



M/X/XPM - SERIES DIGITAL SERVO DRIVES USER'S MANUAL

MANUAL NO. 20008-B

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Dear Reader

Thank you for choosing the DSP Automation M or X series Digital Servo Drives. This manual will help you understand the operation of the servo drives, so you can easily integrate them to your application. Read the manual carefully and you will soon become familiar with all the great features of the M-X Digital Servo Drives. Please observe the safety rules in order to avoid hazards and product failures.

Warning! Failure to comply with the safety rules can result electrical hazards leading to personal injury and/or equipment malfunction. Make sure you read Section 1 “Safety”, before you attempt to operate the servo drives.

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REVISION HISTORY

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1 Safety

Only qualified personnel may install, adjust, and maintain the digital servo drives. Personnel should be knowledgeable of performing tasks such as installing, commissioning, and operating the servo system. Failure to comply with the safety rules can result personal injury or death. Product damage is also possible.

1.1 Safety Rules

Always observe the following safety rules to avoid accidents and electrical hazards:

- Always keep cover of the servo drive on. Do not touch terminals for at least two minutes after the power has been turned OFF. Residual voltage in the drive's capacitors can cause electric shock. Measure with a multimeter the DC bus link voltage to ensure the voltage has dropped to a safe level.
- Always observe the national codes for proper cabinet wiring.
- Ensure all system components are connected to low resistance earth ground. Improper grounding can cause electric shock. Do not attempt to change wiring while power is applied to the system. Take special care of proper grounding when isolation transformers are being used.
- The servo drives contain electrostatic sensitive devices. To prevent damage, avoid contact with insulating materials, such as plastic film and synthetic fibers. Make sure you ground yourself in order to get rid of any possible charges.
- Do not touch the servo drives during operation. Doing so may result in burns due to high temperatures. These can be as high as 85°C.
- Make sure you provide adequate cooling and/or air flow in a cabinet, in order not to exceed the rated ambient temperature (40°C). If this cannot be avoided then the servo drives have to be operated at less than rated power levels in order not to exceed the maximum operating temperature
- Electrical arcing can damage the servo drive power contacts. Never connect or disconnect power or motor cables while the servo drive is on.
- Read carefully the nameplate on the drive for proper voltage rating. Wrong voltage, higher than rated, can result equipment failure and possible explosion.
- Do not operate the servo drive in environments that contain explosive gases, corrosive acids, or any other hazardous gases and liquids. Also

- make sure solid particles (especially conductive) do not enter the air vents of the drives
- The M and X servo drives are supposed to be used in industrial environments. When there are used in different environments (i.e. residential, medical equipment) additional filtering measures have to taken to ensure acceptable EMI/RFI levels.

2 Packaging & Handling

2.1 Packaging

The M and X series servo drives are shipped in cartons with adequate cushioning material to protect from shocks. However, it is good practice to avoid serious shocks during storage and transportation. Cartons are not water proof and special precautions have to be taken to prevent water/moisture from entering the boxes. Servo drives are enclosed in anti-static bags to protect from static charges damaging the sensitive terminals. Use proper caution when you take the drive out of the bag. Make sure you discharge yourself or any handling tools used.

Each servo drive box includes the following:

- Either: M servo drive / X servo drive / XPM power module
- Encoder and Signal Connector plugs and crimp contacts. Please read wiring section for appropriate crimping tools
- Power and Motor mating plugs (on the servo drive side).
- For the M and X servo drives, CD-ROM with the Setup Software (DSP Tool) and documentation

For motor power/encoder cables, USB communication cable, or any other accessories please contact DSP Automation.

2.2 Handling

Please comply with the following rules for proper equipment handling:

- Avoid serious shocks such as dropping the equipment
- Transport and store in the temperature range of -25°C to 60°C
- Relative Humidity should be less than 95%, non-condensing
- Always clean the equipment with a dry cloth and make sure no liquids or solids enter the air vents.

2.3 Repair

Repair is done only by DSP Automation at the factory. Equipment has to be shipped back after contacting the manufacturer. Do not open/disassemble the product because it will void the warranty.

2.4 Warranty

The standard equipment warranty is two years after the day of purchase. Please contact DSP Automation for extended warranty options.

3 Technical Specifications

3.1 Nameplate Data

Each drive/power module has a nameplate like the one shown in Fig.1, attached on the side of the device. The interpretation of its data is also shown in Fig. 1.

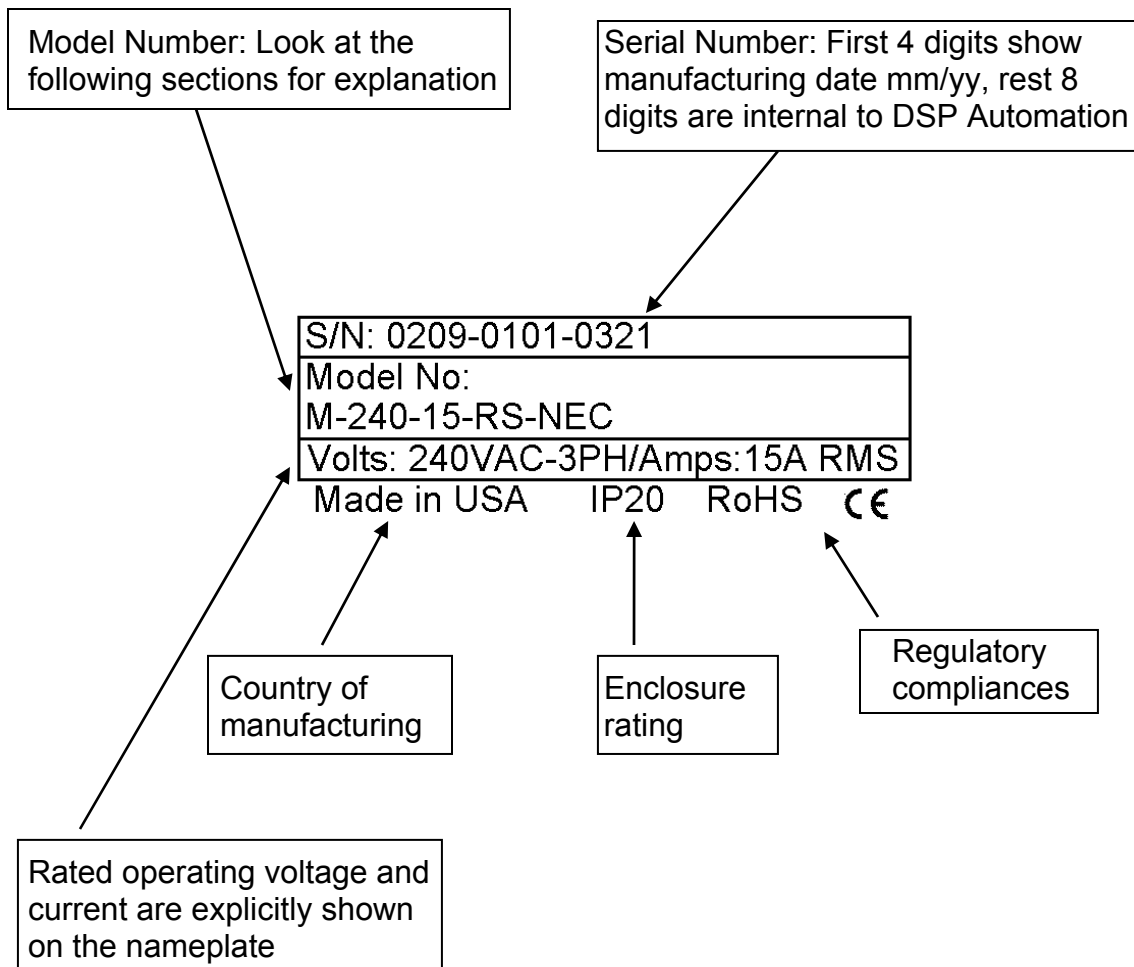


Figure 1: Nameplate

3.2 Model Number Format

Please use the following model number format to order equipment suitable to your application:

3.2.1 X Series Digital Servo Drives (DC Power Input)

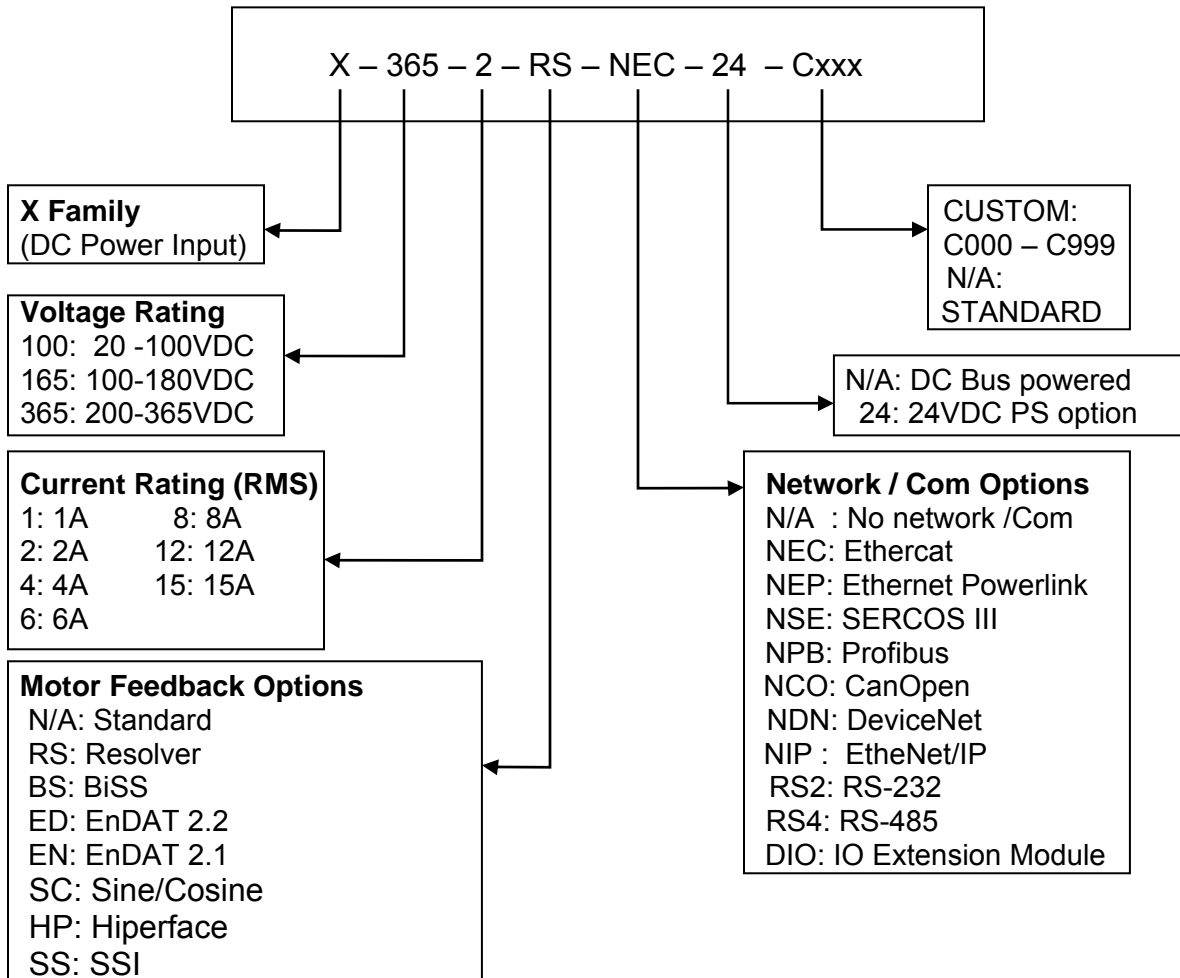


Figure 2: X Series Model Number Format

3.2.2 M Series Digital Servo Drives (AC Power Input)

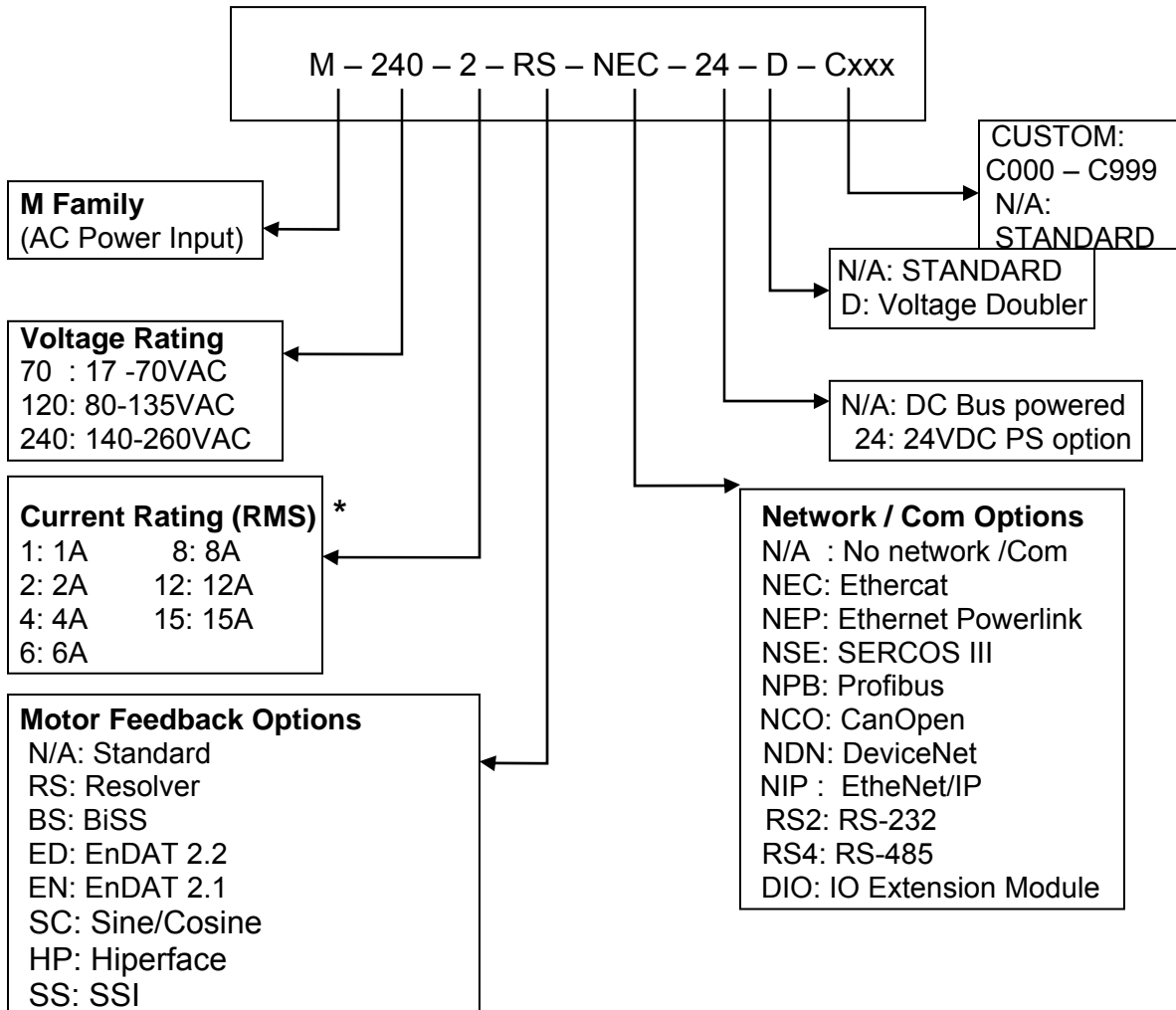


Figure 3: M Series Model Number Format

* : 8, 12, and 15A standard units are available only for three phase AC input.
Special versions exist for single phase applications at those current ratings.
Please contact DSP Automation for those special models.

3.2.3 XPM Series Power Modules

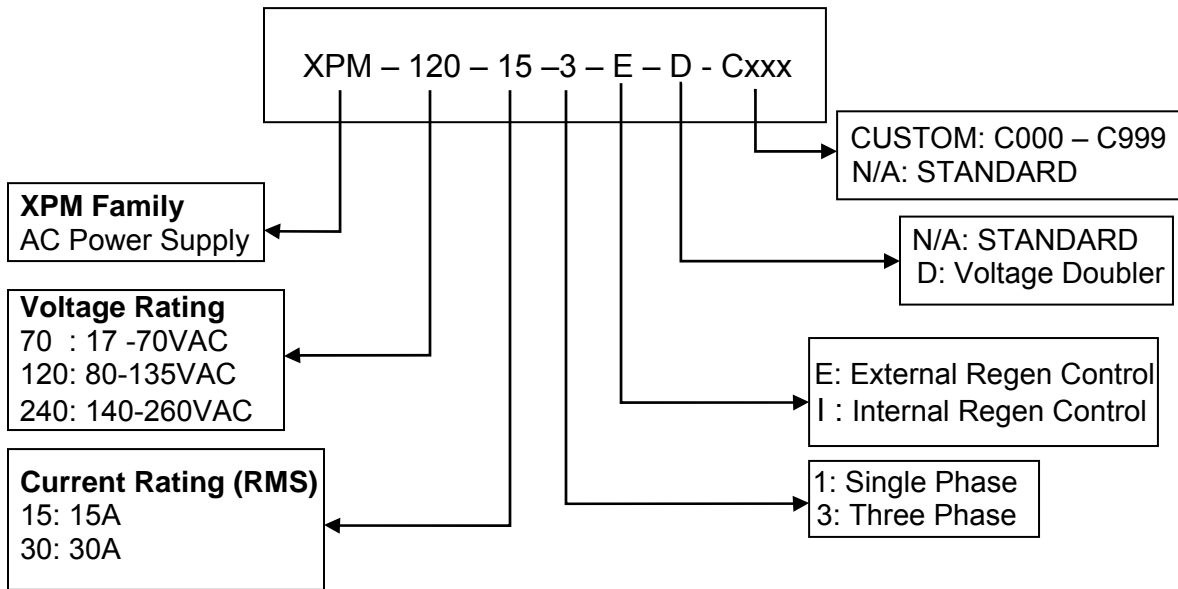


Figure 4: XPM Series Model Number Format

3.3 Environmental Specifications

X/M/XPM SERIES	
Ambient Temperature	-10 °C to 40 °C (for higher ambient temperature contact manufacturer for derating information)
Storage temp	-25 °C to 60 °C
Maximum humidity	95% non-condensing
Protection level	IP 20
Air Flow	External or Integrated fan on drives with current rating \geq 8A

Table 1: Environmental Specifications

3.4 Mechanical Specifications

X SERIES							
Current Rating	1	2	4	6	8	12	15
Height in(mm)	6.0 (152.4)						
Depth (incl. connectors) in(mm)	4.75 (120.65)						
Width in(mm)	1.9(48.26)				2.45(62.23)		
Weight lbs (kg)	1.1(0.5)				1.54(0.7)		

Table 2: X Series Mechanical Specifications

M SERIES							
Current Rating	1	2	4	6	8	12	15
Height in(mm)	6.0 (152.4)						
Depth (incl. connectors) in(mm)	4.75 (120.65)						
Width in(mm)	2.7(68.58)				3.2(81.28)		
Weight lbs (kg)	1.76(0.8)				2.2(1.0)		

Table 3: M Series Mechanical Specifications

XPM SERIES		
Current Rating	15	30
Height in(mm)	6.0 (152.4)	
Depth (incl. connectors) in(mm)	4.75 (120.65)	
Width in(mm)	2.7(68.58)	3.2(81.28)
Weight lbs (kg)	1.9(0.86)	2.86(1.3)

Table 4: XPM Series Mechanical Specifications

3.5 Electrical Specifications

X SERIES								
Continuous Output Current (RMS)	A	1	2	4	6	8	12	15
Peak Output Current (RMS)	A	3	6	12	18	24	30	30
Max. Peak Current Time	Sec	3 sec @ peak output current						
Bus Voltage (X-100)	VDC	20 – 100						
Bus Voltage (X-165)	VDC	100-180						
Bus Voltage (X-365)	VDC	200-365						
External Control Logic Power Supply (Option)	V	24VDC/0.5A (min: 15VDC, max: 30VDC)						

Table 5: X Series Electrical Specifications

M SERIES								
Continuous Output Current (RMS)	A	1	2	4	6	8	12	15
Peak Output Current (RMS)	A	3	6	12	18	24	30	30
Max. Peak Current Time	Sec	3 sec @ peak output current						
Bus Voltage (M-70)	VAC	17 – 70 (50/60Hz)(1-Ph)						
Bus Voltage (M-120)	VAC	80-135 (50/60Hz)(1-Ph)						
Bus Voltage (M-240)	VAC	140-260 (50/60Hz)(1/3-Ph)						
External Control Logic Power Supply (Option)	V	24VDC/0.5A (min: 15VDC, max: 30VDC)						
Internal/External Regen Capability	-	25W / 100% drive rating						

Table 6: M Series Electrical Specifications

XPM SERIES			
Continuous Output Current (RMS)	A	15	30
Peak Output Current (RMS)	A	30	45
Max. Peak Current Time	Sec	3 sec @ peak output current	
Bus Voltage (M-70)	VAC	17 – 70 (50/60Hz)(1-Ph)	
Bus Voltage (M-120)	VAC	80-135 (50/60Hz)(1-Ph)	
Bus Voltage (M-240)	VAC	140-260 (50/60Hz)(1/3-Ph)	
Internal/External Regen Capability	-	25W / 100% drive rating	

Table 7: XPM Series Electrical Specifications

3.6 Performance Specifications

X/M SERIES	
Max Current Loop BW	3 kHz
Max Velocity Loop BW	600Hz
PWM Frequency	16kHz (min:8, max:20) Custom: 2-100kHz
Commissioning / Diagnostics	Real-Time PC Software - USB Communication, Status LEDs
Analog Inputs (x2)	+/-10V, 16-bit A/D Resolution, Software Scalable/Selectable
Analog output	+/-10V, Software Scalable/Selectable
Digital Inputs (x3)	4.5-30.0VDC Input Range, Software Configurable
Digital Outputs(x2)	4.5-30.0VDC/ 100mA max Software Configurable Open Collector (Pull-up Optional)
Servomotor Brake Control	Software Configurable Output, 24VDC(+/-30%), 3A max. (user supplied power)
Motor Temperature Sensor	Thermostat, NTC, PTC, Software Configurable
Auxiliary Power Outputs	12VDC/10mA, -12VDC/10mA, 5V/50mA
Motor Current Waveform	Sinusoidal/Trapezoidal (Software Selectable)
Motor Feedback	Incremental Encoder / Halls Halls Only(Differential or Single Ended) Absolute Serial: 17-25bit, BiSS / EnDAT 2.2 / SSI (Single / Multiturn) Tachometer: (+/-50V max.) 16-bit A/D Resolution
Emulated Encoder	5V Differential Outputs (A,B,Z), 2.5MHz max. Software Configurable Division
Pulse & Direction	5V Differential Inputs, 2.5MHz max.
Operating Modes	Torque, Velocity, Pulse & Direction, Encoder Follower, Sensorless (Brushed only), Position (Custom interface), 2-Phase Analog
Motors Supported	Brushless (Rotary/Linear), Brushed

Table 8: X/M Series Performance Specifications

4 Mechanical Installation

4.1 Dimensions

4.2 Mounting

4.3 Airflow

5 Electrical Installation

This chapter provides all the necessary information to properly wire the M/X-series servo drives. The power connections differ between the M and the X series, but the low voltage signals are identical. Figure 5 shows an X-series drive which makes clear the connectors' designations. Every X-Series drive has a side overlay that is pretty much self-sufficient to wire a drive.

Make sure you properly strain relief all cables that are connected to the drives, in order to avoid problems with the control of the motors, or even electrical hazards with the power connectors.

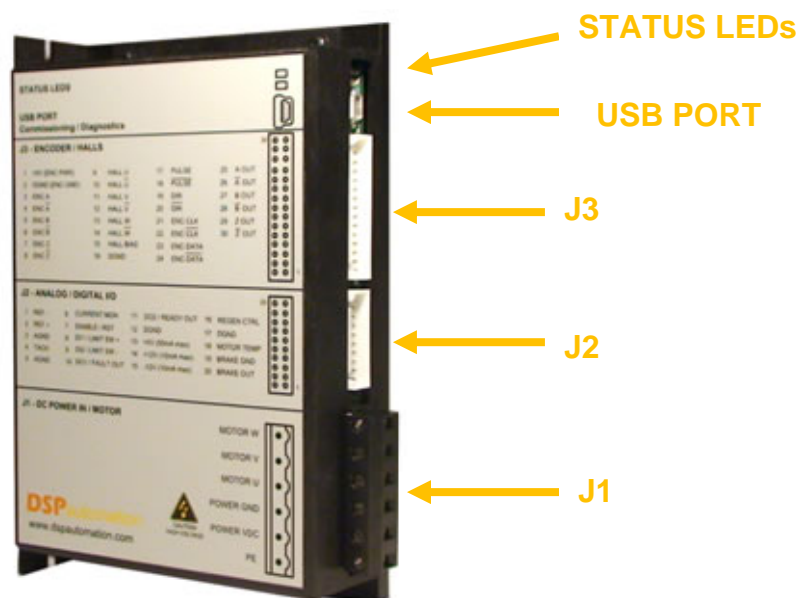


Figure 5: X-Series Drive

5.1 X-Series Power / Motor Connectivity

The X-series drives accept DC power in order to power both motor and the drive control electronics through a DC/DC converter. There is only one power connector, J1 which can be seen in Figure 5. Both the DC bus and the motor are connected to this connector. Here are the cables to connect to this motor.

- Connect **J1-PE** to the machine ground and to the motor ground cable. If the motor cable shield is terminated to the motor power connector and the motor is electrically connected to the machine ground, leave the cable shield open-ended on the drive side. If the shield is not terminated at the motor and/or the motor is electrically isolated from the machine ground, connect the shield to **J1-PE**.

- Connect the power bus positive lead to **J1-POWER VDC**
- Connect the power bus ground (or negative) to **J1-POWER GND**
- Connect motor phase leads U-V-W to the respective **J1-U**, **J1-V**, **J1-W** screw terminals.
- If it is a brushed motor connect the positive lead to **J1-V** and the negative lead to **J1-W**.

5.2 XPM Power Module Connectivity

X-series drives can be used either with XPM power modules or with the customer's own power supply. If the XPM is used, consult DSP Automation for specific XPM model and number of servo axes it can support for your application. An XPM power module can be seen in Figure 6.



Figure 6: XPM Power Module

Follow the following steps to properly wire an XPM module to one or more X drives.

For the AC input:

- Connect the machine (system ground) to **J1:PE**
- If three-phase input, connect the three phases L1, L2, L3 leads to the respective **J1-L1**, **J1-L2**, **J1-L3**.
- If single-phase input connect the phase (L1) to **J1-L1**, and the neutral (N) to **J1-L2**.
- XPM modules are equipped with internal regen resistors with a continuous power rating of 25W. If an external bigger regen resistor is required, connect the two resistor leads to **J1-RGN+** and **J1-RGN-**.

For the DC output:

- J2 can accept up to three pairs of cables to power three X-series drive with direct connections to the XPM module. **J2-Power VDC** is connected to the bus positive and **J2-Power GND** is connected to the bus ground.
- A second way to wire more drives to a single XPM module is to use appropriate bus harnesses with power drops to each axis. This is usually recommended with the 30A XPM which can support 30A continuous current on the bus.

5.2.1 XPM Regen Control

XPM modules are active power supplies that protect from bus over-voltages. Depending on the model, the logic can be contained in the XPM itself, or one of the system's axes can control it. In the second case a third connector **J3** exists between **J1** and **J2**. Look at section 5.13 for connection instructions.

5.2.2 Voltage Doubler Option

When an XPM comes with a voltage doubler option, connect per single phase instructions above. The DC output will be equal to $2 \times 1.414 \times \text{AC input}$.

5.3 M-Series Power / Motor Connectivity

M-series drives can accept single or three phase power input. Figure 7 shows motor connector J1 on the left, and power input connector J4 on the right.



Figure 7: M-Series Motor/Power Connectors

Motor Connector J1:

- Connect **J1-PE** to the motor ground cable. If the motor cable shield is terminated to the motor power connector and the motor is electrically connected to the machine ground, leave the cable shield open-ended on the drive side. If the shield is not terminated at the motor and/or the motor

is electrically isolated from the machine ground, connect the shield to **J1-PE**.

- Leave the DC power bus leads (**J1-POWER VDC**, **J1-POWER GND**) unconnected
- Connect motor phase leads U-V-W to the respective **J1-U**, **J1-V**, **J1-W** screw terminals.
- If it is a brushed motor connect the positive lead to **J1-V** and the negative lead to **J1-W**.

Power Input Connector J4:

- Follow exactly the instructions for the XPM AC power input connection (Section 5.2)

5.4 PC Connectivity – Diagnostics

M/X series drives can be real-time configured and diagnosed when connected to a computer. The USB connector for an M drive can be seen in Figure 8. For an X drive the connector is in the same place. Chapters 7, 8, and 9, deal with the configuration software installation and operation.



Figure 8: USB Connector / Status LEDs / J2 and J3 Connectors

Also, each M/X drive has two LEDs (one red and one green) to the right of the USB port, used to identify the operating status of the drive. Lit LEDs show that the unit is under power. Non-lit LEDs show that the unit is not powered. If power to the unit was shut off, LEDs will remain lit until the capacitors discharge down to 70V.

5.5 Motor Feedback Connectivity

The standard version of the M/X version drives will accept the following kinds of motor feedback:

- Incremental Encoder with Halls

- Halls only
- Incremental Encoder (brushed motors only)
- Tachometer
- Serial Absolute Encoders

More feedback options are available with extension modules, listed in Chapter 6. Feedback devices are connected to connector J3, with the exception of the tachometer which is connected to J2. Table 9 lists J3 signals. Connectivity for each sensor is explained in the next sections. Remember, odd pin numbers are in the lower connector row, as you view the unit from the front. Pin 1 is on the lower left corner, and pin 30 on the upper right corner.

Pin #	Name	Signal
1	+5V (ENC PWR)	Encoder Power (+5V DC/ up to 300mA)
2	DGND (ENC GND)	Encoder Ground
3	ENC A	Encoder Phase A
4	ENC ~A	Encoder Phase ~A
5	ENC B	Encoder Phase B
6	ENC ~B	Encoder Phase ~B
7	ENC Z	Encoder Index Z
8	ENC ~Z	Encoder Index ~Z
9	HALL U	Hall Sensor U
10	HALL ~U	Hall Sensor ~U
11	HALL V	Hall Sensor V
12	HALL ~V	Hall Sensor ~V
13	HALL W	Hall Sensor W
14	HALL ~W	Hall Sensor ~W
15	HALL BIAS	1.9V Bias Voltage, Used only for single-ended halls
16	DGND	Digital Ground
17	PULSE	PULSE Input for Pulse & Direction Mode
18	~PULSE	~PULSE Input for Pulse & Direction Mode
19	DIR	DIRECTION Input for Pulse & Direction Mode
20	~DIR	~DIRECTION Input for Pulse & Direction Mode
21	ENC CLK	CLOCK Input for Serial Encoders
22	ENC ~CLK	~CLOCK Input for Serial Encoders

23	ENC DATA	DATA Input/Output for Serial Encoders
24	ENC ~DATA	~DATA Input/Output for Serial Encoders
25	A OUT	Emulated Encoder Output A
26	~A OUT	Emulated Encoder Output ~A
27	B OUT	Emulated Encoder Output B
28	~B OUT	Emulated Encoder Output ~B
29	Z OUT	Emulated Encoder Output Z
30	~Z OUT	Emulated Encoder Output ~Z

Table 9: J3 Motor Feedback Connector

Attention!! For each motor feedback connector cable, terminate the shield only on the motor side.

5.5.1 Incremental Encoder with Hall Sensors

A very common motor feedback option is incremental encoder with emulated hall sensors. In almost all these cases all signals are differential. Connect per table 9. The encoder index signal Z is not required by the drive. Connect only if it is needed for further processing by the motion controller.

In certain cases you have differential encoder signals but single ended hall sensors. The hall sensors can be open collector or TTL. In this case connect the U, V, W hall signals to pins 9, 11, 13, and connect pins 10, 12, 14 to pin 15 which is the hall bias voltage. Do not connect anything else at pin 15.

Although single-ended encoder signals (A, B, Z) can be accommodated, it is strongly recommended you avoid them because the system will become sensitive to noise. If it is absolutely necessary, contact DSP Automation for instructions.

5.5.2 Hall Sensors Only

When only hall sensors are available the drive can only operate in trapezoidal torque mode or velocity mode with rough velocity estimation. Wire hall sensors as described in the previous section. Use the 5VDC encoder power to power the hall sensor circuits.

5.5.3 Incremental Encoder

When only incremental encoder is available (no halls), only a brushed motor can be controlled. Connect channels A, B, Z per table 9.

5.5.4 Tachometer

Although tachometer is not connected at J3, it is listed here since it is a feedback option. Connect tachometer leads to pins J2-3 (AGND) and J2-4 (TACH).

Tachometer can be used with either brushed motors, or brushless when they use it as an auxiliary feedback device to the encoder and halls.

5.5.5 Absolute Serial Encoder

Absolute serial encoders (i.e. BiSS, SSI, EnDat 2.2) need to have 6-10 wires connected, depending on the application. Wiring instructions follow:

- Power the encoder with 5VDC from pins 1 and 2
- Connect the Clock and Data Signals per table 9
- If you do not need the drive to provide position feedback you do not need to connect any more cables. If position feedback to the motion controller is required, connect the Sin/Cos Encoder signals to the A and B differential inputs. The differential input circuitry will transform the sinusoidal waves to rectangular signals. An index pulse is created by the internal circuitry

5.5.6 Emulated Encoder Outputs

M/X drives provide emulated encoder signals to the motion controller. There are three differential outputs (A, B, and Z). Connect the 6 differential signals and ground (pin 16) to the controller respective input signals and ground. The encoder signal can be passed directly to the controller or after division. Please look at the software section (chapter 9) for configuration of these outputs.

5.6 Pulse & Direction / Encoder Follower

When Pulse & Direction Mode is used, connect signals per table 9. Do not forget to connect the grounds between the controller and the drive (pin 16).

When in Encoder Follower Mode, PULSE input becomes QUAD A input, and DIRECTION input becomes QUAD B input.

When master-slaving drives, connect the emulated encoder outputs (A, B) from the master drive to the QUAD A, B inputs of the slave drive.

5.7 J2 Connector: Digital – Analog I/O

Connector J2 contains all the control signals to and from the drive. You can see J2 in Figure 8 and its signals in Table 10. Connectivity for each signal is explained in the next sections. Remember, odd pin numbers are in the lower connector row, as you view the unit from the front. Pin 1 is on the lower left corner, and pin 20 on the upper right corner.

Pin #	Name	Signal
1	REF-	Differential Analog Input 1 -
2	REF+	Differential Analog Input 1 +
3	AGND	Analog Ground
4	TACH	Tachometer Input / Second Analog Input + for 2-Phase Analog Mode
5	AGND	Analog Ground
6	CURRENT MON	Analog Output (Software Configurable, Default: Current Monitor)
7	ENABLE / RST	Enable / Disable Input (Reset Faults)
8	DI1 / LIMIT SW+	Digital Input 1 (Limit Switch +)
9	DI2 / LIMIT SW-	Digital Input 2 (Limit Switch -)
10	DO1 / FAULT OUT	Digital Output 1 (Software Configurable, Default: Fault Output)
11	DO2 / READY OUT	Digital Output 2 (Software Configurable, Default: Servo Ready)
12	DGND	Digital Ground
13	+5V (50mA max)	Auxiliary Power supply output
14	+12V (10mA max)	Auxiliary Power supply output
15	-12V (10mA max)	Auxiliary Power supply output
16	REGEN CTRL	External Regen Control
17	DGND	Digital Ground
18	MOTOR TEMP	Motor Temperature Sensor
19	BRAKE GND	Brake Ground
20	BRAKE OUT	Brake Control Output (Open Collector)

Table 10: J2 Control Signal Connector

5.7.1 Digital Inputs

All digital inputs are referred to digital ground (DGND, pins 12, 17). Digital ground is connected to the drive's chassis ground. The inputs can accept signals in the 4.5 – 30VDC range. Any voltage in the range of 0-3VDC range or floating will be recognized as low-level. Do not use signal in the 3-4.5VDC range or negative signals.

The three inputs are:

- Pin 7: Enable / RST
- Pin 8: DI1 / LIMIT SW+
- Pin 9: DI2 / LIMIT SW-

5.7.2 Digital Outputs

There are three digital outputs (including the brake output). These are:

- Pin 10: DO1/Fault Out
- Pin 11: DO2/Ready Out
- Pin 19: Brake GND, Pin 20: Brake OUT

Outputs DO1, DO2 are software configurable outputs, preset to output the FAULT and SERVO READY signals. Look for configuration details in the software chapter. These outputs are referred to DGNG (pins 12, 17) and they are open collector with maximum ratings 28V/200mA. In certain cases, the manufacturer can add internal pullup resistors to these outputs, if this is desired.

The third output controls the brake, and it is explained in the following section.

5.7.3 Brake

In order to use the brake, you need to provide external brake power. The maximum rating is 28V/3A.

Connect the brake positive lead to +24V and the brake negative lead to pin 20 (BRAKE OUT). Then make sure you connect directly the 24V power supply ground to pin 19 (BRAKE GND). With most brakes polarity of the brakes leads does not matter. Look at the software configuration chapter for instructions on how to control the brake logic.

5.7.4 Analog Inputs / Tachometer

There are two analog inputs with the M/X series drives. These are:

- AIN1: Pin1(REF-) and Pin2(REF+)
- AIN2: Pin4 (TACH)

Both inputs are referred to Analog Ground (pins 3 and 5). AIN1 is differential input and AIN2 is single-ended.

AIN1 is the torque/velocity input for the drive. The input range is +/- 10V and the inputs are protected up to +/-15V. When this differential input is configured as single-ended, which is usually the case, connect Pin1 (REF-) to Pin 3 (AGND).

AIN2 is the tachometer input. Connect the tachometer positive lead to Pin 4 (TACH), and the tachometer negative lead to Pin 5 (AGND). This input can accept voltages up to +/-50V.

In the case of 2-Phase Analog Mode, AIN1 is the U current reference, and AIN2 is the V current reference. In this case the inputs are internally configured to be identical (both differential) with the AIN2 negative input tied internally to AGND.

The impedance of AIN1 (and AIN2 in 2-Phase Analog Mode is 28kOhm) and the impedance of AIN2 in Tach Mode is 200kOhm.

5.7.5 Analog Outputs

There is one software configurable output (AO1) with the M/X series drives, Pin 6 (CURRENT MONITOR). The default signal attached to the output is the motor current (RMS). You can change the signal from the software configuration.

The output range is +/-10V, and the output impedance is 120Ohm. The output maximum current rating is +/-10 mA.

5.7.6 Auxiliary Power Supply Outputs

Connector J2 outputs three power supply busses in order to accommodate applications that don't have external power supplies to enable the digital and analog inputs. The power supply pins are:

- Pin 13: +5V (50mA max)
- Pin 14: +12V (10mA max)
- Pin 15: -12V (10mA max)

If you do not need these voltages, leave those pins disconnected. If you need to power the digital inputs you can do it either with +5V or +12V. In many cases, the +/-12V can power an external potentiometer for simple velocity/torque control.

5.7.7 External Regen Control

This function is only used with X series drives. When there is only one XPM power module powering several X drives, then one of the X drives controls the regen control for the power module. Connect pin J2-16 (REGEN CTRL) to XPM pin J3-2 (REGEN CTRL), and pin J2-13(+5V) to XPM J3-1 (+5V). Make sure you use the X drive that is always enabled.

The option of internal XPM regen control is available, but it comes with limited control abilities as opposed to being controlled by an X-drive.

5.7.8 Motor Temperature Sensor

When a motor temperature sensor (thermostat) is available, connect the two sensor leads at pins 17 (DGNG) and 18 (MOTOR TEMP). If an NTC or PTC sensor is available, please contact the manufacturer for proper configuration instructions.

5.8 Wire Specifications

Use braid-shielded cable for all motor power connections and twisted-pair cable (braid and foil shielded) for all encoder connections. It is strongly recommended you use shielded cable for all control I/O cables and power input cables. Use flexible wires (stranded) in order to make sure you don't put excess mechanical stress on the connectors. Please contact DSP Automation for recommended cable brands and models.

Follow the following table for proper wire sizes based on the drive's current rating

Current Rating (A RMS)	Power Input Cable	Motor Cable	Control I/O and Encoder Cables
2	18 AWG	18 AWG	24AWG
4,6	16 AWG	16 AWG	
8	14 AWG	14 AWG	
12	12 AWG	12 AWG	
15	10 AWG	10 AWG	

Table 11: Recommended Cables for M/X Series Drives

5.9 Fuses/Breakers

Every M/X/XPM device needs to have appropriate fuses or breakers in the power inputs. Please contact DSP Automation if you think you need assistance in this area.

5.10 EMI/RFI Filters

In many applications external EMI/RFI filters may be required before the power input of the drive(s). Please contact DSP Automation if you think you need assistance in this area.

6 Extension Modules

Future versions of this manual will list at this Chapter the extension modules available for the X and M digital servo drives. These modules will offer a variety of networking options, several more motor feedback device interfaces and several other options as extended I/O, custom modules, etc.

7 Software Installation

DSP Automation digital servo drives are configured with DSP Tool, the appropriate software for configuring and monitoring the drives. DSP Tool is the real time software that communicates with each drive through a USB port. User has full access to a list of parameters that will help to commission any application from the easiest to the more demanding ones. This section explains the system requirements and the software installation process.

7.1 System Requirements

The following requirements should be met for acceptable software performance:

- PC with 1.5 GHz or higher processor clock speed. Intel Pentium/Celeron family, AMD K6/Athlon/Duron family, or compatible processor recommended
- Operating system: Windows 2000 / XP / VISTA
- 10 MB of available hard disk space.
- 1 GB RAM or higher recommended
- USB 2.0 port and 5-Pin Mini-B USB Cable on the drive side
- CD-ROM Drive
- Super VGA (800 × 600) or higher resolution video adapter and monitor

7.2 DSP Tool Installation

- Make sure no servo drive is connected to the PC
- Obtain DSP Tool from either the installation CD that comes with the product or obtain it from www.dspautomation.com
- Insert the CD to the CD-ROM and open Windows explorer to the root CD-ROM directory (usually D:\). There you will find "DSP Tool" folder. Open the folder and double-click on Setup.exe. This will initiate the software installation. Follow the instructions on the screen and click "OK" to complete installation.
- Your Windows version needs to have .NET Framework 1.1 software installed. If this is not present in your system, DSP Tool will prompt you to install it before it can continue with installation. Execute dotnetfx.exe from the DSP Tool folder and install it. Then you can continue with the DSP tool installation
- At this point your software installation is almost complete. You still need to install the USB drivers the first time you connect a servo drive to your computer. The following section explains how to install the USB drivers.

7.3 USB Drivers Installation

Power the servo drive. Then connect the USB Cable (5-Pin Mini-B USB on servo drive side) between the PC and the servo drive. Windows will detect the presence of the servo drive and display the following screen



Figure 9: Software installation screen 1/6

Leave the selection at “No, not this time” and click “Next”. The following screen comes up

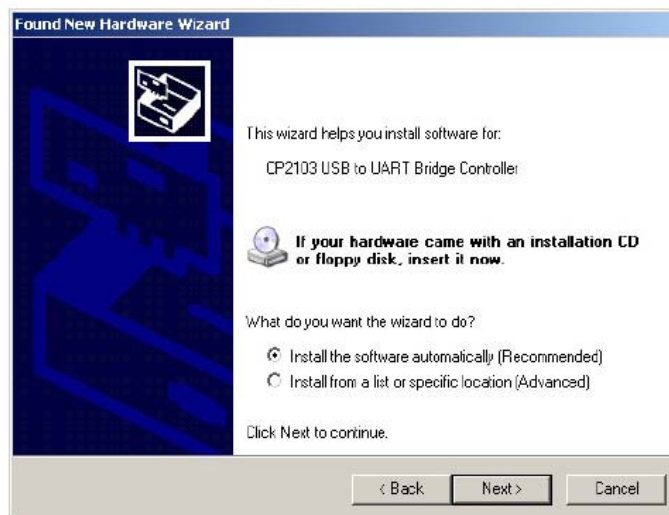


Figure 10: Software installation screen 2/6

Select “Install from a list or specific location (Advanced)” and click “Next”. The following screen comes up



Figure 11: Software installation screen 3/6

Click “Browse”, select folder “D:\DSP Tool\USB Drivers” in the CD-ROM and click “Next”. Windows will search for drivers in this location. Sometimes this process may take more than one would anticipate. Please be patient and windows will find the drivers. The following screen comes up



Figure 12: Software installation screen 4/6

Click "Continue Anyway". The USB drivers are installed. The following screen comes up



Figure 13: Software installation screen 5/6

Click "Finish". At this point the USB drivers are installed but the virtual RS-232 drivers still need to be installed. You can now see the following screen



Figure 14: Software installation screen 6/6

Continue the same way you did with the previous installation screens 1-5. After this you will have completed the software drivers installation. You are now ready to interface to the servo drive.

8 Software Configuration

DSP Tool is a powerful software tool that configures the DSP Automation servo drives for a specific operation. It helps with the selection of certain features necessary for a specific application. DSP tool also features real-time monitoring of numerous servo drive parameters that reflect the operation of the system. Configuration data can be saved for configuration management purposes.

DSP Tool also features a real-time two-channel oscilloscope (soft scope) which is almost necessary for the proper tuning of a motion control system. Finally, the software is capable of retrieving the error-code drive history which reflects the proper operation of the servo system and identifies potential issues to be fixed.

8.1 Connecting to the Drive

A drive has to be powered up and connected to the computer in order to access its data. From the toolbar menu select **Connection** and then **Connect to Device**. This can be seen in the following figure.

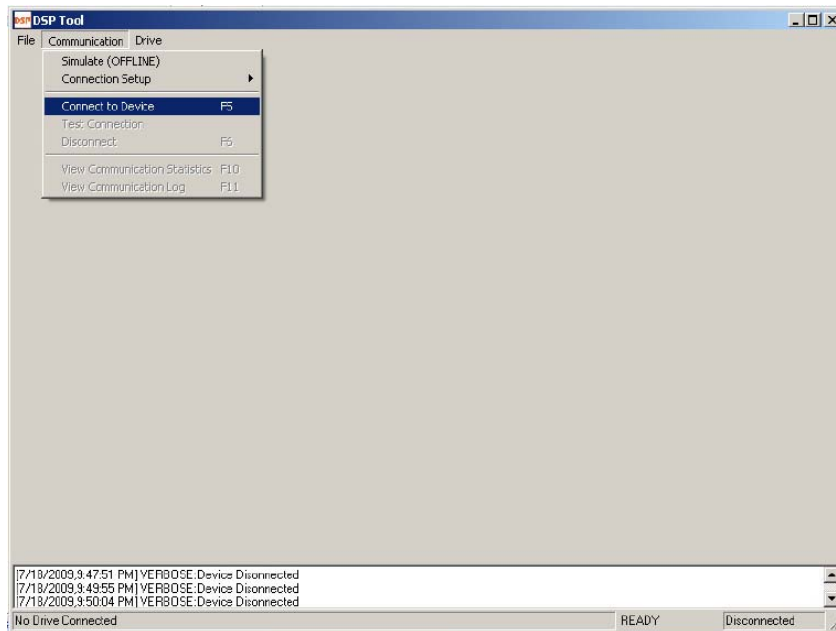


Figure 15: Connecting to the Drive

The next screen that comes up displays the first drive data page available. This is shown below

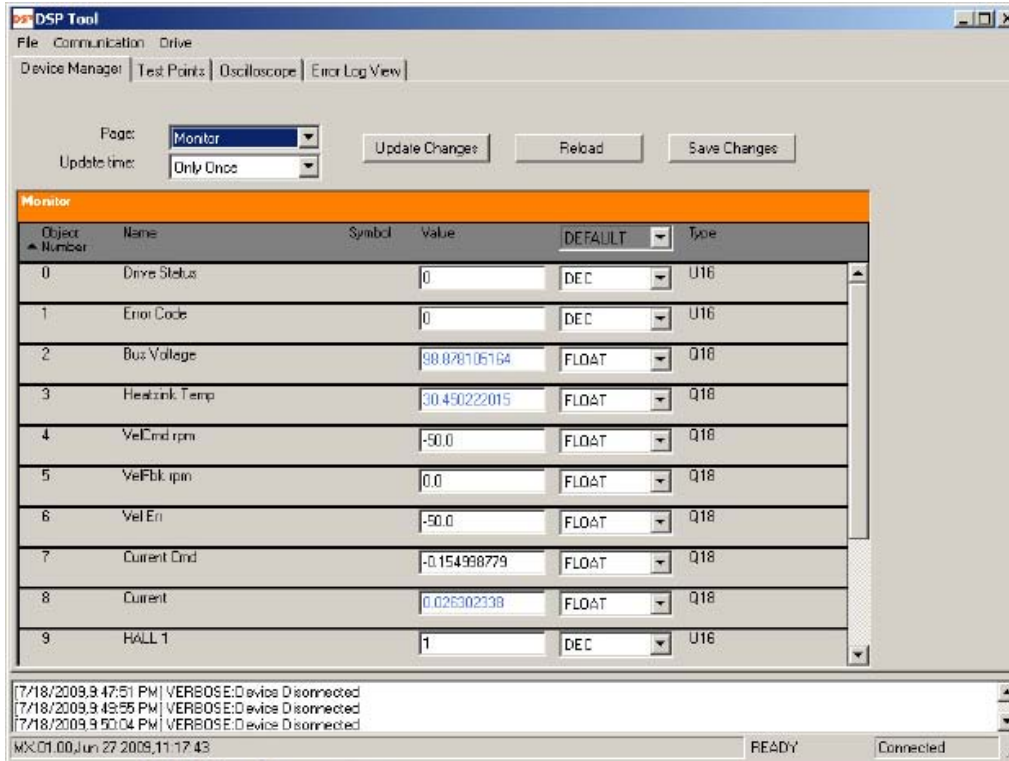


Figure 16: Software Parameter Screen

Figure 20 shows the first parameter page visible when you connect to the drive. The following section explains the software structure.

8.2 Software Structure

DSP Tool consists of the following four tabs:

- Device Manager
- Test Points
- Oscilloscope
- Error Log View

Device Manager accesses all the drive configuration parameters. Those parameters will be described in detail in Chapter 9: Drive Operation. This Chapter describes how to view, update, and save those parameters.

8.2.1 Device Manager

Device Manager consists of several pages that contain different parameters. You can select which page to access from the scroll-down menu **Page:** that can be seen in Figure 20. The available pages are:

- Monitor
- Drive Parameters
- Motor Parameters
- Analog Inputs
- Analog Outputs
- Digital Inputs
- Digital Outputs
- Current Controller
- Velocity Controller
- 2-Phase Analog
- Protected parameters

All the parameters at these pages will be explained in Chapter 9.

The scroll-down menu **Update time:** selects the real-time rate your parameters are updated on the screen. Usually an update rate of 200msec to 1 sec offers adequate insight to the system. Use update rates faster than 200msec only if you have a very fast computer, otherwise the parameters may fail to update.

There are several parameters you can edit and others you can just monitor. Chapter 9 will list which is which. To update a parameter (or many in the same page) edit the parameter box and then click the **Update Changes** button. The changes will be immediately updated at the drive's RAM, which means they immediately affect drive operation. The changes will not get saved permanently until you click the **Save Changes** button which updates the drive's EEPROM memory. Usually one saves changes when he is done with drive configuration

Attention!! You can update changes anytime but save changes only when the servo is off. This means parameter #1: Drive Status is 0.

The last button **Reload** is used when you have changed certain fields (but not updated them) and changed your mind about changing them, but you cannot remember the previous parameters. Then you push **Reload**, and this will restore the previous parameters.

8.2.2 Test Points

Please disregard this page, it is for manufacturer's use only. Future versions of the software will not display this page.

8.2.3 Oscilloscope

The software oscilloscope is a great tool when it comes viewing fast-changing parameters. It can be used to monitor speed, current, analog inputs, temperatures, and many other useful internal variables to the drive. Perhaps the most critical application of this tool is the control loop tuning for optimum motion system performance. Figure 21 shows the oscilloscope.

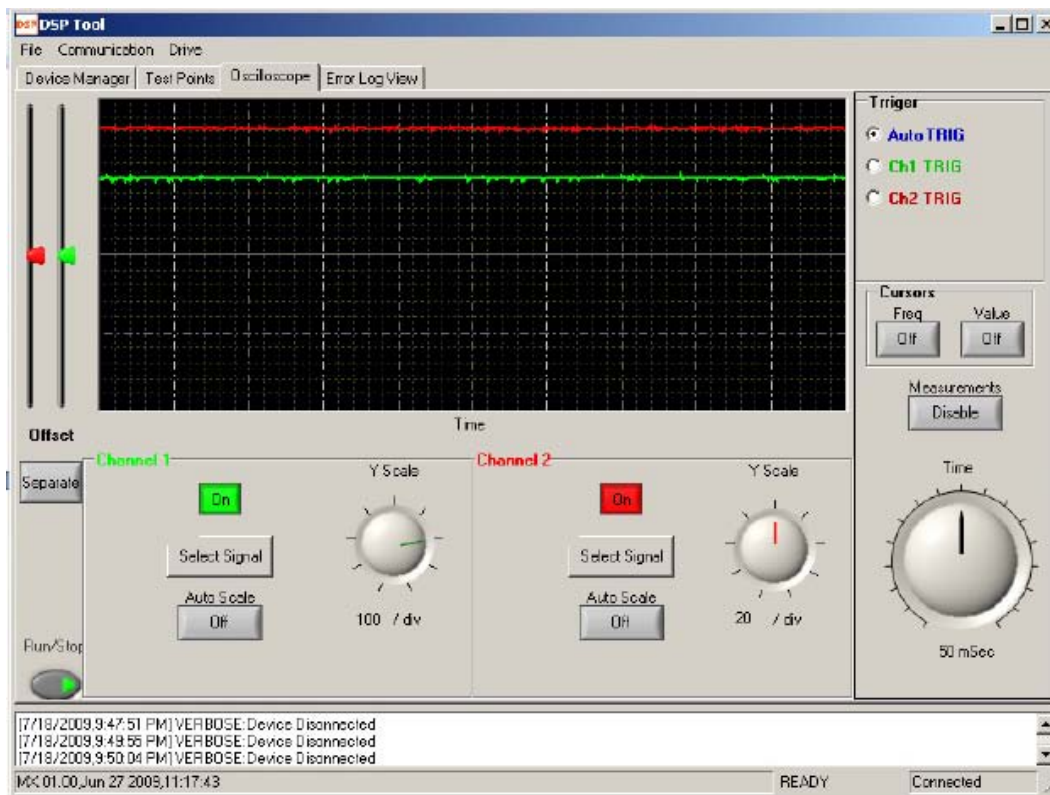


Figure 17: Oscilloscope

There are quite a few controls that provide with many features that approach the functionality of a real bench oscilloscope. DSP Automation continuously improves this tool, and future version of the software will offer more features and monitoring capabilities.

This is a two-channel scope. One or two channels can be viewed at the main scope window. To activate/stop/restart the scope press the **Run/Stop** button located on the lower left of the screen.

Next select the time scale of the scope with the **Time** knob on the lower right of the screen. You can leave this at the default rate of 50msec, but if your computer does not update fast enough, you will need to raise it to a bigger value. The value selected represents one big subdivision on the horizontal axis.

Then select the signal you want to monitor by pressing the **Select Signal** button for either channel 1 or 2. A menu will appear where you can select the signal you want to view. You can also turn channels 1 and 2 On/Off by pressing the corresponding **On/Off** Button.

Then select the vertical axis scaling by adjusting the **Y Scale** knobs for each channel used. The value selected represents one big subdivision on the vertical axis. Use appropriate scaling for optimum signal monitoring. Alternatively, you can use **Auto Scale** for automatic signal scaling which changes according to the amplitude of the signal.

You can offset the signals with respect to the Y-axis by using the two slides on the left of the screen (together when you press the button **Separate/Both Chs**). This feature is useful when you want to see minor signal fluctuations on a signal with a large constant value. An example is to view the AC bus ripple on the DC power bus. Offset the signal with the slide so you bring it around 0 and the with the Y-scale knob amplify the small AC signal on the DC bus.

Triggering can be automatic (default) or you can select positive/negative edge triggering by either channel 1 or 2. The trigger level is configurable.

Finally the scope has measuring abilities. Press the **Measurement** button to display Average and RMS values of the signals, and turn on the **Frequency and Value Cursors** to perform the corresponding measurements.

8.2.4 Error Log View

Every drive is equipped with a non-volatile memory (EEPROM) used to store parameters and error codes. The drive can store up to a 1000 error codes. When you want to retrieve those error codes you select the **Error Log View** tab, shown in Figure 22, and press **Download Logs**. The error codes will appear in the same time order they were generated (more recent code at the bottom of the list). Each error code comes with a brief description on the last column of the list. For a more detailed description and possible causes look at the Error Code Section in Chapter 9.

You can save the error code history on an XML file by pressing the **Save Logs** button. You can also format the Error Log by pressing the **Format the EEPROM** button and then select **Error Log Only**.

Caution!! Do not select Constant Table Only or Complete Format as this will erase all the parameters and bring the drive to its default configuration, prior being released by the manufacturer. These functions should only be used when you are instructed to do so by the manufacturer when you work together to commission/troubleshoot an application.

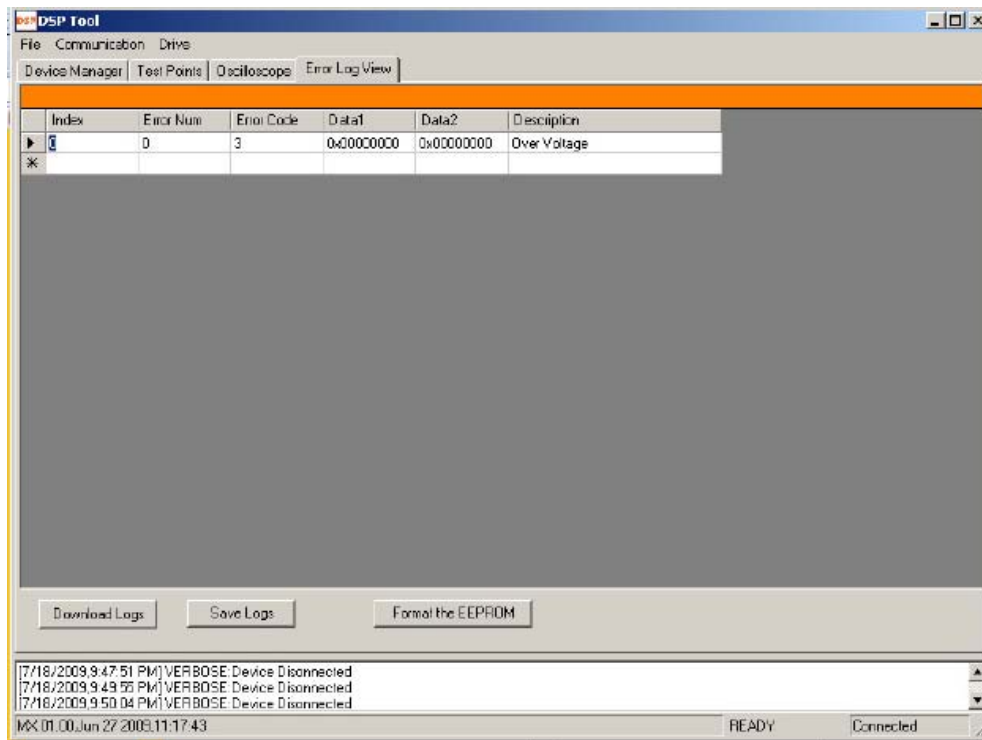


Figure 18: Error Log View

8.3 Miscellaneous DSP Tool Features

This section describes several other features and functions that are available with DSP Tool.

8.3.1 Connection Setup (Advanced)

Certain times you may experience difficulty connecting to the drive. Then from the toolbar menu select **Communication**, then select **Connection Setup**, **USB/RS-232**, and **Auto Detect**. This will detect which USB/COM port configuration is available. Select **Yes**, and then try to connect to the drive as

described in Section 8.1. You can optionally set the port yourself by selecting **Manual Set** instead of **Auto Detect**, although it is recommended you do this only after the manufacturer advises you to do so.

8.3.2 Device Programmer

By selecting **Drive** from the toolbar menu, and then **Device Programmer**, you can access advanced capabilities for updating the drive's firmware. This must be done only if necessary and only per the manufacturer's instructions.

Caution!! Do not access the Device Programmer screen on your own because you may erase the drive's flash memory and the drive will become non-operable, and it will need to be returned to DSP Automation for reloading the firmware.

8.3.3 Software/Firmware Versions

You can see the DSP Tool version you are using by selecting **Drive** from the main bar menu and then by selecting **About**. A screen with the software version and the release date will appear.

To access the firmware version loaded on the drive's processor (DSP) You will need to connect to the drive, select **Drive** from the main bar menu and the **Drive Info**. A screen with the firmware version and the release date will appear.

8.3.4 Saving>Loading Configuration Data To\From a File

Many times it is useful to save all the configuration data in a file for configuration management purposes. Also this is very helpful when you want to get support from the manufacturer. You can e-mail the saved file to DSP Automation so the support engineers will be able to assist you with your application.

To save the parameters in an XML file:

- Connect to the drive
- Select **File** and then **Save to File**
- Select the file name and location
- A screen appears. Leave everything at default and press **Save**

Your XML file has been saved.

A very useful application of this file is to load it to new drives received from the manufacturer with default configuration, to your specific configuration, without editing the parameters individually. Simply:

- Connect to the drive

- Select **File** and then **Open from File**
- Select the saved file and press **Open**
- In the new screen press **Load**

This will overwrite all the drive's writable parameters and substitute them with the ones saved in the file, with the exception of the Protected Parameters, which are always the manufacturer's responsibility for each individual drive. Click OK to certain messages that may come up. These messages come up only for non-writable parameters that cannot be updated from the file.

After you load the file you have to press **Save Changes** in order to save them permanently.

8.3.5 Simulation Mode

Simulation Mode is very useful when you want to view a data file and a drive is not available (i.e. office environment). You can load the file as described in the previous section, after the software confirms with you that you want to operate in Simulation Mode.

9 Drive Operation

A modern digital servo drive is supposed to offer many features which can improve performance and accommodate application specific needs. In order to achieve this, quite a few configuration parameters have to be available at the user level. Although sometimes one can be overwhelmed with the number of parameters, it has to be understood that usually only very few parameters need to be configured. Careful study of this chapter will lead you to integrate quickly the servo drive to your system, while at the same time you can utilize features that will improve you motion system's performance.

As it was mentioned previously, the configuration parameters are grouped in pages. Each page name is self-explanatory of what kind of parameters can be found in it. The following sections list the parameters and describe how these should be configured based on the application's needs.

Certain parameters are Read-Only (R), while others are Read and Write (RW). Few parameters are writable but only in RAM (TempW). The parentheses next to each variable show if it is R, RW, or TempW. Password protected parameters are PRW.

9.1 Monitor

Page Monitor can be seen in the following Figure. It is used for monitoring certain drive variables.

Object Number	Name	Symbol	Value	DEFAULT	Type
0	Drive Status		0	DEC	U16
1	Error Code		0	DEC	U16
2	Bus Voltage		108.910102844	FLOAT	Q18
3	Heatink Temp		42.229400635	FLOAT	Q18
4	VelCmd rpm		0.189971924	FLOAT	Q18
5	VelBk rpm		0.0	FLOAT	Q18
6	VelErr		0.229448608	FLOAT	Q18
7	Current Cmd		0.001389662	FLOAT	Q18
8	Current		0.033721924	FLOAT	Q18
9	HALL 1		1	DEC	U16
10	HALL 2		1	DEC	U16
11	HALL 3		1	DEC	U16
12	Jog Enable		0	DEC	U16
13	JogVel(RPM)/(A)		0.0	FLOAT	Q18

Figure 19: Monitor

9.1.1 Parameter No. 0 (R): Drive Status

This parameter displays the drive's operational status. It takes the following values:

- 0: Servo power is Off (Idle\Disabled)
- 1: Servo power is On (Enabled)
- 2: Drive is Powering Up (May not be able to see because it is fast)
- 3: RSVD
- 4: RSVD
- 5: Fault has occurred. Servo power automatically turns off
- 6+:RSVD

9.1.2 Parameter No. 1 (R): Error Code

This parameter displays the drive's error code when an error has occurred and the drive has not reset the error yet (by disabling/re-enabling the drive or cycling power). Look at section 9.2 for the error code table and possible causes for each error.

9.1.3 Parameter No. 2 (R): Bus Voltage

This is the voltage on the DC power bus of the drive. Remember when the input to the drive is AC voltage, then this value is 1.414 times the AC input.

9.1.4 Parameter No. 3 (R): Heatsink Temperature

This variable displays the heatsink temperature in degrees Celsius. The drive will shut down servo power at 85 degrees C. If your application brings your servo drive close to this temperature, then external direct airflow to the heatsink is required. Look at the Chapter 4: Mechanical Installation for airflow requirements.

9.1.5 Parameter No. 4 (R): Velocity Command (RPM)

This variable shows the velocity command in rounds per minute (RPM). This is only valid when the drive is in velocity or position mode. Velocity command can be either positive or negative.

9.1.6 Parameter No. 5 (R): Velocity Feedback (RPM)

This variable shows the velocity of the motor in RPM. This variable is always valid. Velocity feedback can be either positive or negative.

9.1.7 Parameter No. 6 (R): Velocity Error (RPM)

This variable is the difference between the Velocity Command and the Velocity Feedback ($V_{err} = V_{cmd} - V_{fbk}$). It is a very useful to view this variable on the scope, so you can see the performance of the velocity loop with precision.

9.1.8 Parameter No. 7 (R): Current Command

This is the current command to the drive current controller in Amps. It represents the motor phase RMS current for brushless motors, and the instantaneous current for brushed motors. Remember that the current form to a brushless motor is sinusoidal, and the peak is equal to 1.414 times this RMS value.

9.1.9 Parameter No. 8 (R): Current

This is the motor current in Amps. It represents the motor phase RMS current for brushless motors, and the instantaneous current for brushed motors. Remember that the current form to a brushless motor is sinusoidal, and the peak is equal to 1.414 times this RMS value.

9.1.10 Parameters No. 9, 10, 11 (R): HALL 1, HALL 2, HALL 3

These parameters show the current state of the motor hall sensors (when available). They are very useful parameter when you are commissioning a system. You want to see that they actually change state when you turn the shaft. They can either be 0 or 1. Also, by turning the shaft with your hand and monitoring the pattern change you can identify how many poles the motor is.

9.1.11 Parameter No. 12 (RW): Jog Enable

This and the next parameter are the only ones writable in this page. When this parameter is 0 nothing happens. When it is equal to 1, the drive will take its velocity command (or current command if in current mode) from the next parameter. This way you can jog the motor when an external signal is not available. You still need to have an external signal to enable/disable the drive. For applications that need to run the motor at a fixed speed, save this parameter to EEPROM.

9.1.12 Parameter No. 13 (RW): Jog Velocity (RPM) / I (A)

This is the actual velocity or current command when you enable this feature with parameter No. 12. You can command any velocity (RPM) or current (A) in their respective modes.

9.2 Drive Parameters

The parameters in this page determine several functions related to operating modes of the drive and several auxiliary functions.

Object Number	Name	Symbol	Value	DEFAULT	Type
14	Drive Mode		0	DEC	U16
15	Vel/Currnt Cmd Dir		0	DEC	U16
16	Enc Out Dir		1	DEC	U16
17	M/S ratio(Master)		1	DEC	U16
18	M/S ratio(Slave)		1	DEC	U16
19	Max Peak Current(A)		5.0	FLOAT	Q18
20	RMS Currnt Limit(A)		5.0	FLOAT	Q18
21	RMS Time(sec)		3.0	FLOAT	Q18
22	RPM/Vol		100.0	FLOAT	Q18
23	Max RPM		1000.0	FLOAT	Q18
24	Regen related power(W)		30.0	FLOAT	Q18
25	Regen resistance(Ohm)		25.0	FLOAT	Q18
26	Disable/Enable Accel/Decel(V1)		0	DEC	U16
27	Max Acceleration(RPM/sec)		10.0	FLOAT	Q18
28	Max Deceleration(RPM/sec)		10.0	FLOAT	Q18

Figure 20: Drive Parameters

9.2.1 Parameter No. 14 (RW): Drive Mode

This parameter determines the operating mode of the drive. The following modes are available:

- **0:** Velocity
- **1:** Current (Torque)
- **2:** Pulse and Direction
- **3:** Encoder Follower (Master / Slave)
- **4:** Position
- **5:** 2-Phase Current
- **6+:** RSVD for custom modes

Chapter 10 explains the operating modes in detail.

9.2.2 Parameter No. 15 (RW): Velocity/Current Command Direction

Switch between 0 and 1 to change the direction of the motor rotation when in velocity mode, or the direction of torque when in torque (current mode).

9.2.3 Parameter No. 16 (RW): Emulated Encoder Output Divider

When you use the emulated encoder outputs, you can use this parameter to divide the signal. If you want the signal to go straight through from the encoder to the output leave this parameter at default (1). Here are the possible dividers:

- **1:** Divide by 1 (/1)
- **2:** Divide by 2 (/2)
- **3:** Divide by 4 (/4)
- **4:** Divide by 8 (/8)
- **5:** Divide by 16 (/16)
- **6:** Divide by 32 (/32)
- **7:** Divide by 64 (/64)

9.2.4 Parameters No. 17, 18 (RW): MS Ratio (Master/Slave)

When in encoder follower (master/slave) mode, these two parameters define the rotation ratio between the master and the slave motors. These can only be a fraction with integral nominator and denominator. For example if Master is set to 1 and Slave is set to 2, it means that for every turn of the master motor, the slave motor will make 2 turns. Another example, if master is 3 and slave is 2, then for every 3 turns of the master motor you get 2 turns of the slave.

9.2.5 Parameter No. 19 (RW): Maximum Peak Current

This is the maximum peak current that can be commanded to the motor. When in velocity mode, select an appropriate value that can be accepted by the motor. Usually this is 2 to 3 times the RMS current of the motor. The drive will allow a max peak current up to 3 times the rated drive current, or 30A for the 12A and 15A models.

When in current mode, the value of this parameter represents the full scale input signal. For example if this parameter is set to 6, it means that an analog input of 10V is equal to a 6A command, or in other words scaling is 0.6A/V. Use this variable appropriately for current (torque) input scaling.

9.2.6 Parameter No. 20 (RW): RMS Current Limit

The drive has a protection algorithm that will turn servo power off if it detects over-RMS conditions. Set here the maximum RMS current for the motor. The drive will not allow you to set this more than the peak current. This can be more than the rated current of the drive. The algorithm will allow three times the rated current drive for 3 seconds before it faults out. If this RMS value is more than the drive rated current, the power integration algorithm will reduce automatically the maximum time allowed.

9.2.7 Parameter No. 21 (RW): RMS Time (sec)

Set this parameter to control the time allowed for the motor to be over the RMS value you set in the previous parameter. The algorithm will prevent you from entering invalid data.

9.2.8 Parameter No. 22 (RW): RPM/Volt

Set this parameter to scale the analog input when in velocity mode. Units are RPM/Volts.

9.2.9 Parameter No. 23 (RW): Max RPM

When in position or velocity mode, set this parameter to limit the velocity command to the desired value. This will prevent the motor going faster than this value, even if the command input is bigger (in either direction).

When in torque mode, if velocity exceeds this value, it creates an over-speed fault condition (error code 12).

9.2.10 Parameter No. 24 (RW): Regen Rated Power (W)

Enter here the rated power of the regen resistor. This parameter and the next one are used by an algorithm that estimates the dissipated power on the regen resistor. If the power is more than the specific regen resistor can handle, the drive will generate a fault code which means you have to use a bigger resistor (wattage).

9.2.11 Parameter No. 25 (RW): Regen Resistance (Ohm)

Enter here the value of the regen resistance in ohms.

9.2.12 Parameter No. 26 (RW): Disable/Enable Accel/Decel (0/1)

This parameter when 0 disables this feature. When 1 it enables the acceleration /deceleration limiter. Enable this feature when you want to control the accel/decel of a motor. A typical example is when the drive is standalone and you want to run a motor at a high speed but if you didn't use this feature the startup would not be very smooth. The next two parameters are the acceleration and deceleration values. Remember when you turn the drive off, the motor does not decelerate with this rate but it spins until it dissipates its kinetic energy. The acceleration/deceleration profile is trapezoidal.

9.2.13 Parameter No. 27 (RW): Max Acceleration (RPM/sec)

Enter here the acceleration value you want to have in RPM/sec. This parameter is only used when parameter No. 26 is equal to 1.

9.2.14 Parameter No. 28 (RW): Max Deceleration (RPM/sec)

Enter here the deceleration value you want to have in RPM/sec. This parameter is only used when parameter No. 26 is equal to 1.

9.3 Motor Parameters

As the name implies, this screen has to do with parameters related to the specific motor you use.

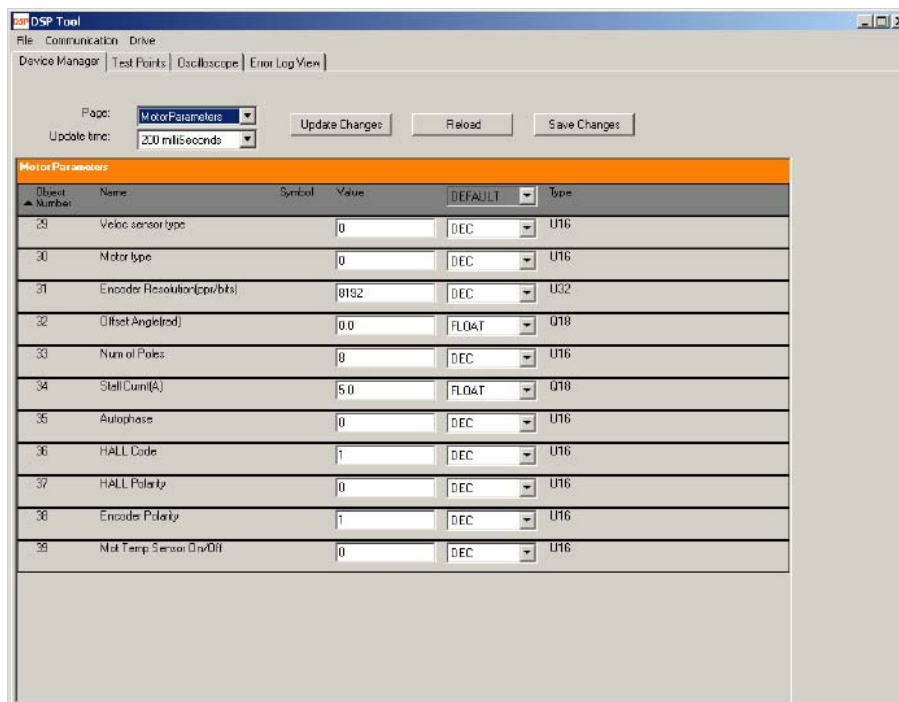


Figure 21: Motor Parameters

9.3.1 Parameter No. 29 (RW): Velocity Sensor type

This parameter selects the kind of motor feedback device used. The following options are available:

- **0:** Incremental Encoder
- **1:** Tachometer
- **2:** Sensorless (Brushed only)

- **3:** Resolver (Not available yet)
- **4:** Sin/Cos Absolute (Not available yet)
- **5:** Entad 2.2 (Not available yet)
- **6:** Entad 2.1 (Not available yet)
- **7:** Hiperface (Not available yet)
- **8:** BiSS
- **9:** SSI (Not available yet)
- **10:** Halls Only

9.3.2 Parameter No. 30 (RW): Motor type

This parameter selects the kind of motor used. The following options are available:

- **0:** Brushless
- **1:** Brushed

9.3.3 Parameter No. 31 (RW): Encoder Resolution (ppr/bits)

Set this parameter to be equal with the resolution of the encoder. If incremental set this to the prequad encoder ppr (pulses per revolution) resolution. If the encoder is absolute enter the resolution in bits.

9.3.4 Parameter No. 32 (RW): Offset Angle

This parameter is only used with absolute encoders. This offset angle is calculated automatically by the autophase algorithm. You need to save it to EEPROM after you execute the autophase procedure.

9.3.5 Parameter No. 33 (RW): Number of Poles

Enter here the number of motor poles (not pole pairs).

9.3.6 Parameter No. 34 (RW): Stall Current (A)

Enter here the stall current of the motor. This value is only used by the autophase algorithm.

9.3.7 Parameter No. 35 (TempW): Autophase

Enter 1 to autophase the motor. The drive has to be in idle mode (servo power off). The motor shaft cannot be coupled to the load and it will perform certain movement to autophase the motor.

In the case of an absolute sensor, the autophase process will identify the offset angle.

In the case of an incremental encoder with halls, it will match the UVW phase of the motor with the UVW hall sensors if they are not in phase. This will identify the hall code which is the next parameter.

9.3.8 Parameter No. 36 (RW): Hall Code

Hall code is a value between 1 and 6. It can be entered manually or identified with the autophase process. For a properly phased motor if the UVW motor phases and hall sensors are connected the same with the drive notation, then the hall code is always 1. This is the preferred method. If autophasing is used then the system will return the right hall code or 0 if it cannot autophase. In that case you will have to manually identify the correct hall code.

9.3.9 Parameter No. 37 (RW): Hall polarity

Almost always this parameter remains 0 unless you want to reverse the polarity of the hall signals. Then you enter 1. This is sometimes necessary with open-collector single-ended halls.

9.3.10 Parameter No. 38 (RW): Encoder polarity

This parameter (0/1) selects the sign of the velocity feedback. Before you close the velocity loop make sure you configure this parameter right. This can be done by operating the drive in current mode and making sure parameters 5 and 8 have the same sign.

9.3.11 Parameter No. 39 (RW): Motor Temperature Sensor (On/Off)

Select 0 when there is no motor temperature sensor or you don't want to use it. Select 1 when you want to use the sensor. Then when the thermostat closes, the drive will generate a fault. For other types of thermal sensors please contact DSP Automation.

9.4 Analog Inputs

This page configures the analog inputs. The drives come with two analog inputs AIN1 and AIN2. AIN1 is used as the reference command for velocity mode, current (torque) mode, and the U_{Iref} in 2-Phase Current mode. AIN2 is used as a tachometer input or the V_{Iref} 2-Phase Current mode.

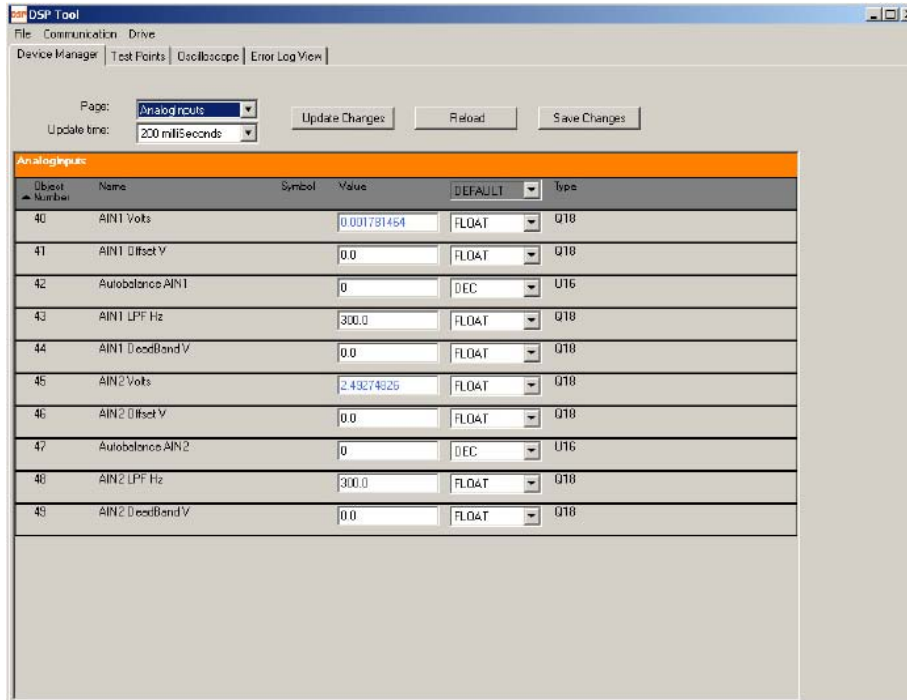


Figure 22: Analog Inputs

9.4.1 Parameters No. 40, 45 (R): AIN1 (Volts), AIN2 (Volts)

These values show the value of the analog inputs in Volts.

9.4.2 Parameters No. 41, 46 (RW): AIN1, AIN2 Offset Voltage

When you want to remove any offsets on the analog channels you can edit these parameters. This is quite easy with the help of the oscilloscope. An alternative that works quite well is the automatic offset adjustment, which is performed by selecting parameters 42 and 47.

9.4.3 Parameters No. 42, 47 (TempW): Autobalance AIN1, AIN2

Enter 1 to automatically find the offsets of the two channels. The algorithm works quite well down to 1-2mV. You can do some fine adjustment after the auto feature, for offsetting in the microvolt level.

9.4.4 Parameters No. 43, 48 (RW): AIN1, AIN2 LPF (Hz)

These are lowpass software filters that are used to reject excessive noise. The value entered is the -3dB cutoff frequency.

9.4.5 Parameters No. 44, 49 (RW): AIN1, AIN 2 Deadband (Volts)

These parameters create a +/- deadband around zero where every signal (and noise) is rejected. Usually deadband is set to a few millivolts to guarantee absolute stiffness at zero speed. When a signal transitions through zero the deadband algorithm is not active in order not to create any discontinuity in the signal.

9.5 Analog Outputs

There is an analog output (+/-10V) used for monitoring several drive parameters. The following parameters configure the output

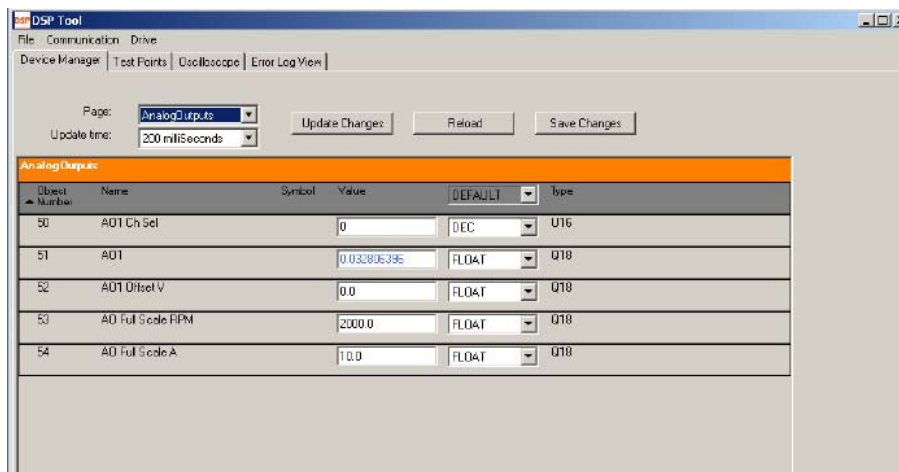


Figure 23: Analog Outputs

9.5.1 Parameter No. 50 (RW): AO1 Channel Select

This parameter selects the variable you want to monitor in the analog output. The following options are available:

- **0:** Motor Current
- **1:** Current Command
- **2:** Current Error
- **3:** Velocity
- **4:** Velocity Command
- **5:** Velocity Error
- **6+:** RSVD

9.5.2 Parameter No. 51 (R): AO1 (Volts)

This variable shows the output in volts.

9.5.3 Parameter No. 52 (RW): AO1 Offset (Volts)

You can offset the analog output by entering the offset voltage here.

9.5.4 Parameter No. 53 (RW): AO Full Scale RPM

When you monitor any velocity parameter, this parameter will scale the analog output. The value entered refers to amplitude of 10V.

9.5.5 Parameter No. 54 (RW): AO Full Scale A

When you monitor any current parameter, this parameter will scale the analog output. The value entered refers to amplitude of 10V.

9.6 Digital Inputs

The M/X series drives have three digital inputs. One of them (DI0) is the Enable/Disable signal and there are two inputs (DI1/DI2) for end-of-travel limit switches. DI1 and DI2 can also be programmed for other special functions if needed. Please contact DSP automation for the availability of this customization.

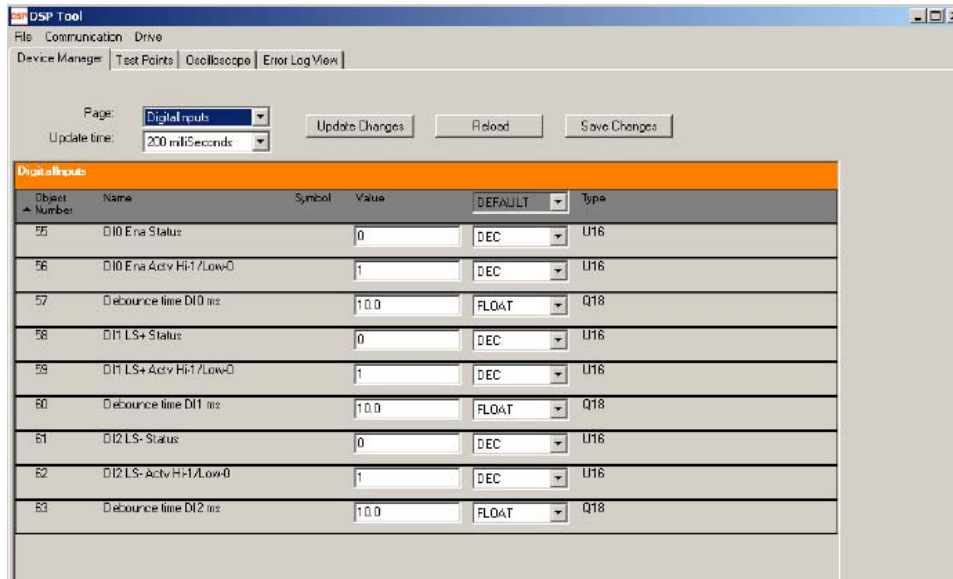


Figure 24: Digital Inputs

9.6.1 Parameter No. 55 (R): DI0 Enable Status

This read-only parameter reflects the status of the enable input. When the drive is disabled (inhibited) then this is equal to 0. When the drive is enabled (or at fault) this is equal to 1.

9.6.2 Parameter No. 56 (RW): DI0 Enable Active Hi/Low (1/0)

This parameter determines the logic level of the input. When this parameter is 1, it means the input is Active High, which means a positive voltage (4.5-30VDC) will enable the drive. A voltage less than 3V (or floating) will disable the drive. Voltages between 3-4.5V should be avoided as well as negative voltages. When this parameter is equal to 0, it means the input is Active Low. A zero voltage/floating input will enable the drive, while a positive voltage will disable it.

9.6.3 Parameter No. 57 (RW): Debounce Time DI0 (ms)

This parameter helps to reject undesired noise in the inputs and/or any mechanical switch/relay bouncing. Any signal not stable at least as long as this parameter will be ignored. Drives ship with default 10ms debouncing time.

9.6.4 Parameters No. 58, 61 (R): DI1 LS+ Status, DI2 LS- Status

These read-only parameters reflect the status of the limit switch inputs. When these parameters become equal to 1, then there is an end-of-travel condition. During normal operation they are 0.

9.6.5 Parameters No. 59, 62 (RW): DI1/DI2 Enable Active Hi/Low (1/0)

These parameters determine the logic levels of the two inputs. When these parameters are equal to 1, it means the input is Active High, which means a positive voltage (4.5-30VDC) will create a fault condition. A voltage less than 3V (or floating) will disable the drive. Voltages between 3-4.5V should be avoided as well as negative voltages. When these parameters are equal to 0, it means the inputs are Active Low. A zero voltage/floating input will not result anything, while a positive voltage will create a fault condition. There are separate fault codes associated with the two inputs.

9.6.6 Parameters No. 60, 63 (RW): Debounce Time DI1/DI2 (ms)

These parameters help to reject undesired noise in the inputs and/or any mechanical switch/relay bouncing. Any signal not stable at least as long as these parameters will be ignored. Drives ship with default 10ms debouncing time.

9.7 Digital Outputs

The M/X series drives have three digital outputs. Other than the standard functions listed below, please contact DSP Automation if any special functions need to be attached to those outputs.

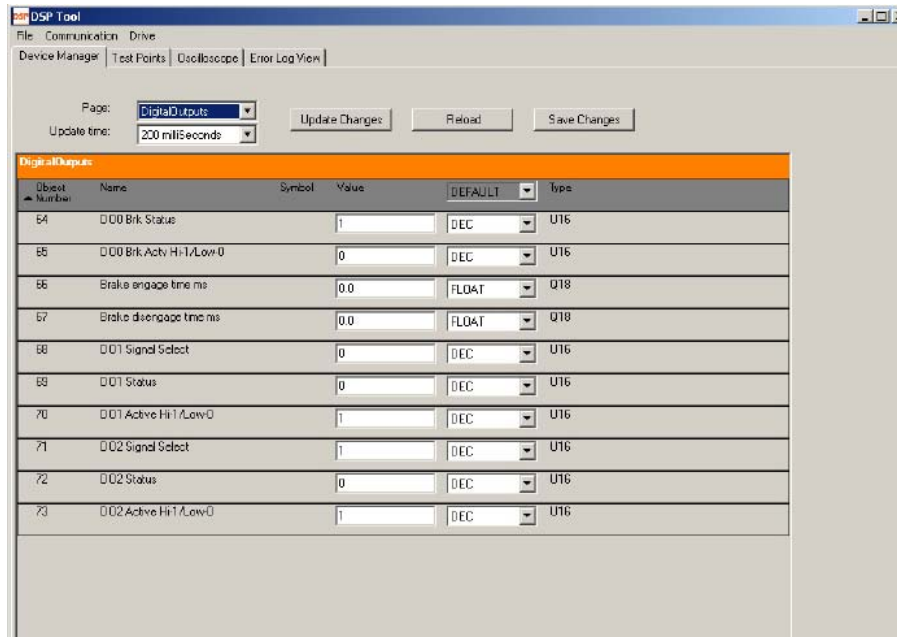


Figure 25: Digital Outputs

9.7.1 Parameter No. 64 (R): DO0 Brake Status

DO0 is the control brake output. When this variable is equal to 1, it means the brake is engaged (no power applied). When it is equal to 0, the brake is disengaged (power applied). Brake output is good for up to 24V/3A.

9.7.2 Parameter No. 65 (RW): DO0 Brake Active Hi/Low (1/0)

When this parameter is equal to 1 the brake output is Active Hi, which is the usual case with brakes (disengaged when powered). For active low output configure this parameter equal to 0.

9.7.3 Parameter No. 66 (RW): Brake Engage Time (ms)

This parameter controls the delay of the brake when you turn power off to the servo. When you enter a positive time (x ms) this means that power will first turn off for the motor and after x ms the brake power will turn off, therefore engaging the brake. If the time entered is negative (-x ms) then the brake will engage first and after x ms power will turn off for the motor.

9.7.4 Parameter No. 67 (RW): Brake Disengage Time (ms)

This parameter controls the delay of the brake when you turn power on to the servo. When you enter a positive time (x ms) this means that power will first turn on for the motor and after x ms the brake power will turn on, therefore disengaging the brake. If the time entered is negative (-x ms) then the brake will disengage first and after x ms power will turn on for the motor.

9.7.5 Parameters No. 68, 71 (RW): DO1, DO2 Signal Select

Outputs DO1 and DO2 are identical and can be configured to connect to any of the following signals:

- 0: Fault Output
- 1: Servo Ready
- 2: At speed

9.7.6 Parameters No. 69, 72 (R): DO1, DO2 Status

These parameters reflect the status of the two outputs. They are 0 when inactive, and 1 when active.

9.7.7 Parameters No. 70, 73 (R): DO1, DO2 Active Hi/Low (1/0)

Outputs are Active High when these parameters are equal to 1, and Active Low when they are equal to 0.

9.8 Current (Torque) Controller

The M/X series drives give access to the current (torque) controller parameter for proper current (torque) loop tuning. The controller is of the PI (Proportional-Integral) with anti-windup correction. Anti-windup parameters are not available to the user, they are automatically configured.

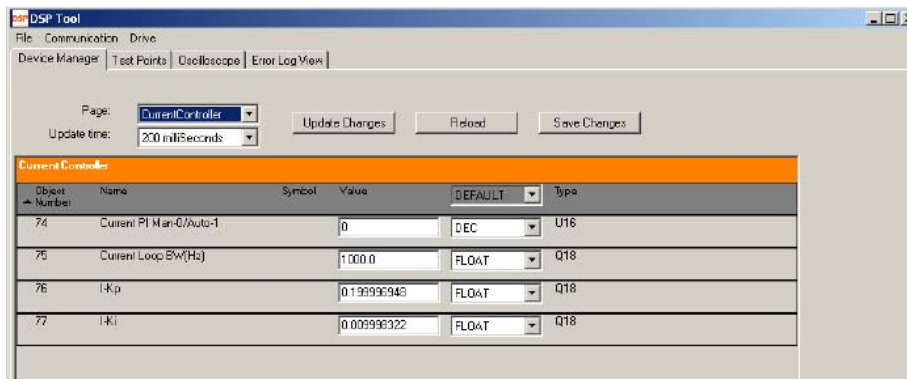


Figure 26: Current Controller

The auto-tuning feature makes current controller tuning a matter of just pressing a button.

9.8.1 Parameter No. 74 (TempW): Current Loop Manual/Auto(0/1)

Leave this parameter equal to 0 if you want to manually adjust the PI gains. If you want to automatically configure them follow the next steps in order:

- Power the drive, keep it disabled
- Motor can be connected to the load
- Select the proper bandwidth (parameter No. 75)
- Enter 1, press the **Update Changes** button, and wait until the controller is auto-tuned

During the auto-tuning process you will hear a high frequency noise (equal to the bandwidth selected) coming from the motor. When the auto-tuning process is successful, parameter No. 74 will turn back to 0, and the PI gains will be adjusted. If the tuning is unsuccessful, then parameter No. 74 returns code 99.

9.8.2 Parameter No. 75 (RW): Current Loop Bandwidth (Hz)

Select the desired bandwidth for the current loop. A common range is anywhere from 800Hz to 2000Hz.

9.8.3 Parameter No. 76 (RW): Current Loop Proportional Gain

Adjust the proportional gain when you manually want to configure the controller. Servo system expertise is required in this case.

9.8.4 Parameter No. 77 (RW): Current Loop Integral Gain

Adjust the integral gain when you manually want to configure the controller. Servo system expertise is required in this case. The preset gain of 0.01 works out good for almost all cases.

9.9 Velocity Controller

This page configures the velocity controller (when in velocity or /position mode). The controller is of the PDFF form with anti-windup correction. Proper tuning of the velocity controller will guarantee good system performance.

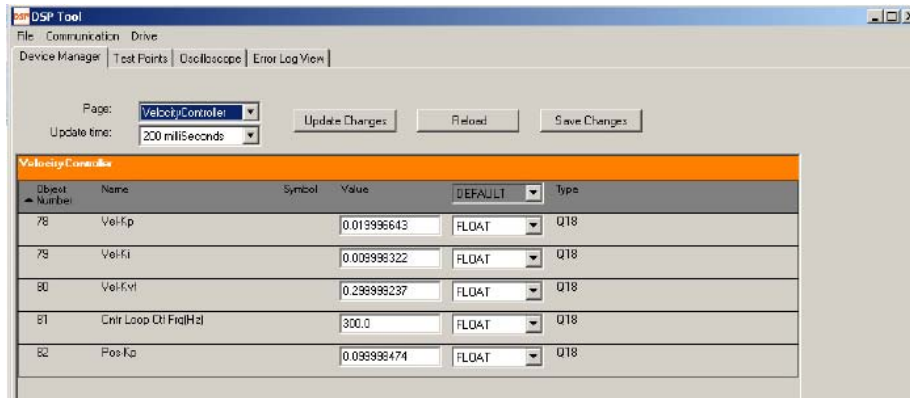


Figure 27: Velocity Controller

9.9.1 Parameter No. 78 (RW): Velocity Loop Proportional Gain

Adjust this gain for desired system performance. Usually start from a low value, and increase until you start getting a slight vibration. Then back-off to a previous value where you had the highest gain with acceptable response. More formal methods are available for controller tuning. Use the soft scope to monitor system response.

9.9.2 Parameter No. 79 (RW): Velocity Loop Integral Gain

Adjust this gain for desired system performance. Usually, a gain of 0.01 works for most applications. Adjust up/down according to your requirements.

9.9.3 Parameter No. 80 (RW): Velocity Loop FeedForward Gain

For most systems this gain should be in the 0.3-0.5 range. This gain is always between 0.0 and 1.0. The main function of this gain is to counteract the overshoot which results with a large integral gain. Set this gain to 0.0 if you want to have a pure PI controller.

9.9.4 Parameter No. 81 (RW): Control Loop Cutoff Frequency (Hz)

The output of the velocity controller is passed to the torque controller through a low-pass filter. Configure its cutoff frequency with this parameter. This filter will attenuate low frequency vibrations for the controlled mechanical system.

9.9.5 Parameter No. 82 (RW): Position Loop Proportional Gain

The position controller used in Pulse & Direction/Encoder Follower modes is of the Proportional type. Adjust this gain for proper system response, after you have tuned the velocity loop.

9.10 2-Phase Analog

2-Phase Analog is a special mode where one can directly control the motor phase currents. Phases U and V are directly commanded by the user, while W is automatically calculated by the drive.

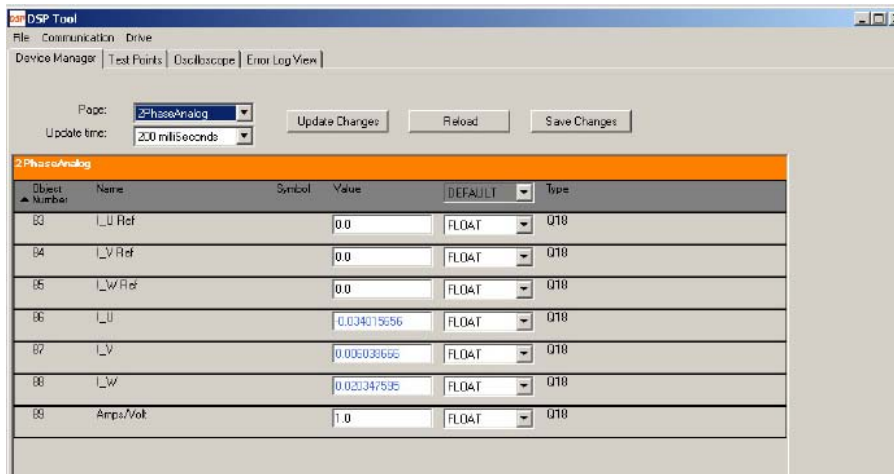


Figure 28: 2-Phase Analog

9.10.1 Parameters No. 83, 84, 85 (R): U, V, W Current References

These parameters display the current command references. The first analog input AIN1 is coupled to I_U, while the second analog input AIN2 is coupled to I_V. Remember $I_W = -(I_U + I_V)$ due to the isolated motor neutral.

9.10.2 Parameters No. 86, 87, 88 (R): U, V, W Current References

These parameters display the motor phase currents.

9.10.3 Parameter No. 89 (RW): Amps/Volt

This parameter is used only in 2-Phase Analog mode, in order to scale the analog inputs. For example, if this parameter is set to 2.0, you will a -20A command for a -10V input.

9.11 Protected Parameters

Although the parameters in this page are not accessible by the user (password protected), there is a brief description here, in order to demonstrate some more drive capabilities.

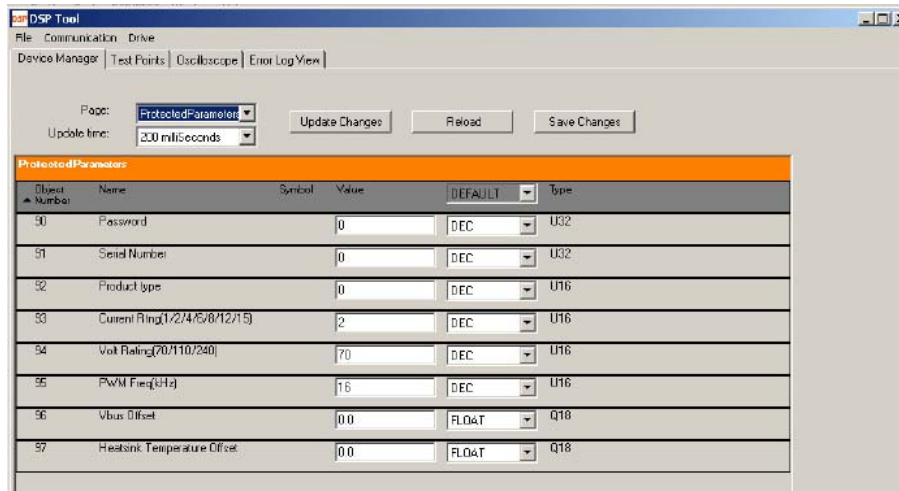


Figure 29: Protected Parameters

9.11.1 Parameter No. 90 (TempW): Password

This is the password, provided to select OEMs and users when they need to have access to it.

9.11.2 Parameter No. 91 (PRW): Serial Number

DSP Automation attaches a Serial Number to every drive which is also reflected in this parameter.

9.11.3 Parameter No. 92 (PRW): Product type

All M/X series drives have this parameter set to 0.

9.11.4 Parameter No. 93 (PRW): Current Rating

This is set by the manufacturer. It is the drive's current rating and has to do with its hardware configuration. Even if you have access to these parameters do not change this parameter because it can permanently damage the drive.

9.11.5 Parameter No. 94 (PRW): Voltage Rating

This is set by the manufacturer. It is the drive's voltage rating and has to do with its hardware configuration. Even if you have access to these parameters do not change this parameter because it can permanently damage the drive.

9.11.6 Parameter No. 95 (PRW): PWM Frequency

This is set by the manufacturer. It is the drive's PWM Frequency. Certain times DSP Automation will allow OEMs to alter this frequency according to their needs. This always happens after DSP Automation's approval.

9.11.7 Parameters No. 96, 97 (PRW): VBus, Temp. Sensor Offsets

These are sensor offsets configured by the manufacturer at production time.

9.12 Error Codes

The following table lists all error codes available, together with a description, possible cause and action to be taken.

Error Code	Description	Possible Cause	Action
0	No Fault	N/A	N/A
1	Current Surge	Motor lead short, Phase to Phase, Phase to Ground. Possible permanent internal damage.	Cycle power to the drive. Make sure there are no motor shorts. If problem persists contact manufacturer.
2	Under voltage	Voltage in the bus is low.	Monitor bus voltage either with a multimeter or with DSP Tool to make sure it is within limits.
3	Over voltage	Either wrong (excessive) bus voltage or insufficient regen capability	Install external regen resistor, capable of handling the applied regenerative loads
4	Over temperature	High Ambient temperature, Insufficient Air Cooling	Apply sufficient direct air flow to the drive

5	Over RMS	Undersized motor and/or drive, wrongly configured parameter	Parameter No. 20 was exceeded. Check if the RMS current set can be increased. Bigger motor and/or drive may be required.
6	RSVD		
7	Hall Sensors	Hall sensors are either disconnected or there is a hardware problem with their connection	Identify hardware problem
8	RSVD		
9	RSVD		
10	EEPROM Access While Servo On	User has tried to save changes while servo power was on.	Disable drive, and then save changes.
11	Wrong data	One or more configuration parameters were set wrong	Go through this manual to identify the proper range for each parameter.
12	Over Speed	Parameter No. 23 was exceeded while in torque mode	Either change the parameter or identify issues with the torque loop logic
13	RSVD		
14	Motor Over Temperature	Motor overheated	Cool motor or use bigger motor
15	RSVD		
16	Over Current	Current controller does not regulate current	Re-tune the current controller. For low inductance motors you may need to add external inductors
17	RSVD		
18	RSVD		
19	RSVD		
20	Limit switch +	Limit switch + activated	Controller should take appropriate action to bring system within limits. Identify why position controller failed
21	Limit switch -	Limit switch -	Controller should

		activated	take appropriate action to bring system within limits. Identify why position controller failed
22	RSVD		
23	Wrong Password	Wrong Password entered	Do not play with the password
24	RSVD		
25	Regen Power Threshold	Regen used is too small	Use bigger regen and set the corresponding parameters
26	Autophase while Servo On	Tried to autophase motor while servo power was on	Disable drive, then autophase
27	Autophase Failed	Algorithm may fail under certain circumstances	Phase system manually, follow procedure
28	Autotune While Servo On	Tried to autotune current loop while servo power was on	Disable drive, then autotune

Table 12: Error Codes

New error codes may be added to newer versions of the firmware. Return drive to manufacturer if any code is 200 or greater.

10 Motion/Motor Control Fundamentals

11 Appendix

11.1 RoHS Compliance

M/X-Series Drives and XPM power modules are RoHS compliant. They are in compliance with EU Directive 2002/95/EC, with respect to the following 6 substances:

- 1) Lead (Pb)
- 2) Cadmium (Cd)
- 3) Mercury (Hg)
- 4) Hexavalent chromium (Cr(VI))
- 5) Polybrominated biphenyls (PBB)
- 6) Polybrominated diphenyl ethers (PBDE)

11.2 UL Compliance

M/X-Series Drives and XPM power modules are compliant with the following UL Directives:

- **UL 508C:** UL 508C describes the fulfillment by design of minimum requirements for electrically operated power conversion equipment, such as inverters and servo amplifiers.
- **UL 840:** UL 840 describes the fulfillment by design of air and insulation creepage spacings for electrical equipment and printed circuit boards.
- **UL60950-1:** UL 60950 (previously UL1950) describes the Safety of Information Technology equipment, including Electrical Business Equipment.

11.3 CE Compliance

M/X-Series Drives and XPM power modules are compliant with the following standards:

- EC Directive 2004/108/EC, Electromagnetic compatibility, Used standard EN61800-3 (07/2005)
- EC Directive 2006/95/EC, Electrical devices for use in special voltage limits, Used standard EN61800-5-1 (04/2008)

11.4 Abbreviations List

11.5 Index