MENU

INDEX

= The information contained in the paragraphs marked with this symbol is essential for the purpose of safety.

SIGNED IN APPROVAL

COMPANY DEPT. SERVICES	**MANAGEMENT EXECUTIVE**	
ENGINEERING SECTION EXECUTIVE		
EXPORT MANAGER		

Publication No. **ACSZP0CA**
Edition: **April 1998**

INTRODUCTION

This equipment enables manually controlled electric power steering and automatic straight line wire guided steering. Manually controlled steering is available in either of the following options:

- manually operated multi-turn steering using a tacho-generator fixed to the steering handle
- manually operated return-to-center steering using a potentiometer attached to the spring returned steering handle that automatically centers steering when the handle is released.

In addition, this hardware controls the guide wire acquisition when the truck is approaching and seeking the guide wire for transition to automatic wire guided steering. Automatic straight line wire guided steering is possible for both directions of travel. Configuration options, manual steering adjustment and measurement functions, and troubleshooting operations are simplified with the use of the ZAPI hand held controller equipped with Eprom release number CKULTRA ZP3.01 or later.
Improved safety and operation are provided by having one microprocessor perform operations and a second microprocessor execute perform supervisor functions.
The microprocessors combined with the ZAPI hand held controller make service interface easy and direct, reducing adjustment and troubleshooting time. Increased steering motor performance and reduced noise levels are achieved by using MOSFET technology operating at 16 kHz, which is above the normally heard frequency band.

EQUIPMENT FOR ADJUSTMENT

ZAPI Hand Set
Digital multimeter that can measure AC voltages up to 10 kHz

1 SYSTEM COMPONENTS

The automatic wire guidance system includes:

1.1 TWO INDUCTIVE WIRE SENSORS (ANTENNAS)

There is a REV (load wheel) antenna mounted under the cab and a FWD (DRIVE UNIT) antenna mounted at the drive end of the truck. Both sensors are mounted on the center line of the truck. Each antenna includes two pick up coils that detect guide wire signal strength. During normal wire guided operations one pick up coil in each of the antennas is to the left of the wire and the other pick up coils are to the right of the wire.

1.2 5kW STEER ANGLE POSITION POTENTIOMETER

A 10 turn 5 kW potentiometer is mounted directly to the end of the output shaft on the steering gear reduction box. This potentiometer measures the angle of the DRIVE UNIT (Master Drive Unit) directly. The full range of possible voltage output is approximately 0 - 5 VDC. This single potentiometer provides steer angle feedback information for manual steering and wire guidance. This potentiometer also provides information for steer angle indicator gauge mounted on the operator console of multi-turn steering equipped trucks.

1.3 STEERING SERVO MOTOR CONTROL UNIT

a) A mother board marked ACSZPAOB operates the steering motor for both manual and automatic steering. There are two different mother boards available:

   1. A universal mother board that provides a maximum of 21 A at 24 - 80 VDC.

   2. A high output mother board that provides a maximum of 34 A at 24 - 48 VDC.

b) A guidance (antenna processing) card marked ACSZPBOB converts the signals from the antennas and from the steer angle feedback potentiometer into a bi-directional steering error that produces steering demand to the mother board. This steering error that produces steering demand is produced directly through electronic combination or comparison of the antenna feedback and the steer angle feedback. This does not go through a microprocessor.

1.4 OPERATOR CONSOLE

In addition to the steer handle feedback device the following devices are also mounted in the operator console:

a) Key switch

b) Manual/automatic steering selection switch (AUTO SEL)

c) An audible warning buzzer (BUZZER)

d) An "automatic" indicator lamp (AUTO LED)

e) A "manual" indicator lamp (MAN LED)

1.5 STEERING SERVO MOTOR

The steering system includes a permanent magnet DC servo motor with a rated power that is:

a) 20 A current rating (Imax = 34 A) if the battery voltage is 48 V DC or less

b) 12 A current rating (Imax = 21 A) if the battery voltage is greater than 48 V DC.

1.6 STEERING HANDLE

Two operator steering input options are provided. These may be selected using the ZAPI hand held controller. They include:

a) A multi-turn steering handle or wheel attached to a tacho-generator. The recommended tacho-generator is (Airpax Part No. 24 VDC - 9904-120-16206). Mounting the tacho-generator to eliminate axial or radial loading on the input shaft is important to reliable operation.

b) A 180 degree rotation steering handle attached to a potentiometer. The potentiometer provides the steering system with the angle of the steering handle.

1.7 LINE DRIVER (GUIDE WIRE SIGNAL GENERATOR)

The line driver provides a sinusoidal (alternating current) signal of the required frequency and strength to the guide wire.

2 ELECTRICAL SPECIFICATIONS

2.1 BATTERY VOLTAGE RANGE

Voltage input range for different releases of steering mother boards.

Universal release	24 - 80 VDC
24/48 release	24 - 48 VDC

2.2 STEER MOTOR CURRENT RANGE

Universal release	Imax £ 21 A DC. Adjustable with TM3.
24/48 release	Imax £ 34 A DC. Adjustable with TM3.

2.3 GUIDE WIRE SIGNAL

6.25 kHz @ 78 mA RMS (± 50 Hz and 60 - 90 mA)

Other frequencies are possible especially including:
5.2 kHz @ 35 mA RMS

Other frequencies are possible such as 7 and 10 kHz.

As the guidance frequency changes, a non-standard guidance card (ref. ACSZPBOB) has to be installed which has the narrow band pass filters tuned to the different frequency. Usually, due to changing signal strength associated with changing frequencies, new guidance antennas will also be required. The antennas have the gain modified to ensure adequate signal strength arrives at the control card.

Note: If the signal strength and frequency change in agreement with the following formula, then no new antennas are required with a changing frequency.

$I_{fd} = I_{f0} + (((f_0 - f_d)/f_0) \times I_{f0})$

I_{f0} = Current at 6.25 kHz (78 mA RMS)
I_{fd} = Current at desired frequency
f_0 = 6.25 kHz
f_d = Desired frequency

2.4 COMMAND DEVICE SPECIFICATIONS

2.4.1 TACHO GENERATOR

Tach Generator is to be AIRPAX 24 VDC - Part No. 9904-120-16206. Use of other devices may provide non-optimum performance.

2.4.2 POTENTIOMETERS

Position potentiometer control loops require typical pot values of 10 kW for both return-to-center steering and steering angle feedback. 10 kW ³ steering handle feedback pot value ³ 2.5 kW. Satisfactory performance requires that both of the following conditions be met:

1) Provide 80% of the electrical range of the steering angle feedback potentiometer corresponding to 180 degrees of DRIVE UNIT steering angle.

2) Provide at least 40% of the electrical range for the steering handle potentiometer.

3 MECHANICAL SPECIFICATIONS

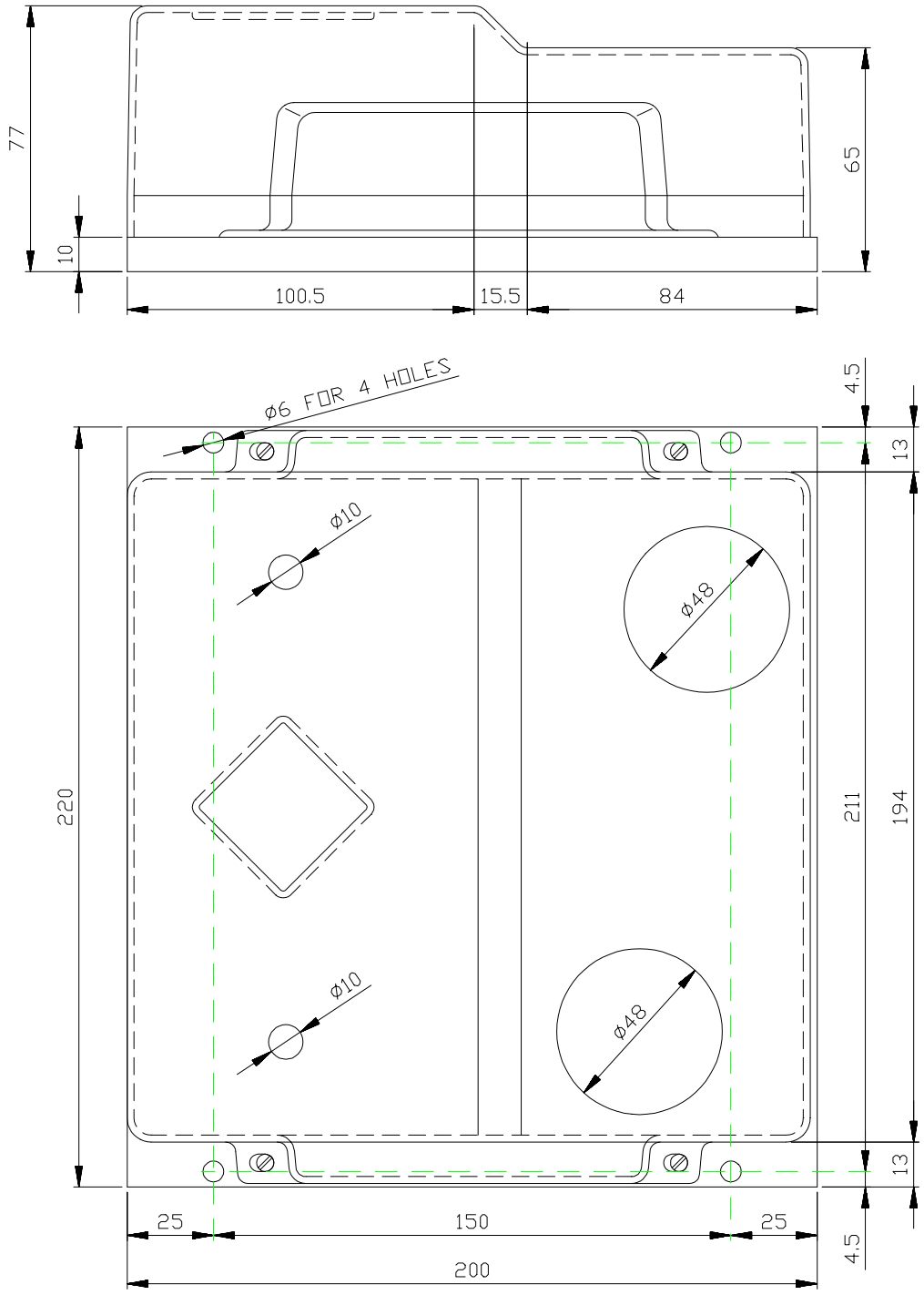


Fig. 3.1

3.1 STEERING REDUCTION RATIO

At rated servo-motor RPM with a reduction gear, the steering speed should be equal to about 180 degrees in 5 seconds. There should also be adequate torque generated to statically steer the truck on smooth concrete.

3.2 STEERING ANGLE FEEDBACK POTENTIOMETER REDUCTION RATIO

The steering angle feedback potentiometer should rotate approximately for the 80% of its total numbers of turns corresponding to 180 degrees of steering angle. The higher is the percent excursion, the better are resolution and accuracy.

The pot. shaft is directly connected to the output shaft of the steer gear box and is secured with a set screw.

3.3 INSTALLING ANTENNA

The bottom edge of each antenna must be positioned approximately 6 to 8 cm above the embedded guide wire. This corresponds to 1.75" - 2.5" above the surface of the floor. This assumes the guide wire is 1.6cm below the surface of the floor.

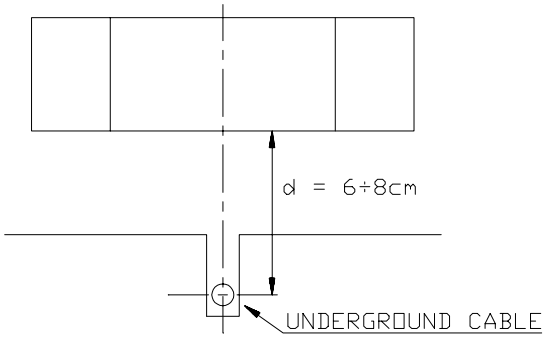


Fig. 3.3.1

The center of the antenna should be aligned with the center line of the truck. The DRIVE UNIT antenna (FWD ANTENNA) is mounted behind the DRIVE UNIT. The load wheel antenna (REV ANTENNA) may be mounted on the load wheel axle line. It is better if this antenna can be mounted further toward the load end of the truck.

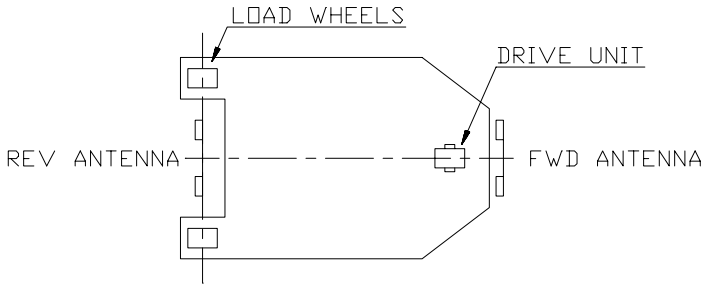


Fig. 3.3.2

The forward and reverse antennas must be mounted so the coil side of the antennas both face the same direction.

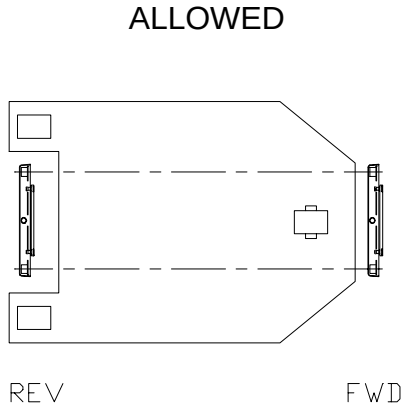


Fig. 3.3.3

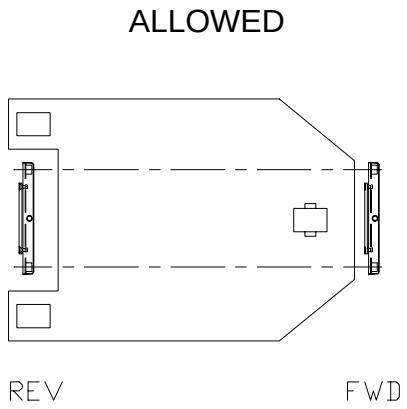


Fig. 3.3.4

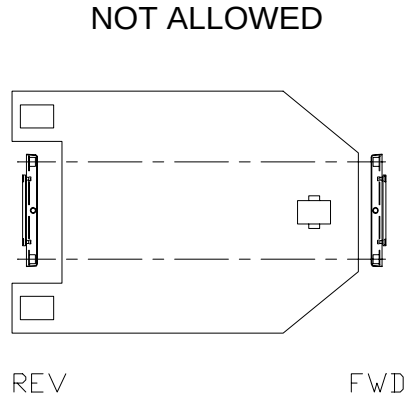


Fig. 3.3.5

4 SYSTEM DESCRIPTION

4.1 AUTOMATIC WIRE GUIDED STEERING

The guide wire embedded in the floor induces an electrical signal in the antennas mounted on the center line of the truck proportional to the position of the truck in relation to the wire. The control electronics continuously steers the truck in an effort to keep the combination of steering angle error and antenna error = zero. When all antenna coils have an equal strength signal there is no steering demand.

4.2 MANUAL STEERING WITH TACHO GENERATOR

This option uses a tacho generator attached to the steering wheel to convert the steering wheel rotation into an electrical signal. The control logic sets the steer servo-motor in motion at a speed that increases with the speed of the steering wheel. Steering sensitivity and maximum speed are adjustable by using the ZAPI hand held controller.

4.3 MANUAL STEERING WITH POTENTIOMETER

This option uses a potentiometer attached to the steering handle to convert handle motion into an electrical signal. The response speed and precision are adjustable using the ZAPI hand held controller.

4.4 WIRE GUIDED STEERING OPERATING SEQUENCE

For your reference here are the different operating modes and light and buzzer operations. Guidance Operational Modes

OPERATION	STEERING	RED LIGHT (MANLED)	GREEN LIGHT (AUTOLED)	BUZZER	BRAKES	TRACTION SLOW DOWN
Guidance off (not near guide wire)	Manual	On	Off	Off	Released	No
Guidance off (near guide wire)	Manual	Flash	Off	Off	Released	Yes
Guidance acquisition does not see wire yet	Manual	Flash	Flash	On	Released	Yes
Guidance acquisition sees wire but not on wire	Automatic	Off	Flash	On	Released	Yes
Guidance acquired	Automatic	Off	On	Off	Released	No
Guidance signal lost	Off	Frozen	Frozen	Fast on	Set	-

Fig. 4.4.1

Manual Steering Mode - All steering input is controlled by the operator.

Wire Acquisition Mode - The operator selects automatic steering using the toggle switch on the console. The steering changes to Wire Acquisition Mode. The operator continues to manually steer the truck. The steering/guidance controller automatically reduces truck travel speed to slow by opening a speed reduction relay.

If the truck is approaching the wire load first, then both antennas have to detect the guide wire before manual steering is taken from the operator and automatic steering attempts to capture the wire. This requires an angle of approach of not more than approximately ± 5 degrees to the guide wire. The operator continues to be responsible for steering until the wire is fully captured.

If the truck is approaching the wire DRIVE UNIT first, then only the DRIVE UNIT antenna has to detect the guide wire before manual steering is taken from the operator and automatic steering attempts to capture the wire. This requires an angle of approach of not more than approximately ± 30 degrees to the guide wire. The operator continues to be responsible for steering until the wire is fully captured.

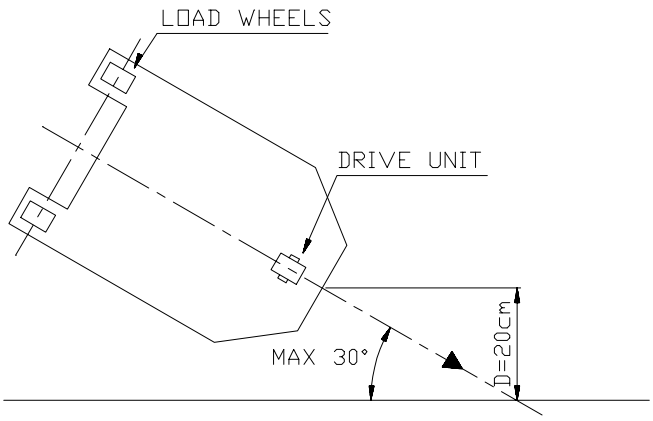


Fig. 4.4.2

Automatic Wire Guided Steering Mode - When both antennas are aligned with the guide wire, then fully automatic steering is enabled. The truck may travel at full speed. The truck is fully in control of steering and automatic stopping is enabled. The signal in the antennas is used to steer the truck.

If the truck is not aligned with the guide wire in Automatic Mode, then the truck automatically stops, brakes are applied, both the AUTO and MANUAL lights are frozen, and the buzzer has the error audibly encoded. Counting the number and sequence of beeps provides an error code to the operator.

4.5 REAL TIME RUNNING CICLE FLOWCHART

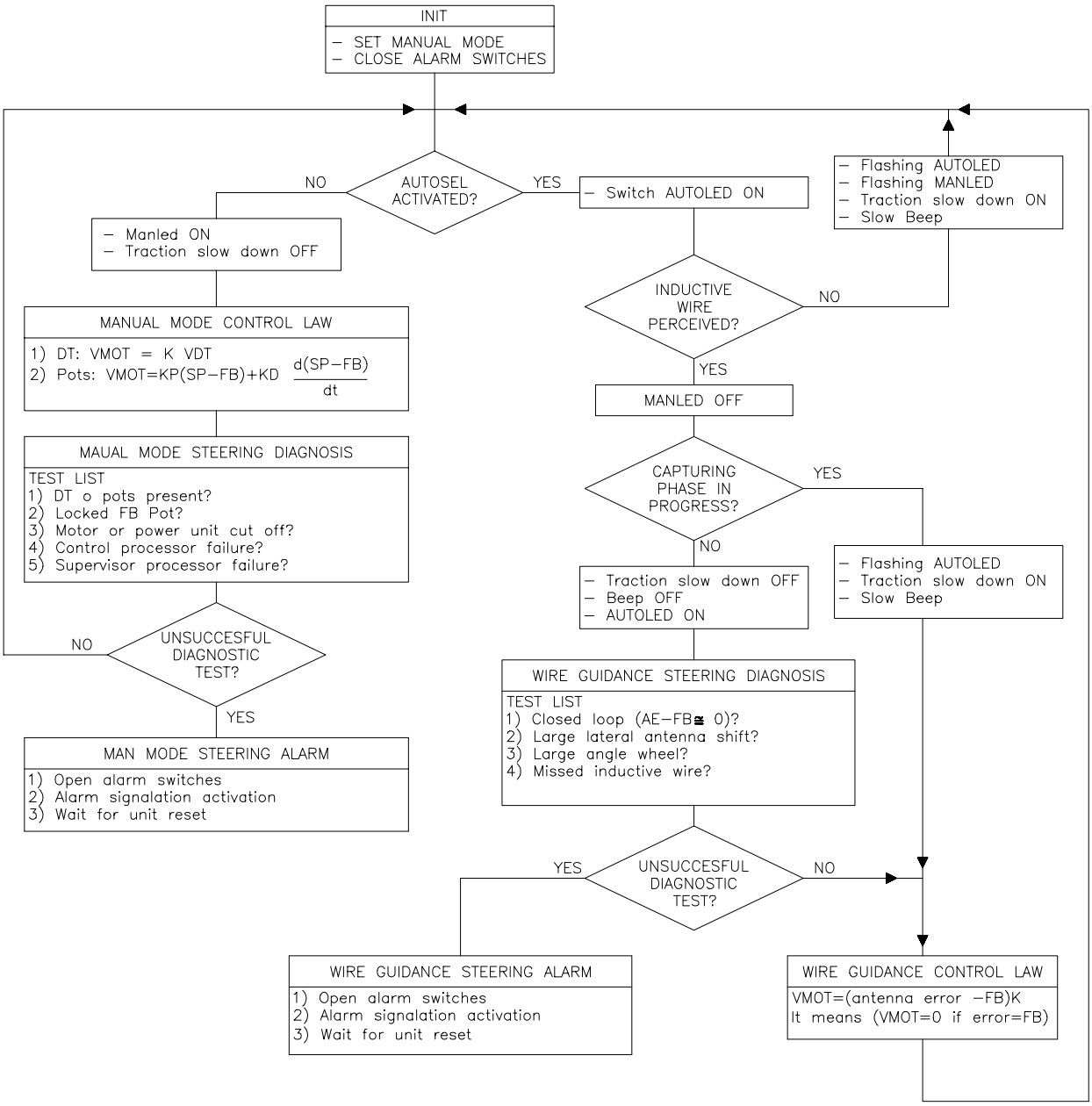


Fig. 4.5.1

5 SYSTEM CONFIGURATION

5.1 JUMPER CONFIGURING

5.1.1 WIRE GUIDED CARD (ACSZPB0B) JUMPER.

J1 = Specifies the control logic for forward and reverse direction of travel on traction. It should be configured in one of the following ways:

a) J1 as in the figure 5.1.1 means the enabling contacts for TRAVEL are ACTIVE HIGH. This means that the external travel enable contacts are connected to battery positive.

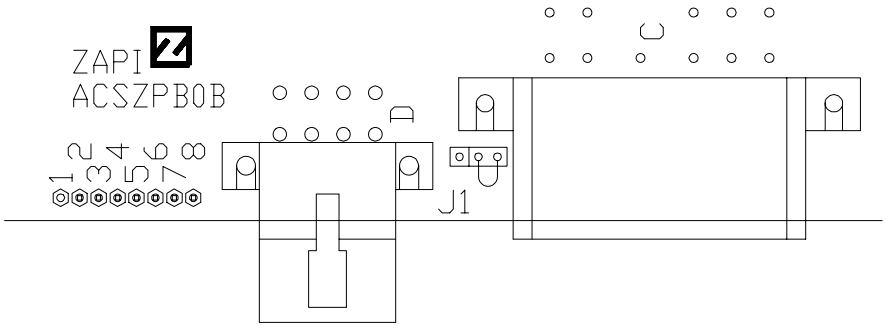


Fig. 5.1.1

b) J1 as in the figure 5.1.2 means the enabling contacts for TRAVEL are ACTIVE LOW. This means that the external travel enable contacts are connected to battery negative.

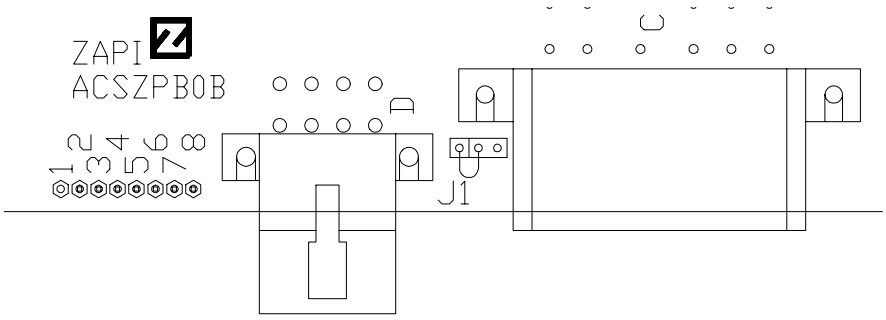


Fig. 5.1.2

NOTE: It is important to set the "DIR INP ACTIVE LOW" (see par. 12.6.2) option using the ZAPI hand set: OFF if a) was chosen for J1
ON if b) was chosen for J1.

5.1.2 MOTHERBOARD (ACSZPA0B) JUMPERS.

J1 = Factory configured with the jumper installed. This is a microprocessor functional mode selection.
J2 = Select the supply voltage for the command encoder.
J3, J4, J5 = For special applications only (see par. 8.2).
J6 = When connected gives the speed reduction switch a ground (GND) reference. The reference is normally floating.
J7 = When connected gives the locking in straight direction steering switch a ground (GND) reference. The reference is normally floating. This features is to control an electromechanical steer straight feature in automatic mode.
J8 = When connected gives the steering alarm switch a ground (GND) reference. The reference is normally floating. This provides a single point disconnect for EPS and stopping travel.

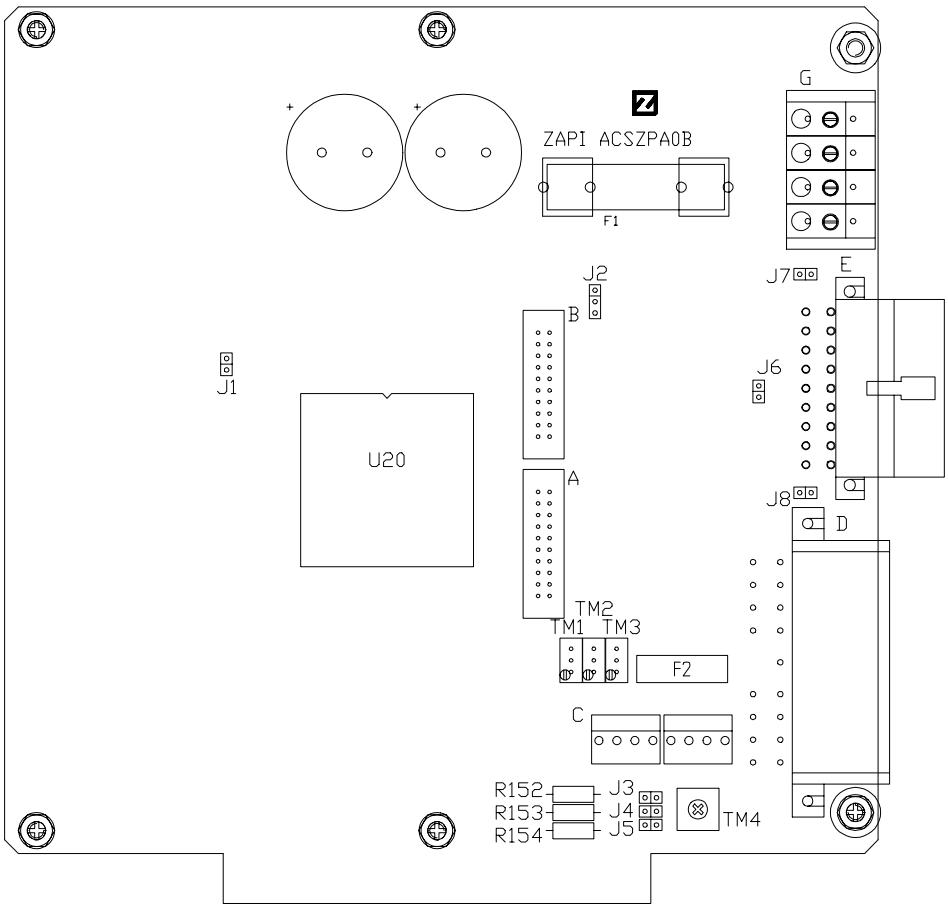


Fig. 5.1.3

5.2 POWER CONNECTION DIAGRAM

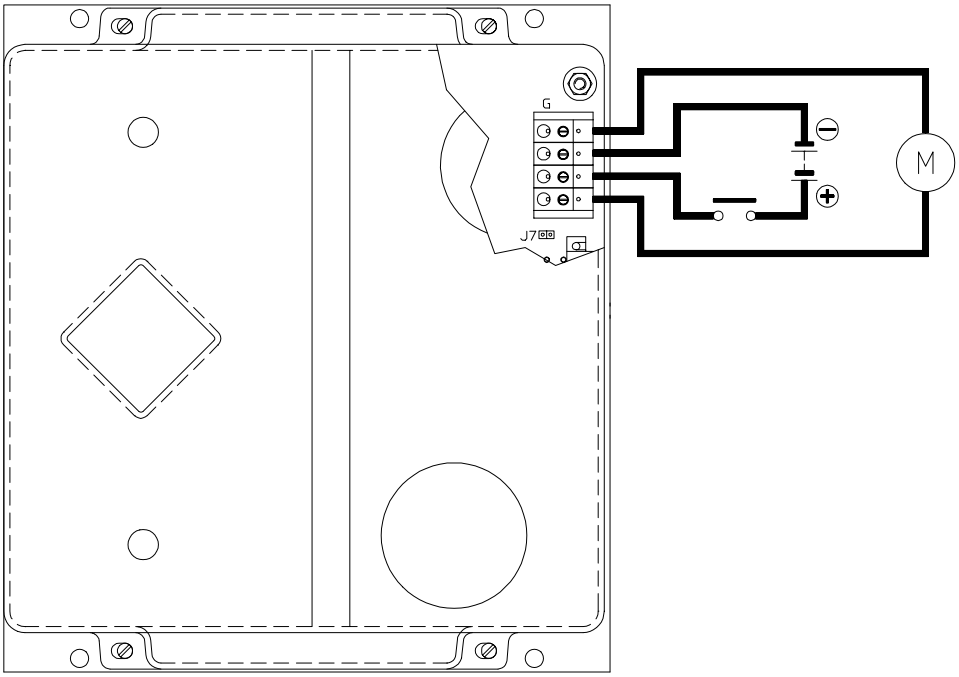


Fig. 5.2.1

The functional diagrams concerning the possible configurations are shown.
Four different operating options (Tacho-generator + wire guidance, Tacho-generator steering only, Pot steering + wire guidance, and Pot steering only) are provided.
"Tacho-generator steering only" and "Pot steering only" support "Automatic Centering" also.

5.3 TACHO HANDWHEEL STEERING PLUS WIRE GUIDANCE ELECTRICAL DRAWING

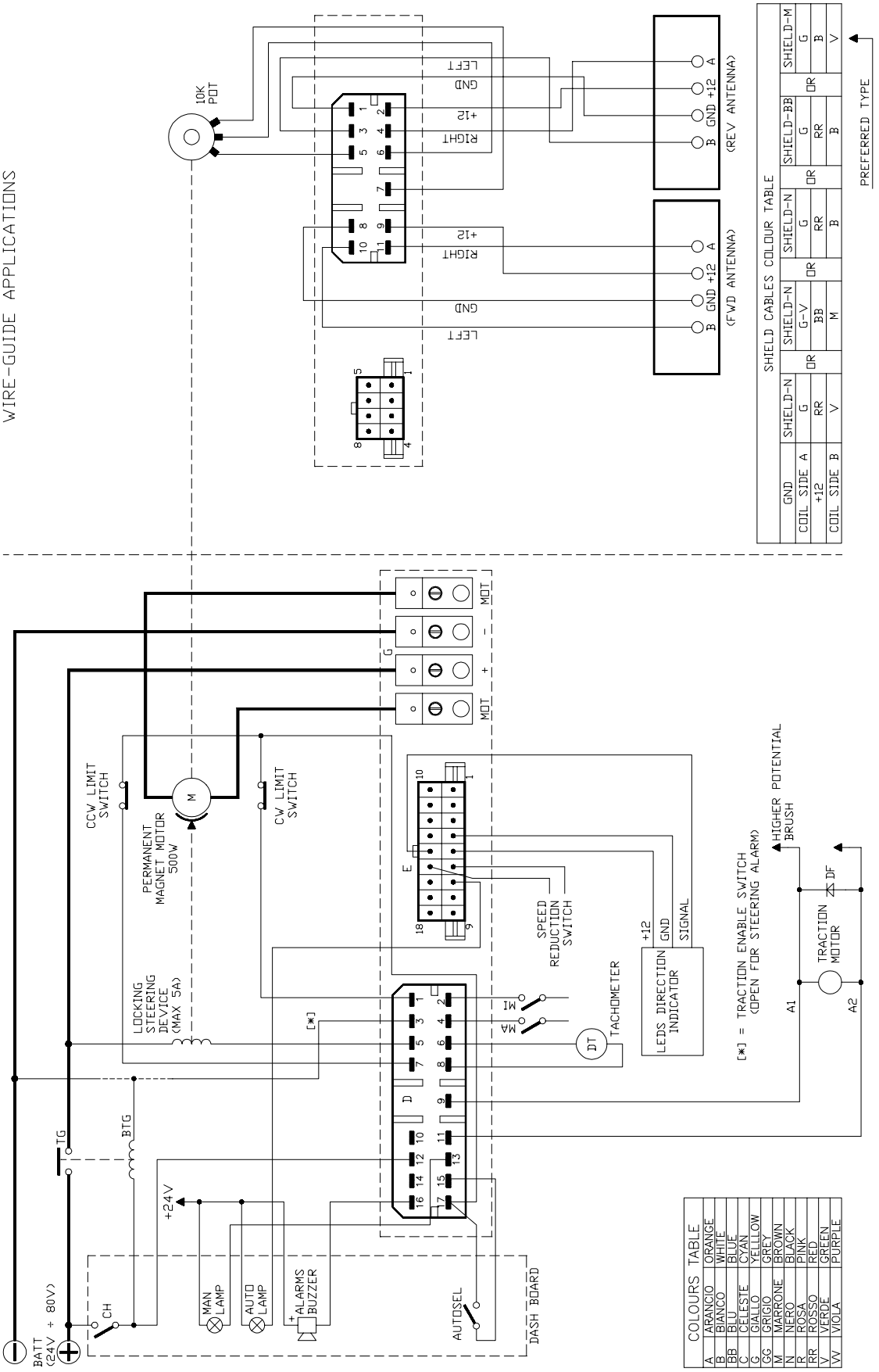


Fig. 5.3.1

5.3.1 INTERFACE DESCRIPTION:

a) The steering angle feedback potentiometer should be rigidly mounted to the steering linkage with no joint clearance..

b) The FWD antenna is mounted on the DRIVE UNIT end of the truck.

c) The REV antenna is mounted on the load end of the truck.

d) The FWD travel input corresponds to travel in the drive unit direction. The REV travel input corresponds to travel in the load end direction.

e) Pins 4 on connector D on the mother board is connected to the FWD (drive unit) travel input. This pin is common with Pin 1 of the guidance board (eight pole) connector. Pins 2 on connector D on the mother board is connected to REV (load wheel) travel input. This pin is common with Pin 2 of the guidance board (eight pole) connector.
Each direction input may be active high (plus battery) or low (minus battery). Specify the mode of operation by configuring the Jumper J1 on the guidance (upper) card (see 5.1.1) and select the operation level using the ZAPI hand held controller (see 12.6.2).

f) Pin 9 of connector D on the motherboard is connected to the highest voltage potential side of the traction motor armature. This pin is common with pin 4 of the guidance card (eight pole) connector. Pin 11 of connector D on the motherboard should be connected to the lowest voltage potential side of the traction motor armature. This pin is common with pin 8 of the guidance card (eight pole) connector (see 6.1.4).

g) The AUTO LAMP comes on when there is a request for wire guided steering, i.e., when the guidance switch is turned on. It is blinking during speed reduction conditions. The active AUTOSEL level for automatic guidance (low or high) is selectable using the ZAPI hand held controller (see 12.6.1).

h) The MAN LAMP is on during manual operation and goes out as soon as the truck steers independently from the manual input. The MAN LAMP is blinking during slow down conditions.

i) Pin 3 of connector D on the mother board is internally connected to a normally open (NO) contact on the mother board. This contact is closed when the key switch is turned on. The contact opens when there is an alarm. This contact provides ground (GND) reference to the brake relay and the main steering relay. When the brake relay loses this ground and opens, the brakes are applied and traction enable ground to the traction card is lost. (Note:The jumper J8 should be installed on the motherboard.)

j) Pin 5 of connector D on the mother board is internally connected to a normally open (NO) contact. This contact is closed when the key switch is turned on and remains in such a position while in manual mode and in wire-seeking operations. The contact opens when the truck is perfectly aligned to the wire (AUTOMATIC mode). This contact should provide and remove ground (GND) connection to an electromechanical device locking the wheel in a quasistraight position. (Note:The jumper J7 should be installed on the motherboard).

k) Pin 6 and 15 of connector E on the mother board are internally connected to a normally open contact on the mother board. This contact is closed by the key switch and open in case of one of the following speed reduction conditions:

1) If the truck is in the manual steering mode and is close to a guide wire. (Minimizes possibility that an operator will go fast when inside an aisle and not on wire guidance.)

2) When the truck is in the wire acquisition mode until both antennas are aligned with the guide wire.

3) When the truck is in the wire guided mode and has shifted sideways more than 2/3 of the "lateral out" alarm threshold (see 9.9).

l) Pin 14 of connector E on the motherboard provides 0 - 4 VDC to control the steering angle indicator gauge LEDs. Pin 4 and Pin 5 of connector E on the motherboard respectively provide negative and postive 12 VDC to the steering indicator.

5.4 TACHO-GENERATOR STEERING WHEEL AND AUTOMATIC CENTERING

Refer to the previous section on Tacho-Generator Steering with wire guidance. Here the wire guidance option is removed and the steering angle feedback potentiometer is connected to Pins 16, 17, and 18 of connector E on the mother board instead of to a connector on the wire guidance board.

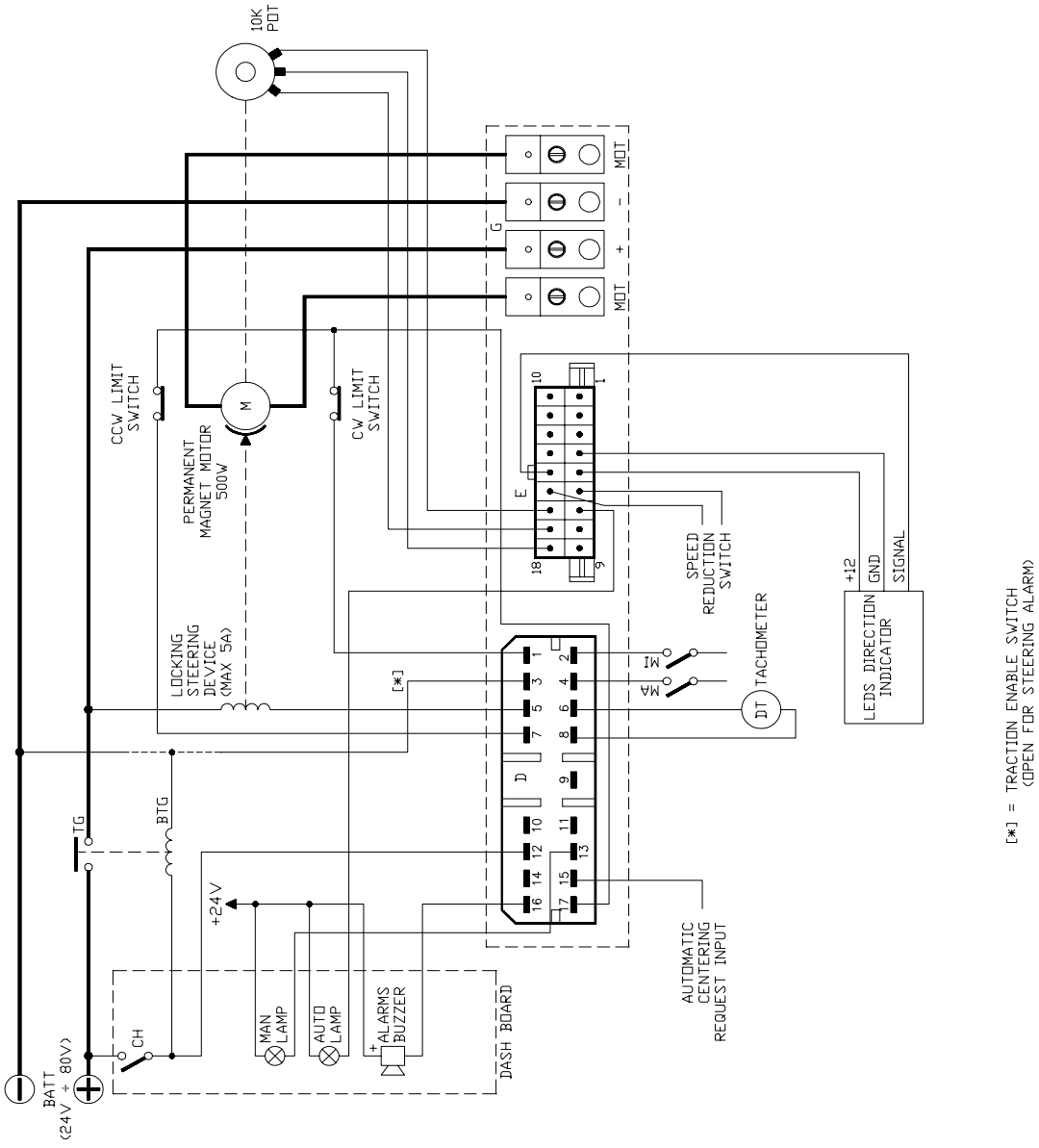


Fig. 5.4.1

5.4.1 INTERFACE DESCRIPTION:

a) The 10kW steering angle feedback potentiometer should be rigidly mounted with no clearance to the steering linkage. The pot. wiper is connected to Pin 18 of connector E on the mother board. The ends of the pot. are connected to Pins 16 and 17 of connector E on the mother board.

b) FWD (drive unit) antenna direction of travel request should be connected to Pin 4 on connector D on the mother board. REV (load end) antenna direction of travel request should be connected to Pin 2 on connector D on the mother board. Applications with pot. steering and without wire guidance require these inputs to stop steering dither when the truck is motionless.

c) The guidance board is not required for automatic centering with rail guidance. The AUTO LAMP comes on when there is a request for automatic centering of steering. The request for automatic steering centering is caused when photo switches detect the presence of the guide rails (in place of the AUTO SEL switch being turned on.)

d) The MAN LAMP is on during manual operation.

e) Pin 3 of connector D on the mother board is internally connected to a normally open (NO) contact on the mother board. This contact is closed when the key switch is turned on. The contact opens when there is an alarm. This contact provides ground (GND) reference to the brake relay and the main steering relay. When the brake relay loses this ground and opens, the brakes are applied and traction enable ground to the traction card is lost. (Note: The jumper J8 should be installed on the mother board to provide ground reference to pin 3.)

f) Pin 5 of connector D on the mother board is internally connected to a normally open (NO) contact on the mother board. This contact closes when the key switch is turned on and remains in this position while in manual mode and in automatic self-centering operations. The contact opens when the automatic self-centering operation has been carried out successfully. (Note: The jumper J7 should be installed on the mother board to provide ground reference to pin 5).

g) Pin 14 of connector E on the motherboard provides 0 - 4 VDC to control the steering angle indicator gauge LEDs. Pin 4 of connector E on the motherboard provides negative and Pin 5 of connector E on the motherboard provides positive 12 VDC to the steering angle indicator gauge.

5.5 POT. (RETURN-TO-CENTER) CONTROLLED STEERING PLUS WIRE GUIDANCE ELECTRICAL DRAWING

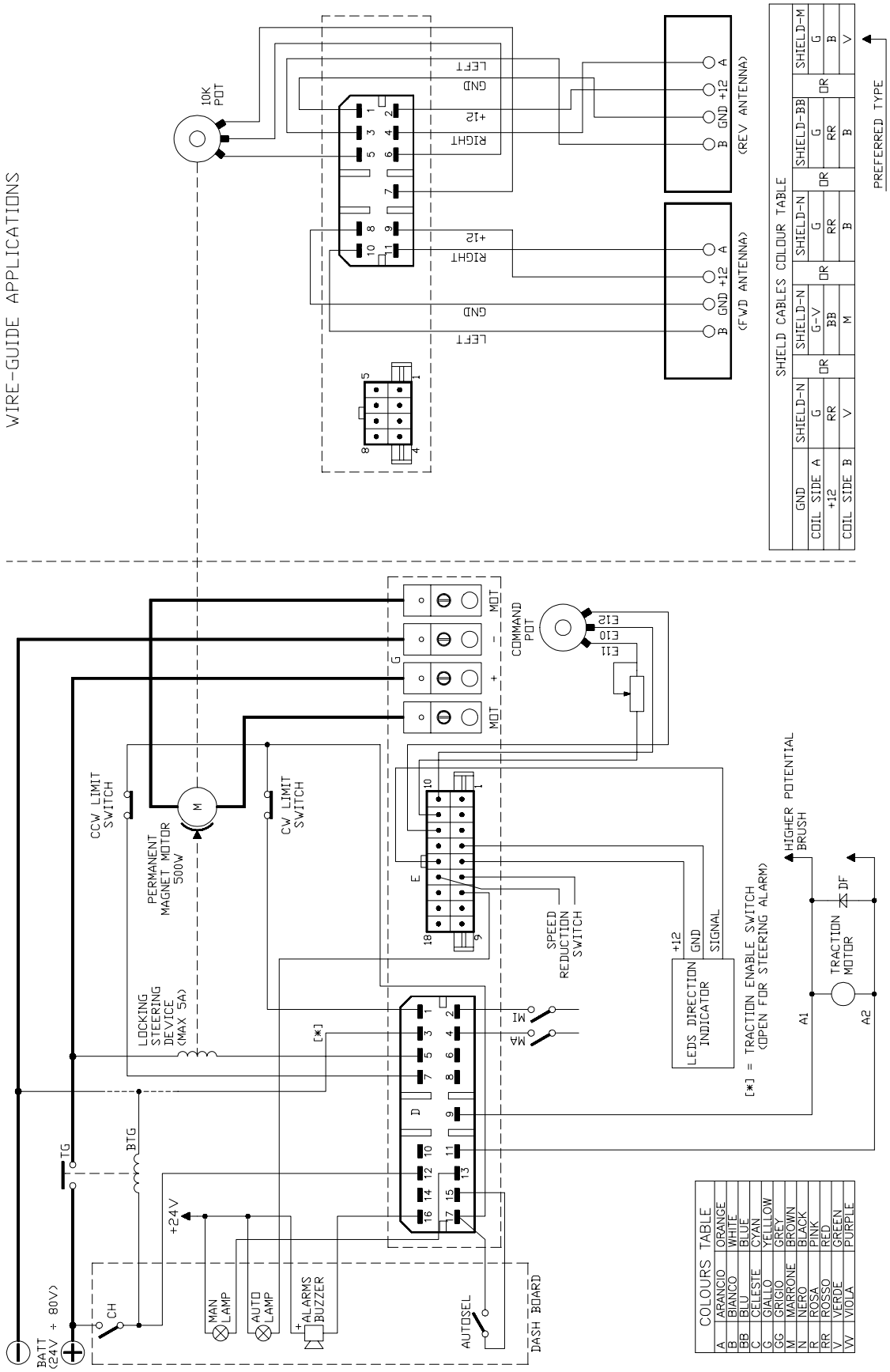


Fig. 5.5.1

5.5.1 INTERFACE DESCRIPTION:

a) The steering angle feedback pot. should be rigidly mounted to the drive unit steering linkage with minimum clearance.

b) The steering handle pot. wiper is connected to Pin 10 of connector E on the mother board. The end points of the pot. are connected to Pins 11 and 12 of connector E on the mother board.

c) The FWD antenna is mounted on the drive unit end of the truck.

d) The REV antenna is mounted on the load wheel end of the truck.

e) Request to travel in the FWD (drive unit) antenna direction should be connected to Pin 4 of connector D on the mother board. Request to travel in the REV (load wheels) antenna direction should be connected to Pin 2 of connector D on the mother board.
Each direction input may be active high (plus battery) or low (minus battery). Specify the mode of operation by configuring the Jumper J1 on the guidance (upper) card (see 5.1.1) and select the operation level using the ZAPI hand held controller (see 12.6.2).

f) Pin 9 of connector D on the motherboard is connected to the highest voltage potential side of the traction motor armature. This pin is common with pin 4 of the guidance card (eight pole) connector. Pin 11 of connector D on the motherboard should be connected to the lowest voltage potential side of the traction motor armature. This pin is common with pin 8 of the guidance card (eight pole) connector (see 6.1.4).

g) When the AUTO SEL switch is turned on, the AUTO LAMP starts blinking when the truck is in the guidance acquisition mode and remains lit continuously when the truck is in the guidance acquired mode. The active (for automatic guide) AUTO SEL level (low=closed or high=open) can be selected using the ZAPI hand held controller (see 12.6.10).

h) MAN LAMP is on when the truck is in the manual steering mode. The MAN LAMP blinks during all slow down conditions. It goes out as soon as the truck steers automatically and there is no slow down condition.

i) Pin 3 of connector D on the mother board is internally connected to a normally open (NO) contact on the mother board. This contact is closed when the key switch is turned on. The contact opens when there is an alarm. This contact provides ground (GND) reference to the brake relay and the main steering relay. When the brake relay loses this ground and opens, the brakes are applied and traction enable ground to the traction card is lost. (Note: The jumper J8 should be installed on the mother board.)

j) Pin 5 of connector D on the mother board is internally connected to a normally open (NO) contact. This contact closes when the key switch is turned on and remains in such a position while in manual mode and in wire-seeking operations. The contact opens when the truck is perfectly aligned to the wire (AUTOMATIC mode). This contact should provide and remove ground (GND) connection to an electromechanical device locking the wheel in a quasistraight position. (Note:The jumper J7 should be installed on the motherboard).

k) Pin 6 and 15 of connector E on the mother board are internally connected to a normally open contact on the mother board. This contact is closed by the key switch and open in case of one of the following speed reduction conditions:

1) If the truck is in the manual steering mode and is close to a guide wire. (Minimizes possibility that an operator will go fast when inside an aisle and not on wire guidance.)

2) When the truck is in the wire acquisition mode until both antennas are aligned with the guide wire.

3) When the truck is in the wire guided mode and has shifted sideways more than 2/3 of the "lateral out" alarm threshold (see 9.9).

l) Pin 14 of connector E on the motherboard provides 0 - 4 VDC to control the steering angle indicator gauge LEDs. Pin 4 of connector E on the motherboard provides negative and Pin 5 of connector E on the motherboard provides positive 12 VDC to the steering indicator gauge.

5.6 POT. (RETURN-TO-CENTER) CONTROLLED STEERING

This is similar to Pot. Controlled Steering with wire guidance. Here the steering angle feedback pot. and steering handle pot. connections have been moved down to the mother board from the guidance card. This application does not require a guidance card.

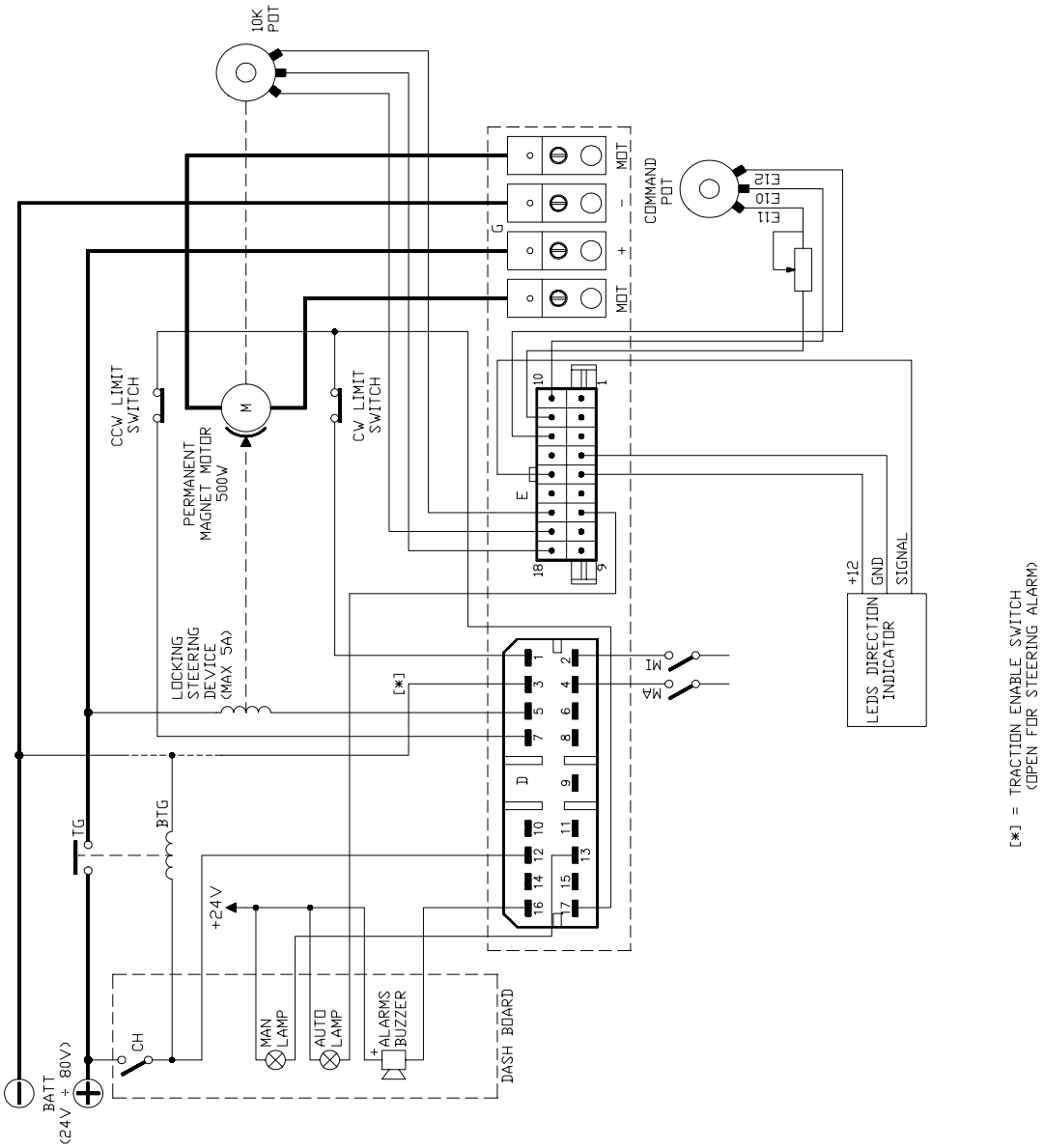


Fig. 5.7.1

5.6.1 INTERFACE DESCRIPTION:

a) The steering angle feedback pot. wiper should be connected to Pin 18 of connector E on the motherboard. The ends of the steering angle feedback pot. should be connected to Pins 16 and 17 of connector E on the motherboard. The pot. should be rigidly mounted to the steering linkage to minimize joint clearance.

b) Pin 4 of connector D on the motherboard is connected to travel request in the FWD (drive unit) antenna direction of truck travel. Pin 2 of connector D on the motherboard is connected to travel request in the REV (load wheel) antenna direction of truck travel. (Jumper J1 on ACSZPF0A should be correctly configured (see 5.7 step 5) and the selected level should also be set by the ZAPI hand held controller see 12.6.2).

c) The guidance board is not required for automatic centering with rail guidance. The AUTO LAMP comes on when there is a request for automatic centering of steering. The request for automatic steering centering is caused when photo switches detect the presence of the guide rails (in place of the AUTO SEL switch being turned on.)

d) The MAN LAMP is on during manual operation.

e) Pin 3 of connector D on the mother board is internally connected to a normally open (NO) contact on the mother board. This contact is closed when the key switch is turned on. The contact opens when there is an alarm. This contact provides ground (GND) reference to the brake relay and the main steering relay. When the brake relay loses this ground and opens, the brakes are applied and traction enable ground to the traction card is lost. (Note: The jumper J8 should be installed on the mother board.)

f) Pin 5 of connector D on the mother board is internally connected to a normally open (NO) contact on the mother board. This contact closes when the key switch is turned on and remains in this position while in manual mode and in automatic self-centering operations. The contact opens when the automatic self-centering operation has been carried out successfully. (Note: The jumper J7 should be installed on the mother board to provide ground reference to pin 5).

g) Pin 14 of connector E on the motherboard provides 0 - 4 VDC to control the steering angle indicator gauge LEDs. Pin 4 of connector E on the motherboard provides negative and Pin 5 of connector E on the motherboard provides positive 12 VDC to the steering angle indicator gauge.

5.7 ONE SHOT INSTALLATION PROCEDURE

This section of the manual describes the connection procedures for the antennas, potentiometers, and tacho-generator.
Carry out the following steps with the steer motor disconnected. Disregard alarms that appear during the first and second step. Work in the manual mode.

Step 1 - STEERING WHEEL OR HANDLE (COMMAND) DEVICE CONNECTIONS

a) TACHO-GENERATOR STEERING - Connect the two wires from the tacho-generator so that clockwise rotation of the steering wheel produces an increasing (higher positive) command value. This may be measured two ways. Using the ZAPI hand held controller see the TESTER MENU (see 12.4.4). The second way is to use a DC voltmeter connected to the tacho-generator wire that you plan to connect to Pin 8 of connector D on the mother board (DT+) and the minus terminal on the battery.

b) POT. STEERING - The steering handle pot. has 3 wires; two end wires and a wiper wire. Connect the two "end wires" from the steering handle pot. so that clockwise rotation of the handle produces an increasing (higher positive) command value. This may be measured two ways. Using the ZAPI hand held controller see the TESTER MENU (see 12.4.1). The second way is to use a DC voltmeter connected to the handle pot. wiper wire that you plan to connect to Pin 10 of connector E on the mother board and the minus terminal on the battery.

c) Perfect adjustment of the steering handle pot. center point is not necessary. The center point value will be memorized later using the ZAPI hand held controller (see 12.7.4).

Step 2 - STEERING ANGLE FEEDBACK POT. CONNECTIONS

a) The steer angle feedback pot. has 3 wires; two end wires and a wiper wire. If the truck has a not leading MDU (Motor Drive Unit - see Fig 5.7.1)* connect the two end wires to Pins 16 and 17 of connector E on the motherboard so when the drive unit(s) is turned counter-clockwise (clockwise for a truck with a leading MDU) the value on the wiper is increasing. This value may be measured in two ways. Using the ZAPI hand held controller through the TESTER MENU (see 12.4.2). The second way is to use a DC voltmeter connected to the steering angle feedback pot. wiper wire and battery negative. The wiper wire should be connected to Pin 18 of connector E on the mother board.

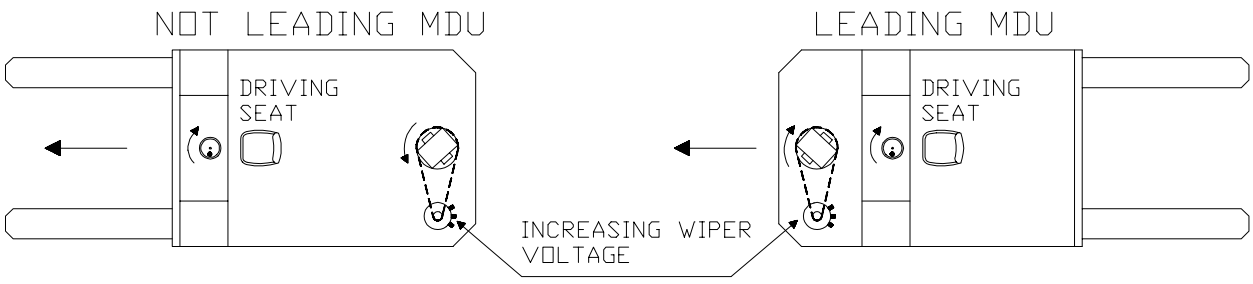


Fig. 5.7.1

* **Not leading MDU** : means the steering-traction wheel is opposite to the driving seat. When the steering handle is turned clockwise, the MDU turns counterclockwise.

Leading MDU : means the steering traction wheel is on the same side of the driving seat. When the steering handle is turned clockwise, the MDU turns clockwise too.

b) Physically adjust the steering angle feedback pot. so with the drive unit straight ahead, the wiper voltage is 2.55 VDC. This will require a minimum trimmer pot. adjustment to get wire guidance performance as required. If wire guidance is not required on the truck, then this precise adjustment is not necessary, because the manual mode zero point for the steering angle feedback pot. can be adjusted using the ZAPI hand held controller. See the CONFIG MENU (see 12.7.1).

STEP 3 - STEER MOTOR CONNECTIONS

After adjusting and connecting the steering handle pot. or tacho-generator and the steering angle feedback pot., connect the two steering motor wires so that a clockwise steering handle movement causes either a counterclockwise steer motor movement, for a not leading MDU truck, or a clockwise steer motor movement, for a leading MDU truck. If this operation is carried out correctly, the truck will turn clockwise when the steering handle is moved clockwise while the truck is travelling in frontal direction (with respect to the driving seat).

STEP 4 - LIMIT SWITCH CONNECTIONS

After completing Steps 1 - 3, check that the limit switch connected to Pin 1 of connector D on the motherboard stops steering in the handwheel clockwise direction. Then, check that the limit switch connected to Pin 7 of connector D on the motherboard stops steering in the counterclockwise direction.

MANUAL STEERING CONNECTION IS COMPLETE. (SET UP AND ADJUSTMENT IS NOT COMPLETE.)

STEP 5 - KEY CONNECTOR

If the wire guidance board is not installed, then a small "key" connector must be inserted into flat cable connector A on the motherboard. This "key" connector uses a transistor and some passive components to provide a travel request to the software. The forward and reverse travel inputs must be externally wired from Pin 2 and 4 on connector D of the motherboard to this "key" connector. This approach eliminates the need to have a guidance board with the Automatic Steering Centering option.

Configure the jumper J1 on ACSZPF0A board as follows:

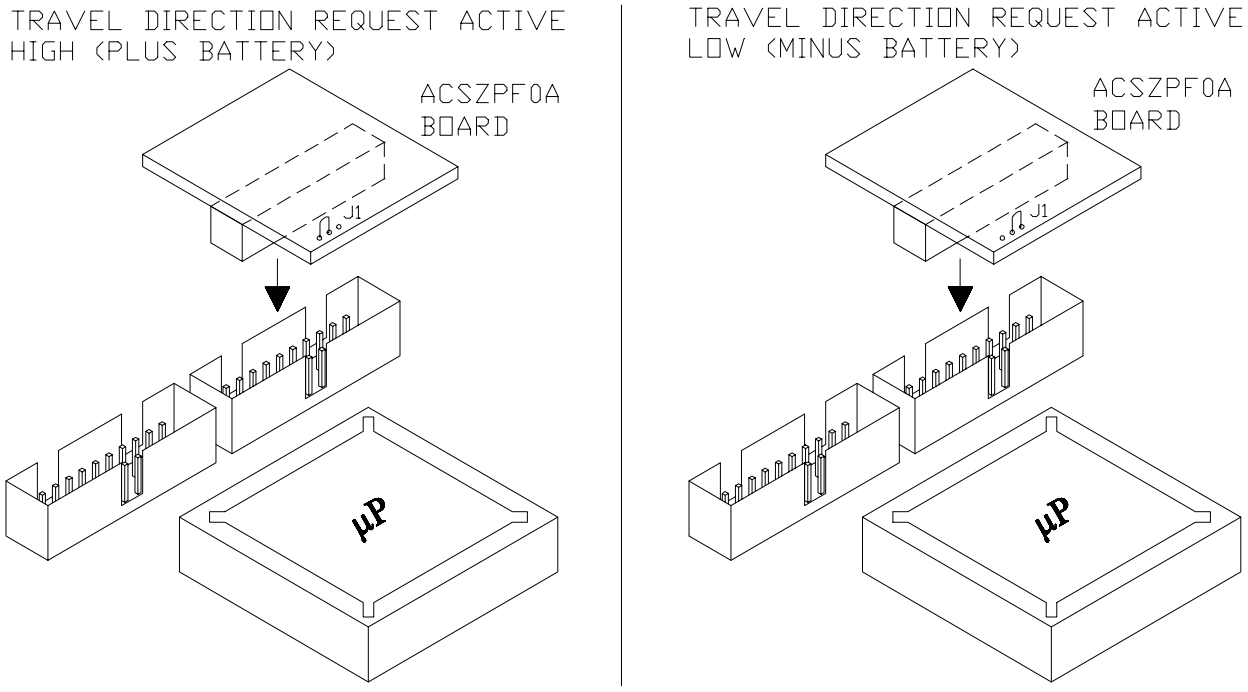


Fig. 5.7.2

STEP 6 - GUIDANCE ONLY - ANTENNA CONNECTIONS

The FWD antenna is mounted on the drive unit end of the truck. The REV antenna is mounted on the load wheel end of the truck.

Determine the connection of the guidance antennas as follows:

a) Assume left and right are determined by an operator on the driving seat. Connect the right FWD (drive unit) antenna coil to (FR) Pin 11 of big connector on the guidance board. Connect the left FWD (drive unit) antenna coil to (FL) Pin 10 of big connector on the guidance board (see 7).

b) Assume left and right are determined by an operator staying on the driving seat. Connect the right REV (load wheel) antenna coil to (RR) Pin 4 of big connector on the guidance board. Connect the left REV (Load wheel) antenna coil to (RL) Pin 3 of big connector on the guidance board (see 7).

c) If you have any problems connecting the wires you may refer to the next two sketches for antenna coil location, mounting orientation and possible wire color combinations in the sensors. From these you should be able to determine which color wire to connect to the guidance board for each antenna.

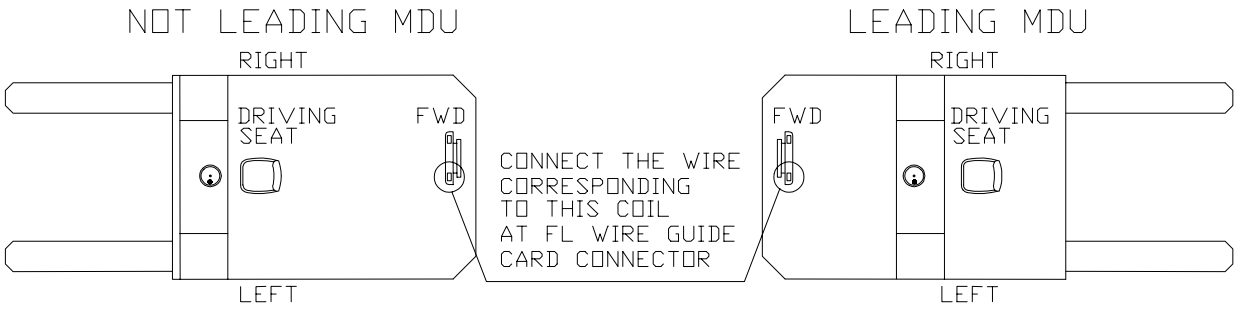
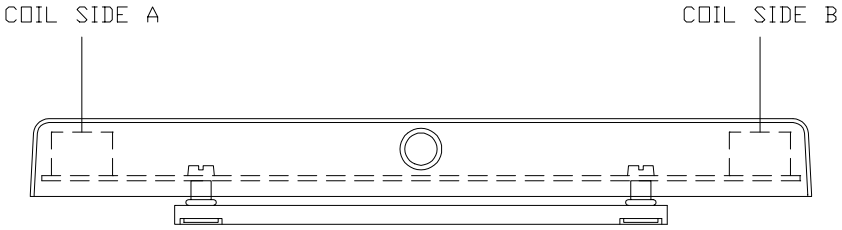


Fig. 5.7.3

It is very important that the coils on each antenna be mounted so they are facing the same direction.



SHIELD CABLES COLOUR TABLE								
GND	SHIELD-N		SHIELD-N		SHIELD-N		SHIELD-BB	SHIELD-M
COIL SIDE A	YELLOW	OR	YELLOW/GREEN	OR	YELLOW	OR	YELLOW	YELLOW
+12	RED		BLUE		RED		RED	WHITE
COIL SIDE B	GREEN		BROWN		WHITE		WHITE	GREEN

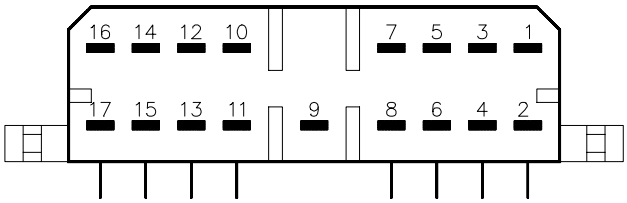
PREFERRED TYPE

Fig. 5.7.4

6 DESCRIPTION OF MOTHERBOARD CONNECTION

This section describes connectors D and E on the mother board

6.1 MOTHERBOARD CONNECTOR D DESCRIPTION



TAB. D CONNECTOR CODE	
1	CLS
2	MI
3	K2
4	MA
5	K3
6	DT–
7	CCLS
8	DT+
9	A1
10	AUTOLED
11	A2
12	CH
13	MANLED
14	+12V
15	AUTOSEL
16	BUZZER
17	GND

N.B. = THE CONNECTORS ARE SEEN THE SIDE THE CAPS STICK OUT

Fig. 6.1.1

6.1.1 AUDIBLE AND VISUAL SIGNALS (MANLED, AUTOLED, BUZZER, +12V)

MANLED (13): This connection provides a ground line to switch on the manual operation light. It is rated for 50 mA. If a LED is chosen, an external series resistor (1.5 kW) is required. If a lamp is chosen, an external supply voltage (up to +24 V DC) is required. This indicator is on during normal manual steering mode and flashing while any slow down or emergency stop action.

AUTOLED (10): This connection provides a ground line to switch on the automatic operation indicator light. It is just for a LED device (the series resistor is inside). This indicator is on during auto steering mode and flashing while any slow down or emergency stop action when guidance has been selected by the operator.

BUZZER (16) This connection provides a ground line to switch on the buzzer. It is rated for 50 mA. This connection also provides the output for encoding alarm conditions using the buzzer (see 11.2). The buzzer sounds during the following three operating states:

- Guidance acquisition mode in progress until the truck is aligned with the wire. This is a slow beeping.
- Aborted guidance acquisition due to lost wire capture lock. Alarm sounds for a maximum of 3 seconds.
- A new steering mode begins, such as switching from manual to automatic or back to manual. The alarm sounds a beep for 0.5 seconds.

+12 V (14) AUTOLED, MANLED, and BUZZER described above can be supplied by +12 VDC from this pin.

6.1.2 AUTOMATIC MODE REQUEST (AUTOSEL, GND).

AUTOSEL (15): This is the steering mode selection input. Depending on the set up used with the ZAPI hand held controller (see 12.6.10), this input (either active level or edge detection) is recognized by the controller when the event happens. Depending on how the truck is equipped, either guidance acquisition mode is entered or the automatic steering centering happens when this input is recognized. This input pin may be connected to:

- directly to external ground (GND)
- an internal ground reference on pin 17 of the same connector
- to an external open collector transistor
- to a push-pull interface stage with a maximum rail voltage of 24V DC

GND (17): Provides GND reference voltage.

6.1.3 TACHO-GENERATOR CONNECTIONS (DT+, DT-)

DT+ (8), DT- (6) Connect the tacho-generator for manual steering control between these two pins. Pin 6 is internally connected to battery negative (GND):

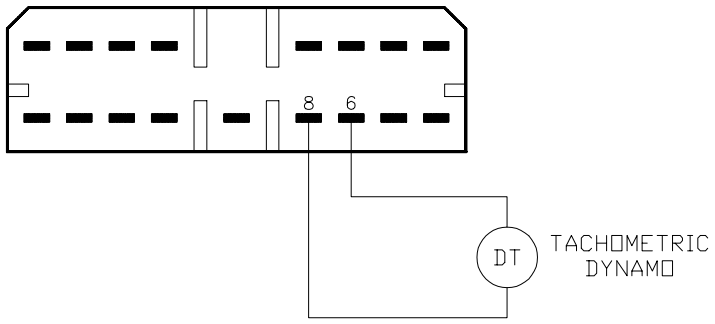


Fig. 6.1.3.1

6.1.4 CONNECTIONS TO THE DRIVE SYSTEM (MA, MI, A1, A2).

MA (4) A request to travel in the drive unit direction must provide a signal on this input, either at battery positive or battery negative. Either level may be selected during set up with the ZAPI hand held controller (see 12.6.1) and configuring Jumper J1 on the guidance card (see 5.1.1).

MI (2) A request to travel in the load wheel direction must provide a signal on this input, either at battery positive or battery negative. Either level may be selected during set up with the ZAPI hand held controller (see 12.6.2) and configuring Jumper J1 on the guidance card (see 5.1.1).

A1 (9): This should be connected to the higher of two connections to the traction motor brushes (armature).

A2 (11): This should be connected to the lower of two connections to the traction motor brushes (armature).

These are used to identify the actual direction of travel of the truck. They make it possible to determine which direction the truck is traveling when regenerative braking is being applied. The most common motor controller configuration is shown in the following drawing.

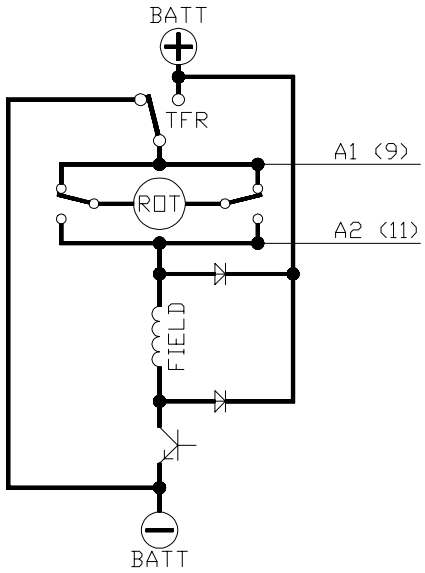


Fig. 6.1.4.1

6.1.5 INTERNAL RELAY CONNECTIONS FOR INTERFACE WITH THE OUTSIDE.

There are 4 external interface relays on the mother board (ACSZPA0B), two of which have contacts accessible on pin K3 (pin 5) and K2 (pin 3) of connector D.

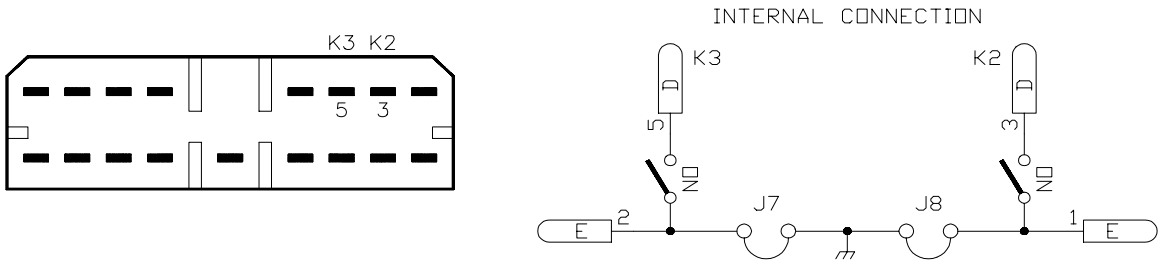


Fig. 6.1.5.1

Each contact can switch direct currents of 4 A DCR at the most.
Description of Internal Relay Control

K2 (3): Normally open contact is closed by switching on the key. When the key switch is on, these contacts open in case of steering or guidance alarm. If Jumper J8 on the mother board is closed, K2 is ground referenced. This means ground is provided out of pin 3 whenever the key switch is on and there is no alarm. If the key switch is turned off or there is an alarm the ground is switch off at pin 3. If Jumper J8 on the mother board is open, K2 is floating and may be referenced to any preferred potential at the second connection of this contact at pin 1 of connector E on the mother board.

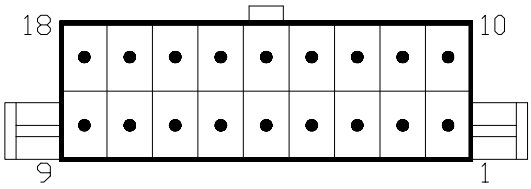
K3 (5): Normally open contact is closed by switching on the key. When either guidance acquisition or automatic centering ends, this contact opens. It remains open in case of alarm in automatic mode. This contact closes again when the steering is returned to manual mode. If Jumper J7 on the mother board is closed, K3 is ground referenced. If Jumper J7 is open, the contacts are floating and may be referenced to the preferred potential at the second connection of this contact at pin 2 of connector E on the mother board.

6.1.6 LIMIT MICROSWITCH CONNECTION (CLS, CCLS).

CLS (1): It is possible to stop steering in the direction that causes either positive signals from the tacho-generator or increasing steering handle pot. voltage by opening the connection between CLS (pin 1) and negative (GND = pin 17 of connector D on the mother board). Therefore, connection of a normally closed switch between pin 1 and pin 17 on connector D of the mother board acts as a clockwise steering limit switch.

CCLS (7): It is possible to stop steering in the direction that causes either negative signals from the tacho-generator or decreasing steering handle pot. voltage by opening the connection between CCLS (pin 7) and negative (GND = pin 17 of connector D on the mother board). Therefore, connection of a normally closed switch between pin 7 and pin 17 on connector D of the mother board acts as a counterclockwise steering limit switch.

6.2 MOTHERBOARD CONNECTOR AND DESCRIPTION



TAB. E CONNECTOR CODE	
1	NK2
2	NK3
3	GND
4	GND
5	+12
6	NRV
7	AUTOLAMP
8	CKOUT
9	+5
10	CPOC
11	NPOC
12	NPOC
13	CFC
14	INDIC
15	RV
16	NPOT
17	PPOT
18	CPOT

Fig. 6.2.1

Connector D is required for compatibility with earlier versions of tacho-generator EPS (Electric Power Steering) and wire guidance. Connector E on the mother board is an added connector used for steering handle pot. input, travel speed reduction switch and to support recently introduced manual steering options.

NK2 (1): This is the second (lower potential) alarm switch connection. The first connection is on pin 3 of connector D on the mother board. If jumper J8 on the motherboard is closed, the pin 1 is ground referenced and NK2 is at ground (GND) potential. If jumper J8 on the mother board is open, NK2 is floating. (It assumes an externally applied potential.) NK2 (Pin 1 of connector E on the mother board) must be connected to a lower potential than K2 (Pin 3 of connector D on the mother board).

NK3 (2): This is the second (lower potential) of the locking-straight-wheel-switch connection. The first connection is on pin 5 of connector D on the mother board. If jumper J7 on the motherboard is closed, pin 2 is ground referenced and NK3 is at ground (GND) potential. If jumper J7 on the mother board is open, NK3 is floating. (It assumes an externally applied potential.) NK3 (Pin 2 of connector E on the mother board) must be connected to a lower potential than K3 (Pin 5 of connector D on the mother board).

GND (3,4): Are internally connected to ground (battery minus) reference, these may be used for Steering Angle Direction LED gauge connections or other interface cards.

+12 VDC (5): Output for internally provided + 12 VDC stabilized supply. It may be used for Steering Angle Direction LED gauge connections or other interface cards. The maximum rated output is 40 mA.
WARNING: Do not short circuit this pin, because it is common with the Electric Power Steering card supply.

NRV (6): This is the one side of the second speed reduction switch connection. The first connection is pin 15 on connector E of the mother board. This pin is one side of a switch and is typically connected in series with other similar switches supplying the traction controller speed reduction input.

AUTOLAMP (7): Provides a switched ground reference for the AUTOLAMP that is cable of switching a maximum lamp rating of 50 mA, +24 VDC. This reference is switched on when the AUTOSEL switch is turned on. Connect the AUTOLAMP between this point and an external supply of + 24 VDC maximum.

CHOUT (8): Outputs key switch voltage. (The input of key switch voltage to the mother board is on Pin 12 of connector D.) It is possible to use this as an outside interface supply.

+5 VDC (9): Outputs regulated + 5 VDC supply. WARNING: Do not short circuit this pin or the power supply on the board will fail.

CPOC (10), PPOC (11), NPOC (12):

The steering handle command potentiometer is connected to these points. CPOC (Pin 10) is the wiper point. PPOC (Pin 11) is the positive end voltage (+5 VDC). NPOC (Pin 12) is the negative end voltage (0 VDC).

CFC (13): Not available - Diagnostic input for limit switch functionality.

INDIC (14): Outputs a scaled and converted 0 to 4 VDC steering angle feedback potentiometer position for the steering angle indicator gauge LEDs. 0 VDC corresponds to the steering angle feedback pot. voltage that was memorized using the ZAPI hand control for SET STEER MAX. 4 VDC corresponds to the steering angle feedback pot. voltage that was memorized using the ZAPI hand control for SET STEER MIN.
See 12.6.6 to reverse turning direction displayed.

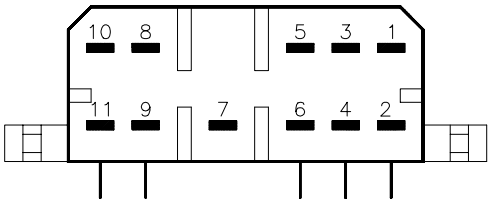
RV (15): First speed reduction switch connection. The second connection is Pin 6 of connector E on the mother board. This is one end of a dry contact that is normally connected in series with other switches in the traction controller input slow down circuit.

NPOT (16), PPOT (17), CPOT (18):
For applications without wire guidance, these are the connections for the steering feedback pot. CPOT(Pin 18) is the wiper point. PPOT(Pin 17) is the positive end voltage (+5 VDC). NPOT(Pin 16) is the negative end voltage (0 VDC).

7 DESCRIPTION OF WIRE GUIDANCE CARD CONNECTIONS

The wire guidance card 11 pin connector needs no description since it is only connected to the wire guidance antennas and input for automatic steering and is described earlier (see the electrical drawings fig. 5.3.1 and fig 5.5.1).

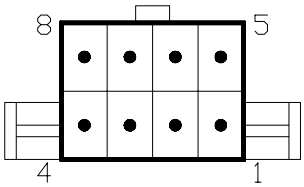
.



TAB.	CONNECTOR CODE
1	GND
2	+12V
3	RL
4	RR
5	PPOT
6	CPOT
7	NPOT
8	GND
9	+12V
10	FL
11	FR

Fig. 7.1

The 8 pin connector on the guidance board passes through some of the connector D signals .



TAB.	CONNECTOR CODE
1	MA
2	MI
3	AUTOSEL
4	A1
5	+12
6	GND
7	GND
8	A2

Fig. 7.2

7.1 EIGHT PIN GUIDANCE CARD CONNECTOR

This connector passes through signals to and from connector D on the mother board.

MA (1) A request to travel in the drive unit direction must provide a signal on this input, either at battery positive or battery negative. Either level may be selected during set up with the ZAPI hand held controller and configuring Jumper J1 on the guidance card.

MI (2) A request to travel in the load wheel direction must provide a signal on this input, either at battery positive or battery negative. Either level may be selected during set up with the ZAPI hand held controller and configuring Jumper J1 on the guidance card.

AUTOSEL (3): This is the steering mode selection input. Depending on the set up used with the ZAPI hand held controller (see 12.6.10), this input (either active level or edge detection) is recognized by the controller when the event happens. Depending on how the truck is equipped, either guidance acquisition mode is entered or the automatic steering centering happens when this input is recognized. This input pin may be connected to:

- directly to external ground (GND)
- an internal ground reference on pins 5, 6, and 7 of the same connector
- to an external open collector transistor
- to a push-pull interface stage with a maximum rail voltage of 24 volt DC

A1 (4): This should be connected to the higher of two connections to the traction motor brushes (armature).

GND (5, 6, 7): Provides GND reference voltage to battery negative.

A2 (8): This should be connected to the lower of two connections to the traction motor brushes (armature).

These are used to identify the actual direction of travel of the truck. They make it possible to determine which direction the truck is traveling when regenerative braking is being applied.

8 SETTING MOTHERBOARD ACSZPA0B

The mother board has 4 trimmer potentiometers. Two of the trimmer pots (TM1 and TM2) are internal settings to be made in the testing stage. The other settings should be made with reference to the particular equipment options on the truck being adjusted. Use the following instructions

MOTHER BOARD POTENTIOMETERS AND ZAPI HAND SET

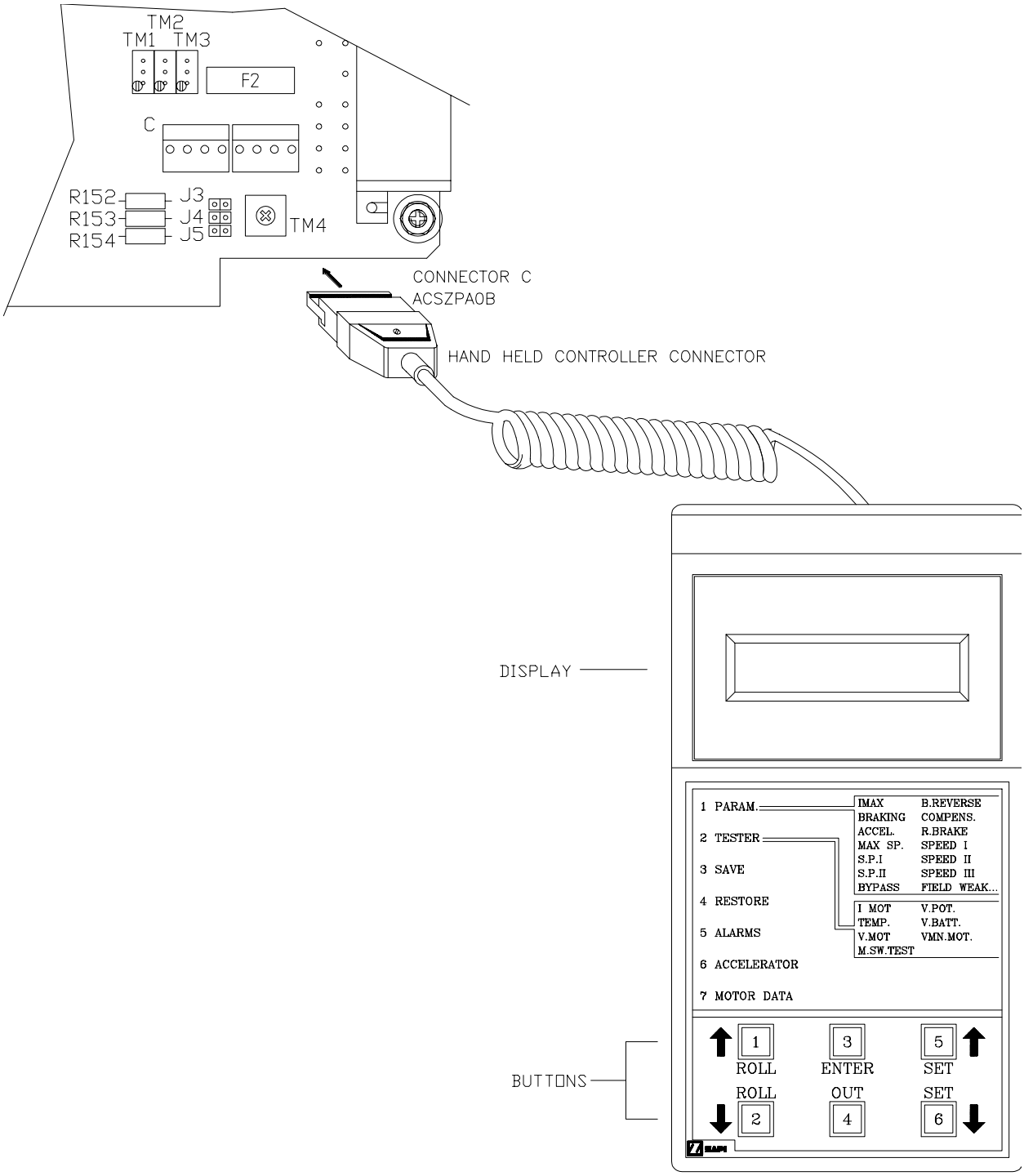


Fig. 8.1

8.1 SETTING THE MAXIMUM CURRENT (IMAX.)

TM3 Adjust clockwise to increase maximum current to the steering motor. Adjust counterclockwise to reduce maximum current to the steering motor. Set maximum steering motor current to 34 A for the 24/48V version of the mother board and 21 amps for the universal version of the mother board. Settings higher than the limit can damage the steering card. Measure the steer motor current by producing a locked rotor condition in the steer motor and connect an ammeter in series with the steer motor.

8.2 SETTING TACHOMETRIC FEEDBACK

TM4 This adjustment is only required in cases of very high steer motor resistance (producing more than a 25% drop in battery voltage at maximum current setting with a locked steer motor). This adjustment is not required unless this condition exists.
This adjustment is used to partially compensate the voltage drop on the motor resistance in order to associate the control signal with the speed (instead of with the voltage) of the motor. This option has been created mainly to improve the dynamics of the system in the event of automatic steering. Therefore, if:

1) The control unit only operates on manual electric steering.

OR:

2) The voltage drop on the motor resistor at the maximum current (Rmot x IMax) is less than 25% VBatt.

   The difficulty of setting TM4, along with the poor benefits produced, advise ignoring this setting by opening J3, J4 and J5.
   In the other cases, TM4 should be set so as to insert a bipolar connection, of the type shown below, in the circuit.

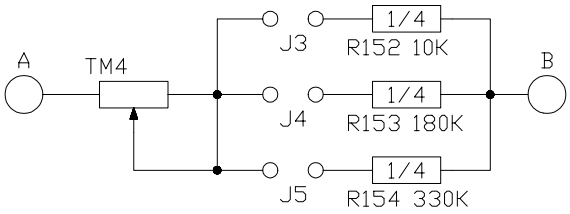


Fig. 8.2.1

This must have a resistance between A and B expressed by the following equation:

$$R_{AB} = \frac{880}{R_{MOT} \cdot I_{MAX}} [k\Omega]$$

Where: Rmot = resistance of the steering servo-motor (W)

Imax = maximum steering current (A)

After determining the desired R_{AB} it is necessary to make the jumper between J3, J4 and J5 which, correcting TM4, allows obtaining the desired R_{AB}.

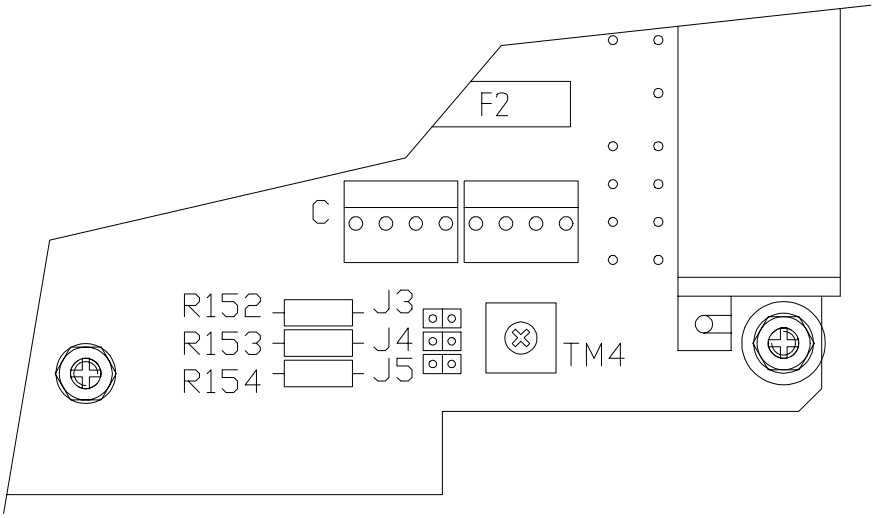


Fig. 8.2.2

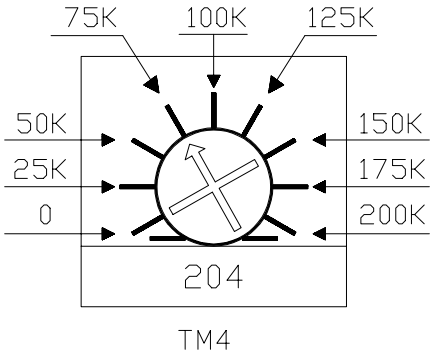


Fig. 8.2.3

For example: in the above drawing, a resistor TM4=75kW is inserted.
The IMax the servo-amplifier is set to, is specified on the hand set.
It is possible to make a practical setting of TM4 by locking the steer motor on maximum current and adjusting TM4 to have 0V on pin 8 of the integrated circuit U19. Should any doubts remain on the correctness of the TM4 setting, leave all 3 jumpers J3, J4, J5 open.

8.3 SETTING THE MANUAL STEERING

Only the ZAPI hand set is required to adjust the manual steering settings.

8.3.1 POT. STEERING:

The following procedure should be used only after the "One Shot Installation Procedure" in Section 5.7 is completed. Complete the procedures in the following sequence.

1) Specify SYSTEM CONFIG as pot. steering (see 12.6.8).
2) Release the steering handle and let it come to its rest position. Without moving it, use the hand set to memorize the steering handle voltage using ZERO SP POT (see 12.7.4).
3) Use the hand set SET STEER 0-POS (see 12.7.1) to adjust the steering angle feedback pot. for straight steering in manual mode. The setting may be adjusted up and down in 5 mV increments from the 2.5 V default voltage. Test the results by driving the truck forward and reverse with hands off the steering handle. Watch for straight travel.
4) Turn the steering handle 90 degrees fully clockwise. Adjust 1ST SPEED COARSE and 1ST SPEED FINE on the hand set until the desired drive unit steering angle is achieved (see 12.3.11 and 12.3.12).
5) Turn the steering handle 90 degrees fully counterclockwise. Adjust 2ND SPEED COARSE and 2ND SPEED FINE on the hand set until the desired drive unit steering angle is achieved (see 12.3.13 and 12.3.14).
6) Adjust the steering angle centering precision using "KP" on the hand set (see 12.3.3). Higher values of KP increase the precision, but make the steering "busy". Adjust KD (see 12.3.4) to provide good precision with minimum oscillation and overshoot.
7) Use SET STEER MIN on the hand set to memorize the steering angle feedback pot voltage corresponding to the maximum counterclockwise rotation of the handwheel (see 12.7.2).
8) Use SET STEER MAX on the hand set to memorize the steering angle feedback pot voltage corresponding to the maximum clockwise rotation of the handwheel (see 12.7.3).
9) Use ACCELERATION on the hand set to adjust manual steering response. Level 0 = 9 seconds for 180 degrees of steering. Level 9 = 3 seconds for 180 degrees of steering (see 12.3.15).
10) Use DESENSIBILIZAT on the hand set to adjust for slower steering response close to a steady state position. This is useful for slowing the steering response when an operator wishes to make small corrections in manual steering (see 12.3.16).

8.3.2 TACH-GENERATOR CONTROLLED STEERING REGULATION

Four adjustment steps are recommended.

1) Use the hand set to specify the steering is Tacho-Generator type using the SYS-TEM CONFIG setting (see 12.6.8).
2) Adjust SET BATTERY TYPE to the battery voltage in the truck using the hand set (see 12.7.6).
3) Regulate the SPEED LIMIT for steering on the hand set. Higher values cause the steered wheel to turn faster (see 12.3.1).
4) Adjust the slow steering response using the SENSIBILITY setting on the hand set. An higher value causes faster response (see 12.3.2).

Notes:

- Low settings of the SPEED LIMIT result in almost no steering response when turning the steering wheel at low speeds. To avoid this problem increase the SENSIBILITY setting.

8.3.3 STEERING ANGLE INDICATOR GAUGE

If your truck equipped with tach-generator steering also has a steering angle indicator gauge with LED's then you will also need to perform steps 3, 7, and 8 described in Pot. Steering for the gauge to respond correctly.

8.3.4 AUTOMATIC CENTERING

If automatic centering is requested, then you will also need to perform steps 3, 6, 7, 8, 9, and 10 described in Pot. Steering for the steered wheel to be properly centered.

9 WIRE GUIDANCE CARD ACSZPB0B

This card processes the signals supplied by the wire guidance antennas and steering angle feedback pot. that are used to generate steering error in the automatic (wire guided) steering mode. This steering error is then used by the mother board to make steering corrections.
On the wire guidance card there are 2 diodes (DL1 and DL2) for warnings:

DL1, DL2 DL1 is on when the drive unit antenna is close to a guide wire in the floor. DL2 is on when the load wheel antenna is close to a guide wire in the floor.

In addition, there are 14 setting to be made in the suggested order for automatic (wire guided) mode.

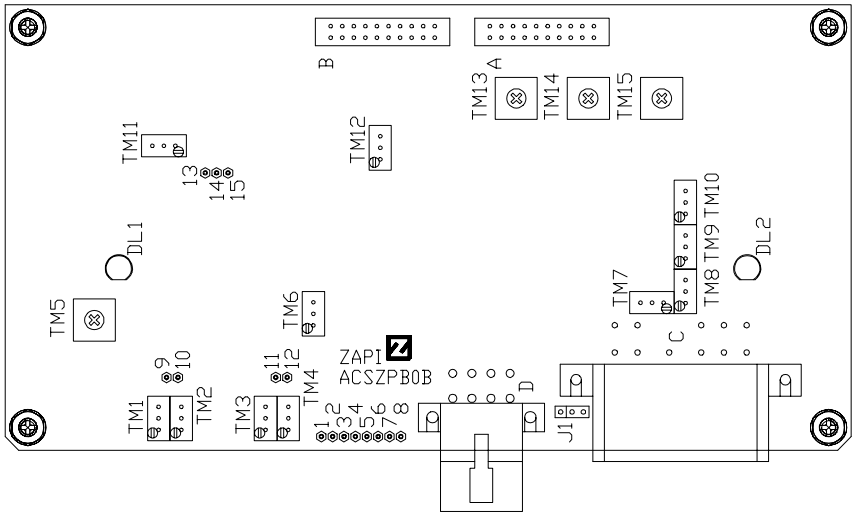


Fig. 9.1

9.1 SETTING PLUGGING

TM12 This setting adjusts the guidance card to distinguish between when the truck is travelling or stopped. Measure the DC voltage at test point 2 (TP2) and gradually accelerate the machine. The voltage at TP2 must be +5 VDC as long as the truck is stopped. This must switch to 0 VDC with the contactor closed, but before the truck begins to move.
Turning TM12 clockwise causes the transition at TP2 from +5 VDC to 0 VDC to take place with higher accelerator demand.

9.2 ANTENNA SETTINGS ON STEERING WHEEL (FWD)

TM1, TM2 Position the truck so the drive unit antenna (FWD) is centered over the guide wire. Adjust the signals from the right and left coils in the antenna so they are equal. Set the output gain from the antenna coils to 180 mV RMS using a multimeter that can measure AC voltages up to 10 kHz (refer to your owner's manual.) Trimmer Pot. 1 (TM1) adjusts the AC voltage at Test Point 9 (TP9). Trimmer Pot. 2 (TM2) adjusts the AC voltage at Test Point 10 (TP10). Turning the pots. clockwise reduces the signal.

9.3 POTENTIOMETER OFFSET SETTING

TM10 The steering angle feedback pot. must be installed so that with the drive unit straight ahead the voltage on Test Point 6 (TP6) (coincidental with the pot. wiper) measures as close to 0 VAC as possible.
If during mechanical tightening of the steering angle feedback pot. shaft, the signal level from the pot shifts it is possible using this adjustment to bring the required value back to the minimum using Trimmer Pot 10 (TM10). In making this adjustment: Travel 10 meters in drive wheel direction on wire guidance. If TM10 is not correctly adjusted the truck will travel parallel to the guide wire some distance but always with a straight wheel. Use the ZAPI hand set on SPECIAL POT ADJ setting (see 12.6.7). This causes an immediate steering alarm and disables the control unit so you may regulate TM10 to give the minimum voltage possible on Test Point 6 (TP6) corresponding to a straight drive wheel position.

9.4 SETTING THE STEERING ERROR OFFSET

TM9 To refine this setting, align the truck in the automatic (guidance) mode with the wire and stop all travel demand. After 30 seconds the guidance system will go into TIME OUT status when it stops steering until there is again a travel demand. Using a voltmeter attached to Test Point 4 (TP4) adjust TM9 until 0VDC is measured.

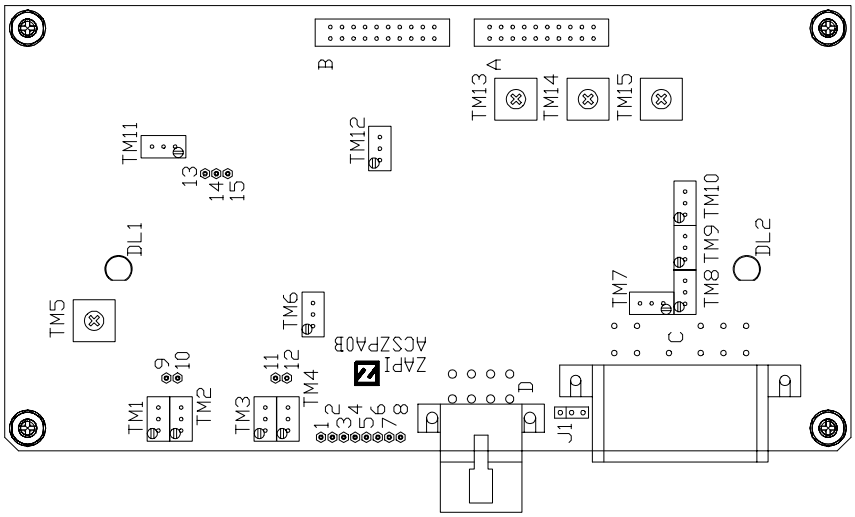


Fig. 9.4

9.5 SETTING POTENTIOMETRIC FEEDBACK

TM13 Adjusting TM13 counterclockwise causes the truck to make larger steering corrections in response to a given antenna error. This setting also affects the steering performance during guidance acquisition mode. Turning TM13 counterclockwise results in shorter faster guidance acquisition.
Turning TM13 clockwise causes the truck to make smaller steering corrections in response to a given antenna error. It also results in shorter and faster guidance acquisition. However, this setting can be used to soften the wire guidance when tracking a guide wire that is not very straight.

WARNING: Turning TM13 too far clockwise will result in the truck "wandering" on wire guidance and failing to track the wire.

9.6 GAIN LOOP ADJUSTMENT.

TM15 Optimum performance of wire guidance is achieved by coordinating the adjustment of trimmers TM13 and TM15 as needed.
Turning TM15 clockwise increases the sensibility of automatic steering response to an antenna error in wire guided mode. This will cause the truck to track the guide wire more closely, but will also cause the steering to be more likely to oscillate (dither).

9.7 SETTING LOAD WHEEL (REV) ANTENNA

TM3, TM4 Travel drive wheel first on guidance for 10m and slow to a stop. Measure TP11 and adjust TM3 for 180 mV RMS. Measure TP12 and adjust TM4 for 180 mV RMS. Turning the trimmer pots clockwise decreases the signal.

NOTE: A multimeter that can accurately measure AC voltages up to 10 kHz is required. (Check your multimeter owner's manual.)

9.8 WEIGHTED SETTING OF ANTENNAS WHEN TRAVELING LOAD WHEEL DIRECTION

TM14 When the truck is traveling in the load wheel direction the steering error is produced by combining the errors of the load wheel (REV) and drive wheel (FWD) antennas. Turning TM14 counterclockwise gives more weight to the antenna on the drive unit (FWD) end. This further limits the side to side movement of the truck at the drive unit end when guiding and travelling load wheels first.
On a short wheel base truck is possible to reduce the correction level while traveling in the load wheel direction by using the ZAPI hand set. Set the LONG VEHICLE option to OFF using the hand set (see 12.6.3).

If the truck guides parallel to, but not centered on, the guide wire when travelling in the load wheel direction:

- Ensure you have already set TM3, TM4, and TM14
- Check that the load wheel antenna is perfectly aligned with the drive wheel antenna

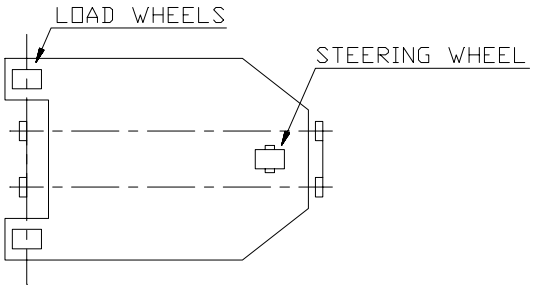


Fig. 9.8.1

If the problem continues, travel on the guide wire in the load wheel direction and stop the truck at a point where the misalignment is very evident. At this point check TP11, which Trimmer 3 (TM3) corresponds to and TP12, which Trimmer 4 (TM4) corresponds to. Adjust whichever point is higher, through trial and observation until the lateral shift is zero when traveling in the load wheel direction on guidance.

9.9 SETTING ACQUISITION ANGLE

TM5 Turning TM5 counterclockwise increases the steering correction during the drive wheel first direction of wire acquisition. NOTE: Increased angles of approach to the guide wire during acquisition mode require longer for the truck to be aligned with the wire for operation in minimum clearance very narrow aisles.

9.10 GUIDANCE ALARM TOLERANCE ADJUSTMENT

TM8 This trimmer adjusts the limit a guidance antenna may be off the wire without setting off an alarm.
The trimmer adjustment is supported by the ZAPI hand set as described below. Move the truck in manual steering mode in the load wheel direction of travel parallel to the guide wire so the center line of the truck is about 70 mm (2.75 in.) from the wire. Using the ZAPI hand set, read the ANTENNA ERROR (see 12.4.3) value and adjust TM8 to obtain an antenna error value of 4.5 VDC (or 0.5 VDC if the truck is on the opposite side of the wire.) Note: if the truck is centered over the wire, then the ANTENNA ERROR will be 2.5 VDC.
NOTE: <u>The ANTENNA ERROR read using the ZAPI hand set will correspond to the antenna on the end of the truck that was leading the last direction traveled/selected.</u>

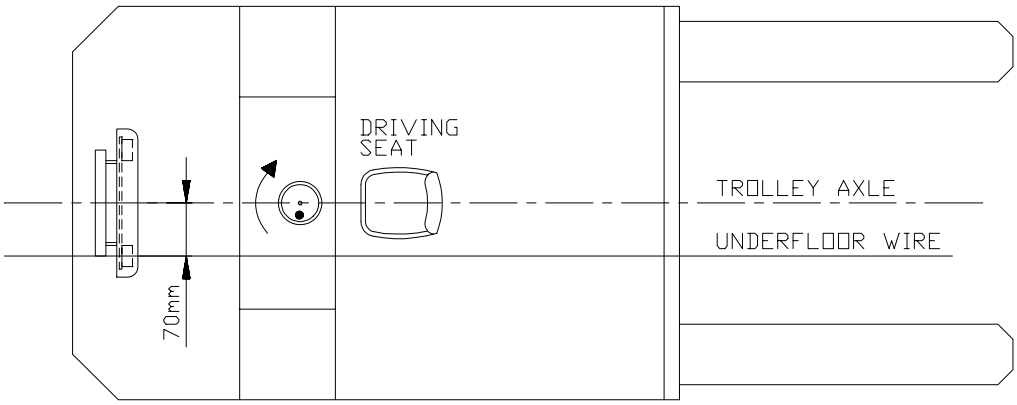


Fig. 9.9.1

To modify the alarm tolerance four parameters are provided (see 12.3.5 ÷ 12.3.8

1) FWD UPP ERR ANT = Adjusts the sideways alarm threshold relative to a lateral shift of the drive wheel (FWD) antenna that increases over 2.5 VDC the ANTENNA ERROR measurement. (UPPer is for higher than 2.5 VDC. We do not use right and left references in this section. They are too easily confused.)
   FWD UPP ERR ANT level = 0 gets alarm for 3.5 VDC on ANTENNA ERROR point. This is a very sensitive alarm threshold.
   FWD UPP ERR ANT level = 8 gets alarm for 4.5 VDC on ANTENNA ERROR point. This is a very insensitive alarm threshold.
   FWD UPP ERR ANT level = 9 disables the alarm for this pickup coil side.
2) FWD LOW ERR ANT = Adjust the sideways alarm threshold relative to a lateral shift of the drive wheel (FWD) antenna for an ANTENNA ERROR measurement that is below 2.5 VDC.
   FWD LOW ERR ANT LEVEL = 0 gives an alarm for 1.5 VDC on ANTENNA ERROR point. This is a very sensitive alarm threshold.
   FWD LOW ERR ANT LEVEL = 8 gives an alarm for 0.5 VDC on ANTENNA ERROR point. This is a very insensitive alarm threshold.
   FWD LOW ERR ANT LEVEL = 9 disables the alarm for this pickup coil side.
3) REV UPP ERR ANT = Adjusts the sideways alarm threshold relative to a lateral shift of the load wheel (REV) antenna for an ANTENNA ERROR measurement that is above 2.5 VDC.
   REV UPP ERR ANT level = 0 gets alarm for 3.5 VDC on ANTENNA ERROR point. This is a very sensitive alarm threshold.
   REV UPP ERR ANT level = 8 gets alarm for 4.5 VDC on ANTENNA ERROR point. This is a very insensitive alarm threshold.
   REV UPP ERR ANT level = 9 disables the alarm for this pickup coil side.
4) REV LOW ERR ANT = Adjusts the sideways alarm threshold relative to a lateral shift of the load wheel (REV) antenna for an ANTENNA ERROR measurement that is below 2.5 VDC.
   REV LOW ERR ANT level = 0 gets alarm for 1.5 VDC on ANTENNA ERROR point. This is a very sensitive alarm threshold.
   REV LOW ERR ANT level = 8 gets alarm for 0.5 VDC on ANTENNA ERROR point. This is a very insensitive alarm threshold.
   REV LOW ERR ANT level = 9 disables the alarm for this pickup coil side.

9.11 MAXIMUM WIRE GUIDANCE STEERING ANGLE ADJUSTMENT (POT. OUT OF RANGE ALARM)

TM7 This trimmer is used to adjust the maximum steering angle correction which can occur during wire guided steering without setting off an alarm. Adjust is supported by the ZAPI hand set controller.
Drive the truck in the manual mode close to the guide wire. Rotate the steering handle until the drive unit has reached the maximum absolute angle allowed in wire guidance mode. Set SPECIAL POT ADJ to "ON" using the ZAPI hand set. Immediately an alarm (ADJ. ZERO POT) occurs and the steering wheel position is frozen. Using the FEEDBACK POT measurement (12.4.2), read the AC/DC converted pot. (see 12.6.7) value and adjust TM7 to obtain a feedback pot value of 4.5 VDC (or 0.5 VDC if the chosen direction of steering is below 2.5 VDC.)
Note: FEEDBACK POT value is 2.5 VDC for steering straight ahead with a correctly adjusted TM10. The value of FEEDBACK POT will either increase, in a not leading MDU truck, or decrease, in a leading MDU truck, for counterclockwise drive unit steering rotation. FEEDBACK POT measures steering angle feedback pot. voltage in automatic (wire guidance) mode and manual mode. Since these measurements are very different, do not confuse the manual mode reading with the automatic mode reading. There is a special exception. When "SPECIAL POT ADJ" is set (see 12.6.7) to "ON", FEEDBACK POT measures the automatic mode reading even with the steering in manual mode. Since only one trimmer is provided for the two directions of drive unit steering, the ZAPI hand set is used to separate them (see 12.3.9 ÷ 12.3.10).

1) UPPER ERROR POT = Adjusts the POT OUT OF RANGE alarm threshold relative to steering angle rotations resulting in values over 2.5 VDC measured with FEEDBACK POT on the ZAPI hand set.
   UPPER ERROR POT = 0 results in an alarm level of 3.5 VDC on the FEEDBACK POT point. This is a very sensitive setting.
   UPPER ERROR POT = 8 results in an alarm level of 4.5 VDC on the FEEDBACK POT point. This is a very insensitive setting.
   UPPER ERROR POT = 9 disables the POT OUT OF RANGE alarm.
2) LOWER ERROR POT = Adjusts the POT OUT OF RANGE alarm threshold relative to steering angle rotations resulting in values less than 2.5 VDC measured with FEEDBACK POT on the ZAPI hand set.
   LOWER ERROR POT = 0 results in an alarm level of 1.5 VDC on the FEEDBACK POT point. This is a very sensitive setting.
   LOWER ERROR POT = 8 results in an alarm level of 0.5 VDC on the FEEDBACK POT point. This is a very insensitive setting.
   LOWER ERROR POT = 9 disables the POT OUT OF RANGE alarm.

Finally, it is possible to make small corrections to the feedback potentiometer's zero position used for "POT OUT OF RANGE" alarm using the ZERO AUTO FB adjustment (see 12.7.5).

10 TIP ON SETTING UP

If the "ONE SHOT INSTALLATION PROCEDURE" has been performed correctly, following information is not necessary. If problems have been found, then the information below provides some ideas on solving them.
Position the truck over the guide wire using manual mode steering.
With the truck positioned over the guide wire, turn on the wire guidance using the AUTOSEL switch on the operator console. Select the desired direction of travel and move the truck a few cm in that direction. At this stage the system will go into automatic steering. If all goes well the steering wheel will set itself in a direction leading the truck to capture the guide wire. It is simple to check this with the truck stationary and the drive unit antenna to the side of the wire. If the truck was last travelling in the drive unit direction the drive unit should be angled to intercept the guide wire. See the drawing below:

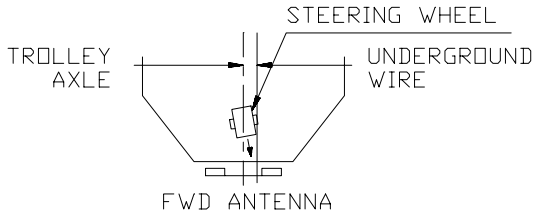


Fig. 10.1

If this is not observed, then there are one of two possible sources of the problem.

10.1 REVERSE POTENTIOMETRIC FEEDBACK

If the drive unit swerves toward either of the two steering limits with the truck over the guide wire and the antenna moved to the side of the wire, then swap over NPOT (7) and PPOT (5) on the big Connector on the wire guidance board (see 7).

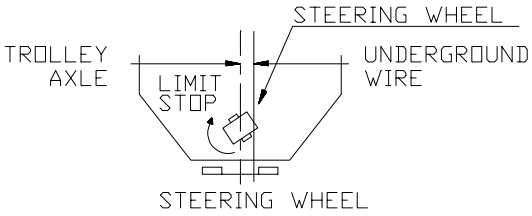


Fig. 10.1.1

10.2 REVERSE ANTENNA FEEDBACK:

If the steering wheel corrects in a proportional manner, but away from the wire when the truck is parked over, but not on the guide wire, then swap the connection FL (10) and FR (11) for the drive wheel (FWD) antenna and the connections RL (3) and RR (4) for the load wheel (REV) antenna on the big connector on the wire guidance board (see 7).

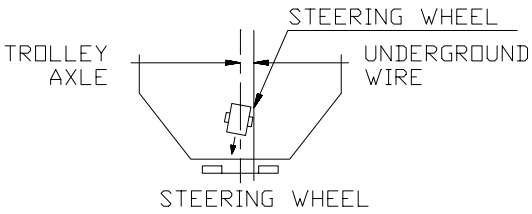


Fig. 10.2.1

11 ALARMS AND TROUBLE SHOOTING

11.1 DESCRIPTION OF FUSES

The system has two fuses.

- A 32 A fuse (F1) in series with the battery positive protecting the power portion of the steering and guidance boards.

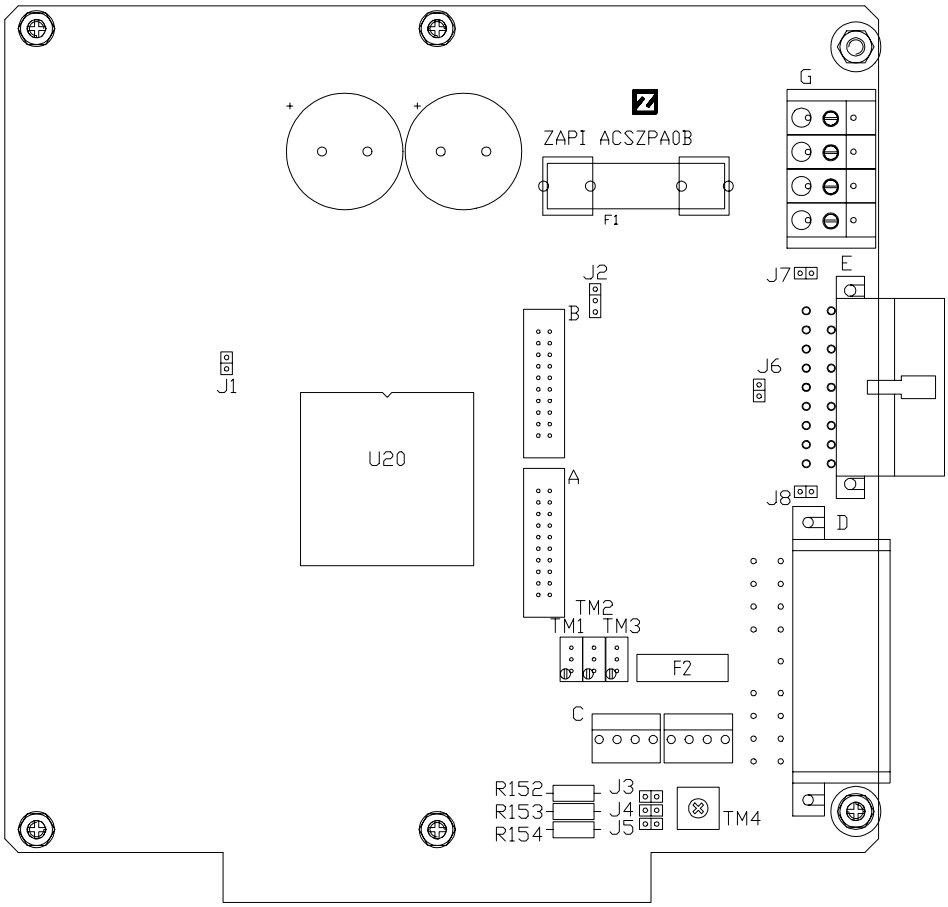


Fig. 11.1.1

- A 3 A fuse (F2) in series with the key and placed on the motherboard to protect the logic.

If the key is switched on and the steering system shows no response, check the 3 A logic fuse. If the fuse on the power portion of the unit is blown, an alarm "I=0 EVER" is produced.

11.2 DESCRIPTION OF ALARMS

If the Fuse (F2) is intact, the system signals through a combination of lights (AUTOLED and MANLED) and audible devices (BUZZER) any failures:
Each alarm or failure is encoded on the BUZZER with a number of high frequency beeps, repeated in bursts, corresponding with the alarm numbers in the list below. Low frequency beeps are reserved for wire acquisition mode only. To discriminate between manual mode and automatic mode alarms, the lights (AUTOLED and MANLED) are frozen when an alarm occurs and give information on the mode of operation the truck was in when the error occurred. The same information is repeated in a more direct fashion on the ZAPI hand set. Below is a list of the alarms with the numbers that correspond to the beep code.

11.2.1 MANUAL MODE ALARMS.

ALARM 1 MICRO SLAVE KO
Signal is repeated single beep burst of the BUZZER and lighted MANLED.

Cause: Occurs when the supervisor microcontroller has found one of the following incorrect events. The number of each possible cause is displayed on the right hand side of the ZAPI hand set.

1) Two series connected alarm switches are used for safety reasons. Each microcontroller controls one of them and diagnoses the other's switch. If the master microcontroller finds the supervisor controlled switch open during steady state operations, this alarm occurs.
If the supervisor microcontroller finds one of the two switches disagrees with the commands, during initial phase, this alarm occur.

2) The supervisor microcontroller has missed receiving an update (every 16 ms) from the master processor. The master processor is reading commands (tach-generator, pots., limit switches, etc.) and informs the supervisor with a regular signal. If this interrupt is missed, the supervisor behaves as through the command inputs are not being processed and stop the truck opening its own alarm switch.

3) The supervisor microcontroller has missed the fixed time (48 ms) watchdog timer pulse on the power portion functionality test. Every 48 ms the master processor sends and update pulse to the supervisor microcontroller. If a pulse is missed it looks like the power portion diagnosis was not executed so the supervisor stops the truck.

4) The supervisor microcontroller has determined a command action that disagrees with generated by the master controller.

5) The supervisor microcontroller has determined a measured steering angle feedback pot. evolution disagrees with the command pot. voltage.

Remedy: Switch off the machine and power it up again. If the problem persists, replace the unit.

ALARM 2 I=0 EVER
Indicated by repeated two beep burst on the BUZZER and a lighted MAN-LED.

Cause: Occurs if there is a power failure on the power portion of the steering controller and in any case where steer motor current cannot increase above zero and with the appropriate sign (+ or -) when commanded.

Remedy: Check that fuse F1 (32 A) on the logic board is intact.
Check that the steer motor and its wires have not been cut off.
Check that the motor is mechanically loaded. With the motor running freely it should require a running current greater than 6% of IMax.
If the problem persists, replace the unit.

ALARM 3 STEER SENSOR KO or FB POT LOCKED
Indicated by repeated three beep burst on the BUZZER and a lighted MAN-LED.

Cause: STEER SENSOR KO occurs if DT (Tach-Generator) is interrupted or short circuited (if the SYSTEM CONFIG option is Tach-Generator selection) or if one of the pins or wires leading to the steering angle feedback pot or the steering handle pot. is disconnected.
FB POT LOCKED occurs when the feedback value does not change its value even though commanded to change.

Remedy: If the problem is not due to the wiring, replace the tach-generator, or suspect potentiometer.
In regard to pot steering, the alarm occurs only if the voltage across the central point and the end of the pot. is greater than 4.9 V or is less than 0.1V. For the FB POT LOCKED alarm confirm the mechanical connection between the pot. and steer motor and the electrical functionality of the pot.

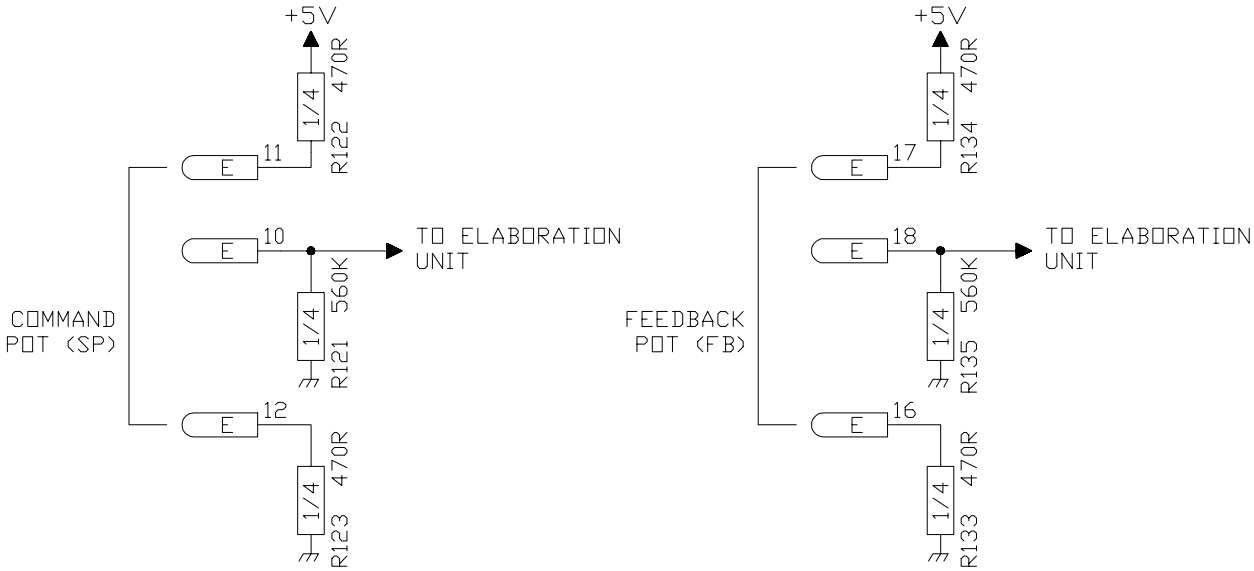


Fig. 11.2.1.1

ALARM 4 EEPROM KO
Indicated by repeated four beep burst on the BUZZER and a lighted MAN-LED.

Cause: Occurs due to a hardware or software defect of the non-volatile on-board parameters memory.

Remedy: Switch off the machine and turn it on again. If the problem persists, replace the unit.

ALARM 5 HIGH TEMPERATURE
Indicated by repeated 5 beep burst on the BUZZER and a lighted MANLED.

Cause: Occurs if temperature of the power base exceeds 78°C (172°F).

Remedy: Let the unit cool down. If the alarm occurs systematically, it is necessary to improve the unit's heat dissipation capability.

ALARM 6 STBY I HIGH
Indicated by repeated 6 beep burst on the BUZZER and a lighted MANLED.

Cause: Occurs when,at rest, there should be no current for a disabled power unit and the sensor shows an unforeseen output voltage level.

Remedy: Try to adjust the sensor offset with TM2 on the mother board. Measure the voltage at pin 1 of U19 (integrated circuit). Voltage must be adjusted to 0 V. If alarm persists, replace the unit.

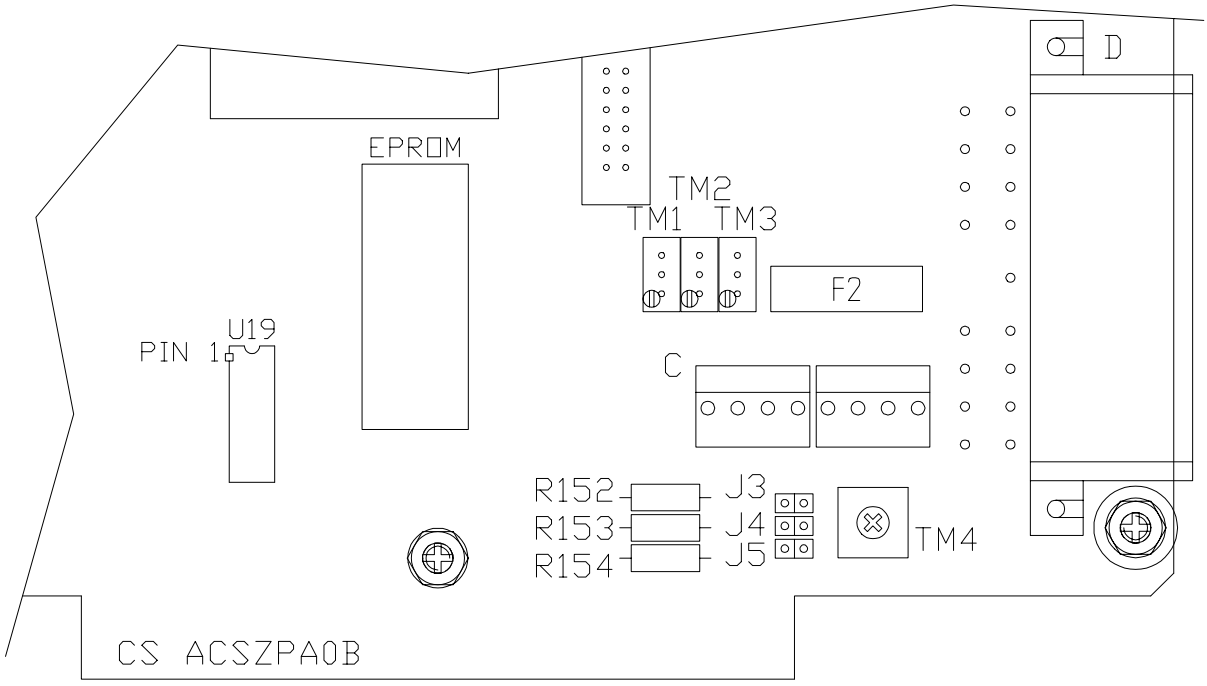


Fig. 11.2.1.2

ALARM 7 RELAY KO
Indicated by repeated 7 beep burst on the BUZZER and a lighted MANLED.

Cause: Two alarm switches are connected in series enabling traction controller to operate. The first switch is closed by the master microcontroller. The second switch is closed by the supervisor microcontroller. Both microcontrollers execute diagnostic tests on their own and the others opened or closed state switches. If the master microcontroller finds its own switch closed before commanding it closed or finds its own switch open before commanding it open, then this alarm occurs.

If this error occurs immediately after switching on the key, then it appears the contact that is shorted (welded) without a driving signal. If the error occurs later, then it appears the contact that is in a locked open position with a driving signal present.

Remedy: Confirm the previous theory about shorted or open contacts. If no faults can be identified, read the explanation below of the open switch diagnostic test to help you understand the alarm reasons.
As the picture below shows, there are three diagnostic points; low voltage, mid point, and high voltage end that are read by software. When the switches are open, the three diagnostic points have different potential values thank to the polarization resistances. If the outside interface connected on Pin 3 of connector D or Pin 1 of connector E on the mother board gets one end equal to the midpoint it looks like the switch is closed before it driven and an unwanted alarm occurs.

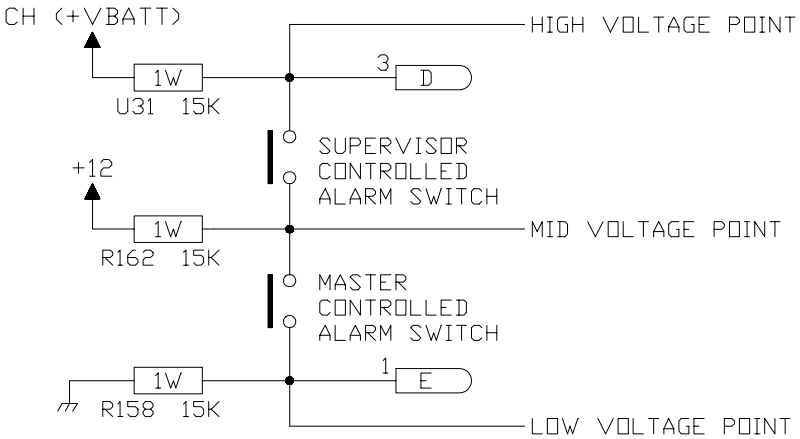


Fig. 11.2.1.3

11.2.2 WIRE GUIDANCE MODE ALARMS.

To escape the steering from any of the following alarms it is necessary to switch off the key.

ALARM 1 MICRO SLAVE KO
Indicated by a repeated single beep burst of the BUZZER and both AUTO-LED and MANLED are lit.

Cause and Remedy: See 11.2.1 ALARM 1 in manual mode.

ALARM 2 LATERAL OUT
Indicated by repeated two beep burst of the BUZZER and both AUTOLED and MANLED are lit.

Cause: It occurs in the case of a higher than set threshold lateral shift during wire guided mode of operation (see 12.3.5 ÷ 12.3.8).

Remedy: Confirm that during motion the antenna error signal does not exceed the threshold. Warning: A disconnected antenna coil wire or a swiftly changing magnetic field deformation around the guide wire (crooked wire, reinforcing rod, AC motor wires in the floor) can cause an alarm condition.

ALARM 3 PATH
Indicated by repeated 3 beep burst on the BUZZER and both AUTOLED and MANLED are lit.

Cause: Occurs if the antenna signal used for guidance in the travelling direction goes below the required threshold. The alarm occurs at the same time that the track present LEDs DL1 for drive wheel sensor and DL2 for load wheel sensors are off.

Remedy: This alarm may occur if the guide wire in the floor is cut, if the signal picked up by the antenna is too low, or if the antenna(s) is not properly adjusted concerning the gain.

ALARM 4 EEPROM KO
Indicated by repeated 4 beep burst on the BUZZER and both AUTOLED and MANLED are lit.

Cause and Remedy: See 11.2.1 ALARM 4 in manual mode.

ALARM 5 HIGH TEMPERATURE
Indicated by repeated 5 beep burst on the BUZZER and both AUTOLED and MANLED are lit.

Cause and Remedy: See 11.2.1 ALARM 5 in manual mode.

ALARM 6 LOOP
Indicated by repeated 6 beep burst on the BUZZER and both AUTOLED and MANLED are lit.

Cause: Occurs when in wire guided mode, the steering angle feedback pot. error will not neutralize the antenna error (regardless of travel direction). This makes it appear as though the closed loop control on steering angle feedback pot. has been opened.

Remedy: Try to reduce the truck oscillation on the guide wire by adjusting TM15 (clockwise increases steering speed response) and TM13 (counterclockwise makes the truck to make larger steering corrections) on the wire guidance card.
The alarm occurs while the truck is travelling in the guided mode of steering and the voltage on pin 7 of IC U6 of the wire guidance card exceeds +5 VDC.

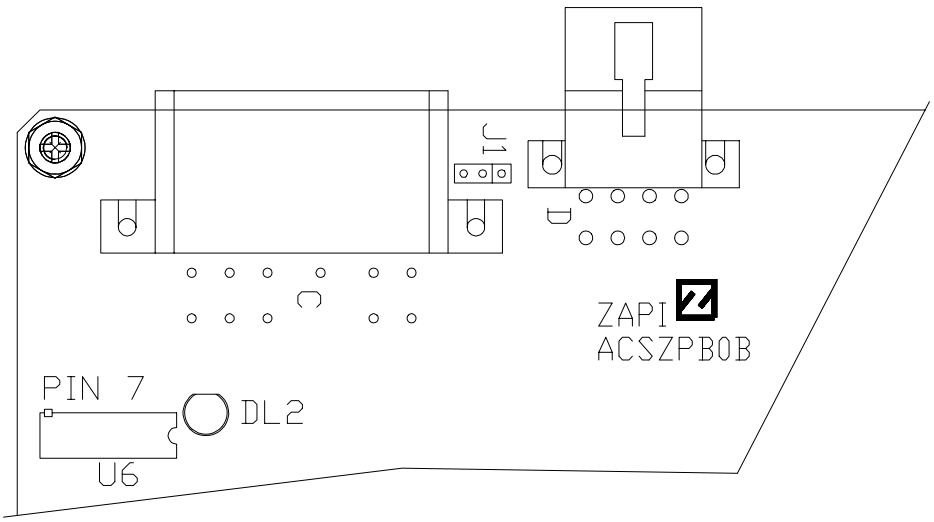


Fig. 11.2.2.1

An open circuit in the steering angle feedback pot., a damage of the steering angle feedback pot., loose mechanical connection of the feedback pot., broken steer chain, broken steering gear box, broken steer motor, or noise induced on a guidance antenna can also cause this alarm.

ALARM 7 RELE KO
Indicated by repeated 7 beep burst on the BUZZER and both AUTOLED and MANLED are lit.

Cause and Remedy: See 11.2.1 ALARM 7 in manual mode.

ALARM 8 STEER HAZARD
Indicated by repeated 8 beep burst on the BUZZER and both AUTOLED and MANLED are lit.

Cause: Occurs if a limit switch opens during an automatic controlled wire guided steering mode or a looking for path phase.

Remedy: To get out of the alarm, select the manual mode steering using the AUTO-SEL switch on the operator console.

ALARM 9 POT OUT OF RANGE
Indicated by repeated 9 beep burst on the BUZZER and both AUTOLED and MANLED are lit.

Cause: During guidance mode (automatic) the drive unit has a too large steering angle. The maximum allowable steering angle is adjustable using the ZAPI hand set and TM7 (see 9.10).

Remedy: If the alarm occurred during normal guidance mode operations without an excessive steering angle and it is practical to increase the steering angle limit, then it is possible to carry out such operation through the ZAPI hand set and TM7 as described in 12.3.6 ÷ 12.3.10 and 9.10 sections.

12 SUPPLEMENT ZAPI HAND SET DESCRIPTION

This section describes the ZAPI hand set functions. Numbers inside the triangles correspond to the same number on the hand set keyboard buttons shown in the figure below. The orientation of the triangle indicates the shift direction of the button effect.

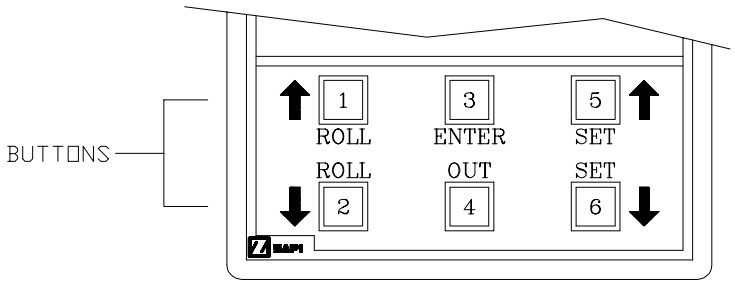


Fig. 12.1

12.1 TACH-GENERATOR STEERING OPTION - HAND SET FUNCTION MAP

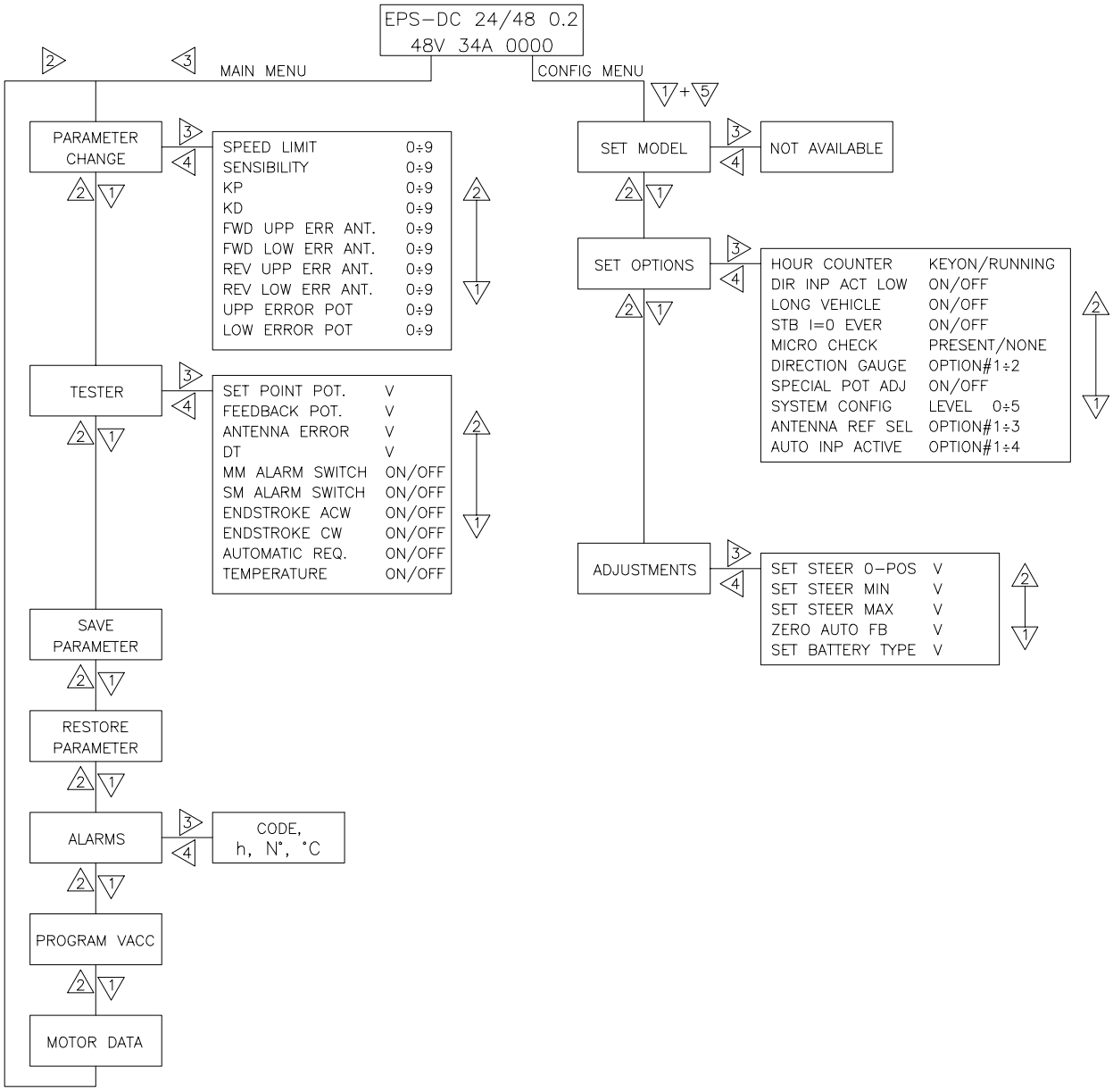


Fig. 12.1.1

12.2 POT. STEERING OPTION - HAND SET FUNCTION MAP

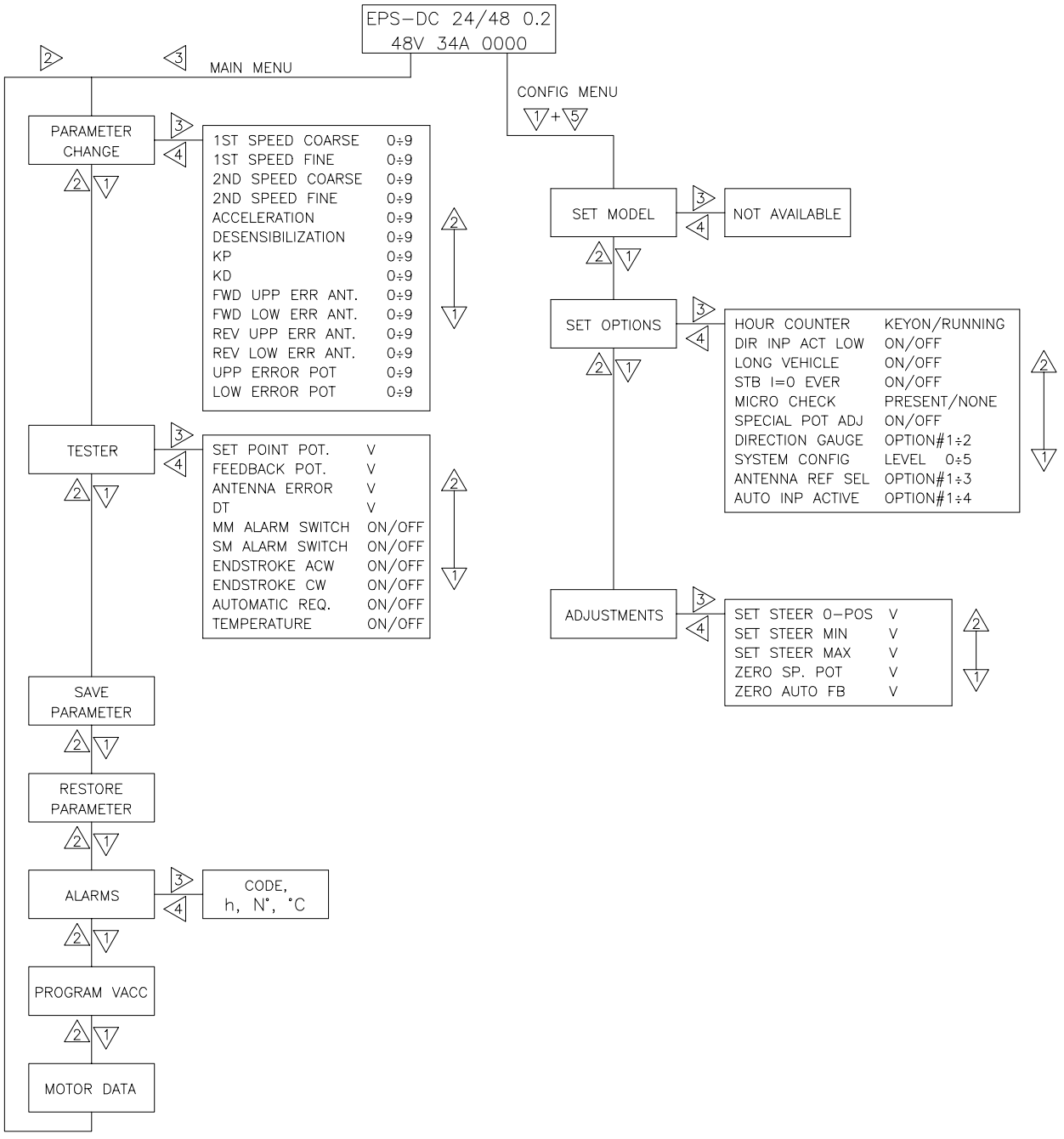


Fig. 12.2.1

12.3 MAIN MENU "PARAMETERS" LIST

The manual steering mode parameters are partially different between Tach-Generator and Pot Steering as described in paragraphs 12.1 and 12.2.
Each parameter is described below without separating between Tach-Generator and Pot steering options. To locate each parameter inside its host menu, see the Function Maps in paragraphs 12.1 and 12.2. In every case a specific attribute is given to each parameter.
After modifying a parameter, memorize it with the hand set by pushing the "4" (OUT) button and a "3" (IN) button. Double pushing the OUT button gets out without saving the modifications.

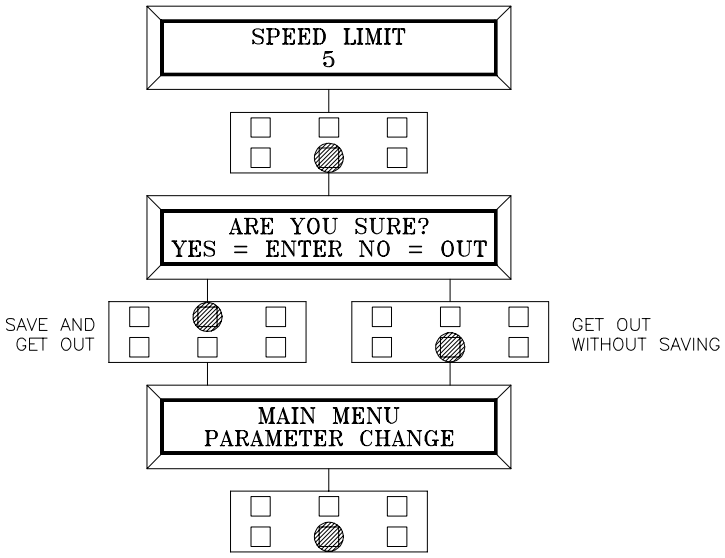


Fig. 12.3.1

Here is a description of the parameter adjustments and what they affect.

.1 SPEED LIMIT: tach-Generator Steering only, it regulates the MDU maximum turning speed.

- Level 0 is for slow turning
- Level 9 is for fast turning

Intermediate levels are for proportionally increasing speed settings. Maximum MDU speed has to be regulated after SET BATTERY TYPE is done (see 12.7.6). The higher the battery type is set to, the higher the MDU turning speed for a given value of the SPEED LIMIT parameter.

.2 SENSIBILITY: tach-Generator steering only, it provides a non-linear relationship between steering handle input (command) and MDU steering speed at small command input changes. This parameter produces increasing steering sensitivity with small changes in steering input.

- Level 0 is for steering response that is less sensitive to small steering handle movements
- Level 9 is for steering response that is very sensitive to small steering handle movements

Intermediate levels are for proportionally increasing speed settings. This parameter does not influence the maximum MDU steering rate.

.3 **KP:** pot. steering and automatic centering option only. It modifies the static precision of the position control loop. To obtain precise return to center feedback pot voltage, increase the KP value. If dither or overshoot becomes evident, try to lower the KP value.

- Level 0 is for less responsive and precise steering.
- Level 9 is for very responsive and precise steering (but "busy").

Intermediate levels are for proportionally increasing speed settings.

.4 **KD:** pot. steering and automatic centering option only. It modifies the dynamic behavior of the position control loop. To reduce steering angle feedback pot. overshoot or oscillations, adjust this parameter. (It is the Derivative (lead) contribution to a typical PD (Proportional/Derivative) control loop dynamic algorithm.

- Level 0 is for a complete proportional controlling algorithm.
- Level 9 is for a maximum leading contribution controlling algorithm. This means the MDU start to slow a lot as it approaches near a steady state position. This is maximum overshoot (dither) reduction.

Intermediate levels are for proportionally increasing the derivative contribution.

.5 **FWD UPP ERR ANT:** wire guidance only. It modifies the threshold for a lateral shift that, when exceeded, provides a "LATERAL OUT" alarm. This parameter adjusts the limit threshold corresponding to FWD antenna side lateral shift relative to the coil side that increases over 2.5 volts the ANTENNA ERROR test value. 2.5 VDC ANTENNA ERROR value is for a perfectly centered antenna.

- Level 0 is for a lateral out alarm threshold of 3.5 VDC (consistent with ANTENNA ERROR value.)
- Level 8 is for a lateral out alarm threshold of 4.5 VDC (consistent with ANTENNA ERROR value.)
- Level 9 disables this alarm in the specified direction.

.6 **FWD LOW ERR ANT:** wire guidance only. It modifies the threshold for a lateral shift that, when exceeded, provides a "LATERAL OUT" alarm. This parameter adjusts the limit threshold corresponding to FWD antenna side lateral shift relative to the coil side that decreases below 2.5 volts the ANTENNA ERROR test value. 2.5 VDC ANTENNA ERROR value is for a perfectly centered antenna.

- Level 0 is for a lateral out alarm threshold of 1.5 VDC (consistent with ANTENNA ERROR value.)
- Level 8 is for a lateral out alarm threshold of 0.5 VDC (consistent with ANTENNA ERROR value.)
- Level 9 disables this alarm in the specified direction.

.7 **REV UPP ERR ANT:** wire guidance only. It modifies the threshold for a lateral shift that, when exceeded, provides a "LATERAL OUT" alarm. This parameter adjusts the limit threshold corresponding to REV antenna side lateral shift relative to the coil side that increases over 2.5 volts the ANTENNA ERROR test value. 2.5 VDC ANTENNA ERROR value is for a perfectly centered antenna.

- Level 0 is for a lateral out alarm threshold of 3.5 VDC (consistent with ANTENNA ERROR value.)
- Level 8 is for a lateral out alarm threshold of 4.5 VDC (consistent with ANTENNA ERROR value.)
- Level 9 disables this alarm in the specified direction.

.8 **REV LOW ERR ANT:** wire guidance only. It modifies the threshold for a lateral shift that, when exceeded, provides a "LATERAL OUT" alarm. This parameter adjusts the limit threshold corresponding to REV antenna side lateral shift relative to the coil side that decreases below 2.5 volts the ANTENNA ERROR test value. 2.5 VDC ANTENNA ERROR value is for a perfectly centered antenna.

- Level 0 is for a lateral out alarm threshold of 1.5 VDC (consistent with ANTENNA ERROR value.)
- Level 8 is for a lateral out alarm threshold of 0.5 VDC (consistent with ANTENNA ERROR value.)
- Level 9 disables this alarm in the specified direction.

.9 **UPP ERROR POT:** wire guidance only. It modifies the threshold for a maximum allowable MDU steering angle in the guided mode that causes POT OUT OF RANGE alarm. This parameter adjusts the steering angle limit that corresponds to an increasing steering angle voltage over 2.5 VDC found on the FEEDBACK POT test value. (2.5 VDC is a perfectly centered MDU.)

- Level 0 is for a POT OUT OF RANGE threshold of 3.5 VDC (consistent with FEEDBACK POT value.)
- Level 8 is for a POT OUT OF RANGE threshold of 4.5 VDC (consistent with FEEDBACK POT value.)
- Level 9 disables this alarm in the specified direction.

.10 **LOW ERROR POT:** wire guidance only. It modifies the threshold for a maximum allowable MDU steering angle in the guided mode that causes POT OUT OF RANGE alarm. This parameter adjusts the steering angle limit that corresponds to a decreasing steer angle voltage below 2.5 VDC found on the FEEDBACK POT test value. (2.5 VDC is a perfectly centered MDU.)

- Level 0 is for a POT OUT OF RANGE threshold of 1.5 VDC (consistent with FEEDBACK POT value.)
- Level 8 is for a POT OUT OF RANGE threshold of 0.5 VDC (consistent with FEEDBACK POT value.)
- Level 9 disables this alarm in the specified direction.

.11 1ST SPEED COARSE: pot steering only. Although the name is ambiguous, it modifies in large steps the MDU maximum steering angle in the direction of increasing steering angle feedback voltage above 2.5 VDC. If the "ONE SHOT INSTALLATION PROCEDURE" was executed correctly, this direction of MDU movement corresponds to clockwise steering handle movement. This parameter is used to regulate the 90 degree MDU steering angle in the specified direction corresponding the 90 degrees of steer handle movement.

- Level 0 is for the smallest maximum MDU steering angle
- Level 9 is for the largest maximum MDU steering angle

Intermediate levels are for proportionally increasing angle.

.12 1st SPEED FINE: pot. steering only. Although the name is ambiguous, it modifies in small steps the MDU maximum steering angle in the direction of increasing steering angle feedback voltage above 2.5 VDC. If the "ONE SHOT INSTALLATION PROCEDURE" was executed correctly this direction of MDU movement corresponds to clockwise steering handle movement. This parameter is used to regulate the 90 degree MDU steering angle in the specified direction corresponding the 90 degrees of steer handle movement.

- Level 0 is for the smallest maximum MDU steering angle
- Level 9 is for the largest maximum MDU steering angle

Intermediate levels are for proportionately increasing angle.

.13 2nd SPEED COARSE: pot. steering only. Although the name is ambiguous, it modifies in large steps the MDU maximum steering angle in the direction of decreasing steering angle feedback voltage below 2.5 VDC. If the "ONE SHOT INSTALLATION PROCEDURE" was executed correctly this direction of MDU movement corresponds to counterclockwise steering handle movement. This parameter is used to regulate the 90 degree MDU steering angle in the specified direction corresponding the 90 degrees of steer handle movement.

- Level 0 is for the smallest maximum MDU steering angle
- Level 9 is for the largest maximum MDU steering angle

Intermediate levels are for proportionately increasing angle.

.14 2nd SPEED FINE: pot. steering only. Although the name is ambiguous, it modifies in small steps the MDU maximum steering angle in the direction of decreasing steering angle feedback voltage below 2.5 VDC. If the "ONE SHOT INSTALLATION PROCEDURE" was executed correctly this direction of MDU movement corresponds to counterclockwise steering handle movement. This parameter is used to regulate the 90 degree MDU steer angle in the specified direction corresponding the 90 degrees of steering handle movement.

- Level 0 is for the smallest maximum MDU steering angle
- Level 9 is for the largest maximum MDU steering angle

Intermediate levels are for proportionately increasing angle.

.15 ACCELERATION: pot. steering only. It increases the amount of time it takes to complete 180 degrees of steering angle sweep beyond the physical time limit imposed by steering motor rating and current limit. It operates by modifying the steering handle feedback voltage with a ramp.

- Level 0 is for about 9 seconds for 180 degrees of steering
- Level 9 is for about 3 seconds for 180 degrees of steering
- Intermediate levels are for proportional time changes

.16 DESENSIBILIZAT: pot. steering only. It slows the MDU steering motion around each steady state position. Its action is evident for a fixed steering handle angle of ± 30 degrees from the center position. This parameter proportionally reduces the MDU steering speed.

- Level 0 is for no slowing of MDU steering near center steer handle position
- Level 9 is for slowing the MDU steering 10 times more than what is imposed with the ACCELERATION parameter.
- Intermediate levels are for proportional changes in response

12.4 MAIN MENU: TESTER FUNCTIONS

The TESTER functions list is common for both tach-generator and pot steering options. Each TESTER function provides the measure, executed by the software, of the specified parameter. To locate each parameter inside its host menu, see the function maps in paragraph 12.1 and 12.2. Descriptions of each TESTER function are given below.

.1 SET POINT POT: pot. steering only. It provides the steering handle feedback voltage in real time.

.2 FEEDBACK POT: pot. steering and wire guidance only. It provides the MDU steering angle feedback voltage in real time. When the system is in manual mode, then hand set measured value is equal to the voltage present on the central terminal of the FB (steering angle feedback) pot. with respect to the GND point. When the system is in wire guidance mode, the FB (steering angle feedback) pot. is supplied with AC voltage, so the hand set displays an AC/DC converted value. 2.5 VDC equals steering angle straight ahead. Higher or lower values are for a turned drive unit.

Exception: When the SPECIAL POT ADJ is set ON, regardless of steering mode, the FEEDBACK POT value is always measured as though the truck is in the wire guided mode of steering.

.3 ANTENNA ERROR: wire guidance only. It provides the antenna error in real time. The antenna error is the difference between the right and left coil voltage on the antenna that leads the last travel direction selected. If the truck was last traveling drive unit first, then the drive unit antenna error is the one measured. If the trucks was last travelling load wheels first, then the load wheel antenna error is the one measured. Since the antennas provide an AC voltage to the hand set, it converts these values to a continuous value. 2.5 VDC corresponds to an antenna that is centered over the guide wire. The value is higher or lower if the antenna is shifted to the side of the guide wire. This measurement is also available in the manual mode of steering if the truck is near a guide wire.

.4 **DT**: tach-generator steering only. It provides the value of the tach-generator input from the steering handle with its sign in real time. The value is scaled for the CPU A/D converter (range = ± 5 VDC). The value measured directly on the tach-generator output is sometimes higher than measured on the hand set.

.5 **MM ALARM SWITCH**: used on all steering options. It provides the real time state (Close = ON, Open = Off) of the Main Microprocessor controlled alarm switch. There are two switches connected in series to this alarm. The first one is controlled by the main microprocessor and the second is controlled by the supervisor microprocessor.

.6 **SM ALARM SWITCH**: used on all steering options. It provides the real time state (Close = ON, Open = Off) of the Supervisor Microprocessor controlled alarm switch. There are two switches connected in series to this alarm. The first one is controlled by the main microprocessor and the second is controlled by the supervisor microprocessor.

.7 **ENDSTROKE ACW**: (Counterclockwise Steering Limit Sw.State): used on all steering options. It provides the real time state (Active (open) = ON, Not Active (Closed) = Off) of the limit switch connected to Pin 7 of connector D on the motherboard.

.8 **ENDSTROKE CW**: (Clockwise Steering Limit Sw.State): used on all steering options. It provides the real time state (Active (open) = ON, Not Active (Closed) = Off) of the limit switch connected to Pin 1 of connector D on the motherboard.

.9 **TEMPERATURE**: used on all steering options. It provides real time the control unit metallic temperature in Celsius degrees. An alarm occurs when the temperature is above 78°C (172° F).

12.5 MAIN MENU: "ALARMS" FUNCTIONS

Inside the "ALARMS" menu of the hand set, the last five alarm events can be displayed with the number of repetitions and the hour of the last occurrence for each kind of alarm.

12.6 CONFIG MENU: "SET OPTIONS" FUNCTION LIST

The SET OPTIONS functions list is used for all steering options. These options modify the system configuration on user request. To locate the function inside its host menu, see the function maps in paragraph 12.1 and 12.2. A description of each option follows in the list below.

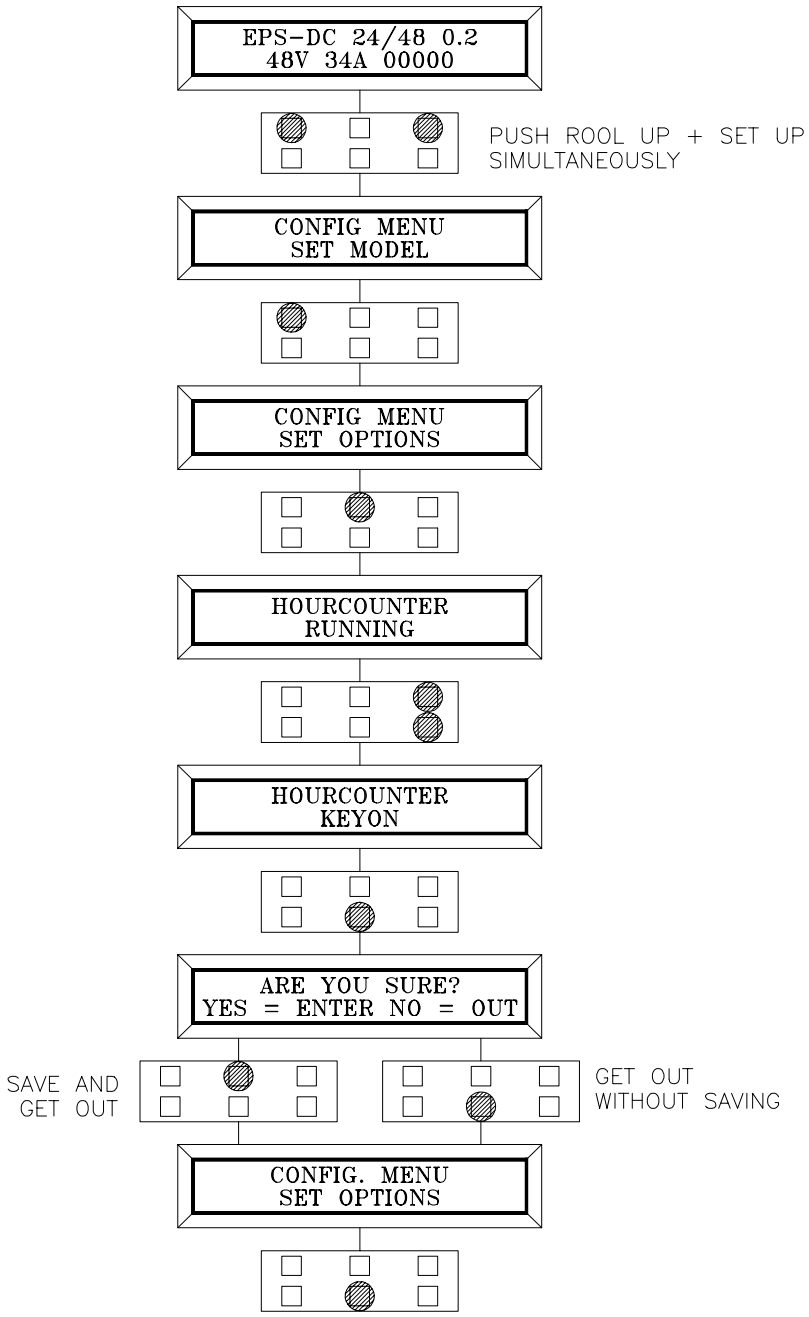


Fig. 12.6.1

.1 **HOUR COUNTER:** there are two possible value options for what will appear in the root menu hand set display.

- RUNNING = Run time when the steering is enabled.
- KEYON = Time counted continuously when the motherboard is supplied.

.2 **INP ACTIVE LOW:** there are two possible options for this value regarding travel direction request.

- ON = External travel requests are active LOW.
- OFF = External travel requests are active HIGH.

.3 **LONG VEHICLE:** there are two options for wire guidance. This is used to reduce the combined wire guidance antenna error when travelling in the load wheel direction (for a short truck).

- ON = Normally weighted combined antennas error (preferred choice.)
- OFF = Reduced weighted combined antennas error (for a short truck)

.4 **STB I=0 EVER:** there are two options for manual mode steering. If set on the power stage functionality. If the motor current goes down near zero when commanded a corresponding alarm occurs. It is continuously diagnosed (also in rest position)

- ON = Continuous diagnosis (with tiresome audible noise but an alarm condition could be discovered before the steering motion)
- OFF = Diagnosis inhibited during steering rest status.

.5 **MICRO CHECK:** this feature supports the debugging activity option. It is used to inhibit the Supervisor microprocessor operation and allow the system to run with just the Main processor support. **This operating mode does not allow the supervisor controlled alarm switch to close. Therefore, traction is disabled.**

- NONE = Inhibits supervisor functions
- PRESENT = Enables diagnostic interaction between Main and Supervisor microprocessors. (This is only allowed in the running mode.)

.6 **DIRECTION GAUGE:** there are two options for trucks equipped with a steering angle direction gauge. This setting permits the indicated turning direction displayed on the gauge to be reversed.

- OPTION #1 = Output on Pin 14 of connector E on the motherboard connector varies from 4 VDC for STEER MAX condition to 0 VDC for STEER MIN condition.
- OPTION #2 = Output on Pin 14 of connector E on the motherboard connector varies from 0 VDC for STEER MAX condition to 4 VDC for STEER MIN condition.

.7 SPECIAL POT ADJ: this special option provides additional assistance in the adjustment of the steering angle feedback pot. When set ON, an ADJ. ZERO POT alarm occurs immediately. Ignore it. The important thing is that the FEED-BACK POT hand set reading is for AC/DC converted value from the steering angle feedback pot. that is used in wire guidance. The SPECIAL POT ADJ feature of the ZAPI hand set is useful in adjusting trimmers TM10 and TM7 on the wire guidance card.

TM10 Travel 10 meters in drive wheel direction on wire guidance. If TM10 is not correctly adjusted the truck will travel parallel to the guide wire some distance. If this is the case, use the ZAPI hand set on **SPECIAL POT ADJ** setting. Immediately an alarm (ADJ. ZERO POT) occurs and the steering wheel position is frozen. You may regulate TM10 to give the minimum voltage possible on Test Point 6 (TP6) corresponding to a straight drive wheel position.

TM7 Drive the truck in the manual mode close to the guide wire. Rotate the steer handle until the drive unit has reached the maximum absolute angle allowed in wire guidance mode. Set SPECIAL POT ADJ to "ON" using the ZAPI hand set. Immediately an alarm (ADJ. ZERO POT) occurs and the steering wheel position is frozen. Using ZAPI hand set, read the FEEDBACK POT value and adjust TM7 to obtain a feedback pot value of 4.5 VDC (or 0.5 VDC if the chosen direction of steering is below 2.5 VDC.)

Note: **FEEDBACK POT** value is 2.5 VDC for steering straight ahead with a correctly adjusted TM10. The value of **FEEDBACK POT** will increase for clockwise drive unit steering and decrease for counterclockwise drive unit steering. **FEEDBACK POT measures steering angle feedback pot. voltage in automatic (wire guidance) mode and manual mode. Since these measurements are very different, do not confuse the manual mode reading with the automatic mode reading. There is a special exception. When "SPECIAL POT ADJ" is set to "ON", FEEDBACK POT measures the automatic mode reading even with the steering in manual mode.** Since only one trimmer is provided for the two directions of drive unit steering, the ZAPI hand set is used to separate them (see 12.3.9 ÷ 12.3.10).

.8 SYSTEM CONFIG: use with all steering options. There are four possible settings:

- LEVEL = 0 = Tach-generator steering plus wire guidance.
- LEVEL = 1 = Tach-generator steering plus automatic centering.
- LEVEL = 2 = Pot steering plus wire guidance.
- LEVEL = 3 = Pot steering plus automatic centering.
- LEVEL = 4 = Encoder plus wire guidance.
- LEVEL = 5 = Encoder plus automatic centering.

In the event that only the manual mode is required, the choice of the level can be made taking into account only the manual steering command (either tachogenerator or potentiometer). For instance, if the steering command is the tachogenerator and no other functions are required, one of the two levels "0" or "1", can be chosen.

.9 ANTENNA REF SEL: use with wire guidance option. It selects which antenna signal must be used to supply the feedback pot.

- OPTION #1 = The pot. is supplied with the antenna signal corresponding to the direction of travel actually selected. (Recommended choice).
- OPTION #2 = The pot. is supplied with the FWD (drive unit) antenna signal.
- OPTION #3 = The pot. is supplied with the REV (load wheel) antenna signal.

.10 AUTO INP ACTIVE: use with all steering options. It sets the active logic level (or edge) for the automatic mode request (AUTOSEL). It is common for both wire guidance or automatic steering centering requests.

- OPTION #1 = External automatic request is active LOW ("LOW" means lower than +4 VDC).
- OPTION #2 = External automatic request is active HIGH ("HIGH" means higher than +5 VDC).
- OPTION #3 = The external automatic request is active for falling edge of odd numbering (i.e., the first falling edge is for automatic, the second is return to manual, the third is for automatic, etc.)
- OPTION #4 = The external automatic request is active for rising edge of odd numbering (i.e., the first falling edge is for automatic, the second is return to manual, the third is for automatic, etc.)

12.7 CONFIG MENU: "ADJUSTMENTS" FUNCTION LIST

The ADJUSTMENTS functions list is a slightly different between tacho-generator and pot. steering options. Tacho-generator has BATTERY TYPE and pot. has ZERO SP. POT. Settings are for parameter values unique to specific applications. To locate each function inside its host menu see the functions maps (paragraph 12.1 and 12.2). A description of each function is given below.

.1 **SET STEER 0-POS:** this parameter only needs to be set for the pot. steering option. It is used to set the steering angle feedback pot. wiper voltage corresponding to the center position of steering for the manual steering mode. The steering handle must be released when adjusting this parameter.
Adjust by entering SET STEER 0-POS and pressing Enter (3) again. The default value is 2500.0 mV. You may roll the value up and down using the (5) and (6) keys in 5 mV increments. (An higher value turns the truck in the clockwise direction when travelling in frontal direction with respect to the driving seat).

.2 **SET STEER MIN:** it is used to adjust the scaling of the 90 degree rotation of the MDU, corresponding to a complete counterclockwise handwheel rotation, for use with the LED steering angle indicator gauge and for other software functions that require full scale range of steering.
Adjust with guidance in Manual Mode after completing 2ND SPEED FINE and 2ND SPEED COARSE adjustments. Turn the handwheel completely counterclockwise and with the SET STEER MIN in the ZAPI hand set display, push the ENTER (3) button. The display changes to the present feedback pot. value. Push the ENTER (3) button again to memorize this new reading.

.3 **SET STEER MAX:** it is used to adjust the scaling of the 90 degree rotation of the MDU, corresponding to a complete clockwise handwheel rotation, for use with the LED steering angle indicator gauge and for other software functions that require full scale range of steering.
Adjust this setting with guidance in Manual Mode after completing 1ST SPEED FINE and 1ST SPEED COARSE adjustments. Turn the handwheel completely clockwise and with the SET STEER MAX in the ZAPI hand set display, push the ENTER (3) button. The display changes to the present feedback pot. value. Push the ENTER (3) button again to memorize this new reading.

.4 **ZERO SP. POT:** it is used to capture the zero setting of the steer handle pot. for manual mode steering.
Adjust this setting by releasing the steer handle on a pot. steered truck. With ZERO SP. POT in the display, press ENTER (3) button on the hand set. The display changes to the present steer handle pot. voltage. Press ENTER (3) button again to memorize this new reading.

.5 **ZERO AUTO FB:** this setting is used for wire guided operations. It is used to modify the 2.5 V default value used to calculate POT OUT OF RANGE limits. The alarm situation occurs if:

1) the FEEDBACK POT in wire guidance state is over ZERO AUTO FB plus the set limit. The set limit is 1 VDC if UPPER ERROR POT parameter is set to 0 and the set limit is 2 VDC if the UPPER ERROR POT parameter is set to 8.

2) the FEEDBACK POT in wire guidance state is less than ZERO AUTO FB minus the set limit. The set limit is 1 VDC if LOWER ERROR POT parameter is set to 0 and the set limit is 2 VDC if the LOWER ERROR POT parameter is set to 8.

Only a small modification of the 2.5 VDC default value is permitted (2.5 ± 0.4 VDC). To adjust this setting, be sure that the truck is in wire guidance mode and the drive unit is straight ahead. With ZERO AUTO FB on the display of the hand set, push ENTER (3) button. The display changes to the current AC/DC converted steering angle pot. feedback voltage. Push ENTER (3) button again to memorize this new reading. This memorized value is only used to modify the POT OUT OF RANGE limits.

.6 **SET BATTERY TYPE:** it is used by software to scale the tach-generator signal with the battery voltage. The higher is the battery voltage, the higher is the software controlled voltage to the steer motor must be for the same tacho-generator rotation speed. There are nine values; 12, 24, 36, 40, 48, 60, 72, 80, and 96 available. The desired value is selected by rolling up or down (pressing the 5 or 6 button) until the desired value is displayed. Then push the OUT (4) button and then ENTER (3) button to save the selected value.

13 SAFETY CONTROLS AND THEIR USE

13.1 SAFETY CONTROLS IN MANUAL STEERING

Six malfunctioning conditions are tested on electric manual steering:

a) Safety on reclosing the internal current loop.

b) Safety on failures of the steering DT (tach generator manually controlled steering)

c) Safety on pot. wires cut off (in pot. controlled manual steering)

d) Safety on the presence of steering current when the truck is at rest

e) Safety on a locked feedback pot. voltage (pot. controlled manual steering only)

f) Crossed diagnosis between master and supervisor microcontroller.

Here is a detailed look at them.

a) The functional diagram of the unit follows

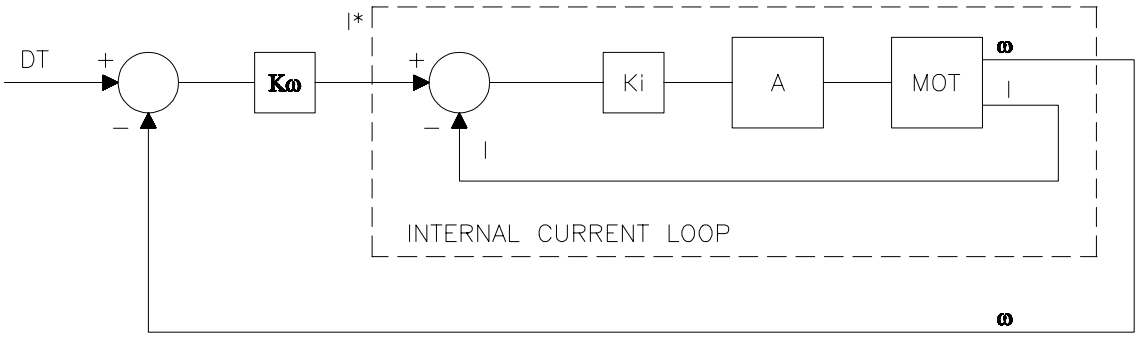


Fig. 13.1.1

Reclose internal current loop verifies in real time the current set point (I*) and the real current of the motor (I) have the same sign.
Since this internal current loop includes the power section and the motor itself, a defect in either of these will cause this alarm.
WARNING: This alarm is unwillingly activated even though while the steering motor is running, absorbs less than 6% of IMax. This possibility is excluded by setting IMax to appropriate values for the power capacity required by the geared motor.

Approximately: $I_{MAX} = \frac{P_{REQ}}{V_{BATT}} \cdot 3$

b) The safety on DT failures detects the presence on the line of DT resistance. This is possible having introduced it as a load for an astable oscillator. It is therefore possible to detect defects due to disconnection and short circuiting the DT.

c) The safety on pots cut off operates searching for either higher than 4.9 VDC or less than 0.1 VDC on the wiper pins of the pots. In fact, each pot is polarized with a couple of resistance that confine its center points inside the two limits specified above if the pots correctly connected (see fig. 11.2.1.1).

d) The microprocessor logic continuously tests the current sensor output at rest and finding to be other than zero, causes an alarm.

e) If the steering angle feedback pot. voltage does not change for more than 0.5 seconds after there has been a change in the steer handle pot, then an FB POT LOCKED alarm occurs.

f) Each microcontroller independently reads the command input (tach-generator or pot) and calculates a consequent controlling action. While the master generated action becomes the executive, the supervisor's is just for a matching comparison. As each microcontroller receives both its own and the other microcontroller's values, if they are mismatched each microcontroller may open its own alarm switch

All six of these alarm conditions make a relay to open removing the negative enable to the traction controller.

13.2 SAFETY DEVICES IN AUTOMATIC STEERING.

Four malfunctioning conditions are tested in automatic (guided mode) steering:

a) Failure due to a persistent wire guidance error detected by the difference between leading antenna signal and feedback pot. voltage (LOOP alarm).

b) Large leading antenna lateral shift (LATERAL OUT alarm).

c) Large drive unit steering angle in guidance mode (POT OUT OF RANGE alarm).

d) Small (or no) induced signal on the leading antenna (PATH alarm).

Each condition is described in more detail below.

a) In guided mode, the operating logic expects to neutralizing the error from the steering antenna with a change in steering angle. The outcome is, that apart from a certain transient, the system moves so quickly that the automatic steering error remains close to zero.

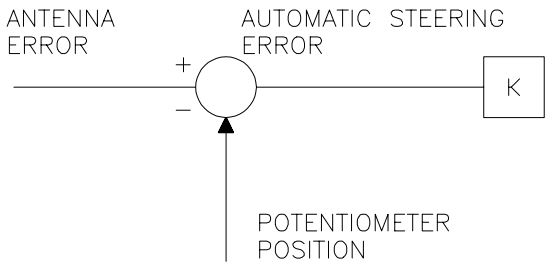


Fig. 13.2.1

If the system fails to accomplish this condition due to a malfunction this alarm is activated.

b) If, during guided mode, the leading antenna comes off the guide wire to the side by a margin greater than set with TM8 (wire guidance card trimmer) and with the ZAPI hand set, then this alarm occurs immediately.

c) If, during guided mode, the drive unit steering angle is greater than the one set with TM7 (wire guidance card trimmer) and the ZAPI hand set, then this alarm occurs immediately.

d) If the leading antenna signal goes to or near zero, this alarm condition occurs immediately.

Any one of these alarm conditions make a relay to open removing the negative enable to the traction controller.

14 PERIODICAL MAINTENANCE TO

Every 3 months perform the following checks:

- Check main remote control switch contact wear. Replace when contacts are worn.
- Check mechanical movement of main remote control switch contactor. It must be free and not jammed up.
- Check power wiring going to the battery and steering motor. The terminals must be tight and firmly connected. The insulation must be sound.

All work must be performed by qualified trained personnel. All replacement parts must be genuine OEM parts.

Any potential problem discovered by the service technician periodically checking the equipment that could lead to additional vehicle damage must be communicated to ZAPI technical staff or the technical sales network so that corrective action and appropriate decision regarding continued operation of the equipment can be made.

If a user detects a steering or guidance problem, it is the user's responsibility to remove the truck from service, tag it, and notify a service technician for corrective action. If an alarm is sounding he must record the number of beeps in each burst and the condition of the AUTOLED and MANLED (lit or unlit) prior to turning the truck off with the key switch, opening a side gate, or changing the position of the guidance switch (AUTOSEL) on the console.

IN THE EVENT OF TROUBLE WITH THE ELECTRICAL EQUIPMENT MAKING IT DANGEROUS TO USE THE VEHICLE, THE USER MUST NOT USE IT.

MENU

ELECTRONIC INDUSTRIAL DEVICES
42028 - POVIGLIO - (R.E.) - Via Parma, 59 - ITALIA
Tel. (0522) 960050 (r.a.) - Tlx. 530021 AINDRE I - Fax (0522) 960259

TECHNICAL DOCUMENTATION

DC-EPS POWER STEERING +

ACSZPB0B WIRE GUIDANCE CARD