, a 500 ohm ±5%, 3W resistor is connected externally across each pair of output terminals TG1 and TG2.

The converter slides into the nest assembly and is held by two captive screws on the top and bottom of the front plate. The converter receives its power from the supply bus in the nest assembly. The signal connections and adjustments are made on the front plate.

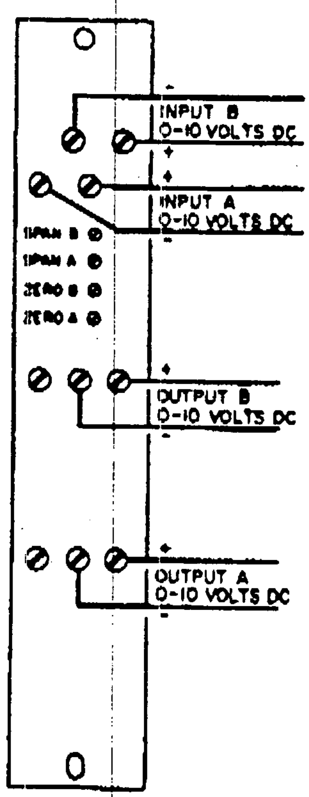


Fig. 2

Wiring

The signal connections are located on the front plate of the converter. The top connections are for Inputs A and B; the lower connections are for Outputs A and B. The input and output signals are 0 to 10 volts dc.

Calibration Procedure

1. Apply 1 volt to Input A and adjust Zero A (R36) for 1 volt ±0.5% at Output A.

2. Apply 10 volts to Input A and adjust Span A (R41) for 10 volts ±0.5% at Output A.

3. Repeat Steps 1 and 2 as required for 0.5% accuracy.

4. Check voltage at Output A for 0.5% accuracy using input voltage of 0 V, 2.5 V, 5 V, and 7.5 V.

5. To calibrate Output B, use same procedure as outlined in Steps 1 through 4 using Zero B (R26) and Span B (R9).

Jumpers must be in the Horizontal Position on the board assembly. (See Figs. 3a and 3b below.)

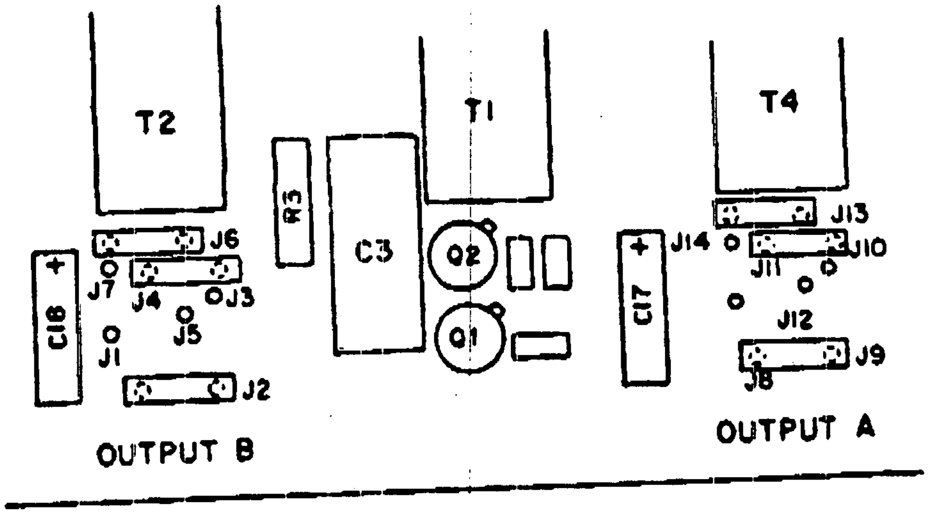


Fig. 3a

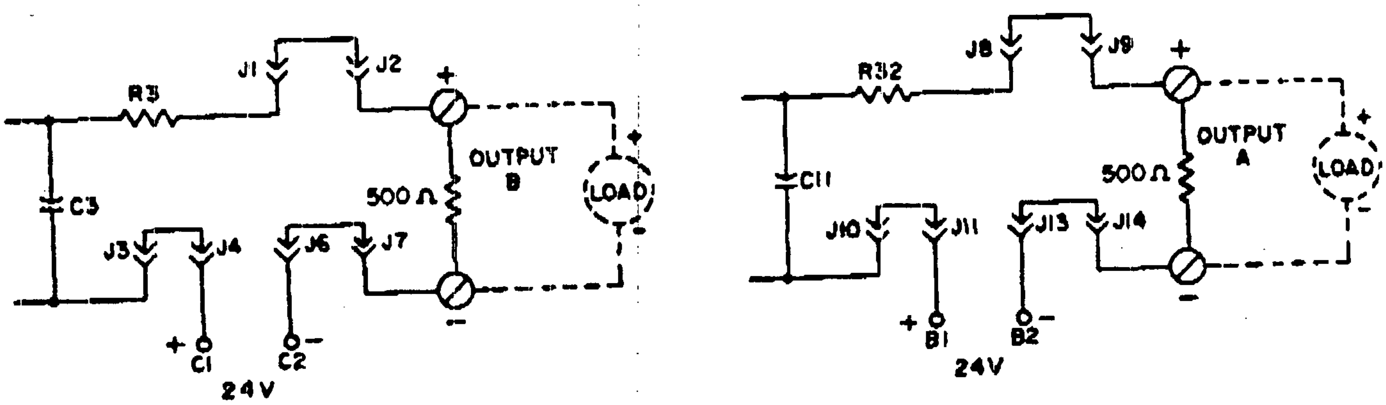


Fig. 3b

Calibration Wiring - Component Unit Removed From Nest

The converter dc power is supplied through a bus strip in the nest assembly. When the converter is removed from the nest, the dc power is disconnected. If bench calibration or troubleshooting is needed, make the field supply (+15 V and - 15 V) connections at the power bus plug as shown below. A power cable (Part Number N0305ZN) is available in the System Calibrator to make the power connections at the bus plug.

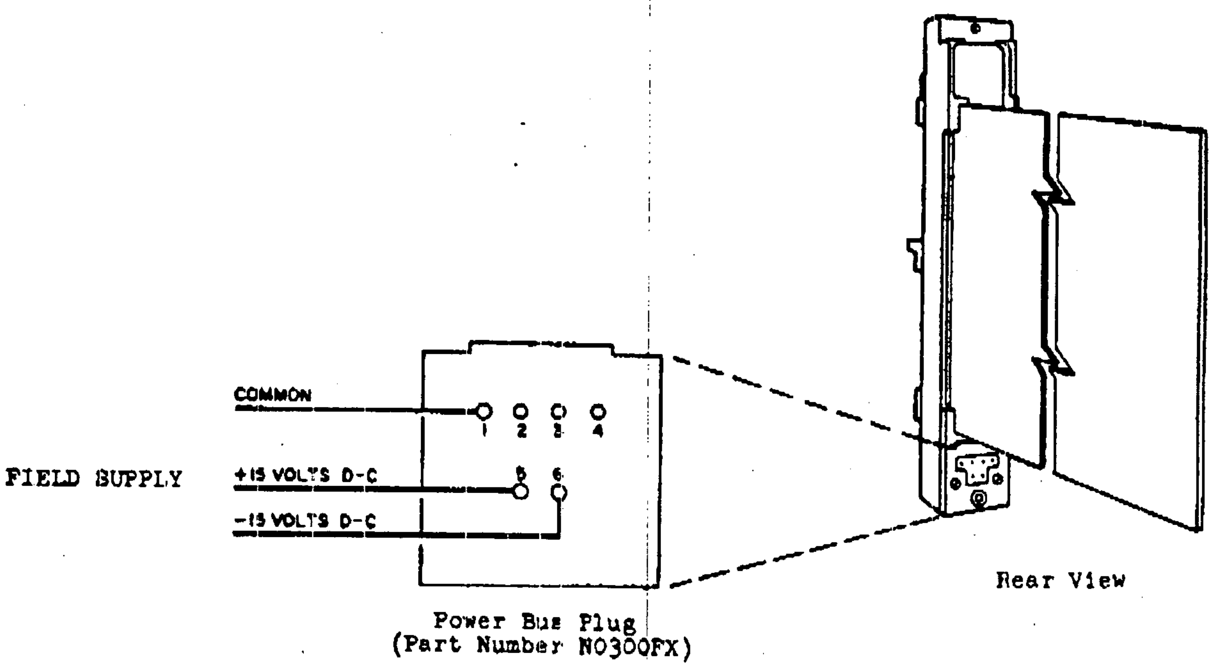


FIG. 4

For schematic wiring, refer to Drawing 10102FY.

For general information on the standard Model 2AO-VAI Voltage-to-Current Converter, refer to MI 2AO-130.

1810-AA037-M0113-0

RMP:kkd - 300

Technical Information

TI
2AO-130
August 1974

SPEC 200 VOLTAGE-TO-CURRENT CONVERTER
Model 2AO-VAI, Isolated, 4 to 20 mA dc, Adjustable Gain & Bias

GENERAL

The Voltage-to-Current Converter, shown in Figure 1, provides the interface between the SPEC 200 system voltage signals and the current signals to the field. The converter is a dual unit with two independent circuits, capable of performing two separate conversions.

Each converter has a linear 4 to 20 mA dc output signal for a 0 to 10 volt dc input signal. The output signals are isolated from the input signals. In addition, the converter provides adjustable bias and gain. The converter receives power from the power bus plug located in the nest assembly. The power is common to both converter circuits. The field circuits are powered by isolated voltage derived from a dc-to-dc conversion of the nest field bus power. Jumpers on the board assembly allow for selecting the internal or external power supply.

The converter is available with intrinsically safe output circuits which can be extended into Class I, Group B, C, or D, Division 1 Hazardous Locations. The load equipment, however, must be that which has been certified by an appropriate testing agency or otherwise certified for use with the SPEC 200 intrinsically safe system.

Bypass plugs are available as options. Each bypass plug permits the external signal to be connected (by means of a phone-type jack) into one of the two output circuits of the converter. Each bypass plug can then be removed from the converter with the output load wires attached. This permits the converter and associated loop components to be serviced while the signal to the output load is maintained via the external signal through the bypass plug. Note: this option can only be used when the load is powered from the nest bus. Two bypass plugs are required to permit removal of the dual converter if both circuits are in operation.

SPECIFICATION

Model Number:
2AO-VAI
2AO-VAI-CGB
2AO-VAI-FGB } Intrinsic Safety Versions
2AO-VAI-UGB

2AX+P One Bypass Plug (See TI 2AT-220)
2AX+P+P Two Bypass Plugs

Note 1: The converter is available in testing laboratory certified versions for use in approved intrinsically safe systems.

Note 2: The use of bypass plug 2AX+P reduces the load capacity by 50 ohms. The use of bypass plug 2AX+P-FGB reduces the load capacity by 150 ohms.

Mounting:
Occupies one space in SPEC 200 nest (see TI 200-275)

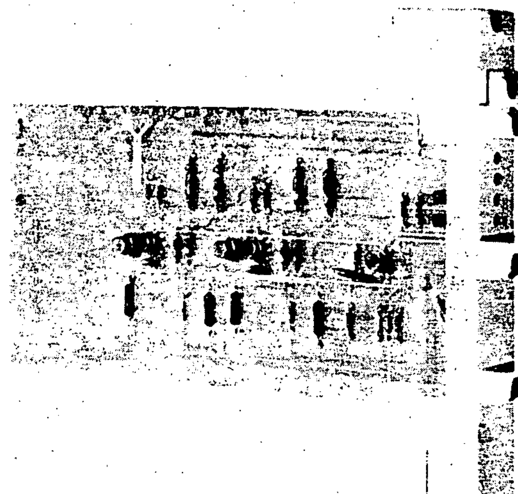


Figure 1. Model 2AO-VAI V/I Converter

Electrical Classification: Ordinary Locations

Intrinsic Safety: See Note 1 above and TI 200-255

Power Requirements (Total for dual-circuit card):
+15 and -15 V dc ±5% at 90 mA when totally powered from system supply via nest bus, or 50 mA when output is connected to external supply in series with load

Input Signals: 0 to 10 V dc (two per converter)

Input Resistance: 500 kilohms minimum

Output Signals: 4 to 20 mA dc (each output)

Output Load:
For total power from nest power bus or 24 V dc external power supply in series with load: 600 ohms max.
For 48 V dc external power supply in series with load: 1800 ohms max.

Adjustments (Front Panel):
Bias: ±100% of output span minimum
Gain: 1 to 4

Accuracy: ±0.5% of output span

Repeatability: Less than 0.1% of input span

Supply Voltage Effect:
±0.5% of output span for a ±5% change within normal operating limits of +15 and -15 V dc supply

Ambient Temperature Range: +40 to 120°F (+5 to 50°C)

Ambient Temperature Effect:
±0.5% of output span maximum for a 50°F (28°C) change within normal operating limits

FOXBORO

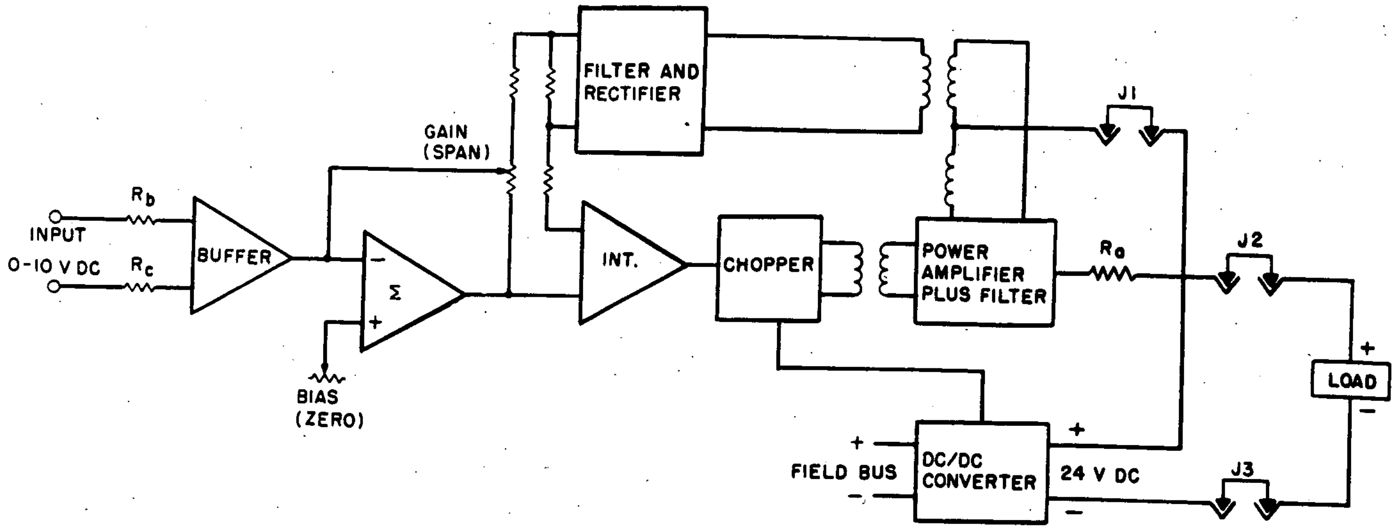


Figure 2. Model 2AO-VAI Converter Diagram

PRINCIPLE OF OPERATION

Isolated, 4-20 mA dc Output Unit with Adjustable Gain and Bias

Figure 2 shows one of the two channels of a dual voltage-to-current converter. The other channel is identical.

In operation, the input voltage (0 to 10 volts dc) is applied to a high impedance buffer amplifier. The output enters a summing amplifier. The other inputs to the summing amplifier are the negative feedback 4:1 span adjustment and the ±100 percent bias adjustment. The output of the summing amplifier is then applied to the input of another high impedance amplifier which is used as an integrator. The output of the integrator is then "chopped" (interrupted and polarized to appear as an ac signal) and fed to the primary of the output amplifier transformer. The output from the transformer is then amplified and filtered to produce the 4-20 mA dc converter output signal. The output voltage is simultaneously stepped-down and rectified/filtered to provide a negative feedback to the input of the summing amplifier for adjustment and control of span.

For an intrinsically safe application, voltage on the field bus is limited by the high voltage limiting circuit in the nest power distribution component. Current limiting is provided by Resistor R_a. Resistors R_b and R_c protect against accidental fault voltages up to 250 volts nominal from the system circuits.

If intrinsic safety is not involved, it is possible to power the field load from a separate source. In this case, the converter is easily changed by relocating jumpers on the printed circuit card, as shown in Figure 3.

The output capability can be extended when external power is used if the source is greater than 24 volts dc. The maximum voltage which can be used is 48 volts dc without seriously overheating the output transistors (in the case of a short circuit fault across the output transducer). If 48 volts dc is used as the external power source, the load capacity is increased to 1800 ohms.

Since only one field bus voltage is available per nest, care must be exercised when different models are used in a single nest.

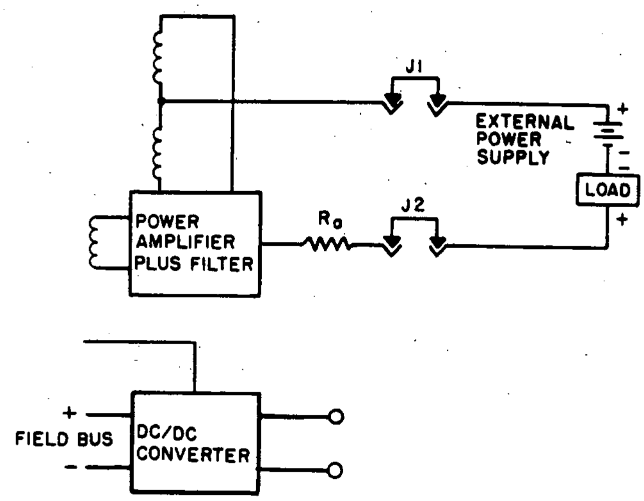


Figure 3. External Power Supply

Instruction

MI
2AO-130
March 1974

— VOLTAGE-TO-CURRENT CONVERTER —

4 to 20 mA, Isolated, Adjustable

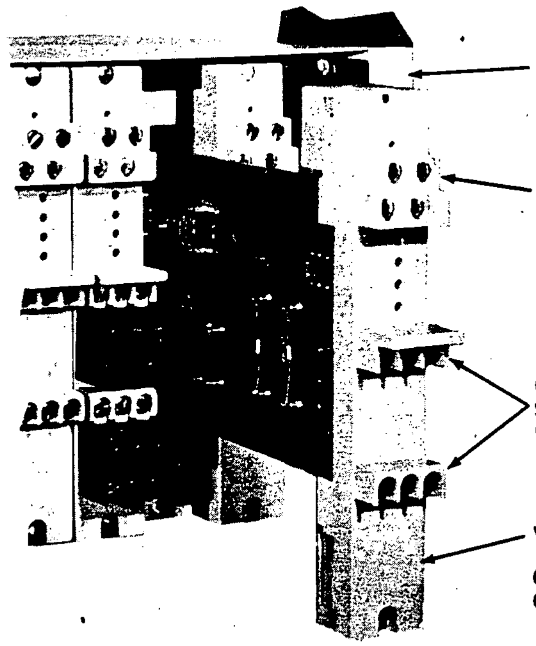
Model 2AO-VAI
Model 2AO-VAI-CGB
Model 2AO-VAI-UGB
Model 2AO-VAI-FGB

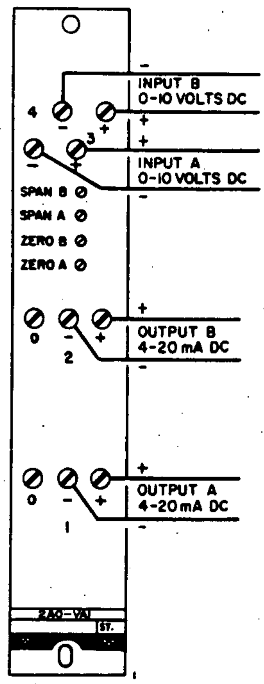
General

The Voltage-to-Current Converter is a solid state output component located in the nest assembly. It provides a 4 to 20 mA output current for spans from 2.5 volts up to 10 volts starting anywhere within the 0 to 10 volt input range. For reverse action, (increasing input-decreasing output) the input leads are reversed and a ±100% bias adjustment will provide the 0% input. The converter has two inputs and outputs for dual operation with a common power supply.

The converter slides into the nest assembly and is held by two captive screws on the top and bottom of the front plate. The converter receives its power from the supply bus in the nest assembly. The signal connections and adjustments are made on the front plate.

The converter is available in two versions: intrinsically safe and nonintrinsically safe. The intrinsically safe version may be used only in conjunction with 2AX+DP10-CGB, -UGB, or -FGB Power Distribution component. The suffixes -CGB, -UGB, and -FGB were formerly -CSA, -ULB, and -F9 respectively.





Wiring

The signal connections are located on the front plate of the converter. The top connections are for Inputs A and B; the lower connections are for Outputs A and B. The input signal may have a span of 2.5 volts up to 10 volts within the 0 to 10 volt input range and the output is a 4 to 20 mA signal. The converter has a set of jumpers on the board assembly to permit the use of converter field power or external field power to operate the output load. See Page 3 for position of jumpers.

The signal connections are the same for intrinsically safe and nonintrinsically safe units. However, for nonintrinsically safe versions there are recommended procedures to follow for safe wiring. See Instruction MI 200-255.

FOXBORO

Calibration

If Converter Unit is removed from nest assembly, connect dc power at bus connector as shown on Page 4.

Equipment Needed

(For Calibration and/or Troubleshooting)

System Calibrator, Model 2AT-CAL

DC Voltmeter, Triplett 630 or equivalent

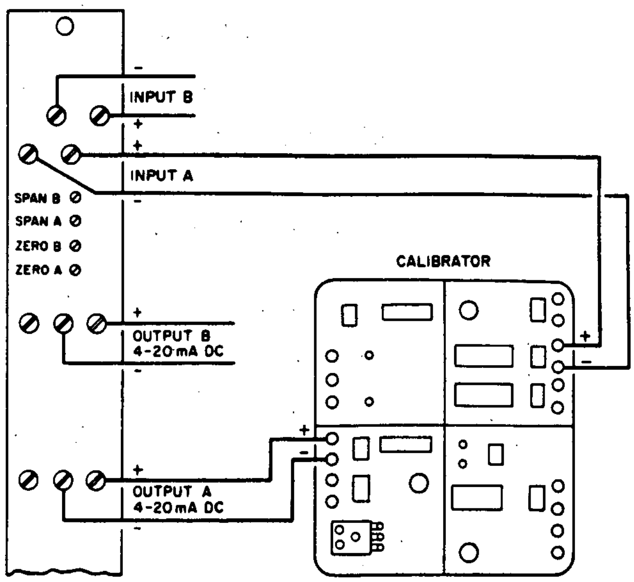
Alternate equipment if System Calibrator is NOT available

DC Voltmeter, Range 0 to 10 volts

DC Voltage Source, Range 0 to 10 volts

DC Milliammeter, Range 0 to 20 mA

DC Power Supply, +15 V and -15 V, 100 mA For bench calibration or troubleshooting



NOTE: Before starting calibration, the jumpers on the board assembly should be in the horizontal position. After calibration, place jumpers to their original position. See Page 3.

1. Connect Calibrator at input and output terminals as shown above. For reverse action (increasing input - decreasing output), the input leads must be reversed.
2. Select the input voltage range that will correspond to 4-20 mA output.
3. Set Calibrator to the input value that should produce 4 mA output.
4. Adjust ZERO A screw on front plate for an output of 4 ±0.1 mA.
5. Set Calibrator to the input value that should produce 20 mA output.
6. Adjust SPAN A screw on front plate for an output of 20 ±0.1 mA.
7. Repeat Steps 3 through 6 until no further adjustment is necessary.
8. For calibration of Input B and Output B, repeat same procedure except adjust ZERO B and SPAN B screws on front plate.

Output Load

The Voltage-to-Current Converter has an output signal of 4 to 20 mA into an output load of 600 ohms provided the internal power supply is used, see Page 3. However, for intrinsically safe version, only the internal power supply may be used.

If the Standby Unit 2AT-SBU, 2AT-SBU-CGB or 2AT-SBU-UGB is used with the Bypass Attachment Module 2AX+P, the output load must be reduced by 50 ohms.

Example: 600 Ω without bypass module
550 Ω with bypass module 2AX+P

For the intrinsically safe -FGB version, the Standby Unit 2AT-SBU-FGB is used with the Bypass Attachment Module 2AX+P-FGB. The output load must be reduced by 150 ohms.

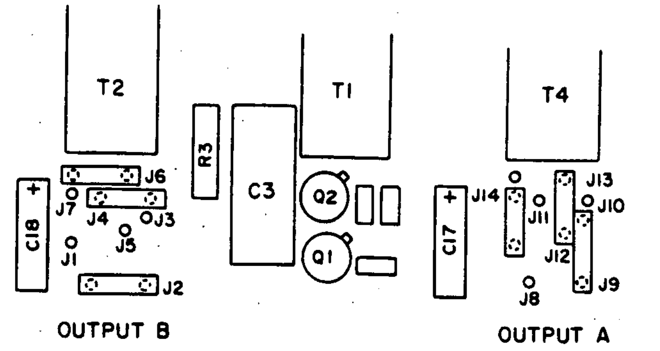
Example: 600 Ω without bypass module
450 Ω with bypass module 2AX+P-FGB

Field Power

The converter has available on the board assembly a dc/dc converter which supplies the power (+24 V dc) to the output stage and also provides isolation. This limits the output load to 600 ohms maximum. However, if desired, an external field power (48 V dc) may be safely used for the output stage, thereby increasing the output load to 1800 ohms maximum. A series of jumpers located on the board assembly will select the desired internal or external dc power.

With the jumpers in the horizontal position, the converter internal supply is used to power the load. With the jumpers in the vertical position, an external dc supply up to 48 volts is used to power the load.

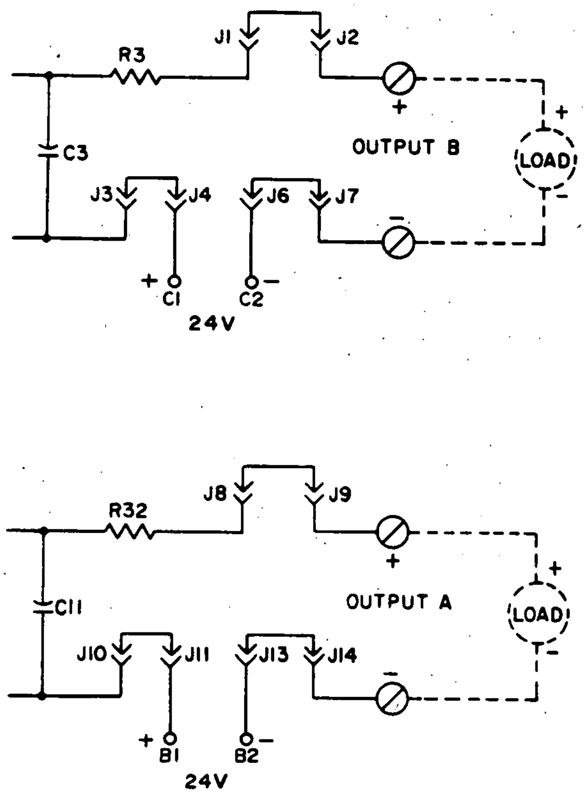
The illustrations below show the effect on the internal wiring and output when jumpers are placed in different positions on the board assembly.



NOTE: When external field power supply is used, the load polarities are connected as shown in illustration below.

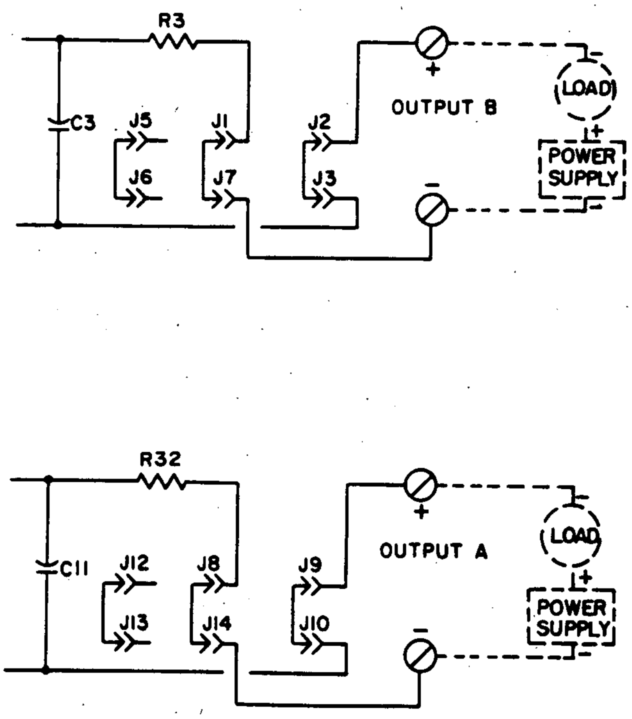
Field Power From Converter

(Jumpers in Horizontal Position) on the Board Assembly



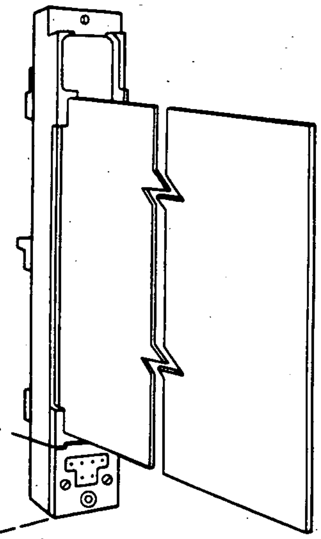
External Field Power

(Jumpers in Vertical Position) on the Board Assembly



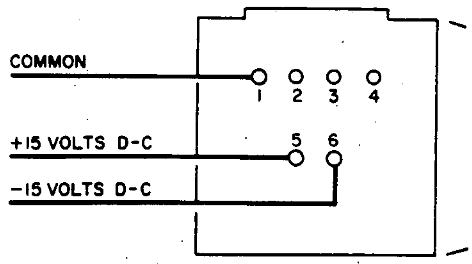
Calibration Wiring - Component Unit Removed From Nest

The converter dc power is supplied through a bus strip in the nest assembly. When the converter is removed from the nest, the dc power is disconnected. If bench calibration or troubleshooting is needed, make the field supply (+15 V and -15 V) connections at the power bus plug as shown below. A power cable (Part Number N0305ZN) is available in the System Calibrator to make the power connections at the bus plug. The signal connections on the front plate remain the same as shown under calibration.



Rear View

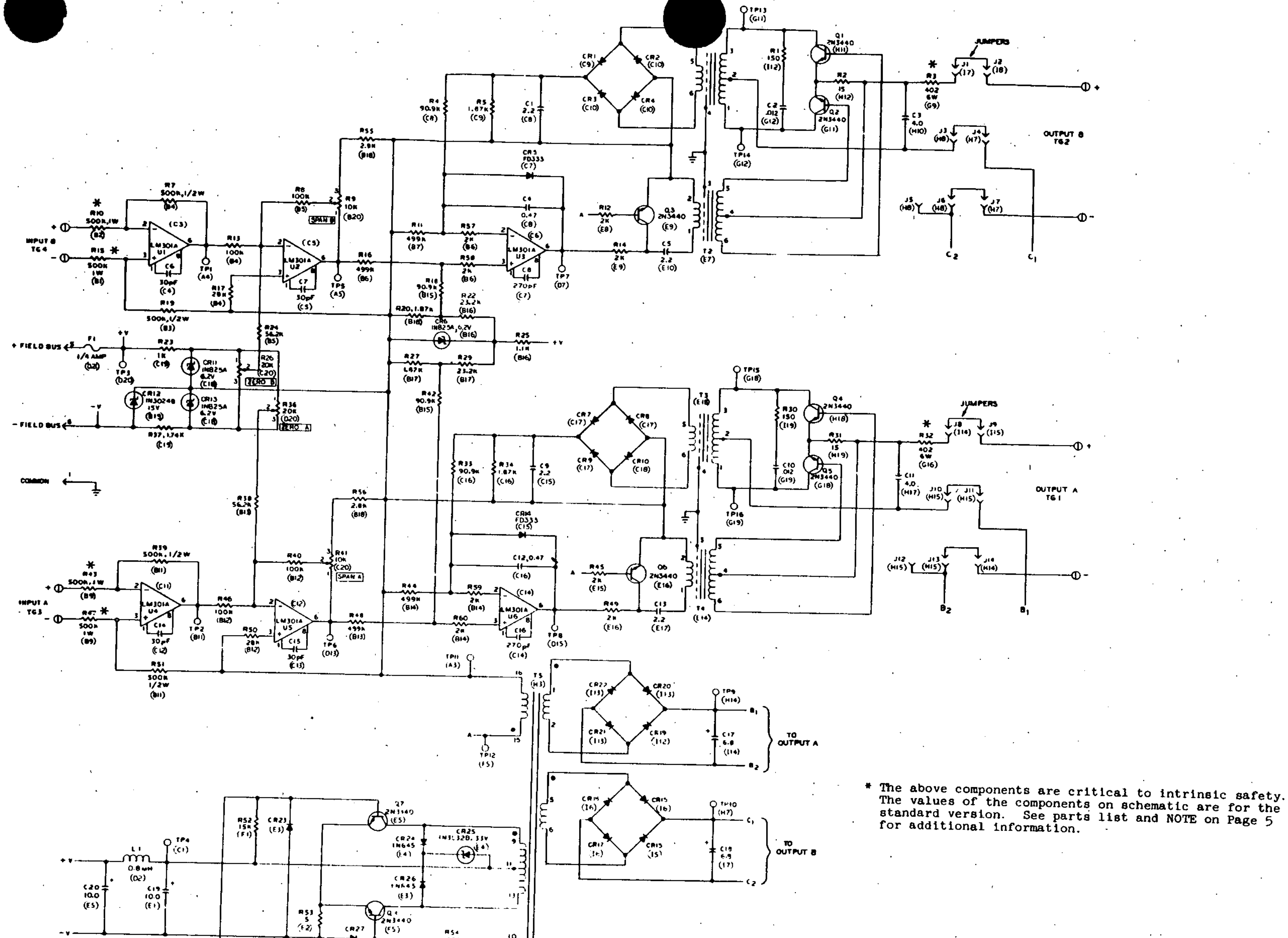
FIELD SUPPLY



Power Bus Plug
(Part Number N0300FX)

Parts List Continued from Page 5

Item	Description	Part No.
C1, C5	Capacitors, 2.2 µF, ceramic	H0140BP
C2	Capacitor, 0.012 µF, ceramic	H0110BM
C3	Capacitor, 4.0 µF, polycarbonate	H0176CM
C4	Capacitor, 0.47 µF, ceramic	H0140BK
C6, C7	Capacitors, 30 pF, ceramic	H0113PN
C8	Capacitor, 270 pF, ceramic	H0113QE
C9, C13	Capacitors, 2.2 µF, ceramic	H0140BP
C10	Capacitor, 0.012 µF, ceramic	H0110BM
C11	Capacitor, 4.0 µF, polycarbonate	H0176CM
C12	Capacitor, 0.47 µF, ceramic	H0140BK
C14, C15	Capacitors, 30 pF, ceramic	H0113PN
C16	Capacitor, 270 pF, ceramic	H0113QE
C17, C18	Capacitors, 6.8 µF, tantalum	H0160CF
C19, C20	Capacitors, 10 µF, tantalum	H0160CL
CR1-CR4, CR7-CR10	Diodes, Type 1N914	N0258AB
CR5, CR14	Diodes, Type FD333	K0120SA
CR6, CR11, CR13	Diodes, Zener, Type 1N825A	N0257WC
CR12	Diode, Zener, Type 1N3024B	N0257AZ
CR15-CR23, CR27	Diodes, Type 1N914	N0258AB
CR24, CR26	Diodes, Type 1N645	N0258AF
CR25	Diode, Zener, Type 1N3032B	N0257BM
Q1-Q8	Transistors, Type 2N3440	N0282BB
T1, T3	Transformers	N0233BK
T2, T4	Transformers	N0233BM
T5	Transformer	N0233BL
U1-U6	Operational Amplifiers, Type LM301A	N0284LW
L1	Inductor, 0.8 mH	N0235AE
F1	Fuse, 1/4 A	N0262AB
--	Wire Wrap Post	D3000YU
--	Jumper	N0308JY
--	Termination Assembly (front plate)	N0300FP
--	Power Bus Plug (rear of termination assembly)	N0300FX



NOTES:

1. UNLESS OTHERWISE SPECIFI
   RESISTORS ARE 1/8 W.
   RESISTANCE VALUES ARE IN
   CAPACITANCE VALUES ARE I
   DIODES ARE TYPE IN914.
2. UNLESS OTHERWISE NOTED, A
   CIRCUITS HAVE +15 VOLTS A
   -15 VOLTS AT PIN 4.
3. THE MANUFACTURER'S DESIGN
   GRATED CIRCUITS IS FOR RE
4. NUMBERS IN PARENTHESES IN
   COORDINATES LOCATED ON PR
   BOARD.

LEGEND:

- SCREW TERMINAL CONNECTION
- BUS CONNECTOR PIN
- DIAGNOSTIC TEST POINT
- SERVICE TEST POINT
- CIRCUIT AND POWER GROUND

* The above components are critical to intrinsic safety. The values of the components on schematic are for the standard version. See parts list and NOTE on Page 5 for additional information.

Schematic Diagram 10102FY
(For Component Diagram, see Page 5)