



ELECTRONIC INDUSTRIAL DEVICES

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INSTALLATION AND USER MANUAL CHOPPER SEM-X



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LEGEND

B SW	=	Belly Switch
CM	=	Common Microswitches
CPOT	=	Wiper Potentiometer
EMB	=	Electromechanical Brake
EV	=	Lowering Valve
FORW SW	=	Forward Switch
H&S	=	Hard & Soft
HORN	=	Horn
HORN SW	=	Horn Switch
LIFT SW	=	Lifting Switch
LOW SW	=	Lowering Switch
MC	=	Main Contactor
NEMB	=	Negative Electromechanical Brake
NEV	=	Negative Lowering Valve
NHORN	=	Negative Horn
NMC	=	Negative Main Contactor
NPC	=	Negative Pump Contactor
NPOT	=	Negative Potentiometer
PC	=	Pump Contactor
PEMB	=	Positive Electromechanical Brake
PEV	=	Positive Lowering Valve
PHORN	=	Positive Horn
PMC	=	Positive Main Contactor
PPC	=	Positive Pump Contactor
PPOT	=	Positive Potentiometer
REV SW	=	Reverse Switch
SR1	=	Speed Reduction 1
SR2	=	Speed Reduction 2
T SW	=	Tiller Switch

COLOUR CODES (SINGLE COLOURS)

The following Codes represent the colours of individual wires used by Zapi (unless specified otherwise).

A - Orange	M - Brown
B - White	N - Black
BB - Blue	R - Pink
C - Sky Blue	RR - Red
G - Yellow	V - Green
GG - Grey	VV - Purple

1 INTRODUCTION TO THE ZAPI-MOS FAMILY

The ZAPIMOS chopper family represents ZAPI's answer to the needs of the 90's. To ensure that products remain on the market, without running the risk of becoming technically obsolescent, the ZAPIMOS family offers the following features:

- Advanced technology.
- Economical costs.
- Maximum safety.
- Maximum flexibility.
- Open to future technical innovations.
- **Optimum level of protection.**

The design has been derived from:

- High Frequency Mos Technology .
- Real time control over the internal and external components that influence the behavior of the machine, with self diagnosis of the checking circuits themselves.
- Stored Program Machine (SPC), where the hardware is completely separate from the functions to be configured. The program is parametric and can easily be modified by the end user.
- Various chopper configurations can be selected by the user, without the need for hardware modifications.
- Future technological updates are made easy for the user.

The communication protocol will continue to evolve, thereby offering increasing possibilities of interaction and expansion. For this reason, the Zapimos family offers a standard dialogue mode with external systems. This allows interfacing with

commercially available machines. Zapi can offer a range of individually designed Console Software with various features and prices.

- SEM-X meets the requirements of (IP54). This provides excellent protection against spray (water, acid.), and against the ingress of dust or small foreign particles. Access to the control logic is very simple, and allows simple substitution or replacement.
- The SEM-X family of Choppers are suitable for operating on DC voltages at 24V, with maximum armature current up to 110A.
The choppers may be used to control DC Separately Excited Motors with power ratings up to 800W.

2 GENERAL CHARACTERISTICS

2.1 TECHNICAL SPECIFICATIONS

Chopper for Separately Excited DC motors	0.35 ÷ 0.8kW
Regenerative Braking	
Voltage Range	24VDC
Maximum Field Current (all the versions)	35 A
Armature Switching Frequency	16kHz
Field Switching Frequency	16kHz
Maximum Ambient temperature	+ 40°C
Minimum Ambient temperature	-30°C
Maximum temperature of Chopper	+ 90°C

VERSIONS	MAXIMUM CURRENT	VOLTAGE DROP IN FULL CONDUCTION
24V	90A (3')	0.14V at 35A, 25°C
24V	110A (2')	0.14V at 35A, 25°C

2.2 CONTROL UNITS

2.2.a Microswitches

- Microswitches should have a contact resistance lower than 0.1Ω , and a leakage current lower than $100\ \mu\text{A}$.
- When full load current is being drawn, the voltage drop across the Key Switch contact must be lower than 0.1V .
- If an Electromagnetic Brake is used, the Key Microswitch must be able to operate the Brake Coil.
- The Microswitches send a voltage signal to the microprocessor when an operating request (running) is made.

2.2.b Potentiometer

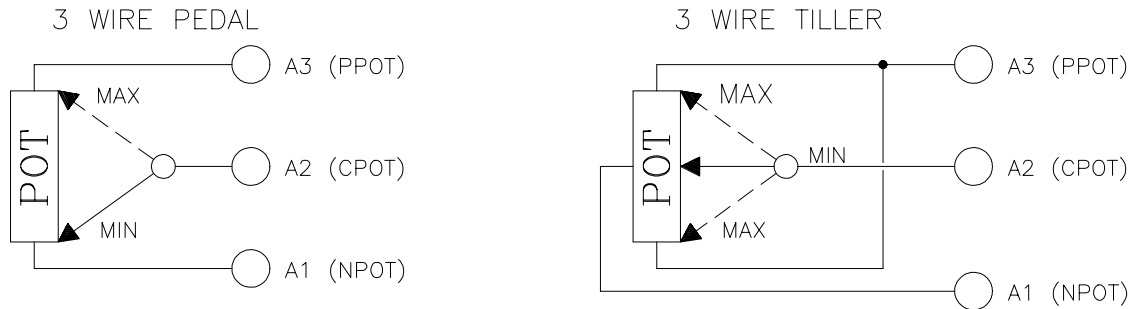
The Potentiometer should be wired in the 3 - Wire Configuration.

CPOT (A2) signal ranges from 0 to 10V.

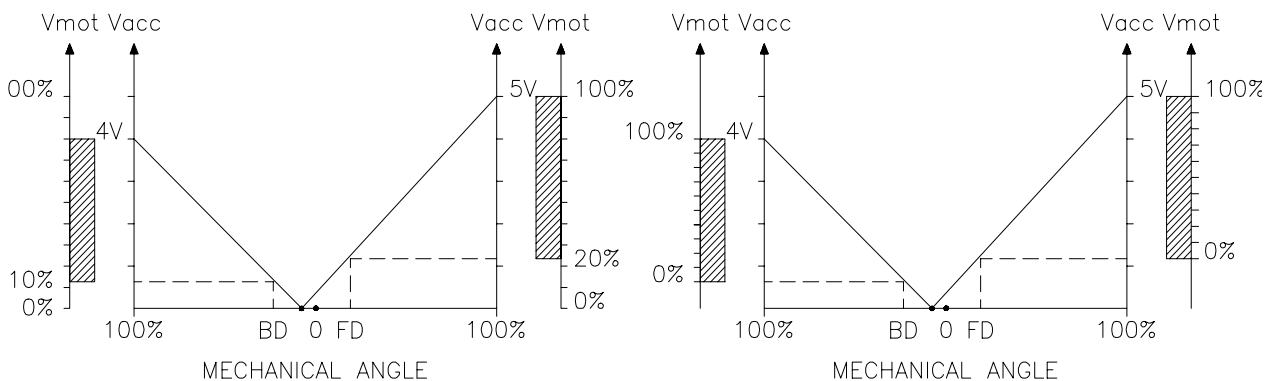
Minimum Potentiometer Resistance : 500Ω

Maximum Potentiometer Resistance : 10kΩ

Faults can occur if the potentiometer is out of this range.



The Procedure for automatic potentiometer signal acquisition is carried out using the Console. This enables adjustment of the minimum and maximum useful signal level (PROGRAM VACC function), in either direction. This function is unique when it is necessary to compensate for asymmetry with the mechanical elements associated with the potentiometer, especially relating to the minimum level.



The two graphs show the output voltage from a non-calibrated potentiometer with respect to the mechanical “zero” of the control lever. MI and MA indicate the point where the direction switches close. 0 represents the mechanical zero of the rotation. The Left Hand graph shows the relationship of the motor voltage without signal acquisition being made. The Right Hand Graph shows the same relationship after signal acquisition of the potentiometer.

2.3 SAFETY & PROTECTION FEATURES

- Connection Errors :

All Inputs are protected against connection errors.

- Thermal Protection :

If the chopper temperature exceeds 75°C, the maximum current reduces in proportion to the thermal increase. The temperature can never exceed 90°C (below - 10°C, the current is reduced to 80%).

- Low Battery Charge :

When the battery charge is low ($\leq 20\%$) and the "BATTERY CHECK" option is "ON", the maximum current is reduced to 50% and the speed is reduced of 60%.

- Protection against accidental Start up :

A precise sequence of operations are necessary before the machine will start. Operation cannot commence if these operations are not carried out correctly. Requests for drive, must be made after closing the key Switch.

- Protection against uncontrolled movements :

The Line Contactor will not close if :

- The Power Unit is not functioning
- The Logic is not functioning perfectly.

- Main / Line Contactor :

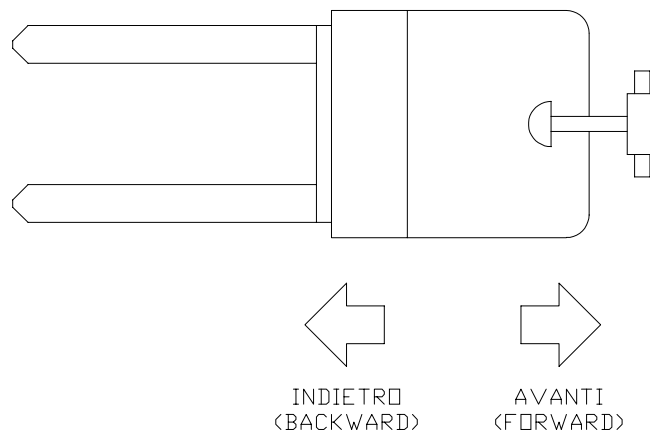
Should be fitted to give protection to the chopper against reverse battery polarity, and safety.

- External Agents :

The chopper is protected against dust and the spray of liquid to a degree of protection meeting IP54.

2.4 DIRECTION ORIENTATION

Machines fitted with Tillers, Belly Switches, and Pulse Control Systems providing rapid reversal should conform to the requirements of Directive prEN 1175. This Directive requires that Direction Orientation should match the following drawing:



2.5 OPERATIONAL FEATURES

- Speed Control.
- Optimum sensitivity at low speeds.
- Speed Reductions in both the directions. Levels can be set using Console.
- Regenerative Braking based on deceleration ramps, in every condition.
- Three different modes of Braking : Release Braking, Inversion Braking, Deceleration Braking.
- Speed Control during descent : the motor speed follows the accelerator. The chopper automatically brakes if the motor speed overcomes the accelerator set point. This provides optimum performance on a gradient.
- Starts on a Ramp without roll back, even without an electric brake:
When the Key Switch is closed, if the motor is rotating, the chopper controls the speed and automatically brakes and keeps the motor at a very low speed during descent on a gradient. This is a very useful safety feature and is not driver dependent.
- The main contactor is open after 60 seconds of stand-by condition.
- Self Diagnosis with indication of fault shown via flashing Red Led. (without Console).
- Modification of the parameters via Digital Console. See the specific description.
- Internal Hour Meter that is displayed on the Console.
- Memory of the last 5 Alarms, with relative Hour meter count and chopper temperature all displayed on the Console.
- Test Function within Console for checking main parameters. See the specific Description.
- High motor and battery efficiency due to High Frequency Switching.
- It is possible to connect SEM-X to MDI instrument.

2.6 SEM-X CHOPPER DIAGNOSIS

The microprocessor continually monitors the chopper and carries out diagnostic procedures on the main functions.

The diagnosis is made in 4 points:

- 1) Diagnosis on key Switch closing that checks: the Watch Dog Circuits, the current sensors, VMN point, Main Contactor Driver, if the switch sequence for operation is correct, and if the output of the accelerator or tiller is correct.
- 2) Standby Diagnosis at rest that checks: VMN Point, Main Contactor Driver, Current Sensor, Watchdog, Brake, Vfield, NPOT.
- 3) Diagnosis during operation that checks: Watchdog, VMN Point, Current (field and armature), Main Contactor, Brake, NPOT.
- 4) Continuous Diagnosis that checks: Chopper temperature, Battery Voltage.

Diagnosis is provided in 3 ways. The Red Led connected to Connector B will flash a certain number of times for a given Alarm (See Listings), or the Digital Console may be used or MDI. A permanent Alarm will be displayed on the Console immediately. An intermittent Alarm will be recorded in the Alarm library.

2.7 THERMAL CONSIDERATIONS

- The heat generated by the power block must be dissipated. For this to be possible, the compartment must be ventilated and the heat sink materials ample.
- The heat sink material and system should be sized on the performance requirement of the machine. Abnormal ambient air temperatures should be considered. In situations where either ventilation is poor, or heat exchange is difficult, forced air ventilation should be used.
- The thermal energy dissipated by the power block module varies and is dependent on the current drawn and the duty cycle.

2.8 GENERAL INSTRUCTIONS AND PRECAUTIONS

- Never combine SCR low frequency choppers with SEM-X modules. The filter capacitors contained in the SEM-X module will change the SCR chopper operation and subject it to excessive workload. If it is necessary to use two or more control units (eg. Lift + traction), the choppers must be of the High Frequency Zapi family.
- Do not connect the chopper to a battery with a different nominal voltage to the value indicated on the chopper. A higher battery voltage may cause MOS failure, and a lower voltage may prevent the logic operating.
- During battery recharge, the SEM-X must be completely disconnected from the battery. As well as altering the charge current read by the battery charger, the module can be damaged by higher than normal voltages supplied via the charger.
- The SEM-X module should only be supplied by a traction battery. Do not use the outputs of converters or power supplies. For special applications please contact the nearest Zapi service centre.
- Start the machine the first time with the drive wheel(s) raised from the floor to ensure that any installation errors do not compromise safety.
- After operation, even with the Key Switch open, the internal capacitors may remain charged for some time. For safe operation, we recommend that the battery is disconnected, and a short circuit is made between Battery Positive and Battery negative power terminals of the chopper using a Resistor between 10Ω and 100Ω. Minimum 5 W.
- The susceptibility and electromagnetic emission levels are seriously influenced by installation conditions. Take particular care with the length of cables and wires, types of electrical connections, and braided/screened wires.
Zapi declines any responsibility for incorrect or bad operation that can be attributed to the above circumstances. Above all, the manufacturer of the machine must ensure that the requirements of EN 50081-2 are met.

3 INSTALLATION

Install the chopper baseplate onto a flat metallic surface that is clean and unpainted. Apply a thin layer of thermo-conductive grease between the two surfaces to permit better heat dissipation.

Despite the protection provided against external agents, the continuous attack of corrosive elements and substances may cause oxidization of connector contacts, resulting in bad operation. Remember this point when deciding the installation position on the vehicle.

Fix the chopper using the special holes located on the baseplate.

Verify that the wiring of the cable terminals and connectors has been carried out correctly. Ensure that suppression devices are fitted to the coils not protected by the SEM-X itself.

3.1 CONNECTION CABLES

For the auxiliary circuits use cables better or equal to 0.5mm² section.

For power connections to the motor armature and battery use cable of 10mm² section.

For the Field connections use cable of 4mm² section.

For the optimum chopper performance, the cables to the battery should be run side by side and be as short as possible.

3.2 CONTACTORS

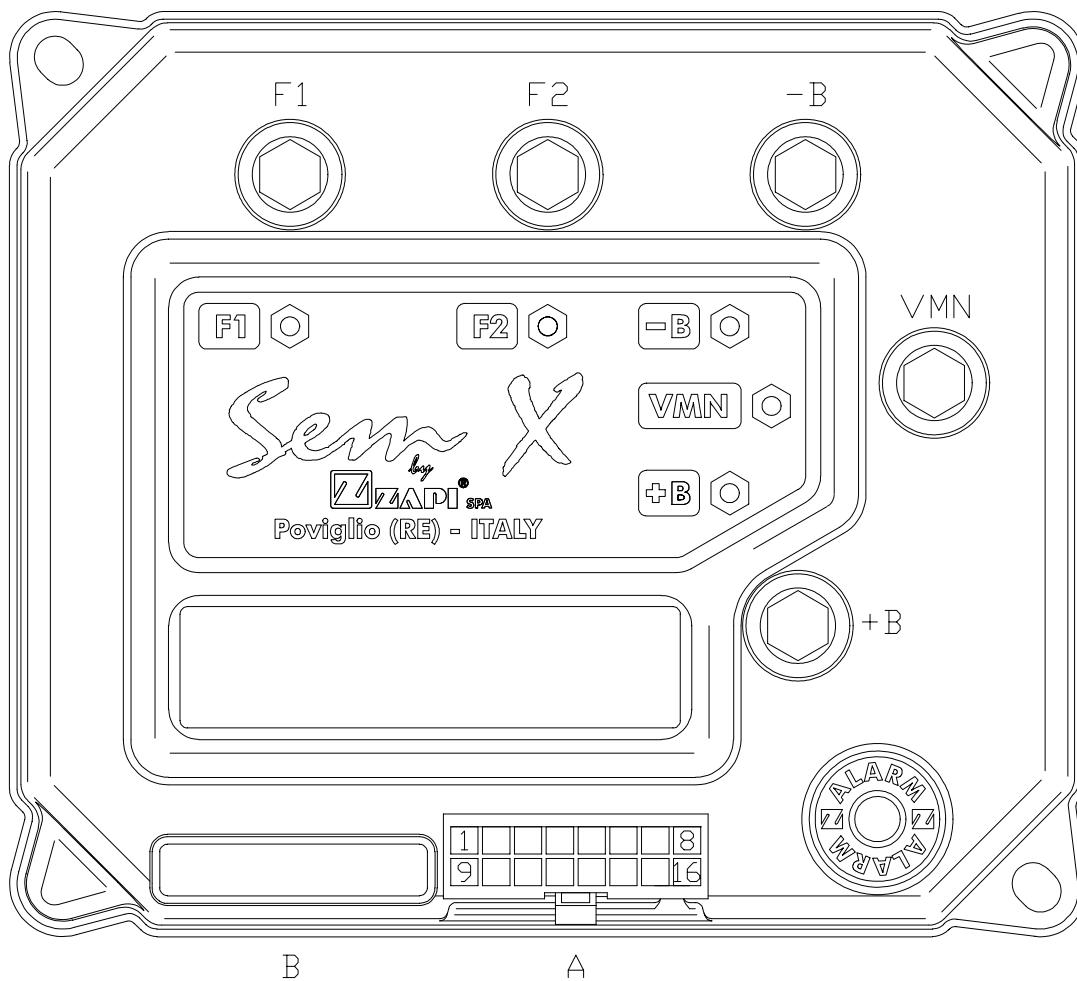
A Line Contactor, designed for Continuous Operation should be installed. This contactor should be fitted with a coil corresponding to the battery voltage. The current absorbed by the coil must not be greater than 3A.

Suppression for this contactor coil is within the chopper. Do not use external suppression. For any Contactor using external suppression, ensure that connections are made respecting correct polarity.

3.3 FUSES

- Use a 6.3A Fuse for protection of the auxiliary circuits.
- For protection of the power unit, refer to diagrams.. The Fuse value shown is the maximum allowable. For special applications or requirements these values can be reduced.
- For Safety reasons, we recommend the use of protected fuses in order to prevent the spread of fused particles should the fuse blow.

3.4 DESCRIPTION OF SEM-X CONNECTORS



PIN REFERENCE DESCRIPTION

A1	NPOT	Provides a negative supply to accelerator's potentiometer; the circuit is designed to provide a control against wire disconnection.
A2	CPOT	Accelerator's potentiometer wire input.
A3	PPOT	Provides a positive to supply accelerator's potentiometer, protected against short to +B and -B.
A4	TILLER	Tiller (seat) microswitch input, active high (+B).
A5	BELLY	Belly switch input, used for quick inversion function, active high (+B).
A6	FW	Forward direction switch input, active high (+B).
A7	REV	Reverse direction switch input, active high (+B).
A8	H&S	Hard&Soft switch input, active high (+B).
A9	DIGITAL IN.	Digital input, free for customization.
A10	---	

PIN REFERENCE DESCRIPTION

A11	NEB	electric brake driver output, 1.5A continuous, protected against shortcircuits.
A12	NLED	Output to drive a led, 100mA max.
A13	---	
A14	NMC	Line contactor driver output, 1.0A continuous, protected against shortcircuit.
A15	PMC	Line contactor coil positive supply, 1.0A continuous.
A16	KEY	Controller supply, must be connected to +B through a cable and a 6.3A fuse.

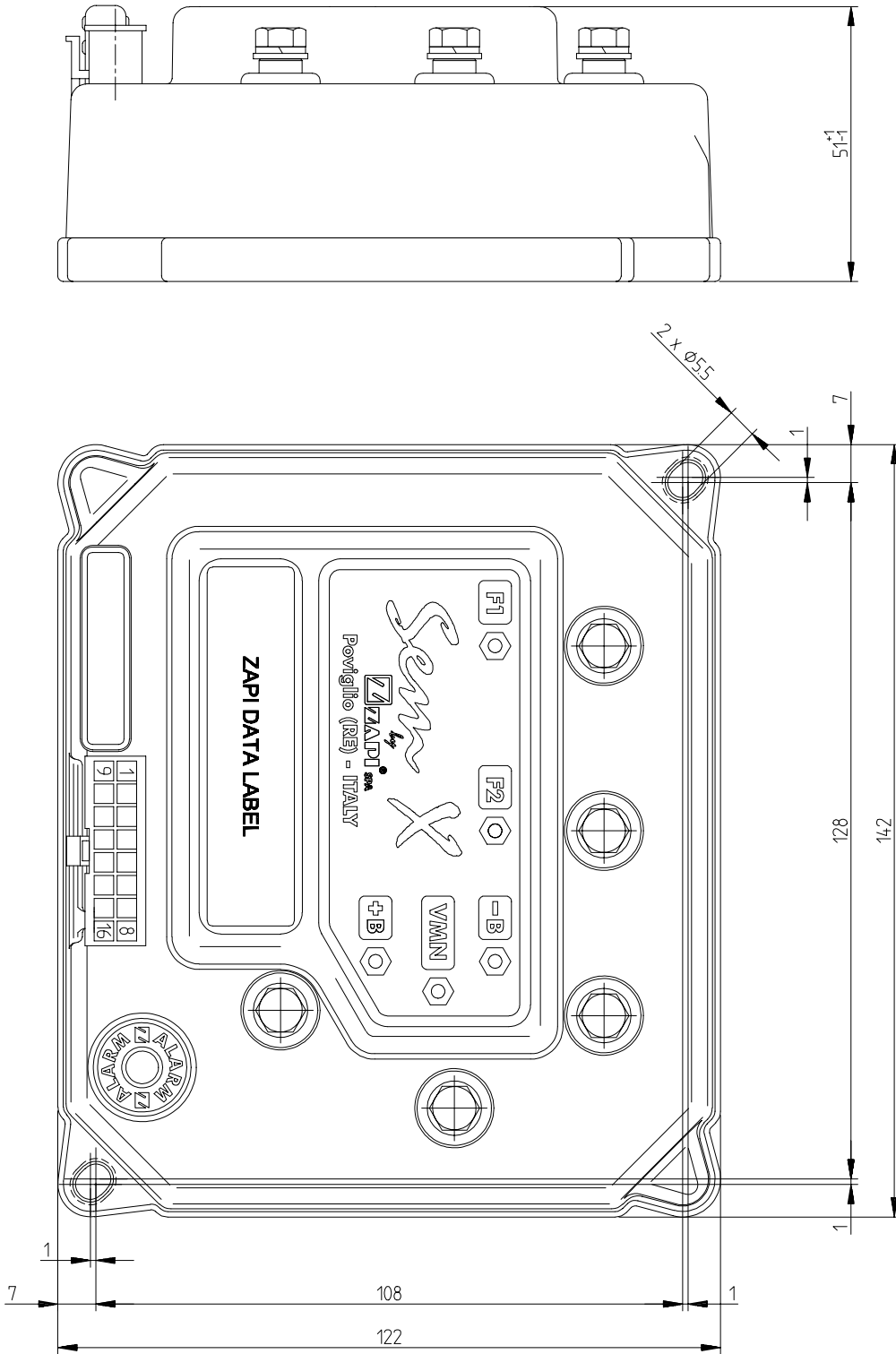
PIN REFERENCE

B1	---
B2	NCLRXD
B3	PCLTXD
B4	NCLTXD
B5	GND
B6	+12
B7	---
B8	---

3.5 DESCRIPTION OF POWER CONNECTIONS

+B	=	Positive Supply from Battery.
-B	=	Negative Supply from Battery.
VMN	=	Negative Supply (via chopper) to Motor.
F1, F2	=	Connections to Drive Motor Field Winding.

3.6 MECHANICAL DRAWING & DIMENSIONS



4 PROGRAMMING & ADJUSTMENTS USING DIGITAL CONSOLE

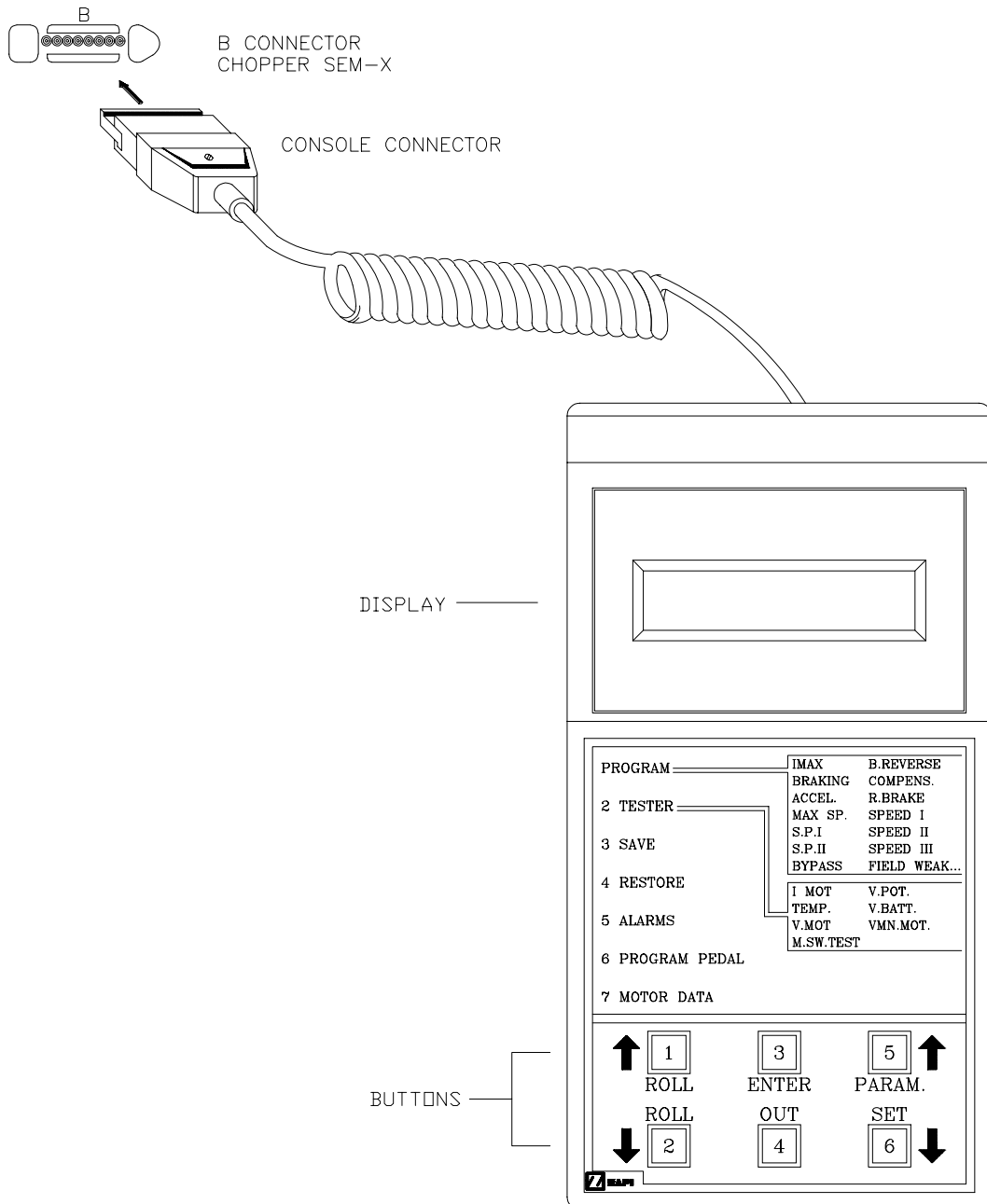
4.1 ADJUSTMENTS VIA CONSOLE

Adjustment of Parameters and changes to the chopper's configuration are made using the Digital Console. The Console is connected to the "B" connector of the SEM-X Chopper.



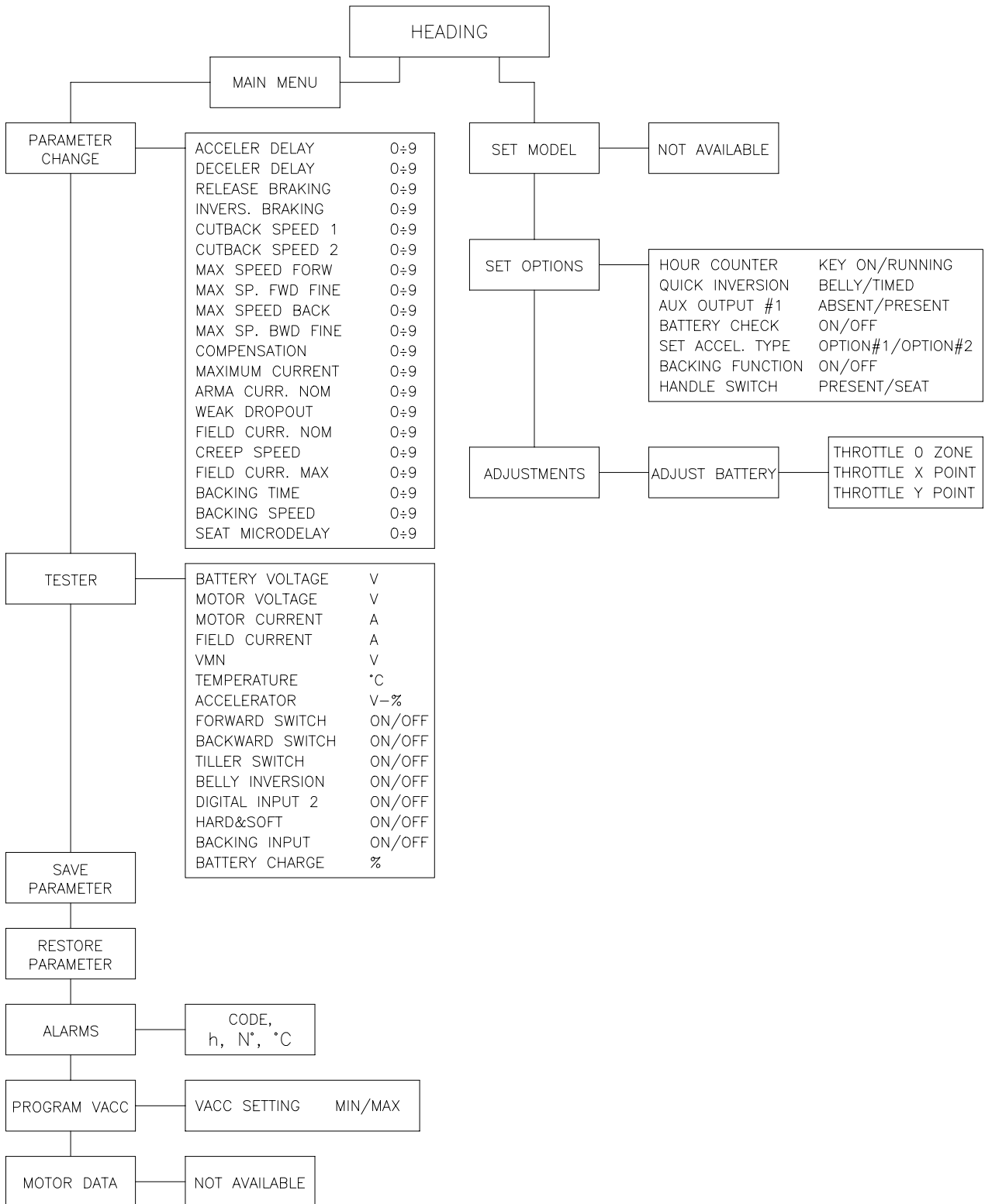
Pay attention to the polarity of the Console Connector when connecting to the chopper. The bevel on the connector should be uppermost.

4.2 DESCRIPTION OF CONSOLE & CONNECTION



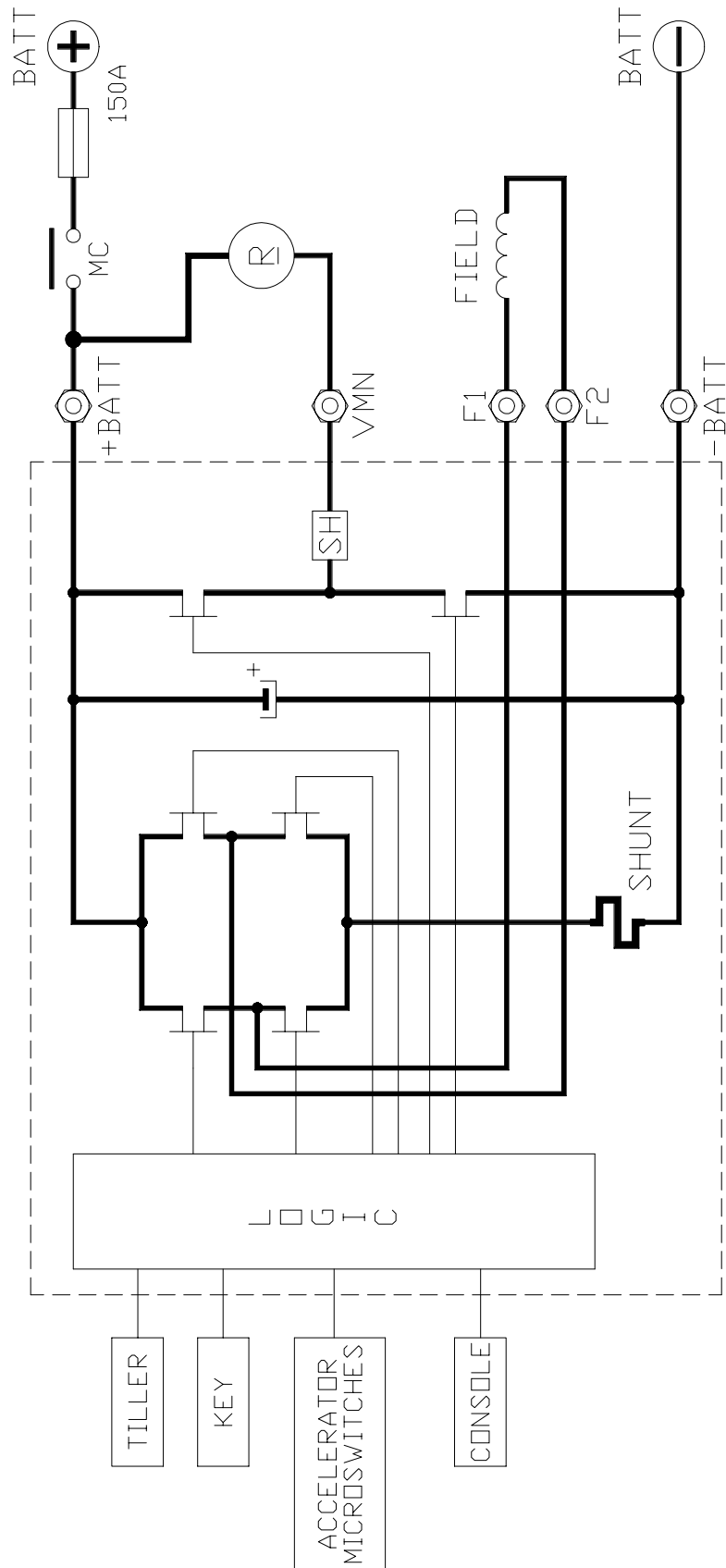
Digital Consoles used to communicate with SEM-X choppers must be fitted with Eprom CK ULTRA.

4.3 DESCRIPTION OF STANDARD CONSOLE MENU



5 SEM-X: CABLING AND CONFIGURATION

5.1 POWER DIAGRAM



5.2 DESCRIPTION OF PROGRAMMABLE FUNCTIONS (OPTIONS)

Using the CONFIG MENU of the console, it is possible to select from the following options:

SUBMENU "SET OPTIONS":

1 HOUR COUNTER:

- RUNNING: The counter registers travel time only.
- KEY ON: The counter registers when the key switch is Closed.

2 QUICK INVERSION:

- BELLY: Quick inversion is activated while the Belly Button is pressed.
- TIMED: Quick inversion is activated, while the Belly Button is pressed, maximum for 3 second.

3 AUX OUTPUT #1:

- ABSENT: A11 output is not used: the controller carry out monitor function as described at the paragraph 2.5.
- PRESENT: A11 output drives an electromechanical brake. The controller does not carry out monitor function, but locks the brake while in rest or alarm status.

4 BATTERY CHECK:

- ON: alarm indication, speed reduction and current reduction when battery charge $\leq 20\%$.
- OFF: no alarm indication, no speed and current reduction with battery discharged.

5 SET ACCEL TYPE:

- OPTION #1: standard 0÷5V potentiometer input.
- OPTION #2: 5÷0V potentiometer input.

6 BACKING FUNCTION:

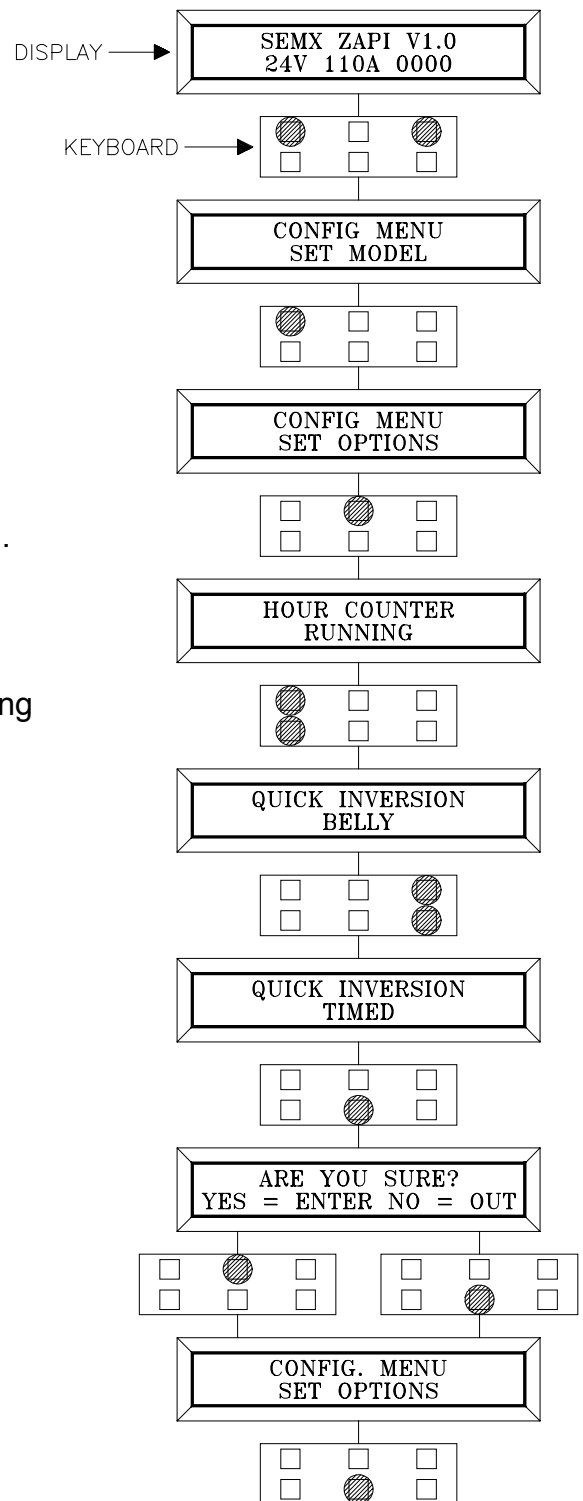
- ON: input A9 is used as enable backing input.
- OFF: input A9 is a speed reduction; no backing function available.

7 HANDLE SWITCH:

- PRESENT: A4 is a tiller input: incorrect start if it's closed at key on; no delay if it is switched off.
- SEAT: A4 is a seat input: no incorrect start if it's closed at key on; programmable delay if it is switched off.

Flow Chart showing how to make changes to Configuration Menu using Digital Console.
(Standard Eprom CK ULTRA fitted).

- 1) Opening Zapi Menu.
- 2) Press Top Left & Top Right Buttons simultaneously to enter the Config. Menu.
- 3) The Display will show :
- 4) Press ROLL UP (Top Left Button) until SET OPTIONS appears.
- 5) The Display will show :
- 6) Press ENTER to go into this part of the menu.
- 7) The first "Option" of the menu appears on the Display.
- 8) Press either ROLL UP or ROLL DOWN to bring up the next the Option.
- 9) A new Option appears on the Display.
- 10) When the desired Option is displayed, press PARAM (Top Right) or SET (Bottom Right) button to change the configuration
- 11) The new Configuration for the selected Option appears on the Display.
- 12) Press OUT to exit the Menu.
- 13) Press ENTER to accept the changes, or Press OUT if you do not accept the changes and wish to make further modifications to the particular Option.
- 14) The Display now shows:
- 15) Press OUT again. Display now shows the Opening Zapi Menu.



5.3 DESCRIPTION OF PARAMETERS THAT MAY BE PROGRAMMED

In addition to the Configuration, Parameter settings may be made by Zapi using standard default settings, settings to Customer Specifications, or the customer may make changes according to the application, using a Digital Console.

During the setting up procedure on the machine, the Console can remain connected to the chopper during travel. The Parameters can be modified in real time, during operation.

Pay attention to the polarity of the Console Connector. Refer to Page 15 of this Manual for connection details.

THE PROGRAMMING CONSOLE MUST BE PLUGGED ONLY WHEN THE KEY-SWITCH IS OFF.

The following Parameters can be modified :

- 1 **ACC. DELAY** = Determines the acceleration ramp.
- 2 **DECELER DELAY** = Determines the deceleration ramp according to the accelerator pedal position.
- 3 **RELEASE BRAKING** = Determines the deceleration ramp when the travel request is released.
- 4 **INVERSION BRAKING** = Determines the deceleration ramp when the Direction Switch is inverted during travel.
- 5 **CUTBACK SPEED 1** = First speed reduction, active when H&S is active.
- 6 **CUTBACK SPEED 2** = Second speed reduction, active when DIGITAL INPUT2 is active.
- 7 **MAX SPEED FORW** = Maximum Forward Speed, obtained by weakening the Field Current after it has reached 100% conduction of the Armature. With the Parameter set at level 0, the armature is in total conduction but the field current does not decrease below the Nominal value (low speed).
- 8 **MAX SP. FWD FINE** = Maximum forward speed.Fine adjustment.
- 9 **MAX SPEED BACK** = Maximum Reverse Speed, obtained by weakening the Field Current after it has reached 100% conduction of the Armature. With the Parameter set at level 0, the armature is in total conduction but the field current does not decrease below the Nominal value (low speed).
- 10 **MAX SP. BWD FINE** = Maximum reverse speed. Fine adjustment.
- 11 **TRACTION I MAX** = Maximum controller current.
- 12 **ARMA NOM.CURR.** = Nominal Armature Current. This parameter fixes a limit for the armature current above which the Field Current is at least the Nominal Value (FIELD NOM.CURR.), regardless of accelerator position.
- 13 **WEAK DROPOUT** = This Parameter fixes a limit on the Armature Current above which the Field Current is increased linearly up to the Nominal Field Current (in proportion to the armature current).

- 14 FIELD NOM. CURR.** = Nominal Field Current. This parameter fixes the minimum Field Current when the potentiometer is between 0% and 60% without total conduction of the Armature. Adjustment should be made with reference to the Data on the Motor Label. (The indication of Nominal Field Current).
- 15 CREEP SPEED** = Minimum Speed. This Parameter sets the minimum voltage applied to the motor at the start of travel.
- 16 FIELD CURR MAX** = Maximum field current. The chopper reaches this field current when the armature current is at the maximum value.
- 17 BACKING TIME** = Maximum backing function time.
- 18 BACKING SPEED** = Fixed speed when the backing function is active.
- 19 SEAT MICRO DELAY** = This parameter sets the time for which the seat switch opening is ignored.

5.4 TABLE OF ADJUSTMENTS

The following Table shows the different values that the SEM2 Parameters may be adjusted to. A suitable acceleration performance assumes: FIELD CURR. NOM is set to level 5, and MAX SPEED (Fwd or Rev) is set to level 9.

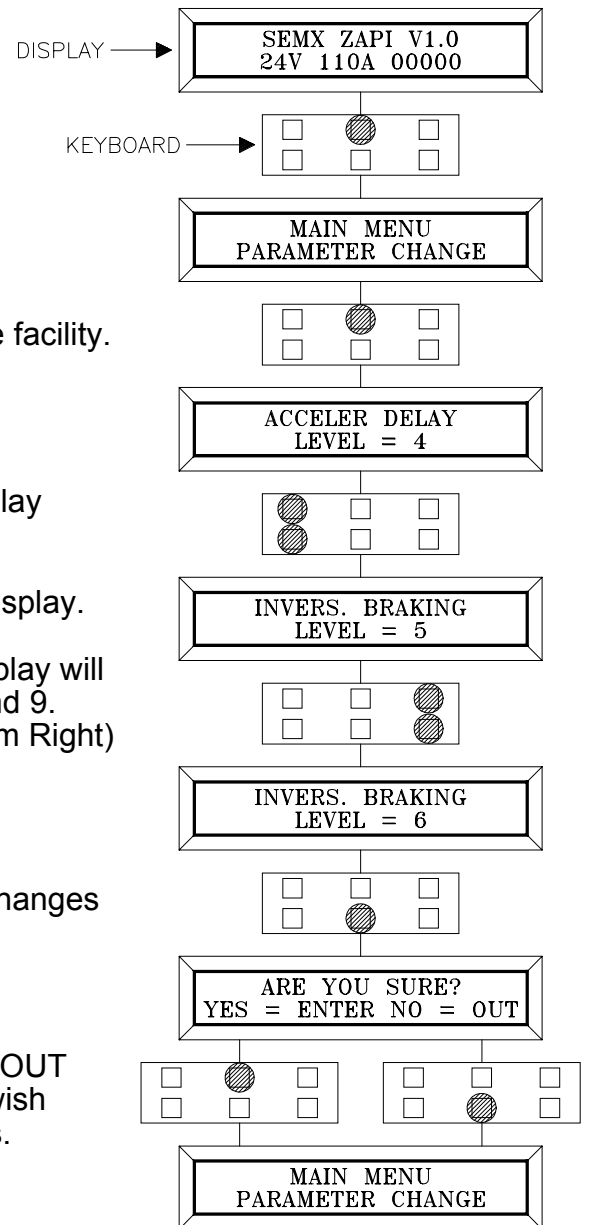
PARAMETERS	PROGRAMMED LEVEL										
	UNIT	0	1	2	3	4	5	6	7	8	9
ACC. DELAY	sec.	0.30	0.50	0.70	0.90	1.10	1.25	1.40	1.55	1.75	2.00
DEC. DELAY	*	9	8	7	6	5	4	3	2	1	0
RELEASE BRAKING	*	0	1	2	3	4	5	6	7	8	9
INVERS BRAKING	*	0	1	2	3	4	5	6	7	8	9
CUTBACK SPEED 1	%ACC	20	25	31	37	43	49	55	61	67	100
CUTBACK SPEED 2	%ACC	20	25	31	37	43	49	55	61	67	100
MAX SPEED FORW.	%FCN	100	92	84	77	70	63	56	48	42	38
MAX SP FORW. FINE	** %FCN	0	1	2	3	4	5	6	7	8	9
MAX. SPEED BACK.	%FCN	100	92	84	77	70	63	56	48	42	38
MAX SP BACK. FINE	** %FCN	0	1	2	3	4	5	6	7	8	9
TRACTION I MAX	%IMax	72	76	79	81	84	86	90	94	96	100
ARMA CUR. NOM. (ACN)	%IMax	29	31	34	36	39	41	44	46	49	51
WEAK DROP OUT	%ACN	30	35	40	45	50	55	60	65	70	75
FIELD CURR. NOM. (FCN)	A	6.7	7.2	7.4	7.6	7.8	8.0	8.2	8.4	8.6	8.8
CREEP SPEED	%VBatt	1.2	1.6	2.3	2.7	3.5	3.9	4.7	5.1	5.9	6.3
FIELD CURR. MAX	A	12.8	13.2	13.6	14.1	14.5	14.9	15.3	15.7	16.1	16.6
BACKING SPEED	%ACC	20	23	27	31	35	39	43	47	51	55
BACKING TIME	sec.	0	0.2	0.5	0.8	1.1	1.5	1.8	2.2	2.6	3.0

*= If the current inclines to raise, then also the braking time raises in order to obtain a smooth braking action. Therefore, the duration of the braking depends on the type of motor and the operating conditions (laden, unladen, on plane, on gradient).

**= Is a percentage of the field current which is subtracted to the value defined by the parameters MAX SPEED FORW and MAX SPEED BACK.

Flow Chart showing how to make Program changes using Digital Console fitted with Eprom CK ULTRA.

- 1) Opening Zapi Display.
- 2) Press ENTER to go into the General Menu.
- 3) The Display will show :
- 4) Press ENTER to go into the Parameter Change facility.
- 5) The Display will show the first Parameter.
- 6) Press either ROLL UP or ROLL DOWN to display the next parameter.
- 7) The names of the Parameters appear on the Display.
- 8) When the desired Parameter appears, the Display will show a Level Number that will be between 0 and 9. press either PARAM (Top Right) or SET (Bottom Right) buttons to change the Level value.
- 9) The Display will show the New Level.
- 10) When you are satisfied with the results of the changes you have made, Press OUT.
- 11) The Display asks " ARE YOU SURE ?
- 12) Press ENTER to accept the changes, or Press OUT if you do not wish to accept the changes and wish to make further modifications to the parameters.
- 13) The Display will show :



5.5 MENU SPECIAL ADJUST

- 1) **SET TEMPERATURE**
Adjusts the temperature of the chopper.
- 2) **MAXIMUM CURRENT**
Software adjustment of the maximum current level of the chopper. It's a password protected parameter.
- 3) **ADJ FIELD NOM FW**
Software adjustment of the field nominal current in forward direction. It's a password protected parameter.
- 4) **ADJ FIELD NOM BW**
Software adjustment of the field nominal current in backward direction. It's a password protected parameter.

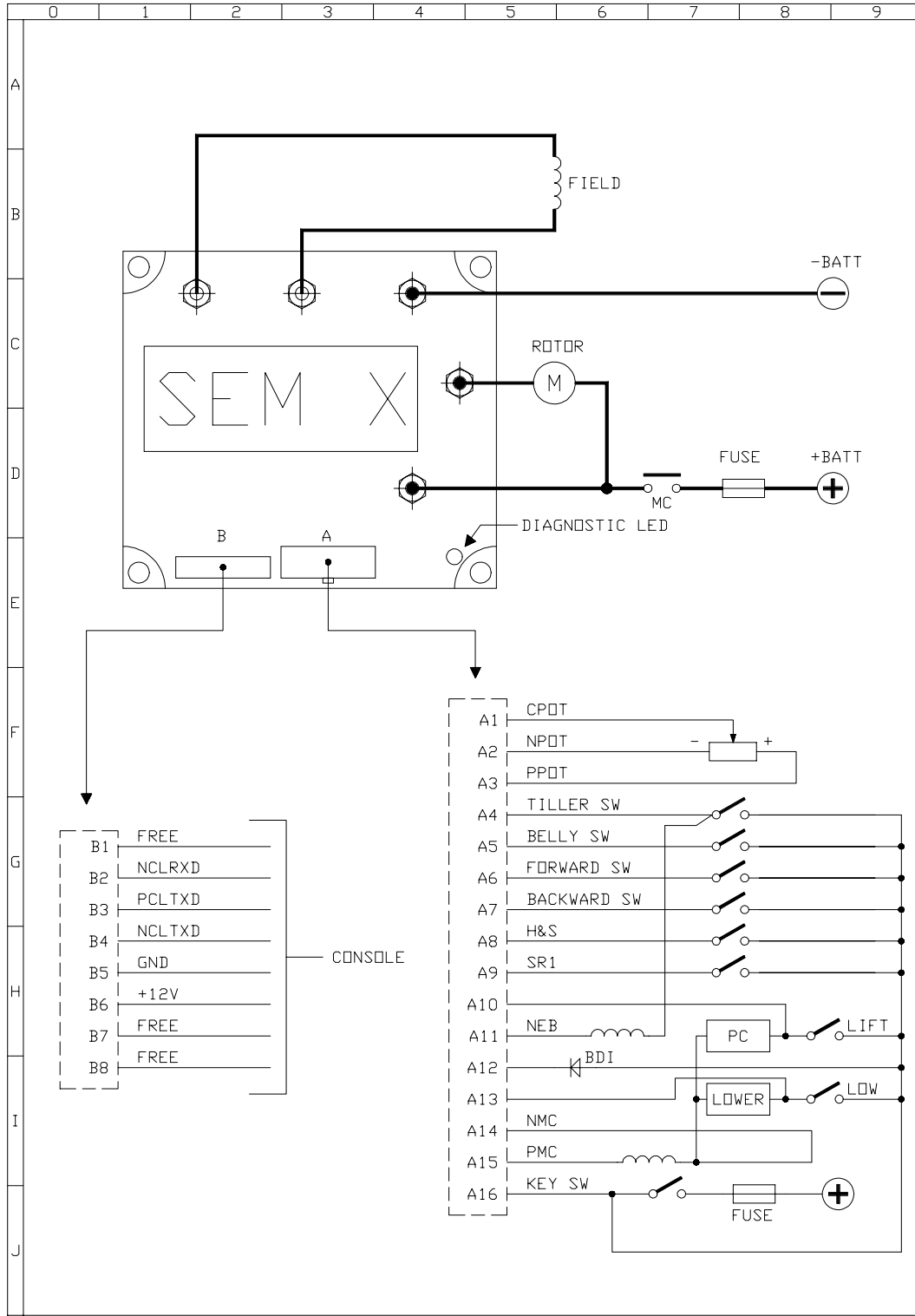
5.6 MENU HARDWARE SETTING

- 1) **SET CURRENT**
Armature current value used by tester menu, only used to calibrate the armature current displayed in the tester menu.
- 2) **SET FLD CURRENT**
Field current maximum value used to calibrate field current displayed in tester menu.
- 3) **ADJUSTMENT #01**
Adjustment of the 90% threshold of the battery discharge table.
- 4) **ADJUSTMENT #02**
Adjustment of the 20% threshold of the battery discharge table.
- 5) **AUX FUNCTION 1**
Load hour meter from MDI option (ON/OFF). Setting this option, turning off the key and connecting MDI. The chopper hour meter will be overwritten by MDI hour meter.
- 6) **CHECK UP TYPE**
Programmable check up function:
0 = no check up
1 = warning after HM hours
2 = warning after HM hours, speed reduction after HM+10 hours
3 = warning after HM hours, speed reduction after HM+10 hours, stop of the functions after HM+20 hours
- 7) **CHECK UP HOURS**
Sets the check up alarm (if enabled) time (HM). It's a 0÷9 parameter.
0 = HM = 200 hours
9 = HM = 650 hours

5.7 MENU ADJUSTMENT


- 1) **ADJUST BATTERY**
Sets the correct battery voltage level.
- 2) **THROTTLE 0 ZONE**
Sets the pedal curve type.
- 3) **THROTTLE X POINT**
Sets the pedal curve type.
- 4) **THROTTLE Y POINT**
Sets the pedal curve type.

5.8 SEM-X TRACTION STANDARD WIRING DIAGRAMS



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SEM-X FUNCTIONAL DRAWING

 ZAPI s.p.a. 42028 POVIGLIO-ITALY	Data/Date	Tecnico/Technician	Serie/Series	Disegno n./Drawing n.	Pagina/Page
	28/06/00	AF Visto/Visa	SEM	ADRZP1AB	1/1

5.9 SEQUENCE FOR SEM-X TRACTION SETTINGS

When the Key Switch is Closed, if no Alarms or Errors are present, the Console Display will be showing the Standard Zapi Opening Display.

If the chopper is not Configured to your requirements, follow the Sequence detailed on Page 20. Remember to re-cycle the Key Switch if you make any changes to the chopper's Configuration. Otherwise follow the sequence detailed below :

- 1) Select the options required (Chapter 5.3).
- 2) Select and set the Battery Voltage.
- 3) Confirm correct installation of all wires. Use the Console's TESTER function to assist.
- 4) Perform the accelerator signal acquisition procedure using the Console "PROGRAM VACC".
- 5) Set the TRACTION IMAX Current, taking into account any Boost requirements. Use Table on Chapter 5.5.
- 6) Set the Acceleration Delay requirements for the machine. Test the parameters in both directions.
- 7) Set the CREEP level starting from level 0. The machine should just move when the accelerator microswitch is closed. Increase the Level accordingly.
- 8) RELEASE BRAKING. Operate the machine at full speed. Release the accelerator pedal. Adjust the level to your requirements. If the machine is a forklift, check the performance with and without load.
- 9) INVERSION BRAKING. Operate the machine at 25% full speed. Whilst traveling INVERT the Direction Switch. Set a soft Level of Inversion Braking. When satisfactory, operate the machine at Full Speed and repeat. If the machine is a Forklift, repeat the tests and make adjustments with and without load. The unladen full speed condition should be the most representative condition.
- 10) Set MAX SPEED FORW.
- 11) Set MAX SPEED BACK (Reverse).
- 12) Set ARMA CURR. NOM., NOM. FIELD CURR. e WEAK DROPOUT

Check the parameters meaning on Chapter 5.3.

6 SEM-X DIAGNOSTICS

The following list shows likely problems associated with the flashing RED LED.

N° FLASHES	MESSAGE	NOTES
1	Watch-dog:	Logic board and/or software failure.
1	EEPROM KO:	Problem with EEPROM or Logic.
1	CHECK UP NEEDED	Check up timeout.
2	INCORRECT START:	Starting sequence for travel not correct.
2	FORW + BACK:	Double running requests.
3	CAPACITOR CHARGE	Problem in Power Block.
3	VMN NOT OK	Problem with Chopper.
3	VFIELD NOT OK	Problem with Field Voltage
4	VACC NOT OK	Potentiometer Wiper.
4	PEDAL WIRE KO	Pedal wire not OK.
5	NO FIELD CURR.	Field wiring not OK or field current sensor not OK.
5	FW HIGH FIELD CUR.	Field wiring not OK or field current sensor not OK in FWD direction.
5	BW HIGH FIELD CURR.	Field wiring not OK or field current sensor not OK in BWD direction.
5	STBY I HIGH	High current at the stand-by sensor of armature current not OK.
5	I= 0 EVER	No current: sensor of armature current not OK.
6	CONTACTOR DRIVER	Contacteur Driver not OK.
6	DRIVER SHORTED	Contacteur driver shorted.
6	CONTACTOR CLOSED	Line Contacteur contact not OK.
7	TH. PROTECTION	Temperature too much high (>70°C) or low (<10°C).
8	POWER FAILURE #1	Shortcircuit on EB or MC coil.
9	EB DRIVER SHORT	Shortcircuit on EB driver.
9	EB DRIVER KO	EB driver doesn't close.
32	BATTERY LOW	Battery too low.

6.1 ANALYSIS OF ALARMS DISPLAYED ON THE CONSOLE

- 1 WATCH DOG **AL 8 MDI**

The test is executed at the key turn-on, at the stand-by and on running. Possible causes:

 - a) Watch-dog hardware circuit not OK;
 - b) Software not OK.
- 2 EEPROM KO **AL 13 MDI**

Fault in the area of memory where the adjustment parameters are stored. This Alarm inhibits machine operation. If the fault continues when the Key Switch is recycled, replace the logic. If the fault disappears, the previously stored Parameters will have been replaced by the default parameters.
- 3 CHECK UP NEEDED **AL 99 MDI**

The "check up type" parameter is active and the time from last check up is > 300 hours.
- 4 INCORRECT START **AL 79 MDI**

Alarm generated by an incorrect Starting Sequence. Possible causes:

 - a) The TILLER microswitch is stuck or failed.
 - b) Error in the starting sequence from the operator.
 - c) Error in the wiring.
- 5 FORW + BACK **AL 80 MDI**

This check is made continually. The alarm is generated when forward and reverse direction are requested simultaneously. Possible causes:

 - a) Error in Wiring.
 - b) Welding or Failure of a direction switch.
 - c) Error in the starting sequence from the operator.
- 6 CAPACITOR CHARGE **AL 60 MDI**

This check is made during the initial diagnosis. This Alarm is generated if the Capacitors are not charged within 500ms after the Key Switch is closed. Probable cause is failure inside the power block.
- 7 VMN NOT OK **AL 32 MDI**

This test is performed at rest, with the general Contactor Closed, and also during operation. At rest if VMN is lower than battery voltage this Alarm is generated. During operation this Alarm is generated if VMN doesn't follow the duty-cycle of the chopper. Possible causes:

 - a) Incorrect Motor connection.
 - b) Short circuit motor windings to chassis.
 - c) Defect in the power unit.

8 VFIELD NOT OK

AL 15 MDI

This test is made at standby with the Line Contactor open. In this condition the voltages on both the connections of field must be to around $\frac{1}{2}$ VBatt. This alarm is generated if the field voltage is different from this value. Possible causes:

- d) Frame fault on the motor to chassis;
- e) Incorrect connection of the field winding to the controller;
- f) Failure of the controller in the section relative to the field.

9 VACC NOT OK

AL 72 MDI

This Alarm is generated if the accelerator output voltage differs more than 2V from the acquired minimum during the PROGRAM VACC. Possible causes:

- a) the track of the potentiometer has become open.
- b) the potentiometer is not wired correctly.
- c) the potentiometer itself is defective.
- d) the values set in PROGRAM VACC routine have not remained or made correctly.

10 PEDAL WIRE KO

AL 86 MDI

This Alarm is generated if potentiometer or wiring fault is detected. (NPOT or PPOT are open circuit).

11 FWD HIGH FIELD CURR (**AL 90 MDI**), BWD HIGH FIELD CURR (**AL 91 MDI**), NO FIELD CURR (**AL 58 MDI**)

Problem detected with the field winding current. Possible causes:

- a) Failure of the field current sensor.
- b) Field cables not connected or incorrectly connected.
- c) Failure of the Field Power Unit.

12 STBY I HIGH

AL 53 MDI

This test is made during the initial diagnosis and at standby. The test verifies that the current is zero. This Alarm disables the machine. Possible causes:

- a) defective current sensor.
- b) logic failure. First replace the logic. If fault remains replace the power unit.

13 I = 0 EVER

AL 49 MDI

This check is made during travel. If the current is not higher than a preset minimum value, this Alarm is generated and the machine disabled. Possible causes: see STBY I HIGH. Check the motor armature (brush connections).

14 CONTACTOR DRIVER (**AL 75 MDI**), DRIVER SHORTED (**AL 74 MDI**)

These Alarms are generated if there is a problem with the Line Contactor. Possible causes:

- a) The Contactor Coil Driver is short-circuit.
- b) Defect in the wiring to the contactor, or logic failure.

15 CONTACTOR CLOSED**AL 37 MDI**

This check is made during the initial diagnosis. With the coil of the line contactor de-energized, the capacitors should not be charged, unless there is divert resistor across the power poles. Possible causes:

- a) The line contactor power poles are welded.
- b) This alarm could be generated even if the line contactor has opened, but there is a problem with either the field circuit, or a problem detected by the safety microprocessor.

16 TH. PROTECTION**AL 62 MDI**

If the temperature of the chopper rises higher than 75°C, this alarm is generated. The chopper current is reduced in proportion to the increase in temperature. At 90°C the chopper totally stops. If the temperature of the chopper is <- 10°C, this Alarm is also generated and the current is reduced by 80 %. If this alarm is displayed when the chopper temperature is the same as ambient or =<10°C:

- a) Check the connection of the temperature sensor.
- b) The temperature sensor may be defective.
- c) The logic may be defective.

17 POWER FAILURE #1**AL 73 MDI**

Short circuit on the brake or on the main contactor coil.
Possible cause

- a) failure of the logic board;
- b) wiring error;
- c) short circuit on contactor coil.

18 EB DRIVER KO**AL 2 MDI**

The EB driver doesn't close.

19 EB DRIVER SHORT**AL 91 MDI**

The EB driver is shorted. Check the negative of the brake: it may be in short circuit with -B.

20 BATTERY LOW**AL 66 MDI**

This Alarm is generated when the battery becomes 50% discharged from the nominal value.

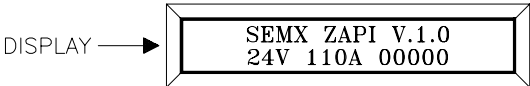
6.2 TESTER DESCRIPTION OF THE FUNCTIONS

The most important input or output signals can be measured in real time using the TESTER function of the console. The Console acts as a multimeter able to read voltage, current and temperature. The following definition listing shows the relative measurements :

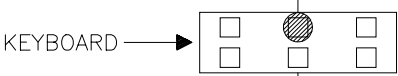
- 1) **BATTERY VOLTAGE:** level of battery voltage measured at the input to the key switch.
- 2) **MOTOR CURRENT:** the current flowing in the drive motor armature.
- 3) **FIELD CURRENT:** the current flowing in the drive motor field winding.
- 4) **VMN:** the voltage effectively dropped across the MOS. It is measured between B- and VMN.
- 5) **TEMPERATURE:** the temperature measured on the aluminum heat sink holding the MOSFET devices.
- 6) **ACCELERATOR:** the voltage of the accelerator potentiometer wiper (CPOT).
The voltage level is shown on the Left Hand Side of the Console Display and the value in percentage is shown on the Right Hand Side.
- 7) **FORWARD SWITCH:** the level of the Forward direction digital entry MA (pin B6).
ON /+ VB = active entry of closed switch.
OFF / GND = non active entry of open switch.
- 8) **BACKWARD SWITCH:** the level of the Reverse direction digital entry MI (pin B4).
ON /+ VB = active entry of closed switch.
OFF / GND = non active entry of open switch.
- 9) **TILLER SWITCH:** the level of the Handle/Seat Microswitch digital entry (pin A4).
ON / + VB = active entry of closed seat switch.
OFF / GND = non active entry of open seat switch.
- 10) **BELLY SWITCH:** the level of the digital entry from Belly Button microswitch (pin A5).
ON /+ VB = active entry, B SW closed.
OFF / GND = non active entry, B SW open.
- 11) **DIGITAL INPUT #2 (A9):** (only with option BACKING FUNCTION PROGRAMMED OFF) the level of the auxiliary microswitch when used for speed reduction.
ON / GND= active entry of speed reduction microswitch.
OFF / +VB = non active entry of microswitch.
- 12) **BACKING INPUT (A9):** (only with option BACKING FUNCTION PROGRAMMED ON) the level of auxiliary microswitch when used as backing enable.
ON / +VB = active.
- 13) **HARD & SOFT (A8):** level of the HARD & SOFT microswitch.
ON / +VB = active.
- 14) **BATTERY CHARGE:** battery charge indication %.

Flow Chart showing how to use the TESTER function of the Digital Console.

1) Opening Zapi Display.



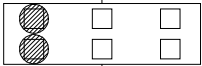
2) Press ENTER to go into the General menu.



3) The Display will show :



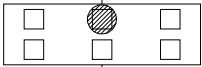
4) Press either ROLL UP or ROLL DOWN button until TESTER MENU appear on the display.



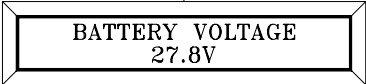
5) The Display shows :



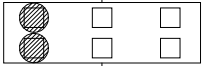
6) Press ENTER to go into the TESTER function.



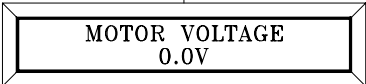
7) The first variable to be tested is shown on the Display.



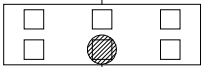
8) Press either ROLL UP or ROLL DOWN buttons until your desired variable for measurement appears on the Display.



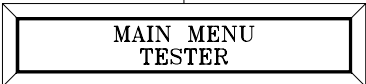
9) Next variable is shown.



10) When you have finished, Press OUT.



11) The Display shows :



12) Press either ROLL UP or ROLL DOWN button to show other MENU or press OUT to finish.

Remember it is not possible to make any changes using TESTER. All you can do is measure as if you were using a pre-connected multimeter.

6.3 DESCRIPTION OF THE CONSOLE SAVE FUNCTION

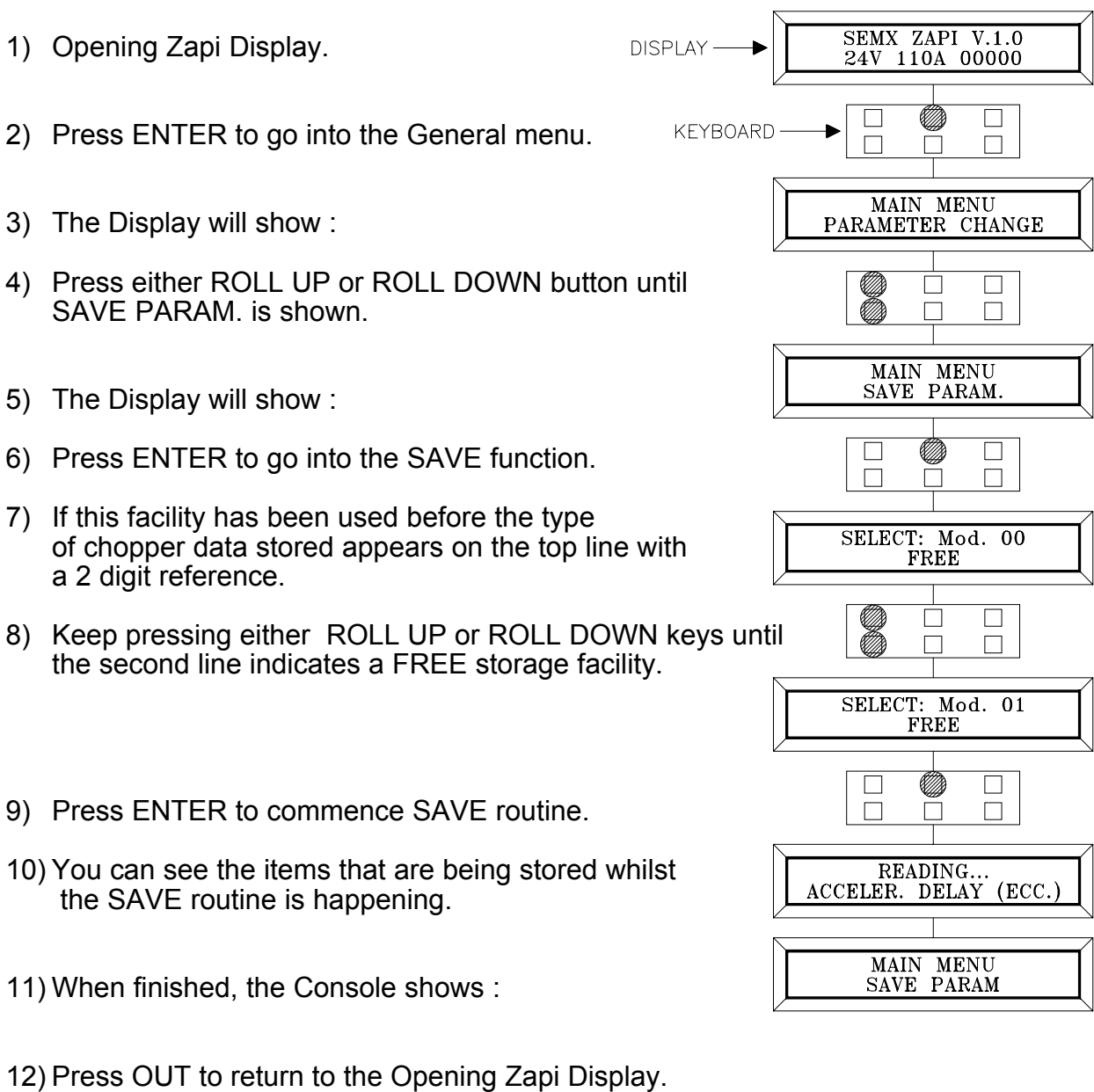
The **SAVE PARAM** function allows the operator to transmit the Parameter values and Configuration data of the chopper into the Console memory. It is possible to load 64 different programs.

The information saved in the Console memory can then be reloaded into another chopper using the **RESTORE** function.

The data that is available via the SAVE function is as follows:

- All Parameter Values (PARAMETER CHANGE).
- Options (SET. OPTIONS).
- The Level of the Battery (ADJUST BATTERY).

Flow Chart showing how to use the SAVE function of the Digital Console.



6.4 DESCRIPTION OF CONSOLE RESTORE FUNCTION

The RESTORE PARAM function allows transfer of the Console's stored data into the memory of the chopper. This is achieved in a fast and easy way using the method previously used with the SAVE PARAM. function.

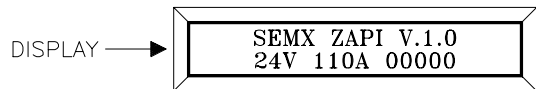
The data that are available via the RESTORE PARAM. function are as follows :

- All Parameter Values (PARAMETER CHANGE).
- Options (SET OPTIONS)
- The level of the Battery (ADJUST BATTERY)

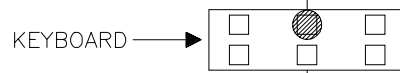
ATTENTION: When the RESTORE operation is made, all data in the chopper memory will be written over and replace with data being restored.

Flow Chart showing how to use the RESTORE function of the Digital Console.

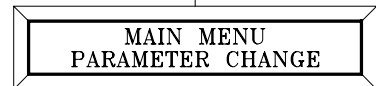
1) Opening Zapi Display.



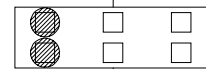
2) Press ENTER to go into the General menu.



3) The Display will show :



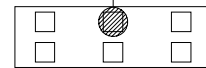
4) Press either ROLL UP or ROLL DOWN button until RESTORE PARAM. appears on the display.



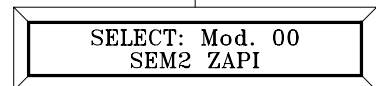
5) The Display will show :



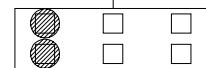
6) Press ENTER to go into the RESTORE PARAM. function.



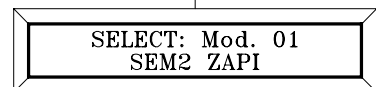
7) The Display shows the type of Model stored, with a Code Number.



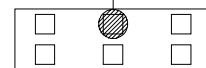
8) Keep pressing either ROLL UP and ROLL DOWN buttons until the desired model appears on the Display.



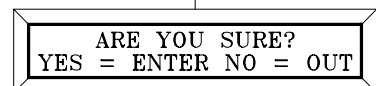
9) The model is shown



10) Press ENTER to commence the Restore operation.



11) The Display will ask "ARE YOU SURE". Press ENTER for YES, or OUT for No.



12) Press ENTER to confirm (OUT to not confirm)



13) You can see the items that are being stored in the chopper memory whilst the RESTORE routine is happening.



14) When finished the Console displays :



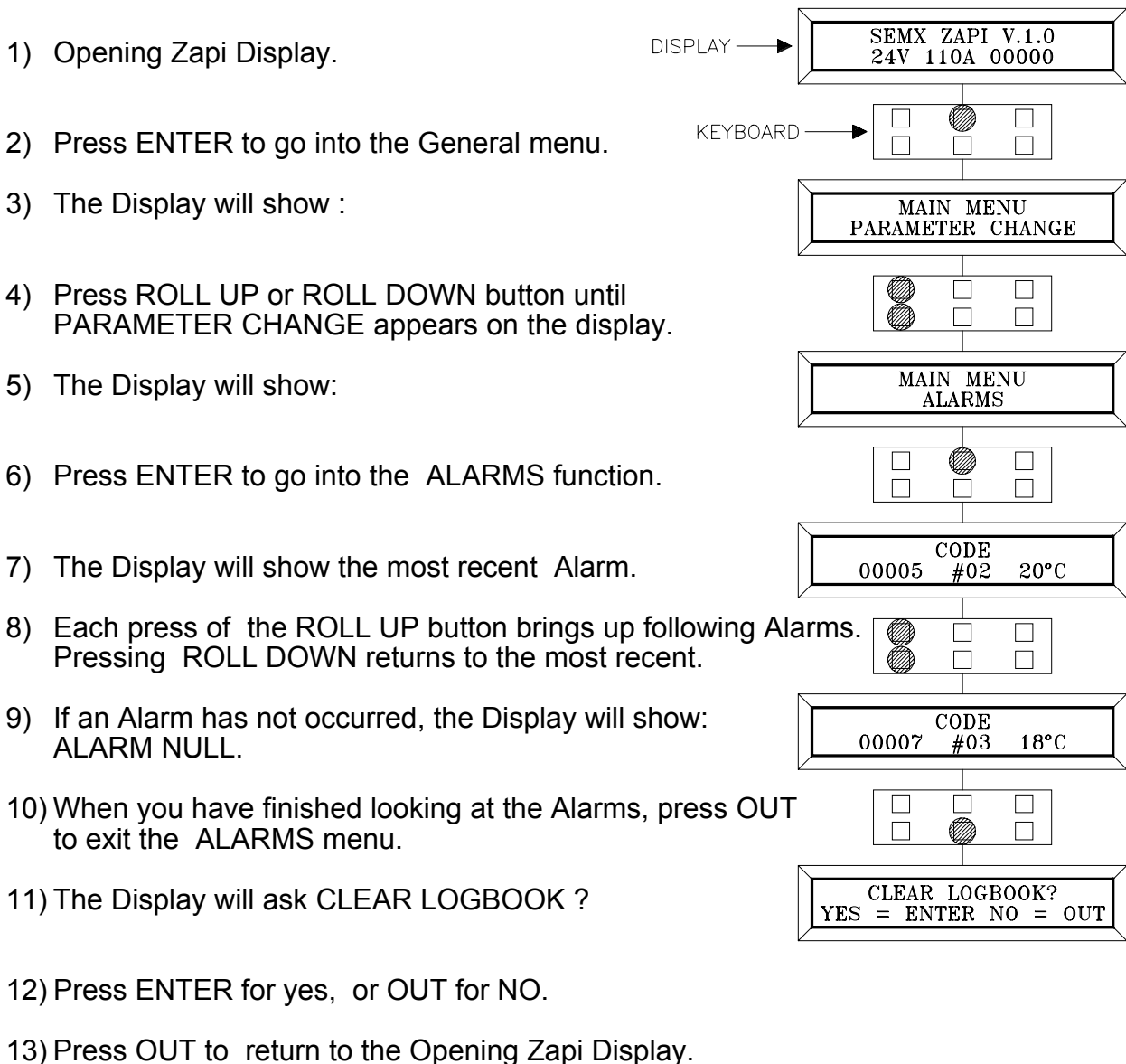
15) Press OUT to return to the Opening Zapi Display .

6.5 DESCRIPTION OF ALARMS MENU

The microprocessor in the chopper remembers the last five Alarms that have occurred. Items remembered relative to each Alarm are : the code of the alarm, the number of times the particular Alarm occurred, the Hour Meter count, and the chopper temperature.

This function permits a deeper diagnosis of problems as the recent history can now be accessed.

Flow Chart showing how to use the ALARMS function via the Digital Console.

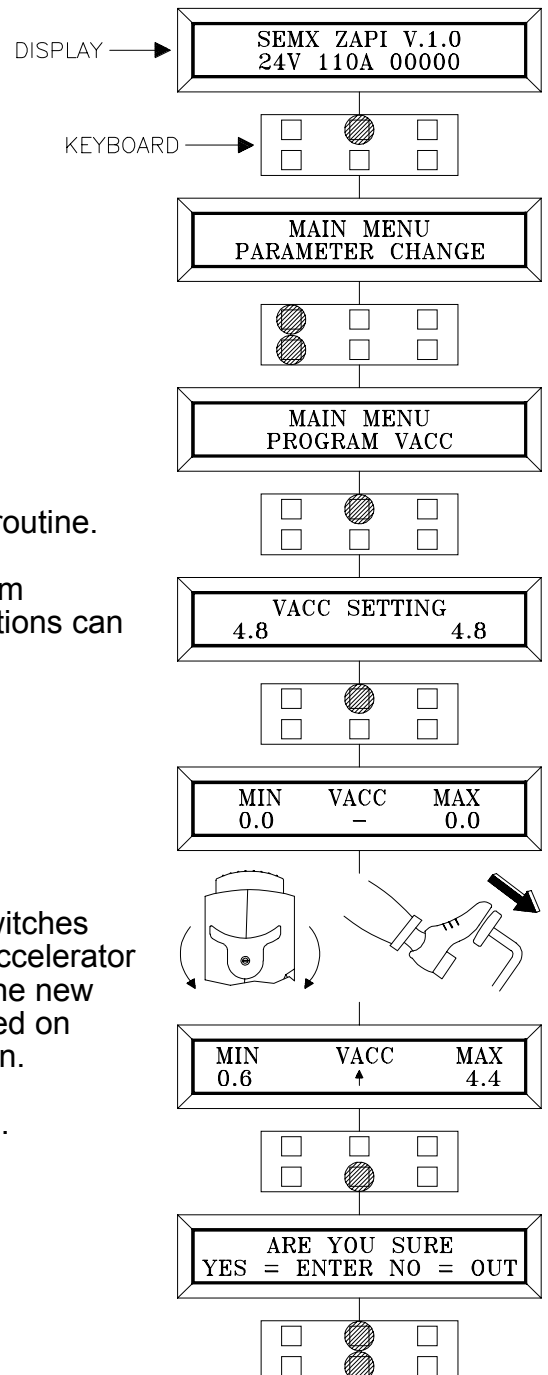


6.6 DESCRIPTION OF CONSOLE PROGRAM VACC FUNCTION

This function looks for and remembers the minimum and maximum potentiometer wiper voltage over the full mechanical range of the pedal. It enables compensation for non symmetry of the mechanical system between directions. The operation is performed by operating the pedal after entering the PROGRAM VACC function.

Flow Chart showing how to use the PROGRAM VACC function of the Digital Console.

- 1) Opening Zapi Display.
- 2) Press ENTER to go into the General Menu.
- 3) The Display will show :
- 4) Press ROLL UP or ROLL DOWN button until PROGRAM VACC appears on the display.
- 5) The Display will show :
- 6) Press ENTER to go into the PROGRAM VACC routine.
- 7) The Display will show the minimum and maximum values of potentiometer wiper output. Both directions can be shown.
- 8) Press ENTER to clear these values.
- 9) Display will show 0.0.
- 10) Select Forward Direction, close any interlock switches that may be in the system. Slowly depress the accelerator pedal (or tiller butterfly) to its maximum value. The new minimum and maximum voltages will be displayed on the Console plus an arrow indicating the direction.
- 11) Select the Reverse Direction and repeat Item 10.
- 12) When finished , press OUT.
- 13) The Display will ask : ARE YOU SURE ?.
- 14) Press ENTER for yes, or OUT for NO.
- 15) Press OUT again to return to the Opening Zapi Menu.



7 RECOMMENDED SPARE PARTS FOR SEM-X

Part Number	Description
C16519	Protected 150A Fuse.
C16503	Protected 200A Fuse
C16520	6.3A 5x20mm Control Circuit Fuse
C12404	16 Way Molex Minifit Connector
C12777	Insert for Molex Minifit Connectors
C29543	SW 80 24V CO Single Pole Contactor

8 PERIODIC MAINTENANCE TO BE REPEATED AT TIMES INDICATED

Check the wear and condition of the Contactors' moving and fixed contacts. Electrical Contacts should be checked every **3 months**.

Check the Foot pedal or Tiller microswitch. Using a suitable test meter, confirm that there is no electrical resistance between the contacts by measuring the volt drop between the terminals. Switches should operate with a firm click sound. Microswitches should be checked every **3 months**.

Check the Battery cables, cables to the chopper, and cables to the motor. Ensure the insulation is sound and the connections are tight. Cables should be checked every **3 months**.

Check the mechanical operation of the pedal or tiller . Are the return springs ok. Do the potentiometers wind up to their full or programmed level. Check every **3 months**.

Check the mechanical operation of the Contactor(s). Moving contacts should be free to move without restriction. Check every **3 months**.

Checks should be carried out by qualified personnel and any replacement parts used should be original. Beware of NON ORIGINAL PARTS.

The installation of this electronic controller should be made according to the diagrams included in this Manual. Any variations or special requirements should be made after consulting a Zapi Agent. The supplier is not responsible for any problem that arises from wiring methods that differ from information included in this Manual.

During periodic checks, if a technician finds any situation that could cause damage or compromise safety, the matter should be brought to the attention of a Zapi Agent immediately. The Agent will then take the decision regarding operational safety of the machine.

Remember that Battery Powered Machines feel no pain.

NEVER USE A VEHICLE WITH A FAULTY ELECTRONIC CONTROLLER.