POWERTEC
Industrial Motors

INSTALLATION AND OPERATION

INSTRUCTION MANUAL

PRODUCTION RELEASE

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POWERTEC Industrial Corporation
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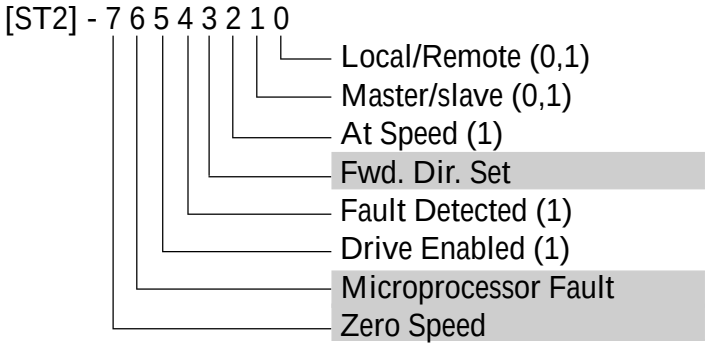
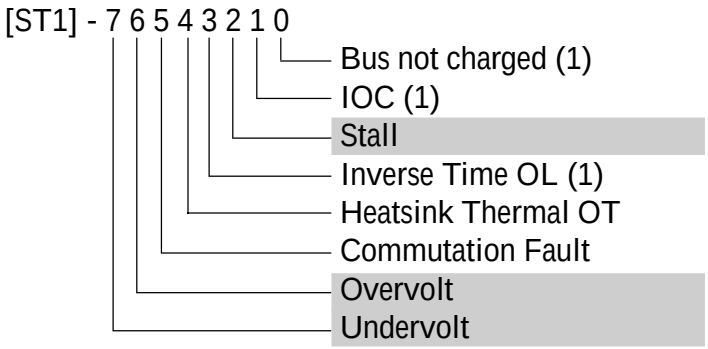
Corrections to page 44 of the manual, Attachment A: Detailed Commands
Read Speed/Status (81)

Changes shown in gray





DFS Software Modification For Dynamic Braking or Output Contactor Operation

25 October, 1994

Functional Description

A new function for Contactor Aux has been added to the digital input choices. When configured as described in the example, 24VDC must be present at this input for the drive to run. Parameter #62, Contactor Delay, is a number of 25ms intervals that will occur between the DFS controller acceptance of a run command and the firing of the transistors. If the Contactor Aux input signal is low, the DFS starts the timer and closes the Contactor Output. If the Contactor Aux input does not switch high before the timer runs out, the drive will return to the stop condition. If the Contactor Aux input does switch high, the drive will start running when the timer runs out.

Example Setup for Dynamic Braking

1 Set Digital Input #7 mode to Contactor Aux, polarity to Active Low.
2 Set Digital Output #4 mode to Contactor, polarity to Normally Closed.
3 Set Contactor Delay to 20 (20 x 25ms = 500ms = 1/2 second).

Run command causes the Contactor Output to close, the Contactor Relay opens, the feedback contacts close and the drive starts to run.

Example Setup for Output Contactor

1 Set Digital Input #7 mode to Contactor Aux, polarity to Active Low.
2 Set Digital Output #4 mode to Contactor, polarity to Normally Closed.
3 Set Contactor Delay to 10 (10 x 25ms = 250ms = 1/4 second).

Run command causes the Contactor Output to close, the Contactor Relay closes, the feedback contacts close and the drive starts to run.

The difference in the operation of the two types of contactors is that the Dynamic Braking Contactor is normally closed whereas the Output Contactor is normally open. In both contactors, the auxilliary contacts are normally open.

Terms Used

1 Contactor Aux - The digital input on the DFS board which is connected to the feedback contacts on the contactor relay.
2 Contactor Output - The digital output on the DFS board which activates the solenoid on the contactor relay.
3 Signal low - 0VDC
4 Signal high - 24VDC

1.0 INSTALLATION

The DFS-1 printed circuit board mounts on any POWERTEC Brushless DC motor control except the Model 500. The Model 1000 is used here for illustration purposes only.

1.1 MOUNTING -- READ THIS ENTIRE SECTION BEFORE STARTING!

The DFS-1 printed circuit board mounts on the Model 1000 or Model 1000AR motor control in place of both the Current Controller board (part #141-108) and the Speed Controller board (part #141-107 on the non-regenerative model 1000, part # 147-101 on the regenerative model 1000AR). These boards are mounted side by side on all standard motor controls. TB1 is located on the Current Controller (left hand board) and TB2 is on the Speed Controller (right hand board). The first eight connections which normally come into TB1 (the motor cable leads) will connect to the same places on the DFS-1. The connections going into TB2 (mainly operators and speed pot) on the standard motor control will go to different connections on the DFS-1.

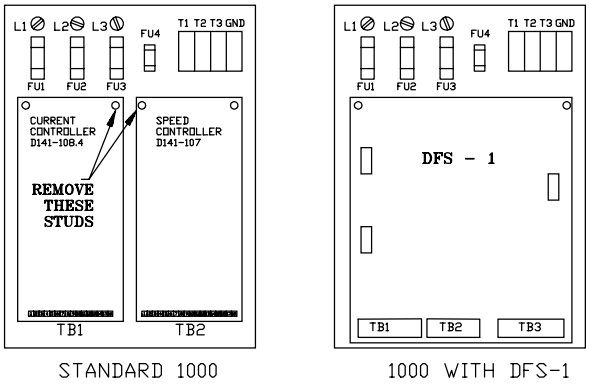


Figure 1: The DFS-1 replaces two boards.

If the board is being installed to replace the boards on a standard control, unplug the strips on TB1 and TB2, but do not disconnect any wires from them yet. Unplug the 14-pin connector on P2 (at the Base Driver Board) and the 10-pin connector on P3 (at the Capacitor Board). Remove these cables and the Speed and Current controller boards from the chassis and set them aside. Remove the studs at the top right of where the Current Controller board was, and at the top left of where the Speed Controller was located (the center studs - see figure 1).

There are two flat ribbon cables which must be connected from the DFS-1 to the other parts of the motor control: one goes to the Base Driver Board (part #141-105), and the other cable goes to the Capacitor Board (part #141-106). See figure 2 for the physical layout of the control and the location of these boards. If the DFS-1 board is being installed in the field, the cables should come with the new board, since the connectors on the DFS-1 end are different from the connectors on the Speed and Current controller ends of the previous cables. Make sure that you have these new cables before proceeding to install the board. If you do not have them, call POWERTEC's service department before proceeding.

The DFS-1 board may be used as either a non-regenerative control or as a regenerative control. This selection is made by one of its parameter settings. The DFS-1 may be installed on a Model 1000 non-regenerative brushless DC control, but if the unit is to be used for a regenerative application, a bus loader of the appropriate voltage and resistors of sufficient wattage must be added before the drive may be used regeneratively. If a bus loader is not installed before regenerative operation occurs, it is likely that the control will trip out repeatedly. A Model 1000AR will already have a bus loader and resistors attached.

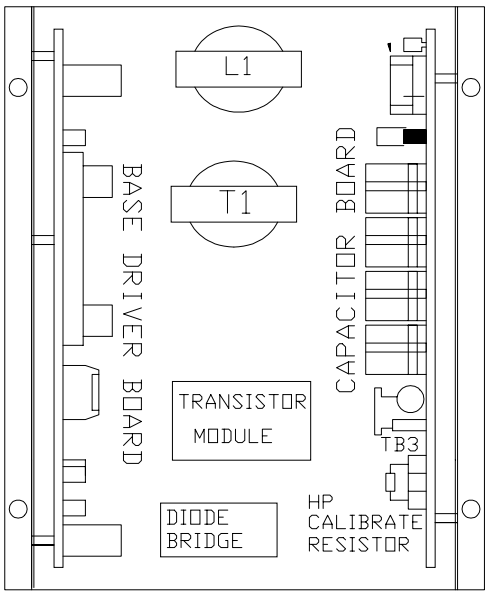


Figure 2: The Model 1000 chassis

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INTRODUCTION

As the computer revolution takes greater control of industrial processes, there is a growing need for more intimate control of the process parameters. It is becoming ever more necessary to control the important characteristics of motors directly from computers and microprocessor-based controllers. Such control cannot wait for operator intervention when changes occur in milli-seconds and tolerances are measured in thousandths.

All of the operational characteristics of a motor are controllable by manipulating its speed, torque, and power. POWERTEC digitally implemented, speed, torque, and power control - the DFS-1.

The Brushless DC motor and its control are digitally based, and are a natural choice for a computer controlled environment. Now computers and PLC's talk to the drive itself when the field-installable DFS-1 control board replaces the Speed and Current boards on the standard POWERTEC Brushless DC drive.

One of the first things you will notice about the DFS-1 is that there are no adjustment potentiometers and no setup switches. All characteristics of the drive are controlled by software parameters which may be entered by the optional KDU-1 keypad or host computer. The KDU-1 keypad can be mounted on the DFS-1 board, in a remote location (usually the enclosure door), or in a handheld unit. A default set of parameters which represent the most common operating conditions will facilitate immediate operation and testing after installation.

Capable of operating on a single drive or in networks, the DFS-1 is programmable by an optional keypad with its two line, 16-character display. A single computer port may be used to monitor and control up to 32 units in an RS-485 communications link.

Programmable analog inputs and analog outputs allow many possibilities for control through external voltages, currents, and frequencies. They may also be used to monitor drive operation. Digital inputs and outputs (also programmable) give control and monitoring flexibility as well as coordination functions.

Provision is made for plug-in options which add input and output options and accomplish special functions. Optional software packages may be ordered for specific application needs.

SUMMARY OF WARRANTY AND DISCLAIMER

POWERTEC Industrial Corporation warrants the DFS-1 to be free from defects in materials and workmanship for a period of one year from the date of shipment from the factory, or if purchased from an authorized POWERTEC distributor or Original Equipment Manufacturer, not more than 18 months from the date of shipment from the factory. Upon written notification to the factory of a possible defect in materials or workmanship, POWERTEC will, at its sole option, repair or replace, at the factory, such defective parts as it deems necessary to restore the unit to its original specifications.

There is no other warranty, express or implied, including fitness of purpose for the application intended. This warranty does not cover accidental or intentional damage; physical or electrical misuse or abuse; defective or incorrect installation; effects on other equipment or caused by other equipment; attempted use outside of specified ranges; or any other situation outside of the control of POWERTEC Industrial Corporation.

The user is responsible for the application of the DFS-1 product and the programming thereof.

This warranty does not encompass any other claims, including, but not limited to, special, incidental, or consequential damages.

This manual has been assembled as a guide to the use of a POWERTEC product. It represents the best efforts to compile and present the information herein. Such errors as may appear in no way affect the above stated warranty. If mistakes of fact are found or suspected in this manual, please notify the factory or your distributor at once.

WARNING!

The DFS-1 contains static sensitive parts which may be damaged by careless handling of the printed circuit board. You can avoid this type of damage by always touching the frame of the drive before you touch the printed circuit board or any of its connections.

The DFS-1 is supplied for field installation in a protective bag. Bring the bag into contact with the motor controller frame before removing the board from the bag.

POWER CONNECTIONS:

POWERTEC Brushless DC motor controllers are supplied with nominal input voltages of 230, 380, and 460VAC. Three phase input power is required. The input is not phase sensitive. Connect the appropriate power supply to the input fuses at L1, L2, and L3 (check nameplate for proper input voltage and capacity).

Connect the output terminals T1, T2, and T3 to the respective terminals on the Brushless DC motor. It is very important that the T1 terminal on the motor connects to T1 on the drive, T2 of the motor connects to T2 of the drive, and T3 of the motor connects to T3 of the drive. An earth ground wire of the same gauge as the motor power leads or one gauge smaller (no smaller than #14 AWG) must be run from a bolt in the motor junction box to the ground terminal on the drive. A wire must then be run from the ground terminal on the drive (next to the motor terminals) to an earth ground at or near the power source. The Model 1000 drive does not have the common circuitry connected to earth ground (chassis). In most cases this works best, but in some cases it does not. POWERTEC recommends connecting a short jumper wire from the drive common at any one of the several places available on the terminal strips to a nearby point on the drive chassis or backpanel that will establish this ground. This is more important in applications where multiple drives are connected together or serial communications from a host are used. All other POWERTEC drives have the common grounded by mounting screws on the regulator boards.

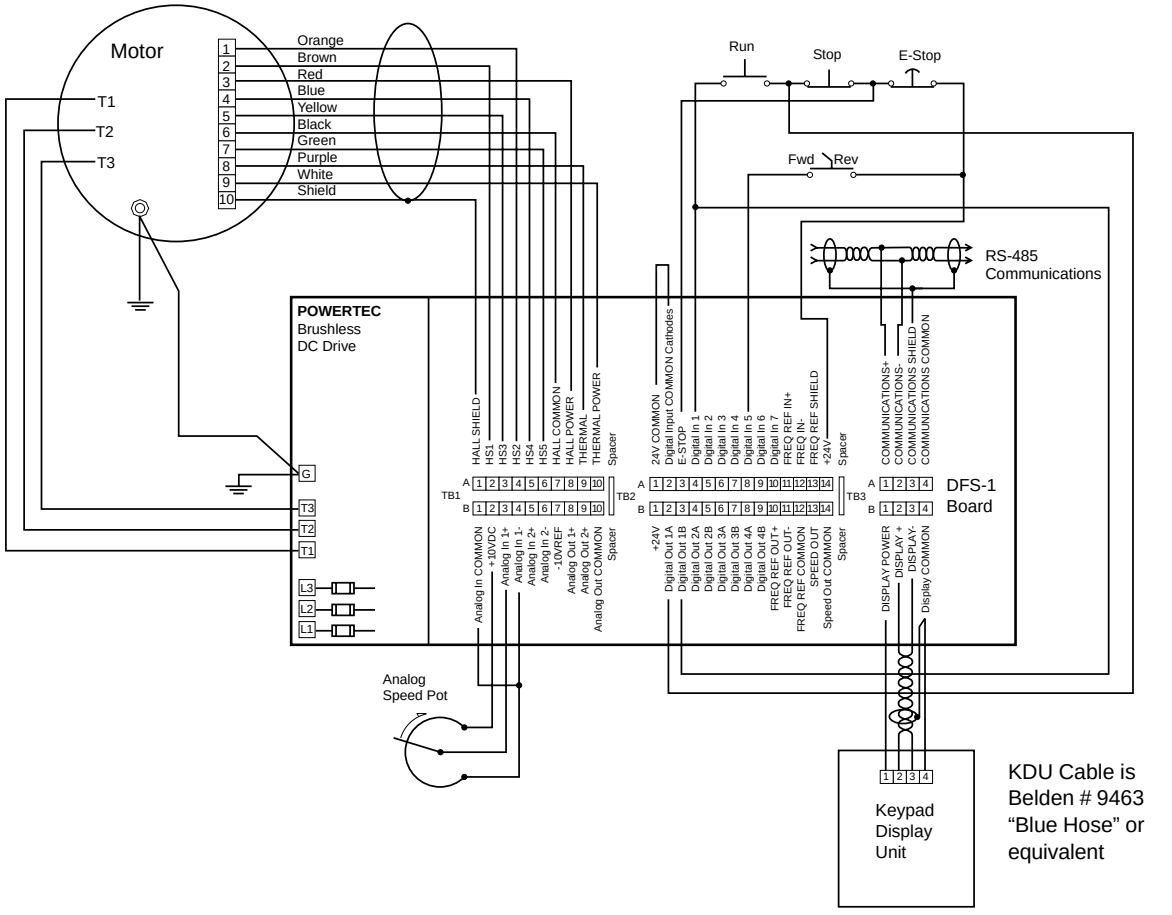


Figure 3: Basic connections to the DFS-1 controlled POWERTEC Brushless DC motor control, using the factory default settings for some of the inputs and outputs. Note that the speed pot input is the default, and that using the 4-20mA input will require a change in the DFS-1 setup.

MOTOR ENCODER CABLE:

The motor encoder cable is connected to plug-in terminal strip TB1:A on the DFS-1 PC board. A shielded cable must be used for the motor encoder cable. The recommended cable is a 9-conductor shielded cable (Belden Cable part # 9539 or equivalent). The shield should be connected at the drive end to the shield terminal (TB1:A1) and to terminal 10 (if there is one) at the motor terminal strip and if not (as on motors built prior to April 1992), the shield should be cut off at the motor end and taped up.

The DFS-1 PC Board contains all of the functions necessary to operate the Brushless DC motor control according to the inputs connected to its terminals and the programmed information in memory. The DFS-1 board takes care of all speed, torque, and control functions. It takes speed information from the encoder, environmental information and current (load) information from the power output circuits of the drive, and compares all that information to the input conditions and programmed parameters. It processes this information and turns the power transistors on and off according to the needs of the system.

The DFS-1 is delivered with an installed set of default parameters which will allow it to operate with a standard set of connections (as illustrated in Figure 3) of the types used with standard motor controls. However, these standard connections will not be in the same physical positions as they are in the standard control, and the default setting will not take care of any optional modes of operation.

There are three plug-in terminal strips on the bottom of the DFS-1 PC board labelled in sections from left to right: TB1, TB2, and TB3. Though the three sections look like two rows of strips, there is a small separator between each of the sections. Each of the sections has an upper row (A) and a lower row (B). The B row is closest to the PC board. The terminals are numbered consecutively from left to right on each level.

ANALOG INPUTS:

There are two analog input ports to the DFS-1 on TB1:B. When used as a voltage input, both of the analog inputs are a differential type of input with a minimum input impedance of 200 Kohms. When using one of the analog inputs for a voltage input, the input common at terminal 1 on TB1:B should be used for shields.

When using an analog input as a milliamp input, the (-) side of the input (terminal 4 for Analog Input #1 or terminal 6 for Analog Input #2) should be connected to the common of the milliamp current source. The milliamp source should be connected to the (+) input (terminal 3 for Analog Input #1 or terminal 5 for Analog Input #2).

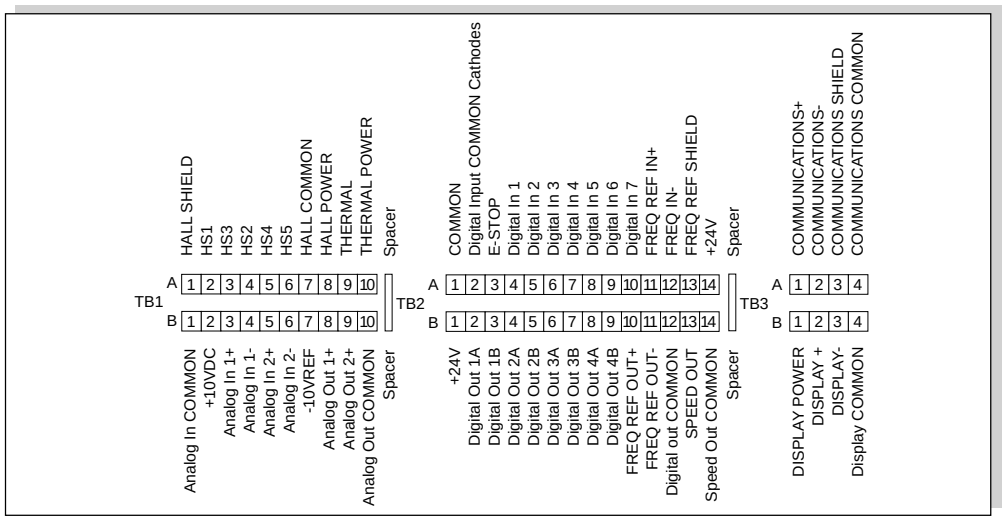


Figure 4: Assignments of the DFS-1 terminals. There are default assignments, but any of the analog and digital inputs and outputs (except the motor connections, power supplies, commons, emergency stop input, and frequency input) may be changed by setup.

The default speed reference input is Analog Input #1, located on TB1:B. The default input is for a 0 to +10VDC for zero to full speed of the motor. Terminal 3 is the positive side of the input and terminal 4 is the negative side. If the speed signal being used is externally supplied, the differential input will have a noise cancelling effect. Terminal 1 on TB1:B is a common for shields.

Reference sources of +10VDC and -10VDC are supplied on the terminal strips at TB2:B2 and TB2:B7, respectively. The default speed pot connections should be made as illustrated in figure 3. Notice that the (-) side of the differential input (terminal 4) is connected by a jumper to common (terminal 1), because the DFS-1 reference source is being used. If an external reference source is to be used, no jumper is necessary.

IN THE DEFAULT SETUP, ONLY ANALOG INPUT #1 IS ACTIVE. WHILE THE OTHER ANALOG INPUT HAS A DEFAULT SETUP, IT IS NOT ACTIVE UNTIL THE USER CHANGES THE SETUP TO MAKE IT ACTIVE.

The microprocessor will look ONLY to Analog Input #1 for speed information until it is told to do otherwise in the setup program.

The other analog input to the DFS-1 is at TB1:B (lower level) terminals 5 (+) and 6 (-). Both of the inputs may be programmed for one of six inputs as shown in the table below.

Input Signal Level	TB1:B (+) input term	TB1:B (-) input term	jumper terms	input impedance
-10 to +10 VDC	3 or 5	4 or 6	none **	200 Kohms
0 to +10 VDC	3 or 5	4 or 6	none **	200 Kohms
0 to +5 VDC	3 or 5	4 or 6	none **	200 Kohms
1 to +5 VDC	3 or 5	4 or 6	none **	200 Kohms
0 to 20 mADC	3 or 5	1	4 or 6 to 1	250 ohms
4 to 20 mADC	3 or 5	1	4 or 6 to 1	250 ohms

** if the DFS-1 supplies are used, jumper 4 or 6 to 1 to establish the reference common.

ANALOG OUTPUTS:

There are two analog outputs on TB1:B. Each of the outputs may be programmed in several ways:

1. Disabled
2. Actual speed (value is proportional to motor speed)
3. Load output (value is proportional to motor load)
4. Comm set (value is set via Communications)
5. Commanded speed

Analog Output #1 default is a -10 to +10VDC signal representing motor speed. The outputs are on TB1:B terminals 8 (+) and 10 (-). The opposite polarity is available by a parameter change. See the description for parameters #26 and #27.

The default for Analog Output #2, terminals 9 (+) and 10 (-), is -10 to +10VDC representing motor load, 0% to 150% load. The opposite polarity is available by changing a parameter.

The maximum output current for the analog outputs is 20 milliamps.

FREQUENCY INPUT:

There is only one frequency input on the DFS-1. This input is used by the drive as the reference to follow when the drive is in the SLAVE Mode of operation. This input cannot be reassigned.

If the DFS-1 is in the MASTER mode, it will ignore the frequency input.

The Frequency input is located at TB2:A terminals 11(+) and 12 (-). This input is a differential line receiver type intended to interface directly with another DFS-1, a BCDMAX or CRM-1. There may be multiple slaves connected to a single Master by daisy-chaining the frequency reference line. The last slave on the line should have the jumper at JP1 on the two rightmost pins. This inserts a terminating resistor at the end of the line to help eliminate electrical noise from the system. All others should be on the two leftmost pins.

Contact POWERTEC's Application Engineering Department before trying to use another type of frequency on this input.

FREQUENCY OUTPUT:

There are two outputs available to supply a frequency for external use.

The first is located at TB2:B terminal 10 (+) and 11 (-). This is an output which is intended to provide a reference frequency input for another DFS-1, BCDMAX or CRM-1. This output is not compatible with the DIGIMAX. It will provide a signal of +/- 1.5V minimum when connected to another DFS-1's reference frequency input. This output on a unit configured as a master, operates at 16 times the frequency of the motor speed output reference. There is a 120 ohm termination resistor built into the output for transmission line termination.

When operating the DFS as a slave, the output frequency is internally divided by 16 in addition to being multiplied by the set ratio from the slave. As a consequence, the frequency output from a DFS slave cannot be used as the reference to another DFS slave without some way of first multiplying this frequency by 16. POWERTEC's Cascade Ratio Multiplier option board (4001-153430-XXX) can be used for this purpose. Contact the factory for any frequency following application which requires a reference source other than a master DFS.

The other frequency output is at TB2:B13. This is a 24VDC peak square wave referenced to the DFS-1 common (TB2:B14). This signal is at the motor speed output reference frequency and may be used to interface with a DIGIMAX or a BLDC motor control. This output sources a maximum of 10mA and can sink 30mA.

DIGITAL INPUTS:

There are eight digital control inputs on TB2:A as well as a +24VDC supply (TB2-A14) and common (TB2-A1). The eight inputs are optical isolator input diodes with a common cathode connection at TB2-A2. When the +24VDC, DFS-1 supply is used to power the inputs, TB2:A2 must be jumpered to the 24VDC common terminal on TB2:A1.

The functions of all inputs are programmable except Emergency Stop (TB2-A3). All digital inputs are electrically isolated from the DFS-1 power supplies and common when an external power supply is used to power the digital inputs (such as from a PLC).

The default parameter setup is for a set of standard motor controller input connections on TB2:A terminal strip (see figure 3 on page 3).

Five of the inputs are set up for standard push-button operation of the DFS-1. They are:

Run	4 (+)
Preset	5 (+)
UP (increase)	6 (+)
DOWN (decrease)	7 (+)
Reverse	8 (+)

All of these inputs are referred to TB2-A2. Note that TB2-A2 (the common cathode connection) must be jumpered to common (TB2:A1) in the basic connections.

Each of these inputs will take a +24VDC input (no more than 30VDC, not less than 18VDC). If an external source of +24VDC is used, TB2-A2 on the upper level must be connected to the negative side of the external source.

Mode of Operation:	differential
Number of receivers:	32 maximum
Maximum Cable Length:	4000 feet
Maximum Frequency:	10 Megahertz
Common Mode Voltage: maximum	+12V, -7V
Driver Output:	+/-1.5V minimum
Driver Load:	60 ohm minimum
Driver Short Circuit: 1	50 mA to ground
Driver Output Resistance:	120 ohms (ON)
Receiver Input Resistance:	12 Kohms
Receiver Sensitivity:	+/-200 mA

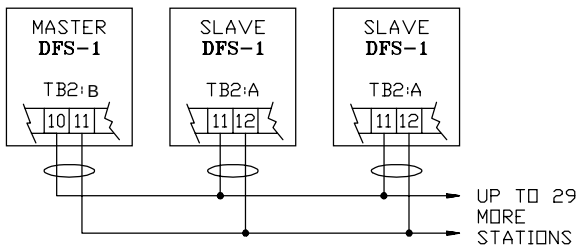


Figure 5: Slaving DFS-1 units with the Reference Frequency Output.

The programmable inputs (TB2-A4 through TB2-A10) may be programmed for jog, thread, or other preset speeds. The inputs may also be used to change torque levels, trim values, or ramp rates. Any value which can be affected by a parameter can be changed by a digital input.

DIGITAL OUTPUTS:

Digital outputs are located on TB2:B. The four outputs are normally open relay contacts. The contacts are rated at 120VAC at 1 amp, resistive.

The default setup assigns the outputs as follows:

Digital Out #1	Run
Digital Out #2	No Fault
Digital Out #3	At Speed
Digital Out #4	Reverse

These assignments may be changed by parameters.

All of the digital outputs are programmable and may be configured as Normally Open or Normally Closed. If more than one contact is required for a certain function, an external relay may be used, or more than one output may be programmed for the same function.

COMMUNICATIONS:

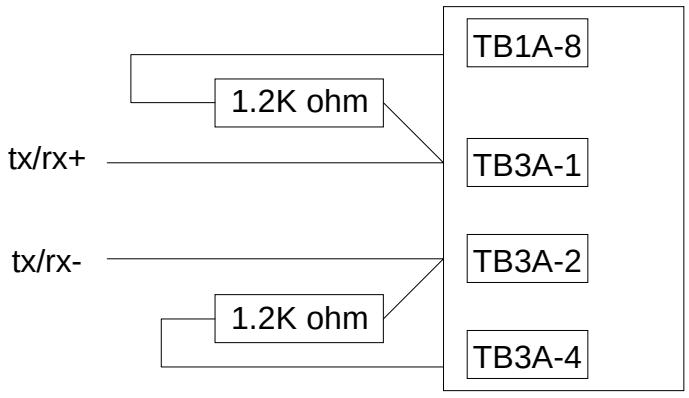
The standard communications for the DFS-1 is the EIA standard RS-485 communications format over a single twisted pair cable into TB3:A terminals 1 and 2. Terminal 3 is for the shield. DO NOT CONNECT TERMINAL 3 TO GROUND! Maximum allowable distance for twisted pair operation is 4000 meters (about 12,000 feet). Maximum nodes without repeaters is 32. Maximum communications rate is 38.4 kilobaud. The last unit on the comm line should have a jumper at JP2 on the rightmost 2 pins. All other units should have the jumper on the leftmost two pins.

There is an RS-485 local programming input at TB3:B for an optional keypad display unit.

RS485 Communications Connections:

Most host or converter devices (including the RS232/485 converter made by POWERTEC) include 1.2 Kohm pull up resistors which insure rx-tx- is pulled down to ground and rx/tx+ is pulled up to +5V when the line is inactive (tristated). This ensures the high impedance (floating) line does not change state due to noise when the line is not being driven. No matter how many units are connected in the network, only one such set of pull ups should be installed.

NOTE: The Allen Bradley RS485 connections on their coprocessor module for the Series 5 PLCs do not provide these pull ups and must be installed or noise will prevent proper communications.



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DEFAULT SETUP

The concept behind the DFS-1 calls for fully programmable inputs and outputs. The ability to change analog and digital inputs and outputs at will lends a whole new meaning to the word "flexibility".

POWERTEC has established a set of "default" parameters which will leave the setup of the DFS-1 in a way that will operate a motor in the basic configuration (see figure 3 on page 3 and figure 4 on page 4). There are two good reasons for doing this:

1. This default setup allows the user to connect and operate a motor using common, everyday connections without having to program the DFS-1 prior to its initial use.
2. The default setup provides a baseline to which the user can return if it appears that something is wrong with either the user's setup or the motor control. There is a command which allows the "reset" of the setup to the default configuration.

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2.0 SPECIFICATIONS

POWER SUPPLIES

+24VDC
- Available at TB2:A14, and TB2:B1.
- The combination is fused at 250 milliamps (mA). The fuse is self-healing.
- The opening of the fuse alerts the microprocessor.
- These supplies should only be used for push-buttons, relays, PLC outputs, etc. which interface directly with the DFS-1. They should not be used as general purpose supplies.

+10VDC
- Reference supply available at TB1:B2. This output is rated at 100mA. This output is current limited and thermally protected.

-10VDC
- Reference supply available at TB1:B7. This output is rated at 100mA, current limited and thermally protected.

+5VDC
- Supply for motor encoder available at TB1:A9. This supply is fused at 100mA with a self-healing fuse. When the fuse opens, it alerts the microprocessor.

THIS SUPPLY IS FOR THE MOTOR ENCODER ONLY!

ANALOG INPUTS

1.0 There are two analog inputs on TB1:B. (see section 1.2, page 4)
2.0 Each input may be set up in one of several modes.
3.0 Pre-programmed modes are:
- 3.1 General purpose Input
- 3.2 Speed Reference Input
- 3.3 Trim (dancer or load cell) Input
- 3.4 External Motoring Torque Limit
- 3.5 External Regenerative Torque Limit
- 3.6 Horsepower Mode

4.0 The mode of the input is set by parameter (#17 for Analog Input #1 and parameter #21 for Analog Input #2).
5.0 Each of the two inputs may be set up one of six ways:

1.	-10	to	+10	VDC
2.	0	to	+10	VDC
3.	0	to	5	VDC
4.	1	to	5	VDC
5.	0	to	20	mADC
6.	4	to	20	mADC

6.0 Setup is by parameter selection (#18 for Analog Input #1 and parameter #22 for Analog Input #2).
7.0 Voltage inputs are a differential input connection.
8.0 Input impedance of each input in voltage input mode is 200 Kilohms minimum.
9.0 Input impedance in milliamp input mode is 250 ohms.

Factory default setups are included so that the DFS-1 does not have to be programmed prior to its initial use. Factory defaults are only one of the many ways the DFS-1 can be set up.

Default setups are as follows:

INPUT	SETUP	FUNCTION
1.	0 to +10VDC	Speed Reference Input
2.	-10 to +10VDC	General Purpose Input

ANALOG OUTPUTS

1.0 There are two analog outputs on TB1:B.
2.0 The analog outputs may be programmed for one of five modes:
- 2.1 Disabled
- 2.2 Motor Speed Output -10 to +10VDC = 0 to 100% (Actual Motor Speed) Default - Analog Output #1
- 2.3 Motor Load Output -10 to +10VDC = 0 to 150% Default - Analog Output #2
- 2.4 Set by Communications Link
- 2.5 Commanded Motor Speed

3.0 Output impedance is less than 100 ohms.
4.0 Maximum output voltage is +/- 10VDC.
5.0 Maximum current is 25mADC.

FREQUENCY INPUTS AND OUTPUTS

There is one frequency input and there are two frequency outputs available.

INPUT
#1 REFERENCE FREQUENCY INPUT
TB2:A Terminals 11 (+) and 12 (-).

- This is a line receiver type input which must be driven by a differential line driver output.
- This frequency input requires a frequency 16 times the feedback from the motor.
- The feedback from the motor is normally 120 PPR for 4 pole motors and 240 PPR for 8 pole motors.
- Normal input is 56 Kilohertz for 0 to full speed for a 1750 RPM motor with a 120ppr encoder.
- Terminal 13 is for the shield. Do not ground terminal 13 directly. It is internally terminated.

OUTPUTS
#1 REFERENCE FREQUENCY OUTPUT
TB2:B Terminals 10 (+) and 11 (-),

- This is a differential line driver output which must be used with a differential line driver input.
- This frequency output is 16 times the reference frequency to the motor.
- This output may drive up to 32 receivers.
- Connect the shield to terminal 12. This will ground the shield internally.

#2 MOTOR SPEED FREQUENCY OUTPUT
TB2:B Terminals 13 (+) and 14 (common),

- This output is a +24VDC peak square wave at the motor feedback pulse rate, which is 2 times RPM for 4 pole motors and 4 times RPM for 8 pole motors.

The reference frequency input and output are capable of receiving and sending at up to 1 Mega-hertz.

Motor Speed output emits frequencies up to 100 Kilohertz.

DIGITAL INPUTS

The eight digital inputs of the DFS-1 are optically coupled requiring +24VDC (+/-6VDC) at about 5mA each. These inputs are isolated from the common of the board.

All inputs are programmable as to function, EXCEPT the EMERGENCY STOP input. Inputs #1 through #7 may be assigned as general purpose inputs.

The defaults are as follows:

	TB2:A terminal 3(+) (Cannot be reassigned)	Emergency Stop
DI 1.	TB2:A4(+)	Run
DI 2.	TB2:A5(+)	Preset Speed
DI 3.	TB2:A6(+)	Up (Increase)
DI 4.	TB2:A7(+)	Down (Decrease)
DI 5.	TB2:A8(+)	Reverse
DI 6.	TB2:A9(+)	Frequency Mode
DI 7.	TB2:A10(+)	Local/Remote

Inputs #1 through #7 may also be programmed for inverted input, i.e., active when input is low.

DIGITAL OUTPUTS

There are four dry contact outputs from the DFS-1. All of these outputs are on TB2:B. All outputs are programmable as to function, and all outputs may be set up as either normally open or normally closed.

Each relay output has a single, isolated, contact output which may be programmed as normally open or normally closed, with the contact rated at 1 Amp, 125VAC resistive.

The default assignments are as follows:

DO 1.	TB2:B terminals 2 and 3 Closed while running	Run relay contact
DO 2.	TB2:B terminals 4 and 5 Closed while no faults	No fault relay
DO 3.	TB2:B terminals 6 and 7 Closed when at speed	At Speed relay
DO 4.	TB2:B terminals 8 and 9 Closed when in Remote	Remote Mode

COMMUNICATIONS

Standard:	RS-485
Data Rates:	300, 600, 1200, 2400, 4800, 9600, 19.2K, and 38.4K baud
Addresses:	1 to 255
Protocols:	POWERTEC Binary protocol
Distance:	4000 meters (about 12,000 feet) maximum with twisted pair shielded cable
Nodes:	32 maximum

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3.0 DFS-1 PARAMETERS

DFS-1 parameters are stored as DOUBLE WORD values (32 bits), regardless of the actual size of the data. This method is used to simplify the entire system at a cost of a little extra data storage.

A double word consists of four BYTES (8 bits). Each byte is a hexadecimal (base 16) value which ranges from 00h (0 decimal) to FFh (255 decimal). The largest number used in the DFS-1 parameters is 99,999 decimal, which, in hexadecimal notation is 0001 869Fh.

In many cases, information other than numbers is passed and stored in the parameters. The left byte is the most significant and the last byte is the least significant. The arrangement of the bytes for this purpose is: VL4 VL3 VL2 VL1 where VL4 is the Most Significant Bit (MSB) and VL1 is the Least Significant Bit (LSB). Each parameter breaks down the bytes accordingly.

All four bytes are required in communications. A number which must be either 0 or 1 must be passed as either 0000 0000h or 0000 0001h.

1 UNIT ID

USE PARAMETER #1 TO IDENTIFY THE ADDRESS OF THE UNIT ON A NETWORK.
RANGE OF VALUES: 0000 0001h to 0000 00FFh
1 to 255 (decimal)
Default Value: 0000 0001h 1 (decimal)

The Unit ID number is installed in parameter #1. This serves as an address on the external communications link. Two DFS-1 units cannot have the same address while installed on the same communications link.

There are 254 possible addresses if the default value of 1 is not used as an address. Since the default value is 1, there could be a problem if a new unit is installed without changing the #1 parameter.

2. BAUD RATE

USE PARAMETER #2 TO SET THE COMMUNICATIONS SPEED OF THE NETWORK.
RANGE OF VALUES: 0000 0000h to 0000 0007h
0 to 7 (decimal)
Default Value: 0000 0002h 2 (decimal)

This establishes the rate at which data is exchanged in the communications link. Every DFS-1 in the communications link must have the same baud rate set up in parameter #2. The parameter selects from among eight industry standard baud rates:

NUMBER	BAUD RATE	
0000 0000h	38.4 Kilobaud	(38,400 baud)
. . . . 01	19.2 Kilobaud	(19,200 baud)
. . . . 02	9,600 baud	
. . . . 03	4,800 baud	
. . . . 04	2,400 baud	
. . . . 05	1,200 baud	
. . . . 06	600 baud	
. . . . 07	300 baud	

3. LOCAL / REMOTE CONTROL

USE PARAMETER #3 TO SET UP WHICH FUNCTIONS ARE CONTROLLED REMOTELY.
RANGE OF VALUES: 0000 0000h to 0000 007Fh
0 to 127 (decimal)
Default Value: 0000 0000h 0 (decimal)

Parameter #3 is first broken down into bytes, and then VL1 is further broken down into bits.

When broken down into bits, 00h = 0000 0000b, and 7Fh = 0111 1111b.

VL4 is always 00h.
VL3 is always 00h.
VL2 is always 00h.
VL1 is broken down into eight bits, which are numbered from right to left: 7654 3210h.

Functions are assigned as follows:

Bit Position	Function
7	NOT USED
6	Master/Slave (not presently functional)
5	Frequency Mode
4	Reverse
3	Down
2	Up
1	Preset
0	Run

A zero in a bit position means that function may be controlled from an input terminal assigned to it. A one in a bit position means that the function may only be controlled via a communications link, such as the operator's station connection or the external RS-485 communications link.

For instance, if VL1 is given a value of 01 (0000

0001b) , the Run FUNCTION cannot be controlled from the terminal strip, but can only be controlled through the external communications link or the local comm link (keypad display unit).

If VL1 has a value of 73 (0111 0011b), all functions except UP and DOWN are controlled remotely.

NOTE: Parameter #3 ONLY determines whether a FUNCTION is controlled locally or remotely. This parameter has nothing to do with the assignment of functions to terminals.

Any input function can be assigned to any input terminal with the exception of the Emergency Stop input. The Emergency stop function is hard-wired on the DFS-1 board and cannot be changed by either programming or parameters.

If the RUN function is assigned to an input terminal, and this parameter is set to remote the RUN function control, the terminal will be IGNORED.

4. COMMUNICATIONS PROTOCOL

USE PARAMETER #4 TO IDENTIFY THE NETWORK COMMUNICATIONS LANGUAGE.
RANGE OF VALUES: 0000 0000h to 0000 0001h
0 to 1 (decimal)
Default Value: 0000 0000h 0 (decimal)

At the present time, the only communications protocol available is Powertec's Binary protocol. This parameter has been included with the intent of providing alternative protocols at some time in the future.

5. MODES OF OPERATION

USE PARAMETER #5 TO SET UP MASTER/ SLAVE AND TORQUE LIMITING MODES.
RANGE OF VALUES: 0000 0000h to 0003 0002h
no decimal significance
Default Value: 0000 0000h no decimal significance

This parameter is a dual purpose command used to set operational modes of the DFS-1:

VL2 VL1 sets the basic operation of the board. There are three modes of basic operation used to determine where the speed and/or torque commands originate:

- 0000h MASTER mode (the board generates its own speed/torque based on its parameters)
- 0001h SLAVE mode (the board follows an external signal in direct proportion)
- 0002h INVERSE Slave mode (board follows an external signal in inverse proportion)

The DFS-1 board in MASTER mode generates its own speed and torque commands.

In SLAVE mode the board follows a reference frequency at TB2:A terminals 11(+) and 12(-), which should be nominally 16 times the desired speed of the motor. This signal is available from another DFS-1 board or from a BCDMAX board. It may also come from another source which has a compatible line driver output. (See the description for frequency input elsewhere in this manual).

In INVERSE slave mode, the board follows the external frequency in a proportion of 1/RATIO. Instead of setting a direct ratio of 0.5000, a ratio of 2.0000 may be entered for half speed. This is useful in cases requiring draw settings where the slave is physically located before the master, which is set for line speed.

VL4 VL3 contains information on modified operational modes in which the torque in the motor is limited below the current limit level (current limits are always set by parameters 44 and 45). These optional modes are defined as follows:

0000h Normal current limits (motor current not limited at a lower level)
0001h Motoring torque setpoint (motoring current to be limited at a lower level)
0002h Regenerative torque setpoint (regenerative current to be limited at a lower level)
0003h Horsepower setpoint (the product of motor current and motor speed is limited)
0004h through 000Fh available for future use

When in the normal mode, the current in the motor is not controlled below current limit.

If one of the modified operational modes is chosen, the torque/horsepower setpoint is selectable in one of three places:

1. Analog Input #1 (must be set up in parameter #17)
2. Analog Input #2 (must be set up in parameter #21)
3. The Set Application Mode (8F) Command via communications

If one of these three setpoints is not present, the setpoint defaults to the appropriate current limit level.

6. MAXIMUM MOTOR SPEED

USE PARAMETER #6 TO SET THE ABSOLUTE MAXIMUM MOTOR SPEED.
RANGE OF VALUES: 0000 0001h to 0000 2710h
1 TO 10,000 (decimal)
Default Value: 0000 06D6h 1750 (decimal)

The maximum motor speed parameter is set directly in Revolutions Per Minute (RPM) once the Encoder Pulses Per Revolution (PPR) is set in parameter # 7. If the incorrect PPR is set in parameter #7, the maximum motor speed will not be correct and the motor may overspeed or not be able to go fast enough.

The maximum motor speed is normally the number given on the nameplate of the motor. This number may be set higher than the motor nameplate in some situations because the Brushless DC motor is capable of some overspeed with light loads.

This parameter may be set to a value which is lower than the motor's base speed in cases where it is not desired to use the full speed of the motor.

7. ENCODER PULSES PER REVOLUTION

USE PARAMETER #7 TO ESTABLISH THE PULSE FEEDBACK RATE FROM THE MOTOR.
RANGE OF VALUES: 0000 0001h to 0000 4E20h
1 TO 20,000 (decimal)
Default Value: 0000 0078h 120 (decimal)

This parameter tells the DFS-1 the resolution of the encoder in Pulses Per Revolution (PPR). This is normally four times (4X) the rate of one channel of the motor's encoder.

Motors from the 42 frame through the 259T frame have a 30 PPR, two channel, quadrature internal encoder. For these motors using the internal encoders the parameter should be set to 120 PPR.

Motors from 287TZ through 5010ATZ have an internal 60 PPR, two channel, quadrature encoder. The parameter for these motors using the internal encoders should be set to 240 PPR.

External encoders may have almost any PPR rate, and they must have two channels in quadrature (the channels have the same pulse rate, but they are 90° out of phase with each other). The pulse rate will be on the ENCODER nameplate.

Encoders with higher pulse rates are normally used to obtain lower speeds and/or finer resolution of motor shaft position. The most common external encoder on POWERTEC motors is a 600 PPR, two channel, quadrature optical encoder. For this encoder the PPR in this parameter will be 2400.

For other encoders, multiply the pulse rate for one channel (the usual number given on the nameplate) by four and enter that number in this parameter.

This parameter may not be changed while running. Attempting to change this parameter while running will result in the effect being delayed until the next time a setpoint command is given or until the control is stopped. Changing this number will drastically affect the calibration of the system.

(Also see Parameter 46)

8. MASTER RAMP UP TIME

USE PARAMETER #8 TO SET THE TIME TO RAMP FROM ZERO TO FULL SPEED.
RANGE OF VALUES: 0000 0001h to 0003 E418h
1 TO 255,000 (decimal)
Default Value: 0000 2710h 10,000 (decimal)

This is the acceleration time from zero speed to full speed in the MASTER mode. The time may be set from 1 millisecond (.001 sec.) to 255 seconds. The default is 10 seconds (10,000 mSec).

The acceleration rate is calculated from zero to maximum motor speed (parameter 6). This rate is used when the speed command in MASTER mode is changed from a lower speed (including 0) to a higher speed.

If the change in speed is from zero speed to full speed, the full amount of time will be used. If the change is from 25% speed to 75% speed, it will take 1/2 of the time set in this parameter to reach the new speed. If the change is from 80% speed to 90% speed, it will take 1/10th the time in this parameter.

The acceleration rate does not affect the JUMP UP change in speed.

9. MASTER RAMP DOWN TIME

USE PARAMETER #9 TO SET THE TIME TO RAMP FROM FULL TO ZERO SPEED.
RANGE OF VALUES: 0000 0001h to 0003 E418h
1 TO 255,000 (decimal)
Default Value: 0000 2710h 10,000 (decimal)

This is the deceleration rate in the MASTER mode. The rate may be set from 1 millisecond (.001 sec.) to 255 seconds. The default is 10 seconds.

The rate is calculated from maximum speed (parameter 6) to zero speed. This rate is used whenever the speed command in the MASTER mode is changed from a higher speed to a lower speed (including 0).

If the change in speed is from full speed to zero speed, the full amount of time will be used. If the change is from 75% speed to 25% speed, it will take 1/2 of the time set in this parameter to reach the new speed. If the change is from 80% speed to 90% speed, it will take 1/10th the time in this parameter.

The deceleration rate does not affect the JUMP DOWN change in speed.

10. SLAVE RAMP UP TIME

USE PARAMETER #10 TO SET THE UP RAMP TIME WHEN THE RATIO IS CHANGED.
RANGE OF VALUES: 0000 0001h to 0003 E418h
1 TO 255,000 (decimal)
Default Value: 0000 2710h 10,000 (decimal)

This is the acceleration rate in the SLAVE mode. The rate may be set from 1 millisecond (.001 sec.) to 255 seconds. The default is 10 seconds (10,000 mSec).

This parameter sets a rate determined by the amount of time it takes to change from a ratio of 0.0000 to a ratio of 1.0000. This rate is used whenever the ratio setpoint in the SLAVE or INVERSE SLAVE mode is changed from a lower ratio (including 0) to a higher ratio.

This rate does not affect the rate at which the DFS-1 responds to changes in the reference frequency, nor does it affect the ratio when the drive is started as a slave if parameter #54 is set to Freeze.

This rate does not affect the Slave JUMP UP time.

11. SLAVE RAMP DOWN TIME

USE PARAMETER #11 TO SET THE down RAMP TIME WHEN THE RATIO IS CHANGED.
RANGE OF VALUES: 0000 0001h to 0003 E418h
1 TO 255,000 (decimal)
Default Value: 0000 2710h 10,000 (decimal)

This is the deceleration rate in the SLAVE mode. The rate may be set from 1 millisecond (.001 sec.) to 255 seconds. The default is 10 seconds (10,000 mSec).

This parameter sets a rate determined by the amount of time it takes to change from a ratio of 1.0000 to a ratio of 0.0000. This rate is used whenever the ratio setpoint in the SLAVE or INVERSE SLAVE mode is changed from a higher ratio to a lower ratio (including 0).

This rate does not affect the rate at which the DFS - 1 responds to changes in the reference frequency, nor does it affect the ratio when the drive is stopped as a slave if parameter #54 is set to Freeze.

This rate does not affect the slave JUMP time.

12. MASTER PRESET SPEED

USE PARAMETER #12 TO SET A PRESET SPEED WHICH CAN BE TOGGLED IN AND OUT.
RANGE OF VALUES: 0000 0000h to 0000 2710h
0 TO 10,000 (decimal)
Default Value: 0000 00C8h 100 (decimal)

The MASTER preset speed is the speed to which the motor will go when a PRESET input is activated on one of the Digital inputs (any of the seven digital inputs may be programmed as a PRESET input) when the DFS-1 is in the MASTER mode. If more than one input is programmed as a PRESET input, they must both be present to activate the PRESET Speed function (the inputs are logically ANDed).

13. SLAVE RATIO PRESET

USE PARAMETER #13 TO SET A PRESET RATIO WHICH CAN BE TOGGLED IN AND OUT.
RANGE OF VALUES: 0000 0000h to 0001 869Fh
0 TO 99,999 (decimal)
Default Value: 0000 2710h 10,000 (decimal)

The SLAVE preset ratio is the ratio to which the motor will go when a PRESET input is activated on one of the Digital inputs (any of the seven digital inputs may be programmed as a PRESET input) when the DFS-1 is in the SLAVE mode. If more than one input is programmed as a PRESET input, they must both be present to activate the PRESET Speed function (the inputs are logically ANDed).

Note: For all ratio setpoints, 4 decimal places are implied. Therefore, the maximum ratio setpoint is 9.999.

14. ENGINEERING UNITS

USE PARAMETER #14 TO SET THE ENGINEERING UNITS AT MAXIMUM MOTOR SPEED.
RANGE OF VALUES: 0000 0001h to 0001 869Fh
1 TO 99,999 (decimal)
Default Value: 0000 06D6h 1750 (decimal)

Engineering Units (EGU) define the relationship between motor speed or torque and process reference points. It allows setting and reading of parameters in terms other than speed and torque. The basic relationship between motor speed and EGU is defined in parameter #14, which sets the value of EGU's at full motor speed. This parameter is used to determine the relationship between units of commanded speed and RPM. The number entered in this parameter is equivalent to the number in parameter #6. This allows the user to enter speed commands in engineering units (such as Feet Per Minute, Yards Per Minute, etc).

Speed commands entered by commands #82 and #84 are entered in terms of this parameter. If the value of this parameter is the same as the value of parameter #6, then there is a 1:1 relationship between the Engineering Units and the RPM (i.e., enter 1750 (06D6h) as a speed command for 1750 RPM).

However, if this parameter is set to 1000 (03E8h) and #6 is set to 1750, then the relationship is 1:1.75. Entering 1000 (03E8h) as a command results in 1750 RPM, but entering 500 (01F4h) results in 875 RPM.

15. BASE RATIO

USE PARAMETER #15 TO SET THE "GEAR RATIO" OF THE MOTOR IN A SLAVE SYSTEM.
RANGE OF VALUES: 0000 0001h to 0001 869Fh
1 TO 99,999 (decimal)
Default Value: 0000 2710h 10,000 (decimal)

This is the "gearing" ratio which corrects for the mechanics of the system and also for differences in motor speeds. The output frequency at TB2:B terminals 10 (+) and 11(-) is determined by the settings of the maximum motor speed (parameter #6) and the encoder PPR (parameter #7). The output frequency will be:

Output Reference Frequency = Motor max RPM x Encoder PPR x 16 / 60

A 1750 RPM motor with a 120 PPR encoder puts out a reference frequency of 56 Kilohertz. This frequency varies with the commanded speed. When this frequency is used as a reference, it is first multiplied by the base ratio, and then by the SETPOINT. These steps change the frequency to the proper level.

For example, it is generally useful in a slave system to be able to enter a SETPOINT of 1.0000 on

the slave unit to match the line speed, motor speed, or section (master). Many times, however, the gearing between the slave motor and the surface of a roll is not the same as the master, or the diameter of the rolls vary from section to section, or motors of different RPM's may have to be tracked. The BASE RATIO is a correction factor which allows the SETPOINT to be adjusted.

The following are other examples of how the Base Ratio parameter is used: if a standard 2500 RPM motor is to follow a standard 1750 RPM motor, and both motors must attain their full speed at the same time, and a setpoint of 1.0000 is desired, enter 1.4826 (2500/1750) into parameter #15 to make the follower motor go 48.26% faster when the setpoint is 1.0000.

If the surface speed of a lead roll is 100 FPM at 1750 RPM (4-pole motor, 120 PPR encoder), and the surface speed of the follower roll is 100FPM at 1550 RPM (4-pole motor, 120 PPR encoder), enter 0.8857 in parameter #15 to make the follower roll go 88.57% of the speed of the lead when the setpoint is set to 1.0000.

If the lead motor is a 100 HP, 1750 RPM (8-pole, 240PPR), and the follower is a 5 HP, 3000 RPM (4-pole, 120 PPR) motor, the reference output frequency of the lead is 1750 x 240 *16 / 60 = 112 kHz. The follower motor needs a frequency of 3000 x 120 * 16 / 60 = 96 kHz to operate at a 1.0000 setpoint. Therefore the maximum 112 kHz must be reduced to a maximum of 96 kHz by setting the base ratio to 0.8571.

If the SETPOINT needs to be something other than 1.0000, make a proportional adjustment in the base ratio. If the desired SETPOINT is 2.0000, use a base ratio of 1/2 of the value necessary for a 1.0000 setpoint.

16. MAXIMUM RATIO

USE PARAMETER #16 TO SET THE HIGHEST ALLOWABLE RATIO IN A SLAVE SYSTEM.
RANGE OF VALUES: 0000 0001h to 0001 869Fh
1 TO 99,999 (decimal)
Default Value: 0001 869Fh 99,999 (decimal)

Set the maximum ratio in the system if it is to be lower than the default, which is the absolute maximum.

Note: For all ratio setpoints, 4 decimal places are implied. Therefore, the maximum ratio setpoint is 9.999.

17. ANALOG INPUT #1 MODE SELECT

USE PARAMETER #17 TO SELECT THE PURPOSE OF A SIGNAL AT ANALOG INPUT #1.
RANGE OF VALUES: 0000 0000h to 0000 001Fh
0 TO 32 (decimal)
Default Value: 0000 0001h 1 (decimal)

Analog Input #1 is a general purpose input which may be programmed for one of several modes of operation. The mode affects how the signal is used for setting or changing of the motor's speed and/or torque.

The following modes are provided for:

- 0000 0000h General Purpose Input - can be read via the COMM port
- 0000 0001h Speed Reference input - Sets the speed of the motor (see below)
- 0000 0002h Trim Input - may be used for dancer or other transducer input (not yet implemented)
- 0000 0003h External Torque Limit, Motoring - Used in conjunction with parameter #5
- 0000 0004h External Torque Limit, Regenerative - Used in conjunction with parameter #5
- 0000 0005h External Horsepower Limit - Used in conjunction with parameter #5
- 0000 0006h to 0000 001Fh Undefined - Reserved for future use

If an undefined mode (...06h through ...1Fh) is selected, Analog Input #1 will be inoperative.

The type of input is selected by parameter #18. Each type of input has a lowest value and a highest value.

The effective range of the input is set by parameters #19 and #20. Parameter #19 sets the low threshold level and parameter #20 sets the highest effective level. These two levels are set in EGU (see parameter #14).

As a general purpose input (... 00h) Analog input #1 may be used by the program to sense any analog signal representing an external parameter for use by the program.

As a Speed Reference input (...01h), Analog input #1 sets the speed of the controlled motor directly if the DFS-1 is set up in Master Mode (parameter #5 - VL2 VL1).

If the DFS-1 is in SLAVE mode, Analog Input #1, when set to ...01h will act as a Ratio SETPOINT.

The External Torque Limits are used to set limits on the motor current which are below the current limit level. When parameter #5 VL4 VL3 is set to 00 01h, or 00 02h, Analog Input #1 may be set to ...03h or ...04h respectively to supply the torque limiting reference.

The External Horsepower Limit sets the maximum horsepower produced by the drive. Horsepower is the PRODUCT of speed and torque. When motor speed is low, motor current is high, and when speed is high, current is low. The drive increases speed until sufficient load is developed and the product of load and speed equals the setpoint. After that is achieved, increasing load reduces speed, and decreasing load increases speed.

18. ANALOG INPUT #1 SIGNAL CONDITIONING

USE PARAMETER #17 TO SELECT THE FORM OF THE SIGNAL AT ANALOG INPUT #1.
RANGE OF VALUES: 0000 0000h to 0000 001Fh
0 TO 32 (decimal)
Default Value: 0000 0001h 1 (decimal)

Six types of signals will be accepted by Analog Input #1. Parameter #18 selects the form of signal to be processed.

The six types of signals are:

0000 0000h	-10VDC to +10VDC bipolar voltage input with zero center value
0000 0001h	0 to +10VDC unipolar voltage signal
0000 0002h	0 to +5VDC unipolar voltage signal
0000 0003h	1 to +5VDC unipolar voltage signal
0000 0004h	0 to 20mA unipolar current signal
0000 0005h	4 to 20mA unipolar current signal
0000 0006h	to 0000 001Fh Undefined - Reserved for future use

If an undefined mode (...06 through ...1F) is selected, Analog Input #1 will be inoperative.

Choosing the incorrect signal conditioning for the actual input signal will result in erratic operation.

19. ANALOG INPUT #1 LOW ENGINEERING UNITS (EGU)

USE PARAMETER #17 TO SELECT THE THRESHOLD OF ANALOG INPUT #1 EFFECT.
RANGE OF VALUES: FFFE 7961h to 0001 869Fh
-99,999 to +99,999(dec.)
Default Value: 0000 0000h 0 (decimal)

(See Parameter 14 for the definition and purpose of EGU)

Parameter #19 sets the threshold level for effectiveness of Analog Input #1 at the lowest signal level.

Assume that the maximum speed of the 1750 RPM motor is set to 12500 EGU's in parameter #14 (representing, perhaps, 125.00 RPM on an extruder screw) and the Analog input is set for a Speed Reference Input of 0 to +10VDC. The default value of parameter 19 is 0. This means that when 0VDC is present at Analog Input #1, the result will be zero speed.

Now, if we want to set a minimum speed on this system, we can set a value of 500 in parameter #19. This means that when 0VDC is present at Analog Input #1, the motor will run at a speed of 500/12500 or 4 percent (70 rpm) of the maximum speed of the motor. (see also parameter #20).

20. ANALOG INPUT #1 HIGH ENGINEERING UNITS (EGU)

USE PARAMETER #18 TO SELECT THE MAXIMUM ANALOG INPUT #1 EFFECT.
RANGE OF VALUES: FFFE 7961h to 0001 869Fh
-99,999 to +99,999 (dec.)
Default Value: 0000 06D6h 1750 (decimal)

(See Parameter 14 for the definition and purpose of EGU)

Parameter #20 sets the maximum level for effectiveness of Analog Input #1 at the highest signal level.

Assume that the maximum speed of the 1750 RPM motor is set to 12500 EGU's in parameter #14 (representing, perhaps, 125.00 RPM on an extruder screw) and the Analog input is set for a Speed Reference Input of 0 to +10VDC. The default value of parameter 20 is 1750. This means that when 10VDC is present at Analog Input #1, the resulting speed will be 1750/12500 = 14 percent of maximum speed, or 245 RPM.

Now, if we want to set the maximum speed of this system at 100.00, we set a value of 10000 in parameter #20. This means that when 10VDC is present at Analog Input #1, the motor will run at a speed of 10000/12500 = 80 percent of the maximum speed of the motor, or 1400 RPM. (see also parameter #19).

21. ANALOG INPUT #2 MODE SELECT

USE PARAMETER #21 TO SELECT THE PURPOSE OF A SIGNAL AT ANALOG INPUT #2.
RANGE OF VALUES: 0000 0000h to 0000 001Fh
0 TO 32 (decimal)
Default Value: 0000 0000h 0 (decimal)

See parameter #17. The operation of Analog Input #2 is identical to the operation of Analog Input #1, EXCEPT the parameters which set the form of the input signal (#22) and low and high EGU's (#23 and #24).

Both Analog Inputs #1 and #2 may be set up as General Purpose Inputs, but all other modes are mutually exclusive. If one of the Analog Inputs is set up as a Speed Reference Input, the other Analog Input may not be set up as a Speed Reference Input. Attempting to set up a second Analog Input as a Speed Reference Input when one is already set up in that mode will cause the second input to be inoperative.

22. ANALOG INPUT #2 SIGNAL CONDITIONING

USE PARAMETER #17 TO SELECT THE FORM OF THE SIGNAL AT ANALOG INPUT #1.
RANGE OF VALUES: 0000 0000h to 0000 001Fh
0 TO 32 (decimal)
Default Value: 0000 0000h 0 (decimal)

See parameter #18. Signal conditioning selection for Analog Input #2 is identical to Analog Input #1.

23. ANALOG INPUT #2 LOW ENGINEERING UNITS (EGU)

USE PARAMETER #23 TO SELECT THE MAXIMUM ANALOG INPUT #2 EFFECT.
RANGE OF VALUES: FFFE 7961h to 0001 869Fh
-99,999 to +99,999 (dec.)
Default Value: 0000 0000h 0 (decimal)

Analog Input #2 works exactly the same way that Analog Input #1 works. Parameter #23 does for Analog Input #2 what parameter #19 does for Analog Input #1. Refer to parameter #19.

24. ANALOG INPUT #2 HIGH ENGINEERING UNITS (EGU)

USE PARAMETER #24 TO SELECT THE MAXIMUM ANALOG INPUT #2 EFFECT.
RANGE OF VALUES: FFFE 7961h to 0001 869Fh
-99,999 to +99,999 (dec.)
Default Value: 0000 0000h 0 (decimal)

Analog Input #2 works exactly the same way that Analog Input #1 works. Parameter #24 does for Analog Input #2 what parameter #20 does for Analog Input #1. Refer to parameter #20.

25. ANALOG OUTPUT #1 MODE SELECT

USE PARAMETER #25 TO SELECT THE SOURCE OF A SIGNAL AT ANALOG OUTPUT #1.
RANGE OF VALUES: 0000 0000h to 0000 0003h
0 to 4 (decimal)
Default Value: 0000 0001h 1 (decimal)

Analog Output #1 may be programmed for several modes of operation. The mode affects where the signal at Analog Output #1 comes from. The following modes are provided for:

0000 0000h Disabled.
0000 0001h Actual Speed - Represents the speed of the motor from 0 to parameter #14.
0000 0002h Load Output - Represents the load on the motor from 0 to 1500.
0000 0003h Analog Output voltage set by communications from parameters #26 and #27.
0000 0004h Commanded Speed

If an undefined mode (...05h through ...1Fh) is selected, Analog Input #1 will be inoperative.

26. ANALOG OUTPUT #1 LOW ENGINEERING UNITS (EGU)

USE PARAMETER #26 TO SELECT THE THRESHOLD OF ANALOG OUTPUT #1 EFFECT.
RANGE OF VALUES: FFFE 7961h to 0001 869Fh
-99,999 to +99,998 (dec.)
Default Value: 0000 0000h 0 (decimal)

Parameter #26 sets the point, in EGU's, at which the Analog Output #1 will be -10VDC.

27. ANALOG OUTPUT #1 HIGH ENGINEERING UNITS (EGU)

USE PARAMETER #27 TO SELECT THE MAXIMUM ANALOG OUTPUT #1 EFFECT.
RANGE OF VALUES: FFFE 7961h to 0001 869Fh
-99,999 to +99,998 (dec.)
Default Value: 0000 06D6h 1750 (decimal)

If parameter #27 is greater on the absolute scale than #26, voltage at Analog Output #1 will be scaled proportionally from low EGU's (parameter #26) to +10VDC at the high engineering units (parameter #27).

If #27 is less than #26, then output sense is inverted, i.e., the higher voltage (from -10VDC to +10VDC) will be at the low EGU setting (#26) and the lower voltage will be at the high EGU setting (parameter #27).

28. ANALOG OUTPUT #2 MODE SELECT

USE PARAMETER #28 TO SELECT THE SOURCE OF A SIGNAL AT ANALOG OUTPUT #2.
RANGE OF VALUES: 0000 0000h to 0000 0003h
0 to 4 (decimal)
Default Value: 0000 0000h 0 (decimal)

Analog Output #2 is a general purpose analog output which may be programmed for one of several modes of operation. The mode defines the origin of the signal at Analog Output #2. The following modes are provided for:

0000 0000h Disabled.
0000 0001h Actual Speed - Represents the speed of the motor from 0 to parameter #14.
0000 0002h Load Output - Represents the load on the motor from 0 to 1500.
0000 0003h Analog Output voltage set by communications from parameters #29 and #30.
0000 0004h Commanded Speed

If an undefined mode ...05h through ...1Fh is selected, Analog Input #2 will be inoperative.

29. ANALOG OUTPUT #2 LOW ENGINEERING UNITS (EGU)

USE PARAMETER #29 TO SELECT THE THRESHOLD OF ANALOG OUTPUT #2 EFFECT.
RANGE OF VALUES: FFFE 7961h to 0001 869Fh
-99,999 to +99,998 (dec.)
Default Value: 0000 0000h 0 (decimal)

(See Parameter 14 for the definition and purpose of EGU)

Parameter #29 sets the point, in EGU's, at which the Analog Output #2 will be -10VDC.

30. ANALOG OUTPUT #2 HIGH ENGINEERING UNITS (EGU)

USE PARAMETER #30 TO SELECT THE MAXIMUM ANALOG OUTPUT #2 EFFECT.
RANGE OF VALUES: FFFE 7961h to 0001 869Fh
-99,999 to +99,998 (dec.)
Default Value: 0000 0096h 150 (decimal)

If parameter #30 is greater on the absolute scale than parameter #29, the voltage at Analog Output #2 will be proportionally scaled from the low EGU's (#29) to +10VDC at the high engineering units (#30).

If parameter #30 is less than parameter #29 on the absolute scale, then the sense of the output will be inverted, i.e., the higher voltage (on an absolute scale from -10VDC to +10VDC) will be present at the low EGU setting (parameter #29) and the lower voltage will be output at the high EGU setting (parameter #30).

Low EGU	High EGU	Speed	Vout
0	+1750	0	-10
0	+1750	1750 (FWD)	+10 VDC
0	+1750	1750 (REV)	0 VDC
-1750	+1750	0	0 VDC
-1750	+1750	1750 (FWD)	+10 VDC
-1750	+1750	1750 (REV)	-10 VDC
-100	+400	0	-6 VDC
+400	-100	0	+6 VDC
+1750	0	875 (FWD)	+5 VDC

Table of Values for Analog Outputs

31. DIGITAL INPUT #1 FUNCTION

USE PARAMETER #31 TO SELECT THE #1 DIGITAL INPUT FUNCTION.
RANGE OF VALUES: 0000 0000h to 0001 000Fh
no decimal significance
Default Value: 0001 0001h no decimal significance

VL4 and VL2 are always 00. VL1 determines function of the input. The following are predefined:

- 00h General Purpose Input
- 01h Run Input
- 02h Preset Input
- 03h Up Input
- 04h Down Input
- 05h Reverse Input
- 06h Frequency Mode
- 07h Remote Input
- 08h Master/Slave (not functional at present)
- 09h Jog
- 0Ah Preset 2
- 0Bh Contactor Aux
- 0Ch through 0Fh Not Assigned, selection will cause input to be General Purpose Input.

Any digital input may be assigned to any function. The factory defaults are included for testing purposes, to provide a baseline setup, and to be able to run the DFS-1 the first time before programming.

VL3 contains the polarity flag, which is either 00h or 01h. A 01h setting means that +24VDC must be applied to the input to make it active. A 00h setting means the input is active with no voltage applied.

A Digital Input may get its +24VDC signal from any source with TB2:A1 common, and may be any parameter, transducer, or switch at which the program or communications wishes to look.

The default, by factory setting, is 0001 0001h, which is a run input which must have +24VDC applied with respect to TB2:A1 to be active.

32. DIGITAL INPUT #2 FUNCTION

USE PARAMETER #32 TO SELECT THE #2 DIGITAL INPUT FUNCTION.
RANGE OF VALUES: 0000 0000h to 0001 000Fh
no decimal significance
Default Value: 0001 0002h no decimal significance

The setting options are the same as parameter #31. The default, by factory setting, is 0001 0002h, which is a preset input which must have +24VDC applied with respect to TB2:A1 to be active.

33. DIGITAL INPUT #3 FUNCTION

USE PARAMETER #33 TO SELECT THE #3 DIGITAL INPUT FUNCTION.
RANGE OF VALUES: 0000 0000h to 0001 000Fh
no decimal significance
Default Value: 0001 0003h no decimal significance

The setting options are the same as parameter #31. The default, by factory setting, is 0001 0003h, which is an UP (increase) input which must have +24VDC applied with respect to TB2:A to be active.

34. DIGITAL INPUT #4 FUNCTION

USE PARAMETER #34 TO SELECT THE #4 DIGITAL INPUT FUNCTION.
RANGE OF VALUES: 0000 0000h to 0001 000Fh
no decimal significance
Default Value: 0001 0004h no decimal significance

The setting options are the same as parameter #31. The default, by factory setting, is 0001 0004h, which is an DOWN (decrease) input which must have +24VDC applied with respect to TB2:A1 to be active.

35. DIGITAL INPUT #5 FUNCTION

USE PARAMETER #35 TO SELECT THE #5 DIGITAL INPUT FUNCTION.
RANGE OF VALUES: 0000 0000h to 0001 000Fh
no decimal significance
Default Value: 0001 0005h no decimal significance

The setting options are the same as parameter #31. The default, by factory setting, is 0001 0005h, which is a reverse input which must have +24VDC applied with respect to TB2:A 1 to be active.

36. DIGITAL INPUT #6 FUNCTION

USE PARAMETER #36 TO SELECT THE #6 DIGITAL INPUT FUNCTION.
RANGE OF VALUES: 0000 0000h to 0001 000Fh
no decimal significance
Default Value: 0001 0006h no decimal significance

The setting options are the same as parameter #31. The default, by factory setting, is 0001 0006h, which is the frequency mode input which must have +24VDC applied with respect to TB2:A 1 to be active.

37. DIGITAL INPUT #7 FUNCTION

USE PARAMETER #37 TO SELECT THE #7 DIGITAL INPUT FUNCTION.
RANGE OF VALUES: 0000 0000h to 0001 000Fh
no decimal significance
Default Value: 0001 0007h no decimal significance

The setting options are the same as parameter #31. The default, by factory setting, is 0001 0007h, which is a local/remote input which must have +24VDC applied with respect to TB2:A 1 to activate remote.

38. DIGITAL OUTPUT #1 FUNCTION

USE PARAMETER #38 TO SELECT THE #1 DIGITAL OUTPUT FUNCTION.
RANGE OF VALUES: 0000 0000h to 0001 000Fh
no decimal significance
Default Value: 0001 0004h no decimal significance

VL4 and VL2 are always 00. VL3 determines the function of the output. The following have been predefined:

00h	General Purpose Output
01h	No Fault Output
02h	At Speed Output
03h	Remote Output
04h	Run Hold
05h	Zero Speed
06h	Set by comm
07h	Contactor
08h	through 0Fh - Not Assigned, selection will cause output to be General Purpose Output.

ANY DIGITAL OUTPUT MAY BE ASSIGNED ANY FUNCTION. The factory defaults are included for testing purposes, to provide a baseline setup, and to be able to run the DFS-1 the first time.

VL3 contains the sense flag, which is either 00h or 01h. A 01h setting means that contact between the output terminals will be closed when the output function is active (a normally open contact). A 00h setting in VL3 means that the contact will be closed when the function is not active (a normally closed contact).

A General Purpose Output may be controlled by the program or communications.

The default, by factory setting, is 0001 0004h, which is a run output which is a closed output contact when the run is active (true). This is normally used as a run hold contact, but it may be used as a run output contact for some other purpose if the run signal is maintained, rather than a momentary push-button.

39. DIGITAL OUTPUT #2 FUNCTION

USE PARAMETER #39 TO SELECT THE #2 DIGITAL OUTPUT FUNCTION.
RANGE OF VALUES: 0000 0000h to 0001 000Fh
no decimal significance
Default Value: 0000 0001h no decimal significance

The setting options are the same as parameter #38. The default, by factory setting, is 0000 0001h, which is the FAULT output. The internal FAULT circuitry of the DFS-1 is off when the input power is applied and energizes if there are NO FAULTS in the drive (the contact closes because VL1 is set to 01h).

40. DIGITAL OUTPUT #3 FUNCTION

USE PARAMETER #40 TO SELECT THE #3 DIGITAL OUTPUT FUNCTION.
RANGE OF VALUES: 0000 0000h to 0001 000Fh
no decimal significance
Default Value: 0001 0002h no decimal significance

The setting options are the same as parameter #38. The default, by factory setting, is 0001 0002h, which is the AT SPEED output. The internal AT SPEED circuitry of the DFS-1 is on when the actual speed of the motor matches the commanded speed (the contact closes because VL3 is set to 01). There are no AT SPEED window parameters because the microprocessor filters and averages the speed signal.

41. DIGITAL OUTPUT #4 FUNCTION

USE PARAMETER #41 TO SELECT THE #4 DIGITAL OUTPUT FUNCTION.
RANGE OF VALUES: 0000 0000h to 0001 000Fh
no decimal significance
Default Value: 0001 0003h no decimal significance

The setting options are the same as parameter #38. The default, by factory setting, is 0001 0003h, which is the REMOTE output. When the DFS-1 is in the remote mode, the contact between the terminals closes (the contact closes because VL3 is set to 01h).

42. DRIVE GAIN SETTING

USE PARAMETER #42 TO SET THE INTERNAL CURRENT GAIN OF THE DRIVE.
RANGE OF VALUES: 0000 0000h to 0000 00FFh
0 to 255 (decimal)
Default Value: 0000 0080h 128 (decimal)

The gain of the DFS-1 is set by parameter #42. The effect of the gain setting is to adjust an internal value which determines how many pulses of accumulated shaft position error it takes to reach current limit. A 00h will allow about 90 pulses of position error while a setting of FFh allows only about 9 pulses, which makes the motor shaft very “stiff”, in that turning it only a few degrees causes current to increase very rapidly. A middle setting is the default.

43. DRIVE STABILITY SETTING

USE PARAMETER #43 TO SET THE INTEGRAL CURRENT GAIN OF THE DRIVE.
RANGE OF VALUES: 0000 0000h to 0000 00FFh
0 to 255 (decimal)
Default Value: 0000 0080h 128 (decimal)

The stability of the DFS-1 is set by parameter #43. The effect of the setting is to adjust an internal value which controls the integral and differential gains of the drive. Smaller numbers mean faster reaction to changes and for higher numbers reaction is more damped. A middle setting is the default.

44. DRIVE MOTORING CURRENT LIMIT

USE PARAMETER #44 TO SET THE MOTORING CURRENT LIMIT OF THE DRIVE.
RANGE OF VALUES: 0000 0000h to 0000 0096h
0 to 150% (decimal)
Default Value: 0000 0032h 50% (decimal)

Parameter #44 allows current limit settings of up to 150% and must be set in terms of MOTOR current. Other circuitry in the motor control will

limit the output DRIVE current to 150%. This parameter CANNOT OVERRIDE that limit, but this parameter may be set for an ultimate current limit on drives which are built with more capability than the motors they run. In this way, short term 300% current ratings can be obtained.

45. DRIVE REGENERATIVE CURRENT LIMIT

USE PARAMETER #45 TO SET THE REGENERATIVE CURRENT LIMIT OF THE DRIVE.
RANGE OF VALUES: 0000 0000h to 0000 0096h
0 to 150% (decimal)
Default Value: 0000 0032h 50% (decimal)

Parameter #44 allows current limit settings of up to 255% and must be set in terms of MOTOR current. Other circuitry in the motor control will limit the output DRIVE current to 150%. This parameter CANNOT OVERRIDE that limit, but this parameter may be set for an ultimate current limit on drives which are built with more capability than the motors they run. In this way, short term 300% current ratings can be obtained.

46. PULSE MULTIPLIER

USE PARAMETER #46 TO SET THE VALUE BY WHICH THE ENCODER PULSE WILL BE MULTIPLIED.
RANGE OF VALUES: 0000 0000h to 0000 0003h
0 to 3 (decimal)
Default Value: 0000 0002h 2 (decimal)

0= X 1 2= X 4
1= X 2 3= Commutation Mode
Encoder loss detection applies only when pulse multiplier is set to 4X.

47. MODULATION AND OPERATION MODES

USE PARAMETER #47 TO SET REGEN / NON-REGEN AND MODULATION MODES.
RANGE OF VALUES: 0000 0000h to 0001 0001h
no decimal significance
Default Value: 0000 0000h no decimal significance

Parameter #47 contains two pieces of information.

VL4 VL3 sets the operational mode of the drive:
0000h sets the drive for non-regenerative operation.
0001h sets the drive for regenerative operation.

VL2 VL1 sets the modulation mode for the drive:
0000h sets the modulation for bottom transistors only.
000h1 sets the modulation for top and bottom transistors.
Normal setup is:
Non-regenerative drives: 0000 0000h
Regenerative drives: 0001 0001h

Normally, in POWERTEC Brushless DC motor controls, non-regenerative drives modulate the bottom transistors only (this generates less heat and makes them more efficient). Regenerative drives modulate both top and bottom transistors for better control. There are some cases where modulating both top and bottom transistors in a non-regenerative drive may be desirable. This can be done by setting VL2 VL1 to 0001h.

Note: If regenerative mode is used, the drive may require an optional DC bus loader to dissipate the regenerative energy and avoid over voltage faults.

48. JUMP OR MOP OPERATION

USE PARAMETER #48 TO SET TEMPORARY OR PERMANENT UP/DOWN SPEED/RATIO CHANGES.
RANGE OF VALUES: 0000 0000h to 0000 0001h
0 to 1 (decimal)
Default Value: 0000 0000h 0 (decimal)

Parameter #48 selects whether the change in speed or ratio made by the up/down inputs is a temporary change which lasts as long as the up or down input is active (JUMP mode), or whether the change will remain after the up/down input has been released (MOP mode). The up/down functions may be generated by software through setting of parameter #3.

When parameter #48 is set to 0000 0000h, the DFS-1 is in the JUMP mode. In MASTER mode (set by parameter #5), when the UP input function is activated, the speed will increase by the amount set in parameter #49. As long as the UP function is active, the speed change will be held. When the UP function is released the speed returns to the SET-POINT. The same action applies to the DOWN function, the speed change set by parameter #50. In SLAVE mode, there is a temporary change in ratio determined by parameter #51 for UP and #52 for DOWN.

When parameter #48 is set to 0000 0001h, the DFS-1 is in the MOP mode. The MOP mode acts like a Motor Operated Potentiometer. When the UP function is activated, the speed, in MASTER mode, will change immediately by the amount in parameter #49. If the function is released within 1/2 second, that speed becomes the new SETPOINT. If the UP function is held for more than 1/2 second, the speed will begin to increase at the ACCEL rate (determined by parameter #8), increasing until the UP function is released. After the UP function is released, the speed will remain at the latest, which becomes the new SETPOINT. The same action applies in the MAS-TER mode to the DOWN function (with parameter #50 and the DECEL rate in parameter #9). In SLAVE mode, the immediate increase is set by parameter #51, the immediate decrease by parameter #52, and the rates by parameters #10 and #11, respectively.

49. MASTER JUMP UP AMOUNT

USE PARAMETER #49 TO SET THE AMOUNT OF SPEED CHANGE ON AN UP FUNCTION.
RANGE OF VALUES: 0000 0000h to 0001 869Fh
0 to 99,999 (decimal)
Default Value: 0000 0001h 1 (decimal)

Parameter #49 is the amount, in Engineering Units, by which the speed changes when the UP function is active.

50. MASTER JUMP DOWN AMOUNT

USE PARAMETER #50 TO SET THE AMOUNT OF SPEED CHANGE ON A DOWN FUNCTION.
RANGE OF VALUES: 0000 0000h to 0001 869Fh
0 to 99,999 (decimal)
Default Value: 0000 0001h 1 (decimal)

Parameter #50 is the amount, in Engineering Units, by which the speed changes when the DOWN function is active.

51. SLAVE JUMP UP AMOUNT

USE PARAMETER #51 TO SET THE AMOUNT OF RATIO CHANGE ON AN UP FUNCTION.
RANGE OF VALUES: 0000 0000h to 0001 869Fh
0 to 99,999 (decimal)
Default Value: 0000 0001h 1 (decimal)

Parameter #51 is the amount, in Engineering Units, by which the ratio changes when the UP function is active.

52. SLAVE JUMP DOWN AMOUNT

USE PARAMETER #52 TO SET THE AMOUNT OF RATIO CHANGE ON A DOWN FUNCTION.
RANGE OF VALUES: 0000 0000h to 0001 869Fh
0 to 99,999 (decimal)
Default Value: 0000 0001h 1 (decimal)

Parameter #52 is the amount, in Engineering Units, by which the ratio changes when the DOWN function is active.

53. INPUT DEBOUNCE VALUE

USE PARAMETER #53 TO SET THE LENGTH OF TIME AN INPUT MUST BE ACTIVE TO BE ACTED UPON.
RANGE OF VALUES: 0000 0000h to 0000 00FFh
0 to 256 (decimal)
Default Value: 0000 0001h 1 (decimal)

Parameter #53 is the length of time, in 10 milliseconds (1 millisecond =.01 second), that a digital input must be active before it is considered legitimate. It is used primarily to eliminate the contact bounce (which may generate multiple commands) from relays used on inputs, but it can also prevent noise problems from push-buttons.

54. FLOAT OR FREEZE

USE PARAMETER #54 TO SELECT WHERE THE SETPOINT WILL BE ON START-UP.
RANGE OF VALUES: 0000 0000h to 0000 0001h
0 to 1 (decimal)
Default Value: 0000 0000h 0 (decimal)

When parameter #54 is set to 0000 0000h, the SETPOINT at start-up (whether after a stop or after a power loss) is always at zero. The speed SETPOINT "floats" down with the motor speed. A new speed SETPOINT must be entered or the UP MOP function may be used to set speed.

When parameter #54 is set to 0000 0001h, the SETPOINT at stop or power loss is "frozen" at the current value, and the DFS-1 will return to this speed when the drive next starts up. It is not necessary to enter a new SETPOINT on start-up if a return to the previous speed is desired.

Parameter #54 also affects the SLAVE mode, but the SETPOINT cannot go to less than the value of the minimum ratio (parameter #55) in FLOAT mode.

55. MINIMUM RATIO

USE PARAMETER #55 TO SET THE LENGTH OF TIME AN INPUT MUST BE ACTIVE TO BE ACTED UPON.
RANGE OF VALUES: 0000 0000h to 0001 869Fh
0 to 99,999 (decimal)
Default Value: 0000 0000h 0 (decimal)

Parameter #55 is the minimum ratio allowed at any time in SLAVE mode.

NOTE THAT THE RATIO CANNOT GO BELOW THIS VALUE, EVEN IN RESPONSE TO DOWN FUNCTIONS OR WHEN THE FLOAT PARAMETER IS SET. This parameter must be set with these restrictions in mind.

56. COMMUNICATIONS TURNAROUND DELAY

SETS THE # OF 500 MICROSECOND DELAYS FROM TRANSFER TO TRANSMIT
RANGE OF VALUES: 0000 0000h to 0000 007Fh
0 to 128 (decimal

57. MASTER JOG SPEED

USE PARAMETER #57 TO SET A JOG SPEED WHICH CAN BE TOGGLED IN AND OUT.
RANGE OF VALUES: FFFE 7961h to 0001 869Fh
-99,999 to 99,999 (decimal)
Default Value: 0000 00C8h 100 (decimal)

The MASTER JOG Speed is the speed to which the motor will go when a JOG input is activated on one of the Digital inputs (any of the seven digital inputs may be programmed as a JOG input) when the DFS-1 is in the MASTER mode. If more than one input is programmed as a JOG input, they must both be present to activate the Master Jog Speed function (the inputs are logically ANDed).

58. SLAVE JOG RATIO

USE PARAMETER #58 TO SET A JOG SPEED WHICH CAN BE TOGGLED IN AND OUT.
RANGE OF VALUES: FFFE 7961h to 0001 869Fh
-99,999 to 99,999 (decimal)
Default Value: 0000 00C8h 100 (decimal)

The SLAVE JOG Speed is the speed to which the motor will go when a JOG input is activated on one of the Digital inputs (any of the seven digital inputs may be programmed as a JOG input) when the DFS-1 is in the SLAVE mode. If more than one input is programmed as a JOG input, they must both be present to activate the SLAVE JOG Speed function (the inputs are logically ANDed).

59. EGU TAG SELECT

(Parameter 59 not functional at present)
RANGE OF VALUES: 0 TO F

0=	UNK	6=	LBS/HR
1=	RPM	7=	PCT
2=	GPM	8=	CFM
3=	FPM	9=	Y/MIN
4=	SPM	10=	M/MIN
5=	LBS-FT	11=	IN/SEC

Default Value: 0000 0000h 0 (decimal)

60. MASTER PRESET #2

USE PARAMETER #60 TO SET A PRESET SPEED WHICH CAN BE TOGGLED IN AND OUT.
RANGE OF VALUES: FFFE 7961h to 0001 869Fh
-99,999 to 99,999 (decimal)
Default Value: 0000 00C8h 100 (decimal)

The MASTER PRESET #2 is the speed to which the motor will go when a PRESET #2 input is activated on one of the Digital inputs (any of the seven digital inputs may be programmed as a PRESET #2 input) when the DFS-1 is in the MASTER mode. If more than one input is programmed as a PRESET #2 input, they must both be present to activate the MASTER PRESET #2 function (the inputs are logically ANDed).

61. SLAVE PRESET #2

USE PARAMETER #61 TO SET A PRESET SPEED WHICH CAN BE TOGGLED IN AND OUT.
RANGE OF VALUES: FFFE 7961h to 0001 869Fh
-99,999 to 99,999 (decimal)
Default Value: 0000 00C8h 100 (decimal)

The SLAVE PRESET #2 is the speed to which the motor will go when a PRESET #2 input is activated on one of the Digital inputs (any of the seven digital inputs may be programmed as a PRESET #2 input) when the DFS-1 is in the SLAVE mode. If more than one input is programmed as a PRESET #2 input, they must both be present to activate the SLAVE PRESET #2 function (the inputs are logically ANDed).

62. CONTACTOR DELAY

USE PARAMETER #62 TO SET TIME INTERVAL BETWEEN RUN COMMAND AND INITIAL FIRING OF TRANSISTORS.
RANGE OF VALUES: 0000 0000 to 0000 0028h
0 TO 40 (decimal)
Default Value: 0000 0000h 0 (decimal)

This parameter sets the time interval between the acceptance of a run command and the initial firing of the transistors. If the Contactor Aux input does not become active in this time period, the transistors will not fire and the drive will return to a stop condition. The value of this parameter is in increments of 25ms. See the Additional Info section for examples.

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Parameter	No.	Value		Parameter	No.	Value
Maximum Motor Speed	6	1750		Master Jump Up Amount	49	1
High Engineering Units	14	1750		Master Jump Down Amount	50	1
Encoder Pulses Per Rev	7	120		Analog Input #1	17	0-10VDC
Pulse Multiplier	46	x 4		Analog Output #1	25	Speed
PWM Mode	47	Non-Regen		Analog Output #2	28	Load
Drive Gain	42	128		Input Debounce Value	53	10 mSec
Drive Stability	43	128		Digital Input #1	31	RUN
Motoring Current Limit	44	100		Digital Input #2	32	PRESET
Regenerative Current Limit	45	100		Digital Input #3	33	UP
Up/Down Function	48	Jump		Digital Input #4	34	DOWN
Float or Freeze Setpoint	54	Float		Digital Input #5	35	REVERSE
Mode of Operation	5	Master		Digital Output #1	38	RUN
Master Accel Rate	8	10k mSec		Digital Output #2	39	NO FAULT
Master Decel Rate	9	10k mSec		Digital Output #3	40	AT SPD
Master Preset Speed	12	200		Digital Output #4	41	REMOTE

The DFS-1 is shipped with a default set of parameters which allows it to be connected as shown in Figure 3 on page 3 and run with basic push-buttons and a speed pot. This supplies a "baseline" of operation which may be used to test the functionality of the board.

The above parameters are the most commonly used ones. For other default settings, refer to the parameter descriptions beginning on page 15.

If your needs are met by the list above, then all you have to do is hook up the drive to power and to the motor and run it. No changes in parameter settings are necessary.

Making parameter changes requires the optional keypad display unit or a computer with serial communications capability.

This section covers the basic steps necessary to set up the DFS-1 beyond the needs of the default parameters. The setup is arranged roughly from the most basic and common steps to the least commonly used parameter changes. You need only follow the steps until you have all the parameters you will use checked and/or changed.

For the purposes of this chapter, it will be assumed that the setup is being accomplished through the use of the KDU-1 keypad display unit.

4.1 BASIC SETUP OF THE DFS-1 CONTROLLER

1. SET PARAMETER #6 FOR THE MAXIMUM SPEED OF THE MOTOR IN RPM.
   The base speed of the motor is listed on the nameplate of the motor. If the base speed of the motor is other than 1750, you must change parameter #6. For instance, if the base speed of your motor is 2500 RPM, enter 2500 into parameter #6.

2. SET PARAMETER #14 TO THE ENGINEERING UNITS VALUE FOR PARAMETER #6.
   This is a number which is set equal to the base speed of the motor. It may be any convenient value in process or reference terms. If the speed of the motor is 2500 RPM, but you want to scale this to 0 to 100.00 %, enter 10000 in parameter #14.

3. SET PARAMETER #7 TO THE PULSES PER REVOLUTION OF THE ENCODER.
   If the motor is a 4 pole motor (259TZ frame or smaller) this number will be 120 (the default). If the motor is an 8 pole motor, the number will be 240. A 600 PPR quadrature encoder will be set up as 2400 in this parameter.

4. SET PARAMETER #46 TO X4 FOR MOST APPLICATIONS.
   Notable exceptions are for a servo application with a 600 ppr encoder or other application where the output frequency of the encoder may exceed 40 Khz. For example, a motor with a 600 ppr encoder will reach 46Khz at 1150 rpm. This assumes that parameter #7 (Encoder PPR) is set to 2400 and the pulse multiplier is set to X4. Where the motor would run faster than 1150 rpm, this parameter should be set to X2 and parameter #7 should be set to 1200 ppr. With these settings, the encoder frequency would reach 50 Khz @ 2500rpm. Above 2500 rpm, the settings should be X1 for Pulse Multiplier and 600 ppr for parameter #7.

5. SET PARAMETER #47 FOR THE MODULATION MODE.
   This parameter is defaulted to Non-Regenerative operation. If you want Regenerative operation, you must change it. Servo operation is regenerative operation. There is also an option for the method of modulation. See page 28.
   Note: If regenerative mode is used, the drive may require an optional DC bus loader to dissapate the regenerative energy and avoid over voltage faults.

6. SET PARAMETER #42 FOR THE DRIVE GAIN.
   This value is defaulted to 50% of the range and therefore set to 128. This should be adequate for many applications. If you are doing VERY close tracking with other motors, it may be necessary to increase this value, but it may be better to leave it alone in the initial setup.

7. SET PARAMETER #43 FOR THE DRIVE STABILITY.
   This value is also defaulted to 50% and, like parameter #42, is set to 128. If you have a high inertia or pulsating load, it may be necessary to increase this value, but it may be better to leave it alone in the initial setup.

8. SET PARAMETER #44 FOR MOTORING CURRENT LIMIT.
   This value is defaulted to 100% of motor current. There may be reasons to set this to a lower value (such as during start-up), but, unless the drive is specially set up, it doesn't do any good to set it to a higher value. Other circuitry limits output current to 150% of drive rating.

9. SET PARAMETER #45 FOR REGENERATIVE CURRENT LIMIT.
   This value is defaulted to 100% of motor current. There may be reasons to set this to a lower value (such as during start-up), but, unless the drive is specially set up, it doesn't do any good to set it to a higher value. Other circuitry limits output current to 150% of drive rating.

10. SET PARAMETER #5 FOR MASTER MODE OR A SLAVE MODE
    Setting this parameter determines which remaining parameters must be set up.

    If setting up in MASTER Mode, proceed to MASTER MODE SETUP (Section 4.2).

    If setting up in a SLAVE mode, proceed to SLAVE MODE SETUP (Section 4.3).

    After setting MASTER or SLAVE, proceed to INPUTS AND OUTPUT (Section 4.4).

    If using an external communications, proceed to COMMUNICATIONS setup (Section 4.5).

4.2 MASTER MODE SETUP

1. SET PARAMETER #5 FOR THE MASTER MODE.
   Set the basic operation in this parameter to MASTER.
   This parameter also has options for current control (see page 16). Selecting MASTER into the parameter takes care of the normal MASTER mode operation case because the default is normal current limits.
   Other choices are torque limiting (either motoring or regenerative) and horsepower control. If one of these choices is made, it will be necessary to either:
   1. Set up one analog input for a reference (see INPUTS and OUTPUTS), or
   2. Make provision to supply reference through communications (see page 16).

2. SET PARAMETER #17 OR PARAMETER #21 IF AN ANALOG INPUT IS TO BE USED.
   If an analog speed reference is to be used, either Analog Input #1 (see page 20) or Analog Input #2 (see page 22) must be set to Speed Reference Input. By default, Analog Input #1 is set up as a Speed Reference Input and Analog Input #2 is a General Purpose Input.
   You must also set parameter #18 (0 to 10VDC by default) or parameter #22 (4 to 20 milliamps default) for the type of input. Then set up the scaling (Engineering units) in parameters #19 and #20 for Analog Input #1, or parameters #22 and #23 for Analog Input #2.
   If neither analog input is set up as a speed reference, then the speed reference must be supplied from the optional front panel control or from the communications.

3. SET PARAMETER #8 FOR THE MASTER ACCELERATION RATE.
   Set the master speed acceleration time in milliseconds (1 millisecond = .001 second). The range is from 0 (speed changes are step functions) to 255 seconds.

4. SET PARAMETER #9 FOR THE MASTER DECELERATION RATE.
   Set the master speed deceleration time in milliseconds (1 millisecond = .001 second). The range is from 0 (speed changes are step functions) to 255 seconds.

5. SET PARAMETER #12 FOR A MASTER PRESET SPEED.
   This step is optional, if you wish to use a preset speed which can be toggled by the PRESET function. Enter the speed in Engineering Units.

6. SET PARAMETER #54 FOR SETPOINT CONDITION (FLOAT OR FREEZE) AT START-UP.
   If you want the motor to return to the speed at which it was running prior to shutdown or power loss, set this parameter to Freeze.
   If you want the motor to wait for the speed to be reentered after a stop or power loss, enter Float in this parameter. See page 30.

7. SET PARAMETER #48 FOR JUMP OR MOP MODE.
   Jump mode operation is to make UP/DOWN speed changes temporary. MOP mode makes the DFS-1 act like a Motor Operated Potentiometer. See page 28.

8. SET PARAMETER #49 FOR MASTER JUMP UP AMOUNT.
   This is the amount (in Engineering Units) by which the speed command will increase when the UP function is activated. See page 29.

9. SET PARAMETER #50 FOR MASTER JUMP DOWN AMOUNT.
   This is the amount (in Engineering Units) by which the speed command will decrease when the DOWN function is activated. See page 29.

4.3 SLAVE MODE SETUP

1. SET PARAMETER #5 FOR THE SLAVE MODE.
   Set basic operation in this parameter to 1 for SLAVE mode. For INVERSE SLAVE mode enter 2. INVERSE SLAVE mode affects the way a setpoint is entered.
   This parameter also has options for current control (see page 16). Setting a 1 takes care of the normal SLAVE mode because the default is normal current limits.
   Other choices are torque limiting (either motoring or regenerative) and horsepower control. For these options see page 16.

2. SET PARAMETER #17 OR PARAMETER #21 IF AN ANALOG INPUT IS TO BE USED.
   If an analog speed reference is to be followed in SLAVE mode, either Analog Input #1 (see page 20) or Analog Input #2 (see page 22) must be set to 1 (Speed Reference Input). By default, Analog Input #1 is set up as a Speed Reference Input.
   You must also set parameter #18 (0 to 10VDC by default) or parameter #22 for the type of input. Then set up the scaling parameters #19 and #20, or #22 and #23.
   If neither analog input is set up as a speed reference input, then the speed reference to be followed must be supplied from the Frequency Reference In.

3. SET PARAMETER #15 FOR THE BASE RATIO.
   This is the number which is used to allow the SETPOINT to be set at a desired number instead of at a number dictated by gear ratios, motor speeds, and other factors. See page 19.

4. SET PARAMETER #16 FOR THE MAXIMUM RATIO.
   This setting is the highest ratio allowed under any circumstances.

5. SET PARAMETER #55 FOR THE MINIMUM RATIO.
   This setting is the smallest ratio allowed under any circumstances.

6. SET PARAMETER #10 FOR THE SLAVE ACCELERATION RATE.
   Set slave speed acceleration time in milliseconds (1 millisecond = .001 second). The range is from 0 (speed changes are step functions) to 255 seconds. See page 18.

7. SET PARAMETER #11 FOR THE SLAVE DECELERATION RATE.
   Set the slave speed deceleration time in milliseconds (1 millisecond = .001 sec). The range is from 0 (speed changes are step functions) to 255 seconds. See page 18.

8. SET PARAMETER #13 FOR A SLAVE PRESET RATIO.
   This step is optional, if you wish to use a preset ratio which can be toggled by the PRESET function. Enter the speed in Engineering Units.

9. SET PARAMETER #54 FOR SETPOINT CONDITION AT START-UP.
   If you want the motor to return to the ratio at which it was running prior to shutdown or power loss, set this parameter to 1. If you want the motor to wait for the ratio to be reentered after a stop or power loss, enter 0. See page 30.

10. SET PARAMETER #48 FOR JUMP OR MOP MODE.
    Jump mode operation is to make UP/DOWN ratio changes temporary. MOP mode makes the DFS-1 act like a Motor Operated Potentiometer. See page 28.

11. SET PARAMETERS #51 AND #52 FOR SLAVE JUMP UP/DOWN AMOUNTS.
    These are the amounts (in Engineering Units) by which the ratio command will increase or decrease when the UP or DOWN functions are activated. See page 29.

4.4 INPUTS AND OUTPUTS SETUP

1. SET PARAMETERS #17, #18, #19, AND #20 TO SET UP ANALOG INPUT #1.
   If Analog Input #1 is to be used for speed reference, which is the default mode, and the reference is to be 0 to +10VDC, no action is necessary to change from the defaults. If the input is to be 4 to 20mA, then parameter #18 must be changed. Set up parameters #19 and #20 to conform with the speed range set up by parameter #14.
   If Analog Input #1 is not used as a speed reference, it may be used for any other signal which may be useful to the processor or the external program. Pre-programmed purposes are listed on page 20, but the uses of the analog inputs are not limited to those items.

2. SET PARAMETERS #21, #22, #23, AND #24 TO SET UP ANALOG INPUT #2.
   If Analog Input #2 is to be used for Speed Reference Input, Analog Input #1 must be changed to something else by changing parameter #17 to something other than 1, and then changing parameter #21 to 1. Parameter #22 must be set up for the form of input (4 to 20mA is the default), and parameters #23 and #24 set up in EGU's conforming to parameter #14.
   Analog Input #2 may be used for any analog input the processor or program may need, either as a predefined use (see page20) or as a General Purpose Input.

3. SET PARAMETERS #25, #26, AND #27 TO SET UP ANALOG OUTPUT #1.
   If Analog Output #1 is to be used for a Speed Output signal from -10 to +10VDC, then nothing needs to be done. If not used for this purpose, it may be used as a General Purpose Output, a Load Output, or a communications output port by changing parameter #25. Parameters #26 and #27 may be set up in Engineering Units.

4. SET PARAMETERS #28, #29, AND #30 TO SET UP ANALOG OUTPUT #2.
   If Analog Output #2 is to be used for a Load Output signal from -10 to +10VDC, then nothing needs to be done. If not used for this purpose, it may be used as a General Purpose Output, a Load Output, or a communications output port by changing parameter #28. Parameters #29 and #30 may be set up in Engineering Units.

5. SET PARAMETERS #31 THROUGH #37 FOR DIGITAL INPUT FUNCTIONS.
   If the digital inputs as listed on page 6 are suitable, then no changes need to be made. However, note that any Digital Input may be used for ANY purpose and more than one input may be used for the same purpose (the inputs will be logically ANDed - i.e., they must both be present to function). The same parameters make provisions for input sense. See page 25.

6. SET PARAMETERS #53 FOR DEBOUNCE TIME.
   If the inputs are driven by relays or push-button, contact bounce and/or noise could generate multiple commands. This command sets the minimum time (in milliseconds) that a command must be present before it is considered valid.

7. SET PARAMETERS #38, #39, #40, AND #41 FOR DIGITAL OUTPUT FUNCTIONS.
   If the outputs listed on page 7 (the defaults) are suitable, no changes need to be made, but each output can be reassigned as necessary (see page 26 - parameter #38) as required. The output relays can also be assigned as normally open or normally closed.

4.5 COMMUNICATIONS SETUP

The local operator's panel operates at CPU level and does not require the setup of any communications parameters. The following setup is for an external communications link.

Before connecting to the external communications link, the following parameters must be set properly. The other parameters may be set after the link is established.

The default parameters set up the DFS-1 as follows:

- the unit has an address of 001
- the baud rate is 9600
- The unit is in local mode
- using a binary communications protocol

1. SET PARAMETER #1 FOR COMMUNICATIONS NETWORK ADDRESS.
   This is the address which the DFS-1 will respond to on the external comm link. Since the default is 001, it might be a good idea to start the network addresses at 002 so that a unit being replaced does not cause an addressing conflict.
   Addresses up to 255 are valid, but the RS-485 protocol only allows for 32 units on a single line without repeaters.

2. SET PARAMETER #2 FOR COMMUNICATIONS NETWORK SPEED.
   This is the communications rate at which the DFS-1 will operate on an external comm link. Rates range from 300 baud to 38.4 Kilobaud (see page 16).

3. SET PARAMETER #3 TO SELECT WHICH FUNCTIONS ARE REMOTE.
   This parameter may be used to include or exclude control functions from local control and assign them to the remote link. The setup of this parameter has nothing to do with assigning functions to input terminals! This parameter ONLY AFFECTS WHETHER THE CONTROL OF THE FUNCTION IS LOCAL OR REMOTE.

4. SET PARAMETER #4 TO SELECT THE COMMUNICATIONS PROTOCOL.
   This parameter selects the POWERTEC binary protocol.

5. SET PARAMETER #56 FOR COMMUNICATIONS TURN AROUND DELAY.
   Set parameter #56 to default to 2 though it may have to be set to 6 or 8 for most reliable communications with Allen Bradley devices.

5.0 DFS - 1 ERROR CODES

ERROR CODES FOR ON-BOARD DISPLAY

The DFS-1 has a single-digit alphanumeric display to show error codes when something is wrong. Following is a list of the meanings of the numbers in that display:

0	All conditions nominal	
1	Undervoltage trip	Line voltage dropped below minimum level
2	Overvoltage trip of drive	Bus voltage exceeded safe limit
3	Undervoltage timer tripped	Line voltage low for too long
4	Instantaneous overcurrent	Excessive transistor current
5	Loss of encoder signal	Encoder speed signals lost. Encoder loss detection applies only when pulse multiplier is set to 4X
6	Motor thermal tripped	Motor is too hot or thermal is disconnected
7	Commutation fault	Signals from position encoder lost
8	+24VDC lost at TB2-A14 and TB2-B1	Fuse FR1 overloaded
9	+24VDC lost at TB3-B1	Fuse FR2 overloaded
A	+5VDC lost at TB1-A8	Fuse FR4 overloaded
B	+24VDC lost at TB1-A10	Fuse FR3 overloaded
C	Current limit	Drive is at maximum current output
D	Timed Overload	Timed overcurrent has occured
E	Display fault	Fault in display module
F	Applications fault	Fault in applications program

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6.0 COMMUNICATIONS PROTOCOL

General Definitions:

[STX] - 02h - Start of data
[ETX] - 03h - End of data
[ACK] - 06h - Acknowledge
[NAK] - 15h - Negative Acknowledge
[DLE] - 10h - Data Link Escape
[CMD] -xxh - Command to be executed
[CSM] - xxh - Checksum, 2's complement sum of the data between the [STX] and [ETX] characters

General Notes:

1. The use of brackets in this document means that there is a single byte of information contained within the brackets. This convention is used to insure that the construction of the message is clear.

2. If the below message was sent, the following checksum would be computed:

DLE	STX	UID	CMD	DATA				DLE	ETX	CSM
[10]	[02]	[01]	[82]	[00]	[00]	[10]	[10]	[00]	[10]	[03]	[6D]

Note the delimited datum character. Since a 10h is the DLE, the only way the software can know that a 10h in the middle of a data word is datum and not the DLE is to put the datum in twice. The driver software must know that a single 10h is the DLE and not datum! The driver software must actually use only one 10h to compute the check-sum value.

01 + 82 + 00 + 00 + 10 + 00 = 93: 2's complement = 6D

3. All data is sent in four bytes regardless of the needed length of data. For instance, parameter 48 has the value of 0 for jump and 1 for MOP. The actual parameter is passed in communications however as a [00][00][00][00] for jump mode and a [00][00][00][01] for MOP mode. In this way, all data has an expected length of 4 bytes.

COMMAND LIST

Following is a list of commands to the unit. Detailed descriptions of each command are shown in attachment A beginning on page 55.

Cmd # Description:

81h Description: (Status Request)
Respond with the current operating status which includes commanded speed, actual speed, and status bits.

82h Description: (Set Speed)
Commands the unit to set a new speed (or ratio) but to delay changing to the new speed until a command to do so is given (#83)

83h Description: (Execute Speed)
Commands the unit to execute the speed commanded in (#82) above.

84h Description: (Set and Execute Speed)
Commands the unit to set a new speed (or ratio) and change to it immediately without waiting for an execution command.

85h Description: (Read Parameter)
Commands the unit to send a specified current parameter setting.

86h Description: (Write Parameter)
Commands the unit to change a specific parameter to a new value.

87h Description: (Read Analog Input)
Commands the unit to send the value of an analog input.

88h Description: (Read Analog Output)
Commands the unit to send the value of an analog output.

89h Description: (Write Analog Output)
Commands the unit to put a specific value out on one of the analog outputs.

8Ah Description: (Read Digital Input)
Commands the unit to send the status of a digital input.

8Bh Description: (Read Digital Output)
Commands the unit to send the status of a digital output.

8Ch Description: (Set Digital Output)
Commands the unit to turn on or off a specific digital output.

8Dh Description: (Set Operational Mode)
Allows setting run, stop, preset, reverse commands via comm link rather than through the hardwired inputs.

8Eh Description: (Read Operational Mode)
Allows reading the status of all command conditions.

8Fh Description: (Application Mode)
Sets the setpoint for torque control or horse-power control or other type of special application when the setpoint is to be set by communication rather than analog input value.

PARAMETER LIST:

Following is a list of the parameters used in DFS-1. For a detailed description of each parameter see the list in attachment B beginning on page 57.

Param# Description

COMMUNICATIONS SETUP
1 Unit Identification number
2 Baud Rate
3 Local/Remote
4 Communications Protocol
5 Mode of Operation
56 Communication Response Delay

BASIC DRIVE SETUP
6 Maximum Motor Speed
7 Encoder Pulses per Revolution
42 Drive Gain Setting
43 Drive Stability Setting
44 Motoring Current Limit
45 Regenerative Current Limit
46 Pulse Multiplier
47 Pulse Width Modulation Mode
48 Jump Or MOP Function
14 High Engineering units
53 Input Debounce Value
54 Freeze or Float Setpoint
59 EGU Tag Select

MASTER SETUP ONLY
12 Master Preset Speed
8 Master Acceleration Rate
9 Master Deceleration Rate
49 Master Jump Up Amount
50 Master Jump Down Amount
57 Master Jog Speed
60 Master Preset #2

SLAVE SETUP ONLY
10 Slave Acceleration Rate
11 Slave Deceleration Rate
13 Slave Preset Ratio
15 Base Ratio for Slave
16 Maximum Ratio for slave
51 Slave Jump Up Amount
52 Slave Jump Down Amount
55 Slave Minimum Ratio
58 Slave Jog Ratio
61 Slave Preset #2

INPUT/OUTPUT SETUP
17 Analog Input #1 Mode Select
18 Analog Input #1 Input Signal Conditioning
19 Analog Input #1 Low Engineering Units
20 Analog Input #1 High Engineering Units
21 Analog Input #2 Mode Select
22 Analog Input #2 Input Signal Conditioning
23 Analog Input #2 Low Engineering Units
24 Analog Input #2 High Engineering Units
25 Analog Output #1 Mode Select
26 Analog Output #1 Low Engineering Units
27 Analog Output #1 High Engineering Units
28 Analog Output #1 Mode Select
29 Analog Output #1 Low Engineering Units
30 Analog Output #1 High Engineering Units
31 Digital Input #1 Mode and Polarity
32 Digital Input #2 Mode and Polarity
33 Digital Input #3 Mode and Polarity
34 Digital Input #4 Mode and Polarity
35 Digital Input #5 Mode and Polarity
36 Digital Input #6 Mode and Polarity
37 Digital Input #7 Mode and Polarity
38 Digital Output #1 Mode and Polarity
39 Digital Output #2 Mode and Polarity
40 Digital Output #3 Mode and Polarity
41 Digital Output #4 Mode and Polarity
62 Contactor Delay

FUTURE EXPANSION
63 Future General use parameters
80-95 Future Special use parameters

ATTACHMENT A: DETAILED COMMANDS

Read Speed/Status (81)

Command: Read Speed/Status

Description:
This command tells the unit to respond with it's current commanded speed, actual speed, load value, & status.

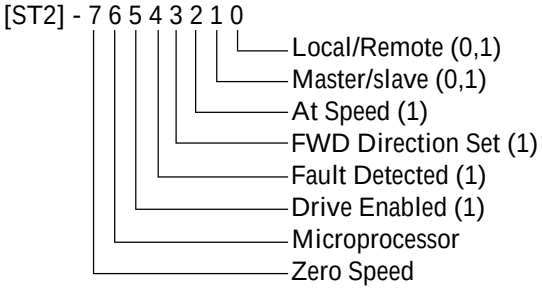
CMD = [81]
UID = [01] - [FF]

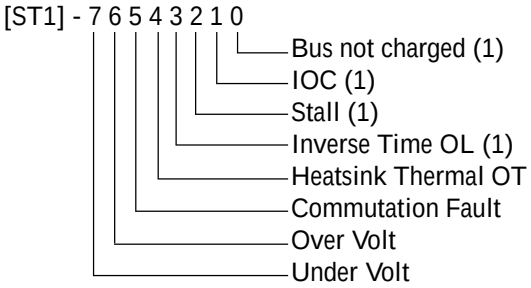
Message:
[DLE][STX][UID][CMD][DLE][ETX][CSM]

Response:

[DLE][STX][UID][ACK][CS4][CS3][CS2][CS1][AS4][AS3][AS2]
[AS1][LOD][ST2][ST1][DLE][ETX][CSM]

Definitions:
[CS4]..[CS1] - Commanded speed, unsigned long integer
[AS4]..[AS1] - Actual speed, unsigned long integer
[LOD] - Load percent
[ST2]..[ST1] - UNIT Status. ST1 is fault codes.





[ERR]- Reported error
[86]- Illegal command number.

Set Speed (82)

Command: Set Speed

Description:
This command tells the unit to set the new commanded speed to the value but not to execute it until told to do so by #83.

CMD = [82]
UID = [01] - [FF]

Message:
[DLE][STX][UID][CMD][CS4][CS3]
[CS2][CS1][DLE][ETX][CSM]

Response:
If no errors

[DLE][STX][UID][ACK][DLE][ETX][CSM]
else
[DLE][STX][UID][NAK][ERR][DLE][ETX][CSM]

Definitions:
[CS4]..[CS1] - Commanded speed, unsigned long integer
[ERR] - Reported Error.
[80] - Unit not in remote mode
[81] - Illegal speed value
[86] - Illegal command number

Execute Speed (83)

Command: Execute Speed

Description:
This command tells the unit to execute the new commanded speed set in 82.

CMD = [83]
UID = [00] - [FF]

Message:

[DLE][STX][UID][CMD][DLE][ETX][CSM]

Response:
If no errors and unit i.d. does not equal 0

[DLE][STX][UID][ACK][DLE][ETX][CSM]

If unit i.d. = 0 (global command) then no response at all but all DIGIMAXes will execute simultaneously.
else

[DLE][STX][UID][NAK][ERR][DLE][ETX][CSM]

Definitions:
[ERR] - Reported Error.
[80] - Unit not in remote mode
[86] - Illegal Command number

Set & Execute Speed (84)

Command: Set & Execute Speed

Description:
This command tells the unit to set the new commanded speed to the value and execute it immediately.

CMD = [84]
UID = [01] - [FF]

Message:

[DLE][STX][UID][CMD][CS4][CS3][CS2][CS1][DLE][ETX][CSM]

Response:
If no errors

[DLE][STX][UID][ACK][DLE][ETX][CSM]
else
[DLE][STX][UID][NAK][ERR][DLE][ETX][CSM]

Definitions:
[CS4]..[CS1] - Commanded speed, unsigned long integer
[ERR] - Reported Error.
[80] - Unit not in remote mode
[81] - Illegal speed value
[86] - Illegal Command number

Read Parameter (85)

Command: Read Parameter

Description:
This command tells the unit to send the value of the selected parameter.

CMD = [85]
UID = [01] - [FF]

Message:

[DLE][STX][UID][CMD][PRM][DLE][ETX][CSM]

Response:
If no errors

[DLE][STX][UID][ACK][DT4][DT3][DT2]DT1][DLE][ETX][CSM]
else
[DLE][STX][UID][NAK][ERR][DLE][ETX][CSM]

Definitions:
[DT4] THRU [DT1] Datum is returned as an long integer.
[PRM] - Parameter number
[ERR] - Reported Error
[82] - Illegal parameter number
[86] - Illegal Command number

Write Parameter (86)

Command: Write Parameter

Description:
This command tells the unit to change the value of the selected parameter.

CMD = [86]
UID = [01] - [FF]

Message:
[DLE][STX][UID][CMD][PRM][VL4]
[VL3][VL2][VL1][DLE][ETX][CSM]

Response:
If no errors

[DLE][STX][UID][ACK][DLE][ETX][CSM]
else
[DLE][STX][UID][NAK][ERR][DLE][ETX][CSM]

Definitions:

[PRM] - Parameter number
[VL4]..[VL1] - parameter value cast as a long integer
[ERR] - Reported Error
[80] - Unit not in remote mode
[82] - Illegal parameter number
[83] - Illegal parameter value
[86] - Illegal Command number

Read Analog Input (87)

Command: Read Analog Input

Description:
This command tells the unit to return the value of one of the analog inputs.

CMD = [87]
UID = [01] - [FF]
ATD = [01]or [02] depending on which Analog input is being read.
Message:

[DLE][STX][UID][CMD][ATD][DLE][ETX][CSM]

Response:
If no errors
[DLE][STX][UID][ACK][AD4][AD3]
[AD2][AD1][DAT][DLE][ETX][CSM]
else
[DLE][STX][UID][NAK][ERR][DLR][ETX][CSM]

Definitions:
[ATD] - Analog input number [01] or [02]
[AD4] - Value of analog input, Most Sig Byte
[AD1] - Value of analog input, Least Sig Byte
[ERR] - Reported error
[80] - Unit not in remote mode
[84] - Illegal channel number
[86] - Illegal Command number

Read Analog Output (88)

Command: Read Analog Output

Description:
This command tells the unit to return the value of one of the analog outputs.

CMD = [88]
UID = [01] - [FF]
DTA = [01] or [02] depending on which Analog output is being read.

Message:

[DLE][STX][UID][CMD][DTA][DLE][ETX][CSM]

Response:
If no errors

[DLE][STX][UID][ACK][DA4][DA3]
[DA2][DA1][DLE][ETX][CSM]
else
[DLE][STX][UID][NAK][ERR][DLE][ETX][CSM]

Definitions:
[DTA] - Analog output number 01 or 02
[DA4] - [DA1] Value of analog output, cast as unsigned long.
[ERR] - Reported error
[80] - Unit not in remote mode
[84] - Illegal channel number
[86] - Illegal Command number

Write Analog Output (89)

Command: Write Analog Output

Description:
This command tells the unit to put out a specific value of analog voltage on a selected analog output.

CMD = [89]
UID = [01] - [FF]
DTA = [01]or [02] depending on which analog output

Message:
[DLE][STX][UID][CMD][DTA][VL4]
[VL3][VL2][VL1][DLE][ETX][CSM]

Response:
If no errors

[DLE][STX][UID][ACK][DLE][ETX][CSM]
else
[DLE][STX][UID][NAK][ERR][DLE][ETX][CSM]

Definitions:
[DTA] - Analog output number 01 or 02
[VL4]..[VL1] - Analog value cast as sealed between low EGU and high EGU.
[ERR] - Reported Error
[80] - Unit not in remote mode
[84] - Illegal channel number
[85] - Illegal channel value
[86] - Illegal Command number

Read Digital Input (8A)

Command: Read Digital Input

Description:
This command tells the unit to return the value of one of the digital inputs.

CMD = [8A]
UID = [01] - [FF]
DIG = [01] - [07] depending on which digital input is being read.

Message:

[DLE][STX][UID][CMD][DIG][DLE][ETX][CSM]

Response:

If no errors
[DLE][STX][UID][ACK][VL4][VL3]
[VL2][VL1][DLE][ETX][CSM]
else
[DLE][STX][UID][NAK][ERR][DLE][ETX][CSM]

Definitions:
[DIG] - Digital input number [01]* thru [07] ([00]=Estop) not used
[VL4] - Always 00
[VL3] - Always 00
[VL2] - Always 00
[VL1] - Status of input [00] = off [01] = on
[ERR] - Reported error
[80] - Unit not in remote mode
[84] - Illegal channel number
[86] - Illegal Command number

Read Digital Output (8B)

Command: Read Digital Output

Description:
This command tells the unit to return the value of one of the digital outputs.

CMD = [8B]
UID = [01]- [FF]
DIG = [01] - [04] depending on which Digital output is being read.

Message:

[DLE][STX][UID][CMD][DIG][DLE][ETX][CSM]

Response:
If no errors:
[DLE][STX][UID][ACK][VL4][VL3]
[VL2][VL1][DLE][ETX][CSM]
else
[DLE][STX][UID][NAK][ERR][DLR][ETX][CSM]

Definitions:

[DIG] - Digital output number 01 to 04
[VL4] - Always 00
[VL3] - Always 00
[VL2] - Always 00
[VL1] - Status of output 00 = off 01 = on
[ERR] - Reported error
[80] - Unit not in remote mode
[84] - Illegal channel number
[86] - Illegal Command number

Write Digital Output (8C)

Command: Write Digital Output

Description:

This command tells the unit to turn on or off a specific digital output contact.

CMD = [8C]
UID = [01] - [FF]
DIG = [01] - [04] depending on which Digital output

Message:
[DLE][STX][UID][CMD][DIG][VL4]
[VL3][VL2][VL1][DLE][ETX][CSM]

Response:

If no errors

[DLE][STX][UID][ACK][DLE][ETX][CSM]

else

[DLE][STX][UID][NAK][ERR][DLE][ETX][CSM]

Definitions:

[DIG] - Digital Output channel choice [00] thru [04]
[VL4] - Always 00
[VL3] - Always 00
[VL2] - Always 00
[VL1] - [00] or [01] contact being open or closed.
[ERR] - Reported Error
[80] - Unit not in remote mode
[84] - Illegal channel number
[85] - Illegal channel value
[86] - Illegal Command number

Set Operational Mode (8D)

Command: Set Operational Mode

Description:

This command tells the unit to turn on or off specific input control functions such as run, stop, etc. Refer to parameter 3 which defines which input controls are allowed by communications link and which MUST BE controlled by inputs on the terminal strip. An error message will be produced if set mode attempts to change the condition of an input that is not allowed to be remotely changed.

CMD = [8D]
UID = [01] - [FF]
SMH = [00] - [FF]
SML = [00] - [FE] depending on which CONTROL INPUT SEE PARAMETER # 3 FOR DEFINITION. This is a bit map that defines the desired state of each control input as follows:

7 6 5 4 3 2 1 0—Bit Position
0 0 0 0 0 0 0 0—Bit value can be 0 (off) or 1 (on)
7 6 5 4 3 2 1 0—Digital input number

BIT PSN	SML
where: 0	is Estop
1	is Run
2	is Preset
3	is Up input
4	is Down input
5	is Reverse mode
6	is Frequency mode
7	is Local/Remote (0 for local)

BIT PSN	SMH
where: 0	is unused
1	is Jog
2	is Preset 2
3	is Contactor Aux

Note that input 1 is Estop which must always be 0 since this cannot be set remotely. This can ONLY be a hardwired function. This means the largest value for [00][00][SMH][SML] is [00][00][FF][FE].

Example: To turn on inputs 1 and 5 the value for [00][00][SMH][SML] is 0000 0022, or [22]. Inputs 1 and 5 are defaulted to RUN and Reverse but can be redefined in parameters 31 through 37.

Message:
[DLE][STX][UID][CMD][00][00]
[SMH][SML][DLE][ETX][CSM]

Response:
If no errors

[DLE][STX][UID][ACK][DLE][ETX][CSM]
else
[DLE][STX][UID][NAK][ERR][DLE][ETX][CSM]

Definitions:
[ERR] - Reported Error
[80] - Unit not in remote. Returned if this command is sent and remote mode is not allowed in parameter 3.
[86] - Illegal Command number.
[87] - Illegal input number.
[88] - Illegal input value. Returned if remote mode is allowed but the specific input asked to be changed is not allowed in remote by parameter # 3.

Read Operational Mode (8E)

Command: Read Operational Mode

Description:
This command tells the unit to return the current status of the commands which are active whether from hardwired inputs or by remote. Note that run, for instance may not be allowed by param #3 from the terminal strip, but could be active from the comm link, or for that matter may even be mapped to operate from a different digital input. THE STATUS SHOWN HERE HAS NOTHING DIRECTLY TO DO WITH THE STATUS OF THE DIGITAL INPUTS EXCEPT FOR E-STOP STATUS WHICH IS ALWAYS HARDWIRED TO INPUT # 1. THE OTHER COMMANDS MAY OR MAY NOT BE ACTIVE FROM THE HARDWIRED INPUTS OR COULD BE REMAPPED. DO NOT BE CONFUSED BETWEEN COMMANDS SUCH AS RUN, STOP, REVERSE AND THE SOURCE OF THOSE COMMANDS WHICH MAY BE ANY OF THE DIGITAL INPUTS, EITHER OF THE TWO COMM INPUTS, OR INTERNAL SOFTWARE IN SPECIAL CASES.

If you wish to determine the status of the digital inputs you must use command 8A (Read Digital Input).

CMD = [8E]
UID = [01] - [FF]

Message:

[DLE][STX][UID][CMD][DLE][ETX][CSM]

Response:
If no errors
[DLE][STX][UID][ACK][00][00]
[RMH][RML][DLE][ETX][CSM]
else
[DLE][STX][UID][NAK][ERR][DLE][ETX][CSM]

Example: If the drive was in remote mode (from Parameter #3) and if the input assignments were the factory defaults, and the drive was in run, reverse, Down and not E-Stopped, then the value for [RML] would be constructed as follows:

7 6 5 4 3 2 1 0 Bit Positions
0 0 1 1 0 0 1 1 Input Status
[3 3] [RMH][RML]= [00][33]

BIT PSN RML
where: 0 is E-stop
1 is Run
2 is Preset
3 is Up input
4 is Down input
5 is Reverse mode
6 is Frequency mode
7 is Local/Remote (0 for local)

BIT PSN RMH
where: 0 is unused
1 is Jog
2 is Preset 2
3 is Contactor Aux

Definitions:
[ERR] - Reported error
[82] - Illegal parameter number
[86] - Illegal Command number

Application Mode (8F)

Command: Application Mode Command

Description:

This command reads/sets the operating setpoint by communications rather than using an analog input for the setpoint when a special application mode is active (see parameter 5). The modes currently defined are shown below. It is possible in the future that additional application modes may be added.

CMD = [8F]
UID = [01] - [FF]
AMD = [20],[21],[22],[23],[30],[31],[32]

Message:
[DLE][STX][UID][CMD][AMD][VL4]
[VL3][VL2][VL1][DLE][ETX][CSM]

Response:

If no errors,
[DLE][STX][UID][ACK][DLE][ETX][CSM]

else,
[DLE][STX][UID][NAK][ERR][DLE][ETX][CSM]

Definitions:

[AMD] - Application Mode
- [20] - Set Motoring torque setpoint
- [21] - Set Regen torque setpoint
- [22] - Set Horsepower setpoint
- [23] - Set Speed/Ratio with ramp rate
- [30] - Read Motoring Torque Setpoint
- [31] - Read Regen Torque Setpoint
- [32] - Read Horsepower Setpoint

[VL4] - Depends on value passed
[VL3] - Depends on value passed
[VL2] - Depends on value passed
[VL1] - Depends on value passed
[ERR] - Reported Error
- [80] - Unit not in remote
- [82] - Illegal parameter number
- [86] - Illegal Command number
- [89] - Illegal Application value
- [8A] - Illegal Application

An error message [8A] will be sent if a setpoint for horsepower [22] for instance is sent when parameter 5 is set to allow motoring torque limit, or any other mode than horsepower.
Examples:

[20] Motoring Torque setpoint can be 0 to 1000 (hex 3E8) where torque is set in tenths of percent (1000 equals 100.0%) A torque of 100.0% would then be sent as [00][00][03][E8].

[21] Regen Torque same description as above
[22] Horsepower setpoint has the same description as torque where hp is set in tenths of percent, 100% maximum
[23] Set speed/ratio with accel and decel ramp. This is used whenever a temporary setpoint for speed is desired and the ramp up and down rates are different from those in the parameter table. This setpoint and ramp rate is temporary and the drive will revert automatically back to the normal setpoint and ramp rates on any successive commands. Speed/ratio requires 4 bytes, accel requires 4 bytes and decel requires 4 bytes. For instance a complete message including the header, etc. for a speed of 1400 rpm and accel rate of 10 seconds and decel rate of 5 seconds to unit # 5 would be:
[10][02][05][8F[23][00][00][05][78][00][00]
[00][0A][00][00][00][05][10][03][CSM]

ATTACHMENT B: PARAMETER DESCRIPTION:

Following is a list of the parameters for the DFS-1. All parameters are 4 byte values regardless of the data. For instance, parameter 5 is master slave and can be only [00] or [01] but the data bytes required for the parameter are [00][00][00][01] or [00][00][00][00]. This is done to keep communications simple when dealing with parameter information, especially with any packed message.

59 through 63 are general use parameters for future use and not currently defined.

80 through 95 are special use parameters for future use and not currently defined.

DFS Software Modification For Dynamic Braking or Output Contactor Operation

Functional Description

A new function for Contactor Aux has been added to the digital input choices. When configured as described in the example, 24VDC must be present at this input for the drive to run. Parameter #62, Contactor Delay, is a number of 25ms intervals that will occur between the DFS controller acceptance of a run command and the firing of the transistors. If the Contactor Aux input signal is low, the DFS starts the timer and closes the Contactor Output. If the Contactor Aux input does not switch high before the timer runs out, the drive will return to the stop condition. If the Contactor Aux input does switch high, the drive will start running when the timer runs out.

Example Setup for Dynamic Braking

1 Set Digital Input #7 mode to Contactor Aux, polarity to Active Low.
2 Set Digital Output #4 mode to Normally Open, polarity to Normally Closed.
3 Set Contactor Delay to 20 (20 x 25ms = 500ms = 1/2 second).

Run command causes the Contactor Output to close, the Contactor Relay opens, the feedback contacts close and the drive starts to run.

Example Setup for Output Contactor

1 Set Digital Input #7 mode to Contactor Aux, polarity to Active Low.
2 Set Digital Output #4 mode to Normally Open, polarity to Normally Closed.
3 Set Contactor Delay to 10 (10 x 25ms = 250ms = 1/4 second).

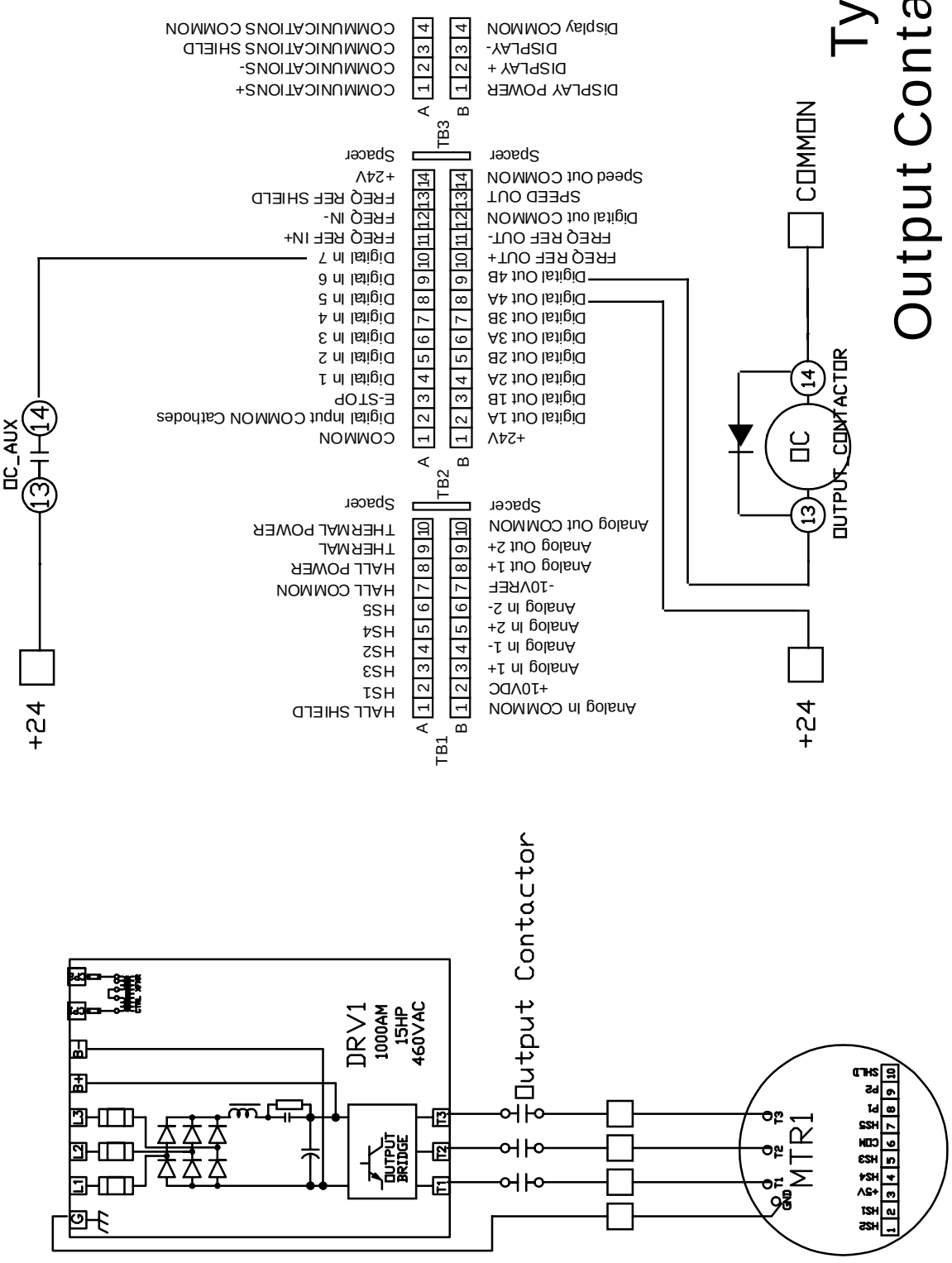
Run command causes the Contactor Output to close, the Contactor Relay closes, the feedback contacts close and the drive starts to run.

The difference in the operation of the two types of contactors is that the Dynamic Braking Contactor is normally closed whereas the Output Contactor is normally open. In both contactors, the auxilliary contacts are normally open.

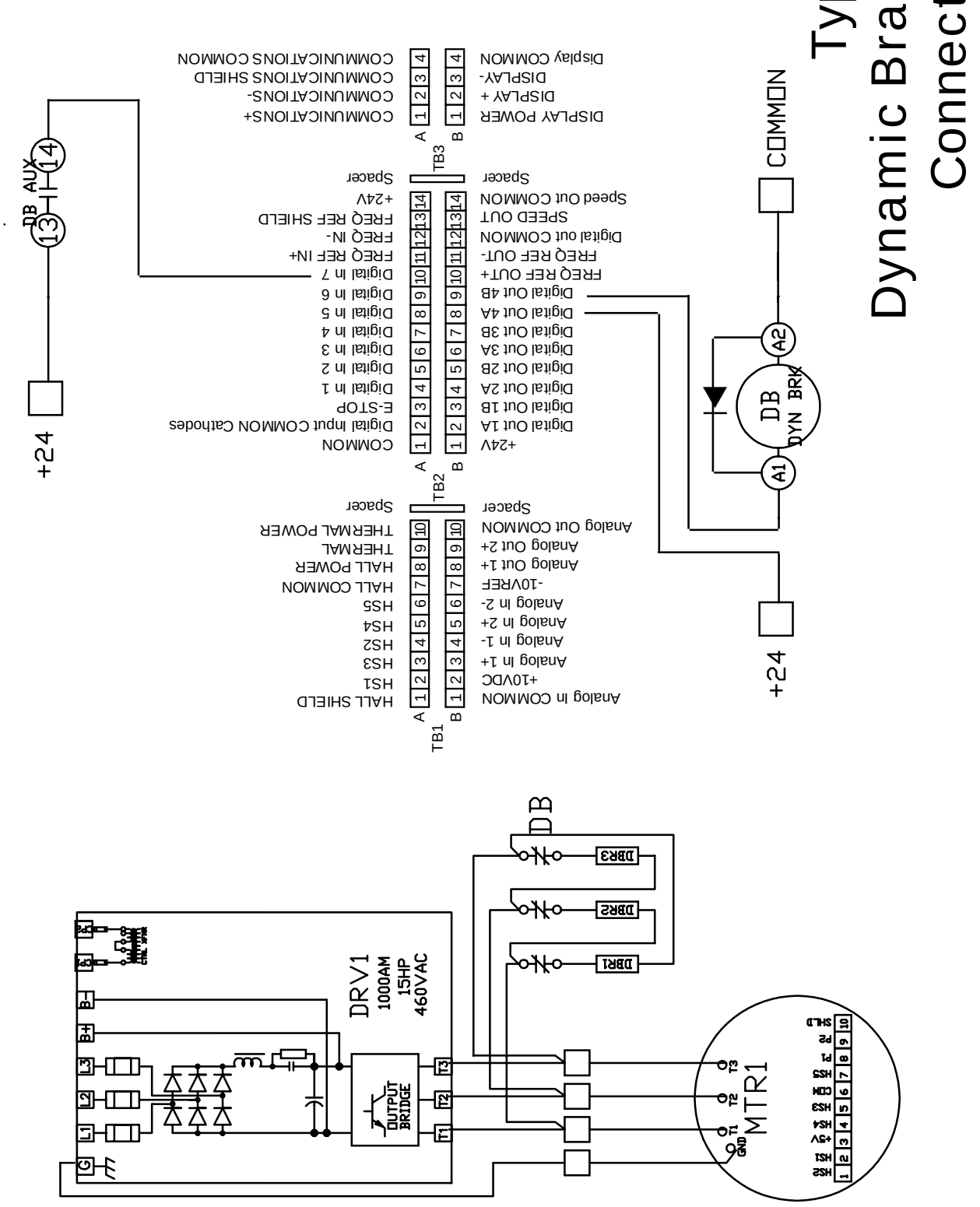
Terms Used

1 Contactor Aux - The digital input on the DFS board which is connected to the feedback contacts on the contactor relay.
2 Contactor Output - The digital output on the DFS board which activates the solenoid on the contactor relay.
3 Signal low - 0VDC
4 Signal high - 24VDC

Typical Output Contactor Connections



Typical Dynamic Braking Connections



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APPENDIX A

RETROFITTING THE MODEL 1000, 1000A, OR 1000AR

The DFS-1 Model 1000 series retro-fit kit consists of:

Quantity	1	DFS-1 Printed Circuit Board with connector plugs
Quantity	1	10 Pin Connector Cable Part # 3570-141420-001
Quantity	1	14 Pin Connector Cable Part # 3570-141419-001
Quantity	2	Nylon Spacer #6 x 1/4" diam x 1/4" long
Quantity	2	Machine Screw, Pan-head, 6/32 x 1/2" long
Quantity	4	Star Washer, #6

1. Disconnect the cables from the Current Controller board to the Driver board (P2) and the Capacitor board (P3) and let them hang for the time being.

2. Remove the 141-108 Current Controller board and the 141-107 Speed Controller board and set them aside. These boards have two screws each which hold them to the metal rail at the bottom and two hex nuts each which hold them to the Fuse board at the top. Save two of the hex nuts to mount the DFS-1 board.

3. There are four metal studs on the bottom of the Fuse board at the top of the drive. The two outside studs will be used to mount the DFS board, but the two center studs must be removed. Remove them and set them aside.

4. Remove the 14 pin connector cable connected to the Driver board (left side of the chassis), and replace it with the new cable 3570-141419-001. WARNING: Do NOT use the original drive cables with the DFS-1 board. This will cause damage to the drive circuitry. Either end of the cable may be plugged into the Driver board. Let the other end hang down the left side of the chassis because it will connect to the left side of the DFS board.

5. Remove the 10 pin connector cable connected to the Capacitor board (right side of the main chassis) and replace it with the new cable 3570-141420-001. Either end of the cable may be plugged into the Capacitor board. The other end of this cable will connect to the left side of the DFS-1 board, so make sure you stretch it across the chassis behind the DFS-1 board.

6. Mount the top of the DFS-1 board on the two outside studs at the bottom of the Fuse board using a star washer on each and the hex nuts saved when the other boards were removed.

7. Secure the bottom of the DFS-1 board to the rail, which previously supported the bottom of the Current and Speed boards, with the two screws supplied. The nylon spacers must be mounted between the DFS-1 board and the metal rail. Use a star washer between the DFS-1 board and the head of the screw.

8. Connect the 14 Pin connector cable to P2 on the left side of the DFS-1 board.

9. Connect the 10 Pin connector cable to P4 on the left side of the DFS-1 board.

   Turn to section 1.0 of the DFS-1 manual to make the connections required.

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APPENDIX B

MENU AND KEYPAD HIERARCHY

When the DFS-1 is shipped, the factory presets the unit's parameters according to the motor and drive's specifications. The following pages describe the keypad's hierarchal menus when the KDU-1 keypad and display unit has been installed and configured.

At the opening menu level, the DFS-1's status is displayed. The STATUS display shows the commanded speed, the load as a percent of Full Load Amps, and the actual motor speed. If speed setpoint changes are allowed, the up and down arrows can be used to trim the drive.

Of the seven keys on the keypad, the CMD key is the only one which always has the same function. If the drive is in LOCAL and there is no analog input associated with speed reference, the CMD key will return to the status display in the edit mode. This edit mode can be recognized by the presence of a cursor under one digit position of the commanded speed being displayed. In this mode, the right and left arrow keys move the cursor left and right changing the digit position being edited. The up and down arrows will modify the value of the digit being edited by incrementing or decrementing the value by one unit.

The SEL key will always return to the next higher level without saving changes.

The ENT key will save changes and return to the status display except in the Setup/Parameters mode where it will save changes and return to the previous parameter menu.

NEMA standards define forward as counterclockwise rotation of the shaft as viewed facing the front of the motor. On a brush DC motor, the front end is the commutator end while on a brushless DC motor the front end is the encoder end (normally opposite from the output shaft).

While in the status display mode, pressing the FWD key will cause the motor to run in the forward (clockwise) mode.

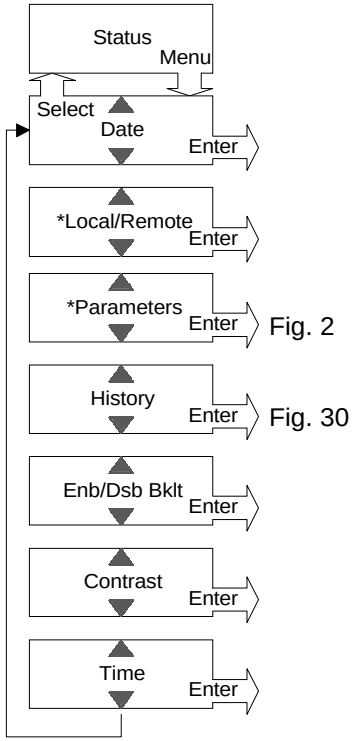
Likewise, pressing the REV key will cause the motor to run in the reverse (counterclockwise) mode.

Pressing the STP key will command the motor to stop. The manner in which the motor stops is determined by Setup Parameters.

In order to begin changing drive setup parameters, one must first press the MENU button. This action will return the options represented by Fig. 1 on the following page.

The charts on the following pages, show the hierachal order of the options available. In most every case, up and down arrow keys scroll through selection for a particular menu level while the ENTER key will either move to the next hierarchal level or set a point and save the change. The SELECT key will return to the top of the hierarchal level without saving any change. For example, pressing the Menu button will result in a two line display of SETUP/PARAMETERS. Pressing the down triangle (arrow) will cause the next menu item, SETUP/ENB/DSB BKLT to appear. At this point pressing ENT will result in choices of up arrow to Enable and Down arrow to disable the LCD backlight. On the other hand, choosing the SEL will go back to the SETUP/ENB/DSB BKLT menu. In cases where a selection will go to another hierarchal level, this chart will show a Fig. number which refers to the next chart. For example, in Figure 1, Parameters, pressing the ENTER key will take one to . . . Fig. 2.

Figure 1.0



* Not visible in some modes.

FIGURE 1

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Fig. 2

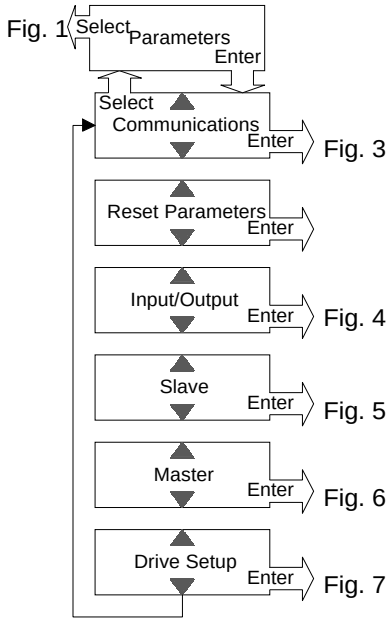


Fig. 3

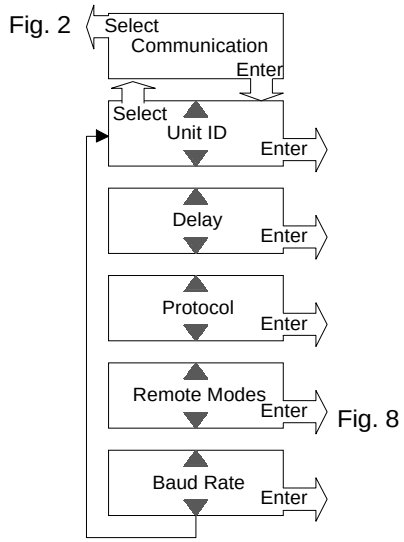
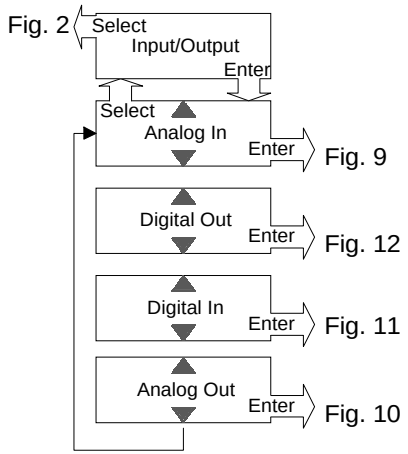


Fig. 4



FIGURES 2 - 4

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Fig. 5

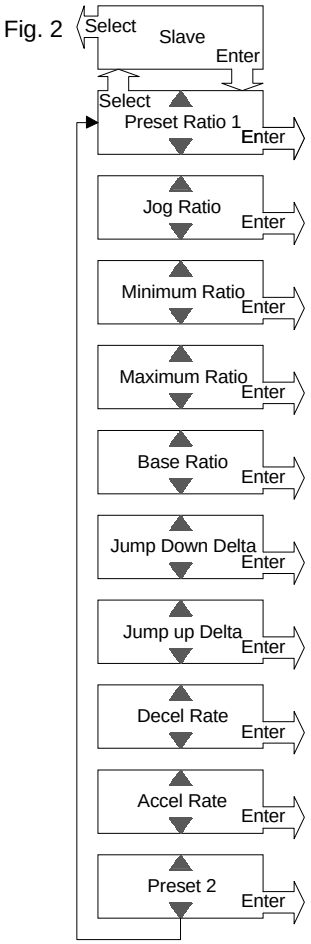


Fig. 6

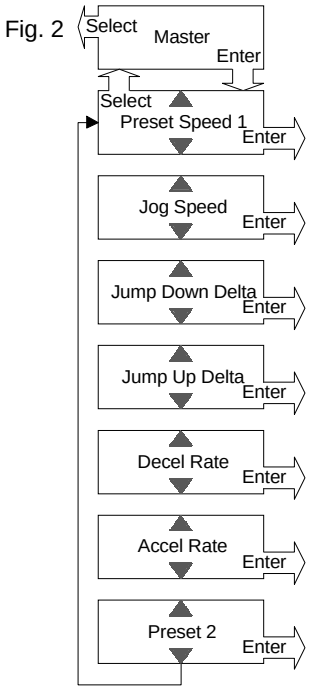
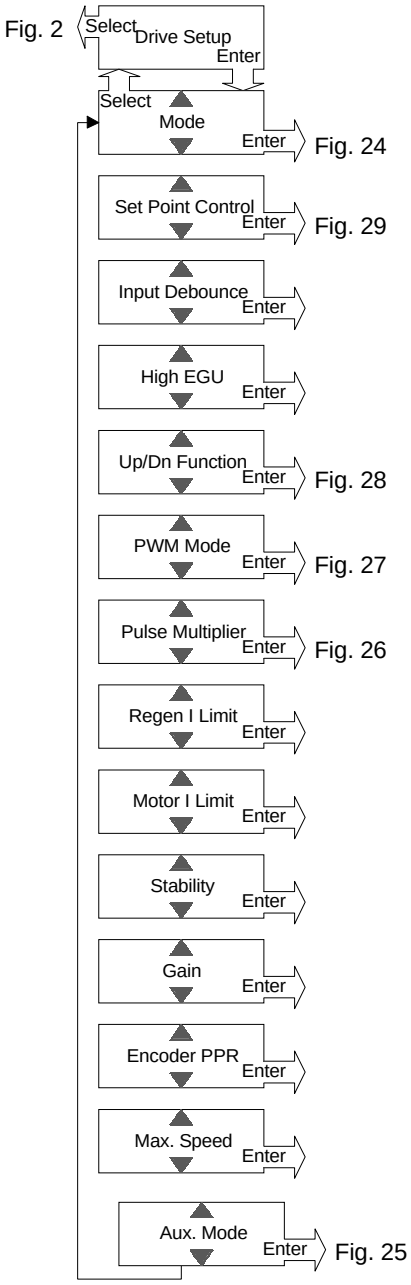


Fig. 7



FIGURES 5 -

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Fig. 9

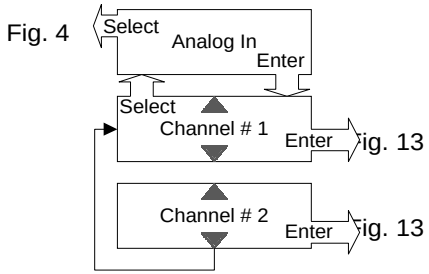


Fig. 10

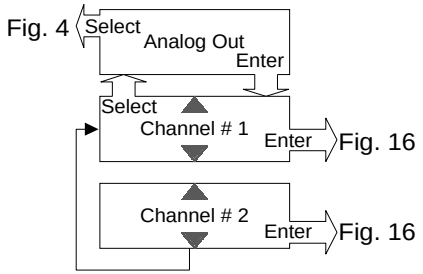


Fig. 11

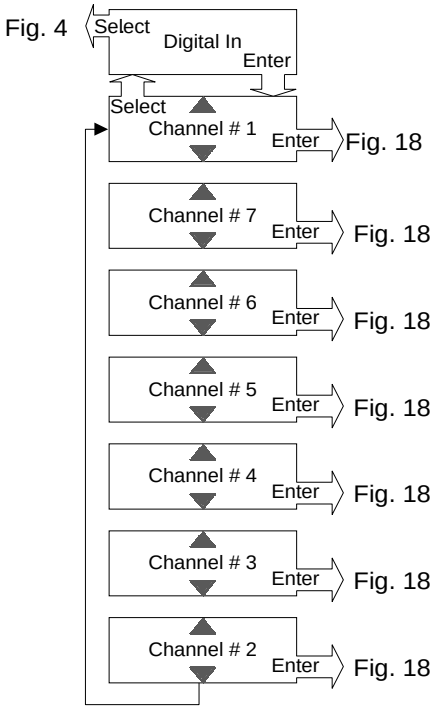


Fig. 12

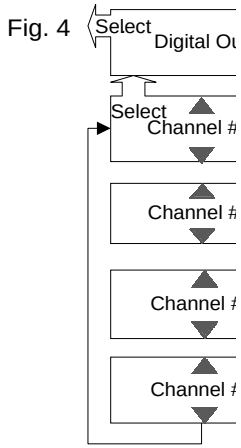
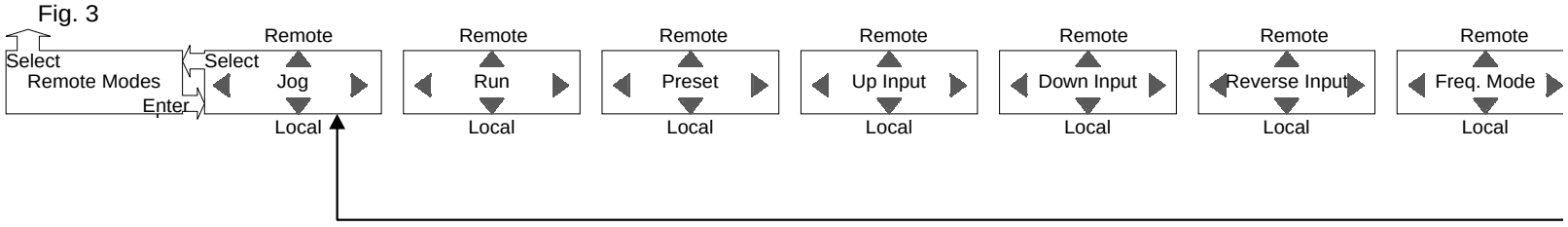


Fig. 8

Fig. 3



FIGUR

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Fig. 13

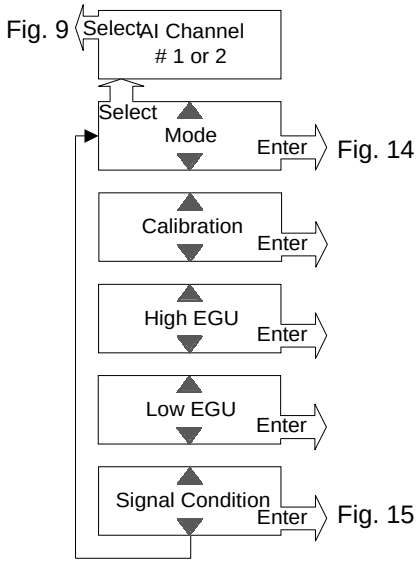


Fig. 14

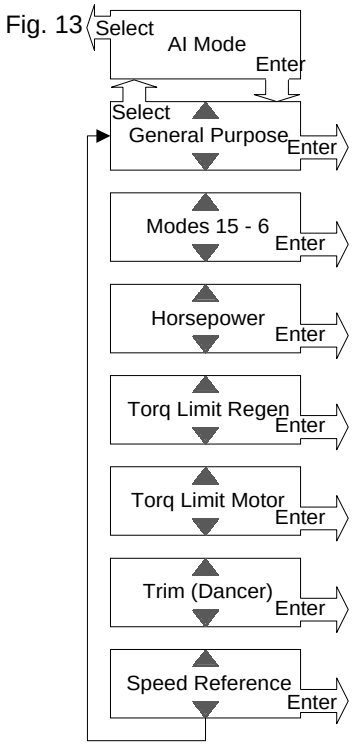


Fig. 15

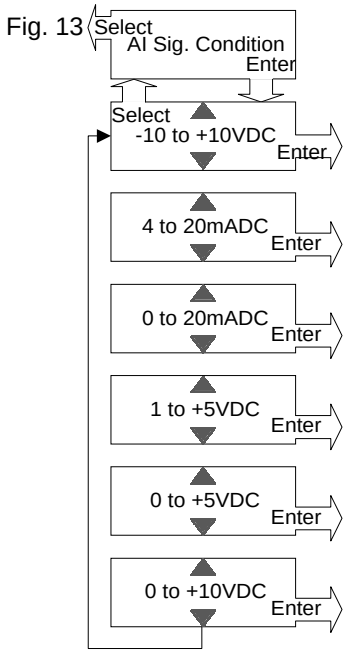
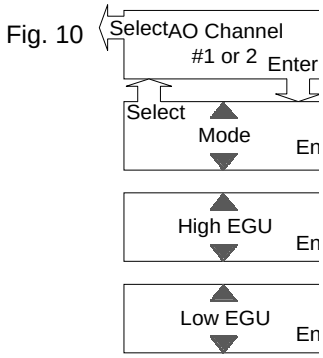


Fig. 16



FIGURE

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Fig. 17

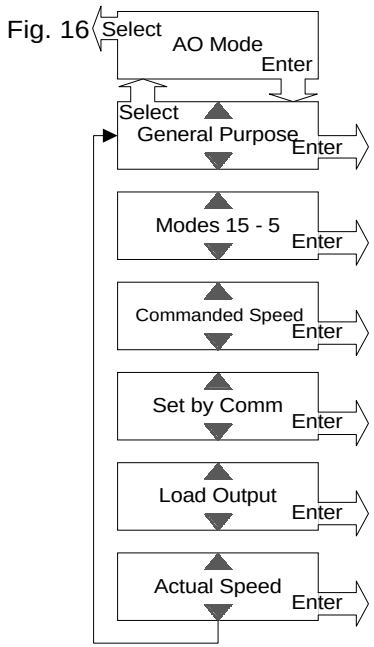


Fig. 18

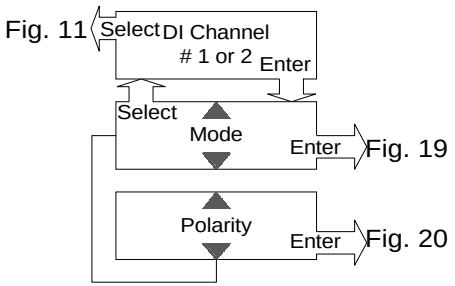
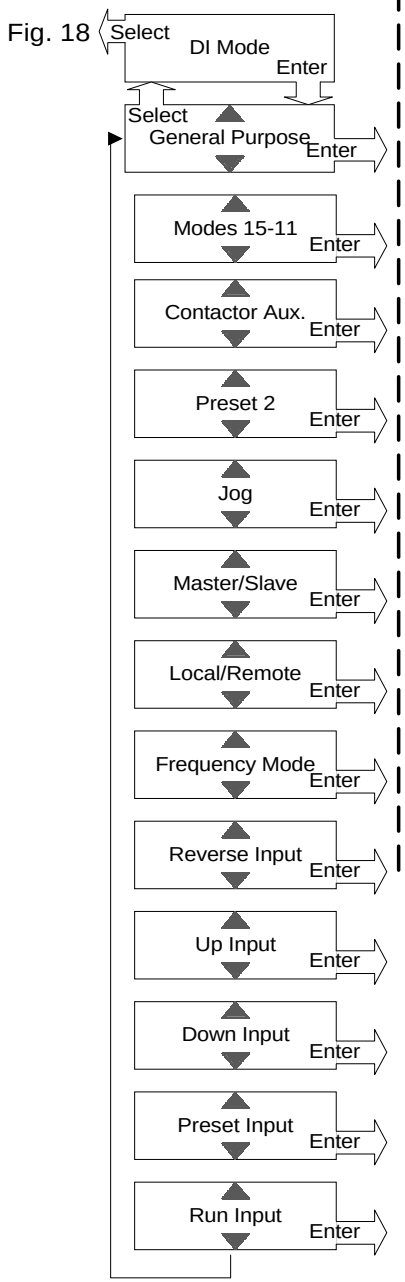
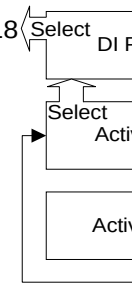


Fig. 19



Fig



FIGUR

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Fig. 21

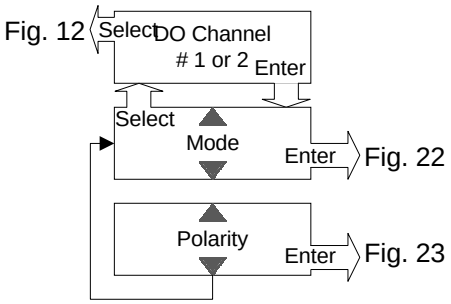


Fig. 22

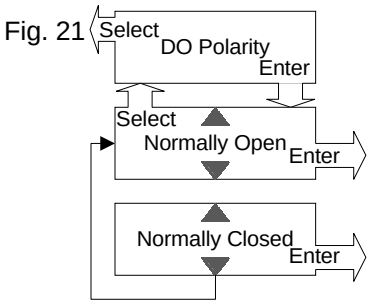
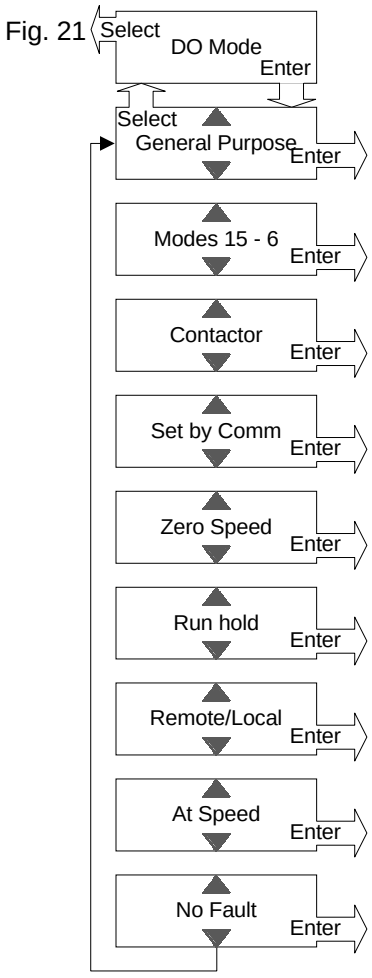
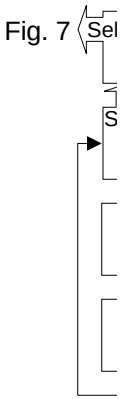


Fig. 23





FIGURE

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Fig. 25

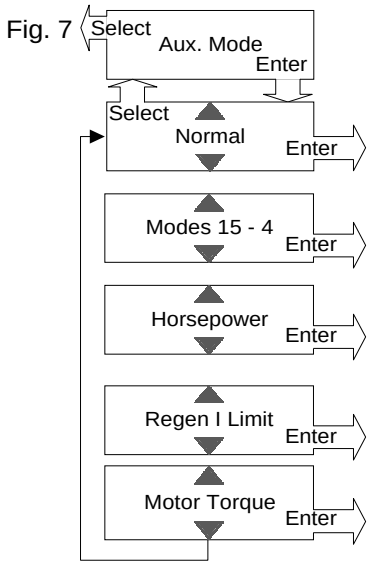


Fig. 26

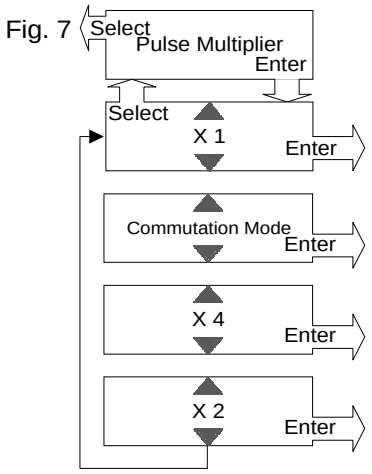


Fig. 27

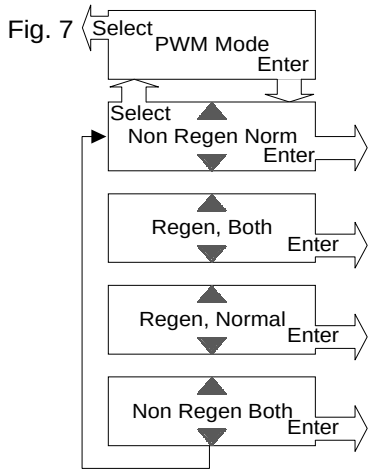
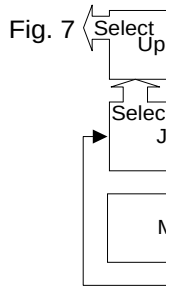


Fig.



FIGURES

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Fig. 29

Fig. 7

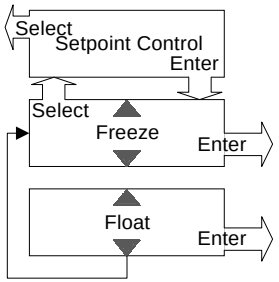
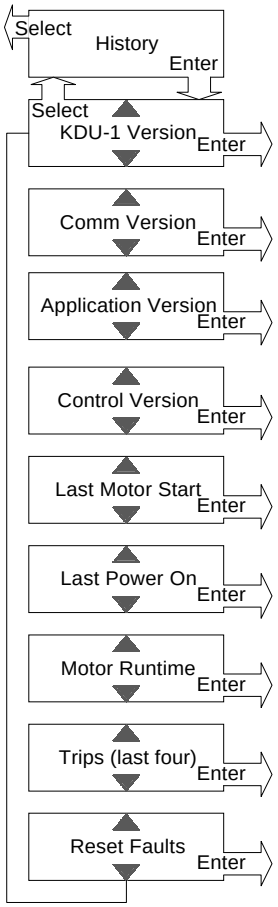


Fig. 30

Fig. 1



FIGURES 29 - 30

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