Litton Marine Systems

MK 37 VT DIGITAL GYROCOMPASS EQUIPMENT OPERATION AND SERVICE MANUAL

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AUGUST 2000

Litton Marine Systems

MK 37 VT DIGITAL GYROCOMPASS EQUIPMENT OPERATION AND SERVICE MANUAL

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The following three safety precautions apply to general service procedures such as those within this publication. Service and operation personnel must understand and apply these safety precautions during maintenance and operation.

KEEP AWAY FROM LIVE CIRCUITS

Operating personnel must at all times observe all safety regulations. Do not replace components inside the equipment with the high voltage supply turned on. High voltage is not present when power is turned off.

DO NOT SERVICE OR ADJUST ALONE

Under no circumstances should any person reach into or enter the enclosure for the purpose of servicing or adjusting the equipment except in the presence of someone who is capable of rendering aid.

RESUSCITATION

Personnel working with or near high voltages should be familiar with modern methods of resuscitation.

The following warnings appear in the text of this publication and are repeated here for emphasis:

WARNING

Make sure all sources of power are turned off and tagged "OUT OF SERVICE." These power sources include (but are not necessarily limited to) system power, solenoid power, and compass data transmission. Lethal voltages may be involved. (pages 6-2, 6-16, 6-17)

The following cautions appear in the text of this publication and are repeated here for emphasis:

CAUTION

The compass indication is only used for service and installation purposes as it is not corrected for errors caused by latitude or speed. (page 1-2)

CAUTION

After initializing any repeater, make certain the repeater and the compass are in synchronization. This double check is especially important if the repeater is used for steering or establishing a bearing. If necessary, repeat the synchronization process. (page 2-6)

CAUTION

All heading repeaters with a stored status of "enabled" at power-up will be turned on after the gyro is up to speed. Synchronization of all the repeaters must be made using the above procedure. (page 2-6)

CAUTION

It is important to update speed when using manual speed entry because speed correction is used to maintain an accurate corrected heading. A compass system with improper speed input may report a corrected heading with as much as 5 degrees of error. (page 2-7)

CAUTION

It is important to update latitude when using manual latitude entry because latitude correction is used to maintain an accurate corrected heading. A compass system with improper latitude input may report a corrected heading with as much as 5 degrees of error, or 10 degrees of error if the hemisphere is wrong. (page 2-8)

CAUTION

Repair of components below the top plate of the Compass Element is beyond the scope of onboard repair. (page 6-1)

CAUTION

Repairs of the Master Compass should be done by Sperry Marine service technicians and should be attempted onboard ship ONLY under emergency conditions if spare parts are available. (page 6-1)

CAUTION

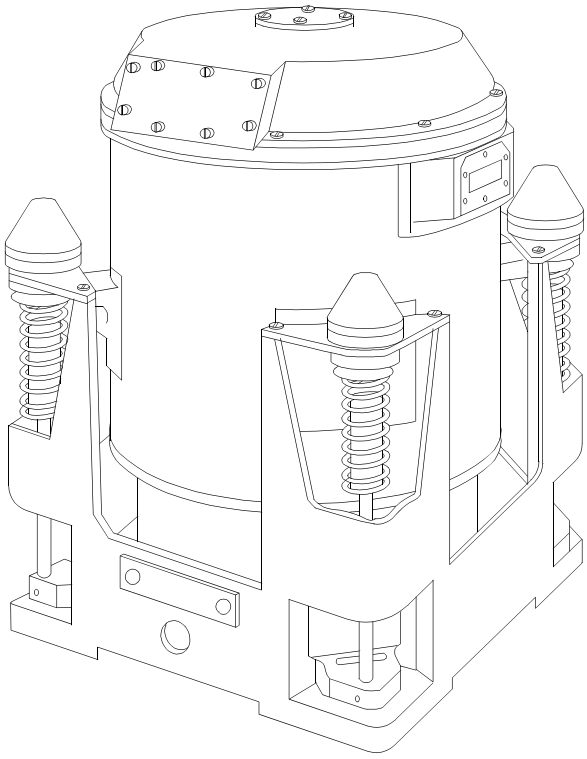
Repairs inside the Master Compass should be undertaken only under conditions of extreme urgency when the Master Compass cannot be replaced and sent back to normal overhaul facilities. Any repairs inside the Master Compass must be done under extremely clean conditions to prevent contamination of the flotation fluid or bearings. Repair must be limited to replacement of components mounted on the support plate of the Compass Element, near the top, inside the Binnacle. No attempt should be made to replace any bearings or sensitive element parts. (page 6-19)

CAUTION

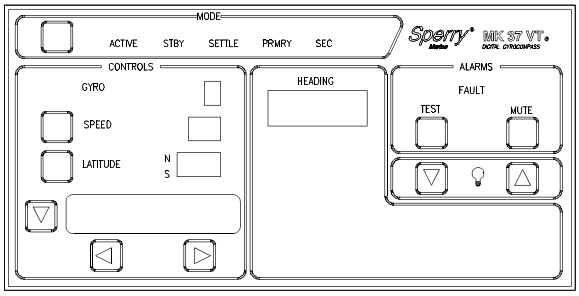
In the following step, be certain to angle the flexible tube toward the window. Inserting the tube in any other direction could damage some of the internal components. (page 6-19)

CAUTION

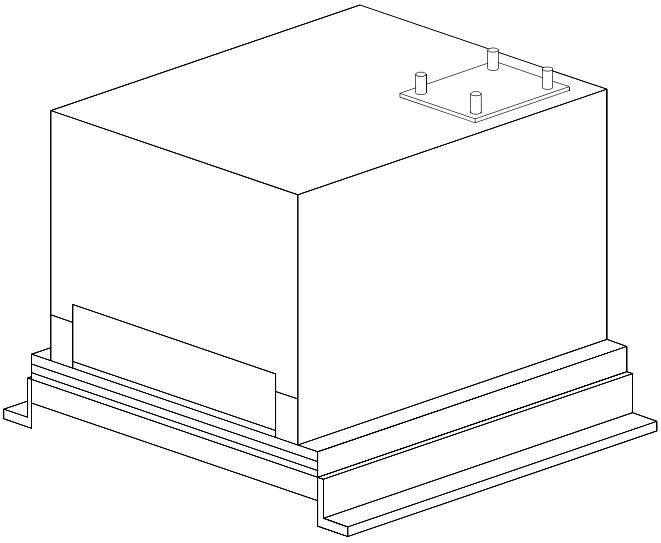
Before applying power to the MK 37 VT from the ship's switchboard, use a voltmeter to check the input voltages that will be supplied to the MK 37 VT. Check all wiring carefully. Make certain that DC polarities are correct. If the proper voltages and polarities are present, power may now be switched on to the MK 37 VT. Check the voltages and polarities at the MK 37 VT interface board. Make sure after checking the AC input voltage that the 115/230 VAC Voltage Select Switch is set to the correct position. (page 8-3)



MASTER COMPASS



DISPLAY ASSEMBLY



ELECTRONICS CONTROL UNIT

Figure 1-1. MK 37 VT Digital Gyrocompass Equipment

CHAPTER 1

GENERAL INFORMATION

1-1 INTRODUCTION.

The MK 37 VT Digital Gyrocompass Equipment consists of a Master Compass, Display Assembly, Electronics Control Unit, and the interconnecting cable assemblies. The MK 37 VT Digital Gyrocompass Equipment computes a true heading with corrections for speed and latitude. The system's standard features allow simple operation while its flexibility supports several options.

This manual provides general information and operational procedures for the single or dual MK 37 VT Digital Gyrocompass Equipment (Figure 1-1). Please refer to the following quick reference for an overview of the manual's organization.

Chapter 1 (General Information): Provides information on the use and format of the manual, the equipment configuration, and the equipment's interface requirements.

Chapter 2 (Operation): Provides operating procedures for the MK 37 VT Digital Gyrocompass Equipment.

Chapter 3 (Functional Description): Provides a description on how the equipment operates.

Chapter 4 (Scheduled Maintenance): Provides preventive maintenance procedures for the MK 37 VT Digital Gyrocompass Equipment.

Chapter 5 (Troubleshooting): Provides information for locating malfunctions in the equipment.

Chapter 6 (Corrective Maintenance): Provides instructions required to adjust and align the equipment, and instructions required to remove and replace all replaceable subassemblies.

Chapter 7 (Parts List): Provides a listing of all replaceable parts.

Chapter 8 (Installation): Provides installation information for the MK 37 VT Digital Gyrocompass Equipment.

1-2 OVERALL GYROCOMPASS EQUIPMENT DESCRIPTION.

The MK 37 VT Digital Gyrocompass Equipment (Figure 1-1) is comprised of a microprocessor-based Electronics Control Unit (ECU), a Display Assembly, and a Master Compass. The Master Compass provides uncorrected heading data to the Electronics Control Unit. The Electronics Control Unit processes the data and provides output signals representing the corrected heading and rate of turn. It transmits the corrected heading as 24 VDC step data and as serial data. The Display Assembly is the system's primary user interface and consists of a Liquid Crystal Display (LCD), Light Emitting Diode (LED) lights and displays, and pushbutton switches. Optional accessories of the gyrocompass equipment include a Digital-To-Synchro Assembly which provides a 1X synchro output and a Course Recorder Assembly containing an RS-232 channel dedicated to a dot matrix printer. The Course Recorder Assembly provides a hard copy of true heading and rudder angle data. If a dual MK 37 VT Digital Gyrocompass system is installed on the ship, one system will be selected as the primary and the other will be the secondary and serve as a backup.

1-2.1 Master Compass. The Master Compass provides uncorrected heading data to the Electronics Control Unit for signal processing. The Master Compass physically consists of a shock-mounted, fluid-filled binnacle assembly sealed and designed for deck mounting.

CAUTION

The compass indication is only used for service and installation purposes as it is not corrected for errors caused by latitude or speed.

The MK 37 VT Digital Gyrocompass Equipment contains an electromechanical gyrocompass with three precision gimbals. The gimbals and additional electromechanical components compensate for the earth's rotation and gravity while taking advantage of gyroscopic inertial properties. The result is a gyrocompass that automatically seeks and aligns itself with a meridian pointing toward true north.

A gyrosphere containing a gyroscope rotor is immersed in silicone fluid and is designed and adjusted to have neutral buoyancy. This feature is a distinct advantage in that:

- The weight of the gyrosphere is removed from the sensitive axis bearings.
- The gyrosphere and bearings are protected from excessive shock loads.
- Sensitivity to shifts of the center of mass of the gyrosphere relative to the sensitive axis is eliminated, thereby providing improved accuracy.
- The effects of accelerations are minimized because the center of mass of the gyrosphere and the center of buoyancy are coincident.

The system's application software compensates for the effects of the ship's varying speed and local latitude. A servo followup system works with the azimuth axis to keep the yoke aligned with the gyrosphere as the vessel turns. The servo system also provides uncorrected heading data to the Electronics Control Unit. The system doesn't require heaters due to the low viscosity of the suspension and ballistic fluids.

1-2.2 Display Assembly. The Display Assembly is the operator's primary user interface to the system and contains the controls and indicators used during normal operation of the gyrocompass equipment. The Display Assembly contains an LCD, LED indicator lights and displays, and switches.

The operator refers to the indicator lights to determine the current operating mode. Possible modes are ACTIVE, STANDBY, SETTLE, PRIMARY, or SECONDARY. A separate indicator light informs the operator of FAULT detection. The operator has front panel access to ten switches on the Display Assembly. The switches enable the operator to select operating modes, mute audible alarms, adjust the intensity of the indicator lights, adjust the Display Assembly's back panel lighting, scroll through menu options, and enter data.

The LCD provides the operator with menu options and fault messages. The LED displays provide the operator:

- Current heading to the nearest tenth of a degree.
- Current speed to the nearest knot.
- Local latitude to the nearest degree. A horizontal indicator light indicates if the latitude is North or South.

1-2.3 Electronics Control Unit. The Electronics Control Unit contains a microcomputer and other control circuitry needed to operate the Master Compass and the Display Assembly. It also contains the circuit boards that drive the step repeaters. Connections are provided on the motherboard for up to eight 24 VDC step repeaters. Included in the Electronics Control Unit is software that compensates for errors due to the effect of the vessel's latitude and speed. The corrected heading data output is provided in both serial and step data format. An analog rate-of-turn output is also provided by the Electronics Control Unit.

1-2.4 Compass Cable Assembly. A cable connects the Master Compass to the Electronics Control Unit. This cable includes a connector for the Master Compass and connectors for connection to boards within the Electronics Control Unit. The standard cable length is 10 feet; however, other lengths are available as options.

1-2.5 Display Cable Assembly. A cable connects the Display Assembly to the Electronics Control Unit. This cable includes a connector for the Display Assembly and a connector for connection to the Electronics Control Unit. The standard cable length is 6 feet; however, other lengths are available as options.

1-2.6 Optional Equipment. Two circuit board assemblies are available as optional equipment. One option functions as a course recorder to provide serial data to a printer for a hard copy record of heading and rudder information. The second option includes a converter module that provides the current heading using standard synchro format.

1-2.6.1 Course Recorder Assembly (Optional Equipment). The Course Recorder Assembly option contains 256K bytes of nonvolatile RAM memory, a Clock/Calendar circuit, an Analog to Digital Converter, a serial communications interface to a serial printer, and a serial communications interface to the alternate compass to support a compass comparison function for dual MK 37 VT installations.

1-2.6.2 Digital-To-Synchro Assembly (Optional Equipment). The Digital-To-Synchro Assembly converts digital azimuth data to 1X synchro format for applications that require a 1X synchro output. The optional Digital-To-Synchro Assembly uses a 14-bit converter module. The circuit's output is designed for 90 volts line-to-line, with a 115 VAC, 400 Hz reference. The maximum power output is 4 VA.

1-2.7 Dual Compass Configuration. This configuration allows two complete MK 37 VT gyrocompass systems to be installed on the ship. The gyrocompass systems are designated as primary and secondary. The primary and secondary gyrocompass systems share a common output bus. However, the system that is currently operating in the active mode maintains control of the output bus. Only the outputs from the active gyrocompass system are available to external devices.

1-3 REFERENCE DATA.

Refer to the following tables for general information concerning the MK 37 VT Digital Gyrocompass Equipment:

- Table 1-1 provides the functional and interface requirements for the MK 37 VT Digital Gyrocompass Equipment.
- Table 1-2 lists and briefly describes the options for the gyrocompass equipment.
- Table 1-3 lists the equipment physical data.
- Table 1-4 lists the spare parts.

Table 1-1. MK 37 VT Digital Gyrocompass Equipment Reference Data

Inputs:	
Speed:	
Pulsed	Automatic from 200 pulse-per-nautical-mile speed log
Serial	Automatic from digital sources via RS-232/422 in NMEA 0183 format $VBW, $VHW, $VTG
Manual	Manually via the control panel on the Display Assembly
Latitude:	Automatic from the Global Positioning System (GPS) via RS-232/422 in NMEA format $GLL, $GGA
	Automatic from digital sources via RS-232/422 in NMEA 0183 format $GLL
	Manually via the control panel on the Display Assembly
Power:	24 VDC + 20%, -20%, 8 amps 115/230 VAC ± 15% 47-64 Hz, 8 amps
Outputs:	
Rate of Turn:	50 mV per deg/min (± 4.5 VDC full scale = ± 90 deg/min) NMEA 0183 format $HEROT, X.XXX, A*hh<CR><LF> 1 Hertz, 4800 Baud
Step Repeaters:	Eight 24 VDC step data outputs. (An additional twelve step data output at 35 VDC or 70 VDC from the optional Transmission Unit PN 1977023.) 7 - switched 1 - unswitched
Heading Data:	One RS-422, capable of driving up to ten loads in NMEA 0183 format $HEHDT, XXX.XXX, T*hh<CR><LF> Two RS-232, each capable of driving one load in NMEA 0183 format $HEHDT, XXX.XXX, T*hh<CR><LF> 10 Hertz, 4800 Baud 1 - 232 switched 1 - 232 unswitched 1 - 422 switched
Alarm Outputs:	An audible alarm is part of the Display Assembly. A relay and a battery-powered circuit activates a fault indicator and the audible alarm during a power loss. Compass alarm - NO/NC contacts Power alarm - NO/NC contacts
Course Recorder (optional):	Output: RS-232 to dot matrix printer
Synchro Output (optional):	Output: 90 volts line-to-line with a 115 VAC 400 Hz reference. Maximum power output of 4 VA. Can be switched or unswitched.

NOTE: For Dual Systems switched and unswitched headings are provided. The switched outputs come from the compass that is currently active. The unswitched output is always from the compass to which you are connected. For Single Systems all heading outputs act as unswitched.

Table 1-2. Available Options for the MK 37 VT Digital Gyrocompass Equipment

Part Number	Name and Description
1980711-1	Digital-To-Synchro Assembly (provides 1X synchro output @ 115 VAC 400 Hz) (switched heading)
1980711-2	Digital-To-Synchro Assembly (provides 1X synchro output @ 115 VAC 400 Hz) (unswitched heading)
1980711-3	Digital-To-Synchro Assembly (provides 1X synchro output @ 26 VAC 400 Hz) (switched heading)
1980709	Course Recorder Assembly
T968606-10	Course Recorder Printer Cable (10 feet / 3 meters)
1812264-VAR	Course Recorder Printer, 24 pin print head, dot matrix printer, serial interface accessory available in two versions: -1: 115 VAC 60 Hz -2: 230 VAC 50 Hz
1977023-2	Transmission Unit (JA17-4488 Operator and Service Manual)
T968593-1	Display Cable (1.5 feet / .5 meters)
T968593-2	Display Cable (3.0 feet / 1 meter)
T968593-3	Display Cable (6.0 feet / 2 meters)
T968593-4	Display Cable (25.0 feet / 7.5 meters)
T968593-5	Display Cable (50.0 feet / 15 meters)
T968572-10	Compass Cable Assembly (10 feet / 3 meters)
T968572-20	Compass Cable Assembly (20 feet / 6 meters)
T968572-30	Compass Cable Assembly (30 feet / 9 meters)
T968572-40	Compass Cable Assembly (40 feet / 12 meters)
T968607-110 T968607-210 T968607-310	Dual Compass Interconnect Cables (10 feet / 3 meters) (All three required for dual installation)

Table 1-3. MK 37 VT Digital Gyrocompass Equipment Physical Data

Part Number	System Component	Overall Dimensions (HxWxD)	Weight: lb(kg)
1891974-VAR	Master Compass	17.5(445) x 14.5(368) x 12.8(325)	84 lb (38 kg)
1980693	Display Unit	5.7(144) x 11.3(288) x 1.7(42.3)	2.6 lb (1.2 kg)
1980690	Electronics Control Unit	18(475) x 17(432) x 10(254)	40 lb (18 kg) (estimated)

Table 1-4. MK 37 VT Digital Gyrocompass Equipment Spare Parts

Quantity Required	Description
1	1980697-VAR CPU Assembly
1	1982163-2 Analog, Digital, Isolated Serial Assembly (replaces 1980699, ADS Assembly)
1	1980701-1 Synchro/Digital Converter Assembly
2	1980705 Step Driver Assembly
1	1980694 Motherboard I/O Assembly
1	1980713 DC/DC Converter Assembly

Table 1-4. MK 37 VT Digital Gyrocompass Equipment Spare Parts (Continued)

Quantity Required	Description
1	1980703 Gyro Control Assembly
1	1980715 Servo Regulator Assembly
1	1980936 AC/DC Power Supply Assembly
1	1982703 AC/DC Power Supply PCB (replaces 1980717 AC/DC Power Supply PCB)
1	1980711-VAR Digital-To-Synchro Assembly (Optional)
1	1980709 Course Recorder Assembly (Optional)
1	1980743 Display/Driver Assembly
1	1980745 Switch Assembly
1	1980737 LCD Display Assembly
1	1810252-4 5 Amp Metric Cartridge Fuse
1	1810252-5 15 Amp Metric Cartridge Fuse
1	1810374-7 1/8 Amp Metric Cartridge Fuse
1	1810252-3 1/4 Amp Metric Cartridge Fuse
1	1812071 Nickel Cadmium Battery

CHAPTER 2

OPERATION

2-1 OPERATION OVERVIEW.

The Display Assembly contains the operating controls for the MK 37 VT Digital Gyrocompass Equipment. During normal operation, the HEADING display continuously shows the corrected heading to the nearest tenth of a degree. The data display presents the operator with menu options and fault messages. SPEED and LATITUDE are also displayed.

The Display Assembly provides the operator with indicators to determine system status. For dual compass configurations, a compass can be configured as PRMRY (primary) or SEC (secondary). Compass configuration as the primary or the secondary is set by the field service technician by setting a jumper on the Gyro Control Assembly. In a dual compass system, the compass can operate in either the ACTIVE or STBY (standby) mode. The primary system operates in the ACTIVE mode while the secondary system operates in the STBY mode. The GYRO indicator is set to either 1 or 2 depending on the motherboard jumper setting. The compass enters the SETTLE mode, which is indicated on the display after completing the initial power-up sequence.

The Display Assembly provides the operator with controls for entering data, selecting the operating mode, testing the display elements, acknowledging audible alarms, and adjusting the backlighting. The controls operate either as toggle switches or as incremental adjustments. Systems equipped with the optional Course Recorder have controls to start and stop printing along with other printer controls.

Up to eight external step repeaters can be connected to the gyrocompass system. ON/OFF switches associated with the repeaters are contained on the Step Driver Assembly in the Electronics Control Unit. These maintenance switches are normally set to "ON" during the installation process by the field service technician and remain set in this position. Control of the repeaters for synchronization is performed from the Display Assembly (see paragraph 2-3.5).

2-2 CONTROLS AND INDICATORS.

Refer to Figure 2-1 for an illustration of the operator controls and indicators for the MK 37 VT Digital Gyrocompass Equipment. Refer to Table 2-1 for a description of each control, indicator, and display on the Display Assembly. The operator should have a complete understanding of the Display Assembly although normal operation does not require continuous attention to the controls, indicators, and displays.

In general, menus are accessed using the SCROLL control arrow or the special use keys (MODE, SPEED, and LATITUDE). Some menus have a timeout associated with them which either locks in the requested value or changes to another menu. Values that may not be changed or that have timed out are shown in square brackets [ ].

Values are changed by pressing the right or left cursor key. Some menus provide wrap around of the selection values and other menus stop when one end of the range is reached. By pressing and holding one of the cursor keys, the values will change at an accelerated rate based on the time the key is depressed. Releasing the cursor key will terminate the value change and allow for slower increments or reversing direction. Many menus provide a delayed activation of a newly entered value until all operator entry has stopped on a timeout basis or the menu has been changed.

Pressing SCROLL without having pressed the right or left cursor key will not change or enter a new value. SCROLL simply passes on to the next menu. Only by leaving the menu or waiting through the timeout after using the right and left cursor keys will a value be entered.

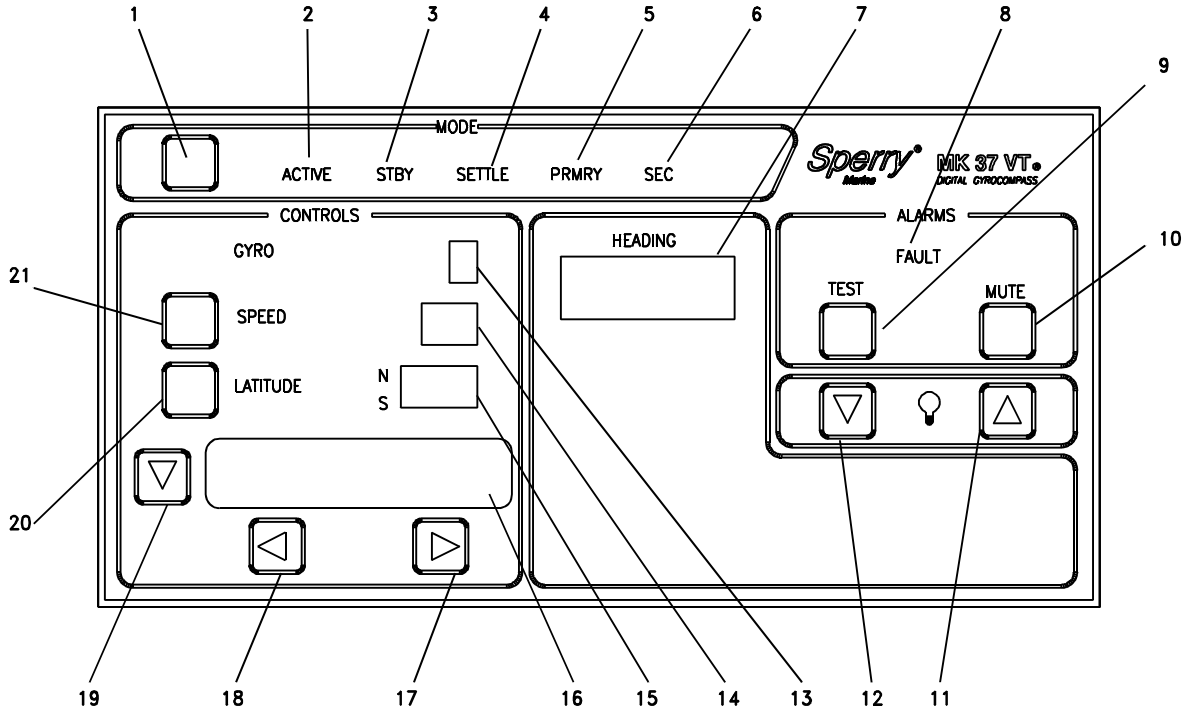


Figure 2-1. Display Assembly, Controls and Indicators

Table 2-1. MK 37 VT Digital Gyrocompass Equipment, Controls and Indicators

Figure 2-1 Find Number	Control, Indicator, or Display	Functional Description
1	MODE switch	When the gyrocompass system is in a dual compass configuration, used to select the active or standby mode. In single systems the switch is fixed and the ACTIVE mode indicator is lit.
2	ACTIVE indicator	Indicator lights to indicate that the gyrocompass is controlling outputs and is supplying heading data. When the gyrocompass is in a dual compass configuration, indicator lights to indicate if the compass is active and controlling the outputs and supplying data.
3	STBY indicator	When the gyrocompass system is in a dual compass configuration, indicator lights to indicate if the gyrocompass is in standby mode (is not controlling outputs).
4	SETTLE indicator	Indicator lights during the gyrocompass start-up (settling) process. Under normal circumstances, with no user input, the gyrocompass will settle in less than five hours. The indicator will turn off after five hours. When heading is entered, the gyrocompass will settle in less than one hour. The indicator will turn off after one hour. **NOTE** The SETTLE indicator is not an absolute indication of compass heading. Heading may or may not be settled when the indicator is turned off.

Table 2-1. MK 37 VT Digital Gyrocompass Equipment, Controls and Indicators (Continued)

Figure 2-1 Find Number	Control, Indicator, or Display	Functional Description
5	PRMRY indicator	Indicator lights after power-up to indicate the gyrocompass is the primary compass system. When the gyrocompass is in a dual compass configuration, indicator lights to indicate gyrocompass is the primary compass.
6	SEC indicator	When the gyrocompass is in a dual compass configuration, indicator lights to indicate the gyrocompass is the secondary or backup compass.
7	HEADING display	After the gyro wheel has obtained operating speed, the compass provides a continuous display of the corrected heading to the nearest tenth of a degree.
8	FAULT indicator	Indicator lights when a fault is detected in the gyrocompass equipment. The indicator flashes when there are unacknowledged alarms.
9	TEST switch	When switch is pressed, all displays and indicators on the Display Assembly are lit and the audible alarm sounds for one second.
10	MUTE switch	The MUTE switch serves two functions: • Used to silence the audible alarm when a fault is detected by the system. This acknowledges new faults. • If the switch is held down when a fault is detected by the system, it is used to step through the stored detected faults displayed in the data display.
11	Increase intensity control	When switch is pressed, increases the intensity of the indicators on the Display Assembly and generally darkens the back panel lighting.
12	Decrease intensity control	When switch is pressed, decreases the intensity of the indicators on the Display Assembly and generally increases the brightness of the back panel lighting.
13	Gyro indicator	Used to identify the hardware as gyro "1" or gyro "2". **NOTE** In a dual system configuration the primary system should be designated gyro 1 and the secondary system should be designated gyro 2.
14	Speed display	Used to indicate the current speed to the nearest knot.
15	Latitude display	Used to indicate the current latitude to the nearest degree. **NOTE** A horizontal bar appears opposite the inscribed "N" or "S" to indicate the sign of the local latitude.

Table 2-1. MK 37 VT Digital Gyrocompass Equipment, Controls and Indicators (Continued)

Figure 2-1 Find Number	Control, Indicator, or Display	Functional Description
16	Data Display	Used to display the menu options and fault messages. The display is arranged as follows: • The first line indicates the current value/setting. • The second line indicates what the available options are. The presence of square brackets around any of the items on the second line indicates that selection is not available and may not be selected. If all entries are bracketed, the item is fixed and cannot be altered. Normally, the display remains at the last item scrolled in by the operator.
17	Increase switch	Used to increase the values displayed in the data display or select next value.
18	Decrease switch	Used to decrease the values displayed in the data display or select previous value.
19	Scroll switch	Used to scroll the menu displayed in the data display.
20	Latitude switch	Used to provide manual input of ship's latitude.
21	Speed switch	Used to provide manual input of ship's speed.

2-3 OPERATING MODES AND PROCEDURES.

Upon initial power-up and prior to entering the Settle mode, the system performs the automatic BITE process, or Built-In Test and Evaluation. The system first determines the hardware configuration. The system then proceeds to diagnose and initialize the system's hardware components. Specifically, the system starts the watchdog timer, looks for a Course Recorder Assembly and a Digital-To-Synchro Assembly. It checks the Gyro jumper (on the motherboard) and sets the GYRO indicator to either 1 or 2. It checks the primary/secondary jumper (on the Gyro Control Assembly) and lights either the PRMRY or SEC indicator on the Display Assembly. The system configures serial communication channels (on the Analog, Digital, Serial Assembly, etc.). The SETTLE indicator lights during gyro wheel auto leveling and settling of the compass. The primary gyrocompass asserts control over the common output bus at power-up, however, data is not sent and all remote heading repeaters are disabled until the gyro is up to speed.

The appropriate ACTIVE or STBY indicator is lit on the Display Assembly of each gyrocompass system (for dual gyrocompass configurations) to indicate the operating mode. The primary gyrocompass system normally operates in the active mode indicating that the system is controlling the output bus. In a dual gyrocompass configuration, the redundant (SEC) system normally operates in the standby mode and is configured as the secondary system. The primary system (by default) controls the common output bus that is shared by the primary and secondary gyrocompass systems. Only the outputs from the active gyrocompass system are enabled onto the common output bus and made available to external devices.

The state of the gyro determines whether compass "cold" or "warm" starting procedures should be followed. The "cold" start procedure is used when the gyro wheel is inactive and the "warm" start procedure is used when the gyro wheel is active as defined in paragraphs 2-3.1 and 2-3.2. Power is applied to the system by turning the main power switch on the Electronics Control Unit to the ON position. The power switch is accessed by removing the small cover plate on top of the ECU cabinet. Upon power-up, the gyro control circuitry is initialized and the gyro wheel is checked for movement. If the wheel is stopped, the system will go through the "cold" start.

2-3.1 Cold Starting the Compass. The following sequence of events will occur when performing the cold start procedure. Some of the listed steps allow operator intervention.

a. Two audio beeps are sounded and the operator will be prompted for a heading input. Enter the ship's heading when the ENTER HEADING prompt appears on the LCD. If heading data is not entered within five minutes, the gyro will proceed with an auto level process.

b. The yoke will be offset based on the reference heading (operator provided or last known heading). The yoke will be slewed clockwise or counterclockwise.

c. The gyro wheel is brought up to speed within fourteen minutes.

d. The yoke is toggled by slewing back and forth to level the ballistic. This process takes approximately four minutes.

e. The gyrocompass will enter the run mode and settle automatically within five hours without any operator action other than turning the power on. If the operator enters a heading, the gyrocompass will settle within one hour as described in paragraph 2-3.3. The SETTLE indicator lamp will go off after one hour.

2-3.2 Warm Starting the Compass. The following sequence of events will occur when performing the warm start procedure.

a. The gyro wheel speed is checked. If the gyro wheel is not at run speed, the gyro wheel is brought up to speed as described in paragraph 2-3.1.c.

b. If the gyro wheel is already up to speed and level, then the HEADING display is available and displayed momentarily. The system will then enter the run mode. After entering the run mode, the system will settle within five hours. The SETTLE indicator lamp will go off after five hours.

c. If the gyro wheel is not level then the gyro wheel leveling process is initiated.

d. The compass enters the run mode and settles automatically within five hours.

2-3.3 Fast Settle Procedure. If the turn-on self-test routine is successful and a cold start-up is in process, ENTER HEADING will appear on the Display Assembly. Entering the ship's present heading allows a much faster settling process. The system will settle within one hour if the operator enters true heading from a reliable source. The ENTER HEADING message appears as:

ENTER HEADING XXX° 0 - 359°

Where XXX is heading in degrees.

NOTE

If the operator enters a heading which is off by more than 20° of the true heading, the settling process will take five hours even though the compass system will report settled within one hour.

NOTE

The operator may ignore the system's request to ENTER HEADING information. The system will time out after 5 minutes and proceed with automatic alignment of the compass with the actual heading.

Enter the correct heading by pressing and holding either the right arrow for increasing the heading value or the left arrow for decreasing the heading value toward the desired heading. Ten seconds after releasing the arrow keys, the ENTER HEADING message will be removed and the Electronics Control Unit will drive the Master Compass to within 30° of the operator-entered heading.

Bypass the Fast Settle Option by pressing the scroll switch and the system will proceed into automatic operation. If a heading is not entered and scroll is not pressed, the system will time out after five minutes and proceed with automatic operation.

2-3.4 Automatic Operation. The system enters automatic operation when startup BITE functions are complete, the heading is manually updated, the five minute system timeout expires, or upon warm start. No further operator action is required until the system has attained wheel speed and completed auto-leveling procedures unless faults occur. This will take approximately 20 minutes. With no further operator action, the system will display the repeater initialization menu; however, the second line of the Display Assembly is bracketed until the gyro is up to speed.

2-3.5 Initializing and Synchronizing Step Repeaters. The system displays the repeater screen to allow the operator to initialize the repeaters. Optionally, the operator may decide to bypass the current repeater screen by pressing the Scroll control arrow. If no repeaters were enabled during installation, a NO REPEATERS menu will be displayed instead. The Display Assembly presents the following information for each enabled repeater.

REPEATER CH R: XXX OFF, 0-359°

Where R indicates applicable repeater 1 through 8 and XXX indicates OFF if applicable repeater is not initialized or selected, or value in degrees during slew to initialize a repeater to the heading value.

To initialize a repeater, read the repeater's current position. If the repeater is set to OFF, use the right arrow switch to scroll through numeric values. The first number to appear will be the ship's current heading. Using the left or right arrow switches, scroll the display to the repeater's current position. If the desired position is overshot, immediately press the arrow in the other direction. As soon as the correct heading is obtained, remove your finger from the switch. After 10 seconds have elapsed or upon moving to another menu, the system will step the repeater to the compass heading. Remember to note the repeater's initial position, then use the MK 37 VT controls to enter the repeater's initial position rather than the desired heading. Repeat this procedure until the repeater's heading indication agrees with the Master Compass heading indication.

CAUTION

After initializing any repeater, make certain the repeater and the compass are in synchronization. This double check is especially important if the repeater is used for steering or establishing a bearing. If necessary, repeat the synchronization process.

After completing initialization of the first repeater, press the Scroll control arrow to access the next repeater. Scroll through the repeaters while looking at the channel number. The Display Assembly will display either OFF or ON. To turn the repeater OFF, press the left arrow switch once.

CAUTION

All heading repeaters with a stored status of "enabled" at power-up will be turned on after the gyro is up to speed. Synchronization of all the repeaters must be made using the above procedure.

2-4 DIRECT ACCESS MENUS.

The operator has the ability to directly access MODE, SPEED, and LATITUDE settings. The Display Assembly provides a control switch for each of these items in addition to separate displays for SPEED and LATITUDE. The Display Assembly provides MODE indicators for GYRO, ACTIVE, STBY, PRMRY, and SEC.

2-4.1 Mode (Active/Standby) Selection. For dual installations, the compass designated as primary at installation can be manually placed in the ACTIVE or STBY mode with this menu option. **This screen can be accessed directly and immediately at any time by pressing the MODE switch.** For single compass configurations or for secondary compasses in a dual configuration, the second line is shown in square brackets. Also, if the secondary compass is not powered or has a critical fault, the menu selections appear in brackets and can not be changed from ACTIVE. Brackets indicate that the choice cannot be changed.

STATE: XXXX ACTIVE, STANDBY

Where XXXX is ACTIVE or STANDBY mode.

Use the right or left pointing arrow to make the desired selection. See paragraph 2-7.3 for further information.

2-4.2 Speed Input. At system turn-on, the system will default to the speed source that existed when the system was last switched off. The available modes are MANUAL or AUTOMATIC (ChA, ChB, PPM). **This segment of the menu is accessed directly and immediately by pressing the switch beside the SPEED control or switch.** If the system is configured for MANUAL only, AUTO will not appear on this screen. The operator sets the speed value when the speed mode is MANUAL. Use the left or right arrow switches to scroll from AUTO to a manual value. The AUTO mode requires a speed source from either ChA, ChB, or Pulses Per Nautical Mile (PPNM).

NOTE

ChA is the Channel A RS-232 input and ChB is the Channel B RS-422 input.

SPEED: XX 0-70 KTS, AUTO

Where XX is the speed in knots.

Use the right pointing arrow to increase the speed toward 70 knots and then to AUTO. Use the left pointing arrow to reduce the speed toward 0 knots. If AUTO is selected no further action is required by the operator. Once the desired selection has been made, the new value will be used by the system after a three second delay or upon changing to a different menu. Automatic speed is filtered and will take approximately six seconds to display the exact received value on the panel LEDs and to use the new speed throughout the system.

CAUTION

It is important to update speed when using manual speed entry because speed correction is used to maintain an accurate corrected heading. A compass system with improper speed input may report a corrected heading with as much as 5 degrees of error.

NOTE

The speed value chosen and displayed by the MK 37 VT may not be the same value used and displayed by other systems. The MK 37 VT must use the best available speed to correct for the effects of motion over the rotating surface of the earth. Other systems may have different requirements for speed input, especially steering equipment which often uses and displays water speed.

2-4.3 Latitude Input. At system turn-on, the system will default to the latitude source that existed when the system was last switched off. The available modes are MANUAL or AUTO. **This segment of the menu is accessed directly and immediately by pressing the switch beside the LATITUDE control or switch.** The operator sets the latitude value when the latitude mode is MANUAL. Use the left or right arrow switches to scroll from AUTO to a manual value. If the system is configured for MANUAL operation, the word AUTO will not appear on this screen.

LATITUDE: XX 80°S-80°N, AUTO

Use the right pointing arrow to move toward more northerly latitudes and then to AUTO or use the left pointing arrow to move toward more southerly latitudes. Three seconds after releasing the pointing arrow, the LAT display and the pointing bar at the LATITUDE indicator will switch indicating whether North (top bar) or South (bottom bar) latitude is applicable. On the Display Assembly, South latitude is indicated by XX°S. North latitude is indicated by XX°N. If automatic input (ChA or ChB) is chosen no further operator action is required.

NOTE

ChA is the Channel A RS-232 input and ChB is the Channel B RS-422 input.

CAUTION

It is important to update latitude when using manual latitude entry because latitude correction is used to maintain an accurate corrected heading. A compass system with improper latitude input may report a corrected heading with as much as 5 degrees of error, or 10 degrees of error if the hemisphere is wrong.

2-5 SYSTEM SHUTDOWN.

Set the system power switch on the Electronics Control Unit to off. This action will remove all operating power to the system.

2-6 COURSE RECORDING.

The optional course recording feature allows the operator to plot a graph or to provide a tabular listing of the ship's course. This feature is optional and is accessed from the data display menu. The graph mode is the preferred method of course recording. The tabular mode is primarily used when closer examination of a section of graphic print is desired. Press the Scroll control arrow to reach the optional Course Recorder menu to adjust the date and time, and to control the EPSON Compatible Graphics Set 24-pin dot matrix printer. These screens are not available unless the Course Recorder Option is installed.

Course recording in the graph mode is available for current heading data or for 27 hours of stored heading data. If printing historical data, data is printed twice as fast than when printing current data since the CPU does not have to wait for the data to be generated. After completing the printing of historical heading data, the printer will begin printing current data. If the system loses power while in the course recorder mode, the system will resume printing when power is restored.

The course recorder stores heading and rudder angle data in NOVRAM every second. Stored data is maintained during power loss. Every ten minutes the following information is stored:

- Date and Time
- Speed and Latitude Source
- Speed and Latitude Values
- Compass Status: Primary or Secondary, Active or Standby, Settled or Not Settled, Critical Fault or No Critical Fault

After 27 hours the oldest stored data gets overwritten with new data. If the system is turned off, gaps in stored data will occur. The NOVRAM will still contain up to 27 hours worth of data, but two ten minute blocks of stored data may not be 10 minutes apart in actual time. Gaps can also occur when the course recorder time or date are adjusted. When a time is requested for historical print that is before any stored samples, the following message will be printed:

Selected time cannot be found.
Oldest available data: DD-MM-YY

There will be cases when, after restoring system power, the recorded heading data will not have any connection to the new heading data. It may not even be within the same heading scale or quadrant. This case is known as a discontinuity in heading. If the course recorder is requested to print historical data before and including a discontinuity, the following message will be printed:

******Discontinuity in Heading Data, New Scale******

If a discontinuity occurs while the system is powered within a ten minute block that would require a heading change greater than 30 degrees from the previous quadrant limits, the following message is printed:

******ERROR2******

If the discontinuity remains and is printed for four contiguous samples, the new heading data will be accepted, the discontinuity line will be printed and a quadrant change will be made.

NOTE

During normal operation, it is not advisable to modify the date or time. If the date or time is changed, especially decreased, the ability to print historical data may be unusable until 27 hours after the date or time was changed.

The DATE menu is accessed by pressing the SCROLL key from the repeater synchronization menu. Either use the left pointing arrow to scroll backward one day at a time or use the right pointing arrow to scroll forward one day at a time. Day, month, and year will wrap around as range limits are reached. If the cursor key is held, the days will change at an accelerated rate. Press the Scroll control arrow to accept the displayed date and advance to the TIME set menu. The course recorder date will be maintained and updated during power loss.

DATE: DD-MMM-YY

Where DD is the day, MMM is the month, and YY is the year.

The TIME menu is accessed by pressing the SCROLL key from the DATE menu. Either use the left pointing arrow to scroll toward 00:00 or use the right pointing arrow to scroll toward 23:59. The minutes will change at an accelerated rate if the cursor key is held. Hours and minutes will wrap around as range limits are reached. Use the Scroll control arrow to accept the displayed time and advance to the printer control menu.

TIME: HH:MM 00:00-23:59 HH:MM

Where HH is hours and MM is minutes.

The PRINTER menu is accessed by pressing the SCROLL key from the TIME menu. The current printer status will be displayed. If the system has not completed auto level, the options will be bracketed [ ] indicating that they may not be changed. The initial default printer mode is OFF. The course recorder mode will be maintained through power loss. If the mode before power loss was GRAPH or TABLE, printing will resume as soon as possible after power-up (wheel up to speed).

PRINTER: XXXX GRAPH, OFF, TABLE

Where XXXX is the printer mode setting OFF, GRAPH, or TABLE. Use either the left or right pointing arrow to reach the desired mode.

Use the left or right pointing arrow to print data in real time. Select OFF to disable the MK 37 VT output to the external dot matrix printer. Select GRAPH to print the data using a graph format. Select TABLE to print the data in a tabular format. Wait five seconds or press the SCROLL key and current data printing will begin. To print historical data, press the SCROLL key before the five second timeout in order to enter the time of the data to be printed.

To print a prior time frame of stored heading data press the Scroll control arrow immediately after selecting GRAPH or TABLE to display the following menu. Print the recorded data by selecting a beginning time and date using the left and right pointing arrows.

PRINT: DD-MMM-YY TIME: __:__ HH:MM

Choose the printout's start time by using the left pointing arrow to scroll backward to the date and time. Use the right pointing arrow to scroll forward in case of overshooting the desired start time. The printer will start five seconds after releasing the pointing arrow or upon moving to another menu. The printer can be stopped by scrolling to the PRINTER screen and selecting OFF.

NOTE

It is recommended that the printer settings such as font select, form feed, etc. **NOT** be changed without first switching the PRINTER menu to OFF.

2-6.1 <u>Course Recording - Graph Mode</u>. The graphic printout contains:

a. An initial banner including which compass (Primary or Secondary) is controlling the course recorder output, an indication of vertical scaling, and a current time stamp.

b. Vertical lines with numeric labels defining the scaling for heading, rudder 1 and rudder 2 (when present).

c. Horizontal lines at two minute intervals indicating time, with a time stamp every ten minutes: XX:XX.

d. A graph within the vertical scaling lines representing:

- Current heading to the nearest tenth of a degree.
- Current Rudder 1 and Rudder 2 position (when configured) to the nearest degree.

The heading data scale represents 90 degrees of heading range in four quadrants. The quadrant is marked by a quadrant graph to the left of the heading plot. The quadrant number is used to select the scale numbers associated with a given heading. Heading values increase to the right in quadrants 1 and 3 and decrease to the right for quadrants 2 and 4 as shown in Table 2-2.

Table 2-2. Ship's Heading Range vs. Graph Quadrant Number

Quadrant Number	Heading Range	Increasing Direction	Decreasing Direction
1	0° - 90°	Right	Left
2	90° - 180°	Left	Right
3	180° - 270°	Right	Left
4	270° - 360°	Left	Right

Rudder data representation has a fixed scale, centered at 0°, with the range set at system installation. The print range of the rudder is configurable at installation in five degree increments. Each dot of the horizontal line represents a given amount of rudder motion based on the configured rudder print range. The rudder scale is divided into ten segments between 0° and the maximum (plus & minus) configured print setting. Table 2-3 gives the degrees per dot resolution versus configured rudder print range.

Table 2-3. Rudder Print Range Resolution

Rudder Print Range (in degrees)	Degrees Per Dot
-20....+20	2.0
-25....+25	2.5
-30....+30	3.0
-35....+35	3.5
-40....+40	4.0
-45....+45	4.5
-50....+50	5.0
-55....+55	5.5
-60....+60	6.0
-65....+65	6.5
-70....+70	7.0
-75....+75	7.5

NOTE

If the rudder print range at time of installation is set smaller than achievable rudder range, no graphic representation for rudder will be printed when the rudder is outside of the limited range. If the rudder print range is set much larger than the possible rudder input values, rudder resolution on the graphic course recorder output will be reduced.

For example, Figure 2-2 shows a graph of the active compass which is the primary compass. The number of rudders is set up during the installation process. For graphs showing no rudder or one rudder printout, each dot on the heading graph represents 2° per dot. For dual rudder printouts, each dot on the heading graph represents 3° per dot. When the ship's heading reaches a limit shown on the graph, a quadrant change occurs. The plot of the quadrant will switch to the new quadrant and the line representing heading will touch the heading graph edge on the edge that was exceeded. Data will increase in the opposite direction from the previous quadrant.

As Figure 2-2 demonstrates, the course position starts in quadrant 2 where at 09:11 the ship's heading decreases to the right from 116° towards 90°. When the heading plot reaches the scale limit at 90°, the plot moves into quadrant 1 where the ship's heading continues to decrease to the left toward 0°. When the heading plot reaches the scale limit at 0°, the plot moves into quadrant 4 where the ship's heading continues to decrease to the right toward 270°. When the heading plot then reaches the scale limit at 270°, the heading plot then moves into quadrant 3 and the ship's heading continues to decrease to the left toward 180°. When the heading plot reaches the scale limit at 180°, the plot moves into quadrant 2 where the ship's heading continues to decrease to the right toward 90°. The ship's heading remains in this quadrant from 09:20 to about 09:30 and changes direction several times until it reaches the scale limit at 180° and increases to the right in quadrant 3 where it then again changes direction several times.

2-6.2 Course Recording - Table Mode. This choice will print a continuous table of the date, time, current heading, and rudder angle sampled every second. Begin printing by using the left or right arrow to select TABLE. After 5 seconds, the printer will begin to print and will continue to print until the operator sets the MK 37 VT PRINTER menu option to OFF. A sample printout is shown in Figure 2-3. The following information is included in the tabular printout:

a. Header printed once every ten minutes:

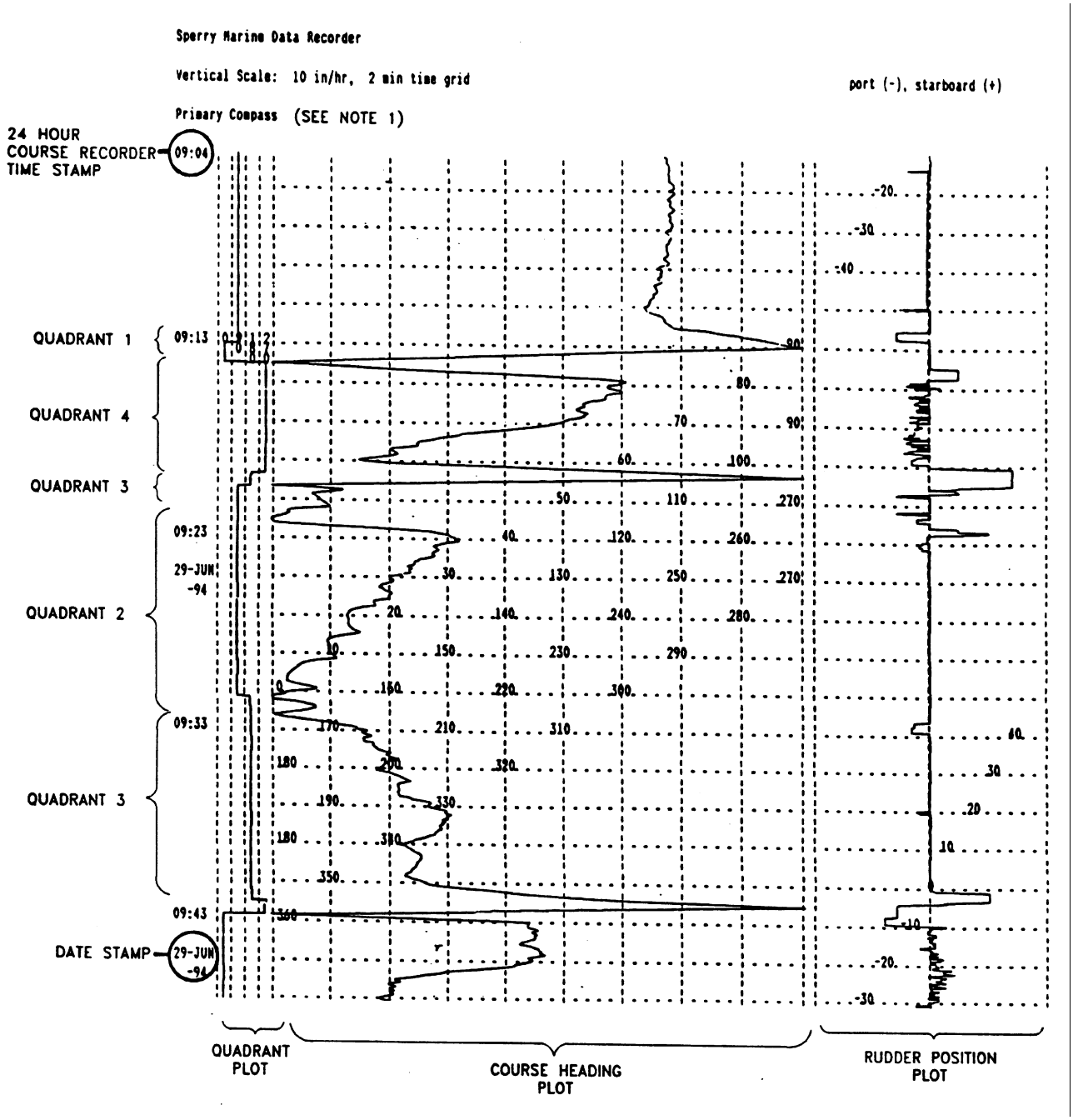
- Date
- Time
- Velocity Source
- Latitude Source
- Velocity
- Latitude

b. Four columns containing:

- Current time to the second in 24 hour format (XX:XX:XX)
- Current heading to the nearest tenth of a degree
- Current Rudder 1 position to the nearest degree or the words "Not Cfg"
- Current Rudder 2 position to the nearest degree or the words "Not Cfg"

2-6.3 Course Recording - Off Mode. The printer will stop printing by pressing the left or right pointing arrow to select OFF. However, heading information, time marks, and rudder angle data will continue to be stored in NOVRAM.

PRINTER: XXXX GRAPH, OFF, TABLE



Note 1: Indicates Active compass (either Primary or Secondary for Dual Configurations)

Figure 2-2. Sample Course Recording (Graph Mode)

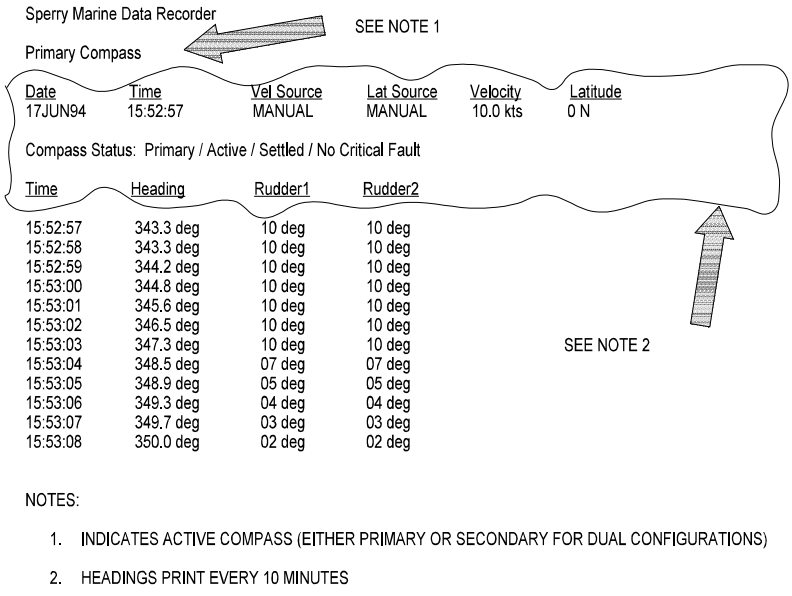


Figure 2-3. Sample Course Recording (Table Mode)

2-7 DUAL COMPASS OPERATION.

In a dual compass configuration, one gyrocompass system is designated as the primary compass and the other gyrocompass system is designated as the secondary or backup compass. The primary gyrocompass system is, by default, the active gyrocompass system that controls the common bus used to communicate heading information to external devices. Should the CPU of the primary gyrocompass system detect a critical fault, an automatic transfer enables the control of the common bus to the secondary gyrocompass system. A transfer of control from the primary gyrocompass system to the secondary gyrocompass system causes the outputs from the primary system to be removed from the common bus and the outputs from the secondary system are gated onto the common bus for use by external devices. The transfer is made only if the secondary system indicates that it is powered and is fully operational. After the transfer is made, the secondary system operates in the ACTIVE mode and the primary system operates in the standby mode.

NOTE

In a dual system, for normal operation the PRIMARY system will run in the ACTIVE mode and the SECONDARY system will run in the STANDBY mode. If the PRIMARY system fails the SECONDARY system will go ACTIVE (providing that the SECONDARY system is turned on and fully operational).

Once the SECONDARY system has gone ACTIVE there is no backup. The PRIMARY system must be repaired and returned to ACTIVE mode as quickly as possible.

The SECONDARY system should not be operated in the ACTIVE mode unless the PRIMARY system is down.

NOTE

In a dual system, the first compass powered up will obtain the ACTIVE status. The PRIMARY system should be powered up first, in which case it will come up ACTIVE and the SECONDARY will be STANDBY.

2-7.1 Compass Comparator (Optional). This menu is only available in dual MK 37 VT systems equipped with the Course Recorder option and configured at installation for the comparator feature in dual compass installations. The menu is accessed by pressing the SCROLL control arrow from the Print Time menu. This optional feature allows the operator to adjust the width of the comparison zone on dual compass installations. When the comparator mode is ON, the "ACTIVE" compass generates a fault if the standby compass heading differs from the "ACTIVE" compass heading value exceeding the operator-entered error band.

COMPARATOR: XXX° 3°-10°, OFF

Where XXX is the comparison zone from 3 to 10 degrees or OFF.

Use the left pointing arrow to decrease the comparison zone, or use the right pointing arrow to increase the comparison zone. Once the display reaches 10°, the display moves to the OFF setting. Press the Scroll control arrow to exit from this menu.

Compass comparison occurs when both gyrocompass systems have settled and are normally computing corrected heading values. The computed heading differences are averaged to prevent spurious alarms. Using data received from the secondary compass, the ACTIVE compass performs the comparison and alarms during a fault condition. Heading differences are averaged over 30 seconds and once that average exceeds the tolerance, an alarm is generated immediately.

2-7.2 Common Output Bus. The primary and secondary gyrocompass systems share a common output bus. However, the system that is currently operating in the ACTIVE mode maintains control of the output bus. Only the outputs from the ACTIVE gyrocompass system are available to external devices. Indicators on the Display Assembly will light to indicate the system's operational mode.

In dual MK 37 VT installations it is sometimes necessary for other equipment (steering systems with Off Course features) to monitor the output of each compass simultaneously. For that reason the following outputs are not on the Common Output Bus (unswitched outputs):

- 24VDC Step Channel No. 8
- RS-232 Serial Output Channel C
- 1X 115VAC, 400Hz Synchro Output (Optional)

It is important to remember that if these outputs are used on a dual MK 37 VT system that they do not switch to the active system.

The system enables the appropriate ACTIVE or STBY indicator lights on the Display Assembly of each gyrocompass system to indicate the operating mode. The primary gyrocompass system normally operates in the active mode. In a dual configuration, the secondary system normally operates in the standby mode. The primary system, by default, controls the common output bus that is shared by the primary and secondary gyrocompass systems. Only the outputs from the ACTIVE gyrocompass system are enabled onto the common output bus and made available to external devices.

2-7.3 Compass Transfer. The compass transfer process activates whenever the operator presses the MODE switch and selects STBY on the Display Assembly of the primary system. The compass transfer process also activates after a critical system fault on the primary system (see paragraph 2-8).

NOTE

The compass transfer process activates only if the primary system's Gyro Control Assembly indicates the system configuration is dual and the secondary compass system is powered and fully operational.

NOTE

Only the outputs from the active compass control the common output bus and provide heading information to external devices.

A compass operating in standby mode will not alarm if the difference in heading values between dual compasses exceeds the operator-selected error tolerance. If, however, a transfer of the compass from the standby mode to the active mode occurs, the operator may decide to turn the comparator feature on after both compasses have settled (see paragraph 2-7.1).

When printing in any mode, the MK 37 VT system generates a banner or printed notice after a compass transfer has occurred. The banner consists of the "Sperry Marine Data Recorder" title, the primary/secondary status of the compass now printing, and the time (to the second) of the transfer.

NOTE

The operator should always operate the primary gyrocompass system in the active mode. The operator should only switch to the secondary system under abnormal situations. If the secondary system should fail when active, there is no automatic transfer back to the primary system.

2-8 FAULT ACKNOWLEDGMENT.

Along with performing basic power checks, the system proceeds with the system monitoring BITE process. The audible alarm activates if any failures occur during the BITE process. An advisory message appears on the Display Assembly if the MUTE control button is pressed. The audible alarm is also silenced when the operator pushes the MUTE control button. After the operator silences the alarm, the fault lamp will remain on if the fault condition still exists. If the fault condition no longer exists, releasing the MUTE key will clear the fault from the display. Record any fault messages that appear on the display. Each fault will be displayed for two seconds before the next fault, if any, is displayed. A small arrow at the end of the second display line will indicate that additional faults are present. After the last fault is displayed, the first fault will be displayed again. Table 2-4 lists the fault messages which the operator can respond to and lists the corrective actions. Table 2-5 lists common problems that can occur with the optional course recorder that can be corrected by the operator.

Several faults are considered critical faults and will stop the gyro wheel. This means the system is non-functional and heading data is not useable. In single systems the operator should attempt to correct the problem by cycling the power. If the problem persists, an alternate heading source should be used. In a dual system an attempt will be made to transfer to the secondary compass (see paragraph 2-7.3). Critical faults include the following:

- PROM checksum self-test failure at power-up
- Volatile RAM read/write self-test failure at power-up
- Excessive gyro spin motor current
- Excessive pickoff voltage fault
- Excessive heading rate fault
- Gyro Control Assembly fault
- Excessive starting voltage
- Synchro-To-Digital Converter Assembly fault

Table 2-4. Operator Intervention Fault Codes Associated with the MK 37 VT Digital Gyrocompass Equipment

Fault Message		Fault Code Description	Appropriate Action or Explanation
Software PROM fails to verify	00	PROM checksum self-test failure (power-up) **Critical fault**	Attempt to clear fault by cycling power. If problem persists, use an alternate heading source. Record fault and contact the Sperry Marine Inc. field service department to provide corrective actions.
Software RAM fails to read/write	01	Volatile RAM read/write self-test failure (power-up) **Critical fault**	Attempt to clear fault by cycling power. If problem persists, use an alternate heading source. Record fault and contact the Sperry Marine Inc. field service department to provide corrective actions.
Panel data fails to verify	02	Nonvolatile RAM operator's data checksum self-test failure (power-up)	Attempt to clear fault by cycling power. Record fault and contact the Sperry Marine Inc. field service department to provide corrective actions.
Panel LCD display busy fault	03	LCD update not complete within 60 μs	Possible faulty Display/Driver Assembly, Analog, Digital, Serial Assembly, or CPU Assembly. Record fault and contact the Sperry Marine Inc. field service department to provide corrective actions.
Excessive current after speed stable	11	Gyro spin motor current has failed to drop below acceptable threshold after gyro wheel has reached operational spin rate **Critical fault**	Attempt to clear fault by cycling power. If problem persists, use an alternate heading source. Possible faulty Servo Regulator Assembly or Binnacle. Record fault and contact the Sperry Marine Inc. field service department to provide corrective actions.
Excessive pickoff voltage	12	Pickoff Error exceeds 0.353 volts **Critical fault**	Attempt to clear fault by cycling power. If problem persists, use an alternate heading source. Possible faulty Servo Regulator Assembly or Binnacle. Record fault and contact the Sperry Marine Inc. field service department to provide corrective actions.

Table 2-4. Operator Intervention Fault Codes Associated with the MK 37 VT Digital Gyrocompass Equipment (Continued)

Fault Message		Fault Code Description	Appropriate Action or Explanation
Heading Change Excessive	13	Heading rate exceeds 80 degrees/second for at least 2 seconds **Critical fault**	Attempt to clear fault by cycling power. If problem persists, use an alternate heading source. Gyro Wheel has possibly dumped. Record fault and contact the Sperry Marine Inc. field service department to provide corrective actions.
Gyro Control analog busy fault	14	A/D conversion not completed within 20 microseconds **Critical fault**	Attempt to clear fault by cycling power. If problem persists, use an alternate heading source. Possible faulty Gyro Control Assembly. Record fault and contact the Sperry Marine Inc. field service department to provide corrective actions.
Gyro Control analog test fault	15	Gyro Control Interface A/D converter fails the self-test	Possible faulty Gyro Control Assembly or DC/DC Converter Assembly. Record fault and contact the Sperry Marine Inc. field service department to provide corrective actions.
Course Recorder analog busy fault	16	A/D conversion not completed within 4 microseconds	Possible faulty Course Recorder Assembly. Record fault and contact the Sperry Marine Inc. field service department to provide corrective actions.
Course Recorder analog test fault	17	Value readback from A/D converter does not match value written to DAC in test mode	Possible faulty Course Recorder Assembly. Record fault and contact the Sperry Marine Inc. field service department to provide corrective actions.
Excessive Voltage fault	18	Voltage sense exceeds 19V BIT fault (power-up) **Critical fault**	Attempt to clear fault by cycling power. If problem persists, use an alternate heading source. Possible faulty Servo Regulator Assembly. Record fault and contact the Sperry Marine Inc. field service department to provide corrective actions.
Panel Data Out of Range	19	User NOVRAM data contains illegal values (power-up).	Possible faulty CPU Assembly. (This could also occur if PROMS are upgraded. In this case all user entered settings should be checked.) Record fault and contact the Sperry Marine Inc. field service department to provide corrective actions.

Table 2-4. Operator Intervention Fault Codes Associated with the MK 37 VT Digital Gyrocompass Equipment (Continued)

Fault Message		Fault Code Description	Appropriate Action or Explanation
Gyro synchro converter fault	20	Synchro/Digital Converter BIT fault **Critical fault**	Attempt to clear fault by cycling power. If problem persists, use an alternate heading source. Possible faulty Synchro-To-Digital Converter or Servo Regulator Assembly. Record fault and contact the Sperry Marine Inc. field service department to provide corrective actions.
Step channel 1 data failure	21	Heading repeater data is erroneous (step code readback differs from step code sent)	Possible faulty Step Driver Assembly #1 in slot J5. Cycle switch #1. Record fault and contact the Sperry Marine Inc. field service department to provide corrective actions.
Step channel 2 data failure	22	Heading repeater data is erroneous (step code readback differs from step code sent)	Possible faulty Step Driver Assembly #1 in slot J5. Cycle switch #2. Record fault and contact the Sperry Marine Inc. field service department to provide corrective actions.
Step channel 3 data failure	23	Heading repeater data is erroneous (step code readback differs from step code sent)	Possible faulty Step Driver Assembly #1 in slot J5. Cycle switch #3. Record fault and contact the Sperry Marine Inc. field service department to provide corrective actions.
Step channel 4 data failure	24	Heading repeater data is erroneous (step code readback differs from step code sent)	Possible faulty Step Driver Assembly #1 in slot J5. Cycle switch #4. Record fault and contact the Sperry Marine Inc. field service department to provide corrective actions.
Step channel 5 data failure	25	Heading repeater data is erroneous (step code readback differs from step code sent)	Possible faulty Step Driver Assembly #2 in slot J6. Cycle switch #5. Record fault and contact the Sperry Marine Inc. field service department to provide corrective actions.
Step channel 6 data failure	26	Heading repeater data is erroneous (step code readback differs from step code sent)	Possible faulty Step Driver Assembly #2 in slot J6. Cycle switch #6. Record fault and contact the Sperry Marine Inc. field service department to provide corrective actions.
Step channel 7 data failure	27	Heading repeater data is erroneous (step code readback differs from step code sent)	Possible faulty Step Driver Assembly #2 in slot J6. Cycle switch #7. Record fault and contact the Sperry Marine Inc. field service department to provide corrective actions.

Table 2-4. Operator Intervention Fault Codes Associated with the MK 37 VT Digital Gyrocompass Equipment (Continued)

Fault Message		Fault Code Description	Appropriate Action or Explanation
Step channel 8 data failure	28	Heading repeater data is erroneous (step code readback differs from step code sent)	Possible faulty Step Driver Assembly #2 in slot J6. Cycle switch #8. Record fault and contact the Sperry Marine Inc. field service department to provide corrective actions.
Auto Level failed: 5 hour settle required	30	The Fast Settle process has failed. A normal 5 hour settle for the compass is required	Electronics Unit was not able to erect the tilt of the compass. Must wait on normal settle to erect Tilt. Not a critical fault, however, it may indicate failures in the tilt sensing. After 5 hour settle, heading should be verified against another compass to ensure proper operation. If heading does not report correctly, record fault and contact the Sperry Marine Inc. field service department to provide corrective actions.
Excessive error between compasses	40	Difference between corrected heading values exceeds operator-set error tolerance (Dual compass configurations only)	One or both of the compasses may be malfunctioning or the tolerance may be too narrow for a tight turn. If a visual examination indicates that both compasses are functioning properly, try increasing the error tolerance; otherwise, call the service representative.
Serial 232A-RX data input missing	50	Loss of receiver interrupts for 30 sec on serial channel 232A-RX (if any NMEA 0183 installed)	Either the sender is down or the serial connection has failed. Record fault and contact the Sperry Marine Inc. field service department to provide corrective actions.
Serial 232A-RX data input invalid	51	Framing Error; invalid bit format (if any NMEA 0183 installed)	Sender's message protocol is incorrect. Record fault and contact the Sperry Marine Inc. field service department to provide corrective actions.
Serial 232A-RX data input invalid	52	Overrun Error; input too fast (if any NMEA 0183 installed)	Check sender. Record fault and contact the Sperry Marine Inc. field service department to provide corrective actions.
Serial 232A-TX data output missing	53	Loss of transmitter interrupts for 1 sec after character sent	Possible faulty CPU Assembly or ADS Assembly. Record fault and contact the Sperry Marine Inc. field service department to provide corrective actions.

Table 2-4. Operator Intervention Fault Codes Associated with the MK 37 VT Digital Gyrocompass Equipment (Continued)

Fault Message		Fault Code Description	Appropriate Action or Explanation
Serial 422B-RX data input missing	54	Loss of receiver interrupts for 30 sec on serial channel 422B-RX (if any NMEA 0183 installed)	Either the sender is down or the serial connection has failed. Record fault and contact the Sperry Marine Inc. field service department to provide corrective actions.
Serial 422B-RX data input invalid	55	Framing Error; invalid bit format (if any NMEA 0183 installed)	Sender's message protocol is incorrect or there is a bad connection. Record fault and contact the Sperry Marine Inc. field service department to provide corrective actions.
Serial 422B-RX data input invalid	56	Overrun Error; input too fast (if any NMEA 0183 installed)	Check sender. Record fault and contact the Sperry Marine Inc. field service department to provide corrective actions.
Serial 422B-TX data output missing	57	Loss of transmitter interrupts for 1 sec after character sent	Possible faulty CPU Assembly or ADS Assembly. Record fault and contact the Sperry Marine Inc. field service department to provide corrective actions.
Serial 232C-TX data output missing	58	Loss of transmitter interrupts for 1 sec after character sent	Possible faulty CPU Assembly. Record fault and contact the Sperry Marine Inc. field service department to provide corrective actions.
Serial PRINT-TX data output missing	60	Loss of transmitter interrupts for 1 sec after character sent (Course Recorder option only)	Printer off or cable bad. Possible faulty Course Recorder Assembly. Record fault and contact the Sperry Marine Inc. field service department to provide corrective actions.
Serial INTR_COM_X data input missing	70	Loss of receiver interrupts for 30 sec on serial channel INTR_COM_X (dual compass configuration only)	Either the standby compass serial connection is down or the primary connection has failed. Record fault and contact the Sperry Marine Inc. field service department to provide corrective actions.
Serial INTR_COM_X data input invalid	71	Framing Error; invalid bit format (dual compass configuration only)	Standby compass message protocol is incorrect. Record fault and contact the Sperry Marine Inc. field service department to provide corrective actions.
Serial INTR_COM_X data input invalid	72	Overrun Error; input too fast (dual compass configuration only)	Possible Course Recorder failure. Record fault and contact the Sperry Marine Inc. field service department to provide corrective actions.

Table 2-4. Operator Intervention Fault Codes Associated with the MK 37 VT Digital Gyrocompass Equipment (Continued)

Fault Message	Fault Code Description	Appropriate Action or Explanation
Serial INTR_COM_X data output missing 73	Loss of transmitter interrupts for 1 sec after character sent (dual compass configuration only)	Possible faulty CPU Assembly or Course Recorder Assembly. Record fault and contact the Sperry Marine Inc. field service department to provide corrective actions.
Speed Log XXXXXX data input missing 80 (Where XXXXXX is "Serial" or "Pulse" depending on configuration)	No VBW/VHW message received for one minute (during Installation timeout can be increased up to 20 minutes) Loss of Pulse data for 5 minutes if speed of at least 8 knots has been reached.	Either the sender is down or the connection has failed. Record fault and contact the Sperry Marine Inc. field service department to provide corrective actions.
Speed Log Serial data format invalid 81	Invalid VBW/VHW message format	Check sender for failure or format fault. Record fault and contact the Sperry Marine Inc. field service department to provide corrective actions.
Speed Log XXXXXX data out of range 82 (Where XXXXXX is "Serial" or "Pulse" depending on configuration)	Speed data is outside 0-99 knots range (any speed <0 or >99 knots)	Either the sender is down or the connection has failed. Record fault and contact the Sperry Marine Inc. field service department to provide corrective actions.
Speed Log Serial data input invalid 83	Speed data null or marked invalid	Sender's method of indicating data unavailable or data invalid. Record fault and contact the Sperry Marine Inc. field service department to provide corrective actions.
Latitude Serial data input missing 84	No GGA/GLL message received for one minute (during Installation timeout can increased up to 60 minutes)	Either the sender is down or the serial connection has failed. Record fault and contact the Sperry Marine Inc. field service department to provide corrective actions.
Latitude Serial data format invalid 85	Invalid GGA/GLL message format	Transmission failure or fault in sender. Record fault and contact the Sperry Marine Inc. field service department to provide corrective actions.
Latitude Serial data out of range 86	Latitude data is outside of [0..80 deg N/S] range	Transmission failure or fault in sender. Record fault and contact the Sperry Marine Inc. field service department to provide corrective actions.

Table 2-4. Operator Intervention Fault Codes Associated with the MK 37 VT Digital Gyrocompass Equipment (Continued)

Fault Message		Fault Code Description	Appropriate Action or Explanation
Latitude Serial data input invalid	87	Latitude data null or marked invalid	Sender's method of indicating data unavailable or data invalid. Record fault and contact the Sperry Marine Inc. field service department to provide corrective actions.
Comparator Serial data input missing	88	No intercompass message received for 30 seconds. (Dual installations only)	PRIMARY or SECONDARY compass is faulty or serial connection has failed. Record fault and contact the Sperry Marine Inc. field service department to provide corrective actions.
Comparator Serial data format invalid	89	Invalid intercompass message format (Dual installations only)	PRIMARY or SECONDARY compass is faulty or serial connection has failed. Record fault and contact the Sperry Marine Inc. field service department to provide corrective actions.
Comparator Serial data out of range	90	Heading data is outside of [0-359.9°] range or Settle data is settled or not settled. (Dual installations only)	PRIMARY or SECONDARY compass is faulty or serial connection has failed. Record fault and contact the Sperry Marine Inc. field service department to provide corrective actions.
Comparator Serial data input invalid	91	Intercompass data null (Dual installations only)	PRIMARY or SECONDARY compass is faulty or serial connection has failed. Record fault and contact the Sperry Marine Inc. field service department to provide corrective actions.

Table 2-5. Course Recorder Trouble Analysis Chart

Symptom	Probable Cause	Remedy
Unable to print Course Recorder historical data	If date or time is changed (decreased) during normal operation, the ability to print historical data may be unusable until 27 hours after the time or date was changed.	It is not advisable to modify date or time during normal operation.
Rudder data line prints on the edge of the rudder graph or is missing (no data)	Rudder print range probably configured smaller than the maximum or minimum achievable rudder angles.	Rudder print range should be set at installation to encompass all possible rudder angles. Contact the Sperry Marine Inc. field service department to provide corrective actions.
While printing Course Recorder historical data, a time gap greater than 10 minutes is present	When a historic time is requested that is newer than some samples in memory, but which cannot be located because the system was off during that time, the printout will begin with the last 10 minute header data stored prior to the entered time. As printing continues, a time gap greater than 10 minutes will be noticed at the next 10 minute header.	None. This is normal operation. Subsequent 10 minute header data will be 10 minutes apart as usual.
Question marks (????) are printed instead of graphic characters on a graphic print or a strange font on a tabular print	If the printer is accidentally turned off during operation, the system will normally reinitialize the printer when power is restored. If the printer is off for a very short time (less than 2 seconds) so that the MK 37 VT has not detected the problem and issued an alarm, the printer may not recover.	Turn printer off at the MK 37 VT panel and restart. The printer should be turned on and remain on at all times.
Printer output in the wrong font or wrong characters	One of the printer buttons may have been pressed.	The only buttons that should be pressed are: 1. LF/FF to load and remove paper 2. ON/OFF (Operate) All other buttons should not be pressed.
Course Recorder historic printout is in current time	Possible printer fault or momentary loss of power	Restart the printer at the MK 37 VT Display Assembly
Course Recorder does not print	Printer may not be on. Paper may not be loaded. Printer cable may not be connected to serial port.	Verify that printer power is on, paper loaded, and that the printer cable is attached to the serial port.
Course Recorder leaves a blank page every 8-10 inches or has paper feed problems	Printer Paper-Release lever not in the middle, push-tractor position	Place lever in the middle position for push tractor installation.

CHAPTER 3

FUNCTIONAL DESCRIPTION

3-1 INTRODUCTION.

This chapter contains a detailed description of the MK 37 VT Digital Gyrocompass Equipment functions. Three levels of breakdown are used to obtain this objective as described in paragraphs 3-1.1 through 3-1.3.

3-1.1 Overall Level. Paragraph 3-2 provides an overall description of the gyrocompass system and Figure 3-1 is the gyrocompass system overall block diagram.

3-1.2 Major Functional Level. Paragraphs 3-3.1 through 3-3.3 provide descriptions of the major functions for the MK 37 VT Digital Gyrocompass Equipment.

3-1.3 Circuit Level. Paragraphs 3-4.1 through 3-4.3 provide circuit level descriptions of the equipment used in the gyrocompass system.

3-2 FUNCTIONAL DESCRIPTION - OVERALL LEVEL.

Figure 3-1 is a simplified block diagram of the MK 37 VT Digital Gyrocompass Equipment. This diagram shows the printed circuit board functions within the Electronics Control Unit and their connections to the equipment associated with the gyrocompass system. The MK 37 VT Digital Gyrocompass Equipment consists of the Master Compass, Electronics Control Unit, and Display Assembly which are described in the following paragraphs.

3-2.1 Master Compass. The Master Compass provides uncorrected heading data to the Electronics Control Unit for signal processing. The Master Compass physically consists of a shock-mounted, fluid-filled binnacle assembly sealed and designed for deck mounting. The viewing window for the compass dial is on the aft end of the Master Compass. The compass dial's indication is accurate to within ±10 degrees of the true compass heading and is only used for service and installation purposes.

3-2.2 Electronics Control Unit. The Electronics Control Unit consists of a drip-proof enclosure that contains a microcomputer and other control circuitry needed to operate the Master Compass and Display Assembly. It contains the circuit boards that drive the step repeaters. Connections are provided on the motherboard for up to eight 24 VDC step repeaters, each controlled by a toggle switch on the associated circuit board. Included in the Electronics Control Unit is software that compensates for errors due to the effect of the vessel's latitude and speed. The corrected heading data output is provided in both serial and step data format. A rate-of-turn output is also provided by the Electronics Control Unit.

3-2.3 Display Assembly. The Display Assembly is the operator's primary user interface to the system and contains the controls and indicators used during normal operation of the gyrocompass equipment. Figure 2-1 shows the front panel of the Display Assembly which contains a Liquid Crystal Display (LCD), indicator lights, and switches.

The operator refers to the indicator lights to determine the current operating mode. Possible modes are ACTIVE, STANDBY, SETTLE, PRIMARY, or SECONDARY. A separate indicator light informs the operator of FAULT detection. The operator has front panel access to eleven switches on the Display Assembly. The switches enable the operator to select operating modes, mute audible alarms, adjust the intensity of the indicator lights, adjust the Display Assembly's backpanel lighting, scroll through menu options, and enter data.

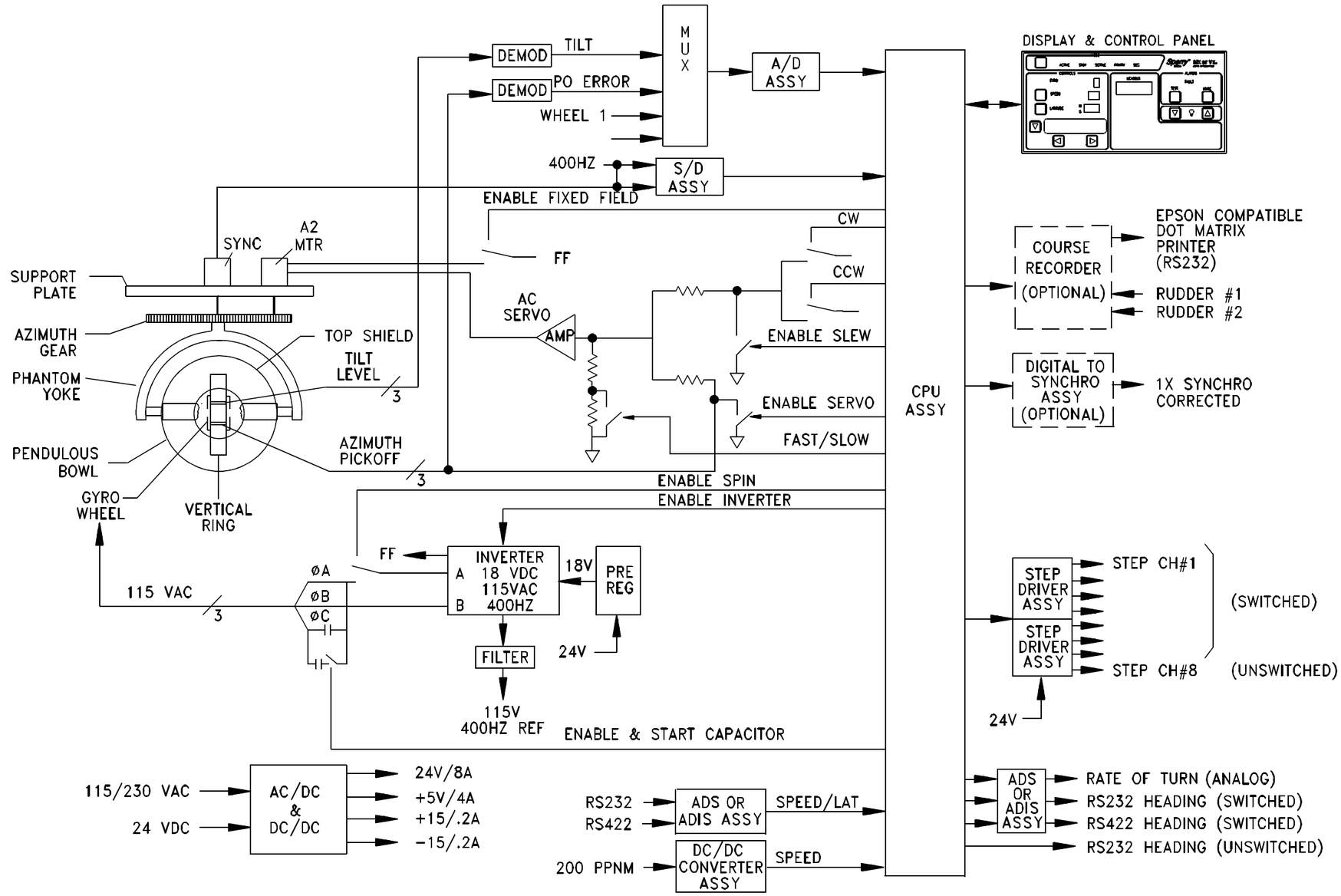


Figure 3-1. MK 37 VT Digital Gyrocompass Equipment Overall Block Diagram

3-3 FUNCTIONAL DESCRIPTION - MAJOR FUNCTIONAL DESCRIPTION.

Paragraphs 3-3.1 through 3-3.3 describe the major functions of the gyrocompass system.

3-3.1 Power Distribution Function. See Figure 3-2. The MK 37 VT has two power input circuits; AC primary and 24 VDC backup. The compass has the ability to automatically switch to the backup supply due to a loss of power on the AC input. Transfer to the 24 volt backup is through a steering diode and relay that switch the positive line to provide full electrical isolation.

The MK 37 VT provides Power Fail relay contacts as an output. As long as either the AC or DC input is present, the Power Fail relay is energized. When the voltage drops to below the relay hold voltage of 16.8 VDC, the relay de-energizes. The normally closed and normally open contacts indicate that no power is applied to the input of the MK 37 VT. An audio alarm sounds and the FAULT alarm lamp illuminates when power is not supplied to the MK 37 VT. Pressing the MUTE switch on the panel causes the audio alarm to cease and the alarm lamp to go out. An internal battery/alarm circuit will be active for a minimum of ten minutes of complete power loss. The main power switch on the AC/DC Power Supply Assembly disconnects the alarm circuit during shipping and storage.

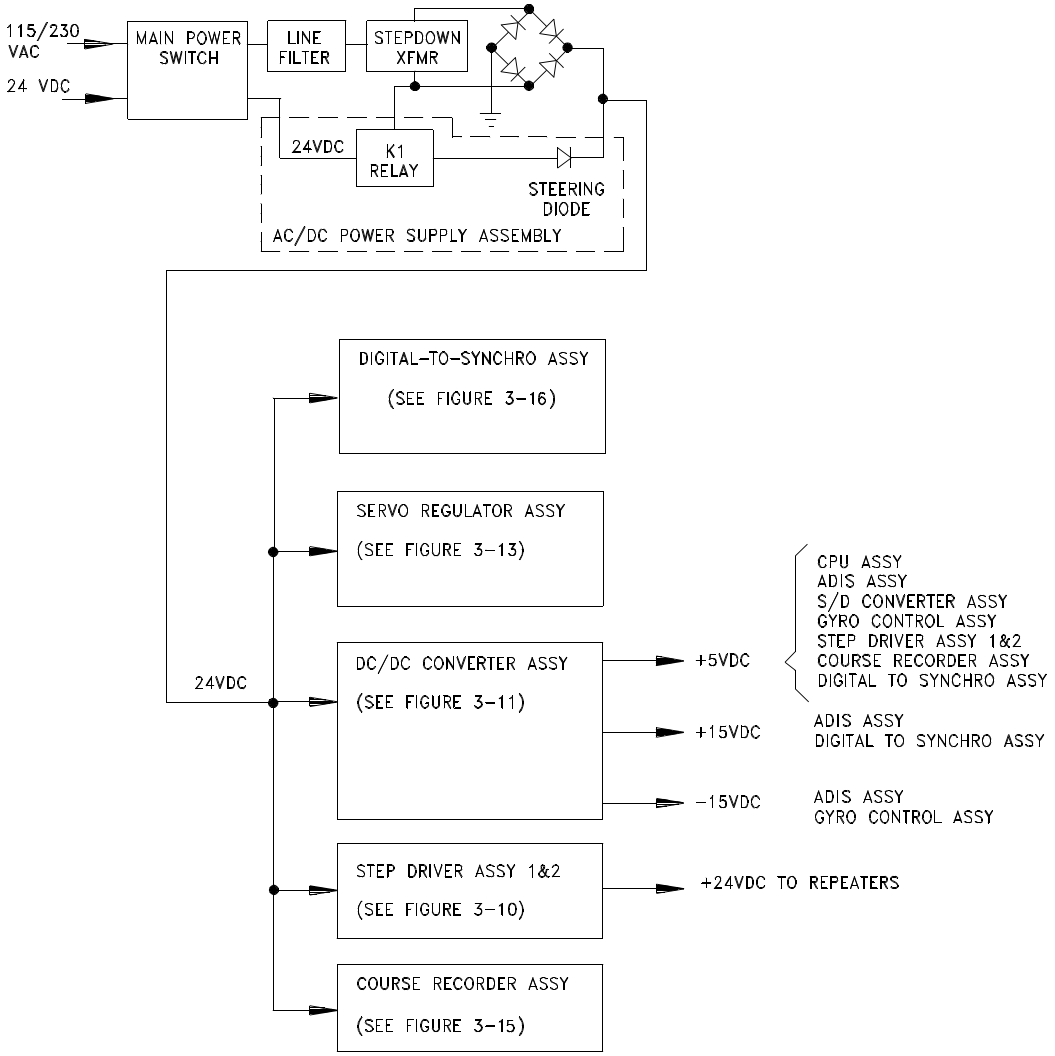


Figure 3-2. MK 37 VT Digital Gyrocompass Equipment Power Distribution Diagram

3-3.2 Standby/Active/Settle Mode Function. For dual compass installations, the standby/active mode function determines which compass is driving the data outputs. Figure 3-3 shows the standby/active mode functional diagram. The Gyro Control Assembly checks for dual compass configuration and monitors the output drive status of the other unit. The secondary compass uses the signal from the primary compass to determine which compass is driving the common output bus. Active/standby switching is accomplished by the mode switch on the PRIMARY compass display panel. The Display Driver Assembly sends the switch data out on a data bus (FB-D0 through FB-D7) to the ADIS Assembly. The data is then sent out on another data bus (D8 - D15) to the CPU Assembly. The CPU Assembly then sends serial data to the Display Driver Assembly where the ACTIVE or STANDBY LED is lit on the display. At the same time, the alternate compass status line on the Gyro Control Assembly of each compass changes state only if the STANDBY compass indicates it is OK.

The settle mode is a function of CPU control and can take anywhere from one to five hours to settle depending on whether an estimate of the ship's heading was entered upon power-up. Figure 3-3 also shows the settle mode functional diagram.

3-3.3 Primary/Secondary Mode Function. The primary/secondary mode function is set by jumpers on the Gyro Control Assembly at installation. The motherboard's E1 jumper must also be properly set for Gyro 1 or Gyro 2 as shown in Figure 3-3. If the compass is set to the active mode as described in paragraph 3-3.2, the compass output enable (COE) signal from the Gyro Control Assembly enables compass output data, which is controlled by the CPU, for rate of turn, heading repeater, printer, and synchro. Figure 3-4 shows the primary/secondary mode functional diagram.

3-4 FUNCTIONAL DESCRIPTION - CIRCUIT LEVEL.

Paragraphs 3-4.1 through 3-4.3 describe the circuits associated with the MK 37 VT Digital Gyrocompass Equipment.

3-4.1 Master Compass Circuits. The Master Compass is used in combination with both the Electronics Control Unit and the Display Assembly to comprise the MK 37 VT Digital Gyrocompass Equipment. The Master Compass consists of a shock-mounted, fluid-filled Binnacle Assembly which houses the Compass Element Assembly. The Master Compass consists of the major subassemblies listed in Table 3-1.

Table 3-1. Master Compass Subassemblies

Master Compass (Unit 2)
Binnacle Assembly (2A1)
Compass Element Assembly (2A1A1)
Support Plate
Phantom Yoke
East-West (E-W) Gimbal Assembly
Vertical Ring (2A1A1A1)
Gyrosphere (2A1A1A1A1)
Liquid Ballistic
Compass Dial
Azimuth Motor (2A1A1A2B1)
Synchro Transmitter (2A1A1B2)

3-4.1.1 Binnacle Assembly (2A1). The Binnacle Assembly (2A1) houses the Compass Element Assembly (2A1A1) and is completely filled with silicon-based damping fluid. In addition to the compass element, it contains a diaphragm located in the bottom of the housing which accommodates the contraction and expansion of the fluid with a change in temperature. Also part of the Binnacle Assembly are the access cover and electrical connector receptacle. The Binnacle Assembly is shock and vibration mounted in a base with the support points positioned to act through the center of gravity of the Binnacle. The base casting has slots for four mounting bolts to provide for ±5 degrees of azimuth adjustment for accurate alignment with the ship's centerline.

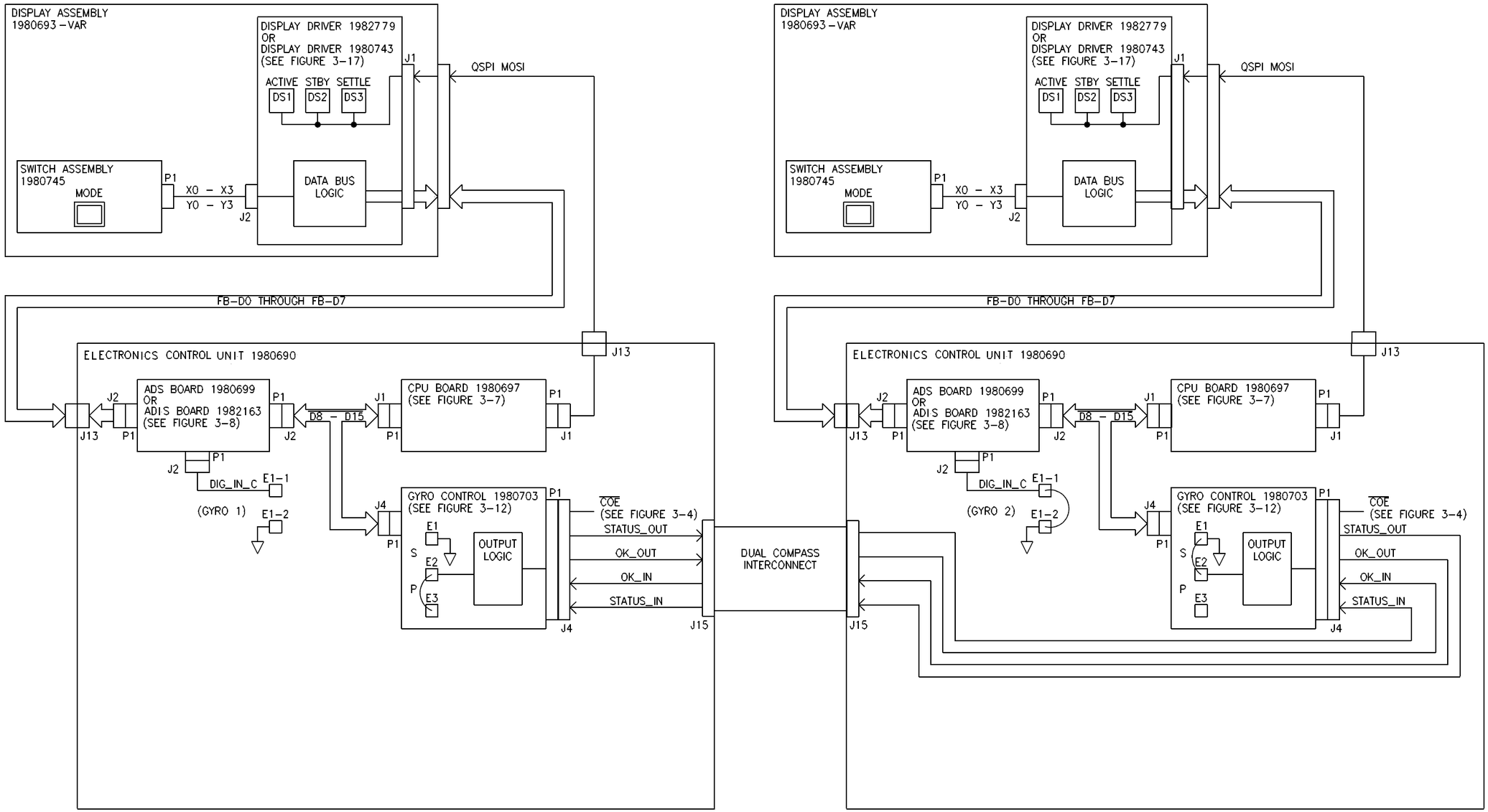


Figure 3-3. Standby/Active/Settle Mode Functional Diagram

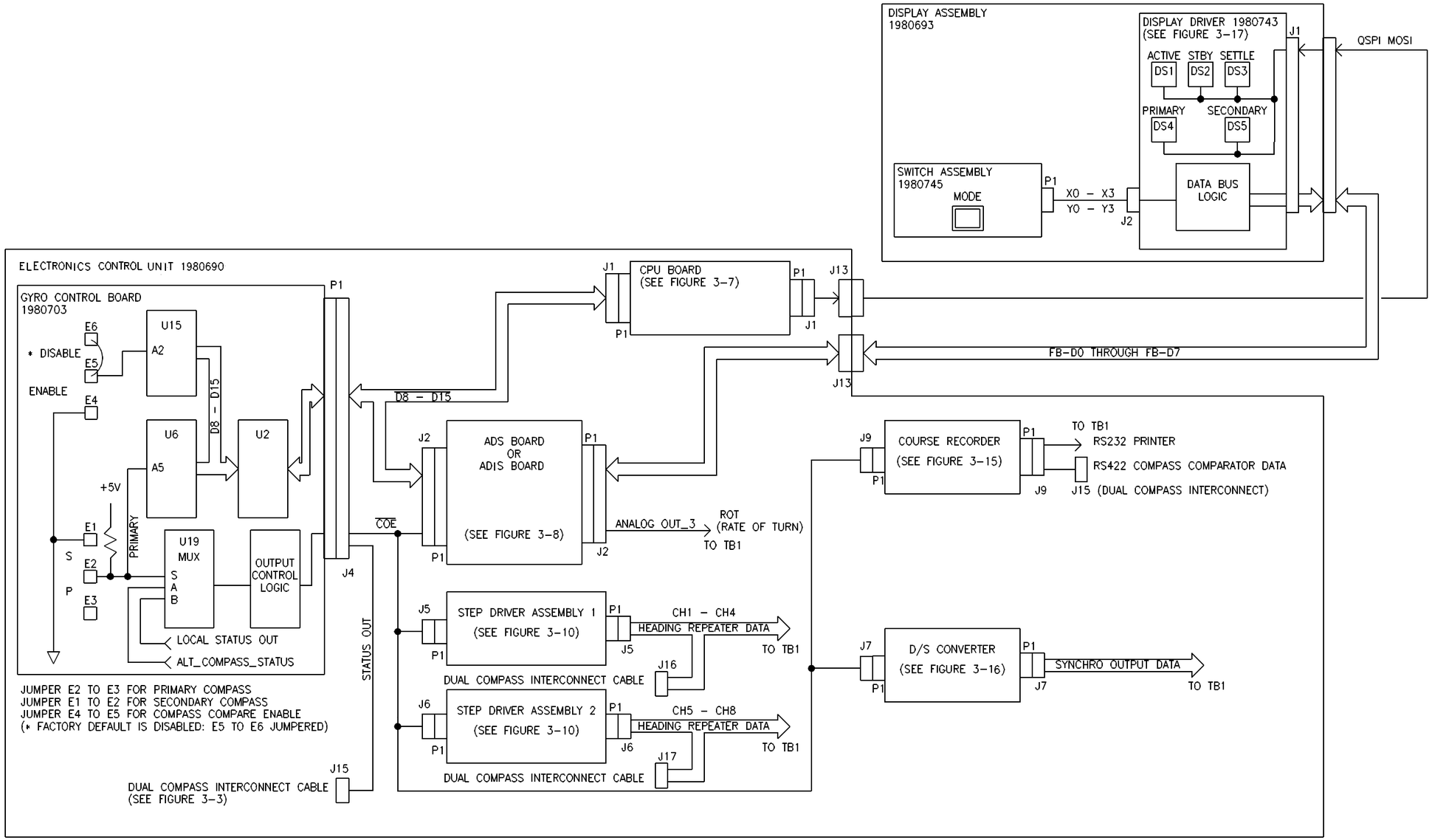


Figure 3-4. Primary/Secondary Mode Functional Diagram

3-4.1.2 Compass Element Assembly (2A1A1). The Compass Element Assembly (2A1A1) is the basic part of the gyrocompass. It consists of the Support Plate, Phantom Yoke, E-W Gimbal Assembly, Vertical Ring, Gyrosphere, Liquid Ballistic, Compass Dial, Azimuth Motor, and Synchro Transmitter.

3-4.1.2.1 Support Plate. The Support Plate suspends the Phantom Yoke and serves as a mounting surface for the terminal boards, compass dial gearing, and Azimuth Motor. A 1-speed Synchro Transmitter is mounted to the Support Plate near the Azimuth Motor and is geared to move with the Compass Dial.

3-4.1.2.2 Phantom Yoke. The Phantom Yoke supports the E-W Gimbal Assembly through horizontal axis bearings. Electrical connection between the yoke and Support Plate is through a slip ring assembly. The slip ring assembly is mounted on top of the yoke and makes contact with the E-W Gimbal Assembly horizontal spring contacts through a flexible cable. This cable is looped at the bearing pivots between the yoke and E-W Gimbal Assembly to allow unrestrained movement.

3-4.1.2.3 East-West (E-W) Gimbal Assembly. The E-W Gimbal Assembly supports the Vertical Ring and Gyrosphere through horizontal axis bearings. The E-W Gimbal Assembly is mounted with a cast hemispherical cover on its lower side and a split hemispherical shield on its upper side, thus surrounding the Vertical Ring and Gyrosphere in a gravity-stabilized pendulous enclosure. The E-W Gimbal Assembly largely eliminates disturbance torques by isolating the flotation fluid surrounding the Gyrosphere from the main body of fluid in contact with the binnacle housing. There is only a slight relative movement between the E-W Gimbal Assembly and the Vertical Ring and Gyrosphere.

Figure 3-5 shows the East-West Gimbal Assembly between the Phantom Yoke and Vertical Ring. The E-W Gimbal Assembly allows the Vertical Ring supporting the Gyrosphere to remain undisturbed when the compass is tilted (through the motion of the vessel).

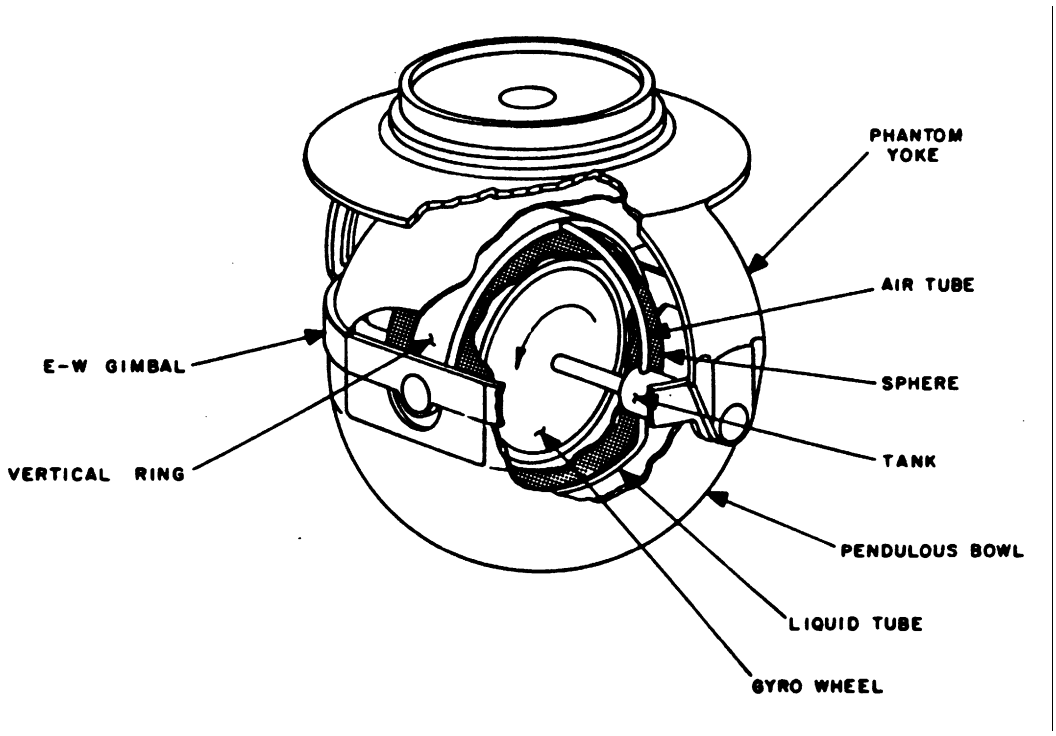


Figure 3-5. Ballistic System of MK-37 VT Gyrocompass

3-4.1.2.4 Vertical Ring (2A1A1A1). The Gyrosphere is pivoted about the vertical axis within the Vertical Ring, which in turn is pivoted about the horizontal axis in the E-W Gimbal Assembly. The bearings that support the Gyrosphere in the vertical axis are located at the top and bottom of the Vertical Ring. Mounted on the top of the Vertical Ring is the electrolytic (liquid) level that develops a signal proportional to the degree of gyro tilt. Also located on the Vertical Ring is the E-section of the azimuth followup pickoff.

Attached to the Vertical Ring near the electrolytic level are bumper stops used in conjunction with flat leaf springs on the Gyrosphere to torque the gyro wheel during leveling. Power to the Gyrosphere is transferred from the Vertical Ring through three spiral hairsprings located below the lower vertical bearing of the ring. An additional hairspring at the top of the Vertical Ring provides a positive ground connection for the Gyrosphere. Horizontal axis pivots mount the Vertical Ring in the E-W Gimbal Assembly and allow rotation about the East-West horizontal axis. Wiper contacts at both horizontal pivots transfer power across the horizontal axis. One set of contacts is mounted below the horizontal pivot on each side of the Vertical Ring and the mating contacts are mounted on the E-W Gimbal Assembly. This provides an essentially friction-free means of making electrical connections to the Vertical Ring.

3-4.1.2.5 Gyrosphere (2A1A1A1A1). The Gyrosphere is the north-seeking part of the gyrocompass. It derives its name from the fact that the gyro wheel is mounted within a spherical enclosure. The sphere is 6.5 inches in diameter. At operating temperature, the specific gravity of the sphere is the same as the fluid in which it is immersed. Since the sphere is in neutral buoyancy, it exerts no load on the vertical bearings. Therefore, the vertical bearings serve only as a guide for the sphere. Flotation of the gyro in this manner not only reduces pivot friction but also protects the gyro pivots from destructive shocks. The sphere is evacuated and partially filled with helium gas that transfers the heat generated by the gyro motor windings to the surface of the sphere.

Inside the Gyrosphere is the gyro wheel. The gyro wheel is symmetrical and consists of an aluminum rotor, two end bells, and an electrically wound stator. An aluminum squirrel cage is cast into the rotor and the rotor is attached to the end bells. This assembly rotates on ball bearings installed between the end bells and the stator shaft, and with the stator constitutes an induction motor. The stator leads are routed through the stator shaft.

The Gyrosphere enclosing the gyro wheel consists of a frame and two hemispherical shells. All parts of the Gyrosphere are attached to the frame, which is a cast, ribbed, cylindrical ring with internal bosses provided for pivots and threaded blind holes for external fasteners. A three-conductor, metal-to-glass, lead-in connector is located on the frame to bring power leads out of the Gyrosphere.

3-4.1.2.6 Liquid Ballistic and Damping Control. In the MK 37 VT Gyrocompass, gravitational torques to make the gyro wheel seek north are provided by a Liquid Ballistic. The Liquid Ballistic assembly is also known as the control element because it is the component that makes the Gyrosphere north seeking. The ballistic consists of two interconnected brass tanks, partially filled with silicon oil, mounted on the Gyrosphere as shown in Figure 3-5. This ballistic system is employed because it is substantially free of roll acceleration effects. The small bore in the tubing connecting the two tanks retards the free flow of fluid between the tanks. Since the time it takes for the fluid to flow will be long compared to the roll period, roll acceleration errors are minimized.

With the use of ballistic control, the initial tilt would cause the fluid to flow to the lower tank, unbalancing the Gyrosphere even more and increasing the tilt angle. Thus, the direction of torque is reversed as a result of using a ballistic control and the torque would move the north end away from the meridian. This can be resolved by reversing the direction of the gyro wheel so that it will rotate counterclockwise when viewed from the south. To achieve damping, a weight must then be added to the west side to reverse the direction of the vertical torque.

3-4.1.2.7 Compass Dial. The Compass Dial is attached to a large gear that has the same number of teeth as the azimuth gear and is supported by two bearings at the top of the Phantom Yoke. A differential gear train drives the Compass Dial so that it can be viewed at the aft side of the compass. This allows the dial to be read in the usual Compass Dial presentation.

3-4.1.2.8 Azimuth Motor (2A1A1A2B1). The Azimuth Motor is used to drive the followup system of the gyrocompass.

3-4.1.2.9 Synchro Transmitter (2A1A1B2). The Synchro Transmitter supplies the raw uncorrected heading data in 1X synchro form, 90V L-L, 400 Hz.

3-4.1.3 Followup Control. The Vertical Ring and Phantom Yoke are made to follow the gyro wheel axle in azimuth as described in the following paragraphs.

A gyro wheel without followup could rotate until the spin axis was aligned to the horizontal axis. Should this happen, the gyro wheel would lose one axis of freedom and could no longer be considered a gyroscope. To keep the Phantom Yoke and Vertical Ring aligned in azimuth with the gyro wheel, a conventional followup system, shown in Figure 3-6, has been added.

A followup pickoff, which detects azimuth movement with respect to the gyro wheel, has the E-core pickoff mounted on the Vertical Ring and an armature on the Gyrosphere. A signal is obtained that is proportional to gyro wheel movement from its null position and, after amplification, drives the Azimuth Motor. The motor positions the Phantom Yoke to maintain alignment of the E-W Gimbal Assembly and Vertical Ring with the Gyrosphere at all times.

With the addition of the movable Phantom Yoke element, another support of a fixed type must be provided for the gyrocompass assembly. This Support Plate Assembly is mounted to the ship through the Binnacle Assembly and shock mount. The Azimuth Motor is positioned on the Support Plate, and through gearing drives the azimuth ring gear attached to the Phantom Yoke.

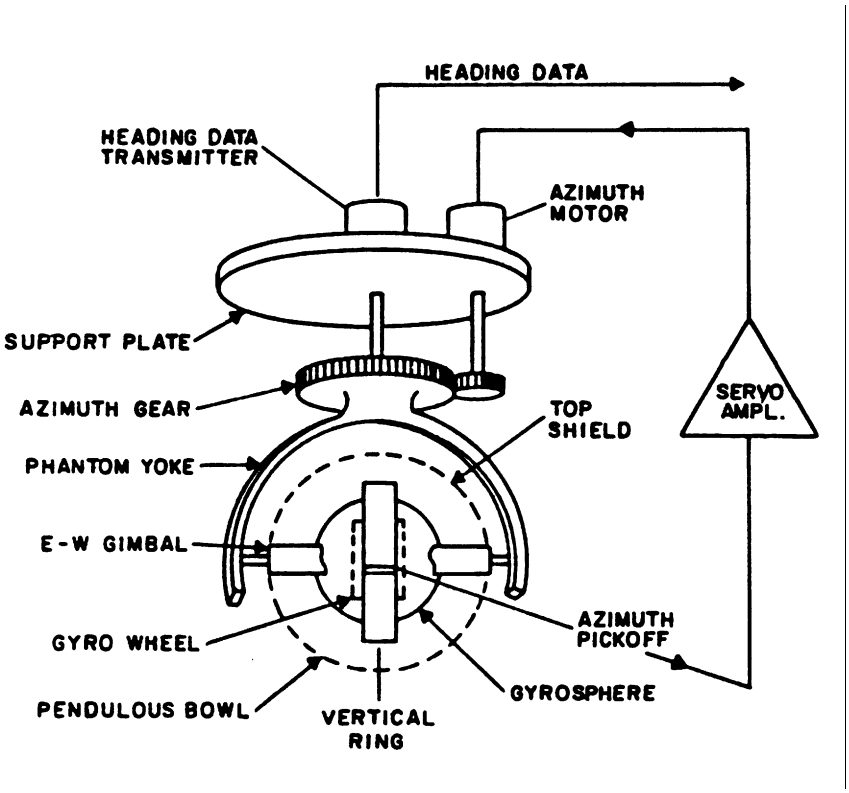


Figure 3-6. Simplified Diagram of Followup Control on Gyrocompass

3-4.2 Electronics Control Unit Circuits. The Electronics Control Unit is the heart of the MK 37 VT Digital Gyrocompass Equipment. It houses the controls and indicators for basic operation of the compass. It distributes the data to the other equipment in the system and performs the speed and latitude corrections. Paragraphs 3-4.2.1 through 3-4.2.11 provide circuit descriptions of the assemblies that make up the Electronics Control Unit.

3-4.2.1 CPU Assembly. The CPU Assembly (see Figure 3-7) is the controlling element of the gyrocompass. It receives, processes, and sends data to the other circuit boards within the MK 37 VT and to the associated equipment with which it interfaces. The CPU Assembly controls the alarms and the data displayed on the Display Assembly.

The CPU Assembly is CMOS based and requires a single +5 volt supply. The core processor operates at a frequency of 16.7 MHz. The onboard memory consists of 256K bytes of programmable read only memory (two 128K byte CMOS PROMS U2A & U2B), 64K bytes of random access memory (two 32K byte CMOS RAM U3 & U4), and 8K bytes of nonvolatile random access memory (one 8K Battery RAM U6).

There is also a power reset circuit that acts as a watchdog timer that will reset the processor. The watchdog timer has a 100 millisecond timeout period during normal operation. However, just after power-up the watchdog timer period is 1.6 seconds until the first stobe is required. The timer is restarted when the WDI (Watchdog Input) signal is toggled. The Watchdog Input is connected to one of the programmable lines on the CPU.

The CPU Assembly also provides the Channel C RS-232 unswitched heading output. Channel C is not galvanically isolated and should not be used for interface to any equipment that may be hull grounded.

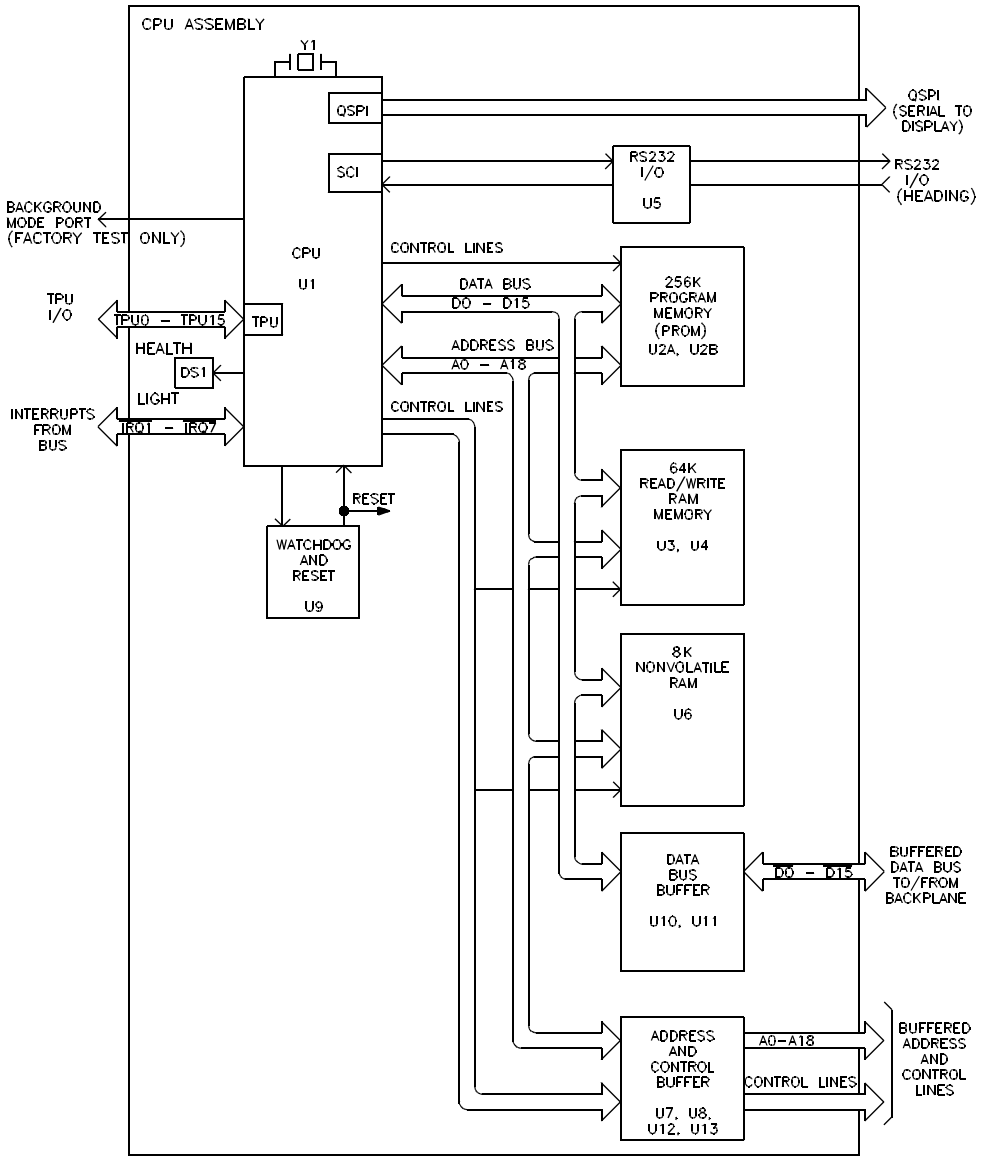


Figure 3-7. CPU Assembly Functional Diagram

3-4.2.2 Analog, Digital, Isolated Serial (ADIS) Assembly. The Analog, Digital, Isolated Serial (ADIS) Assembly (see Figure 3-8) performs three different functions. It produces three analog outputs, and has a parallel digital interface and two serial input/output channels.

The analog output of the ADIS Assembly is produced by a dual channel, 12-bit digital-to-analog converter (U6). The dual digital-to-analog converter (DAC) is configured for ±5 volts output. Its two outputs are referred to as channel A and channel B. Channel A is not used at this time. The channel B analog output of the DAC is buffered by an inverting, unity gain amplifier (U7) and routed through an analog switch (P/O U8) which is enabled by the active compass, thus gating the output of the active compass onto the common bus. This output, ANALOG OUT 3 (channel 3), is used to drive the analog rate-of-turn indicators. The output will be 50 mV per degree/minute (±4.5 volts full scale =±90 degrees/minute).

The ADIS Assembly also provides a parallel data bus interface (Flexbus) used to control the Display Assembly functions. The Flexbus is an 8-bit bidirectional data and control port. The ADIS Assembly is the buffer path to a block of memory on the CPU Assembly that is used for display functions. This interface provides buffered 8-bit, bidirectional data interface, address, and control lines. Although the Flexbus interface resides on the ADIS Assembly, the memory block is selected and controlled via an independent chip select from the CPU Assembly.

The ADIS Assembly also contains two serial input/output channels that are provided through the DUART (U11). Channel A of U11 is configured as RS-232 and channel B of U11 is configured as RS-422. These two serial output lines can be turned on or off by the CPU Assembly. The serial input lines are always active.

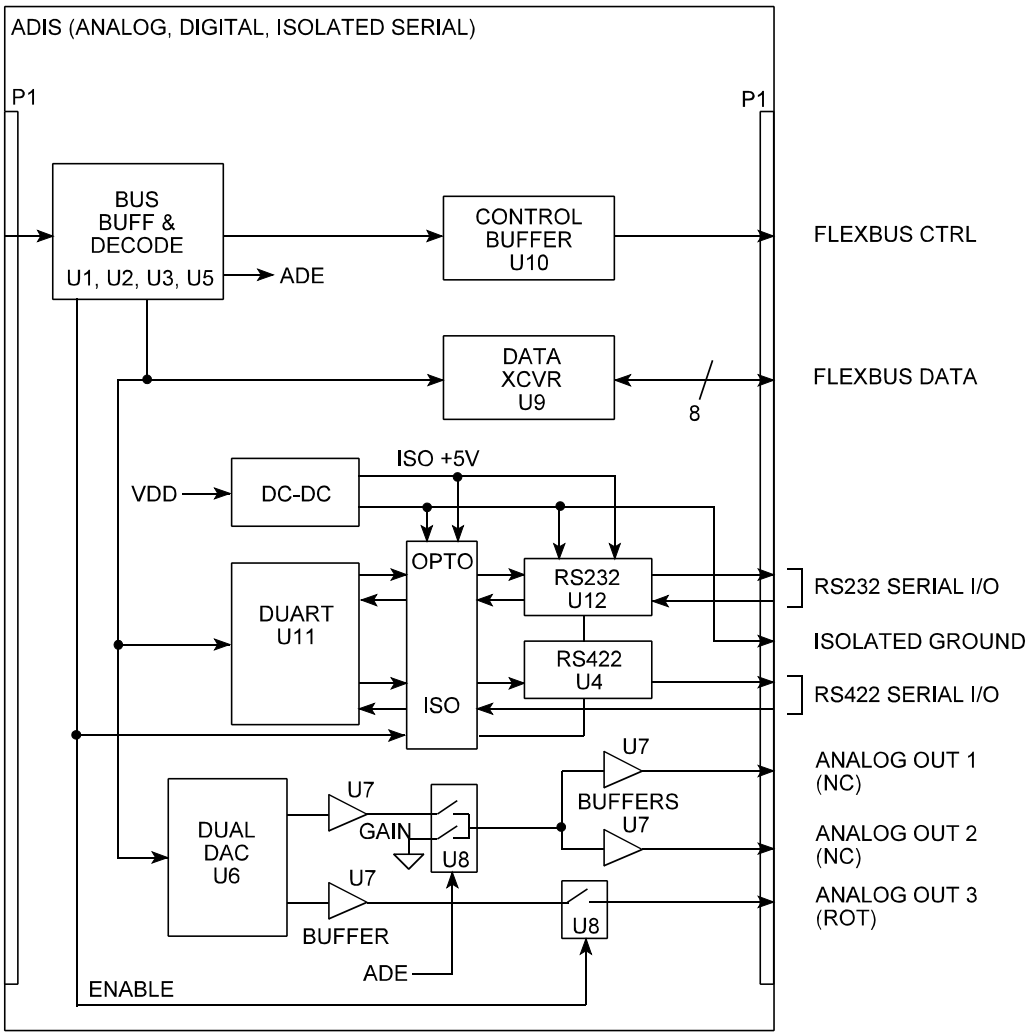


Figure 3-8. ADIS Assembly Functional Diagram

3-4.2.3 Synchro-to-Digital Converter Assembly. The Synchro-to-Digital Converter (SDC) Assembly (see Figure 3-9) is a general purpose synchro-to-digital converter card. It accepts uncorrected 1X synchro heading data from the Master Compass and converts it to a buffered 14-bit word for use by the CPU Assembly. The synchro heading data is in the standard 115 VAC, 400 Hz reference, 90 volt line-to-line synchro format. The synchro heading data is uncorrected for errors caused by the ship's speed or latitude. These corrections are performed by the CPU Assembly on the system outputs only.

The SDC Assembly provides transient protection on the "S" leads and reference inputs. It also employs transformer isolation on the reference input. This isolation prevents ground faults in the monitoring circuits of accessory systems which may be installed in the reference signal path.

The SDC Assembly uses an integrated circuit resolver-to-digital converter. This converter also provides a built-in test function that identifies faults such as a loss of reference or a large tracking error. The converter's read cycle is held at least 300 ns to ensure valid data.

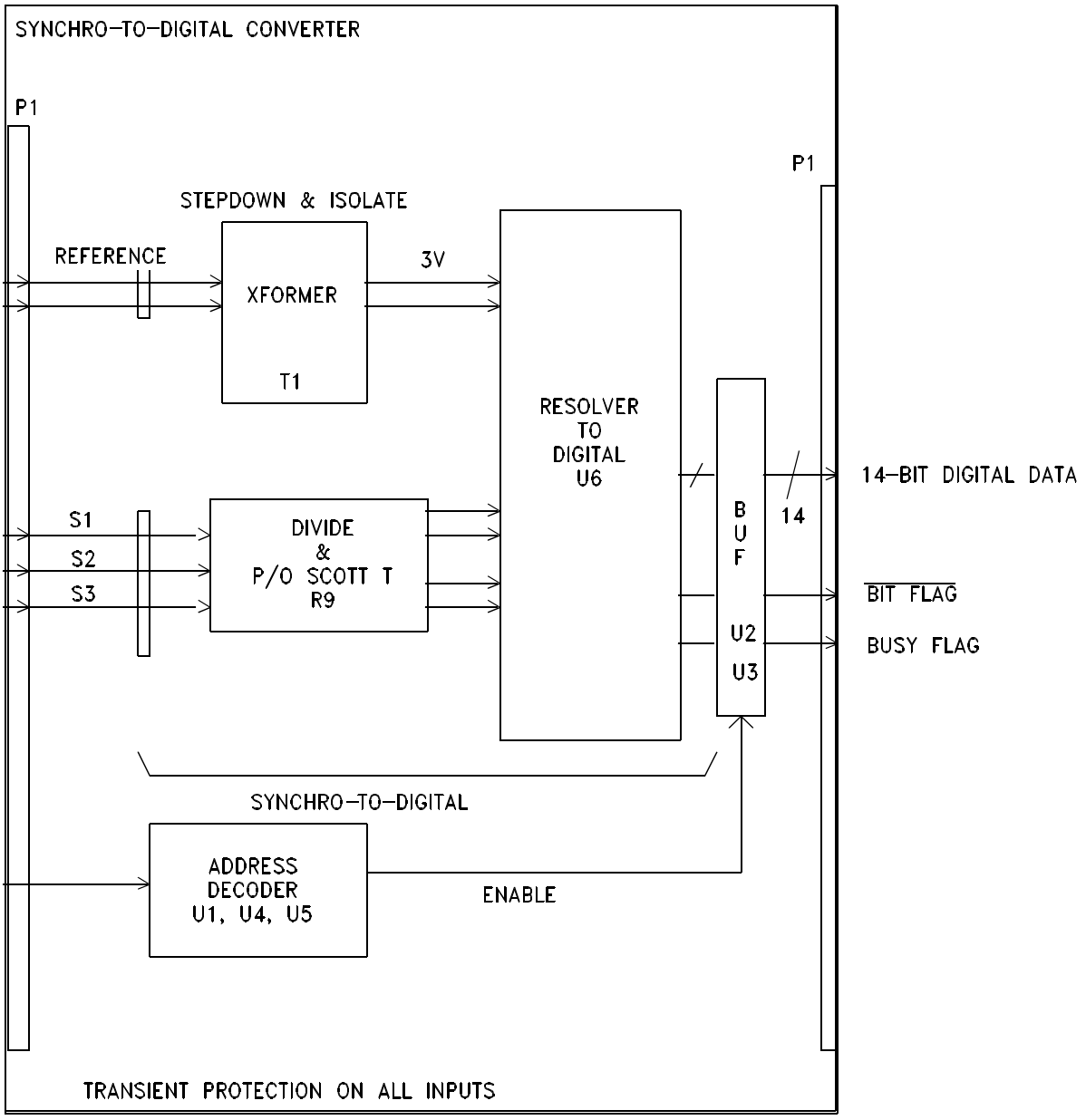
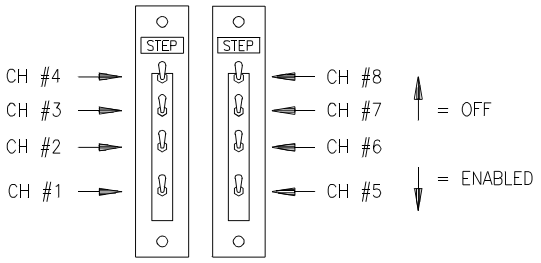


Figure 3-9. Synchro-to-Digital Converter Assembly Functional Diagram

3-4.2.4 Step Driver Assembly. The Step Driver Assembly (see Figure 3-10) contains circuitry for four channels that control up to four remote heading repeaters. The standard MK 37 VT configuration has two Step Driver Assembly boards (Step Driver Assembly 1 and Step Driver Assembly 2) to drive up to a total of eight remote heading repeaters.

Each channel is comprised of a 24 VDC line (V+), a ground or return line (RTN), and three data lines (D1, D2, and D3). The 24 VDC line is also used with the return line for repeater dial lighting, when required. The three step data lines indicate a change in heading, using a modified Grey Code, as shown in the following table.

Step Data			Step	
D3	D2	D1	Fraction	
0	0	1	0/6	Decrease Heading
1	0	1	1/6	▲
1	0	0	2/6	|
1	1	0	3/6	|
0	1	0	4/6	▼
0	1	1	5/6	Increase Heading



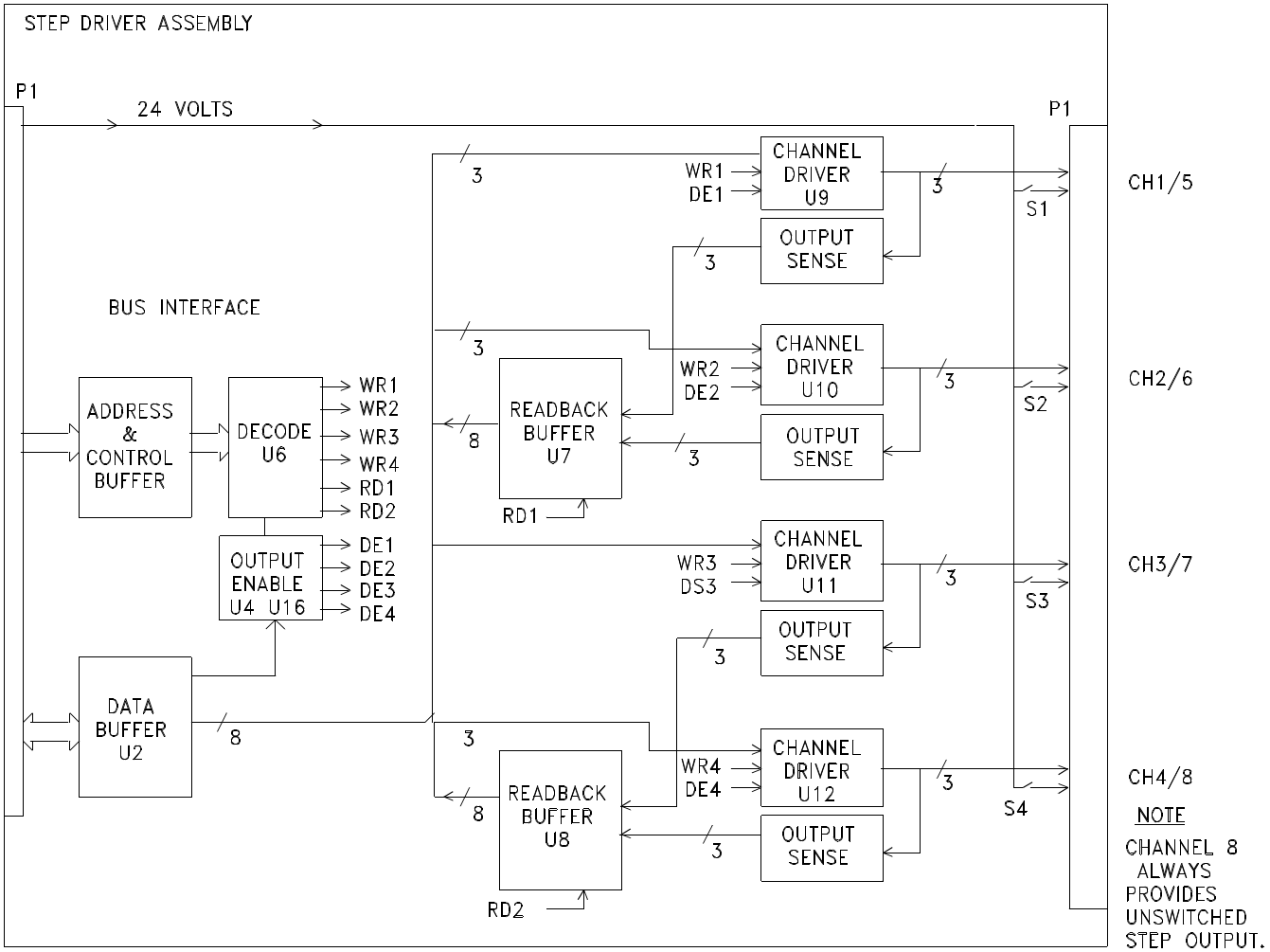


Figure 3-10. Step Driver Assembly Functional Diagram

The Driver Assembly is designed for 24 volt negative step operation. Each of the four channels has the cability of a maximum of 900 mA. This assumes 400 mA per step leg (only two of the three step legs can be high at the same time) and 100 mA for repeater lighting.

Each channel contains an individual three data line driver IC and a +24 vdc line. The 24 vdc line is controlled by a toggle switch on the Step Driver Assembly circuit board. For protection on the 24 vdc line, there is a blocking diode and a temperature-dependent resistor (Polyswitch Resettable Fuse) that will trip under high current conditions. If the current demand on any 24 vdc line exceeds approximately 1.3 amps, the thermal resistor will latch and isolate that repeater drive channel. The thermal resistor will remain latched until power is removed by turning off the toggle switch for that repeater. (It is necessary to leave the switch off for a few seconds to allow the thermal resistor to cool off.)

The main processor controls each of the step data outputs using enable (DE) and write (WR) lines. Each step channel can be individually turned on and off by the processor. The actual step data output lines are part of an open collector circuit. A logic 0 on the output enable line causes the output transistor to turn off. The open circuit voltage approaches +24 volts during normal operation when the repeater is connected. A logic 1 to the step driver causes the transistor to turn on and complete a current path to ground bringing the output voltage to nearly zero. The step driver output also feeds a loop back through the Output Sense and Read-Back Buffer circuits of the Step Driver Assembly to allow the MK 37 VT CPU to verify proper operation.

NOTE

Make sure that all of the step data channels are set to off on both compass systems in a dual compass configuration when removing the Step Driver Assembly.

3-4.2.5 DC/DC Converter Assembly. The primary function of the DC/DC Converter Assembly (see Figure 3-11) is to convert unregulated 24 vdc into three regulated outputs: +5, +15, and -15 vdc. The input to the DC/DC Converter Assembly is 24 vdc from the AC/DC Power Supply Assembly. This 24 vdc is applied to a 25 watt, triple output , DC-DC converter brick (PS1). The input to PS1 is protected by a surge suppressor diode. The three outputs of PS1 can be measured at the following test points: TP1 (-15), TP2 (+15), and TP3 (+5). TP4 is the return to converter brick PS1. DS1, a green LED, is connected to the +5 vdc output of converter brick PS1.

An optocoupler (U2) is provided for the speed log contact closure input. The speed log input must be 200 pulses per nautical mile. The output of the optocoupler is a square wave that is applied to the CPU Assembly. The interface isolates and drives a schmitt trigger circuit on the CPU Assembly with a clean noise-free speed log signal.

The DC/DC Converter Assembly also contains relay K1 that supports the system alarm function. This relay provides a normally open contact, TB1 108 & 106 (will close for an alarm until the alarm is muted), and a normally closed contact, TB1 107 & 106 (will open for an alarm until the alarm is muted). This relay is activated for any fault message other than power failure, which has it's own set of alarm contacts. These contacts are used to interface to the customer's external alarm system, if necessary.

Battery BT1 provides a +5 volts Standby signal to the audio alarm and lamp circuit in the Display Assembly to alert the operator of power failure in the event of loss of the internal 24 vdc. The battery is a 3.6 volt, 100 mA-hour assembly that consists of three 1/3 AA cells about the same size of a single AA battery. The display circuit draws less than 80 mA during alarm operation. When power is applied to the unit, the battery is trickle charged. The Electronics Control Unit ON/OFF switch provides a set of contacts to disconnect the battery when the unit is turned OFF (if that is the desired mode of operation) to conserve the battery charge.

NOTE

The system relay interface is designed to activate if the cable to the display is disconnected or the path is broken.

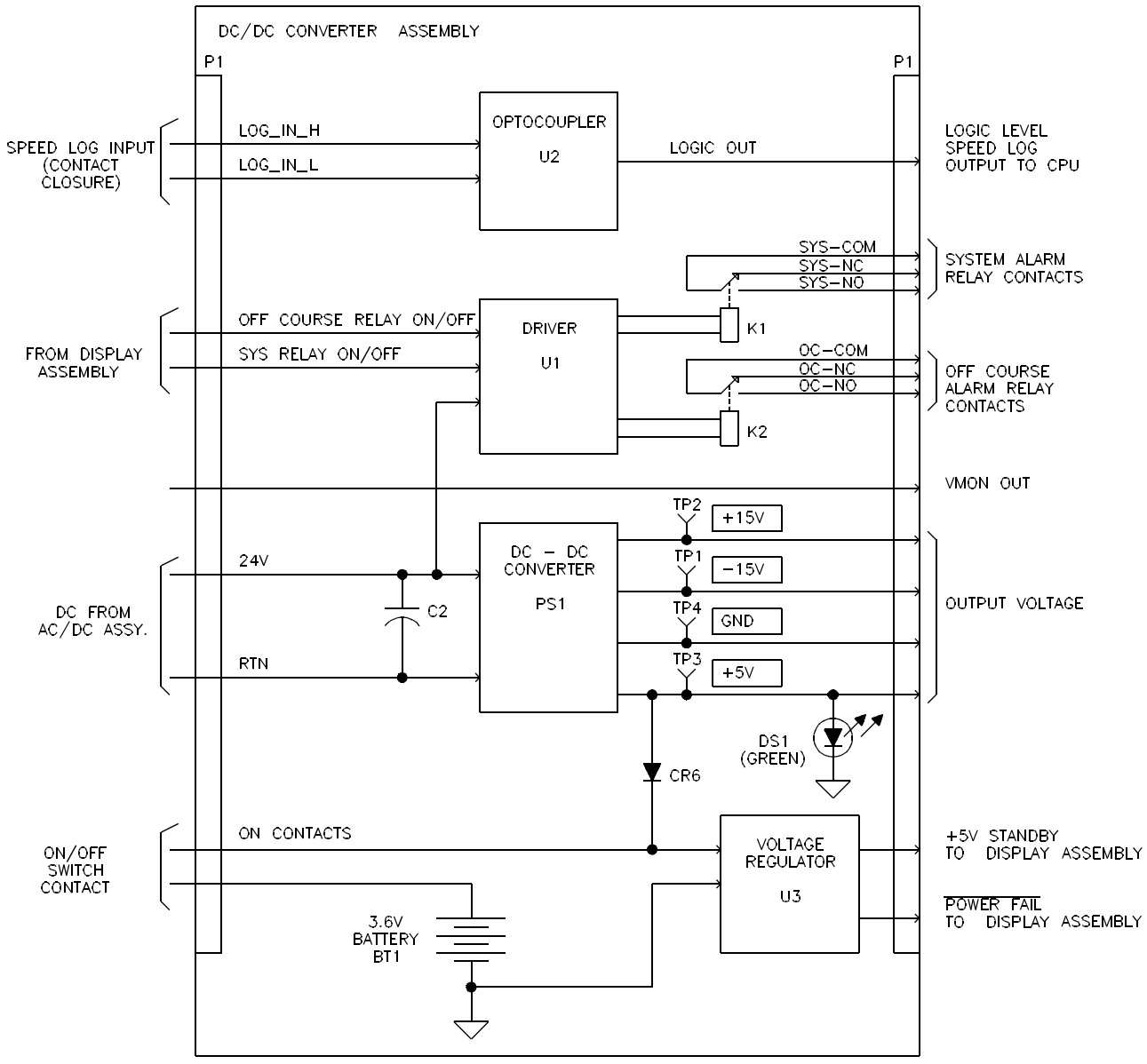


Figure 3-11. DC/DC Converter Assembly Functional Diagram

3-4.2.6 Gyro Control Assembly. The Gyro Control Assembly (see Figure 3-12) primarly serves as a software interface between the CPU Assembly and the Servo Regulator Assembly. It consists of an 8-channel, 12-bit A/D converter used to monitor voltages and currents within the Servo Regulator Assembly. It also provides two 8-bit read/write ports for control of the Servo Regulator Assembly.

The Gyro Control Assembly provides two primary functions concerning the Servo Regulator Assembly. First, the CPU Assembly writes into the decoders on the Gyro Control Assembly to enable the Servo Regulator Assembly to start the Master Compass. These control signals include:

D7: Enable Slew (1 enables slew, 0 disables slew)
D6: Slew Rate (1 is normal, 0 is fast)
D5: Enable Slew CCW (1 slew CCW, 0 no slew)
D4: Enable Slew CW (1 slew CW, 0 no slew)
D3: Enable Start Capacitor (1 capacitor in, 0 capacitor out)
D2: Enable Spin Motor (1 enables motor, 0 disables motor)
D1: Enable Servo Loop (1 disables servo, 0 enables servo)
D0: Enable Static Inverter (1 enables, 0 disables)

Secondly, the Gyro Control Assembly monitors certain analog voltages on the Servo Regulator Assembly. These signals are multiplexed into a 12-bit A/D Converter so that they can be read by the CPU Assembly. The voltages monitored include:

Mux Channel 0: Wheel Current
Mux Channel 1: Pickoff Error
Mux Channel 2: Reserved for future option
Mux Channel 3: Reserved for future option
Mux Channel 4: Spare
Mux Channel 5: 19 Volt Buck
Mux Channel 6: +5 Volt Test
Mux Channel 7: Tilt Meter

In addition, the Gyro Control Assembly provides control signals to the CPU Assembly when there is a dual MK 37 VT installation. Pins E1, E2, and E3 are used to determine which system will be considered PRIMARY and which system will be considered SECONDARY. The PRIMARY MK 37 VT should have a terminal link (jumper) between pins E2 and E3. (This is also the default position for a single MK 37 VT installion.) The SECONDARY MK 37 VT should have the jumper between pins E1 and E2. Pins E4, E5, and E6 are used to enable the course comparator option. To disable the course comparator option, connect the jumper between pins E5 and E6. (This is also the default position for a single MK 37 VT installion.) To enable the course comparator option, connect the jumper between pins E4 and E5.

The Alternate Compass signal indicates the status of the other compass in a dual MK 37 VT system. Electrical cross connection of control lines between gyros in dual installations will prevent two units active on the output bus at the same time.

3-4.2.7 Servo Regulator Assembly. The Servo Regulator Assembly (see Figure 3-13), in conjunction with the Gyro Control Assembly, is the interface between the Master Compass and the CPU Assembly in the Electronics Control Unit. The Servo Regulator Assembly receives CPU signals that control start-up of the gyro motor and slewing of the servo motor. The Servo Regulator Assembly also sends signals via the Gyro Control Assembly to the CPU that monitor the tilt sensor level, azimuth pick-off error, phase A current sense, 24VDC overvoltage, and the gyro wheel speed signal.

The Servo Regulator Assembly is the only card not located in the card rack. It is mounted on the side of the card rack and plugs into J12 of the motherboard. The assembly also has connectors J2 & J3 for interfacing to the Master Compass. A chassis-mounted toroidal transformer, T968544, is also part of the Servo Regulator Assembly and plugs into connector J4.

The Servo Regulator Assembly consists of a number of circuits, including a DC-DC converter, an AC-DC inverter, a modulator/demodulator for the level, a servo motor driver, a wheel speed sensor, and numerous control relays.

The DC-DC converter is a switching regulator (VR1) that takes the incoming 24 vdc supply and converts it to approximately 19.2 vdc. The regulator will hold the 19.2 vdc as long as the input power remains above 22 vdc. If input voltage falls below 22 vdc the regulator will track the input. The regulator has short circuit current limiting set to approximately 6 amps.

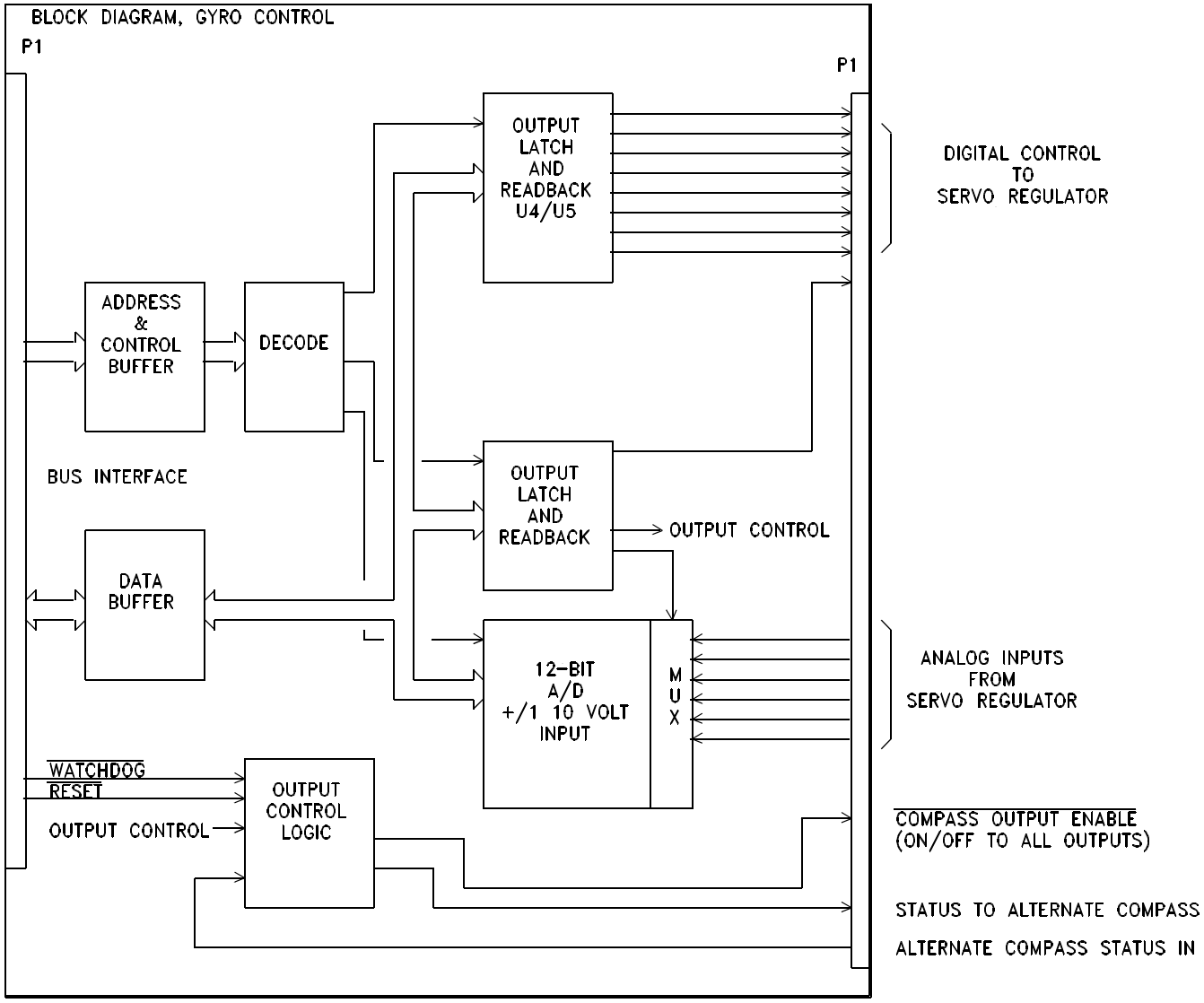


Figure 3-12. Gyro Control Assembly Functional Diagram

The DC-AC inverter converts the regulated 19.2 vdc from the switching regulator into 115 VAC 400 Hz. Pulse width modulator U5 drives the FETs in a push-pull configuration connected on a center-tapped torroidal transformer, T968544. The switching frequency is 400 Hertz. The transformer has a turns ratio of approximately 1 to 6, providing a step up in voltage. The FETs used to drive the transformer have a “Kelvin” provision to sense load current. The two sense lines are combined into one signal which is monitored by the pulse width modulator. The current limit is set at 4.5 amps.

The tilt sensor circuit consists of an oscillator/driver that creates an AC excitation for the level in the Master Compass. The excitation to the level must have no DC components or the level would be damaged. (Never try to read the resistance of the level.) The center tap of the level is fed back to the Servo Regulator Assembly. This output is synchronously sampled using the excitation voltage as a reference and a phase sensitive DC signal is produced.

The gyro motor start circuit consists of two power relays and current transformer T3. Under CPU control, relay K3 applys phase A AC voltage to the motor and relay K4 switches the start capacitor into the motor circuit. The start capacitor is added whenever the gyro motor is coming up to full speed. Current transformer T3 is inserted in the phase A line to produce a voltage proportional to phase A current. The AC voltage is rectified into a DC signal suitable for monitoring by the CPU Assembly. The CPU Assembly monitors the drop-in motor current to determine when the motor is up to operational speed and then removes the start capacitor from the circuit.

The compass followup consists of a servo amplifier circuit to provide demodulation of the pick-off error signal from the Master Compass and the drive to the AC servo motor in the Master Compass. Relay K5 is used to apply the fixed field to the servo motor. Analog switches with control lines from the CPU Assembly are used to slew the servo motor clockwise or counterclockwise for prepositioning the compass in azimuth during start-up. The CPU Assembly can also open or close the servo loop or change the slew rate.

The Servo Regulator Assembly can also check the gyro wheel speed at start-up. This function is needed to determine if the operator is performing a "cold" start or a "hot" start. The speed sense circuit takes the low amplitude AC waveform (back emf) generated by the gyro wheel motor during free spin and converts it into a logic pulse suitable for the CPU Assembly. The wheel speed is proportional to the frequency of the waveform. However, this monitoring function can only be used when power is not applied to the gyro wheel motor. Isolation relay K6 is used to connect the monitor circuit to the phase A and phase C inputs of the gyro wheel motor at start-up and then break the connection during normal operation.

The Servo Regulator Assembly also provides the phase A and phase B 115 VAC 400 Hz reference as an output for both internal and external use. The square wave is routed through a simple filter. A fuse is provided for external connections.

The start-up procedure for the Servo Regulator Assembly is approximately as follows:

After the CPU Assembly completes its self-test and initialization it will set the ENABLE INVERTER signal high, turning on the 400 Hertz. It will set the EN_SERVO signal high to disable the servo loop (normal followup) and set the RLY_ENABLE signal high for one second to sample the back emf and determine if a "cold" or "hot" start is required. For a "cold" start, the CPU will wait five minutes for the operator-entered heading (the operator can override this). The CPU will then check the polarity of output signal TILT_METER. If the tilt is negative the CPU will add 30° to the operator-entered heading and if the tilt is positive the CPU will subtract 30°. This will aid the settling process.

Next, the CPU will slew to the heading as determined above. It does this by setting the SLEW_FAST signal high for normal speed, EN_SLEW signal high for slewing, and the EN_FIX_FLD signal high to turn on the fixed field to the servo motor. Then, to actually slew the system to the heading, the CPU will either set the EN_SLEW_CW or EN_SLEW_CCW signal high, depending on which direction is shorter, clockwise or counterclockwise. Once on the heading, the CPU will disable the EN_SLEW, EN_FIX_FLD, EN_SLEW_CW, and EN_SLEW_CCW signals.

The next step is for the CPU to start the gyro wheel motor. It does this by setting the EN_SPIN_MOTOR signal high to energize the motor, and setting the EN_START_CAP signal high to enable the start capacitor. After approximately eight minutes the wheel should have sufficient speed that the CPU will set the EN_START_CAP signal low to disable the start capacitor. After approximately six minutes the wheel should be at its running speed and the CPU will read output signal TILT_METER. If the output is greater than two volts, the CPU will start the Auto Level.

For Auto Level, the CPU will set the EN_FIX_FLD signal high to turn on the fixed field to the servo motor, set the EN_SLEW signal high for slewing, and set the EN_SLEW_CW signal high if the tilt is positive (or EN_SLEW_CCW high if the tilt is negative). Once the tilt goes negative the CPU will set the EN_SLEW_CW signal low and the EN_SLEW_CCW high to drive the tilt back to positive. The CPU will toggle the two signals back and forth for approximately four minutes, keeping the maximun tilt voltage less than or equal to ± 1 volt. It does this for four minutes to level out the ballistic fluid. At the end of four minutes, the CPU sets the EN_SLEW, EN_SLEW_CW, and EN_SLEW_CCW signals low to disable them. It then sets EN_SERVO low to enable the servo loop (normal followup).

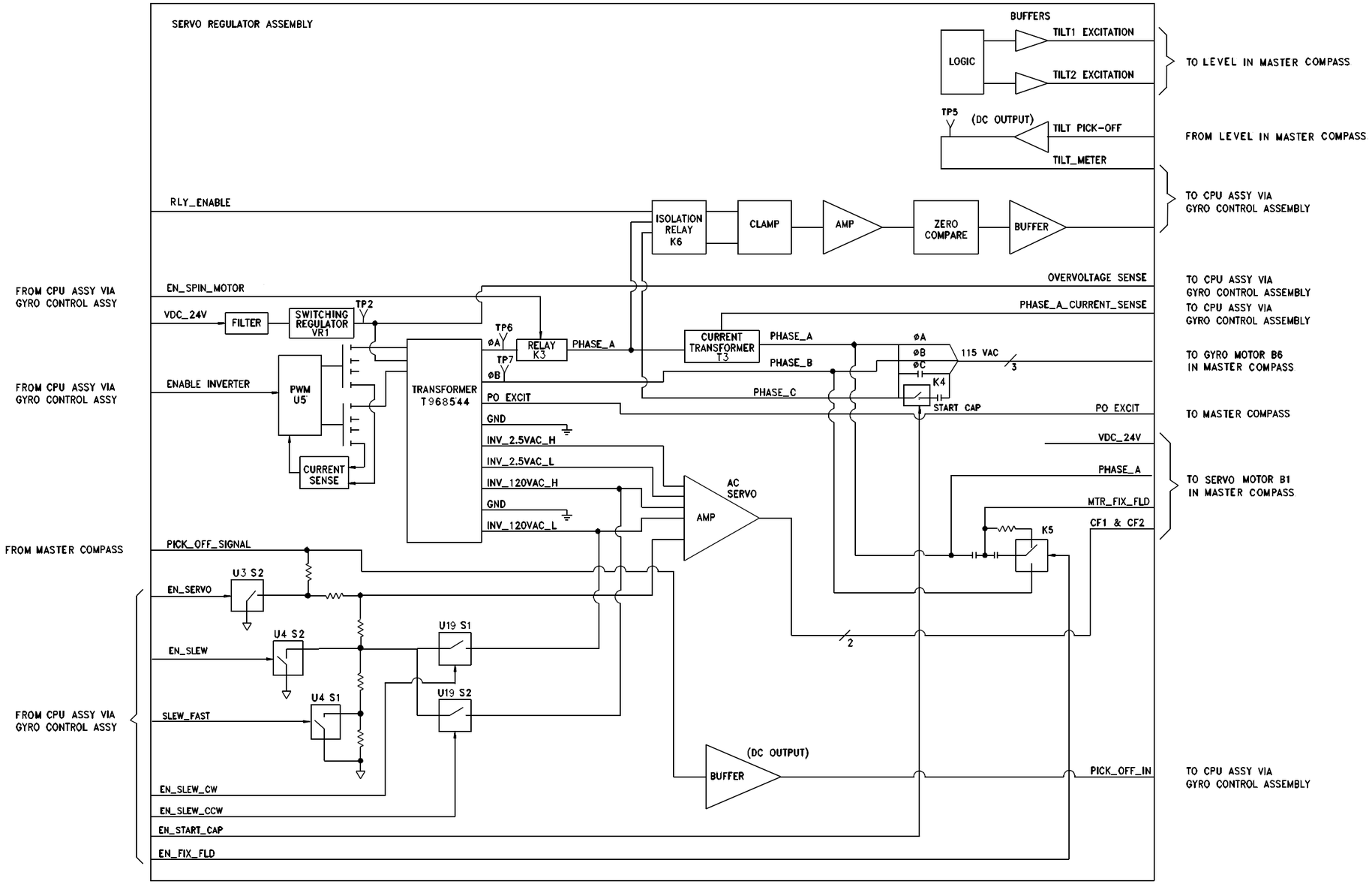


Figure 3-13. Servo Regulator Assembly Functional Diagram

3-4.2.8 AC/DC Power Supply Assembly. The AC/DC Power Supply Assembly (see Figure 3-14) controls the switching to a backup supply due to a loss of power on the primary AC input. Transfer to the 24 volt backup is through a steering diode and relay that switches the positive line to provide full electrical isolation.

The AC/DC Power Supply Assembly provides Power Fail relay contacts as an output. As long as either the AC or DC input is present, relay K2 is energized. When the power drops to below the relay hold voltage of 16.8 VDC, the relay de-energizes. The normally-closed contacts and the normally-open contacts indicate that no power is available. An audio alarm sounds and the FAULT alarm lamp illuminates on the Display Assembly.

3-4.2.9 Motherboard I/O Assembly. The Motherboard Input/Output (I/O) Assembly (referred to as the motherboard) (see Figure 5-4) consists of a multilayer backplane with connectors that route the data for signal processing to control the gyrocompass. The motherboard also routes the power required to operate the internal circuitry of the MK 37 VT to the appropriate circuit boards within the Electronics Control Unit and to the Display Assembly. All signals and data transfer are also routed through the motherboard. The data bus on the motherboard is controlled by the Central Processor Unit (CPU). The interface of input and output data from the Electronics Control Unit motherboard to the externally connected equipment is through terminal board TB1.

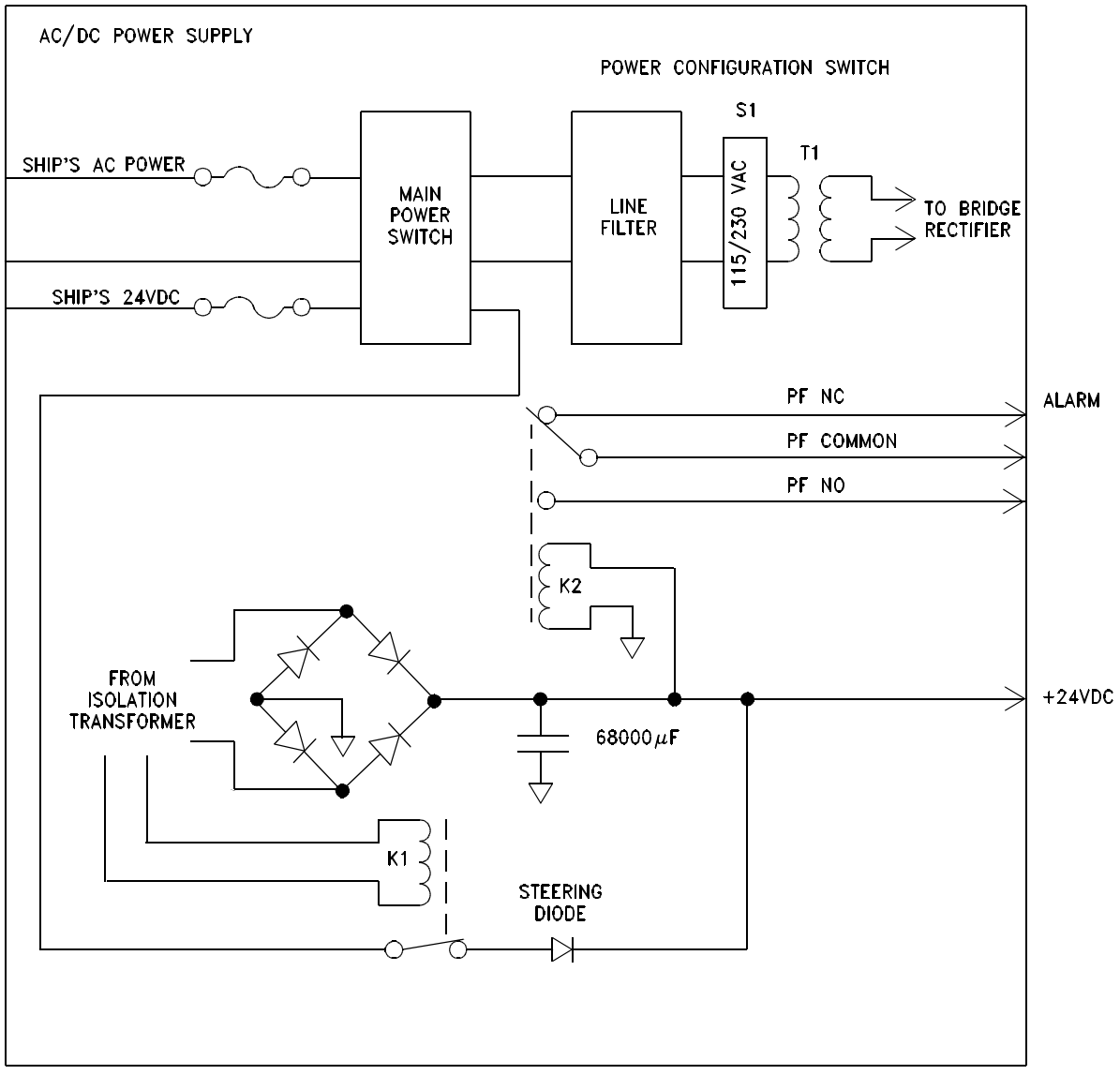


Figure 3-14. AC/DC Power Supply Assembly Functional Diagram

3-4.2.10 Course Recorder Assembly (Optional Equipment). The Course Recorder option card (see Figure 3-15) contains 256K bytes of nonvolatile RAM (NOVRAM), a complete clock/calendar circuit, an analog-to-digital converter (ADC), and a DUART for serial communications with a printer and the alternate compass (to support a compass comparator function). Software determines if the Course Recorder option is present by reading the CPU's TPU Channel 2 at power-up.

NOVRAM is composed of two memory modules. Each module is a composite unit consisting of 128K bytes of very low current CMOS static RAM, a dual lithium battery, and a power switchover circuit to retain data when power is removed. The Course Recorder's NOVRAM is removable at the board level for factory analysis.

The clock/calendar circuit is an integrated clock/calendar circuit and RAM module with battery backup. The module includes a time base and a power switchover circuit. The time-keeping function remains active when normal operating power is removed. The clock/calendar circuit provides seconds, minutes, hours, day, month, and year.

One of the DUART channels is configured for RS-232 operation and drives the external dot matrix printer in the graphics mode. A Clear-To-Send (CTS) handshake input is provided along with the transmitted data line (TXD). The DUART's output is controlled by the Compass Output Enable line. The second DUART channel is used during the compass comparator function. The secondary compass sends heading data to the primary compass for comparison.

The Course Recorder Assembly also has a dual A/D converter channel. The 8-bit data can be stored in nonvolatile memory and/or sent to the hard-copy device for printing. These channels are intended for logging rudder position or rudder angle. The full scale interpretation of the analog value is adjustable from 20 to 70 degrees with 1 degree resolution for storage.

The Course Recorder Assembly generates voltages of +15 VDC and -15 VDC for the rudder repeatback excitation signals. The repeatback potentiometers must be 1K ohm or larger. The repeatback circuit is also protected against short circuits.

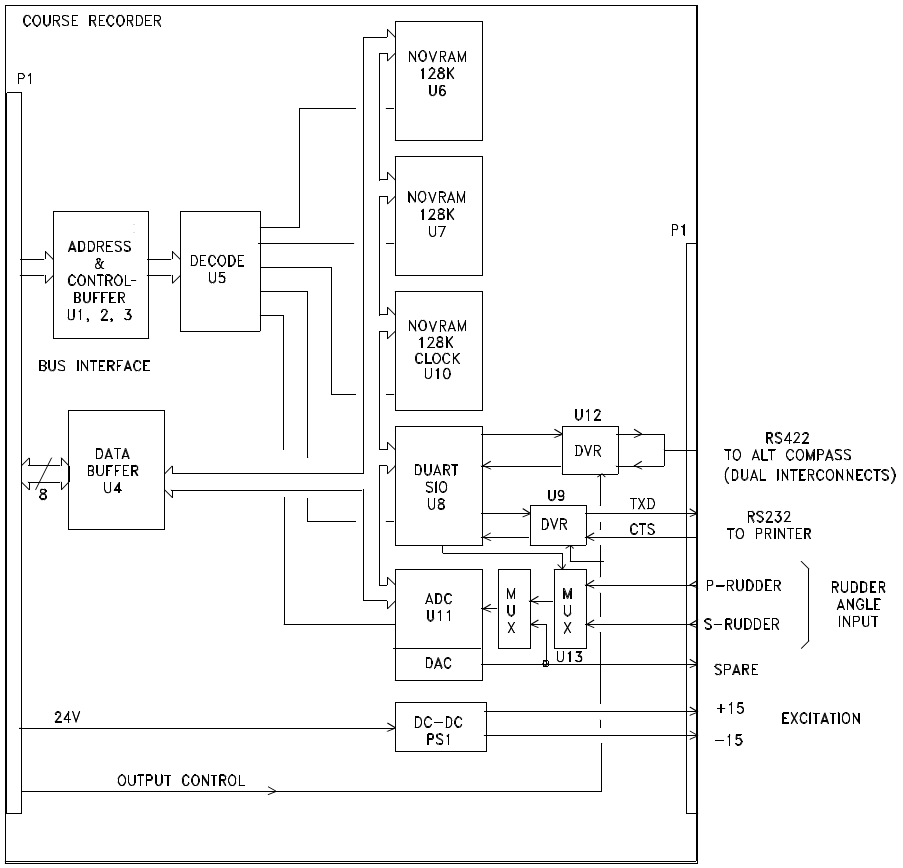


Figure 3-15. Course Recorder Assembly Functional Diagram

3-4.2.11 Digital-To-Synchro Assembly (Optional Equipment). The Digital-To-Synchro Assembly (see Figure 3-16) converts digital azimuth data to 1X synchro format for 1X synchro repeaters or other applications that require a 1X synchro output. The Digital-To-Synchro Assembly converts 14 data bits to 90 volt line-to-line synchro data using 115 VAC at 400 Hz as a reference. The output stage uses power from the reference input and is rated at 4 VA. This reduces the load requirements on the internal MK 37 VT power DC-DC converter. The Digital-To-Synchro Assembly only uses about 25 mA each from the ±15 volts available through the backplane supply.

The power output stage employs current limiting for short circuit protection along with overvoltage transient protection. A thermal cutoff protects the circuitry from high temperatures due to excessive current. To support the dual compass mode, all signals must be routed through an external relay for switched output. The switch on the front panel of the circuit board disables the output.

The output of the Digital-To-Synchro Assembly is controlled by either the Compass Output Enable line or a signal from the main processor. This control line enables the outputs when the compass is functioning properly. One bit of a latched register allows the processor to override the output enable and shut off the output relays regardless of the state of the Compass Output Enable signal.

3-4.3 Display Assembly Circuits. The Display Assembly (see Figure 3-17) consists of a bus interface, a controller PAL, LCD interface, audio alarm and fault lamp circuit, encoder interface, parallel-to-serial shift registers, four serial load LED display drivers and their associated LEDs, and a number of backlight LEDs.

The bus interface circuit consists of termination resistors and buffer ICs to clean up the signals after the trip through the interface cable. The termination resistors are used to minimize reflections. Interleaved grounds are also used to maintain signal integrity.

The display ICs use a 16-bit serial interface. Data is transferred into the part by a load signal. The processor loads the four LED display drivers in a single 64-bit serial transfer. A common clock and load signal is routed to all four drivers in parallel while the data is cascaded from one unit to the next in a serial fashion. Serial data originates on the CPU Assembly.

The interface to the LCD module is a direct connection to the buffered parallel data bus. The least significant address line is used to select between command and data operations. The backlighting of the LCD is by pulse width modulation of the backlight.

The audio alarm and fault lamp circuits are powered by the +5 volt standby supply. This circuit indicates a fault if the processor crashes (sensed via the watchdog timer) or if a power failure occurs when the system is turned on. The alarm sounds for at least 10 minutes and the MUTE key is used to silence the alarm. The piezo alarm is set for 2 KHz. The audio alarm does not have volume control and the fault lamp does not have intensity control.

The keyboard interface is an X-Y scan matrix. The processor scans the X select lines and monitors each of the Y return lines sequentially looking for a key press. When a key is pressed, the X select gets transferred to a particular Y line. The processor selects an X line by placing a logic 0 on that line while all of the others remain at logic 1. Since the MUTE switch must work in a power fail condition, it is not in the scan matrix.

Serial input LED display drivers are used to control the LEDs. The drivers provide intensity control and decode/no-decode control on a digit basis. The backlighting LEDs are used to illuminate legends and keys on the display board. Backlighting is intensity controlled by pulse width modulation from the CPU. The backlight LEDs are powered by the +5 volt supply.

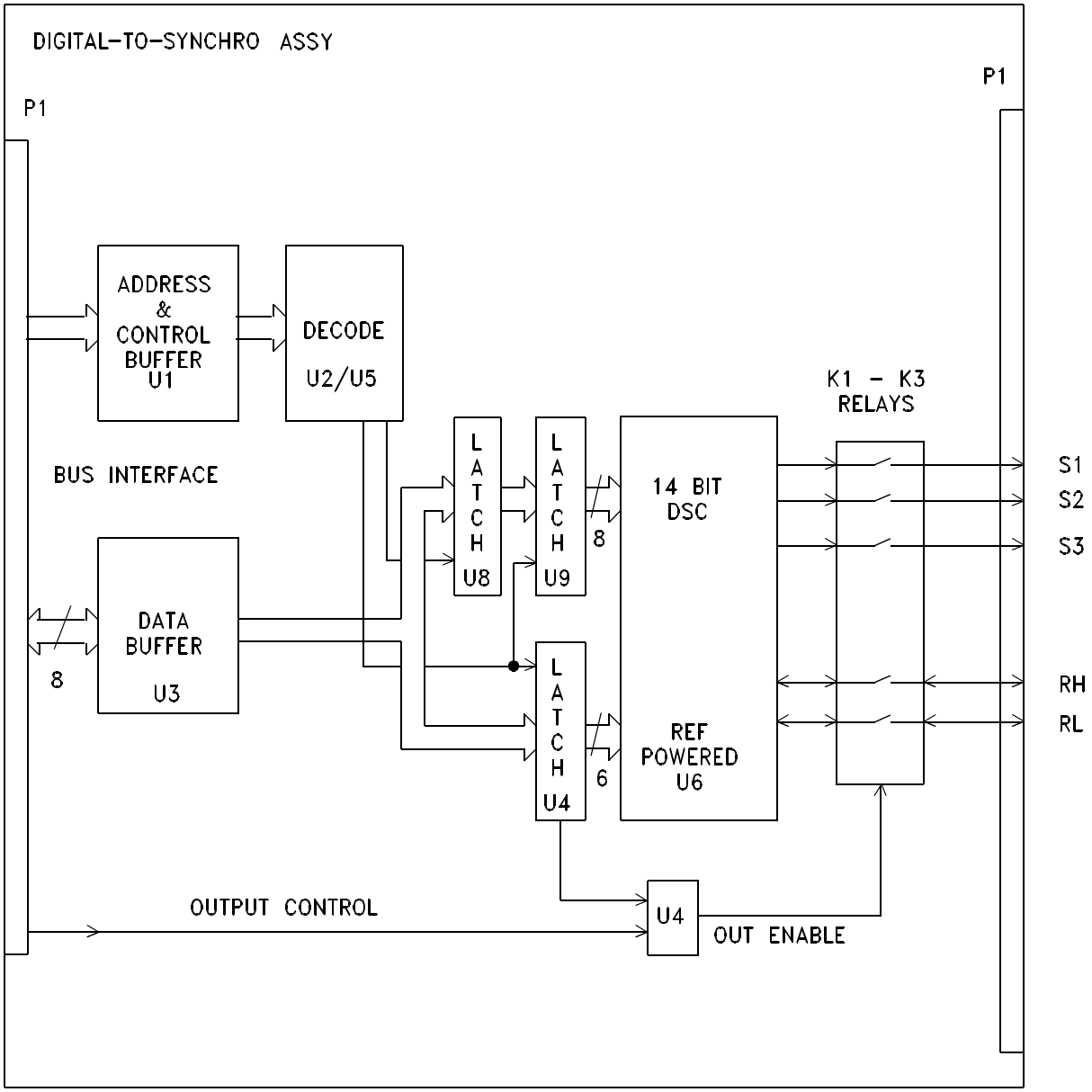


Figure 3-16. Digital-To-Synchro Assembly Functional Diagram

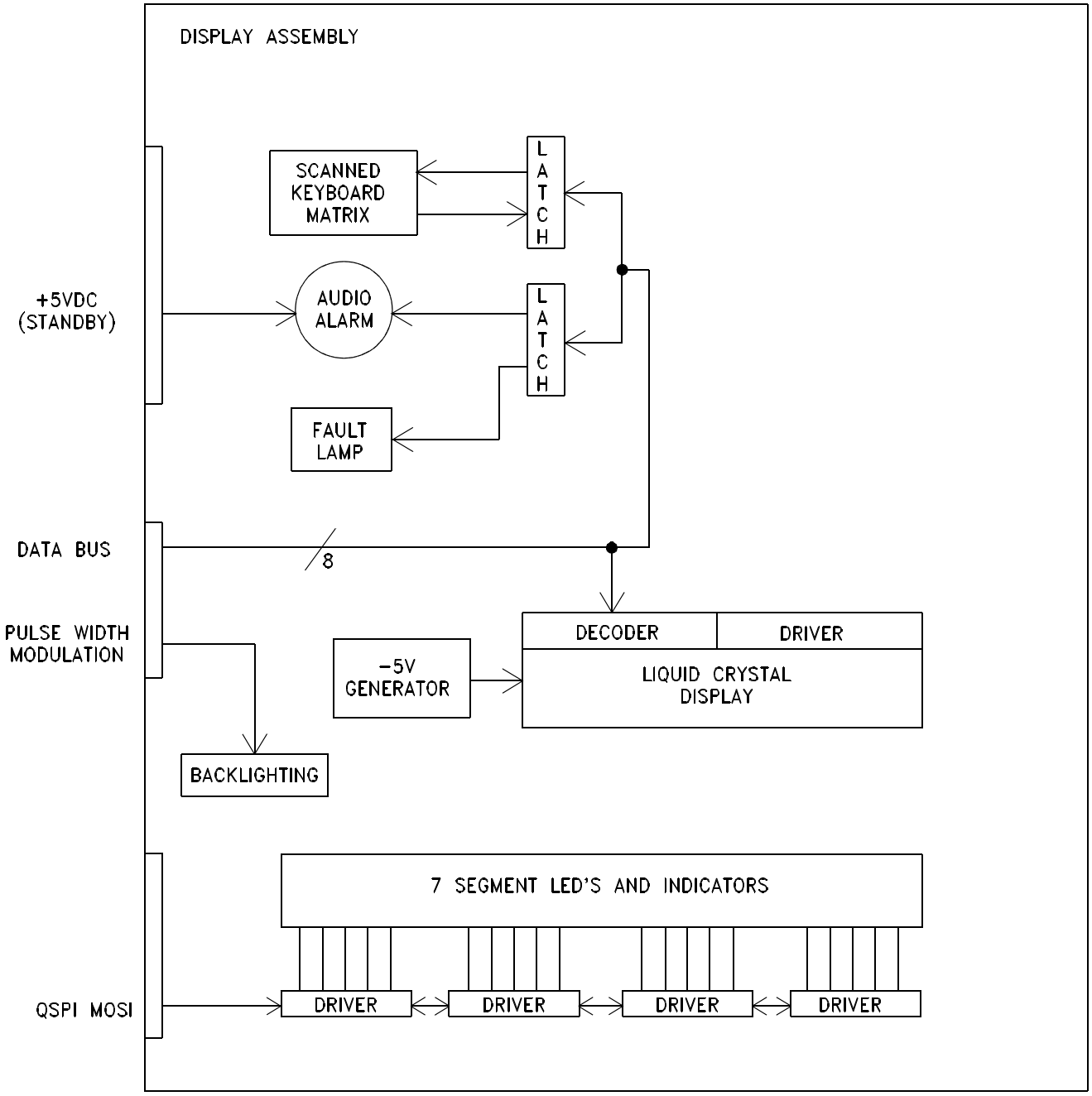


Figure 3-17. Display Assembly Functional Diagram

CHAPTER 4

SCHEDULED MAINTENANCE

4-1 INTRODUCTION.

This chapter provides information concerning scheduled maintenance procedures for the MK 37 VT Digital Gyrocompass Equipment.

4-2 PREVENTIVE MAINTENANCE PROCEDURES.

The inspections listed in Table 4-1 are to be performed with the frequency indicated to assure proper operation of the gyrocompass equipment.

Table 4-1. Visual Inspection Checks

Inspect or Check	Frequency	Indication Desired	Corrective Action
MASTER COMPASS			
Shock mounts	Weekly	Binnacle free in its shock mounts	Check for dirt and obstructions; be sure that cable from Binnacle is free and flexible
Master Compass	Weekly	No indication of oil seepage around any seam or seal	Tighten screws on Binnacle cover

4-3 CLEANING INSTRUCTIONS.

The Master Compass is completely sealed and, therefore, requires no cleaning internally. Each month, however, any accumulated dirt and oil on the exterior surface should be removed. This can be done using a lint-free cloth moistened with mild soap and water to remove oil deposits. Particular attention should be given to shock mounts to ensure that dirt has not accumulated in this area. The Electronics Control Unit should be cleaned externally in the same manner as the Master Compass.

CHAPTER 5

TROUBLESHOOTING

5-1 INTRODUCTION.

This chapter contains troubleshooting information that will enable the technician to isolate malfunctions associated with the MK 37 VT Digital Gyrocompass Equipment. The fault isolation information contained in this manual supports the maintenance concept of shipboard maintenance. Accordingly, the information contained in this chapter will aid in isolating malfunctions to the circuit board level and to the chassis-mounted modules and parts.

5-2 TROUBLESHOOTING PROCEDURES.

Paragraphs 5-2.1 through 5-2.5 contain the troubleshooting data for the MK 37 VT Digital Gyrocompass Equipment.

5-2.1 Turn-On and Checkout Procedure. The maintenance turn-on and checkout procedure contained in Table 5-1 is used to energize the MK 37 VT Digital Gyrocompass Equipment from the fully de-energized condition to full operation. Information used for isolating malfunctions when performing this procedure is contained in Table 5-4, MK 37 VT Digital Gyrocompass Equipment Fault Codes.

5-2.2 Trouble Analysis. Table 5-2 is the trouble analysis chart for the MK 37 VT Digital Gyrocompass Equipment. This chart supplements the information contained in the maintenance turn-on and checkout procedure and the fault logic diagram in the event a failure exists with the equipment.

5-2.3 Supplemental Troubleshooting Data. Table 5-3 lists the potentiometers, test points, and switches in the Electronics Control Unit that are used for calibrating the Electronics Control Unit.

5-2.4 Fault Codes. Table 5-4 lists all of the fault messages that might appear when operating the MK 37 VT Digital Gyrocompass Equipment. The information in the "Appropriate Action or Explanation" column provides the location of information that will aid the technician to correct faults associated with the particular fault code. Procedures for responding to fault codes are contained in Chapter 2, Operation.

5-2.5 Master Compass Continuity and Resistance. Table 5-5 is a continuity and resistance table for the Master Compass. This table should be used to help verify suspected failures inside the Master Compass before the unit is opened for repair. Table 5-7 lists the Master Compass interconnection signals.

5-3 TROUBLESHOOTING DIAGRAMS.

Table 5-6 lists the fault logic diagram and the schematic diagrams contained in this chapter.

Table 5-1. MK 37 VT Digital Gyrocompass Equipment Maintenance Turn-On and Checkout Procedure

Step	Procedure	Observation	Reference
1.	Initial Turn-On Procedure		
	Apply power to the system by energizing the Electronics Control Unit.	The system will go through an internal BITE and check the power supplies and hardware components. Pressing the MUTE switch will clear any alarm and display the cause for the fault.	Paragraph 2-3.1
2.	Lamp Test		
2a.	Press and hold the TEST switch.	All displays and indicators on the Display Assembly are lit and the audible alarm sounds for one second. LED displays show "8"s and the LCD has all the pixels lit.	Paragraph 2-2
2b.	Release the TEST switch.	The indicators and the displays return to the state prior to when the TEST switch was pressed.	Paragraph 2-2
3.	Dimmer Test		
3a.	Press and hold the Intensity ▲ switch.	The indicators and displays on the Display Assembly increase to maximum brightness and darkens brightness of back panel lighting.	Paragraph 2-2
3b.	Press and hold the Intensity ▼ switch.	The indicators and displays on the Display Assembly decrease to minimum brightness and increases brightness of back panel lighting.	Paragraph 2-2
3c.	Set the intensity of the control panel to the desired level using the Intensity ▲ or ▼ switches.	The control panel intensity changes when the appropriate switch is pressed.	Paragraph 2-2
4.	LCD Display Scroll Switch Test		
	Press Scroll ▼ switch.	Display data scrolls through menu options.	Paragraph 2-2

Table 5-2. MK 37 VT Digital Gyrocompass Equipment Trouble Analysis Chart

Symptom	Probable Cause	Remedy
Unable to print Course Recorder historical data	If date or time is changed (decreased) during normal operation, the ability to print historical data may be unusable until 27 hours after the time or date was changed.	It is not advisable to modify date or time during normal operation.
Rudder data line prints on the edge of the rudder graph or is missing (no data)	Rudder print range probably configured smaller than the maximum or minimum achievable rudder angles.	Rudder print range should be set at installation to encompass all possible rudder angles. Contact the Sperry Marine Inc. field service department to provide corrective actions.
While printing Course Recorder historical data, a time gap greater than 10 minutes is present	When a historical time is requested that is newer than some samples in memory, but which cannot be located because the system was off during that time, the printout will begin with the last 10 minute header data stored prior to the entered time. As printing continues, a time gap greater than 10 minutes will be noticed at the next 10 minute header.	None. This is normal operation. Subsequent 10 minute header data will be 10 minutes apart as usual.
Question marks (????) are printed instead of graphic characters on a graphic print or a strange font on a tabular print	If the printer is accidentally turned off during operation, the system will normally re-initialize the printer when power is restored. If the printer is off for a very short time (less than 2 seconds) so that the MK 37 VT has not detected the problem and issued an alarm, the printer may not recover.	Turn printer off at the MK 37 VT panel and restart. The printer should be turned on and remain on at all times.
Printer output in the wrong font or wrong characters	One of the printer buttons may have been pressed. The only buttons that should be pressed are: 1. LF/FF to load and remove paper 2. ON/OFF (Operate) All other buttons should not be pressed.	Turn printer off at the MK 37 VT panel and restart. The printer should be turned on and remain on at all times.
Course Recorder historical printout is in current time	Possible printer fault or momentary loss of power	Restart the printer at the MK 37 VT Display Assembly
Course Recorder does not print	Printer may not be on. Paper may not be loaded. Printer cable may not be connected to serial port.	Verify that printer power is on, paper loaded, and that the printer cable is attached to the serial port.

Table 5-2. MK 37 VT Digital Gyrocompass Equipment Trouble Analysis Chart (Continued)

Symptom	Probable Cause	Remedy
Course Recorder leaves a blank page every 8-10 inches or has paper feed problems	Printer Paper-Release lever not in the middle, push-tractor position	Place lever in the middle position for push tractor installation.
Repeater does not follow MK 37 VT heading	Repeater channel may not be on or not synchronized to the MK 37 VT heading.	Check repeater switch on Step Driver Assembly. Make sure repeater is synchronized to the MK 37 VT Gyrocompass.
Speed value does not change	Speed selection may not be in AUTO.	Verify that Speed Menu selection is in AUTO. Check for faults on serial channel.
Latitude value does not change	Latitude selection may not be in AUTO.	Verify that Latitude Menu selection is in AUTO. Check for faults on serial channel.
Manual transfer (Dual system) does not occur	Other system may not be powered, attached, or may have a critical fault. Manual transfer must be initiated from the Primary compass only.	Verify that other system is powered, attached, and does not have a critical fault.
Unit makes buzzing sound for at least 15 minutes after being turned on	If sound persists longer than 15 minutes, the AC/DC Power Supply Assembly relay is bad.	Replace AC/DC Power Supply Assembly.

Table 5-3. Electronics Control Unit Potentiometers, Test Points, and Switches

Potentiometer, Switch, or Test Point	Figure Number	Descriptive Name	Function
A3TP1	6-4	DAC VOUTA (analog)	Not used
A3TP2	6-4	DAC VOUTB (analog)	50 mV per deg/min
A4TP1	6-5	OUTPUT_READ	Normally high
A4TP2	6-5	D0 (BIT flag output)	Normally high
A4TP3	6-5	GROUND	-
A5TP1	6-6	ANALOG	Factory Test Only
A5TP2	6-6	~~CPU_RESET~~	Normally high
A6S1, A7S1	6-7	Repeater (4 Channel) Switches	OPEN (up) - removes +24 vdc from repeater channel CLOSED (down) - applies +24 vdc to repeater channel
A6S2, A7S2	6-7		OPEN (up) - removes +24 vdc from repeater channel CLOSED (down) - applies +24 vdc to repeater channel

Table 5-3. Electronics Control Unit Potentiometers, Test Points, and Switches (Continued)

Potentiometer, Switch, or Test Point	Figure Number	Descriptive Name	Function
A6S3, A7S3	6-7		OPEN (up) - removes +24 vdc from repeater channel CLOSED (down) - applies +24 vdc to repeater channel
A6S4, A7S4	6-7		OPEN (up) - removes +24 vdc from repeater channel CLOSED (down) - applies +24 vdc to repeater channel
A8S1	6-8	MANUAL OUTPUT DISABLE	Switches +24V coil voltage to relays K1, K2, K3 which provide S1, S2, S3 and 115Vrms synchro data
A9TP1	6-9	+15VDC	+15 volt excitation to Rudder Repeatback (RRB) potentiometers
A9TP2	6-9	-15VDC	-15 volt excitation to RRB potentiometers
A9TP3	6-9	-5VDC	-5V supply voltage to U11 D/A converter
A9TP4	6-9	GND	Ground test point
A10TP1	6-10	-15VDC	DC/DC Converter Assembly power supply voltage test point
A10TP2	6-10	+15VDC	DC/DC Converter Assembly power supply voltage test point
A10TP3	6-10	+5VDC	DC/DC Converter Assembly power supply voltage test point
A10TP4	6-10	GND	DC/DC Converter Assembly power supply voltage test point
A11R90	6-11	Level Balance	Factory Set
A11R60	6-11	400HZ TRIM	Factory Set
A11TP1	6-11	T1 Secondary Centertap pin 8	Not used
A11TP2	6-11	VREG_20V	~19 vdc
A11TP3	6-11	Current Sense	1 vdc = 1 amp
A11TP4	6-11	CF1, Control Field Servo Motor	400 mvac minimum
A11TP5	6-11	Buffered TILT PICK-OFF	Factory Test Only
A11TP6	6-11	PHASE_A	130 vac output
A11TP7	6-11	PHASE_B	130 vac output
A11TP8	6-11	CF2, Control Field Servo Motor	400 mvac minimum
A11TP9	6-11	TILT2 EXCITATION	3450 Hz square wave

Table 5-3. Electronics Control Unit Potentiometers, Test Points, and Switches (Continued)

Potentiometer, Switch, or Test Point	Figure Number	Descriptive Name	Function
A11TP10	6-11	CW	20-60 mvac during slew
A11TP11	6-11	OUT_A	4 vac, 400 Hz square wave
A11TP12	6-11	INV_120VAC_L	120 vac
A11TP13	6-11	INV_120VAC_H	120 vac
A11TP14	6-11	OUT_B	4 vac, 400 Hz square wave
A12S1	6-12	115/230VAC SELECT	Input Voltage Select Switch on AC/DC Power Supply Assembly

Table 5-4. MK 37 VT Digital Gyrocompass Equipment Fault Codes

Fault Message		Fault Code Description	Appropriate Action or Explanation
Software PROM fails to verify	00	PROM checksum self-test failure (power-up), if checksum of memory <>0. **Critical fault**	Replace the CPU 1980697-VAR.
Software RAM fails to read/write	01	Volatile RAM read/write self-test failure (power-up), failed memory pattern test. **Critical fault**	Replace the CPU 1980697-VAR.
Panel data fails to verify	02	Nonvolatile RAM operator's data checksum self-test failure (power-up), current checksum does not equal stored checksum.	Replace the CPU 1980697-VAR. (Will also occur after software update.)
Panel LCD display busy fault	03	LCD update not complete within 60 µs of a write operation.	1. Check Display cable T968593-VAR. 2. Replace cable or Display Assembly 1980693-VAR. 3. Replace ADS 1980699 or ADIS 1982163. 4. Replace CPU 1980697-VAR.

Table 5-4. MK 37 VT Digital Gyrocompass Equipment Fault Codes (Continued)

Fault Message		Fault Code Description	Appropriate Action or Explanation
Excessive current after speed stable	11	Gyro spin motor current has failed to drop below acceptable threshold after gyro wheel has reached operational spin rate: 1. Current <120 ma Cold Start or <70 ma Hot Start 2. Current >300 ma and wheel speed <91% of steady state speed 3. Current <70 ma or >360 ma at steady state **Critical fault**	1. Replace Servo Regulator Assembly 1980715 or Toroid T968544. 2. Replace Binnacle cable or Binnacle.
Excessive pickoff voltage	12	Pickoff Error exceeds 0.353 volts when wheel is up and level **Critical fault**	1. Replace Servo Regulator Assembly 1980715 or Toroid T968544. 2. Replace Binnacle cable or Binnacle.
Heading Change Excessive	13	Heading rate exceeds 80 degrees/second for at least 2 seconds **Critical fault**	1. Replace Servo Regulator Assembly 1980715 or Toroid T968544. 2. Replace S/D Converter 1980701-1. 3. Replace Binnacle cable or Binnacle.
Gyro Control analog busy fault	14	A/D conversion not completed within 20 microseconds **Critical fault**	1. Replace Gyro Control Assembly 1980703.
Gyro Control analog test fault	15	Gyro Control Interface A/D converter fails the self-test, 5 volt supply is more than 5% out of tolerance	1. Check DC/DC Converter Assembly 1980713. 2. Replace Gyro Control Assembly 1980703.
Course Recorder analog busy fault	16	A/D conversion busy status does not drop within 12 microseconds	Replace Course Recorder 1980709.
Course Recorder analog test fault	17	Value read-back from A/D converter does not match 2 volts written to DAC within ±6%	Replace Course Recorder 1980709.
Excessive Voltage fault	18	Voltage sense exceeds 21V BIT fault (power-up), static inverter sense output >5.376 volts **Critical fault**	1. Check internal 24 vdc power. 2. Replace Servo Regulator Assembly 1980715.
Panel Data Out of Range	19	User NOVRAM data contains illegal values (power-up), specific parameters are out of range	1. Check NOVRAM settings. 2. Replace CPU 1980697-VAR.
Gyro synchro converter fault	20	Synchro/Digital Converter BIT fault **Critical fault**	1. Replace the S/D Converter 1980701-1. 2. Replace Servo Regulator Assembly 1980715 or Toroid T968544. 3. Replace CPU 1980697-VAR. 4. Replace Binnacle cable or Binnacle.

Table 5-4. MK 37 VT Digital Gyrocompass Equipment Fault Codes (Continued)

Fault Message		Fault Code Description	Appropriate Action or Explanation
Step channel 1 data failure	21	Heading repeater data is erroneous (step code read-back differs from step code sent)	1. Cycle Repeater Switch. 2. Check cables and repeater. 3. Replace Step Driver Assembly #1 in slot J5.
Step channel 2 data failure	22	Heading repeater data is erroneous (step code read-back differs from step code sent)	1. Cycle Repeater Switch. 2. Check cables and repeater. 3. Replace Step Driver Assembly #1 in slot J5.
Step channel 3 data failure	23	Heading repeater data is erroneous (step code read-back differs from step code sent)	1. Cycle Repeater Switch. 2. Check cables and repeater. 3. Replace Step Driver Assembly #1 in slot J5.
Step channel 4 data failure	24	Heading repeater data is erroneous (step code read-back differs from step code sent)	1. Cycle Repeater Switch. 2. Check cables and repeater. 3. Replace Step Driver Assembly #1 in slot J5.
Step channel 5 data failure	25	Heading repeater data is erroneous (step code read-back differs from step code sent)	1. Cycle Repeater Switch. 2. Check cables and repeater. 3. Replace Step Driver Assembly #2 in slot J6.
Step channel 6 data failure	26	Heading repeater data is erroneous (step code read-back differs from step code sent)	1. Cycle Repeater Switch. 2. Check cables and repeater. 3. Replace Step Driver Assembly #2 in slot J6.
Step channel 7 data failure	27	Heading repeater data is erroneous (step code read-back differs from step code sent)	1. Cycle Repeater Switch. 2. Check cables and repeater. 3. Replace Step Driver Assembly #2 in slot J6.
Step channel 8 data failure	28	Heading repeater data is erroneous (step code read-back differs from step code sent)	1.Cycle Repeater Switch. 2. Check cables and repeater. 3. Replace Step Driver Assembly #2 in slot J6.
Auto Level failed: 5 hour settle required	30	The Fast Settle process has failed. A normal 5 hour settle for the compass is required: 1. If tilt did not change sign during leveling and/or 2. If heading changed by more than 50 degrees	Electronics Unit was not able to erect the tilt of the compass. Must wait on normal settle to erect Tilt. Not a critical fault, however, it may indicate failures in the tilt sensing. After 5 hour settle, heading should be verified against another compass to ensure proper operation. If heading does not report correctly: 1. Replace Servo Regulator Assembly 1980715 or Toroid T968544. 2. Replace Binnacle cable or Binnacle.

Table 5-4. MK 37 VT Digital Gyrocompass Equipment Fault Codes (Continued)

Fault Message		Fault Code Description	Appropriate Action or Explanation
Excessive error between compasses	40	Difference between corrected heading values exceeds operator-set error tolerance, takes six readings, throws out the largest and takes an average of the other five (Dual compass configurations only)	One or both of the compasses may be malfunctioning or the tolerance may be too narrow for a tight turn. If a visual examination indicates that both compasses are functioning properly, try increasing the error tolerance; check Binnacle alignment.
Serial 232A-RX data input missing	50	Loss of receiver interrupts for X minutes on serial channel 232A-RX (if any NMEA 0183 installed), where X=operator-set one to sixty minutes (default is one minute)	1. Check cables between MK 37 VT and sending device. 2. Check sending device. 3. Replace ADS 1980699 or ADIS 1982163.
Serial 232A-RX data input invalid	51	Framing Error; invalid bit format (if any NMEA 0183 installed)	1. Check cable shielding. 2. Sending device's message protocol is incorrect.
Serial 232A-RX data input invalid	52	Overrun Error; input too fast (if any NMEA 0183 installed)	1. Check sending device. 2. Replace CPU 1980697-VAR. 3. Replace ADS 1980699 or ADIS 1982163.
Serial 232A-TX data output missing	53	Loss of transmitter interrupts for 1 sec after character sent	1. Replace ADS 1980699 or ADIS 1982163. 2. Replace CPU 1980697-VAR.
Serial 422B-RX data input missing	54	Loss of receiver interrupts for X minutes on serial channel 422B-RX (if any NMEA 0183 installed), where X=operator-set one to sixty minutes (default is one minute)	1. Check cables between MK37 VT and sending device. 2. Check sending device. 3. Replace ADS 1980699 or ADIS 1982163.
Serial 422B-RX data input invalid	55	Framing Error; invalid bit format (if any NMEA 0183 installed)	1. Check cable shielding. 2. Sending device's message protocol is incorrect.
Serial 422B-RX data input invalid	56	Overrun Error; input too fast (if any NMEA 0183 installed)	1. Check sending device. 2. Replace CPU 1980697-VAR. 3. Replace ADS 1980699 or ADIS 1982163.
Serial 422B-TX data output missing	57	Loss of transmitter interrupts for 1 sec after character sent	1. Replace ADS 1980699 or ADIS 1982163. 2. Replace CPU 1980697-VAR.
Serial 232C-TX data output missing	58	Loss of transmitter interrupts in CPU for 1 sec after character sent	1. Replace CPU 1980697-VAR.
Serial PRINT-TX data output missing	60	Loss of CR Channel A transmitter interrupts for 1 sec after character sent (Course Recorder option only)	1. Check cables. 2. Check if printer power is on. 3. Check printer paper supply. 4. Replace Course Recorder 1980709.

Table 5-4. MK 37 VT Digital Gyrocompass Equipment Fault Codes (Continued)

Fault Message		Fault Code Description	Appropriate Action or Explanation
Serial INTR_COM_X data input missing	70	Loss of CR Channel B receiver interrupts for 30 sec on serial channel INTR_COM_X (dual compass configuration only)	1. Check the Dual Compass cable connections J15, J16, J17. 2. Replace Course Recorders 1980709.
Serial INTR_COM_X data input invalid	71	CR Channel B Framing Error; invalid bit format (dual compass configuration only)	1. Check the Dual Compass cable shields. 2. Replace Course Recorders 1980709. 3. Replace CPU 1980697-VAR.
Serial INTR_COM_X data input invalid	72	CR Channel B Overrun Error; input too fast (dual compass configuration only)	1. Replace Course Recorder 1980709. 2. Replace CPU 1980697-VAR.
Serial INTR_COM_X data output missing	73	Loss of CR Channel B transmitter interrupts for 1 sec after character sent (dual compass configuration only)	1. Replace Course Recorder 1980709. 2. Replace CPU 1980697-VAR.
Speed Log XXXXXX data input missing	80	No VBW/VHW message received for 1 minute (during installation time out can be increased up to 20 minutes)	Check sender or the serial connection.
(Where XXXXXX is "Serial" or "Pulse" depending on configuration)		Loss of Pulse data for 5 minutes if speed of at least 8 knots has been reached.	1. Check Speed Log. 2. Replace DC/DC Converter 1980713.
Speed Log Serial data format invalid	81	Invalid VBW/VHW message format, NMEA checksum error	1. Check sender for failure or format fault. 2. Replace ADS 1980699 or ADIS 1982163.
Speed Log XXXXXX data out of range	82	Speed data is outside range (Serial, speed <1 or >103 knots; Pulse, speed >99 knots)	Check sender or the serial connection.
(Where XXXXXX is "Serial" or "Pulse" depending on configuration)			1. Check Speed Log. 2. Replace DC/DC Converter 1980713.
Speed Log Serial data input invalid	83	Speed data null or marked invalid	Check sender.
Latitude Serial data input missing	84	No GGA/GLL message received for 1 minute (during installation time out can be increased up to 20 minutes)	1. Check sender. 2. Check serial connection.
Latitude Serial data format invalid	85	Invalid GGA/GLL message format, NMEA checksum error	1. Check sender for failure or format fault. 2. Replace ADS 1980699 or ADIS 1982163.
Latitude Serial data out of range	86	Latitude data is outside of [0..80 deg N/S] range	1. Check sender for failure or format fault. 2. Replace ADS 1980699 or ADIS 1982163.

Table 5-4. MK 37 VT Digital Gyrocompass Equipment Fault Codes (Continued)

Fault Message		Fault Code Description	Appropriate Action or Explanation
Latitude Serial data input invalid	87	Latitude data null or marked invalid	Check sender.
Comparator Serial data input missing	88	No inter-compass message received for 30 seconds. (Dual installations only)	1. PRIMARY or SECONDARY compass may be faulty. 2. Check dual Compass cables T968607. 3. Replace Course Recorder 1980709.
Comparator Serial data format invalid	89	Invalid inter-compass message format (Dual installations only)	1. PRIMARY or SECONDARY compass may be faulty. 2. Check dual Compass cables T968607. 3. Replace Course Recorder 1980709.
Comparator Serial data out of range	90	Heading data from other compass is outside of [0-359.9°] range (Dual installations only)	1. PRIMARY or SECONDARY compass may be faulty. 2. Check dual Compass cables T968607. 3. Replace Course Recorder 1980709.
Comparator Serial data input invalid	91	Other compass is reporting settled but heading data null (Dual installations only)	1. PRIMARY or SECONDARY compass may be faulty. 2. Check dual Compass cables T968607. 3. Replace Course Recorder 1980709.

Table 5-5. Master Compass Continuity and Resistance

From	To	Resistance	Comments
J1-R	J1-UU	25 ±5 ohms	C to B (gyro wheel)
J1-UU	J1-T	25 ±5 ohms	C to B (gyro wheel)
J1-V	J1-W	120 ±25 ohms	FF (azimuth motor B1)
J1-X	J1-Z	10 ±2 ohms	CF1 to CF2 (B1)
J1-Z	J1-Y	5 ±1 ohms	CF2 to CF3 (B1)
J1-X	J1-Y	5 ±1 ohms	CF1 to CF3 (B1)
J1-RR	J1-MM	640 ±100 ohms	P.O. Sig. (T1)

Table 5-6. Drawing Index

Drawing Type	Figure Number
Electronics Control Unit Schematic Diagram	5-1
Master Compass Schematic Diagram	5-2
MK 37 VT Gyrocompass Fault Logic Diagram	5-3
MK 37 VT Motherboard I/O Schematic Diagram	5-4

Table 5-7. Master Compass Interconnect

From	Signal Name		To
P1-RR	P.O. SIG		J3-2
P1-MM	SIG COMMON		J3-3
P1-U	P.O. EXCITE		J3-4
P1-R	PHASE C		J3-5
P1-UU	PHASE B	GYRO MOTOR	J3-6
P1-T	PHASE A		J3-7
P1-V	PHASE A		J3-8
P1-W	MOTOR FF		J3-9
P1-Y	MOTOR CF3	SERVO MOTOR	J3-11
P1-Z	MOTOR CF2		J3-12
P1-X	MOTOR CF1		J3-13
P1-JJ	TILT 1		J3-16
P1-LL	TILT 2		J3-17
P1-NN	LEVEL SIG		J3-18
P1-K	S1		J2-8
P1-J	S2		J2-9
P1-F	S3		J2-10
P1-EE	R1		J2-11
P1-FF	R2		J2-12

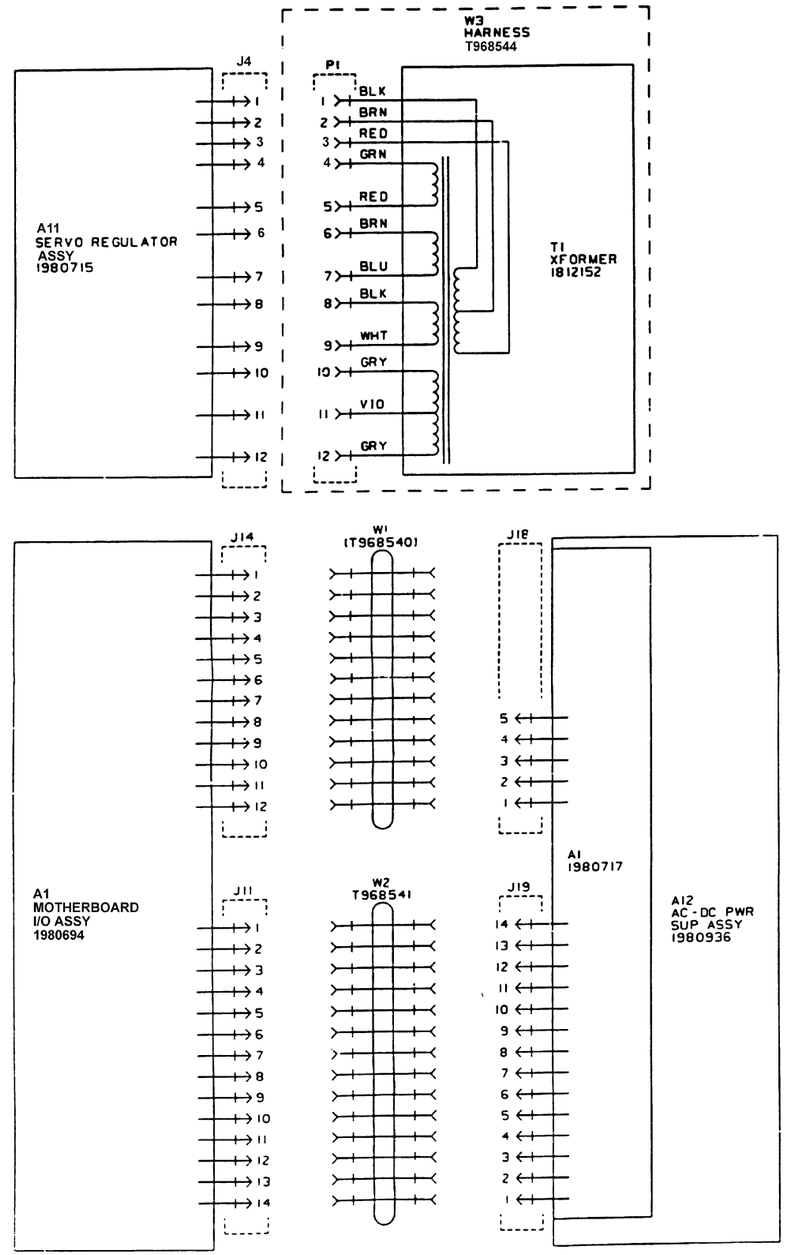
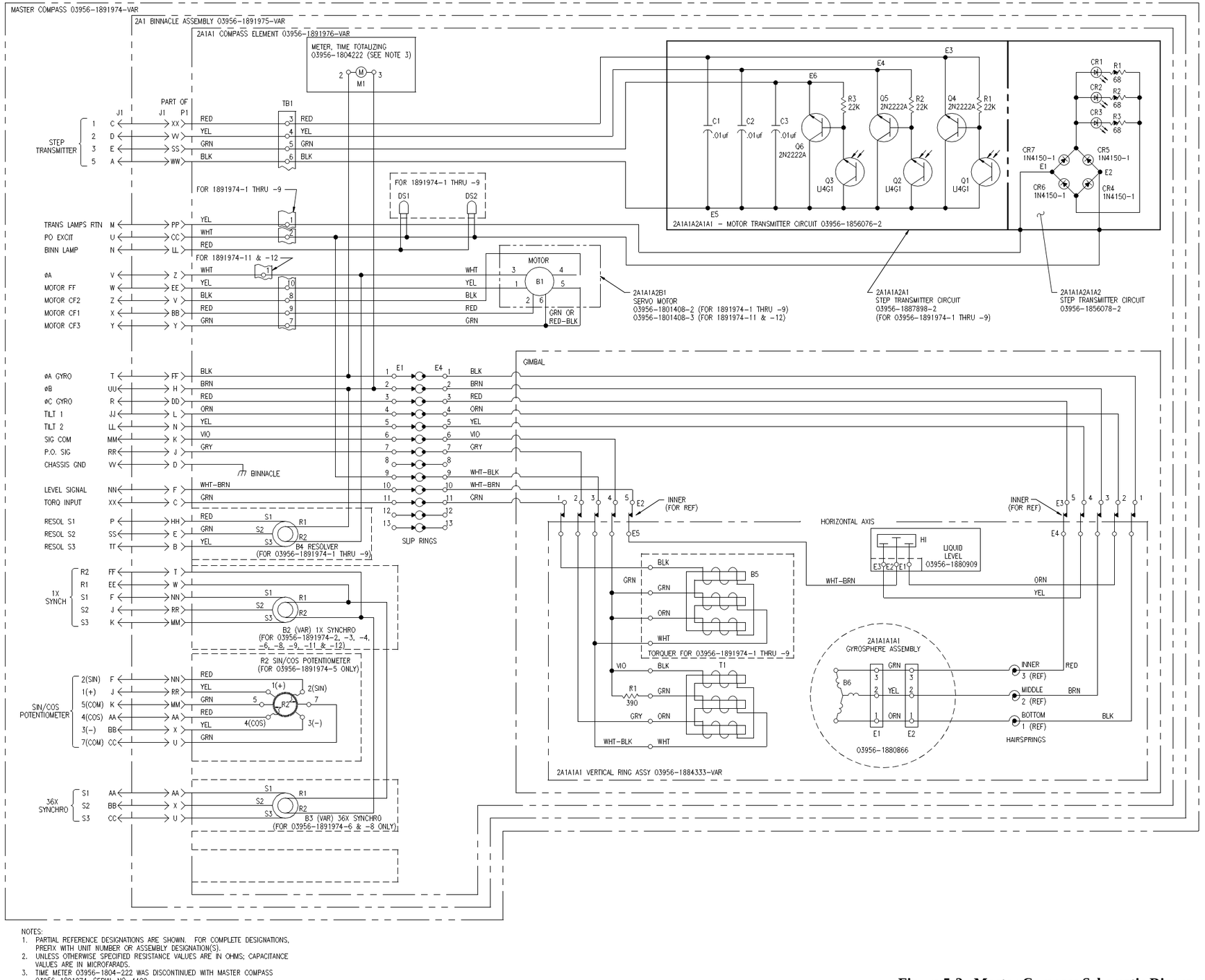


Figure 5-1. Electronics Control Unit Schematic Diagram

1980690 (Sheet 3)



NOTES:
1. PARTIAL REFERENCE DESIGNATIONS ARE SHOWN. FOR COMPLETE DESIGNATIONS, PREFIX WITH UNIT NUMBER OR ASSEMBLY DESIGNATION(S).
2. UNLESS OTHERWISE SPECIFIED RESISTANCE VALUES ARE IN OHMS; CAPACITANCE VALUES ARE IN MICROFARADS.
3. TIME METER 03956-1804-222 WAS DISCONTINUED WITH MASTER COMPASS 03956-1891974, SERIAL NO. 4499.

Figure 5-2. Master Compass Schematic Diagram

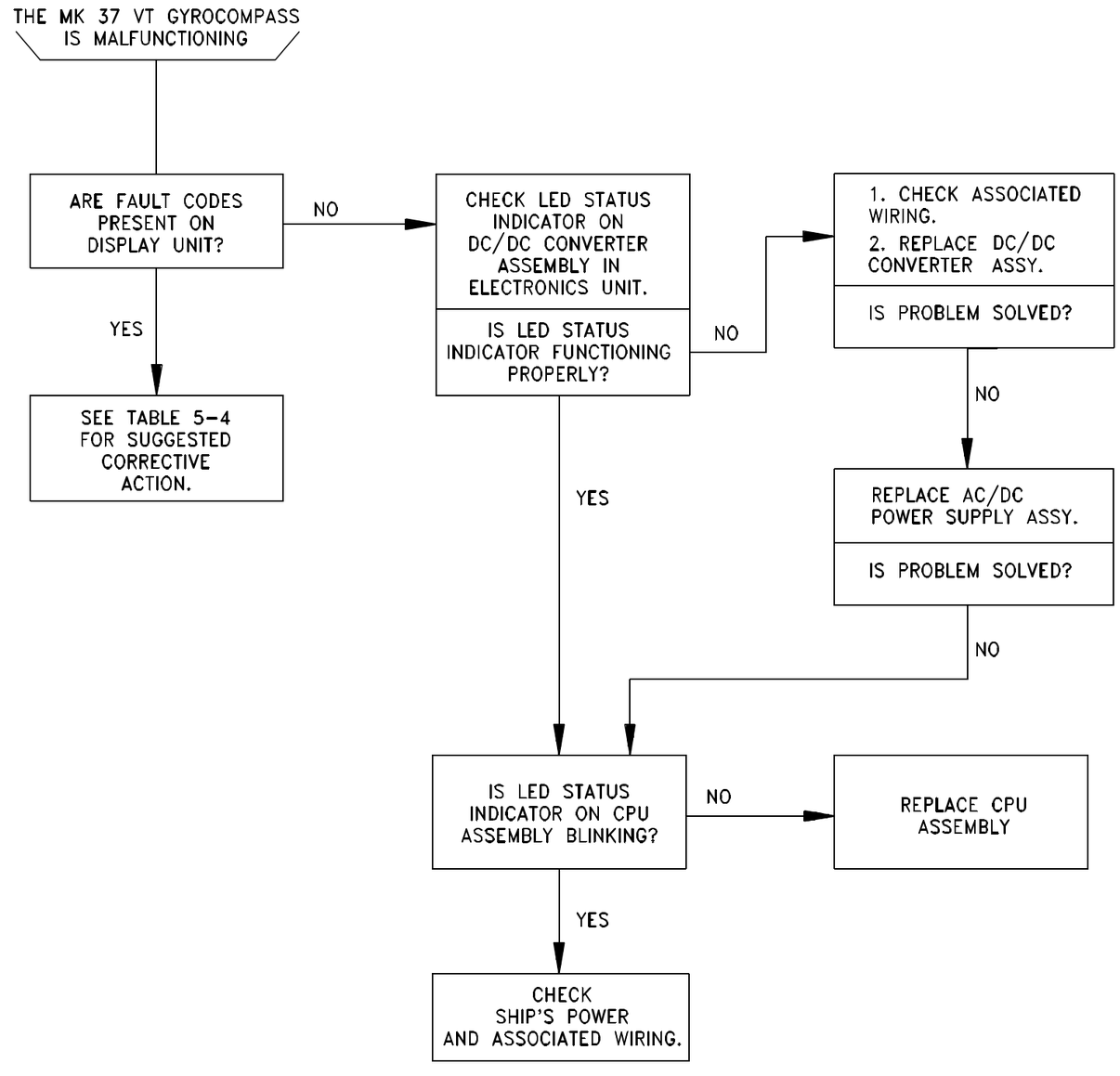


Figure 5-3. MK 37 VT Gyrocompass Fault Logic Diagram

CONNECTOR SIGNALS

J13 DISPLAY I/O	
1	+5VLED
2	+5VLED
3	+5VLOGIC
4	LED_RTN
5	LED_RTN
6	INTENSITY_PWM
7	+5V_STBY
8	
9	MOSI
10	RELAY_ON/$\overline{\text{OFF}}$
11	SERIAL CLOCK
12	$\overline{\text{WDO}}$
13	LGROUND
14	FB-D0
15	FB-D1
16	FB-D2
17	FB-D3
18	LGROUND
19	FB-D4
20	FB-D5
21	FB-D6
22	FB-D7
23	LGROUND
24	$\overline{\text{FB-STROBE}}$
25	FB-A0
26	FB-A1
27	FB-A2
28	LGROUND
29	FB-A3
30	RESERVED MISO
31	$\overline{\text{RESET}}$
32	FB-R\$\overline{\text{W}}$
33	CONTRAST_PWM
34	$\overline{\text{PCS0}}$
35	PCS1
36	
37	

J11 FROM AC-DC	
1	+24V
2	+24V
3	24_RTN
4	24_RTN
5	
6	
7	
8	
9	
10	
11	
12	ON/OFF
13	
14	ON/OFF

E1:

OUT = GYRO 1
IN = GYRO 2

J14 TO AC-DC	
1	PF_NO
2	PF_NC
3	PF_COM
4	24V_RTN
5	24V_RTN
6	+24V
7	+24V
8	
9	
10	AC
11	
12	AC

J15 INTERCONNECT	
1	ROT
2	GND
3	PRINT-CTS
4	PRINT-TX
5	GND
6	
7	232A-TX
8	422B-TX+
9	422B-TX-
10	
11	
12	
13	
14	ICC_RX+
15	ICC_RX-
16	ICC_RTN
17	ICC_TX+
18	ICC_TX-
19	GND
20	OK_RTN
21	OK_IN
22	OK_OUT
23	STATUS_IN
24	STATUS_OUT
25	GND

J16 INTERCONNECT	
1	CH1-D1
2	CH1-D2
3	CH1-D3
4	CH1-V+
5	CH1-IDX
6	RTN
7	CH2-D1
8	CH2-D2
9	CH2-D3
10	CH2-V+
11	CH2-IDX
12	RTN
13	CH3-D1
14	CH3-D2
15	CH3-D3
16	CH3-V+
17	CH3-IDX
18	RTN
19	CH4-D1
20	CH4-D2
21	CH4-D3
22	CH4-V+
23	CH4-IDX
24	RTN
25	

J17 INTERCONNECT	
1	CH5-D1
2	CH5-D2
3	CH5-D3
4	CH5-V+
5	CH5-IDX
6	RTN
7	CH6-D1
8	CH6-D2
9	CH6-D3
10	CH6-V+
11	CH6-IDX
12	RTN
13	CH7-D1
14	CH7-D2
15	CH7-D3
16	CH7-V+
17	CH7-IDX
18	RTN
19	CH8-D1
20	CH8-D2
21	CH8-D3
22	CH8-V+
23	CH8-IDX
24	RTN
25	

NOTE:
2.1 UNLESS NOTED OTHERWISE, ALL RESISTOR VALUES ARE IN OHMS AND ALL CAPACITOR VALUES ARE IN MICROFARADS.
2.2 PARTIAL REFERENCE DESIGNATIONS ARE SHOWN. FOR COMPLETE DESIGNATIONS PREFIX WITH UNIT NUMBER OR ASSEMBLY DESIGNATIONS.
2.3 HIGH VOLTAGE TRACES ARE ROUTED ON THE BOTTOM LAYER OF THIS CIRCUIT BOARD FOR PROTECTION OF OTHER CIRCUIT ELEMENTS. DO NOT ALTER WITHOUT REVIEW.
2.4 THE TOP LAYER OF THE PWB IS A COMBINED GROUND PLANE IN THE RACK AREA AND EMI BARRIER IN THE I/O AREA. DO NOT ALTER WITHOUT REVIEW.
2.5 C1-C3, C15-C43 ARE OPTIONAL FILTER CAPS.

HIGHEST REFERENCE DESIGNATIONS USED							
J17	TB1	E1	C43	RV1			
REFERENCE DESIGNATIONS NOT USED							
J8,C6,C7							

1980694 (Sheet 2, Rev A)

Figure 5-4. MK 37 VT Motherboard I/O Schematic Diagram (Sheet 1 of 12)

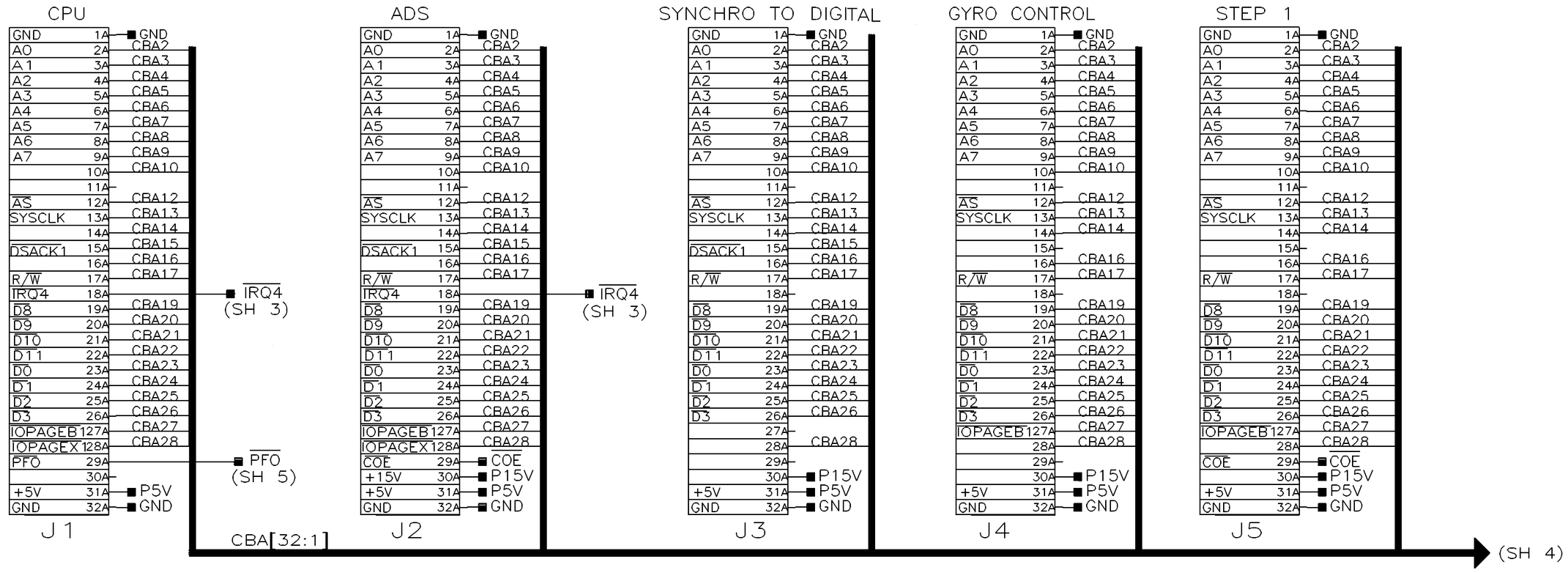


Figure 5-4. MK 37 VT Motherboard I/O Schematic Diagram (Sheet 2 of 12)

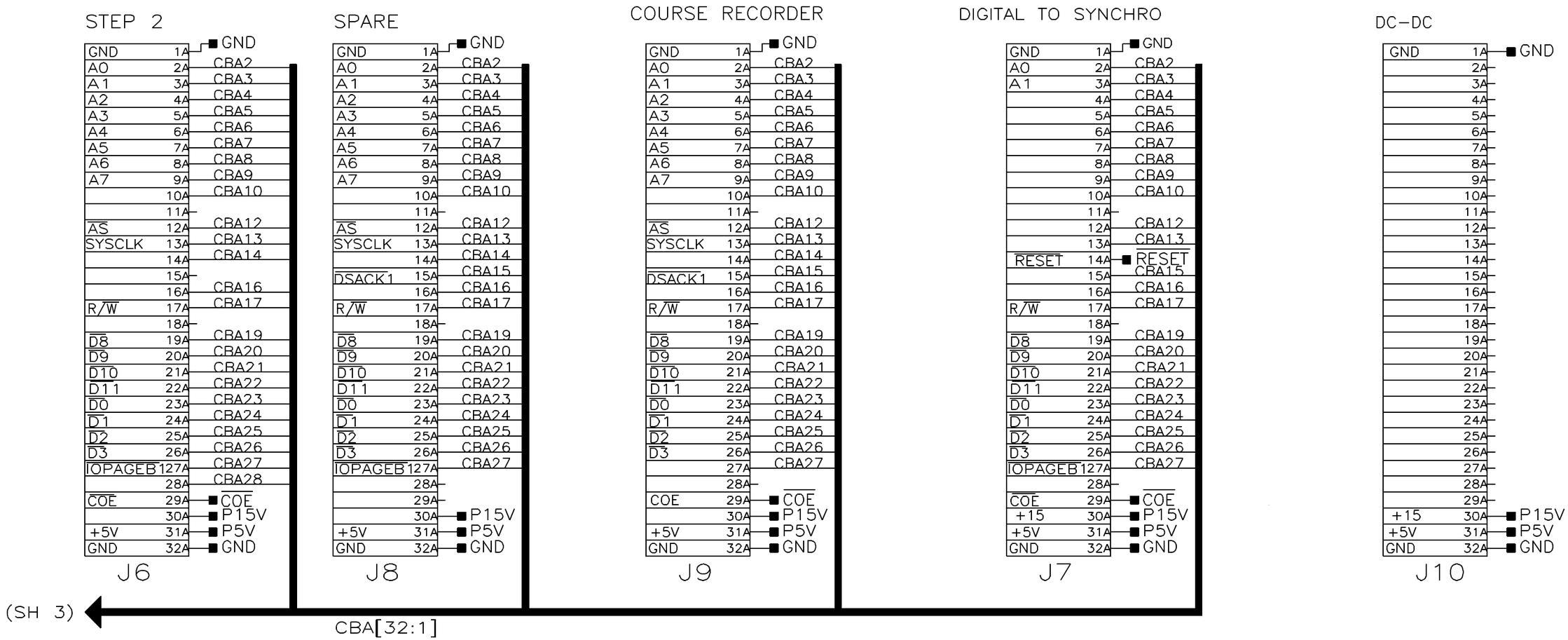


Figure 5-4. MK 37 VT Motherboard I/O Schematic Diagram (Sheet 3 of 12)

1980694 (Sheet 4)

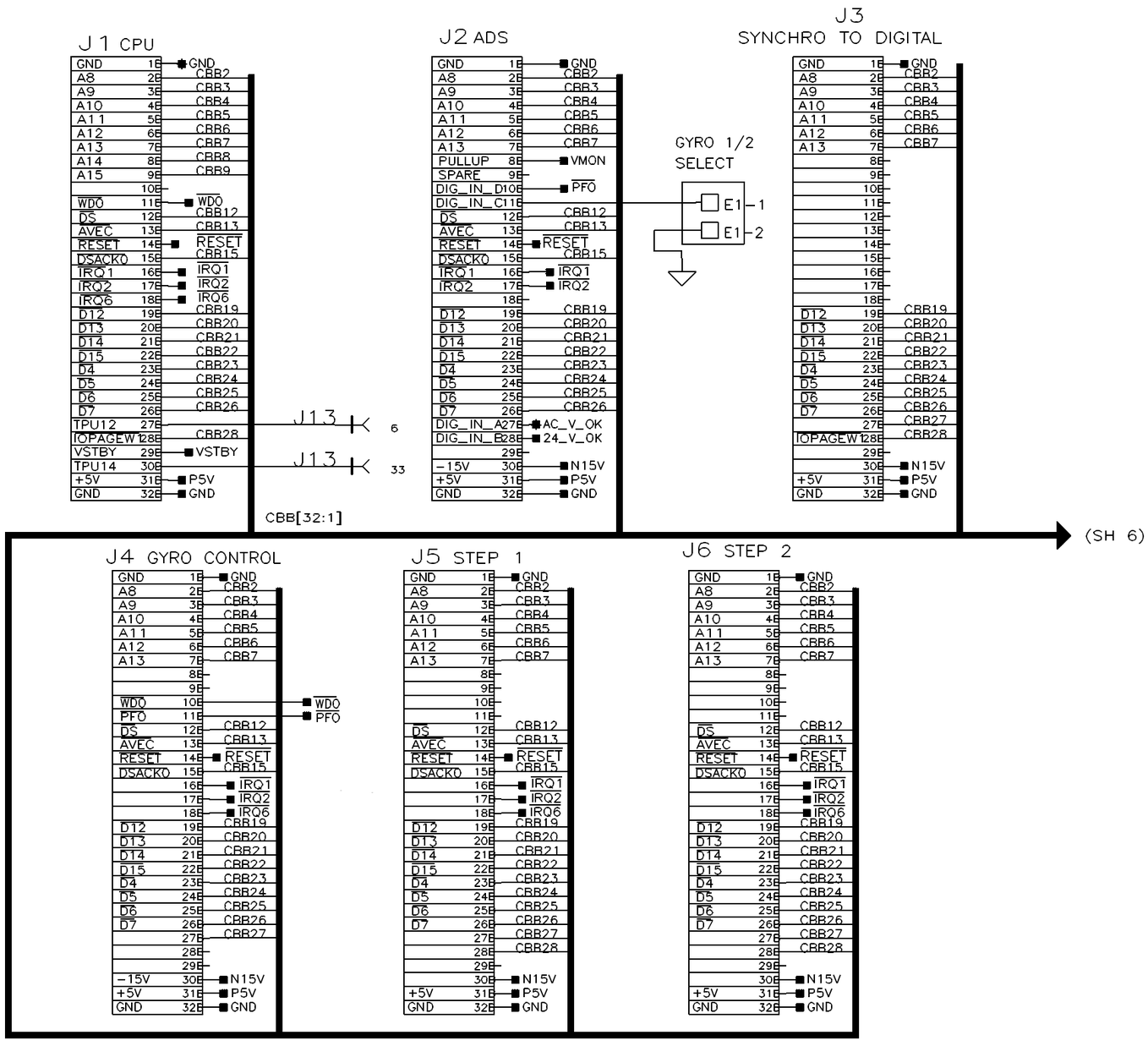


Figure 5-4. MK 37 VT Motherboard I/O Schematic Diagram (Sheet 4 of 12)

1980694 (Sheet 5)

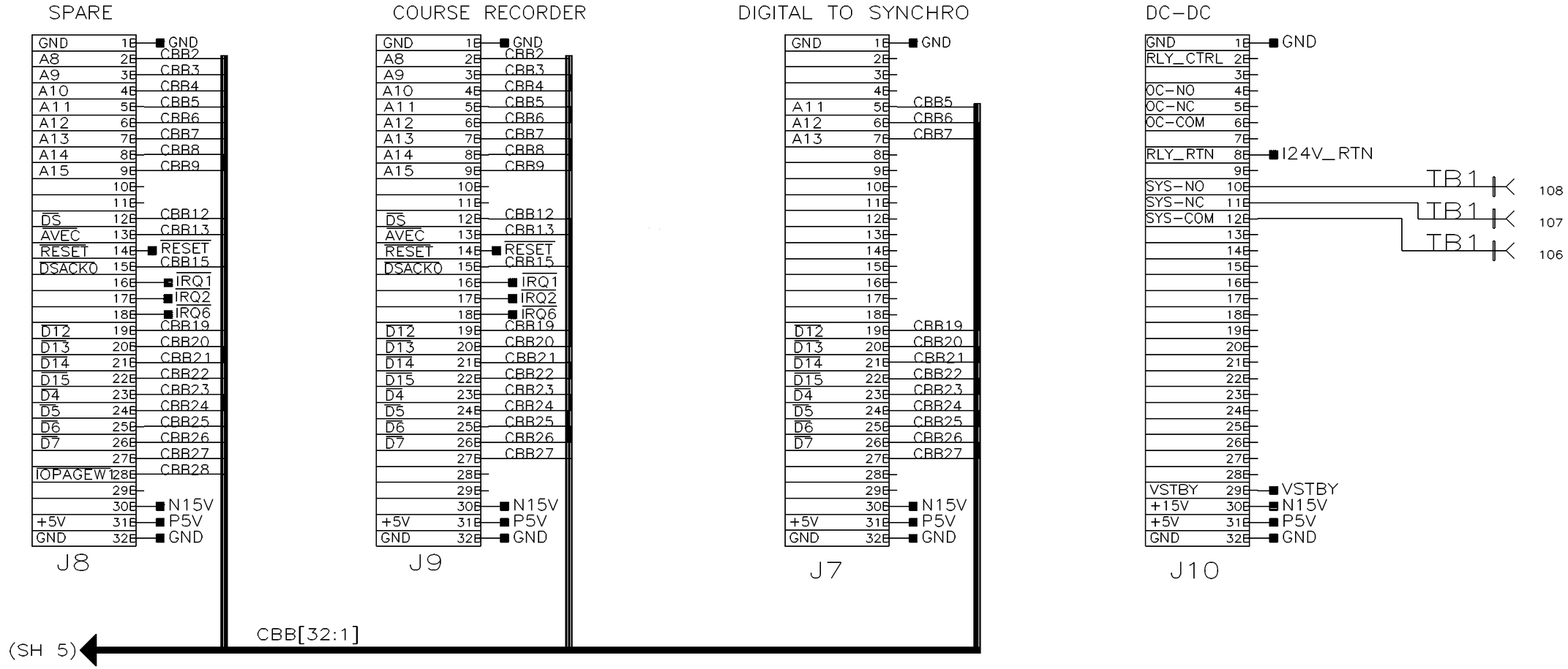
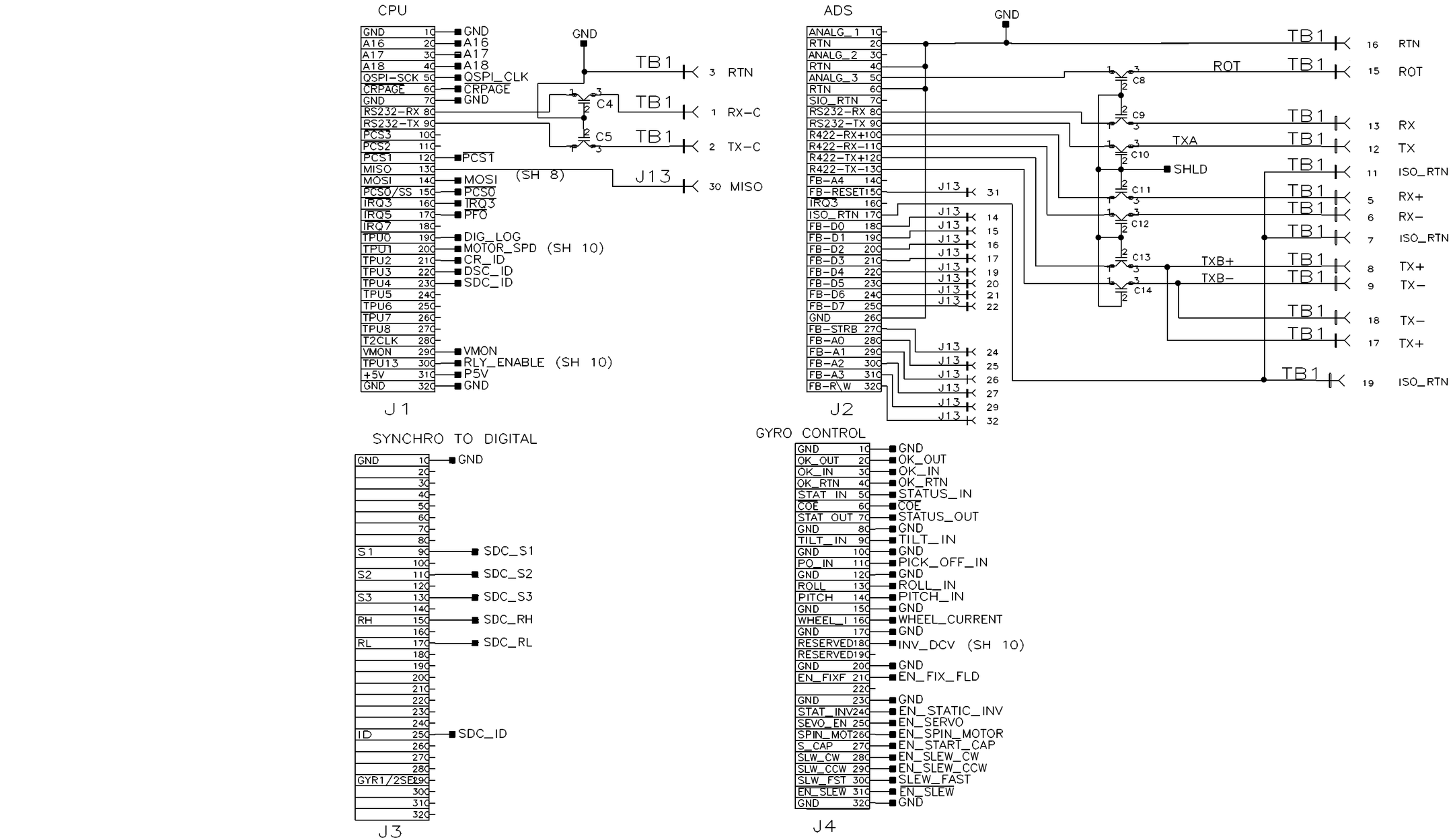
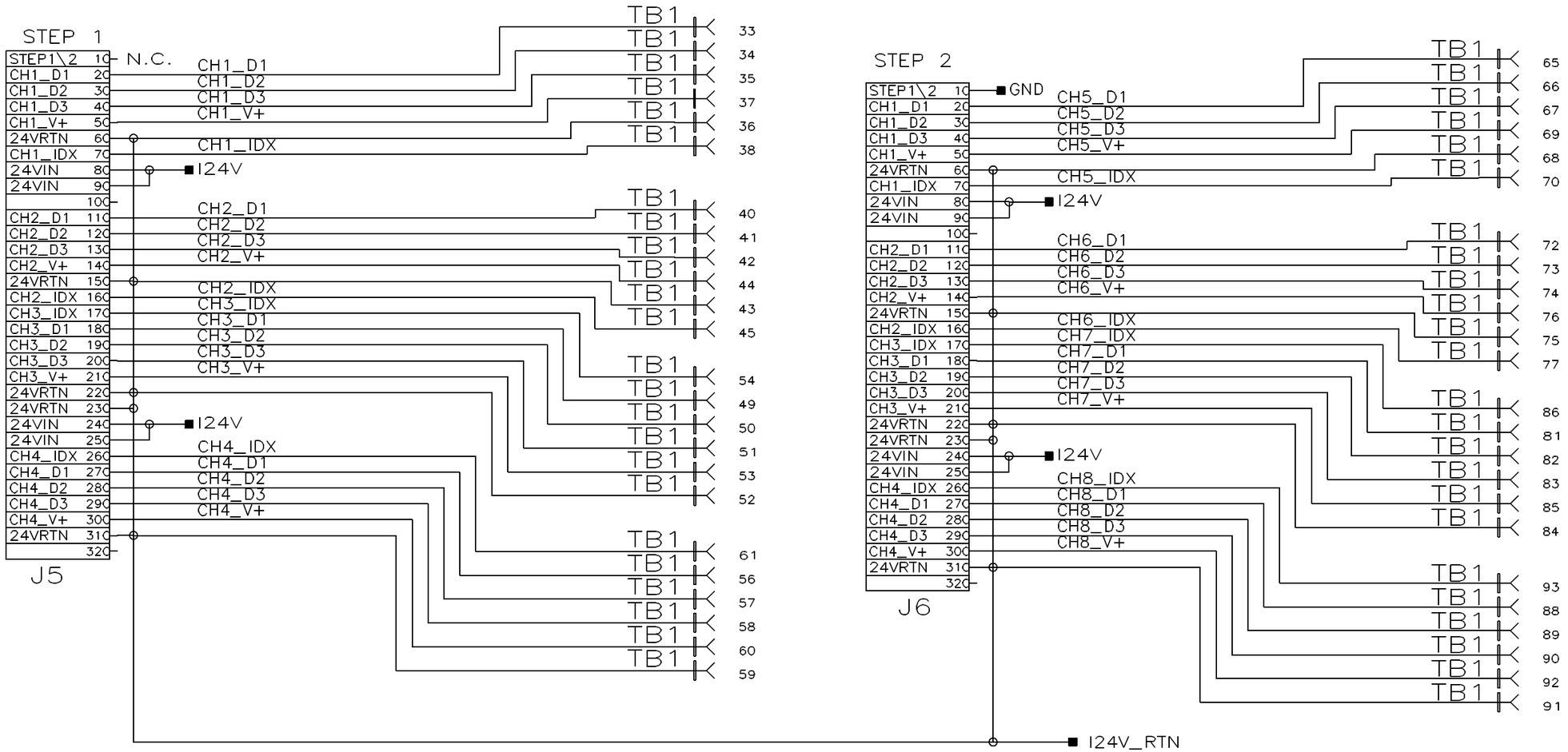


Figure 5-4. MK 37 VT Motherboard I/O Schematic Diagram (Sheet 5 of 12)



1980694 (Sheet 7, Rev C)

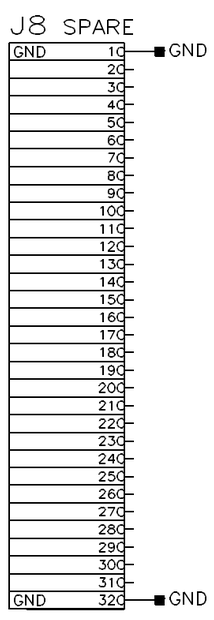
Figure 5-4. MK 37 VT Motherboard I/O Schematic Diagram (Sheet 6 of 12)

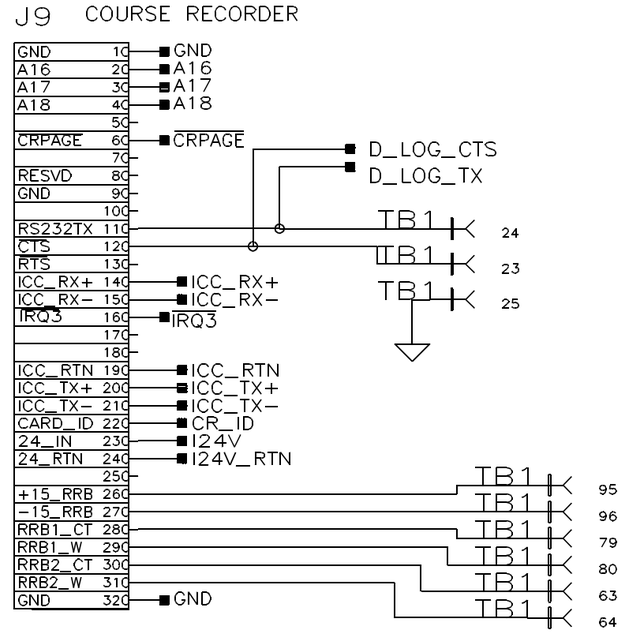


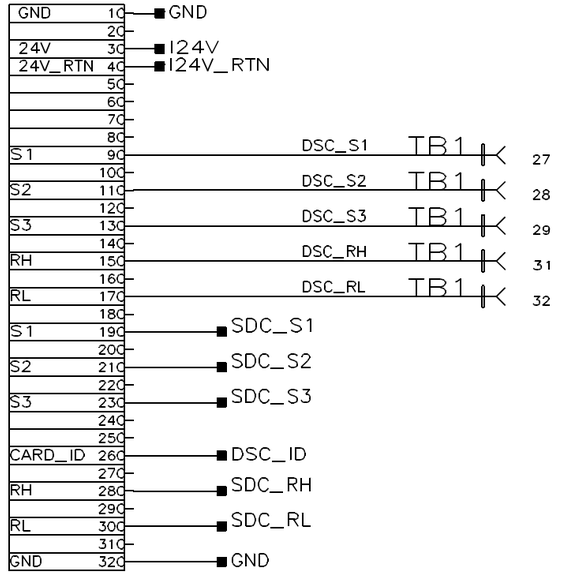
NOTE: EMI FILTER CAPS ARE SHOWN ON SHEET 13.

Figure 5-4. MK 37 VT Motherboard I/O Schematic Diagram (Sheet 7 of 12)

1980694 (Sheet 8)







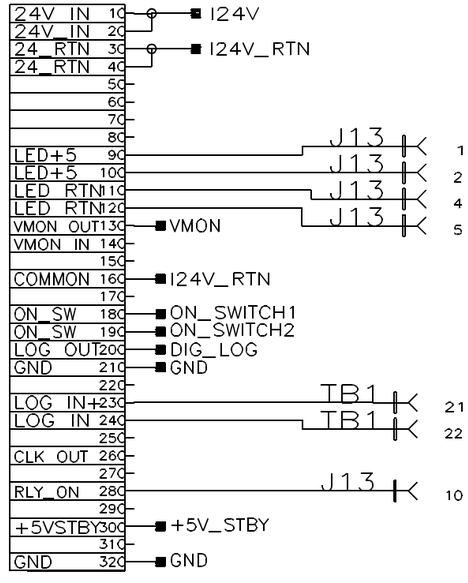


Figure 5-4. MK 37 VT Motherboard I/O Schematic Diagram (Sheet 8 of 12)

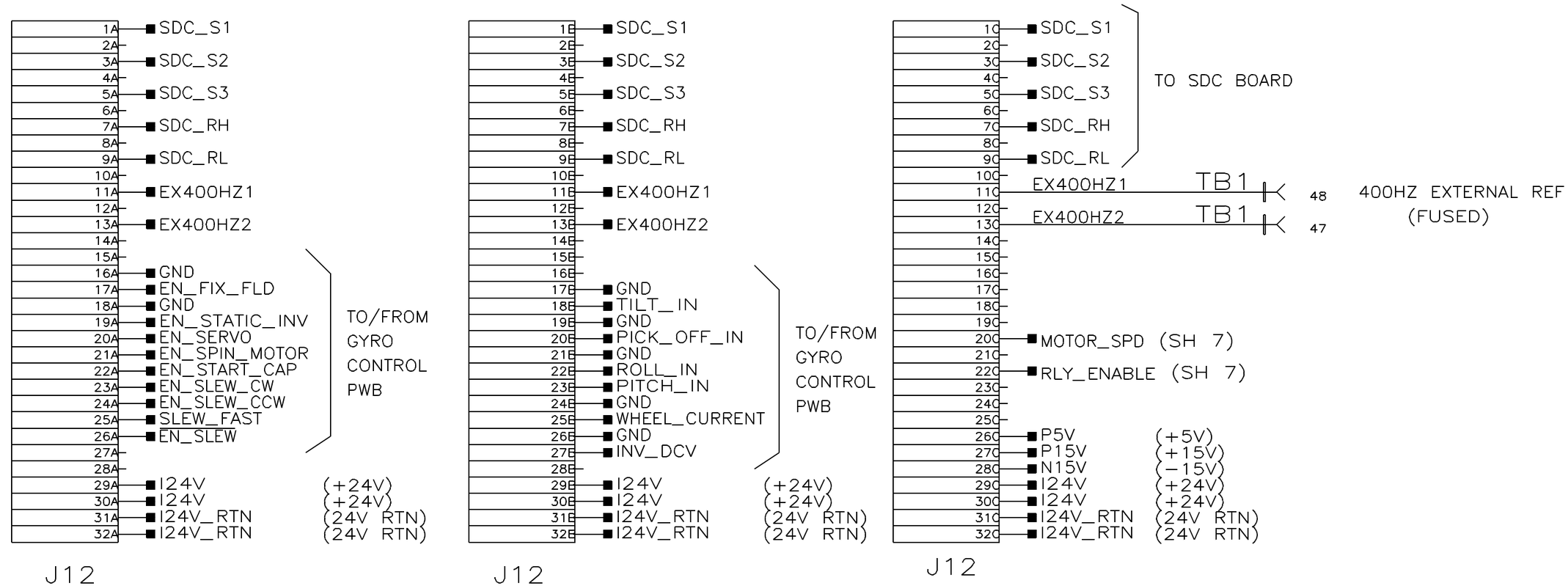
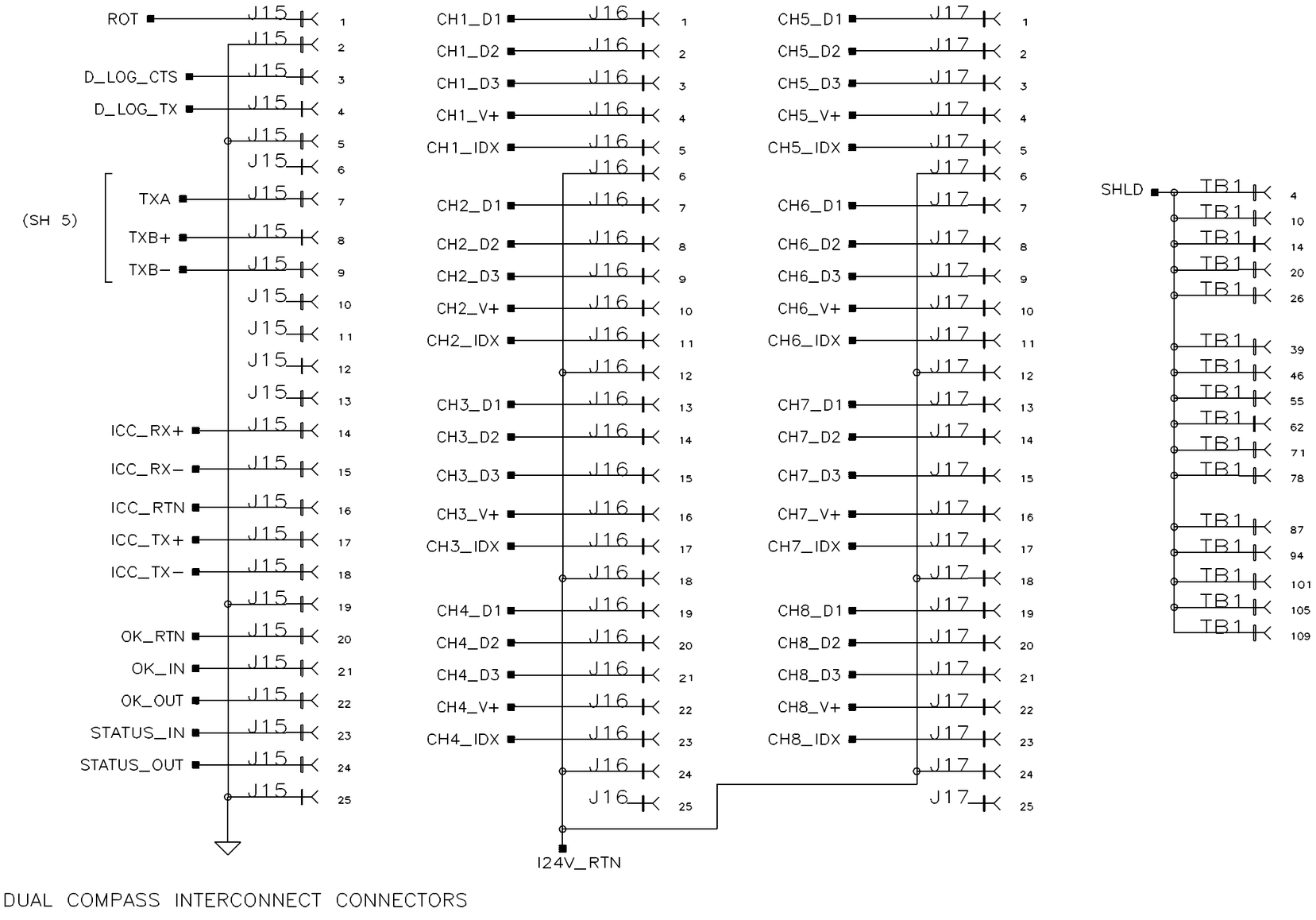


Figure 5-4. MK 37 VT Motherboard I/O Schematic Diagram (Sheet 9 of 12)



1980694 (Sheet 11, Rev A)

Figure 5-4. MK 37 VT Motherboard I/O Schematic Diagram (Sheet 10 of 12)

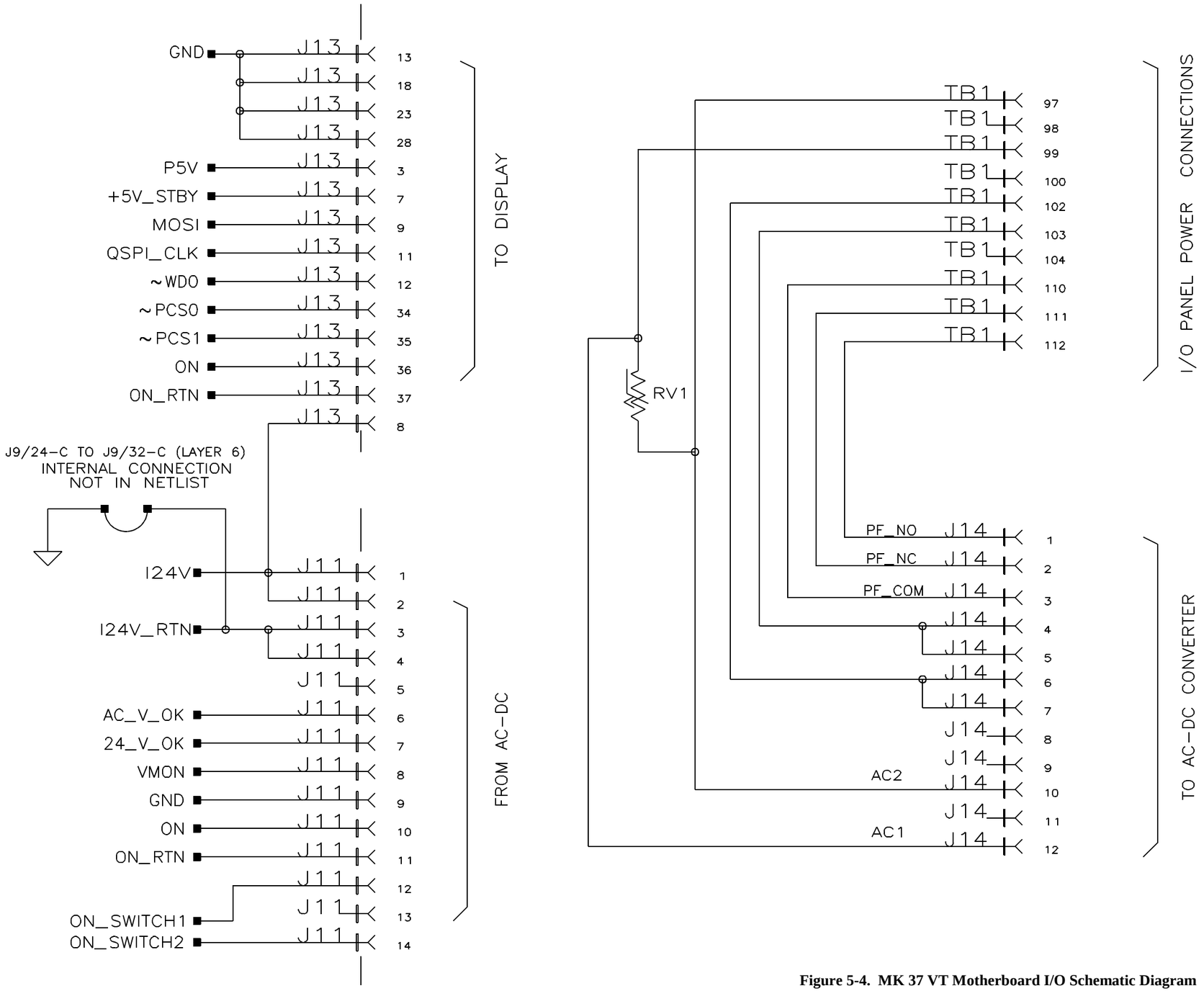


Figure 5-4. MK 37 VT Motherboard I/O Schematic Diagram (Sheet 11 of 12)

1980694 (Sheet 12, Rev A)

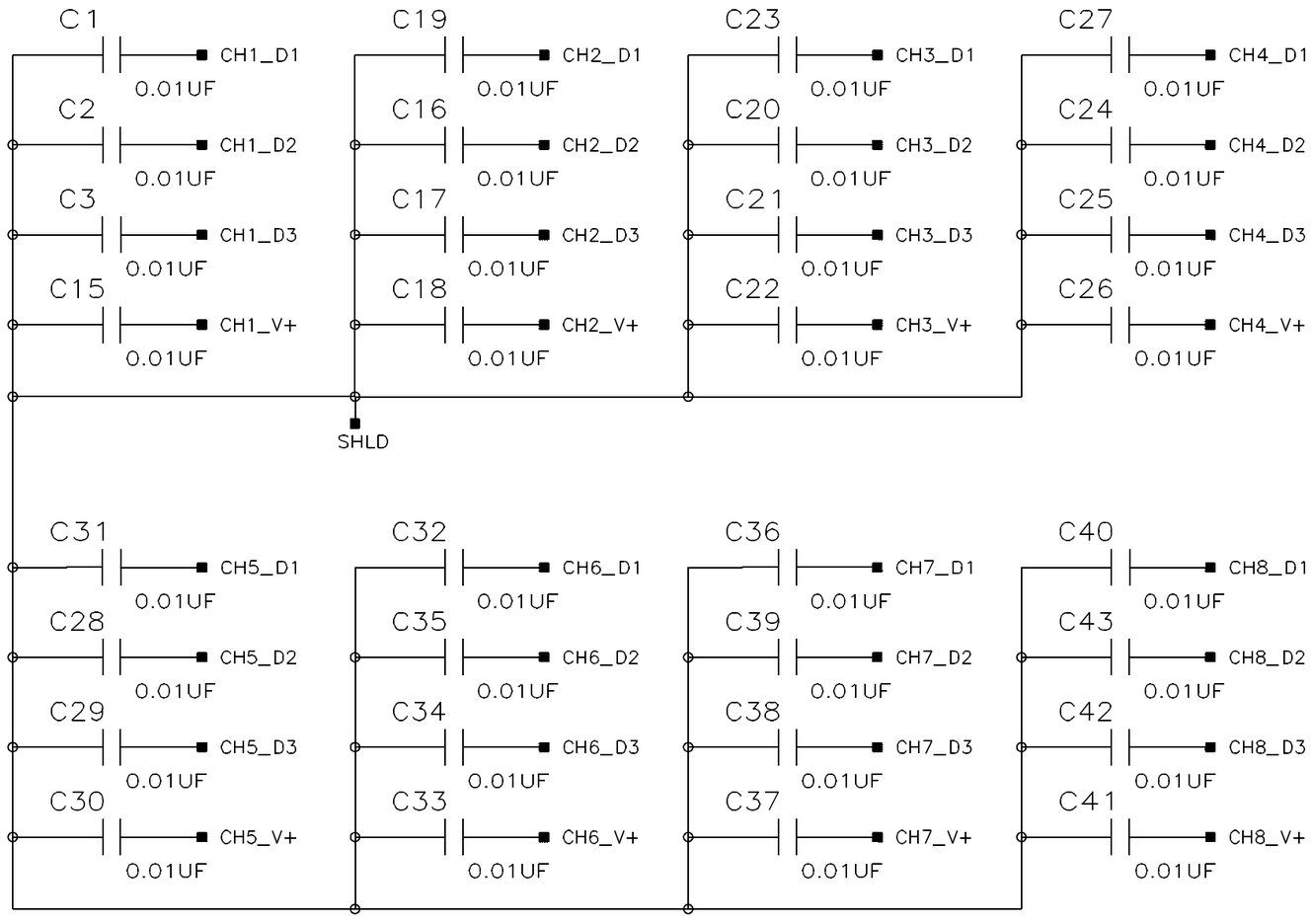


Figure 5-4. MK 37 VT Motherboard I/O Schematic Diagram (Sheet 12 of 12)

CHAPTER 6

CORRECTIVE MAINTENANCE

6-1 INTRODUCTION.

This chapter provides information required to repair the MK 37 VT Digital Gyrocompass Equipment. This equipment is designed and constructed for ease and simplicity of onboard repair by the average technician using common tools and test equipment in conjunction with the technical manual.

The design features of the MK 37 VT Digital Gyrocompass Equipment allow rapid isolation and repair of malfunctions to replaceable component boards and individual components and isolation of malfunctions within the Compass Element.

CAUTION

Repair of components below the top plate of the Compass Element is beyond the scope of onboard repair.

CAUTION

Repairs of the Master Compass should be done by Sperry Marine service technicians and should be attempted onboard ship ONLY under emergency conditions if spare parts are available.

6-2 CONFIGURATION SETUP AND ADJUSTMENT PROCEDURES.

Table 6-1 provides instructions for setting default values for configuration switches and for setting adjustment parameters for the circuit boards in the Electronics Control Unit. Figure 6-1 shows the location of the Electronics Control Unit assemblies and Figures 6-2 through 6-13 are layout drawings that identify the location of the jumpers, test points, switches, and adjustments.

Table 6-1. Configuration Switches and Adjustments

Unit	Figure Number	Switch/Adjustment or Programmable Assembly	Function
Motherboard I/O Assembly (A1)	6-2	E1	Install jumper for gyro #2 Remove jumper for gyro #1
CPU Assembly (A2)	6-3	U2A, U2B U6	EPROMs NOVRAM
Analog, Digital, Isolated Serial Assembly (A3)	6-4	U5	Programmable logic array device (PLAD)
Gyro Control Assembly (A5)	6-6	E2 - E3 E1 - E2 E4 - E5 E5 - E6	Jumper to select primary compass system Jumper to select secondary compass system Jumper to enable compass compare Jumper to disable compass compare (factory default setting)

Table 6-1. Configuration Switches and Adjustments (Continued)

Unit	Figure Number	Switch/Adjustment or Programmable Assembly	Function
Step Driver Assembly (A6, A7)	6-7	S1, S2, S3, S4	Each board has four 24 volt step outputs There is an individual switch for each load
Digital-to-Synchro Converter Assembly (A8)	6-8	S1	Place to OFF position to disable reference input and disable the synchro output. Place to AUTO position for normal operation.
AC/DC Power Supply Assembly (A12)	6-12	A12A1S1 Slide Switch A12S1 Toggle Switch	115/230 Voltage Select Switch Main Power On/Off Switch (shipped in "off" position to save the internal battery)

6-3 ELECTRONICS CONTROL UNIT REPAIR.

Repair of the Electronics Control Unit consists of replacing the circuit boards and the chassis mounted components. These procedures are contained in paragraphs 6-3.1 through 6-3.3. Table 6-1 lists the configuration switches, potentiometers, and programmed assemblies along with any special notes associated with the circuit cards in the Electronics Control Unit.

6-3.1 Circuit Boards A2 through A10 Replacement. To replace circuit boards A2 through A-10, perform the following procedure:

a. Position Electronics Control Unit power switch to OFF.

WARNING

Make sure all sources of power are turned off and tagged "OUT OF SERVICE." These power sources include (but are not necessarily limited to) system power, solenoid power, and compass data transmission. Lethal voltages may be involved.

b. Position circuit breaker supplying power to MK 37 VT Digital Gyrocompass Equipment to OFF. Danger tag circuit breaker "OUT OF SERVICE" in accordance with ship's tag-out procedures.

c. Loosen nine captive screws securing cover on Electronics Control Unit.

d. Loosen two screws securing circuit board to card rack. Remove defective circuit board.

e. Refer to Table 6-1 to verify if there are any configuration switches, potentiometers, or any special procedures for the replacement circuit board. Perform the applicable referenced data.

f. Install replacement circuit board in card slot. Tighten captive screws.

g. Perform the maintenance turn-on and checkout procedure (Table 5-1).

h. Secure cover on Electronics Control Unit by tightening nine captive screws.

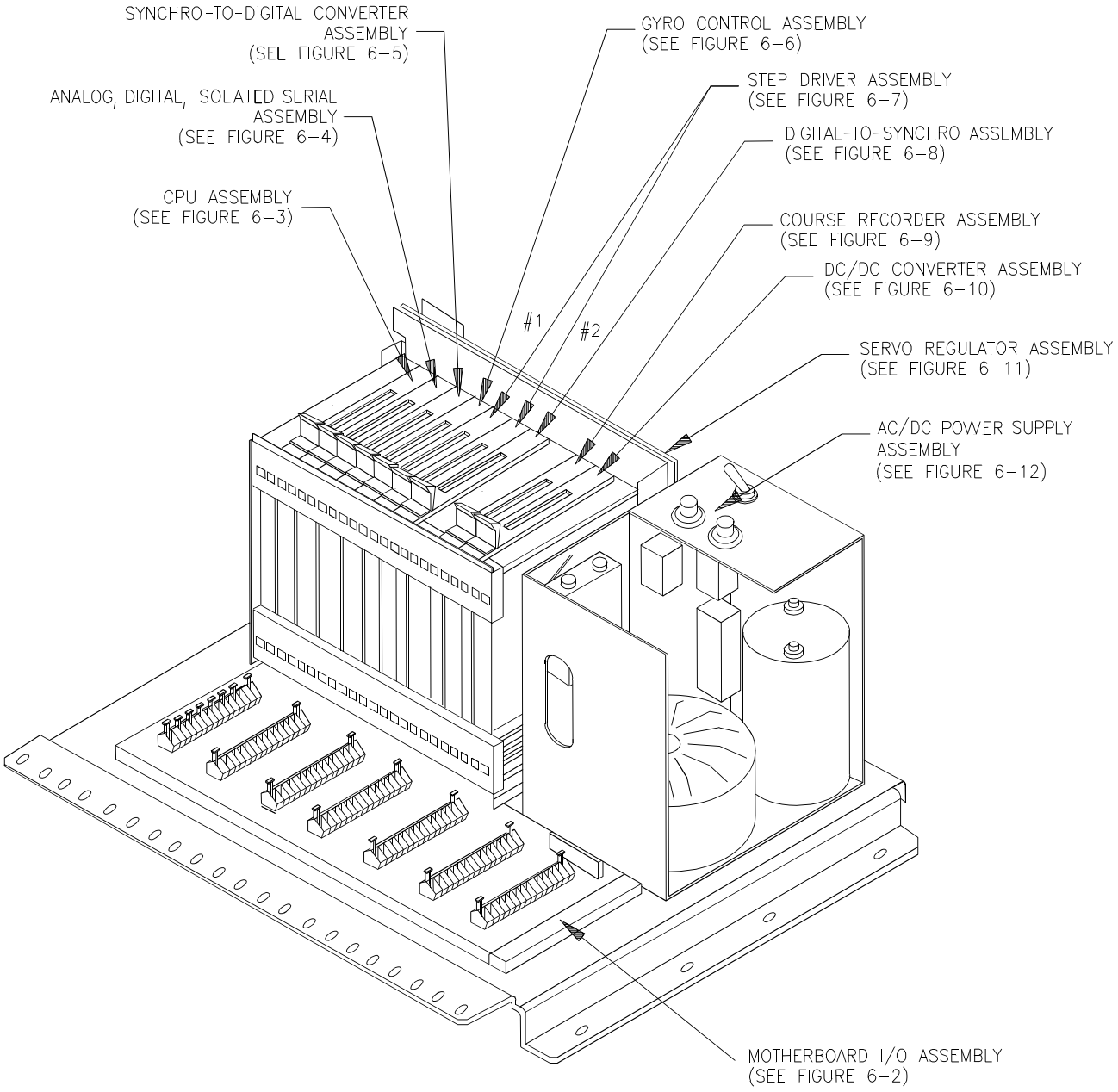


Figure 6-1. Location of Electronics Control Unit Assemblies

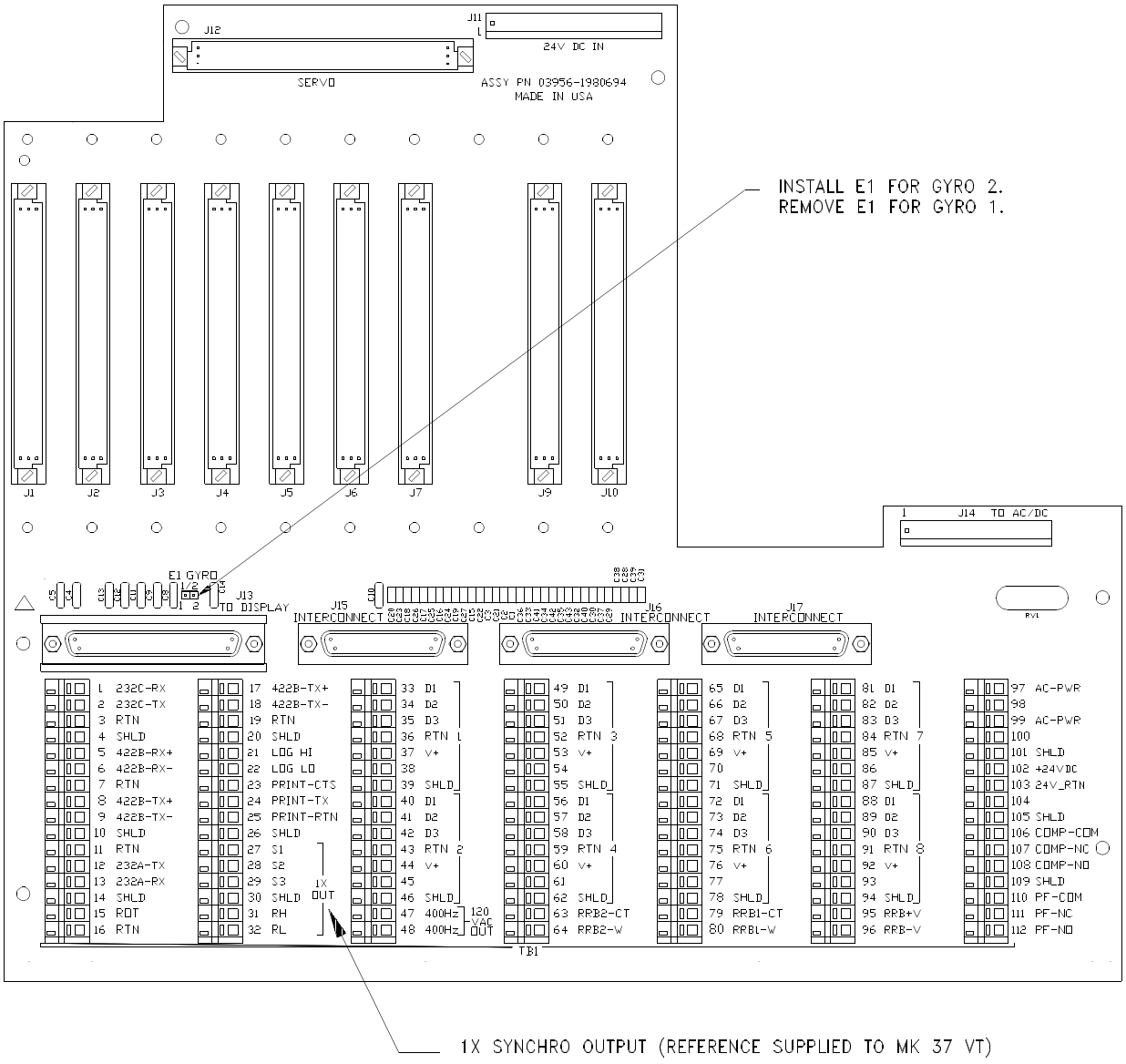


Figure 6-2. Motherboard I/O Assembly (A1) Configuration Identification

TABLE 1. PROGRAMMED ASSEMBLY PART NO.	
REF. DESIGN.	PART NUMBER
U2A U2B	XXXXXXX-502 XXXXXXX-501

TABLE 2. REPLACEABLE CPU COMPONENTS	
ITEM NO.	DESCRIPTION
1	EPROM U2A
2	EPROM U2B
3	NOVRAM

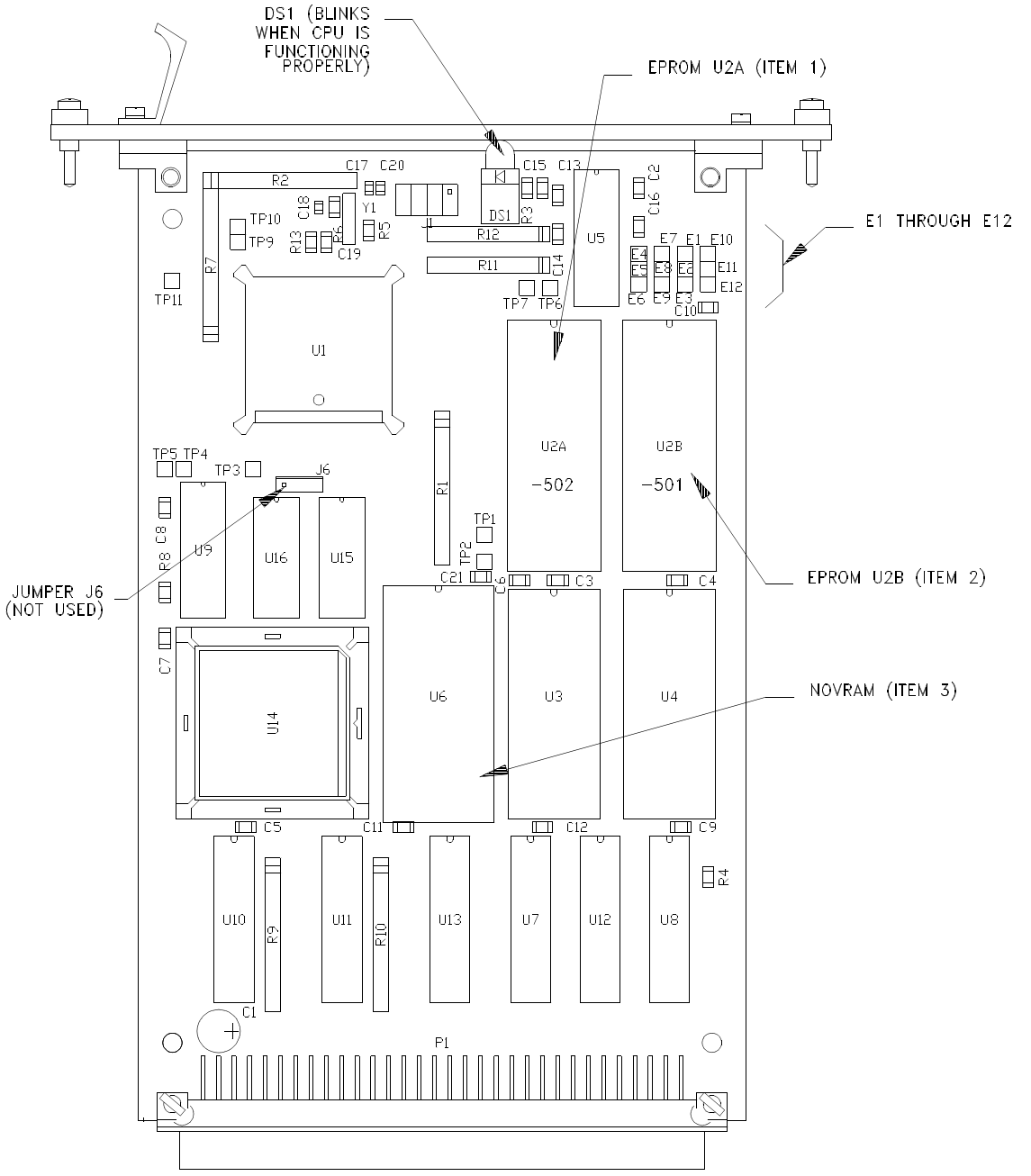


Figure 6-3. CPU Assembly (A2) Configuration Identification

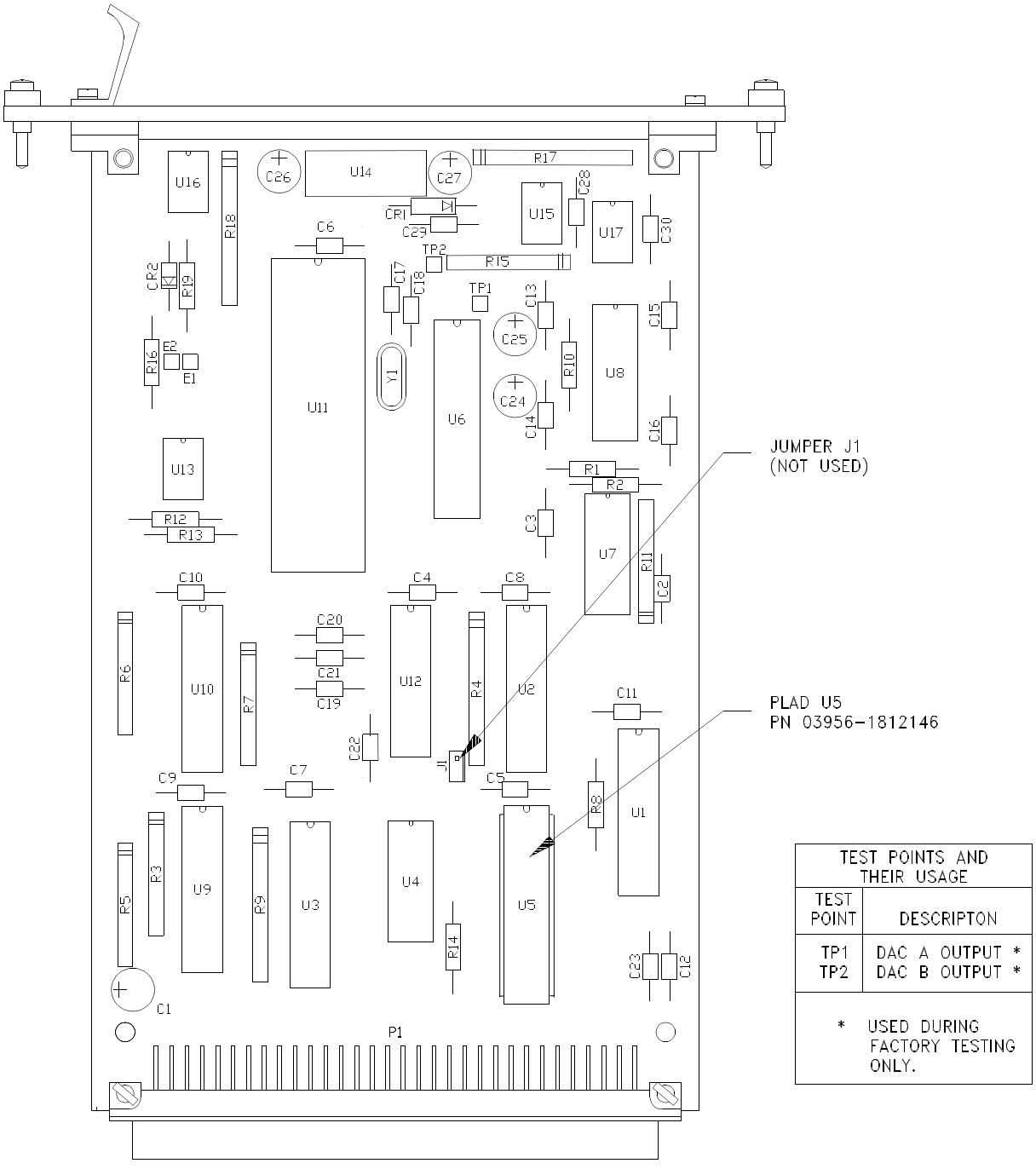


Figure 6-4. Analog, Digital, Isolated Serial Assembly (A3) Configuration Identification

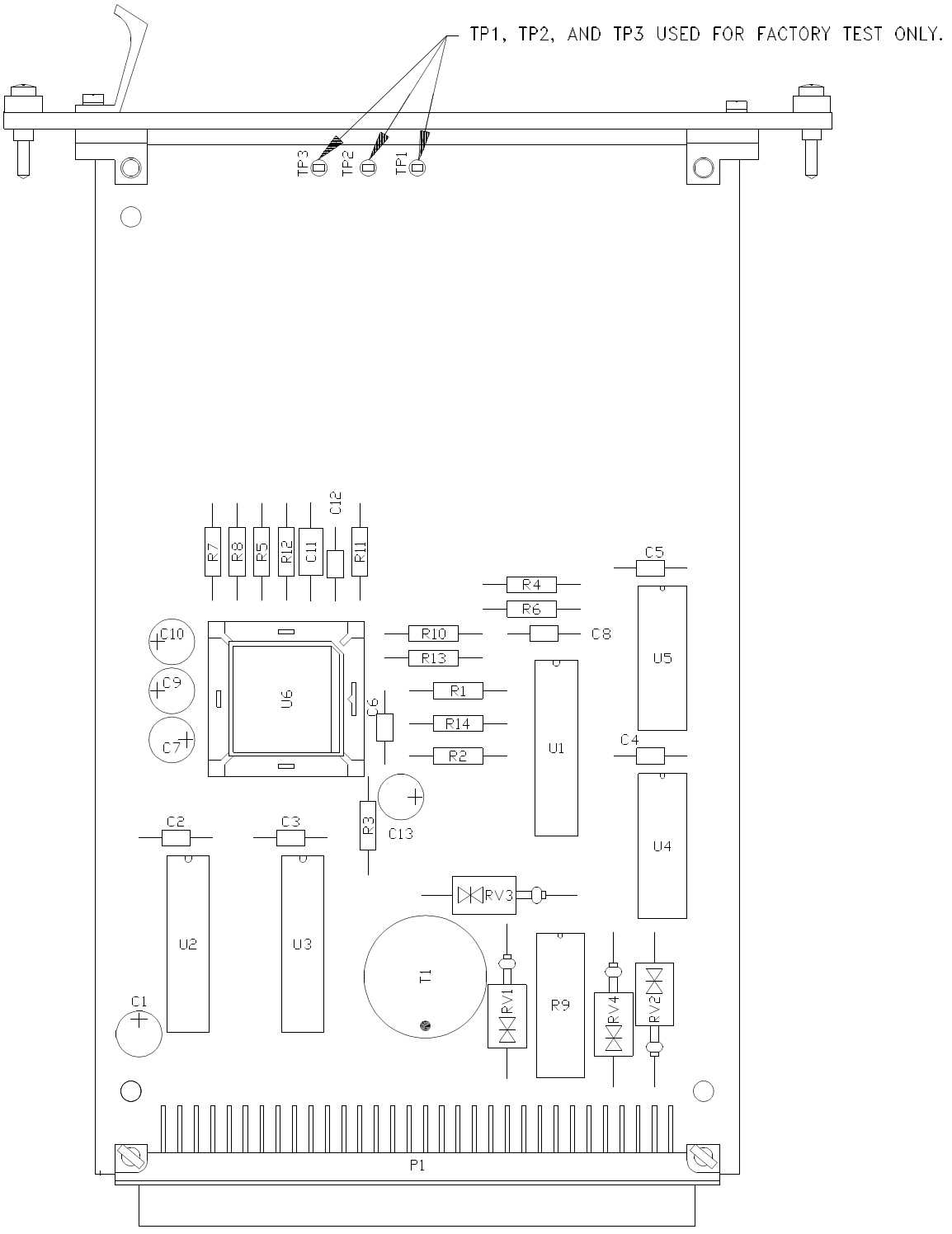
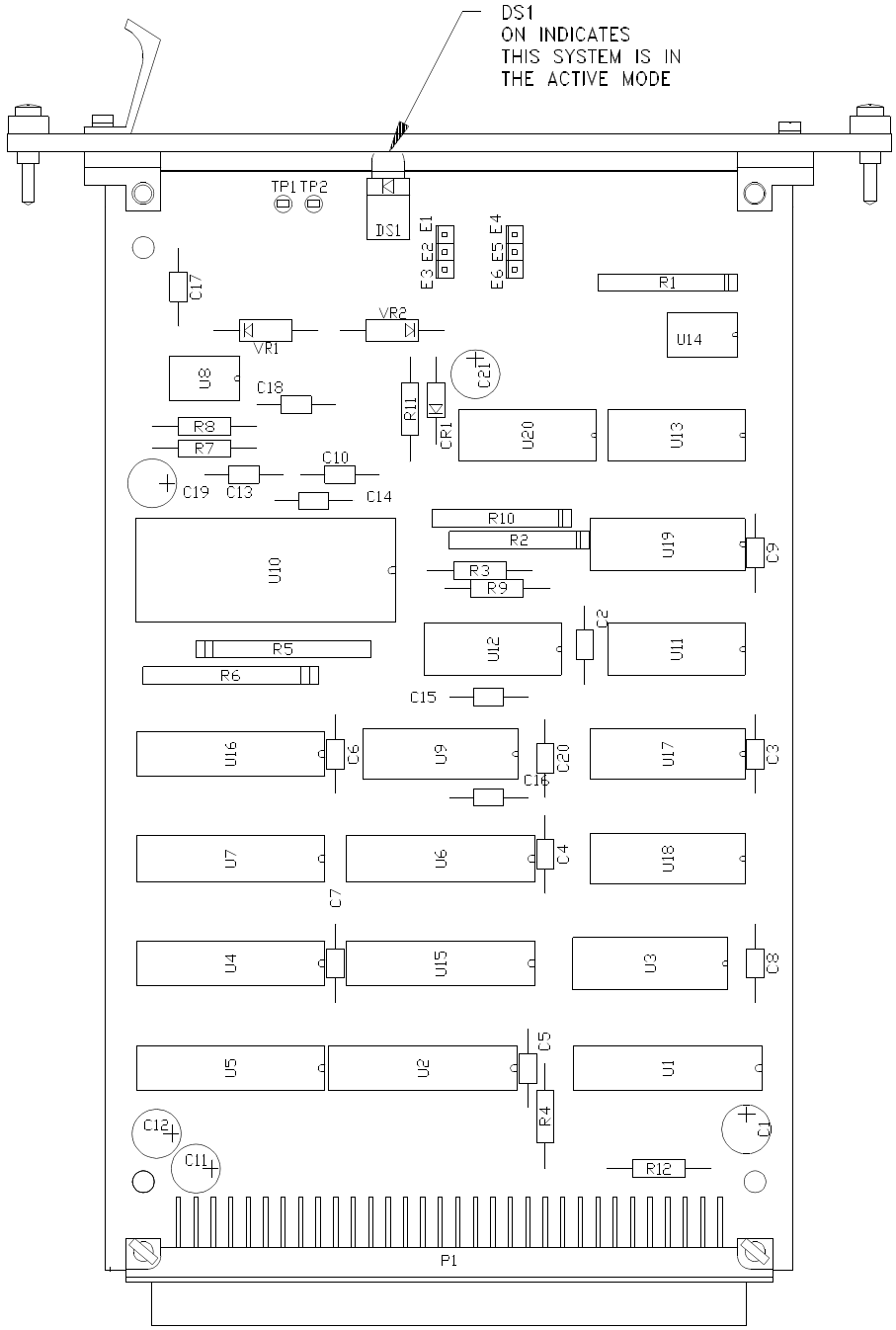


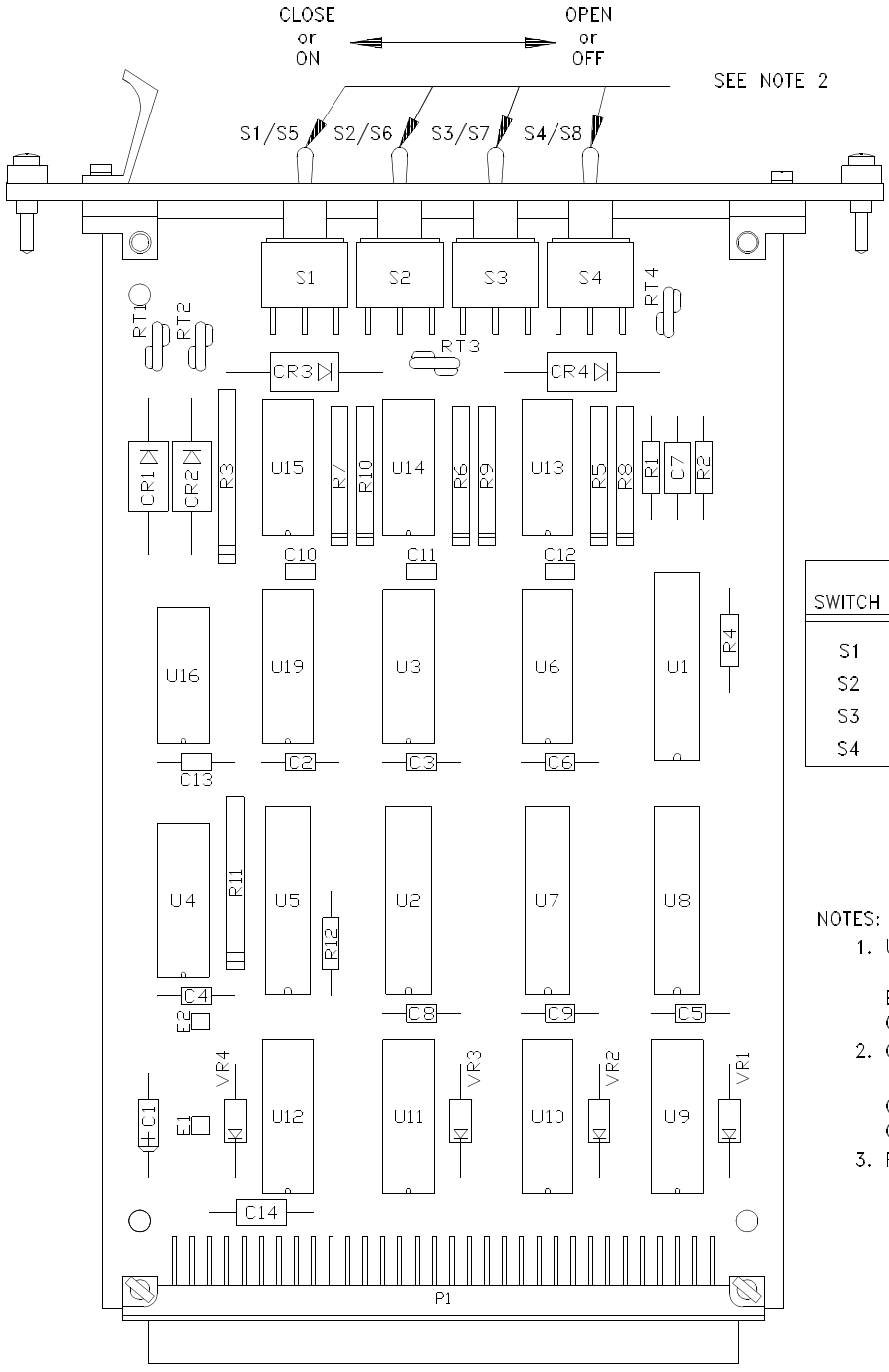
Figure 6-5. Synchro-To-Digital Converter Assembly (A4) Configuration Identification



NOTES:

1. USE TP1 AND TP2 FOR FACTORY TEST ONLY.
2. CONNECT E2 TO E3 TO DESIGNATE AS PRIMARY SYSTEM.
3. CONNECT E1 TO E2 TO DESIGNATE AS SECONDARY SYSTEM.
4. CONNECT E4 TO E5 TO ENABLE COMPASS COMPARE.
5. CONNECT E5 TO E6 TO DISABLE COMPASS COMPARE.

Figure 6-6. Gyro Control Assembly (A5) Configuration Identification



SWITCH	STEP DRIVER ASSY (A6)	STEP DRIVER ASSY (A7)
S1	REPEATER #1	REPEATER #5
S2	REPEATER #2	REPEATER #6
S3	REPEATER #3	REPEATER #7
S4	REPEATER #4	REPEATER #8

NOTES:

1. USE TWO PRINTED CIRCUIT BOARD ASSEMBLIES FOR EIGHT STEP CHANNEL OUTPUTS.
2. CLOSE S1, S2, S3, AND S4 TO APPLY +24 VDC TO THE CORRESPONDING REPEATER CHAINS.
3. REFER TO THE TABLE FOR REPEATER CONFIGURATION.

Figure 6-7. Step Driver Assembly (A6, A7) Configuration Identification

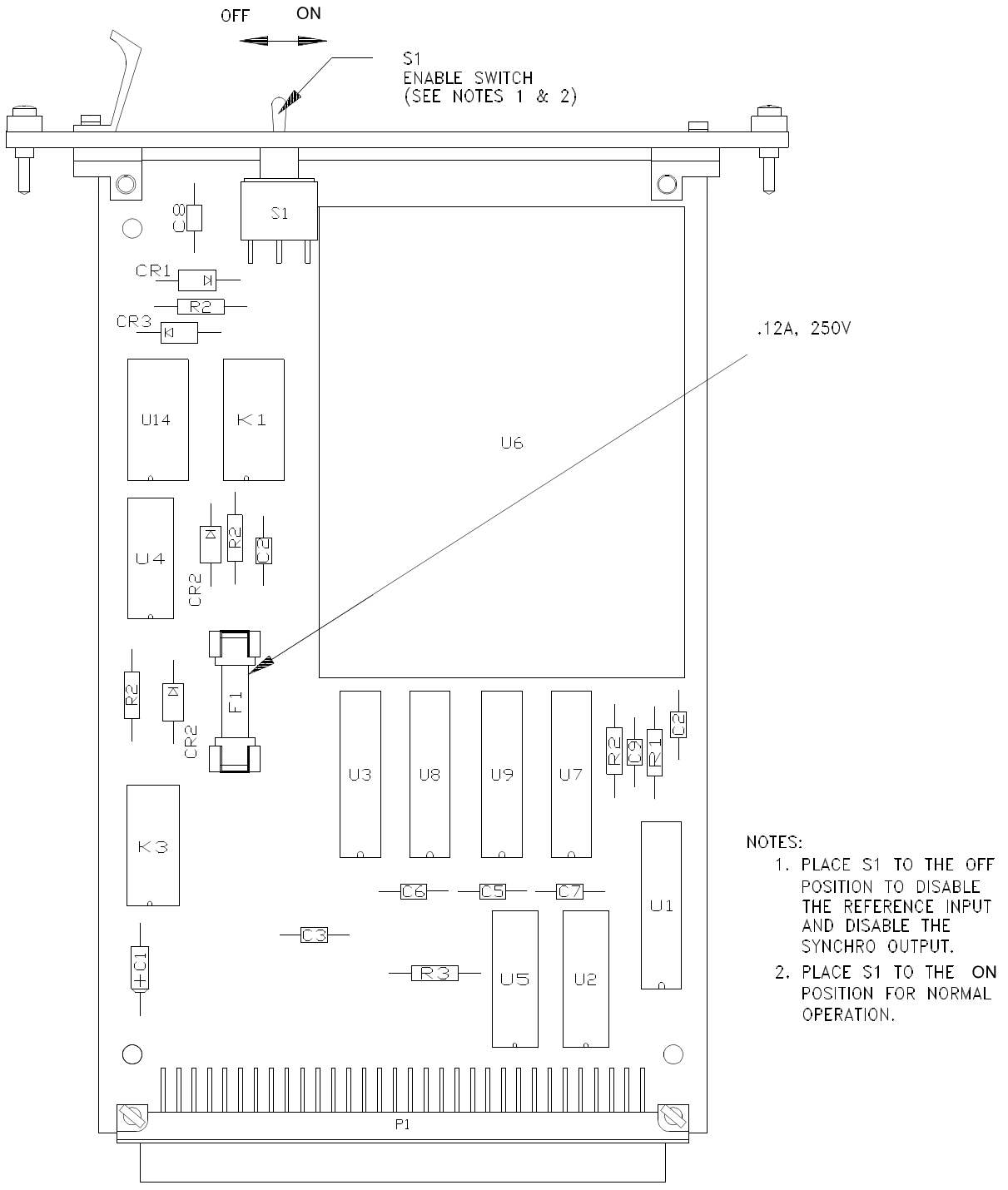
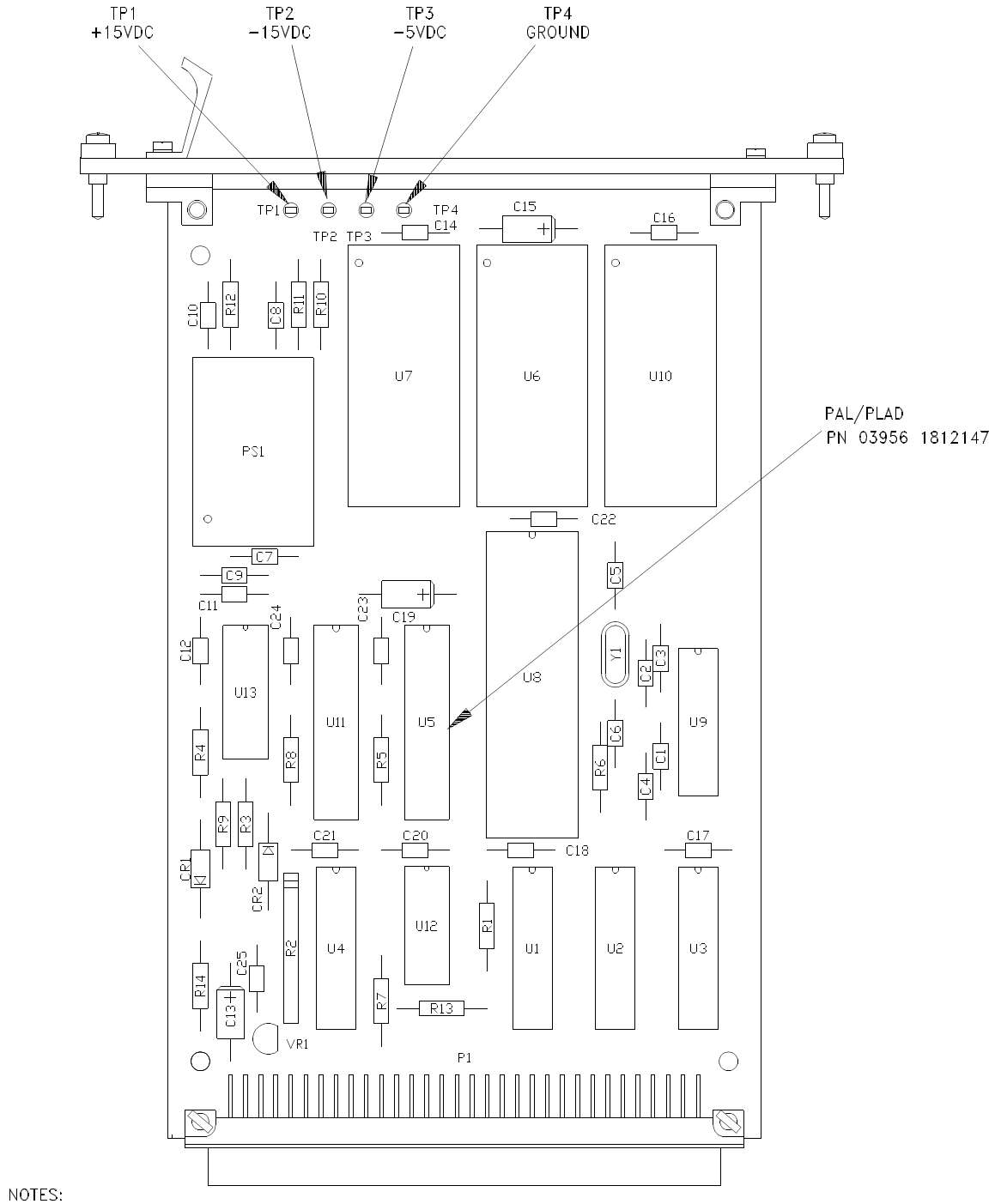


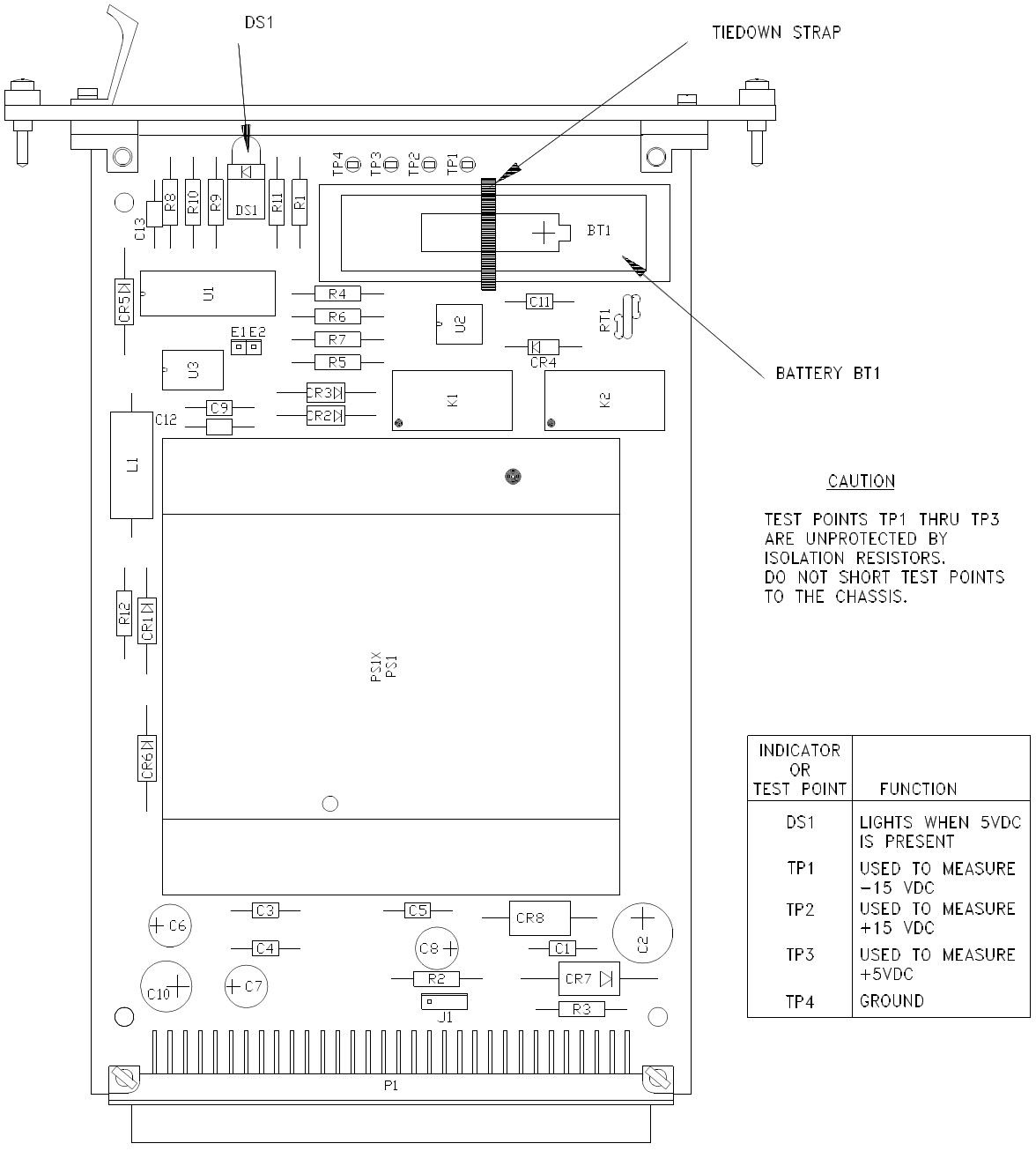
Figure 6-8. Digital-To-Synchro Assembly (A8) Configuration Identification



NOTES:

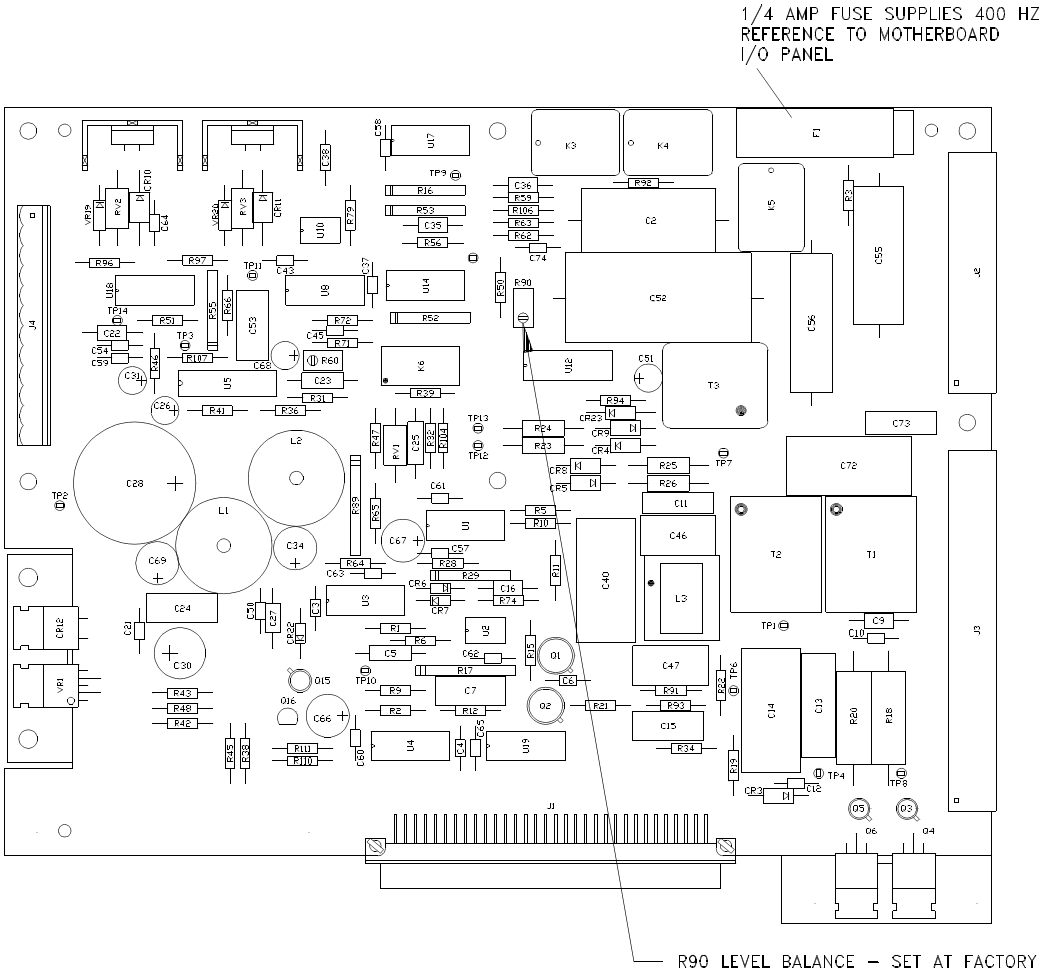
1. PLAD: PROGRAMMED LOGIC ARRAY DRAWING
2. TP1, 2, AND 3 ARE PROTECTED BY 4.7K Ω RESISTORS.

Figure 6-9. Course Recorder Assembly (A9) Configuration Identification



INDICATOR OR TEST POINT	FUNCTION
DS1	LIGHTS WHEN 5VDC IS PRESENT
TP1	USED TO MEASURE −15 VDC
TP2	USED TO MEASURE +15 VDC
TP3	USED TO MEASURE +5VDC
TP4	GROUND

Figure 6-10. DC/DC Converter Assembly (A10) Configuration Identification



TEST POINTS AND THEIR USAGE	
TEST POINT	DESCRIPTION
TP1	FACTORY TEST *
TP2	FACTORY TEST *
TP3	800HZ SQ WAVE
TP4	CF1 SIGNAL *
TP5	TILT PICK–OFF *
TP6	130VAC OUTPUT
* USED DURING FACTORY TEST ONLY	

TEST POINTS AND THEIR USAGE	
TEST POINT	DESCRIPTION
TP7	130VAC OUTPUT
TP8	CF2 SIGNAL *
TP9	3200HZ SQ WAVE *
TP10	FACTORY TEST *
TP11	SHUTDOWN SIGNAL *
TP12	120VAC
TP13	120VAC
* USED DURING FACTORY TEST ONLY	

Figure 6-11. Servo Regulator Assembly (A11) Configuration Identification

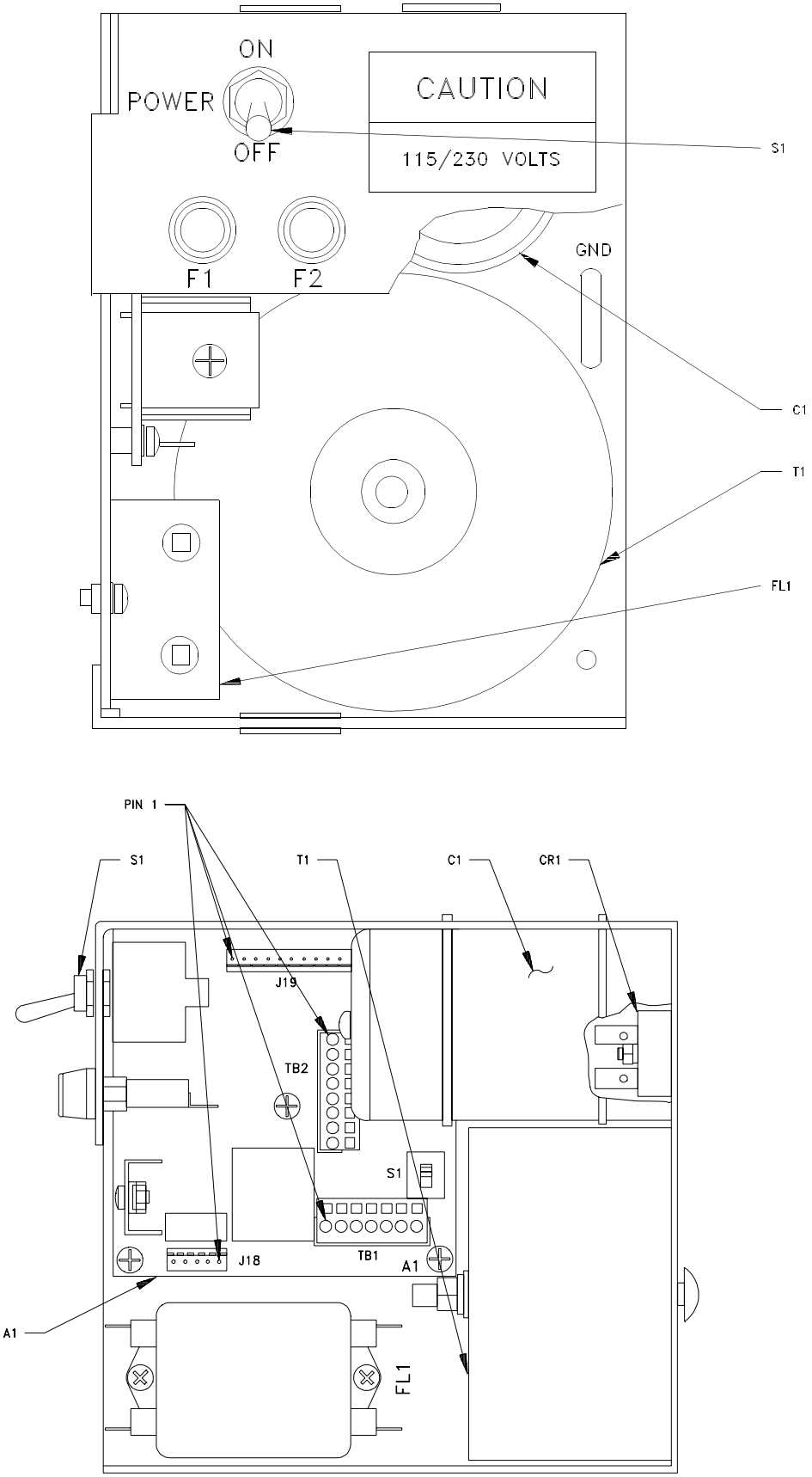
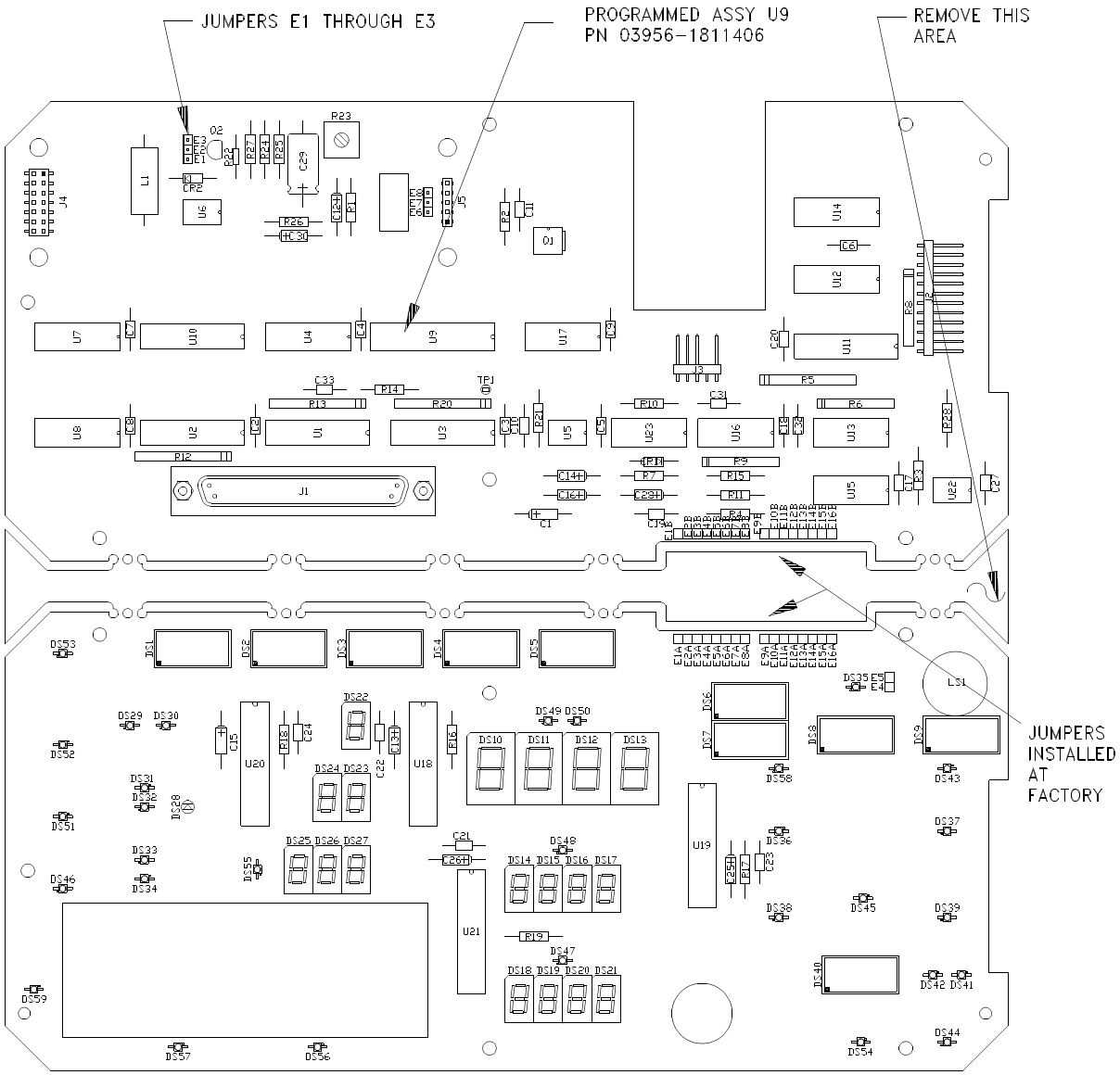


Figure 6-12. AC/DC Power Supply Assembly (A12) Configuration Identification



FACTORY PRESET JUMPER CONFIGURATIONS	
JUMPER CONFIGURATION	USAGE
E1 – E2	INSTALLED FOR EXTENDED TEMPERATURE LCD DISPLAY. *
E2 – E3	INSTALLED FOR NORMAL TEMPERATURE LCD DISPLAY.
* PRESET AT THE FACTORY; DO NOT DISTURB.	

Figure 6-13. Display/Driver Assembly Configuration Identification

6-3.2 AC/DC Power Supply Assembly (A12) Repair. Repair of the AC/DC Power Supply Assembly consists of replacing fuses F1 and/or F2. If replacement of the fuses does not correct the fault then the AC/DC Power Supply Assembly must be replaced by performing the following procedure:

a. Position Electronics Control Unit power switch to OFF.

WARNING

Make sure all sources of power are turned off and tagged "OUT OF SERVICE." These power sources include (but are not necessarily limited to) system power, solenoid power, and compass data transmission. Lethal voltages may be involved.

b. Position circuit breaker supplying power to MK 37 VT Digital Gyrocompass Equipment to OFF. Danger tag circuit breaker "OUT OF SERVICE" in accordance with ship's tag-out procedures.

c. Loosen nine captive screws securing cover on Electronics Control Unit.

d. Loosen two screws with captive washers securing the assembly to the chassis. Loosen screws near the rear of the chassis securing the rear of the assembly to the baseplate.

e. Loosen nut and remove lockwasher and flat washer.

f. Remove two connectors from the assembly.

g. Loosen carriage head bolt on AC/DC Power Supply Assembly transformer T1 and slide the bolt head from the chassis keyslot. Retighten the carriage bolt (see Figure 6-12).

h. Replace the assembly in the reverse order as described above. Ensure the 115/230 Voltage Select Switch matches the power source to the unit.

i. Perform the maintenance turn-on and checkout procedure (Table 5-1).

j. Secure cover on Electronics Control Unit by tightening nine captive screws.

6-3.3 Servo Regulator Assembly (A11) Replacement. To replace the Servo Regulator Assembly perform the following procedure:

a. Position Electronics Control Unit power switch to OFF.

WARNING

Make sure all sources of power are turned off and tagged "OUT OF SERVICE." These power sources include (but are not necessarily limited to) system power, solenoid power, and compass data transmission. Lethal voltages may be involved.

b. Position circuit breaker supplying power to MK 37 VT Digital Gyrocompass Equipment to OFF. Danger tag circuit breaker "OUT OF SERVICE" in accordance with ship's tag-out procedures.

c. Loosen nine captive screws securing cover on Electronics Control Unit.

d. Remove three screws with captive washers securing assembly mounting plate to chassis.

e. Loosen two screws securing assembly mounting plate to card rack.

f. Disconnect connector J4. Be careful not to damage the heavy gauge wire of the toroidal.

g. Remove eight screws with captive washers securing the assembly to the mounting plate.

h. Remove four screws with captive washers securing assembly heatsink bar to the mounting plate.

i. Replace assembly in reverse order as described above.

j. Perform the maintenance turn-on and checkout procedure (Table 5-1).

k. Secure cover on Electronics Control Unit by tightening nine captive screws.

6-4 DISPLAY ASSEMBLY REPAIR.

Repair of the Display Assembly consists of replacing the Display/Driver Assembly, the LCD Display Assembly, or the Switch Assembly. To repair the Display Assembly perform the following procedure. Refer to Figure 6-14 for the location of parts contained in the Display Assembly.

WARNING

Make sure all sources of power are turned off and tagged "OUT OF SERVICE." These power sources include (but are not necessarily limited to) system power, solenoid power, and compass data transmission. Lethal voltages may be involved.

a. Set all circuit breakers supplying power to the units connected to the MK 37 VT to OFF. Danger tag circuit breakers "OUT OF SERVICE" in accordance with the ship's tag-out procedures.

b. Position circuit breaker supplying power to the MK 37 VT to OFF. Danger tag circuit breaker "OUT OF SERVICE" in accordance with ship's tag-out procedures.

c. Remove two screws that secure the cable to Display Assembly with the grounding braid. Disconnect the cable from the rear of the Display Assembly.

d. Remove Display Assembly from mounting surface by removing four nuts that secure the Display Assembly to the mounting surface.

e. Disassemble Display Assembly to gain access to defective component as follows:

(1) Remove six screws on plate and remove plate.

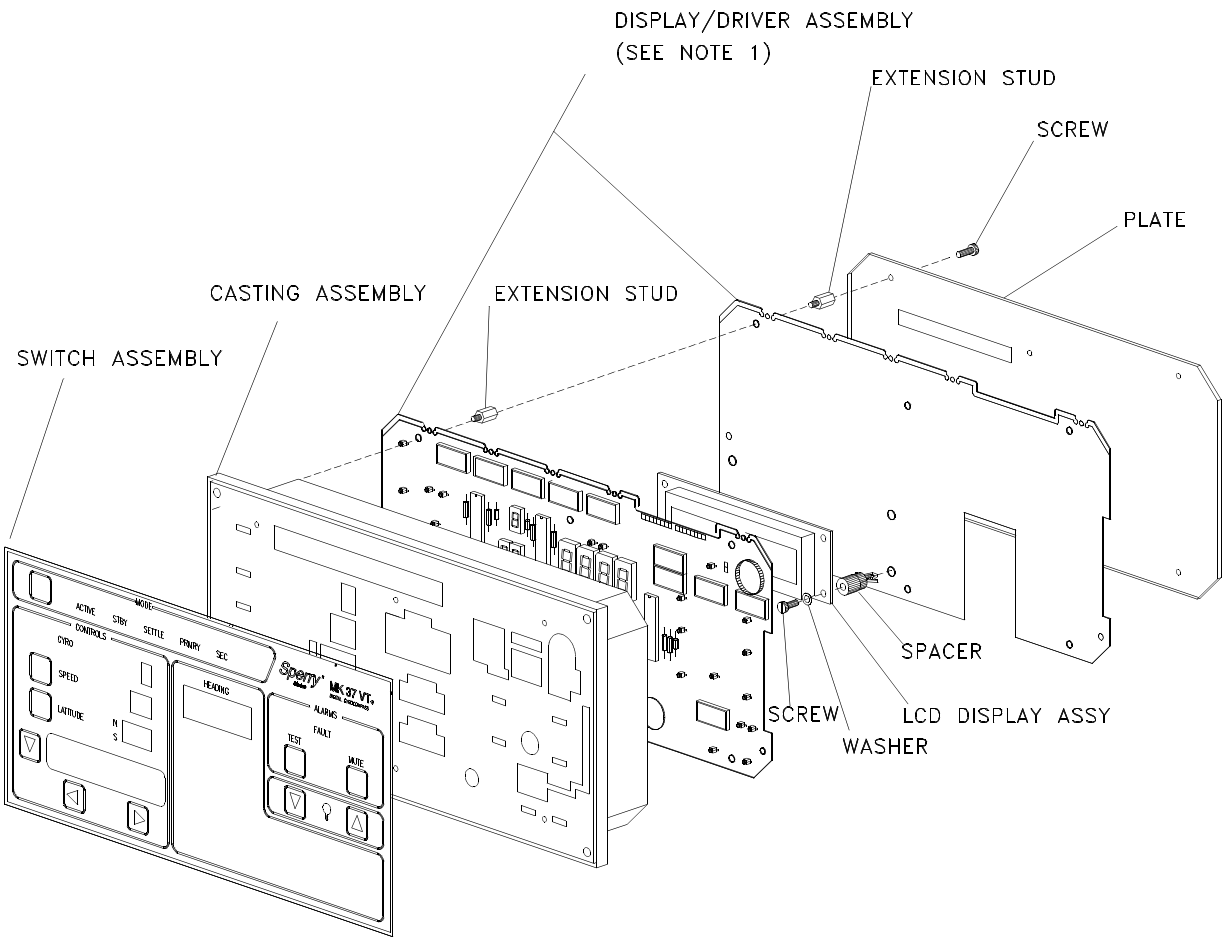
(2) Unplug cable from switch assembly that plugs into Display/Driver Assembly.

(3) Note that Display/Driver Assembly consists of two separate circuit boards that are connected by a ribbon cable. Both of these circuit boards must be removed as a single unit. Unscrew six extension studs that hold rear circuit board in place.

(4) Remove six extension studs that secure front half of Display/Driver Assembly to casting assembly. Remove Display/Driver Assembly.

(5) Remove three screws and four printed circuit board spacers securing LCD Display Assembly to Display/Driver Assembly.

(6) Reassemble Display Assembly in the reverse order of disassembly.



NOTES

1. THE DISPLAY/DRIVER ASSEMBLY CONSISTS OF TWO HALVES INTERCONNECTED BY WIRING.

Figure 6-14. Display Assembly Parts Location

6-5 MASTER COMPASS REPAIR.

CAUTION

Repairs inside the Master Compass should be undertaken only under conditions of extreme urgency when the Master Compass cannot be replaced and sent back to normal overhaul facilities. Any repairs inside the Master Compass must be done under extremely clean conditions to prevent contamination of the flotation fluid or bearings. Repair must be limited to replacement of components mounted on the support plate of the Compass Element, near the top, inside the Binnacle. No attempt should be made to replace any bearings or sensitive element parts.

6-5.1 Draining and Filling the Binnacle. A filling kit (T-958110) is used for draining and filling the Master Compass Binnacle. The following procedures describe the use of this kit. The fluid used in the Master Compass is Dow Corning 200 Silicone Fluid, 5 centistoke viscosity. It is harmless to the skin and may be removed using soap and water.

a. Draining the Binnacle.

(1) Turn off power to the Master Compass.

(2) Clean the outside of the Master Compass so that it is free of dust, dirt, grease, and other foreign material (refer to Chapter 4).

(3) Perform work in an area that is clean and free from dust or dirt and is not subject to air currents that can carry dirt or dust into the open Binnacle. Cleaning the work area prior to the start of work and the using plastic covers is recommended. Do not use cloths or rags that can introduce lint or threads.

(4) Remove six screws, six lockwashers, and six flat washers to remove the cover.

(5) Remove plate cover and gasket. (The fluid level in the Binnacle should now be approximately 3/8-inch below the top of the window.)

(6) Using the Adapter Cap (T-958427), attach the 10-inch long flexible tube to the bottom of the longer Adapter Cap tube. Screw the Adapter Cap onto the empty gallon cubitainer package (T-958430).

(7) Attach the 24-inch long flexible tube to the pressure side of the Atomizer Bulb (T-958429-2) having two hose fitting valves. Attach other end of tube to the longer tube on top of the Adapter Cap.

CAUTION

In the following step, be certain to angle the flexible tube toward the window. Inserting the tube in any other direction could damage some of the internal components.

(8) Attach the 60-inch long flexible tube to the suction side of the same Atomizer Bulb. Immerse this flexible tube into the top of the Binnacle, angling it down and towards the window.

(9) Apply pressure to the Atomizer Bulb to siphon out about three quarts of silicon fluid into the empty container. The remaining fluid in the Binnacle should now be well below the parting line of the Binnacle cover.

(10) Remove eight screws, eight lockwashers, and eight flat washers to remove the access cover. (The compass is now open and work can be performed on the components mounted on the support plate of the compass elements. Cover the Binnacle with plastic covers when work is not being performed.)

b. Filling the Binnacle.

(1) Assemble access cover to housing using eight screws, eight lockwashers, and eight flat washers.

(2) Using the same Atomizer Bulb flexible tube arrangement as used for draining, attach the 60-inch long flexible suction tube onto the longer tube on top of the Adapter Cap. Insert the 24-inch long flexible pressure tube through the hole in the access cover on top of the Binnacle. Do not force the tube down into the support plate.

(3) Pump fluid into the Binnacle until the level is about 3/8-inch below upper edge of the window. Note that the last bit of fluid can be poured directly from the container into the Binnacle.

(4) Gently shake the Binnacle in its shock mounts to work out any trapped air bubbles.

(5) Insert adapter T-958111 into the black hose of the second atomizer bulb T-958429-1, then install the adapter into the threaded hole in the base of the Binnacle. Access to this hole is through a 3/4-inch hole in the Master Compass base under the nameplate. Shift the Binnacle in its shock mounts as necessary to permit threading the adapter into the base.

(6) Apply pressure to the bellows in the Binnacle by pumping the atomizer, which will raise the fluid level. Continue pumping the atomizer until fluid level is even with the top of the cover.

(7) Pinch the tube of the atomizer to maintain the pressure and fluid level while installing plate cover, using six screws, six flat washers, and six lockwashers.

(8) Remove atomizer and adapter.

6-5.2 Azimuth Motor (B1) Replacement.

a. Drain fluid from Master Compass Binnacle (see paragraph 6-5.1).

b. Manually position Compass Dial so that it indicates a 000 degree heading. Insert alignment pin T-957470 through hole in dial and into support plate to lock yoke in azimuth. Remove three screws near inside diameter of dial gear. Remove alignment pin, then remove dial and gear assembly by lifting off gear hub. Place assembly in plastic bag. Reinsert alignment pin and note or mark position of yoke with respect to support plate on the two plates which hold main bearing.

c. Disconnect leads of motor at TB1 and fold them back out of the way so they are clear of the brushes at the slip ring.

d. Loosen screws slightly to free the three clamps holding motor and rotate clamps to provide clearance for motor. Lift motor to disengage it from mounting plate and the pinion from the azimuth gear.

e. Manually turn pinion that engages dial gear and check that there is freedom through one complete turn of the yoke without binding or backlash. Adjust gear mesh if necessary.

f. Realign yoke with support using the alignment pin and reference established in step 6-5.2.b. Lower dial and gear into position so that 000 heading is re-established. This must be done carefully to engage dial gear with its pinion. Reinstall the three screws that hold gear. Recheck dial alignment. If it has shifted, loosen the six screws holding dial to gear and shift dial to realign it with lubber line exactly at 000 heading. Retighten screws and remove alignment pin.

g. It is advisable to check the gear mesh by reconnecting Electronics Control Unit and operating Master Compass switch before refilling Master Compass.

6-5.3 Synchro Transmitter (B2) Replacement.

a. Drain fluid from Master Compass (see paragraph 6-5.1).

b. Manually position Compass Dial so that it indicates a 000 degree heading. Insert alignment pin T-957470 through hole in dial and into support plate to lock yoke in azimuth. Remove three screws near inside diameter of dial gear. Remove alignment pin, then remove dial and gear assembly by lifting off gear hub. Place assembly in plastic bag. Reinsert alignment pin and note or mark position of yoke with respect to support plate on the two plates which hold the main bearing.

c. Use an allen wrench to loosen the setscrews in the collar holding the anti-backlash gear on the transmitter shaft. Loosen the screws that tighten the clamps used to hold the transmitter to the support bracket and move the clamps out of the way. Carefully withdraw the transmitter from its mounting bracket with one hand while holding the anti-backlash gear with the other so that the gear will slide off the shaft.

d. Assemble the new transmitter by holding the gear and collar in the position it will normally occupy against the worm gear, and slide the transmitter into its bracket while the shaft slides into the gear and collar. Do not overload the anti-backlash gear as this will cause excessive drag on the motor. Tighten the transmitter clamps first, then position the anti-backlash gear on the transmitter shaft so that it is centered with respect to the worm gear. Tighten the collar screws. The yoke should be rotated through at least one complete turn to check that the transmitter runs freely with minimum backlash. Readjustment of the gear position on the shaft will probably be necessary.

e. Zero the synchro transmitter (see paragraph 6-5.4).

f. Manually turn pinion that engages dial gear and check that there is freedom through one complete turn of the yoke without binding or backlash. Adjust gear mesh as necessary.

g. Realign yoke with support using alignment pin and reference established in step 6-5.3.b. Lower dial and gear into position so that 000 degree heading is re-established. This must be done carefully to engage dial gear with its pinion. Reinstall three screws that hold gear. Recheck dial alignment. If it has shifted, loosen six screws holding dial to gear and shift dial to realign it with lubber line exactly at 000 heading. Retighten screws and remove alignment pin.

h. It is advisable to check the gear mesh by reconnecting the Electronics Control Unit and operating the Master Compass before refilling the Master Compass.

6-5.4 Synchro Transmitter Zeroing.

a. Drain fluid from Master Compass (see paragraph 6-5.1).

b. Manually position Compass Dial so that it indicates a 000 degree heading. Insert alignment pin T-957470 through hole in dial and into support plate to lock yoke in azimuth. Remove three screws near inside diameter of dial gear. Remove alignment pin, then remove dial and gear assembly by lifting off gear hub. Place assembly in plastic bag. Reinsert alignment pin and note or mark position of yoke with respect to support plate on the two plates which hold the main bearing.

c. Zero the 15CX4 synchro as follows:

(1) Loosen the clamp holding the Synchro Transmitter and remove the wires from the stator leads (S1, S2, S3).

(2) Connect a precision voltmeter (0 to 250 volts ac) as shown in Figure 6-15 (A).

(3) Turn the transmitter housing until the voltmeter reads about 37 volts. This is the approximate zero setting.

(4) Connect the voltmeter as shown in Figure 6-15 (B). Turn the transmitter housing until the voltmeter indicates a null (minimum) reading. Tighten the clamp holding the Synchro Transmitter and reconnect the wires to the stator leads.

6-5.5 <u>Adjusting the Dial</u>. If either of the dial shafts are disengaged, the dial has to be adjusted after the synchro is zeroed. Proceed as follows to adjust the dial.

a. Loosen four pan head screws.

b. Set dial pointer so that it aligns to zero.

c. Apply staking compound to pan head screw. Tighten screws.

d. It is advisable to check the gear mesh by reconnecting the Electronics Control Unit and operating the Master Compass switch prior to refilling the Master Compass with silicon fluid (see paragraph 6-5.1).

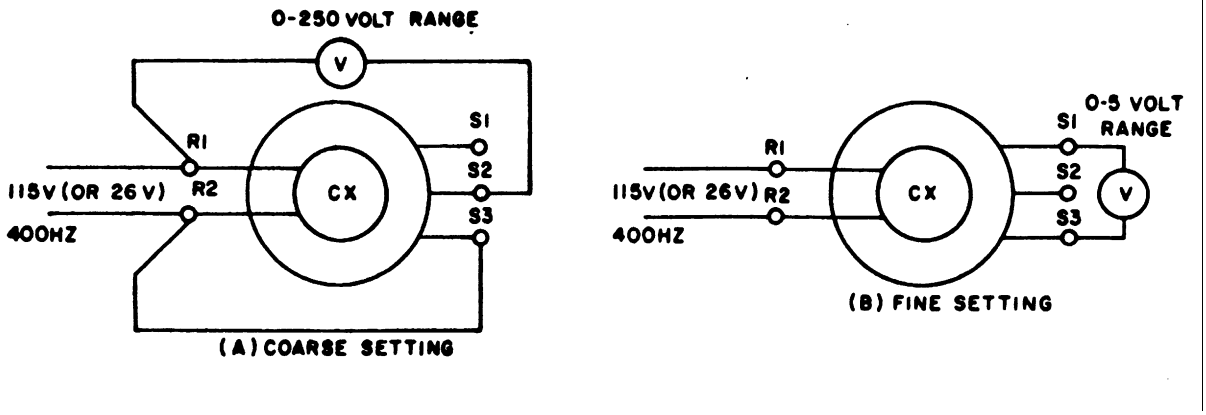


Figure 6-15. Zeroing the 15CX4 Synchro Transmitter

CHAPTER 7

PARTS LIST

7-1 INTRODUCTION.

This chapter contains parts identification data for the MK 37 VT Digital Gyrocompass Equipment. The parts identified in this chapter support the maintenance concept which limits the repair of the unit to replacement of the circuit board, replacement of chassis mounted components, and replacement of consumable parts. The Display Assembly is non-repairable in the field and therefore is replaced as a complete assembly. The parts listed in this chapter are keyed to the parts location drawings listed in Table 7-1.

7-2 PARTS LIST DESCRIPTION.

Table 7-1 lists the replaceable parts in the MK 37 VT Digital Gyrocompass Equipment. The parts list consists of five columns: figure and index number, name and description, quantity, federal supply code number, and part number.

Table 7-1. MK 37 VT Digital Gyrocompass Equipment Parts List

Figure, (Index Number)	Name and Description	Quantity	Federal Supply Code Number	Part Number
7-1	Electronics Control Unit	1	03956	1980690
7-1, (1)	(A1) Motherboard I/O Assembly	1	03956	1980694
7-1, (2)	(A2) CPU Assembly	1	03956	1980697
7-1, (3)	(A3) Analog, Digital, Isolated Serial Assembly (ADIS)	1	03956	1982163-2 (replaces 1980699)
7-1, (4)	(A4) Synchro-To-Digital Converter Assembly	1	03956	1980701-1
7-1, (5)	(A5) Gyro Control Assembly	1	03956	1980703
7-1, (6)	(A6, A7) Step Driver Assembly (4 Channels)	2	03956	1980705
7-1, (7)	(A8) Digital-To-Synchro Assembly	Ref	03956	1980711-1
7-1, (8)	(A10) DC/DC Converter Assembly	1	03956	1980713
7-1, (9)	(A11) Servo Regulator Assembly	1	03956	1980715
7-1, (10)	(A12) AC/DC Power Supply Assembly	1	03956	1980936
7-1, (11)	(A9) Course Recorder Assembly	Ref	03956	1980709
7-1, (12)	(A12T1) Transformer, Power Toroidal	Ref	03956	1812151
7-1, (13)	Not Used			
7-1, (14)	(F1) 5 Amp Metric Cartridge Fuse	1	03956	1810252-4
7-1, (15)	(F2) 15 Amp Metric Cartridge Fuse	1	03956	1810252-5
7-1, (16)	1/4 Amp Metric Cartridge Fuse	1	03956	1810252-3
7-2	Master Compass	1 or 2	03956	1891974-VAR
7-2, (1)	Azimuth Motor (B1)	1	03956	1801408-3
7-2, (2)	Synchro Transmitter (B2) (used with the -11 & -12 Master Compass)	1	03956	M20708/14-OID
7-3	Display Assembly	1	03956	1980693-VAR
7-3, (1)	Casting Assembly	1	03956	1980740
7-3, (2)	Switch Assembly	1	03956	1980745
7-3, (3)	Display/Driver Assembly	1	03956	1980743
7-3, (5)	Stud, Extension	6	03956	1808922-9
7-3, (6)	Stud, Extension	6	03956	1808922-10
7-3, (7)	Screw, Assembled Captive Washers Metric	6	03956	1810045-31
7-3, (8)	Plate	1	03956	1980741
7-3, (9)	Screw, Round Head, Nylon #6-32 X .31 L	4	96906	MS18212-27
7-3, (10)	LCD Display Assembly	1	03956	1980737
7-3, (11)	Spacer, Printed Circuit Board	4	03956	1812175-1
7-3, (12)	Washer, Flat #6, Non-Metallic	1	03956	1800544-4
7-4	Digital-To-Synchro Assembly	1	03956	1980711-1
7-4, (1)	1/8 Amp Metric Cartridge Fuse	1	03956	1810374-7

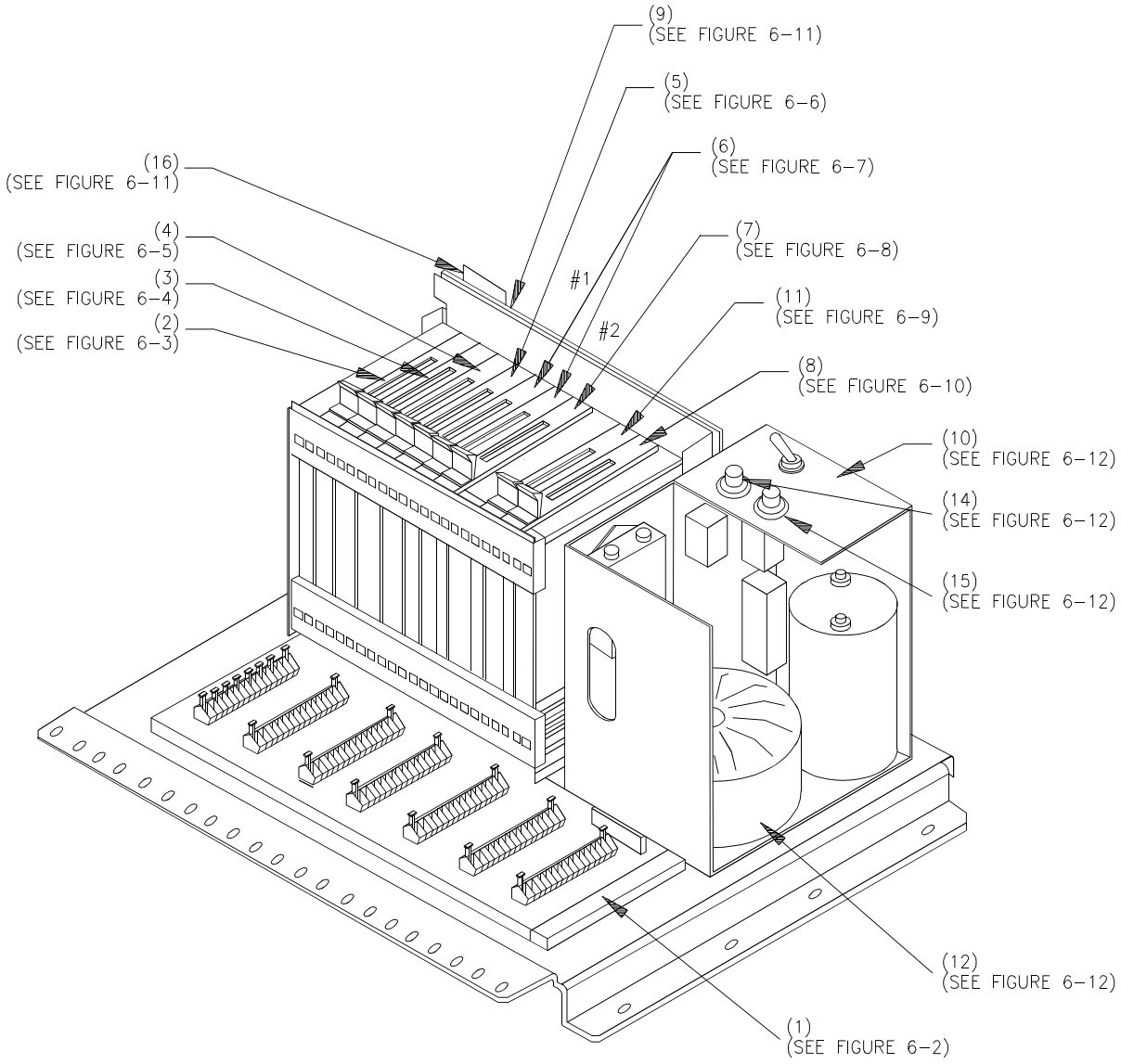


Figure 7-1. Electronics Control Unit Parts Identification Drawing

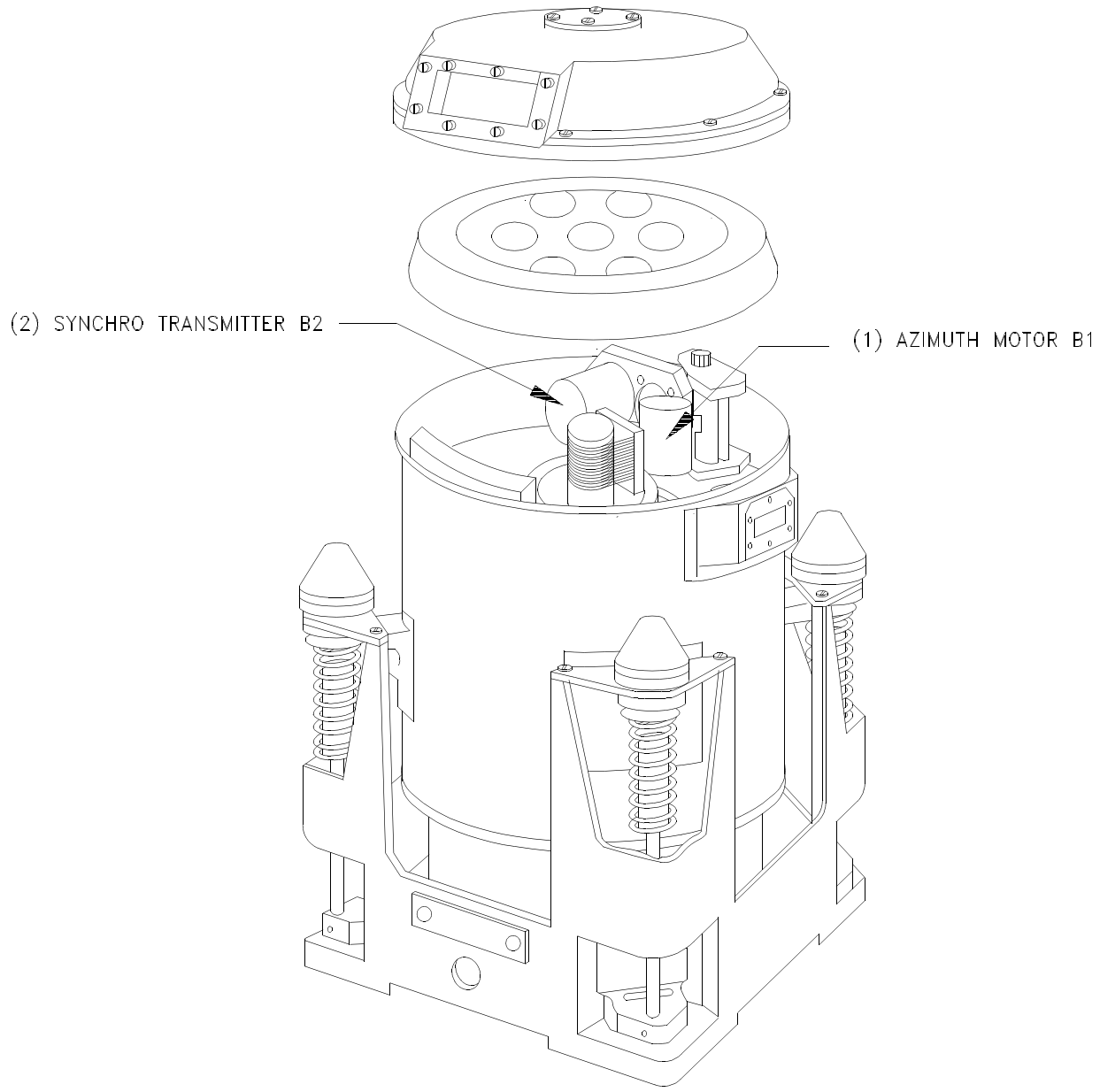
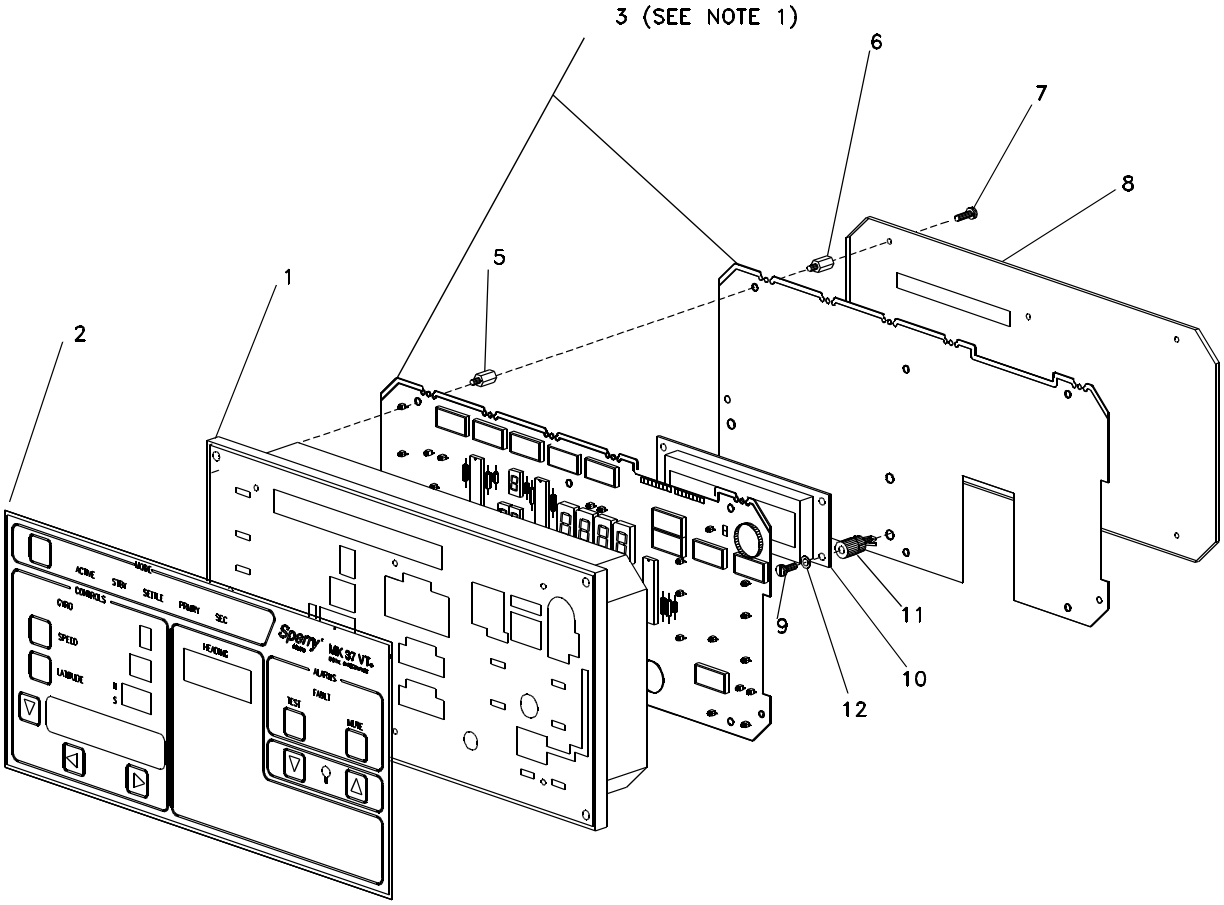


Figure 7-2. Master Compass Parts Identification Drawing



NOTES

1. THE DISPLAY/DRIVER ASSEMBLY (ITEM 3) CONSISTS OF TWO HALVES INTERCONNECTED BY WIRING.
2. SEE TABLE 7-1 FOR THE PARTS LIST.

Figure 7-3. Display Assembly Parts Identification Drawing

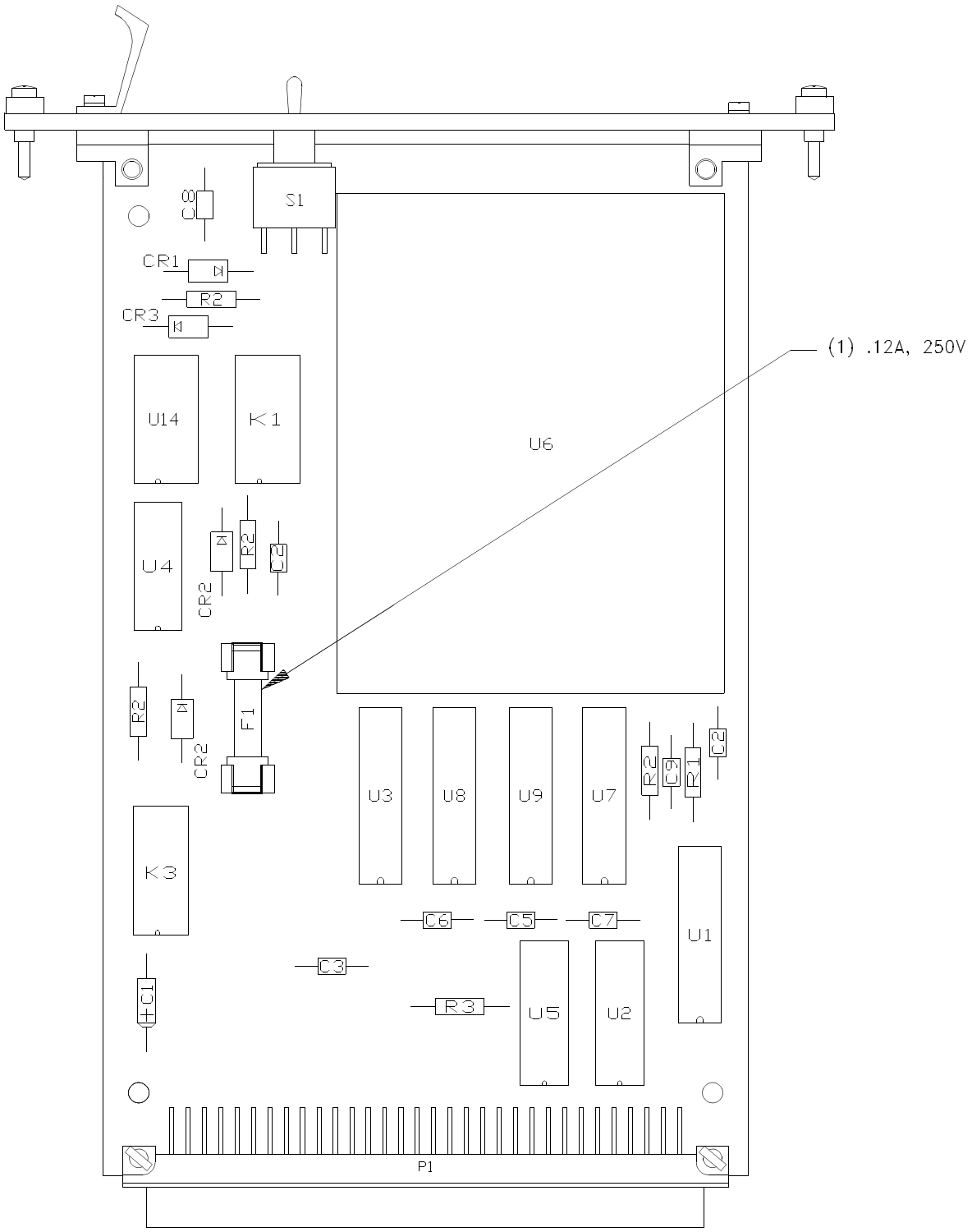


Figure 7-4. Digital-To-Synchro Assembly (A8) Parts Identification Drawing

CHAPTER 8

INSTALLATION

8-1 INTRODUCTION.

This chapter contains installation and checkout data for the MK 37 VT Digital Gyrocompass Equipment. Before the actual installation begins, all equipment required for installation should be on hand and checked for damage during shipment, storage, or handling.

8-2 INSTALLATION DRAWINGS.

Table 8-1 lists the figures required to install the equipment associated with the MK 37 VT Digital Gyrocompass Equipment. All interconnecting cables must be manufactured according to drawings listed in Table 8-1.

Table 8-1. Installation Drawings

Equipment or Document	Figure Number
MK 37 VT System Mechanical Installation Drawing	8-1
MK 37 VT System Electrical Installation Drawing	8-2

8-3 SITE INFORMATION.

Figure 8-1 provides outline dimensional data for mounting the MK 37 VT Digital Gyrocompass Equipment. Make sure that the equipment is installed so that adequate service clearances are achieved.

8-4 TOOLS AND MATERIALS REQUIRED FOR INSTALLATION.

Standard hand tools such as screwdrivers, wrenches, and ratchets are the only tools required to install the MK 37 VT Digital Gyrocompass Equipment.

8-5 INPUT REQUIREMENTS.

Table 8-2 lists the power and interface requirements for the MK 37 VT Digital Gyrocompass Equipment.

Table 8-2. Input Requirements

Characteristics	Requirements
Power Requirements:	
Ship's Power for Electronics Control Unit	115VAC, 230VAC, or 24VDC
Interface Requirements:	RS-232 and RS-422 Serial Interfaces

8-6 INSTALLATION PROCEDURES.

Paragraphs 8-6.1 through 8-6.3 provide installation procedures for installing the MK 37 VT Digital Gyrocompass Equipment.

8-6.1 Master Compass Installation. The Master Compass is installed remotely for an input to the Electronics Control Unit. It should be mounted as close to the ship's center of roll and pitch as possible. The Master Compass should be located no closer to a magnetic compass than the distance defined in Table 8-3. Install the Master Compass as follows:

a. Prepare a flat and level surface to mount the Master Compass. Installation of the mounting bolts in relationship with the ship's centerline is shown in Figure 8-1.

b. Mount the Master Compass on the prepared foundation so the fore and aft alignment marks on the base of the compass are aligned with the ship's fore and aft lines. A 1/32-inch misalignment between the fore and aft alignment marks equals a 1/6-degree compass error. Slots on the base of the compass permit a plus or minus 5-degree adjustment when making the alignment. If the mounting surface is not flat and level, shims should be used so the mounting base is not warped or strained.

c. Connect cable number 1 to gyrocompass connector J1 per Figure 8-2. Make certain that the cable is run so that it does not interfere with the movement of the Binnacle in its shock mounts.

d. Connect the Master Compass to the ship's hull (ground) by using a bonding strap connected to the bonding screw terminal on the compass.

Table 8-3. Safe Distance From Magnetic Compass

Safe Distance From	Master Compass	Electronics Control Unit
Standard Magnetic Compass	0.9 meters	2.5 meters
Steering Magnetic Compass	0.6 meters	1.5 meters

8-6.2 Electronics Control Unit Installation. The Electronics Control Unit can be mounted on any horizontal or vertical surface providing that the cover can be removed and that there is adequate clearance for accessing the internal components for servicing. When mounting the unit on a vertical surface, make sure that the unit is oriented such that the cable access plate is located at the bottom. The unit should be connected to the ship's hull (ground) by a bonding strap connected to the bonding screw terminal provided.

The Electronics Control Unit is cooled by conduction and convection and must not be located adjacent to any large heat source. A well ventilated area is preferred.

At installation, the unit must be configured to match the ship's voltage source as defined in paragraph 8-7. Configuration jumpers for the designation of the compass (such as primary or secondary) and selection of the repeaters must be set in accordance with Table 6-1.

Cable number 1 from the Master Compass has individual labeled wires for connection to their terminal boards within the unit. The Electronics Control Unit should be located no closer to a magnetic compass than the distance defined in Table 8-3.

8-6.3 Display Assembly Installation. The Display Assembly is designed for panel mounting. Cutout and mounting details for installing the Display Assembly are contained on Figure 8-1.

8-7 INSTALLATION SETUP.

Paragraphs 8-7.1 and 8-7.2 provide the procedures required to set up the MK 37 VT Digital Gyrocompass Equipment.

8-7.1 Initial Set-Up. The following system settings must be set prior to system turn-on for initial set-up/alignment.

a. **115/230 VAC Select Switch** - The applied voltage switch, A12A1S1, must be set to the ship's VAC position at this time (see Figure 6-12 for switch location).

b. **Mode (Active, Standby)** - If this is a dual MK 37 VT Gyrocompass installation, one of the two compasses must be designated as the primary and the other as secondary. Select the primary gyrocompass as the compass that has all repeaters connected. The compass designated as primary must have E2 wired to E3 on its Gyro Control Assembly. The compass designated as secondary must have E1 wired to E2 on its Gyro Control Assembly (see Figures 3-3 and 6-6).

c. **Comparator** - In dual installations with the Course Recorder option, the Comparator function can be enabled by jumpering E4 to E5 on the Gyro Control Assembly at installation. The factory default has E6 jumpered to E5 which disables the compass compare function. The comparator menu will appear only if the Gyro Control Assembly jumper connects E4 to E5 (see Figures 3-4 and 6-6).

d. **Gyro 1/Gyro 2** - The Display Assembly provides a GYRO 1 or GYRO 2 indicator to distinguish between systems in a dual configuration. The Motherboard jumper E1 determines the GYRO indication. Install E1 for a GYRO 2 indication and remove E1 for a GYRO 1 indication (see Figures 3-3 and 6-2).

8-7.2 Set-Up/Installation Menu. At the time of installation, each compass must be customized to fit the particular characteristics of the installation with which it is to be used. This is done through the Set-Up/Installation menu. Make sure that steps a through c of paragraph 8-7.1 have been completed prior to entering the set-up menu.

CAUTION

Before applying power to the the MK 37 VT from the ship's switchboard, use a voltmeter to check the input voltages that will be supplied to the MK 37 VT. Check all wiring carefully. Make certain that DC polarities are correct. If the proper voltages and polarities are present, power may now be switched on to the MK 37 VT. Check the voltages and polarities at the MK 37 VT interface board. Make sure after checking the AC input voltage that the 115/230 VAC Voltage Select Switch is set to the correct position.

a. Turn the power ON/OFF switch on the Electronics Control Unit to ON to energize the MK 37 VT Digital Gyrocompass Equipment.

b. Enter the Set-Up/Installation menu by pressing the MODE switch and the SCROLL switch simultaneously. The menus can then be scrolled using the scroll key beside the LCD.

8-7.2.1 Repeater Installation. When this screen appears, TEST can be chosen to run a repeater in a constant counterclockwise motion (constantly increasing heading) to ensure that the repeater has been wired for proper step direction.

REPEATER CH (X): DSBL ENBL, DSBL, TEST

Where X is the repeater channel from 1 To 8.

When this screen appears, it will indicate DSBL. Use the right or left arrow key to scroll through the choices. If TEST is selected, the repeater will begin rotating counterclockwise and will complete whole revolutions until disabled. Verify that the repeater is slewing in the correct direction. ENBL will enable the displayed repeater channel while DSBL will disable the displayed repeater channel. A disabled repeater channel is unavailable to the operator.

NOTE

If a fault occurs during repeater test, ensure that the repeater is wired correctly and the switch on the Step Driver Assembly associated with the repeater is turned on.

8-7.2.2 Speed Input Selection. During installation the automatic speed source (if available) must be designated for each gyrocompass. If there is not an automatic source available at the compass, MAN (manual) must be designated.

SPEED SOURCE: MAN MAN, CHA, CHB, PPNM

Use the right or left arrow key to scroll toward the automatic speed source that is available. If there is none available, scroll to MAN. Press the down arrow to move to the next screen and to record the choice of an automatic source or MAN. Select CHA if serial NMEA speed input will be on the RS-232 channel A input. Select CHB if NMEA speed input will be on the RS-422 channel B input. To configure the MK37 VT for 200 Pulse Per Nautical Mile Contact Closure input, select PPNM. When CHA, CHB, or PPNM is selected, the operator can choose between manual and automatic speed input.

NOTE

The system will only accept a rate of 200 PPNM.

8-7.2.3 Speed Timeout. (Applicable only to software PN 1813422 and later.) This menu allows selection of the timeout before speed data loss faults are reported. It is only available when Speed Source has been selected as CHA or CHB.

SPEED TIMEOUT: 1 MIN 1-20 MIN

Use the right and left cursor keys to select the desired timeout. By default, the system will alarm one minute after it detects a loss of serial speed messages. Other speed message faults, such as invalid message format, range faults or missing data, will be reported immediately and will not be affected by the speed timeout value.

8-7.2.4 Latitude Selection. During installation, the latitude source (such as a Global Positioning System), must be designated for each gyrocompass. If there is not an automatic source available, MAN (manual) must be designated.

SOURCE: ??? MAN, CHA, or CHB

Use the right or left arrow key to scroll toward the automatic latitude sources available. If there are none available, scroll to MAN. Press the down pointing arrow to move to the next screen and to record the choice of an automatic source or MAN. Select CHA if serial NMEA latitude input will be on the RS-232 channel A input. Select CHB if NMEA latitude input will be on the RS-422 channel B input. When CHA or CHB is selected, the operator can choose between manual and automatic latitude input.

8-7.2.5 Latitude Timeout. (Applicable only to software PN 1813422 and later.) This menu allows a selection of the timeout before latitude data loss faults are reported. It is only available when Latitude Source has been selected as CHA or CHB.

LAT TIMEOUT: 1 MIN 1-60 MIN

Use the right and left cursor keys to select the latitude timeout. By default, the system will alarm one minute after it detects a loss of serial latitude messages. Other latitude message faults, such as invalid message format, range faults or missing data, will be reported immediately and will not be affected by the latitude timeout value.

8-7.2.6 Serial Rate Of Turn. (Applicable only to software PN 1813422 and later.) This menu allows turn-on of the serial rate of turn data.

OUTPUT ROT: OFF OFF, ON

Use the right and left cursor keys to turn on or off the serial ROT message. This adds a NMEA 0183 format $HEROT message to the serial outputs.

8-7.2.7 Heading Offset. (Applicable only to software PN 1813422 and later.) This menu provides entry of a heading offset error.

ALIGN OFFSET: +0.0 [-2.5° - 2.5°]

When this menu is accessed, the second line will be presented in brackets to prevent accidental change. Press the TEST and SCROLL keys simultaneously to enable value input. Use the right and left cursor keys to select the desired heading offset.

The alignment offset is used to correct for a fixed heading error introduced by misalignment of the Master Compass during installation. The error should be corrected by moving the Master Compass, however, in situations where this is not practical (such as IGP stands) this menu provides for up to 2.5 degrees of correction in either direction. The alignment offset will be added to all heading values on the display assembly and system outputs (step, serial, and synchro), not to the Master Compass dial.

8-7.2.8 Rudder Scaling. This measurement will be required only if the MK 37 VT is equipped with the Course Recorder Option and a rudder repeatback signal on the given channel. Up to two rudders can be configured for course recorder storage and output.

8-7.2.8.1 Rudder 1 Zeroing. The Rudder 1 zero menu is used to center the rudder.

RUD 1: ZERO sX.XX V RRB sY.YY V

NOTE

s = + for Port or - for Starboard; X.XX is the signed rudder wheel potentiometer voltage; Y.YY is the signed scaled repeatback rudder potentiometer voltage.

Upon accessing this menu, the rudder wheel should then be set to zero rudder. After the rudder wheel is set to zero, the rudder wheel potentiometer and rudder repeatback voltages will be stored by pressing the left or right arrow. That voltage now represents the zero rudder voltage for this channel.

8-7.2.8.2 Rudder Calibration. Rudder calibration is a two step process. Both left and right rudder calibration angles must be entered so that the system can properly scale the rudder repeatback information. The initial default rudder calibration angles are zero (0) for both channels.

RUD 1 R: sZZ° 0 - 75 sXX.XX° / V RRB sYY.Y°

NOTE

R = Right; s = + for Port or - for Starboard; ZZ = rudder calibration angle; XX.XX is the signed scale factor; YY.Y is the signed scaled repeatback rudder angle.

The scaling is most accurate if the rudder is driven hard over and the displayed ZZ degree matches the rudder angle. Use the left and right arrows until the ZZ degree matches the mechanical indicator at the rudder. The right rudder calibration angle must be a non-zero value to enable the left rudder channel and vice versa. To disable the rudder repeatback, set the rudder calibration angle to zero (0).

RUD 1 L: sZZ° -75 - 0 sXX.XX° / V RRB sYY.Y°

NOTE

L = Left; s = + for Port or - for Starboard; ZZ = rudder calibration angle; XX.XX is the signed scale factor; YY.Y is the signed scaled repeatback rudder angle.

The Rudder Calibration Left menu is accessed by pressing the SCROLL arrow on the Rudder Calibration Right menu. The Rudder Calibration Left menu and Rudder Print Range menu will not be presented if the right rudder calibration angle is set to zero (0). The right rudder calibration angle must be a non-zero value to enable the left rudder channel. If the left rudder calibration angle is set to zero, the system will automatically disable the rudder channel and clear any previously entered right rudder calibration angle. The left rudder calibration is the same as described for the right rudder calibration.

8-7.2.8.3 Rudder 2 Zeroing. The procedure for zeroing Rudder 2 is the same as zeroing Rudder 1. Refer to paragraph 8-7.2.8.1.

8-7.2.8.4 Rudder 2 Calibration. The Rudder 2 calibration is the same as calibration for Rudder 1. Refer to paragraph 8-7.2.8.2.

8-7.2.8.5 Rudder 1 Print Range. This menu will not be presented if the right or left rudder calibration angle has been set to zero (0) for the channel 1.

RUD 1 PRT RNG: ±X ±20° - ±75°

NOTE

X is the rudder print range.

The rudder print range menu controls the presentation of graphic rudder course recorder output. The range should be set to the full range of rudder motion. It represents the maximum and minimum rudder angles to be printed on the graph. The initial default rudder print range is 30° for both channels.

The right or left cursor arrows are used to select an angle between 20° and 75°. The available rudder angle ranges will change in increments of 5 degrees. Input values will not wrap around. The range is symmetric and must encompass the largest possible positive and negative values in order to print all rudder samples.

NOTE

The maximum rudder angle expected for the ship's rudder must match the input value. Course recording print scale is the basis for the number input here. If the number is incorrect, an inaccurate record of rudder activity will be recorded. It is suggested that about five (5) degrees be added to the rated maximum rudder angle specified and input at installation to prevent any rudder angle overshoot from occurring.

8-7.2.8.6 Rudder 2 Print Range. This print range menu is the same as Rudder 1. Refer to paragraph 8-7.2.8.5.

8-7.2.9 Software Revision. This screen is accessed by pressing the SCROLL arrow on the Rudder Print Range Menu. The revision of software contained in the system can be determined but may not be changed.

SOFTWARE PN: XXXXXXX [REV: X]

Press the SCROLL key to return to the Repeater Initialization menu or press any normal operation key to exit from the Set-Up/Installation menus.

LIST OF EQUIPMENT

ITEM NO.	NAME	CODE IDENT	SPERRY MARINE PART NUMBER
1	MK37 VT DISPLAY ASSEMBLY	03956	1980693–VAR
2	MK37 VT ELECTRONICS CONTROL UNIT	03956	1980690–VAR
3	MK37 VT MASTER COMPASS ASSEMBLY	03956	1891974–VAR
4	MK37 VT COMPASS CABLE	03956	T968572–VAR
5	MK37 VT DISPLAY CABLE	03956	T968593–VAR

NOTES:

1.1 DISPLAY ASSY MUST BE MOUNTED USING PROVIDED HARDWARE PER THE CUTOUT SHOWN ON SHEET 2.

1.2 THE MK37 VT DISPLAY ASSEMBLY SHOULD BE MOUNTED SO AS TO AVOID SHALLOW VIEWING ANGLES AND EXPOSURE TO DIRECT SUNLIGHT OR DISTRACTING REFLECTIONS MAY OCCUR. SEE SHEET 3.

1.3 UNIT IS NOT INTENDED TO BE EXPOSED TO WEATHER OR SUBMERGED IN OR HAVE CONTINUOUS CONTACT WITH SEAWATER.

1.4 THE ELECTRONICS CONTROL UNIT SHOULD BE LOCATED IN A DRY, ACCESSIBLE LOCATION WITH LIGHTING PROVISIONS TO FACILITATE BOTH INSTALLATION AND SERVICE. AN ELECTRICAL SERVICE OUTLET (115VAC OR 230VAC) SHOULD BE PROVIDED NEARBY FOR OPERATION OF TEST OR SERVICE EQUIPMENT. THE ELECTRONICS CONTROL UNIT SHOULD ALSO BE LOCATED IN AN AREA WHICH MINIMIZES THE CABLE LENGTH BETWEEN THE ELECTRONICS CONTROL UNIT AND THE DISPLAY UNIT.

1.5 FOR ENVIRONMENTAL SPECIFICATIONS CHART SEE SHEET 4.

1.6 FORE AND AFT ALIGNMENT MARKS TO BE ALIGNED WITH SHIP'S CENTERLINE. 0.8MM MISALIGNMENT BETWEEN FORE AND AFT MARKS = 1/6° ERROR.

1.7 SLOTS IN THE BASE OF THE MASTER COMPASS ASSEMBLY PERMIT ±5° OF ROTATION FOR ALIGNMENT PURPOSES.

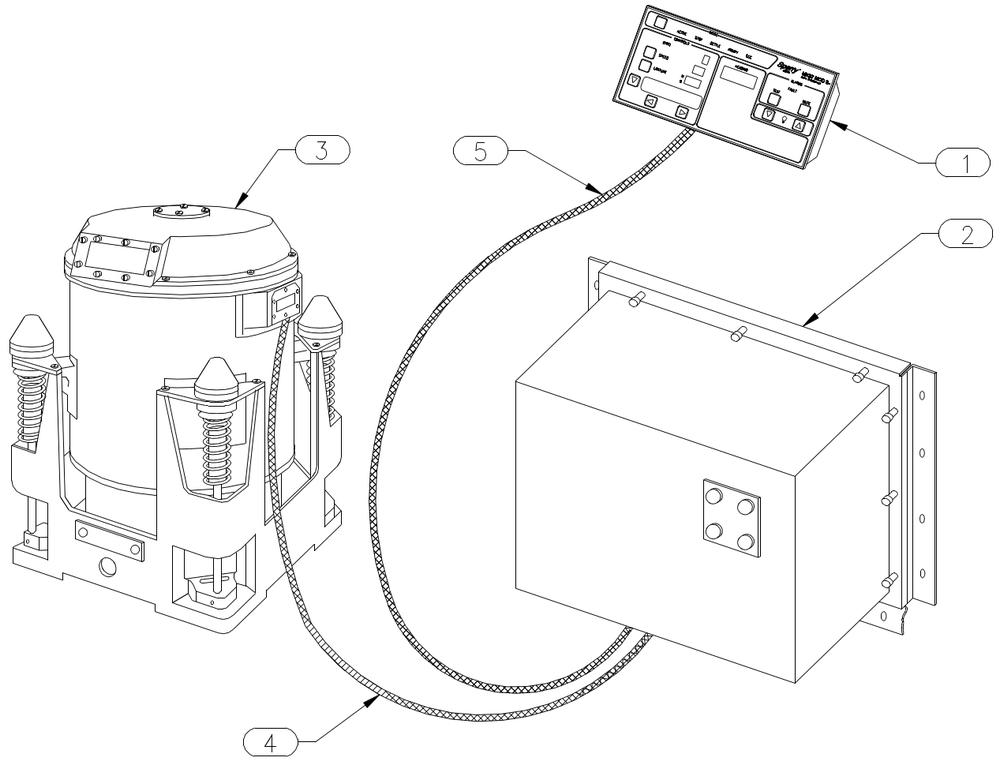
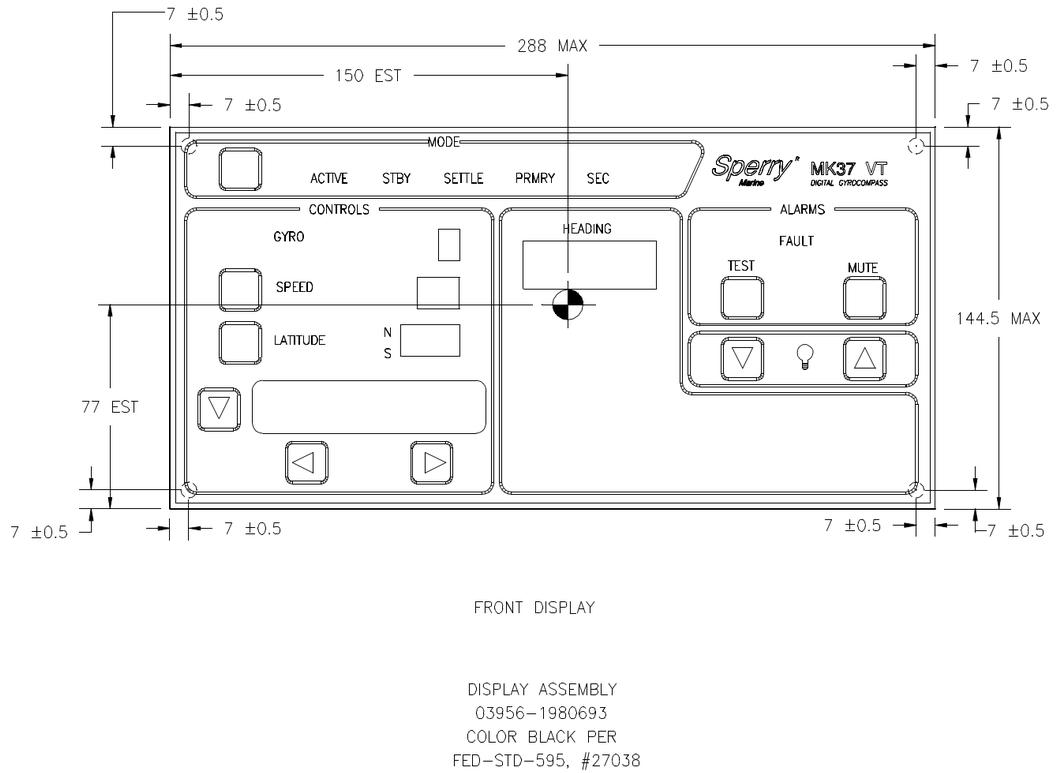


Figure 8-1. MK 37 VT System Mechanical Installation Drawing (Sheet 1 of 5)

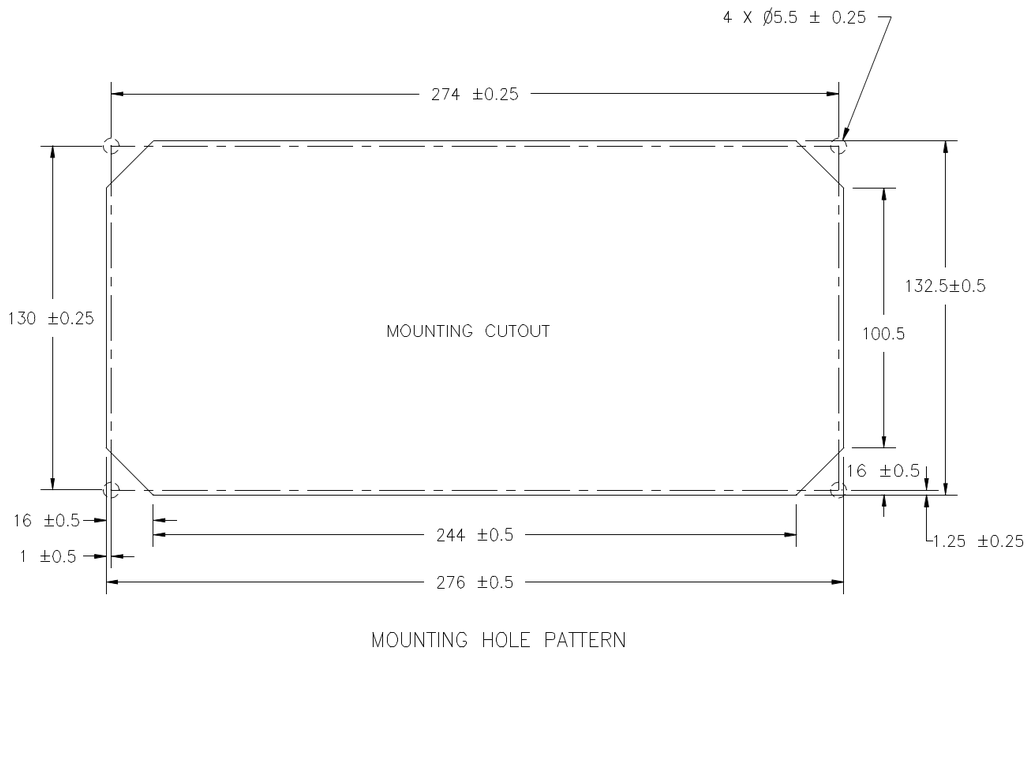
1820374 (Sheet 1, Rev A)



FRONT DISPLAY

DISPLAY ASSEMBLY
03956-1980693
COLOR BLACK PER
FED-STD-595, #27038

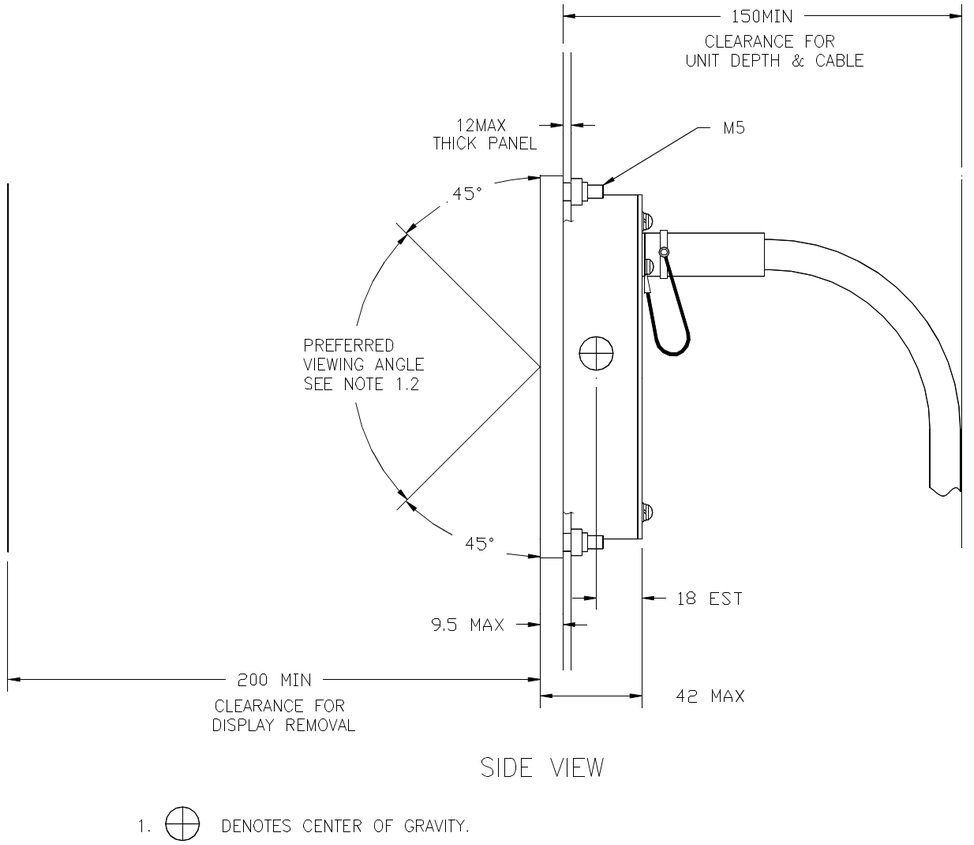
DENOTES CENTER OF GRAVITY



MOUNTING HOLE PATTERN

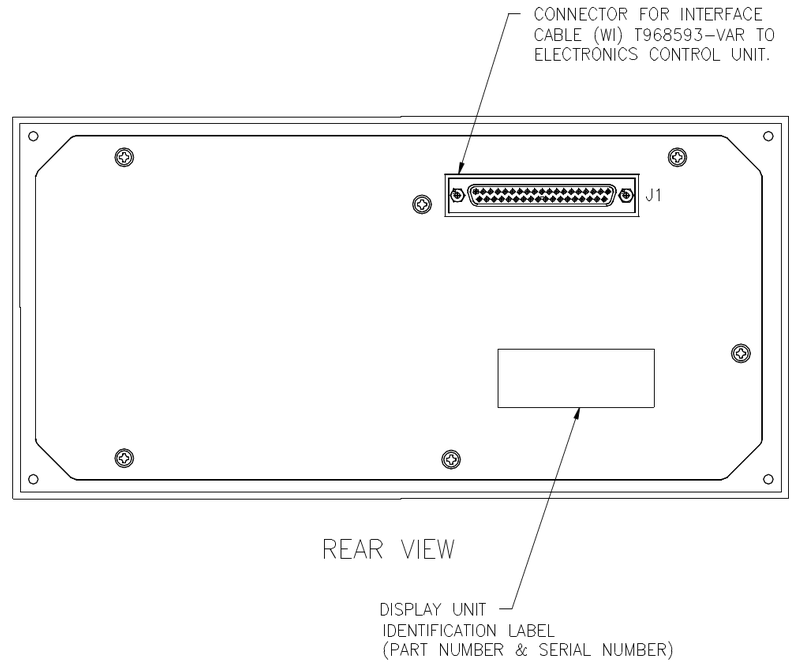
MK37 VT DISPLAY ASSEMBLY
03956-1980693
FRONT VIEW & MOUNTING CUTOUT

Figure 8-1. MK 37 VT System Mechanical Installation Drawing (Sheet 2 of 5)



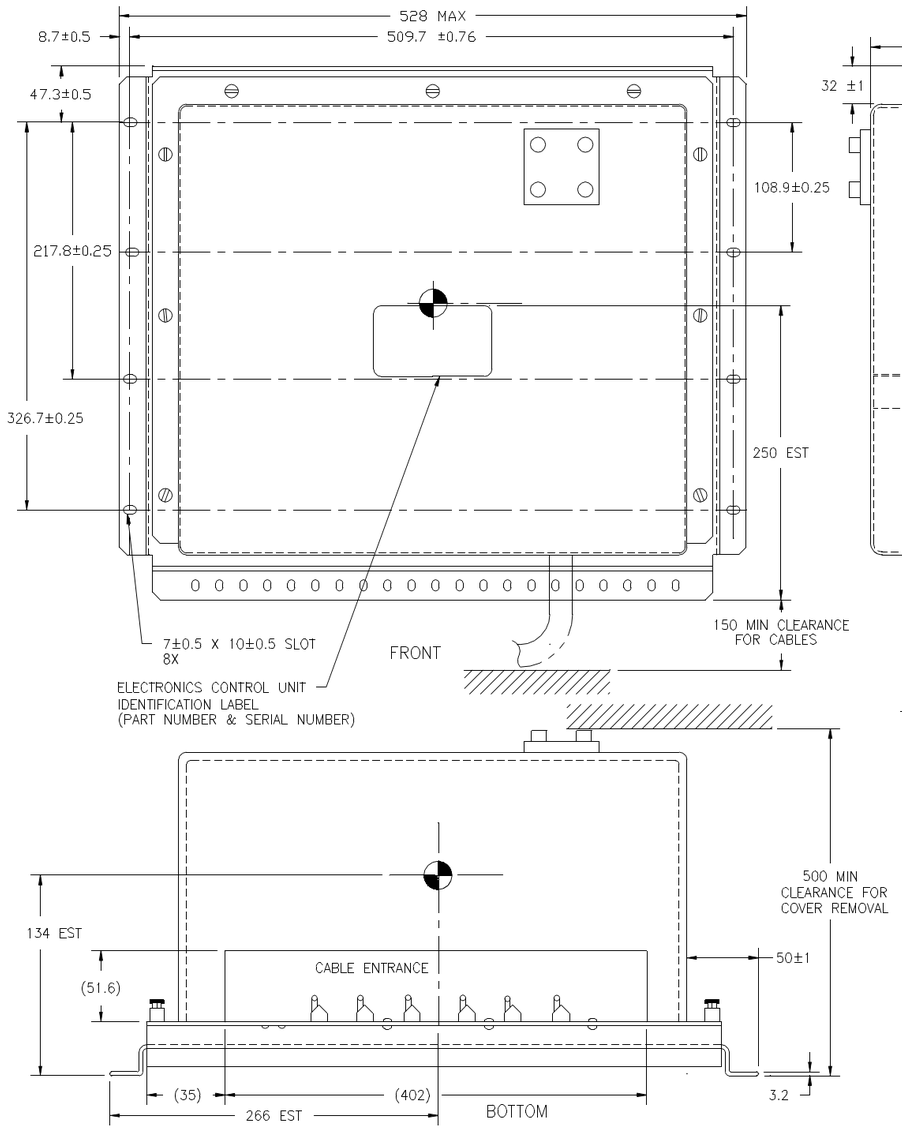
SIDE VIEW

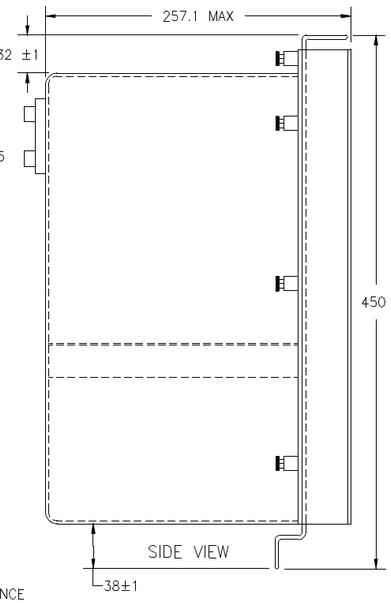
1. ⊕ DENOTES CENTER OF GRAVITY.



DISPLAY ASSEMBLY
CLEARANCES, SIDE & REAR VIEW

Figure 8-1. MK 37 VT System Mechanical Installation Drawing (Sheet 3 of 5)





DENOTES CENTER OF GRAVITY.

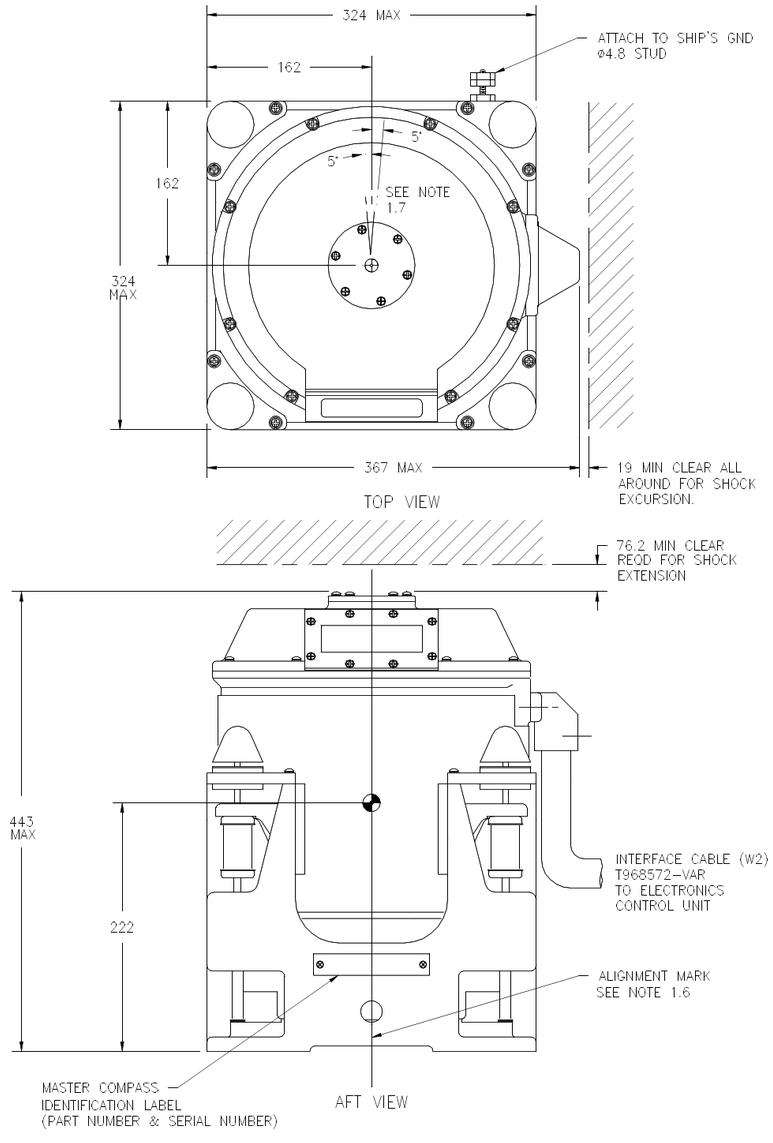
ENVIRONMENTAL SPECIFICATIONS		
	DISPLAY ASSY & ECU	GYROCOMPASS
OPERATING TEMPERATURE	−15°C TO +55°C	0°C TO +45°C
STORAGE TEMPERATURE	−40° TO +70°C	−40°C TO +70°C
HUMIDITY	93%	93%
VIBRATION	* IEC 945, CLASS B	* ISO 8728
EMI/RFI	* IEC 945, CLASS B	* IEC 945, CLASS B
DEGREE OF ENCLOSURE	* IEC 529	* IEC 529
COMPASS SAFE DISTANCE		0.9 METERS
HEAT DISSIPATION	10 WATTS MAX	10 WATTS MAX

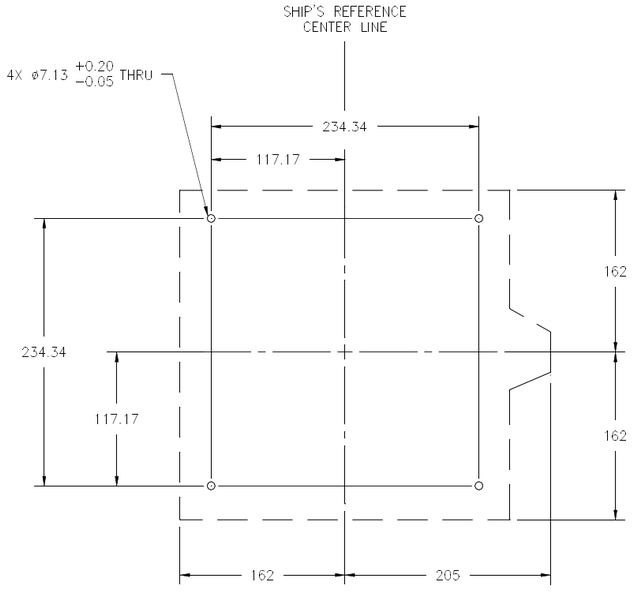
* MEETS OR EXCEEDS

MK37 VT ELECTRONICS CONTROL UNIT ASSEMBLY
03956−1980690
COLOR LIGHT GREY PER
FED−STD−595, #26492
VIEWS AND MOUNTING REQT'S

Figure 8-1. MK 37 VT System Mechanical Installation Drawing (Sheet 4 of 5)

1820374 (Sheet 4, Rev A)





MASTER COMPASS ASSEMBLY
03956-1891974-VAR
COLOR LIGHT GREY PER
FED-STD-595, #26942
VIEWS AND MOUNTING REQUIREMENTS

Figure 8-1. MK 37 VT System Mechanical Installation Drawing (Sheet 5 of 5)

1820374 (Sheet 5, Rev A)

NOTES:

1.1 CABLING:

1.1.1 TYPE TO BE DETERMINED FROM APPLICABLE SYSTEM CONNECTION DRAWING.
1.1.2 IF ARMORED CABLES ARE USED, TERMINATE ARMOR OUTSIDE OF UNIT.
1.1.3 SECURE CABLING TO SLOTS AT ENCLOSURE OPENING USING CUSTOMER SUPPLIED TIES AS REQUIRED.

1.2 USE CARE IN DRESSING CABLE TO ALLOW ACCESS TO INPUT/OUTPUT MEASUREMENT POINTS FOLLOWING INSTALLATION.

1.3 ACCEPTABLE WIRE SIZES ARE LISTED ON TABLE II. IF MORE THAN ONE WIRE IS TO BE CONNECTED TO A TERMINAL, CONNECT THE MULTIPLE WIRES EXTERNALLY AND RUN A SINGLE WIRE TO THE TERMINAL.

1.4 DO NOT MAKE ANY SHIPS CABLE CONNECTIONS TO CABLES W1, W2, W23, W25, W26, OR W27 (DUAL SYSTEM). BOTH W1 AND W2 ARE INTERCONNECT CABLES. W24 IS USED IN THE COURSE RECORDER OPTION. W25, W26, W27 ARE PRESENT IN DUAL COMPASS CONFIGURATION ONLY.

1.5 ALL CABLES ARE CUSTOMER FURNISHED EXCEPT W1 (DISPLAY UNIT CABLE), W2 (MASTER COMPASS CABLE), W24 (COURSE RECORDER PRINTER CABLE), AND W25, W26, W27 (DUAL COMPASS INTERCONNECT CABLE). SEVERAL LENGTH OPTIONS ARE AVAILABLE TO MINIMIZE EXCESS LENGTH. CABLES SHALL NOT BE MODIFIED OR SPLICED IN ANY MANNER.

1.6 CABLE TYPES SHOULD CONTAIN EXTRA CONDUCTORS OR SPARES. INSULATE ENDS OF EXTRA CONDUCTORS IN CABLE AND TIE BACK TO AVOID SHORTING WITH OTHER CONDUCTORS.

1.7 BOTH RS232 AND RS422 SERIAL INTERFACES MAY HAVE TRANSMIT AND RECEIVE LINES SPLIT AND ROUTED TO DIFFERENT EQUIPMENT. IN THESE SPLIT APPLICATIONS, AN ELECTRICAL RETURN (RTN) MUST BE COMPLETED TO BOTH UNITS. BOTH THE TRANSMIT AND THE RECEIVE MUST HAVE THE SAME BAUD RATE INTO THE COMPASS. WHEN IT IS NECESSARY TO CONNECT TWO LINES INTO A SINGLE I/O CONNECTOR, SPLICE THE SINGLES EXTERNALLY AND RUN A SINGLE WIRE INTO THE I/O CONNECTOR.

1.8 THE ELECTRONICS CONTROL UNIT SHOULD BE LOCATED IN A DRY ACCESSIBLE LOCATION WITH LIGHTING PROVISIONS TO FACILITATE BOTH INSTALLATION AND SERVICE. AN ELECTRICAL SERVICE OUTLET (115VAC OR 230VAC) SHOULD BE PROVIDED NEARBY FOR OPERATION OF TEST OR SERVICE EQUIPMENT. THE ELECTRONICS CONTROL UNIT SHOULD ALSO BE LOCATED IN AN AREA WHICH MINIMIZES THE CABLE LENGTH BETWEEN THE ELECTRONICS CONTROL UNIT AND THE DISPLAY UNIT.

1.9 CABLE DESIGNATIONS W3 THROUGH W24 ARE REPRESENTATIVE OF A TYPICAL INSTALLATION, DEPENDING ON THE INSTALLATION, MANY OF THE CABLES MAY NOT BE REQUIRED. ALSO, SOME CABLE GROUPS MAY BE COMBINED INTO A SINGLE, LARGER CABLE TO SIMPLIFY INTERCONNECTION. INDIVIDUAL SIGNAL FUNCTIONS MAY BE COMBINED WITHIN OTHER SIGNAL CABLES, BUT NOT WITH HIGHER CURRENT/VOLTAGE SIGNALS OR WITH POWER CABLES.

1.10 INITIAL SET UP, THE FOLLOWING MUST BE PERFORMED PRIOR TO SYSTEM TURN ON.
A. 115/230 SWITCH S1 MUST BE SET TO SHIP'S VOLTAGE. REFER TO SHEET 14.
B. FOR DUAL INSTALLATION, JUMPERS ON GYRO CONTROL BOARD MUST BE SET, REFER TO SHEET 12.
C. FOR DUAL INSTALLATION, JUMPERS ON MOTHER BOARD MUST BE SET, REFER TO SHEET 13.
D. AT INSTALLATION, COMPASS NEEDS TO BE CUSTOMIZED FOR INPUT/OUTPUT OPTIONS. THIS IS DONE USING SET UP/INSTALLATION MENU AT TURN ON. MENU IS ACCESSED BY PRESSING MODE SWITCH AND SCROLL SWITCH SIMULTANEOUSLY. REFER TO CHAPTER 8 OF SERVICE MALUAL.
E. FOR STEP REPEATERS THE APPROPRIATE CHANNEL HAS TO BE ENABLED FROM THE DISPLAY ASSEMBLY AND TURNED ON AT THE STEP DRIVER BOARD. REFER TO SHEET 12. FOR DUAL INSTALLATION THE SECONDARY SYSTEM MUST SET UP THE SAME AS THE PRIMARY SYSTEM.

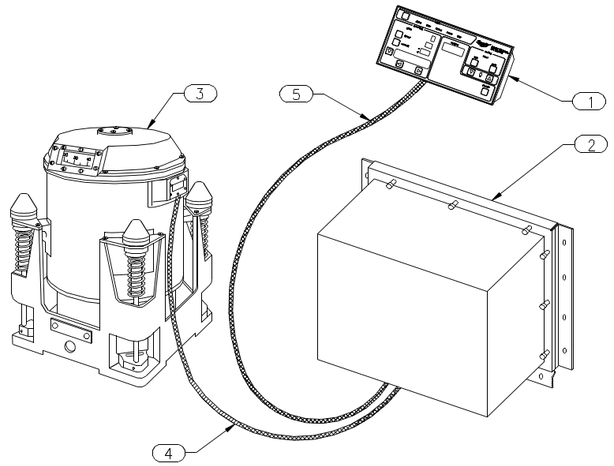
1.11 WHEN CONNECTING TO THE SHIP'S 24VDC SUPPLY, TO PREVENT GROUNDING OF THE SHIP'S BATTERY, DISCONNECT THE CHASIS GROUND BY REMOVING CABLE T968542 FROM THE NEGATIVE TERMINAL OF CAPACITOR C1, LOCATED IN THE POWER SUPPLY ASSEMBLY 1980936.

1.12 WHEN INSTALLING A DUAL SYSTEM, IT IS NECESSARY TO DESIGNATE WHICH SYSTEM IS NO. 1 AND WHICH SYSTEM IS NO. 2 (THIS IS DONE BY THE JUMPER ON THE MOTHERBOARD, SEE SHEET 13). BUT THIS IN NO WAY AFFECTS HOW THE SYSTEM WORKS. IT IS RECOMMENDED THAT THE PRIMARY SYSTEM ALSO BE THE NO. 1 SYSTEM AND THE SECONDARY SYSTEM BE THE NO. 2 SYSTEM.

1.13 WHEN INSTALLING A DUAL SYSTEM, IT IS NECESSARY TO DESIGNATE WHICH SYSTEM IS PRIMARY AND WHICH SYSTEM IS SECONDARY (THIS IS DONE BY THE JUMPER ON THE GYRO CONTROL BOARD, SEE SHEET 12). FOR NORMAL OPERATION THE PRIMARY SYSTEM WILL RUN IN THE ACTIVE MODE AND THE SECONDARY WILL RUN IN THE STANDBY MODE. IF THE PRIMARY SYSTEM FAILS THE SECONDARY SYSTEM WILL GO ACTIVE (PROVIDING THAT THE SECONDARY IS TURNED ON, SETTLED AND HAS NO FAULTS). ONCE THE SECONDARY HAS GONE ACTIVE THERE IS NO BACKUP. THE PRIMARY SYSTEM MUST BE REPAIRED AND RETURNED TO ACTIVE MODE AS SOON AS POSSIBLE. THE SECONDARY SYSTEM SHOULD NOT BE OPERATED IN THE ACTIVE MODE UNLESS THE PRIMARY SYSTEM IS DOWN.

LIST OF EQUIPMENT

ITEM NO.	NAME	CODE IDENT	SPERRY MARINE PART NUMBER
1	MK37 VT DISPLAY ASSEMBLY	03956	1980693–VAR
2	MK37 VT ELECTRONICS CONTROL UNIT	03956	1980690–VAR
3	MK37 VT MASTER COMPASS ASSEMBLY	03956	1891974–VAR
4	MK37 VT COMPASS CABLE	03956	T968572–VAR
5	MK37 VT DISPLAY CABLE	03956	T968593–VAR



GENERAL ARRANGEMENT

Figure 8-2. MK 37 VT System Electrical Installation Drawing (Sheet 1 of 15)

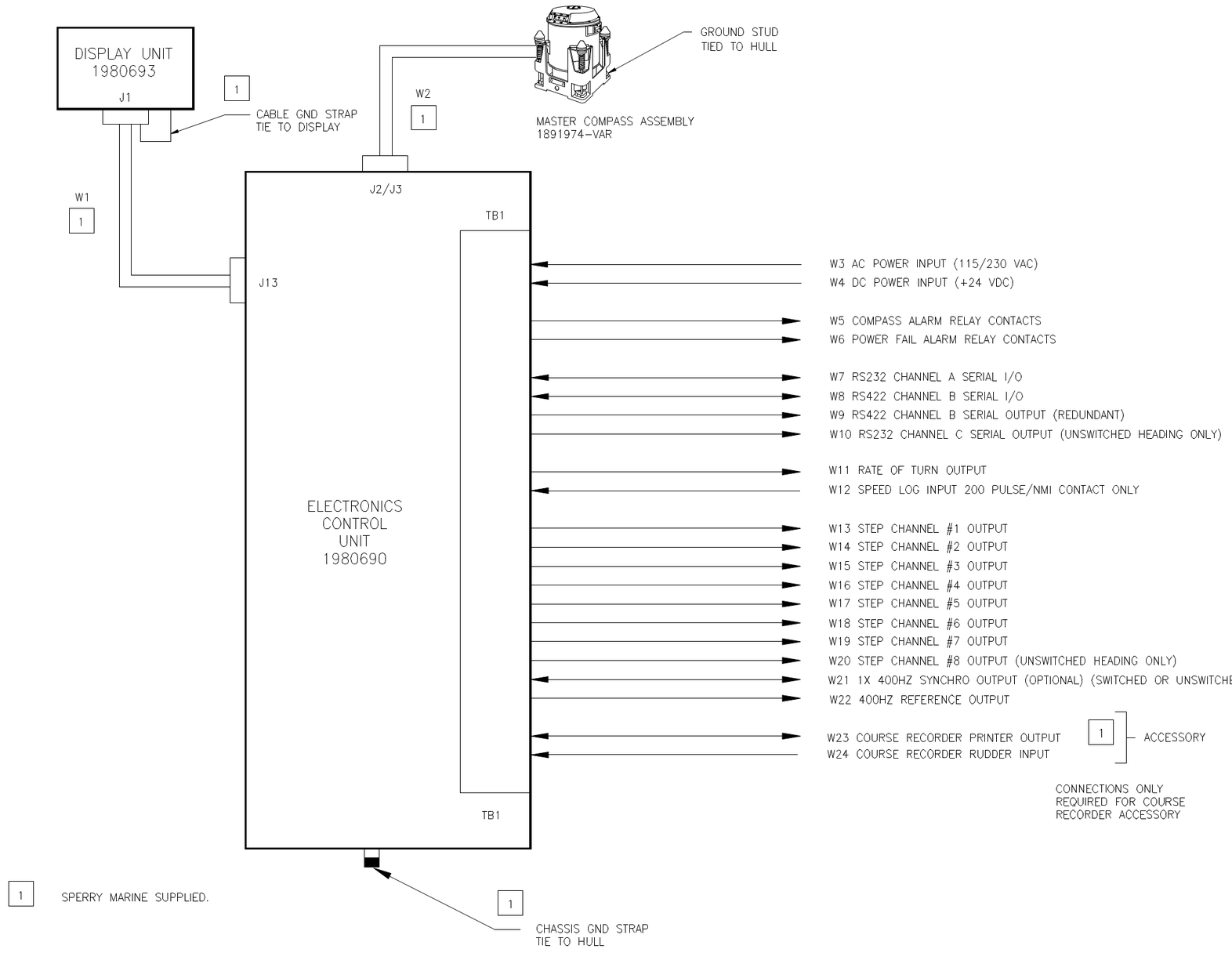


Figure 8-2. MK 37 VT System Electrical Installation Drawing (Sheet 2 of 15)

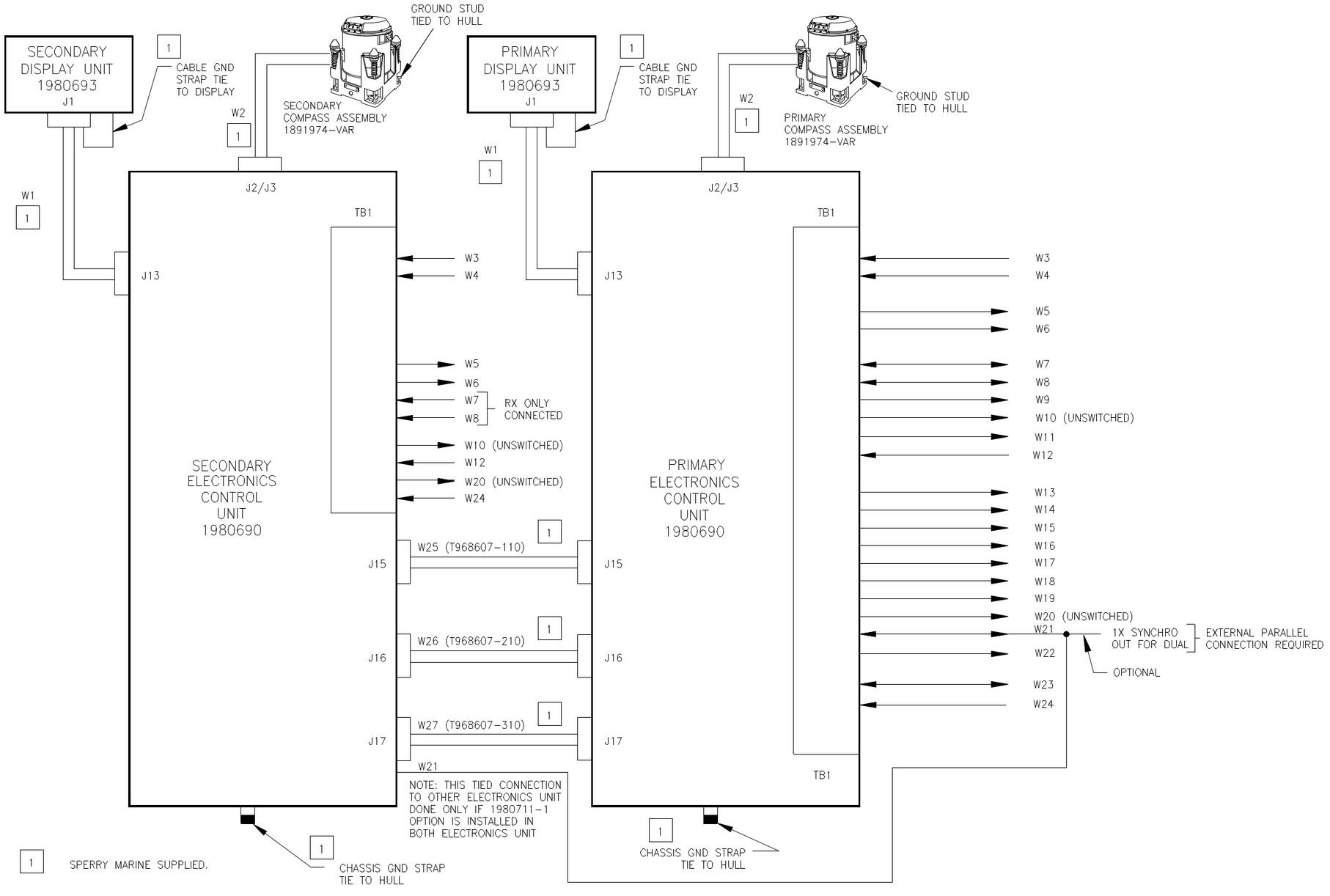
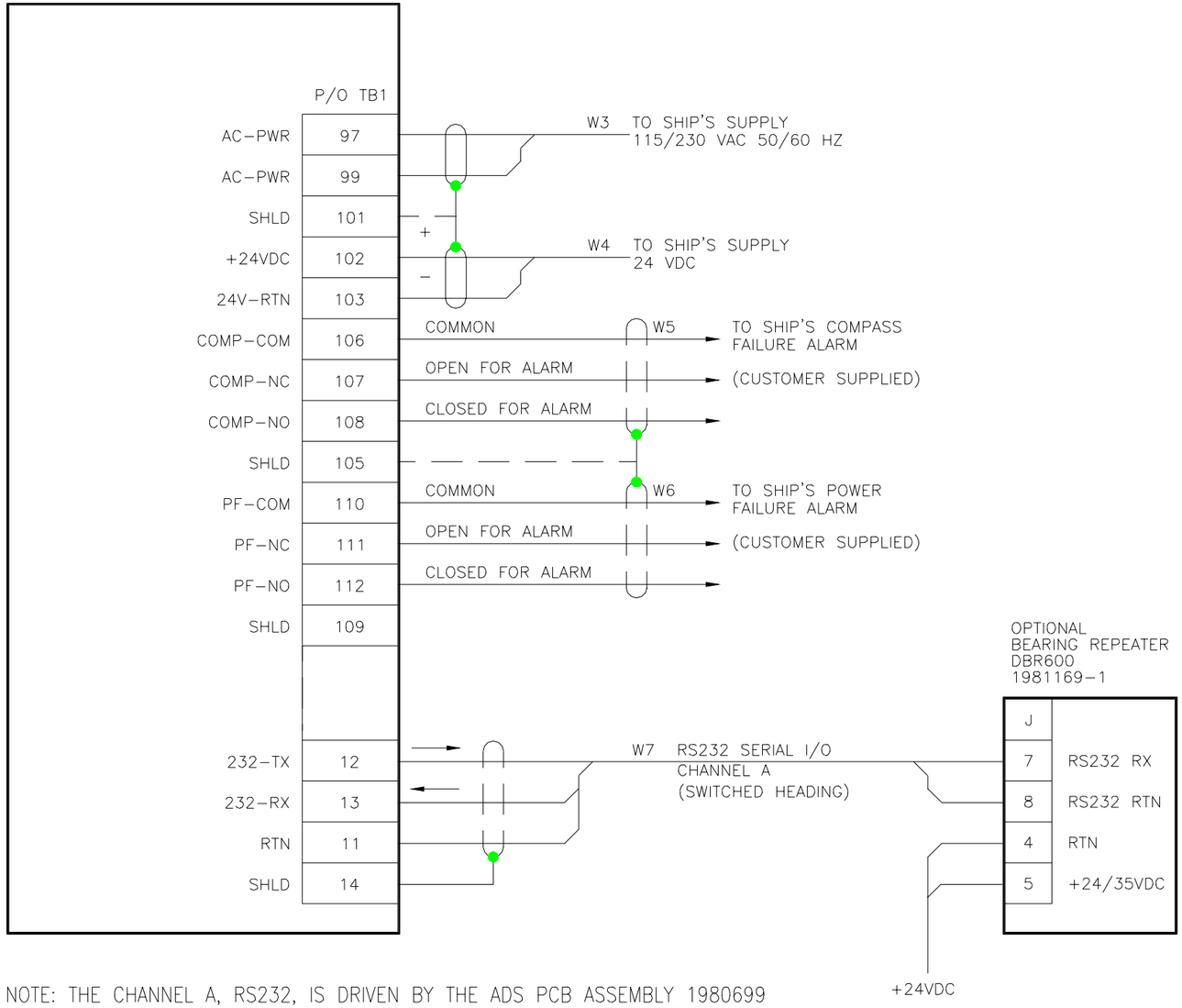
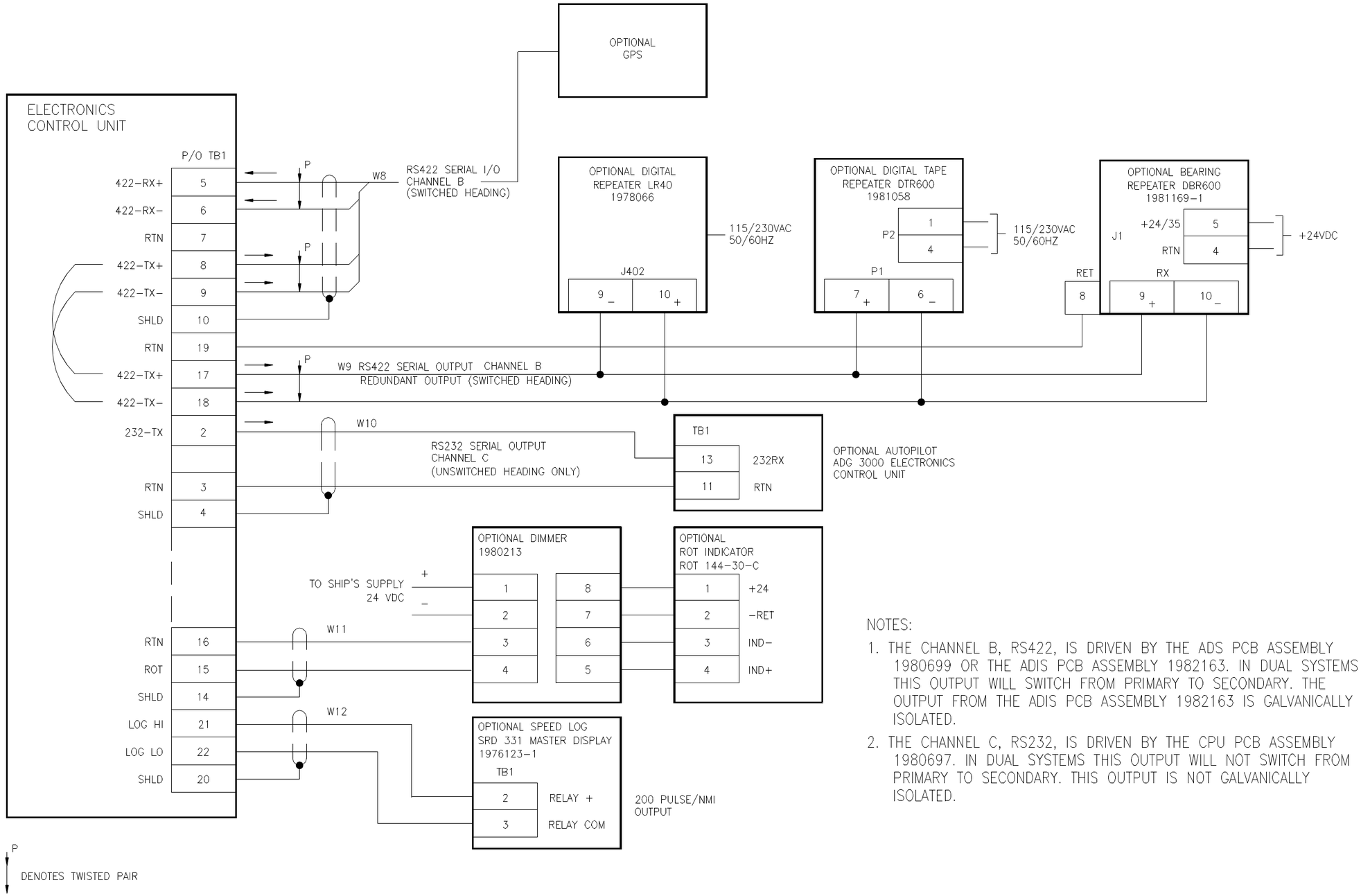


Figure 8-2. MK 37 VT System Electrical Installation Drawing (Sheet 3 of 15)



NOTE: THE CHANNEL A, RS232, IS DRIVEN BY THE ADS PCB ASSEMBLY 1980699 OR THE ADIS PCB ASSEMBLY 1982163. IN DUAL SYSTEMS THIS OUTPUT WILL SWITCH FROM PRIMARY TO SECONDARY. THE OUTPUT FROM THE ADIS PCB ASSEMBLY 1982163 IS GALVANICALLY ISOLATED.

Figure 8-2. MK 37 VT System Electrical Installation Drawing (Sheet 4 of 15)



NOTES:

1. THE CHANNEL B, RS422, IS DRIVEN BY THE ADS PCB ASSEMBLY 1980699 OR THE ADIS PCB ASSEMBLY 1982163. IN DUAL SYSTEMS THIS OUTPUT WILL SWITCH FROM PRIMARY TO SECONDARY. THE OUTPUT FROM THE ADIS PCB ASSEMBLY 1982163 IS GALVANICALLY ISOLATED.
2. THE CHANNEL C, RS232, IS DRIVEN BY THE CPU PCB ASSEMBLY 1980697. IN DUAL SYSTEMS THIS OUTPUT WILL NOT SWITCH FROM PRIMARY TO SECONDARY. THIS OUTPUT IS NOT GALVANICALLY ISOLATED.

Figure 8-2. MK 37 VT System Electrical Installation Drawing (Sheet 5 of 15)

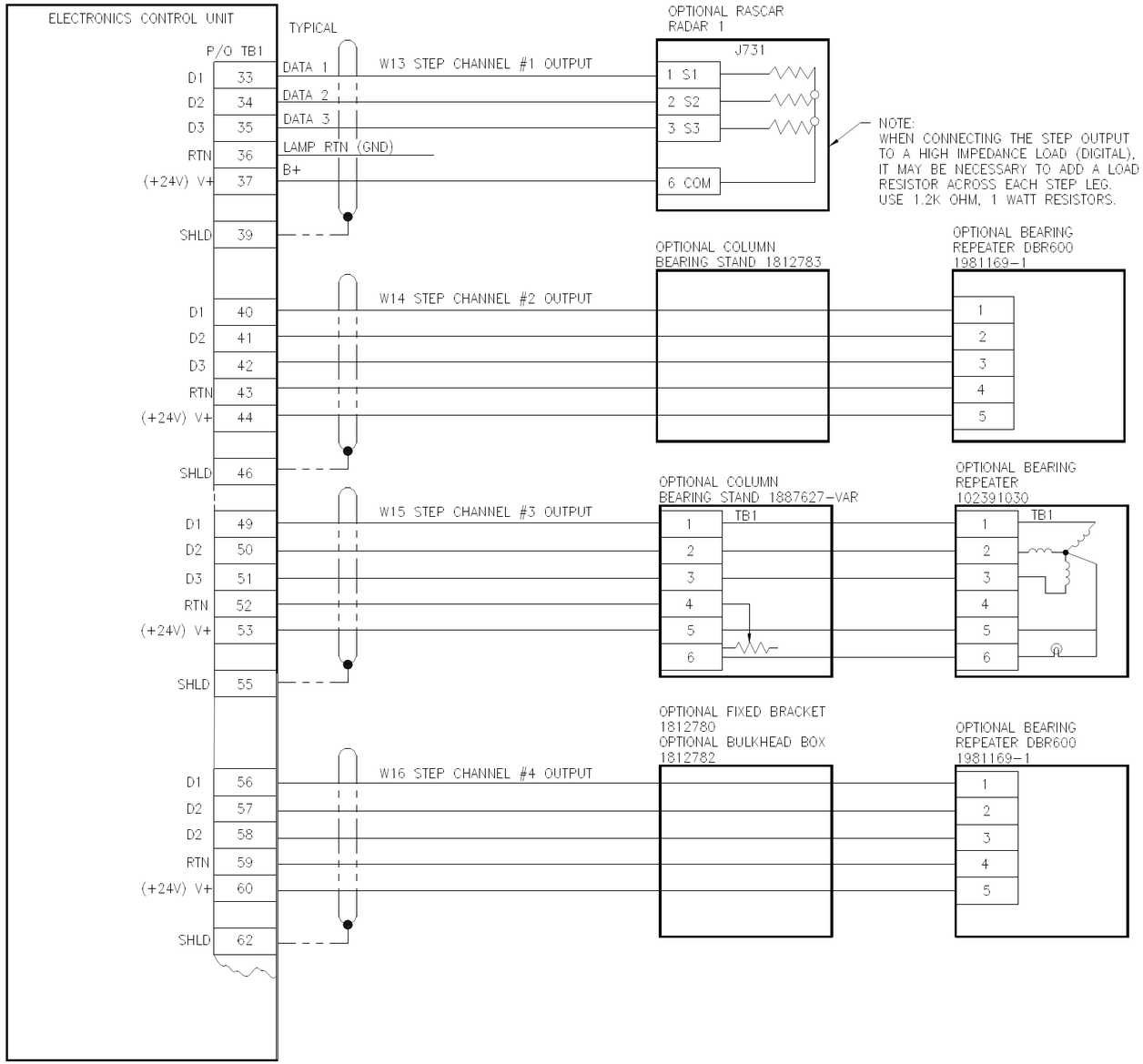
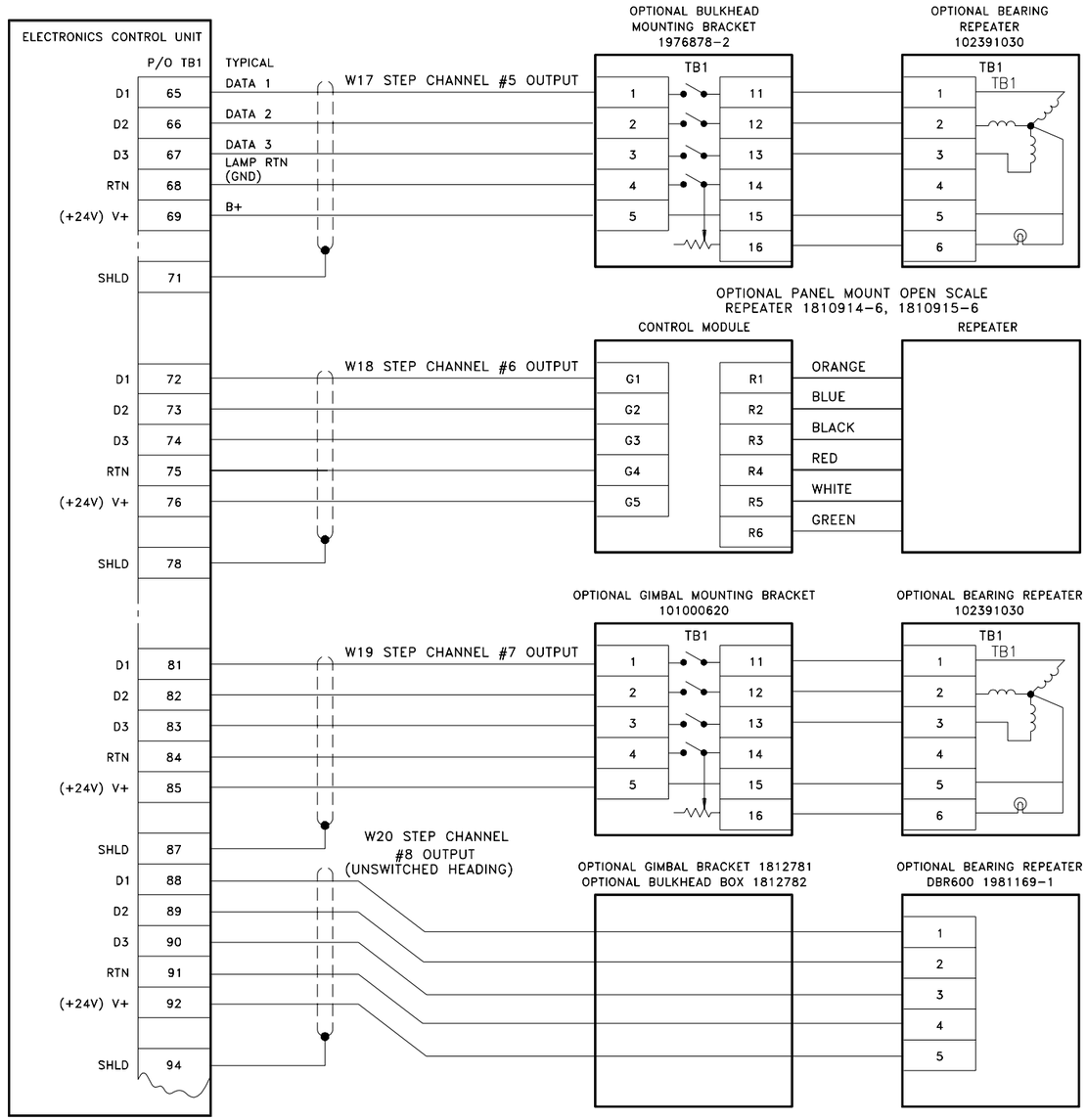
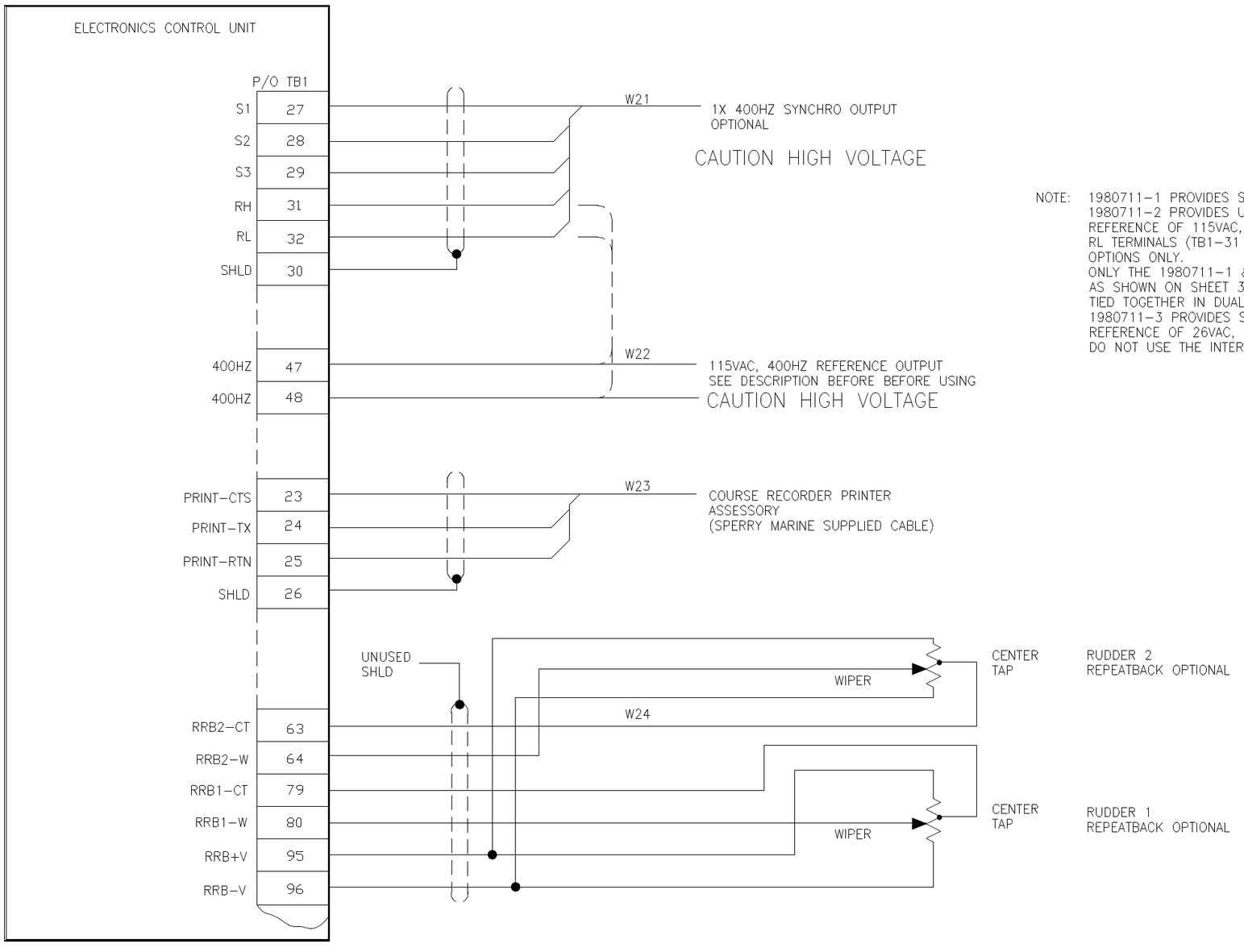


Figure 8-2. MK 37 VT System Electrical Installation Drawing (Sheet 6 of 15)



MK37 VT ELECTRICAL INSTALLATION

Figure 8-2. MK 37 VT System Electrical Installation Drawing (Sheet 7 of 15)



NOTE: 1980711–1 PROVIDES SWITCHED 1X CORRECTED HEADING OUTPUT
1980711–2 PROVIDES UNSWITCHED 1X CORRECTED HEADING OUTPUT
REFERENCE OF 115VAC, 400HZ MUST BE SUPPLIED WITH THE RH AND RL TERMINALS (TB1–31 & TB1–32). FOR EITHER 1980711–VAR OPTIONS ONLY.
ONLY THE 1980711–1 & –3 OPTION CAN ACCEPT PARALLELED OUTPUTS AS SHOWN ON SHEET 3. THE 1980711–2 OUTPUTS CANNOT BE TIED TOGETHER IN DUAL INSTALLATIONS.
1980711–3 PROVIDES SWITCHED 1X CORRECTED HEADING OUTPUT. REFERENCE OF 26VAC, 400HZ MUST BE SUPPLIED BY THE CUSTOMER. DO NOT USE THE INTERNAL 400HZ (TB1–47 & TB1–48).

Figure 8-2. MK 37 VT System Electrical Installation Drawing (Sheet 8 of 15)

TABLE I

CABLE	FUNCTION	DESCRIPTION/NOTES
W1	ECU TO DISPLAY	SPERRY MARINE SUPPLIED CABLE. POWER AND SIGNALS FROM ELECTRONICS UNIT TO THE DISPLAY UNIT. MAXIMUM LENGTH 15 METERS.
W2	ECU TO MASTER COMPASS	SPERRY MARINE SUPPLIED CABLE, POWER AND SIGNALS FROM ELECTRONICS UNIT TO THE MASTER COMPASS ASSEMBLY. MAXIMUM LENGTH 12 METERS.
W3	AC POWER INPUT	115/230 VOLTS A.C. INPUT, ±10%, 60/50 HZ, SINGLE PHASE, 400 WATTS MAXIMUM. SET POWER SELECT SWITCH ON AC – DC POWER SUPPLY BOARD BEFORE APPLICATION OF POWER.
W4	DC POWER UNIT	24 VOLTS D.C. INPUT, ±10%, 250 WATTS MAXIMUM. TO PROVIDE EMERGENCY BACK UP POWER, MUST BE CAPABLE OF INSTANTANEOUSLY TAKING ON THE GYROCOMPASS AND REPEATER POWER LOAD.
W5	COMPASS ALARM RELAY CONTACTS	COMPASS ALARM RELAY CONTACTS. FORM C WITH NORMALLY OPEN AND NORMALLY CLOSED CONTACTS ARE PROVIDED ON EACH. CONTACTS ARE RATED AT 115 VAC 0.5 AMP OR 30 VDC 1 AMP. CONTACT RESISTANCE IS LESS THAN 1 OHM.
W6	POWER FAIL ALARM RELAY CONTACTS	POWER ALARM RELAY CONTACTS, FORM C WITH NORMALLY OPEN AND NORMALLY CLOSED CONTACTS ARE PROVIDED ON EACH. CONTACTS ARE RATED AT 115 VAC 0.5 AMP OR 30 VDC 1 AMP. CONTACT RESISTANCE IS LESS THAN 1 OHM.
W7	RS232 SERIAL I/O CHANNEL A	RS232 SERIAL INPUT AND OUTPUT VIA 4800 BAUD NMEA MESSAGES ONLY. MAXIMUM LENGTH 30 METERS. MUST CONFORM TO RS232C ELECTRICAL SPECIFICATIONS.
W8	RS422 SERIAL I/O CHANNEL B	RS422 SERIAL INPUT AND OUTPUT VIA 4800 BAUD NMEA MESSAGES ONLY. MAXIMUM LENGTH 200 METERS. SINGLE 100 OHM TERMINATION RECOMMENDED. MAXIMUM OF 10 RECEIVERS.
W9	RS422 SERIAL OUTPUT CHANNEL B REDUNDANT	RS422 SERIAL OUTPUT VIA 4800 BAUD NMEA MESSAGES ONLY. MAXIMUM LENGTH 200 METERS. SINGLE 100 OHM TERMINATION RECOMMENDED.
W10	RS232 SERIAL OUTPUT CHANNEL C	RS232 SERIAL OUTPUT IS UNSWITCHED HEADING ONLY AND CAN BE USED TO COMPARE THE HEADING OF THE COMPASSES IN A DUAL SYSTEM. MAXIMUM CABLE LENGTH 30 METERS. MUST CONFORM TO RS232C ELECTRICAL SPECIFICATIONS.
W11	RATE OF TURN	ANALOG RATE OF TURN OUTPUT TO A MAXIMUM OF THREE DISPLAYS. THE TOTAL IMPEDANCE ON THE OUTPUT MUST BE GREATER THAN 1K OHM TO PREVENT LOADING EFFECTS. SCALE FACTOR IS 50 MV PER DEGREE/MINUTE. MAXIMUM OUTPUT VOLTAGE IS 4.5 VOLTS (AT 1.5 DEGREE/SECOND).
W12	SPEED LOG INPUT (CONTACT CLOSURE)	200 PULSE PER NAUTICAL MILE CONTACT CLOSURE INPUT. INTERNAL PULLUP TO 15 VOLTS. SIGNALS MUST BE SUPPLIED TO BOTH ELECTRONICS UNITS IN A DUAL INSTALLATION. SIGNAL LINES SHOULD NOT BE PARALLELED BETWEEN UNITS.
W13–W20	STEP CHANNEL OUTPUTS 1...8	EIGHT 24 VOLT STEP REPEATER OUTPUT CHANNELS. STANDARD 1/6 DEGREE PER STEP. MAXIMUM CURRENT LIMITED TO 900 MA PER OUTPUT FOR STEP DRIVE AND LIGHTING. MAXIMUM OF 400 MA PER PHASE. MAXIMUM LENGTH 300 METERS. NOTE: W20 (CHANNEL 8) PROVIDES UNSWITCHED STEP HEADING IN DUAL SYSTEMS, WHICH CAN BE USED TO COMPARE THE HEADING OF THE COMPASSES.

(CONTINUED ON PAGE 10)

Figure 8-2. MK 37 VT System Electrical Installation Drawing (Sheet 9 of 15)

1820373 (Sheet 9, Rev B)

TABLE 1 (CONTINUED)

CABLE	FUNCTION	DESCRIPTION/NOTES
W21	1X SYNCHRO OUTPUT (OPTIONAL)	THIS OUTPUT PROVIDES TWO TYPES OF OUTPUT INFORMATION DEPENDING UPON THE OPTION BOARD INSTALLED IN THE ELECTRONICS UNIT. SPECIAL ATTENTION MUST BE GIVEN TO WHICH OPTION BOARD IS INSTALLED. THE TWO ARE DEFINED BELOW: 1980711−1 1X SYNCHRO OPTION BOARD − REFERENCE POWERED 1X 400 HZ CORRECTED HEADING SWITCHED SYNCHRO OUTPUT AT 4VA MAXIMUM. CUSTOMER MAY SUPPLY THE 115 VAC 400 HZ REFERENCE TO RH AND RL TERMINALS OR MAY USE THE 400 HZ REFERENCE PROVIDED FROM THE ELECTRONICS UNIT (SEE W22 CABLE DESCRIPTION). DAMAGE WILL RESULT IF 60/50 HZ POWER IS INPUT TO THE UNIT. IN A DUAL INSTALLATION THE OUTPUTS OF THE TWO 1X SYNCHRO OUTPUTS (S1, S2, S3) MAY BE EXTERNALLY TIED TOGETHER TO PROVIDE A SWITCHED OUTPUT. AN EXTERNAL REFERENCE FOR THE SYNCHRO OUTPUTS SHOULD BE PROVIDED FROM A SINGLE SOURCE TO BOTH REFERENCE INPUTS. AT NO TIME CAN THE INTERNAL REFERENCES (W22) BE TIED TOGETHER. 1980711−2 1X SYNCHRO OPTION BOARD − REFERENCE POWERED 1X 400 HZ CORRECTED HEADING UNSWITCHED SYNCHRO OUTPUT AT 4 VA MAXIMUM. CUSTOMER MAY SUPPLY THE 115 VAC 400 HZ REFERENCE TO RH AND RL TERMINALS OR MAY USE THE 400 HZ REFERENCE PROVIDED FROM THE ELECTRONICS UNIT (SEE W22 CABLE DESCRIPTION). DAMAGE WILL RESULT IF 60/50 HZ POWER IS INPUT TO THE UNIT. IN A DUAL INSTALLATION THE OUPUTS OF THE TWO 1X SYNCHRO OUTPUTS (S1, S2, S3) CAN NEVER BE TIED TOGETHER. ALL OUTPUT LINES ARE UNSWITCHED AND ALWAYS DRIVEN ON BY THE RESPECTIVE ELECTRONICS UNITS. THIS IS TO PROVIDE AN UNSWITCHED HEADING REFERENCE FROM EACH COMPASS SYSTEM FOR DERIVATION OF ITEMS SUCH AS OFF−COURSE ALARMS. 1980711−3 1X SYNCHRO OPTION BOARD − REFERENCE POWERED 1X 400 HZ CORRECTED HEADING UNSWITCHED SYNCHRO OUTPUT AT 4 VA MAXIMUM. CUSTOMER MUST SUPPLY THE 26VAC 400 HZ REFERENCE TO RH AND RL TERMINALS.
W22	400 HZ REF OUTPUT	115 VAC 400 HZ AC, MAXIMUM OF 4 VA AVAILABLE FOR USE AS A REFERENCE TO THE 1980711−VAR 1X SYNCHRO OPTION. THIS OUTPUT IS FUSE PROTECTED AT 0.25 AMP.
W23	COURSE RECORDER PRINTER OUTPUT (ACCESSORY)	SPERRY MARINE SUPPLIED CABLE. RS232 SERIAL INTERFACE FOR USE WITH THE ACCESSORY COURSE RECORDER. MAXIMUM LENGTH 21 METERS.
W24	COURSE RECORDER RUDDER INPUT CHANNELS 1 &2 (ACCESSORY)	±15 VOLTS EXCITATION IS PROVIDED ALONG WITH TWO RUDDER REPEATBACK INPUTS. V+ IS +15 VOLTS AND V− IS −15 VOLTS. THE REPEATBACK MUST BE GREATER THAN 1K OHMS. THE "W" OR WIPER INPUT IS THE POSITION SIGNAL INPUT. THE "CT" INPUT IS GROUNDED ON THE INTERFACE BOARD. AN EXTERNAL VOLTAGE MAY BE USED TO DRIVE THE RUDDER INPUT IF THE SIGNAL DOES NOT EXCEED 15 VOLTS. WHEN USING AN EXTERNAL VOLTAGE SOURCE, APPLY THE SIGNAL TO THE WIPER INPUT AND THE RETURN TO THE "CT" INPUT. RUDDER REPEATBACK SIGNALS NEED TO BE SUPPLIED TO BOTH ELECTRONICS UNITS IN A DUAL INSTALLATION.
W25 W26 W27	DUAL COMPASS INTERCONNECT (OPTIONAL)	SPERRY MARINE SUPPLIED CABLE. THREE CABLE SET USED TO INTERCONNECT TWO COMPASS UNITS IN A DUAL CONFIGURATION. ALL OUTPUTS EXCEPT THE 1X SYNCHRO, STEP CHANNEL #8, AND RS−232 CHANNEL C ARE TIED IN PARALLEL AND OUTPUTTED THROUGH THE PRIMARY ELECTRONICS CONTROL UNIT. INPUTS MUST BE PROVIDED TO BOTH UNITS ON SEPARATE CHANNELS FOR PROPER OPERATION. MAXIMUM LENGTH 3 METERS.

TABLE II : CABLE CROSS−REFERENCE

CABLE NUMBER	MINIMUM CORE REQUIREMENTS	CABLE DESCRIPTION
W3, W4	MULTIPLE CONDUCTOR, OVERALL SHIELD, 600 VOLTS. CROSS SECTION 2.08 MM^2 (AWG−14)	POWER CABLE
W5−W7, W10−W24	MULTIPLE CONDUCTOR, OVERALL SHIELD, 300 VOLTS. CROSS SECTION 0.82 MM^2 (AWG−18)	SIGNAL/ CONTROL
W8−W9	TWISTED PAIRS, OVERALL SHIELD, 250 VOLTS. CROSS SECTION 0.82 MM^2 (AWG−18)	SIGNAL/ CONTROL

Figure 8-2. MK 37 VT System Electrical Installation Drawing (Sheet 10 of 15)

1820373 (Sheet 10, Rev B)

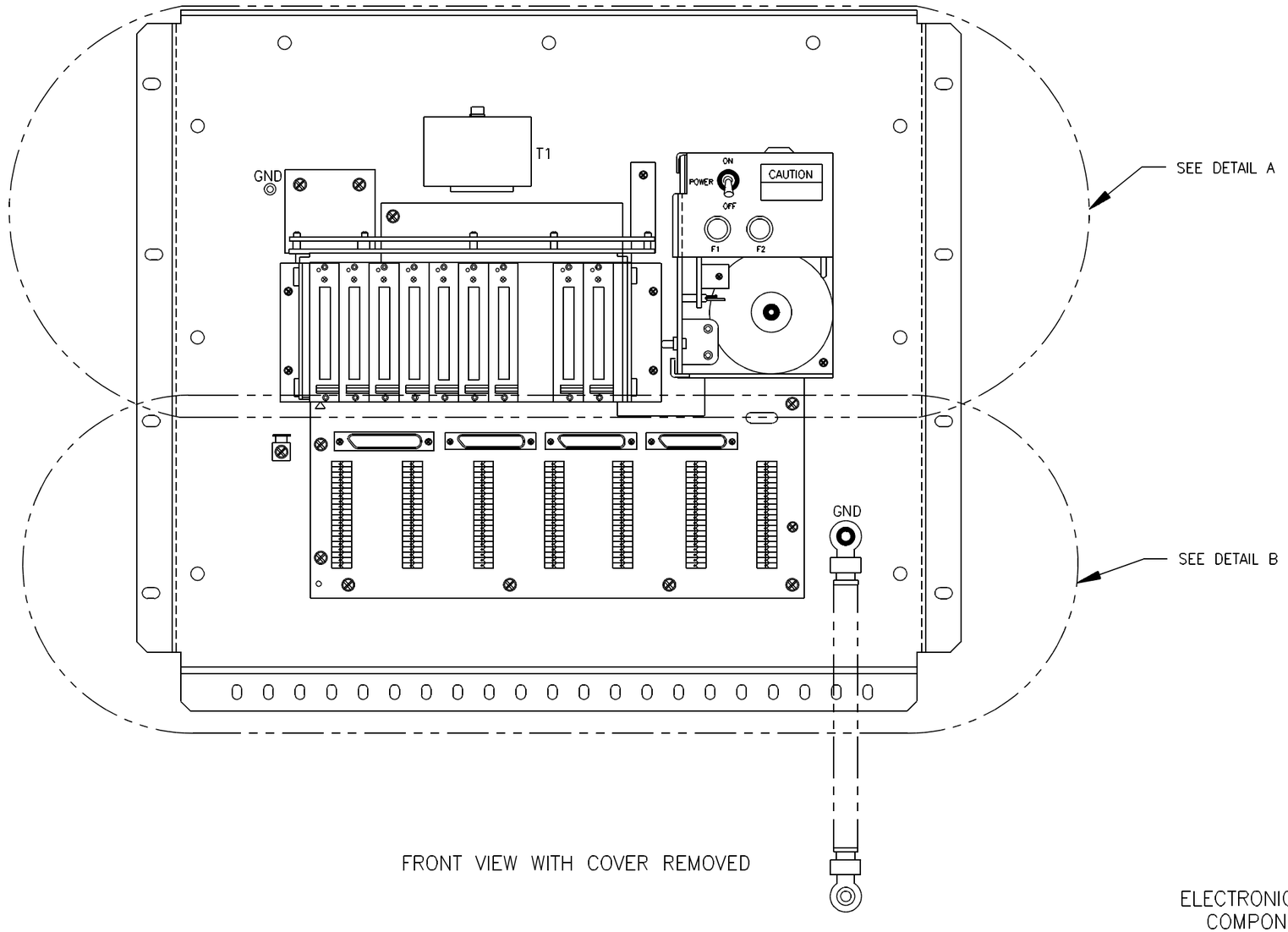
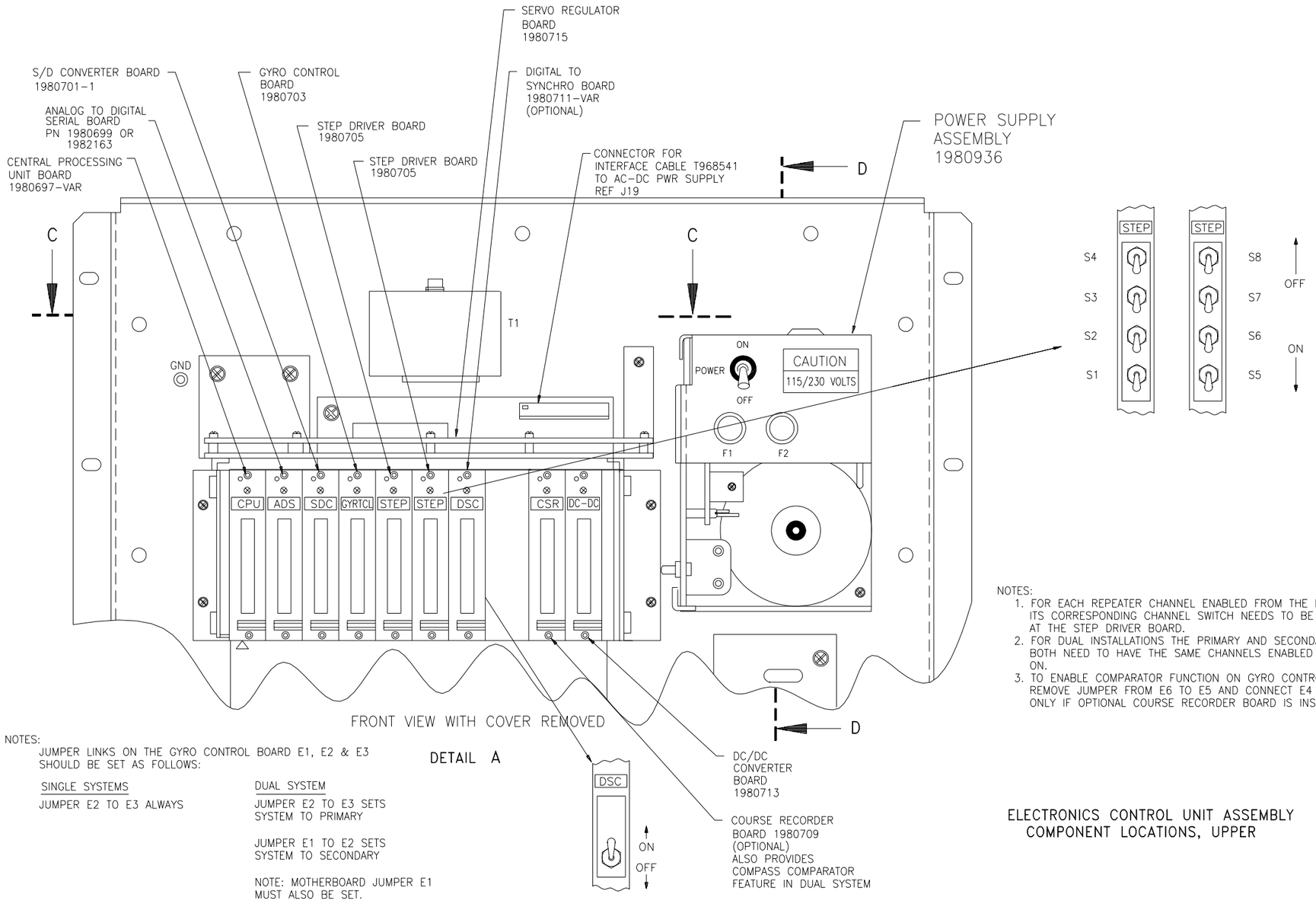


Figure 8-2. MK 37 VT System Electrical Installation Drawing (Sheet 11 of 15)



NOTES:

JUMPER LINKS ON THE GYRO CONTROL BOARD E1, E2 & E3 SHOULD BE SET AS FOLLOWS:

SINGLE SYSTEMS	DUAL SYSTEM
JUMPER E2 TO E3 ALWAYS	JUMPER E2 TO E3 SETS SYSTEM TO PRIMARY
	JUMPER E1 TO E2 SETS SYSTEM TO SECONDARY
	NOTE: MOTHERBOARD JUMPER E1 MUST ALSO BE SET.

NOTES:

1. FOR EACH REPEATER CHANNEL ENABLED FROM THE DISPLAY ASSY, ITS CORRESPONDING CHANNEL SWITCH NEEDS TO BE TURNED ON AT THE STEP DRIVER BOARD.
2. FOR DUAL INSTALLATIONS THE PRIMARY AND SECONDARY SYSTEMS BOTH NEED TO HAVE THE SAME CHANNELS ENABLED AND TURNED ON.
3. TO ENABLE COMPARATOR FUNCTION ON GYRO CONTROL BOARD REMOVE JUMPER FROM E6 TO E5 AND CONNECT E4 TO E5 ONLY IF OPTIONAL COURSE RECORDER BOARD IS INSTALLED.

ELECTRONICS CONTROL UNIT ASSEMBLY
COMPONENT LOCATIONS, UPPER

Figure 8-2. MK 37 VT System Electrical Installation Drawing (Sheet 12 of 15)

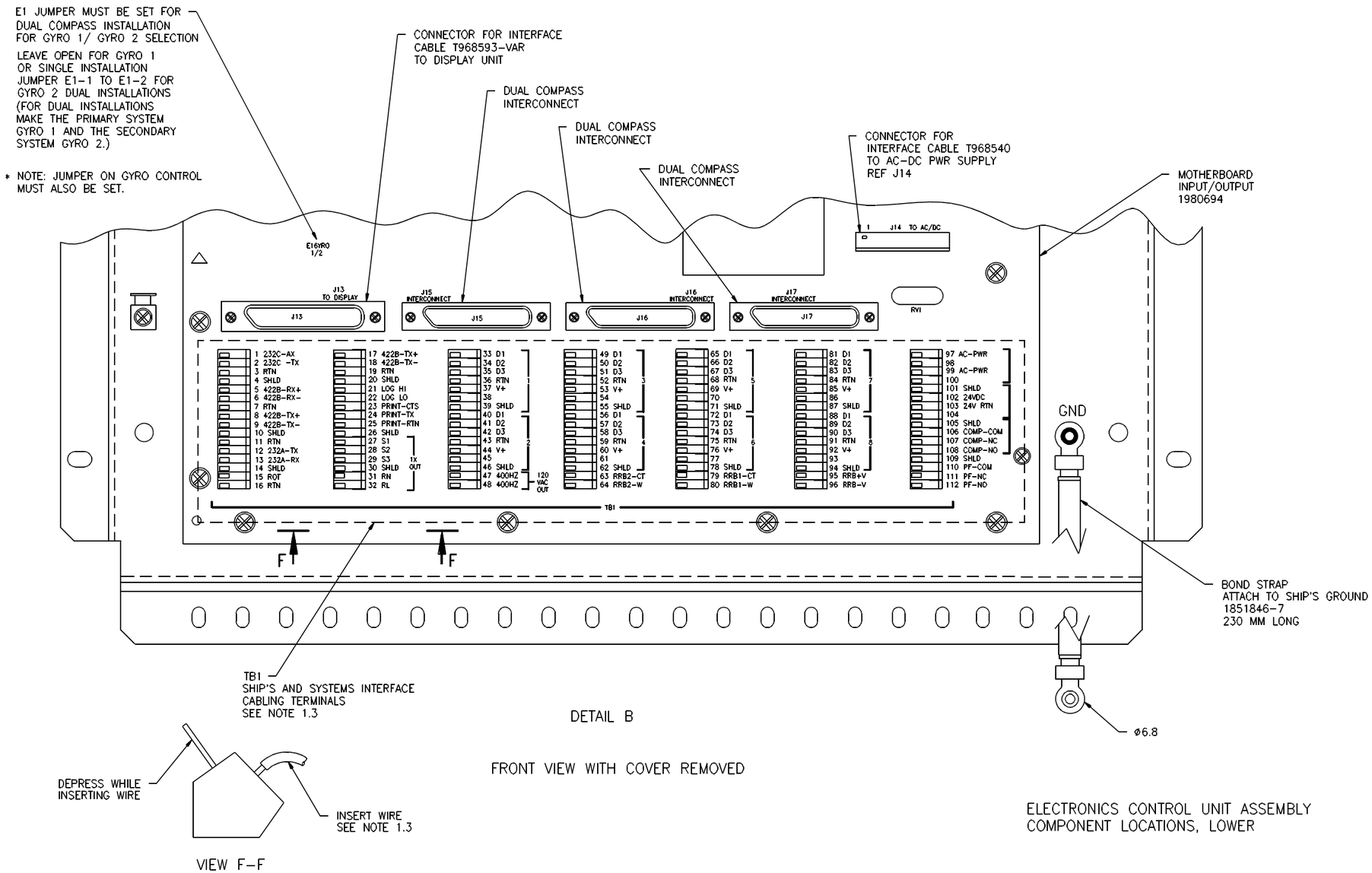
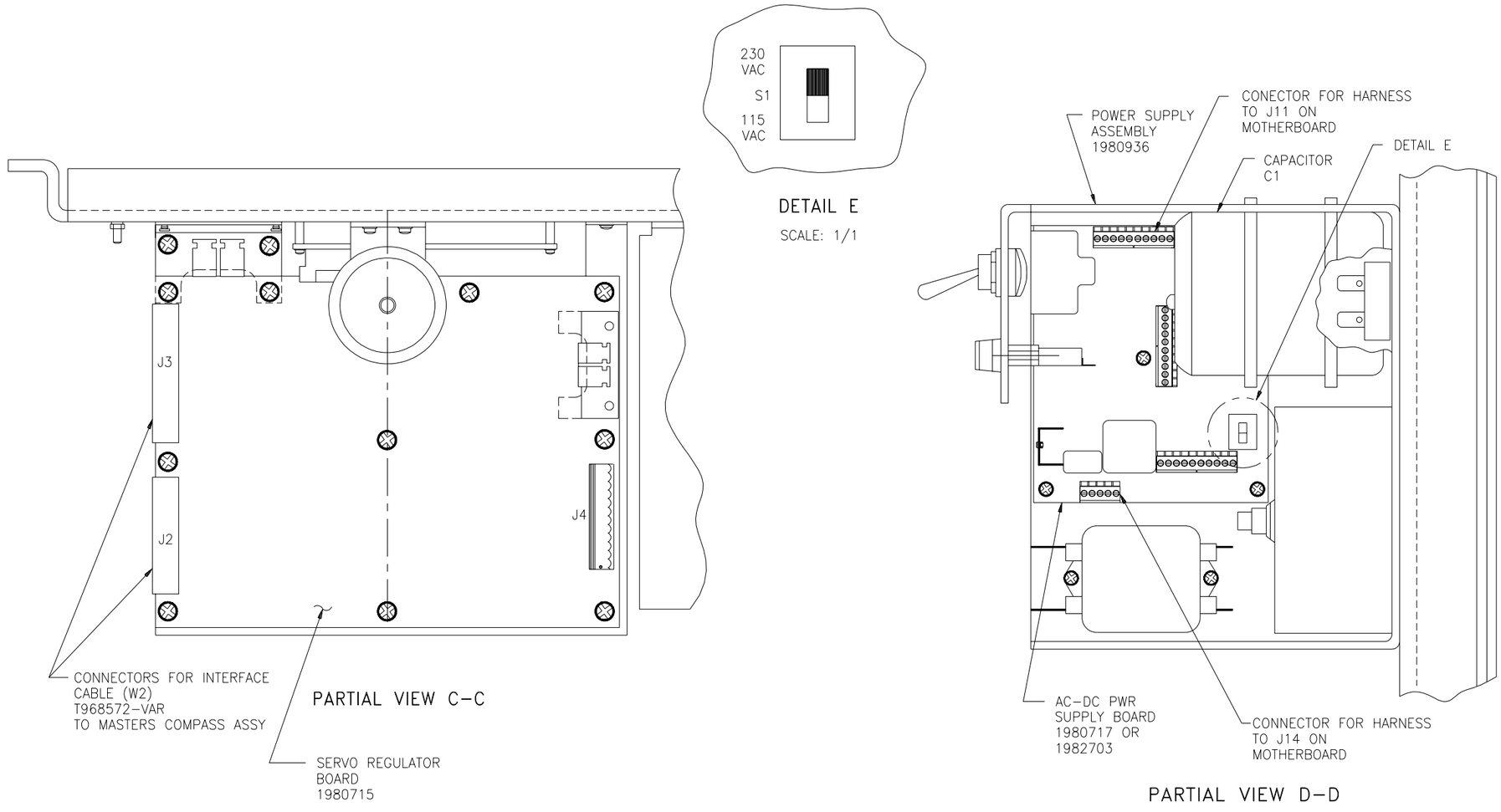


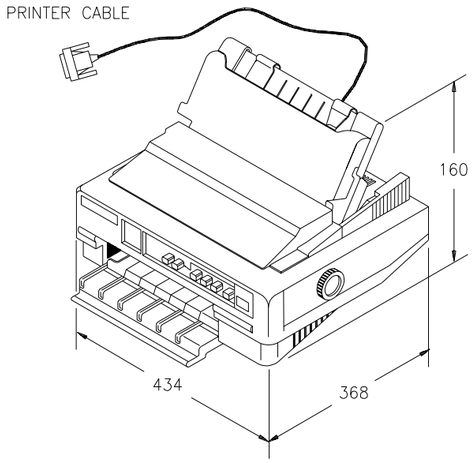
Figure 8-2. MK 37 VT System Electrical Installation Drawing (Sheet 13 of 15)

1820373 (Sheet 13)



ELECTRONICS CONTROL UNIT ASSEMBLY
INTERCONNECT LOCATIONS

Figure 8-2. MK 37 VT System Electrical Installation Drawing (Sheet 14 of 15)



OPTIONAL COURSE RECORDER PRINTER 1812264-1/2 SET UP

PRINTER PANEL BUTTONS

THERE ARE SEVERAL BUTTONS ON THE CONTROL PANEL OF THE COURSE RECORDER PRINTER INCLUDING ON/OFF (OPERATE), LF/FF, FONT, etc. FOR USE WITH THE MK 37 VT, THE PRINTER SHOULD BE TURNED ON AND REMAIN ON AT ALL TIMES. IF THE PRINTER IS ACCIDENTALLY TURNED OFF DURING OPERATION, THE SYSTEM WILL NORMALLY REINITIALIZE THE PRINTER WHEN POWER IS RESTORED. IF THE PRINTER IS OFF FOR A VERY SHORT TIME (LESS THAN 2 SECONDS) SO THAT THE MK 37 VT HAS NOT DETECTED THE PROBLEM AND ISSURED AN ALARM, THE PRINTER MAY NOT RECOVER. A SYMPTOM OF THIS PROBLEM WILL BE ??S PRINTED INSTEAD OF THE GRAPHIC CHARACTERS ON A GRAPHIC PRINT OR A STRANGE FONT ON A TABULAR PRINT. IF EITHER OF THESE ARE SEEN, TURN PRINTING OFF AT THE MK 37 VT PANEL AND RESTART.

THE LF/FF BUTTON ON THE PRINTER CONTROL PANEL IS USED TO LOAD AND REMOVE PAPER. IF PRESSED DURING PRINTER OPERATION, A GAP WILL OCCUR IN THE PRINTED RECORD.

ALL OTHER BUTTONS ON THE PRINTER CONTROL PANEL SHOULD NOT BE TOUCHED. IF ANY OF THE OTHER BUTTONS IS PRESSED, THE RESULTING OUTPUT COULD BE UNUSABLE. IF FOR INSTANCE THE FONT BUTTON IS PRESSED, FURTHER OUTPUT WILL BE PRINTED IN THE WRONG FONT. THERE IS NO CAPABILITY FOR THE MK 37 VT SYSTEM TO DETECT THAT A PRINTER CONTROL BUTTON HAS BEEN PRESSED. IF OUTPUT DOES NOT APPEAR AS SPECIFIED IN THIS DOCUMENT, TURN PRINTING OFF AT THE MK 37 VT PANEL AND RESTART.

THE PRINTER PAPER-RELEASE LEVER SHOULD REMAIN IN THE MIDDLE, PUSH-TRACTOR POSITION. IF IT IS MOVED FROM THIS POSITION BLANK SHEETS OR OTHER PAPER FEEDING PROBLEMS MAY OCCUR.

ON/OFF SCENARIOS

DURING NORMAL OPERATION, THE PRINTER SHOULD NEVER BE TURNED OFF. HOWEVER, IF THE PRINTER IS TURNED OFF OR LOSES POWER, SEVERAL SCENARIOS ARE POSSIBLE. IF THE PRINTER GOES OFF DURING A CURRENT DATA PRINTOUT, WHETHER GRAPHIC OR TABULAR, AND THE FAULT IS DETECTED, ONCE THE PRINTER REGAINS POWER, THE MK 37 VT WILL BEGIN AND CONTINUE PRINTING AT THE CURRENT TIME. IF AN HISTORIC PRINT IS INTERRUPTED BY PRINTER FAULT, PRINTING WILL RESTART AT THE CURRENT TIME. IF THE HISTORIC DATA THAT WAS REQUESTED PREVIOUSLY HAS NOT COMPLETELY PRINTED, THE OPERATOR MUST RESTART HISTORIC PRINTING AT THE DESIRED TIME FROM THE MK 37 VT PANEL.

IF THE PRINTER IS OFF ONLY MOMENTARILY SO THAT THE MK 37 VT SYSTEM DOES NOT DETECT A FAULT, THE OUTPUT MAY BE UNPREDICTABLE AND THE OPERATOR MUST RESTART PRINTING AT THE MK 37 VT PANEL.

PAPER LOADING

TURN OFF PRINTING AT THE MK 37 VT PANEL. ACKNOWLEDGE PRINTER FAULT.

SEE PRINTER USER'S MANUAL UNDER CONTINUOUS PAPER. PRESS AND HOLD THE PRINTER LF/FF CONTROL BUTTON UNTIL PAPER LOADS INTO POSITION. INSURE THAT THE PAPER-RELEASE LEVER REMAINS IN THE PUSH-TRACTOR (MIDDLE) POSITION. RESTART PRINTING AT THE MK 37 VT PANEL.

OPTIONAL COURSE RECORDER PRINTER 1812264-1/2 INSTALLATION

INSURE THAT THE PRINTER DIP SWITCHES ARE SET AS FOLLOWS:

DIP SW 1		DIP SW 2	
1-1	ON	2-1	OFF
1-2	ON	2-2	OFF
1-3	ON	2-3	OFF
1-4	OFF	2-4	OFF
1-5	OFF		
1-6	OFF		
1-7	OFF		
1-8	OFF		

MAKE SURE THAT THE 32K OPTIONAL SERIAL INTERFACE CARD HAS BEEN INSTALLED IN THE PRINTER. IF NOT, SET THE SWITCHES AND JUMPERS TO THE FOLLOWING AND INSTALL THE CARD PER EPSON INSTRUCTIONS.

DIP SW 1		DIP SW 2		DIP SW 3	
1-1	ON	2-1	ON	3-1	OFF
1-2	ON	2-2	ON	3-2	OFF
1-3	OFF	2-3	OFF	3-3	OFF
1-4	OFF	2-4	OFF	3-4	OFF
1-5	ON	2-5	OFF	3-5	OFF
1-6	ON	2-6	OFF	3-6	OFF
				3-7	OFF
				3-8	OFF

JUMPERS

J1 (3 PIN)	JUMPER CENTER PIN TO PIN A
J2 (3 PIN)	JUMPER CENTER PIN TO PIN A
J3 (2 PIN)	JUMPER
J4 (2 PIN)	NO JUMPER
JG (2 PIN)	NO JUMPER

ATTACH SERIAL PRINTER CABLE TO SERIAL PORT CONNECTOR ON PRINTER SERIAL OPTIONAL CARD. ATTACH OTHER END OF CABLE TO WAGO CONNECTORS ON MK 37 VT.

LOAD PAPER INTO PRINTER PER MANUFACTURERS INSTRUCTIONS (SEE CONTINUOUS PAPER). INSURE THAT THE PAPER-RELEASE LEVER IS LEFT IN THE PUSH-TRACTOR POSITION. CONNECT POWER INTO PRINTER PER MANUFACTURERS INSTRUCTIONS (115VAC FOR 1812264-1 OR 230VAC FOR 1812264-2).

MK37 VT ELECTRICAL INSTALLATION

Figure 8-2. MK 37 VT System Electrical Installation Drawing (Sheet 15 of 15)

APPENDIX A

GYROSCOPIC PRINCIPLES

A-1 INTRODUCTION.

If a heavy wheel rotating at high speed is supported in rings as shown in Figure A-1, it becomes a true gyroscope. The supporting rings provide three mutually perpendicular axes which allow the spin axis of the wheel to point in any direction. As shown in Figure A-1, the axes are known as the spin axis, horizontal axis and vertical axis. The assembly is balanced about all axes. All applications of the gyroscope are based on gyroscopic inertia and gyroscopic precession.

A-2 INERTIA.

Gyroscopic inertia, or rigidity in space as it is sometimes called, is that property of a gyroscope which makes it try to keep the spin axis parallel to its original position. This property is explained by Newton's Law of Motion which states that a rotating wheel will continue to rotate at constant speed in the same direction unless it is acted upon by an outside torque. Thus, the rotating wheel tends to rotate in the same plane and resists any torque which tries to change its plane of rotation. Gyroscopic inertia may be illustrated by slowly tipping the base of the gyroscope as shown in Figure A-2. If the gyroscope rotor is stationary, bearing friction will cause the rotor to tip as the base is tipped. However, if the rotor is spinning, the rotor maintains its original plane of rotation. It will continue to maintain its original plane of rotation no matter how much the base of the gyroscope is tipped about, as long as it continues to spin with sufficient velocity. Although bearing friction still affects the gyro wheel, it affects it to a much lesser degree than when the gyro wheel was stationary.

Gyroscopic inertia depends upon the angular velocity, weight, and radius at which the weight is concentrated. Maximum effect is obtained, therefore, from a wheel rotating at high speed with its principal weight concentrated near the rim.

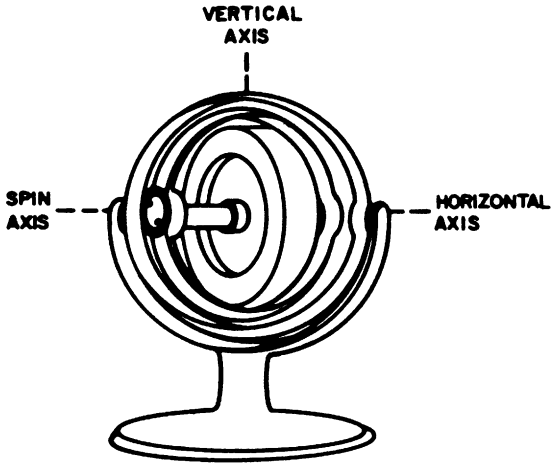


Figure A-1. Gyroscope

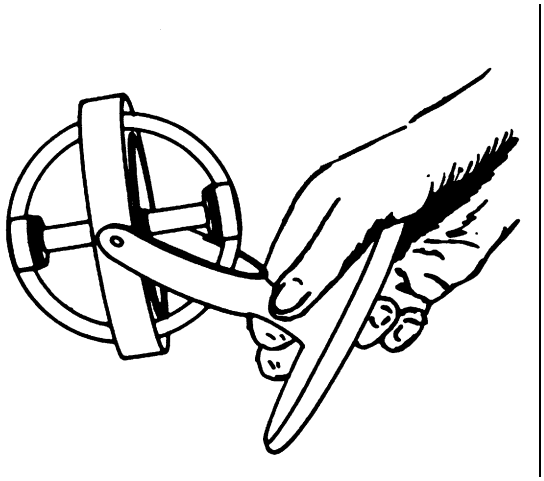


Figure A-2. Gyroscopic Inertia

A-3 PRECESSION.

Precession is that property of a gyroscope which causes the spin axis to change direction when a torque is applied to the gyro wheel. Precession may be illustrated by applying a torque to the spinning gyro wheel about the horizontal axis as shown in Figure A-3. The applied torque meets with resistance and the gyro wheel, instead of turning about the horizontal axis as it would if it were not spinning, turns or precesses about its vertical axis in the direction indicated by the arrow P. Similarly, if we apply a torque about the vertical axis, the gyro wheel will precess about the horizontal axis, as shown by P in Figure A-4. The rate of precession will be such that the resistance of the gyro wheel will be exactly equal to the applied torque at any instant, and no movement in the direction of the torque will take place.

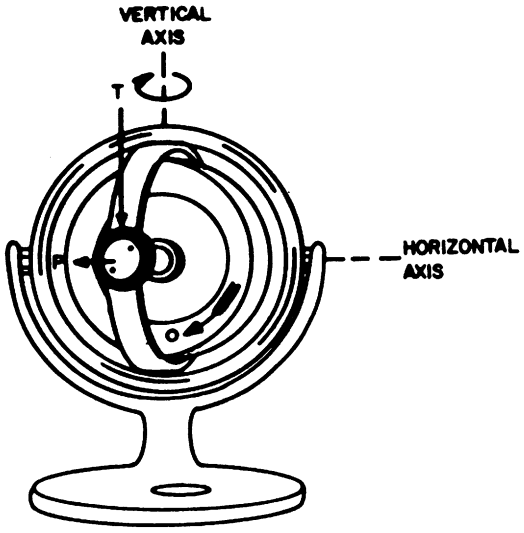


Figure A-3. Precession About Vertical Axis

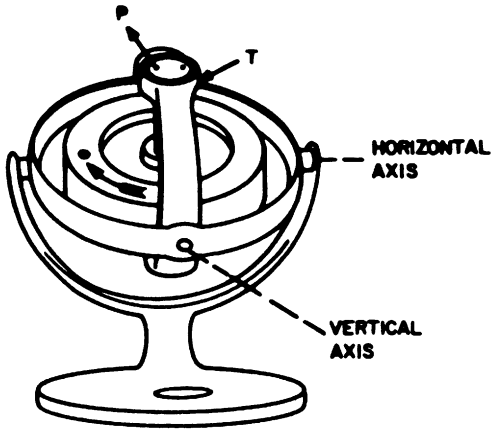


Figure A-4. Precession About Horizontal Axis

The reason for precession may be explained simply by considering what happens to a single particle on the rim of the gyro wheel as shown in Figure A-5. Force F exerts a force upon this small particle along vector BL and therefore accelerates it in that direction. During a short interval of time, acceleration will give the particle a component of velocity BL. This velocity combines with velocity of the particle along vector BK, different from BJ. This is equivalent to a rotation about the Y axis. Therefore, the effect of a torque acting about the XX axis is to cause rotation of the gyro wheel about the YY axis. This rotation about the YY axis is called precession.

A convenient way to remember the direction in which precession takes place is to regard the pressure as though it acted at a single point on the rim of the gyro wheel as indicated by the black dot in Figure A-3. This point will not move in response to the pressure, but a point 90 degrees beyond (in the direction of the gyro wheel's rotation) will move away instead.

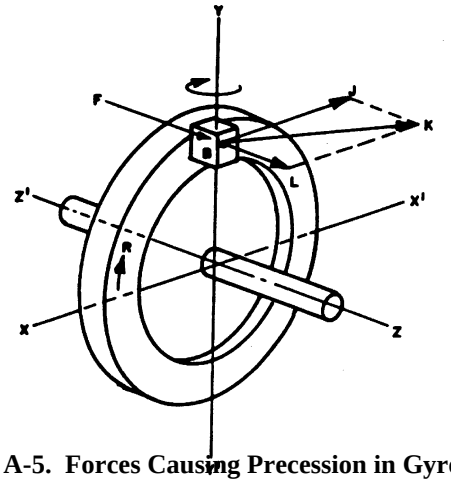


Figure A-5. Forces Causing Precession in Gyro Wheel

A-4 APPARENT ROTATION.

Consider the gyro wheel to be mounted at the Equator with its axle pointing east and west. From a point in space beyond the South Pole, the gyro wheel appears as shown in Figure A-6. To avoid confusion, the supporting rings are omitted and only the gyro wheel and axle are shown. From the observation point in space, the Earth can be seen to turn in the direction of the arrow with an angular velocity of one revolution in 24 hours carrying the gyro wheel around with it. However, the gyro wheel, because of gyroscopic inertia, remains fixed in space just as it did when the base was tilted in Figure A-2. If the gyro wheel is observed while standing on the Earth, it appears to rotate about its horizontal axis with an equal velocity (one revolution in 24 hours) but in the opposite direction to rotation of the Earth. This effect is commonly referred to as horizontal earth rate.

Similarly, if the gyro wheel is assumed to be mounted at the North or South Pole with its axis horizontal, as shown in Figure A-7, the gyro wheel will appear to rotate about its vertical axis. This effect is commonly referred to as vertical earth rate.

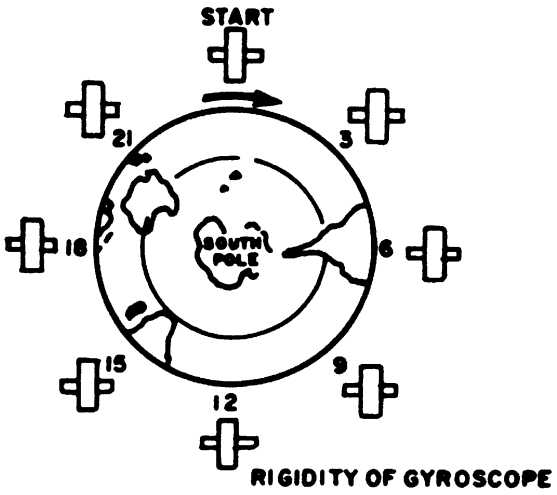


Figure A-6. Apparent Rotation, Gyro Wheel at Equator

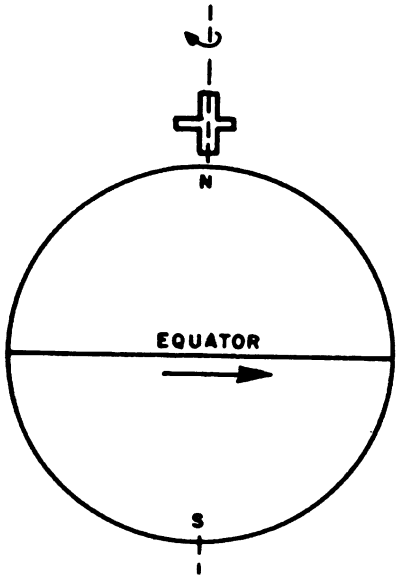


Figure A-7. Apparent Rotation, Gyro Wheel at Pole

At points between the Poles and the Equator, the gyro wheel appears to turn partly about the horizontal axis and partly about the vertical axis, as shown in Figure A-8, because it is affected by both the horizontal and vertical earth rates. The relative magnitudes of the effects are a function of the latitude. The effect of horizontal earth rate is maximum at the Equator and zero at the Poles and varies as the cosine of the latitude. The effect of the vertical earth rate will vary as the sine of the latitude, being maximum at the Poles and zero at the Equator.

In general, the horizontal earth rate causes the gyro wheel to tilt and the vertical earth rate causes the gyro wheel to move in azimuth with respect to the Earth. If it is recalled that the apparent motion of the stars through the sky is a counterclockwise rotation about the North Star, a convenient reminder of the effects of the Earth's rotation on a free gyroscope is to consider the gyro axle pointing at a star. The axle will continue to point at the same star (because the stars are fixed in space) and will describe a circle about the North Star. Thus the difference between gyroscopic inertia and apparent rotation is simply one of point of view. As far as space is concerned, the gyro wheel remains fixed; with respect to the Earth, however, the gyro wheel actually rotates as described above.

As will be seen later, it is this rotation of the gyro wheel with respect to the Earth which makes it possible to apply the force of gravity so as to convert the free gyroscope into a north-seeking gyrocompass.

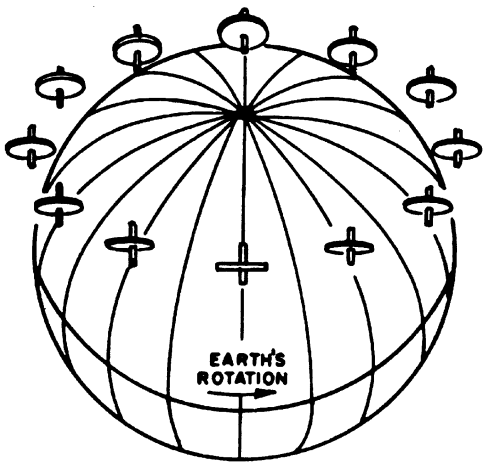


Figure A-8. Apparent Rotation, Gyro Wheel Between Equator and Pole

A-5 GYROSCOPE AS A GYROCOMPASS.

Before a free gyroscope can be converted into a gyrocompass, the mounting structure must be changed slightly. As shown in Figure A-9, the gyro wheel is mounted in a Gyrosphere and the Gyrosphere is supported in what is called the Vertical Ring Assembly. The Gyrosphere and Vertical Ring are, in turn, mounted in a base called the Phantom Yoke Assembly. At this point in the discussion, assume that the Vertical Ring and Phantom Yoke follow the gyro wheel about the vertical axis as it turns in azimuth.

With no further additions, the gyroscope shown in Figure A-9 will, neglecting friction, maintain its position in space so long as no outside forces are exerted on it. To make a gyroscope into a gyrocompass, the gyroscope has to be made to seek and maintain a true north indication. Because north is the direction represented by a horizontal line in the meridian plane from the point of observation to the North Pole, some means have to be provided to (a) make the gyro wheel axle seek the meridian plane, (b) make the axle nearly horizontal, and, (c) make it maintain its position once reached.

A-6 SEEKING THE MERIDIAN.

The first step in making a gyroscope a gyrocompass is to make the gyro wheel seek the meridian. To do this, a weight W is added to the bottom of the Vertical Ring, as shown in Figure A-10. This causes the Vertical Ring to be pendulous about the horizontal axis. (As explained later, a weight is not actually used on the MK 37 Gyrocompass. Figure A-10 is used only to illustrate the principles involved.)

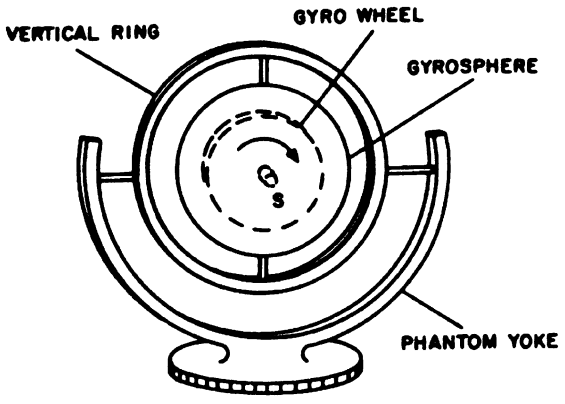


Figure A-9. Modified Model Gyroscope

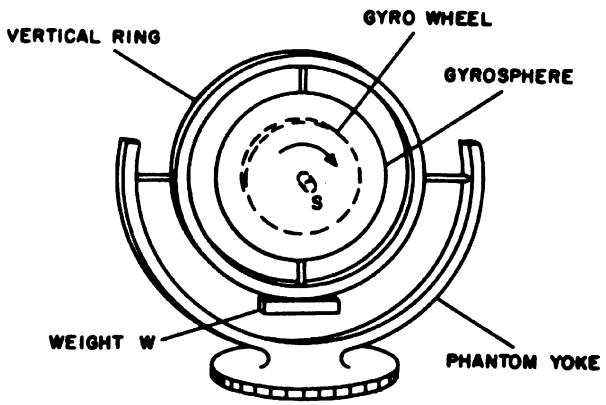


Figure A-10. Gyroscope With Addition of Weight to Vertical Ring

With the gyro wheel at the Equator, the axle horizontal pointing east-west, and the gyro wheel spinning clockwise viewed from the west (point A in Figure A-11) the gyro wheel and Vertical Ring are vertical and no torque is created by the added weight. At this point both properties of the gyroscope, gyroscopic inertia and precession, are brought into play. As the Earth rotates, the axle and therefore the Vertical Ring become inclined to the horizontal as shown at B in Figure A-11. The weight W is raised against the pull of gravity and consequently causes a torque about the horizontal axis of the gyro wheel. This torque causes precession about the vertical axis in the direction indicated at C in Figure A-11; the gyro wheel then has moved out of its original east-west position.

As the end of the gyro wheel which was first pointing east (which will now be referred to as the north end) continues to rise, the torque on the gyro wheel caused by the weight becomes greater because the moment arm through which the weight acts gets longer due to the greater tilt. Because the speed of precession is directly proportional to the tilt, the gyro wheel turns about the vertical axis as shown at D (in azimuth) at an increasing speed until the axis is on meridian E.

At the meridian the tilt, the torque caused by the weight, and speed of precession are all at a maximum. It should be noted here that it is the righting couple applied to the tilted axle by the pendulous weight which causes the gyrocompass to precess past the meridian. The kinetic energy of precession, being entirely negligible, plays no part here. After the north end of the gyro wheel axle crosses the meridian, the higher (north) end of the tilted axle is to the west of the meridian. As a result, referring back to Figure A-6, the Earth's rotation reduces the tilt. As the tilt becomes less, the speed of precession in azimuth decreases. Finally the axle becomes horizontal and precession to the west stops; the weight on the Vertical Ring causes no torque about the horizontal axis because it is hanging straight down. At this point, the axle has precessed as far west of the meridian as it was east originally.

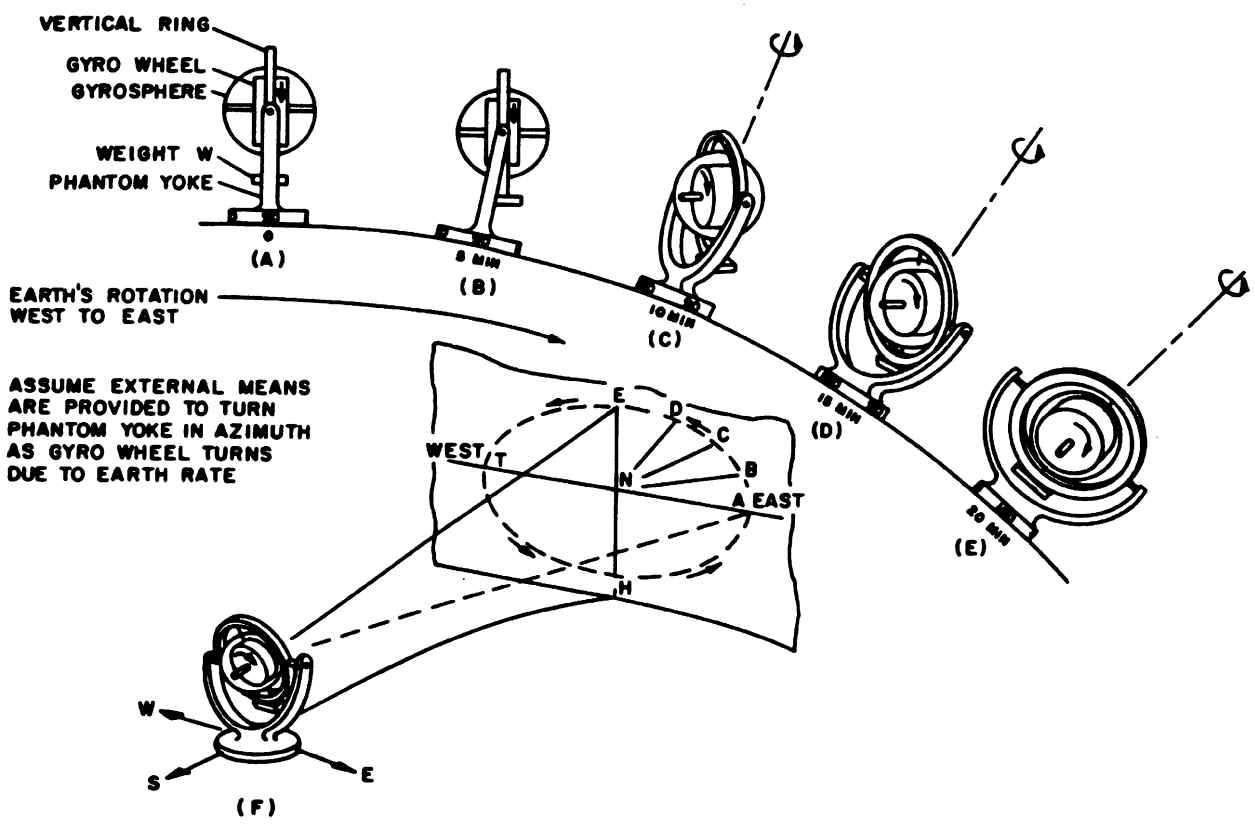


Figure A-11. Effect of Weight and Earth's Rotation on Gyroscope

As the Earth continues to rotate, the north end of the axle starts to dip. The weight W is raised on the opposite side of the horizontal axis in the opposite direction to what it was originally. Precession takes place in the opposite direction carrying the gyro wheel axle back across the meridian to its original position. At this point, the cycle is repeated and will go on indefinitely unless something is done to stop the oscillations. The oscillation about the meridian may be clearly understood by referring to F in Figure A-11 which shows the movement of the gyro wheel axle projected on a vertical plane. The ellipse in the figure is the result of a displacement of the gyro wheel axle only a few degrees from the meridian. If the axle were pointing east-west at the beginning of the cycle as shown in (A), precession would take place through 180 degrees in each direction, and at one extreme the axle would point east; at the other,west. In any case, the gyro wheel never comes to rest because there is no force tending to restore the axle to the horizontal position until it has passed the meridian.

The ratio of the movement about the horizontal axis (caused by apparent rotation) to the precessional movement about the vertical axis, caused by swing of the weight, determines the shape of the ellipse. If the weight is increased, the speed of precession will increase and the ellipse will be flatter. If the weight is decreased, the speed of precession will decrease and the ellipse will change in shape to where the ellipse would, theoretically, be almost circular. The time, in minutes, required for one complete oscillation, is called the period of oscillation. For any given wheel size and speed at a certain spot on the Earth, the period will be nearly the same regardless of the angle through which the wheel axis oscillates. The period can be changed by changing the amount of weight on the bottom of the Vertical Ring.

With such a gyroscope modified by hanging a weight on the Vertical Ring, the first condition required to make a gyroscope into a gyrocompass, that of making the gyro wheel axle seek the meridian, has been fulfilled. However, some means must be provided for suppressing the oscillations so the gyro wheel will quickly come to rest with its axle level in the north-south position.

A-7 SETTLING ON THE MERIDIAN.

To suppress the oscillations of the gyro wheel about the meridian, a small weight W1 is added to the Gyrosphere in which the gyro wheel is housed. This weight is placed on the east side of the Gyrosphere in a position shown in Figure A-12. With the gyro wheel axle level, the torque produced by gravity acting upon the weight W1 is restrained by the vertical axis bearings. When the gyro wheel axle tilts due to earth rate, the vertical axis is no longer vertical; the force of gravity, however, still pulls straight down on the weight. This allows the torque to act about the vertical axis and causes the spin axis to precess back toward the horizontal.

Now, with both weights, the gyro wheel will begin to tilt due to earth rate if it is off meridian and precesses in azimuth toward the meridian and downward toward the level position. As a result of the leveling action of weight W1, the gyro wheel axle does not have as much tilt when it reaches the meridian as it had with only weight W. Because the gyro wheel axle is not tilted as much, the torque produced by weight W is not as great. Therefore, the gyro wheel axle will not precess as far to the west of the meridian as it was east of the meridian when it started.

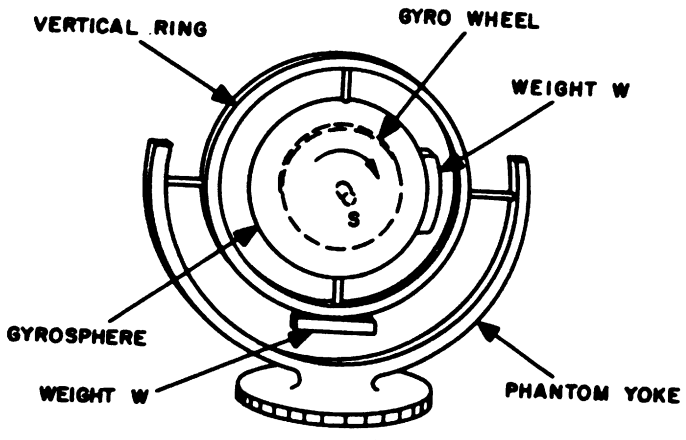


Figure A-12. Gyroscope with Weights on Vertical Ring and Gyrosphere

After reaching a point where the axle is level and as far west of the meridian as it is going due to the action of weight W, earth rate is still causing the north end of the gyro wheel axle to tilt downward. As a result, the forces due to the weights are reversed and the torques are created which precess the north end of the gyro wheel axle to the east and up. The gyro wheel, during this half of the cycle, is not precessed as far to the east as it was to the west. Thus, the added weight W1 causes the movement of the north end of the gyro wheel axle to be reduced each successive oscillation; the north end of the gyro wheel axle will thus follow a spiral path as shown in Figure A-13 instead of an elliptical path as previously described.

A careful consideration of the action of the two weights will make it apparent that the only position of rest that the gyro wheel can find will be with the gyro wheel axle horizontal and on the meridian. In other words, the free gyroscope has been converted into a true meridian-seeking gyrocompass. The gyrocompass period can be changed by varying the weight W, and the speed with which it settles to a level position (damping percentage) can be changed by varying the weight W1.

An instrument such as that described will indicate true north only as long as it is at the equator and not transported over the surface of the Earth. When this gyrocompass is moved, accelerations on the weights (because they are gravity sensitive) will cause torques on the gyro wheel, and the effect of change in latitude from the Equator will result in false indications. The gyrocompass in its present stage does not fulfill requirement (c), that of maintaining the true north and level position other than at the Equator. Some means must be used to eliminate the effect of accelerations on the unbalanced weights hanging on the gyrocompass and to adjust for the changes in latitude. This is accomplished as described in Chapter 3.

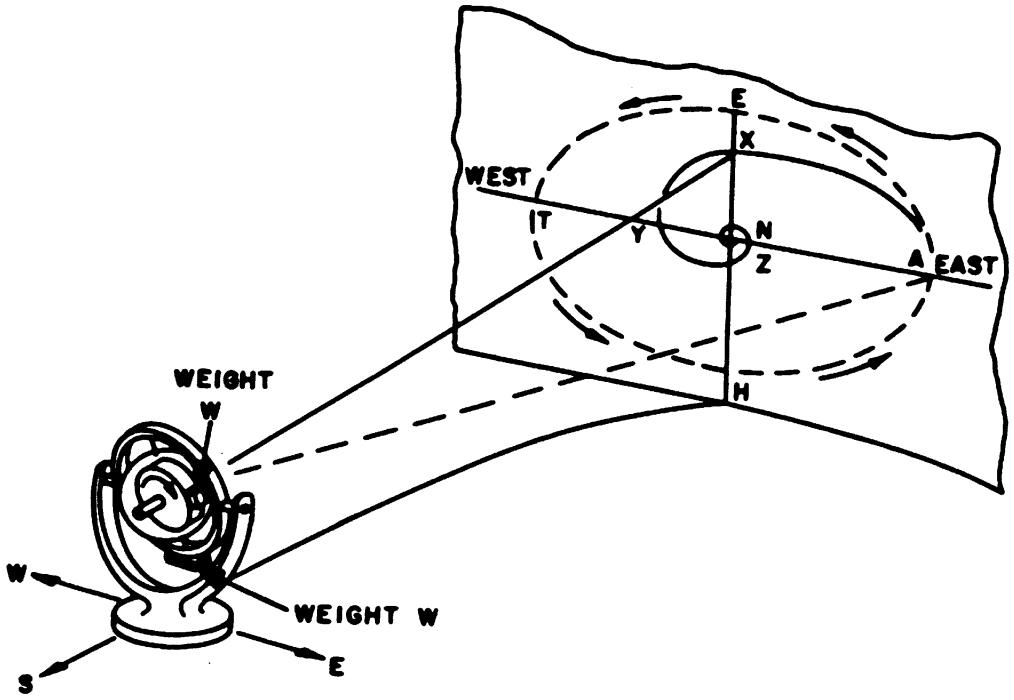


Figure A-13. Effect of Both Weights on Gyroscope