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Find the *ITT / Cleveland Machine Controls SDB05* at our website: *Click HERE*

SDB SERIES

DC BRUSH TYPE SERVO AMPLIFIERS

MA1371

Cleveland Motion Controls
An IMC Company

Engineered Systems & Drives

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CLEVELAND MACHINE CONTROLS

SDB SERIES
DC SERVO AMPLIFIER

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INDEXES

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Chapter
INTRODUCTION

Section
Receiving Information

Verify Model Number

Remove the units from their shipping cartons and check the items against the packing list. Each module is labeled with model number and serial number. Verify the model number received against your purchase order.

Inspect For Damage

Inspect the units for any physical damage that may have occurred during shipment. All damage claims must be made to the shipper by the buyer as soon as possible after receipt of the units. Because the equipment is sent F.O.B., factory, it is the customer's responsibility to file any damage claims. Claims for loss or damage must not be deducted from the invoice or payment withheld pending adjustment of any claims.

Storage

After completing inspection, the unit should be stored in its original shipping carton in a clean and dry location with the temperature between -20°C and 70°C.

When storage time reaches 16 months, the SDB Series amplifiers should be removed from storage and energized to insure that no damage occurs to the electrolytic capacitors due to excessive storage time. The components then may be stored for another 16 months without damage.

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CLEVELAND MACHINE CONTROLS

SDB SERIES
DC SERVO AMPLIFIER

Chapter
INTRODUCTION

Section
Product Description

General

The SDB Series servo amplifiers are a cost effective family of single-axis panel mounted dc servo amplifier modules for use with dc brush-type servo motors.

The compact controller consists of a single PCB in a double eurocard format and accommodates the power supply as well as the control and braking circuits. The amplifier plugs into the panel mounted PCB block which contains integral screw terminals.

The controller may be connected to a 3-phase or dc power supply. All auxiliary voltages needed are provided by the controller, making it suitable for battery operation.

SDB Series Units

The SDB Series units comprise a set of speed regulation units for dc motors. A standard control system comprises:

- One or more card holders.
- One or more servo amplifiers.

Card Holders

The card holders permit the servo amplifier to be mounted and connected. They are composed of a guidance system, a motherboard and terminals.

Servo Amplifiers

The servo amplifiers are double euro-card format modular units. They include all the functions necessary for regulating dc motors including

- Speed control of PI (Proportional & Integral gain) configuration
- Current regulation of PI configuration
- Current control and PWM circuit
- Choice between regulation with or without tachometer ($V-R_{int} \times I$ compensation)
- Current regulation possibility

There are three sizes of SDB servo amplifiers:

SDB05: I_{cont} = 5 amp	I_{pk} = 10 amp
SDB12: I_{cont} = 12.5 amp	I_{pk} = 25 amp
SDB20: I_{cont} = 20 amp	I_{pk} = 40 amp

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SDB SERIES
DC SERVO AMPLIFIER

Chapter
INTRODUCTION

Section
Product Description

Protections

The SDB Series amplifiers incorporate the following protections:

- I (RMS)
- Tachometer fault
- Short-circuit
- Thermostat
- Automatic power limiting as a function of the ambient temperature
- Current limiting as a function of the motor speed
- Supervision of max bus voltage during braking (regeneration)

Display (LED)

Power
Tachometer fault
Overcurrent
Stand-by
Thermostat
Braking action

Adjustment On the Front

Potentiometer adjustments on the front panel are:

- Gain, velocity loop
- Max (peak) output current
- RMS current
- Max Speed adjust (tachometer gain)
- Offset, command

Auxiliary Functions

STAND-BY via opto-coupler 24V
END LIMIT SWITCH 1 & 2 inputs via opto-coupler 24V
NULL COMMAND via opto-coupler 24V
READY acknowledge via relay contact output
+15V, ground -15V output (20mA available for customer use)

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CLEVELAND MACHINE CONTROLS

SDB SERIES
DC SERVO AMPLIFIER

Chapter
INTRODUCTION

Section
Card Holders

Characteristics Of The Card Holders

The card holders serve as a mechanical fixture and provide an electrical connection to the servo amplifiers in the SDB Series.

The card holders are fitted with a guide/extraction system. The dimensions of the card holders are listed Appendix 4. The rating plate of the card holder shows the connections of the components to the two terminals.

There are two alternate motherboards:

Standard Motherboard

The standard motherboard is used for connections between the servo amplifier's 48 pin edge connector and two screw terminals.

Special Motherboard (optional)

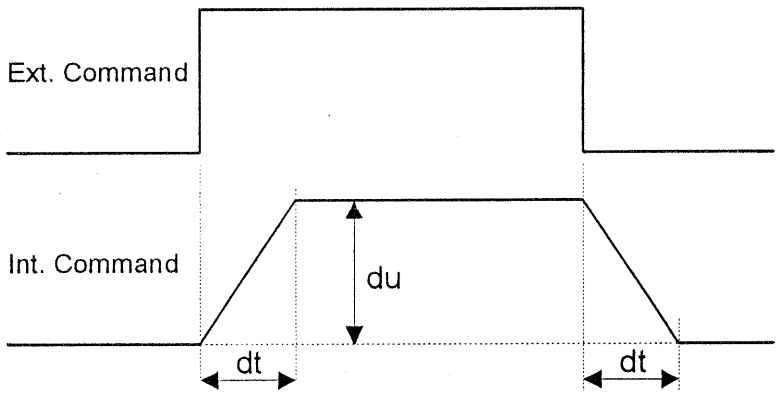
The special motherboard is used for connections between the servo amplifier's 48 pin edge connector and the screw terminals. In addition it has an integrated ramp function generator, which can be used to integrate the external speed command.

The external speed command must be connected to the motherboard terminal 14 (+S). Terminal 16 (-S) is connected to the ground (terminal 4) in an internal way.

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Ramp Function Generator (optional)

Only the special version of the motherboard is equipped with a ramp function generator. The ramp function generator can be used to transform external speed command with steep edges into internal speed command with a "longer" accel/decel slope, it does so as follows:



$$\frac{8ms}{V} < \frac{dt}{du} < \frac{160ms}{V}$$

The potentiometer on the motherboard is used to set the slope angle of the internal speed command function.

The minimum adjustment range is as follows:

$$\frac{u}{t} = 10 \text{ to } 100 \frac{V}{sec}$$

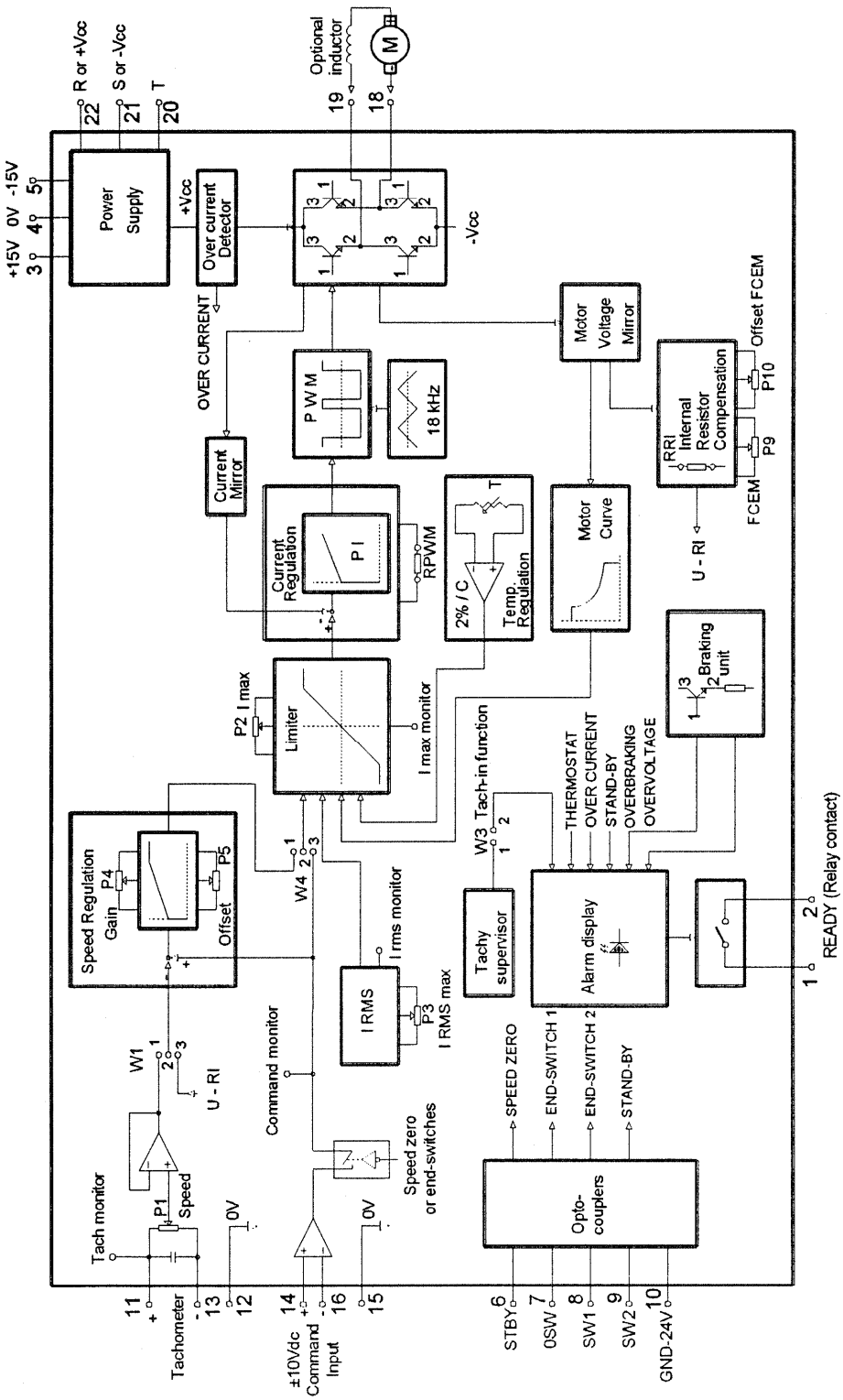
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INTRODUCTION

Section
Block Diagram



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CLEVELAND MACHINE CONTROLS

SDB SERIES
DC SERVO AMPLIFIER

Chapter
SPECIFICATION

Section
Electrical Specification

General Amplifier Specs

Parameter	SDB5	SDB12	SDB20
Cont. current (Amps)	5.0	12.5	20.0
Peak current (Amps) (2 Seconds Maximum)	10.0	25.0	40.0
Rated power at 150Vdc (kW)	0.750	1.9	3.0
Min. armature inductance (mH)	3.0	1.2	0.8

Supply Voltage:
AC input: 3 x 20 to 55Vac, and 3 x 40 to 115Vac ±10% 50/60 Hz
DC input: 24 to 75V, and 50 to 160V

Max. Output Voltage: 150Vdc

Max. Ref. Voltage: ±10Vdc

Max. Tach Voltage: 100Vdc

Operating Temp Range: 0 to 45°C
45-65°C with reduced power 2%/°C

Control Range: 1:20,000 (with tachometer feedback)

Control Accuracy: < 0.5% at N_{max}

Wt. include PCB block: 4.95lbs. (2.25Kg)

PWM Frequency: 9.0 kHz

Max command voltage: ±10Vdc

Form factor: < 1.01 at nominal current

Filtering capacity of 1000µF @250Vdc

Instantaneous power dissipation during braking: 900W

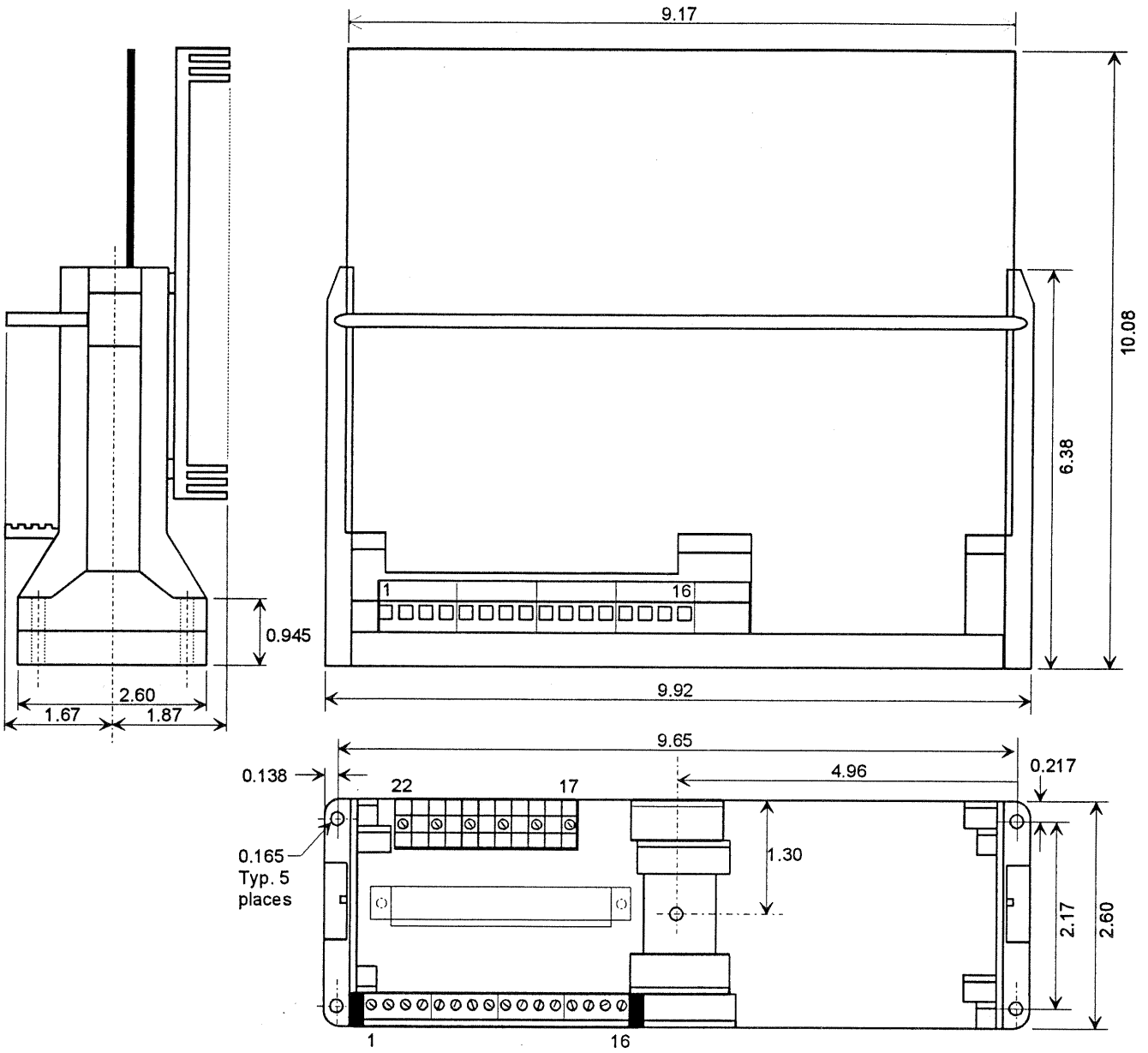
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SPECIFICATION

Section
Mechanical Specification



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CLEVELAND MACHINE CONTROLS

SDB SERIES
DC SERVO AMPLIFIER

Chapter
STUDY PROJECT

Section
Elements Of A Control System

General

The success of a control system is dependent to a large extent on a harmonious combination of the various components which make up the system.

The aim of this section is to provide the user with all information necessary to define the "power" component of a control loop.

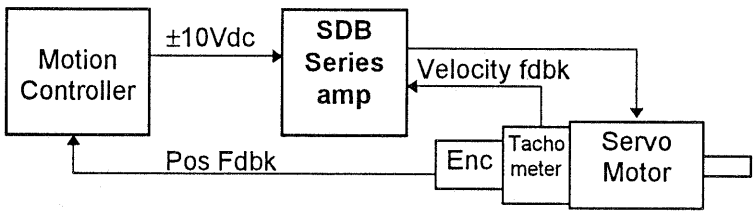
The SDB Series has been specially developed for speed control of dc motors. The components of the SDB Series convert the control commands into mechanical energy on drive shafts.

If the power component of the control system has been correctly adapted, it will not be questioned by the end user, and will take the form of a "black box".

Position Control Alternatives (Numeric or Application-Specific)

The type of control selected is directly dependent on the performance requirements of the machine. The components of the SDB Series are suitable for all types of control.

The motion control system must have an analog speed command of ±10V on each axis. The illustration below shows a typical single-axis system with the SDB amplifier and encoder position feedback.



Each axis of the control system may have the following inputs/outputs:

- One logical output for the STAND-BY mode
- One input for READY
- Two logical outputs for END LIMIT SWITCH 1 & 2
- One logical output for ZERO COMMAND

The control system can on the last stage use the ±15V voltage (20mA) generated by the servo amplifiers power supply.

Motor Alternatives

A number of different parameters must be taken into account when selecting the motor.

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Maximum speed - price - technology - weight - voltage - space requirement - gearboxes - use of electromagnetic-brakes - demagnetization limit - service life, etc.

The velocity and position feedback devices, often used in conjunction with motors, must also be taken into account:

1. **Tachometer** (tachogenerator) for velocity feedback information.
2. **Resolver** or **Incremental encoder** for position feedback information.
3. **Absolute encoder** for position feedback information over a specific distance such as a machine cycle.

In their performance range, the SDB Series allows almost all dc motors (with or without a tachometer) available on the market to be controlled.

Calculation Of The dc Supply Voltage

The dc supply voltage of motors is calculated using the formula below:

$$V_{supply} = Ke \times N + (r \times I) + 5$$

Where:

V_{supply} = supply voltage for the desired speed (Vdc)
Ke = back EMF constant (V/rpm)
N = maximum desired speed (rpm)
r = internal resistance of motor (ohms)
I = maximum current (amps)
5 = maximum voltage drop in servo amplifier (Vdc)

Motors with different back EMF constants can be operated with the same supply voltage, providing the three conditions below are fulfilled:

1. The supply voltage of the complete system must correspond to that of the motor, which must be of the highest voltage.

2. The ratio between the highest and lowest voltages must not exceed 50%.

3. The supply voltage of the complete system must not exceed the minimum no-load voltage of each motor.

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CLEVELAND MACHINE CONTROLS

SDB SERIES
DC SERVO AMPLIFIER

Chapter
STUDY PROJECT

Section
Amplifier Current Calculations

Servo Amplifier Alternatives

The choice of a servo amplifier must take into account the technical data of the motor for which it is used and the performance required of this motor.

The decision regarding the type of servo amplifier used for a motor is based primarily on two important factors:

1. **The rms current** of the motor for the desired power: this determines the minimum rms current of the servo amplifier.

The rms current of the motor determines the maximum power which can be transmitted to the drive shaft without time limit.

2. **The peak current** of the motor for the desired power: this determines the minimum peak current of the servo amplifier.

The peak current of the motor determines the dynamics of the complete mechanical system, i.e. the positive and negative acceleration capacity to overcome inertia.

Minimum rms Current of the Servo Amplifier

The rms current of the amplifier (I_{eff}) should be greater than or equal to the rms current rating of the motor (I_N): $I_{eff} \geq I_N$. This will insure that the motor can be operated at its rated torque.

Two possible cases are described below:

1. It must be possible to operate the motor at its rated speed and its rated current I_N.

2. The motor is operated at a known speed and a known torque.

   The current I_{eff} of the servo amplifier must satisfy the following equation:

$$I_{eff} \geq \frac{1}{K_t} \times \left(M_U + M_F + K_L \times N\right)$$

   Where:

   K_t = torque constant (lb-in/A)
   M_u = torque acting on drive shaft (lb-in)
   M_F = friction torque of motor (lb-in)
   K_L = loss constant of motor (lb-in/rpm)
   N = motor speed (rpm)

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If the friction torque of the motor M_F is not known, between 2% and 5% of the torque acting on the drive shaft can be estimated. If the attenuation constant of the motor K_L is not known, it is generally sufficient to increase the rms current I_{eff} by 1 or 2%.

Max Peak Current

The maximum peak current of the SDB Series servo amplifier is twice as the maximum rms (continuous) current.

Amplifier peak current is required for machine acceleration and deceleration. The peak current is available for 1 to 2 seconds. When choosing a servo amplifier, the peak torque of the application will determine the peak current requirements.

Example
It is determined that the peak torque required for an application is $T_{pk} = 90$ lb-in. From the motor data sheet the torque constant is $K_t = 4.80$ lb-in/amp. Therefore, the required peak current from the amplifier is $I_{pk} = T_{pk} / K_t = 90/4.80 = 18.75$ amps. The SDB12 has 24 amps of peak current available and would be chosen.

In any case, the minimum peak current of the servo amplifier used must satisfy the equation: $I_{\text{max peak current of servo amplifier}} > I_{\text{motor dynamics}}$

Power Calculations of the Main Transformer

The power of a main transformer is determined by three factors:

1. Winding
2. Voltage
3. Power

Winding Alternatives

A three-phase transformer should be used, in order to keep the ripple factor to a minimum.

The primary winding is generally a wye "Y" (or star winding) with the neutral of the Y connected to the center.

The secondary windings on the other hand are connected in delta "Δ". Certain secondary windings intended as auxiliary windings may also be single-phase (e.g. an 18V secondary winding which supplied a 24Vdc voltage for the STAND-BY, ZERO COMMAND and END LIMIT SWITCH functions).

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The primary and secondary windings can be physically separated by means of a shield connected to earth. The frame of the transformer must likewise be grounded.

Voltage Calculation

The ac voltages supplied to the servo amplifiers can be derived from the dc voltage calculated using the formula below. (See also ***Minimum rms Current of the Servo Amplifier*** in Section 303).

$$V_{rms\ transformer} = V_{dc} \times 0.707$$

Example
Suppose a transformer has a secondary voltage of 72Vac and is connected to an SDB05 amplifier. The bus voltage generated would be 72 x 1.414 = 102Vdc.

Power Calculation

Transformer power for each winding is specified in VA or kVA (1000VA or 1kVA).

The power for a three-phase secondary side is calculated using the formula: $P = V \times A \times 1.73$

The power for a one-phase secondary side is calculated using the formula: $P = V \times A$

where:

P = power in watts
V = rms volts
A = rms amperes

Theoretically the current which must be taken into account in the power calculation for the secondary sides is the sum of the rated currents of the motors. In many cases, however, the motors cannot be operated with their rated currents simultaneously. This factor must be taken into account in the power calculations for the windings on the secondary sides.

Smoothing Chokes Calculation

The current form factor must be of 1.01 max at the nominal voltage. The form factor is function of the motor circuit inductance. Where the motor inductance is insufficient to ensure a form factor of 1.01, it is necessary to connect a smoothing choke in series with the motor power leads (see section 103 for location).

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The total inductance (motor or motor and choke) which *guarantees* a form factor (FF) of 1.01 is given using the formula:

$$L_{min} = \frac{V_{nom}}{I_{nom}} \times 0.093 \ \ mH$$

Where:

L_{min} = minimum inductance (mH)
V_{nom} = nominal bus voltage of the amplifier (Vdc)
I_{nom} = nominal current rating (amps)

The choke inductance is calculated as follows:

$$L_{choke} = L_{min} - L_{motor}$$

Example

The amplifier being used is the SDB05. L_{min} for a minimum form factor of 1.01 is:

$$L_{min} = \frac{V_{nom}}{I_{nom}} \times 0.093 = \frac{100Vdc}{5A} \times 0.093 = 1.86 \text{ mH}$$

$$L_{motor} = 1.0mH \quad \text{(from motor data sheet)}$$

Determine the required choke inductance to satisfy the amplifier:

$$L_{choke} = L_{min} - L_{motor} = 1.86mH - 1.0mH = 0.86mH$$

L_{choke} is therefore at least 0.86mH. Large values (5mH+) for L_{choke} should be avoided. Too much inductance will make the servo system "sluggish" in dynamic performance.

Current Calculation

The current taken into account is the motor nominal current. The smoothing chokes need to be dimensioned so as to support a current equal to a servo amplifier max current for about 10 seconds (without saturation).

Usable Frequency

The materials used to manufacture the chokes depend on the working frequency. For the SDB Series the frequency to take into account is 18kHz.

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CLEVELAND MACHINE CONTROLS

SDB SERIES
DC SERVO AMPLIFIER

Chapter
INSTALLATION

Section
General Mounting Requirements

Single Axis Module

The SDB Series single axis module is a compact unit suitable for panel mounting using four (4) #8 machine screws or M4 metric (4.2mm diameter mounting holes). The shunt regulator resistor is an integral part of the single-axis amplifier. The mounting holes are on 2.17 in. x 9.65 in. centers.

Enclosure Requirements

The SDB Series amplifiers are intended to be mounted in a standard NEMA cabinet which should be ventilated by filtered or conditioned air.

The system should not be mounted where it will be subject to shock or excessive vibration. The environment should be free of corrosives, moisture, and dust, and the ambient temperature should not exceed 45°C.

Mounting Orientation

The SDB amplifiers should be mounted vertically. Vertical mounting provides the easiest access to the connectors and allows for proper cooling. There should be a minimum of 4 inches (100mm) of unobstructed space above and below the system to ensure proper airflow. 2 inches (50mm) of free space is required on both sides of the single axis modules to insure proper cooling.

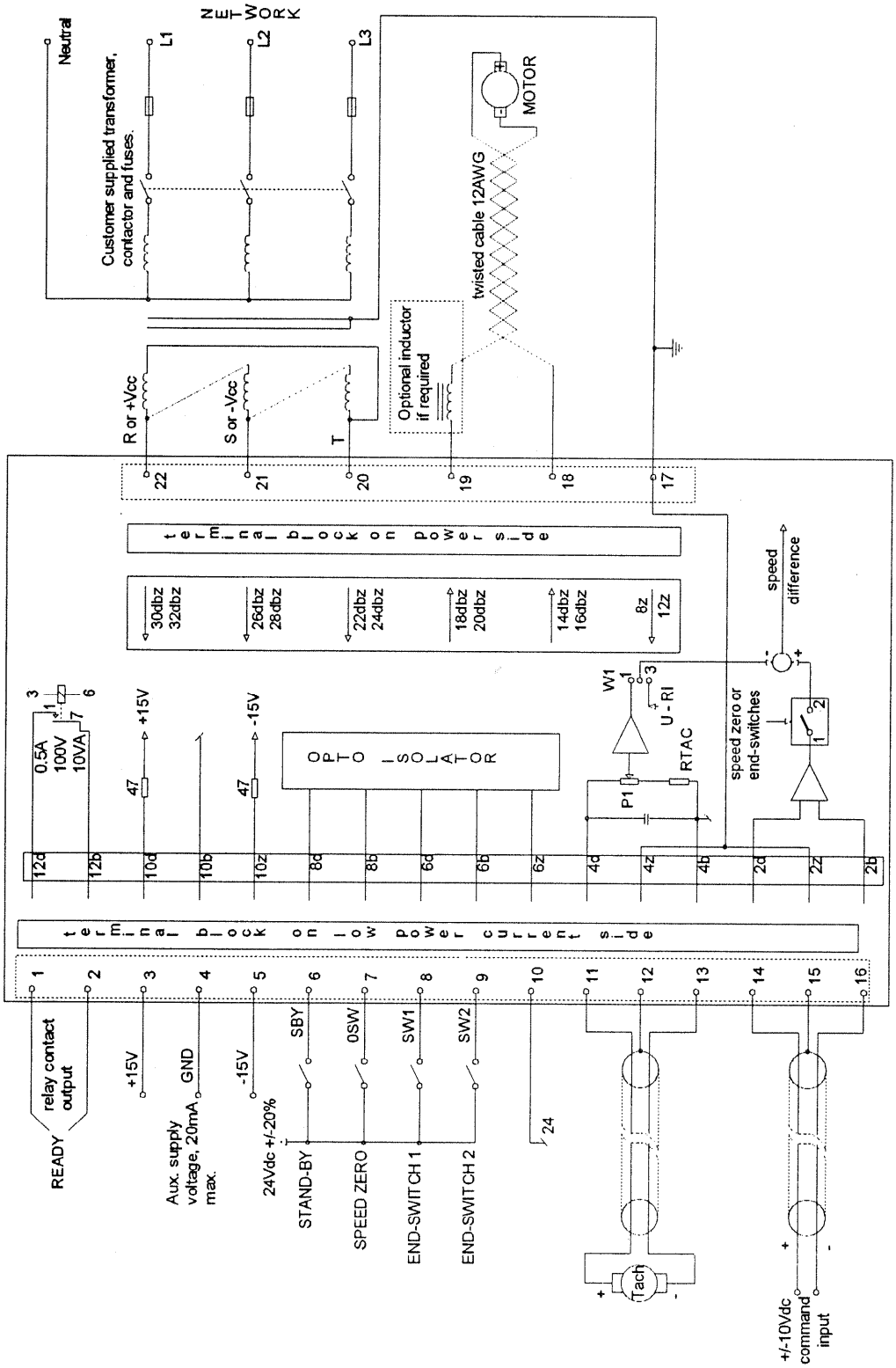
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SDB SERIES
DC SERVO AMPLIFIER

Chapter
INSTALLATION

Section
Amplifier Interconnection



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CLEVELAND MACHINE CONTROLS

SDB SERIES
DC SERVO AMPLIFIER

Chapter
INSTALLATION

Section
Terminal Descriptions

Terminal Strip Connections

The SDB Series servo amplifiers are connected via the two terminal trips of the card holder. The terminal functions are described in this section.

Terminals 20, 21, 22 - Power supply input

a.) 3-Phase Supply:
Terminals 20, 21 and 22 must be connected to the delta secondary winding of a 3-phase transformer with a maximum rms voltage of 115V ±10%.

b.) If the servo amplifier is to be run from a dc input supply, the assignment of terminals 20, 21 and 22 is as follows:

Terminal 20 : not connected
Terminal 21 : connected to -Vcc (0V dc voltage)
Terminal 22 : connected to +Vcc (+dc voltage)

The maximum dc input voltage is 160V.

Terminals 18 and 19 - Motor Terminals

These terminals must be connected to the motor via suitable cables, which should preferably be 12AWG twisted cable. In addition, a choke can be installed in series with the motor (See ***Smoothing Choke Calculations*** in Section 305).

Terminal 17 - Earth

This terminal must be connected to the earth of the unit controlled by the servo amplifier via a 12AWG wire. This connection serves to shield the power signals and permits the heat sink to be grounded.

Terminals 14, 15, 16 - Speed Command Input

Terminals 14 and 16 must be connected to the speed command source, numerical control system or potentiometer. Terminal 15 is for the shield return. The speed command feeds a differential amplifier. The maximum level is ±10Vdc.

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Terminal 11, 12, 13 - Tachometer Input

a.) If the motor speed is controlled *without* a tachometer (control by V-IR) compensation, these terminals are not connected.

b.) If the motor speed is controlled using a tachometer, the terminals are connected as follows:

Terminal 11 : Connected to the + of the tachometer
Terminal 13 : Connected to the - of the tachometer
Terminal 12 : Connected to the shield of the tachometer signal cable

Terminals 6 to 10 - Inputs For The Optoelectronically Coupled Signals

The servo amplifiers SDB Series have four (4) optoelectronically coupled inputs:

SBY	- STAND-BY (inhibit)	(terminal 6)
OSW	- ZERO SPEED command	(terminal 7)
SW1	- END LIMIT SWITCH 1	(terminal 8)
SW2	- END LIMIT SWITCH 2	(terminal 9)

and a ground for the optoelectronically coupled voltage (terminal 10).

There inputs are provided for operation with an external 24Vdc Voltage. They are electrically isolated from the voltage used for the speed command. This isolation prevents interference in the control loop generally encountered in the 24V.

Terminals 6 to 10 must be connected as follows:

Terminal 10 : Connected to the ground (0V) of the dc voltage (24V).

Terminals 6 to 9 : Connected to the 24V circuit via switch or a relay contact.

STAND-BY (SBY)

The servo amplifier is in STAND-BY mode when the SBY contact circuit is open. The STAND-BY mode is indicated by the "SBY" LED on the front panel: **LED lit = STAND-BY**

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ZERO SPEED (0SW)
Zero (0) speed is selected as the internal speed command when the **0SW** contact is open (i.e. Normally Closed). If the servo amplifier is "in operation" and **0SW** has been selected (opened) as the internal speed command, the motor speed will be zero within the set offset.

END LIMIT SWITCH 1 (SW1)
A positive external speed command is canceled if the SW1 contact is open.

END LIMIT SWITCH 2 (SW2)
A negative external speed command is canceled if the SW2 contact is open.

If the servo amplifier is in operation and one of the end switch contacts is opened, the motor speed in the direction of the end switch will be zero within the set offset.

If no external 24Vdc voltage is available, terminal 10 can be connected to the ground of the servo amplifier (terminal 4) and the +15V output (terminal 3) used instead of 24V .

Note: Optical isolation is no longer effective.

Terminal 3, 4, 5 - ±15Vdc voltage outputs and ground of the servo amplifier

These voltages make available to the customer ±15Vdc voltages generated inside the servo amplifier by a chopped power supply. The maximum available current is 20mA from each rail.

Terminals 1 and 2 - READY relay output contact

This potential free output can be used to signal in a numeric control system that the servo amplifier is in operation, stand by contact closed and without alarms.

If more than one servo amplifier is used in the same application, the relay contacts for READY can also be connected in series. The characteristics of the relay are as follows: 0.5A / 100V / 10VA

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CLEVELAND MACHINE CONTROLS

SDB SERIES
DC SERVO AMPLIFIER

Chapter
AMPLIFIER CONFIGURATION

Section
Configuration And Variable Components

Configuration And Variable Components

The configuration of a servo amplifier in the SDB Series is dependent of the type of control mode (speed control with or without tachometer or current control) and on the desired protection facilities.

The various control modes and protection facilities are factory tested. The servo amplifiers in the SDB Series are supplied with the variable components used during this test.

The factory configuration does not generally permit optimized operation if a different motor from that taken for the test is used.

Depending on the application the user must check and compute the configuration of the variable components, or integrate additional components.

The measures which concern the selected control mode are essential, while those features which concern the protection facilities (tachometer supervisor and speed/torque limitation) may be omitted.

The positions of the variable components (jumpers, resistors and potentiometers) are specified in the component layout.

The table below lists the different variable components associated with the control and protection of the system:

	CONTROL OPTIONS		
	WITH Tachometer	*WITHOUT* Tachometer	*WITH* V-IR
Necessary Operations	- Jumper W1 between 1-2 - Bridge W4 between 2-3 - Calculate and solder RTAC - Adjust P1 (front panel)	- Jumper W1 between 2-3 - Bridge W4 between 2-3 - Calculate and solder RRI - Adjust P8 and P9	- Bridge W4 between 1-2
Tachometer Supervisor	- Set jumper W3 - Calculate RRI - Adjust P8 and P9	- Not in use (W3 not set)	- Not in use (W3 not set)
"Speed/Torque" Limitation	Calculate and solder components for "speed/torque" module		- Not in use module

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CLEVELAND MACHINE CONTROLS

SDB SERIES
DC SERVO AMPLIFIER

Chapter
AMPLIFIER CONFIGURATION

Section
With Tachometer Feedback

Amplifier Configuration For Use WITH Tachometer

The following section outlines the required steps for configuring the SDB amplifier for use with a tachometer.

Required

1. Tachometer jumpers W1 and W4 installation.
2. Tachometer EMF setting for the specific voltage used.

Optional

3. Tachometer Supervisor for extra fault detection
4. Speed/Torque limitation

Tachometer Jumpers

Check that jumper W1 is set on position 1-2 (factory default) and that the bridge W4 is set on position 2-3 (factory default).

Tachometer EMF Setting

It is necessary to calculate resistor RTAC for the specific tach voltage used. Once RTAC is set, the tach voltage can be scaled using potentiometer P1. RTAC determines the maximum speed as a function of the EMF of the tach. The factory default: RTAC= 8.2k for a tach EMF of 10V/1000 rpm, maximum speed = 4000 rpm. The maximum voltage generated by the tach is therefore 40Vdc.

The EMF of the tachometer and the maximum speed must be specified in volts per thousand revolutions per minute (rpm) and in thousands of rpms. The normalized value which is closest to the calculated value must be used for RTAC.

The tachometer must be connected on terminals 11 and 13 connections of the card holder mother board. The tach cable shield is connected to the mother board terminal 12. The tach input circuit consists of a voltage divider, which permits adjustment of the motor speed.

The tach scaling adjustment is possible with the potentiometer P1 located on the amplifier's front panel. The resistor RTAC permits the reference speed adaptation that is a function of the tachometer voltage gradient.

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Other values of RTAC corresponding to other tach voltages can be calculated as follows:

$$RTAC = \frac{250}{(\text{EMF tacho} \times \text{max speed}) - 10} \text{ kohm}$$

Examples:

1. Tach output:10V/1000 rpm max. speed 4000 rpm = 4krpm

$$RTAC = \frac{250}{(10\text{V} \times 4\text{krpm}) - 10} = 8.33\text{kohm} \rightarrow \text{8.2k 1\%}$$

2. Tach 3V / 1000 rpm and max speed 4000 rpm

$$RTAC = \frac{250}{12 - 10} = 120 \rightarrow \text{120k 1\%}$$

For tach control the jumper W1 must be set-up on position 1-2. In cases when precise regulation is not essential, it is possible to use the back-electromotive force (EMF) instead of the tach feedback. In that case, the jumper W1 must be set-up on position 2-3.

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Tachometer Supervisor (optional)

Activation and adaptation of tachometer supervisor is optional. The tachometer supervisor is not absolutely essential for operation of the control system, however, it permits the following faults to be located.

- motor not connected
- tachometer not connected, inverted or faulty

The tachometer supervisor requires the compensation circuit to be adapted to the internal motor resistance and the circuit to be adapted to the motor voltage. This adaptation can be done as follows:

a. Calculate and solder the resistance RRI, see ***Motor Resistance Compensation*** later in this Section.
b. Put Jumper W1 between 2-3 (control system by back EMF = V-RI).
c. Set potentiometer P8 to the full minimum value by turning counter-clockwise (no IR compensation).
d. Set potentiometer P9 to the full minimum value by turning counter-clockwise.
e. Switch power on, then turn P9 in a way to obtain the correct motor speed.
f. Turn P8 until the overcompensation limit (the motor oscillates in overcompensation) then back off slightly.
g. Switch power off. Set W1 between 1-2 (with tacho control system).

Speed/Torque Limitation (optional)

This limitation is achieved using a motor-specific module. The calculation for the components used for the module is described in Section 505. The limitation is activated by connecting Pins 7 and 9 of the module together.

Amplifier Configuration For Use WITHOUT Tachometer

The following section outlines the required steps for configuring the SDB amplifier for use without a tachometer.

Required

1. Tachometer jumpers W1 and W4 configuration.
2. Compensation for the internal resistance of the motor.

Optional

3. Speed/Torque limitation.

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Tachometer Jumpers

Check that Jumper W1 is on position 2-3 and verify that the bridge W4 is on position 2-3.

Motor Resistance Compensation

To compensate for the internal motor resistance it is necessary to calculate and solder the resistance RRI (adapts the circuits for the motor voltage and the compensation circuit).

$$RRI = k_{servo} / r \qquad \text{in kohms}$$

where

r :is the internal motor resistance + resistance of the cable in ohms.

k_{servo} :depends on the servo amplifier type and its voltage (See Table Below).

AMPLIFIER TYPE	24 TO 75Vdc k_{servo}	50 TO 160Vdc k_{servo}
SDB05	72	150
SDB12	29	60
SDB20	18	37.5

Example:
Servo amplifier used is: SDB12
Output bus voltage: 100Vdc
Motor resistance and cable resistance (measured): r = 0.82 ohm

Find the required RRI resistance:
1. Find the k_{servo} from the table above based on output bus voltage. For the SDB12 at 100Vdc, k_{servo} = 60.

2. RRI = 60 / 0.82 = 73.2k ohm. Therefore, use 68k (nearest standard value).

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Speed/Torque Limitation (optional)

This limitation is achieved using a *motor-specific module*. The calculation for the components which must be used for the module is described in Section 505. The limitation is activated by connecting Pins 7 and 8 of the module together.

Current Control System (Torque Amplifier)

It is possible to configure the SDB series amplifiers for control as a current (torque) amplifier. The standard configuration is for velocity control using a tachometer for feedback.

Required

1. Remove Jumper W1
2. Solder bridge W4 between 1-2

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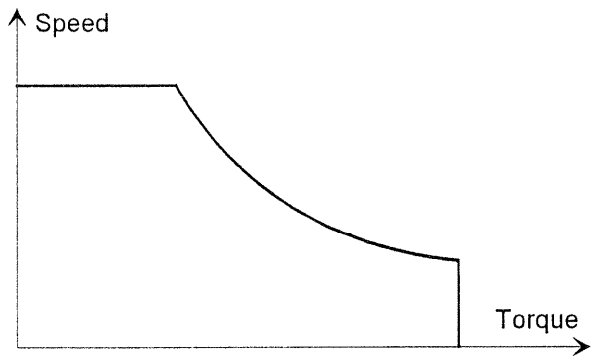
Speed/Torque Limitation (optional)

A speed/torque limitation is necessary to avoid the motor running at an excessively high speed and high torque simultaneously. If the motor runs in this conditions it might lead to commutator destruction or to demagnetization.

The **speed/torque** limitation is set by means of a DIL socket (14 pins, with 4 resistors and 1 Zener diode).

The following steps must be taken to determine the module elements.

Translation Of The Motor Curve Into 2 Segments:
The curve defining the motor commutation limit is generally of the type: speed (rpm) = f torque (Nm)



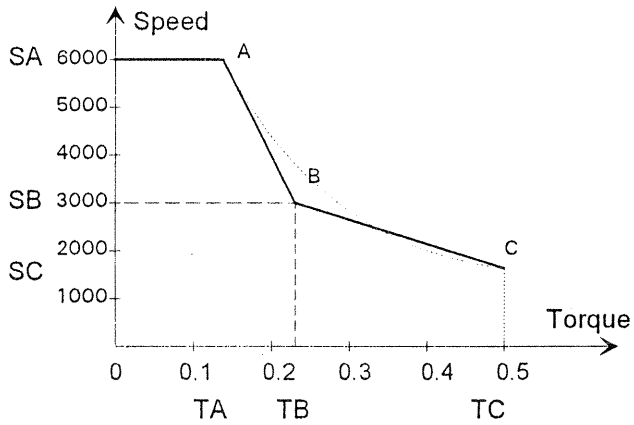
Typical Speed/Torque Commutation Limit

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To define the **speed/torque** module components, it is necessary to translate this curve in 2 segments AB and BC which have for coordinates the following points:

A (TA,SA) B(TB,SB) C(TC,SC)

The point B must be chosen so that the curve AB and BC goes as near as possible of the theoretical curve.



Translation Of Speed/Torque Into Voltage/Current

The A, B and C coordinates have to be calculated with the help of the formulas:

T (Nm) torque → t (V) current
S (t/mn) speed → s (V) EMF

A (TA,SA) → A (tA, sA)
B (TB, SC) → B (tB, sB)
C (TC,SC) → C (tC,sC)

$$t = \frac{10 \times T}{K_t \times I_{max}}$$

where: T = motor torque (lb-in)
K_t = torque constant (lb-in/A)
I_{max} = max current of the servo-amplifier in A

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$$s = \frac{10 \times s}{N_{max}} \qquad \text{when:} \qquad N_{max} = \text{max motor speed}$$

The new A, B and C coordinates (t,s) are used to calculate the Ag, Ap values according to the following formula:

$$Ag = \frac{tC - tB}{sB - sC} \qquad \text{and} \qquad Ap = \frac{tB - tA}{sA - sB}$$

Calculation Of The Module Elements

The resistors R1 to R4 as the diode Zener Z2 constitute the **speed/torque** module. Those components are calculated from: Ag, Ap, tA, tB, tC and sB.

Z2 = tC + 0.7 (V) if Z2 ≥ 10.7, then Z2 is not mounted.
R3 = Ag x 2.7 (k ohm)

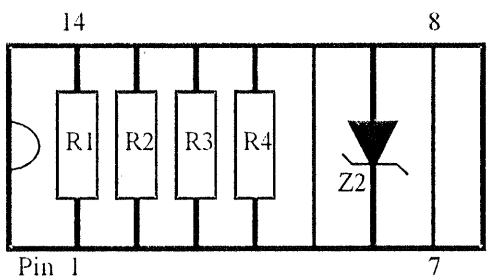
$$R2 = \frac{40.5 \times R3}{R3 \times (sB - 0.7) + 2.7(tB + 0.7)} \quad \text{(k ohms)}$$

$$R4 = 10 \times \frac{15 - V_{ref}}{V_{ref}} \quad \text{(k ohms)} \qquad \text{with:} \qquad V_{ref} = \frac{sB}{2} - 0.7$$

$$R1 = 20 \times \frac{Ap}{Ag - Ap} \quad \text{(k ohms)}$$

Setting Into Operation

R1 to R4 and Z2 components must be soldered onto a component header as follows:



COMPONENT HEADER

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The module must be fitted on the MD regulation board.

A short circuit between the Pins 7 and 8 enables the function of the **speed/torque** module. When the Pins 7 and 8 are not connected, the function of the **speed/torque** module is disabled.

Module Verification

The verification of the good operation of the **speed/torque** module is done as follows:

1. Vary the speed between 0 and Nmax, applying a very heavy load to the motor.

2. Measure the max current which corresponds to each speed V at the I MAX terminal knowing that:

   SDB05 : I_{max} (amps) = 1.0 x $V_{measured}$ (volts)
   SDB12 : I_{max} (amps) = 2.5 x $V_{measured}$ (volts)
   SDB20 : I_{max} (amps) = 4.0 x $V_{measured}$ (volts)

3. Trace the curve V = F (I)

4. Compare the speed theoretical curve V = F (torque) to the measured curve V = F (current).

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Example: (Motor MT30M4-38 and Servo-Amplifiers SDB12):

For this type of motor:

a. The point B and C have for coordinates (T, S):

A (2.3, 3700)
B (6, 2000)
C (14, 1250)

b. The (t, s) coordinates calculation is made with the following formulas:

$$t = \frac{10 \times T}{0.35 \times 25} = 1.14 \times T$$

or: K_t = 0.35 lb-in/A

I_{max} = 25A (SDB12)

$$s = \frac{10 \times S}{3700} = \frac{S}{370}$$

or: N_{max} = 3700 rpm

it gives:

A (2.6, 10)
B (6.8, 5.4)
C (16, 3.4)

c. Ag and Ap calculations are:

$$Ag = \frac{16 - 6.8}{5.4 - 3.4} = 4.6 \qquad Ap = \frac{6.8 - 2.6}{10 - 5.4} = 0.91$$

d. Calculation of R1 to R4 and Z2:

Z2 = 16 + 0.7 = 16.7 → Z2 not mounted.

R3 = 4.6 x 2.7 = 12.4 k → 12k 1%

$$R2 = \frac{40.5 \times 12}{12 \times (5.4 - 0.7) + 2.7 \times (6.8 + 0.7)} = 6.34 \rightarrow \text{6.2k 1\%}$$

$$V_{ref} = \frac{5.4}{2} - 0.7 = 2.0V$$

$$R4 = 10 \times \frac{15 - 2.0}{2.0} = 65 \rightarrow \text{65k 1\%}$$

$$R1 = 20 \times \frac{0.91}{4.6 - 0.91} = 4.93 \rightarrow \text{4.7k 1\%}$$

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Before Applying Power

The initial power up should be done with the motor disengaged from the machine.

Before applying power perform the following steps:

1. Check the connections on the terminal strip of the card holder for proper wiring and that no short across terminals exist.
2. Turn potentiometer I MAX full counter-clockwise to cancel I_{max}.
3. Close the contacts of the opto-coupled inputs OSW, SW1, SW2 and SBY.

Amplifier Checkout

Apply power to the amplifier and follow the steps below to insure that the amplifier is functioning properly.

1. Check that the SBY LED lights up briefly.
2. Check that only the POWER LED remains lit.
3. If any other LED remains lit, switch off the device and determine the cause of the fault, see Troubleshooting Section 1001.
4. Select 0SW (terminal 7) by closing switch to 24Vdc or amplifiers +15Vdc supply to command a *non-zero* speed to the servo amplifier.
5. Turn the I MAX potentiometer clockwise continuously until the motor starts running.
6. If the motor runs away or the TACH OFF alarm LED is lit, remove power to the amplifier and determine the cause of the fault, see Troubleshooting Section 1001.
7. Check operation of the motor in both directions by applying a speed command to terminals 14 (+) and 16 (-), then reverse polarity.
8. Check the inputs for END LIMIT SWITCH 1 and END LIMIT SWITCH 2. The motor should rotate in one direction only if one of limit switch contacts *open*.
9. Check that the motor stops when the 0SW contact is *opened*.
10. Check stand-by mode when the SBY contact is *opened*.

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Current Settings

The SDB Series servo amplifiers are supplied with standard settings. These settings are specified both on the device itself and on the packing. Special settings are generally necessary when a servo amplifier is adapted to a specific application. These settings must be made in the following sequence:

1. Setting The Maximum Current:

Setting (and measurement of) the current I_{max}, connect a voltmeter between the monitor sockets I MAX and GND. Adjust the potentiometer I MAX (P2) to the desired value using the formula:

SDB05 : I_{max} (amps) = 1.0 x $V_{measured}$ (volts)
SDB12 : I_{max} (amps) = 2.5 x $V_{measured}$ (volts)
SDB20 : I_{max} (amps) = 4.0 x $V_{measured}$ (volts)

2. Setting The rms Current, I_{rms}:

Connect a voltmeter between the monitor sockets I RMS and GND. Adjust the potentiometer I RMS (P3) to the desired value using the formula:

SDB05 : I_{rms} (amps) = 1.0 x $V_{measured}$ (volts)
SDB12 : I_{rms} (amps) = 2.5 x $V_{measured}$ (volts)
SDB20 : I_{rms} (amps) = 4.0 x $V_{measured}$ (volts)

3. Reading the instantaneous current, I_{inst}:

Connect a voltmeter between the monitor sockets I INS and GND. The instantaneous current value is obtained by:

SDB05 : I_{inst} (amps) = 1.0 x $V_{measured}$ (volts)
SDB12 : I_{inst} (amps) = 2.5 x $V_{measured}$ (volts)
SDB20 : I_{inst} (amps) = 4.0 x $V_{measured}$ (volts)

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Setting Speed With Tachometer

When using the servo amplifier with tachometer feedback, it is necessary to adjust the tach voltage for a given speed reference command. Follow the steps below to set the tach voltage.

1. Calculate the desired speed using a given speed command (preferably a low one).

Example: 1 V speed command = 500 rpm

2. Determine the desired tachometer voltage (V_{tach}) using the speed calculated in 1.

Example: If the tach has an output voltage of 7V/1000 rpm,

$$V_{tach}\,(\text{at } 500\,\text{rpm}) = \frac{7\,\text{V} \times 500}{1000} = 3.5\,\text{V}$$

3. Apply the speed command taken from step 1. to the amplifier.

Adjust the TACHO potentiometer (P1) to obtain the tachometer voltage determined in step 2. at the TACHY and GND test points.

Example: voltage setpoint = 1V V_{tach} = 3.5V

Setting Speed Without Tachometer

When using the servo amplifier *without* tachometer feedback, the motor speed is set based on the back EMF. The higher the bus voltage, the higher speed that can be obtained. Follow the steps below to set the motor speed.

1. Calculate the desired speed using a given speed command (preferably a low one).

Example: 1 V speed command = 500 rpm

2. Determine the desired armature voltage using the speed calculated in step 1.

Example: EMF constant of motor = 38V/1000 rpm

$$\text{EMF}(\text{at } 500\,\text{rpm}) = \frac{38\,\text{V} \times 500}{1000} = 19\,\text{V}$$

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3. Turn the potentiometer P8 fully counter-clockwise (no IR compensation).

4. Apply the speed command taken from step 1. to the amplifier.

Adjust the potentiometer P9 in order to obtain the voltage determined in step 2. at the terminals of the motor.

Example: speed command = 1V EMF_{motor} = 19V

5. Determine the instantaneous current absorbed by the motor.

This measurement can be performed using an ammeter connected in series with the motor or by reading the voltage between the monitor sockets I INS and GND.

Example: I_{inst} = 0.5 amps

6. Determine the voltage V_{motor}, taking into account the voltage drop due to the internal resistance of the motor (r_{motor}):

   V_{motor} = EMF motor + r_{motor} I_{inst}

Example: r_{motor} = 2 ohm

   V_{motor} = 19V + (2 x 0.5) = 20V

7.) Modify the setting of P9 in order to measure the voltage calculated in step 6. at the terminals of the motor.

The following steps are required:

8. Apply a zero command.

9. Increase the setting of P8 until the motor starts oscillating, then back off just until the motor stabilizes.

10. Check the control system during real operation, and back off the setting of P8 further if necessary, in the event of instability.



Note

If the setting is performed with the motor off-load, steps 5. 6. and 7. can be omitted.

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CLEVELAND MACHINE CONTROLS

SDB SERIES
DC SERVO AMPLIFIER

Chapter
START-UP

Section
Setting The Amplifier Gain

Setting The Gain

The type of speed regulation used in the SDB Series servo amplifiers is PI (proportional/integral). These two parameters are set simultaneously with the GAIN potentiometer P4. The range of the P parameter varies between 20 and 2000. The amplifiers are delivered with a factory setting 30% of the maximum value (P = 600).

There two alternative methods of setting the gain factor:

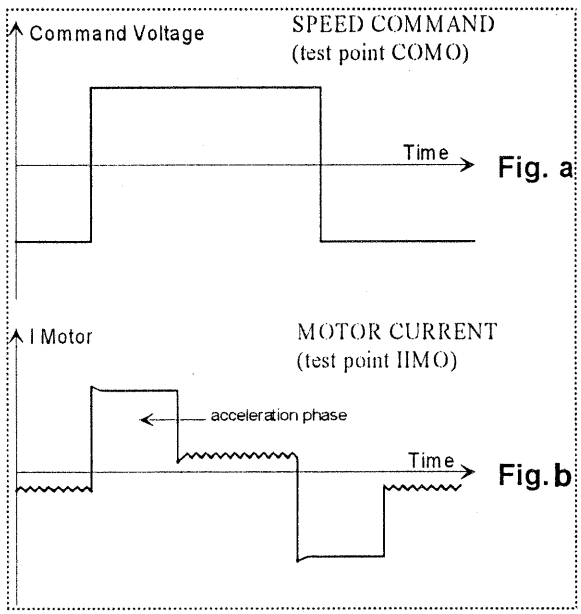
1. Acoustic Method
2. Oscilloscope Method

Acoustic Method

During normal operation of the mechanical system, increase the gain factor by turning the GAIN potentiometer P4 clockwise until a *whistling* or *humming* noise can be heard in the motor. Then reduce the gain factor until oscillation stops, and then a further half turn.

Oscilloscope Method

Measure the instantaneous current and the tachometer voltage with an oscilloscope. Set up a circuit to provide a step function and speed reference such as a function generator. Adjust the GAIN potentiometer P4 so that the waveform is as close as possible to the curves shown in Figures a, b, c below. Figures d, e and f are the most commonly observed *unfavorable* cases.



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Oscilloscope Tuning

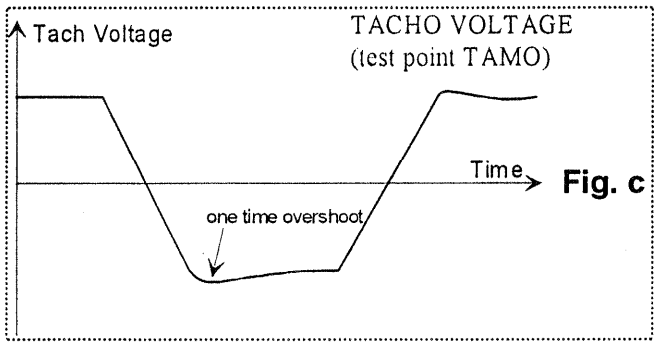


Fig. c

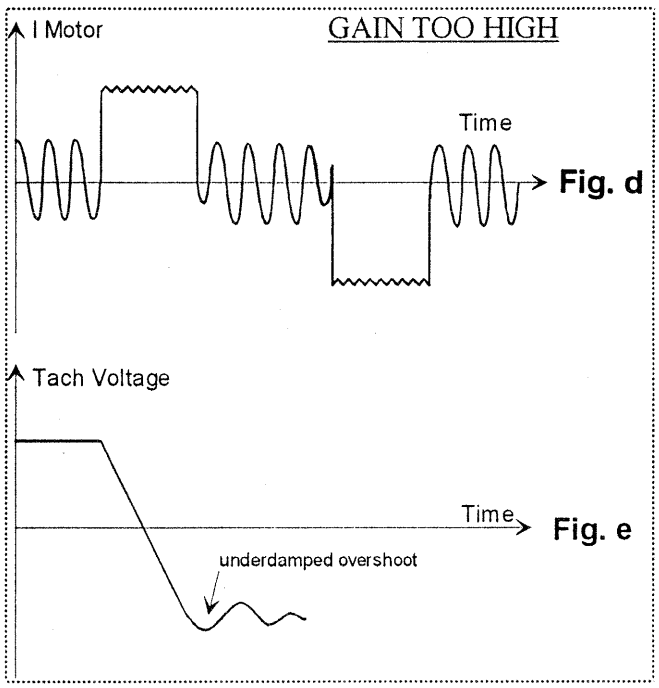


Fig. d

Fig. e

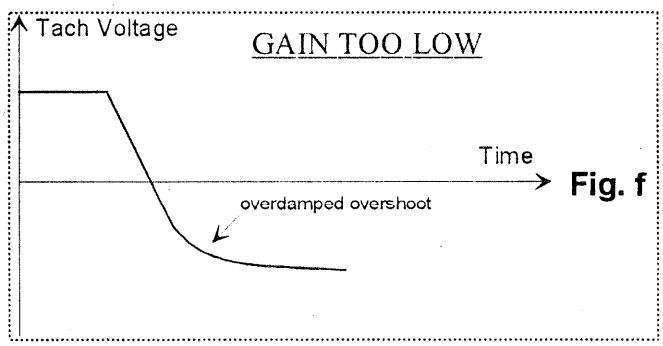


Fig. f

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Setting The Offset

The offset is set using the OFFSET potentiometer P5. The offset must be set without any position control loop.

If the offset correction must apply to the entire CNC system and the servo-amplifier, a zero speed command must be defined by the CNC system and the OFFSET potentiometer adjusted such as to obtain a motor speed of zero.

If the offset correction is made with the servo amplifier only, an internal zero speed command must be set using the 0SW switch (contact *open*). Adjust the OFFSET potentiometer to obtain a motor speed of zero.

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Input Command Voltage Or Current:

The input command voltage is given by an analog voltage of +10V and -10V. The input command is located on card holder mother board terminals 14 and 16.

The supply command voltage passes through an analog switch. When this analog switch is open, the internal command is null. The inputs NULL COMMAND, END LIMIT SWITCH 1 and END LIMIT SWITCH 2 could be connected to the external command to give a null internal command.

Current Limiting Control

The control current level can be limited in several ways:

- by an ambient temperature increase
- with the motor max current adjustment
- with the motor nominal current adjustment
- as a function of the motor speed

Limitation As A Function Of The Ambient Temperature

The SDB Series servo amplifiers are protected by an ambient temperature measuring circuit. This circuit, which is a linear sensor, decreases the maximum output current by 2% per degree above 45°C.

This limitation does not depend on the motor max current (I MAX) adjustment pot P2, but operates on the servo amplifier peak current (SDB05=10A, SDB12=25A or SDB20=40A). The designer must consider this limitation when choosing the type of SDB amplifier.

Limitation With The Motor Maximum Current Adjustment

This limitation sets the servo amplifier max output current to the max current acceptable by the motor. The limitation adjustment is done with the P2 (IMAX) potentiometer by measuring the voltage between the monitor sockets IMAX and GND knowing that:

SDB05 : I_{max} (amps) = 1.0 x $V_{measured}$ (volts)
SDB12 : I_{max} (amps) = 2.5 x $V_{measured}$ (volts)
SDB20 : I_{max} (amps) = 4.0 x $V_{measured}$ (volts)

Limitation With The Motor Nominal Current Adjustment (I^2T)

This limitation is designated to give the motor a thermal protection. DC motors generally tolerate peak currents, or pulsed currents, from two to four times the nominal current but for only a short time.

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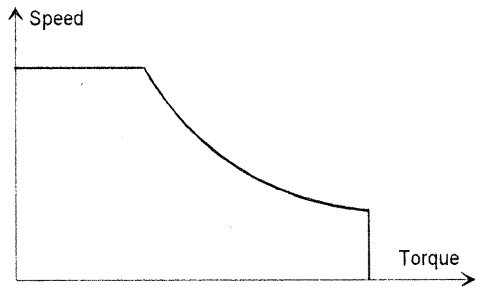
The principle of the motor nominal current adjustment is as follows:
1. The instantaneous current going through the motor is squared.
2. The square root of the squared currents sum is then calculated. This square root represents the absolute value of the RMS current value responsible for the motor overheating.

The RMS current value is integrated with a rate time equivalent to the motor thermal time constant. This integrated RMS value is compared to the motor nominal current value adjusted with the P3 (I RMS) located on the device front panel. When two currents are equal, that is, when the motor temperature has reached an equal level to the one which could have occurred by continuous running at nominal current, the current which goes through the motor is limited to the adjusted nominal current.

The servo amplifiers have a standard time constant of 13 seconds. When the motor max current is adjusted to twice the motor nominal current, the motor max current time is limited to 6.5 sec. This motor max current time increases in an inversely proportional way to the difference between the max current and the nominal current.

Limitation As A Function Of The Motor Speed

Some dc motor types can not operate with both maximum torque and maximum speed. This characteristic is defined by the curve:



Characteristic Speed/Torque Curve

The SDB servo amplifiers are designed to accept a **speed/torque** module which ensures a precise and accurate limitation of the torque as a function of the motor speed.

The **speed/torque** module components and their settings are described in Section 505.

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Current Regulating, PWM And Duty Cycle Limit

The current limited output is used as a current command. The output of the motor measuring current circuit is used as feedback current. The difference between current command and feedback current represents the current *error*. This error is connected to the current regulator circuit input. The regulator is of the PI type.

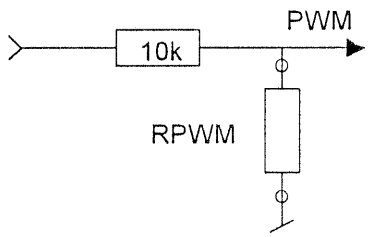
The P and I parameters of the current regulator are not user adjustable. The current regulator output is connected to the input of a pulse width modulation circuit whose frequency is 9kHz.

This PWM circuit transforms the current regulator output in four digital signals which control the power H bridge.

A voltage divider placed between the current regulator and the PWM circuit permits limitation of the power components commutation duty cycle.

This limitation is used to decrease the voltage seen by the motor. This permits supplying motors of different back EMF with the same supply voltage.

The RPWM resistor placed into the voltage circuit as follows:



Vcc represents the supply voltage and Vmot the motor voltage. The voltage drops in the H bridge are approximately of 10V.

$$\frac{Vcc}{10k + RPWM} = \frac{Vmot + 10V}{RPWM}$$

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$$RPWM = \frac{10\,Vmot + 100}{Vcc - Vmot - 10} \quad \text{kohm}$$

Example: Vcc = 100V and Vmot = 50V

$$RPWM = \frac{500 + 100}{100 - 50 - 10} = 15\text{k ohm}$$

This motor voltage limitation is possible only if the supply voltage is equal to or greater than the motor free running maximum voltage.

Over Current Supervisor And Fuses

Over Current Supervisor

The servo amplifiers are equipped with a current supervisor circuit in the high voltage supply. This circuit inhibits the commutation of the power components as soon as the supply current exceeds the double of the servo amplifier max current.

An overcurrent is indicated by the front panel LEDs OVER I and SBY. The alarm is memorized and can only be reset by a power off/on of the amplifier device.

Fuses

The SDB servo amplifiers are protected by 2 fuses:

1. One fuse (F1) time delay on the regulation part auxiliary supply:
   1A version HT (50 to 160V_{DC})
   2.5A version BT (24 to 75V_{DC})

2. One fuse (F2) time delay on the H bridge supply:

   8A for the type SDB05
   16A for the type SDB12
   25A for the type SDB20

Damaged fuses have to be replaced by similar ones. Before replacing a damaged fuse, it is necessary to search for the excess current cause in order to eliminate it.

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CLEVELAND MACHINE CONTROLS

SDB SERIES

DC SERVO AMPLIFIER

Chapter

REGULATION AND PROTECTION

Section

Voltage Measuring With IR Compensation

Motor Voltage Measuring Circuit With IR Compensation

This circuit measures the differential voltage on the motor. The internal resistor instantaneous current product is then subtracted from this motor voltage. The voltage obtained is proportional to the motor back EMF, that is, proportional to the motor speed. This voltage is called back EMF. The back EMF is used with respect to the following functions:

- Motor servo control without tachometer
- Supervision of tachometer
- Torque limitation in function of the speed

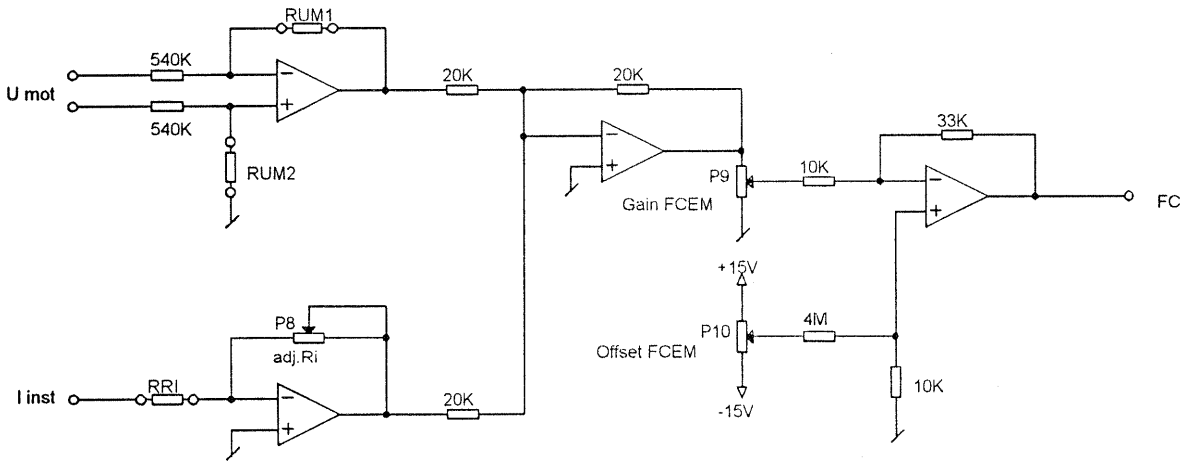
Set Up And Calculation Of The Back EMF

Set-up and regulation necessary to the back EMF. See ***Tachometer Supervisor*** in Section 502, ***Motor Resistance Compensation*** in Section 503, and ***Setting Speed Without Tachometer*** in Section 603.

Elements Used In The Measuring Circuit

The measuring circuit of back EMF contains:

- Two resistances **RUM1** and **RUM2** which depend on the servo amplifier voltage.
- One resistance **RRI** compensation of the internal resistance of the motor.
- One potentiometer **P8** for the fine adjustment of the IR compensation.
- One potentiometer **P9** for the adjustment of the amplitude of back EMF.
- One potentiometer **P10** for the offset adjustment of back EMF.



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Tachometer Supervisor

A tachometer failure, a tacho/servo amplifier cable break, or an inverse polarity of the tachometer can have dramatic consequences. The servo amplifiers have a tachometer supervisor circuit which ensures safety in these cases. The tachometer supervisor operates as follows if:

- the tachometer does not give any voltage
- the back EMF voltage is not connected

The tachometer normalized voltage (tacho voltage reduced to 10V) is permanently compared to the back EMF. The "tachometer" defect alarm appears under the following conditions:

Back EMF > 2V and V_{tach} normalized < 1V

The tachometer supervisor circuit needs a back EMF adjustment which ensures a minimal voltage of 2V when the motor is not controlled in speed, that is, when the motor works at:

$$N(\text{rpm}) = \frac{\text{Vcc (V)}}{\text{Ke (V / rpm)}}$$

A tachometer fault is indicated by the TACH OFF and SBY LEDs. This alarm is memorized and inhibits all power components commutation. It can only be unlatched by switching the amplifier off and on. The tachometer supervisor alarm is selected out of function when positioning the jumper W3 to "off".

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CLEVELAND MACHINE CONTROLS

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Chapter
REGULATION AND PROTECTION

Section
Over Temperature And Over Voltage

Detection Of The Power Components Over Temperature

A thermostat mounted on the heatsink of the power components monitors the temperature. This overheating alarm is indicated by the display LEDs: T > 90°C and SBY. It goes off when the heatsink temperature reduces.

Braking And Over Voltage Control

The SDB servo amplifiers nominal max voltage is 160Vdc. When braking, the motor works as a generator and has a tendency to increase the bus voltage above this value.

The energy is then dumped into the power capacitor. If this voltage goes up to 215Vdc, a power dissipation control system switches on and permits an instantaneous power dissipation of 900W. It goes off when the voltage falls below 205Vdc.

If the braking energy causes the bus voltage to reach 230Vdc or when the average power to dissipated goes over P_{moy}, the servo amplifier goes into "stand-by" to protect itself. The servo amplifier switches on again when the power voltage is under 220V and when the braking power goes under P_{moy}.

The LED "LD6" signals that the power dissipation control system is on.

The P_{moy} values of the servo amplifiers type are:

SDB05: P_{moy} = 20W
SDB12: P_{moy} = 20W
SDB20: P_{moy} = 100W

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Output "Ready"

The SDB servo amplifiers are equipped with a relay contact that is closed when the amplifier is "ready" (i.e. not in STAND-BY and no alarms). This contact is connected on terminals 1 and 2 of the card holder (pins12d and 12b on the amplifier card). This contact is potential free. The rating of the contact is: 0.5A, 100V, 10VA

Optocoupled Inputs

The SDB servo amplifiers have 4 opto-coupled inputs 24V.

- STAND-BY
- END LIMIT SWITCH 1
- END LIMIT SWITCH 2
- ZERO COMMAND

The purpose of using optocouplers is to isolate the servo amplifier from the noise present on the control command. The +24V must be applied to the appropriate input to activate it. The 24V ground must be connected on the main connector terminal 10 on the card holder. In normal functioning, the 4 inputs above must be connected to the +24V.

Stand-By Input

The STAND-BY input permits the servo amplifiers to be in/out of function. The setting into "function" is realized when this input is connected to the +24V. The setting "out-of-function" is realized when this same input is not connected. The STAND-BY input is connected to terminal 6 on the card holder.

End Limit Switch 1 and 2 Inputs

The SDB servo amplifiers are equipped of 2 end limit switch inputs. The END LIMIT SWITCH 1 cancels all the *negative* commands but does not affect the positive ones. The END LIMIT SWITCH 2 cancels all the *positive* commands but does not affect the negative ones.

Zero Command Input

The ZERO COMMAND input imposes a zero command to the servo amplifier. A zero command is imposed when the zero command input is not connected. The zero command input is connected terminal 7 of the card holder.

Power Supply ±15V

The ±15V voltages necessary for the servo amplifier operation are derived from an internal chopper power supply. This power supply chops the high voltage at a frequency of 20 kHz. the +15V, ground and -15V are available on terminals 3, 4 and 5 on the card holder respectively. These voltages supply the auxiliary circuits such as: command or specific circuits. The consumption on the ±15V voltages must not exceed 20mA. The user must avoid short circuit on those voltages. The POWER LED is illuminated when the servo amplifier is enabled.

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CLEVELAND MACHINE CONTROLS

SDB SERIES
DC SERVO AMPLIFIER

Chapter
VARIABLE COMPONENTS

Section
Jumpers And Potentiometers

Jumpers

No.	Function	Factory Configuration	Position
W1	Servo control choice tacho/BEMF	Tachometer servo control	1-2
W3	In/out of function tacho control	In function	ON

Potentiometers

No.	Function	Factory Configuration	Note
P1	Motor speed adj. (TACHY) in function of the BEMF/tacho	3000 rpm for tacho 9.5V 1000 rpm	In relation with RTAC front panel
P2	I MAX adjustment	Adjusted to max I_{max}	Front panel
P3	I RMS (I_{eff}) adjustment	Adjusted to max I_{eff}	Front panel
P4	**PI** gain adjustment		Front panel
P5	OFFSET adjustment		Front panel
P6	Adjustment of the current reading symmetric circuit		Must not be adjusted
P7	End of instantaneous current amplitude adjustment		Must not be adjusted
P8	Motor resistor end of feedback adjustment	Positioned at the minimum	In relation with RRI
P9	BEMF tension amplitude adjustment		
P10	Offset adjustment BEMF voltage (factory adjusted)		Must not be adjusted

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CLEVELAND MACHINE CONTROLS

SDB SERIES
DC SERVO AMPLIFIER

Chapter
VARIABLE COMPONENTS

Section
Resistors

Resistors

No.	Function	Factory Configuration	Note
RTAC	BEMF adaptation motor speed	8k ohm	Servo control with tachometer
RPWM	Limitation of the commutation cyclic ratio	No limitation	
RUM1	Adaptation of the motor voltage reading circuit	36k / 75k HT / BT	
RRI	Resistor feedback internal motor	20k	Servo control without tachometer
RUM2	Adaptation of the motor voltage reading circuit	36k / 75k HT / BT	

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CLEVELAND MACHINE CONTROLS

SDB SERIES
DC SERVO AMPLIFIER

Chapter
TROUBLESHOOTING

Section
General

The list below indicates the most common faults and their possible causes:

NO.	FAULT	POSSIBLE CAUSE
1	No "POWER" indication	a.) No supply voltage. b.) Supply voltage < 50V DC
2	Alarm "TACHY OFF"	a.) Tacho and/or motor connections b.) Tacho or motor cable faulty. c.) Gain factor too high. d.) EMF of motor set incorrectly. e.) Tach faulty.
3	Alarm "OVER I"	Insulation of motor or motor cable faulty.
4	No alarm but motor at standstill	END LIMIT SWITCH or ZERO SPEED command switch open.
5	Motor oscillating	a.) Gain factor too high. b.) Control without tach over compensation of Rint x I 9P8
6	Motor overspeeding	Jumper W3 missing, tach and/or motor connections inverted.
7	Motor has no torque	a.) I_{max} setting too low. b.) Control system without tach: insufficient compensation of internal resistance.

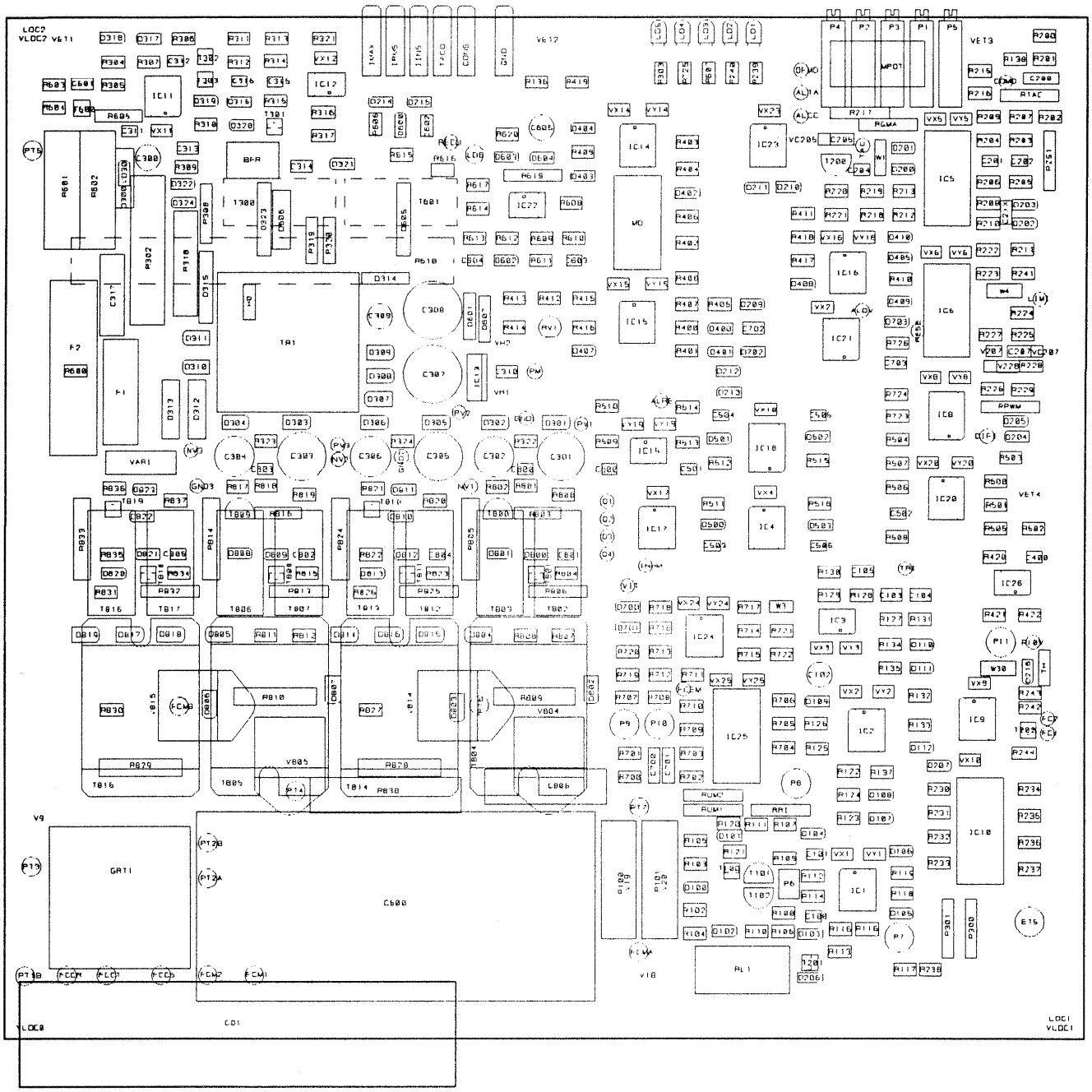
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SDB SERIES
DC SERVO AMPLIFIER

Chapter
APPENDIX 1

Section
Component Layout



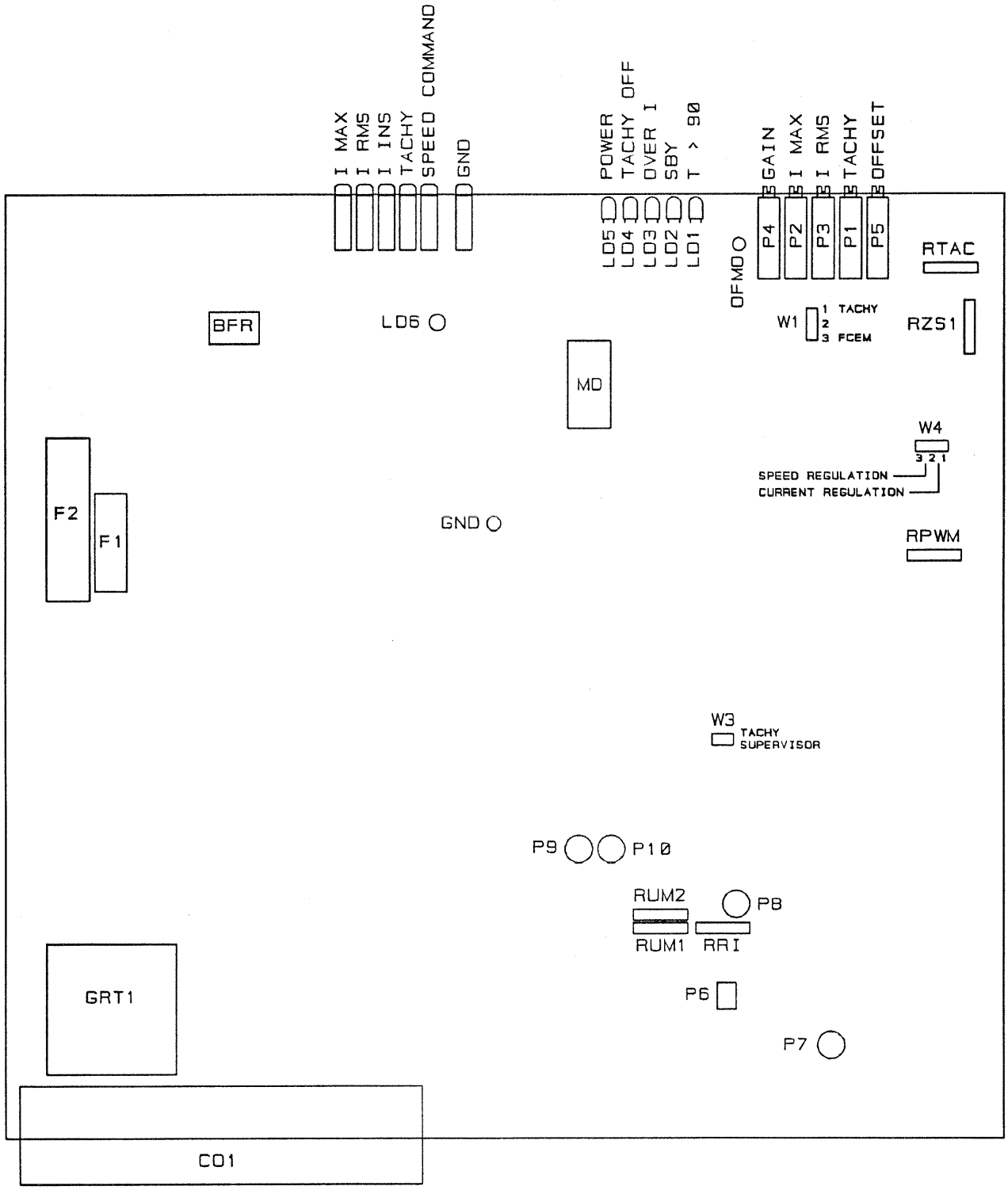
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SDB SERIES
DC SERVO AMPLIFIER

Chapter
APPENDIX 2

Section
Abbreviated Component Layout



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Pin Out Of The Amplifier Edge Connector, 48 Poles

No.	d	b	z
2	.+command	.-command	.earth
4	.+tacho	.-tacho	.earth
6	.end limit switch 1	.end limit switch 2	.ground 24V
8	.stand-by	.null command	.earth
10	.+15V	.ground 15V	.-15V
12	.ready	.ready	.earth
14 16	.-motor	.-motor	.-motor
18 20	.+motor	.+motor	.+motor
22 24	.phase T	.phase T	.phase T
26 28	.phase S or -Vcc	.phase S or -Vcc	.phase S or -Vcc
30 32	.phase R or +Vcc	.phase R or +Vcc	.phase R or +Vcc

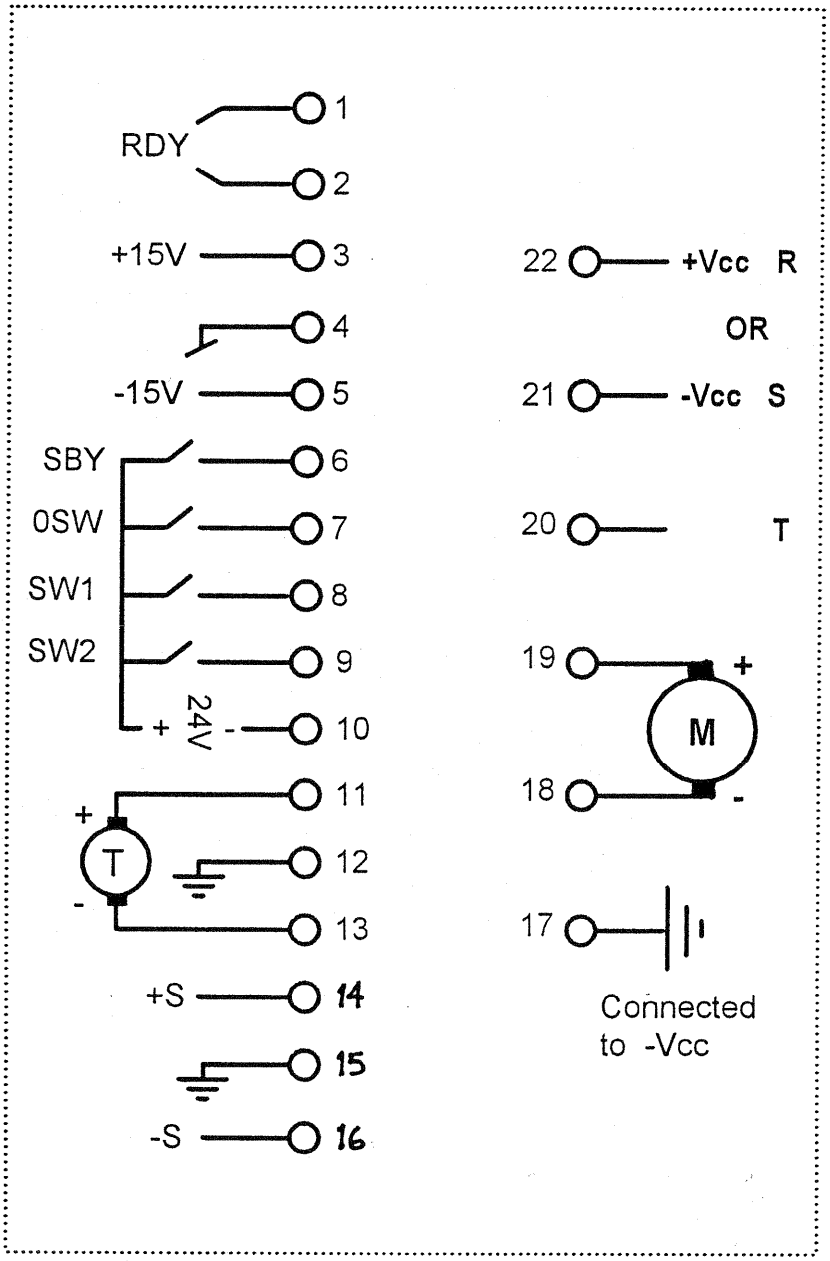
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SDB SERIES
DC SERVO AMPLIFIER

Chapter
APPENDIX 4

Section
Card Holder Labeling



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