dcM Series

MICRO PROCESSOR DC DRIVE

dcM Series

INSTRUCTION MANUAL CONTENTS

1.0 DESCRIPTION

1.1 Overview

These instructions cover the installation, adjustment, operation and maintenance of the Saftronics dcM Digital DC drive. These drives are 6-pulse controllers, either single quadrant (non-regenerative) or 4-quadrant (fully-regenerative, non-circulating current). The closed-loop and open-loop control functions are performed by a high speed, 16-bit microprocessor. A wide range of functions can be performed by the standard drive without adding options.

Since this manual covers a variety of drive unit ratings, the information contained herein is generally applicable to all the sizes of controllers. Supplied with each drive unit is a separate drawing set which contains the detailed schematics, outline drawings, connection information and spare parts data for the specific rating of drive that has been supplied. If custom engineered modifications are provided as part of your installation, additional instructions, operation and maintenance information is provided as a part of this package.

The drawing set contains charts for documenting the drive rating data, adjustments, and settings that result from the start-up procedures. It is strongly recommended that these charts be filled out promptly after the initial start-up. Any later changes should be noted in the places provided. This information can be useful at a later date should difficulties occur, or if less familiar service people should become involved with the equipment.

This manual is primarily intended to serve as a guide to the installation and start-up of standard drives and not a detailed repair manual.

1.2 Operating Components

The Saftronics dcM drive consists of the following major functional sections:

The Microprocessor Control Board ES600 contains most of the closed-loop and open-loop control functions such as the speed, current, and gating controllers. It also contains the keypad and display that are used for entering and observing the various parameters that affect the operation of the drive.

All of the major functions on this board are handled by a 16-bit microprocessor. The actual program that calls out the routines to be run is stored in the EPROMs (Electrically Programmable Read Only Memory). The EPROMs are factory programmed and the program can only be changed by replacing the EPROM chips.

The drive controller adjustments are accomplished using a built-in keypad. The parameter values that are set via the keypad are stored in the EEPROM (Electrically Erasable Programmable Read Only Memory).

1.2 Operating Components (cont'd)

The EEPROM is programmed via the keypad each time a new parameter value is set. These values remain in memory, even when the power is turned off.

The High Voltage Board ES630 contains the circuits that interface with the High Voltage Thyristors (SCR's) and the connection for line voltage. The Current Feedback is also on this control board.

The Armature SCR Converter is a 6-pulse bridge configuration. The converter rectifies the incoming 3-phase voltage and permits the average DC output voltage to be varied, thereby controlling the speed of the connected DC motor. Fuses protect the converter against overcurrents caused by short circuits.

In the 4-Quadrant, Regenerative Version, dcM12, two 6-pulse bridges (6 SCR modules) arranged in back-to-back (non-circulating current) configuration are used to control the voltage and current for both motoring and braking in both forward and reverse directions of operation.

AA1127-1 Current Feedback Board is located on the SCR Power converter and incorporates the armature feedback and current scaling burden resistors.

The DC Motor Shunt Field Supply consists of a 3-phase diode bridge which controls the excitation current to the motor's shunt wound field. The AC supply for the bridge comes from the main supply.

2.0 INSTALLATION & WIRING PRACTICES

2.1 Receiving

Thoroughly inspect the equipment before accepting shipment from the transportation company.

On the drive controller unit, check the condition of the chassis and its heatsink for damage, dents, loose or broken parts. Open the door on the front and inspect the circuit boards for loose or missing components or disconnected wires. Check all connectors for tightness.

2.2 Storage

If the drive unit is not to be installed immediately, it should be stored in a clean, dry location at an ambient temperature from -20° C to 55° C (-4° F to +131° F). The surrounding air must be free of corrosive fumes or electrically conductive contaminants. Care must be taken to prevent condensation from forming within the equipment enclosure during storage. **Failure to store the equipment properly could damage the equipment and void the warranty.**

Motors, transformers and other equipment supplied as part of the order may also have storage limitations. Refer to the manuals supplied with this equipment for specific recommendations.

2.3 Drive Controller Location

Drives supplied as open chassis units will normally require an enclosure for installation that meets the applicable safety codes. The type of enclosure, (NEMA 1, NEMA 4, NEMA 12, etc.), will depend on the environmental conditions at the installation site. The purchaser of open chassis units is responsible for assuring proper installation that meets the requirements listed below as well as any applicable safety codes.

IMPORTANT: This equipment contains hazardous voltages and rotating mechanical parts. Loss of life, severe personal injury or property damage can result if instructions contained in this manual are not followed.

Only qualified personnel should work on this equipment, and only after becoming familiar with all safety notices, installation, operation and maintenance procedures contained in this manual. The successful and safe operation of this equipment is dependent upon proper handling, installation, operation and maintenance of the equipment.

Drive units supplied in either wall mounted or free standing enclosures are generally suitable for installation in most factory areas. In choosing a location for the controller, be sure to consider the need for adequate clearance to allow cooling air circulation. Ample room must also be provided to permit the door to swing open for maintenance and service.

Drive units should be installed where the following conditions exist:

- Ambient temperature is between 0° C and +50° C, (+32° F to +122° F), for open chassis mounted units, (0° C to +40° C, (+32° F to +104° F), for units in enclosures).
- Altitude above sea level does not exceed 3,300 feet (1000 meters).
- Relative humidity is noncondensing and does not exceed 95%.
- Atmosphere is reasonably free of dirt, dust, combustible vapors, chemical fumes, oil vapor, and electrically conductive or corrosive materials.

2.3 Drive Controller Location (cont'd)

- Mounting surfaces are level and sufficiently rigid to support the weight of the equipment without settling or damage to cable duct and conduit enclosed connections. DO NOT MOUNT TO SURFACES THAT ARE SUBJECT TO SHOCK OR VIBRATION
- The area is free of electromagnetic interference or noise, caused for example, by:

  A. Radio frequency signals, such as those generated by portable transmitters used near the drive or its wiring.

  B. Stray high voltage or high frequency signals, such as those generated by arc welders or unsuppressed inductive loads, (e.g., relay, contactor or brake coils), which are connected to circuits used within, or in the vicinity of, the drive or its wiring.

2.4 Wiring The Equipment

This equipment contains hazardous voltages and rotating mechanical parts. Loss of life, severe personal injury or property damage can result if instructions in this manual are not followed.

The user is responsible for installation of the motor, drive controller, transformer, and other devices in accordance with the National Electrical Code and other applicable local codes which cover such items as wiring size, grounding, disconnects and overcurrent protection.

Hazardous voltages may be present on external surfaces of ungrounded controllers. This can result in loss of life, severe personal injury or substantial property damage. If the drive cabinet or open chassis unit is mounted such that it is not grounded, a ground wire must be connected to the panel or enclosure frame for personnel safety. Also the motor frame, transformer enclosure and operator station must be connected to earth ground. Consult the National Electrical Code and other local codes for specific equipment grounding requirements.

Protective guards must be installed around all exposed rotating parts.

Consult the rating plate inside the drive controller to determine the AC and DC current ratings required for operation. The wiring can then be sized in accordance with the National Electrical Code and other applicable local codes.

When a drive controller is supplied with additional options, components, or circuits that are not part of the standard drive unit, a "custom" schematic will be supplied. Refer to this drawing for details on how to wire the controller and associated equipment.

2.4 Wiring The Equipment (cont'd)

Drilling or punching can create loose metal chips. This can result in shorts or grounds that can be hazardous to equipment. If it is necessary to drill or punch holes in the equipment enclosures for conduit entry, be sure that metal chips do not enter the circuits.

Circuits shown on the drawings that require shielded cable are sensitive to pick-up from other electrical circuits. Examples include wiring from the tachometer and from the speed setting device. Erratic or improper operation of the equipment is likely if the following precautions are not observed.

A. Where shielded cable is require, use 2- or 3- conductor TWISTED AND SHIELDED cable with the shield either connected as shown in the drawings, or "floating", if so specified. If the shield is to be connected, do so only at the specified terminal in the drive unit: NOT AT A REMOTE LOCATION.

B. Shielded cables outside the drive enclosure should be run in separate steel conduit, and should not be mixed in with other circuits that are not wired with shielded cable.

C. Inside the drive equipment, wherever possible, avoid running the shielded cable close to other circuits. Avoid long parallel runs to other non-shielded circuits, and cross other cable bundles at right angles.

Meggering circuits connected to the drive can cause damage to electronic components. ***Do not megger or hi-pot this equipment***. Use a battery operated Volt-Ohm-Meter (VOM) to check for shorts, opens or miswiring.

Connection of unsuppressed inductive devices to the power feed or control circuits can cause malfunction and possible component damage to the equipment.

3.0 STANDARD FEATURES

3.1 Standard Features

- **Application**
  The dcM series drive is a fully digital, three phase AC to DC converter used to supply DC motors with the ability to perform speed and torque control.

- **Line Voltage**
  Three phase, 240/480 VAC +10/-10%, 45-65Hz (with automatic adjustment).

- **Output Voltage**
  0 - ± 240VDC, for 240VAC input
  0 - ± 500 VDC, for 480VAC input

- **SCR Conversion Bridge**
  dcM6 Non-Regenerative SCR three phase bridge, fully controlled with dv/dt protection of SCR's

  dcM12 Regenerative SCR three phase bridge, fully controlled with dv/dt protection of SCR's for four quadrant operation.

- **Cooling**
  Convection or fan cooled depending on rating.

- **Overload Capability**
  150% of motor full load current for 1 minute.

- **Field Supply**
  Internal rectifier protected by a fast acting fuse. Field loss relay with dry contact for field loss detection.

- **Auto-Tune**
  The drive automatically calculates the ideal gain parameters for both the current, and the speed loops, by recognizing the basic motor characteristics (armature resistance, inductance, and the ratio between the back-EMF and the angular speed).

- **Serial Interface**
  RS485 Serial interface is standard for remote communication and parameter input. The protocol used is ANSI X3.28 for multidrop connection between a master (typically a PC) and a number of drives (up to 32 slaves). On request, an opto-isolated conversion model RS485/RS232-C is available for direct connection to a PC.

3.1 Standard Features (cont'd)

- **Typical Speed Regulation Accuracy and Ranges**

Speed Feedback Device	Speed Regulation with 95% Load Change, as a % of Rated Max Speed	Regulation from Other Variables	Controlled Speed Range
Armature Voltage	2%	5%	25:1
5PY DC Tachometer	1%	2%	50:1
BC42 DC Tachometer	0.5%	1%	100:1
BC46 DC Tachometer	0.1%	0.25%	250:1

IMPORTANT: Regulation from other variables includes ± 10% change in line voltage, field "warm-up" (cold to hot), and ± 10°C change in ambient temperature

- **External Speed References**
  Two (2) voltage inputs ±10VDC (input impedance 20kΩ).

- **Ramp Function**
  Completely digital with independent adjustment of the acceleration and deceleration time in both forward and reverse directions. Starting and ending rounding of the ramps with a 2nd order function (S curve) can be programmed.

- **Analog Output Signals**
  -Bi-polar voltage signal "OUT V" proportional to motor rotational speed. 0 - ± 10 VDC

  -Current signal "OUT I", proportional to the armature current (bi-polar or unipolar single polarity). 0 - ± 4 VDC

  -Programmable Auxiliary signal "OUT Aux".

NOTE: Length of control cable not to exceed 10 feet.

- **Internal Relay for Speed Threshold**
  Intermediate level switching between zero and set speed. (e.g.: overspeed function).

- **Internal Relay for Zero Speed**
  Indicates the drive is no longer braking and the motor has stopped.

- **Internal Alarm Relay**
  Indicates drive fault.

- **Control Board ES600**
  An EEPROM (non-volatile memory) is installed on the control board where the characteristic parameters of the drive and the specific settings are stored. This component can be easily removed and installed on a replacement board, ensuring interchangeability of the control board, without having to repeat the start-up operations.

3.1 Standard Features (cont'd)

- **Control Inputs:**

Digital:

-Run
-Stop
-Jog Forward
-Jog Reverse
-Reset
-Current Limit Reduction

Analog:

-0-(±)10VDC Resolution is 10 bits
-Main Speed Reference
-Speed Trim
-Qty (1) Programmable

- **Control Outputs**

Digital:

-Drive Fault Relay Contact
-Zero Speed Relay Contact
-Speed Threshold Relay Contact
-Current Limit Relay Contact

Analog:

-0-(±)10VDC Resolution is 10 Bits
-Armature Current (Scaleable)
-Qty (1) Programmable

- **Drive Protection Features**
  - Against line overvoltages, RC filters and MOV's on all three phases.
  - dv/dt networks on the SCR's
  - Against overloads by adjustable current limits (see parameters #32 to 43)
  - Against incorrect phase rotation, alarm A01.
  - Against unstable line frequency or frequency out of tolerance, alarms A02 and A03.
  - Against line voltage out of tolerance, alarm A04.
  - Against phase loss, alarm A05.
  - Against tachometer loss, alarm A11.
  - Against motor overheating via thermal imaging, alarm A14.
  - Against insufficient ventilation, detected by heatsink temperature switch, alarm A31.

4.0 BURDEN RESISTOR SELECTION CHART

4.1 dcM Drive Burden Resistor Selection Chart For AA1127-1 Current Feedback Control Card

240 Input Controller					480V Input Controllers			
HP	Input Amps @ Full Load (RMS)	DC Arm Amps @ 240VDC Full Load	CT Ratio	Bunden Resistor	Input Amps @ Full Load (RMS)	DC Arm Amps @ 500VDC Full Load	CT Ratio	Bunden Resistor
5	14	17	1000:1	125	7	8.5	1000:1	270
7.5	21	25	1000:1	82	10	13	1000:1	180
10	28	34	1000:1	62	14	17	1000:1	125
15	42	51	1000:1	40	21	25	1000:1	100
20	56	68	1000:1	35	28	34	1000:1	75
25	70	85	1000:1	27	35	42	1000:1	56
30	84	102	1000:1	22	42	51	1000:1	47
40	104	127	2500:1	40	56	68	1000:1	35
50	139	169	2500:1	33	70	85	1000:1	27
60	174	212	2500:1	30	84	102	1000:1	25
75	208	254	2500:1	22	104	127	1000:1	20
100	278	339	5000:1	35	139	169	2500:1	35
125	348	424	5000:1	27	174	212	2500:1	30
150	402	486	5000:1	25	208	254	2500:1	25
200	CONSULT FACTORY				265	318	5000:1	35
250					312	375	5000:1	30
300					375	450	5000:1	25

NOTE:
All Burden Resistors are to be 1% or better and minimum 3 watts.

NOTE:
Burden Resistor Formula :

$$R_b = \frac{(3x\ CT\ Ratio)}{(DC\ FLA^*\ 1.25)}$$

NOTE:
Burden Resistors may vary between calculated and recommended, due to the use of standard NEMA Resistor Values.

4.2 Armature Feedback Resistor For AA1127-1 Feedback Control Card

AC Input	DC Output	R_2 Value
240V	240V	47k
480V	500V	22k

NOTE:
Feedback Resistors are to be 1% or better, minimum 1/4 watts.

5.1 Control Board Layout ES600

IMPORTANT:
Potentiometers RV5 & RV6 are used to set maximum motor rated speed in Tachometer Feedback mode only. Refer to parameter #73 for complete details.

- **Adjustment Potentiometers**

RV1 (LCD) LCD contrast (factory preset)

RV4 (OUT I) Analog output of the current signal at terminal K1/20. Factory adjusted to provide ±4VDC at the terminal with parameters #32,#33 and #49 at 100% (maximum current limit).

RV5 (N Coarse) To adjust for maximum speed of motor with parameter #02 = 100%

RV6 (N fine) To adjust for maximum speed of motor with parameter #02 = 100%

RV7 (Out V) Analog output of the speed signal at terminal K1/11 **Do Not Adjust.** Factory adjusted to ±10VDC at the terminal with 100% of speed feedback (see parameter #02).

- **Factory Preset Soldered Links**

BR1 closed (default): Ground the OV of the board.

BR1 open: Enables the OV of the board to float with respect to ground.

BR2 closed (default): Connects the internal +24VDC to the terminal board for digital inputs.

BR2 open: For the digital inputs, an external +24VDC is used for opto-isolation.

BR3 closed (default): Connects the internal OV to the terminal board for the digital inputs.

BR3 open: For the digital inputs, an external OV is used for opto-isolation.

- **Display LED's:**

L1 +15VDC supply present for analog circuitry.

L2 -15VDC supply present for analog circuitry.

L3 +5VDC supply present for digital circuitry.

5.2 ES600 Control Board Terminal Description

Terminal Block	Description	Values
K1/1 (OV)	OV Analog Common	Rin ≈ 20kΩ
K1/2 (IN1)	Master Speed reference input (-10V to +10V)	Rin ≈ 20kΩ
K1/3 (IN2)	Auxilliary speed reference input (-10V to +10V)	Rin ≈ 20kΩ
K1/4 (IN AUX)	Auxiliary programable reference input (-10V to +10V) (see parameter #57)	Rin ≈ 20kΩ
K1/5 (TG < 30V)	Tachometer feedback (0-30VDC Maximum Voltage)	Rin ≈ 20kΩ
K1/6 (OV)	OV analog common for tachometer	Rin ≈ 20kΩ
K1/7 (TG ≥ 30V)	Tachometer feedback (0-200VDC Maximum Voltage)	Rin ≈ 20kΩ
K1/8 (LIM)	Open Collector output to signal that the drive is in current limit. Transistor ON when I=ILM.	24VDC max. 100mA max.
K1/9 (OUT AUX)	Auxiliary analog output that can be preset by parameter #58	10VDC max. 5mA max.
K1/10 (OUT I)	Output current signal for an optional ammeter. With #59=0 the signal is positive if bridge A is operating. With #59=1, the signal has only positive polarity. Adjustable through potentiometer RV4. Standard calibration, ±4V equals maximum current limit (without overlimit).	10VDC max. 5mA max.
K1/11 (OUT V)	Output voltage signal (speed) for an optional voltmeter. Positive polarity if bridge A is operating and with motoring current. Adjustable through RV7. Standard calibration; ±10V at maximum speed.	10VDC max.

Note:
Maximum cable length to wire amp meter is not to exceed 10 feet.

5.2 ES600 Control Board Terminal Description (cont'd)

Terminal Block	Description	Values
K1/12 (+10V)	+10 VDC Reference power supply output	5mA max
KI/13 (OV)	0V Analog common	
K1/14 (-10V)	-10VDC Reference power supply output	5mA max
K1/15 (RUN)	Run command. Active signal when contact is closed to 0V. By opening the contact, the drive stops in the time preset by parameter #25.	24V/3mA
K1/16 (IMP1)	1st reference value for jog. (see Parameter #21). Active signal when contact is closed to 0V.	24V/3mA
K1/17 (IMP2)	2nd reference value for jog. (see Parameter #22). Active signal when contact is closed to 0V.	24V/3mA
K1/18 (MDI)	Progammable current limit reduction or master/slave mode. Refer to parameters #43 and #74 for complete details. Active signal when contact is closed to 0V.	24V/3mA
K1/19 (ST (C))	Speed threshold internal relay common.	
K1/20 (ST (NO))	Internal relay NO contact to signal speed threshold has been exceeded. (Value can be preset with Parameter #31).	250V max 2A max
K1/21 (K lock (C))	Internal relay current overlimit common.	
K1/22 (K Lock (NO))	Internal relay NO contact to signal that the drive has been in overlimit for the maximum preset time. i.e.: The relay energizes (and closes the contact) if the drive remains in overlimit (parameters #41 and #42) for the maximum preset time as preset by parameters #39 and #40. The display shows the warning message A13. The relay de-energizes when the drive is in Stand-By Mode.	250V max 2A max

IMPORTANT:
K1/16 and K1/17, motor rotation will depend on the polarity of the reference signal, (ie. (+) -Forward, (-) - Reverse).

NOTE:
Refer to parameters #86 and #87 for other relay control functions.

5.2 ES600 Control Board Terminal Description (cont'd)

Terminal Block	Description	Values
K1/23 (BZ (C))	Internal relay for zero speed indication.	
K1/24 (BZ (NO))	Internal relay NO contact for zero speed. i.e.: The relay de-energizes (and opens the contact) when the speed is equal to zero.	250V max 2A max
K1/25 (AL (C))	Internal relay alarm signaling common	
K1/26 (AL (NO))	Internal relay NO contact for alarm signaling. i.e.: The relay de-energizes (and opens the contact) when any of the alarms which are signaled by the display	250V max 2A max
K1/27 (Reset)	Drive reset after an alarm trip. Active signal if closed momentarily to 0V.	24V/3mA
K1/28 Inhibit	Control enabling the drive operation. Active signal when closed to 0V. The opening of the contact disables the drive (motor idles, drive in Stand-by).	24V/3mA
K1/29 (0V OPTO)	External 0V digital common for digital input opto-isolation. i.e.: For isolation, jumper BR3 must be unsoldered.	
K1/30	External voltage +24 VDC for digital input opto-isolating (K1/15, K1/16, K1/17. K1/18, K1/27, K1/28). i.e.: For isolation solder jumper BR2. Do not use this terminal with BR2 closed to supply external loads, but use the +24VDC, available at terminal 54 (ES630 Firing Board).	

IMPORTANT:
The drive can also be reset after a fault condition by simultaneously pressing the "INC" & "DEC" push-buttons on the key pad display.

5.3 ES600 Control Board Test Point Description

Test Point	Description
TP1	+5 Volt power supply for digital devices.
TP2	Common for digital devices.
TP3	-15 Volt power supply for analog devices.
TP4	+5 Volt power supply for Analog to digital converters of the microprocessor.
TP5	Common for analog devices.
TP6	+15 Volts power supply for analog devices.
TP7	H.S.I. (1) square wave form of armature current.
TP8	H.S.I. (0) network synchronizing.
TP9	NOT USED.
TP10	+10 Volt power supply for the reference (TERMINAL K1 / 12).
TP11	IARM Current feedback signal (PARAMETER #05).
TP12	-10 Volts power supply for the reference (TERMINAL K1 / 14).
TP13	IN-AUX Auxiliary refence input (TERMINAL K1 / 4 : PARAMETER #09).
TP14	ERN. Speed loop error (PARAMETER #03).
TP15	VDTN. Motor speed (PARAMETER #02).
TP16	VREF. Input reference voltage.
TP17	VMAINS. Mains input voltage.
TP18	NOT USED.

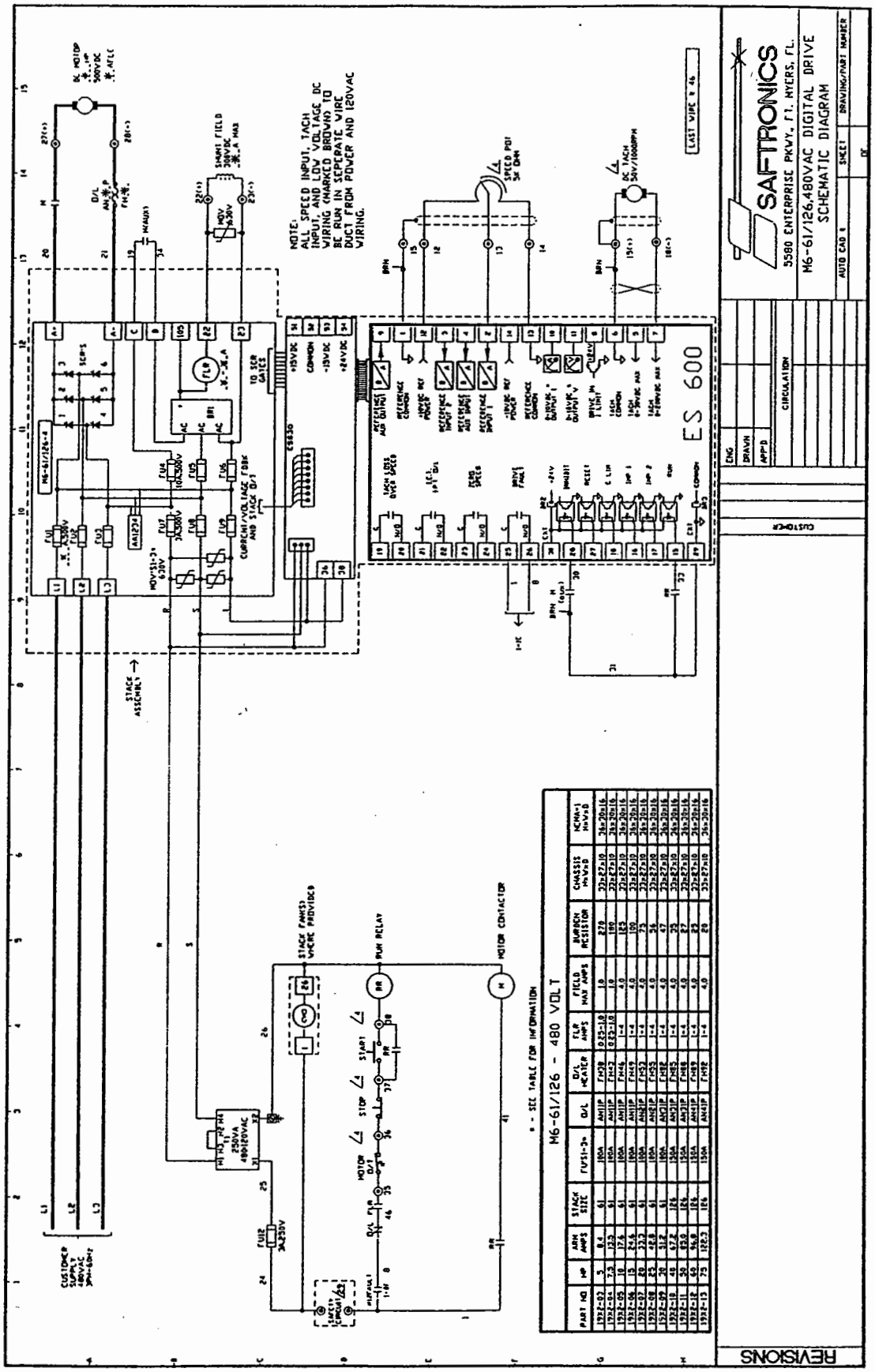
5.4 ES600 Control Board Jumper Description

Jumper	Description
J1 & J2	When open, provides the drive with galvanic isolation, the armature feedback is removed and the drive uses tach feedback only. The feed forward or CEMF is calculated from the firing angle. When closed, provides the drive with high impedance isolation, the armature feedback is included and the drive may be used without a tach see #73. When a tach is used the feed forward or CEMF is calculated from the armature feedback.
J3, J4, J5	When connected between common and HALL, the drive uses a hall device and accompanying control card for current feedback.
J6	When connected between common and F, the current feedback signal filter is used. When connected between common and NOF, the current feedback signal filter is not used.
J7	When connected between common and 27C256, a 32Kx8 EPROM (IC28 & IC29) is used. When connected between common and 27C512, an 64Kx8 EPROM (IC28 & IC29) is used.
J8	When connected between common and 4364, an 8Kx8 RAM (IC34) is used. When connected between common and 43256, an 32Kx8 RAM (IC34) is used.
J9	When connected between common and 28C16, an 2Kx8 EEPROM (IC39) is used. When connected between common and 28C64, an 8Kx8 EEPROM (IC39) is used.

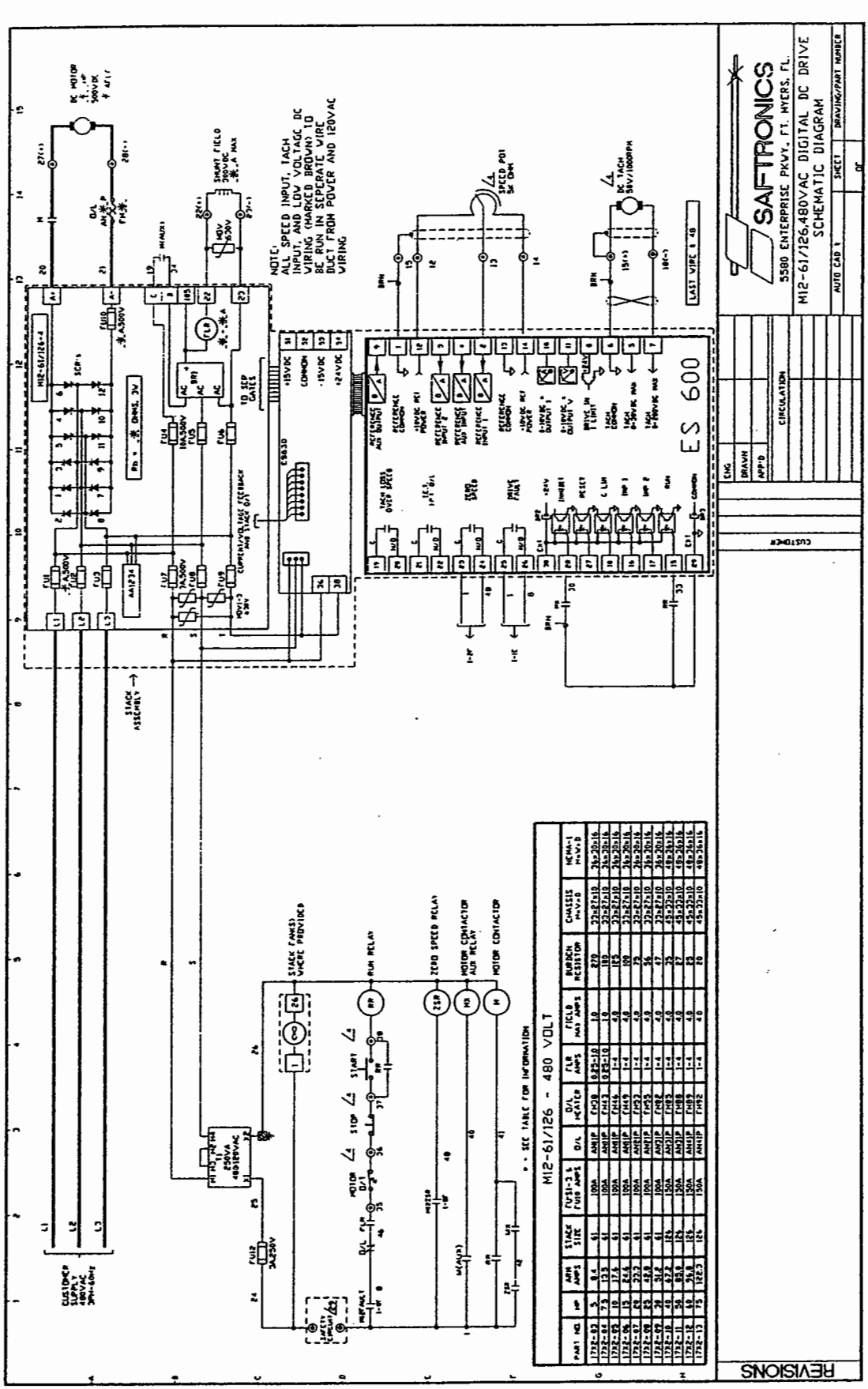
5.4 ES600 Control Board Jumper Description (cont'd)

Jumper	Description
J10	When connected between common and 0WS, the drive uses a RAM chip with an access time of 100ns or less. When connected between common and 1WS, the drive uses a RAM chip with an access time of greater than 100ns.
J11	When connected between common and 0WS, the drive uses an EPROM with an access time of 120ns or less. When connected between common and 1WS, the drive uses an EPROM with an access time of greater than 120ns.

5.5 Standard Connection for dcM6



5.6 Standard Connection for dcM12



6.0 ES630 FIRING BOARD TERMINAL DESCRIPTION

NOTE:
Connect terminals 36 and 38 in phase with power terminals L1 and L2.

Terminal Block	Description	Values
36 38	Supply from three phase (standard 190-480VAC - 50/60Hz) for power supplies and phase synchronization.	
37	No connection.	
39	No connection.	
40	No connection.	
41	No connection.	
42	No connection.	
43	No connection.	
44	No connection.	
51	+15VDC Supply.	40mA max
52	0V	
53	-15VDC Supply.	40mA max
54	+24VDC Supply.	80mA max

R7 & R12 = 33KΩ
10 WATT

3 PHASE AC LINE VOLTAGE SELECTION JUMPERS

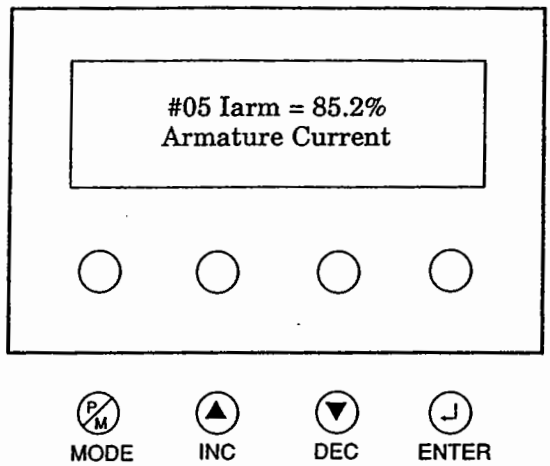
NOTE:
Preset at factory, prior to shipment.

VOLTAGE	LINKS IN	LINKS OUT	RESISTORS
480	LK4	LK1, 2, 3, 5	R7 & R12 Installed
240	LK1, 2, 3, 5	LK4	R7 & R12 Not Installed

7.0 KEYBOARD AND ALPHA-NUMERIC DISPLAY

7.1 Keyboard and Alpha-Numeric Display

The drive is equipped with an LCD display, with two lines of 16 characters, and with 4 keys to preset or display the chacteristic parameters of the system. The LCD also displays complete alarm messages.



The keys are labeled MODE, INC, DEC and ENTER and have the following meanings:

MODE: Pressing the "mode" change button alternately selects between display of the parameter number or the ability to change the parameter value (#12 - #87).

Note: If the blinking cursor "□" does not appear on the display when changing the parameter data values check the following:

1.) Is the parameter Read-only

2.) Security code has not be entered at parameter #14=1

NOTE:
For its operation, the drive uses the parameters preset by the user. A parameter that has been updated with the keys INC or DEC is immediately used instead of the previous value, even if ENTER has not been pressed. This changed parameter will be lost when the drive is switched off, if it has not been saved to the EEPROM by pressing the ENTER key.

INC: Increases the parameter number or the value shown according to the selected mode (as indicated by the cursor state).

DEC: Decreases the parameter number or the value shown according to the selected mode (as indicated by the cursor state).

ENTER: Saves to the EPROM (non-volatile memory) the actual value shown on the display. This value will remain stored after the drive is switched off, and will be available when the drive is turned on again.

DRIVE FAULT RESET: To reset the controller after a fault diagnostic message **(momentarily press)("Inc", "Dec")** push buttons at the same time.

7.1 Keyboard and Alpha-Numeric Display (cont'd)

The parameters are sequentially numbered from #00 to #87 and their list (with the corresponding meaning) is shown on page 27 of this manual, namely:

- Parameters from #00 to #11 are for display only and cannot be adjusted by the user.
- Parameter #12 can be changed by the user, updated during drive operation, and can be automatically calculated by calibrating the back-EMF (#14=4).
- Parameter #13 (only for display) can be "calibrated" by the user.
- Parameter #14 is the "key" parameter, containing the access code that allows the user to change all other parameters (#12, #13 and #15 to #87) and enable the auto-tune software.
- Parameters #15 to #87are user programmable to allow complete configuration of the system; some may be set during automatic calibration (see the corresponding section).

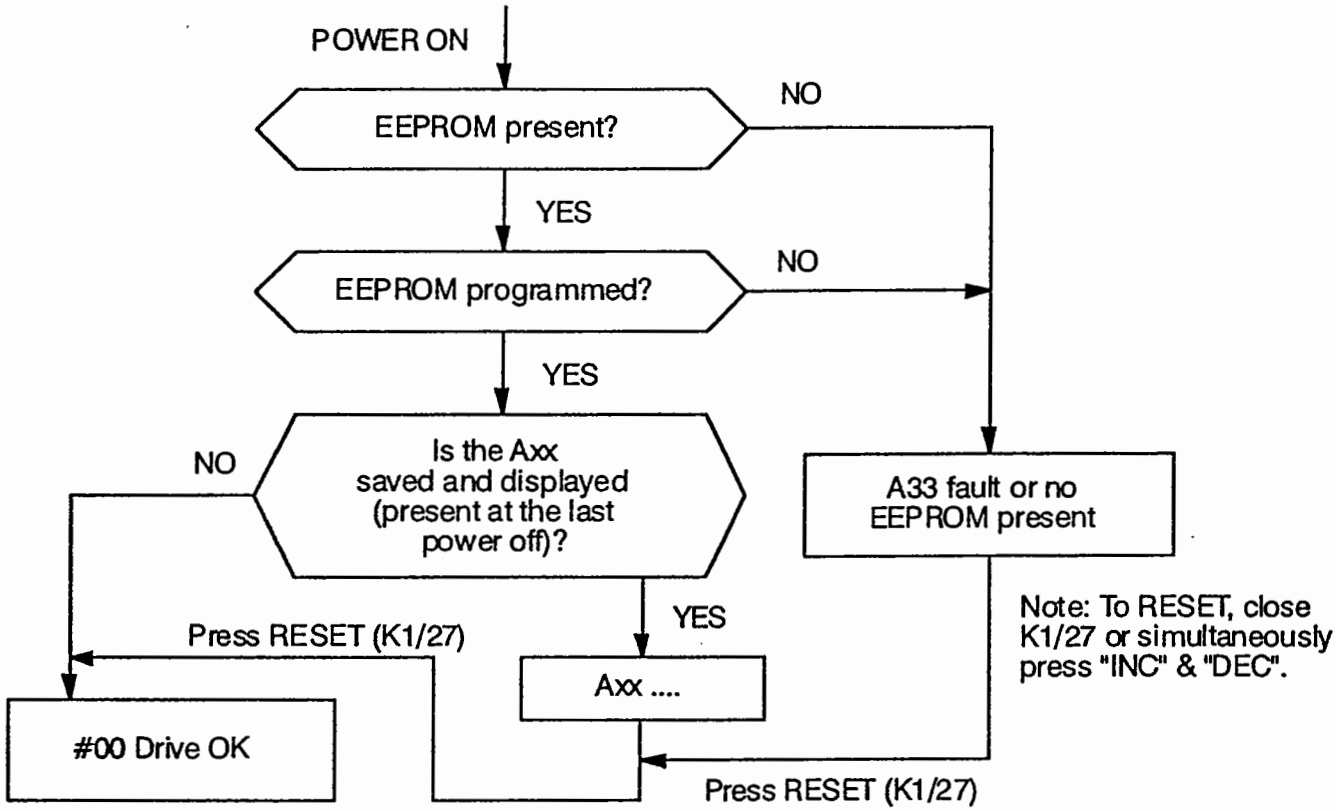
NOTE:
The rectangles show what is on display; wording near the arrows indicate the actions to be made; the symbol "□" means "blinking cursor".

Here are some examples of how to interact with the display and the keys:

1) Power up (See Fig. 2, Page 21);
2) Displaying a parameter (See Fig. 3, Page 21);
3) Changing a parameter and saving it (See Fig. 4, Page 22 and 23);
4) Alarm tripping (See Fig. 5, Page 23)

7.2 Power Up

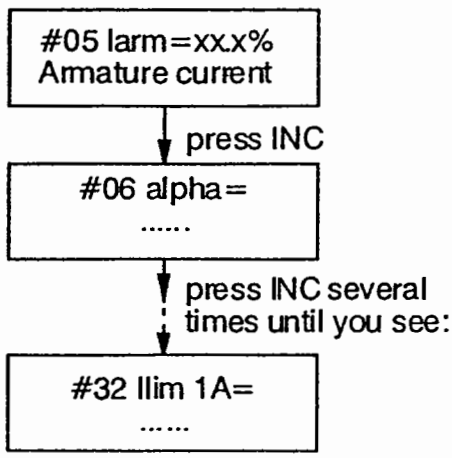
Fig 2. - POWER UP



7.3 Displaying a Parameter

Fig. 3. - DISPLAYING A PARAMETER

Example: I am at param #05;
I want to see param #32.

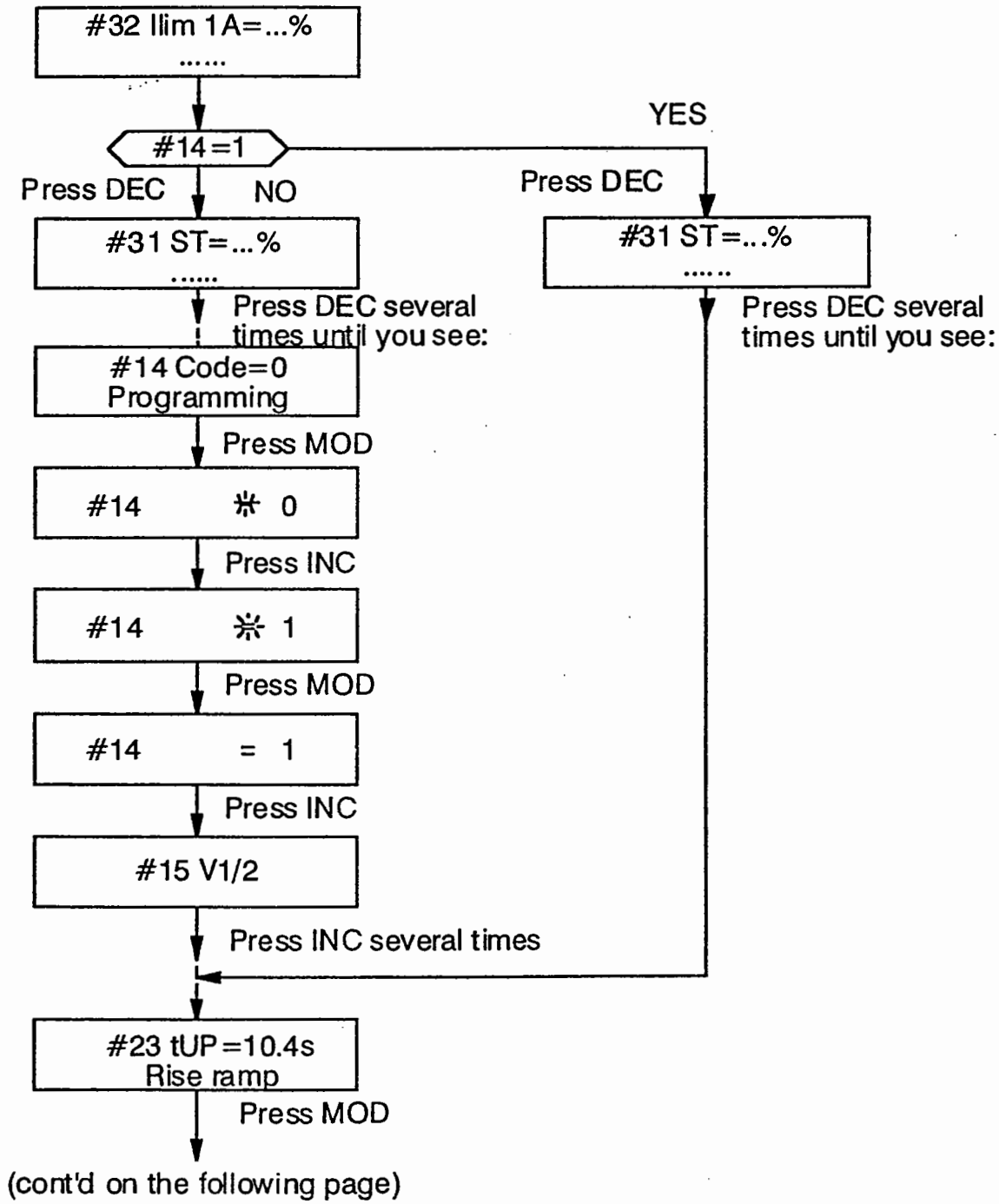


Note:
The parameter sequence is circular (that is: ->0->1->...76->77->0->...) in both directions, therefore you can go from #05 to #32 by pressing DEC several times.

7.4 Changing a Parameter and Saving it (if required)

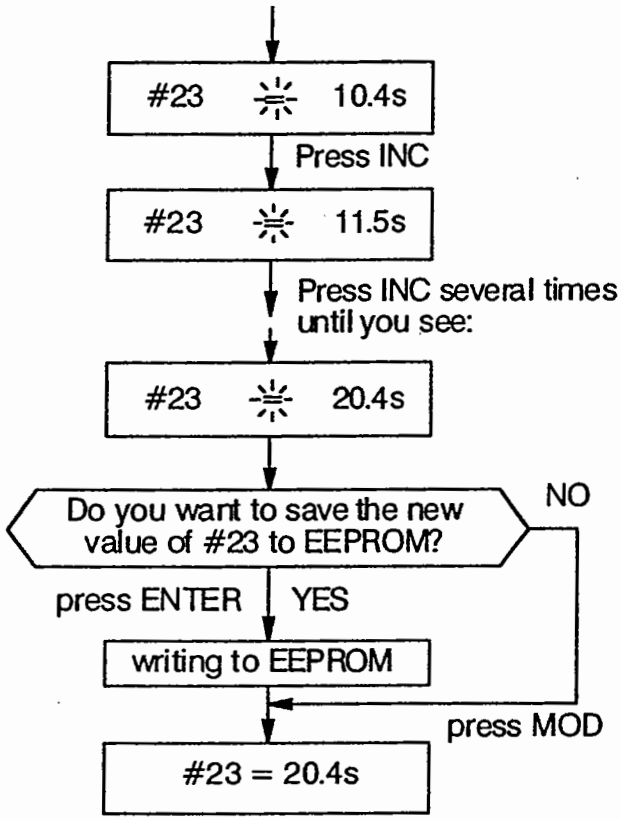
Fig 4. - CHANGING A PARAMETER AND SAVING IT (IF REQUIRED)

Example: I am at parameter #32;
I want to change parameter #23 from 10.4s to 20.4s;
I know that I have to enter the security code in parameter #14.



7.4 Changing a Parameter and Saving it (if required) (cont'd)

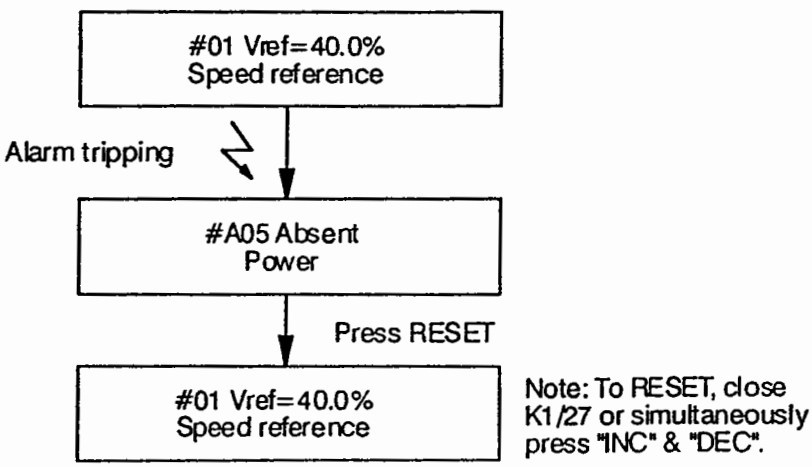
Fig 4. - cont'd from previous page



7.5 Tripping of an Alarm

Fig 5. - TRIPPING OF AN ALARM

Example: I am at parameter #01;
the alarm A05 trips (absent power)



8.0 AUTOMATIC TUNING AND CALIBRATION

8.1 Automatic Tuning and Calibration

The dcM Series is equipped with a special mode of operation which automatically calculates the ideal parameters to be used in both the current and speed loops by recognizing the basic motor characteristics.

This display-assisted procedure is performed off-line at the first start-up or every time required by the user for (example, when the electro-mechanical characteristics of the machine changes).

Three types of automatic calibration are performed:

1) **The current loop** (setting parameter #14=2): The drive calculates parameters #18, #19, #45 and #46;

2) **The speed loop** (setting parameter #14=3): The drive calculates parameter #28 and #29;

IMPORTANT:
This calibration may not be absolutely accurate, but is a fast way to go from a "non calibrated" drive to a drive where the basic adjustment and stability parameters are close to the optimum settings. The user can then easily make fine adjustments to these values, by means of the keys and display.

Note: For drives that use armature voltage feedback (no tachometer) the automatic speed and CEMF self-tuning software will not operate and therefore, parameters #12, #28 and #29 need to be adjusted manually. For armature feed back drives, refer to parameter #87

3) **The Back-EMF** (setting parameter #14=4): The drive calculates parameter #12. Values calculated are automatically saved to the E^2PROM at the end of the calibration.

Note: For drives that use armature voltage feedback, this operation will not work. Refer to manual calibration section Page 55 for details.

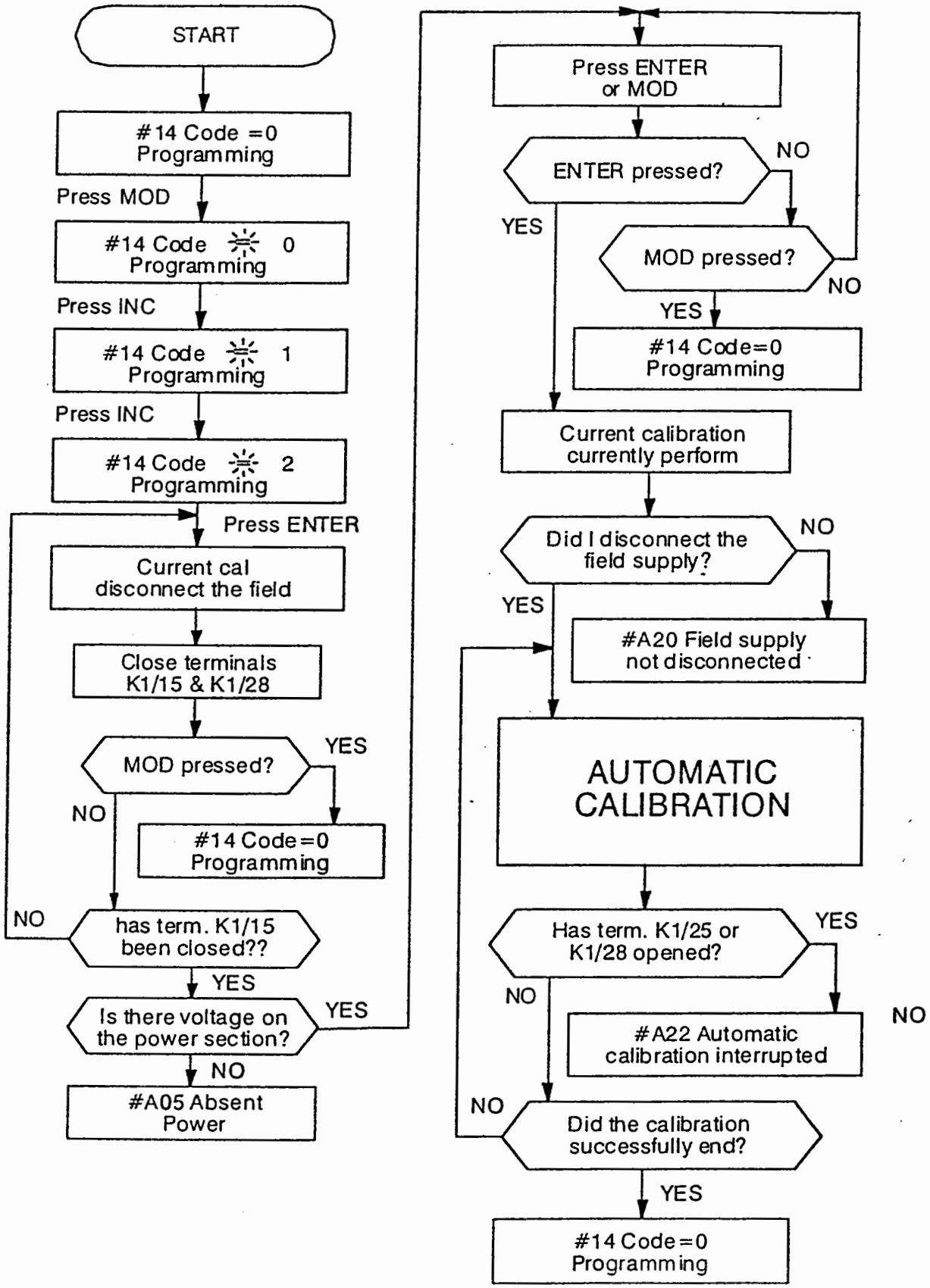
CAUTION:
There is a possibility of the motor overspeeding during the following tests. This can cause personal injury and property damage.

During the current self-tuning, the field current is absent so the motor will not produce significant torque. Because of residual magnetic field, there is a possibility that the motor will turn and could overspeed. The motor should be connected to a load that will require substantial starting torque or if necessary the shaft should be blocked with a bar or other object to prevent tuning.

The following is an example of how to interact with the display and the keys when performing the calibration of the current loop (for the other two cases, the procedures are similar).

8.2 Auto Tune & Calibration Procedure

Fig 6.



9.0 PARAMETER LIST

9.1 Description of Parameters

Parameter Number	Function
#00	**Drive in normal operation - "Drive OK"**
#01	**V_{ref} - Analog Speed Reference** (Read only) Range: -100% to +100%. Vref represents the sum of the values present at the terminals K1/2 & K1/3. The scaling of this value is controlled by parameter #15: With #15=10.0V and with 10.0V on terminals K1/2 and K1/3, the displays reads 100%.
#02	**N - Speed feedback** (Read only) Range: -100% to +100%. The value present at terminal K1/5 (TG ≥30V) is displayed. 100% of this value corresponds to the maximum speed as preset via the potentiometer RV5 and RV6. In case of armature voltage feedback (parameter #73), the % armature is displayed.
#03	**E_{rr} - Digital Speed Error** (Read only) Range: -5% to +5%. The difference between the values #01 and #02 is displayed.
#04	**I_{ref} - Current Reference** (Read only) Range: 0% to 100% The current loop input is displayed (Iref is equal to the output of the speed loop as modified by one of the parameters #32 to #43. The scaling is the same as for parameter #5
#05	**I_{arm} - Armature Current** (Read only) Range: 0% to 100% Armature current as obtained via AC feedback CT's. 100% of this value corresponds to the drive size.

9.1 Description of Parameters (cont'd)

Parameter Number	Function
#06	**A_{lfa} - Phase Angle** (Read only) Range: 0° to 180°. SCR on delay angle. Calculated starting from zero crossing.
#07	**f_{cem} - Back-EMF** (Read only) Range: -5000V to +5000V It is calculated based on the formula $E=k_e n$. For this calculation, it is necessary to know the value of k_e (set through the parameter #12 or calculated with the automatic calibration of #14=4).
#08	**V_{arm} - Armature Voltage** (Read only) Range: -1000 to +1000V. Armature voltage is calculated based on the formula: $V=E+RI+Ldi/dt$. For this calculation, it is necessary to know the value of K_e (set through parameter #12 or calculated with the automatic calibration #14=4) and R and L (set through parameter #18 and #19 or calculated with the automatic calibration #14=2). **Note: This parameter will read zero for drives set up in armature feedback. (Refer to parameter #73).**
#09	**INAUX - Auxiliary Analog Input** (Read only) Range: -100% to +100%. Auxiliary input is set through parameter #57, its value is displayed at terminal K1/4. The scaling of this value is obtained from parameter #16, with #16=10.0V and with 10.0V on terminal K1/4, the display reads 100%.
#10	**OUTAUX - Auxiliary Analog Output** (Read only) Range: -10V to +10V. Auxiliary output is set through parameter #58, its value is displayed at terminal K1/9

9.1 Description of Parameters (cont'd)

IMPORTANT:
To set Maximum Armature Voltage for drives that use Armature Voltage Feedback, (parameter #73) the user must adjust parameter #12 to scale the drives output voltage to match the rated motor armature voltage.

IMPORTANT:
Before tuning the drive for Back-EMF(#14=4) make sure that the motor maximum speed has already been calibrated. For tachometer feedback use RV5 & RV6. For Armature Feedback Drives this operation can not be done. Refer to manual calibration section for details.

Parameter Number	Function
#11	**f - Line frequency** (Read only) Range: 45Hz - 65Hz.
#12	**k_e - Back-EMF** Range: 0V to +1000V. Value of the back-EMF (E=ken) where n=100%. This value is required for feed forward, (see parameter #63).
#13	**V_{mains} - Line Voltage** Range: 100/600 VAC +10% - 15% Value of the line voltage at the terminals 36 and 38. This value can be software changed. Changes of ± 5% are allowed.
#14	**Access Code** Range: 0 to 4 *Default value 0* Access code for programming and calibration: **0:** Normal operation; only the same parameter #14 can be changed. At the beginning and end of every automatic calibration this is always #14=0; **1:** All parameters #12 through #87 can be changed; **2:** Automatic calibration of the current loop (parameters #18, #19, #45 and #46 are calculated); **3:** Automatic calibration of the speed loop (parameters #28 and #29 are calculated); **4:** Back-EMF (E=ken) calibration (required for feed forward) (see parameter #63) (parameter #12 is calculated).
#15	**V1/2 - Analog Reference Scale** Range: 0V to 10 *Default value 10V.* Full scale voltage (corresponding to 100%) for the speed reference at terminals K1/2 and K1/3 (see#01).

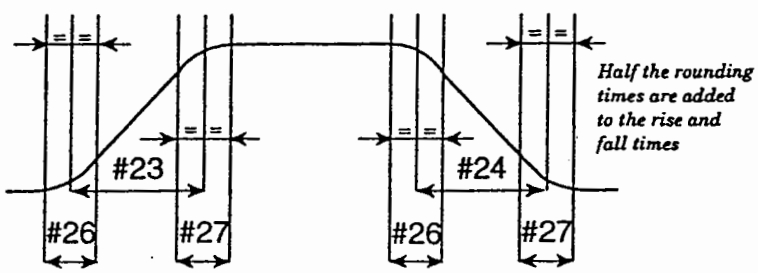
9.1 Description of Parameters (cont'd)

Parameter Number	Function
#16	**VAUX - Auxiliary Analog Reference Scale** Range: 0V to 10V ***Default value 10V.*** Full scale voltage (corresponding to 100%) for the auxiliary input to terminal K1/4 (see #09 and #57).
#17	**AC Line Voltage Input** ***Default value 240 for 240VAC Input Drives*** ***480 for 480VAC Input Drives***
#18	**RxI (resistance x current)** Range: 0 to 338 volts ***No Default.*** This value must be calculated unless it has been preset in the factory for a specific motor. The calculation is made as follows: The motor armature resistance value in ohms is multiplied by the total current of the motor. ***EX.*** A motor armature resistance = 0.2 ohms A total current value of 100 amps. 0.2 x 100 = 20 volts This value may be changed when a current auto tune is performed.
#19	**LDI/DT** Range: 158 to 15840 volts. ***No Default.*** This value must be calculated unless it has been preset in the factory for a specific motor. The calculation is made as follows: The motor armature inductance in mH is multiplied by the total current of the motor. **EX.** A motor with an inductance of 10 mH and a total current of 100 amperes. 10 x 100 = 1000 volts This value may be changed when a current auto-tune is performed.

9.1 Description of Parameters (cont'd)

Parameter Number	Function
#20	**Jog Operation** Range: 0,1 or 2 ***Default Value 1*** **0 (without ramp)** The selected percent of motoring speed is accessed with no time delay and this speed is achieved in the time indicated by the ability of the motor to accelerate under the given load. **1 (with ramp)** The selected percent of motoring speed is accessed by the time set in parameters #23 and #24. **2 (with ramp)** The selected percent of motoring speed is accessed by the time set in parameter #75 and #76.
#21	**I_{mpi} - First Point Jog** Range: -100% to +100%. ***Default value +5%.*** 1st reference value jog. This value is active with an open contact on RUN (K1/15) and closed contact on IMP1 (K1/16), and K1/28 drive inhibit.
#22	**I_{mp2} - Second Point Jog** Range: -100% to +100% ***Default Value -5%*** 2nd reference value jog: This value is active with an open contact on RUN (K1/15) and closed contact on IMP2 (K1/17) and K1/28 drive inhibit.
#23	**t_{up} - Acceleration Time** Range: 0 seconds to 300 seconds. ***Default Value 0s.*** Acceleration time of the drive from 0% to 100% of set reference. **NOTE:. This value is common for both motoring directions.**

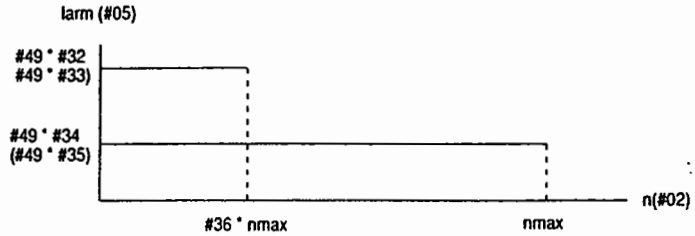
9.1 Description of Parameters (cont'd)

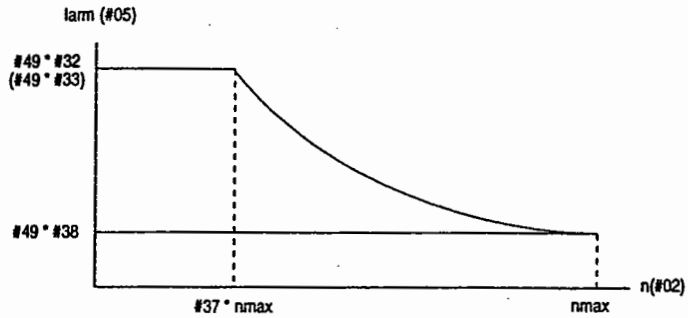
Parameter Number	Function
#24	**t_{Down} - Deceleration Time** Range: 0 seconds to 300 seconds. ***Default Value 0s.*** Deceleration time from 100% to 0% **NOTE: This value is common for both regenerating directions.**
#25	**t_{Stop} - Fast Stop Deceleration** Range: 0 seconds to 300 seconds. ***Default Value 0s.*** Fast deceleration time occurs when the RUN contact at terminal K1/15. **NOTE: This value is unique for both bridges and, therefore, for both directions of rotation.**
#26	**Arr. - s - Ramp Rounding Acceleration** Range: 0 to 10 seconds. ***Default value 0s.*** S-curve rounding, rounds the beginning and end of the acceleration ramp and is calculated dependent on the settings entered. The total time of the two s-ramps may not exceed the value of the acceleration or deceleration time, this will cause instability in the drive.
#27	**Arr. f - s - Ramp Rounding Deceleration** Range: 0 to 10 seconds. ***Default value 0.s.*** S-curve rounding, rounds the beginning and end of the deceleration ramp and is calculated dependent on the setting entered. The total time of the two s-ramps may not exceed the value of the acceleration or deceleration time, this will cause instability in the drive. NOTE: Check the ratio #26/2+#27/2≤#23(24)(25) 

9.1 Description of Parameters (cont'd)

Parameter Number	Function
#28	**kp - Speed loop Proportional Gain** Range: 0 to 100. ***Default value 2.87.*** Gain k_p of the speed loop expressed according to the formula $G(s) = k_p(1+1/T_i s)$. **NOTE: This value may be changed by performing a speed loop auto-tune, parameter #14-3.**
#29	**T_i - Speed Loop Integral Gain** Range: 0.01 seconds to 1 second. ***Default value 0.51s.*** Integral time T_i of the speed loop expressed according to the formula $G(s) = k_p(1+1/T_i s)$. **NOTE: This value may be changed by performing a speed loop auto-tune, parameter #14-3.**
#30	**os-n-Offset to the Speed Loop Output** Range: -15% to +15%. ***Default value 0%.*** Percent of full speed added to or subtracted from the speed loop, may be used as a minimum speed or a bias offset. (Active with parameter #61=0 or #61=1).
#31	**st-Speed Threshold Set Point** Range: 0-110%. ***Default value 100%.*** When the speed or armature voltage is greater than or equal to this setting the relay ST contacts close. May be used as an over speed detector when the drive is in armature feedback. **NOTE: For other types of operation refer to parameters #86 and #87.**

9.1 Description of Parameters (cont'd)

Parameter Number	Function
#32	**I_{lim1A} - Motor Current Limit - Bridge A** Range: 0% to 300%. ***Default value - 100%.*** Bridge A current limit 1st value. This value is given as a percentage of the power unit rated current (parameter #49) and is used as long as n ≤ #36. For n > #36, parameter #34 is used.
#33	**I_{lim1B} - Motor Current Limit - Bridge B** Range: 0% to 300%. ***Default value - 100%.*** Bridge B current limit 1st value. This value is given as a percentage of the power unit rated current parameter #49 and is used as long as n ≤ #36. For n > #36, parameter #34 is used.
#34	**I_{lim2A} - 2nd motor Current Limit - Bridge A** Range: 0% to 300%. ***Default value - 100%.*** Bridge A current limit 2nd value. This value is given as a percentage of the power unit rated current parameter # (49) and is used only if n > #36. For n ≤ #36, parameter #32 is used.
#35	**I_{lim2B} - 2nd Motor Current Limit - Bridge B** Range: 0% to 300%. ***Default value - 100%.*** Bridge B current limit 2nd value. This value is given as a percentage of the power unit rated current (parameter#49) and is used only if n > #36. For n ≤ #36, parameter #32 is used.
#36	**n_{lim} - Two stage Current** Range: 0% to 100%. Default value - 100% Speed at which switching from the 1st to the 2nd current limit value occurs (that is from #32 to #34 and from #33 to #35). 

Parameter Number	Function
#37	**n_o - Current limit Switchover Above Base Speed** Range: 0% to 100%. ***Default value - 100%.*** Above speed n_o current limit becomes a function of speed n according to the formula, Ilim = k/(n-n_o) where k = #37(1-#38)/(1-#37) and N_o = (#38 - #37)/(1-#37) where #37 and #38 are dimensional numbers. N_o is used to obtain a hyperbolic current/speed characteristic used in constant HP applications. 
#38	**I_{lim} - Current Limit Value at Extended Maximum Speed** Range: 0% to 300%. ***Default value - 100%.*** Current limit value at maximum speed (n=100%). See parameter #37 for its use. **NOTE: for each speed value, the current limit value used is the lower of those from the block of parameters #32 to #38 inclusive.**
#39	**t_{limA} - Bridge A and B Overload Time** Range: 2 seconds to 120 seconds. ***Default value - 2s.*** During this time bridge A current limit is allowed to increase by a percentage as set by parameter #41. If, at the end of this time period, Bridge A is not in current limit then the transient can be repeated each time the drive reaches current limit, but only if a time interval equal to 6.4 times parameter #39 has elapsed. If the drive is in current limit when time as set by parameter #39 has elapsed, then relay KLOCK closes (terminal K1/23 and K1/22) and trips the corresponding alarm.

9.1 Description of Parameters (cont'd)

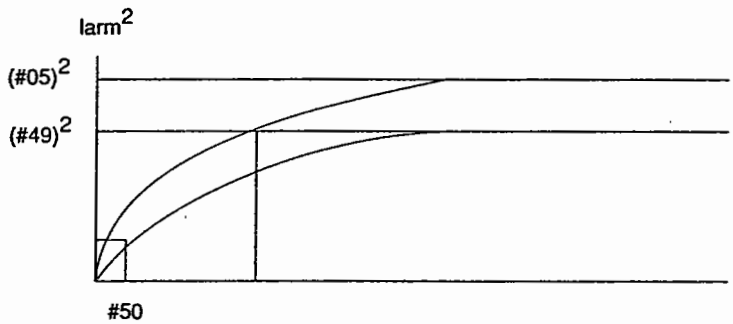
Parameter Number	Function
#41	**+limA - Power Unit current limit - Bridge A** Range: 100% to 200%. ***Default value - 100%.*** Percentage of overload limit for Bridge A for the time preset by #39. This value is intended to be applied to the value of effective limit existing for a given speed (see the NOTE: for parameter#38). **NOTE: It is not possible to set an effective overload limit value higher than 200% (that is the product of #41 and #49). If a higher rating is required, replace the drive and its external circuits by the next large size.**
#42	**+limB - Power Unit Current Limit - Bridge B** Range: 100% to 200%. ***Default value - 100%.*** Percentage of overload limit for Bridge B, for the time as preset by #39. This value is intended to be applied to the value of effective limit existing for a given speed (see the NOTE: for parameter #38). **NOTE: It is not possible to set an effective overload limit value higher than 200% (that is the product of #41 and #49). If a higher rating is required, replace the drive and its external circuits by next larger size.**
#43	**clim - Current Limit Reduction** Range: 1% to 100%. ***Default value - 50%.*** Percentage current limit reduction on both bridges upon closing the contact CLIM at terminal K1/18. This new value is applied to the existing current limit settings (see parameters #32 to #42 inclusive and their notes).

9.1 Description of Parameters (cont'd)

WARNING:
If too much integration is added, the drive may become drastically unstable, it will also become less responsive as the integration time is increased, this will cause a lack of accuracy in speed regulation.

Parameter Number	Function
#44	**tcorr - Current Slew Rate** Range: 0ms to 100ms. ***Default value - 0ms.*** This is an intergrater added to the output of the current loop.
#45	**k_{pin} - Current Loop Proportional Gain** Range: 0.05 to 5. ***Default value - 0.14.*** Current loop gain k_{pin} based on the formula: $G(s) = k_{pin}(1 + 1/T_{iin}s)$
#46	**T_{iin} - Current loop Integral Gain** Range: 0.5ms to 50ms. ***Default value - 25.5 ms.*** Current loop integral time T_{iin} based on the formula: $G(s) = k_{pin}(1 = 1/T_{iin}s)$
#47	**SCR Bridge Enable** Range: 0 to 2. ***Default Value 0 for 4 Quadrant Operation.*** ***Default Value 2 for 2 Quadrant Operation.*** Choice of the active values: **0:** Both bridges operating (A and B), with Interblock Logic enabled. **1:** Bridge A disabled. **2:** Bridge B disabled.
#48	**I_{min} - Interblock Logic Trip Current** Range: 0.01% to 10%. ***Default Value 0.1%*** Current level in % at which the interblock logic operates (i.e. disabling the active bridge and simultaneously enabling the inactive one). This operation starts when #04 is < #48.

9.1 Description of Parameters (cont'd)

Parameter Number	Function
#49	**I_{nom} - Power Unit Rating** Range: 0% to 100%. ***Default Value 100%*** The relationship between motor rated current and drive rated current. This becomes the reference value for all calculations involving the different current limits and is the one used for motor I^2t alarm (See parameter #50).
#50	**I^2t - Motor Thermal Time Constant** Range: 0 min. to 180 min. ***Default Value 10 min.*** A motor receiving a constant unit current can be represented by the heating curve $f(t) = 1-e^{t/T}$. Heating is proportional to the square of the armature current ($Iarm^2$). T is the thermal time constant of the motor. The corresponding alarm (A14) trips if the armature current supplied to the motor, during the time allowed, exceeds the asymptotic value. 
#51	**$\propto_{mot.}$ - Minimum Gate Angle** Range: 0° to 180°. ***Default Value 30°.*** Minimum delay angle for SCR's turning on when the drive operates as a motor. It limits the value of parameter #06.

IMPORTANT:
This value should not be changed from the standard default without first consulting the factory.

9.1 Description of Parameters (cont'd)

IMPORTANT:
This value should not be changed from the standard default without first consulting the factory.

Parameter Number	Function
#52	**$\propto_{brake}$ - Maximum Gate Angle** Range: 0° to 180°. ***Default Value 150°.*** Maximum delay angle for SCR's turning on when the drive operates as brake (regeneration). It limits the value of parameter #06.
#53	**Speed Error** Range: 0 or 1. ***Default Value 0.*** The speed error is fed either through a 1st order low-pass filter or through a 2nd order notch filter: **0:** 1st order filter (delay adjustable with parameter #54); **1:** 2nd order filter (the resonance frequency and merit factor can be preset respectively by #55 and #56).
#54	**RC - Low-pass Filter Time Constant** Range: 0ms to 300ms. ***Default Value 0ms.*** The time constant "tau" of the 1st order low-pass filter is represented by the formula G(s)=1/(1+"tau"). **NOTE: Parameter #54=0 means filter disconnected.**
#55	**F_r - Resonant Frequency of Notch Filter** Range: 0Hz to 140Hz. ***Default Value 0Hz.*** The resonance frequency f_0 of the 2nd order notch filter is represented by the formula: $$G(s) = \frac{Q(s/2\pi f_0 + 2\pi f_0/s)}{1+Q(s/2\pi f_0 + 2\pi f_0/s)}$$

9.1 Description of Parameters (cont'd)

Parameter Number	Function
#56	**Band Filter** Range: 0 to 3. ***Default Value 0.*** The merit factor Q of the 2nd order band-eliminating filter is represented by the formula: $G(s) = \frac{Q(s/2\pi f_0+2\pi f_0/s)}{1+Q(s/2\pi f_0+2\pi f_0/s)}$
#57	**Analog Input Select** Range: 0 to 5. ***Default value 0.*** The auxiliary input IN AUX (terminal K1/4) (parameters #09 and #16) can be programmed as follows: **0:** Cut off (no meaning) **1:** Additional speed loop reference (additive to the value at terminals K1/2 and K1/3). **2:** Additional reference. **3:** Bridge A; external limit. **4:** Bridge B; external limit. **5:** Bridges A & B; external limit.
#58	**Analog Output Select** Range: 0 to 6. ***Default Value 0.*** The auxiliary output OUT AUX (terminal K1/9) can be programmed as follows: **0:** 0 volt. **1:** Speed loop input (5V at 100%). **2:** Speed loop output (6V at 100%). **3:** Current reference (parameter #04) (6V at 100%). **4:** Ramp block output (10V at 100%). **5:** Power effectively delivered to the motor (P=V • I), (8V at 100%). **6:** Back-EMF ($E=k_e n$) (parameter #07), (10V at 510V).

9.1 Description of Parameters (cont'd)

Parameter Number	Function
#59	**Current Output Polarity - Output I** Range: 0 to 1. ***Default Value 0.*** This sets the polarity of the analog output OUT I (terminal k1/10). **0:** Bi-polar (optional ammeter must be a center zero meter). **1:** Single Direction (optional ammeter must be a zero left meter).
#60	**I_{ref}+ - Min Current References** Range: -100% to +100%. ***Default value 0.*** This is a percentage of total amount as represented in #49 which is added to or subtracted from the desired current reference. It will also add to or subtract from the current reference at terminal K1/4 when parameter #57=2.
#61	**Drive Speed Loop Operation** Range: 0 to 3. ***Default Value 0.*** Types of operation of the speed loop are as follows: **0:** Both the proportional and the integral are active. **1:** Only the proportional is active. **2:** The speed loop is not operating, the current reference is given by the parameter #60. **3:** The speed loop is not operating, the current reference is given by the speed reference at terminals K1/2 and K1/3.
#62	**Drive Current Loop Operation** Range: 0 to 3. ***Default Value 0.*** Types of operation of the current loop (see also parameter #63); **0:** Both the proportional and the integral are active. **1:** The current loop is not operating, feed forward is active. **2:** Only the proportional part is active, the feed forward is active. **3:** The current loop is not operating and the feed forward is not active.

9.1 Description of Parameters (cont'd)

Parameter Number	Function
#63	**Drive Feed Forward Operation** Range: 0 to 3. ***Default Value 0.*** Types of operation of the feed forward (see also parameter #62) are as follows: Feed forward provides armature compensation. **0:** Back-EMF is used. **1:** Back-EMF not in use.
#64	**Inhibit or enable the alarm A01 for incorrect phase rotation.** ***Default Value: Enable.***
#65	**Inhibit or enable the alarms A02 for mains frequency out of tolerance and A03 for unstable mains frequency.** ***Default Value: Enable.***
#66	**Inhibit or enable the alarm A04 for mains voltage out of tolerance.** ***Default Value: Enable.***
#67	**Inhibit or enable the alarm A05 for phase loss at the power terminals.** ***Default Value: Enable.*** Refer to parameter #72 for additional feature.
#68	**Inhibit or enable the alarm - A11 tachometer faulty.** ***Default Value: Enable.***
#69	***nSlave Drive Address*** Range: 0 to 31. ***Default Value 1.*** Shows the drive address in a serial network..

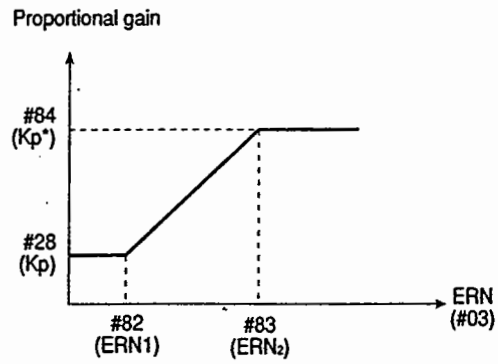
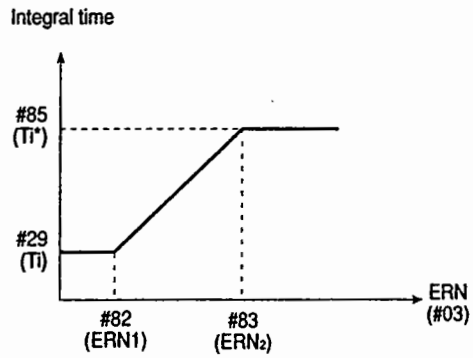
Parameter Number	Function
#70	**Baud Rate** Range: 4800 baud to 9600 baud. ***Default Value 9600 baud.*** Shows the baud rate of the serial connection.
#71	**Parity Type** Range: 0 to 1. ***Default Value 0.*** Shows parity status serial connection **0:** even parity. **1:** no parity.
#72	**Alarm AO5 Phase Failure** Range: 0 to 1 ***Default 0*** **0:** After 0.4 seconds, the alarm AO5 trips. If within this time window the phase appears again the drive will automatically continue its operation. **1:** The drive will immediately trip on alarm AO5 when any one of the power phases is missing.
#73	**Speed Feedback Mode** Range: 0 to 1 ***Default 0*** **0: From tachometer:** The speed loop feedback is derived from tachometer generator. Maximum motor speed is adjusted by potentiometer RV5 & RV6. **1: From Armature:** The speed loop feedback is taken from the motor armature. Maximum motor speed is adjusted by parameter #12.

Parameter Number	Function
#74	**Terminal K1/18 Function Control** Range: 0 to 1 ***Default 0*** 1: Sets parameter #61=3 when terminal K1/18 is jumpered to K1/29. The speed loop is removed and the analog reference on K1/2 and K1/3 becomes a current reference.
#75	**t up J Jog Acceleration Time** Range: 0 to 300 seconds ***Default 0 seconds*** Jog acceleration time for both motoring quadrants when digital inputs K1/16 or K1/17 are jumpered to K1/29. This parameter is active when #20=2.
#76	**t dn J Jog deceleration Time** Range: 0 to 300 seconds ***Default 0 seconds*** Jog deceleration time for both regenerative quadrants when digital inputs K1/16 or K1/17 are open. This parameter is active when #20=2.
#77	**Polarity of External Current Limit Reference** Range: 0 to 1 ***Default 0*** **0:** Positive polarity only (0- +10VDC) **1:** Negative polarity only (0 - (-) 10VDC) **NOTE: This parameter is effective only when #57=3,4, or 5.**

9.1 Description of Parameters (cont'd)

Parameter Number	Function
#78	**Not Used**
#79	**Not Used**
#80	**Intergral time (#29) Modified During Speed Transients** Range: 1 to 1000. ***Default 1*** During transients of the speed loop caused by load or speed command the intergral time (parameter #29) is multiplied by the factor in parameter #80.
#81	**Adapative Speed Loop Gain Control (#28, and #29)** Range: Included or excluded. ***Default excluded.*** By including this function both proportional and intergral gains (parameters #28 and #29) are modified depending on the programmed speed loop error. See parameter #82, 83, 84, and 85 for complete setup.
#82	**First point Speed Error ERN,** Range: 0 to 100% ***Default 0%*** With parameter #81 included, the proportional and intergral gains (parameters #28 and #29) are used as long as parameter #03 (ERN) < #82 (ERN_2). See figure on page 46.
#83	**Second Point Speed Error ERN_2** Range: 0 to 100% ***Default 0%*** With parameter #81 included, the proportional and intergral gains (parameters #84 and #85) are used as long as parameter #03 (ERN) > #83 (ERN_2). See figure on page 46.

IMPORTANT:
This function will only be affective in tachometer feedback mode (parameter #73). When using armature feedback make sure parameter #81 is excluded.

Parameter Number	Function
#84	**Second Point Proportional Gain Kp*** Range: 0 to 100 ***Default 0*** With parameter #81 included, the value of the proportional gain Kp* will be used as long as parameter #03 (ERN) > #83 (ERN_2). See figure on page 46.
#85	**Second Point Intergral Gain Ti*** Range: 0.01 to 1 second ***Default 0*** With parameter #81 included, the value of the Intergral gain Ti* will be used as long as parameter #03 (ERN) > #83 (ERN_2).  

Parameter Number	Function
#86	**Terminals K1/19-20 Configuration** Range: 0, 1, 2 ***Default 0*** **0: Speed Threshold:** See parameter #31 **1: Motor at Speed:** Contacts K1/19-20 will close based on the speed ERROR setting between parameter #31 and #03. When the speed ERROR exceeds the value in parameter #31 contacts K1/19-20 will open. ***EX.*** Contacts close: #31 = #03 **2: Current Threshold:** Contacts K1/19-20 will closed base on the current ERROR setting between parameter #31 and #05. When the current ERROR exceeds the value in parameter #05 contacts K1/19-20 will open. ***EX.*** Contacts close: #31 = #05 **NOTE: When the user has selected either #1 or #2 the range of parameter #31 is 0-10%.**
#87	**Hysteresis for #31** Range: 0 to 100% ***Default 5%*** Value to help reduce the contact bounce on terminal K1/19-20.

10.0 ALARM LIST

10.1 Alarm Description

Alarm Number	Description
A01	**Incorrect Phase Rotation** 1) The sequence L1, L2, L3 of the power section is incorrect, or: 2) The sequence L1 and L2 are not in phase with the terminals 36 and 38.
A02	**Line Frequency out of Range** The line frequency is below 45Hz or above 65Hz.
A03	**Unstable Frequency** The line frequency is unstable (changes greater than 1 Hz/ second).
A04	**Line Voltage out of Tolerance** 1) The line voltage is below 85% of the rated voltage. 2) Line voltage is above 110% of the rated voltage.
A05	**Power Absent** No voltage present at the power section. At least one phase of the power section is missing. **NOTE: The alarm trips after 0.4 seconds during the normal run, it is delayed for about 2 seconds when the RUN contact K1/15 is closed.**
A11	**Tachometer** 1) The tachometer is not connected to one of the terminals K1/5-K1/6 or K1/7-K1/6, or, 2) The tachometer is reversed or, 3) The tachometer is faulty. **NOTE: This fault can be by-passed with parameter #68.**
A12	**Current Higher than 200%** The instantaneous armature current (peak value) exceeded 200% of the rated drive current.

10.1 Alarm Description (cont'd)

Alarm Number	Description
A13	**Overlimit Tripping** The drive has been in current overlimit (see parameters #41 and #42) for the total allowed time (see parameters #39 and #40). NOTE: this is only a warning and does not, unlike all other alarms, inhibit the drive and open the alarm relay AL (k1/25-K1/26). It only closes the relay KLOCK (K1/21-K1/22). The message disappears when the drive enters the STAND-BY state (opening of K1/28).
A14	**I^2t Control Tripping** The motor is too hot. This alarm trips after a set time dependent on parameters #49 (motor rated current in respect to the rated current of the drive), and #50 (thermal time constant of the motor). For a more detailed description, see parameter #50.
A16	**Interrupted Armature** 1) One of the connections to the armature terminals is open, or, 2) DC Fuse is open. The alarm has a built in delay of about 0.5 seconds.

10.2 Alarms During Calibration

Alarm Number	Description
A20	**Excitation not disconnected** 1) During the current calibration cycle (parameter #14=2) the field circuit has not been disconnected or, 2) The motor is rotating due to residual magnetism. If this is the case, mechanically block the motor so calibration can be performed.
A21	**Too Low Limit** During current calibration (parameter #14=2) the current limit has been set too low.

10.2 Alarms During Calibration (cont'd)

Alarm Number	Description
A22	**Automatic Calibration Interrupted** During an automatic calibration, the RUN contact (K1/15) or the STAND-BY relay (K1/28) has been opened.
A24	**Speed Not Reached** During CEMF calibration (parameter #14=4), the drive can not reach the necessary speed (probably caused by the field current being too high).

10.3 Alarms Internal to the Drive

Alarm Number	Description
A30	**No 24V at the pulse transformers** The SCR's are unable to turn on due to the loss of the voltage on the primaries of the pulse transformers.
A31	**Heatsink Overtemperature** Heatsink too hot (T>80°C).
A32	**Micro-controller Fault** Fault in the synchronization circuit between micro-controller and line.
A33	**Faulty or not Pre-set EPROM** 1) EPROM absent, or 2) EPROM not programmed, or 3) EPROM faulty, or 4) Jumper J9 on control board not corresponding to the actual size of the EPROM. In all these cases the drive can operate with the standard set of parameters stored in the EPROM (values can be changed but not stored).

10.3 Alarms Internal to the Drive (cont'd)

Alarm Number	Description
A38	**Current Can Not be Formed** CEMF is to high and the drive can not develop the current. (Possibly caused by the field current being too high). This alarm is sometimes activated when there is a problem in the current feedback circuit.

11.0 START UP PROCEDURE FOR AUTO-TUNE

11.1 Procedure

IMPORTANT:
When changing any parameter data value the security code #14=1 must be entered first. When saving any new parameter values, the "Enter" key must be used. Refer to page 19 for complete details.

CAUTION:
There is a possibility of the motor overspeeding during the following tests. This can cause personal injury and property damage.

1. ***Visually check to make sure of the following:***
   - All field connections to control terminal blocks are tight
   - DC Motor connections are correct:
     - -Armature
     - -Shunt Field
     - -Tachometer (If supplied)
     - -Blower Motor (If supplied)

2. ***Verify the following on the Drive before power is applied:***
   - Value of Burden Resistor on AA1127-1 current feedback board mounted on SCR power stack. Refer to page 9 for details.
   - Value of Armature Feedback Resistor on AA1127-1. 22K for 480V input, 47K for 240V input
   - Fuses for tightness
   - Incoming power matches Drive voltage rating

3. ***Apply power to Drive and verify the following:***
   - LCD display shows "#00 Drive OK", or a fault. If fault, momentarily press "INC" and "DEC" push buttons at the same time. This procedure will reset the Drive.
   - LED's L1, L2, L3 on the main control board (ES600) are illuminated
   - Field voltage and current match the motor name plate.
   - Blower motor rotation is correct. (If supplied)

4. ***Verify the following Parameters before starting the Drive:***
   - Parameters #32,33,34,35,36,37,38,41,42 and 49 are set at 100%
   - Select the correct type of motor feedback
     - #73 = 0 "Feedback from Tach"
     - #73 = 1 "Feedback form Armature"

11.2 Verify Drive Current Limit Setting

WARNING:
During the current self-tuning, the field current is absent so the motor will not produce significant torque. Because of residual magnetic field, there is a possibility that the motor will turn and could overspeed. The motor should be connected to a load that will require substantial starting torque or if necessary the shaft should be blocked with a bar or other object to prevent tuning.

1. Remove the incoming AC supply. Disconnect the motor field supply from the control terminal blocks. Isolate the field wires. Jumper the field loss relay contact FLR in the AC control logic.

2. Connect a DC Amp clamp meter to measure true armature amps.

3. Reapply AC power and set parameter #61=3 "I reference given by K1/2 and K1/3". DO NOT SAVE THIS PARAMETER.

4. Set speed command reference to zero. Parameter #01 should also read 0.0%.

11.2 Verify Drive Current Limit Setting (cont'd)

5. Lock motor shaft to prevent rotation.
6. Close the Run relay to start drive.
7. Monitoring the DC Amps, slowly increase the speed command to 50%. The DC amps should be approximately 60% of motor name plate. If this is not the case, check for correct Burden Resistor. Increase the speed command to maximum. The DC amps should be approximately 125% of motor name plate.
8. Confirm with a DC Volt Meter that the voltage between terminal 1 and 10 on the ES600 board reads 4VDC with maximum speed command.
9. Reset speed command to zero and disable the RUN relay.
10. Set parameter #61 back to "PI Operating". Press Enter.

11.3 Current Loop Auto Tune

1. Keep the motor shaft locked, field disconnected and the field loss relay FLR still jumpered.
2. Set parameter #14=2
3. The display will read "Current Cal.. disconnect field" and then flash "Close terminals (K1/15 and K1/28).
4. Close the Run relay.
5. The display will show "Press Enter or MOD". Press the Enter push button. This automatically saves the current loop gain parameter when this procedure is completed. The display will show "Current calibration now performed". When the calibration is complete, the display will read #14=0.
6. Remove the AC supply, unlock motor shaft, reconnect the shunt field. Remove the field loss relay jumper.

11.4 Speed Loop Auto Tune

IMPORTANT:
This procedure will not work for drive using Armature Feedback. Refer to manual calibration section.

1. Make certain that the machine and motor can rotate freely in both directions.
2. Apply AC power and set parameter #73=1 "Feedback from Armature". Press the Enter push button.
3. Enable the Run relay and slowly increase the speed command until the motor starts to rotate. Check for correct motor rotation. Verify that the Tachometer polarity is the same as the speed command with respect to common. Remove power and make all changes.

11.4 Speed Loop Auto Tune (cont'd)

4. Reapply AC power.

5. Set parameter #73=2 "Feedback from Tach". Press Enter

6. Set parameter #14=3. The display will show "Speed calibration Connect Field" and then flash "Close Terminals K1/15 and K1/28". Enable the Run relay. The display will show "Press Enter or MOD". Press Enter. The display will show "Speed Calibration Now Performed". When the calibration is complete the display will show parameter #14=0.

11.5 Maximum Speed Calibration for Tachometer Feedback Drives Only

1. Set speed command to zero.

2. Install a DC Volt meter across the motor armature and DC tachometer.

3. Increase the speed command to 50%. Adjust potentiometers RV5 (N coarse) and RV6 (N fine) to achieve 50% motor rated speed. Increase the speed command to 100%. Adjust RV5 and RV6 to reach motor name plate speed.

11.6 Maximum Speed Calibration for Armature Feedback Drives Only

1. Set speed command to zero.

2. Install a DC Volt meter across the motor armature

3. Increase the speed command to 50%. Adjust parameter #12 to achieve 50% motor rated armature voltage. If the motor is unstable adjust parameters #28 and #29. Increase speed command to 100%. Adjust parameter #12 for maximum rated armature voltage.

4. Press Enter to store value.

11.7 Counter EMF Auto Tune for Tachometer Feedback Drives Only

1. Make sure the machine and motor can rotate freely.

2. Set parameter #14=4

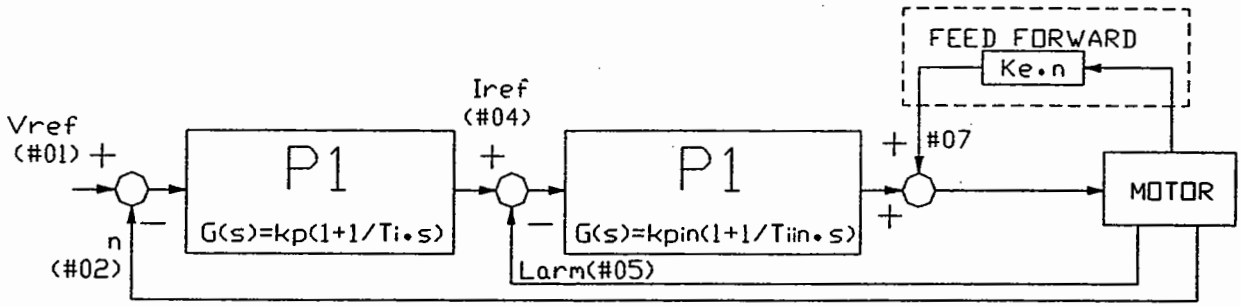
3. The display will show "CEMF Calibration Connect Field" and the flash "Close Terminals K1/15 and K1/28". Enable the Run relay. The display will show "Press Enter or MOD". Press the Enter push button. The display will show "CEMF Calibration Now Performed". When the calibration is complete the display will show #14=0.

12.0 MANUAL CALIBRATION

12.1 Manual Calibration

To change the results of the automatic calibration concerning current, speed and the calculation of counter-EMF or when automatic calibration is not possible, manually adjust the characteristic parameters of the control loops.

Drawing below shows the block diagram with both proportional and integral adjustment loops.



12.2 Current Loop Calibration

Generally the automatic calibration of current gives satisfactory values, therefore it is not necessary to adjust manually. However, if you need to change some parameters, this calibration must be performed before the speed calibration (automatic or manual).

The parameters to be set are:

#18 (R•I) = armature resistive voltage drop
#19 (Ldi/dt) = armature inductive voltage drop
#45 (kpin) = current PI gain
#46 (Tiin) = integral time of current PI

Parameters #18 and #19 are obtained through the following calculation:

R (Armature Resistance in Ω)	x	I (Motor Rated Current) Amps	=#18 (R•I)
L (Armature Inductance in mH)	x	dI/dT (Rated Change in 1ms)	= #19 (LdI/dt)

NOTE:
Any error beyond 20-30% in these parameter settings may cause a unstable operation during the speed transient. Tachometer generator fault alarm, may appear as these values are used in the calculation of forward feed, counter EMF (#07) and armature voltage (#08).

EXAMPLE: Motor:
Armature Resistance R = .099 Ohms
Armature Inductance L = 1.8 mH
Motor rated current 330 Amps DC

#18 = .099 • 330 = 33V
#19 = (1.8 • 330) = 594V

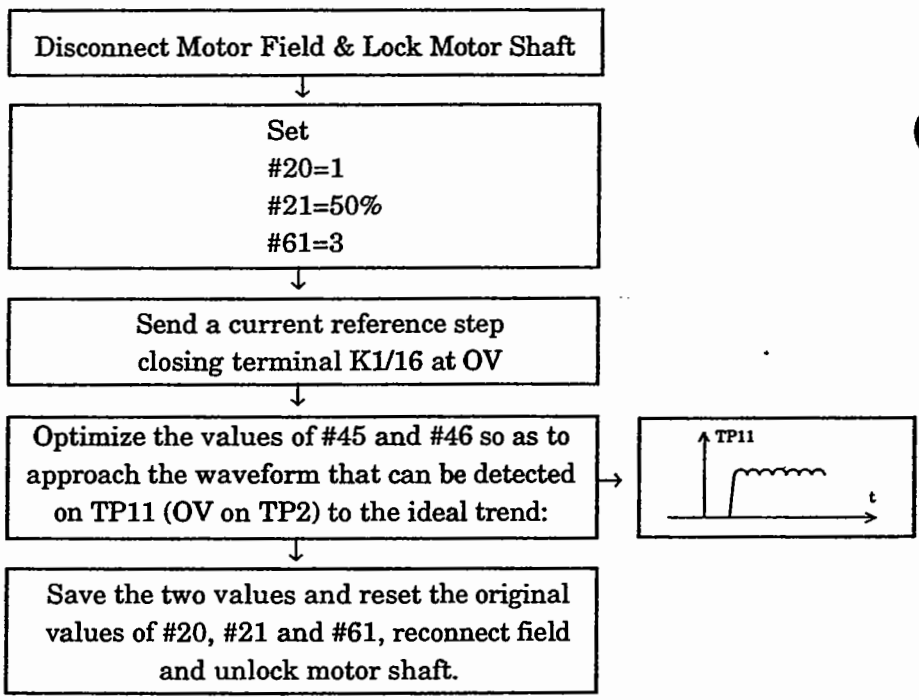
Current Loop Calibration (cont'd)

The following parameters may require manual adjustment if the drive is unable to auto tune.

To better understand what the proportional gain #45 and integral time #46 accomplish, we must first look at the motor. Any DC motor armature represents a value of DC resistance and impedance in combination representing an inductive reactance. When voltage is applied, the current rises to match the voltage by a delay which represents the electrical time constant of the motor. Since the control is a fast responding device relative to the motors load, i.e., current, it becomes neccessary to match the portional gain so that the current does not overshoot the current rise of the motor armature. The optimum portional gain #45 causes the current to rise as fast as possible without over shooting the motors response to load current. The integral time #46 counteracts the current or dampens the proportional current rise. The proper wave form on the output current to the motor will be indicated by the best response to current without over shoot or excessive distortion of the current wave form.

NOTE:
Pay attention not to excessively increase #45 and not to excessively decrease #46, so as to avoid excessive overshoots on the current which may cause fuses to blow.

Set-up Procedure



IMPORANT:
Applying such a current reference for extended periods can cause extreme motor damage. Complete this step as quickly as possible.

12.3 Speed Loop Calibration

Sometimes, the automatic speed calibration can give values that are not completely acceptable, especially when the drive load (ex: flywheel load) can dynamically change during the operation. However, this calibration should be performed after the current loop.

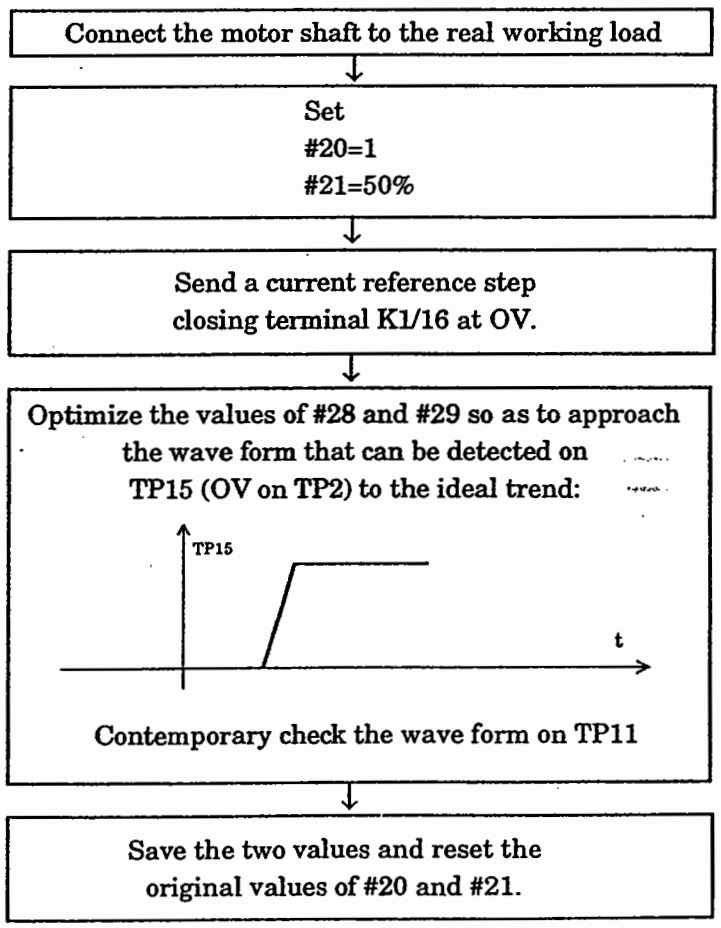
#28 (kp) = speed PI gain
#29 (Ti) = speed PI time

They can be changed by starting from the default values or from the ones obtained with the automatic calibration. Perform the following procedure:

Set-up Procedure

Gain Increase #28
The system accelerates and the initial speed overshoot decreases causing a higher irregularity of the current wave form.

Integral Time Decrease #29
The response time decreases to the detriment of the presence of oscillations in the two speed and current wave forms.



12.3 Speed Loop Calibration (cont'd)

The speed rise ramp is set by the drive current limit (the ramp slope directly depends on the delivered current).

In certain cases, the best results are obtained by adjusting parameters #53, #54, #55 and #56 (error signal filtering).

In particular, setting the time constant RC #54 to a value other than 0 (according to the kind of motor and load), can give a stabilizing effect, without affecting the dynamic performance.

12.4 Calibration of Maximum Counter-Electromotive Force

The parameter to be set is:
#12 ($K_e \bullet {}^{n}max$)

Remember that, when the drive starts operating, whichever is the value stored in parameter #12 (default value, or obtained through manual or automatic calibration), it is constantly recalculated.

Therefore, the initial value of this parameter can be ignored, provided that the drive operation does not start with particularly rapid speed and/or current transients. In fact, in transients, the feed forward (normally deriving from the counter-EMF) is predominant as regard to the PI control.

On the contrary, this initial value must be as close as possible to the exact one when, for example, a drive in STAND-BY state has to suddenly accelerate or brake a moving motor. In this case, if the default value is far from the real one and the automatic calibration has not been performed, it may be necessary to manually insert the parameter.

After a manual or automatic calibration of this parameter, with the drive in STAND-BY state, do not change the maximum speed result far from the required one.

The rated values Vnom, R and Inom of armature voltage, resistance and current give the counter-EMF at rated speed:

c.EMF nom = Vnom - R • Inom

Finally, for the required maximum calibration speed, the following formula is obtained:

$$\boxed{\text{c. EMF}_{nom} \bullet \frac{n_{max}}{n_{nom}}} \rightarrow \#12 \left(k_e \bullet n_{max} \right)$$

13.0 FACTORY DEFAULTS

#	Description	Factory Default	User Setting
00	Normal Operation - "Drive OK"	Read Only	
01	Vref - Analog of speed reference signal	Read Only	
02	N-Reading of % of Max speed	Read Only	
03	Ern-Reading of speed error	Read Only	
04	Iref-Reading of Current Reference	Read Only	
05	Iarm-Reading of % of drive capacity	Read Only	
06	Alfa-Reading of Phase angle	Read Only	
07	Fcem-Reading of back EMF	Read Only	
08	Varm-Reading of armature voltage	Read Only	
09	INaux-Reading of auxillary input %	Read Only	
10	OUTaux-Reading of auxillary output %	Read Only	
11	F-Line frequency	Read Only	
12	Ke-Setting of back EMF		
13	Vmains-Reading of line voltage	240/480V	
14	Access Code		_____
	0=Normal		_____
	1=Access to change parameters (sercurity code)		
	2=Current loop auto tune		
	3=Speed loop auto tune		
	4=Back EMF auto tune		
15	V 1/2-Voltage for full scale speed reference	10V	_____
16	Vaux-Voltage for full scale auxillary input	10V	_____
17	Line Voltage	240/480V	_____
18	Arm RxI (Set through auto tune)	10V	_____
19	(LdI/dt) (Electrical time constant) (Set through auto tune)	260V	_____
20	Jog with or without ramp	with ramp	_____
21	Imp1-Jog reference #1	+5%	_____
22	Imp2-Jog reference #2	-5%	_____
23	Tup-Accel Time	0.0 sec.	_____
24	Tdown-Decel Time	0.0 sec.	_____
25	Tstop-Stop time on a stop command	0.0 sec.	_____
26	Arr.i-S rounding start	0.0 sec.	_____
27	Arr.f-S rounding end	0.0 sec.	_____
28	kp-Speed loop Proportional Gain (set through auto tune)	2.87	_____
29	Ti-Speed loop Integral Time (set through auto tune)	.51 sec.	_____
30	os n-Analog Reference Offset	0%	_____
31	Speed Threshold Set Point	100%	_____
32	Ilim1a-Current Limit-Bridge A	100%	_____
33	Ilim1b-Current Limit-Bridge B	100%	_____
34	Ilim2a-2nd Current Limit-Bridge A	100%	_____
35	Ilim2b-2nd Current Limit-Bridge B	100%	_____
36	Nlim-2nd Stage Current Limit Speed Setting	100%	_____
37	No-Current Limit Switchover above Base Speed	100%	_____
38	Ilim-Current Limit at Max Speed	100%	_____
39	Tlima-Bridge Overload Time	2.5	_____
40	Not Used	-	_____
41	+Iima-Power Unit Current Limit-Bridge A	100%	_____

Factory Defaults Cont'd

#	Description	Factory Default	User Setting
42	+limb-Power Unit Current Limit-Bridge B	100%	
43	clim-Current Limit Reduction-By Input	50%	
44	Tcurr-Current Slew Rate	0ms	
45	Kpin-Current Loop Proportional Gain (set through auto tune)	.14	
46	Tiin-Current Loop Integral Time (set through auto tune)	25.5ms	
47	SCR Bridge Enable	A&B	
48	Imin-Interblock Logic Trip Current	.1%	
49	Inom-Power Unit to Motor Ratio	100%	
50	IT-Motor Thermal Time Constant	10 min	
51	Minimum Gate Angle	30°	
52	Maximum Gate Angle	150°	
53	Speed Error Filter	0	
54	RC-Low Pass Filter Time Constant	0ms	
55	Fr-Notch Filter Resonant Frequency	0HZ	
56	Band Filter Q Factor	0	
57	Aux Analog Input Select	0	
58	Analog Output Select	0	
59	Current Output Polarity	0	
60	Iref-Current Reference Boost	0%	
61	Speed Loop Operation	0	
62	Current Loop Operation	0	
63	Feed Forward Operation	0	
64	A01-Enable phase Rotation Alarm	Enable	
65	A02 & A03-Frequency Stability and Tolerance Alarm	Enable	
66	A04-Enable Input Voltage Alarm	Enable	
67	A05-Enable Phase Loss Alarm	Enable	
68	A11-Enable Tach Faulty Alarm	Enable	
69	nSlave-Serial Address	1	
70	Baud Rate	9600	
71	Parity Type	0	
72	Phase Fail Time	0	
73	Tach/Armature Feedback	Tachometer	
74	Term K1/18 function	0	
75	Jog Acceleration	0 sec.	
76	Jog Deceleration	0 sec.	
77	External Limit Polarity	0	
78	Not Used		
79	Not Used		
80	Intergral time (#29) Modified During Speed Transients	1	
81	Adapative Speed Loop Gain Control (#28, and #29)	Excluded	
82	First Point Speed Error ERN	0%	
83	Second Point Speed Error ERN_2	0%	
86	Terminals K1/19-20 Configuration	0	
87	Hysteresis for #31	5%	

14.0 WARRANTY

Saftronics warrants to buyer that products, and any services furnished hereunder will be free from defects in material, workmanship and title, and will be of the kind and quality specified in the quotation. The foregoing shall apply only to failures to meet said warranties (excluding any defects in title) which appear within one year from the date of shipment hereunder, provided, however, that if buyer, in the course of its regular and usual business, transfers title to or leases such products (including equipment incorporating such products) to a third party, such period shall run until one year from such transfer or lease or eighteen months from shipment by Saftronics whichever occurs first. The warranties and remedies set forth herein are conditioned upon (a) proper storage, installation, use and maintenance, and conformance with any applicable recommendations of Saftronics and, (b) buyer promptly notifying Saftronics of any defects and, if required, promptly making the product available for correction.

If any products or services fails to meet the foregoing warranties (except title), Saftronics shall thereupon correct any such failure either, at its option, (i) by repairing any defective or damaged part or parts of the products, or (ii) by making available FOB Saftronics plant or other point of shipment, any necessary repaired or replacement parts. The preceding paragraph sets forth the exclusive remedies for claims (except as to title) based on defect in or failure of products or services, whether claim in contract or tort (including negligence) and however instituted. Upon expiration of the warranty period, all such liability shall terminate. The foregoing warranties are exclusive and in lieu of all other warranties, whether written, oral, implied or statutory. No implied statutory warranty of merchantability or fitness for particular purpose shall apply and Saftronics will not be liable for any consequential damage arising from any product defect or failure to deliver on time. Saftronics does not warrant any products or services of other which buyer has designated.

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TECHNICAL NOTE #:
EFFECTIVE DATE:
SUPERSEDES DATE:
ORIGINATOR:
NO. OF PAGES:

M6/12 Voltage Selection Chart

AA1127-1 FEEDBACK CARD

AC INPUT	DC OUTPUT	R2 VALUE
240VAC	240VDC	47K
480VAC	500VDC	22K
575VAC	600VDC	18K
660VAC	700VDC	15K

SAFTRONICS PN AD1002 (ES630) HIGHVOLTAGE CARD

Note: Terminal 36 and 38 must be in phase and must be 240vac input or 480vac.

VOLTAGE	LINKS IN	LINKS OUT	RESISTORS
240	LK1,2,3.5	LK4	R7&R12, installed, 33K, 10W
480	LK4	LK1,2,3.5	R7&R12 Not installed
575	LK4	LK3.5	R5,6,9,10 change to 20K, 5W R7,12 change to 40K,5W