



ELECTRONIC EQUIPMENT  
FOR LIFT TRUCKS

**EU 3/12 - EU 3/15 - EU 3/17.5**  
**EU 15 - EU 17.5**

**EU 18 - EU 20 - EU 20L - EU 22**  
**EU 25 - EU 28 - EU 30**

FROM SERIAL No.

**EU 3/12 - EU 3/15 - EU 3/17.5**  
**EU 15 - EU 17.5**

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## **INTRODUCTION**

This publication may contain information that is not up-to-date as a result of modifications made by the constructor, at any time, for technical or trade reasons or to comply with law provisions of the different countries.

Descriptions and photos may refer to non-standard equipments.

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## SAFETY REGULATIONS



### WATCH OUT FOR THIS SYMBOL

It warns about a danger for health and personal safety.  
It suggests the safety precautions to be taken. It means:  
"WARNING - BE CAREFUL - IT'S ABOUT YOUR PERSONAL SAFETY"



### Accidents prevention

- Most accidents occurring in workshops are due to non-compliance with some simple care and safety rules. This means that in most cases accidents may be prevented: you just have to anticipate the possible causes and act with the necessary caution.
- Remember that it is impossible, with any kind of machinery, no-matter how well designed and manufactured, to rule out any possibilities of accidents.
- A careful mechanic is the best guarantee against accidents.
- The strict observance of just one elementary safety rule could be enough to avoid many serious accidents.

### General information

Follow carefully the maintenance and servicing procedures.



### ATTENTION



**Never perform any cleaning, oiling or maintenance with battery on**

- Do not wear rings, wrist-watches, jewels, loose or untied clothes, such as ties, torn clothes, scarves, unbuttoned jackets or unzipped blouses, which could get caught into moving parts.
- We recommend the use of safety clothings, such as: hard-hats, non-skid shoes, gloves, safety glasses.
- Do not perform any servicing on the forklift with people on the seat, unless they are qualified operators, helping with the work to be done.
- Do not operate the forklift or use its attachments unless properly seated on the driver's seat.
- Stop the engine and make sure that there is no pressure in the hydraulic circuits before removing any plugs or lids.
- See the enclosed instructions about this subject.
- All the servicing must be performed with the maximum care.
- All the stairs and the platforms used in the workshop or on site must comply with all safety rules in force.

- Label all controls to warn that servicing is under way. Block the machine and any equipment to be lifted.
- Do not check or fill up the fuel tank, the hydraulic-system oil tank and the battery while smoking, as these fluids are inflammable.
- The brakes do not work when manually released for servicing. In this case, the forklift must be fixed with proper blockings.
- For towing, use only the appropriate towing points. Carefully do the connections, make sure that the provided pins and/or latches are tightly fastened before towing. Do not stand close to under-stress towing bars, ropes or chains.
- To move a broken-down forklift use a truck-trailer or a lowered flat-bed trailer, if available.
- To load or unload the forklift from the transportation mean, choose a level area, offering a solid support to the trailer or truck's wheels.
- Fix tightly the forklift to the truck or trailer deck and block its wheels.
- For electric heaters, battery chargers and the like, use only properly grounded power sources to avoid possible electric shocks.
- In case of lifting or moving heavy components, use suitable hoists or similar equipment and have close people move away.
- Be careful of people standing nearby.
- Never pour gasoline or diesel fuel in open, large and low containers because of the risk of flammable vapours and spillage.
- Never use gasoline, diesel fuel or other flammable liquids as cleansing agents: use non-flammable and non-toxic solvents.
- When using compressed-air to clean small parts, use safety glasses with lateral guards.
- Limit the pressure to max 2.1 bar, according to current local or national rules.
- Do not smoke, do not use open flames nor cause sparkles nearby when using easily flammable materials.
- Do not use flames to light things up when operating the forklift or when looking for "leaks" from the machine.
- Leave all the guards at their proper places when the machine is running.
- Do not leave the forklift unattended while running.
- Do not leave the driver's seat without pulling the parking brake, after switching off the engine. Take the ignition key off.
- Should any parts get stuck, free them only after cutting the engine.
- Move very carefully when you have to work under the machine or close to it.
- Wear the required safety equipment: hard-hats, safety glasses and shoes.
- In case of servicing outside the workshop, move the forklift to a level area and block the wheels. If working on a slope cannot be avoided, first block the truck and then move it on a level area, as soon as it is safe to do so.

- Do not trust damaged and bent chains or ropes: do not use them in lifting or towing. Handling them, always wear safety gloves.
- The chains must be tightly fastened: make sure that the coupling is strong enough to bear the load. No one must stay near the coupling, the chains or the ropes.
- The maintenance area must be kept always clean and dry. Clean immediately any water puddles or oil spills.
- Do not pile up greasy or oily rags.
- Put them in a closed metal container.
- Before starting the forklift or the attachments, check, adjust and lock the driver's seat.
- Be sure that there are no people within the forklift or the attachments field of action.
- Do not carry in your pockets things that may unintentionally fall, into open parts of the machine.
- When there is the possibility of being hit by flying metal parts or the like, wear glasses with lateral guards, hard-hats, special shoes and safety gloves.
- During welding, safety equipment must be used: dark glasses, hard-hats, overalls, gloves and shoes. Dark glasses shall be used also, by any person standing nearby during welding.
- **Never look at the welding electric arc without wearing suitable eye protection.**
- Wire ropes, get frayed with use: when handling them, always wear protection clothing (gloves, glasses, and so on).
- Handle every part very carefully. Keep your fingers away from gaps, wheelworks and so on.
- Always use approved safety equipment, such as safety glasses, safety shoes.
- If you need to work under the forklift, use only the pit or an adequate auto lift.
- After each servicing, remove all the tools from the machine; then check for loosen parts or screws.
- Before driving on the road at night, check the lights efficiency and position of the lights

## Electric system

- When using batteries, remember that the cables must be connected, at both ends, as follows: (+) with (+) and (-) with (-).
- Do not short the terminals. The gas released by the battery is highly inflammable. During recharging, leave the battery compartment open so to have a better ventilation and remove the plugs. Never check the battery charge by "bridging" the terminals with metal objects. Avoid sparkles or flames near the battery.
- Do not smoke to prevent explosion.
- Before any maintenance service, check for any electrolyte leaks: stop these leaks before doing the job.
- Before any maintenance service check for shorted components: take care of these short circuits before doing the job.
- When recharging batteries in closed rooms, make sure that there is a proper ventilation to prevent accidental explosions due to accumulation of gases released during recharging.

## Hydraulic system

- A fluid leaking from a very small hole may be almost invisible, yet it may be strong enough to penetrate under your skin. In such a situation, if you need to check, use a thin cardboard or a piece of wood. Never check with your bare hands: if skin contact occurs, get immediate medical attention, to avoid serious infections or dermatosis.
- In case the system pressures, use shall be checked only adequate instruments.

## Assembling and disassembling

- Lift and handle all the heavy components with a suitable lift. Make sure that all the parts are held by suitable slings and hooks. Use the special lifting eyes. Watch out for people near the load to be lifted.
- Handle all the parts with great care. Do not put your hands or fingers between components. Wear approved safety clothing, such as safety glasses, gloves and shoes.
- Do not twist chains or wire ropes.
- Always wear safety gloves when handling cables or chains.



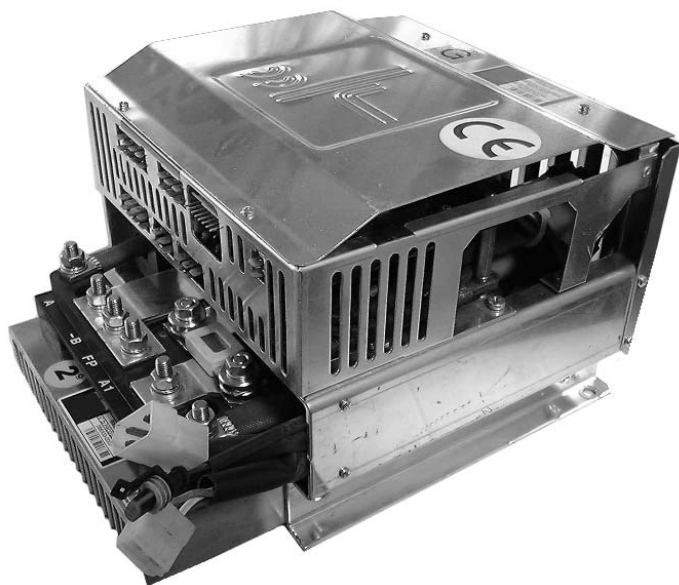
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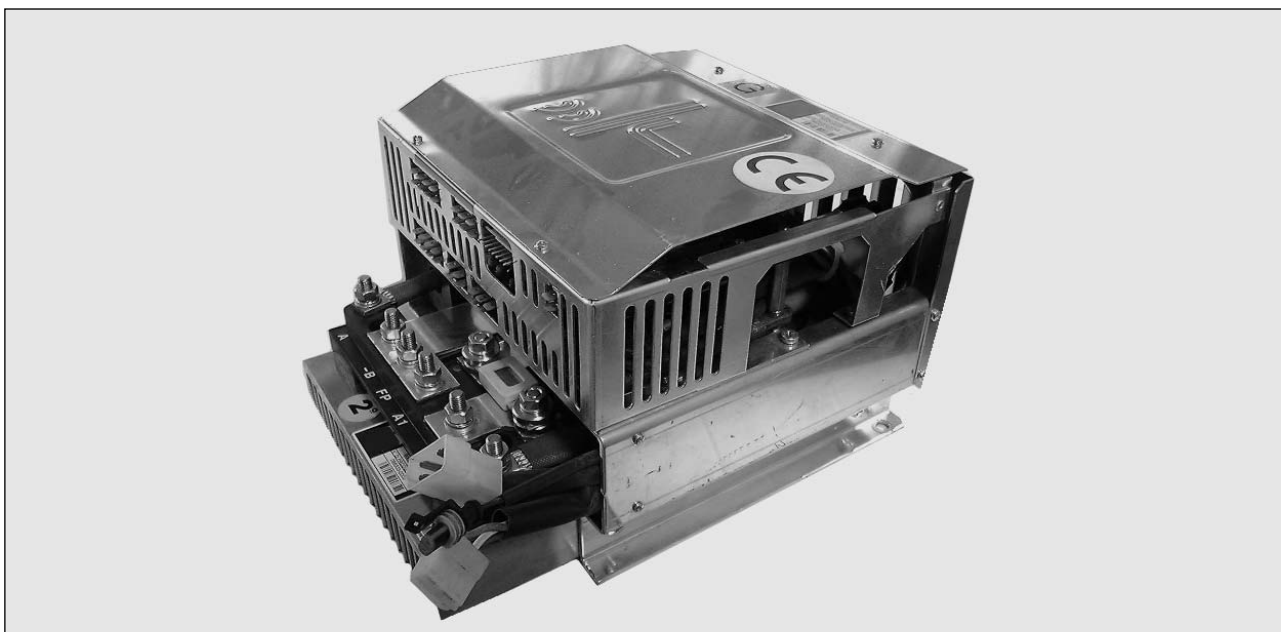


## INTRODUCTION

The SME chopper separately controls the drive motors, drive field and pump motor with a single 16-bit micro-processor. It is a completely static device built with MOSFET modules for driving, both the pump motor and, the independent excitation drive motor.

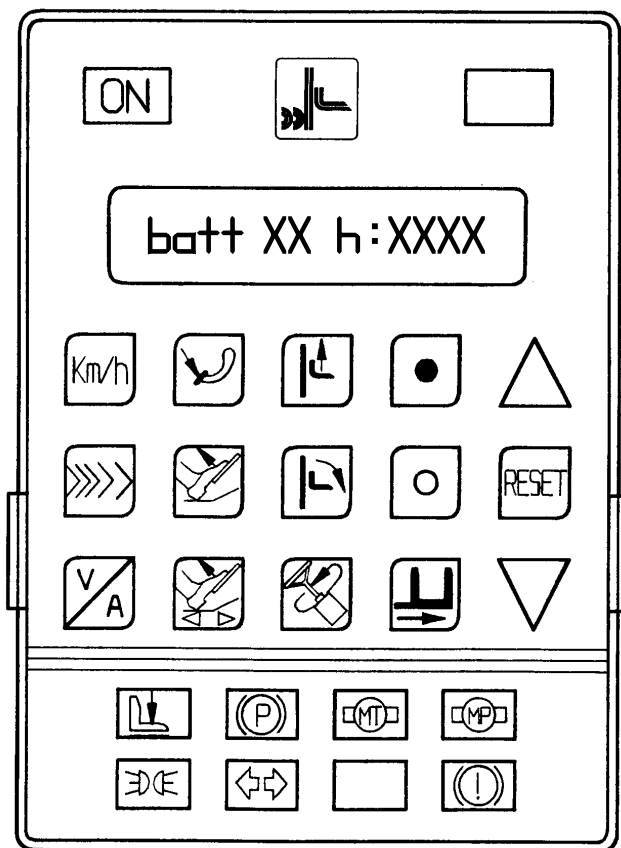
The power components and electronic cards, which are completely immersed in resin and housed in a case, are mounted on a finned aluminium dissipator. Therefore, this version of panel can operate in very aggressive environments (high humidity, strong vibrations, dust, aggressive chemical agents). In particular, the design has focused on resetting electronic switches for the protection device for both the chopper components and drive and pump motor. The software-controlled protection devices and the high-speed hardware-driven devices are processed by the microprocessor and remain stored even when the key has been removed, thus allowing faults diagnostics and a fault frequency analysis.

The control algorithms are completely built through software and therefore can be easily adapted to different types of motors while maintaining the existing hardware. In addition, the dashboard panel is equipped with a push-button panel and liquid-crystal back-lit alphanumeric display for programming and displaying, the operating parameters.



## TECHNICAL DATA

- Battery voltage: .....48V
- Rated voltage - drive motor: .....24V
- Maximum armature current - drive motors: .....600A
- Maximum field current - drive motor: .....20A
- Maximum current - pump motor: .....280A
- Maximum speed: .....7÷14 km/h
- Acceleration: .....2÷10 s
- Maximum braking current with brake pedal: .....200A
- Maximum braking current during pedal release: .....180A
- Maximum braking current when reversing running direction: .....270A
- Lift speed: .....0÷2800 rpm
- Swing speed: .....800÷1100 rpm
- Power steering speed: .....900÷1150 rpm
- Side shift speed: .....800÷1100 rpm

**DISPLAY****Leds**

-  Commutator ON
-  Truck failure (red color)
-  Safety switch active
-  Parking brake
-  Drive motor brushes wear indicator
-  Pump motor brushes wear indicator
-  Parking lights and low beams
-  Turn signal L.R. indicators
-  Available
-  Brake fluid level indicator

**Function buttons**

-  Speed button
-  Acceleration button
-  Voltmeter-Ammeter button
-  Brake pedal button
-  Pedal release braking button
-  Inversion-braking button
-  Lift speed button
-  Swing speed button
-  Power steering speed button
-  4th element speed button
-  Distributor-setting button
-  Side shift speed button
-  Increase button (for each function)
-  Reset button
-  Decrease button (for each function)

**batt XX h:XXXX**

- Service hours display
- Fault display and storage
- Battery charge status measurement
- Battery voltage and current measurement

## THE DRIVE CHOPPER (Armature - Field)

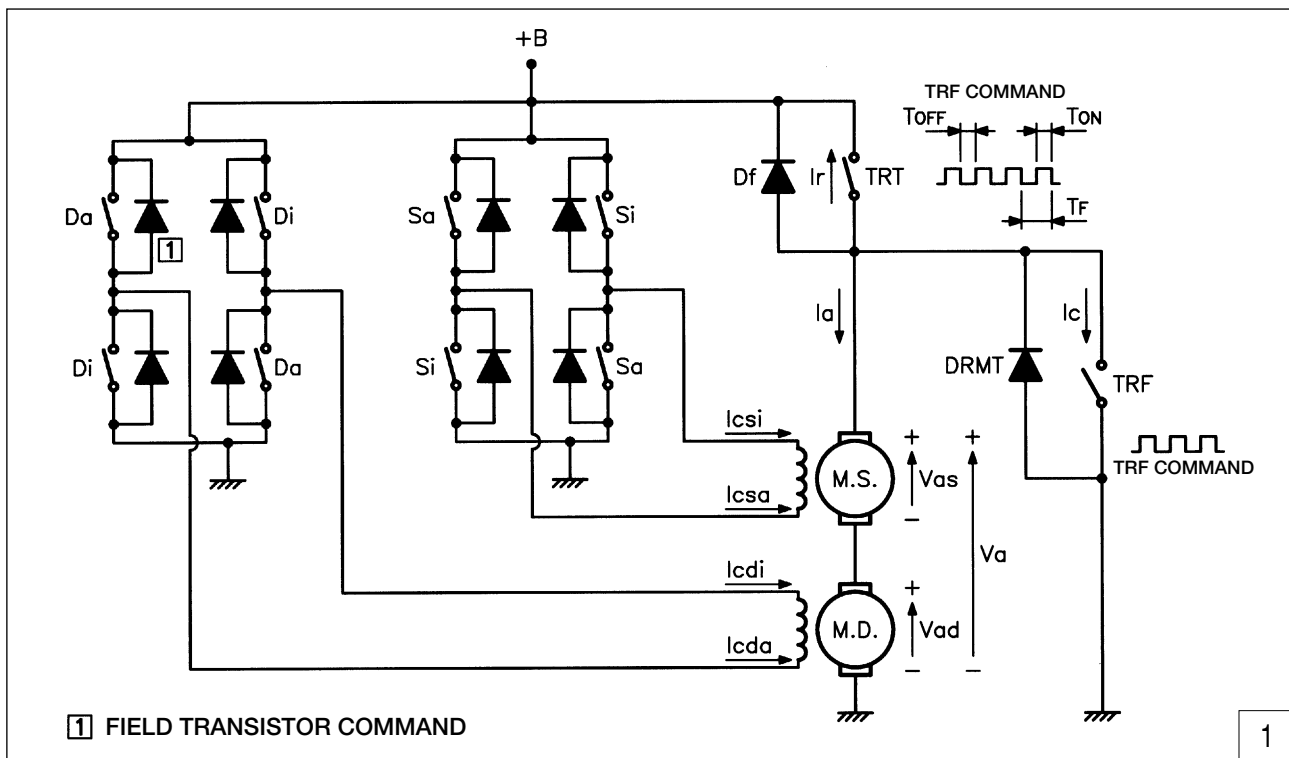


Figure 1 illustrates a general diagram of a chopper for the drive circuit of two independent excitation d.c. motors with regenerative braking.

As it is known, the following relations refer to a d.c. motor (where  $\equiv$  is the proportionality symbol):

• **counter-electromotive force 1)  $e \equiv n \cdot I_f$**

where **n** is the number of revolutions per minute of the motor and **I<sub>f</sub>** is the field current

• **speed 2)  $v \equiv (V_a - R \cdot I_a) / I_f$**

where **V<sub>a</sub>** is the voltage at the terminals of the motor;  
**R** is the resistance of the armature winding  
**I<sub>a</sub>** is the armature current

• **torque 3)  $C \equiv I_a \cdot I_f$**

• **power 4)  $P \equiv C \cdot v$**

Since the armature voltage and field current can be controlled separately and independently, it is possible to adjust the torque and speed within a "range" defined by the electric and mechanical characteristics of the motor.

The voltage or current on the load (armature or field) is controlled through pulse signals to transistors (indicated in fig. 1 for the sake of simplicity as deviators). By operating at a fixed frequency, and increasing the ignition time of the "T on" transistor, and thus to the detriment of the extinction time "T off", the voltage or the current on the load increases. The quantity " $\delta = T_{on} / T_f$ " is called "duty cycle" and expresses the time during which the transistor is on (as a percentage).

The quantity "**T<sub>f</sub>**" is called "**period**" while "**f = 1/T<sub>f</sub>**" is called **frequency**.

Let's look again at the diagram in figure 1: by driving the TRT transistors, Sa-Sa, Da-Da, we will create a voltage of  $V_a - V_{as} + V_{ad}$  at the terminals of the two armatures and the currents  $I_{csa}$  and  $I_{cda}$  through the excitation windings. The two motors will begin to rotate in the same direction (clockwise, for example). On the contrary, if we drive the TRT transistors, Si-Si, Di-Di, the motors will again turn in the same but opposite direction as described in the previous case (counterclockwise).

Therefore, it is clear that if they are TRT, Sa-Sa and Di-Di controlled, the left motor will run clockwise and the right motor will run anticlockwise, and vice-versa if the control is TRT, Si-Si, Da-Da.

During braking, the TRT drive transistor is completely inactive and only the TRF braking transistor is driven.

During this phase, the motor turns because it is "entrained" by the vehicle. Under these conditions, the field transistors are driven to create a current through the excitation windings. The motor acts like a generator (dynamo) and the produced voltage is expressed in relation 1).

During the extinction time of the braking transistor, the generated current  $I_r$  passes through the diode **Df** and charges the battery, while it circulates through the same transistor during the ignition time (**Ic**). The braking current is regulated by modulating the conduction time of TRF and the field current.

### Characteristics of the output voltage waveforms

The control voltage for the drive/braking and pump armature choppers is completely software controlled, operating at a fixed frequency of about 15.6 kHz and modulating the duration of the conduction time. At this frequency, which is beyond the audible range, the current ripple on the motors is practically zero. Under these conditions, the chopper is completely silent. On the contrary, the field chopper control is not completely software driven. The control frequency is around 1 kHz. Silent operation is still guaranteed since the field current is almost continuous (because of the high time constant of the winding).

### PUMP CHOPPER

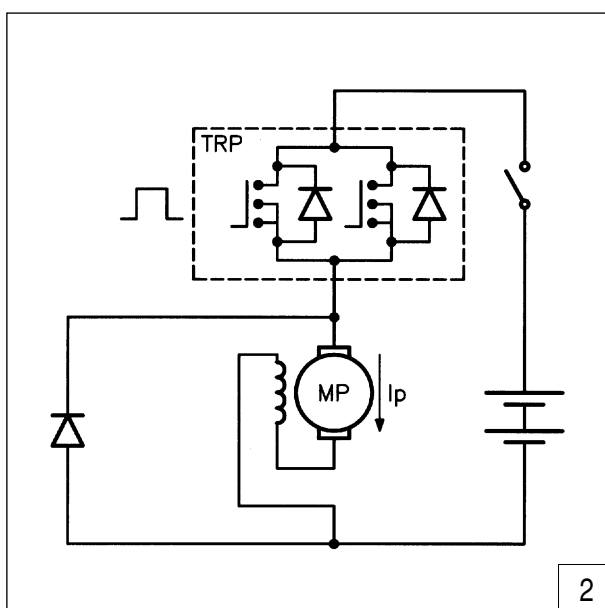
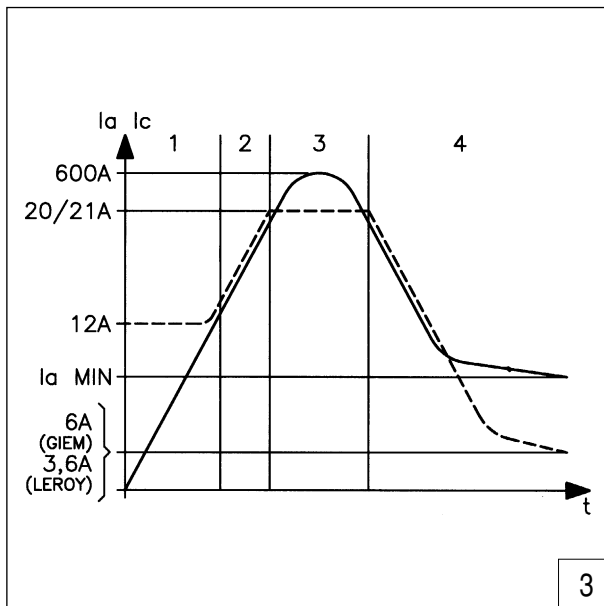


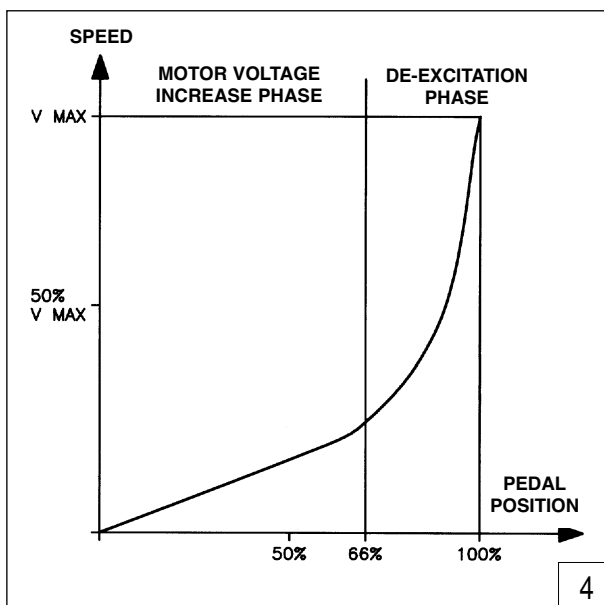
Figure 2 illustrates the power circuit of a chopper using a series excitation d.c. motor to drive a lift pump.

Motor current and voltage are regulated by a control on the base of the pump transistor so that the number of revolutions remains constant even in case of variations in the current  $I_p$  and battery voltage.

## DRIVE CONTROL



$I_a$  MAX: 600A  
 $I_c$  MAX: 20/21A  
 $I_c$  NOM: 12A  
 $I_c$  MIN:  $\left\{ \begin{array}{l} 6A \text{ (GIEM)} \\ 3.6A \text{ (LEROY)} \end{array} \right.$



The slope of the armature and excitation currents during acceleration is shown in figure 3. There are four distinct phases:

In the first phase, as long as the armature current is lower than the rated value (chosen according to the motor characteristics), the field current remains constant (at the rated value of about 12A). During the second phase, when the armature current exceeds the rated value, the field current increases and thus produces a greater torque: therefore during this phase, the motor acts as excited in series. In any case (phase 3), the excitation current never exceeds 1.7 times the rated current a value chosen considering the magnetic saturation characteristic. The armature current is limited to about 600A, thus restricting the voltage on the motor. During this last phase, when the truck has overcome the pickup phase, the armature current begins to drop and the excitation current decreases to a value (about 5A) allowing the truck to reach its maximum speed.

The speed is controlled by the pedal which generates a signal from 0 to 9V (max 11V). The characteristic in relation to the position is illustrated in figure 4.

The speed increases for about two-thirds of the pedal travel, increasing the voltage on the motor, controlling the drive transistor until reaching full conduction (if the armature current is lower than the rated value). As pointed out in figure 4, the curve is rather flat at the beginning in order to guarantee good modulability of the speed at low values. The field current is already at the rated value in this phase, generating a rather high torque that allows the truck to make extremely precise movements.

During the second part of the pedal travel, the speed increases up to the maximum value, deexciting the field.

It is obvious that if the armature current increases beyond the rated value (for example if the truck moves up a ramp), the excitation current must increase to create the torque required and the armature current reaches the maximum stall value (about 600A) in which the voltage on the motor is limited to a few volts and the excitation current is about 20A (phase three of figure 3).

The push-button panel can be used to vary the profile of the acceleration and maximum speed.

## BRAKING CONTROL

The truck is equipped with an electric regenerative/dissipative braking system which is activated by releasing the accelerator pedal or by pressing the brake pedal or the reverse direction pedal.

The push-button panel can be used to vary the maximum braking current as well as the braking distance.

When reversing the operating direction, the braking torque may be modulated with the pedal. Electric braking is maintained until the truck has come to a complete stop and the current is controlled by adjusting the field current and varying the conduction time of the braking transistor.

This time period increases according to a specific slope up to full conduction. Therefore, with reference to figure 1, it is understood that at the beginning of the braking, when the conduction time is small, most of the generated current charges the battery (Ir, regenerative braking).

As the conduction time increases, the percentage of the dissipated current on the braking transistor also increases (Id, dissipative braking), and the current sent to the battery decreases.

The main parameter of the braking effect is the set inversion value and, as a consequence, the braking values generated by releasing the pedal and by pressing the brake pedal are a percentage of the set inversion value. In this way, the combinations of the braking values increase.

The maximum effect is obtained by setting all three parameters to 10 while the minimum is obtained by setting them to 1.

## OPERATION DURING TURNS

The two drive motors, one for each front wheel of the truck, are connected with armatures in series. This connection creates a perfect electric differential. In fact, since voltages at the terminals of the motors are proportional to the speed (relation 1 in the "drive chopper" paragraph), if the motors turn at the same speed, the truck travels straight) and we have:

$$1a) V_a = V_{as} + V_{ad}$$

where

$$1b) V_{as} = V_{ad}$$

Now, let's assume that the truck has to turn. The motor of the internal wheel will be more "charged" than the external motor, and its speed will tend to decrease along with the voltage. Therefore, the motor of the external wheel will increase both speed and voltage in order to satisfy relationship 1a. In practice, the motors speeds in a turn "adapt" and therefore there is no "skidding of the wheels", as with a mechanical differential.

In the extreme case in which the motor is blocked, the maximum voltage at the terminals of the two armatures is about 28V (remember that the motors have a rating of 24V).

## FUNCTION OF STEERING MICROSWITCHES

On three-wheeled trucks, four microswitches are provided to signal that a specific steering angle has been obtained. More precisely, when the right steering angle reaches 68°, the first micro trips, and then the second one is activated at 72°. The other two microswitches trip in a similar manner for left steering angles.

When the first microswitches trip (68°), the field relevant to the motor of the internal wheel is "turned off". In this case, the truck can turn around the stopped wheel.

When the second microswitches trip (72°), the field relevant to the motor of the external wheel is inverted and the truck turns around, its own axis.

## PUMP MOTOR CONTROL

The constant speed during variations in load is the main characteristic of this type of control. The current is “read” by the microprocessor which calculates the conduction time of the pump transistor, thus allowing a constant speed. The operating frequency of the pump chopper is set at 15.6 kHz.

The push-button panel can be used to select various pump motor speeds for lifting, swinging, optional movement and for power steering.

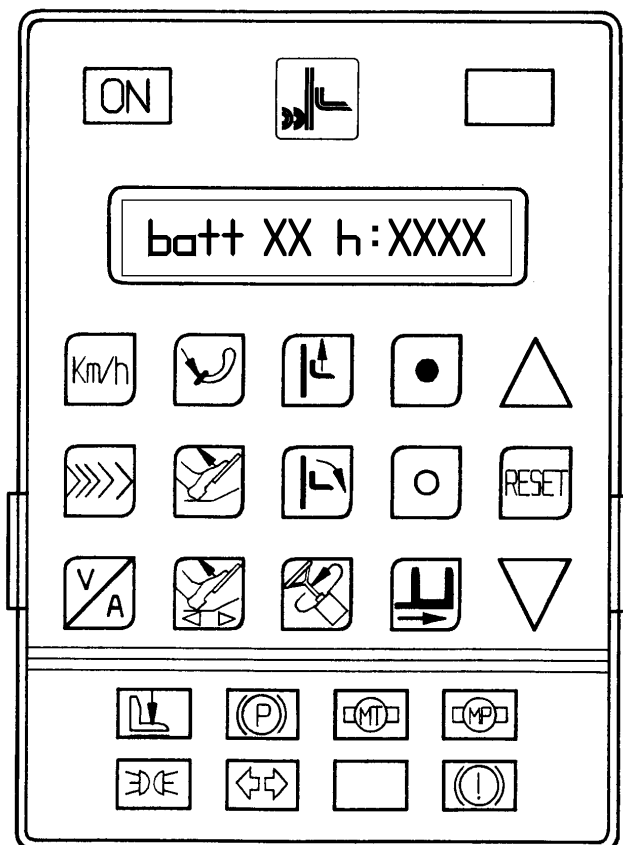
## START-UP AND PARAMETER PROGRAMMING

After plugging in the truck battery cable, turn the key to energize the cards on the panel. The green “ON” led in the upper left-hand part of the dashboard and the green led on the microprocessor card will light and a message indicating the type of truck and power supply voltage will be displayed for a few seconds.

Fit. EU 48 V

Afterwards, the following message will be displayed:

batt XX h:XXXX



where “xxxx” are numbers. The left part indicates the charge status of the battery while the right part indicates the number of service hours.

The microprocessor implements a few-seconds testing of the power circuit. If no problems are detected, the emergency contactor switch is closed and the truck is ready to begin service.

After the remote-control switch has been closed and before the truck starts moving, it is possible to display and modify the parameters listed in the following table:

| PARAMETER                         | RANGE      |
|-----------------------------------|------------|
| maximum speed                     | 7-14       |
| acceleration ramp                 | 1-5        |
| braking with brake pedal          | 1-10       |
| braking by releasing the pedal    | 1-10       |
| braking using the inversion pedal | 1-10       |
| lift speed                        | adjustable |
| swing speed                       | 1-5        |
| power steering speed              | 1-3        |
| lateral movement speed            | 1-5        |

By pressing the button relevant to one of the parameters listed above, the left part of the screen will display the corresponding parameter and its current value. For example, for the acceleration button, the system will display:

**Acc 3 h:0001**

The right part continues to display the service hours. By pressing the same button along with the increase or decrease button, it is possible to change the value of the parameter within the pre-set limits.

The RESET button assigns the following values to the various parameters:

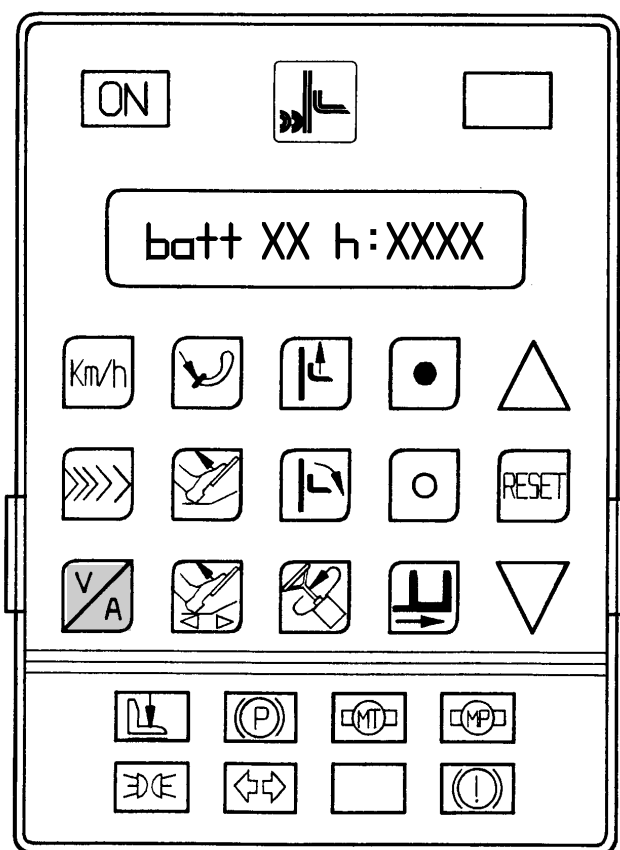
|                                 |                   |
|---------------------------------|-------------------|
| <b>speed</b>                    | <b>11</b>         |
| <b>acceleration</b>             | <b>3</b>          |
| <b>braking with brake pedal</b> | <b>7</b>          |
| <b>inversion-braking</b>        | <b>8</b>          |
| <b>release braking</b>          | <b>6</b>          |
| <b>lift speed</b>               | <b>adjustable</b> |
| <b>swing speed</b>              | <b>1</b>          |
| <b>power steering speed</b>     | <b>1</b>          |
| <b>side shift speed</b>         | <b>1</b>          |



## HOUR COUNTER

Since the system is provided with a 16 MHz quartz oscillator, an EEPROM and a liquid crystal display, it was possible to fit a counter allowing measurements up to 65535 hours of operation (about 20 years of real work) having the precision of the best clocks.

## BATTERY VOLTAGE AND CURRENT DISPLAY



Press the button:



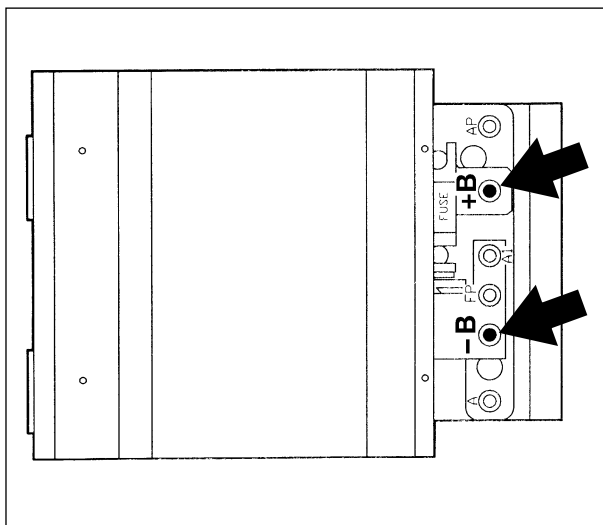
VOLTMETER-AMMETER

the left side of the screen will display the current battery voltage and the right side will indicate the actual battery current. For example:

V47.5 I 0085

which indicates a battery voltage of 47,5V and a current of 85A. Press the V/A button again to reset normal displaying.

## CALIBRATION OF THE BATTERY VOLTAGE INDICATOR

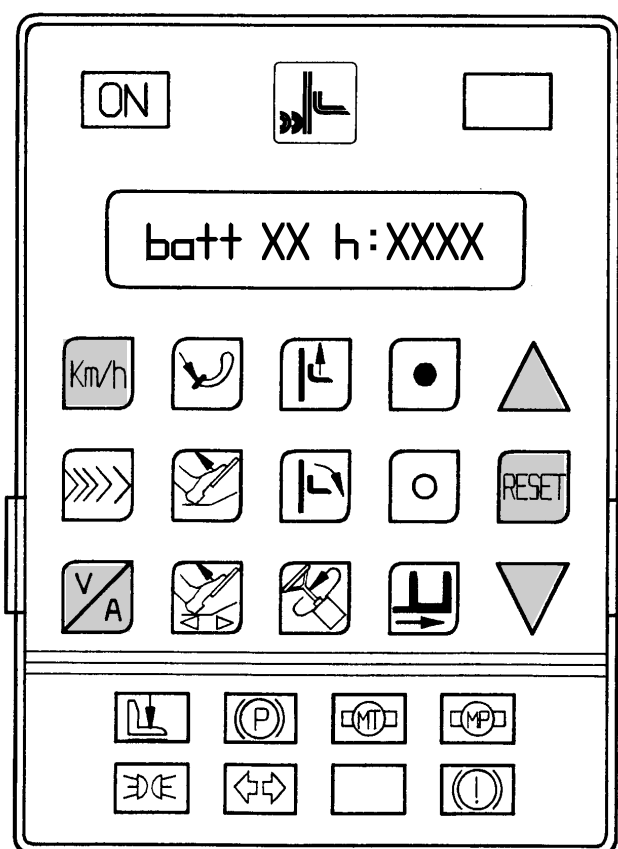


Turn the key on the ON position.

Make sure that the voltage shown on the battery is the same as the one shown on the points of the figure:

### +B and -B

If this is not the case, check the contacts of the remote control switches (see page 38) and the plug/socket of the battery.



Press the button:



VOLTMETER-AMMETER

The screen will display the battery voltage and current as specified following above. Release the V/A button and press the following buttons at the same time.



SPEED



RESET

Release the two keys.

Then use the INCREASE or DECREASE keys



INCREASE

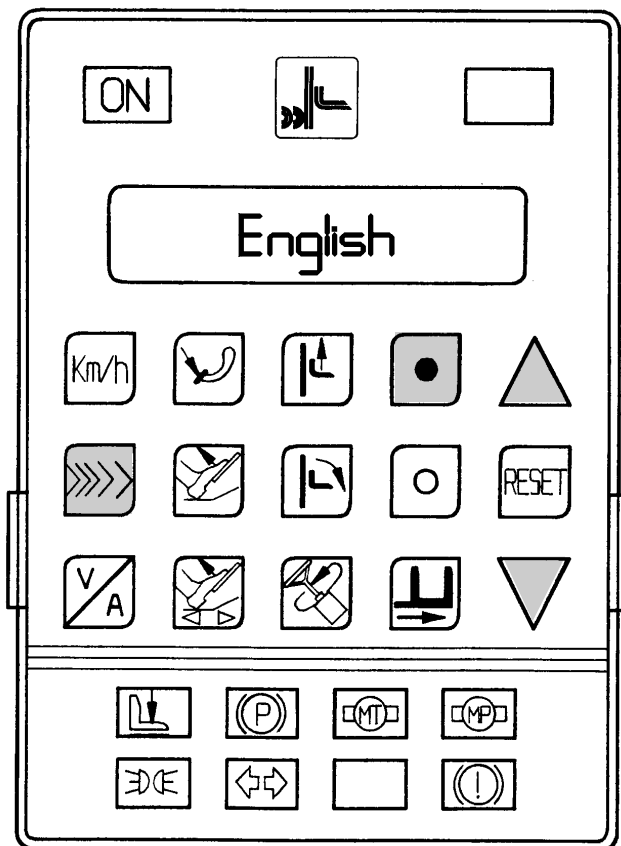


DECREASE

to set the voltage value shown on the display to the battery voltage value measured by a suitable instrument. Press the V/A button again and turn OFF the truck to store the new voltage value.

Turn the truck ON and check whether the display indicates the correct value.

## LANGUAGE SELECTION



Press and keep the following buttons pressed:



4<sup>th</sup> ELEMENT SPEED



ACCELERATION

Language selection:

then use the INCREASE or DECREASE keys



INCREASE



DECREASE

to select the language the system will use to show the various messages on the liquid crystal alphanumeric display.

Possible languages:

Italian

French

English

German

Spanish

Release the keys.

## DISPLAY OF PROTECTION DEVICE OPERATIONS

Special attention has been focused on the system protection devices for chopper components (power components) as well as drive and lift motor parts. The software-managed protection devices as well as those controlled by hardware are processed by the microprocessor and remain stored even after the key has been removed. Thus it is possible to diagnose faults and to analyse their frequency.

## SOFTWARE PROTECTION

### 1 - Maximum Voltage Limitation on the Drive Motor due to Overheating of the Power Modules.

If the temperature of the finned dissipator exceeds a value of about 90°C, the maximum voltage on the armature of the drive motor is limited to 55% of the battery voltage. The display will flash the following message:

Thermistor

The protection will be reset only by removing the key.

### 2 - Maximum Voltage Limitation on the Drive Motor when the Battery is Drained.

When the battery charge status lowers below 20, the maximum voltage on the armature of the drive motor is limited to 35% of the battery voltage. The display will flash the following message:

battery

The protection will be reset only by removing the key.

### 3 - Protection Against Premature Use of the Accelerator Pedal.

If the accelerator pedal is pressed before the emergency contactor is closed, this switch is disabled and at the same time the following wording is displayed:

Pedal !!! h:0003

with flashing exclamation points. All controls are disabled. To reset normal operating conditions release the pedal.

### 4 - Protection against pedal malfunctions.

If during acceleration there is more than 3.5V at the input of the accelerator reference without pressing the traction pedal, the red "truck malfunction" led in the upper right-hand portion of the dashboard lights up, the controls are disabled and the following wording is displayed:

Pedal !!! h:0003

with flashing exclamation points. The protection circuit will be reset only by removing the key.

### 5 - Short-circuit Protection during Start-up.

Once the key is turned, the system implements the precharge of the battery filter condensers (CFB). If the voltage of the condensers does not reach the set value, there is an irregular absorption of current between the battery + and -. In this case, the red "truck malfunction" led in the upper right-hand portion of the dashboard turns on, all controls are disabled and the following wording is displayed:

V<sub>cond</sub> !!! h:0003

with flashing exclamation points.

Or the system displays:

"TRT" "TRP"

depending on whether the malfunctioning power component is the drive transistor the pump transistor or the field transistor.

#### **6 - Protection Against a Fault in the Capacitor Precharge Circuit and the Power Card Emergency Remote-Control Switch Command Circuit.**

During start-up, the system performs a test to check the above-mentioned circuits. If a fault is detected the red "truck malfunction" led in the upper right-hand part of the dashboard turns on, the controls are disabled and the the following wording is displayed:

Emerg. !!! h:0003

with flashing exclamation points.

#### **7 - Protection Against Steering Microswitch Malfunction.**

If one of the microswitches does not operate properly, during the steering phase the screen will display the following wording is displayed:

Micro switch

and the voltage on the drive motors is limited to 30% of the battery voltage. The protection device will be reset only by removing the key.

#### **8 - Protection Against a Malfunction of the Drive Motor Fans.**

If one of the drive motor fans is not operating properly, during the running phase the display will flash the following:

Motor fans

and the voltage on the drive motors will be limited to 25% of the battery voltage. The protection device will be reset only by removing the key.

#### **9 - Protection Against an Interruption in Current on the Excitation Windings.**

If during the running phase the current on any of the excitation windings should be interrupted, the following wording is displayed:

Field !!! h:0003

with flashing exclamation points. All controls are disabled and the red "truck malfunction" led in the upper right-hand part of the dashboard will turn on. The protection device will be reset only by removing the key.

**10 - Short-circuit Protection of the Excitation Windings or Field Transistor.**

If the field windings or one of the field mosfets are short-circuited during the running phase, the system will display:

Field !!! h:0003

with three flashing exclamation point.

**11 - Low Voltage Protection.**

If the card power supply voltage (+B) or the 24V voltage tapping drop below 27V and 8V, respectively, the system will display:

Tens. off h:0003

the red “truck malfunction” led in the upper right-hand part of the dashboard will turn on and all controls are disabled. The protection device will be reset only by removing the key.

**12 - Protection Against Pump Motor Current Overload.**

If the pump motor current exceeds 280A, the display will flash the following:

Rot. pump

The red “truck malfunction” led in the upper right-hand part of the dashboard will turn on and all controls are disabled. The protection device will be reset only by removing the key.

**13 - Protection Against the Non-Acquisition of System Electrical Parameters.**

In case of failures preventing the microprocessor from acquiring the electrical parameters (for example a fault on the micro card), the following wording is displayed:

Andl !!! h:0003

with flashing exclamation points. The red “truck malfunction” led in the upper right-hand part of the dashboard will turn on and all controls are disabled. The protection will be reset only by removing the key and.

Switching on again.

**14 - Stand-by**

If for about 5 consecutive minutes the pump commands are not activated, and the instrument panels keys are not pressed, the system will display the following message:

Stand-by

the system turns on the red “truck malfunction” lamp located in the upper right-hand corner of the instrument panel and all controls are disabled. To restore operating conditions, turn the truck off and back on again.

## PRECHARGE PHASE TEST

During start-up and before closing the remote-control switch, the pump transistor is driven in order to discharge the battery filter condensers if they are charged. If the transistor has failed, the pump motor is malfunctioning or disconnected or if the power card is defective, the condensers are not discharged, the system displays the message

**Emerg !!! h:0003**

and all controls are disabled.

On the contrary, if everything is operating normally, a circuit on the power card is driven to charge the battery filter capacitors with a certain time constant. If some components should absorb an abnormal amount of current (for example a drive transistor in short-circuit), or if the power card precharge circuit does not work, the system will display:

**V<sub>cond</sub> !!! h:0003**

and all controls are disabled.

To test the whole phase, use an analogue tester to obtain an indexed direct voltage measurement and follow the procedure here below:

- positive prod on terminal +B of the chopper and negative prod on terminal-B
- turn the truck on and turn it off immediately
- turn the truck on again and check that the residual voltage is cancelled and that shortly afterwards it begins to increase up to about 30-35V, the voltage value at which the remote-control switch closes
- if there is a drop in initial voltage, this means that the pump transistor has failed, or the pump motor is not connected or it is defective or that the power card is malfunctioning
- if everything seems to be operating normally, but the screen displays:

**Emerg !!! h:0003**

then the power card shall be replaced

- if on the contrary, after discharging, the voltage does not rise, the system will display:

**V<sub>cond</sub> !!! h:0003**

whose meaning is described above.

## HARDWARE PROTECTION DEVICES

The hardware protection devices have been designed on the basis of two different principles: the first, and more classic one, compares the set voltage level and the voltage generated by the current that crosses a HALL-effect current sensor :

**SHTF : HALL drive and braking current sensor**

**SHCMD : HALL right motor field current sensor**

**SHCMS : HALL left motor field current sensor**

**SHMP : HALL pump motor current sensor**

Instead, in the second case, the protection device will trip (called an “anti-desaturation protection”) based on a comparison of a set voltage level and the DRAIN-SOURCE saturation voltage of the MOSFET transistors which, during the ignition time, must not exceed 2-3 Volt if the current crossing the transistor is below the maximum value allowed for that transistor. **(The anti-desaturation protection does not involve the field transistor).**

As soon as the voltage generated by the overcurrent exceeds the reference level, the system inhibits all controls on the power transistor in less than 7-8 microseconds, the emergency contactor is opened, the red “truck malfunction” led in the upper right-hand part of the dashboard turns on and the screen displays a message indicating where the overcurrent has occurred.

The following table indicates the messages displayed and stored in the EEPROM:

| DISPLAY MESSAGE | RELATIVE HALL SENSOR | RELATIVE TRANSISTOR |
|-----------------|----------------------|---------------------|
| <b>ARMAT!!!</b> | SHTF                 | TRT or TRF          |
| <b>FIELD!!!</b> | SHCMD or SHCMS       | -                   |
| <b>PUMP!!!</b>  | SHMP                 | TRP                 |

## PROTECTION AGAINST POLARITY REVERSAL

If the polarity is reversed, the chopper remains off even after the key has been turned.



## TROUBLESHOOTING PROGRAMME

The troubleshooting procedure can be divided into three phases depending on the problem that is displayed on the dashboard during normal operation, during truck start-up operations or if it is not displayed at all.

### PHASE 1: FAILURES DURING START-UP OPERATIONS

#### a)

- display:

**Emerg !!! h:0003**

- probable causes: malfunction in the capacitor precharge and emergency contactor circuits;  
no control to the pump motor;
- correction action:
  - 1) check the precharge phase
  - 2) check the pump transistor and the relevant control
  - 3) replace the power card

#### b)

- display:

**Vcond !!! h:0003**

- probable causes: no command to the emergency contactor;  
malfunction of the emergency remote-control switch;  
short-circuit between the battery + and -;  
presence of a hardware alarm;
- correction action:
  - 1) check that the cables of the contactor coil are connected;
  - 2) clean the remote-control switch with compressed air;
  - 3) check that there is 0V between pins k8-2, k8-7 of the micro card and earth;  
otherwise check that the drive and pump HALL sensor connectors are properly inserted;
  - 4) disconnect the flat cable that connects the field card to the micro card. If the defect is still present go on to the next point, otherwise replace the field card;
  - 5) check the power mosfet and the diodes;
  - 6) if a mosfet is defective check the power card as well;
  - 7) replace the power card

#### c)

- display:

**TRT !!! h:0003**

or

**TRP !!! h:0003**

- probable causes: presence of a hardware alarm;  
short-circuit between the battery + and -;

- correction action:
  - 1) check that there is 0V between pins k8-2, k8-7 of the micro card and earth, otherwise check that the drive and pump HALL sensor connectors are properly inserted;
  - 2) check the power mosfet and the diodes;
  - 3) if a mosfet is defective, check the power card as well;
  - 4) replace the power card.

d)

- display:

### Discharge battery

- probable causes:
  - battery voltage too low on pin k 1-5 of the power;
  - malfunction in the micro card;
  - storage of erroneous data on the EEPROM;
- correction action:
  - 1) check the battery voltage;
  - 2) energize the truck and check that the voltage on pin k1-5 and at the terminals of the emergency remote-control switch coil are about equal to the battery voltage, otherwise check the wiring;
  - 3) clean the power contacts of the emergency remote-control switch with compressed air;
  - 4) reset the EEPROM on the micro card and calibrate the battery voltage;
  - 5) replace the micro card.

e)

- display:

### Push reset

- probable causes:
  - storage of erroneous data on the EEPROM;
  - malfunction in the micro card;
- correction action:
  - 1) reset the EEPROM;
  - 2) change and reset the EEPROM;
  - 3) replace the micro card.

f)

- display:

### Pedal !!! h:0003

- probable causes:
  - malfunction in the pedal, in the micro card or in the power card;
- correction action:
  - 1) check the pedal;
  - 2) disconnect the connectors of the pedal, turn the truck on check that there is about 11-12 Volt on pin k13-3 of the power card, otherwise replace the power card;
  - 3) under the same conditions as described in point 2) check that there is about 0 Volt on pin k3-6 of the micro card, otherwise replace the micro card.

**PHASE 2: FAILURES DURING THE RUNNING OR LIFTING PHASE****a)**

- display:

Vcond !!! h:0003

- probable causes: battery voltage less than 25V at the input of the micro card;
- correction action:
  - 1) turn the truck off and on again; if the message is still displayed, carry out procedure b) as described in phase 1;
  - 2) turn the truck off and on again and issue the running instruction; if the truck does not start and the display indicates VCOND!!!, check the power fuse and the remote-control switch and, if necessary, clean it with compressed air; check the TRT
  - 3) turn the truck off and disconnect the flat cable connecting the micro card to the field card; turn the truck on and if the system displays VCOND!!! go on to the next point, otherwise replace the field card.
  - 4) turn the truck off and on again and issue the lifting instruction; if the VCOND!!! messages appears, TRP, DRMP and the power card.

**b)**

- display:

Field !!! h:0003

- probable causes: short-circuit of the field winding of one of the motors;  
interruption of current in one of the field windings  
FIELD;
- correction action:
  - 1) turn the truck off and again; if the PC!!! message appears, check the field card, otherwise issue the traction instruction and if the "FIELD!!!" message reappears, the wiring;
  - 2) check the field resistance;
  - 3) check the field.

**c)**

Pump !!! h:0003

- probable causes: TRP malfunction;  
pump motor malfunction;
- correction action:
  - 1) turn the truck off and on again; if the message TRP!!! appears, check TRP and if it is defective, check the recirculation circuit DRMP of the motor pump and the power card;
  - 2) check the power card;
  - 3) check the pump motor.

**d)**

- display:

Armat !!! h:0003

- probable causes: TRT malfunction;  
malfunction of the recirculation diode of the DRMT drive motor;  
drive motor malfunction;
- correction action:
  - 1) turn the truck off and on again; if the message TRT!!! appears, check TRT and if defective check the power card;
  - 2) if when the running instruction is issued the screen displays ARMAT!!!, check the recirculation diode of the DRMT and TRF drive motor. If the TRF is defective, check the power card;
  - 3) check the drive motors.

### PHASE 3: FAILURES NOT DISPLAYED

**a)**

- truck behaviour: turning the key, the green "ON" led in the upper right-hand portion of the dashboard does not light and the truck is not energized.
- probable causes: no 24V;
- correction action:
  - 1) check the 24V fuse;
  - 2) turn the key and check that there is 24V on connector k13-4 of the power card.

**b)**

- truck behaviour: turning the key, the green "ON" led in the upper right-hand portion of the dashboard lights but the truck is not energized;
- probable causes: the cards are not fed;
- correction action:
  - 1) check the card power supply fuse on the panel;
  - 2) check that the fuse voltage is almost equal to the battery value;
  - 3) check that the flat cable between the micro card and power card is properly inserted;
  - 4) check the wiring.

**c)**

- truck behaviour: when the accelerator pedal is pressed the truck does not move and the power steering system also does not work;
- probable causes: no running instruction is issued;
- correction action:
  - 1) check the handbrake micro safety contact;
  - 2) check that the pedal power supply and cursor voltage values are correct;
  - 3) check that the voltage on pins k4-4 and k4-1 of the micro card goes from about 5V to 0V when the forward and reverse accelerator pedals are pressed, otherwise check the pedal.

**d)**

- truck behaviour: when the accelerator pedal is pressed the power steering system begins operating but the truck does not move
- probable causes: no pedal cursor instruction or the command on the drive transistor;
- correction action: 1) follow out procedure 2) described in point c).

**e)**

- truck behaviour: the pump does not start;
- probable causes: no command on the pump transistor, the pump transistor is broken, the pump motor is malfunctioning;
- correction action: 1) check the micro signal;  
2) check the pump command on the power card and on the base - emitter of the pump transistor;

**f)**

- truck behaviour: turning the key, the system display black squares and the truck does not work
- probable causes: the EPROM is malfunctioning;  
the micro card is malfunctioning;
- correction action: 1) replace the EPROM;  
2) replace the micro card.

**g)**

- truck behaviour: the truck moves slowly and the power steering is continuously operating after the running pedal is released;
- probable causes: the brake pedal micro is always on;
- correction action: 1) check the brake pedal micro.

**h)**

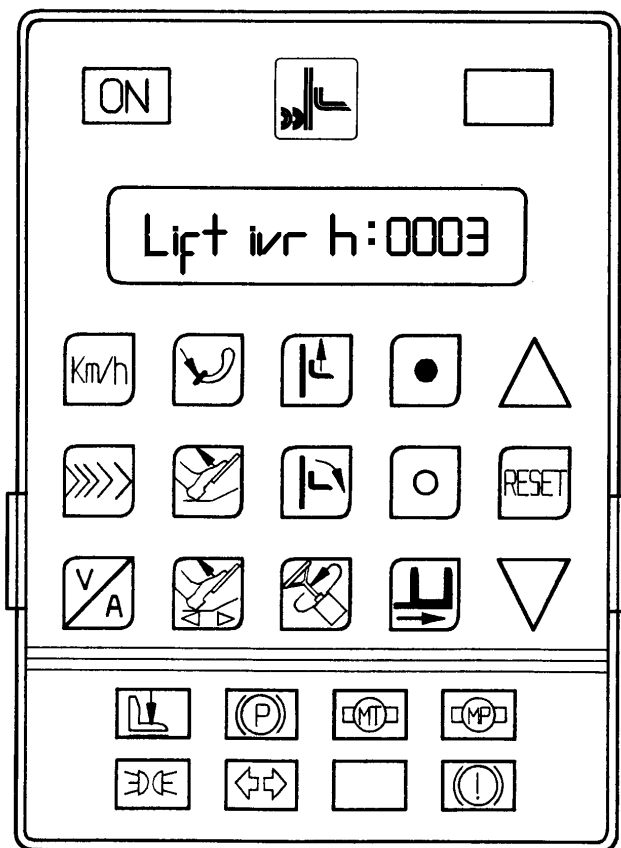
- truck behaviour: the truck moves slowly but the power steering system cuts out only several seconds after the running pedal is released;
- probable causes: the accelerator reference signal is incorrect;
- correction action: 1) check the pedal and reference power supply voltage

## KEY CONTACT

It is connected to the battery positive pole.

This solution excludes any possibility of misconnection to the battery, eliminating any intermediate plug cable.

## FUNCTIONS OF THE DIGITAL DISPLAY



In this case the hall probe needs setting.

This alarm may appear whenever the distributor, the Hall probe or the electronic panel (in case of serious failure) are replaced.

When the alarm is on, the traction is limited and the pump allows only power steering to work.

Lift irr h:0003

This message appears on the digital display time, at the truck switching any the panel detects the lever already engaged: by releasing the lever it goes back to normal.

The alarm goes off also when the electronic system receives a faulty signal from the Hall probe.

When the alarm is on, the traction is limited and the pump allows only power steering to work.

Setting

This message appears on the digital display, in case the electronic system reads faulty and inconsistent signals at the truck switching



**WARNING**



**The "SETTING" (calibration) alarm appears only in case of serious signal-reading by logics. IT IS ALWAYS NECESSARY TO CALIBRATE THE HALL PROBE ANY TIME THE DISTRIBUTOR, THE HALL PROBE OR THE ELECTRONIC PANEL ARE REPLACED.**

## PROCEDURE FOR THE CALIBRATION OF THE HALL PROBE (POTENTIOMETER) RELEVANT TO THE LIFTING FUNCTION

- Get on the truck and turn the key on "ON"

- Press for at least 4 sec. the "**Distributor calibration**"  pushbutton on the display, in order to enter the "SETTING" (calibration) mode, which will be confirmed by the message "LIFT SET" on the left side of the digital display, while the right side will show the BIT value (between 450 and 500), with the Hall probe on stand-by

Example

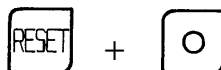
Lift set h: 0485

(A value between 700 and 800, means that this procedure has already been done, therefore you need to run the "RESET" procedure first).

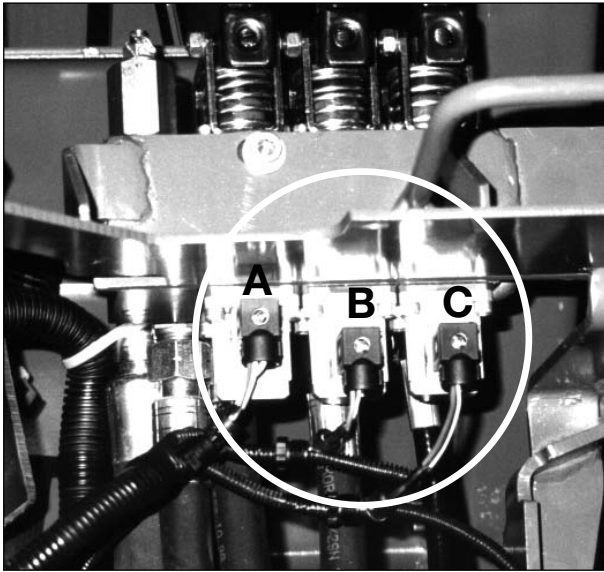
- While keeping the above pushbutton pressed, press also pushbutton  with lift lever at rest. The OFFSET value will thus be stored by the Hall probe.
- Release the pushbutton  and while keeping pushbutton  pressed, pull the lifting lever travel up to end of. The output value of the Hall probe will be stored. (During calibration the pump motor is disabled).
- Release the pushbutton  and then release also the lift lever
- Turn the key on OFF 
- Turn the key on ON again 

Now the adjustment operation has been correctly performed.

By pressing "**Reset**" key at the same time with "**Distributor calibration**" key on the display it is possible to repeat the whole calibration procedure.



## HALL ACTING SENSOR - REED SWITCHES (ON/OFF)



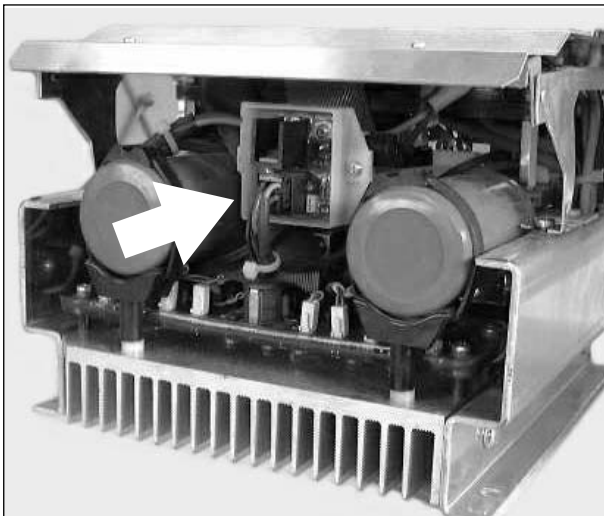
**A** = Hall acting sensor  
**B-C** = Reed switches (ON/OFF)

The hall acting sensor **A** on the distributor lift-lever: it allows a motor speed (and therefore an oil flow-rate) proportional to the lever shifting.

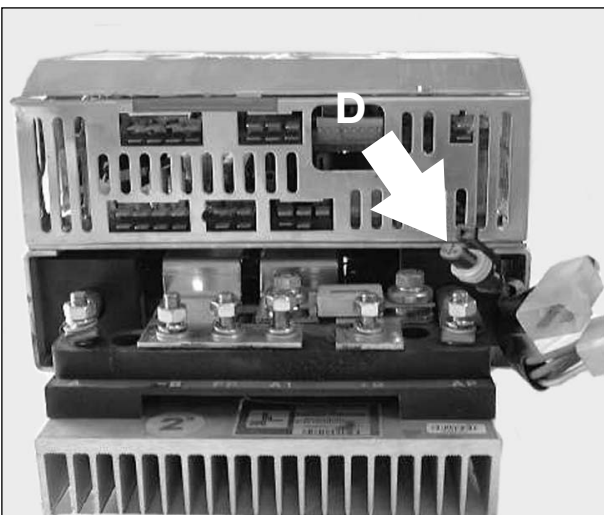
This solution allows energy saving, less oil heating and more quietness during the lifting operation.

The reed switches (ON/OFF), **B** and **C** are placed on the other distributor levers instead of the micro-switches.

The yare highly reliable and need no maintenance.

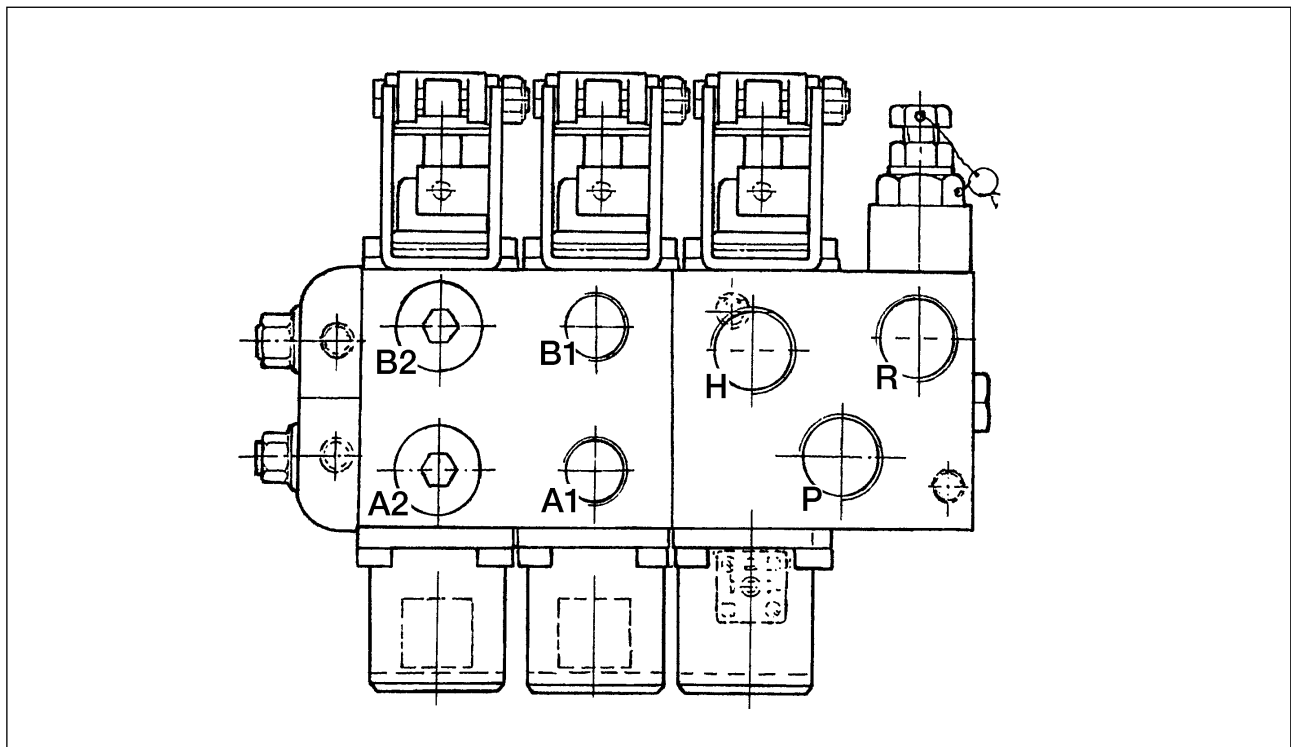


The Hall effect (Hall acting) sensor is powered by a card placed on the electronic board (as shown in the figure).



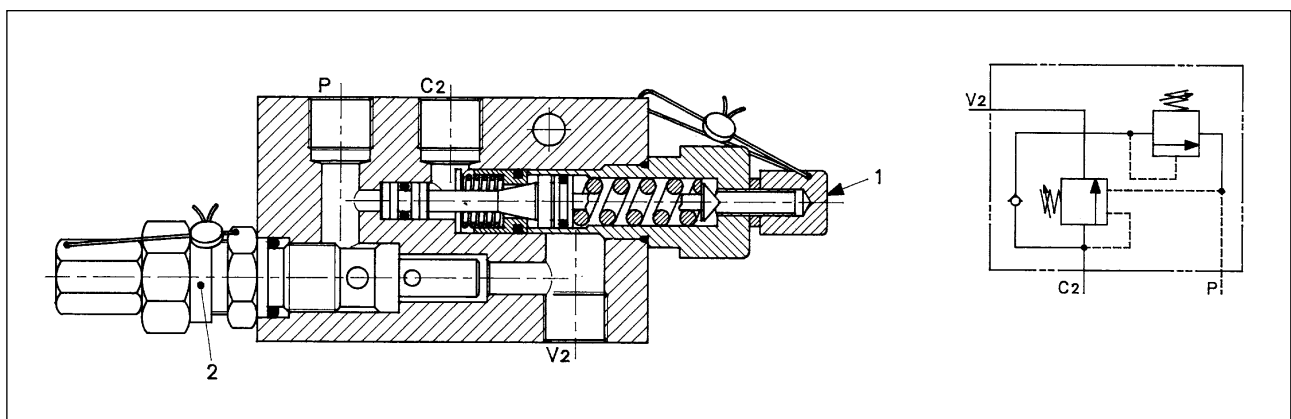
The power supply is through the 2-pin, **D** connector.

## CONTROL VALVE BLOCK



- A1** To the cylinders for the upright inclination
- B1** To the cylinders for the upright inclination
- A2** To the cylinder for the sideshift control
- B2** To the cylinder for the sideshift control
- R.** Oil inlet
- P.** Oil outlet
- H.** To the lift group

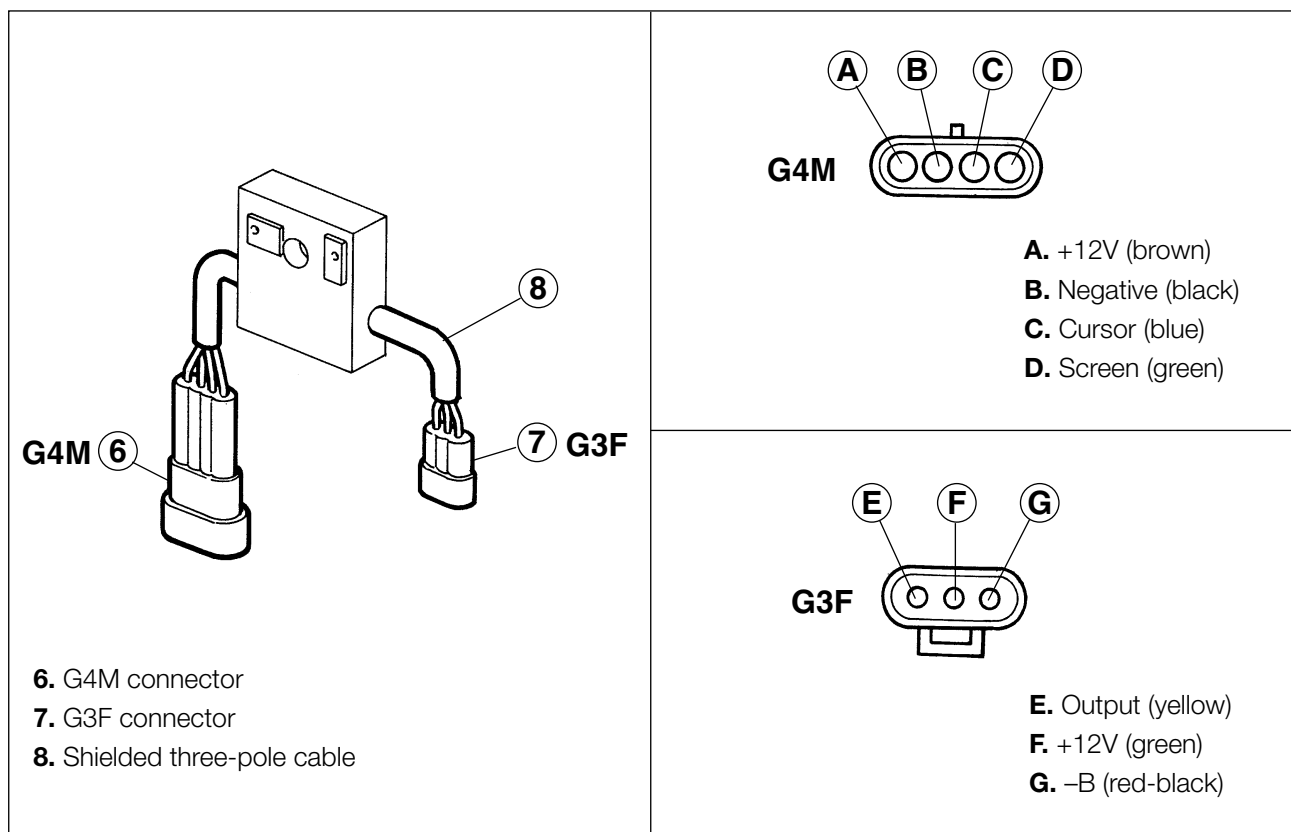
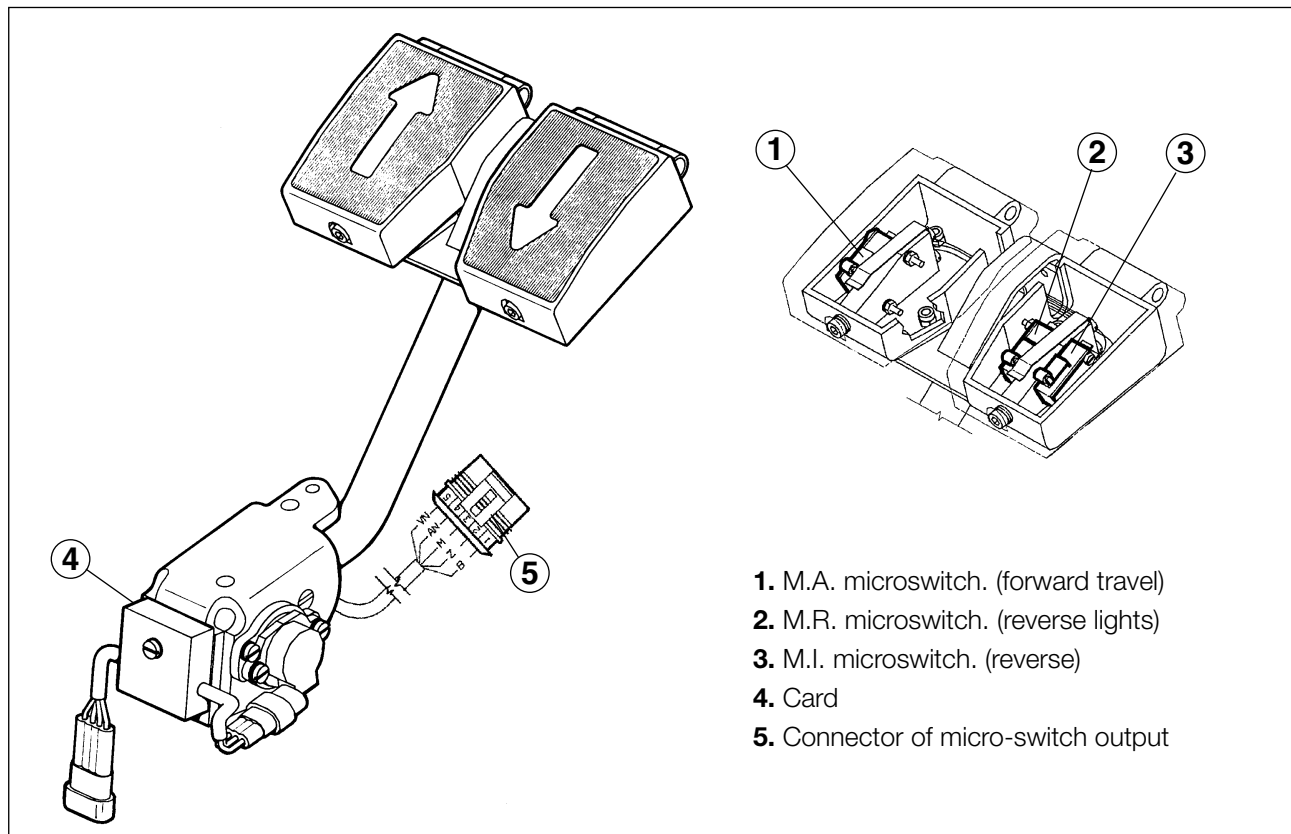
## LOCK VALVE



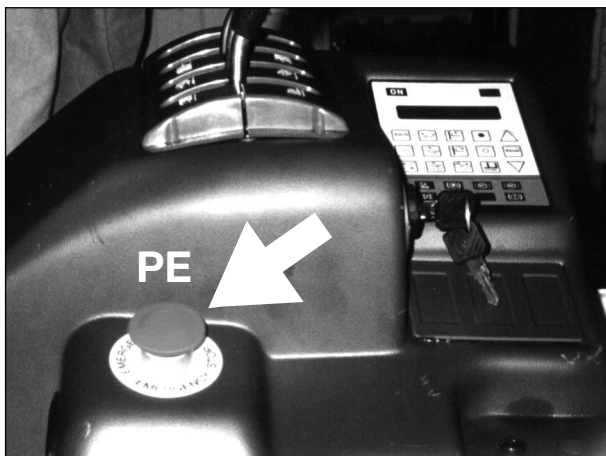
- 1.** Lock valve
- 2.** Over-pressure valve
- V2.** To the hydraulic directional control valve block
- C2.** To the cylinders for the upright inclination
- P.** To the cylinders for the upright inclination (pilot system)

## ACCELERATOR PEDAL

Accelerator pedal, with a more ergonomic and reliable design and reduced maintenance



## EMERGENCY PUSH-BUTTON (PE)



Emergency Push-button (PE) located next to the distributor.

When pressed, it will immediately shut off the power (battery positive pole) of the electronic system neutralizing the truck electrical functions.

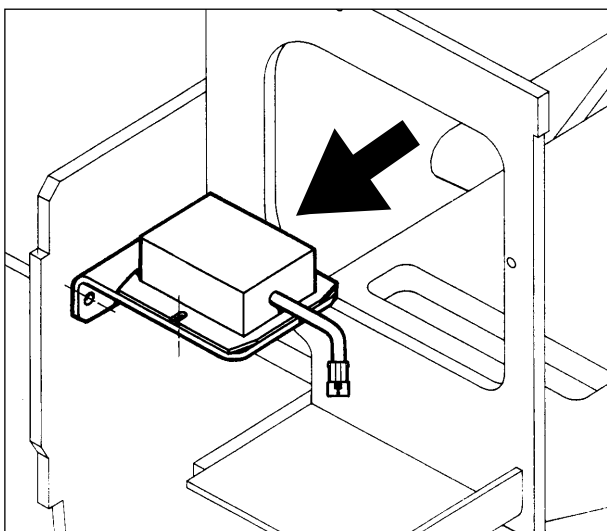
## LINE CONTACTORS



Two Line contactors (**T/G. 1 and T.G.2 realy switches**) serially connected to the battery positive make the truck electronically safe in any working condition or in emergencies.

They are located inside the right hand side housing, behind the wheel arch.

## 80W DC/DC CONVERTER



The 80W DC/DC converter, provides a constant and balanced battery discharge.

It is located in the left compartment (opposite to the electronic panel compartment) and is intended to power the truck reverse and brake lights.

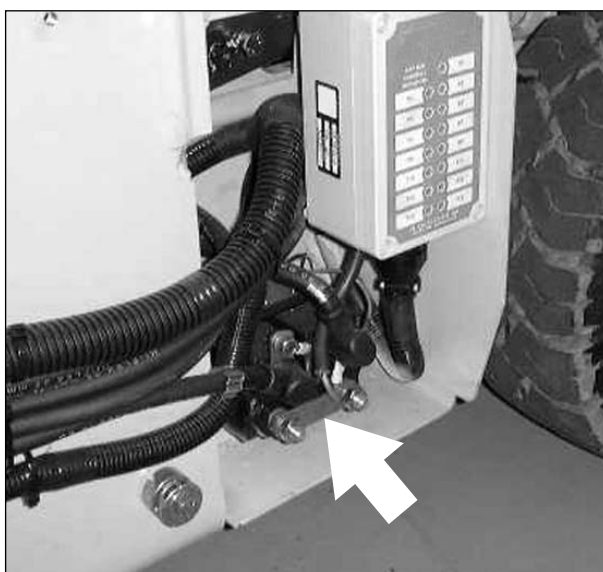
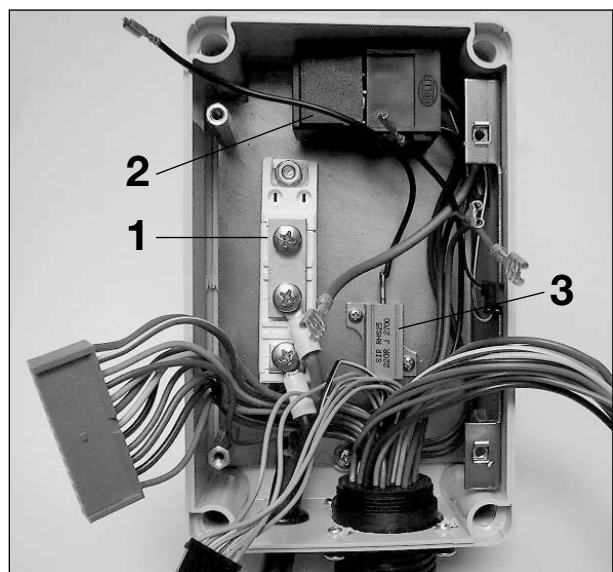
**Should the Customer require other electric applications, a suitable second converter will be installed.**

## PREARRANGEMENT OF THE LIGHTS

The harness and fuses provided on the truck speed up the application of any electrical options required by the Customer.

## ELECTRONIC COMPONENT BOX

It is positioned under the left truck wheelhouse (as shown in the picture) and houses all control fuses, a duplex diode, a relay and a ballast resistance.



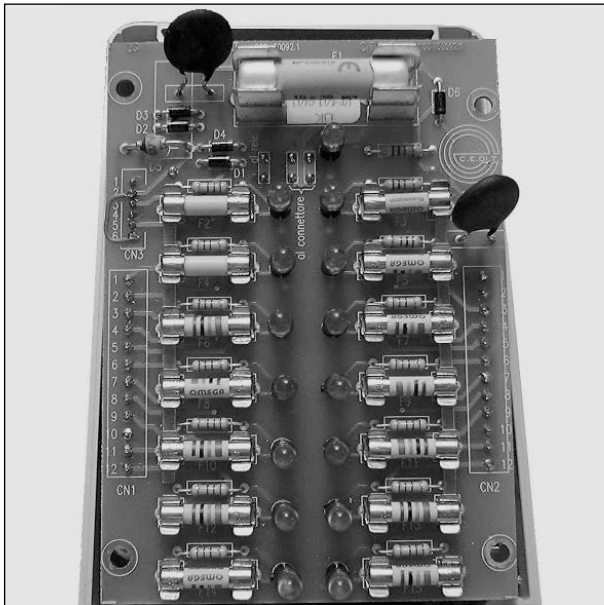
1. Duplex diode
2. Relay
3. Ballast resistance

The duplex diode operates as anti-jamming and energy circulation in case the emergency button is voluntary powered when using the truck.

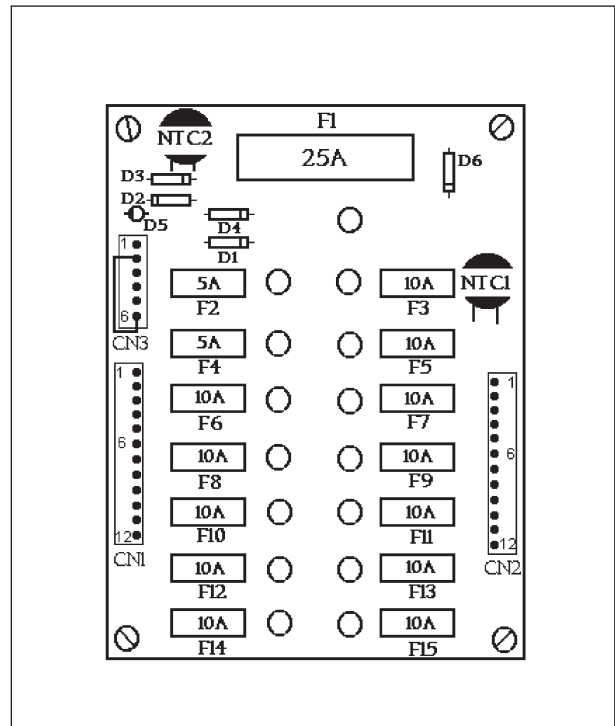
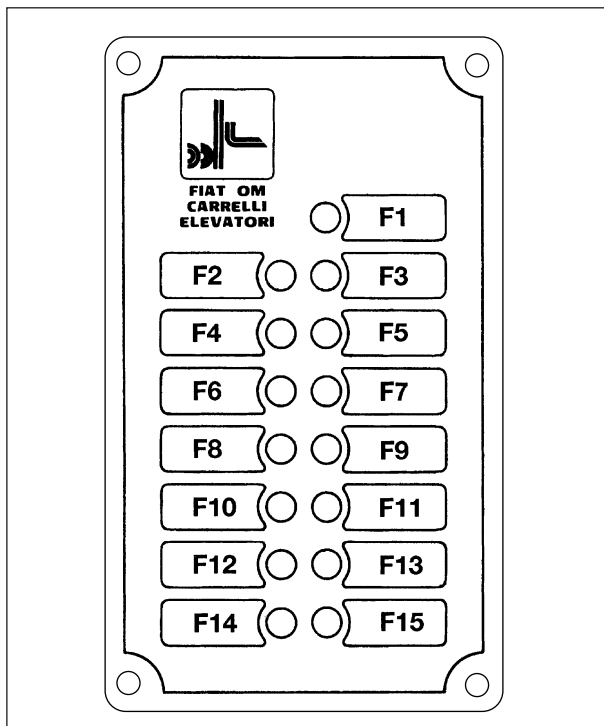
It is connected in parallel position to the power contacts corresponding to the two **T.G.1** and **T.G.2** remote control switches shown in the figure (see chapter on page 37).

The relay has the function to feed the voltage reducer (from 48V to 24V) used for powering the series lights that the truck has been equipped with (the voltage reducer does not accept any other additional appliances).

The resistance is used in order to reach a voltage drop (from 48V to 24V) to feed the above-mentioned relay coil.

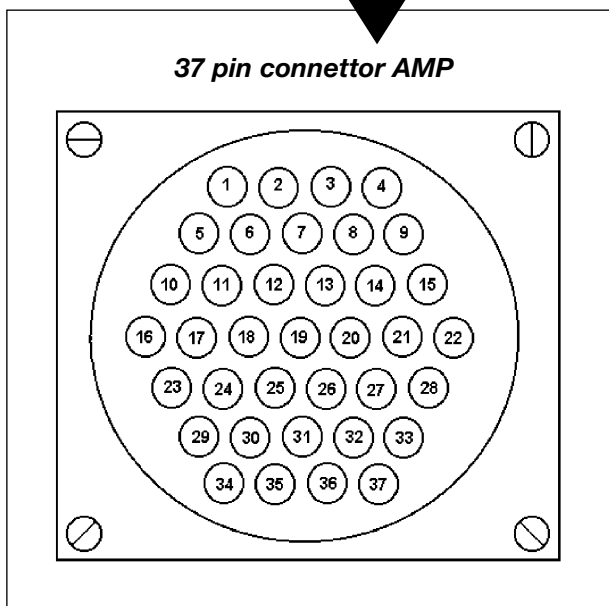
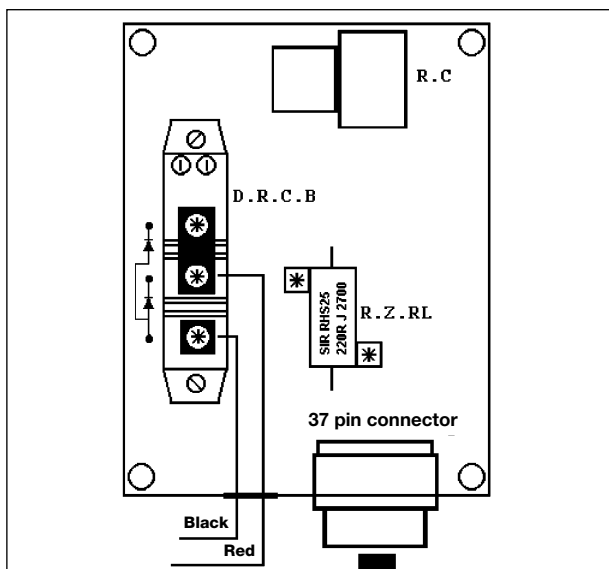
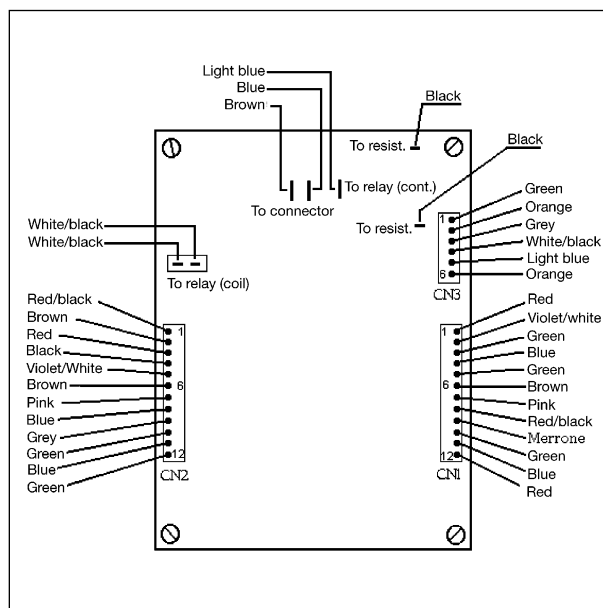
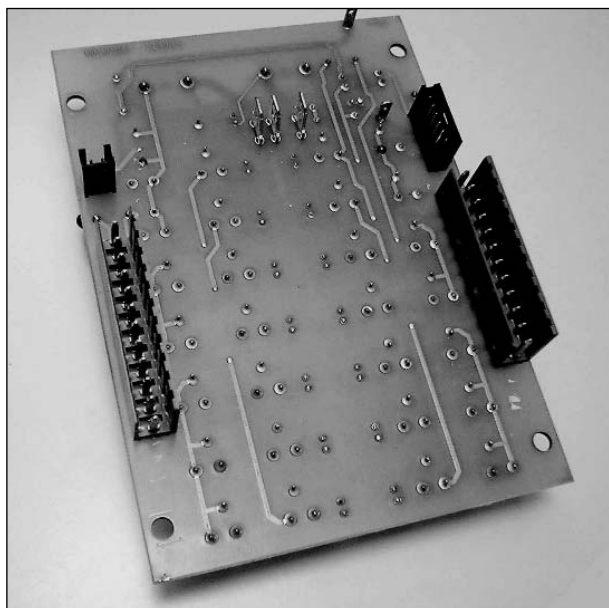


Every fuse is connected to a led that will light up in case of malfunctioning. Every fuse can be immediately recognized thanks to the clearly visible mark on the box (the fuses indications match those on the operational diagram)



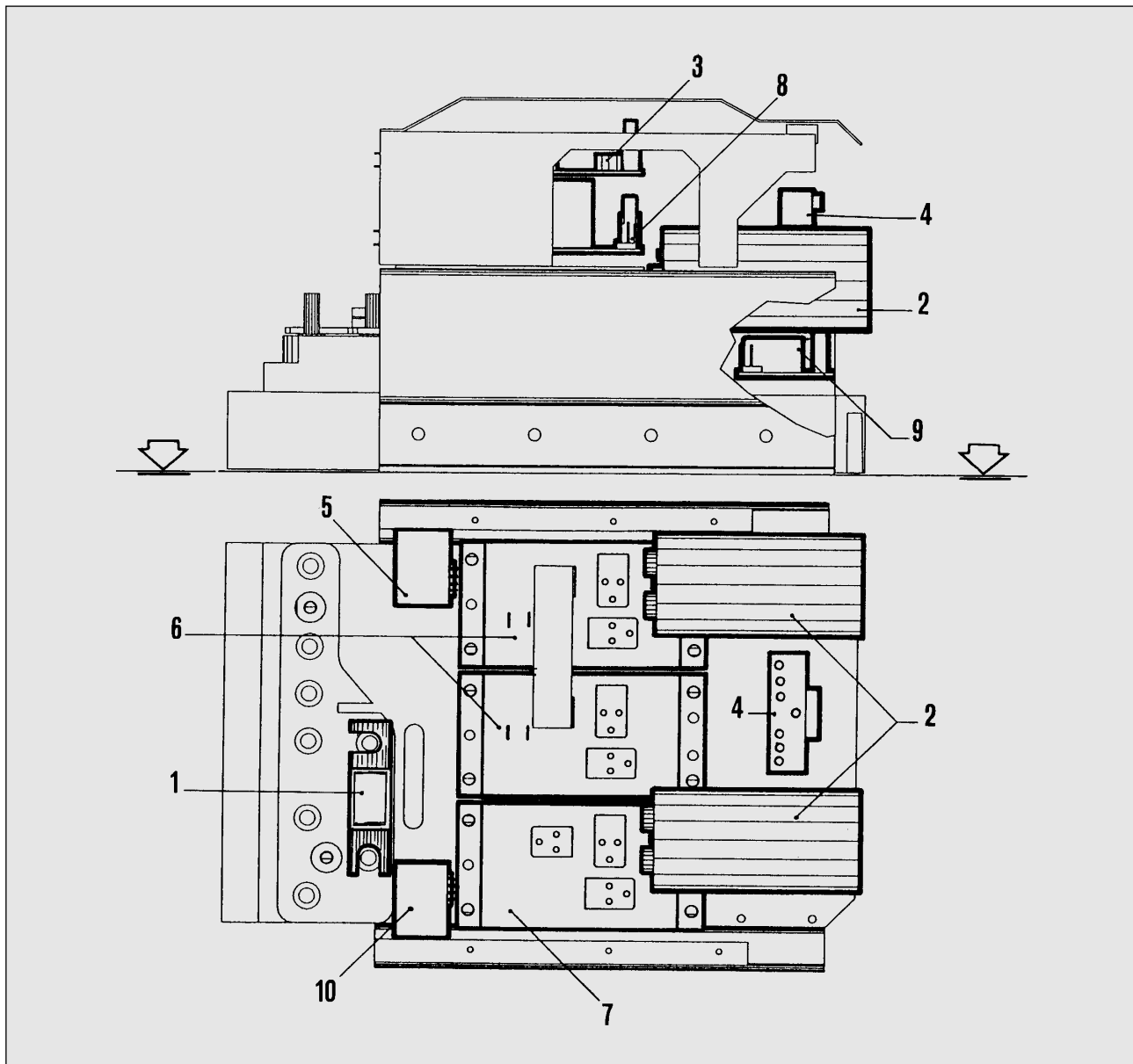
- F1. 25A** - Converter fuse
- F2. 5A** - Brakelights fuse
- F3. 10A** - Ignition switch fuse
- F4. 5A** - Reverse lights fuse
- F5. 10A** - Electric horn fuse
- F6. 10A**
- F7. 10A**
- F8. 10A**

- F9. 10A**
- F10. 10A**
- F11. 10A**
- F12. 10A**
- F13. 10A**
- F14. 10A**
- F15. 10A**

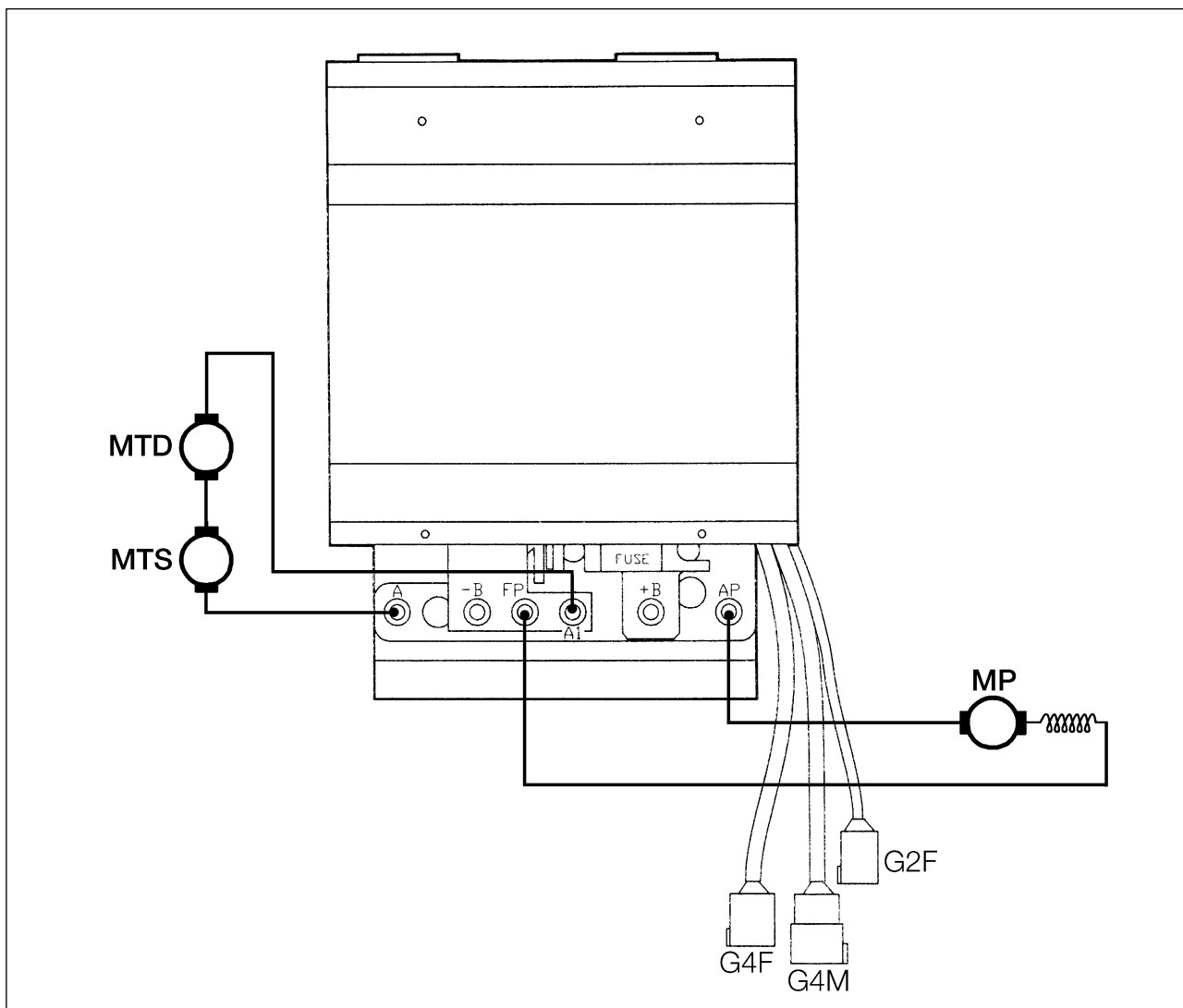


1. empty
2. Violet / white (CN1-pin 2)
3. empty
4. green (CN2 – pin10)
5. Blue (CN2 – pin11)
6. Green (CN2 – pin 12)
7. Blue (CN2 – pin 8)
8. Grey (CN2 – pin9)
9. Red (CN1 – pin 1)
10. Red (CN2 – pin 3)
11. Black (CN2 – pin 4)
12. Green (CN1 – pin 3)
13. Pink (CN2 – pin 7)
14. Violet / White (CN2 – pin 5)
15. Brown (CN2 – pin2)
16. Brown (faston)
17. Brown (CN1 – pin 9)
18. Red (CN1 – pin 12)
19. Red / Black (CN1 – pin 8)
20. Pink (CN1 – pin 7)
21. Grey (CN1 – pin 5)
22. Brown (CN1 – pin 6)
23. Blue (faston)
24. Red / Black (CN2 – pin 1)
25. Blue (CN1 – pin 4)
26. Green ( CN1 – pin 10)
27. Blue (CN1 – pin 11)
28. empty
29. Blue (relay contact)
30. Green ( CN3 – pin 1)
31. Brown (CN2 – pin 2)
32. Light Blue (CN3 – pin 3)
33. Grey (CN3 – pin 3)
34. Blue (relay contact)
35. empty
36. Orange (CN3 – pin 2)
37. White / Black (CN3 – pin 4)

## CHOPPER COMPONENTS



- |                                            |                                          |
|--------------------------------------------|------------------------------------------|
| 1. Fuse                                    | 6. Braking traction module               |
| 2. Battery filter condensers               | 7. Pump module                           |
| 3. Micro-switch board                      | 8. Power supply card (card power supply) |
| 4. Card                                    | 9. Field control card                    |
| 5. Hall probe for braking traction current | 10. Hall probe for pump current          |

**CHOPPER CONNECTIONS****CONNECTOR G4F**

|                          |       |
|--------------------------|-------|
| Pin 1= RIGHT MOTOR FIELD | white |
| Pin 2= RIGHT MOTOR FIELD | blue  |
| Pin 3= LEFT MOTOR SUPPLY | black |
| Pin 4= LEFT MOTOR SUPPLY | red   |

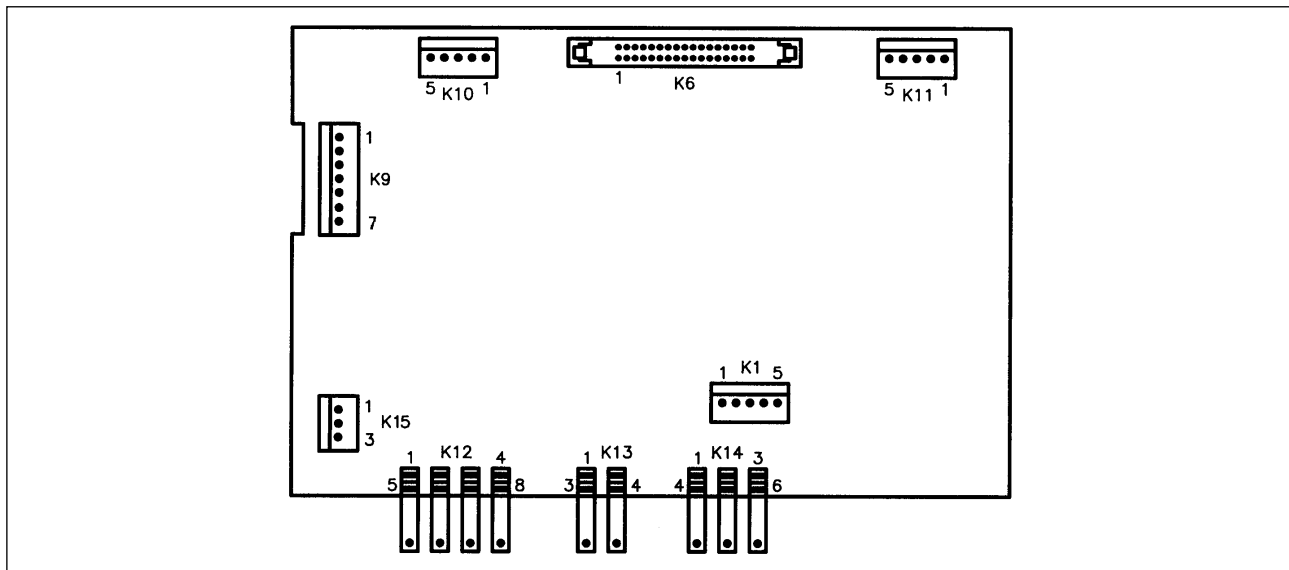
**CONNECTOR G4M**

|                                   |             |
|-----------------------------------|-------------|
| Pin 1= + CARD POWER SUPPLY        | pink/yellow |
| Pin 2= + MOTOR FAN POWER SUPPLY   | blue/red    |
| Pin 3= + CHOPPER FAN POWER SUPPLY | mauve       |
| Pin 4= Free                       |             |

**CONNECTOR G2F**

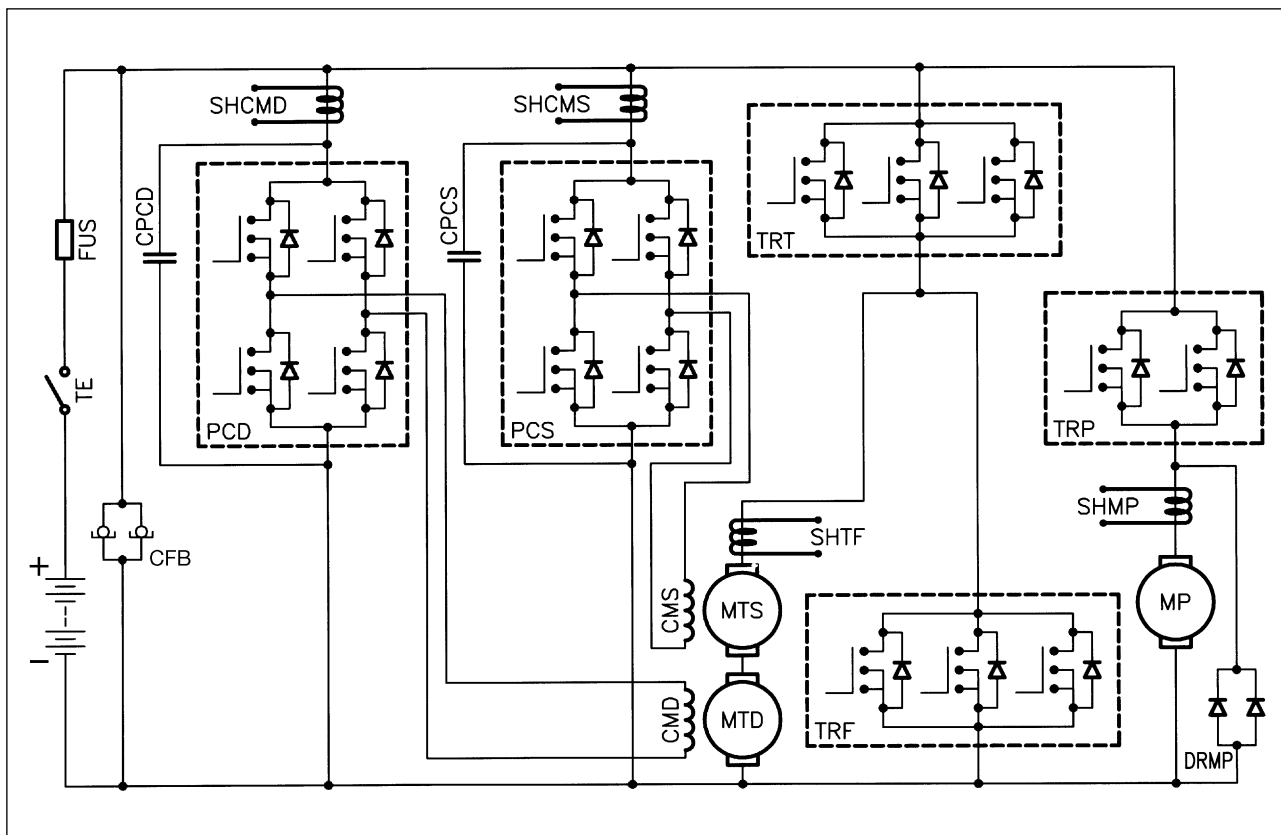
|                                            |      |
|--------------------------------------------|------|
| Pin 1= HALL PROBE POWER SUPPLY FOR LIFTING | red  |
| Pin 2= HALL PROBE POWER SUPPLY FOR LIFTING | blue |

**MP.** Pump/power steering**MTD.** Right**MTS.** Left**+B.** Battery positive input**-B.** Battery negative input**A.** Motors power supply**A1.** Motors power supply**AP.** Pump/power steering power supply**FP.** Pump/power steering power supply

**POWER CARD**

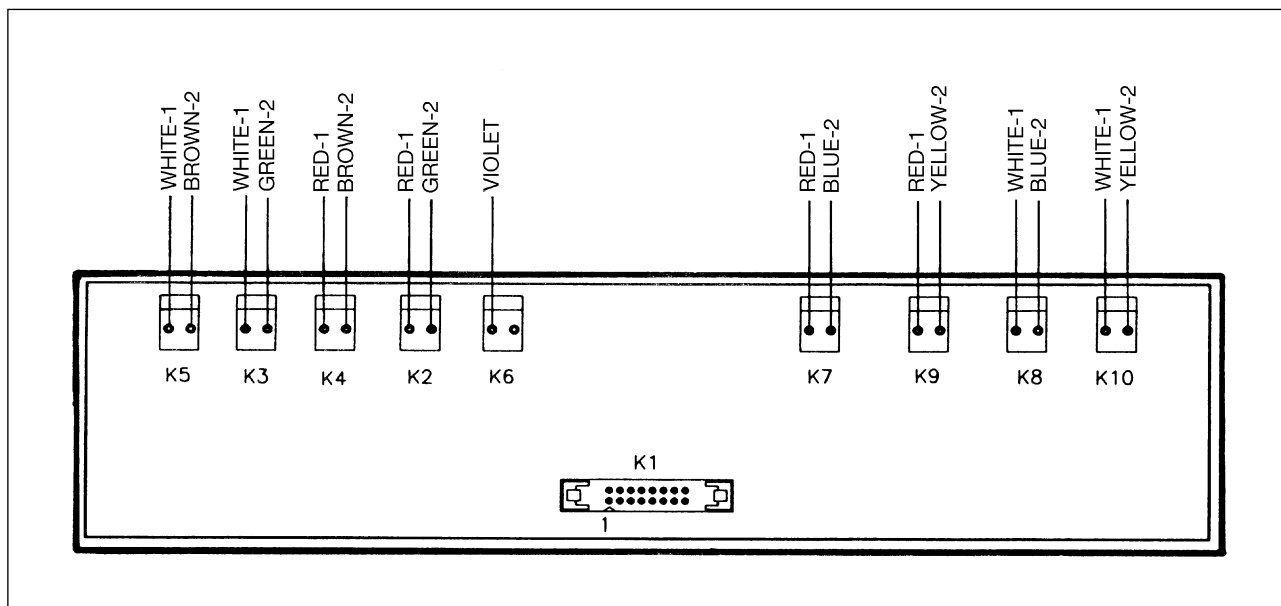
|       |                                        |            |                     |
|-------|----------------------------------------|------------|---------------------|
| K1 1  | - + MOTOR FAN POWER SUPPLY             | +B         | Blue/Red            |
| K1 2  | - - BATTERY                            | -B         | Black               |
| K1 3  | - CONDENSER PRECHARGE                  | +B         | Violet              |
| K1 4  | - FREE                                 |            |                     |
| K1 5  | - + CARD POWER SUPPLY BATTERY          | +B         | Pink/yellow         |
| K 6   | - MICRO CARD CONNECTIONS               |            |                     |
| K9 1  | - TRT GATE                             |            | Red                 |
| K9 2  | - TRT SOURCE                           | 0V → 14V } | Blue                |
| K9 3  | - TRT GATE                             |            | Red                 |
| K9 4  | - TRT SOURCE                           | 0V → 14V } | Blue                |
| K9 5  | - FREE                                 |            |                     |
| K9 6  | - FREE                                 |            |                     |
| K9 7  | - TRT DRAIN                            | +B         | Violet              |
| K10 1 | - TRF GATE                             |            | Red                 |
| K10 2 | - TRF SOURCE                           | 0V → 12V } | Light Blue          |
| K10 3 | - TRF DRAIN                            | +B         | Pink                |
| K10 4 | - TRF GATE                             |            | Red                 |
| K10 5 | - TRF SOURCE                           | 0V → 12V } | Light Blue          |
| K11 1 | - TRP GATE                             |            | Red                 |
| K11 2 | - TRP SOURCE                           | 0V → 14V } | Light Blue          |
| K11 3 | - TRP DRAIN                            | +B         | Violet              |
| K11 4 | - FREE                                 |            |                     |
| K11 5 | - FREE                                 |            |                     |
| K12 1 | - DRIVE MOTOR 1 BRUSHES                |            | Grey/Green          |
| K12 2 | - DRIVE MOTOR 1 BRUSHES                | 0V → +B }  | Grey/Green          |
| K12 3 | - DRIVE MOTOR 2 BRUSHES                |            | Grey/Green          |
| K12 4 | - DRIVE MOTOR 2 BRUSHES                | 0V → +B }  | Grey/Green          |
| K12 5 | - PUMP MOTOR FAN BRUSHES               |            | Light Blue/White    |
| K12 6 | - -B MOTOR FAN POWER FEEDER            | 0V → +B    | White/Green         |
| K12 7 | - PUMP MOTOR BRUSHES                   |            | Light Blue/White    |
| K12 8 | - + REMOTE-CONTROL SWITCH POWER FEEDER | +B         | Red/Green           |
| K13 1 | - - PEDAL BATTERY AND SHIELDING        |            | White - White/Black |
| K13 2 | - FREE.                                |            |                     |
| K13 3 | - + PEDAL POWER SUPPLY                 | +12V       | Green               |
| K13 4 | - + 24V AFTER KEY                      | +24V       | Red/Black           |
| K14 1 | - 1° LH STEERING MICRO                 | +5V → -B   | Yellow/Black        |
| K14 2 | - 2° RH STEERING MICRO                 | +5V → -B   | White/Black         |
| K14 3 | - 1° RH STEERING MICRO                 | +5V → -B   | Pink/Black          |
| K14 4 | - 2° LH STEERING MICRO                 | +5V → -B   | Grey/Black          |
| K14 5 | - - STEERING MICRO COMMON BATTERY      |            | Black               |
| K14 6 | - FREE                                 |            |                     |
| K15 1 | - FREE                                 |            |                     |
| K15 2 | - + 24V INNER KEY                      | +24V       | Orange              |
| K15 3 | - FREE                                 |            |                     |

## POWER CARD ELECTRIC PLANT



|              |                                 |
|--------------|---------------------------------|
| <b>TE</b>    | EMERGENCY REMOTE-CONTROL SWITCH |
| <b>TRT</b>   | DRIVE TRANSISTOR                |
| <b>TRF</b>   | BRAKING TRANSISTOR              |
| <b>CFB</b>   | BATTERY FILTER CONDENSER        |
| <b>TRP</b>   | PUMP TRANSISTOR                 |
| <b>MP</b>    | PUMP MOTOR                      |
| <b>DRMP</b>  | PUMP MOTOR RECIRCULATION DIODE  |
| <b>FUS</b>   | FUSE                            |
| <b>CPCD</b>  | RIGHT FIELD BRIDGE CONDENSER    |
| <b>CPSC</b>  | LEFT FIELD BRIDGE CONDENSER     |
| <b>PCD</b>   | RIGHT FIELD BRIDGE              |
| <b>PCS</b>   | LEFT FIELD BRIDGE               |
| <b>MTD</b>   | RIGHT DRIVE MOTOR               |
| <b>MTS</b>   | LEFT DRIVE MOTOR                |
| <b>SHCMD</b> | RIGHT MOTOR FIELD HALL SENSOR   |
| <b>SHCMS</b> | LEFT MOTOR FIELD HALL SENSOR    |
| <b>SHTF</b>  | BRAKING DRIVE HALL SENSOR       |
| <b>SHMP</b>  | PUMP MOTOR HALL SENSOR          |
| <b>CMD</b>   | RIGHT MOTOR FIELD               |
| <b>CMS</b>   | LEFT MOTOR FIELD                |

## FIELD CARD



K1 - MICRO CARD CONNECTION

K2 1 - GATE FORWARD  
K2 2 - SOURCE FORWARD

K3 1 - GATE REVERSE  
K3 2 - SOURCE REVERSE

K4 1 - GATE REVERSE  
K4 2 - SOURCE REVERSE

K5 1 - GATE FORWARD  
K5 2 - SOURCE FORWARD

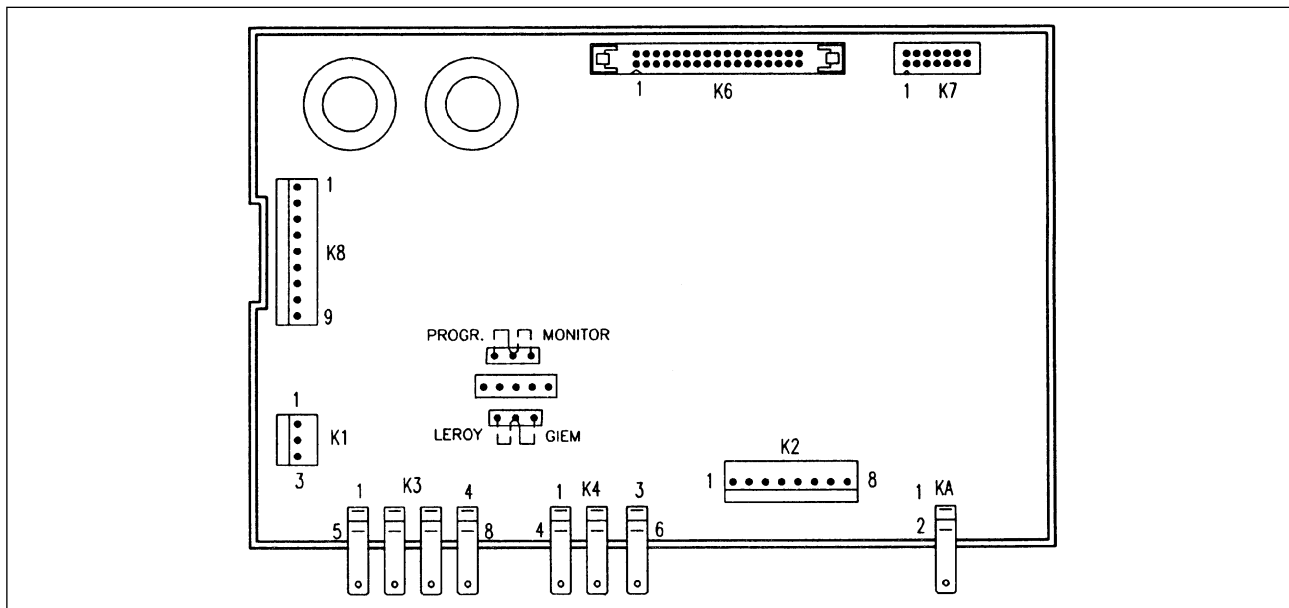
K6 1 - + V CONDENSERS  
K6 2 - + V CONDENSERS

K7 1 - GATE FORWARD  
K7 2 - SOURCE FORWARD

K8 1 - GATE REVERSE  
K8 2 - SOURCE REVERSE

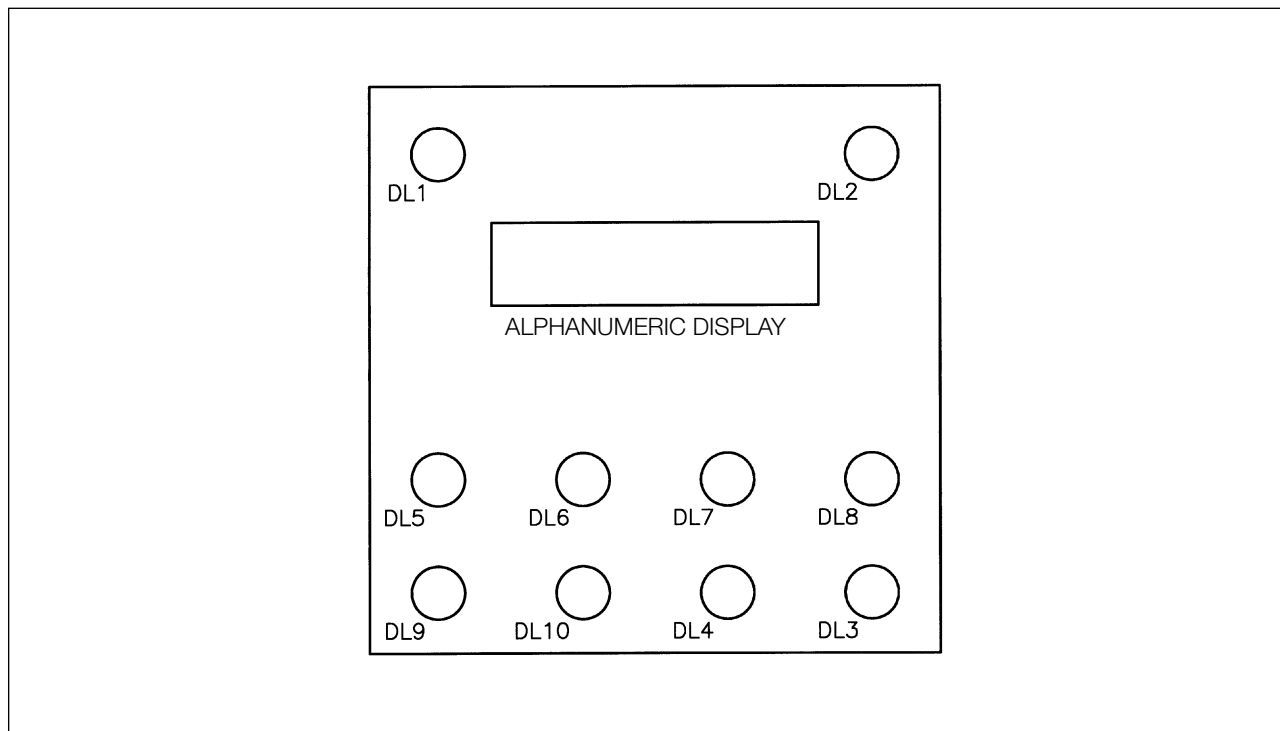
K9 1 - GATE REVERSE  
K9 2 - SOURCE REVERSE

K10 1 - GATE FORWARD  
K10 2 - SOURCE FORWARD

**MICRO CARD**

|      |                                           |           |               |
|------|-------------------------------------------|-----------|---------------|
| K1 1 | - + SWITCH THERMO                         | -B → 5V   | Yellow        |
| K1 2 | - - SWITCH THERMO                         | -B        | Yellow        |
| K1 3 | - FREE                                    |           |               |
| K2 1 | - DISPLAY POWER SUPPLY                    | +7,5V     | Pink          |
| K2 2 | - CLOCK                                   |           | Brown         |
| K2 3 | - RX D                                    |           | Blue          |
| K2 4 | - S/P                                     |           | Yellow        |
| K2 5 | - - DISPLAY BATTERY                       |           | Grey          |
| K2 6 | - TX D                                    |           | White         |
| K2 7 | - ALARM                                   |           | Green         |
| K2 8 | - FREE                                    |           |               |
| K3 1 | - SAFETY CONTACT (SEAT MICRO)             | +5V → 0V  | Pink          |
| K3 2 | - DRIVE MOTOR CONTACT                     |           | Grey          |
| K3 3 | - FREE                                    |           |               |
| K3 4 | - BRAKE PEDAL                             | +5V → 0V  | White/Red     |
| K3 5 | - HANDBRAKE                               | -B → 5V   | Grey/Black    |
| K3 6 | - PEDAL OUTPUT                            | 0V → 11V  | Brown         |
| K3 7 | - FREE                                    |           |               |
| K3 8 | - LIFT SPEED SIGNAL                       | 4,5 → 8V~ | Yellow/Green  |
| K4 1 | - REVERSE MICRO                           | +5V → 0V  | White         |
| K4 2 | - SWING MICRO                             | -B → 5V   | Violet /White |
| K4 3 | - FREE                                    |           |               |
| K4 4 | - FORWARD MICRO                           | +5 → 0V   | Brown         |
| K4 5 | - LATERAL MOVEMENT MICRO                  | -B → 5V   | Brown/White   |
| K4 6 | - 4° ELEMENT DISTRIBUTOR MICRO            | -B → 5V   | Yellow/Black  |
| K6   | - POWER CARD CONNECTIONS                  |           |               |
| K7   | - FIELD CARD CONNECTION                   |           |               |
| K8 1 | - - PUMP CURRENT SENSOR                   | -B        | Brown         |
| K8 2 | - + PUMP CURRENT SENSOR                   |           | Black         |
| K8 3 | - + 12V PUMP CURRENT SENSOR POWER SUPPLY  |           | Yellow        |
| K8 4 | - - 12V PUMP CURRENT SENSOR POWER SUPPLY  |           | Blue          |
| K8 5 | - - CURRENT SENSOR BATTERY                |           | Grey          |
| K8 6 | - - DRIVE CURRENT SENSOR                  | -B        | Brown         |
| K8 7 | - + DRIVE CURRENT SENSOR                  |           | Black         |
| K8 8 | - + 12V DRIVE CURRENT SENSOR POWER SUPPLY |           | Yellow        |
| K8 9 | - - 12V DRIVE CURRENT SENSOR POWER SUPPLY |           | Blue          |
| KA 1 | - FREE                                    |           |               |
| KA 2 | - FREE                                    |           |               |

## DISPLAY CONNECTIONS



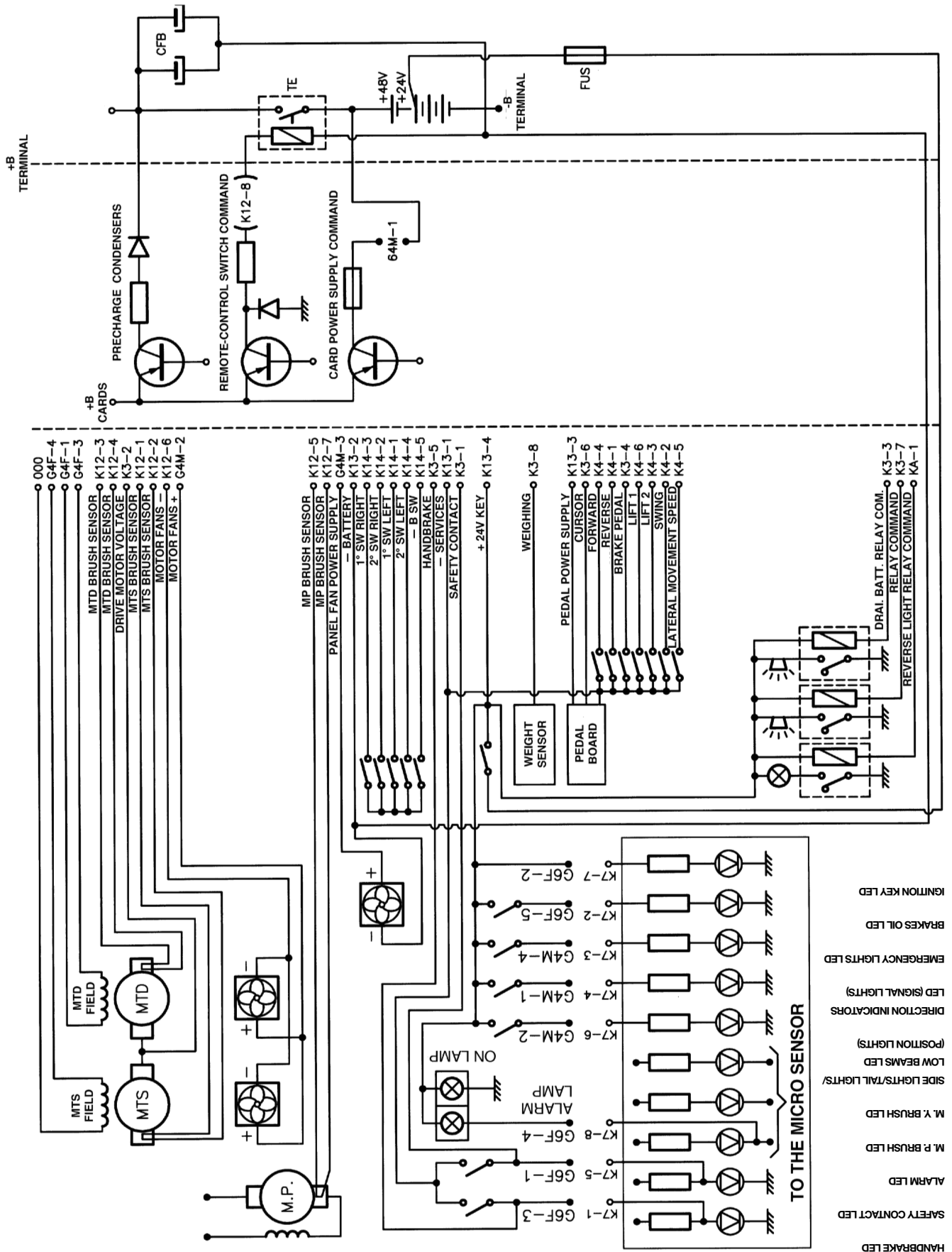
- K3 1 - DISPLAY POWER SUPPLY
- K3 2 - DISPLAY BATTERY
- K3 3 - Tx D
- K3 4 - CLOCK
- K3 5 - S/P
- K3 6 - Rx D
- K3 7 - ALARM
- K3 8 - N.C.
- K3 9 - N.C.

- K1 1 - HANDBRAKE LED COMMAND
- K1 2 - BRAKE OIL LED COMMAND
- K1 3 - EMERGENCY LIGHTS LED COMMAND
- K1 4 - SIGNAL LIGHTS LED COMMAND
- K1 5 - SAFETY CONTACT LED COMMAND
- K1 6 - POSITION AND LOW BEAM LIGHTS LED COMMAND
- K1 7 - KEY LED COMMAND
- K1 8 - ALARM LED COMMAND

- DL1 - KEY LED
- DL2 - ALARM LED
- DL3 - BRAKE OIL LED
- DL4 - EMERGENCY LIGHTS LED
- DL5 - SAFETY CONTACT LED
- DL6 - HANDBRAKE LED
- DL7 - DRIVE MOTOR BRUSHES LED
- DL8 - PUMP MOTOR BRUSHES LED
- DL9 - POSITION AND LOW BEAM LIGHTS LED
- DL10 - SIGNAL LIGHTS LED

N.B. THE K3 AND K1 CONNECTORS ARE LOCATED ON THE BACK OF THE DISPLAY CARD

## CONTROL CABLING



## HYDRAULIC CIRCUIT CALIBRATION

### GIEM Pump Motor (Marelli)

| Hydraulic Pump Speed | Idling Motor Speed | Idling Motor. Acc. | By-Pass Motor S. | By-pass Motor Acc. | Revolutions |
|----------------------|--------------------|--------------------|------------------|--------------------|-------------|
| Level 1              | 6                  | 40                 | 13,6             | 107                | 950         |
| Level 2              | 6,7                | 41                 | 15               | 126                | 1050        |
| Level 3              | 7,5                | 53                 | 16               | 127                | 1150        |

### Lift Speed

The lift speed is adjusted from the position of the lever on the distributor

| Azimuth Rate | Idling Motor Speed | Idling Motor. Acc. | By-Pass Motor S. | By-pass Motor Acc. | Revolutions |
|--------------|--------------------|--------------------|------------------|--------------------|-------------|
| Level 1      | 7,5                | 58                 | 20,7             | 259                | 800         |
| Level 2      | 8,5                | 62                 | 22,1             | 261                | 900         |
| Level 3      | 9                  | 61                 | 23,5             | 261                | 1000        |
| Level 4      | 10                 | 62                 | 24               | 262                | 1050        |
| Level 5      | 11,5               | 63                 | 25               | 266                | 1100        |

| Integr. Side Move. (ISM) Speed | Idling Motor Speed | Idling Motor. Acc. | By-Pass Motor S. | By-pass Motor Acc. | Revolutions |
|--------------------------------|--------------------|--------------------|------------------|--------------------|-------------|
| Level 1                        | 11,5               | 96                 | 14               | 148                | 800         |
| Level 2                        | 12,5               | 106                | 15,5             | 152                | 900         |
| Level 3                        | 13,5               | 109                | 16,8             | 160                | 1000        |
| Level 4                        | 14                 | 115                | 18,5             | 165                | 1050        |
| Level 5                        | 14                 | 115                | 18,5             | 165                | 1050        |

## HYDRAULIC CIRCUIT CALIBRATION

### LEROY Pump Motor

| Hydraulic Pump Speed | Idling Motor Speed | Idling Motor. Acc. | By-Pass Motor S. | By-pass Motor Acc. | Revolutions |
|----------------------|--------------------|--------------------|------------------|--------------------|-------------|
| Level 1              | 5                  | 51                 | 12               | 125                | 950         |
| Level 2              | 6                  | 52                 | 13               | 126                | 1050        |
| Level 3              | 7                  | 54                 | 15               | 126                | 1150        |

### Velocità sollevamento

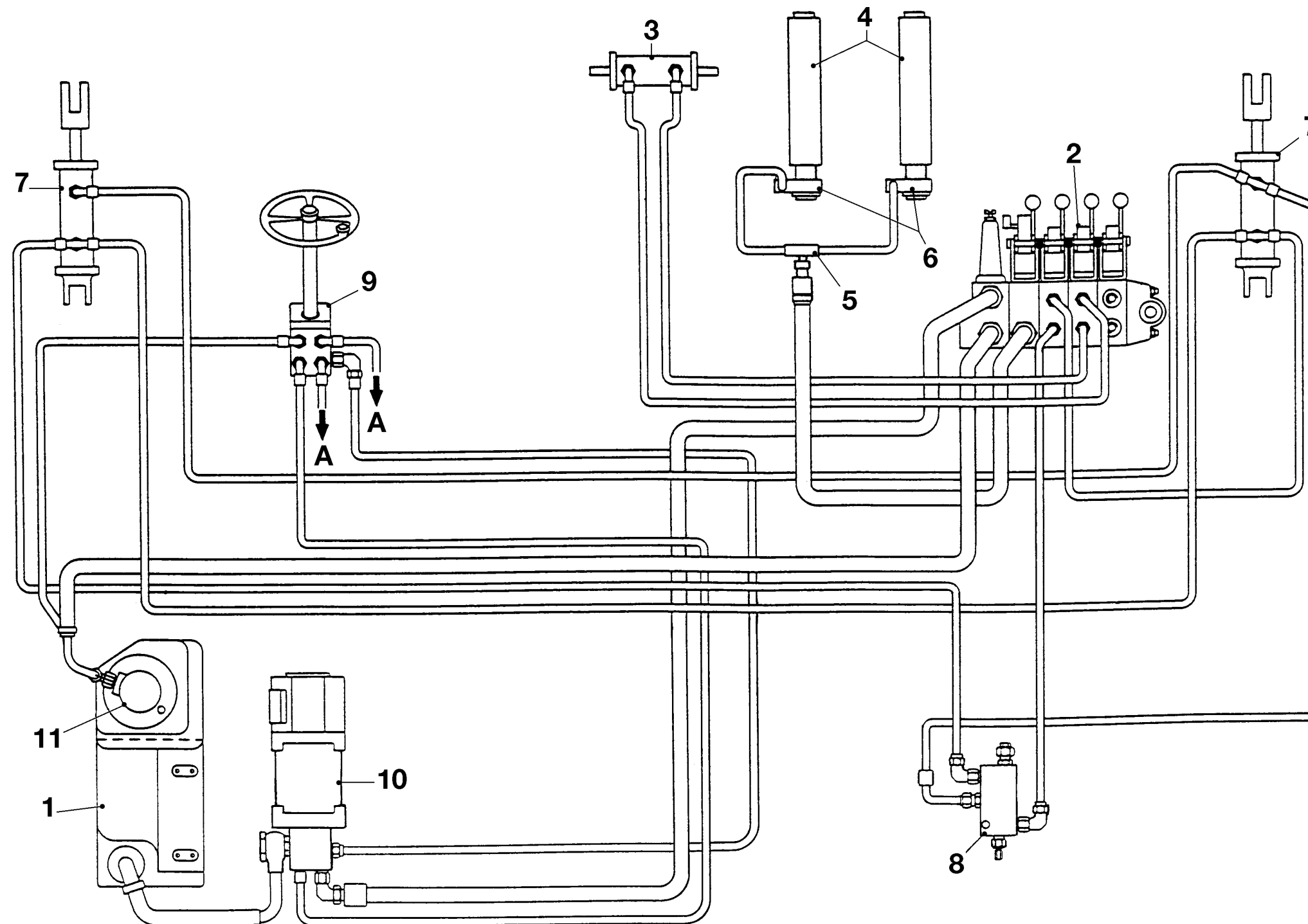
La velocità di sollevamento viene regolata dalla posizione della leva sul distributore.

| Azimuth Rate | Idling Motor Speed | Idling Motor. Acc. | By-Pass Motor S. | By-pass Motor Acc. | Revolutions |
|--------------|--------------------|--------------------|------------------|--------------------|-------------|
| Level 1      | 6                  | 65                 | 17               | 230                | 800         |
| Level 2      | 7                  | 66                 | 18               | 230                | 900         |
| Level 3      | 8                  | 68                 | 19               | 230                | 1000        |
| Level 4      | 9                  | 69                 | 20               | 230                | 1050        |
| Level 5      | 9,5                | 75                 | 21               | 230                | 1100        |

| Integr. Side Move. (ISM) Speed | Idling Motor Speed | Idling Motor. Acc. | By-Pass Motor S. | By-pass Motor Acc. | Revolutions |
|--------------------------------|--------------------|--------------------|------------------|--------------------|-------------|
| Level 1                        | 8                  | 96                 | 17               | 230                | 800         |
| Level 2                        | 11                 | 100                | 18               | 230                | 900         |
| Level 3                        | 12                 | 105                | 20               | 230                | 1000        |
| Level 4                        | 12,5               | 108                | 21               | 230                | 1050        |
| Level 5                        | 12,5               | 108                | 21               | 230                | 1050        |

# HYDRAULIC CIRCUITS

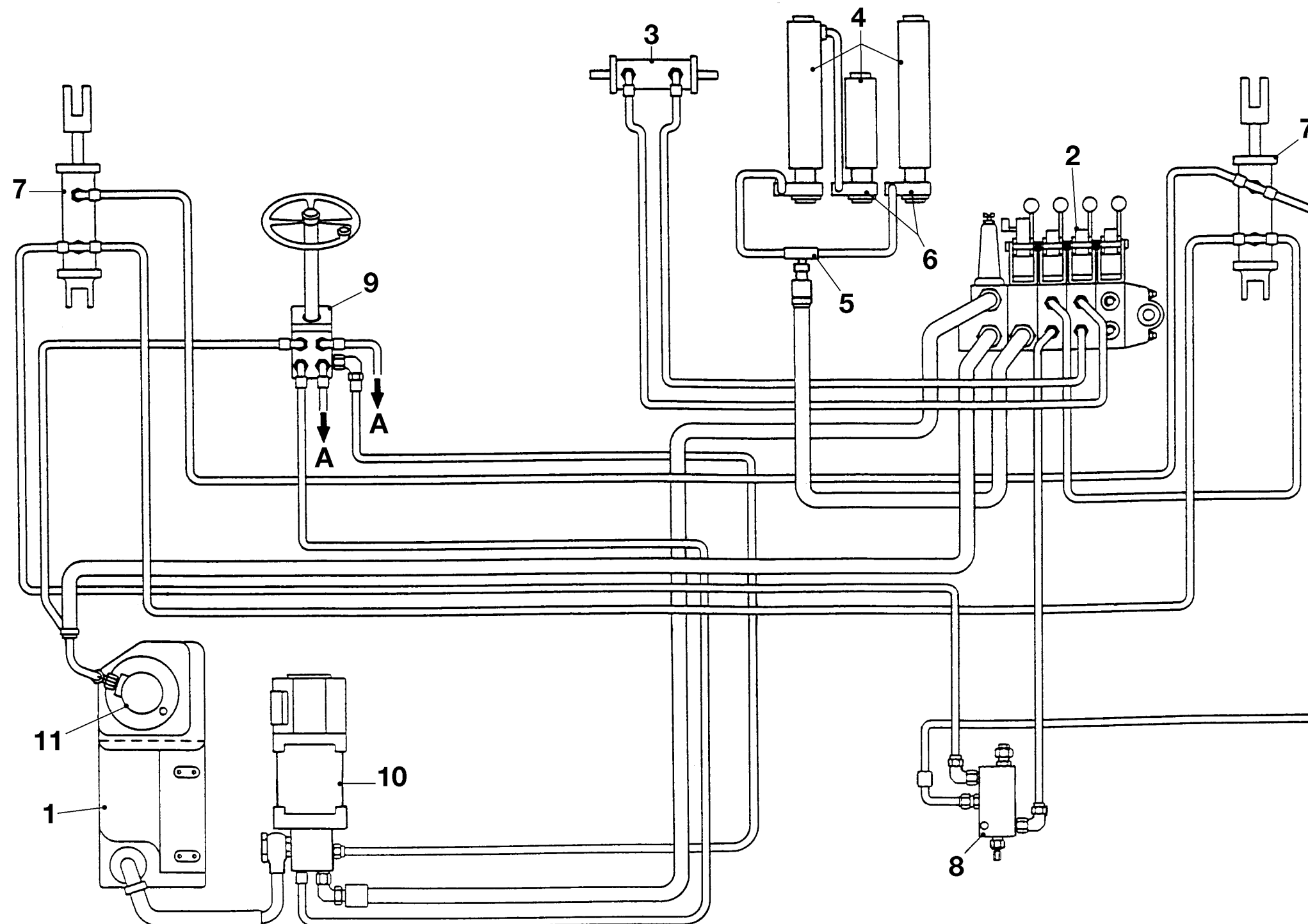




- A. to power steering cylinder
- 1. oil tank
  - 2. hydraulic distributor
  - 3. side movement cylinder
  - 4. lift cylinders
  - 5. deceleration valve
  - 6. safety valve
  - 7. upright tilt cylinders
  - 8. anticavitation stop valve
  - 9. hydraulic pump
  - 10. motor pump
  - 11. oil filter

**EU 3/12**  
**EU 3/15**  
**EU 3/17.5**  
**EU 15**  
**EU 17.5**

Hydraulic System Diagram referring to SIMPLEX Lift-truck



- A. to power steering cylinder
- 1. oil tank
- 2. hydraulic distributor
- 3. side movement cylinder
- 4. lift cylinders
- 5. deceleration valve
- 6. safety valve
- 7. upright tilt cylinders
- 8. anticavitation stop valve
- 9. hydraulic pump
- 10. motor pump
- 11. oil filter

**EU 3/12**  
**EU 3/15**  
**EU 3/17.5**  
**EU 15**  
**EU 17.5**

# WIRING DIAGRAMS



**KEYS OF DIAGRAM NO: 95351810**

|                     |                                                  |
|---------------------|--------------------------------------------------|
| <b>BATT.</b>        | 48V BATTERY                                      |
| <b>BZ.R. (VAR.)</b> | REVERSE BUZZER (589 VARIANT)                     |
| <b>C.A.</b>         | STARTING SWITCH                                  |
| <b>C.F.B.</b>       | BATTERY FILTER CAPACITOR                         |
| <b>C.S.</b>         | SEAT CONTACT                                     |
| <b>CLAC.</b>        | ELECTRIC HORN WITH BLANKER                       |
| <b>CONV.</b>        | 48/24V-200W VOLTAGE CONVERTER                    |
| <b>D.C.A.1</b>      | STARTING SWITCH DIODE 1                          |
| <b>D.C.A.2</b>      | STARTING SWITCH DIODE 2                          |
| <b>D.L.A.G.</b>     | GENERAL ALARM LED DIODE                          |
| <b>D.L.C.A.</b>     | STARTING SWITCH LED DIODE                        |
| <b>D.L.C.S.</b>     | SAFETY CONTACT LED DIODE                         |
| <b>D.L.F.M.</b>     | HAND BRAKE LED DIODE                             |
| <b>D.L.I.O.F</b>    | BRAKE OIL SWITCH LED DIODE                       |
| <b>D.L.L.D.</b>     | TURN INDICATOR LIGHT LED DIODE                   |
| <b>D.L.L.E.</b>     | EMERGENCY LIGHT LED DIODE                        |
| <b>D.I.P.A.</b>     | RUNNING LIGHT/LOW BEAM LED DIODE                 |
| <b>D.I.S.M.S.</b>   | LIFT BRUSH LED DIODE                             |
| <b>D.L.S.M.T.</b>   | TRACTION BRUSH LED DIODE                         |
| <b>D.P.E.</b>       | EMERGENCY BUTTON DIODE                           |
| <b>D.R.C.B.</b>     | BATTERY CURRENT CIRCULATION DUPLEX DIODE         |
| <b>D.TG.2</b>       | GENERAL REMOTE CONTROL SWITCH DUPLEX CIRCULATION |
| <b>D.V.M.P.</b>     | LIFT WHEEL DIODE                                 |
| <b>D.V.M.T.</b>     | WHEEL DIODE                                      |
| <b>F.C. (F1)</b>    | CONVERTER FUSE (250V-25A)                        |
| <b>F.CH (F3)</b>    | KEY FUSE (250V-10A)                              |
| <b>F.CL (F5)</b>    | HORN FUSE (250V-10A)                             |
| <b>F.G.</b>         | GENERAL FUSE                                     |
| <b>F.L.A. (F2)</b>  | STOP LIGHT FUSE (250V-5A)                        |
| <b>F.L.R. (F4)</b>  | BACKUP LIGHT FUSE (250V-5A)                      |
| <b>I.F.S.</b>       | STOP LIGHT AND BRAKING SWITCH                    |
| <b>I.O.F.</b>       | BRAKE OIL SWITCH                                 |
| <b>L.A.D.</b>       | RIGHT STOP LAMP                                  |
| <b>L.A.S.</b>       | LEFT STOP LAMP                                   |
| <b>L.R.D.</b>       | RIGHT BACKUP LAMP                                |
| <b>L.R.S.</b>       | LEFT BACKUP LAMP                                 |
| <b>M.S.I.</b>       | LIFT AND HYDRAULIC PUMP                          |
| <b>M.T.D.</b>       | RIGHT                                            |
| <b>M.T.S.</b>       | LEFT                                             |
| <b>MOS.F.T.</b>     | BREAKING MOS                                     |
| <b>MOS.P.</b>       | PUMP MOS                                         |
| <b>MOS.T.</b>       | MOS                                              |
| <b>NTC"1"</b>       | BACKUP LIGHT NTC                                 |
| <b>NTC"2"</b>       | STOP LIGHT NTC                                   |
| <b>P.A.</b>         | ACCELERATOR PEDAL                                |
| <b>P.CL.</b>        | HORN BUTTON                                      |
| <b>P.E.</b>         | EMERGENCY BUTTON                                 |
| <b>R.C.</b>         | CONVERTER RELAY                                  |
| <b>R.Z.RL.</b>      | BALLAST RESISTANCE RELAY                         |
| <b>S.A.</b>         | POWER CARD                                       |
| <b>S.C.M.T.</b>     | MOTOR FIELD CARD                                 |
| <b>S.CL.</b>        | HORN BLANKER                                     |
| <b>S.H.M.P.</b>     | LIFT HALL-ACTING SENSOR                          |
| <b>S.H.M.T.</b>     | HALL SENSOR                                      |
| <b>S.H.S.</b>       | LIFT SPEED CHANGE HALL SENSOR                    |
| <b>S.M.</b>         | MICRO CARD                                       |
| <b>S.R.B.</b>       | AZIMUTH RATE REED SWITCH                         |
| <b>S.R.D. 4TH</b>   | DISTRIBUTOR REED SWITCH 4TH ELEMENT              |
| <b>S.R.F.M.</b>     | HAND BRAKE REED SENSOR                           |
| <b>S.R.S.L.</b>     | SIDE MOVEMENT REED SWITCH                        |
| <b>T.G.1</b>        | GENERAL REMOTE CONTROL SWITCH 1                  |
| <b>T.G.2</b>        | GENERAL REMOTE CONTROL SWITCH 2                  |
| <b>V.P.</b>         | PANEL FAN                                        |

**Cable colours**

|          |             |
|----------|-------------|
| <b>A</b> | light blue  |
| <b>B</b> | white       |
| <b>C</b> | orange      |
| <b>G</b> | yellow      |
| <b>H</b> | grey        |
| <b>L</b> | blue        |
| <b>M</b> | brown       |
| <b>N</b> | black       |
| <b>O</b> | light brown |
| <b>R</b> | red         |
| <b>S</b> | pink        |
| <b>V</b> | green       |
| <b>Z</b> | purple      |

- FLASH LAMP 717 VAR. PREARR.
- 3-WHEEL VERSION STEERING
- POWER CARD
- MICRO CARD
- MANUAL REVERSE GEAR VARIANT
- REVERSE GEAR MICRO
- REVERSING GEAR
- RIGHT STEERING
- LEFT STEERING
- FORWARD GEAR



Electric System  
Operation Diagram  
N° 95351810 - (Rev. 01-12/2001)  
Printed 604.24.127

**KEYS OF DIAGRAM NO. 95351811/2/3**

BASIC LIGHTS VARIANT LOCATION  
GENERAL VARIANT LOCATION. (200/400W)  
DUPLEX AND PIVOTABLE HEADLIGHT VAR. LOCATION. (200/400W)  
DUPLEX AND WORKING HEADLIGHT VAR. LOCATION (200/400W)  
80W CONVERTER VAR. LOCATION  
FLASH HEADLIGHT VAR. LOCATION  
TO HORN BUTTON  
LIGHT LOCATION  
TO BRAKE OIL CONTACT  
TO HAND BRAKE MICRO  
TO DUPLEX BRAKE CONTACT  
TO PEDAL CARD  
TO PEDAL MICRO  
TO HORN  
TO MOTOR  
TO COMPONENT BOX  
CABLE LAYING SIDE VIEW  
COUPLING SIDE VIEW  
TO DISPLAY  
TO DISTRIBUTOR  
LIFT  
AZIMUTH RATE  
SIDE MOVEMENT  
TO BATTERY + (POS.)  
TO REMOTE CONTROL SWITCHES  
SCREENED CABLE  
TO STARTING SWITCH  
TO PANEL FAN  
TO EMERGENCY BUTTON  
TO PANEL  
TO BATTERY NEGATIVE

**Cable colours**

|          |             |
|----------|-------------|
| <b>A</b> | light blue  |
| <b>B</b> | white       |
| <b>C</b> | orange      |
| <b>G</b> | yellow      |
| <b>H</b> | grey        |
| <b>L</b> | blue        |
| <b>M</b> | brown       |
| <b>N</b> | black       |
| <b>O</b> | light brown |
| <b>R</b> | red         |
| <b>S</b> | pink        |
| <b>V</b> | green       |
| <b>Z</b> | purple      |





**KEYS OF DIAGRAM NO: 95350828**

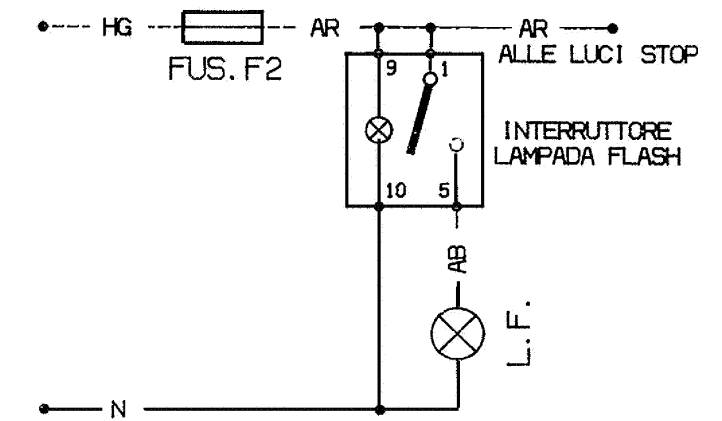
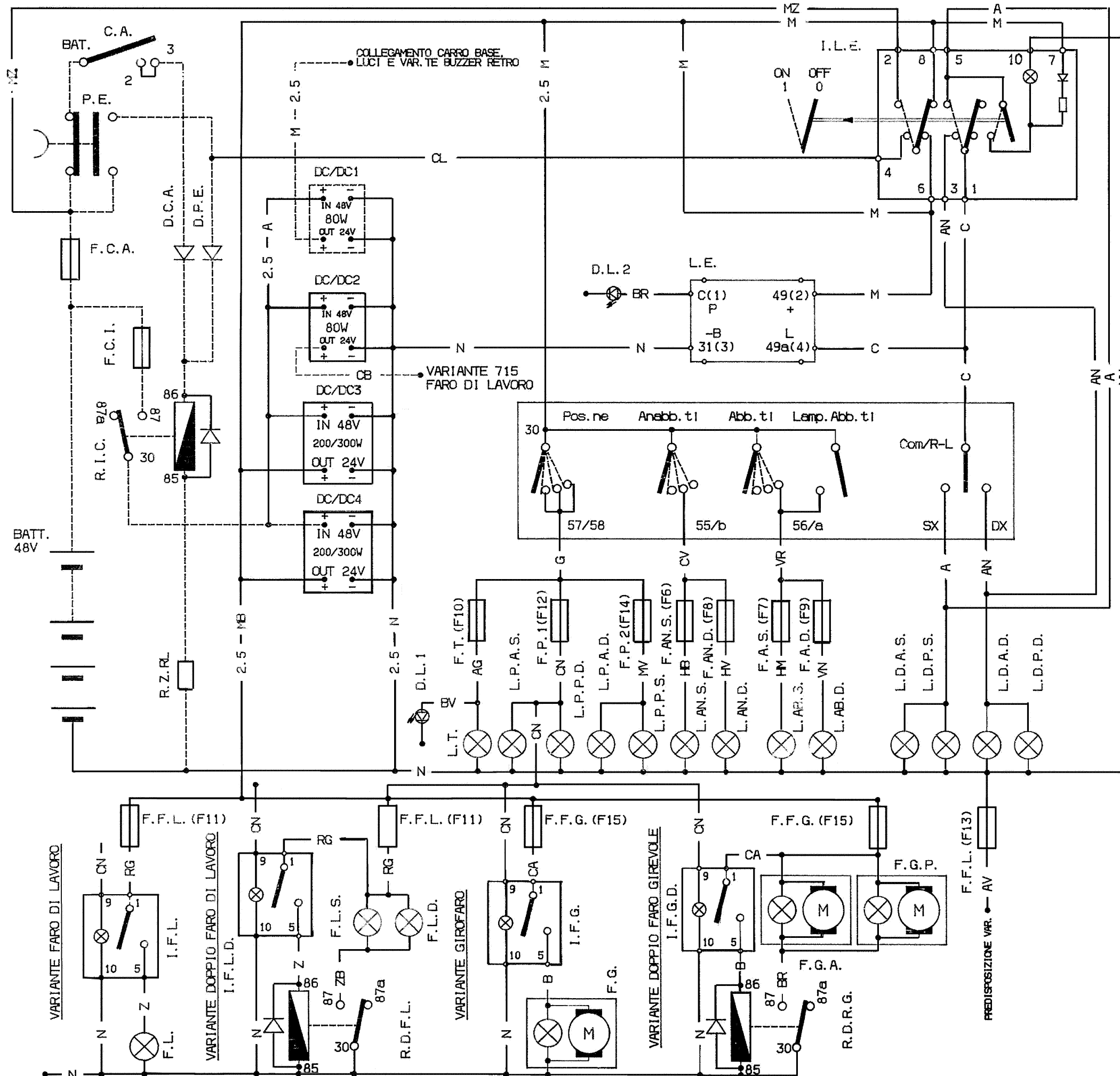
|                       |                                                               |
|-----------------------|---------------------------------------------------------------|
| <b>BATT.</b>          | 48V BATTERY                                                   |
| <b>CAN.</b>           | STARTING SWITCH                                               |
| <b>D.C.A.</b>         | STARTING SWITCH DIODE                                         |
| <b>D.L.1</b>          | DASHBOARD RUNNING LIGHT/LOW BEAM LED DIODE                    |
| <b>D.L.2</b>          | DASHBOARD BLINKER LED DIODE                                   |
| <b>D.P.E.</b>         | EMERGENCY BUTTON DIODE                                        |
| <b>DC/DC1</b>         | (BASE) LINDE CONVERTER (IN 48V OUT 24V-80W)                   |
| <b>DC/DC2</b>         | LINDE CONVERTER (WORKING HEADLIGHT VAR.) (IN 48V OUT 24V-80W) |
| <b>DC/DC3</b>         | ADDITIONAL DC/DC CONVERTER (IN 48V OUT 24V-200W)              |
| <b>DC/DC4</b>         | ADDITIONAL DC/DC CONVERTER (IN 48V OUT 24V-200W)              |
| <b>F.ABB.D. (F9)</b>  | RIGHT DRIVING BEAM FUSE                                       |
| <b>F.ABB.S. (F7)</b>  | LEFT DRIVING BEAM FUSE                                        |
| <b>F.AN.D. (F8)</b>   | RIGHT LOW BEAM                                                |
| <b>F.AN.S. (F6)</b>   | LEFT LOW BEAM                                                 |
| <b>F.C.A.</b>         | STARTING SWITCH FUSE                                          |
| <b>F.C.I.</b>         | CONVERTER FUSE                                                |
| <b>F.F.G.(F15)</b>    | PIVOTABLE HEADLIGHT FUSE                                      |
| <b>F.F.L. (F11)</b>   | WORKING HEADLIGHT FUSE                                        |
| <b>F.G.</b>           | PIVOTABLE HEADLIGHT                                           |
| <b>F.G.A.</b>         | FRONT PIVOTABLE HEADLIGHT                                     |
| <b>F.G.P.</b>         | BACK PIVOTABLE HEADLIGHT                                      |
| <b>F.L.</b>           | WORKING HEADLIGHT                                             |
| <b>F.L.D.</b>         | RIGHT WORKING HEADLIGHT                                       |
| <b>F.L.S.</b>         | LEFT WORKING HEADLIGHT                                        |
| <b>F.P.1 (F12)</b>    | RIGHT POS.LEFT FRONT RUNNING LIGHT FUSE                       |
| <b>F.P.2 (F14)</b>    | LEFT POS. LEFT FRONT RUNNING LIGHT FUSE                       |
| <b>F.T. (F10)</b>     | NUMBER PLATE LAMP                                             |
| <b>F.V.F.L. (F13)</b> | VARIANT FUSE                                                  |
| <b>I.F.G.</b>         | PIVOTABLE HEADLIGHT SWITCH                                    |
| <b>I.F.G.D.</b>       | DOUBLE PIVOTABLE HEADLIGHT SWITCH                             |
| <b>I.F.L.</b>         | WORKING HEADLIGHT SWITCH                                      |
| <b>I.F.L.D.</b>       | DOUBLE WORKING HEADLIGHT SWITCH                               |
| <b>I.L.E.</b>         | EMERGENCY LIGHT SWITCH                                        |
| <b>L.AB.D.</b>        | RIGHT DRIVING BEAM                                            |
| <b>L.AB.S.</b>        | LEFT DRIVING BEAM                                             |
| <b>L.AN.D.</b>        | RIGHT LOW BEAM                                                |
| <b>L.AN.S.</b>        | LEFT LOW BEAM                                                 |
| <b>L.DA.D.</b>        | RIGHT SIDE FRONT TURN INDICATOR                               |
| <b>L.DA.S.</b>        | LEFT SIDE FRONT TURN INDICATOR                                |
| <b>L.D.P.D.</b>       | RIGHT BACK TURN INDICATOR                                     |
| <b>L.D.P.S.</b>       | LEFT BACK TURN INDICATOR                                      |
| <b>L.E.</b>           | ELECTRONIC FLASH LIGHT                                        |
| <b>L.P.A.D.</b>       | RIGHT FRONT RUNNING LAMP                                      |
| <b>L.P.A.S.</b>       | LEFT FRONT RUNNING LAMP                                       |
| <b>L.P.P.D.</b>       | RIGHT BACK RUNNING LAMP                                       |
| <b>L.P.P.S.</b>       | LEFT BACK RUNNING LAMP                                        |
| <b>L.T.</b>           | NUMBER PLATE LAMP                                             |
| <b>P.E.</b>           | EMERGENCY BUTTON                                              |
| <b>R.D.F.L.</b>       | WORKING HEADLIGHT DUPLEX RELAY                                |
| <b>R.D.R.G.</b>       | PIVOTABLE HEADLIGHT DUPLEX RELAY                              |
| <b>R.I.C.</b>         | CONVERTER CONNECTION RELAY                                    |
| <b>R.Z.RL.</b>        | BALLAST RESISTANCE RELAY                                      |

**Cable colours**

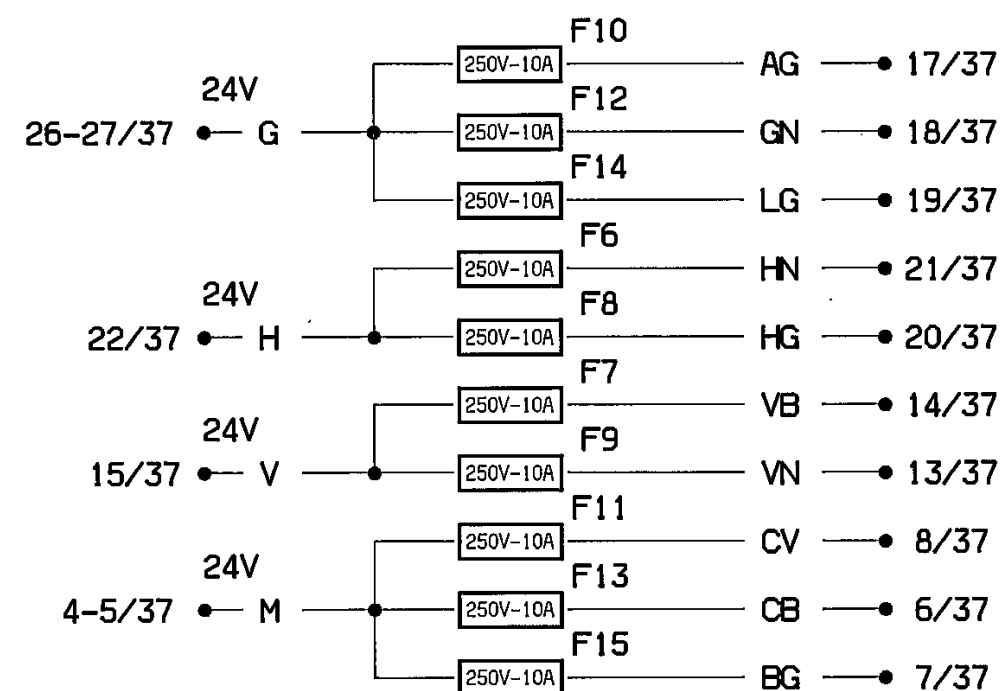
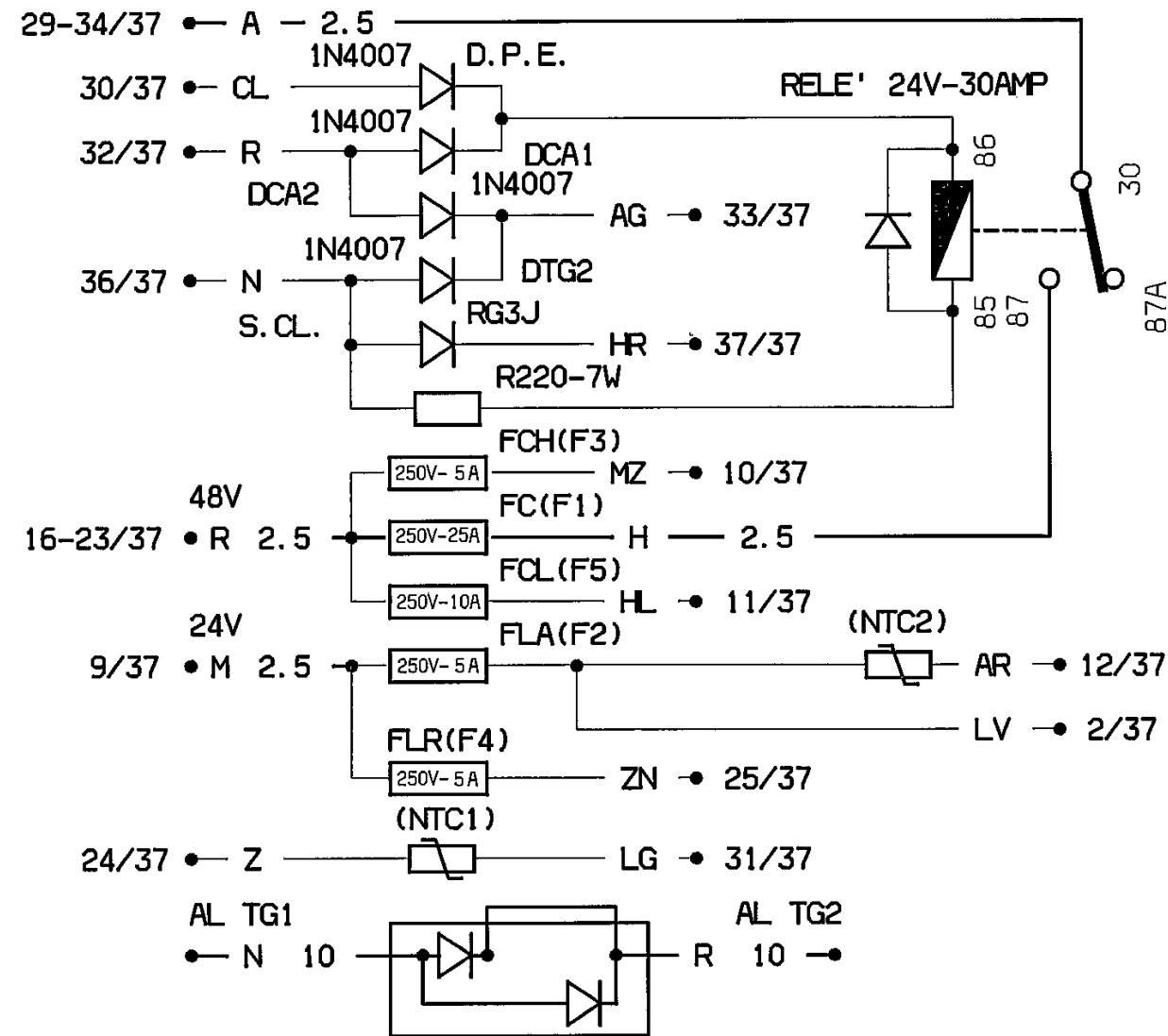
|          |             |
|----------|-------------|
| <b>A</b> | light blue  |
| <b>B</b> | white       |
| <b>C</b> | orange      |
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| <b>S</b> | pink        |
| <b>V</b> | green       |
| <b>Z</b> | purple      |

- WORKING HEADLIGHT VARIANT
- DOUBLE WORKING HEADLIGHT VARIANT
- PIVOTABLE HEADLIGHT VARIANT
- DOUBLE PIVOTABLE HEADLIGHT VARIANT
- LIGHT BASE TRUCK CONNECTION AND REVERSE
- GEAR BUZZER VAR.
- WORKING HEADLIGHT 715 VAR.
- RUNNING LIGHT
- LOW BEAM
- DRIVING LIGHT
- LOW BEAM LAMP
- TO STOP LIGHTS
- FLASH LAMP SWITCH
- FLASH LAMP





**EU 3/12**  
**EU 3/15**  
**EU 3/17.5**  
**EU 15**  
**EU 17.5**



| C O D I C E |         | C O L O R I |          |
|-------------|---------|-------------|----------|
| A           | Azzurro | N           | Nero     |
| B           | Bianco  | O           | Nocciola |
| C           | Arancio | R           | Rosso    |
| G           | Giallo  | S           | Rosa     |
| H           | Grigio  | V           | Verde    |
| L           | Blu     | Z           | Viola    |
| M           | Marrone |             |          |

**EU 3/12**  
**EU 3/15**  
**EU 3/17.5**  
**EU 15**  
**EU 17.5**



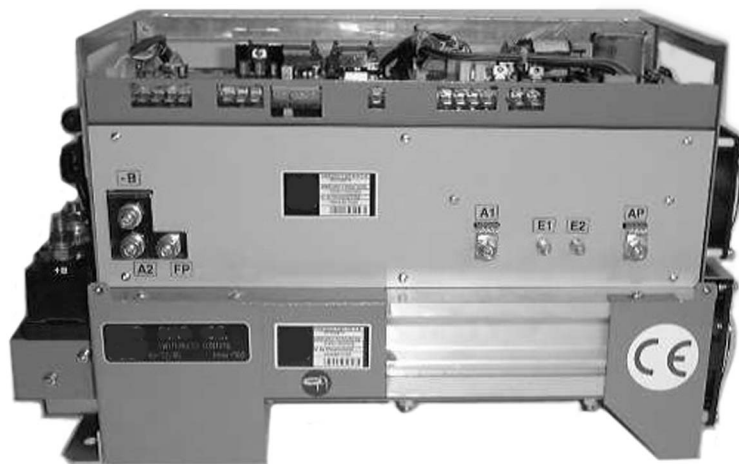
ELECTRONIC EQUIPMENT  
FOR LIFT TRUCKS

**EU 18 - EU 20 - EU 20L - EU 22**  
**EU 25 - EU 28 - EU 30**

FROM SERIAL No.

**EU 18 - EU 20 - EU 20L - EU 22**  
**EU 25 - EU 28 - EU 30**

F14004M00165  
F14007M00185





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## INTRODUCTION

The drive motor, drive field and pump motor are controlled separately by the SME chopper through a single microprocessor. This completely static device is built with MOSFET transistors to drive both the pump motor and the independent-excitation drive motor. There is a single power supply contactor which acts as a battery isolator. The power components and the electronic circuit boards, which are completed resin coated, are mounted on a finned aluminium dissipator. Therefore, this panel can operate in even severe environments (high humidity, strong vibrations, dusty locations, etc.)

Special attention was focused on the design of the electronic reset fuses to protect the chopper as well as the drive and pump motor components. The protection devices managed by the software and the high-speed types built through hardware processed by the microprocessor and remain stored even when the key has been removed, thus allowing fault diagnostics and a fault frequency analysis.

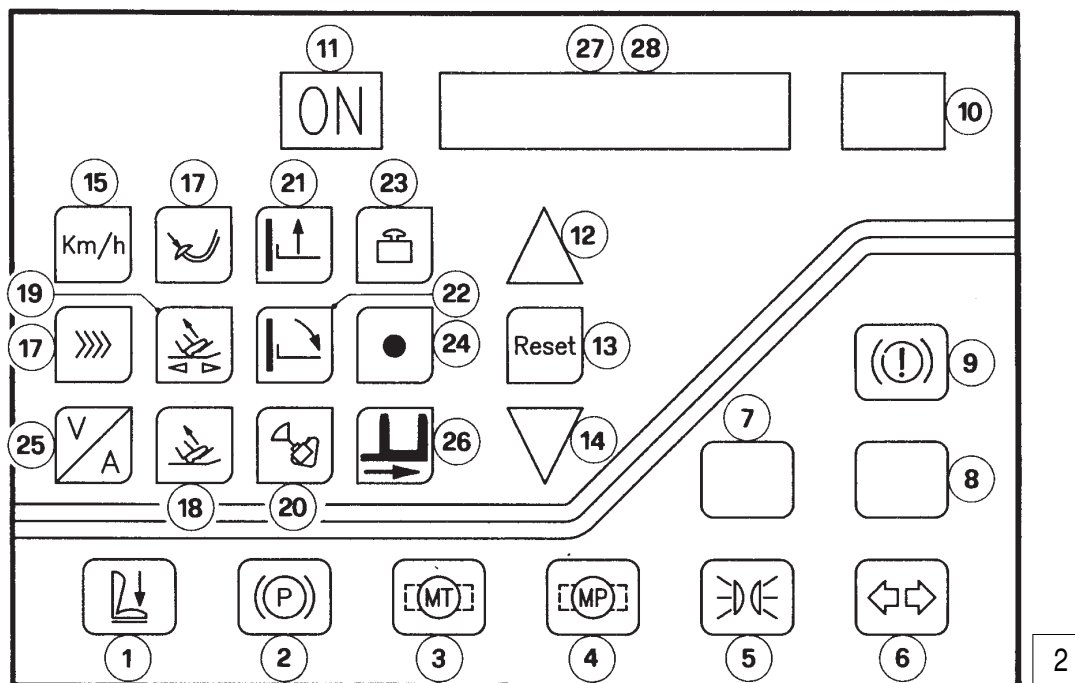
Operating parameters can be programmed and displayed using a push-button membrane instrument panel and liquid-crystal alphanumeric display (fig. 2).



1

## TECHNICAL DATA

|                                                |                      |
|------------------------------------------------|----------------------|
| • Battery voltage:                             | 72/80V               |
| • Maximum drive motor armature current:        | 600A                 |
| • Maximum drive motor field current:           | 17A                  |
| • Maximum pump motor current:                  | 300A                 |
| • Maximum speed:                               | 10 -17 Km/h          |
| • Acceleration:                                | 2 -10s               |
| • Maximum braking current:                     | 250A                 |
| • Maximum braking current with brake pedal:    | 200A                 |
| • Maximum braking current with pedal released: | 160A                 |
| • Maximum braking current during reverse:      | 250A                 |
| • Lifting speed:                               | 0 - 2600 giri/min.   |
| • Tilting speed:                               | 900 - 1400 giri/min. |
| • Power speed:                                 | 750 - 1050 giri/min. |

**DISPLAY****Leds**

1. Safety switch active
2. Parking brake
3. Drive motor brushes wear indicator
4. Pump motor brushes wear indicator
5. Parking lights and low beams
6. Turn signal L.R. indicators
7. Driving lights prearr.
8. Emergency lights prearr.
9. Brake fluid level indicator
10. Truck failure
11. Commutator insert
12. Increase button (\*)
13. Reset button (\*)
14. Decrease button (\*)

(\*) Enabled for each single function

**Function buttons**

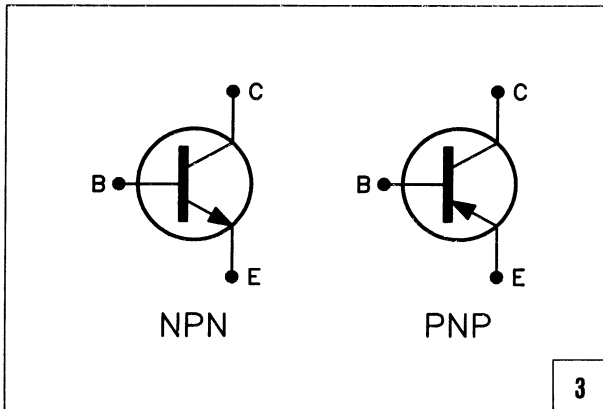
15. Speed button
16. Acceleration button
17. Electric braking key regenerative with brake pedal
18. Electric braking key regenerative when accelerator pedal is release
19. Inversion-braking button
20. Power steering speed button
21. Lift speed button
22. Swing speed button
23. 4<sup>th</sup> element speed button
24. Distributor-setting button
25. Voltmeter-Ammeter button
26. Side shift speed

**Display**

27. Service hours display  
Fault display and storage
28. Battery charge status measurement  
Battery voltage and current measurement

## INFORMATION ABOUT TWO-POLE TRANSISTORS

The transistor is a component with three terminals called the “base” **B**, “collector” **C** and “emitter” **E**. Its symbol is shown in figure 3. It regulates the current flow **I<sub>c</sub>** which flows between **C** and **E** driving the base **B** with a variable current **I<sub>b</sub>**.

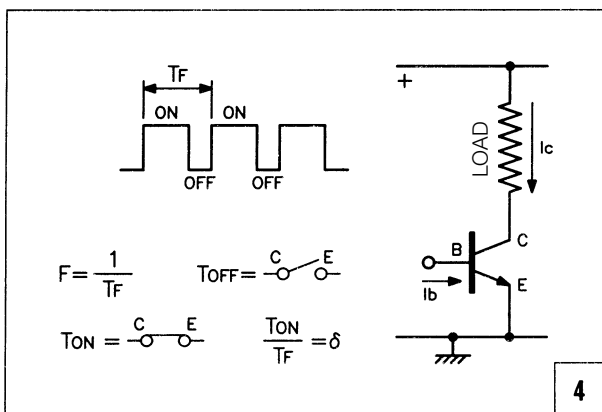


In most electronic power applications, the transistor is used as a switch, and therefore drives the base with a “pulse” current which completely enables or prevents current from flowing between the collector and emitter (Fig. 4).

The on time “**T<sub>on</sub>**” is the time during which the transistor is on (switch closed), while the off time “**T<sub>off</sub>**” is the time during which the transistor is off (switch open). The cycle time “**T<sub>f</sub>**” is the sum of “**T<sub>on</sub>**” and “**T<sub>off</sub>**”.  $1/T_f$  is the transistor control frequency.

The ratio “**T<sub>on</sub>/T<sub>f</sub>**” indicated with  $\delta$  (delta), is called the **duty cycle** (useful cycle) and indicates the percentage of “**T<sub>on</sub>**” compared to “**T<sub>f</sub>**”.

Therefore, it can be seen that a transistor may act as a contactor in a traditional controller, as here in after explained.

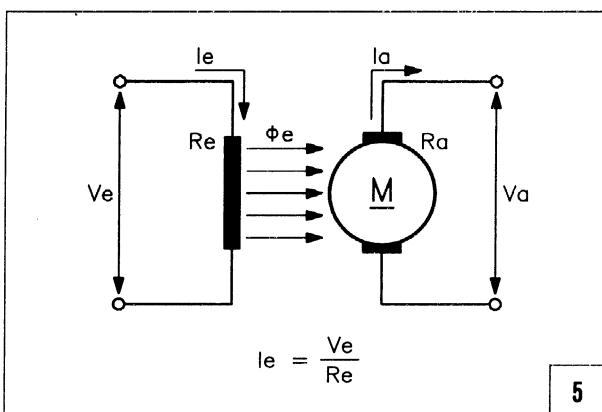


## INFORMATION ABOUT SEPARATELY EXCITED MOTORS

To better understand the operation of variable-speed drives, it is useful to briefly review the principal characteristics of the independently excited d.c. motor. The motor consists basically of two circuits: **armature or rotor, inductor or stator**. The stator can house two or four coils, defined as “fields coils” while the rotor starting circuit is connected to the brushes through the collector.

By feeding the excitation circuit with a continuous voltage **V<sub>e</sub>**, the excitation current **I<sub>e</sub>** flows through the circuit.

The current **I<sub>e</sub>** generates a flow  $\Phi_e = K_e \cdot I_e$  in the magnetic circuit of the motor, where **K<sub>e</sub>** is a constant. By applying a continuous voltage **V<sub>a</sub>** to the armature circuit, the motor is crossed by a current **I<sub>a</sub>** which, by reacting with the flow  $\Phi_e$ , generates a torque **C<sub>m</sub>**. Through the brushes, the collector always feeds the rotor turn which at that moment is positioned at 90° with respect to the magnetic field.



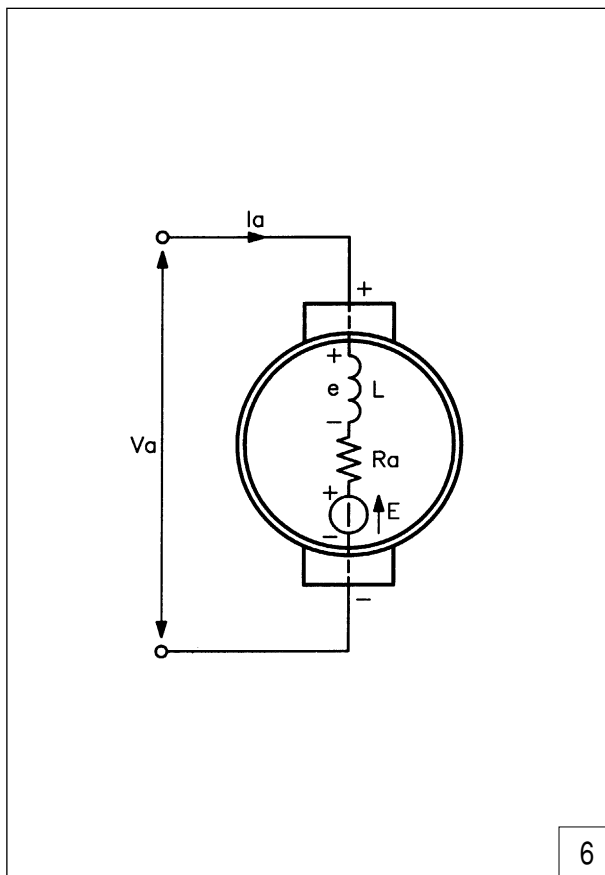
**R<sub>e</sub>** = Excitation resistance

Therefore, with reference to the torque generated by the flow, we will have **C<sub>m</sub>=K<sub>a</sub>F<sub>e</sub> I<sub>a</sub>** where **K<sub>a</sub>** is an armature constant.

If this generated torque exceeds the resistance torque **C<sub>r</sub>**, the motor begins to rotate, thus producing an electromagnetic force **E**. Therefore, we will have **E=K<sub>a</sub>F<sub>e</sub>Ω** where **Ω** is the angular speed in Rad/sec.

According to Lenz's law, the sign of the electromagnetic force **E** will be the opposite of the cause that produced it **V<sub>a</sub>**.

## EQUIVALENT ARMATURE CIRCUIT



The static relations linking the motor output parameters, i.e. the speed  $\Omega$  and the generated torque  $C$  to the electrical input parameters are:

$$\Omega = (\mathbf{V_a - R_a \cdot I_a}) / \mathbf{K \cdot \Phi_e}$$

$$\mathbf{C_m = K \cdot \Phi_e \cdot I_a}$$

where  $\mathbf{V_a}$  is the power supply voltage,  $\mathbf{I_a}$  the armature current,  $\Phi_e$  the excitation flow and  $\mathbf{k}$  a constant depending on the motor design. The term  $\mathbf{R_a}$  includes all series resistors of the armature circuit including brush resistors. However, the value of this term is rather small (a few mOhm) and therefore the term  $(\mathbf{V_a - R_a \cdot I_a})$  is very similar to  $\mathbf{V_a}$ .

From the equations, it is clear that the torque can be changed by modifying the excitation flow  $\Phi_e$ . In addition, the motor speed can be modified by changing the power supply voltage and the field excitation. This is a different situation compared to series-wound motors in which the speed is adjusted by varying the power supply voltage  $\mathbf{V_a}$ . Consistently with the electrical, thermal and mechanical characteristics of the motor, and since the motor voltage  $\mathbf{V_a}$  and field excitation flow  $\Phi_e$  can be regulated independently, the required speed and torque characteristics can be obtained under various operating conditions.

$\mathbf{R_a}$  = Armature resistance

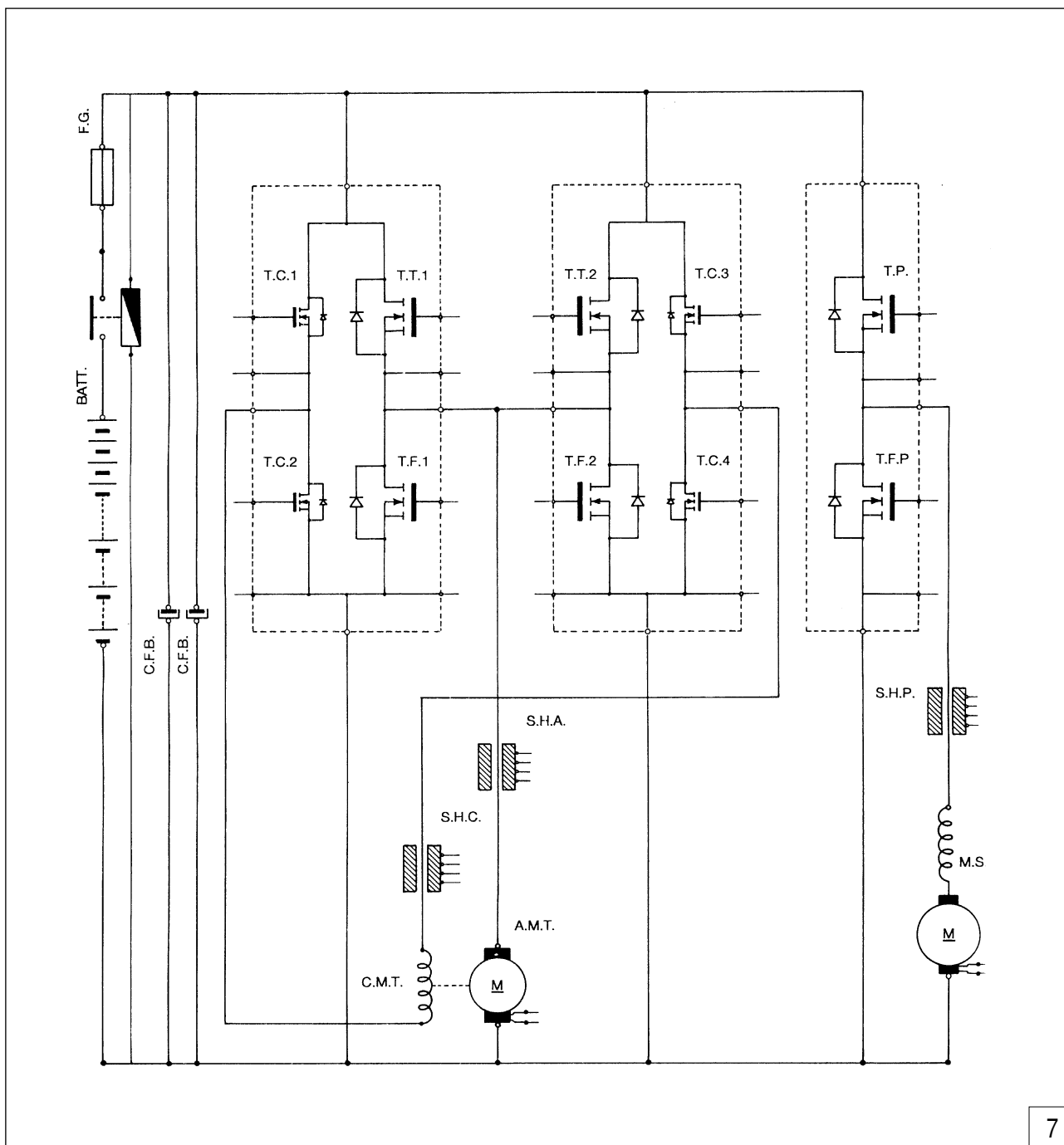
$\mathbf{L}$  = Inductance with polarities which are opposite to  $\mathbf{V_a}$  when the circuit is opened

$\mathbf{E}$  = Electromotive force with the same polarities as  $\mathbf{V_a}$

$\mathbf{e}$  = Self-induction c.e.m.f.

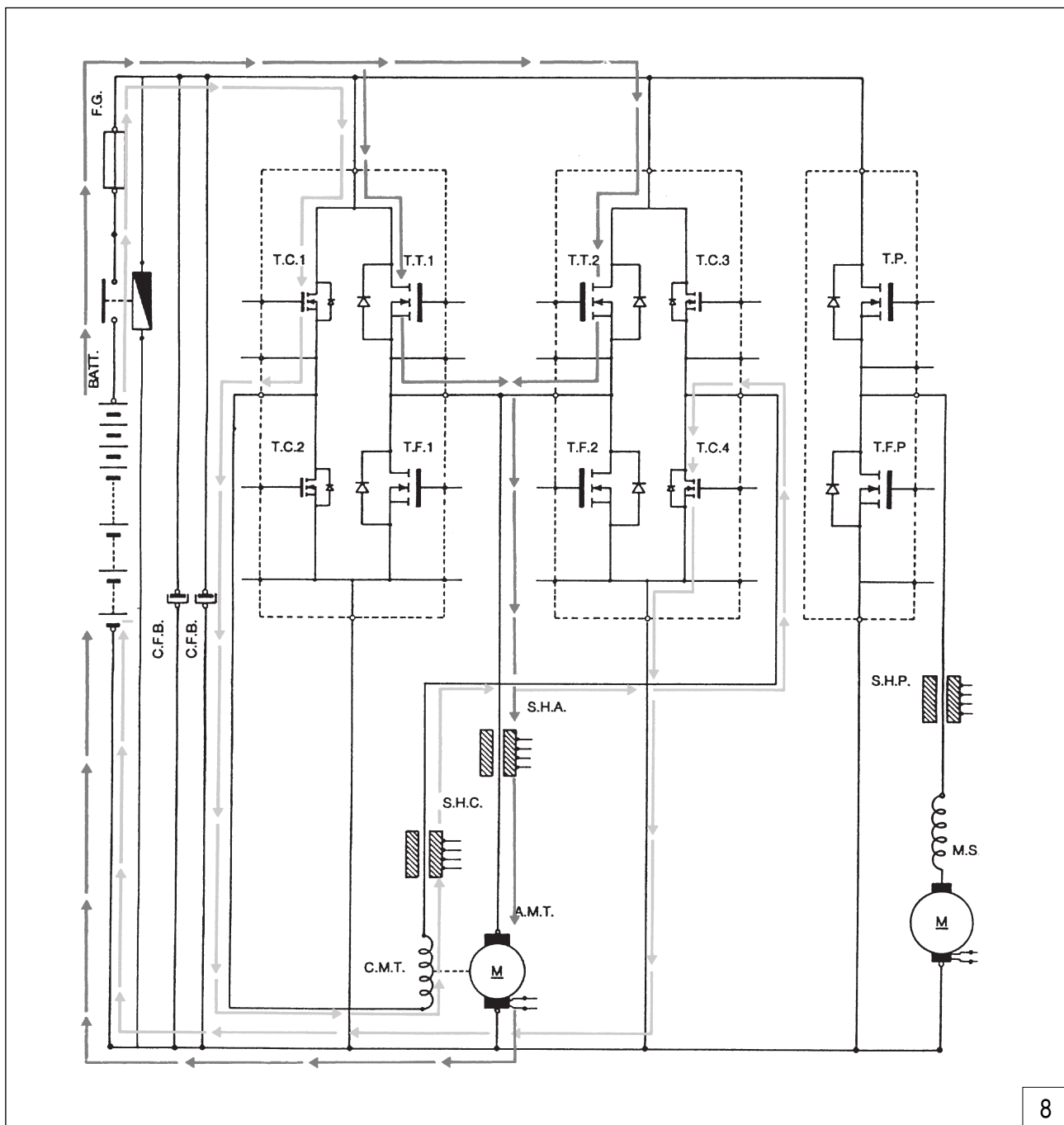
**TRACTION CONTROLLER (Armature - Field)**

Figure 7 illustrates the operating diagram of a chopper with a separately excited motor.



**DRIVE** (Fig. 8)

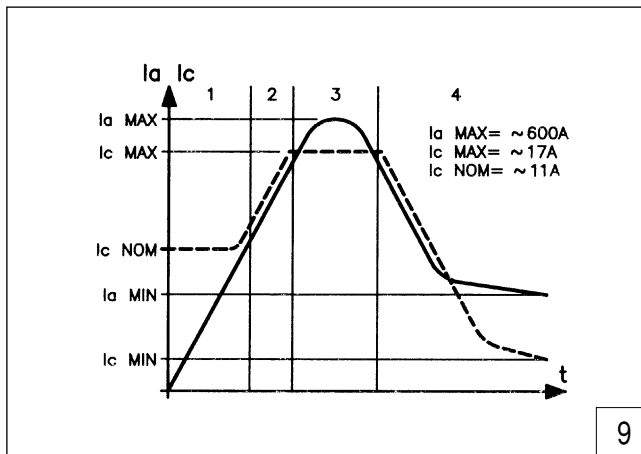
The control can control the drive Mosfets **T.T.1 - T.T.2** and a pair of field Mosfets **T.C.1 - T.C.4** or **T.C.2 - T.C.3** generating a voltage **V<sub>a</sub>** and a current **I<sub>a</sub>** through the armature and a current **I<sub>ecc</sub>** through the excitation winding (Fields). The motor will turn clockwise or counterclockwise depending on the DIRECTION OF THE EXCITATION CURRENT. Therefore, speed will vary depending on the relative voltages and currents.



- FIELD current (stator)
- ARMATURE current

## DRIVE REGULATION

The curve of the armature and excitation currents during acceleration is shown in figure 9. The graph illustrates four distinct phases: in the first phase, as long as the armature current is lower than the rated current (selected according to the motor characteristics), the field current remains constant (at the rated value); during the second phase, when the armature current exceeds the rated value, the field current increases to create a greater torque and it is during this phase that the motor acts as if it were series-wound. In any case (phase 3), the excitation current does not exceed 1.8 times the rated current, a value selected considering the magnetic saturation characteristic. The armature current is limited to about 600A, thus limiting the voltage on the motor.



**Ia** = Armature current

**Ic** = Field Current

During this last phase, i.e. when the truck has gone beyond the pickup phase, the armature current begins to drop and the excitation current decreases until reaching a value that allows the truck to reach maximum speed.

The speed is controlled by the pedal which transmits a signal from 0 to 11V.

The characteristic as a function of position is illustrated in figure (10).

For about two-thirds of the pedal stroke, the speed increases, thus increasing the voltage on the motor controlling the drive transistor until reaching full conduction (if the armature current is less than the rated value).

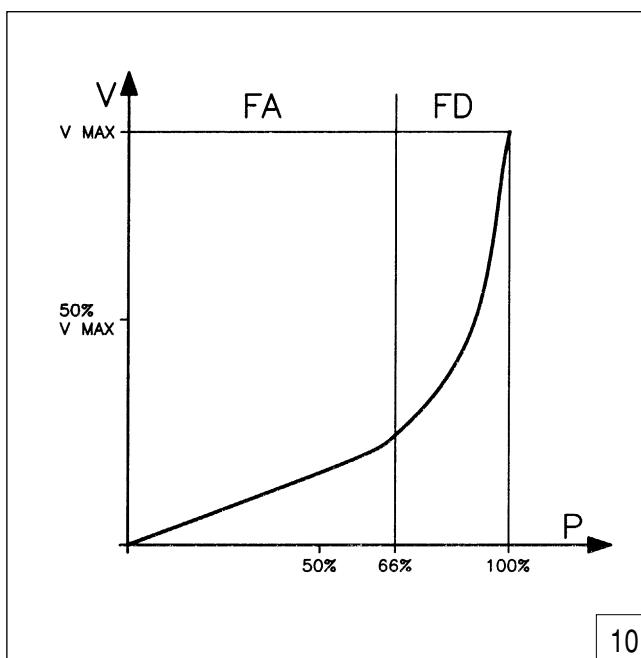
As pointed out in the figure, the curve is rather flat at the beginning so that the speed can be easily modulated at low values.

In this phase, the field current is already at the rated value and generates a rather high torque and thus the truck can execute very precise movements.

During the second part of the pedal stroke, the speed increases up to the maximum value, deexciting the magnetic field.

It is evident that if the armature current increases beyond the rated value (e.g. if the truck runs up a ramp), the excitation current must increase to create the necessary torque and the armature current reaches the maximum stall value (about 600A) in which the voltage on the motor is limited to a few volts and the excitation current is about 17A (phase three in figure 10).

The acceleration ramp and the maximum speed may be varied through the keypad.



**V** = Speed

**FA** = Motor voltage increase phase

**FD** = De-excitation phase

**P** = Pedal position

## BRAKING CONTROL

The electric braking is regenerative and occurs when the accelerator pedal is released and by pressing the brake pedal or reverse pedal. The maximum braking current and therefore the braking distance can be varied using the push-button panel. When reversing the direction, the braking torque can be modulated with the pedal. Electric braking continues until the truck has come to a complete stop and the current is controlled by regulating the field current and varying the conduction time of the braking transistor. This time increases according to a specific ramp up to full conduction. It can be seen how at the beginning of braking, when the conduction time is small, most of the generated current charges the battery (**Ir**, regenerative braking). Increasing the conduction time increases the percentage of the current dissipated on the braking transistor (**Id**, dissipative braking), and therefore the current sent to the battery decreases.

During the braking phase, the drive mosfets **T.T.1** and **T.T.2** are inhibited (kept in the off mode), while the system commands the braking mosfets **T.F.1** and **T.F.2**

Therefore, since the pair of field mosfets **T.C.2** and **T.C.3** is still controlled through the field winding, and current flows, there is a magnetic flux.

This condition forces the motor to act as a dynamo and therefore it generates current.

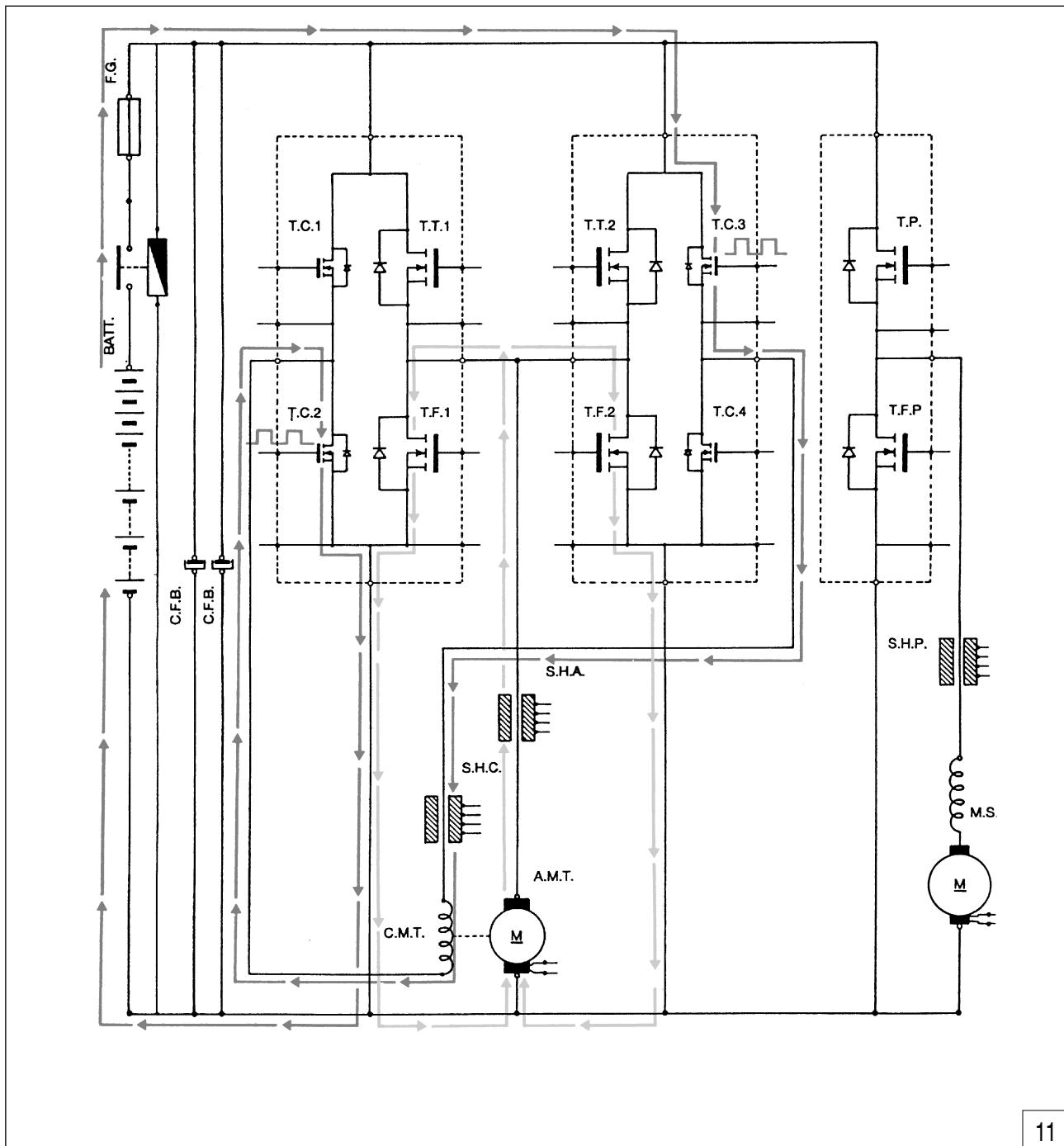
At this point, there are 2 conditions:

### 1°) BRAKING MOSFETS CONDUCTING

### 2°) BRAKING MOSFETS OFF.

**First phase: BRAKING MOSFETS CONDUCTING** (Fig. 11)

During this phase, the current generated by the motor is short-circuited by mosfets **T.F.1** e **T.F.2**. This current will change as a function of the motor speed and the field excitation.

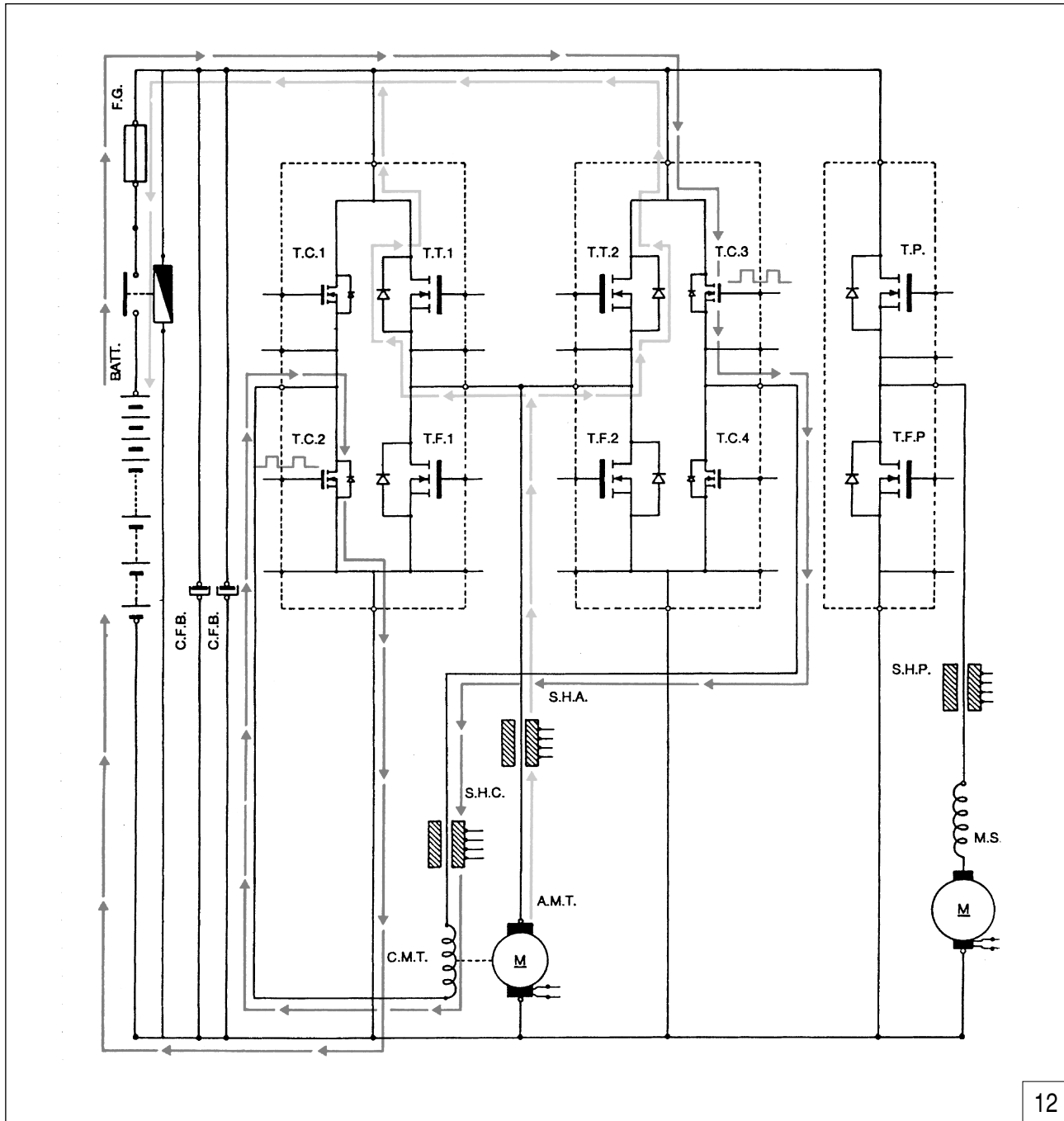


- FIELD current (stator)
- ARMATURE current

**Second phase: BRAKING MOSFETS OFF (inhibited)** Fig. 12

During this phase, the current generated by the motor is sent to the battery through the two Braking diodes DF. In practice, the work frequency of the braking mosfets **T.F.1** and **T.F.2** is inversely proportional to the rpm of the drive motor. Thus, the work frequency of the braking mosfets increases in case of rpm reduction.

Therefore, it is possible to recover the maximum current generated by the motor during the electronic braking phase.



- FIELD current (stator)
- ARMATURE current

## PUMP CONTROLLER

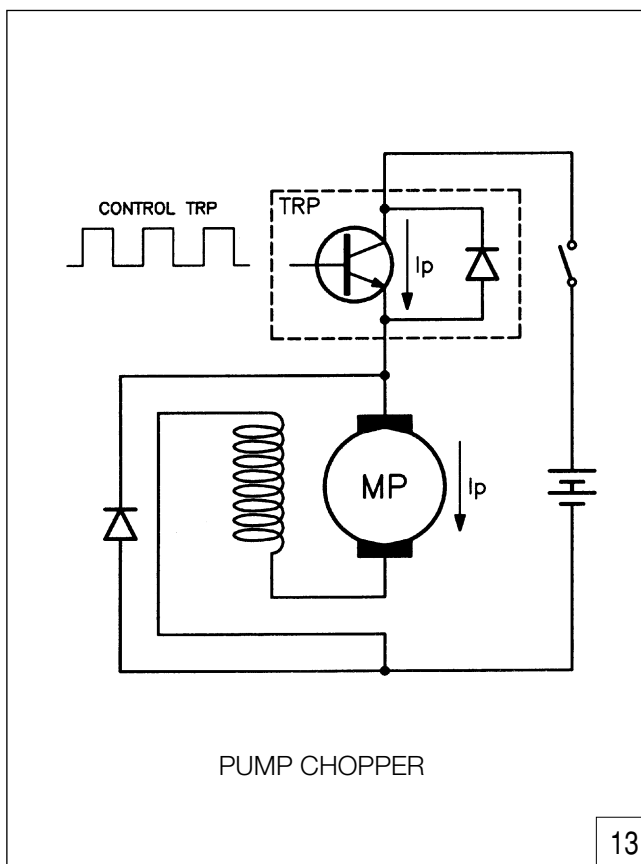


Figure 13 illustrates the power section of a chopper which drives the lift/power steering pump with a series-wound d.c. motor.

Motor current and voltage are regulated by the control through the command on the base of the pump transistor **TRP** so that the rpm remains constant while the current **Ip** is varied.

## PUMP MOTOR CONTROL

The constant speed during variations in load is the main characteristic of this type of control. The current is “read” by the microprocessor which calculates the conduction time of the pump transistor thus allowing a constant speed. The work frequency is set at **8 KHz**.

The push-button panel can be used to select various pump motor speeds for lifting, swinging, power steering and for any optionals.

## CHARACTERISTICS OF THE OUTPUT VOLTAGE WAVEFORMS

The control voltage for the drive/braking and pump armature choppers is completely software controlled, operating at a fixed frequency of about **8KHz** and modulating the duration of the conduction time. At this frequency, which is beyond the audible range, the current ripple on the motors is practically zero. Under these conditions, the chopper is completely silent. On the contrary, the field chopper control is not completely software driven. The control frequency is around **1 KHz**. Silent operation is still guaranteed since the field current is almost continuous (=because of the high time constant of the winding).

## HYDRAULIC CIRCUIT CALIBRATION

**72V/80V**

| <b>EU 18   EU 20   EU 20L   EU 22</b> | <b>V mot.</b> | <b>A mot.</b> | By Pass       |               | Giri/1 |
|---------------------------------------|---------------|---------------|---------------|---------------|--------|
|                                       |               |               | <b>V mot.</b> | <b>A mot.</b> |        |
| Power steering speed                  | 8,5           | 32            | 17            | 75            | 800    |
| Lift speed (*)                        |               |               |               |               |        |
| Tilt speed                            | 12            | 42            | 21            | 96            | 900    |
| Attachment speed                      | 20            | 80            | 40            | 200           | 1300   |

(\*) The lift speed is adjusted from the distributor lever position

**72V/80V**

| <b>EU 25   EU 28   EU 30</b> | <b>V mot.</b> | <b>A mot.</b> | By Pass       |               | Giri/1 |
|------------------------------|---------------|---------------|---------------|---------------|--------|
|                              |               |               | <b>V mot.</b> | <b>A mot.</b> |        |
| Power steering speed         | 5,8           | 45            | 13,5          | 100           | 800    |
| Lift speed (*)               |               |               |               |               |        |
| Tilt speed                   | 8,7           | 56            | 29,5          | 240           | 900    |
| Attachment speed             | 20            | 80            | 40            | 200           | 1300   |

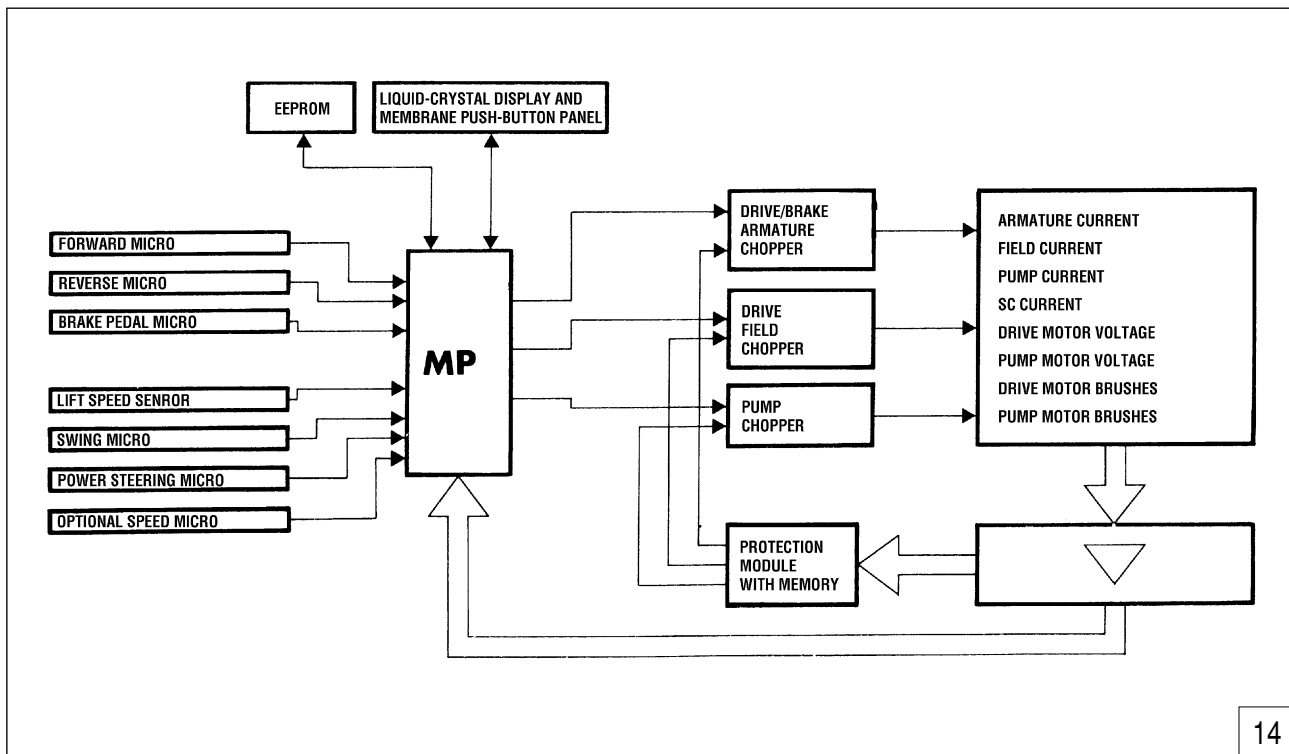
(\*) The lift speed is adjusted from the distributor lever position

## ELECTRONIC CIRCUIT BOARDS

### The logic circuit board

This board has very compact dimensions thanks to the use of surface mounted components which are smaller than the traditional types and to the INTEL 86C196 16-bit microprocessor allowing to a reduction of hardware.

The functions of this board are illustrated in the block diagram shown in figure 14.



### The power circuit board

The power circuit board feeds all the power supplies and contains the power transistor pilot circuits.

### The field circuit board

The field circuit board contains the field transistor pilot circuits.

## START-UP AND PARAMETER PROGRAMMING

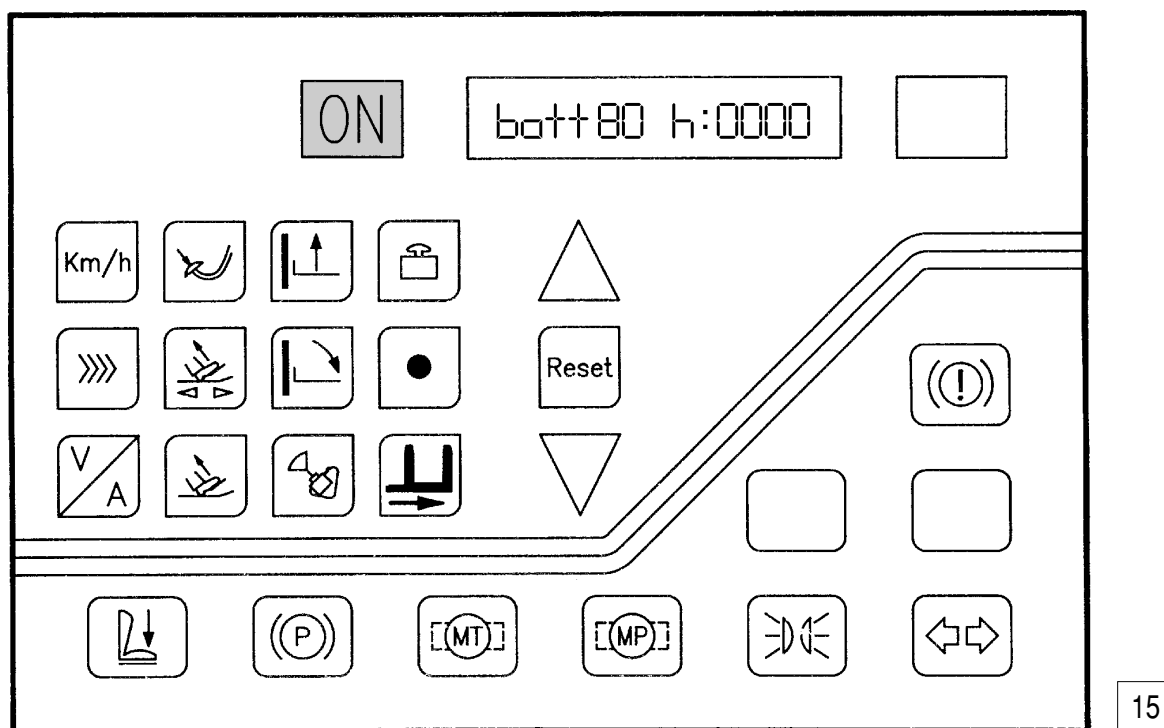
After plugging in the truck battery cable, turning the key energizes the cards on the panel. The green "ON" led in the upper left-hand part of the dashboard and the green led on the microprocessor card will light and a message indicating the type of truck and power supply voltage will be displayed for a few seconds.

Fit. E 20 72V

afterwards, the following message will be displayed:

batt XX h:XXXX

where "XXXX" are numbers. The left part indicates the charge status of the battery while the right part indicates the number of service hours.



The microprocessor implements a few-second testing of the power circuit. If no problems are detected, the emergency remote-control switch is closed and the truck is ready to begin service.

After the remote-control switch has been closed and before the truck starts moving, it is possible to display and modify the various parameters listed in the following table:

| PARAMETER                         | RANGE      |
|-----------------------------------|------------|
| maximum speed                     | 10 - 17    |
| acceleration ramp                 | 1 - 5      |
| braking with brake pedal          | 1 - 10     |
| braking by releasing the pedal    | 1 - 10     |
| braking using the inversion pedal | 1 - 10     |
| Lift speed                        | adjustable |
| swing speed                       | 1 - 5      |
| power steering speed              | 1 - 3      |
| lateral movement speed            | 1 - 5      |

By pressing the button relevant to one of the parameters listed above, the left part of the screen will display the corresponding parameter and its current value. For example, for the acceleration button, the system will display:

Acc 3 h:0001

The right continues to display the service the service hours. By pressing the same button along with the increase or decrease button, it is possible to change the value of the parameter within the pre-set limits.

The RESET button assigns the following values to the various parameters:

|                                 |                   |
|---------------------------------|-------------------|
| <b>speed</b>                    | <b>15</b>         |
| <b>acceleration</b>             | <b>3</b>          |
| <b>braking with brake pedal</b> | <b>7</b>          |
| <b>reverse braking</b>          | <b>8</b>          |
| <b>braking by release</b>       | <b>8</b>          |
| <b>lift speed</b>               | <b>adjustable</b> |
| <b>swing speed</b>              | <b>1</b>          |
| <b>power steering speed</b>     | <b>1</b>          |
| <b>later movement speed</b>     | <b>1</b>          |

## BATTERY CHARGE STATUS

The battery charge status is indicated in two ways:

- 1) when the truck is started
- 2) during operation with a load of about 100A

In both cases, the system reads the battery voltage corresponding to a given charge status (depleted/charged). During normal truck operation, the battery charge status appears on the left of the display: as follows:

batt 80 h:0057

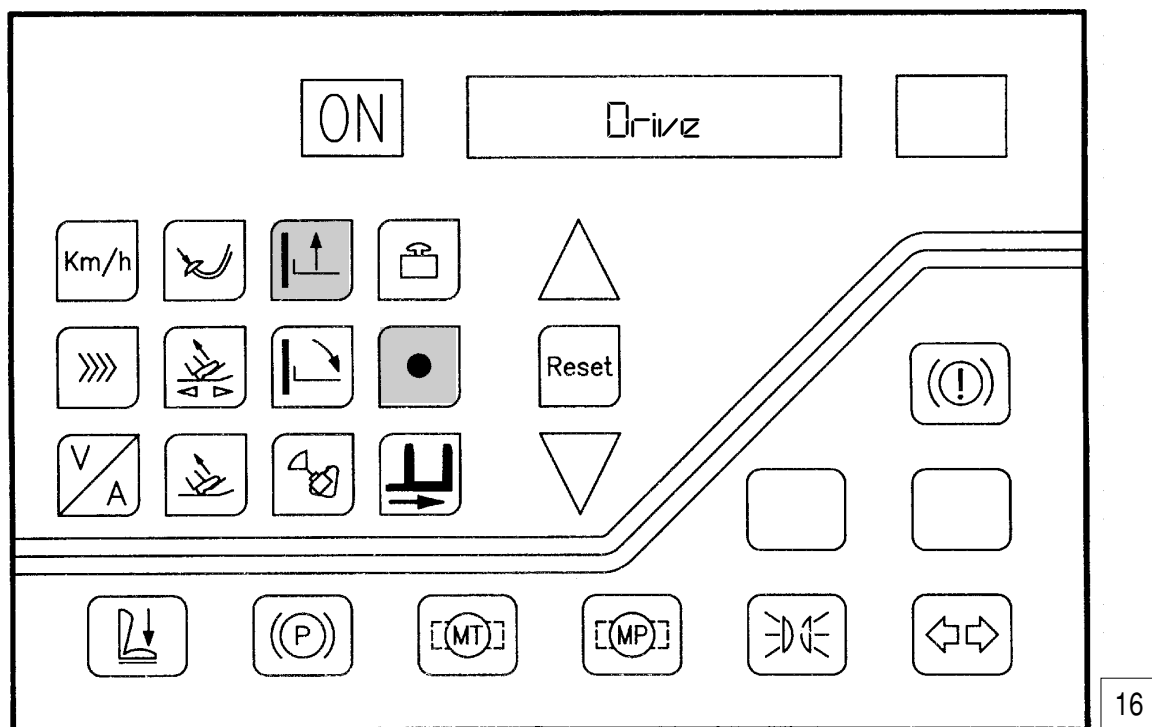
where the number 80 indicates that the actual residual capacity of the battery is 80%. When the capacity lowers below 20%, the display will indicate the following flashing message:

Discharge battery

Under these conditions, it is possible to select whether to limit the maximum voltage on the drive motor, and therefore the maximum truck speed, or to deactivate the lifting, tilting and optional movement controls, while the power steering circuit can still be operated, if necessary.

The limitation can be selected as follows:

press the "DISTRIBUTOR-SETTING" and "LIFTING" keys at the same time and, using the increase key, the words "PUMP" or "DRIVE" will be displayed, to indicate the type of limitation to select. The keys shall be released after selection.



## HOUR COUNTER

Since the truck is equipped with a quartz oscillator and a liquid-crystal display, it was possible to fit an hour counter having the precision of some of the best clocks.

The hour counter is updated only when the pump motor and the drive motor are operating (real operating hours of the panel/truck).

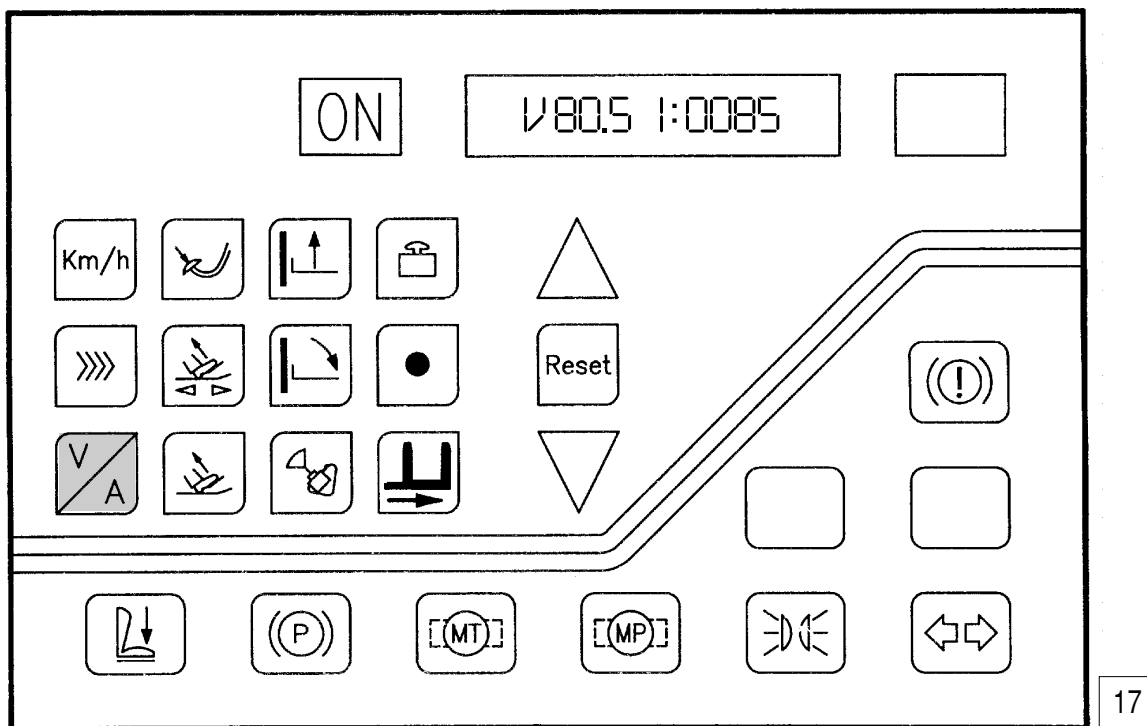
## BATTERY VOLTAGE AND CURRENT DISPLAY

By pressing the Voltmeter - Ammeter (V/A) button, the left side of the screen will display the current battery voltage and the right side will indicate the actual battery current. For example:

V 80.5 1:0085

which indicates a battery voltage of 80.5V and a current of 85A.

Press the V/A button again to reset normal display.



## BATTERY VOLTAGE INDICATOR CALIBRATION

Press the V/A button.

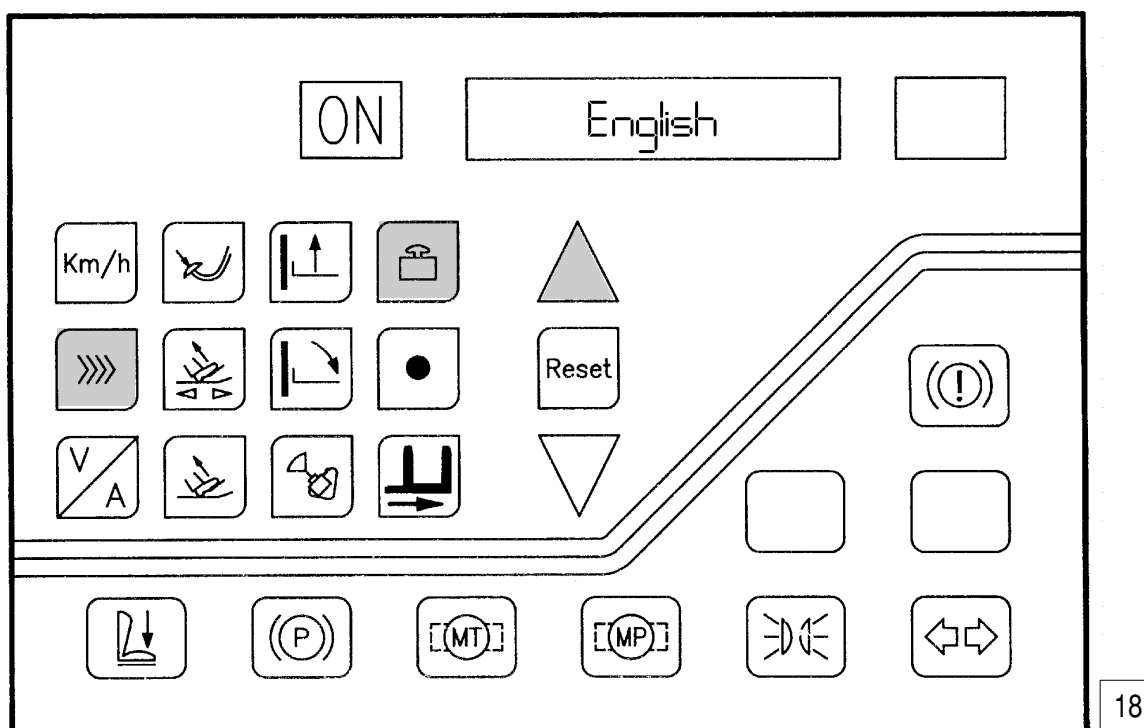
The screen will display the battery voltage and current as specified above. Release the V/A button and press the km/h and RESET button at the same time.

Then use the increase and decrease buttons to set the voltage value shown on the display to the battery voltage value measured by a suitable instrument.

Press the V/A button again and then turn off the truck to store the new voltage value. Turn the truck on and check whether the display indicates the correct value.

## LANGUAGE SELECTION

Press the "4<sup>th</sup> ELEMENT SPEED" and "ACCELERATION" buttons at the same time. Then use the increase or decrease buttons to select the language that the system will use to display the various messages on the liquid crystal alphanumeric screen. There are five possible languages:



## DISPLAY OF PROTECTION DEVICE OPERATIONS

Special attention has been focused on the system protection devices for chopper components (power components) as well as drive and lift motor parts.

The software-managed protection devices as well as those controlled by hardware are processed by the micro-processor and remain stored even after the key has been removed. Thus it is possible to diagnose faults and analyse their frequency.

## SOFTWARE PROTECTION DEVICES

### 1 - Maximum Voltage Limitation on the Drive Motor due to Overheating of the POver Modules.

If the temperature of the finned dissipater exceeds a value of about 90° C, the maximum voltage on the drive motor armature is limited to 55% of the battery voltage. In addition, the maximum current of the pump motor is limited to about 90A. The **TAR-POMP** alarm is activated when this value is exceeded. The display will flash the following message:

Thermistor

The protection will be reset only by removing the key.

### 2 - Maximum voltage limit on the drive motor or inhibition of lifting commands when battery is depleted:

When the battery charge status lowers below 20%, the maximum voltage on the drive motor armature is limited to 35% of the battery voltage, or the lifting 1 and lifting 2, tilting, optional shifting commands are disabled.

The display will flash the following message:

Discharge battery

The protection will be reset only by removing the key.

### 3 - Protection Against Premature Use of the Accelerator Pedal .

If the accelerator pedal is pressed before the emergency remote-control switch is closed, this switch is disabled and at the same time the following wording is displayed:

Pedal !!! h:0005

with three flashing exclamation points. All controls are disabled. To reset normal operating conditions the truck gear shall be disengaged.

### 4 - Protection Against Pedal Malfunctions.

If during acceleration there is more than 1,2V at the input of the accelerator reference without pressing the running microswitch, the red "truck malfunction" led in the upper right-hand portion of the dashboard turns on, the controls are disabled and the following wording is displayed.

Pedal !!! h:0005

with three flashing exclamation points. The protection device will be reset only by removing the key.

## 5 - Short-circuit Protection during Start-up.

Once the key is turned, the system implements the precharge phase of the battery filter condensers (CFB). If the voltage of the condensers does not reach the set value, there is an irregular absorption of current between the battery + and -. In this case, the red "TRUCK MALFUNCTION" led in the upper right-hand portion of the dashboard turns on, all controls are disabled and the following wording is displayed:

V<sub>cond</sub> !!! h:0005

with three flashing exclamation points. Or the system displays:

"TRT" "TRP"

depending on whether the malfunctioning power component is, respectively, the drive transistor, the pump transistor or the field transistor.

## 6 - Protection Against a Fault in the Condenser Precharge Circuit and the Power Card Emergency. Remote - Control Switch Command Circuit

During start-up, the system performs a test to check the above-mentioned circuits. If a fault is detected, the red "TRUCK MALFUNCTION" led in the upper right-hand part of the dashboard turns on, the controls are disabled the following wording is displayed

Emerg. !!! h:0005

with three flashing exclamation points.

**Note:** The condensers are precharged after they have been discharged through the pump motor.

## 7 - Protection Against an Interruption in Current on the Excitation Windings.

If during the running phase the current on any of the excitation windings should be interrupted, the following wording is displayed:

Field !!! h:0005

with three flashing exclamation points. All controls are disabled and the red "TRUCK MALFUNCTION" led in the upper right-hand part of the dashboard will turn on. The protection device will be reset only by removing the key.

## 8 - Short-circuit Protection of the Excitation Windings or Field Transistors.

If the field windings or one of the field mosfets are short-circuited during the running phase, the system will display:

Field !!! h:0005

with three flashing exclamation point.

## 9 - Low Voltage Protection.

If the card power supply voltage (+B) or the +24V voltage lower below a specific threshold the following wording is displayed:

Tens. off h:0005

the red "TRUCK MALFUNCTION" led in the upper right-hand part of the dashboard will turn on and all controls are disabled. The protection device will be reset only by removing the key.

## 10 - Protection Against Pump Motor Current Overload.

If the pump motor current exceeds 300A for more that 3-4 seconds, the display will flash the following:

Rat. pump

the red "TRUCK MALFUNCTION" led in the upper right-hand part of the dashboard will turn on and all controls are disabled. The protection device will be reset only by removing the key.

## 11 - Protection Against the Non-Acquisition of System Electrical Parameters.

In case of failures preventing the microprocessor from acquiring the electrical parameters (for example a fault on the micro card), the following wording is displayed:

And !!! h:0005

with three flashing exclamation points. The red "TRUCK MALFUNCTION" led in the upper right-hand part of the dashboard will turn on and all controls are disabled. The protection device will be reset only by removing the key.

## 12 - Stand-by

If for about 5 consecutive minutes the drive of pump command are not activated, and the instrument panels keys are not pressed, the system will display the following message:

Stand-by

and the system turns on the red "TRUCK MALFUNCTION" lamp located in the upper right-hand corner of the instrument panel and all controls are disabled. To restore operating conditions, turn the truck of and back on again.

## HARDWARE PROTECTION DEVICES

The hardware protection devices have been designed on the basis of two different principles: the first and more classic one, compares the set voltage level and the voltage generated by the current that crosses a HALL-effect current sensor:

**SHTF: HALL drive and braking current sensor**

**SHC : HALL motor field current sensor**

**SHMP: HALL pump motor current sensor**

In the second case, the protection device will trip (called an “anti-desaturation protection”) based on a comparison of a set voltage level and the DRAI-SOURCE saturation voltage of the MOSFETS transistors which, during the ignition time, must not exceed 2-3 Volt if the current crossing the transistor is below the maximum value allowed for that transistor.

As soon as the voltage generated by the overcurrent exceeds the reference level, the system inhibits all controls on the power transistors in less than 7-8 microseconds, the emergency remote-control switch is opened the red “TRUCK MALFUNCTION” led in the upper right-hand part of the dashboard turns on and the screen displays a message indicating where the overcurrent has occurred.

The following table indicates the messages displayed and stored in the EPROM:

| DISPLAY MESSAGE | RELATIVE HALL SENSORS | RELATIVE TRANSISTOR |
|-----------------|-----------------------|---------------------|
| <b>ARMAT!!!</b> | <b>SHTF</b>           | <b>TRT or TRF</b>   |
| <b>FIELD!!!</b> | <b>SHC</b>            | <b>—</b>            |
| <b>PUMP!!!</b>  | <b>SHMP</b>           | <b>TRP</b>          |

## PROTECTION AGAINST POLARITY REVERSAL

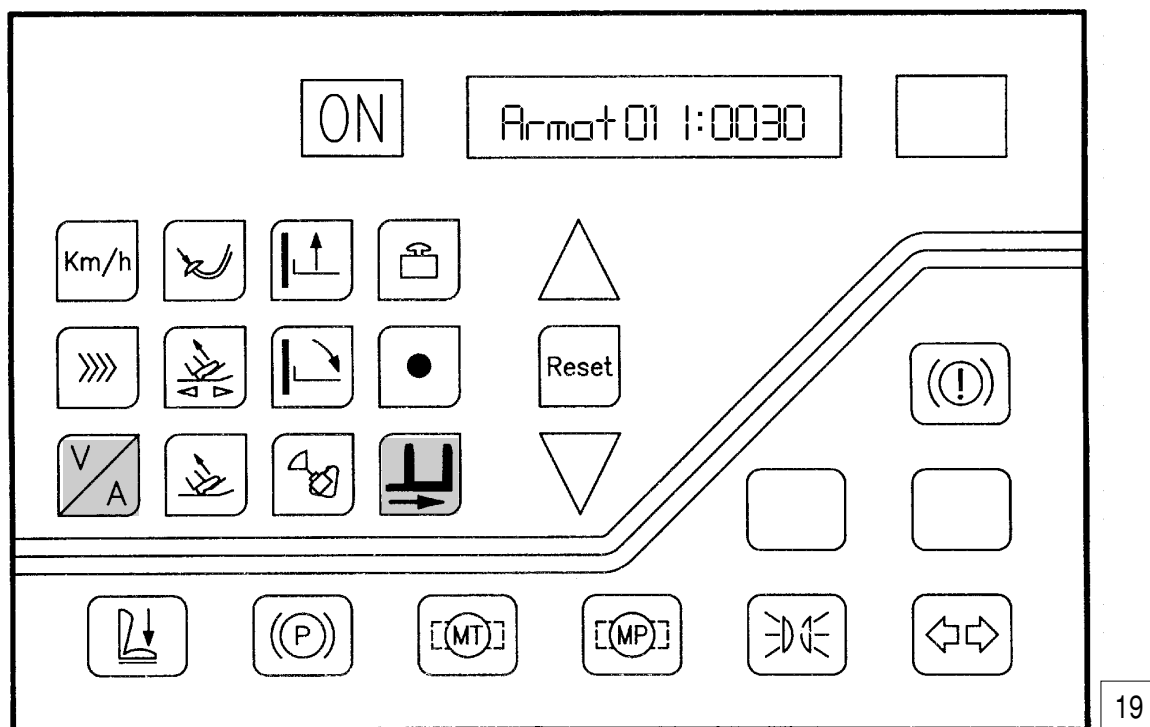
If the polarity is reversed, the chopper remains off even after the key has been turned.

## TROUBLESHOOTING

Each time a hardware protection device trips, the EEPROM stores the event with the same messages of the table above, together with the time at which it occurred. By pressing the V/A and lateral movement speed buttons at the same time (black point), the screen will display the latest alarm, as follows:

Armat 01 1:0030

The meaning of ARMAT is described in the previous paragraph 01 indicates the latest alarm occurred (the next will be 02 and so on up to 10). The right-hand part of the display will indicate the time the trip occurred. Pressing the above buttons together with the increase button, the screen will display the last ten alarms. Each new trip will be stored and will eliminate the first of the ten stored alarms.

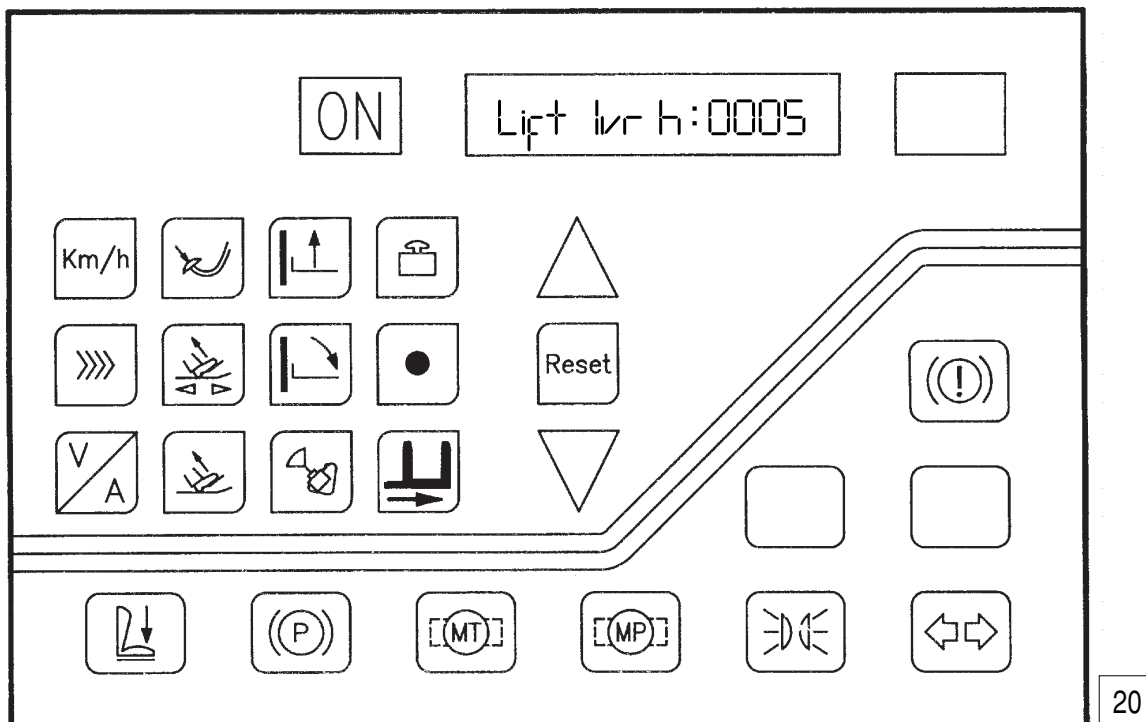


**FUNCTIONS OF THE DIGITAL DISPLAY**

Lift lvr h:0005

This message appears on the digital display any time, the panel detects the lever already engaged at the truck switching: by releasing the lever it goes back to normal. The alarm goes off also when the electronic system receives a faulty signal from the Hall probe.

When the alarm is on, the traction is limited and the pump allows only power steering to work.



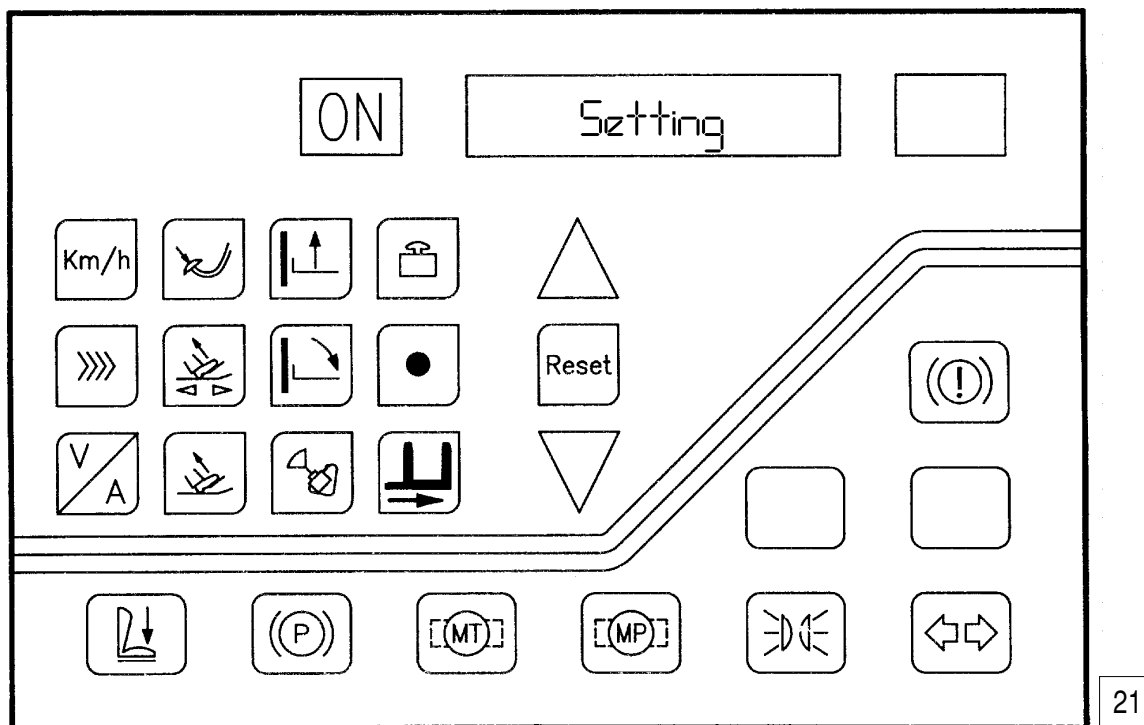
## Setting

This message appears on the digital display, in case the electronic system reads faulty and inconsistent signals at the truck switching.

In this case the hall probe needs setting.

This alarm may appear whenever the distributor, the Hall probe or the electronic panel (in case of serious failure) are replaced.

When the alarm is on, the traction is limited and the pump allows only power steering to work.



**WARNING**



The "SETTING" (calibration) alarm appears only in case of serious signal-reading by logics. IT IS ALWAYS NECESSARY TO CALIBRATE THE HALL PROBE ANY TIME THE DISTRIBUTOR, THE HALL PROBE OR THE ELECTRONIC PANEL ARE REPLACED.

## PROCEDURE FOR THE CALIBRATION OF THE HALL PROBE (POTENTIOMETER) RELEVANT TO THE LIFTING FUNCTION

- Get on the truck and turn the key on "ON"

- Press for at least 4 sec. the "DISTRIBUTOR CALIBRATION"  pushbutton on the new display, in order to enter the "SETTING" (calibration) mode, which will be confirmed the message "LIFT SET" on the left side of the digital display, while the right side will show the BIT value (between 450 and 500), while the Hall probe on stand-by

Example:

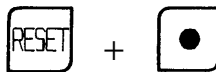
Lift set h: 0485

(A value between 700 and 800, means that this procedure has already been done, therefore you need to run "RESET" procedure first).

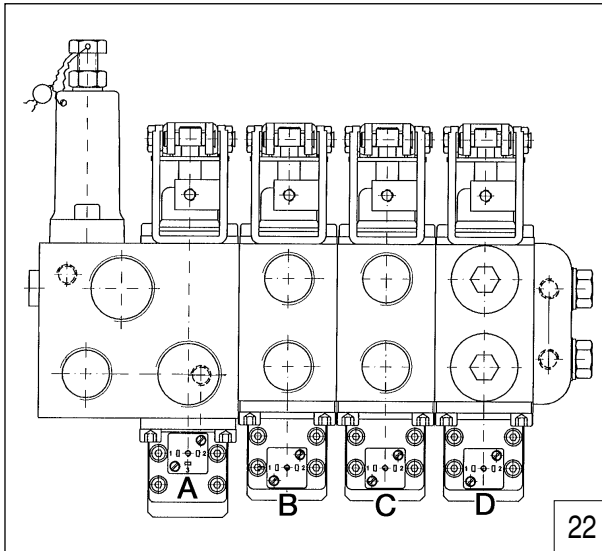
- While keeping the above pushbutton pressed, press also pushbutton  with lift lever at rest. The OFFSET value will thus, be stored by the Hall probe.
- Release the pushbutton  and while keeping pushbutton  pressed, pull the lifting lever up to end of travel, the output value of the Hall probe will be stored. (During calibration the pump motor is disabled).
- Release the pushbutton  and then release the lift lever
- Turn the key on OFF. 
- Turn the key on ON again. 

By pressing "RESET" key at same time with "DISTRIBUTOR CALIBRATION" key on the display.

It is possible to repeat the whole calibration procedure.



## HALL-ACTING SENSOR - REED SWITCHES (ON/OFF)



A= Hall-acting sensor

B-C-D= Reed switches (ON/OFF)

Sensor A placed on the distributor lift lever allows achieving a motor speed (and, therefore, an oil flow) proportional to the lever move.

This solution allows obtaining energy saving, minor oil heating and better silentless during hoisting.

Reed switches (ON/OFF) A and B are positioned on the other levers of the distributor instead of micros.

They ensure maximum reliability and do not require any maintenance operation.

## LIFT SPEED HALL-ACTING SENSOR POWER CARD

An S electronic card with corresponding H connector (see picture) feeds the Hall-acting sensor, positioned under the hydraulic distributor element, referring to the lift speed, with a 12 V stabilised voltage.

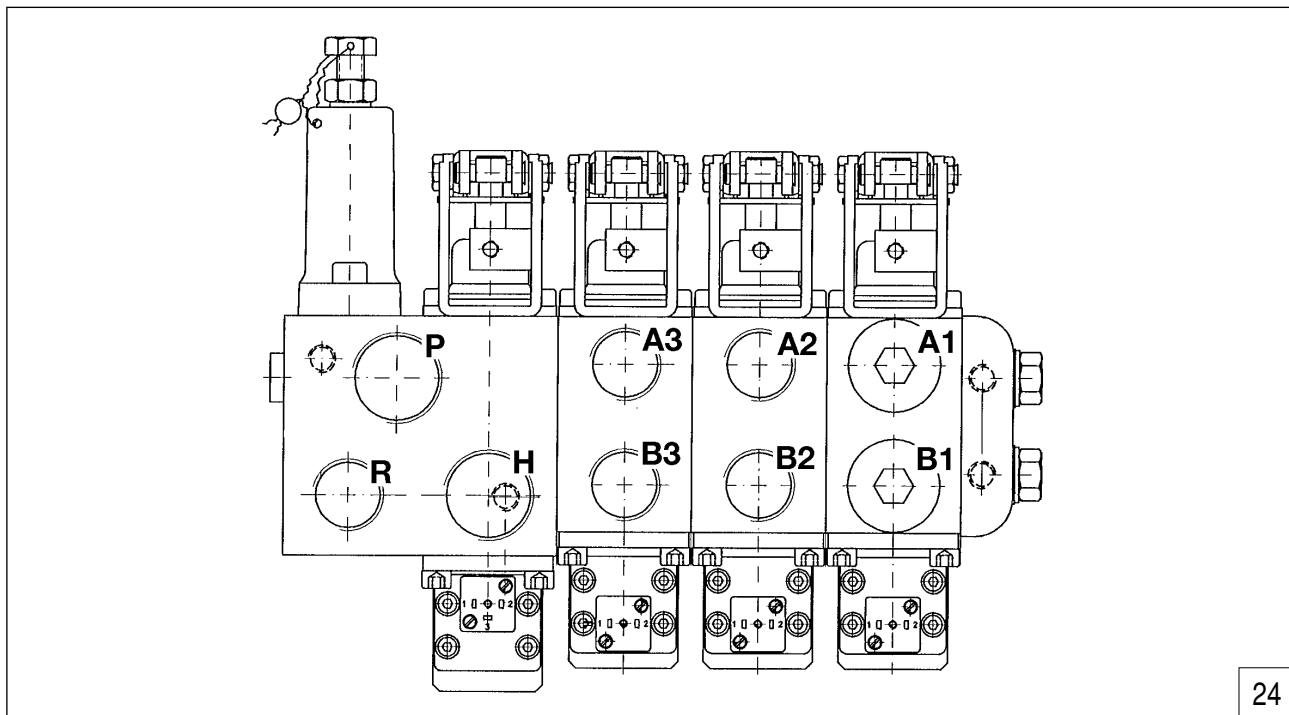


The electronic card allows a non-stop change of PUMP revolutions during such function.

A non-operation or an inadequate operation of such Hall-acting sensor starts the safety system, showing on the screen "LIFT LEVER" or "CALIBRATION" (see pages 104-105).

In both cases, it is necessary to adjust the feeler.

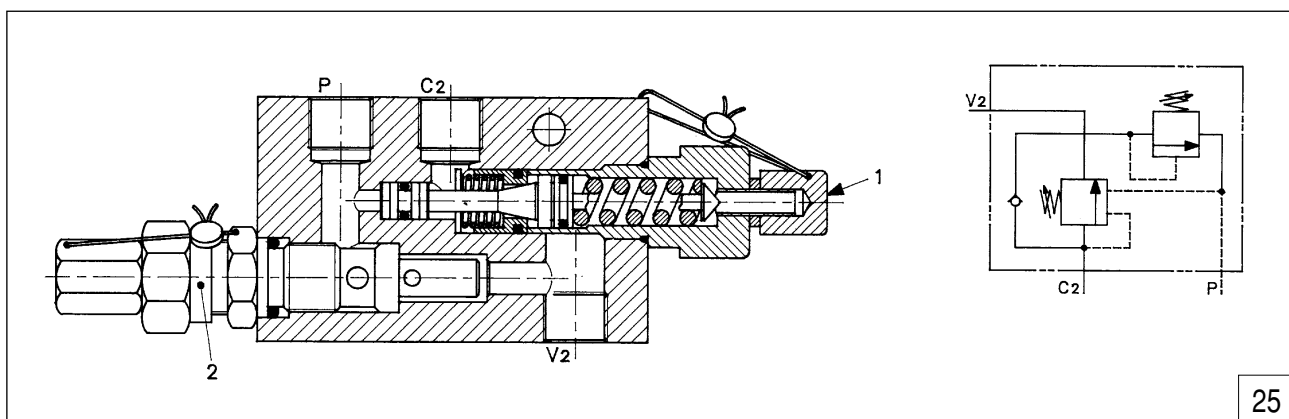
## CONTROL VALVE BLOCK



24

- |            |                                   |           |           |
|------------|-----------------------------------|-----------|-----------|
| <b>A1.</b> | to upright tilt cylinders         | <b>P.</b> | oil input |
| <b>B1.</b> | to upright tilt cylinders         | <b>R.</b> | exhaust   |
| <b>A2.</b> | to side movement control cylinder | <b>H.</b> | to lifter |
| <b>B2.</b> | to side movement control cylinder |           |           |
| <b>A3.</b> | equipment                         |           |           |
| <b>B3.</b> | equipment                         |           |           |

## ANTICAVITATION STOP VALVE

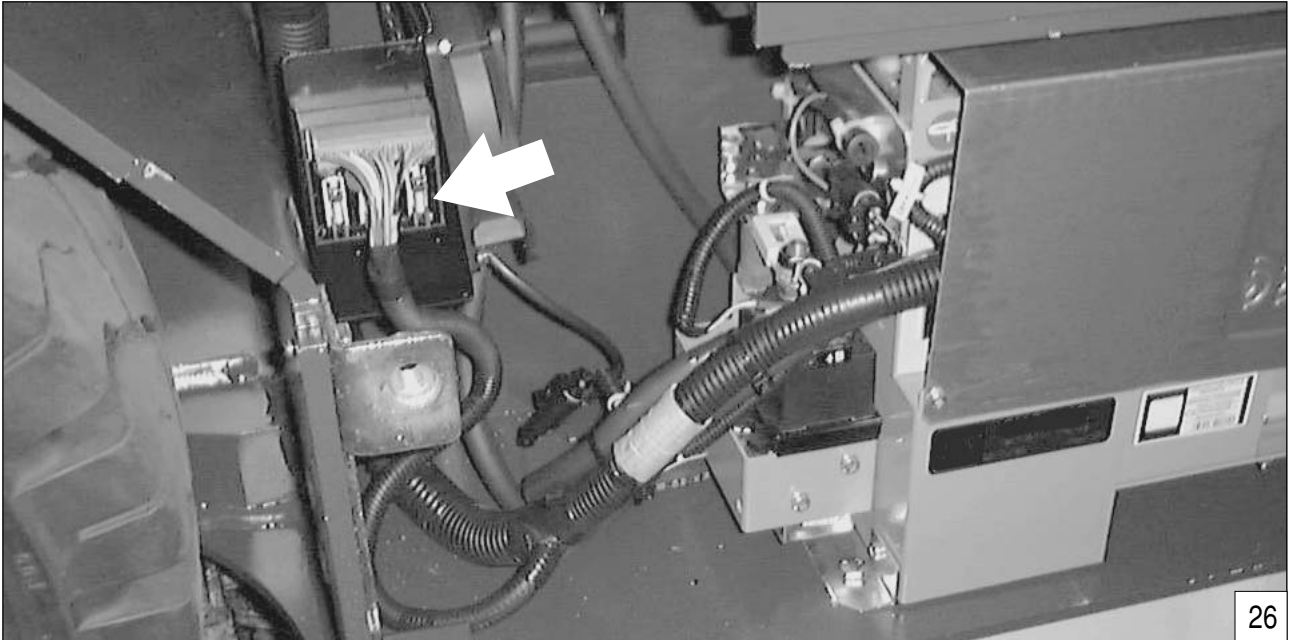


25

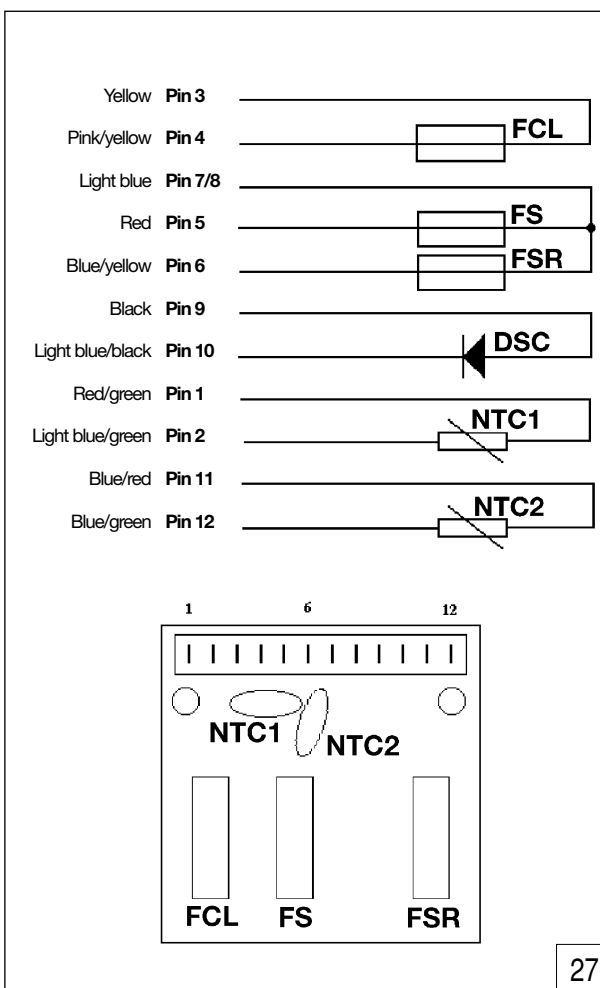
- |           |                    |            |                                      |
|-----------|--------------------|------------|--------------------------------------|
| <b>1.</b> | stop valve         | <b>V2.</b> | to hydraulic distributor             |
| <b>2.</b> | overpressure valve | <b>C2.</b> | to upright tilt cylinders            |
|           |                    | <b>P.</b>  | to upright tilt cylinders (piloting) |

## TERMINAL BOARD

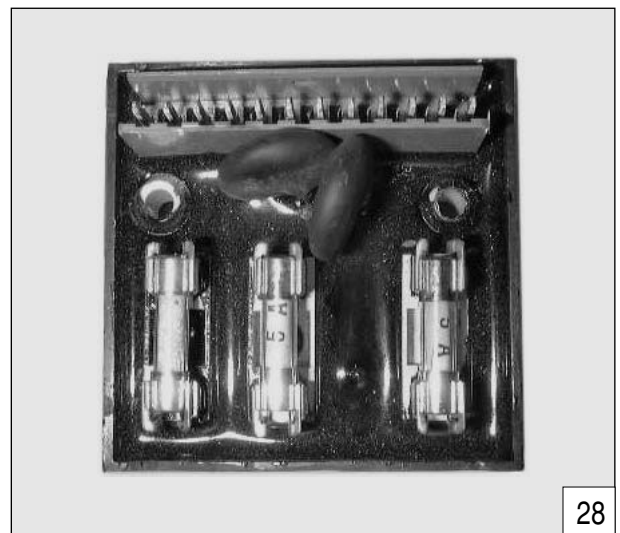
A terminal board, positioned in the same way as shown in the figure, has the function to protect the electronic system, against possible short-circuits.



26



27



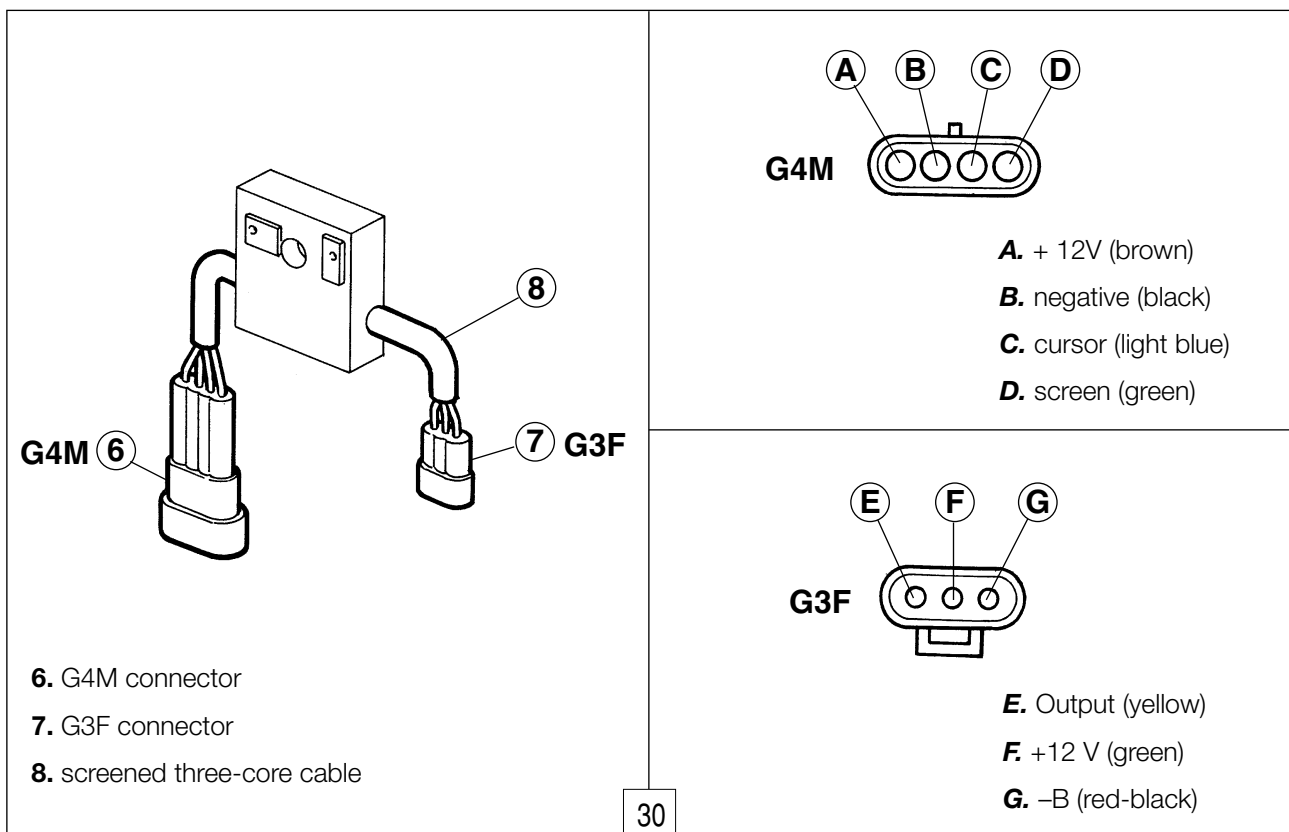
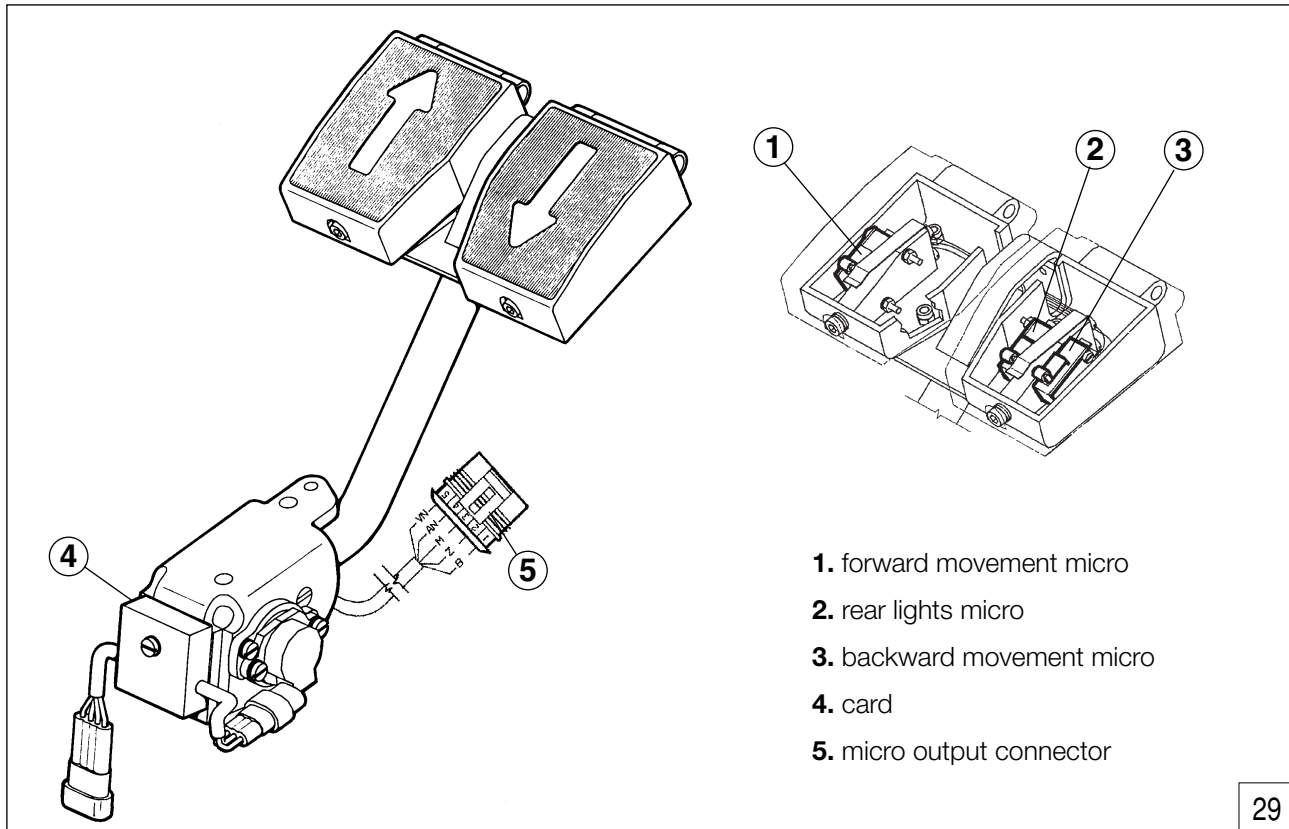
28

In addition, it houses an anti-jamming DSC diode for the horn and two NCT1 and NTC2 protection filters, for rear lights and stop lights.

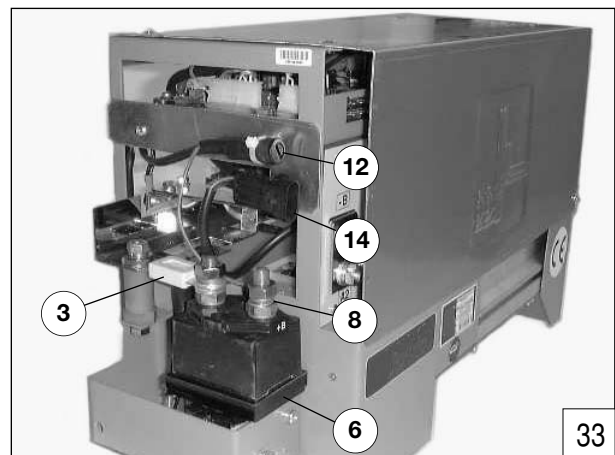
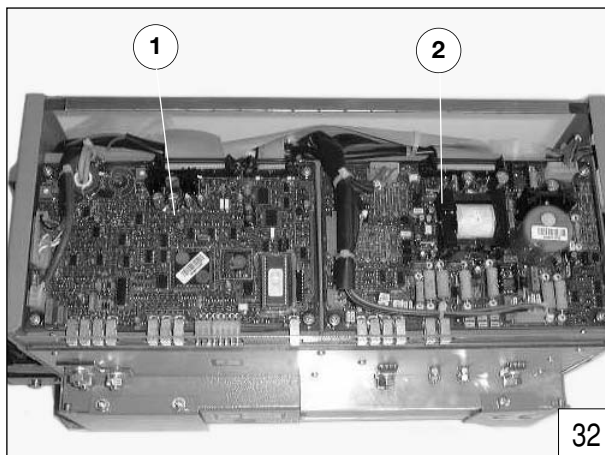
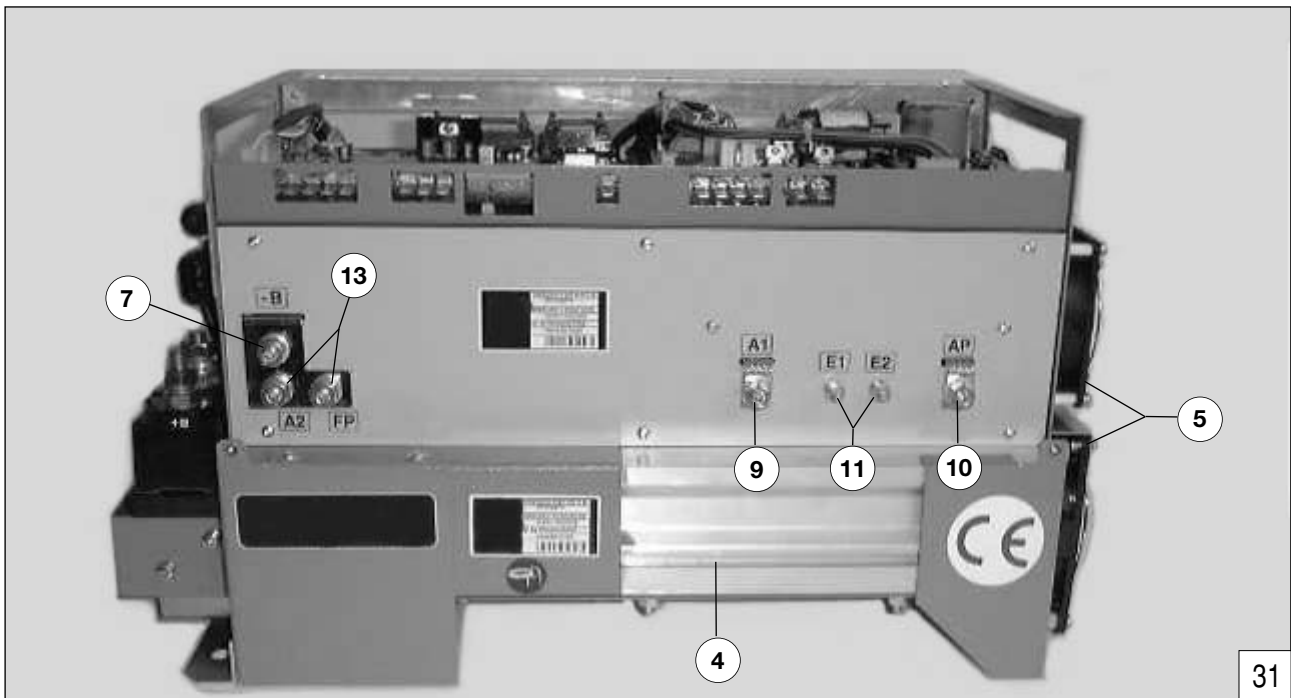
|              |                       |          |
|--------------|-----------------------|----------|
| <b>FCL.</b>  | Horn fuse             | 80V-10A  |
| <b>FS.</b>   | Equipment fuse        | 80V-5A   |
| <b>FSR.</b>  | Reverse and stop fuse | 80V-5A   |
| <b>DSC.</b>  | Horn blanker diode    | RG31     |
| <b>NTC1.</b> | Reverse light         | N15SP010 |
| <b>NTC2.</b> | Stop light            | N12SP010 |

## ACCELERATOR PEDAL

It has been designed to improve the ergonomics, reliability and requires less maintenance operations.

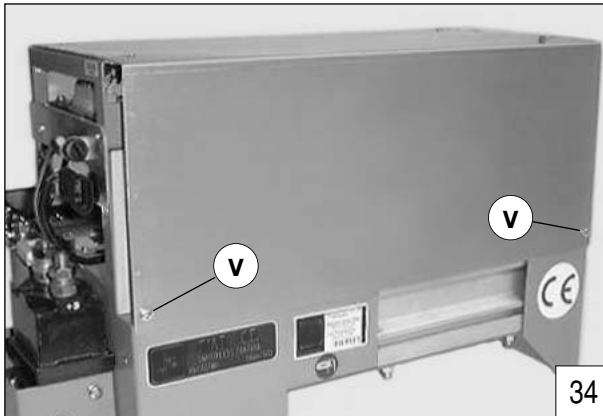


## “HIGH-FREQUENCY” SWITCHLESS CHOPPER ELEMENTS

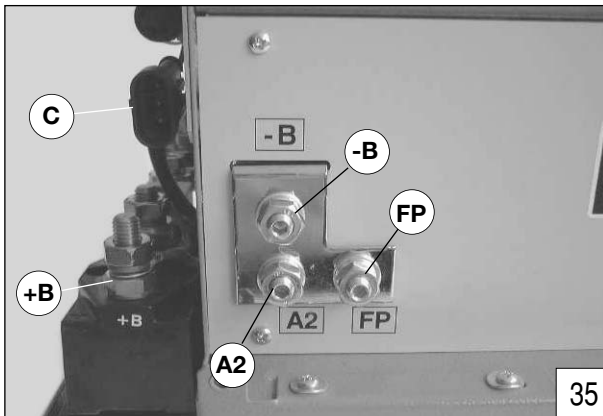


- |                           |                                                        |
|---------------------------|--------------------------------------------------------|
| 1. Micro board            | 8. Battery positive input                              |
| 2. Power board            | 9. Drive motor positive output                         |
| 3. Fuse 350A              | 10. Pump motor positive output                         |
| 4. Power unit             | 11. Field outputs                                      |
| 5. Fans                   | 12. Fuse 6,3A                                          |
| 6. Contactor              | 13. Pump motor drive motor negative output             |
| 7. Battery negative input | 14. Hall-acting sensor power on distributor lift lever |

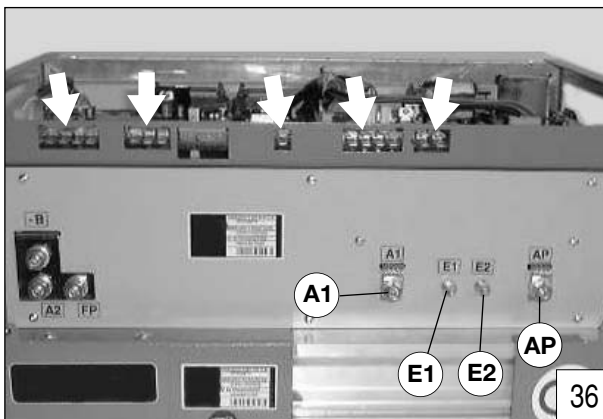
## REPLACEMENT OF PANEL



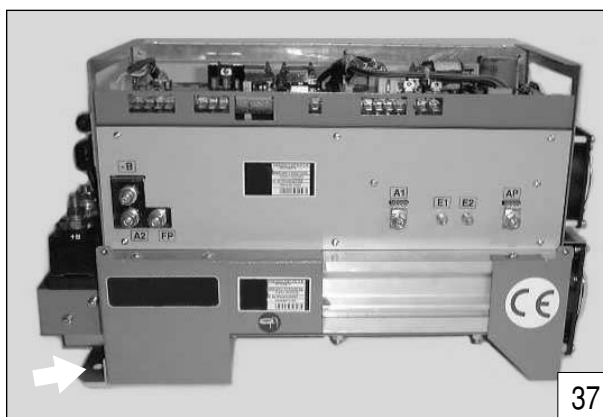
1. Remove the 2 screws that fasten the higher part of the front cover (Fig. 34)



2. Disconnect **+B** and **-B** power cables, **FP -A2** cables and **C** connector shown in figure 35.

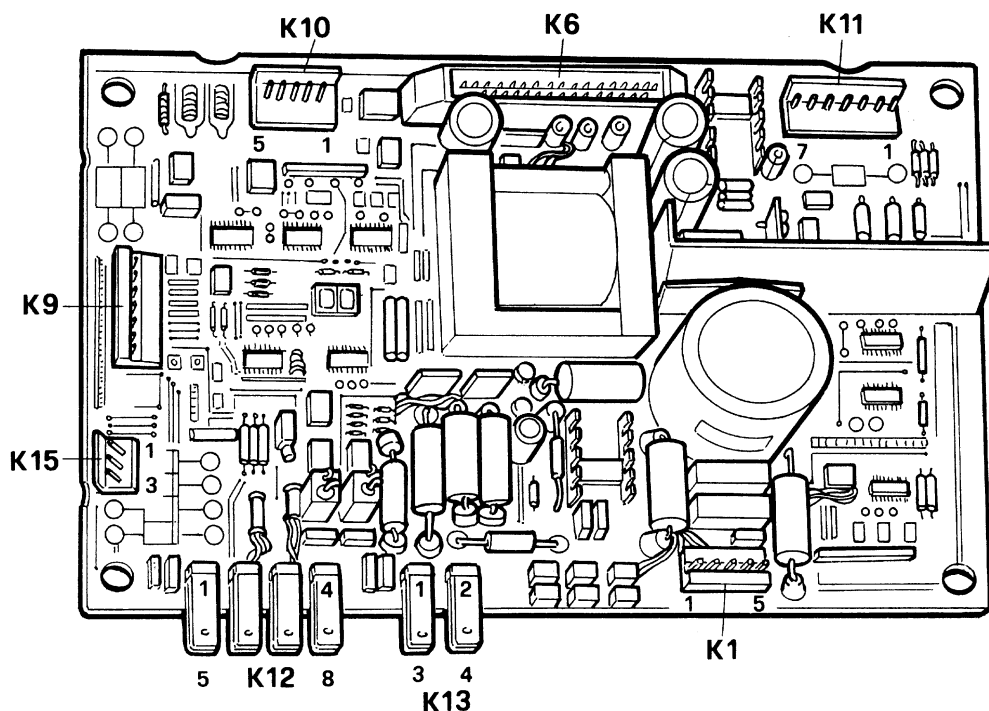


3. Disconnect cables in points **A1 - E1 - E2 - AP** and card connections indicated by the arrows.



4. Remove screws that fix the panel against the truck frame.

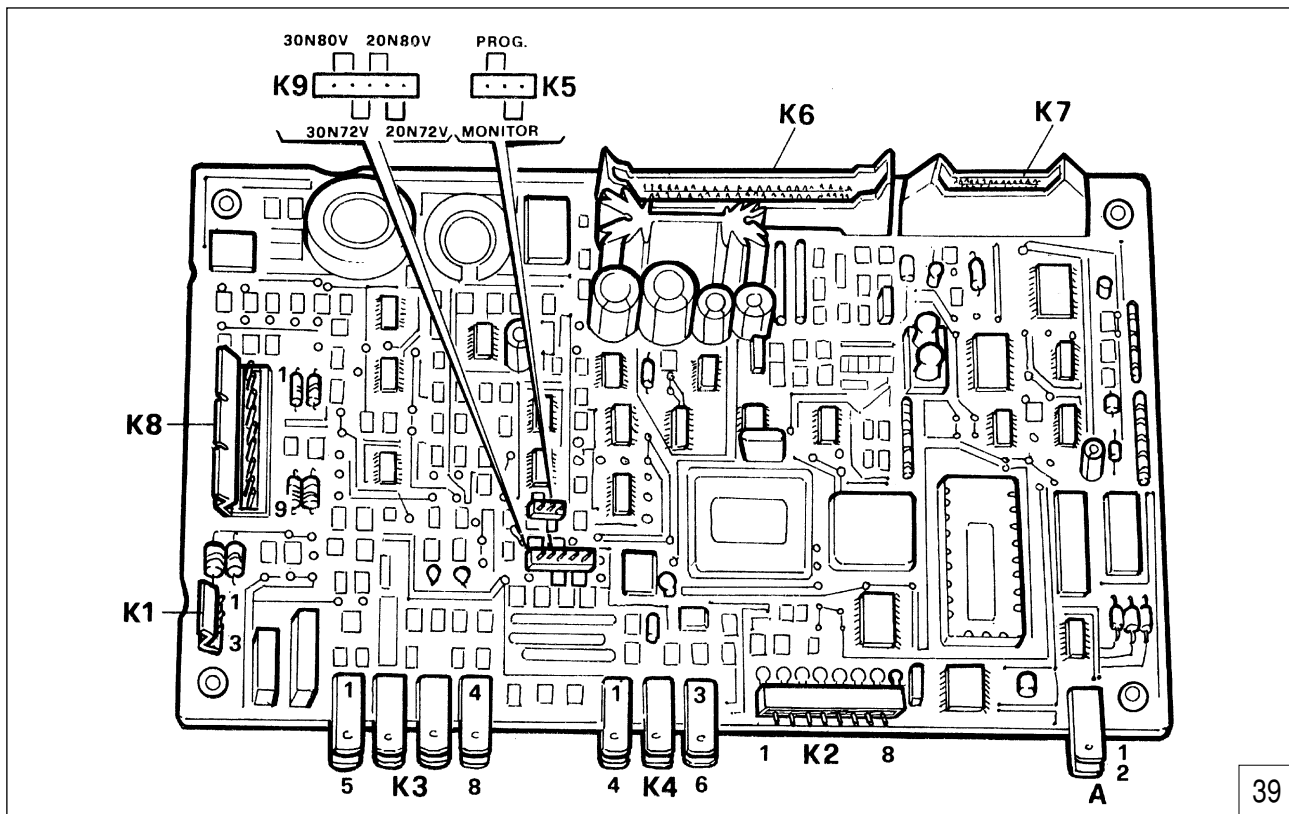
Replace the panel and repeat the operations backwards.

**POWER CARD**

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|     |   |   |                            |              |                      |
|-----|---|---|----------------------------|--------------|----------------------|
| K1  | 1 | — | FREE                       |              |                      |
| K1  | 2 | — | - BATTERY                  | - B          |                      |
| K1  | 3 | — | CONDENSER PRECHARGE        | +B 72/80V    |                      |
| K1  | 4 | — | FREE                       |              |                      |
| K1  | 5 | — | +CARD POWER SUPPLY BATTERY | +B 72/80V    |                      |
| K6  |   | — | MICRO CARD CONNECTIONS     |              |                      |
| K9  | 1 | — | TRT GATE                   | ) 0V→14V     |                      |
| K9  | 2 | — | TRT SOURCE                 |              |                      |
| K9  | 3 | — | TRT GATE                   | ) 0V→14V     |                      |
| K9  | 4 | — | TRT SOURCE                 |              |                      |
| K9  | 5 | — | FREE                       |              |                      |
| K9  | 6 | — | FREE                       |              |                      |
| K9  | 7 | — | TRT DRAIN                  | +B 72/80V    |                      |
| K10 | 1 | — | TRF GATE                   | ) 0V→12V     |                      |
| K10 | 2 | — | TRF SOURCE                 |              |                      |
| K10 | 3 | — | TRF DRAIN                  | +B 72/80V    |                      |
| K10 | 4 | — | TRF GATE                   | ) 0V→12V     |                      |
| K10 | 5 | — | TRF SOURCE                 |              |                      |
| K11 | 1 | — | TRP GATE                   | ) 0V→12V     |                      |
| K11 | 2 | — | TRP SOURCE                 |              |                      |
| K11 | 3 | — | TRP DRAIN                  | +B 72/80V    |                      |
| K11 | 4 | — | FREE                       |              |                      |
| K11 | 5 | — | FREE                       |              |                      |
| K11 | 6 | — | T DRMP GATE                |              |                      |
| K11 | 7 | — | T DRMP SOURCE              |              |                      |
| K12 | 1 | — |                            |              | WHITE/GREEN          |
| K12 | 2 | — | JUMPER                     |              | WHITE/GREEN (JUMPER) |
| K12 | 3 | — | DRIVE MOTOR BRUSHES        | 0V→+B 72/80V | PINK/YELLOW          |
| K12 | 4 | — | DRIVE MOTOR BRUSHES        |              | PINK/YELLOW          |
| K12 | 5 | — | PUMP MOTOR BRUSHES         |              | PINK/YELLOW          |
| K12 | 6 | — | - PANEL FAN POWER SUPPLY   | 0V→+B 72/80V | EMPTY                |
| K12 | 7 | — | - PUMP MOTOR BRUSHES       |              | PINK/YELLOW          |
| K12 | 8 | — | FREE                       |              | EMPTY                |
| K13 | 1 | — | -BATTERY                   | -B           | BLACK                |
| K13 | 2 | — | -BATTERY                   | -B           | BLACK                |
| K13 | 3 | — | PEDAL POWER SUPPLY         | + 11V        | ORANGE               |
| K13 | 4 | — | KEY                        | + 24V        | RED/BLACK            |
| K15 | 1 | — | - PANEL FAN                | - B          |                      |
| K15 | 2 | — | +PANEL FAN                 | +24V         |                      |
| K15 | 3 | — | +CONTACTOR COIL            | +B 72/80V    |                      |

## MICRO CARD

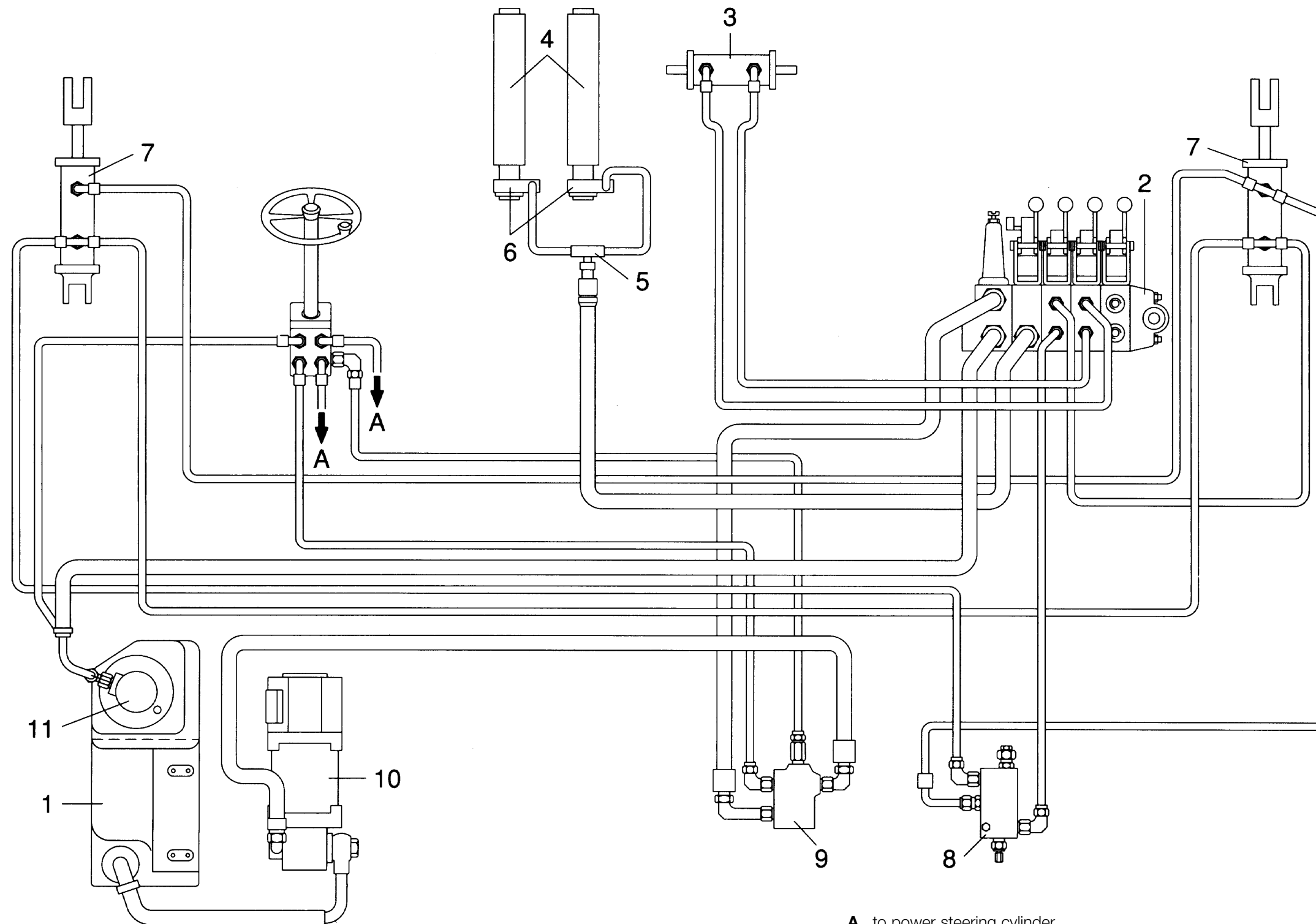


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|    |   |   |                                         |         |              |
|----|---|---|-----------------------------------------|---------|--------------|
| K1 | 1 | — | +SWITC THERMO                           | - B→5V  |              |
| K1 | 2 | — | -SWITC THERMO                           | - B     |              |
| K1 | 3 | — | FREE                                    |         |              |
| K2 | 1 | — | DISPLAY POWER SUPPLY                    | +7.5V   |              |
| K2 | 2 | — | CLOCK                                   |         |              |
| K2 | 3 | — | Rx D                                    |         |              |
| K2 | 4 | — | S/P                                     |         |              |
| K2 | 5 | — | - DISPLAY BATTERY                       |         |              |
| K2 | 6 | — | - Tx D                                  |         |              |
| K2 | 7 | — | ALARM                                   |         |              |
| K2 | 8 | — | FREE                                    |         |              |
| K3 | 1 | — | SAFETY CONTACT                          | + 5V→0V | PINK         |
| K3 | 2 | — | FREE                                    |         | EMPTY        |
| K3 | 3 | — | FREE                                    |         | EMPTY        |
| K3 | 4 | — | BRAKE PEDAL                             | + 5V→0V | LIGHT BLUE   |
| K3 | 5 | — | HANDBRAKE                               | - B→5V  | GREY/BLACK   |
| K3 | 6 | — | PEDAL OUTPUT                            | 0V→11V  | GREEN        |
| K3 | 7 | — | FREE                                    |         | EMPTY        |
| K3 | 8 | — | LIFT SPEED SIGNAL INPUT                 | 4,5V→8V | YELLOW/GREY  |
| K4 | 1 | — | REVERSE                                 | + 5V→0V | WHITE        |
| K4 | 2 | — | SWING                                   | - B→5V  | YELLOW/BLACK |
| K4 | 3 | — | 2° LIFT SPEED                           | - B→5V  | GREEN/GREY   |
| K4 | 4 | — | FORWARD                                 | + 5V→0V | BROWN        |
| K4 | 5 | — | LATERAL MOVEMENT                        | - B→5V  | PINK/BLACK   |
| K4 | 6 | — | FREE                                    |         |              |
| K6 | — | — | POWER CARD CONNECTIONS                  | - B     |              |
| K7 | — | — | FIELD CARD CONNECTIONS                  |         |              |
| K8 | 1 | — | -PUMP CURRENT SENSOR                    | - B     |              |
| K8 | 2 | — | -PUMP CURRENT SENSOR                    |         |              |
| K8 | 3 | — | - 12V PUMP CURRENT SENSOR POWER SUPPLY  |         |              |
| K8 | 4 | — | - 12V PUMP CURRENT SENSOR POWER SUPPLY  |         |              |
| K8 | 5 | — | - CURRENT SENSOR BATTERY                |         |              |
| K8 | 6 | — | - DRIVE CURRENT SENSOR                  | - B     |              |
| K8 | 7 | — | + DRIVE CURRENT SENSOR                  |         |              |
| K8 | 8 | — | + 12V DRIVE CURRENT SENSOR POWER SUPPLY |         |              |
| K8 | 9 | — | 12V DRIVE CURRENT SENSOR POWER SUPPLY   |         |              |
| KA | 1 | — | REVERSE LIGHT RELAY COMMAND             | +24V→-B |              |
| KA | 2 | — | FREE                                    |         |              |

# HYDRAULIC CIRCUITS

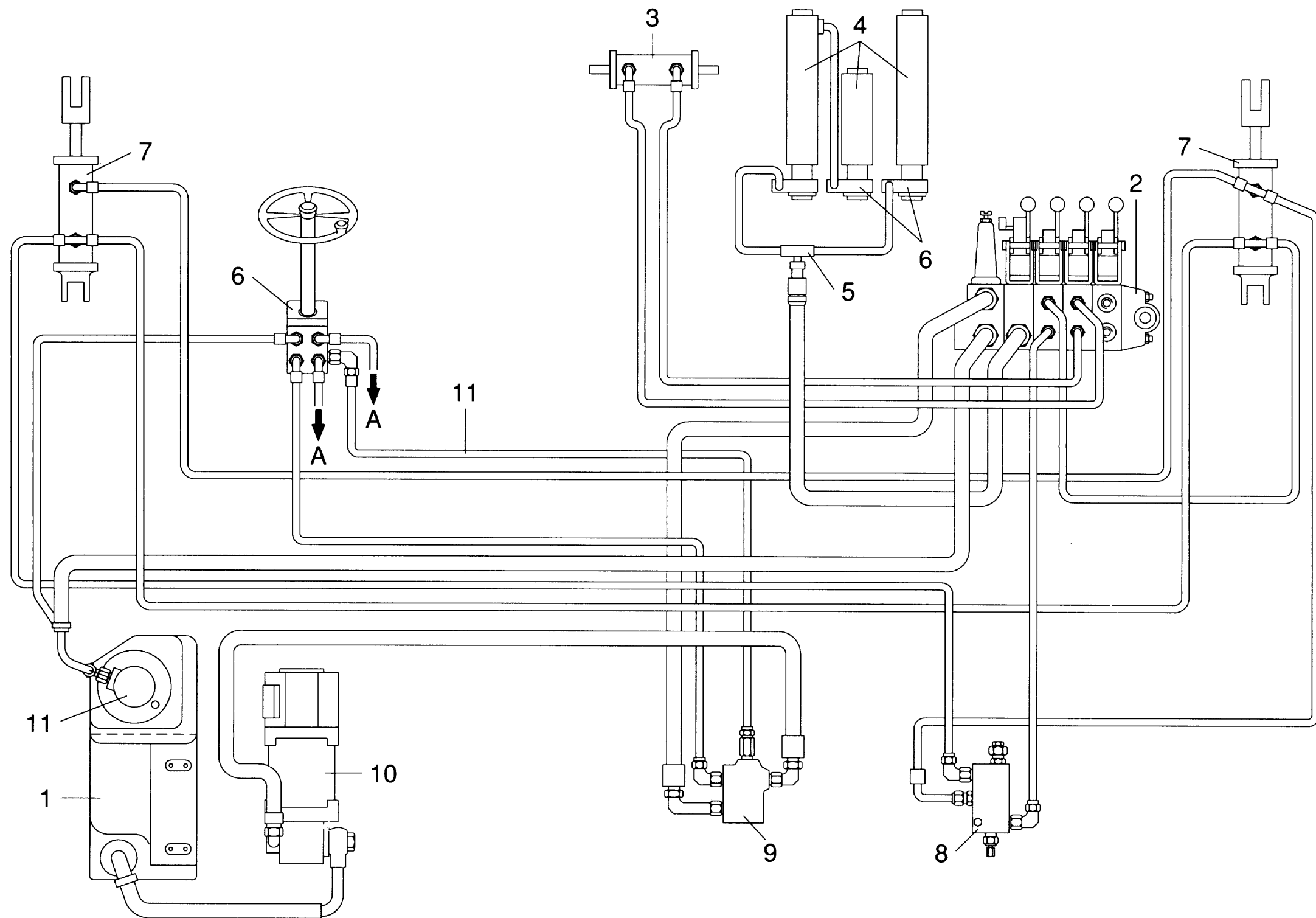




- A. to power steering cylinder
- 1. oil tanks
  - 2. distributor
  - 3. side movement control cylinder
  - 4. lifting cylinders
  - 5. deceleration valve
  - 6. safety valves
  - 7. displacing cylinder
  - 8. anticavitation stop valve
  - 9. priority valve
  - 10. motor pump
  - 11. oil filter

**EU 18**  
**EU 20**  
**EU 20L**  
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**EU 30**

Hydraulic System Diagram referring to SIMPLEX Lift-truck



- A. to power steering cylinder
- 1. oil tanks
  - 2. distributor
  - 3. side movement control cylinder
  - 4. lifting cylinders
  - 5. deceleration valve
  - 6. safety valves
  - 7. displacing cylinder
  - 8. anticavitation stop valve
  - 9. priority valve
  - 10. motor pump
  - 11. oil filter

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# WIRING DIAGRAMS



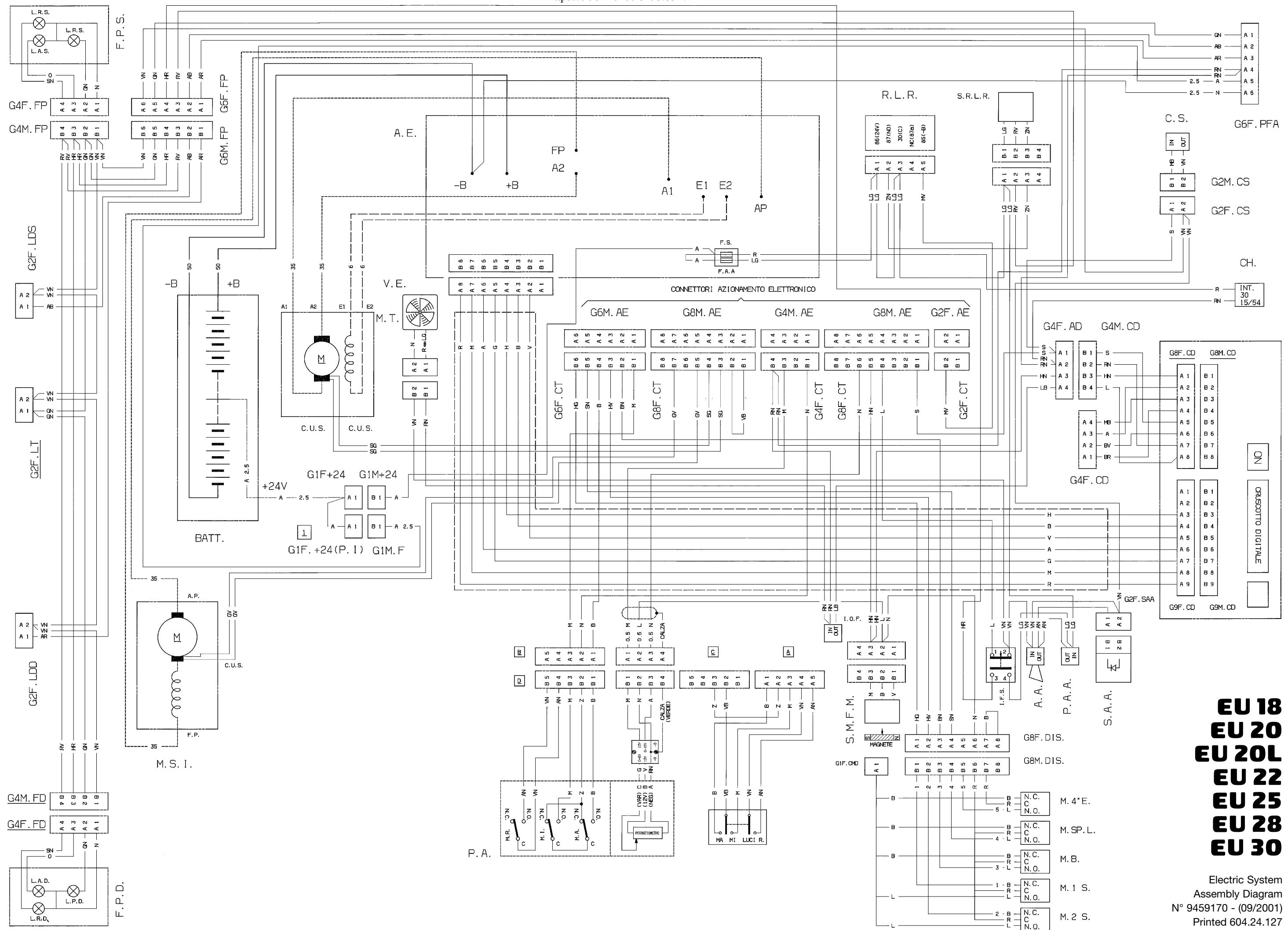
**KEYS OF DIAGRAM N. 9459170**

|                   |                                                                            |
|-------------------|----------------------------------------------------------------------------|
| <b>A.A.</b>       | acoustic signal                                                            |
| <b>A.E.</b>       | electronic driving                                                         |
| <b>BATT.</b>      | 72/80V battery                                                             |
| <b>C.S.</b>       | seat contact                                                               |
| <b>CH.</b>        | Key                                                                        |
| <b>F.A.A.</b>     | acoustic signal fuse                                                       |
| <b>F.P.D.</b>     | right rear light                                                           |
| <b>F.P.S.</b>     | left rear light                                                            |
| <b>F.S.</b>       | equipment fuse                                                             |
| <b>G1F.CMD</b>    | one-way connector of distributor micro cables                              |
| <b>G1F.+24(P)</b> | one-way connector of light power inter. outlet receptacles                 |
| <b>G1F.+24</b>    | one-way connector of battery side outlet receptacles                       |
| <b>G1M.F</b>      | one-way connector of pin header for lamps                                  |
| <b>G1M+24</b>     | one-way connector of remote control switch cable interm. outlet pin header |
| <b>G2F.AE</b>     | two-way connector of electronic driving power pin header                   |
| <b>G2F.CS</b>     | two-way connector of receptacle for seat contact                           |
| <b>G2M.CT</b>     | two-way connector of frame cable receptacle                                |
| <b>G2F.LDO</b>    | two-way connector of right turn indicator light loc. receptacle            |
| <b>G2F.LDS</b>    | two-way connector of left turn indicator light loc. receptacle             |
| <b>G2F.LT</b>     | two-way connector of number plate lamp loc. receptacle                     |
| <b>G2M.CS</b>     | two-way connector of pin header for seat contact                           |
| <b>G4(F)</b>      | receptacle four-way connector                                              |
| <b>G4F.AD</b>     | digital dashboard power receptacle four-way connector                      |
| <b>G4F.CD</b>     | digital dashboard receptacle four-way connector                            |
| <b>G4F.CT</b>     | frame cable pin header four-way connector                                  |
| <b>G4F.FD</b>     | right lamp receptacle four-way connector                                   |
| <b>G4F.FP</b>     | rear lamp receptacle four-way connector                                    |
| <b>G4M.AE</b>     | electronic driving power pin header four-way connector                     |
| <b>G4M.CD</b>     | digital dashboard pin header four-ways                                     |
| <b>G4M.FD</b>     | right lamp pin header four-way connector                                   |
| <b>G4M.FP</b>     | left turn indicator light lamp pin header four-way connector               |
| <b>G4M.IM</b>     | manual reversing gear pin header four-way connector                        |
| <b>G4M.PED</b>    | pedal pin header four-way connector                                        |
| <b>G5(F)</b>      | receptacles five-way coupling                                              |
| <b>G5F.RR</b>     | reverse relay receptacle five-way connector                                |
| <b>G5F.CT</b>     | frame cable receptacle six-way connector                                   |
| <b>G6F.FP</b>     | front lamp loc. receptacle six-way connector                               |
| <b>G6F.PFA</b>    | light system loc. receptacle. six-way connector                            |
| <b>G6M.AE</b>     | electronic driving power pin header six-way connector                      |
| <b>G6M.FP</b>     | front lamp loc. pin header six-way connector                               |
| <b>G6 (F)</b>     | receptacle 8-way connector                                                 |
| <b>G6(F)</b>      | pin header 8-way connector                                                 |
| <b>G8F.CD</b>     | digital dashboard receptacle eight-way connector                           |
| <b>G8F.CT</b>     | frame cable receptacle eight-way connector                                 |
| <b>G8F.DIS</b>    | distributor receptacle eight-way connector                                 |
| <b>G8M.AE</b>     | electronic driving power pin header eight-way connector                    |
| <b>G8M.CD</b>     | digital dashboard pin header eight-way connector                           |
| <b>G8M.DIS.</b>   | distributor receptacle eight-way connection                                |
| <b>G9F.CD</b>     | digital dashboard receptacle nine-way connector                            |
| <b>G9M.CD</b>     | digital dashboard pin header nine-way connector                            |
| <b>I.F.S.</b>     | stop light and braking switch                                              |
| <b>I.M.</b>       | manual reversing gear                                                      |
| <b>I.O.F.</b>     | brake oil switch                                                           |
| <b>M.B.</b>       | azimuth rate micro                                                         |
| <b>M.S.I.</b>     | hydraulic pump and lift motor                                              |
| <b>M.SP.L.</b>    | side movement micro                                                        |
| <b>M.T.</b>       | traction motor                                                             |
| <b>M. 1 S.</b>    | first lift speed micro                                                     |
| <b>M. 2 S.</b>    | second lift speed micro                                                    |
| <b>M. 4 E.</b>    | fourth element micro                                                       |
| <b>P.A.</b>       | accelerator pedal                                                          |
| <b>P.A.A.</b>     | acoustic signal button                                                     |
| <b>R.L.R.</b>     | backup light relay                                                         |
| <b>S.A.A.</b>     | acoustic signal blanker                                                    |
| <b>S.M.F.M.</b>   | handbrake magnetic sensor                                                  |
| <b>S.R.L.R.</b>   | backup light and relay blanker                                             |
| <b>V.E.</b>       | external fan                                                               |

**Cable colours**

|          |             |
|----------|-------------|
| <b>A</b> | light blue  |
| <b>B</b> | white       |
| <b>C</b> | orange      |
| <b>G</b> | yellow      |
| <b>H</b> | grey        |
| <b>L</b> | blue        |
| <b>M</b> | brown       |
| <b>N</b> | black       |
| <b>O</b> | light brown |
| <b>R</b> | red         |
| <b>S</b> | pink        |
| <b>V</b> | green       |
| <b>Z</b> | purple      |





**EU 18**  
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**EU 20L**  
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**KEYS OF DIAGRAM N. 95351974**

|                     |                                |
|---------------------|--------------------------------|
| <b>A.M.T.</b>       | traction motor armature        |
| <b>B.R. (V.589)</b> | reverse buzzer                 |
| <b>BATT.</b>        | 72/80 battery                  |
| <b>C.A.</b>         | starting switch                |
| <b>C.F.B.</b>       | battery filter capacitors      |
| <b>C.M.T.</b>       | traction motor field           |
| <b>C.O.F.</b>       | brake oil contact              |
| <b>C.S.</b>         | seat contact                   |
| <b>CL.</b>          | horn                           |
| <b>D.S.C.</b>       | horn blanker diode             |
| <b>F.A.</b>         | card power fuse                |
| <b>F.CL.</b>        | horn fuse                      |
| <b>F.G.</b>         | general fuse                   |
| <b>F.S.</b>         | equipment fuse                 |
| <b>M.S.</b>         | stop light micro               |
| <b>M.F.</b>         | braking micro                  |
| <b>L.A.D.</b>       | right stop lamp                |
| <b>L.A.S.</b>       | left stop lamp                 |
| <b>L.R.D.</b>       | right rear lamp                |
| <b>L.R.S.</b>       | left rear lamp                 |
| <b>M.S.I.</b>       | hydraulic pump and lift motor  |
| <b>NTC 1</b>        | NTC 1 rear lights stop         |
| <b>NTC 2</b>        | NTC 2 rear lights reverse gear |
| <b>P.A.</b>         | accelerator pedal              |
| <b>P.CL.</b>        | horn button                    |
| <b>S.A.P.S.</b>     | lift potentiometer supply card |
| <b>S.A.A.</b>       | accelerator supply card        |
| <b>S.B.</b>         | azimuth rate sensor            |
| <b>S.H.A.</b>       | armature hall-acting sensor    |
| <b>S.H.C.</b>       | field hall sensor              |
| <b>S.H.P.</b>       | pump hall sensor               |
| <b>S.M.F.M.</b>     | hand-brake magnetic sensor     |
| <b>S.O.4E</b>       | optional fourth element sensor |
| <b>S.S.L.</b>       | side movement sensor           |
| <b>T.C.1.</b>       | field transistor               |
| <b>T.C.2.</b>       | field transistor               |
| <b>T.C.3.</b>       | field transistor               |
| <b>T.C.4.</b>       | field transistor               |
| <b>T.F.P.</b>       | pump braking transistor        |
| <b>T.F.1</b>        | braking transistor             |
| <b>T.F.2</b>        | braking transistor             |
| <b>T.G.</b>         | general remote control switch  |
| <b>T.P.</b>         | pump transistor                |
| <b>T.T.1</b>        | traction transistor            |
| <b>T.T.2</b>        | traction transistor            |
| <b>TER.</b>         | thermistor                     |
| <b>V.P.</b>         | panel fan                      |
| <b>V.V.P.</b>       | panel room fan                 |

**Cable colours**

|          |             |
|----------|-------------|
| <b>A</b> | light blue  |
| <b>B</b> | white       |
| <b>C</b> | orange      |
| <b>G</b> | yellow      |
| <b>H</b> | grey        |
| <b>L</b> | blue        |
| <b>M</b> | brown       |
| <b>N</b> | black       |
| <b>O</b> | light brown |
| <b>R</b> | red         |
| <b>S</b> | pink        |
| <b>V</b> | green       |
| <b>Z</b> | purple      |

- Ex collegamento luci retro = Former rear light connection
- Pedale trazione = Traction pedal
- Distributore = Distributor
- Scheda micro = Micro card
- Scheda campo trazione = Traction field card
- Scheda potenza = Power card
- Cruscotto digitale = Digital dashboard
- Predisizione fanaleria = Light location
- Variante inversore manuale = Alternative manual inverter
- Luci retro = Rear lights reverse gear
- Inversore di marcia = Drive inverter
- Alla fanaleria = To the light



Electric System  
Operation Diagram  
N° 95351974 - (Rev. 01-12/2001)  
Printed 604.24.127

**KEYS OF DIAGRAM N. 95351640**

- To handbrake magnetic contact
- To digital dashboard
- Acoustic signal button
- Reverse light relay
- RC set
- To electronic panel
- Acoustic signal blanker
- Acoustic signal
- To fuses
- To electric panel
- To seat contact
- To (stop-brake) switch
- To braking switch
- Screened cable electronic stepless speed change gear
- Power switch
- Brake oil switch
- Hydraulic distributor
- Pump motor brushes

**Cable colours**

|          |             |
|----------|-------------|
| <b>A</b> | light blue  |
| <b>B</b> | white       |
| <b>C</b> | orange      |
| <b>G</b> | yellow      |
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